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Form No. 14209SL Rev E

Service Manual

Groundsmaster® 3500 **(Models 30807 and 30809)**

Revision History

[illegible]

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NOTES



Service Manual

Groundsmaster® 3500

Models 30807 and 30809

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 3500-D (Model 30807) and 3500-G (Model 30809).

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

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

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

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



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Safety

Product Records
and Maintenance

Kubota
Diesel Engine

Kubota
Gasoline Engine

Hydraulic
System

Electrical
System

Wheels, Brakes,
and Chassis

Cutting Decks

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Drawings

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General Safety Instructions

The GROUNDMASTER 3500 was tested and certified by TORO for compliance with existing standards and specifications as identified in the Operator's Manual. Although hazard control and accident prevention are dependent partially 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 by the operator or owner of the machine can re-

sult in injury. To reduce the potential for any injury, comply with the following safety instructions.



WARNING

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

Before Operating

1. Operate machine only after reading and understanding the contents of the Operator's Manual and viewing the Operator's Video. Copies of the Operator's Manual are available on the internet at www.Toro.com.
2. Only trained operators who are skilled in slope operation and who have read the Operator's Manual and viewed the Operator's Video should operate the machine. Never allow children to operate the machine or adults to operate it without proper instructions.
3. Become familiar with the controls and know how to stop the machine and engine quickly.
4. Do not carry passengers on the machine. Keep everyone, especially children and pets, away from the areas of operation.
5. Keep all shields, safety devices, and decals in place. Repair or replace damaged, malfunctioning, or illegible shields, safety devices, or decals before operating the machine.
6. Always wear substantial shoes. Do not operate machine while wearing sandals, tennis shoes or sneakers. Do not wear loose fitting clothing because it could get caught in moving parts and possibly cause personal injury.
7. Wearing safety glasses, safety shoes, long pants and a helmet is advisable and required by some local ordinances and insurance regulations.
8. Make sure the work area is clear of objects which might be picked up and thrown by the blades.
9. Fill fuel tank with diesel fuel before starting engine. Avoid spilling any fuel. Since fuel is highly flammable, handle it carefully.
 - A. Use an approved fuel container.
 - B. Do not remove cap from fuel tank when engine is hot or running.
 - C. Do not smoke while handling diesel fuel.
 - D. Fill fuel tank outdoors and not over one inch from the top of the tank (bottom of the filler neck). Do not overfill.

While Operating

1. Always wear your seat belt.
2. Do not run the engine in a confined area without adequate ventilation. Exhaust fumes are hazardous and could be deadly.
3. Sit on the seat when starting and operating the machine.
4. Check interlock switches daily for proper operation (see Chapter 5 - Electrical System). Do not rely entirely on safety switches: shut off engine before getting off seat. If a switch fails, replace it before operating the machine. The interlock system is for your protection, so do not bypass it.
5. Operator must be skilled and trained in how to drive on hillsides. Failure to use caution on slopes or hills may cause vehicle to tip or roll, possibly resulting in personal injury or death.
6. This triplex mower has a unique drive system for superior traction on hills. The uphill wheel will not spin out and limit traction like conventional triplexes. If operated on a side hill that is too steep, rollover may occur before losing traction.
7. Before backing up, look to the rear and assure no one is behind the machine. Watch out for traffic when near or crossing roads. Always yield the right of way.
8. Keep hands, feet and clothing away from moving parts and the deck discharge area.
9. Establish special procedures and work rules for unusual operating conditions (e.g. slopes, sand traps, water hazards). Survey the mowing site completely to determine which areas can be operated on safely. When performing this site survey, always use common sense and take into consideration the turf condition and the rollover risk. To perform a site survey, follow the procedure outlined in the Operator's Manual.

Stay alert for holes in terrain and other hidden hazards which can cause a sudden change in side hill angle. Use extreme caution when operating close to sand traps, ditches, creeks, steep hillsides, or other hazards. Reduce speed when making sharp turns. Do not turn on hills. Avoid sudden stops and starts. Use reverse pedal for braking. Cutting units must be lowered when going down slopes for steering control.

10. When starting the engine:

- A. Engage parking brake.
- B. Be sure traction pedal is in neutral and blade drive is in disengage position.
- C. After engine starts, release parking brake and keep foot off traction pedal. Machine must not move. If movement is evident, the neutral control linkage is incorrectly adjusted: therefore, shut engine off and adjust until machine does not move when traction pedal is released (see Adjust Traction Drive for Neutral in the Adjustments section of Chapter 4 - Hydraulic System).

11. This product may exceed noise levels of 85 dB(A) at the operator position. Ear protectors are recommended for prolonged exposure to reduce the potential of permanent hearing damage.

12. Raise the cutting units when driving from one work area to another.

13. Do not touch engine, muffler, exhaust pipe or hydraulic tank while engine is running or soon after it has stopped because these areas could be hot enough to cause burns.

14. If a cutting unit strikes a solid object or vibrates abnormally, stop immediately. Turn engine off, wait for all motion to stop and inspect for damage.

15. Before getting off the seat:

- A. Move traction pedal to neutral.
- B. Set the parking brake.
- C. Disengage the cutting units and wait for the blades to stop spinning.
- D. Stop the engine and remove key from the ignition switch.

16. Whenever machine is left unattended, make sure key is removed from ignition switch and parking brake is set.

Maintenance and Service

1. Before servicing or making adjustments to the machine, stop the engine and remove key from switch to prevent accidental starting of the engine.
2. Check performance of all interlock switches daily. Do not disable or bypass interlock system components. The interlock system is for your protection.
3. To ensure entire machine is in good operating condition, frequently check and keep all nuts, bolts, screws and hydraulic fittings tight.
4. Make sure all hydraulic line connectors are tight, and all hydraulic hoses and lines are in good condition before applying pressure to the system.
5. Keep body and hands away from pin hole leaks 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 skin and do serious damage. If fluid is injected into the skin it must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.
6. Before disconnecting or performing any work on the hydraulic system, all pressure in system must be relieved by stopping engine and lowering cutting units to the ground.
7. If major repairs are ever needed, or if assistance is desired, contact an Authorized Toro Distributor.
8. To reduce potential fire hazard, keep the engine area free of excessive grease, grass, leaves and accumulation of dirt.
9. If the engine must be running to perform a maintenance adjustment, keep hands, feet, clothing, and any other parts of the body away from the cutting units and any moving parts. Keep everyone away.
10. Do not overspeed the engine by changing governor settings. To assure safety and accuracy, have an Authorized Toro Distributor check maximum engine speed with a tachometer.
11. Engine must be shut off before checking oil or adding oil to the crankcase.
12. To insure optimum performance and safety, use genuine Toro replacement parts and accessories. Replacement parts and accessories made by other manufacturers could be dangerous, and such use could void the product warranty of The Toro Company.

Jacking Instructions



CAUTION

When changing attachments, tires, or performing other service, use correct blocks, hoists, and jacks. Make sure machine is parked on a solid level floor 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 solid wood blocks to support the raised machine. If the machine is not properly supported by blocks or jack stands, the machine may move or fall, which may result in personal injury.

Use the following positions when jacking up the machine:

Jacking the Front End

1. If the front wheel motor is to be removed, position jack securely under the square tube of the lower frame as closely to the side plate as possible (Fig. 1).
2. If the front tire is to be removed, position the jack securely under the front wheel motor.
3. Use jack stands or hardwood blocks under the square tube or wheel motors to support the machine.

Jacking the Rear End

1. The preferred method for removing the rear fork, the rear wheel, or the rear wheel motor is to lift the rear end of the machine from above:
 - A. Secure a chain fall or hoist to the rear casting (Fig. 2).
 - B. Chock both front tires. Lift rear tire off the ground.
 - C. Use jack stands or hardwood blocks under the frame to support the machine (Fig. 3).
2. If the rear of the machine cannot be lifted from above:
 - A. Chock both front tires.

IMPORTANT: Make sure jack is as close to the rear fork as possible when jacking the rear wheel.

- B. Place jack securely under the rear wheel motor as close to the fork as possible (Fig. 3). Jack rear tire off the ground.
- C. Use jack stands or blocks under the frame to support the machine.

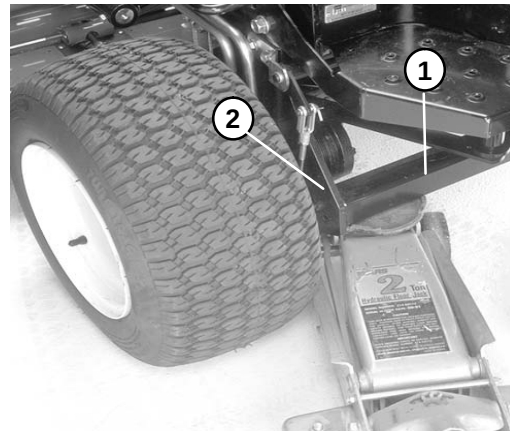


Figure 1

1. Square tube

2. Side plate

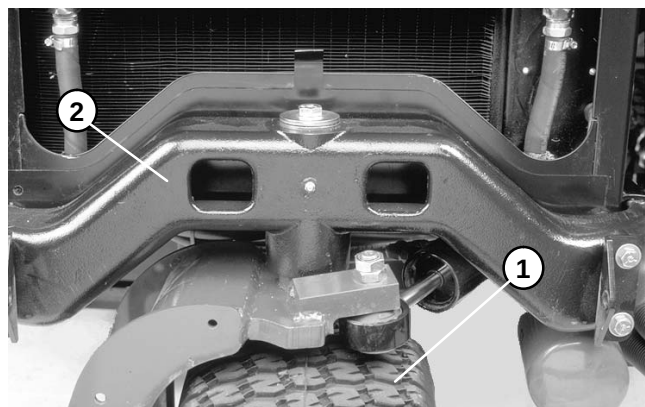


Figure 2

1. Rear tire

2. Rear casting

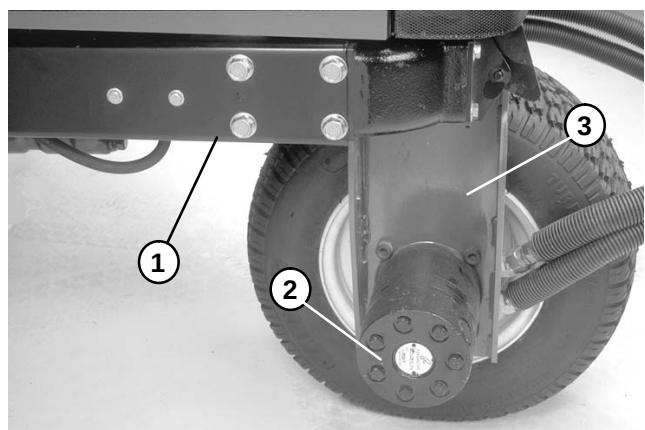


Figure 3

1. Frame

2. Rear wheel motor

3. Rear fork

Safety and Instruction Decals

Numerous safety and instruction decals are affixed to the Groundsmaster 3500. If any decal becomes illegible or damaged, install a new decal. Part numbers for replacement decals are listed in your Parts Catalog. Order replacement decals from your Authorized Toro Distributor.

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Product Records and Maintenance

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Product Records

Insert a copy of the Operator's Manual and Parts Catalog for your Groundsmaster 3500 at the end of this chapter. Additionally, if any optional equipment or accessories have been installed to your Groundsmaster, 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 3500 are covered in the Operator's Manual. Refer to that publication when performing regular equipment maintenance.

Equivalents and Conversions

Decimal and Millimeter Equivalents

Fractions	Decimals	mm	Fractions	Decimals	mm
1/64	0.015625	— 0.397	33/64	0.515625	— 13.097
1/32	0.03125	— 0.794	17/32	0.53125	— 13.494
3/64	0.046875	— 1.191	35/64	0.546875	— 13.891
1/16	0.0625	— 1.588	9/16	0.5625	— 14.288
5/64	0.078125	— 1.984	37/64	0.578125	— 14.684
3/32	0.09375	— 2.381	19/32	0.59375	— 15.081
7/64	0.109375	— 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. Subtract 32°
			2. Multiply by 5/9

Torque Specifications

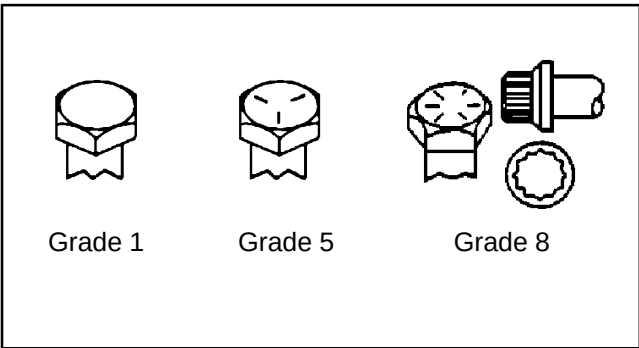
Recommended fastener torque values are listed in the following tables. For critical applications, as determined by Toro, either the recommended torque or a torque that is unique to the application is clearly identified and specified in this Service Manual.

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

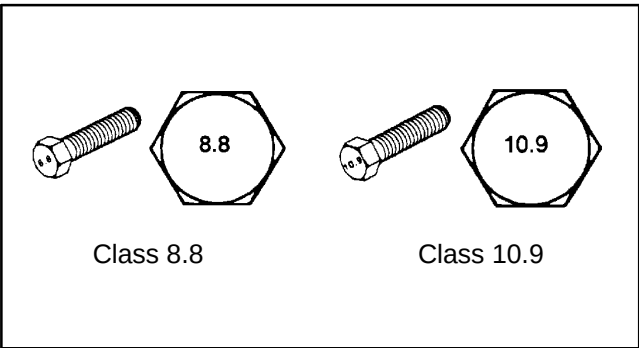
As noted in the following tables, torque values should be **reduced by 25% for lubricated fasteners** to achieve the similar stress as a dry fastener. Torque values may also have to be reduced when the fastener is threaded into aluminum or brass. The specific torque value should be determined based on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



Inch Series Bolts and Screws



Metric Bolts and Screws

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	170 ± 20	23 ± 2	260 ± 20
# 6 – 40 UNF				17 ± 2	190 ± 20	25 ± 2	280 ± 20
# 8 – 32 UNC	13 ± 2	25 ± 5	282 ± 30	29 ± 3	330 ± 30	41 ± 4	460 ± 45
# 8 – 36 UNF				31 ± 3	350 ± 30	43 ± 4	485 ± 45
# 10 – 24 UNC	18 ± 2	30 ± 5	339 ± 56	42 ± 4	475 ± 45	60 ± 6	675 ± 70
# 10 – 32 UNF				48 ± 4	540 ± 45	68 ± 6	765 ± 70
1/4 – 20 UNC	48 ± 7	53 ± 7	599 ± 79	100 ± 10	1125 ± 100	140 ± 15	1580 ± 170
1/4 – 28 UNF	53 ± 7	65 ± 10	734 ± 113	115 ± 10	1300 ± 100	160 ± 15	1800 ± 170
5/16 – 18 UNC	115 ± 15	105 ± 17	1186 ± 169	200 ± 25	2250 ± 280	300 ± 30	3390 ± 340
5/16 – 24 UNF	138 ± 17	128 ± 17	1446 ± 192	225 ± 25	2540 ± 280	325 ± 30	3670 ± 340
	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 ± 4	58 ± 5
3/8 – 24 UNF	17 ± 2	18 ± 2	24 ± 3	35 ± 3	47 ± 4	50 ± 4	68 ± 5
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 ± 5	75 ± 7	77 ± 7	104 ± 9
1/2 – 13 UNC	30 ± 3	48 ± 7	65 ± 9	75 ± 8	102 ± 11	105 ± 10	142 ± 14
1/2 – 20 UNF	32 ± 3	53 ± 7	72 ± 9	85 ± 8	115 ± 11	120 ± 10	163 ± 14
5/8 – 11 UNC	65 ± 10	88 ± 12	119 ± 16	150 ± 15	203 ± 20	210 ± 20	285 ± 27
5/8 – 18 UNF	75 ± 10	95 ± 15	129 ± 20	170 ± 15	230 ± 20	240 ± 20	325 ± 27
3/4 – 10 UNC	93 ± 12	140 ± 20	190 ± 27	265 ± 25	359 ± 34	375 ± 35	508 ± 47
3/4 – 16 UNF	115 ± 15	165 ± 25	224 ± 34	300 ± 25	407 ± 34	420 ± 35	569 ± 47
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 ± 45	644 ± 61	660 ± 60	895 ± 81

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 oil, graphite, or thread sealant such as Loctite.

NOTE: Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based

on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

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

Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Metric 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 ± 5 in-lb	640 ± 60 N-cm	78 ± 7 in-lb	885 ± 80 N-cm
M6 X 1.0	96 ± 9 in-lb	1018 ± 100 N-cm	133 ± 13 in-lb	1500 ± 150 N-cm
M8 X 1.25	19 ± 2 ft-lb	26 ± 3 N-m	27 ± 2 ft-lb	36 ± 3 N-m
M10 X 1.5	38 ± 4 ft-lb	52 ± 5 N-m	53 ± 5 ft-lb	72 ± 7 N-m
M12 X 1.75	66 ± 7 ft-lb	90 ± 10 N-m	92 ± 9 ft-lb	125 ± 12 N-m
M16 X 2.0	166 ± 15 ft-lb	225 ± 20 N-m	229 ± 22 ft-lb	310 ± 30 N-m
M20 X 2.5	325 ± 33 ft-lb	440 ± 45 N-m	450 ± 37 ft-lb	610 ± 50 N-m

NOTE: Reduce torque values listed in the table above by 25% for lubricated fasteners. Lubricated fasteners are defined as threads coated with a lubricant such as oil, graphite, or thread sealant such as Loctite.

NOTE: Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based

on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

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

Other Torque Specifications

SAE Grade 8 Steel Set Screws

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

Wheel Bolts and Lug Nuts

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

* For steel wheels and non-lubricated fasteners.

Thread Cutting Screws (Zinc Plated Steel)

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

Thread Cutting Screws (Zinc Plated Steel)

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

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

Conversion Factors

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

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

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

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



Kubota Diesel Engine

Model 30807

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Specifications

Item	Description
Make / Designation	Kubota D1105- E3B or D1105- E4B, 4- Stroke, Liquid Cooled, OHV Diesel
Number of Cylinders	3
Bore in. (mm)	3.07 (78.0)
Stroke in. (mm.)	3.09 (78.4)
Total Displacement cu. In. (cc)	68.53 (1123)
Firing Order	1 (fan end) - 2 - 3 (flywheel end)
Combustion Chamber	Spherical Type
Fuel	No. 2 Diesel Fuel (ASTM D975)
Fuel Capacity gallons (liters)	14 (53)
Fuel Injection Pump	Bosch MD Type Mini Pump
Governor	Centrifugal Mechanical
Low Idle (no load)	1400 $\pm$ 50 RPM
High Idle (no load)	3220 $\pm$ 50 RPM
Injection Nozzles	Mini Nozzle (DNOPD)
Engine Oil	API classification CH- 4, CI- 4 or Higher (see Traction Unit Operator's Manual for viscosity recommendations)
Oil Pump	Gear Driven Trochoid Type
Crankcase Oil Capacity U.S. Qt. (liters)	4 (3.8) with Filter
Starter	12 VDC, 1.4 KW
Alternator/Regulator	12 VDC, 40 AMP
Dry Weight U.S. Lbs (kilograms)	205.0 (93.0)
Coolant Capacity U.S. qt. (liters)	5.5 (5.2)

Introduction

This Chapter gives information about specifications, maintenance, troubleshooting, testing, and repair of the diesel engine used in the Groundsmaster 3500-D (Model 30807).

Most repairs and adjustments require tools which are commonly available in many service shops. The use of some specialized test equipment is explained in the engine service manual included at the end of this chapter. 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 gasoline engines are supplied through your local Toro Distributor. If a parts list is not available, be sure to provide your distributor with the Toro model and serial number.

Operator's Manuals

The Traction Unit Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for the Kubota diesel engine that powers your Groundsmaster 3500-D. Refer to this publication for additional information when servicing the machine.

Kubota Workshop Manual

The engine that powers your Groundsmaster machine is a Kubota model D1105. The Kubota Workshop Manual is available for these engines. Make sure that the correct engine manual is used when servicing the engine on your Groundsmaster 3500-D.

Kubota Diesel Engine

The Kubota D1105 engine used in your Groundsmaster 3500-D is a naturally aspirated diesel engine that complies with either EPA emission regulations Tier 4i (model D1105-E3B) or Tier 4 (model D1105-E4B) depending on manufacture date. The engine includes a Bosch in-line injection pump.

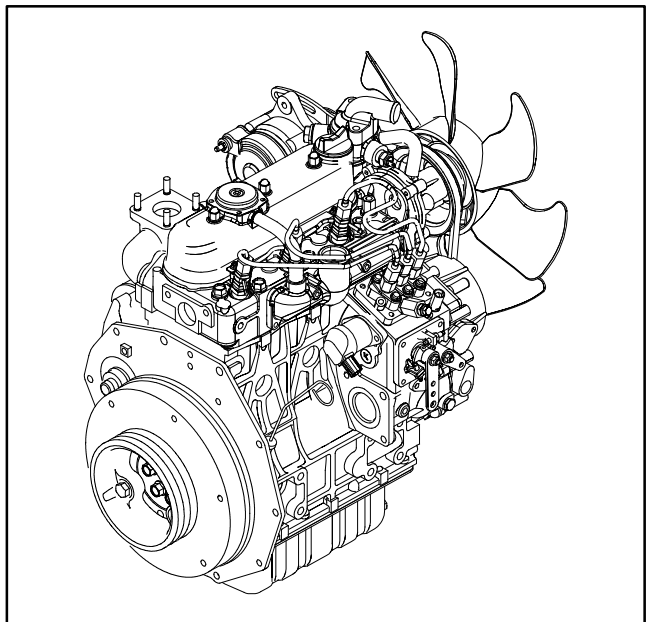


Figure 1

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Service and Repairs

Air Cleaner and Muffler

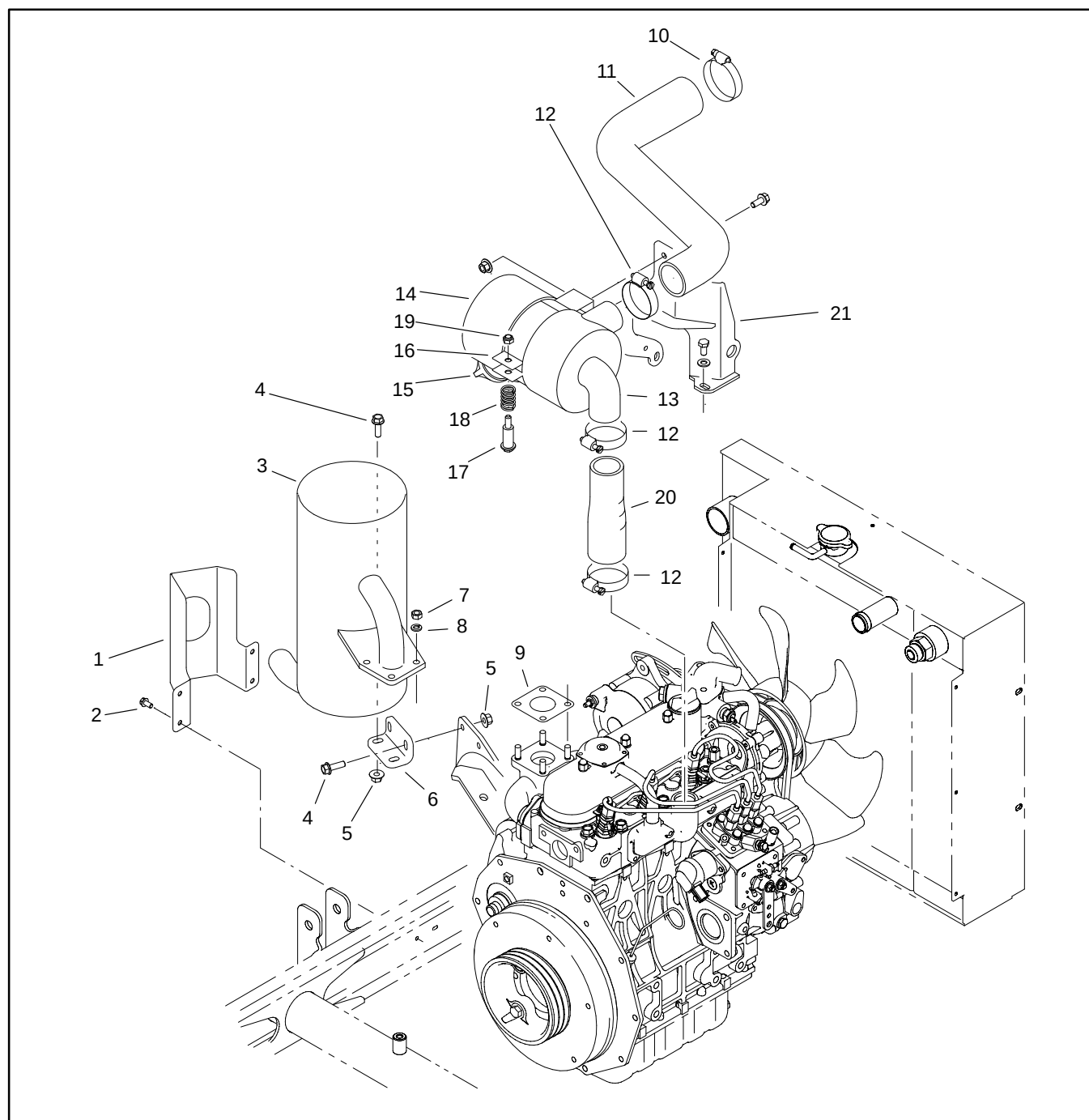


Figure 2

- | | | |
|----------------------|----------------------------|----------------------------|
| 1. Exhaust guard | 8. Lock washer | 15. Burp (Actuator) valve |
| 2. Cap screw | 9. Exhaust gasket | 16. Mounting band assembly |
| 3. Muffler | 10. Hose clamp | 17. Shoulder bolt |
| 4. Flange head screw | 11. Air inlet hose (upper) | 18. Compression spring |
| 5. Flange nut | 12. Hose clamp | 19. Lock nut |
| 6. Muffler bracket | 13. Air cleaner body | 20. Air inlet hose (lower) |
| 7. Hex nut | 14. Filter cover | 21. Air filter mount |

Check Air Filter, Dust Cup, & Burp Valve

The air cleaner body, air filter, dust cup, and burp valve should be checked daily, prior to operation.

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

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch. Unlatch and raise hood.
2. Check air cleaner body for damage that could cause possible air leaks. Make sure dust cup seals completely to the air cleaner body (Fig. 3).
3. Check burp valve and dust cup for damage.
4. Make sure air hoses connecting the air cleaner to the engine and radiator are secured tightly and free of possible air leaks.

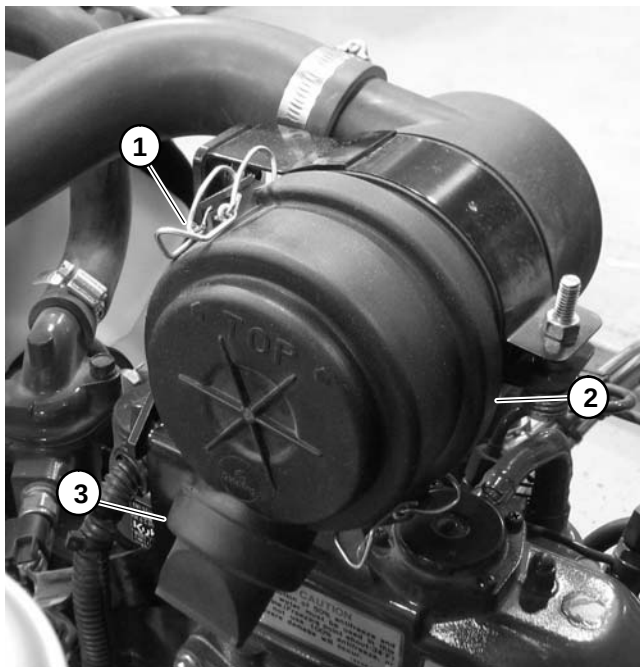


Figure 3

1. Latch
2. Dust cup
3. Burp valve

Muffler Removal

**CAUTION**

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

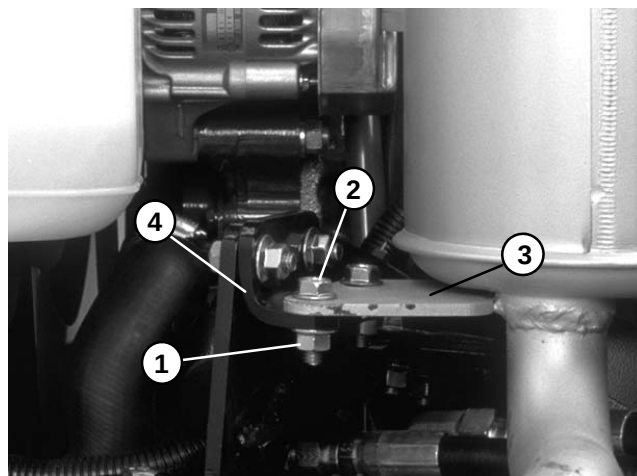


Figure 4

1. Flange head nut
2. Flange head screw
3. Muffler plate
4. Muffler bracket

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Open engine hood to gain access to engine.
3. Remove exhaust guard.
4. Remove both flange head nuts and screws securing the muffler plate to the muffler bracket (Fig. 4).
5. Remove four hex nuts and lock washers from the exhaust manifold studs. Separate muffler flange from the exhaust manifold. Remove muffler from the machine.
6. Remove exhaust gasket. Replace gasket if damaged or torn.

Muffler Installation

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

1. Place exhaust gasket on the exhaust manifold.

IMPORTANT: Finger tighten all fasteners before securing the muffler plate to the muffler bracket so there is no preload on the exhaust manifold.

2. Position muffler flange to the exhaust manifold with four lock washers and hex nuts.
3. Position muffler plate to the muffler bracket with both flange head screws and nuts (Fig. 4).
4. Tighten muffler flange hex nuts and then muffler plate screws and nuts.
5. Install exhaust guard.
6. Close and latch engine hood.

Fuel System

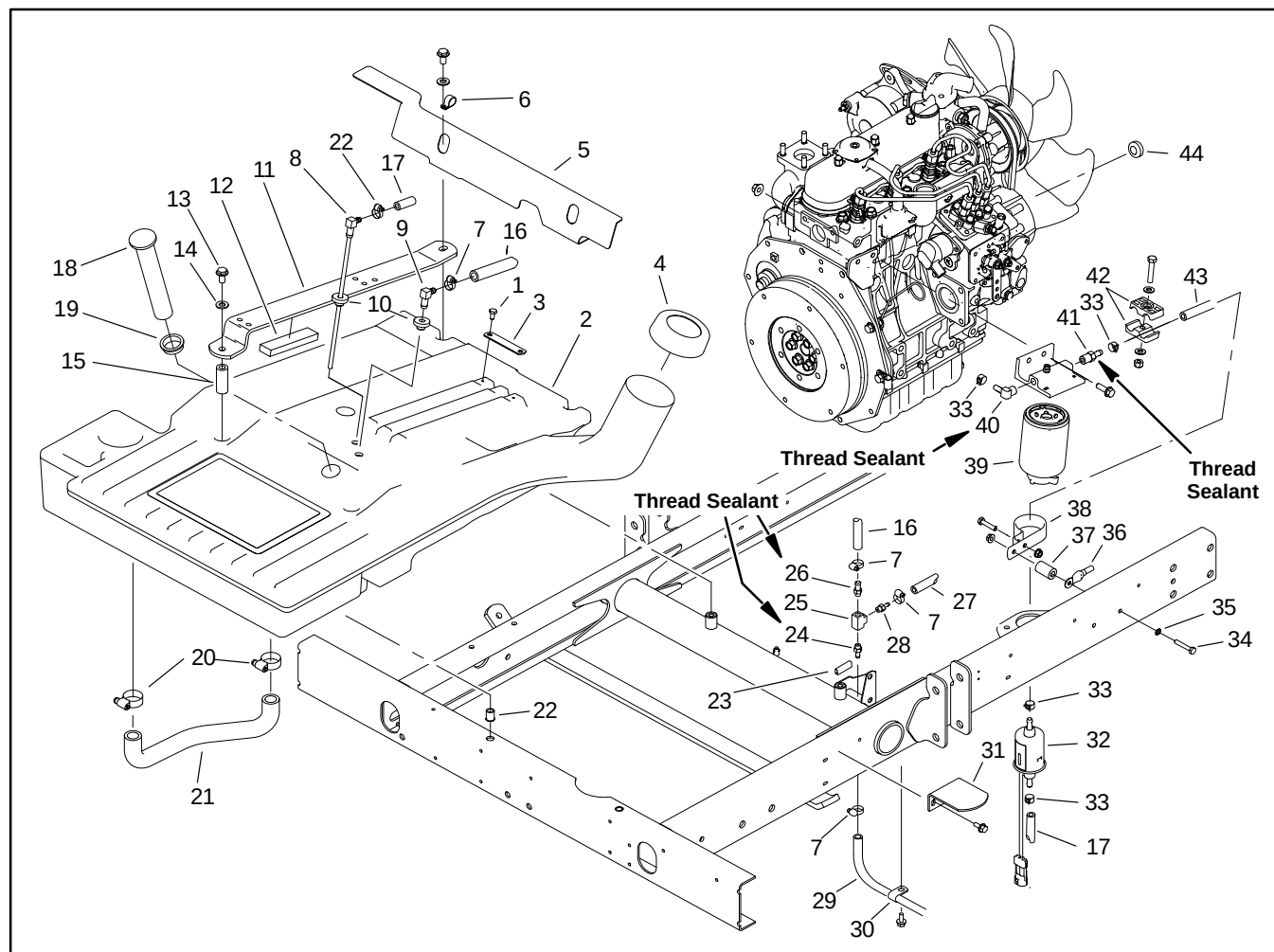


Figure 5

- | | | |
|--------------------------|----------------------------|---------------------------------|
| 1. Cap screw | 16. Fuel hose – tank | 30. R-clamp |
| 2. Fuel tank | 17. Fuel hose – stand pipe | 31. Tank support |
| 3. Cap screw | 18. Fuel gauge | 32. Fuel pump |
| 4. Fuel cap | 19. Grommet | 33. Hose clamp |
| 5. Heat shield | 20. Hose clamp | 34. Cap screw |
| 6. Hex flange head screw | 21. Fuel hose – crossover | 35. Lock washer |
| 7. Hose clamp | 22. Insert nut | 36. Chassis ground |
| 8. Stand pipe | 23. Trim | 37. Spacer |
| 9. Connector fitting | 24. Barb fitting – 1/4" | 38. R-clamp |
| 10. Bushing | 25. Tee fitting | 39. Fuel filter/water separator |
| 11. Seat support strap | 26. Barb fitting 5/16" | 40. Fuel fitting – 5/16" |
| 12. Foam | 27. Fuel hose – engine | 41. Fuel fitting |
| 13. Cap screw | 28. Barb fitting – 3/16" | 42. Clamp block |
| 14. Flat washer | 29. Fuel hose | 43. Fuel hose |
| 15. Spacer | | 44. Grommet |



DANGER

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

Fuel Tank Removal (Fig. 5)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch. Unlatch and raise hood.
2. Remove fuel from the tank into a suitable container. If necessary, remove crossover fuel hose to drain tank completely.
3. Remove seat and seat support straps from the frame. Note location of spacers under front of seat support straps. Disconnect seat switch from the electrical harness (Fig. 6).
4. Remove fuel hose strap and both fuel hoses from the fuel tank. Remove fuel tank from the machine.

Clean Fuel Tank

Clean the fuel tank every 2 years. Also, clean the fuel tank if the fuel system becomes contaminated or if the machine is to be stored for an extended period.

1. Remove fuel tank from the machine (see Fuel Tank Removal).
2. Flush fuel tank out with clean diesel fuel. Make sure tank is free of contaminants and debris.
3. Install fuel tank to the machine (see Fuel Tank Installation).

Fuel Tank Installation (Fig. 5)

1. Position fuel tank to the machine.
2. Connect both fuel hoses to the tank and secure with hose clamps. Apply anti-seize lubricant to inserts on top of tank and install fuel hose strap.
3. Connect seat switch to the electrical harness. Route seat switch wire under seat support strap. Secure seat support straps and seat to the frame with hex flange head screws.
4. Check for correct seat operation and that seat switch wires and connector are not pinched and do not contact any moving parts.
5. Install crossover fuel hose if removed and fill fuel tank.

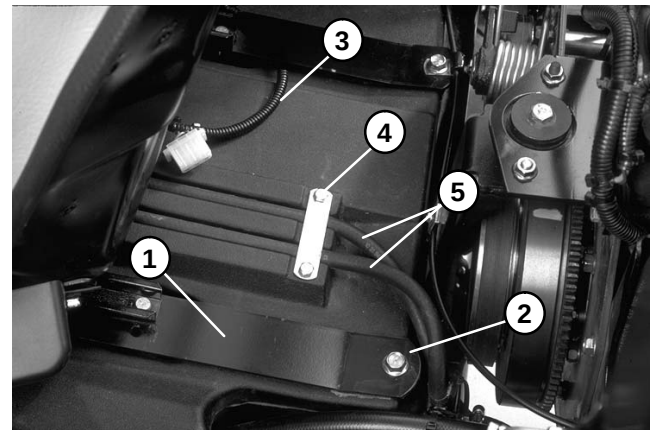


Figure 6

- | | |
|--------------------------|--------------------|
| 1. Seat support strap | 4. Fuel hose strap |
| 2. Hex flange head screw | 5. Fuel hose |
| 3. Electrical harness | |

Radiator – Radiator/Hydraulic Fluid Cooler

Traction Units Prior to
Serial No 314000001

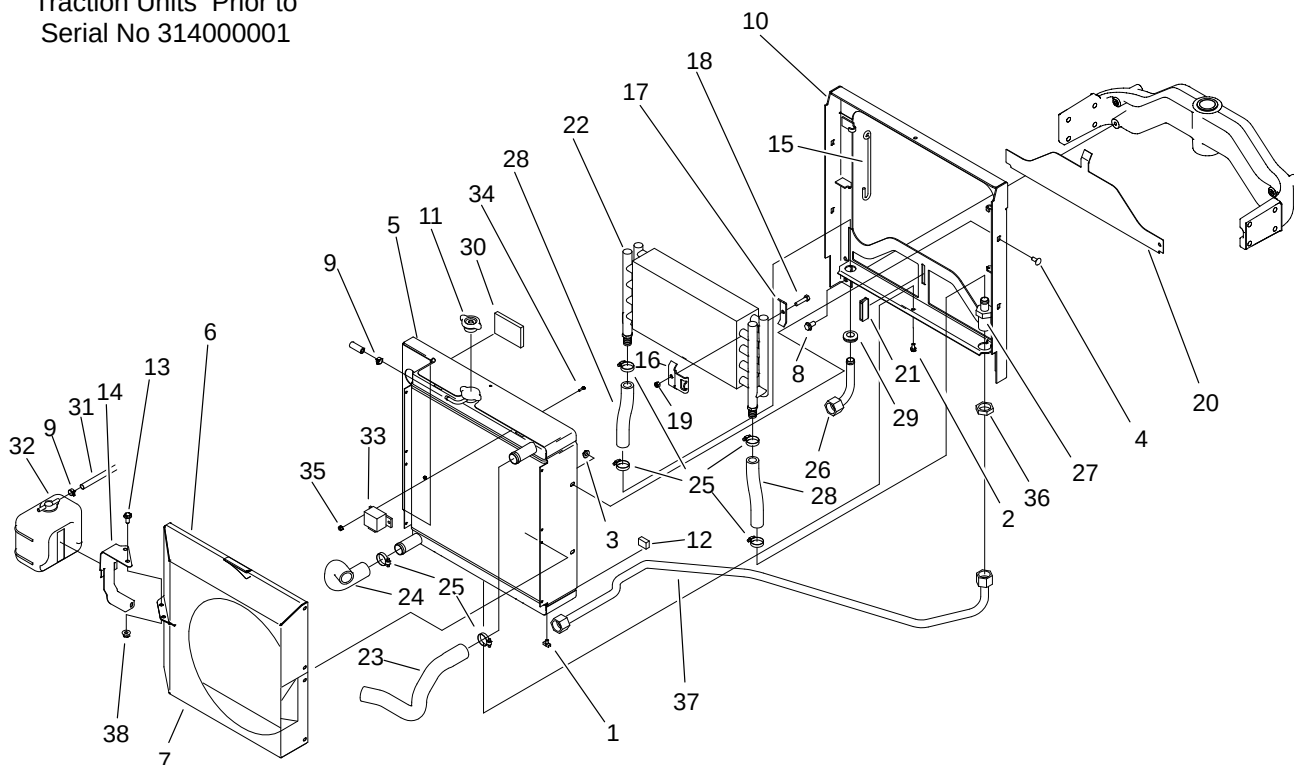


Figure 7

- | | | |
|------------------------|------------------------------------|---------------------------------|
| 1. Drain-cock valve | 14. Reservoir bracket | 27. Hydraulic tube |
| 2. Flange head screw | 15. Wire form latch | 28. Hydraulic fluid cooler hose |
| 3. Flange nut | 16. Hydraulic fluid cooler bracket | 29. Grommet |
| 4. Carriage bolt | 17. Bracket clamp | 30. Foam seal |
| 5. Radiator | 18. Screw | 31. Expansion tank hose |
| 6. Fan shroud (top) | 19. Lock nut | 32. Expansion tank |
| 7. Fan shroud (bottom) | 20. Radiator shield (lower) | 33. Glow plug relay |
| 8. Flange head screw | 21. Magnetic catch | 34. Thread forming screw |
| 9. Hose clamp | 22. Hydraulic fluid cooler | 35. Flange lock nut |
| 10. Radiator frame | 23. Radiator hose (upper) | 36. Bulkhead nut |
| 11. Radiator cap | 24. Radiator hose (lower) | 37. Tube assembly |
| 12. Radiator foam seal | 25. Hose clamp | 38. Nut |
| 13. Flange head screw | 26. Hydraulic tube | |

Traction Units
Serial No 314000001 & Up

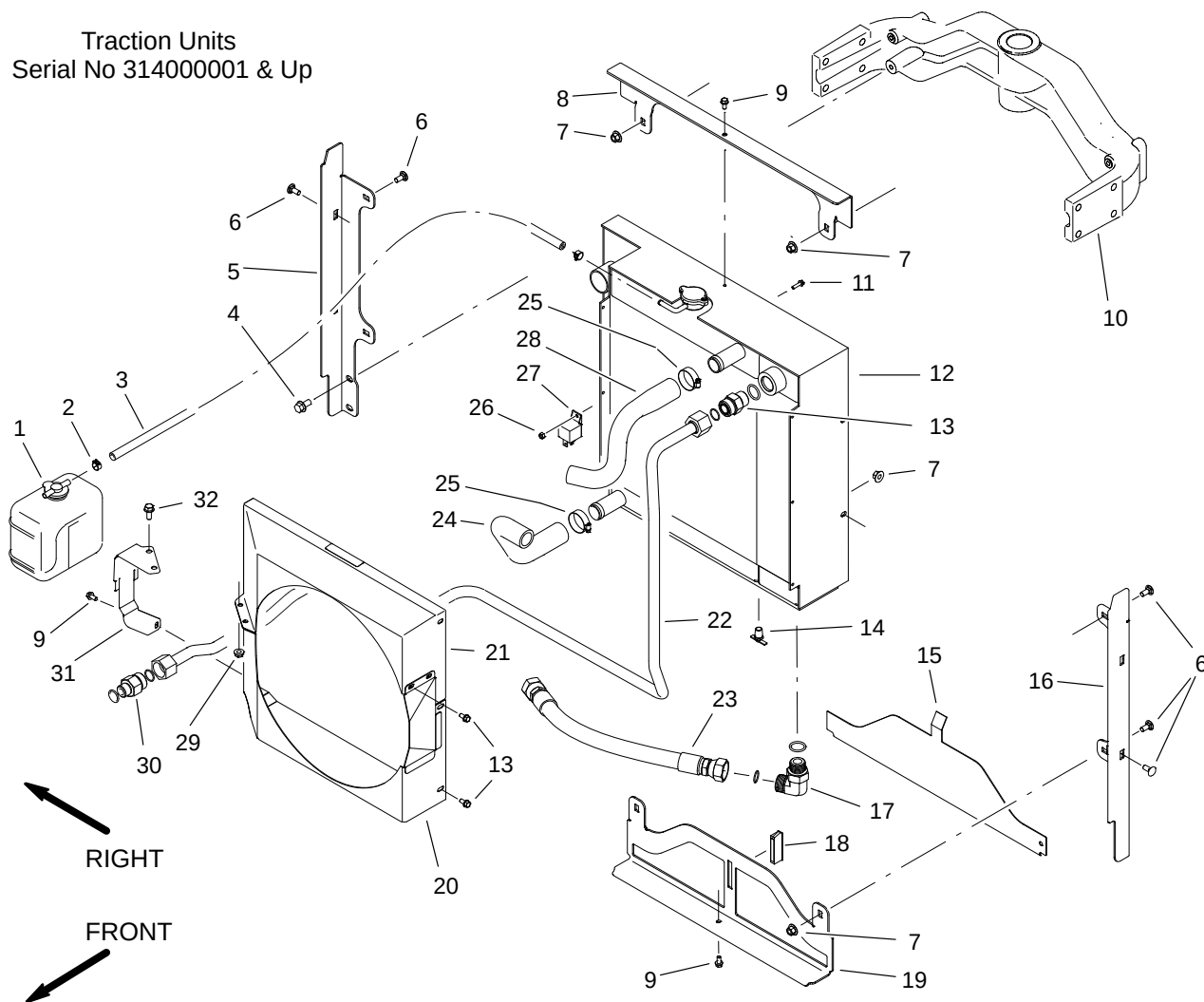


Figure 8

- | | | |
|---------------------------|-------------------------------|----------------------------|
| 1. Expansion tank | 12. Radiator | 23. Hydraulic hose |
| 2. Hose clamp | 13. Straight fitting | 24. Lower radiator hose |
| 3. Coolant hose | 14. Drain-cock | 25. Hose clamp |
| 4. Flange head screw | 15. Lower radiator shield | 26. Hex nut |
| 5. Radiator bracket - RH | 16. Radiator bracket - LH | 27. Relay |
| 6. Carriage bolt | 17. Elbow fitting | 28. Upper radiator hose |
| 7. Flange nut | 18. Magnet | 29. Flange nut |
| 8. Radiator bracket - top | 19. Radiator bracket - bottom | 30. Straight fitting |
| 9. Flange head screw | 20. Lower fan shroud | 31. Expansion tank support |
| 10. Frame casting | 21. Upper fan shroud | 32. Flange head screw |
| 11. Cap screw | 22. Hydraulic tube | |

Removal

Units prior to serial no. 314000001 use a separate hydraulic oil cooler. The hydraulic oil cooler on later units is combined with the radiator assembly. It is not necessary to drain the hydraulic system when removing the radiator on early units prior to serial no. 314000001.

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



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 radiator to collect the coolant. Open drain-cock valve, and completely drain the radiator.
4. Remove glow plug relay from the radiator assembly. Position relay away from the radiator.
5. Place a suitable container under the hydraulic filter to collect the hydraulic fluid. The container should have a 6 gal. (23 Ltr.) minimum capacity. Disconnect the hydraulic hose below the filter head or remove the hydraulic filter element and drain the hydraulic system (Fig. 9).
6. Disconnect following hoses from the radiator or radiator/oil cooler assembly:
 - A. Upper radiator hose to the water pump.
 - B. Lower radiator hose to the engine block.
 - C. Coolant hose to the expansion tank.
 - D. Air hose to the air cleaner.
7. For units serial no. 314000001 & up, disconnect the following hoses from the oil cooler section of the radiator/oil cooler assembly:
 - A. Hydraulic tube from top of hydraulic fluid cooler.
 - B. Hydraulic hose from bottom of hydraulic fluid cooler.
8. Remove expansion tank from the fan shroud.

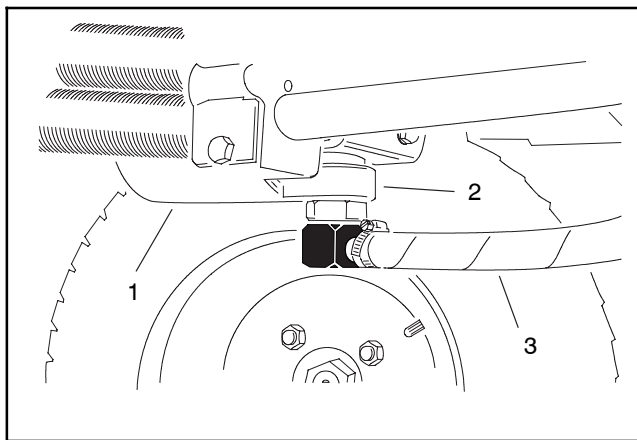


Figure 9

1. Hydraulic filter element
2. Hydraulic filter head
3. Hydraulic hose

9. Remove expansion tank bracket and both fan shrouds from radiator assembly.
10. Remove flange head screws securing the top and bottom of the radiator frame to the radiator. Remove four carriage bolts and lock nuts securing the radiator to the radiator frame.
11. Carefully remove radiator from the radiator frame.
12. Plug any openings to prevent contamination.

Installation

1. Remove any plugs used during the removal procedures.
2. Position radiator carefully to the radiator frame.
3. Secure radiator assembly to the radiator frame with four carriage bolts and lock nuts. Secure top and bottom of radiator to frame with flange head screws.
4. Secure both fan shrouds to the radiator assembly with flange head screws.
5. Secure expansion tank bracket and tank to the top fan shroud with both flange head screws and flange nuts.
6. For units serial no. 314000001 & up, connect the following hoses to the oil cooler section of the radiator/oil cooler assembly:
 - A. Hydraulic tube from top of hydraulic fluid cooler.
 - B. Hydraulic hose from bottom of hydraulic fluid cooler.

7. Connect following hoses to the radiator or radiator/oil cooler assembly:

- A. Upper radiator hose to the water pump.
- B. Lower radiator hose to the engine block.
- C. Coolant hose to the expansion tank.
- D. Air hose to the air cleaner.

8. Secure glow plug relay to the radiator assembly with both thread forming screws.

9. Make sure drain-cock valve is closed. Fill radiator with coolant to the bottom of the filler neck.

10. Install engine hood to the machine. Close and latch hood.

11. Start engine. Check for fluid leaks and proper engine operation.

12. After running engine for a short time on units with serial no. 314000001 & up, stop engine and make sure hydraulic tank is full. Add correct oil if necessary.

Diesel Engine

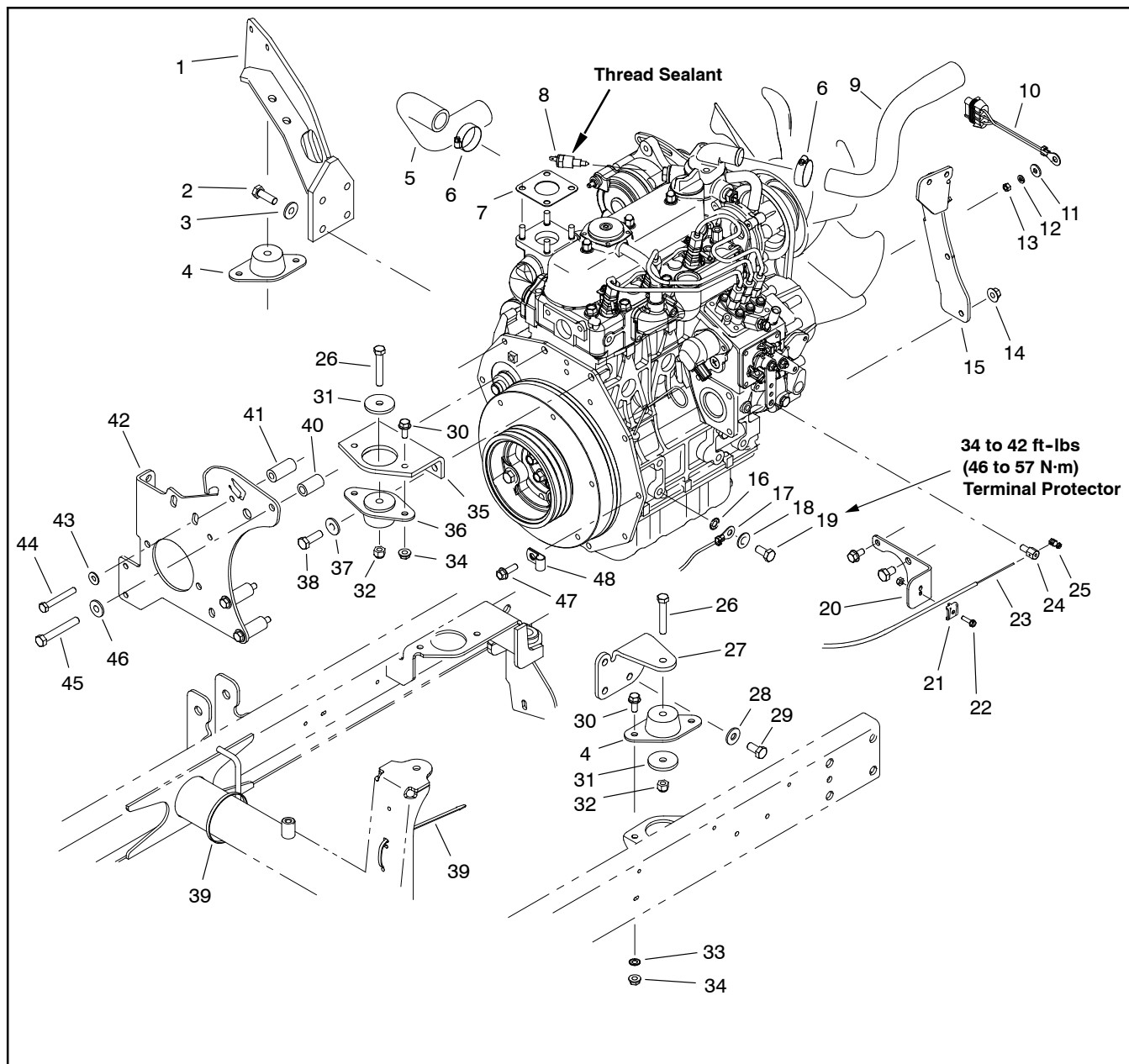


Figure 10

- | | | |
|---------------------------------|-------------------------------|----------------------------------|
| 1. Engine mount bracket - RH | 17. Engine ground | 33. Lock washer |
| 2. Cap screw | 18. Flat washer | 34. Flange nut |
| 3. Hardened washer | 19. Cap screw | 35. Engine mount bracket - front |
| 4. Engine mount | 20. Throttle cable bracket | 36. Engine mount |
| 5. Lower radiator hose | 21. Cable clamp | 37. Hardened washer |
| 6. Hose clamp | 22. Cap screw | 38. Cap screw |
| 7. Exhaust flange gasket | 23. Throttle cable | 39. Cable tie |
| 8. Coolant temperature switch | 24. Swivel clamp | 40. Spacer (1) |
| 9. Upper radiator hose | 25. Cable stop | 41. Spacer (4) |
| 10. Wire Harness - fusible link | 26. Cap screw | 42. Pump mount plate |
| 11. Flat washer | 27. Engine mount bracket - LH | 43. Hardened washer |
| 12. Lock washer | 28. Hardened washer | 44. Cap screw |
| 13. Hex nut | 29. Cap screw | 45. Cap screw |
| 14. Flange nut | 30. Flange head screw | 46. Hardened washer |
| 15. Fuel filter bracket | 31. Hardened washer | 47. Flange head screw |
| 16. External tooth lock washer | 32. Hex nut | 48. Clamp |

Removal

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

2. Open and remove engine hood from the machine. Slide seat all the way forward.

3. Disconnect both battery cables at the battery (see Battery Service in Chapter 6 – Electrical System).

4. Disconnect air hose from the air cleaner and radiator. Remove air cleaner assembly from the engine.

5. Remove muffler from the exhaust manifold and muffler bracket (see Muffler Removal in this Chapter).

6. Drain radiator from the drain cock valve into a suitable container (see Radiator Removal in this Chapter). Disconnect coolant hoses from the water pump and engine block.

7. Remove coolant expansion tank and bracket from the top fan shroud. Remove top fan shroud from the radiator (see Radiator Removal in this Chapter).

8. Disconnect wire harness and electrical wires from the following:

A. Battery, wire harness and engine grounds (Fig. 11).

B. Glow plug bus (Fig. 12) and fuel stop solenoid.

C. High temperature warning switch (Fig. 13).

D. High temperature shutdown switch, alternator, and low oil pressure switch (Fig. 14).

9. Disconnect throttle cable from the support and swivel on the speed control lever (Fig. 11).

10. Disconnect fuel hose from the fuel pump (Fig. 11) and front injector nozzle.

11. Remove traction control cable from the neutral arm assembly on the piston pump. Remove all hydraulic hoses from the piston and gear pumps (see Piston Pump Removal in Chapter 5– Hydraulic System).

12. Remove cable ties securing the wire harness to the front lift tab and other engine parts. Connect hoist or lift to the front and rear lift tabs (Fig. 12 and 13).

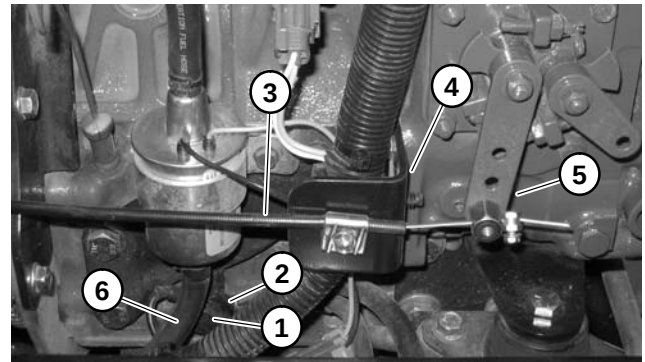


Figure 11

- | | |
|-------------------------|------------------------|
| 1. Battery ground cable | 4. Support bracket |
| 2. Wire harness ground | 5. Speed control lever |
| 3. Throttle cable | 6. Fuel hose |

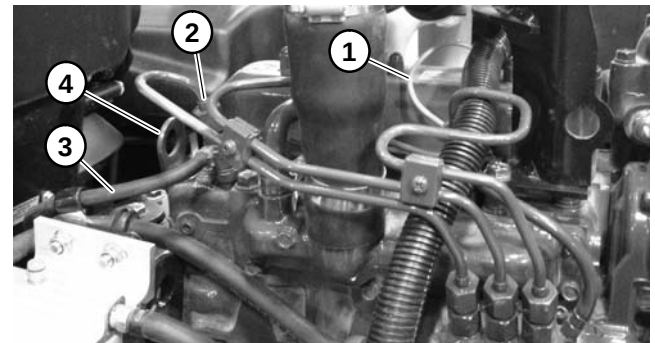


Figure 12

- | | |
|-------------------------|--------------|
| 1. Glow plug wire | 3. Fuel hose |
| 2. Rear injector nozzle | 4. Lift tab |

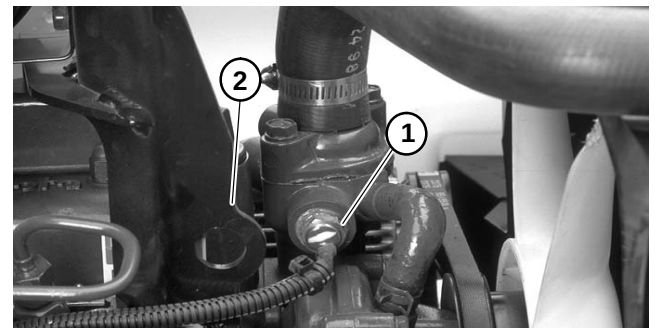


Figure 13

- | | |
|-------------------------|-------------|
| 1. Temp. warning switch | 2. Lift tab |
|-------------------------|-------------|

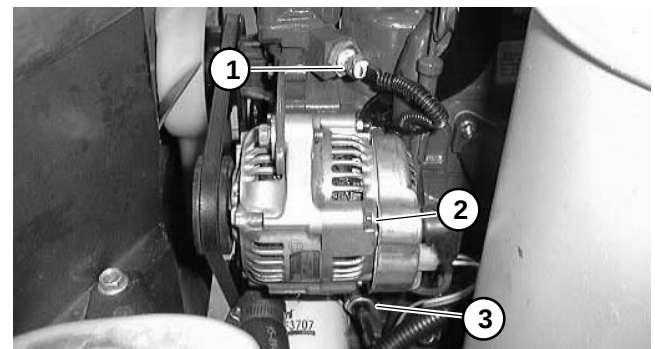


Figure 14

- | | |
|--------------------------|--------------------------|
| 1. Temp. shutdown switch | 3. Low oil press. switch |
| 2. Alternator | |

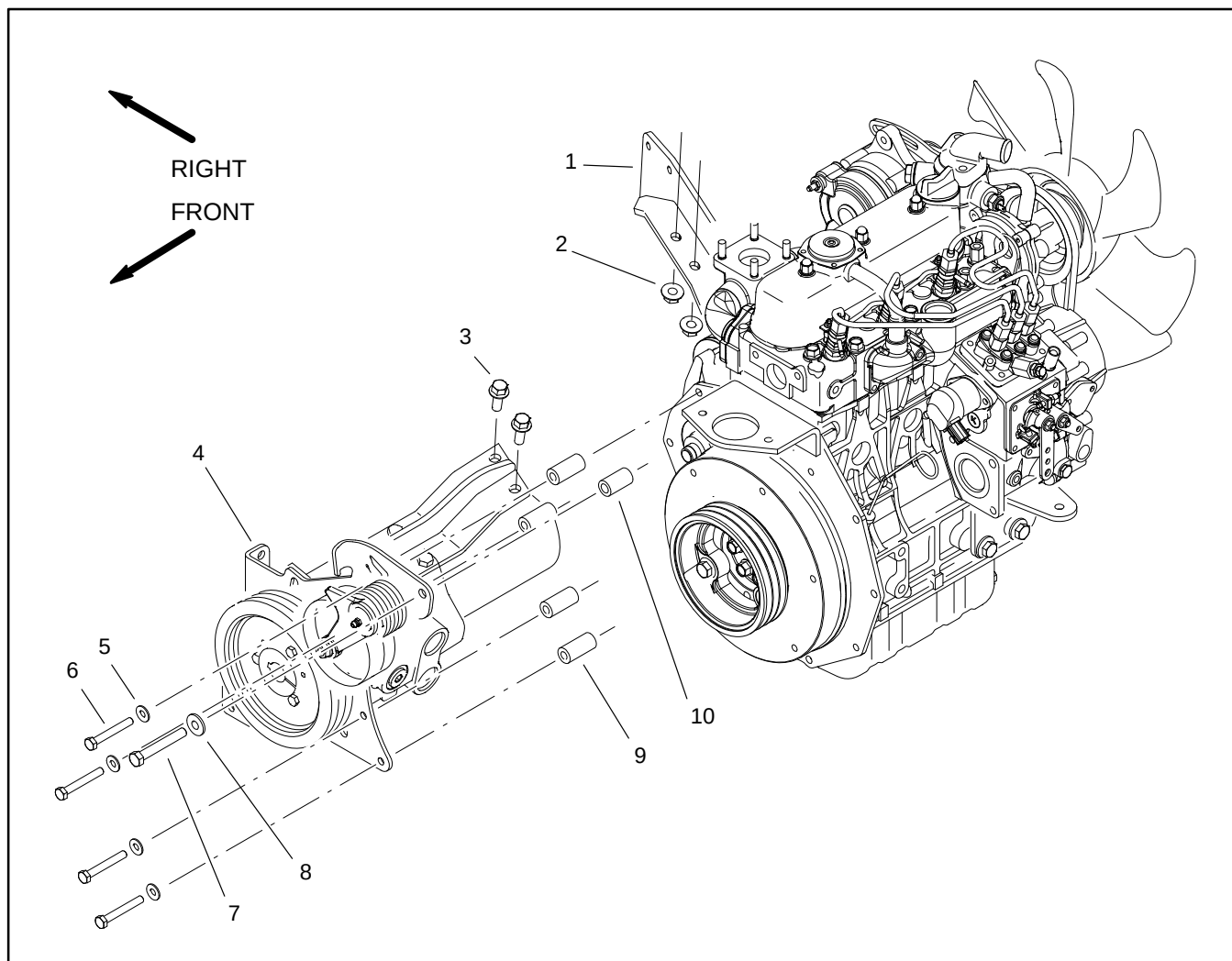


Figure 15

- 1. Engine mount bracket
- 2. Flange nut
- 3. Flange screw
- 4. Pump mount plate

- 5. Hardened washer
- 6. 10 mm cap screw (4)
- 7. 8 mm cap screw (1)

- 8. Hardened washer
- 9. Long spacer (4)
- 10. Short spacer (1)



CAUTION

Make sure lift or hoist can support the total weight of the engine before removing the cap screws from the engine and engine brackets.



CAUTION

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

13. Remove hex nuts, cap screws, and washers from the center of the three engine mounts.

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

14. Remove engine slowly from the machine.

15. Separate hydrostat and pump assembly from the engine as follows (Fig. 15):

- A. Remove traction belt from the engine flywheel and hydrostat pulleys.
- B. Remove five cap screws, washers, and spacers securing the pump mount plate to the engine.
- C. Remove two cap screws and flange nuts securing the pump support to the engine mount bracket and remove the hydrostat and pump assembly from the engine.

16. As necessary, remove engine mounts, front engine mounting bracket, throttle support bracket and left engine mounting bracket.

Installation

1. If removed, install engine mounts, front engine mounting bracket, throttle support bracket and left engine mounting bracket. Also, make sure that all switches and sensors are installed on engine.

2. Install hydrostat and pump assembly to the engine as follows (Fig. 15):

- A. Secure the pump support to the engine mount bracket with two flange nuts and cap screws.
- B. Secure pump mount plate to the engine with five spacers, washers, and cap screws.
- C. Install traction belt to the engine flywheel and hydrostat pulleys.

3. Connect hoist or lift to the front and rear engine lift tabs (Fig. 12 and 13).



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

- 4. Position engine slowly into the machine.
- 5. Secure all three engine mounts to the engine mounting brackets with cap screws, washers, and hex nuts.
- 6. Secure wire harness to the front lift tab and the engine with cable ties.
- 7. Install all hydraulic hoses to the piston and gear pumps. Install traction control cable to the neutral arm assembly on the piston pump (see Piston Pump Installation in Chapter 5- Hydraulic System).

8. Connect fuel hose to the fuel pump (Fig. 11) and front injector nozzle.

9. Install top fan shroud to the radiator. Install expansion tank and bracket to the top fan shroud (see Radiator Installation in this Chapter).

10. Connect wire harness and electrical wires to the following:

- A. Engine grounds to the battery and wire harness (Fig. 11). Torque the engine ground bolt to **34 to 42 ft-lbs (46 to 57 N·m)** and apply a coat of aerosol terminal protector.
- B. Torque the frame ground bolt to **175 to 225 in-lbs (19.7 to 25.4 N·m)** and apply a coat of aerosol terminal protector.

NOTE: Make sure that the engine and frame ground surfaces are free from corrosion, oil and paint.

- C. Glow plug bus (Fig. 12) and fuel stop solenoid.
- D. High temperature warning switch (Fig. 13).
- E. High temperature shutdown switch, alternator, and low oil pressure switch (Fig. 14).

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

12. Connect coolant hoses to the water pump and engine block. Make sure drain cock valve is closed. Fill radiator with coolant.

13. Install muffler to the exhaust manifold and muffler bracket (see Muffler Installation in this Chapter).

14. Connect throttle cable to the support and swivel on the speed control lever (Fig. 11).

15. Connect both battery cables at the battery (see Battery Service in Chapter 6 - Electrical system).

16. Install air cleaner to the engine. Connect air hose to air cleaner and radiator.

17. Adjust throttle cable.

18. Bleed fuel system.

19. Install engine hood to the machine. Close and latch hood.

20. Check the hydraulic fluid level and fill the hydraulic fluid tank if necessary.

21. Start the unit and run engine to normal operating temperature. Use all of the hydraulic controls while the engine is running to distribute the hydraulic fluid throughout the system.

22. Stop the engine and check the hydraulic fluid and coolant levels. Adjust as necessary.

23. Adjust traction drive for neutral.

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Kubota Gasoline Engine

Model 30809

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Specifications

Item	Description
Make / Designation	Kubota, Vertical, 4-Cycle, 3 Cylinder, Liquid Cooled, Gasoline Engine
Bore in. (mm)	2.93 (74.5)
Stroke in. (mm)	2.90 (73.6)
Total Displacement cu. In. (cc)	58.68 (962)
Compression Ratio	9.2:1
Ignition Timing	31° BTDC @ 3600 rpm
Ignition System	Full Transistor Battery Ignition Type
Firing Order	1-2-3
Spark Plug Type/Gap in. (mm)	NGK BKR6E 0.028 to 0.031 (0.7 to 0.8)
Intake & Exhaust Valve Clearance in. (mm) (check when engine is cold)	0.0065 ± 0.0001 (0.165 ± 0.02)
Fuel	Unleaded Gasoline (up to 10% ethanol)
Fuel Capacity gallons (liters)	11 (41.7)
Governor	Electronic
Low Idle (no load)	1600 ± 30 RPM
High Idle (no load)	3420 ± 30 RPM
Direction of Rotation	Counterclockwise (Viewed from Flywheel)
Engine Oil	API classification SL or higher (see Traction Unit Operator's Manual for viscosity recommendations)
Oil Pump	Trochoid Type
Crankcase Oil Capacity U.S. qt. (liters)	3.6 (3.4) with Filter
Starter	12 VDC, 1.2 KW
Alternator/Regulator	12 VDC, 480W
Dry Weight U.S. lbs (kilograms)	163 (74)
Coolant Capacity U.S. qt. (liters)	6 (5.7) with 1.0 (0.9) Reservoir

Introduction

This Chapter gives information about specifications, maintenance, troubleshooting, testing, and repair of the gasoline engine used in the Groundsmaster 3500–G (Model 30809).

Most repairs and adjustments require tools which are commonly available in many service shops. The use of some specialized test equipment is explained in the engine service manual included at the end of this chapter. 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 gasoline engines are supplied through your local Toro Distributor. If a parts list is not available, be sure to provide your distributor with the Toro model and serial number.

Traction Unit Operator's Manuals

The Traction Unit Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for your Groundsmaster 3500–G. Refer to this publication for additional information when servicing the machine.

Kubota Workshop and Diagnostics Manuals

The engine that powers your Groundsmaster 3500–G is a Kubota model WG972–G–E3F. Both the Kubota Workshop Manual and Kubota Diagnostics Manual are available for this engine. Make sure that the correct engine manuals are used when servicing the engine.

Kubota Gasoline Engine

The engine used in your Groundsmaster 3500–G is a Kubota WG972 Series gasoline engine. Engine features include an electronic control unit (ECU) that controls a common rail fuel injection system with port injection, electronic throttle valve (ETV), an electronic governor and a catalytic muffler exhaust system with an oxygen sensor. The ECU receives information from the traction unit Standard Control Module (SCM) as well as numerous engine sensors. The information provided allows the engine ECU to monitor and control engine operation for optimum engine performance.

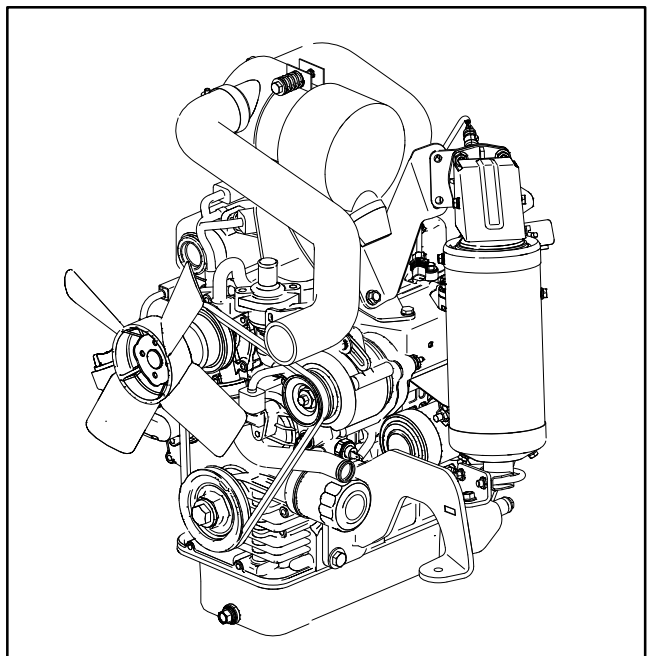


Figure 1

Kubota Gasoline Engine Electronic Control Unit (ECU)

The Kubota gasoline engine that powers your Groundsmaster 3500-G uses an electronic control unit (ECU) for engine management. All wire harness electrical connectors should be plugged into the ECU before the machine ignition switch is moved from the OFF position to either the ON or START position.

The engine electrical components (e.g. ECU, O2 sensor, throttle control, power relay, ETV relay) are identified and matched in the engine ECU program. If engine electrical components are replaced on the engine, the Kubota electronic tool must be used to update the ECU program which will ensure correct engine operation.

If the engine ECU identifies that an engine problem exists, the check engine light on the Operator's Control Panel will illuminate. The engine speed may be reduced or the engine might stop. The Kubota Gasoline Service Tool (KGST) software, the Ecom interface driver and diagnostic cable, and the Kubota Diagnostic Manual should be used to provide assistance in identifying the cause of the problem and any repairs that are necessary. Use the diagnostic cable to connect a PC running the KGST software and Ecom interface driver to the diagnostic connector above the engine ECU (Fig. 3). Contact your Toro distributor for assistance in Kubota engine troubleshooting, or to acquire Kubota engine software and hardware.

IMPORTANT: Two (2) communication connectors are located near the engine ECU. The connector along side of the ECU (near the middle of the engine) is not used for service diagnostics.

Do not plug or unplug the engine ECU for a period of thirty (30) seconds after the machine key switch is turned OFF. The ECU may remain energized even though the ignition switch is OFF.

If the engine ECU is to be disconnected for any reason, make sure that the ignition switch is in the OFF position with the key removed before disconnecting the engine ECU. Also, to prevent possible ECU damage when welding on the machine, disconnect and remove the engine ECU from the machine before welding.

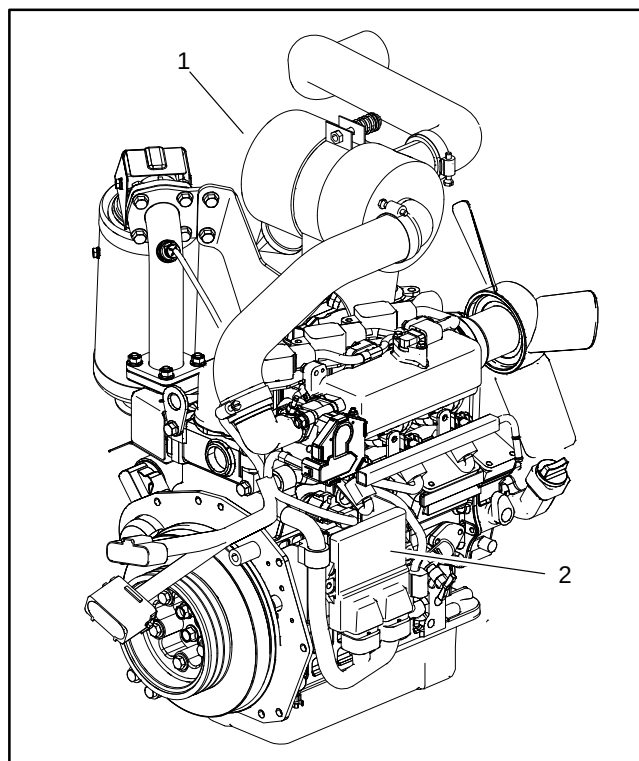


Figure 2

1. Engine (Model 30809)
2. Engine ECU

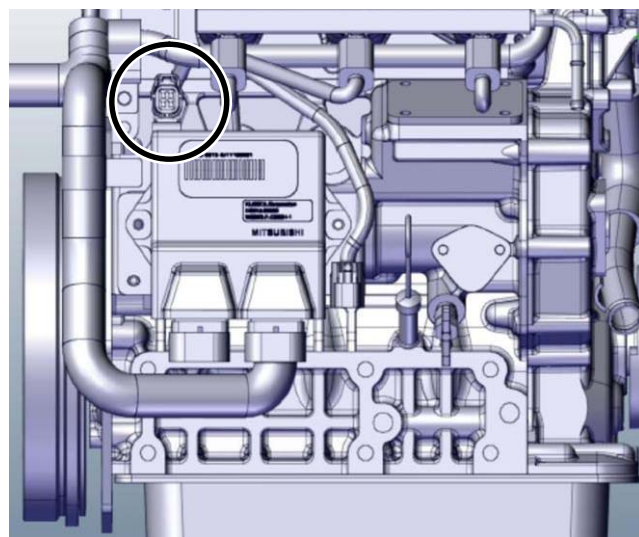


Figure 3
Diagnostic connector

Service and Repairs

Air Cleaner and Muffler

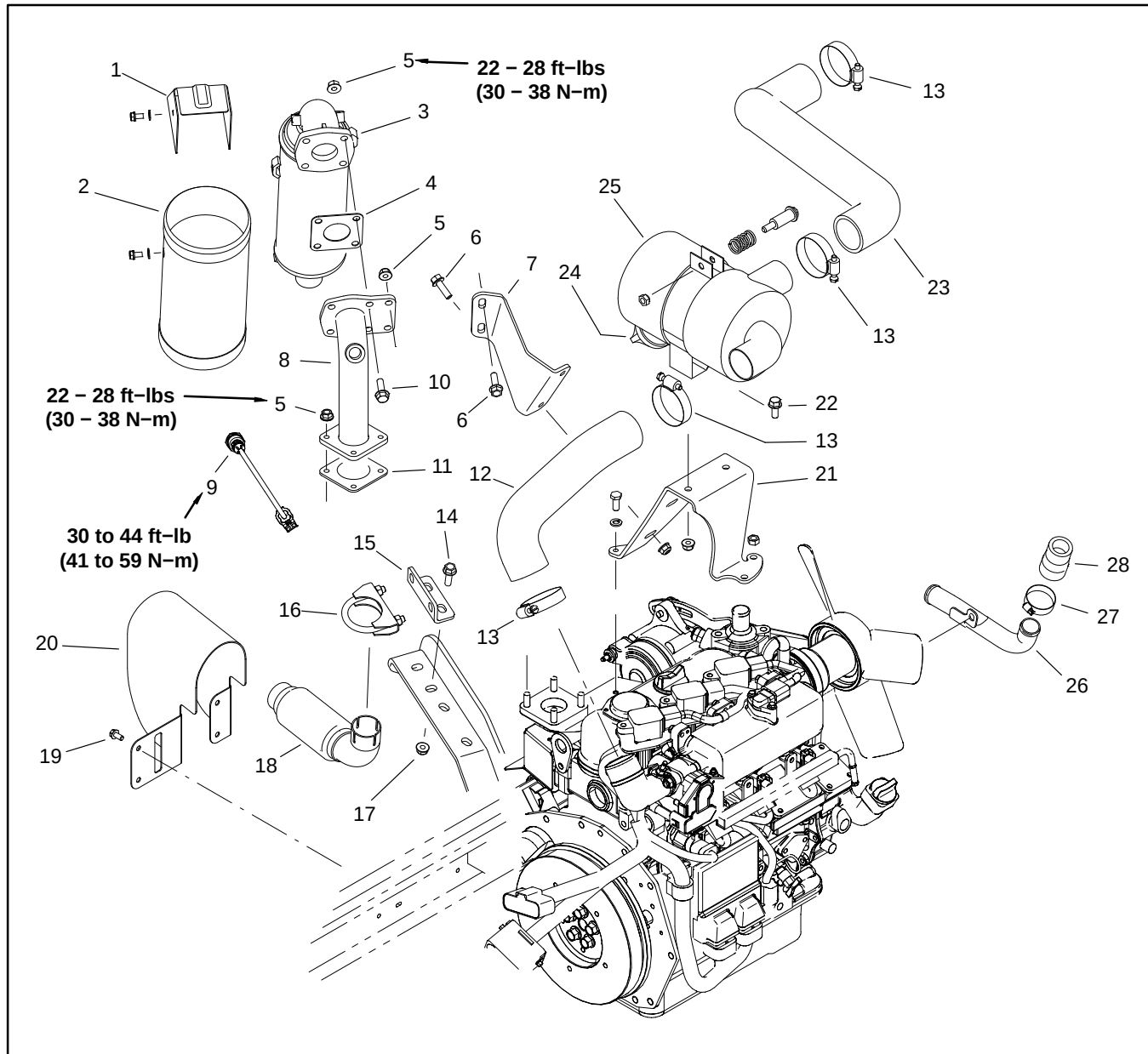


Figure 4

- | | | |
|------------------------------------|-----------------------|---------------------------|
| 1. Muffler flange cover | 11. Exhaust gasket | 20. Heat shield |
| 2. Muffler cover | 12. Lower intake hose | 21. Air cleaner bracket |
| 3. Muffler | 13. Hose clamp | 22. Flange head screw |
| 4. Exhaust gasket | 14. Flange head screw | 23. Upper intake hose |
| 5. Flange nut | 15. Muffler bracket | 24. Air cleaner assembly |
| 6. Flange head screw | 16. Exhaust clamp | 25. Burp (actuator) valve |
| 7. Muffler bracket | 17. Flange nut | 26. Radiator inlet tube |
| 8. Muffler mount tube | 18. Exhaust tube | 27. Hose clamp |
| 9. Oxygen (O ₂) sensor | 19. Cap screw | 28. Radiator hose adapter |
| 10. Flange head screw | | |

Check Air Filter, Dust Cup, & Burp Valve

The air cleaner body, air filter, dust cup, and burp valve should be checked daily, prior to operation.

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

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch. Unlatch and raise hood.
2. Check air cleaner body for damage that could cause possible air leaks. Make sure dust cup seals completely to the air cleaner body (Fig. 5).
3. Check burp valve and dust cup for damage.
4. Make sure air hoses connecting the air cleaner to the engine and radiator are secured tightly and free of possible air leaks.

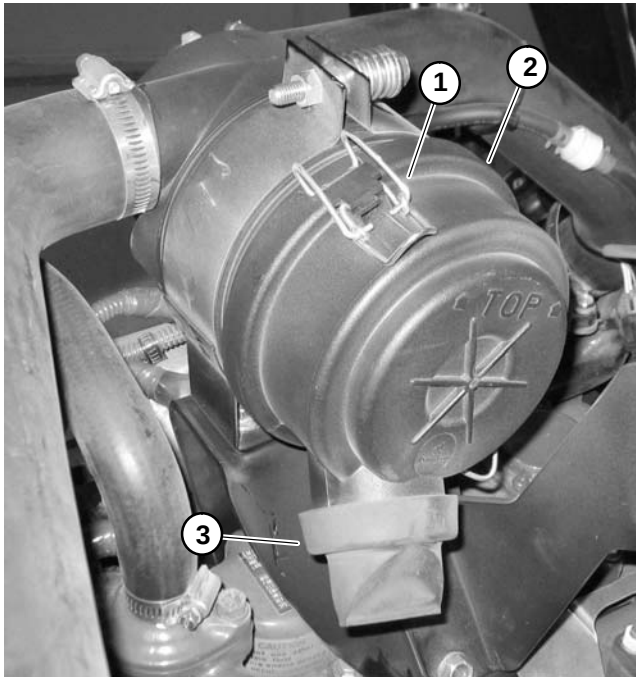


Figure 5

- | | |
|-------------|---------------|
| 1. Latch | 3. Burp valve |
| 2. Dust cup | |

Muffler

To meet gasoline engine emission requirements, the Kubota engine used on your Groundsmaster has a catalytic muffler. In addition to providing sound damping and spark arresting, the muffler also includes a three way catalyst to treat the exhaust gases which are created from the combustion process. The three-way catalyst consists of a honeycomb core coated with a mixture of precious metals. The hot exhaust gases flow through the catalyst where oxidation and reduction reactions

take place. These chemical reactions reduce the amount of CO, HC and NO_x in the exhaust. Two (2) oxygen sensors are included in the exhaust system and are used as inputs for the engine ECU to monitor exhaust system operation. The exhaust exits the catalytic muffler through the tailpipe outlet.

Muffler Removal (Fig. 4)



CAUTION

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

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Open engine hood to gain access to engine.
3. Remove exhaust guard from frame.
4. Remove both flange head nuts and screws securing the muffler bracket to the hydraulic pump support.
5. Remove four flange head nuts and screws securing the muffler flange to the muffler mount tube. Separate muffler flange from the mount tube. Remove muffler assembly from the machine.
6. Remove exhaust gasket. Replace gasket if damaged or torn.

Muffler Installation (Fig. 4)

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

1. Hold the exhaust gasket on the muffler flange and position the muffler assembly to the muffler mount tube with four flange head screws and nuts.

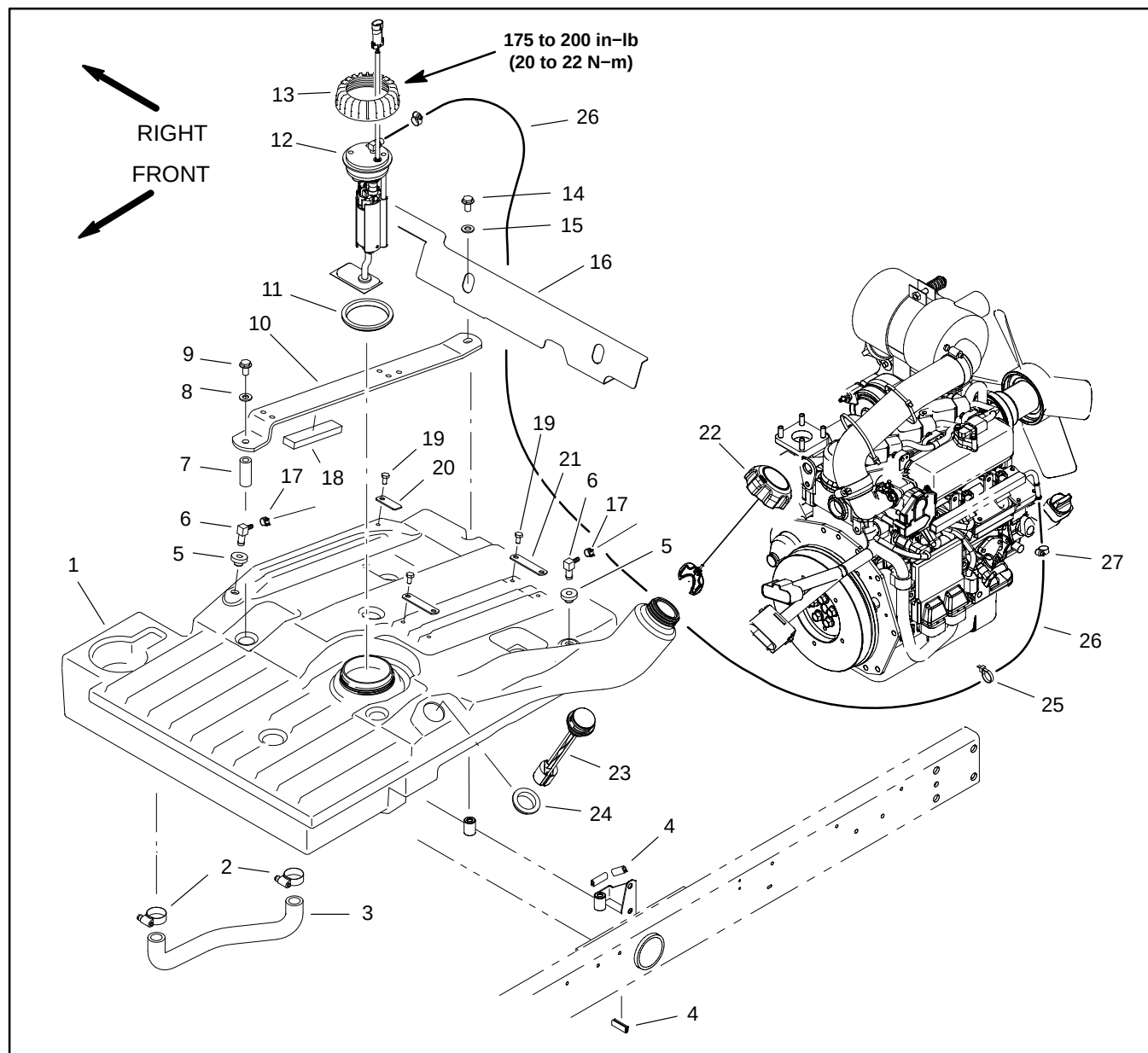
IMPORTANT: Finger tighten all fasteners before securing the muffler bracket to the pump support so there is no preload on the muffler mount tube.

2. Position muffler bracket to the hydraulic pump support with both flange head screws and nuts.
3. Torque muffler flange nuts from **22 to 28 ft-lb (30 to 38 N-m)** and then muffler bracket screws and nuts.

NOTE: If oxygen sensor was removed, torque sensor from **30 to 44 ft-lb (41 to 59 N-m)**.

4. Install exhaust guard to frame.
5. Close and latch engine hood.

Fuel System



- 1. Fuel tank
- 2. Hose clamp
- 3. Fuel hose - crossover
- 4. Protective trim
- 5. Bushing
- 6. Elbow fitting
- 7. Spacer
- 8. Flat washer
- 9. Cap screw

- 10. Seat support strap
- 11. Pump gasket
- 12. Fuel pump
- 13. Fuel pump cap
- 14. Flange screw
- 15. Flat washer
- 16. Heat shield
- 17. Hose clamp
- 18. Foam

- 19. Cap screw
- 20. Strap
- 21. Strap
- 22. Fuel tank cap
- 23. Fuel gauge
- 24. Seal
- 25. Cable tie
- 26. Fuel Hose
- 27. Hose clamp



DANGER

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

Fuel Tank Removal (Fig. 6)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch. Unlatch and raise hood.
2. Remove fuel from the tank into a suitable container. If necessary, remove crossover fuel hose to drain tank completely.
3. Remove seat and seat support straps from the frame. Note location of spacers under front of seat support straps. Disconnect seat switch from the electrical harness.
4. Disconnect the fuel pump from the electrical harness.
5. Remove fuel hose straps and three fuel hoses from the fuel tank. Remove fuel tank from the machine.

Clean Fuel Tank

Clean the fuel tank every 2 years. Also, clean the fuel tank if the fuel system becomes contaminated or if the machine is to be stored for an extended period.

1. Remove fuel tank from the machine (see Fuel Tank Removal).
2. Flush fuel tank out with clean gasoline. Make sure tank is free of contaminants and debris.
3. Install fuel tank to the machine (see Fuel Tank Installation).

