Part No. 05138SL (Rev. A)

Service Manual

Groundsmaster® 3280−D/3320

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 3280−D and Groundsmaster 3320.

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 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
Minneapolis, MN 55420

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.

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Chapter 1

Safety

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Safety Instructions

The Groundsmaster 3280−D and 3320 meet or exceeds CEN standard EN 836:1997, ISO standard 5395:1990 (when appropriate decals applied), and ANSI B71.4−2004 specifications when weights are installed according to information in the Traction Unit Operator's Manual. Although hazard control and accident prevention partially are dependent upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern and proper training of the personnel involved in the operation, transport, maintenance and storage of the machine. Improper use or maintenance of the machine can result in injury or death. To reduce the potential for injury or death, comply with the following safety instructions.

WARNING

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

Before Operating

1. 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.

3. Assure interlock switches are adjusted correctly so engine cannot be started unless traction pedal is in NEUTRAL and P.T.O. switch is OFF (disengaged).

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

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

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

   C. Do not smoke while handling fuel.

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

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

   F. If fuel is spilled, do not attempt to start the engine but move the machine away from the area of the spillage. Avoid creating any source of ignition until fuel vapors have dissipated. Wipe up any spilled fuel.

While Operating

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

2. Before starting the engine:

   A. Engage the parking brake.

   B. Make sure traction pedal is in neutral and the P.T.O. 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 (see Traction Unit Operator's Manual).

3. Do not run engine in a confined area without adequate ventilation. Exhaust fumes are hazardous and could possibly be deadly.

4. Do not touch engine, radiator or exhaust system while engine is running or soon after it is stopped. These areas could be hot enough to cause burns.

5. Before getting off the seat:

   A. Ensure that traction pedal is in neutral.

   B. Lower and disengage cutting deck (or implement) and wait for all movement to stop.

   C. Set parking brake.

   D. Stop engine and remove key from ignition switch.

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

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

Maintenance and Service

1. Before servicing or making adjustments, lower cutting deck (or implement), 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 hydraulic system.

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

6. Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved by lowering the cutting deck (or implement) to the ground, stopping the engine and then using all of the hydraulic controls (depressing the traction pedal, turning the steering wheel and moving the lift/lower lever to both raise and lower).

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

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

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

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

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

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

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

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

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

16. If welding on the machine is necessary, disconnect the negative battery cable to prevent electrical system damage.

17. At the time of manufacture, the machine conformed to the safety standards for riding mowers. To assure optimum performance and continued safety certification of the machine, use genuine Toro replacement parts and accessories. Replacement parts and accessories made by other manufacturers may result in non-conformance with the safety standards, and the warranty may be voided.

18. When changing attachments, tires or performing other service, use correct blocks, hoists and jacks. Make sure machine is parked on a solid level 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 in this section).

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.

Front End Jacking

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

2. Position jack securely under the frame (not the axle), 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 wheel as possible to support the machine.

Rear End Jacking

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

2. Place jack securely under the frame (not the axle) directly in front of the rear axle.

3. Jack rear of machine off the ground.

4. Position jack stands or hardwood blocks under the frame to support the machine.

Safety and Instruction Decals

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

Chapter 2

Product Records and Maintenance

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Product Records

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

Maintenance

Maintenance procedures and recommended service intervals for the Groundsmaster 3280−D and Groundsmaster 3320 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	0.9375	— 2.381	19/32	0.59375	— 15.081
7/64	0.109275	— 2.778	39/64	0.609375	— 15.478
1/8	0.1250	— 3.175	**5/8**	0.6250	— 15.875
9/64	0.140625	— 3.572	41/64	0.640625	— 16.272
5/32	0.15625	— 3.969	21/32	0.65625	— 16.669
11/64	0.171875	— 4.366	43/64	0.671875	— 17.066
3/16	0.1875	— 4.762	11/16	0.6875	— 17.462
13/64	0.203125	— 5.159	45/64	0.703125	— 17.859
7/32	0.21875	— 5.556	23/32	0.71875	— 18.256
15/64	0.234375	— 5.953	47/64	0.734375	— 18.653
1/4	0.2500	— 6.350	**3/4**	0.7500	— 19.050
17/64	0.265625	— 6.747	49/64	0.765625	— 19.447
9/32	0.28125	— 7.144	25/32	0.78125	— 19.844
19/64	0.296875	— 7.541	51/64	0.796875	— 20.241
5/16	0.3125	— 7.938	13/16	0.8125	— 20.638
21/64	0.328125	— 8.334	53/64	0.828125	— 21.034
11/32	0.34375	— 8.731	27/32	0.84375	— 21.431
23/64	0.359375	— 9.128	55/64	0.859375	— 21.828
3/8	0.3750	— 9.525	**7/8**	0.8750	— 22.225
25/64	0.390625	— 9.922	57/64	0.890625	— 22.622
13/32	0.40625	— 10.319	29/32	0.90625	— 23.019
27/64	0.421875	— 10.716	59/64	0.921875	— 23.416
7/16	0.4375	— 11.112	15/16	0.9375	— 23.812
29/64	0.453125	— 11.509	61/64	0.953125	— 24.209
15/32	0.46875	— 11.906	31/32	0.96875	— 24.606
31/64	0.484375	— 12.303	63/64	0.984375	— 25.003
1/2	0.5000	— 12.700	**1**	1.000	— 25.400

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

U.S.to Metric Conversions

	To Convert	Into	Multiply By
Linear Measurement	Miles	Kilometers	1.609
	Yards	Meters	0.9144
	Feet	Meters	0.3048
	Feet	Centimeters	30.48
	Inches	Meters	0.0254
	Inches	Centimeters	2.54
	Inches	Millimeters	25.4
Area	Square Miles	Square Kilometers	2.59
	Square Feet	Square Meters	0.0929
	Square Inches	Square Centimeters	6.452
	Acre	Hectare	0.4047
Volume	Cubic Yards	Cubic Meters	0.7646
	Cubic Feet	Cubic Meters	0.02832
	Cubic Inches	Cubic Centimeters	16.39
Weight	Tons (Short)	Metric Tons	0.9078
	Pounds	Kilograms	0.4536
	Ounces (Avdp.)	Grams	28.3495
Pressure	Pounds/Sq. In.	Kilopascal	6.895
	Pounds/Sq. In.	Bar	0.069
Work	Foot-pounds	Newton-Meters	1.356
	Foot-pounds	Kilogram-Meters	0.1383
	Inch-pounds	Kilogram-Centimeters	1.152144
Liquid Volume	Quarts	Liters	0.9463
	Gallons	Liters	3.785
Liquid Flow	Gallons/Minute	Liters/Minute	3.785
Temperature	Fahrenheit	Celsius	1. Subract 32° 2. Multiply by 5/9

Torque Specifications

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

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

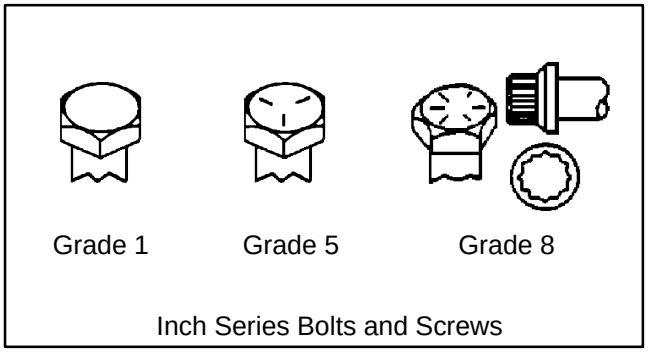

Figure 1

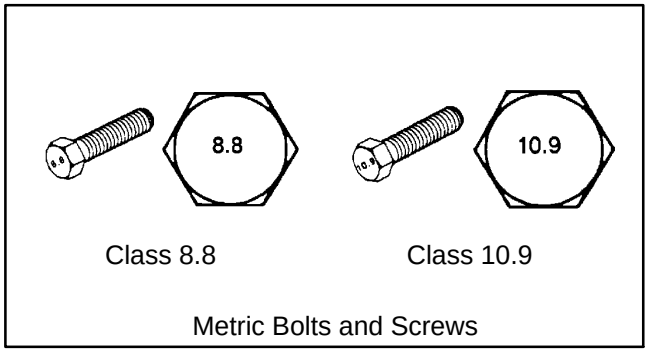

Figure 2

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 ± 2	13 ± 2	147 ± 23	15 ± 2	169 ± 23	23 ± 3	262 ± 34
# 6 − 40 UNF				17 ± 2	192 ± 23	25 ± 3	282 ± 34
# 8 − 32 UNC	13 ± 2	25 ± 5	282 ± 56	29 ± 3	328 ± 34	41 ± 5	463 ± 56
# 8 − 36 UNF				31 ± 4	350 ± 45	43 ± 5	486 ± 56
# 10 − 24 UNC	18 ± 2	30 ± 5	339 ± 56	42 ± 5	475 ± 56	60 ± 6	678 ± 68
# 10 − 32 UNF				48 ± 5	542 ± 56	68 ± 7	768 ± 79
1/4 − 20 UNC	48 ± 7	53 ± 7	599 ± 79	100 ± 10	1130 ± 113	140 ± 15	1582 ± 169
1/4 − 28 UNF	53 ± 7	65 ± 10	734 ± 113	115 ± 12	1299 ± 136	160 ± 17	1808 ± 192
5/16 − 18 UNC	115 ± 15	105 ± 15	1186 ± 169	200 ± 25	2260 ± 282	300 ± 30	3390 ± 339
5/16 − 24 UNF	138 ± 17	128 ± 17	1446 ± 192	225 ± 25	2542 ± 282	325 ± 33	3672 ± 373
	ft−lb	**ft−lb**	**N−m**	**ft−lb**	**N−m**	**ft−lb**	**N−m**
3/8 − 16 UNC	16 ± 2	16 ± 2	22 ± 3	30 ± 3	41 ± 4	43 ± 5	58 ± 7
3/8 − 24 UNF	17 ± 2	18 ± 2	24 ± 3	35 ± 4	47 ± 5	50 ± 6	68 ± 8
7/16 − 14 UNC	27 ± 3	27 ± 3	37 ± 4	50 ± 5	68 ± 7	70 ± 7	95 ± 9
7/16 − 20 UNF	29 ± 3	29 ± 3	39 ± 4	55 ± 6	75 ± 8	77 ± 8	104 ± 11
1/2 − 13 UNC	30 ± 3	48 ± 7	65 ± 9	75 ± 8	102 ± 11	105 ± 11	142 ± 15
1/2 − 20 UNF	32 ± 4	53 ± 7	72 ± 9	85 ± 9	115 ± 12	120 ± 12	163 ± 16
5/8 − 11 UNC	65 ± 10	88 ± 12	119 ± 16	150 ± 15	203 ± 20	210 ± 21	285 ± 28
5/8 − 18 UNF	75 ± 10	95 ± 15	129 ± 20	170 ± 18	230 ± 24	240 ± 24	325 ± 33
3/4 − 10 UNC	93 ± 12	140 ± 20	190 ± 27	265 ± 27	359 ± 37	375 ± 38	508 ± 52
3/4 − 16 UNF	115 ± 15	165 ± 25	224 ± 34	300 ± 30	407 ± 41	420 ± 43	569 ± 58
7/8 − 9 UNC	140 ± 20	225 ± 25	305 ± 34	430 ± 45	583 ± 61	600 ± 60	813 ± 81
7/8 − 14 UNF	155 ± 25	260 ± 30	353 ± 41	475 ± 48	644 ± 65	667 ± 66	904 ± 89

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

NOTE: Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

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

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

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

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

NOTE: Torque values may have to be reduced when installing fasteners into threaded aluminum or brass. The specific torque value should be determined based on the fastener size, the aluminum or base material strength, length of thread engagement, etc.

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

Other Torque Specifications

SAE Grade 8 Steel Set Screws

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

Wheel Bolts and Lug Nuts

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

** For steel wheels and non−lubricated fasteners.

Thread Cutting Screws (Zinc Plated Steel)

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

Thread Cutting Screws (Zinc Plated Steel)

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

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

Conversion Factors

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

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

Chapter 3

Gasoline Engine

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Introduction

This Chapter gives information about specifications, troubleshooting, testing and repair of the Briggs & Stratton/Daihatsu gasoline engine used in the Groundsmaster 3320.

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

Service and repair parts for Briggs & Stratton/Daihatsu gasoline engines are supplied through your local Toro Distributor. If no parts list is available, be sure to provide your distributor with the Toro model and serial number.

Specifications

Item	Description
Make / Designation	Briggs & Stratton/Daihatsu, 4−stroke, Liquid Cooled, OHV, Gasoline
Number of Cylinders	3
Bore x Stroke mm (in.)	72 x 78 (2.834 x 3.07)
Total Displacement cc (cu. in.)	952 (58.1)
Compression Ratio	8.6:1
Firing Order	1 − 2 − 3
Dry Weight (approximate) kg (lb.)	62 (137)
Fuel	Unleaded, regular grade (87 octane minimum)
Carburetor	Single barrel, float feed, 12 VDC shut−off solenoid
Fuel Tank Capacity liter (U.S. gal.)	48.5 (12.8)
Governor	Mechanical
Idle Speed (no load)	1400 to 1550 RPM
High Idle (no load)	3100 to 3250 RPM
Engine Oil	API Service Classification SE or better (see Traction Unit Operator's Manual for viscosity)
Oil Pump	Gear driven trochoid type
Crankcase Oil Capacity liter (U.S. qt.)	3.3 (3.5) with filter
Water Pump	Belt driven centrifugal type
Cooling System Capacity (including reserve tank) liter (U.S. qt.)	4.3 (4.5)
Starter	12 VDC 1.2 KW
Alternator/Regulator	12 VDC 40 AMP

Adding Oil to Engine

When adding oil to the engine, maintain clearance between the oil fill device and the oil fill opening in the valve cover (Fig. 1). This clearance is necessary to allow venting when adding engine oil which will prevent oil from running into the breather tube and intake system.

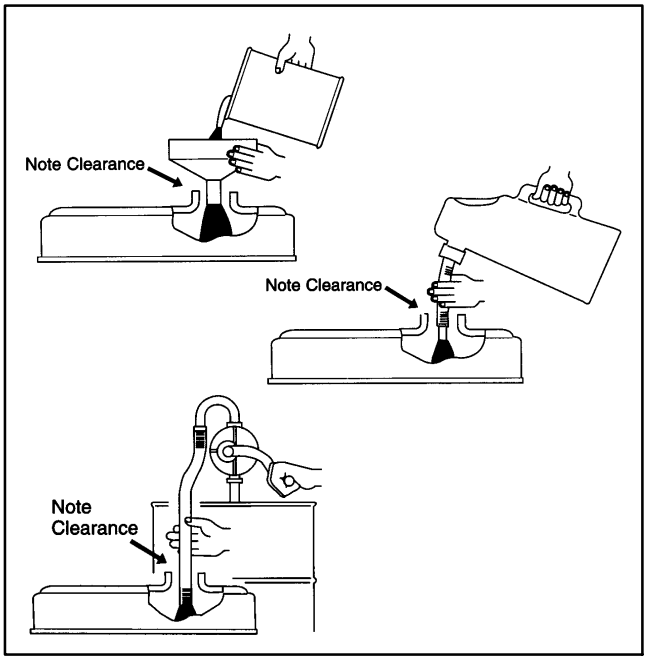

Figure 1

Adjustments

Adjust Throttle Control

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

1. Move remote throttle control lever to **FAST** position.

2. Check position of speed control lever on governor bracket. Speed control lever should be contacting high speed screw when throttle control lever is in **FAST** position.

3. If necessary, throttle control can be adjusted by loosening cable clamp screw and repositioning control cable until speed control lever contacts high speed screw when throttle control lever is in **FAST** position.

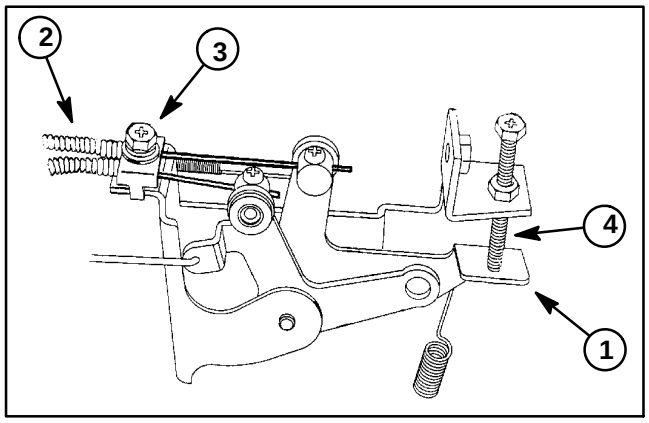

Figure 2

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

Adjust Choke Control

Proper cold engine starting is dependent upon proper adjustment of choke control. Make sure choke control is operating properly.

1. Move choke control lever to **START** position.

2. Check position of choke lever on carburetor. Choke lever should be fully closed when choke lever is in **START** position.

3. If necessary, choke control can be adjusted by loosening cable clamp screw and repositioning choke cable until carburetor choke lever is fully closed when choke control lever is in **START** position.

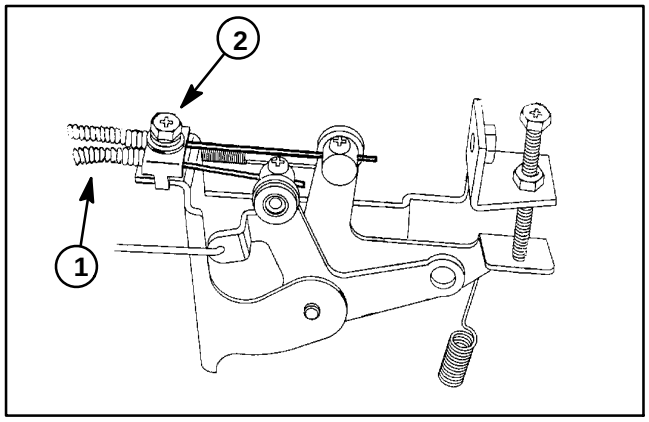

Figure 3

1. **Choke cable**
2. **Cable clamp screw**

Adjust Engine Speed

1. Allow engine to reach operating temperature before checking or adjusting engine speed. Make sure that throttle control is adjusted properly before adjusting engine speed (see Adjust Throttle Control in this section).

2. Park machine on a level surface, lower cutting deck (or implement) and engage parking brake. Make sure that P.T.O. switch is OFF. Raise hood to gain access to engine controls.

3. With engine running, move remote throttle control lever to **FAST** position.

4. Using a tachometer, check that engine is operating at **3100 to 3250 RPM**.

5. If high idle speed is incorrect, adjust high speed screw on governor bracket (Fig. 4).

   A. Loosen lock nut on high speed screw.

   B. Adjust high speed screw to obtain **3100 to 3250 RPM**.

   C. Tighten lock nut. Recheck high speed.

6. Move remote throttle control lever to **SLOW** position.

7. Rotate and hold carburetor throttle lever against the idle speed screw (Fig. 5). Using a tachometer, check that engine idle speed is **1400 to 1550 RPM**. If idle speed is incorrect, adjust carburetor idle speed screw to obtain **1400 to 1550 RPM**.

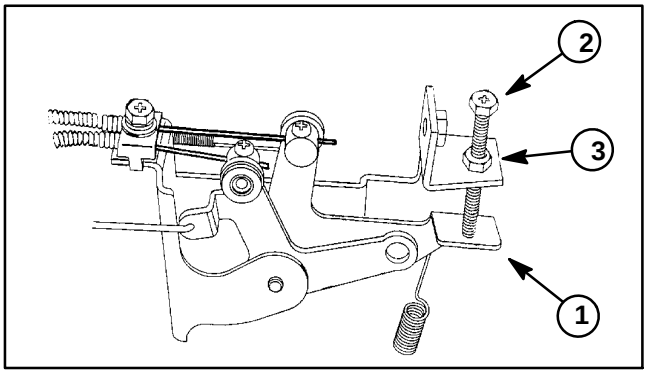

Figure 4

1. **Speed control lever**
2. **High speed screw**
3. **Lock nut**

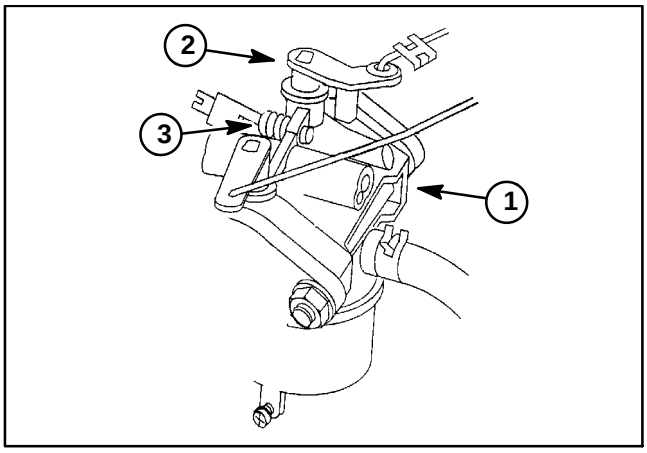

Figure 5

1. **Carburetor**
2. **Throttle lever**
3. **Idle speed screw**

Fuel System

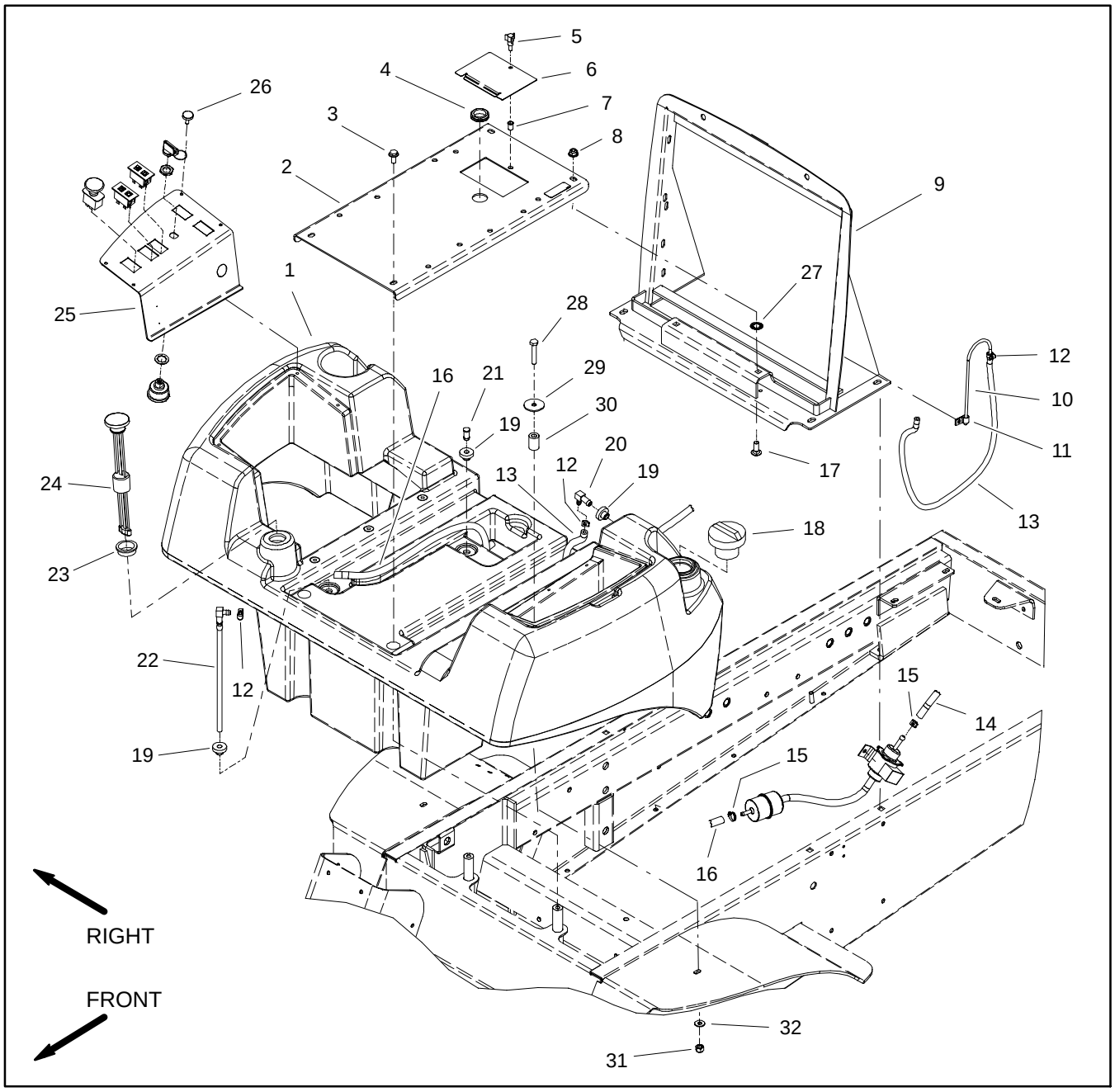

Figure 6

1. Fuel tank
2. Seat plate
3. Flange head screw (2 used)
4. Grommet
5. Knob
6. Bypass cover
7. Threaded insert
8. Flange nut (2 used)
9. Radiator support
10. Vent tube
11. R−clamp
12. Hose clamp
13. Fuel hose (tank venting)
14. Fuel hose (fuel pump to carburetor)
15. Hose clamp
16. Fuel hose (fuel supply)
17. Carriage screw (2 used)
18. Fuel cap
19. Grommet
20. Elbow fitting
21. Grommet plug
22. Stand pipe
23. Grommet
24. Fuel gauge
25. Control panel
26. Thumb screw (4 used)
27. Retaining ring
28. Cap screw
29. Flat washer
30. Spacer
31. Lock nut
32. Flat washer

DANGER

Because gasoline is highly flammable, use caution when storing or handling it. Do not smoke while filling the fuel tank. Do not fill fuel tank while engine is running, hot, or when machine is in an enclosed area. Always fill fuel tank outside and wipe up any spilled fuel before starting the engine. Store fuel in a clean, safety−approved container and keep cap in place. Use gasoline 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 solvent. Make sure tank is free of contaminates and debris.

Fuel Tank Removal (Fig. 6)

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

2. Unplug seat switch from machine wire harness.

3. Remove seat and seat suspension from machine (see Standard Seat or Suspension Seat Removal in Service and Repairs section of Chapter 7 − Chassis).

4. Remove seat plate (item 2) from machine.

5. Remove thumb screws that secure control panel (item 25) to fuel tank. Unplug wire harness connections from panel components and remove panel.

6. Remove flange head screws and flange nut that secure lower control panel to machine (Fig. 7).

7. Remove lock nut (item 31) and flat washer (item 32) from left fender.

8. Use a fuel transfer pump to remove fuel from the fuel tank and into a suitable container.

9. Disconnect fuel hoses from standpipe (item 22) and elbow fitting (item 20) on the top of the fuel tank.

10. Remove fuel tank using Figure 6 as a guide.

Fuel Tank Installation (Fig. 6)

1. Install fuel tank to frame using Figure 6 as a guide.

2. Connect fuel hoses to standpipe (item 22) and elbow fitting (item 20) on the top of the fuel tank. Secure hoses with clamps.

3. Secure lower control panel to machine with flange head screws and flange nut (Fig. 7).

4. Secure tank to left fender with flat washer (item 32) and lock nut (item 31).

5. Position control panel to fuel tank, connect wire harness to panel components and secure panel to machine with thumb screws.

6. Install seat plate to machine.

7. Install seat suspension and seat to machine (see Standard Seat or Suspension Seat Installation in Service and Repairs section of Chapter 7 − Chassis).

8. Connect seat switch to machine wire harness. Close hood.

9. Fill fuel tank (see Traction Unit Operator's Manual).

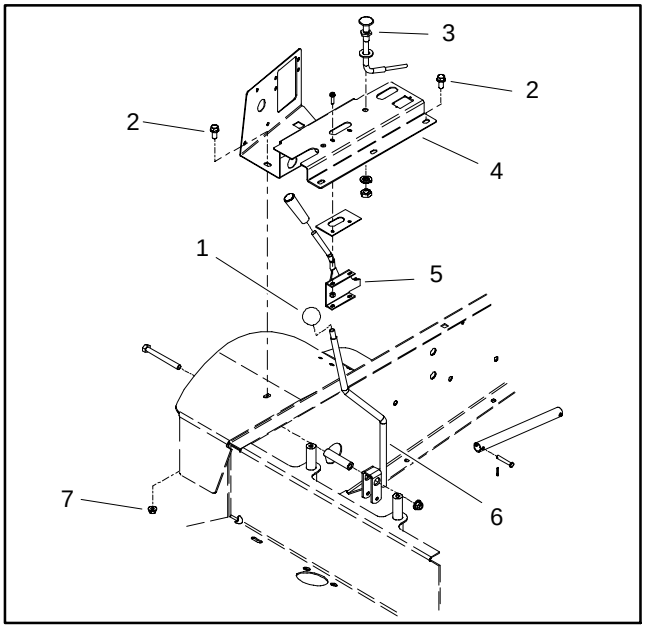

Figure 7

1. **Knob**
2. **Flange head screw**
3. **Choke control**
4. **Lower control panel**
5. **Throttle control**
6. **Lift control lever**
7. **Flange nut**

Air Cleaner

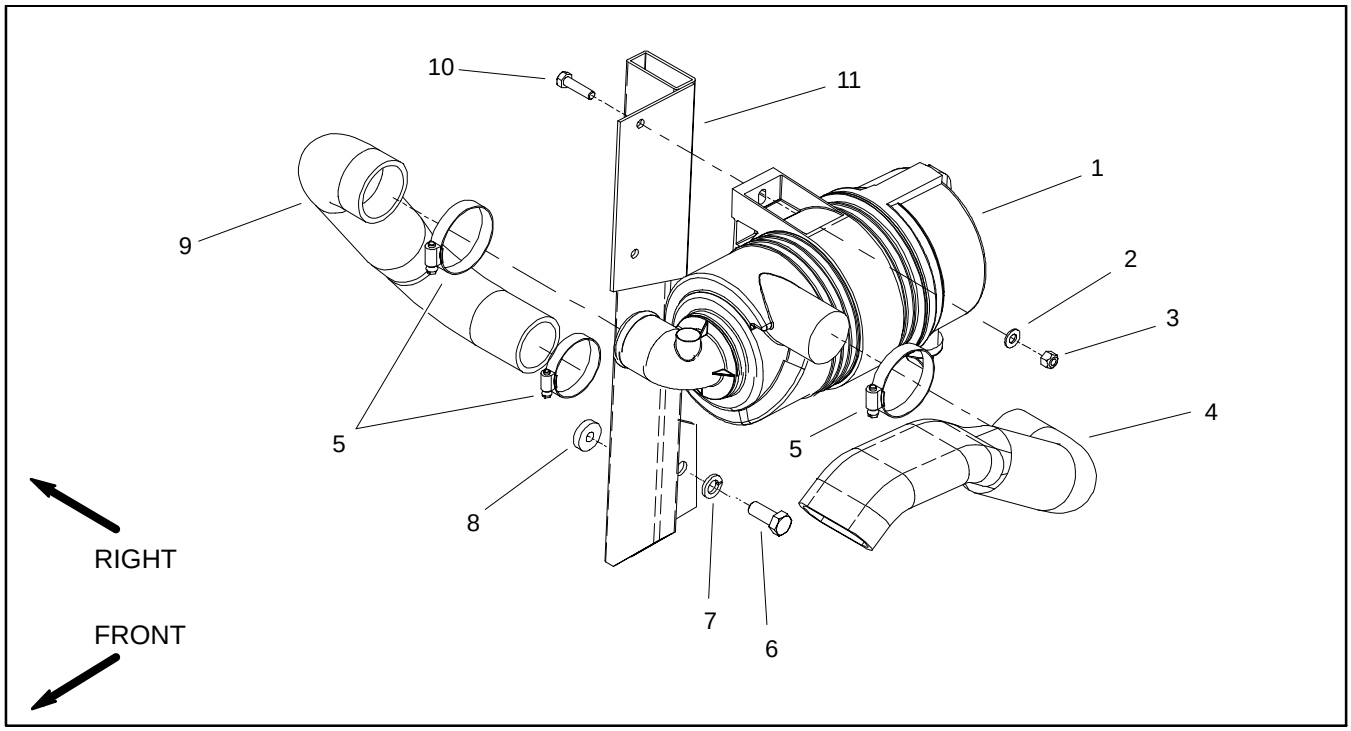

Figure 8

1. **Air cleaner assembly**
2. **Flat washer (2 used)**
3. **Lock nut**
4. **Air inlet hose**
5. **Hose clamp**
6. **Cap screw (2 used)**
7. **Lock washer (2 used)**
8. **Spacer**
9. **Air inlet hose**
10. **Cap screw (2 used)**
11. **Mounting bracket**

Removal

1. Remove air cleaner components as needed using Figures 8 and 9 as guides.

2. See Traction Unit Operator's Manual for air cleaner service procedures.

Installation

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

1. Assemble air cleaner system using Figures 8 and 9 as guides. Make sure that vacuator valve is pointed down after assembly.

