

TORO[®]

Count on it.

Service Manual

Groundsmaster[®] 4500-D/4700-D

Revision History

Reader Comments

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

or Mail to:

**Technical Publication Manager, Commercial
The Toro Company
8111 Lyndale Avenue South
Bloomington, MN 55420-1196
Phone: +1 952-887-8495**

NOTES



Service Manual

Groundsmaster® 4500-D/4700-D

Preface

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

REFER TO THE TRACTION UNIT AND CUTTING UNIT OPERATOR'S MANUALS FOR OPERATING, MAINTENANCE, AND ADJUSTMENT INSTRUCTIONS. Space is provided in Chapter 2 of this book to insert the Operator's Manuals and Parts Catalogs for your machine. Replacement Operator's Manuals and Parts Catalogs are available on the internet at www.Toro.com or by sending complete Model and Serial Number to:

The Toro Company
Attn. Technical Publications
8111 Lyndale Avenue South
Bloomington, MN 55420-1196

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



This safety symbol means DANGER, WARNING, or CAUTION, PERSONAL SAFETY INSTRUCTION. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions may result in personal injury.

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

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



This page is intentionally blank.

Table Of Contents

Chapter 1 - Safety

General Safety Instructions	1 - 2
Jacking Instructions	1 - 4
Safety and Instruction Decals	1 - 5

Chapter 2 - Product Records and Maintenance

Product Records	2 - 1
Maintenance	2 - 1
Equivalents and Conversions	2 - 2
Torque Specifications	2 - 3

Chapter 3 - Kubota Diesel Engine

General Information	3 - 2
Specifications	3 - 3
Adjustments	3 - 4
Service and Repairs	3 - 5
KUBOTA WORKSHOP MANUAL, DIESEL ENGINE, V2003-T SERIES	

Chapter 4 - Hydraulic System

Specifications	4 - 2
General Information	4 - 3
Hydraulic Schematics	4 - 6
Hydraulic Flow Diagrams	4 - 8
Special Tools	4 - 20
Troubleshooting	4 - 22
Testing	4 - 25
Service and Repairs	4 - 52

Chapter 5 - Electrical System

Electrical Schematics and Electrical Harness and Connectors Drawings	5 - 2
Special Tools	5 - 2
Troubleshooting	5 - 3
Electrical System Quick Checks	5 - 6
Component Testing	5 - 7
Service and Repairs	5 - 27

Chapter 6 - Axles, Planetaries, and Brakes

Specifications	6 - 2
Adjustments	6 - 3
Service and Repairs	6 - 4

Chapter 7 - Chassis

General Information	7 - 1
Service and Repairs	7 - 2

Chapter 8 - Cutting Units

Specifications	8 - 2
Troubleshooting	8 - 3
Special Tools	8 - 4
Adjustments	8 - 5
Service and Repairs	8 - 8

Chapter 9 - Electrical Diagrams

Electrical Schematics	9 - 3
Circuit Diagrams	9 - 9
Wire Harness Drawings	9 - 14

This page is intentionally blank.



Chapter 1

Safety

Safety

Table of Contents

GENERAL SAFETY INSTRUCTIONS	2	JACKING INSTRUCTIONS	4
Before Operating	2	SAFETY AND INSTRUCTION DECALS	5
While Operating	2		
Maintenance and Service	3		

General Safety Instructions

The GROUNDSMASTER 4500-D/4700-D was tested and certified by TORO for compliance with the B71.4-1999 specifications of the American National Standards Institute. Although hazard control and accident prevention partially are dependent upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern, and proper training of the personnel involved in the operation, transport, maintenance, and storage of the machine. Improper use or maintenance of the machine can result in injury

Before Operating

1. Read and understand the contents of the Operator's Manual before starting and operating the machine. Become familiar with the controls and know how to stop the machine and engine quickly. A replacement Operator's Manual is available on the Internet at www.Toro.com or by sending the complete model and serial number to:

The Toro Company
Attn. Technical Publications
8111 Lyndale Avenue South
Bloomington, Minnesota 55420-1196

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

While Operating

1. Sit on the seat when starting and operating the machine.
2. Before starting the engine:
 - A. Engage the parking brake.
 - B. Make sure traction pedal is in neutral and the PTO switch is OFF (disengaged).
 - C. After engine is started, release parking brake and keep foot off traction pedal. Machine must not move. If movement is evident, the traction pedal linkage is adjusted incorrectly; therefore, shut engine off and adjust traction pedal linkage until machine does not move when traction pedal is released.
3. Do not run engine in a confined area without adequate ventilation. Exhaust fumes are hazardous and could possibly be deadly.
4. Do not touch engine, muffler or exhaust pipe while engine is running or soon after it is stopped. These areas could be hot enough to cause burns.

Safety

Page 1 - 2

Groundsmaster 4500-D/4700-D

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



WARNING

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

3. Assure interlock switches are adjusted correctly so engine cannot be started unless traction pedal is in NEUTRAL and cutting units are DISENGAGED.
4. Since diesel fuel is highly flammable, handle it carefully:
 - A. Use an approved fuel container.
 - B. Do not remove fuel tank cap while engine is hot or running.
 - C. Do not smoke while handling fuel.
 - D. Fill fuel tank outdoors and only to within an inch of the top of the tank, not the filler neck. Do not overfill.
 - E. Wipe up any spilled fuel.

5. Before getting off the seat:
 - A. Ensure that traction pedal is in neutral.
 - B. Set parking brake.
 - C. Disengage cutting units and wait for blades to stop.
 - D. Stop engine and remove key from switch.
 - E. Toro recommends that anytime the machine is parked (short or long term), the cutting units should be lowered to the ground. This relieves pressure from the lift circuit and eliminates the risk of cutting units accidentally lowering to the ground.
 - F. Do not park on slopes unless wheels are chocked or blocked.

Maintenance and Service

1. Before servicing or making adjustments, lower decks, stop engine, set parking brake, and remove key from the switch.
2. Make sure machine is in safe operating condition by keeping all nuts, bolts and screws tight.
3. Never store the machine or fuel container inside where there is an open flame, such as near a water heater or furnace.
4. Make sure all hydraulic line connectors are tight, and all hydraulic hoses and lines are in good condition before applying pressure to the system.
5. Keep body and hands away from pin hole leaks in hydraulic lines that eject high pressure hydraulic fluid. Use cardboard or paper to find hydraulic leaks. Hydraulic fluid escaping under pressure can penetrate skin and cause injury. Fluid accidentally injected into the skin must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.
6. Before disconnecting or performing any work on the hydraulic system, all pressure in system must be relieved by stopping engine and lowering cutting units to the ground.
7. If major repairs are ever needed or assistance is desired, contact an Authorized Toro Distributor.
8. To reduce potential fire hazard, keep engine area free of excessive grease, grass, leaves and dirt. Clean protective screen on machine frequently.
9. If engine must be running to perform maintenance or an adjustment, keep hands, feet, clothing, and other parts of the body away from cutting units and other moving parts. Keep bystanders away.
10. Do not overspeed the engine by changing governor setting. To assure safety and accuracy, check maximum engine speed.
11. Shut engine off before checking or adding oil to the crankcase.
12. Disconnect battery before servicing the machine. Disconnect negative battery cable first and positive cable last. If battery voltage is required for troubleshooting or test procedures, temporarily connect the battery. Reconnect positive cable first and negative cable last.
13. Battery acid is poisonous and can cause burns. Avoid contact with skin, eyes, and clothing. Protect your face, eyes, and clothing when working with a battery.
14. Battery gases can explode. Keep cigarettes, sparks, and flames away from the battery.
15. At the time of manufacture, the machine conformed to the safety standards for riding mowers. To assure optimum performance and continued safety certification of the machine, use genuine Toro replacement parts and accessories. Replacement parts and accessories made by other manufacturers may result in non-conformance with the safety standards, and the warranty may be voided.
16. When changing attachments, tires, or performing other service, use correct blocks, hoists, and jacks. Make sure machine is parked on a solid level floor such as a concrete floor. Prior to raising the machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands or 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 (see Jacking Instructions).

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 surface such as a concrete floor. Prior to raising machine, remove any attachments that may interfere with the safe and proper raising of the machine. Always chock or block wheels. Use jack stands or 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.

Jacking the Front End (Fig. 1)

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

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

2. Position jack securely under the frame, just to the inside of the front tire.
3. Jack front of machine off the ground.
4. Position jack stands or hardwood blocks under the frame as close to the wheels as possible to support the machine.

Jacking the Rear End (Fig. 2)

1. Set parking brake and chock both front tires to prevent the machine from moving.
2. Place jack securely under the center of rear axle.
3. Jack rear of machine off the ground.
4. Position jack stands or hardwood blocks under the rear axle to support the machine.

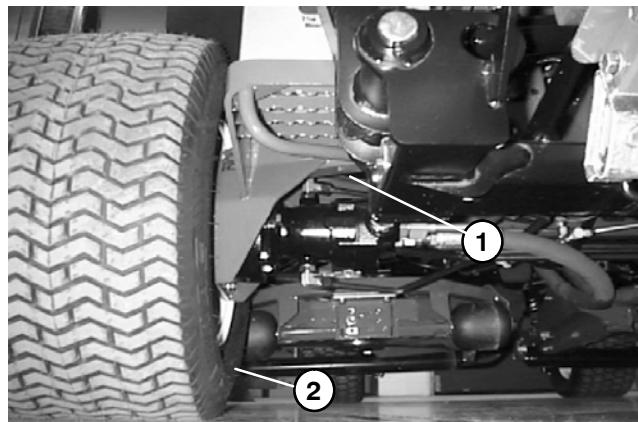


Figure 1

1. Frame

2. Front tire (RH shown)

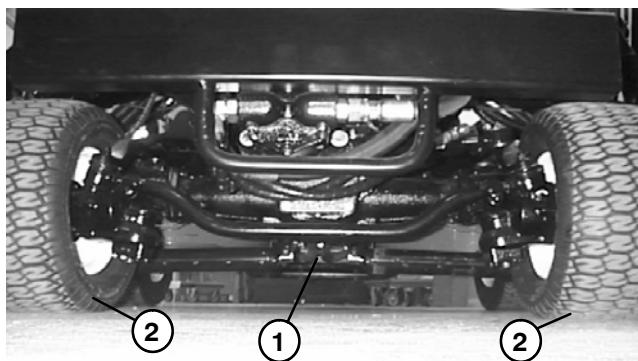


Figure 2

1. Rear axle

2. Rear tire

Safety and Instruction Decals

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

This page is intentionally blank.

Product Records and Maintenance

Table of Contents

PRODUCT RECORDS	1
MAINTENANCE	1
EQUIVALENTS AND CONVERSIONS	2
Decimal and Millimeter Equivalents	2
U.S. to Metric Conversions	2
TORQUE SPECIFICATIONS	3
Fastener Identification	3
Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Inch Series)	4
Standard Torque for Dry, Zinc Plated, and Steel Fasteners (Metric Fasteners)	5
Other Torque Specifications	6
Conversion Factors	6

Product Records

Insert Operator's Manual and Parts Catalog for your Groundsmaster 4500-D/4700-D at the end of this chapter. Additionally, if any optional equipment or accessories have been installed to your machine, insert the Installation Instructions, Operator's Manuals and Parts Catalogs for those options at the end of this chapter.

Maintenance

Maintenance procedures and recommended service intervals for the Groundsmaster 4500-D/4700-D are covered in the Operator's Manual. Refer to that publication when performing regular equipment maintenance.

Equivalents and Conversions

Decimal and Millimeter Equivalents

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

U.S.to Metric Conversions

	To Convert	Into	Multiply By
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 (e.g. 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

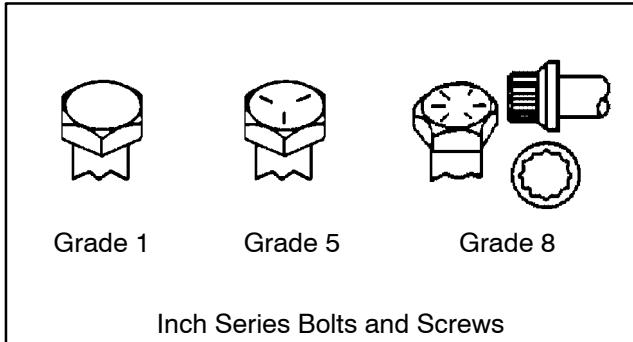


Figure 1

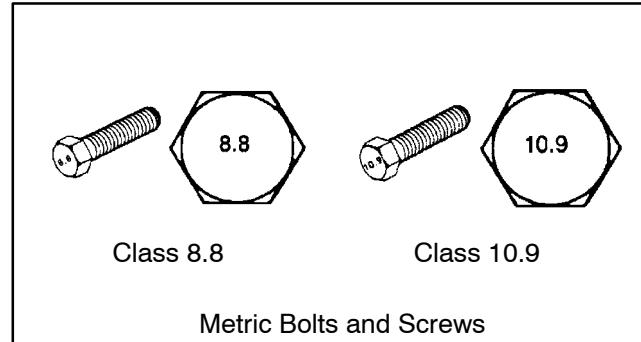


Figure 2

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 \pm 2	13 \pm 2	147 \pm 23	15 \pm 2	170 \pm 20	23 \pm 2	260 \pm 20
# 6 - 40 UNF				17 \pm 2	190 \pm 20	25 \pm 2	280 \pm 20
# 8 - 32 UNC	13 \pm 2	25 \pm 5	282 \pm 30	29 \pm 3	330 \pm 30	41 \pm 4	460 \pm 45
# 8 - 36 UNF				31 \pm 3	350 \pm 30	43 \pm 4	485 \pm 45
# 10 - 24 UNC	18 \pm 2	30 \pm 5	339 \pm 56	42 \pm 4	475 \pm 45	60 \pm 6	675 \pm 70
# 10 - 32 UNF				48 \pm 4	540 \pm 45	68 \pm 6	765 \pm 70
1/4 - 20 UNC	48 \pm 7	53 \pm 7	599 \pm 79	100 \pm 10	1125 \pm 100	140 \pm 15	1580 \pm 170
1/4 - 28 UNF	53 \pm 7	65 \pm 10	734 \pm 113	115 \pm 10	1300 \pm 100	160 \pm 15	1800 \pm 170
5/16 - 18 UNC	115 \pm 15	105 \pm 17	1186 \pm 169	200 \pm 25	2250 \pm 280	300 \pm 30	3390 \pm 340
5/16 - 24 UNF	138 \pm 17	128 \pm 17	1446 \pm 192	225 \pm 25	2540 \pm 280	325 \pm 30	3670 \pm 340
	ft-lb	ft-lb	N-m	ft-lb	N-m	ft-lb	N-m
3/8 - 16 UNC	16 \pm 2	16 \pm 2	22 \pm 3	30 \pm 3	41 \pm 4	43 \pm 4	58 \pm 5
3/8 - 24 UNF	17 \pm 2	18 \pm 2	24 \pm 3	35 \pm 3	47 \pm 4	50 \pm 4	68 \pm 5
7/16 - 14 UNC	27 \pm 3	27 \pm 3	37 \pm 4	50 \pm 5	68 \pm 7	70 \pm 7	95 \pm 9
7/16 - 20 UNF	29 \pm 3	29 \pm 3	39 \pm 4	55 \pm 5	75 \pm 7	77 \pm 7	104 \pm 9
1/2 - 13 UNC	30 \pm 3	48 \pm 7	65 \pm 9	75 \pm 8	102 \pm 11	105 \pm 10	142 \pm 14
1/2 - 20 UNF	32 \pm 3	53 \pm 7	72 \pm 9	85 \pm 8	115 \pm 11	120 \pm 10	163 \pm 14
5/8 - 11 UNC	65 \pm 10	88 \pm 12	119 \pm 16	150 \pm 15	203 \pm 20	210 \pm 20	285 \pm 27
5/8 - 18 UNF	75 \pm 10	95 \pm 15	129 \pm 20	170 \pm 15	230 \pm 20	240 \pm 20	325 \pm 27
3/4 - 10 UNC	93 \pm 12	140 \pm 20	190 \pm 27	265 \pm 25	359 \pm 34	375 \pm 35	508 \pm 47
3/4 - 16 UNF	115 \pm 15	165 \pm 25	224 \pm 34	300 \pm 25	407 \pm 34	420 \pm 35	569 \pm 47
7/8 - 9 UNC	140 \pm 20	225 \pm 25	305 \pm 34	430 \pm 45	583 \pm 61	600 \pm 60	813 \pm 81
7/8 - 14 UNF	155 \pm 25	260 \pm 30	353 \pm 41	475 \pm 45	644 \pm 61	660 \pm 60	895 \pm 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 \pm 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 \pm 5 in-lb	640 \pm 60 N-cm	78 \pm 7 in-lb	885 \pm 80 N-cm
M6 X 1.0	96 \pm 9 in-lb	1018 \pm 100 N-cm	133 \pm 13 in-lb	1500 \pm 150 N-cm
M8 X 1.25	19 \pm 2 ft-lb	26 \pm 3 N-m	27 \pm 2 ft-lb	36 \pm 3 N-m
M10 X 1.5	38 \pm 4 ft-lb	52 \pm 5 N-m	53 \pm 5 ft-lb	72 \pm 7 N-m
M12 X 1.75	66 \pm 7 ft-lb	90 \pm 10 N-m	92 \pm 9 ft-lb	125 \pm 12 N-m
M16 X 2.0	166 \pm 15 ft-lb	225 \pm 20 N-m	229 \pm 22 ft-lb	310 \pm 30 N-m
M20 X 2.5	325 \pm 33 ft-lb	440 \pm 45 N-m	450 \pm 37 ft-lb	610 \pm 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 \pm 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 \pm 20 in-lb	73 \pm 12 in-lb
5/16 - 18 UNC	215 \pm 35 in-lb	145 \pm 20 in-lb
3/8 - 16 UNC	35 \pm 10 ft-lb	18 \pm 3 ft-lb
1/2 - 13 UNC	75 \pm 15 ft-lb	50 \pm 10 ft-lb

Wheel Bolts and Lug Nuts

Thread Size	Recommended Torque**	
7/16 - 20 UNF Grade 5	65 \pm 10 ft-lb	88 \pm 14 N-m
1/2 - 20 UNF Grade 5	80 \pm 10 ft-lb	108 \pm 14 N-m
M12 X 1.25 Class 8.8	80 \pm 10 ft-lb	108 \pm 14 N-m
M12 X 1.5 Class 8.8	80 \pm 10 ft-lb	108 \pm 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 \pm 5 in-lb
No. 8 - 32 UNC	30 \pm 5 in-lb
No. 10 - 24 UNC	38 \pm 7 in-lb
1/4 - 20 UNC	85 \pm 15 in-lb
5/16 - 18 UNC	110 \pm 20 in-lb
3/8 - 16 UNC	200 \pm 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 \pm 5 in-lb
No. 8	15	18	30 \pm 5 in-lb
No. 10	12	16	38 \pm 7 in-lb
No. 12	11	14	85 \pm 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

$$\begin{aligned} \text{in-lb} \times 11.2985 &= \text{N-cm} \\ \text{ft-lb} \times 1.3558 &= \text{N-m} \end{aligned}$$

$$\begin{aligned} \text{N-cm} \times 0.08851 &= \text{in-lb} \\ \text{N-m} \times 0.7376 &= \text{ft-lb} \end{aligned}$$



Chapter 3

Kubota Diesel Engine

Table of Contents

GENERAL INFORMATION	2	Radiator	10
SPECIFICATIONS	3	Engine	12
ADJUSTMENTS	4	Engine Removal	13
Engine Run Solenoid	4	Engine Installation	14
SERVICE AND REPAIRS	5	Pump Adapter Plate	16
Air Filter System	5	KUBOTA WORKSHOP MANUAL, DIESEL ENGINE, V2003-T SERIES	
Exhaust System	6		
Fuel System	8		
Check Fuel Lines and Connections	8		
Drain and Clean Fuel Tank	8		
Fuel Tank Removal	9		
Fuel Tank Installation	9		

General Information

This Chapter gives information about specifications and repair of the diesel engine used in the Groundsmaster 4500-D/4700-D.

General maintenance procedures are described in your Traction Unit Operator's Manual. Information on engine troubleshooting, testing, disassembly and reassembly is identified in the Kubota Workshop Manual, Diesel Engine, V2003-T that is included at the end of this section.

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

tools are described in the Kubota Workshop Manual, Diesel Engine, V2003-T. The use of some specialized test equipment is explained. However, the cost of the test equipment and the specialized nature of some repairs may dictate that the work be done at an engine repair facility.

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

Specifications

Item	Description
Make / Designation	Kubota, 4-Cycle, 4 Cylinder, Water Cooled, Turbocharged, Diesel Engine
Horse Power	58 HP (43.3 kW) @ 2600 RPM
Bore mm (in.)	83.0 (3.27)
Stroke mm (in.)	92.4 (3.64)
Total Displacement cc (cu. in.)	1999 (122.12)
Firing Order	1-3-4-2
Combustion Chamber	Spherical Type
Fuel	No. 2 Diesel Fuel (ASTM D975)
Fuel Capacity liters (U.S. gallons)	79.5 (21.0)
Fuel Injection Pump	Bosch Type Mini Pump (PFR)
Governor	Centrifugal Mechanical
Low Idle (no load)	1300 ± 50 RPM
High Idle (no load)	2800 ± 50 RPM
Direction of Rotation	Counterclockwise (Viewed from Flywheel)
Compression Ratio	22.0:1
Injection Nozzle	Bosch Throttle Type
Engine Oil	SAE 10W30 or 10W40 Detergent (API CD, or higher)
Oil Pump	Trochoid Type
Crankcase Oil Capacity liters (U.S. quarts)	7.6 (8.0) with Filter
Starter	12 VDC, 1.4 kW
Alternator/Regulator	12 VDC, 40 AMP
Coolant Capacity liters (U.S. quarts)	10.4 (11) with 0.9 (1.0) Reservoir
Engine Dry Weight kilograms (U.S. pounds)	184 (406)

Adjustments

Engine Run Solenoid

1. When ignition switch is in the RUN position, the engine run solenoid should energize and position the fuel stop lever to within 1/16" (1.6 mm) of stop on the injection pump.
2. If adjustment is needed, loosen lock nut and rotate the threaded end of the swivel until the lever is properly positioned.
3. Tighten lock nut. Recheck adjustment.

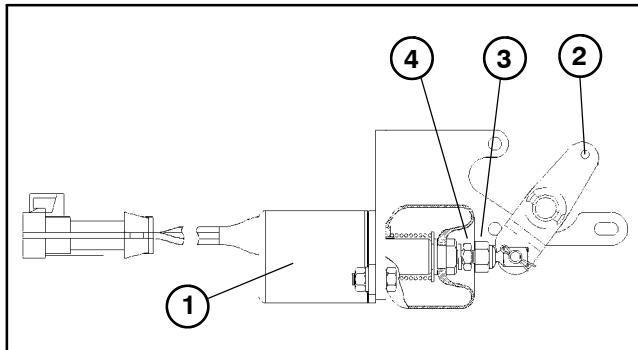


Figure 1

1. Run solenoid (ON)
2. Lever
3. Swivel
4. Lock nut

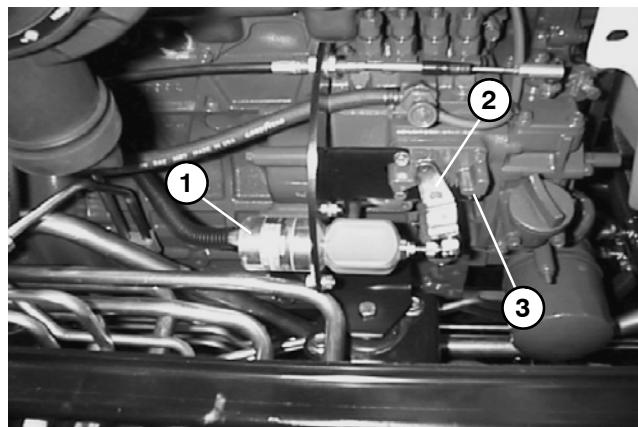


Figure 2

1. Run solenoid (OFF)
2. Solenoid lever
3. Injection pump stop

Service and Repairs

Air Filter System

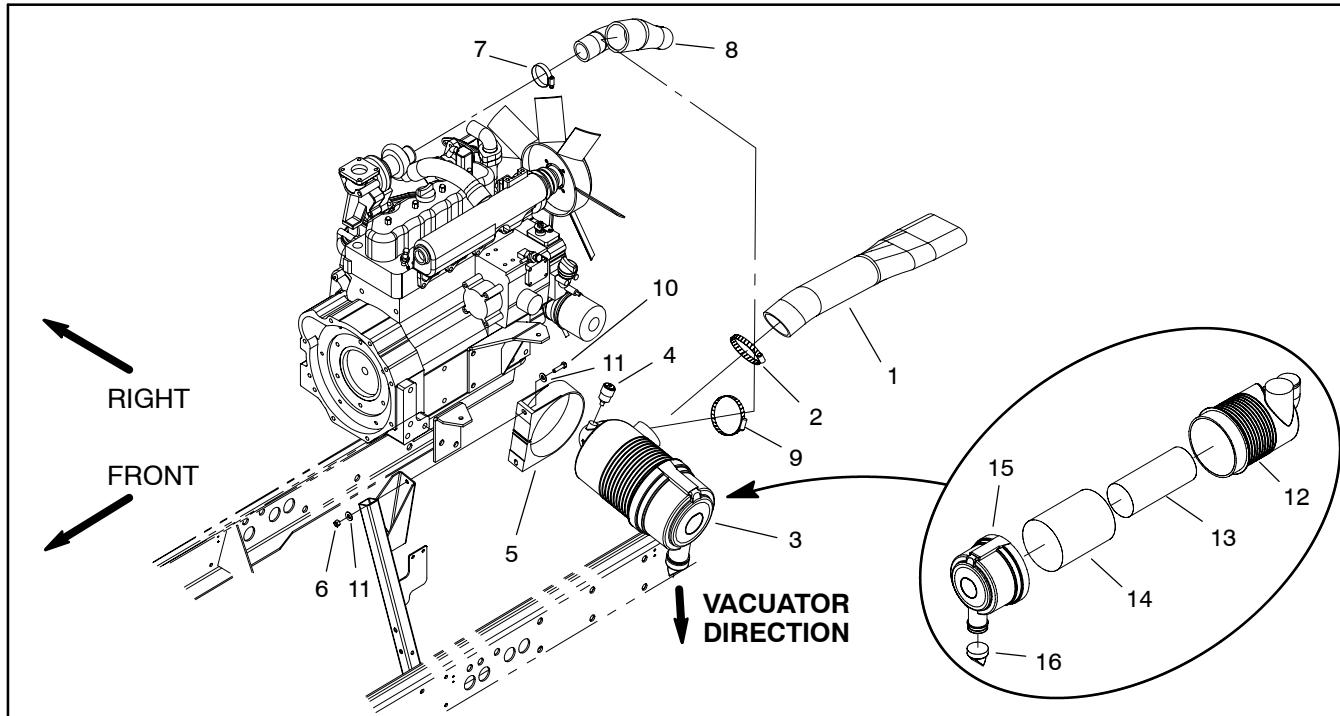


Figure 3

- 1. Air cleaner hose
- 2. Hose clamp
- 3. Air cleaner assembly
- 4. Service indicator
- 5. Air cleaner strap
- 6. Lock nut

- 7. Hose clamp
- 8. Air cleaner hose
- 9. Hose clamp
- 10. Cap screw
- 11. Flat washer

- 12. Air cleaner body
- 13. Filter element
- 14. Filter element
- 15. Air cleaner cover
- 16. Vacuator valve

Removal

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

Installation

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

1. Assemble air filter system using Figure 3 as a guide.

2. When installing air cleaner hose (8) between air cleaner and turbo-charger (Fig. 4):

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

B. Position hose to allow 5/16" (7.9 mm) clearance between air cleaner hose and muffler bracket.

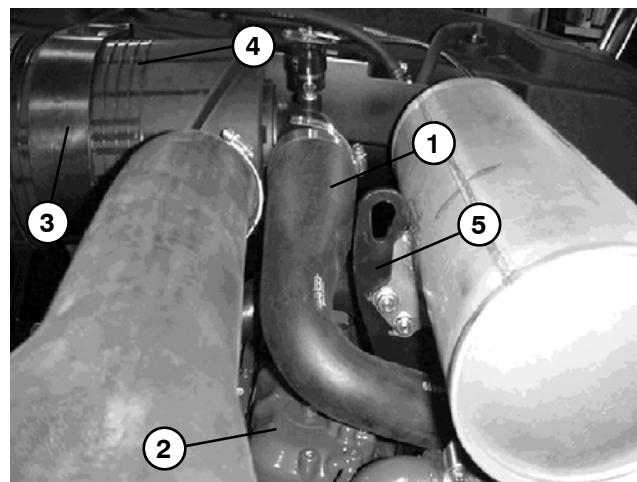


Figure 4

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

Exhaust System

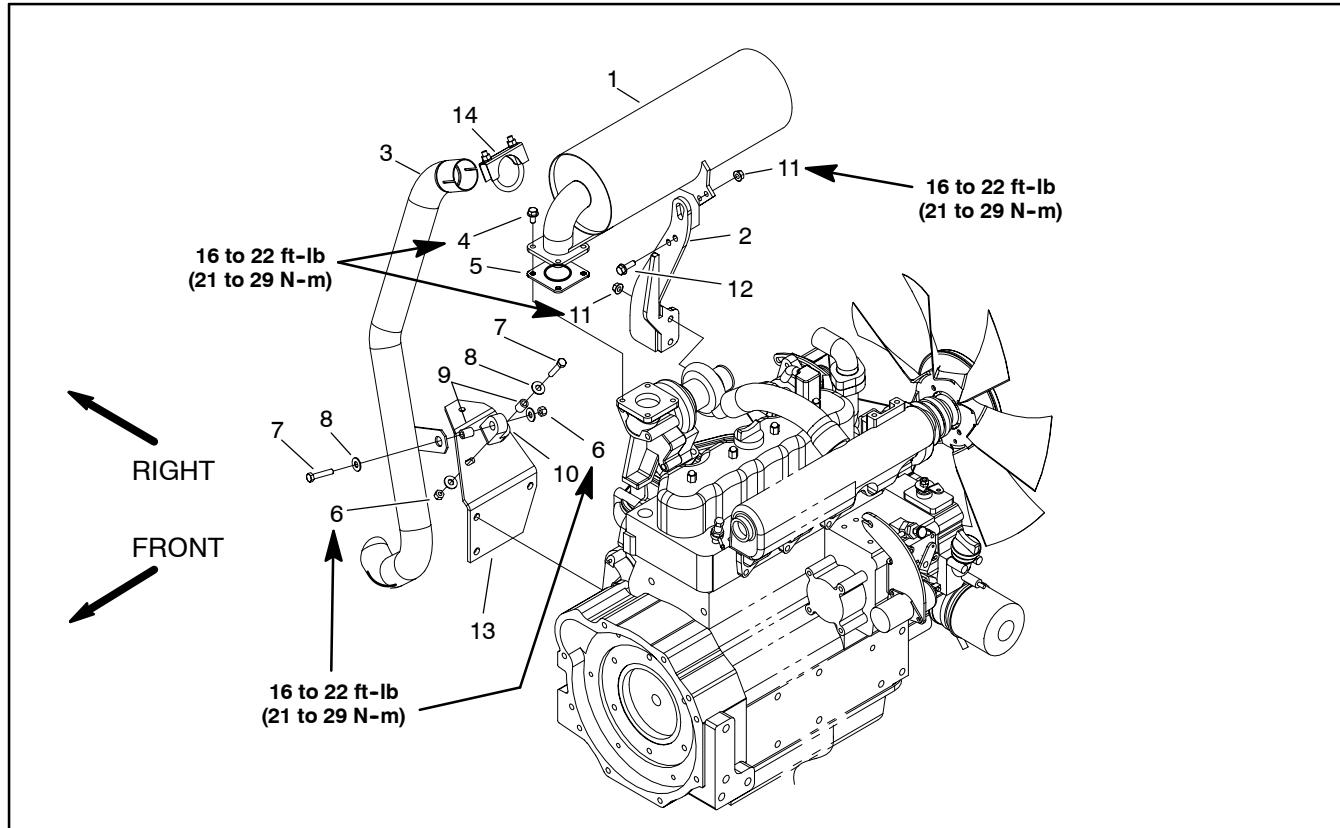


Figure 5

- | | | |
|-----------------------------|-------------------|-----------------------|
| 1. Muffler | 6. Lock nut | 11. Flange nut |
| 2. Muffler bracket/lift tab | 7. Cap screw | 12. Flange head screw |
| 3. Exhaust tailpipe | 8. Flat washer | 13. Engine mount |
| 4. Flange head screw | 9. Spacer | 14. Muffler clamp |
| 5. Exhaust gasket | 10. Rubber hanger | |

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.

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Remove muffler and/or muffler bracket from the engine as necessary using Figure 5 as a guide.

Installation

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

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

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

2. Install muffler and/or muffler bracket to the engine using Figure 5 as a guide. Hand tighten and then torque the following fasteners from 16 to 22 ft-lb (21 to 29 N-m) in the sequence listed (Fig. 6):

- A. Locknuts used on rubber hanger cap screws.
 - B. Flange nuts that secure muffler to muffler bracket.
 - C. Flange head screws that secure muffler flange to engine.
 - D. Flange nuts that secure muffler bracket to engine.
3. Adjust tailpipe so it has equal clearance between frame and engine before tightening muffler clamp.

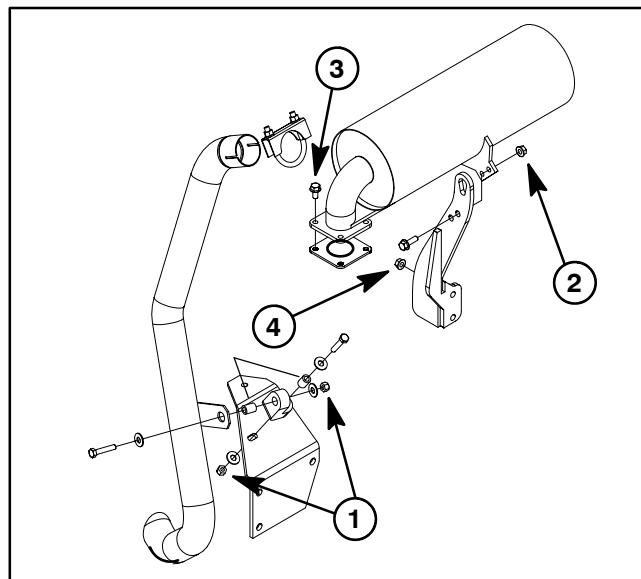


Figure 6

Fuel System

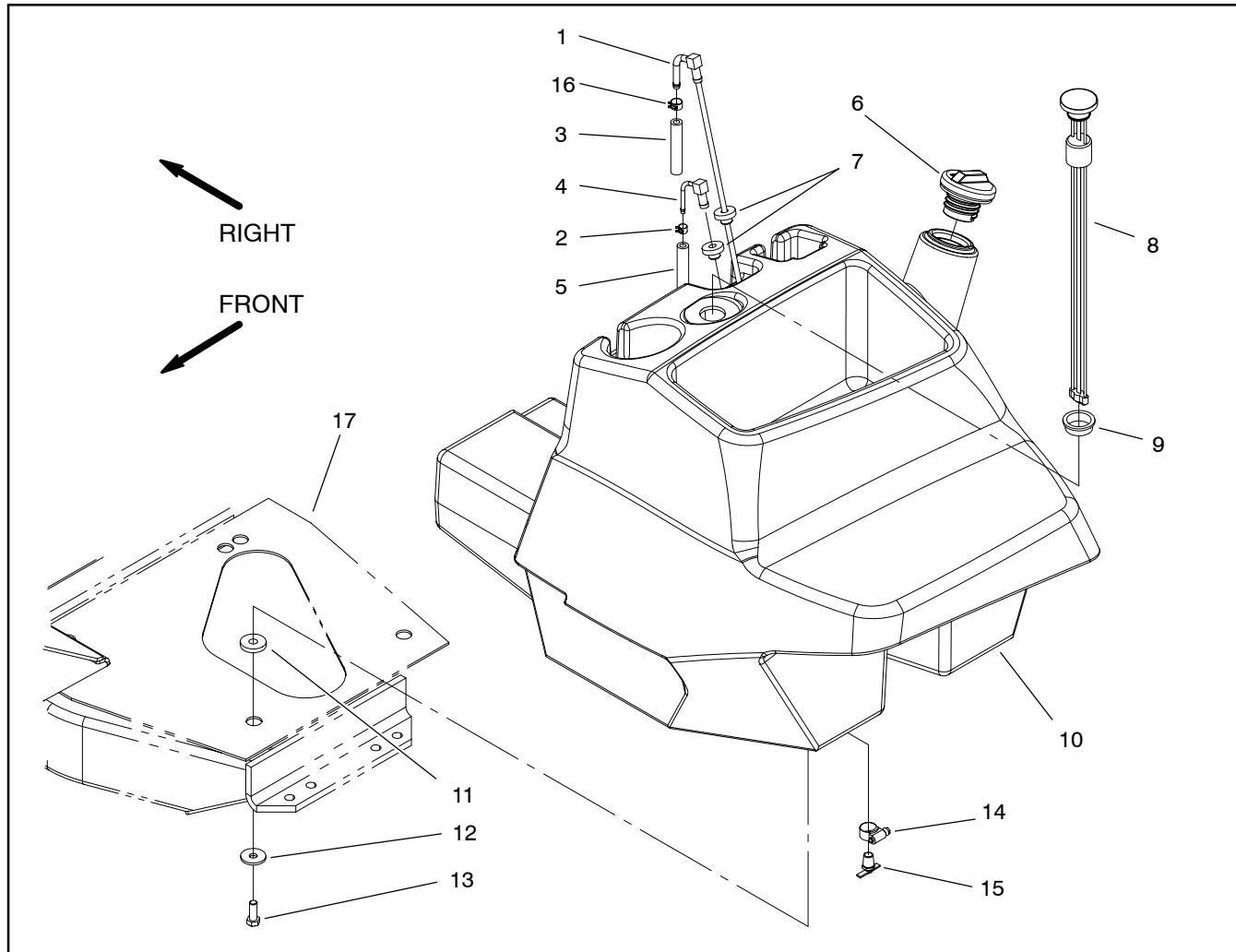


Figure 7

- | | | |
|--------------------|---------------------------------|------------------------|
| 1. Suction fitting | 7. Bushing | 13. Cap screw (4 used) |
| 2. Fuel line clamp | 8. Fuel level gauge | 14. Hose clamp |
| 3. Fuel hose | 9. Grommet | 15. Draincock |
| 4. Return fitting | 10. Fuel tank | 16. Hose clamp |
| 5. Fuel hose | 11. Tank mount grommet (4 used) | 17. Frame |
| 6. Fuel tank cap | 12. Flat washer (4 used) | |



DANGER

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

Check Fuel Lines and Connections

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

Drain and Clean Fuel Tank

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

Fuel Tank Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Disconnect fuel hoses from the suction and return fittings in top of tank.
3. Use draincock to empty fuel tank into a suitable container.
4. Remove fuel tank using Figure 7 as a guide.

Fuel Tank Installation

1. Install fuel tank to frame using Figure 7 as a guide.
2. Connect fuel hoses to the suction and return fittings in top of tank.
3. Make sure that draincock is closed.
4. Fill fuel tank (see Traction Unit Operator's Manual).

Radiator

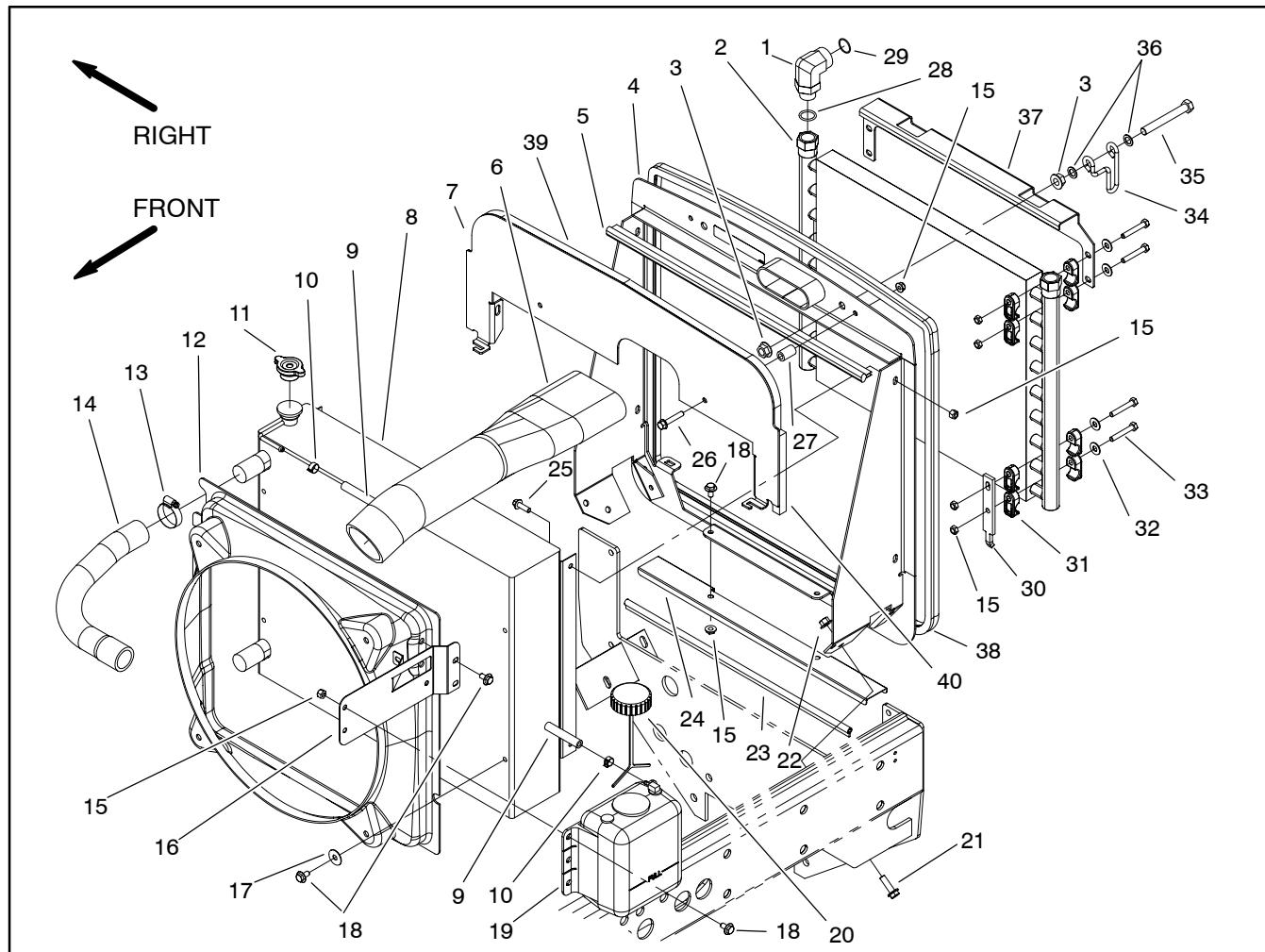


Figure 8

- | | | |
|-------------------------|-----------------------|------------------------------|
| 1. Hydraulic fitting | 15. Flange nut | 28. O-ring |
| 2. Oil cooler | 16. Tank bracket | 29. O-ring |
| 3. Flange nut | 17. Flat washer | 30. Oil cooler mount plate |
| 4. Radiator bracket | 18. Flange head screw | 31. Oil cooler clamp |
| 5. Bulb seal | 19. Coolant reservoir | 32. Flat washer |
| 6. Air cleaner hose | 20. Reservoir cap | 33. Cap screw |
| 7. Hood seal bracket | 21. Flange head screw | 34. Wire form clamp |
| 8. Radiator | 22. Flange nut | 35. Cap screw |
| 9. Reservoir hose | 23. Bulb seal | 36. Washer |
| 10. Hose clamp | 24. Bottom cover | 37. Oil cooler bracket (top) |
| 11. Radiator cap | 25. Flange head screw | 38. Bulb seal |
| 12. Radiator fan shroud | 26. Washer head screw | 39. Foam seal |
| 13. Clamp | 27. Spacer | 40. Foam seal |
| 14. Radiator hose | | |

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 (see Traction Unit Operator's Manual).



CAUTION

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

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

3. Remove radiator cap. Drain radiator into a suitable container using the coolant draincock. The coolant draincock and hose is attached to the engine oil filter housing (Figures 9 and 10).
4. Disconnect hoses (upper and lower) from the radiator.
5. Remove air cleaner hose.
6. Disconnect reservoir hose from the vent tube.
7. Detach radiator fan shroud from the radiator by removing four flange head screws and flat washers. Position shroud away from radiator.
8. Pivot rear screen and oil cooler away from radiator (see Traction Unit Operator's Manual).
9. Remove flange head screws and lock nuts securing the radiator to the support frame. Pull radiator from the machine.
10. Plug any radiator or hose openings to prevent contamination.

Installation

1. Remove any plugs used during the removal procedure.
2. Position radiator to the support frame. Secure radiator to the support frame with lock nuts and flange head screws.
3. Pivot and secure oil cooler and rear screen (see Traction Unit Operator's Manual).

4. Attach radiator fan shroud to the radiator with flange screws and flat washers. Make sure that clearance between shroud and fan is at least .180" (4.6 mm) at all points.
5. Connect reservoir hose to the vent tube.
6. Connect hoses (upper and lower) to the radiator.
7. Reinstall air cleaner hose.
8. Make sure coolant drain is closed. Fill radiator with coolant (see Traction Unit Operator's Manual).
9. Install hood on the machine.

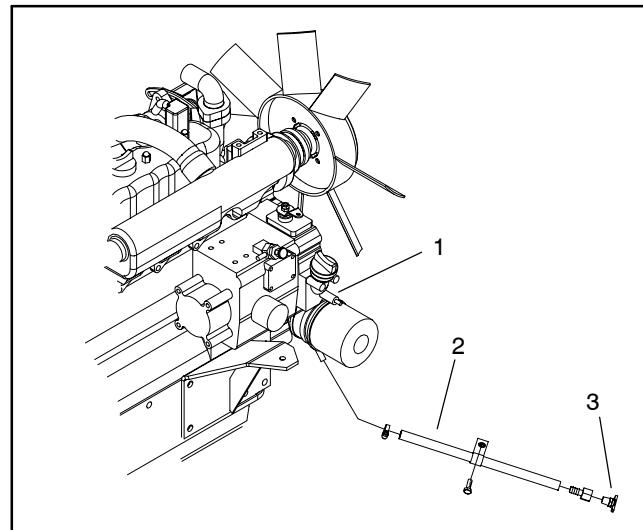


Figure 9

1. Oil filter housing
2. Coolant drain hose
3. Coolant draincock

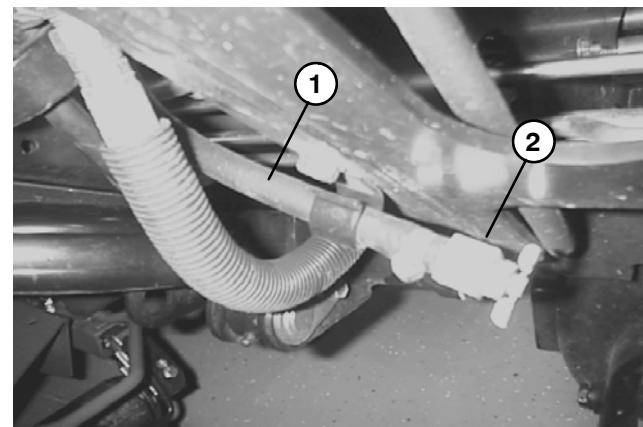


Figure 10

1. Coolant drain hose
2. Coolant draincock

Engine

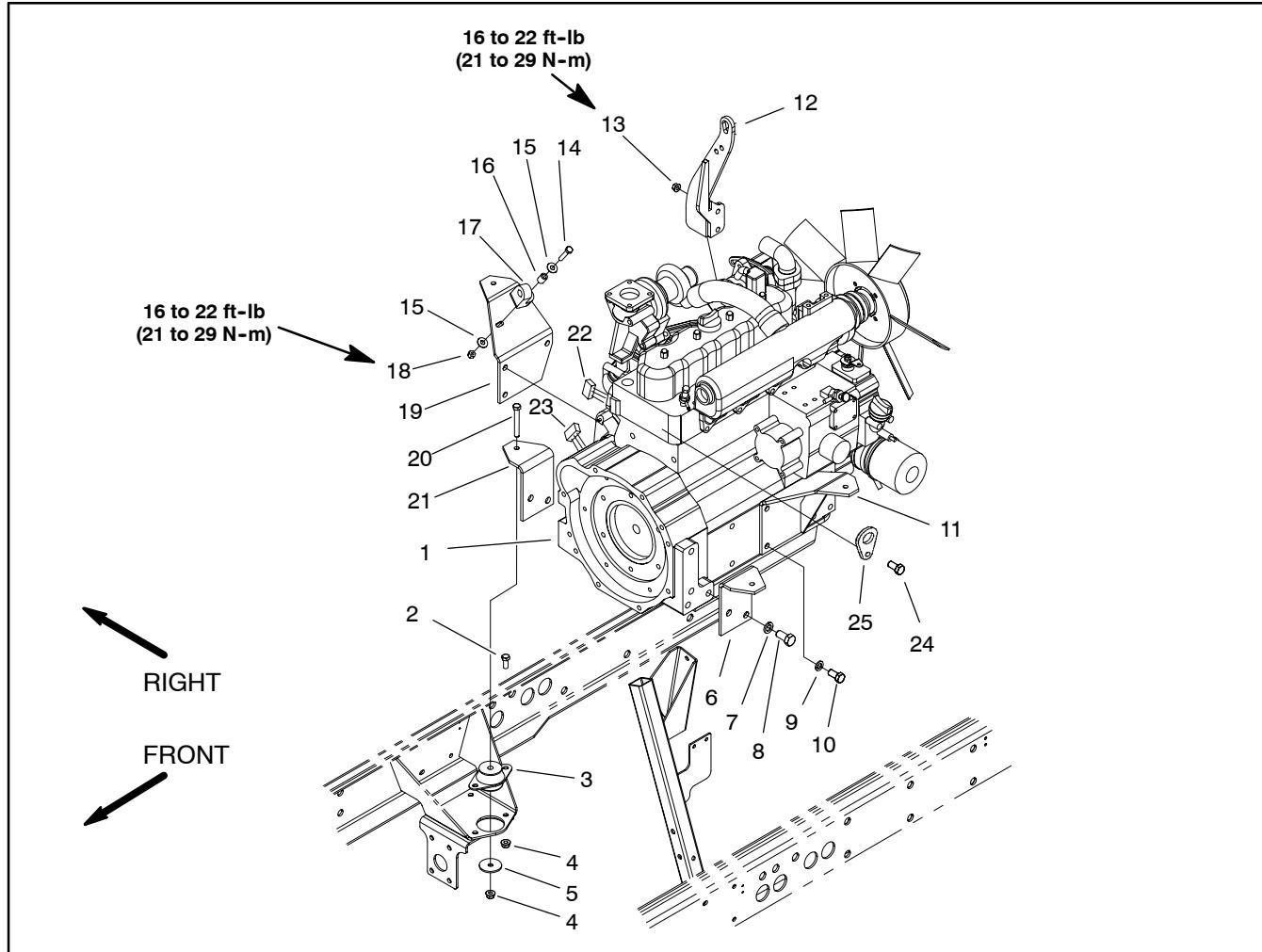


Figure 11

- | | | |
|--------------------------|------------------------------|-------------------------|
| 1. Engine | 10. Bolt | 18. Lock nut |
| 2. Flange head screw | 11. LH engine mount | 19. RH engine mount |
| 3. Rubber engine support | 12. Muffler bracket/lift tab | 20. Cap screw |
| 4. Flange nut | 13. Flange nut | 21. RH engine mount |
| 5. Rebound washer | 14. Cap screw | 22. Fusible link |
| 6. LH engine mount | 15. Flat washer | 23. Engine wire harness |
| 7. Lock washer | 16. Spacer | 24. Cap screw |
| 8. Cap screw | 17. Rubber hanger (exhaust) | 25. Lift tab |
| 9. Lock washer | | |

Engine Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch. Raise hood.
2. Remove battery strap and cover. Disconnect negative battery cable first and then positive battery cable. Remove battery from 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. Drain coolant from radiator into a suitable container (see Radiator Removal). Disconnect coolant hoses from the radiator (Fig. 12).



CAUTION

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

4. Remove exhaust system from engine (see Muffler Removal).
5. Remove air cleaner system from engine (see Air Cleaner Removal).
6. Note location of cable ties used to secure wires. Disconnect the following electrical components:
 - A. The temperature sender and alternator (Fig 12). Note: red wire attached to alternator with washer, nut, and boot does not have to be removed.
 - B. The engine run solenoid (Fig. 13).
 - C. The high temperature shutdown switch and glow plug connection (Fig. 14).
 - D. Battery, frame, and wire harness ground at the engine block (Fig. 15).
 - E. The electric starter (Fig. 15).
 - F. Fusible link harness connector and low oil pressure switch located on alternator side of engine (near electric starter) (Fig. 16).

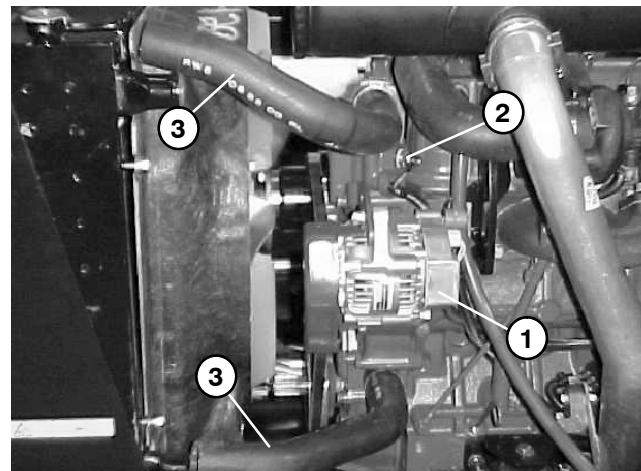


Figure 12

1. Alternator
2. Temperature sender
3. Coolant hose

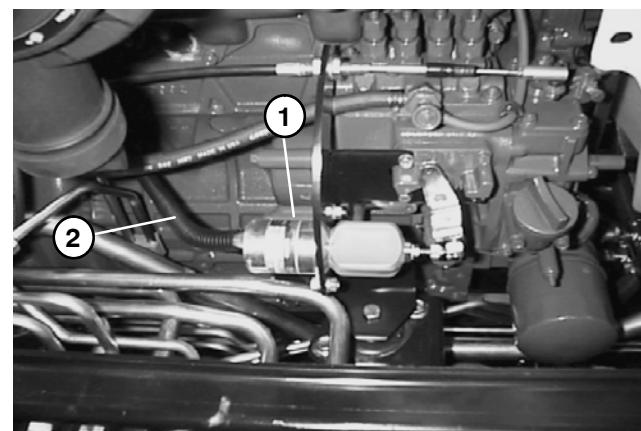


Figure 13

1. Engine run solenoid
2. Solenoid harness

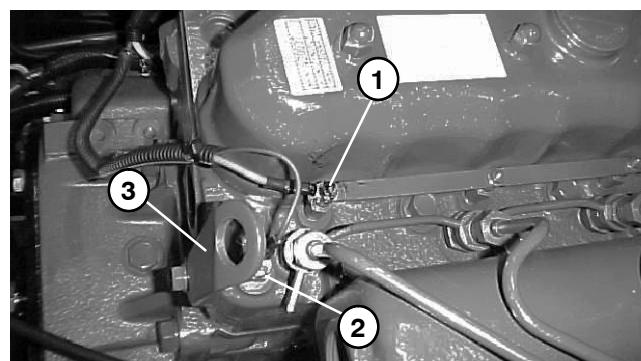


Figure 14

1. Glow plug connection
2. High temp shutdown
3. Engine lift tab

7. Disconnect fuel line from injection pump (Fig. 17). Cap fuel line and injector pump fuel inlet to prevent contamination.

8. Disconnect throttle cable from the speed control lever by removing the washer and lock nut. Loosen jam nut and take cable from mounting bracket (Fig. 17).

9. Remove coolant reservoir and bracket from fan shroud.

10. Remove four flange head screws and flat washers securing the fan shroud to the radiator.

11. Disconnect two wires from neutral switch on hydraulic traction pump.

IMPORTANT: Support hydraulic pump assembly to prevent it from falling and being damaged.

12. Remove hydraulic pump assembly from engine (see Pump Assembly in Chapter 4 – Hydraulic Systems).

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

14. Connect hoist or lift to the front (Fig. 11) and rear (Fig. 14) lift tabs on engine.

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



CAUTION

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

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

16. Slowly remove engine from the machine.

17. If necessary, remove engine mounts from the engine using Figure 11 as a guide.

Engine Installation

1. If removed, install engine mounts to the engine using Figure 11 as a guide.

2. Connect hoist or lift to the front (Fig. 11) and rear (Fig. 14) lift tabs on engine.

3. Position fan shroud around the engine fan.

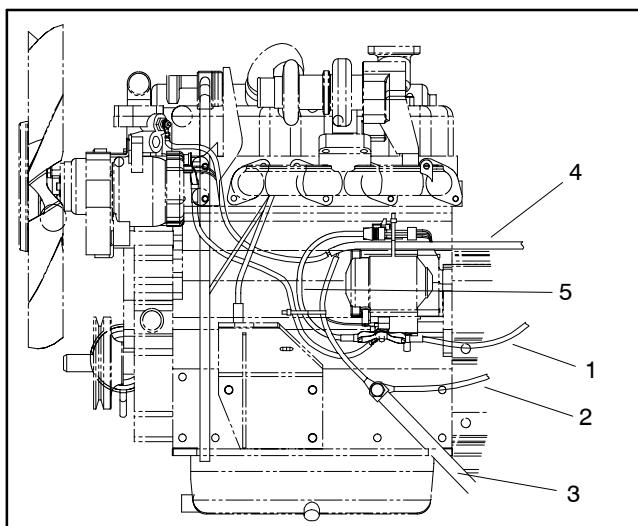


Figure 15

- 1. Battery cable (+)
- 2. Battery cable (-)
- 3. Engine to frame ground
- 4. Engine wire harness
- 5. Fusible link harness

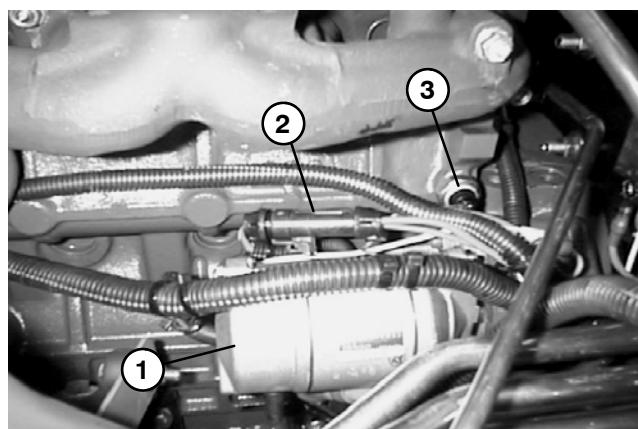


Figure 16

- 1. Electric starter
- 2. Fusible link connection
- 3. Oil pressure switch

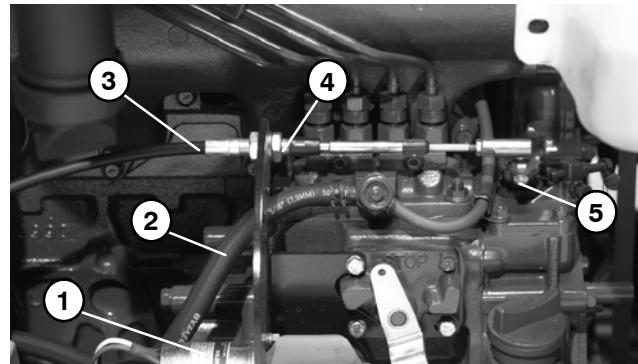


Figure 17

- 1. Engine run solenoid
- 2. Fuel line
- 3. Throttle cable
- 4. Cable jam nut
- 5. Cable washer/lock nut



CAUTION

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

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

4. Slowly lower engine into the machine.
5. Align engine mounts to the rubber engine supports. Secure engine with cap screws, rebound washers, and flange head nuts.
6. Secure fan shroud to the radiator with four flange head screws and flat washers. Make sure that clearance between shroud and fan is at least .180" (4.6 mm) at all points.
7. Install coolant reservoir bracket and reservoir to fan shroud.
8. Connect throttle cable to the speed control lever with washer and lock nut. Install cable to mounting bracket (Fig. 17). Adjust throttle cable (see Traction Unit Operator's Manual).
9. Connect fuel line to the injection pump (Fig. 17).

IMPORTANT: Support hydraulic pump assembly to prevent it from falling and being damaged.

10. Install hydraulic pump assembly to engine (see Pump Assembly in Chapter 4 – Hydraulic Systems).
11. Connect two wires to neutral switch on traction pump.
12. Connect wires and/or electrical connections to the following electrical components:
 - A. The temperature sender and alternator (Fig 12).
 - B. The engine run solenoid (Fig. 13).
 - C. The high temperature shutdown switch and glow plug connection (Fig. 14).
 - D. Battery, frame, and wire harness ground to the engine block (Fig. 15).
 - E. The electric starter (Fig. 15).
 - F. Fusible link harness connector and low oil pressure switch located on alternator side of engine (near electric starter) (Fig. 16).

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

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

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

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

17. Position battery to machine. Connect positive battery cable first and then negative battery cable. Secure battery to machine with cover and strap.

18. Check and adjust engine oil as needed (see Traction Unit Operator's Manual).

19. Check and adjust hydraulic oil as needed (see Traction Unit Operator's Manual).

20. Bleed fuel system (see Traction Unit Operator's Manual).

21. Operate hydraulic controls to properly fill hydraulic system (see Charge Hydraulic System in Chapter 4 – Hydraulic Systems).

Pump Adapter Plate

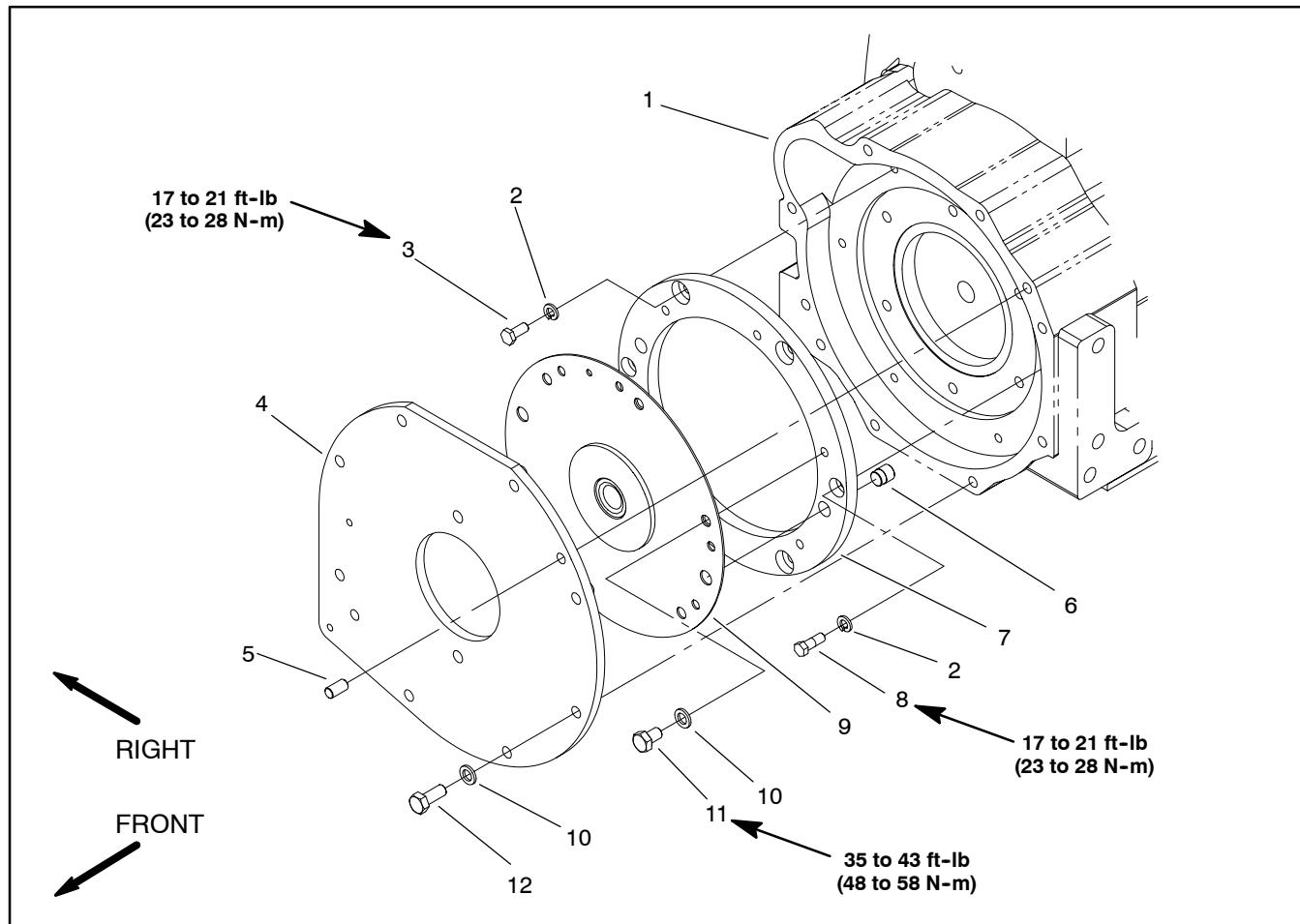


Figure 18

- 1. Engine
- 2. Lock washer
- 3. Cap screw (4 used)
- 4. Pump adapter plate

- 5. Plate pin (2 used)
- 6. Dowel (2 used)
- 7. Coupling spacer
- 8. Shoulder bolt (2 used)

- 9. Spring center coupling
- 10. Lock washer
- 11. Cap screw (6 used)
- 12. Cap screw (9 used)

Disassembly

1. Hydraulic pump assembly needs to be removed from engine before coupling can be serviced (see Pump Assembly in Chapter 4 – Hydraulic Systems).
2. Remove pump adapter plate, spring center coupling, and coupling spacer from engine using Figure 18 as a guide.

Assembly

1. Position coupling spacer to engine and align mounting holes. Use two shoulder bolts and lockwashers in the positions shown in Figure 19 to secure the spacer to the half threaded holes in engine flywheel. Torque shoulder bolts from 17 to 21 ft-lb (23 to 28 N-m).
2. Install four cap screws and lockwashers to coupling spacer and flywheel. Torque cap screws from 17 to 21 ft-lb (23 to 28 N-m).
3. Place dowels in locating holes of coupling spacer (Fig. 19).
4. Position spring center coupling (coil springs toward engine (Fig. 20)) over dowels. Secure coupling to coupling spacer with cap screws and lockwashers. Torque cap screws from 35 to 43 ft-lb (48 to 58 N-m).
5. Install plate pins into engine casting. Position pump adapter plate to engine using plate pins as alignment points. Secure adaptor plate with cap screws and lock washers using a star pattern tightening procedure.

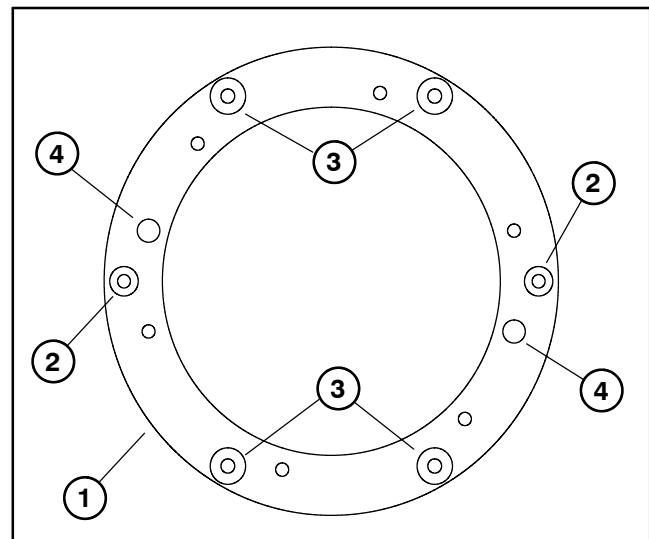


Figure 19

1. Coupling spacer
 2. Shoulder bolt position
 3. Cap screw position
 4. Dowel position

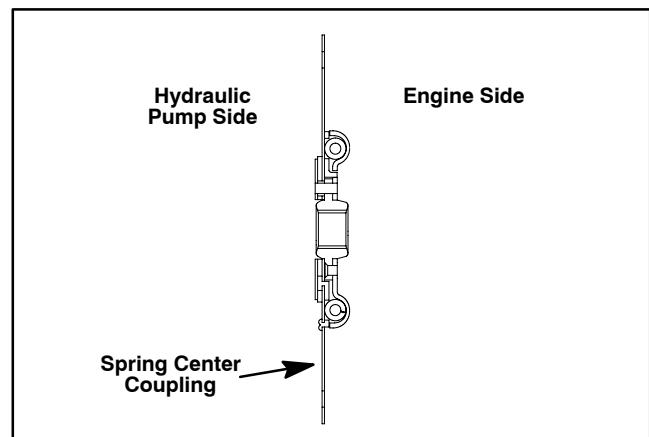


Figure 20

This page is intentionally blank.

Hydraulic System

Table of Contents

SPECIFICATIONS	2	Flush Hydraulic System	53
GENERAL INFORMATION	3	Charge Hydraulic System	54
Hydraulic Hoses	3	Gear Pump	56
Hydraulic Fitting Installation	3	Gear Pump Service	58
Towing Traction Unit	5	Piston (Traction) Pump	62
Check Hydraulic Fluid	5	Piston (Traction) Pump Service	64
HYDRAULIC SCHEMATICS	6	Piston Pump Manual Servo Control Assembly	68
GM 4500-D Hydraulic Schematic	6	Hydraulic Control Manifolds: 2 Wheel/4 Wheel	
GM 4700-D Hydraulic Schematic	7	Drive, Filtration and Charge, Power Down and	
HYDRAULIC FLOW DIAGRAMS	8	Traction Assist	70
Traction Circuit	8	Hydraulic Control Manifold Service:	
Lower Cutting Units	10	2 Wheel/4 Wheel Drive Control	72
Raise Cutting Units	12	Hydraulic Control Manifold Service:	
Mow Circuit	14	Filtration and Charge Control	74
Cutting Deck Blade Braking	16	Hydraulic Control Manifold Service: Power Down	
Steering Circuit	18	and Traction Assist (GM 4500-D)	75
SPECIAL TOOLS	20	Hydraulic Control Manifold Service: Power Down	
Hydraulic Pressure Test Kit	20	and Traction Assist (GM 4700-D)	76
Hydraulic Tester (Pressure and Flow)	20	Hydraulic Control Manifold: Deck Drive	
Hydraulic Test Fitting Kit	21	(GM 4500-D)	78
Measuring Container	21	Hydraulic Control Manifold Service: Deck	
TROUBLESHOOTING	22	Drive (GM 4500-D)	79
TESTING	25	Hydraulic Control Manifold: Deck Drive	
Test No. 1: Traction Circuit Charge Pressure	26	(GM 4700-D)	80
Test No. 2: Traction Circuit Relief Pressure	28	Hydraulic Control Manifold Service: Deck	
Test No. 3: Cutting Deck Circuit Pressure	30	Drive (GM 4700-D)	81
Test No. 4: Cutting Deck Gear Pump Flow	32	Rear Axle Motor	82
Test No. 5: Cutting Deck Manifold		Front Wheel Motors	84
Relief Pressure	34	Rear Axle/Front Wheel Motor Service	86
Test No. 6: Cutting Deck Motor Case		Cutting Deck Motor	89
Drain Leakage	36	Cutting Deck Motor Service	90
Test No. 7: Steering Circuit Relief Pressure	38	Lift/Lower Control Valve (GM 4500-D)	94
Test No. 8: Lift/Lower Circuit Relief Pressure	40	Lift/Lower Control Valve Service (GM 4500-D)	96
Test No. 9: Steering and Lift/Lower		Lift/Lower Control Valve (GM 4700-D)	98
Gear Pump Flow	42	Lift/Lower Control Valve Service (GM 4700-D)	100
Test No. 10: Counterbalance (RV1) Pressure	44	Steering Valve	102
Test No. 11: Rear Traction Circuit (RV5) Relief		Steering Valve Service	104
Pressure	46	Lift Cylinders: Decks #1, #4, and #5	106
Test No. 11: Traction Circuit Reducing Valve		Lift Cylinders: Decks #2 and #3	108
(PR1) Pressure	48	Lift Cylinders: Decks #6 and #7 (GM 4700-D)	110
Test No. 13: Traction Assist (RV2) Pressure	50	Lift Cylinder Service	112
SERVICE AND REPAIRS	52	Steering Cylinder	114
General Precautions for Removing and		Steering Cylinder Service	116
Installing Hydraulic System Components	52	Hydraulic Reservoir	118
Check Hydraulic Lines and Hoses	52	Hydraulic Oil Cooler	119

Specifications

Item	Description
Piston (Traction) Pump System Relief Pressure: Forward System Relief Pressure: Reverse Charge Pressure	Variable displacement piston pump 5000 PSI (345 bar) 5000 PSI (345 bar) 260 PSI (17.9 bar)
Gear Pump Cutting Deck Relief Pressure Steering Relief Pressure Lift/Lower Relief Pressure	3 section, positive displacement gear type pump 3500 PSI (241.5 bar) 1180 PSI (81.4 bar) 2200 PSI (151.8 bar)
Front Wheel Motors	Fixed displacement piston motors
Rear Axle Motor	Fixed displacement piston motor
Cutting Deck Motors	Gear motor
Hydraulic Filters In-line Suction Strainer	2 Micron (nominal) spin-on cartridge type 100 mesh (in reservoir)
Hydraulic Reservoir	7.5 gal. (28.4 l)
Hydraulic Oil	See Traction Unit Operator's Manual

General Information

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 damage or premature deterioration. Some hoses are more susceptible to these conditions than others. Inspect the hoses frequently for signs of deterioration or damage.

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 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.



WARNING

Before disconnecting or performing any work on hydraulic system, relieve all pressure in system. Stop engine; lower or support all 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 Fitting Installation

O-Ring Face Seal

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.
2. Make sure the O-ring is installed and properly seated in the groove. It is recommended that the O-ring be replaced any time the connection is opened.
3. Lubricate the O-ring with a light coating of oil.
4. Put the tube and nut squarely into position on the face seal end of the fitting and tighten the nut until finger tight.
5. Mark the nut and fitting body. Hold the body with a wrench. Use another wrench to tighten the nut to the correct Flats From Finger Tight (F.F.F.T.). The markings on the nut and fitting body will verify that the connection has been tightened.

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	0.75 ± 0.25
6 (3/8 in.)	0.75 ± 0.25
8 (1/2 in.)	0.75 ± 0.25
10 (5/8 in.)	1.00 ± 0.25
12 (3/4 in.)	0.75 ± 0.25
16 (1 in.)	0.75 ± 0.25

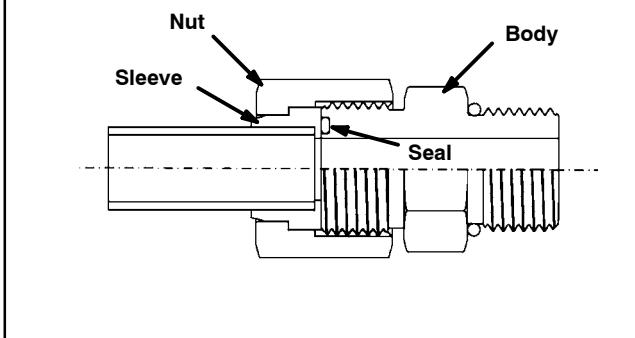


Figure 1

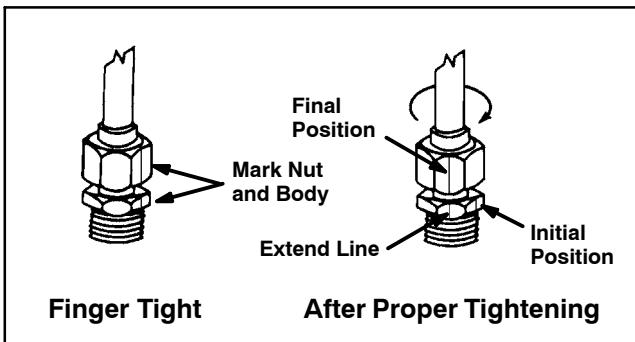


Figure 2

SAE Straight Thread O-Ring Port - Non-adjustable

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.
2. Always replace the O-ring seal when this type of fitting shows signs of leakage.
3. Lubricate the O-ring with a light coating of oil.
4. Install the fitting into the port and tighten it down full length until finger tight.
5. Tighten the fitting to the correct Flats From Finger Tight (F.F.F.T.).

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

NOTE: Installation torque values for non-adjustable fittings are listed in Figure 4. These torque values should **only** be used when a fitting can be accessed with a socket. Use of an offset wrench (e.g. crowfoot wrench) will affect torque wrench accuracy and should not be used.

SAE Straight Thread O-Ring Port - Adjustable

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.
2. Always replace the O-ring seal when this type of fitting shows signs of leakage.
3. Lubricate the O-ring with a light coating of oil.
4. Turn back the jam nut as far as possible. Make sure the back up washer is not loose and is pushed up as far as possible (Step 1).
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 turn the jam nut with another wrench to the correct Flats From Finger Tight (F.F.F.T.) (Step 4).

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

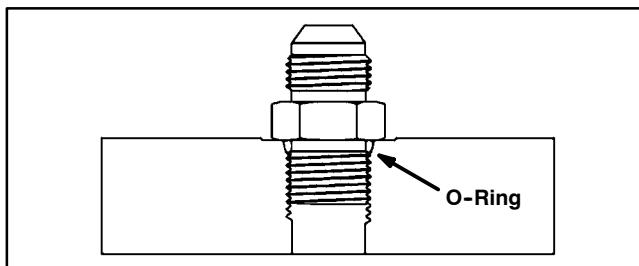


Figure 3

Fitting Size	Installation Torque
4	9-10 ft-lb (12-13 N-m)
6	20-21 ft-lb (27-28 N-m)
8	35-37 ft-lb (47-50 N-m)
10	60-66 ft-lb (81-89 N-m)
12	81-87 ft-lb (110-117 N-m)
16	121-131 ft-lb (164-177 N-m)

Figure 4

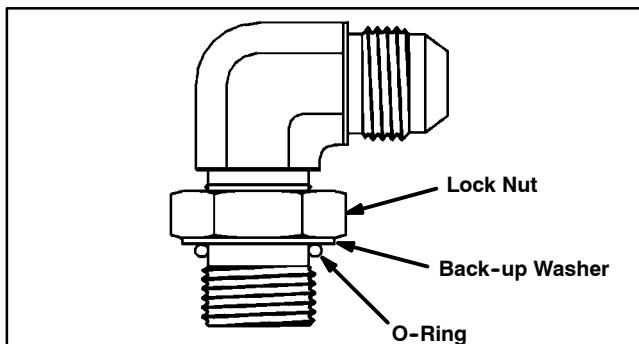


Figure 5

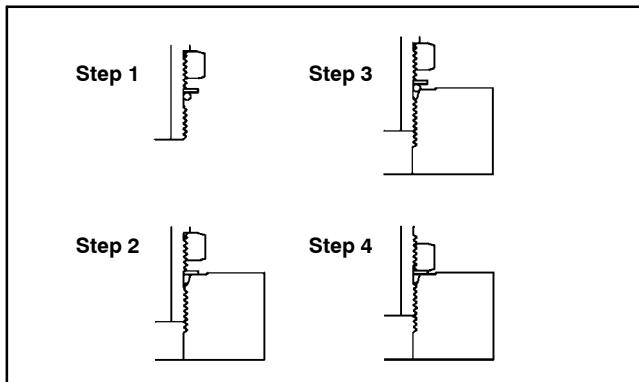


Figure 6

Towing Traction Unit

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

If it becomes necessary to tow (or push) the machine, tow (or push) in a **forward direction only**, at a speed **below 3 mph (4.8 kph)**, and for a distance **less than 1/4 mile (0.4 km)**. The piston (traction) pump is equipped with a by-pass valve that needs to be turned 90° for towing.

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

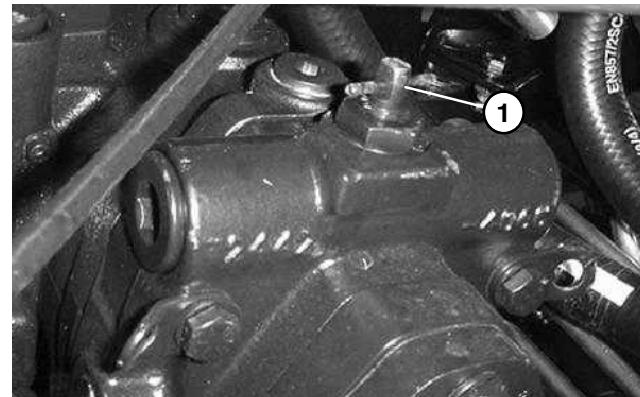


Figure 7

1. By-pass valve location

Check Hydraulic Fluid

The Groundsmaster 4500-D and 4700-D hydraulic systems are designed to operate on anti-wear hydraulic fluid. The reservoir holds about 7.5 gallons (28.4 liters) of hydraulic fluid. **Check level of hydraulic fluid daily.** See Traction Unit Operator's Manual for fluid level checking procedure and oil recommendations.

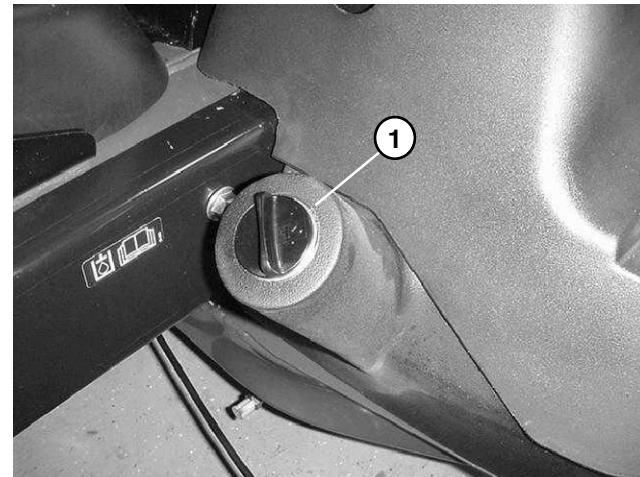
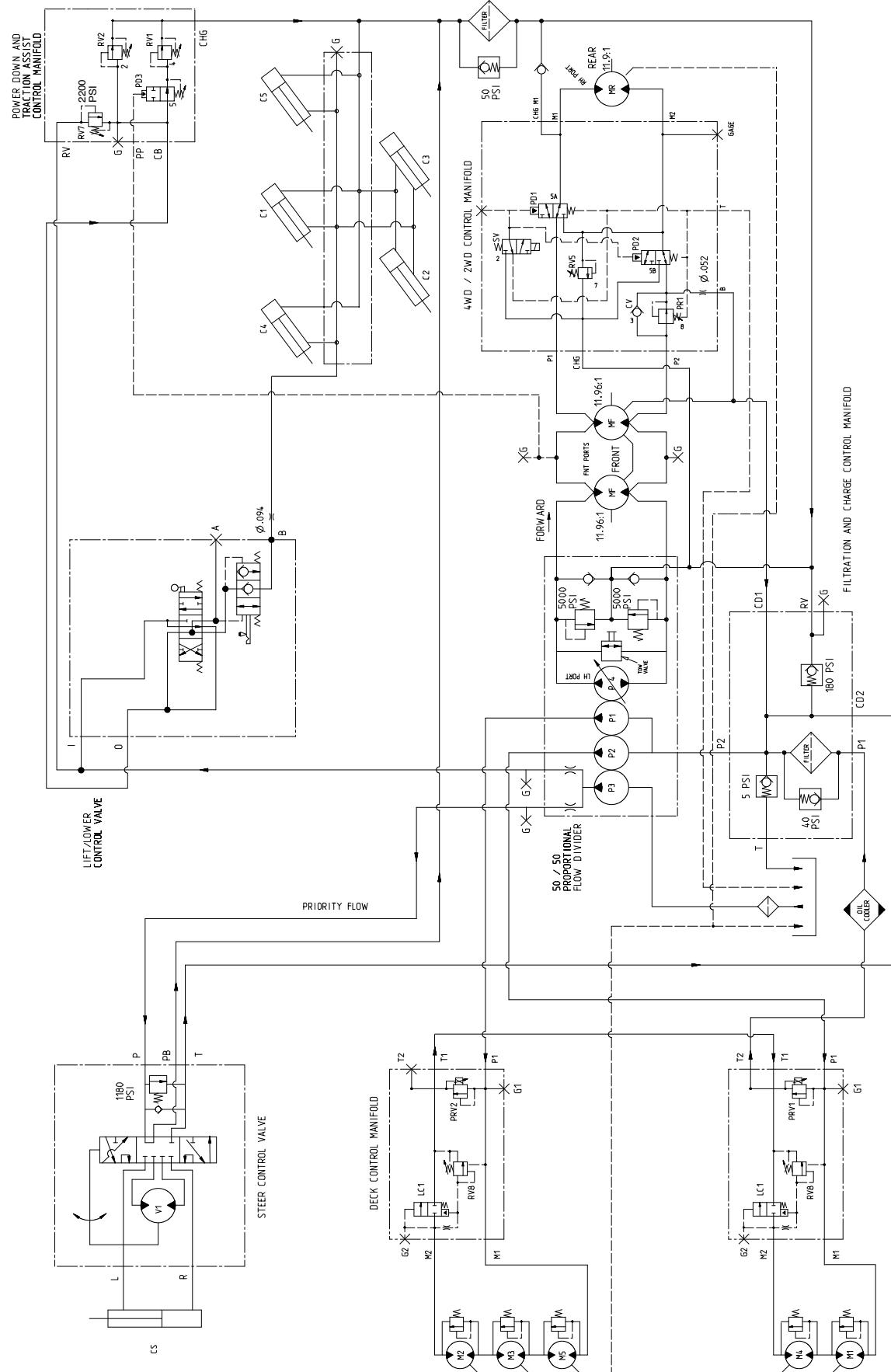


Figure 8

1. Hydraulic reservoir cap

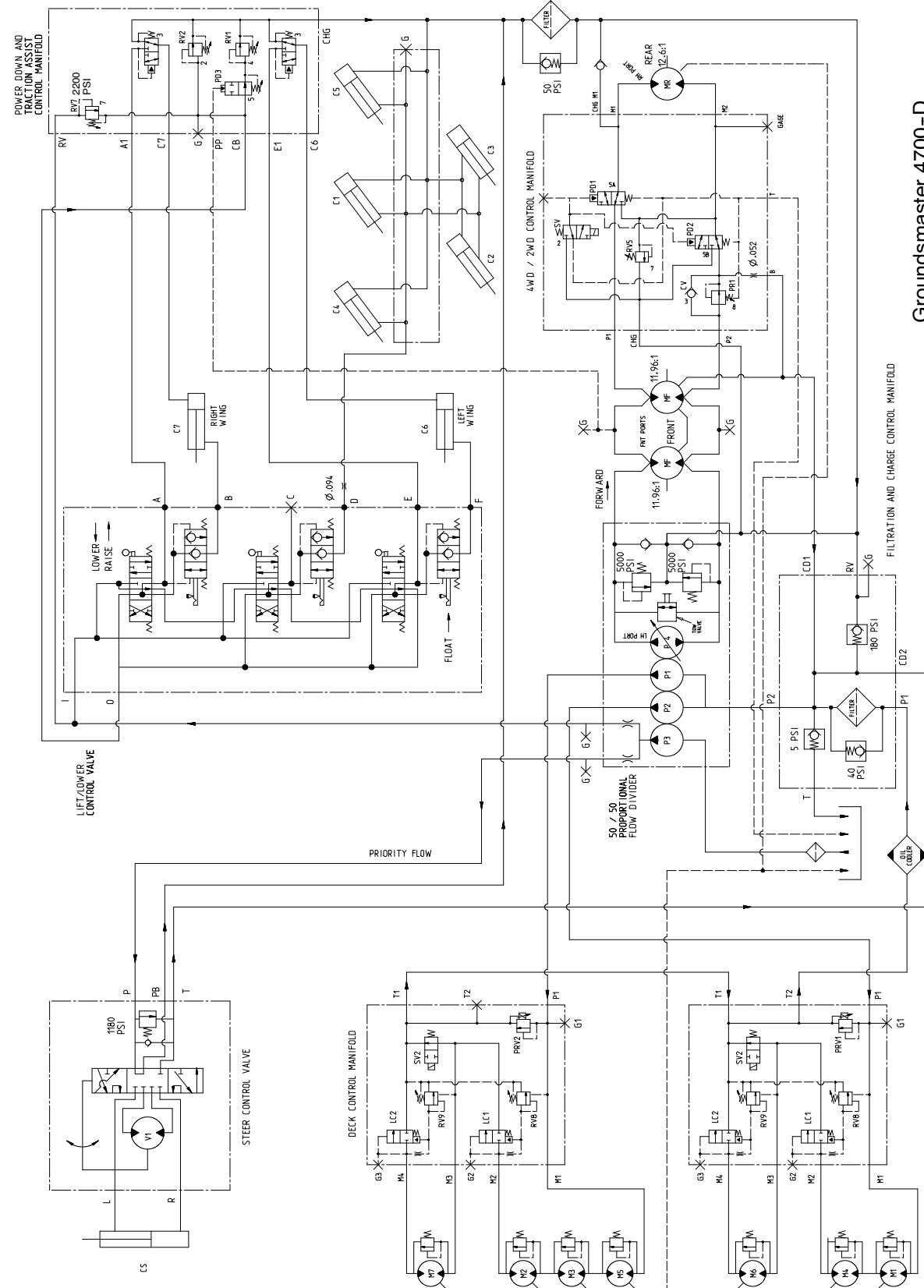
Hydraulic Schematics



Hydraulic System (Rev. A)

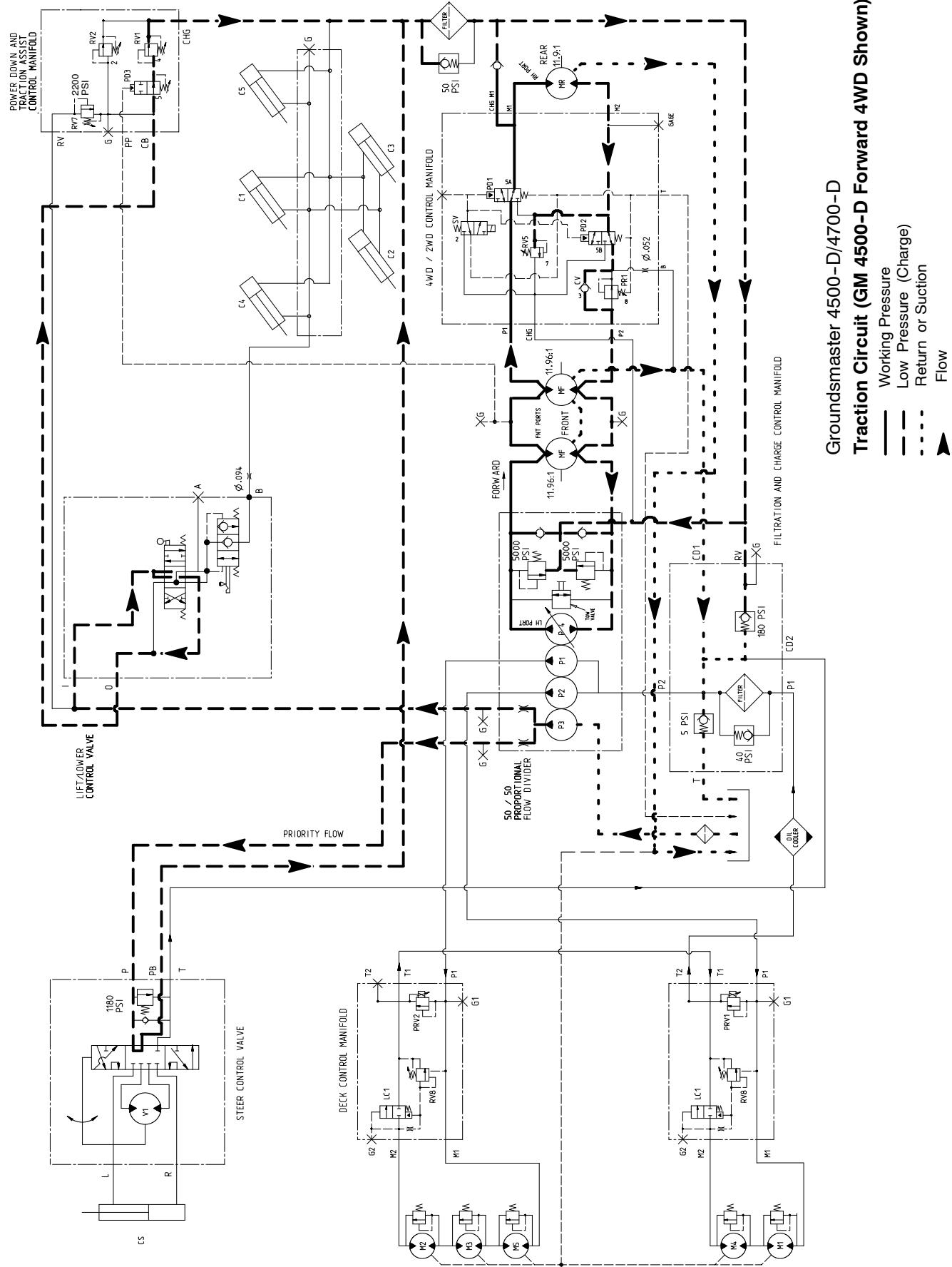
**Groundmaster 4500-D
Hydraulic Schematic**

All solenoids are shown as de-energized



Groundsmaster 4700-D
Hydraulic Schematic
 All solenoids are shown as
 de-energized

Hydraulic Flow Diagrams



Traction Circuit

The traction circuit piston pump is a variable displacement pump that is directly coupled to the engine flywheel. Pushing the top of the traction pedal engages a hydraulic servo valve which controls the variable displacement piston pump swash plate to create a flow of oil. This oil is directed to the front wheel and rear axle motors. Operating pressure on the high pressure side of the closed traction circuit loop is determined by the amount of load developed at the fixed displacement wheel and axle motors. As the load increases, circuit pressure can increase to relief valve settings: 5000 PSI in both forward and reverse. If pressure exceeds the relief setting, oil flows through the relief valve to the low pressure side of the closed loop traction circuit. The traction circuit provides operation in either mow (four wheel drive) or transport (two wheel drive).

Traction circuit pressure (forward and reverse) can be measured at test ports located on the traction circuit hydraulic tubes of the machine.

The traction pump and wheel motors use a small amount of hydraulic fluid for internal lubrication. Fluid is designed to leak across pump and motor parts into the case drain. This leakage results in the loss of hydraulic fluid from the closed loop traction circuit that must be replaced.

The gear pump section (P3) that supplies oil to the steering and lift/lower circuits also provides charge oil for the traction circuit. The gear pump is driven directly off the traction pump. It provides a constant supply of charge oil to the traction circuit to make up for oil that is lost due to internal leakage in the traction pump and motors.

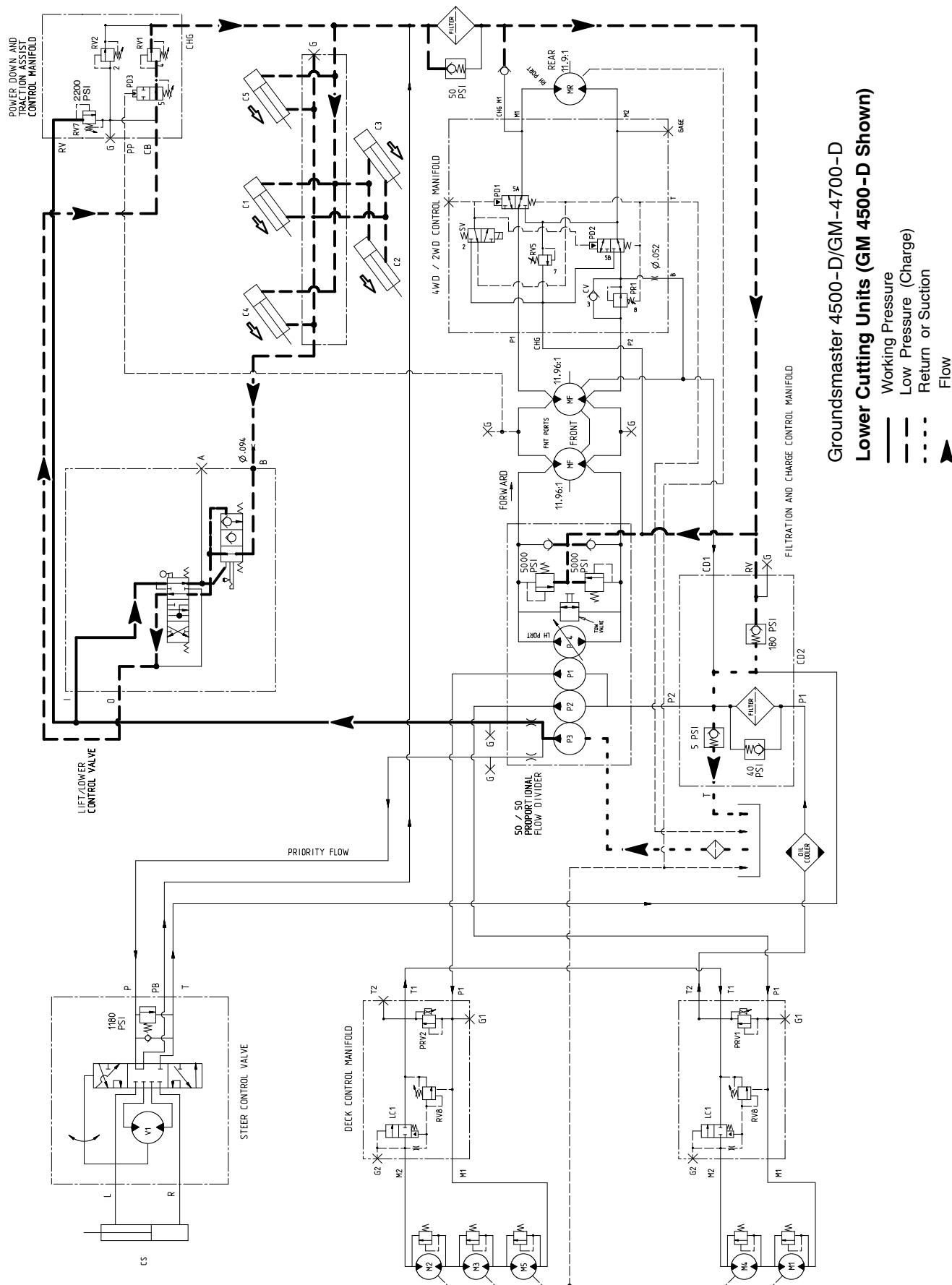
Charge pump flow is directed through the oil filter and to the low pressure side of the closed loop traction circuit. A filter bypass valve allows charge oil flow to the closed loop if the filter becomes plugged.

Charge pressure is limited by a relief valve located in the filtration and charge control manifold. Charge pressure can be measured at the charge circuit pressure test port on the filtration and charge control manifold.

The 4WD/2WD control manifold provides hydraulic flow management in a variety of situations. Pressure testing of this control manifold can be performed at a test port on the manifold.