Fuel Tank Installation (Fig. 6)

1. Position fuel tank to the machine.
2. Connect three fuel hoses to the tank and secure with hose clamps. Apply anti-seize lubricant to inserts on top of tank and install fuel hose straps.
3. Connect fuel pump to electrical harness.
4. Connect seat switch to the electrical harness. Route seat switch wire under seat support strap. Secure seat support straps and seat to the frame with hex flange head screws.
5. Check for correct seat operation and that seat switch wires and connector are not pinched and do not contact any moving parts.
6. Install crossover fuel hose if removed and fill fuel tank.

Fuel Evaporative Control System (Unit Serial No. Prior to 315000001)

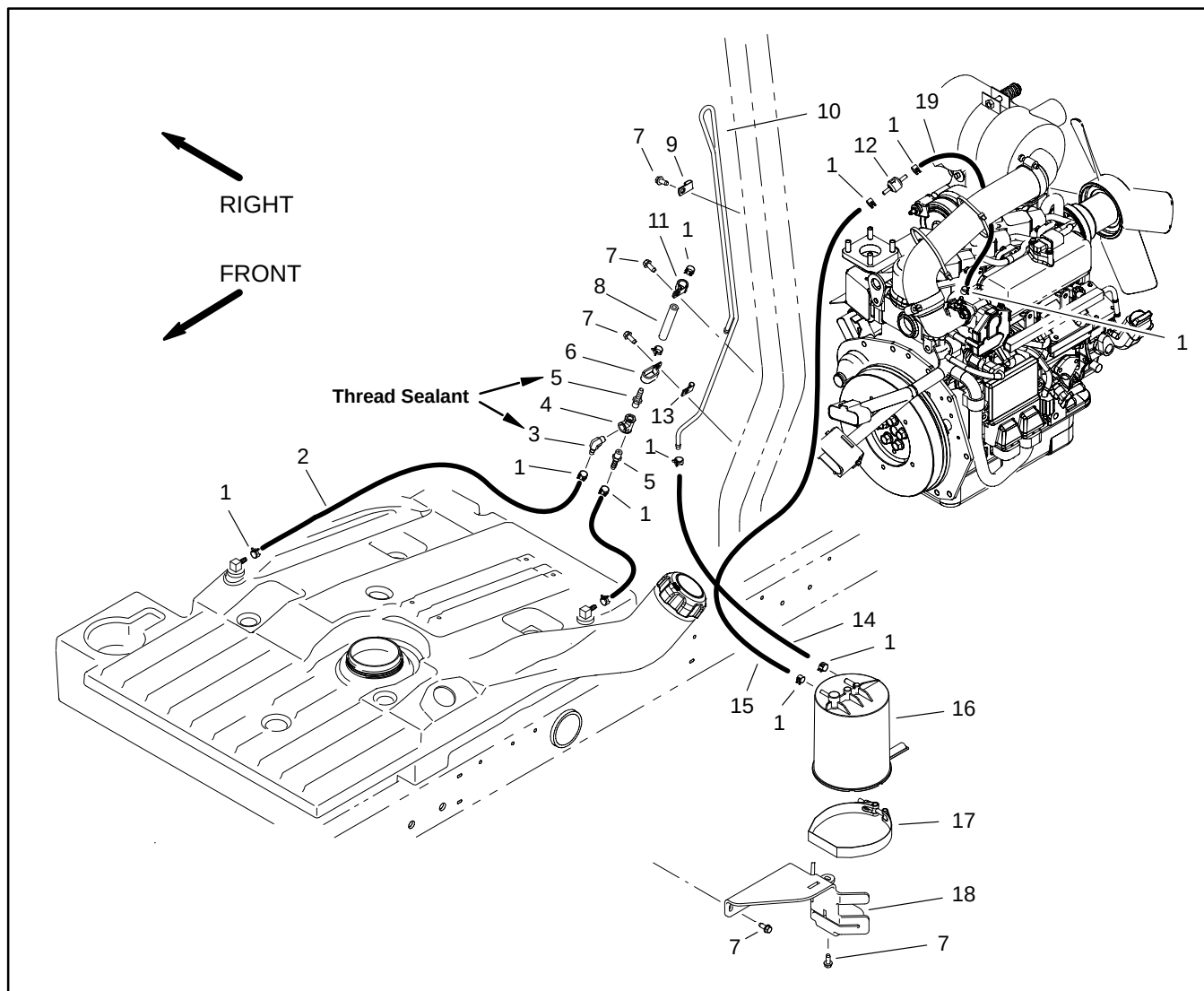


Figure 7

- 1. Hose clamp
- 2. Fuel hose
- 3. Elbow fitting
- 4. Tee fitting
- 5. Straight barb fitting
- 6. Anchor clamp
- 7. Cap screw

- 8. Fuel hose
- 9. Anchor clamp
- 10. Vent tube
- 11. Anchor clamp
- 12. Vacuum check valve
- 13. Anchor clamp

- 14. Fuel hose
- 15. Fuel hose
- 16. Carbon canister
- 17. Canister clamp
- 18. Canister support
- 19. Fuel hose

The function of the fuel evaporative control system is to collect and store evaporative emissions from the fuel tank and engine. A carbon canister that is mounted to the left side of the frame is used to collect these evaporative emissions. Fuel vapors from the engine and fuel tank are vented to the canister when the engine is not running. Vapors from the canister are consumed when the engine is running.

NOTE: If there is restriction in the canister breather, the carbon canister or the vacuum check valve, the fuel tank may distort due to venting issues. If the fuel tank returns to it's normal shape when the fuel cap is removed, restriction in the evaporative control system is likely.

Carbon Canister Removal

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



DANGER

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

3. Inspect carbon cannister and attached hoses for damage or obvious leaks. A damaged or leaking cannister should be replaced.
4. Note hose routing, cable tie and anchor clamp locations. Remove fuel evaporative control system components as needed (Fig. 7).

Carbon Canister Installation

1. Install all removed EVAP components. Make sure that fuel hoses are not kinked after installation. Secure all hoses with hose clamps, anchor clamps and cable ties as shown (Fig. 7 and 8). If hoses were removed from the carbon canister, check hose connections for correct system operation (Fig. 9).
2. After all evaporative control system components are installed, close and secure hood.

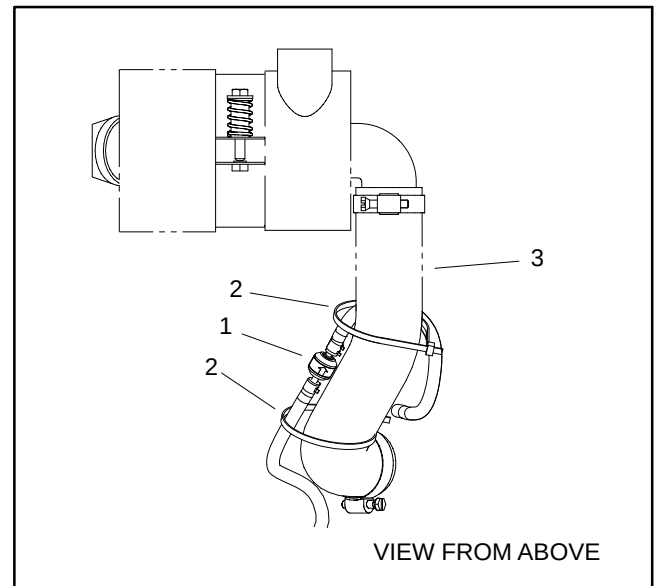


Figure 8

- | | |
|-----------------------|----------------------|
| 1. Vacuum check valve | 3. Lower intake hose |
| 2. Cable tie | |

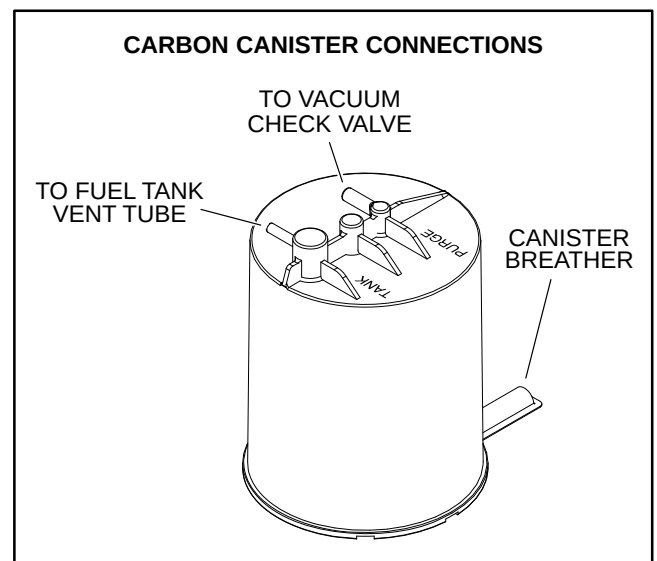


Figure 9

Radiator/Hydraulic Fluid Cooler

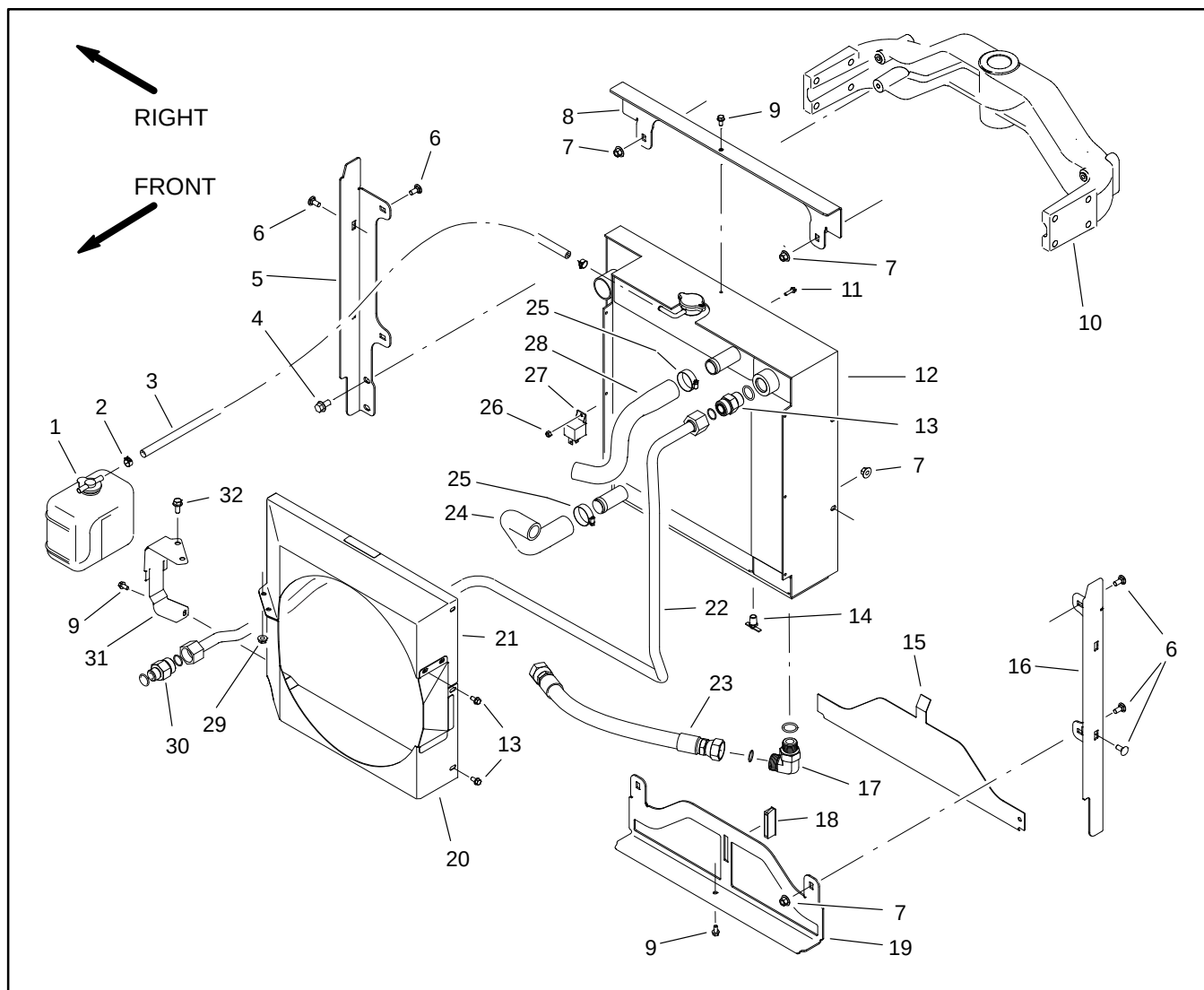


Figure 10

- | | | |
|---------------------------|-------------------------------|----------------------------|
| 1. Expansion tank | 12. Radiator | 23. Hydraulic hose |
| 2. Hose clamp | 13. Straight fitting | 24. Lower radiator hose |
| 3. Coolant hose | 14. Drain-cock | 25. Hose clamp |
| 4. Flange head screw | 15. Lower radiator shield | 26. Hex nut |
| 5. Radiator bracket - RH | 16. Radiator bracket - LH | 27. Relay |
| 6. Carriage bolt | 17. Elbow fitting | 28. Upper radiator hose |
| 7. Flange nut | 18. Magnet | 29. Flange nut |
| 8. Radiator bracket - top | 19. Radiator bracket - bottom | 30. Straight fitting |
| 9. Flange head screw | 20. Lower fan shroud | 31. Expansion tank support |
| 10. Frame casting | 21. Upper fan shroud | 32. Flange head screw |
| 11. Cap screw | 22. Hydraulic tube | |

Radiator Removal

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

**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 radiator/hydraulic fluid cooler to collect the coolant. The container should have a 2 gal. (8 Ltr.) minimum capacity. Open drain-cock valve, and completely drain the radiator.
4. Place a suitable container under the hydraulic filter to collect the hydraulic fluid. The container should have a 6 gal. (23 Ltr.) minimum capacity. Disconnect the hydraulic hose below the filter head or remove the hydraulic filter element and drain the hydraulic system (Fig. 11).
5. Disconnect following hoses from the radiator/hydraulic fluid cooler:
 - A. Upper radiator hose to the water pump.
 - B. Lower radiator hose to the coolant inlet tube at engine.
 - C. Coolant hose to the expansion tank.
 - D. Air hose to the air cleaner.
 - E. Hydraulic tube from top of hydraulic fluid cooler.
 - F. Hydraulic hose from bottom of hydraulic fluid cooler.
6. Remove expansion tank from bracket on fan shroud.
7. Remove both fan shrouds from radiator assembly.
8. Remove flange head screws securing the top and bottom of the radiator frame to the radiator. Remove four carriage bolts and lock nuts securing the radiator to the radiator frame.
9. Carefully remove radiator/hydraulic fluid cooler from the radiator frame.
10. Plug any openings in the radiator/hydraulic fluid cooler and hydraulic system to prevent contamination.

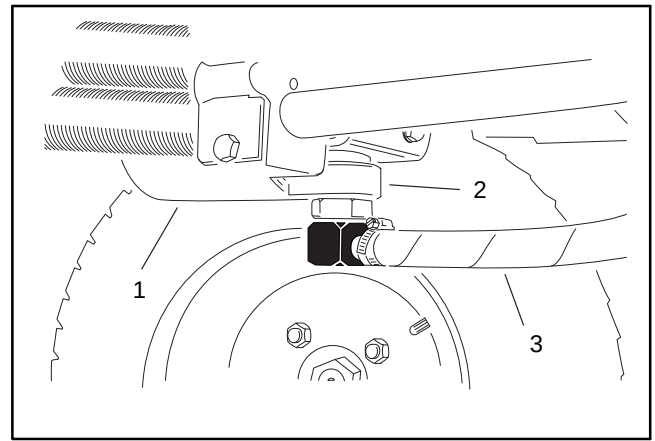


Figure 11

- | | |
|-----------------------------|-------------------|
| 1. Hydraulic filter element | 3. Hydraulic hose |
| 2. Hydraulic filter head | |

Radiator Installation

1. Remove any plugs from the radiator/hydraulic fluid cooler and hydraulic system used during the removal procedure.
2. Position radiator carefully to the radiator frame.
3. Secure radiator assembly to the radiator frame with four carriage bolts and lock nuts. Secure top and bottom of radiator to frame with flange head screws.
4. Secure both fan shrouds to the radiator assembly with flange head screws, and to each other with flange head screws and nuts.
5. Secure expansion tank to bracket on fan shroud.
6. Connect following hoses to the radiator:
 - A. Upper radiator hose to the water pump.
 - B. Lower radiator hose to the coolant inlet tube at engine.
 - C. Coolant hose to the expansion tank.
 - D. Air hose to the air cleaner.
 - E. Hydraulic tube from top of hydraulic fluid cooler.
 - F. Hydraulic hose from bottom of hydraulic fluid cooler.
7. Make sure drain-cock valve is closed. Fill radiator with coolant to the bottom of the filler neck.
8. Fill the hydraulic fluid tank.

9. Prime the hydraulic pumps (see Prime the Hydraulic Pumps in Chapter 5– Hydraulic System in this manual).

10. Start the unit and run engine to normal operating temperature. Use all of the hydraulic controls while the engine is running to distribute the hydraulic fluid throughout the system. Stop the engine and check the fluid levels. Adjust as necessary.

11. Install engine hood to the machine. Close and latch hood.

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Engine

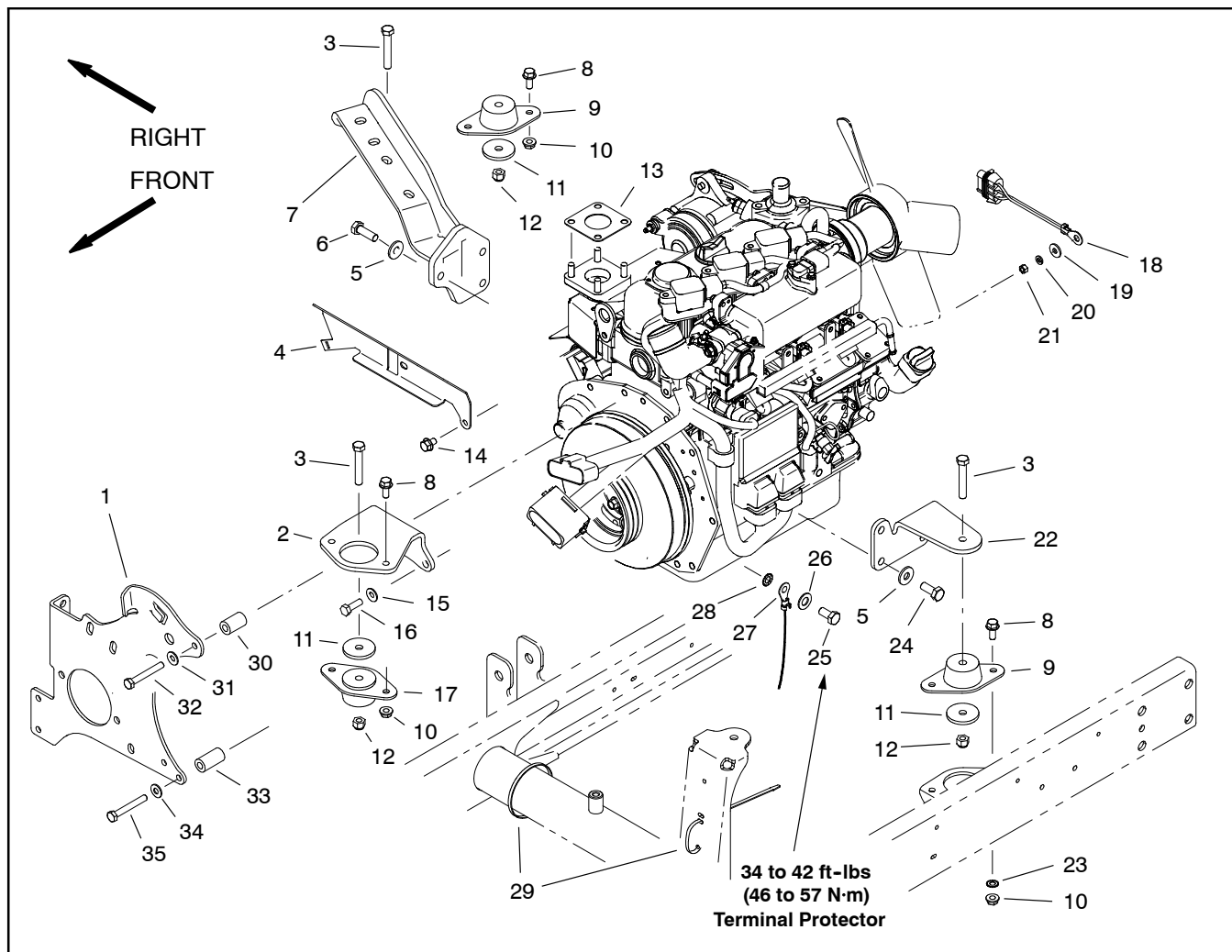


Figure 12

- | | | |
|--------------------------|------------------------|---------------------|
| 1. Pump mount plate | 13. Exhaust gasket | 25. Cap screw |
| 2. Mount bracket - front | 14. Flange head screw | 26. Flat washer |
| 3. Cap screw | 15. Hardened washer | 27. Engine ground |
| 4. Wire harness bracket | 16. Cap screw | 28. Lock washer |
| 5. Hardened washer | 17. Engine mount | 29. Cable tie |
| 6. Cap screw | 18. Fusible link | 30. Spacer |
| 7. Mount bracket - RH | 19. Flat washer | 31. Hardened washer |
| 8. Flange head screw | 20. Lock washer | 32. Cap screw |
| 9. Engine mount | 21. Hex nut | 33. Spacer |
| 10. Flange nut | 22. Mount bracket - LH | 34. Hardened washer |
| 11. Hardened washer | 23. Lock washer | 35. Cap screw |
| 12. Lock nut | 24. Cap screw | |

Engine Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Open and remove engine hood from the machine. Slide seat all the way forward.
3. Disconnect air hose from the air cleaner and radiator. Remove air cleaner from the engine.
4. Disconnect both battery cables at the battery.
5. Remove muffler assembly (see Muffler Removal in this chapter).
6. Place a suitable container under the radiator/hydraulic fluid cooler to collect the coolant. Open drain-cock valve, and completely drain the radiator.
7. Disconnect following hoses from the radiator/hydraulic fluid cooler:
 - A. Upper radiator hose to the water pump.
 - B. Lower radiator hose to the coolant inlet tube at engine.
 - C. Coolant hose to the expansion tank.
8. Remove expansion tank from bracket on fan shroud.
9. Remove both fan shrouds from radiator assembly.
10. Disconnect wire harness and electrical wires at the following locations:
 - A. Positive (+) cable from battery
 - B. Fusible link harness at starter
 - C. Connector at battery B+ terminal
 - D. Wire harness and frame grounds
 - E. O2 sensor
 - F. Two connections at alternator
 - G. Engine electronic control unit (ECU)

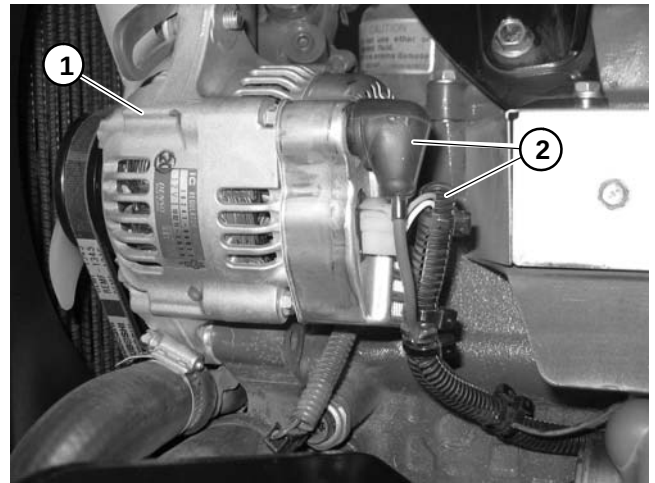


Figure 13

1. Alternator

2. Harness connections

11. Note the locations and remove any cable ties securing the wire harness to the engine. Connect hoist or lift to the front and rear lift tabs.

12. Disconnect fuel hoses at engine from fuel pump and from carbon canister.

13. Remove traction control cable from the neutral arm assembly on the piston pump. Remove all hydraulic hoses from the piston and gear pumps (see Piston Pump Removal in Chapter 5– Hydraulic System in this manual).



CAUTION

Make sure lift or hoist can support the total weight of the engine before removing the cap screws from the engine and engine brackets.

14. Remove hex nuts, cap screws, and washers from the center of the three engine mounts.



CAUTION

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

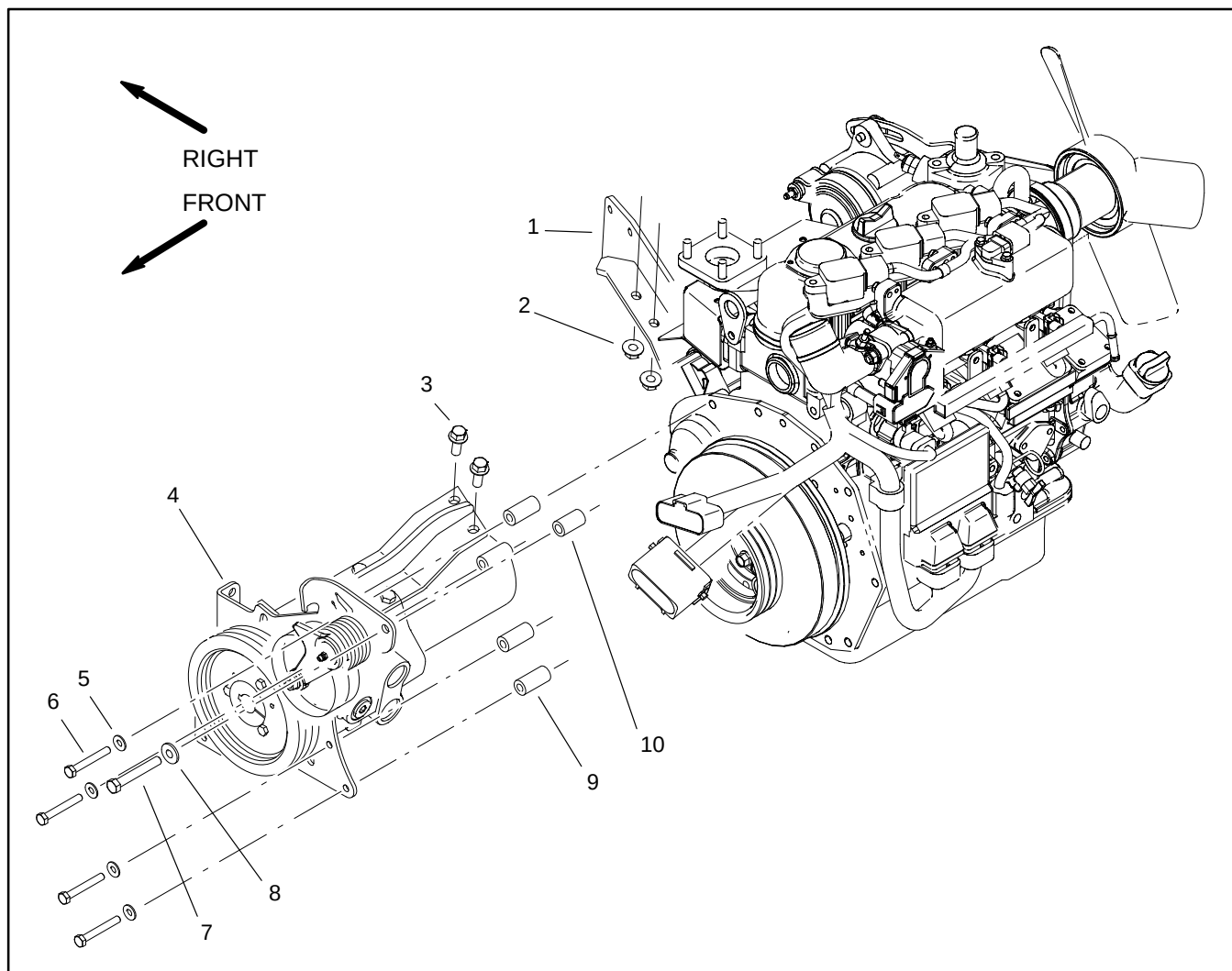


Figure 14

- 1. Engine mount bracket
- 2. Flange nut
- 3. Flange screw
- 4. Pump mount plate

- 5. Hardened washer
- 6. 10 mm cap screw (4)
- 7. 8 mm cap screw (1)

- 8. Hardened washer
- 9. Long spacer (4)
- 10. Short spacer (1)

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

15. Remove engine slowly from the machine.

16. Separate hydrostat and pump assembly from the engine as follows (Fig. 14):

- A. Remove traction belt from the engine flywheel and hydrostat pulleys.
- B. Remove five cap screws, washers, and spacers securing the pump mount plate to the engine.
- C. Remove two cap screws and flange nuts securing the pump support to the engine mount bracket and remove the hydrostat and pump assembly from the engine.

17. As necessary, remove engine mounts, front engine mounting bracket and left engine mounting bracket.

Engine Installation

1. If removed, install engine mounts, front engine mounting bracket and left engine mounting bracket.

2. Install hydrostat and pump assembly to the engine as follows (Fig. 14):

- A. Secure the pump support to the engine mount bracket with two flange nuts and cap screws.
- B. Secure pump mount plate to the engine with five spacers, washers, and cap screws.
- C. Install traction belt to the engine flywheel and hydrostat pulleys.

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



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

4. Position engine slowly into the machine.

5. Secure all three engine mounts to the engine mounting brackets with cap screws, washers, and hex nuts.

6. Install all hydraulic hoses to the piston and gear pumps. Install traction control cable to the neutral arm assembly on the piston pump (see Piston Pump Installa-

tion in Chapter 5- Hydraulic System in this manual).

7. Connect fuel hoses from the fuel pump and carbon canister to engine.

8. Connect wire harness and electrical wires at the following locations:

- A. Positive (+) cable from battery.
- B. Fusible link harness at starter.
- C. Connector at battery B+ terminal.
- D. Engine grounds to the battery and wire harness. Torque the engine ground bolt to **34 to 42 ft-lbs (46 to 57 N·m)** and apply a coat of aerosol terminal protector.
- E. Torque the frame grounds bolts to **175 to 225 in-lbs (19.7 to 25.4 N·m)** and apply a coat of aerosol terminal protector.

NOTE: Make sure that the engine and frame ground surfaces are free from corrosion, oil and paint.

- F. O2 sensor.
- G. Two connections at alternator.
- H. Engine electronic control unit (ECU).

9. Secure wire harness to the engine at locations previously noted with cable ties.

10. Secure both fan shrouds to the radiator assembly with flange head screws, and to each other with flange head screws and nuts.

11. Secure expansion tank to bracket on fan shroud.

12. Connect following hoses to the radiator:

- A. Upper radiator hose to the water pump.
- B. Lower radiator hose to the coolant inlet tube at engine.
- C. Coolant hose to the expansion tank.

13. Make sure drain-cock valve is closed. Fill radiator with coolant.

14. Install muffler assembly (see Muffler Installation in this chapter).

15. Connect both battery cables at the battery (see Battery Service in Chapter 6 - Electrical system in this manual).

16. Install air cleaner to the engine. Connect air hose to air cleaner and radiator.

17. Install engine hood to the machine. Close and latch hood.

- 18.Fill the hydraulic fluid reservoir.
- 19.Prime the hydraulic pumps (see Prime the Hydraulic Pumps in Chapter 5- Hydraulic System in this manual).
- 20.Start the unit and run engine to normal operating temperature. Use all of the hydraulic controls while the engine is running to distribute the hydraulic fluid throughout the system.
- 21.Stop the engine and check the hydraulic fluid and coolant levels. Adjust as necessary.
- 22.Adjust traction drive for neutral.



Hydraulic System

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Specifications

Item	Description
Piston Pump (Hydrostat) Charge Relief Pressure Traction Circuit Relief Pressure (Forward Only) Maximum Displacement	Variable displacement piston pump 100 to 150 PSI (6.9 to 10 Bar) 3500 PSI (241.3 Bar) 1.44 cu. in./rev (23.6 cc/rev)
Gear Pump Displacement Section 1 (P1) Displacement Section 2 (P2)	2 stage fixed displacement gear type pump 0.95 cu. in./rev (15.65 cc/rev) 0.33 cu. in./rev (5.34 cc/rev)
Wheel Motors (see note) Front Wheel Motor Displacement Rear Wheel Motor Displacement	Orbital geroller motor 12 cu. in./rev (195 cc/rev) 24.7 cu. in./rev (405 cc/rev)
Mow Circuit Relief Pressure	3200 PSI (221 Bar)
Cutting Unit Motor Cross-over Relief Pressure Displacement	Gear motor 1813 PSI (125 Bar) 1.16 cu. in./rev (19 cc/rev)
Steering Control Valve Maximum Displacement Implement (Steering and Lift) Relief Valve Pressure	Distributor valve with rotary meter 6.10 cu. in./rev (100.0 cc/rev) 1000 PSI (69 Bar)
Hydraulic Filter	10 Micron, spin-on cartridge type
Hydraulic Fluid	See Hydraulic System Fluid in this Chapter
Hydraulic Tank	6 Gal. U.S. (22.6 L)

NOTE: The three wheel motors are similar in construction with only minor differences. The right front wheel motor and rear wheel motor have a reverse timed manifold, and the front left wheel motor does not. The end cover of the rear motor has a check valve consisting of a ball and spring, and both front motors lack this feature.

General Information

Operator's Manual

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

Relieving Hydraulic System Pressure

Before disconnecting or performing any work on the Groundsmaster 3500 hydraulic system, all pressure in the hydraulic system must be relieved. Park machine on a level surface with the cutting units lowered and the PTO switch off. Turn key switch to OFF and allow engine to stop.

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

To relieve cutting unit system pressure, turn key switch to ON (engine not running). Move PTO switch to engage which will energize the solenoid valve on hydraulic manifold to relieve circuit pressure. Move PTO switch to disengage, return key switch to OFF and remove key from the ignition switch.

NOTE: Moving steering wheel with engine off may unseat implement relief valve. If steering or lift circuits appear weak or inoperative after machine is returned to service, repeat relieving hydraulic system pressure procedure.

Traction Circuit Component Failure

The Groundsmaster 3500 traction circuit is a closed loop system that includes the hydrostat and three (3) 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 contaminants are removed from the closed loop and thus, do not cause additional component damage.

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

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

Hydraulic Hoses

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

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

Kinked, crushed, flattened or twisted hose.

Blistered, soft, degraded or loose hose cover.

Cracked, damaged or badly corroded hose fittings.

When replacing a hydraulic hose, be sure that the hose is straight (not twisted) before tightening the fittings. This can be done by observing the imprint (layline) on the hose. Use two wrenches; hold the hose straight with one wrench and tighten the hose swivel nut onto the fitting with the other wrench (See Hydraulic Hose and Tube Installation in this section in this chapter). 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. Stop engine; lower or support cutting units and/or other attachment(s).

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 3. 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

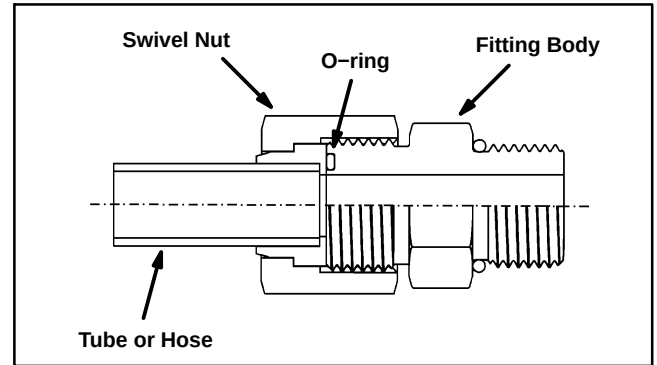


Figure 1

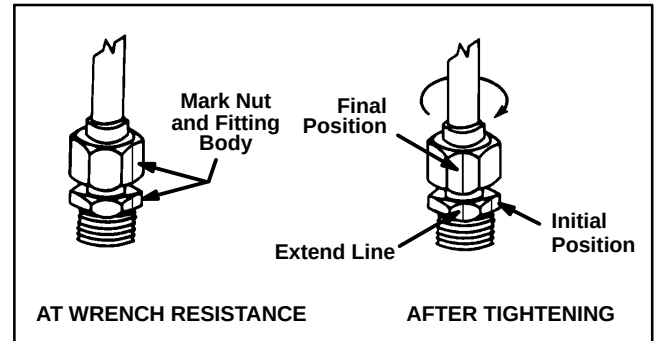


Figure 2

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 3

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

Non-Adjustable Fitting (Fig. 4)

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 5.

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

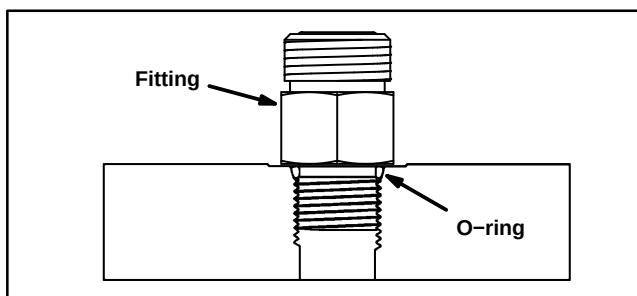


Figure 4

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 5

Adjustable Fitting (Fig. 6)

1. Make sure all threads and sealing surfaces of fitting and component port are free of burrs, nicks, scratches or any foreign material.
2. As a preventative measure against leakage, it is recommended that the O-ring be replaced any time the connection is opened.
3. Lightly lubricate the O-ring with clean hydraulic oil. Fitting threads should be clean with no lubricant applied.
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 7).

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

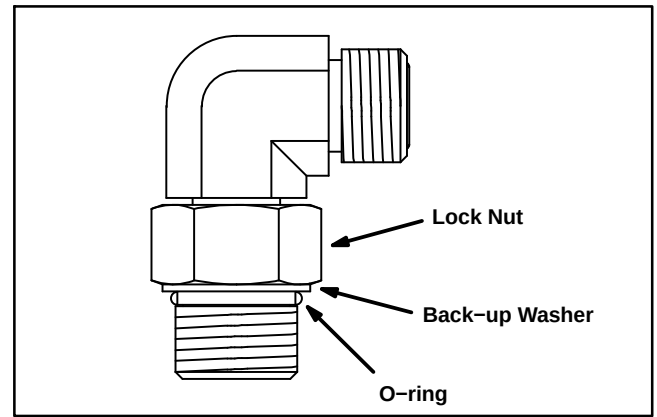


Figure 6

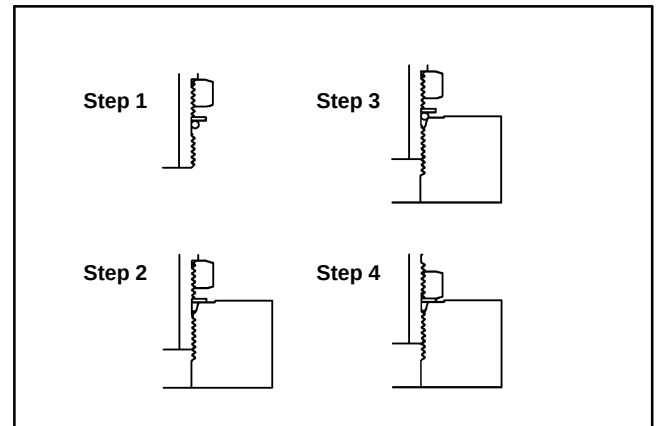


Figure 7

Special Tools

Hydraulic Pressure Test Kit

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

Toro Part Number: **TOR47009**



Figure 8

15 GPM Hydraulic Tester (Pressure and Flow)

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

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

Toro Part Number: **TOR214678**



Figure 9

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 fluid flow in the operating circuit with a gauge rated from 4 to 40 GPM (20 to 150 LPM).

Toro Part Number: **AT40002**

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



Figure 10

Hydraulic Hose Kit

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

Toro Part Number: **TOR6007**

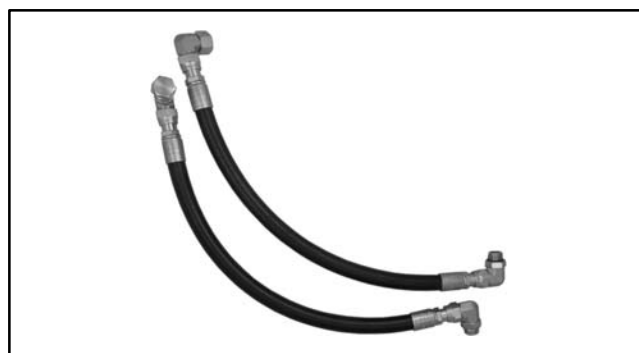


Figure 11

High Flow Hydraulic Filter Kit

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

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

Toro Part Number: **TOR6011**

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

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



Figure 12

O-Ring Kit

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

Toro Part Number: **117-2727**



Figure 13

Hydraulic Test Fitting Kit

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

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

Toro Part Number: **TOR4079**

Toro Test Fitting Kit TOR4079			Union	
Fitting	Tool Number		Size	Quantity
	Swivel Nut Base Tee		No. 4 to No. 8	1 Each
	Tee Tool Number		No. 10 to No. 8	1 Each
	Size		No. 12 to No. 8	1 Each
	Tee Tool Number		No. 14 to No. 8	1 Each
	Plug		Size	Quantity
	Tee Tool Number		No. 4	2 Each
	Size		No. 6	2 Each
	Tee Tool Number		No. 8	2 Each
	Cap		Size	Quantity
	Tee Tool Number		No. 4	2 Each
	Size		No. 6	2 Each
	Tee Tool Number		No. 8	2 Each
	Reducer		Size	Quantity
	Tee Tool Number		No. 10 to No. 8	1 Each
	Size		No. 12 to No. 8	1 Each
	Tee Tool Number		No. 14 to No. 8	1 Each
	Test Cap Fitting		Size	Quantity
	Tee Tool Number		No. 4	2 Each
	Size		No. 6	2 Each
	Tee Tool Number		No. 8	2 Each
	Test Fitting		Size	Quantity
	Tee Tool Number		7/16 - 20	1 Each
	Size		1/2 Pipe Thread	1 Each
	Tee Tool Number			

Figure 14

Measuring Container

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

The table in Figure 16 provides gallons per minute (GPM) conversion for measured milliliter or ounce motor case drain leakage.

Toro Part Number: **TOR4077**



Figure 15

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

Figure 16

Remote Starter Switch

After flushing the hydraulic system or replacing a hydraulic component (e.g. gear pump, piston pump, wheel motor), it is necessary to prime the hydraulic pumps. A remote starter switch (Fig. 17) can be used for this purpose. Obtain a remote starter switch locally.

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

A remote starter switch can also be constructed using Toro switch #106-2027, a length of 14 gauge wire, a 20 amp in-line fuse, two (2) alligator clips and necessary connectors. Connecting the wire to switch terminals 1 and 2 will allow the momentary switch contacts to be used for the remote starter switch (Fig. 18).

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



Figure 17

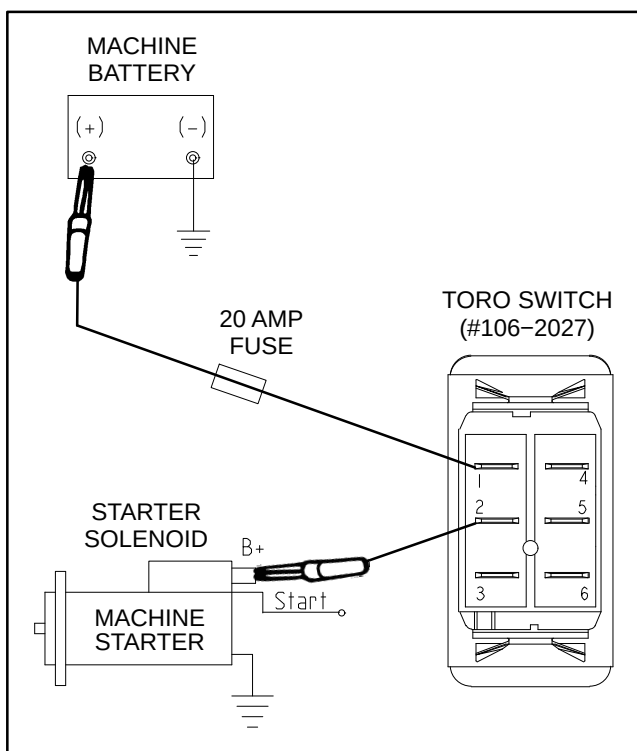


Figure 18

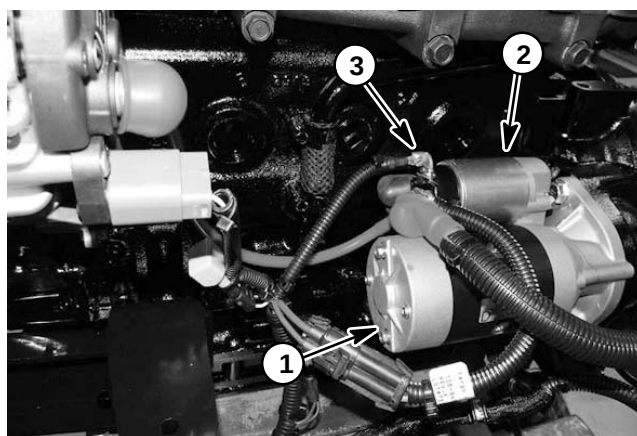


Figure 19

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

Wheel Hub Puller

Toro Part Number: **TOR4097**

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

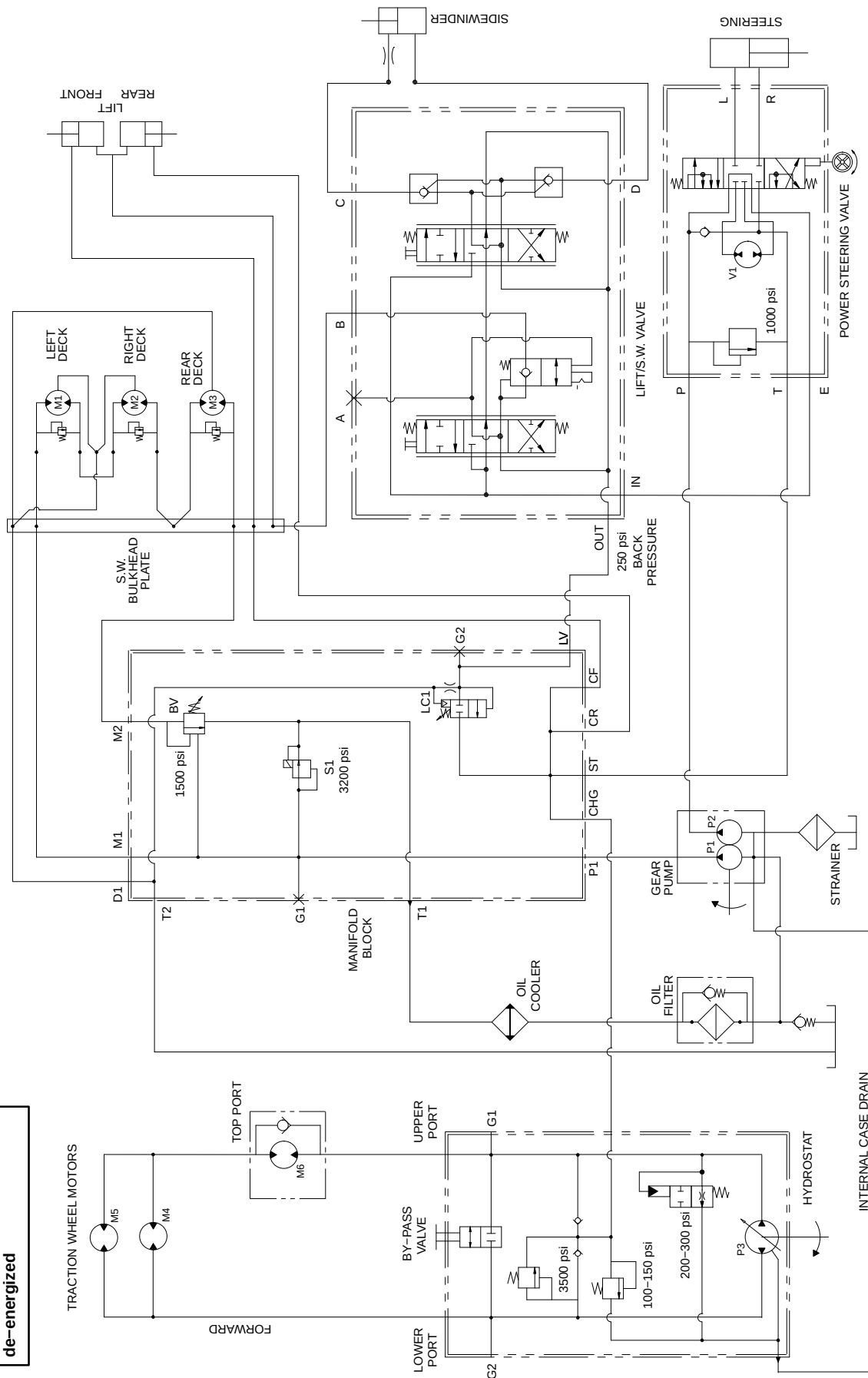


Figure 20

Hydraulic Schematics



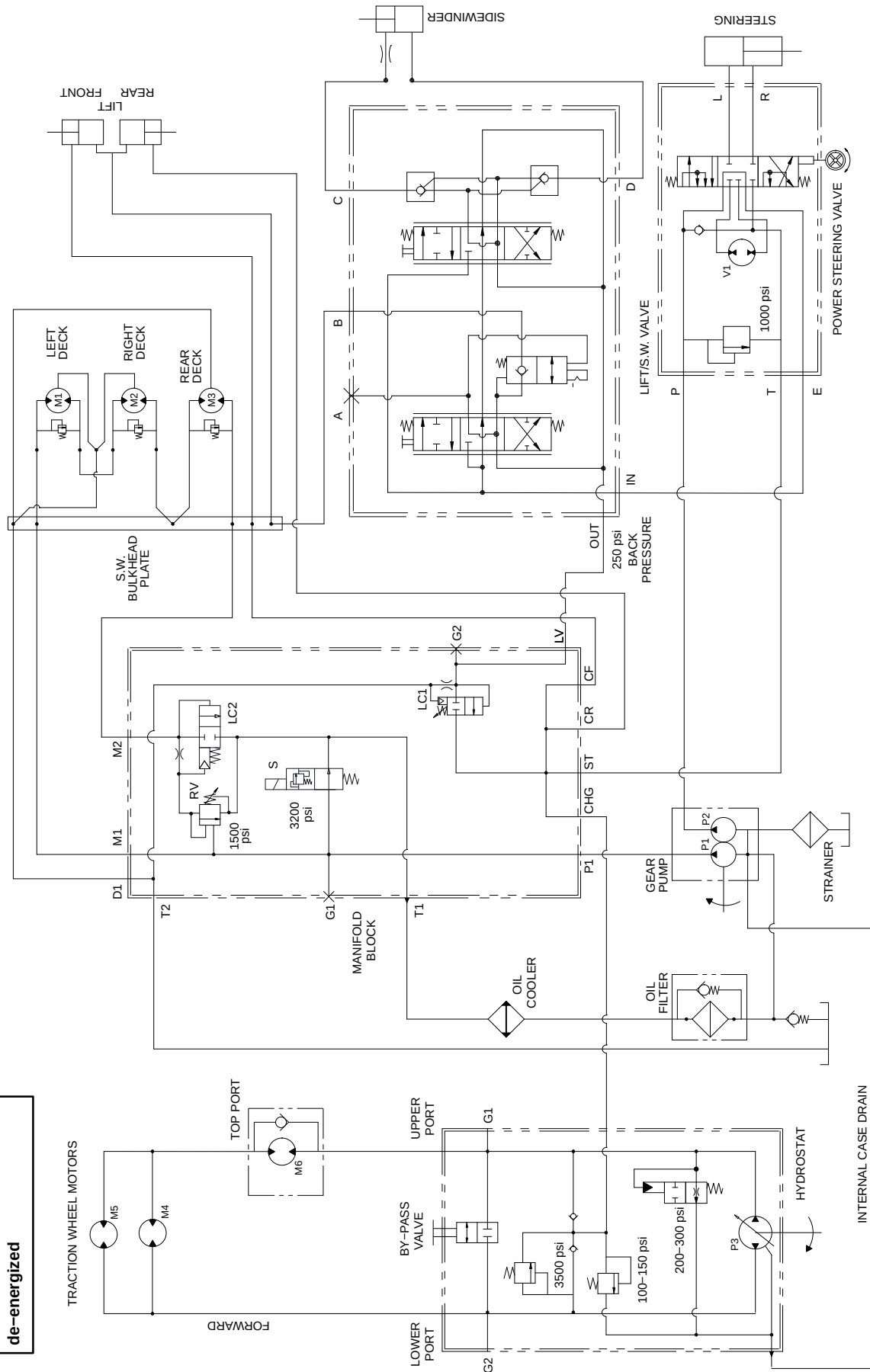
All solenoids are shown as de-energized



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

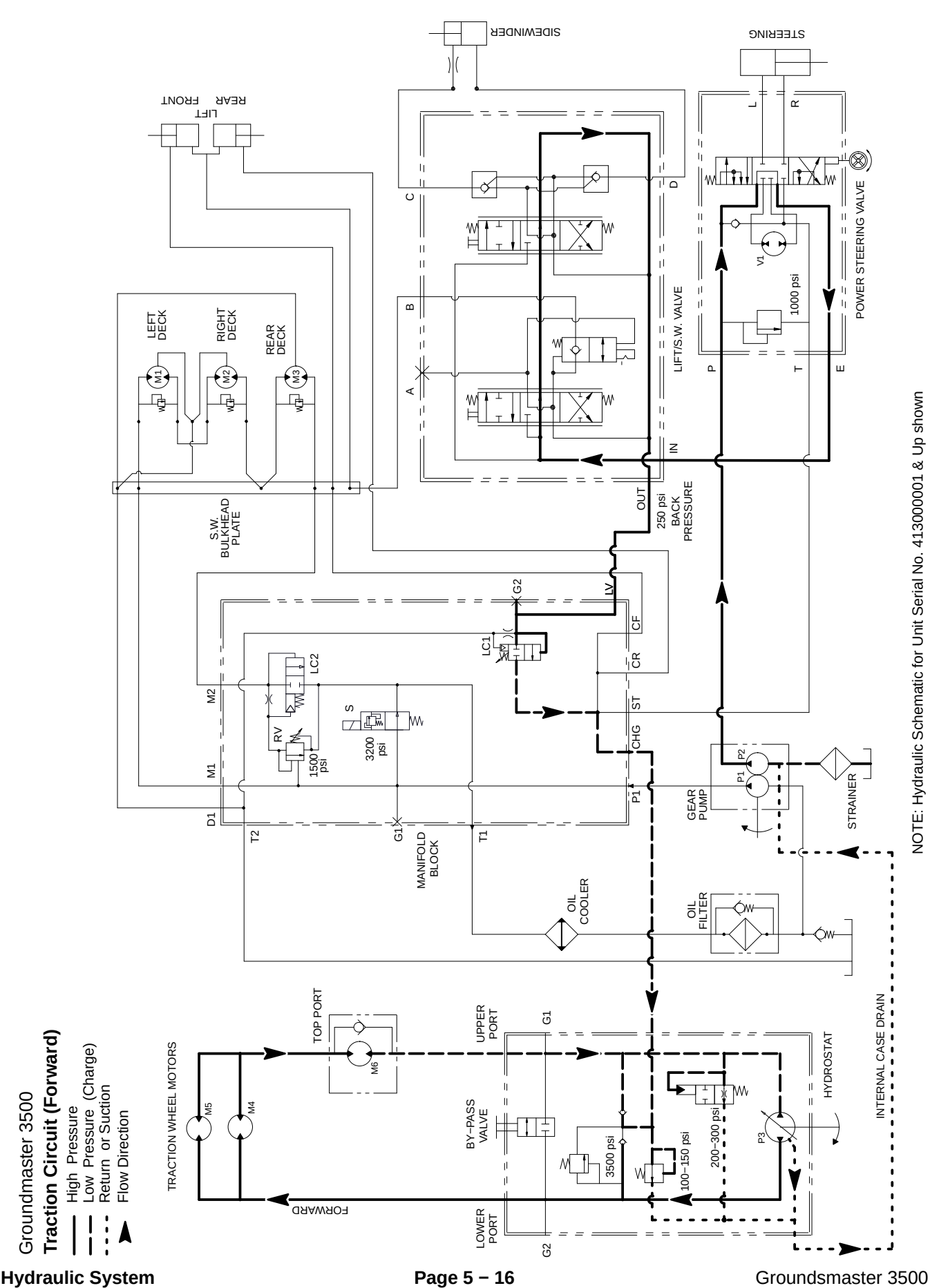
Groundsmaster 3500
Hydraulic Schematic (Unit Serial No. 314000001 & Up)

All solenoids are shown as de-energized



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

Hydraulic Flow Diagrams



Traction Circuit

The traction circuit of the hydraulic system consists of a hydrostat connected in a closed loop circuit to three orbital geroller wheel motors.

The mow/transport slide control on Groundsmaster 3500 machines has positions for mow and transport. The mow position allows traction pedal inputs that are appropriate for mow speeds by limiting the movement of the traction pedal and the piston pump swash plate. The transport position allows full movement of the traction pedal so complete pump swash rotation is possible.

Forward

The engine drives traction pump (P3) indirectly through pulleys and a V-belt. The traction pump is a variable displacement piston pump/hydrostat. The traction pedal connects through a cable to the trunnion shaft and swash plate of the pump. With the engine running and the traction pedal in the neutral position, traction pump (P3) supplies no flow to the wheel motors. When the traction pedal is pressed to the forward position, the cable from the pedal positions the swash plate in the traction pump so fluid flows out of the hydrostat lower port. Fluid flow out of the lower port goes to the front wheel motors first, turning them in the forward direction. Fluid flowing out of the front wheel motors flows to the rear wheel motor, turning it in a forward direction. Fluid flowing out of the rear wheel motor returns to the upper port of the hydrostat and is continuously pumped out of the lower port.

Operating pressure in the closed traction circuit is determined by the amount of load developed by the wheel motors. As the load increases, circuit pressure can increase to the relief valve setting of **3500 psi (241.3 bar)**. In forward operation, fluid flows through the internal hydrostat relief valve to the low pressure side of the traction circuit when circuit pressure exceeds the relief setting.

Reverse

The traction circuit operates essentially the same in reverse as it does in forward. However, there are a few differences in operation.

When the reverse traction pedal is depressed, the cable from the pedal positions the swash plate in the traction pump (P3) so fluid flows out of the hydrostat upper port. Fluid flow out of the upper port goes to the rear wheel motor where an internal check valve allows the hydraulic fluid to bypass the motor. Fluid flow out of the rear

wheel motor flows to the front wheel motors, turning them in the reverse direction. Fluid flow out of the front wheel motors returns to the lower port of the hydrostat and is continuously pumped out of the upper port.

NOTE: The rear wheel motor does not help propel the traction unit in reverse.

Charge Circuit

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

The gear pump (P2) is directly coupled to the hydrostat through gear pump (P1) and driven by the engine. Gear pump (P2) supplies hydraulic pressure for operating the power steering system, raising and lowering the cutting units, and operating the sidewinder unit. Gear pump (P2) may also be referred to as the charge pump as flow from the gear pump also replenishes the closed loop traction circuit. Hydraulic fluid exits the lift/sidewinder valve, passes through the hydraulic manifold where it actuates logic cartridge (LC1), and continues on to the hydrostat. A relief valve located in the hydrostat provides sufficient resistance so that flow is guided to the low pressure side of the traction circuit through one of two check valves (charge circuit). Pump flow in excess of charge circuit requirements is relieved through the relief valve back to the gear pump inlet and hydraulic tank.

Traction Circuit Cooling

The traction circuit is cooled by a bleed off circuit in the piston pump. The piston pump includes an internal bleed valve which allows a small amount of hydraulic oil to pass from the return side of the pump while operating the traction unit in the forward direction. The charge circuit replenishes oil that is bled from the traction circuit by the bleed valve.

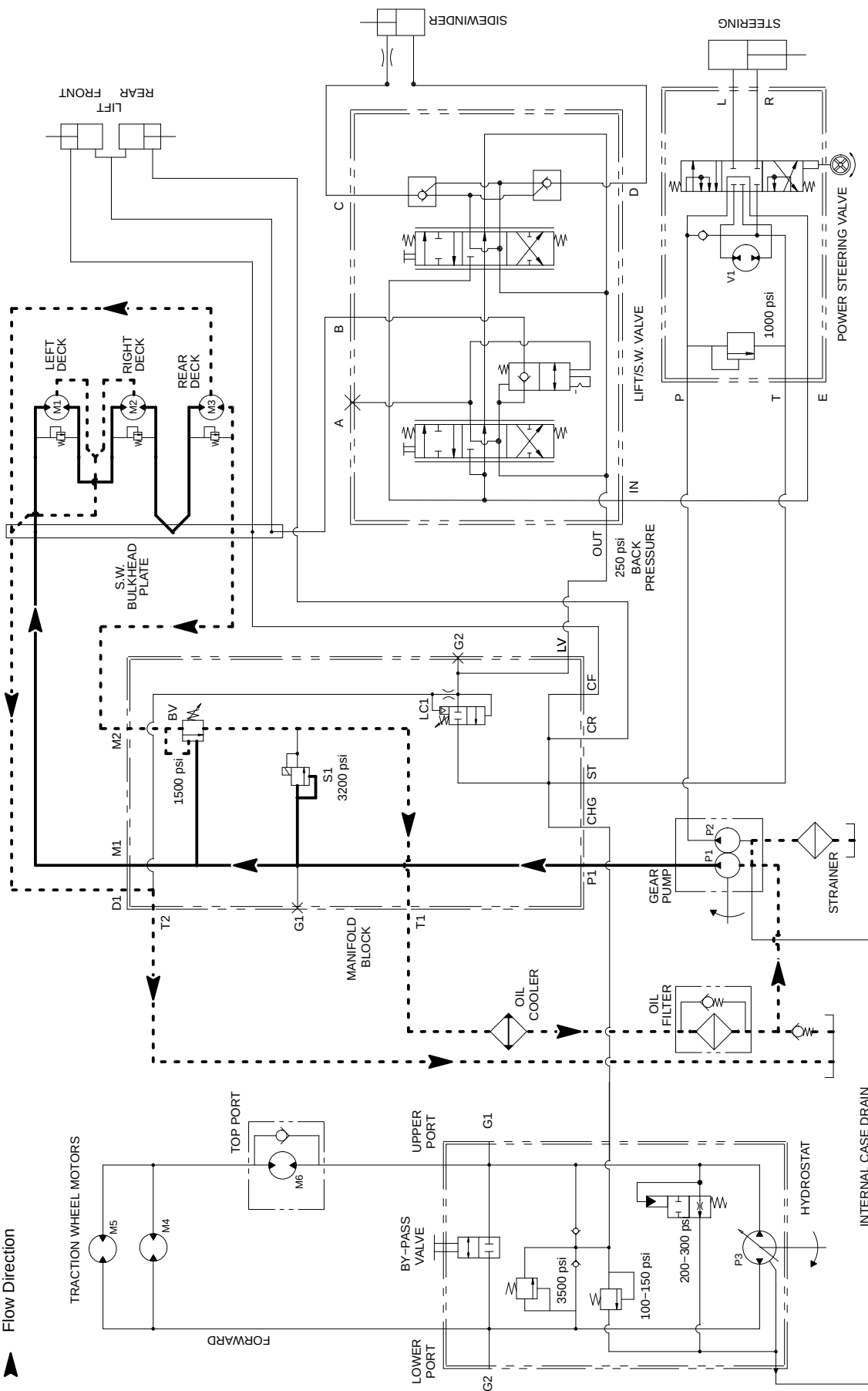
When operating the traction circuit in the reverse direction, the bleed valve closes once reverse pressure reaches **200 to 300 PSI (13.8 to 20.6)** to allow normal reverse operation.

NOTE: The bleed valve threads into the piston pump back plate. Access to the bleed valve requires removal of the back plate from the piston pump.

Groundmaster 3500

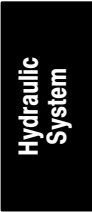
Cutting Unit Circuit (Units Prior to Serial No. 314000001)

— High Pressure
 - - Low Pressure (Charge)
 - - - Return or Suction
 ▲ Flow Direction



Groundmaster 3500

— High Pressure
 - - - Low Pressure (Charge)
 - - - Return or Suction
 ▲ Flow Direction



Cutting Unit Circuit

Mow

The gear pump (P1) is directly coupled to the the hydros-tat which is driven by the engine. Taking its suction di-rectly from the hydraulic tank, the gear pump (P1) supplies fluid flow to the manifold block and to the cutting unit motors.

Solenoid valve (S or S1) is de-energized with the engine running when either the PTO switch is in DISENGAGE, or the transport/mow slide is in TRANSPORT. When solenoid valve (S or S1) is de-energized, flow by-passes the cutting deck motors through the solenoid valve (S or S1) and moves on to the fluid cooler, filter, and gear pump inlet.

Solenoid valve (S or S1) is energized with the engine running when the PTO switch is in ENGAGE, and the transport/mow slide is in MOW. When energized, sole-noid valve (S or S1) allows flow out manifold block port M1 to the cutting unit motors.

Fluid flows through the left, right, and then rear cutting unit motors before returning to the manifold block port (M2). When solenoid valve (S or S1) is energized, fluid pressure shifts return circuit components in the hydraul-ic manifold as follows:

Units Prior to Serial No 314000001: When solenoid valve (S1) is energized, fluid pressure shifts blade relief valve (BV) which allows flow returning from the deck motors to pass through the manifold. Returning fluid continues on to the fluid cooler, filter, and gear pump inlet.

Unit Serial No. 314000001 & Up: When solenoid valve (S) is energized, fluid pressure shifts relief valve (RV) which allows a small amount of hydraulic flow returning from the deck motors past the relief valve. This returning flow is restricted by the orifice in the logic cartridge (LC2) creating a pressure im-balance that shifts the logic cartridge to allow oil flow from the deck motors to pass through the manifold. Returning fluid continues on to the fluid cooler, filter, and gear pump inlet.

If cutting unit circuit pressure exceeds relief pressure of 3200 PSI (221 bar) during deck motor operation, sole-noid valve (S or S1) shifts to allow circuit pressure relief.

Cutting Unit Blade Braking (Units Prior to Serial No. 314000001)

When the solenoid valve (S1) is de-energized, the blade relief cartridge (BV) shifts to its closed position, blocking return flow from the deck motors and slowing the cutting blades. The inertia of the rotating cutting blades, however, effectively turns the deck motors into pumps causing an increase in pressure as the flow from the motors comes up against the closed blade relief car-tridge (BV). When this pressure builds to **1500 PSI (103 bar)**, blade relief cartridge (BV) opens which allows hy-draulic flow to return to tank and reduces return pres-sure. When return pressure drops below **1500 PSI (103 bar)**, blade relief cartridge (BV) reseats to further slow the cutting blades. This action repeats several times in a very short period as the blades finally come to a stop. Once the blades have stopped, blade relief cartridge (BV) remains closed to keep the deck motors from rota-ting.

Cutting Unit Blade Braking (Unit Serial No. 314000001 & Up)

When the solenoid valve (S) is de-energized, the flow to the cutting deck motors and the relief valve (RV) is removed allowing relief valve (RV) to shift. The shifted relief valve removes flow from the orifice at the logic cartridge (LC2), causing a balanced pressure condition which shifts the logic cartridge, blocking the return oil path from the deck motors (Fig. 21).

The inertia of the rotating cutting blades, however, effectively turns the deck motors into pumps immediately causing an increase in return pressure against the closed relief valve (RV) and logic cartridge (LC2). When this pressure builds to approximately **1500 PSI (104 bar)**, the relief valve (RV) opens which allows a small amount of hydraulic flow past the relief valve (Fig. 22). This returning flow is restricted by the orifice in the logic cartridge (LC2) creating a pressure imbalance that shifts the logic cartridge to allow oil flow from the deck motors to pass through the manifold (Fig. 23). When return pressure drops below **1500 PSI (104 bar)**, the relief valve reseats blocking flow through the orifice in the logic cartridge. The loss of flow causes the logic cartridge to close again, stopping the cutting blades. Once the blades have stopped, the logic cartridge remains in the closed position to keep the deck motors from rotating.

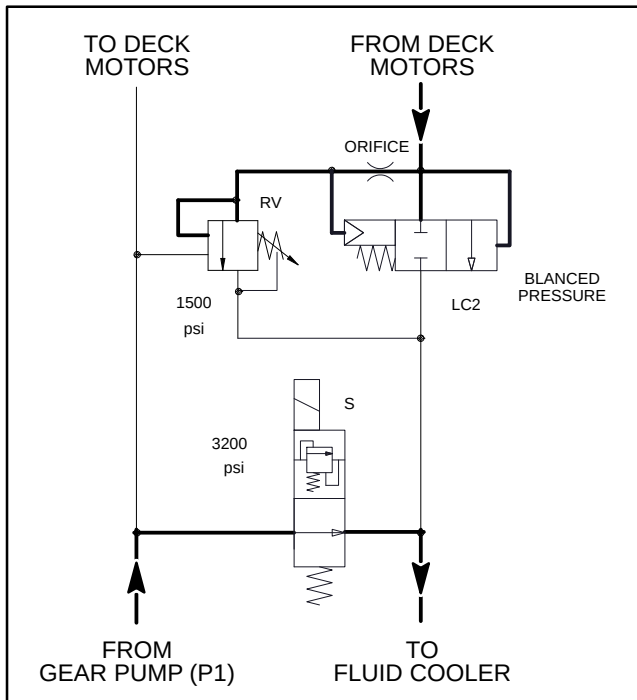


Figure 21

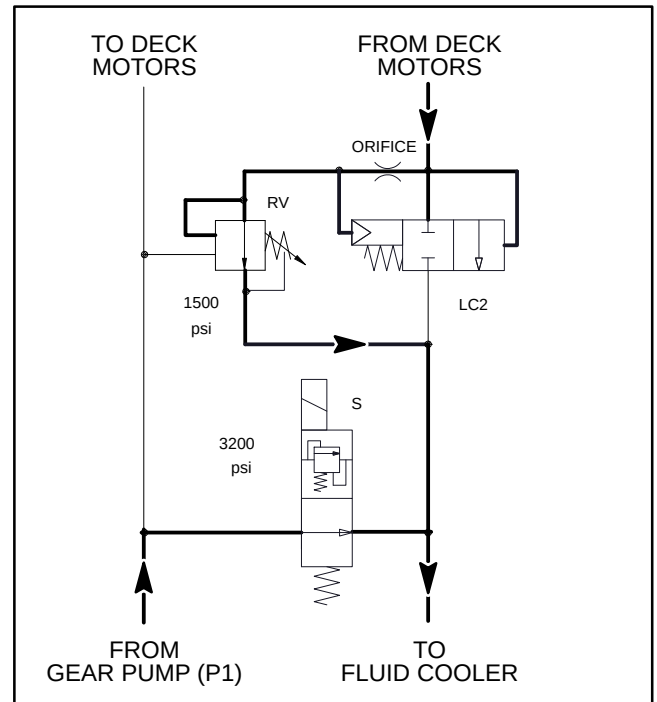


Figure 22

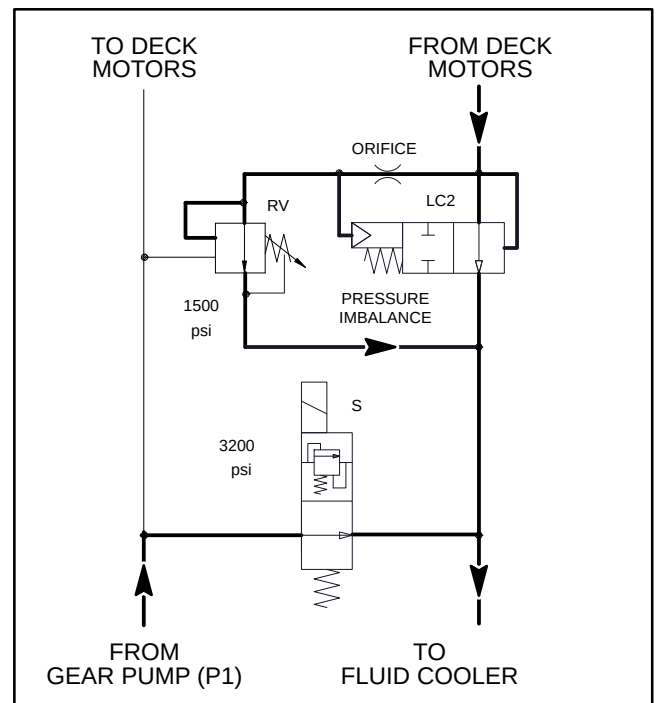
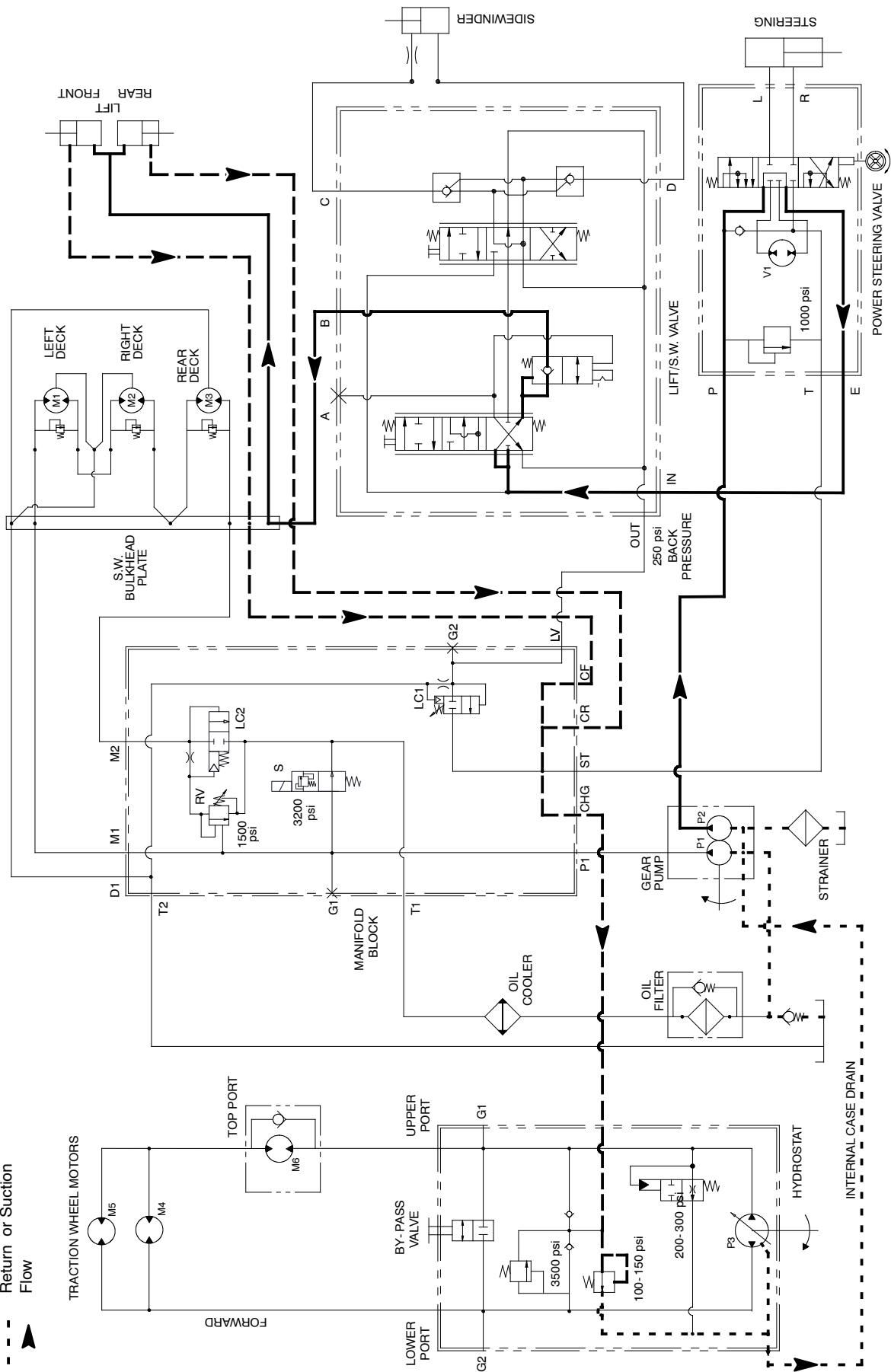


Figure 23

Groundmaster 3500

Lift Circuit (Up)

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



NOTE: Hydraulic Schematic for Unit Serial No. 314000001 & Up Shown

Lift Circuit (Up)

Raise Cutting Units

The gear pump (P2) is directly coupled to the hydrostat through gear pump (P1) and driven by the engine. It supplies hydraulic pressure for operating the power steering system, raising and lowering the cutting units, operating the sidewinder unit, and replenishing the closed loop traction circuit (charge pressure). The pump takes its suction directly from the hydraulic tank.

During conditions of not lifting or lowering cutting units, flow from the gear pump (P2) is by-passed through the power steering valve, 2- spool lift/sidewinder valve, and hydraulic manifold directly to the hydrostat and the charge relief valve. Flow then returns to the gear pump inlet and hydraulic tank.

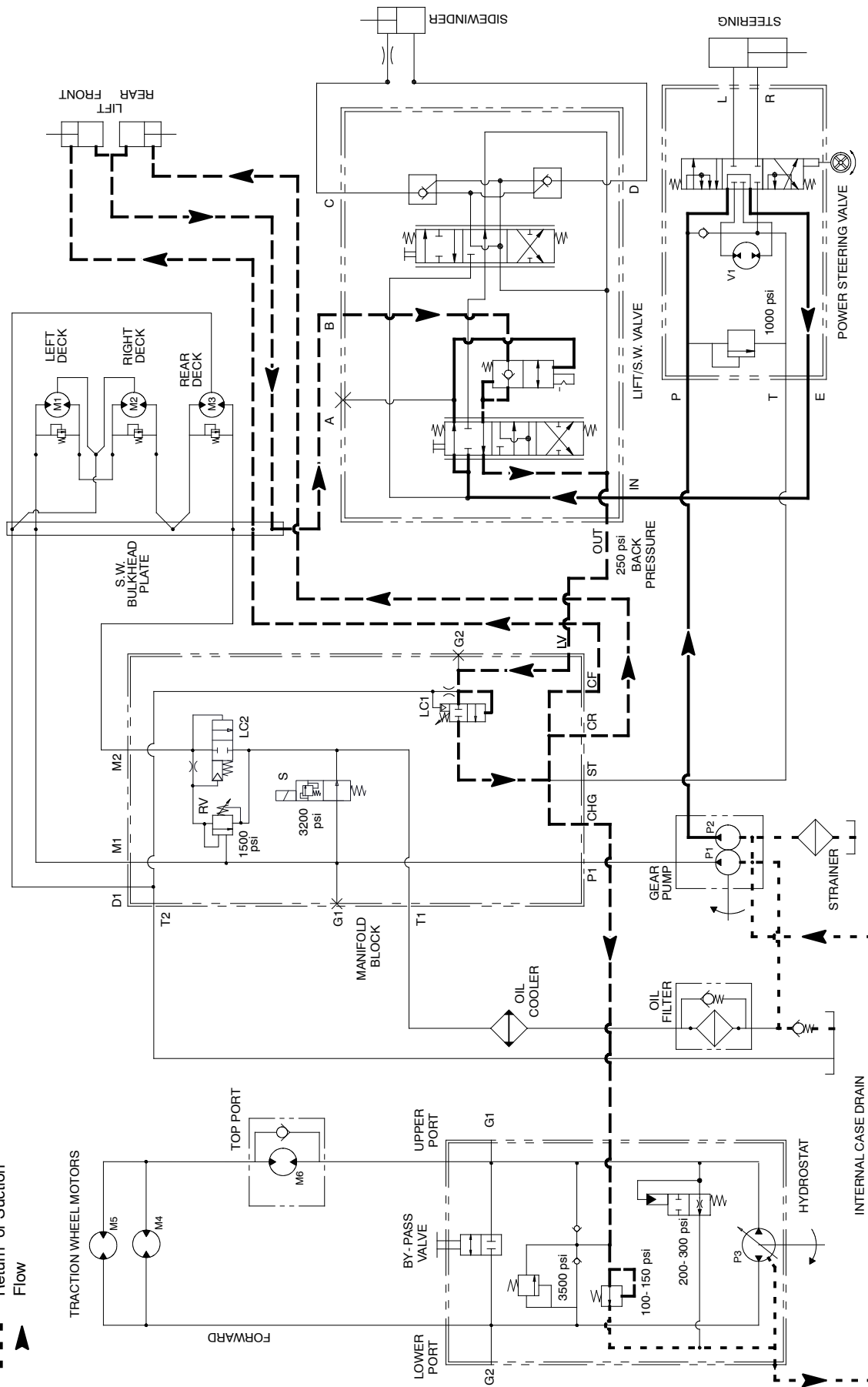
When the cutting units are to be raised, the 2- spool valve is positioned by moving the cutting unit shift lever to RAISE. Flow is directed to cap ends of the lift cylinders. Hydraulic pressure against the cylinder pistons moves their shafts causing the cutting units to raise. At the same time, the pistons push the hydraulic fluid out of the lift cylinders and back through the hydraulic manifold to the hydrostat.

When the cutting unit shift lever is released, spring action returns the valve to its original position and by-passes flow back to the hydrostat stopping lift cylinder movement. The cylinder position is locked in place by the load holding checks in the lift control valve.

Groundmaster 3500

Lift Circuit (Down) & Counterbalance

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



NOTE: Hydraulic Schematic for Unit Serial No. 314000001 & Up Shown

Lift Circuit (Down) & Counterbalance

Lower Cutting Units

The gear pump (P2) is directly coupled to the hydrostat through gear pump (P1) and driven by the engine. It supplies hydraulic pressure for operating the power steering system, raising and lowering the cutting units, operating the sidewinder unit, and replenishing the closed loop traction circuit (charge pressure). The pump takes its suction directly from the hydraulic tank.

During conditions of not lifting or not lowering cutting units, flow from the gear pump (P2) is by-passed through the power steering valve, 2- spool lift/sidewinder valve, and hydraulic manifold directly to the hydrostat and the charge relief valve. Flow then returns to the gear pump inlet and hydraulic tank.

Circuit operation for lowering the cutting units is similar to raising them. However, pressure is relieved from the lift cylinders, and this action allows them to lower.

When the cutting units are to be lowered, the 2- spool valve is positioned by moving the cutting unit shift lever

to LOWER. Pressure from gear pump (P2) is used to shift the pilot valve in the 2- spool valve. This shifting of the pilot valve allows hydraulic pressure to relieve from the cap end of the lift cylinders. Flow from the cap end of the lift cylinders causes the cutting units to lower. At the same time, the fluid relieved from the cap end of the lift cylinders goes into the rod end of the cylinders and back through the hydraulic manifold to the hydrostat.

When the cutting unit shift lever is released, spring action returns and detents the valve into the float position while by-passing flow back to the hydrostat. The pilot valve remains shifted to allow the lift cylinders to float until the lift control valve is moved to the raise position.

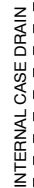
Counterbalance

The logic cartridge valve (LC1) in the manifold block maintains **250 PSI (17.2 bar)** back pressure on the lift cylinders. This back pressure (counterbalance) transfers cutting unit weight to the machine to improve traction and minimize turf marking by the cutting decks.

Groundmaster 3500

Sidewinder Circuit (Move Right - Extend)

 High Pressure
 Low Pressure (Charge)
 Return or Suction
 Flow



NOTE: Hydraulic Schematic for Unit Serial No. 314000001 & Up Shown

Sidewinder Circuit

The gear pump (P2) is directly coupled to the hydrostat through gear pump (P1) and driven by the engine. It supplies hydraulic pressure for operating the power steering system, raising and lowering the cutting units, operating the sidewinder unit, and replenishing the closed loop traction circuit (charge pressure). The pump takes its suction directly from the hydraulic tank.

During conditions of not lifting or not lowering cutting units, flow from the gear pump (P2) is by-passed through the power steering valve, 2- spool lift/sidewinder valve, and hydraulic manifold directly to the hydrostat and the charge relief valve. Flow then returns to the gear pump inlet and hydraulic tank.

Move Right (Extend)

When the sidewinder is to be shifted right, the 2- spool valve is positioned by moving the cutting unit shift lever to RIGHT. Flow is directed to the cap end of the sidewinder cylinder. Hydraulic pressure against the cylinder piston moves the rod causing the sidewinder cylinder to extend (move right). At the same time, the piston pushes the hydraulic fluid out of the cylinder, back through the

spool valve and hydraulic manifold, and to the hydrostat. When the cutting unit shift lever is released, spring action returns the valve to its original position and by-passes flow back to the hydrostat and stopping cylinder movement. The cylinder position is locked in place since there is no complete circuit of flow to or from the sidewinder cylinder when the lever is released.

Move Left (Retract)

When the sidewinder is to be shifted left, the 2- spool valve is positioned by moving the cutting unit shift lever to LEFT. Flow is directed to the rod end of the sidewinder cylinder. Hydraulic pressure against the cylinder piston moves the rod causing the cylinder to retract (move left). At the same time, the piston pushes the hydraulic fluid out of the cylinder, back through the spool valve, hydraulic manifold, and to the hydrostat. When the cutting unit shift lever is released, spring action returns the valve to its original position and by-passes flow back to the hydrostat stopping cylinder movement. The cylinder position is locked in place since there is no complete circuit of flow to or from the sidewinder cylinder when the lever is released.

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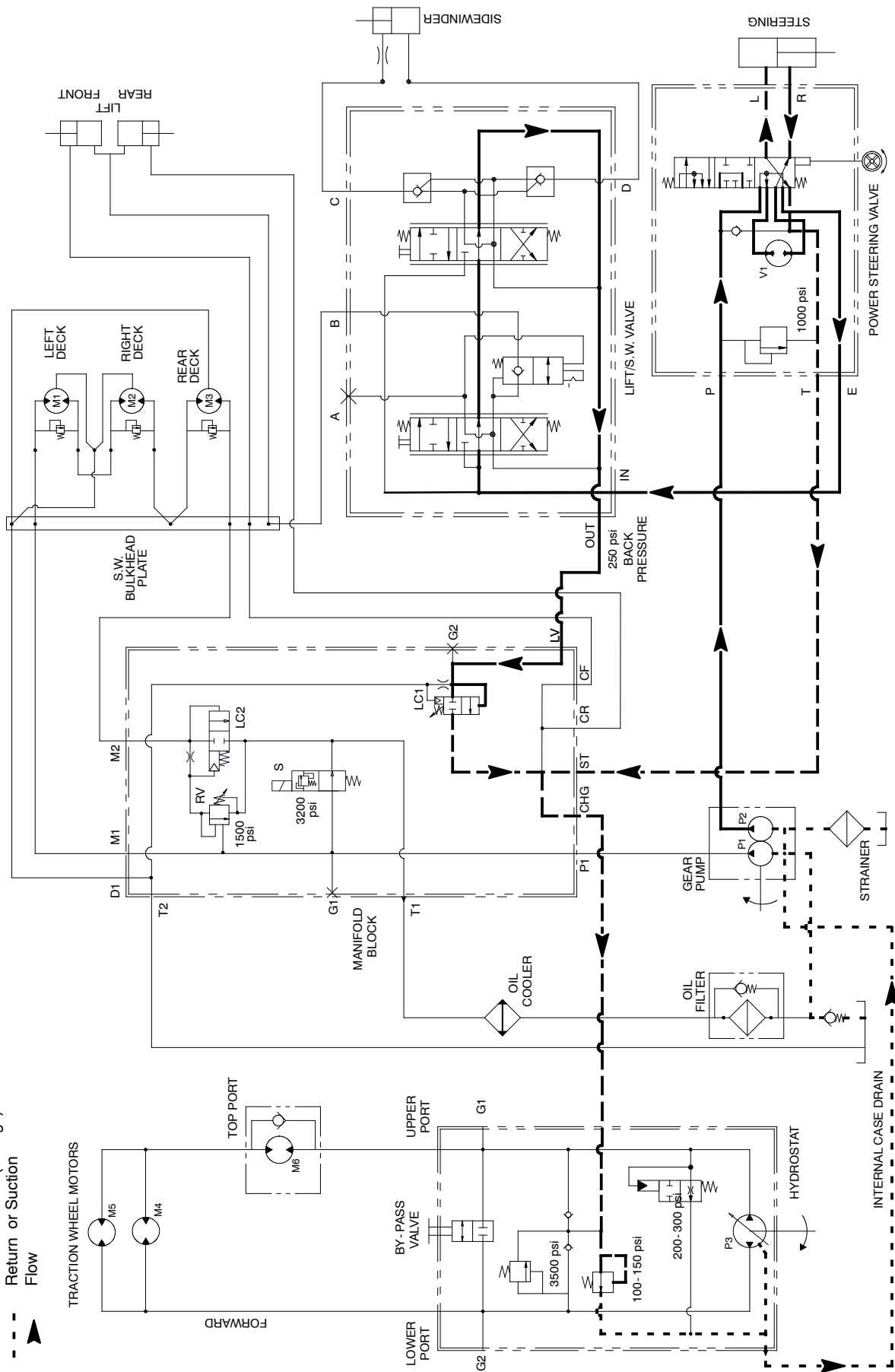
Steering Circuit (Right Turn)

High Pressure

Low Pressure (Charge)

Return or Suction

Flow



NOTE: Hydraulic Schematic for Unit Serial No. 314000001 & Up Shown

Steering Circuit

The gear pump (P2) is directly coupled to the hydrostat through gear pump (P1) and driven by the engine. It supplies hydraulic pressure for operating the power steering system, raising and lowering the cutting units, operating the sidewinder unit, and maintaining **100 to 150 PSI (6.9 to 10.0 bar)** to the low pressure side of the closed loop traction circuit (charge pressure). The pump takes its suction directly from the hydraulic tank.

With the steering wheel in the neutral position, the engine running, and the lift/sidewinder spool valve in the center position, flow enters the steering control valve at the P port and goes through the valve, by-passing the rotary meter (V1) and steering cylinder. Flow leaves the steering control valve through the E port, passes through the lift/sidewinder valve, hydraulic manifold, hydrostat and charge relief valve, and continues on to the gear pump inlet and hydraulic tank.