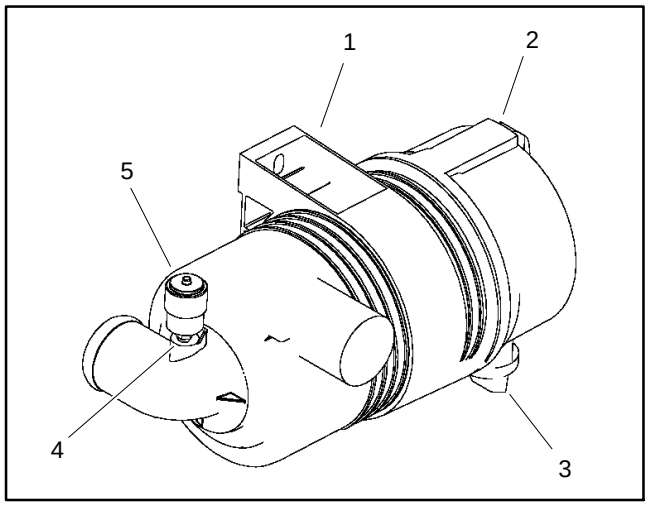

Figure 9

1. **Bracket**
2. **Cover**
3. **Vacuator valve**
4. **Pipe nipple**
5. **Indicator**

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Radiator

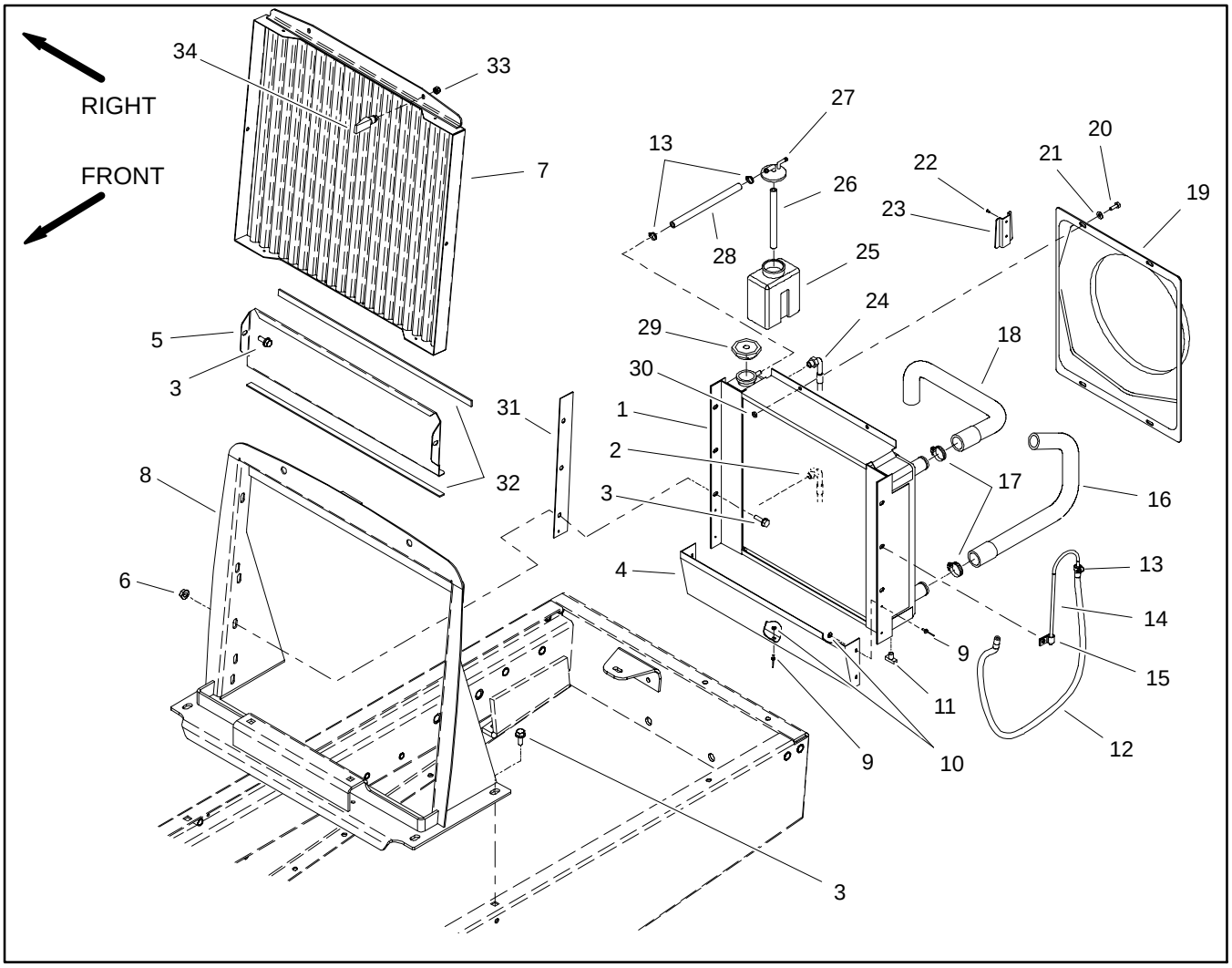

Figure 10

1. Radiator
2. Hydraulic hose
3. Screw (8 used)
4. Radiator shield
5. Intake cover
6. Flange nut (8 used)
7. Screen
8. Radiator support
9. Pop rivet (5 used)
10. Backup washer (5 used)
11. Draincock
12. Vent hose
13. Hose clamp
14. Vent tube
15. Clamp (2 used)
16. Lower radiator hose
17. Hose clamp
18. Upper radiator hose
19. Fan shroud
20. Cap screw (4 used)
21. Flat washer (4 used)
22. Pop rivet (2 used)
23. Reservoir bracket
24. Hydraulic hose
25. Coolant reservoir
26. Hose
27. Reservoir cap
28. Overflow hose
29. Radiator cap
30. Lock nut (4 used)
31. Radiator shim
32. Foam strip
33. Lock nut (2 used)
34. Latch (2 used)

Removal (Fig. 10)

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

2. Open hood (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. Drain coolant from radiator (see Traction Unit Operator's Manual).

4. Remove screen from machine (see Traction Unit Operator's Manual).

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil.

5. Disconnect hydraulic hoses from radiator. Position hoses away from radiator.

6. Disconnect radiator hoses (upper and lower) from the radiator.

7. Loosen hose clamp and remove overflow hose from radiator fill opening.

8. Remove coolant reservoir from bracket on fan shroud.

9. Remove four (4) cap screws, flat washers and lock nuts that secure fan shroud to radiator. Position fan shroud away from the radiator.

10. Support the radiator assembly before loosening mounting fasteners.

11. Remove screws and flange nuts that secure radiator to radiator support.

12. Carefully pull radiator assembly from the machine. Locate and retrieve radiator shim (item 31). Plug radiator and hose openings to prevent contamination.

Installation (Fig. 10)

1. Remove any plugs placed during the removal procedure.

2. Carefully position radiator assembly to the radiator support. Place radiator shim (item 31) between radiator and support. Secure radiator with screws and flange nuts.

3. Position fan shroud to the radiator. Secure fan shroud to radiator with four (4) cap screws, flat washers and lock nuts. Make sure that a minimum of .250" (6.4 mm) clearance exists at all points between shroud and fan.

4. Apply hydraulic thread sealant to hydraulic hose fitting threads. Connect hydraulic hoses to radiator.

5. Connect upper and lower radiator hoses.

6. Install coolant reservoir to bracket on fan shroud.

7. Connect overflow hose to radiator fill opening and secure with hose clamp.

8. Make sure radiator drain plug is tight. Fill radiator with coolant (see Traction Unit Operator's Manual).

9. Install screen to machine (see Traction Unit Operator's Manual).

10. Close hood (see Traction Unit Operator's Manual).

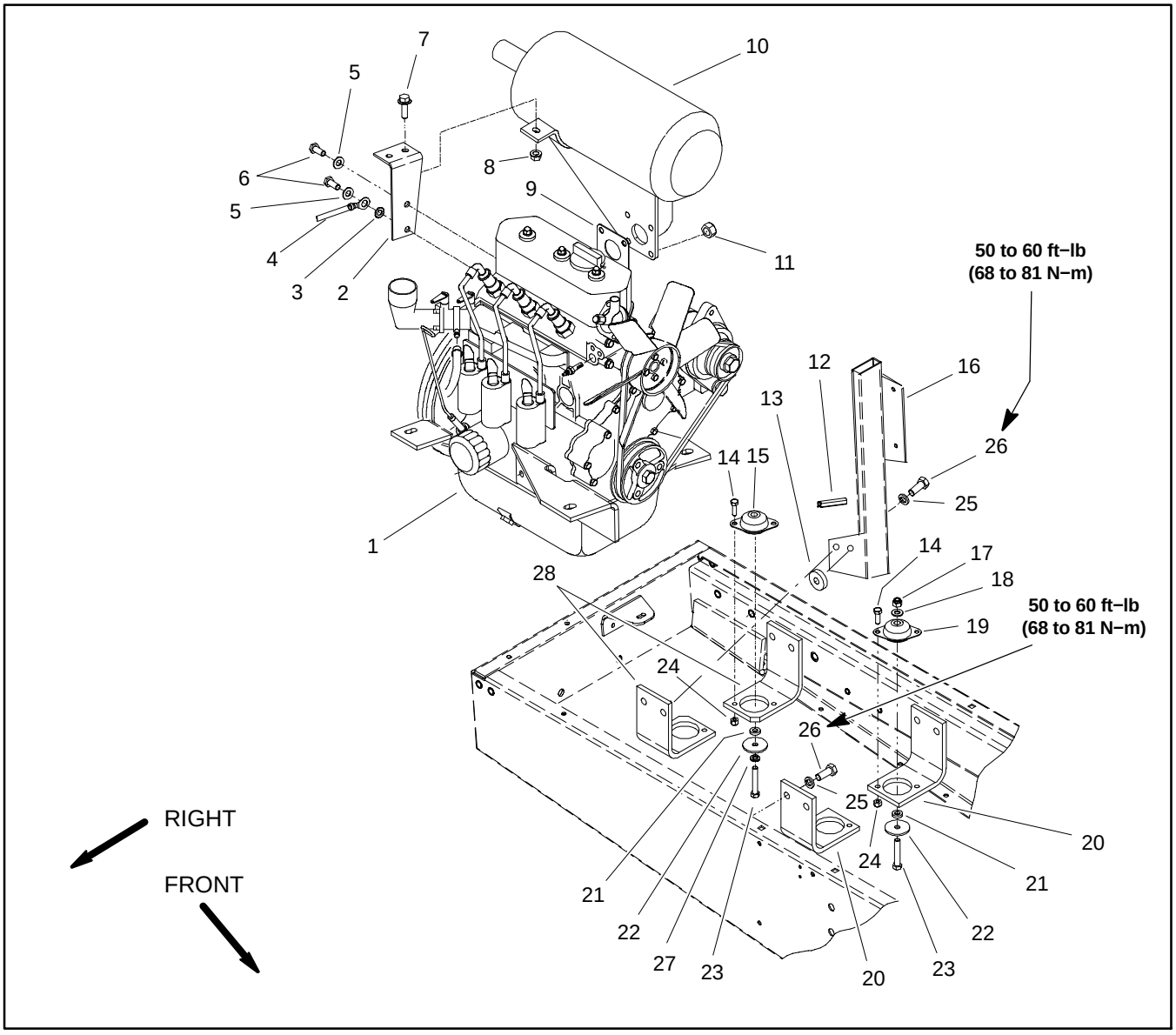

Figure 11

1. **Engine**
2. **Muffler bracket**
3. **Lock washer**
4. **Negative battery cable**
5. **Flat washer**
6. **Cap screw**
7. **Flange head screw**
8. **Flange nut**
9. **Muffler gasket**
10. **Muffler**
11. **Hex nut (4 used)**
12. **Frame trim**
13. **Spacer**
14. **Cap screw (2 used per mount)**
15. **Engine shock mount (red patch)**
16. **Air cleaner mounting bracket**
17. **Lock nut (3 used)**
18. **Flat washer (3 used)**
19. **Engine shock mount (3 used)**
20. **Engine mount bracket**
21. **Spacer (4 used)**
22. **Rebound washer (4 used)**
23. **Cap screw (4 used)**
24. **Lock nut (2 used per mount)**
25. **Lock washer (2 used per mount)**
26. **Cap screw (2 used per mount)**
27. **Lock washer (1 used)**
28. **Engine mount bracket**

Removal (Fig. 11)

1. Park machine on a level surface, lower cutting deck (or implement), stop engine and remove key from the ignition switch. Chock wheels to keep the machine from moving.

2. Open hood (see Traction Unit Operator's Manual).

3. Disconnect negative (−) and then positive (+) battery cables at the battery.

4. Remove battery from machine (see Battery Service in the Service and Repairs section of Chapter 6 − Electrical System).

5. Remove cap screws and flange nuts that secure battery base to brackets. Remove battery base from machine (Fig. 12).

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.

6. Drain coolant from radiator (see Traction Unit Operator's Manual).

7. Loosen hose clamp and remove overflow hose from radiator fill opening (Fig. 13). Remove coolant reservoir from bracket on radiator fan shroud.

8. Remove four (4) cap screws, flat washers and lock nuts that secure fan shroud to radiator (Fig. 13). Position fan shroud away from the radiator.

9. Remove P.T.O. shaft from machine (see P.T.O. Shaft Removal in Service and Repairs section of Chapter 9 − P.T.O. System).

10. Remove air cleaner (see Air Cleaner Removal in this section).

11. Loosen screw that secures cable clamp to governor bracket (Fig. 14). Remove throttle and choke cables from governor levers. Position cables away from the engine.

12. Disconnect hoses from engine.

A. Loosen clamps and disconnect upper and lower radiator hoses from the engine.

B. At carburetor, loosen hose clamp and disconnect fuel hose. Plug hose to prevent leakage and contamination.

13. Disconnect transmission drive shaft from engine pulley (see Hydraulic Transmission Drive Shaft Removal in the Service and Repairs section of Chapter 5 − Hydraulic System).

14. Remove cotter pin and clevis pin that secure hood cable to muffler bracket on rear of engine. Support hood in the open position.

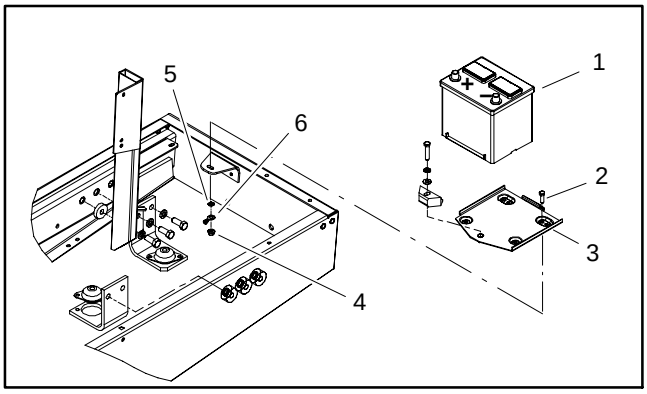

Figure 12

1. **Battery**
2. **Cap screw (3 used)**
3. **Battery base**
4. **Flange nut (3 used)**
5. **Lock washer**
6. **Ground cable**

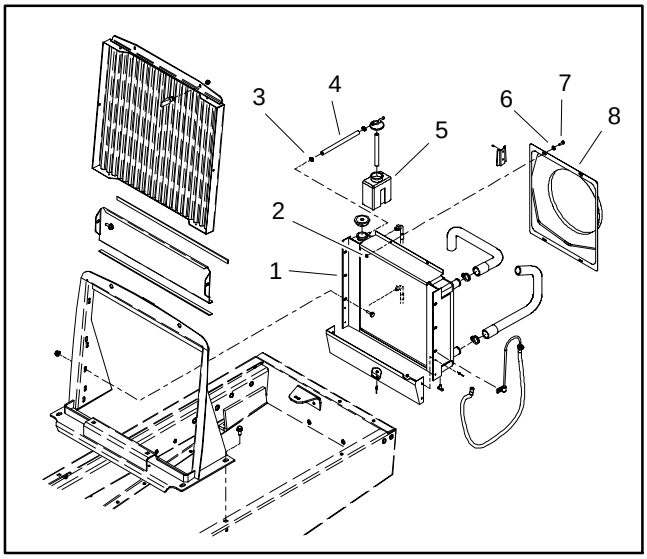

Figure 13

1. **Radiator**
2. **Lock nut**
3. **Hose clamp**
4. **Overflow hose**
5. **Coolant reservoir**
6. **Flat washer**
7. **Cap screw**
8. **Fan shroud**

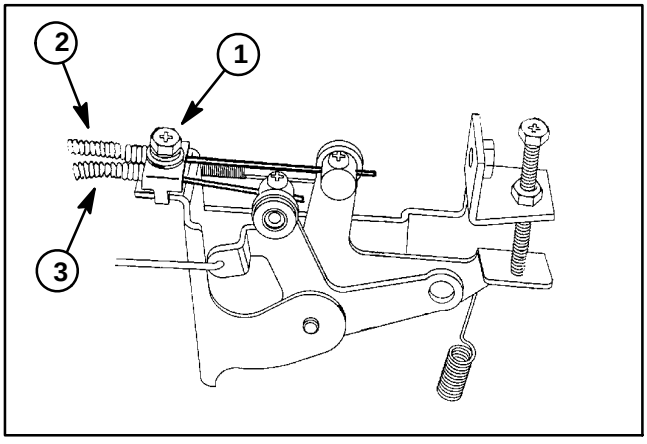

Figure 14

1. **Cable clamp**
2. **Throttle cable**
3. **Choke cable**

15. Disconnect wire harness connectors from the following engine components:

NOTE: Label all electrical leads for reassembly purposes.

A. Alternator connector and stud.

B. High temperature shut down switch and temperature sender located on the water pump housing.

C. Fuel solenoid on carburetor.

D. Oil pressure switch located near the engine oil dipstick.

E. Ignition coils located on the right side of the engine.

F. Connector, fusible link connector and positive battery cable from the starter motor.

G. Wire harness ground wire from the muffler bracket.

H. P.T.O. clutch wire connector.

I. Crank position wire connector.

16. Remove engine from machine:

A. Attach short section of chain between lift tabs located on each end of the cylinder head.

B. Connect a hoist or chain fall at the center of the short section of chain. Apply enough tension on the short chain so that the engine will be supported.

C. Remove fasteners that secure the engine (with brackets) to the engine shock mounts and engine mount brackets.

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 hoses, hydraulic lines, electrical harness or other parts while removing the engine.

D. Raise engine and remove from machine.

17. If necessary, remove engine brackets from engine (Fig. 15).

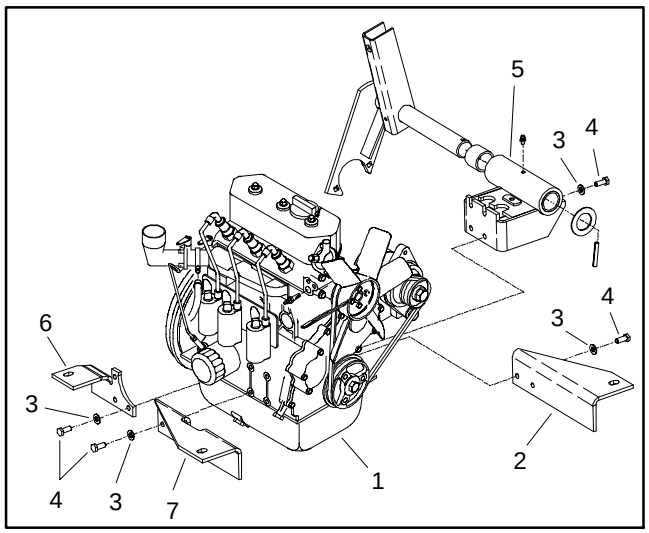

Figure 15

1. **Gasoline engine**
2. **Engine bracket**
3. **Flat washer**
4. **Cap screw**
5. **Pivot plate**
6. **Engine bracket**
7. **Engine bracket**

Installation (Fig. 11)

1. Locate machine on a level surface with cutting deck (or implement) lowered and key removed from the ignition switch. Chock wheels to keep the machine from moving.

2. Make sure that all parts removed from the engine during maintenance or rebuilding are reinstalled to the engine.

3. If engine brackets were removed from the engine, reinstall them to engine (Fig. 15).

4. If engine mount brackets (items 20 and 28) were removed from frame, secure them to frame with cap screws and lock washers. Torque screws from 50 to 60 ft−lb (68 to 81 N−m).

IMPORTANT: The left, rear shock mount (item 15) is different than the other three mounts (item 19). If shock mounts were removed from engine mount brackets on frame, make sure that shock mount with red patch is correctly installed at left, rear position.

5. Position fan shroud around the engine fan.

6. Reinstall engine to machine.

A. Attach short section of chain between lift tabs located on each end of the cylinder head

B. Connect a hoist or chain fall at the center of the short section of chain. Apply enough tension on the short chain so that the engine can be supported.

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 hoses, hydraulic lines, electrical harness or other parts while installing the engine.

C. Lower engine to the machine frame. Make sure that the engine bracket holes are aligned with the holes in the engine shock mounts.

D. Secure engine to the engine mounts.

7. Install clevis pin and cotter pin to secure hood cable to muffler bracket.

8. Connect transmission drive shaft to engine pulley (see Hydraulic Transmission Drive Shaft Installation in the Service and Repairs section of Chapter 5 − Hydraulic System).

9. Reconnect all wire harness connectors to engine components.

10. Remove plugs installed in hoses during disassembly. Connect hoses to the engine.

A. Connect fuel hose to the carburetor inlet fitting. Secure with hose clamp.

B. Connect upper and lower radiator hoses to the engine. Secure with hose clamps.

11. Position throttle and choke cables to engine governor levers (Fig. 14). Secure cables to governor bracket with cable clamp and screw. Adjust cables (see Adjust Throttle Control and Adjust Choke Control in the Adjustments section of this chapter).

12. Install air cleaner (see Air Cleaner Installation in this section).

IMPORTANT: Make sure that clutch pulley and P.T.O. pulley are aligned during P.T.O. shaft installation.

13. Install P.T.O. shaft to machine (see P.T.O. Shaft Installation in Service and Repairs section of Chapter 9 − P.T.O. System).

14. Position fan shroud to radiator. Make sure that a minimum of .250” (6.4 mm) clearance exists at all points between shroud and fan. Secure fan shroud to radiator with four (4) cap screws, flat washers and lock nuts.

15. Install coolant reservoir to bracket on radiator fan shroud (Fig. 13). Install overflow hose to radiator fill opening and secure with hose clamp.

16. Add coolant to radiator (see Traction Unit Operator’s Manual).

NOTE: Make sure to attach negative battery cable as battery base is installed.

17. Position battery base to brackets and secure with cap screws and flange nuts (Fig. 12).

18. Install battery to machine (see Battery Service in the Service and Repairs section of Chapter 6 − Electrical System).

19. Check engine oil level (see Traction Unit Operator’s Manual).

20. Connect positive (+) and then negative (−) battery cables to the battery.

21. Close hood (see Traction Unit Operator’s Manual).

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Chapter 4

Diesel Engine

Table of Contents

Introduction

This Chapter gives information about specifications, troubleshooting, testing and repair of the Kubota 1105NA diesel engine used in the Groundsmaster 3280−D.

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

Service and repair parts for Kubota diesel engines are supplied through your local Toro Distributor. If a parts list is not available, be sure to provide your distributor with the Toro model and serial number.

Specifications

Item	Description
Make / Designation	Kubota, 4−stroke, Liquid Cooled, OHV Diesel
Number of Cylinders	3
Bore x Stroke mm (in.)	78 x 78.4 (3.07 x 3.09)
Total Displacement cc (cu. in.)	1123 (68.53)
Compression Ratio	22.0:1
Firing Order	1 (front) − 2 − 3
Dry Weight (approximate) kg (lb.)	93 (205)
Fuel	No. 2−D Diesel Fuel (ASTM D975)
Fuel Injection Pump	Bosch MD type mini
Fuel Injector Nozzle	Mini Nozzle (DNOPD)
Fuel Tank Capacity liter (U.S. gal.)	48.5 (12.8)
Governor	Centrifugal Mechanical
Idle Speed (no load)	1500 to 1650 RPM
High Idle (no load)	3100 to 3250 RPM
Engine Oil	API Classification CH−4, CI−4 or higher (see Traction Unit Operator's Manual for viscosity)
Oil Pump	Gear driven trochoid type
Crankcase Oil Capacity liter (U.S. qt.)	3.8 (4.0) with filter
Cooling System Capacity (including reserve tank) liter (U.S. qt.)	7.6 (8)
Starter	12 VDC 1.4 KW
Alternator/Regulator	12 VDC 40 AMP

Adjustments

Adjust Throttle Control

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

1. Move remote throttle control lever to **FAST** position.

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

3. If necessary, throttle control can be adjusted by loosening cable clamp screw and repositioning control cable until speed control lever contacts high speed screw.

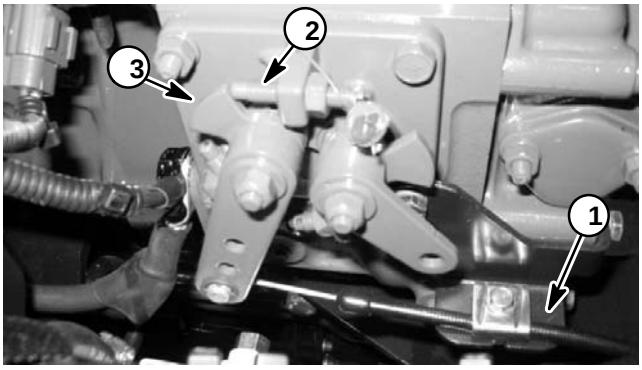

Figure 1

1. **Throttle cable**
2. **High speed screw**
3. **Speed control lever**

Fuel System

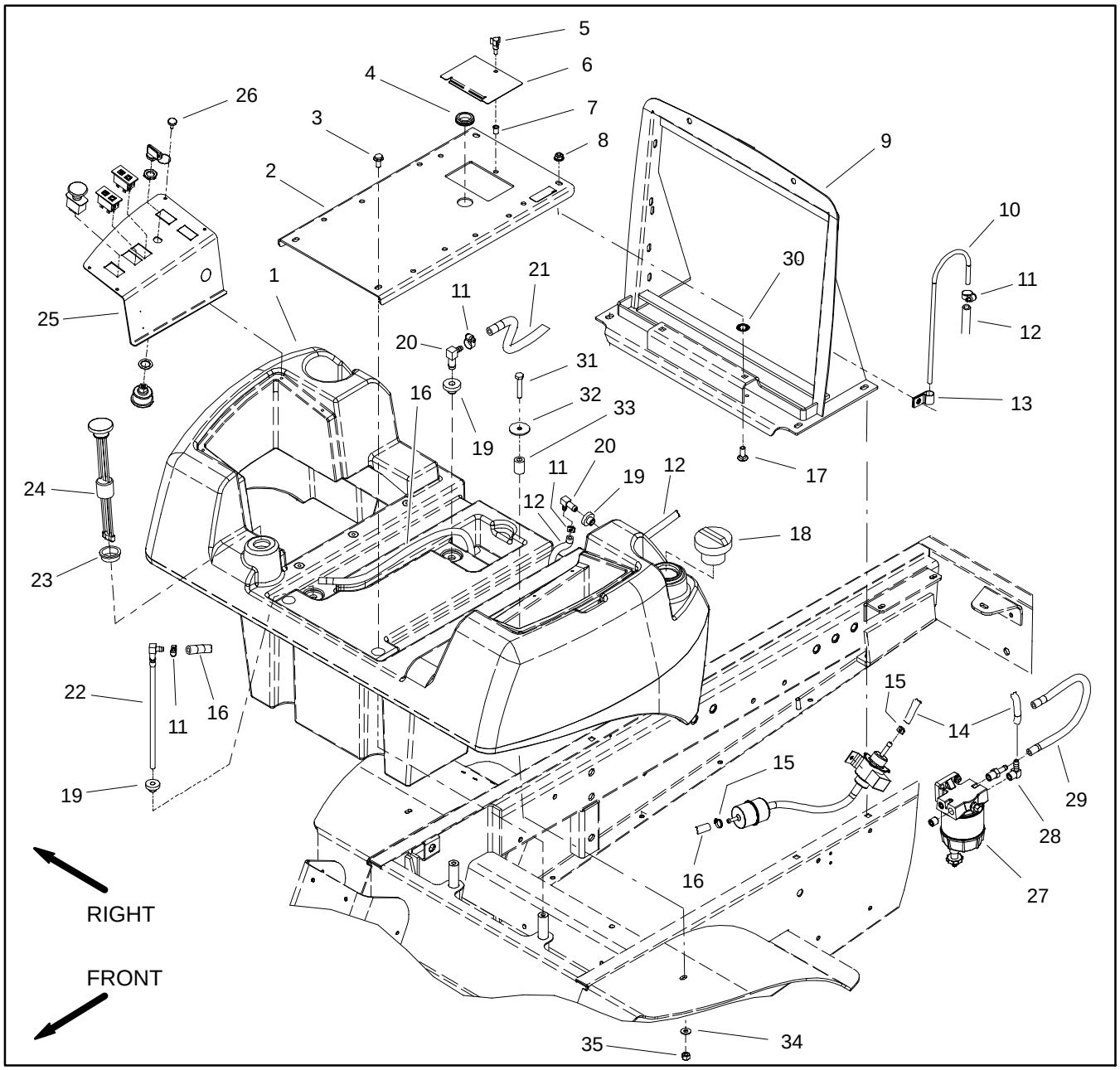

Figure 2

1. Fuel tank
2. Seat plate
3. Flange head screw (2 used)
4. Grommet
5. Knob
6. Bypass cover
7. Threaded insert
8. Flange nut (2 used)
9. Radiator support
10. Vent tube
11. Hose clamp
12. Fuel hose (tank venting)
13. R−clamp
14. Fuel hose (fuel pump to separator)
15. Hose clamp
16. Fuel hose (fuel supply)
17. Carriage screw (2 used)
18. Fuel cap
19. Grommet
20. Elbow fitting
21. Fuel hose (return)
22. Stand pipe
23. Grommet
24. Fuel gauge
25. Control panel
26. Thumb screw (4 used)
27. Fuel/water separator
28. Fitting
29. Fuel hose (separator to injector)
30. Retainer
31. Cap screw
32. Flat washer
33. Spacer
34. Flat washer
35. Lock nut

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 contaminates and debris.

Fuel Tank Removal (Fig. 2)

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

2. Unplug seat switch from machine wire harness.

3. Remove seat and seat suspension from machine (see Standard or Suspension Seat Removal in Service and Repairs section of Chapter 7 − Chassis).

4. Remove seat plate (item 2) from machine.

5. Remove thumb screws that secure control panel to fuel tank. Unplug wire harness connections from panel components and remove panel from machine.

6. Remove flange head screws and flange nut that secure lower control panel to machine (Fig. 3).

7. Remove lock nut (item 35) and flat washer (item 34) from left fender.

8. Use a fuel transfer pump to remove fuel from the fuel tank and into a suitable container.

9. Disconnect fuel hoses from standpipe (item 22) and elbow fittings (item 20) on the top of the fuel tank.

10. Remove fuel tank using Figure 2 as a guide.

Fuel Tank Installation (Fig. 2)

1. Install fuel tank to frame using Figure 2 as a guide.

2. Connect fuel hoses to standpipe (item 22) and elbow fittings (item 20) on the top of the fuel tank. Secure fuel hoses with hose clamps.

3. Secure lower control panel to machine with flange head screws and flange nut (Fig. 3).

4. Secure tank to left fender with flat washer (item 34) and lock nut (item 35).

5. Position control panel to fuel tank, connect wire harness to panel components and secure panel to machine with thumb screws.

6. Install seat plate to machine.

7. Install seat suspension and seat to machine (see Standard or Suspension Seat Installation in Service and Repairs section of Chapter 7 − Chassis).