1. Four wheel drive (mow) and two wheel drive (transport) operation is controlled by a solenoid valve (SV) located in the 4WD/2WD control manifold. When in transport (2WD), the solenoid valve (SV) is energized and directs charge pressure to shift control valves PD1 and PD2. The shifted valves block hydraulic flow to the rear axle motor in both forward and reverse directions when in transport (2WD).
2. A pressure reducing valve (PR1) in the 4WD/2WD control manifold lowers pressure to the rear axle motor when the machine is operated in reverse. The lower pressure prevents rear tire scuffing and provides added pressure to the front wheels during reverse operation.
3. An adjustable relief valve (RV5) in the 4WD/2WD control manifold reduces rear axle motor pressure created in down-hill, dynamic braking conditions.

To enhance traction control, the lift/lower circuit is equipped with a counterbalance system. An adjustable counterbalance valve (RV1) located in the power down and traction assist control manifold transfers cutting unit weight to the machine to improve traction. Additionally, the counterbalance system has a secondary relief valve (RV2) that provides additional cutting unit weight transfer when traction circuit pressure increase is sensed by directional valve (PD3) located in the power down and traction assist control manifold.



Lower Cutting Units

A three section gear pump is coupled to the piston (traction) pump. The gear pump section (P3) farthest from the piston pump supplies hydraulic flow to both the lift/lower control valve and the steering control valve. Hydraulic flow from this pump section is delivered to the circuits through a proportional flow divider. This pump section takes its suction from the hydraulic reservoir. Maximum lift/lower circuit pressure (2200 PSI) is limited by a relief valve in the power down and traction assist control manifold (RV7).

On the Groundsmaster 4500-D, a single lift lever is used to lift and lower the five cutting decks. The Groundsmaster 4700-D has three lift levers to control the cutting decks: the center lever is for the five center decks, the left lever controls the left, rear deck (#6), and the right lever controls the right, rear deck (#7).

Pressure to the lift/lower control valve can be monitored at a port on the end of the gear pump.

When the cutting units are in a stationary position, flow from the gear pump is by-passed through the lift/lower control valve, power down and traction assist control manifold, oil filter, and traction charge circuit.

To lower the center five cutting decks, the lift lever on the lift/lower control valve is pushed to allow valve shift in the lift/lower control. This valve change allows a passage for oil flow from the rod end of the lift cylinders. The weight of the cutting decks causes the lift cylinders to extend, lowering the cutting units. An orifice positioned in the lift/lower control valve restricts oil flow from the lift cylinders to control deck drop speed. Oil from the rod end of the cylinders is allowed to return to the traction charge circuit. The piston end of the cylinders are replenished by the charge circuit. When the lift lever is released, the lift cylinders are held in position.

To lower a side cutting unit on the Groundsmaster 4700-D (deck #6 or #7), the appropriate lift lever on the lift/lower control valve is pushed to allow valve shift in the lift/lower control. This valve change causes a shift in the sequence valve located in the power down and traction assist manifold and also allows a passage for oil flow from the rod end of the lift cylinder. Oil flow to the piston end of the lift cylinder causes the cylinder shaft to extend, and lowers the cutting unit. Oil from the rod end of the cylinders returns to the traction charge circuit. When the lift lever is released, the lift cylinder is held in position.

An adjustable counterbalance valve (RV1) maintains back pressure on the deck lift cylinders. This counterbalance pressure transfers cutting unit weight to the machine to improve traction. Excess circuit flow is routed to the oil filter and then to the traction charge circuit.

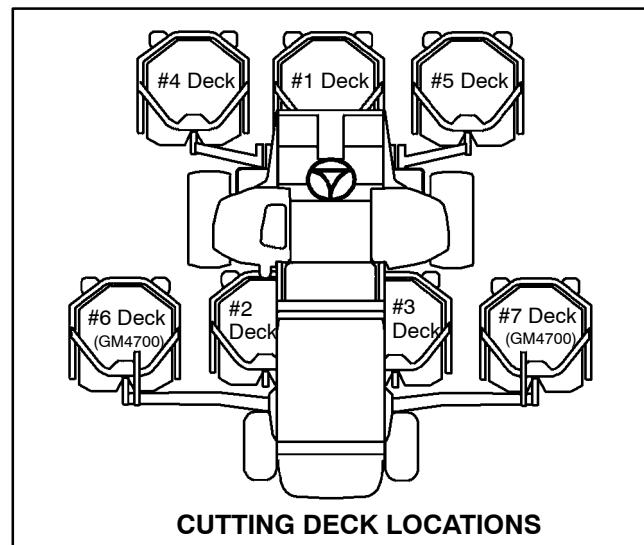


Figure 9

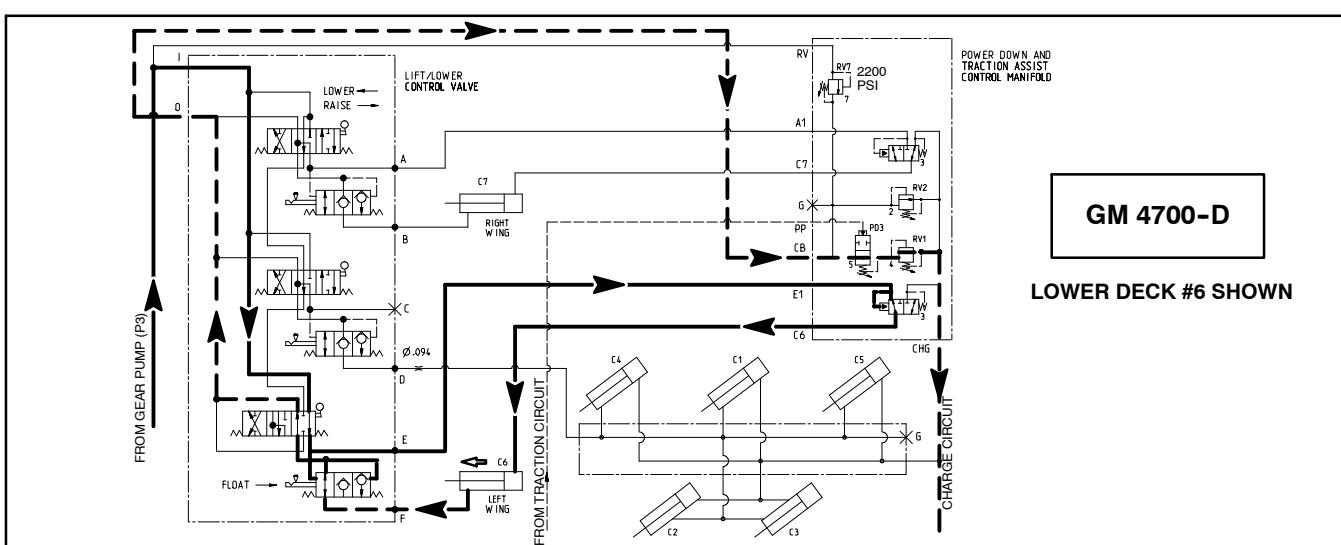
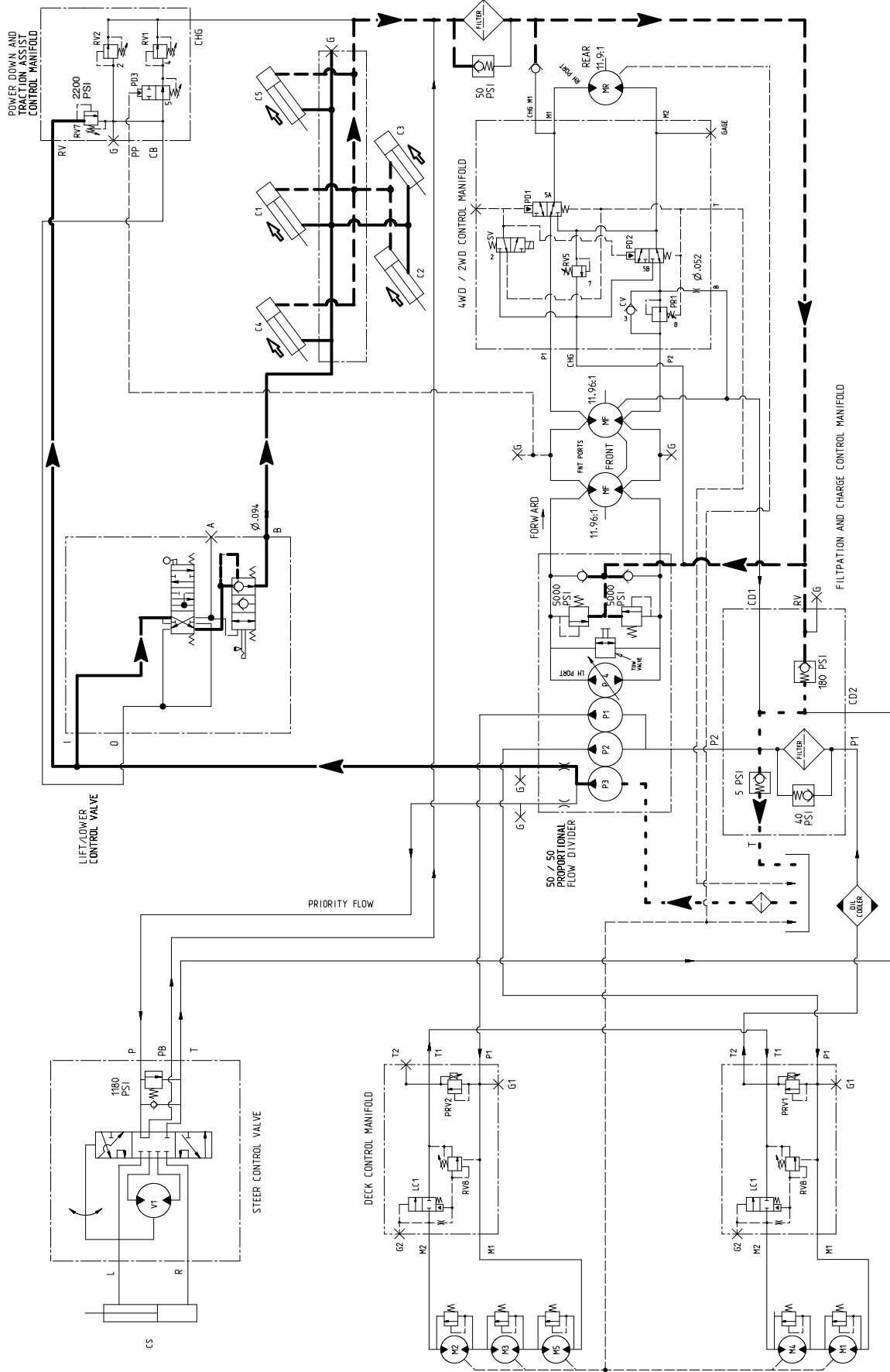


Figure 10



Groundmaster 4500-D/4700-D
Raise Cutting Units (GM 4500-D Shown)

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

Raise Cutting Units

A three section gear pump is coupled to the piston (traction) pump. The gear pump section (P3) farthest from the piston pump supplies hydraulic flow to the lift/lower control valve and the steering control valve. Hydraulic flow from this pump section is delivered to the two circuits through a proportional flow divider. The gear pump takes its suction from the hydraulic reservoir. Maximum lift/lower circuit pressure (1500 PSI) is limited by a relief valve in the power down and traction assist control manifold (RV7).

On the Groundsmaster 4500-D, a single lift lever is used to lift and lower the five cutting decks. The Groundsmaster 4700-D has three lift levers to control the cutting decks: the center lever is for the five center decks, the left lever controls the left, rear deck, and the right lever controls the right, rear deck.

Pressure to the lift/lower control valve can be monitored at a port on the end of the gear pump.

When the cutting units are in a stationary position, flow from the gear pump is by-passed through the lift/lower control valve, power down and traction assist control manifold, oil filter, and traction charge circuit.

To raise the center five cutting decks, the lift lever on the lift/lower control valve is pulled to allow valve shift in the lift/lower control valve. This valve change allows hydraulic pressure to the rod end of the lift cylinder and causes the shaft to retract, raising the cutting units. Oil from the piston end of the cylinder flows to the traction charge circuit. When the lift lever is released, the lift cylinders are held in position.

To raise a side cutting unit on the Groundsmaster 4700-D (deck #6 or #7), the appropriate outer lift lever on the lift/lower control valve is pulled to allow valve shift in the lift/lower control. This valve change allows hydraulic pressure to the rod end of the cylinder and causes the lift cylinder shaft to retract, raising the cutting unit. Oil from the piston end of the cylinder returns to the traction charge circuit. When the lift lever is released, the lift cylinder is held in position.

An adjustable counterbalance valve (RV1) in the power down and traction assist control manifold maintains back pressure on the lift cylinders. This counterbalance pressure transfers cutting unit weight to the machine to improve traction. Excess circuit flow is routed to the oil filter and then to the traction charge circuit.

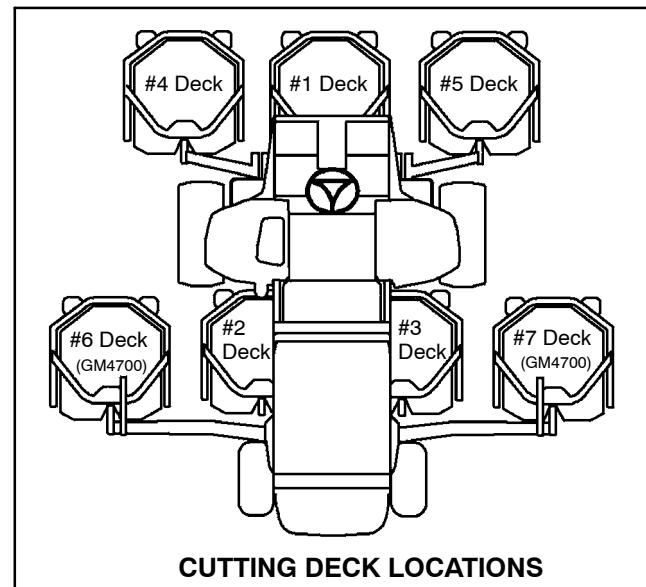


Figure 11

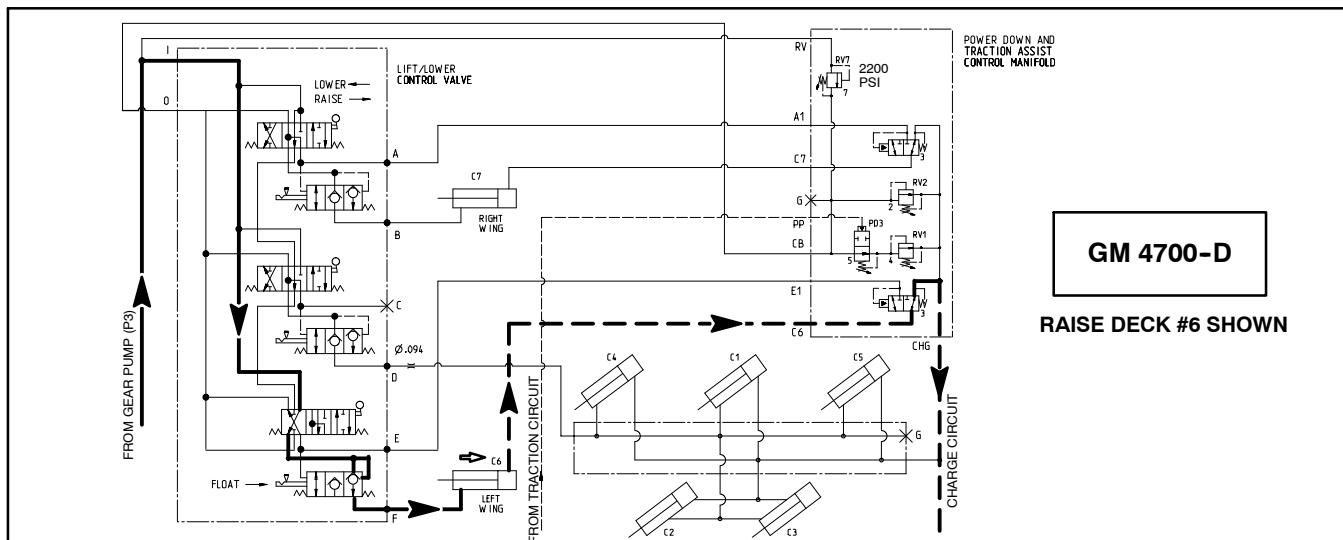
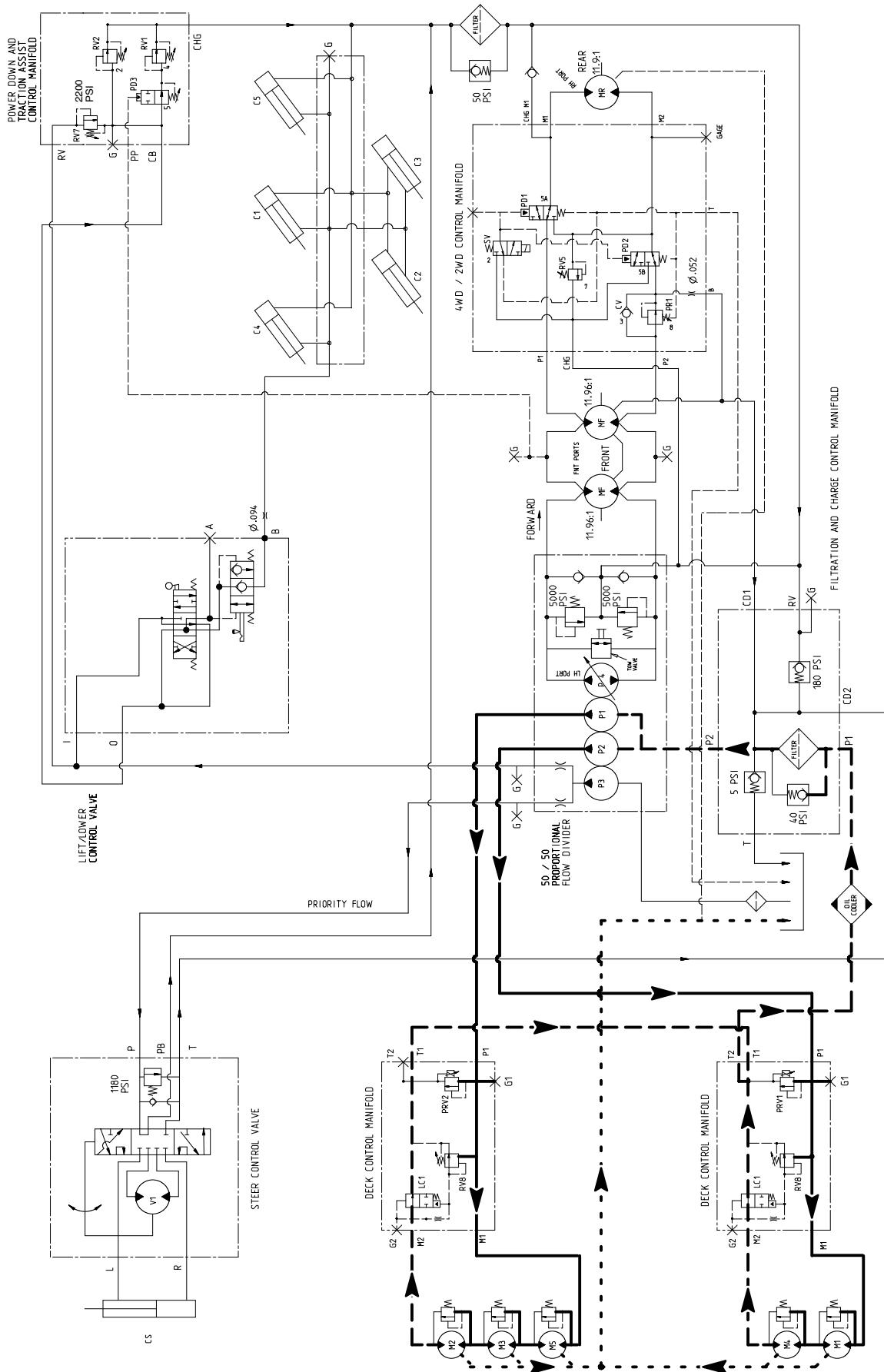


Figure 12



Mow Circuit

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

On the Groundsmaster 4500-D, hydraulic flow from the two pump sections is controlled by two hydraulic manifolds each equipped with a solenoid controlled, proportional relief valve (PRV1/PRV2), logic cartridge (LC1), and brake relief cartridge (RV8). When the PTO switch is OFF (or if the decks are raised), the deck solenoid valves (PRV1/PRV2) are not energized, allowing hydraulic flow to by-pass the deck motors through the manifold. When the PTO switch is turned ON with the decks lowered, the solenoid valves (PRV1 and PRV2) energize, causing a shift of the logic cartridges (LC1) and allowing hydraulic flow to the deck motors. Brake relief cartridges (RV8) control the stopping rate of the blade when the solenoid valves are de-energized as the PTO switch is turned OFF.

On the Groundsmaster 4700-D, hydraulic flow from the two pump sections is controlled by two hydraulic manifolds each equipped with a solenoid controlled, proportional relief valve (PRV1/PRV2), a solenoid valve (SV2), two logic cartridges (LC1 and LC2), and two brake relief cartridges (RV8 and RV9). When the PTO switch is OFF (or if decks are raised), the deck solenoid valves (SV2 and PRV1/PRV2) are not energized, allowing hydraulic flow to by-pass the deck motors through the manifold. When the PTO switch is turned ON with the decks lowered, the solenoid valves (SV2 and PRV1/PRV2) energize, causing a shift of the logic cartridges (LC1 and LC2) and allowing hydraulic flow to the deck motors. Brake relief cartridges (RV8 and RV9) control the

stopping rate of the blade when the solenoid valves are de-energized as the PTO switch is turned OFF. Decks #6 and #7 are controlled by solenoid valve (SV2), logic cartridge (LC2), and brake relief cartridge (RV9).

Return oil from the deck motors is directed to the oil cooler and oil filter. Deck motor case drain leakage returns to the hydraulic reservoir.

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

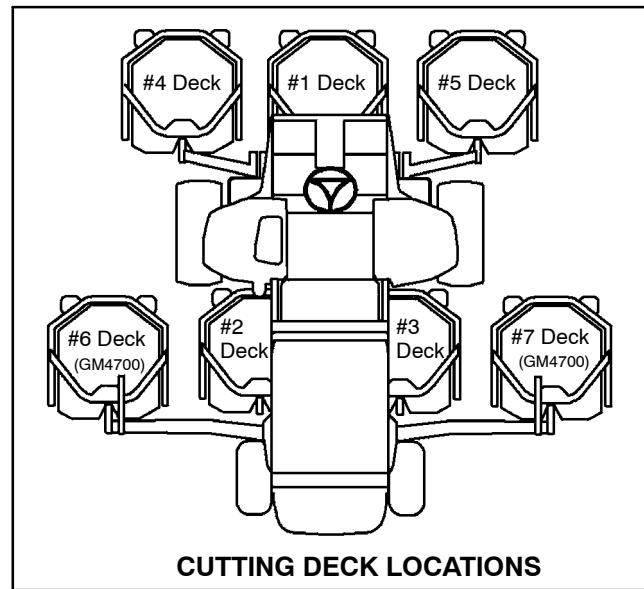


Figure 13

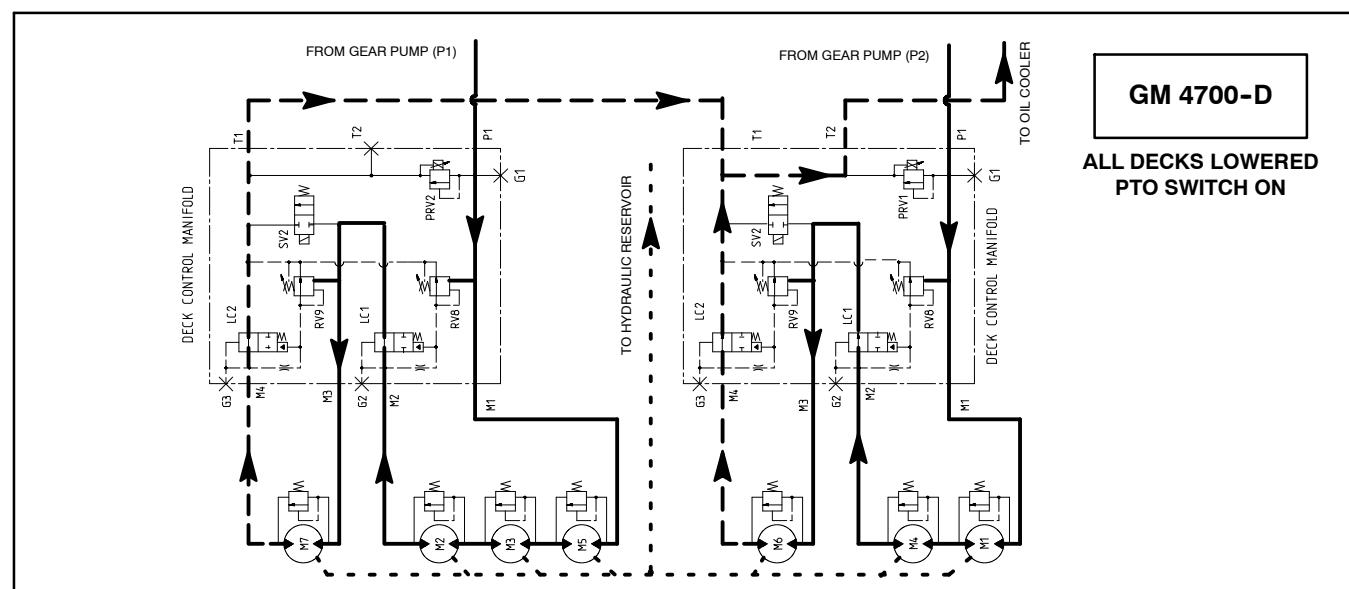


Figure 14

Cutting Deck Blade Braking

When the operator turns the cutting decks OFF, proportional relief valve (PRV) shift occurs in the deck control manifold (Fig. 15). This shifted valve allows oil return to the oil cooler and gear pump. Hydraulic pressure is reduced to the cutting deck motors which begins to slow the cutting blades and also allows the manifold relief valve (RV) to shift. (Fig. 16).

The inertia of the rotating cutting blades increases pressure of the oil return to the deck control manifold. This pressure increase along with the orifice in the manifold and the shifted relief valve (RV) cause logic cartridge (LC1) to shift (Fig. 16). The oil from the deck motors is finally directed through the orifice and to relief valve (RV) which bleeds the residual pressure in the circuit and allows the blades to stop in a controlled manner (Fig. 17).

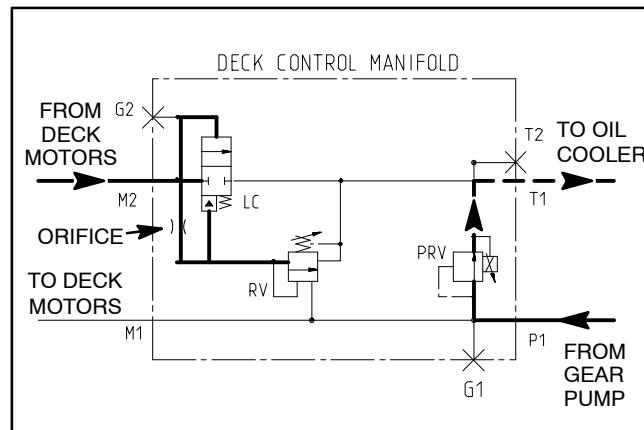


Figure 15

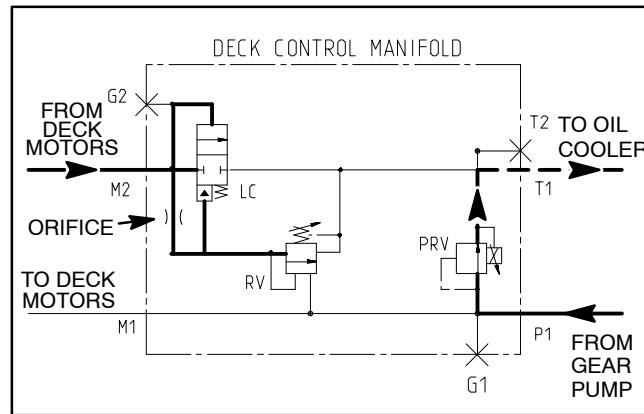


Figure 16

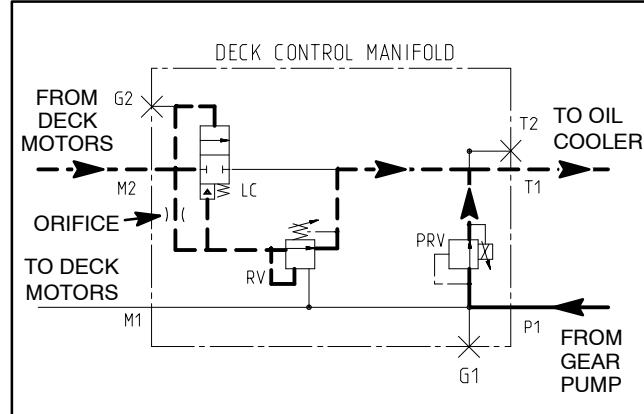
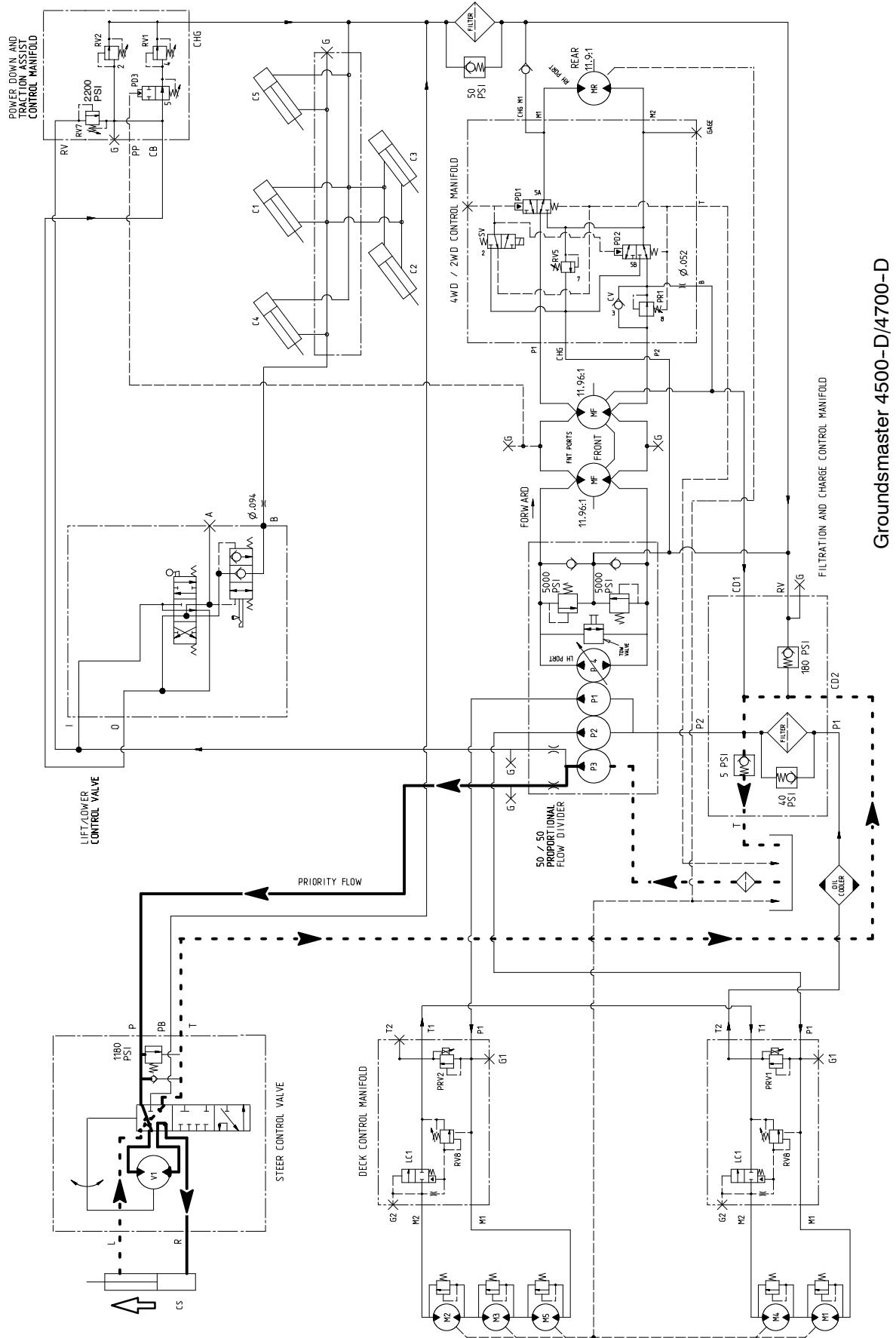


Figure 17

This page is intentionally blank.



Steering Circuit

A three section gear pump is coupled to the piston (traction) pump. The gear pump section (P3) supplies hydraulic flow to the steering control valve and the lift/lower control valve. Pump hydraulic flow is delivered to the two circuits through a proportional flow divider. The gear pump takes its suction from the hydraulic reservoir. Steering circuit pressure is limited by a relief valve located in the steering control.

Pressure to the steering control valve can be monitored at a port on the end of the gear pump.

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

Left Turn

When a left turn is made with the engine running, the turning of the steering wheel positions the spool valve so that flow goes through the top of the spool. Flow entering the steering control valve at the P port goes through the spool and is routed to two places. First, most of the flow through the valve is by-passed out the PB port back to the oil filter and traction charge circuit. Second, the remainder of the flow is drawn through the rotary meter (V1) and out the L port. Pressure contracts the piston for

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

The steering wheel and steering control valve return to the neutral position when turning is completed.

Right Turn

When a right turn is made with the engine running, the turning of the steering wheel positions the spool valve so that flow goes through the bottom of the spool. Flow entering the steering control valve at the P port goes through the spool and is routed to two places. As in a left turn, most of the flow through the valve is by-passed out the PB port back to the oil filter and traction charge circuit. Also like a left turn, the remainder of the flow is drawn through rotary meter (V1) but goes out port R. Pressure extends the piston for a right turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve then through the T port and to the hydraulic reservoir.

The steering wheel and steering control valve return to the neutral position when turning is completed.

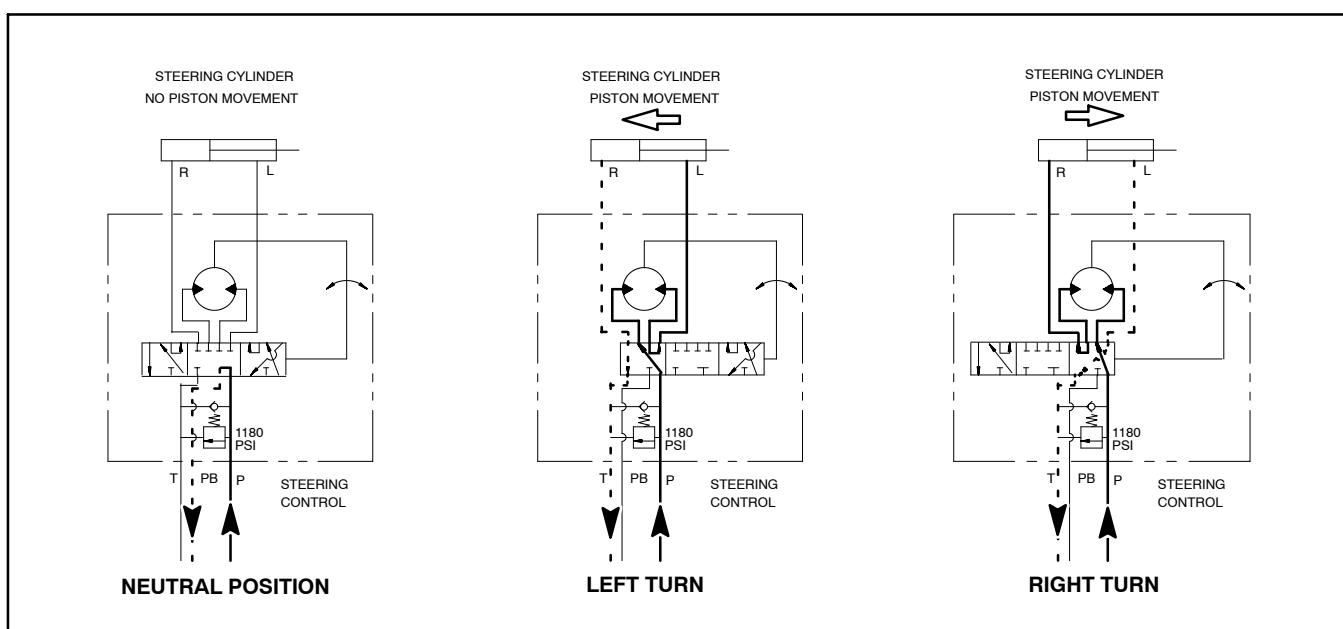


Figure 18

Special Tools

Order these special tools from your Toro Distributor.

Hydraulic Pressure Test Kit - TOR47009

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.



Figure 19

Hydraulic Tester (Pressure and Flow) - TOR214678

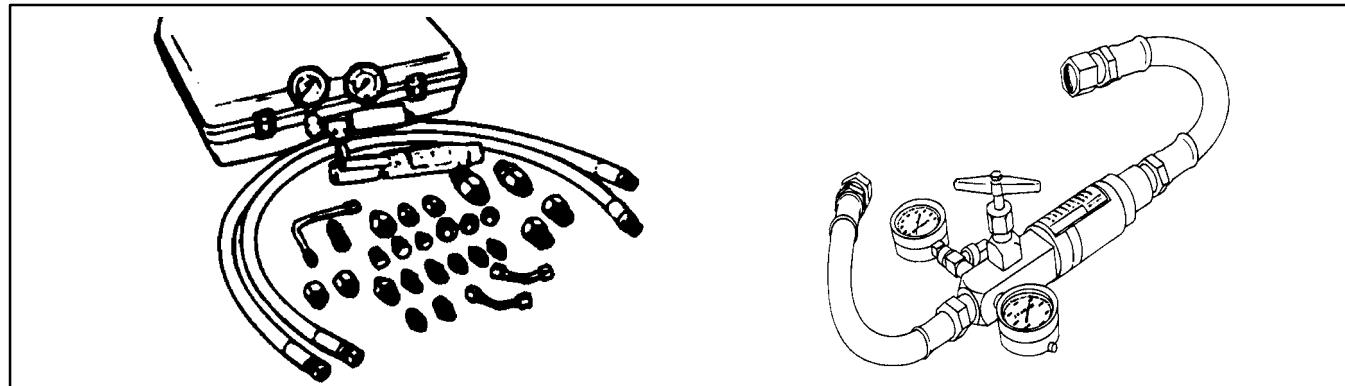


Figure 20

This tester requires O-ring Face Seal (ORFS) adapter fittings for use on this machine.

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. LOW PRESSURE GAUGE: Low range gauge to provide accurate reading at low pressure: 0 to 1000 PSI.

A protector valve cuts out when pressure is about to exceed the normal range for the gauge. The cutout pressure is adjustable.

4. HIGH PRESSURE GAUGE: High range gauge which accommodates pressures beyond the capacity of the low pressure gauge: 0 to 5000 PSI.
5. FLOW METER: This meter measures actual oil flow in the operating circuit with a gauge rated at 15 GPM.
6. OUTLET HOSE: A hose from the outlet side of the hydraulic tester connects to the hydraulic system circuit.

Hydraulic Test Fitting Kit - TOR4079

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

Figure 21

Measuring Container - TOR4077

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



Figure 22

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 23

Troubleshooting

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

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

Problem	Possible Cause
Hydraulic system operates hot.	Engine RPM is too low. Hydraulic reservoir oil level is low. Hydraulic oil is contaminated or the wrong type. Brakes are engaged or sticking. Piston pump by-pass valve is open or damaged. Cooling system is not operating properly. Charge pressure is low. Traction circuit pressure is incorrect. Pump(s) or motor(s) are damaged.
Hydraulic oil in reservoir foams.	Hydraulic reservoir oil level is low. Wrong type of oil is in the hydraulic system. Air is leaking in suction line.
Machine operates in one direction only.	Traction control linkage is faulty. System charge check valve and/or system relief valve is defective. Pilot direction valve in 4WD manifold is damaged or sticking.
Traction pedal is sluggish.	Traction control linkage is stuck or binding. Piston pump servo control valve is damaged. Charge pressure is low.
Traction power is lost or unit will not operate in either direction.	Brakes are engaged or sticking. Traction control linkage is damaged or disconnected. Hydraulic reservoir oil level is low. Piston pump by-pass valve is open or damaged. Charge pressure is low. System charge check valve and/or system relief valve is defective. Traction circuit pressure is low. Front wheel motor couplers are damaged.

Problem	Possible Causes
Machine travels too far before stopping when the traction pedal is released.	Traction linkage is out of adjustment. Piston pump servo control valve is damaged. Traction pedal does not return to neutral.
Four wheel drive will not engage.	Electrical problem exists (see Chapter 5 – Electrical System). Solenoid valve in 4WD hydraulic manifold is faulty. Cartridge valve in 4WD manifold is damaged or sticking. Rear axle motor is damaged.
Four wheel drive will not disengage.	Electrical problem exists (see Chapter 5 – Electrical System). Solenoid valve in 4WD/2WD control manifold is faulty. Cartridge valve in 4WD/2WD control manifold is damaged or sticking.
No cutting decks will operate.	Electrical problem exists (see Chapter 5 – Electrical System). Gear pump sections P1 and P2 are damaged. Gear pump coupler is damaged (steering and lift/lower also affected).
One cutting deck will not operate.	System pressure to the affected deck is low. Spline on affected deck motor (or spindle) is damaged. Deck motor relief valve is stuck or damaged. Deck motor is damaged. Note: If appropriate, transfer a suspected damaged motor to another cutting deck. If problem follows the motor, motor needs repair or replacement. Cartridge valve in deck manifold (SV2) is damaged or sticking (GM 4700-D decks #6 or #7).
Several cutting decks will not operate.	Electrical problem exists (see Chapter 5 – Electrical System). Control manifold solenoid for affected decks is faulty. Proportional relief valve (PRV1 or PRV2) in deck control manifold is stuck or damaged. Gear pump section (P1 or P2) is damaged or inefficient.
All cutting decks operate slowly.	Engine RPM is low. Deck motor is damaged. Gear pump section (P1 or P2) is damaged or inefficient.
Cutting deck stops under load.	Relief valve in deck manifold is by-passing. Deck motor relief valve is stuck or damaged. Deck motor has internal leakage (by-passing oil). Cutting deck gear pump section (P1 or P2) is inefficient.

Problem	Possible Causes
Cutting units will not raise.	<p>Engine RPM is too low.</p> <p>Hydraulic oil level in reservoir is low.</p> <p>Lift cylinder(s) is (are) damaged.</p> <p>Lift arm pivots are binding.</p> <p>Relief valve for lift/lower circuit is stuck.</p> <p>Pilot valve in lift/lower manifold is damaged or sticking.</p> <p>Proportional valve in gear pump is faulty.</p> <p>Gear pump section for lift/lower circuit (P3) is inefficient.</p>
Cutting units raise, but will not stay up.	<p>Lift circuit lines or fittings are leaking.</p> <p>Detents in lift/lower control valve are worn.</p> <p>Lift cylinder is damaged.</p>
Cutting units will not lower.	<p>Lift arm pivots are binding.</p> <p>Lift cylinder is damaged.</p> <p>Counterbalance pressure is excessive.</p> <p>Lift/lower control valve is worn or damaged.</p> <p>Pilot valve in lift/lower manifold is damaged or sticking.</p>

Testing

The most effective method for isolating problems in the hydraulic system is by using hydraulic test equipment such as pressure gauges and flow meters in the circuits during various operational checks (See the Special Tools section in this Chapter).

Before Performing Hydraulic Tests

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

Precautions for Hydraulic Testing



CAUTION

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



CAUTION

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



CAUTION

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



WARNING

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

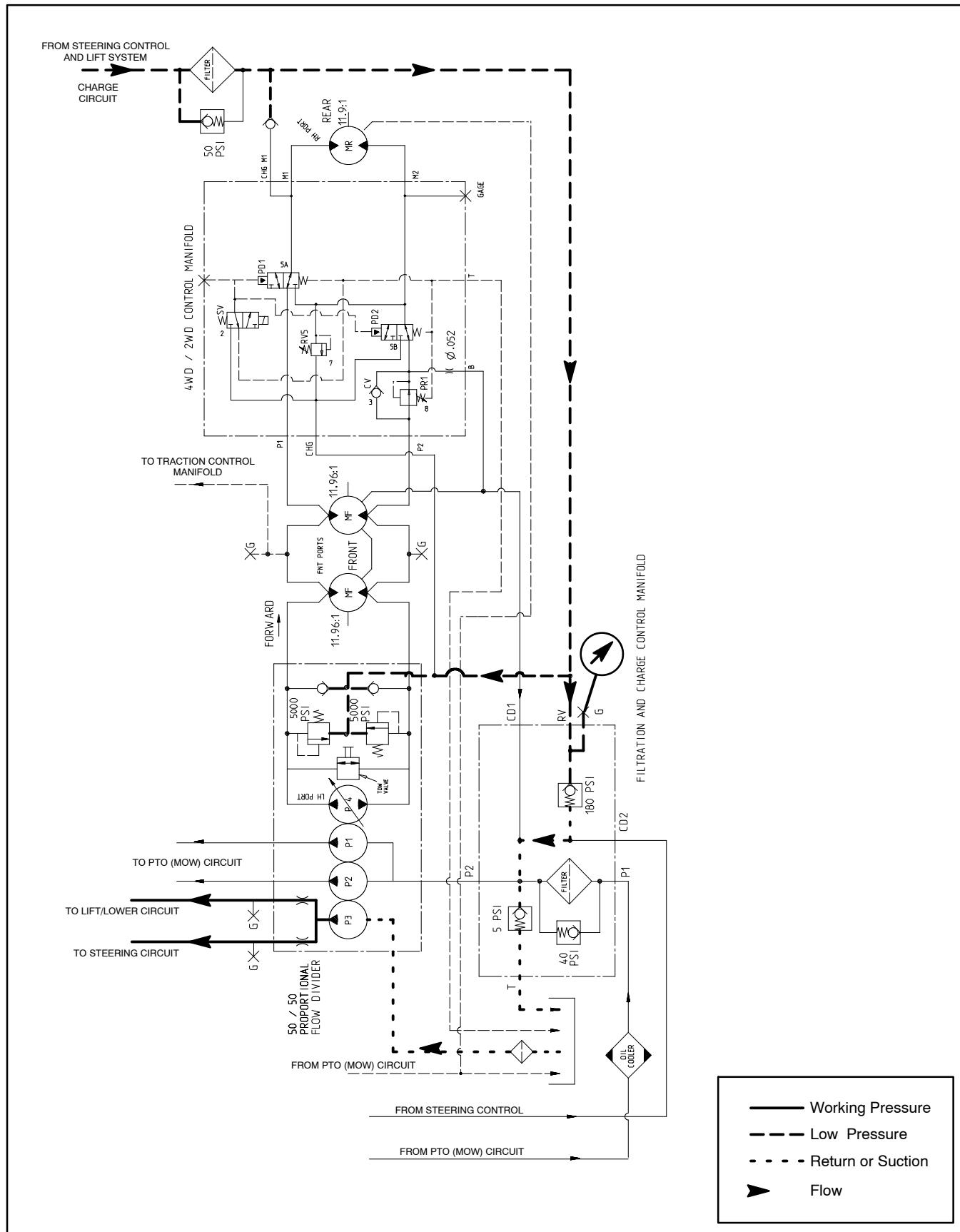


WARNING

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

1. Clean machine thoroughly before disconnecting or disassembling any hydraulic components. Always keep in mind the need for cleanliness when working on hydraulic equipment. Contamination will cause excessive wear of components.
2. Put metal caps or plugs on any hydraulic lines left open or exposed during testing or removal of components.
3. The engine must be in good operating condition. Use a phototac to determine engine speed when performing a hydraulic test. Engine speed can affect the accuracy of the tester readings. Check actual speed of the pump when performing flow testing.
4. The inlet and the outlet hoses must be properly connected and not reversed (tester with pressure and flow capabilities) to prevent damage to the hydraulic tester or components.
5. When using hydraulic tester with pressure and flow capabilities, open load valve completely in the tester to minimize the possibility of damaging components.
6. Install fittings finger tight and far enough to make sure that they are not cross-threaded before tightening them with a wrench.
7. Position tester hoses to prevent rotating machine parts from contacting and damaging the hoses or tester.
8. Check oil level in the hydraulic reservoir. After connecting test equipment, make sure tank is full.
9. Check control linkages for improper adjustment, binding, or broken parts.
10. All hydraulic tests should be made with the hydraulic oil at normal operating temperature.
11. Before returning machine to use, make sure that hydraulic reservoir has correct fluid level.

TEST NO. 1: Traction Circuit Charge Pressure (Using Pressure Gauge)



Procedure for Traction Circuit Charge Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.
2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.



CAUTION

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

3. Connect a 1000 PSI gauge onto charge pressure test port located on rear of filter manifold under right hand frame rail (Fig. 24 and 25).
4. Start the engine and put throttle at full engine speed (**2800 ± 50 RPM**) with no load on the hydraulic system.

GAUGE READING TO BE 230 to 300 PSI.

5. If there is no pressure, or pressure is low, check for restriction in pump intake line. Also, inspect charge relief valve located in filter manifold and charge check valve /system relief valve in hydrostat. If necessary, check for internal damage or worn parts in gear pump.
6. Also, with the pressure gauge still connected to the charge pressure test port, monitor the gauge reading while operating the machine in forward and reverse. Start the engine and put throttle at full engine speed (**2800 ± 50 RPM**). Apply the brakes and push the traction pedal forward, then reverse.

GAUGE READING TO BE 230 to 300 PSI.

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

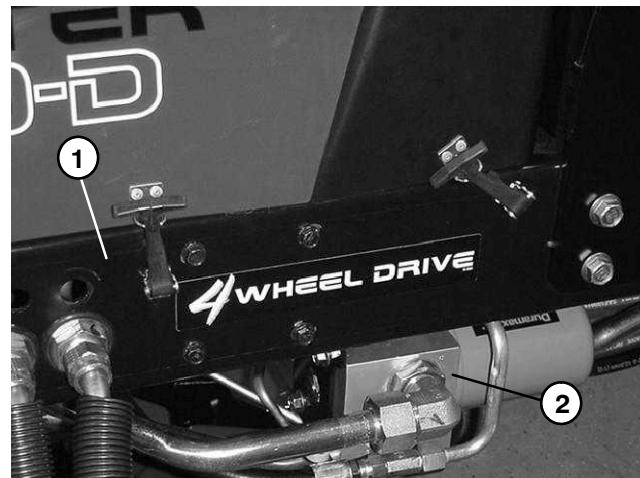


Figure 24
1. Right side frame rail 2. Filter manifold

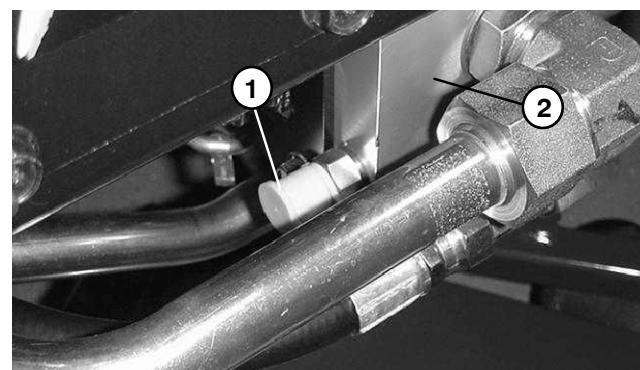
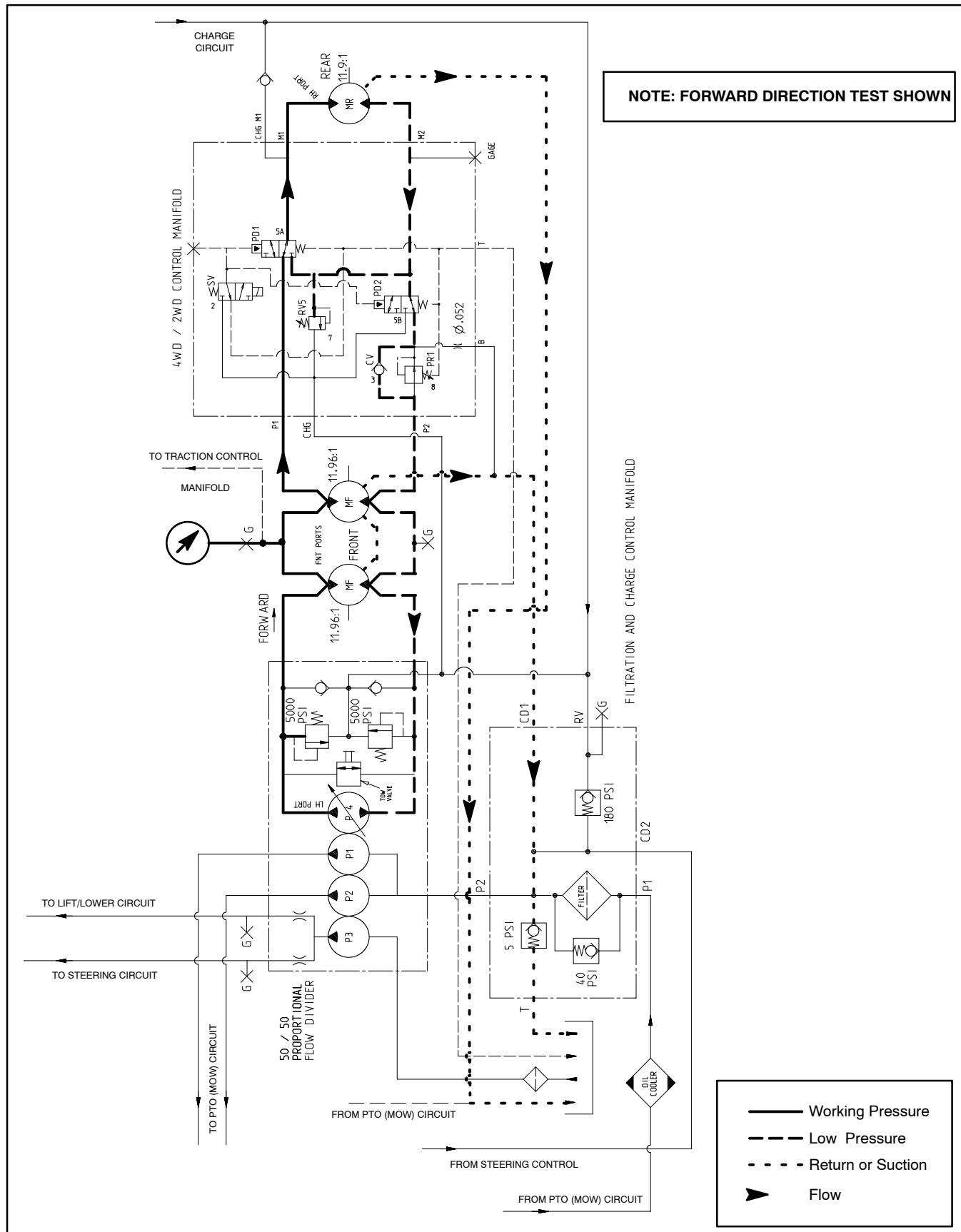


Figure 25
1. Charge pressure port 2. Filter manifold

TEST NO. 2: Traction Circuit Relief Pressure (Using Pressure Gauge)



Procedure for Traction Circuit Relief Pressure Test

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



CAUTION

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

2. Drive machine to an open area, lower cutting units, turn the engine off and engage the parking brake.



CAUTION

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

3. Connect a 10,000 psi gauge to traction circuit test port for function to be checked (Fig. 26). Test ports are located on hydraulic lines toward the front of machine. Forward traction port faces the front and reverse port faces rearward.
4. Start the engine and move throttle to full speed (**2800 ± 50 RPM**). Release parking brake.
5. Sit on seat, apply brakes fully, and slowly depress the traction pedal in the appropriate direction. While pushing traction pedal, look at pressure reading on gauge:

GAUGE READING TO BE:

Forward: **5000 PSI**

Reverse: **5000 PSI**

6. If traction pressure is too low, inspect traction pump relief valves in piston (traction) pump (Fig. 27). Clean or replace valves as necessary. These cartridge type valves are factory set and are not adjustable. If relief valves are in good condition, piston (traction) pump, wheel motors, and/or rear axle motor should be suspected of wear and inefficiency.

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

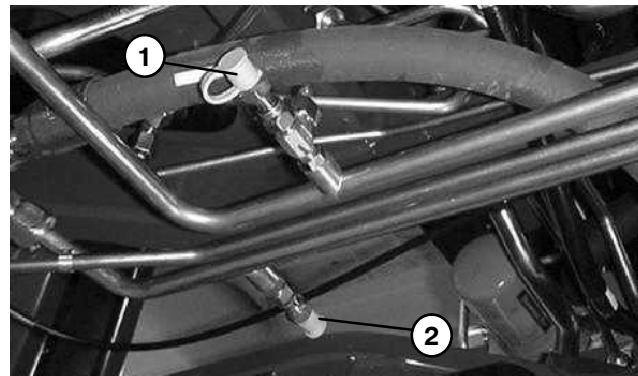


Figure 26

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

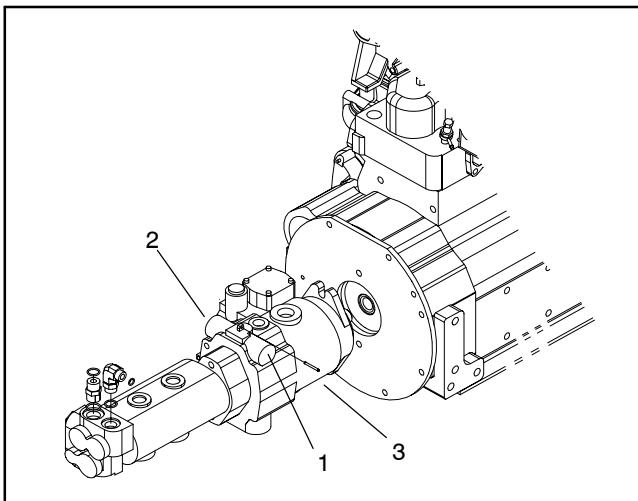
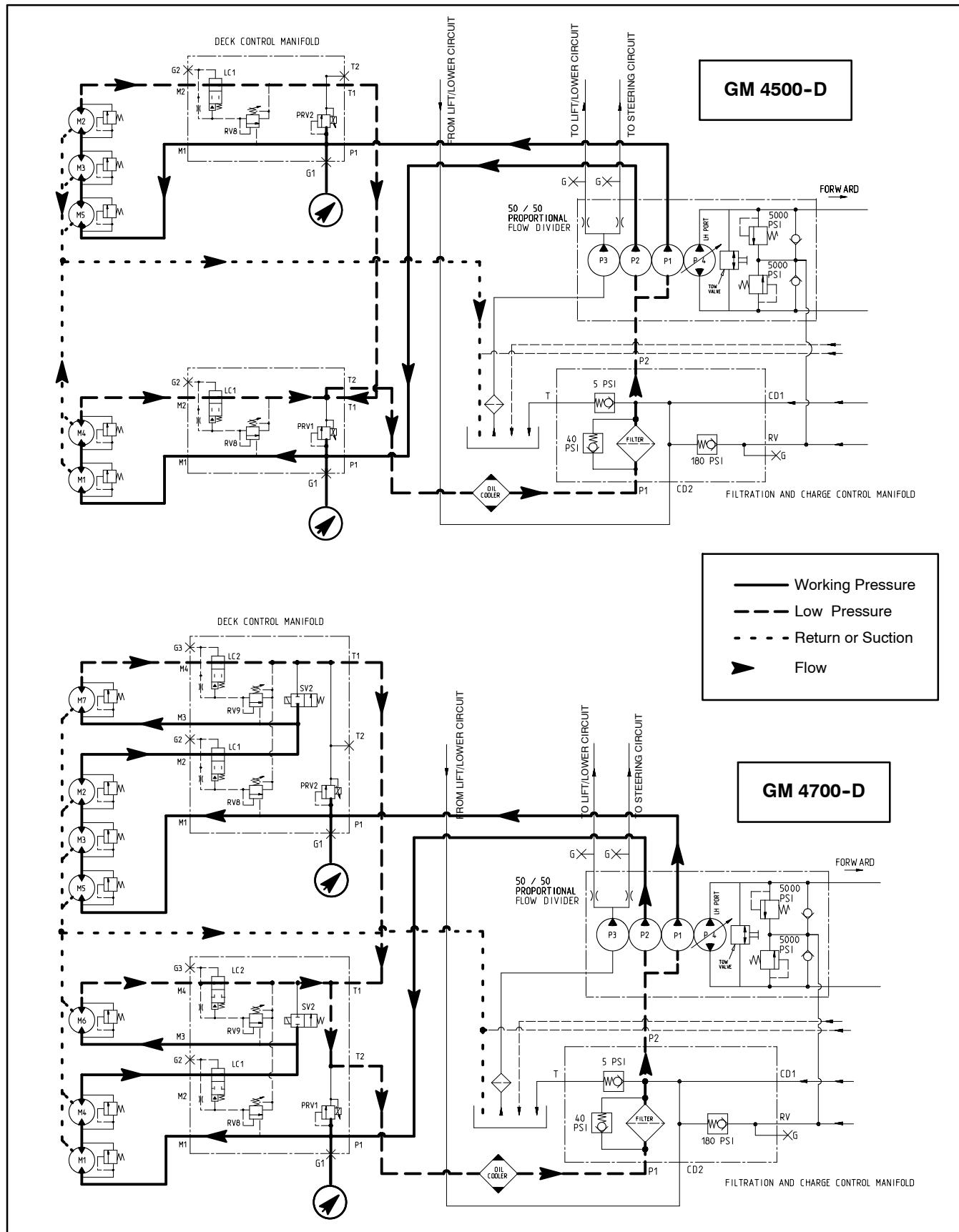


Figure 27

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

TEST NO. 3: Cutting Deck Circuit Pressure (Using Pressure Gauge)



Procedure for Cutting Deck Circuit Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.
2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.



CAUTION

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

3. Install test gauge with hydraulic hose attached to deck control manifold test port for the gear pump section to be tested (Fig. 28 or 29).



CAUTION

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

4. Start engine and move throttle to full speed (**2800 ± 50 RPM**). Engage the cutting units.
5. Watch pressure gauge carefully while mowing with the machine.
6. Cutting deck circuit pressure should be from **1000 to 3500 PSI** and will vary depending on mowing conditions.
7. Disengage cutting units. Shut off engine.
8. Disconnect test gauge with hose from manifold test port.

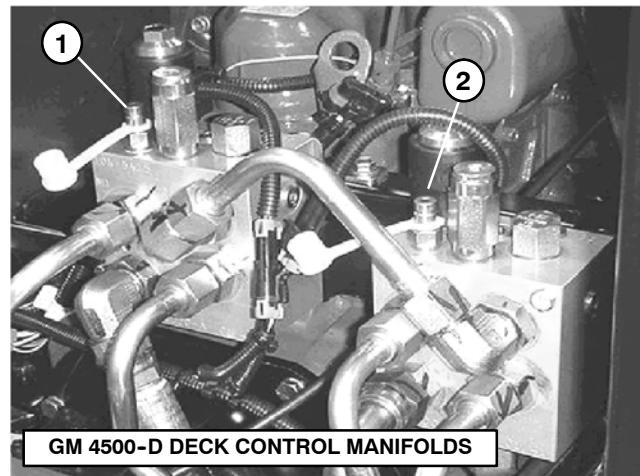


Figure 28

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

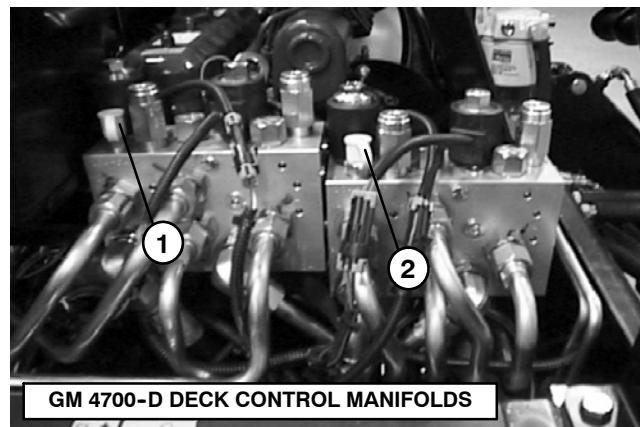


Figure 29

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

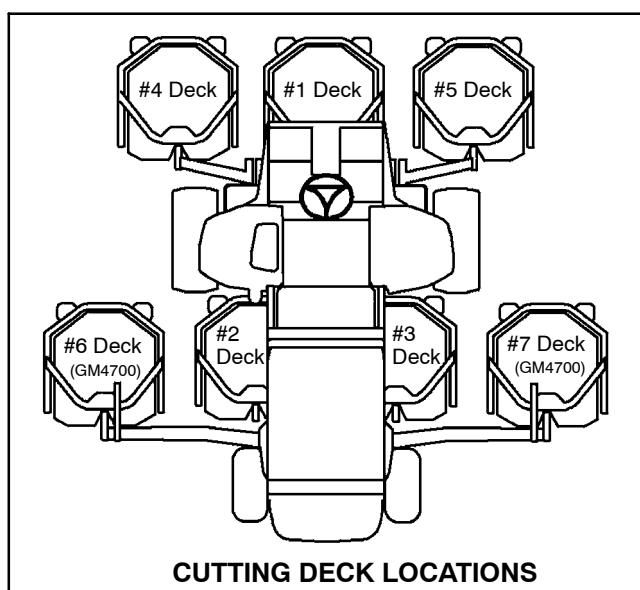
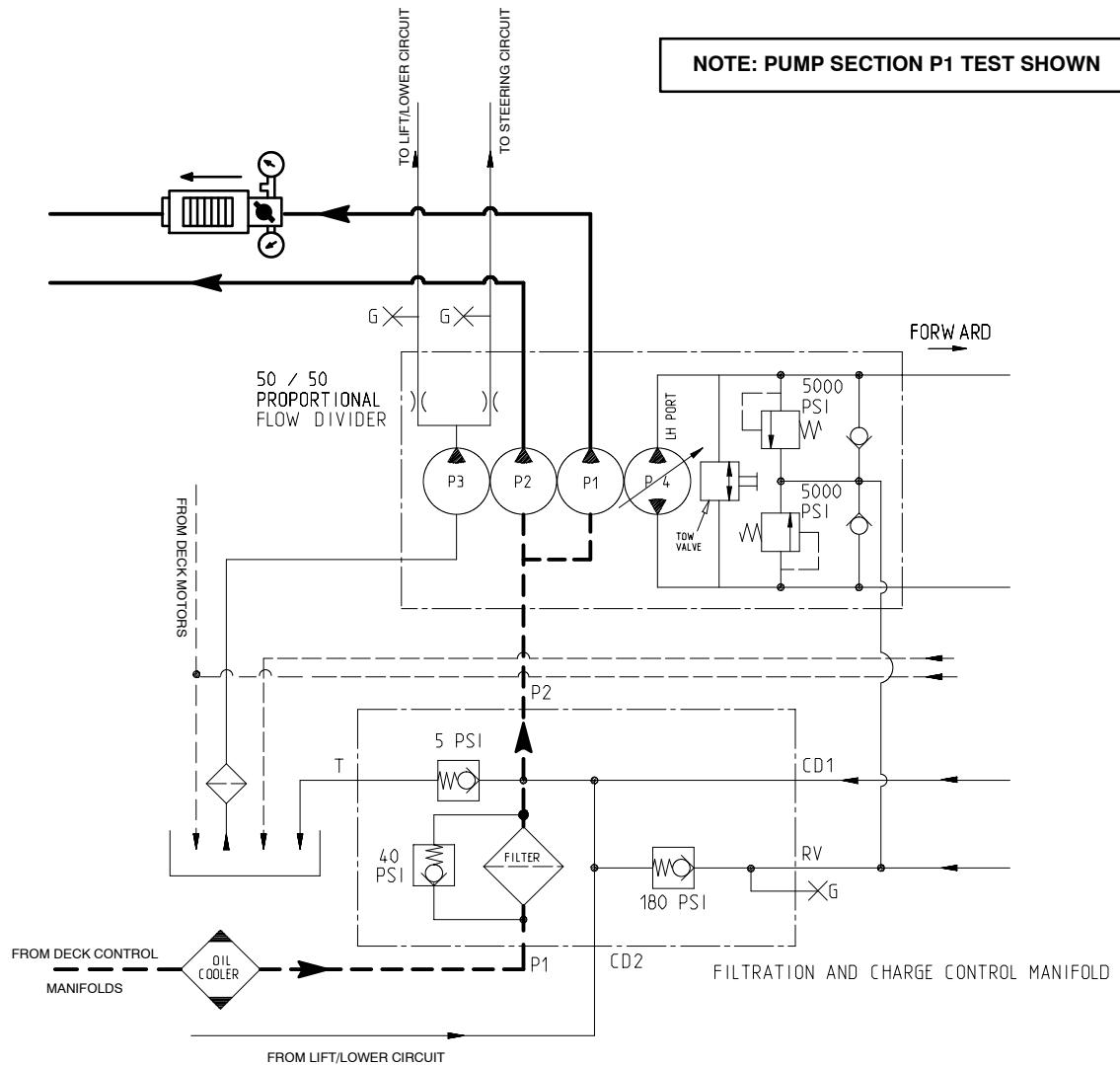


Figure 30

TEST NO. 4: Cutting Deck Gear Pump Flow (Using Tester with Pressure Gauges and Flow Meter)



— Working Pressure
 - - - Low Pressure
 - - - - Return or Suction
 ➤ Flow

Procedure for Cutting Deck Gear Pump Flow Test

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

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.
2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.



CAUTION

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

3. Locate gear pump section to be tested (P1 or P2). Disconnect appropriate hydraulic hose from 90° hydraulic fitting in gear pump (Fig. 31).
4. Install hydraulic flow meter in series with the disconnected hose and fitting in gear pump section.
5. Make sure the flow control valve on the tester is fully open.
6. Start engine and move throttle to full speed (**2800 ± 50 RPM**). **Do not engage the cutting units.**

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

7. Watch pressure gauge carefully while slowly closing the flow control valve until **2000 PSI** is obtained. Verify with a phototac that the **engine speed** is **2800 ± 50 RPM**.

8. Flow indication should be approximately **11.5 GPM**.

9. Shut off engine.

10. Disconnect flow tester from hydraulic hose and fitting. Reconnect hose to the fitting.

11. If flow was less than **11.5 GPM** or a pressure of **2000 PSI** cannot be obtained, check for restriction in the pump intake line (including oil filter and oil cooler). If line is not restricted, remove gear pump and repair or replace as necessary.

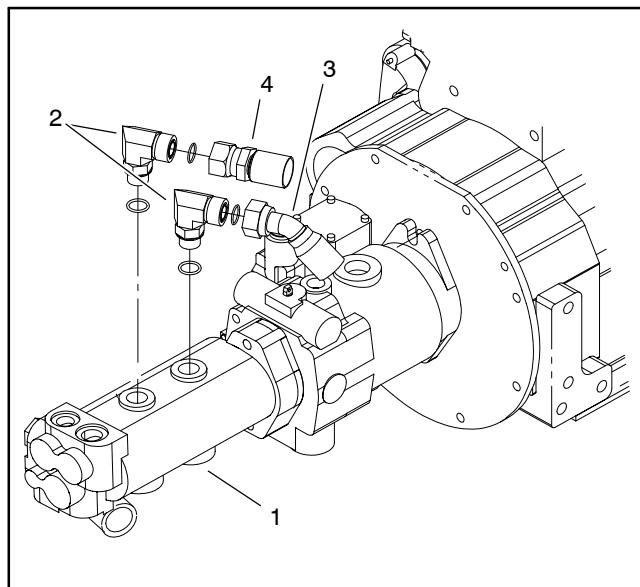
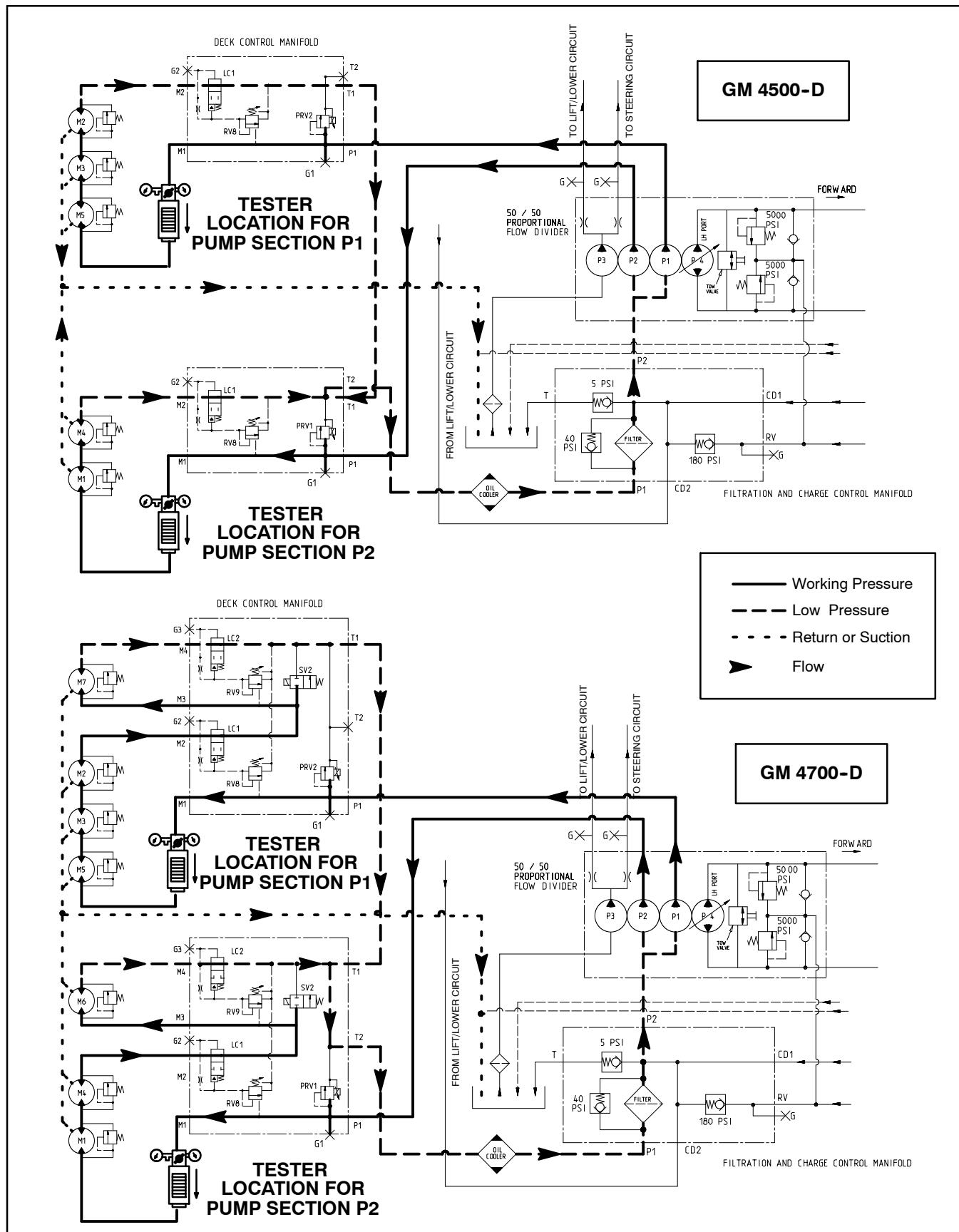


Figure 31

1. Gear pump
2. 90° hydraulic fitting
3. Pump section P1 hose
4. Pump section P2 hose

TEST NO. 5: Cutting Deck Manifold Relief Pressure (Using Tester with Pressure Gauges and Flow Meter)



Procedure for Cutting Deck Manifold Relief Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.
2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.



CAUTION

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

3. Determine deck manifold relief to be tested. Disconnect the inlet hydraulic hose to the appropriate deck motor (Fig. 32):
 - A. For pump section (P1), deck manifold relief is tested at the inlet to the motor on deck #5.
 - B. For pump section (P2), deck manifold relief is tested at the inlet to the motor on deck #1.
4. Install hydraulic flow meter in series with the the disconnected hose and deck motor inlet.
5. Make sure the flow control valve on the tester is fully open.



CAUTION

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

6. Start engine and move throttle to full speed (**2800 ± 50 RPM**). Engage the cutting units.
7. Watch pressure gauge carefully while slowly closing the flow control valve to fully closed.
8. As the relief valve lifts, system pressure should be **3400 to 3750 PSI**.
9. Disengage cutting units. Shut off engine. If specification is **not** met, clean or replace relief valve (PRV1 or PRV2) located in the hydraulic deck control manifold (Fig. 33 and 34).
10. Disconnect tester from motor and hose. Reconnect hydraulic hose to deck motor.

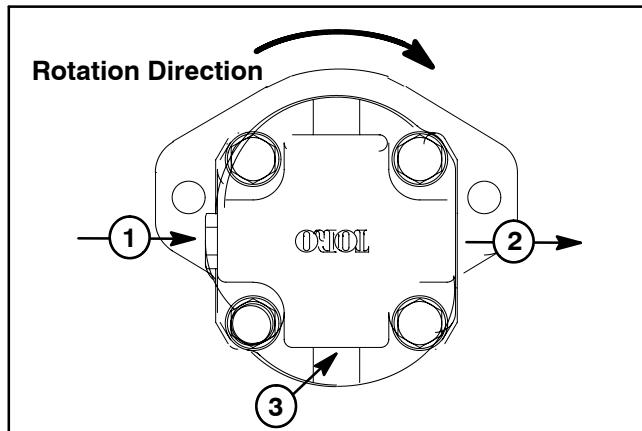


Figure 32

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



Figure 33

1. Deck 2, 3, & 5 relief valve (pump section P2)
2. Deck 1 & 4 relief valve (pump section P1)

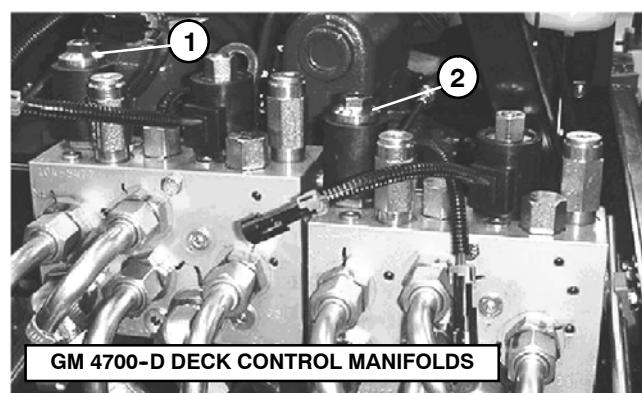


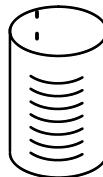
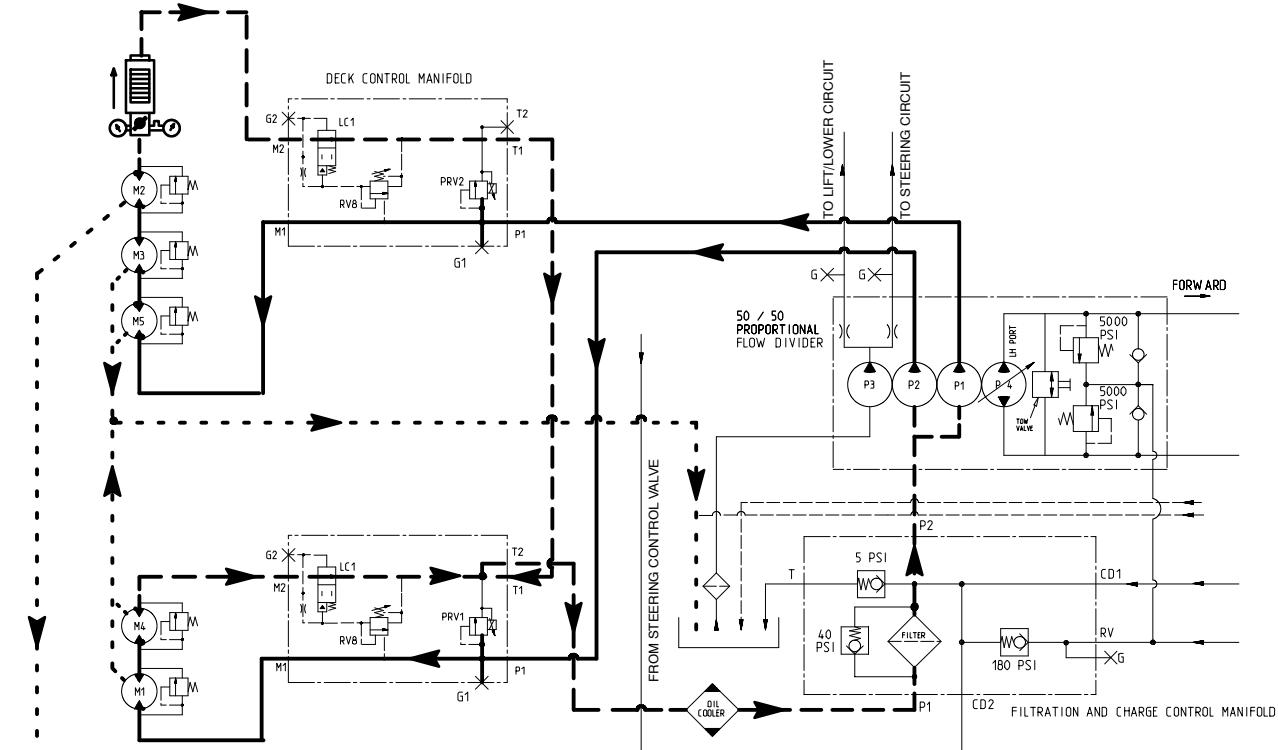
Figure 34

1. Deck 2, 3, 5, & 7 relief valve (pump section P2)
2. Deck 1, 4, & 6 relief valve (pump section P1)

TEST NO. 6: Cutting Deck Motor Case Drain Leakage (Using Tester with Pressure Gauges and Flow Meter)

**TESTER
LOCATION FOR
DECK 2**

GM 4500-D DECK #2 TEST SHOWN



**MEASURING
CONTAINER**

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

— Working Pressure
 - - - Low Pressure
 - - - - Return or Suction
 ➤ Flow

Procedure for Cutting Deck Motor Case Drain Leakage Test

NOTE: Over a period of time, a deck motor can wear internally. A worn motor may by-pass oil to its case drain causing the motor to be less efficient. Eventually, enough oil loss will cause the deck motor to stall under heavy cutting conditions. Continued operation with a worn, inefficient motor can generate excessive heat, cause damage to seals and other components in the hydraulic system, and affect quality of cut.

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

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.
2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.



CAUTION

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

NOTE: The deck motors are connected in series. To isolate a faulty motor, all motors in the circuit may have to be tested by starting with the first motor in the circuit (see Hydraulic Schematic).

3. Disconnect pressure return hose from the motor to be tested (Fig. 35). Install flow tester in series with the motor and the disconnected return hose. Make sure the flow control valve on tester is fully open. (Fig. 36).
4. Disconnect the motor case drain hose (small diameter hose) where it connects to bulkhead fitting at the frame rail (not at the motor). Put a steel cap on the bulkhead fitting; leave the case drain hose open (Fig. 36).



CAUTION

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

5. Sit on seat and start the engine. Move throttle to full speed (**2800 ± 50 RPM**). Move PTO switch to ON.

6. While watching pressure gauge, slowly close flow control valve on tester until a pressure of **1200 PSI** is obtained.

NOTE: Use a graduated container, special tool TOR4077, to measure case drain leakage (Fig. 36).

7. Have another person measure flow from the case drain line for **15 seconds**, then move the PTO switch to OFF and stop the engine.

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

8. Disconnect tester from motor and hose. Reconnect hose to the deck motor. Remove cap from bulkhead fitting and reconnect case drain hose.
9. If flow is more than **0.7 GPM**, the motor is worn or damaged and should be repaired or replaced.

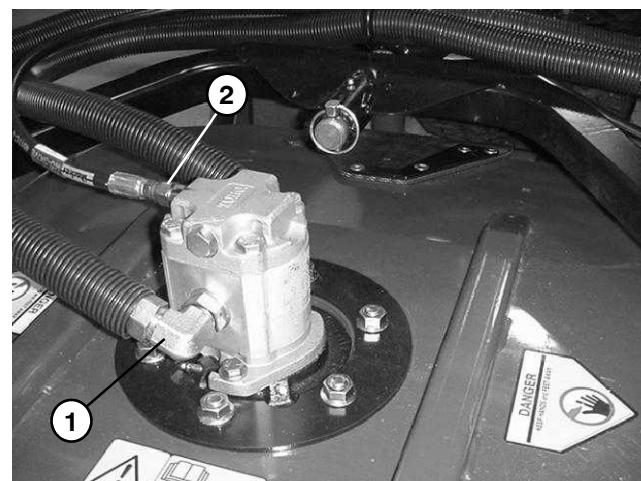


Figure 35

1. Pressure return hose 2. Case drain hose

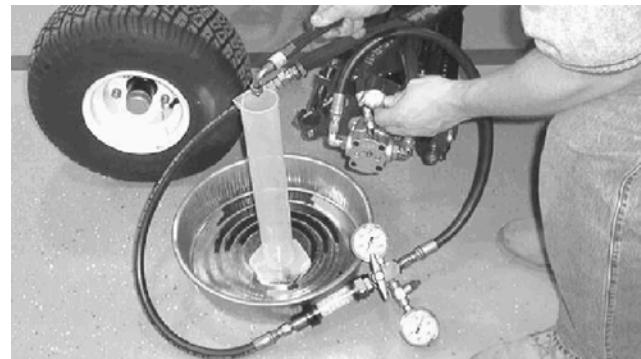
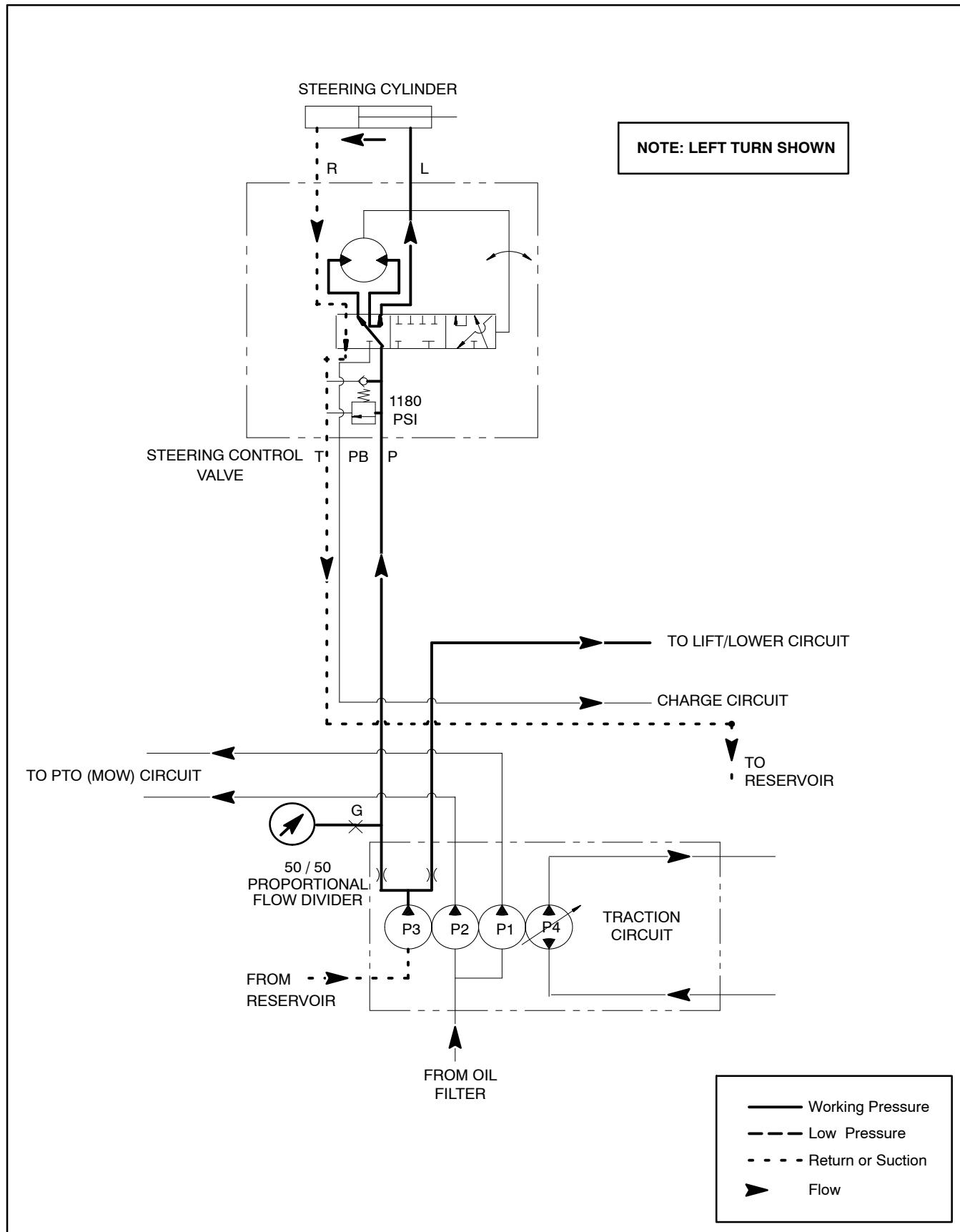


Figure 36

TEST NO. 7: Steering Circuit Relief Pressure (Using Pressure Gauge)



Procedure for Steering Circuit Relief Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.
2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.



CAUTION

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

3. Raise seat to gain access to steering circuit test port located on the front end of the gear pump (Fig. 37). Connect a 5000 PSI gauge onto steering circuit test port. Route gauge hose to allow seat to be safely lowered.
4. Start the engine and move throttle to full engine speed (**2800 ± 50 RPM**).

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

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

GAUGE READING TO BE 1150 TO 1500 PSI.

6. Stop the engine.
7. If pressure is incorrect, inspect steering relief valve located in the steering control valve (Fig. 38). If relief valve is operating properly and if lift/lower problems also exist, gear pump should be suspected of wear and inefficiency. If steering wheel continues to turn at end of cylinder travel (with lower than normal effort), steering cylinder or steering control valve should be suspected of wear or damage.

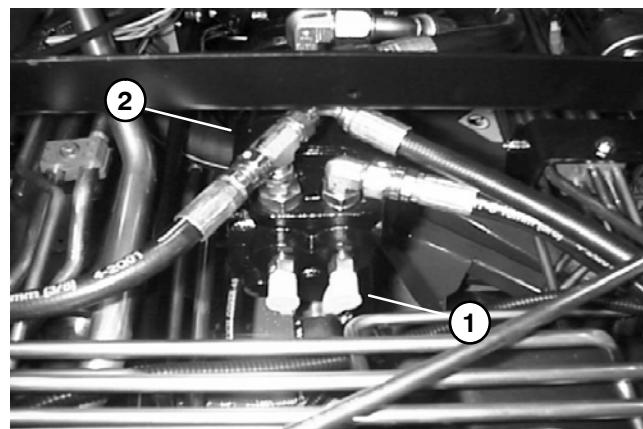


Figure 37
1. Steering circuit test port 2. Gear pump

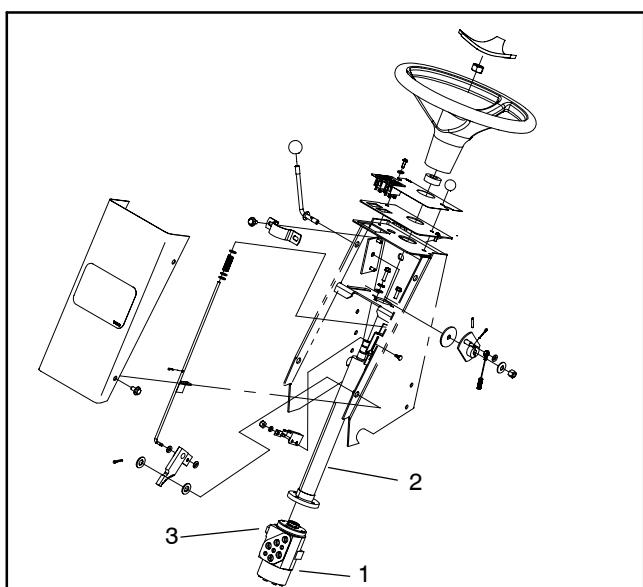
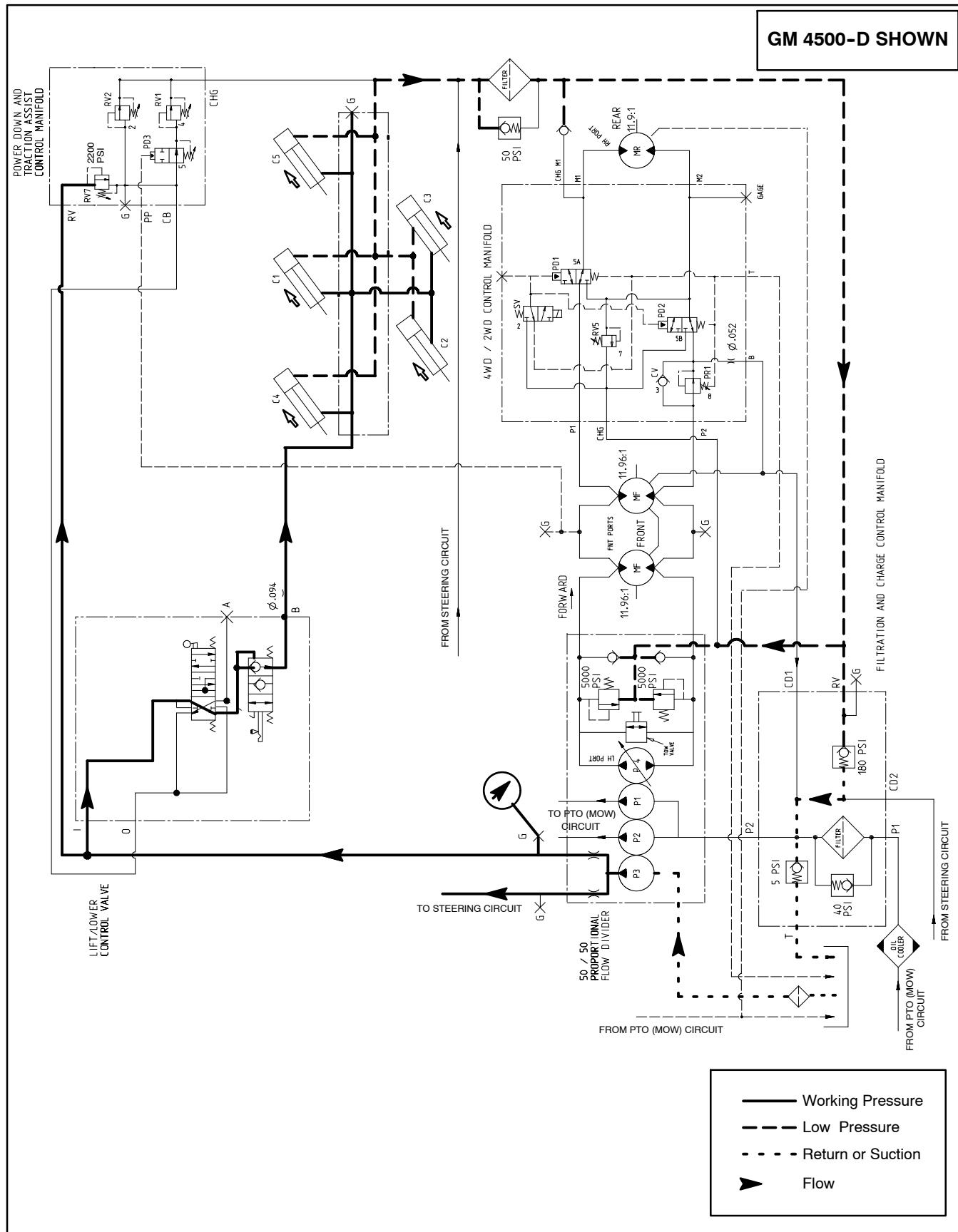


Figure 38
1. Steering control valve 2. Steering column 3. Steering relief valve

TEST NO. 8: Lift/Lower Circuit Relief Pressure (Using Pressure Gauge)



Procedure for Lift/Lower Circuit Relief Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.
2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.



CAUTION

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

3. Raise seat to gain access to lift circuit test port located on the front end of the gear pump (Fig. 39). Connect a 5000 PSI gauge onto lift circuit test port. Route gauge hose to allow seat to be safely lowered.
4. Sit on the seat and start the engine. Move throttle to full speed (**2800 ± 50 RPM**).
5. While sitting on the seat, pull lift lever back to raise the cutting units. Momentarily hold the lever with the lift cylinder at full extension while looking at the gauge.

GAUGE READING TO BE 2000 to 2600 PSI.

6. Stop the engine.
7. If specification is not met, adjust or clean relief valve located on the side of power down and traction assist control manifold under operator seat (Fig. 40).
 - A. If pressure is too high, remove cap on relief valve (Fig. 41). Adjust relief valve by rotating adjustment socket counterclockwise (decreasing relief pressure).
 - B. If pressure is too low, check for restriction in gear pump intake line. Check the lift cylinders for internal leakage. If pump intake line is not restricted and lift cylinders are not leaking, remove cap on relief valve (Fig. 41). Adjust the relief valve by rotating adjustment socket clockwise (increasing relief pressure).
 - C. If pressure is still too low after relief valve adjustment, pump or lift cylinder(s) should be suspected of wear, damage or inefficiency.