Right Turn

When a right turn is made with the engine running, the turning of the steering wheel positions the steering control spool valve so that flow goes through the bottom of the spool. Flow entering the steering control valve at the P port goes through the spool and is routed to two places. First, most of the flow through the steering control valve is by-passed out the E port back through the lift/sidewinder valve, hydraulic manifold, hydrostat and charge relief valve, and continues on to the gear pump inlet and hydraulic tank. Second, the remainder of the flow is drawn through the rotary meter (V1) and out port (R). Pressure retracts the piston for a right turn. The rotary meter (V1) ensures that the fluid flow to the cylinder is proportional to the amount of steering wheel rota-

tion. Fluid leaving the cylinder flows back through the steering control spool valve and through the T port. Return flow passes through the hydraulic manifold, hydrostat and charge relief valve, and continues on to the gear pump inlet and hydraulic tank.

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

Left Turn

When a left turn is made with the engine running, the turning of the steering wheel positions the steering control spool valve so that flow goes through the top of the spool. Flow entering the steering control valve at the P port goes through the spool and is routed to two places. Most of the flow through the steering control valve is by-passed out the E port back through the lift/sidewinder valve, hydraulic manifold, hydrostat and charge relief valve, and continues on to the gear pump inlet and hydraulic tank (as in a right turn). The remainder of the flow is drawn through rotary meter (V1) but during a left turn the flow goes out port (L). Pressure extends the piston for a left turn. The rotary meter (V1) ensures that the fluid flow to the cylinder is proportional to the amount of steering wheel rotation. Fluid leaving the cylinder flows back through the spool valve then through the T port. Return flow passes through the hydraulic manifold, hydrostat and charge relief valve, and continues on to the gear pump inlet and hydraulic tank.

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

Troubleshooting

The chart that follows contains information to assist in troubleshooting. There may possibly be more than one cause for a machine malfunction.

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

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

General Hydraulic System Problems

Problem	Possible Cause
Hydraulic oil leaks from system.	Hydraulic fitting(s), hose(s) or tube(s) are loose or damaged. O-ring(s) or seal(s) are missing or damaged.
Hydraulic fluid foams.	Oil level in hydraulic tank is low. Hydraulic system has wrong type of hydraulic oil. The pump suction line has an air leak. Incompatible hydraulic oils are mixed in the hydraulic system. Water contamination is in the hydraulic system.
Hydraulic system operates hot (above 200F (93C)).	Traction pressure is high due to excessive load or brake applied. Oil level in hydraulic tank is low, or inlet filter is loose or clogged (NOTE: Other hydraulic systems are affected as well). Hydraulic oil is contaminated or oil viscosity is too light. Oil cooler is damaged or plugged. Bypass valve in traction pump/hydrostat is open or defective. Charge pressure is low. Wheel motor(s) or cutting unit motor(s) are worn or damaged. Traction pump/hydrostat is worn or damaged.

Traction Circuit Problems

Problem	Possible Cause
Neutral is difficult to find or machine operates in one direction only.	External control linkage is misadjusted, disconnected, binding or damaged. Traction pump/hydrostat is worn or damaged.
Traction response is sluggish.	Bypass valve in traction pump/hydrostat is open or defective. Brake is not released. Hydraulic oil is very cold. Traction charge pressure is low. Traction pump/hydrostat or wheel motor(s) are worn or damaged.
No traction exists in either direction.	Brake is not released. Oil level in hydraulic tank is low (NOTE: Other hydraulic systems are affected as well). Bypass valve in traction pump/hydrostat is open or defective. Traction pump/hydrostat drive belt is loose or broken. Traction relief valve is damaged – open. Traction charge pressure is low. Traction pump/hydrostat or wheel motor(s) are worn or damaged.
Wheel will not turn.	Brakes are binding. Key on wheel motor shaft is sheared or missing. Internal parts in wheel motor are damaged.
Unit rolls when stopped on an incline – Engine Running (up to 10% grade and parking brake disengaged).	Make up fluid from charge pump is not available. Hydrostat check valves are damaged.
Unit rolls when stopped on an incline – Engine Not Running (up to 10% grade, wheels straight and parking brake disengaged).	Wheel motor(s) are worn or damaged (see Testing in this Chapter). NOTE: If unit rolls away straight, both front wheel motors are worn. If the unit turns to one side as it rolls away, the wheel motor on the outside of the turn is worn.

Lift Circuit Problems

Problem	Possible Cause
Cutting units will not lift or lift slowly.	Engine speed is too low. Hydraulic tank oil level is low (NOTE: Other hydraulic systems are affected as well). Lift arm bushings are binding. Implement relief valve (in steering control valve) is stuck open. Lift cylinders leak internally. Gear pump (P2) is worn or damaged (NOTE: Steering and traction charge systems are affected as well).
Cutting units raise, but will not stay up as the traction units travels between adjacent fairways or fields.	Lift circuit hydraulic lines or fittings are leaking. Lift control valve detent pin is worn or has failed. Lift control valve check valve (in pilot valve) leaks. Lift cylinders leak internally.
Cutting units will not lower.	Lift arm pivots are binding. Lift control valve is faulty. Lift cylinder(s) for affected cutting unit(s) is damaged.

Steering Circuit Problems

Problem	Possible Cause
Steering inoperative or sluggish	Oil level in hydraulic reservoir is low (NOTE: Other hydraulic systems are affected as well). Steering components (e.g. steering fork assembly, steering cylinder ends) are worn or binding. Relief valve in steering control valve is damaged – open. Steering cylinder leaks internally. Steering control valve is worn or damaged (see Troubleshooting Guide in the Sauer/Danfoss Steering Unit Type OSPM Service Manual.). Tandem gear pump rear section is worn or damaged (NOTE: The lift/lower and traction charge circuits are affected as well).
Turning steering wheel turns machine in the wrong direction.	Hoses to the steering cylinder are reversed.

Mow Circuit Problems

Problem	Possible Cause
Gear pump is noisy (cavitation).	Hydraulic tank oil level is low (NOTE: Other hydraulic systems are affected as well). Suction line is restricted. Suction line has an air leak.
None of the cutting reels will turn. NOTE: To engage the mow circuit, the seat must be occupied, the cutting units must be fully lowered, the transport/mow switch must be in the MOW position and the enable/disable switch must be in the ENABLE position.	Solenoid valve (S) or (S1) is stuck open. An electrical problem exists that prevents the solenoid valve (S) or (S1) in the manifold from being energized (See Chapter 6 – Electrical System in this manual). Gear pump (P1) is worn or damaged.
Poor after-cut appearance (cutting blades(s) turn too slowly).	Cutting unit spindle bearing(s) is (are) damaged. Cutting unit motor has internal leakage (see Testing in this chapter). Gear pump (P1) is inefficient (see Testing in this chapter).

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 various hydraulic circuits to perform various operational checks (See the Special Tools section in this chapter).

Remember that pressure specifications that appear on hydraulic schematics are the design specifications for the specific component. Actual system pressure will vary depending on oil temperature, the location of the test port, and the specific components used in the hydraulic circuit.

IMPORTANT: The hydraulic test procedures listed in this manual represent actual performance for this machine. To correctly measure product or component performance, be sure to follow the test procedures provided.

Before Performing Hydraulic Tests

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

Precautions for Hydraulic Testing



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.



CAUTION

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



CAUTION

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

1. Clean machine thoroughly before disconnecting or disassembling any hydraulic components. Always keep in mind the need for cleanliness when working on hydraulic equipment. Hydraulic fluid contamination will cause excessive wear of components.
2. Put metal caps or plugs on any hydraulic lines left open or exposed during testing or while hydraulic components are removed.



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. The engine must be in good operating condition. Use a phototach (non-contact tachometer) when performing a hydraulic test. Engine speed can affect the accuracy of the test readings. Monitor engine RPM during hydraulic testing. Use the information below when performing hydraulic system tests. If engine RPM is above or below the specified speed during a test, you will need to adjust the expected hydraulic performance parameters (approx. 3% per 100 engine rpm at full throttle)

IMPORTANT: Hydraulic component output volume relates directly to engine RPM. For every 100 engine rpm the following component output volumes will change by the volume listed.

Hydrostat: 100 engine RPM = **0.55 GPM or 70.6 oz. (2077 cc)** of hydraulic fluid displaced per minute

Gear Pump (P1): 100 engine RPM = **0.36 GPM or 46.6 oz. (1377 cc)** of hydraulic fluid displaced per minute.

Gear Pump (P2): 100 engine RPM = **0.12 GPM or 15.9 oz. (469 cc)** of hydraulic fluid displaced per minute

NOTE: Engine-to-Pump ratio is 1:0.88 for diesel units and 1:0.83 for gasoline units. In other words, 1 engine RPM = 0.88 pump RPM for a diesel powered unit.

4. The inlet and the outlet hoses must be properly connected and not reversed (hydraulic tester with pressure and flow capabilities) to prevent damage to the hydraulic tester or components.
5. When using a hydraulic tester with pressure and flow capabilities, open load valve completely in the hydraulic tester to minimize the possibility of damaging components.
6. Install fittings finger tight and far enough to make sure that they are not cross-threaded before tightening them with a wrench.
7. Position hydraulic tester hoses to prevent moving machine parts from contacting and damaging the hoses or tester.
8. Check fluid level in the hydraulic tank. After connecting test equipment, make sure tank is full.
9. Check control linkages for improper adjustment, binding, or broken parts.
10. All hydraulic tests should be made with the hydraulic fluid at normal operating temperature.

Hydraulic Test Selection

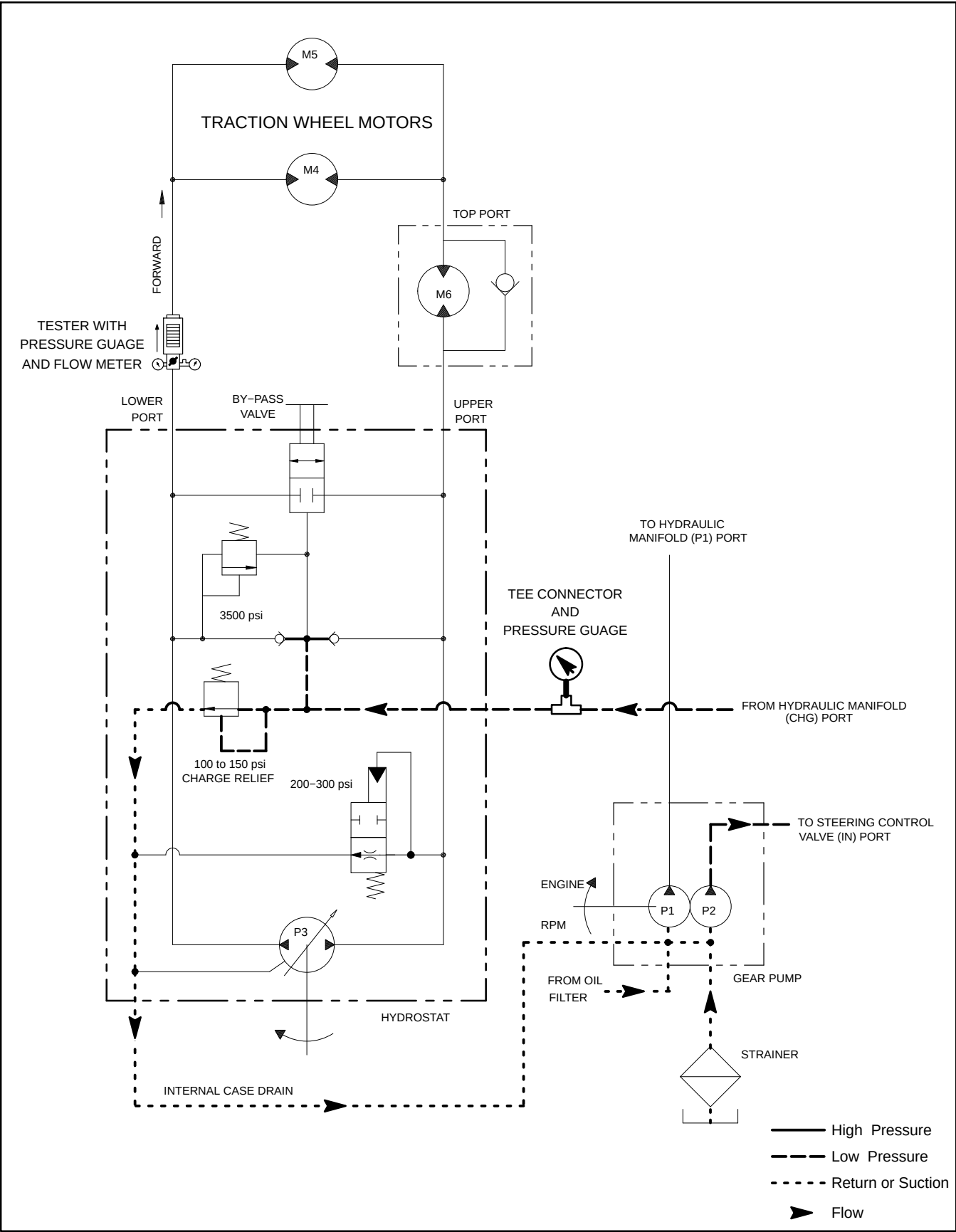
Before beginning any hydraulic test, identify if the problem is related to the traction circuit, cutting (mow) circuit or steering and lift/sidewinder circuit. Once the faulty system has been identified, perform tests that relate to that circuit.

If a traction circuit problem exists, consider performing one or more of the following tests: Charge Pressure Test, Wheel Motor Efficiency Test, and/or Piston Pump/Hydrostat (P3) Flow and Relief Valve Tests.

If a cutting (mow) circuit problem exists, consider performing one or more of the following tests: Circuit Pressure Test, Deck Motor Efficiency/Case Drain Test, Manifold Relief Pressure Test, and/or Gear Pump (P1) Flow Test.

If a steering or lift/sidewinder circuit problem exists, consider performing one or more of the following tests: Gear Pump (P2) Flow Test, Relief Valve Pressure Test, and/or Steering Control Valve and Steering Cylinder Test.

Traction Circuit Testing – Charge Pressure Test



Traction Circuit Testing – Charge Pressure Test:

The charge pressure test is the first in a series of tests recommended to determine traction circuit performance. A charge pressure drop of more than **20%** indicates an internal leak in the piston pump/hydrostat. Continued unit operation can generate excessive heat, cause damage to seals and other components in the hydraulic system, and affect overall machine performance.

Special Equipment Required:

- Pressure Gauge
- Flow Meter with Pressure Gauge that has at least an 18 GPM (68 LPM) capacity.
- Phototach (non-contact tachometer).

1. Park machine on a level surface with the cutting units lowered and PTO switch off. Make sure engine is off and the parking brake is engaged.

2. Read Precautions for Hydraulic Testing in this chapter.

3. Make sure that traction pedal is adjusted to the neutral position.

4. Disconnect hose to the rear hydraulic fitting on the piston pump coming from the hydraulic manifold port (CHG) (Fig. 24).

5. Install a T-connector and pressure gauge between the fitting and disconnected hose.

6. Disconnect hose from the lower hydraulic fitting on the engine side of the hydrostat (Fig. 25).

7. Install tester in series with the pump and the disconnected hose. Make sure the tester flow control valve is fully open.

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

9. Chock the wheels to prevent wheel rotation during testing.

10. Start engine. Move throttle to full speed (Diesel engine = **3220 ± 50 RPM**, Gas engine = **3420 ± 30 RPM**).

11. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.

12. Verify with a phototach that the **pump speed** is approximately **2850 RPM**.

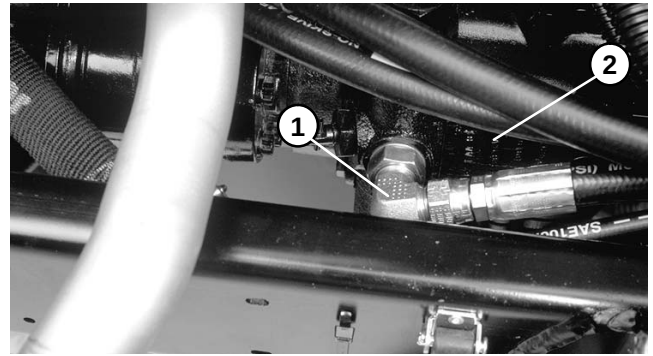


Figure 24

1. Hydraulic fitting

2. Piston pump

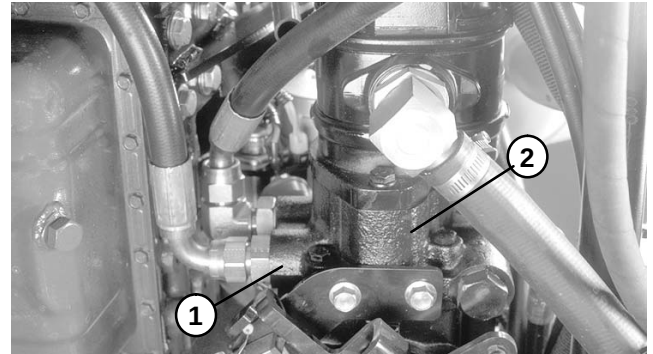


Figure 25

1. Lower hydraulic fitting

2. Piston pump

13. Record reading on pressure gauge from CHG manifold port. Charge pressure (without load) should read from **150 to 200 PSI (10.3 to 13.8 Bar)**. If charge relief pressure specification is not met, consider the following:

A. Gear pump (P2) is faulty (steering/lift/sidewinder circuit performance will also be affected). Test gear pump (P2) flow (see Gear Pump (P2) Flow Test in this chapter).

B. The piston pump charge relief valve is faulty. Repair or replace the piston pump charge relief valve (see Piston Pump Service in this chapter).

14. Sit in the operator's seat, release the parking brake, and slowly depress the forward traction pedal until **1000 to 1500 PSI (68.9 to 103.4 Bar)** is reached on the flow meter pressure gauge.

15. Record reading on pressure gauge from CHG manifold port (under load). Charge pressure (under load) should not drop **more than 20%** when compared to charge pressure (without load) recorded in step 13.

If specifications are not met, perform Piston Pump/Hydrostat (P3) Flow and Traction Relief Pressure Test as outlined in this chapter.

16. Release traction pedal, move throttle to low speed and turn the engine off.

Traction Unit Testing – Wheel Motor Efficiency Tests

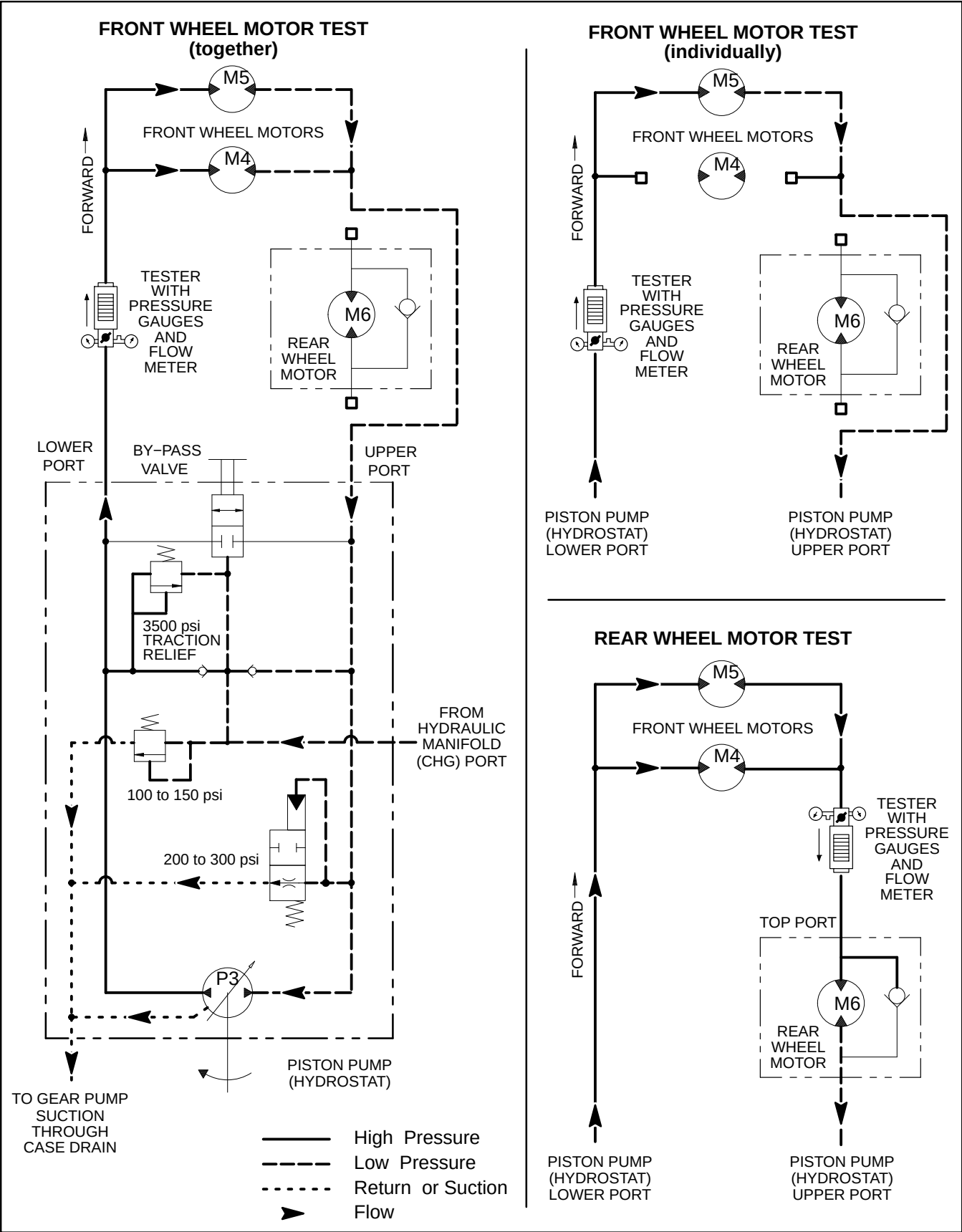


Figure 26

Traction Circuit Testing – Wheel Motor Efficiency Test:

Wheel motor efficiency is the second in a series of tests recommended to determine traction circuit performance. Hydraulic fluid flow of **1.5 GPM (5.7 LPM)** or more through a stationary wheel motor under load indicates an internal leak in the wheel motor. A worn wheel motor is less efficient. Eventually, enough fluid by-pass will cause the wheel motor to stall under heavy load conditions. Continued operation can generate excessive heat, cause damage to seals and other components in the hydraulic system, and affect overall machine performance.

There are moments during wheel motor operation (roller position) when fluid flow through the motor is less restricted. If a wheel motor is tested in this position, the test results will be higher should not be used to determine wheel motor efficiency. Test wheel motors in three (3) different wheel positions to obtain accurate test results. Record test readings for all three (3) wheel positions.

Hydraulic fluid flows through both front wheel motors (in parallel) before passing through the rear wheel motor (in series). In this configuration, the rear wheel motor can mask front wheel motor performance issues, and the front wheel motors can mask rear wheel motor performance issues. Start by testing both front wheel motors together, then individually if necessary. Finish by testing the rear wheel motor.

Special Equipment Required:

- Pressure Gauge
- Flow Meter with Pressure Gauge that has at least an 18 GPM (68 LPM) capacity.
- Phototach (non-contact tachometer).

1. Park machine on a level surface with the cutting units lowered and the PTO switch off. The engine should be off and the parking brake engaged.

2. Read Precautions for Hydraulic Testing in this chapter.

3. Make sure that traction pedal is adjusted to the neutral position.

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

Front Wheel Motor Test:s

Hydraulic fluid flows through both front wheel motors (in parallel) before passing through the rear wheel motor (in series). To accurately test the front wheel motors, the rear wheel motor must be removed from the traction circuit.

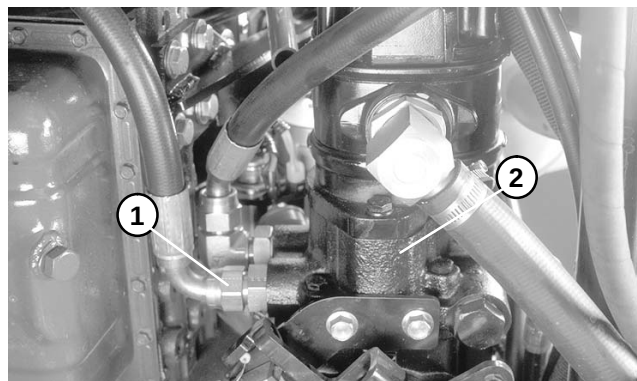


Figure 27

1. Lower hydraulic fitting 2. Piston pump

1. Disconnect hose from the lower hydraulic fitting on the bottom of the hydrostat (Fig. 27).

NOTE: An alternate testing location would be at the hydraulic hose from the hydrostat and the hydraulic tube supplying the front wheel motors under the left floor plate.

2. Install flow tester between the hydrostat and the disconnected hose. Make sure the tester flow control valve is fully open.

3. Disconnect both hydraulic lines from the rear wheel motor, then reconnect the lines to each other. Plug ports in wheel motor to prevent contamination.

4. Chock front wheels to prevent wheel rotation.

5. Start engine. Move throttle to full speed (Diesel engine = 3220 ± 50 RPM, Gas engine = 3420 ± 30 RPM).

6. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

7. Verify with a phototach that the **pump speed** is approximately **2850 RPM**.



CAUTION

Use extreme caution when performing wheel motor tests. The wheel motors will be trying to move the machine forward.

8. Sit in the operators seat, release the parking brake, and set the Transport/Mow slide to the transport position.

9. Slowly depress forward traction pedal until **1000 to 1500 PSI (68.9 to 103.4 Bar)** is displayed on the pressure gauge.

Flow meter should read **less than 1.5 GPM (5.7 LPM)**.

10. Release traction pedal, shut engine off, and record test results.

11. Rotate each front wheel 120 degrees and retest. Repeat this procedure until each wheel motor has been tested in three (3) different positions.

Proceed to testing rear wheel motor If test results are within specification. If specifications are not met, test front wheel motors individually as follows:

12. Disconnect hydraulic lines from front wheel motor that is not being tested. Cap disconnected hydraulic lines and plug ports in wheel motor to prevent contamination.

13. Chock front wheel being tested to prevent wheel rotation.

14. Start engine. Move throttle to full speed.



CAUTION

Use extreme caution when performing wheel motor tests. The wheel motors will be trying to move the machine forward.

15. Sit in the operators seat, release the parking brake, and set the Transport/Mow slide to the transport position.

16. Slowly depress forward traction pedal until **1000 to 1500 PSI (68.9 to 103.4 Bar)** is displayed on the pressure gauge.

Flow meter should read **less than 1.5 GPM (5.7 LPM)**.

17. Release traction pedal, shut engine off, and record test results.

18. Rotate front wheel 120 degrees and retest. Repeat this procedure until wheel motor has been tested in three (3) different positions.

19. Reconnect hydraulic lines to front wheel motor and repeat procedure for remaining front wheel motor.

20. If specifications are not met, repair or replace worn wheel motor.

Rear Wheel Motor Test:

Hydraulic fluid flows through both front wheel motors (in parallel) before passing through the rear wheel motor (in series). To accurately test the rear wheel motor, the front wheel motors must be allowed to rotate.

1. Disconnect hose from the upper hydraulic fitting of the rear wheel motor (Fig. 28).

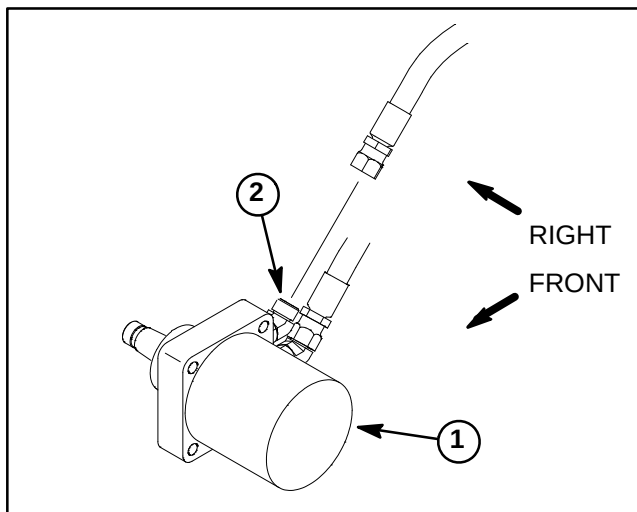


Figure 28

1. Rear wheel motor 2. Upper fitting

2. Install flow tester between the disconnected hydraulic hose and the rear wheel motor. Make sure the tester flow control valve is fully open.



WARNING

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

3. Raise off the floor and support both front wheels.
4. Chock rear wheel to prevent wheel rotation.
5. Start engine. Move throttle to full speed.



CAUTION

Use extreme caution when performing wheel motor tests. The wheel motors will be trying to move the machine forward.

6. Sit in the operators seat, release the parking brake, and set the Transport/Mow slide to the transport position.

7. Slowly depress forward traction pedal until **1000 to 1500 PSI (68.9 to 103.4 Bar)** is displayed on the pressure gauge.

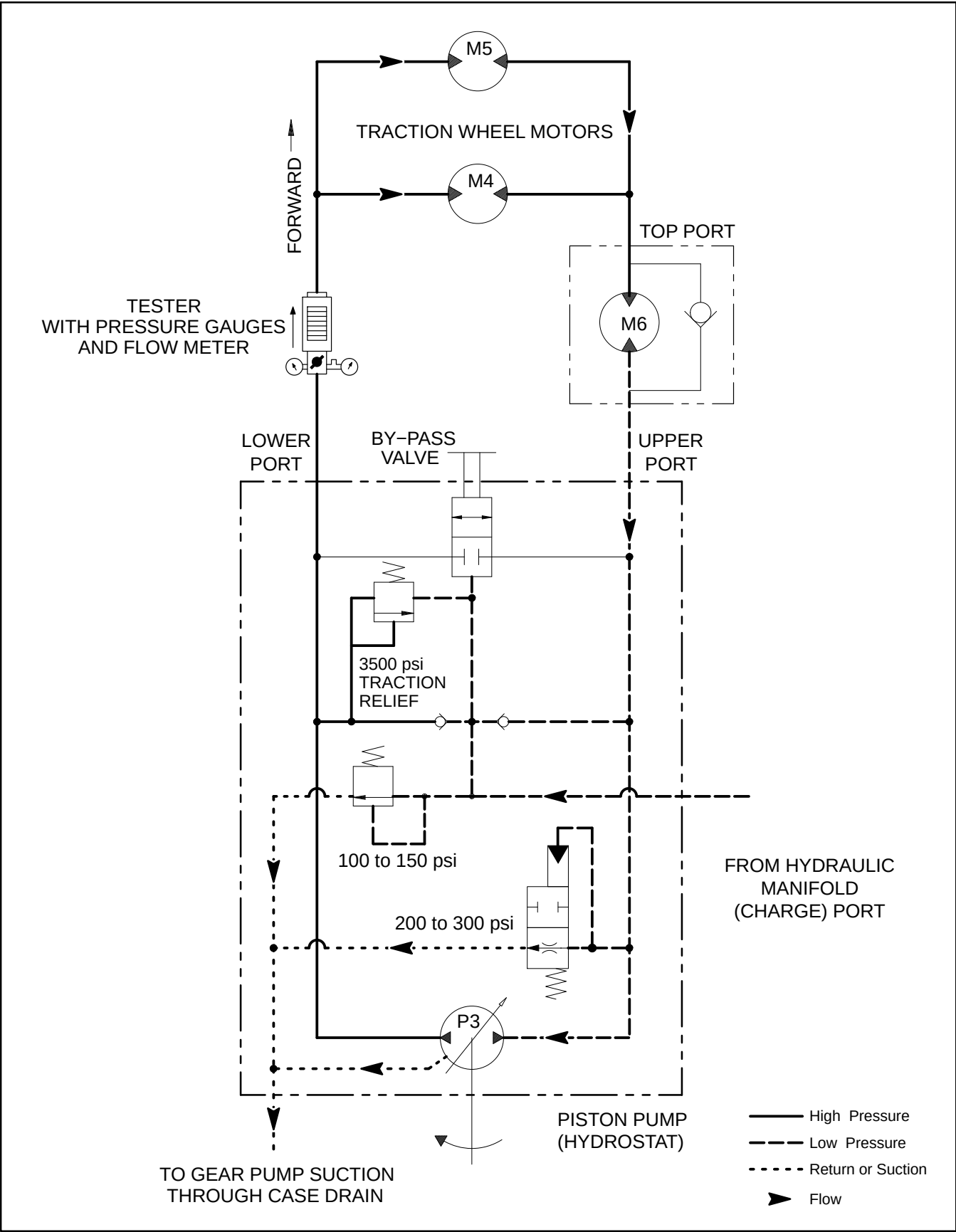
Flow meter should read **less than 1.5 GPM (5.7 LPM)**.

8. Release traction pedal, shut engine off, and record test results.

9. Rotate rear wheel 120 degrees and retest. Repeat this procedure until wheel motor has been tested in three (3) different positions.

10. If specifications are not met, repair or replace worn wheel motor.

Traction Circuit Testing – Piston Pump/Hydrostat (P3) Flow and Relief Pressure Test



Traction Circuit Testing – Piston Pump/Hydrostat (P3) Flow and Relief Pressure Test:

The hydrostat flow test is the third in a series of tests recommended to determine traction circuit performance. The final traction circuit test is verifying the hydrostat relief valve operation. This test compares fluid flow at No Load with fluid flow Under Load. A drop in flow under load of more than **12%** indicates an internal leak or malfunctioning relief valve in the piston pump/hydrostat. A worn hydrostat or malfunctioning relief valve is less efficient. Eventually, enough fluid by-pass will cause the unit to stall under heavy load conditions. Continued operation can generate excessive heat, cause damage to seals and other components in the hydraulic system, and affect overall machine performance.

Special Equipment Required:

- Pressure Gauge
- Flow Meter with Pressure Gauge that has at least an 18 GPM (68 LPM) capacity.
- Phototach (non-contact tachometer).

1. Park machine on a level surface with the cutting units lowered and the PTO switch off. The engine should be off and the parking brake engaged.

2. Read Precautions for Hydraulic Testing in this chapter.

3. Make sure that traction pedal is adjusted to the neutral position.

**WARNING**

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

4. Raise off the floor and support both front wheels and the rear wheel.

5. Disconnect hose from the lower hydraulic fitting on the engine side of the hydrostat (Fig. 29).

6. Install tester in series with the pump and the disconnected hose. Make sure the tester flow control valve is fully open.

7. Start engine. Move throttle to full speed (Diesel engine = **3220 ± 50 RPM**, Gas engine = **3420 ± 30 RPM**).

8. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.

9. Verify with a phototach that the **pump speed** is approximately **2850 RPM**.

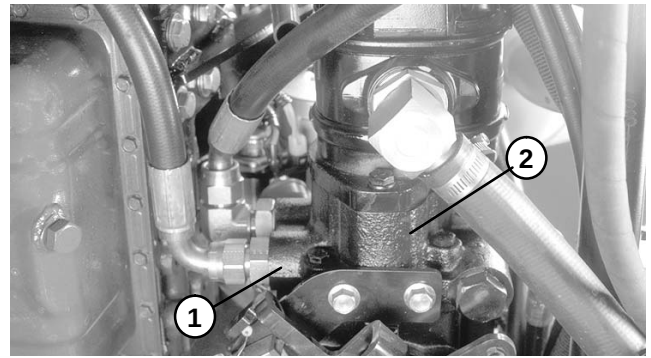


Figure 29

1. Lower hydraulic fitting 2. Piston pump

10. Sit in the operator's seat, release the parking brake, and set the Transport/Mow slide to the transport position.

**CAUTION**

Use extreme caution when performing hydrostat flow tests. The traction unit wheels will be rotating during the test.

11. Verify pump flow at No Load as follows:

- A. Slowly depress forward traction pedal to full forward position.
- B. Record tester pressure and flow readings. Unrestricted pump output should be approximately **16 GPM (60.5 LPM)** at **650 PSI (44.8 Bar)**.

12. Verify pump flow Under Load as follows:

- A. Slowly depress forward traction pedal to full forward position.
- B. Apply an **additional load of 1000 to 1500 PSI (68.9 to 103.4 Bar)** by slowly closing the flow meter. The flow meter pressure gauge should read **1700 to 2100 PSI (117.2 to 144.8 Bar)**.
- C. Record tester pressure and flow readings.

13. Verify traction relief valve operation as follows:

- A. Return the traction pedal to neutral.
- B. Fully close the flow meter flow control valve.
- C. Slowly set traction pedal to full forward position.
- D. Record tester pressure reading.

System pressure should reach **3600 to 3650 PSI (248 to 251 Bar)** before the relief valve opens.

NOTE: The relief valve setting is **3500 PSI (241 Bar)**. An additional **100 to 150 PSI (6.9 to 10.3 Bar)** is necessary to overcome system charge pressure before the relief valve opens.

E. Release traction pedal, open flow control valve fully, move throttle to low speed and turn the engine off.

14. If relief pressure can not be met or is greater than specified, the traction relief valve is faulty and should be replaced.

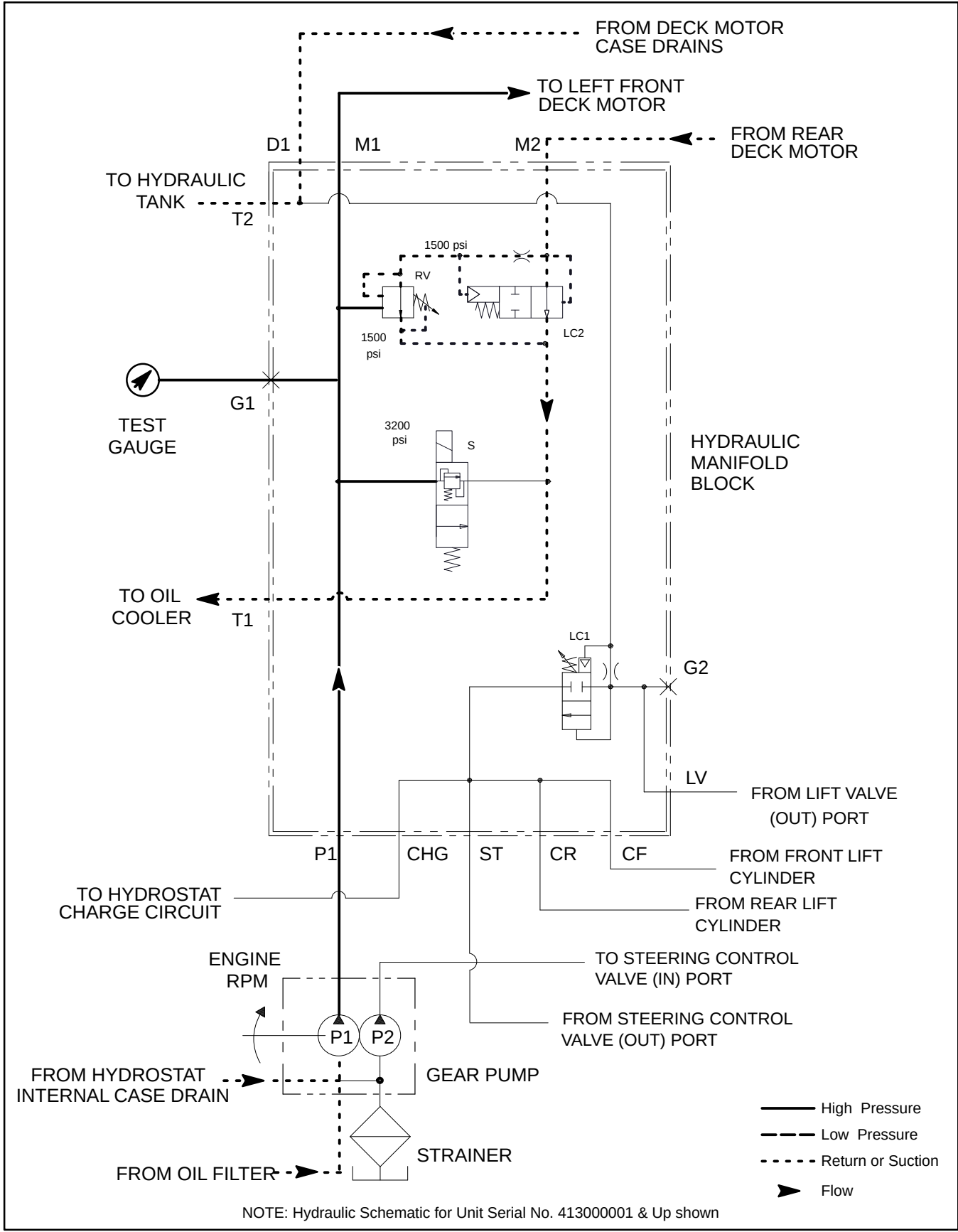
15. The Under Load test flow reading (step 12.) should not drop **more than 12%** when compared to the No Load test flow reading (step 11.). A difference of more than 12% may indicate:

A. The traction belt is worn and/or slipping.

B. The piston pump/hydrostat (P3) is worn and should be repaired or replaced.

16. Disconnect tester and reconnect hose to pump.

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Cutting Deck Circuit Testing – Pressure Test:

Cutting deck circuit pressure is the first in a series of tests recommended to check cutting deck circuit performance. The results from this test will help determine which component(s) are the cause of cutting deck performance issues.

Special Equipment Required:

NOTE: If available, connecting a flow meter with pressure gauge that has at least a 12 GPM (45 LPM) capacity at the hydraulic manifold (M1) port instead of connecting a pressure gauge at manifold port (G1) as described in this test, will allow performing the pressure test and manifold relief valve test with the same test configuration (see Cutting Deck Circuit Testing – Manifold Relief Valve Pressure Test in this chapter).

- Pressure Gauge with extension hose
- Test fitting and cover Toro p/n 354-77 and 354-79

1. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is disengaged.
2. Read Precautions for Hydraulic Testing in this chapter.
3. Remove plug from hydraulic manifold port (G1) and install a test fitting and cover (Fig. 30 and 31).
4. Install test gauge with hydraulic hose to manifold port (G1).



CAUTION

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

5. Sit in the Operator's seat, start the engine, and move throttle to full speed (Diesel engine = **3220 ± 50 RPM**, Gas engine = **3420 ± 30 RPM**).
6. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
7. Engage the cutting units.

When engaged, the cutting circuit pressure should exceed manifold relief valve pressure setting of **3200 PSI (220.6 Bar)** momentarily opening the relief valve. Circuit pressure should then stabilize at approximately **1000 PSI (68.9 Bar)** with standard combination sail blades installed.

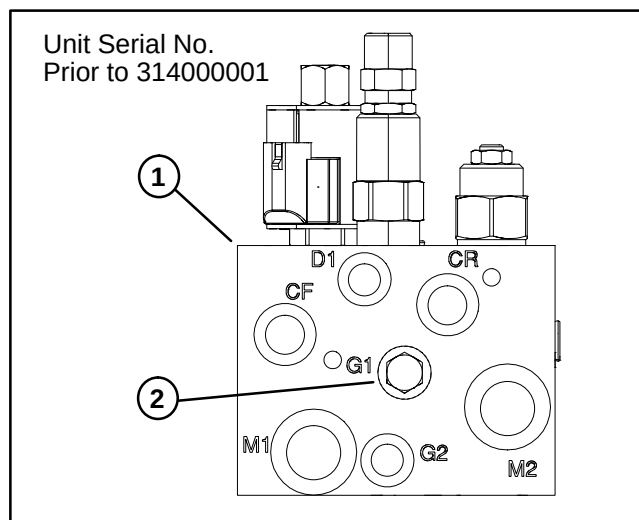


Figure 30

1. Hydraulic manifold
2. Manifold port (G1)

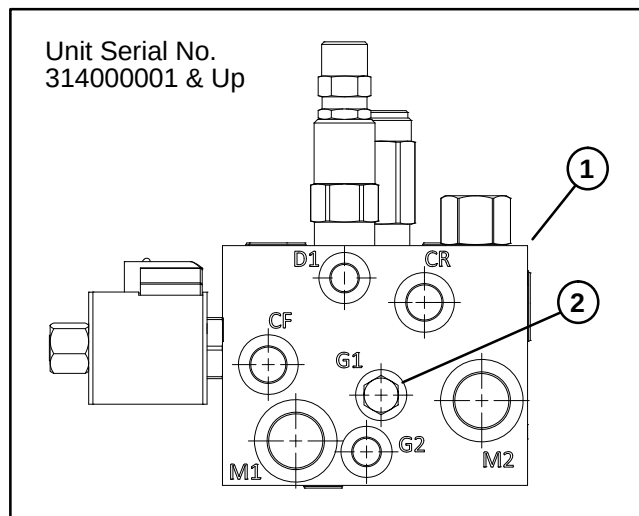


Figure 31

1. Hydraulic manifold
2. Manifold port (G1)

8. Safely secure the test pressure gauge and operate the machine under your specific mowing conditions. Monitor test gauge while mowing. Cutting deck circuit pressure should be approximately **1500 to 2000 PSI (103.4 to 137.9 Bar)** under low load conditions, and can reach a maximum pressure equal to the manifold relief valve setting of **3200 PSI (220.6 Bar)**.

9. Disengage cutting decks, move throttle to low speed and shut off engine.

10. If pressure readings are within specifications and cutting deck performance is still in question, test cutting deck motors individually (see Cutting Deck Circuit – Deck Motor Efficiency/Case Drain Test).

11. If pressure specifications are not met, consider the following:

A. Manifold relief valve is faulty (see Cutting Deck Circuit – Manifold Relief Valve Pressure Test in this chapter)

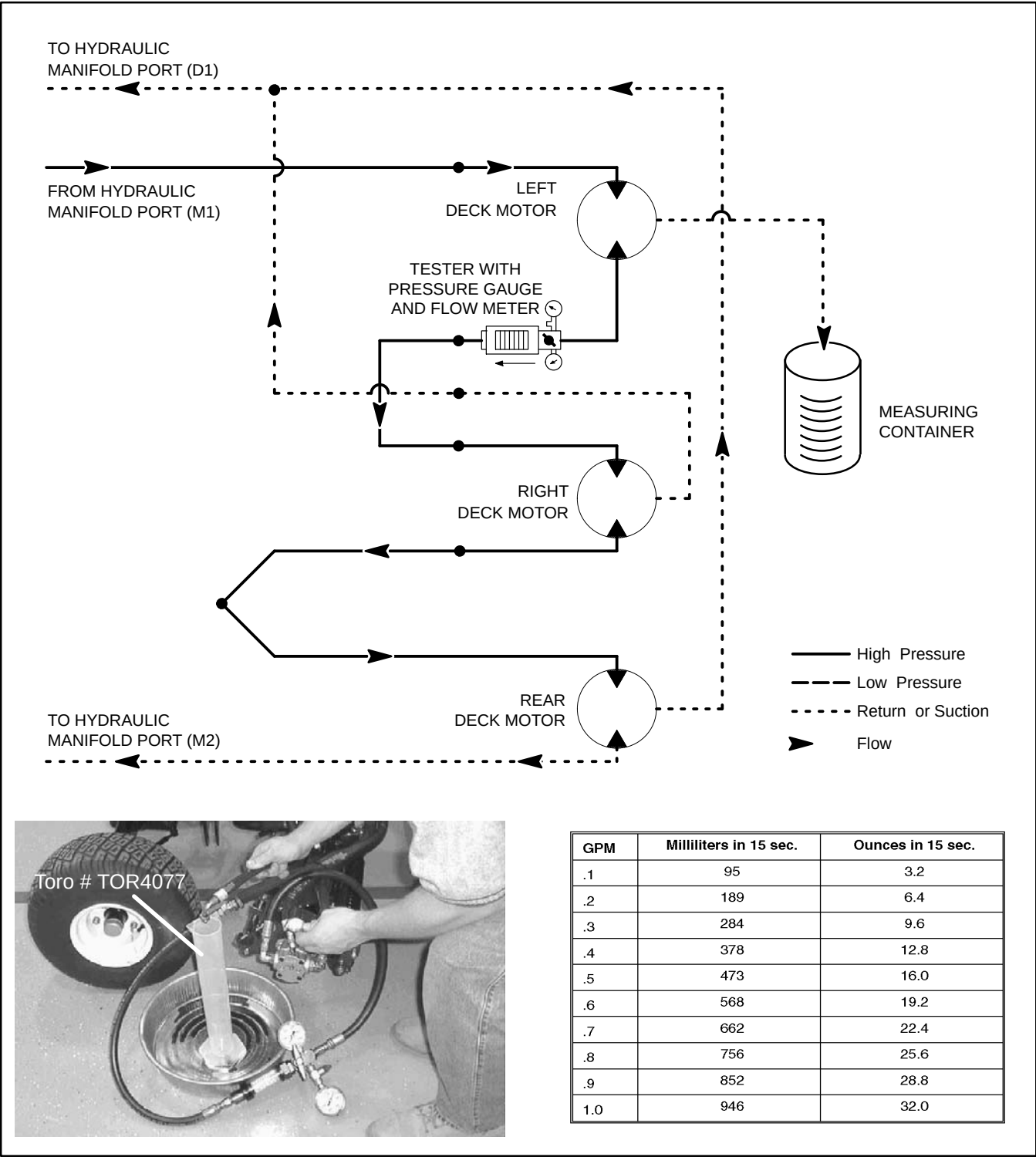
B. Gear pump (P1) is faulty (see Cutting Deck Circuit – Gear Pump (P1) Flow Under Load Test in this chapter)

C. The blade braking valve (BV – Unit Serial No. Prior to 31400000) or the blade braking relief valve and/or logic cartridge (RV and LC2 – Unit Serial No. 314000001 & Up) is faulty. Adjust, repair, or replace the necessary components (see Adjustments – Blade Braking Valve/Relief Valve in this chapter).

12. Disconnect test equipment from hydraulic manifold.

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Cutting Deck Circuit Testing – Deck Motor Efficiency/Case Drain Test



Cutting Deck Circuit Testing – Deck Motor Efficiency/Case Drain Test

The deck motor efficiency/case drain test is the second in a series of tests recommended to check cutting deck circuit performance. Over a period of time, a deck motor can wear internally. This test measures case drain volume while restricting flow across the motor ports. Case drain volume under load of more than **9%** of total motor flow indicates the gears and wear plates in the motor have worn. A worn motor may by-pass hydraulic fluid to its case drain causing the motor to be less efficient. Eventually, enough fluid loss will cause the deck motor to stall under heavy cutting conditions. Continued operation with a worn, inefficient motor can generate excessive heat, cause damage to seals and other components in the hydraulic system, and affect quality of cut.

Special Equipment Required:

- Flow Meter with Pressure Gauge that has at least a 12 GPM (45 LPM) capacity.
- Phototach (non-contact tachometer).

1. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.

2. Park the machine on a level surface with the cutting units lowered and PTO switch off. Make sure engine is off, transport/mow switch in the MOW position, and the parking brake is disengaged.

3. Read Precautions for Hydraulic Testing in this chapter.

4. Make sure that traction pedal is adjusted to the neutral position.

NOTE: The deck motors are connected in series. If a faulty deck motor is not obvious (based on quality of cut issues) you may have to test all three motors in the circuit. If testing all cutting deck motors, start with the first motor in the series (front left).

5. Remove the deck motors from all cutting decks (Fig. 32).

6. Disconnect the return hose from the motor. The return hose is the first hose counterclockwise of the smaller (center) case drain hose (Fig. 33).

7. Install hydraulic tester between the motor and the disconnected return hose. Make sure the tester flow control valve is fully open.

8. Disconnect hose from deck motor case drain at the bulkhead T-fitting (Fig. 33). Plug the T-fitting to prevent system contamination. Place open end of disconnected case drain hose into a drain pan.

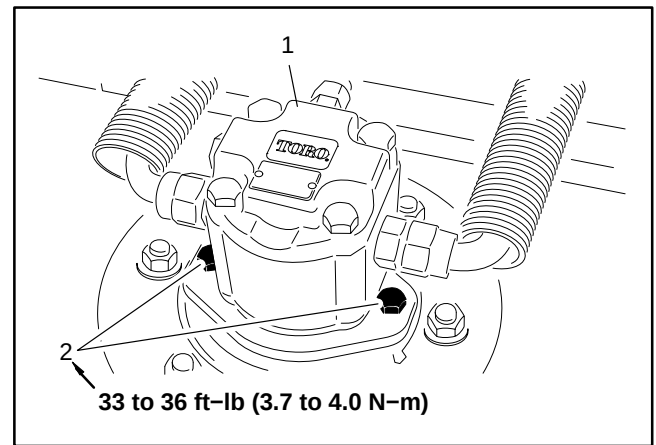


Figure 32

1. Deck motor

2. Motor mounting screws

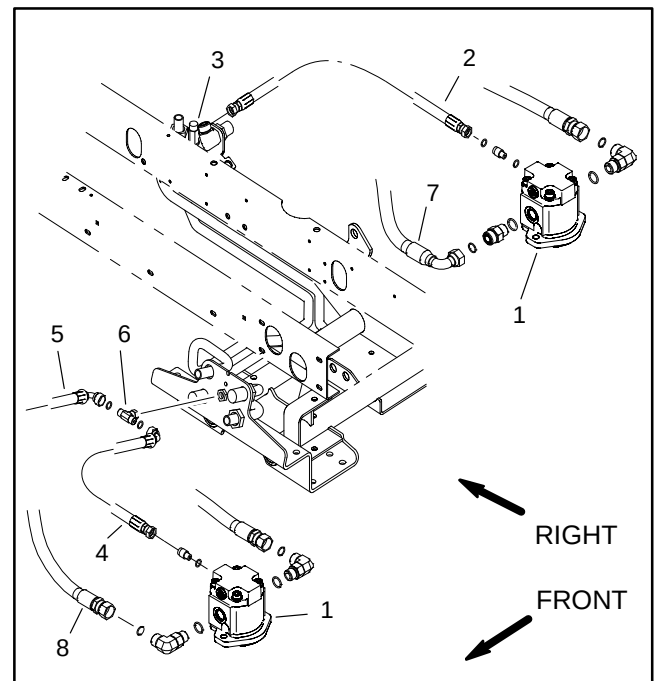


Figure 33

- 1. Deck motor
- 2. Rear case drain hose
- 3. Rear T-fitting
- 4. Front left case drain hose

- 5. Front right case drain hose
- 6. Front T-fitting
- 7. Rear return hose
- 8. Front left return hose

9. Two people are required to complete the following steps. One person should sit in the operator's seat and operate the machine while another person reads the tester and measures deck motor case drain volume.

Start the engine and move throttle to full speed (Diesel engine = **3220 ± 50 RPM**, Gas engine = **3420 ± 30 RPM**). Engage the cutting units.

10. Verify with a phototach that the **pump speed** is approximately **2850 RPM**.

11. Engage cutting decks and slowly close tester flow control valve until a pressure of **2000 PSI (138 Bar)** is obtained.

12. Hold disconnected motor case drain hose into a container graduated in ounces or milliliters (e.g. Toro #TOR4077) and collect hydraulic fluid for **30** seconds. After **30** seconds, remove hose end from container.

13. Record amount of fluid collected in the container.

14. Disengage cutting decks, set throttle to low speed and stop engine.

15. If volume is more than **80 oz (2366 milliliters)**, repair or replace the tested deck motor.

16. Remove tester and reconnect hydraulic hoses.

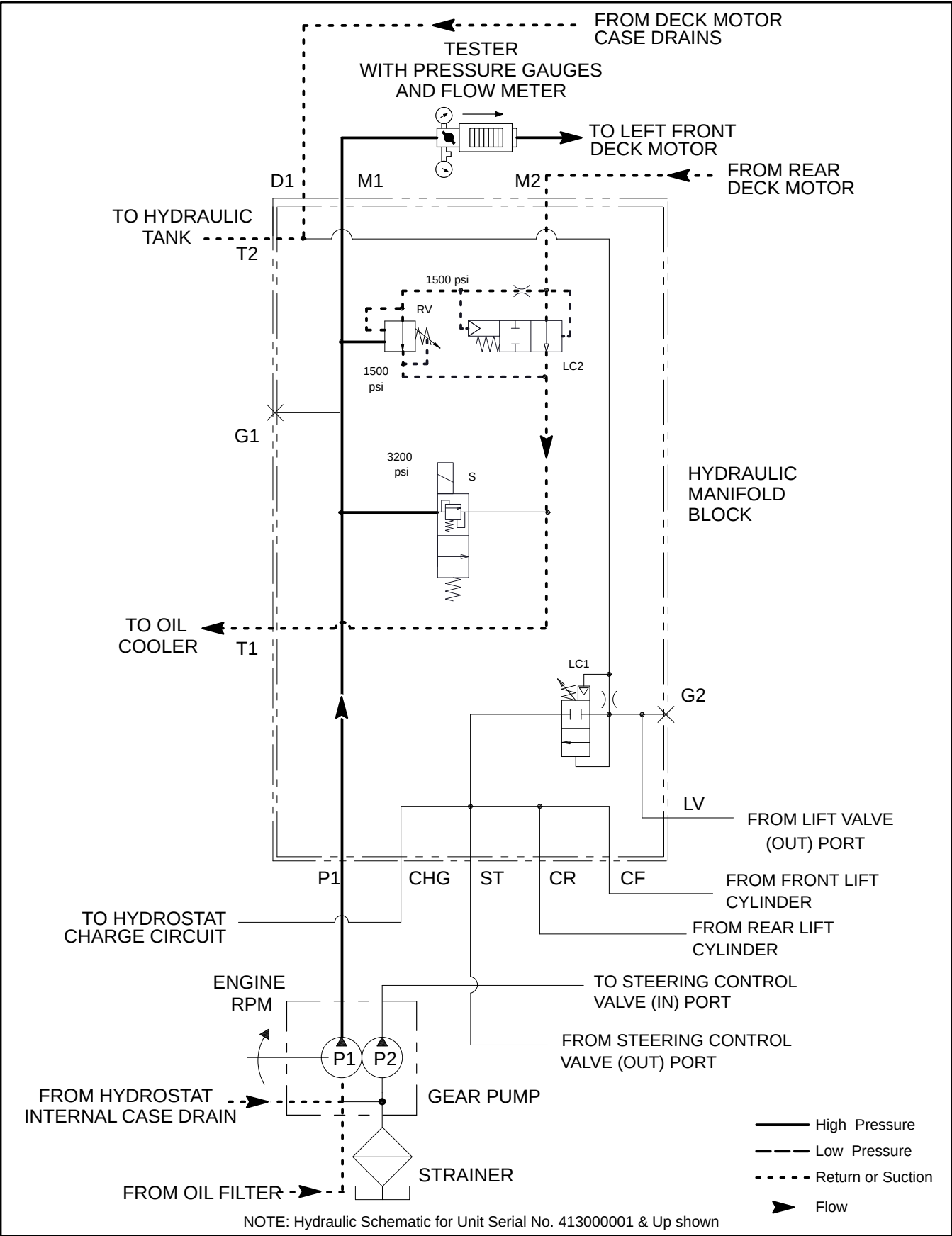
17. Check hydraulic fluid level (see Traction Unit Operator's Manual).

18. Repeat test with remaining deck motors as needed.

19. Install deck motors after testing is completed. (see Cutting Deck Operator's Manual). Tighten mounting screws from 33 to 36 ft-lb (3.7 to 4.0 N-m).

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Cutting Deck Circuit Testing – Manifold Relief Valve Pressure Test



Cutting Deck Circuit Testing – Manifold Relief Valve Pressure Test:

Test the performance of the manifold relief valve (S or S1) to make sure that the maximum amount of fluid is available to the cutting deck motors up to the set relief pressure. This test also ensures that pump (P1) is capable of generating enough pressure to open a properly functioning manifold relief valve. The manifold relief valve is part of the cutting deck solenoid valve.

Special Equipment Required:

- Flow Meter with Pressure Gauge that has at least a 12 GPM (45 LPM) capacity.

1. Park machine on a level surface with the cutting units lowered and PTO switch off. Engine should be off and the parking brake disengaged.

2. Read Precautions for Hydraulic Testing in this chapter.

3. Disconnect the hose from hydraulic fitting at manifold port (M1) (Fig. 34 and 35).

NOTE: An alternative to using manifold port (M1) would be to disconnect the inlet hydraulic hose to the front left deck motor. The inlet hose is the first hose clockwise of the smaller (center) case drain hose. (Fig. 36).

4. Install tester between the hose and hydraulic fitting. Make sure the flow control valve on tester is fully open.



CAUTION

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

5. Start the engine and move throttle to full speed (Diesel engine = 3220 ± 50 RPM, Gas engine = 3420 ± 30 RPM).

6. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.

7. Engage the cutting units.

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

9. System pressure should reach **3100 to 3330 PSI (213.7 to 227.5 Bar)** before the relief valve opens.

10. Set throttle to low speed and shut off engine.

11. If specification is met, test pump (P1) flow (see Cutting Deck Circuit Testing – Gear Pump (P1) Flow Test in this chapter) If specification is not met, clean or replace relief valve (S or S1) (see Hydraulic Manifold Service in this chapter) and retest.

Groundsmaster 3500

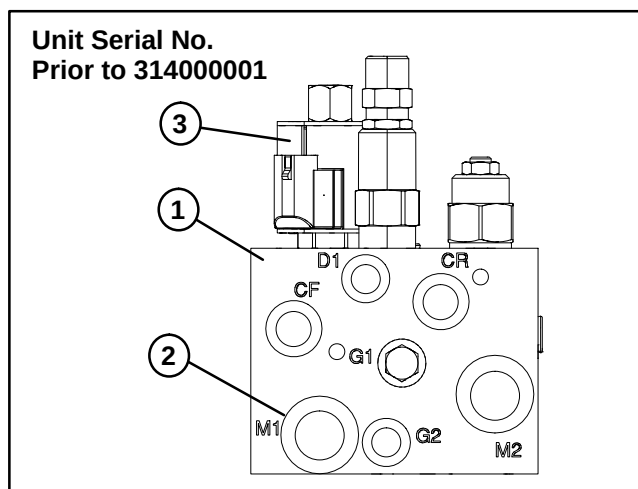


Figure 34

1. Hydraulic manifold
2. Manifold port (M1)
3. Relief valve (S1)

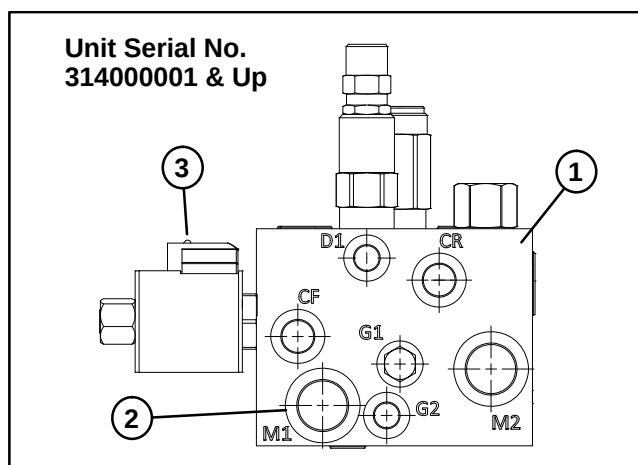


Figure 35

1. Hydraulic manifold
2. Manifold port (M1)
3. Relief valve (S)

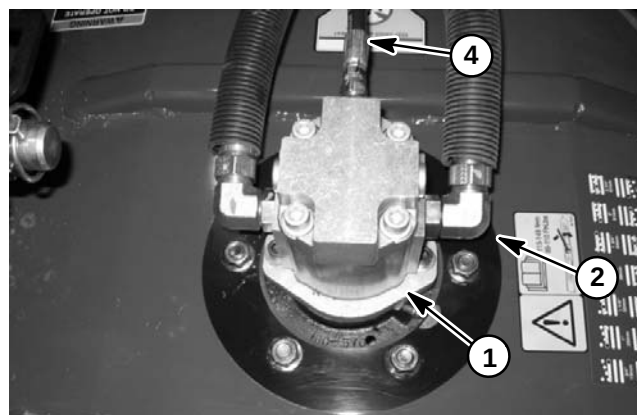
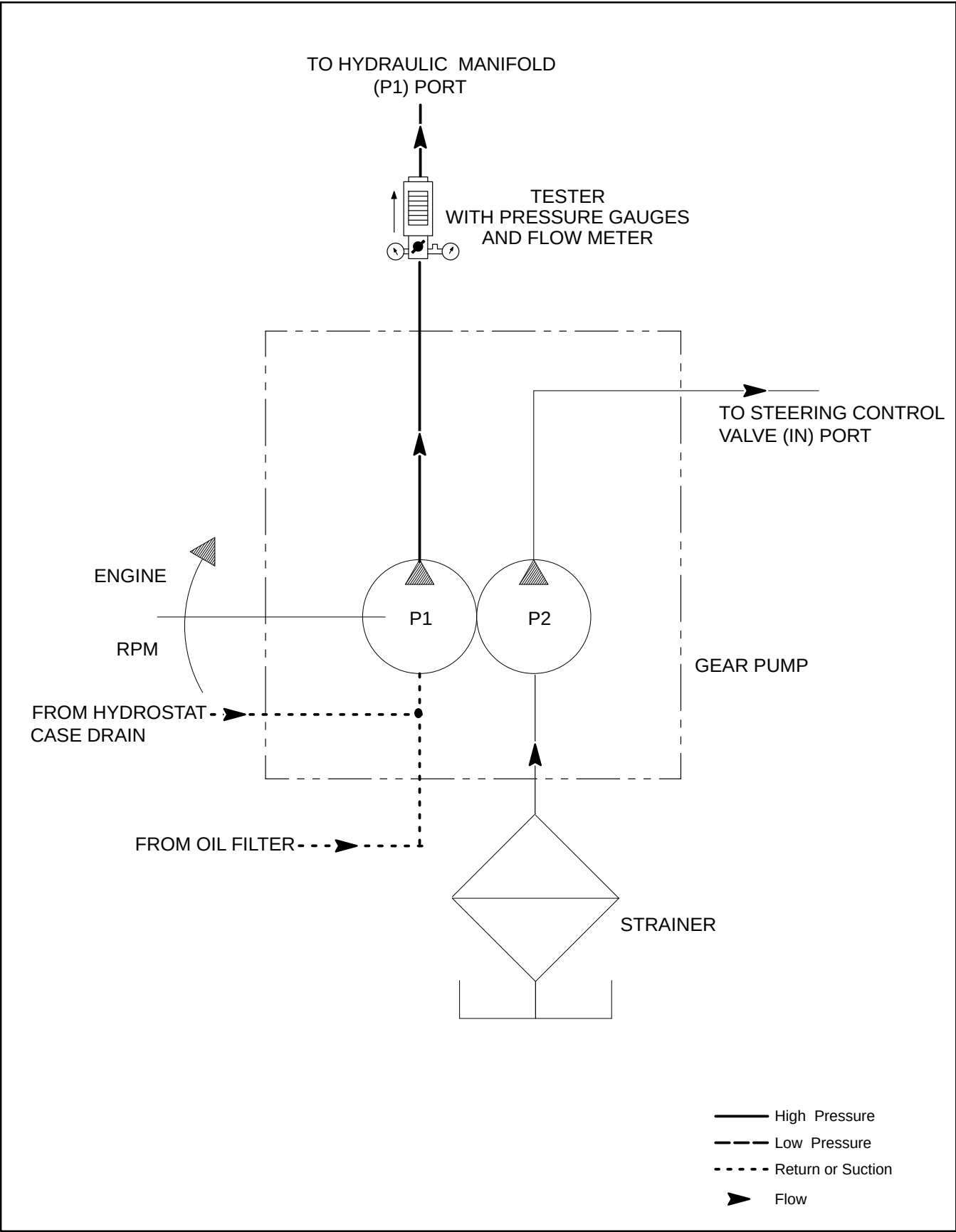


Figure 36

1. Deck motor
2. Inlet hose
3. Case drain hose

12. Disconnect tester and reconnect hydraulic hose.

Cutting Deck Circuit Testing – Gear Pump (P1) Flow Test



Cutting Deck Circuit Testing – Gear Pump (P1) Flow Test:

The gear pump (P1) flow test is the last in a series of tests recommended to determine cutting deck circuit performance. This test compares fluid flow at No Load with fluid flow Under Load. A drop in flow under load of more than **15%** indicates the gears and wear plates in the pump have worn. A worn pump will by-pass hydraulic fluid and make the pump less efficient. Eventually, enough fluid 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 the seals and other components in the hydraulic system.

Special Equipment Required:

- Flow Meter with Pressure Gauge that has at least a 12 GPM (45 LPM) capacity.
- Phototach (non-contact tachometer).

1. Park machine on a level surface with the cutting units lowered and PTO switch off. Make sure engine is off and the parking brake is engaged.
2. Read Precautions for Hydraulic Testing in this chapter.
3. Disconnect hose connection on the gear pump (P1) leading to port (P1) on the hydraulic manifold (Fig. 37).
4. Install tester between the gear pump and the disconnected hose.
5. Make sure the flow control valve on the tester is fully open.
6. Sit in the Operator's seat, start the engine, and move throttle to full speed (Diesel engine = **3220 ± 50 RPM**, Gas engine = **3420 ± 30 RPM**). Do not engage the cutting units.
7. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.

Use a phototach to verify that the **pump speed** is approximately **2850 RPM**.

8. Verify pump flow at No Load as follows:

Record tester pressure and flow reading at no load. Unrestricted pump output should be approximately **11.1 GPM (42.1 LPM)**.

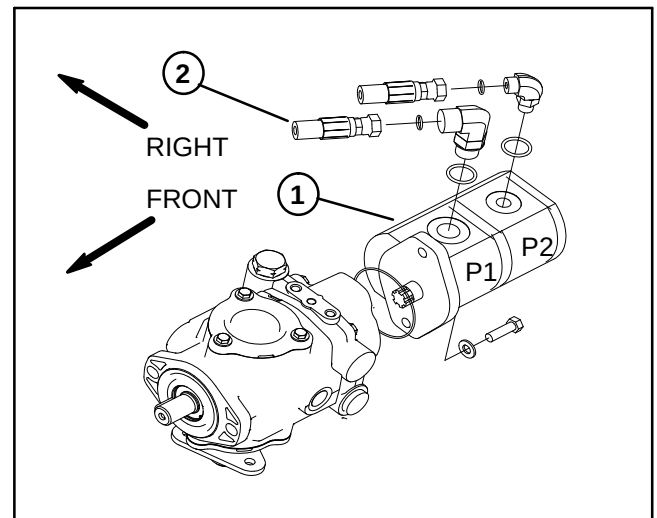


Figure 37

1. Gear pump assembly 2. To hydraulic manifold

9. Verify pump flow Under Load as follows:



CAUTION

Do not close tester valve fully when performing this test. In this test, the hydraulic tester is positioned before the manifold relief valve. Pump damage can occur if the fluid flow is fully restricted by fully closing the tester flow control valve.

A. Watch flow meter pressure gauge carefully while slowly closing the flow control valve until **2000 PSI (137.9 Bar)** is obtained on gauge.

B. Record tester pressure and flow readings under load.

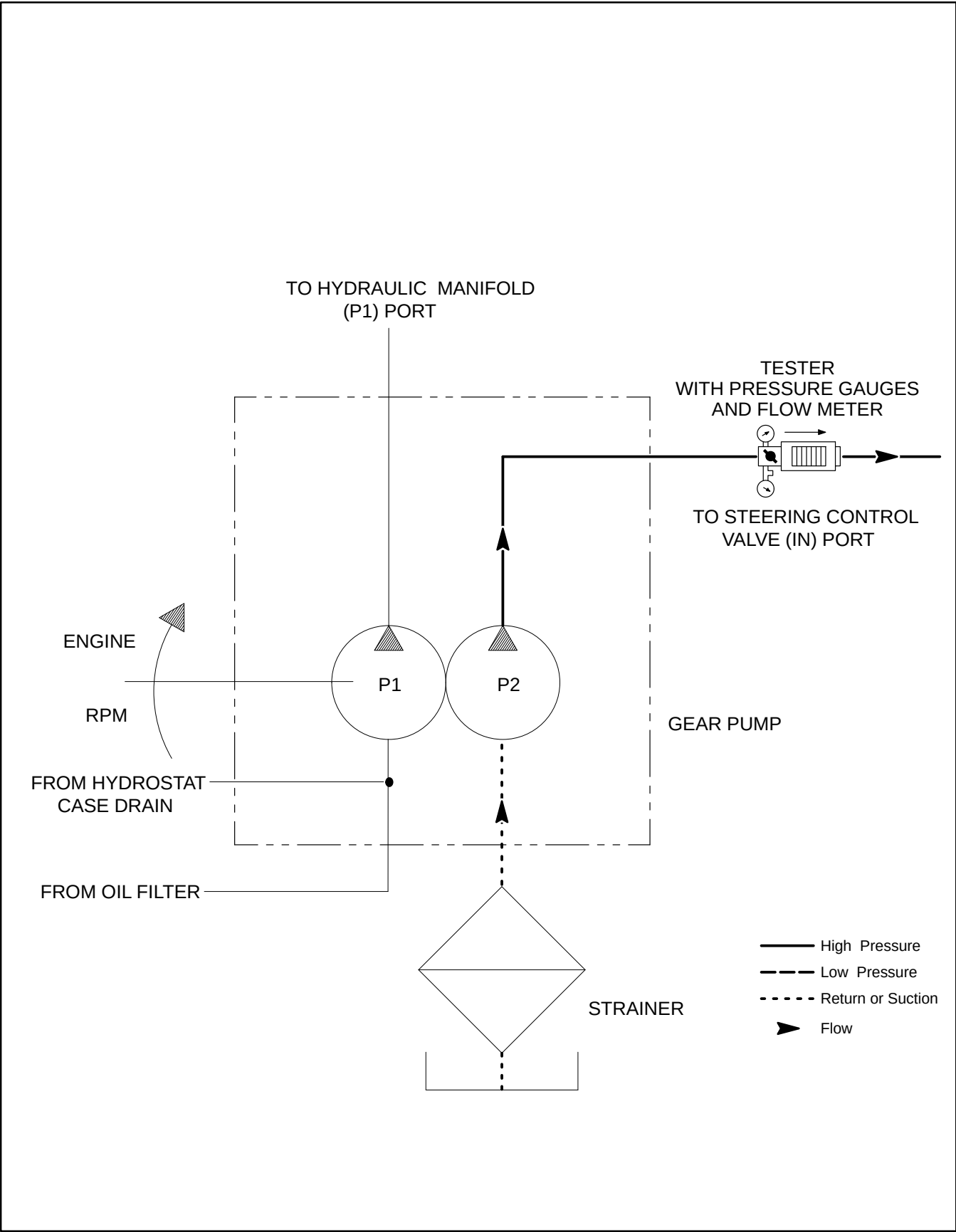
10. Set throttle to low speed and shut off engine.

11. The under load test flow reading (step 9.B) should not drop **more than 15%** when compared to no load test flow reading (step 8.A). A difference in flow of more than 15%, or the inability to achieve specified pressure may indicate:

- A. A restriction in the pump intake line
- B. A Worn and/or slipping traction belt
- C. The gear pump (P1) is worn and should be repaired or replaced

12. Disconnect tester and reconnect hose to pump.

Steering/Lift/Sidewinder Circuit Testing – Gear Pump (P2) Flow Test



Steering/Lift/Sidewinder Circuit Testing – Gear Pump (P2) Flow Test:

Gear pump (P2) is designed to satisfy both steering cylinder and lift/sidewinder cylinder needs simultaneously (at full speed throttle). The Gear Pump (P2) Flow Test compares fluid flow at No Load with fluid flow Under Load. A drop in flow under load of more than **15%** indicates the gears and wear plates in the pump have worn. Continued operation with a worn pump can generate excessive heat and cause damage to the seals and other components in the hydraulic system.

If unit steering is sluggish or otherwise performs poorly, see Steering/Lift/Sidewinder Circuit – Steering Control Valve and Steering Cylinder Test in this chapter.

If cutting deck lift or sidewinder operation is unsatisfactory, check lift/sidewinder control valve and/or lift and sidewinder cylinders. Additional information on these components is available in this chapter.

If both steering and lift operations perform poorly, perform the gear pump (P2) flow test and circuit relief valve pressure test (see Steering/Lift/Sidewinder Circuit – Relief Valve Pressure Test in this chapter).

Special Equipment Required:

- Flow Meter with Pressure Gauge that has at least a 5 GPM (16 LPM) capacity.
- Phototach (non-contact tachometer).

1. Park machine on a level surface with the cutting units lowered and PTO switch off. The engine should be off and the parking brake engaged.
2. Read Precautions for Hydraulic Testing in this chapter.
3. Disconnect hose connection on the gear pump (P2) leading to the steering control valve (Fig. 38).
4. Install tester between gear pump and the disconnected hose.
5. Make sure the flow control valve on the tester is fully open.
6. Start engine and move throttle to full speed (Diesel engine = **3220 ± 50 RPM**, Gas engine = **3420 ± 30 RPM**).
7. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.

Use a phototach to verify that the **pump speed** is approximately **2850 RPM**.

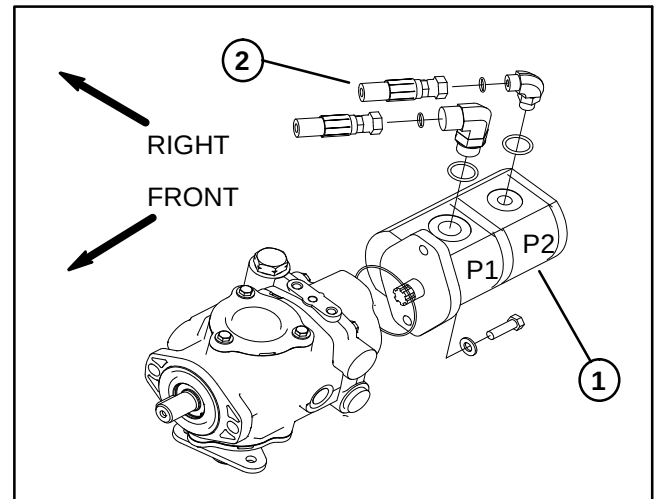


Figure 38

1. Gear pump assembly
2. To steering control valve

8. Verify pump flow at No Load as follows:

Record tester pressure and flow readings at no load. Unrestricted pump output should be approximately **3.8 GPM (14.4 LPM)**.

9. Verify pump flow Under Load as follows:



CAUTION

Do not close tester valve fully when performing this test. In this test, the hydraulic tester is positioned before the manifold relief valve. Pump damage can occur if the fluid flow is fully restricted by fully closing the tester flow control valve.

A. Watch pressure gauge carefully while slowly closing the flow control valve until **800 PSI (55.2 Bar)** is obtained on gauge.

B. Record tester pressure and flow readings under load.

10. Set throttle to low speed and shut off engine.

11. The under load test flow reading (step 9.B) should not drop **more than 15%** when compared to the no load test flow reading (step 8.A). A difference in flow of more than 15%, or the inability to achieve specified pressure may indicate:

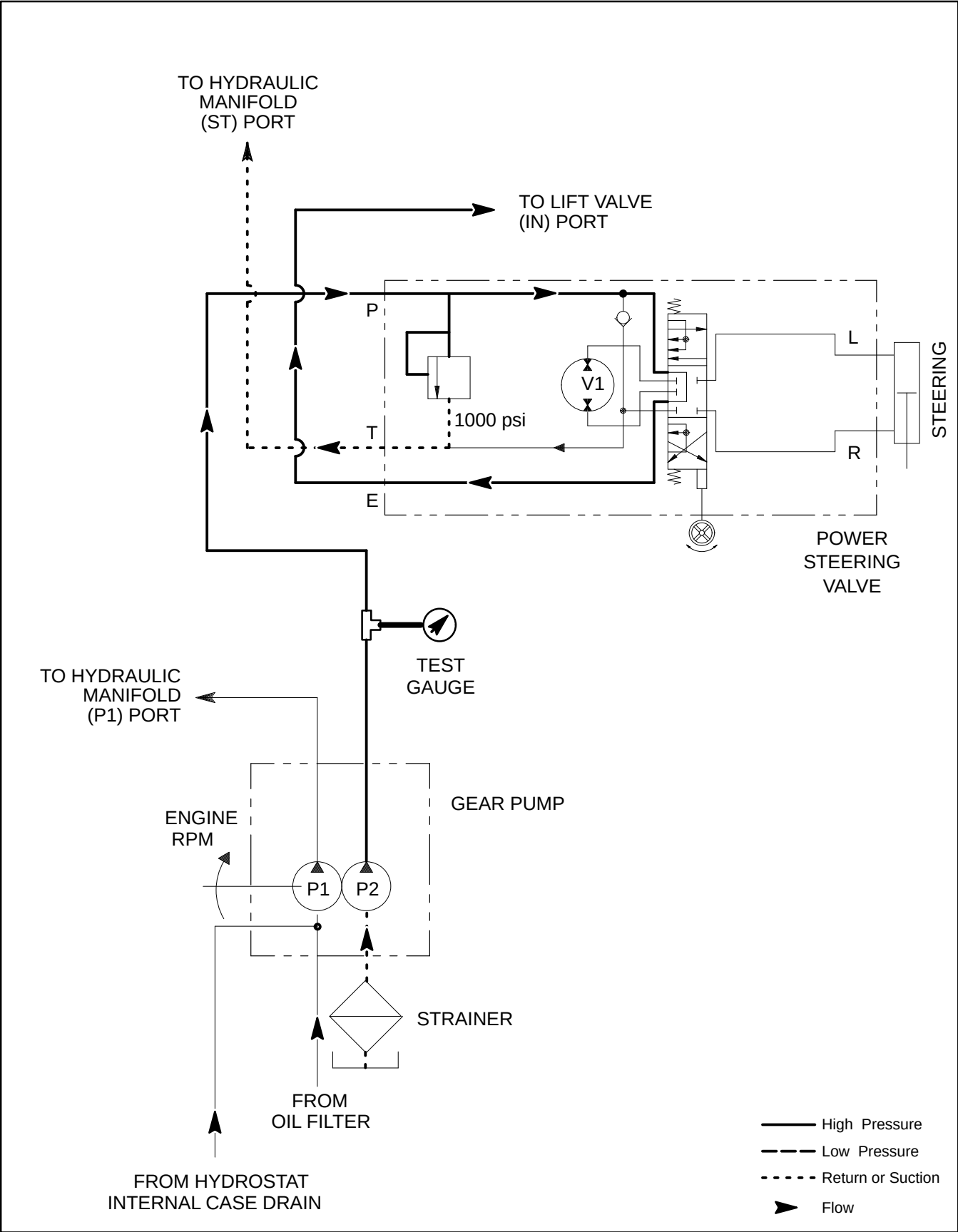
- A. A restriction in the pump intake line
- B. A Worn and/or slipping drive belt
- C. The gear pump (P1) is worn and should be repaired or replaced

12. Disconnect tester and reconnect hose to pump.

NOTE: If necessary, circuit relief valve pressure test can be conducted with tester in the same location as for this test (see Steering/Lift/Sidewinder Circuit – Relief Valve Pressure Test in this chapter).

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Steering/Lift/Sidewinder Circuit Testing – Relief Valve Pressure Test



Steering/Lift/Sidewinder Circuit Testing – Relief Valve Pressure Test:

The relief valve for the steering, lift, and sidewinder circuits is integrated into the steering control valve. If both steering and lift operations perform poorly, perform the relief valve pressure test and gear pump (P2) flow test (see Steering/Lift/Sidewinder Circuit – Gear Pump (P2) Flow Test in this chapter).

NOTE: If available, using a flow meter with pressure gauge that has at least a 5 GPM (16 LPM) capacity instead of a pressure gauge (as described in this test) will allow performing the relief valve test and the pump (P2) flow test with the same test configuration (see Steering/Lift/Sidewinder Circuit – Gear Pump (P2) Flow Test in this chapter).

1. Park machine on a level surface with the cutting units lowered and PTO switch off. Make sure engine is off and the parking brake is engaged.
2. Read Precautions for Hydraulic Testing in this chapter.
3. Disconnect hose connection on gear pump (P2) leading to the steering control valve (Fig. 39).
4. Install T-connector with test gauge between the gear pump and the disconnected hose.
5. Make sure steering wheel is positioned so the rear wheel points directly ahead.
6. Start engine and move throttle to full speed (Diesel engine = **3220 ± 50 RPM**, Gas engine = **3420 ± 30 RPM**).
7. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
8. Watch pressure gauge carefully while turning the steering wheel completely in one direction and holding.



CAUTION

Do not allow pressure to exceed 1500 PSI. Hold steering wheel at full lock only long enough to get a system pressure reading. Holding the steering wheel against the stop for an extended period may damage the steering control valve.

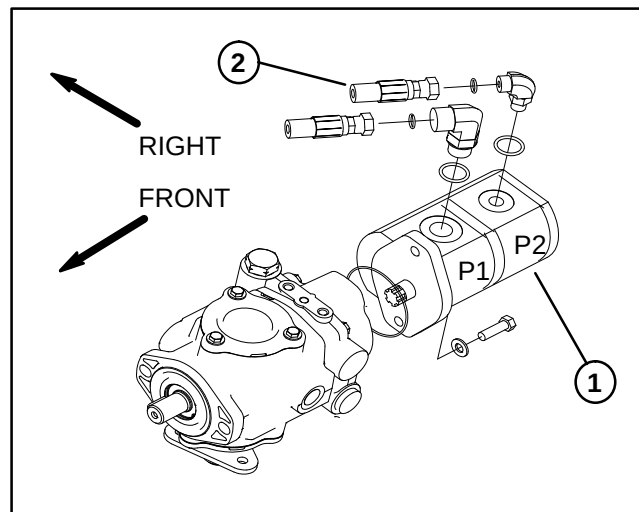


Figure 39

1. Gear pump assembly 2. To steering control valve

9. System pressure should reach **940 to 1015 PSI (65 to 70 Bar)** as the relief valve opens.
10. Return steering wheel to the center position and shut off engine.
11. If specification is not met, repair or replace steering control valve.
12. Disconnect T-connector with test gauge and reconnect hydraulic hose to gear pump.

STEERING CYLINDER

OPEN FITTING

PLUG

L

R

POWER STEERING VALVE (LEFT TURN)

V1

1000 psi

P

T

E

High Pressure

Low Pressure

Return or Suction

Flow

Steering/Lift/Sidewinder Circuit Testing – Steering Control Valve and Steering Cylinder Test:

Unit steering performance will be affected by incorrect rear tire pressure, binding in the hydraulic steering cylinder, extra weight on the vehicle, and/or binding of the steering fork assembly. Make sure that these conditions are checked and functioning properly before proceeding with any steering system hydraulic testing.

1. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.
2. Drive machine slowly in a figure eight on a flat level surface.
 - A. There should be no shaking or vibration in the steering wheel or rear wheel.
 - B. Steering wheel movements should be followed immediately by a corresponding rear wheel movement without the steering wheel continuing to turn.
3. Stop unit with the engine running. Turn steering wheel with small quick movements in both directions. Let go of the steering wheel after each movement.
 - A. The steering control valve should respond to each steering wheel movement.
 - B. When steering wheel is released, steering control should return to the neutral position with no additional turning.

4. If either of these performance tests indicate a steering problem, determine if the steering cylinder is faulty using the following procedure.

- A. Park machine on a level surface with the cutting units lowered, PTO switch off, and the parking brake engaged.
 - B. With the engine running, turn the steering wheel to the left (counterclockwise) until the steering cylinder rod is fully extended and turn the engine off.
 - C. Read Precautions for Hydraulic Testing in this chapter.
 - D. Remove hydraulic hose from the fitting on the rod end of the steering cylinder. Plug the end of the hose removed.
 - E. With the engine off, continue turning the steering wheel to the left (counterclockwise) with the steering cylinder fully extended. Observe the open fitting on the steering cylinder as the wheel is turned. If hydraulic fluid comes out of the fitting while turning the steering wheel to the left, the steering cylinder has internal leakage and must be repaired or replaced.
 - F. Remove plug from the hydraulic hose and reconnect the hose.
5. If steering problem exists and steering cylinder passed test, perform the Gear Pump (P2) Flow Test and Circuit Relief Valve Pressure Test (see specific test procedures in this chapter) to make sure the steering control valve and cylinder are receiving adequate fluid flow and pressure. Based on the results of these tests, repair or replace steering control valve as necessary (see Steering Control Valve and Steering Control Valve Service in this chapter).

Adjustments

Blade Braking Valve (BV) Adjustment (Traction Units Prior to No 314000001)

The blade braking valve (BV) on the hydraulic manifold controls the stopping time for the cutting deck blades. The braking valve is adjustable. If adjustment of the braking valve is correct, the cutting deck blades should come to a complete stop within 7 seconds after the PTO switch is disengaged.

If blade stopping time is incorrect, adjustment of the braking valve (BV) can be performed as follows:

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

1. Loosen lock nut on braking valve (Fig. 40).
2. To decrease blade stopping time, turn the adjustment shaft on the valve in a counterclockwise direction.
3. To increase blade stopping time, turn the adjustment shaft on the valve in a clockwise direction.
4. Tighten lock nut to secure adjustment.
5. Check blade stopping time and readjust braking valve as needed.

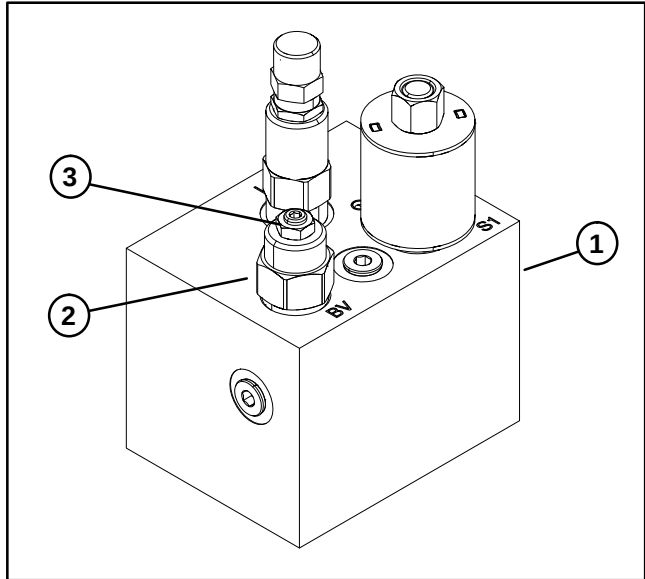


Figure 40

- | | |
|------------------------|-------------|
| 1. Hydraulic manifold | 3. Lock nut |
| 2. Blade braking valve | |

Blade Braking Relief Valve (RV) Adjustment (Traction Units No 314000001 & Up)

The blade braking relief valve (RV) on the hydraulic manifold works in conjunction with logic cartridge valve (LC2) to control the stopping time for the cutting deck blades. The relief valve is adjustable. If adjustment of the relief valve is correct, the cutting deck blades should come to a complete stop within 7 seconds after the PTO switch is disengaged.

If blade stopping time is incorrect, adjustment of the relief valve (RV) can be performed as follows:

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

1. Remove cap on relief valve with an allen wrench.
2. To **increase** pressure setting, turn the adjustment socket on the valve in a clockwise direction. A 1/8 turn on the socket will make a measurable change in relief pressure.
3. To **decrease** pressure setting, turn the adjustment socket on the valve in a counterclockwise direction. A 1/8 turn on the socket will make a measurable change in relief pressure.
4. Install and tighten cap on relief valve.
5. Check blade stopping time and readjust relief valve as needed.