8. Connect seat switch to machine wire harness.

9. Fill fuel tank (see Traction Unit Operator's Manual).

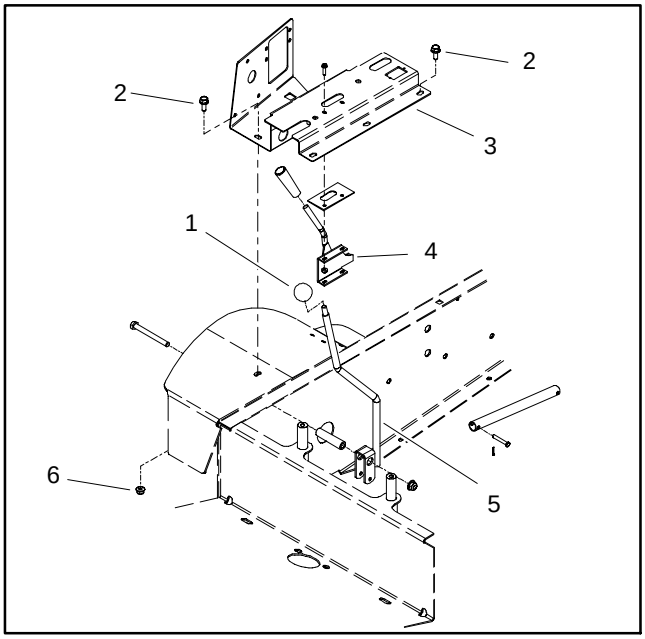

Figure 3

1. **Knob**
2. **Flange head screw**
3. **Lower control panel**
4. **Throttle control**
5. **Lift control lever**
6. **Flange nut**

Air Cleaner

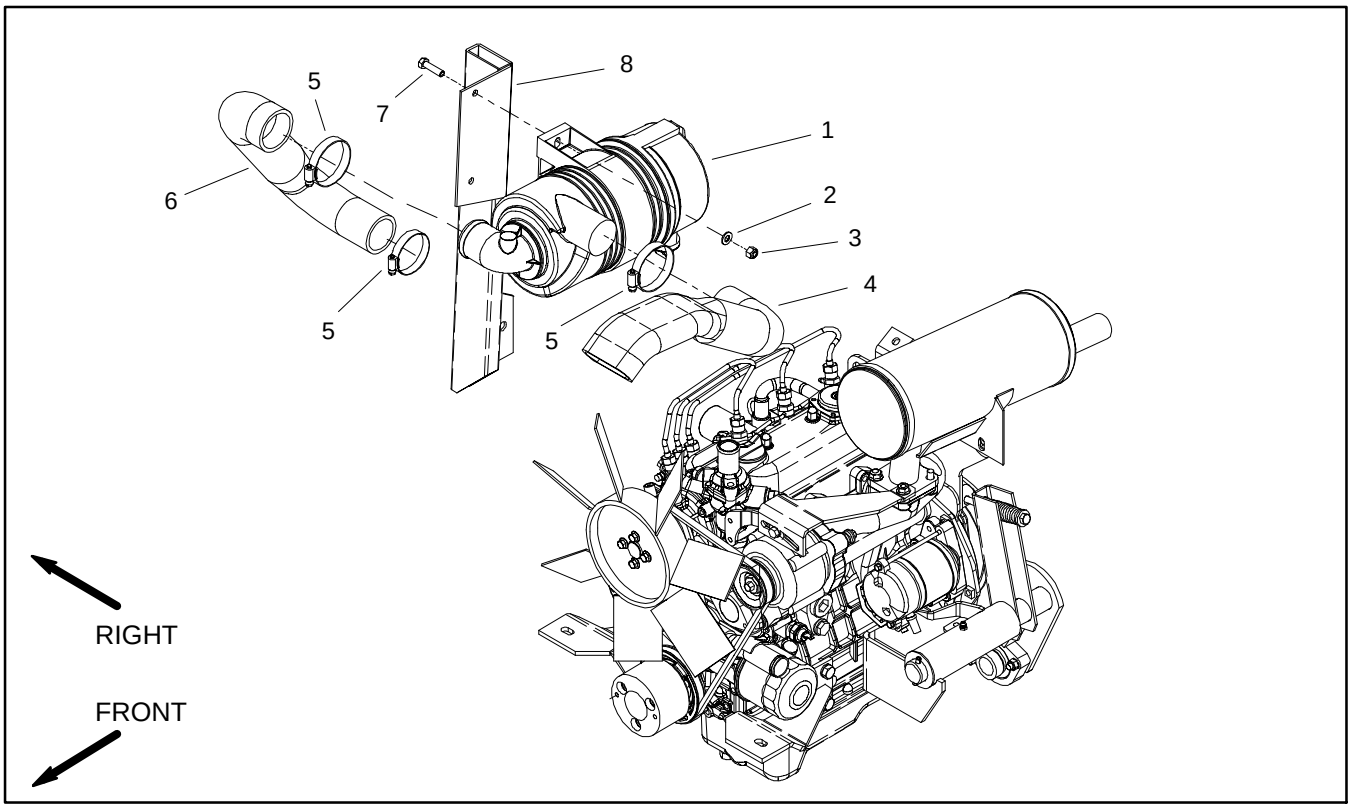

Figure 4

1. **Air cleaner assembly**
2. **Flat washer (2 used)**
3. **Lock nut (2 used)**
4. **Intake air hose**
5. **Hose clamp**
6. **Air hose**
7. **Cap screw (2 used)**
8. **Air cleaner mount**

Removal

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

2. Remove air cleaner components as needed using Figures 4 and 5 as guides.

3. See Traction Unit Operator's Manual for air cleaner service procedures.

Installation

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

1. Reassemble air cleaner system using Figures 4 and 5 as guides. Make sure that vacuator valve is pointed down after assembly.

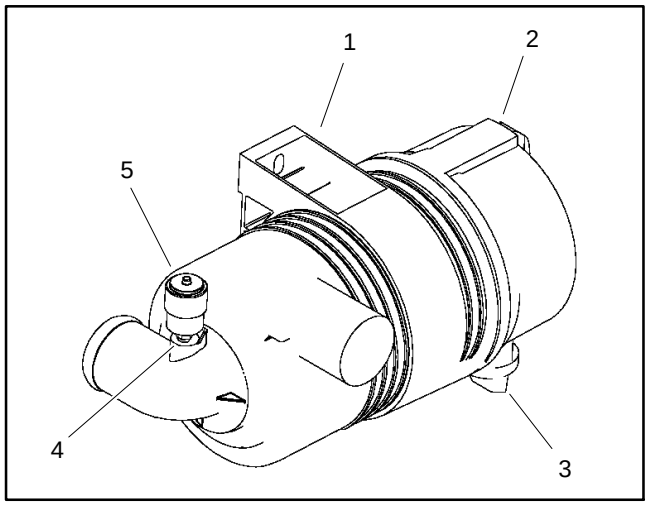

Figure 5

1. **Bracket**
2. **Cover**
3. **Vacuator valve**
4. **Pipe nipple**
5. **Indicator**

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Radiator

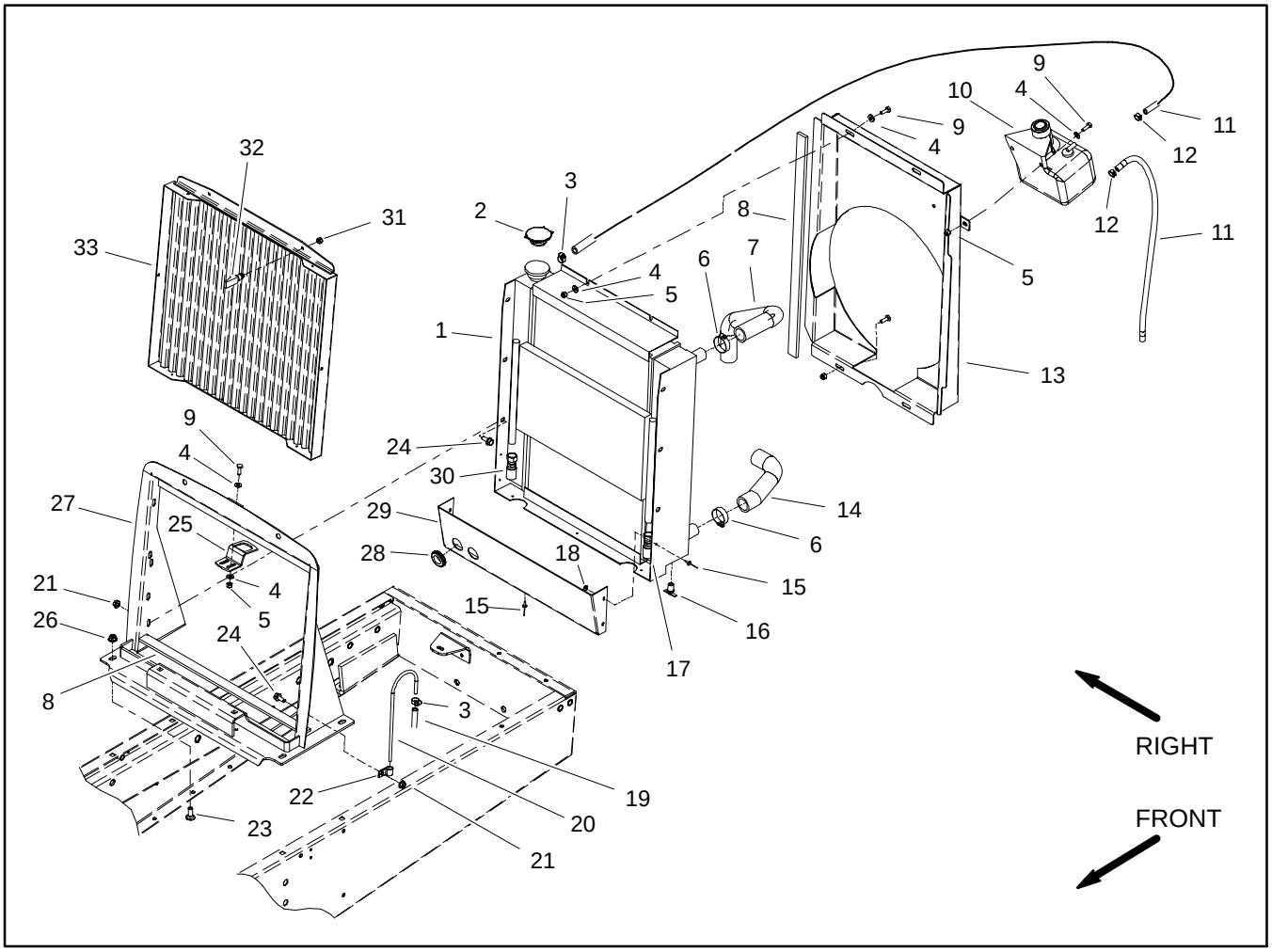


Figure 6

1. **Radiator/oil cooler assembly**
2. **Radiator cap**
3. **Hose clamp**
4. **Flat washer**
5. **Lock nut**
6. **Hose clamp**
7. **Upper radiator hose**
8. **Foam seal**
9. **Cap screw**
10. **Coolant reservoir**
11. **Hose**
12. **Hose clamp**
13. **Fan shroud**
14. **Lower radiator hose**
15. **Pop rivet**
16. **Radiator draincock**
17. **Hydraulic hose**
18. **Back washer**
19. **Vent hose**
20. **Vent tube**
21. **Flange nut**
22. **Clamp (2 used)**
23. **Carriage screw (4 used)**
24. **Flange head screw**
25. **Hood latch**
26. **Flange nut**
27. **Radiator support**
28. **Grommet (2 used)**
29. **Radiator shield**
30. **Hydraulic hose**
31. **Lock nut (2 used)**
32. **Latch (2 used)**
33. **Screen**

Removal (Fig. 6)

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

2. Raise the hood (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. Drain coolant from radiator.

A. Slowly remove radiator cap from the radiator.

B. Place drain pan below the radiator drain plug located on the bottom of the radiator. Loosen draincock and allow coolant to drain from radiator.

4. Remove screen from machine (see Traction Unit Operator's Manual).

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil.

5. Disconnect hydraulic hoses from oil cooler. Locate and discard o−rings. Route hoses out of grommets in lower radiator shield.

6. Disconnect radiator hoses (upper and lower) from the radiator.

7. Loosen hose clamp and remove overflow hose from radiator fill opening.

8. Remove four (4) cap screws, flat washers and lock nuts that secure fan shroud to radiator. Position fan shroud away from the radiator.

9. Support the radiator assembly before loosening mounting fasteners.

10. Remove six (6) flange head screws and flange nuts that secure radiator to radiator support.

11. Carefully pull radiator assembly from the machine. Plug radiator and hose openings to prevent contamination.

12. As required, remove radiator shield and oil cooler from radiator using Figures 6 and 7 as guides.

Installation (Fig. 6)

1. If removed, install radiator shield and oil cooler to radiator using Figures 6 and 7 as guides.

2. Remove any plugs placed during the removal procedure.

3. Carefully position radiator assembly to the radiator support. Secure radiator with six (6) flange head screws and flange nuts.

4. Position fan shroud to the radiator. Secure fan shroud to radiator with four (4) cap screws, flat washers and lock nuts. Make sure that a minimum of .250" (6.4 mm) clearance exists at all points between shroud and fan.

5. Route hydraulic hoses through grommets in lower radiator shield. Lubricate new o−rings and connect hoses to oil cooler.

6. Connect upper and lower radiator hoses and secure with clamps.

7. Connect overflow hose to radiator fill opening and secure with hose clamp.

8. Make sure radiator drain plug is tight. Fill radiator with coolant (see Traction Unit Operator's Manual).

9. Install screen to machine (see Traction Unit Operator's Manual).

10. Lower hood (see Traction Unit Operator's Manual).

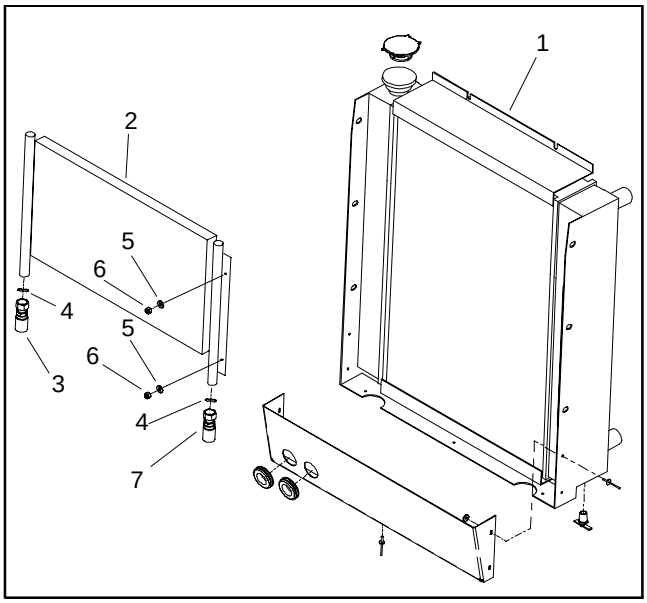


Figure 7

1. **Radiator**
2. **Oil cooler**
3. **Hydraulic hose**
4. **O−ring**
5. **Lock washer**
6. **Hex nut**
7. **Hydraulic hose**

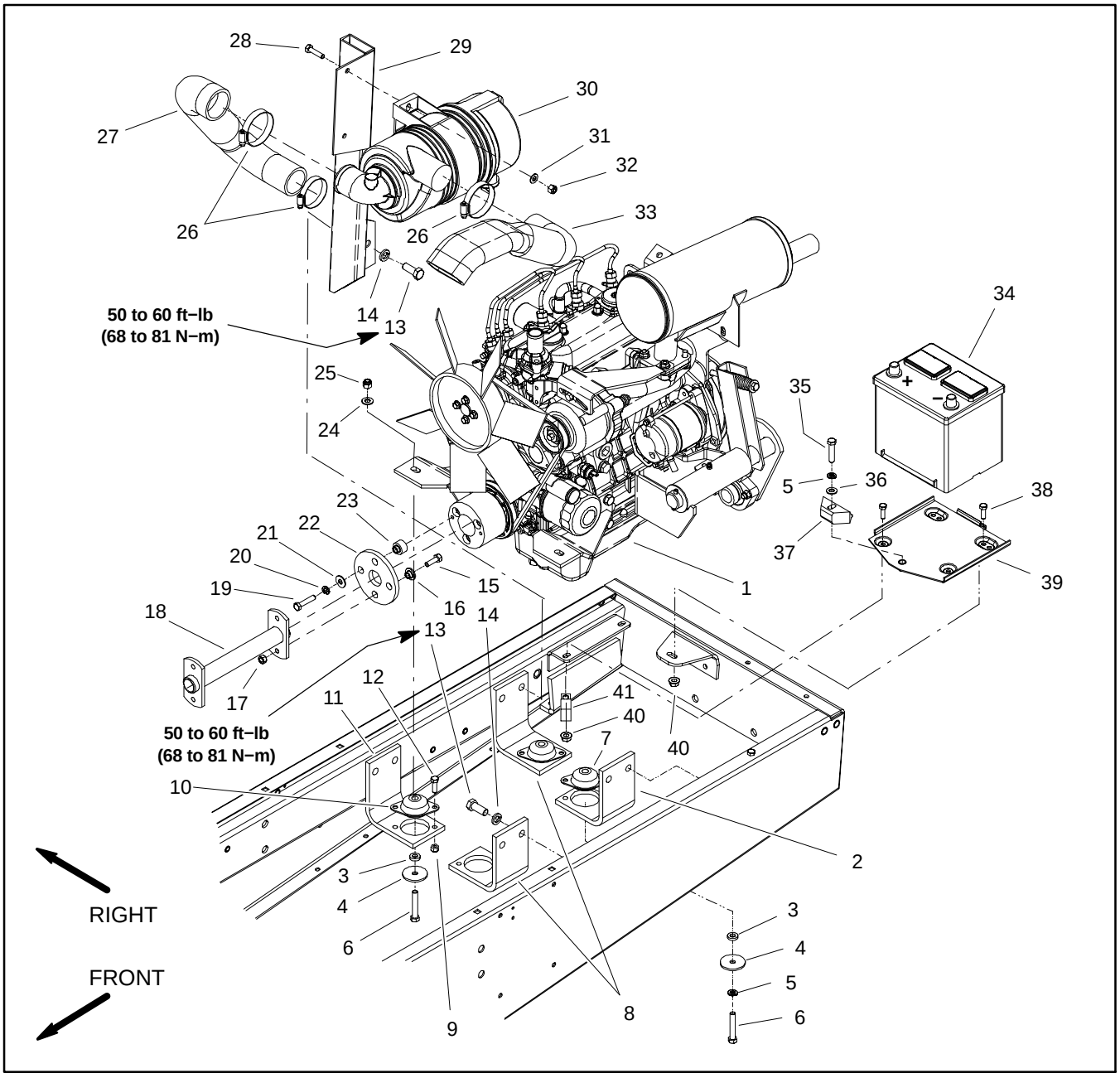


Figure 8

1. Diesel engine
2. Engine mount bracket
3. Spacer (4 used)
4. Rebound washer (4 used)
5. Lock washer
6. Cap screw (4 used)
7. Engine shock mount (red patch)
8. Engine mount bracket
9. Lock nut (2 used per mount)
10. Engine shock mount (3 used)
11. Engine mount bracket
12. Cap screw (2 used per mount)
13. Cap screw (2 used per bracket)
14. Lock washer (2 used per bracket)
15. Cap screw (2 used per coupling)
16. Coupling spacer (2 used per coupling)
17. Lock nut (2 used per coupling)
18. Drive shaft
19. Cap screw (2 used per coupling)
20. Lock washer (2 used per coupling)
21. Flat washer (2 used per coupling)
22. Rubber coupling
23. Spacer (2 used per coupling)
24. Flat washer (3 used)
25. Lock nut (3 used)
26. Hose clamp
27. Air inlet hose
28. Cap screw (2 used)
29. Air cleaner bracket
30. Air cleaner assembly
31. Flat washer (2 used)
32. Lock nut (2 used)
33. Air inlet hose
34. Battery
35. Cap screw
36. Flat washer
37. Battery retainer
38. Cap screw (3 used)
39. Battery base
40. Flange nut (3 used)
41. R−clamp

Removal (Fig. 8)

1. Park machine on a level surface, lower cutting deck (or implement), stop engine and remove key from the ignition switch. Chock wheels to keep the machine from moving.

2. Open hood (see Traction Unit Operator's Manual).

3. Disconnect negative (−) and then positive (+) battery cables at the battery.

4. Remove battery from machine (see Battery Service in the Service and Repairs section of Chapter 6 − Electrical System).

5. Remove cap screws and flange nuts that secure battery base to brackets. Remove battery base 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.

6. Drain coolant from radiator (see Traction Unit Operator's Manual).

7. Loosen hose clamp and remove overflow hose from radiator fill opening (Fig. 9). Remove coolant reservoir from radiator fan shroud.

8. Remove four (4) cap screws, flat washers and lock nuts that secure fan shroud to radiator (Fig. 9). Position fan shroud away from the radiator.

9. Remove P.T.O. shaft from machine (see P.T.O. Shaft Removal in Service and Repairs section of Chapter 9 − P.T.O. System).

10. Remove air cleaner (see Air Cleaner Removal in this section).

11. Remove throttle cable from injector pump (Fig. 10):

A. Remove retaining ring that secures throttle cable end to injector pump control arm.

B. Loosen throttle cable clamp and remove throttle cable from the injector pump.

C. Position throttle cable away from the engine.

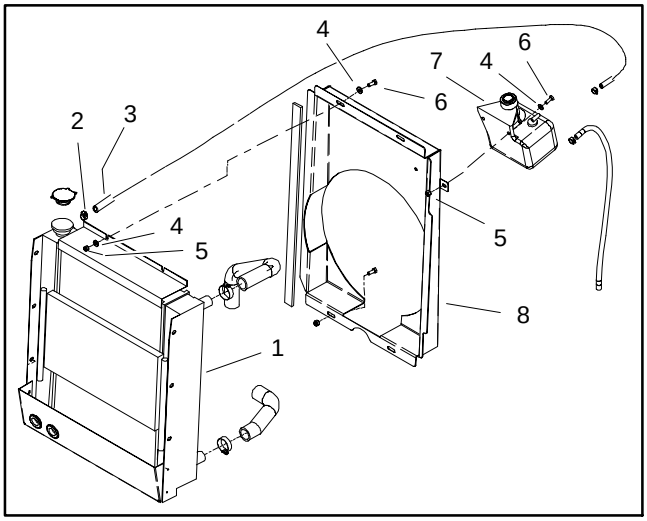


Figure 9

1. **Radiator**
2. **Hose clamp**
3. **Overflow hose**
4. **Flat washer**
5. **Lock nut**
6. **Cap screw**
7. **Coolant reservoir**
8. **Fan shroud**

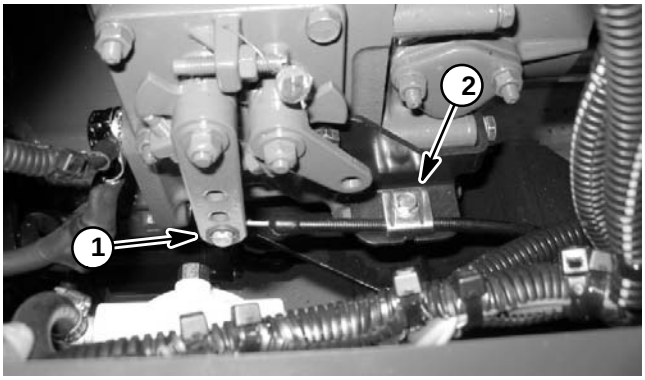


Figure 10

1. **Cable end**
2. **Cable clamp**

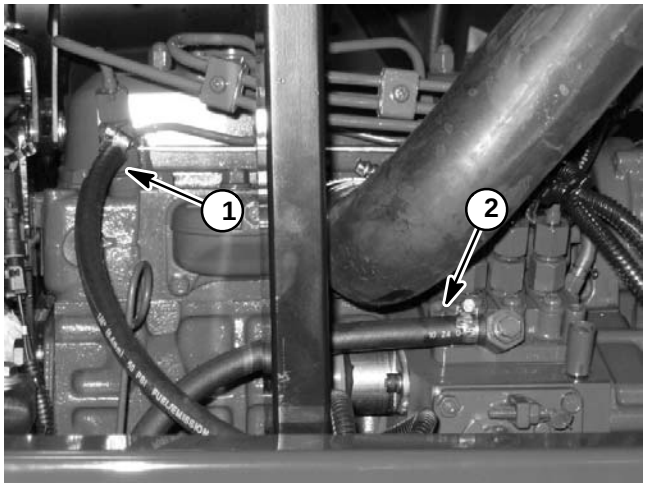


Figure 11

1. **Fuel return hose**
2. **Fuel supply hose**

12. Disconnect hoses from engine:

    A. Loosen clamps and disconnect upper and lower radiator hoses from the engine.

    B. At injector pump, loosen hose clamps and disconnect supply and return fuel hoses from the pump fittings (Fig. 10). Plug hoses to prevent leakage and contamination.

13. Disconnect transmission drive shaft from engine (see Hydraulic Transmission Drive Shaft Removal in the Service and Repairs section of Chapter 5 − Hydraulic System).

14. Remove cotter pin and clevis pin that secure hood cable to muffler bracket. Support hood in the open position.

15. Disconnect wire harness connectors from the following engine components:

NOTE: Label all electrical leads for reassembly purposes.

    A. Alternator connector and stud.

    B. Oil pressure switch located near the engine oil filter.

    C. Connector, fusible link connector and positive battery cable from the starter motor.

    D. High temperature shut down switch and temperature sender located on the water pump housing.

    E. Fuel stop solenoid on injector pump.

    F. Negative battery cable from injector pump.

    G. Glow plug strip.

    H. P.T.O. clutch wire connector.

16. Remove engine from machine:

    A. Attach short section of chain between lift tabs located on each end of the cylinder head.

    B. Connect a hoist or chain fall at the center of the short section of chain. Apply enough tension on the short chain so that the engine will be supported.

    C. Remove fasteners that secure the engine (with brackets) to the engine shock mounts and engine mount brackets.

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 hoses, hydraulic lines, electrical harness or other parts while removing the engine.

    D. Raise engine and remove from machine.

17. If necessary, remove engine brackets from engine (Fig. 12 and 13).

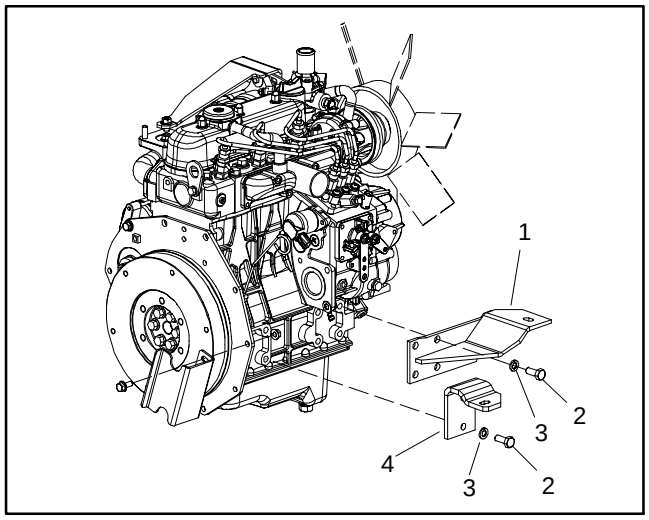


Figure 12

1. **Front engine bracket**
2. **Cap screw**
3. **Lock washer**
4. **Rear engine bracket**

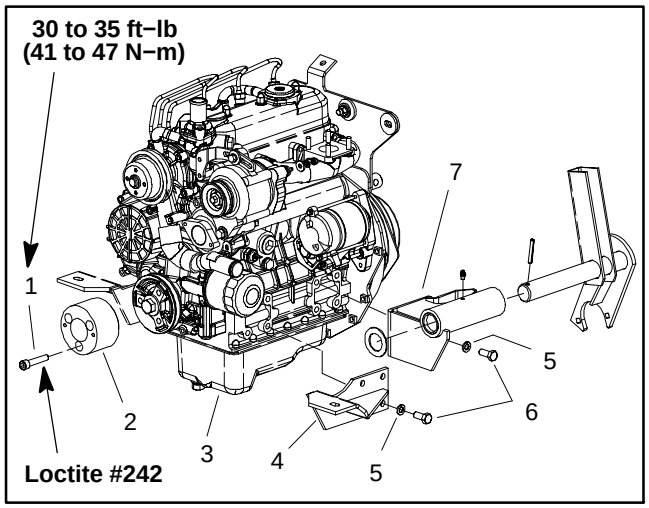


Figure 13

1. **Socket hd screw (3 used)**
2. **Drive adapter**
3. **Diesel engine**
4. **Engine bracket**
5. **Lock washer**
6. **Cap screw**
7. **Engine bracket**

Installation (Fig. 11)

1. Locate machine on a level surface with cutting deck (or implement) lowered and key removed from the ignition switch. Chock wheels to keep the machine from moving.

2. Make sure that all parts removed from the engine during maintenance or rebuilding are reinstalled to the engine.

3. If drive adapter was removed from crankshaft pulley (Fig. 13), apply Loctite #242 (or equivalent) to threads of socket head screws. Secure adapter to pulley with three (3) socket head screws. Torque screws from 30 to 35 ft−lb (41 to 47 N−m).

4. If engine brackets were removed from the engine, reinstall them to engine (Fig. 12 and 13).

5. If engine mount brackets (items 2 and 11) were removed from frame, secure them to frame with cap screws and lock washers. Torque screws from 50 to 60 ft−lb (68 to 81 N−m).

IMPORTANT: The left, rear shock mount (item 7) is different than the other three mounts (item 10). If shock mounts were removed from engine mount brackets on frame, make sure that shock mount with red patch is correctly installed at left, rear position.

6. Position fan shroud around the engine fan.

7. Reinstall engine to machine.

   A. Attach short section of chain between lift tabs located on each end of the cylinder head

   B. Connect a hoist or chain fall at the center of the short section of chain. Apply enough tension on the short chain so that the engine can be supported.

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 hoses, hydraulic lines, electrical harness or other parts while installing the engine.

   C. Lower engine to the machine frame. Make sure fastener holes of the engine brackets are aligned with the holes in the engine shock mounts.

   D. Secure engine to the engine mounts.

8. Install clevis pin and cotter pin to secure hood cable to muffler bracket.

9. Connect transmission drive shaft to engine pulley (see Hydraulic Transmission Drive Shaft Installation in the Service and Repairs section of Chapter 5 − Hydraulic System).

10. Connect all wire harness connectors to engine components.

11. Remove plugs installed in hoses during disassembly. Connect hoses to the engine:

   A. Connect supply and return fuel hoses to injector pump fittings (Fig. 10). Secure with hose clamps.

   B. Connect upper and lower radiator hoses to the engine. Secure with hose clamps.

12. Connect throttle cable to injector pump (Fig. 10):

   A. Route throttle cable to injector pump on engine.

   B. Install the throttle cable end into the lowest hole on the injector pump control arm. Secure cable end with retaining ring.

   C. Position cable under cable clamp.

   D. Adjust throttle control (see Adjust Throttle Control in the Adjustments section of this chapter).

13. Install air cleaner (see Air Cleaner Installation in this section).

IMPORTANT: Make sure that clutch pulley and P.T.O. pulley are aligned during P.T.O. shaft installation.

14. Install P.T.O. shaft to machine (see P.T.O. Shaft Installation in Service and Repairs section of Chapter 9 − P.T.O. System).

15. Position fan shroud to radiator. Make sure that a minimum of .250” (6.4 mm) clearance exists at all points between shroud and fan. Secure fan shroud to radiator with four (4) cap screws, flat washers and lock nuts (Fig. 9).

16. Install coolant reservoir to bracket on radiator fan shroud (Fig. 9). Install overflow hose to radiator fill opening and secure with hose clamp.

17. Add coolant to radiator (see Traction Unit Operator’s Manual).

NOTE: Make sure to attach R−clamp as battery base is installed.

18. Position battery base to brackets and secure with cap screws and flange nuts.

19. Install battery to machine (see Battery Service in the Service and Repairs section of Chapter 6 − Electrical System).