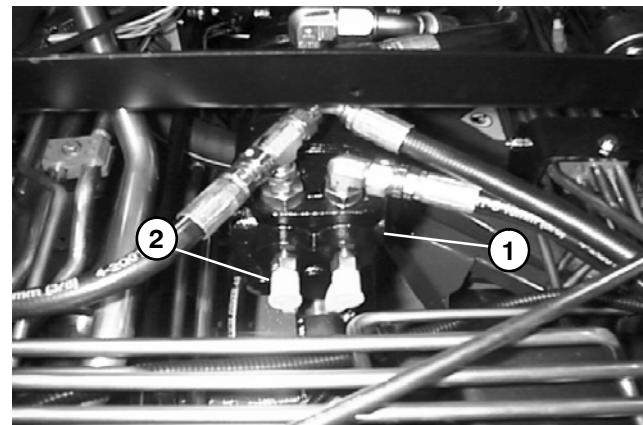


Figure 39
1. Lift circuit test port
2. Gear pump

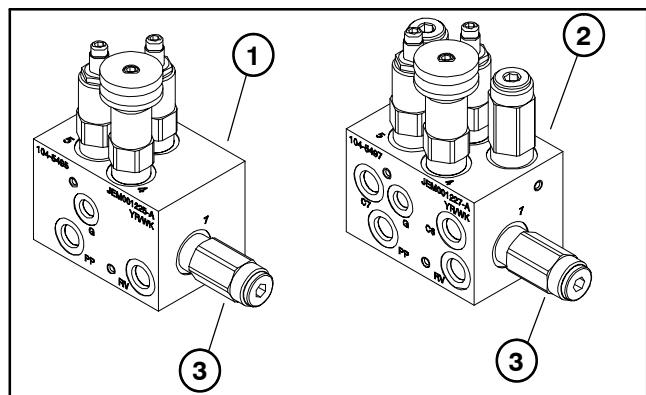


Figure 40
1. GM 4500-D control manifold
2. GM 4700-D control manifold
3. Lift/lower relief valve

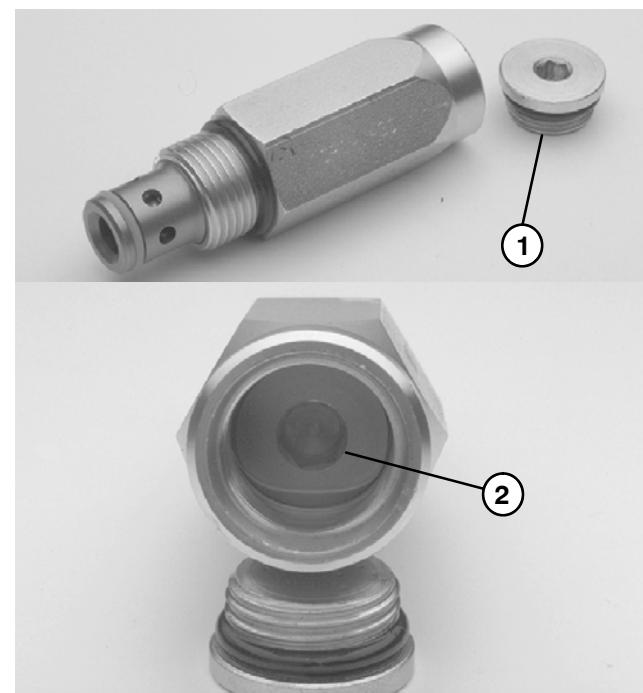
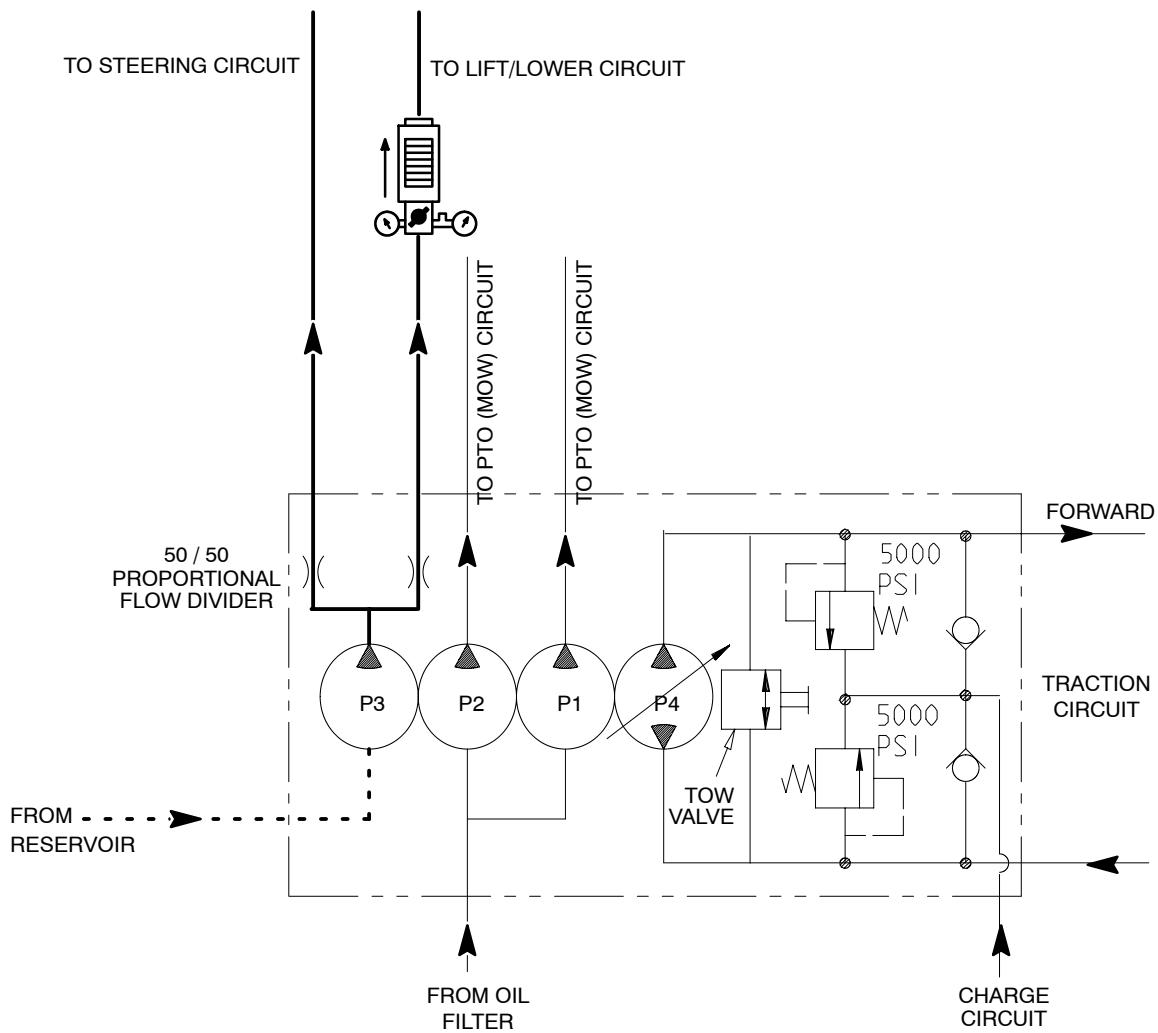


Figure 41
1. Relief valve cap
2. Adjustment socket

TEST NO. 9: Steering and Lift/Lower Gear Pump Flow (Using Tester with Pressure Gauges and Flow Meter)

NOTE: LIFT/LOWER GEAR PUMP FLOW TEST SHOWN



———	Working Pressure
— - -	Low Pressure
- - - -	Return or Suction
►	Flow

Procedure for Steering and Lift/Lower Gear Pump Flow Test

Output from the steering and lift/lower gear pump section is equally divided by a proportional valve to provide flow to the steering circuit and the lift circuit. To test gear pump flow, testing of both circuits is required. Total gear pump flow is the combined flow from the two circuits.

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.
2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.



CAUTION

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

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

3. With the engine off and cutting units lowered, install tester in series between the last gear pump section and one of the circuit hoses (Fig. 42). Make sure the tester flow control valve is OPEN.

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

4. Start the engine and move throttle to full speed (**2800 ± 50 RPM**). DO NOT engage the cutting units.
5. While watching pressure gauges, slowly close flow control valve until **1000 PSI** is obtained on gauge. Verify engine speed continues to be correct (**2800 ± 50 RPM**).

FLOW GAUGE READING TO BE: Flow approximately **3.2 GPM** at **1000 PSI**.

6. Stop engine. Remove tester and reinstall hydraulic hose to gear pump. Complete steps 3 through 6 for other circuit hose.

7. If the **total** of the two flows is lower than **6.4 GPM** or a pressure of **1000 PSI** could not be obtained, check for restriction in pump intake line. If intake line is not restricted, remove gear pump and repair or replace as necessary.

If the **total** of the two flows is **6.4 GPM** but individual circuit flow is less than **3.2 GPM** (e.g. steering circuit has 2 GPM and lift circuit has 4.4 GPM), suspect a problem with the proportional valve in the gear pump.

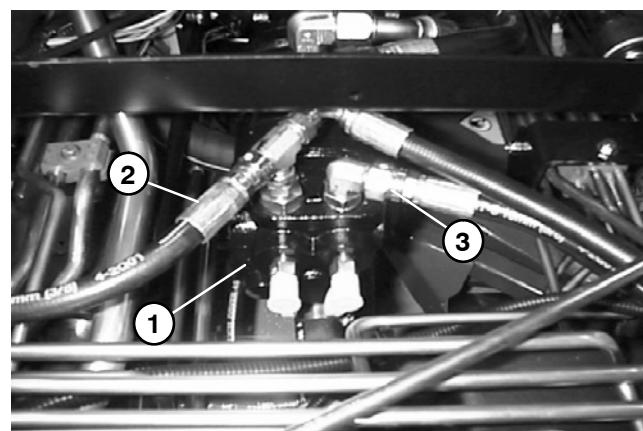


Figure 42

1. Gear pump
2. Lift circuit hose

3. Steering circuit hose

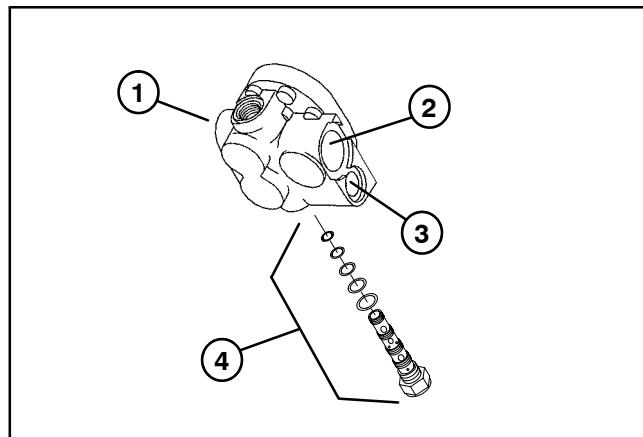
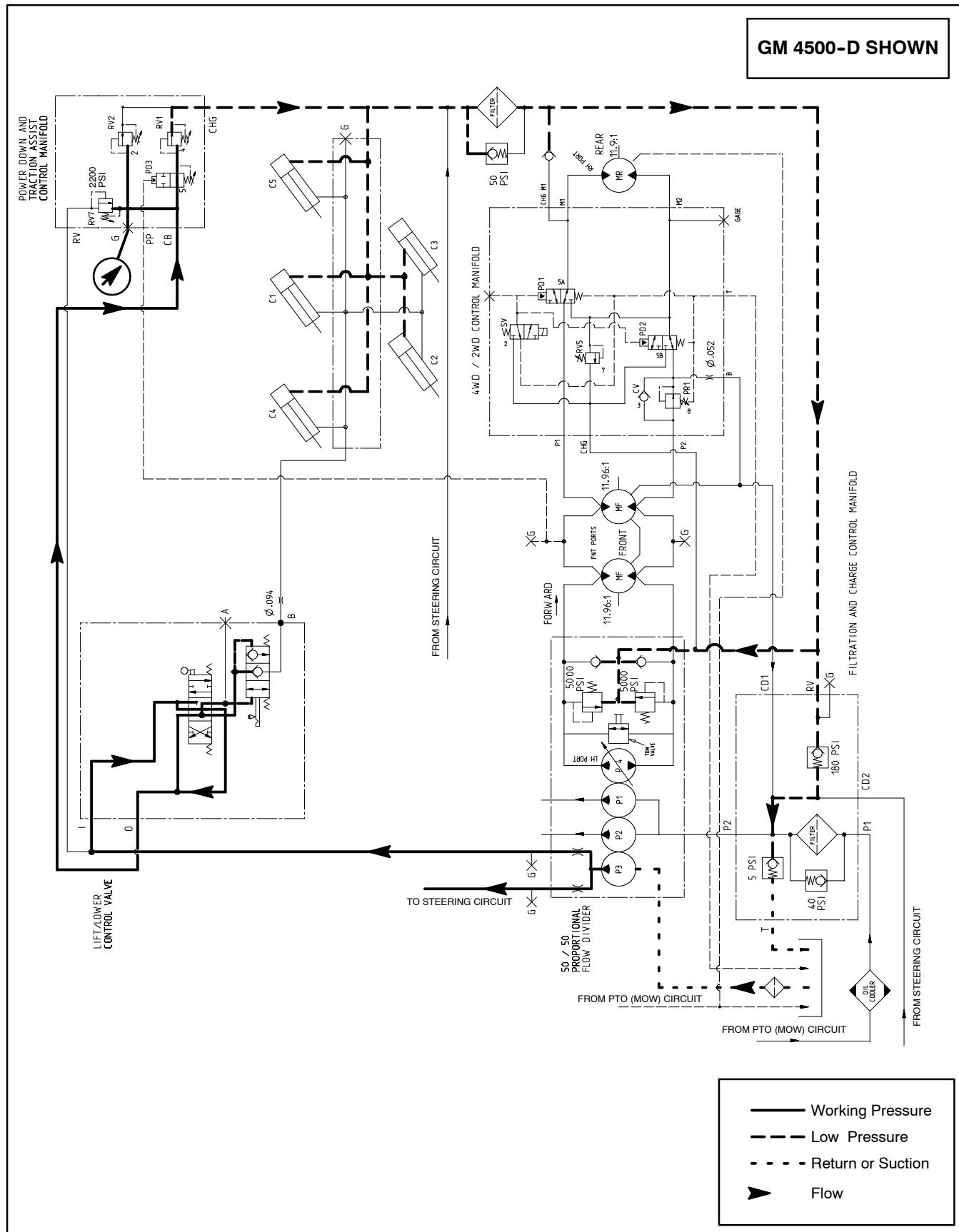


Figure 43

1. Gear pump backplate
2. Lift circuit
3. Steering circuit
4. Proportional valve

TEST NO. 10: Counterbalance (RV1) Pressure (Using Pressure Gauge)



Procedure for Counterbalance (RV1) Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.
2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.



CAUTION

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

3. Connect a 1000 PSI gauge to counterbalance test port on power down and traction assist manifold under operator's seat (Fig. 44).
4. Start the engine and put throttle at full engine speed (**2800 ± 50 RPM**) with no load on the system. **Do not engage the cutting units.**

GAUGE READING TO BE 600 to 640 PSI.

NOTE: Counterbalance pressure setting toward the higher specification (640 PSI) will improve traction on slopes. Counterbalance pressure setting toward the lower specification (600 PSI) improves quality of cut.

5. Adjustment of the counterbalance valve can be performed as follows:

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

A. To **increase** pressure setting, turn the adjusting dial on the counterbalance valve in a clockwise direction. A 1/8 turn on the dial will make a measurable change in counterbalance pressure (Fig. 45).

B. To **decrease** pressure setting, turn the adjusting dial on the counterbalance valve in a counterclockwise direction. A 1/8 turn on the dial will make a measurable change in counterbalance pressure (Fig. 45).

C. Recheck counterbalance pressure and readjust as needed.

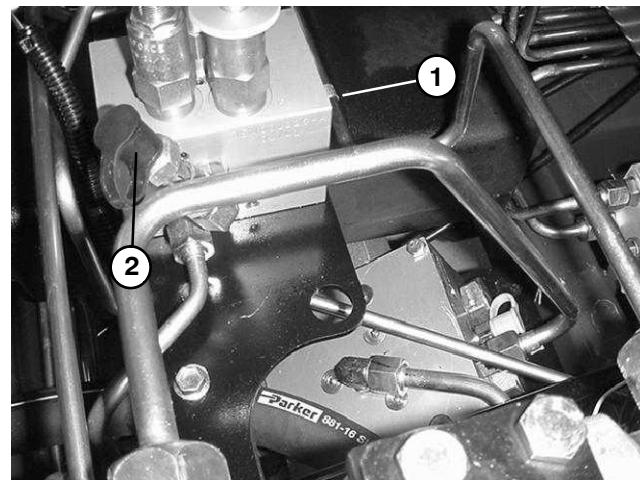


Figure 44

1. Traction assist manifold (GM 4500-D shown)
2. Counterbalance test port

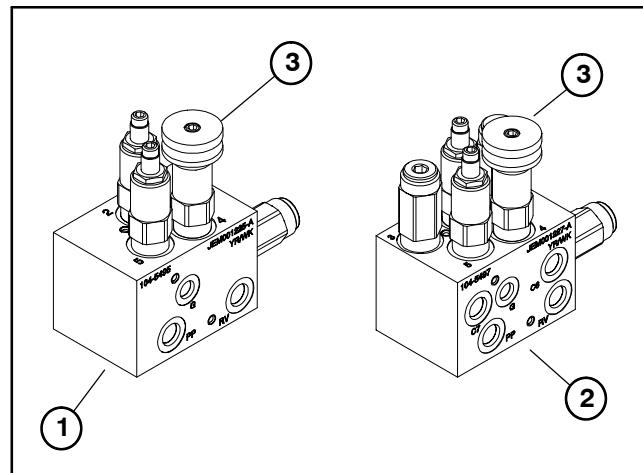
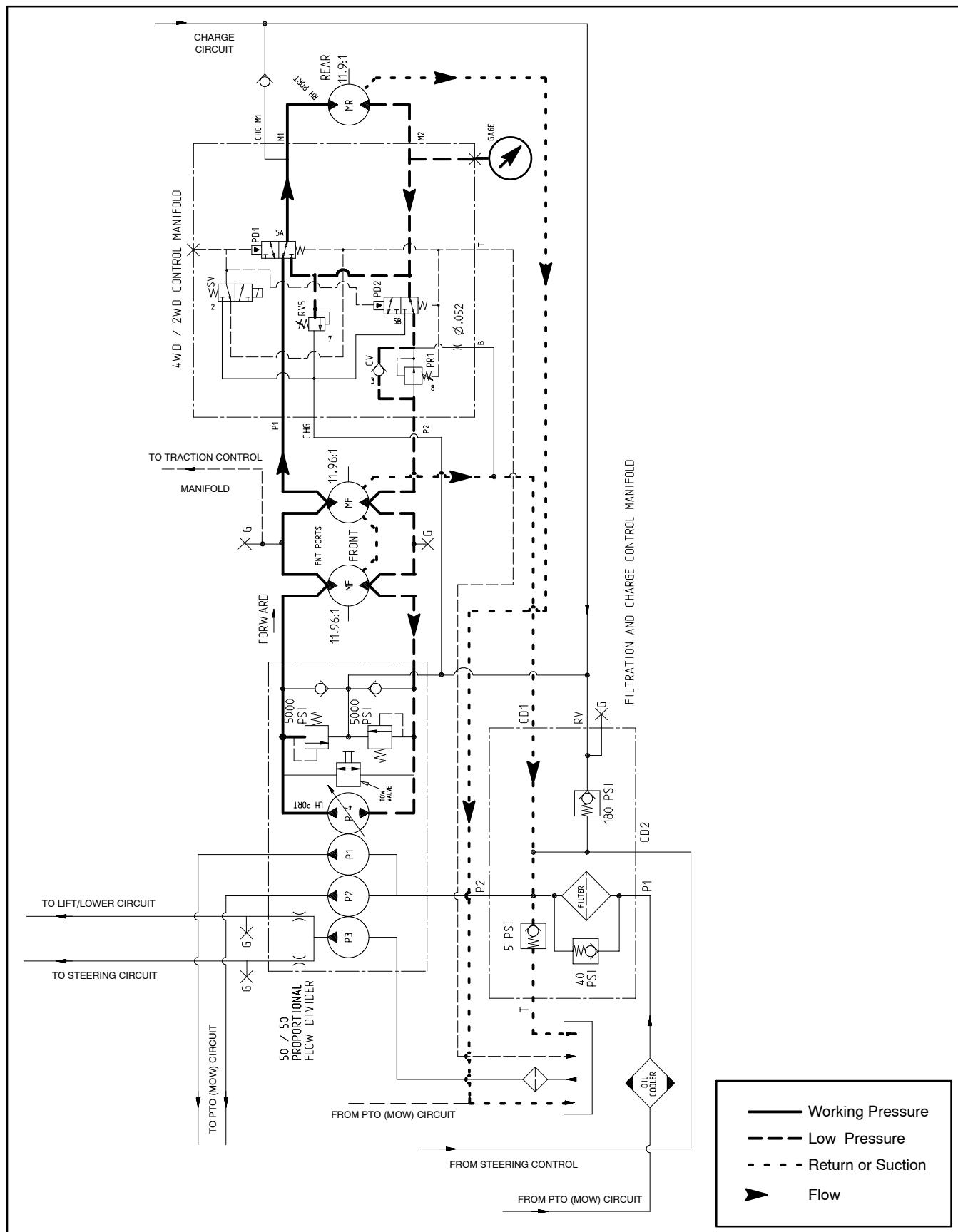


Figure 45

1. GM 4500-D traction assist manifold
2. GM 4700-D traction assist manifold
3. Counterbalance valve (RV1)

TEST NO. 11: Rear Traction Circuit (RV5) Relief Pressure (Using Pressure Gauge)



Procedure for Rear Traction Circuit (RV5) Relief Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.
2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.



CAUTION

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

3. Connect a 1000 PSI gauge to test port on 2WD/4WD control manifold under operator's seat (Fig. 46).
4. Start the engine and put throttle at full engine speed (**2800 ± 50 RPM**).
5. Operate the machine in 4WD with the cutting units lowered. Drive down a slope in a forward direction, decrease pressure on the traction pedal, and monitor the pressure gauge. Pressure should increase until the relief valve lifts.

GAUGE READING TO BE 520 to 570 PSI.

6. Relief valve (RV5) is located on the lower, rear side of the 2WD/4WD control manifold (Fig. 47). Adjustment of the relief valve can be performed as follows:

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

A. To **increase** relief pressure setting, remove cap on relief valve and turn the adjustment socket on the relief valve in a clockwise direction. A 1/8 turn on the socket will make a measurable change in relief pressure (Fig. 48).

B. To **decrease** pressure setting, remove cap on relief valve and turn the adjustment socket on the relief valve in a counterclockwise direction. A 1/8 turn on the socket will make a measurable change in relief pressure (Fig. 48).

C. Recheck relief pressure and readjust as needed.

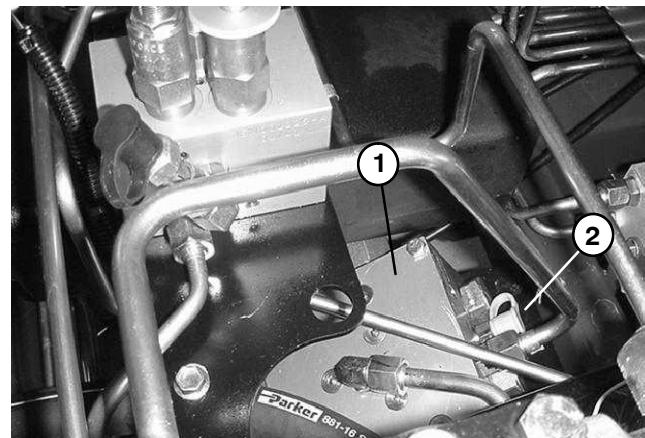


Figure 46

1. 2WD/4WD control manifold (GM 4500-D shown)
2. Relief valve test port

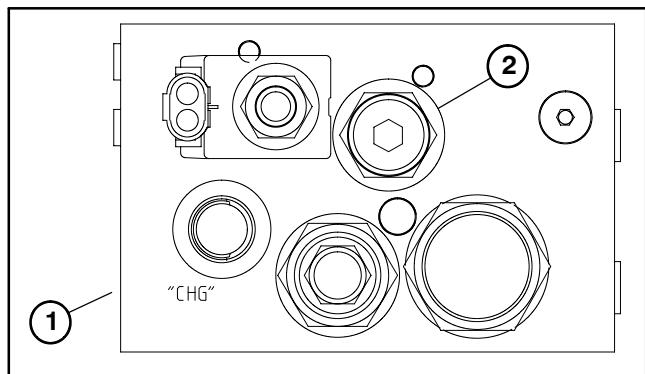


Figure 47

1. Manifold: lower side
2. Relief valve (RV5)

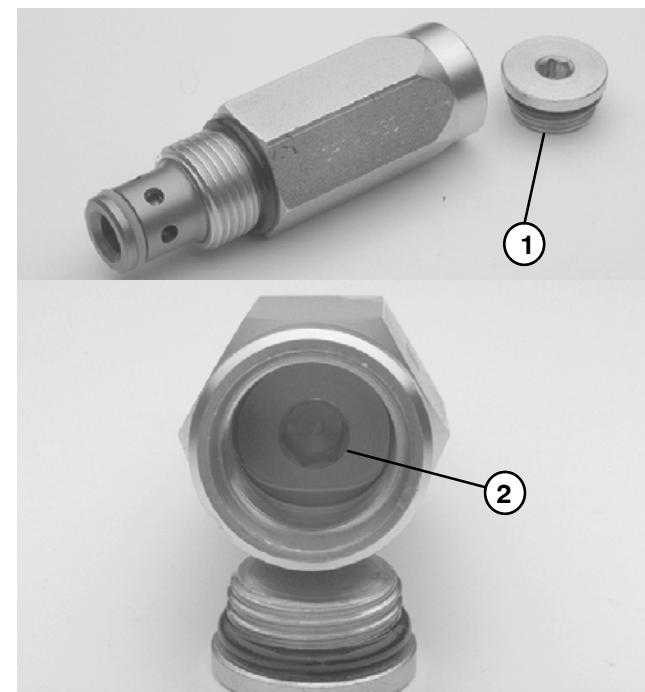
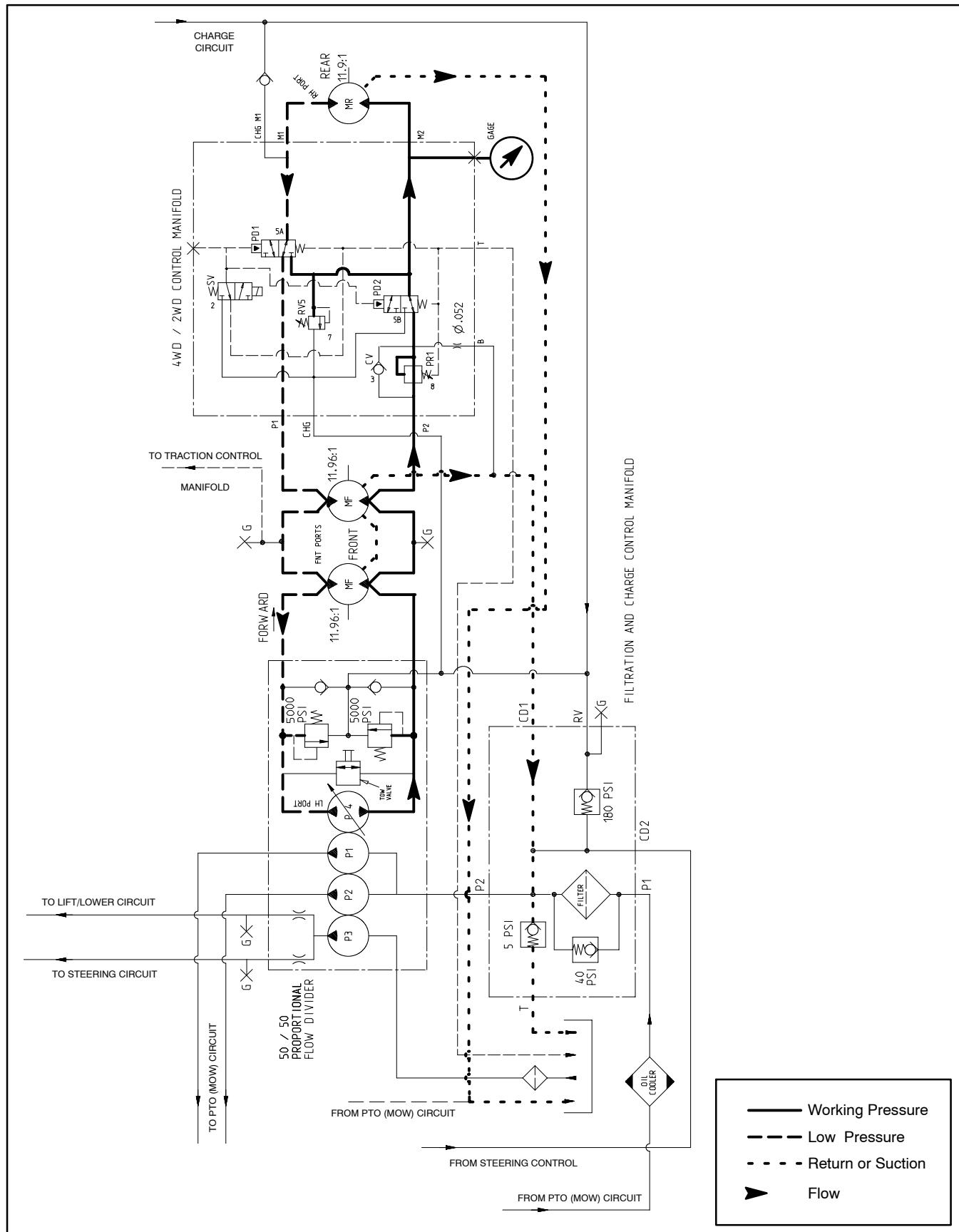


Figure 48

1. Relief valve cap
2. Adjustment socket

TEST NO. 12: Traction Circuit Reducing Valve (PR1) Pressure (Using Pressure Gauge)



Procedure for Traction Circuit Reducing Valve (PR1) Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.
2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.



CAUTION

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

3. Connect a 1000 PSI gauge to test port on 2WD/4WD control manifold under operator's seat (Fig. 49).
4. Start the engine and put throttle at full engine speed (**2800 ± 50 RPM**).
5. Sit on seat, apply brakes fully, and slowly depress the traction pedal in the reverse direction. While pushing traction pedal, look at pressure reading on gauge:

GAUGE READING TO BE 420 to 470 PSI.

6. Pressure reducing valve (PR1) is located on the lower, rear side of the 2WD/4WD control manifold (Fig. 50). Adjustment of this valve can be performed as follows:

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

- A. To **increase** pressure setting, remove cap on reducing valve and turn the adjustment socket on the valve in a clockwise direction. A 1/8 turn on the socket will make a measurable change in pressure setting.
- B. To **decrease** pressure setting, remove cap on reducing valve and turn the adjustment socket on the valve in a counterclockwise direction. A 1/8 turn on the socket will make a measurable change in pressure setting.
- C. Recheck pressure setting and readjust as needed.

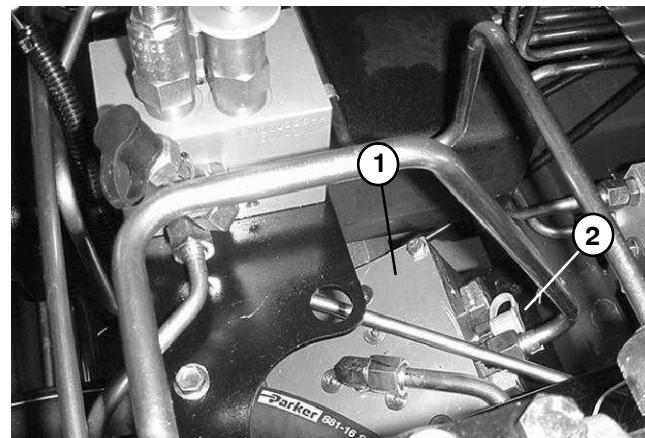


Figure 49

1. 2WD/4WD control manifold (GM 4500-D shown)
2. Relief valve test port

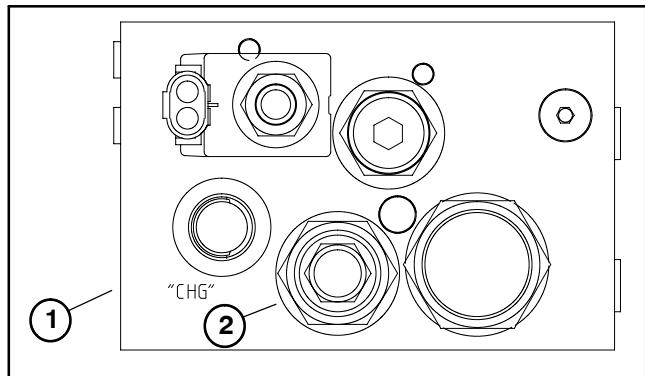
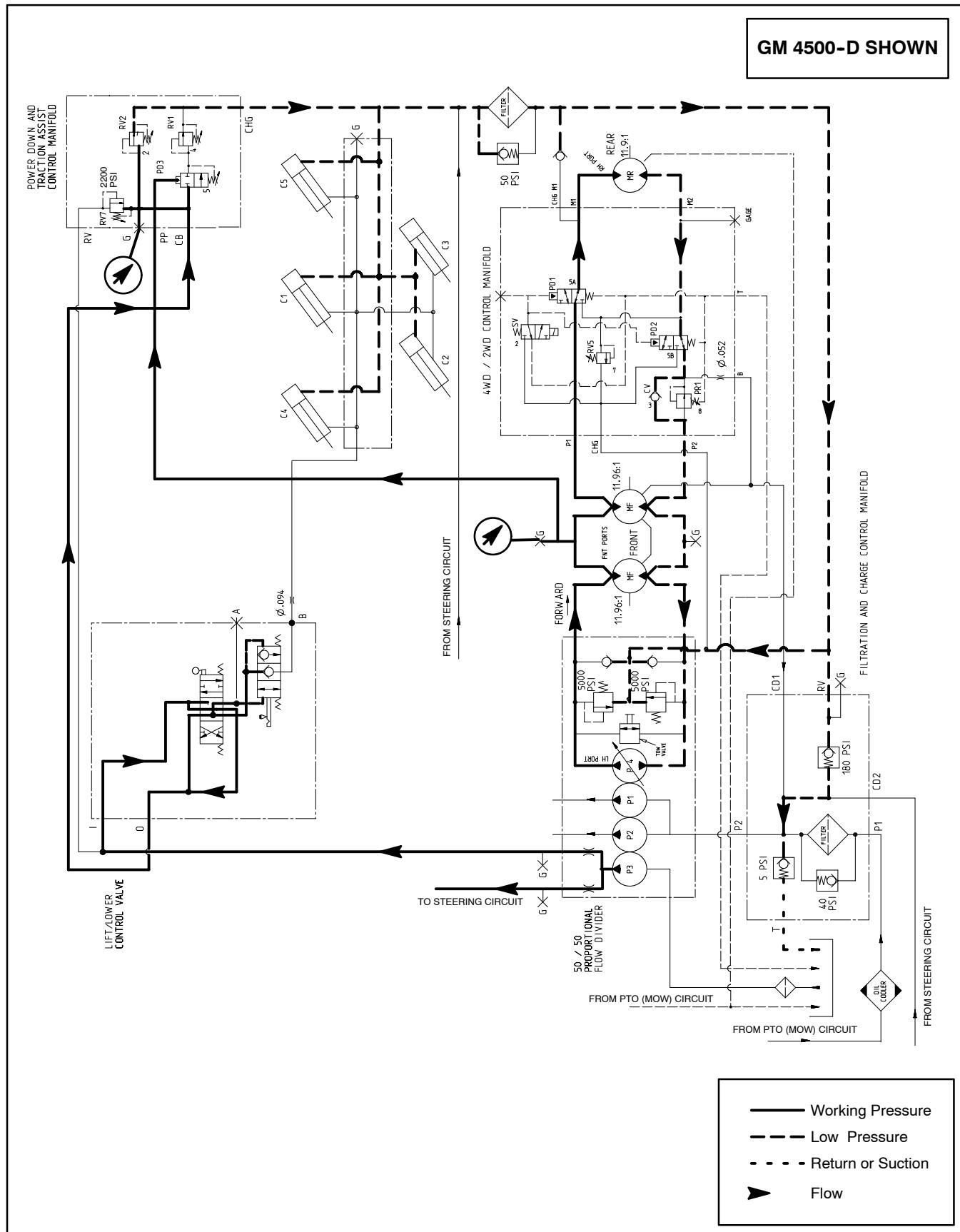


Figure 50

1. Manifold: lower side
2. Reducing valve (PR1)

TEST NO. 13: Traction Assist (RV2) Pressure (Using Pressure Gauges)



Procedure for Traction Assist (RV2) Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the machine for approximately 10 minutes. Make sure the hydraulic tank is full.
2. Park machine on a level surface with the cutting units lowered and off. Make sure engine is off and the parking brake is engaged.



CAUTION

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

3. Connect a 1000 PSI gauge to counterbalance test port on power down and traction assist manifold under operator's seat (Fig. 51). Also, connect a 5000 PSI gauge to forward traction port on traction circuit hydraulic tube (Fig. 52).
4. Start the engine and put throttle at full engine speed (**2800 ± 50 RPM**) with no load on the system. **Do not engage the cutting units.**
5. Sit on seat, apply brakes fully, and slowly depress the traction pedal in the forward direction. While pushing traction pedal monitor both pressure gauges.
6. As traction circuit pressure reaches approximately 1800 PSI, directional valve (PD3) should shift. This shift will allow counterbalance hydraulic flow to be directed to the traction assist valve (RV2). While maintaining traction circuit pressure, look at pressure reading on gauge connected to the counterbalance test port:

GAUGE READING TO BE 650 to 750 PSI.

7. Adjustment of the traction assist valve (RV2) can be performed as follows:

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

- A. To **increase** pressure setting, loosen the locknut and turn the adjusting screw on the relief valve in a clockwise direction. A 1/8 turn on the dial will make a measurable change in pressure (Fig. 45).
- B. To **decrease** pressure setting, loosen the locknut and turn the adjusting screw on the relief valve in a counterclockwise direction. A 1/8 turn on the dial will make a measurable change in pressure (Fig. 45).
- C. Recheck pressure and readjust as needed.

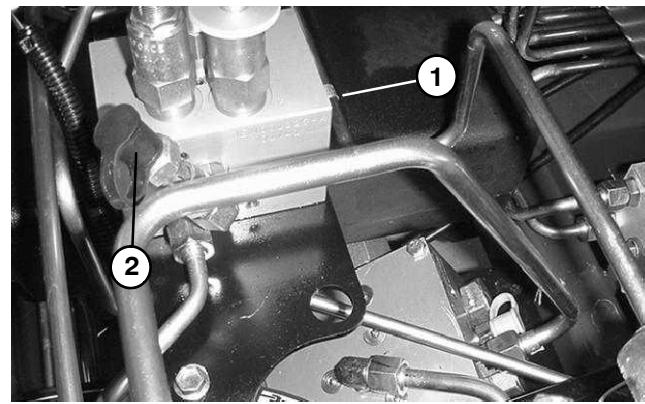


Figure 51
1. Traction assist manifold (GM 4500-D shown)
2. Counterbalance test port



Figure 52
1. Forward traction port (faces forward)

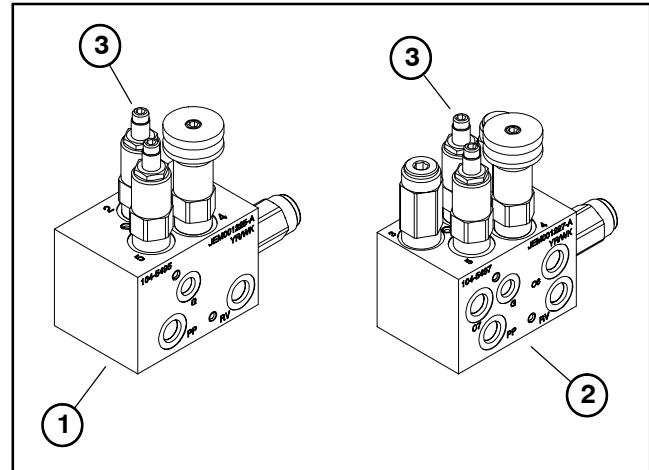


Figure 53
1. GM 4500-D traction assist manifold
2. GM 4700-D traction assist manifold
3. Traction assist valve (RV2)

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 equipment.



CAUTION

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

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

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.

After Repair or Replacement of Components

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

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

Flush Hydraulic System

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

IMPORTANT: Flush hydraulic system when changing from petroleum base hydraulic fluid to a biodegradable fluid such as Mobil EAL 224H. Operate machine under normal operating conditions for at least four (4) hours before draining.

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



CAUTION

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

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

2. Drain hydraulic reservoir (see Traction Unit Operator's Manual).
3. Drain hydraulic system. Drain all hoses, tubes, and components while the system is warm.
4. Change and replace both hydraulic oil filters (see Traction Unit Operator's Manual).
5. Inspect and clean hydraulic reservoir (see Hydraulic Reservoir Inspection).

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

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

7. Fill hydraulic reservoir with **new** hydraulic fluid (see Traction Unit Operator's Manual).

8. Disconnect electrical connector from engine run solenoid.

9. Turn ignition key switch; engage starter for 10 seconds to prime pump. Repeat this step again.

10. Connect electrical connector to engine run solenoid.

11. Start engine and let it idle at low speed (**1300 RPM**) for a minimum of 2 minutes. Increase engine speed to high idle (**2800 ± 50 RPM**) for minimum of 1 minute under no load.

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

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

14. Operate machine for 2 hours under normal operating conditions.

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

16. Assume normal operation and follow recommended maintenance intervals.

Charge Hydraulic System

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

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

1. Park machine on a level surface. Lower cutting units, 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).
4. Make sure hydraulic reservoir is full. Add correct hydraulic oil if necessary (see Traction Unit Operator's Manual).
5. Disconnect engine run solenoid lead to prevent the engine from starting.
6. Check control rod to the piston (traction) pump for proper adjustment, binding, or broken parts.
7. Make sure traction pedal and lift control lever are in the **neutral** position. Turn ignition key switch; engage starter for **fifteen (15) seconds** to prime the traction and gear pumps.
8. Reconnect engine run solenoid lead.



WARNING

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

9. Raise one front and one rear wheel off the ground, and place support blocks under the frame. Chock remaining wheels to prevent movement of the machine.
10. Make sure traction pedal and lift control lever are in **neutral**. Start engine and run it at low idle (**1300 rpm**). The charge pump should pick up oil and fill the hydraulic system. If there is no indication of fill in **30 seconds**, stop the engine and determine the cause.

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

- A. Loose filter or suction lines.
 - B. Blocked suction line.
 - C. Faulty charge relief valve.
 - D. Faulty gear pump.
12. If cylinder does move in **10 to 15 seconds**, proceed to step 13.
13. Operate the traction pedal in the forward and reverse directions. The wheels off the ground should rotate in the proper direction.
- A. If the wheels rotate in the wrong direction, stop engine, remove lines from bottom of piston (traction) pump, and reverse the connections.
 - B. If the wheels rotate in the proper direction, stop engine.
14. Adjust traction pedal to the neutral position (see Traction Unit Operator's Manual).
15. Check operation of the traction interlock switch (see Traction Unit Operator's Manual).
16. Remove blocks from frame and lower machine. Remove chocks from remaining wheels.
17. If the piston (traction) pump or a traction motor was replaced or rebuilt, run the machine so all wheels turn slowly for 10 minutes.
18. Operate machine by gradually increasing its work load to full over a 10 minute period.
19. Stop the machine. Check hydraulic reservoir and fill if necessary. Check hydraulic components for leaks and tighten any loose connections.

This page is intentionally blank.

Gear Pump

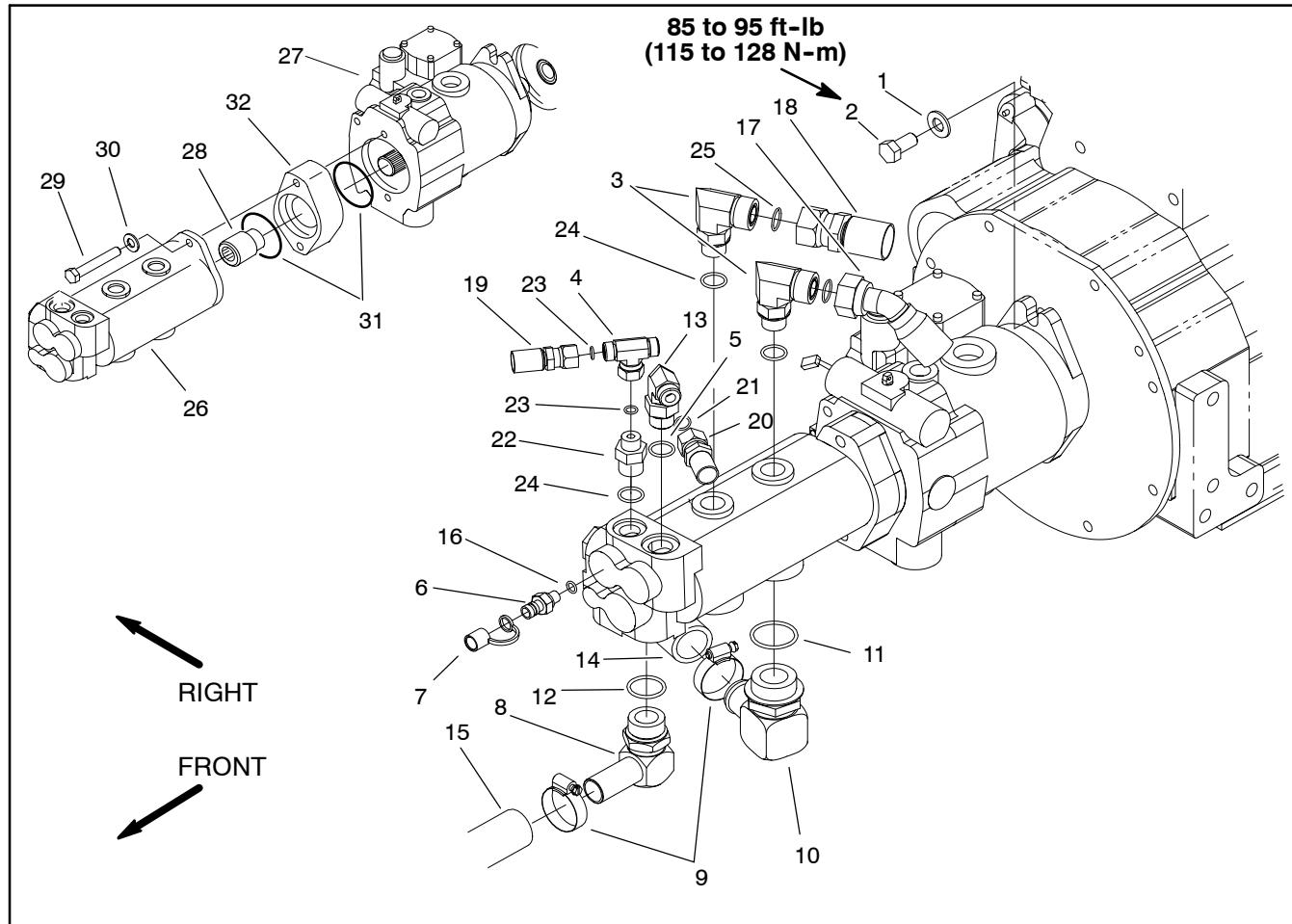


Figure 54

- | | | |
|---------------------------|---------------------------|--------------------------|
| 1. Flat washer | 12. O-ring | 23. O-ring |
| 2. Cap screw | 13. 90° hydraulic fitting | 24. O-ring |
| 3. 90° hydraulic fitting | 14. Suction hose | 25. O-ring |
| 4. Hydraulic tee fitting | 15. Suction hose | 26. Gear pump assembly |
| 5. O-ring | 16. O-ring | 27. Piston pump assembly |
| 6. Quick fitting | 17. Hydraulic hose | 28. Coupler |
| 7. Dust cap | 18. Hydraulic hose | 29. Cap screw |
| 8. 90° hydraulic fitting | 19. Hydraulic hose | 30. Washer |
| 9. Clamp | 20. Hydraulic hose | 31. O-ring |
| 10. 90° hydraulic fitting | 21. O-ring | 32. Spacer |
| 11. O-ring | 22. Hydraulic fitting | |

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 seat and secure it with prop rod to gain access to gear pump.
3. Drain the hydraulic reservoir (see Traction Unit Operator's Manual).
4. To prevent contamination of hydraulic system during removal, thoroughly clean exterior of pump and fittings.
5. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.
6. Disconnect hydraulic lines from gear pump and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper reassembly.
7. Support gear pump assembly to prevent it from falling.
8. Remove two (2) cap screws and washers securing gear pump to piston pump. Remove gear pump, coupler, spacer, and o-rings from machine.

Installation

1. Lubricate new o-rings with clean hydraulic oil and position on gear pump.
2. Slide coupler onto the piston pump output shaft.
3. Position o-rings and spacer to gear pump. Align gear teeth and slide gear pump input shaft into coupler. Secure gear pump to piston pump with two (2) cap screws and washers.
4. Remove caps and plugs from hydraulic lines and fittings. Install lines to gear pump.
5. Replace hydraulic filter and fill hydraulic reservoir with new hydraulic oil.
6. Disconnect engine run solenoid electrical connector to prevent engine from starting. Prime the hydraulic pump by turning the ignition key switch to start and crank the engine for 10 seconds. Repeat cranking procedure again.
7. Connect engine run solenoid electrical connector, start the engine, and check for proper operation.
8. Properly fill hydraulic system (see Charge Hydraulic System).
9. Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level.

Gear Pump Service

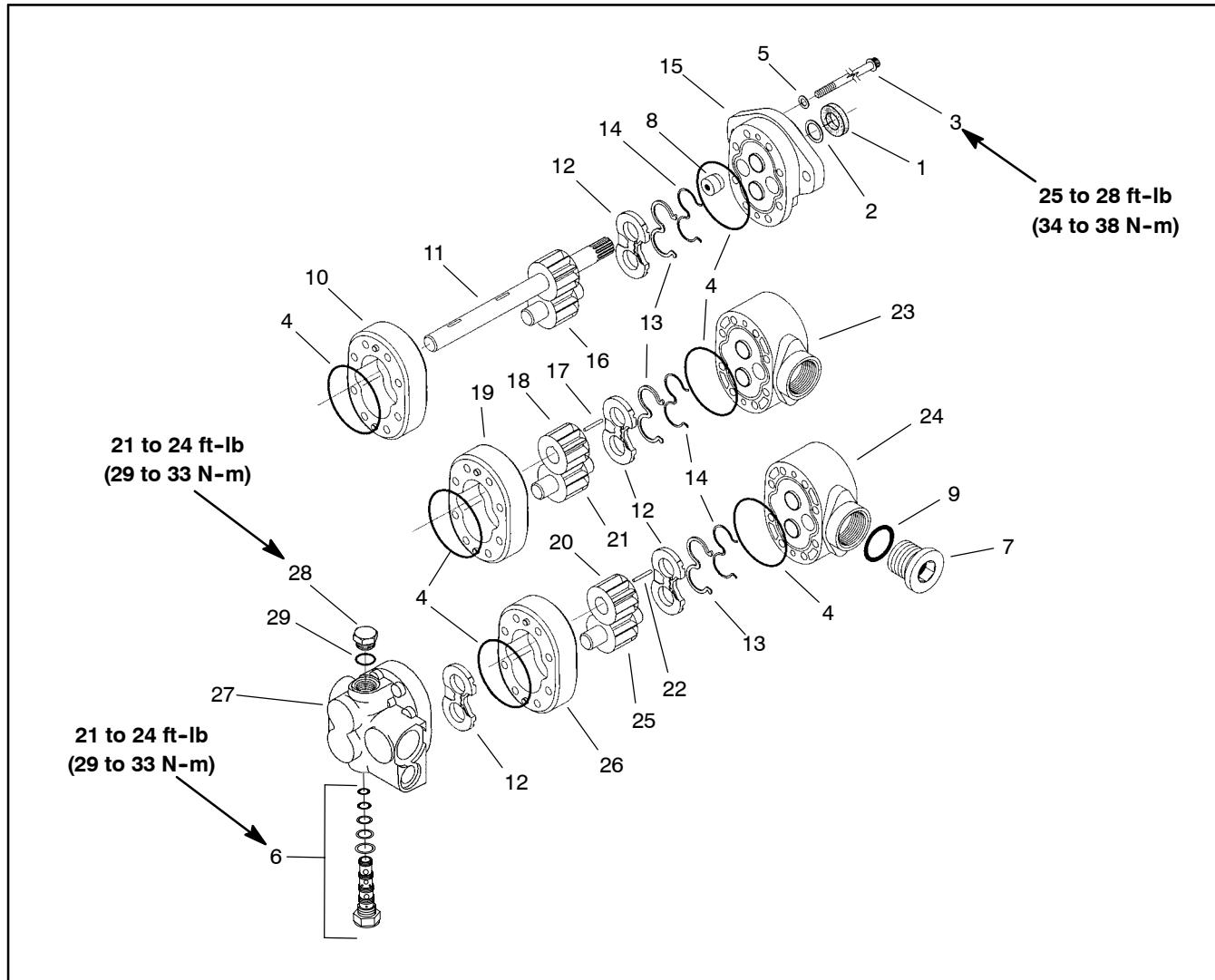


Figure 55

- | | | |
|-----------------------|--------------------------|-------------------------|
| 1. Shaft seal | 11. Drive gear assembly | 21. Idler gear |
| 2. Washer | 12. Wear plate | 22. Key |
| 3. Cap screw | 13. Pressure seal | 23. Front adapter plate |
| 4. O-ring | 14. Backup gasket | 24. Rear adapter plate |
| 5. Washer | 15. Front plate assembly | 25. Idler gear |
| 6. Proportional valve | 16. Idler gear | 26. Rear body |
| 7. Plug | 17. Key | 27. Backplate assembly |
| 8. Plug | 18. Gear | 28. Plug |
| 9. O-ring | 19. Middle body | 29. O-ring |
| 10. Front body | 20. Gear | |

Disassembly

Work in a clean area as cleanliness is extremely important when repairing hydraulic pumps. Thoroughly clean the outside of pump. After cleaning, remove port plugs and drain oil from pump.

1. Scribe a line, at an angle, across front plate (15), bodies (10, 19, 26), adapter plates (23, 24) and backplate (27). This will assure proper reassembly.

NOTE: To maintain maximum pump efficiency, keep body, gears and wear plates for each section together. **do not mix parts between different pump sections.**

IMPORTANT: Avoid using excessive clamping pressure on the pump housing to prevent distorting the housing.

2. Clamp pump in vise, shaft end up and remove the eight cap screws (3).

3. Remove pump from vise, hold pump in hands and bump shaft against wooden block to separate front pump sections. Front body (10) will remain with either front plate (15) or front adapter plate (23).
4. Place front idler gear (16) into gear pocket and tap with soft face hammer until the front body separates. Remove idler gear from front plate or adapter plate.
5. Remove plug (8) from front plate (15).
6. Remove front adapter plate (23) from front body (10) by tapping on the adapter plate with a soft face hammer.
7. Remove idler gear (21), slip fit gear (18), and key (17).
8. Remove backplate (27) from rear body (26) by tapping on backplate with soft face hammer.
9. Remove rear idler gear (25), slip fit gear (20) and key (22).
10. Remove drive gear assembly (11) from rear adapter plate (24).
11. Place rear idler gear assembly (25) back into gear pocket and tap protruding end with soft face hammer to remove rear body (26) from the backplate assembly (27) or the rear adapter plate (24).

IMPORTANT: Note position of the open and closed side of the wear plates before removing.

12. Remove the wear plates (12) and o-rings (4) from front plate (15), front adapter plate (23), and rear adapter plate (24).
13. Remove backup gaskets (14) and pressure seals (13) from wear plates (15) by carefully prying out with a sharp tool.

IMPORTANT: Do not damage the seal bore in the front plate during seal removal.

14. Remove shaft seal (1) and washer (2) from front plate (15).
15. Remove plug (7) and o-ring (9) from rear adapter plate (24).
16. Remove proportional valve (6) from backplate assembly (27).

Inspection

1. Clean and dry all pump components. Remove nicks and burrs from all parts with emery cloth.
2. Check spline drive shaft for twisted or broken teeth. Also check for damaged keyway, on drive shaft, that drives the slip fit gears of the pump.
3. Inspect both the drive gear and idler gear shafts at bushing points and seal area for rough surfaces and excessive wear.
4. Replace gear assembly if shaft measures less than .873" (22.17mm) in bushing area. (One gear assembly may be replaced separately; shafts and gears are available as assemblies only. The slip fit gear is available separately).
5. Inspect gear faces for scoring or excessive wear.
6. Replace gear assembly if gear width is below 1.181" (30.00 mm).
7. Assure that snap rings are in grooves on either side of drive and idler gears.
8. If any edge of gear teeth is sharp, break edge with emery cloth.
9. Oil groove in bushings in front plate, backplate and adapter plates should be in line with dowel pin holes and 180 degrees apart. This positions the oil grooves closest to respective dowel pin holes.
10. Replace the backplate, front plate or adapter plates if I.D. of bushings exceed .879" (22.33mm) (Bushings are not available as separate items).
11. Bushings in front plate and backup gasket side of adapter plates should be flush with face of plate.
12. Check for scoring on face of backplate and adapter plates. Replace if wear exceeds .0015" (.038mm).
13. Check bodies inside gear pockets for excessive scoring or wear.
14. Replace bodies if I.D. of gear pockets exceeds 2.100" (53.34mm).

Reassembly

It is important that the relationship of the backplate, adapter plates, bodies, wear plates and front plate is correct. The two half moon cavities in the bodies must face away from the front plate or adapter plate. The smaller half moon port cavity must be on the pressure side of the pump. The side of the wear plate with mid section cut out must be on suction side of pump. Suction side of backplate or adapter plate is always the side with larger port boss.

1. Replace the wear plates, pressure seals, backup gaskets, shaft seal and o-rings as new parts. During reassembly, check the scribe mark on each part to make sure the parts are properly aligned.

2. Install o-rings (4) in groove of front plate (15), adapter plates (23 and 24), and backplate (27) using a small amount of petroleum jelly to hold in place.

3. Install new pressure seals (13) and backup gaskets (14) into new wear plates (12). The flat section in the middle of the backup gasket must face away from the wear plate inside the seal.

4. Place plug (8) into pocket of front plate (15).

5. Apply a thin coat of petroleum jelly to both milled gear pockets of front body (10). Position body onto front plate (15) with half moon port cavities in body facing away from front plate.

NOTE: The small half moon port cavity must be on the pressure side of pump.

6. Place wear plate (12) into the gear pocket with the pressure seal and backup gasket against the front plate. The side with the mid section cut away must be on suction side of pump.

7. Dip drive gear assembly (11) and idler gear assembly (16) into clean hydraulic oil. Slip both gear assemblies into gear pocket of front body (10) and into front plate bushings.

8. Install front adapter plate (23) in place on front body (10). Check positioning marks for correct orientation.

9. Install middle body (19) onto front adapter plate (23). Place wear plate (12) into the gear pocket with the pressure seal and backup gasket against the front adapter plate.

10. Install key (17) in slot of drive gear shaft. Dip slip fit gear (18) in clean hydraulic oil and slide on shaft and into gear pocket of middle body (19). Check key for proper alignment.

11. Dip idler gear (21) in clean hydraulic oil and install in gear pocket of middle body.

12. Install rear adapter plate (24) in place on middle body (19). Check positioning mark on all sections of pump.

13. Position rear body (26) onto rear adapter plate (24). Place wear plate (12) into the gear pocket with the pressure seal and backup gasket against the rear adapter plate.

14. Install key (22) in slot of drive gear shaft. Dip slip fit gear (20) in clean hydraulic oil and slide on shaft and into gear pocket of rear body (26). Check key for proper alignment.

15. Dip rear idler gear (25) in clean hydraulic oil and install in gear pocket of rear body.

16. Position backplate (27) over shafts until dowel pins in body are engaged.

17. Secure pump components with cap screws (3). Torque cap screws evenly in a crisscross pattern from 25 to 28 ft-lb (34 to 38 N-m).

18. Place washer (2) over drive shaft into housing. Liberally oil shaft seal (1) and install over drive shaft carefully so that rubber sealing lips are not cut.

19. Place 1-3/8" O.D. sleeve over shaft and press in shaft seal .200" (5.08mm) below surface of front plate.

20. Install plug (7) and o-ring (9) into rear adapter plate.

21. If removed, install plug (28) with o-ring into backplate and torque from 21 to 24 ft-lb (29 to 33 N-m).

22. Install proportional valve (6) into backplate. Torque plug from 21 to 24 ft-lb (29 to 33 N-m).

This page is intentionally blank.

Piston (Traction) Pump

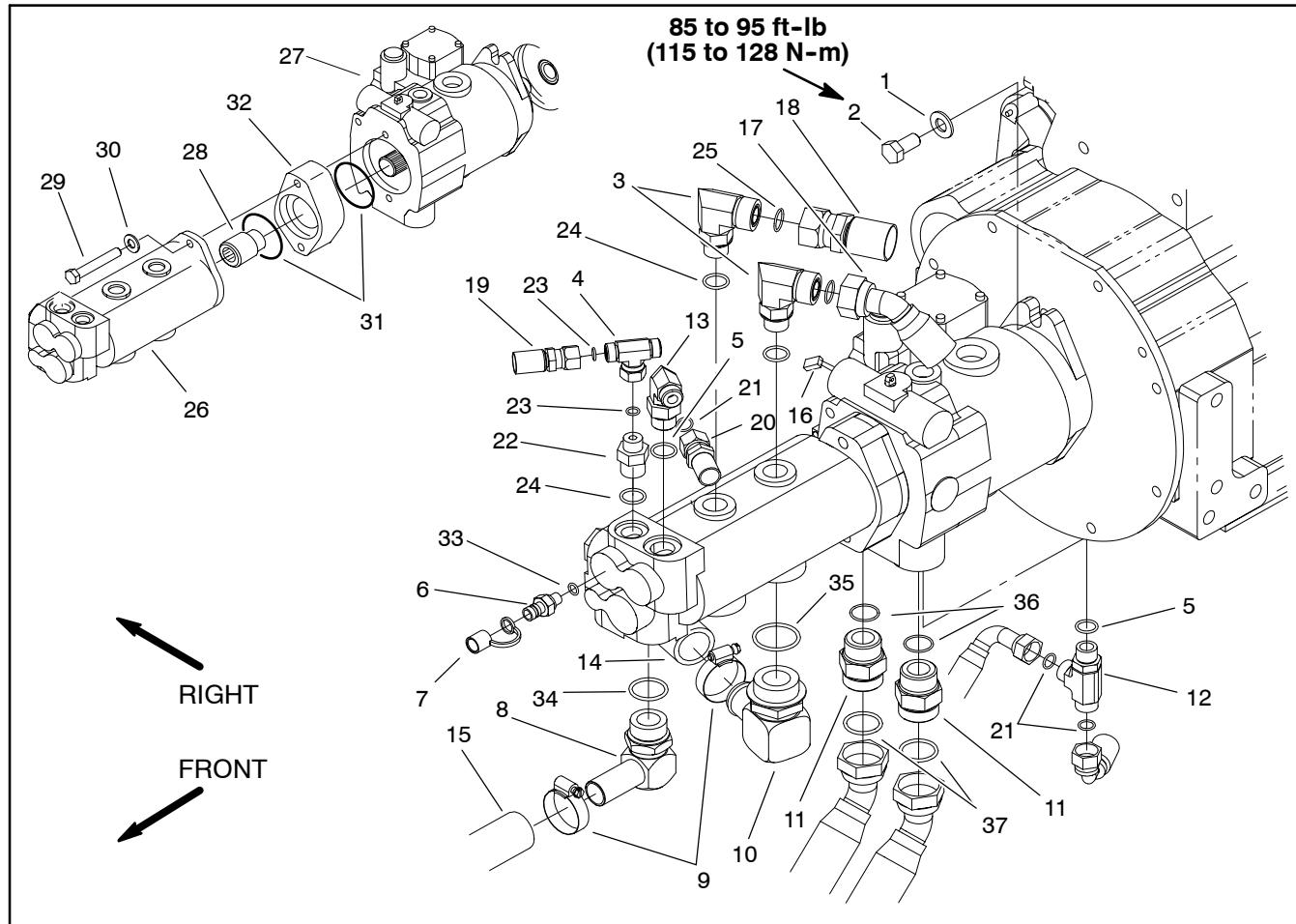


Figure 56

- | | | |
|---------------------------|-----------------------|--------------------------|
| 1. Flat washer | 14. Suction hose | 26. Gear pump assembly |
| 2. Cap screw | 15. Suction hose | 27. Piston pump assembly |
| 3. 90° hydraulic fitting | 16. Wire harness | 28. Coupler |
| 4. Hydraulic tee fitting | 17. Hydraulic hose | 29. Cap screw |
| 5. O-ring | 18. Hydraulic hose | 30. Washer |
| 6. Quick fitting | 19. Hydraulic hose | 31. O-ring |
| 7. Dust cap | 20. Hydraulic hose | 32. Spacer |
| 8. 90° hydraulic fitting | 21. O-ring | 33. O-ring |
| 9. Clamp | 22. Hydraulic fitting | 34. O-ring |
| 10. 90° hydraulic fitting | 23. O-ring | 35. O-ring |
| 11. Hydraulic fitting | 24. O-ring | 36. O-ring |
| 12. Hydraulic tee fitting | 25. O-ring | 37. O-ring |
| 13. 90° hydraulic fitting | | |

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. To prevent contamination of hydraulic system during removal, thoroughly clean exterior of pump assembly.
3. Remove traction rod from control arm on piston pump by removing lock nut, spacer and cap screw.
4. Disconnect two wires from neutral switch on traction pump.
5. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.
6. Put a drain pan below the pump assembly. Remove hydraulic hoses and fittings connected to piston and gear pumps. Put plugs or caps on disconnected hydraulic hoses to prevent contamination of the system. Put plugs in open ports of pumps.
7. Remove gear pump from machine (see Gear Pump Removal).
8. Support the piston pump to prevent it from falling while removing two (2) cap screws and washers retaining pump assembly to engine adapter plate. Carefully pull pump assembly from adapter plate and raise it out of the machine.

Installation

1. Carefully lower piston pump into the machine and position it to the engine adapter plate. Support pump to prevent it from falling while installing two (2) cap screws and washers securing piston pump to engine adapter plate. Torque screws from 85 to 95 ft-lb (115 to 128 N-m).
2. Install gear pump to piston pump (see Gear Pump Installation).
3. Position traction rod to control arm on piston pump by installing cap screw, spacer and lock nut.
4. Connect two wires to neutral switch on traction pump.
5. Remove plugs and caps from disconnected hydraulic hoses and open ports of the pump assembly. Install fittings and hoses to correct location on gear and piston pumps.
6. Install new filter and fill hydraulic reservoir with correct oil.
7. Disconnect engine run solenoid electrical connector to prevent engine from starting. Prime pumps by turning ignition key switch to crank engine for 10 seconds. Repeat cranking procedure again.
8. Connect engine run solenoid electrical connector, start the engine, and check for proper operation.
9. Properly fill hydraulic system (see Charge Hydraulic System).
10. Stop engine and check for hydraulic oil leaks. Check hydraulic reservoir oil level.

Piston (Traction) Pump Service

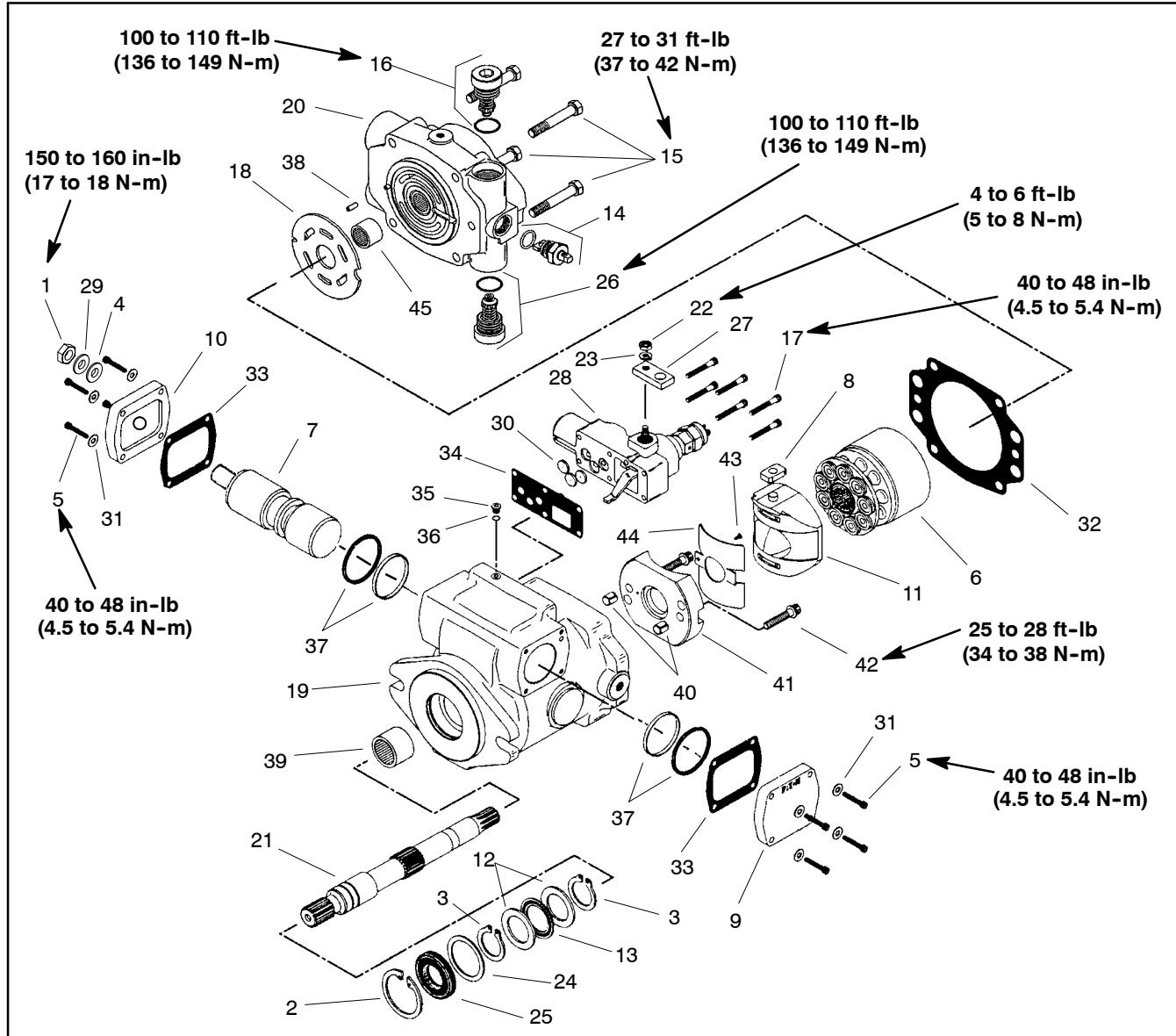


Figure 57

- | | | |
|--------------------------|----------------------------|-----------------------------|
| 1. Jam nut | 16. Relief valve (Reverse) | 31. Flat washer |
| 2. Retaining ring | 17. Socket head screw | 32. Housing gasket |
| 3. Retaining ring | 18. Valve plate | 33. Cover plate gasket |
| 4. Seal washer | 19. Pump housing | 34. Control assembly gasket |
| 5. Socket head screw | 20. Backplate assembly | 35. Plug |
| 6. Rotating kit assembly | 21. Drive shaft | 36. O-ring |
| 7. Servo piston assembly | 22. Nut | 37. Seal sub-assembly |
| 8. Piston follower | 23. Lock washer | 38. Roll pin |
| 9. Cover plate | 24. Washer | 39. Bearing |
| 10. Cover plate | 25. Shaft seal | 40. Dowel bushing |
| 11. Camplate assembly | 26. Relief valve (Forward) | 41. Cradle sub-assembly |
| 12. Thrust race | 27. Control arm | 42. Cap screw |
| 13. Thrust bearing | 28. Servo control assembly | 43. Button head cap screw |
| 14. Bypass valve | 29. Washer | 44. Bushing |
| 15. Cap screw | 30. Orifice plate (3 used) | 45. Bearing |

Disassembly

Work in a clean area as cleanliness is extremely important when repairing hydraulic pumps. Thoroughly clean the outside of pump. After cleaning, remove port plugs and drain oil from pump.

1. Position the pump into a protected jaw vise, clamping onto the outer portion of the flange, with the cap screws up. Mark the relationship of the working ports (for reassembly identification) to the servo control assembly with a scribe. Remove the four cap screws (15) retaining backplate (20).
2. Lift backplate (20) straight up off drive shaft (21) and housing (19). Remove valve plate (18) from backplate (20) or from rotating kit assembly (6), still in housing (19).
3. From backplate (20), remove bypass valve (14), forward relief valve (26) and reverse relief valve (16). Note: Mark the valves in relationship to the cavity it was removed, for reassembly purposes.
4. Remove housing gasket (32) from housing (19) or backplate (20).
5. With pump still in vise, remove the six socket head screws (17) retaining the servo control assembly (28). Remove the control assembly and control housing gasket (34) from the housing. Remove orifice plates (30), noting location for reassembly. Remove nut (22), lock washer (23), and control arm (27) from servo control input shaft. Note position of control arm for reassembly.
6. To remove rotating kit assembly (6) from housing, first remove pump from vise holding the rotating kit assembly in position. Lower pump so that the shaft end (flange end) is up. Set the rear of housing onto table with housing flat and rotating kit assembly at rest on table. (Hole in table, for protruding shaft, is required.) Lift and remove the housing (19) and drive shaft (21) from rotating kit assembly (6) and camplate assembly(11).
7. Remove camplate (11) from rotating kit assembly (6) and servo piston follower (8) from camplate (11).
8. Remove the four socket head screws (5) and washers (31) retaining each cover plate (9 & 10).
9. Remove jam nut (1), washer (29), and seal washer (4). Hold the servo piston bolt with hex key and unscrew cover plate (10) from bolt.
10. Remove servo piston assembly (7) and seal sub-assemblies (two sets) (37) from housing. Note: Disassembly of servo piston assembly is not required.
11. Remove retaining ring (2) from the front of pump housing (19). Press the drive shaft (21), shaft seal (25), and washer (24) from housing. Remove retaining ring (3), thrust race (12), thrust bearing (13), second thrust race (12), and second retaining ring (3) from drive shaft (21).

12. Remove the two cap screws (42) that secure cradle sub-assembly inside housing. Move the cradle sub-assembly back-and-forth to release dowel bushings (40) and remove cradle sub-assembly from housing.

13. Remove button head cap screw (43) to remove bushing (44) from cradle.

14. Remove remaining plugs from housing.

15. Discard the shaft seal (25), gaskets (32, 33, 34), and o-rings from all assemblies. Replace with new seals upon reassembly.

Inspection

1. Inspect backplate assembly:

A. Check the bearing (45) (press fit) in backplate (20). If needles remain in cage, move freely, and setting is at the dimension shown in Figure 58, bearing removal is not required.

B. Check roll pin (38) in backplate (20). If tight and set to the dimension shown in Figure 58, removal not required.

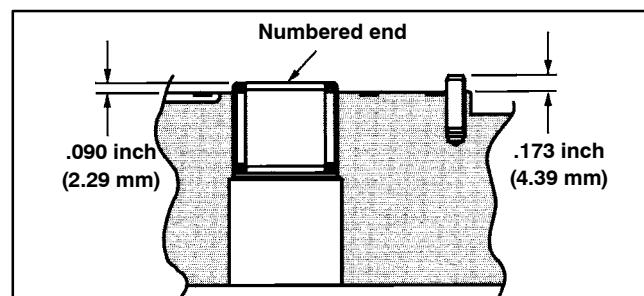


Figure 58

2. Check the bearing (39) (press fit) in pump housing (19). If needles remain in cage, move freely, and setting at the dimension shown in Figure 59, bearing removal is not required.

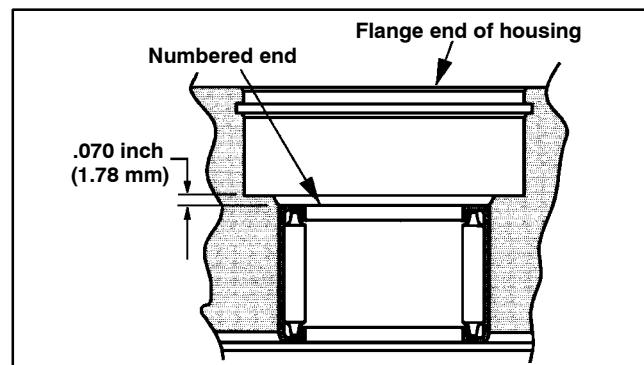


Figure 59

3. Inspect camplate assembly:

- A. The finish on the piston shoe surfaces of the camplate (11) should show no signs of scoring.
- B. Inspect camplate (11) bushing surface for wear. Also inspect surface for coating transfer from bushing.
- 4. Inspect bushing (44) for contamination embedment within coating of bushing surface coming in contact with camplate (11).

5. Inspect rotating kit (Fig. 60):

- A. The pistons should move freely in the rotating kit piston block bore. If they are sticky in the bore, examine the bore for scoring or contamination.
- B. Examine the O.D. of the pistons for finish condition. They should not show wear or deep scratches. Inspect the shoes for a snug fit on the ball end of the pistons and a flat smooth surface that comes in contact with the camplate. **Do not lap piston shoes.**
- C. Examine the spider for wear in the pivot area.
- D. Examine the spider pivot to insure smoothness and no signs of wear.

Reassembly

1. All parts should be cleaned and internal pump parts lubricated with clean hydraulic oil before reassembly.
2. If necessary, press new bearing into pump housing to dimension shown in Figure 59 with the numbered end of bearing outward.
3. Install the two new seal sub-assemblies (37) into the servo piston cavity of pump housing (19).
4. Screw the cover plate (10) onto the servo piston assembly (7). Install new cover plate gasket (33) in place on pump housing. Install servo piston assembly (7) and cover plate (10) into servo piston bore in right side of housing (Fig. 61). Retain cover plate with four washers (31) and socket head screws (5). Torque screws from 40 to 48 in-lb (4.5 to 5.4 N-m). To obtain neutral, centering the servo piston assembly is required. Measure in from the left side and set servo piston .500" (12.7 mm) from surface of housing servo bore as shown in Figure 61.

NOTE: Re-adjustment may be required for neutral at unit start-up.

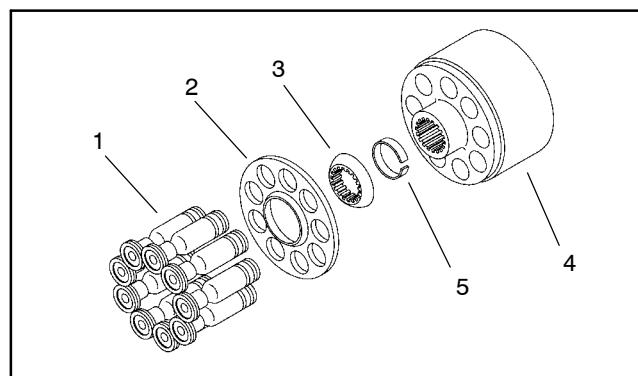


Figure 60

- | | |
|----------------------|-----------------|
| 1. Piston assemblies | 4. Piston block |
| 2. Spider | 5. Retainer |
| 3. Spider pivot | |

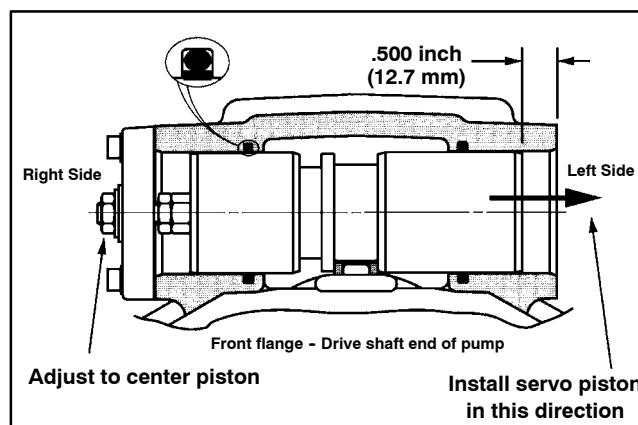


Figure 61

5. Install new seal washer (4), washer (29), and jam nut (1) to servo piston bolt. Holding servo piston bolt with hex key wrench, torque jam nut from 150 to 160 in-lb (17 to 18 N-m). Check the centering of servo piston assembly (7). Install new cover plate gasket (33) and cover plate (9) to open side of servo piston and retain with four washers (31) and socket head screws (5). Torque screws from 40 to 48 in-lb (4.5 to 5.4 N-m).
6. Press dowel bushings (40) into cradle and secure bushing (44) onto cradle with button head cap screw (43). Torque button head cap screw from 14 to 16 in-lb (1.6 to 1.8 N-m).
7. Place cradle sub-assembly (41) into housing (19) making sure dowel bushings (40) and cradle (41) are completely seated into housing. Retain cradle sub-assembly with two cap screws (42) after applying Loctite #277 (or equivalent) to the end of threads. Torque cap screws from 25 to 28 ft-lb (34 to 38 N-m).

8. Place exterior retaining ring (3), thrust race (12), thrust bearing (13), second thrust race (12), and second retaining ring (3) onto drive shaft (21). Position washer (24) and shaft seal (25) onto shaft.
9. Install shaft assembly into front of housing. Seat seal (25) into position with seal driver and retain with interior retaining ring (2).
10. Install servo piston follower (8) onto camplate dowel pin. Install camplate (11) carefully onto bushing (44) (coat bushing surface with hydraulic oil), aligning servo piston follower (8) with slot in servo piston assembly (7).
11. Position housing in a horizontal position. Holding camplate (11) in position with screw driver through controller linkage passageway at the top of housing, place rotating kit assembly (6) over shaft and into housing until pistons are against camplate (11). Make sure all parts are in housing completely and are properly positioned. Return the pump to the vise with open end of housing up, clamping housing on the outer portion of the flange.
12. Install gasket (32) onto housing.
13. If necessary, press new bearing (45) and roll pin (38) in backplate (20) to dimension shown in Figure 58. Note: Bearing should be installed with the numbered end outward. Roll pin should be installed with split oriented away from bearing.
- NOTE:** Forward and reverse relief valves are identical.
14. Install new o-ring on relief valves (16 & 26). Install relief valve in the cavity in backplate and torque from 100 to 110 ft-lb (136 to 149 N-m).
15. Install new o-ring on bypass valve (14). Install bypass valve (14) into backplate (20). Note: Make sure paddle of bypass valve is perpendicular to relief valve axis prior to installing or damage could result.
16. Apply a small amount of petroleum jelly to the steel side of valve plate (18) to hold in place for installation. Aligning the index pin, place the valve plate (18) in position onto the backplate (20), with steel side against backplate.
17. Install backplate assembly (20) onto housing assembly (19). Make sure ports are positioned correctly, and that valve plate (18) and gasket (32) stay in place.
18. Retain backplate (20) with four cap screws (15). Torque cap screws from 27 to 31 ft-lb (37 to 42 N-m).
19. Install control housing gasket (34) onto housing. Install orifices (30) into servo control assembly (28) and retain in position with petroleum jelly. Position the feed-back link at 90 degrees from control housing. Install manual servo control assembly (28) onto housing making sure feedback link entered small groove in servo piston assembly (7).
20. Secure control assembly with six socket head screws (17). Torque screws from 40 to 48 in-lb (4.5 to 5.4 N-m).
21. Install control arm (27) onto control assembly input shaft. Retain with lock washer (23) and nut (22). Torque nut from 4 to 6 ft-lb (5 to 8 N-m).
22. Install remaining plugs that were removed from pump. Torque 3/4 in. plug from 21 to 24 ft-lb (28 to 32 N-m). Torque 1-1/4 in. plug from 40 to 45 ft-lb (54 to 61 N-m).

Piston Pump Manual Servo Control Assembly

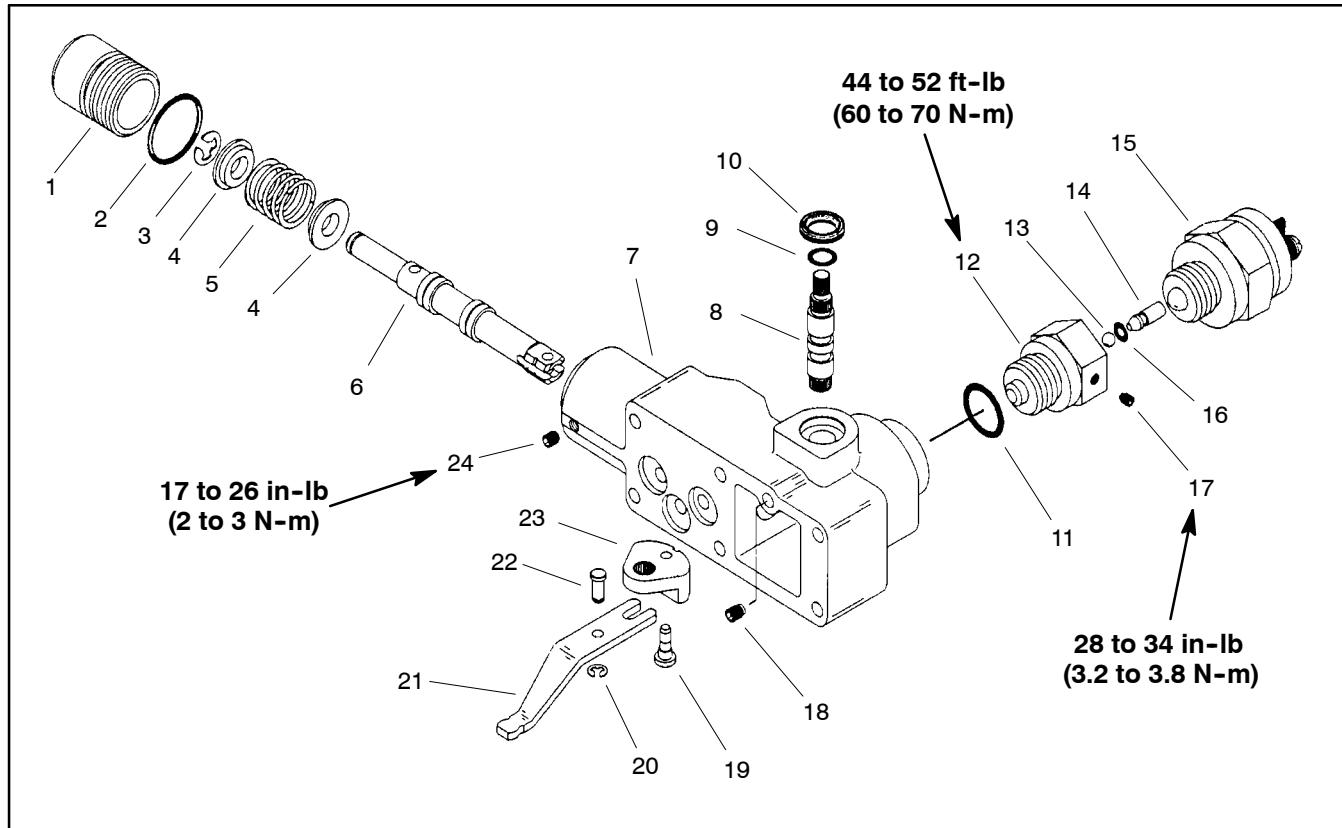


Figure 62

1. Plug
2. O-ring
3. Retaining ring
4. Spring retainer
5. Spring
6. Spool valve
7. Control housing
8. Input shaft

9. O-ring
10. Wiper seal
11. O-ring
12. Adaptor
13. Ball
14. Pin
15. Neutral switch
16. O-ring

17. Set screw
18. Set screw
19. Pin
20. Retaining ring
21. Feedback link
22. Dowel pin
23. Bell crank
24. Set screw

Disassembly

1. Remove wiper seal with screw driver. Remove set screw (18) that retains input shaft and remove input shaft from control housing. Remove o-ring from shaft.
2. Remove set screw (24) from plug that retains valve spool. Remove plug from control housing and o-ring from plug.
3. Remove retaining ring (20) from pin that retains feedback link and spool valve. Remove pin, feedback link, spool valve, and bell crank from control housing.
4. Compress spring and remove retaining ring (3). Remove spring retainer, spring, and second spring retainer from spool valve.
5. Clean all parts and lubricate in clean hydraulic oil for reassembly.

Reassembly

1. Install spring retainer, spring, and second spring retainer onto spool valve. Compress spring to allow retaining ring (3) to be installed onto spool valve.
2. Install spool valve into control housing making sure that metering notches on spool valve can be seen in the metering ports.
3. Position bell crank in housing. Slide feedback link into position between clevis on valve spool, aligning holes, and install dowel pin and retaining ring (20).
4. Install new o-ring (9) onto input shaft. Hold bell crank in position with feedback link slot and align splined hole of bell crank with input shaft cavity. Install input shaft into control housing and bell crank.

5. Apply Loctite #242 or equivalent to set screw (18) and install into control housing. Adjust set screw until it bottoms out on input shaft and back out one-quarter turn.

6. Install wiper seal on input shaft.

7. Install new o-ring (2) onto plug and install plug. Adjust plug until there is no end play in the valve spool with input shaft held stationary. Secure plug in place with set screw (24). Torque set screw from 17 to 26 in-lb (2 to 3 N-m).

Disassembly - Neutral Switch

1. Loosen set screw (17) in adapter and remove neutral switch from adapter.

2. Remove adapter from control housing.

3. Remove pin, ball, and o-rings (11 & 16) from adapter.

Reassembly - Neutral Switch

1. Install new o-ring (11) onto adapter and new o-ring (16) onto pin.

2. Install ball and pin into adapter. Lubricate with petroleum jelly to hold in place during installation.

3. Install adapter into control housing. Torque from 44 to 52 ft-lb (60 to 70 N-m).

4. Apply Loctite #222 or equivalent to threads of neutral switch and install switch into adapter. The adjustment procedure for the switch are as follows.

A. Install switch, while moving link back and forth, until "detent" action is detected. Back out the switch until the "detent" action is very slight.

B. Attach the leads from a test light to the switch terminals. **Note:** A multimeter could be used instead of a test light.

C. Move the link out of the detent position. The test light will go on. Screw in the switch until the light goes off. Mark this as position "A" (Fig. 63). Move the link to the detent position and the test light should come back on.

D. Leaving the link in the detent position, the light will remain on. Screw in the switch until the light goes off. Mark this position "B".

E. Unscrew the switch one third of the distance between "B" and "A". Install and tighten the set screw (17) in one of the upper quadrants of the hex of the switch adapter (Fig. 63). Torque set screw from 28 to 34 in-lb (3.2 to 3.8 N-m).

5. Test the switch by moving the control arm to the detent position, the light should be on. Move the control arm out of detent, the light should go off.

6. Remove test light and put servo control assembly into operation.

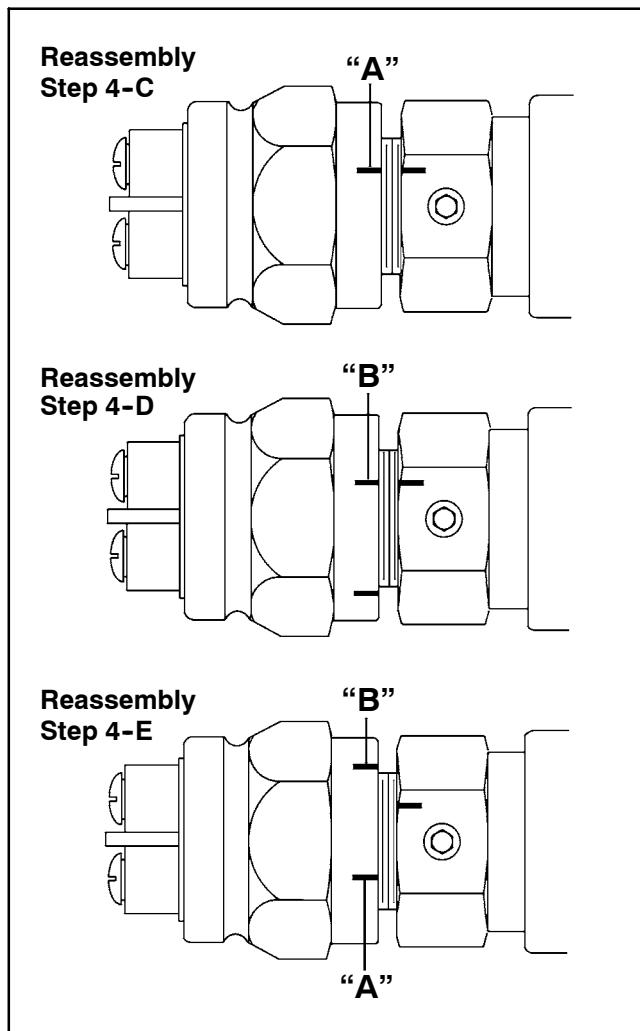


Figure 63

Hydraulic Control Manifolds: 2 Wheel/4 Wheel Drive, Filtration and Charge, Power Down and Traction Assist

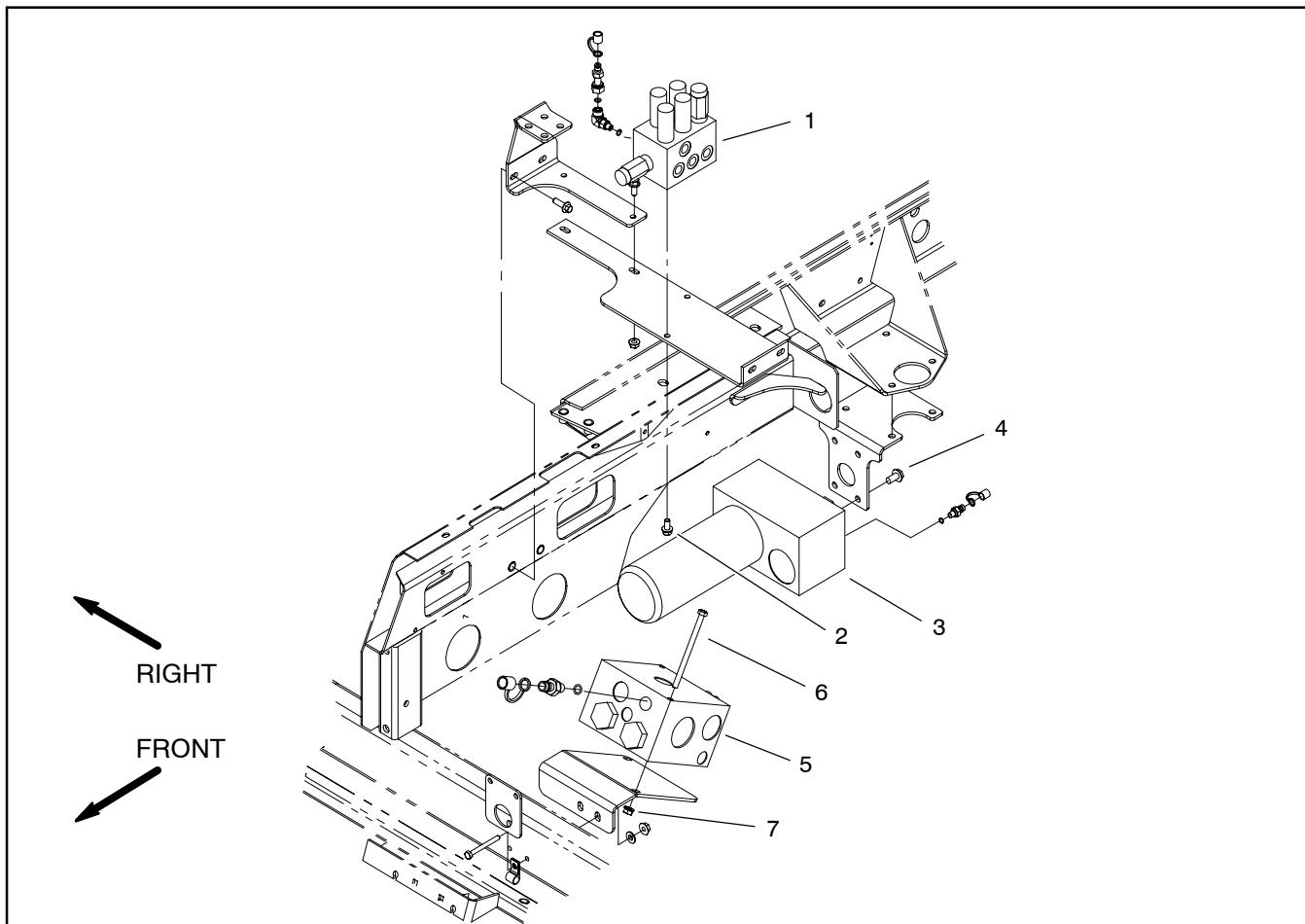


Figure 64

- | | | |
|--|-------------------------------|------------------------|
| 1. Power down/traction assist manifold | 4. Flange head screw (4 used) | 6. Cap screw (2 used) |
| 2. Flange head screw (3 used) | 5. 2WD/4WD manifold | 7. Flange nut (2 used) |
| 3. Filtration/charge manifold | | |

Removal

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

1. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.
2. If 2WD/4WD control manifold is being removed, disconnect electrical connector from the solenoid valve.
3. Disconnect hydraulic lines from manifold being removed and put caps or plugs on open hydraulic lines and fittings. Label disconnected hydraulic lines for proper reassembly.
4. Remove hydraulic manifold from the frame using Figure 64 as guide.

Installation

1. Install hydraulic manifold to the frame using Figure 64 as guide.
2. Remove caps and plugs from fittings and hoses. Properly connect hydraulic lines to manifold.
3. If 2WD/4WD control manifold was removed, connect electrical connector to the solenoid valve.
4. Fill hydraulic reservoir with hydraulic fluid as required (see Traction Unit Operator's Manual).

Hydraulic Control Manifold Service: 2 Wheel/4 Wheel Drive Control

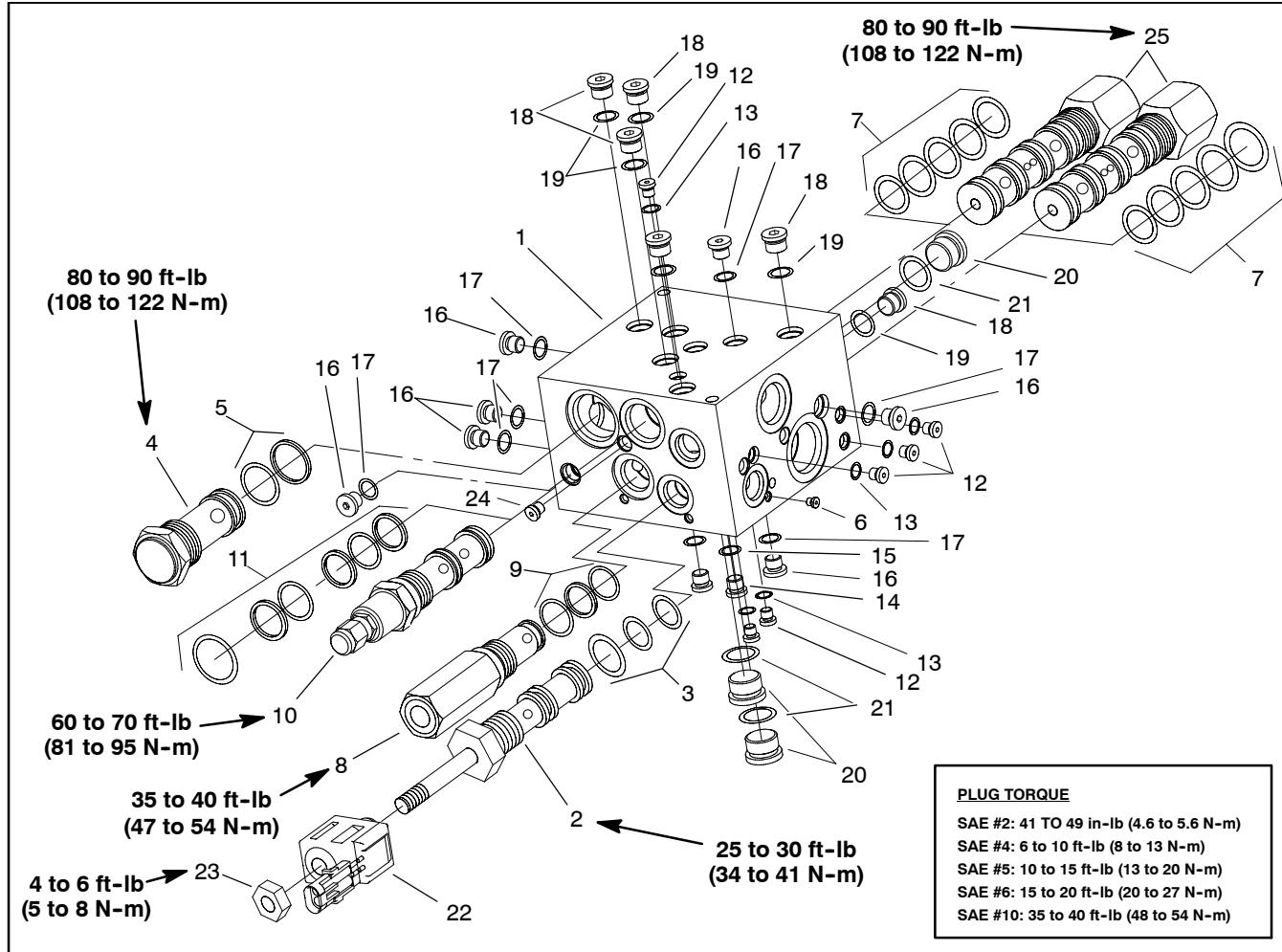


Figure 65

- | | | |
|---------------------------------|----------------------------------|--|
| 1. Manifold body | 10. Reducing valve (PR1: port 8) | 19. O-ring |
| 2. Solenoid valve (SV: port 2) | 11. Seal kit | 20. Plug (SAE #10) |
| 3. Seal kit | 12. Plug (SAE #2) | 21. O-ring |
| 4. Check valve (CV: port 3) | 13. O-ring | 22. Solenoid coil |
| 5. Seal kit | 14. Plug (SAE #4) | 23. Nut |
| 6. Expander plug (not serviced) | 15. O-ring | 24. Expander plug (not serviced) |
| 7. Seal kit | 16. Plug (SAE #5) | 25. Control valve (PD1 & PD2: ports 5A & 5B) |
| 8. Relief valve (RV5: port 7) | 17. O-ring | |
| 9. Seal kit | 18. Plug (SAE #6) | |

NOTE: The ports on the manifold are marked for easy identification of components. Example: P1 is a piston pump connection port and 2 is the location for the solenoid valve (See Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port).