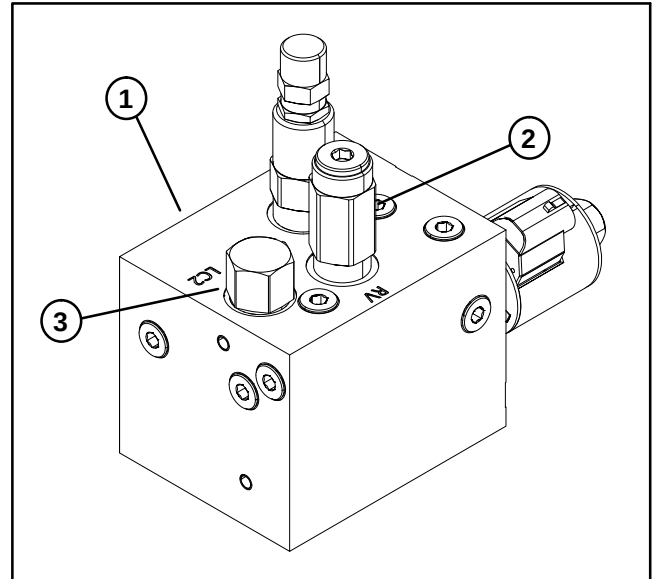


Figure 41

1. Hydraulic manifold
2. Relief valve (RV)
3. Logic valve (LC2)

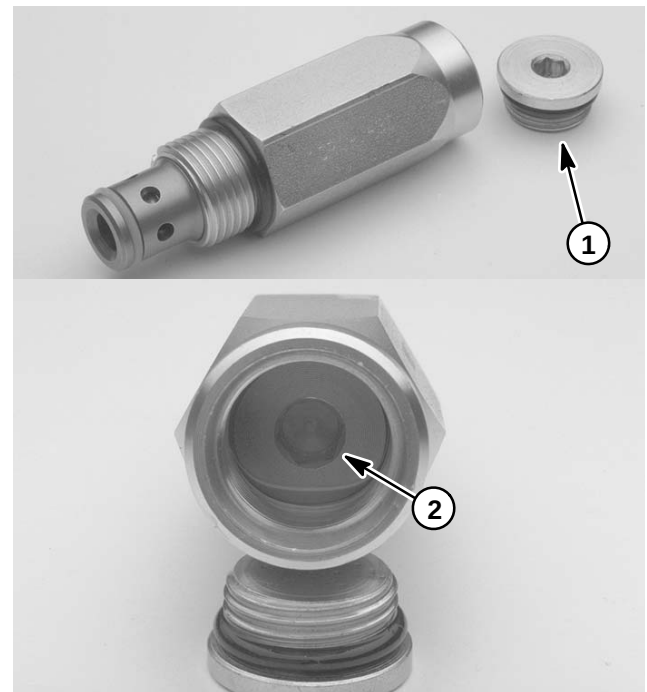
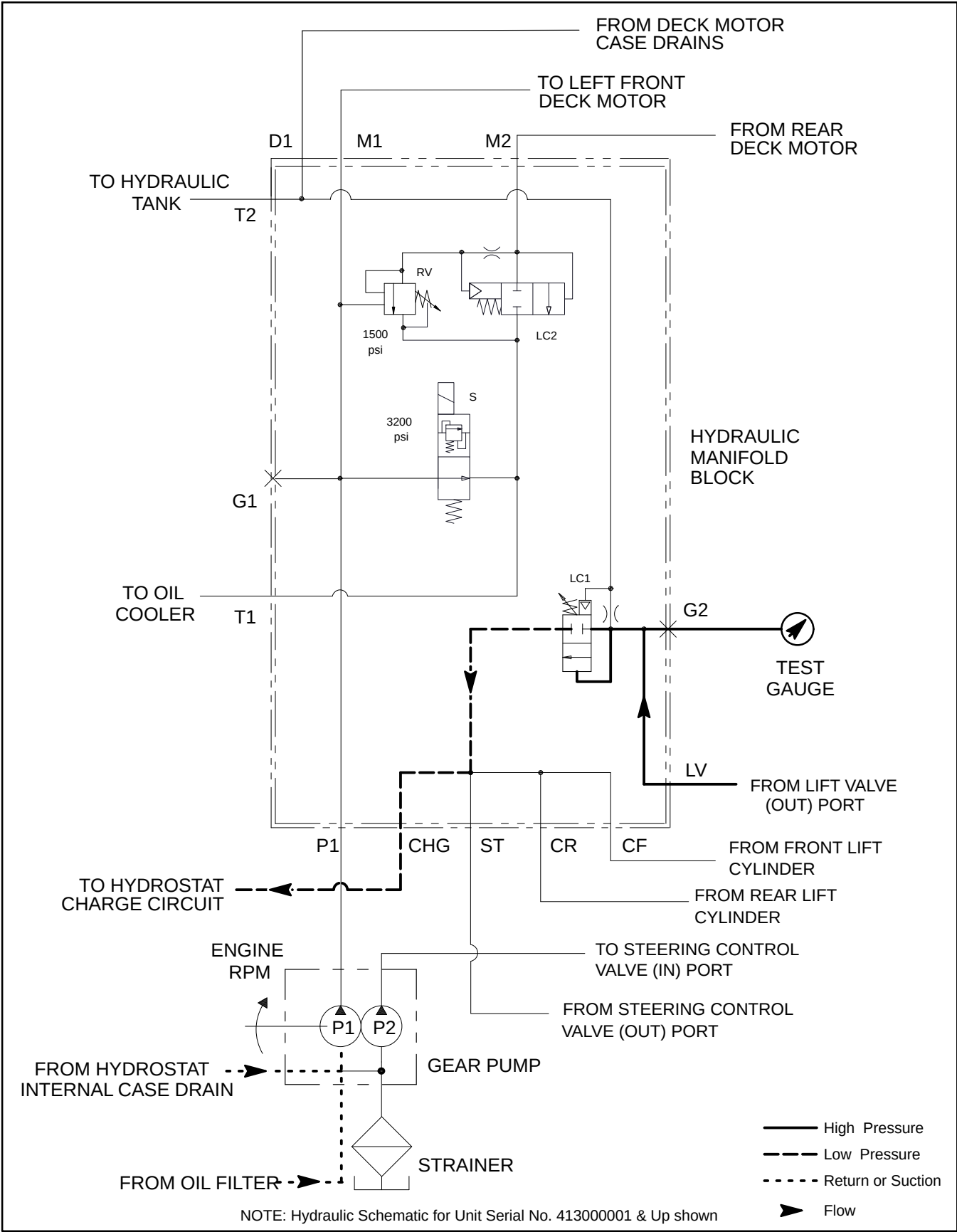


Figure 42

1. Relief valve cap
2. Adjustment socket

Counterbalance Logic Valve (LC1) Adjustment



Counterbalance Logic Valve (LC1) Adjustment:

The counterbalance system helps distribute the overall unit weight across the drive wheels and cutting decks for improved traction and reduced turf marking. The system is functioning properly if the machine settles slightly when the engine is started while the cutting decks are in the fully lowered position.

1. Park machine on a level surface with the cutting units lowered and PTO switch off. Make sure engine is off and the parking brake is engaged.

2. Read Precautions for Hydraulic Testing in this chapter.

3. Remove cap from test fitting at manifold port (G2) (Fig. 43 and 44).

4. Install test gauge with hydraulic hose attached to port (G2).

5. Start engine and move throttle to full speed (Diesel engine = **3220 ± 50 RPM**, Gas engine = **3420 ± 30 RPM**).

6. Make sure hydraulic fluid is at normal operating temperature by operating the machine for approximately 10 minutes.

The standard counterbalance pressure should be **250 PSI (17 Bar)** with a range of **180 to 300 psi (12.4 to 20.7 Bar)**. A lower counterbalance pressure is more desirable for flat terrain, while a higher counterbalance pressure will improve performance in hilly terrain. Adjust the Logic Valve (LC1) as necessary.

7. Adjust the Logic Valve (LC1) with the engine running as follows:

A. Remove hex cap from logic valve (Fig. 43 and 44).

B. Loosen locknut.

C. To increase pressure setting, turn the adjustment shaft on the valve in a clockwise direction. A 1/8 turn on the shaft will make a measurable change in counterbalance pressure.

D. To decrease pressure setting, turn the adjustment shaft on the valve in a counterclockwise direction. A 1/8 turn on the shaft will make a measurable change in counterbalance pressure.

E. Tighten locknut. Check counterbalance pressure and readjust as needed.

F. Replace hex cap to Logic valve (LC1).

Unit Serial No. Prior to 314000001

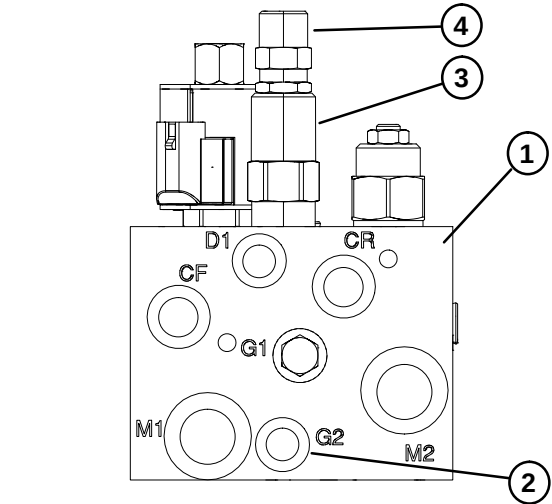


Figure 43

- | | |
|-----------------------|----------------|
| 1. Hydraulic manifold | 3. Logic valve |
| 2. Manifold port (G2) | 4. Hex cap |

Unit Serial No. 314000001 & Up

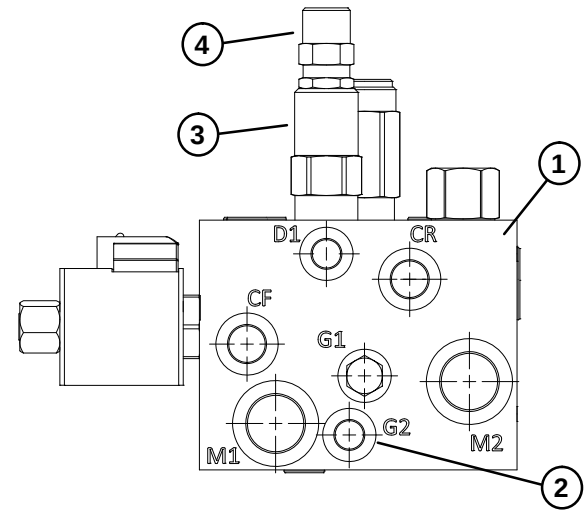


Figure 44

- | | |
|-----------------------|----------------|
| 1. Hydraulic manifold | 3. Logic valve |
| 2. Manifold port (G2) | 4. Hex cap |

8. Shut off engine.

9. Disconnect test gauge and install cap on test fitting at manifold port (G2).

Service and Repairs

General Precautions for Removing and Installing Hydraulic System Components

Before Repair or Replacement of Components

1. Before removing any parts from the hydraulic system, park machine on a level surface, engage parking brake, lower cutting units or attachments, and stop engine. Remove key from the ignition switch.
2. Clean machine before disconnecting, removing, or disassembling any hydraulic components. Make sure hydraulic components, hoses, connections, and fittings are cleaned thoroughly. Always keep in mind the need for cleanliness when working on hydraulic components.



CAUTION

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

3. Put caps or plugs on any hydraulic lines, hydraulic fittings, and components left open or exposed to prevent contamination.
4. Put labels on disconnected hydraulic lines and hoses for proper installation after repairs are completed.
5. Note the position of hydraulic fittings (especially elbow fittings) on hydraulic components before removal. Mark parts if necessary to make sure they will be aligned properly when reinstalling hydraulic hoses and tubes.

After Repair or Replacement of Components

1. Check fluid level in the hydraulic tank and add correct hydraulic fluid if necessary. Drain and refill hydraulic tank, and change fluid filter if component failure was severe or system is contaminated (see Flush Hydraulic System in this chapter).
2. Lubricate O-rings and seals with clean hydraulic fluid before installing hydraulic components.
3. Make sure caps or plugs are removed from the hydraulic tubes, hydraulic fittings, and components before reconnecting.
4. Use proper tightening methods when installing hydraulic hoses and fittings (see Hydraulic Fitting Installation in 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 chapter).
7. Check for hydraulic fluid leaks. Shut off engine and correct leaks if necessary. Check fluid level in hydraulic reservoir and add correct hydraulic fluid if necessary.

Check Hydraulic Lines and Hoses



WARNING

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

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

Priming Hydraulic Pumps

Whenever the hydraulic system is flushed, the hydraulic system is charged or hydraulic components are removed, it is important to properly prime the hydraulic pumps. Hydraulic pump priming ensures that the gear pump and piston (traction) pump have adequate oil during initial start-up and running. The pumps can be primed by using a remote starter switch (see Special Tools in this chapter) to crank engine which allows the pumps to prime.

Use the following procedure to prime the hydraulic pumps:

1. Make sure that ignition switch is in the OFF position and key is removed from switch.
2. Check hydraulic reservoir oil level and adjust if necessary.

NOTE: It may not be necessary to remove the wire from the starter solenoid B+ terminal when connecting a remote starter switch.

3. Connect remote starter switch electrical leads to the starter motor solenoid B+ terminal (Fig. 45) and the positive (+) terminal at the starter or battery.

4. Engage remote starter switch and crank starter for thirty (30) seconds to prime hydraulic pumps. Wait thirty (30) seconds to allow the starter motor and starter solenoid to cool. Repeat cranking procedure a second time.

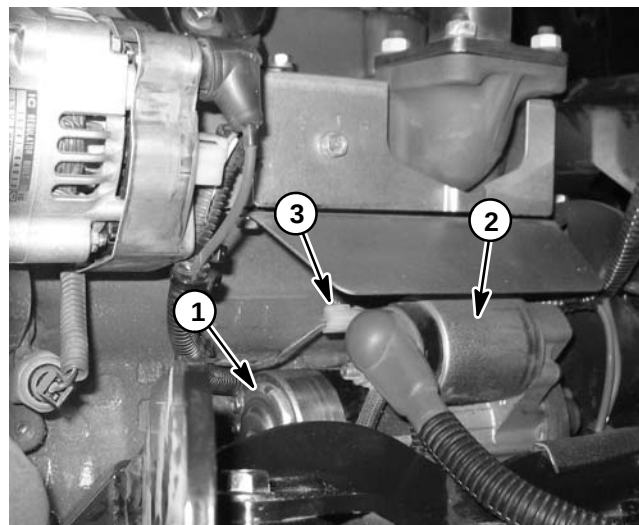


Figure 45

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

5. Disconnect remote starter switch leads from starter motor solenoid terminal and positive post of the battery.

Flush Hydraulic System

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

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

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

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



WARNING

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

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

2. Drain hydraulic tank.
3. Drain hydraulic system. Drain all hoses, tubes, and components while the system is warm.
4. Change and replace hydraulic fluid filter.
5. Inspect and clean hydraulic fluid tank (see Hydraulic Tank Inspection in this chapter).

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

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

NOTE: Use only hydraulic fluids specified (see Traction Unit Owner's Manual). Other fluids may cause system damage.

7. Fill hydraulic tank with new hydraulic fluid.

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

9. Start engine and let it idle at low speed for a minimum of 2 minutes. Increase engine speed to high speed for a minimum of 1 minute under no load.

10. Raise and lower cutting units several times. Turn steering wheel fully left and right several times.

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

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

13. Operate the machine for 2 hours under normal operating conditions.

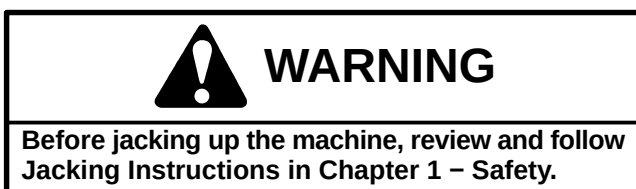
14. Check condition of hydraulic fluid. If the new fluid shows any signs of contamination, repeat steps 1 through 13 again until fluid is clean. If changing to biodegradable fluid, repeat steps 1 through 13 again at least once and until the fluid is clean.

15. Assume normal operation and follow recommended maintenance intervals.

Filtering Closed-Loop Traction Circuit

Filtering of a closed-loop hydraulic system after a major component failure (e.g. traction (piston) pump 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 and subsequent damage to other hydraulic components in the system will occur. To effectively remove contamination from closed-loop traction circuit, use of the Toro high flow hydraulic filter and hydraulic hose kit are recommended (see Special Tools in this chapter).

1. Park machine on a level surface, stop engine and remove key from ignition switch.



2. Raise and support machine so all wheels are off the ground.

NOTE: If a wheel motor was replaced, install high flow filter to the inlet (when traveling forward) of new wheel motor instead of to the inlet (when traveling forward) of the traction pump. This will prevent system contamination from entering and damaging the new motor.

3. Thoroughly clean junction of hydraulic hose and lower fitting on rear wheel motor (Fig. 46). Disconnect hose from lower fitting on wheel motor.

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

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

5. After installing high flow filter to machine, check and fill hydraulic reservoir with new hydraulic oil as required.
6. Sit in the operator's seat and start engine. Run engine at low idle speed and check for any hydraulic leakage from filter and hose connections. Correct any leaks before proceeding.

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

Groundsmaster 3500

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

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

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

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

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

11. Remove high flow hydraulic filter and hydraulic hose kit from machine. Reconnect hydraulic hose to rear wheel motor fitting. Make sure to properly tighten hose (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

12. Lower machine to ground.

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

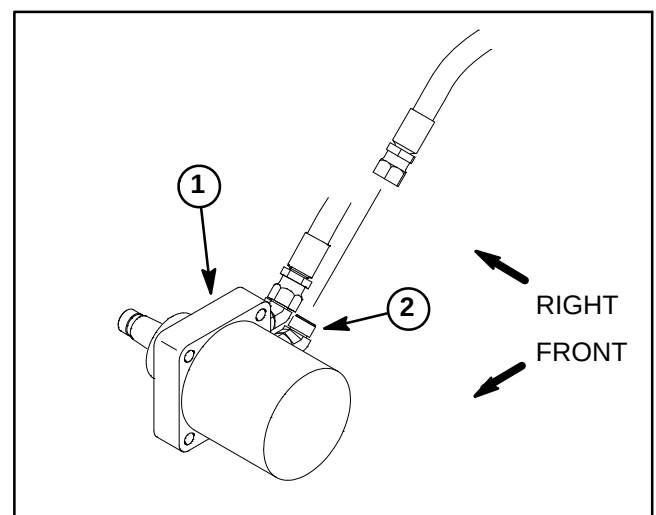


Figure 46

1. Rear wheel motor

2. Lower fitting

Charge Hydraulic System

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

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

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



WARNING

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

6. Raise all 3 wheels off the floor and safely support, the traction unit.

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

7. Make sure traction pedal is in neutral. Sit in the operator's seat and start engine and let it idle at low speed. The hydraulic pumps should pick up hydraulic fluid and fill the hydraulic system. If there is no indication of fill in **30 seconds**, stop the engine and determine the cause.

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

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

9. Operate the traction pedal in the forward and reverse directions. The wheels should rotate in the proper direction. If the wheels rotate in the wrong direction, stop engine, remove lines from rear of hydrostat pump, and reverse the connections.

10. Make sure that traction pedal returns to the neutral position when released from the forward or reverse direction.

11. Check operation of the traction interlock switches (see Check Operation of Interlock Switches in Chapter – 6, Electrical Systems in this manual).

12. Stop the engine, remove blocks from wheels and lower machine.

13. If the traction (traction) pump or a wheel motor was replaced or rebuilt, run the traction unit so all wheels turn slowly for 10 minutes.

14. Operate traction unit by gradually increasing its work load to full over a 10 minute period.

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

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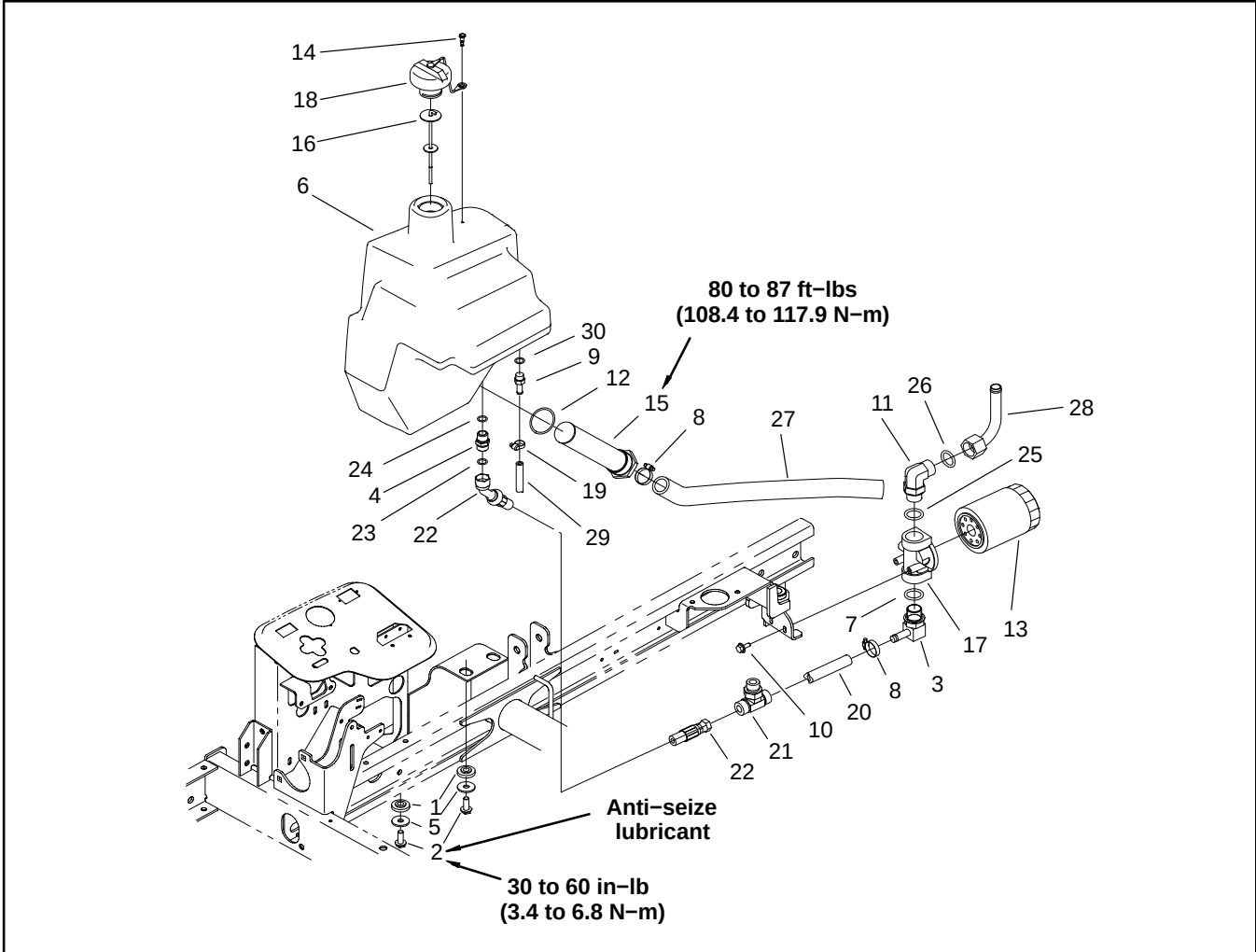


Figure 47

- | | | |
|----------------------------|--------------------------|--|
| 1. Grommet | 11. Elbow fitting | 21. Tee fitting |
| 2. Flange head screw | 12. O-ring | 22. Hydraulic hose |
| 3. Barb fitting | 13. Fluid filter element | 23. O-ring |
| 4. Check fitting | 14. Shoulder screw | 24. O-ring |
| 5. Flat washer | 15. Suction strainer | 25. O-ring |
| 6. Hydraulic tank | 16. Dipstick | 26. O-ring |
| 7. O-ring | 17. Filter head | 27. Hydraulic hose (suction) |
| 8. Hose clamp | 18. Hydraulic tank cap | 28. Hydraulic tube (from fluid cooler) |
| 9. Barb fitting (straight) | 19. Hose clamp | 29. Hydraulic hose (from manifold) |
| 10. Flange head screw | 20. Hydraulic hose | 30. O-ring |

Hydraulic Tank Removal

1. Drain hydraulic fluid from Hydraulic tank.
2. Remove hydraulic tank (Fig. 47). Discard and replace any O-rings that are removed.

Hydraulic Tank Inspection (Fig. 47)

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

Hydraulic Tank Installation

1. Apply anti-seize lubricant or equivalent to the four (4) flange head screws that secure the hydraulic tank. Tighten the tank mounting screws from **30 to 60 in-lb (3.4 to 6.8 N-m)**. Install tank (Fig 47).
2. Lubricate and install new O-ring on suction strainer.
3. Thread suction strainer into hydraulic tank. Torque strainer into tank port from **80 to 87 ft-lb (109 to 117 N-m)**.
4. Fill hydraulic tank with new hydraulic fluid.

Hydraulic Fluid Cooler



CAUTION

The radiator and hydraulic fluid cooler may be hot. To avoid possible burns, allow the engine and cooling systems to cool before working on the hydraulic fluid cooler.

Removal (Diesel Engine)

Traction Unit Serial No. Prior to 314000001, remove hydraulic fluid cooler (Fig. 48 and 49).

Traction Unit Serial No. 314000001 & Up, remove radiator/hydraulic fluid cooler assembly (see Radiator/Hydraulic Fluid Cooler Removal in Chapter 3 – Kubota Diesel Engine).

Removal (Gasoline Engine)

Remove radiator/hydraulic fluid cooler assembly (see Radiator/Hydraulic Fluid Cooler Removal in Chapter 4 – Kubota Gasoline Engine).

Inspection



CAUTION

Use eye protection such as goggles when using compressed air.

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

2. Dry inside of fluid cooler using compressed air in the opposite direction of the fluid flow.

3. Plug both ends of hydraulic fluid cooler. Clean exterior of cooler. Make sure fluid cooler fins are clear of dirt and debris.

4. The fluid cooler should be free of corrosion, cracked tubes, or excessive pitting of tubes.

Installation (Diesel Engine)

1. Traction Unit Serial No. Prior to 314000001, install hydraulic fluid cooler (Fig. 48 and 49).

1. Install radiator/hydraulic fluid cooler assembly (see Radiator/Hydraulic Fluid Cooler Installation in Chapter 3 – Kubota Diesel Engine).

2. Make sure hydraulic tank is full. Add hydraulic fluid if necessary.

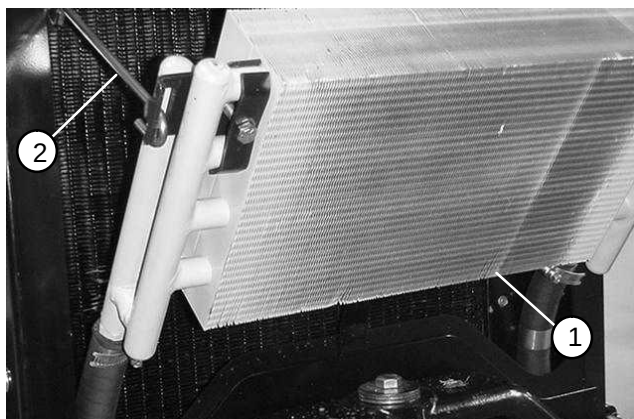


Figure 48

1. Fluid cooler

2. Latch

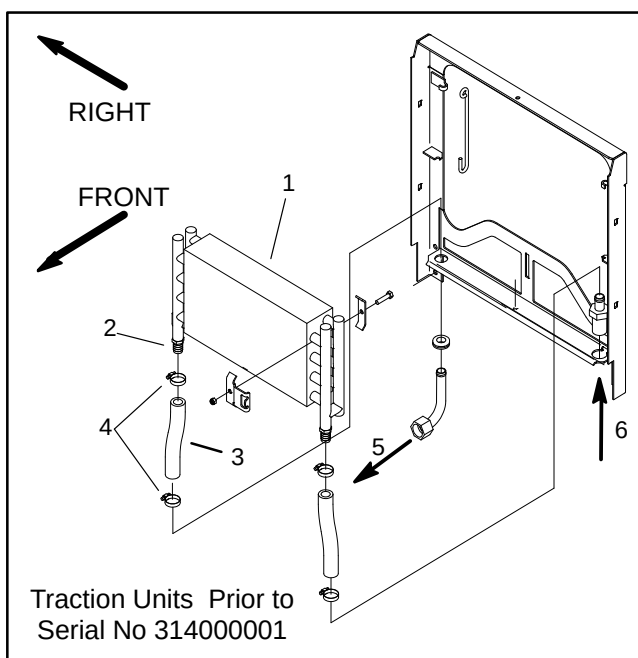


Figure 49

1. Fluid cooler

2. Barb fitting

3. Hydraulic hose

4. Hose clamp

5. Flow to fluid filter

6. Flow from manifold

Installation (Gasoline Engine)

1. Install radiator/hydraulic fluid cooler assembly (see Radiator/Hydraulic Fluid Cooler Installation in Chapter 4 – Kubota Gasoline Engine).

2. Make sure hydraulic tank is full. Add hydraulic fluid if necessary.

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Piston Pump/Hydrostat Assembly

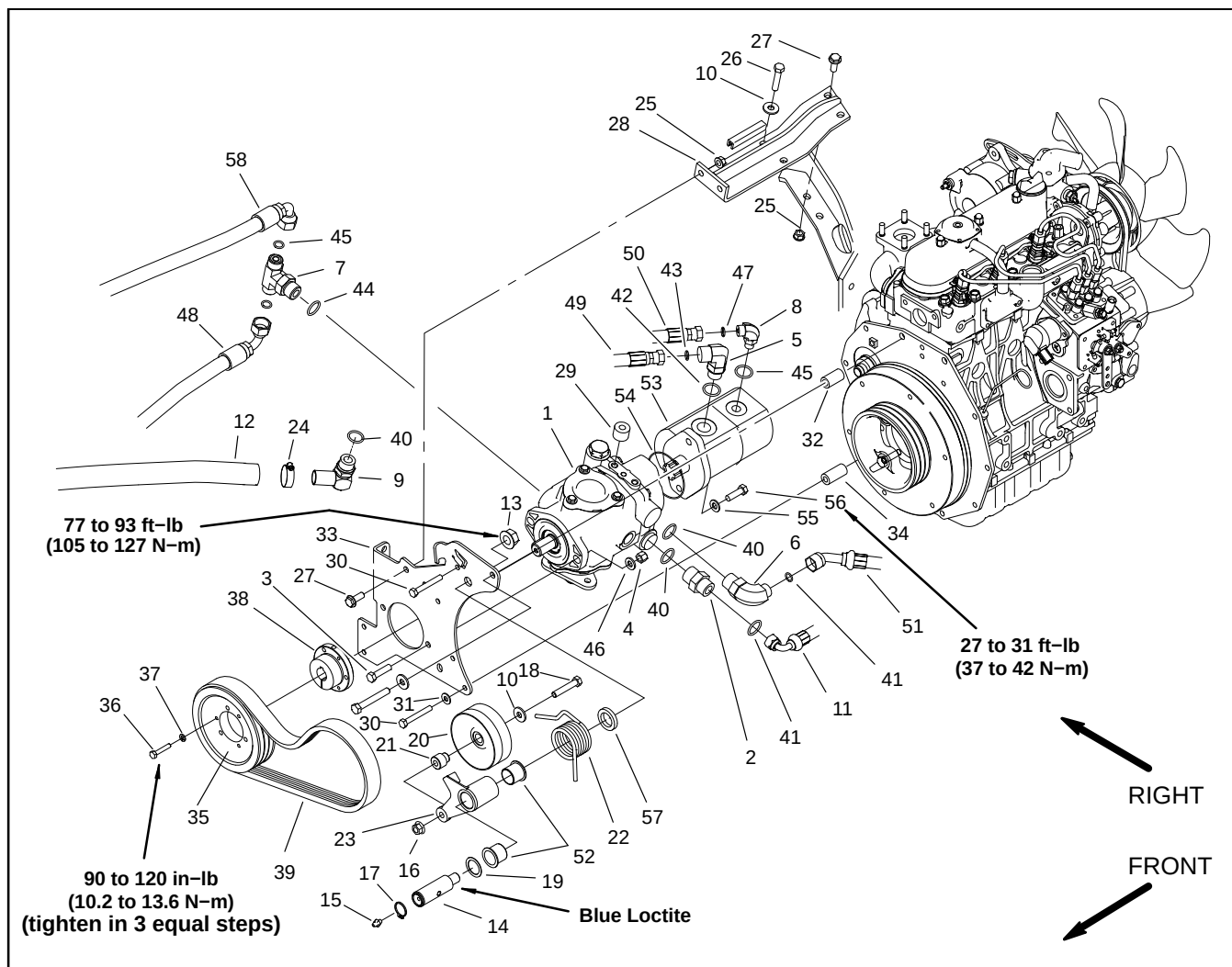
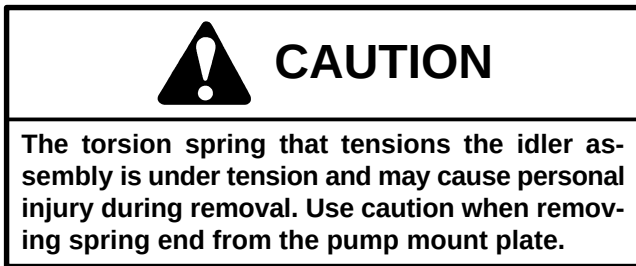


Figure 50

- | | | |
|-------------------------------|------------------------|-----------------------|
| 1. Piston pump | 21. Spacer | 40. O-ring |
| 2. Straight hydraulic fitting | 22. Torsion spring | 41. O-ring |
| 3. Cap screw | 23. Idler arm | 42. O-ring |
| 4. Lock nut | 24. Hose clamp | 43. O-ring |
| 5. 90° hydraulic fitting | 25. Flange nut | 44. O-ring |
| 6. 90° hydraulic fitting | 26. Cap screw | 45. O-ring |
| 7. Tee fitting | 27. Flange head screw | 46. Flat washer |
| 8. 90° hydraulic fitting | 28. Pump support | 47. O-ring |
| 9. 90° hydraulic fitting | 29. Spacer | 48. Hydraulic hose |
| 10. Washer | 30. Cap screw | 49. Hydraulic hose |
| 11. Hydraulic hose | 31. Flat washer | 50. Hydraulic hose |
| 12. Suction hose | 32. Spacer | 51. Hydraulic hose |
| 13. Flange nut | 33. Pump mount plate | 52. Bushing |
| 14. Idler pivot pin | 34. Pump mount spacer | 53. Gear pump |
| 15. Grease fitting | 35. Pulley | 54. O-ring |
| 16. Flange nut | 36. Cap screw | 55. Flat washer |
| 17. Retaining ring | 37. Lock washer | 56. Socket head screw |
| 18. Cap screw | 38. Taper lock bushing | 57. Idler arm spacer |
| 19. Thrust washer | 39. V-belt | 58. Hydraulic hose |
| 20. Idler pulley | | |

Drive Belt Removal (Fig. 50)

1. Park machine on a level surface. Lower cutting units, stop engine and engage parking brake. Remove key from the ignition switch.
2. Raise and support hood.



3. Remove pump drive belt tension from torsion spring on idler arm (Fig. 51).
 - A. Insert nut driver or small piece of pipe onto the end of the torsion spring that is secured on the pump mount plate tab.
 - B. Push down and forward on the spring end to unhook the spring from the tab on the pump mount plate.
4. Rotate idler pulley away from pump drive belt and remove drive belt from pulleys. Make sure that drive belt is in good condition if it is to be re-installed. Replace drive belt if worn or damaged.
5. Remove drive belt idler components as needed.

Drive Belt Installation (Fig. 50)

1. Install all removed drive belt idler components. Make sure that idler pulley and idler arm rotate freely after assembly.
2. Install drive belt onto pulleys. Position idler pulley toward the pump drive belt.
3. Using a straight edge across the lower face of the pump pulley, verify pump drive belt alignment across engine and pump pulleys. If pulleys are not in alignment, adjust location of pump pulley on pump shaft so alignment is correct (see Piston Pump/Hydrostat in this chapter).



CAUTION

Use caution when installing torsion spring end onto the pump mount plate. Applying tension to the spring may cause personal injury during installation.

4. Apply pump drive belt tension with torsion spring on idler arm (Fig. 51).
 - A. Insert nut driver or small piece of pipe onto the end of the torsion spring.
 - B. Push down on the spring end and then hook the spring under the tab on the pump mount plate.
5. Lubricate grease fitting on end of idler pivot shaft.
6. Lower and secure hood.

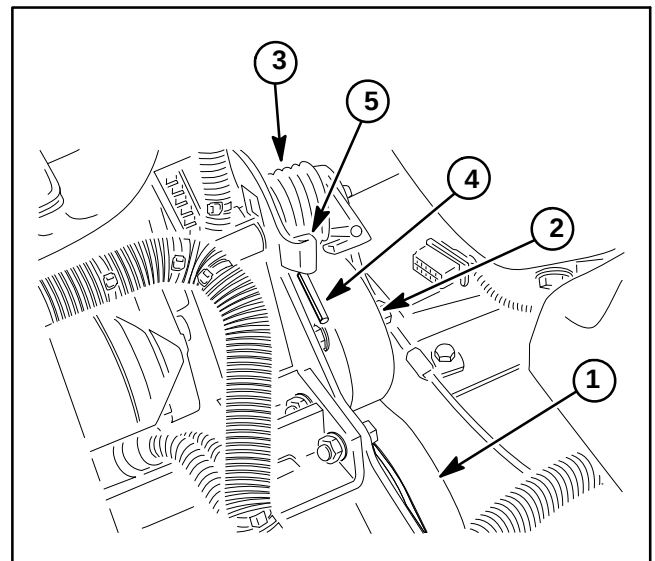


Figure 51

- | | |
|-----------------------|-------------------------|
| 1. Pump drive belt | 4. Spring end |
| 2. Idler pulley | 5. Pump mount plate tab |
| 3. Torsion spring end | |

Neutral Arm Assembly

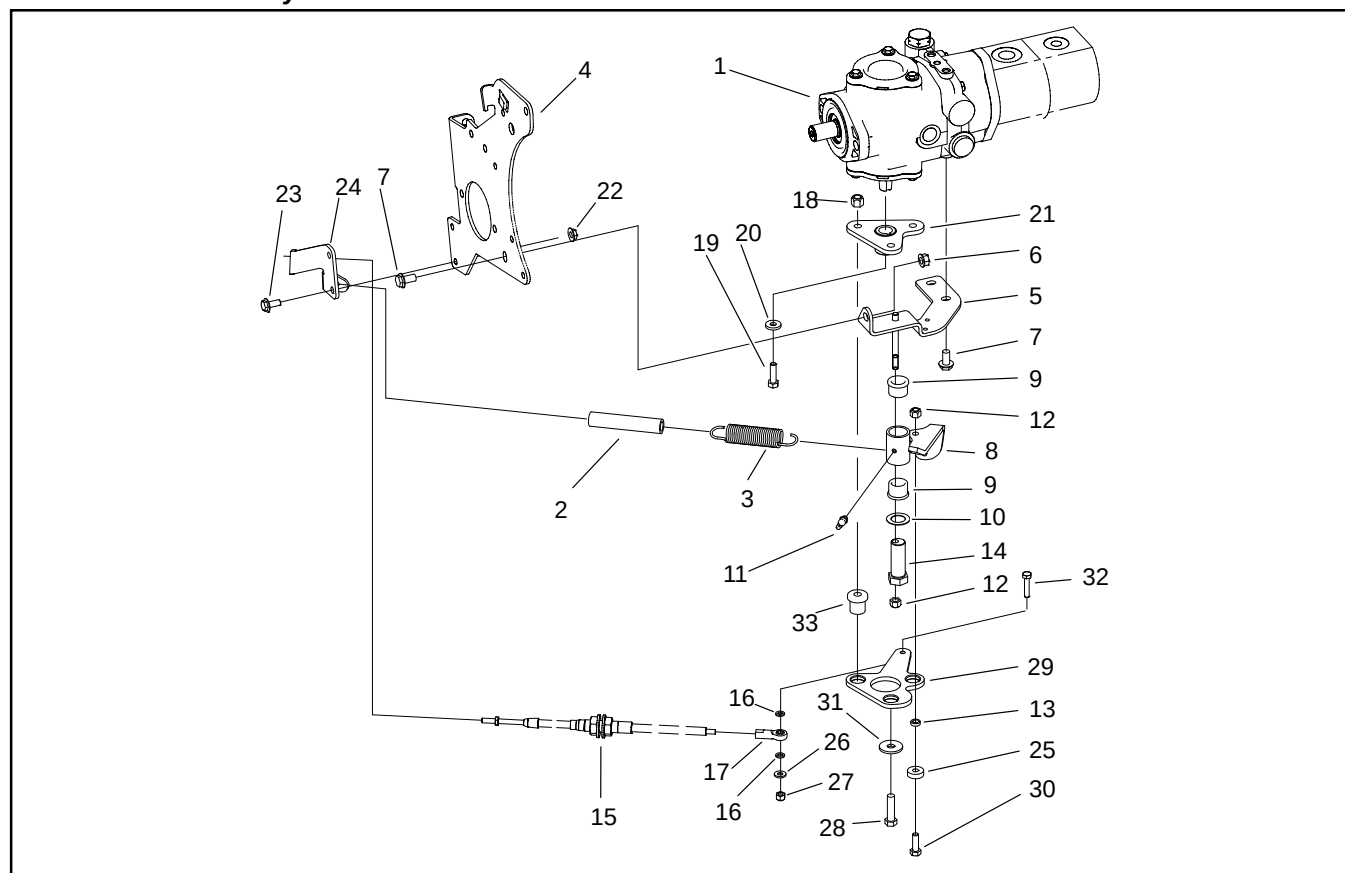


Figure 52

- | | | |
|------------------------|----------------------------|---------------------------|
| 1. Pump assembly | 12. Lock nut | 23. Flange head screw |
| 2. Hose | 13. Spacer | 24. Cable support bracket |
| 3. Extension spring | 14. Traction stud | 25. Ball bearing |
| 4. Pump mount plate | 15. Traction control cable | 26. Flat washer |
| 5. Neutral bracket | 16. Flat washer | 27. Lock nut |
| 6. Flange nut | 17. Ball joint | 28. Cap screw |
| 7. Flange head screw | 18. Lock nut | 29. Pump lever |
| 8. Neutral arm | 19. Cap screw | 30. Cap screw |
| 9. Flange bushing | 20. Flat washer | 31. Flat washer |
| 10. Thrust washer | 21. Hub assembly | 32. Cap screw |
| 11. 90° grease fitting | 22. Flange nut | 33. Mount |

Neutral Arm Removal (Fig. 52)

1. Park machine on a level surface. Lower cutting units, stop engine and engage parking brake. Remove key from the ignition switch.
2. Raise and support hood.



3. Remove extension spring from the cable support bracket and neutral arm.
4. Disconnect traction control cable from the pump lever. Locate and retrieve three (3) flat washers and note their position for assembly purposes.
5. Remove both flange head screws securing the neutral bracket to the piston pump. Remove flange nut and flange head screw securing the neutral bracket to the pump mount plate.
6. Remove cap screw and flat washer that secure the pump lever and hub assembly to the piston pump trunnion.
7. Separate pump lever and hub assembly from pump trunnion and neutral bracket from mount plate. Locate and retrieve key from trunnion.

Neutral Arm Installation (Fig. 52)

1. Install key into trunnion slot. Position neutral bracket to the mount plate and the pump lever and hub assembly to the pump trunnion.
2. Secure pump lever and hub assembly to the piston pump trunnion with flat washer and cap screw.
3. Secure neutral bracket to the pump mount plate with flange head screw and flange nut. Secure neutral bracket to the piston pump with both flange head screws.
4. Position three (3) flat washers to traction control cable end. Secure traction control cable to the pump lever with cap screw and lock nut.



5. Install extension spring to the cable support bracket and neutral arm.
6. Adjust traction drive for neutral.
7. Lower and secure hood.

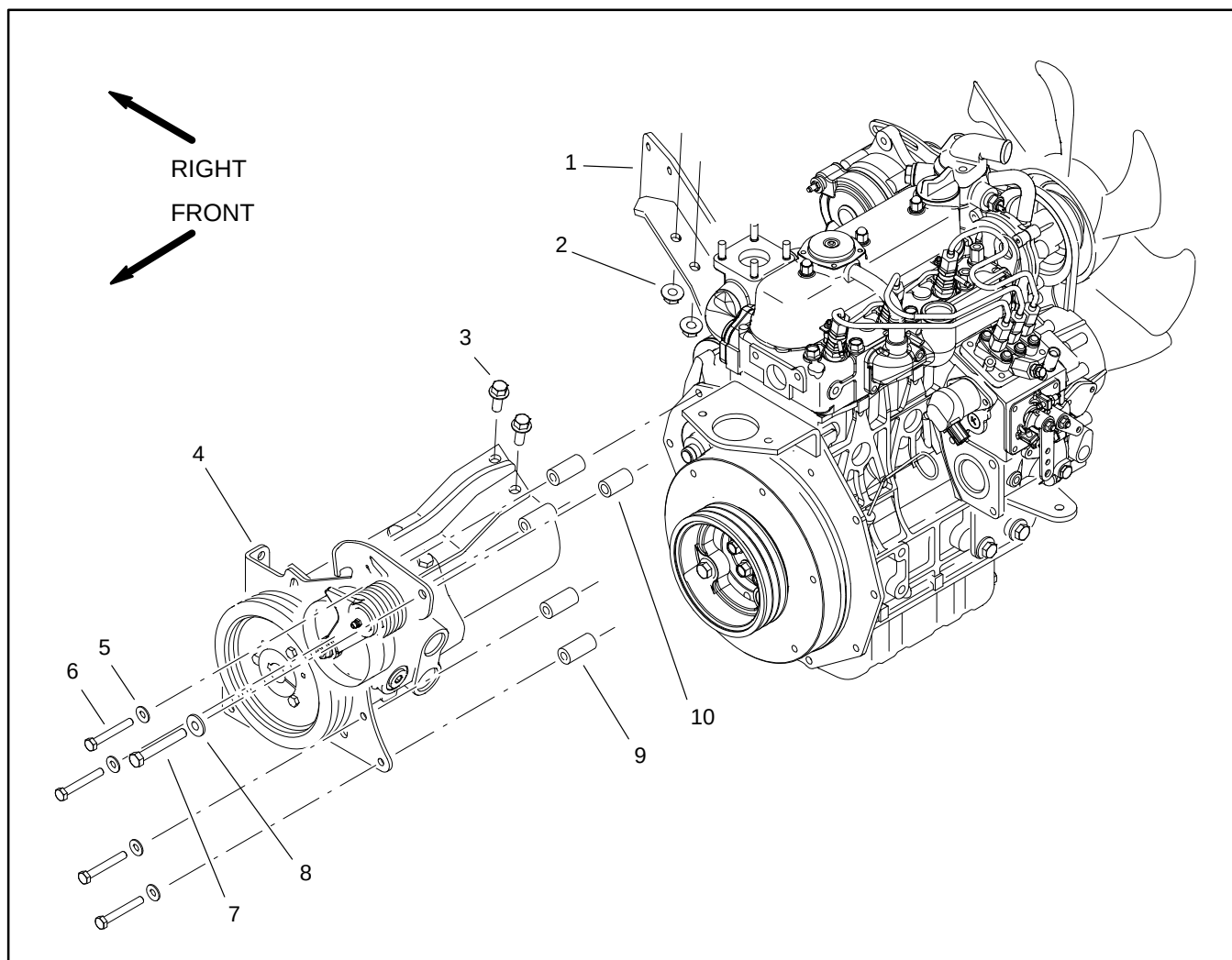


Figure 53

- | | | |
|-------------------------|------------------------|----------------------|
| 1. Engine mount bracket | 5. Hardened washer | 8. Hardened washer |
| 2. Flange nut | 6. 10 mm cap screw (4) | 9. Long spacer (4) |
| 3. Flange screw | 7. 8 mm cap screw (1) | 10. Short spacer (1) |
| 4. Pump mount plate | | |

Piston Pump/Hydrostat Removal (Fig. 50 and 53)

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

2. Raise and support hood.



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.

3. Remove pump drive belt (see Drive Belt Removal in this chapter).

4. Remove neutral arm assembly (see Neutral Arm Removal in this chapter).

5. Thoroughly clean hydraulic hose ends and fittings on piston pump/hydrostat and gear pumps to prevent hydraulic system contamination.

6. Disconnect the suction hose from the barbed fitting on the bottom of the gear pump and drain hydraulic tank into a suitable container.

7. Label all hydraulic hoses and fittings for assembly purposes.

8. Disconnect all hydraulic hoses connected to the hydraulic fittings on the piston pump/hydrostat and gear pump. Allow hoses to drain into a suitable container. Plug hose and fitting openings to prevent contamination.



9. Support hydraulic pump assembly to prevent it from shifting.

10. Remove both flange head screws and flange nuts that secure pump support to engine mount.

11. Remove fasteners and spacers securing the pump mount plate to the engine (Fig. 53). Note location of cap screws, washers and spacers for assembly purposes.

12. Carefully remove pump mount plate with pumps, pulley, pump support and idler assembly from the machine.

NOTE: A case drain exists in the piston pump/hydrostat and a suction port is near the input shaft of the gear pump (Fig. 54). When the gear pump is removed from the piston pump/hydrostat, plug both case drain holes to prevent draining the pumps.

13. Remove both cap screws and flat washers securing gear pump to the piston pump. Separate gear pump from the piston pump. Locate and retrieve O-ring. Plug openings of gear pump to prevent contamination.

14. Remove pump pulley from the taper lock bushing on the piston pump shaft:

A. Remove three (3) cap screws and lock washers securing pulley to the taper lock bushing.

IMPORTANT: Excessive or unequal pressure on the cap screws can break the bushing flange.

B. Insert cap screws into threaded removal holes of the pulley. Tighten screws progressively and evenly until the pulley is loose on the bushing. Remove pulley from the bushing.

15. Loosen set screw that secures taper lock bushing to piston pump shaft. Remove bushing from the pump shaft. Locate and retrieve key from pump shaft.

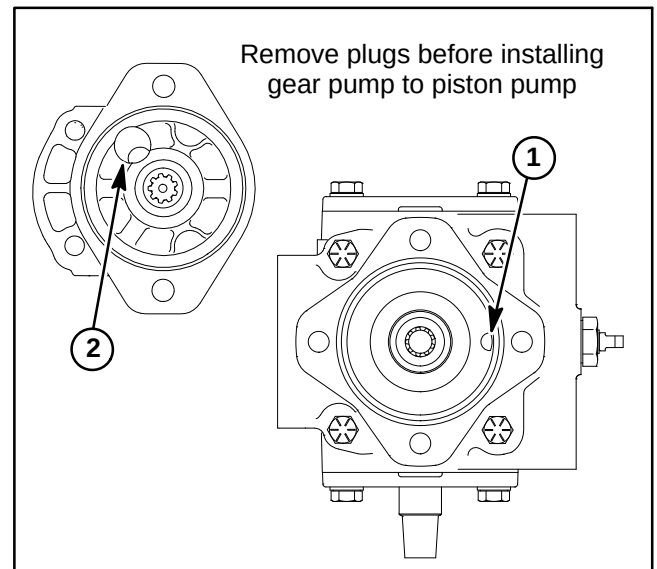


Figure 54

1. Piston pump/hydrostat case drain

2. Gear pump suction port

16. Remove both cap screws and washers that secure piston pump to pump support. Locate and retrieve spacers.

17. Remove lock nuts, flat washers and cap screws that secure the piston pump to the pump mount plate. Remove pump from plate.

18. If hydraulic fittings are to be removed from piston pump, mark fitting orientation to allow correct assembly. Remove hydraulic fittings and O-rings from the piston pump as needed. Discard removed O-rings.

Piston Pump Installation (Fig. 50 and 53)

1. Position and secure piston pump to the pump mount plate with cap screws, flat washers and lock nuts.

2. Lubricate and place new O-rings onto all removed pump fittings. Install fittings into pump openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Hydraulic Fitting Installation in this chapter).

IMPORTANT: A case drain exists in the piston pump/hydrostat and a suction port is near the input shaft of the gear pump (Fig. 54). Before the gear pump is installed to the piston pump, make sure that plugs placed in either of these ports are removed. Failure to remove plugs will cause excessive pressure in the piston pump and damage seals. Also, before installing gear pump to piston pump, fill piston pump housing with clean hydraulic oil through case drain hole.

3. Install and secure gear pump to the piston pump (see Gear Pump in this chapter).

4. Place key into piston pump shaft slot. Slide taper lock bushing onto the piston pump shaft with bushing flange toward pump housing.

5. Make sure that tapered surfaces of pump pulley and taper lock bushing are thoroughly clean (no oil, grease, dirt, rust, etc.).

6. Position pump pulley to taper lock bushing and align non-threaded holes of pulley with threaded holes of bushing. Loosely install three (3) cap screws with lock washers to bushing and pulley.



CAUTION

Support pump assembly during installation to prevent them from falling and causing personal injury or component damage.

7. Position pump assembly to the machine. Install fasteners and spacers securing the pump mount plate to the engine and pump support (Fig. 53). Tighten fasteners securely.

8. Position and secure pump support to pump mount plate, piston pump and engine mount with removed fasteners and spacers.

9. Install pump drive belt (see Drive Belt Installation in this chapter).

10. Using a straight edge across the lower face of the pump pulley, verify pump drive belt alignment across engine and pump pulleys. Slide pulley and taper lock bushing on pump shaft so that drive belt and straight edge are aligned indicating correct position of pump pulley. Secure taper lock bushing in position with set screw.

IMPORTANT: When tightening taper lock bushing cap screws, tighten in three (3) equal steps and in a circular pattern.

11. Secure taper lock bushing and pump pulley by tightening three (3) cap screws to a torque from **90 to 120 in-lb (10.2 to 13.6 N-m)** in three (3) equal steps and in a circular pattern.

12. Check that pump drive belt alignment is still correct. If needed, loosen and re-adjust pulley and taper lock bushing location on pump shaft to allow for correct belt alignment.

13. Remove caps and plugs from all fittings and hydraulic hoses. Using labels placed during pump removal, properly connect hydraulic lines to pump assembly (see Hydraulic Hose and Tube Installation in this chapter).

14. Install neutral arm assembly to the piston pump (see Neutral Arm Installation in this chapter).

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

16. Properly charge hydraulic system (see Charge Hydraulic System in this chapter)

17. Adjust traction drive for neutral (see Traction Unit Operator's Manual).

18. Lower and secure hood.

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Piston Pump/Hydrostat Service

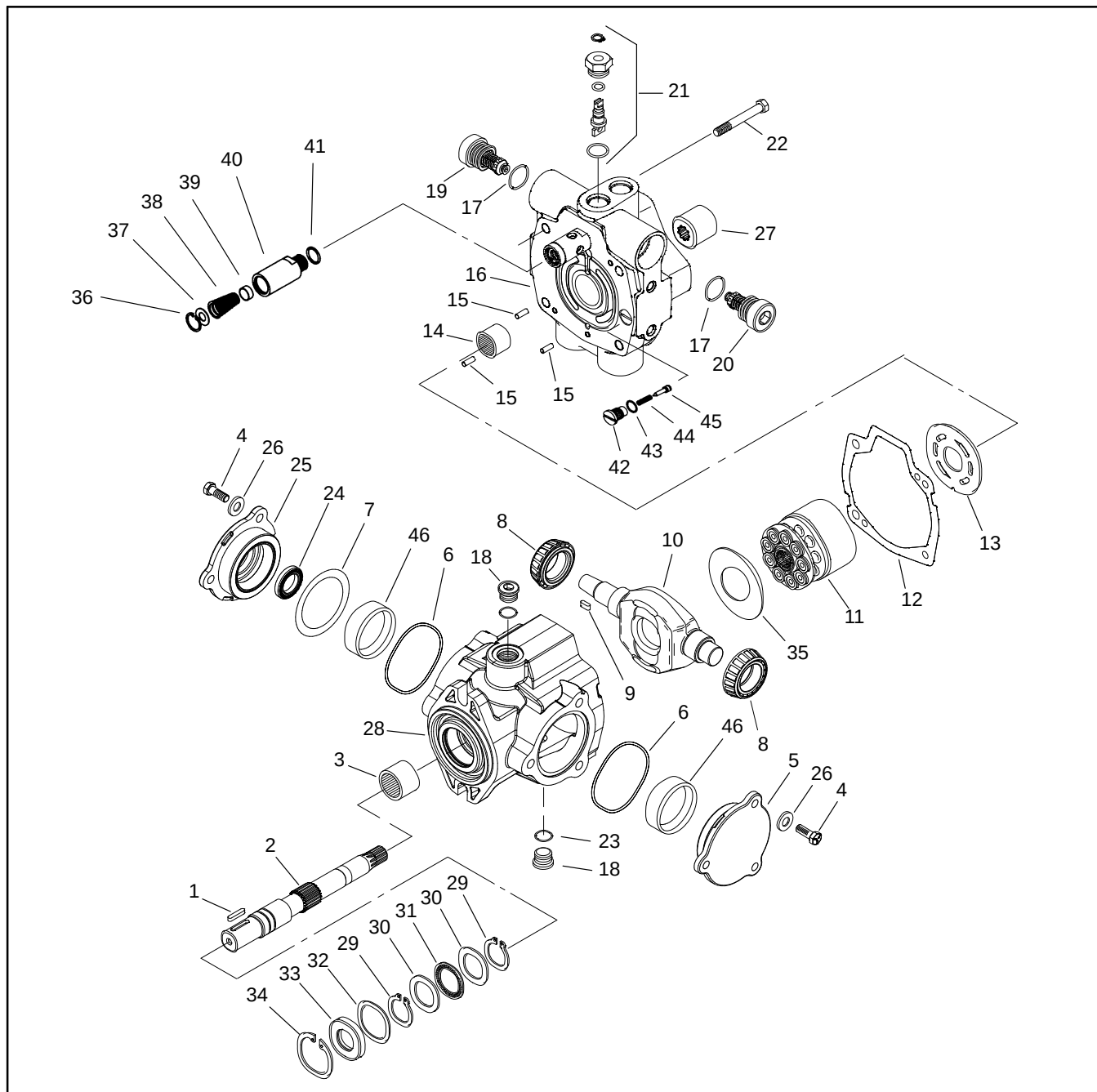


Figure 55

- | | | |
|---------------------------------|-------------------------------|----------------------------|
| 1. Key | 17. O-ring | 32. Washer |
| 2. Drive shaft | 18. Plug | 33. Shaft seal |
| 3. Bearing | 19. Relief valve asm. | 34. Retaining ring |
| 4. Cap screw (3 used per plate) | 20. Check valve asm. | 35. Cam plate insert |
| 5. Cover plate | 21. Bypass valve asm. | 36. Retaining ring |
| 6. O-ring | 22. Cap screw | 37. Washer |
| 7. Shim kit | 23. O-ring | 38. Charge relief spring |
| 8. Bearing cone | 24. Shaft seal | 39. Charge relief poppet |
| 9. Key | 25. Cover plate | 40. Charge relief housing |
| 10. Swashplate | 26. Washer (3 used per plate) | 41. O-ring |
| 11. Rotating kit | 27. Coupler | 42. Cartridge |
| 12. Gasket | 28. Housing | 43. O-ring |
| 13. Valve plate | 29. Retaining ring | 44. Bleed-off spring |
| 14. Bearing | 30. Thrust washer | 45. Bleed-off valve poppet |
| 15. Dowel pin | 31. Thrust bearing | 46. Bearing cup |

IMPORTANT: If a piston pump failure occurred, refer to **Traction Circuit (Closed Loop) Component Failure** in this chapter for information regarding the importance of removing contamination from the traction circuit.

NOTE: The traction circuit charge relief valve and the bleed off valve for traction circuit cooling are attached to the piston pump back plate assembly (Fig. 56). The back plate assembly must be removed from the piston pump/hydrostat to service either the relief valve or the bleed off valve.

IMPORTANT: The shim kit is used to replace the original crush ring (not shown) in the cover plate. If the swash plate, cover plate or housing is replaced during servicing, the old crush ring must be replaced. See **Piston Pump Crush Ring Replacement** in this chapter in conjunction with the Eaton service manual at the end of this chapter for additional information.

NOTE: For repair of the piston pump, see the Eaton Medium Duty Piston Pump Repair Information Model 70160 Variable Displacement Piston Pump at the end of this chapter.

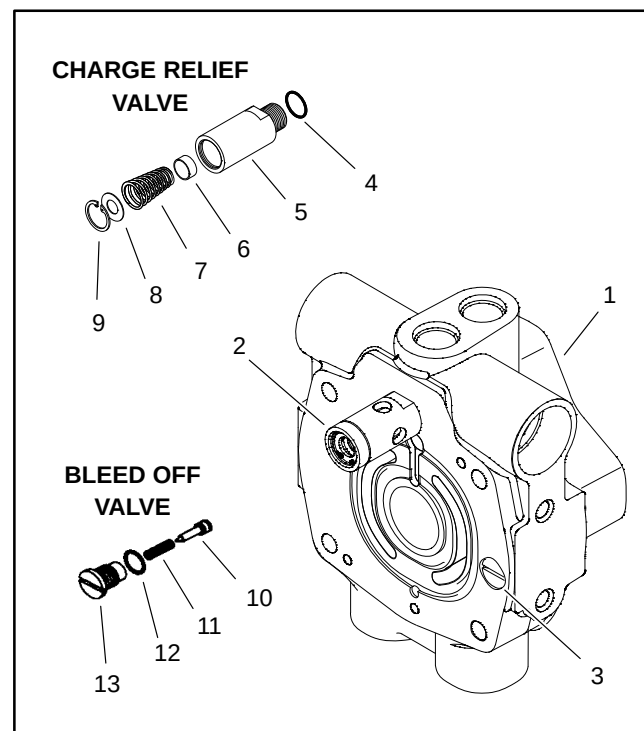


Figure 56

- | | |
|------------------------|---------------------|
| 1. Back plate assembly | 8. Washer |
| 2. Charge relief valve | 9. Retaining ring |
| 3. Bleed off valve | 10. Bleed off valve |
| 4. O-ring | 11. Spring |
| 5. Housing | 12. O-ring |
| 6. Poppet | 13. Cartridge |
| 7. Spring | |

Piston Pump/Hydrostat Crush Ring Replacement

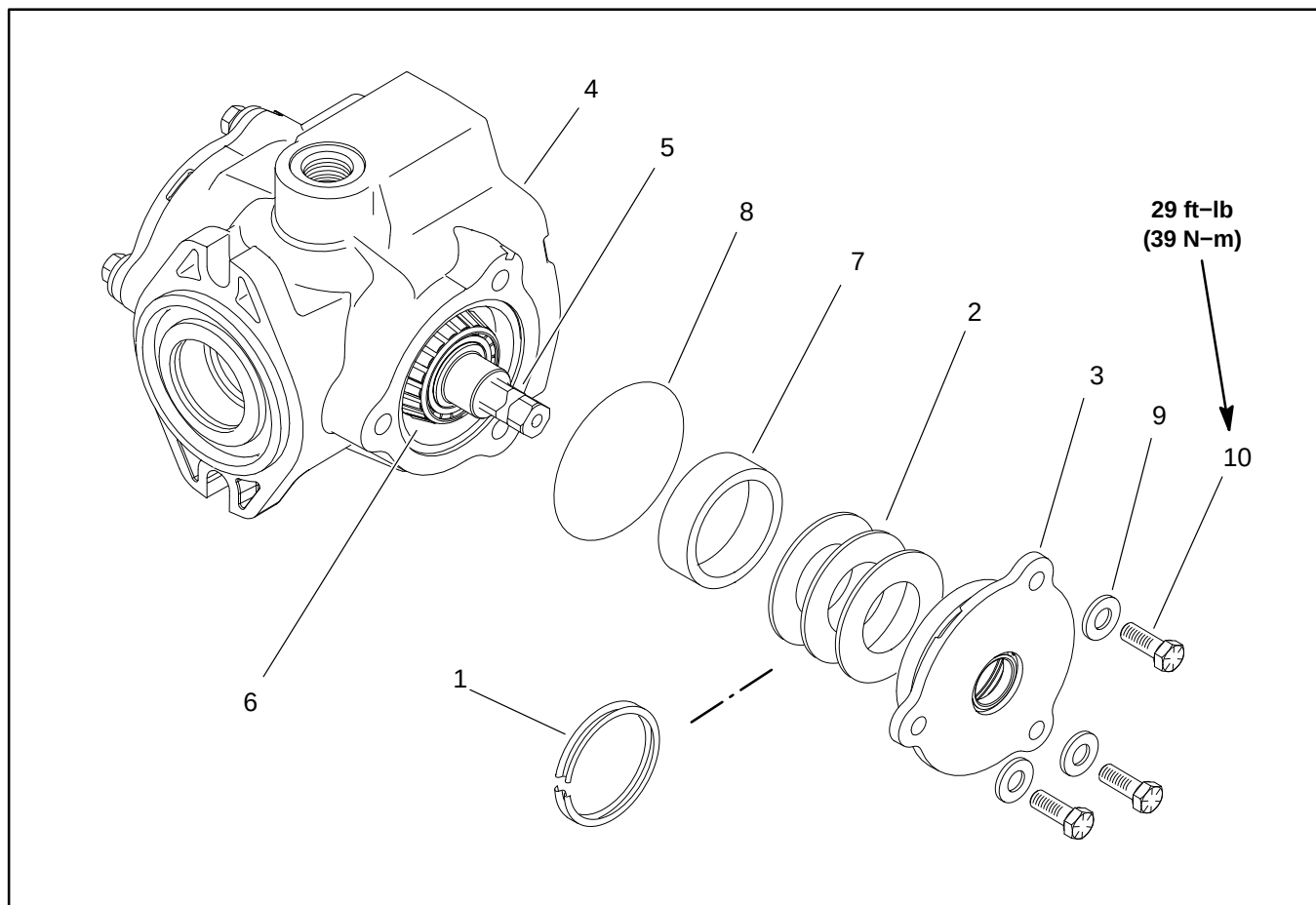


Figure 57

- | | | |
|----------------|-----------------------------|-------------------|
| 1. Crush ring | 5. Camplate (control shaft) | 8. O-ring |
| 2. Shims | 6. Bearing cone | 9. Washer (3) |
| 3. Cover plate | 7. Bearing cup | 10. Cap screw (3) |
| 4. Housing | | |

Piston Pump Crush Ring Replacement (Fig. 57)

NOTE: The shims replace the crush ring in the cover plate. If the camplate, cover plate or housing is replaced during servicing of the pump, the old crush ring can not be used to make sure of proper preload.

1. Remove crush ring from the cover plate. Measure thickness of crush ring.
2. Stack shims to the thickness of the crush ring.
3. Insert shims into the cover plate in the same location that the crush ring was removed from.
4. Assemble housing sub assembly consisting of the housing, camplate, bearing cone, bearing cup and cover plate (see Eaton, Medium Duty Piston Pump, Repair Information, Model 70160 Variable Displacement Piston Pump at the end of this chapter).
5. Install washers and cap screws to the cover plate and housing. Torque cap screws to **29 ft-lbs (39 N-m)**.
6. Check torque required to rotate control shaft. Torque should be from **15 to 25 in-lbs (1.7 to 2.8 N-m)**.
 - A. If torque is **too low**, add additional shims and repeat steps 3 through 6 until the specified torque is achieved.
 - B. If torque is **too high**, remove shims and repeat steps 3 through 6 until the specified torque is achieved.
7. Complete assembly of the pump (see Eaton, Medium Duty Piston Pump, Repair Information, Model 70160 Variable Displacement Piston Pump at the end of this chapter).

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Gear Pump

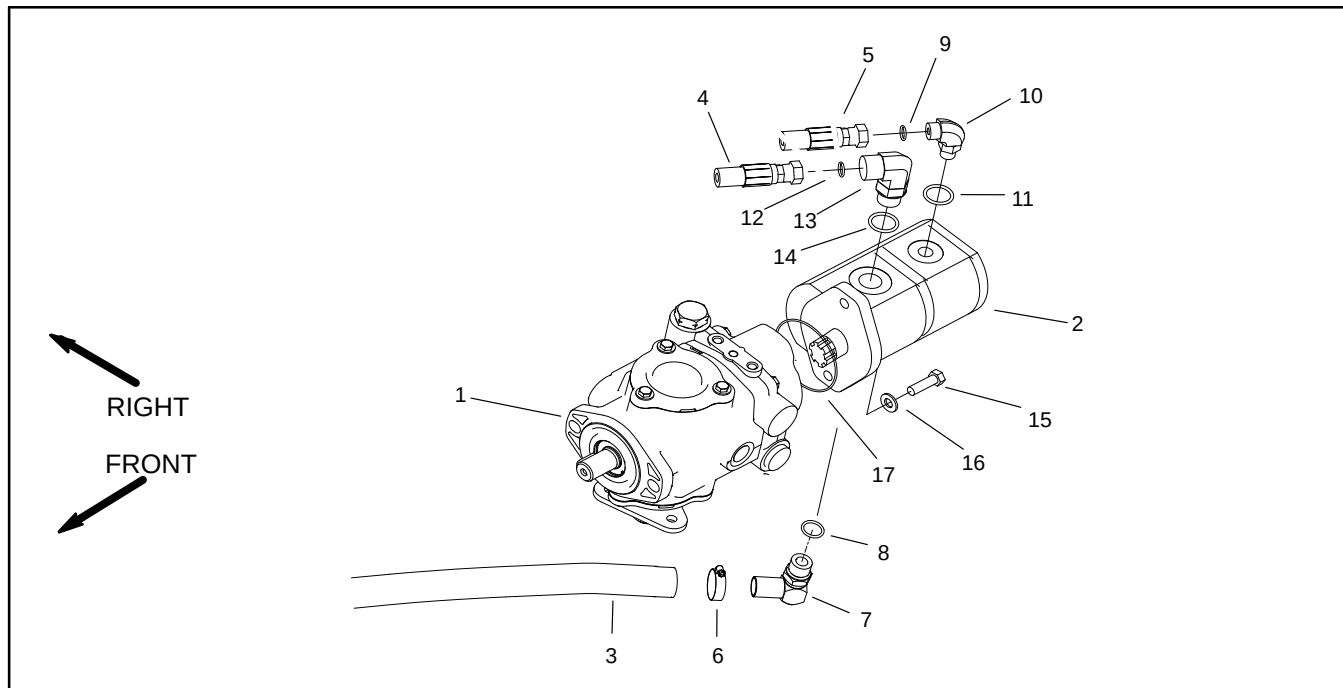


Figure 58

- | | | |
|--|---------------------------|---------------------------|
| 1. Piston pump | 7. Hydraulic barb fitting | 13. 90° hydraulic fitting |
| 2. Gear pump | 8. O-ring | 14. O-ring |
| 3. Hydraulic hose (tank suction) | 9. O-ring | 15. Cap screw |
| 4. Hydraulic hose (hydraulic manifold) | 10. 90° hydraulic fitting | 16. Flat washer |
| 5. Hydraulic hose (steering valve) | 11. O-ring | 17. O-ring |
| 6. Hose clamp | 12. O-ring | |

Removal (Fig. 58)

1. Park machine on a level surface. Lower cutting units, stop engine and engage parking brake. Remove key from the ignition switch. Raise and support hood.
2. Remove muffler from the engine to gain access to the gear pump (see Exhaust System in Chapter 3 – Kubota Diesel Engine in this manual).



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 this chapter.

3. Thoroughly clean hydraulic hose ends and fittings on gear pump to prevent hydraulic system contamination.
4. Drain hydraulic oil from hydraulic tank by disconnecting the suction hose from the barbed fitting in the bottom of the gear pump. Drain tank into a suitable container.

5. Label hydraulic hoses and fittings on gear pump for assembly purposes.

6. Disconnect hydraulic hoses connected to the hydraulic fittings on the gear pump. Allow hoses to drain into a suitable container. Plug hose openings to prevent contamination.

NOTE: A case drain exists in the piston pump/hydrostat and a suction port is near the input shaft of the gear pump (Fig. 59). When the gear pump is removed from the piston pump, plug piston pump case drain hole to prevent draining the piston pump.

7. Remove both cap screws and flat washers securing gear pump to the piston pump. Separate gear pump from the piston pump. Locate and retrieve O-ring. Plug openings of gear pump to prevent contamination.

8. If hydraulic fittings are to be removed from gear pump, mark fitting orientation to allow correct assembly. Remove hydraulic fittings and O-rings from the gear pump as needed. Discard removed O-rings.

Installation (Fig. 58)

1. If fittings were removed from gear pump, lubricate and place new O-rings onto fittings. Install fittings into pump openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).
2. Make sure mounting and O-ring sealing surfaces on the gear pump and piston pump are clean.
3. Apply clean hydraulic oil to gear pump flange O-ring. Place O-ring on the gear pump.

IMPORTANT: A case drain exists in the piston pump/hydrostat and a suction port is near the input shaft of the gear pump (Fig. 59). Before the gear pump is installed to the piston pump, make sure that plugs placed in either of these ports are removed. Failure to remove plugs will cause excessive pressure in the piston pump and damage seals. Also, before installing gear pump to piston pump, fill piston pump housing with clean hydraulic oil through case drain hole.

4. Remove plugs that were placed in piston pump case drain and gear pump suction port. Fill piston pump housing with clean hydraulic oil through case drain hole.

IMPORTANT: The gear pump suction fitting must be on the same side as the trunnion of the piston pump.

5. Align gear teeth and slide gear pump input shaft into piston pump coupler. Secure gear pump to piston pump with two (2) cap screws and flat washers.

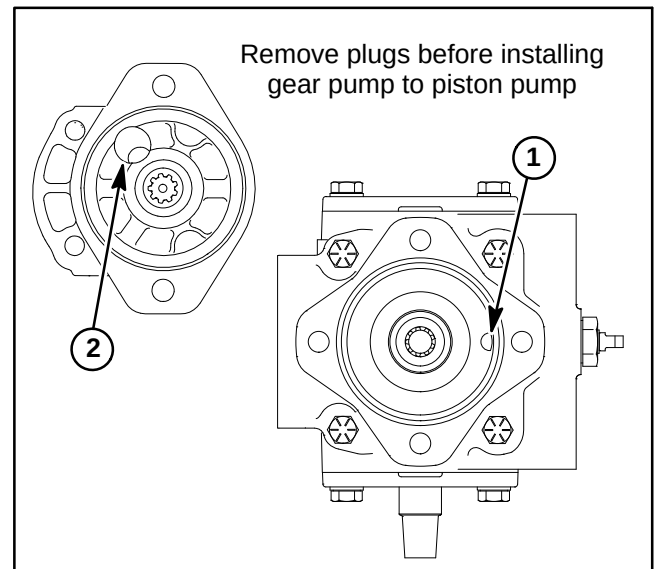


Figure 59

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

6. Remove caps and plugs from gear pump fittings and hoses. Using labels placed during gear pump removal, properly connect hydraulic lines to pump (see Hydraulic Hose and Tube Installation in this chapter).
7. Fill hydraulic tank with **new** hydraulic fluid.
8. Install muffler to the engine (see Exhaust System in Chapter 3 – Kubota Diesel Engine in this manual).
9. Properly fill hydraulic system (see Charge Hydraulic System in this chapter).
10. Lower and secure hood.

Gear Pump Service

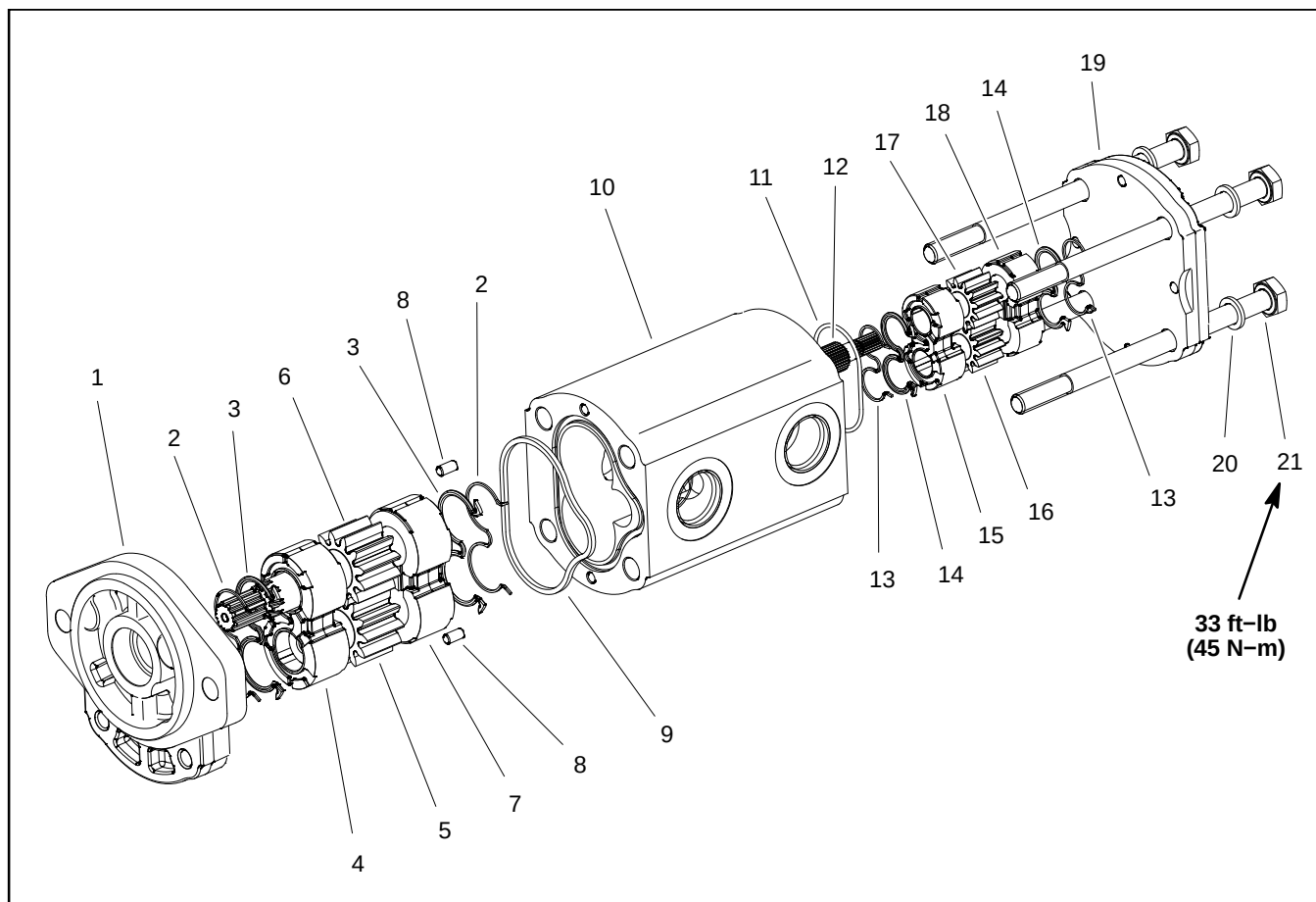


Figure 60

- | | | |
|-----------------------|------------------------------|------------------------|
| 1. Front cover | 8. Dowel pin | 15. Front thrust plate |
| 2. Pressure seal | 9. Seal | 16. Idler gear |
| 3. Back-up gasket | 10. Body | 17. Drive gear |
| 4. Front thrust plate | 11. Seal | 18. Rear thrust plate |
| 5. Idler gear | 12. Splined connecting shaft | 19. Rear cover |
| 6. Drive shaft | 13. Pressure seal | 20. Washer (4 used) |
| 7. Rear thrust plate | 14. Back-up gasket | 21. Cap screw (4 used) |

Disassembly (Fig. 60)

NOTE: The gear pump must be replaced as a complete assembly. Individual gears, housings and thrust plates are not available separately. Disassemble gear pump for cleaning, inspection and seal replacement only.

1. Plug pump ports and thoroughly clean exterior of pump with cleaning solvent. Make sure work area is clean.

2. Use a marker to make a **diagonal** line across the gear pump for assembly purposes (Fig. 61).

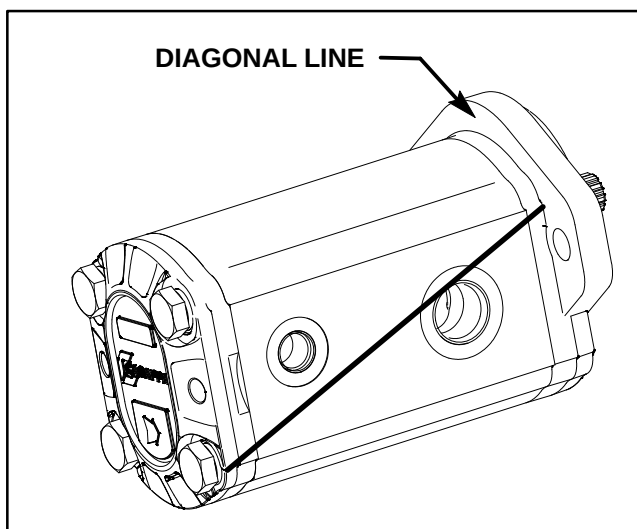


Figure 61

IMPORTANT: Use caution when clamping gear pump in a vise to avoid distorting any pump components.

3. Secure the front cover of the pump in a vise with the drive shaft pointing down.
4. Loosen the four (4) cap screws that secure pump assembly.
5. Remove pump from vise and remove fasteners.
6. Support the pump assembly and gently tap the pump case with a soft face hammer to loosen the pump sections. Be careful to not drop parts or disengage gear mesh.

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

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

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

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

Assembly (Fig. 60)

1. Apply clean hydraulic fluid to all parts before assembling.

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

2. Assemble pump sections starting at front cover end. Apply grease or petroleum jelly to new section seals to hold them in position during gear pump assembly.
3. After pump has been assembled, tighten cap screws by hand. Rotate the drive shaft to check for binding. Protect the shaft if using a pliers to rotate shaft.
4. Tighten the four (4) cap screws evenly in a crossing pattern to a torque of **33 ft-lb (45 N-m)**.

Front Wheel Motors

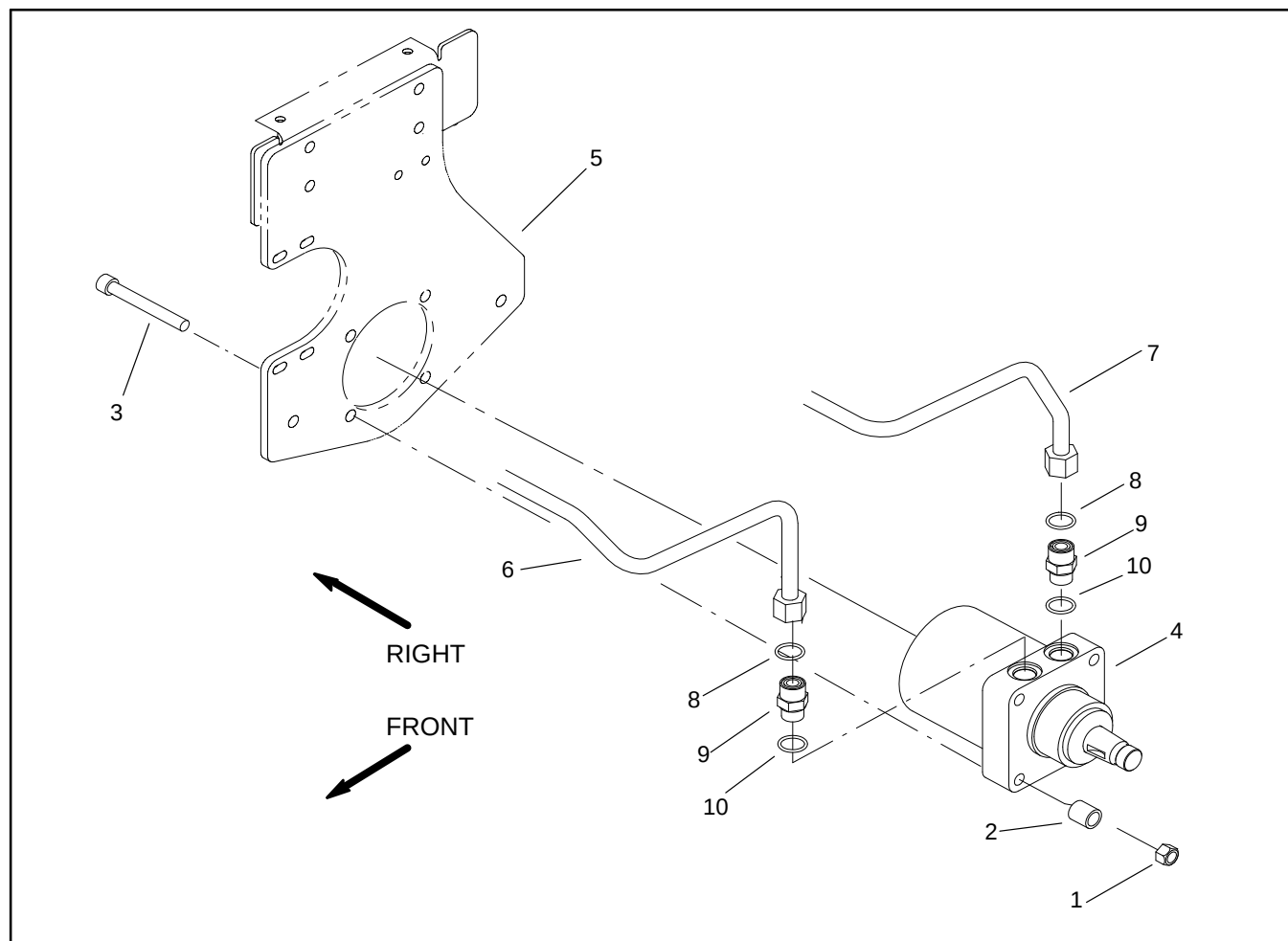


Figure 62

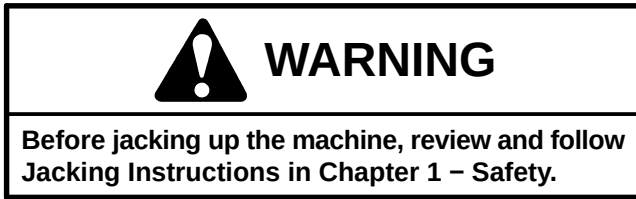
- 1. Lock nut
- 2. Spacer
- 3. Socket head screw
- 4. Hydraulic wheel motor

- 5. Frame
- 6. Hydraulic tube
- 7. Hydraulic tube

- 8. O-ring
- 9. Hydraulic fitting
- 10. O-ring

Removal (Fig. 62)

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

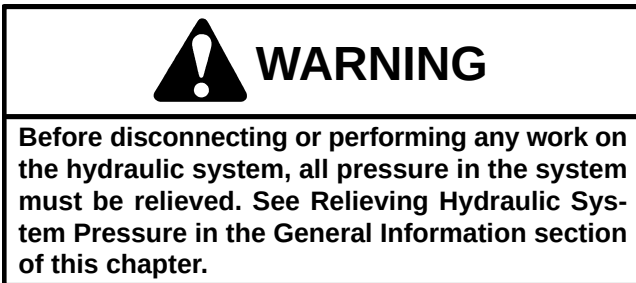


2. Jack up front of machine enough to allow the removal of the front wheel. Support machine with appropriate jackstands.

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

3. Remove wheel assembly, wheel hub and brake drum from the hydraulic motor. Remove brake assembly from the brake bracket (see Front Wheel and Brake Removal in Chapter 7 – Wheels, Brakes, and Miscellaneous in this manual).

4. Thoroughly clean hydraulic line ends and wheel motor fittings to prevent hydraulic system contamination.



5. Disconnect hydraulic tubes from adapters on wheel motors. Plug hose openings to prevent contamination.

6. Remove four (4) socket head screws and lock nuts that secure brake bracket and wheel motor to frame. Locate and retrieve spacers. Remove brake bracket and wheel motor from machine.

7. If necessary, remove hydraulic adapters and O-rings from the wheel motor. Discard removed O-rings.

Installation (Fig. 62)

1. If adapters were removed from wheel motor, lubricate and place new O-rings onto fittings. Install adapters into motor openings and tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).

2. Install wheel motor and brake bracket to frame using four (4) socket head screws, spacers and lock nuts.

3. Remove caps and plugs from wheel motor fittings and hoses. Using labels placed during motor removal, properly connect hydraulic lines to motor (see Hydraulic Hose and Tube Installation in this chapter).

4. Install brake assembly to the brake bracket. Install brake drum, wheel hub and wheel assembly to the hydraulic motor (see Front Wheel and Brake Installation in the Chapter 7 – Wheels, Brakes, and Miscellaneous in this manual).

5. Lower the machine to the ground.

6. Make sure that lock nut is torqued from **250 to 275 ft-lb (339 to 372 N-m)**. Also, make sure that wheel lug nuts are torqued from **45 to 65 ft-lb (61 to 88 N-m)**.