20. Check engine oil level (see Traction Unit Operator's Manual).

21. Connect positive (+) and then negative (−) battery cables to the battery.

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

23. Close hood (see Traction Unit Operator's Manual).

TORO

Chapter 5

Hydraulic System

Table of Contents

Specifications

Item	Description
Hydrostatic Transmission Pump Maximum Displacement (per revolution) Motor Displacement (per revolution)	Sauer Danfoss (Sundstrand), U-type, Axial Piston Design, Model Series 15 .9 Cubic Inches (15 cc) .9 Cubic Inches (15 cc)
Charge Pump Displacement (per revolution)	Gerotor Pump in Hydrostat .3 Cubic Inches (4.9 cc)
Implement (Lift/Steering) Relief Pressure	700 to 1000 PSI (48.2 to 69.0 Bar)
Steering Valve	Sauer Danfoss Steering Unit, Type OSPM
Lift Control Valve	Spool Type Directional Control Valve with Adjustable Counterbalance Valve
Counterbalance Pressure	See Traction Unit Operator's Manual
Hydraulic Filter	25 Micron Spin-on Cartridge Type
Hydraulic Oil	See Traction Unit Operator's Manual
Hydraulic Reservoir (Front Axle) Capacity	6 Qts. U.S. (5.7 L)

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

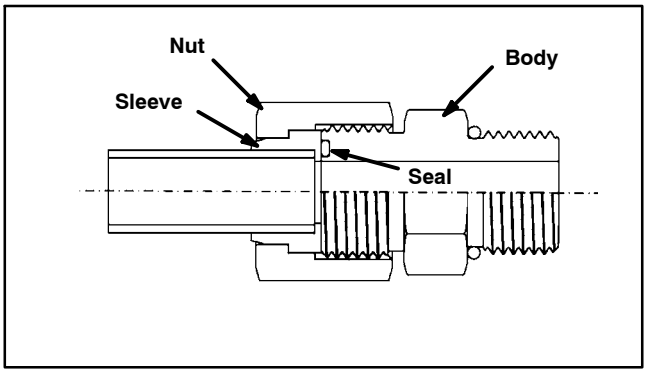


Figure 1

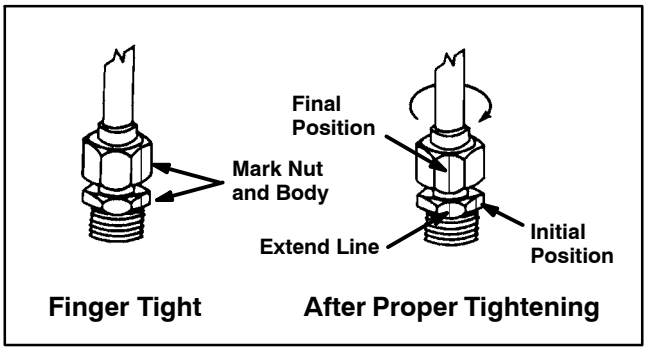


Figure 2

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 ± 0.25
6 (3/8 in.)	1.50 ± 0.25
8 (1/2 in.)	1.50 ± 0.25
10 (5/8 in.)	1.50 ± 0.25
12 (3/4 in.)	1.50 ± 0.25
16 (1 in.)	1.50 ± 0.25

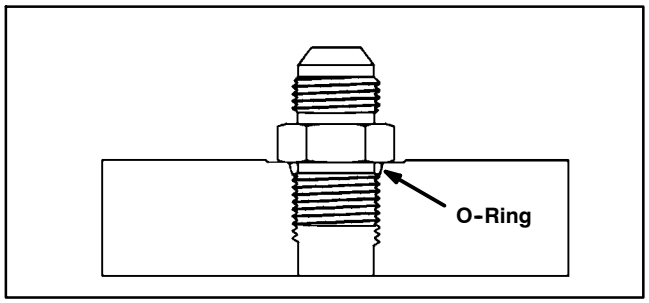


Figure 3

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 ± 0.25
6 (3/8 in.)	1.50 ± 0.25
8 (1/2 in.)	1.50 ± 0.25
10 (5/8 in.)	1.50 ± 0.25
12 (3/4 in.)	1.50 ± 0.25
16 (1 in.)	1.50 ± 0.25

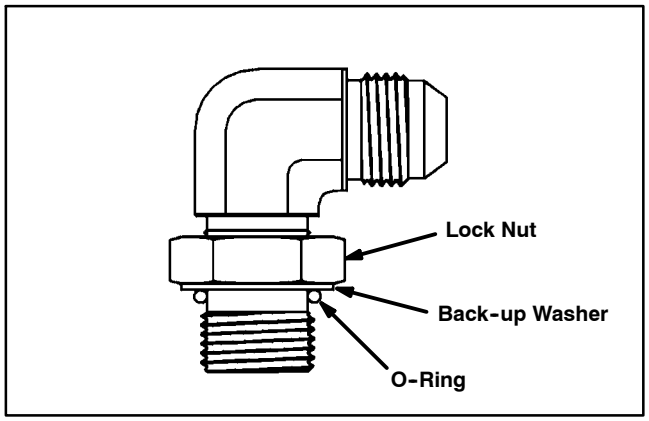


Figure 4

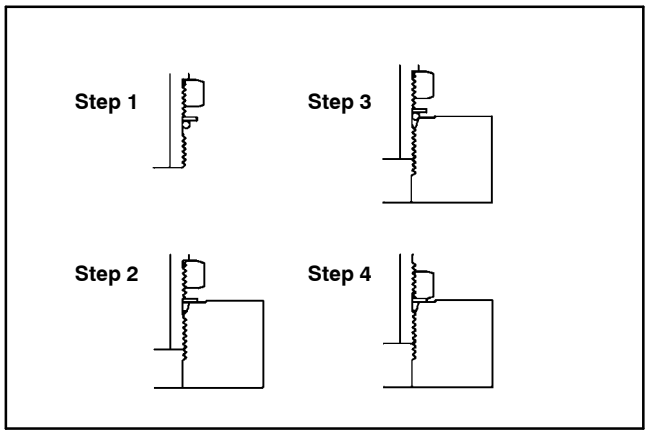


Figure 5

Towing Traction Unit

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

If it becomes necessary to tow (or push) the machine, tow (or push) at a speed below 3 mph (4.8 kph), and for a very short distance. If machine needs to be moved a considerable distance, machine should be transported on a trailer. The transmission is equipped with two check valves that need to be pressed for towing or pushing (Fig. 6). See Traction Unit Operator's Manual for Towing Procedures.

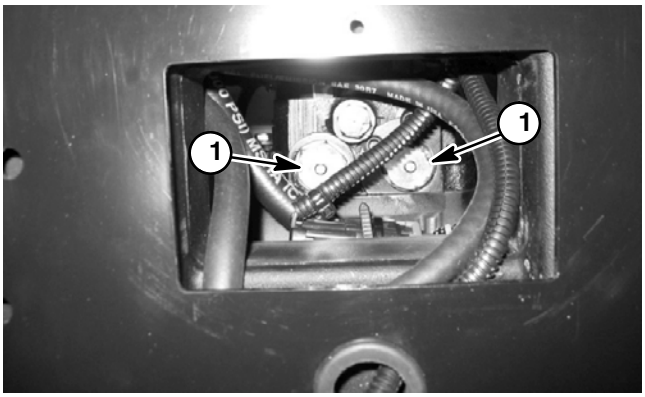


Figure 6

1. Check valve location

Check Hydraulic Fluid

The Groundsmaster 3280–D/3320 hydraulic system is designed to operate on high quality hydraulic fluid. The front axle housing acts as the hydraulic system reservoir and it holds approximately 6 quarts (5.7 liters) of hydraulic fluid. **Check level of hydraulic fluid daily.** See Traction Unit Operator's Manual for fluid level checking procedure and hydraulic oil recommendations.

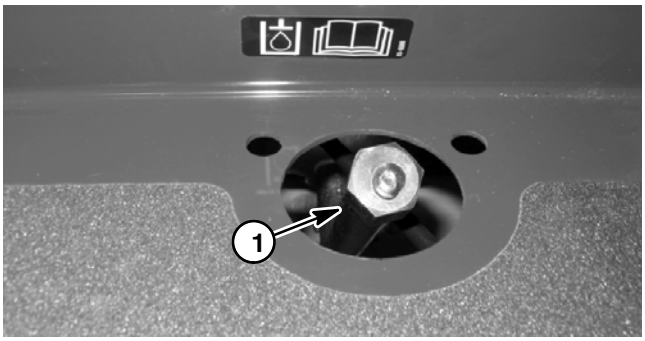
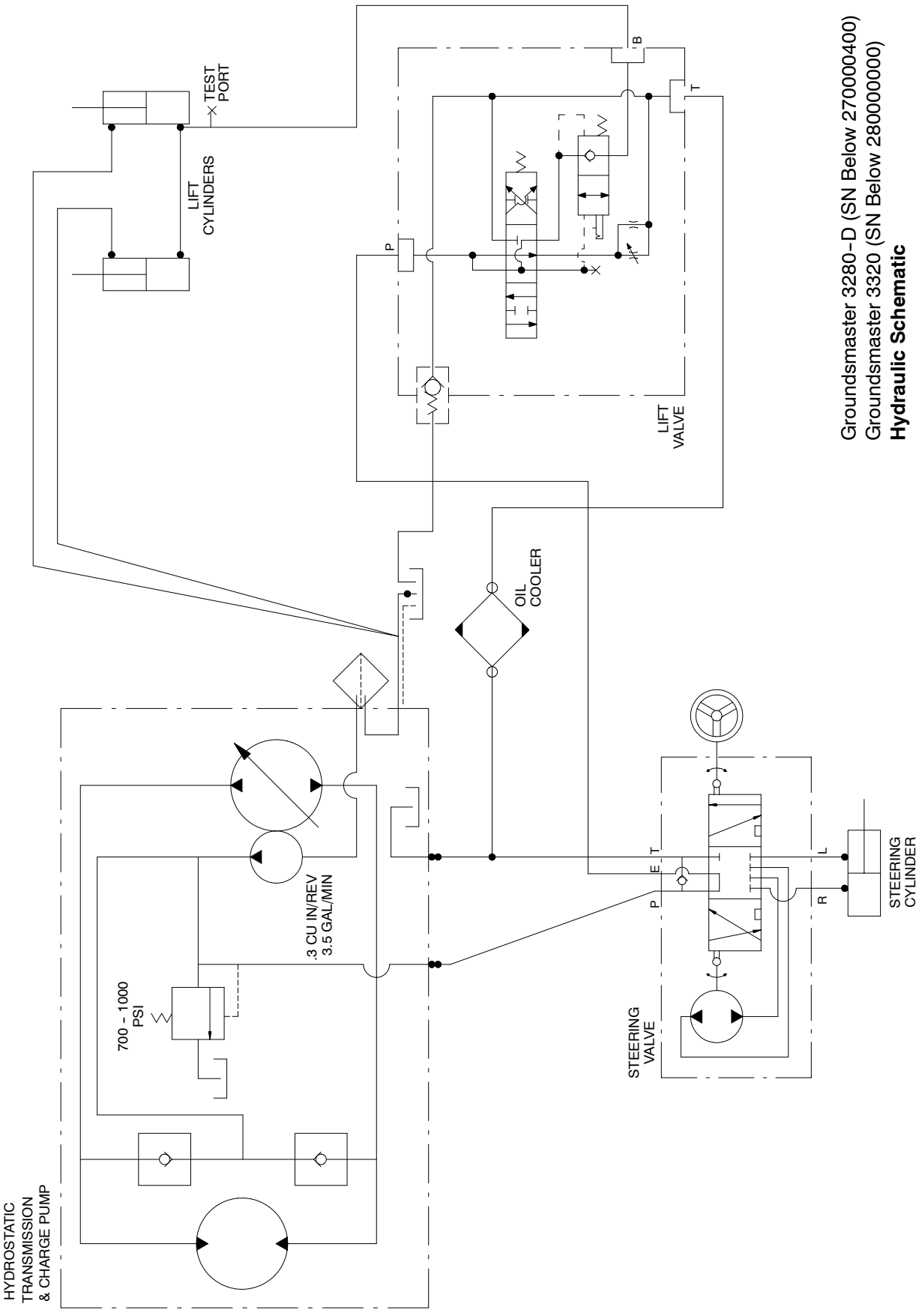


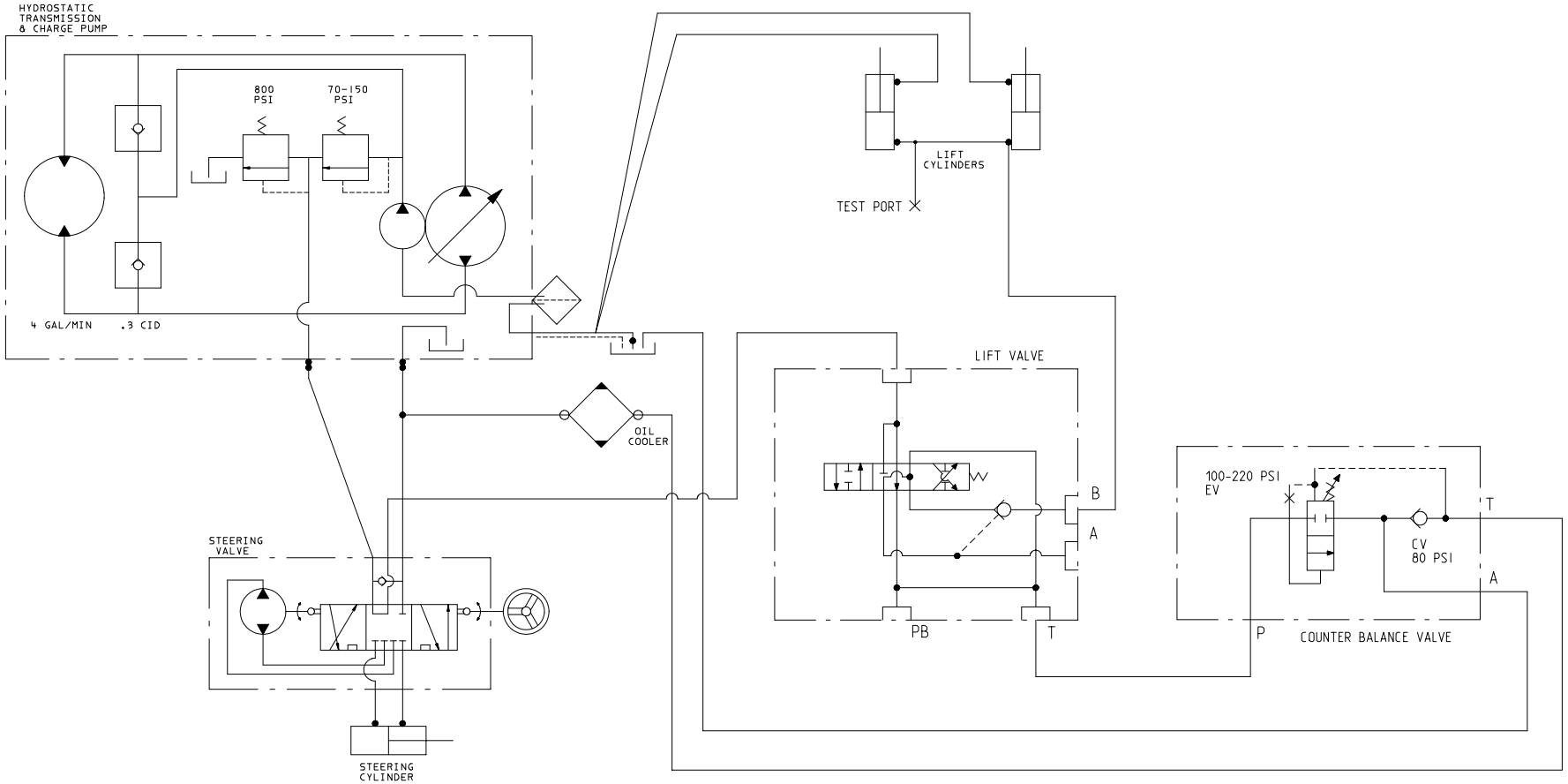
Figure 7

1. Hydraulic reservoir dipstick

Hydraulic Schematics



Groundsmaster 3280-D (SN Below 270000400)
Groundsmaster 3320 (SN Below 280000000)
Hydraulic Schematic



Groundsmaster 3280-D (SN Above 270000400)
Groundsmaster 3320 (SN Above 280000000)
Hydraulic Schematic

Hydraulic Flow Diagrams

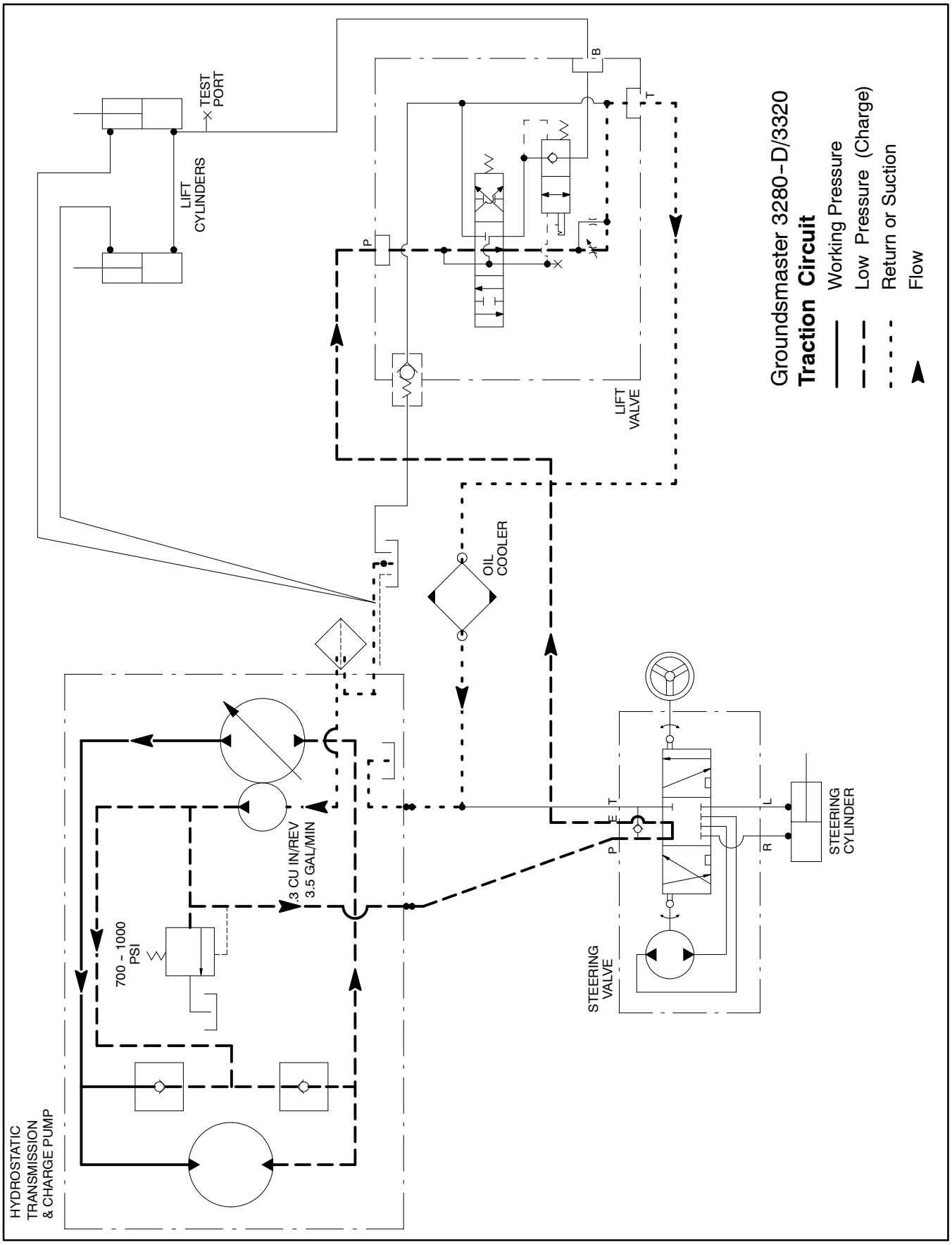


Figure 8

Traction Circuit

Forward Direction (Fig. 8)

The hydrostatic transmission input shaft is rotated by a drive shaft off the front of the engine crankshaft. Pushing the top of the traction pedal rotates the variable displacement pump swash plate in the transmission to create a flow of oil. This oil is directed to the fixed displacement motor in the transmission which turns the front axle input shaft to drive the front wheels in the forward direction.

Oil flowing from the motor returns to the variable displacement pump and is continuously pumped through the closed traction circuit as long as the traction pedal is pushed.

A gerotor charge pump in the hydrostat provides a constant supply of charge oil to the closed loop traction circuit for lubrication and to make up for oil that is lost due to internal leakage in the transmission pump and motor. The charge pump takes its suction through a filter from the reservoir (front axle). Charge pump flow is directed to the low pressure side of the closed loop circuit. Charge pressure is limited by backpressure created by the lift control valve. Charge pressure can be monitored at the transmission charge pump test port. Charge pump flow in excess of traction circuit charge needs provides hydraulic flow for the steering and lift circuits.

Reverse Direction

The traction circuit operates essentially the same in reverse as it does in the forward direction. However, the flow through the circuit is reversed. Pushing the bottom of the traction pedal rotates the variable displacement pump swash plate in the transmission to create a flow of oil. This oil is directed to the fixed displacement motor in the transmission which turns the differential input shaft to drive the front wheels in a reverse direction.

Oil flowing from the motor returns to the variable displacement pump and is continuously pumped through the closed traction circuit as long as the traction pedal is pushed.

The charge circuit functions the same in reverse as it does in the forward direction.

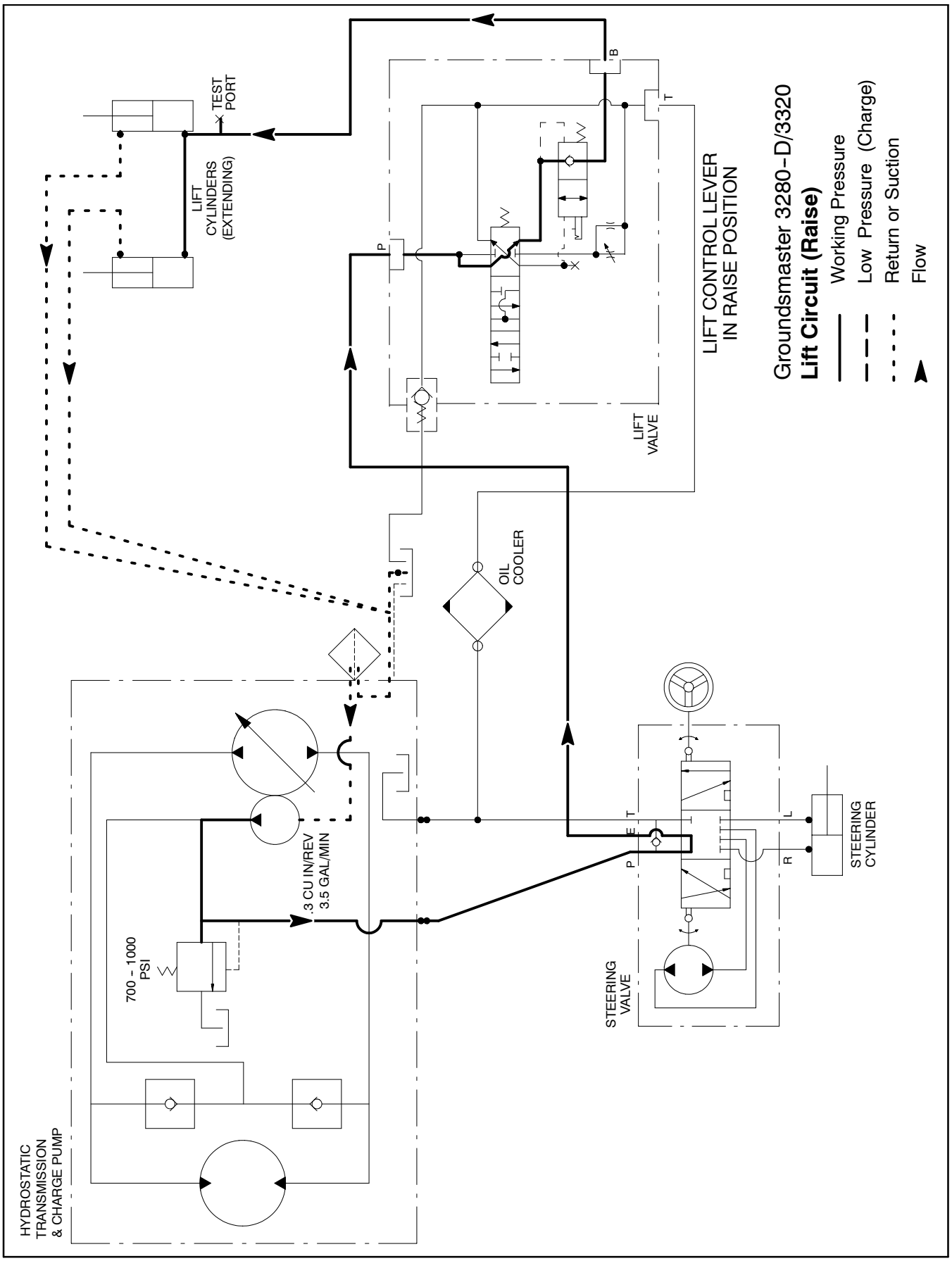

Groundsmaster 3280-D/3320
Lift Circuit (Raise)
Working Pressure
Low Pressure (Charge)
Return or Suction
Flow
LIFT CONTROL LEVER
IN RAISE POSITION
TEST
PORT
LIFT
CYLINDERS
(EXTENDING)
LIFT
VALVE
OIL
COOLER
.3 CU IN/REV
3.5 GAL/MIN
700 – 1000
PSI
STEERING
VALVE
STEERING
CYLINDER
HYDROSTATIC
TRANSMISSION
& CHARGE PUMP

Figure 9

Lift Circuit

The hydrostatic transmission charge pump supplies charge oil for the closed loop traction circuit in addition to supplying flow for the steering circuit and the cutting deck (or implement) lift circuit. The charge pump takes its suction through a filter from the reservoir (front axle). Pump output flows to the steering control valve before reaching the lift valve so the steering circuit has priority. Lift circuit pressure is limited from 700 to 1000 PSI by the implement relief valve located in the hydrostat.

During conditions of not steering or raising/lowering the cutting deck (or implement), flow from the charge pump goes to the lift control valve and is by–passed through the oil cooler and then to the reservoir (front axle).

Raise Cutting Deck (Or Implement) (Fig. 9)

When the cutting deck (or implement) is to be raised, the control valve spool is positioned back and flow is directed out the B port of the control valve to the cylinder (upper) end of the lift cylinders. Hydraulic pressure against the cylinder pistons extends the lift cylinders. At the same time, the pistons push the hydraulic fluid in the lower portion of the lift cylinders out and to the reservoir (front axle). The extending lift cylinders cause the cutting deck (or implement) to raise.

When the control valve lever is released, spring action returns the lift control spool to the center position and by–passes flow back to the reservoir (front axle). Lift cylinder movement is stopped.

Lower Cutting Deck (Or Implement) (Fig. 10)

When the cutting deck (or implement) is to be lowered, the control valve spool is moved forward causing the pilot valve to shift. This shifted valve allows a return path from the lift cylinders to the reservoir (front axle) (Fig. 10). The weight of the cutting deck (or implement) causes the cylinders to retract thus lowering the cutting deck (or implement). As the cylinders retract, the pistons draw hydraulic fluid from the reservoir (front axle) into the lower portion of the lift cylinders.

When the control valve lever is released, the lift control spool returns to the center position and causes the pilot valve to shift. Oil flow by–passes to the reservoir (front axle) and lift cylinder movement is stopped.

Counterbalance

An adjustable counterbalance valve allows cutting unit weight transfer to the machine to improve traction. On early production machines, the counterbalance valve is incorporated in the lift control valve. Later production machines have a separate counterbalance manifold. Changes in traction conditions (e.g. moving up an incline) will cause a valve shift to slightly lift or lower the cutting deck to alter weight transfer. Counterbalance pressure settings are dependant on the cutting deck used on a machine. Refer to Traction Unit Operator's Manual for counterbalance pressure recommendations.

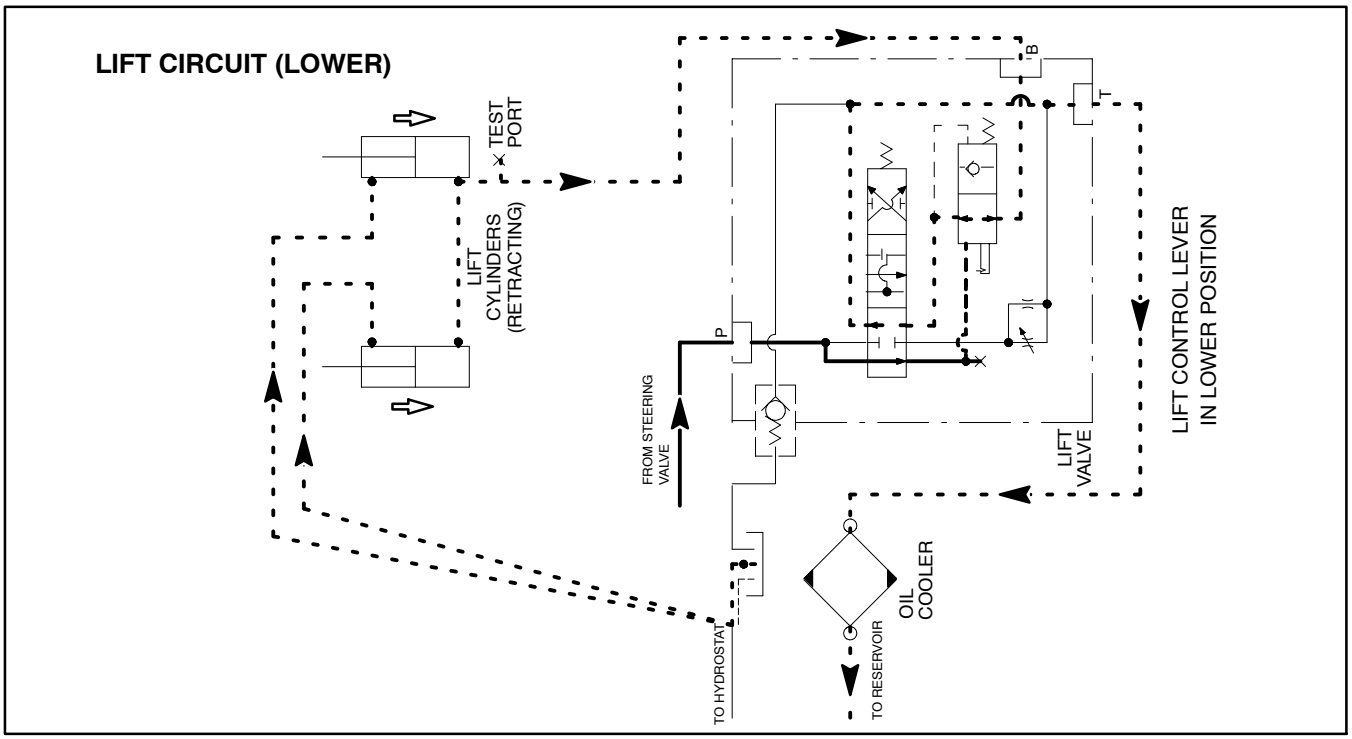


Figure 10

Steering Circuit

The charge pump in the hydrostat supplies flow for the steering circuit and for the cutting deck (or implement) lift circuit. Pump output flows to the steering control valve before reaching the lift valve so the steering circuit has priority. Steering circuit pressure is limited from 700 to 1000 PSI by the implement relief valve located in the hydrostat.

When the steering wheel is not being turned and the engine is running (hydrostat input shaft being rotated), charge pump flow enters the steering control valve at the P port and by–passes the rotary meter and steering cylinder. Flow leaves the steering control valve through the E port and is directed to the lift control valve.

Left Turn (Fig. 11)

When a left turn is made with the engine running, the turning of the steering wheel positions the steering control spool valve so that flow goes through the bottom of the spool. Flow entering the steering control valve at the P port passes through the rotary meter and is directed out the L port. Pressure retracts the steering cylinder for a left turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the steering cylinder flows back through the spool valve, then out the T port and returns to the hydraulic reservoir (front axle).

Right Turn (Fig. 11)

When a right turn is made with the engine running, the turning of the steering wheel positions the steering control spool valve so that flow goes through the top of the spool. Flow entering the steering control valve at the P port passes through the rotary meter and is directed out port R. Pressure extends the steering cylinder for a right turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve, then out the T port and to the hydraulic reservoir (front axle).

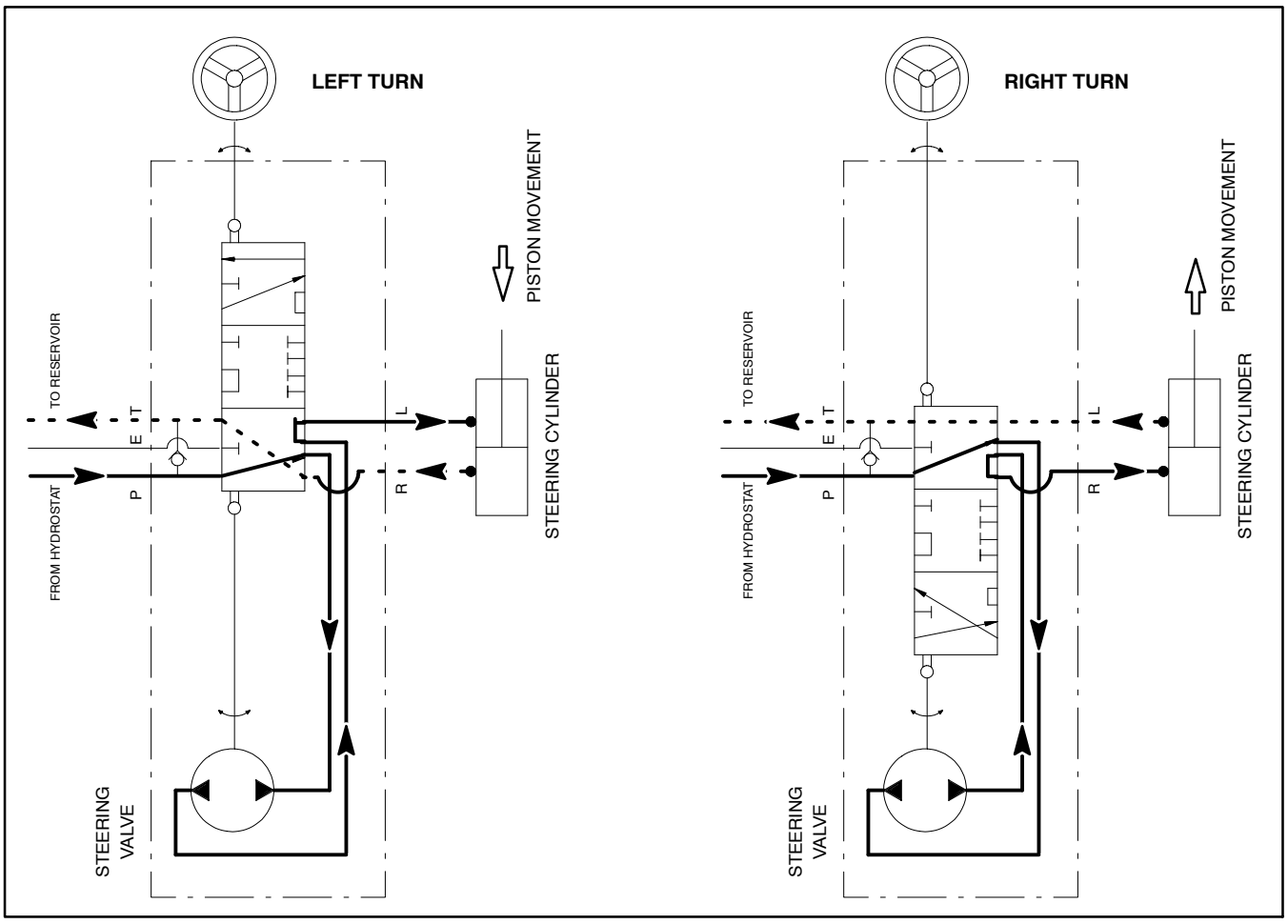


Figure 11

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Special Tools

Order these tools from your Toro Distributor.