Cartridge Valve Service

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 off the valve.

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

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

5. Visually inspect cartridge valve for damaged sealing surfaces and contamination.
 - A. Contamination may cause valves to stick or hang up. Contamination can become lodged in small valve orifices or seal areas causing malfunction.
 - B. If valve sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.
- **CAUTION**

Use eye protection such as goggles when using compressed air.
6. Clean cartridge valve using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. If cartridge design allows, use a wood or plastic probe to push the internal spool in and out 20 to 30 times to flush out contamination. Be extremely careful not to damage cartridge. Use compressed air for cleaning.
7. Reinstall the cartridge valve:
 - A. Lubricate new seal kit components with clean hydraulic oil and install on valve. The o-rings, sealing rings, and backup rings must be arranged properly on the cartridge valve for proper operation and sealing.
- IMPORTANT: Use care when handling the valve cartridge. Slight bending or distortion of the stem tube can cause binding and malfunction.**
- B. Thread cartridge valve carefully into manifold port. The valve should go in easily without binding.
- C. Torque cartridge valve using a deep socket to value identified in manifold illustration.
- D. If cartridge is solenoid operated, carefully install solenoid coil to the cartridge valve. Apply Loctite #242 or equivalent to the threads of the valve. Torque nut to value identified in manifold illustration.
8. If problems still exist, remove valve and clean again or replace valve.

Hydraulic Control Manifold Service: Filtration and Charge Control

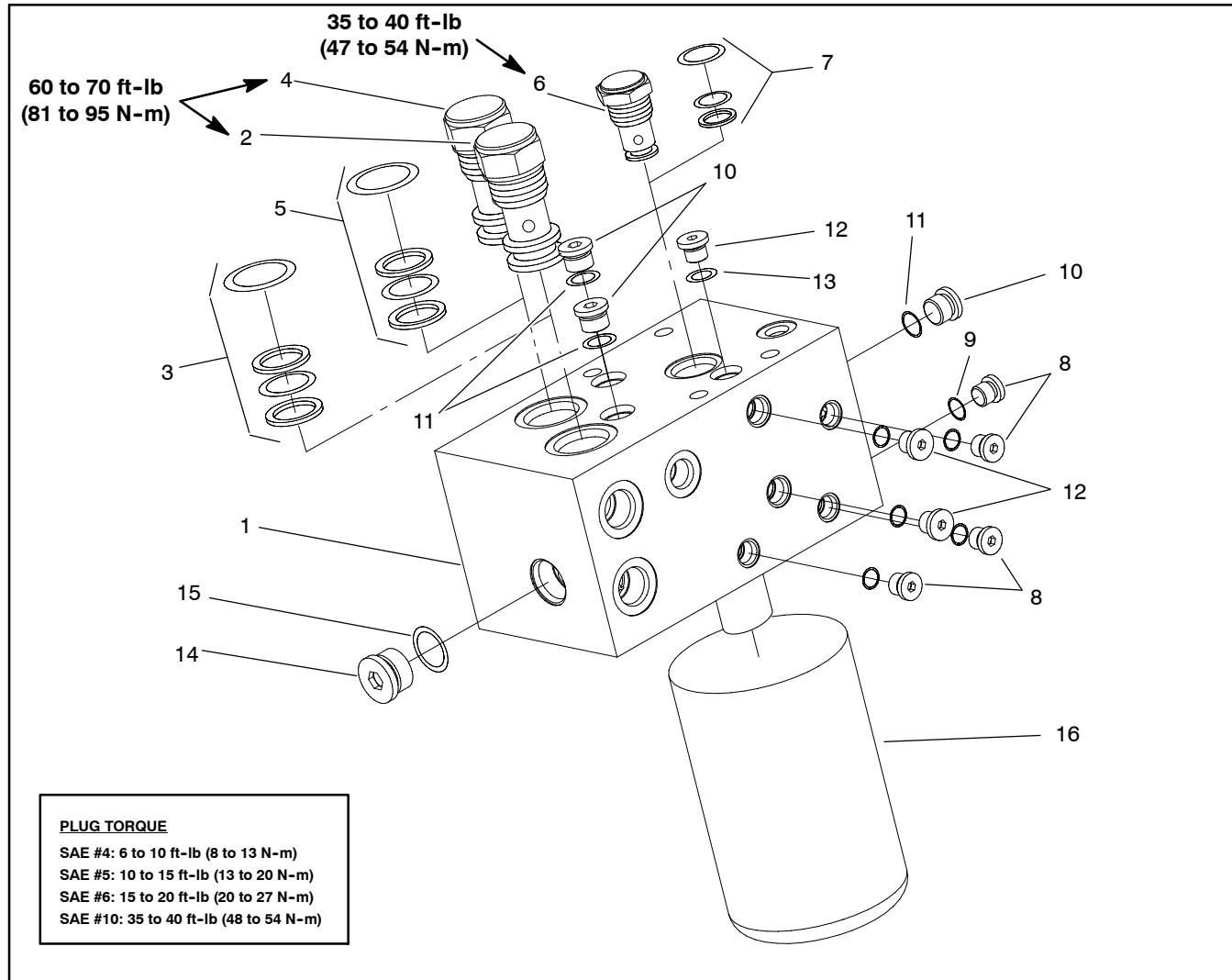


Figure 66

- | | | |
|-----------------------------------|-------------------|------------------------|
| 1. Filter manifold assembly | 7. Seal kit | 12. Plug (SAE #5) |
| 2. Check valve (Reservoir return) | 8. Plug (SAE #4) | 13. O-ring |
| 3. Seal kit | 9. O-ring | 14. Plug (SAE #10) |
| 4. Check valve (Filter bypass) | 10. Plug (SAE #6) | 15. O-ring |
| 5. Seal kit | 11. O-ring | 16. Oil filter element |
| 6. Check valve (Charge pressure) | | |

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

For cartridge valve service procedures, see Hydraulic Control Manifold Service: 2 Wheel/4 Wheel Drive Control in this section. Refer to Figure 66 for cartridge valve installation torque.

Hydraulic Control Manifold Service: Power Down and Traction Assist (GM 4500-D)

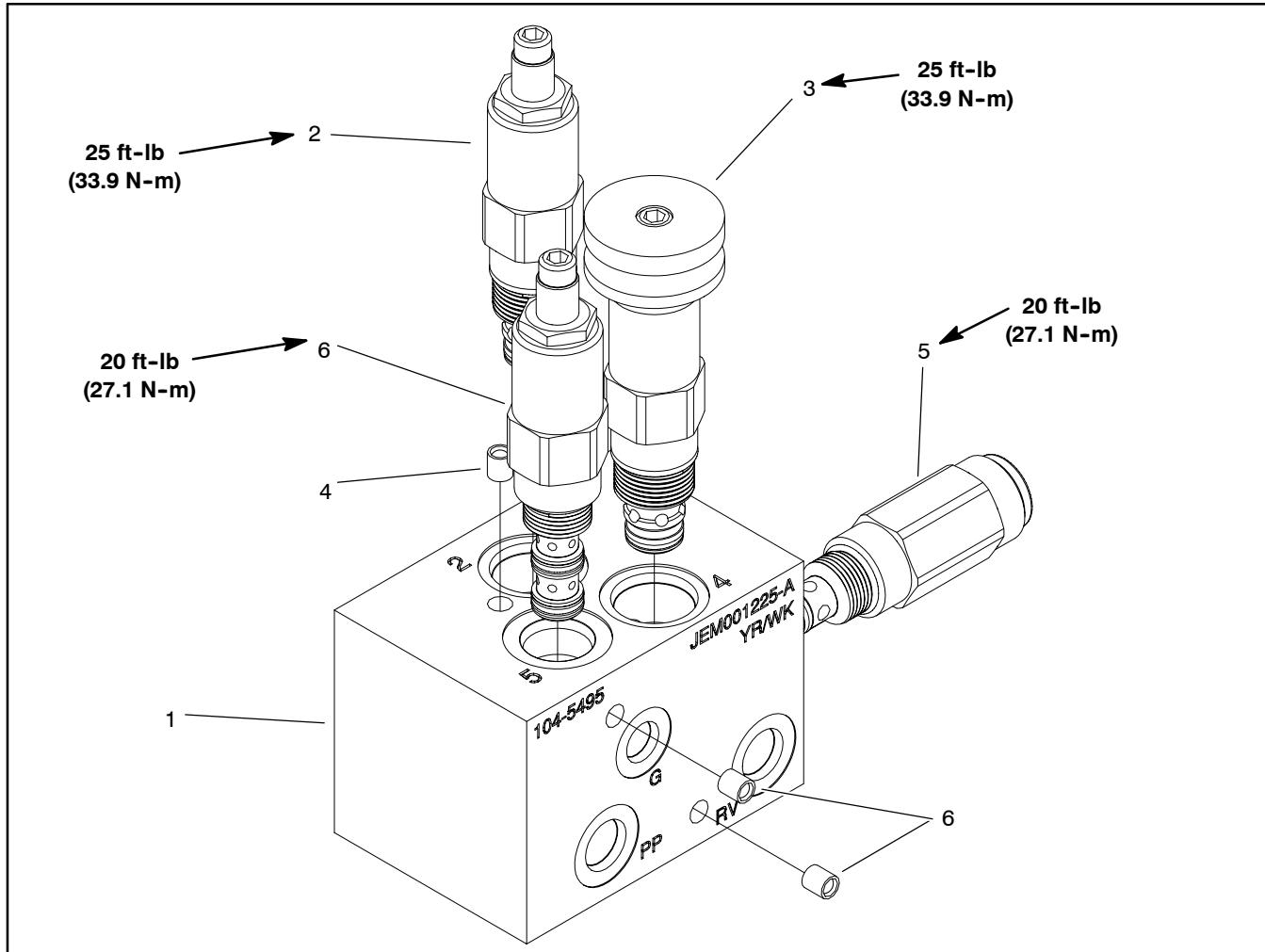


Figure 67

- | | | |
|--|------------------------------------|--|
| 1. Manifold body | 4. Expanding plug (not serviced) | 6. Traction pressure sensing valve (PD3: port 5) |
| 2. Traction assist valve (RV2: port 2) | 5. Lift relief valve (RV7: port 7) | |
| 3. Counterbalance valve (RV1: port 4) | | |

NOTE: The ports on the manifold are marked for easy identification of components. Example: CB is the connection port from the lift/lower control valve and CHG is the charge circuit connection (See Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port).

For cartridge valve service procedures, see Hydraulic Control Manifold Service: 2 Wheel/4 Wheel Drive Control in this section. Refer to Figure 67 for cartridge valve installation torque.

Hydraulic Control Manifold Service: Power Down and Traction Assist (GM 4700-D)

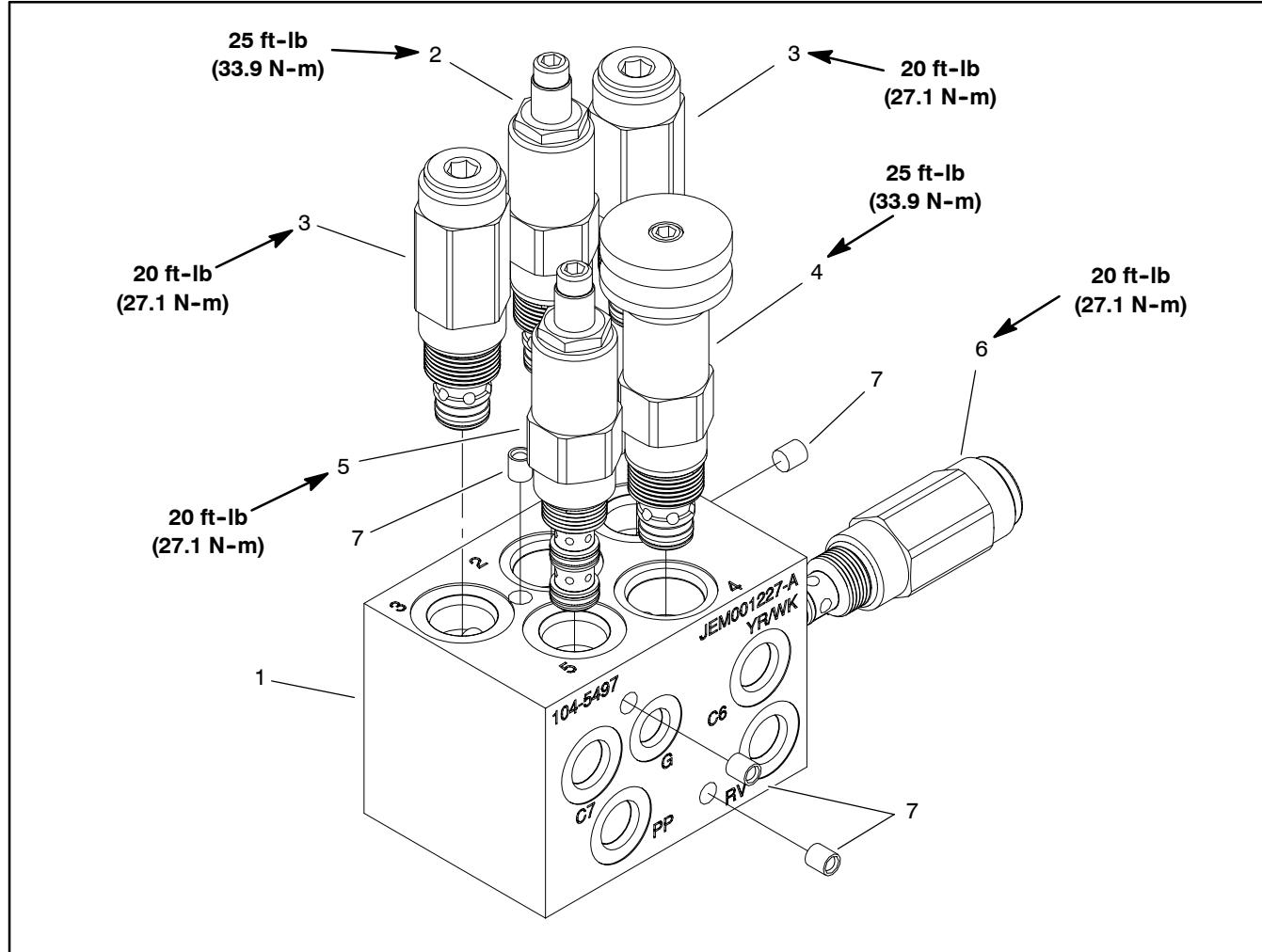


Figure 68

- | | | |
|--|--|------------------------------------|
| 1. Manifold body | 4. Counterbalance valve (RV1: port 4) | 6. Lift relief valve (RV7: port 7) |
| 2. Traction assist valve (RV2: port 2) | 5. Traction pressure sensing valve (PD3: port 5) | 7. Expanding plug (not serviced) |
| 3. Power down valve (deck 6) | | 8. Power down valve (deck 7) |

NOTE: The ports on the manifold are marked for easy identification of components. Example: C1 is the connection port from the LH deck lift cylinder and CHG is the charge circuit connection (See Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port).

For cartridge valve service procedures, see Hydraulic Control Manifold Service: 2 Wheel/4 Wheel Drive Control in this section. Refer to Figure 68 for cartridge valve installation torque.

This page is intentionally blank.

Hydraulic Control Manifold: Deck Drive (GM 4500-D)

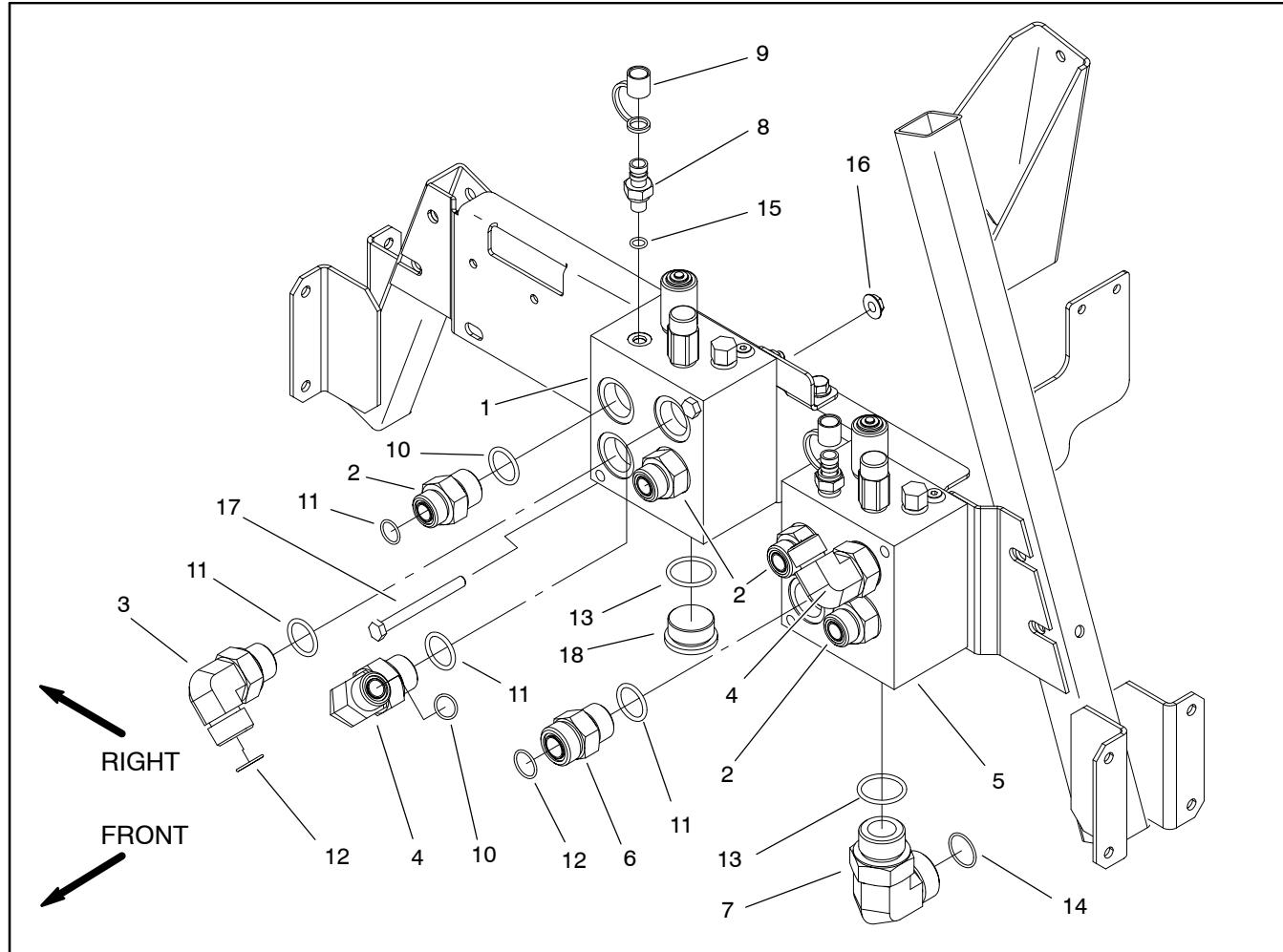


Figure 69

- | | | |
|--|--------------------------|----------------|
| 1. Hydraulic manifold: decks 2, 3, & 5 | 7. 90° hydraulic fitting | 13. O-ring |
| 2. Hydraulic adapter | 8. Quick fitting | 14. O-ring |
| 3. 90° hydraulic fitting | 9. Dust cap | 15. O-ring |
| 4. 90° hydraulic fitting | 10. O-ring | 16. Flange nut |
| 5. Hydraulic manifold: decks 1 & 4 | 11. O-ring | 17. Cap screw |
| 6. Straight hydraulic fitting | 12. O-ring | 18. Plug |

Removal

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

1. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.
2. Disconnect electrical connector from the solenoid valve.

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

4. Remove hydraulic manifold from the frame using Figure 69 as guide.

Installation

1. Install hydraulic manifold to the frame using Figure 69 as guide.
2. Remove caps and plugs from fittings and hoses. Properly connect hydraulic lines to manifold.
3. Connect electrical connector to the solenoid valve.

Hydraulic Control Manifold Service: Deck Drive (GM 4500-D)

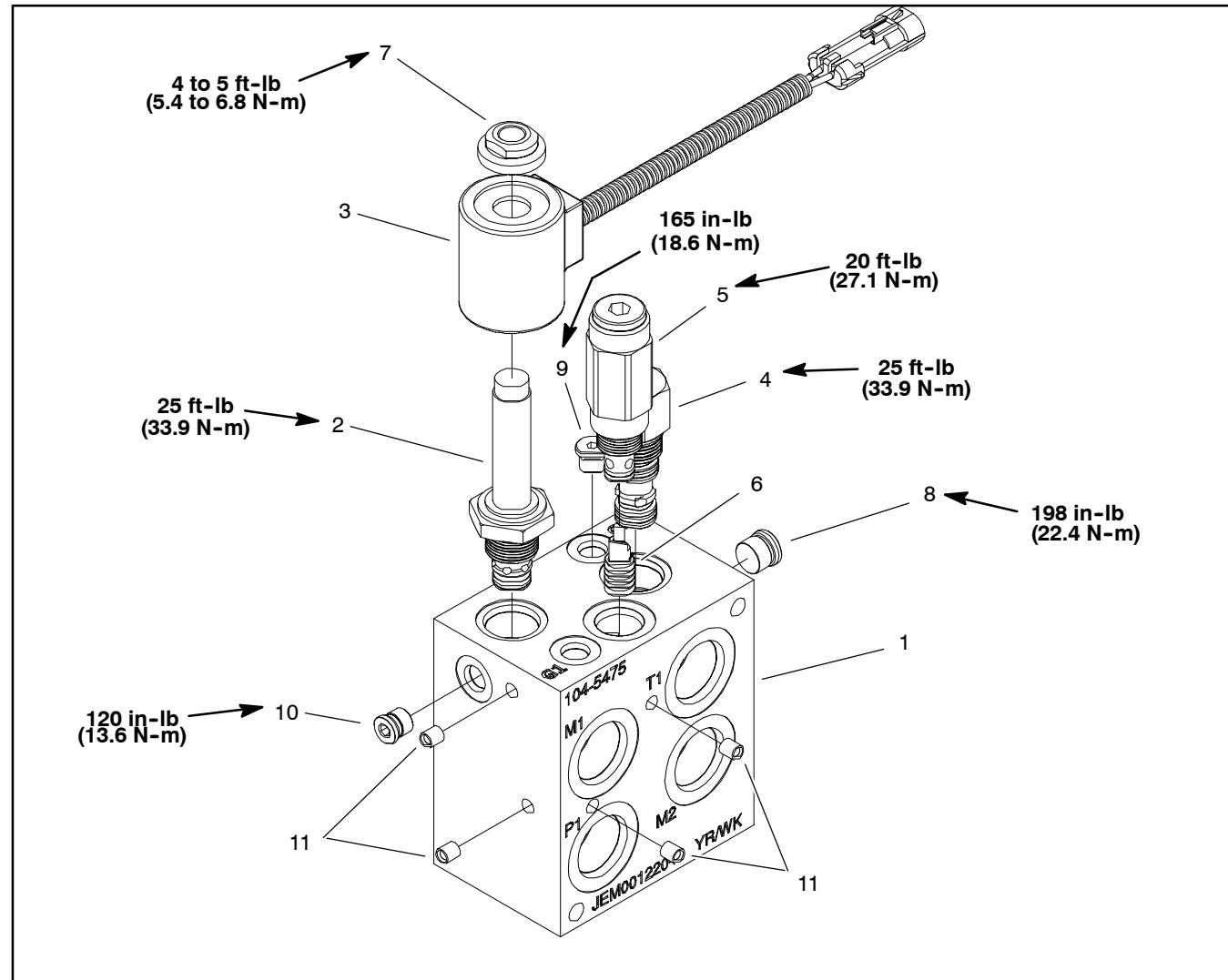


Figure 70

- | | | |
|--------------------------|------------------------|-----------------------------------|
| 1. Manifold body | 5. Relief valve (RV8) | 9. Plug (SAE #4) |
| 2. Solenoid valve (PRV2) | 6. Pilot piston | 10. Zero leak plug (#4) |
| 3. Solenoid coil | 7. Nut | 11. Expanding plug (not serviced) |
| 4. Logic cartridge (LC1) | 8. Zero leak plug (#6) | |

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

For solenoid and control valve service procedures, see Hydraulic Control Manifold Service: 2 Wheel/4 Wheel Drive Control in this section. Refer to Figure 70 for cartridge valve installation torque.

NOTE: The Groundsmaster 4500-D deck drive manifold uses several zero leak plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an o-ring as a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a pin punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug.

Hydraulic Control Manifold: Deck Drive (GM 4700-D)

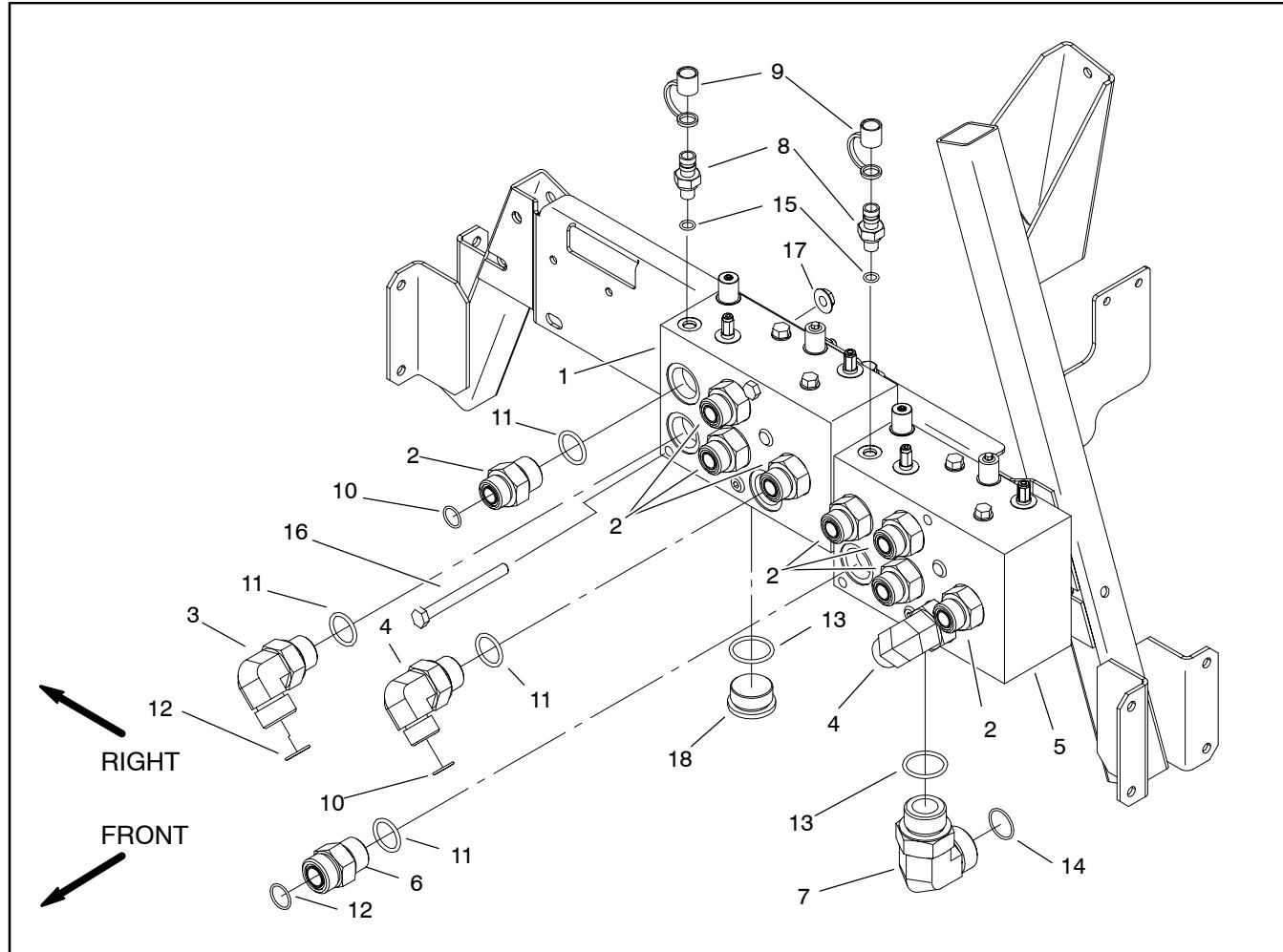


Figure 71

- | | | |
|---|--------------------------|----------------|
| 1. Hydraulic manifold: decks 2, 3, 5, & 7 | 7. 90° hydraulic fitting | 13. O-ring |
| 2. Hydraulic adapter | 8. Quick fitting | 14. O-ring |
| 3. 90° hydraulic fitting | 9. Dust cap | 15. O-ring |
| 4. 90° hydraulic fitting | 10. O-ring | 16. Cap screw |
| 5. Hydraulic manifold: decks 1, 4, & 6 | 11. O-ring | 17. Flange nut |
| 6. Straight hydraulic fitting | 12. O-ring | 18. Plug |

Removal

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

1. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.
2. Disconnect electrical connector from the solenoid valve.

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

4. Remove hydraulic manifold from the frame using Figure 71 as guide.

Installation

1. Install hydraulic manifold to the frame using Figure 71 as guide.
2. Remove caps and plugs from fittings and hoses. Properly connect hydraulic lines to manifold.
3. Connect electrical connector to the solenoid valve.

Hydraulic Control Manifold Service: Deck Drive (GM 4700-D)

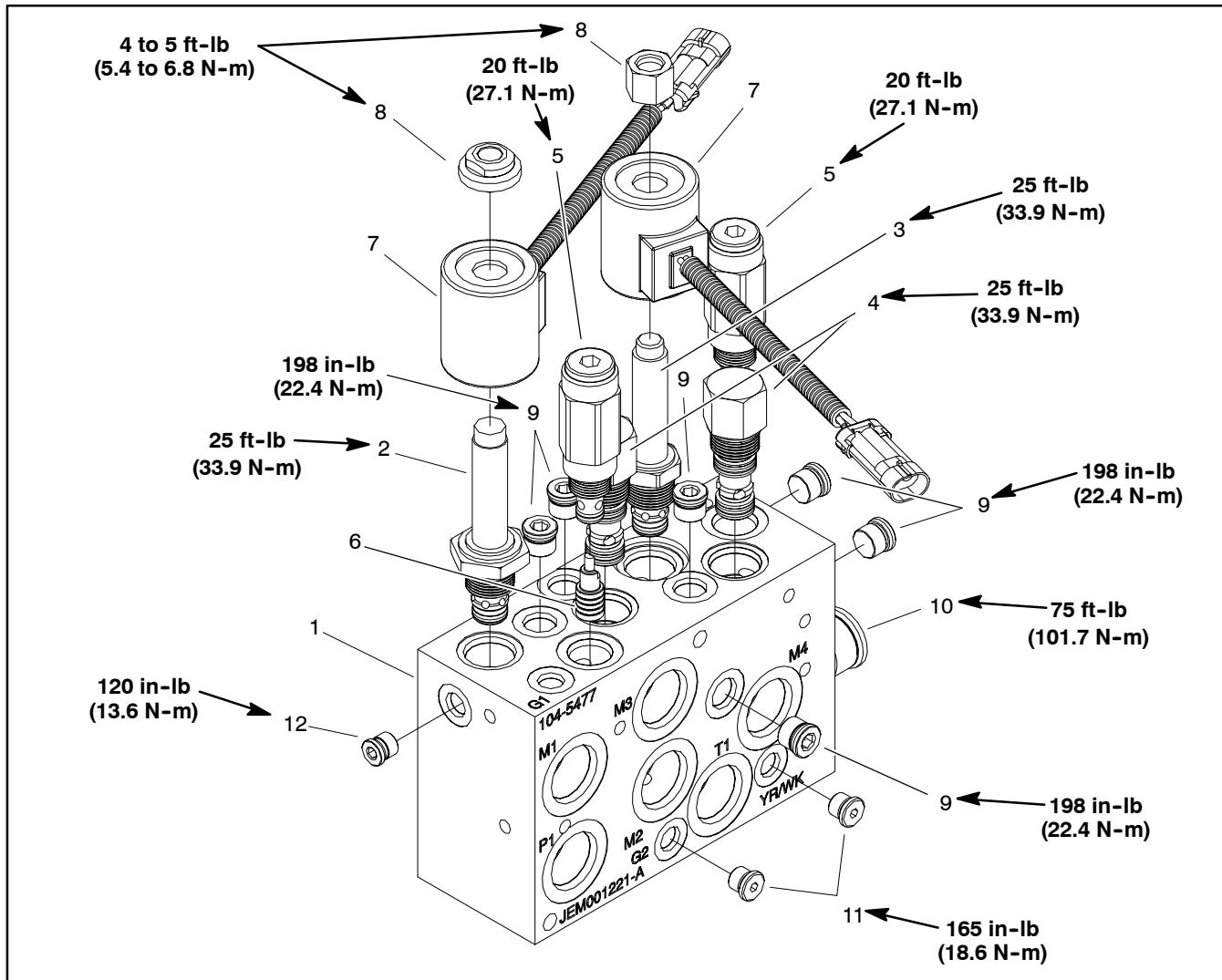


Figure 72

- | | | |
|--|-------------------------------|--------------------------|
| 1. Manifold body | 5. Relief valve (RV8 and RV9) | 9. Zero leak plug (#6) |
| 2. Proportional relief solenoid (PRV2) | 6. Pilot piston | 10. Zero leak plug (#12) |
| 3. Solenoid valve (SV2) | 7. Solenoid coil | 11. Plug (SAE #4) |
| 4. Logic valve (LC1 and LC2) | 8. Nut | 12. Zero leak plug (#4) |

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

For solenoid and control valve service procedures, see Hydraulic Control Manifold Service: 2 Wheel/4 Wheel Drive Control in this section. Refer to Figure 72 for cartridge valve installation torque.

NOTE: The Groundsmaster 4700-D deck drive manifold uses several zero leak plugs. These plugs have a tapered sealing surface on the plug head that is designed to resist vibration induced plug loosening. The zero leak plugs also have an o-ring as a secondary seal. If zero leak plug removal is necessary, lightly rap the plug head using a punch and hammer before using an allen wrench to remove the plug: the impact will allow plug removal with less chance of damage to the socket head of the plug.

Rear Axle Motor

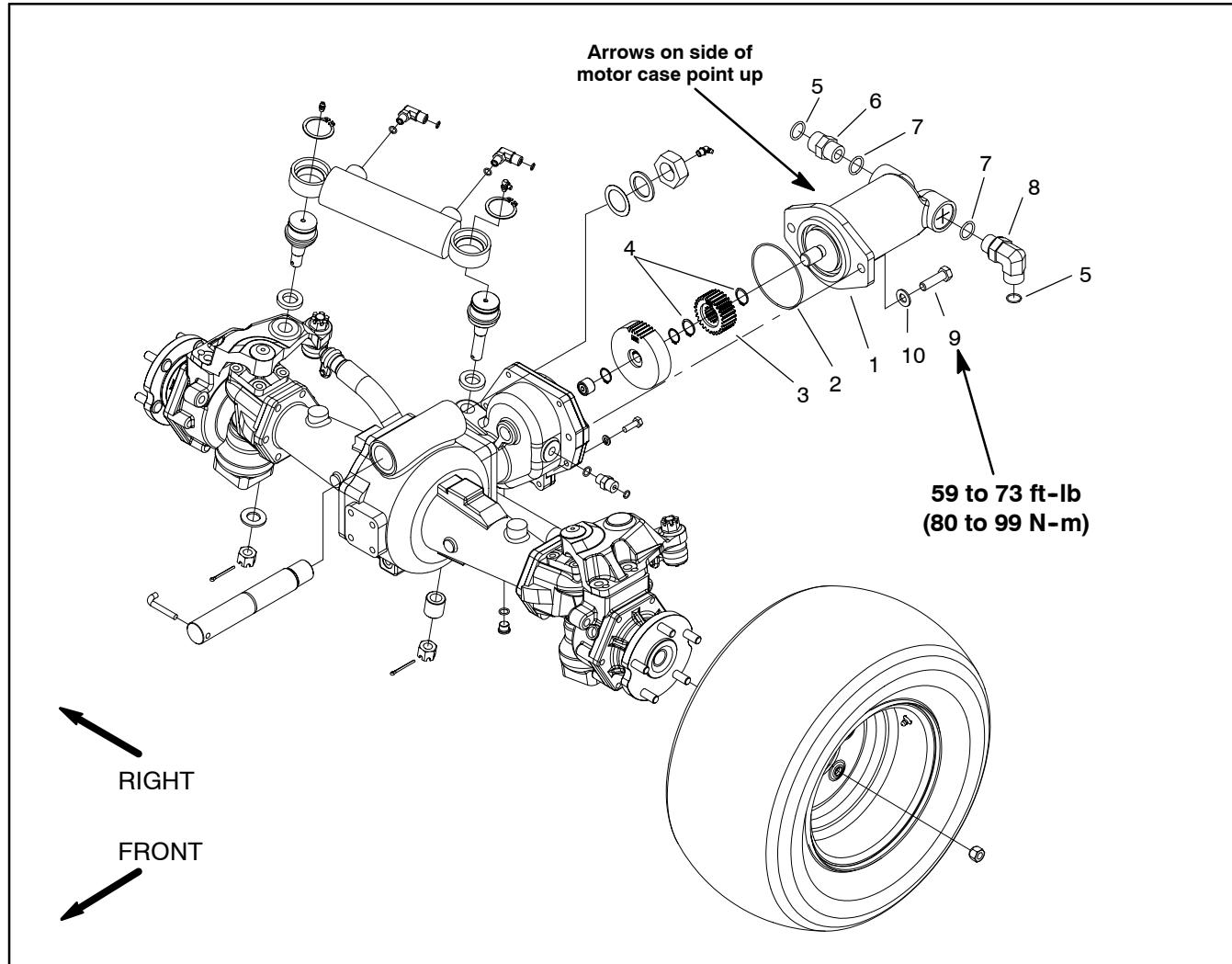


Figure 73

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

Removal

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

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

NOTE: To ease reassembly, tag the hydraulic hoses to show their correct position on the axle motor. Also, clean the port areas of the motor before disconnecting hydraulic lines.

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

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

4. Remove motor using Figure 73 as a guide.

Installation

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

2. Install o-ring onto motor. Position motor to rear axle assembly making sure that arrows on the side of motor case point upward. Align gear teeth and slide motor into place.

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

4. Remove plugs from ports. Attach hydraulic hoses to axle motor.

5. Fill hydraulic reservoir with hydraulic fluid as required (see Traction Unit Operator's Manual).

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

Front Wheel Motors

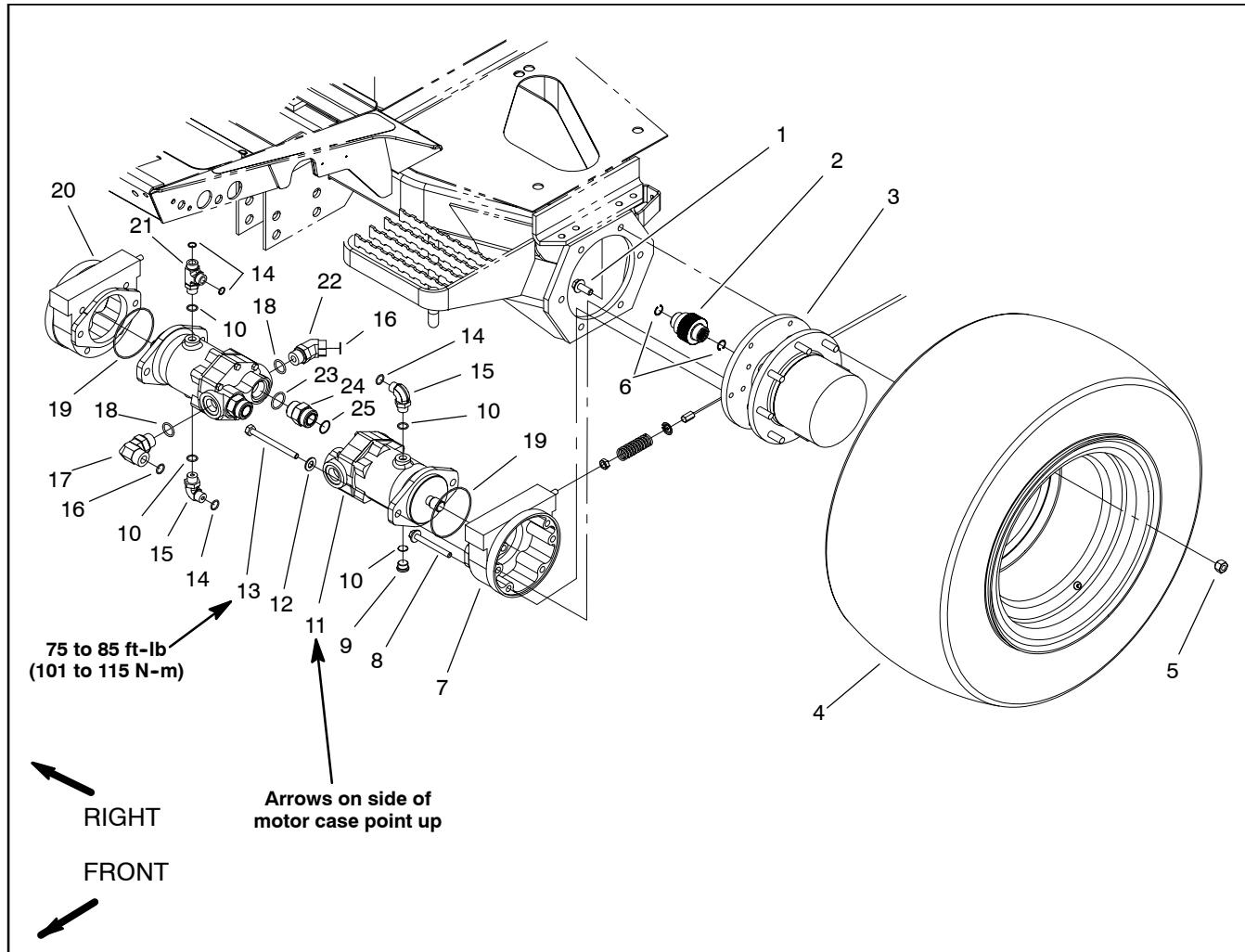


Figure 74

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

Removal

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

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

NOTE: To ease reassembly, tag the hydraulic hoses to show their correct position on the wheel motor. Also, clean the port area of the motor before disconnecting the hydraulic lines.

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

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

4. Remove wheel motor using Figure 74 as a guide.

Installation

1. Position wheel motor to brake assembly making sure that arrows on the side of motor case point upward.

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

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

4. Remove plugs from motor ports. Attach hydraulic hoses and tubes to wheel motor.

5. Fill reservoir with hydraulic fluid as required (see Traction Unit Operator's Manual).

Rear Axle/Front Wheel Motor Service

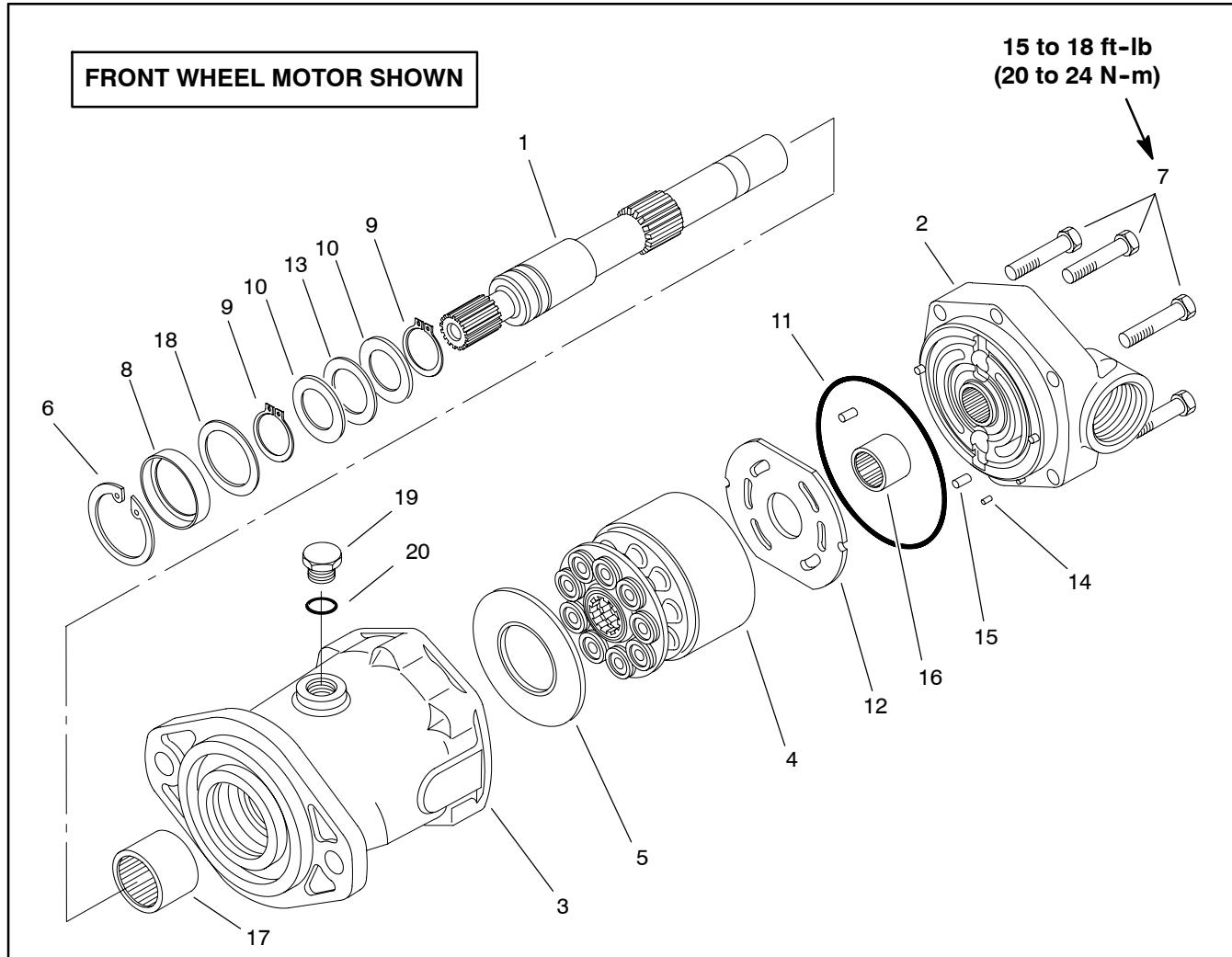


Figure 75

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

NOTE: The front wheel motors (shown in Figure 75) are identical. The rear axle motor is similar to the front wheel motors. Service of the front and rear motors requires the same procedure.

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

Cleanliness is extremely important when repairing hydraulic motors. Work in a clean area. Before disconnecting the lines, clean port area of motor. Thoroughly clean the outside of the motor. After cleaning, remove port plugs and drain oil from motor.

Disassembly

1. Clamp the drive shaft end of the piston motor in a protected jaw vise with the cap screws up. Remove the six cap screws (7) from the motor assembly.
2. Use a soft face hammer and tap the backplate (2) to loosen and remove from housing.
3. Remove valve plate (12) and O-ring (11) from backplate. It is not necessary to remove roll pins (14 and 15) in backplate.

4. Remove motor from vise and remove rotating assembly (4) from motor housing.
5. Remove the camplate insert (5) from housing. Use caution not to mar the finish that makes contact with pistons.
6. Remove retaining ring (6) from housing. Press shaft from housing and remove shaft seal (8) and washer (18).
7. Remove retaining rings (9) from shaft and remove thrust races (10) and thrust bearing (13).
8. Discard the shaft seal and o-ring, and replace with new items upon reassembly.

Inspection

1. Check the condition of the needle bearing (16) in backplate (2) and replace if necessary.
2. Inspect valve plate (12) on the bronze side next to the piston block for wear. A smooth surface is required. **Do not lap valve plate bronze surface.** Replace valve plate if any wear exists.
3. Inspect the piston block surface that makes contact with valve plate. This surface should be smooth and free of deep scratches. **Do not lap piston block.**
4. The pistons should move freely in the piston block bore. If they are sticky in the bore, examine the bore for scoring or contamination.
5. Examine the O.D. of the pistons for finish condition. They should not show wear or deep scratches. Inspect the shoes for a snug fit on the ball end of the pistons and a flat smooth surface that comes in contact with the camplate. **Do not lap piston shoes.**
6. Examine the spider for wear in the pivot area.
7. Examine the spider pivot to insure smoothness and no signs of wear.
8. The polished finish on the shoe surface of the camplate insert (5) should show no signs of scoring.
9. Inspect the shaft for wear in the seal, bearing and spline areas.
10. Inspect thrust bearing (13) and races (10) for wear.
11. Check the condition of the needle bearing (17) in housing and replace if necessary.

Reassembly

1. Clean all parts in suitable solvent and lubricate all internal parts with clean hydraulic oil before reassembly.

2. If necessary, install new needle bearing (17) in housing (3) with numbered end of the bearing outward.

3. Install retaining ring (9) on shaft. Install thrust race (10), thrust bearing (13), and second thrust race (10). Secure with second retaining ring (9).

4. Install shaft in housing. Install washer (18), new shaft seal (8), and retaining ring (6).

5. Install camplate insert (5) with the lettering side of insert to the front of the housing. Use petroleum jelly to hold in place during assembly.

6. Install rotating assembly (4) into housing. Make sure that piston shoes make contact with the camplate insert.

7. Clamp motor assembly in a protected jaw vise with the open end of the housing up.

8. If roll pins were removed, install to dimension shown in Figure 76 and with opening of roll pin oriented away from bearing within 5° of bearing center line.

9. To replace bearing (16) in backplate (2). Press bearing down to the dimension shown (Fig. 76) protruding from backplate with numbered end of bearing facing up next to valve plate.

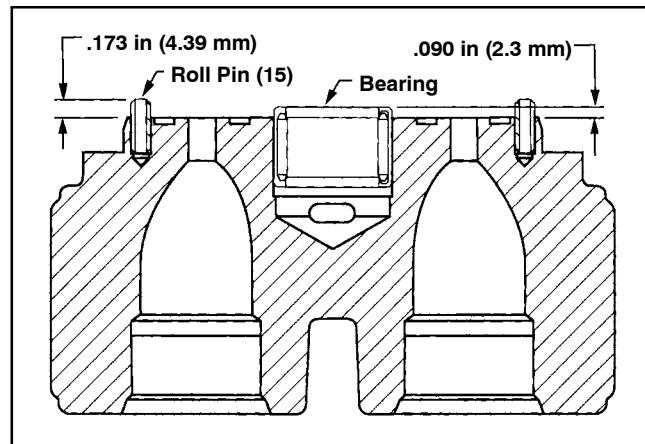


Figure 76

10. Apply small amount of petroleum jelly to the steel side of valve plate (12) to hold in place for installation. Place the valve plate in position onto the backplate (2), with steel side against backplate, bronze colored side against piston block.

11. Placing new o-ring (11) onto backplate, install backplate assembly (2) onto housing assembly. Make sure valve plate stays in position.

12. Insert cap screws and torque from 15 to 18 ft-lb (20 to 24 N-m) in a criss-cross pattern.

13. Fill case half full of new hydraulic oil.

This page is intentionally blank.

Cutting Deck Motor

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

Removal

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

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

NOTE: Before disconnecting the hydraulic lines, clean the port area of the deck motor.

3. Disconnect hydraulic lines from deck motor. Put caps or plugs on fittings and hoses to prevent contamination. Tag hydraulic lines for proper reassembly.
4. Remove two socket head screws that secure hydraulic motor to cutting deck (Fig. 77).
5. Lift hydraulic motor from cutting deck.

Installation

1. Align splines on motor shaft and spindle shaft. Position hydraulic motor to the cutting unit.
2. Secure motor to cutting deck with two socket head screws (Fig. 77).
3. Remove caps or plugs from hydraulic fittings and hoses. Connect hydraulic hoses to deck motor.
4. After assembly is completed, verify that hydraulic hoses and fittings are not contacted by moving components.

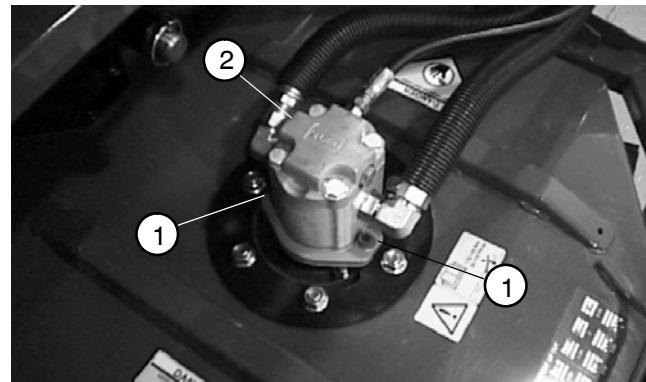


Figure 77

1. Socket head screw 2. Hydraulic motor

Cutting Deck Motor Service

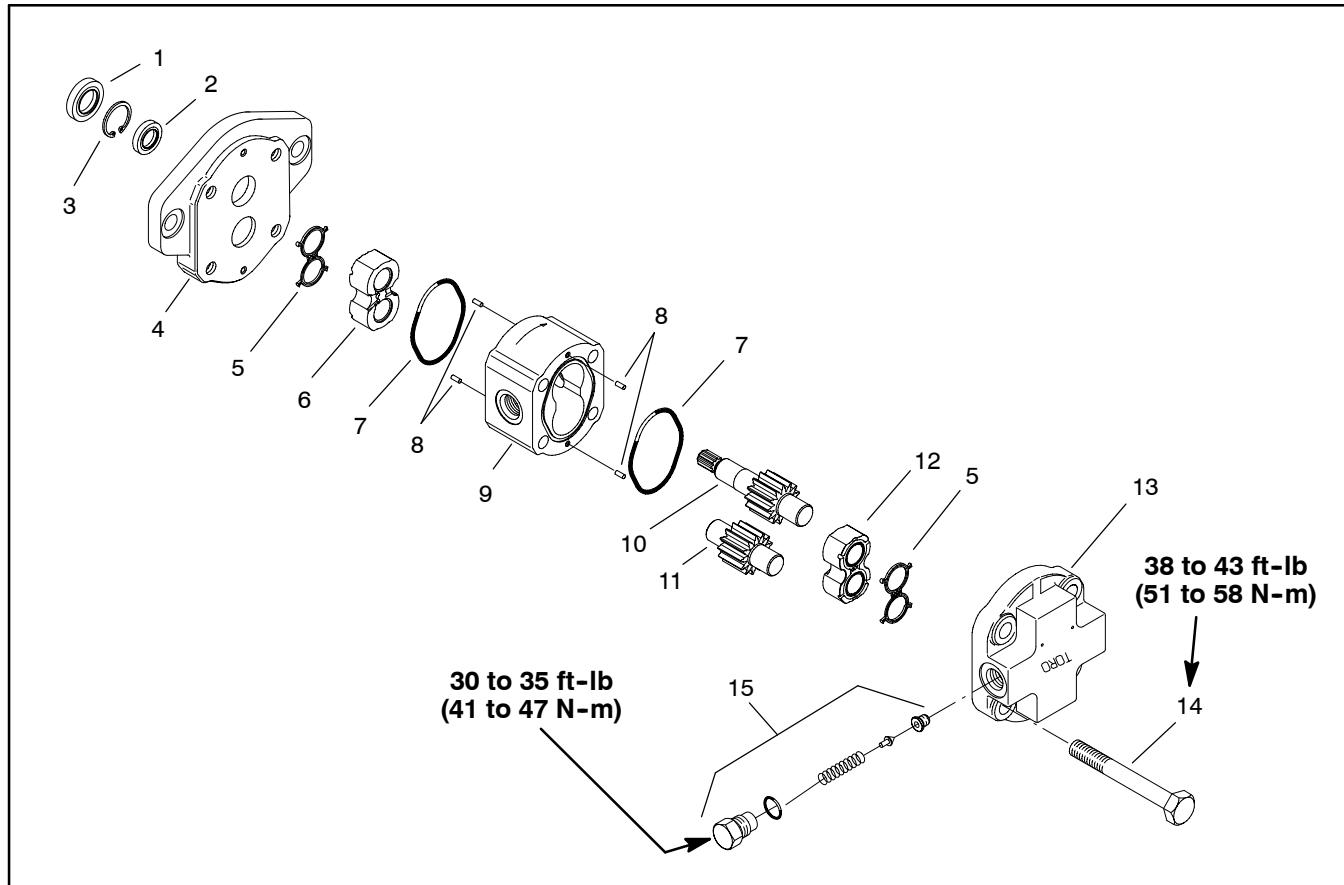


Figure 78

1. Outer shaft seal
2. Inner shaft seal
3. Retaining ring
4. Front flange
5. Pressure seal

6. Front bearing block
7. O-ring
8. Dowel pin
9. Housing
10. Drive gear

11. Idler gear
12. Rear bearing block
13. Rear cover
14. Cap screw
15. Relief valve assembly

Disassembly (Fig. 78)

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

2. Use a marker or scribe to make a **diagonal** mark across the front flange, housing, and rear cover for reassembly purposes (Fig. 79).

IMPORTANT: Avoid using excessive clamping pressure on the motor housing to prevent distorting the housing.

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

4. Loosen cap screws from the rear cover.

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

6. Remove rear cover from the housing.

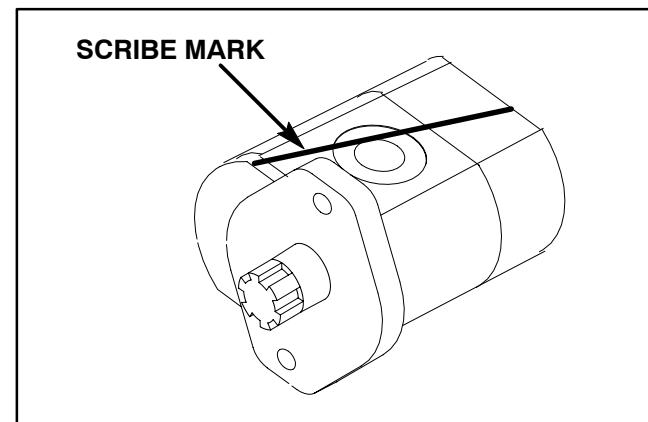


Figure 79

7. Carefully remove housing by lifting housing straight up. Make sure the rear bearing block remains on the drive and idler gear shafts. Remove and discard o-rings from the housing.

IMPORTANT: Note position of the open and closed side of the bearing blocks before removing. Also, identify bearing blocks (front and rear) for proper re-assembly.

8. Carefully remove rear bearing block, idler gear, drive gear, and front bearing block from the front flange.

9. Remove and discard pressure seals from bearing blocks.

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

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

11. Remove outer shaft seal, retaining ring and inner shaft seal from the front flange. Discard seals.

Inspection

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



CAUTION

Use eye protection such as goggles when using compressed air.

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

3. Inspect drive gears and idler gears for the following (Fig. 80):

A. Drive gear shaft spline should be free of twisted or broken teeth.

B. 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.

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

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

4. Inspect bearing blocks for the following:

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

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

C. Thickness of bearing blocks should be equal.

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

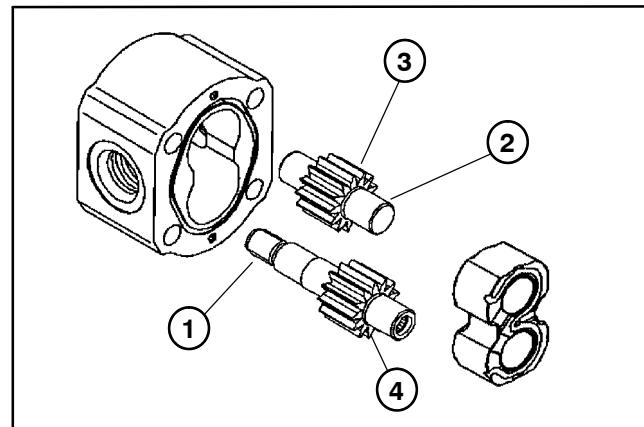


Figure 80

1. Gear shaft spline
2. Gear shaft

3. Gear teeth
4. Gear face edge

Reassembly (Fig. 78)

NOTE: When reassembling the motor, check the marker or scribe marks on each part to make sure the parts are properly aligned during reassembly.

1. Lubricate o-rings, pressure seals, and bearing block grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic oil.

2. Install inner shaft seal into front flange with seal lip facing in (Fig. 81). Seal should be pressed into place until it reaches the bottom of the bore.

3. Install retaining ring into the groove of the front flange.

4. Install outer shaft seal in front flange with seal lip facing out (Fig. 81). Seal should be pressed into place until it reaches the bottom of the bore.

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

6. Install the pressure seals into the grooves in the bearing blocks.

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

8. Lubricate the drive gear shaft with clean hydraulic oil. Noting the open and closed sides of the front bearing block, insert the drive end of the drive shaft through the bearing block with the pressure seal side down. Carefully install shaft into front flange.

9. Lubricate the idler gear shaft with clean hydraulic oil. Install idler gear shaft into the remaining position in the bearing block. Apply a light coating of clean hydraulic oil to gear faces.

10. Noting the open and closed sides of the front bearing block, install rear bearing block with pressure seal side up.

11. Apply a light coating of petroleum jelly to new o-rings and o-ring grooves in the housing. Install new o-rings to the housing.

12. Install locating dowel pins in housing. Align scribe marks on the housing and front flange.

IMPORTANT: Do not dislodge pressure seals from bearing blocks when installing housing to assembly.

13. Gently slide the housing onto the assembly. Firm hand pressure should be sufficient to engage the dowel pins.

14. Check to make sure that the surface of the rear bearing block is slightly below the face of the housing. If the bearing block is not below the housing, check assembly for a shifted pressure seal, backup seal, or o-ring. Correct before proceeding.

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

16. Place rear cover on assembly using marker or scribe mark for proper location. Firm hand pressure should be sufficient to engage the dowel pins.

17. Install the four cap screws and hand tighten.

IMPORTANT: Avoid using excessive clamping pressure on the motor housing to prevent distorting the housing.

18. Place front flange of the motor into a vise and alternately torque the cap screws from 38 to 43 ft-lb (51 to 58 N-m).

19. Remove motor from vise.

20. Place a small amount of clean hydraulic oil in the inlet of the motor and rotate the drive shaft one revolution (Fig. 82). If any binding is noted, disassemble the motor and check for assembly problems.

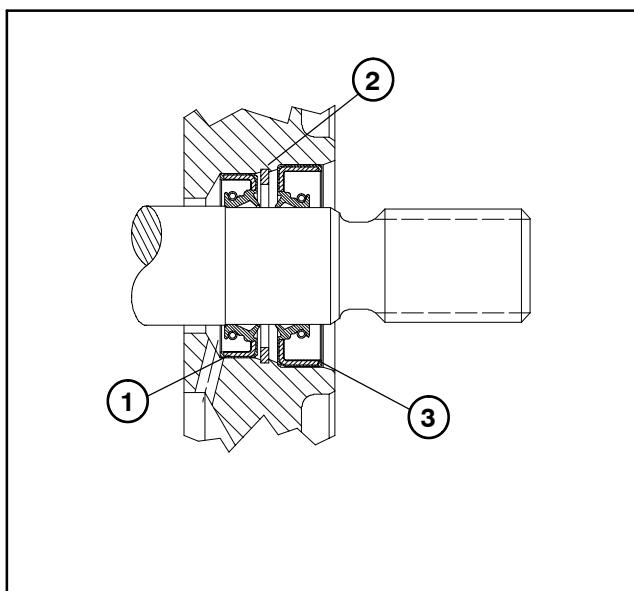


Figure 81

1. Inner shaft seal
2. Retaining ring

3. Outer shaft seal

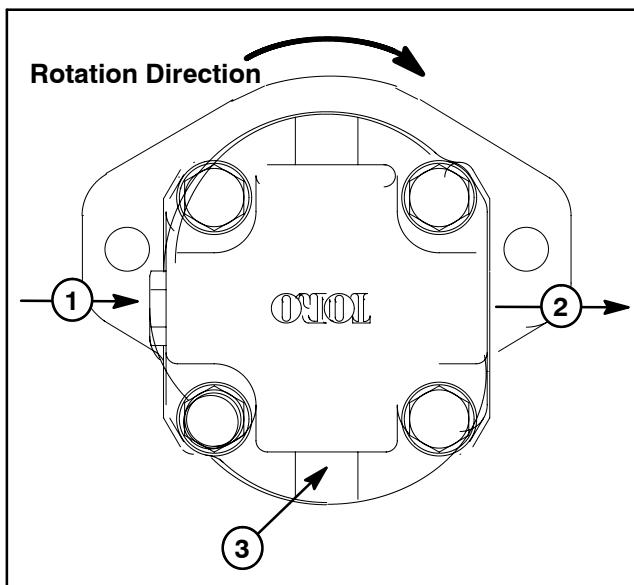


Figure 82

1. Pressure IN
2. Pressure OUT

3. Case drain

Relief Valve Service

IMPORTANT: Do not remove the relief valve assembly unless testing shows it to be faulty.

1. When removing or installing the relief valve, motor should be removed from deck and positioned horizontally with the relief valve pointed down (Fig. 83). This process will prevent the relief valve from falling into motor passages.

NOTE: The relief valve seat is difficult to remove because it has a thin, hex head and has sealant applied to the threads. Inspect the seat carefully and remove it only if damage or wear is identified.

2. Remove plug with o-ring, spring, and relief valve from the rear cover.

3. Clean and inspect removed parts. Visually inspect relief valve seat and plug threads in the rear cover.

4. If relief valve seat was removed, apply medium strength thread locking compound (e.g. Loctite #242) to seat and install in rear cover. Torque seat from 4 to 6 ft-lb (5.4 to 8.1 N-m).

5. Apply hydraulic oil to relief valve components. Replace the relief valve assembly: install relief valve, spring, and plug with o-ring into the rear cover. Torque plug from 30 to 35 ft-lb (41 to 47 N-m).

6. Install motor on cutting deck.

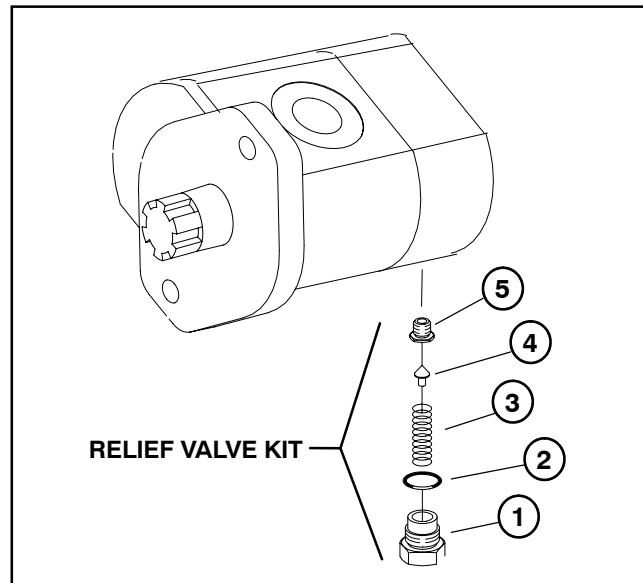


Figure 83

- | | |
|-----------|----------------------|
| 1. Plug | 4. Relief valve |
| 2. O-ring | 5. Relief valve seat |
| 3. Spring | |

Lift/Lower Control Valve (GM 4500-D)

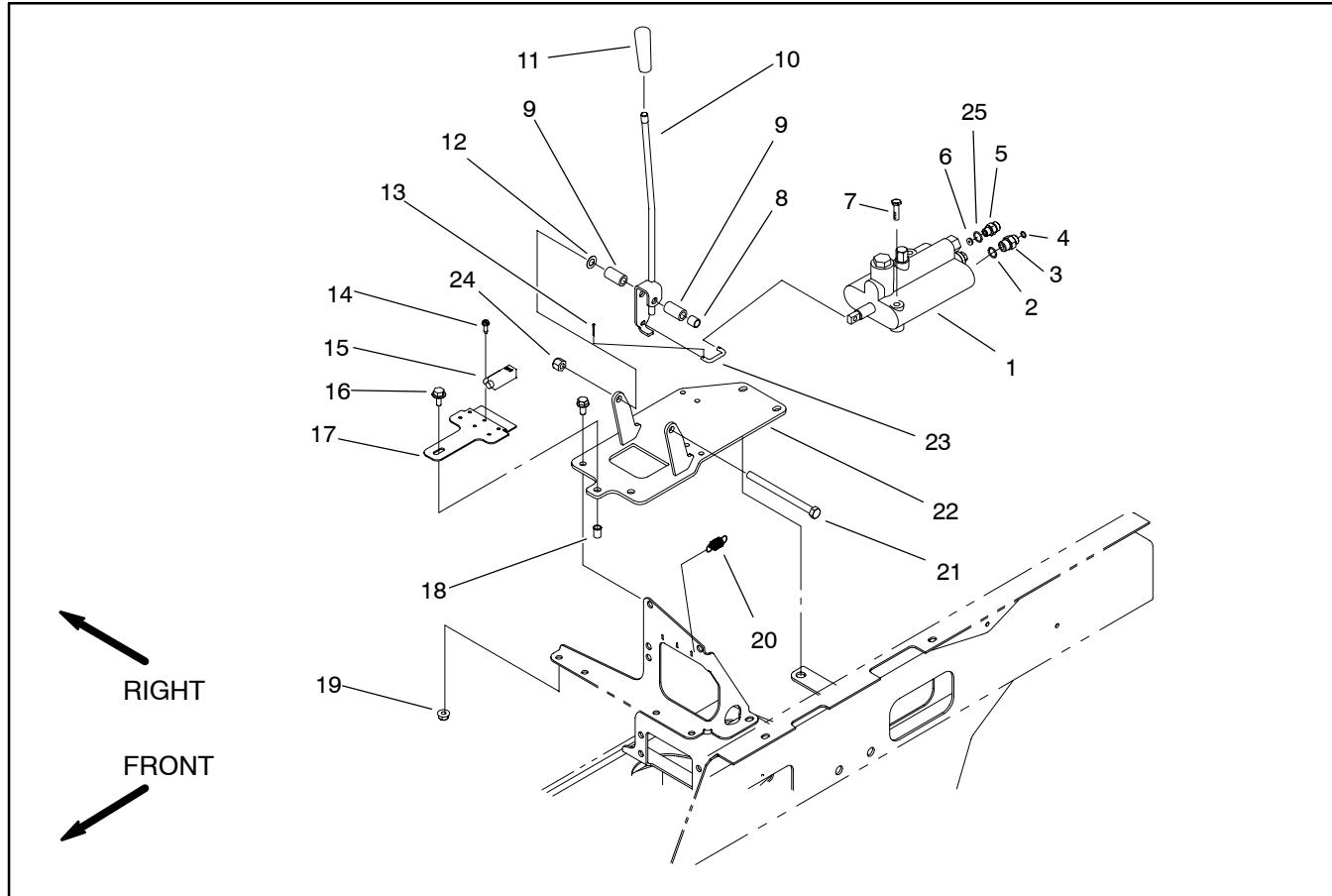


Figure 84

- | | | |
|-------------------------------------|--------------------------|----------------------|
| 1. Control valve assembly (1 spool) | 10. Lift lever | 18. Insert nut |
| 2. O-ring | 11. Control knob | 19. Flange nut |
| 3. Hydraulic adapter | 12. Curved washer | 20. Extension spring |
| 4. O-ring | 13. Cotter pin | 21. Cap screw |
| 5. Hydraulic fitting | 14. Thread forming screw | 22. Valve support |
| 6. Orifice (port B) | 15. Proximity switch | 23. Link |
| 7. Cap screw | 16. Flange head screw | 24. Lock nut |
| 8. Spacer | 17. Switch plate | 25. O-ring |
| 9. Spacer tube | | |

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

NOTE: Before disconnecting the hydraulic lines, clean the port area of the lift/lower control valve assembly.

3. Tag hydraulic lines for proper reassembly.
4. Remove lift/lower control valve using Figure 86 as a guide.

Installation

1. Install control valve using Figure 86 as a guide.
2. Make sure hydraulic tank is full. Add correct oil if necessary before returning machine to service.

Lift/Lower Control Valve Service (GM 4500-D)

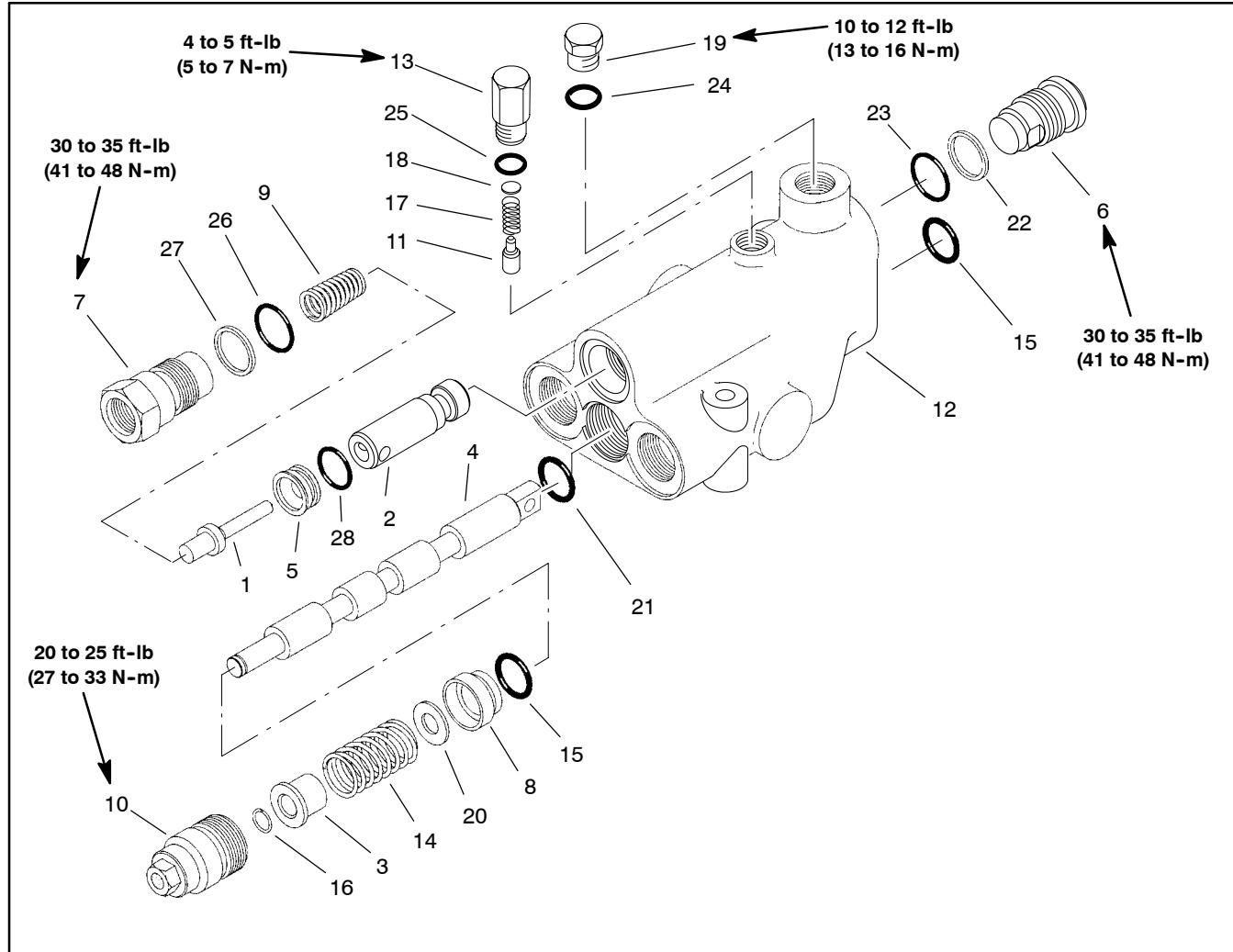


Figure 85

- | | | |
|------------------------|------------------------|-------------------|
| 1. Poppet | 11. Detent plunger | 20. Washer |
| 2. Plunger | 12. Control valve body | 21. Wiper seal |
| 3. Spacer | 13. Detent plug | 22. Backup washer |
| 4. Spool | 14. Spool spring | 23. O-ring |
| 5. Seat | 15. O-ring | 24. O-ring |
| 6. Plug | 16. Retaining ring | 25. O-ring |
| 7. Seat retaining plug | 17. Detent spring | 26. O-ring |
| 8. Bushing | 18. Disc | 27. Backup washer |
| 9. Lockout spring | 19. Plug | 28. O-ring |
| 10. Spool cap | | |

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

Disassembly

1. Plug all ports and clean outside of valve thoroughly.
2. Remove spool cap (10). Do not remove retaining ring (16) from spool (4) unless spool spring (14) is broken.
3. Remove spool (4) from control valve body (12).
4. Remove bushing (8) and O-rings (15) from spool and O-ring from spool bore.
5. Remove plug (6).

IMPORTANT: Check location and positioning of plunger when removing from body to assure proper assembly.

6. Remove seat retaining plug (7), lockout spring (9), poppet (1), seat (5) and plunger (2).
7. Remove plug (19).
8. Remove detent plug (13), disc (18), spring (17) and detent plunger (11).
9. Remove all O-rings and back-up rings from all plugs and seats.

Inspection

1. Remove all nicks and burns from parts and inspect for excessive wear.
2. Inspect plunger and seats for burrs or roughness.
3. Inspect spool spring (14), lockout spring (9), and detent spring (17) for breakage.
4. If spool (4) has excessive wear, the control valve becomes non-serviceable as the spool and spool bore are matched. Damaged spools cannot be replaced.

Assembly

1. Thoroughly clean and dry all parts. Apply a light coating of clean hydraulic oil to parts prior to assembly.

NOTE: All O-rings, back-up washers, wiper seals and nylon poppet should be replaced as new items.

2. Install new O-ring (15) in proper groove in spool bore.
3. Install plug (6) with new back-up washer (22) and O-ring (23). Torque plug from 30 to 45 ft-lb (41 to 48 N-m).
4. Lubricate plunger (2) with clean hydraulic oil and install it into control valve body.

IMPORTANT: Check location and positioning of plunger during installation.

5. Install new O-ring (28) on seat (5). Install new back-up washer (27) and O-ring (26) on seat retaining plug (7).
6. Lubricate seat (5) with clean hydraulic oil. Install seat (5), new poppet (1), lockout spring (9) and seat retaining plug (7). Torque plug from 30 to 45 ft-lb (41 to 48 N-m).
7. Install plug (19) with new O-ring (24).
8. Lubricate detent plunger (11) with clean hydraulic oil. Install plunger, detent spring (17), disc (18), and detent plug (13) with new O-ring (25).
9. If retaining ring (16) was removed to replace spool spring (14), install washer (20), spring (14), spacer (3), and secure with retaining ring (16).
10. Slide bushing (8) over spool. Slide new O-ring (21) over spool and position next to bushing. Dip spool in clean hydraulic oil and install spool assembly into proper location of control valve body.
11. Install spool cap (10) and tighten from 20 to 25 ft-lb (27 to 33 N-m).
12. Install new wiper seal (21).

Lift/Lower Control Valve (GM 4700-D)

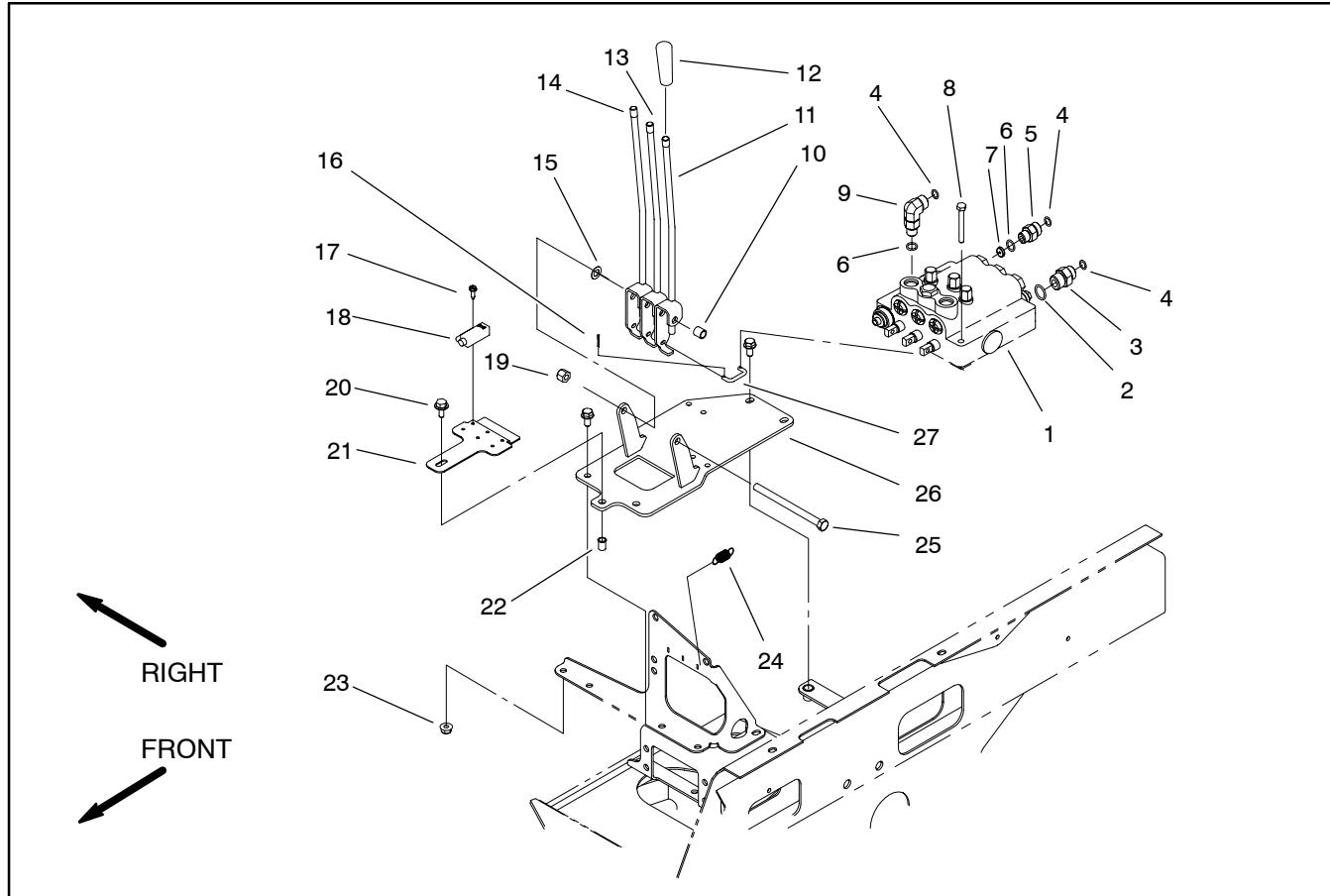


Figure 86

- | | | |
|-------------------------------------|---------------------------------|-------------------------------|
| 1. Control valve assembly (3 spool) | 10. Spacer | 19. Lock nut |
| 2. O-ring | 11. Left lift lever | 20. Flange head screw |
| 3. Hydraulic adapter | 12. Control knob (3 used) | 21. Switch plate |
| 4. O-ring | 13. Center lift lever | 22. Nut insert |
| 5. Hydraulic fitting | 14. Right lift lever | 23. Flange nut |
| 6. O-ring | 15. Curved washer (if equipped) | 24. Extension spring (3 used) |
| 7. Orifice (port D) | 16. Cotter pin | 25. Cap screw |
| 8. Cap screw | 17. Thread forming screw | 26. Valve support |
| 9. 90° hydraulic fitting | 18. Proximity switch (3 used) | 27. Link (3 used) |

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.

NOTE: Before disconnecting the hydraulic lines, clean the port area of the lift/lower control valve assembly.

3. Tag hydraulic lines for proper reassembly.
4. Remove lift/lower control valve using Figure 86 as a guide.

Installation

1. Install control valve using Figure 86 as a guide.
2. Make sure hydraulic tank is full. Add correct oil if necessary before returning machine to service.

Lift/Lower Control Valve Service (G 4700-D)

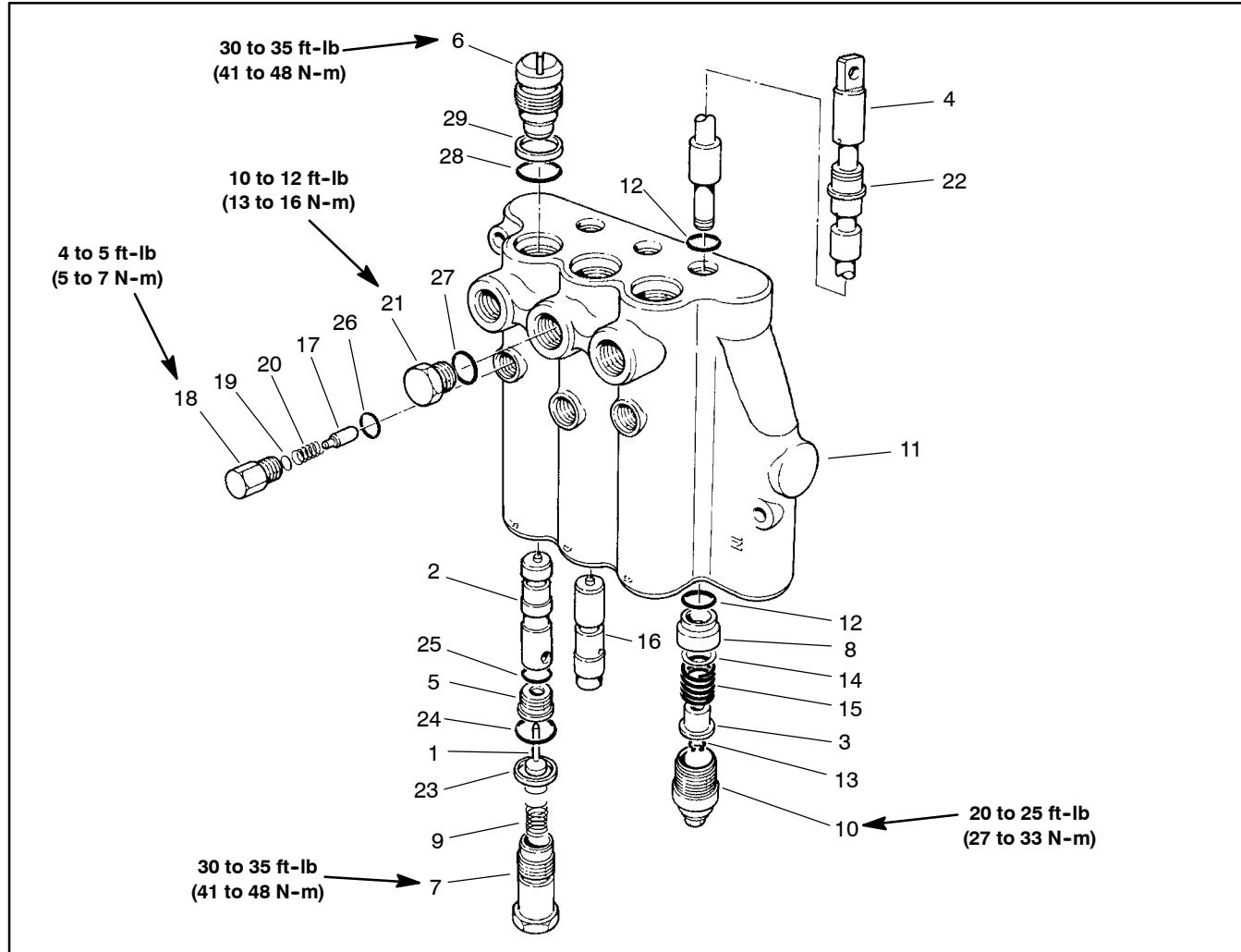


Figure 87

- | | | |
|------------------------|------------------------|-------------------|
| 1. Poppet | 11. Control valve body | 21. Plug |
| 2. Plunger | 12. O-ring | 22. Wiper seals |
| 3. Spacer | 13. Retaining ring | 23. Backup washer |
| 4. Spool | 14. Washer | 24. O-ring |
| 5. Seat | 15. Spool spring | 25. O-ring |
| 6. Plug | 16. Plunger | 26. O-ring |
| 7. Seat retaining plug | 17. Detent plunger | 27. O-ring |
| 8. Bushing | 18. Detent plug | 28. O-ring |
| 9. Lockout spring | 19. Disc | 29. Backup washer |
| 10. Spool cap | 20. Detent spring | |

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

Disassembly

1. Plug all ports and clean outside of valve thoroughly.
2. Remove spool caps (10). Do not remove retaining rings (13) from spools unless spool spring (15) is broken.
- NOTE:** Spools and spool bores are matched sets. Be sure each spool is identified with the correct control valve body spool bore.
3. Remove spools (4) from control valve body (11).
4. Remove bushings (8) and O-rings (12) from spools and O-rings from spool bores.
5. Remove plugs (6).

IMPORTANT: Check location and positioning of plungers when removing from body to assure proper assembly.

6. Remove seat retaining plugs (7), lockout springs (9), poppets (1), seats (5) and plungers (2 and 16).
7. Remove plug (21).
8. Remove detent plugs (18), discs (19), detent springs (20) and detent plungers (17).
9. Remove all O-rings and back-up rings from all plugs and seats.

Inspection

1. Remove all nicks and burns from parts and inspect for excessive wear.
2. Inspect all plungers and poppet seats for burrs or roughness.
3. Inspect spool springs (15), lockout springs (9), and detent springs (20) for breakage.
4. If spools (4) have excessive wear, the control valve becomes non-serviceable as the spools and spool bores are matched. Damaged spools cannot be replaced.

Assembly

1. Thoroughly clean and dry all parts. Apply a light coating of clean hydraulic oil to parts prior to assembly.

NOTE: All O-rings, back-up washers, wiper seals and nylon poppets should be replaced as new items.

2. Install new O-rings (12) in proper grooves in spool bores.
3. Install plugs (6) with new back-up washers (29) and O-rings (28). Torque plugs from 30 to 35 ft-lb (41 to 48 N-m).
4. Lubricate plungers (2 and 16) with clean hydraulic oil and install them into their correct position in valve body.

IMPORTANT: Check location and positioning of plungers during installation.

5. Install new O-rings (25) on seats (5). Install new back-up washers (23) and O-rings (24) on plugs (7).
6. Lubricate seats (5) with clean hydraulic oil. Install seats (5), new poppets (1), and seat retaining plugs (7). Torque plugs from 30 to 35 ft-lb (41 to 48 N-m).
7. Install plug (21) with new O-ring (27). Torque plug from 10 to 12 ft-lb (13 to 16 N-m).
8. Lubricate detent plunger with clean hydraulic oil. Install detent plunger (17), detent spring (20), disc (19), and detent plug (18) with new O-ring (26). Torque plug from 4 to 5 ft-lb (5 to 7 N-m).
9. If retaining ring (13) has been removed to replace spool spring (15), install washer (14), spring (15), spacer (3), and secure with retaining ring (13).

10. Slide bushings (8) over spools. Slide new O-rings (12) over spools and position next to bushings. Dip spools in clean hydraulic oil and install spool assemblies into proper location of body.
11. Install spool caps (10) and tighten from 20 to 25 ft-lb (27 to 33 N-m).
12. Install new wiper seals (22).

Steering Valve

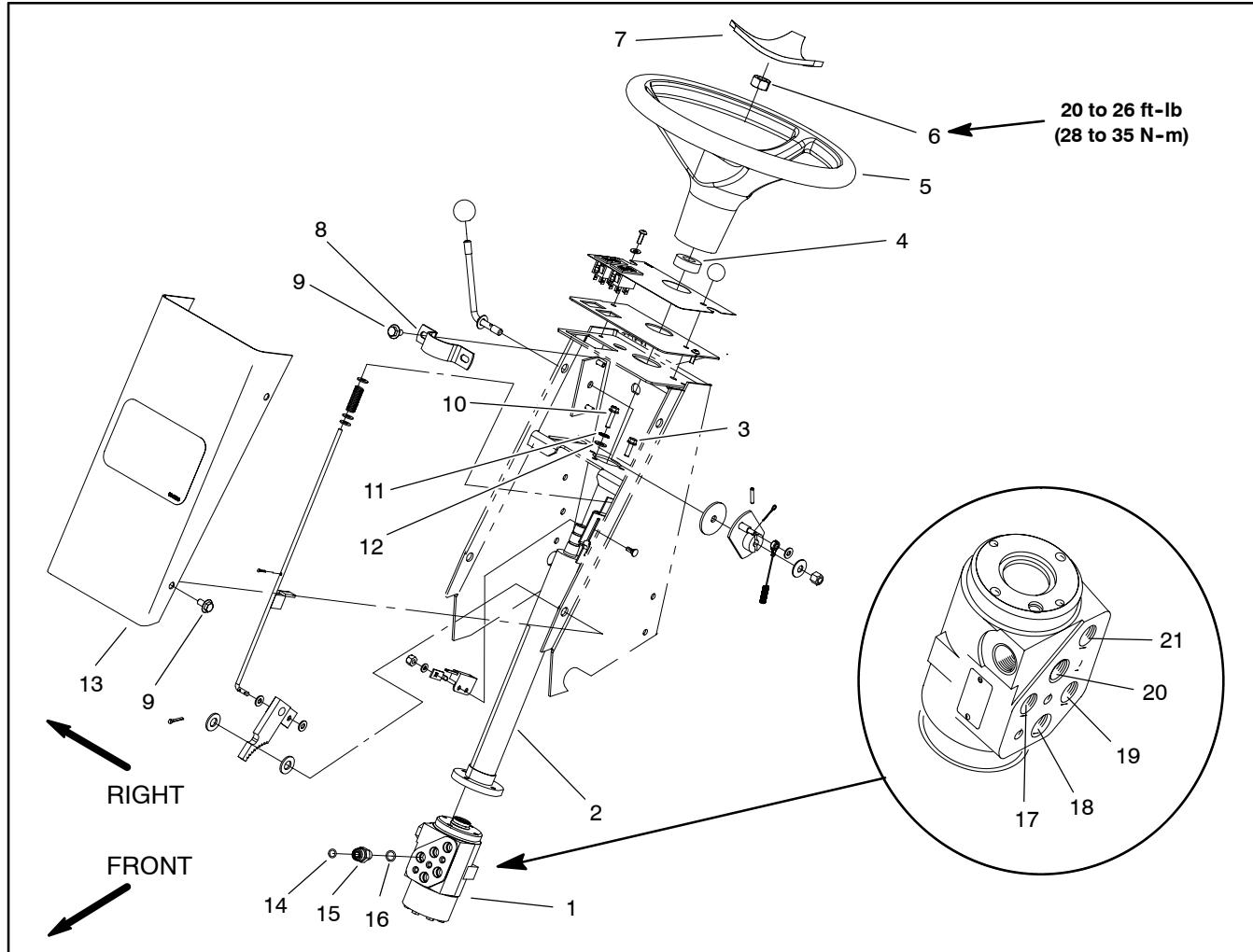


Figure 88

- | | | |
|-------------------------------|--------------------------------|----------------------------|
| 1. Steering valve | 8. Steering column bracket | 15. Hydraulic adapter |
| 2. Steering column | 9. Flange head screw | 16. O-ring |
| 3. Flange head screw (3 used) | 10. Flange head screw (1 used) | 17. In port (P) |
| 4. Dust cover | 11. Lock washer | 18. Right turn port (R) |
| 5. Steering wheel | 12. Flat washer | 19. Load sensing port (PB) |
| 6. Hex nut | 13. Steering tower cover | 20. Left turn port (L) |
| 7. Steering wheel cover | 14. O-ring | 21. Out port (T) |

Removal

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

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

NOTE: Before disconnecting the hydraulic lines, clean the port area of the steering valve assembly.

3. Tag hydraulic lines for proper reassembly.

4. Remove steering valve from machine using Figure 88 as a guide.

Installation

1. Install steering valve using Figure 88 as a guide.

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

Steering Valve Service

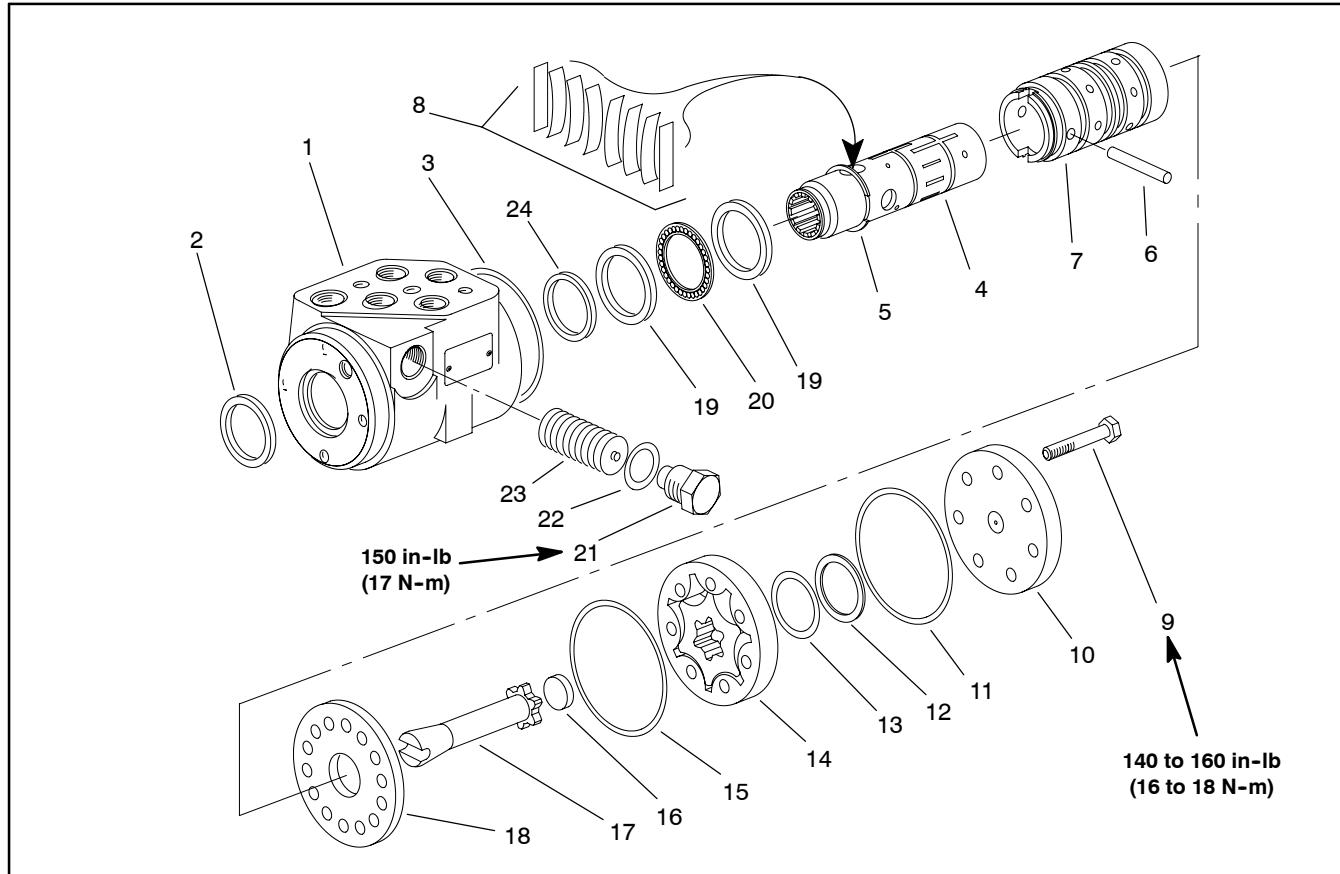


Figure 89

1. Steering valve housing
2. Dust seal
3. O-ring
4. Spool
5. Spring retaining ring
6. Pin
7. Sleeve
8. Centering springs/spacers

9. Cap screw
10. End cap
11. O-ring
12. Seal ring
13. O-ring
14. Geroter
15. O-ring
16. Spacer

17. Geroter drive
18. Wear plate
19. Bearing race
20. Thrust bearing
21. Plug
22. O-ring
23. Relief valve
24. Quad seal

Disassembly

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

1. Remove the seven cap screws from the steering valve assembly.
2. Remove end cap, geroter, spacer, geroter drive, wear plate, seal ring, and o-rings from housing (Fig. 89).
3. Remove the plug and relief valve.