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

Rear Wheel Motor

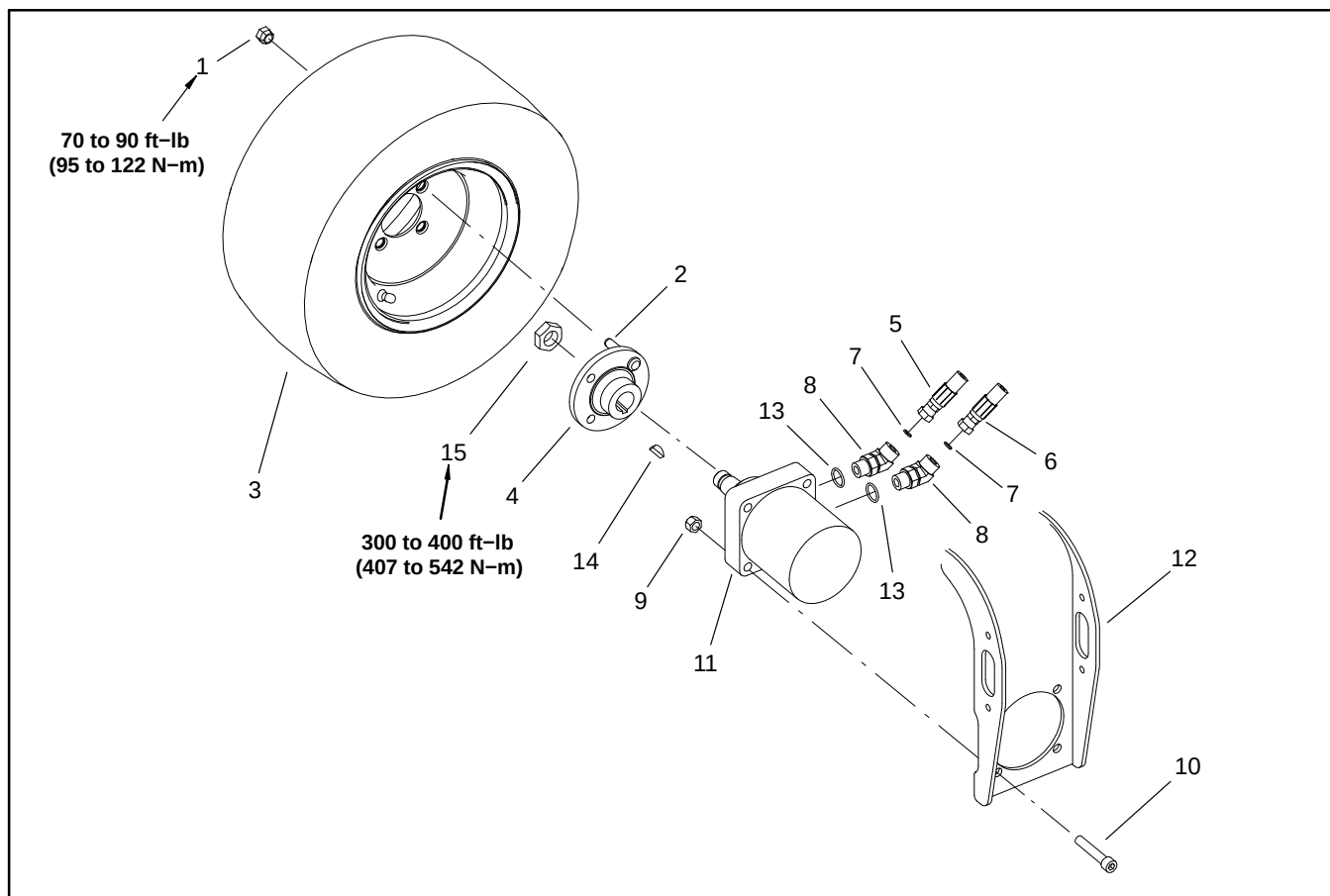


Figure 63

- | | | |
|--------------------------|--------------------------|---------------------|
| 1. Lug nut | 6. Hydraulic hose | 11. Hydraulic motor |
| 2. Drive stud | 7. O-ring | 12. Rear fork |
| 3. Tire and rim assembly | 8. 45° hydraulic fitting | 13. O-ring |
| 4. Wheel hub | 9. Lock nut | 14. Woodruff key |
| 5. Hydraulic hose | 10. Socket head screw | 15. Lock nut |

Removal (Fig. 63)

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



WARNING

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

2. Raise and safely support rear of machine enough to allow the removal of the rear wheel.
3. Remove rear tire and rim assembly from machine.
4. Remove rear wheel motor with wheel hub attached from the rear fork.

5. Secure wheel hub in a vise. Loosen but do not remove lock nut that secures wheel hub to wheel motor.

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

6. Using hub puller (see Special Tools), loosen wheel hub from wheel motor.

7. Remove wheel hub and motor from vise. Remove lock nut and hub from motor shaft. Locate and retrieve woodruff key.

8. If hydraulic fittings are to be removed from wheel motor, mark fitting orientation to allow correct assembly.

Installation (Fig. 63)

1. If hydraulic fittings were removed from wheel motor, install fittings to motor using marks made during the removal process to properly orientate fittings.
2. Thoroughly clean wheel motor shaft and wheel hub taper.
3. Lock wheel hub in a vise. Install woodruff key into the wheel motor shaft. Slide motor shaft into hub and secure with lock nut. Torque lock nut from **300 to 400 ft-lb (407 to 542 N-m)**. Remove wheel motor and hub from vise.
4. Install wheel motor to the rear fork (Fig. 63).
5. Install tire and rim assembly to machine.
6. Lower the machine to the ground.
7. Torque wheel lug nuts in a crossing pattern from **70 to 90 ft-lb (95 to 122 N-m)**.

IMPORTANT: If a wheel motor failure occurred, refer to Traction Circuit Component Failure in this chapter for information regarding the importance of removing contamination from the traction circuit.

8. Charge hydraulic system (see Charge Hydraulic System in this chapter).

Wheel Motor Service

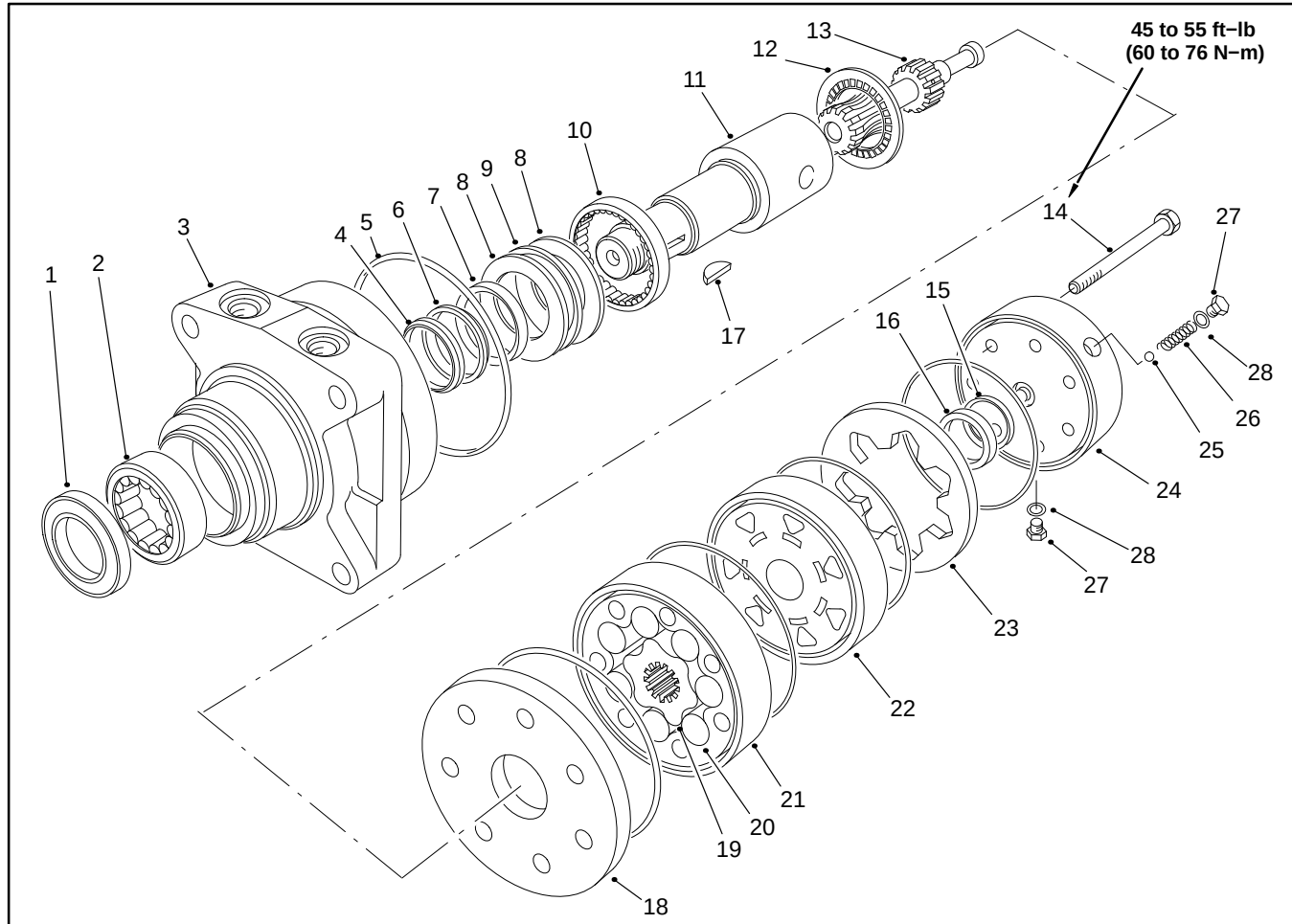


Figure 64

- | | | |
|-------------------|---------------------|---------------------|
| 1. Dirt seal | 11. Coupling shaft | 20. Vane |
| 2. Bearing | 12. Thrust bearing | 21. Stator |
| 3. Housing | 13. Drive link | 22. Manifold |
| 4. Back-up washer | 14. Cap screw | 23. Commutator ring |
| 5. Seal rings | 15. Commutator seal | 24. End cover |
| 6. Back-up washer | 16. Commutator | 25. Ball |
| 7. Inner seal | 17. Woodruff key | 26. Spring |
| 8. Thrust washer | 18. Wear plate | 27. Plug |
| 9. Thrust bearing | 19. Rotor | 28. O-ring |
| 10. Bearing | | |

NOTE: The wheel motor illustrated (Fig. 64) is the rear motor. The three wheel motors are identical in construction except for some minor differences. The front wheel motors have a 12 cu. in. (195 cc) displacement while the rear wheel motor has a 24.7 cu. in. (405 cc) displacement. The right front and rear wheel motors have reverse timed manifolds, and the front left motor does not. The end cover of the rear motor has a check valve consisting of a ball and spring, and both front motors lack this feature.

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

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

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Hydraulic Manifold

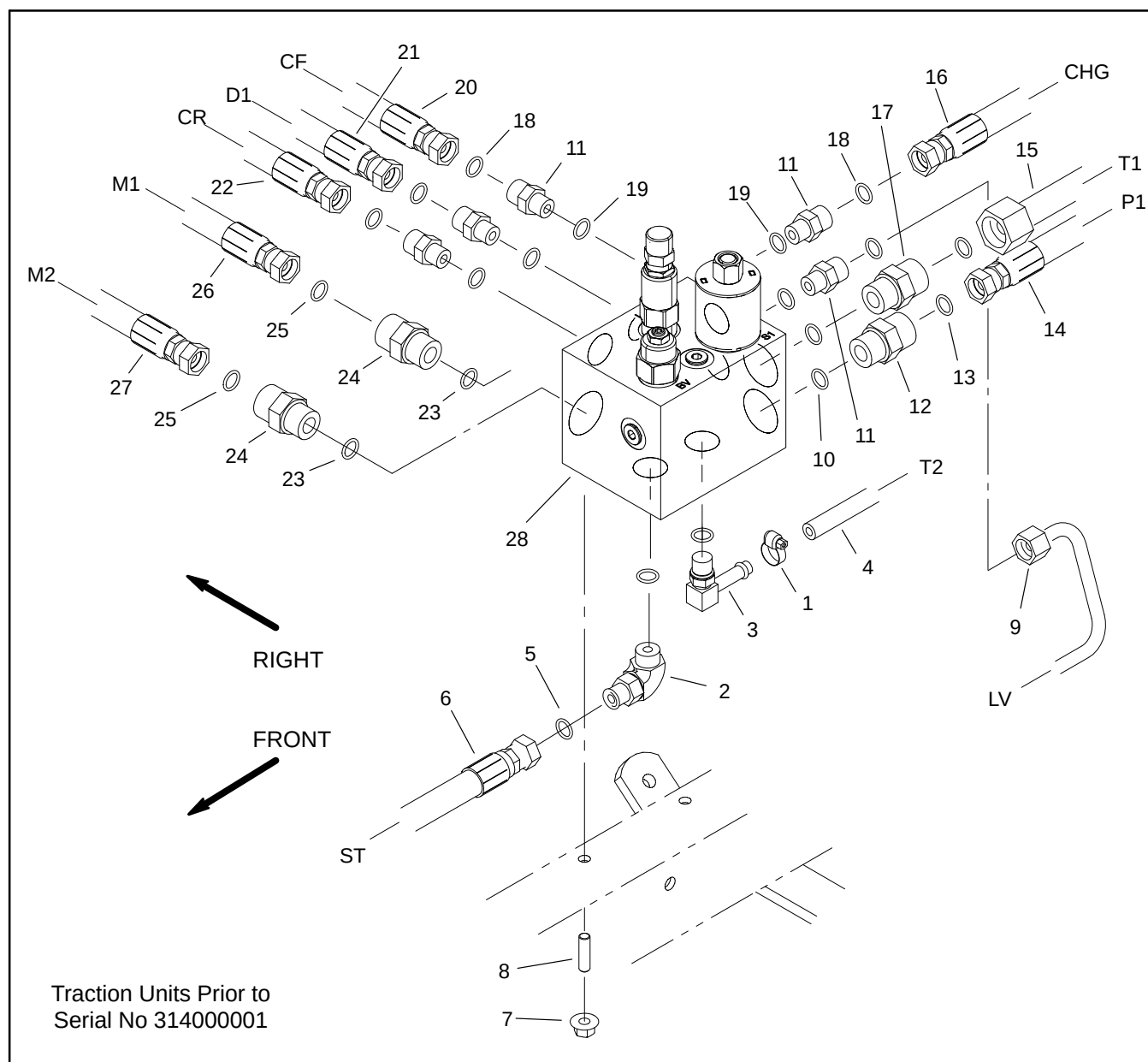


Figure 65

- | | | |
|--------------------------|--------------------------------|--------------------------------|
| 1. Hose clamp | 11. Straight hydraulic fitting | 20. Hydraulic hose – CF |
| 2. 90° hydraulic fitting | 12. Straight hydraulic fitting | 21. Hydraulic hose – D1 |
| 3. Barb fitting | 13. O-ring | 22. Hydraulic hose – CR |
| 4. Hydraulic hose – T2 | 14. Hydraulic hose – P1 | 23. O-ring |
| 5. O-ring | 15. Hydraulic tube – T1 | 24. Straight hydraulic fitting |
| 6. Hydraulic hose – ST | 16. Hydraulic hose – CHG | 25. O-ring |
| 7. Flange head nut | 17. Straight hydraulic fitting | 26. Hydraulic hose – M1 |
| 8. Stud | 18. O-ring | 27. Hydraulic hose – M2 |
| 9. Hydraulic tube – LV | 19. O-ring | 28. Hydraulic manifold |
| 10. O-ring | | |

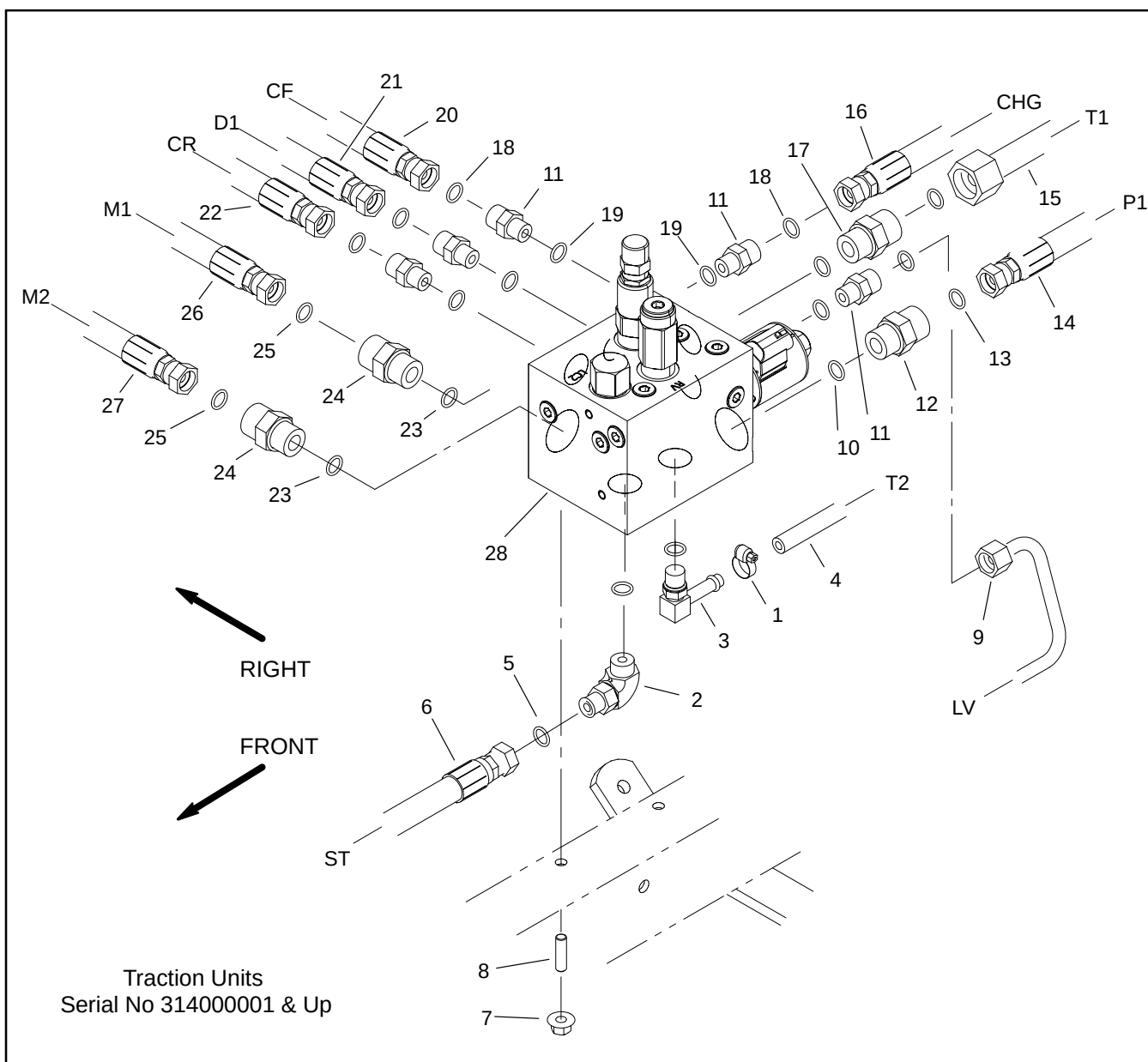


Figure 66

- | | | |
|--------------------------|--------------------------------|--------------------------------|
| 1. Hose clamp | 11. Straight hydraulic fitting | 20. Hydraulic hose – CF |
| 2. 90° hydraulic fitting | 12. Straight hydraulic fitting | 21. Hydraulic hose – D1 |
| 3. Barb fitting | 13. O-ring | 22. Hydraulic hose – CR |
| 4. Hydraulic hose – T2 | 14. Hydraulic hose – P1 | 23. O-ring |
| 5. O-ring | 15. Hydraulic tube – T1 | 24. Straight hydraulic fitting |
| 6. Hydraulic hose – ST | 16. Hydraulic hose – CHG | 25. O-ring |
| 7. Flange head nut | 17. Straight hydraulic fitting | 26. Hydraulic hose – M1 |
| 8. Stud | 18. O-ring | 27. Hydraulic hose – M2 |
| 9. Hydraulic tube – LV | 19. O-ring | 28. Hydraulic manifold |
| 10. O-ring | | |

Removal (Fig. 65 and 66)

NOTE: The ports on the manifold are marked for easy identification of components. Example: port LV connects the the lift valve circuit and port P1 connects the gear pump (P1). See Hydraulic Schematics in this chapter to identify the function of the hydraulic lines and cartridge valves at each port location.

1. Clean hydraulic manifold before doing any disassembly.



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 this chapter.

2. Remove hydraulic manifold from the machine.
3. If hydraulic fittings are to be removed from manifold, note or mark fitting orientation to allow correct assembly.

Installation (Fig. 65 and 66)

1. If hydraulic fittings were removed from manifold, install fittings to manifold using notes or marks made during the removal process to properly orientate fittings.
2. Install hydraulic manifold to the frame.
3. Make sure hydraulic tank is full. Add hydraulic fluid if necessary.

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Hydraulic Manifold Service

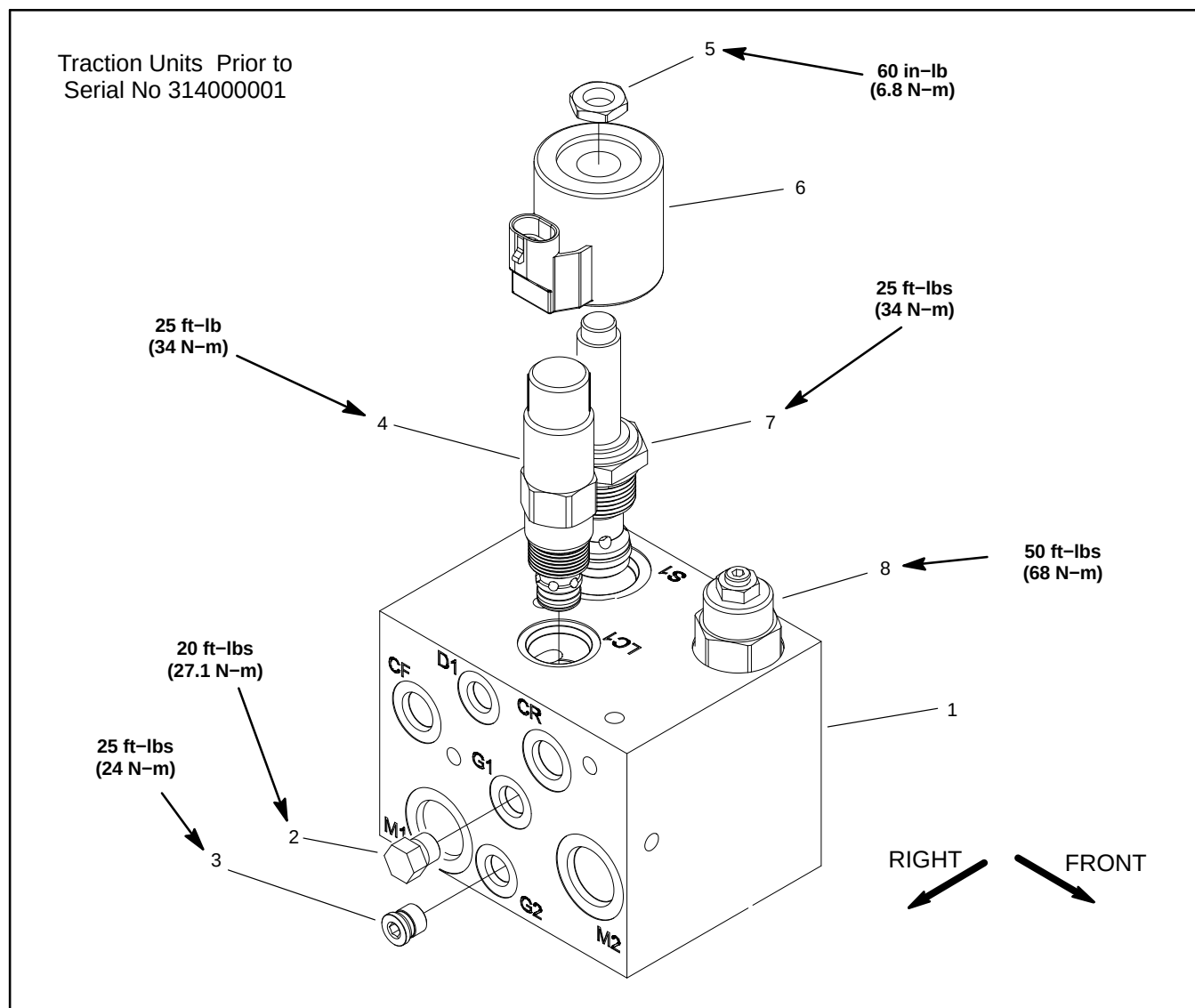


Figure 67

- | | | |
|----------------------|--------------------------------|----------------------------------|
| 1. Manifold body | 4. Logic cartridge valve (LC1) | 7. Solenoid cartridge valve (S1) |
| 2. #4 Hex head plug | 5. Nut | 8. Braking cartridge valve (BV) |
| 3. #4 Zero leak plug | 6. Solenoid coil | |

Traction Units
Serial No 314000001 & Up

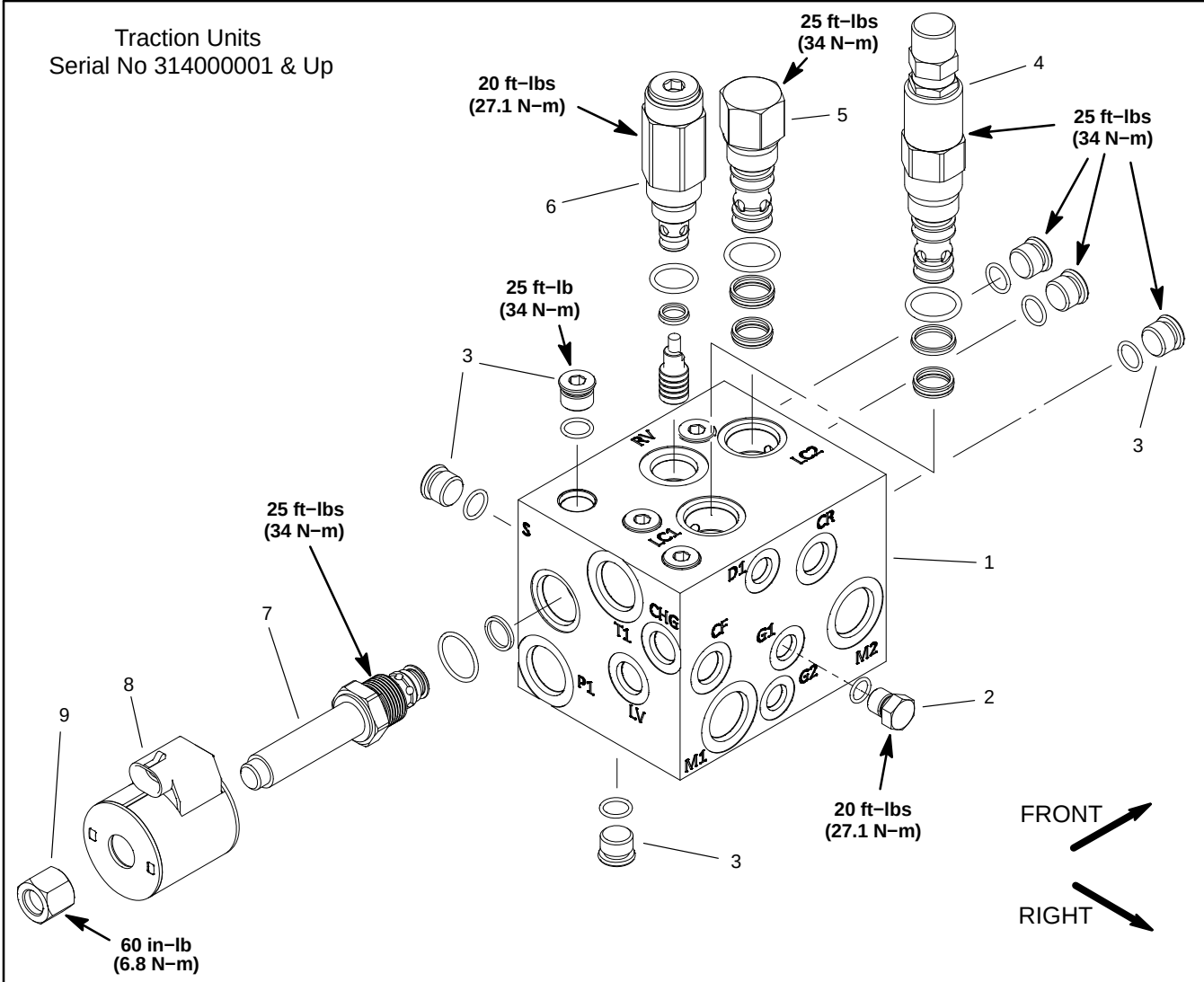


Figure 68

- 1. Manifold body
- 2. #4 Hex hd plug
- 3. #4 Zero leak plug

- 4. Logic cartridge valve (LC1)
- 5. Logic cartridge valve (LC2)
- 6. Relief valve (RV)

- 7. Solenoid cartridge valve (S)
- 8. Solenoid coil
- 9. Nut

Cartridge Valve Service (Fig. 67 and 68)

NOTE: The ports on the manifold are marked for easy identification of components. Example: port LV connects the the lift valve circuit and port P1 connects the gear pump (P1). See Hydraulic Schematics in this chapter to identify the function of the hydraulic lines and cartridge valves at each port location.

NOTE: The Groundsmaster 3500 hydraulic manifold uses several zero leak plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an O-ring as a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug; the impact will allow plug removal with less chance of damage to the socket head of the plug.

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

IMPORTANT: Use care when handling the cartridge valve. Slight bending or distortion of the stem tube can cause binding and malfunction.

3. Remove cartridge valve with a deep socket wrench. Note correct location for O-rings, sealing rings and backup rings. Remove and discard seal kit.
4. Visually inspect the port in the manifold for damage to the sealing surfaces, damaged threads or contamination.
5. Visually inspect cartridge valve for damaged sealing surfaces and contamination.
 - A. Contamination may cause valves to stick or hang up. Contamination can become lodged in small valve orifices or seal areas causing malfunction.
 - B. If valve sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.



CAUTION

Use eye protection such as goggles when using compressed air.

6. Clean cartridge valve using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. Be extremely careful not to damage cartridge. Use compressed air for cleaning.
7. Reinstall the cartridge valve into the manifold block:
 - A. Lubricate new seal kit components with clean hydraulic fluid and install on valve. The O-rings, sealing rings and backup rings must be arranged properly on the cartridge valve for proper operation and sealing.

IMPORTANT: Use care when handling the valve cartridge. Slight bending or distortion of the stem tube can cause binding and malfunction.

 - B. Thread cartridge valve carefully into manifold port. The valve should go in easily without binding.
 - C. Torque cartridge valve using a deep socket to value identified in manifold illustrations (Fig. 67 and 68).
 - D. If cartridge is solenoid operated, carefully install solenoid coil to the cartridge valve. Torque solenoid nut to 60 in-lbs (6.8 N-m).
8. If problems still exist, remove valve and clean again or replace valve.

Cutting Deck Motor

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

Removal

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components in this chapter.
3. To prevent contamination of hydraulic system during deck motor removal, thoroughly clean exterior of motor.
4. Disconnect hydraulic lines from deck motor. Put caps or plugs on fittings and hoses to prevent contamination of hydraulic system. Label hydraulic lines for proper assembly.
5. Remove two (2) socket head screws and flat washers that secure hydraulic motor to cutting deck (Fig. 69).
6. Lift hydraulic motor from cutting deck.
7. Place cover on deck spindle opening to prevent contamination.
8. If hydraulic fittings are to be removed from deck motor, mark fitting orientation to allow correct assembly. Remove fittings from motor and discard O-rings.

Installation

1. If fittings were removed from deck motor, lubricate and place new O-rings onto fittings. Install fittings into motor ports using marks made during the removal process to properly orientate fittings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).
2. Remove cover from deck spindle opening.
3. Align splines on motor shaft and spindle shaft. Position hydraulic motor to the cutting deck.
4. Secure motor to cutting deck with two (2) socket head screws and flat washers (Fig. 69).
5. Remove caps or plugs from hydraulic fittings and hoses. Connect hydraulic hoses to deck motor (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
6. After assembly is completed, verify that hydraulic hoses and fittings are not contacted by any moving components.

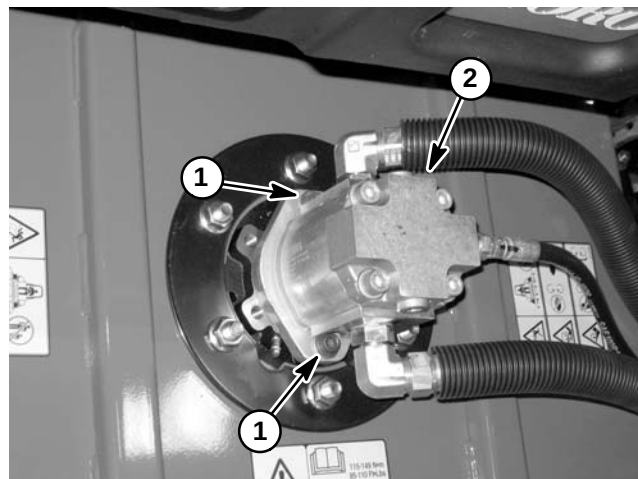


Figure 69

1. Socket head screw 2. Hydraulic motor

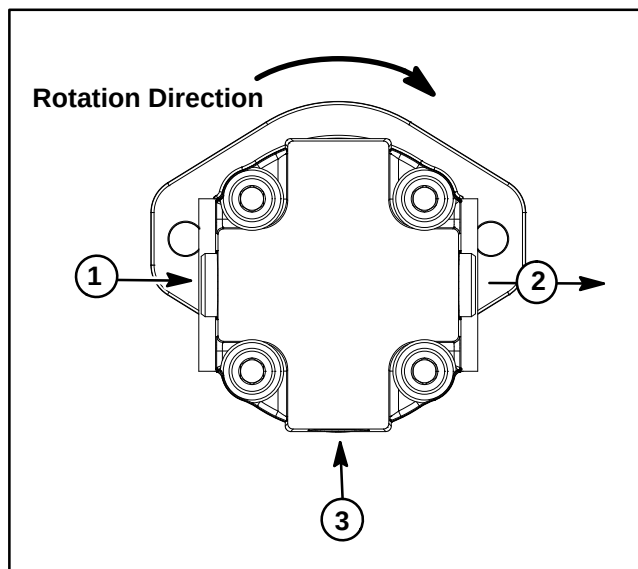


Figure 70

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

Cutting Deck Motor Service

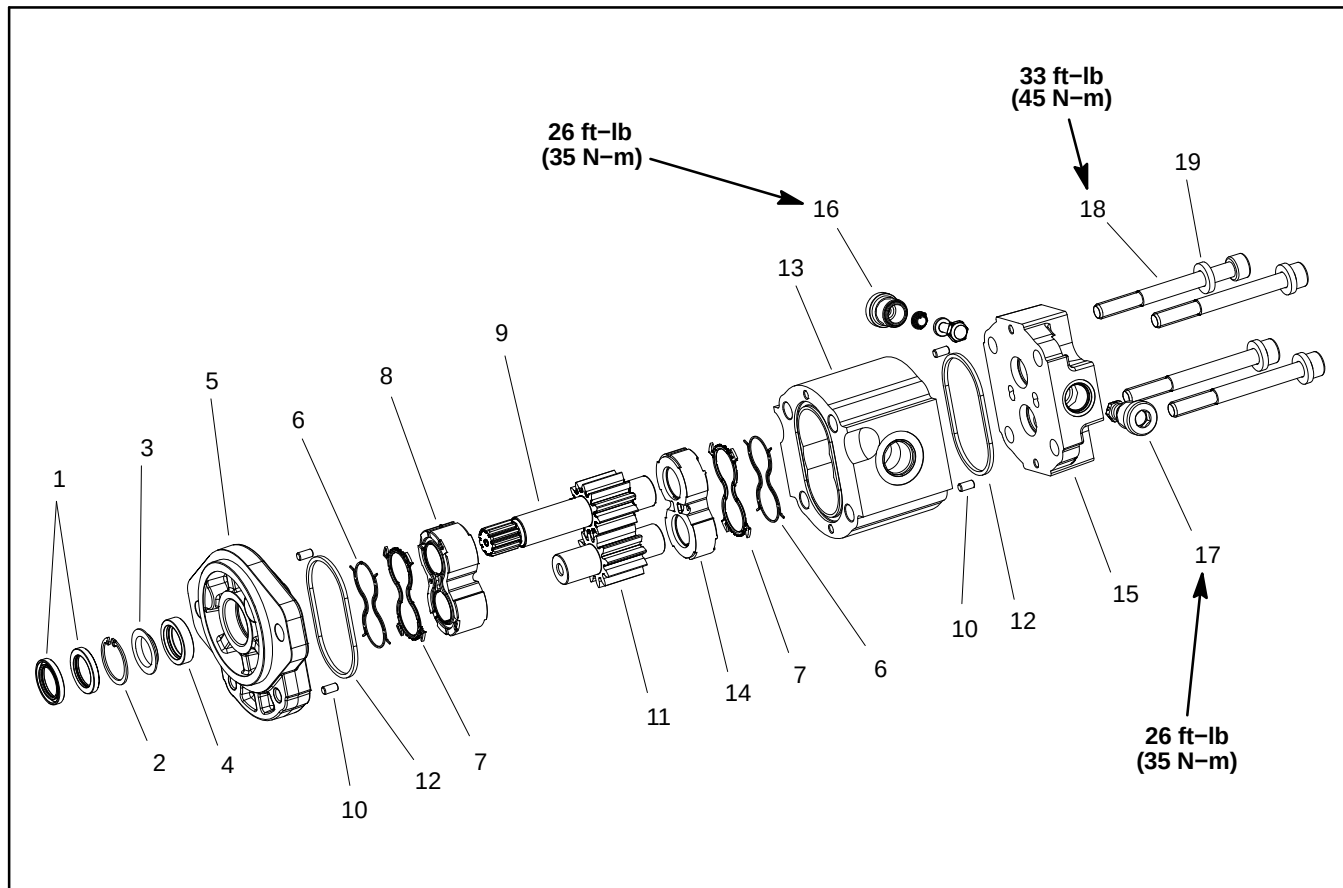


Figure 71

1. Dust seal (2 used)
2. Retaining ring
3. Flange washer
4. Shaft seal
5. Front flange
6. Pressure seal
7. Backup gasket

8. Front wear plate
9. Drive gear
10. Dowel pin (4 used)
11. Idler gear
12. O-ring
13. Body

14. Rear wear plate
15. Rear cover
16. Anti-cavitation valve
17. Relief valve
18. Cap screw (4 used)
19. Washer (4 used)

Disassembly (Fig. 71)

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

2. Use a marker to make a **diagonal** line across the front flange, body and rear cover for assembly purposes (Fig. 72).

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

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

4. Loosen cap screws from the rear cover.

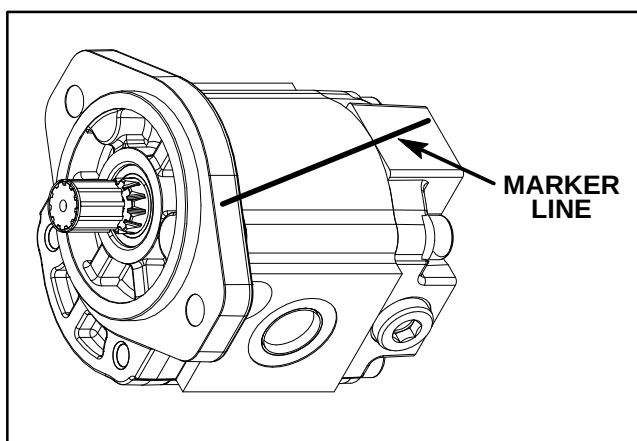


Figure 72

5. Remove motor from the vise. Turn motor so that the shaft end is facing down. Remove cap screws.
6. Separate rear cover from body. Lift rear cover from motor.
7. Carefully remove body. Lift body straight up to remove. Make sure the rear wear plate remains on the drive and idler gear shafts. Remove and discard O-rings from the body. Locate and retrieve dowel pins.

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

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

8. Carefully remove rear wear plate, idler gear, drive gear and front wear plate from the front flange.
9. Remove and discard back-up gaskets and pressure seals from wear plates.
10. Turn front flange over, with seal side up.

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

11. Carefully remove dust seals, retaining ring, flange washer and shaft seal from the front flange (Fig. 73). Discard removed seals.

Inspection

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



2. Clean all parts with solvent. Dry all parts with compressed air.
3. Inspect drive gears and idler gears for the following (Fig. 74):
 - A. Gear shafts should be free of rough surfaces and excessive wear at bushing points and sealing areas. Scoring, rough surfaces or wear on gear shafts indicates need for replacement.

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

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

4. Inspect wear plates for the following:

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

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

C. Thickness of wear plates should be equal.

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

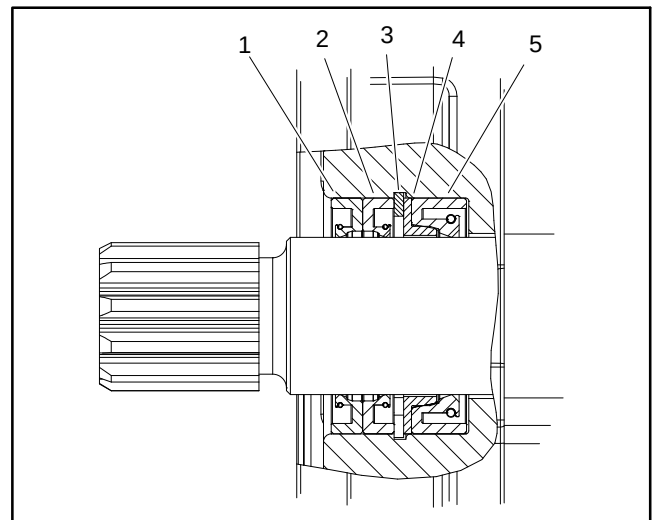


Figure 73

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

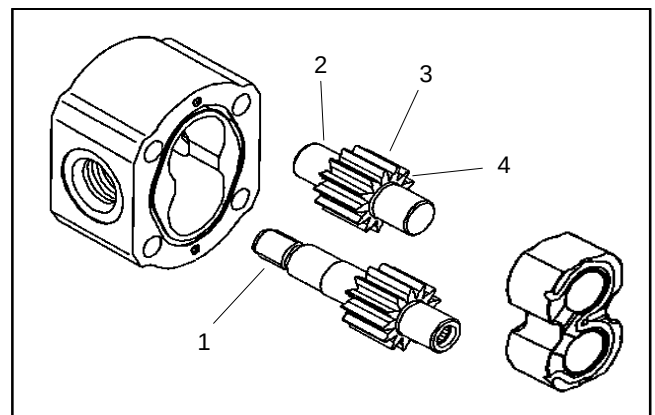


Figure 74

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

Assembly (Fig. 71)

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

1. Lubricate O-rings, pressure seals, back-up gaskets and wear plate grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic fluid.
2. Install new seals into front flange (Fig. 73):
 - A. Press shaft seal into front flange until it reaches the bottom of the bore.
 - B. Install flange washer into front flange and then install retaining ring into the groove of the front flange.
 - C. Install new dust seals into front flange.
3. Place front flange, seal side down, on a flat surface.
4. Install the pressure seals, flat side outward, into the grooves in the wear plates. Follow by carefully placing the backup gaskets, flat side outward, between the pressure seals and the grooves in the wear plate.
5. Apply a light coating of petroleum jelly to the exposed side of the front flange.
6. Lubricate the drive gear shaft with clean hydraulic fluid. Insert the drive end of the drive shaft through the wear plate with the pressure seal side down and the open side of the pressure seal pointing to the inlet side of the motor. Carefully install shaft into front flange.
7. Lubricate the idler gear shaft with clean hydraulic fluid. Install idler gear shaft into the remaining position in the front wear plate. Apply a light coating of clean hydraulic fluid to gear faces.
8. Install rear wear plate with pressure seal side up and open side of the pressure seal pointing to the inlet side of the motor.

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

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

IMPORTANT: Do not dislodge seals during installation.

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

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

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

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

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

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

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

17. Remove motor from vise.

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

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Steering Control Valve

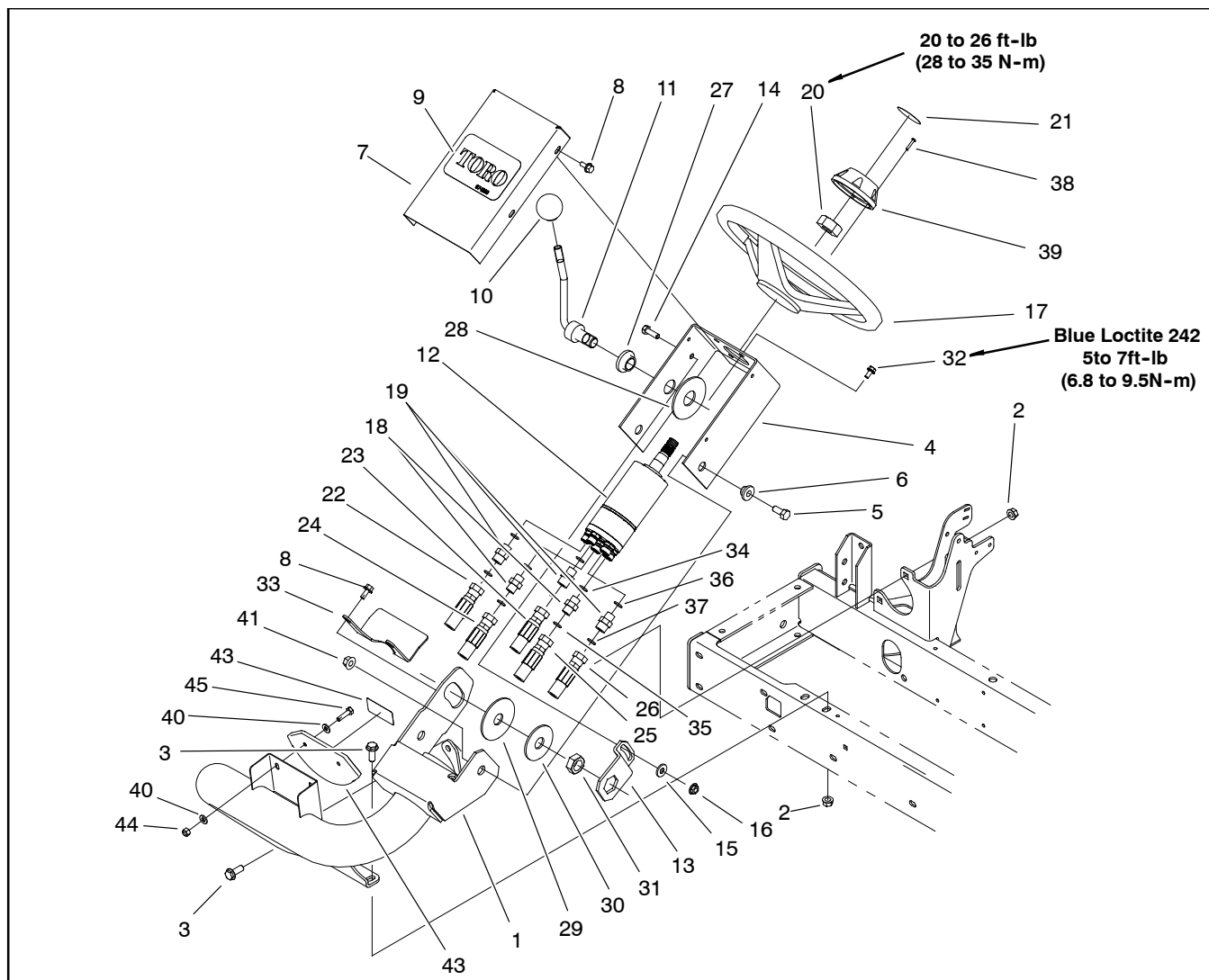


Figure 75

- | | | |
|----------------------------|------------------------|------------------------|
| 1. Steering arm | 16. Flange nut | 31. Jam nut |
| 2. Flange nut | 17. Steering wheel | 32. Flange screw |
| 3. Flange head screw | 18. Hydraulic fitting | 33. Steering shield |
| 4. Steering valve bracket | 19. Hydraulic fitting | 34. O-ring |
| 5. Cap screw | 20. Steering wheel nut | 35. O-ring |
| 6. Pivot hub | 21. Toro decal | 36. O-ring |
| 7. Steering cover | 22. Hydraulic hose | 37. O-ring |
| 8. Cap screw | 23. Hydraulic hose | 38. Philips head screw |
| 9. Toro decal | 24. Hydraulic hose | 39. Steering wheel cap |
| 10. Ball knob | 25. Hydraulic hose | 40. Flat washer |
| 11. Steering tilt lever | 26. Hydraulic hose | 41. Flange nut |
| 12. Steering control valve | 27. Tilt steering boss | 42. Slope indicator |
| 13. Tilt bracket | 28. Friction disc | 43. Decal |
| 14. Cap screw | 29. Friction disc | 44. Lock nut |
| 15. Flat washer | 30. Flat washer | 45. Cap screw |

Removal (Fig. 75)



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. Remove Philips head screws and steering wheel cap from steering wheel.
2. Remove the nut securing the steering wheel to the steering control valve and pull the steering wheel from the control valve.
3. Remove the steering cover.
4. To prevent contamination of hydraulic system during steering valve removal, thoroughly clean exterior of valve.
5. Disconnect hydraulic lines from steering valve. Put caps or plugs on fittings and hoses to prevent contamination of hydraulic system. Label hydraulic lines for proper assembly.
6. Remove the four (4) flange screws securing the steering control valve to the steering valve bracket and remove the valve from the bracket (Fig. 76).

Installation (Fig. 75)

1. If fittings were removed from steering valve, lubricate and place new O-rings onto fittings. Install and tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).
2. Apply blue Loctite 242 to flange hd. screws and install steering control valve to the steering valve bracket. Tighten the flange hd screws in crisscross pattern and torque to **5 to 7 ft-lb (6.8 to 9.5 N-m)**.

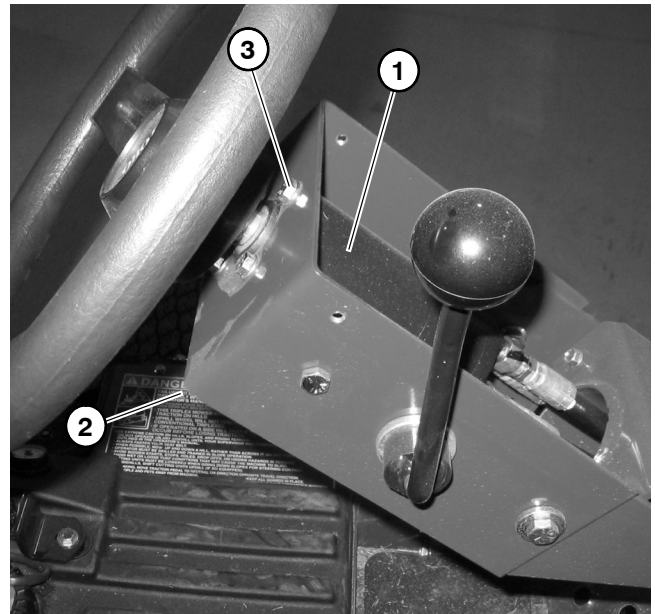


Figure 76

- | | |
|---------------------------|---------------------|
| 1. Steering valve | 3. Flange screw (4) |
| 2. Steering valve bracket | |

3. Remove caps or plugs from hydraulic fittings and hoses. Connect hydraulic hoses to steering valve (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
4. Install steering wheel to the steering control valve. Torque steering wheel nut from 20 to 26 ft-lb (28 to 35 N-m).
5. Secure steering wheel cap to the steering wheel with philips head screws.
6. Operate the unit. Check for leaks and check steering function. Make sure hydraulic tank is full and add hydraulic fluid if necessary.
7. Install the steering cover.

Steering Control Valve Service

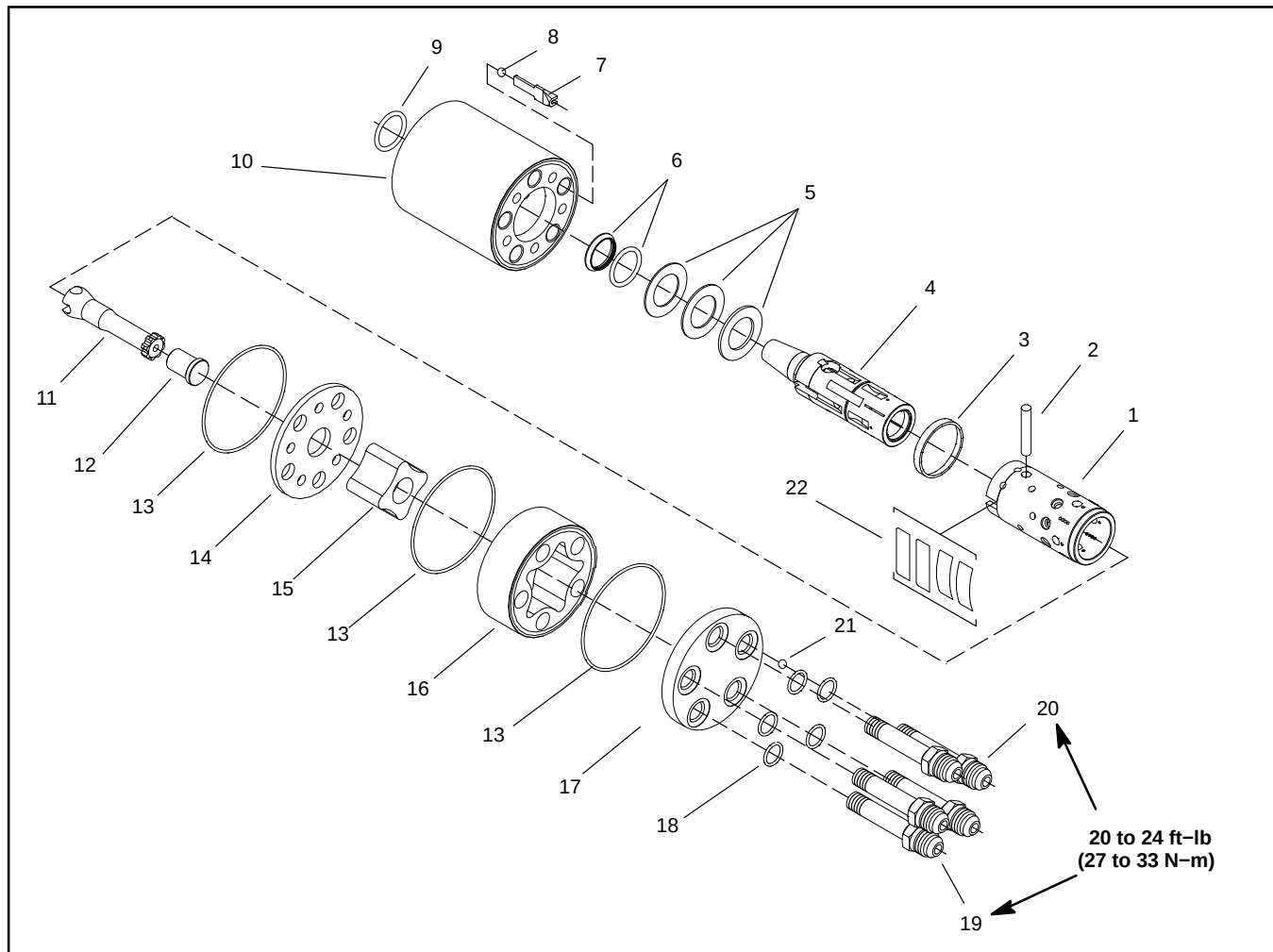


Figure 77

- | | | |
|---------------------|------------------------|-----------------------------------|
| 1. Sleeve | 9. Dust seal ring | 16. Outer gearwheel |
| 2. Cross pin | 10. Housing | 17. End cover |
| 3. Ring | 11. Cardan shaft | 18. O-ring (5 used) |
| 4. Spool | 12. Spacer | 19. Screw/fitting (ports L, R, T) |
| 5. Bearing assembly | 13. O-ring | 20. Screw/fitting (ports P and E) |
| 6. Shaft seal | 14. Distribution plate | 21. P port check ball |
| 7. Ball stop | 15. Inner gearwheel | 22. Spring set |
| 8. Ball | | |

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

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Steering Cylinder

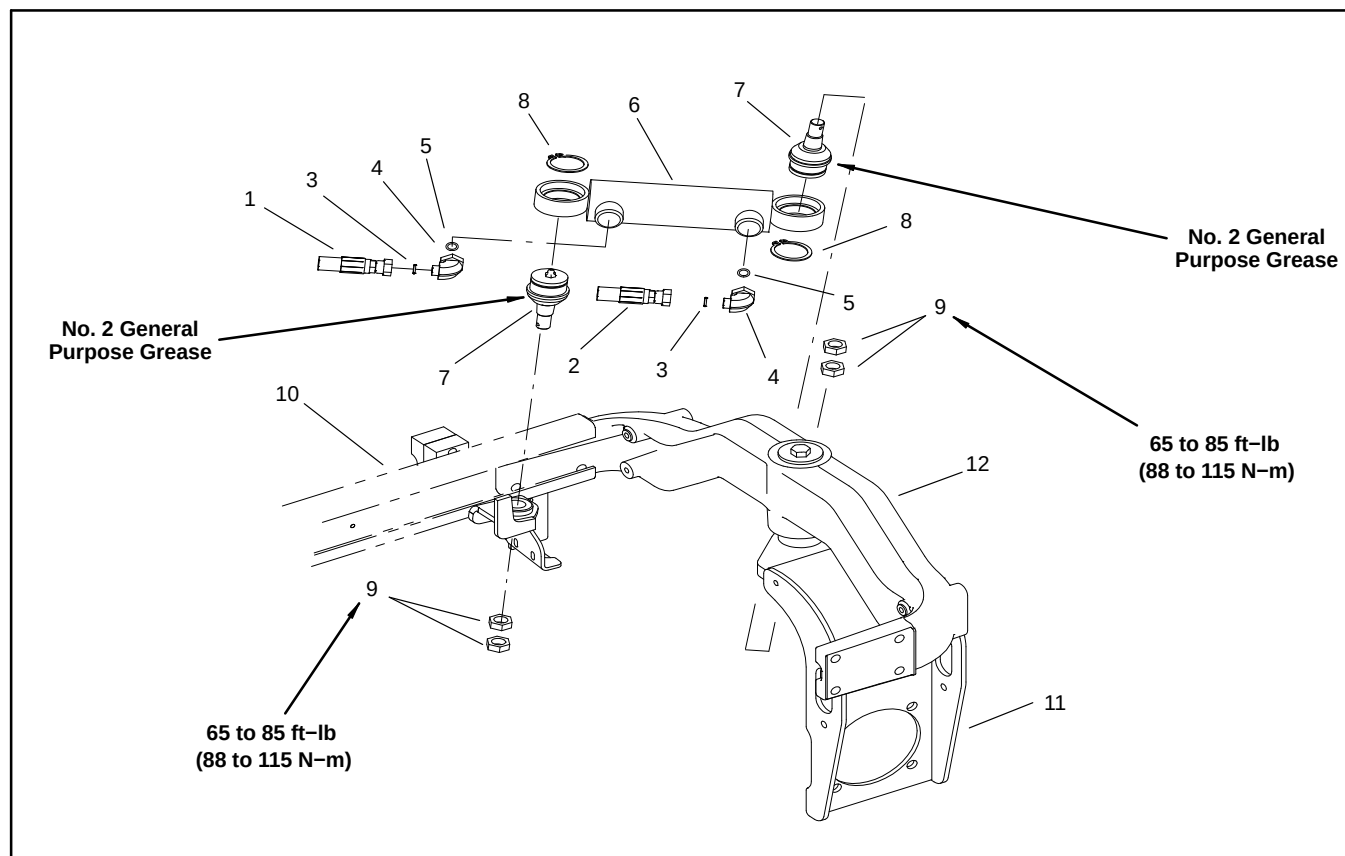


Figure 78

- 1. Hydraulic hose
- 2. Hydraulic hose
- 3. O-ring
- 4. Hydraulic fitting

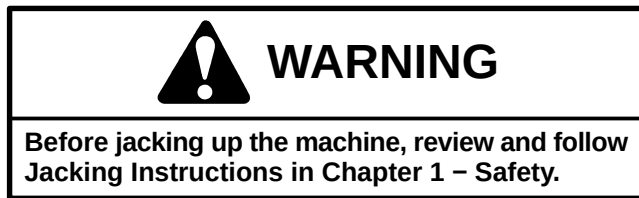
- 5. O-ring
- 6. Steering cylinder
- 7. Ball joint
- 8. Retaining ring

- 9. Jam nuts
- 10. Frame
- 11. Rear fork
- 12. Rear casting

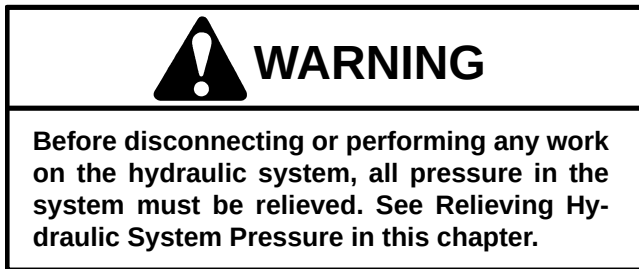
Removal (Fig. 78)

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

NOTE: The rear wheel must be removed to allow sufficient clearance to remove the steering cylinder from the machine.



2. Jack or lift rear wheel off the ground.
3. Remove rear wheel from the drive studs and wheel hub.
4. Thoroughly clean hydraulic hose ends and fittings on steering cylinder to prevent hydraulic system contamination.



5. Remove steering cylinder from the frame and rear fork (Fig. 79 and 80).
6. If hydraulic fittings are to be removed from steering cylinder, note and mark fitting orientation to allow correct assembly.

Installation

1. If hydraulic fittings were removed from steering cylinder, install fittings to cylinder using marks made during the removal process to properly orientate fittings.

2. Install steering cylinder to the frame and rear fork using. When securing cylinder ball joints to machine, tighten the first jam nut from **65 to 85 ft-lb (88 to 115 N-m)**, then tighten the second jam nut to the same specification.

3. Lubricate ball joint grease fittings with No. 2 general purpose grease.

4. Mount rear wheel to the machine with four (4) lug nuts. Lower machine to the ground. Torque wheel lug nuts in a crossing pattern from **70 to 90 ft-lb (95 to 122 N-m)**.

5. Make sure hydraulic tank is full. Add correct hydraulic fluid if necessary.



Figure 79

1. Steering cylinder
2. Jam nuts

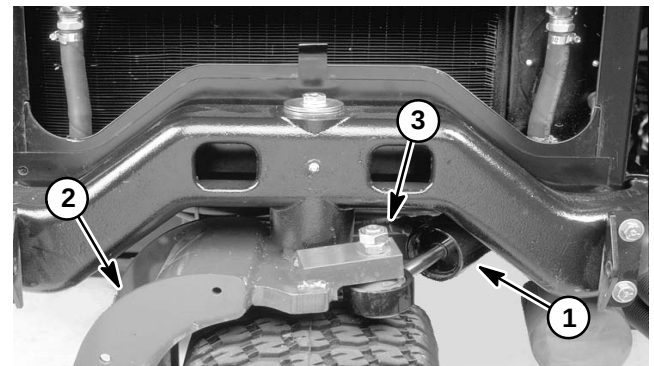


Figure 80

1. Steering cylinder
2. Rear fork
3. Jam nuts

Steering Cylinder Service

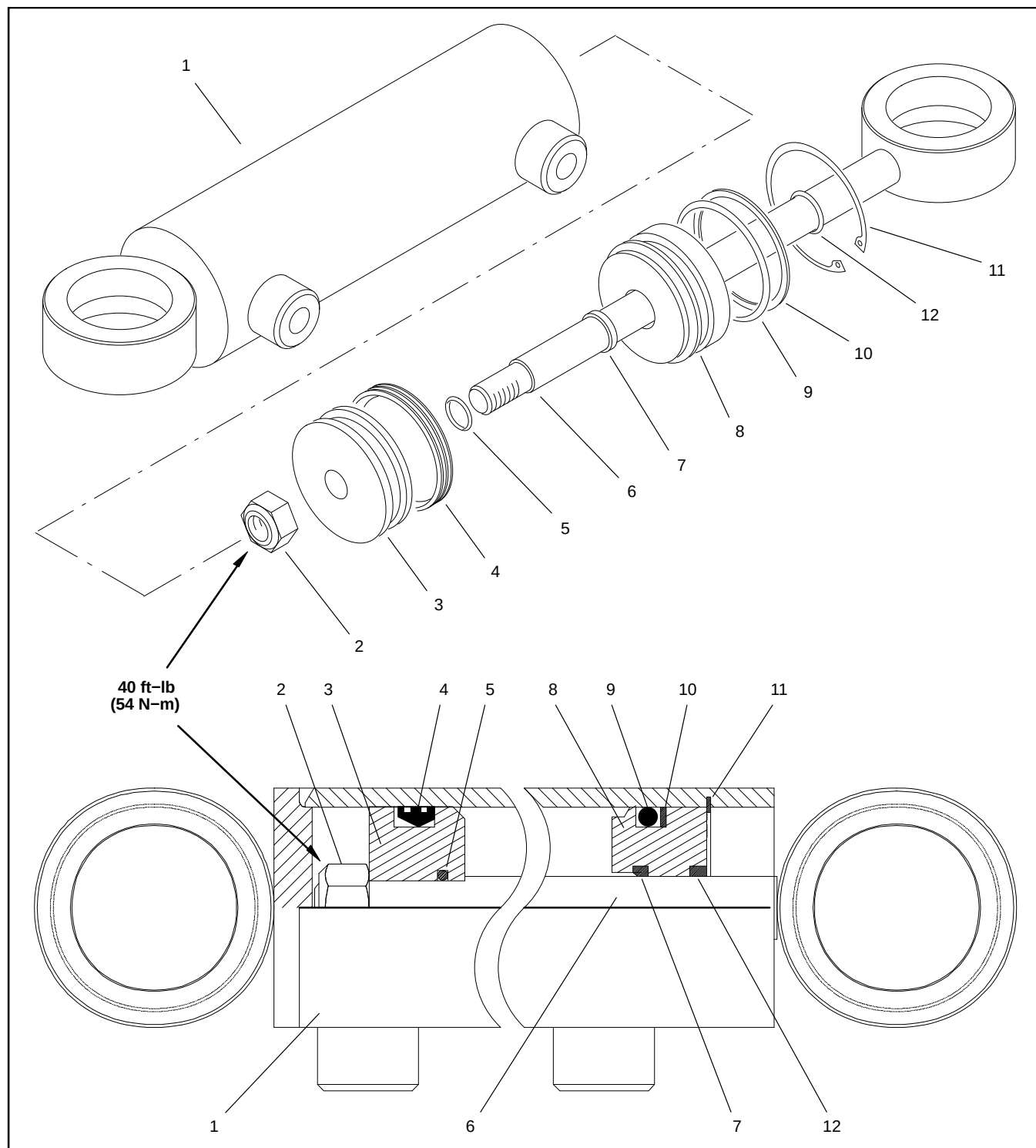


Figure 81

- 1. Barrel with clevis
- 2. Lock nut
- 3. Piston
- 4. Uni-ring

- 5. O-ring
- 6. Piston rod
- 7. Rod seal
- 8. Cylinder gland

- 9. O-ring
- 10. Back-up ring
- 11. Retaining ring
- 12. Dust seal

Disassembly

1. Remove hydraulic fluid from the steering cylinder into a drain pan by slowly pumping the cylinder shaft. Plug both ports and clean the outside of the cylinder.

IMPORTANT: Prevent damage when clamping the hydraulic cylinder into a vise; clamp on the clevis only.

2. Mount clevis end of steering cylinder in a vice. Remove retaining ring.

3. Remove plugs from ports. Extract shaft, cylinder gland, and piston by carefully twisting and pulling on the shaft.

IMPORTANT: Do not clamp vise jaws against the shaft surface. Protect shaft surface before mounting in a vice.

4. Mount shaft securely in a vise by clamping on the clevis of the shaft. Remove lock nut and piston from the shaft. Slide cylinder gland off the shaft.

5. Remove Uni-ring and O-ring from the piston.

6. Remove back-up ring, O-rings, and rod seal from the cylinder gland.

Inspection

Carefully inspect internal surface of cylinder barrel for damage (deep scratches, out-of-round, etc.). Inspect piston rod for straightness, excessive scoring, and pitting or wear. Inspect piston and head for evidence of excessive scoring and pitting or wear. Replace entire cylinder assembly if necessary.

Assembly

1. Make sure all parts are clean before reassembly.

2. Coat new O-rings, Uni-ring, rod seal, and back-up ring with clean hydraulic fluid.

A. Install Uni-ring and O-ring to the piston.

B. Install O-rings, back-up ring, and rod seal to the cylinder gland.

IMPORTANT: Do not clamp vise jaws against the shaft surface. Protect shaft surface before mounting in a vice.

3. Mount shaft securely in a vise by clamping on the clevis of the shaft.

A. Coat shaft with a light coat of clean hydraulic fluid.

B. Slide cylinder gland assembly onto the shaft. Install piston and lock nut onto the shaft. Torque nut from **40 ft-lb (54 N-m)**.

C. Remove shaft from the vise.

IMPORTANT: Prevent damage when clamping the hydraulic cylinder into a vise; clamp on the clevis only.

4. Mount clevis of the barrel in a vice.

5. Coat all internal parts with a light coat of clean hydraulic fluid. Slide piston, shaft, and cylinder gland assembly into the barrel being careful not to damage the seals.

6. Secure head into the barrel with the retaining ring.

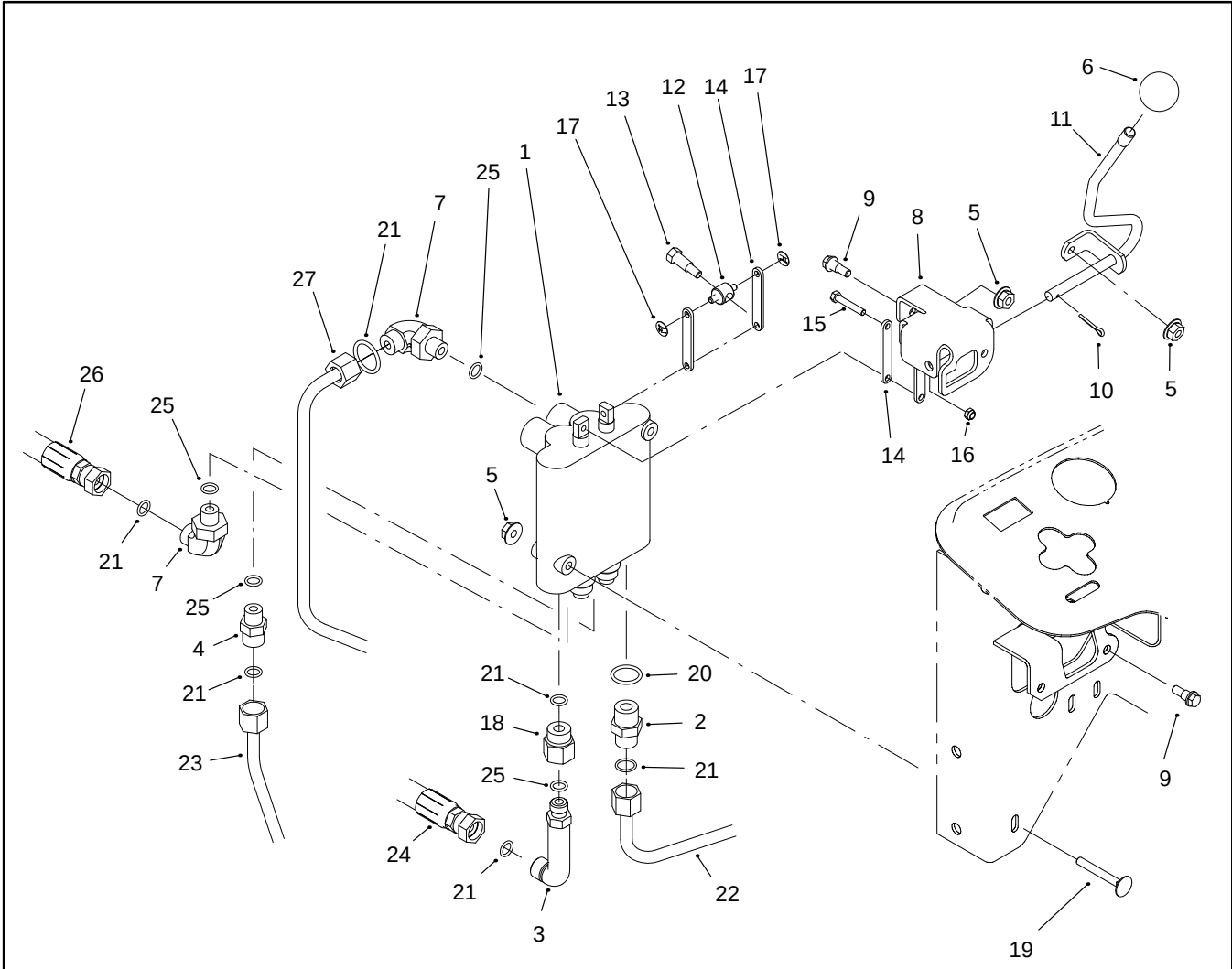


Figure 82

- | | | |
|---------------------------------|-----------------------------|--------------------|
| 1. Control valve (2-spool) | 10. Cotter pin | 19. Carriage screw |
| 2. Hydraulic fitting (straight) | 11. Valve lever | 20. O-ring |
| 3. 90° hydraulic fitting | 12. Valve actuator trunnion | 21. O-ring |
| 4. Hydraulic fitting (straight) | 13. Shoulder bolt | 22. Hydraulic tube |
| 5. Flange nut | 14. Link | 23. Hydraulic tube |
| 6. Knob | 15. Bolt | 24. Hydraulic hose |
| 7. 90° hydraulic fitting | 16. Lock nut | 25. O-ring |
| 8. Valve actuator bracket | 17. Push nut | 26. Hydraulic hose |
| 9. Shoulder bolt | 18. Hydraulic fitting | 27. Hydraulic tube |

Removal (Fig. 82)



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. Remove cover from operator's control panel.
2. Remove control valve from the frame.
3. If hydraulic fittings are to be removed from control valve, note and mark fitting orientation to allow correct assembly.

Installation

1. If hydraulic fittings were removed from control valve, install fittings to valve using marks made during the removal process to properly orientate fittings.
2. Install control valve to the frame.
3. Reinstall operator's control panel cover.
4. Make sure hydraulic tank is full. Add correct hydraulic fluid if necessary.

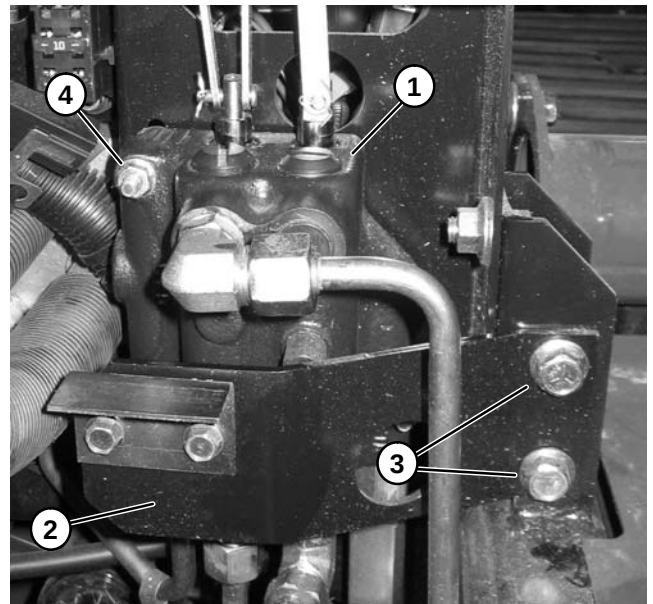


Figure 83

- | | |
|--------------------------|-------------------------------|
| 1. Spool valve | 4. Carriage bolt & flange nut |
| 2. Cover support bracket | |
| 3. Flange head screws | |

Lift/Sidewinder Control Valve Service

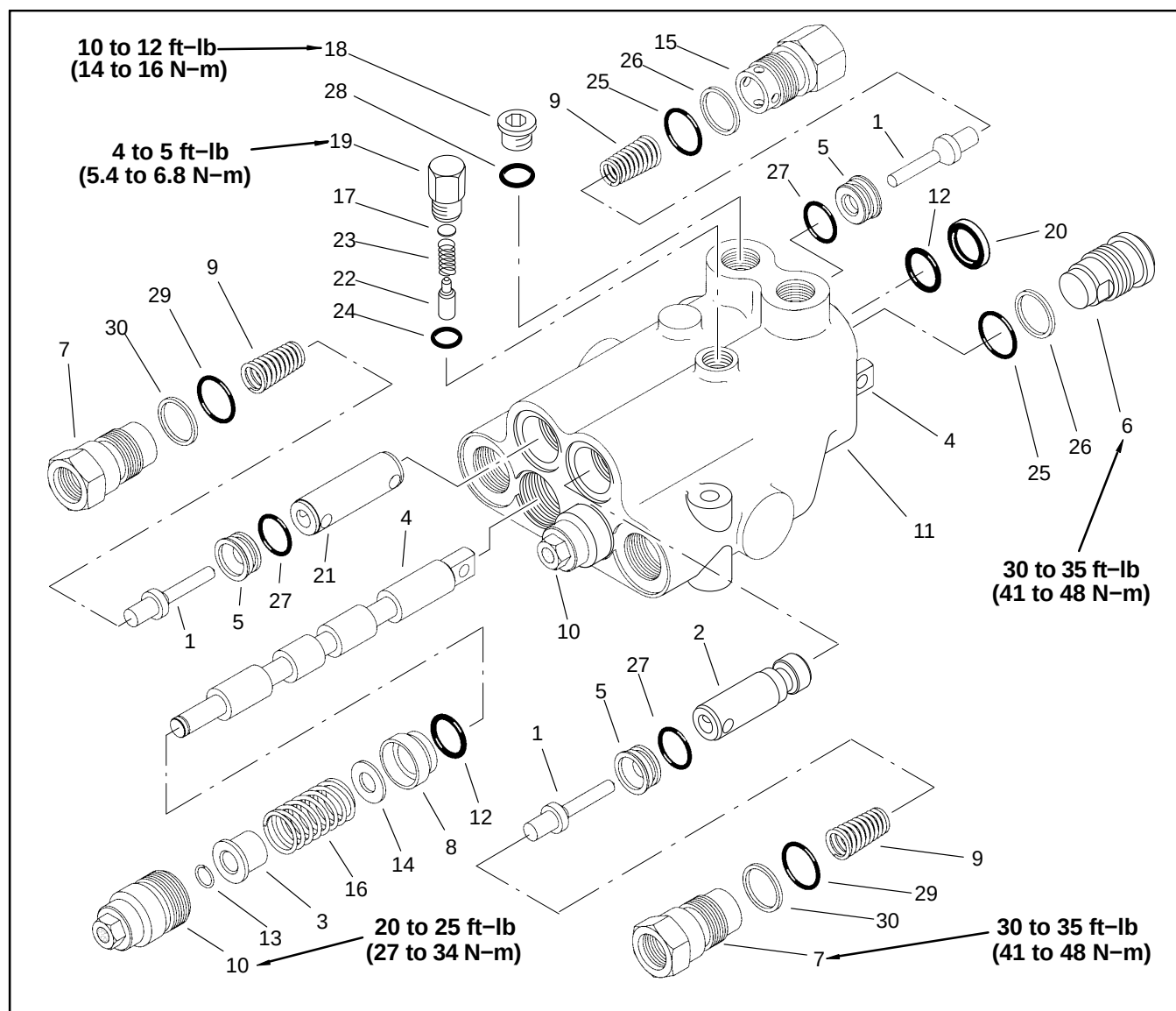


Figure 84

- | | | |
|----------------------------------|-------------------------|--------------------|
| 1. Check poppet | 11. Valve body | 21. Plunger |
| 2. Grooved plunger | 12. O-ring | 22. Plunger detent |
| 3. Spacer | 13. Retaining ring | 23. Detent spring |
| 4. Spool | 14. Washer | 24. O-ring |
| 5. Seat | 15. Seat retaining plug | 25. O-ring |
| 6. Solid plug | 16. Spool spring | 26. Back-up washer |
| 7. Seat retaining plug with port | 17. Disc | 27. O-ring |
| 8. Bushing | 18. Plug | 28. O-ring |
| 9. Check spring | 19. Detent plug | 29. O-ring |
| 10. Spool cap | 20. Wiper seal | 30. Back-up washer |

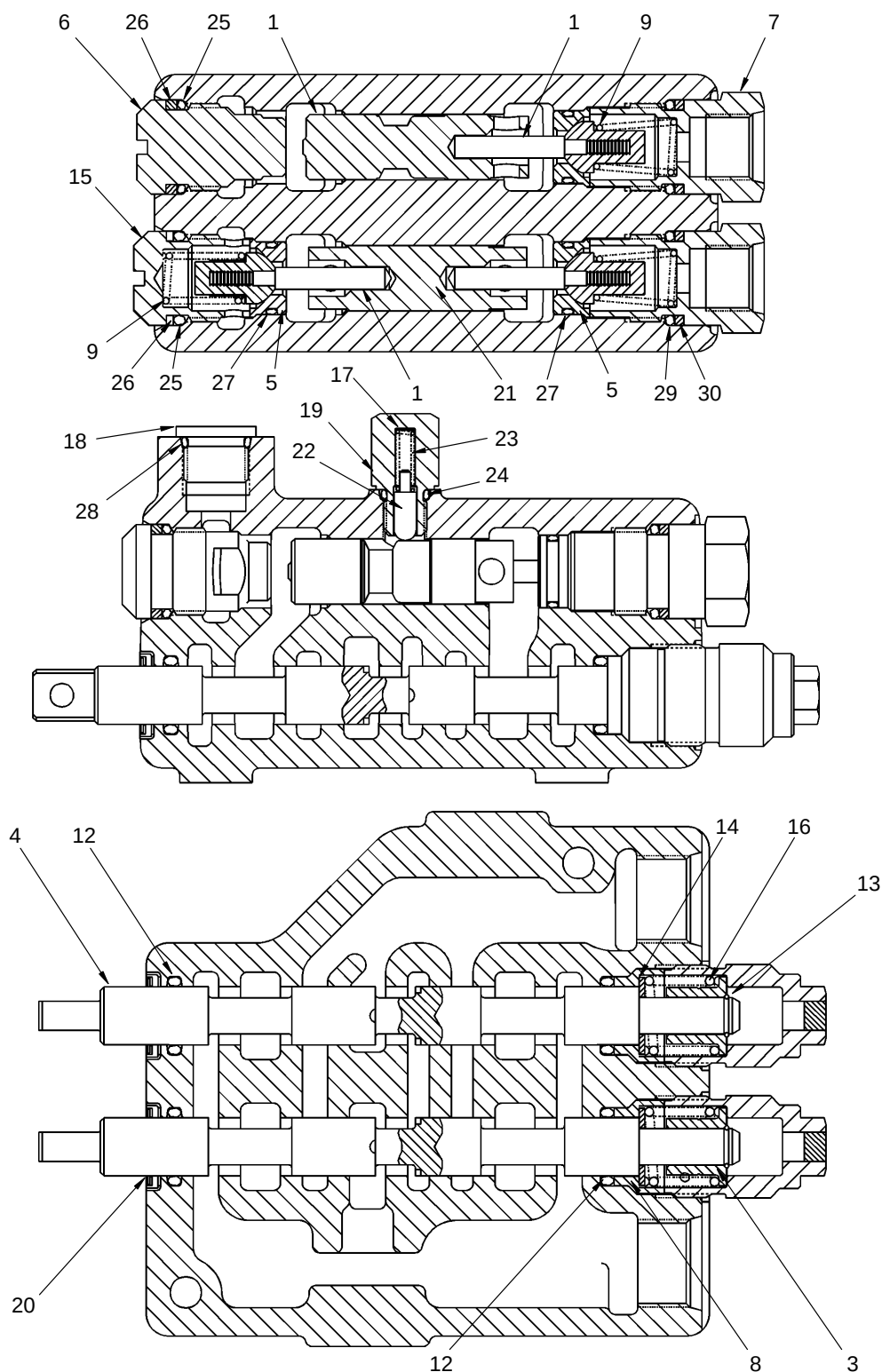


Figure 85

- 1. Check poppet
- 2. Grooved plunger
- 3. Spacer
- 4. Spool
- 5. Seat
- 6. Solid plug
- 7. Seat retaining plug with port
- 8. Bushing
- 9. Check spring
- 10. Spool cap

- 11. Valve body
- 12. O-ring
- 13. Retaining ring
- 14. Washer
- 15. Seat retaining plug
- 16. Spool spring
- 17. Disc
- 18. Plug
- 19. Detent plug
- 20. Wiper seal

- 21. Plunger
- 22. Plunger detent
- 23. Detent spring
- 24. O-ring
- 25. O-ring
- 26. Back-up washer
- 27. O-ring
- 28. O-ring
- 29. O-ring
- 30. Back-up washer

Disassembly

1. Plug all ports and clean the outside of the valve thoroughly.

IMPORTANT: Match-mark spools to their associated bores before disassembly. Spools must be reinstalled to the bore from which they were removed.

2. Remove both spool caps and slide the spool assemblies from their bores.
3. Remove O-ring and bushing from each spool assembly.
4. Remove wiper seals and O-rings from the spool bore ends that are opposite the spool caps.

NOTE: Disassemble spool assemblies only if the retaining ring, spacer, spring, or washer need replacing.

5. Remove seat retaining plugs, back-up washers, O-rings, and check springs from the valve body.
6. Remove check poppets, seats, O-rings, and plungers from the valve body.
7. Remove solid plug, back-up washer, and O-ring from the opposite end of the plunger.
8. Remove plug and O-ring from the top of the valve body next to the detent plug.
9. Remove detent plug and O-ring from the valve body. Remove disc, spring, and detent plunger from the body.

Inspection

1. Inspect spools and spool bores for wear. If wear is excessive, replace valve with new one.
2. Inspect springs and replace as necessary.
3. Inspect plunger, detent plunger, and check poppet for wear. Replace as necessary.
4. Inspect seat, spacer, and bushing for wear. Replace as necessary.
5. Inspect disc and washer. Replace as necessary.
6. Inspect cap and plugs for damaged threads and inspect O-ring sealing surfaces. Replace as necessary.

Assembly

IMPORTANT: Do not wipe parts with dry paper towels or rags. Lint may cause damage to the hydraulic system.



CAUTION

Use eye protection such as goggles when using compressed air.

1. Clean all metal parts with solvent and blow dry with compressed air.
2. Replace check poppets, O-rings, and back-up washers with new ones.
3. Install new O-rings into the valve body.
4. Slide bushings and new O-rings over the spools.
5. If a spool was disassembled, install washer, spool spring, spacer, and retaining ring to the spool.
6. Lubricate spools liberally with clean hydraulic fluid and install into their proper bore.
7. Install spool caps into valve body. Torque caps from **20 to 25 ft-lb (27 to 34 N-m)**.
8. Lubricate both plungers liberally with clean hydraulic fluid and install into their proper bore.
9. Install new O-rings, seats, check poppets, and check springs into the plunger bores.
10. Install O-rings, back-up washers, and seat retaining plugs into their plunger bores. Torque both plugs from **30 to 35 ft-lb (41 to 48 N-m)**.
11. Install new O-ring, back-up washer, and solid plug into the bore with the grooved plunger. Torque plug from **30 to 35 ft-lb (41 to 48 N-m)**.
12. Install new O-ring, seat, check poppet, check spring, new O-ring, back-up washer, and seat retaining plug into the bore with the plunger. Torque plug from **30 to 35 ft-lb (41 to 48 N-m)**.
13. Install O-ring and plug into the top of the valve body next to the detent plug bore. Torque plug from **10 to 12 ft-lb (14 to 16 N-m)**.
14. Lubricate plunger detent, spring, and disc liberally with clean hydraulic fluid and install into its valve body bore.
15. Install O-ring and detent plug into its proper bore. Torque plug from **4 to 5 ft-lb (5.4 to 6.8 N-m)**.

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Front Lift Cylinder

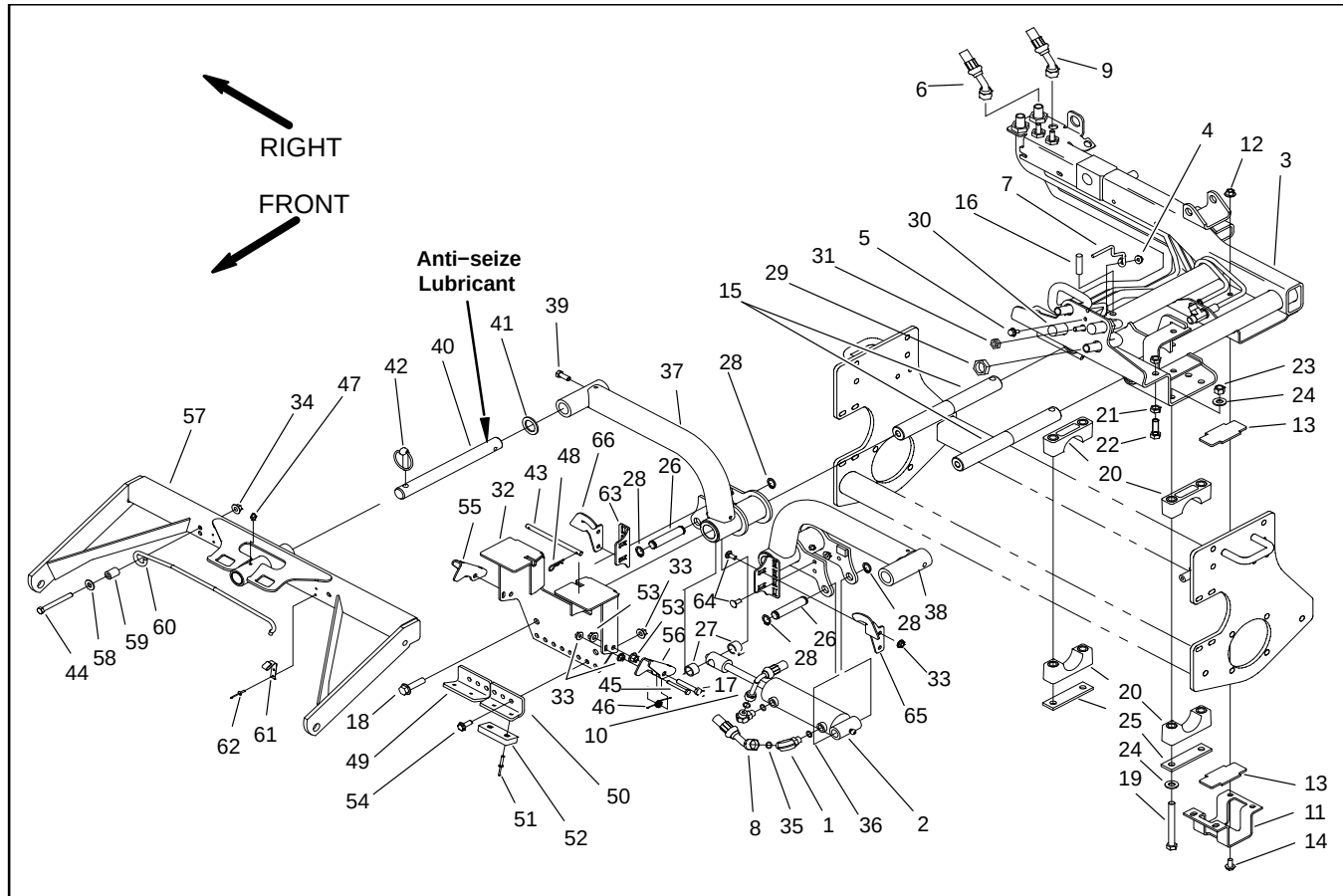


Figure 86

- | | | |
|--------------------------------|-----------------------------|-------------------------|
| 1. 90° hydraulic fitting | 23. Lock nut | 45. Cap screw |
| 2. Hydraulic cylinder | 24. Thrust washer | 46. Torsion spring |
| 3. Sidewinder carrier assembly | 25. Slide support bar | 47. Grease fitting |
| 4. Flange nut | 26. Pin | 48. Hair pin |
| 5. Flange head screw | 27. Spacer | 49. RH deck stop |
| 6. Hydraulic hose | 28. External retaining ring | 50. LH deck stop |
| 7. Centering wire | 29. Bulkhead nut | 51. Rivet |
| 8. Hydraulic hose | 30. Hydraulic tube | 52. Rubber bumper |
| 9. Hydraulic hose | 31. Bulkhead nut | 53. Flange nut |
| 10. Hydraulic hose | 32. Carrier stop bracket | 54. Flange head screw |
| 11. Slide bracket | 33. Nut | 55. RH pivot bracket |
| 12. Flange nut | 34. Flange nut | 56. LH pivot bracket |
| 13. Plastic slide | 35. O-ring | 57. Front carrier frame |
| 14. Flange head screw | 36. O-ring | 58. Flat washer |
| 15. Lift arm pivot shaft | 37. RH lift arm | 59. Latch tube |
| 16. Roll pin | 38. LH lift arm | 60. Latch rod |
| 17. Cap screw | 39. Cap screw | 61. Rod clip |
| 18. Flange head screw | 40. Shaft | 62. Rivet |
| 19. Cap screw | 41. Thrust washer | 63. Actuator bracket |
| 20. Bearing cap | 42. Lynch pin | 64. Carriage screw |
| 21. Jam nut | 43. Rod | 65. RH actuator |
| 22. Cap screw | 44. Cap screw | 66. LH actuator |

Removal (Fig. 86)



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. Remove front lift cylinder from the frame and lift arm.
2. If hydraulic fittings are to be removed from lift cylinder, note and mark fitting orientation to allow correct assembly.