Hydraulic Pressure Test Kit

Toro Part Number: **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 12

Hydraulic Tester (Pressure and Flow)

Toro Part Number: **TOR214678**

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.

Figure 13

Hydraulic Test Fitting Kit

Toro Part Number: **TOR4079**

This kit includes a variety of o−ring Face Seal fittings to enable connection of test gauges to the system.

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

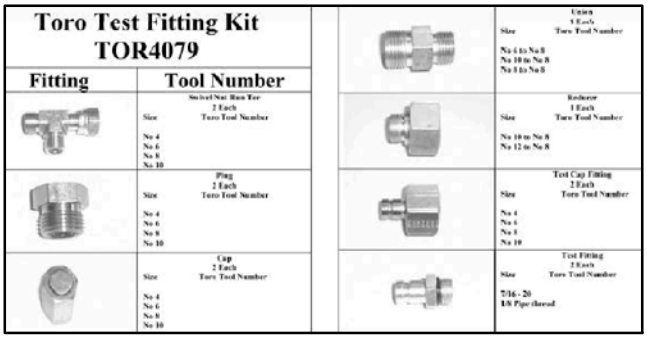

Figure 14

O−Ring Kit

Toro Part Number: **16−3799**

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

Figure 15

Troubleshooting

The cause of an improperly functioning hydraulic system is best diagnosed with the use of proper testing equipment and a thorough understanding of the complete hydraulic system.

A hydraulic system with an excessive increase in heat or noise has a potential for failure. Should either of these conditions be noticed, immediately stop the machine, turn off the engine, locate the cause of the trouble, and correct it before allowing the machine to be used again.

Continued use of an improperly functioning hydraulic system could lead to extensive internal component damage.

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 oil leaks	Fitting(s), hose(s) or tube(s) is (are) loose or damaged. O–ring(s) or seal(s) is (are) missing or damaged.
Foaming hydraulic fluid	Oil level in reservoir (front axle) is low. Hydraulic system has wrong kind of oil. Pump suction line has an air leak.
Hydraulic system operates hot	Traction system pressure is high due to excessive load or brakes applied. Oil level in reservoir (front axle) is low. Oil is contaminated or too light. Engine speed is too low. Oil cooler is damaged or plugged. Air flow through oil cooler is obstructed. Oil filter is plugged. Charge pressure is low. Hydrostat check valve is not seating or is damaged. Hydrostat is worn or damaged.
Traction jerky when starting	Friction wheel on traction pedal out of adjustment or worn. Traction control linkage is misadjusted, disconnected, binding or damaged. Hydrostat check valve is not seating or is damaged.
Neutral is difficult to find or unit operates in one direction only	Traction control linkage is misadjusted, disconnected, binding or damaged. Hydrostat check valve is not seating or is damaged. Hydrostat is worn or damaged.

Problem	Possible Cause
Traction response is sluggish	Charge pressure is low. Hydraulic oil is very cold. Hydrostat check valve is not seating or is damaged. Brakes are not released. Hydrostat is worn or damaged.
No traction in either direction	Brakes are not released. Oil level in reservoir (front axle) is low. Hydrostat check valve is not seating or is damaged. Charge pressure is low. Transmission drive shaft or key damaged (steering and lift circuits affected as well). Hydrostat is worn or damaged. Front axle is damaged.
Cutting deck (or implement) will not lift or lifts slowly	Engine speed is too low. Cutting deck has excessive debris buildup in cutting chambers. Lift arm(s) is (are) binding. Lift valve control linkage is binding or broken. Lift cylinder(s) is (are) binding. Reservoir (front axle) oil level is low. Charge pump pressure or flow is insufficient. Implement relief valve is stuck or damaged (Note: steering circuit also affected). Lift control valve is damaged. Lift cylinder leaks internally.

Problem	Possible Cause
Cutting deck (or implement) raises, but will not stay up	Lift cylinder leaks internally. Lift control valve leaks.
Steering inoperative or sluggish	Engine speed is too low. Reservoir (front axle) oil level is low. Steering components (e.g. tie rods, steering cylinder ends) worn or binding. Steering cylinder is binding. Implement relief valve stuck or damaged (Note: lift circuit also affected). Steering control valve is worn or damaged. Steering cylinder leaks internally. Charge pump flow or pressure is low (Note: Low charge pump flow or pressure will also affect the lift circuit).

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 Special Tools section in this Chapter).

CAUTION

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

Before Performing Hydraulic Tests

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

Precautions For Hydraulic Testing

WARNING

Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved by stopping the engine and lowering or supporting the cutting deck or other implement.

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

1. Thoroughly clean the machine before disconnecting or disassembling any hydraulic components. Always keep in mind the need for cleanliness when working on hydraulic equipment. Contamination will cause excessive wear of hydraulic components.

2. Put 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 tachometer when making a hydraulic test. Engine speed will affect the accuracy of the hydraulic test readings.

4. To prevent damage to tester or components, the inlet and the outlet hoses must be properly connected, and not reversed (when using tester with pressure and flow capabilities).

5. To minimize the possibility of damaging components, completely open load valve in hydraulic tester (when using tester with pressure and flow capabilities).

6. Install fittings finger tight, far enough to insure that they are not cross–threaded, before tightening with a wrench.

7. Position the tester hoses so that rotating machine parts will not make contact with them and result in hose or tester damage.

8. Check and adjust the oil level in the reservoir (front axle) after connecting hydraulic test equipment.

9. Check the control linkage for improper adjustment, binding or broken parts.

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

11. After testing is completed, check oil level in reservoir (front axle) and adjust if necessary. Also, make sure that no leakage from hydraulic components exist.

Charge Pressure Test (Using Pressure Gauge)

A charge pressure test should be performed to identify if a worn or damaged hydrostatic transmission is causing a hydraulic system problem.

NOTE: Before conducting charge pressure test, determine counterbalance pressure setting for the machine (see Traction Unit Operator's Manual).

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

2. Park machine on a level surface with the cutting deck (or implement) lowered and P.T.O. switch off. Make sure engine is off. Set the parking brake and block the front wheels to prevent machine movement.

3. Read Precautions For Hydraulic Testing.

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil.

4. Thoroughly clean the area around the 1/8 inch pipe plug located on the top of the transmission between the two check valves (Figs. 16 and 17). Remove the plug from the transmission.

5. Connect a 1000 PSI (70 Bar) hydraulic pressure gauge to the transmission opening.

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

7. Run engine at full speed **(3200 ± 50 RPM)**. Use a tachometer to verify that engine speed is correct.

8. Observe pressure gauge. The pressure reading should be approximately the same as counterbalance pressure.

9. Turn off machine. Record test results.

10. Perform a dynamic charge pressure test to identify possible hydrostat (pump or motor) problems as follows:

A. With pressure gauge still connected, sit in the operator seat, start engine and press the traction pedal to forward.

B. While machine is moving straight ahead on level ground (no turning or deck lifting), monitor the pressure reading on the pressure guage. Record test results.

11. The pressure should drop no more than 15% from initial test reading (Step 8 above). A pressure drop of more than 15% may indicate a traction circuit leak (e.g. check valve not seating, worn or damaged hydrostat).

If charge pressure drop is more than 15%, inspect the condition of the charge pump gerotor and internal housing (See Charge Pump Service in the Sauer–Danfoss (Sundstrand) 15 Series Service Manual at the end of this chapter).

If the charge pump is in good condition (no scoring, scratches or excessive wear), the general condition of the transmission's piston pump and piston motor might be suspected of wear and inefficiency.

12. Disconnect pressure gauge from the transmission. Install pipe plug back in the transmission. Check hydraulic oil level in reservoir (front axle).

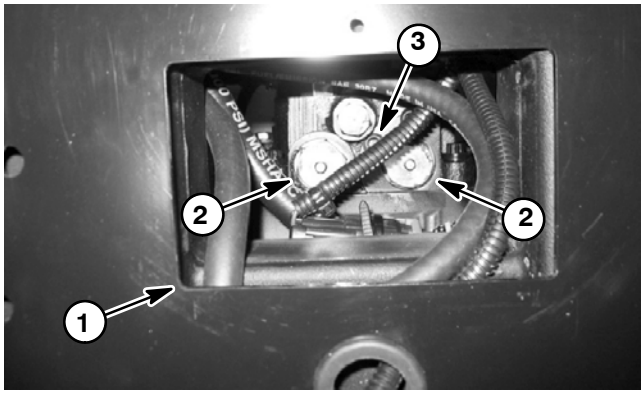

Figure 16

1. **Seat base opening**
2. **Check valve**
3. **Pipe plug**

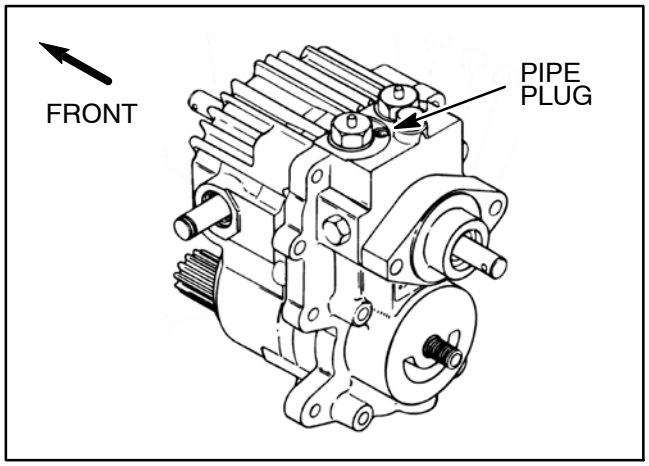

Figure 17

Implement Relief Pressure Test (Using Pressure Gauge)

The implement relief pressure test should be done if a problem is suspected with the implement relief valve.

NOTE: When conducting the Implement Relief Pressure Test, use a 5000 PSI (350 Bar) Pressure Gauge.

1. Perform steps 1 through 8 of the Charge Pressure Test (see Test No. 1 in this section). Make sure to use a 5000 PSI (350 Bar) Pressure Gauge.

2. With the engine running at 3200 RPM, move the lift control lever to the RAISE position and allow the cutting unit (or implement) to fully raise. Continue to hold the lever in the RAISE position and observe the pressure gauge. The pressure reading should be from **700 to 1000 PSI (48.2 to 69.0 bar)** as the implement relief valve lifts.

3. Move the lift control lever to the LOWER position to lower the cutting deck (or implement) to the ground. Shut off engine. Record test results.

NOTE: If the implement relief pressure is 700 to 1000 PSI (48.2 to 69.0 bar) and a steering or lift problem occurs, inspect for a problem unrelated to the hydraulic circuit (e.g. binding steering or lift system components, debris build–up on/under the cutting deck). Check and repair other items before continuing with hydraulic tests.

4. If the implement relief pressure is below 700 PSI (48.2 bar), adjust the implement relief valve in the transmission by adding the required amount of shims from the shim pack (see Implement Relief Valve in the Sauer–Danfoss (Sundstrand) 15 Series Service Manual at the end of this chapter).

NOTE: For every 0.010 in. (.254 mm) of shim thickness, there is an approximate 50 PSI (3.4 bar) change in implement relief pressure.

If adding shims to the relief valve does not increase pressure, inspect the condition of the charge pump gerotor and internal housing (See Charge Pump Service in the Sauer–Danfoss (Sundstrand) 15 Series Service Manual at the end of this chapter).

If the charge pump is in good condition (no scoring, scratches or excessive wear), the general condition of the transmission's piston pump and piston motor might be suspected of wear and inefficiency. A lack of minimum implement relief pressure could be due to the charge pump having to direct all flow to the main traction circuit (piston pump and piston motor).

5. Disconnect pressure gauge from the transmission. Install pipe plug back in the transmission. Check hydraulic oil level in reservoir (front axle).

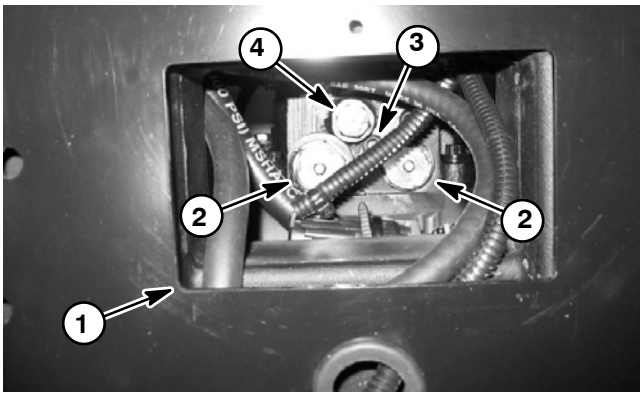

Figure 18

1. **Seat base opening**
2. **Check valve**
3. **Pipe plug**
4. **Implement relief valve**

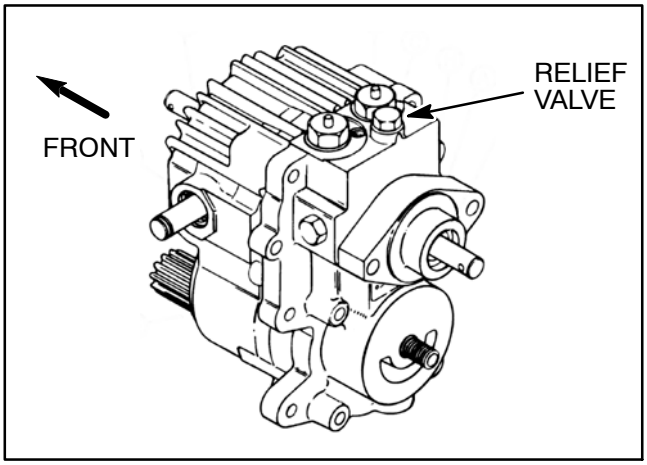

Figure 19

Lift Cylinder Internal Leakage Test

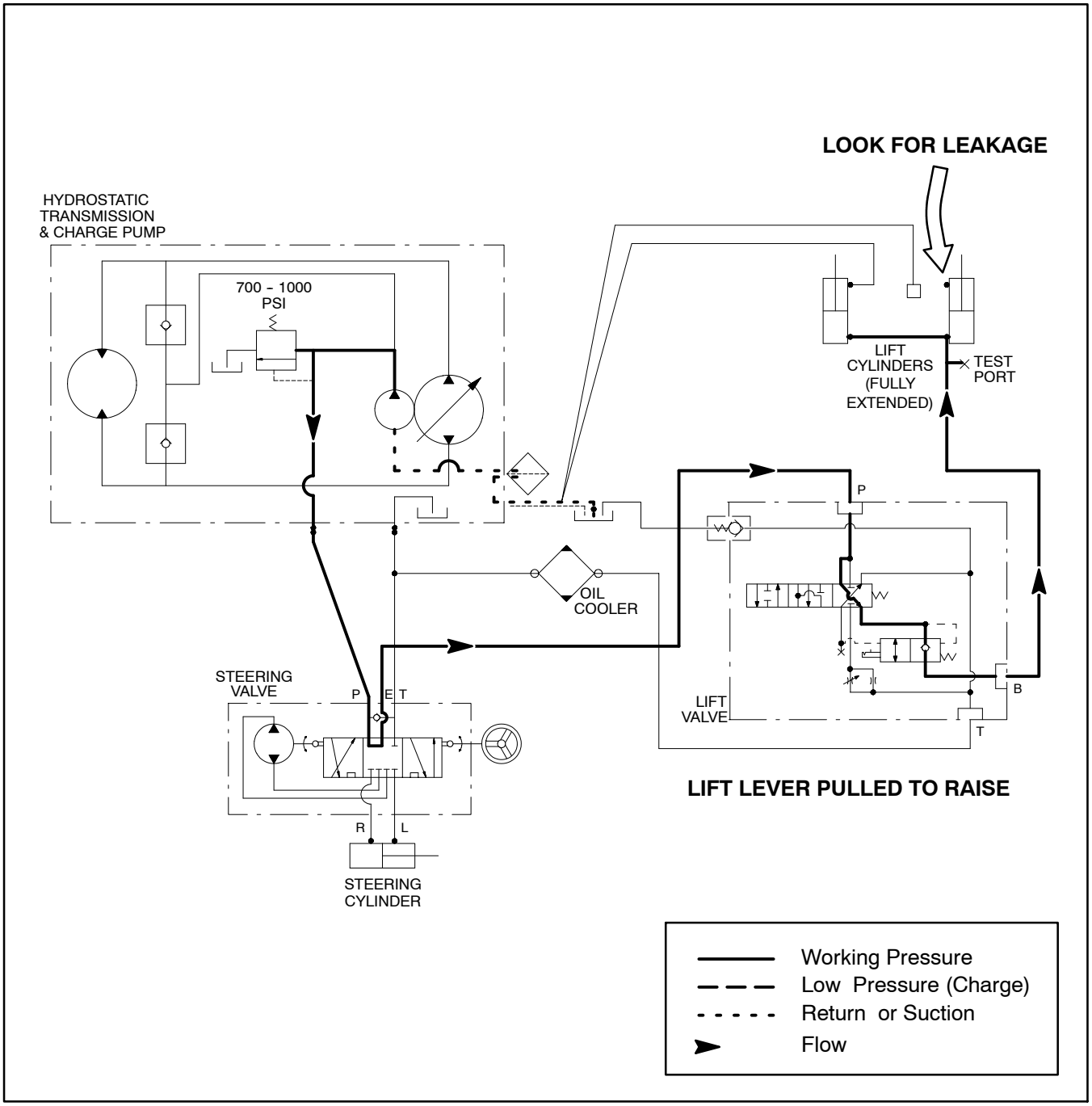

Figure 20

Procedure for Lift Cylinder Internal Leakage Test:

The lift cylinder internal leakage test should be performed if a cutting deck (or implement) raise and lower problem is identified. This test will determine if the lift cylinders are faulty.

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

1. Park machine on a level surface with the P.T.O. switch OFF. Set the parking brake and block the front wheels to prevent machine movement.

2. With the engine running, raise the cutting deck (or implement) completely. Using blocking or a hoist, support the cutting deck (or implement) to keep it in the fully raised position. Turn engine OFF.

3. Place a drain pan under the lift cylinder that is to be tested for internal leakage. Thoroughly clean the area around the cylinder return hose at the bottom of the lift cylinder.

4. Loosen the hose clamp and disconnect the cylinder return hose from the bottom of the lift cylinder (Fig. 21). Leave the other end of the return hose connected to the filter adapter on the transmission.

5. Securely plug the open end of the disconnected lift cylinder return hose to prevent hydraulic oil leakage or suction of air by the transmission.

6. Remove all hydraulic oil from drain pan. Make sure that empty drain pan remains under the open fitting of the lift cylinder.

7. Start the engine and briefly hold the lift control lever in the RAISE position to pressurize the lift cylinders. Turn engine OFF.

8. Check to see if any oil has leaked into the drain pan from the open fitting of the lift cylinder. If there is any oil in the drain pan, the lift cylinder has internal leakage and must be replaced (see Lift Cylinder in the Service and Repairs section).

9. If the lift cylinder shows no sign of leakage, remove the plug from the return hose and install the hose on the lift cylinder fitting. Secure the hose by tightening the hose clamp.

10. If needed, repeat steps 3 through 9 for the other lift cylinder.

11. After testing is completed, remove the support from the cutting deck (or implement). Start engine and operate lift cylinders through several up and down cycles. Stop the engine and check for any leakage.

12. Check hydraulic oil level in reservoir (front axle).

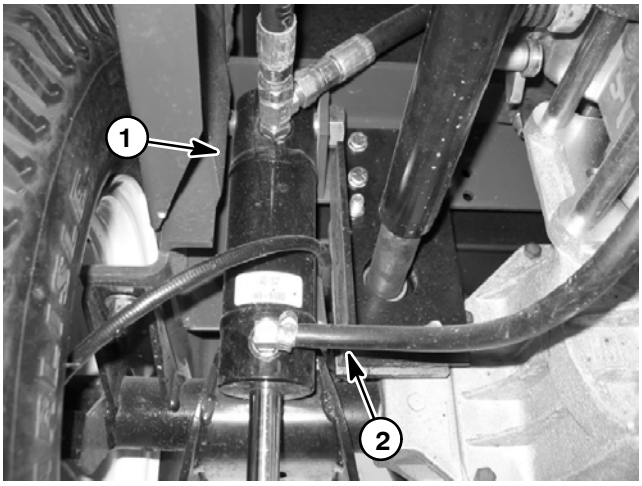

Figure 21

1. **Lift cylinder**
2. **Return hose**

Steering Cylinder Internal Leakage Test

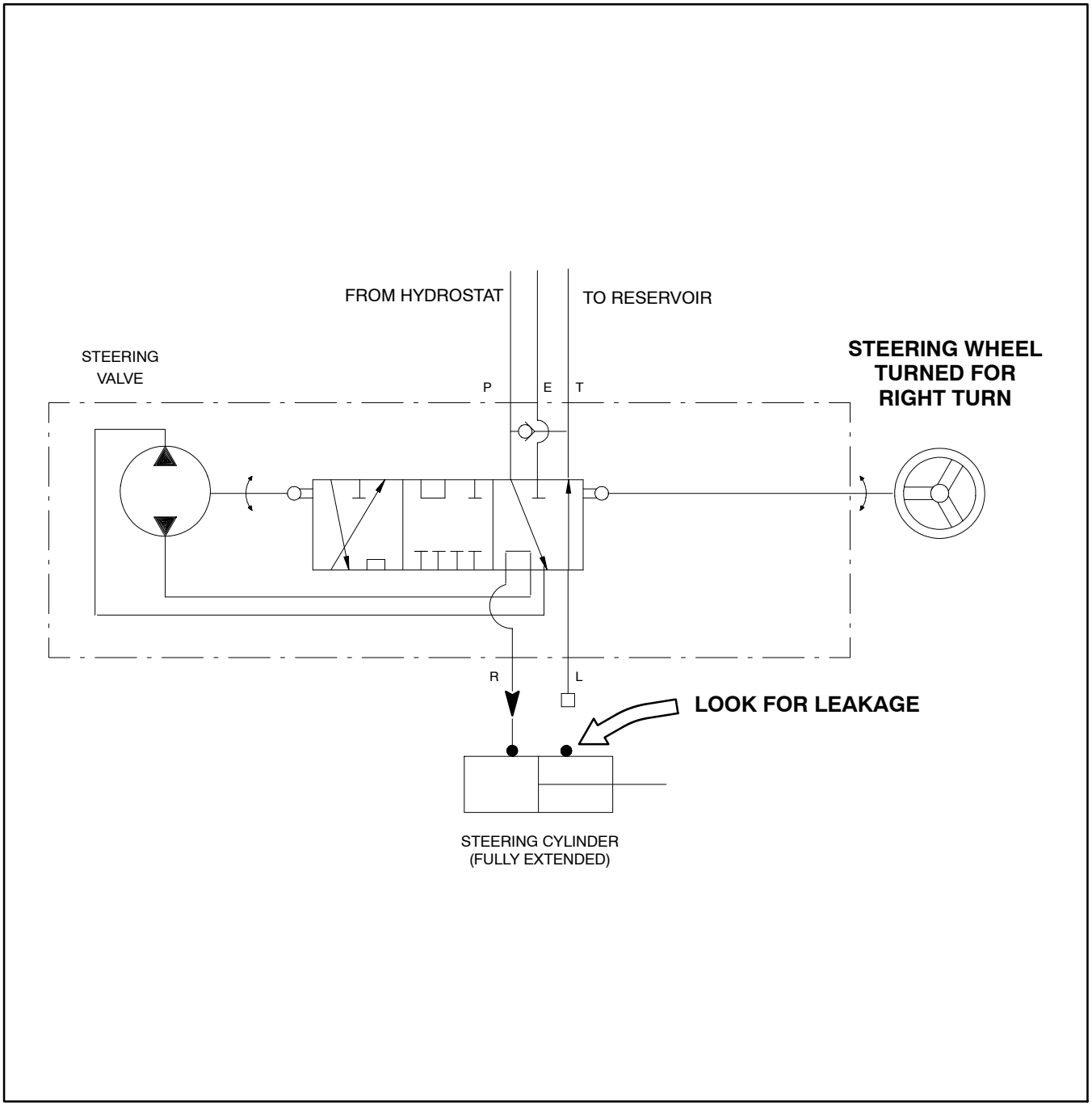

Figure 22

Procedure for Steering Cylinder Internal Leakage Test:

The steering cylinder internal leakage test should be performed if a steering problem is identified. This test will determine if the steering cylinder is faulty.

NOTE: Steering circuit operation will be affected by rear tire pressure, steering cylinder binding, extra weight on the vehicle and/or binding of rear axle steering components. Make sure that these items are checked before proceeding with steering cylinder internal leakage test.

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

2. Park machine on a level surface with the cutting deck (or implement) lowered and P.T.O. switch off. Make sure engine is off. Set the parking brake.

3. Read Precautions For Hydraulic Testing.

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil.

4. Turn the steering wheel for a right turn (clockwise) so the steering cylinder rod is fully extended.

5. Remove hydraulic hose from the fitting on the rod end of the steering cylinder. Plug the end of the hose.

6. With the engine off, continue turning the steering wheel for a right turn (clockwise) with the steering cylinder fully extended. Observe the open fitting on the steering cylinder as the wheel is turned. If oil comes out of the fitting while turning the steering wheel to the right, the steering cylinder has internal leakage and must be repaired or replaced.

7. Remove plug from the hydraulic hose. Reconnect hose to the steering cylinder fitting.

8. If a steering problem exists and the steering cylinder tested acceptably, steering control valve requires service (see Steering Control Valve and Steering Control Valve Service in the Service and Repairs section).

Charge Pump Flow Test (Using Tester With Pressure Gauges and Flow Meter)

The charge pump flow test should be performed if a hydraulic problem is identified that affects both the steering and lift circuits.

NOTE: The charge pump provides make–up oil for internal hydrostat components before flow is available for the steering and lift circuits. Flow measured in this test will be less than total charge pump output.

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

2. Park machine on a level surface with the cutting deck (or implement) lowered and P.T.O. switch off. Make sure engine is off. Set the parking brake and block the front wheels to prevent machine movement.

3. Read Precautions For Hydraulic Testing.

CAUTION

Before opening hydraulic system, operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil.

4. Place a drain pan under the transmission. Thoroughly clean the area around the transmission charge pump outlet (pressure) fitting (Fig. 23). Disconnect the hydraulic hose from the outlet fitting.

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

5. Connect inlet hose of tester with pressure gauges and flow meter to the transmission charge pump outlet (pressure) fitting. Connect the tester outlet hose to the hydraulic hose disconnected from the transmission fitting in step 5.

6. Make sure that the flow control valve on the tester is fully open. Also, make sure that traction pedal and lift valve are in neutral and that the parking brake is engaged.

7. Start engine and run at idle speed. Check for any hydraulic leakage from test connections and correct before proceeding with test.

8. Run engine at full speed **(3200 ± 50 RPM)**. Use a tachometer to verify that engine speed is correct.

IMPORTANT: The charge pump is a positive displacement pump. If the flow control valve on the tester is fully closed, transmission damage can occur.

9. Watch tester pressure gauges carefully while slowly closing the flow control valve until pressure gauge reads **500 PSI (34.5 bar)**.

10. Flow gauge reading should be at least **1 GPM (3.8 LPM)**.

11. Open flow control valve on tester and turn off engine. Record results of hydraulic flow test.

12. If pressure of 500 PSI (34.5 bar) or flow of 1 GPM (3.8 LPM) could not be achieved, check the following:

A. Perform the charge pressure test (see Charge Pressure Test in this section). Also, a dynamic charge pressure test can be performed to identify if a worn or damaged hydrostatic transmission exists.

B. Perform the implement relief pressure test (see Implement Relief Pressure Test in this section).

C. Inspect the condition of the charge pump gerotor and internal housing (See Charge Pump Service in the Sauer–Danfoss (Sundstrand) 15 Series Service Manual at the end of this chapter).

D. The general condition of the transmission's piston pump and piston motor might be suspected of wear and inefficiency.

13. Disconnect tester from the transmission and hydraulic hose. Reconnect hydraulic hose to the transmission fitting. Check hydraulic oil level in reservoir (front axle).

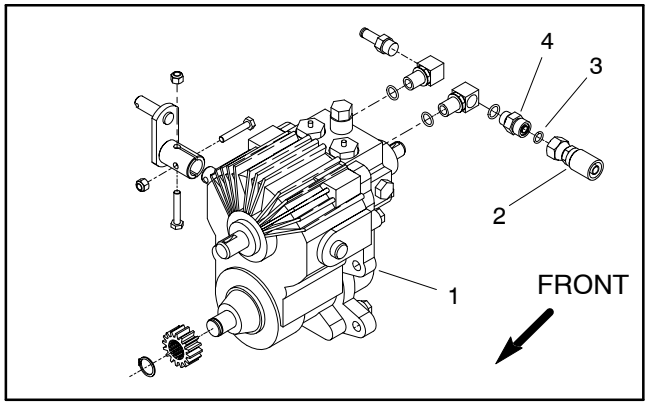

Figure 23

1. Hydrostatic transmission
2. Hydraulic hose
3. O–ring
4. Outlet fitting

Traction Pedal Friction Wheel

The traction pedal friction wheel is designed to reduce transmission oscillation caused by rapid back and forth foot movements against the traction pedal. This is most noticeable when operating over bumpy terrain.

Occasionally inspect the friction wheel surface that contacts the traction pedal (Fig. 24). If the friction wheel is worn flat at this point, the wheel should be rotated to restore contact with the pedal.

Adjustment (Fig. 25)

1. Loosen the flange nuts that secure the traction pedal shaft to the machine frame.

2. Rotate the shaft to move the worn friction wheel section away from the traction pedal.

3. Tighten the flange nuts to secure traction pedal shaft and friction wheel in position.

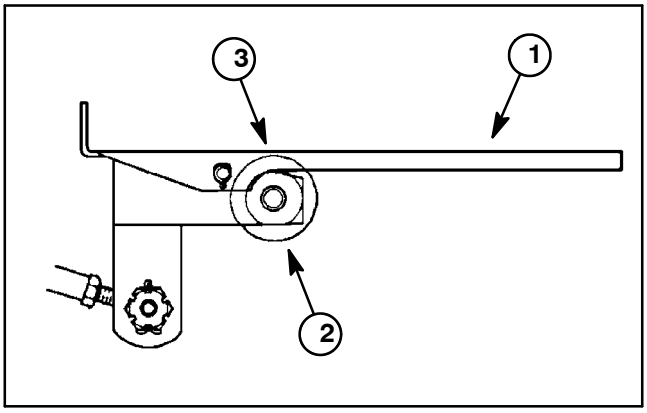

Figure 24

1. **Traction pedal**
2. **Friction wheel**
3. **Inspection point**

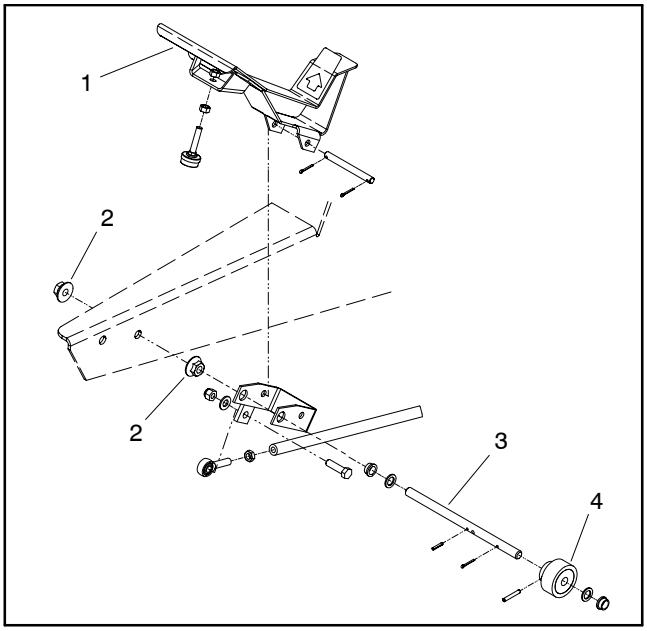

Figure 25

1. **Traction pedal**
2. **Flange nut**
3. **Traction pedal shaft**
4. **Friction wheel**

General Precautions for Removing and Installing Hydraulic System Components

Before Repair or Replacement of Components

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

2. Clean machine before disconnecting, removing or disassembling any hydraulic components. Make sure hydraulic components, hose connections and fittings are cleaned thoroughly. Always keep in mind the need for cleanliness when working on hydraulic components.

CAUTION

Before loosening any hydraulic component, operate all hydraulic controls (traction pedal, steering wheel and lift control) to relieve system pressure and avoid injury from pressurized hydraulic oil. Controls must be operated with the engine OFF.

3. Put caps or plugs on any hydraulic lines, hydraulic fittings or 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 that fittings will be aligned properly when reinstalling hydraulic hoses and tubes.