4. Slide the spool and sleeve assembly from the housing.
5. Remove the thrust bearing and bearing races (2).
6. Remove the quad seal.
7. Use a small blade screwdriver to carefully pry the dust seal from the housing. Be careful to not damage the dust seal seat in the housing.
8. Remove the pin that holds the spool and sleeve together.
9. Carefully slide the spool out of the sleeve. The centering springs and spring retaining ring will stay with the spool as it is removed.



CAUTION

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

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

Reassembly

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

NOTE: Always use new seals and o-rings when reassembling the steering control unit.

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

1. Install the quad seal:

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

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

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

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

E. Remove the sleeve and bearing race.

2. Lubricate and install the dust seal.

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

4. Fit the retaining ring over the centering springs.

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

6. Install the pin.

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

8. Put the thrust bearing and races into the housing. The thrust bearing goes between the two races (Fig. 90).

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

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

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

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

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

NOTE: The holes in the wear plate are symmetrical.

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

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

15. Install the gerotor and align the screw holes.

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

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

18. Install the spacer.

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

20. Remove the steering control unit from the vise.

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

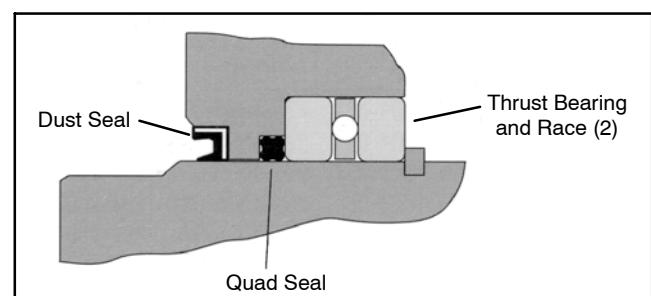


Figure 90

Lift Cylinders: Decks #1, #4, and #5

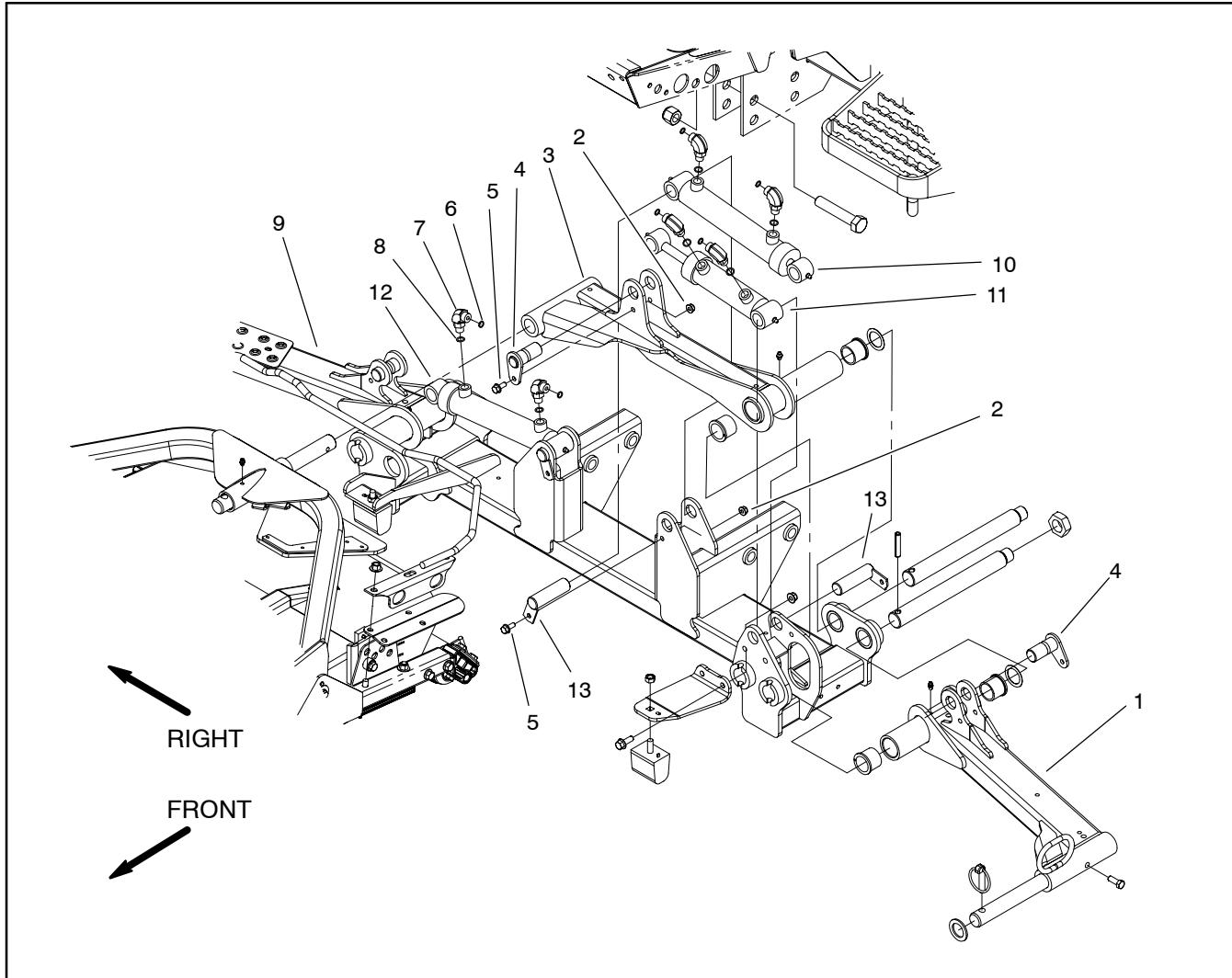


Figure 91

- | | | |
|--------------------------|--------------------------|-----------------------------|
| 1. Lift arm (deck #4) | 6. O-ring | 10. Lift cylinder (deck #4) |
| 2. Flange nut | 7. 90° hydraulic fitting | 11. Lift cylinder (deck #1) |
| 3. Lift arm (deck #1) | 8. O-ring | 12. Lift cylinder (deck #5) |
| 4. Cylinder pin (3 used) | 9. Lift arm (deck #5) | 13. Cylinder pin (3 used) |
| 5. Flange head screw | | |

Removal (Fig. 91)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.
- NOTE:** To ease reassembly, tag the hydraulic hoses to show their correct position on the lift cylinder. Also, clean hydraulic fittings and hose ends prior to disconnecting the hoses.
3. Disconnect hydraulic hoses from lift cylinder.
4. Remove flange nut and flange head screw that secure the cylinder pin (4) to the lift arm. Remove pin from lift arm and cylinder shaft clevis which will free lift cylinder from lift arm.
5. Remove flange nut and flange head screw that secure the cylinder pin (13) to the frame. Pull pin from frame and cylinder barrel clevis.
6. Remove lift cylinder from machine.

Installation (Fig. 91)

1. Position cylinder barrel clevis to frame and insert cylinder pin (13) into frame and clevis. Secure pin with flange nut and flange head screw.
2. Insert cylinder pin (4) through lift arm and cylinder shaft clevis. Secure pin to lift arm with flange nut and flange head screw.
3. Attach hydraulic hoses to lift cylinder.
4. Fill reservoir with hydraulic fluid as required (see Traction Unit Operator's Manual).
5. After assembly is completed, operate lift cylinder to verify that hydraulic hoses and fittings are not contacted by anything.

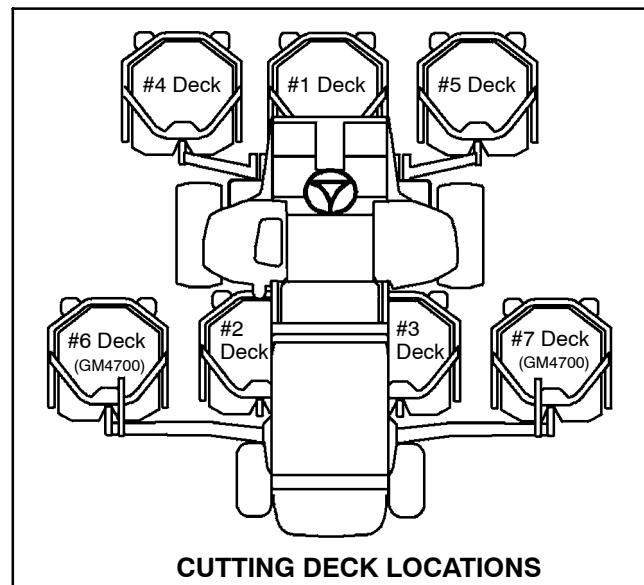


Figure 92

Lift Cylinders: Decks #2 and #3

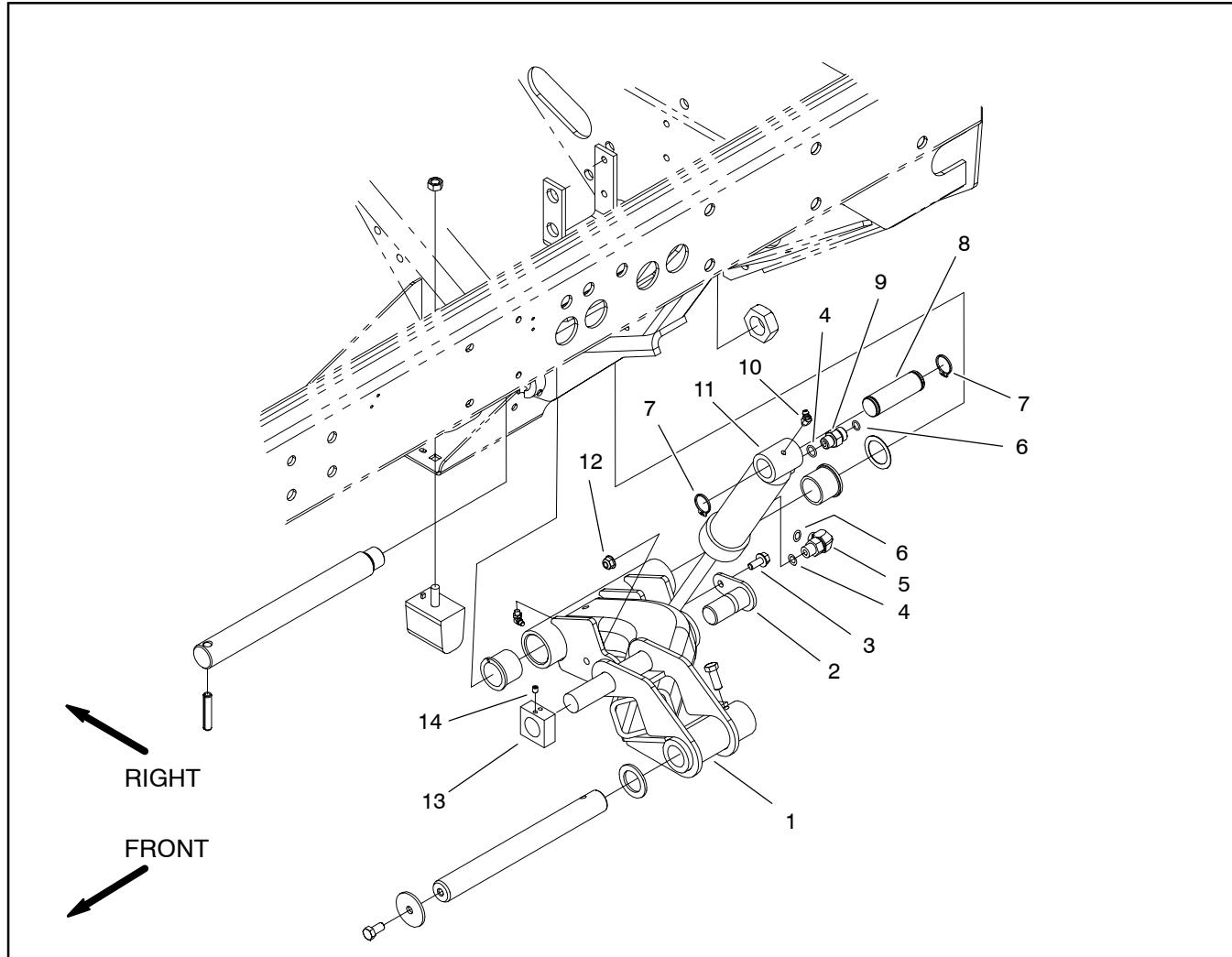


Figure 93

- | | | |
|-----------------------------|----------------------|-------------------|
| 1. Lift arm (deck #2 shown) | 6. O-ring | 11. Lift cylinder |
| 2. Cylinder pin | 7. Retaining ring | 12. Flange nut |
| 3. Flange head screw | 8. Cylinder pin | 13. Rotation stop |
| 4. O-ring | 9. Hydraulic fitting | 14. Set screw |
| 5. 90° hydraulic fitting | 10. Grease fitting | |

Removal (Fig. 93)

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

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

NOTE: Before disconnecting the hydraulic lines, clean the port area of the steering valve assembly.

NOTE: To ease reassembly, tag the hydraulic hoses to show their correct position on the lift cylinder. Also, clean hydraulic fittings and hose ends prior to disconnecting the hoses.

3. Disconnect hydraulic hoses from lift cylinder.

4. Remove flange head screw and flange nut that secure the cylinder pin (2) to the lift arm. Remove pin from lift arm and cylinder shaft clevis.

5. Remove one retaining ring from the cylinder pin (8). Remove cylinder pin from the frame and cylinder barrel clevis.

6. Remove lift cylinder from machine.

Installation (Fig. 93)

1. Position cylinder barrel clevis to frame and insert cylinder pin (8) with one retaining ring installed through the frame and cylinder clevis. Secure pin with second retaining ring.

2. Insert cylinder pin (2) through the lift arm and cylinder shaft clevis. Secure pin to lift arm with flange head screw and flange nut.

3. Attach hydraulic hoses to lift cylinder.

4. Fill reservoir with hydraulic fluid as required (see Traction Unit Operator's Manual).

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

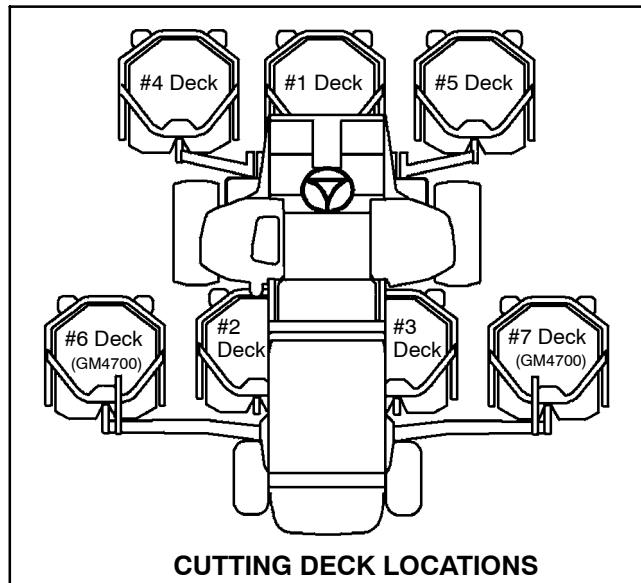


Figure 94

Lift Cylinders: Decks #6 and #7 (GM 4700-D)

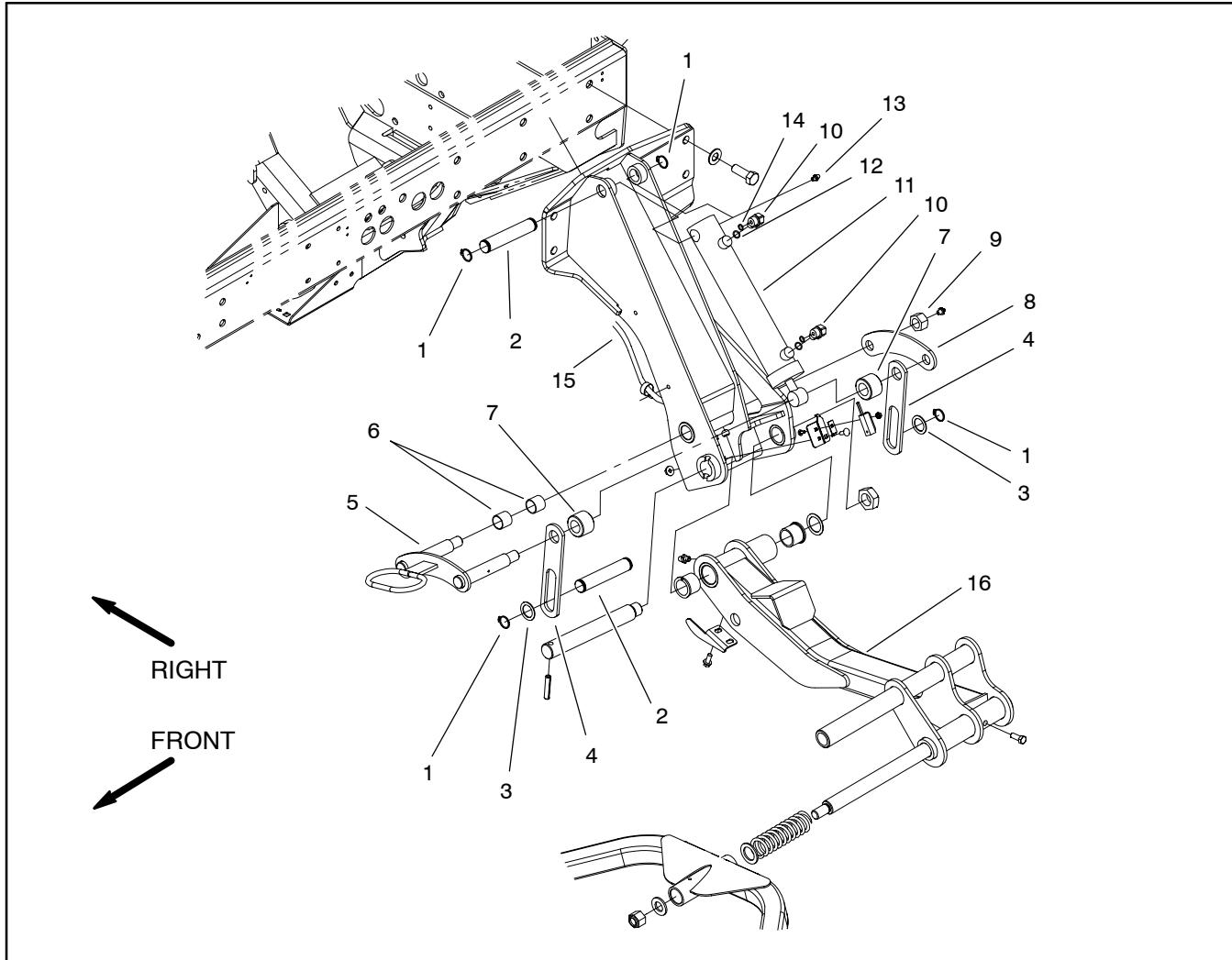


Figure 95

- | | | |
|-------------------|---------------------------|------------------------------|
| 1. Retaining ring | 7. Plastic roller | 12. O-ring |
| 2. Cylinder pin | 8. Rear link | 13. Grease fitting |
| 3. Thrust washer | 9. Lock nut | 14. O-ring |
| 4. Lift link | 10. 90° hydraulic fitting | 15. Support frame |
| 5. Link assembly | 11. Lift cylinder | 16. Lift arm (deck #6 shown) |
| 6. Bushing | | |

Removal (Fig. 95)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
 2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.
- NOTE:** To ease reassembly, tag the hydraulic hoses to show their correct position on the lift cylinder. Also, clean hydraulic fittings and hose ends prior to disconnecting the hoses.
3. Disconnect hydraulic hoses from lift cylinder.
 4. Remove lock nuts (9) that secure link assembly (5). Remove rear link (8) from link assembly. Pull link assembly from support frame, lift links (4), and cylinder shaft clevis which will free lift cylinder from lift arm. Locate and remove plastic rollers (7) positioned on both sides of cylinder clevis.
 5. Remove one retaining ring that secures the cylinder pin (2) to the support frame. Pull pin from frame and cylinder barrel clevis.
 6. Remove lift cylinder from machine.

Installation (Fig. 95)

1. Position cylinder barrel clevis to support frame and insert cylinder pin (2) into frame and clevis. Secure pin with retaining ring.
2. Position plastic rollers (7) to cylinder shaft clevis. Insert link assembly (5) through support frame, lift links (4), plastic rollers, and cylinder shaft clevis. Install rear link to link assembly and secure assembly with lock nuts.
3. Attach hydraulic hoses to lift cylinder.
4. Fill reservoir with hydraulic fluid as required (see Traction Unit Operator's Manual).
5. After assembly is completed, operate lift cylinder to verify that hydraulic hoses and fittings are not contacted by anything.

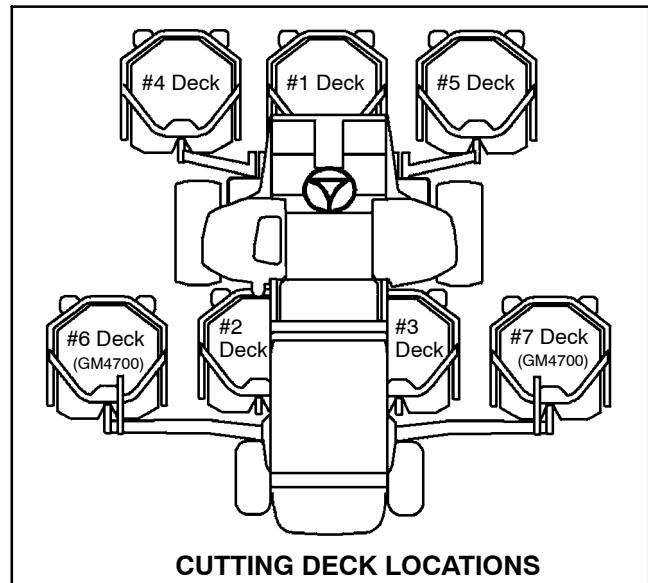


Figure 96

Lift Cylinder Service

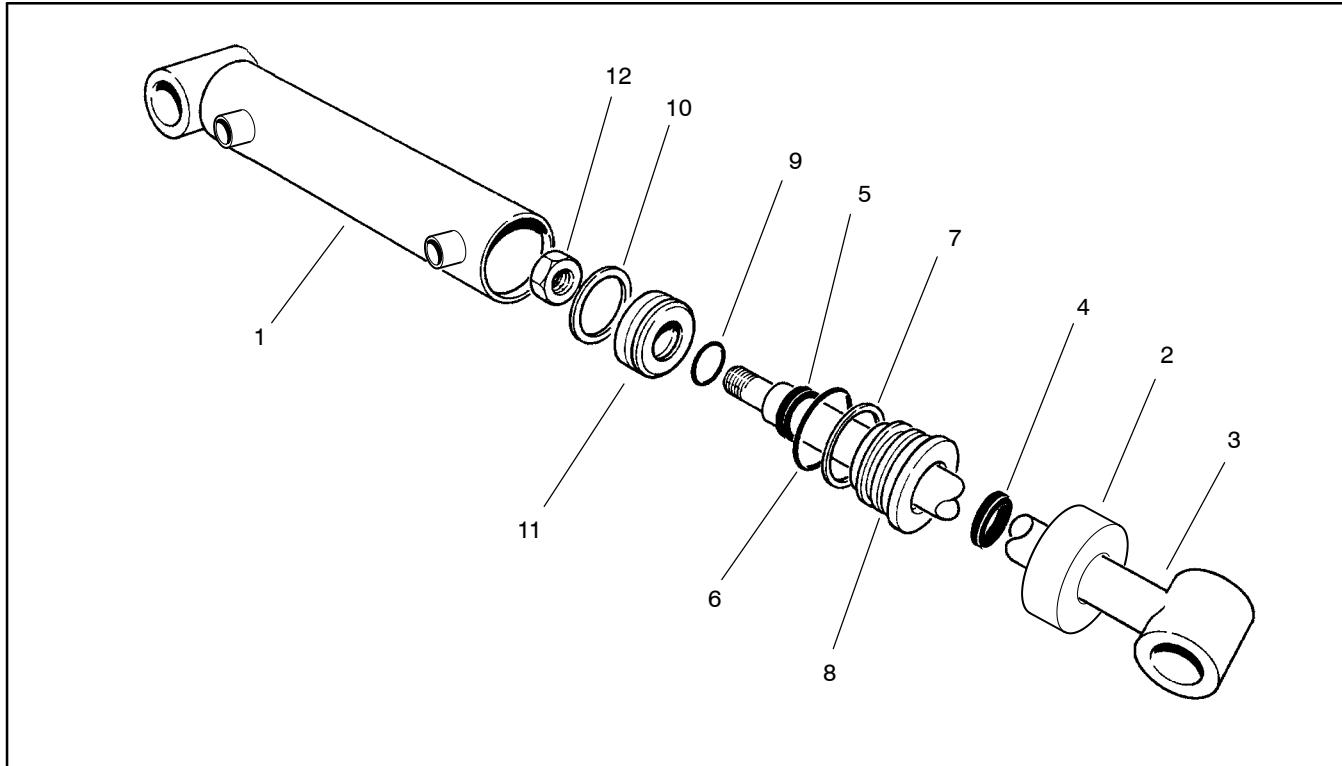


Figure 97

- 1. Barrel with clevis
- 2. Collar
- 3. Shaft with clevis
- 4. Dust seal

- 5. Rod seal
- 6. O-ring
- 7. Back-up ring
- 8. Head

- 9. O-ring
- 10. Uni-ring
- 11. Piston
- 12. Locking nut

Disassembly

1. Remove oil from lift cylinder into a drain pan by slowly pumping the cylinder shaft. Plug both ports and clean the outside of the cylinder.

IMPORTANT: Prevent damage when clamping the cylinder's barrel into a vise; clamp on the clevis only. Do not close vise enough to distort the barrel.

2. Mount lift cylinder into a vise. Remove collar with a spanner wrench.
3. Extract shaft with head and piston by carefully twisting and pulling on the shaft.

IMPORTANT: Do not clamp vise jaws against the shaft surface. Protect shaft surface before mounting in a 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 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.

Assembly

1. Make sure all parts are clean before reassembly.
2. Coat new O-rings, Uni-ring, rod seal, back-up ring, and dust seal with clean hydraulic oil.

- A. Install Uni-ring and O-ring to the piston.
- B. Install dust seal, O-ring, back-up ring, and dust seal to the head.

IMPORTANT: Do not clamp vise jaws against the shaft surface. 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 clean hydraulic oil.
 - B. If removed, install collar onto shaft.
 - C. Slide head and piston onto the shaft. Secure piston to shaft with locknut.
4. Lubricate head and piston with hydraulic oil. Slide shaft assembly carefully into cylinder barrel.

IMPORTANT: Prevent damage when clamping the cylinder's barrel into a vise; clamp on the clevis only. Do not close vise enough to distort the barrel.

5. Mount lift cylinder into a vise. Install collar with a spanner wrench.

Steering Cylinder

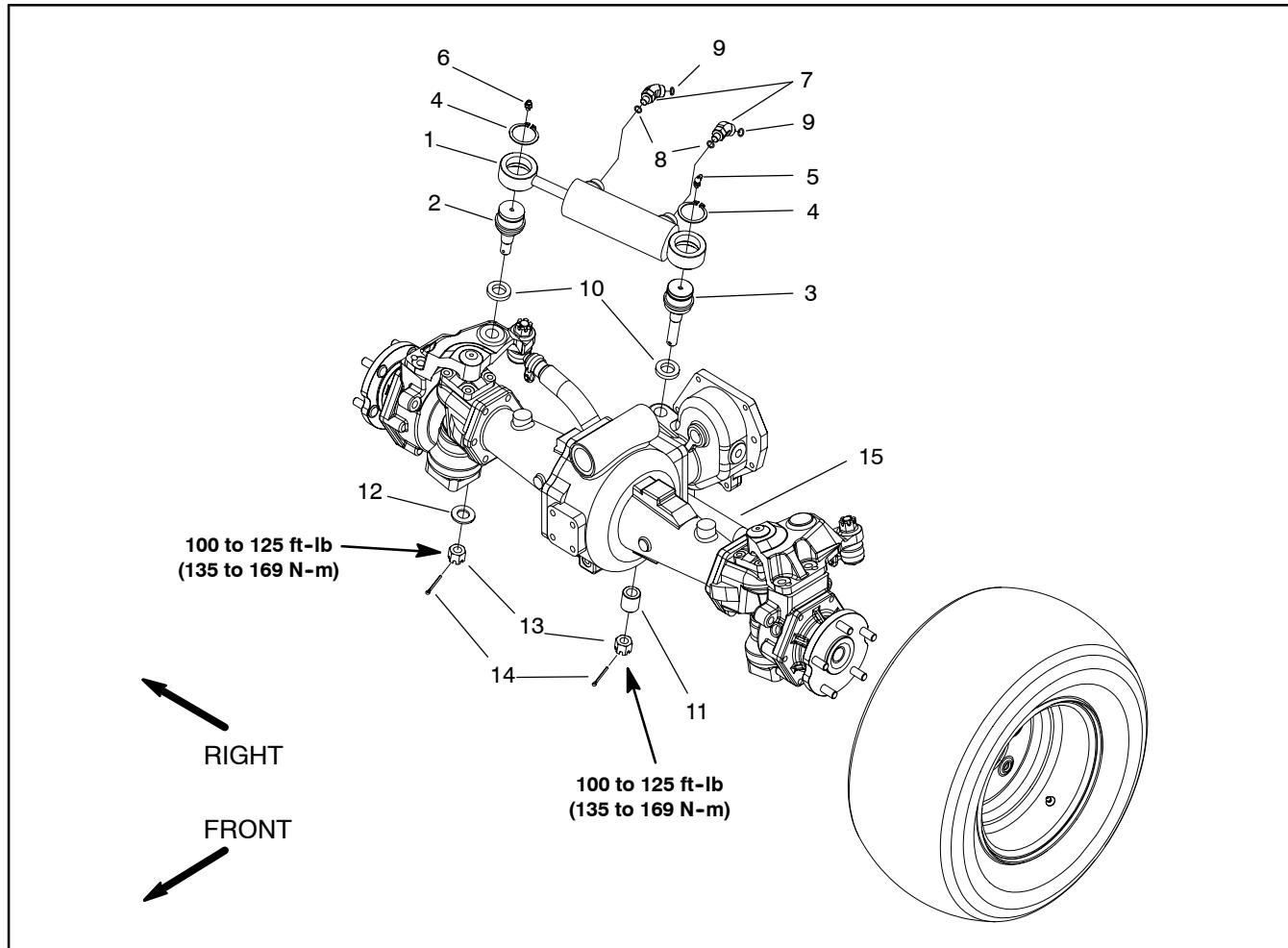


Figure 98

- 1. Steering cylinder
- 2. Ball joint
- 3. Ball joint
- 4. Retaining ring
- 5. Grease fitting

- 6. Grease fitting
- 7. 90° hydraulic fitting
- 8. O-ring
- 9. O-ring
- 10. Ball joint spacer

- 11. Ball joint spacer
- 12. Axle washer
- 13. Hex slotted nut
- 14. Cotter pin
- 15. Drive axle assembly

Removal

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

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

NOTE: To ease reassembly, tag the hydraulic hoses to show their correct position on the steering cylinder. Also, clean hydraulic fittings and hose ends prior to disconnecting the hoses.

3. Remove hydraulic hoses from steering cylinder.

4. Remove cotter pins, hex slotted nuts, axle washer, and ball joint spacer from the threaded ends of ball joints (Fig. 98). Remove steering cylinder with ball joints from machine. Locate and retrieve ball joint spacers from top of axle assembly.

Installation

1. Place a washer onto each ball joint. Slide ram end ball joint through hole on steering arm. Secure with axle washer and hex slotted nut. Slide fixed end of cylinder through hole on axle. Install spacer onto ball joint and secure with hex slotted nut. Torque slotted nuts from 100 to 125 ft-lbs (135 to 169 N-m) prior to inserting cotter pins.

2. Install hydraulic hoses to steering cylinder.

3. Fill reservoir with hydraulic fluid as required (see Traction Unit Operator's Manual).

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

Steering Cylinder Service

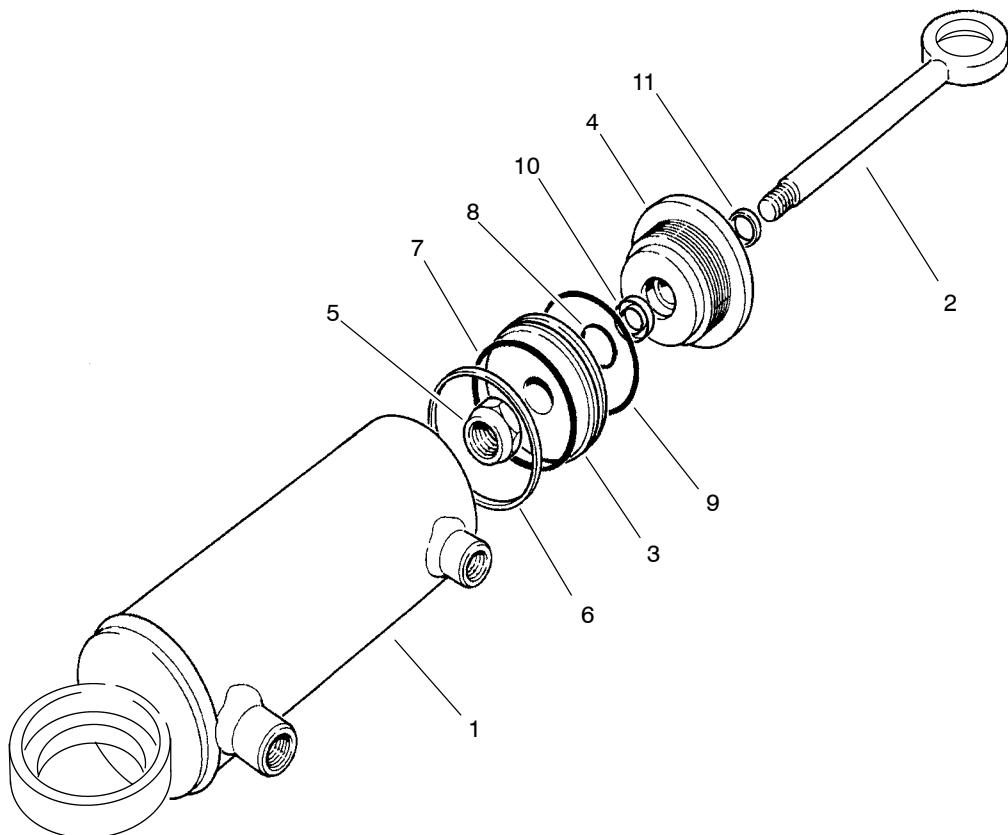


Figure 99

- | | | |
|---------------------------|--------------|-----------|
| 1. Butt and tube assembly | 5. Lock nut | 9. O-ring |
| 2. Shaft | 6. O-ring | 10. U-cup |
| 3. Piston rod assembly | 7. PTFE seal | 11. Wiper |
| 4. Gland | 8. O-ring | |

Disassembly

IMPORTANT: To prevent damage when clamping cylinder barrel or rod in a vise, clamp only on pivotal ends.

1. Pump oil out of cylinder into a drain pan by SLOWLY moving rod and piston in and out of cylinder bore. Plug ports and clean outside of cylinder.
2. Mount cylinder in a vise so piston rod end of cylinder is tilted up slightly. Do not close vise so firmly that cylinder tube could become distorted. Loosen gland with spanner wrench.
3. Grasp end of piston rod and use a twisting and pulling motion to carefully extract piston, piston rod, and gland from cylinder tube.

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

4. Securely mount piston, piston rod, and gland into vise and remove lock nut. Remove piston and gland from rod.
5. Remove all seals and O-rings.
6. Wash parts in clean solvent. Dry parts with compressed air. Do not wipe parts dry with paper towels or cloth. Lint in a hydraulic system will cause damage.
7. Carefully inspect internal surface of barrel for damage (deep scratches, out-of-round, etc.). Replace entire cylinder if barrel is damaged. Inspect piston rod and piston for evidence of excessive scoring, pitting, or wear. Replace any damaged parts.

Assembly

1. Use a complete repair kit when rebuilding the cylinder. Put a coating of clean hydraulic oil on all new seals, and O-rings.
2. Install new O-rings and PTFE seal to the piston rod and new O-ring, U-cup, and wiper to gland.
3. Lubricate shaft with clean hydraulic oil. Slide gland and piston onto shaft. Install and tighten lock nut.
4. Put a coating of clean hydraulic oil on all cylinder parts to ease assembly.
5. Slide piston rod assembly into cylinder tube.
6. Install and tighten gland with spanner wrench.

Hydraulic Reservoir

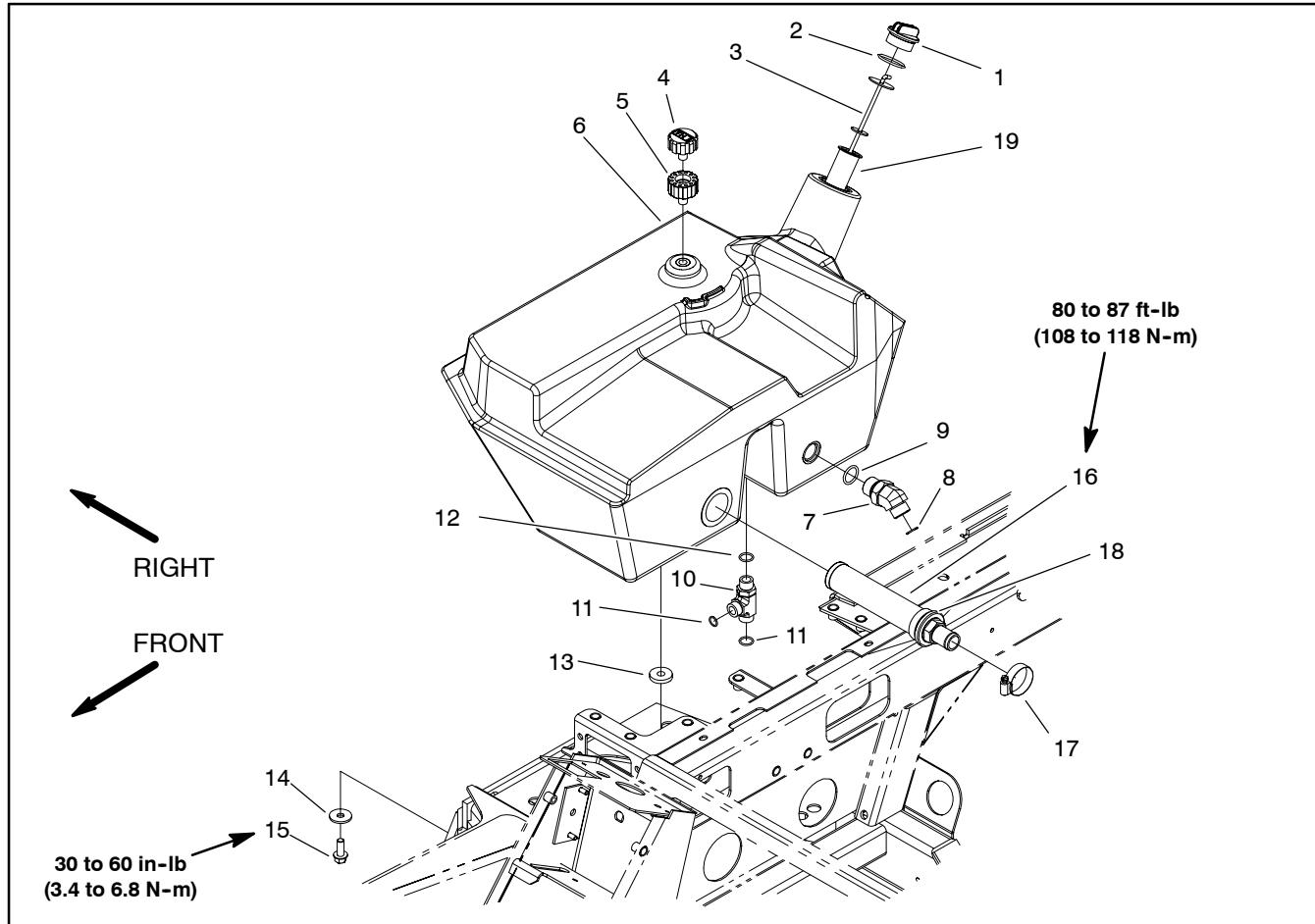


Figure 100

- | | | |
|----------------------------|---------------------------------|--------------------------------|
| 1. Hydraulic reservoir cap | 8. O-ring | 14. Flat washer (3 used) |
| 2. O-ring | 9. O-ring | 15. Flange head screw (3 used) |
| 3. Dipstick | 10. Hydraulic tee fitting | 16. Tank strainer |
| 4. Air breather | 11. O-ring | 17. Clamp |
| 5. Breather adapter | 12. O-ring | 18. O-ring |
| 6. Hydraulic tank | 13. Tank mount grommet (3 used) | 19. Filter screen |
| 7. Hydraulic fitting | | |

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.
3. Drain reservoir into a suitable container (see Traction Unit Operator's Manual).
4. Disconnect hydraulic hoses from reservoir.
5. Remove hydraulic reservoir using Figure 100 as a guide.

Inspection

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

Installation

1. Install reservoir using Figure 100 as a guide. Torque mounting cap screws (15) from 30 to 60 in-lb (3.4 to 6.8 N-m).
2. Using a wrench, tighten strainer into port to a torque from 80 to 87 ft-lb (108 to 118 N-m).
3. Reconnect hydraulic hoses.
4. Fill reservoir with hydraulic fluid as required (see Traction Unit Operator's Manual).

Hydraulic Oil Cooler

Removal



CAUTION

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

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.
3. Remove oil cooler using Figures 101, 102, and 103 as guides.

Inspection

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



CAUTION

Use eye protection such as goggles when using compressed air.

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

Installation

1. Install oil cooler using Figures 101, 102, and 103 as guides.
2. Fill reservoir with hydraulic fluid as required (see Traction Unit Operator's Manual).

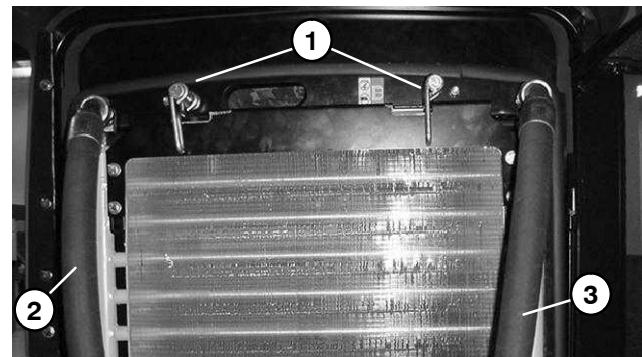


Figure 101

1. Oil cooler latch
2. Hose to oil cooler

3. Hose from oil cooler

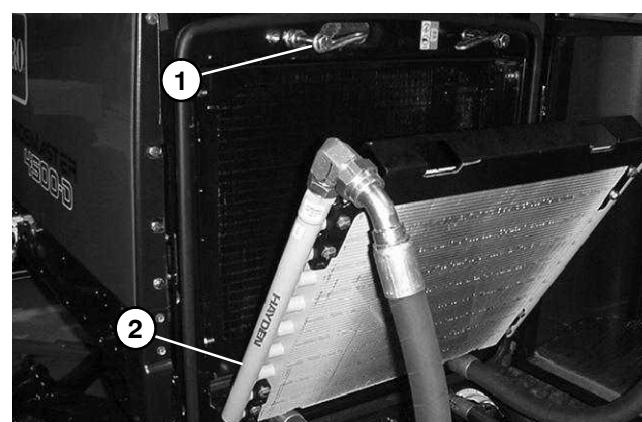


Figure 102

1. Oil cooler latch

2. Oil cooler

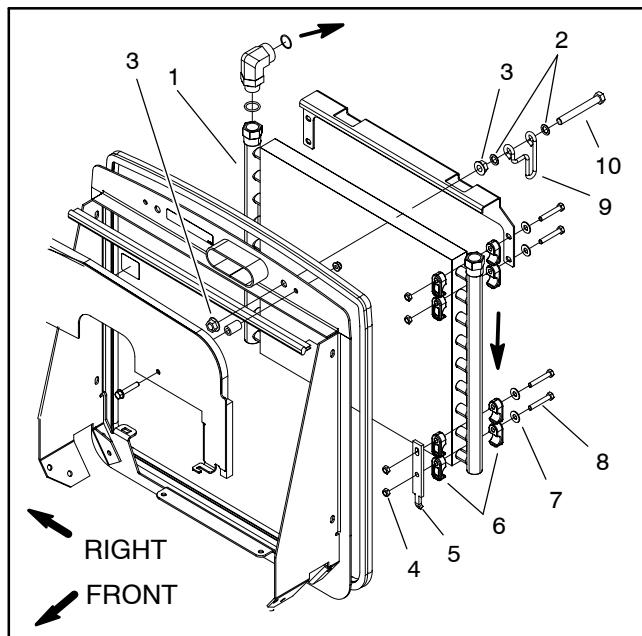


Figure 103

- | | |
|----------------------|--------------------|
| 1. Oil cooler | 6. Clamp |
| 2. Washer | 7. Flat washer |
| 3. Flange head screw | 8. Cap screw |
| 4. Flange nut | 9. Wire form latch |
| 5. Mount plate | 10. Cap screw |

This page is intentionally blank.

**Table of Contents**

ELECTRICAL SCHEMATICS AND ELECTRICAL HARNESS AND CONNECTORS DRAWINGS	2
SPECIAL TOOLS	2
TROUBLESHOOTING	3
Starting Problems	3
General Run & Transport Problems	4
Cutting Unit Operating Problems	5
ELECTRICAL SYSTEM QUICK CHECKS	6
Battery Test (Open Circuit)	6
Check Operation of Interlock Switches	6
COMPONENT TESTING	7
Ignition Switch	7
Fuses	8
Indicator Lights	9
PTO and Hi-Lo Speed Control Switches	10
Seat Switch	11
Parking Brake Switch	11
Cutting Deck Position Switch	12
Cutting Deck Lift/Lower Switch	13
Ramp-up Module	14
Hour Meter	15
Glow Relay	15
Start, Neutral, Seat, Cutting Deck, Parking Brake, and High Temperature Relays	16
Hydraulic Valve Solenoids	17
Engine Run Solenoid	18
Fuel Pump	19
Glow Controller	20
Temperature Sender	21
Temperature Gauge	22
High Temperature Shutdown Switch	23
Traction Neutral Switch	24
Diode Assemblies	24
Diode Circuit Board	25
Standard Control Module	26
SERVICE AND REPAIRS	27
Battery Storage	27
Battery Care	27
Battery Service	28

Electrical Schematics and Electrical Harness and Connectors Drawings

The electrical schematics and other electrical drawings for the Groundsmaster 4500-D and Groundsmaster 4700-D are located in Chapter 9 - Electrical Diagrams.

Special Tools

Order special tools from your Toro distributor. Some tools may also be available from a local supplier.

Multimeter

The multimeter can test electrical components and circuits for current, resistance, or voltage.

NOTE: Toro recommends the use of a DIGITAL Volt-Ohm-Amp multimeter when testing electrical circuits. The high impedance (internal resistance) of a digital meter in the voltage mode will make sure that excess current is not allowed through the meter. This excess current can cause damage to circuits not designed to carry it.

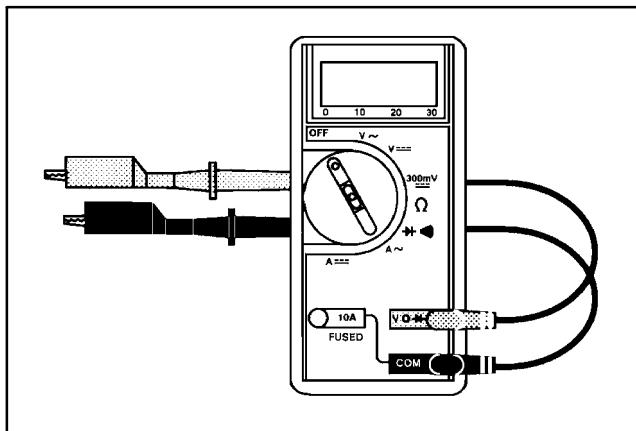


Figure 1

Skin-Over Grease

Special non-conductive grease (Toro Part No. 505-165) which forms a light protective skin to help waterproof electrical switches and contacts.



Figure 2

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 Chapter 9 – Electrical Diagrams).

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

Starting Problems

Problem	Possible Causes
All electrical power is dead, including gauges.	The battery charge is low. Fuse 1 to the ignition switch is open (failed). Bad ground connection on machine. The ignition switch or circuit wiring is faulty. The fusible link from the battery is faulty.
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.
Nothing happens when start attempt is made. Control panel lights and gauges operate with the ignition switch in ON.	The traction pedal is not in neutral position or the neutral switch or circuit wiring is faulty. The cutting units are engaged. Faulty ignition switch or circuit wiring. Start relay or circuit wiring is faulty. Starter solenoid or starter motor is faulty.
Engine starts, but stops when the ignition switch is released from the START position.	The engine run solenoid is out of adjustment or circuit wiring is faulty. High temperature shutdown switch or circuit wiring is faulty.

Starting Problems (continued)

Problem	Possible Causes
Engine cranks, but does not start.	Engine is not cranking fast enough. Engine run solenoid, circuit wiring, or fuel pump is faulty. The problem is not electrical (see Chapter 3 – Kubota Engines).
Starter cranks, but should not when the traction pedal is depressed.	The traction neutral switch is out of adjustment. The traction neutral switch or circuit wiring is faulty.

General Run and Transport Problems

Engine continues to run, but should not, when the ignition switch is turned off.	The engine fuel stop solenoid is stuck open. Ignition switch or circuit wiring is faulty.
Engine continues to run, but should not, when the traction pedal is engaged with no operator in the seat.	The seat switch or circuit wiring is faulty. Traction neutral switch or circuit wiring is faulty.
The engine stops during operation, but is able to restart.	The operator is lifting off the seat. The seat switch or circuit wiring is faulty. The engine shutdown delay is faulty. The ignition switch or circuit wiring is faulty.
The engine kills when the traction pedal is depressed.	The operator is lifting off the seat switch. The parking brake is on. The seat switch, seat relay, or circuit wiring is faulty. The parking brake switch, relay, or circuit wiring is faulty.
Battery does not charge.	Loose, corroded, or broken wire(s). The fusible link to the battery is faulty. Faulty alternator or dead battery. Charge indicator lamp is faulty or burned out. Charge indicator lamp wiring loose, corroded, or damaged.

Cutting Unit Operating Problems

Cutting units run, but should not, when raised. Units shut off with PTO switch.	The cutting deck position switch or circuit wiring is faulty. The cutting deck lift/lower switch or circuit wiring is faulty.
Cutting units run, but should not, when raised. Units do not shut off with the PTO switch.	The deck position switch, cutting deck lift/lower switch, or circuit wiring, and PTO switch or circuit wiring are faulty. A hydraulic problem exists (see Troubleshooting Section of Chapter 4 – Hydraulic System).
Cutting units run, but should not, when lowered with PTO switch in the OFF (disengage) position.	The PTO switch or circuit wiring is faulty.
Cutting deck(s) do not operate.	The cutting deck position switch or circuit wiring to the affected decks is faulty. The cutting deck lift/lower switch or circuit wiring to the affected decks is faulty. The PTO relay or circuit wiring to the affected decks is faulty. The Ramp-up module or circuit wiring is faulty. Hydraulic valve solenoid(s) or circuit wiring to the affected decks is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 – Hydraulic System).
All cutting decks do not operate.	The cutting decks are raised. Fuse 2 (PTO) is faulty. The ignition switch or circuit wiring is faulty. The PTO switch or circuit wiring is faulty. The 2WD/4WD switch or circuit wiring is faulty. A hydraulic problem exists (see Troubleshooting section of Chapter 4 – Hydraulic System).
Cutting deck(s) operation is intermittent over rough terrain.	The cutting deck lift/lower switch or circuit wiring for the affected decks is faulty. Diode D1-C on Diode Circuit Board is faulty.

Electrical System Quick Checks

Battery Test (Open Circuit Test)

Use a multimeter to measure the voltage between the battery terminals.

Set multimeter to the DC volts setting. The battery should be at a temperature of 60 to 100°F (16 to 38°C). The ignition key should be off and all accessories turned off. Connect the positive (+) meter lead to the positive battery post and the negative (-) meter lead to the negative battery post.

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

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

Check Operation of Interlock Switches



CAUTION

Do not disconnect safety switches. They are for the operator's protection. Check the operation of the interlock switches daily for proper operation. Replace any malfunctioning switches before operating the machine.

Interlock switch operation is described in the Traction Unit Operator's Manual. Testing of interlock switches and relays is included in the Component Testing section of this Chapter.

Component Testing

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g. unplug the ignition switch connector before doing a continuity check).

NOTE: For engine component testing information, see the Kubota Workshop Manual, Diesel Engine, V2003-T Series at the end of Chapter 3 – Kubota Diesel Engine.



CAUTION

When testing electrical components for continuity with a multimeter (ohms setting), make sure that power to the circuit has been disconnected.

Ignition Switch

The ignition (key) switch has three positions (OFF, ON/ PREHEAT, and START). The terminals are marked as shown. The circuit wiring of the ignition switch is shown in the chart. 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.

POSITION	CIRCUIT
OFF	NONE
ON / PREHEAT	B + I + A, X + Y
START	B + I + S

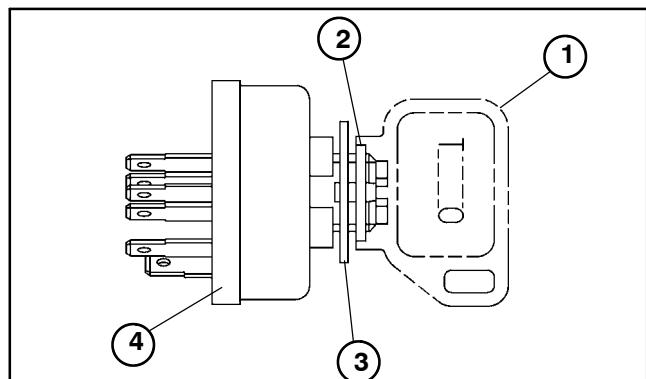
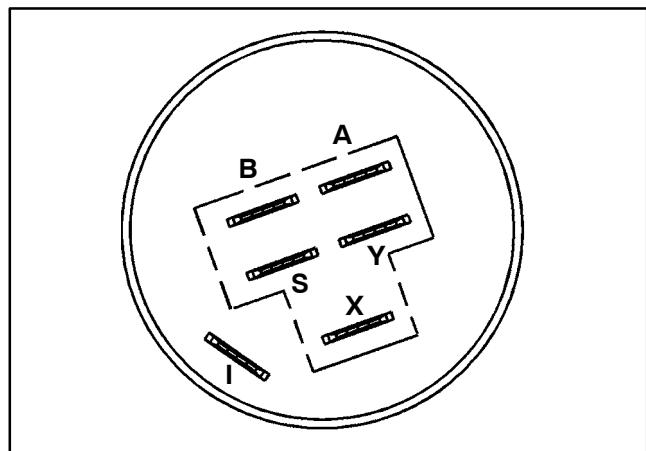


Figure 3
1. Key
2. Hex nut
3. Lock washer
4. Ignition switch

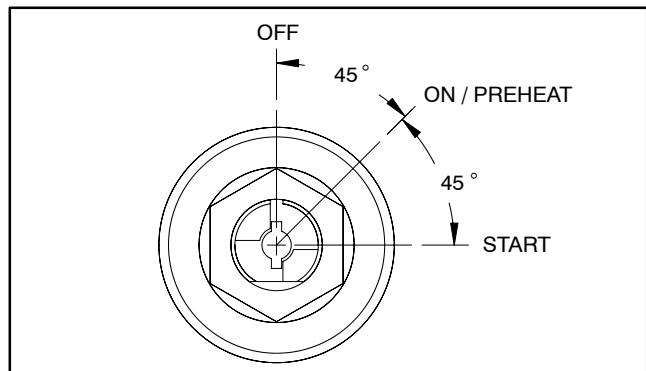


Figure 4

Fuses

The fuse block is located under the operator's control panel. Machines with serial numbers below 220999999 have four (4) fuses (Fig. 5). Machines with serial numbers above 230000000 have six (6) fuses (Fig. 6).

Identification, Function, and Wiring

The fuses are held in the fuse block. Use Figure 7 to identify each individual fuse and its correct amperage. Each fuse holder has the following functions and wire connected to it.

Fuse 1 (15 Amp)

- A. Supplies power to ignition switch terminal B.

Fuse 2 (10 Amp)

- A. Supplies power to the PTO circuit.

Fuse 3 (10 Amp)

- A. Supplies power to the power point outlet.

Fuse 4 (10 Amp)

- A. Supplies power from ignition switch terminal I.

Fuse 5 (2 Amp) (Only on machines with Serial Number above 230000000)

- A. Supplies power from ignition switch terminal I to Standard Control Module.

Fuse 6 (10 Amp) (Only on machines with Serial Number above 230000000)

- A. Supplies power from ignition switch terminal S.

Testing

Remove fuses from the fuse block for testing. Fuse should have continuity between fuse terminals.

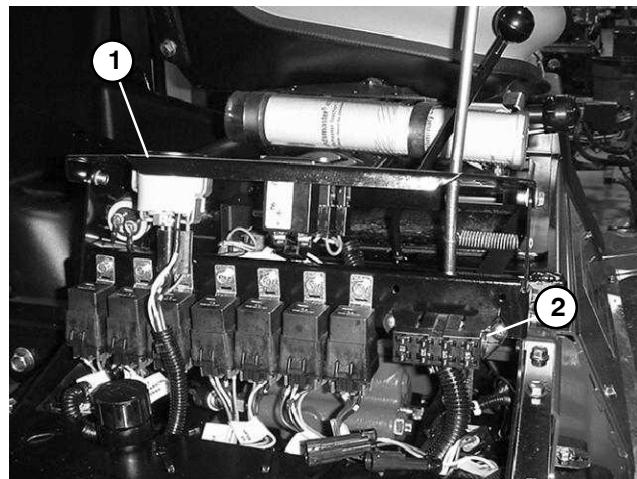


Figure 5

1. Control panel

2. Fuse block

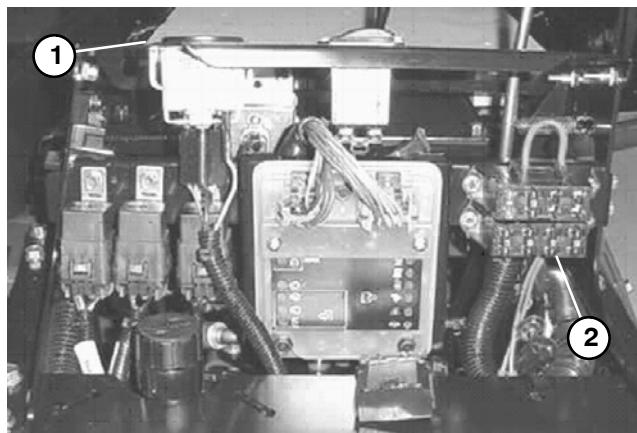


Figure 6

1. Control panel

2. Fuse block

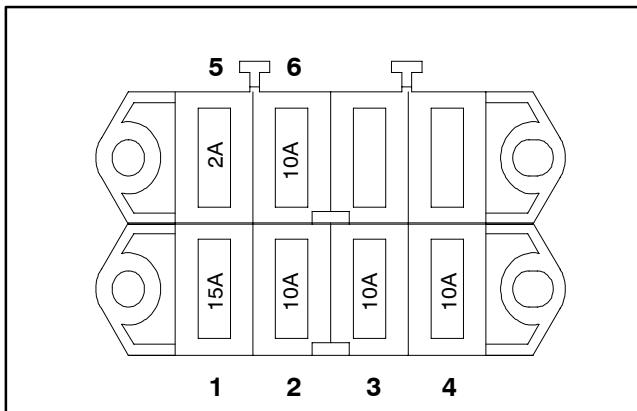


Figure 7

Indicator Lights

Testing Indicator Lights

1. Apply 12 VDC to terminals 1A and 2A.
2. Ground terminals 1B and 2B.
3. Both indicator lights should light.

Engine Oil Pressure Light

The oil pressure light should come on when the ignition switch is in the ON position with the engine not running. Also, it should light with the engine running if the engine oil pressure drops below 7 PSI (0.5 kg/cm²).

To test the oil pressure light and circuit wiring, ground the green wire attached to oil pressure switch located on right side of engine near the starter motor. Turn ignition switch to ON; the oil pressure light should come on indicating correct operation of the electrical wiring to the oil pressure switch.

High Temperature Shutdown Light

If the engine coolant temperature rises to 230°F (110°C), the high temperature light should come on as the high temperature shutdown switch stops the engine.

To test the high temperature shutdown light and circuit wiring, start the engine and ground the blue/white wire attached to high temperature shutdown switch on flywheel end of engine (see High Temperature Shutdown Switch in this Chapter). Warning light should illuminate and engine should stop running.

Glow Plug Indicator Light

The glow plug light should come on when the ignition switch is placed in ON prior to placing the ignition switch in START. The light should stay lit for 7 to 10 seconds while the ignition switch is left in ON.

Charge Indicator Light

The charge indicator light should come on when the ignition switch is in ON with the engine not running, or with an improperly operating charging circuit while the engine is running.

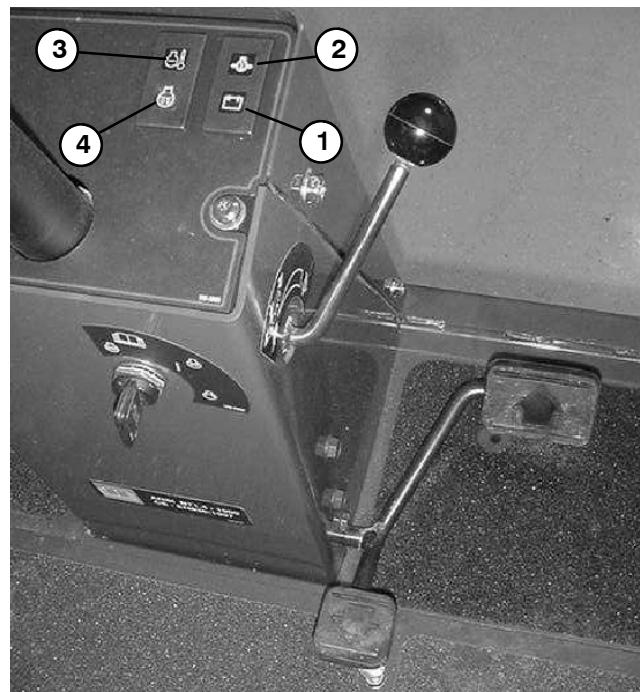


Figure 8

- | | |
|------------------------|------------------------|
| 1. Charge indicator | 3. High temp shutdown |
| 2. Engine oil pressure | 4. Glow plug indicator |

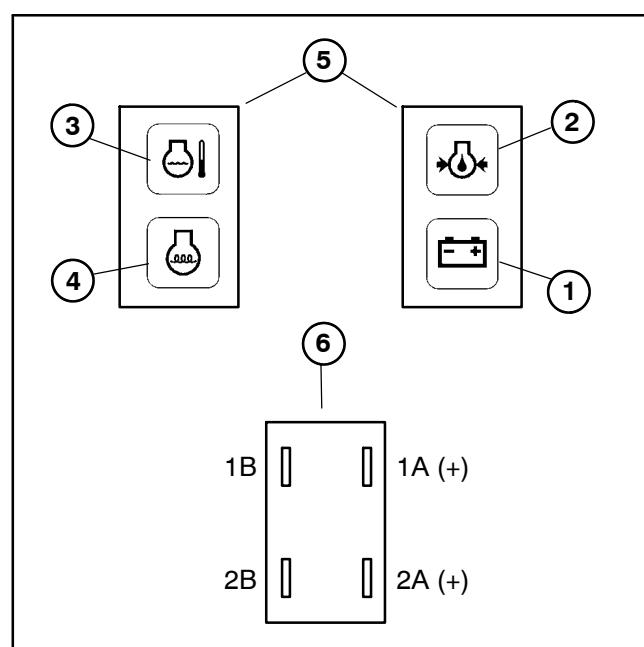


Figure 9

- | | |
|------------------------|------------------------|
| 1. Charge indicator | 4. Glow plug indicator |
| 2. Engine oil pressure | 5. Warning light front |
| 3. High temp shutdown | 6. Warning light back |

PTO and Hi-Lo Speed Control Switches

The PTO and Hi-Lo Speed Control Switches are located on the control console (Fig. 10). These rocker switches have common switching logic.

The switch terminals are marked as shown in Figure 11. The circuitry of these switches is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each switch position. Verify continuity between switch terminals.

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
ON	2 + 3	5 + 6
OFF	1 + 2	4 + 5



Figure 10

1. PTO switch

2. Hi-Lo speed switch

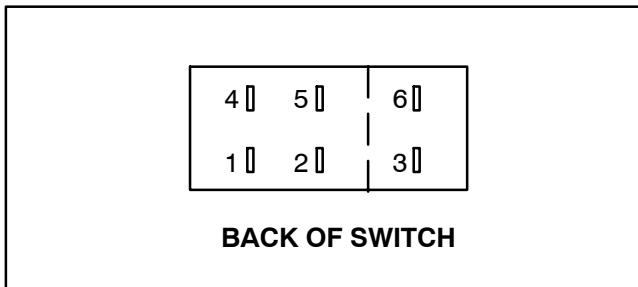


Figure 11

Seat Switch

The seat switch is normally open and closes when the operator is on the seat. If the traction system or PTO switch is engaged when the operator raises out of the seat, the engine will stop. The seat switch and its electrical connector are located directly under the seat. Testing of the switch can be done without seat removal by disconnecting the seat wire from the machine wiring harness.

1. Make sure the engine is off.
2. Disconnect electrical connector for the seat switch.
3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the 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. Replace switch as needed. Reconnect switch connector.

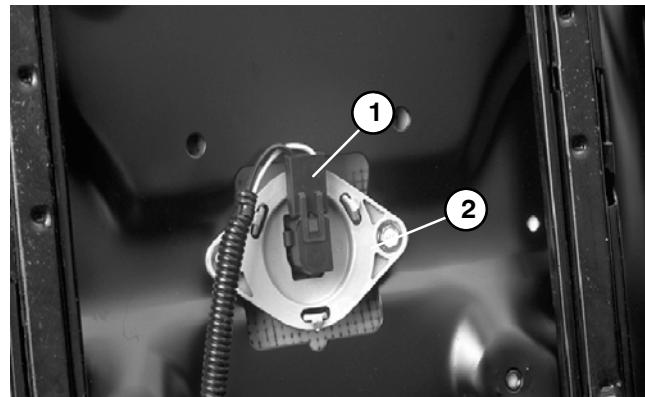


Figure 12

1. Electrical connector 2. Seat switch

Parking Brake Switch

The switch used for the parking brake is a normally open proximity switch. The parking brake switch is located under the steering tower cover (Fig. 13) and closes when the parking brake is released. The sensing plate for the switch is an integral component of the parking brake rod.

Switch Testing

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 connector terminals.
4. With the parking brake released, there should be continuity across the switch terminals.
5. Apply the parking brake. There should be no continuity across the switch terminals.
6. Replace switch as needed. Reconnect switch.

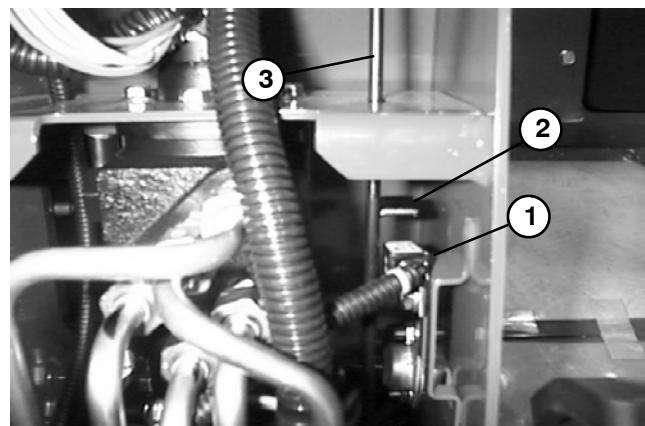


Figure 13

1. Parking brake switch 2. Sensing plate 3. Brake rod (brake ON)

Switch Adjustment

1. Adjust switch to have 1/16 in (1.6 mm) clearance between switch and sensing plate on the brake rod when the parking brake is released.

Cutting Deck Position Switch

The cutting deck position switch is a normally open proximity switch that is located on the traction unit frame (Fig. 14). The sensing plate is located on the cutting deck lift arm. The GM 4500-D uses two cutting deck position switches: for decks 4 and 5. There are four deck position switches on the GM 4700-D: for decks 4, 5, 6, and 7.

When the cutting deck is raised, the sensing plate is moved away from the position switch and the switch opens. This open switch prevents current flow to the PTO relay and the cutting deck hydraulic solenoid valve, keeping the cutting decks from operating.

Switch Testing

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Disconnect deck position switch that requires testing from machine wiring harness.
3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch connector terminals.
4. With the cutting unit in the lowered position, there should be continuity across the switch terminals.
5. Raise the cutting unit. There should be no continuity across the switch terminals.
6. Replace switch as needed. Reconnect switch.

Switch Adjustment

1. Adjust switch to have 1/16 in (1.6 mm) clearance between switch and sensing plate on the lift arm.

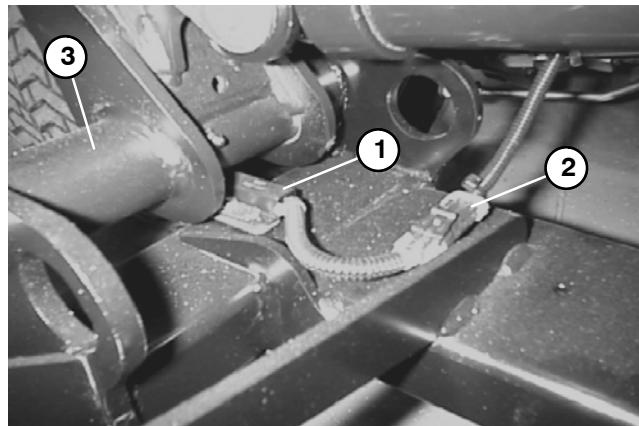


Figure 14

1. Position switch
2. Switch connector

3. Lift arm (#5 shown)

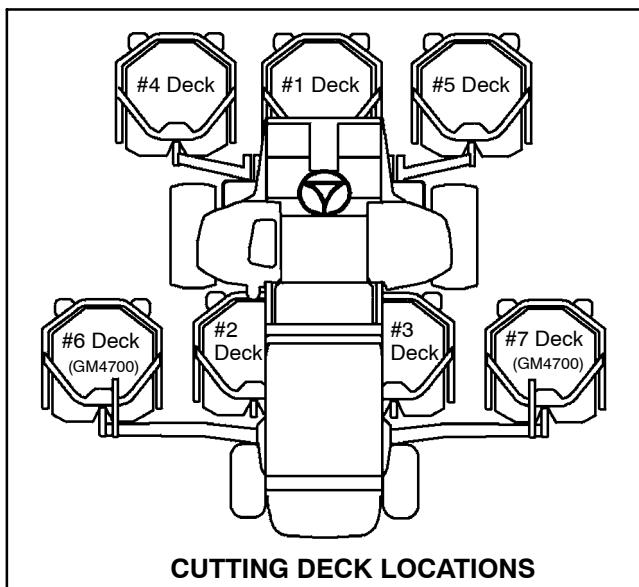


Figure 15

Cutting Deck Lift/Lower Switch

The lift/lower switch is a normally open proximity switch that is closed when a lift lever is in the neutral position. When a lift lever is moved to raise, the lift/lower switch opens. Each lift lever is equipped with a cutting deck lift/lower switch.

When the machine operator engages the cutting decks (PTO switch ON and decks lowered), the cutting deck lift/lower switch and circuit board diode D1-C provide a latching circuit to keep the PTO relay energized (Fig. 18). Operating the machine on uneven ground could cause a cutting deck to raise enough to open a deck position switch. The cutting deck lift/lower switch is designed to keep the PTO relay energized in this situation to maintain cutting deck operation.

Switch Testing and Adjustment

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Remove console cover from machine.
3. Locate cutting deck lift/lower switch that requires testing. Disconnect switch connector from machine wiring harness.
4. Check the continuity of the switch by connecting a multimeter (ohms setting) across the switch connector terminals.
5. With the lift lever in the neutral position there should be continuity across the switch terminals.
6. Pull back on the lift lever enough to take up all free play in the lever. The switch should open before the lever applies any pressure to the spool in the lift/lower control valve.
7. Switch position can be adjusted for correct operation by loosening the switch plate screw and moving switch plate. After any adjustment, recheck switch operation.

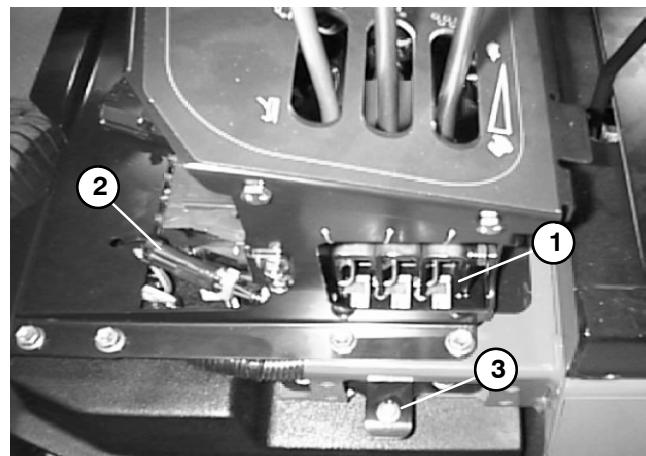


Figure 16

1. Lift/lower switch location (GM4700 shown)
2. Switch connector
3. Switch plate screw

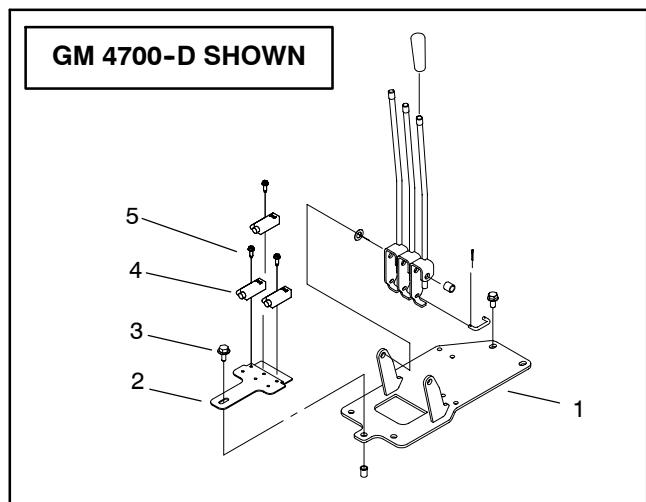


Figure 17

1. Lever support
2. Switch plate
3. Switch plate screw
4. Lift/lower switch
5. Thread forming screw

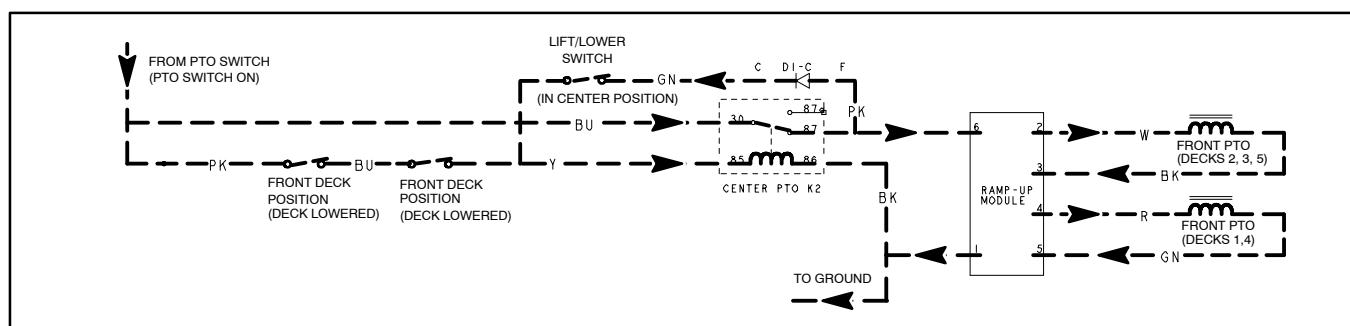


Figure 18

Ramp-up Module

The ramp-up module is located under the console cover (Fig. 19).

The ramp-up module is used to prevent hydraulic spikes that could affect cutting system hydraulic components. As the PTO relay for decks #1 to #5 is energized, the ramp-up module provides a gradual, increasing current flow to the cutting deck solenoid valves. Solenoid ramp-up time occurs in 1.75 seconds. The Ramp-up module has no affect on operation of decks #6 and #7 on the GM 4700-D.

The ramp-up module can be monitored by the three LED's located on the module below the harness connection.

1. All module LED's will be off when the PTO switch is OFF.
2. When the PTO switch is turned ON and interlock switches allow cutting deck operation (seat occupied, decks lowered, etc.), the "Power" LED will illuminate immediately. The "S1" and "S2" LED's will gradually illuminate during the 1.75 second ramp-up time.
3. After initial PTO startup, all LED's will be illuminated fully while PTO is ON.
4. All LED's will go out immediately with the interruption of PTO operation (e.g. PTO switch turned off or cutting deck raised).

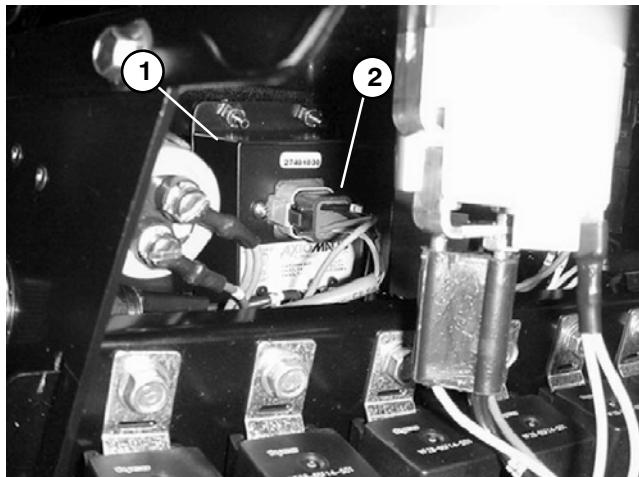


Figure 19

1. Ramp-up module

2. Harness connection

Hour Meter

The meter is located on the control console next to the operator seat.

1. Connect the positive (+) terminal of a 12 VDC source to the positive (+) terminal of the hour meter.
2. Connect the negative (-) terminal of the voltage source to the other terminal of the hour meter.
3. The hour meter should move a 1/10 of an hour in six minutes.
4. Disconnect voltage source from the hour meter.

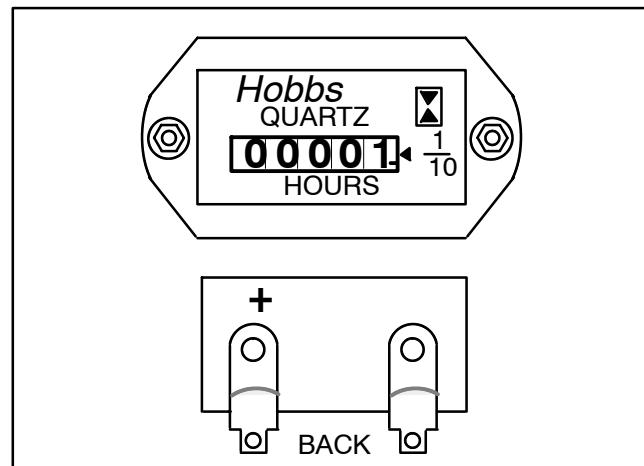


Figure 20

Glow Relay

The glow relay is attached to the battery support bracket. When energized, the glow relay allows electrical current to the engine glow plugs.

Two styles of glow relays have been used on the Groundsmaster 4500-D/4700-D. On machines with serial numbers below 260000600, two of the four relay connections are secured with screws (Fig. 21). On machines with serial numbers above 260000600, the relay is attached to the wire harness with a four wire connector (Fig. 22).

NOTE: Prior to taking small resistance readings with a digital multi meter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from from the measured value of the component you are testing.

1. Verify coil resistance between terminals 86 and 85 with a multimeter (ohms setting).
 - A. On machines with serial numbers below 260000600, resistance should be from 41 to 51 ohms.
 - B. On machines with serial numbers above 260000600, resistance should be approximately 72 ohms.
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.

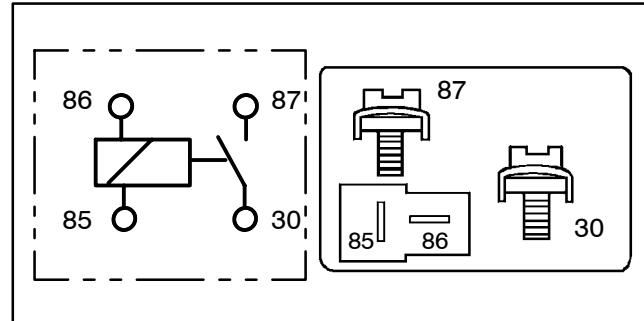


Figure 21

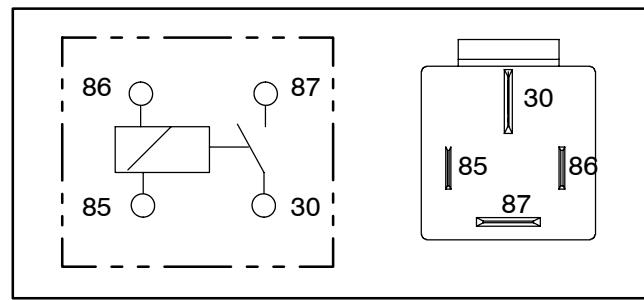


Figure 22

Start, Neutral, Seat, Cutting Deck, Parking Brake, and High Temperature Relays

The relays are located under the console cover (Fig. 23). The wiring harness is tagged to identify each relay.

NOTE: Machines with serial numbers above 230000000 use a standard control module to monitor several switches. These machines do not use a start, neutral, seat, parking brake or high temperature relay.

NOTE: The relays may be manufactured by one of two different manufacturers. Verify manufacturer name and part number before performing the resistance check on the relay coil.

NOTE: Prior to taking small resistance readings with a digital multi meter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the component you are testing.

1. Verify coil resistance between terminals 85 and 86 with a multimeter (ohms setting):

- A. For the Tyco Electronics relay (#VF4-65F11), resistance should be from 71 to 88 ohms.
- B. For the Hella Electronics relay (#66211), resistance should be from 70 to 80 ohms.
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 from terminal 85 and multimeter lead from terminal 87.
4. Connect multimeter (ohms setting) leads to relay terminals 30 and 87A. Apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87A as +12 VDC is applied and removed from terminal 85.
5. Disconnect voltage and multimeter leads from the relay terminals.

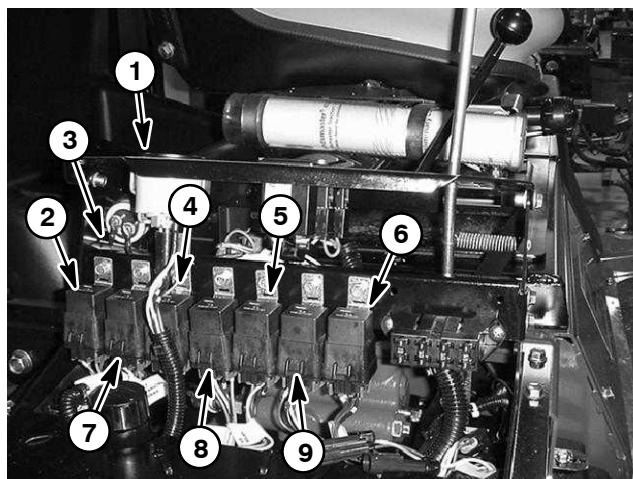


Figure 23

- | | |
|-------------------------------|----------------------------|
| 1. Control panel | 6. K2 relay: decks 1 - 5 |
| 2. K8 relay: seat | 7. K6 relay: high temp |
| 3. K9 relay: neutral (behind) | 8. K5 relay: start |
| 4. K7 relay: parking brake | 9. K1 relay: GM4700 deck 6 |
| 5. K3 relay: GM4700 deck 7 | |

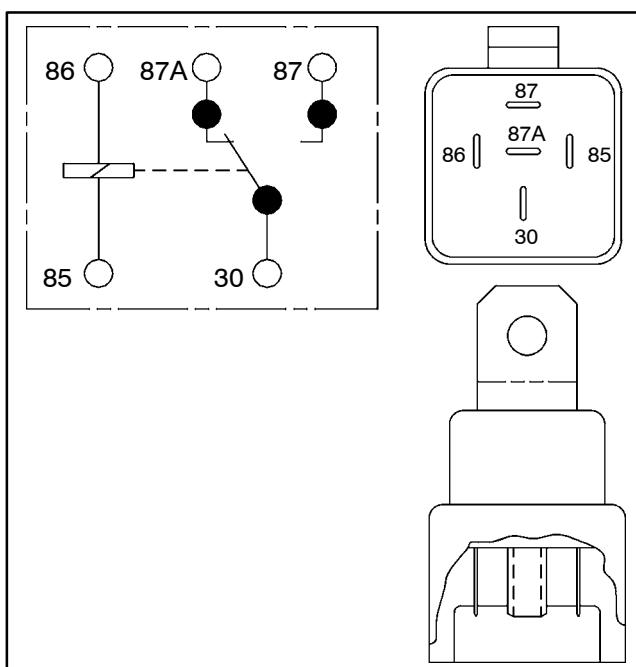


Figure 24

Hydraulic Valve Solenoids

The Groundsmaster 4500-D has three hydraulic valve solenoids: one on each cutting deck manifold and one on the traction manifold. The Groundsmaster 4700-D has five solenoids: two on each cutting deck manifold and one on the traction manifold. Testing of these solenoids can be done with the solenoid on the hydraulic valve.

NOTE: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the component you are testing.

1. Make sure engine is off. Disconnect hydraulic valve solenoid electrical connector (Fig. 25).
2. Apply 12VDC source directly to the solenoid. Listen for solenoid to switch on.
3. Remove 12VDC source from the solenoid. Listen for solenoid to switch off.
4. Measure resistance between the two connector terminals. The resistance for the solenoid coil should be about 7.2 ohms.
5. Install **new** solenoid if necessary.
 - A. Apply "Loctite 242" or equivalent to threads on end of valve stem before installing nut.
 - B. For traction manifold solenoid, torque nut from 4 to 6 ft-lb (5 to 8 N-m). For cutting deck solenoid, torque nut to 5 ft-lb (7 N-m). Over-tightening may damage the solenoid or cause the valve to malfunction.
6. Reconnect electrical connector to the solenoid.

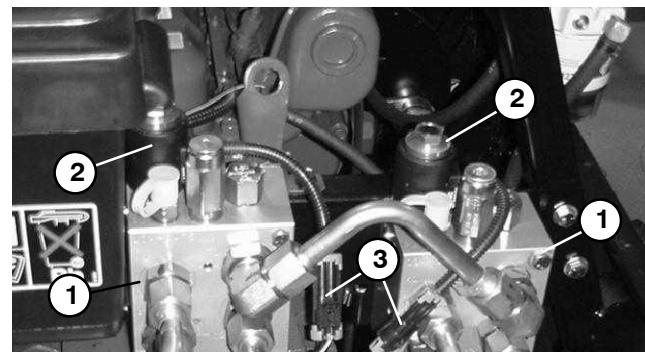


Figure 25

1. Deck manifold (4500-D) 3. Solenoid connector
2. Valve solenoid

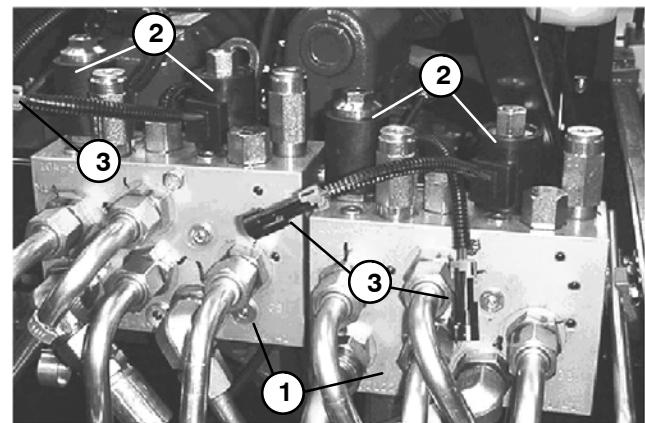


Figure 26

1. Deck manifold (4700-D) 3. Solenoid connector
2. Valve solenoid

Engine Run Solenoid

The engine run solenoid must be energized for the engine to run. The solenoid is mounted on the engine block near the injection pump.

In Place Testing

NOTE: Prior to taking small resistance readings with a digital multimeter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the component you are testing.

1. Disconnect the connector from the engine run solenoid.
2. Using a digital multimeter, touch one lead to the pin of the black wire and the other lead to the pin of the white wire. The resistance of the pull coil should be about 0.26 ohms.
3. Using a digital multimeter, touch one lead to the pin of the black wire and the other lead to the pin of the red wire. The resistance of the hold coil should be about 10.9 ohms.
4. Connect solenoid to the wiring harness.

Live Testing

1. Disconnect connector from the engine run solenoid.

NOTE: The solenoid may be removed from the engine or tested in place.

2. If the solenoid is removed from the engine, make sure that the solenoid linkage moves freely and is free of dirt, debris, and corrosion.
3. Connect a positive (+) test lead from a 12 VDC source to the pins of the red and white wires.
4. Touch a negative (-) test lead from the 12 VDC source to the pin of the black wire. The solenoid should engage making an audible “click”.
5. Remove positive (+) voltage from the pin of the white wire. The solenoid should stay engaged.
6. Remove positive (+) voltage from the pin of the red wire. The solenoid should release.
7. Reinstall solenoid if removed from engine.
8. Reconnect the harness wire connector to the solenoid.

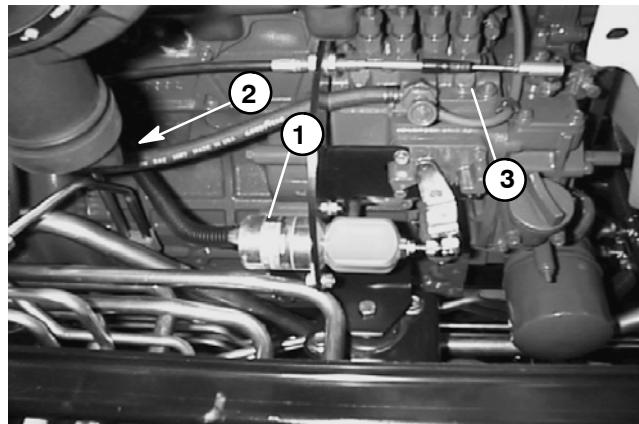


Figure 27

1. Engine run solenoid 3. Injection pump
2. Solenoid connector

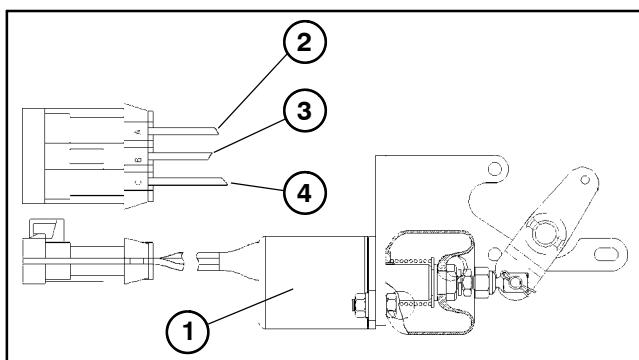


Figure 28

1. Engine run solenoid 3. White wire (pull coil)
2. Red wire (hold coil) 4. Black wire (common)

Fuel Pump

The fuel pump is attached to the frame near the fuel pre-filter (Fig. 29).

IMPORTANT: When testing fuel pump, make sure that pump is not operated without fuel.

Fuel Pump Capacity Test

1. Park machine on a level surface, lower cutting units, stop engine, and engage parking brake.
2. Disconnect electrical connector from the engine run solenoid to prevent the engine from firing.
3. Disconnect fuel pump discharge hose from the water separator.
4. Make sure fuel hoses attached to the fuel pump are free of obstructions.
5. Place disconnected pump discharge hose into a large, graduated cylinder sufficient enough to collect 1 quart (0.95 liter).
6. Collect fuel in the graduated cylinder by turning ignition switch ON. Allow pump to run for 30 seconds, then release ignition switch to OFF.
7. The amount of fuel collected in the graduated cylinder should be approximately 11.75 fl oz (350 ml) after 30 seconds.
8. Replace fuel pump as necessary. Install fuel hose to the water separator.
9. Reconnect electrical connector to the engine run solenoid.
10. Bleed the fuel system (see Traction Unit Operator's Manual).

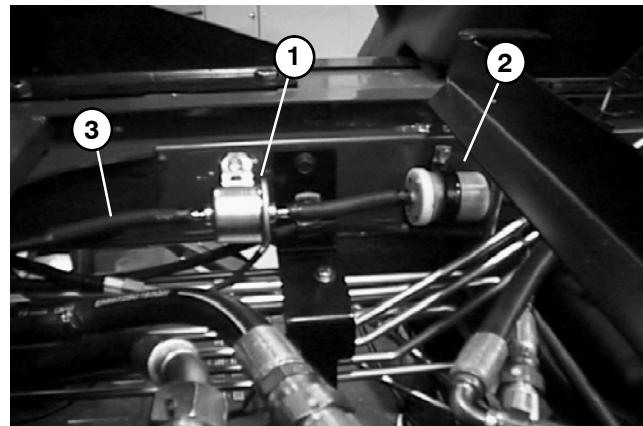


Figure 29

1. Fuel pump
2. Fuel pre-filter
3. Pump discharge hose

Fuel Pump Specifications

Pump Capacity	23.5 fl oz/min (695 ml/min)
Pressure	3.3 psi (22.8 kPa)
Max. Current Draw	0.9 amp

Glow Controller

The glow controller is located under the console cover.

NOTE: Refer to Chapter 9 – Electrical Schematics and Diagrams when troubleshooting the controller.

Controller Operation

1. When the ignition switch is placed in the ON position, the controller energizes the glow plugs and lights up the glow lamp for 7 to 10 seconds.
2. When the ignition switch is held in the START position, the glow plugs will energize and the glow lamp will **not** light.
3. When the ignition switch is released from START to ON, the glow plugs will deenergize and the glow lamp will remain off.

Controller Checks

1. Make sure there is power from the battery.
2. Disconnect electrical connector to the run solenoid to prevent the engine from starting.
3. Place ignition switch in the ON position. Verify the following while in the ON 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 deenergize 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 to 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 Chapter 9 – Electrical Schematics and Diagrams).

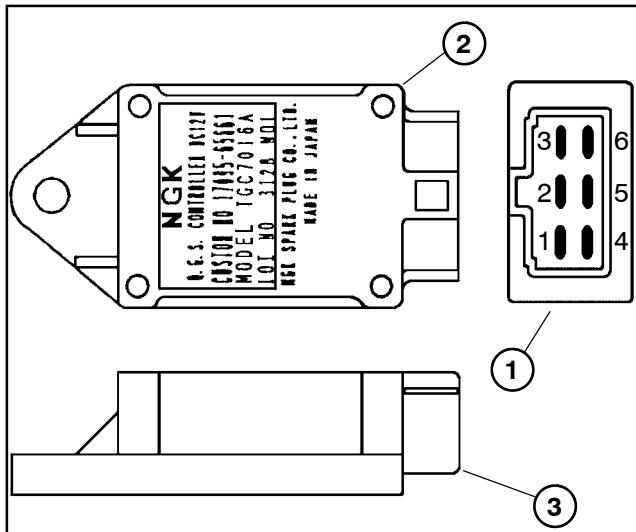


Figure 30

1. Glow controller end view 3. Controller side view
2. Controller top view

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 Chapter 9 – Electrical Schematics and Diagrams).
 - B. Verify continuity of the circuitry from the battery to ignition switch, glow controller, glow lamp, glow relay, and ground (see Chapter 9 – Electrical Schematics and Diagrams).
 - C. Replace parts as necessary.
6. Connect electrical connector to the run solenoid.

Temperature Sender

The temperature sender is located near the alternator on the water flange attached to the engine cylinder head (Fig. 31). There is a gray wire attached to the terminal of the switch.

Temperature Sender Test

1. Lower coolant level in the engine and remove the temperature sender from water flange.
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.

NOTE: Prior to taking resistance readings with a digital multi meter, short the meter test leads together. The meter will display a small resistance value (usually 0.5 ohms or less). This resistance is due to the internal resistance of the meter and test leads. Subtract this value from the measured value of the component you are testing.

3. Check resistance of the sender with a multimeter (ohms setting) as the temperature increases.
 - A. The meter should indicate more than 600 ohms at 70°F (21°C).
 - B. The meter should indicate approximately 460 ohms at 100°F (38°C).
 - C. The meter should indicate from 54 to 78 ohms at 200°F (93°C).
 - D. Replace sender if specifications are not met.
4. Install sender to the water flange.
 - A. Clean threads of water flange and sender thoroughly. Apply thread sealant to the threads of the sender.
 - B. Screw sender into the water flange. Torque sender from 16 to 20 ft-lb (21.7 to 27.1 N-m).
 - C. Reconnect gray wire to sender. Apply skin-over grease (Toro Part No. 505-47) to sender terminal.
5. Fill engine cooling system (see Traction Unit Operator's Manual).