Installation

1. If hydraulic fittings were removed from lift cylinder, install fittings to cylinder using marks made during the removal process to properly orientate fittings.

IMPORTANT: With lift arms raised fully, hydraulic hoses should be routed as shown (Fig 87). Make sure clearance between hydraulic hose and lift arm is from 0.040 to 0.120 inches (1.0 to 3.0 mm). Do not loosen hoses for repositioning without relieving system hydraulic pressure first.

2. Install front lift cylinder to the frame and lift arm.
3. Make sure hydraulic tank is full. Add correct hydraulic fluid if necessary.
4. Adjust front lift arms.

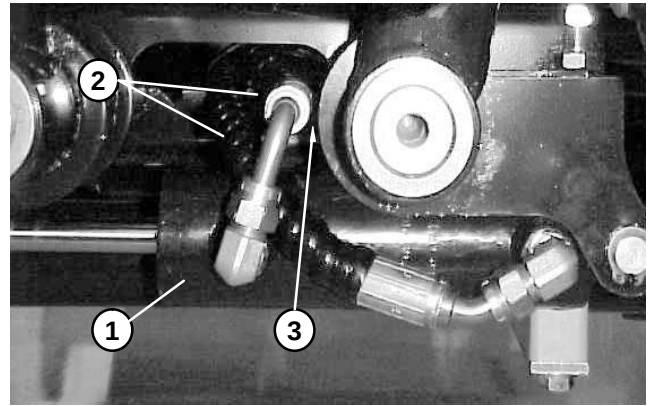


Figure 87

1. Lift cylinder
2. Hydraulic hoses
3. Clearance

Rear Lift Cylinder

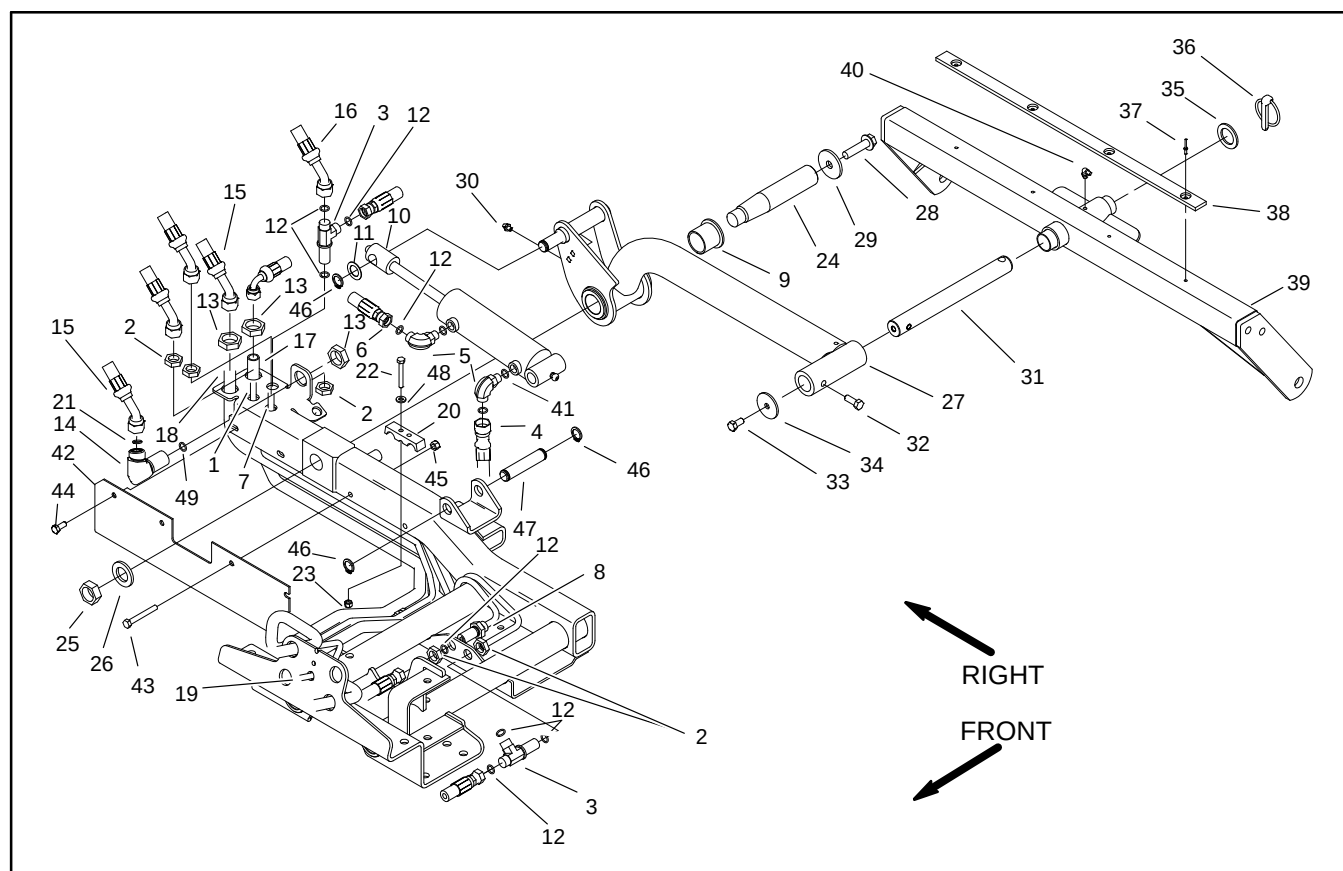


Figure 88

- | | | |
|-------------------------------|------------------------------|-----------------------------|
| 1. Hydraulic tube | 18. Hydraulic tube | 34. Rebound washer |
| 2. Bulkhead locknut | 19. Hydraulic tube | 35. Thrust washer |
| 3. Hydraulic T-fitting | 20. Tube clamp | 36. Lynch pin |
| 4. Hydraulic hose | 21. O-ring | 37. Pop rivet |
| 5. 90° hydraulic fitting | 22. Cap screw | 38. Wear strip |
| 6. Hydraulic hose | 23. Lock nut | 39. Rear cutting unit frame |
| 7. Hydraulic tube | 24. Rear pivot shaft | 40. Grease fitting |
| 8. Straight hydraulic fitting | 25. Jam nut | 41. O-ring |
| 9. Castor bushing | 26. Washer | 42. Guard |
| 10. Hydraulic cylinder | 27. Lift arm assembly | 43. Cap screw |
| 11. Thrust washer | 28. Flange head screw | 44. Cap screw |
| 12. O-ring | 29. Thrust washer | 45. Lock nut |
| 13. Bulkhead locknut | 30. Grease fitting | 46. External retaining ring |
| 14. Bulkhead elbow union | 31. Cutting unit pivot shaft | 47. Pin |
| 15. Hydraulic hose | 32. Cap screw | 48. Flat washer |
| 16. Hydraulic hose | 33. Cap screw | 49. O-ring |
| 17. Hydraulic tube | | |

Removal (Fig. 88)



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. Remove rear lift cylinder from the frame and lift arm.
2. If hydraulic fittings are to be removed from lift cylinder, note and mark fitting orientation to allow correct assembly.

Installation

1. If hydraulic fittings were removed from lift cylinder, install fittings to cylinder using marks made during the removal process to properly orientate fittings.
2. Install rear lift cylinder to the frame and lift arm.
3. Make sure hydraulic tank is full. Add correct hydraulic fluid if necessary.
4. Adjust rear lift arm.

Lift Cylinder Service

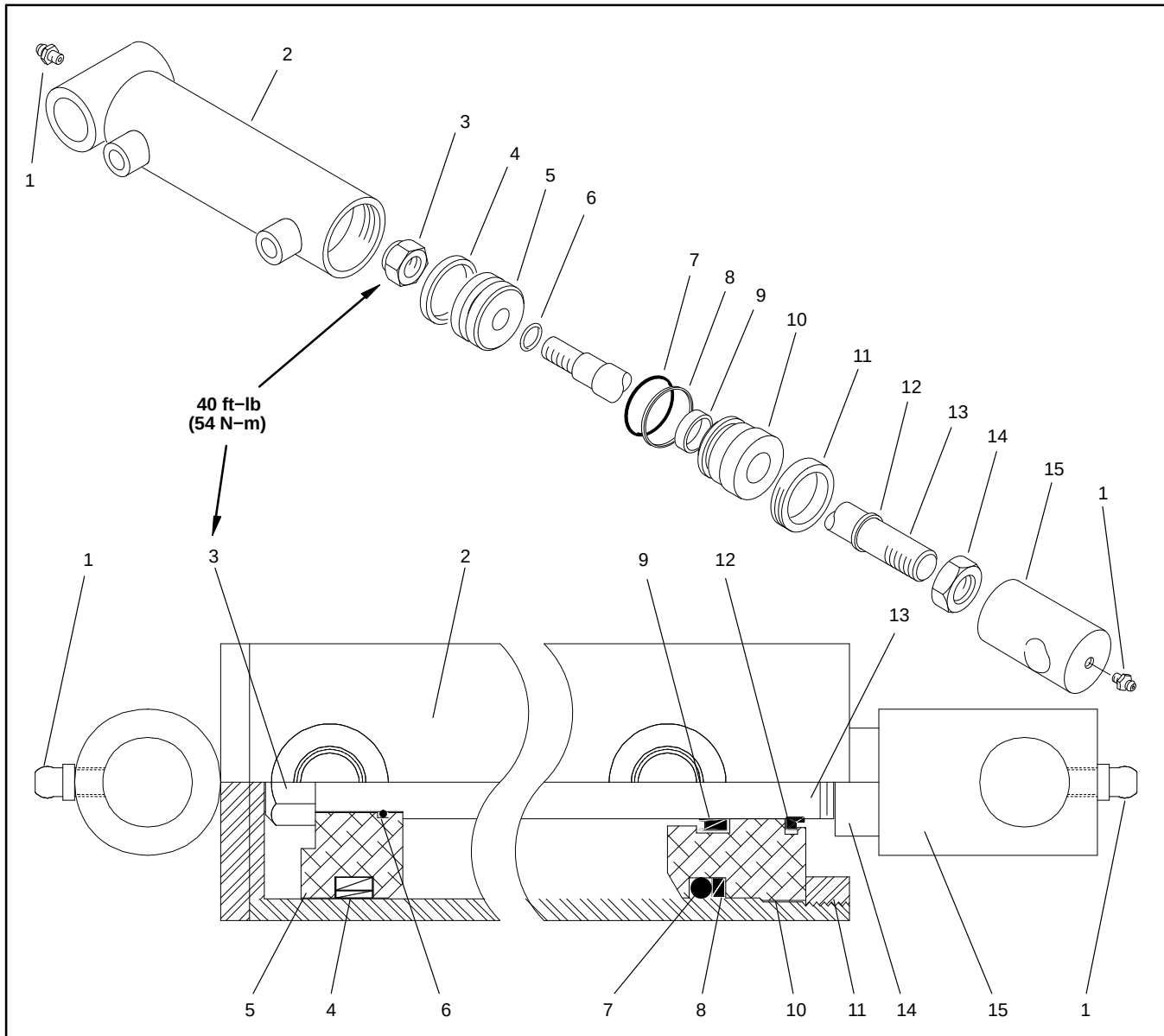


Figure 89

- 1. Grease fitting
- 2. Barrel with clevis
- 3. Nut
- 4. Uni-ring
- 5. Piston

- 6. O-ring
- 7. O-ring
- 8. Back-up ring
- 9. Rod seal
- 10. Head

- 11. Internal collar
- 12. Dust seal
- 13. Shaft
- 14. Nut
- 15. Clevis

Disassembly

1. Remove hydraulic fluid 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. Remove internal collar with a spanner wrench.
3. 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. Protect shaft surface before mounting in a vise.

4. Mount shaft securely in a vise by clamping on the clevis of the shaft. Remove lock nut and piston from the shaft. Slide head off the shaft.
5. Remove Uni-ring and O-ring from the piston. Remove O-ring, back-up ring, rod seal, and dust seal from the head.

Inspection

Carefully inspect internal surface of cylinder barrel for damage (deep scratches, out-of-round, etc.). Inspect piston rod for straightness, excessive scoring, and pitting or wear. Inspect piston and head for evidence of excessive scoring and pitting or wear. Replace entire cylinder assembly if necessary.

Assembly

1. Make sure all parts are clean before assembly.
2. Coat new O-rings, Uni-ring, rod seal, back-up ring, and dust seal with clean hydraulic fluid.
 - A. Install Uni-ring and O-ring to the piston.
 - B. Install rod seal, O-ring, back-up ring, and dust seal to the head.

IMPORTANT: Do not clamp vise jaws against the shaft surface. Protect shaft surface before mounting in a vise.

3. Mount shaft securely in a vise by clamping on the clevis of the shaft.
 - A. Coat shaft with clean hydraulic fluid.
 - B. Slide head onto the shaft. Install rod seal onto shaft and into head.
 - C. Install piston and lock nut onto the shaft. Torque nut from **40 ft-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 fluid. Slide piston, shaft, and head assembly into the barrel being careful not to damage the seals.
6. Secure head in the barrel with internal collar using a spanner wrench. Tighten collar until snug and the outer end of the collar is flush with end of the barrel.
7. If clevis was removed from cylinder shaft, fully retract cylinder shaft and thread jam nut and clevis onto shaft. Adjust center to center length to dimension shown before tightening jam nut (Fig. 90).

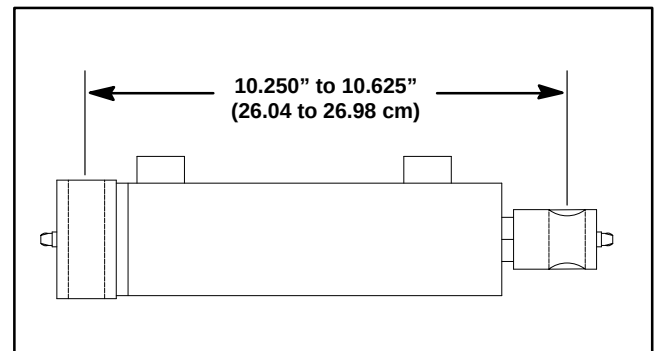


Figure 90

Sidewinder

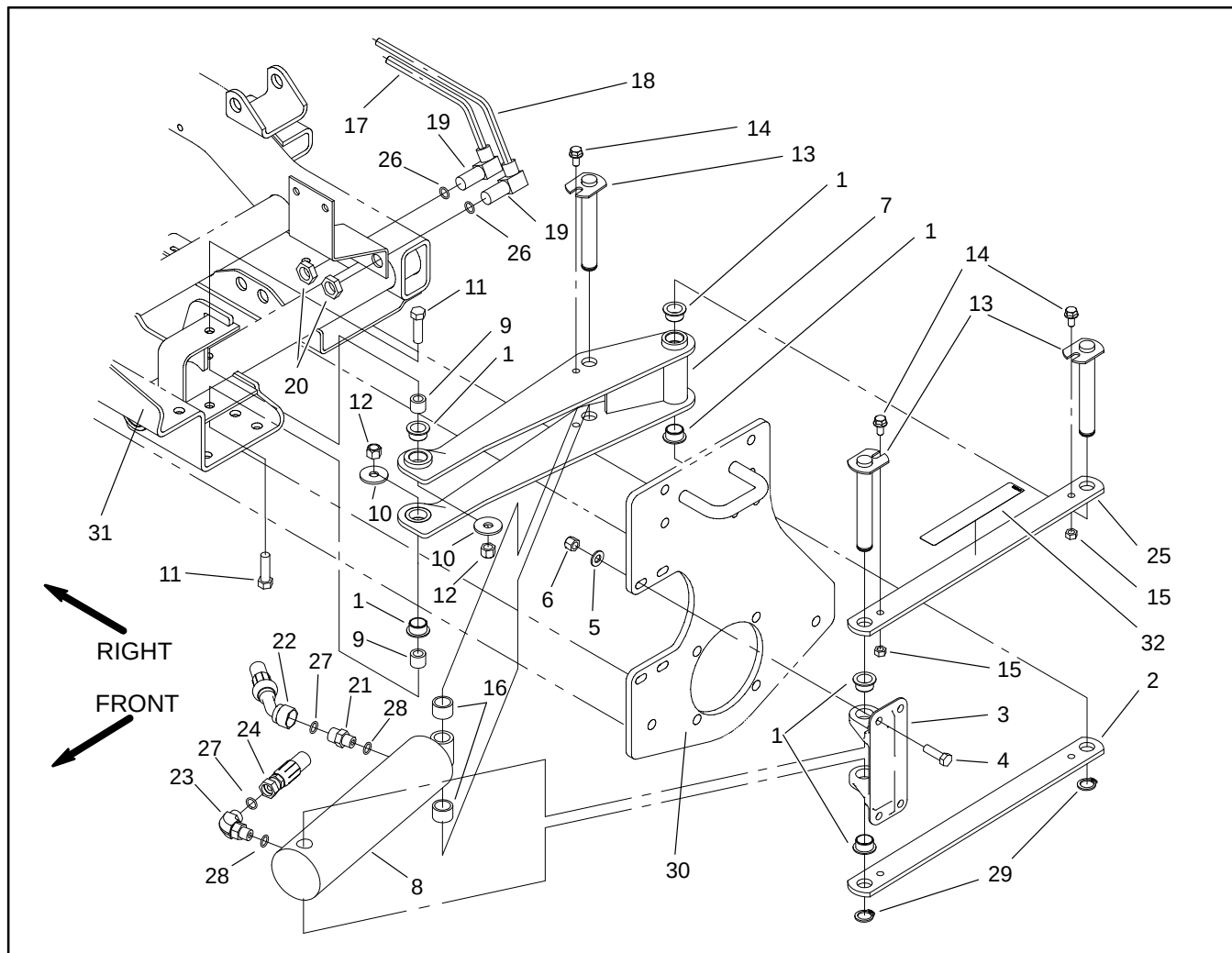


Figure 91

- | | | |
|-----------------------|--------------------------------|---------------------------|
| 1. Bushing | 12. Lock nut | 23. 90° hydraulic fitting |
| 2. Scissor link | 13. Welded pin | 24. Hydraulic hose |
| 3. Scissor mount | 14. Flange head screw | 25. Scissor link |
| 4. Cap screw | 15. Lock nut | 26. O-ring |
| 5. Flat washer | 16. Spacer | 27. O-ring |
| 6. Lock nut | 17. Hydraulic tube | 28. O-ring |
| 7. Scissor frame | 18. Hydraulic tube | 29. Retaining ring |
| 8. Hydraulic cylinder | 19. 90° hydraulic fitting | 30. Lower frame |
| 9. Spacer | 20. Bulkhead lock nut | 31. Frame |
| 10. Flat washer | 21. Straight hydraulic fitting | 32. Pinch point decal |
| 11. Cap screw | 22. Hydraulic hose | |

Removal (Fig. 91)



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.

The hydraulic cylinder used in the Groundsmaster 3500 sidewinder assembly is a non-serviceable cylinder. Replace the cylinder if it becomes worn or damaged.

1. Remove hydraulic cylinder from the frame.
2. If hydraulic fittings are to be removed from cylinder, note and mark fitting orientation to allow correct assembly.

Installation

1. If hydraulic fittings were removed from cylinder, install fittings to cylinder using marks made during the removal process to properly orientate fittings.
2. Install hydraulic cylinder to the frame.
3. Make sure hydraulic tank is full. Add correct hydraulic fluid if necessary.
4. Adjust scissors mount as follows:
 - A. Shift sidewinder fully to the left (fully retract cylinder).
 - B. Loosen four cap screws and locknuts securing the scissor mount to lower frame.
 - C. The gap between the scissor frame and lower frame and the gap between the scissor frame and the sidewinder carrier must be equal distances within 0.060 inch (1.5 mm) (Fig. 92).
 - D. Tighten four cap screws and lock nuts to secure the scissor mount.

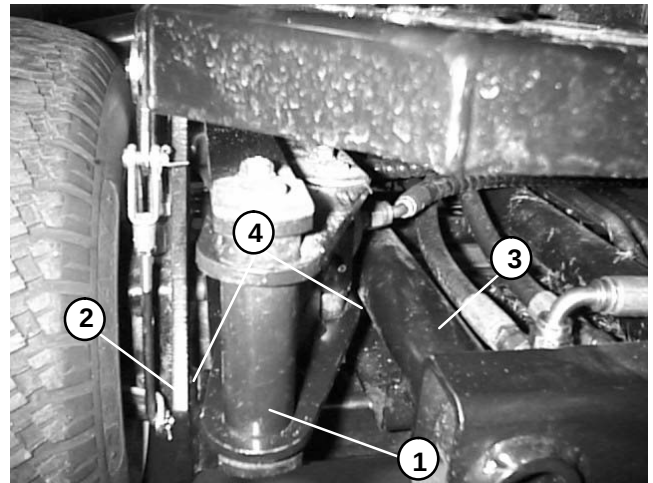


Figure 92

- | | |
|------------------|-----------------------|
| 1. Scissor frame | 3. Sidewinder carrier |
| 2. Lower frame | 4. Gaps |

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Electrical System

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General Information

Operator's Manual

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

Electrical Drawings

The electrical schematic and wire harness drawings for the Groundsmaster 3500-D Model 30807 and the Groundsmaster 3500-G Model 30809 are located in Chapter 9 – Foldout Drawings.

Standard Control Module (SCM)

All Groundsmaster 3500 machines with 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. Detailed information on the Standard Control Module can be found later in this chapter.

Kubota Diesel Engine – Electrical Components

The engine used in the Groundsmaster 3500-D incorporates the following electrical components to start and run properly:

- Glow plug controller and relay
- Fuel stop Solenoid
- High Temp Warning and Shutdown Switches
- Oil Pressure Switch
- Alternator

Additional information on troubleshooting and servicing engine electrical components can be found in the appropriate Kubota Workshop Manual.

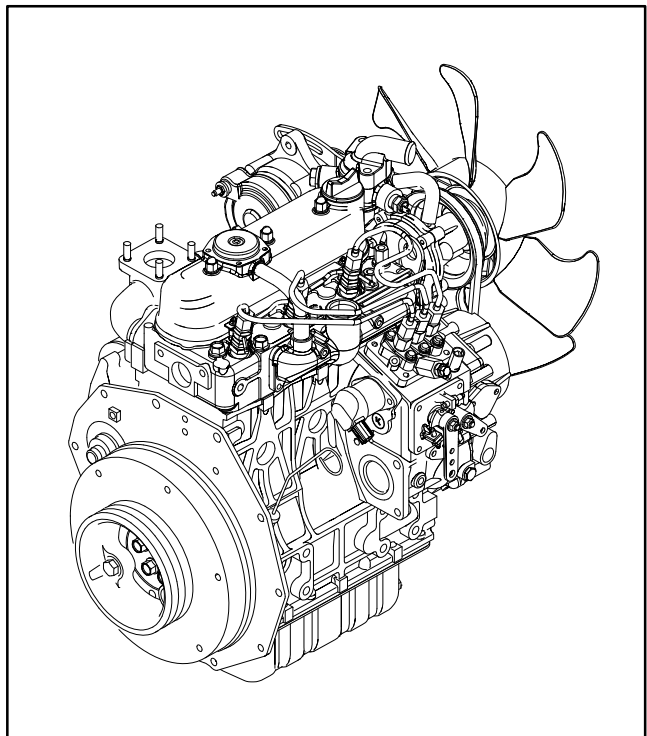


Figure 1

Kubota Gasoline Engine – Electrical Components

The engine used in the Groundsmaster 3500-G features an electronic control unit (ECU) that controls a common rail fuel injection system, electronic throttle valve (ETV), and a catalytic muffler exhaust system with a pre-muffler oxygen (O₂) sensor. The ECU receives information from numerous Kubota engine sensors and the following traction unit inputs:

- Standard Control Module (SCM)
- Electronic Throttle Control

The information provided by the various inputs allows the engine ECU to monitor and control engine operation for optimum engine performance.

All wire harness electrical connectors should be plugged into the ECU before the machine ignition switch is moved from the OFF position to either the ON or START position. If the engine ECU is to be disconnected for any reason, make sure that the ignition switch is in the OFF position with the key removed before disconnecting the engine ECU. See Chapter 4 – Kubota Gasoline Engine In this manual for additional engine ECU information.

Additional information on troubleshooting and servicing engine electrical components can be found in the appropriate Kubota Workshop Manual and Diagnostic Manual.

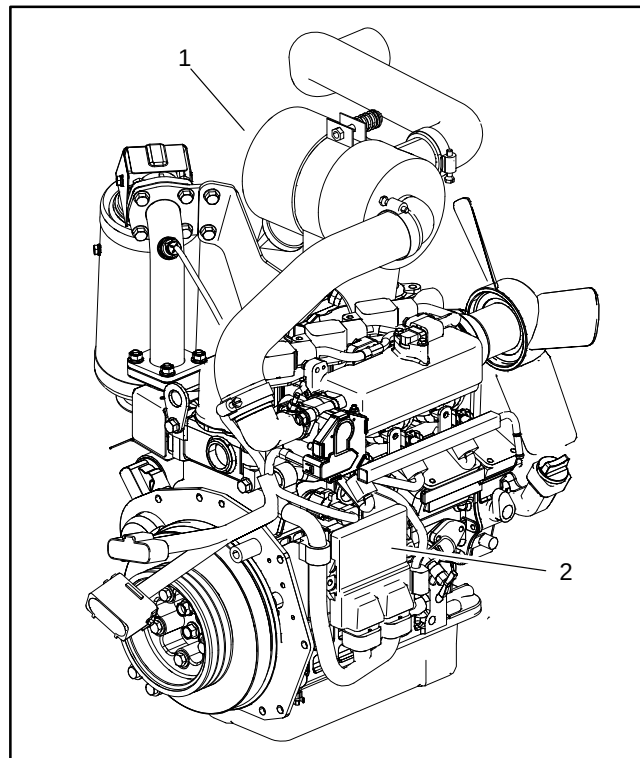


Figure 2

1. Engine (Model 30809)
2. Engine ECU

Special Tools

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

Multimeter

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

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

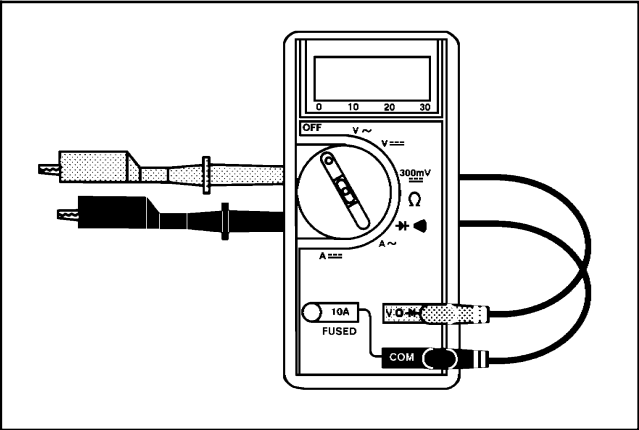


Figure 3

Dielectric Lubricant/Sealant

Dielectric gel should be used to prevent corrosion of unsealed 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 4

Battery Hydrometer

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



Figure 5

Battery Terminal Protector

Aerosol spray that should be used on battery terminals, ring terminals, and fork terminals to reduce corrosion problems. Apply battery terminal protector to the connection after the battery cable, ring terminal, or fork terminal has been secured.

Toro Part Number: **107-0392**



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, you must have a good understanding of the electrical circuits and components used on this machine (see Foldout Drawings – Chapter 9).

Switch and switch circuit operation can be checked using the LED indicators on the Standard Control Module

(SCM) (see Standard Control Module in this chapter). If the machine has had any interlock switches by-passed, they must be reconnected for proper troubleshooting and safety.

Gasoline Engines Only – If the engine ECU identifies that an engine problem exists (including electrical faults with the various engine sensors), the check engine light on the Operator's Control Panel will illuminate. The Kubota Gasoline Service Tool and software, and the Kubota Diagnostics Manual should be used to identify the cause of the problem, and any repairs that are necessary. Contact your Toro distributor for assistance in Kubota engine troubleshooting.

Starting Problems

Problem	Possible Causes
Nothing happens when start attempt is made.	The traction pedal is not in neutral position or the neutral switch is faulty. Operator seat is unoccupied AND the parking brake is not applied. The PTO switch is in the ENGAGE position or faulty. The battery is dead. Fuse F1 or F3 is faulty or blown. Loose or corroded battery or ground cables. Loose or corroded engine ground. The fusible link at the engine starter is faulty. Wiring in the engine crank circuit is loose, corroded, or damaged. The ignition switch is faulty. Starter solenoid wiring loose, corroded or damaged. Starter solenoid is faulty. The Standard Control Module (SCM) is faulty. Diesel Engines Only The engine coolant temperature is above 230F (110C) or the over temperature shutdown switch is faulty (grounded). Gasoline Engines Only The main power relay or main power relay circuit wiring is faulty.

Starting Problems (continued)

Problem	Possible Causes
Starter solenoid clicks, but starter will not crank NOTE: If the solenoid clicks, the problem is not in the interlock circuit.	Low battery charge. Loose or corroded battery cables. Loose or corroded ground. Faulty wiring at the starter. Faulty starter solenoid. Faulty starter motor.
Engine cranks, but does not start.	The fuel tank is empty. The fuel pump or fuel pump circuit wiring is faulty. Wiring in the engine crank circuit is loose, corroded, or damaged. Diesel Engines Only Engine stop solenoid is faulty. The glow circuit (glow plug controller, glow plug relay, glow plugs, fuse F4) is faulty. The engine and/or fuel may be too cold. The fuel filter may be plugged. Gasoline Engines Only The Electronic Throttle Valve (ETV) relay or ETV relay circuit wiring is faulty.
Diesel Engines Only – The glow circuit does not operate properly.	Wiring in the glow circuit is loose, corroded, or damaged. Fuse F4 is blown or faulty. The glow relay or glow plug controller is faulty. One or more of the engine glow plugs is faulty. The fusible link at the engine starter is faulty.
Engine cranks (but should not) with the PTO switch in the ENGAGE position.	The PTO switch or PTO switch circuit wiring is faulty. The Standard Control Module (SCM) is faulty.
The engine starts, but stops when the ignition switch is released from the START position.	The ignition switch is faulty. Diesel Engines Only The engine stop solenoid (hold coil) or stop solenoid hold coil circuit wiring is faulty.

General Run and Transport Problems

Engine stops running during operation (operator sitting on seat and unit moving).	Operator not in center of seat (seat switch is not depressed). The seat switch is faulty or seat switch circuit wiring is loose, corroded or damaged. The parking brake was engaged or the parking brake switch is faulty or parking brake switch circuit wiring is loose, corroded or damaged. Fuel tank is empty or very low and unit is operating on a slope or grade. The fuel pump is faulty. Fuse F1 or F3 is faulty. Wiring in the run circuit is loose, corroded, or damaged. Diesel Engines Only The engine coolant temperature is above 230F (110C) or the over temperature shutdown switch is faulty (grounded). The stop solenoid is faulty.
Battery does not charge.	Faulty battery. Faulty alternator. Alternator belt is loose or damaged. Wiring in the charging circuit is loose, corroded, or damaged. The fusible link at the engine starter is faulty. Alternator warning lamp is faulty or alternator warning lamp wiring is loose, corroded or damaged.

Cutting Deck Operating Problems

The cutting units will not run during the following normal operating conditions: Operator in seat or parking brake engaged Mow/transport switch in MOW PTO switch in ENGAGE	Operator in seat – the seat switch is faulty or seat switch circuit wiring is loose, corroded or damaged. Parking brake engaged – the parking brake switch is faulty or parking brake switch circuit wiring is loose, corroded or damaged. The reel drive solenoid valve (S) or (S1) is faulty or the reel drive solenoid valve (S) or (S1) circuit wiring is loose, corroded, or damaged. The PTO switch is faulty. The cutting unit up limit switch is faulty. Mow/transport switch is faulty. There is insufficient hydraulic oil pressure to turn the cutting units (see Chapter 5 – Hydraulic System in this manual). The Standard Control Module (SCM) is faulty. Gasoline Engines Only The engine temperature is above 220F (105C) High temperature warning switch or high temperature warning switch circuit wiring is loose, corroded, or damaged.
---	---

Electrical System Quick Check

Battery Test (Open Circuit Test)

Use a multimeter to measure the voltage between the battery terminals.

Set multimeter to the DC volts setting. The battery should be at a temperature of 60 to 100F (16 to 38C). The ignition key should be off and all accessories turned off. Connect the positive (+) meter lead to the positive battery post and the negative (-) meter lead to the negative battery post.

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

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

Tool required: Digital multimeter set to DC volts.

Test instructions: 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. Allow the battery to charge for at least 3 minutes. Record the battery voltage.

After running the engine for at least 3 minutes, battery voltage should be at least 0.50 volt higher than initial battery voltage.

Example of a charging system that is functioning properly:

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 (Diesel Engines Only)

This is a fast, simple test that can help to determine the integrity and operation of the Groundsmaster 3500-D 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.

Tool(s) required: Digital multimeter and/or inductive Ammeter (AC/DC Current Transducer).

Test instructions: Properly connect the ammeter to the digital multimeter (refer to manufacturers' instructions).

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 (see Traction Unit Operator's Manual) and record the multimeter results.

The Groundsmaster 3500-D glow plug system should have a reading of approximately 27 Amps.

Check Operation of Interlock Switches



CAUTION

The interlock switches are for the operator's protection; do not disconnect them. Check the operation of the interlock switches daily for proper operation. Replace any malfunctioning switches before operating the machine.

The machine is equipped with a number of interlock switches. The engine will not start, or if the engine is running, the engine will stop if one or more of the interlock conditions are met.

To start the engine:

- The PTO switch must be in the DISENGAGE position.
- The traction pedal must be in neutral (with pedal and switch properly adjusted)
- An operator must be in the seat or the parking brake must be engaged.

When the engine is running, the engine should stop in 1–3 seconds if:

- The operator leaves the seat without engaging the parking brake.
- The traction pedal is depressed with the parking brake engaged.

Use the Standard Control Module (SCM) to check operation of the interlocks.

1. Remove the cover over the instrument panel to expose the Standard Control Module (SCM) (Fig. 8).
2. Turn the ignition switch to the on RUN position

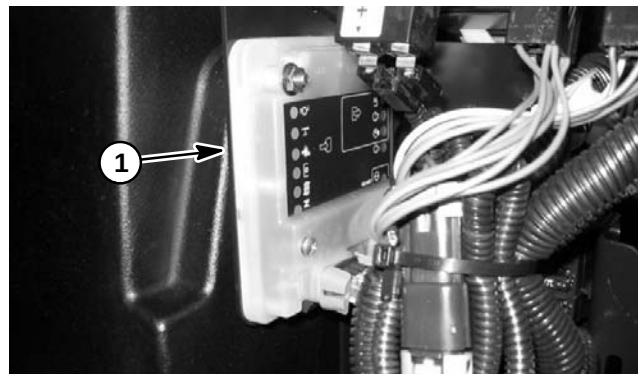


Figure 8

1. Standard Control Module

3. Sit in the operators seat and the In Seat LED on the SCM should be on. Remove your weight from the seat and the In Seat LED on the SCM should be off.
4. The Parking Brake LED on the SCM should be on when the parking is disengaged and go off when the parking brake is engaged.
5. The PTO LED on the SCM should be off when the PTO switch is in the DISENGAGED position and go on when the PTO switch is in the ENGAGED position.
6. The Neutral LED on the SCM should be on when the traction pedal is in the neutral position and off when the traction pedal is in the forward or reverse position.
7. Take corrective action immediately if any of the interlocks do not perform as described.

Standard Control Module (SCM)

Groundsmaster 3500 machines are equipped with a Standard Control Module to monitor and control electrical components required for safe operation. This Module is attached to the back of the instrument panel.

Inputs from the neutral, parking brake, PTO, ignition, seat, and high temperature switches are monitored by the Module. Output to the PTO (deck drive solenoid), engine starter motor, fuel pump, and engine stop solenoid (diesel engines) or the power relay (gasoline engine) are controlled based on the inputs received by the Module.

The Standard Control Module does not connect to an external computer or hand held device, can not be re-programmed, and does not record intermittent fault data.

The Standard Control Module can be used to check operation of machine switches by monitoring the LEDs of the module. If a Module LED does not illuminate (e.g. the in seat input LED does not illuminate with the seat occupied and the ignition switch in the run position), testing of the switch and circuit wiring would be required.

Refer to the Traction Unit Operator's Manual for additional Standard Control Module information.

Control Module Inputs (Fig. 9)

The Power input LED should be illuminated when the ignition key switch is in the RUN or START position.

The Start input LED should be illuminated when the ignition key switch is in the START position.

The Neutral input LED should be illuminated when the traction pedal is in the neutral position.

The Parking Brake Off input LED should be illuminated when the parking brake is not engaged.

The PTO Switch input LED should be illuminated when the PTO switch is engaged.

The In Seat input LED should be illuminated when the operator is sitting in the seat.

Diesel Engines Only – The Over Temperature Shutdown input LED should be illuminated when the engine coolant temperature exceeds 230F(110C) causing the high temperature shutdown switch to close. The Over Temperature Warning input LED is not used with diesel powered units.

Gasoline Engines Only – The Over Temperature Warning input LED should be illuminated when the engine

coolant temperature exceeds 230F(110C) causing the high temperature warning switch to close. The Over Temperature Shutdown input LED is not used with gasoline powered units.

The Backlap input LED is not used on the Groundsmaster 3500.

Control Module Outputs (Fig. 9)

The Start output LED should be illuminated when the ignition key switch is in the START position with the traction pedal in neutral, the PTO switch off and either the seat occupied or parking brake engaged.

The Run output LED should be illuminated when the ignition key switch is in the ON position and inputs from the neutral, parking brake, PTO, seat and over temperature switches indicate safe engine operation (e.g. seat occupied and parking brake disengaged when traction pedal is depressed).

The PTO output LED should be illuminated when the ignition key switch is in the ON position, the parking brake is disengaged, the operator is sitting in the seat, and the PTO switch is pulled out.

NOTE: For gasoline powered units, if the Over Temperature Warning input LED is illuminated, PTO output LED will not be illuminated and PTO will not be engaged regardless of PTO, ignition, parking brake, or in seat switch position.

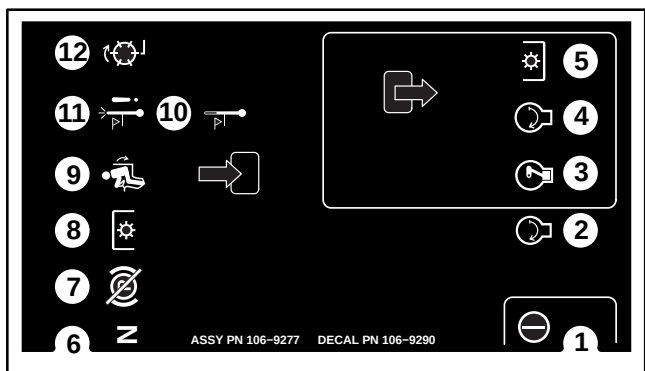


Figure 9

- | | |
|-----------------------------|---|
| 1. Power input LED | 9. In seat input LED |
| 2. Start input LED | 10. High temp warning input LED (Gas Engine Only) |
| 3. Engine run output LED | 11. High temp shutdown input LED (Diesel Engine Only) |
| 4. Start output LED | 12. Backlap input (not used) |
| 5. PTO output LED | |
| 6. Neutral input LED | |
| 7. Park brake off input LED | |
| 8. PTO switch input LED | |

Standard Control Module (SCM) Logic Chart

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 the following conditions must be met: the ignition key is in START, the operator is in the seat, the traction control pedal is in the neutral position and the parking brake is applied. When these conditions are met the Energize to Run (ETR) and Engine Start relays are energized.

MACHINE FUNCTION		INPUTS								OUTPUTS			
		Power	Start	Neutral	Parking BrakeOff*	PTO Switch	In Seat	High Temperature Warning (Gasoline Engine ONLY)	High Temperature Shutdown (Diesel Engine ONLY)	Backlap	Engine Run	Engine Start	PTO
	Engine Start (Operator in Seat)	⬤	⬤	⬤	⬤	◯	⬤	◯	◯	NA	⬤	⬤	◯
	Engine Start (No Operator in Start)	⬤	⬤	⬤	◯	◯	◯	◯	◯	NA	⬤	⬤	◯
	Engine Run (Operator in Seat)	⬤	◯	◯	⬤	◯	⬤	◯	◯	NA	⬤	◯	◯
	Engine Run (No Operator in Seat)	⬤	◯	⬤	◯	◯	◯	◯	◯	NA	⬤	◯	◯
	Mow	⬤	◯	◯	⬤	⬤	⬤	◯	◯	NA	⬤	◯	⬤
	High Temperature Warning (Gasoline Engine ONLY)	⬤	◯					⬤	◯	NA	⬤	⬤	◯
	High Temperature Shutdown (Diesel Engine ONLY)	⬤	◯						⬤	NA	◯	◯	◯

* Parking Brake circuit is open to ground when parking brake is ON (applied)

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 3500

IMPORTANT (Diesel Engine Units): The console temperature warning light illuminates when engine coolant temperature exceeds 221F (105C). The engine shuts down and the console temperature warning light remains illuminated when the engine coolant temperature exceeds 230F (110C). The engine should be allowed to cool to a temperature below 221° F (105° C). The cooling system should be checked before returning the machine to service.

IMPORTANT (Gasoline Engine Units): During machine operation, the PTO shuts down and the console temperature warning light illuminates when the engine coolant temperature exceeds 230F (110C). Under this condition the operator should avoid shutting off the engine, push the PTO switch to OFF (disengage), 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 idle at low speed until it cools to a safe level. The cooling system should be checked before returning the machine to service.

Component Testing

For accurate resistance and/or continuity checks, disconnect the component being tested from its electrical circuits (e.g. unplug the ignition switch connector before doing a continuity check on the switch).

NOTE: For additional electrical component testing information, see the Kubota Workshop Manual for 05 Series Diesel Engines, or the Kubota Workshop and Diagnostics Manuals for WG972 Gasoline Engines.



CAUTION

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

Ignition Switch

The ignition (key) switch has three positions (OFF, ON/PREHEAT, and START). The terminals are marked as shown. The circuitry of the ignition switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. Verify continuity between switch terminals.

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
OFF	NONE	NONE
ON/PREHEAT	B + A + I	X + Y
START	B + S + I	NONE

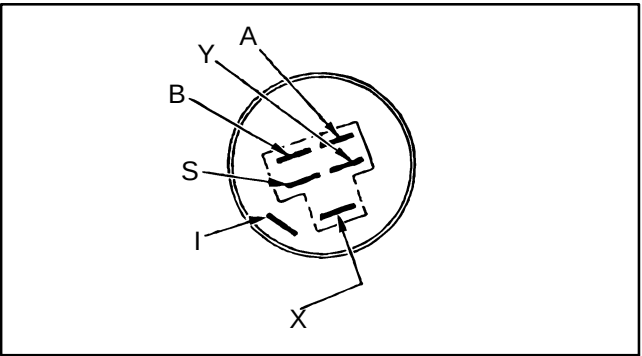


Figure 10

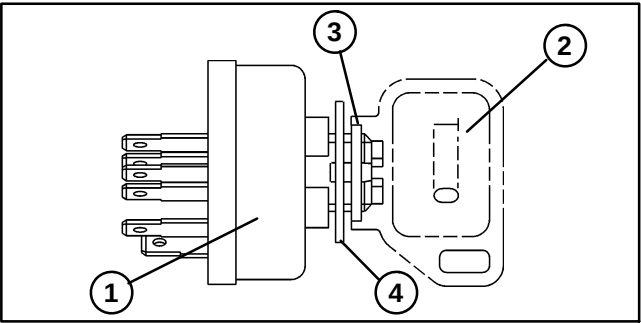


Figure 11

1. Switch

2. Key
3. Hex nut

4. Lock washer

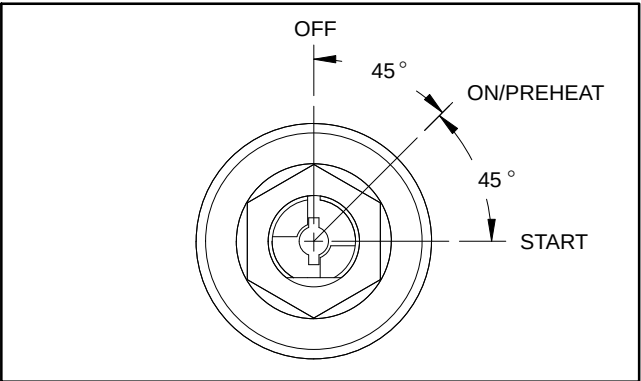


Figure 12

Glow Controller (Diesel Engines Only)

The controller is located under the instrument panel.

NOTE: Refer to Foldout Drawings – Chapter 9 in this manual when troubleshooting the glow controller.

Controller Operation

1. When the ignition switch is placed in the RUN position, the controller energizes the glow plug relay and illuminates the glow lamp for 10 seconds.
2. When the ignition switch is held in the START position, the glow plug relay will energize while the switch is held in START and the glow lamp will not illuminate.
3. When the ignition switch is released from START to RUN, the glow plug relay will de-energize and the glow lamp will remain off.

Controller Checks

1. Make sure there is power from the battery.
2. Disconnect electrical connector to the 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 indicator lamp is on.
 - B. Glow relay is energized.
 - C. Glow plugs are energized.
 - D. Glow indicator lamp goes out and glow plugs de-energize after 10 seconds.
4. Place ignition switch in the START position. Verify the following while in the START position:
 - A. Glow indicator lamp is out.
 - B. Glow relay is energized.
 - C. Glow plugs are energized.
 - D. Power exists at terminal 1 of the glow controller.

NOTE: If there is no power to terminal 1 of the glow controller, verify continuity of the circuitry from the ignition switch to the controller and perform Step 4 again (see Foldout Drawings – Chapter 9 in this manual).

5. If any of the conditions in Step 3 are not met or 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 Foldout Drawings – Chapter 9 of this manual).
- B. Verify continuity of the circuitry from the battery to ignition switch, glow controller, glow lamp, glow relay, and ground (see Foldout Drawings – Chapter 9 in this manual).
- C. Replace parts as necessary.

6. Connect electrical connector to the fuel stop solenoid when finished.

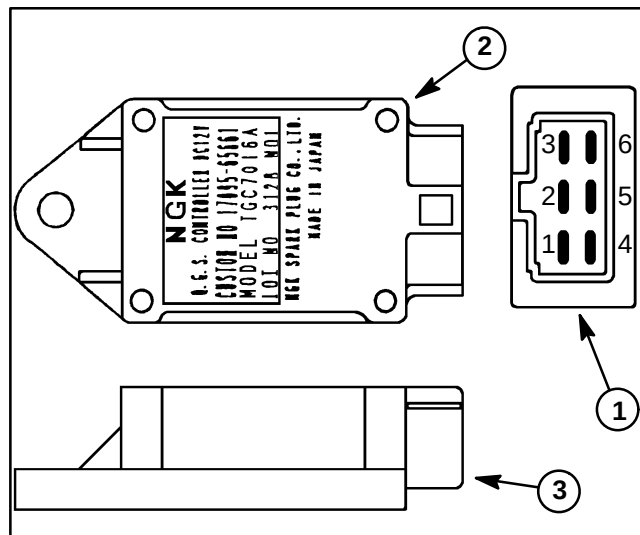


Figure 13

1. Glow controller end view
2. Top view
3. Side view

Glow Relay (Diesel Engine Only)

The glow relay is attached to the radiator assembly. When energized, the glow relay allows electrical current to the engine glow plugs.

1. Verify coil resistance between terminals 86 and 85 with a multimeter (ohms setting). Resistance should be approximately 72 ohms (Fig. 13).
2. 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.

3. Disconnect voltage and leads from the terminals.

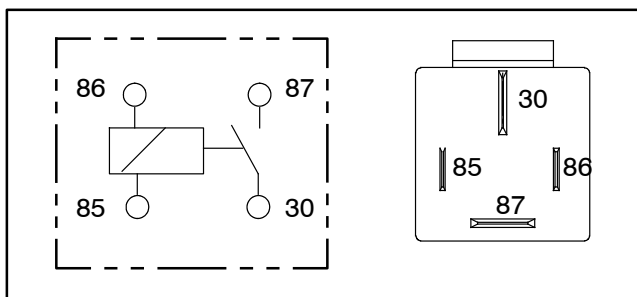


Figure 13

Start/PWR/ENG ETV/Fuel Pump Relays (Gasoline Engine Only)

The relays are attached to the control panel support. When energized, the relays allow electrical current to the specific circuits (see Chapter 9 - Foldout Drawings in this manual).

1. Verify coil resistance between terminals 86 and 85 with a multimeter (ohms setting). Resistance should be approximately 80 ohms (Fig. 14).
2. 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.

3. Disconnect voltage and leads from the terminals.

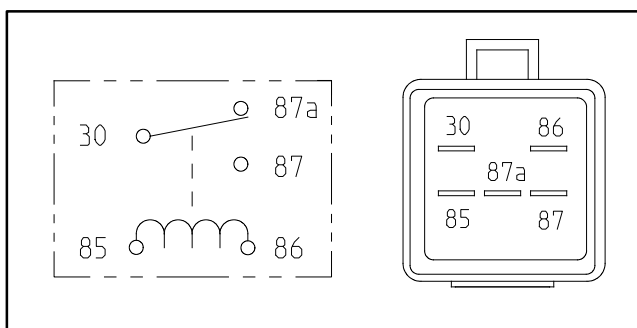


Figure 14

Hour Meter

1. Connect the positive (+) terminal of a 12 VDC source to the positive terminal of the hour meter.
2. Connect the negative (-) terminal of the voltage source to the other terminal of the hour meter.
3. The hour meter should move 1/10 of an hour in six minutes.
4. Disconnect the voltage source from the hour meter.

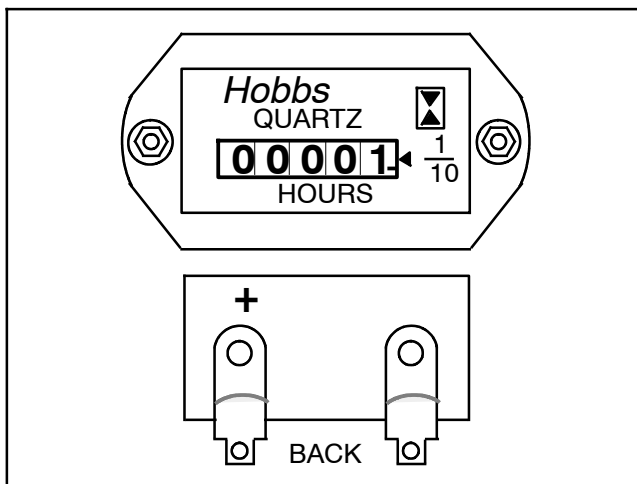


Figure 15

Diode Assemblies

Groundsmaster 3500 machines use diodes that plug into the wiring harness (Fig. 16). Location of the diodes is under the control console.

Diode D1 is used on both diesel and gasoline powered units. Diode D1 is used to protect the PTO solenoid valve coil from reverse polarity.

Diodes D2 and D3 are used on gasoline powered units only. Diode D2 is used to protect the circuits from voltage spikes when the engine starter solenoid is de-energized. Diode D3 protects the engine start relay circuit from reverse polarity.

The diode assemblies can be identified by a black color and a diode symbol on the end of the diode assembly body. Refer to the engine wire harness drawing in Chapter 9 in this manual for additional information on diode assembly location.

Testing

The diodes can be individually tested using a digital multimeter (diode test or ohms setting) and the table below.

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

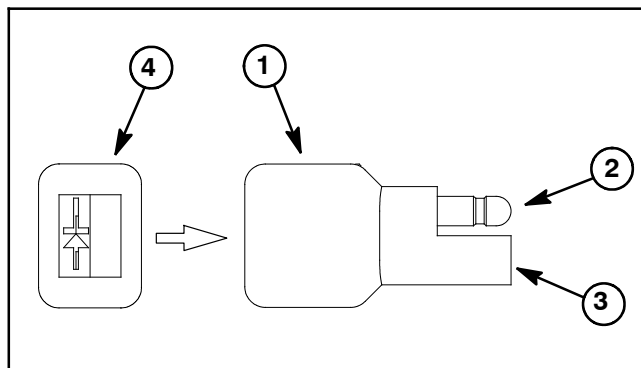


Figure 16

- 1. Diode
- 2. Male terminal
- 3. Female terminal
- 4. End of diode body

CAN-bus Termination Resistor (Gasoline Engines Only)

System communication between electrical components on Groundsmaster 3500- G machines is accomplished on a CAN-bus communication system. Two (2) specially designed, twisted cables form the bus for the network used on the machine. These wires provide the data pathways between machine components. At the end of one of the cables is a 120 ohm termination resistor.

The CAN-bus termination resistor plugs into the main wire harness under the operator's control panel (see Chapter 9 - Foldout Drawings in this manual). The resistor can be accessed by removing the control panel cover. The termination resistor and the wire harness connector have blue inserts to identify the proper location for the termination resistor. The resistor also has a center keyway to prevent it from plugging into the wrong wire harness connector.

IMPORTANT: The termination resistor is required for proper electrical system operation.

Termination Resistor Test

Remove the termination resistor from the main wire harness (Fig. 17). Test the resistor using a digital multimeter (ohms setting). There should be **120 ohms** resistance across terminals A and B of the termination resistor.

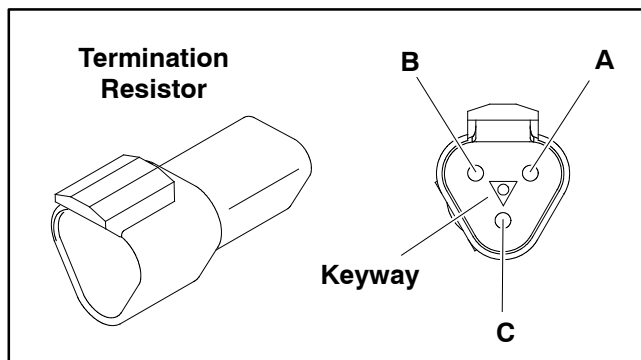


Figure 17

Indicator Lights

Charge Indicator Light

The charge indicator light should come on when the ignition switch is in the ON position with the engine not running. It should also illuminate while the engine is running and the charging circuit is malfunctioning.

Engine Oil Pressure Light

The engine oil pressure light should come on when the ignition switch is in the ON position with the engine not running. It should also illuminate while the engine is running and 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 ON position; the engine oil pressure light should come on indicating correct operation of the indicator light and circuit wiring.

High Temperature Warning Light

Diesel Engines Only – If the engine coolant temperature reaches approximately 221F (105C) (diesel powered units), or approximately 230F (110C) (gasoline powered units) the high temperature warning light should come on.

To test the high temperature warning light and circuit wiring on diesel powered units, turn ignition switch to the ON position and ground the gray wire attached to high temperature sender located on the engine water pump housing (see Temperature Sender in this chapter). The high temperature warning light should illuminate.

Glow Plug Indicator Light (Diesel Engines Only)

The glow plug light should come on when the ignition switch is placed in the ON position prior to placing the ignition switch in START. The light should stay lit for approximately 6 seconds while the ignition switch is left in the ON position.

Check Engine Light (Gasoline Engines Only)

The check engine light should remain off while the engine is running. If the engine ECU identifies that an engine problem exists, the check engine light will illuminate. The Kubota Gasoline Service Tool and software, and the Kubota Diagnostic Manual should be

used to identify the cause of the problem and any repairs that are necessary. Contact your Toro distributor for assistance in Kubota engine troubleshooting

Testing Indicator Lights

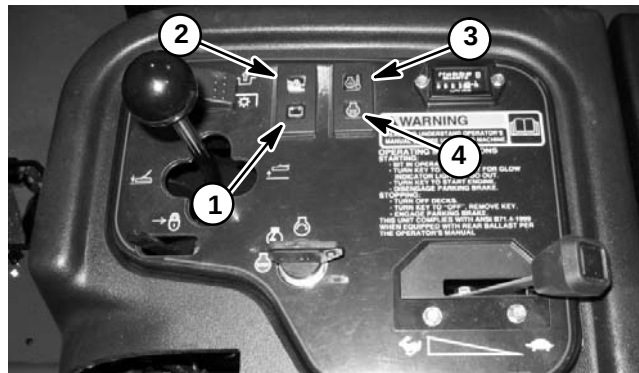


Figure 19

- | | |
|------------------------|------------------------|
| 1. Charge indicator | 3. High temp shutdown |
| 2. Engine oil pressure | 4. Glow plug indicator |

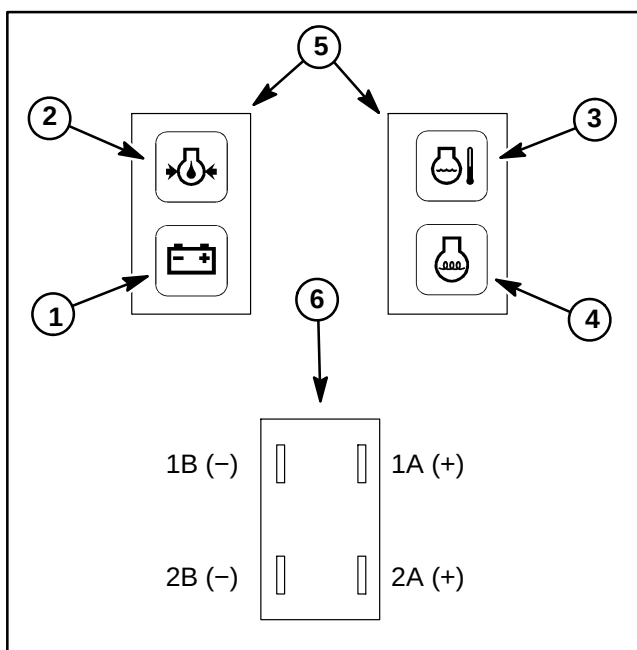


Figure 20

- | | |
|------------------------|---------------------------------------|
| 1. Charge indicator | 4. Glow plug indicator (diesel units) |
| 2. Engine oil pressure | Check engine light (gasoline units) |
| 3. High temperature | 5. Indicator light front |
| | 6. Indicator light back |

1. Apply 12 VDC to terminals 1A and 2A (Fig. 20).
2. Ground terminals 1B and 2B (Fig. 20).
3. Both indicator lights should illuminate.

PTO Switch

The PTO switch is located on the control panel. Most Groundsmaster 3500 machines use a pull type switch (shown in Fig. 20) while early production diesel powered units use a rocker switch (shown in Fig. 21). The switch allows the decks to be engaged or disengaged. Along with additional switches in the interlock system, the PTO switch controls the solenoid valve on the hydraulic manifold.

The switch terminals are marked as shown in Fig. 20 and 21. The circuitry of the switch is shown in the charts in the right column. 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.

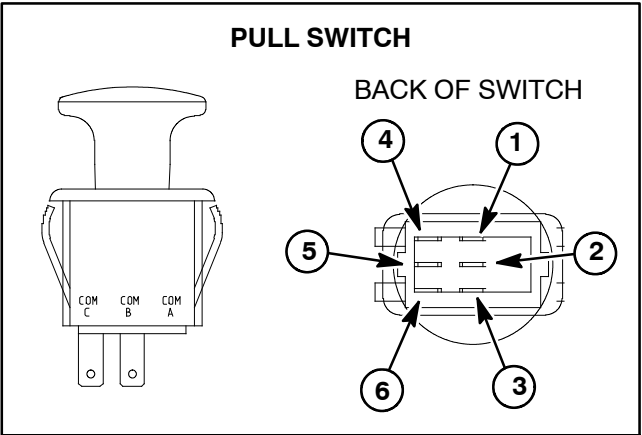


Figure 20

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

PULL SWITCH		
SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
ENGAGE	C COM + C NO	B COM + B NO
DISENGAGE	C COM + C NC	B COM + B NC

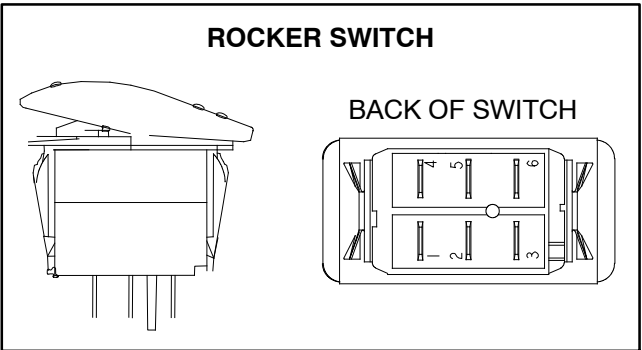


Figure 21

ROCKER SWITCH		
SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
ENGAGE	2 + 3	5 + 6
DISENGAGE	1 + 2	4 + 5

Neutral Switch

The neutral switch is a proximity type, normally open reed switch that closes when the traction pedal is in the neutral position. The neutral switch is located under the floor support plate.

1. Disconnect electrical connector from the neutral switch.
2. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch connector terminals.
3. With the traction pedal in the neutral position, there should be continuity between the two switch leads.
4. Slowly depress the traction pedal. The continuity tester should show no continuity as the pedal is moved in either the forward or reverse direction.
5. Reconnect switch after testing.

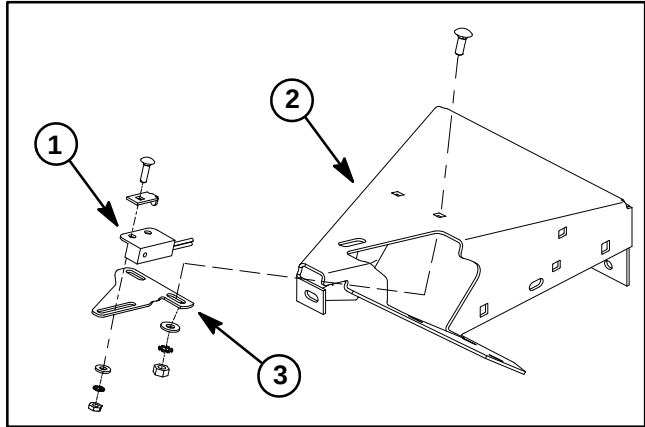


Figure 23

1. Neutral switch
2. Floor plate
3. Switch bracket

Adjustment

The neutral switch should be installed so that the pin on the traction pedal (neutral position) is centered with the switch when the pedal is in the neutral position. The switch must open with forward or reverse movement of 0.25" to 1.00" (6.3mm to 25.4mm) when measured at the top of the traction pedal.

Seat Switch

The seat switch is normally open and closes when the operator is on the seat. If the neutral switch is open when the operator raises out of the seat, the engine will stop.

The standard seat uses a switch that is fastened to the underside of the seat (Fig. 24). The deluxe seat has a switch that is mounted to the seat base under the cushion. The switch electrical connector for either seat type is located directly under the seat. Testing is the same for either switch type:

1. Make sure the engine is off. Remove seat by removing four cap screws that secure seat mounting straps to traction unit.
2. Disconnect electrical connector from the switch.
3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch connector terminals.
4. With no pressure on the seat, there should be no continuity between the seat switch terminals.
5. Press directly onto the seat switch through the seat cushion. There should be continuity as the seat cushion approaches the bottom of its travel.
6. Reconnect switch connector. Reinstall seat assembly.

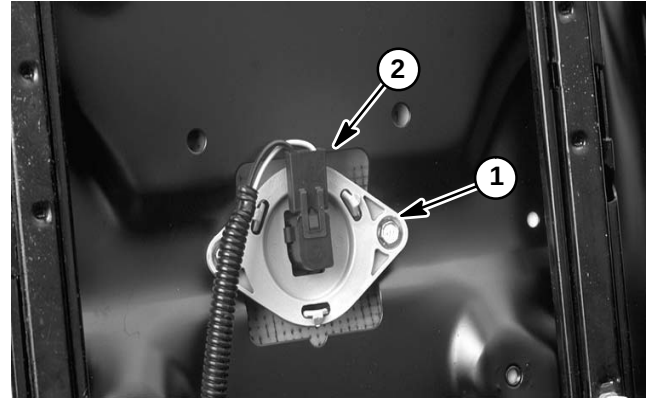


Figure 24

1. Standard seat switch 2. Electrical connector

Parking Brake and Transport/Mow Switches

The switches used for the parking brake and transport/mow are the same, normally closed switch. The parking brake switch is located under the dash cover and opens when the parking brake lever is engaged. The transport/mow switch is located under the floor plate and opens when the transport/mow slide is in the transport position.

The Standard Control Module monitors the operation of the parking brake switch. If the ignition switch is in the ON position and the parking brake is disengaged, the Parking Brake Off input LED should be illuminated.

1. Make sure the engine is off. Locate switch for testing.
2. Disconnect electrical connector from the switch.
3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch connector terminals.
4. When the switch plunger is extended there should be continuity between the switch terminals.
5. When the switch plunger is depressed, there should be no continuity between the switch terminals.
6. Reconnect switch connector.

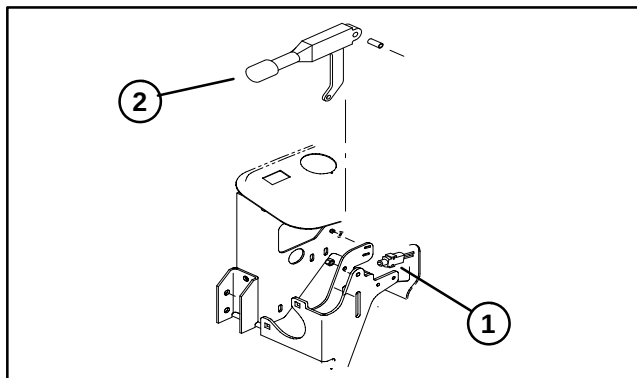


Figure 25

1. Parking brake switch 2. Parking brake lever

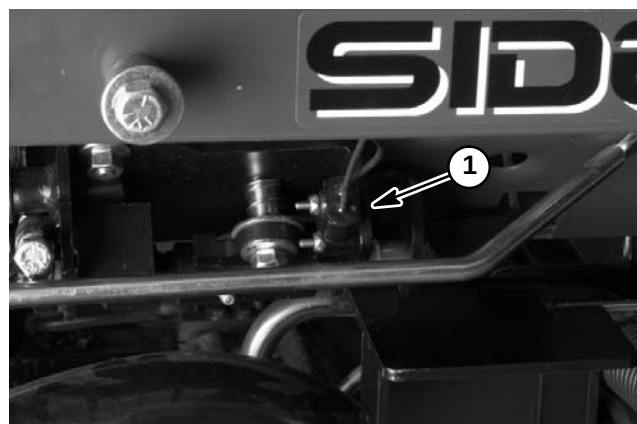


Figure 26

1. Transport/Mow switch

Fuses

Four fuses are held in a fuse block located below the control panel. An additional fuse is mounted alongside the fuse block in a separate fuse holder (Fig. 27).

Gasoline Engines Only – An additional 30 Amp fuse is located near the battery along the main wire harness in a separate fuse holder.

Identification and Function (Fig. 27)

- F1 (15A): Main
- F2 (10A): Lighting (optional)
- F3 (10A): System Gauges/Switches/SCM
- F4 (10A): Diesel Units – Ignition/Glow Controller
Gasoline Units – Ignition
- F5 (2A): Standard Control Module (SCM)
- F6 (30A): Gasoline Units Only – Engine ECU

Testing

Remove fuses from the fuse block for testing. Fuse should have continuity between fuse terminals.

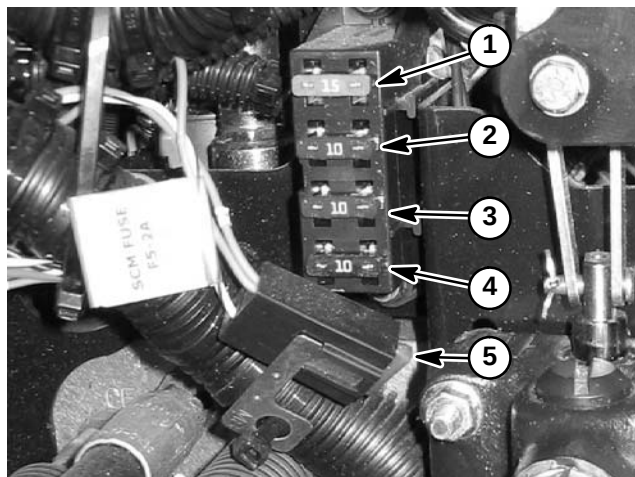


Figure 27

Fusible Links

The Groundsmaster 3500 uses a number of fusible links for circuit protection. A number of fusible links are located in a harness that connects the starter B+ terminal to the main wire harness. Power from the alternator, power to the ignition switch, and in the case of diesel powered units, power to the glow relay is protected by the fusible link harness.

Diesel powered units have an additional fusible link integrated into the main wire harness between the starter G terminal and the stop solenoid pull coil.

If any of these links should fail, current flow in the protected circuit will be interrupted. Refer to wire harness drawings in Chapter 9 – Foldout Drawings in this manual for additional information.

Testing

1. Make sure that ignition switch is OFF.
2. 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).
3. For fusible link harness (Fig. 28):
 - A. Locate and unplug fusible link connector from machine wire harness.
 - B. Use a multimeter to make sure that continuity exists between the fusible link terminal on the starter B+ terminal (terminal J1 on fusible link harness) and each of the terminals in the link harness connector P1. If any of the fusible links are open, replace the fusible link harness.
4. For fusible link integrated into wire harness:
 - A. Locate and unplug machine wire harness connector from the fuel stop solenoid (Fig. 29).
 - B. Use a multimeter to make sure that continuity exists between the wire harness connector at the starter and the engine fuel stop solenoid connector for the solenoid pull coil (Fig. 30 – yellow wire).
 - C. If this fusible link should fail, make sure that the wire harness is repaired with the correct fusible link. Do not replace a failed harness fusible link with a regular section of wire.

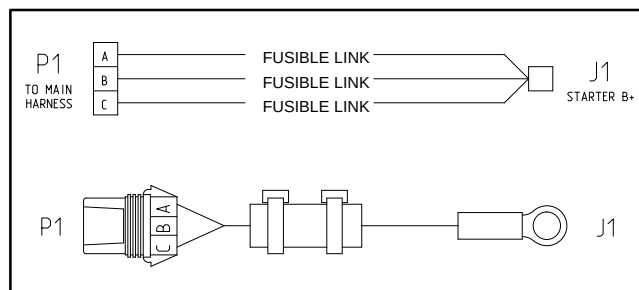


Figure 28

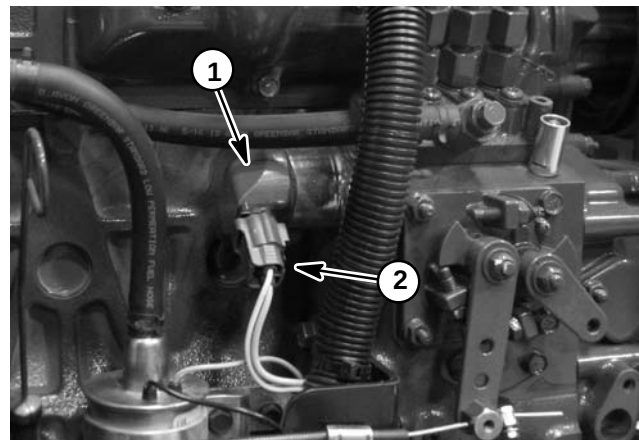


Figure 29

1. Fuel stop solenoid 2. Harness connector

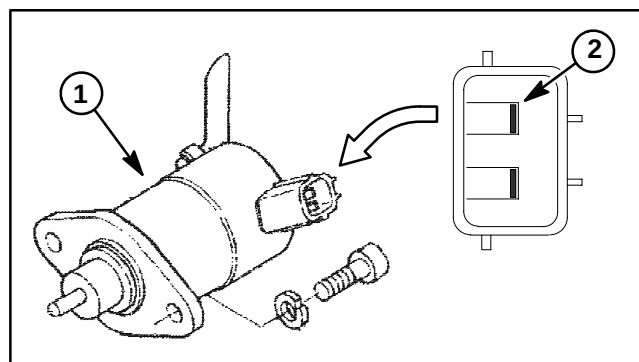


Figure 30

1. Fuel stop solenoid 2. Pull coil terminal

5. When testing is completed, make sure to connect all disconnected wire harness components. Connect positive (+) battery cable and then negative (–) cable (see Battery Service in the Service and Repairs section of this chapter).

High Temperature Warning and Shutdown Switches (Diesel Engines Only)

The high temperature warning and shutdown switches are located on the water pump housing, which is located on the rear end of the engine block (alternator end) (Fig. 31).



CAUTION

Make sure engine is cool before removing the temperature switch.

1. Lower coolant level in the engine and remove the temperature switch.
2. Put switch in a container of oil with a thermometer and slowly heat the oil (Fig. 32).



CAUTION

Handle the hot oil with extreme care to prevent personal injury or fire.

3. Check continuity of the switch with a multimeter (ohms setting).
 - A. The high temperature warning switch is normally open and should close between 216 to 226F (102 to 108C).
 - B. The high temperature shutdown switch is normally open and should close between 225 to 235F (107 to 113C).
4. Allow oil to cool while observing temperature.
 - A. The high temperature warning switch should open at about 208F (98C).
 - B. The high temperature shutdown switch should open at about 219F (104C).
5. Replace switch if necessary.

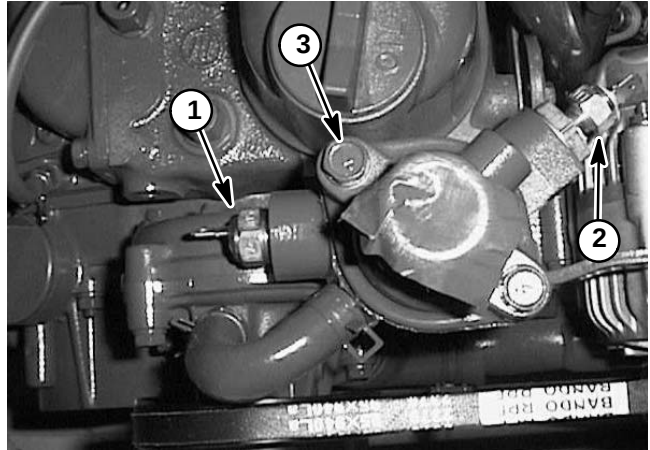


Figure 31

1. Temp. warning switch
2. Temp. shutdown switch
3. Water pump housing

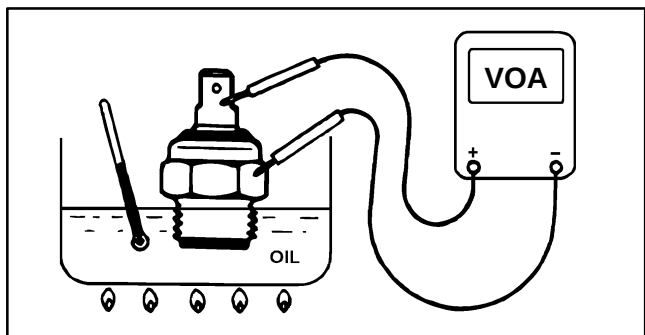


Figure 32

Oil Pressure Switch

The engine oil pressure switch is located on the engine below the alternator (Fig.33). 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/cm²)**.

If low engine oil pressure allows the oil pressure switch to close during engine operation, the engine oil pressure light should illuminate.

Testing

NOTE: Refer to the Kubota Workshop Manual for information regarding engine lubrication system and testing.

1. Set 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 harness wire from the switch.
4. With the ignition switch in the RUN position, ground the disconnected wire to the engine block.

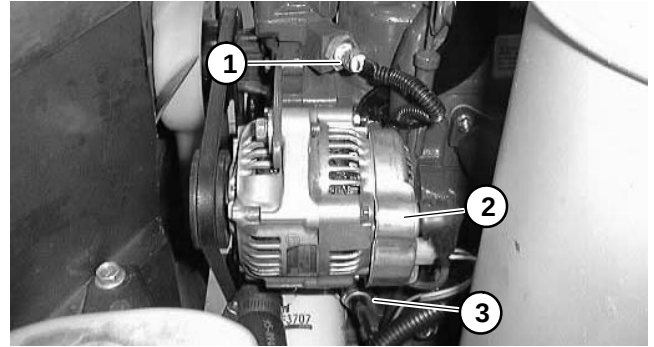


Figure 33

- | | |
|------------------------|------------------------|
| 1. Engine temp. sensor | 3. Oil pressure switch |
| 2. Alternator | |
5. If the light comes on, the oil pressure switch is faulty.
 6. If the light does not come on after step 4, check the oil pressure light circuit wiring and indicator light (see Indicator Lights in this section).
 7. After testing is completed, connect the harness wire to the switch. Lower and secure hood.

Fuel Pump (Diesel Engine Only)

The fuel pump is attached to the left frame rail near the engine.

Operational Test

1. Park machine on a level surface, lower cutting decks, stop engine, and engage parking brake. Unlatch and raise hood.
2. Disconnect electrical connector from the fuel stop solenoid to prevent the engine from starting.
3. Disconnect the fuel hose between the pump and the filter/separator (pump discharge) at the filter separator.
4. Make sure fuel hoses to and from the fuel pump are not kinked, damaged, and free of obstructions.
5. Place disconnected fuel hose into a graduated cylinder with at least a 1 quart (0.95 liter) capacity.

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 time listed below, then return switch to OFF. The amount of fuel collected in the graduated cylinder should be approximately **21 to 37 fl oz (0.62 to 1.1 Ltr) after thirty (30) seconds.**
7. Replace fuel pump as necessary. Reconnect fuel hose to the fuel filter/separator.
8. Reconnect electrical connector to the fuel stop solenoid.
9. Bleed fuel system.

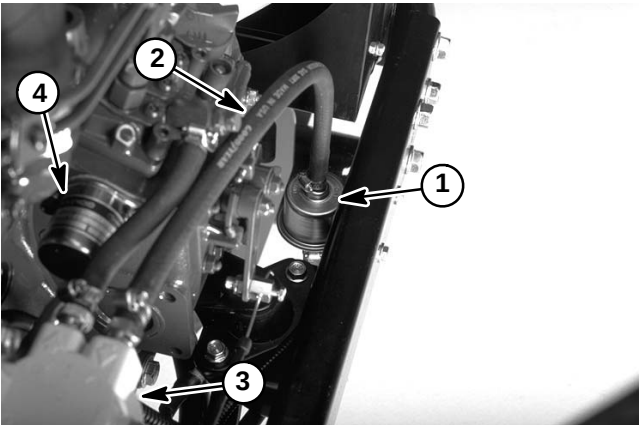


Figure 34

- | | |
|--------------------------|-----------------------|
| 1. Fuel pump | 3. Fuel filter |
| 2. Fuel hose (discharge) | 4. Fuel stop solenoid |

Fuel Pump Specifications

Pump Capacity	42 to 74 fl oz/min (1.2 to 2.2 Ltr/min)
Pressure	2.3 psi (15.8 kPa)
Max. Current Draw	1.8 amp

Fuel Pump (Gasoline Engine Only)

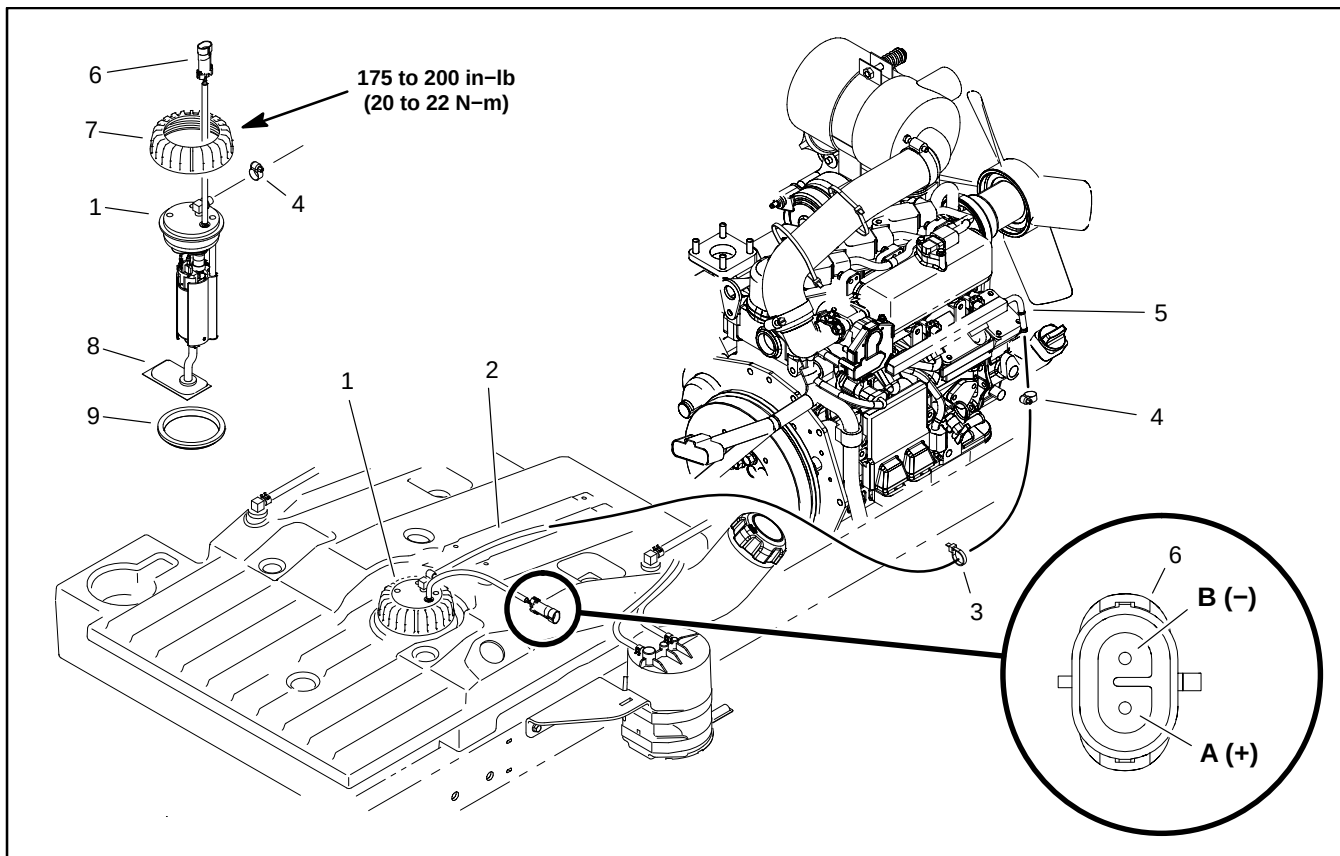


Figure 35

- | | | |
|--------------|------------------------------|-----------|
| 1. Fuel pump | 4. Hose clamp | 7. Nut |
| 2. Fuel hose | 5. Fuel rail | 8. Filter |
| 3. Cable tie | 6. Pump electrical connector | 9. Gasket |

The electric fuel pump used on the Groundsmaster 3500-G is a positive displacement in-tank pump that provides pressurized fuel to the engine fuel rail in a return-less system (Fig. 35). The fuel pump assembly includes a regulator to maintain fuel pressure. Electrical power for the fuel pump is controlled by the engine ECU through the PWR relay.

Fuel Pump Test (Fig 35)

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

3. Install a fuel pressure gauge capable of measuring 50 PSI (350 kPa) to the disconnected hose.

NOTE: If pressure gauge is connected in-line (using a tee fitting), fuel rail and injectors can be checked for potential leakage while measuring fuel pump pressure.

4. While monitoring pressure gauge, turn ignition switch to ON so the fuel pump is energized. Fuel pressure displayed on the gauge should rise. Turn ignition switch to OFF and then back to ON to re-energize the fuel pump and fully pressurize the fuel line. Fuel pump pressure should be approximately 43 PSI (300 kPa).



CAUTION

The fuel supply hose will contain pressurized fuel. Be careful when disconnecting fuel supply hose. Wipe away any spilled fuel before starting the engine.



CAUTION

Make sure test wire connections are secure before turning ignition switch to ON to prevent an explosion or fire from sparks.

2. Disconnect fuel supply hose from engine fuel rail.

5. If fuel pump does not operate or pressure is low, test the pump while supplying power directly, bypassing the engine ECU and PWR relay.

- A. Disconnect fuel pump electrical connector.
- B. Connect a jumper from the A (+) terminal of the pump connector (red wire) to the mating A (+) terminal of the wire harness connector.
- C. Connect the B (–) terminal at the pump connector (black wire) to an engine or chassis ground.
- D. Repeat step 4.

If fuel pump pressure is low and power supply to the pump has been verified, consider a clogged fuel filter or faulty fuel pump.

6. After testing is completed, remove pressure gauge from fuel supply hose. Connect fuel supply hose to engine fuel rail and secure with hose clamp.

Fuel Pump Specifications

Pump Capacity	45 fl oz/min (1.3 Ltr/min)
Pressure	43.5 psi (300 kPa)
Max. Current Draw	4.4 amp

Fuel Stop Solenoid (Diesel Engine Only)

The fuel stop solenoid used on the Groundsmaster 3500–D must be energized for the diesel engine to run. The solenoid is mounted to the injection pump on the engine (Fig. 36).

The fuel stop solenoid includes two coils for operation, the pull coil and the hold coil. When the ignition switch is turned to START, the 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.

NOTE: Refer to Chapter 9 – Foldout Drawings in this manual when troubleshooting the fuel stop solenoid.

Testing

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. For accurate test results, subtract this value from the measured value of the component you are testing.

1. Make sure ignition switch is in the OFF position. Disconnect wire harness connector from stop solenoid.
2. Using a digital multimeter, touch one test lead to the pull coil terminal and the other test lead to the stop solenoid frame (ground) (Fig. 37). The resistance of the pull coil should be less than 1 ohm (but not zero).

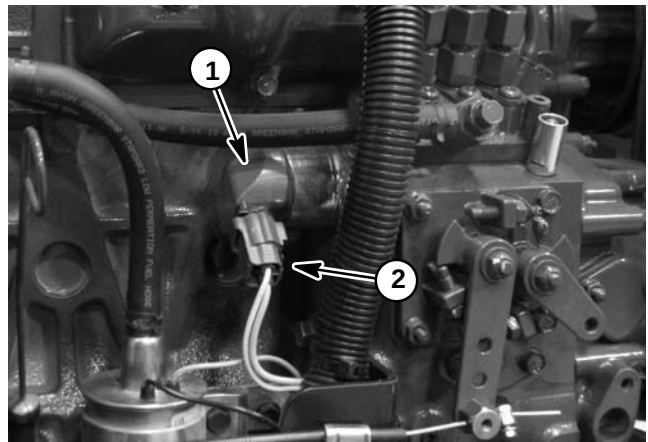


Figure 36

1. Fuel stop solenoid
2. Harness connector

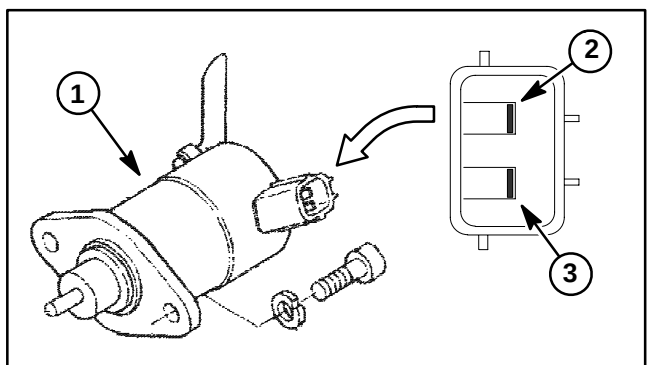


Figure 37

1. Fuel stop solenoid
2. Pull coil terminal
3. Hold coil terminal

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. 37). The resistance of the hold coil should be approximately 15.5 ohms.

4. Reconnect solenoid to the wiring harness.

Electronic Throttle Control (Gasoline Engine Only)

The engine speed on the Groundsmaster 3500-G is controlled by an electronic throttle system. The system includes an electronic throttle control at the operator's control panel and a throttle control valve at the Kubota gasoline engine. The engine ECU uses the position of the throttle control at the operator panel as an input to determine the appropriate signal output for the throttle control valve at the engine to set the engine speed.

The electronic throttle control at the operator's panel is a rotary hall effect sensor that varies output voltage based on the sensor position. Use the Kubota Gasoline Service Tool (KGST) and software, and the Kubota Diagnostic Manual for WG972 engines to test the electronic throttle control. Contact your Toro distributor for assistance in Kubota engine troubleshooting.

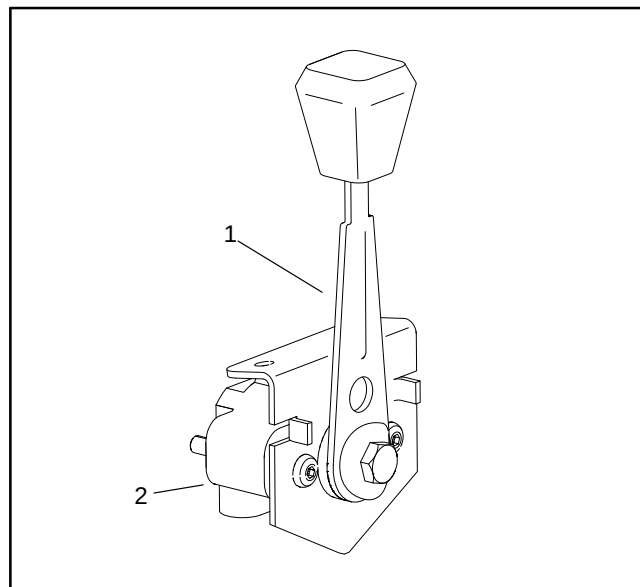


Figure 38

1. Throttle control lever 2. Rotary hall effect sensor

Hydraulic Cartridge Solenoid Valve Coils

The hydraulic system on the Groundsmaster 3500 uses a solenoid valve coil to actuate a cartridge valve on the hydraulic manifold (Fig. 39). When the solenoid valve coil is energized, spool shift in the valve will direct hydraulic flow to the cutting decks.