After Repair or Replacement of Components

1. Check oil level in the hydraulic reservoir (front axle) and add correct oil if necessary (see Traction Unit Operator's Manual). Drain and refill hydraulic system reservoir (front axle), and change oil filter, if component failure was severe or system is contaminated (see Flush Hydraulic System in this section).

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

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

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

5. After repairs, check control linkages and 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 Hydraulic System Start Up in this section).

7. Check for hydraulic oil leaks. Shut off engine and correct leaks if necessary. Check oil level in hydraulic reservoir (front axle) and add correct oil if necessary.

Check Hydraulic Lines and Hoses

WARNING

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

Check hydraulic lines and hoses daily for leaks, kinked lines, loose mounting supports, wear, loose fittings, 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 or black or contains metal particles).

1. Park machine on a level surface. Lower cutting deck (or implement), stop engine, engage parking brake and remove key from ignition switch.

2. Drain hydraulic reservoir (front axle) (see Traction Unit Operator's Manual).

3. Clean area around hydraulic filter mounting area. Remove and discard hydraulic filter.

4. Drain entire hydraulic system. Drain all hoses, tubes and components while the system is warm. Flush hoses and tubes to remove any contamination.

IMPORTANT: If a failure occurred in the traction circuit, traction circuit component disassembly and thorough cleaning may be required to remove contaminates from the traction circuit. Because the traction circuit is a closed loop, any contamination will remain in the circuit and can cause additional component damage unless it is removed.

5. Make sure hydraulic filter mounting surface is clean. Apply clean hydraulic oil to gasket on new filter. Screw filter on until gasket contacts mounting plate, then tighten filter half a turn.

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

6. Fill hydraulic reservoir (front axle) (see Traction Unit Operator's Manual).

7. Perform the following to prevent engine from starting:

   A. Disconnect electrical connector to the fuel stop solenoid on Groundsmaster 3280−D machines.

   B. Disconnect and ground all engine spark plug wires on Groundsmaster 3320 machines.

8. Make sure traction pedal is in **neutral** and the P.T.O. switch is **off**. Turn ignition key switch to start; engage starter for ten (10) seconds to prime hydraulic pump. Repeat this step again.

9. Connect fuel stop solenoid (Groundsmaster 3280−D) or spark plug wires (Groundsmaster 3320) to allow engine to start.

10. Start engine and let it idle at low speed for a minimum of two (2) minutes.

11. Increase engine speed to high idle for minimum of one (1) minute under no load.

12. Rotate steering wheel in both directions several times. Raise and lower cutting deck (or implement) several times.

13. Shut off engine and check for hydraulic oil leaks. Check oil level in hydraulic reservoir (front axle) and add correct oil if necessary.

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

15. Check condition of hydraulic oil. If the fluid shows any signs of contamination, repeat steps 1 through 14 again.

16. Resume normal operation and follow recommended maintenance intervals.

Hydraulic System Start-up

NOTE: When initially starting the hydraulic system with new or rebuilt components such as pumps or lift cylinders, it is important that this start–up procedure be used. This procedure reduces the chance of damaging the system or its components from not purging the system of air.

1. After the hydraulic system components have been properly installed and if the hydrostatic transmission was rebuilt or replaced, make sure hydrostat housing is at least half full of clean hydraulic oil.

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

3. Drain, flush and refill hydraulic system and change hydraulic oil filter if component failure was severe or system is contaminated (See Flush Hydraulic System in this section).

4. Make sure hydraulic reservoir (front axle) is full. Add correct oil if necessary (see Traction Unit Operator's Manual).

5. Check control linkage for proper adjustment, binding or broken parts.

6. Perform the following to prevent engine from starting:

   A. Disconnect electrical connector to the fuel stop solenoid on Groundsmaster 3280–D machines.

   B. Disconnect and ground all engine spark plug wires on Groundsmaster 3320 machines.

7. Make sure traction pedal is in **neutral** and the P.T.O. switch is **off**. Turn ignition key switch to start; engage starter for ten (10) seconds to prime hydraulic pump.

8. Connect fuel stop solenoid (Groundsmaster 3280–D) or spark plug wires (Groundsmaster 3320) to allow engine to start.

9. Make sure traction pedal is in **neutral** and the P.T.O. switch is **off**. Start engine and run it at low idle. 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.

10. If the hydrostat was replaced or rebuilt, run the traction unit so the wheels turn slowly for 10 minutes.

11. Operate the traction unit (including steering and cutting deck lift/lower) by gradually increasing the work load to full over a 10 minute period.

12. Stop the machine. Check hydraulic reservoir (front axle) level and fill if necessary. Check hydraulic components for leaks and tighten any loose connections.

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Transmission Drive Shaft

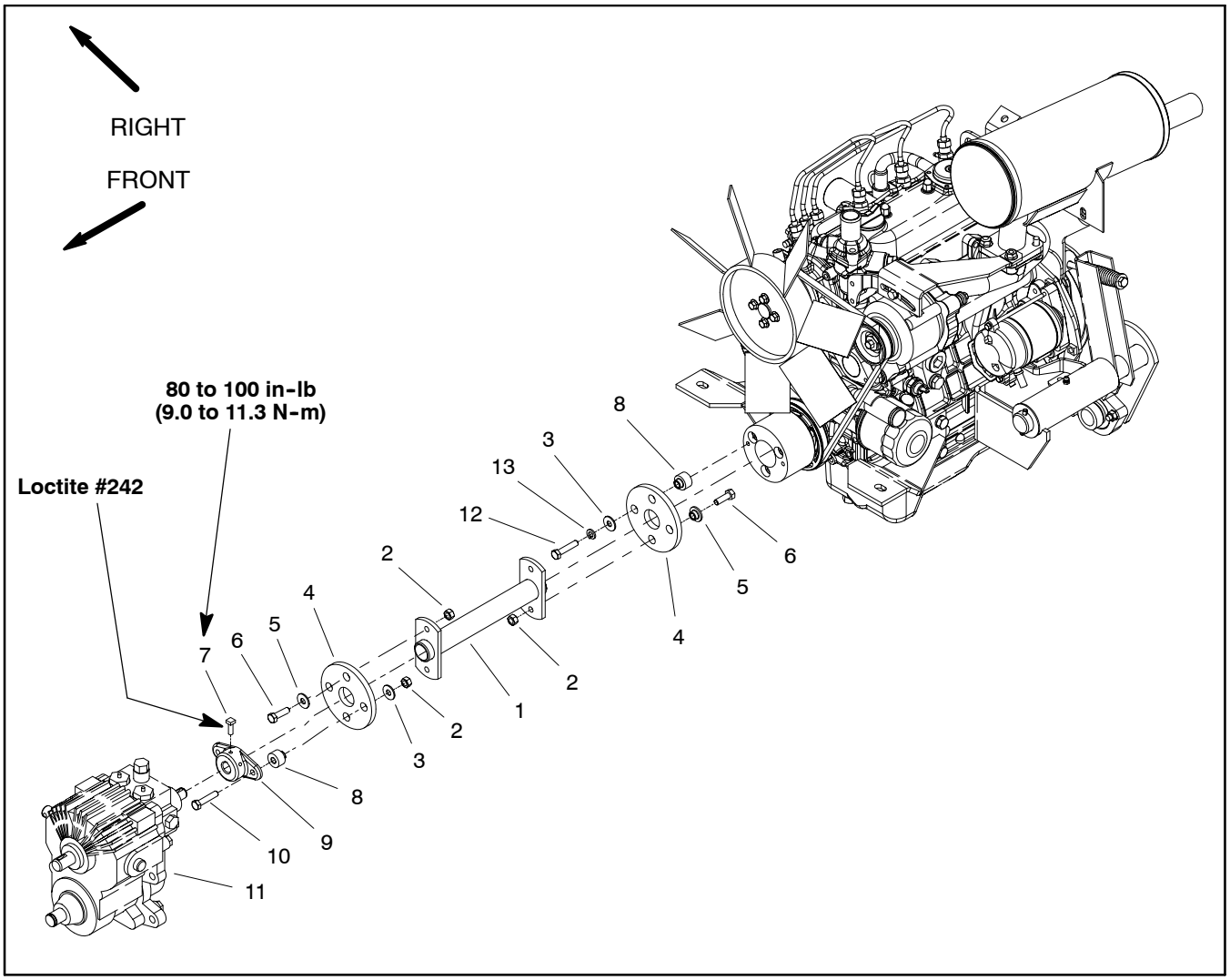

Figure 26

1. **Drive shaft**
2. **Conelock nut**
3. **Flat washer**
4. **Rubber coupling**
5. **Coupling spacer**
6. **Cap screw**
7. **Square head screw (2 used)**
8. **Coupling spacer**
9. **Pump hub**
10. **Cap screw**
11. **Transmission**
12. **Cap screw**
13. **Lock washer**

Removal (Fig. 26)

1. Park the machine on a level surface, engage parking brake, lower cutting deck (or implement) and stop engine. Remove key from the ignition switch.

2. Remove conelock nuts (item 2), flat washers (item 3) and cap screws (item 10) that secure rubber coupling to pump hub. Remove coupling spacers (item 8).

3. Remove cap screws (item 12), lock washers (item 13) and flat washers (item 3) that secure rubber coupling to engine hub. Remove coupling spacers (item 8).

4. Remove drive shaft assembly from machine.

5. Remove conelock nuts (item 2), coupling spacers (item 5) and cap screws (item 6) that secure drive shaft to rubber couplings.

6. Inspect rubber couplings and replace if cracked or damaged.

Alignment (Fig. 26)

The engine crankshaft and the transmission input shaft must be aligned within .125” (3 mm) of each other.

1. Verify that the drive shaft is straight and that the flanges are perpendicular to the tube and are not bent.

2. Attach the drive shaft directly to the engine hub to allow verification of drive shaft alignment.

3. Loosen square head screws (item 7) that secure pump hub to transmission input shaft. Slide pump hub toward engine, align holes in pump hub with drive shaft flanges and place cap screws in holes.

4. Rotate drive shaft to check alignment of the drive shaft in all positions. Drive shaft and hub must be aligned within .125" (3 mm).

5. If alignment adjustment is needed, loosen lock nut and jam nut that secure transmission anchor (Fig. 27).

NOTE: If necessary, loosen the lift arm carrier bracket before installing shims between frame and axle mounting pad.

6. Loosen fasteners that secure front axle to frame. Install shims between frame and axle mounting pads to adjust location of transmission input shaft.

A. If the transmission input shaft is high at the drive coupling, lower input shaft by installing shim(s) between the rearward axle mounting pads and the frame (or by removing shim(s) that may exist at forward mounting pads).

B. If the transmission input shaft is low at the drive coupling, raise input shaft by installing shim(s) between the forward axle mounting pads and the frame (or by removing shim(s) that exist at rearward axle mounting pad).

7. When drive shaft alignment is correct, tighten fasteners to secure front axle to frame.

IMPORTANT: Do not overtighten jam nut for transmission anchor as drive shaft alignment will be affected.

8. Tighten upper jam nut (item 8) until it contacts top of transmission anchor and then tighten lock nut (item 6) below transmission anchor (Fig. 27).

Installation (Fig. 26)

IMPORTANT: Make sure that drive shaft alignment is correct before installing drive shaft.

1. Insert coupling spacers (item 5) into rubber coupling holes. Secure rubber couplings to drive shaft with conelock nuts (item 2) and cap screws (item 6). Tighten so spacers are tight against drive shaft.

2. Insert coupling spacers (item 8) into rubber couplings. Position drive shaft assembly to engine and pump hubs.

3. Secure rubber coupling to engine hub with cap screws (item 12), lock washers (item 13) and flat washers (item 3). Tighten cap screws so spacers are tight against flat washers.

4. After attaching drive shaft to pump hub, make sure that neither rubber coupling is deformed more than .250" (6.4 mm) in either direction. If necessary, remove square head screws (item 7) from pump hub. Reposition hub on shaft until coupling deflection is less than .250" (6.4 mm). Apply Loctite #242 (or equivalent) to threads of square head screws. Install screws into hub and torque from 80 to 100 in-lb (9.0 to 11.3 N-m).

5. Secure rubber coupling to pump hub with conelock nuts (item 2), flat washers (item 3) and cap screws (item 10). Tighten cap screws so spacers are tight against flat washers.

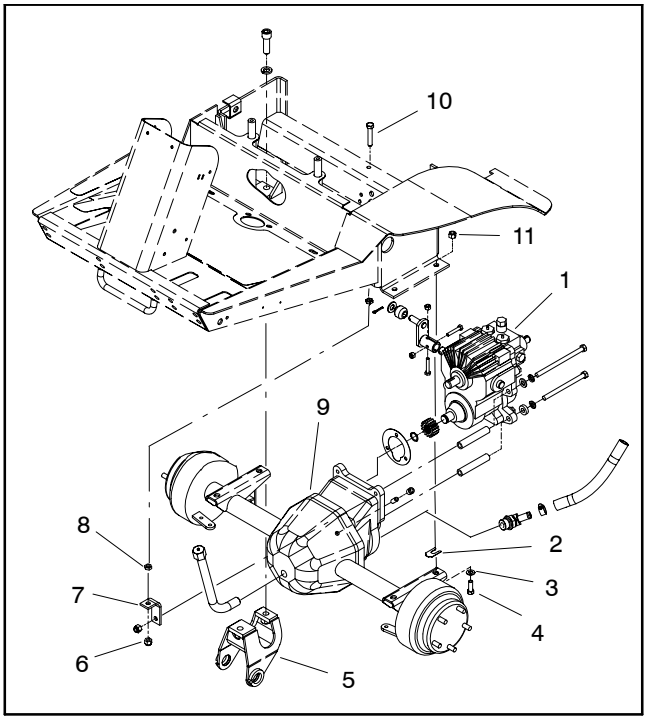

Figure 27

1. **Transmission**
2. **Shim**
3. **Flat washer**
4. **Cap screw**
5. **Carrier bracket**
6. **Lock nut**
7. **Transmission anchor**
8. **Jam nut**
9. **Front axle**
10. **Cap screw**
11. **Lock nut**

Hydrostatic Transmission

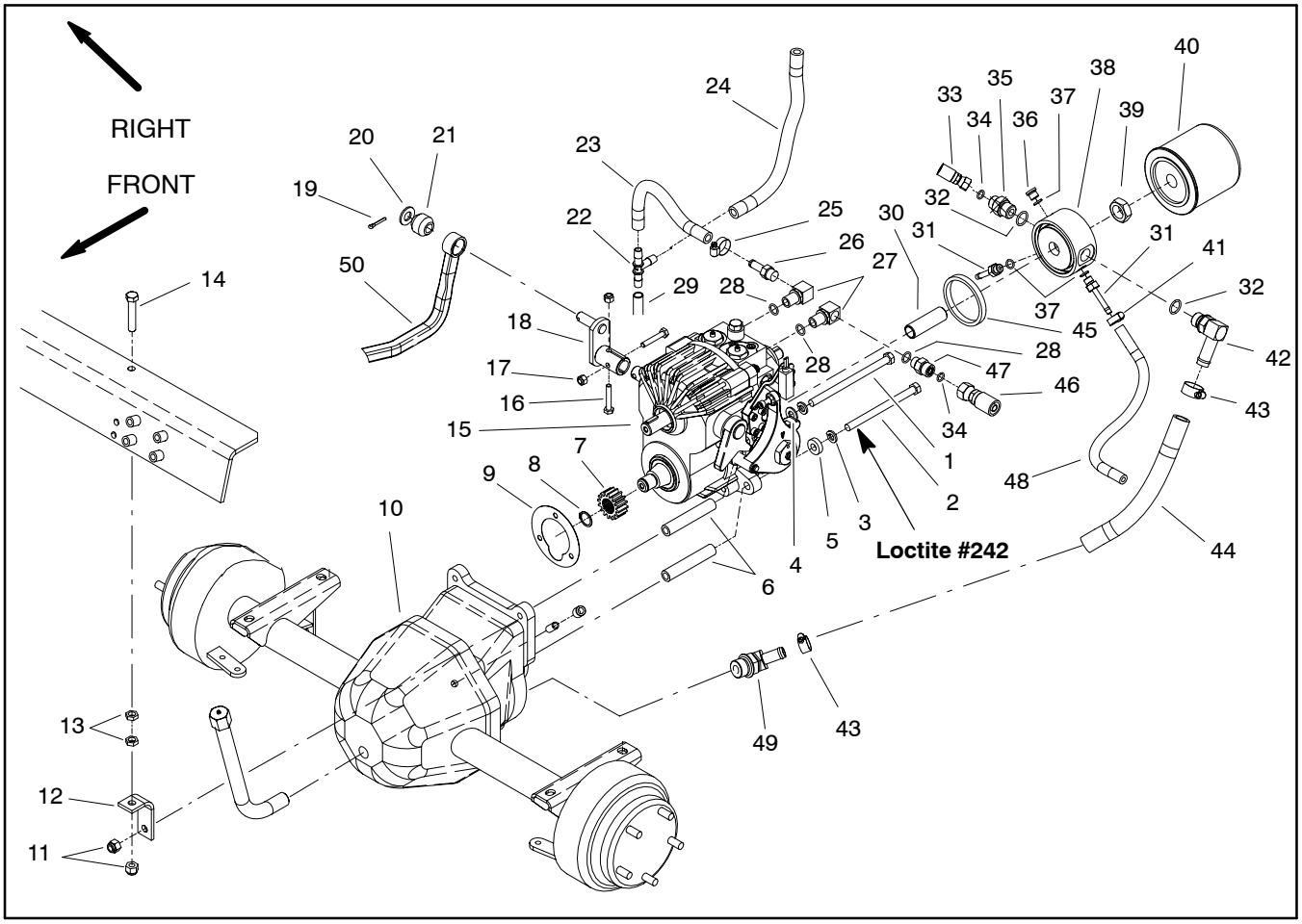

Figure 28

1. Cap screw
2. Cap screw (3 used)
3. Lock washer (4 used)
4. Flat washer
5. Spacer
6. Mounting spacer (4 used)
7. Pinion gear
8. Snap ring
9. Transmission gasket
10. Front axle assembly
11. Lock nut
12. Transmission anchor
13. Jam nut
14. Cap screw
15. Transmission
16. Cap screw (2 used)
17. Lock nut (2 used)
18. Pump lever
19. Cotter pin
20. Flat washer
21. Rubber bushing
22. Hydraulic tee fitting
23. Hydraulic hose
24. Hydraulic hose
25. Hose clamp
26. Hydraulic fitting
27. Hydraulic fitting
28. O-ring
29. Hydraulic hose
30. Filter union
31. Hydraulic fitting
32. O-ring
33. Hydraulic hose
34. O-ring
35. Adapter
36. Plug
37. O-ring
38. Filter adapter
39. Jam nut
40. Hydraulic filter
41. Hose clamp
42. Elbow fitting
43. Hose clamp
44. Hydraulic hose
45. Filter adapter seal
46. Hydraulic hose
47. Straight hydraulic fitting
48. Hydraulic hose
49. Elbow fitting
50. Traction rod

Removal (Fig. 28)

1. Park the machine on a level surface, engage parking brake, lower cutting deck (or implement) and stop engine. Remove key from the ignition switch.

2. To prevent contamination of the hydraulic system, thoroughly clean transmission and front axle.

CAUTION

Operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil.

3. Label hydraulic hoses to assist in assembly. Disconnect all hydraulic hoses from the transmission assembly. Allow hoses to drain into a suitable container. Plug or cap openings of transmission and hoses to prevent contamination.

4. On 4 wheel drive machines, disconnect 4WD driveshaft from transmission (see Rear Axle Drive Shaft (4 Wheel Drive) Removal in the Service and Repairs section of Chapter 8 – Drive Axles). Position drive shaft away from transmission.

5. Remove transmission drive shaft (see Transmission Drive Shaft Removal in this section).

6. Remove cotter pin (item 19) and flat washer (item 20) that retain traction rod end (item 50) to pump lever. Remove traction rod from lever.

7. Label location of wires attached to neutral switch. Disconnect wires from switch and position away from transmission.

8. Remove lock nut (item 11) that secures transmission to transmission anchor (item 12).

CAUTION

Support transmission when removing it from the front axle to prevent it from falling and causing personal injury.

9. Loosen and remove four (4) cap screws (items 1 and 2) that secure transmission to front axle. Locate and retrieve washers (items 3 and 4) and spacers (items 5 and 6). Note location of washers and spacers for assembly purposes.

10. Carefully pull the transmission from the front axle differential.

11. Remove and discard gasket (item 9). Clean gasket surfaces of transmission and front axle.

12. If necessary, remove hydraulic fittings from transmission. Note orientation of fittings for assembly purposes.

13. Remove and discard all o–rings from removed hydraulic hoses and fittings.

IMPORTANT: Pump lever is secured to transmission shaft with Loctite #680 Retaining Compound in addition to cap screws and lock nuts. Use puller to remove pump lever from transmission. To prevent transmission damage, do not strike lever with hammer during removal.

14. If pump lever (item 18) removal is necessary, remove two (2) cap screws and lock nuts. Use puller to remove lever from transmission shaft.

Installation (Fig. 28)

1. Coat new hydraulic fitting o–rings lightly with clean hydraulic oil. Install fittings with new o–rings to the transmission. Orientate the fittings as noted during disassembly.

2. If pump lever (item 18) was removed, clean pump shaft thoroughly and apply Loctite #680 Retaining Compound (or equivalent) to pump shaft. Slide pump lever onto shaft and secure with two (2) cap screws and lock nuts.

3. Apply non–hardening gasket sealant to both sides of gasket (item 9). Position gasket to front axle gasket surface.

4. Carefully position transmission to front axle taking care not to move or damage gasket. Make sure that transmission and axle gears mesh properly.

IMPORTANT: During assembly, make sure that upper left screw (item 1) extends through hole in transmission anchor (item 12).

5. Apply Loctite #242 (or equivalent) to threads of cap screws (items 1 and 2). Secure transmission to front axle with cap screws, washers (items 3 and 4) and spacers (items 5 and 6) using locations noted during disassembly. Tighten cap screws in a crossing pattern. After tightening, make sure that mounting spacers (item 6) do not rotate.

6. Secure transmission to anchor (item 12) with lock nut (item 11). Retain upper left cap screw (item 1) while tightening lock nut.

7. Connect machine harness wires to neutral switch.

8. Slide traction rod (item 50) to pump lever and secure with flat washer (item 20) and cotter pin (item 19).

9. Check transmission drive shaft alignment and adjust if necessary (see Transmission Drive Shaft in this section). Install transmission drive shaft.

10. On 4 wheel drive machines, connect 4WD driveshaft to transmission (see Rear Axle Drive Shaft (4 Wheel Drive) Installation in the Service and Repairs section of Chapter 8 – Drive Axles).

11. Install hydraulic hoses to fittings on transmission in positions noted during disassembly.

12. Check hydraulic fluid level in reservoir (front axle) and adjust as required (see Traction Unit Operator's Manual).

13. Follow Hydraulic System Start–up procedures.

14. Check traction drive for neutral and neutral switch adjustment (see Traction Unit Operator's Manual).

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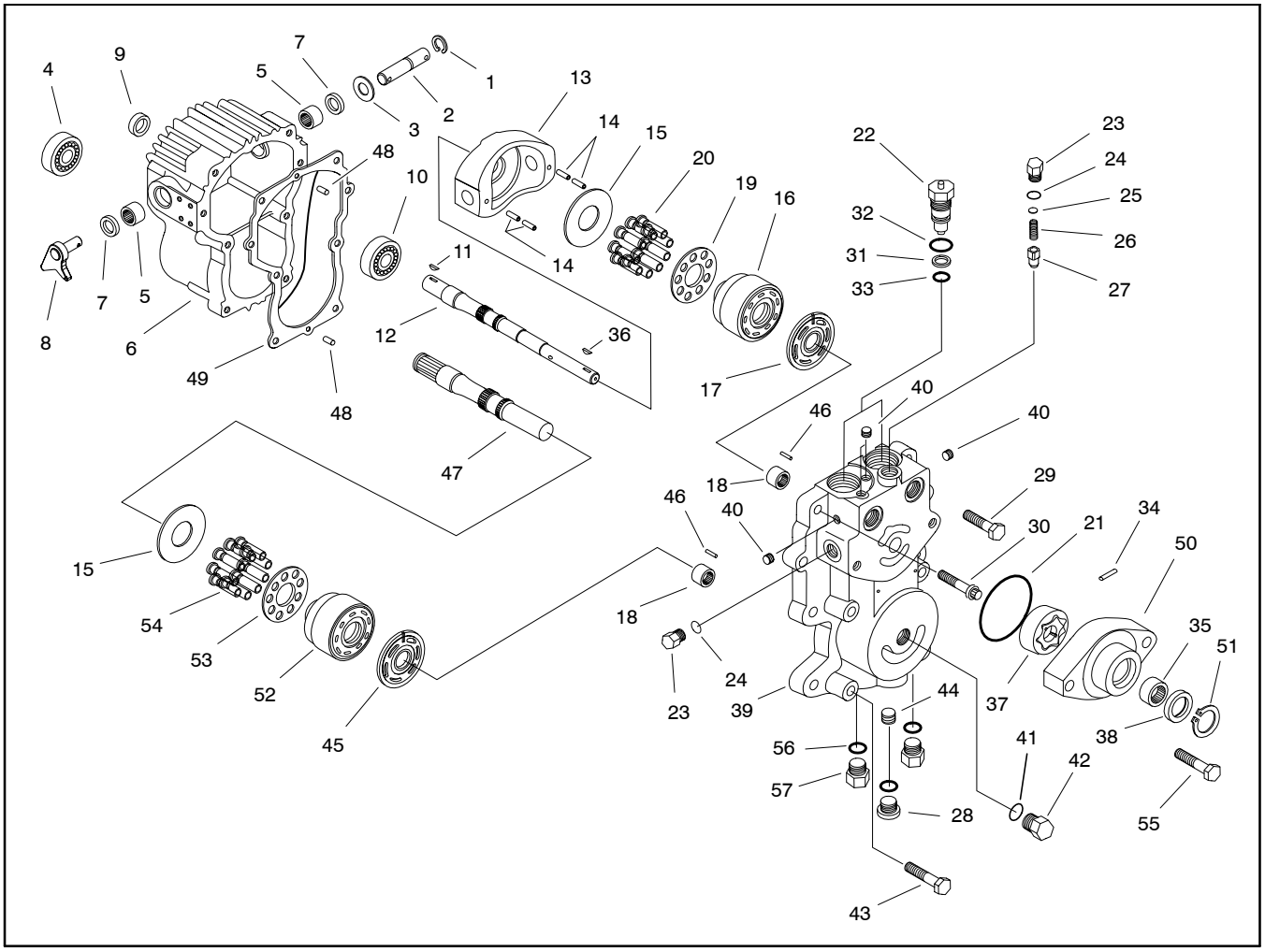

Figure 29

1. Retaining ring
2. Trunnion shaft
3. Flat washer
4. Roller bearing
5. Needle bearing
6. Transmission housing
7. Lip seal
8. Trunnion cam
9. Lip seal
10. Ball bearing
11. Woodruff key
12. Pump shaft
13. Swash plate
14. Spring pin
15. Thrust plate
16. Cylinder block (pump)
17. Pump valve plate
18. Needle bearing
19. Slipper retainer (pump)
20. Piston (pump) (9 used per block)
21. O-ring
22. Check valve
23. Plug
24. O-ring
25. Shim pack
26. Relief valve spring
27. Relief valve cone
28. Plug
29. Cap screw (2 used)
30. Cap screw (2 used)
31. Backup ring
32. O-ring
33. O-ring
34. Pin
35. Bearing
36. Woodruff key
37. Gerotor (charge) pump
38. Shaft seal
39. Center section
40. Pipe plug (4 used)
41. O-ring
42. Threaded plug
43. Cap screw (4 used)
44. Expansion plug
45. Motor valve plate
46. Dowel pin
47. Motor shaft
48. Dowel pin (2 used)
49. Housing gasket
50. Charge pump housing
51. Retaining ring
52. Cylinder block (motor)
53. Slipper retainer (motor)
54. Piston (motor) (9 used per block)
55. Flange head screw (2 used)
56. O-ring (2 used)
57. Threaded plug (2 used)

NOTE: For transmission repair information, see the Sauer-Danfoss (Sundstrand) 15 Series Repair Manual and Service Manual at the end of this chapter.

Hydrostatic Transmission Neutral Arm Assembly

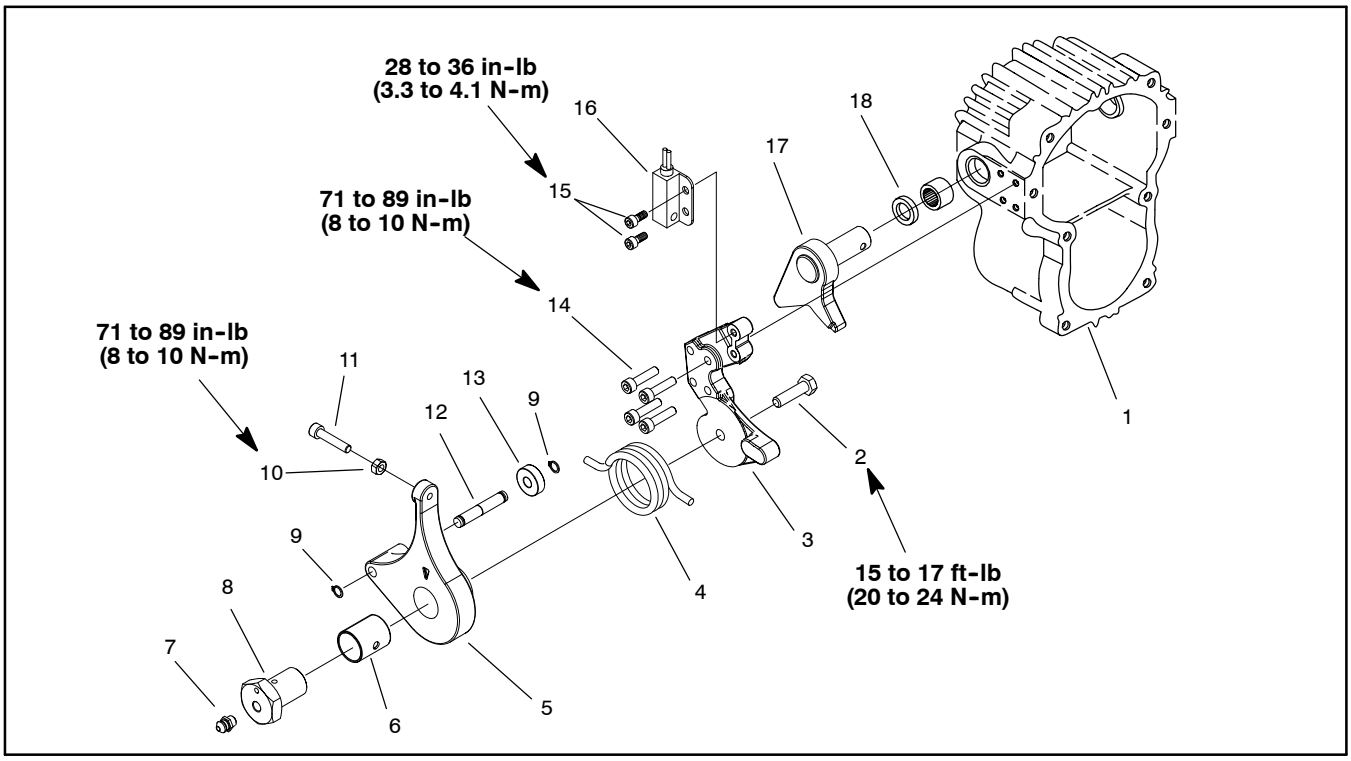

Figure 30

1. Transmission housing
2. Cap screw
3. Mounting plate
4. Neutral return spring
5. Neutral return arm
6. Bushing
7. Grease fitting
8. Eccentric pin
9. Retaining ring
10. Jam nut
11. Socket head screw
12. Pin
13. Bearing
14. Socket head screw (4 used)
15. Socket head screw
16. Neutral proximity switch
17. Trunnion cam
18. Seal

Disassembly (Fig. 30)

1. Disassemble neutral arm components on hydrostatic transmission as needed using Figure 30 as a guide.

NOTE: To remove trunnion cam (item 17) from hydrostatic transmission, transmission has to be disassembled.

Assembly (Fig. 30)

1. Assemble neutral arm components to hydrostatic transmission using Figure 30 as a guide. If eccentric pin (item 8) was removed, make sure that mark on eccentric pin is orientated to top of transmission. Note fastener torque specifications shown in Figure 30.

2. Lubricate grease fitting on eccentric pin (see Traction Unit Operator's Manual).

3. Check and adjust neutral position (see Traction Unit Operator's Manual).

4. Check for correct operation of neutral switch and adjust if needed (see Traction Neutral Switch adjustment in the Components section of Chapter 6 – Electrical System).