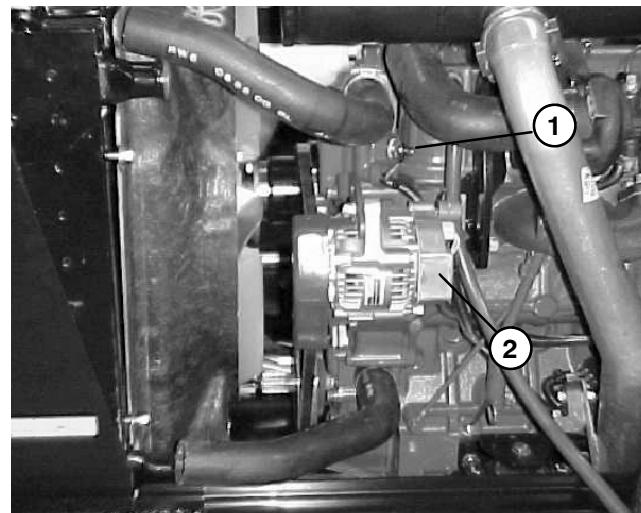


Figure 31
1. Temperature sender 2. Alternator

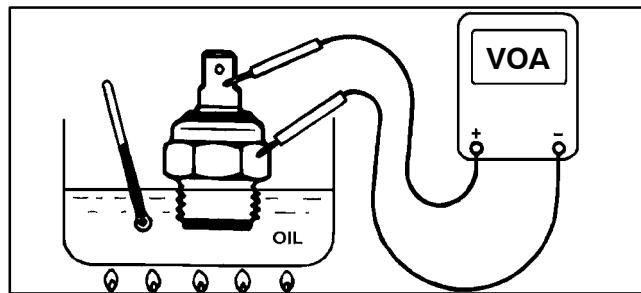


Figure 32

Temperature Gauge

The temperature gauge can be tested using a new gauge as a substitute or by the use of a DC voltage source and a variable resistance box.

Temperature Gauge Test



CAUTION

Make sure the voltage source is turned OFF before connecting it to the electrical circuit to avoid electrical shock and prevent damaging the gauge.

1. Connect temperature gauge to the variable resistance and DC voltage source (Fig. 33).

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

2. Take test point readings (Fig. 33).

IMPORTANT: Allow circuit to warm up for at least 5 minutes before taking test readings.

- A. Set variable resistance to 71 ohms. Apply a 14 ± 0.01 VDC to the circuit. The needle should point to the middle of the green area (80°C).
- B. Set variable resistance to 38 ohms. The needle should point between the green and red area (105°C).
3. Turn off the voltage source. Disconnect voltage source, gauge, and variable resistance.

Temperature Gauge Check

The following procedure can be used to check the temperature gauge and the gauge circuit:

1. Disconnect wire from temperature sender on engine (Fig. 35) Turn ignition key to ON (do not start engine).
2. Temperature gauge needle should remain in the cold temp range.
3. Ground the wire that was disconnected from the temperature sender. The gauge needle should move toward the high temp position.
4. Reconnect wire to temperature sender.

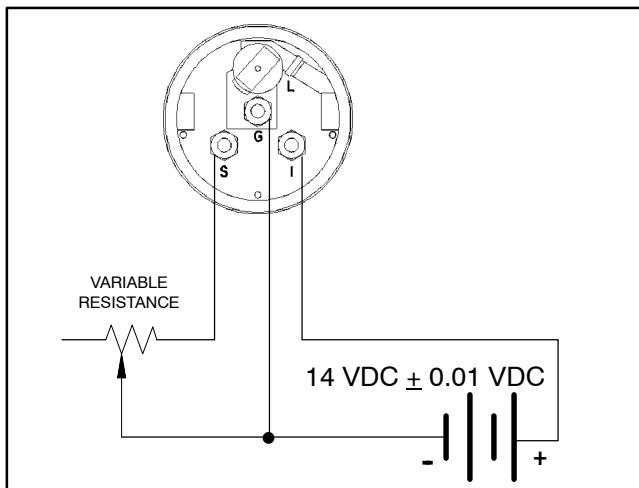


Figure 33

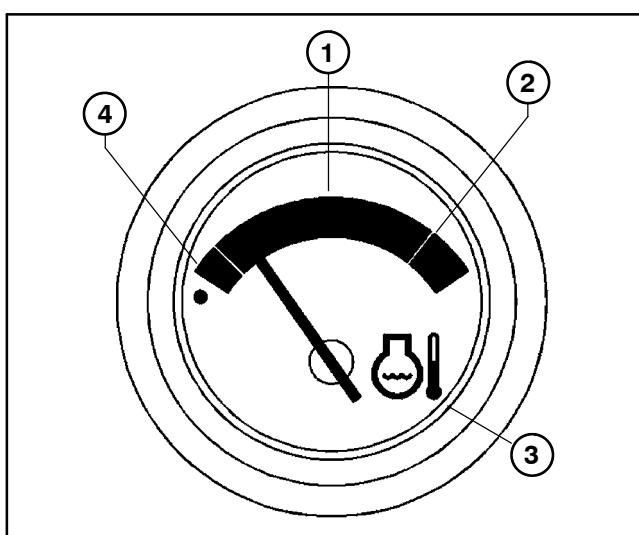


Figure 34

1. Middle position
2. High temp position
3. Edge of glass cover
4. Cold temp position

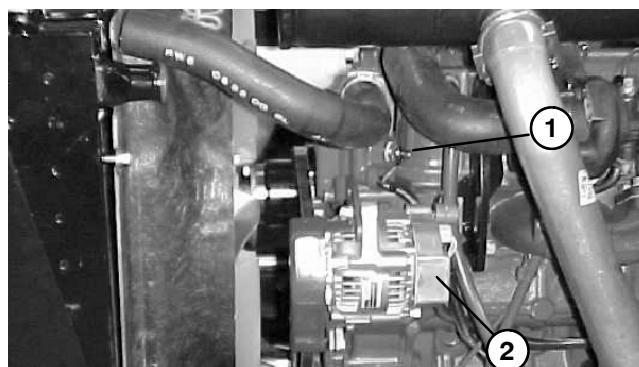


Figure 35

1. Temperature sender
2. Alternator

High Temperature Shutdown Switch

The high temperature shutdown switch is located near the glow plug connection on the engine cylinder head (Fig. 36). There is a blue/white wire attached to the switch.

The high temperature shutdown switch is designed to shut the engine off when engine coolant temperature reaches an unsafe level. If problems with the switch system are encountered, the following procedure can be used to determine if the problem is related to the switch or the switch circuit:

1. Start engine.
2. Use a jumper wire to ground the high temperature shutdown switch terminal.
3. Engine should stop running indicating that the switch circuit is functioning correctly. If the engine continues running with the grounded jumper wire, the switch circuit needs repair.

Shutdown Switch Test



CAUTION

Make sure engine is cool before removing the temperature switch.

1. Lower coolant level in the engine and remove the temperature shutdown switch.
2. Put switch in a container of oil with a thermometer and slowly heat the oil (Fig. 37).



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). The temperature switch is normally open and should close between 225° to 235°F (107° to 113°C).
4. Allow oil to cool while observing temperature. The temperature switch should open at about 219°F (104°C).
5. Replace switch if necessary.

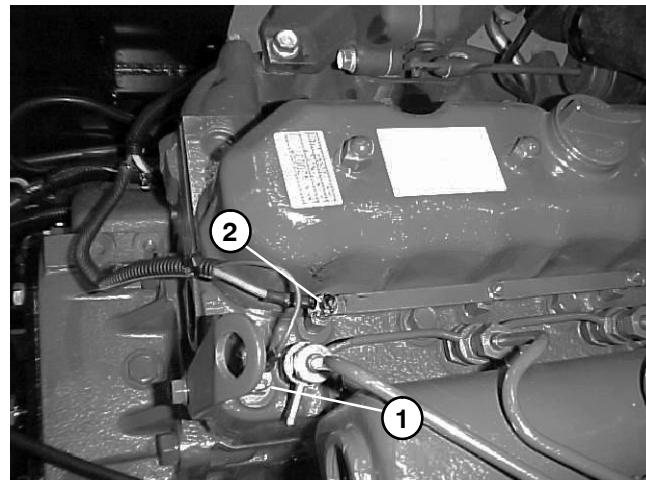


Figure 36

1. High temperature shutdown switch
2. Glow plug connection

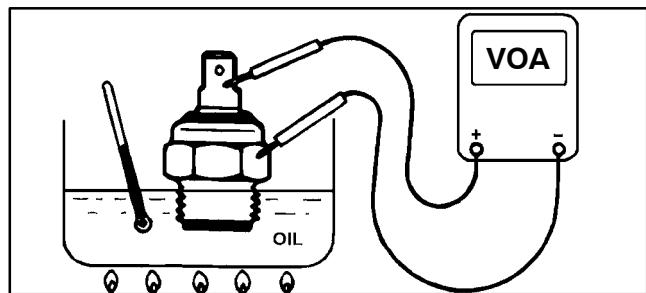


Figure 37

6. Install switch to the water flange.
 - A. Clean threads of cylinder head and switch thoroughly. Apply thread sealant to the threads of the switch.
 - B. Screw switch into the cylinder head and tighten.
 - C. Connect blue/white wire to switch.
7. Fill engine cooling system (see Traction Unit Operator's Manual).

Traction Neutral Switch

The traction neutral switch is closed when the traction pedal is in the neutral position and opens when the pedal is depressed in either direction. The switch is located on the right side of the piston (traction) pump.

Test the switch by disconnecting the wires from the switch terminals and connecting a continuity tester across the two switch terminals. With the engine turned off, slowly push the traction pedal in a forward or reverse direction while watching the continuity tester. There should be indications that the traction neutral switch is opening and closing. Allow the traction pedal to return to the neutral position. There should be continuity across the switch terminals when the traction pedal is in the neutral position.

See Piston Pump Control Assembly in Chapter 4 – Hydraulic Systems for disassembly and reassembly procedures for the neutral switch.



Figure 38

1. Piston (traction) pump 2. Neutral switch

Diode Assemblies

Diode D8 provide logic for the interlock switches. Diodes D2, D3, D4 (GM 4700-D only), and D5 (GM 4700-D only) are used for circuit protection from voltage spikes when relays and hydraulic valve solenoids are de-energized. The diodes plug into the wiring harness at various locations (see Wire Harness Drawings in Chapter 9 – Electrical Diagrams).

Diode Test

The diodes (Fig. 39) can be individually tested using a digital multimeter (diode test or ohms setting) and the table to the right.

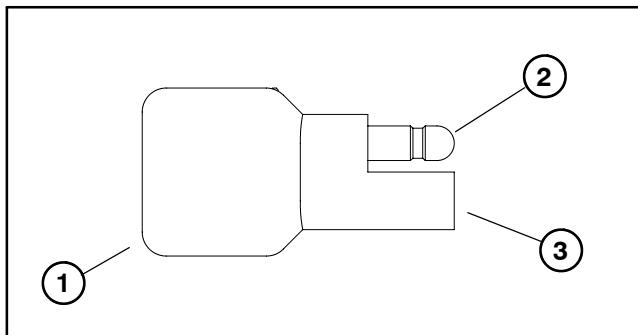


Figure 39

1. Diode 2. Male terminal 3. Female terminal

Multimeter Red Lead (+) on Terminal	Multimeter Black Lead (-) on Terminal	Continuity
Female	Male	YES
Male	Female	NO

Diode Circuit Board

The diode circuit board contains four diodes (Fig. 40) and is located under the console housing. Diode D1-A provide logic for the interlock switches. Diodes D1-C, D1-B (GM 4700-D right deck), and D1-D (GM 4700-D left deck) are used for circuit protection from voltage spikes when PTO relays are de-energized.

Diode Circuit Board Test

The diodes can be individually tested using a digital multimeter (ohms setting) and the table to the right. If any of the diodes are damaged, the diode circuit board must be replaced.

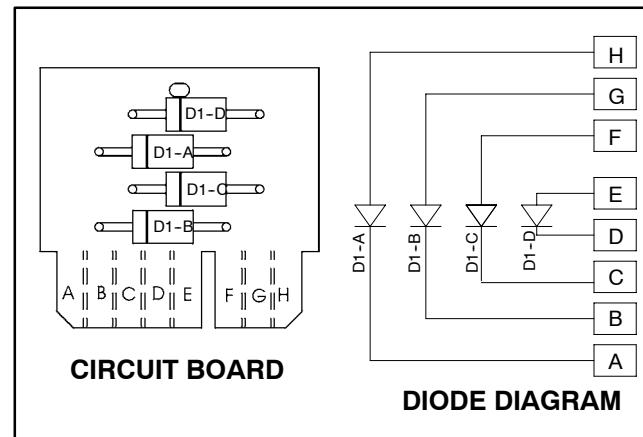


Figure 40

Red Lead (+) on Terminal	Black Lead (-) on Terminal	Continuity
H	A	YES
A	H	NO
G	B	YES
B	G	NO
F	C	YES
C	F	NO
E	D	YES
D	E	NO

Standard Control Module

Groundsmaster 4500-D and 4700-D machines with Serial Numbers above 230000000 are equipped with a Standard Control Module to monitor and control electrical components required for safe operation. This Module is located under the console cover.

Inputs from the neutral, parking brake, PTO, start (ignition), and high temperature switches are monitored by the Module. Output to the PTO (deck drive solenoids), fuel pump, and engine run solenoid 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 LED's 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 Operator's Manual for operation and troubleshooting of the Standard Control Module.

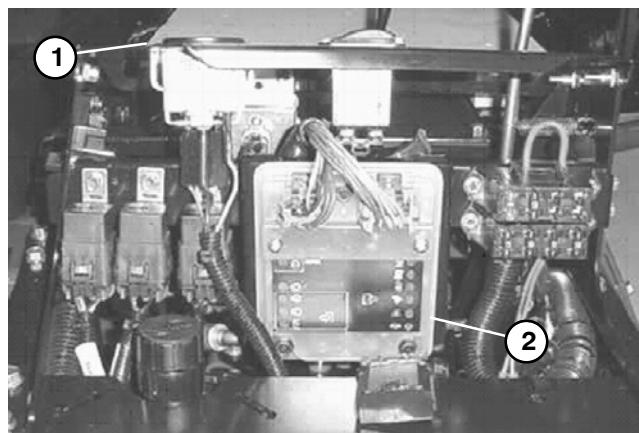


Figure 41

1. Control panel
2. Standard control module

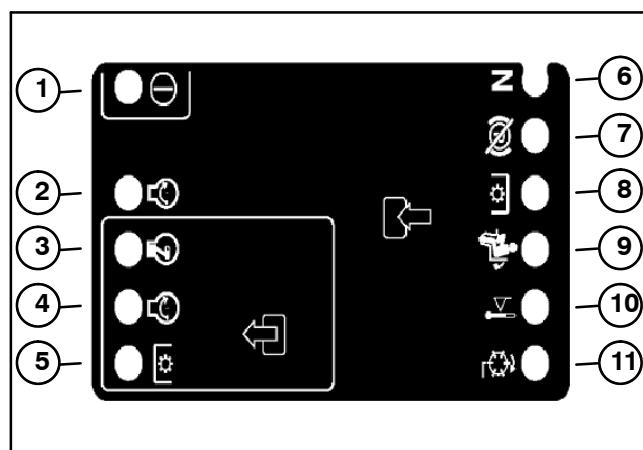


Figure 42

- | | |
|--------------------------|------------------------------|
| 1. Power input LED | 6. Neutral input LED |
| 2. Start input LED | 7. Park brake off input LED |
| 3. Engine run output LED | 8. PTO switch input LED |
| 4. Start output LED | 9. In seat input LED |
| 5. PTO output LED | 10. High temp input LED |
| | 11. Backlap input (not used) |

Service and Repairs

NOTE: For more component repair information, see the Kubota Workshop Manual, Diesel Engine, V2003-T Series at the end of Chapter 3 – Kubota Diesel Engines.

Battery Storage

If the machine will be stored for more than 30 days:

1. Remove the battery and charge it fully (see Battery Service).
2. Either store battery on a shelf or on the machine.
3. Leave cables disconnected if the battery is stored on the machine.

4. Store battery in a cool atmosphere to avoid quick deterioration of the battery charge.
5. To help prevent the battery from freezing, make sure it is fully charged (see Battery Service).

Battery Care

1. Battery electrolyte level must be properly maintained. The top of the battery must be kept clean. If the machine is stored in a location where temperatures are extremely high, the battery will run down more rapidly than if the machine is stored in a location where temperatures are cool.

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



WARNING

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

WARNING

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

4. If corrosion occurs at terminals, disconnect cables. Always disconnect negative (-) cable first. Clean clamps and terminals separately. Reconnect cables with positive (+) cable first. Coat battery posts and cable connectors with skin-over grease (Toro Part No. 505-165) or petroleum jelly to prevent corrosion.
5. Check electrolyte level every 25 operating hours, and every 30 days if machine is in storage.
6. Maintain cell level with distilled or demineralized water. Do not fill cells above the fill line.

IMPORTANT: Do not remove fill caps while cleaning.

2. Check battery condition weekly or after every 50 hours of operation. Keep terminals and entire battery case clean because a dirty battery will discharge slowly.

- A. Clean battery by washing entire case with a solution of baking soda and water. Rinse with clear water.
- B. Coat battery posts and cable connectors with skin-over grease (Toro Part No. 505-165) or petroleum jelly to prevent corrosion.

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 (26.7°C)
Discharged: less than 1.240

Battery Specifications

BCI Group Size 24
650 CCA at 0°F (-17.8°C)
Reserve Capacity of 105 minutes at 80°F (26.7°C)

Dimensions (including terminal posts and caps)

Length 11 inches (27.9 cm)
Width 6.76 inches (17.2 cm)
Height 9.2 inches (23.4 cm)

Removal and Installation (Fig. 43)

See Traction Unit Operator's Manual for battery removal and installation information.

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 0 amps. If the reading is 0.1 amp or more, this indicates a parasitic draw and the unit's electrical system should be tested and repaired.

Inspection, Maintenance, and Testing

1. Perform following inspections and maintenance:
 - A. Replace battery if case is cracked or leaking.
 - B. Check battery terminal posts for corrosion. Use wire brush to clean corrosion from posts.

IMPORTANT: Before cleaning the battery, tape or block vent holes to the filler caps and make sure the caps are on tightly.

- C. Check for signs of wetness or leakage on the top of the battery which might indicate a loose or missing filler cap, overcharging, loose terminal post, or overfilling. Also, check battery case for dirt and oil. Clean the battery with a solution of baking soda and water, then rinse it with clean water.

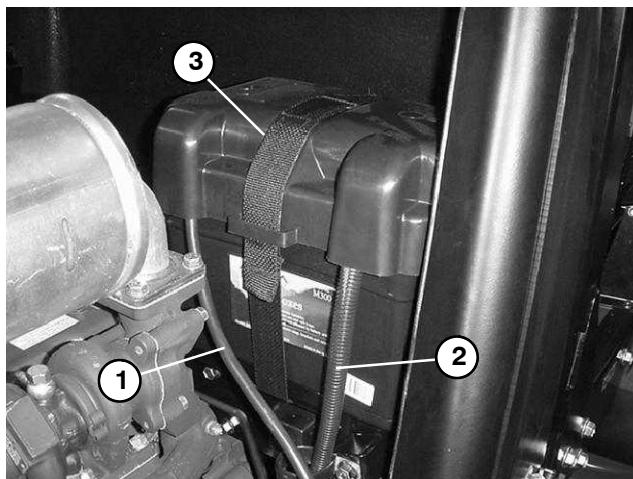


Figure 43

1. Negative cable
2. Positive cable
3. Battery strap

D. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.

E. Check the electrolyte level in each cell. If the level is below the tops of the plates in any cell, fill all cells with **distilled water** between the minimum and maximum fill lines. Charge at 15 to 25 amps for 15 minutes to allow sufficient mixing of the electrolyte.

2. Conduct a hydrometer test of the battery electrolyte.

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

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

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

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

C. If the difference between the highest and lowest cell specific gravity is 0.050 or greater or the lowest cell specific gravity is less than 1.225, charge the battery. Charge at the recommended rate and time given in **Charging** or until all cells specific gravity is 1.225 or greater with the difference in specific gravity between the highest and lowest cell less than 0.050. If these charging conditions can not be met, replace the battery.

3. Perform a high-discharge test with an adjustable load tester.

This is one of the most reliable means of testing a battery as it simulates the cold-cranking test. A commercial battery load tester is **required** to perform this test.



CAUTION

Follow the manufacturer's instructions when using a battery tester.

- A. Check the voltage across the battery terminals prior to testing the battery. If the voltage is less than 12.4 VDC, recharge the battery.
- B. If the battery has been charged, apply a 150 amp load for 15 seconds to remove the surface charge. Use a battery load tester following the manufacturer's instructions.
- C. Make sure battery terminals are free of corrosion.
- D. Measure the temperature of the center cell.
- E. Connect a battery load tester to the battery terminals **following the manufacturer's instructions**. Connect a digital multimeter to the battery terminals.
- F. Apply a test load of one half the Cranking Performance (see Battery Specifications) rating of the battery for 15 seconds.
- G. Take a voltage reading at 15 seconds, then remove the load.

H. Using the table below, determine the minimum voltage for the cell temperature reading:

Minimum Voltage	Battery Electrolyte Temperature	
9.6	70°F (and up)	21.1°C (and up)
9.5	60°F	15.6°C
9.4	50°F	10.0°C
9.3	40°F	4.4°C
9.1	30°F	-1.1°C
8.9	20°F	-6.7°C
8.7	10°F	-12.2°C
8.5	0°F	-17.8°C

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

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 shops.



CAUTION

Follow the manufacturer's instructions when using a battery charger.

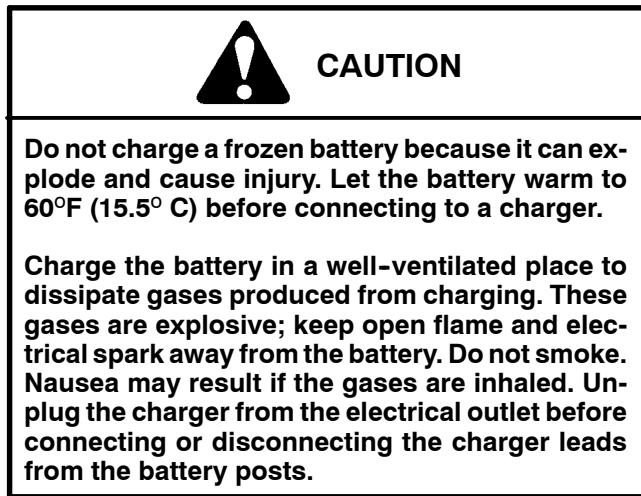
NOTE: Using specific gravity of the battery cells is the most accurate method of determining battery condition.

1. Determine the battery charge level from either its specific gravity or open circuit voltage.

Battery Charge Level	Specific Gravity	Open Circuit Voltage
100%	1.265	12.68
75%	1.225	12.45
50%	1.190	12.24
25%	1.155	12.06
0%	1.120	11.89

2. Determine the charging time and rate **using the manufacturer's battery charger instructions** or the following table.

Battery Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	50%	25%	0%
80 or less	3.8 hrs @ 3 amps	7.5 hrs @ 3 amps	11.3 hrs @ 3 amps	15 hrs @ 3 amps
81 to 125	5.3 hrs @ 4 amps	10.5 hrs @ 4 amps	15.8 hrs @ 4 amps	21 hrs @ 4 amps
126 to 170	5.5 hrs @ 5 amps	11 hrs @ 5 amps	16.5 hrs @ 5 amps	22 hrs @ 5 amps
171 to 250	5.8 hrs @ 6 amps	11.5 hrs @ 6 amps	17.3 hrs @ 6 amps	23 hrs @ 6 amps
above 250	6 hrs @ 10 amps	12 hrs @ 10 amps	18 hrs @ 10 amps	24 hrs @ 10 amps



3. **Following the manufacturer's instructions**, connect the charger cables to the battery. Make sure a good connection is made.

4. Charge the battery **following the manufacturer's instructions**.

5. Occasionally check the temperature of the battery electrolyte. If the temperature exceeds 125°F (51.6°C) or the electrolyte is violently gassing or spewing, the charging rate must be lowered or temporarily stopped.

6. Three hours prior to the end of the charging, measure the specific gravity of a battery cell once per hour. The battery is fully charged when the cells are gassing freely at a low charging rate and there is less than a 0.003 change in specific gravity for three consecutive readings.



Axles, Planetaries, and Brakes

Table of Contents

SPECIFICATIONS	2
ADJUSTMENTS	3
SERVICE AND REPAIRS	4
Brake Assembly	4
Brake Inspection and Repair	6
Planetary Wheel Drive Assembly	8
Planetary Wheel Drive Service	10
Rear Axle Assembly	12
Bevel Gear Case and Axle Case	14
Differential Shafts	18
Axe Shafts	19
Input Shaft/Planion Gear	20
Differential Gear	22
Pinion Gear to Ring Gear Engagement	25

Specifications

Item	Specification
Wheel lug nut torque (front and rear)	85 to 100 ft-lb (115 to 135 N-m)
Steering cylinder bolt torque	100 to 125 ft-lb (135 to 169 N-m)
Planetary brake housing and wheel motor mounting screw torque	75 to 85 ft-lb (101 to 115 N-m)
Rear wheel toe-in	.125 in (3.2 mm)
Tire pressure (front and rear)	20 psi (1.4 bar)
Planetary gear drive lubricant Planetary gear lube capacity (each wheel)	SAE 85W-140 wt. gear lube 16 fl oz (.47 l)
Rear axle lubricant Rear axle gear lube capacity	SAE 85W-140 wt. gear lube 80 fl oz (2.37 l)

Adjustments

See Traction Unit Operator's Manual for adjustment procedures for Groundsmaster 4500-D and Groundsmaster 4700-D axles, planetaries, and brakes.

Axes, Planetaries,
and Brakes

Service and Repairs

Brake Assembly

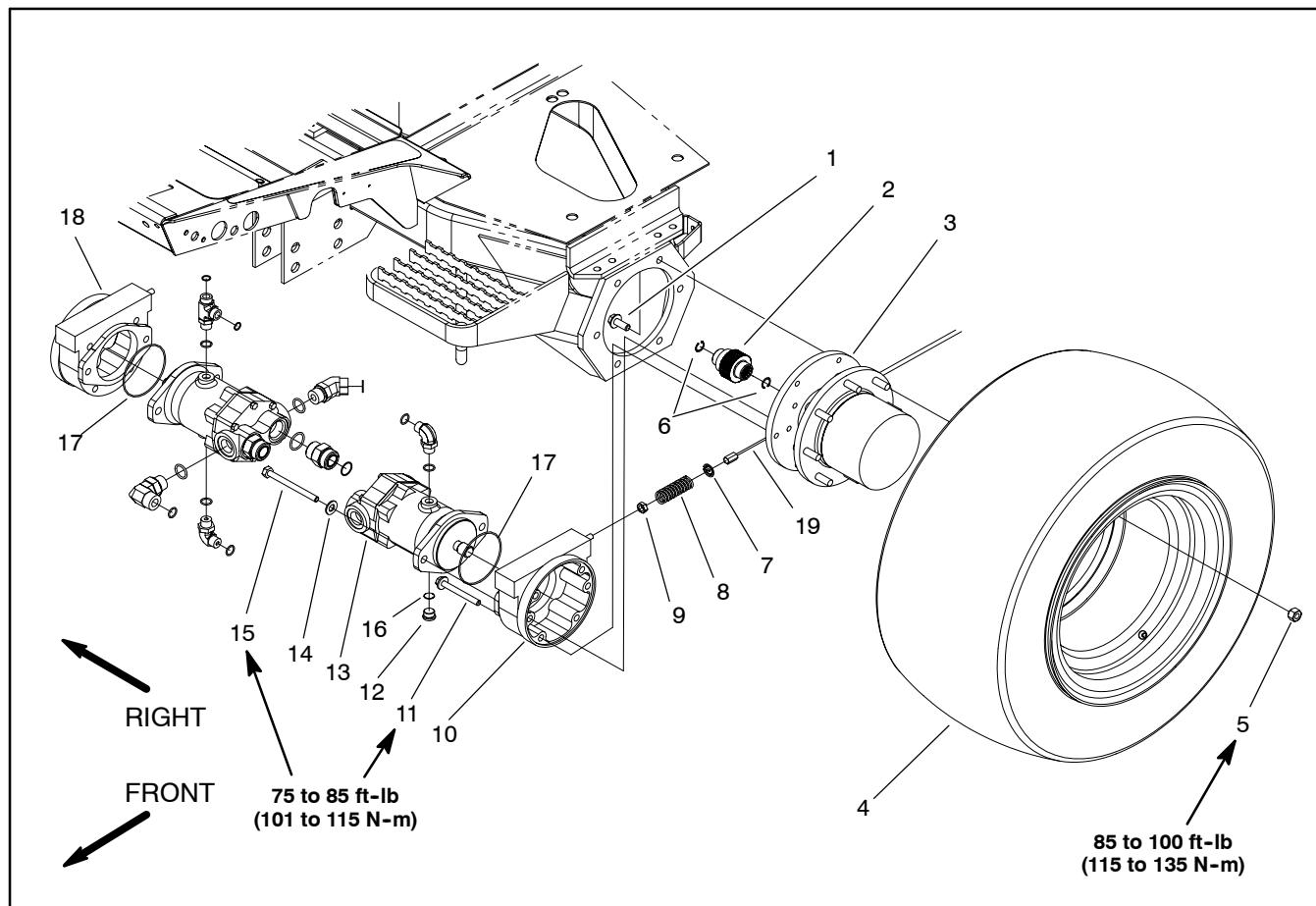


Figure 1

- | | | |
|----------------------------|-----------------------|-----------------------|
| 1. Flange head screw | 8. Compression spring | 14. Flat washer |
| 2. Splined brake shaft | 9. Jam nut | 15. Cap screw |
| 3. Planetary assembly | 10. LH Brake assembly | 16. O-ring |
| 4. Tire and wheel assembly | 11. Flange head screw | 17. O-ring |
| 5. Lug nut | 12. Hex plug | 18. RH brake assembly |
| 6. Retaining ring | 13. Piston motor | 19. Brake cable |
| 7. Spring plate | | |

Remove Brake Assembly (Fig. 1)

1. Park machine on a level surface and raise cutting units to allow easier access to front brake assembly. Stop engine, engage parking brake, and remove key from the ignition switch.
2. Drain oil from planetary wheel drive/brake assembly (see Traction Unit Operator's Manual).



CAUTION

When changing attachments, tires, or performing other service, use correct blocks, hoists, and jacks. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising 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.

3. Chock rear wheels and jack up front of machine (see Jacking Instructions in Chapter 1 – Safety). Support machine with jack stands or solid wood blocks.
4. Remove wheel assembly.
5. Remove hydraulic wheel motor (see Front Wheel Motors in Service and Repairs section of Chapter 4 – Hydraulic System).
6. Disconnect brake cable from pull rod on brake.

NOTE: Be careful not to drop splined brake shaft as brake assembly is removed.

7. Support brake assembly and remove flange head capscrews (11) securing brake assembly to frame. Remove brake assembly.
8. Remove splined brake shaft.
9. Complete brake inspection and repair.

Install Brake Assembly (Fig. 1)

NOTE: The stepped end of the splined brake shaft must be aligned toward the hydraulic wheel motor (Fig. 2).

1. Install splined brake shaft into brake assembly.
2. Install brake assembly onto frame, aligning splined brake shaft with input shaft on planetary wheel drive.

3. Install flange head screws (11) to secure brake assembly to frame. Tighten screws in a crossing pattern to a torque from 75 to 85 ft-lb (101 to 115 N-m).

4. Install brake cable to pull rod on brake assembly. Brake cable end should be completely threaded onto pull rod.

5. Install new o-ring on hydraulic wheel motor. Install wheel motor and torque capscrews from 75 to 85 ft-lb (101 to 115 N-m).



WARNING

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

6. Install wheel assembly. Torque lug nuts from 85 to 100 ft-lb (115 to 135 N-m).
7. Lower machine to ground.
8. Make sure drain plug is installed in bottom of brake assembly (Fig. 3). Fill planetary wheel drive/brake assembly with SAE 85W-140 gear lube (see Traction Unit Operator's Manual).
9. Check and adjust brake cables for proper brake operation (see Traction Unit Operator's Manual).

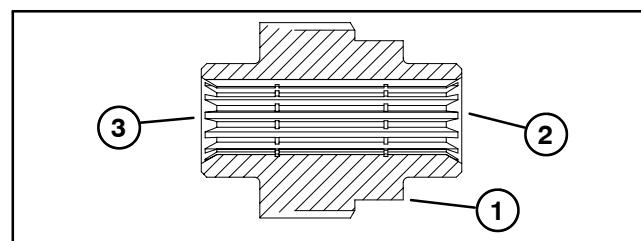


Figure 2

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

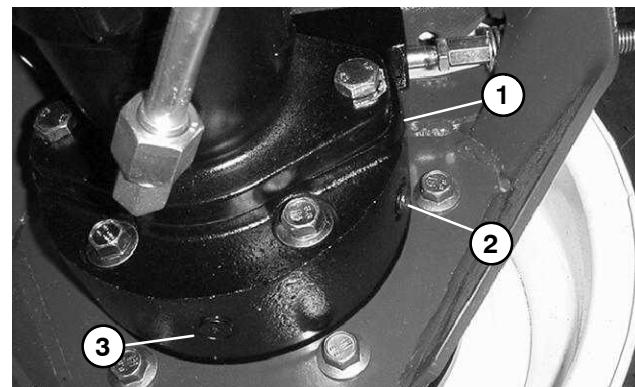


Figure 3

1. Brake housing
2. Check plug
3. Drain plug

Brake Inspection and Repair

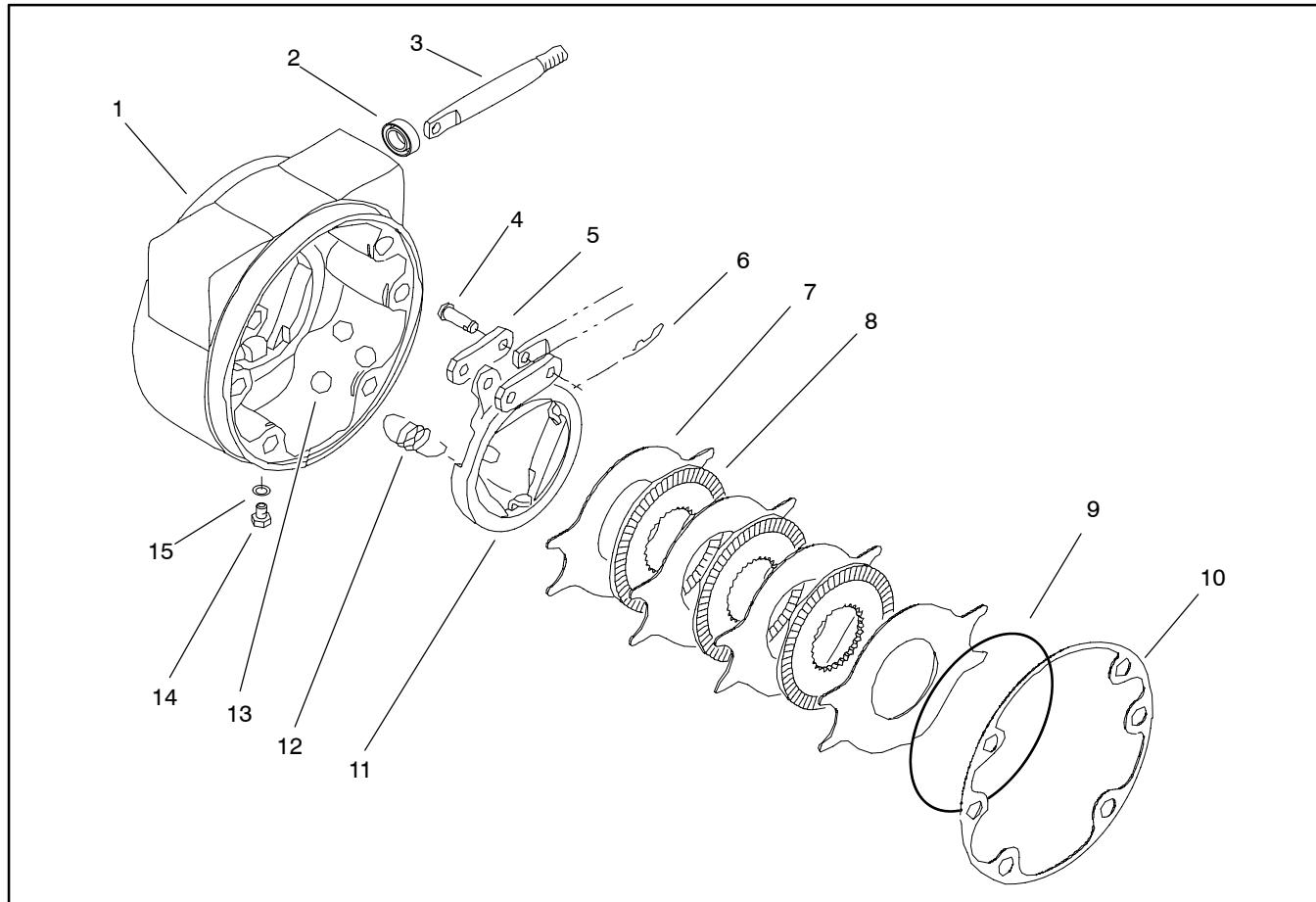


Figure 4

1. Brake housing (LH shown)

2. Seal

3. Pull rod

4. Clevis pin

5. Link

6. Hitch pin

7. Stationary disc

8. Rotating disc

9. Retaining ring

10. Gasket

11. Rotating actuator

12. Extension spring

13. Ball

14. Plug

15. O-ring

Brake Inspection and Repair (Fig. 4)

1. Scrape gasket material (10) from brake housing and planetary wheel drive mounting surfaces.
2. Remove retaining ring (9).
3. Remove stationary discs (7) and rotating discs (8).
4. Remove extension springs (12).
5. Remove actuator assembly (3, 4, 5, 6, and 11) and balls (13).

6. Remove seal (2) from brake housing.

7. Wash parts in cleaning solvent. Inspect components for wear or damage.

8. Reverse steps 2 – 6 to assemble brakes, installing new parts as necessary. Install a new seal (2).

9. Use a new gasket (10) when installing brake assembly to machine.

This page is intentionally blank.

Axles, Planetaries,
and Brakes

Planetary Wheel Drive Assembly

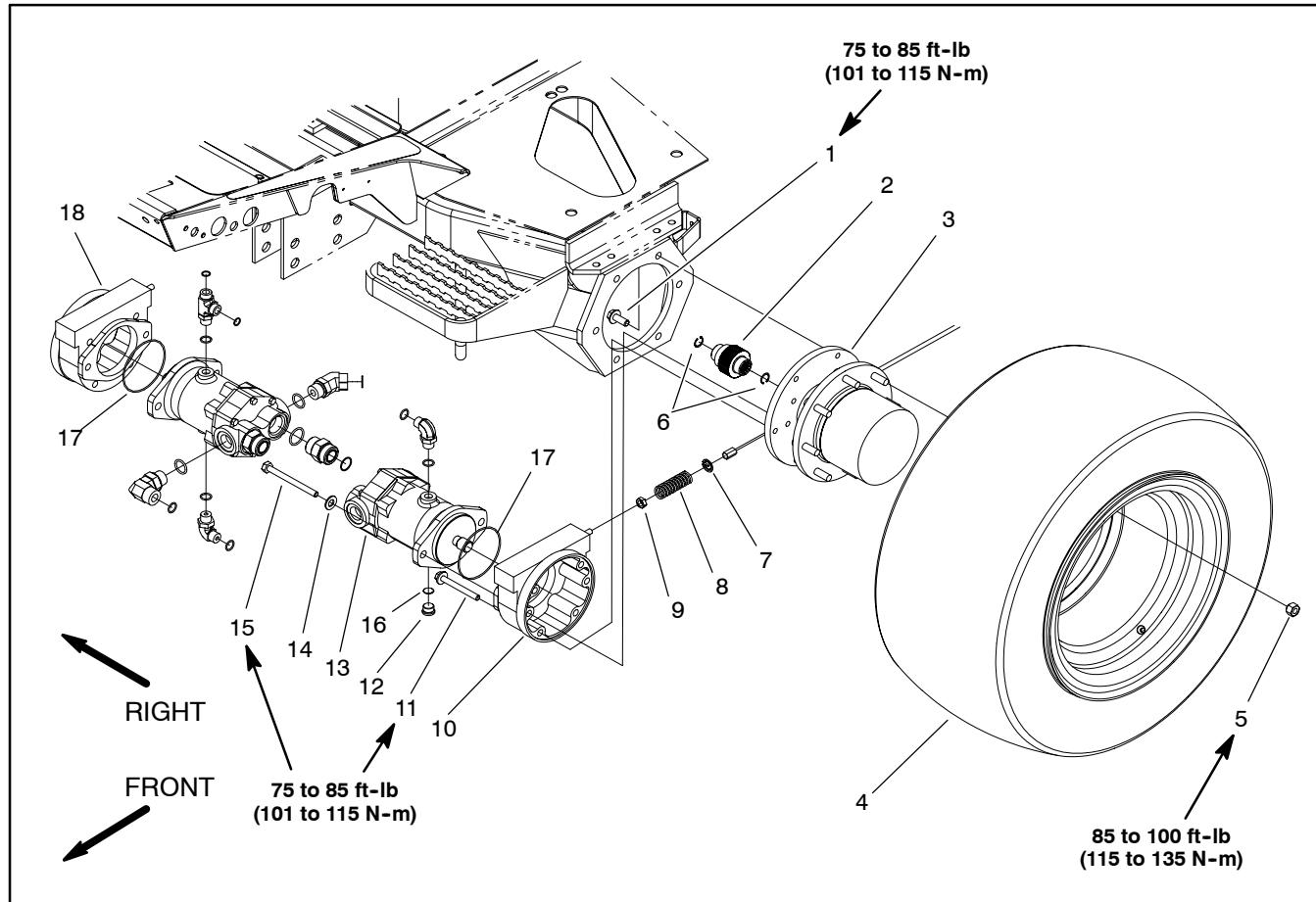


Figure 5

- | | | |
|----------------------------|-----------------------|-----------------------|
| 1. Flange head screw | 7. Spring plate | 13. Piston motor |
| 2. Splined brake shaft | 8. Compression spring | 14. Flat washer |
| 3. Planetary assembly | 9. Jam nut | 15. Cap screw |
| 4. Tire and wheel assembly | 10. LH Brake assembly | 16. O-ring |
| 5. Lug nut | 11. Flange head screw | 17. O-ring |
| 6. Retaining ring | 12. Hex plug | 18. RH brake assembly |

Planetary Wheel Drive Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Drain oil from planetary wheel drive/brake assembly (see Traction Unit Operator's Manual).



CAUTION

When changing attachments, tires, or performing other service, use correct blocks, hoists, and jacks. Make sure machine is parked on a solid, level surface such as a concrete floor. Prior to raising 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.

3. Chock rear wheels and jack up front of machine (see Jacking Instructions in Chapter 1 – Safety). Support machine with jack stands or solid wood blocks.
4. Remove front wheel assembly.
5. Remove flange head screws that secure brake assembly to planetary assembly (see Brake Assembly).
6. Support planetary assembly to prevent it from falling. Loosen and remove flange head screws that secure planetary assembly to frame. Remove planetary assembly from machine.

Planetary Wheel Drive Installation

1. Position planetary assembly to machine. Install flange head screws that secure planetary assembly. Torque screws from 75 to 85 ft-lb (101 to 115 N-m).
2. Install brake assembly to planetary (see Brake Assembly).

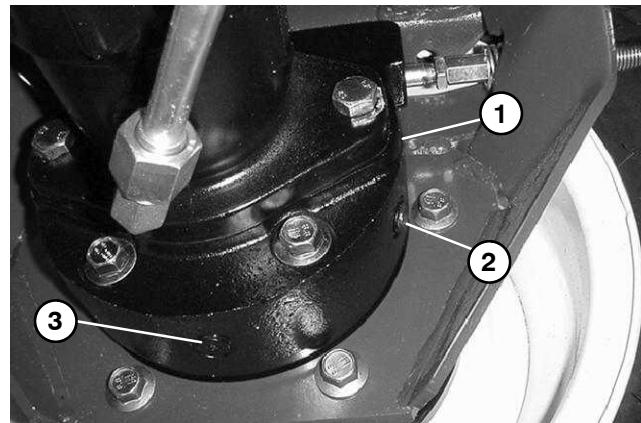


Figure 6

1. Brake housing
2. Check plug
3. Drain plug

- 

WARNING

Failure to maintain proper wheel lug nut torque could result in failure or loss of wheel and may result in personal injury.
3. Install wheel assembly. Torque lug nuts from 85 to 100 ft-lb (115 to 135 N-m).
 4. Lower machine from jack stands.
 5. Make sure drain plug is installed in bottom of brake assembly (Fig. 6). Fill planetary wheel drive/brake assembly with SAE 85W-140 gear lube (see Traction Unit Operator's Manual). Capacity is approximately 16 oz. (.47 l) per wheel.
 6. Check and adjust brake cables for proper brake operation (see Traction Unit Operator's Manual).

Planetary Wheel Drive Service

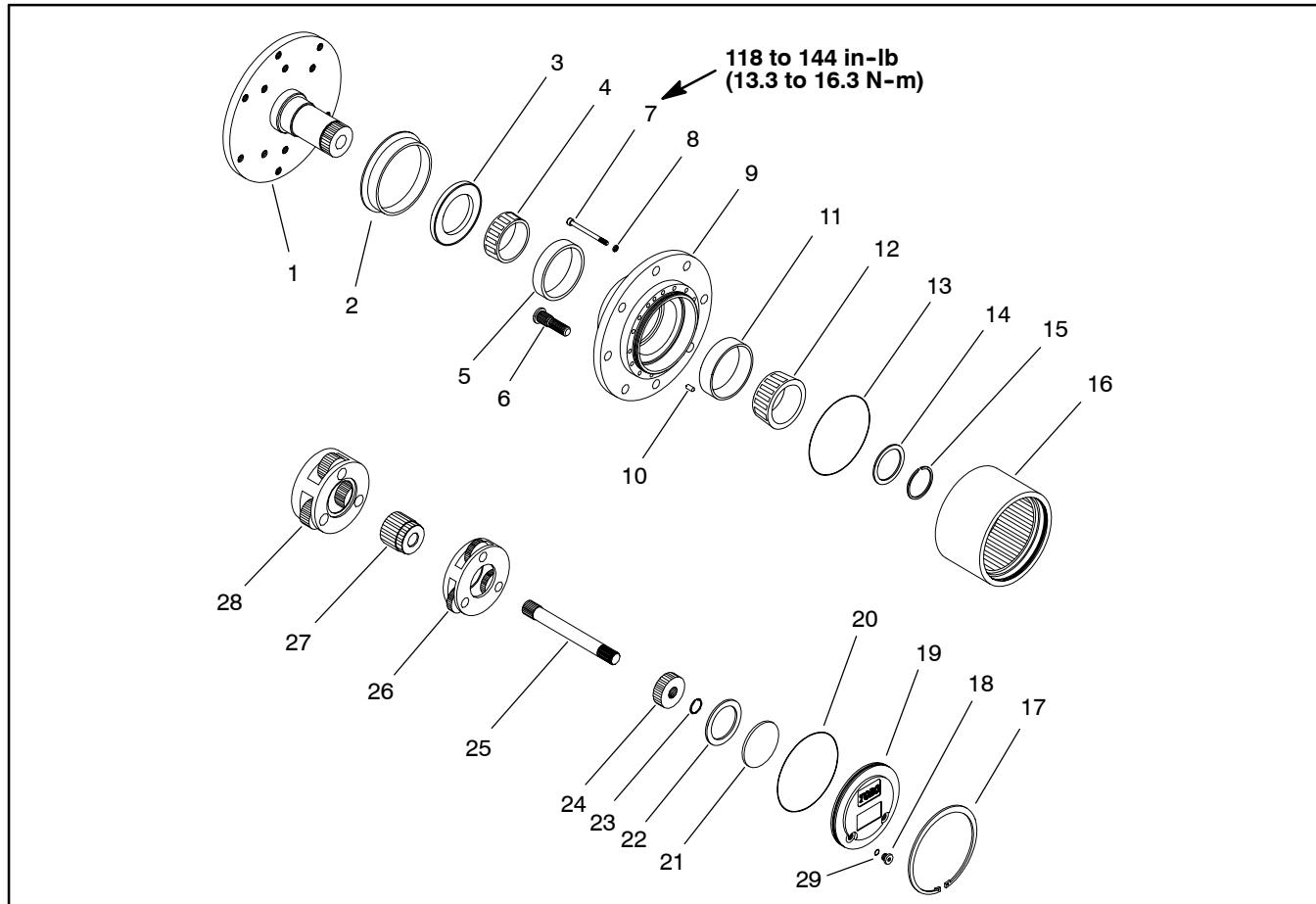


Figure 7

- | | | |
|----------------------|--------------------|-----------------------|
| 1. Spindle | 11. Bearing cup | 21. Thrust plug |
| 2. Boot seal | 12. Bearing cone | 22. Thrust washer |
| 3. Oil seal | 13. O-ring | 23. Retaining ring |
| 4. Bearing cone | 14. Bearing shim | 24. Primary gear |
| 5. Bearing cup | 15. Snap ring | 25. Drive shaft |
| 6. Wheel stud | 16. Ring gear | 26. Primary carrier |
| 7. Socket head screw | 17. Retaining ring | 27. Secondary gear |
| 8. Lock washer | 18. Plug | 28. Secondary carrier |
| 9. Housing | 19. End cap | 29. O-ring |
| 10. Dowel pin | 20. O-ring | |

Planetary Wheel Drive Disassembly (Figure 7)

1. Remove retaining ring (17).
2. Remove end cap (19) and o-ring (20).
3. Remove thrust plug (21) and thrust washer (22).
4. Remove retaining ring (23), primary gear (24), and drive shaft (25).
5. Remove primary carrier (26), secondary gear (27), and secondary carrier (28).

NOTE: Steps 6 – 10 are necessary only if inspecting or replacing bearings and/or seals.

6. Remove socket head screws (7) and remove ring gear (16).
7. Remove snap ring (15) and bearing shim (14).
8. Use a puller to remove spindle (1) from housing (9). Remove bearing cone (12).
9. Remove and discard all seals.
10. If bearings will be replaced, use a puller to remove bearing cone (4) from spindle. Remove bearing cups (5 and 11) from housing (9).

Planetary Wheel Drive Assembly (Figure 7)

NOTE: Use new seal kit when assembling planetary wheel drive.

1. Clean parts in solvent. Inspect parts for damage or excessive wear and replace as necessary.
2. Install oil seal (3) to spindle (1).
3. Press bearing cups (5 and 11) into housing (9).
4. Press bearing cone (4) onto spindle (1).
5. Install boot seal (2) to housing (9). Assemble housing (9) to spindle (1).
6. Press bearing cone (12) onto spindle and secure with bearing shim (14) and snap ring (15).
7. Install o-ring (13), then secure ring gear (16) to housing (9) with socket head screws (7) and lock washers (8). Torque screws from 118 to 144 in-lb (13.3 to 16.3 N-m).

8. Install secondary carrier (28), secondary gear (27), and primary carrier (26).

9. Install drive shaft (25) and primary gear (24). Secure gear with retaining ring (23).

10. Install thrust washer (22) and thrust plug (21).

11. Install o-ring (20) and end cap (19). Secure end cap with retaining ring (17).

12. Check operation of planetary wheel drive before installing assembly on the machine. With a constant turning force applied, rotation of the planetary should be consistent. If there is more drag at certain points, gears are not rolling freely and the planetary should be examined for improper assembly or damaged components.

Rear Axle Assembly

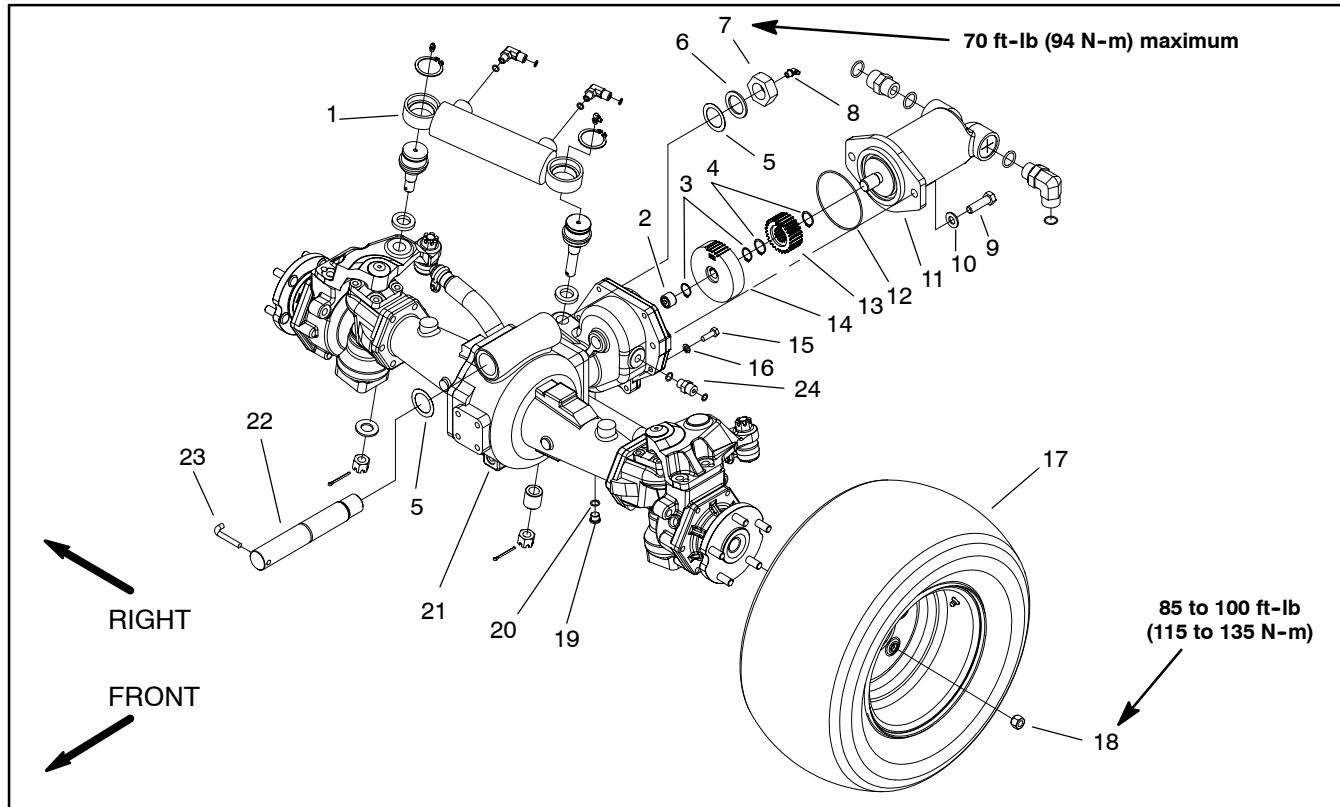


Figure 8

1. Steering cylinder
2. Needle bearing
3. External snap ring
4. External snap ring
5. Thrust washer
6. Flat washer
7. Lock nut
8. Grease fitting

9. Cap screw
10. Flat washer
11. Piston motor
12. O-ring
13. Pinion gear
14. Gear
15. Cap screw
16. Lock washer

17. Tire and wheel assembly
18. Lug nut
19. Hex plug
20. O-ring
21. Drive axle assembly
22. Axle pivot pin
23. Stop pin
24. Hydraulic fitting

Remove Rear Axle

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Drain oil from rear axle and axle gearbox (see Traction Unit Operator's Manual).

3. Chock front wheels and jack up rear of machine (see Jacking Instructions in Chapter 1 – Safety). Support machine with jack stands or solid wood blocks.
4. Remove wheels from rear axle.
5. Remove hydraulic motor from axle assembly (see Rear Axle Motor in Service and Repairs section of Chapter 4 – Hydraulic System).
6. Remove hydraulic hoses from steering cylinder.
7. Remove hydraulic hose from hydraulic fitting on side of input gear case.
8. Remove lock nut and flat washer from pivot pin.
9. Support rear axle to prevent it from falling. Remove pivot pin. Lower rear axle from machine. Note location of thrust washer on both ends of axle mounting boss.



CAUTION

When servicing rear axle, use correct blocks, hoists, and jacks. Make sure machine is parked on a solid, level surface such as a concrete floor. 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.

10. If needed for further axle disassembly, remove steering cylinder from axle (see Steering Cylinder in Service and Repairs section of Chapter 4 – Hydraulic System).
11. If required, remove tie rod ends from steering arms on rear axle (Fig. 9). Remove the cotter pins and castle nuts from the tie rod ball joints. Use a ball joint fork and remove the tie rod ends from the axle steering arms.
12. Clean the rear axle pivot pin and pivot bushings. Inspect the pin and bushings for wear or damage. Replace components as necessary.

Install Rear Axle

1. If removed, install steering cylinder to axle assembly (see Steering Cylinder in Service and Repairs section of Chapter 4 – Hydraulic System).
2. If removed, install the tie rod to rear axle (Fig. 9). Tighten ball joint castle nuts and install new cotter pins.
3. Support axle under machine with a jack. Position axle assembly to rear frame mount.
4. Install axle pivot pin to secure axle to frame. Make sure to install thrust washer between axle pivot and frame on both ends of the pivot. With washers installed, there should be from .002 to .020 inch (.05 to .51 mm) clearance between rear frame mount and axle mounting boss. Add thrust washers if needed to adjust clearance.
5. Install flat washer and lock nut onto pivot pin. Lock nut should be tightened enough to allow pivot pin to rotate (70 ft-lb (94 N-m) maximum).
6. Install hydraulic motor to axle assembly (see Rear Axle Motor in Service and Repairs section of Chapter 4 – Hydraulic System).
7. Install hydraulic hoses to steering cylinder and input gear case.



WARNING

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

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

9. Fill axle with SAE 85W-140 weight gear lube (see Traction Unit Operator's Manual).

10. Check rear wheel toe-in and adjust if necessary (see Traction Unit Operator's Manual).

11. Check steering stop bolt adjustment. When the steering cylinder is fully extended (right turn), a gap of $1/16$ " (1.6 mm) should exist between bevel gear case casting and stop bolt on left axle case. Figure 10 shows stop bolt location.

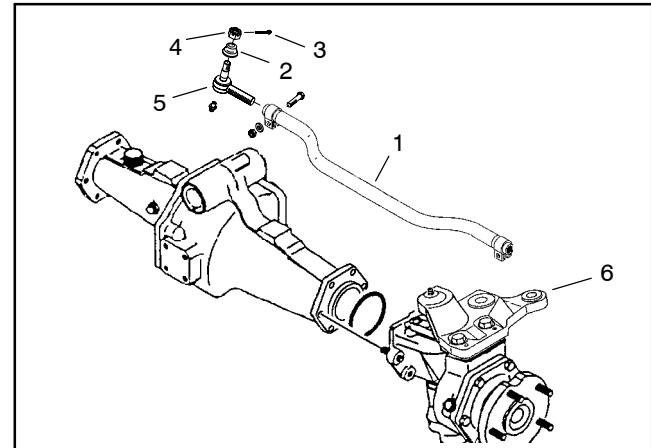


Figure 9
 1. Tie rod
 2. Dust cover
 3. Cotter pin
 4. Castle nut
 5. Tie rod end
 6. Steering arm (LH)

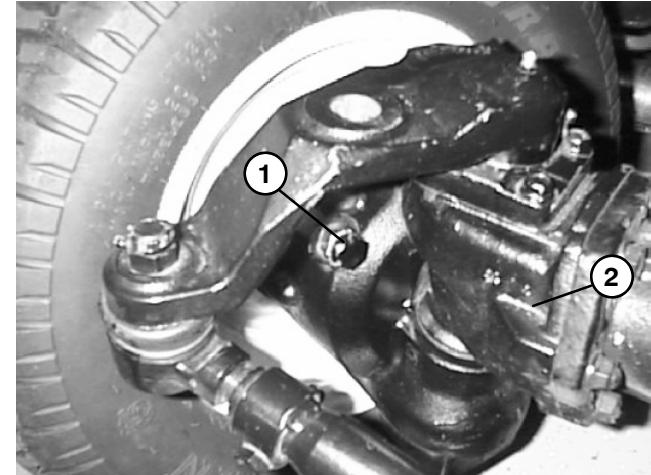


Figure 10
 1. Steering stop bolt
 2. Bevel gear case (LH)

Bevel Gear Case and Axle Case

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove the mounting screws, nuts, and lock washers. Remove the bevel gear case/axle case assembly and O-ring from the axle support (Fig. 11).

2. Mark both right and left bevel gear case/axle case assemblies.

IMPORTANT: Do not interchange right and left bevel gear case/axle case assemblies.

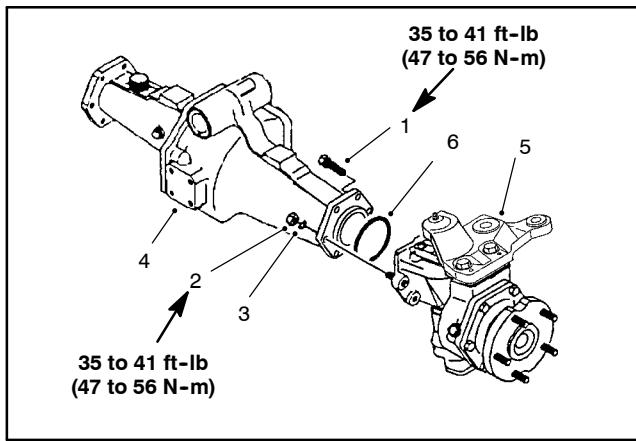


Figure 11

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

3. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly (Fig. 12).

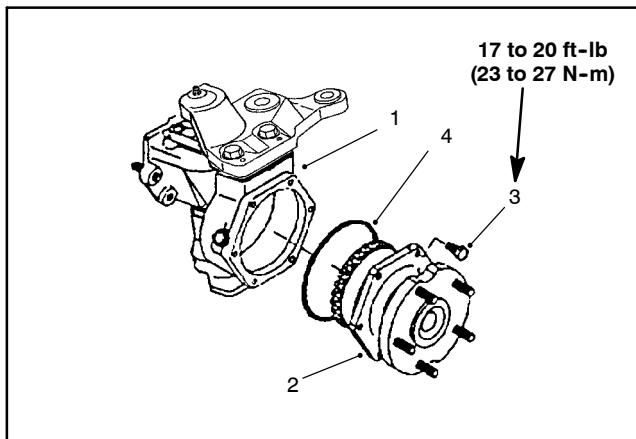


Figure 12

- | | |
|------------------------|-------------------|
| 1. Axle case | 3. Mounting screw |
| 2. Axle cover assembly | 4. O-ring |

4. Remove the axle case support mounting screws, the axle case support, and the support shims (Fig. 13).

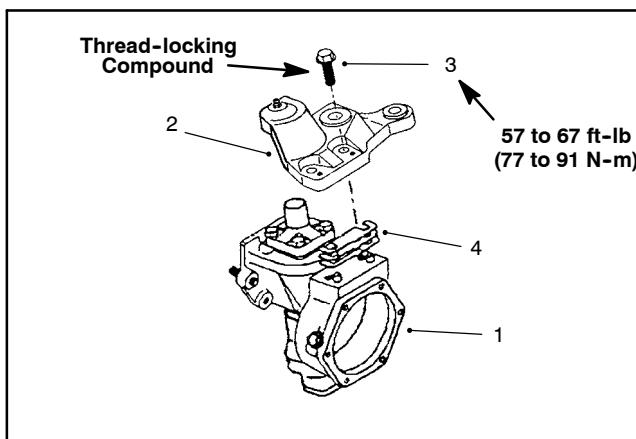


Figure 13

- | | |
|----------------------|-------------------|
| 1. Axle case | 3. Mounting screw |
| 2. Axle case support | 4. Support shim |

5. Remove the knuckle pin mounting screws and the knuckle pin. Remove the gasket and any remaining gasket material from either mating surface (Fig. 14).

6. While holding the bevel gear case, tap the upper end of the bevel gear shaft out of the upper bearing and upper bevel gear.

7. Pull the bevel gear case from the axle case and remove the upper bevel gear, and collar from the gear case.

8. Remove the axle case cover screws, cover, and the O-ring from the axle case.

9. Remove the plug and sealing washer from the center of the axle case cover. While holding the axle case cover, lightly tap the lower end of the bevel gear shaft out of the lower bearing and lower bevel gear.

10. Remove and discard bevel gear shaft seal from axle case (Fig. 14).

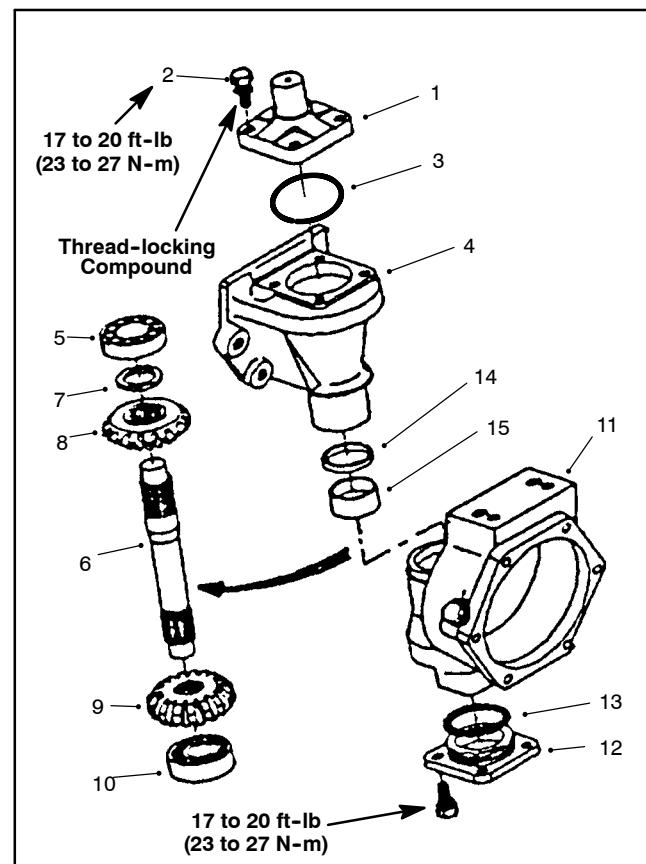


Figure 14

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

Inspection

1. Measure the knuckle pin O.D. and the axle case support bushing I.D. to determine the bushing to pin clearance (Fig. 15). Replace components as necessary.

BUSHING TO PIN CLEARANCE:

0.002 to 0.016 in. (0.05 to 0.40 mm)

KNUCKLE PIN O.D. (Factory Spec.):

0.982 to 0.983 in. (24.95 to 24.98 mm)

AXLE CASE SUPPORT BUSHING I.D.

(Factory Spec.):

0.984 to 0.987 in. (25.00 to 25.08 mm)

2. Inspect all gears, shafts, bearings, cases, and covers for damage and wear. Replace components as necessary.

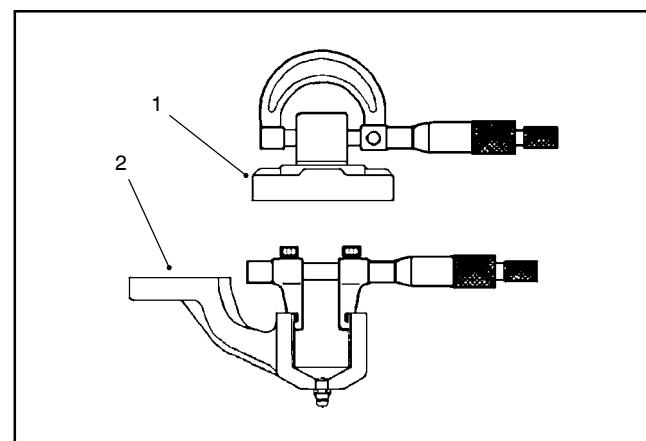


Figure 15

- | | |
|----------------|----------------------|
| 1. Knuckle pin | 2. Axle case support |
|----------------|----------------------|

Installation

1. Coat new shaft seal with grease and install in axle case as shown (Fig. 16).

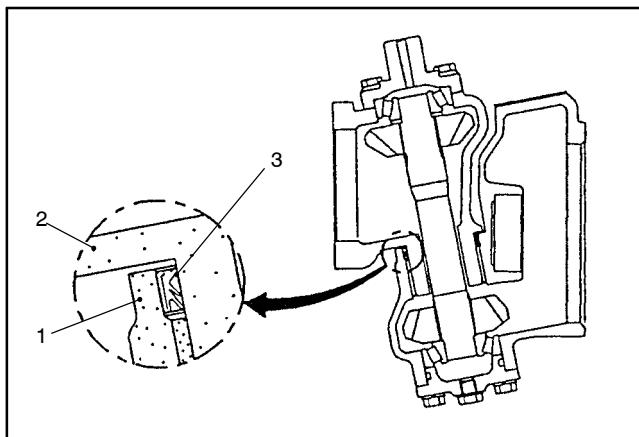


Figure 16

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

2. Install the lower bevel gear, and bevel gear shaft in the axle case cover. Coat a new O-ring with grease and install the axle case cover (Fig. 17). Tighten cover screws from 17 to 20 ft-lb (23 to 27 N-m).

3. Slide the bevel gear case over the bevel gear shaft and install the bevel gear and collar. Make sure the bevel gear shaft is completely seated in the upper and lower bearings (Fig. 17).

4. Install the knuckle pin. Use medium strength thread-locking compound and tighten the knuckle pin mounting screws from 17 to 20 ft-lb (23 to 27 N-m).

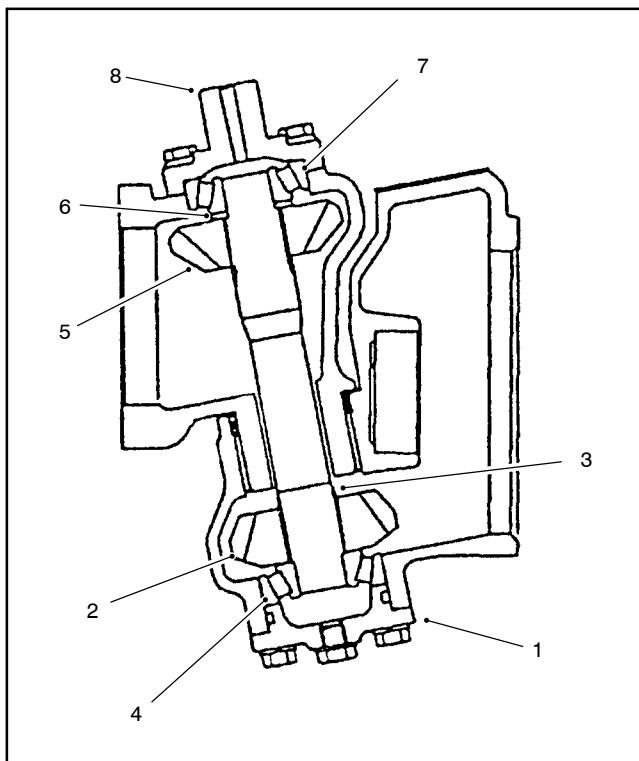


Figure 17

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

5. Determine necessary quantity of support shims.

A. Lubricate the axle case support bushing with a thin coat of grease and slide axle case support onto knuckle pin.

B. Position support shims that were removed during disassembly between axle case support and axle case. Install mounting screws into axle case. Slowly tighten screws while frequently checking for clearance (vertical endplay) between axle case support and knuckle pin. If binding of components is noted before screws are fully tightened, add additional support shims. Torque screws from 57 to 67 ft-lb (77 to 91 N-m).

C. Use dial indicator to measure vertical endplay of axle case (Fig. 18).

AXLE CASE ASSEMBLY ENDPLAY:

0.001 to 0.008 in. (0.02 to 0.20 mm)

D. Adjust endplay by increasing or reducing number of axle case support shims.

NOTE: Axle case support shims are available in 0.004 in. (0.1 mm), 0.008 in. (0.2 mm), and 0.016 in. (0.4 mm) thickness.

6. After correct support shims have been determined, remove mounting screws, apply heavy strength thread-locking compound to screw threads, reinstall screws, and torque from 57 to 67 ft-lb (77 to 91 N-m).

IMPORTANT: Correct engagement between bevel gears is critical to axle performance and durability.

7. Temporarily install the bevel gear case/axle case assembly on the axle support. Position a dial indicator at the teeths center. Prevent the axle from turning and measure the upper bevel gear to differential shaft gear backlash (Fig. 19).

UPPER BEVEL GEAR BACKLASH:

0.004 to 0.016 in. (0.10 to 0.40 mm)

8. Adjust backlash by increasing or reducing axle bearing shim thickness (see Differential Shafts in this section of this manual).

NOTE: Axle bearing shims are available in 0.004 in. (0.1 mm), 0.008 in. (0.2 mm), and 0.020 in. (0.5 mm) thickness.

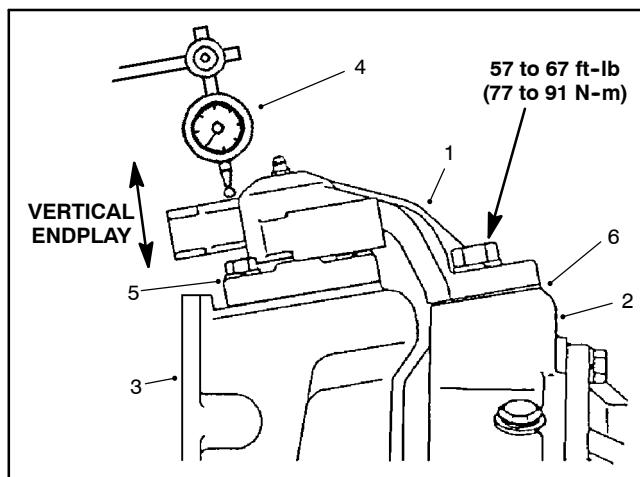


Figure 18

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

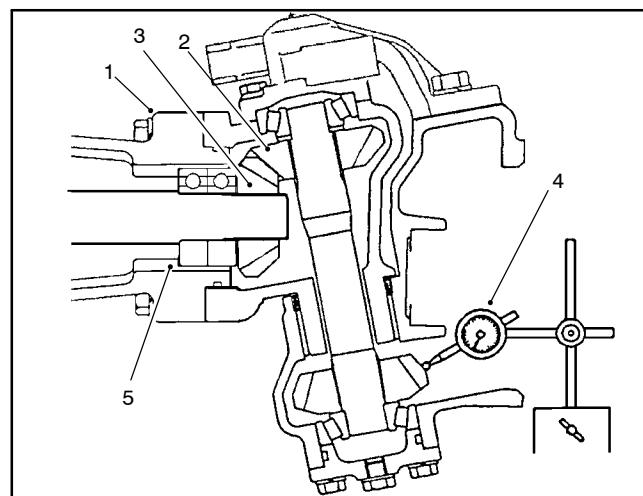


Figure 19

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

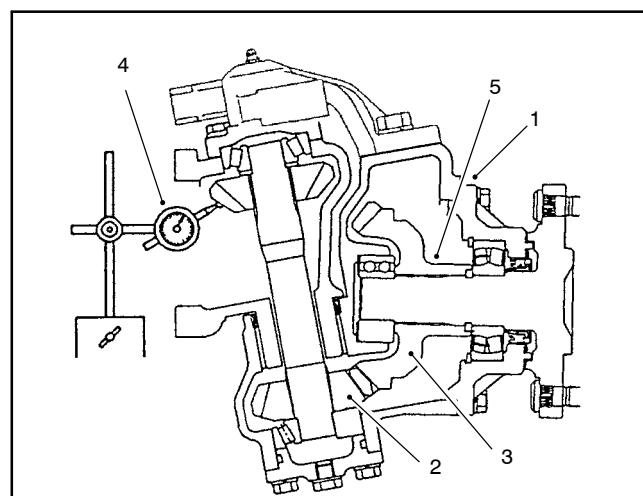


Figure 20

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

9. Remove the bevel gear case/axle case assembly from the axle support. Coat a new O-ring with grease and temporarily install the axle cover assembly. Position a dial indicator at the teeths center. Prevent the axle from turning and measure the lower bevel gear to axle gear backlash (Fig. 20).

LOWER BEVEL GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

10. Adjust backlash by increasing or reducing axle bearing shim thickness (see Axle Shafts in this section of this manual).

Differential Shafts

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

IMPORTANT: Do not interchange right and left differential shaft assemblies.

1. Remove the mounting screws, nuts, and lock washers. Remove the bevel gear case/axle case assembly and O-ring from the axle support (Fig. 21).
2. Mark and pull the differential shaft assembly from the axle support.
3. Remove the retaining ring and bevel gear (Fig 22).
4. Drive the differential shaft out of the bearings. Remove the bearings and bearing shims.
5. Inspect all gears, shafts, bearings, and cases for damage and wear. Replace components as necessary.

Installation

1. Press bearings onto differential shaft. Place correct combination of bearing shims in axle support and drive differential shaft and bearing assembly into axle support.
2. Install bevel gear and retaining ring.
3. Coat new O-ring with grease. Align differential shaft splines with differential gear assembly and slide differential shaft assembly onto axle support.
4. Install bevel gear case/axle case assembly (see Bevel Gear Case/Axle Case Assembly in this section of this manual).

NOTE: Axle bearing shims are available in 0.008 in. (0.2 mm), 0.012 in. (0.3 mm), and 0.020 in. (0.5 mm) thickness.

11. Tighten axle cover screws from 17 to 20 ft-lb (23 to 27 N-m).

12. Coat a new O-ring with grease and install the bevel gear case/axle case assembly on the axle support. Tighten mounting screws and nuts from 35 to 41 ft-lb (47 to 56 N-m) (Fig. 11).

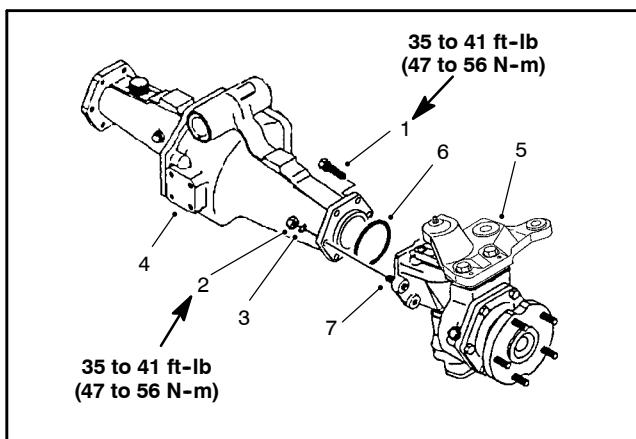


Figure 21

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

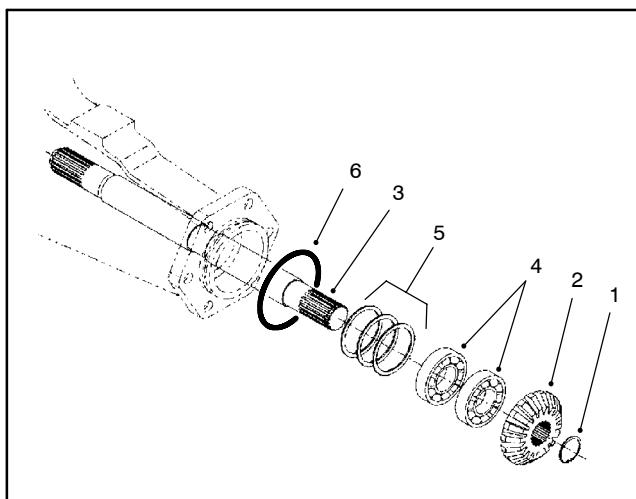


Figure 22

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

Axle Shafts

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly (Fig. 23).
 2. Use a bearing puller to remove the bearing and bevel gear as shown (Fig. 24).
 3. Remove the shims, spacer, and retaining ring. Drive the axle out of the bearing and cover. Remove and discard the axle shaft seal.
 4. Inspect all gears, shafts, bearings, spacers, and cases for damage and wear. Replace components as necessary.

Installation

1. Coat new axle shaft seal with grease and install in axle cover as shown (Fig. 25).
 2. Press the axle cover and bearing assembly onto the axle shaft. Press only on the inner race of the cover bearing (Fig. 25).
 3. Install retaining ring, spacer, and correct combination of bearing shims. Install bevel gear and bearing.
 4. Coat a new O-ring with grease and install the axle cover assembly. Tighten axle cover screws from 17 to 20 ft-lb (23 to 27 N-m).

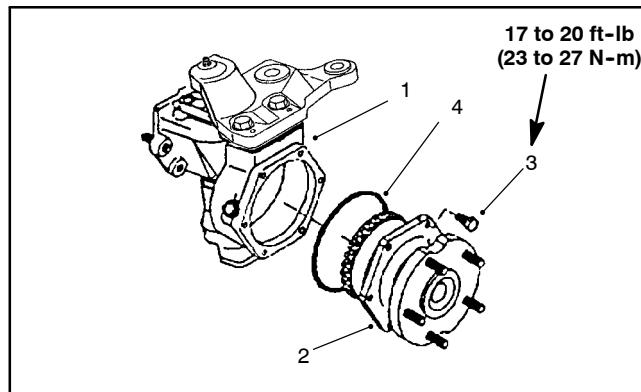


Figure 23

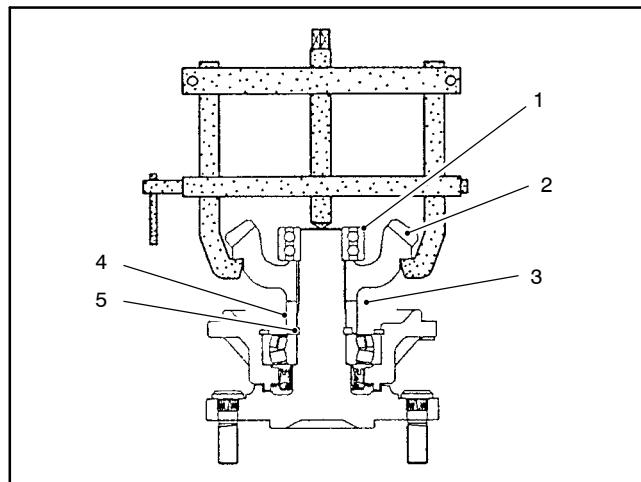


Figure 24

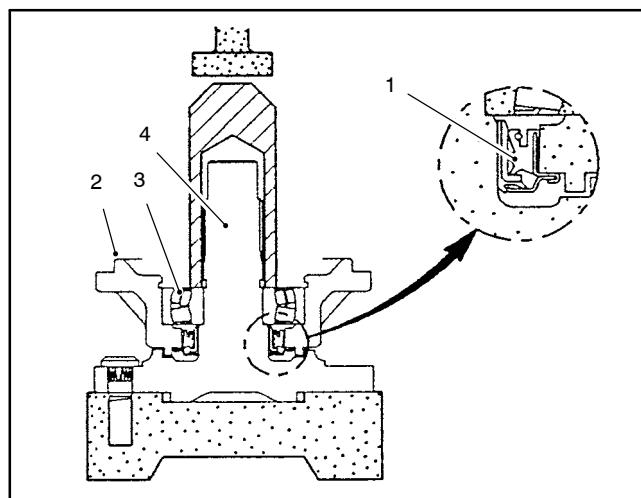


Figure 25

Input Shaft/Pinion Gear

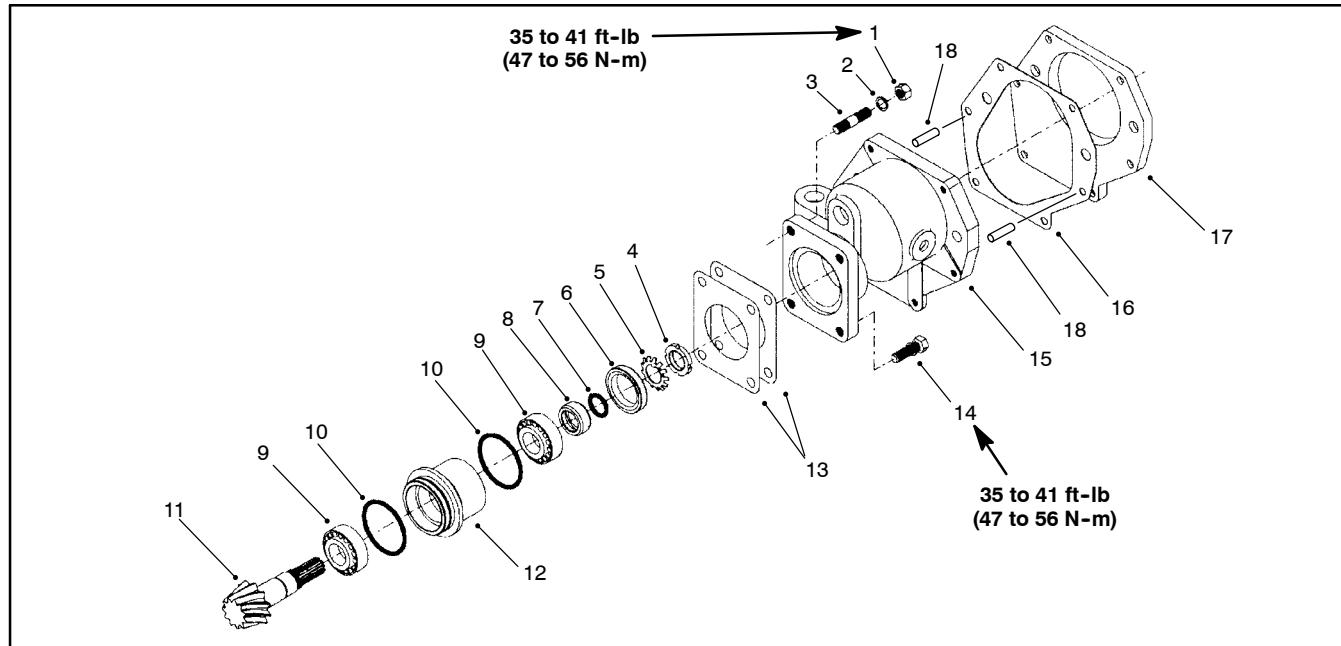


Figure 26

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

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove the cover plate, gasket, and gear case assembly from the axle assembly. Remove the gasket and any remaining gasket material.
2. Remove the retaining rings and the driven gear from the input shaft/pinion gear.
3. Remove input shaft/pinion gear assembly from the gear case. Remove the shims and bearing case O-rings.
4. Release the stake washer and remove the locknut. Remove and discard the stake washer.
5. Drive the input shaft/pinion gear out from the outer bearing cone and bearing case. Remove and discard the oil seal and O-ring.
6. Inspect all gears, shafts, bearings, spacers, and cases for damage and wear. Replace components as necessary.

NOTE: Replacement input shaft/pinion gear (11) is only available in matched set with differential ring gear.

Installation

NOTE: When installing bearing cones onto the input shaft/pinion gear, press only on the inner race of the bearing cone.

1. If the inner bearing cone was removed, press a new bearing cone all the way onto the input shaft/pinion gear.
2. Place the shaft and bearing assembly in the bearing case and install the outer bearing cone.
3. Coat a new oil seal with grease and install as shown (Fig. 27). The seal should be installed with the garter spring towards the hydraulic motor.
4. Coat new O-ring with grease. Install O-ring in the oil seal collar, and install the collar.
5. Install a new stake washer. Install the lock nut finger tight.

6. Set the bearing preload by securing the bearing case in a vise. Thread a M12 x 1.5 hex head cap screw into the splined end of the input shaft/pinion gear and slowly tighten the locknut until 4 to 6 in-lb (0.4 to 0.7 N-m) of force is required to rotate the input shaft/pinion gear in the bearing case.

7. Secure the lock nut with the stake washer.

8. Use a depth gauge to measure the distance from the end face of the input shaft/pinion gear to the mating surface of the bearing case. Subtract the "Design Cone Center Distance" from this distance to determine initial shim thickness (Fig. 28).

DESIGN CONE CENTER DISTANCE

(distance from mating surface of axle support to end face of pinion gear):

1.870 ± 0.002 in. (47.5 ± 0.05 mm)

NOTE: Bearing case shims are available in 0.004 in. (0.1 mm) and 0.008 in. (0.2 mm) thickness.

9. Coat new O-rings with grease and install the bearing case in the gear case. Place shims on the gear case and temporarily install gear case assembly into axle case. Tighten mounting nuts and screws from 35 to 41 ft-lb (47 to 56 N-m).

10. Insert a screwdriver through the drain plug hole to hold ring gear and measure the pinion gear to ring gear backlash (Fig. 29).

PINION GEAR TO RING GEAR BACKLASH:

0.004 to 0.016 in. (0.10 to 0.40 mm)

11. Adjust backlash by increasing or reducing gear case shim thickness.

12. Check pinion gear to ring gear engagement (see Pinion Gear to Ring Gear Engagement in this section of this manual).

13. Place the correct combination of shims on the gear case. Tighten mounting nuts and screws from 35 to 41 ft-lb (47 to 56 N-m).

14. Install retaining rings and driven gear on input shaft/pinion gear.

15. If the drive gear (on drive motor shaft) was removed, install the retaining rings and drive gear on the motor shaft.

16. Use a new gasket and install the cover plate. Use a new O-ring and install the drive motor.

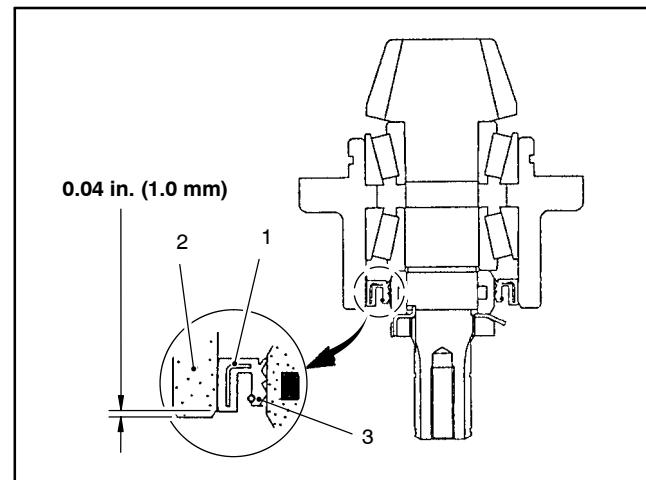


Figure 27
 1. Oil seal
 2. Bearing case
 3. Seal garter spring

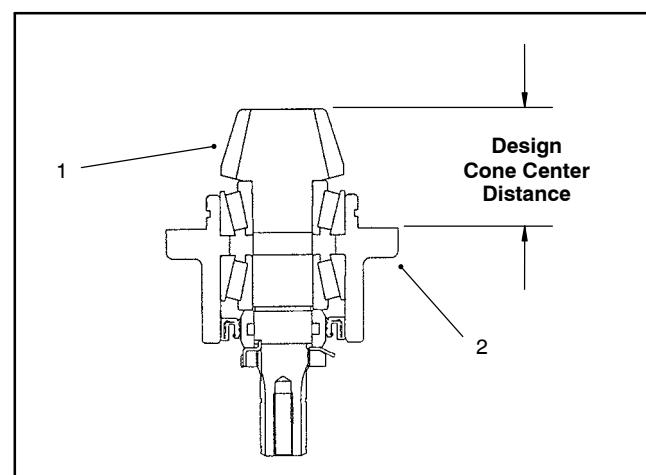


Figure 28
 1. Input shaft/pinion gear
 2. Bearing case

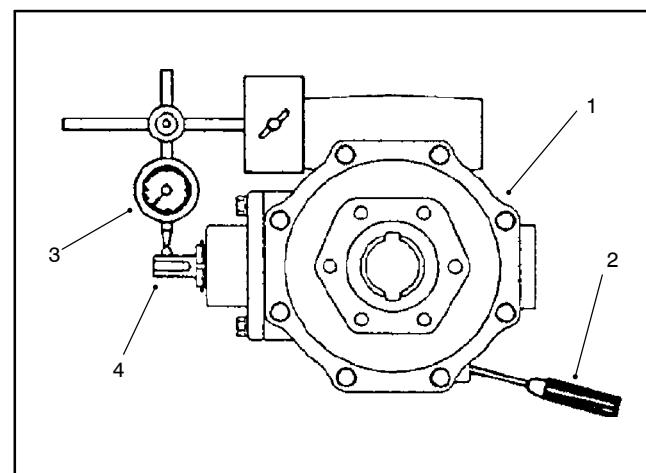


Figure 29
 1. Axle case
 2. Screwdriver
 3. Dial indicator
 4. Input shaft/pinion gear

Differential Gear

The following procedures assume the rear axle assembly has been removed from the machine.

Removal

1. Remove bevel gear case/axle case assemblies (see Bevel Gear Case/Axle Case Assembly in this section of this manual).

IMPORTANT: Do not interchange right and left differential shaft assemblies.

2. Mark and pull the differential shaft assemblies from the axle support.
3. Remove input shaft/pinion gear assembly, shims, and O-ring from the axle support (Fig. 30).
4. Remove the axle support case screws. Separate the axle support halves and remove the O-ring.
5. Remove the differential gear assembly, bearings, and adjusting shims from the axle case.
6. Drive the spring pin from the differential case with a punch and hammer. Discard the spring pin (Fig. 31).

NOTE: Mark and arrange all components so they can be reassembled in their original position.

7. Remove the differential pinion shaft, pinion gears, and pinion washers. Remove the differential side gears and side gear shims. Remove the ring gear only if it will be replaced (Fig. 32).

NOTE: Replacement ring gears are only available in matched ring and pinion sets.

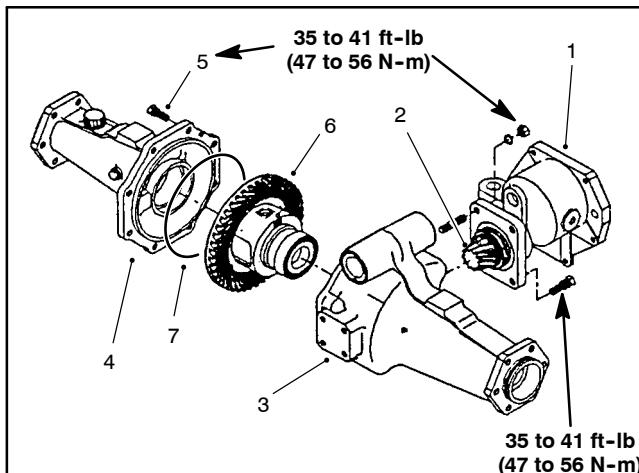


Figure 30

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

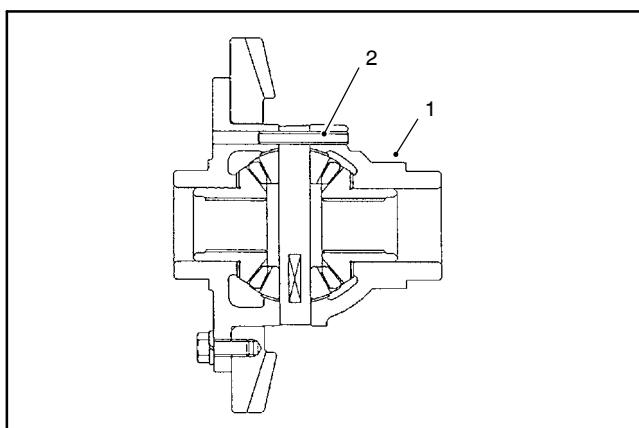


Figure 31

- | | |
|----------------------|---------------|
| 1. Differential case | 2. Spring pin |
|----------------------|---------------|

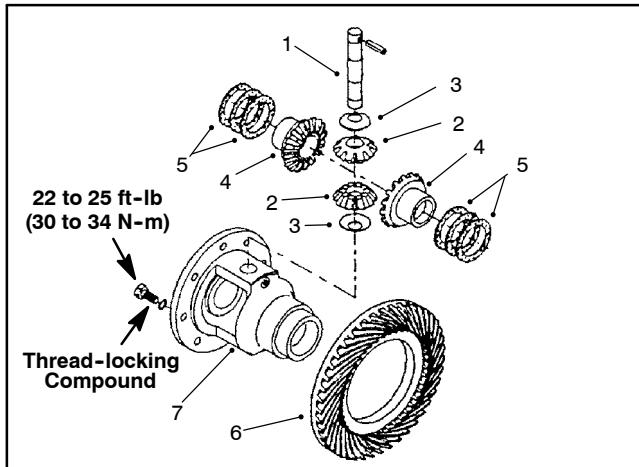


Figure 32

- | | |
|------------------------------|----------------------|
| 1. Differential pinion shaft | 5. Side gear shims |
| 2. Pinion gear | 6. Ring gear |
| 3. Pinion washer | 7. Differential case |
| 4. Side gear | |

Inspection

1. Measure the differential side gear O.D. and the differential case I.D. to determine the side gear to case clearance (Fig. 33). Replace components as necessary.

SIDE GEAR TO CASE CLEARANCE:

0.002 to 0.012 in. (0.05 to 0.30 mm)

SIDE GEAR O.D. (Factory Spec.):

1.335 to 1.337 in. (33.91 to 33.95 mm)

DIFFERENTIAL CASE I.D. (Factory Spec.):

1.339 to 1.341 in. (34.00 to 34.06 mm)

2. Measure the differential pinion shaft O.D. and the pinion gear I.D. to determine the pinion shaft to pinion gear clearance (Fig. 34). Replace components as necessary.

PINION SHAFT TO PINION GEAR CLEARANCE:

0.001 to 0.010 in. (0.03 to 0.25 mm)

PINION SHAFT O.D. (Factory Spec.):

0.550 to 0.551 in. (13.97 to 13.10 mm)

PINION GEAR I.D. (Factory Spec.):

0.551 to 0.552 in. (13.10 to 14.02 mm)

3. Inspect all gears, shafts, bearings, cases, and covers for damage and wear. Replace components as necessary.

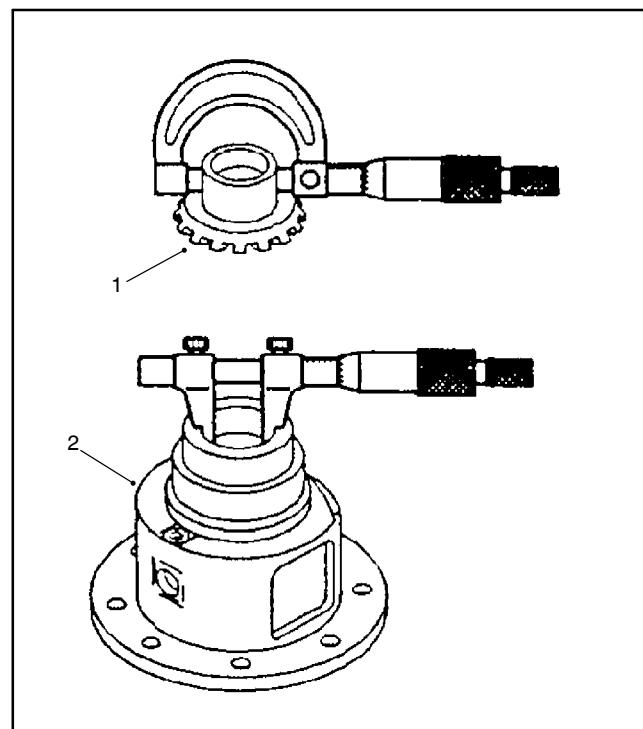


Figure 33

1. Side gear

2. Differential case

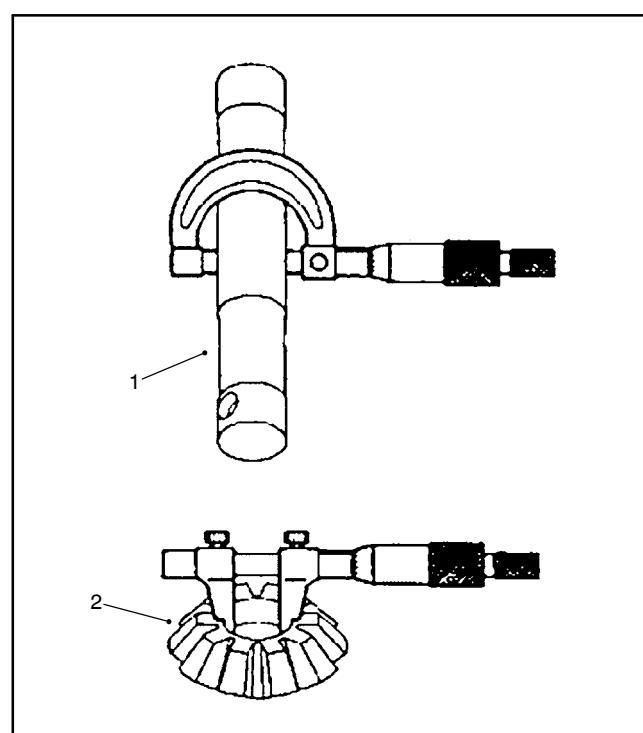


Figure 34

1. Pinion shaft

2. Pinion gear

Installation

1. If the ring gear was removed from the differential case, use medium strength Loctite thread locker and tighten the mounting screws from 22 to 25 ft-lb (30 to 34 N-m).
2. Apply molybdenum disulfide lubricant (Three Bond 1901 or equivalent) to the splines and bearing surfaces of the differential pinion gears, pinion washers and side gears.
3. Install the side gear shims and side gears in their original location in the differential case.
4. Place the differential pinion gears and pinion washers in their original location in the differential case. Temporarily install the differential pinion shaft.
5. Secure the differential case in a soft jawed vise. Position a dial indicator on a tooth of the differential pinion gear. Press the pinion and side gear against the differential case and measure the pinion gear to side gear backlash (Fig. 35).