Testing

1. Make sure engine is off. Disconnect wire harness electrical connector from the 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 component you are testing.

2. Measure resistance between the two connector terminals on the solenoid coil. The resistance should be approximately 7.2 ohms.

3. Reconnect electrical connector to the solenoid.

4. If solenoid coil needs replacement, see Hydraulic Cartridge Valve Coil in the Service and Repairs section of this chapter.

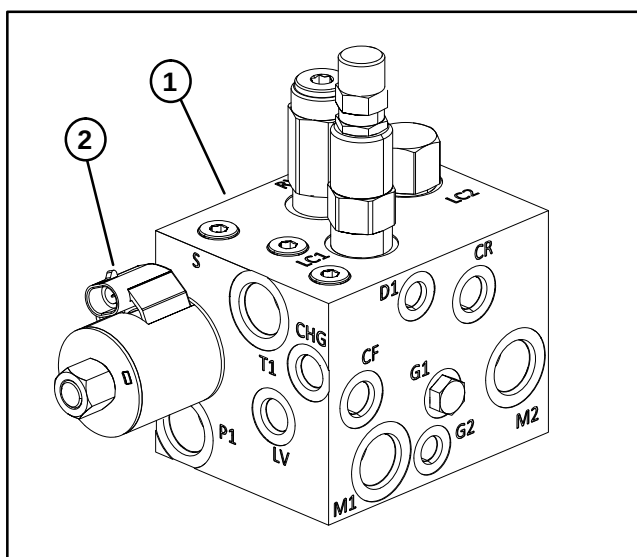


Figure 39

1. Manifold assembly

2. Solenoid valve coil

Service and Repairs

NOTE: For additional electrical component service and repair information, see the Kubota Workshop Manual for 05 Series Diesel Engines, or the Kubota Workshop and Diagnostics Manuals for WG972 Gasoline Engines.

Battery Care

1. The top of the battery must be kept clean. If the machine is stored in a location where temperatures are extremely high, the battery will discharge more rapidly than if the machine is stored in a location where temperatures are cool.

**WARNING**

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

IMPORTANT: Do not remove fill caps (if equipped) while cleaning the battery.

2. Check battery condition weekly or after every 50 hours of operation. Keep terminals and entire battery case clean because a dirty battery will discharge slowly.

A. Clean battery by washing entire case with a solution of baking soda and water. Rinse with clear water.

B. Coat battery posts and cable connectors with battery terminal protector (Toro Part No. 107-0392) or petroleum jelly to prevent corrosion.

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

**WARNING**

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

4. If corrosion occurs at terminals, disconnect cables. Always disconnect negative (-) cable first. Clean clamps and terminals separately. Reconnect cables with positive (+) cable first. Coat battery posts and cable connectors with battery terminal protector (Toro Part No. 107-0392) or petroleum jelly to prevent corrosion.

5. If the battery electrolyte is accessible, check electrolyte level every 25 operating hours and every 30 days if machine is in storage. Maintain cell level with distilled water. Do not fill cells above the fill line.

Battery Service

The battery is the heart of the electrical system. With regular and proper service, battery life can be extended. Additionally, battery and electrical component failure can be prevented.



CAUTION

When working with batteries, use extreme caution to avoid splashing or spilling electrolyte. Electrolyte can destroy clothing and burn skin or eyes. Always wear safety goggles and a face shield when working with batteries.

Electrolyte Specific Gravity

Fully charged: 1.265 corrected to 80°F (27°C)

Discharged: less than 1.240

Battery Specifications

BCI Group Size 55:

540 CCA at 0°F (-18°C)

75 minute reserve capacity at 80°F (27°C)

Dimensions

(including terminal posts and caps)

Length 9.0 inches (22.8 cm)

Width 6.0 inches (15.2 cm)

Height 8.5 inches (21.6 cm)

Removal and Installation (Fig. 40 and 41)

IMPORTANT: Be careful not to damage terminal posts or cable connectors when removing the battery cables.

1. Remove battery cover from the frame. Loosen battery retainer securing the back of the battery to the battery support.
2. Loosen and remove negative (-) cable from battery. After negative cable is removed, loosen and remove positive (+) cable from battery.
3. Carefully remove battery from machine.
4. Install battery in reverse order making sure to connect and tighten positive cable to battery before connecting the negative cable.

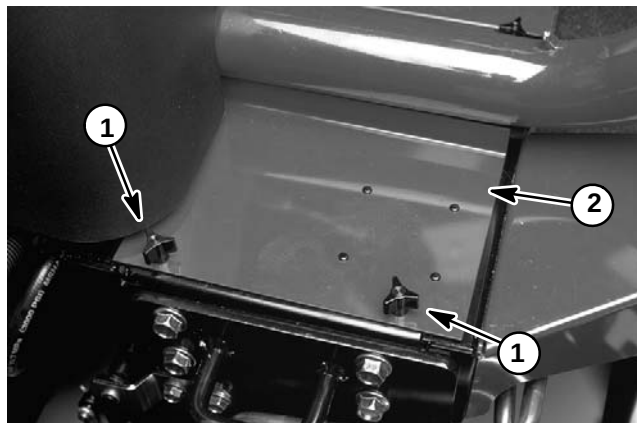


Figure 40

1. Knobs

2. Battery cover



Figure 41

1. Ground cable

2. Positive cable

NOTE: Before connecting the negative (ground) cable, connect a digital multimeter (set to amps) between the negative battery post and the negative (ground) cable connector. The reading should be less than 0.1 amp. If the reading is 0.1 amp or more, the machine's electrical system should be tested for short circuits or faulty components and repaired.

5. Make sure that rubber boot is properly placed over positive cable end and positive battery post.

Battery Inspection and Maintenance

1. Replace battery if case is cracked or leaking.
2. Check battery terminal posts for corrosion. Use wire brush to clean corrosion from posts.

IMPORTANT: Before cleaning the battery, tape or block vent holes to the filler caps and make sure the caps are on tightly.

3. Check for signs of wetness or leakage on the top of the battery which might indicate a loose or missing filler cap, overcharging, loose terminal post or overfilling. Also, check battery case for dirt and oil. Clean the battery with a solution of baking soda and water, then rinse it with clean water.

4. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.

5. Check the electrolyte level in each cell, if possible. If the level is below the tops of the plates in any cell, fill all cells with distilled water between the minimum and maximum fill lines. Charge at 15 to 25 amps for fifteen (15) minutes to allow sufficient mixing of the electrolyte.

Battery Testing

1. Conduct a hydrometer test of the battery electrolyte.

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

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

B. Temperature correct each cell reading. For each 10F (5.5C) above 80F (27C) add 0.004 to the specific gravity reading. For each 10F (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 2F (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)	<u>0.008</u>
Correction to 80F (26.7C)	1.253

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

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

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



CAUTION

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

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

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

C. Make sure battery terminals are free of corrosion.

D. Measure the temperature of the center battery cell.

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

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

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

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

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

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

Battery Charging

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

CAUTION

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

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

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

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

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

Battery Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	50%	25%	0%
80 or less	3.8 hrs @ 3 amps	7.5 hrs @ 3 amps	11.3 hrs @ 3 amps	15 hrs @ 3 amps
81 to 125	5.3 hrs @ 4 amps	10.5 hrs @ 4 amps	15.8 hrs @ 4 amps	21 hrs @ 4 amps
126 to 170	5.5 hrs @ 5 amps	11 hrs @ 5 amps	16.5 hrs @ 5 amps	22 hrs @ 5 amps
171 to 250	5.8 hrs @ 6 amps	11.5 hrs @ 6 amps	17.3 hrs @ 6 amps	23 hrs @ 6 amps
above 250	6 hrs @ 10 amps	12 hrs @ 10 amps	18 hrs @ 10 amps	24 hrs @ 10 amps

CAUTION

Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 60°F (16°C) before connecting to a charger.

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

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

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

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

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

Hydraulic Cartridge Solenoid Valve Coil

The solenoid valve coil on the hydraulic control manifold (Fig. 42) can be replaced without opening the hydraulic system.

Removal

1. Park machine on a level surface, lower cutting decks, engage parking brake, stop engine and remove key from the ignition switch.
2. Disconnect the wire harness electrical connector from the solenoid valve coil.
3. Remove the nut from the spool assembly.
4. Slide the coil assembly from the solenoid valve stem. Discard the coil.
5. Clean any corrosion or dirt from the valve stem.

Installation

1. Slide new coil assembly onto the solenoid valve stem.
2. Install the nut onto the spool assembly and torque nut **60 in-lb (6.8 N-m)** (do not over tighten).
3. Connect the wire harness electrical connector to the solenoid valve coil.

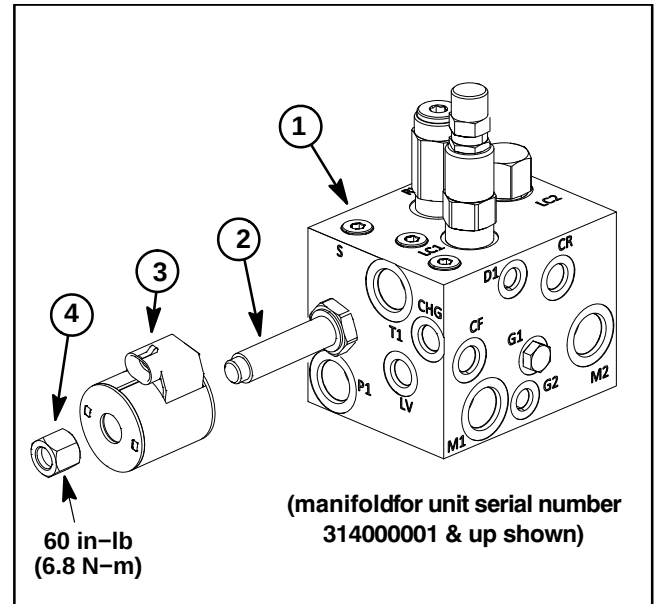


Figure 42

- | | |
|------------------------|------------------------|
| 1. Hydraulic manifold | 3. Solenoid valve coil |
| 2. Solenoid valve (R1) | 4. Nut |

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Wheels, Brakes, and Chassis

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Specifications

Item	Description
Tire pressure	14 to 18 PSI (97 to 124 kPa)
Wheel lug nut torque	70 to 90 ft- lb (95 to 122 N- m)

Special Tools

Order special tools from your Toro Distributor.

Wheel Hub Puller

Part Number: **TOR4097**

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



Figure 1

Adjustments

Adjust Brakes



CAUTION

Before and after adjusting the brakes, always check the brakes in a wide open area that is flat and free of other persons and obstructions.

1. Check brake adjustment as follows:

A. Park machine on a level surface, lower cutting units, stop engine, and remove key from the ignition switch.

B. Rotate by-pass valve on the piston pump 90 degrees to allow front wheels to turn freely (Fig. 2).



CAUTION

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

C. Chock rear wheel. Jack up both front wheels and safely support the machine.

D. Apply the parking brake. The force to actuate the brake lever should be from **30 to 40 lbs (133 to 178 N)**.

E. With the parking brake applied, use a torque wrench on the wheel hub lock nut to identify the break away torque at each front wheel. The minimum break away torque with the parking applied should be **300 ft-lb (407 N-m)**.

2. If adjustment is necessary, adjust brakes as follows:

A. Remove both front wheel assemblies from the machine (see Front Brake and Wheel Removal in this section).

B. Adjust brakes by turning clevis to increase or decrease shoe pressure on the brake drum (Fig. 3). Make sure that brake shoes do not drag against drums with the parking brake lever released.

C. If brakes can not be adjusted properly, repair or replace brake components as necessary.

D. After adjustment is complete, install both front wheel assemblies to the machine (see Front Brake and Wheel Installation in this section).

E. Lower front wheels to the ground.

F. Before starting engine, close by-pass valve on pump by rotating it 90 degrees (Fig. 2).

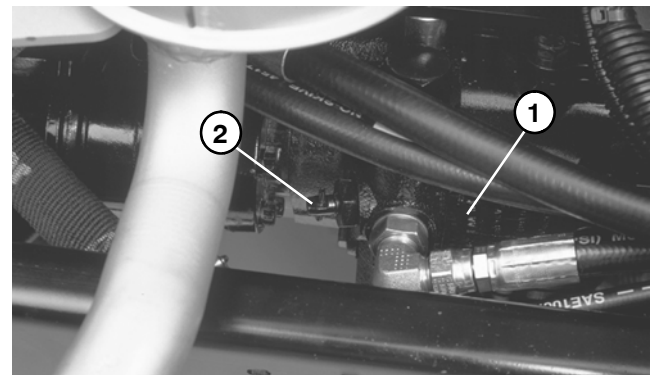


Figure 2

1. Piston pump

2. By-pass valve

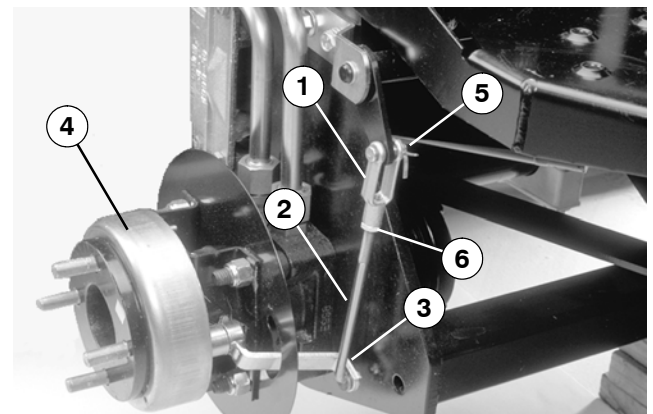


Figure 3

1. Clevis

2. Adjustment rod

3. Brake lever

4. Brake drum

5. Cotter pin

6. Jam nut

Adjust Front Lift Arms

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

IMPORTANT: Keep front cutting units on the lift arms when performing this adjustment.

2. Make sure clearance between each lift arm and floor plate bracket is from 0.18 to 0.32 inch (4.6 to 8.1 mm) (Fig. 4).

3. If the clearance is not in this range, attain proper clearance as follows:

A. Lower front lift arms, stop engine, engage parking brake, and remove key from the ignition switch. Back off stop bolts if reducing the clearance between the lift arm and the floor plate bracket (Fig. 5).

B. Adjust front hydraulic cylinder by backing off jam nut on the cylinder, removing the pin from the clevis, and rotating the clevis (Fig. 6).

C. Install pin to clevis. Fully raise front lift arms and check clearance. Repeat steps A and B if necessary.

D. Tighten jam nut on the hydraulic cylinder when clearance is correct.

IMPORTANT: The lack of clearance at the front stops can damage the lift arms.

4. With the front lift arms fully raised, make sure clearance between each lift arm and stop bolt is from **0.005 to 0.040 inch (0.13 to 1.02 mm)**. If the clearance is not in this range, adjust stop bolts as necessary (Fig 5).

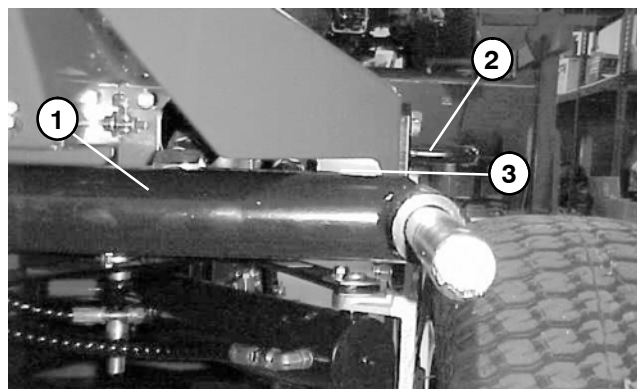


Figure 4

- 1. Lift arm
- 2. Floor plate bracket
- 3. Clearance

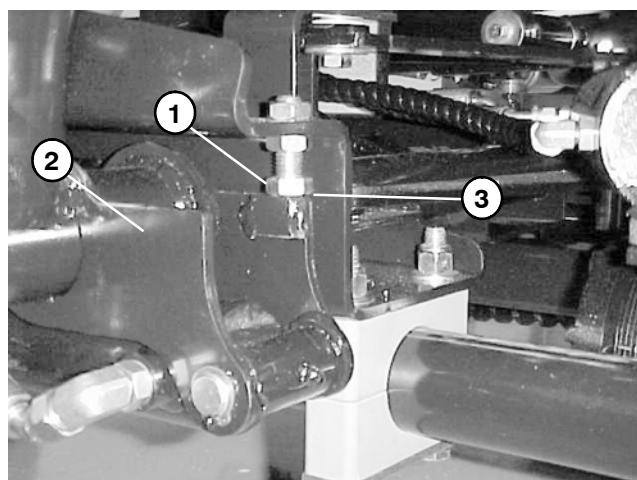


Figure 5

- 1. Stop bolt
- 2. Lift arm
- 3. Clearance

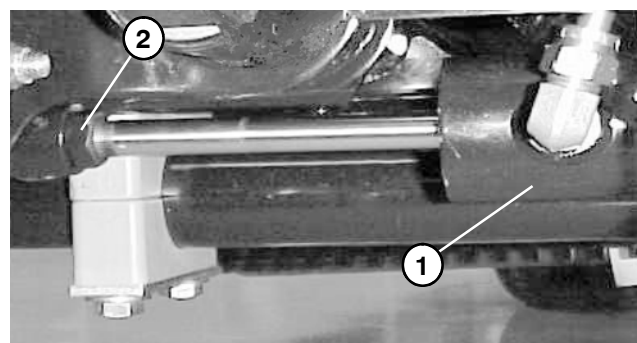


Figure 6

- 1. Hydraulic cylinder
- 2. Jam nut

Adjust Front Lift Arm Carrier Stop Bracket Assembly

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

2. Make sure that pivot brackets (items 6 and 9) are not overtightened. They should pivot and return freely.

3. To allow horizontal movement of the actuators (items 2 and 8), loosen carriage screws and flange nuts that secure actuators to actuator mount brackets.

4. To allow vertical movement of the actuator mount brackets (item 3), loosen carriage screws and flange nuts that secure actuator mount brackets to lift arms.

5. Simultaneously move both actuators against back of the carrier stop bracket and pivot brackets. Secure actuators (items 2 and 8) to actuator mount brackets with carriage screws and flange nuts.

6. With pivot brackets tipped forward, slide actuator mount brackets down so that the actuators just contact the pivot brackets. Secure actuator mount brackets to lift arms with carriage screws and flange nuts.

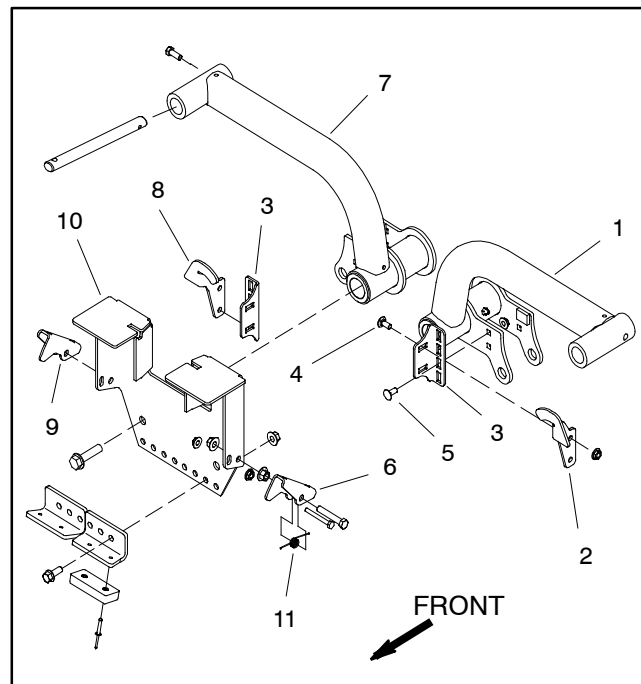


Figure 7

- | | |
|---------------------------|--------------------------|
| 1. LH lift arm | 7. RH lift arm |
| 2. LH actuator | 8. RH actuator |
| 3. Actuator mount bracket | 9. RH pivot bracket |
| 4. Horizontal screw | 10. Carrier stop bracket |
| 5. Vertical screw | 11. Return spring |
| 6. LH pivot bracket | |

Adjust Rear Lift Arm

NOTE: If rear lift arm makes clunking noises during transport, the clearance should be adjusted/reduced.

1. Park machine on a level surface and engage parking brake.

IMPORTANT: This adjustment must be performed with the rear cutting unit attached to the rear lift arm.

2. Raise lift arms. Make sure clearance between one end of wear strip and bumper bar on frame is from **.020 to .100 inch (0.51 to 2.54 mm)** when other end of wear strip is in contact with bumper bar (Fig. 8).

3. If the clearance is not in this range, attain proper clearance by adjusting the rear hydraulic cylinder as follows (Fig. 9):

A. Lower cutting units, turn engine off, and remove key from the ignition switch.

B. Back off jam nut from the rear hydraulic cylinder clevis.

IMPORTANT: Use a protective covering around the hydraulic cylinder rod when rotating the rod to prevent damage to the rod.

C. Grasp cylinder rod near the jam nut and rotate the rod.

D. Raise cutting units and check clearance. Repeat steps A through C as necessary. Tighten jam nut on hydraulic cylinder rod when clearance is correct.

IMPORTANT: The lack of clearance at the rear wear strip can damage the rear lift arm.

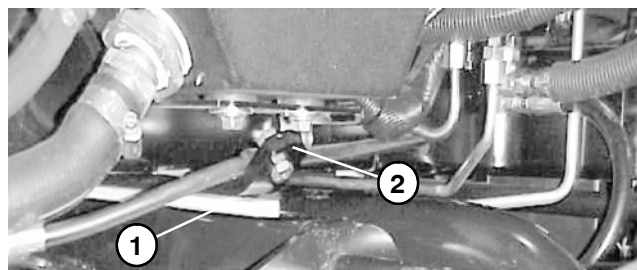


Figure 8

1. Wear strip
2. Bumper bar

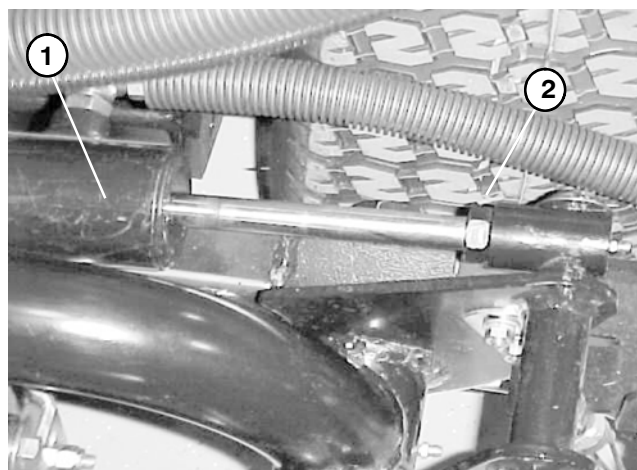


Figure 9

1. Rear hydraulic cylinder
2. Jam nut

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Service and Repairs

Standard Seat

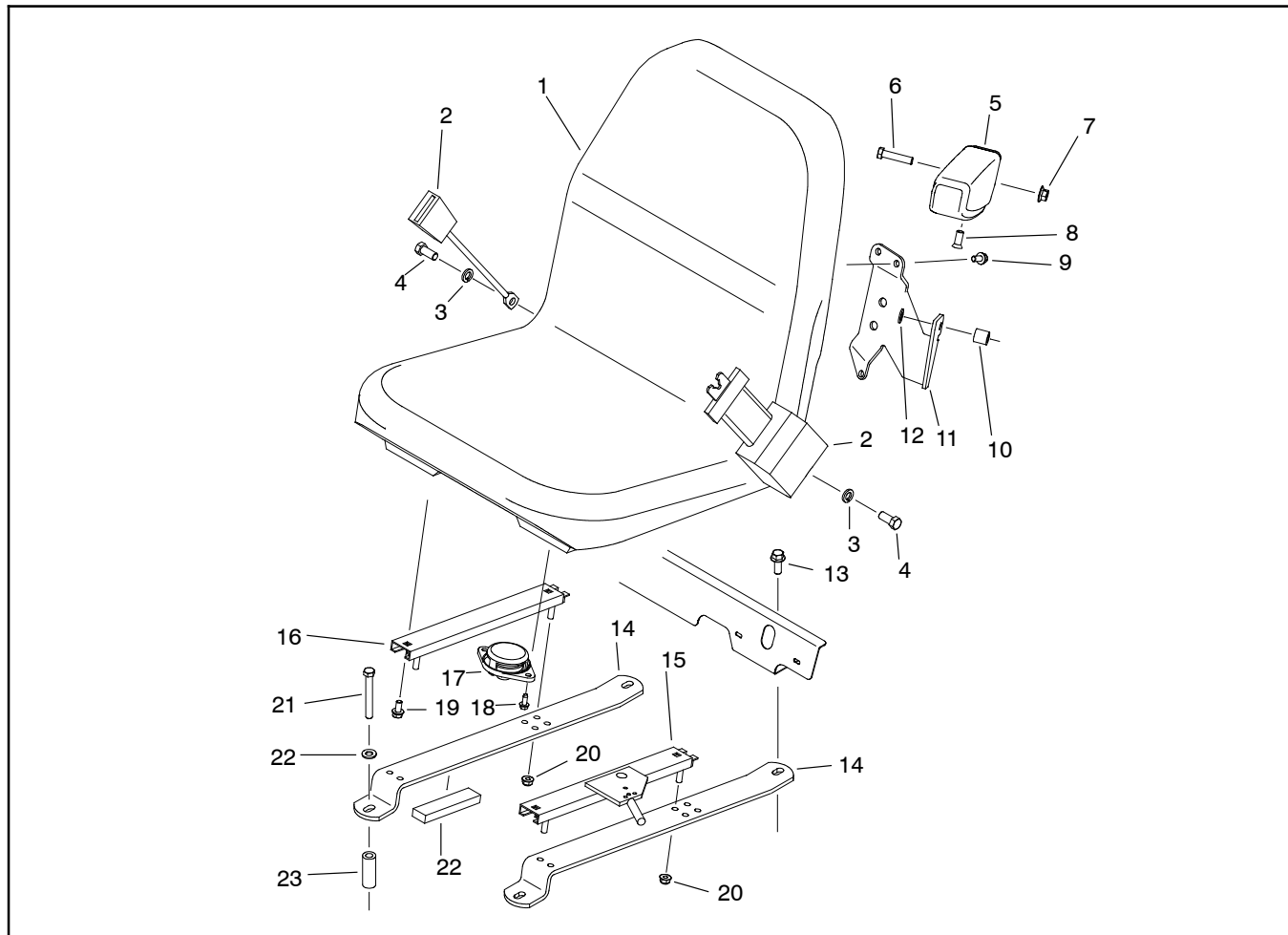


Figure 10

- | | | |
|------------------------------------|------------------------------|---------------------------|
| 1. Seat (incl. 4 thru 7, 14, & 15) | 9. Hex flange hd screw | 17. Seat switch |
| 2. Seat belt | 10. Spacer | 18. Hex flange head screw |
| 3. Lock washer | 11. Armrest bracket | 19. Hex flange head screw |
| 4. Cap screw | 12. Washer | 20. Flange hex nut |
| 5. Armrest | 13. Hex flange hd screw | 21. Cap screw |
| 6. Cap screw | 14. Seat support strap | 22. Lock washer |
| 7. Flange hex nut | 15. Seat adjuster with latch | 23. Spacer |
| 8. Screw | 16. Seat adjuster | |

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Remove four hex flange head screws securing the seat support straps to the frame. Note location of spacers under front of seat support straps.
3. Disconnect electrical connector from the seat switch. Separate seat from the frame.
4. Remove seat parts as necessary to make repairs (Fig. 10).

Installation

1. Install any new seat parts (Fig 10).
2. Position seat, spacers and support straps to the fuel tank and frame.
3. Connect electrical connector to the seat switch.
4. Secure seat support straps to the frame with four hex flange head screws.

Deluxe Seat

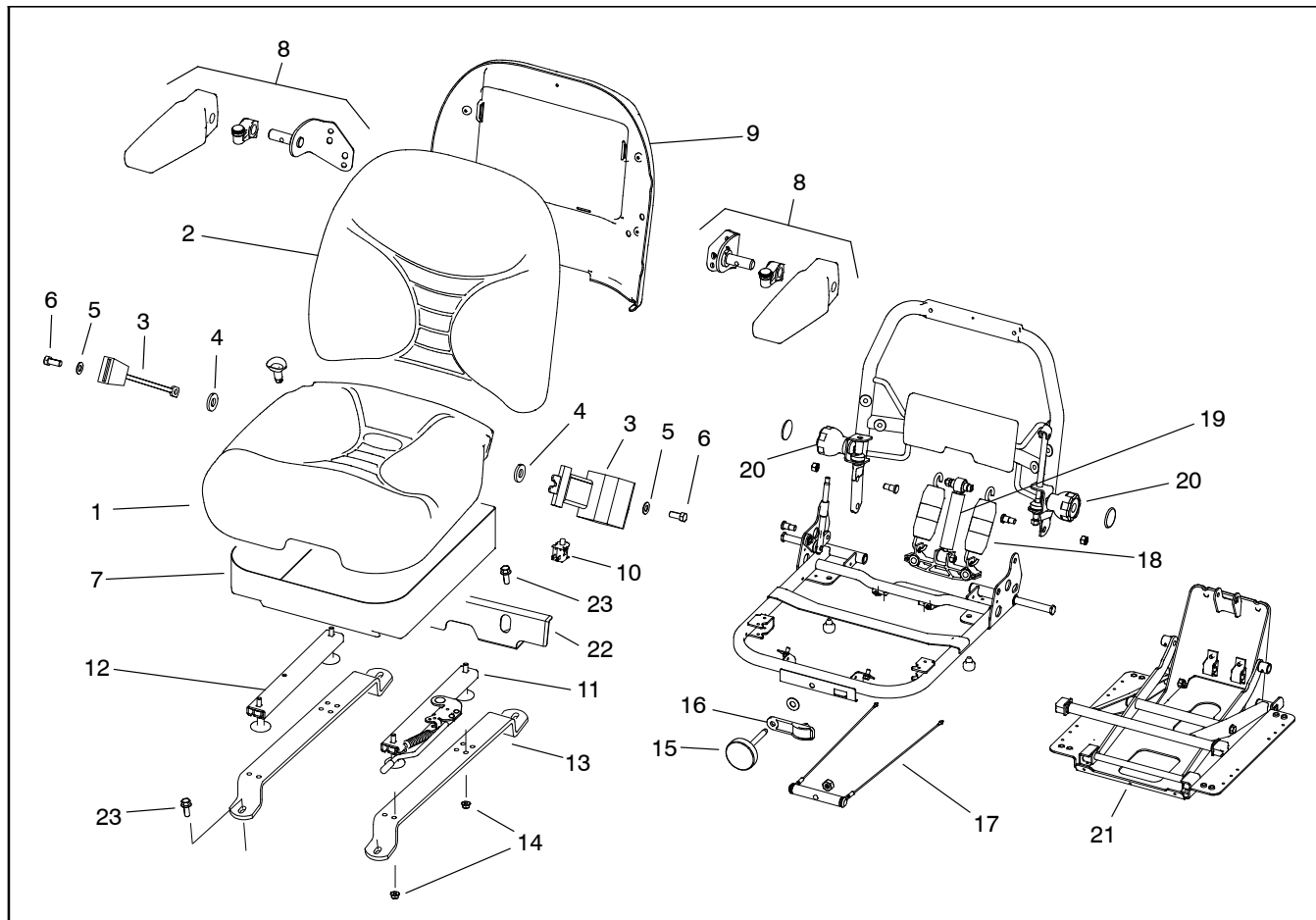


Figure 11

- 1. Bottom cushion
- 2. Back cushion
- 3. Seat belt
- 4. Flat washer
- 5. Flat washer
- 6. Cap screw
- 7. Bottom cover
- 8. Armrest kit

- 9. Back cover
- 10. Seat switch
- 11. Adjusting track - RH
- 12. Track - LH
- 13. Support strap
- 14. Flange nut
- 15. Knob kit
- 16. Weight indicator

- 17. Weight adjust kit
- 18. Spring and saddle kit
- 19. Shock absorber kit
- 20. Knob kit
- 21. Chassis assembly
- 22. Heat shield
- 23. Flange head screw (4)

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Remove heat shield and seat support straps with seat attached from the frame. Note location of spacers under front of seat support straps.
3. Disconnect electrical connector from the seat switch and remove seat assembly.
4. Remove seat parts as necessary to make repairs (Fig. 11).

Installation

1. Install any new seat parts (Fig. 11) as a guide.
2. Position seat with support straps attached to the fuel tank and frame.
3. Attach electrical connector to the seat switch.
4. Secure seat support straps to the frame with four hex flange head screws.

Front Wheel and Brake

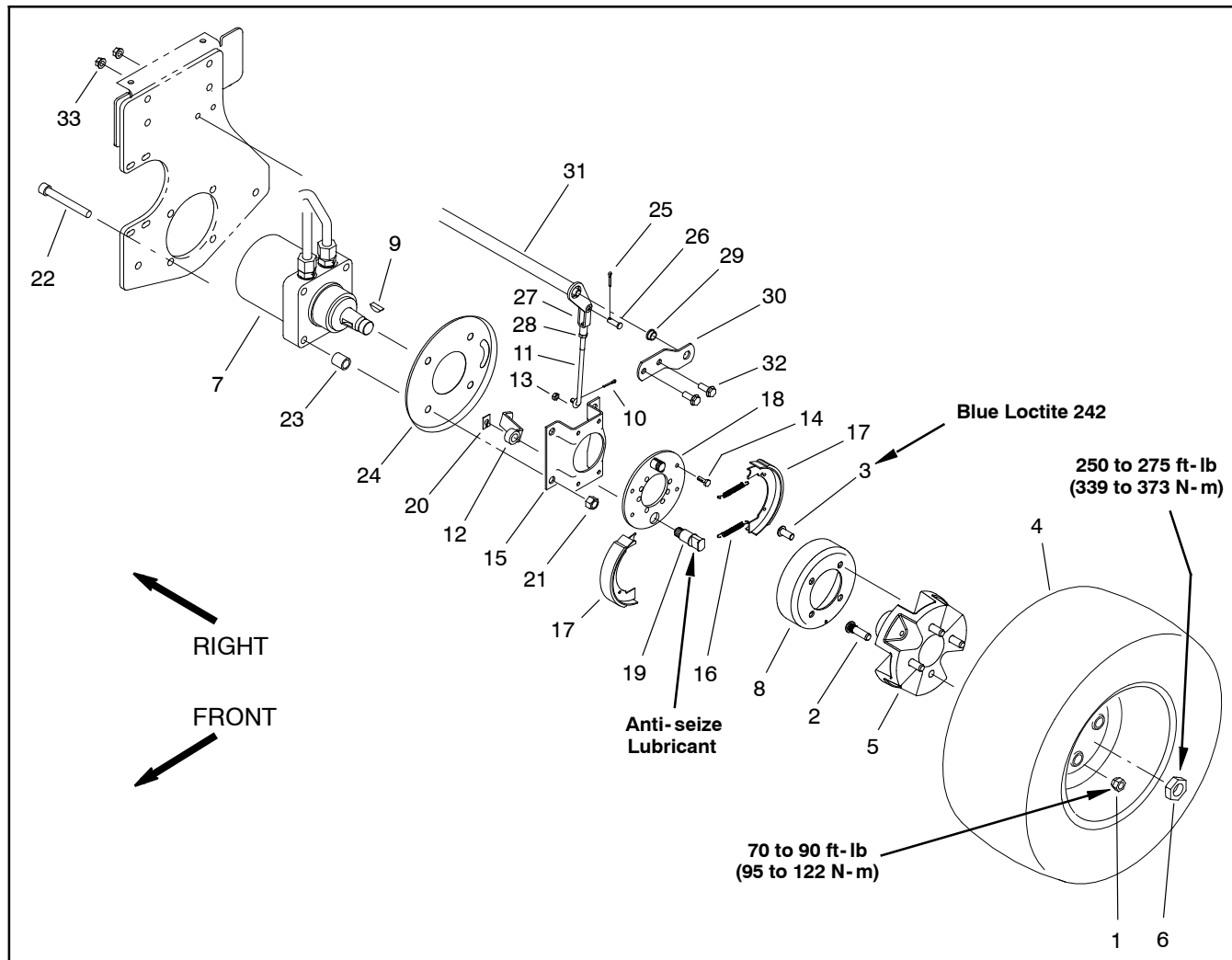


Figure 12

- | | | |
|--------------------------|-------------------|---------------------------|
| 1. Lug nut | 12. Brake lever | 23. Spacer |
| 2. Drive stud | 13. Lock nut | 24. Wheel shield |
| 3. Button head screw | 14. Cap screw | 25. Cotter pin |
| 4. Wheel and tire | 15. Brake bracket | 26. Clevis pin |
| 5. Wheel hub | 16. Return spring | 27. Clevis |
| 6. Lock nut | 17. Brake shoe | 28. Jam nut |
| 7. Hydraulic wheel motor | 18. Backing plate | 29. Flange bushing |
| 8. Brake drum | 19. Cam shaft | 30. Brake pivot bracket |
| 9. Woodruff key | 20. Retainer clip | 31. Brake pivot shaft |
| 10. Cotter pin | 21. Lock nut | 32. Hex flange head screw |
| 11. Adjustment rod | 22. Cap screw | 33. Hex flange nut |

Removal (Fig. 12)

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

2. Jack up and safely support the front wheel.

3. Remove lug nuts. Pull wheel from drive studs and wheel hub.

NOTE: The installation torque of the lock nut is from **250 to 275 ft-lb (339 to 373 N-m)**. Use impact wrench to loosen, but do not remove, lock nut from the hydraulic motor shaft.

4. Release parking brake.



WARNING

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

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

5. Using hub puller (see Special Tools), loosen wheel hub from wheel motor.

6. Remove lock nut, hub, and brake drum from motor shaft. Locate and retrieve woodruff key.

7. Remove cotter pin from the adjustment rod. Separate adjustment rod from the brake lever.

NOTE: The brake lever, backing plate, retaining clip, return springs, brake shoes, and cam shaft can be removed as a complete brake assembly.

8. Remove the brake assembly from the brake bracket if desired. Remove four cap screws and lock nuts securing the assembly to the bracket.

9. Disassemble brake assembly as follows (Fig. 13):

A. Remove return springs from the brake shoes. Remove brake shoes from the backing plate.

B. Mark brake cam and brake lever to assure proper alignment during reassembly. Remove retaining clip from the brake cam. Pull brake lever from the cam and remove cam from backing plate.

10. The brake bracket and wheel shield can be removed as follows:

A. Remove lock nuts, spacers, and cap screws securing the brake bracket, wheel shield, and hydraulic motor to the frame.

B. Separate bracket and shield from the frame.

Installation (Fig. 12)

1. If removed, insert four cap screws through the frame, hydraulic motor, spacers, wheel shield, and brake bracket. Secure with lock nuts, but do not fully tighten.

2. Assemble brake assembly as follows (Fig. 13):

A. Secure backing plate to the brake bracket with four cap screws and lock washers.

B. Apply antiseize lubricant to cam shaft splines. Insert cam shaft through the backing plate.

C. Attach brake lever to the cam shaft. Make sure matchmarks are aligned properly. Secure lever to shaft with retaining clip.

D. Lubricate brake shoe pivot points with a light coating of grease.

E. Position both brake shoes on the backing plate so that the concave heels attach to the anchor pin.

F. Insert both return springs into the holes of both brake shoes. Make sure shoes fit snugly against the anchor pin and cam.

3. If the brake assembly was not disassembled but was removed as a complete assembly, secure backing plate to the brake bracket with four cap screws and lock washers. Tighten fasteners.

4. Attach adjustment rod to the brake lever. Secure adjustment rod with cotter pin.

5. Thoroughly clean wheel motor shaft and wheel hub taper.

6. Install woodruff key and slide wheel hub and brake drum assembly onto the shaft.

7. Secure wheel hub and brake drum to the hydraulic motor shaft with lock nut.

NOTE: For proper brake operation, the brake shoes and backing plate must be concentrically aligned with the brake drum.

8. To align brake shoes and drum, apply parking brake. Then tighten four socket head screws and lock nuts that secure the brake bracket, shield, and wheel motor to the frame.

9. Install wheel and tire assembly. Secure with lug nuts on drive studs.

10. Lower wheel to ground. Torque lug nuts from **70 to 90 ft-lb (95 to 122 N-m)** in a criss-cross pattern. Torque lock nut from **250 to 275 ft-lb (339 to 373 kg-m)**.

11. Check and adjust brake.

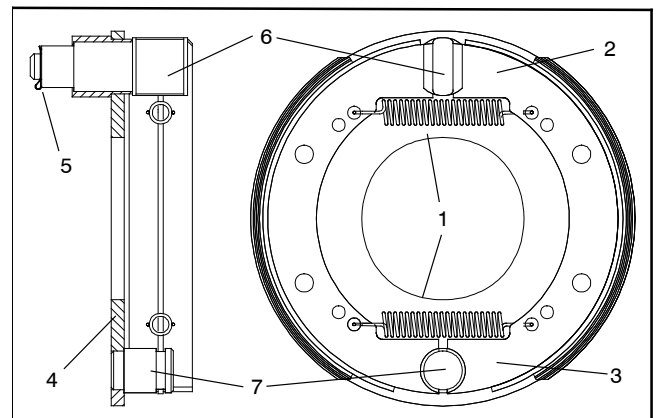


Figure 13

- | | |
|--------------------------|-------------------|
| 1. Return spring | 5. Retaining clip |
| 2. Brake shoe (toe end) | 6. Cam shaft |
| 3. Brake shoe (heel end) | 7. Anchor pin |
| 4. Backing plate | |

Burnish Brake Pads

After brake pad replacement, burnish (break-in) the brakes before use.

1. Bring the machine to full speed and apply the brakes to rapidly stop the machine without skidding or locking up the wheels.

2. Repeat this procedure 10 times. To avoid overheating the brakes, wait 1 minute between each stop.

Rear Fork and Wheel

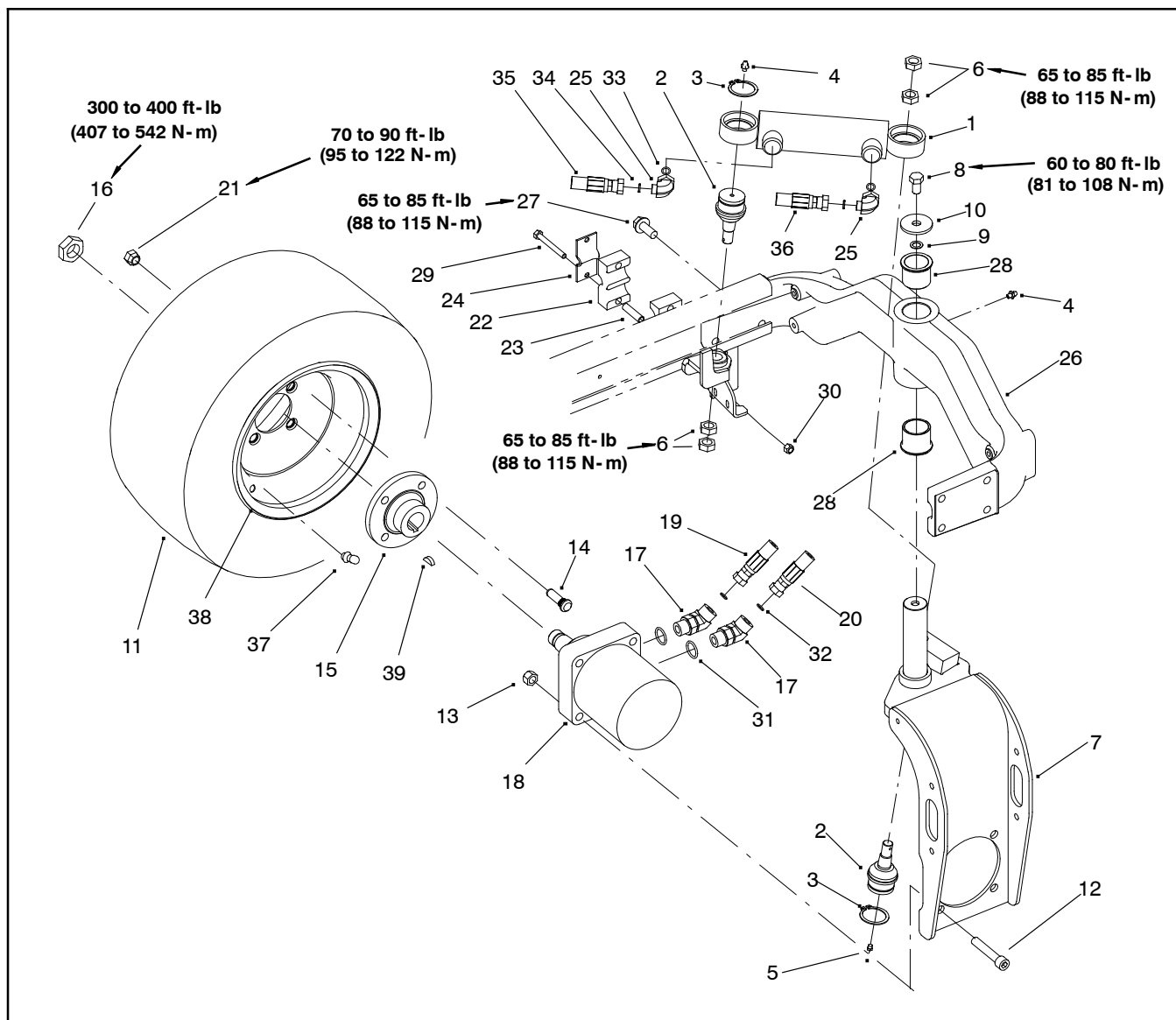


Figure 14

- | | | |
|--------------------------------|---------------------------|---------------------------|
| 1. Hydraulic steering cylinder | 14. Drive stud | 27. Hex flange head screw |
| 2. Ball joint | 15. Wheel hub | 28. Bushing |
| 3. External retaining ring | 16. Lock nut | 29. Cap screw |
| 4. Grease fitting | 17. 45° hydraulic fitting | 30. Lock nut |
| 5. Grease fitting plug | 18. Hydraulic motor | 31. O-ring |
| 6. Jam nut | 19. Hydraulic hose | 32. O-ring |
| 7. Rear fork | 20. Hydraulic hose | 33. O-ring |
| 8. Cap screw | 21. Lug nut | 34. O-ring |
| 9. Lock washer | 22. Clamp | 35. Hose assembly |
| 10. Thrust washer | 23. Spacer | 36. Hose assembly |
| 11. Tire | 24. Clamp | 37. Valve stem |
| 12. Hex socket head screw | 25. Hydraulic fitting | 38. Wheel rim |
| 13. Lock nut | 26. Rear casting | 39. Woodruff key |

Removal

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



3. Raise and safely support rear of machine enough to allow the removal of the rear wheel.
4. Remove lug nuts and remove tire and wheel assembly from hub.
5. Separate hydraulic cylinder from the rear fork as follows:
 - A. Remove both jam nuts securing the ball joint to the rear fork.
 - B. Separate ball joint from the rear fork.
 - C. Swing cylinder clear of the rear fork.
6. Remove four lock nuts and hex socket head screws securing the hydraulic motor to the rear fork. Remove motor from the fork and position it away from the fork.



7. Remove cap screw, thrust washer, and lock washer from the rear fork shaft.
8. Lower rear fork from machine.
9. Check bushings for wear and damage. Replace if necessary.

Installation

1. Position rear fork through the frame.
2. Install lock washer, thrust washer, and cap screw to the rear fork shaft. Torque cap screw from **60 to 80 ft-lb (81 to 108 N-m)**. Make sure fork turns freely.
3. Install hydraulic motor to the rear fork. Secure motor to the fork with four hex socket head screws and lock nuts.
4. Secure hydraulic cylinder to the rear fork as follows:
 - A. Swing cylinder to the rear fork.
 - B. Install ball joint to rear fork.
 - C. Secure ball joint to the rear fork with both jam nuts. Tighten the first jam nut from **65 to 85 ft-lb (88 to 115 N-m)**, then tighten the second jam nut to the same specification.
5. Lower wheel to ground. Torque lug nuts from **70 to 90 ft-lb (95 to 122 N-m)** in a criss-cross pattern.

Brake Lever Linkages

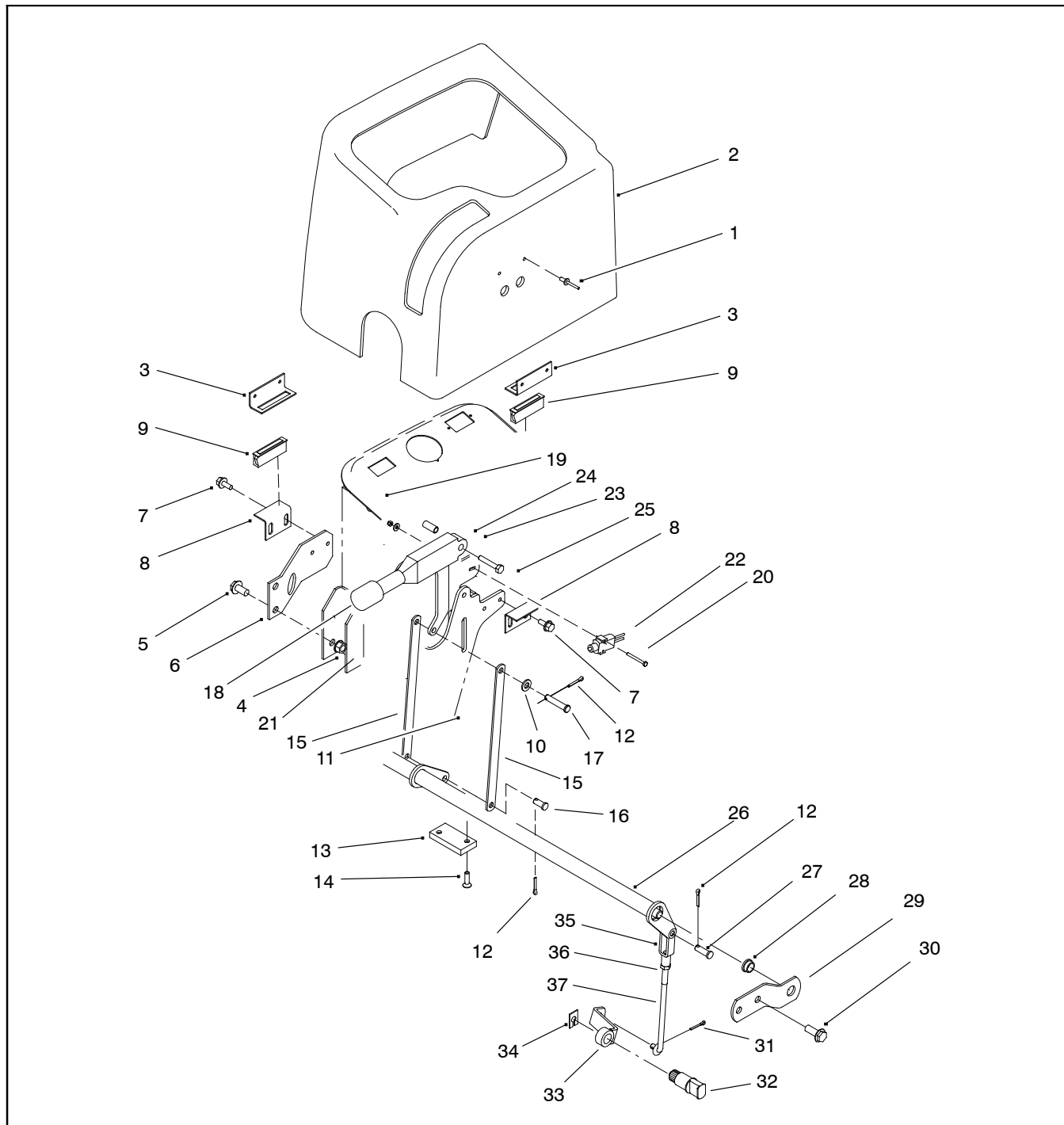


Figure 15

- | | | |
|--------------------------|--------------------------------|---------------------------|
| 1. Pop rivet | 14. Hex socket flat head screw | 26. Brake pivot shaft |
| 2. Control panel cover | 15. Parking brake link | 27. Clevis pin |
| 3. Cover bracket | 16. Clevis pin | 28. Flange bushing |
| 4. Flange nut | 17. Clevis pin | 29. Brake pivot bracket |
| 5. Hex flange head screw | 18. Lever assembly | 30. Hex flange head screw |
| 6. Magnet support | 19. Parking brake spacer | 31. Cotter pin |
| 7. Hex washer head screw | 20. Slotted hex head screw | 32. Brake cam shaft |
| 8. Strike bracket | 21. Frame | 33. Brake lever |
| 9. Magnetic catch | 22. Switch | 34. Retainer clip |
| 10. Flat washer | 23. Flat washer | 35. Adjustable clevis |
| 11. Lock nut | 24. Lock nut | 36. Jam nut |
| 12. Cotter pin | 25. Cap screw | 37. Adjustment rod |
| 13. Bumper pad | | |

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

2. Remove control panel cover from the machine.

IMPORTANT: When removing the adjustable clevis, adjustment rod, or the brake lever, make sure to mark both parts. Marking both parts will make reassembly and brake adjustment easier.

3. Remove and replace parts as necessary to repair brake linkages.

4. Install control panel cover to the machine.

IMPORTANT: Always check and adjust brakes anytime brake linkages are disassembled or repaired.

Steering Column

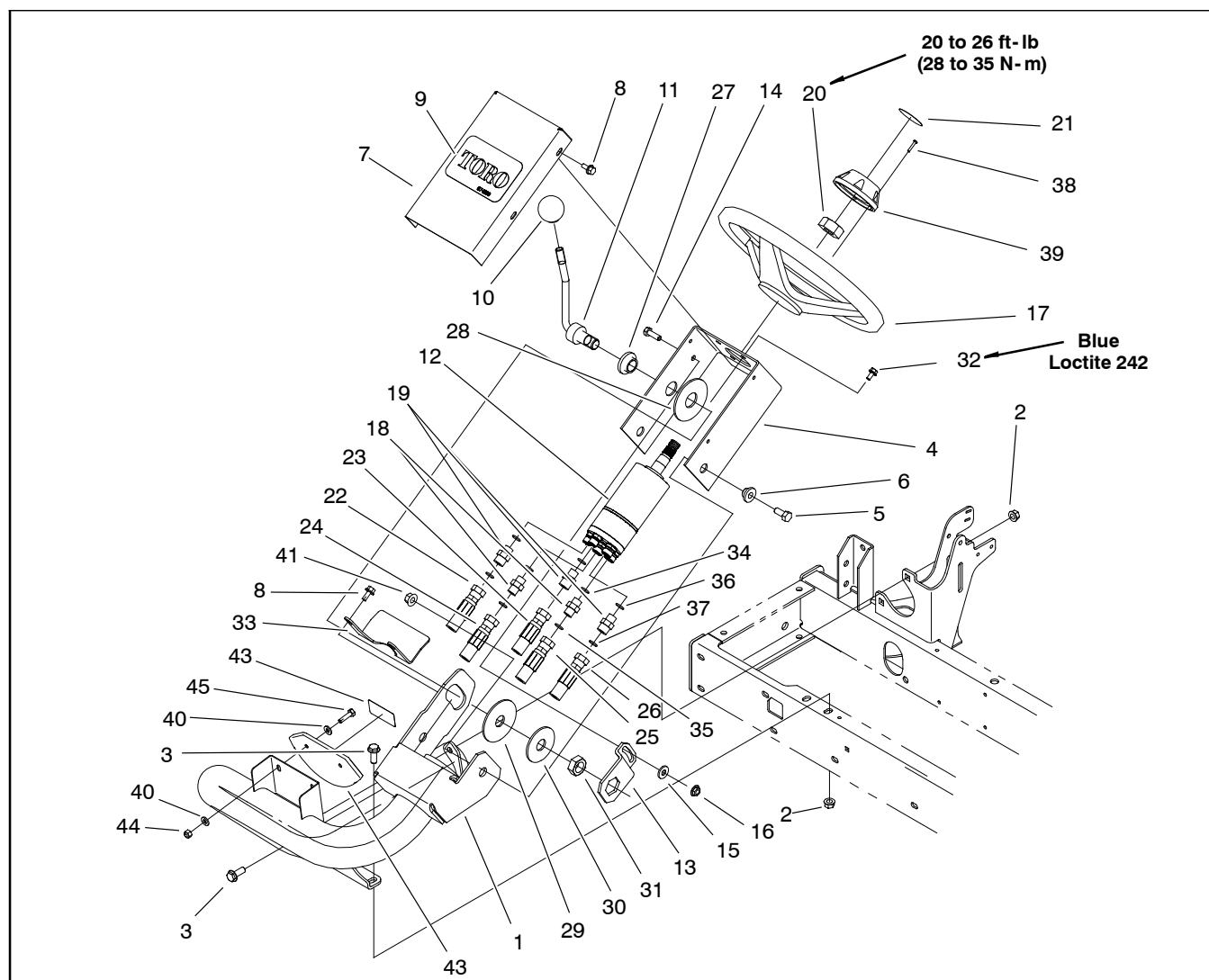


Figure 16

- | | | |
|----------------------------|------------------------|------------------------|
| 1. Steering arm | 16. Flange nut | 31. Jam nut |
| 2. Flange nut | 17. Steering wheel | 32. Flange screw |
| 3. Flange head screw | 18. Hydraulic fitting | 33. Steering shield |
| 4. Steering valve bracket | 19. Hydraulic fitting | 34. O-ring |
| 5. Cap screw | 20. Steering wheel nut | 35. O-ring |
| 6. Pivot hub | 21. Toro decal | 36. O-ring |
| 7. Steering cover | 22. Hydraulic hose | 37. O-ring |
| 8. Cap screw | 23. Hydraulic hose | 38. Philips head screw |
| 9. Toro decal | 24. Hydraulic hose | 39. Steering wheel cap |
| 10. Ball knob | 25. Hydraulic hose | 40. Flat washer |
| 11. Steering tilt lever | 26. Hydraulic hose | 41. Flange nut |
| 12. Steering control valve | 27. Tilt steering boss | 42. Slope indicator |
| 13. Tilt bracket | 28. Friction disc | 43. Decal |
| 14. Cap screw | 29. Friction disc | 44. Lock nut |
| 15. Flat washer | 30. Flat washer | 45. Cap screw |

Disassembly

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Remove philips head screws and steering wheel cap from the steering wheel.
3. Remove steering wheel nut from the steering control valve. Pull steering wheel from the control valve.
4. Remove cover from the steering control valve bracket.
5. Remove four flange screws securing the steering control valve to the steering control valve bracket.
6. Remove both hex flange nuts, cap screws, and pivot hubs securing the steering control valve bracket to the steering arm. Slide bracket from the steering control valve and steering arm.
7. Remove and replace parts as necessary to repair steering column (Fig. 16 and 17).

Assembly

1. Make sure lever and friction discs are properly assembled to the steering control valve bracket (Fig. 16 and 17).
2. Position steering control bracket to the steering control valve and steering arm. Secure bracket to the steering arm with pivot hubs, cap screws, and hex flange nuts.
3. Apply blue Loctite 242 to flange hd. screws and install steering control valve to the steering valve bracket.
4. Secure cover to the steering control valve bracket with cap screws.
5. Install steering wheel to the steering control valve. Torque steering wheel nut from 20 to 26 ft-lb (28 to 35 N-m).
6. Secure steering wheel cap to the steering wheel with six philips head screws.

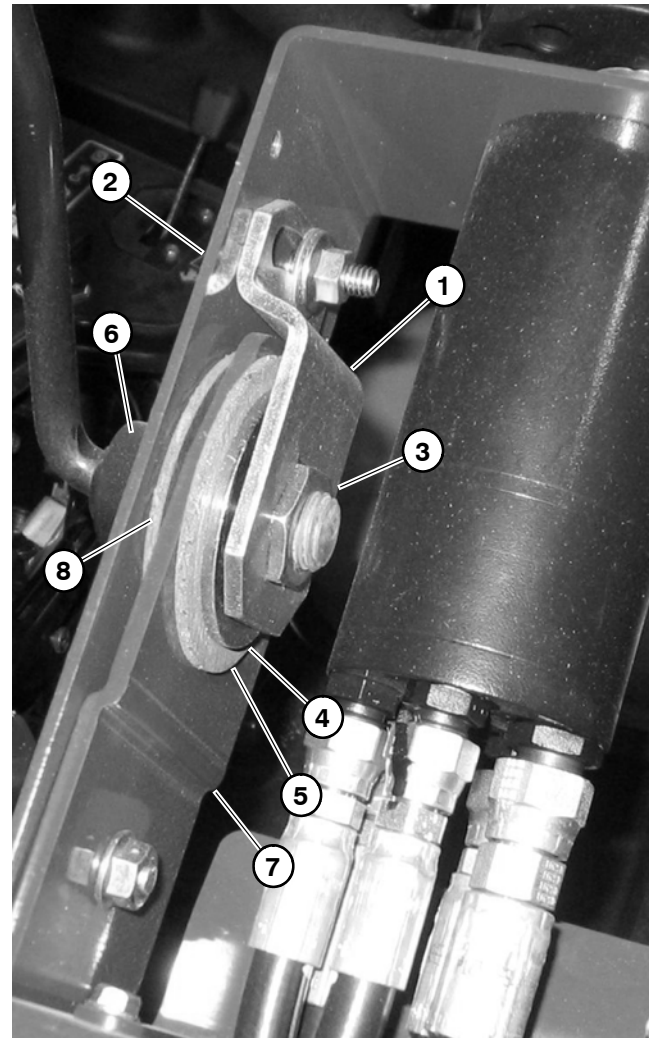


Figure 17

- | | |
|---------------------------|------------------------|
| 1. Tilt bracket | 5. Friction disc |
| 2. Steering valve bracket | 6. Tilt steering lever |
| 3. Jam nut | 7. Steering arm |
| 4. Flat washer | 8. Friction disc |

Front Lift Arms

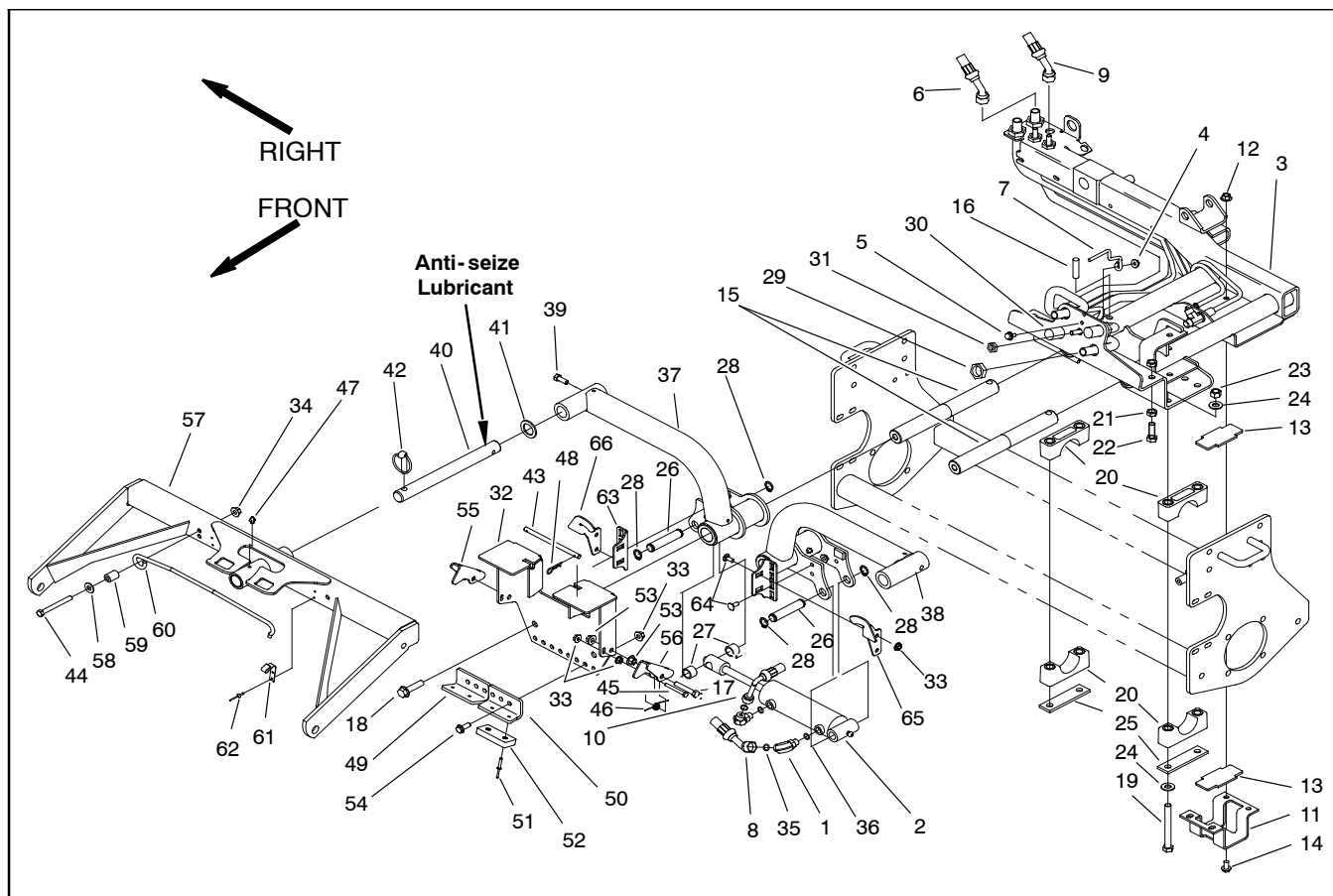


Figure 18

- | | | |
|--------------------------------|-----------------------------|-------------------------|
| 1. 90° hydraulic fitting | 23. Lock nut | 45. Cap screw |
| 2. Hydraulic cylinder | 24. Thrust washer | 46. Torsion spring |
| 3. Sidewinder carrier assembly | 25. Slide support bar | 47. Grease fitting |
| 4. Flange nut | 26. Pin | 48. Hair pin |
| 5. Flange head screw | 27. Spacer | 49. RH deck stop |
| 6. Hydraulic hose | 28. External retaining ring | 50. LH deck stop |
| 7. Centering wire | 29. Bulkhead nut | 51. Rivet |
| 8. Hydraulic hose | 30. Hydraulic tube | 52. Rubber bumper |
| 9. Hydraulic hose | 31. Bulkhead nut | 53. Flange nut |
| 10. Hydraulic hose | 32. Carrier stop bracket | 54. Flange head screw |
| 11. Slide bracket | 33. Nut | 55. RH pivot bracket |
| 12. Flange nut | 34. Flange nut | 56. LH pivot bracket |
| 13. Plastic slide | 35. O-ring | 57. Front carrier frame |
| 14. Flange head screw | 36. O-ring | 58. Flat washer |
| 15. Lift arm pivot shaft | 37. RH lift arm | 59. Latch tube |
| 16. Roll pin | 38. LH lift arm | 60. Latch rod |
| 17. Cap screw | 39. Cap screw | 61. Rod clip |
| 18. Flange head screw | 40. Shaft | 62. Rivet |
| 19. Cap screw | 41. Thrust washer | 63. Actuator bracket |
| 20. Bearing cap | 42. Lynch pin | 64. Carriage screw |
| 21. Jam nut | 43. Rod | 65. RH actuator |
| 22. Cap screw | 44. Cap screw | 66. LH actuator |

Removal (Fig. 18)

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

2. Remove cutting units (see Chapter 8 - Cutting Deck and Carrier Frame in this manual).

NOTE: Remove both spacers from the hydraulic cylinder clevis when removing the right, front lift arm.

3. Disconnect hydraulic cylinder from the front lift arms by removing external retaining rings and pins.

4. Remove both flange head screws and carrier stop bracket.

5. Slide lift arm off the pivot shaft.

6. Repair lift arm as necessary.

Installation (Fig. 18)

1. If the cutting unit pivot shaft was removed from lift arm:

A. Apply anti-seize lubricant to pivot shaft before inserting into lift arm.

B. Secure pivot shaft with cap screw.

2. Slide lift arm onto the lift arm pivot shaft.

3. Secure carrier stop bracket with both flange head screws to the lift arm pivot shafts.

NOTE: Install both spacers to the hydraulic cylinder shaft clevis when installing the right, front lift arm.

4. Secure hydraulic cylinder to the lift arm with pins and external retaining rings.

5. Route hydraulic hoses so they clear the lift arm by 0.040 to 0.120 inch (1.0 to 3.0 mm) when the lift arm is fully raised (Fig. 19).

6. Adjust lift arms to proper clearance (see Adjust Front Lift Arms in this chapter).

7. Install cutting unit to the front lift arm pivot shaft (see Chapter 8 - Cutting Deck and Carrier Frame in this manual).

8. Grease front lift arm.

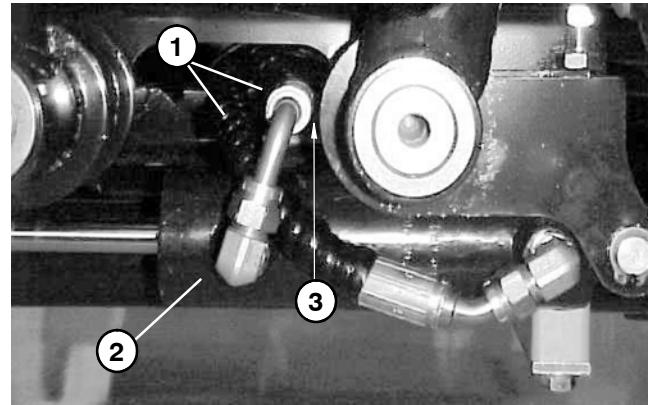


Figure 19

1. Hydraulic hoses
2. Hydraulic cylinder

3. Clearance

Rear Lift Arm

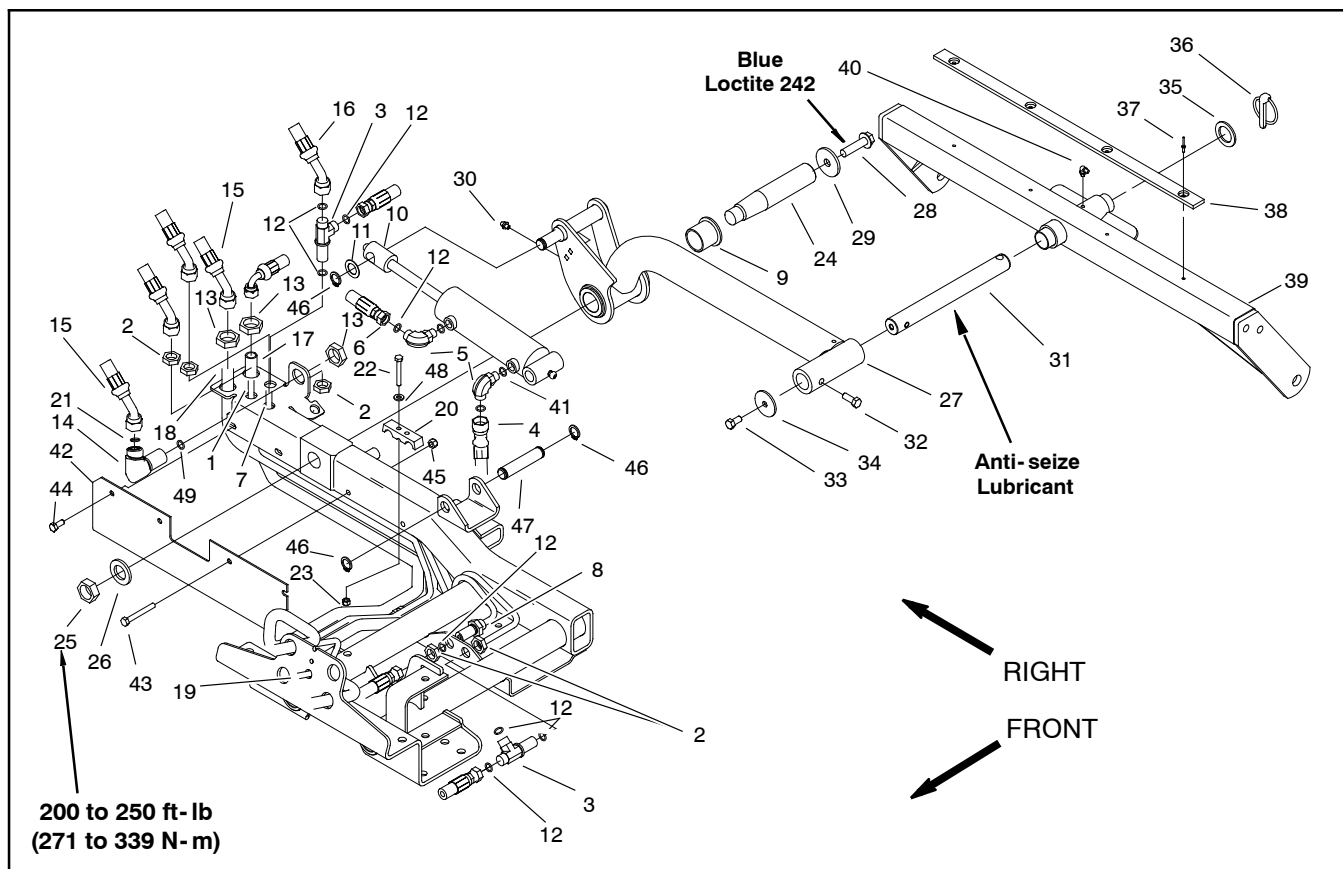


Figure 20

- | | | |
|-------------------------------|------------------------------|-----------------------------|
| 1. Hydraulic tube | 18. Hydraulic tube | 34. Rebound washer |
| 2. Bulkhead locknut | 19. Hydraulic tube | 35. Thrust washer |
| 3. Hydraulic T-fitting | 20. Tube clamp | 36. Lynch pin |
| 4. Hydraulic hose | 21. O-ring | 37. Pop rivet |
| 5. 90° hydraulic fitting | 22. Cap screw | 38. Wear strip |
| 6. Hydraulic hose | 23. Lock nut | 39. Rear cutting unit frame |
| 7. Hydraulic tube | 24. Rear pivot shaft | 40. Grease fitting |
| 8. Straight hydraulic fitting | 25. Jam nut | 41. O-ring |
| 9. Castor bushing | 26. Washer | 42. Guard |
| 10. Hydraulic cylinder | 27. Lift arm assembly | 43. Cap screw |
| 11. Thrust washer | 28. Flange head screw | 44. Cap screw |
| 12. O-ring | 29. Thrust washer | 45. Lock nut |
| 13. Bulkhead locknut | 30. Grease fitting | 46. External retaining ring |
| 14. Bulkhead elbow union | 31. Cutting unit pivot shaft | 47. Pin |
| 15. Hydraulic hose | 32. Cap screw | 48. Flat washer |
| 16. Hydraulic hose | 33. Cap screw | 49. O-ring |
| 17. Hydraulic tube | | |

Removal (Fig. 20)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Remove cutting unit from the pivot shaft of the rear lift arm (see Chapter 8 - Cutting Deck and Carrier Frame in this manual).
3. Remove external retaining ring and thrust washer from the lift cylinder shaft.
4. Remove flange head screw and thrust washer from the rear pivot shaft.
5. Slide rear lift arm from rear pivot shaft and hydraulic cylinder.
6. Repair lift arm as necessary.

Installation

1. If the rear lift arm pivot shaft was removed from frame:
 - A. Thoroughly clean tapered surfaces of shaft and frame.
 - B. Position pivot shaft to frame and secure with washer and jam nut. Torque jam nut from 200 to 250 ft-lb (271 to 339 N-m).
2. If the cutting unit pivot shaft was removed from lift arm:
 - A. Apply anti-seize lubricant to pivot shaft before inserting into lift arm.
 - B. Secure pivot shaft with two (2) cap screws and washer.

3. Slide rear lift arm onto rear pivot shaft and through lift cylinder clevis simultaneously.
4. Apply blue Loctite 242 to cap screw and secure lift arm to pivot shaft with cap screw and washer.
5. Secure hydraulic cylinder clevis with the thrust washer and external retaining ring.
6. Install cutting unit to the rear lift arm (see Chapter 8 - Cutting Deck and Carrier Frame in this manual).
7. Adjust lift arm to proper clearance (see Adjust Rear Lift Arm in this chapter).

IMPORTANT: Make sure hoses are free of twists and sharp bends. Raise cutting units and shift them to the left. Rear cutting unit hoses must not contact the traction cable bracket. If required, reposition fittings and hoses.

8. Grease rear lift arm.

Sidewinder Carrier

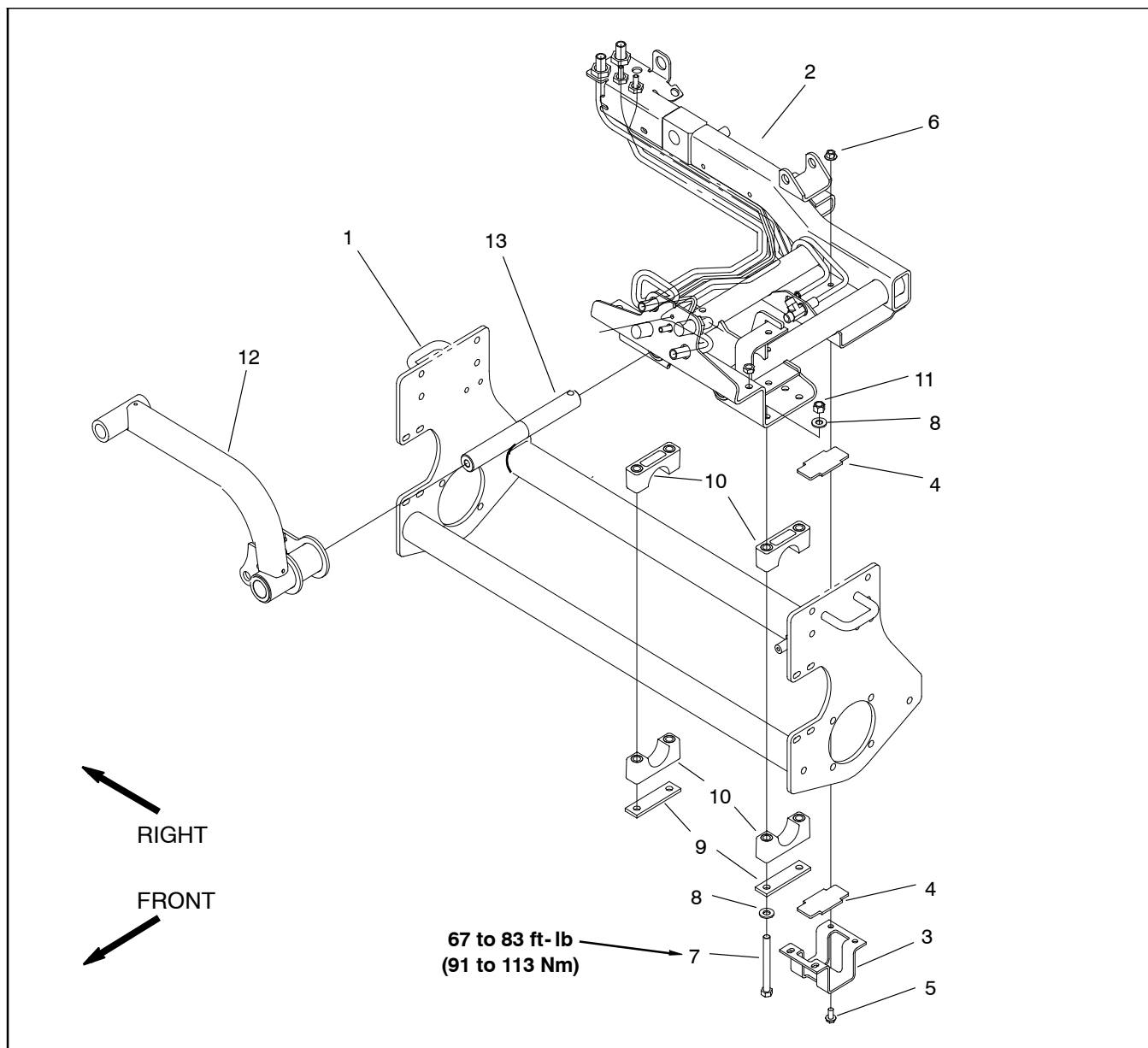


Figure 21

- | | | |
|--------------------------------|----------------------|--------------------------|
| 1. Lower frame | 6. Flange nut | 10. Bearing cap |
| 2. Sidewinder carrier assembly | 7. Cap screw | 11. Lock nut |
| 3. Slide bracket | 8. Thrust washer | 12. Lift arm (RH shown) |
| 4. Plastic slide | 9. Slide support bar | 13. Lift arm pivot shaft |
| 5. Flange head screw | | |

Disassembly

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Remove lift arms (Fig. 18 and 20) (see Front and Rear Lift Arms in this chapter).
3. Disassemble sidewinder carrier as needed (Fig. 21).

Assembly

1. Assemble sidewinder carrier using (Fig. 21).
 - A. Do not lubricate sidewinder cross tube as bearing caps and slides are self lubricating.
 - B. Tighten the bearing cap screws from 67 to 83 ft-lb (91 to 113 Nm).
2. Install lift arms (Fig. 18 and 20) (see Front and Rear Lift Arms in this chapter).



Cutting Decks

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Specifications



MOUNTING: All cutting units are supported by equal length, independent lift arms and are interchangeable to all three cutting unit positions.

CONSTRUCTION: Deck chamber and frame are welded steel construction reinforced with channels and plates.

HEIGHT-OF-CUT RANGE: 3/4 to 4 inch (19 to 101 mm) in 1/4 inch (6.4 mm) increments. Height-of-cut adjustment is made by repositioning deck on deck frame.

DECK DRIVE: Closed loop, integrated relief, hydraulic system operates cutting deck hydraulic motors. Blade spindles are 1-1/4 inch (31.7 mm) shafts supported by greaseable, tapered roller bearings in a ductile iron housing.

CUTTING BLADE: Each cutting deck equipped with a 27 inch (686 mm) length, 0.250 inch (6.4 mm) thick, heat treated, steel blade. Anti-scalp cup installed on cutting blade. The standard blade is optimized for most cutting applications. Optional high lift, angled sail and Atomic blades are available for those situations where the standard blade is not ideal.

DISCHARGE: Clippings are discharged from the rear of the mowing decks. Pre-drilled mounting holes allow attachment of optional mulching baffle.

CUTTING DECK LIFT: Cutting decks are controlled with one (1) lift lever.

SUSPENSION SYSTEM: A fully floating suspension with hydraulic counterbalance. Main center pivot allows side-to-side deck oscillation. Individual decks supported with two (2) front rollers and one, full width, rear roller.

WEIGHT: Individual cutting deck weighs approximately 195 lb (89 kg).

General Information



CAUTION

Never install or work on the cutting decks or lift arms with the engine running. Always stop engine and remove key from ignition switch first.

Operator's Manual

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

Troubleshooting

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. Turf conditions such as excessive thatch, “sponginess”, uneven ground conditions or attempting to cut off too much grass height may not always be overcome by adjusting the machine. It is important to remember that the lower the height-of-cut, the more critical these factors are.

Remember that the “effective” or actual height-of-cut depends on cutting deck weight, counterbalance setting and turf conditions. Effective height-of-cut will be different than the bench set height-of-cut.

Factors That Can Affect Quality of Cut

Factor	Possible Problem/Correction
1. Maximum governed engine speed.	Check maximum governed engine speed. Adjust speed to specifications if necessary.
2. Blade speed.	All deck blades should rotate at the same speed. See items in Troubleshooting Section of Chapter 4 – Hydraulic System.
3. Tire pressure.	Check air pressure of each tire. Adjust to pressures specified in Traction Unit Operator's Manual.
4. Blade condition.	Sharpen blades if their cutting edges are dull or nicked. Inspect blade sail for wear or damage. Replace blade if needed.
5. Mower housing condition.	Make sure that cutting chambers are in good condition. Keep underside of deck clean. Debris buildup will reduce cutting performance.
6. Height-of-cut.	Make sure all cutting decks are set at the same height-of-cut. Adjust cutting decks as specified in the Cutting Deck Operator's Manual. Adjust height-of-cut setting to remove only 1 inch (25 mm) or 1/3 of the grass blade when cutting.
7. Cutting deck alignment and ground following.	Check lift arms and cutting deck pivot linkages for wear, damage or binding. Also inspect for bent or damaged pivot shafts.
8. Roller condition.	All rollers should rotate freely. Replace bearings if worn or damaged.
9. Grass Conditions.	Mow when grass is dry for best cutting results.

Special Tools

Order special tools from your Toro Distributor.

Rear Roller Bearing and Seal Installation Tools

These tools are used to assemble the cutting deck rear roller.

Toro Part Numbers:	
Inner Seal Tool	115-0852
Bearing/Outer Seal Tool	115-0853
Bearing Installation Washer	107-8133

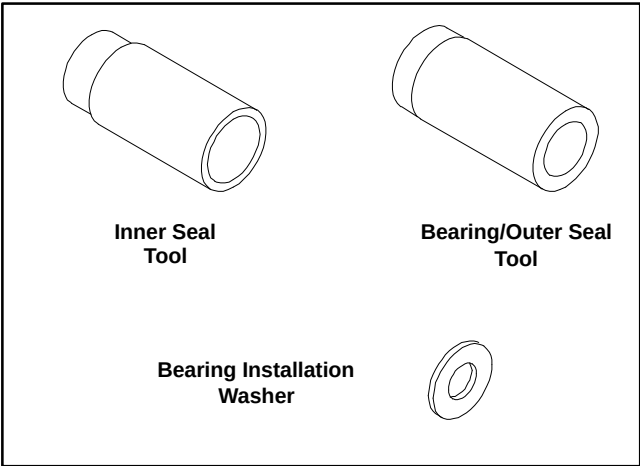


Figure 1

Front Roller Bearing Installation Tool

The front roller bearing installation tool should be used when installing bearings into the front rollers. This tool presses equally against both the inner and outer bearing races to ensure that no side load is applied to the bearings during installation into the front rollers.

Toro Part Number: **TOR6018**



Figure 2

Spindle Plug

The spindle plug can be used to prevent contaminant entry into the cutting deck spindle assembly when the hydraulic motor is removed from the spindle.

Toro Part Number: **94-2703**

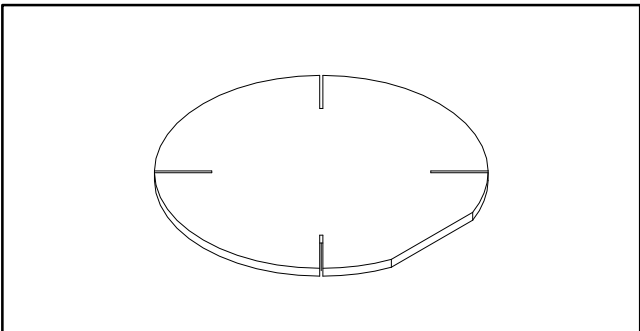


Figure 3

Adjustments



CAUTION

Never install or work on the cutting decks or lift arms with the engine running. Always stop engine and remove key from ignition switch first.

See the Cutting Deck Operator's Manual for adjustment procedures for cutting decks on the Groundsmaster 3500.

Blade Stopping Time

The blades of the cutting decks are to come to a complete stop in approximately five (5) seconds after the PTO is disengaged.

NOTE: Make sure the decks are lowered onto a clean section of turf or hard surface to avoid dust and debris.

To verify this stopping time, have a second person stand back from the machine at least twenty (20) feet and watch the blade on one of the cutting decks. Have the machine operator disengage the PTO and record the time it takes for the cutting deck blade to come to a complete stop. If this time is greater than seven (7) seconds, adjust the blade braking valve (BV) on units prior to Serial No. 314000001 or the blade braking relief valve (RV) on units Serial No. 314000001 & Up (see Chapter 5 – Hydraulic System in this manual).

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Service and Repairs



CAUTION

Never install or work on the cutting decks or lift arms with the engine running. Always stop engine and remove key from ignition switch first.