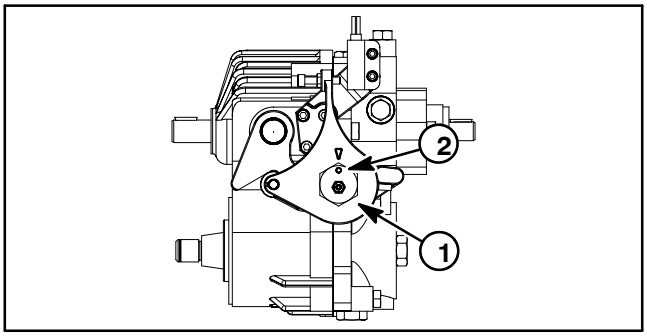

Figure 31

1. Eccentric pin
2. Alignment mark

Lift Cylinder

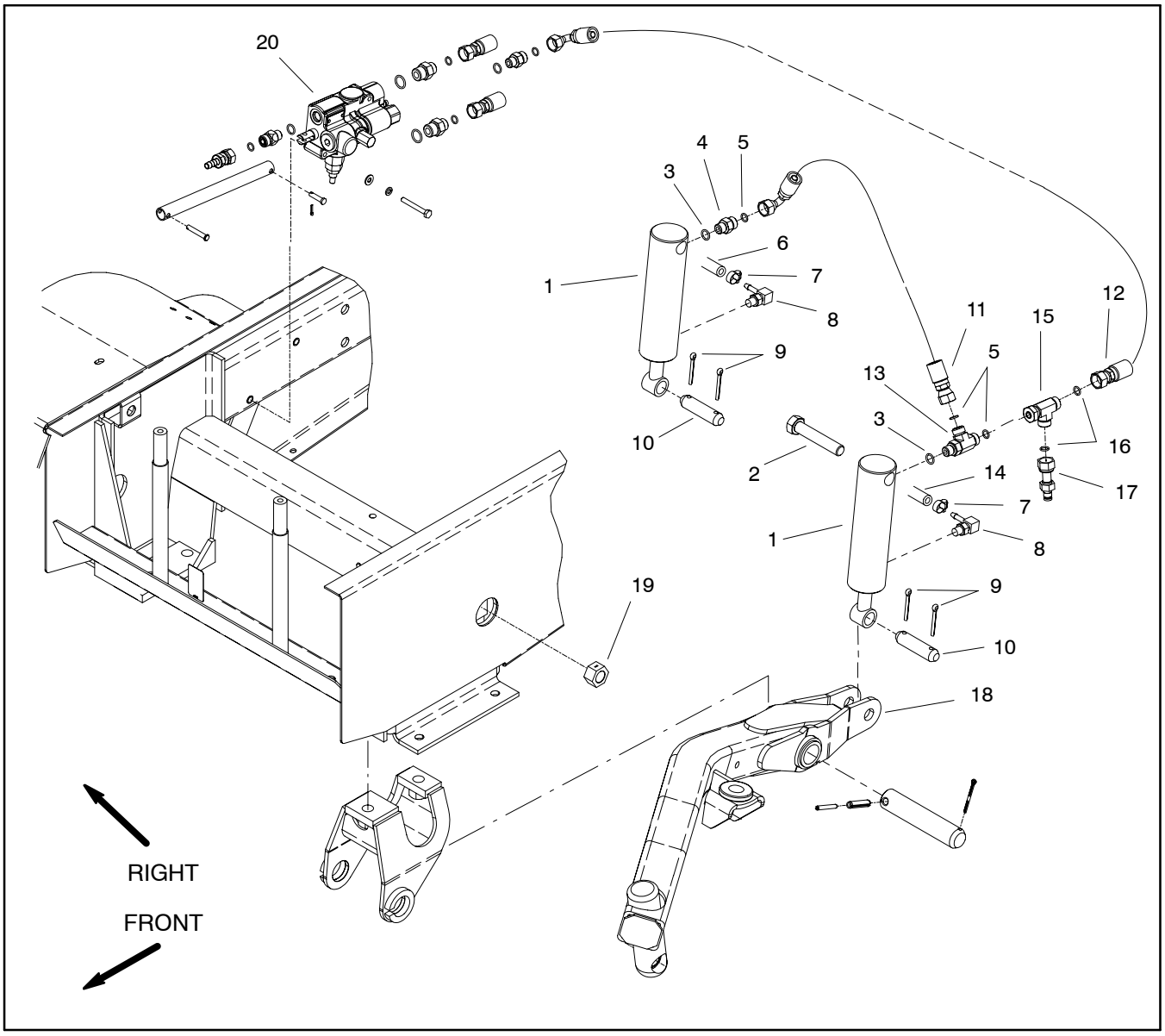

Figure 32

1. **Lift cylinder**
2. **Cap screw**
3. **O-ring**
4. **Hydraulic fitting**
5. **O-ring**
6. **Hydraulic hose**
7. **Hose clamp**
8. **Hose stem**
9. **Cotter pin**
10. **Cylinder pin**
11. **Hydraulic hose**
12. **Hydraulic hose**
13. **Hydraulic tee fitting**
14. **Hydraulic hose**
15. **Hydraulic tee fitting**
16. **O-ring**
17. **Test port**
18. **Lift arm (LH shown)**
19. **Lock nut**
20. **Lift control valve**

NOTE: If lift cylinder wear or damage occurs, lift cylinder replacement is necessary. Lift cylinders are not rebuildable.

NOTE: On machines with serial numbers above 260000001, the test port (item 17) is located on the RH lift cylinder.

Removal (Fig. 32)

1. Park the machine on a level surface, engage the parking brake, lower the cutting deck (or implement) and stop the engine. Remove the 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.

CAUTION

Operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil.

3. Disconnect hydraulic hoses from fittings in lift cylinder that is to be removed. Allow hoses to drain into a suitable container. Remove and discard o−rings.

4. Put caps or plugs on disconnected hoses and fittings to prevent contamination.

5. Remove one cotter pin (item 9) from the cylinder pin (item 10). Pull cylinder pin from the lift cylinder and lift arm.

6. Remove lock nut (item 11) from cap screw (item 2) that retains lift cylinder to frame.

7. Support lift cylinder and slide cap screw (item 2) from the lift cylinder and frame.

8. Lower lift cylinder from the frame.

9. Remove hydraulic fittings and o−rings from the lift cylinder as required. Discard o−rings.

Installation (Fig. 32)

1. Coat new o−rings lightly with clean hydraulic oil. Install hydraulic fittings with new o−rings to the lift cylinder.

2. Position lift cylinder to the frame with the barrel end up.

3. Slide cap screw (item 2) through lift cylinder and frame mounting holes.

4. Align lift cylinder to lift arm mounting holes. Slide cylinder pin (item 10) through the lift cylinder and lift arm.

5. Secure cylinder pin with cotter pin (item 9).

6. Remove caps and plugs from disconnected hoses and fittings.

7. Install new o−ring(s) and connect hydraulic hoses to hydraulic fittings on lift cylinder. Tighten hose connections.

8. Check hydraulic fluid level in reservoir (front axle) and adjust as required (see Traction Unit Operator's Manual).

9. Follow Hydraulic System Start−up procedures.

Steering Control Valve

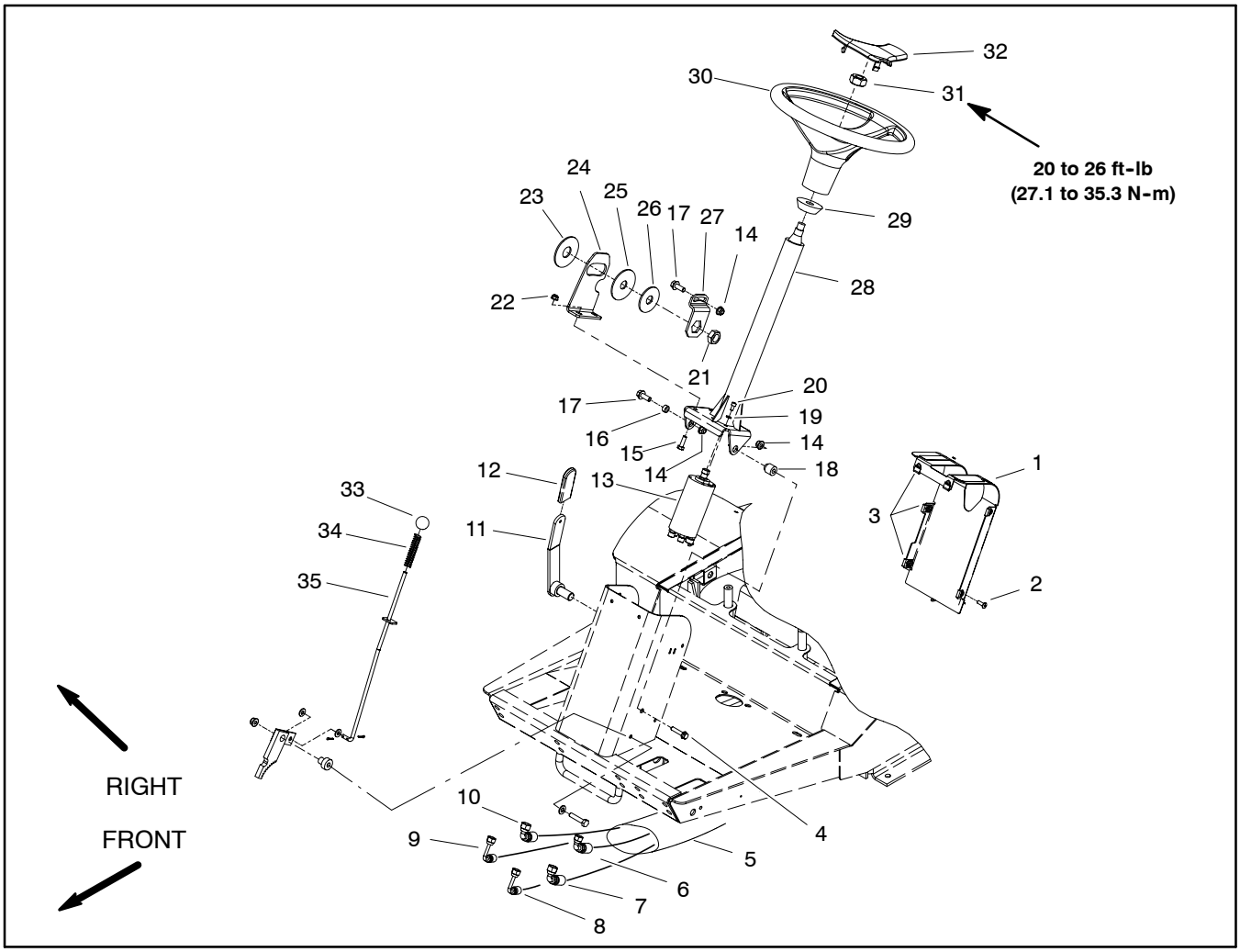

Figure 33

1. Tower panel
2. Phillips head screw (6 used)
3. Nut retainer (6 used)
4. Flange head screw
5. Sleeve protector
6. Hydraulic hose
7. Hydraulic hose
8. Hydraulic hose
9. Hydraulic hose
10. Hydraulic hose
11. Tilt steering lever
12. Grip
13. Steering control valve
14. Flange nut
15. Cap screw (2 used)
16. Spacer
17. Flange head screw
18. Spacer
19. Spring washer (4 used)
20. Socket head screw (4 used)
21. Jam nut
22. Flange nut (2 used)
23. Friction disc
24. Pivot plate
25. Friction disc
26. Flat washer
27. Tilt bracket
28. Steering column
29. Foam collar
30. Steering wheel
31. Hex nut
32. Steering wheel cover
33. Knob
34. Compression spring
35. Parking brake rod

Removal (Fig. 33)

1. Park the machine on a level surface, engage the parking brake, lower the cutting deck (or implement) and stop the engine. Remove the key from the ignition switch.

2. Remove knob from end of parking brake rod.

3. Remove six (6) phillips head screws that secure tower panel to machine. Raise tower panel to allow access to steering control valve.

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

5. Label all hydraulic connections for assembly purposes. Note port designations on steering control valve (Fig. 34).Clean hydraulic hose ends prior to disconnecting the hoses.

CAUTION

Operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil.

6. Disconnect hydraulic hoses from steering control valve. Allow hoses to drain into a suitable container.

7. Put caps or plugs on disconnected hoses and fittings to prevent contamination.

8. Support steering control valve to prevent it from falling during removal.

9. Loosen and remove four (4) socket head screws (item 20) and spring washers (item 19) that secure steering control valve to steering column.

10.Slide steering control valve from steering column and remove from machine.

Installation (Fig. 33)

1. Slide steering control valve onto steering column. Secure steering control valve to steering column with four (4) socket head screws (item 20) and spring washers (item 19).

2. Remove caps and plugs from disconnected hoses and fittings.

3. Lubricate new o-rings and connect hydraulic hoses to steering control valve. Tighten hose connections.

4. Position tower panel in place and secure with six (6) phillips head screws.

5. Install knob on end of parking brake rod.

6. Check hydraulic fluid level in reservoir (front axle) and adjust as required (see Traction Unit Operator's Manual).

7. After assembly is completed, rotate steering wheel to verify that hydraulic hoses and fittings are not contacted by anything and that there are no leaks.

8. Follow Hydraulic System Start-up procedures.

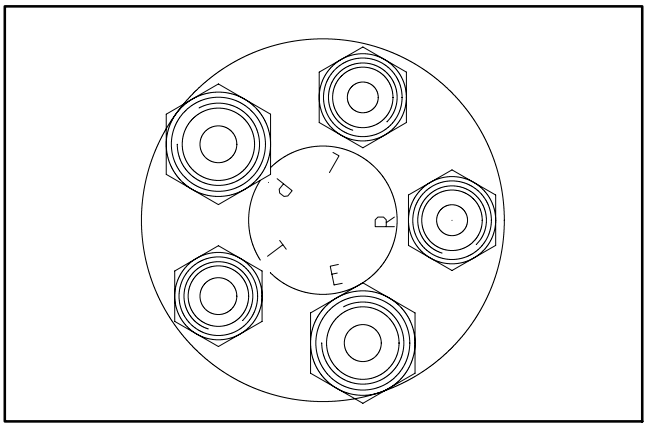

Figure 34

Steering Control Valve Service

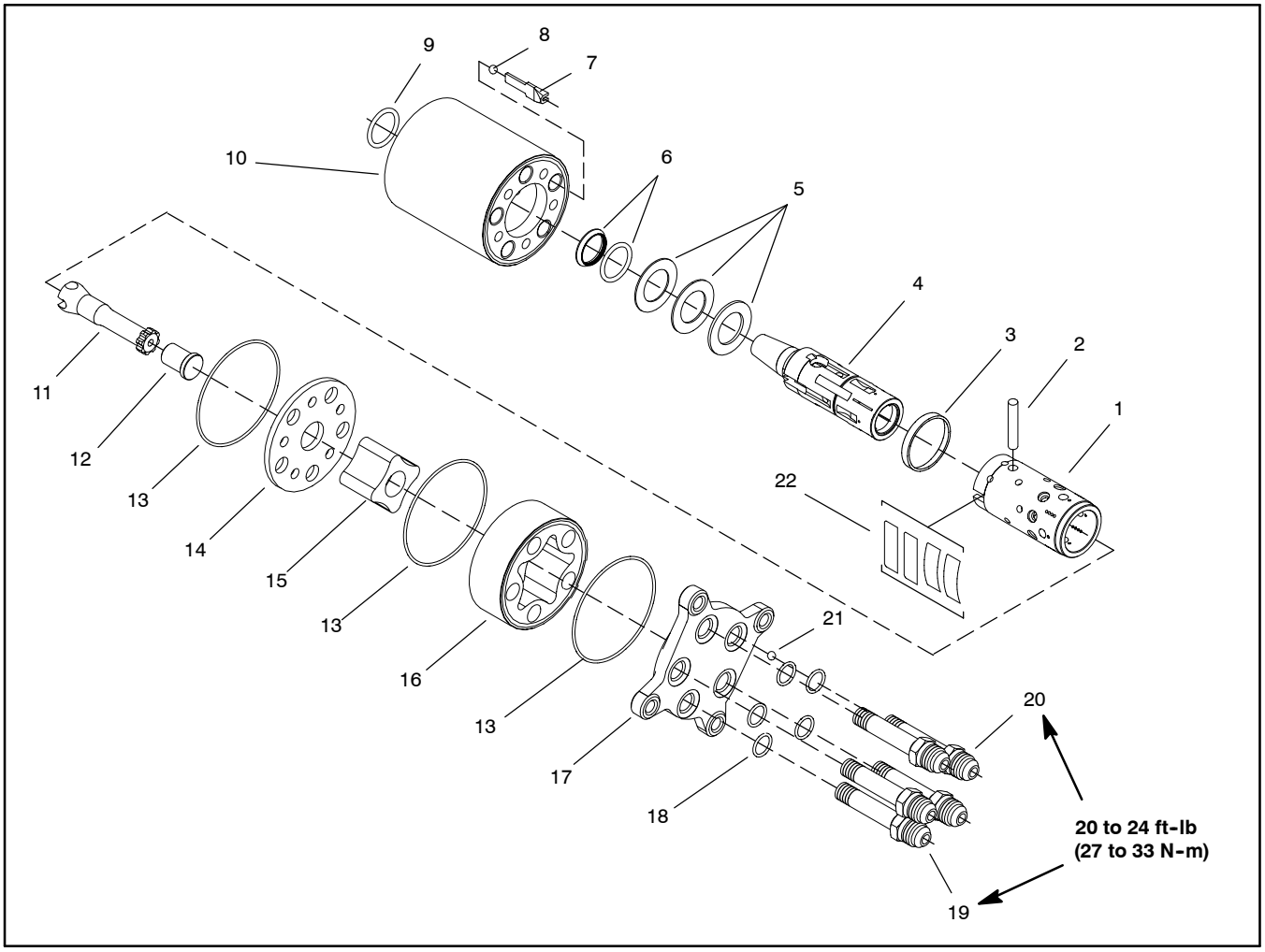

Figure 35

1. **Sleeve**
2. **Cross pin**
3. **Ring**
4. **Spool**
5. **Bearing assembly**
6. **Shaft seal**
7. **Ball stop**
8. **Ball**
9. **Dust seal ring**
10. **Housing**
11. **Cardan shaft**
12. **Spacer**
13. **O-ring**
14. **Distribution plate**
15. **Inner gearwheel**
16. **Outer gearwheel**
17. **End cover**
18. **O-ring (5 used)**
19. **Screw/fitting (ports L, R, T)**
20. **Screw/fitting (ports P and E)**
21. **P port check ball**
22. **Spring set**

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

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Steering Cylinder (2 Wheel Drive)

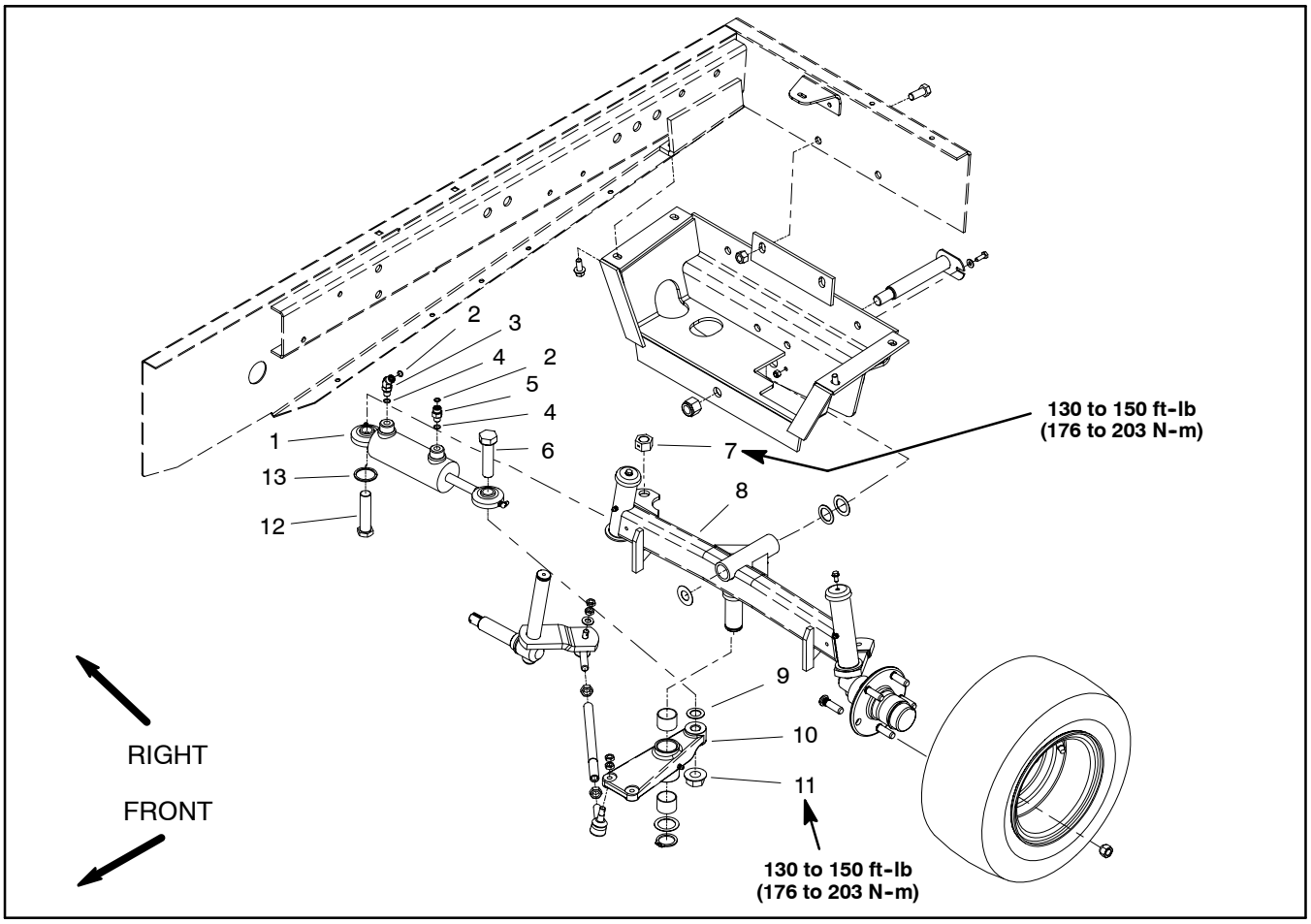

Figure 36

1. **Steering cylinder**
2. **O-ring**
3. **45º hydraulic fitting**
4. **O-ring**
5. **Hydraulic fitting**
6. **Cap screw**
7. **Lock nut**
8. **Rear axle (2WD)**
9. **Washer**
10. **Steering pivot**
11. **Flange lock nut**
12. **Cap screw**
13. **Spacer ring**

Removal (Fig. 36)

1. Park the machine on a level surface, engage the parking brake, lower the cutting deck (or implement) and stop the engine. Remove the 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.

CAUTION

Operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil.

3. Label all hydraulic connections for assembly purposes. Clean hydraulic hose ends prior to disconnecting the hoses.

4. Disconnect hydraulic hoses from steering cylinder.

5. Put caps or plugs on disconnected hoses and fittings to prevent contamination.

6. Remove cap screws (items 12 and 6) and lock nuts (items 7 and 11) that secure steering cylinder to machine.

7. Pull steering cylinder from machine. Locate and retrieve spacer ring (item 13) and washer (item 9) and note location for installation purposes (Fig. 37).

8. Remove hydraulic fittings from steering cylinder if required. Note orientation of 45º fitting before removing from steering cylinder.

Installation (Fig. 36)

1. Coat new o−rings lightly with clean hydraulic oil. If removed, install hydraulic fittings with new o−rings to the steering cylinder. Make sure that 45º fitting is positioned correctly.

2. Position steering cylinder to machine. Make sure to place spacer ring (item 13) and washer (item 9) in locations noted during removal (Fig. 37).

3. Secure steering cylinder to machine with cap screws (items 12 and 6) and lock nuts (items 7 and 11). Torque lock nuts from 130 to 150 ft−lb (176 to 203 N−m).

4. Remove caps and plugs from hydraulic hoses and fittings.

5. Correctly connect hydraulic hoses to steering cylinder.

6. Check hydraulic fluid level in reservoir (front axle) and adjust as required (see Traction Unit Operator's Manual).

7. Lubricate cylinder grease fittings (see Traction Unit Operator's Manual).

8. Follow Hydraulic System Start−up procedures.

9. Check that steering cylinder does not contact the axle or frame as cylinder moves from fully retracted to fully extended.

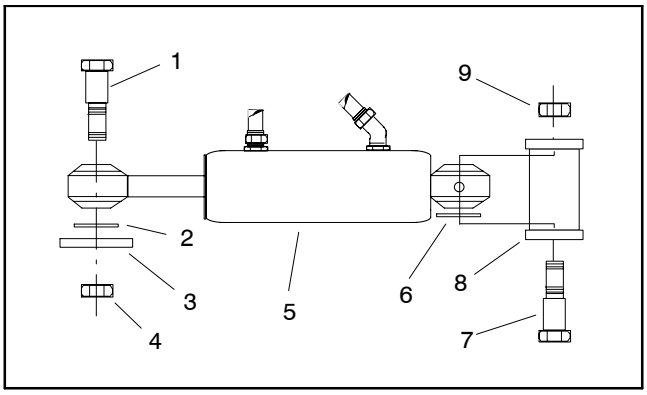

Figure 37

1. **Cap screw**
2. **Washer**
3. **Steering pivot mount**
4. **Lock nut**
5. **Steering cylinder**
6. **Spacer ring**
7. **Cap screw**
8. **Axle cylinder mount**
9. **Lock nut**

Steering Cylinder Service (2 Wheel Drive)

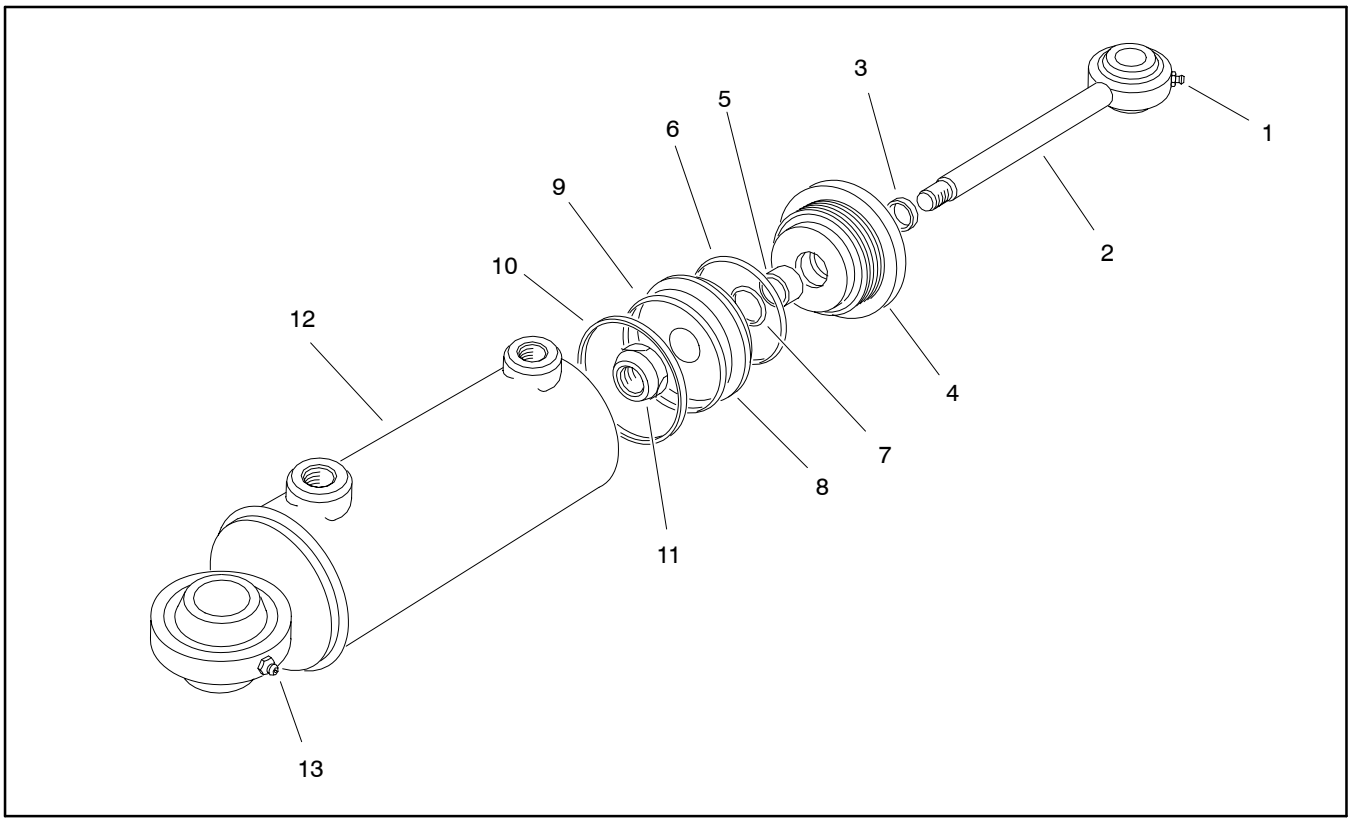

Figure 38

1. **Grease fitting**
2. **Piston rod**
3. **Wiper**
4. **Gland**
5. **Seal**
6. **O-ring**
7. **O-ring**
8. **Piston**
9. **Seal**
10. **O-ring**
11. **Lock nut**
12. **Barrel**
13. **Grease fitting**

Disassembly (Fig. 38)

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

IMPORTANT: Prevent damage when clamping the steering cylinder into a vise; clamp on the pivot end only. Do not close vise enough to distort the barrel.

2. Mount steering cylinder in a vise so that the shaft end tilts up slightly.

3. Using a spanner wrench, remove gland (item 4) from the barrel.

4. Grasp clevis end of piston rod (item 2); extract rod, gland (item 4) and piston (item 8) by carefully twisting and pulling the rod from the barrel.

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

5. Mount rod securely in a vise. Remove lock nut (item 11) and piston from the rod. Slide gland off the rod.

6. Remove and discard seal (item 9) and o-rings (items 7 and 10) from the piston. Remove and discard wiper (item 3), o-ring (item 6) and seal (item 5) from the head.

Inspection

CAUTION

Use eye protection such as goggles when using compressed air.

1. Wash all cylinder components in solvent. Dry parts with compressed air.

2. Inspect internal surface of barrel for deep scratches, out-of-roundness and bending. Replace if worn or damaged.

3. Inspect head, piston rod and piston for excessive pitting, scoring and wear. Replace any worn or damaged parts.

Assembly (Fig. 38)

1. Coat new seals, wiper and all o−rings lightly with hydraulic oil. Install new seal and o−rings to the piston. Install wiper, o−ring and seal to the gland.

IMPORTANT: Do not clamp vise jaws against piston rod surface. Protect rod surface before mounting in vise.

2. Mount rod securely in a vise.

3. Coat rod lightly with hydraulic oil. Slide gland onto the shaft being careful not to damage the wiper, o−ring and seal.

4. Install piston onto the rod being careful not to damage o−ring. Install lock nut onto the rod and tighten.

5. Remove shaft from vise.

IMPORTANT: Prevent damage when clamping the barrel into a vise; clamp on the pivot end only. Do not close vise enough to distort barrel.

6. Mount barrel in a vise so that the rod end tilts up slightly.

7. Coat all internal steering cylinder parts with a light coat of hydraulic oil. Slide piston, rod and gland assembly into barrel being careful not to damage the seals.