PINION GEAR TO SIDE GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

6. Adjust backlash by increasing or reducing side gear shim thickness.

NOTE: Side gear shims are available in 0.043 in. (1.10 mm), 0.047 in. (1.20 mm) and 0.051 in. (1.30 mm) thickness.

7. Apply gear marking compound, such as DyKem® Steel Blue lightly over several gear teeth.
8. While applying a light load to either side gear, rotate either pinion gear until the side gears have made one complete revolution.
9. Ideal tooth contact should cover more than 35% of each tooth surface. The contact area should be in the center of each tooth and extend 1/3 to 1/2 way across each tooth from the toe (small) end (Fig. 36).
10. Adjust side gear shims if necessary to correct tooth contact. Recheck differential pinion gear to side gear backlash if any changes are made.
11. After backlash and tooth contact have been adjusted, align the hole in the differential pinion shaft with the hole in the differential case and install a new spring pin.

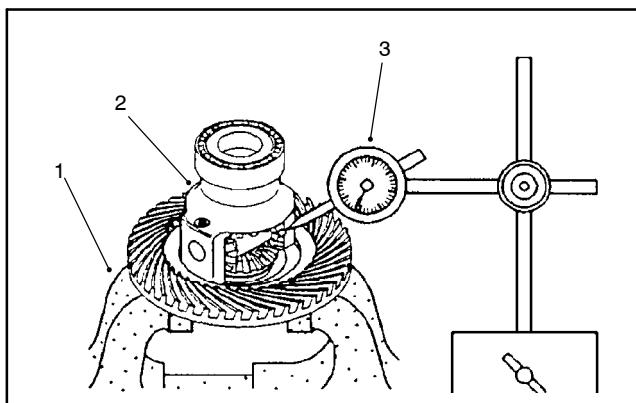


Figure 35

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

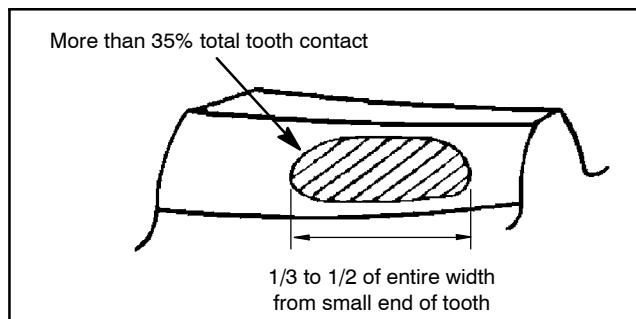


Figure 36

12. Install differential gear assembly in right side axle support half.
13. Coat a new o-ring with grease and install left side axle support half. Tighten axle support case screws from 35 to 41 ft-lb (47 to 56 N-m).
14. Install input shaft/pinion gear assembly (see Input Shaft/Pinion Gear in this section of this manual).
15. Coat new o-rings with grease, align differential shaft splines with differential gear assembly and slide differential shaft assemblies onto axle support.
16. Install bevel gear case/axle case assemblies (see Bevel Gear Case/Axle Case Assembly in this section of this manual).

Pinion Gear to Ring Gear Engagement

The final position of the pinion gear is verified by using the gear contact pattern method as described in the following procedure.

GEAR TOOTH DEFINITIONS (Fig. 37):

Toe – the portion of the tooth surface at the end towards the center.

Heel – the portion of the gear tooth at the outer end.

Top Land – top surface of tooth.

1. Paint the teeth of the ring gear, both drive and coast side, with a gear marking compound, such as DyKem® Steel Blue.

2. Install the input shaft/pinion gear assembly into axle case.

3. While applying a light load to the ring gear, rotate the pinion gear in the direction of forward travel until the ring gear has made one complete revolution.

Ideal tooth contact observed on the ring gear should cover more than 35% of each tooth surface. The contact area should be in the center of each tooth and extend 1/3 to 1/2 way across each tooth from the toe end (Fig. 38).

Adjustments to the gear contact position are made by moving the input shaft/pinion gear (bearing case shims) or by moving the differential gear case (differential bearing shims) (Fig. 39).

NOTE: Bearing case shims are available in 0.004 in. (0.10 mm) and 0.008 in. (0.20 mm) thickness.

NOTE: Differential bearing shims are available in 0.004 in. (0.10 mm), 0.008 in. (0.20 mm) and 0.016 in. (0.40 mm) thickness.

Study the different contact patterns (Figs. 40 and 41) and correct gear engagement as necessary.

NOTE: When making changes, note that two variables are involved (see Gear Pattern Movement Summary in this section of this manual).

Example: If the pinion gear to ring gear backlash is set correctly to specifications and the bearing case shim is changed to adjust tooth contact, it may be necessary to readjust backlash to the correct specification before checking the contact pattern.

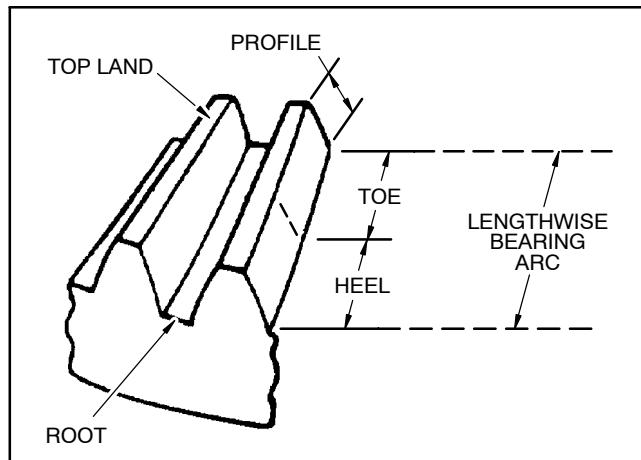


Figure 37

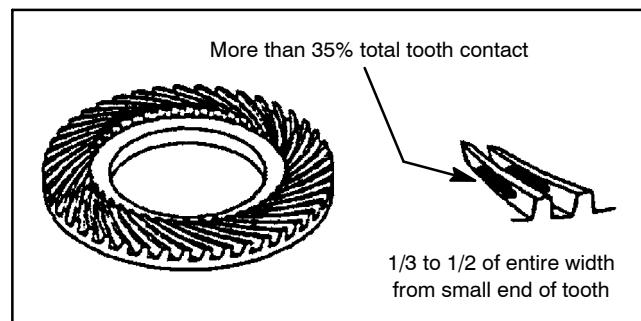


Figure 38

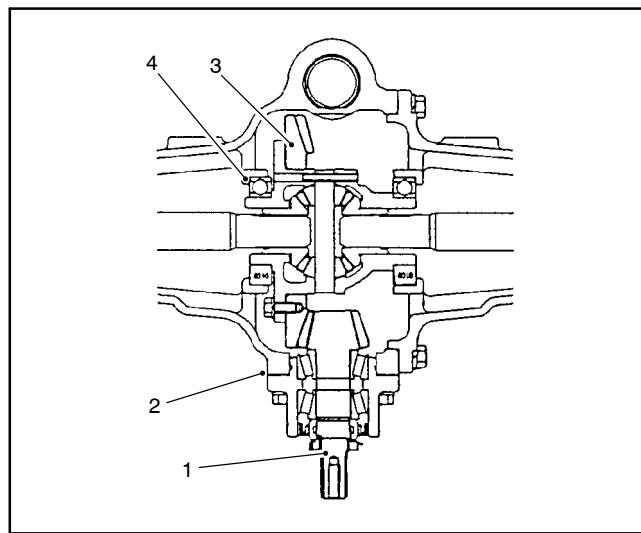


Figure 39
1. Input shaft/pinion gear 4. Differential bearing shims
2. Bearing case shims 3. Differential gear case

Gear Pattern Movement Summary

Every gear has a characteristic pattern. The illustrations show typical patterns only and explain how patterns shift as gear location is changed.

1. If contact is toward the heel or base of the gear (Fig. 40):

- A. Install thicker or additional bearing case shim(s) to move pinion shaft toward ring gear.
- B. Install thinner or remove differential bearing shim(s) to move ring gear backward.
- C. Repeat until proper tooth contact and pinion gear to ring gear backlash are correct.

2. If contact is toward the toe or tip of the gear (Fig. 41):

- A. Install thinner or remove bearing case shim(s) to move pinion shaft away from ring gear.
- B. Install thicker or additional differential bearing shim(s) to move ring gear forward.
- C. Repeat until proper tooth contact and pinion gear to ring gear backlash are correct.

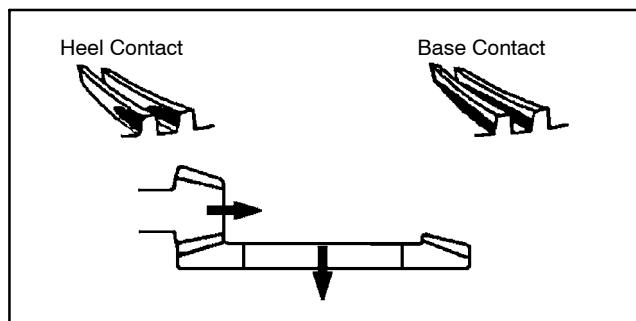


Figure 40

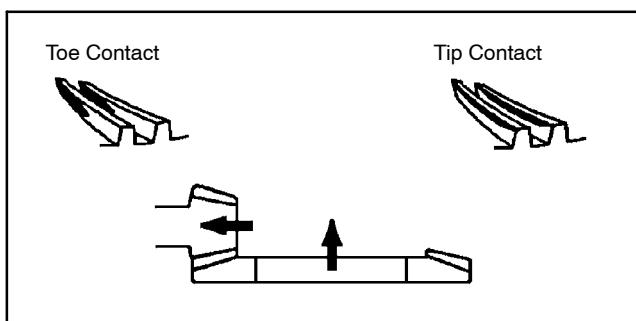


Figure 41

Table of Contents

GENERAL INFORMATION	1
Cutting Deck Identification	1
SERVICE AND REPAIRS	2
Steering Tower	2
Lift Arms For Cutting Decks #1, #4, and #5	4
Lift Arms For Cutting Decks #2 and #3	6
Lift Arms For Cutting Decks #6 and #7 (Groundsmaster 4700-D only)	8
Hood	10

General Information

Cutting Deck Identification

Cutting decks on the Groundsmaster 4500-D and 4700-D are identified as shown in Figure 1.

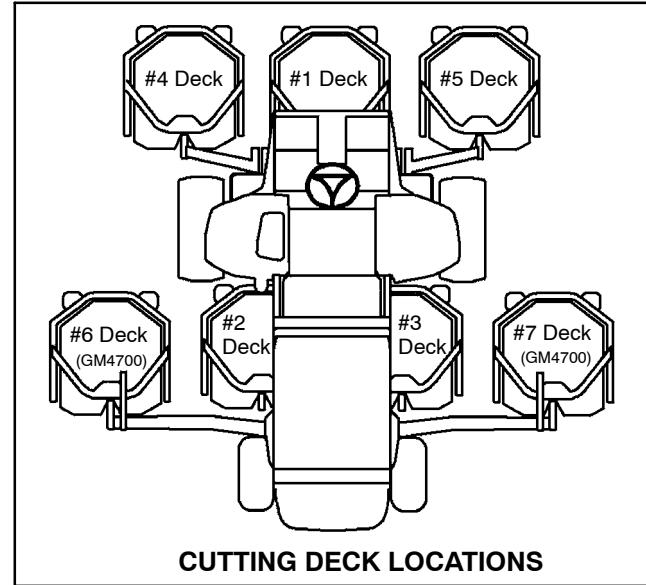


Figure 1

Service and Repairs

Steering Tower

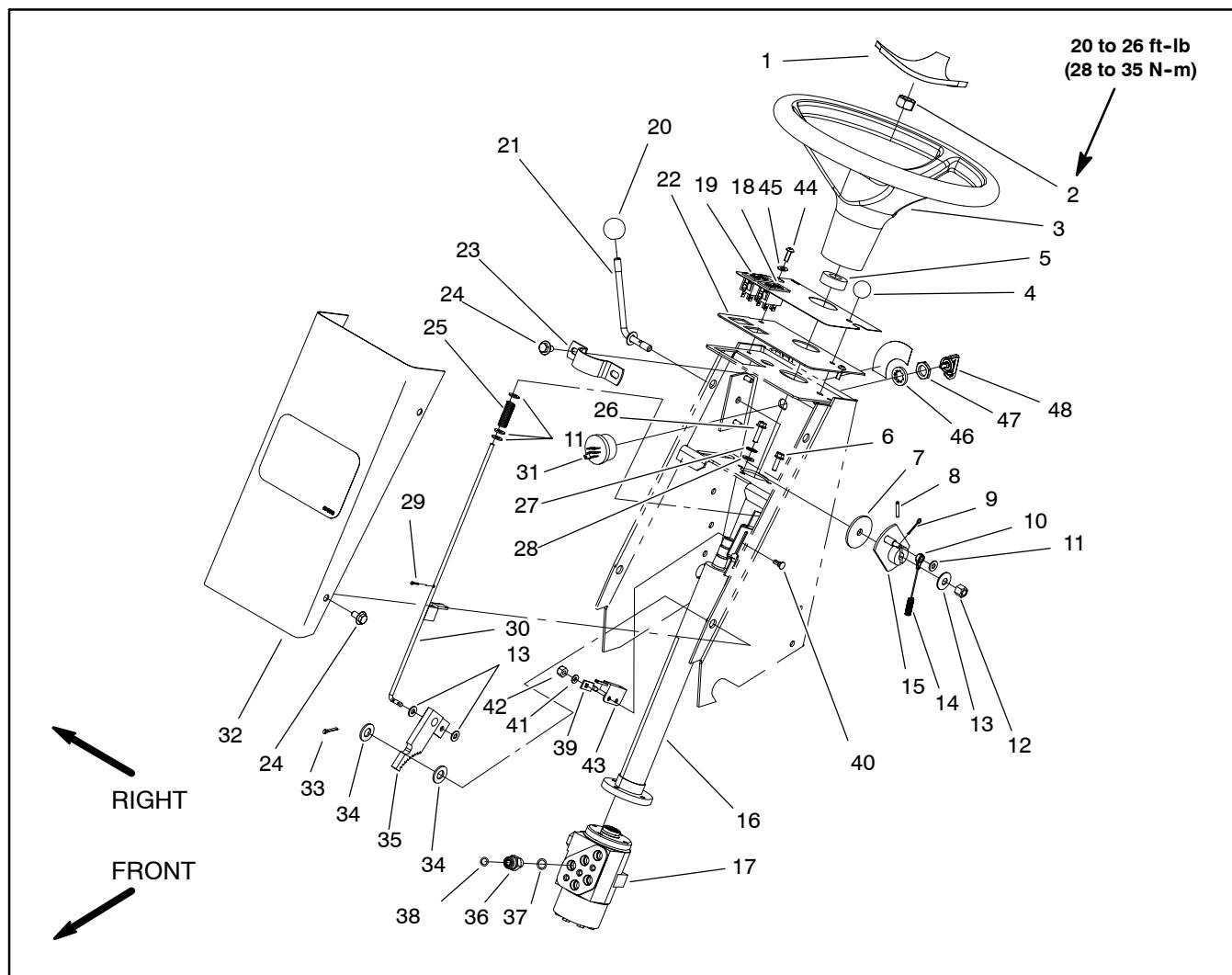


Figure 2

- | | | |
|-------------------------|--|------------------------------------|
| 1. Steering wheel cover | 17. Steering valve | 33. Cotter pin |
| 2. Hex nut | 18. Warning lamp (temp/glow plug) | 34. Flat washer |
| 3. Steering wheel | 19. Warning lamp (oil pressure/charge) | 35. Parking brake rack |
| 4. Parking brake knob | 20. Speed control knob | 36. Hydraulic fitting |
| 5. Dust cover | 21. Speed control lever | 37. O-ring |
| 6. Flange head screw | 22. Instrument plate | 38. O-ring |
| 7. Friction disc | 23. Steering column bracket | 39. Switch plate |
| 8. Spring pin | 24. Flange head screw | 40. Carriage bolt |
| 9. Cotter pin | 25. Compression spring | 41. Flat washer |
| 10. Cable | 26. Flange head screw | 42. Lock nut |
| 11. Flat washer | 27. Lock washer | 43. Parking brake proximity switch |
| 12. Lock nut | 28. Flat washer | 44. Screw |
| 13. Spring washer | 29. Cotter pin | 45. Flat washer |
| 14. Tube | 30. Parking brake rod | 46. Lock washer |
| 15. Lever bracket | 31. Ignition switch | 47. Nut |
| 16. Steering column | 32. Tower cover | 48. Ignition key |

Disassembly

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Disassemble steering tower as needed using Figure 2 as a guide.

Assembly

1. Assemble steering tower using Figure 2 as a guide.

Chassis

Lift Arms for Cutting Decks #1, #4, and #5

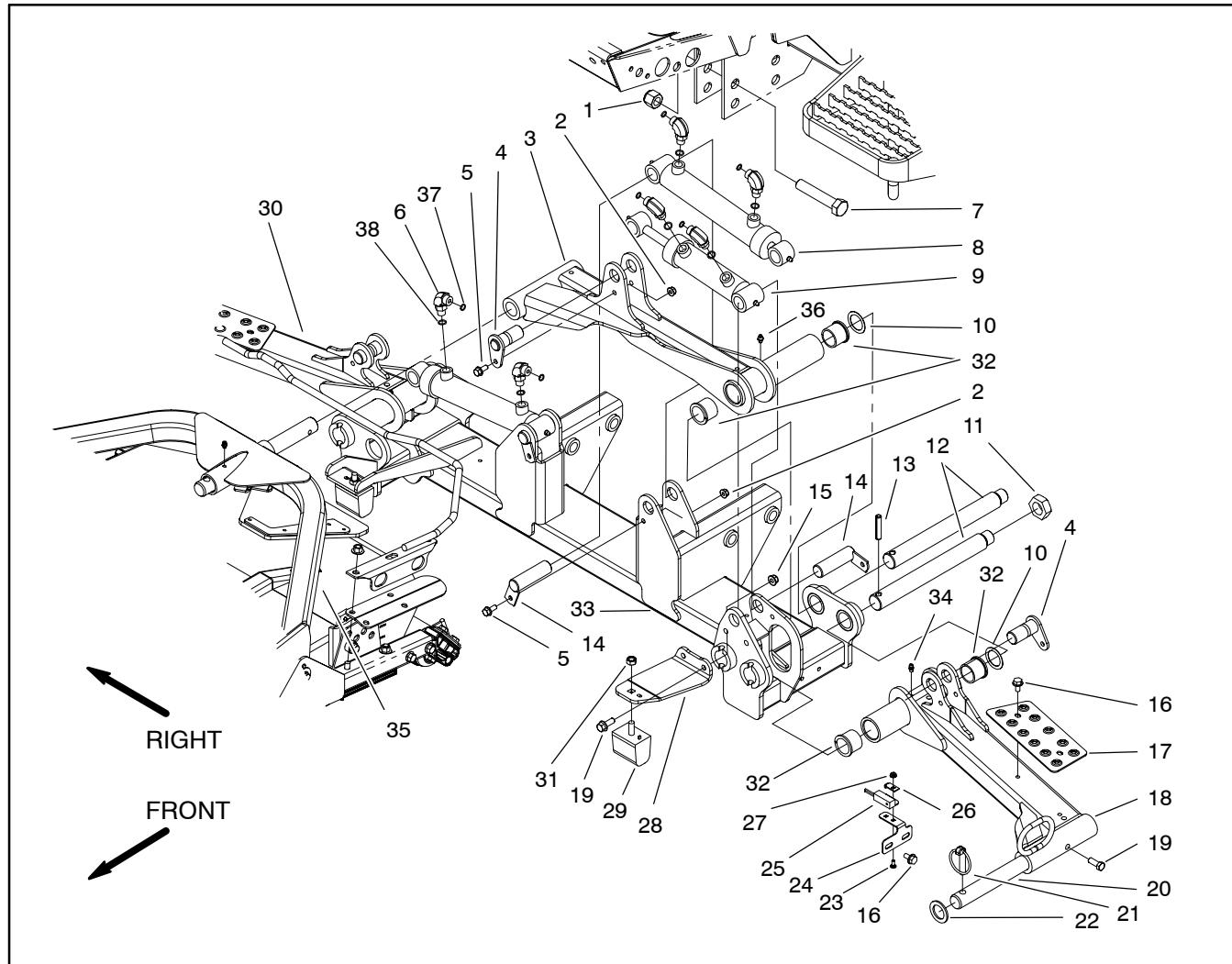


Figure 3

- | | | |
|------------------------------------|----------------------------|----------------------------|
| 1. Lock nut | 14. Lift cylinder pin | 27. Lock nut |
| 2. Flange nut | 15. Flange nut | 28. Bumper support bracket |
| 3. Lift arm (#1 deck) | 16. Washer head screw | 29. Bumper |
| 4. Lift cylinder pin | 17. Skid plate | 30. Lift arm (#5 deck) |
| 5. Flange head screw | 18. Lift arm (#4 deck) | 31. Lock nut |
| 6. Hydraulic fitting | 19. Cap screw | 32. Flange bushing |
| 7. Cap screw | 20. Carrier frame shaft | 33. Front carrier frame |
| 8. Lift cylinder (#4 and #5 decks) | 21. Lynch pin | 34. Grease fitting |
| 9. Lift cylinder (#1 deck) | 22. Thrust washer | 35. Deck carrier frame |
| 10. Thrust washer | 23. Carriage bolt | 36. Grease fitting |
| 11. Lock nut | 24. Switch bracket | 37. O-ring |
| 12. Pivot pin | 25. Proximity switch | 38. O-ring |
| 13. Slotted roll pin | 26. Proximity switch plate | |

Removal

- Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
- Remove cutting deck from lift arm (see Cutting Unit Operator's Manual).

3. If lift arm for either deck #4 or #5 (Fig. 4) is to be removed, tag and remove hydraulic hoses from the deck motor (Fig. 5). Slide hoses out of the hose retaining loop on the lift arm.

- Remove lift cylinder pin that secures lift cylinder to lift arm.
- Loosen and remove lock nut from lift arm pivot pin.

6. Support lift arm and pull lift arm pivot pin from lift arm and frame. Locate and remove thrust washer from rear of lift arm during pivot pin removal.

7. Remove lift arm from machine.

8. Clean lift arm and pivot pin. Inspect lift arm flange bushings and pivot pin for damage or wear.

Installation

1. Position lift arm to frame (Fig. 3). Fit thrust washer between rear of lift arm and frame. Slide pivot pin into frame and lift arm. Align roll pin in pivot pin with slot in frame flange.

2. Install and tighten lock nut to secure lift arm pivot pin.

3. Install lift cylinder to lift arm with cylinder pin. Secure cylinder pin to lift arm with flange head screw and flange nut.

NOTE: Install thrust washer on deck pivot shaft before installing cutting deck on pivot shaft.

4. Position and install cutting deck to lift arm (see Cutting Unit Operator's Manual).

5. If lift arm for either deck #4 or #5 was removed, slide hydraulic hoses through the hose retaining loop on the lift arm and install hoses to the deck motor (Fig. 5). Make sure that deck is lowered to the ground before tightening hoses.

6. Lubricate lift arm and lift cylinder grease fittings after assembly is complete (see Traction Unit Operator's Manual).

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

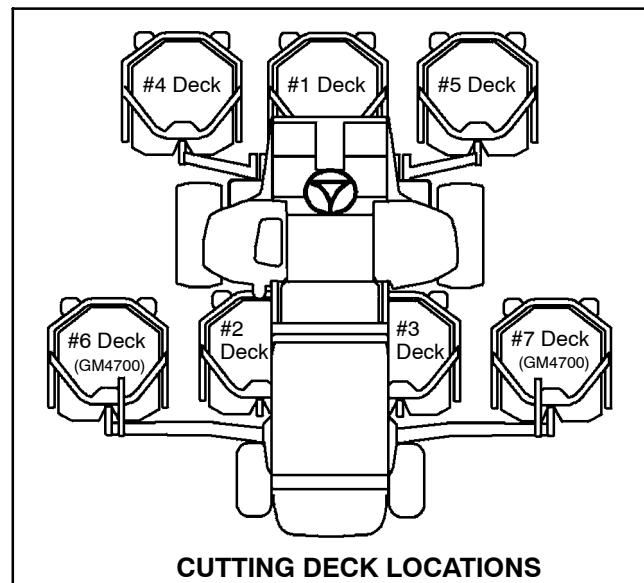


Figure 4

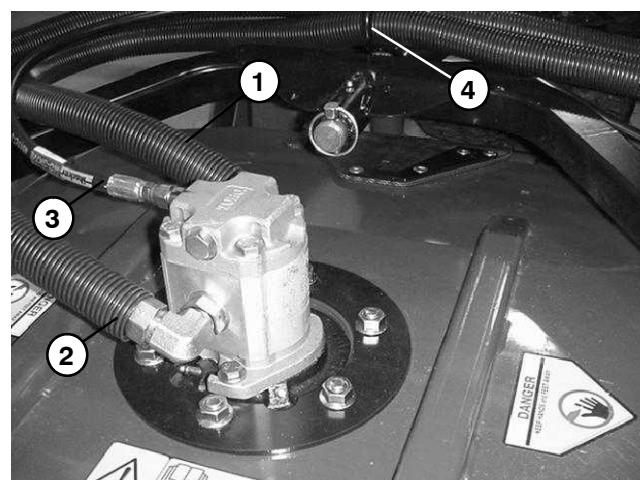


Figure 5

- | | |
|------------------------|------------------------|
| 1. Pressure "in" hose | 3. Case drain hose |
| 2. Pressure "out" hose | 4. Hose retaining loop |

Lift Arms for Cutting Decks #2 and #3

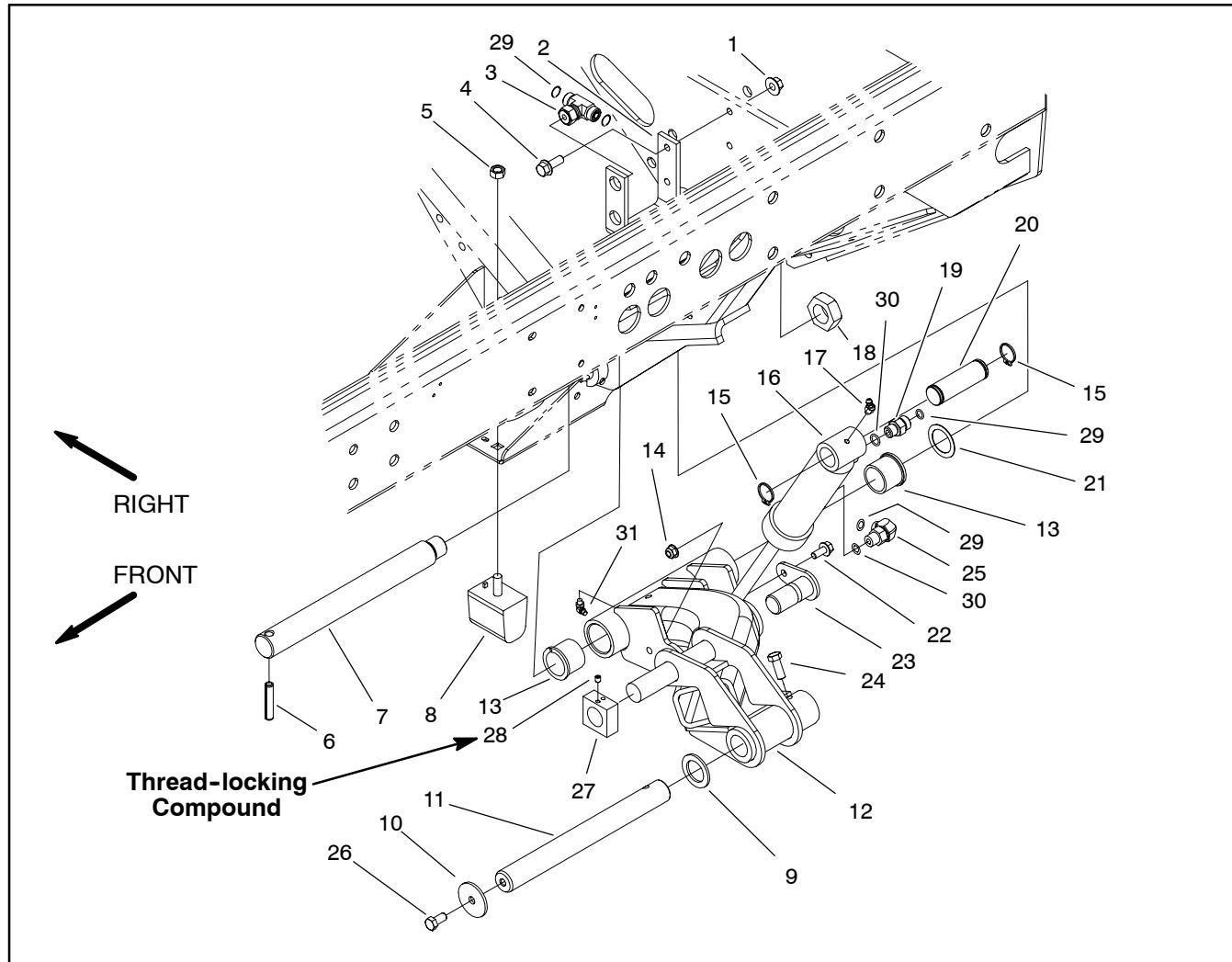


Figure 6

- | | | |
|------------------------|------------------------------|----------------------------|
| 1. Flange nut | 12. Lift arm (#2 deck shown) | 22. Flange head screw |
| 2. Bulkhead bracket | 13. Flange bushing | 23. Lift cylinder pin |
| 3. Hydraulic t-fitting | 14. Flange nut | 24. Cap screw |
| 4. Flange head screw | 15. Retaining ring | 25. Hydraulic fitting |
| 5. Lock nut | 16. Lift cylinder | 26. Cap screw |
| 6. Slotted roll pin | 17. Grease fitting | 27. Lift arm rotation stop |
| 7. Pivot pin | 18. Lock nut | 28. Set screw |
| 8. Bumper | 19. Hydraulic fitting | 29. O-ring |
| 9. Thrust washer | 20. Lift cylinder pin | 30. O-ring |
| 10. Rebound washer | 21. Thrust washer | 31. Grease fitting |
| 11. Deck pivot shaft | | |

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 cutting deck from lift arm (see Cutting Unit Operator's Manual).
3. Remove lift cylinder pin that secures lift cylinder to lift arm.
4. Loosen and remove lock nut from pivot pin.
5. Support lift arm and pull lift arm pivot pin from lift arm and frame. Locate and remove thrust washer from rear of lift arm during pivot pin removal.
6. Remove lift arm from machine.
7. Clean lift arm and pivot pin. Inspect lift arm flange bushings and pivot pin for damage or wear.

Installation

1. Position lift arm to frame (Fig. 6). Fit thrust washer between rear of lift arm and frame. Slide pivot pin into frame and lift arm. Align roll pin in pivot pin with slot in frame flange.
 2. Install and tighten lock nut to secure lift arm pivot pin.
 3. Install lift cylinder to lift arm with cylinder pin. Secure cylinder pin to lift arm with flange head screw and flange nut.
- NOTE:** Install thrust washer on deck pivot shaft before installing cutting deck on pivot shaft.
4. Position and install cutting deck to lift arm (see Cutting Unit Operator's Manual).

NOTE: The lift arms for cutting decks #2 and #3 are fitted with a lift arm rotation stop block (27). This stop is to keep the deck stable while raised. To adjust rotation stop, loosen set screws and fully raise cutting deck to position the stop. Apply medium strength thread-locking compound (e.g. Loctite blue) to set screws and retighten set screws to secure stop. The rotation stop should contact the lift arm across the full width of the stop.

5. Lubricate lift arm and lift cylinder grease fittings after assembly is complete (see Traction Unit Operator's Manual).
6. After assembly, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

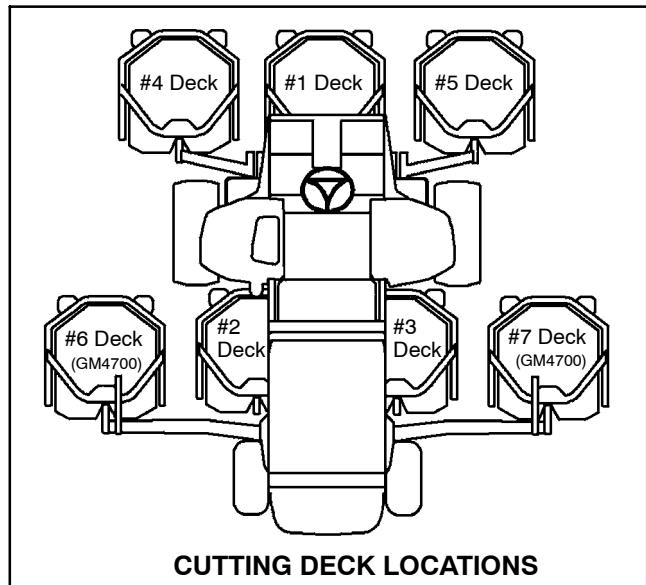


Figure 7

Lift Arms for Cutting Decks #6 and #7 (Groundsmaster 4700-D only)

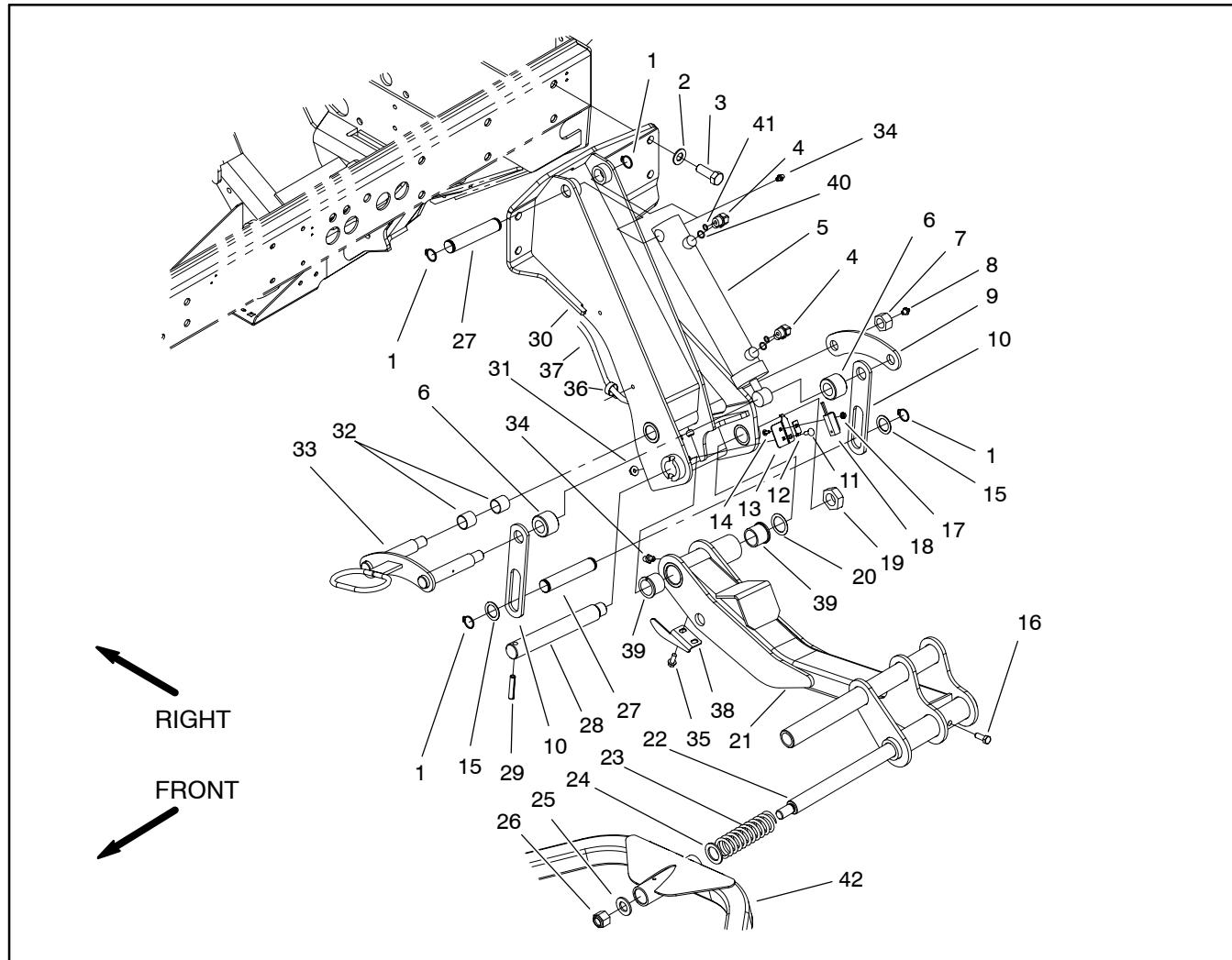


Figure 8

- | | | |
|--------------------------|------------------------------|---------------------------------|
| 1. Retaining ring | 15. Thrust washer | 29. Slotted roll pin |
| 2. Flat washer | 16. Cap screw | 30. Support arm (deck #6 shown) |
| 3. Cap screw | 17. Lock nut | 31. Flange nut |
| 4. Hydraulic fitting | 18. Proximity switch | 32. Bushing |
| 5. Lift cylinder | 19. Lock nut | 33. Link |
| 6. Plastic roller | 20. Thrust washer | 34. Grease fitting |
| 7. Lock nut | 21. Lift arm (deck #6 shown) | 35. Self tapping screw |
| 8. Grease fitting | 22. Carrier pivot pin | 36. R-clamp |
| 9. Rear link | 23. Compression spring | 37. Wire harness |
| 10. Lift link | 24. Thrust washer | 38. Switch actuator |
| 11. Carriage screw | 25. Flat washer | 39. Flange bushing |
| 12. Neutral switch plate | 26. Lock nut | 40. O-ring |
| 13. Switch bracket | 27. Pin | 41. O-ring |
| 14. Carriage bolt | 28. Pivot pin | 42. Deck carrier frame |

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 cutting deck from lift arm (see Cutting Unit Operator's Manual).
3. Remove pin that secures lift links (10) to lift arm.
4. Loosen and remove lock nut from pivot pin.
5. Support lift arm and pull lift arm pivot pin from lift arm and support arm. Locate and remove thrust washer from rear of lift arm during pivot pin removal.
6. Remove lift arm from machine.
7. Clean lift arm and pivot pin. Inspect lift arm flange bushings and pivot pin for damage or wear.

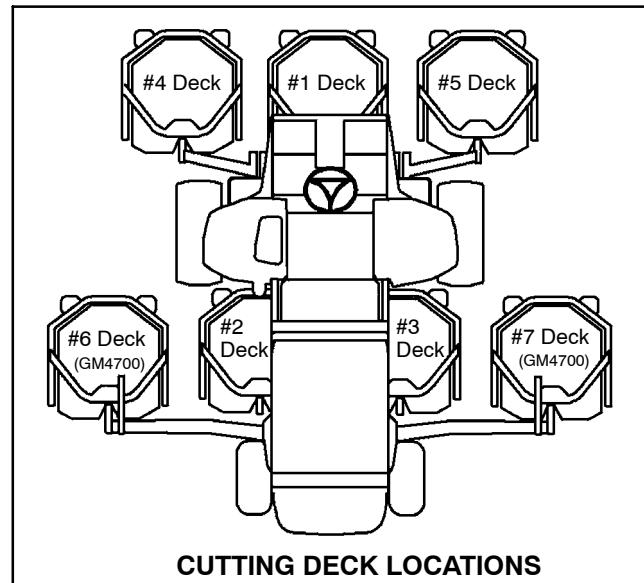


Figure 9

Installation

1. Position lift arm to support arm (Fig. 8). Fit thrust washer between rear of lift arm and support arm. Slide pivot pin into support arm and lift arm. Align roll pin in pivot pin with slot in support arm flange.
2. Install and tighten lock nut to secure lift arm pivot pin.
3. Install lift cylinder to lift arm with cylinder pin. Secure cylinder pin to lift arm with flange head screw and flange nut.

NOTE: Install compression spring and thrust washer on carrier pivot pin before installing cutting deck on pivot pin.

4. Position and install cutting deck to lift arm (see Cutting Unit Operator's Manual).
5. Lubricate lift arm and lift cylinder grease fittings after assembly is complete (see Traction Unit Operator's Manual).
6. After assembly, raise and lower the cutting deck to verify that hydraulic hoses and fittings do not contact anything.

Hood

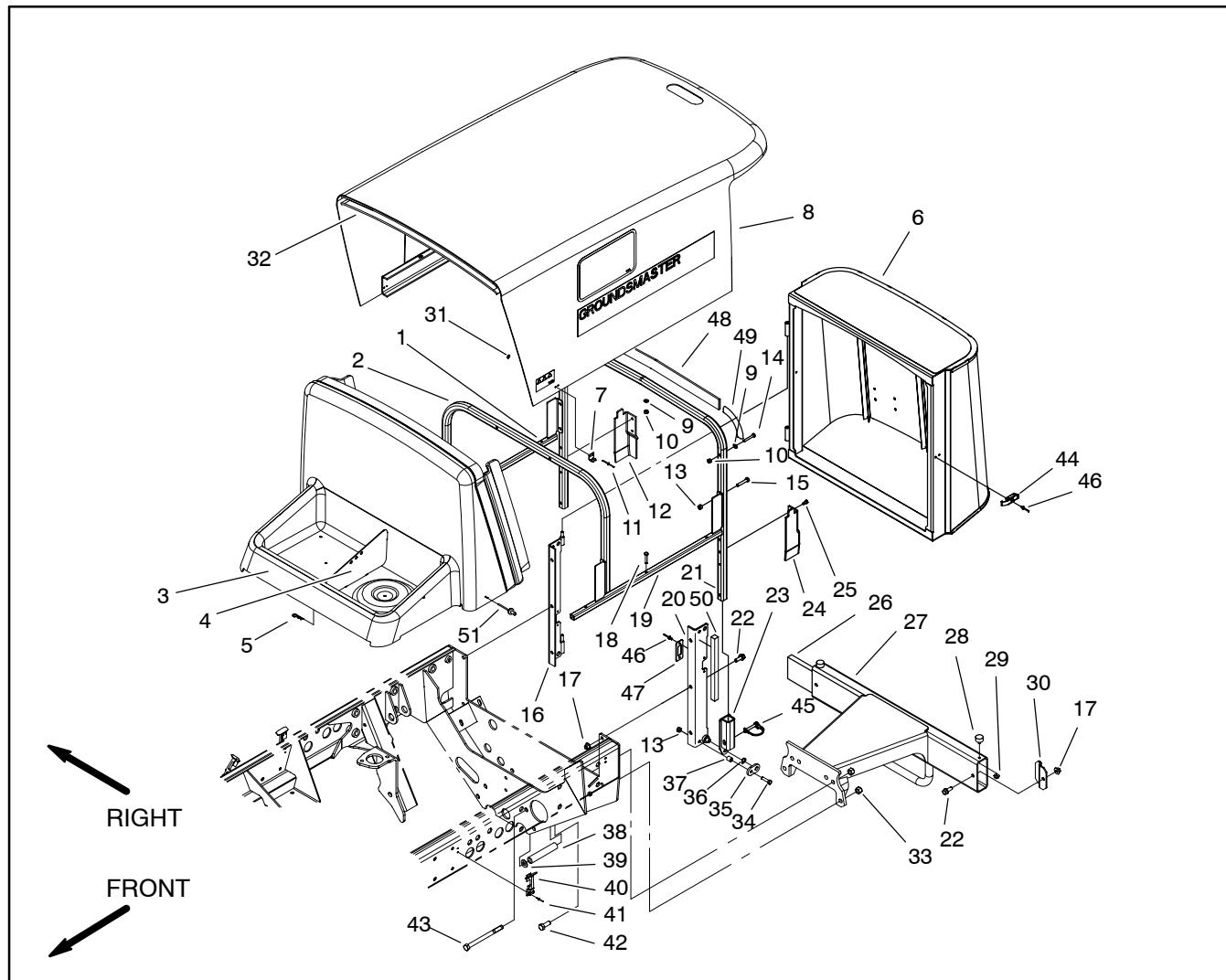


Figure 10

- | | | |
|-----------------------|-------------------------|----------------------------|
| 1. RH hood frame tube | 18. Cap screw | 35. Hood receiver retainer |
| 2. Front hood tube | 19. LH hood frame tube | 36. Spring washer |
| 3. Front shroud | 20. LH support | 37. Hood receiver spacer |
| 4. Shroud divider | 21. Rear hood tube | 38. Axle stop |
| 5. Hair pin | 22. Flange head screw | 39. Flat washer |
| 6. Screen | 23. Hood receiver | 40. Hood latch |
| 7. Keeper | 24. LH tube cover | 41. Pop rivet |
| 8. Hood | 25. Cap screw | 42. Cap screw |
| 9. Flat washer | 26. Bumper weight | 43. Cap screw |
| 10. Lock nut | 27. Rear bumper | 44. Draw latch |
| 11. Pop rivet | 28. Rubber bumper | 45. Hood lock pin |
| 12. RH tube cover | 29. Flange head screw | 46. Pop rivet |
| 13. Lock nut | 30. Bumper weight clamp | 47. Latch plate |
| 14. Cap screw | 31. Back washer | 48. Foam seal |
| 15. Cap screw | 32. Foam seal | 49. Foam seal |
| 16. RH support | 33. Lock nut | 50. Foam seal |
| 17. Flange nut | 34. Cap screw | |

Removal

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. Release hood latches (Fig. 11) and raise hood.
3. Unhook lanyard from hood lock pin, remove pin, and slide hood tubes rearward off guides (Fig. 12).

Installation

1. Slide hood tubes onto guides, install hood lock pin, and hook lanyard to hood pin (Fig. 12).
2. Secure hood to frame with latches (Fig. 11).
3. Check hood alignment for correct operation of hood latches and dust seals.



Figure 11

1. Hood latch

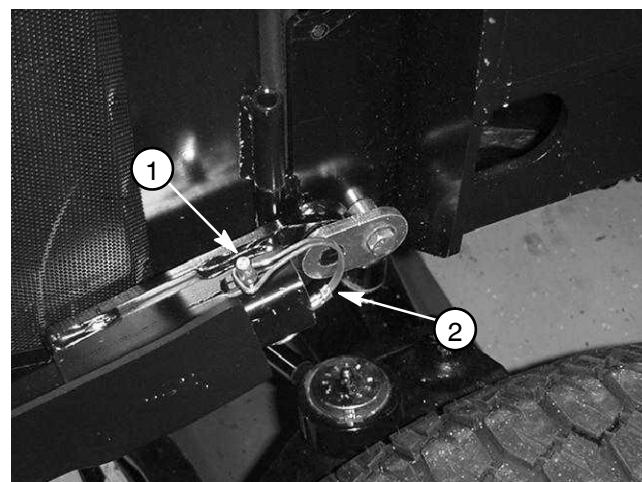


Figure 12

1. Hood lock pin

2. Lanyard

This page is intentionally blank.



Chapter 8

Cutting Units

Table of Contents

SPECIFICATIONS	2	SERVICE AND REPAIRS	8
TROUBLESHOOTING	3	Blade Spindle Assembly	8
Factors That Can Affect Quality of Cut	3	Blade Spindle Service	10
SPECIAL TOOLS	4	Rear Roller	12
ADJUSTMENTS	5	Rear Roller Service (Non-Greasable Bearings)	13
Blade Stopping Time	5	Rear Roller Service (Greasable Bearings with Retaining Ring)	14
Blade Plane Inspection and Adjustment	6	Rear Roller Service (Greasable Bearings with Bearing Nut)	16
		Front Roller Service	18
		Cutting Deck Carrier Frame	20

Specifications



MOUNTING: All cutting units are supported by independent lift arms and are interchangeable to any cutting unit positions. The Groundsmaster 4700-D (shown above) uses 7 cutting units. The Groundsmaster 4500-D uses 5 cutting units.

CONSTRUCTION: Deck chamber is welded 7, 10, and 12 gauge steel. Deck frame is welded 1-1/2 inch square tubing with 7 gauge side supports.

HEIGHT-OF-CUT RANGE: 3/4 to 4 inch (1.91 to 10.16 cm) in 1/4 inch (.64 cm) 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.

CUTTING BLADE: Each cutting unit equipped with 27 inch (68.6 cm) length, .250 inch (6 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, angle 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 UNIT LIFT: Cutting units on the Groundsmaster 4500-D are controlled with one lift lever. The Groundsmaster 4700-D uses three lift levers: one for the right wing deck, one for the left wing deck, and the third (center) lever for the remaining five decks.

SUSPENSION SYSTEM: A fully floating suspension with hydraulic counterbalance. Main center pivot allows side-to-side deck oscillation. Individual decks supported with two front rollers and one, full width, rear roller.

WEIGHT: Complete cutting unit weighs 190 lb (86 kg).

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 unit 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 Cutting 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 units are set at the same height-of-cut. Adjust cutting units as specified in the Cutting Unit Operator's Manual. Adjust height-of-cut setting to remove only 1 inch (2.5 cm) or 1/3 of the grass blade when cutting.
7. Cutting unit alignment and ground following.	Check lift arms and cutting unit 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 these special tools from your Toro Distributor.

Cutting Unit Tool Kit - TOR4070

This tool kit includes special tools used to assemble the cutting unit rear roller that has greasable bearings with a grease fitting on the ends of the roller shaft.

- TOR4064 Spanner Wrench
- TOR4065 Inner Oil Seal Installer
- TOR4066 Bearing Installer
- TOR4067 Shaft Support Tool
- TOR4068 Inner Seal Installer
- TOR4869 Outer Seal Installer
- TOR4071 Outer Oil Seal Installer
- TOR4072 Shaft Seal Protector
- TOR4073 Handle
- TOR4074 Spline Insert Tool



Figure 1

Rear Roller Grease Nozzle - 107-1998

This tool is used to grease the cutting unit rear roller bearings when equipped with greasable bearings.

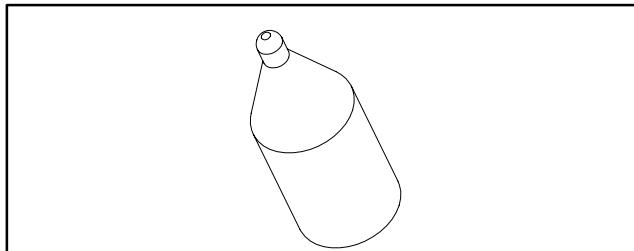


Figure 2

Rear Roller Bearing and Seal Installation Tools

These tools are used to assemble the cutting unit rear roller that has greasable bearings and a bearing lock nut used to retain the bearings.

- 115-0852 Inner Seal Tool
- 115-0853 Bearing/Outer Seal Tool
- 107-8133 Bearing Installation Washer

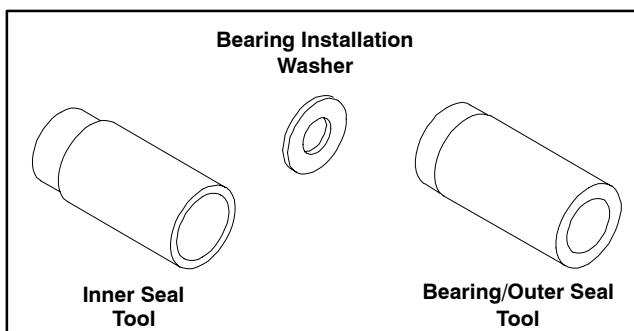


Figure 3

Adjustments



CAUTION

Never install or work on the cutting units or lift arms with the engine running. Always stop engine and remove key first.

See the Cutting Unit Operator's Manual for adjustment procedures for cutting units on the Groundsmaster 4500-D and Groundsmaster 4700-D.

Blade Stopping Time

The blades of the cutting deck are to come to a complete stop in approximately 5 seconds after the cutting deck engagement switch is shut down.

NOTE: Make sure the decks are lowered onto a clean section of turf or hard surface to avoid dust and debris.

To verify this stopping time, have a second person stand back from the deck at least 20 feet and watch the blades on one of the cutting decks. Have the machine operator shut the cutting decks down and record the time it takes for the blades to come to a complete stop. If this time is greater than 7 seconds, the braking valve (RV in the deck control manifold) needs adjustment.

Blade Plane Inspection and Adjustment

If a solid object is struck by the cutting deck, the blade plane of the deck should be inspected.

Blade Plane Inspection

1. Remove cutting unit to be inspected (see Cutting Unit Operator's Manual).
2. Use hoist (or minimum of two people) and place cutting deck on flat table.
3. Mark one end of blade with paint pen or marker. Use this end of blade to check all heights.
4. Position cutting edge of marked end of blade at 12 o'clock (straight ahead in direction of mowing). Measure height from table to cutting edge of blade.
5. Rotate marked end of blade to the 3 and 9 o'clock positions and measure heights.
6. Compare 12 o'clock measured height to the height-of-cut setting. It should be within .090 inch (2.3 mm). The 3 and 9 o'clock heights should be $.150 \pm .090$ inch (3.8 ± 2.3 mm) higher than the 12 o'clock setting and within .090 inch (2.3 mm) of each other. If any of these measurements are not within specification, proceed to Adjusting Blade Plane.

Adjusting Blade Plane

Start with front bracket adjustment and change one height-of-cut bracket at a time.

1. Remove height-of-cut bracket (front, left, or right) from deck frame.
2. Position .060 inch (1.5 mm) and/or .030 inch (.8 mm) shims between the deck frame and bracket to achieve the desired blade height setting.
3. Install height-of-cut bracket to deck frame with remaining shims assembled below the height-of-cut bracket.

NOTE: Socket head bolt and spacer for front bracket are held together with Loctite to prevent spacer from falling inside the deck frame.

4. Secure front height-of-cut bracket to deck frame with socket head bolt/spacer and flange nut.
5. Verify 12 o'clock height. Re-adjust if needed.

6. Determine if one or both (RH and LH) height-of-cut brackets need to be adjusted. If the 3 or 9 o'clock side is $.150 \pm .090$ inch (3.8 ± 2.3 mm) higher than the new front height, then no adjustment is needed for that side. Adjust other side (if needed) to within $\pm .090$ inch (± 2.3 mm) of correct side.
7. Adjust right and/or left height-of-cut brackets by repeating steps 1 thru 3.
8. Secure right and/or left height-of-cut brackets with carriage bolts and flange nuts.
9. Verify 12, 3, and 9 o'clock heights.
10. Reinstall cutting unit (see Cutting Unit Operator's Manual).

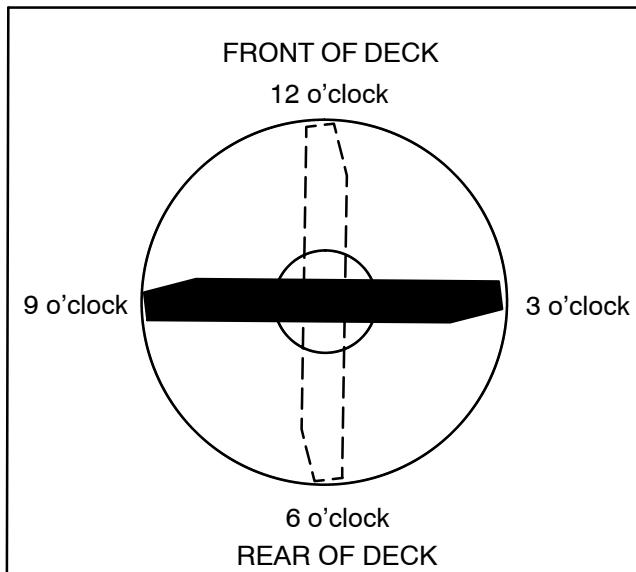


Figure 1

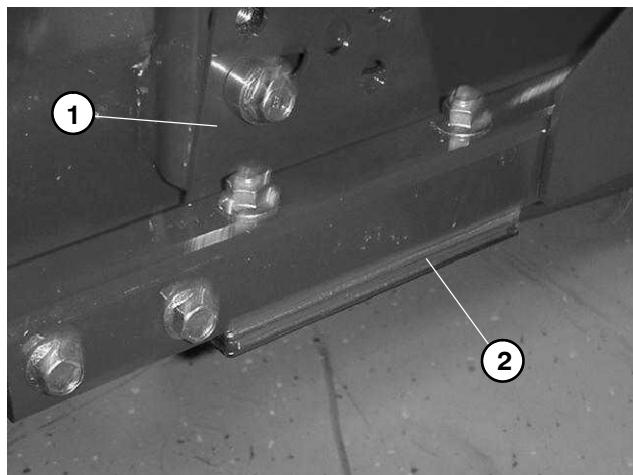


Figure 2

1. Height-of-cut bracket 2. Shims

This page is intentionally blank.

Service and Repairs



CAUTION

Never install or work on the cutting units or lift arms with the engine running. Always stop engine and remove key first.

Blade Spindle Assembly

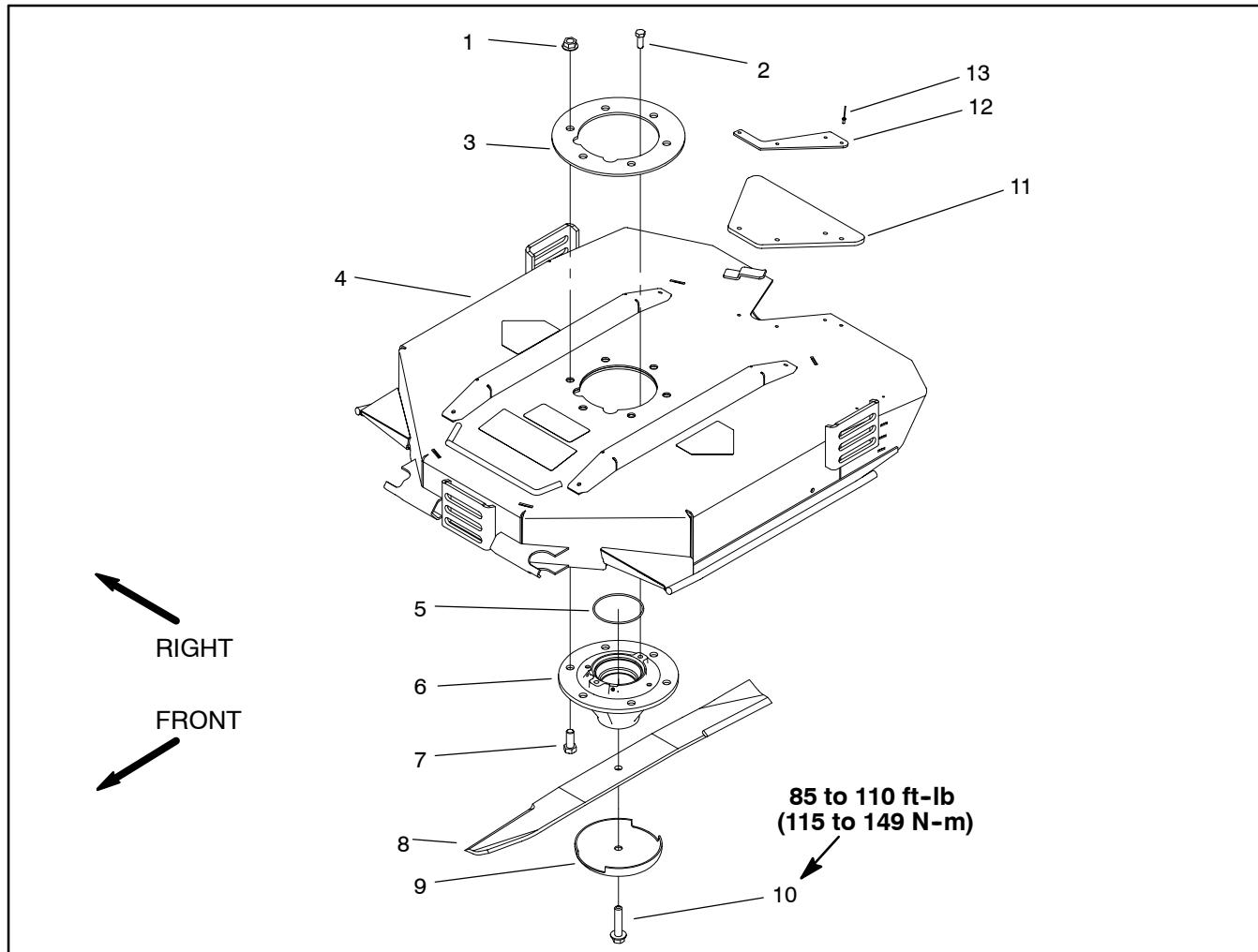


Figure 3

- | | | |
|---------------------------------------|---------------------|-------------------------------------|
| 1. Flange nut | 6. Spindle assembly | 10. Blade bolt |
| 2. Socket head screw (motor mounting) | 7. Cap screw | 11. Rubber flap (if equipped) |
| 3. Spindle plate | 8. Cutting blade | 12. Flap plate (if equipped) |
| 4. Cutting deck | 9. Anti-scalp cup | 13. Pop rivet (steel) (if equipped) |
| 5. O-ring | | |

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 two socket head screws that secure hydraulic motor to the cutting unit (Fig. 4). Remove hydraulic motor and O-ring from deck.
3. Cover top of spindle to prevent contamination. Spindle plug (Toro Part No. 94-2703) can be used to cover spindle.
4. Start the engine and raise the cutting unit. Stop engine and remove key from the ignition switch. Block up the cutting unit so it cannot fall accidentally. If required for easier service, remove cutting unit (see Cutting Unit Operator's Manual).
5. Remove blade bolt, anti-scalp cup and cutting blade (see Cutting Unit Operator's Manual).
6. Remove cap screws and flange nuts securing spindle assembly to cutting deck. Slide spindle assembly out the bottom of the deck. Remove spindle plate from top of deck.

Installation

1. Install spindle assembly and spindle plate to cutting deck with cap screws and flange nuts. Notches on cutting deck and spindle plate should be aligned to front of deck.
2. Install cutting blade, anti-scalp cup and bolt (see Cutting Unit Operator's Manual). Tighten blade bolt from 85 to 110 ft-lb (115 to 149 N-m).
3. Position O-ring to top of spindle housing. Install hydraulic motor to the cutting unit with two socket head screws.

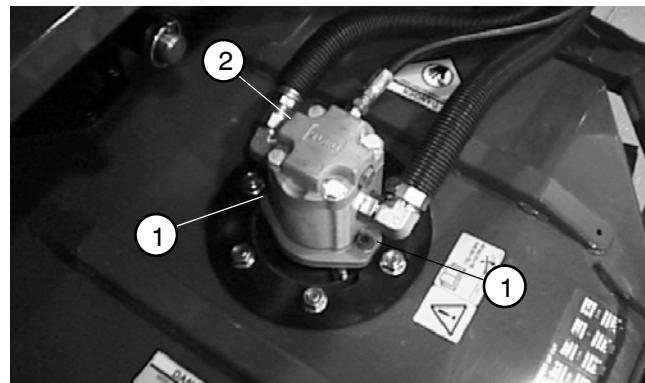


Figure 4

1. Socket head screw

2. Hydraulic motor

Blade Spindle Service

Disassembly

1. Remove blade spindle from cutting deck (see Blade Spindle Removal).
2. Loosen and remove spindle nut from top of spindle shaft.
3. Press the spindle shaft out of the spindle housing using an arbor press. The shaft spacer remains on the spindle shaft as the shaft is being removed.
4. Remove seals from spindle housing.
5. Allow the bearings, inside spacer and spacer ring to drop out of the spindle housing.
6. Using a punch and hammer, drive both of the bearing cups out of the spindle housing. Also, remove the large spacer from the housing.
7. The large snap ring can remain inside the spindle housing. Removal of large snap ring is very difficult.

Assembly

IMPORTANT: If new bearings will be installed into a used spindle housing that has the original large snap ring installed, discard the snap ring that comes with the new bearings because it is not necessary to replace the original snap ring. If a spindle housing is being replaced, new bearings with their matched spacer set and snap ring must be installed. Replacement bearings are sold only with a matched spacer set and snap ring. These parts cannot be purchased separately.

1. If large snap ring was removed, or if replacing the spindle housing, install snap ring into spindle housing groove. Make sure snap ring is seated in groove.

IMPORTANT: If bearings are being replaced, make sure to use the large spacer, inside spacer, and spacer ring that are included in bearing set.

2. Install large spacer into top of spindle housing. The spacer should fit against the snap ring.
3. Using an arbor press, push the bearing cups into the top and bottom of the spindle housing. The top bearing cup must contact the spacer previously installed, and the bottom bearing cup must contact the snap ring. Make sure that the assembly is correct by supporting the first bearing cup and pressing the second against it (Fig. 6).
4. Pack the bearing cones with grease. Apply a film of grease on lips of seals.

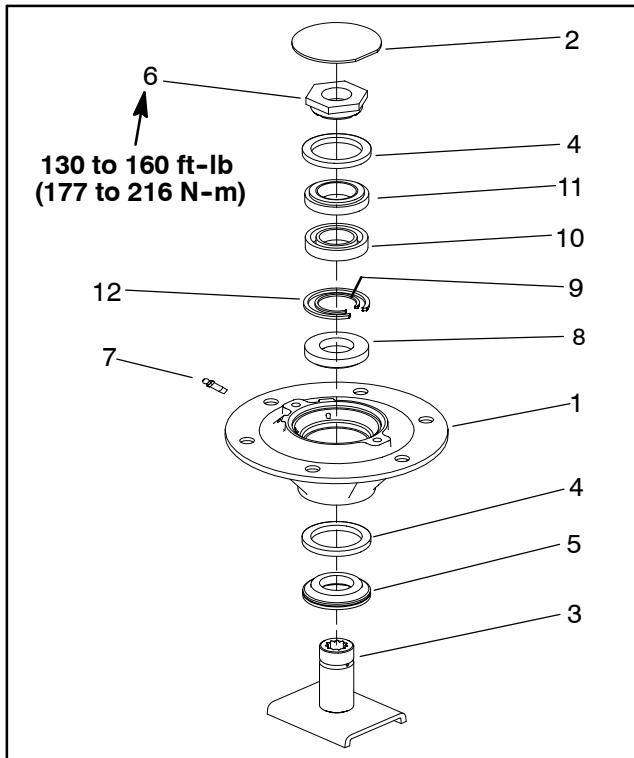


Figure 5

- | | |
|--------------------|--------------------------|
| 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 |

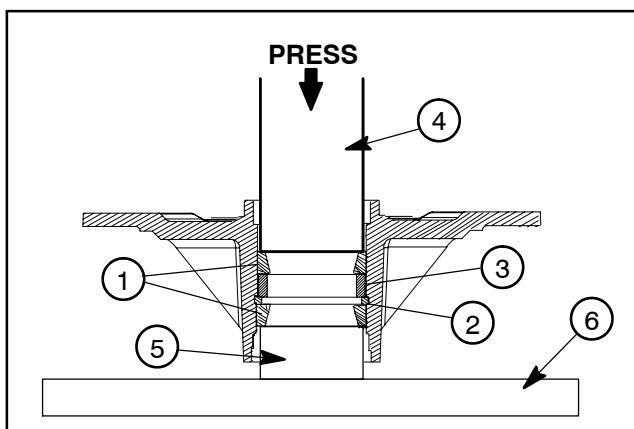


Figure 6

- | | |
|--------------------|---------------------|
| 1. Bearing cups | 4. Arbor press |
| 2. Large snap ring | 5. Support |
| 3. Large spacer | 6. Arbor press base |

5. Install lower bearing and seal into bottom of spindle housing. **Note:** The bottom seal must have the lip facing out (down) (Fig. 7).
6. Slide spacer ring and inside spacer into spindle housing, then install upper bearing and seal into top of housing. **Note:** The upper seal must have the lip facing out (up) (Fig. 7).
7. Inspect the spindle shaft to make sure it is free of burrs or nicks that could possibly damage the seals. Lubricate the shaft with grease.
8. Install spindle spacer onto shaft. Carefully slide spindle shaft through spindle housing. The bottom seal and spindle spacer fit together when the spindle is installed fully.
9. Thread spindle nut onto shaft and tighten nut from 130 to 160 ft-lb (177 to 216 N-m).
10. Install spindle plug to top of spindle housing. Attach a hand pump grease gun to either grease fitting and fill housing cavity with grease until grease starts to come out of lower seal. **Note:** Pneumatic grease guns can produce air pockets when filling large cavities.
11. Install blade spindle to cutting deck (see Blade Spindle Installation).

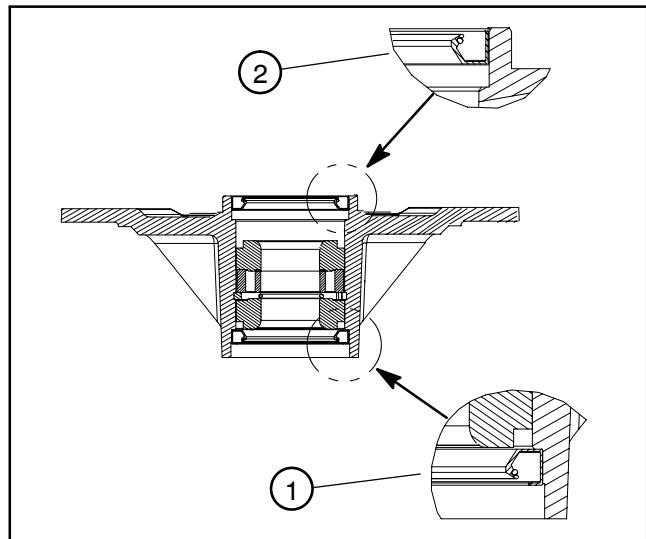


Figure 7

1. Bottom seal installation 2. Upper seal installation

Rear Roller

Three types of rear rollers have been used on the Groundsmaster 4500-D and 4700-D. One roller design has sealed bearings with no grease fittings on the roller shaft. The second design has grease fittings in the roller shaft ends. The third design has grease fittings incorporated into the roller fasteners. Removal and installation of the rear roller from the cutting deck is the same, regardless of roller type.

Removal (Fig. 8)

1. Park machine on a level surface, lower cutting units, stop engine, engage parking brake, and remove key from the ignition switch.
2. If cutting deck is equipped with a roller scraper, 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 from roller.

Installation (Fig. 8)

1. Place roller assembly into roller mounts.
2. Install roller and roller mount assembly into rear of deck frame. Secure assembly to deck frame with flange head screws.
3. Tighten fasteners that secure each end of roller to roller mounts.
4. If removed, install scraper rod assembly to roller mounts. Adjust scraper rod (see Cutting Unit Operator's Manual).

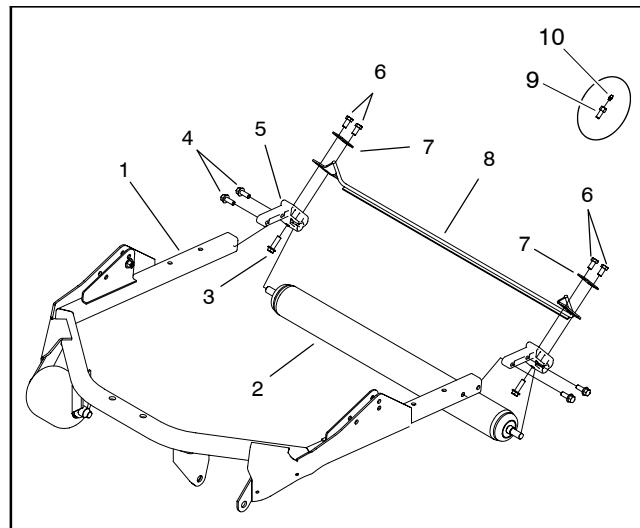


Figure 8

- | | |
|-------------------------|----------------------------|
| 1. Deck frame | 6. Cap screw |
| 2. Rear roller assembly | 7. Scraper plate |
| 3. Flange head screw | 8. Roller scraper |
| 4. Flange head screw | 9. Cap screw (if equipped) |
| 5. Roller mount | 10. Grease fitting |

Rear Roller Service (Non-Greasable Bearings)

Seal Removal (Fig. 9)

1. Using a 1/4 inch thick, 3" X 3" square piece of steel, make a seal removal tool as shown in Figure 10.
2. Slide seal removal tool over roller shaft.
3. Using the tool as a template, locate, mark, and drill two 7/64 inch (.109 inch diameter) holes in outer face of seal.
4. Screw two No. 8 (.164 inch diameter) by 3/4 inch long self-tapping screws into outer face of seal.
5. Install two 1/4-20 by 1 inch long cap screws into seal removal tool.
6. Alternately tighten cap screws to pull seal out of roller assembly.

NOTE: Seals will be destroyed when servicing the rear roller. Do not re-use seals that have been removed.

Bearing Removal (Fig. 9)

NOTE: The bearings are pressed onto the roller shaft and loose fit into the roller.

1. Remove seals from roller. Remove retaining rings from roller shaft: catch ring removal notch with pick and pull ring from shaft.
2. Loosely secure roller assembly in bench vise and lightly tap one end of roller shaft until free from bearing and housing.
3. Remove second bearing from shaft by supporting bearing on inner race and tapping on roller shaft.
4. Discard removed bearings. Inspect shaft, retaining rings, and roller for damage. Replace components as needed.

Roller Assembly (Fig. 9)

1. Press new bearing onto one end of roller shaft. Apply pressure equally to inner and outer bearing races.
2. Place spiral retaining ring on same end of shaft as installed bearing.
3. Install shaft with single bearing into roller.
4. Install second new bearing onto roller shaft. Apply pressure equally to inner and outer bearing races. The inner race will contact shoulder of shaft before outer race contacts shoulder of roller.

5. Install second spiral retaining ring onto roller shaft to secure second bearing.

6. Install new seals to .030 inch (.76 mm) recessed into roller.

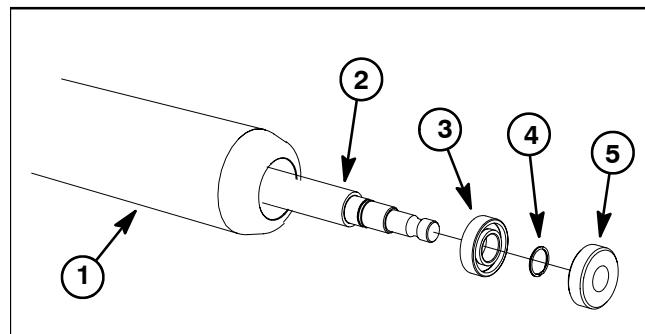


Figure 9
1. Roller
2. Roller shaft
3. Bearing
4. Retaining ring
5. Oil seal

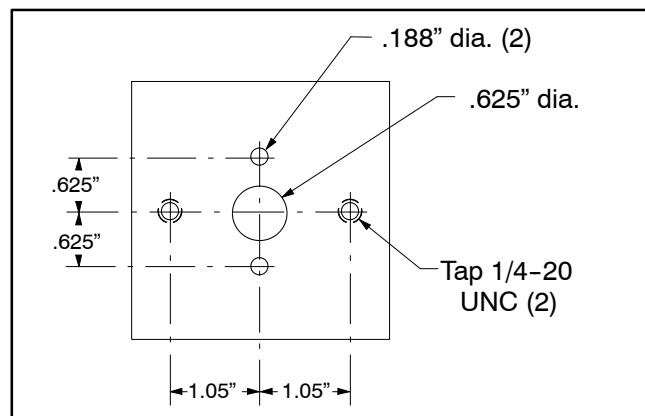


Figure 10

Rear Roller Service (Greasable Bearings with Retaining Ring)

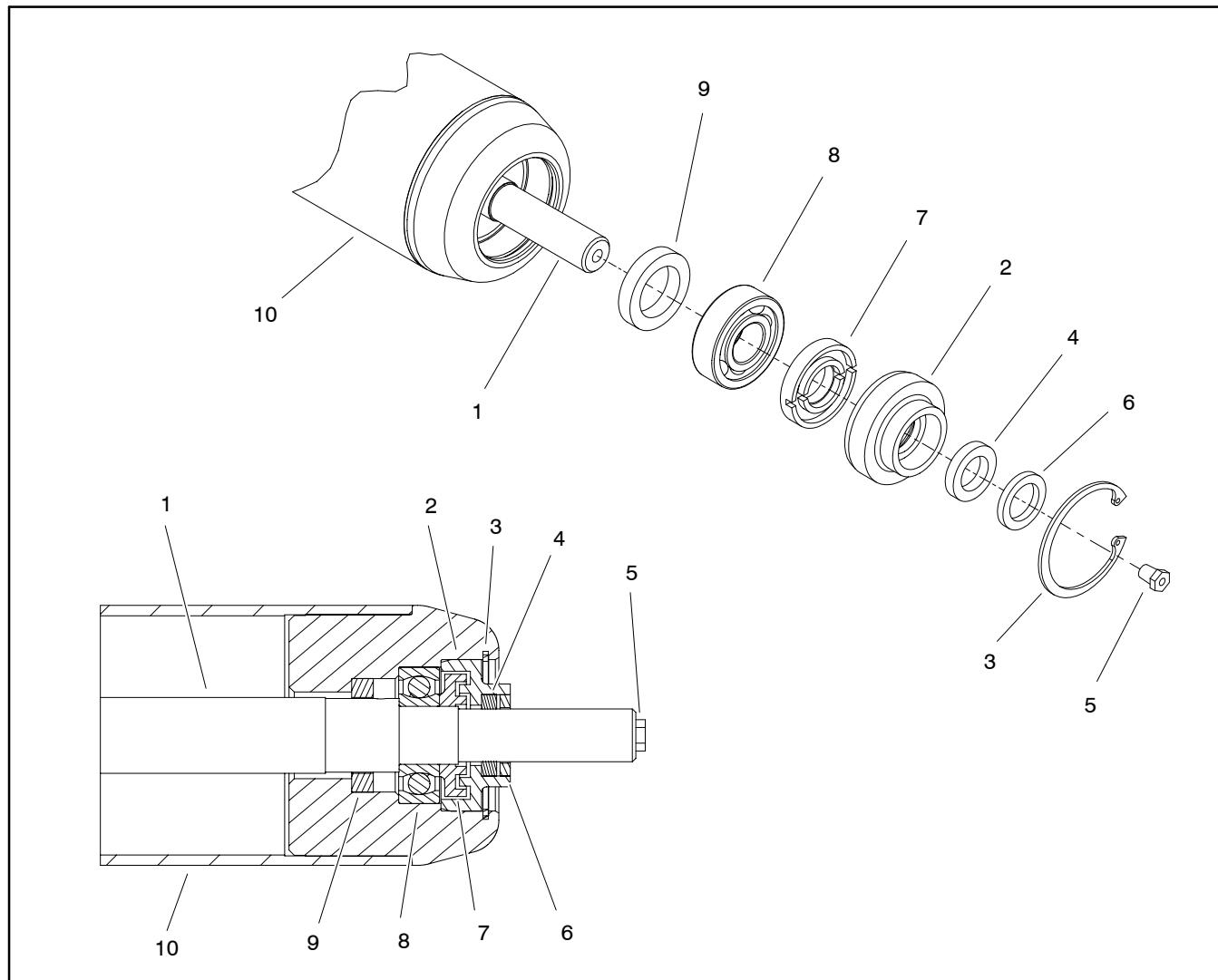


Figure 11

- | | | |
|-------------------|-------------------|-------------------|
| 1. Roller shaft | 5. Grease fitting | 8. Ball bearing |
| 2. Outer seal | 6. Washer | 9. Inner oil seal |
| 3. Retaining ring | 7. Inner seal | 10. Roller tube |
| 4. Outer oil seal | | |

Roller Disassembly (Fig. 11)

1. Remove retaining ring from both ends of roller.
2. Hit end of roller shaft with a soft face hammer to remove seals and bearing from one end of roller. Hit other end of roller shaft to remove seals and bearing from other end of roller. Be careful not to drop roller shaft.
3. Discard seals and bearings.

Roller Assembly (Fig. 11)

NOTE: A soft face hammer can be used with the special tools listed (see Special Tools) to assemble the roller, however use of a press is recommended.

1. Use installation tool TOR4065 and handle TOR4073 to install inner oil seal into each end of roller tube.

2. Install ball bearings:

NOTE: Ball bearings have a press fit into the roller tube and a slip fit onto the roller shaft.

IMPORTANT: If ball bearing has a seal on one side, install bearing with seal orientated toward the outside of the roller.

- A. Use tool TOR4066 and handle TOR4073 to install ball bearing into one end of roller tube.
- B. Install roller shaft from opposite end of roller. Be careful not to damage the inner oil seals.
- C. Put roller in a vertical position and support shaft and bearing with tool TOR4067.
- D. Use tool TOR4067 to install second ball bearing.

3. Use tool TOR4068 to install inner seal.
4. Use tool TOR4069 to install outer seal.
5. Install retaining ring so that side with sharp edges faces end of roller (out).
6. Use tool TOR4071 to install outer oil seal.
7. Use tool TOR4067 to install washer.
8. Put opposite end of roller facing up and support bottom end with tool TOR4067. Repeat steps 3 - 7.
9. Use a hand operated grease gun and No. 2 general purpose lithium base grease to lubricate bearings until grease appears at washer. Wipe off excess grease.

Rear Roller Service (Greasable Bearings with Bearing Nut)

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) 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) 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) 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.

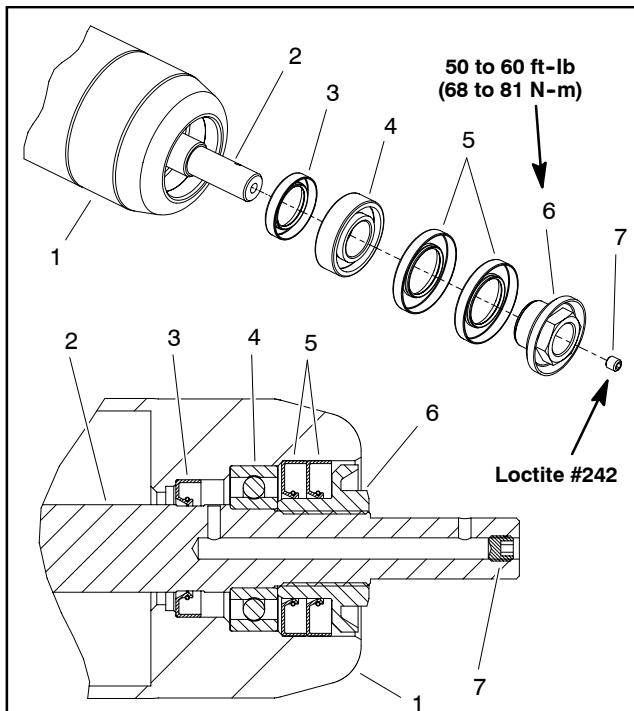


Figure 12

- | | |
|-----------------|---------------------|
| 1. Roller tube | 5. Outer seal |
| 2. Roller shaft | 6. Bearing lock nut |
| 3. Inner seal | 7. Set screw |
| 4. Bearing | |

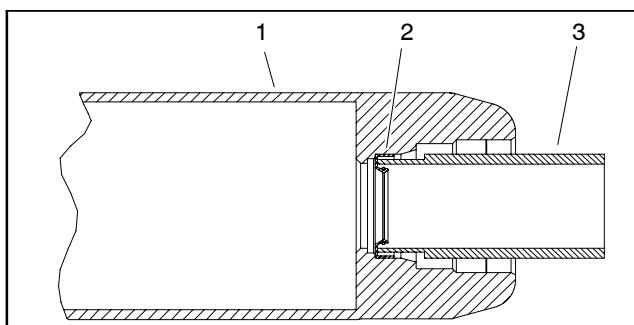


Figure 13

- | | |
|----------------|--------------------|
| 1. Roller tube | 3. Inner seal tool |
| 2. Inner seal | |

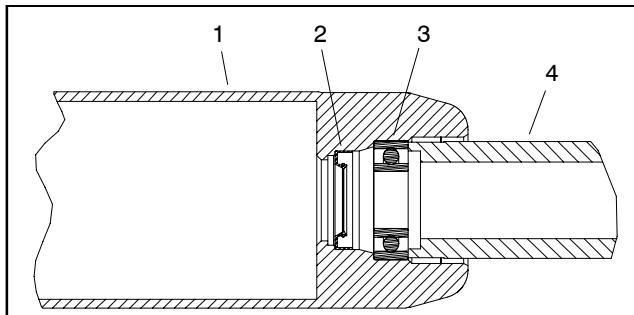


Figure 14

- | | |
|----------------|----------------------------|
| 1. Roller tube | 4. Washer |
| 2. Inner seal | 5. Bearing/outer seal tool |
| 3. Bearing | |

3. From the roller tube end with only the inner seal installed, carefully install the roller shaft into the roller tube. Make sure that seals are not damaged as shaft is installed.

4. Install new bearing and outer seals into second end of roller tube:

A. Position a second new bearing to roller shaft and tube. Position washer (see Special Tools) on bearing to allow pressing on both inner and outer bearing races simultaneously.

B. Use washer and bearing/outer seal tool (see Special Tools) with a soft face hammer to fully seat bearing (Fig. 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) 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.

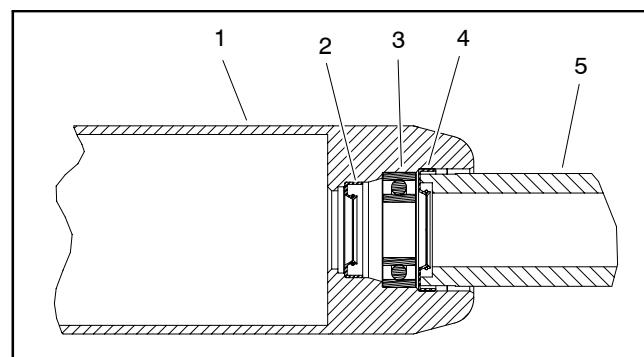


Figure 15

- | | |
|----------------|----------------------------|
| 1. Roller tube | 4. Outer seal |
| 2. Inner seal | 5. Bearing/outer seal tool |
| 3. Bearing | |

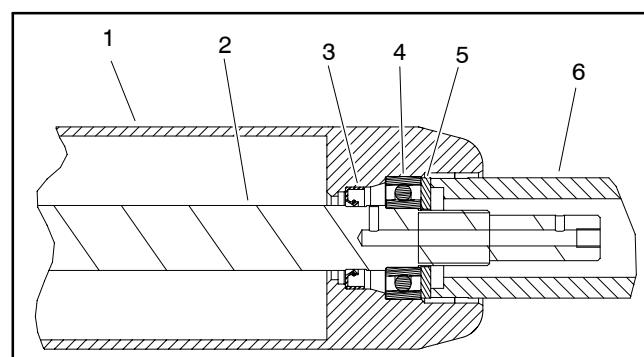


Figure 16

- | | |
|-----------------|----------------------------|
| 1. Roller tube | 4. Bearing |
| 2. Roller shaft | 5. Washer |
| 3. Inner seal | 6. Bearing/outer seal tool |

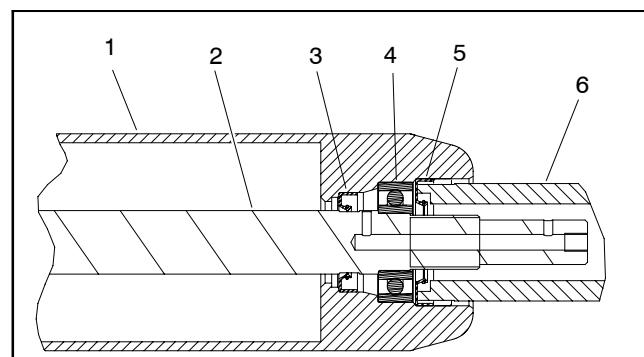


Figure 17

- | | |
|-----------------|----------------------------|
| 1. Roller tube | 4. Bearing |
| 2. Roller shaft | 5. Outer seal |
| 3. Inner seal | 6. Bearing/outer seal tool |

Front Roller Service

Disassembly (Fig. 18)

1. Remove roller mounting bolt.
2. Remove roller assembly from carrier frame.
3. To remove bearings and 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 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:
 - A. Press first bearing into housing. Press on outer race only or equally on inner and outer races.
 - B. Insert bearing spacer.
 - C. Press second bearing into roller housing pressing equally on inner and outer races until the inner race comes in contact with the spacer.
2. Install roller assembly into deck frame.

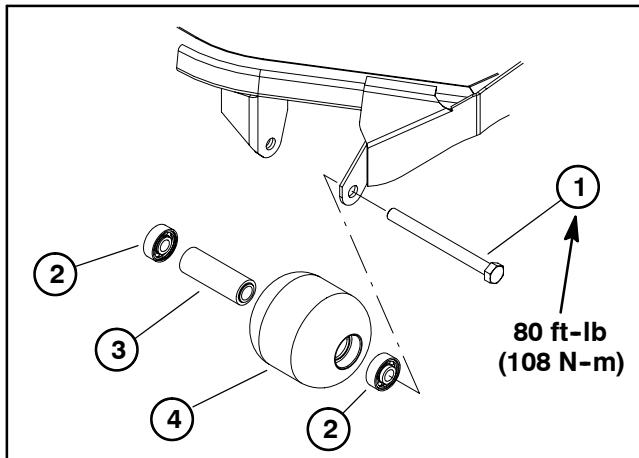


Figure 18

1. Mounting bolt 3. Spacer
2. Bearing 4. Front roller

NOTE: Securing roller assembly with a gap larger than .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 .060 inch (1.5 mm) gap between roller assembly and the roller mount brackets of the deck frame. If this gap is larger than .060 inch (1.5 mm), shim excess clearance with 5/8" washers.
4. Insert mounting bolt and tighten to 80 ft-lb (108 N-m).

This page is intentionally blank.

Cutting Deck Carrier Frame

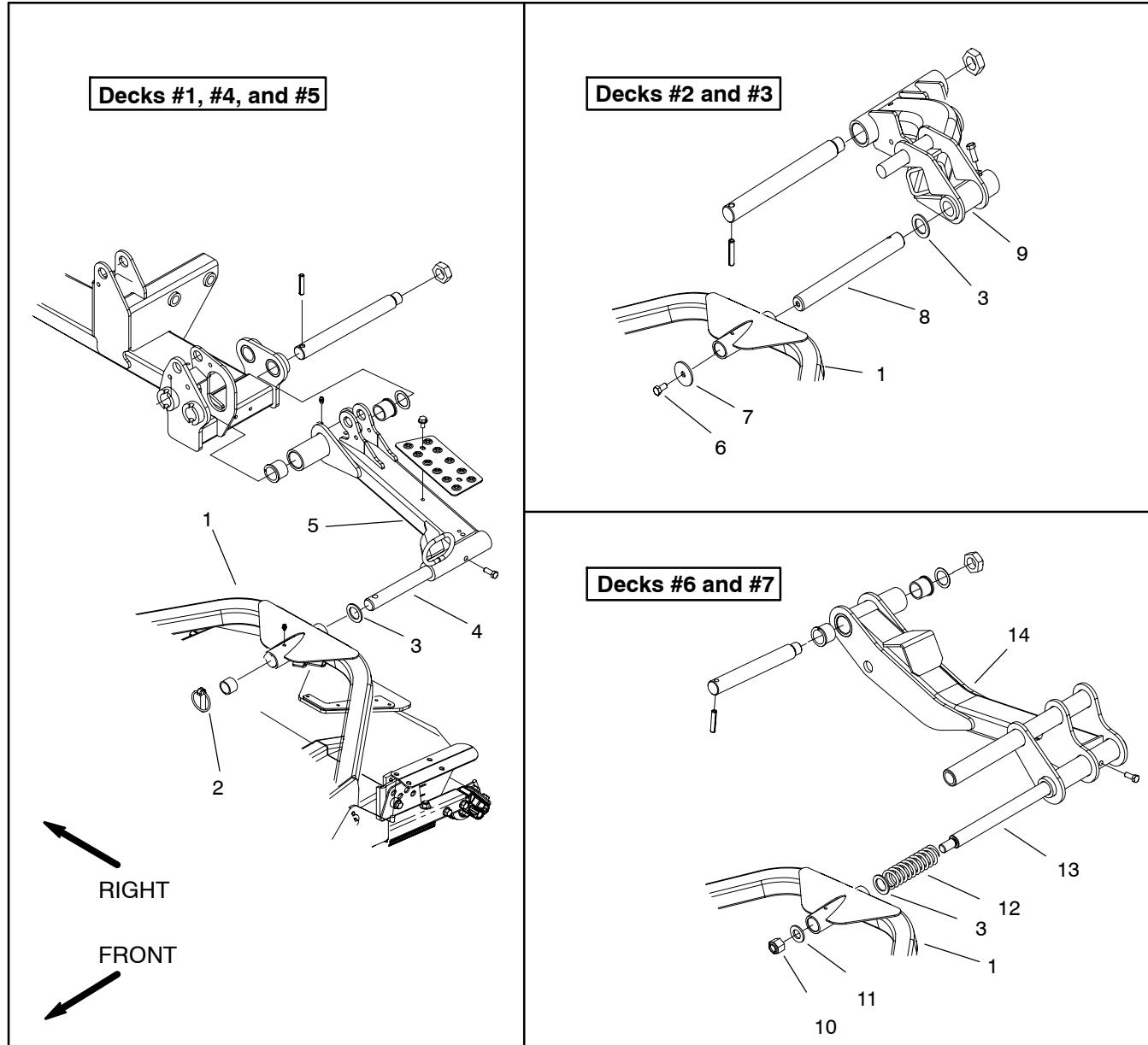


Figure 19

- | | | |
|------------------------|------------------------|-------------------------|
| 1. Carrier frame | 6. Cap screw | 11. Flat washer |
| 2. Lynch pin | 7. Rebound washer | 12. Compression spring |
| 3. Thrust washer | 8. Pivot shaft | 13. Pivot shaft |
| 4. Pivot shaft | 9. Lift arm (#2 shown) | 14. Lift arm (#6 shown) |
| 5. Lift arm (#4 shown) | 10. Lock nut | |

Installation

Each cutting deck is suspended from a carrier frame. Decks should be attached to the carrier frame using the lower hole in deck bracket (Fig. 20).

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 lift arms as follows:

1. Carrier frames for the front three cutting decks (#1, #4, and #5) have a thrust washer between the carrier frame and the lift arm. The frame is secured to the lift arm pivot shaft with a lynch pin (Fig. 19).
2. Carrier frames for the center two cutting decks (#2 and #3) have a thrust washer between the carrier frame and the lift arm. The frame is secured to the lift arm pivot shaft with a rebound washer and cap screw (Fig. 19).
3. Carrier frames for the rear two cutting decks (#6 and #7 on the GM4700-D) have a compression spring and thrust washer between the carrier frame and the lift arm. The frame is secured to the lift arm pivot shaft with a flat washer and lock nut (Fig. 19).

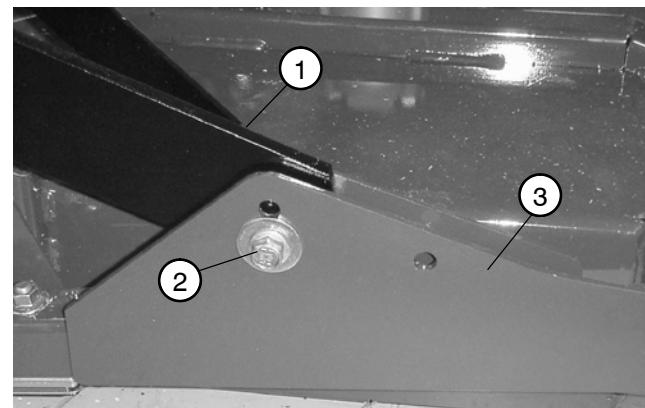


Figure 20

1. Carrier frame
2. Lower hole

3. Deck bracket

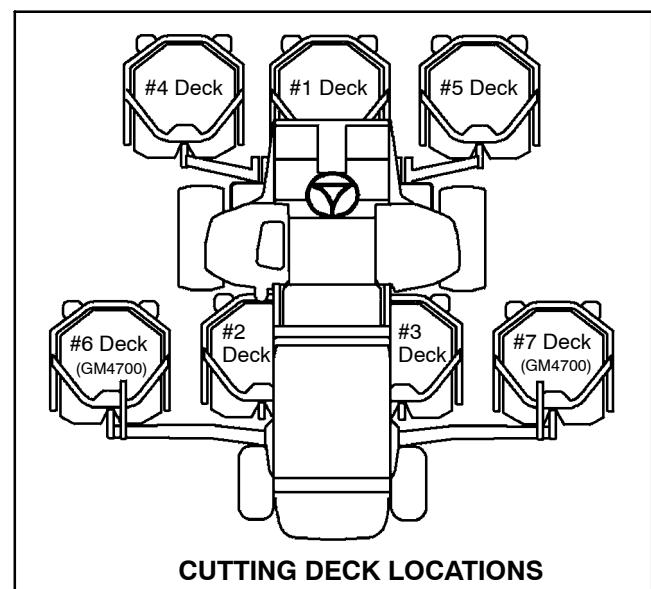


Figure 21

This page is intentionally blank.