Blade Spindle Assembly

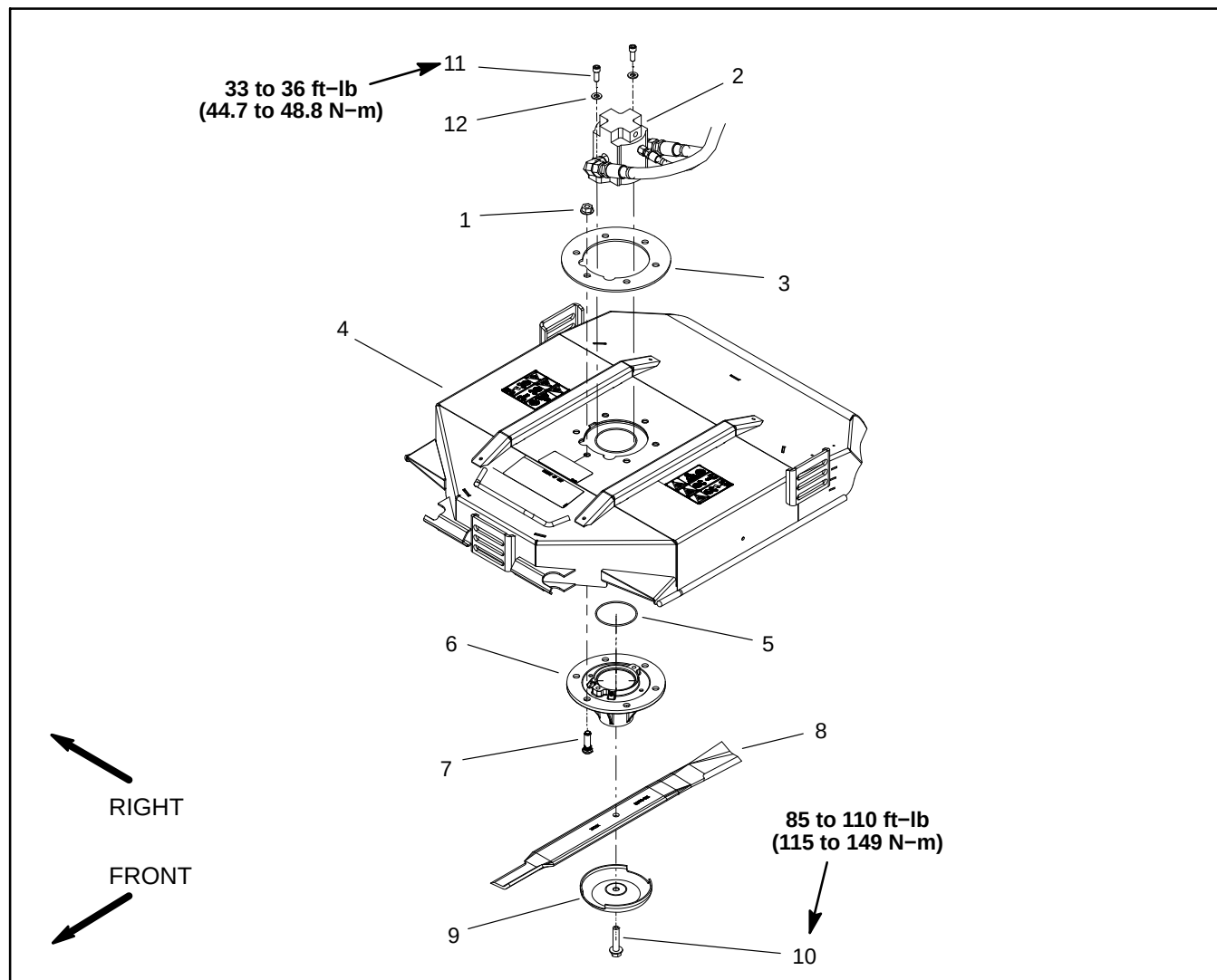


Figure 4

- | | | |
|-------------------------|------------------------|--------------------------------|
| 1. Flange nut (6 used) | 5. O-ring | 9. Anti-scalp cup |
| 2. Hydraulic deck motor | 6. Spindle assembly | 10. Blade bolt |
| 3. Spindle plate | 7. Drive stud (6 used) | 11. Socket head screw (2 used) |
| 4. Cutting deck | 8. Cutting blade | 12. Flat washer (2 used) |

Removal (Fig. 4)

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

2. Remove two (2) socket head screws and flat washers that secure hydraulic motor to the cutting deck (Fig. 5). Remove hydraulic motor and O-ring from deck.

3. Cover top of spindle to prevent debris from entering spindle. A spindle plug (see Special Tools in this chapter) can be used to cover spindle.

NOTE: If desired, cutting deck can be removed from machine for spindle removal from cutting deck.

4. If spindle is to be removed with cutting deck attached to the machine, start the engine and raise the cutting deck. Stop engine and remove key from the ignition switch. Support the cutting deck so it cannot fall accidentally.

5. Remove blade bolt, anti-scalp cup and cutting blade.

6. Remove flange nuts that secure spindle assembly to cutting deck. Slide spindle assembly out the bottom of the deck. Remove spindle plate from top of deck.

7. If necessary, press drive studs (item 7) from spindle assembly.

Installation (Fig. 4)

1. If drive studs (item 7) were removed from spindle assembly, press new drive studs into spindle. Make sure that stud heads are fully pressed against spindle surface.

2. Position spindle assembly and spindle plate to cutting deck. Notches on cutting deck and spindle plate should be aligned to front of deck.

3. Secure spindle assembly and spindle plate to cutting deck with flange nuts. Tighten flange nuts in a star pattern.

4. Install cutting blade, anti-scalp cup and bolt. Tighten blade bolt from **88 to 108 ft-lb (120 to 146 N-m)**.

5. Remove cover from top of spindle that was placed to prevent debris from entering spindle.

6. Position O-ring to top of spindle housing. Secure hydraulic motor to the cutting deck with two (2) socket head screws and flat washers.

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

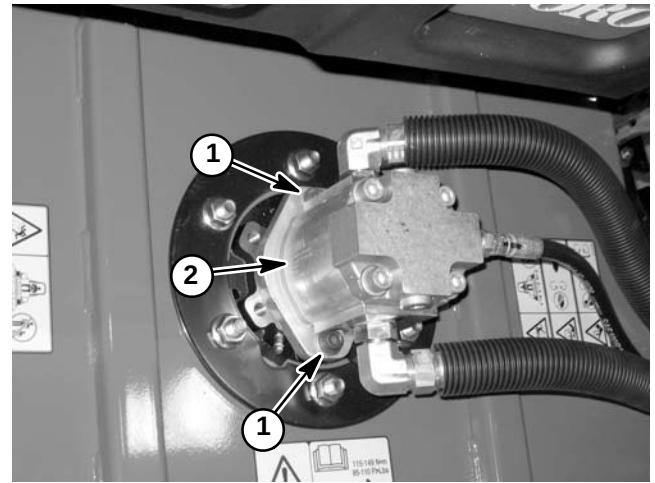


Figure 5

1. Socket head screw

2. Hydraulic motor

Blade Spindle Service

Disassembly (Fig. 6)

1. Remove blade spindle from cutting deck (see Blade Spindle Removal in this section).
2. Loosen and remove spindle nut from top of spindle shaft.
3. Remove the spindle shaft from the spindle housing which may require the use of an arbor press. The spindle shaft spacer should remain on the spindle shaft as the shaft is being removed.
4. Carefully remove oil seals from spindle housing noting direction of seal lips.
5. Allow the bearing cones, inner bearing spacer and spacer ring to drop out of the spindle housing.
6. Using an arbor press, remove both of the bearing cups and the outer bearing spacer from the housing.
7. The large snap ring can remain inside the spindle housing. Removal of this snap ring is very difficult.

Assembly (Fig. 6)

NOTE: A replacement spindle bearing set contains two (2) bearings, a spacer ring and a large snap ring (items 1, 2 and 3 in Fig. 7). These parts cannot be purchased separately. Do not mix bearing set components from one deck spindle to another.

NOTE: A replacement bearing spacer set includes the inner spacer and outer spacer (items 4 and 5 in Fig. 7). Do not mix bearing spacers from one deck spindle to another.

IMPORTANT: If new bearings are installed into a used spindle housing, it may not be necessary to replace the original large snap ring. If the original large snap ring is in good condition with no evidence of damage (e.g. spun bearing), leave the snap ring in the housing and discard the large snap ring that comes with the new bearings. If the large snap ring is found to be damaged, replace the snap ring.

1. If large snap ring was removed from spindle housing, install snap ring into housing groove. Make sure snap ring is fully seated in groove.
2. Install outer bearing spacer into top of spindle housing. The spacer should fit against the large snap ring.

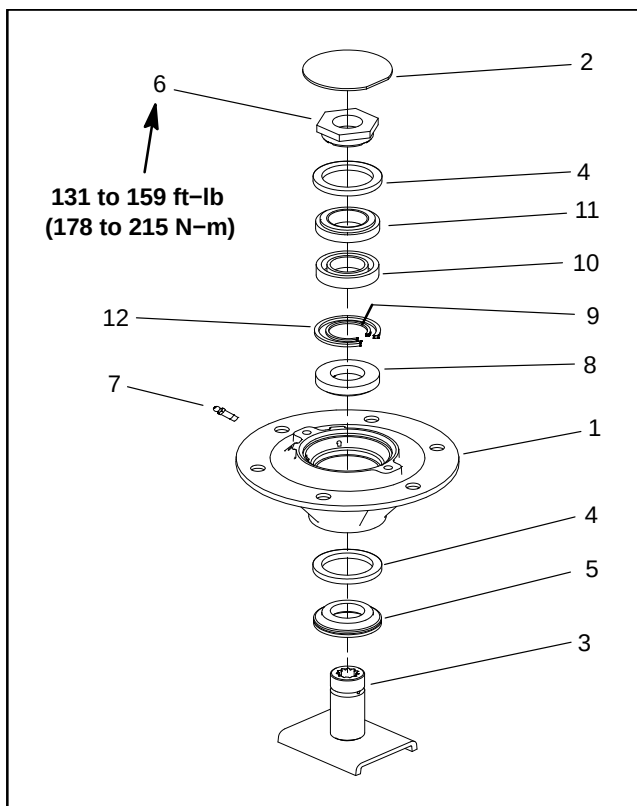


Figure 6

- | | |
|--------------------|--------------------------|
| 1. Spindle housing | 7. Grease fitting |
| 2. Spindle plug | 8. Bearing |
| 3. Spindle shaft | 9. Spacer ring |
| 4. Oil seal | 10. Spacer set (2 piece) |
| 5. Shaft spacer | 11. Bearing |
| 6. Spindle nut | 12. Large snap ring |

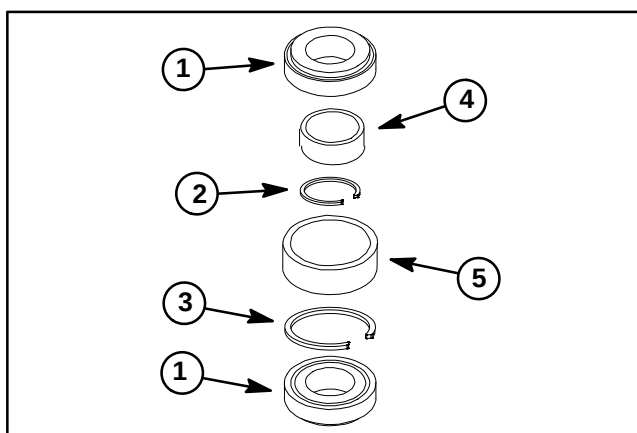


Figure 7

- | | |
|--------------------|-------------------------|
| 1. Bearing | 4. Inner bearing spacer |
| 2. Spacer ring | 5. Outer bearing spacer |
| 3. Large snap ring | |

3. Using an arbor press, push the bearing cups into the top and bottom of the spindle housing. The top bearing cup must contact the outer bearing spacer previously installed, and the bottom bearing cup must contact the large snap ring. Make sure that the assembly is correct by supporting the first bearing cup and pressing the second cup against it (Fig 8).

4. Pack the bearing cones with grease. Apply a film of grease on lips of oil seals.

5. Install lower bearing cone and greased oil seal into bottom of spindle housing.

NOTE: The bottom seal must have the lip facing out (down) (Fig. 9). This seal installation allows grease to purge from the spindle during the lubrication process.

IMPORTANT: If bearings are being replaced, make sure to use the spacer ring that is included with the new bearing set (Fig. 7).

6. Slide spacer ring and inner bearing spacer into spindle housing, then install upper bearing cone and greased oil seal into top of housing.

NOTE: The upper seal must have the lip facing out (up) (Fig. 9).

7. Inspect the spindle shaft and shaft spacer to make sure there are no burrs or nicks that could possibly damage the oil seals. Lubricate the shaft and spacer with grease.

8. Install spindle shaft spacer onto shaft. Place thin sleeve or tape on spindle shaft splines to prevent seal damage during shaft installation.

9. Carefully slide spindle shaft with spacer up through spindle housing. The bottom oil seal and spindle spacer should fit together when the spindle is fully installed.

10. Thread spindle nut onto shaft and tighten nut from **131 to 159 ft-lb (178 to 215 N-m)**.

IMPORTANT: Pneumatic grease guns can produce high pressure inside spindle housing that can damage spindle seals. Pneumatic grease guns, therefore, are not recommended to be used for greasing of spindle housings.

11. Attach a hand pump grease gun to one of the grease fittings on housing and fill housing cavity with grease until grease starts to come out of lower seal.

12. Rotate spindle shaft to make sure that it turns freely.

13. Install blade spindle assembly to cutting deck (see Blade Spindle Installation in this section).

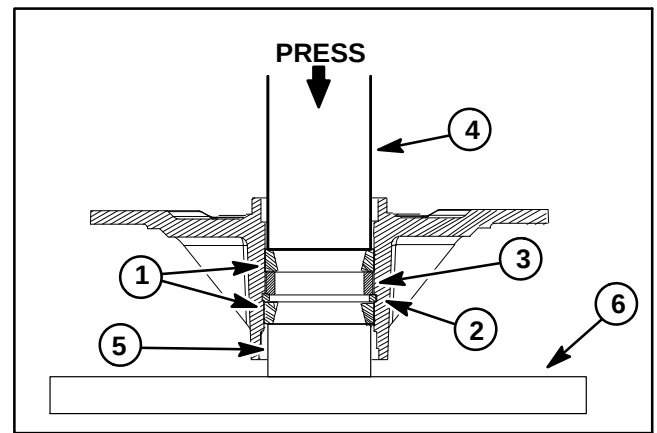


Figure 8

- | | |
|--------------------|---------------------|
| 1. Bearing cup | 4. Arbor press |
| 2. Large snap ring | 5. Support |
| 3. Large spacer | 6. Arbor press base |

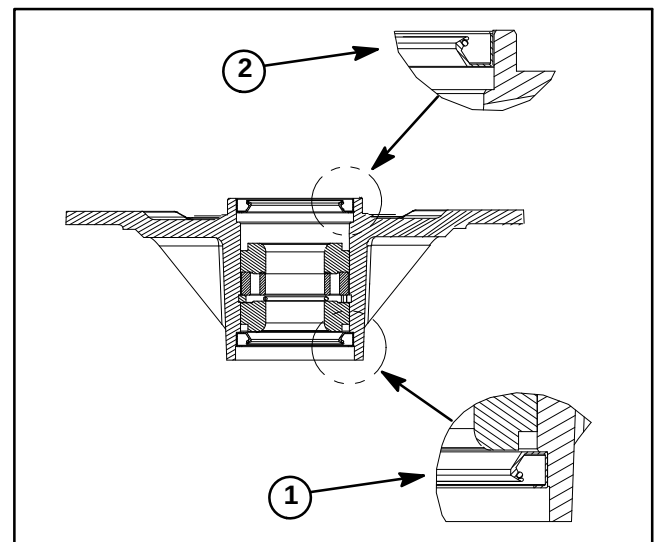


Figure 9

- | | |
|-----------------------------|----------------------------|
| 1. Bottom seal installation | 2. Upper seal installation |
|-----------------------------|----------------------------|

Rear Roller

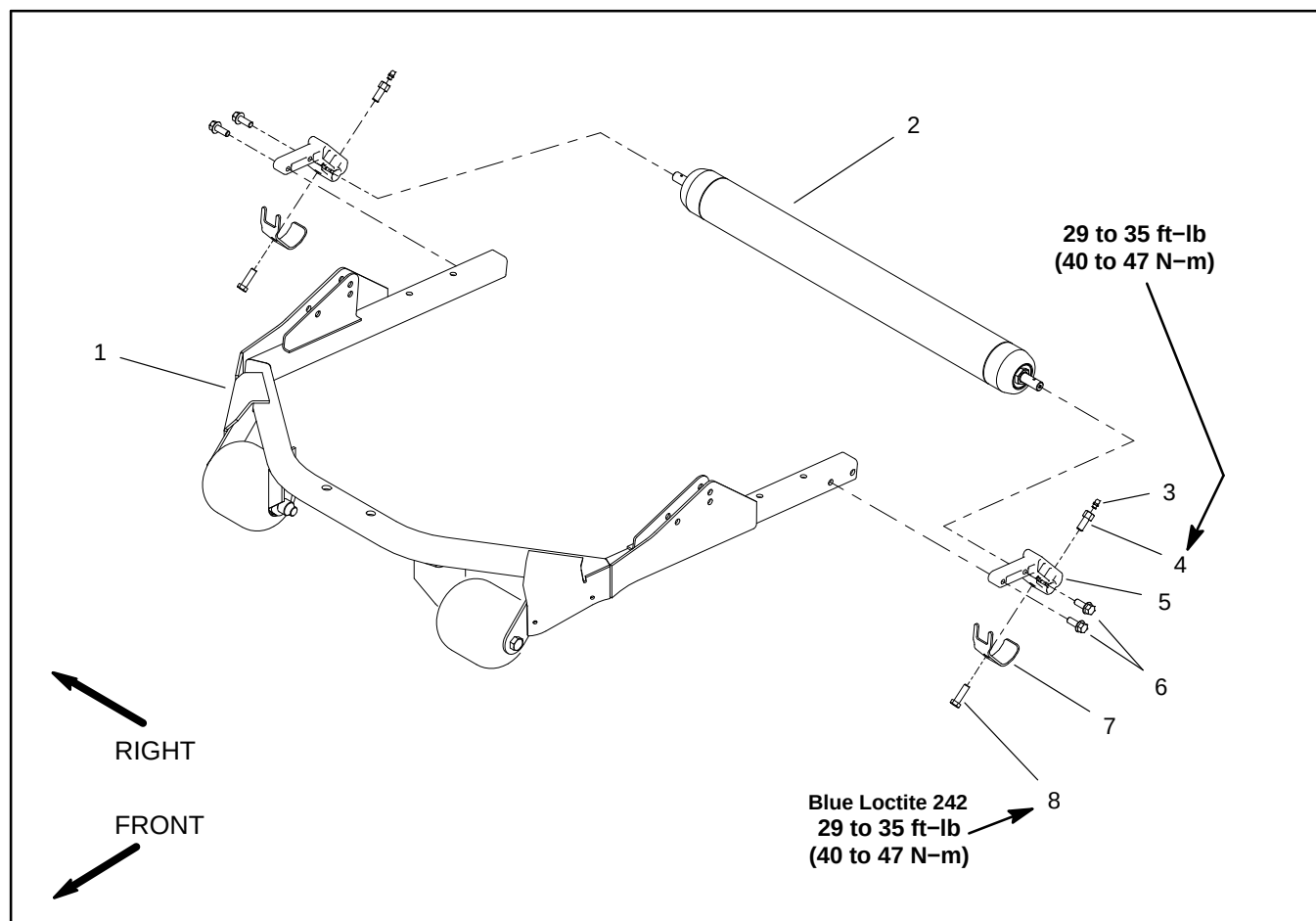


Figure 10

- 1. Deck frame
- 2. Rear roller assembly
- 3. Grease fitting

- 4. Roller shaft screw
- 5. Roller mount
- 6. Flange head screw

- 7. Skid bracket
- 8. Cap screw

Removal (Fig. 10)

1. Park machine on a level surface, lower cutting decks, stop engine, engage parking brake and remove key from the ignition switch.
2. If cutting deck is equipped with a roller scraper (Fig. 11), remove fasteners securing left and right scraper rod brackets to roller mounts. Remove scraper rod assembly.
3. Remove four (4) flange head screws securing roller mounts to rear of deck frame. Remove roller mounts and rear roller assembly from deck frame.
4. Loosen fasteners securing each end of roller to roller mounts. Remove mounts and skid brackets from roller.

Installation (Fig. 10)

1. Slide roller mounts onto roller shaft.
2. Install roller and roller mount assembly into rear of deck frame. Secure assembly to deck frame with four (4) flange head screws.

IMPORTANT: During assembly, make sure the grease groove in each roller mount aligns with the grease hole in each end of the roller shaft.

3. Align roller shaft grease hole with the roller mount grease groove. Use alignment mark on end of roller shaft to assist with alignment.
4. Position skid brackets to roller mounts and install cap screws to retain brackets in place.
5. If equipped with scraper rod, install and adjust scraper rod assembly to roller mounts (Fig. 11). The gap between the scraper rod and roller should be from 0.020 to 0.040 in (0.5 to 1.0 mm). Torque cap screws **30 ft-lb (41 N-m)**.
6. Install and tighten fasteners that secure each end of roller to roller mounts. Torque roller shaft screws (item 4) and cap screws (item 8) from **29 to 35 ft-lb (40 to 47 N-m)**.
7. After assembly, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

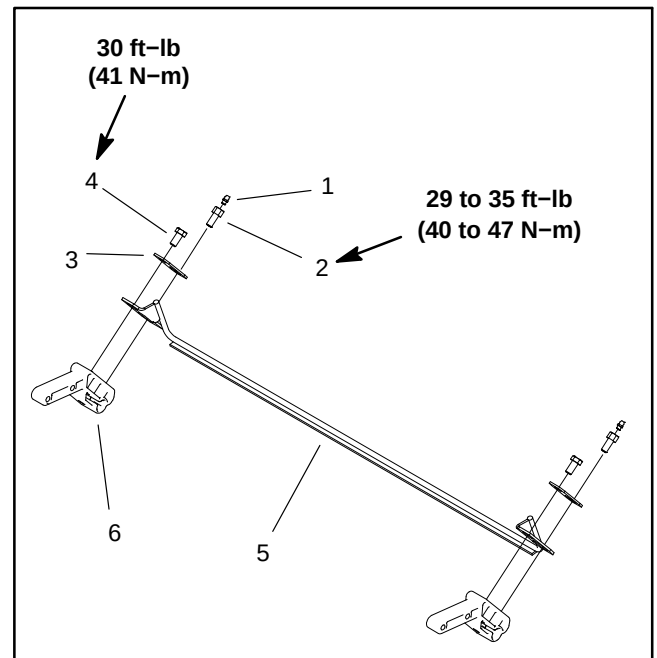


Figure 11

- | | |
|-----------------------|-------------------|
| 1. Grease fitting | 4. Cap screw |
| 2. Roller shaft screw | 5. Roller scraper |
| 3. Scraper plate | 6. Roller mount |

Rear Roller Service

Disassembly (Fig. 12)

1. Remove bearing lock nut from each end of roller shaft.
2. Loosely secure roller assembly in bench vise and lightly tap one end of roller shaft until outer seals and bearing are removed from opposite end of roller tube. Remove second set of outer seals and bearing from roller tube by tapping on opposite end of shaft. Remove shaft from roller tube.
3. Carefully remove inner seal from both ends of roller tube taking care to not damage tube surfaces.
4. Discard removed seals and bearings.
5. Clean roller shaft and all surfaces on the inside of the roller tube. Inspect components for wear or damage. Also, carefully inspect seating surface and threads of bearing lock nuts. Replace all damaged components.

Assembly (Fig. 12)

1. Install inner seals into roller tube making sure that seal lip (and garter spring) faces end of tube. Use inner seal tool (see Special Tools in this chapter) and soft face hammer to fully seat seals against roller shoulder (Fig. 13). Apply a small amount of grease around the lip of both inner seals after installation.

IMPORTANT: During assembly process, frequently check that bearings rotate freely and do not bind. If any binding is detected, consider component removal and reinstallation.

2. Install new bearing and outer seals into one end of roller tube:

A. Position a new bearing into one end of roller tube. Use bearing/outer seal tool (see Special Tools in this chapter) with a soft face hammer to fully seat bearing against roller shoulder (Fig. 14). After bearing installation, make sure that it rotates freely with no binding.

B. Apply a small amount of grease around the lip of both outer seals.

C. Install first outer seal into roller tube making sure that seal lip (and garter spring) faces end of tube. Use bearing/outer seal tool (see Special Tools in this chapter) and soft face hammer to lightly seat seal against roller shoulder (Fig. 15). Make sure that bearing still freely rotates after seal installation.

D. Using the same process, install second outer seal making sure to not crush the installed outer seal. Again, make sure that bearing still freely rotates.

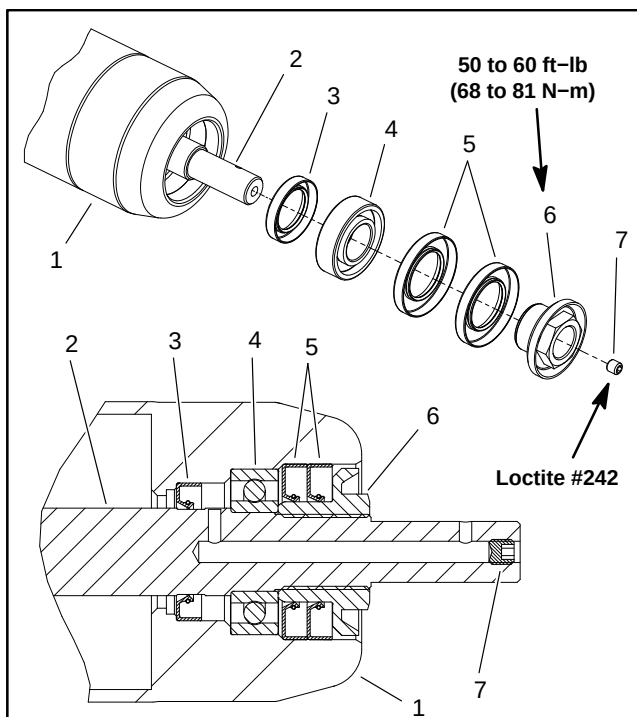


Figure 12

- | | |
|-----------------|---------------------|
| 1. Roller tube | 5. Outer seal |
| 2. Roller shaft | 6. Bearing lock nut |
| 3. Inner seal | 7. Set screw |
| 4. Bearing | |

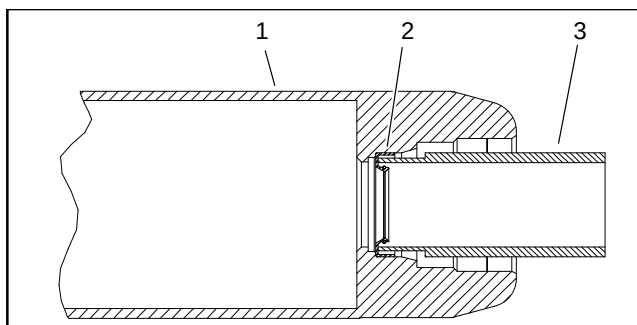


Figure 13

- | | |
|----------------|--------------------|
| 1. Roller tube | 3. Inner seal tool |
| 2. Inner seal | |

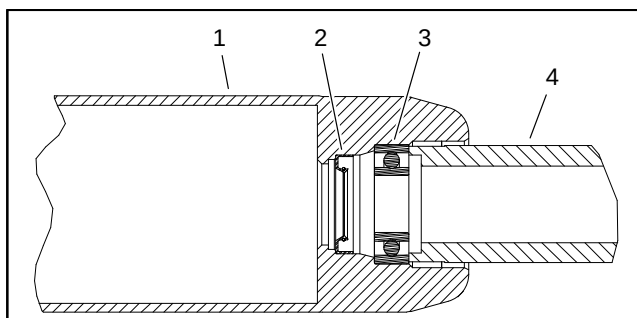


Figure 14

- | | |
|----------------|----------------------------|
| 1. Roller tube | 3. Bearing |
| 2. Inner seal | 4. Bearing/outer seal tool |

3. From the roller tube end with only the inner seal installed, carefully install the roller shaft into the roller tube. Make sure that seals are not damaged as shaft is installed.

4. Install new bearing and outer seals into second end of roller tube:

A. Position a second new bearing to roller shaft and tube. Position washer (see Special Tools in this chapter) on bearing to allow pressing on both inner and outer bearing races simultaneously.

B. Use washer and bearing/outer seal tool (see Special Tools in this chapter) with a soft face hammer to fully seat bearing (Fig. 16). After bearing installation, make sure that shaft freely rotates and that no binding is detected. If necessary, lightly tap bearing and/or shaft ends to align shaft and bearings. Remove washer from roller.

C. Apply a small amount of grease around the lip of both outer seals.

D. Carefully install first outer seal into roller tube making sure that seal lip (and garter spring) faces end of tube. Use bearing/outer seal tool (see Special Tools in this chapter) and soft face hammer to lightly seat seal (Fig. 17). Make sure that shaft and bearings still freely rotate after seal installation.

E. Using the same process, install second outer seal making sure to not crush the installed outer seal. Again, make sure that shaft and bearings still freely rotate.

IMPORTANT: Make sure that all grease is removed from shaft threads to prevent bearing lock nut loosening.

5. Thoroughly clean threads on both ends of roller shaft.

NOTE: If original bearing lock nut(s) are being used, apply Loctite #242 (or equivalent) to threads of lock nut(s).

6. Install bearing lock nut onto each end of the roller shaft. Make sure that outer seals are not damaged during nut installation. Torque lock nuts from **50 to 60 ft-lb (68 to 81 N-m)**.

7. If set screw was removed from either end of roller shaft, apply Loctite #242 (or equivalent) to threads of removed set screw and install into roller shaft. Tighten set screw until it bottoms in shaft and is recessed in shaft.

IMPORTANT: When roller assembly is installed to cutting deck, make sure that grease groove in each roller mount aligns with the grease hole in each end of roller shaft.

NOTE: After roller is installed to cutting deck, lubricate roller grease fittings, rotate roller to properly distribute grease in bearings and clean excess grease from roller ends. A properly assembled roller should rotate with less than 5 in-lbs (0.68 N-m) resistance.

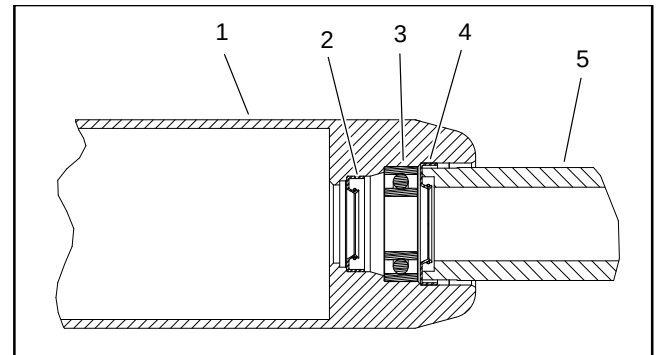


Figure 15

- | | |
|----------------|----------------------------|
| 1. Roller tube | 4. Outer seal |
| 2. Inner seal | 5. Bearing/outer seal tool |
| 3. Bearing | |

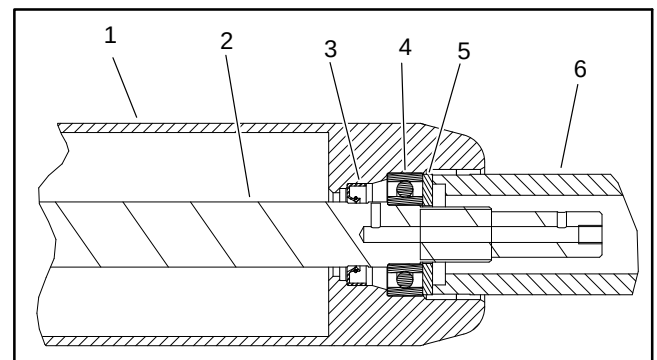


Figure 16

- | | |
|-----------------|----------------------------|
| 1. Roller tube | 4. Bearing |
| 2. Roller shaft | 5. Washer |
| 3. Inner seal | 6. Bearing/outer seal tool |

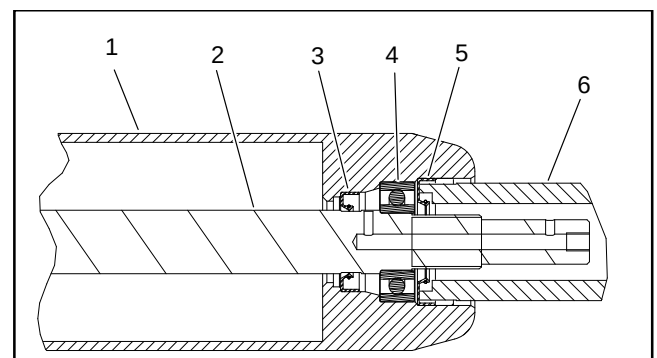


Figure 17

- | | |
|-----------------|----------------------------|
| 1. Roller tube | 4. Bearing |
| 2. Roller shaft | 5. Outer seal |
| 3. Inner seal | 6. Bearing/outer seal tool |

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Front Roller Service

Disassembly (Fig. 18)

1. Remove roller mounting bolt.
2. Remove roller assembly from carrier frame.
3. To remove bearings and bearing spacer:
 - A. Insert punch through end of roller and drive opposite bearing out by alternating taps to opposite side of inner bearing race. There should be a lip of inner race exposed for this process.
 - B. Remove bearing spacer. Remove second bearing from roller using a press.
4. Inspect roller housing, bearings and bearing spacer for damage or wear. Replace components as needed.

Assembly (Fig. 18)

1. Install bearings and bearing spacer into roller:

IMPORTANT: Use Front Roller Bearing Installation Tool (see Special Tools in this chapter) when installing bearings into roller. This tool ensures that no side load is applied to the bearings during installation into the front rollers.

- A. Press first bearing into housing. Press equally on inner and outer races during installation.
 - B. Insert bearing spacer.
 - C. Press second bearing into roller housing pressing equally on inner and outer races until the inner race comes in contact with the bearing spacer.
2. Install roller assembly to deck frame.

NOTE: Securing roller assembly with a gap larger than 0.060 inch (1.5 mm) creates a side load on bearings and can lead to premature bearing failure.

3. Verify that there is no more than a 0.060 inch (1.5 mm) gap between roller assembly and the roller mount brackets of the deck frame. If this gap is larger than 0.060 inch (1.5 mm), shim excess clearance with 5/8" washers.

4. Insert mounting bolt and tighten to **65 to 95 ft-lb (89 to 128 N-m)**.

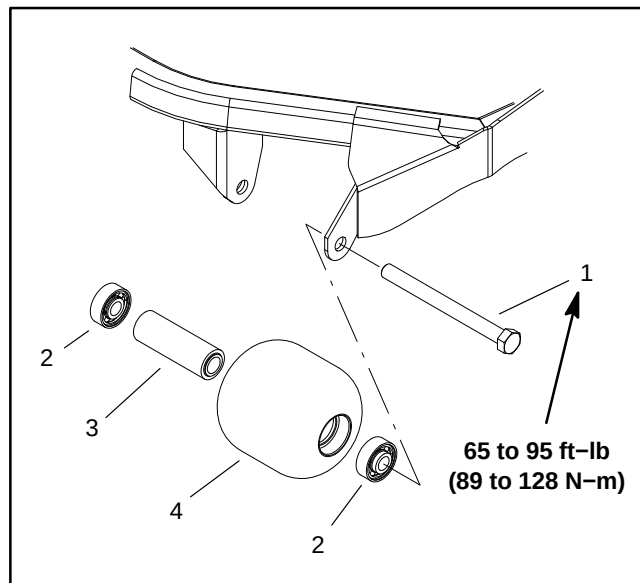


Figure 18

- | | |
|------------------|-------------------|
| 1. Mounting bolt | 3. Bearing spacer |
| 2. Bearing | 4. Front roller |

Cutting Deck Carrier Frame

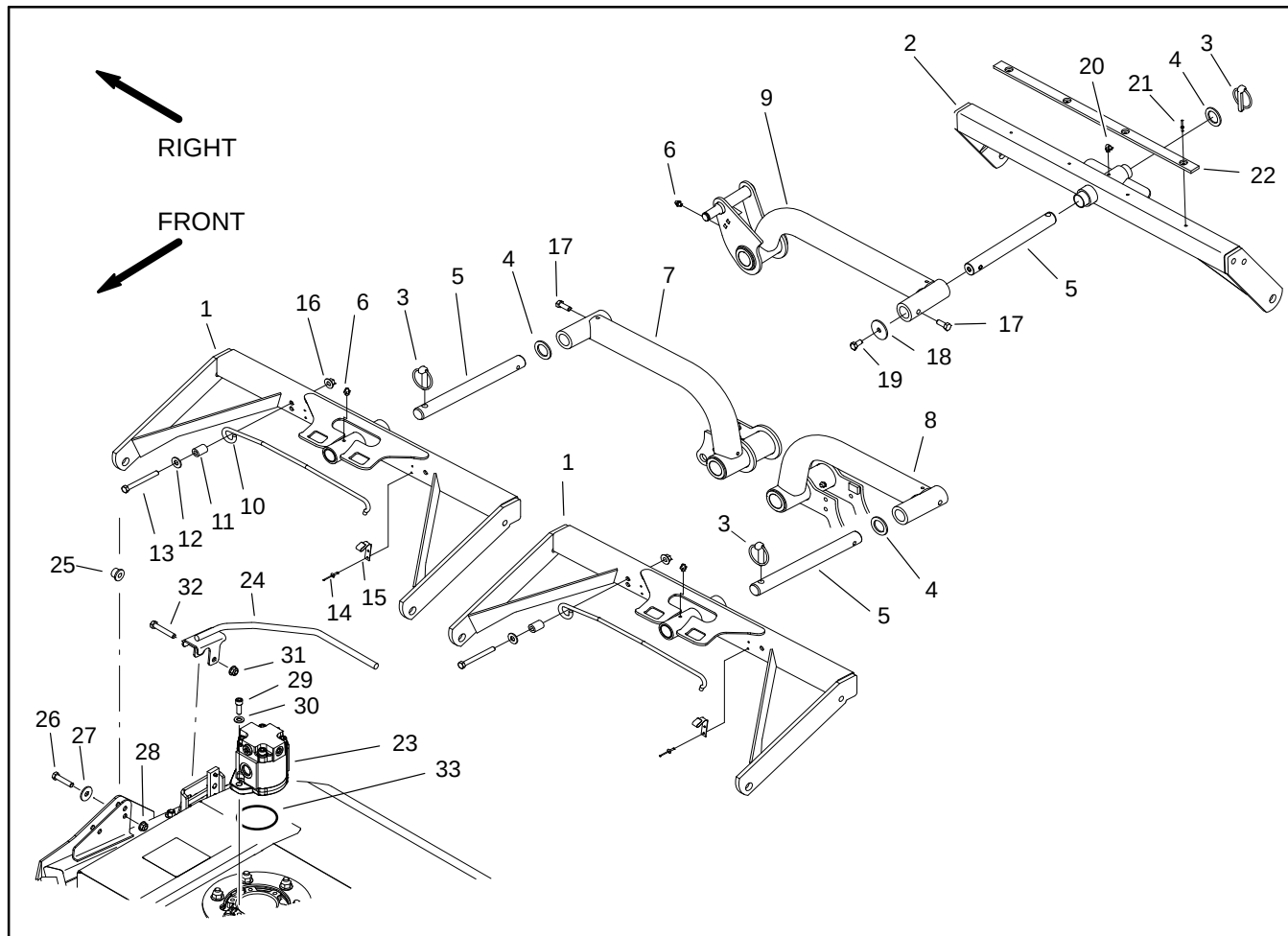


Figure 19

- | | | |
|-------------------------|---------------------|---------------------|
| 1. Front carrier frame | 12. Hardened washer | 23. Deck motor |
| 2. Rear carrier frame | 13. Cap screw | 24. Foot guard |
| 3. Lynch pin | 14. Pop rivet | 25. Flange bushing |
| 4. Thrust washer | 15. Rod clip | 26. Cap screw |
| 5. Pivot pin | 16. Cap screw | 27. Hardened washer |
| 6. Grease fitting | 17. Cap screw | 28. Flange nut |
| 7. Front right lift arm | 18. Rebound washer | 29. Cap screw |
| 8. Front left lift arm | 19. Cap screw | 30. Flat washer |
| 9. Rear lift arm | 20. Grease fitting | 31. Flange nut |
| 10. Latch rod | 21. Pop rivet | 32. Cap screw |
| 11. Latch tube | 22. Wear strip | 33. O-Ring |

Each cutting deck is suspended from a carrier frame. The cutting deck carrier frame is attached to the lift arm and allows the cutting deck to pivot on the lift arm pivot shaft.

Carrier frames are secured to the lift arm pivot shaft with a lynch pin. The front cutting decks are pushed by the traction unit and have a thrust washer between the carrier frame and the lift arm. The rear cutting deck is pulled by the traction unit and has a thrust washer between the carrier frame and the lynch pin.

Removal and Installation (Fig. 19)

1. Position the machine on a level surface, lower the cutting decks to the floor, shut the engine off, and engage the parking brake.

IMPORTANT: Support the cutting deck hydraulic motor when removed from the deck. Do not allow the hydraulic motor to hang from the hydraulic hoses.

2. Disconnect and remove the hydraulic motor from the deck (Fig. 20). Cover the top of the spindle to prevent contamination.

3. Remove the lynch pin securing the deck carrier frame to the lift arm pin (Fig. 21).

4. Roll the cutting deck away from the traction unit.

Installation (Fig. 19)

1. Position machine on a level surface and shut engine off.

2. Move cutting deck into position near lift arm.

3. Slide deck carrier frame onto lift arm pivot pin. Secure with lynch pin (Fig. 21).

4. Install the hydraulic motor to the deck (Fig. 20). Make sure that the O-ring is in position and not damaged.

5. Grease the spindle.

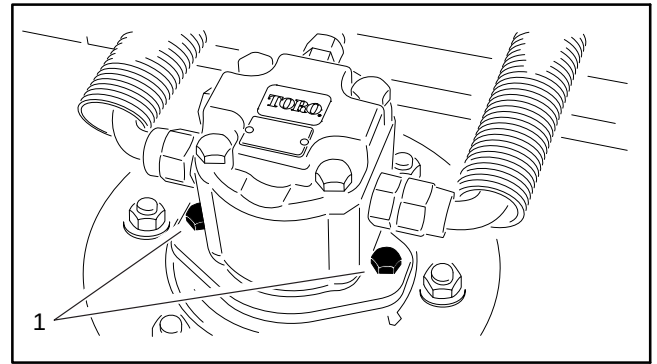


Figure 20

1. Motor mounting screws

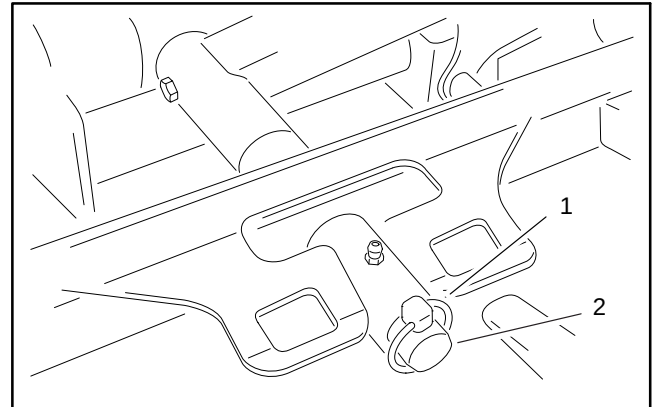


Figure 21

1. Lynch pin

2. Lift arm pivot pin

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Foldout Drawings

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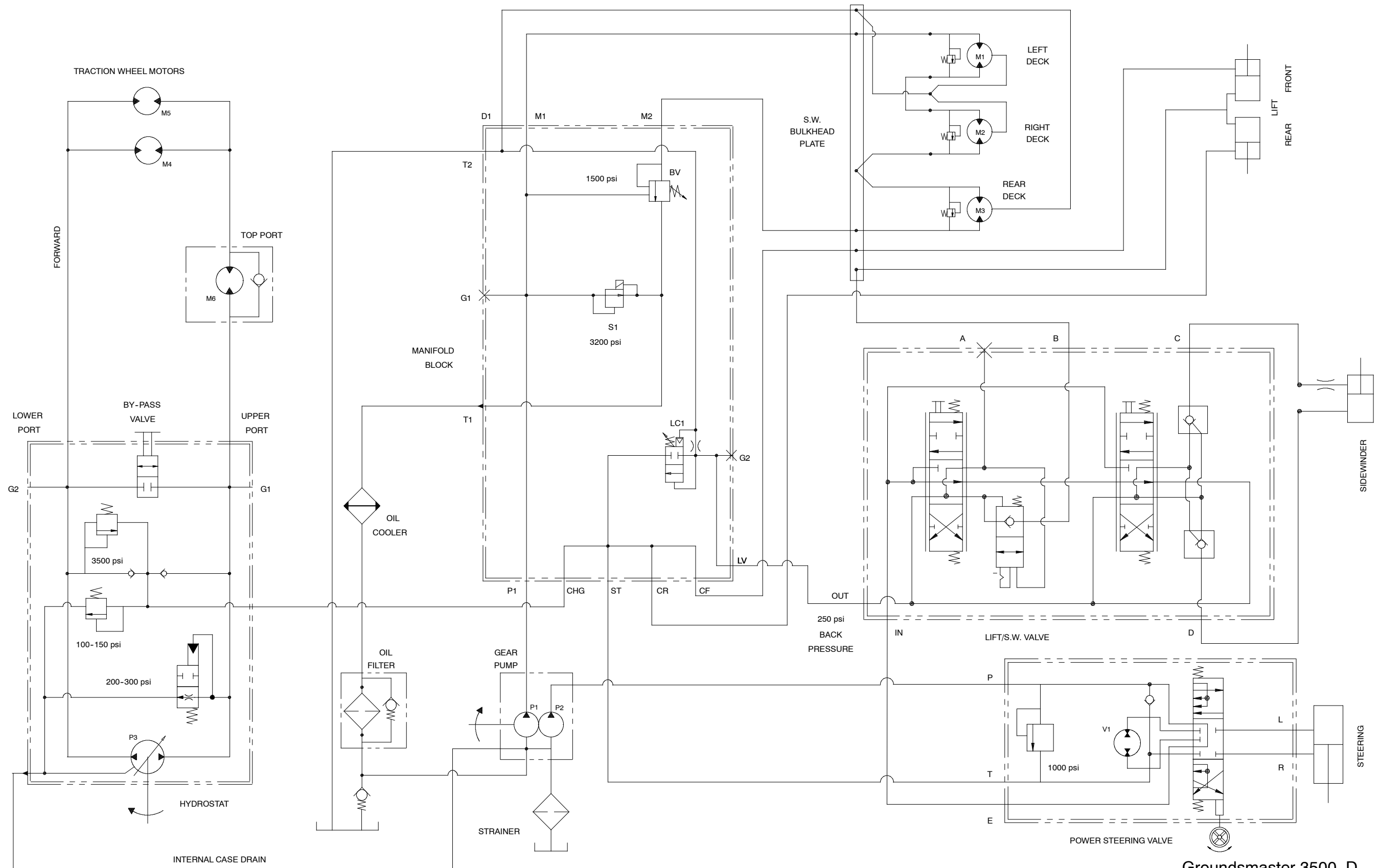
Electrical Drawing Designations

The following abbreviations are used for wire harness colors on the electrical schematics and wire harness drawings in this chapter.

<u>ABBREVIATION</u>	<u>COLOR</u>
BK	BLACK
BR or BN	BROWN
BU	BLUE
GN	GREEN
GY	GRAY
OR	ORANGE
PK	PINK
R or RD	RED
T	TAN
VIO	VIOLET
W or WH	WHITE
Y or YE	YELLOW

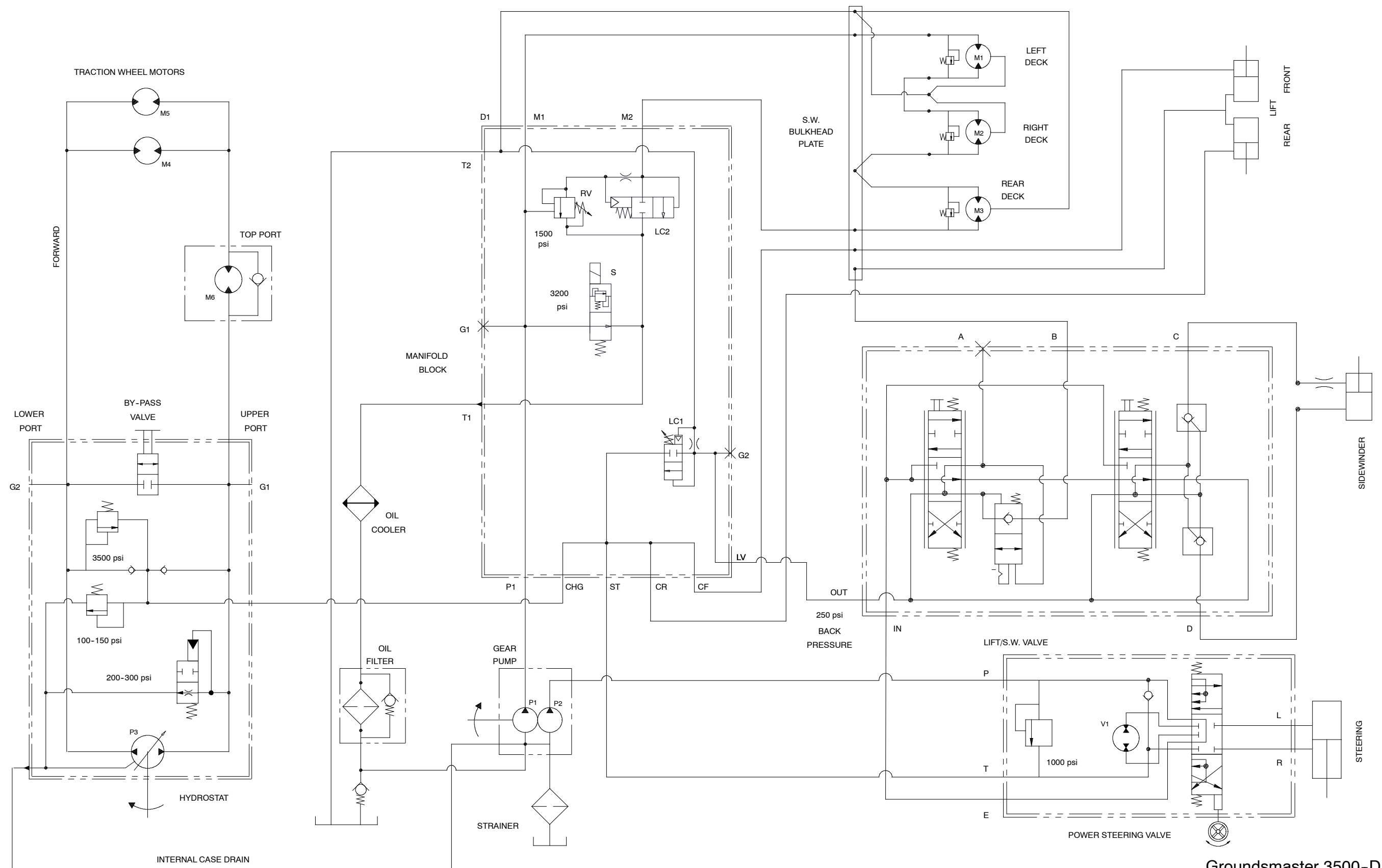
Numerous harness wires used on Groundsmaster machines include a line with an alternate color. These wires are identified with the wire color and line color with either a / or _ separating the color abbreviations listed above (e.g. R/BK is a red wire with a black line, OR_BK is an orange wire with a black line).

NOTE: 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).



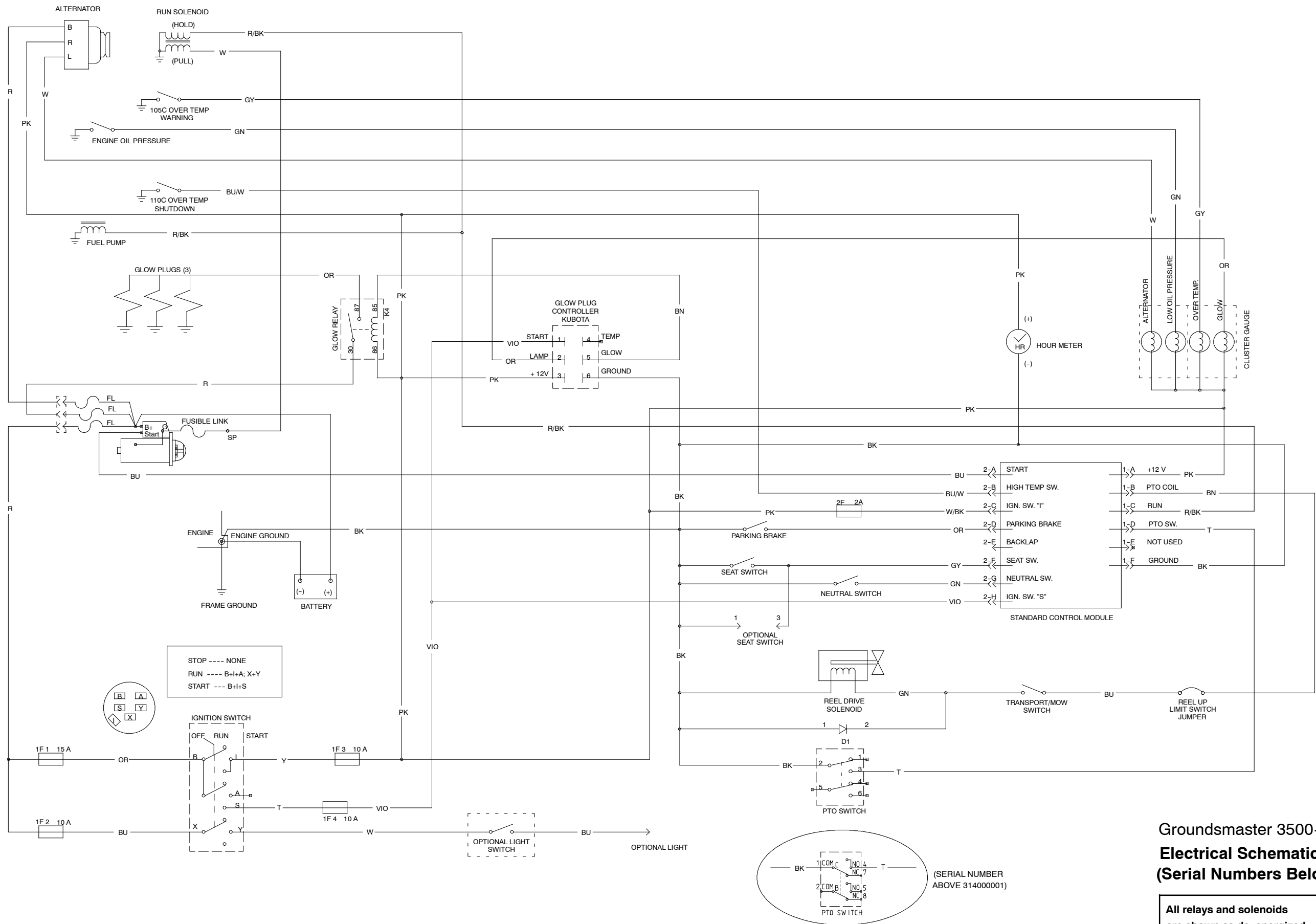
Groundmaster 3500-D
(Units Prior to Serial No. 314000001)
Hydraulic Schematic

All relays and solenoids
are shown as de-energized.



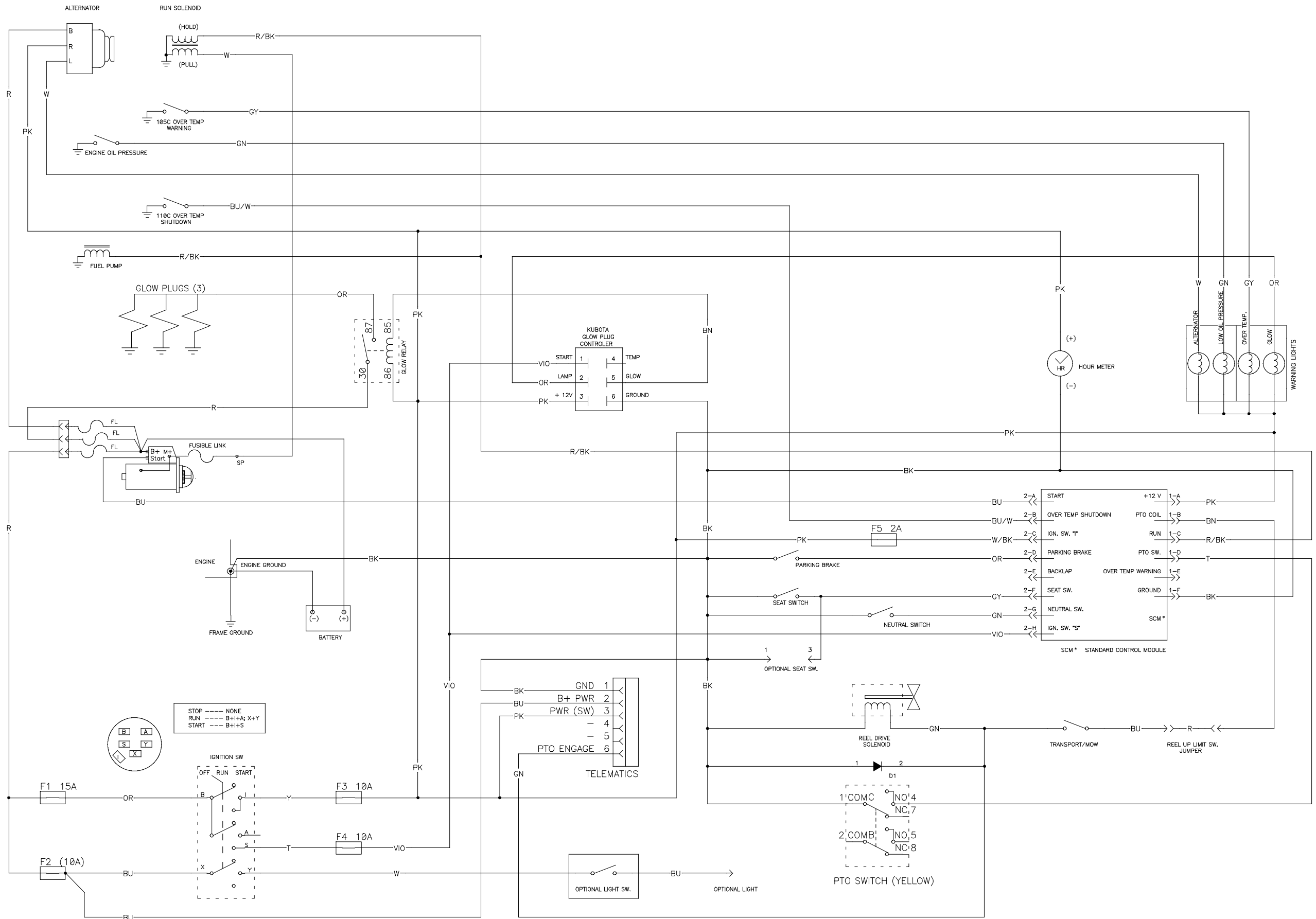
Groundmaster 3500-D
(Unit Serial No. 314000001 & Up)
Hydraulic Schematic

All relays and solenoids
are shown as de-energized.



Groundsmaster 3500-D
Electrical Schematic
(Serial Numbers Below 403440000)

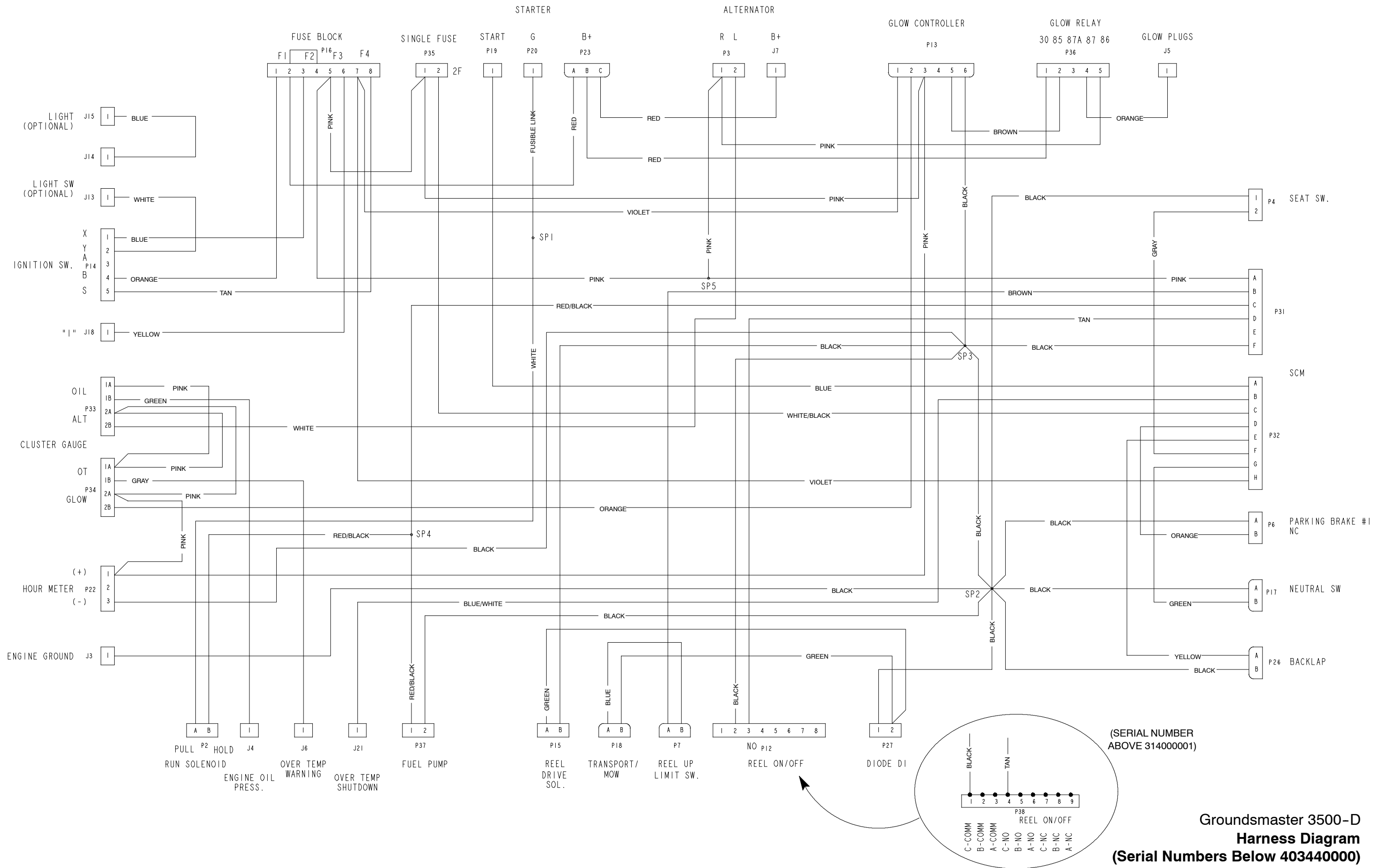
All relays and solenoids
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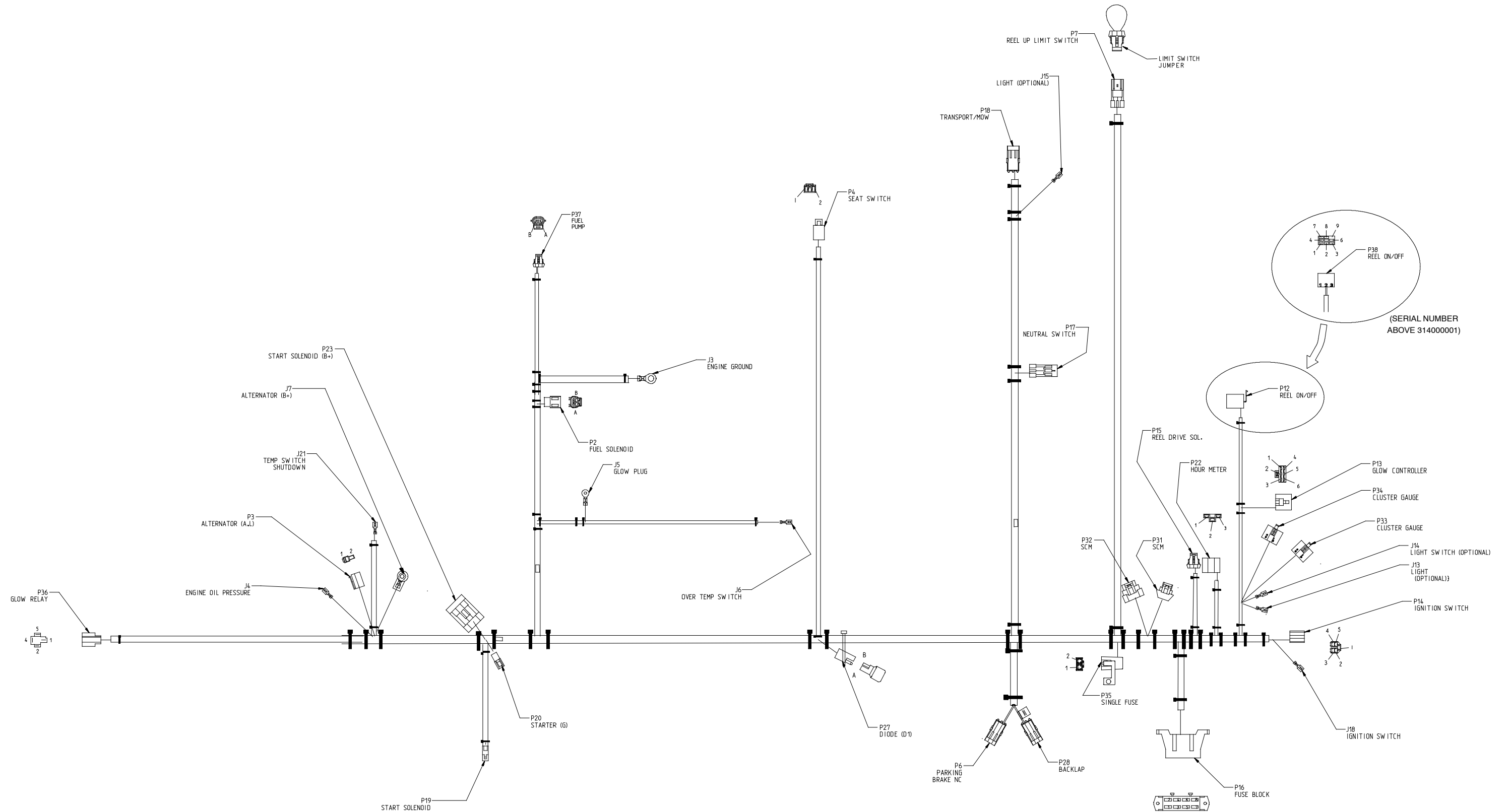


122-1521 Rev. A
 Groundsmaster 3500-D

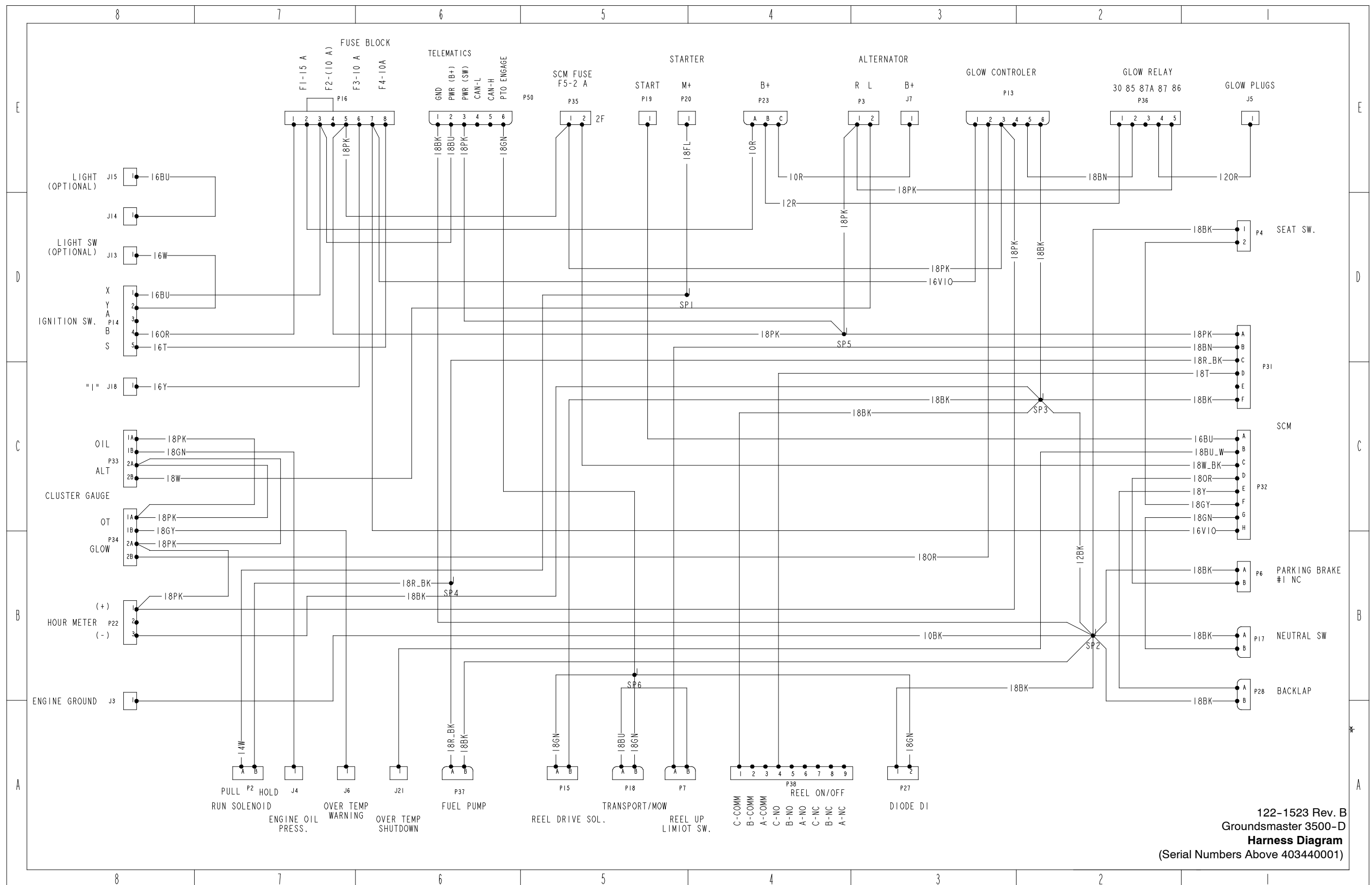
Electrical Schematic

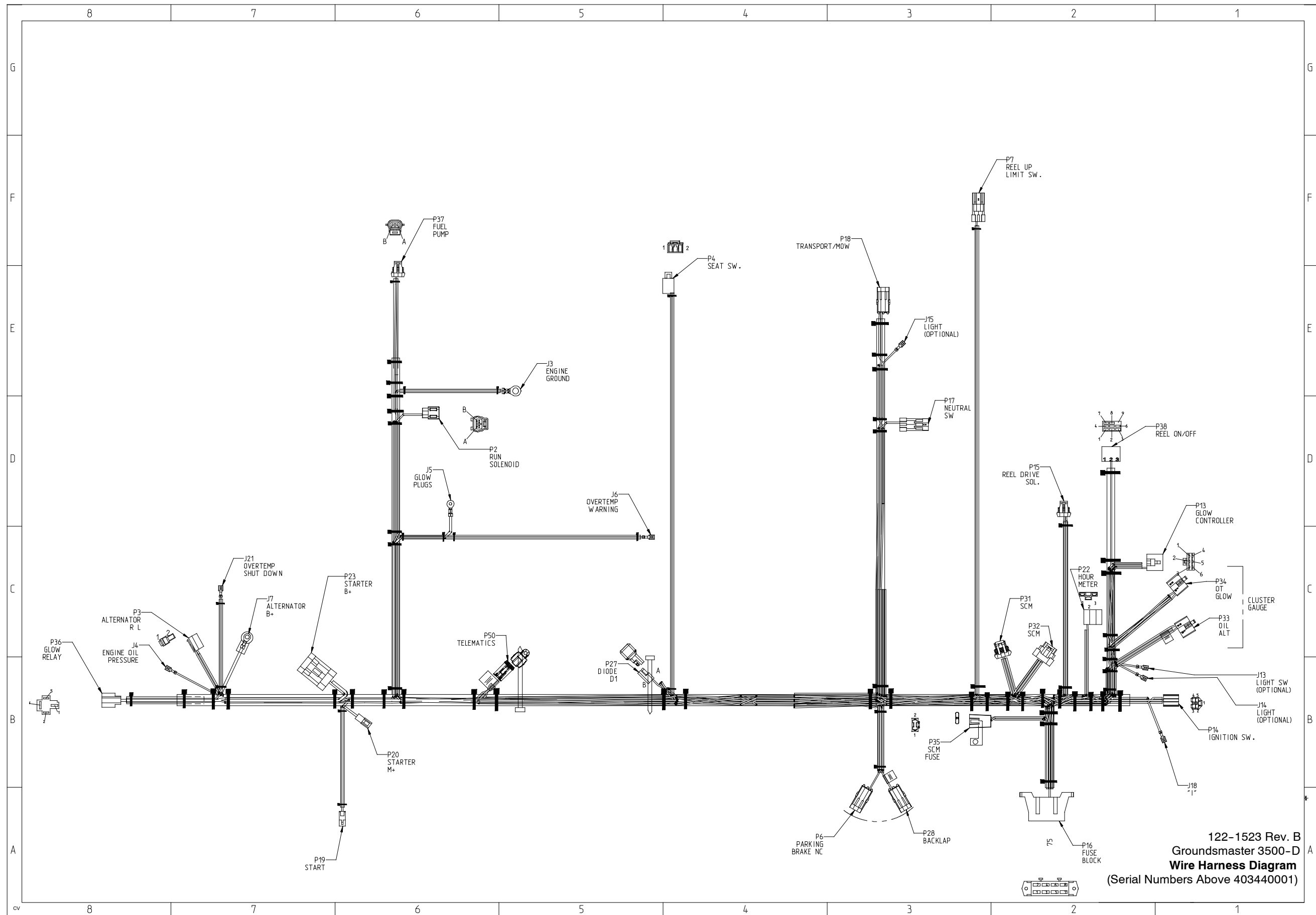
(Serial Numbers Above 403440001)
 (All relays and solenoids are shown as de-energized)

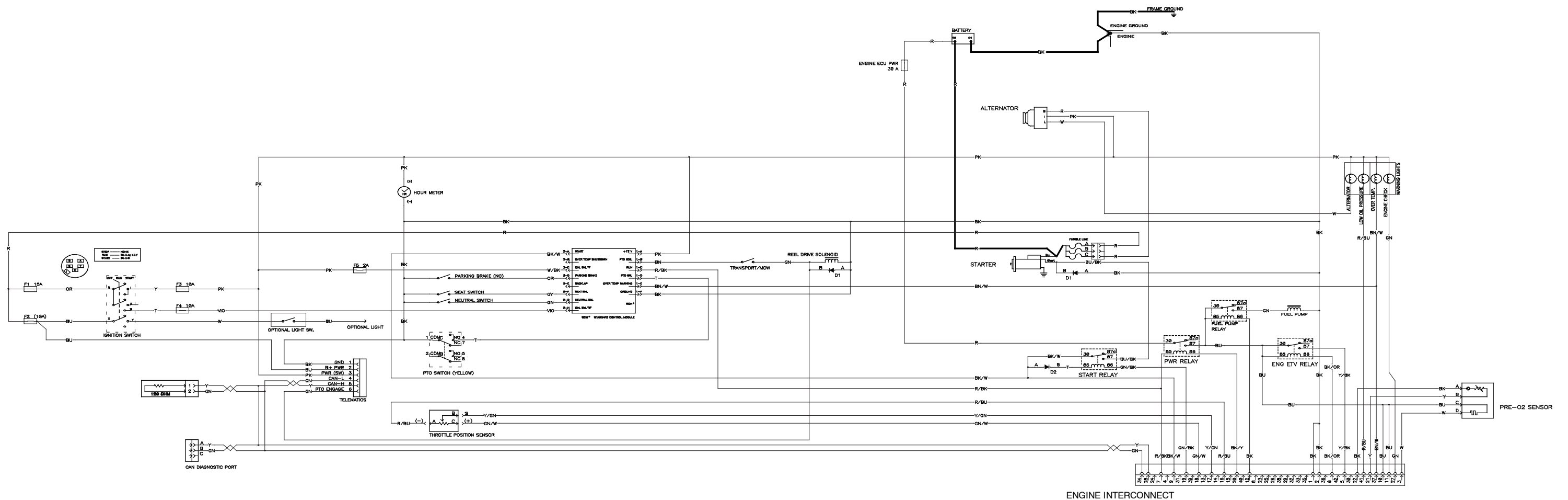




Groundsmaster 3500-D
 Harness Drawing
 (Serial Numbers Below 403440000)

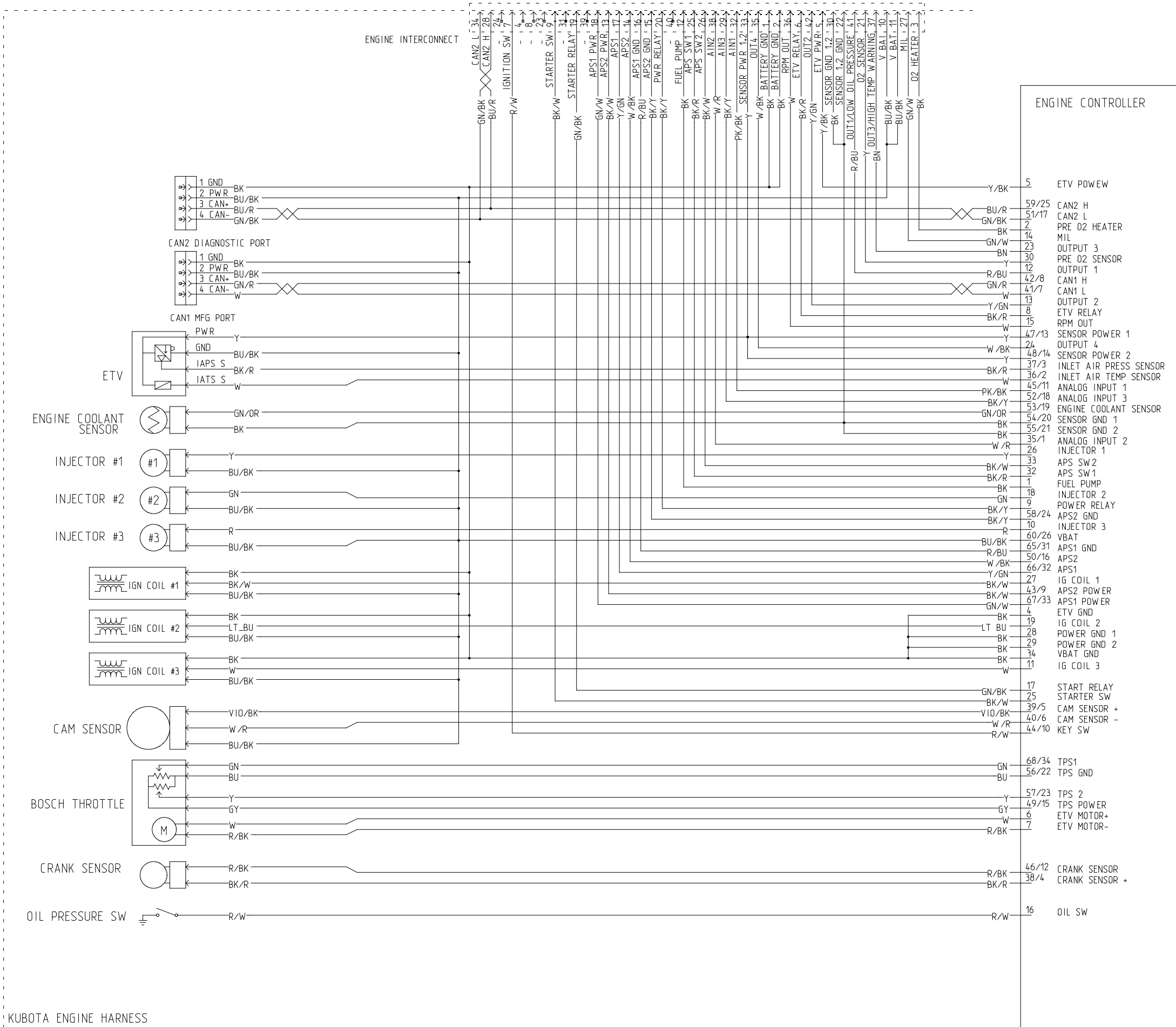


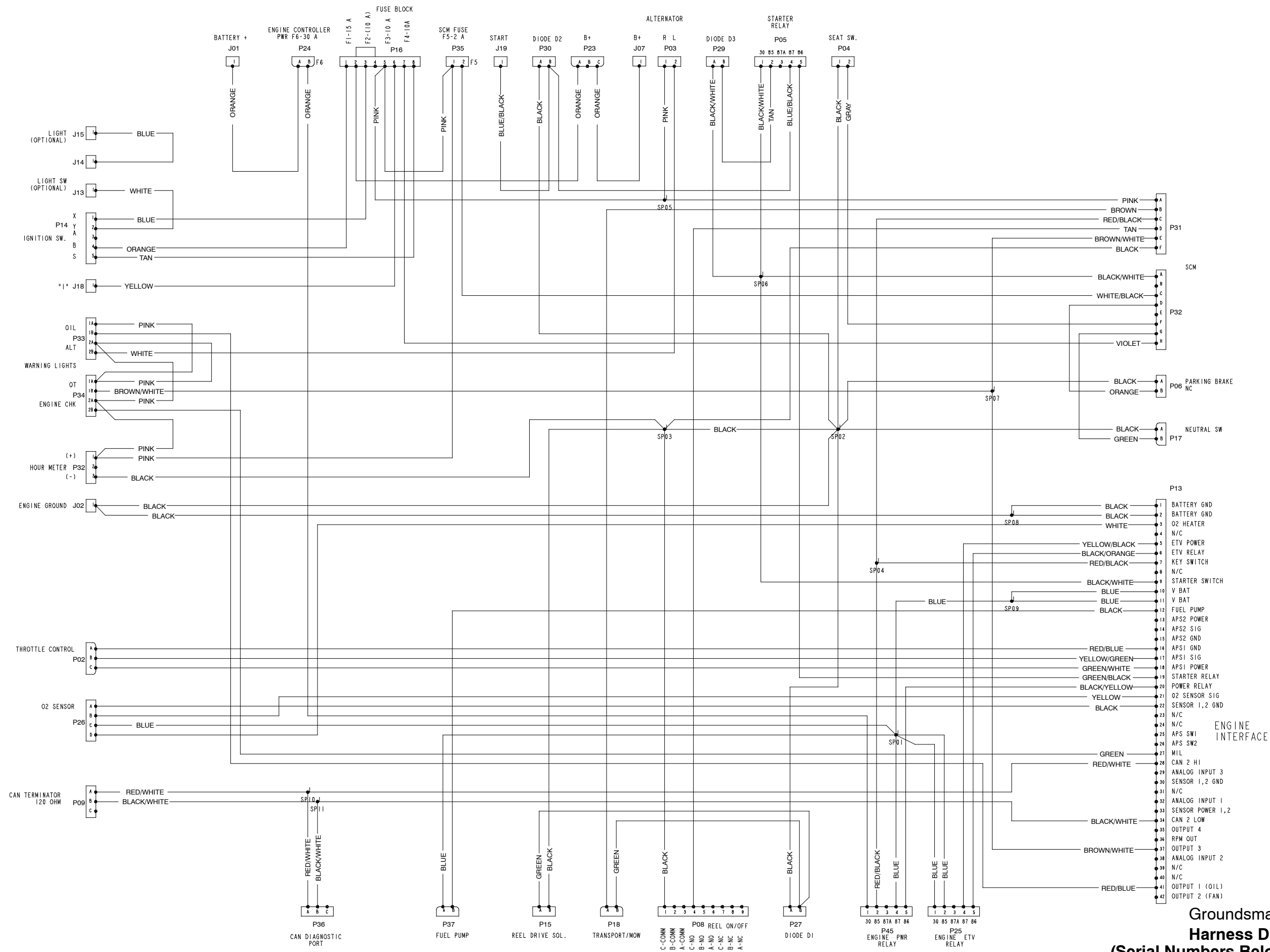




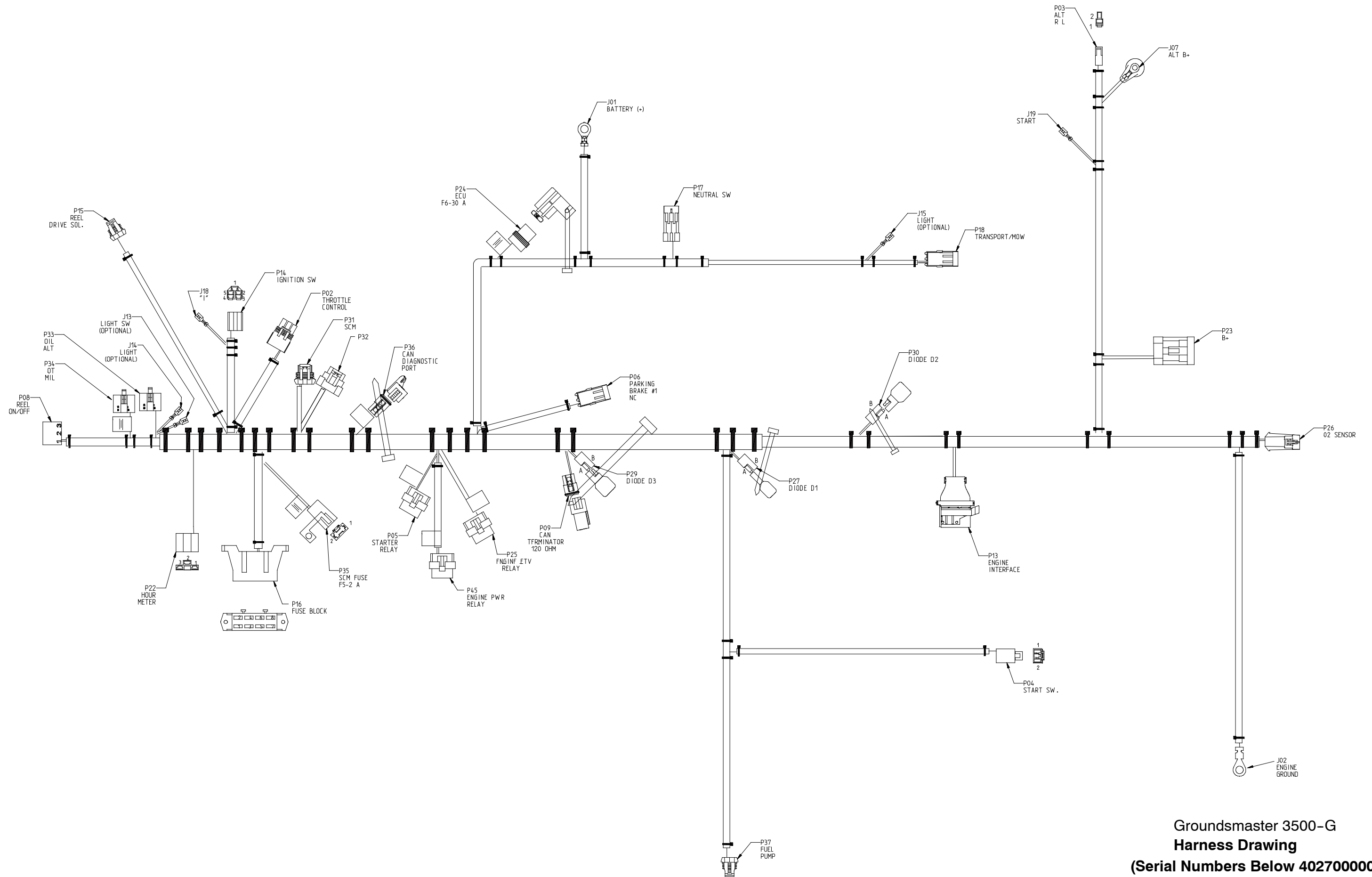
122-1552 Rev A
Groundsmaster 3500-G
Electrical Schematic (sheet 1 of 2)

All relays and solenoids
 are shown as de-energized.



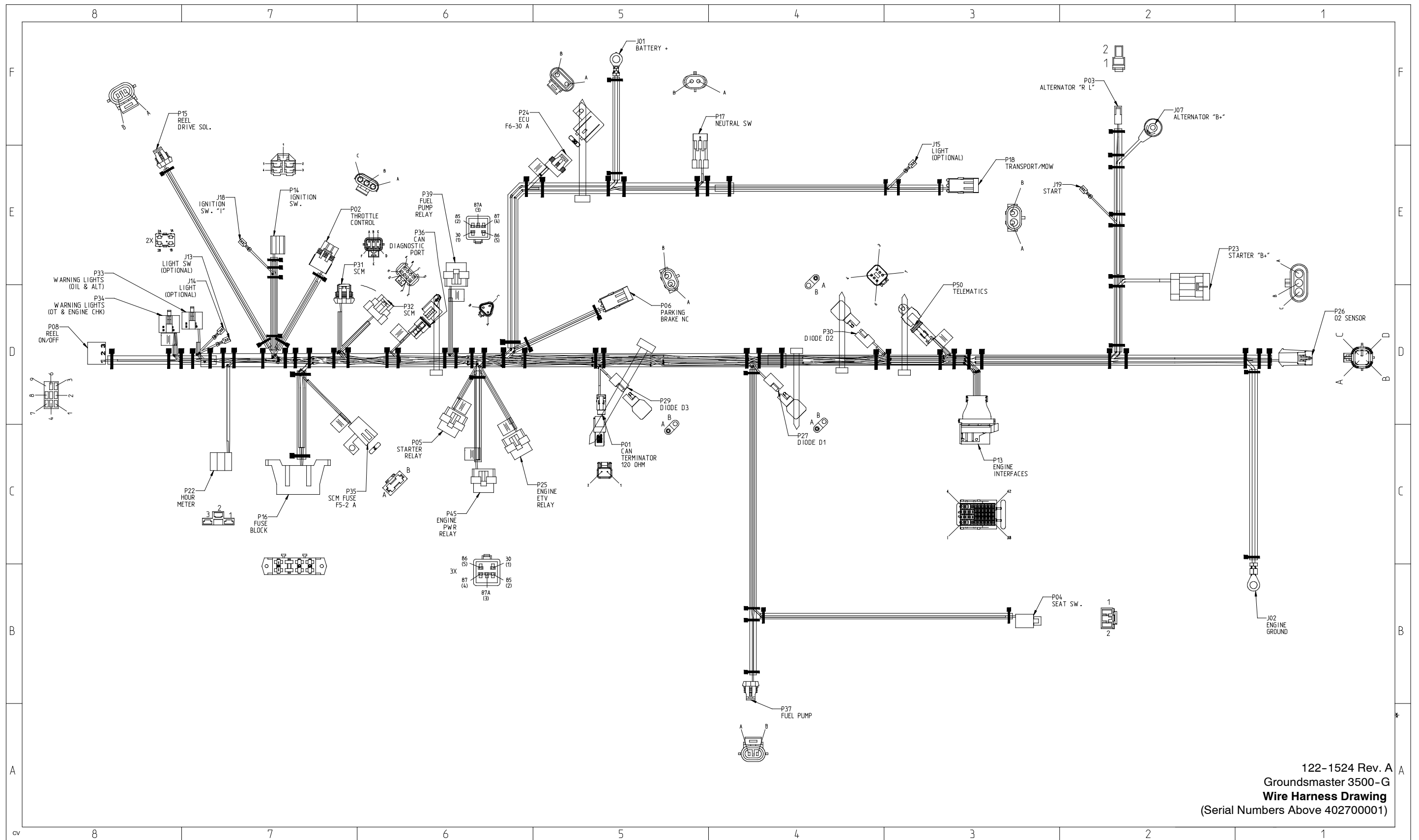


Groundmaster 3500-G
Harness Diagram
(Serial Numbers Below 402700000)



Groundsmaster 3500-G
Harness Drawing
 (Serial Numbers Below 402700000)





122-1524 Rev. A
Groundsmaster 3500-G
Wire Harness Drawing
(Serial Numbers Above 402700001)