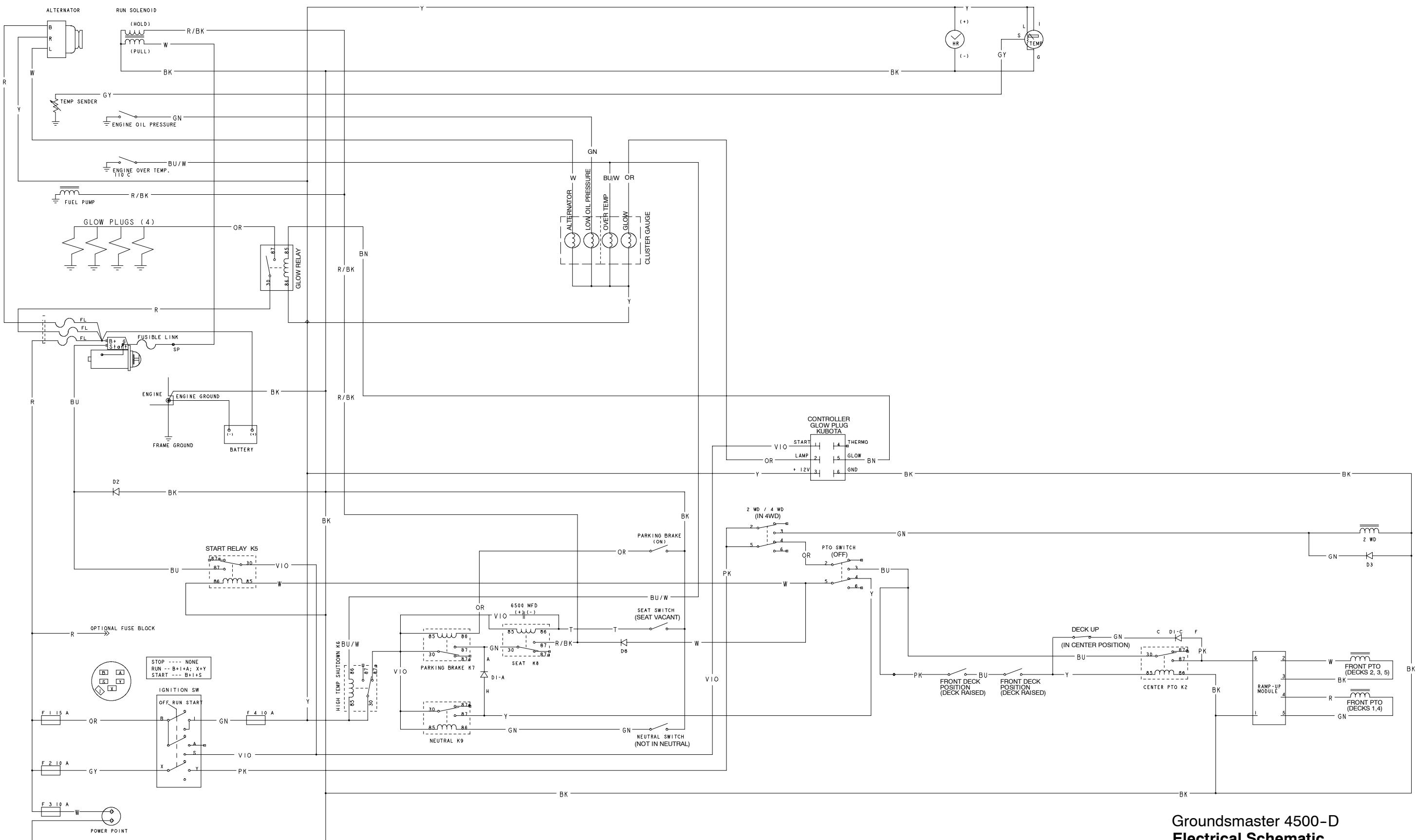


Electrical Diagrams

Table of Contents

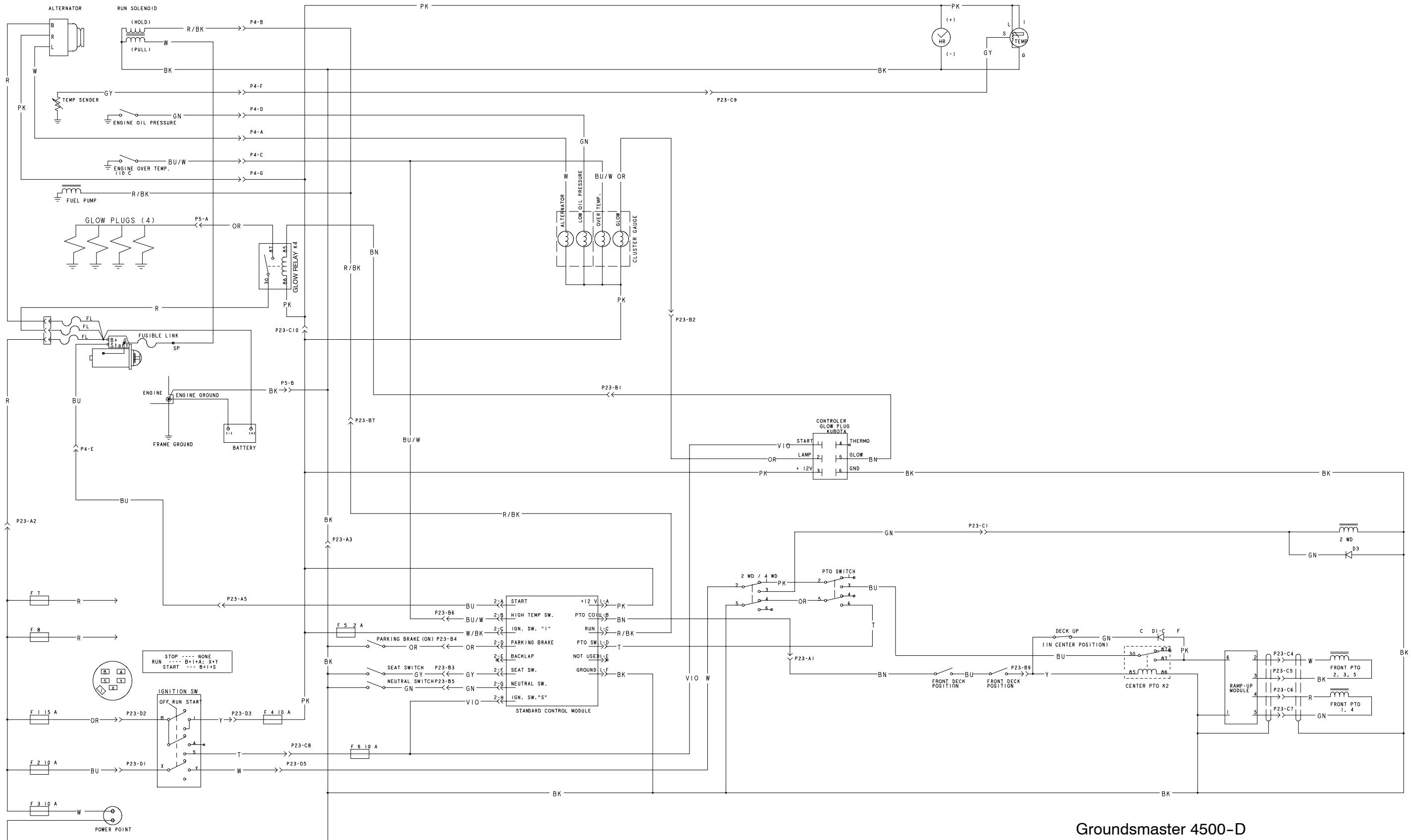
ELECTRICAL SCHEMATICS	3
Groundsmaster 4500-D	
Serial Number Below 220999999	3
Serial Number From 230000001 to 260000600	4
Serial Number Above 260000600	5
Groundsmaster 4700-D	
Serial Number Below 220999999	6
Serial Number From 230000001 to 260000600	7
Serial Number Above 260000600	8
CIRCUIT DIAGRAMS	
Glow Plug Circuit Diagram	9
Crank Circuit Diagram	10
Run (Transport) Circuit Diagram	11
Run (Mow) Circuit Diagram	12
WIRE HARNESS DRAWINGS	
Main Wire Harness Drawing	
Serial Number Below 220999999	14
Serial Number From 230000001 to 26000060016	
Serial Number Above 260000600	18
Console Wire Harness Drawing	
Serial Number Below 220999999	20
Serial Number From 230000001 to 26000060022	
Serial Number Above 260000600	24
Engine Wire Harness Drawing	
Serial Number Below 220999999	26
Serial Number Above 230000000	28
Cutting Deck 6 and 7 Wire Harness Drawing	
(Groundsmaster 4700-D)	30

This page is intentionally blank.



Groundsmaster 4500-D
Electrical Schematic
Serial Number Below 220999999

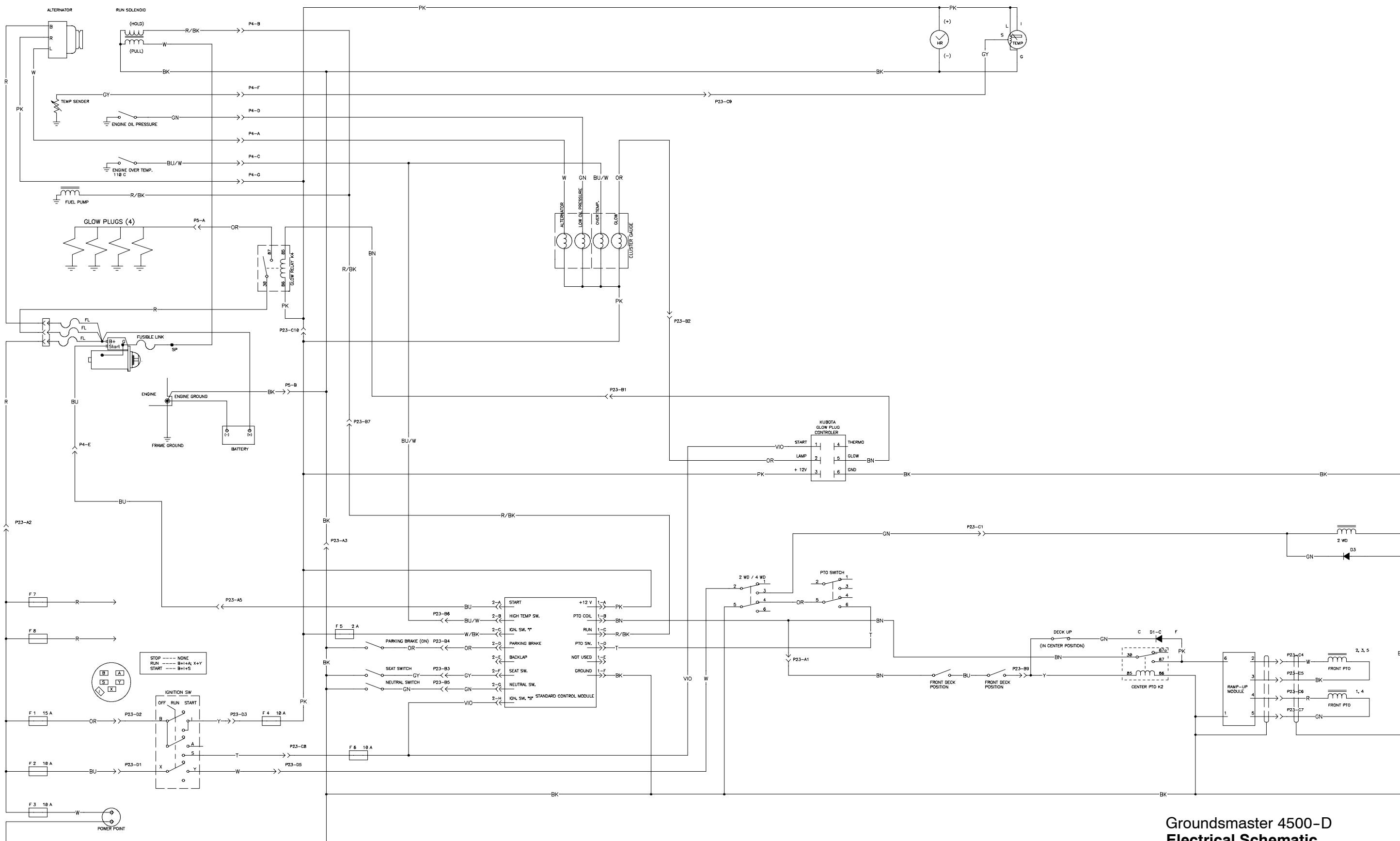
All relays and solenoids
are shown as de-energized.
All ground wires are black.

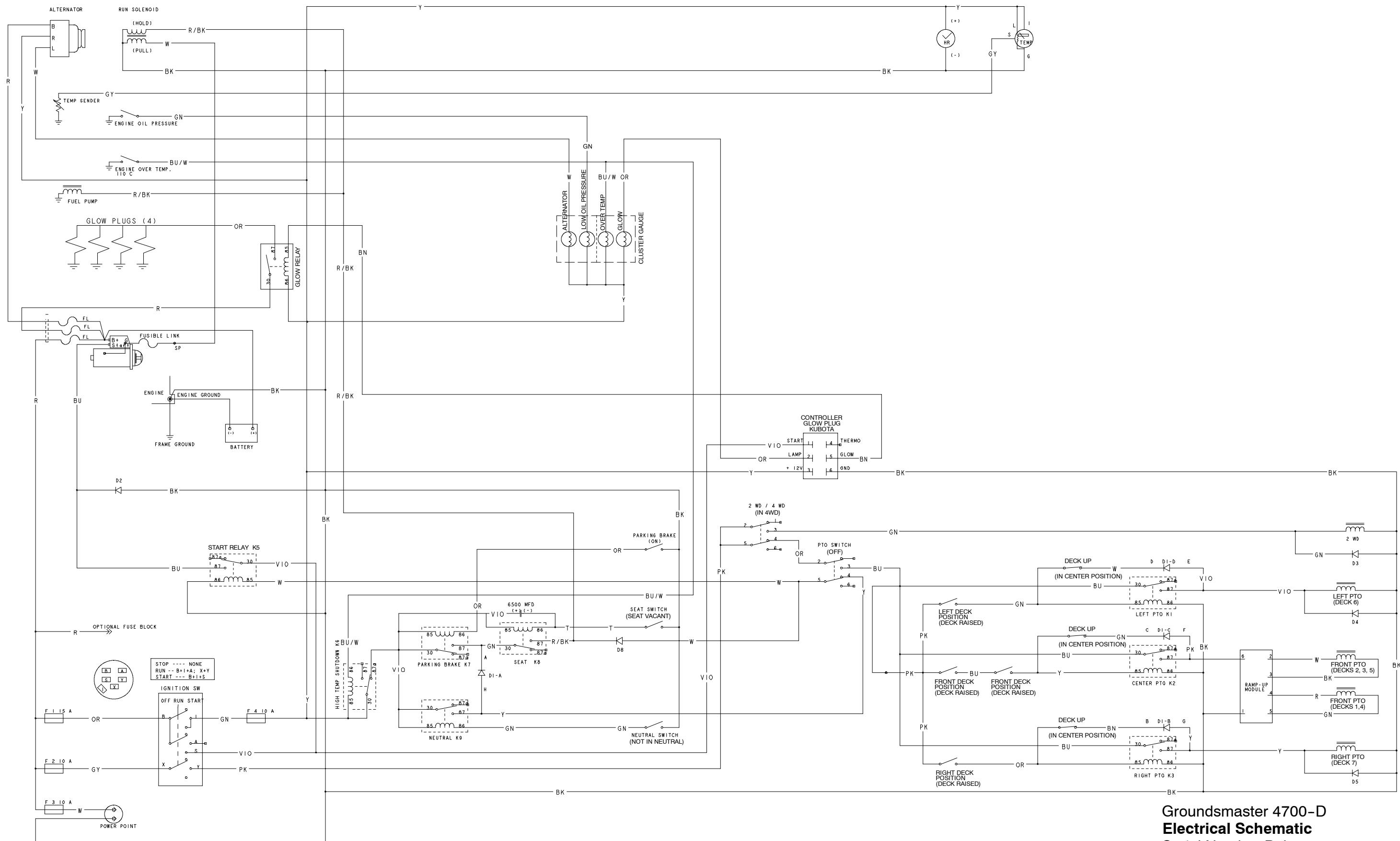


Groundsmaster 4500-D
Electrical Schematic

Serial Number From 230000001 to 260000600

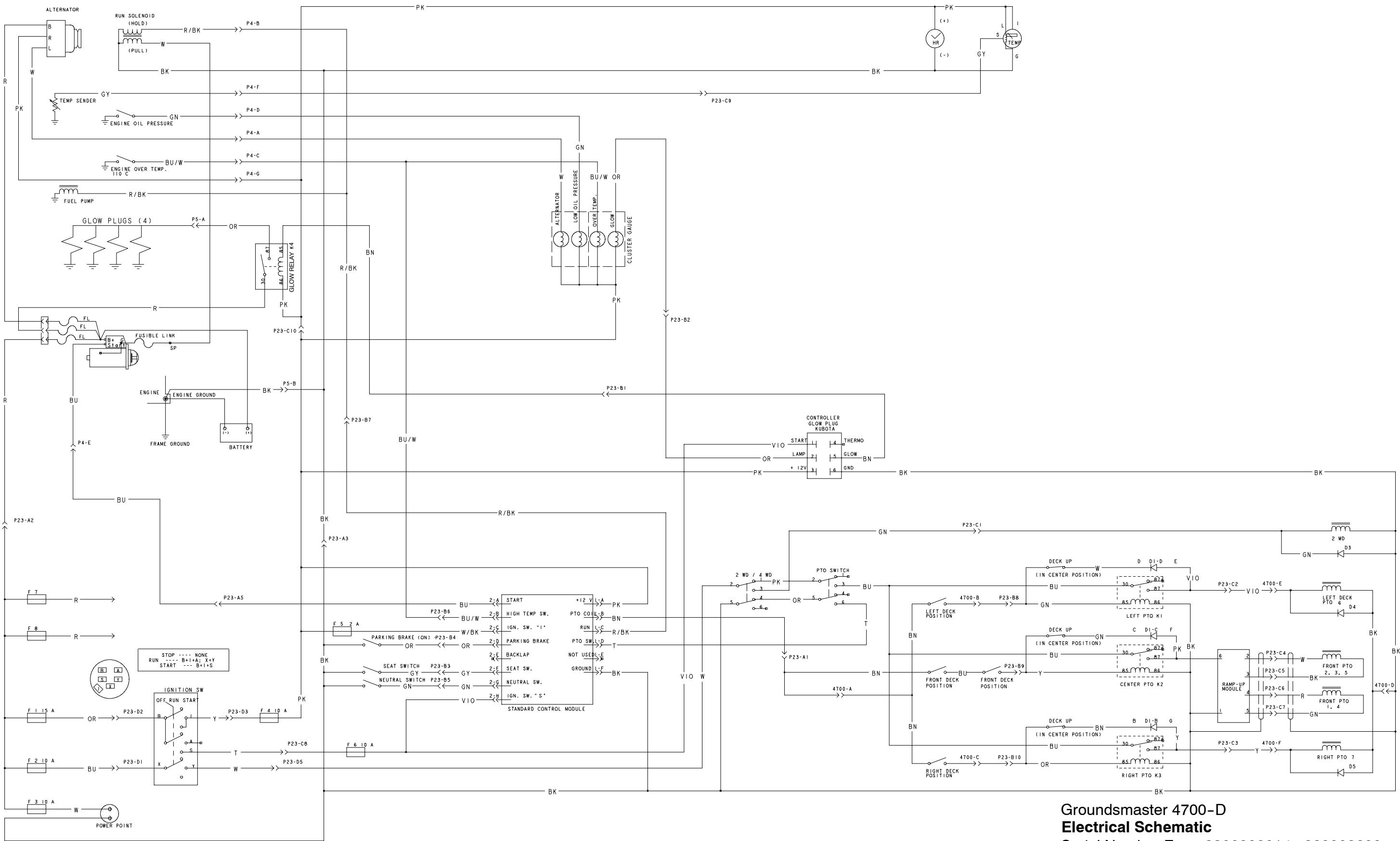
All relays and solenoids
are shown as de-energized.
All ground wires are black.





Groundsmaster 4700-D
Electrical Schematic
Serial Number Below 220999999

All relays and solenoids
are shown as de-energized.
All ground wires are black.

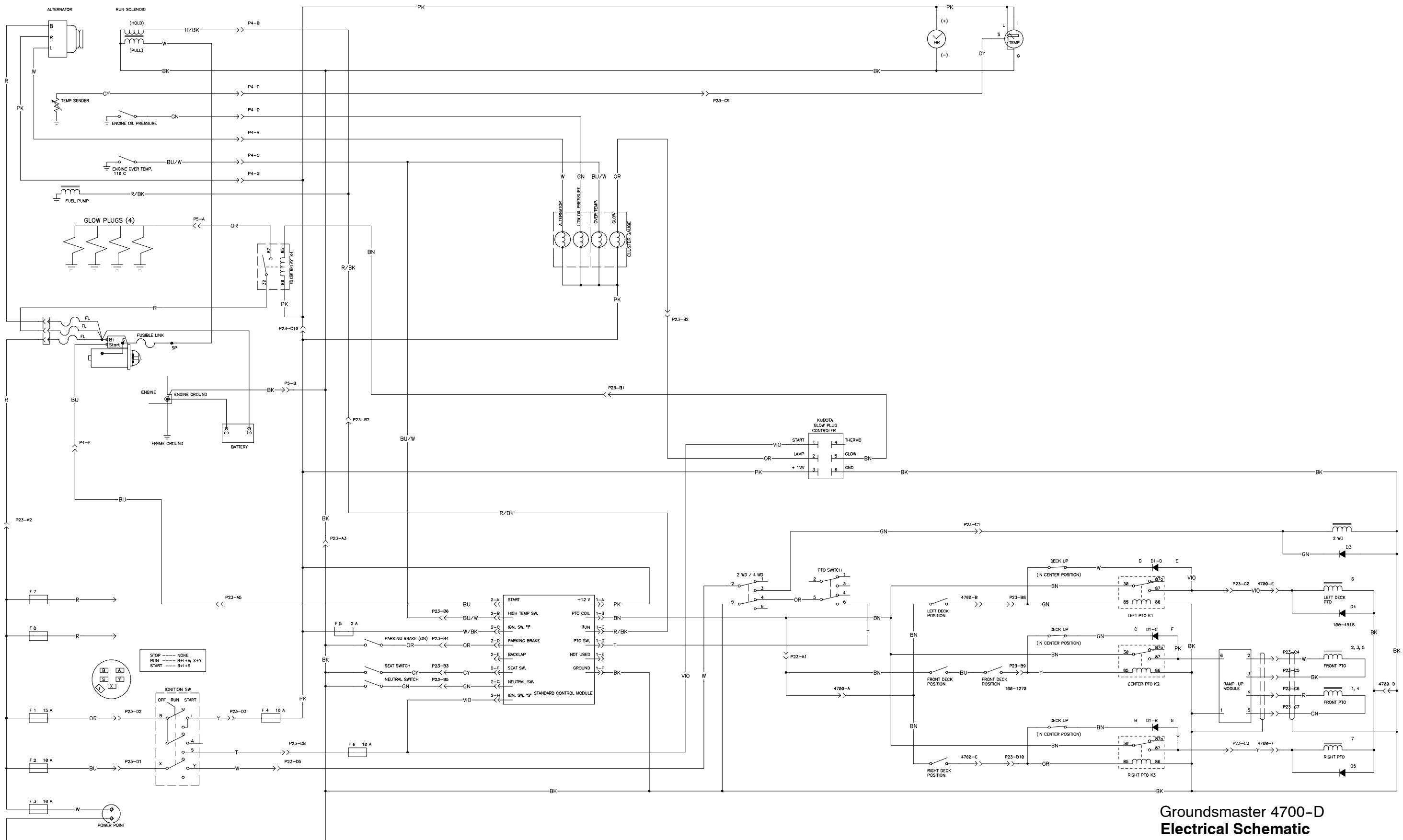


Groundsmaster 4700-D

Electrical Schematic

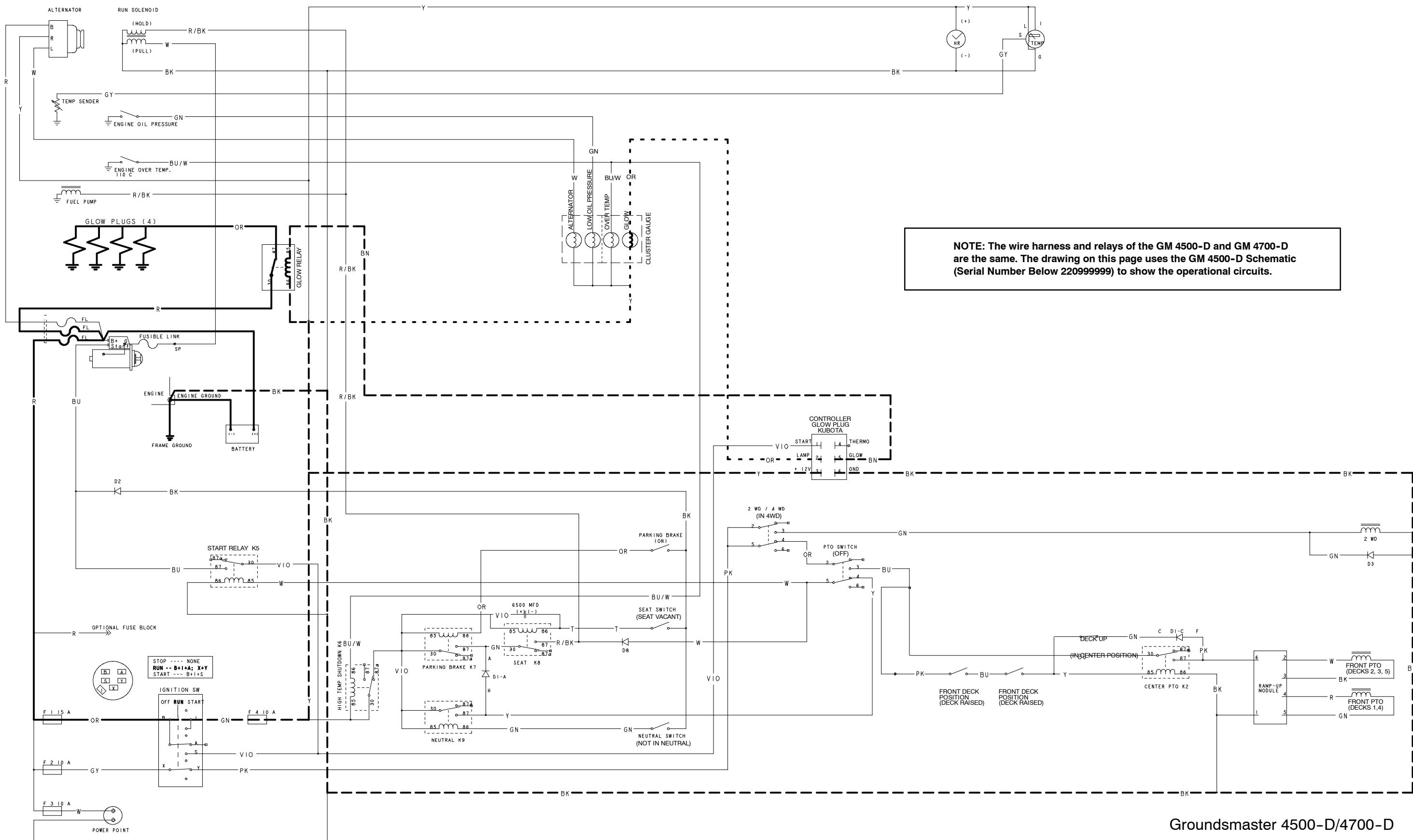
Serial Number From 230000001 to 260000600

All relays and solenoids
are shown as de-energized.
All ground wires are black.



Groundsmaster 4700-D
Electrical Schematic
Serial Number Above 260000600

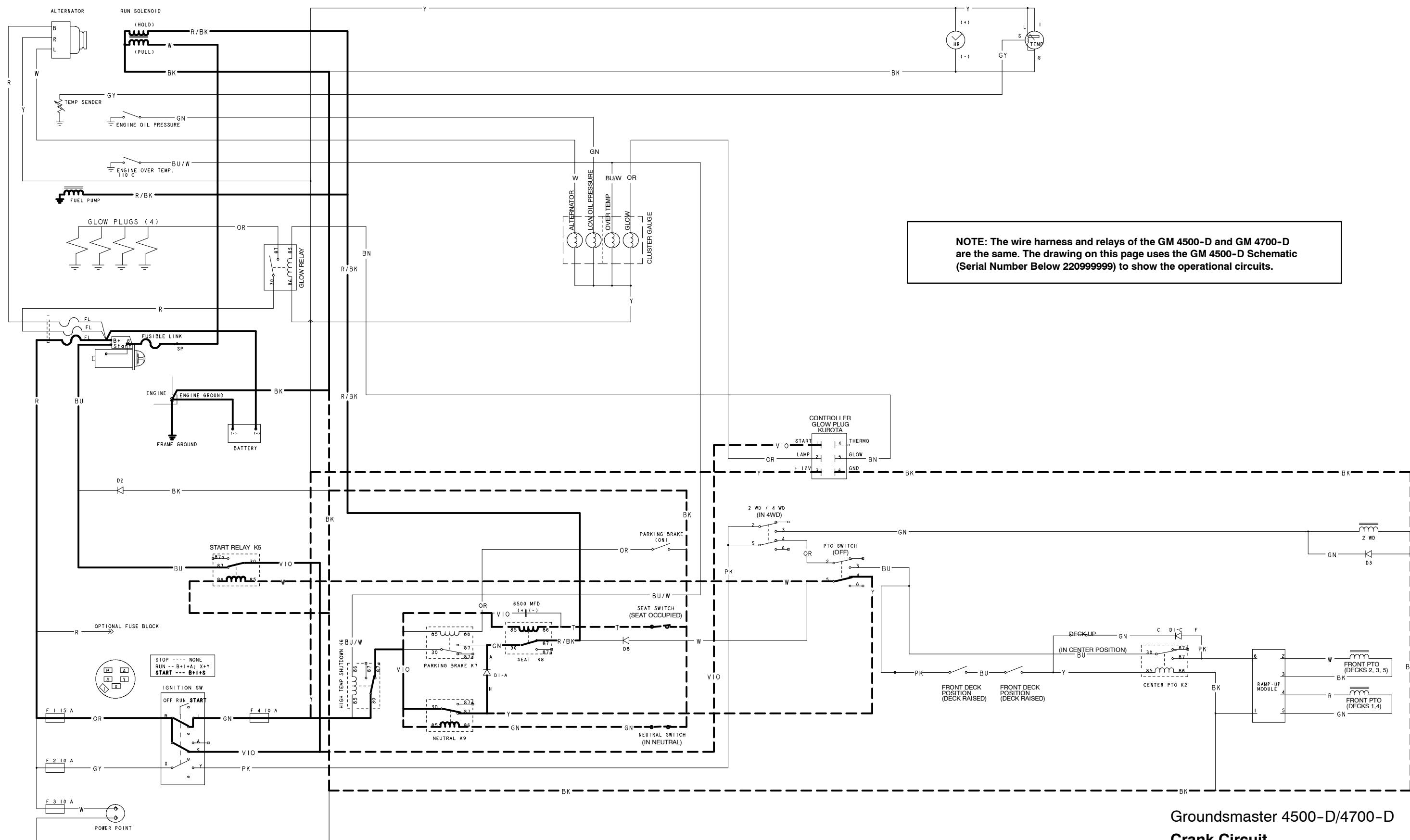
All relays and solenoids
are shown as de-energized.
All ground wires are black.



Groundsmaster 4500-D/4700-D

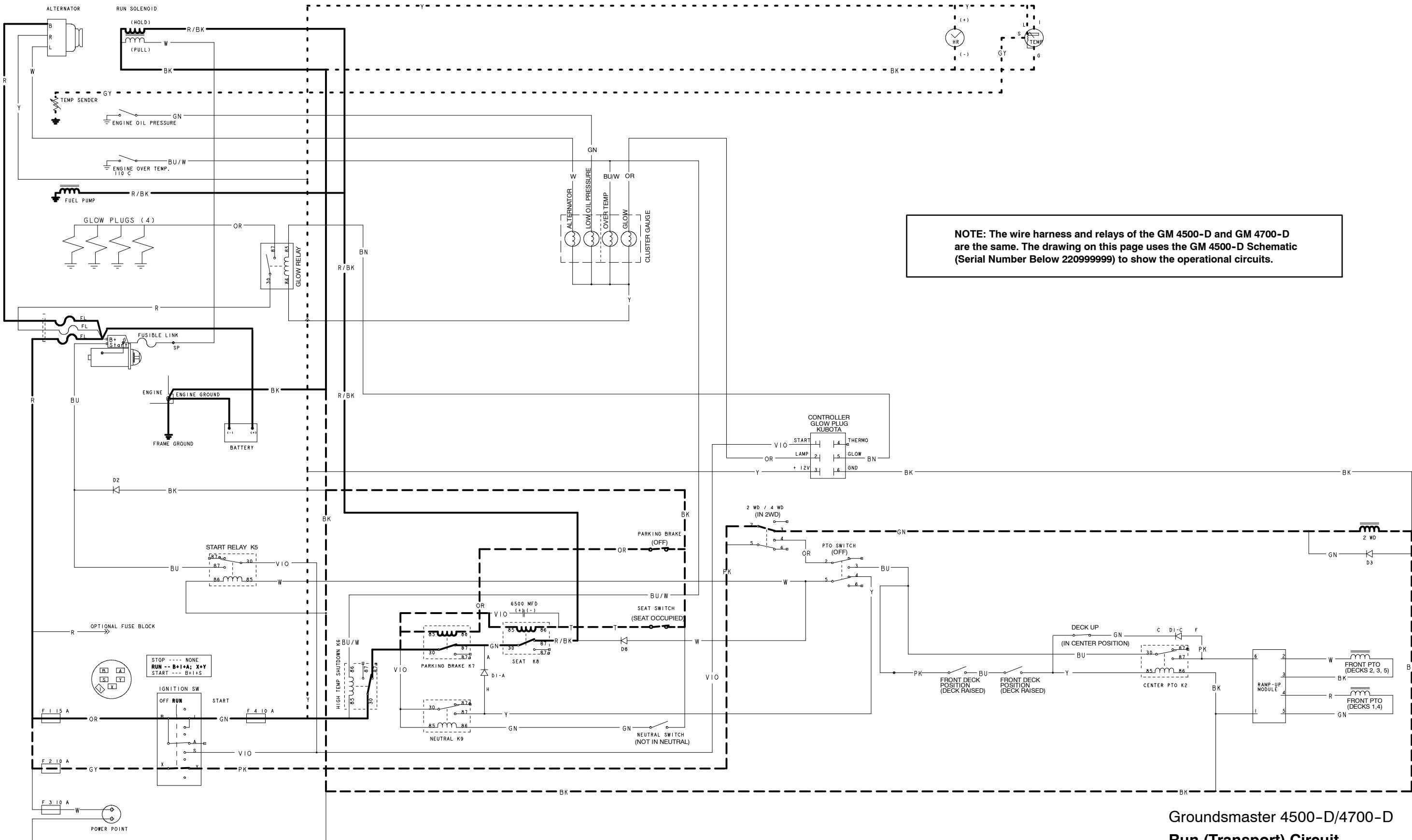
Glow Plug Circuit

— Power Current
 - - - Control Current
 - - - - Indicator/Gauge Current



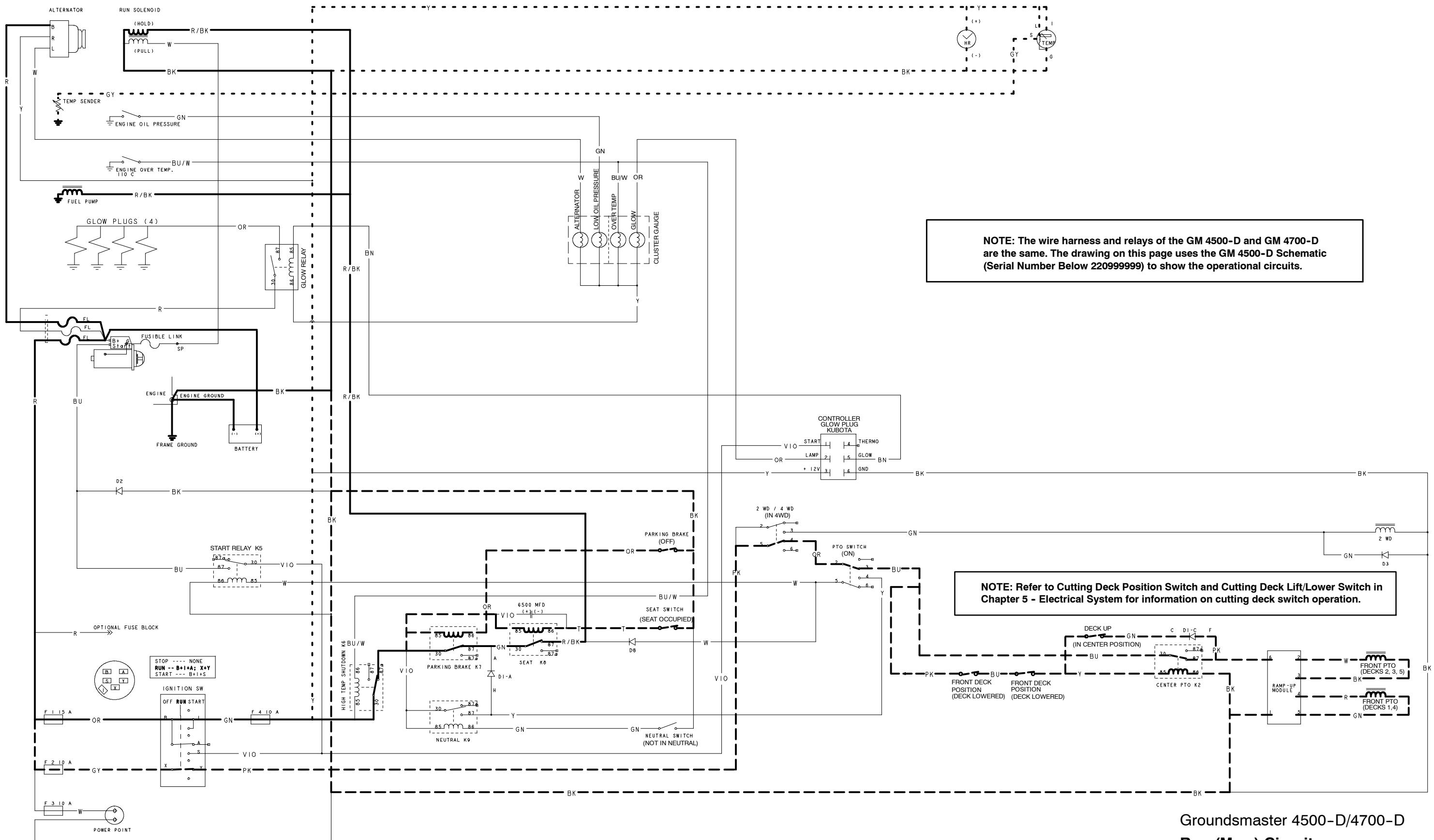
Groundsmaster 4500-D/4700-D
Crank Circuit

— Power Current
- - - Control Current
- - - - Indicator/Gauge Current



Groundsmaster 4500-D/4700-D
Run (Transport) Circuit

— Power Current
- - - Control Current
- - - - Indicator/Gauge Current

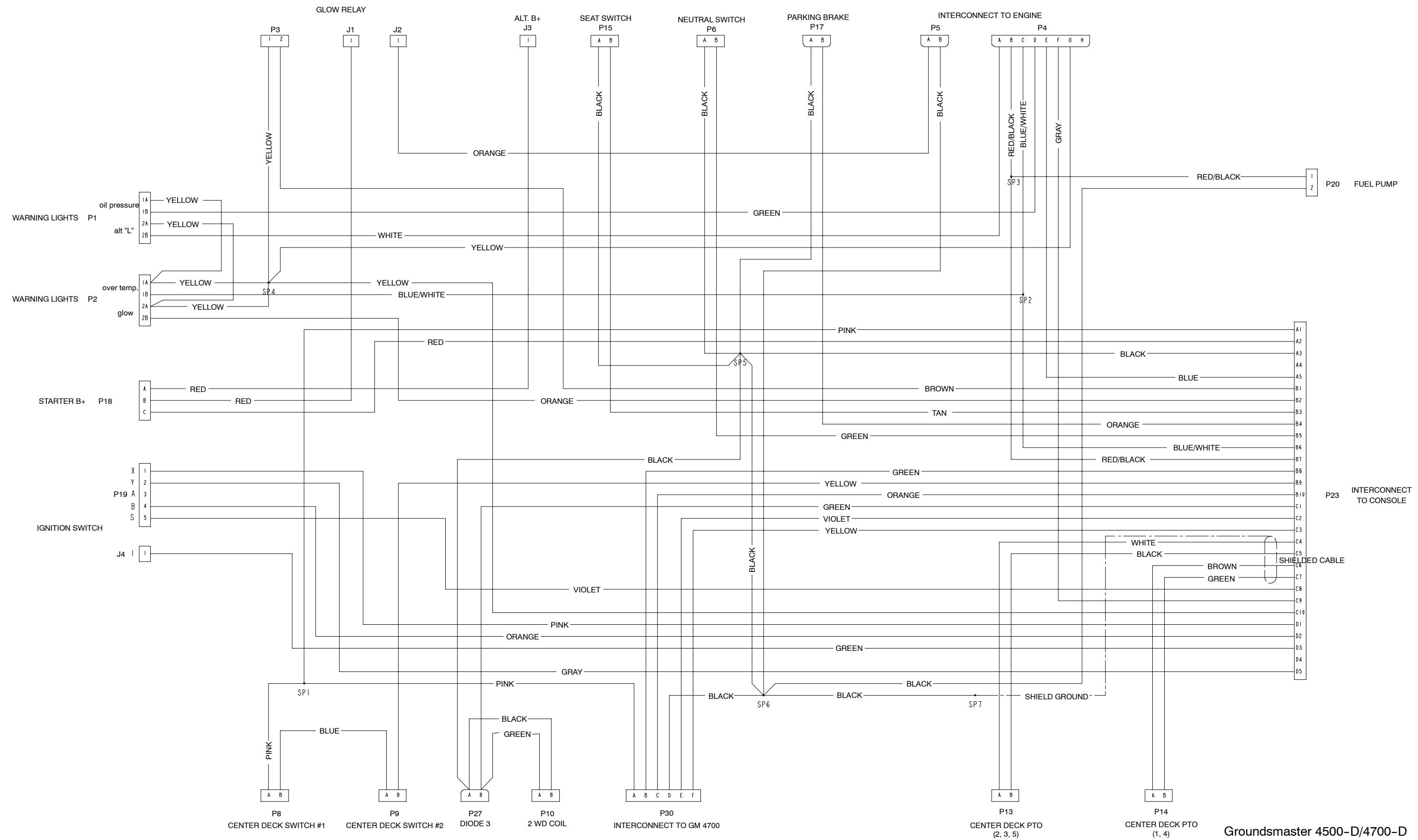


Groundsmaster 4500-D/4700-D

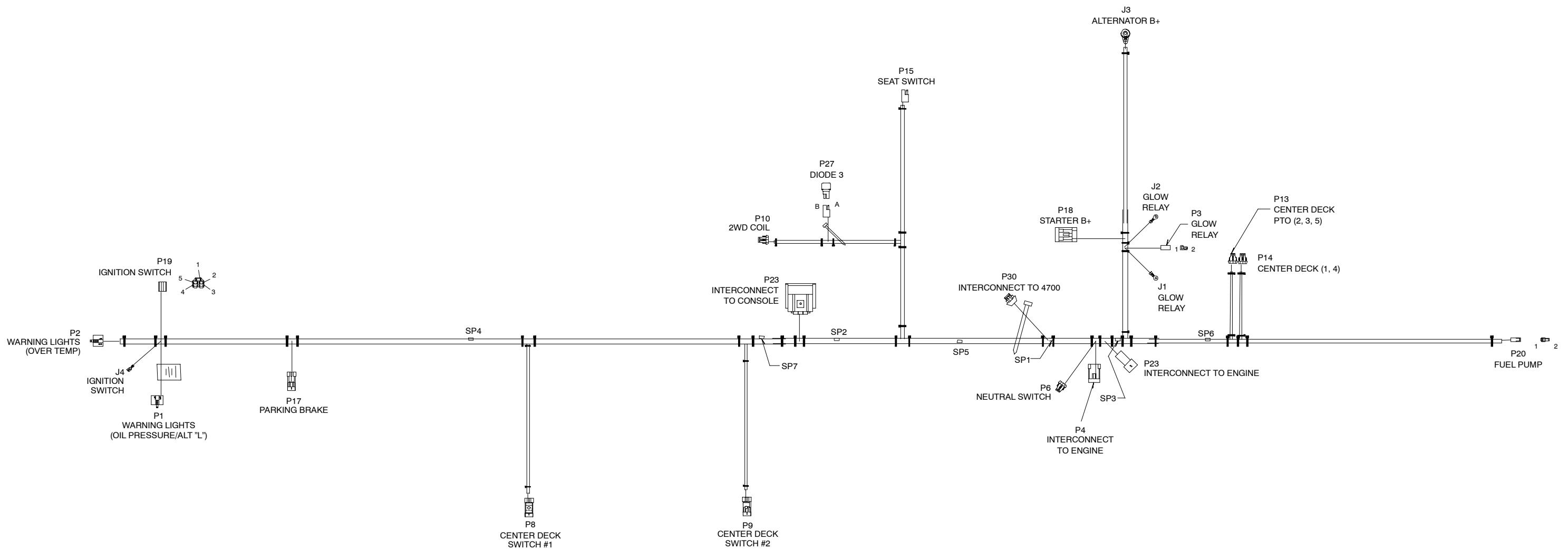
Run (Mow) Circuit

— Power Current
 - - - Control Current
 - - - - Indicator/Gauge Current

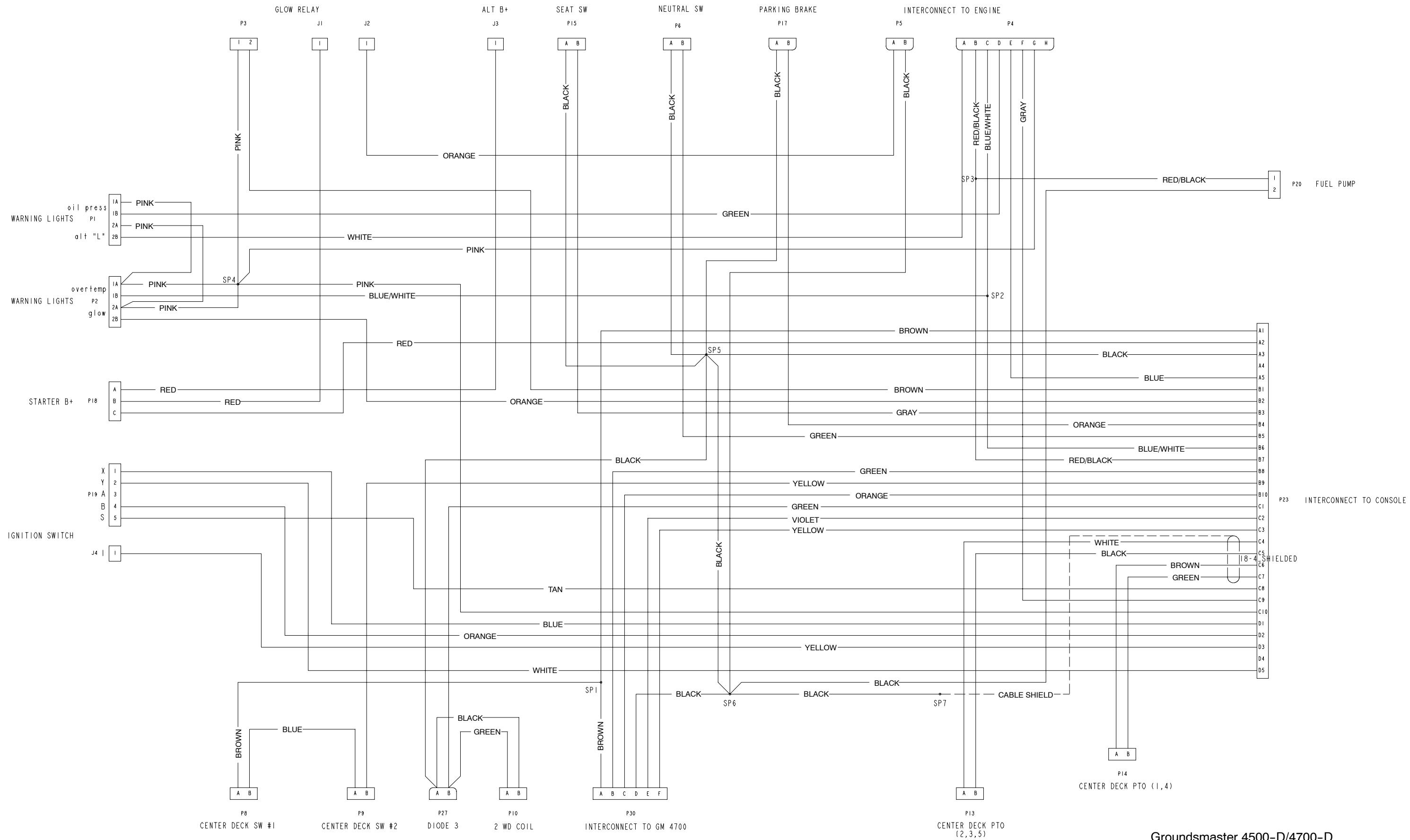
This page is intentionally blank.



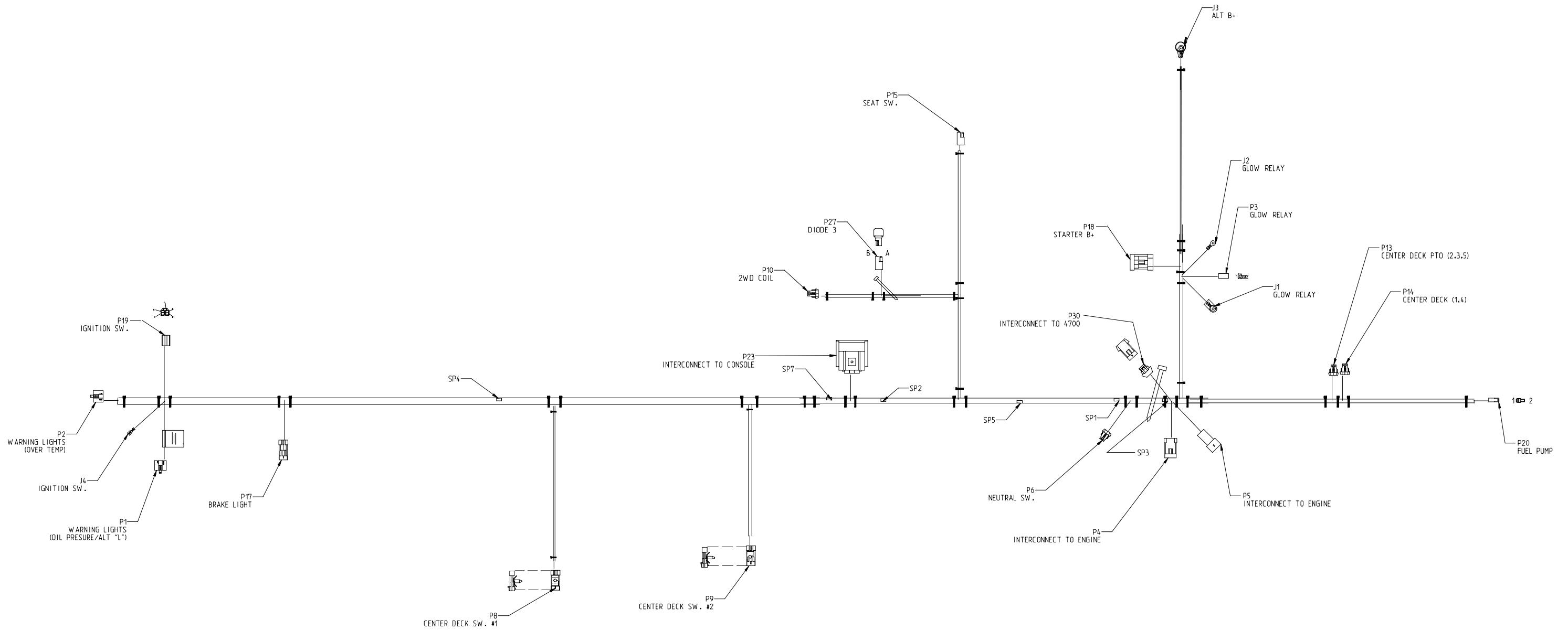
Groundsmaster 4500-D/4700-D
Serial Number Below 220999999
Main Wire Harness



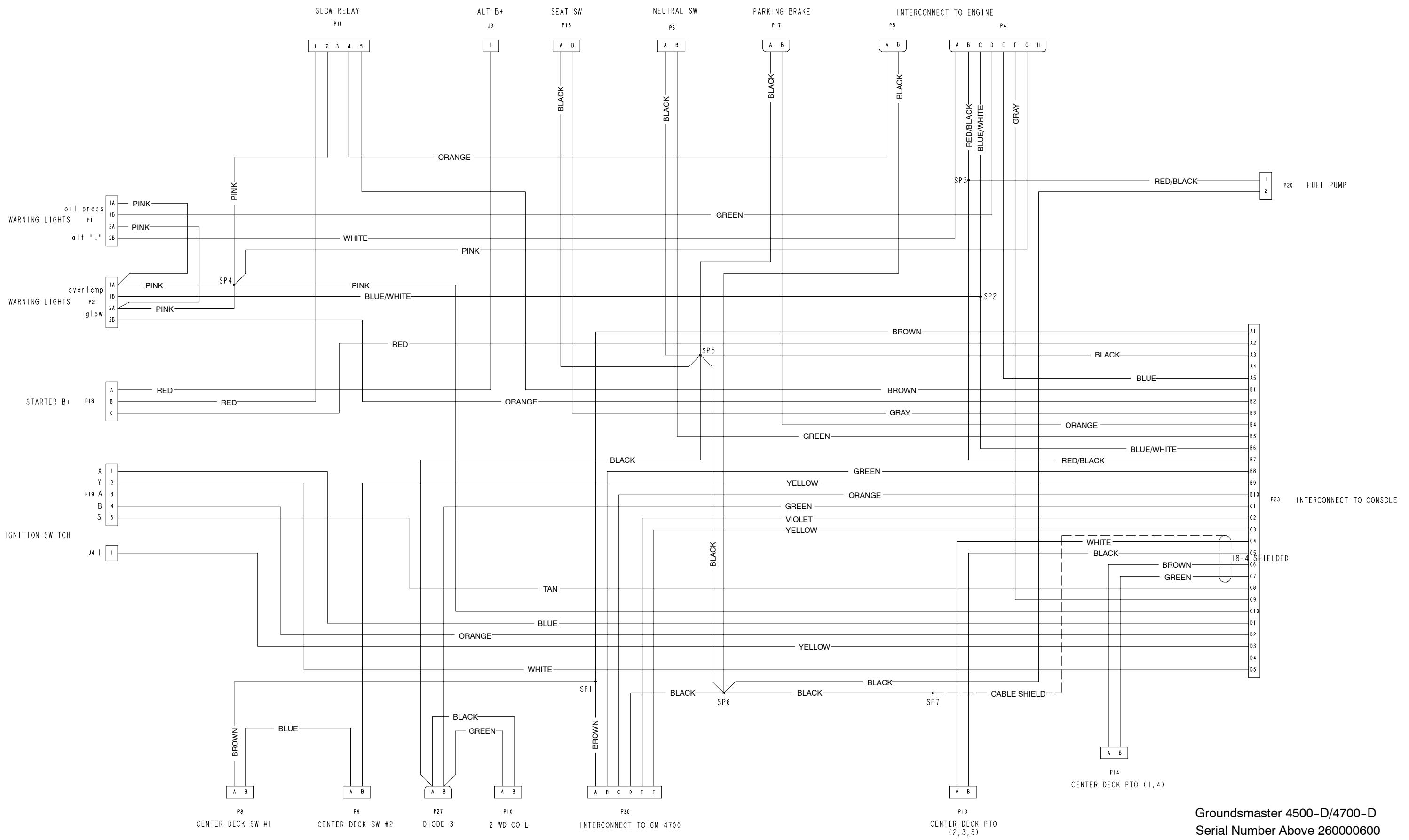
Groundsmaster 4500-D/4700-D
 Serial Number Below 220999999
Main Wire Harness



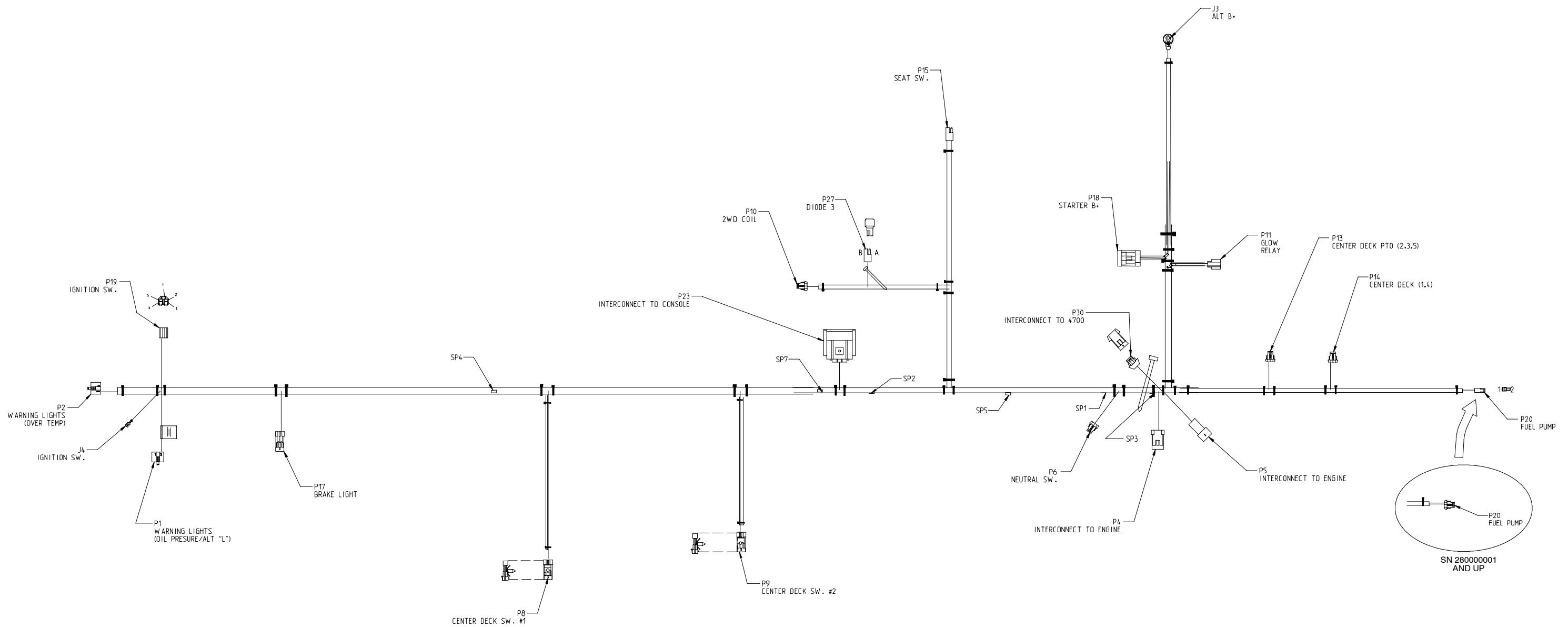
Groundsmaster 4500-D/4700-D
Serial Number From 230000001 to 260000600
Main Wire Harness



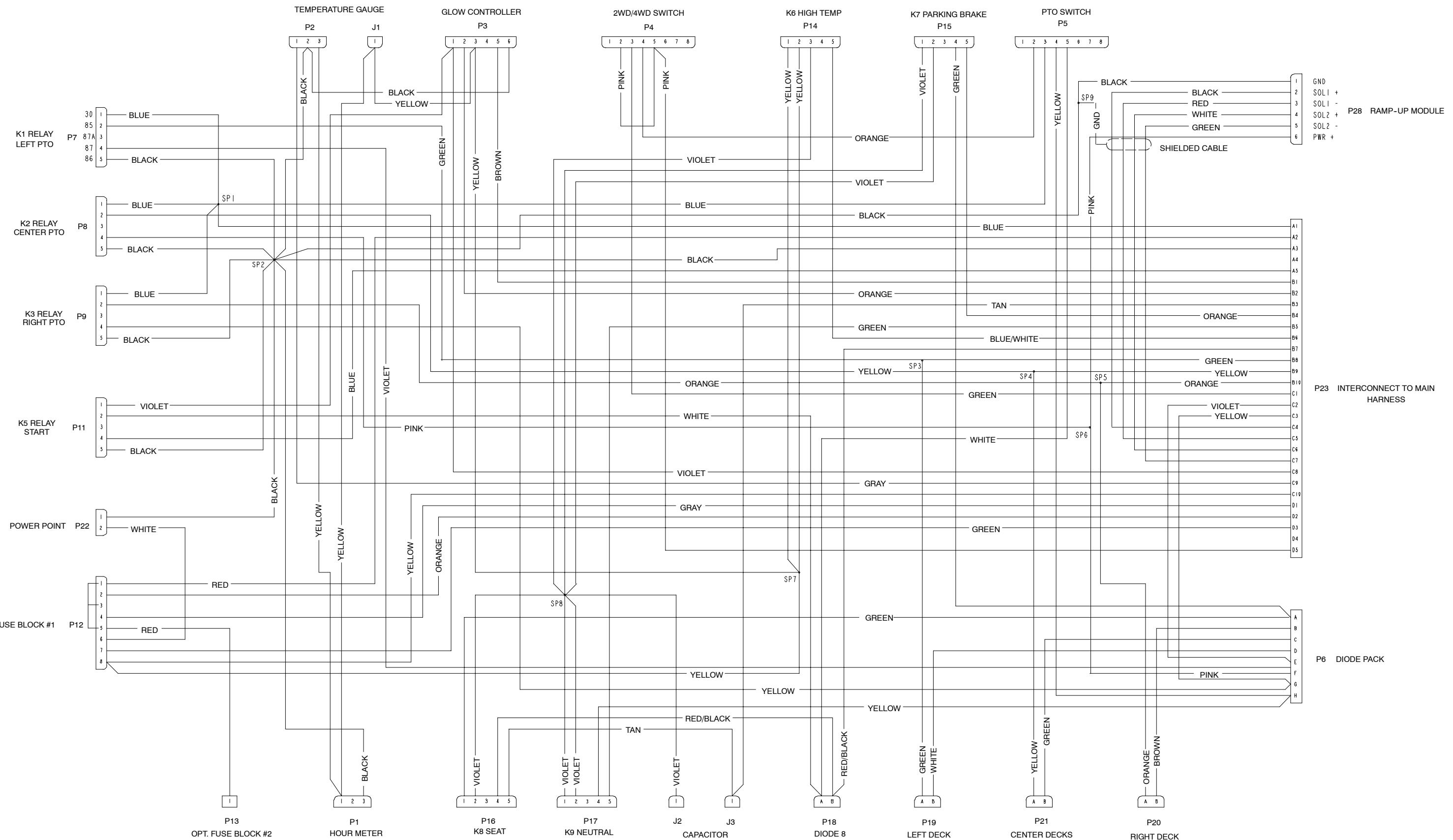
Groundsmaster 4500-D/4700-D
 Serial Number From 230000001 to 260000600
Main Wire Harness



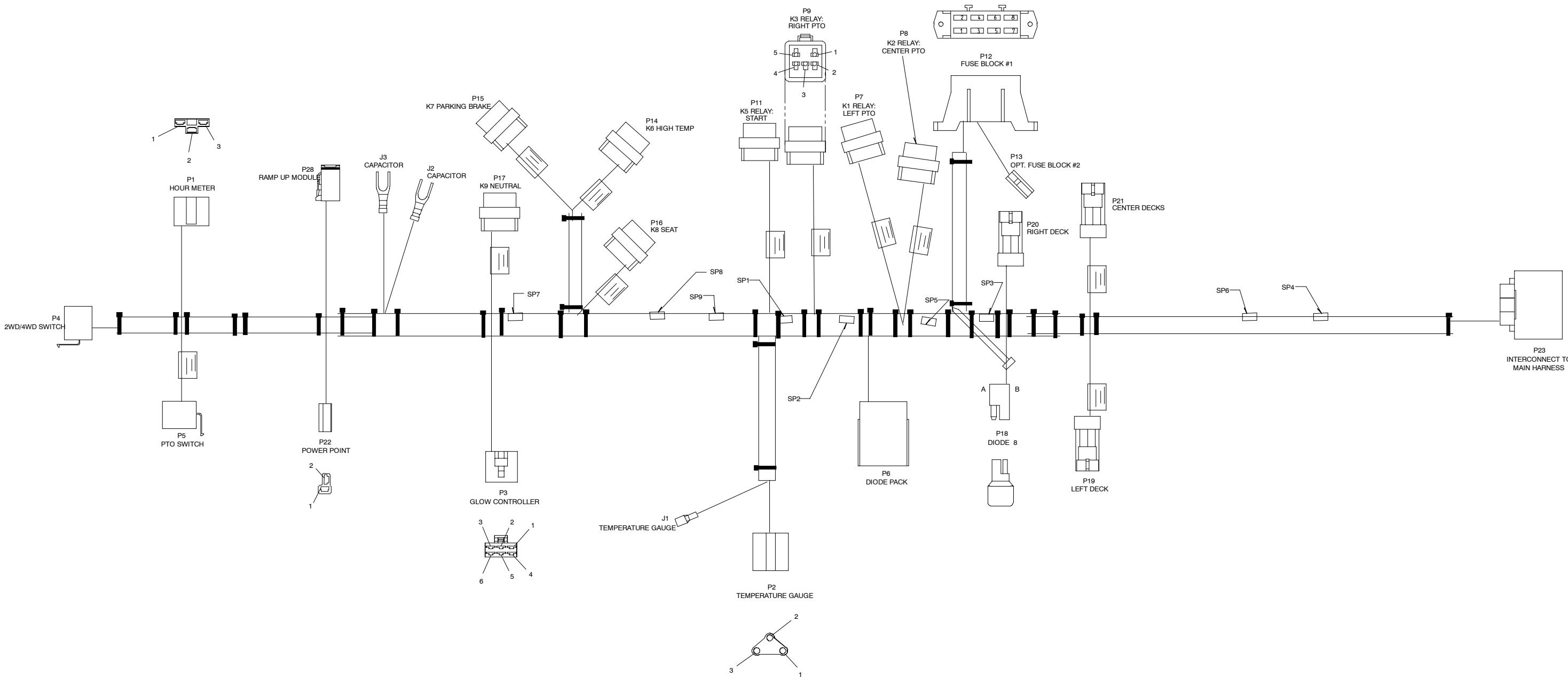
Groundsmaster 4500-D/4700-D
 Serial Number Above 260000600
Main Wire Harness



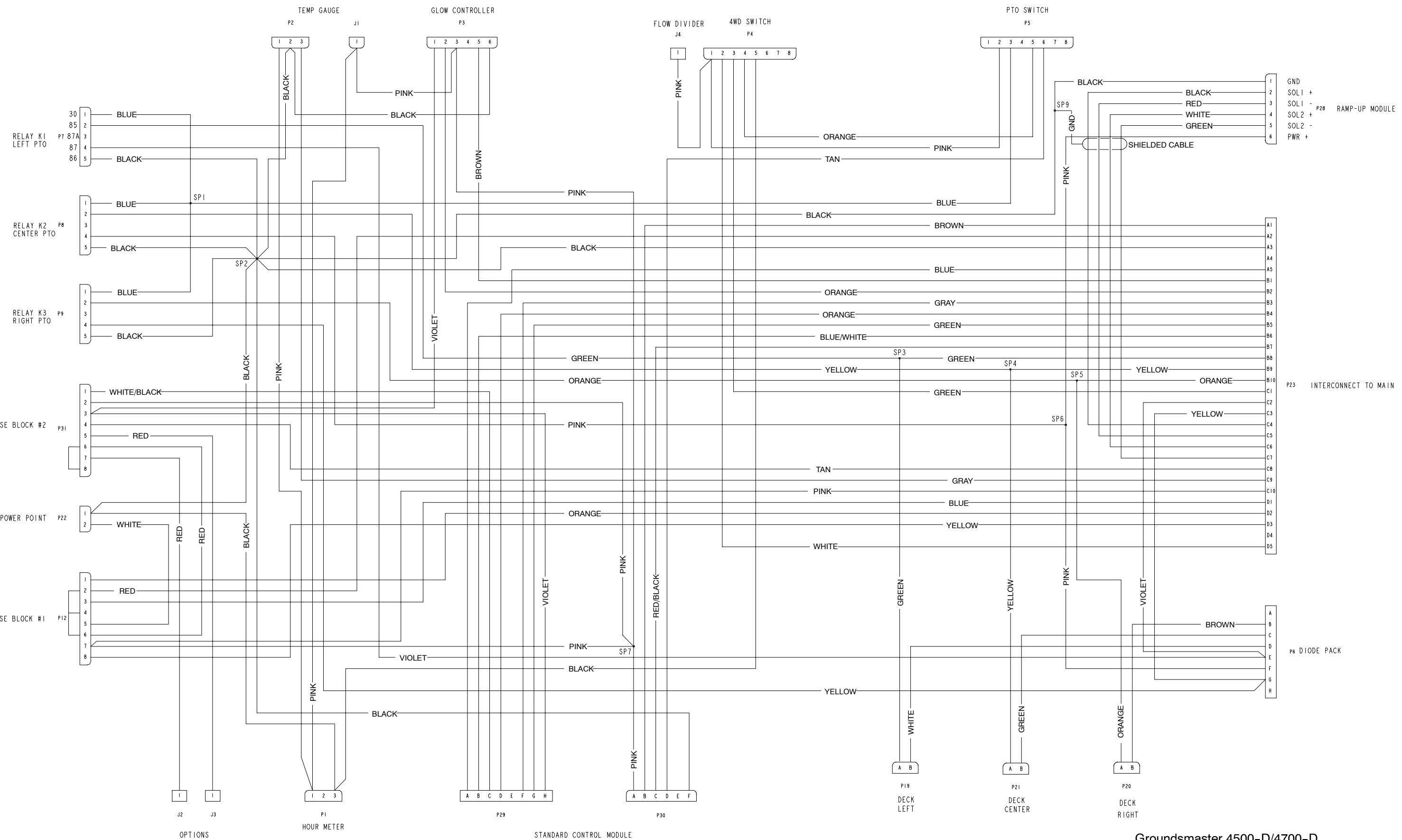
Groundsmaster 4500-D/4700-D
Serial Number Above 260000600
Main Wire Harness

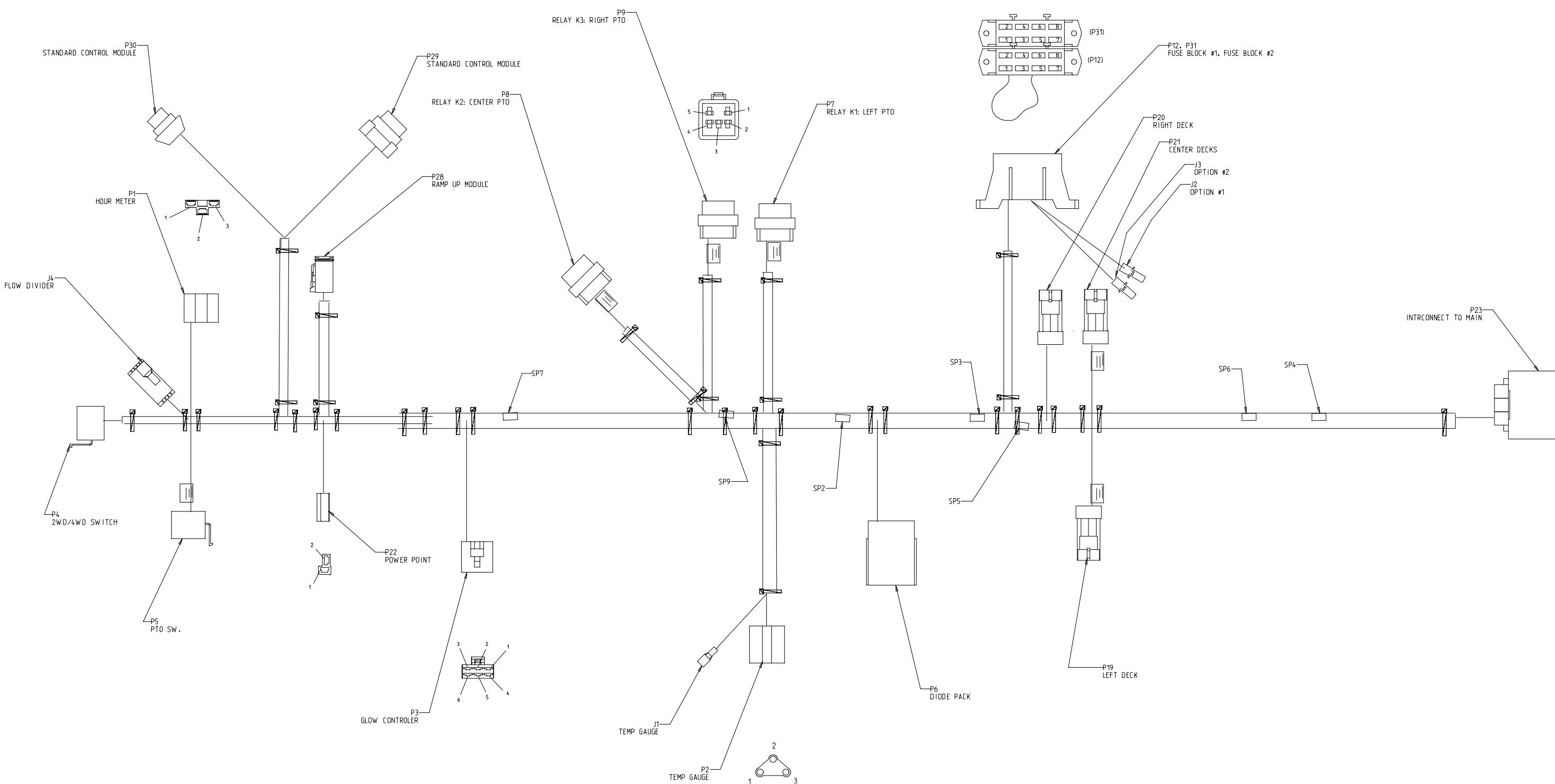


Groundsmaster 4500-D/4700-D
Serial Number Below 220999999
Console Wire Harness

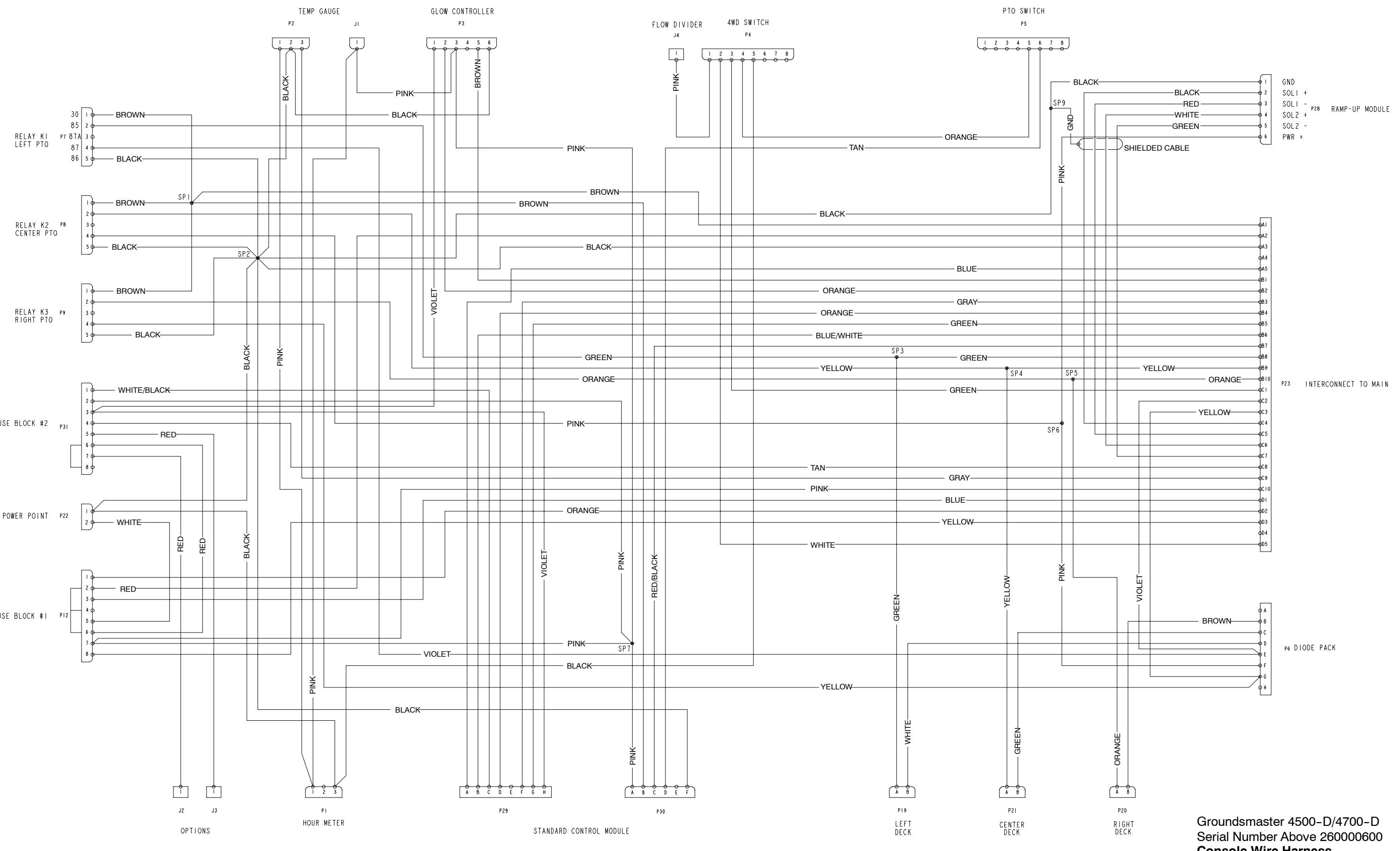


Groundsmaster 4500-D/4700-D
Serial Number Below 220999999
Console Wire Harness

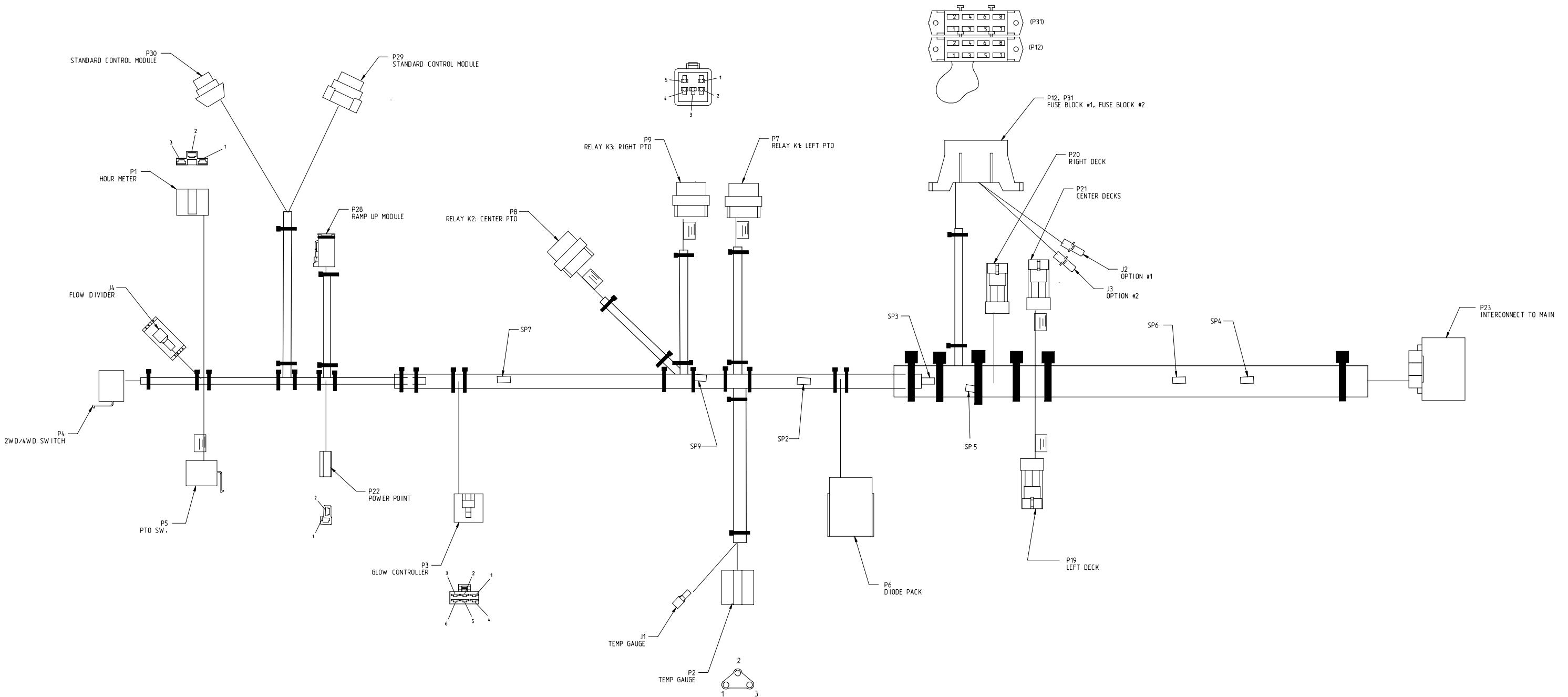




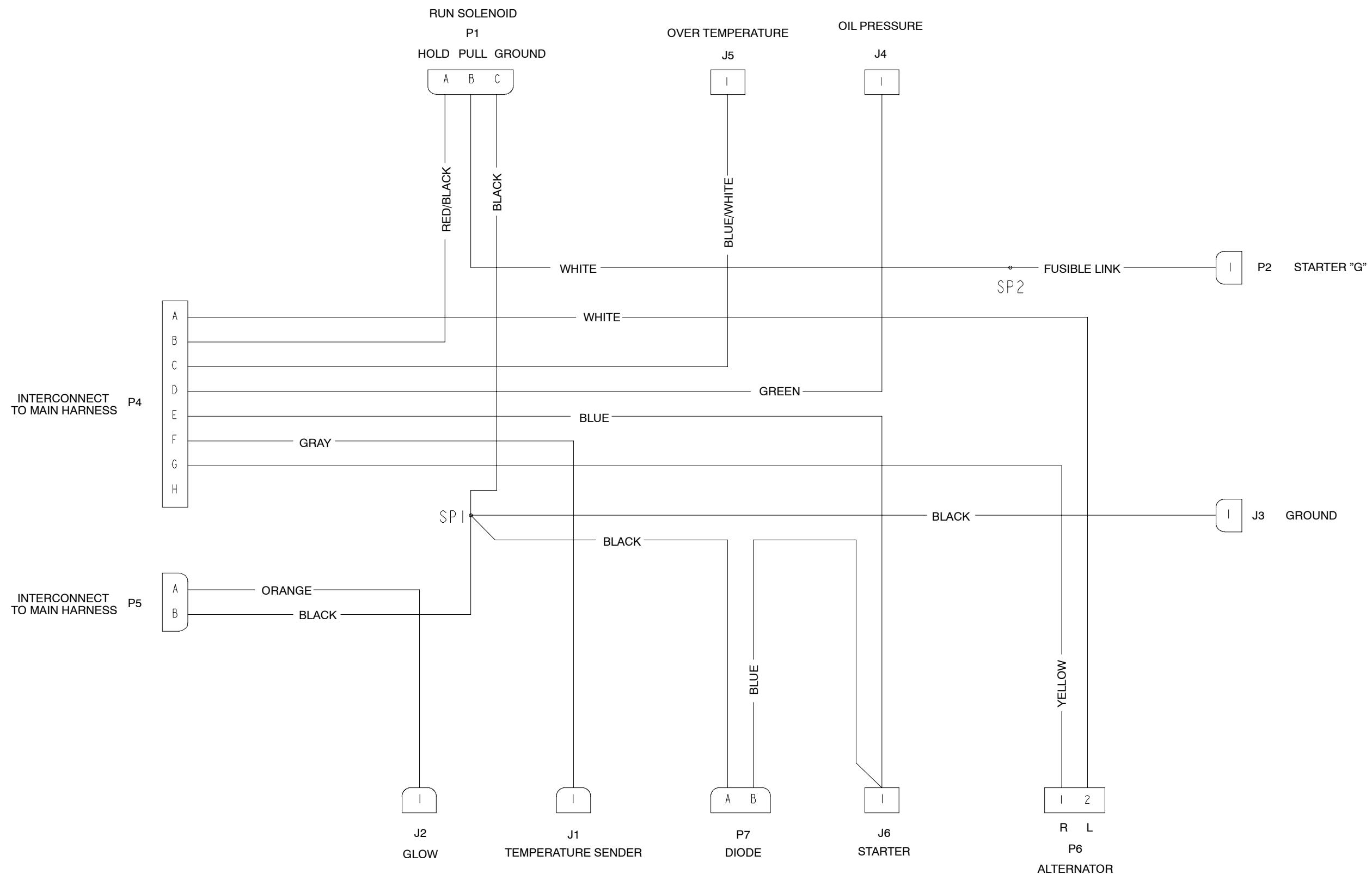
Groundsmaster 4500-D/4700-D
Serial Number From 230000001 to 260000600
Console Wire Harness



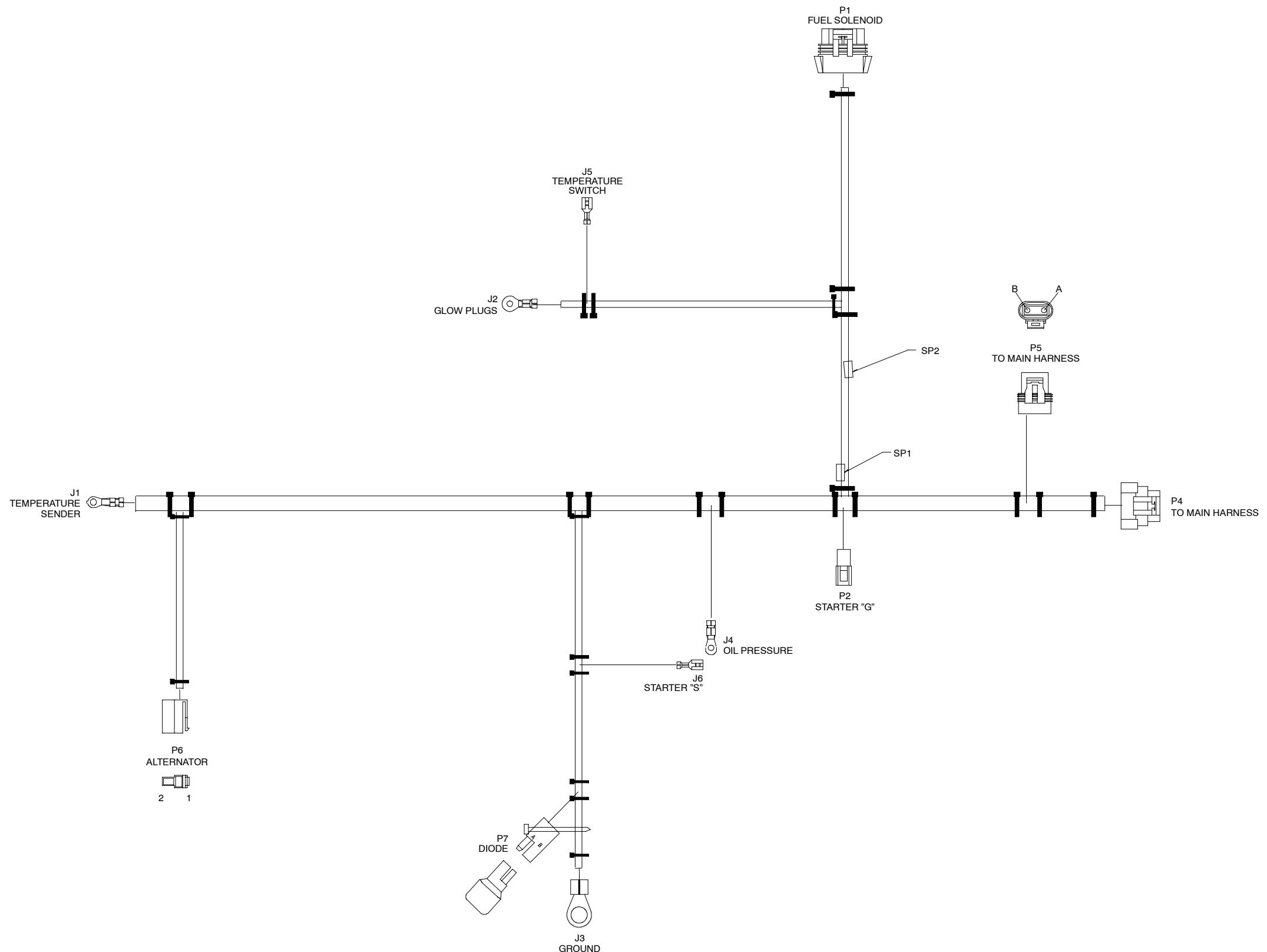
Groundsmaster 4500-D/4700-D
Serial Number Above 260000600
Console Wire Harness



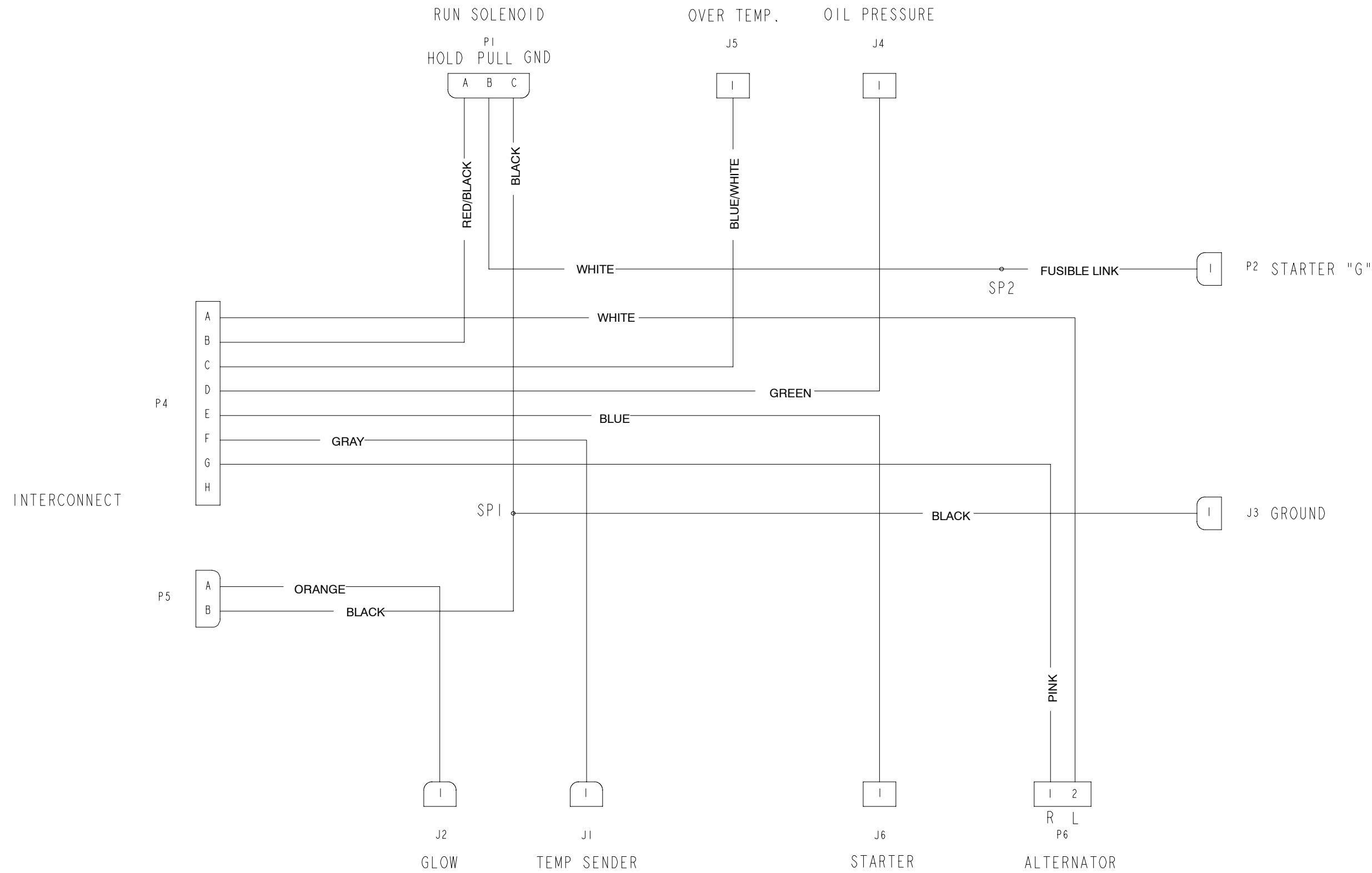
Groundmaster 4500-D/4700-D
Serial Number Above 260000600
Console Wire Harness



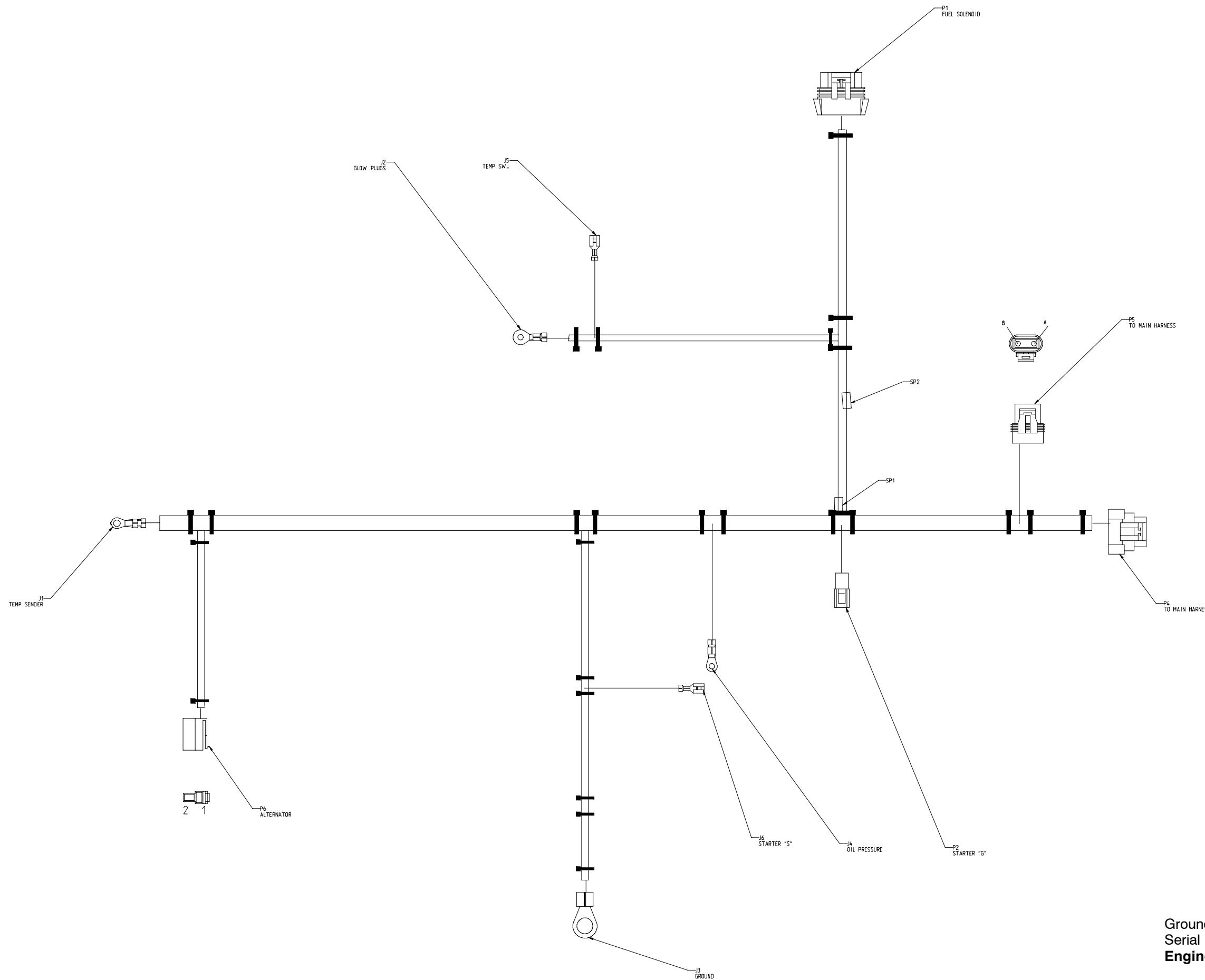
Groundsmaster 4500-D/4700-D
Serial Number Below 220999999
Engine Wire Harness



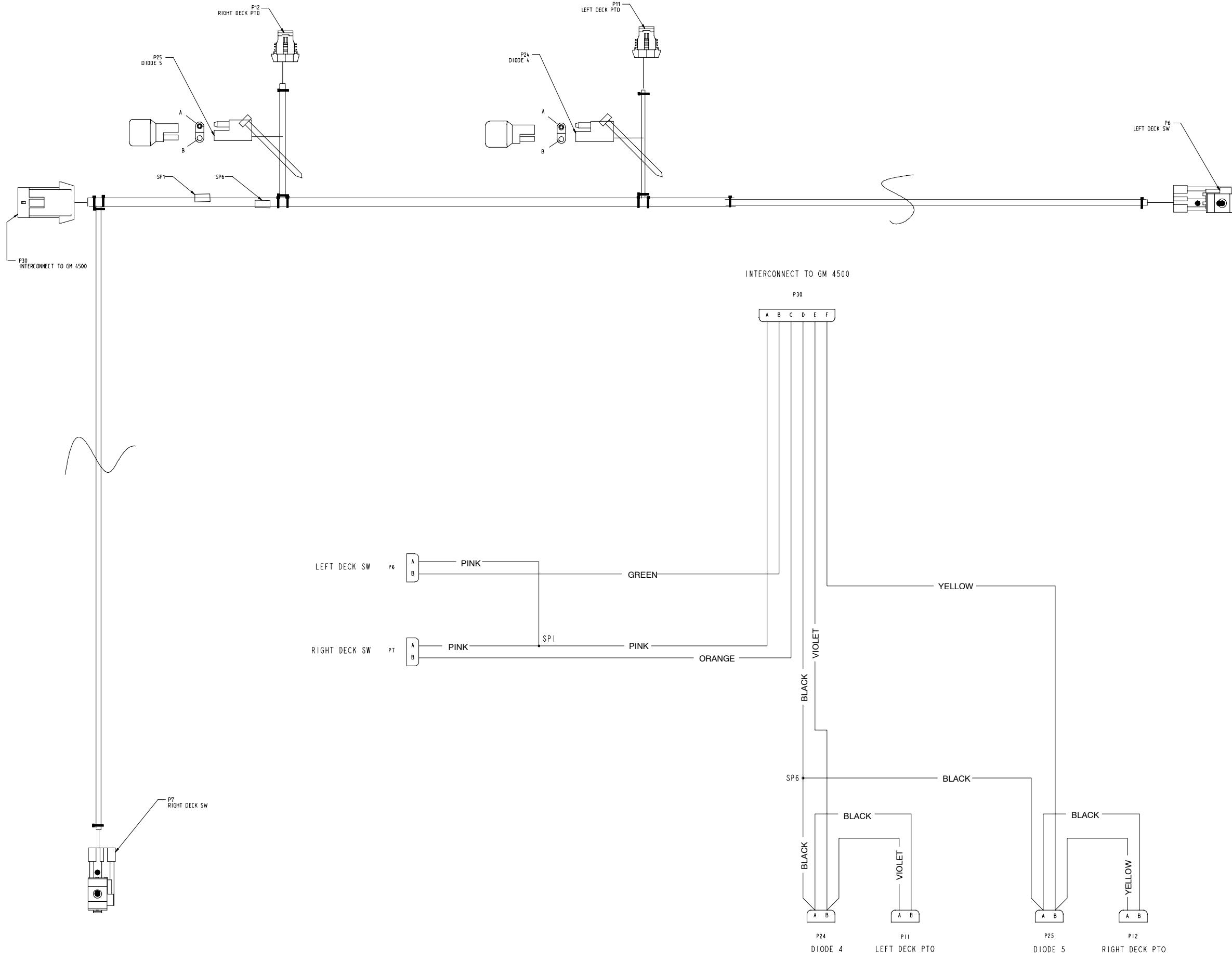
Groundsmaster 4500-D/4700-D
Serial Number Below 220999999
Engine Wire Harness



Groundmaster 4500-D/4700-D
Serial Number Above 230000000
Engine Wire Harness



Groundsmaster 4500-D/4700-D
Serial Number Above 230000000
Engine Wire Harness



Groundsmaster 4700-D
Deck 6 and 7 Wire Harness