8. Using a spanner wrench, secure gland in barrel.

Steering Cylinder (4 Wheel Drive)

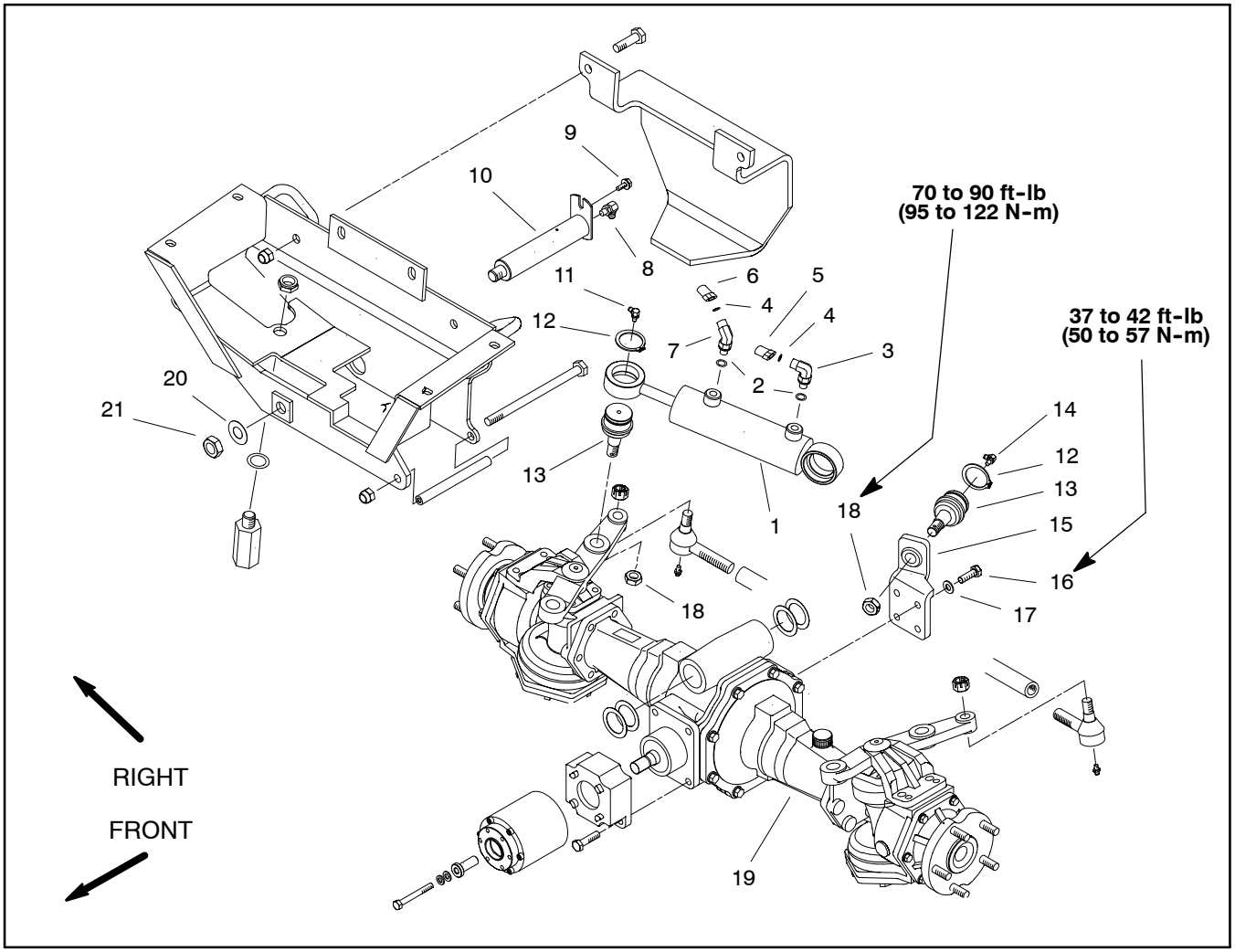

Figure 39

1. Steering cylinder
2. O-ring
3. 90º hydraulic fitting
4. O-ring
5. Hydraulic hose
6. Hydraulic hose
7. 45º hydraulic fitting
8. Grease fitting
9. Washer head screw
10. Rear axle pin
11. Grease fitting
12. Retaining ring
13. Ball joint
14. Grease fitting
15. Cylinder support bracket
16. Cap screw (4 used)
17. Washer (4 used)
18. Jam nut (4 used)
19. Rear axle (4WD)
20. Thrust washer
21. Jam nut

Removal (Fig. 39)

1. Park the machine on a level surface, engage the parking brake, lower the cutting deck (or implement) and stop the engine. Remove the 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.

CAUTION

Operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil.

3. Label all hydraulic connections for assembly purposes. Clean hydraulic hose ends prior to disconnecting the hoses.

4. Disconnect hydraulic hoses from steering cylinder.

5. Put caps or plugs on disconnected hoses and fittings to prevent contamination.

6. Remove four (4) jam nuts that secure steering cylinder to machine.

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

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

9. Remove hydraulic fittings from steering cylinder if required. Note orientation of fittings before removing from steering cylinder.

Installation (Fig. 39)

1. Coat new o−rings lightly with clean hydraulic oil. If removed, install hydraulic fittings with new o−rings to the steering cylinder. Make sure to position fittings correctly in cylinder.

2. If removed, install ball joints to steering cylinder.

3. Position steering cylinder to rear axle. Secure cylinder to axle with jam nuts. Install first jam nut onto cylinder ball joint threads and torque from 70 to 90 ft−lb (95 to 122 N−m). Then, while retaining first jam nut with wrench, install and torque second jam nut from 70 to 90 ft−lb (95 to 122 N−m).

4. Remove caps and plugs from hydraulic hoses and fittings.

5. Correctly connect hydraulic hoses to steering cylinder.

6. Check hydraulic fluid level in reservoir (front axle) and adjust as required (see Traction Unit Operator's Manual).

7. Lubricate cylinder grease fittings (see Traction Unit Operator's Manual).

8. Follow Hydraulic System Start−up procedures.

9. Check that steering cylinder does not contact the axle or frame as cylinder moves from fully retracted to fully extended.

Steering Cylinder Service (4 Wheel Drive)

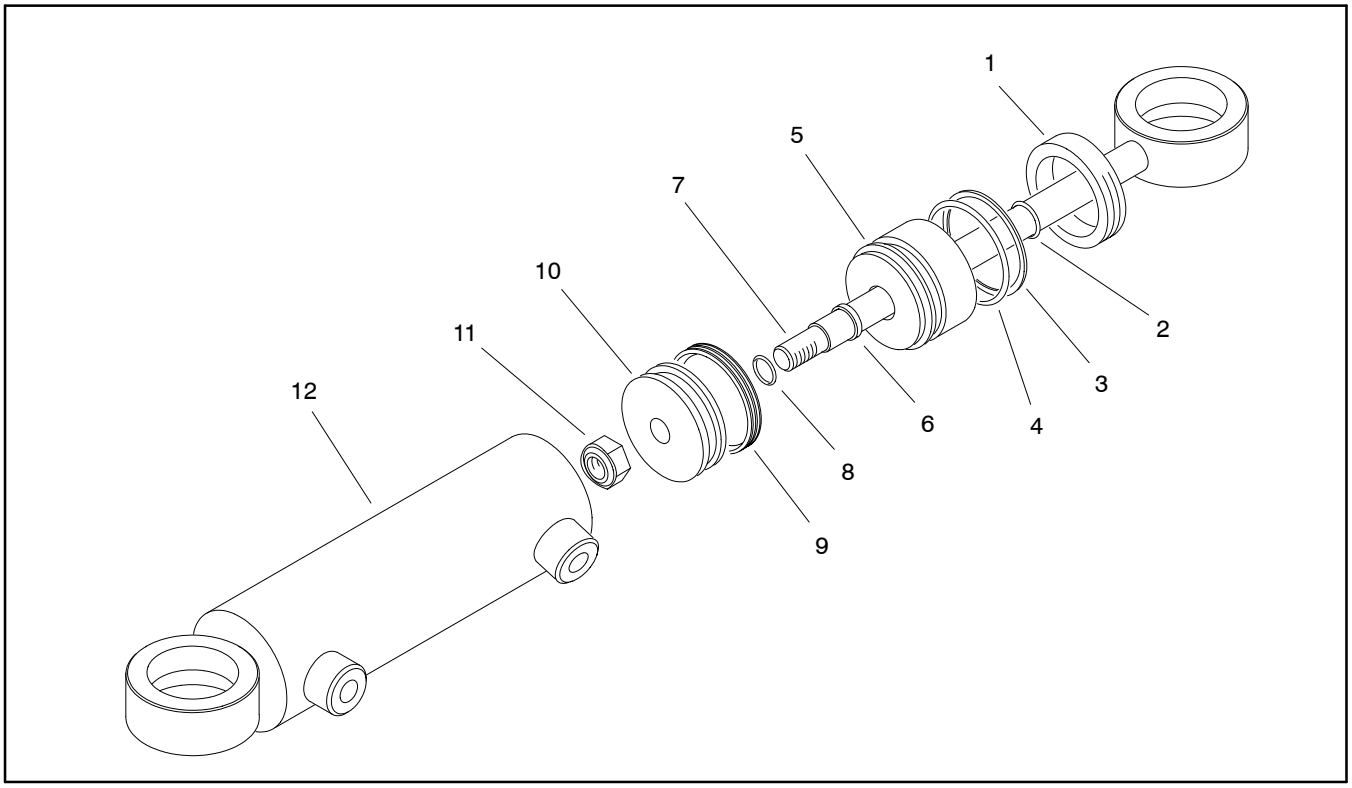

Figure 40

1. **Internal collar**
2. **Dust seal**
3. **Backup washer**
4. **O-ring**
5. **Head**
6. **Rod seal**
7. **Shaft**
8. **O-ring**
9. **Uni-ring**
10. **Piston**
11. **Lock nut**
12. **Barrel**

Disassembly (Fig. 40)

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

IMPORTANT: Prevent damage when clamping the steering cylinder into a vise; clamp on the pivot end only. Do not close vise enough to distort the barrel.

2. Mount steering cylinder in a vise so that the shaft end tilts up slightly.

3. Remove internal collar (item 1) from the barrel.

4. Grasp clevis end of shaft (item 7); extract shaft, head (item 5) and piston (item 10) by carefully twisting and pulling the shaft from the barrel.

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

5. Mount shaft securely in a vise. Remove lock nut (item 11) and piston from the shaft. Slide head and internal collar off the shaft.

6. Remove and discard uni-ring (item 9) and o-ring (item 8) from the piston. Remove and discard dust seal (item 2), backup washer (item 3), o-ring (item 4) and rod seal (item 6) from the head.

Inspection

CAUTION

Use eye protection such as goggles when using compressed air.

1. Wash all cylinder components in solvent. Dry parts with compressed air.

2. Inspect internal surface of barrel for deep scratches, out-of-roundness and bending. Replace if worn or damaged.

3. Inspect head, shaft and piston for excessive pitting, scoring and wear. Replace any worn or damaged parts.

Assembly (Fig. 40)

1. Coat new dust seal, uni−ring, backup washer, rod seal and all o−rings lightly with hydraulic oil. Install new o−ring and uni−ring to the piston. Install dust seal, back-up washer, o−ring and rod seal to the head.

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

2. Mount shaft securely in a vise.

3. Coat shaft lightly with hydraulic oil. Slide internal collar and head onto the shaft being careful not to damage the rod seal and dust seal.

4. Install piston onto the shaft being careful not to damage o−ring. Install lock nut onto the shaft and tighten.

5. Remove shaft from vise.

IMPORTANT: Prevent damage when clamping the barrel into a vise; clamp on the pivot end only. Do not close vise enough to distort barrel.

6. Mount barrel in a vise so that the shaft end tilts up slightly.

7. Coat all internal steering cylinder parts with a light coat of hydraulic oil. Slide piston, shaft and head assembly into barrel being careful not to damage the seals.

8. Secure head in barrel by installing internal collar into barrel.

Lift Control Valve

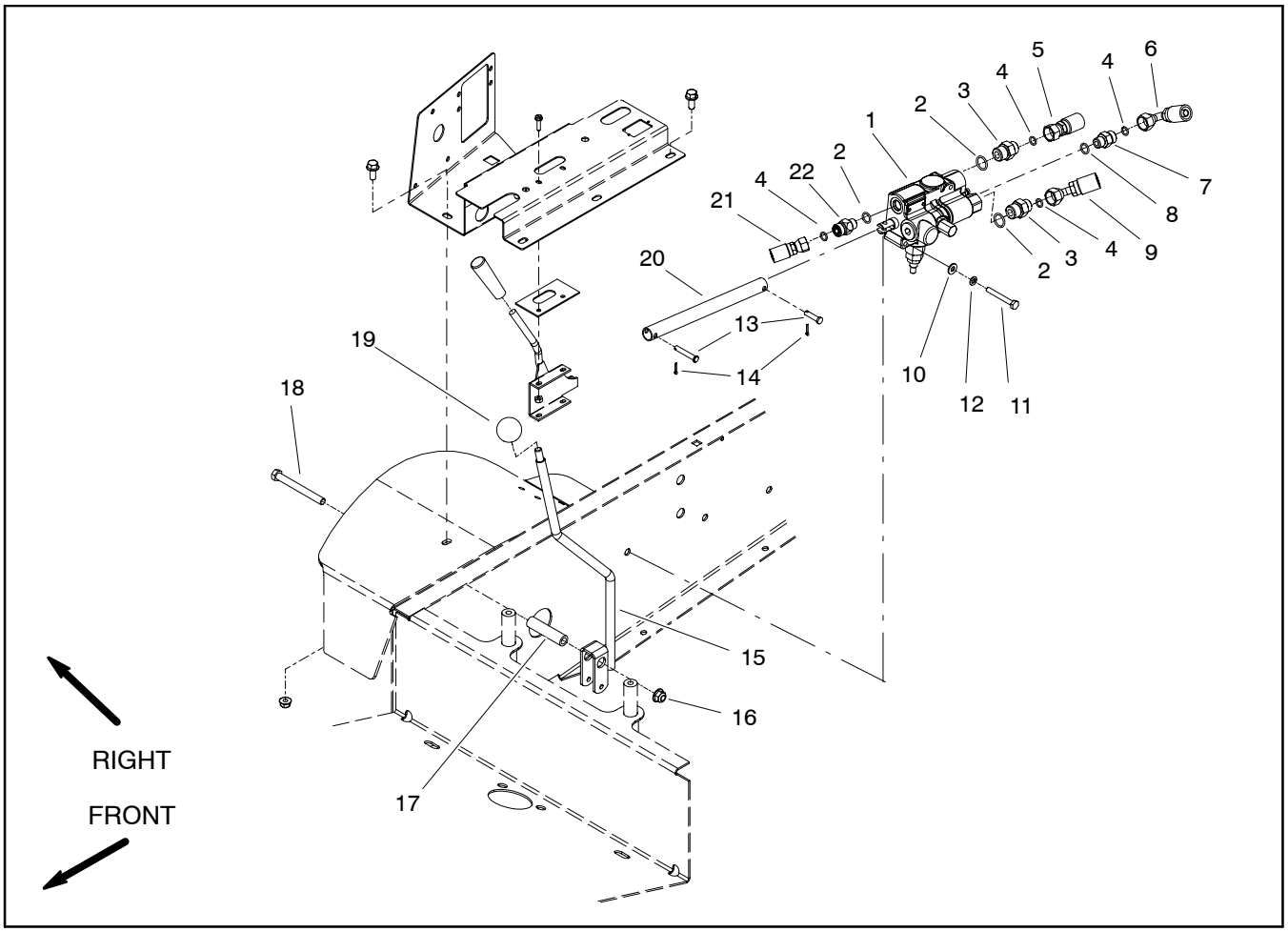

Figure 41

1. **Lift control valve**
2. **O-ring**
3. **Hydraulic adapter**
4. **O-ring**
5. **Hydraulic hose**
6. **Hydraulic hose**
7. **Hydraulic fitting**
8. **O-ring**
9. **Hydraulic hose**
10. **Flat washer (2 used)**
11. **Cap screw (2 used)**
12. **Lock washer (2 used)**
13. **Pin**
14. **Cotter pin**
15. **Lift lever**
16. **Flange nut**
17. **Spacer**
18. **Cap screw**
19. **Knob**
20. **Link tube**
21. **Hydraulic hose**
22. **Check valve**

NOTE: On Groundsmaster 3280-D machines with serial numbers below 270000401 and Groundsmaster 3320 machines with serial numbers below 280000000, the lift control valve incorporates the counterbalance valve (Fig. 41). On later machines (larger serial numbers), the counterbalance valve is located in a separate manifold (Fig. 42).

Removal (Figs. 41 and 42)

1. Park the machine on a level surface, engage the parking brake, lower the cutting deck (or implement) and stop the engine. Remove the 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 fuel tank from machine (see Fuel Tank Removal in Chapter 3 – Gasoline Engine or Chapter 4 – Diesel Engine).

4. Label all hydraulic connections for assembly purposes. Clean hydraulic hose ends prior to disconnecting the hoses.

CAUTION

Operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil.

5. Disconnect hose connections from hydraulic fittings on lift control valve. Allow hoses to drain into a suitable container.

6. Put caps or plugs on disconnected hoses and fittings to prevent contamination.

7. Remove cotter pin (item 14) and pin (item 13) that secure link tube (item 20) to control valve.

8. Remove two (2) cap screws (item 11), lock washers (item 12) and flat washers (item 10) that secure lift control valve to machine.

9. Remove control valve from the machine.

10. Remove hydraulic fittings as necessary from the control valve. Discard all removed o–rings.

Installation (Figs. 41 and 42)

1. Coat new o–rings lightly with clean hydraulic oil. Install all removed hydraulic fittings with new o–rings to the lift control valve.

2. Position lift control valve to machine frame. Secure control valve to machine with two (2) cap screws (item 11), lock washers (item 12) and flat washers (item 10).

3. Secure link tube (item 20) to control valve with pin (item 13) and cotter pin (item 14).

4. Remove all caps or plugs from hydraulic hoses and fittings.

5. Connect hydraulic hoses to hydraulic fittings on lift control valve.

6. Install fuel tank to machine (see Fuel Tank Installation in Chapter 3 – Gasoline Engine or Chapter 4 – Diesel Engine).

7. Check hydraulic fluid level in reservoir (front axle) and adjust as required (see Traction Unit Operator's Manual).

8. Follow Hydraulic System Start–up procedures.

9. Check counterbalance valve adjustment (see Traction Unit Operator's Manual).

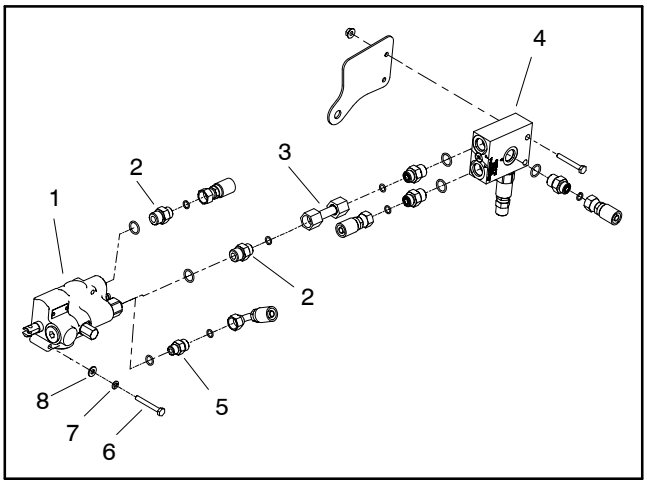

Figure 42

1. **Lift control valve**
2. **Hydraulic adapter**
3. **Hydraulic tube**
4. **Counterbalance manifold**
5. **Hydraulic fitting**
6. **Cap screw (2 used)**
7. **Lock washer (2 used)**
8. **Flat washer (2 used)**

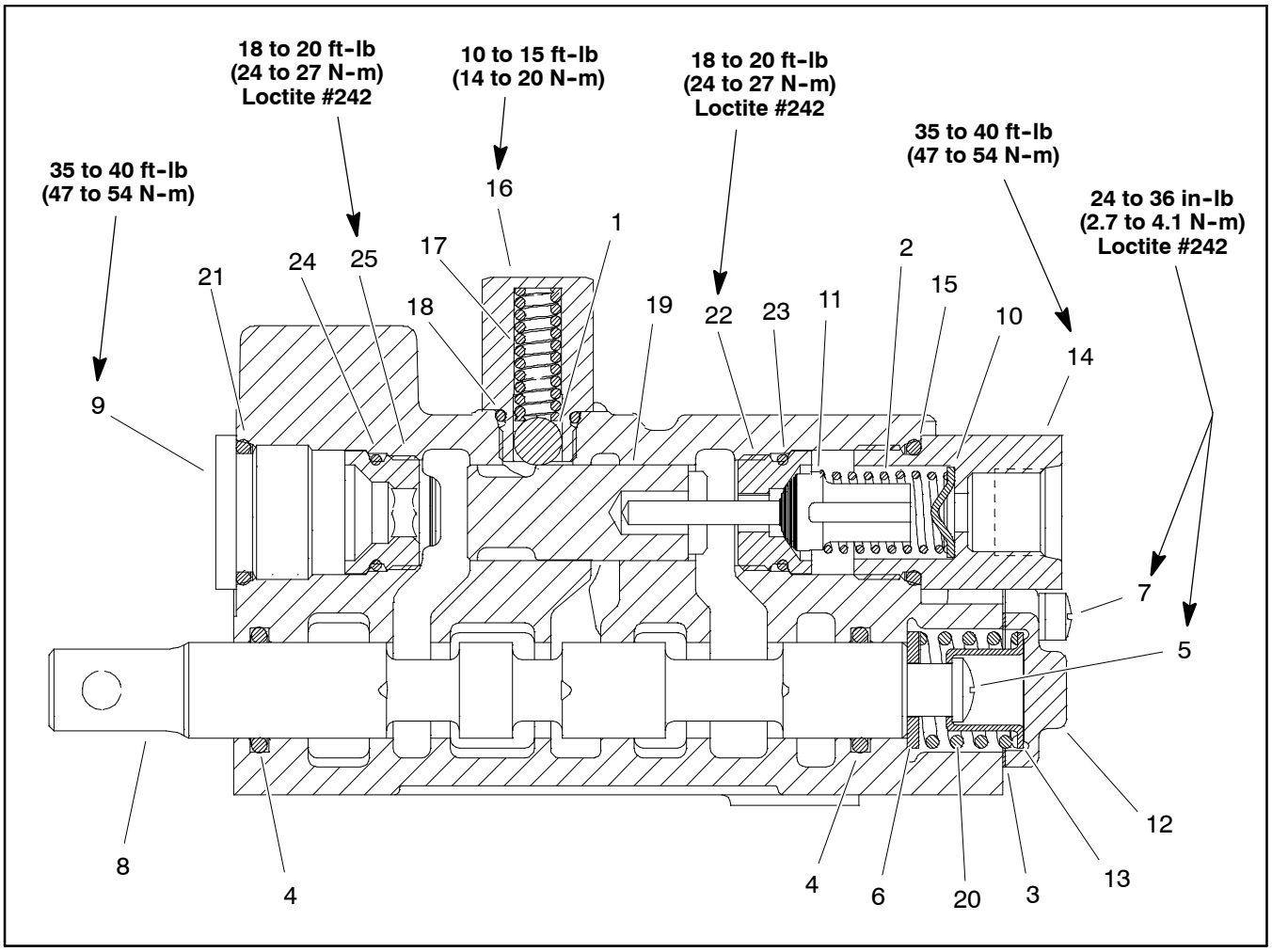

Figure 43

1. Detent ball
2. Spring
3. Gasket
4. O-ring
5. Screw
6. Washer
7. Screw and lock washer (2 used)
8. Spool
9. Plug
10. Poppet stop
11. Poppet
12. End cap
13. Spacer
14. Adapter plug
15. O-ring
16. Detent plug
17. Spring
18. O-ring
19. Detent plunger
20. Spring
21. O-ring
22. Lockout seat (black)
23. O-ring
24. O-ring
25. Lockout seat (silver)

Disassembly (Fig. 43)

1. Plug all ports and clean the outside of control valve thoroughly.

2. Remove two (2) screws with lock washers (item 7) that secure end cap (item 12) to control valve. Remove end cap.

3. Remove screw (item 5), spacer (item 13), spring (item 20) and washer (item 6) from control valve.

4. Carefully slide spool (item 8) from housing bore.

5. Carefully remove o-rings (item 4) from spool bore. Take care not to damage spool bore or o-ring cavities during o-ring removal.

6. Remove detent plug (item 16), o-ring (item 18), spring (item 17) and detent ball (item 1).

7. Remove plug (item 9) with o-ring (item 21) and lockout seat (item 25) with o-ring (item 24) from valve body.

8. Remove adapter plug (item 14) with o-ring (item 15), poppet stop (item 10), spring (item 2), and poppet (item 11) from control valve body.

9. Remove lockout seat (item 22) with o−ring (item 23) from control valve body. Remove detent plunger (item 19).

10. If control valve is equipped with counterbalance valve (Fig. 44), remove valve from control valve if needed. Counterbalance valve disassembly is not recommended.

Inspection

1. Inspect spool and spool bore for wear. If wear is excessive, replace lift control valve assembly.

2. Inspect all springs and replace if damaged or broken.

3. Inspect detent plunger, detent ball and poppet for wear. Replace as necessary.

4. Inspect lockout seats for wear or damage. Replace as necessary.

5. Inspect control valve housing threads and o−ring sealing surfaces. Replace as necessary.

6. Inspect threads and o−ring sealing surfaces on plugs. Replace as necessary.

Assembly (Fig. 43)

IMPORTANT: Do not wipe parts with dry paper towels or rags. Lint may cause damage to the hydraulic system.

CAUTION

Use eye protection such as goggles when using compressed air.

1. Clean all control valve components with clean solvent and blow dry with compressed air.

2. Replace all removed o−rings. Lightly lubricate new o−rings with clean hydraulic oil before assembly.

3. Install new o−rings into control valve spool bore.

4. Lubricate spool liberally with clean hydraulic fluid and carefully install into control valve bore.

5. Coat spacer (item 13), spring (item 20) and washer (item 6) liberally with MPG−2 (or equivalent) grease. Apply Loctite #242 (or equivalent) to threads of screw (item 5). Install washer, spring and spacer into valve and secure with screw. Torque screw from 24 to 36 in−lb (2.7 to 4.1 N−m).

6. Apply Loctite #242 (or equivalent) to threads of screws (item 7).

7. Position gasket (item 3) and end cap (item 12) to control valve. Secure end cap to valve with two (2) screws with lock washers (item 7). Torque screws from 24 to 36 in−lb (2.7 to 4.1 N−m).

8. Lubricate detent plunger (item 19) with clean hydraulic oil and slide into control valve bore.

9. Install new o−rings (items 23 and 24) to lockout seats (items 22 and 25). Apply Loctite #242 (or equivalent) to threads of lockout seats. Install seats into control valve. Torque seats from 18 to 20 ft−lb (24 to 27 N−m).

10. Lubricate poppet (item 11), poppet stop (item 10) and spring (item 2) liberally with clean hydraulic fluid and install into control valve bore.

11. Install adapter plug (item 14) with new o−ring (item 15) and plug (item 9) with new o−ring (item 21) into control valve. Torque plugs from 35 to 40 ft−lb (47 to 54 N−m).

12. Install new o−ring to detent plug (item 16). Lubricate detent ball (item 1) and spring (item 17) with clean hydraulic fluid and install into detent plug.

13. Install detent plug assembly to control valve. Torque plug from 10 to 15 ft−lb (14 to 20 N−m).

14. If counterbalance valve was removed, carefully thread valve into control valve housing (Fig. 44). Torque counterbalance valve from 35 to 40 ft−lb (47 to 54 N−m).

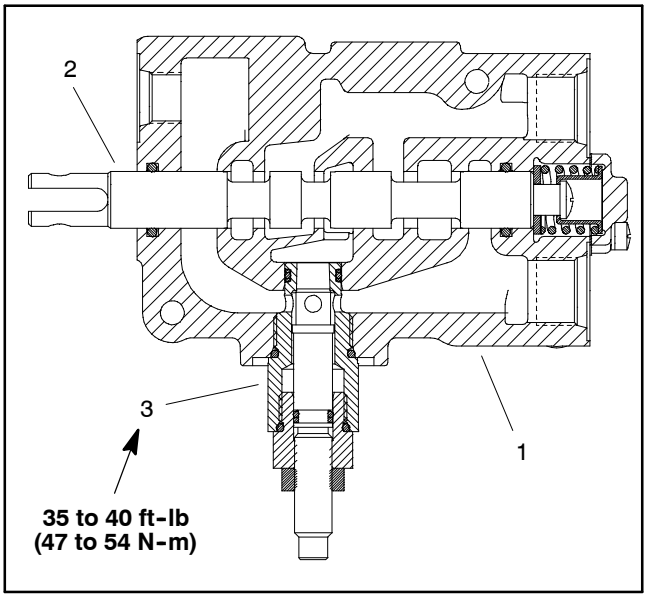

Figure 44

1. Lift control valve
2. Spool
3. Counterbalance valve

Counterbalance Valve Manifold (If Equipped)

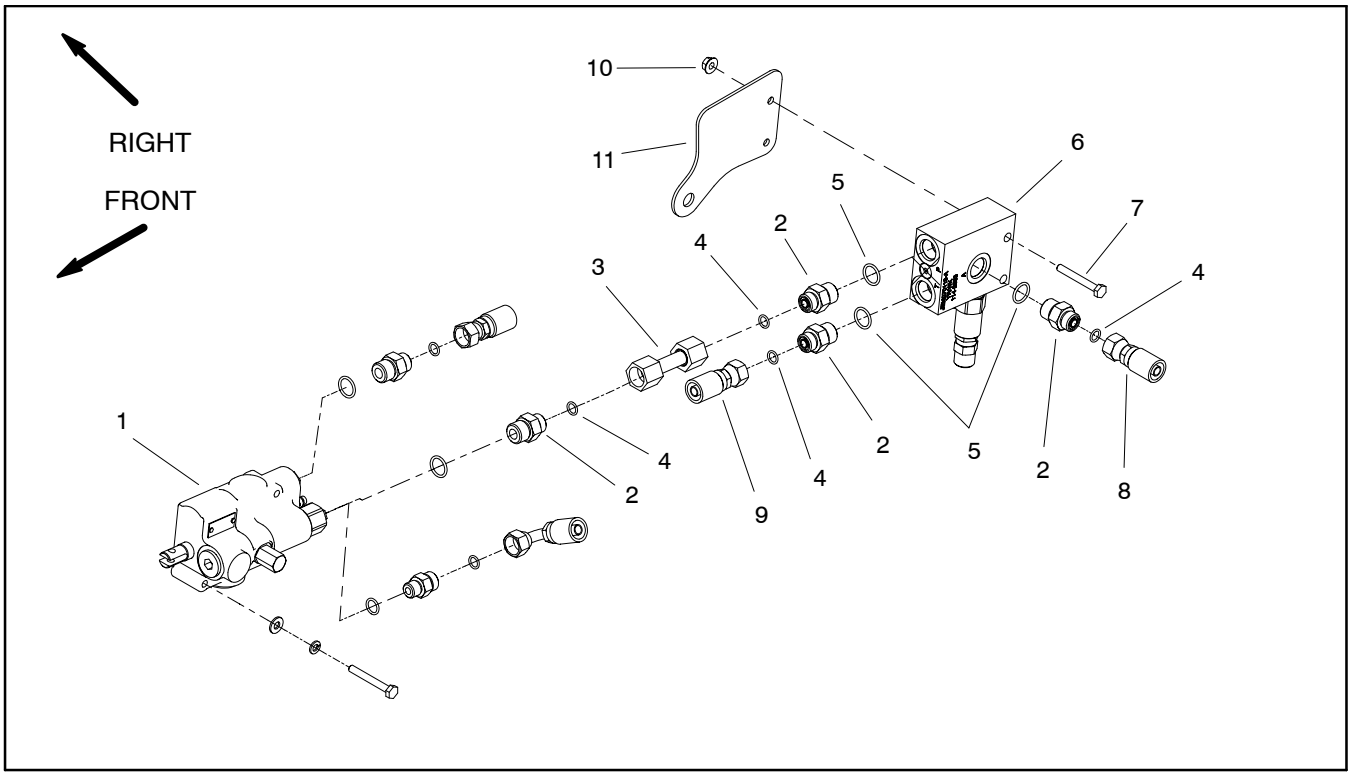

Figure 45

1. **Lift control valve**
2. **Hydraulic adapter**
3. **Hydraulic tube**
4. **O-Ring**
5. **O-Ring**
6. **Counterbalance manifold**
7. **Cap screw (2 used)**
8. **Hydraulic hose**
9. **Hydraulic hose**
10. **Flange nut (2 used)**
11. **Mounting bracket**

NOTE: The counterbalance valve manifold is used on Groundsmaster 3280-D machines with serial numbers above 270000401 and Groundsmaster 3320 machines with serial numbers above 280000000.

Removal (Fig. 45)

1. Park the machine on a level surface, engage the parking brake, lower the cutting deck (or implement) and stop the engine. Remove the 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 fuel tank from machine (see Fuel Tank Removal in Chapter 3 - Gasoline Engine or Chapter 4 - Diesel Engine).

4. Label all hydraulic connections for assembly purposes. Clean hydraulic hose ends prior to disconnecting the hoses from control manifold.

CAUTION

Operate all hydraulic controls to relieve system pressure and avoid injury from pressurized hydraulic oil.

5. Disconnect hose connections from hydraulic fittings on counterbalance valve manifold. Allow hoses to drain into a suitable container.

6. Put caps or plugs on disconnected hoses and fittings to prevent contamination.

7. Remove two (2) cap screws and flange nuts that secure manifold to machine.

8. Remove manifold from the machine.

9. Remove hydraulic fittings as necessary from the manifold. Discard all removed o-rings.

Manifold Service (Fig. 46)

1. Make sure the manifold is thoroughly cleaned before removing either of the valves.

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

2. Using a deep socket, remove valves from manifold. Note correct location of o−rings, sealing rings and backup rings. Remove and discard seal kit from valves.

3. Visually inspect the manifold port and removed valves for damage to the sealing surfaces, damaged threads and contamination.

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

4. Clean valves by submerging valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of the valve. Be extremely careful not to damage cartridge. Use compressed air for cleaning.

5. Lubricate new valve seal kit components with clean hydraulic oil and install on valves. The o−rings, sealing rings and backup rings must be arranged properly on the valves for proper operation and sealing.

6. Thread valves carefully into correct manifold port. The valves should go in easily without binding. Using a deep socket, torque valves to values identified in Figure 46.

Installation (Fig. 45)

1. Coat new o−rings lightly with clean hydraulic oil. Install all removed hydraulic fittings with new o−rings to the manifold.

2. Position counterbalance valve manifold to machine frame. Secure manifold to machine with two (2) cap screws and flange nuts.

3. Remove all caps or plugs from hydraulic hoses and fittings.

4. Connect hydraulic hoses to hydraulic fittings on manifold.

5. Install fuel tank to machine (see Fuel Tank Installation in Chapter 3 − Gasoline Engine or Chapter 4 − Diesel Engine).

6. Check hydraulic fluid level in reservoir (front axle) and adjust as required (see Traction Unit Operator's Manual).

7. Follow Hydraulic System Start−up procedures.

8. Check counterbalance valve adjustment (see Traction Unit Operator's Manual).

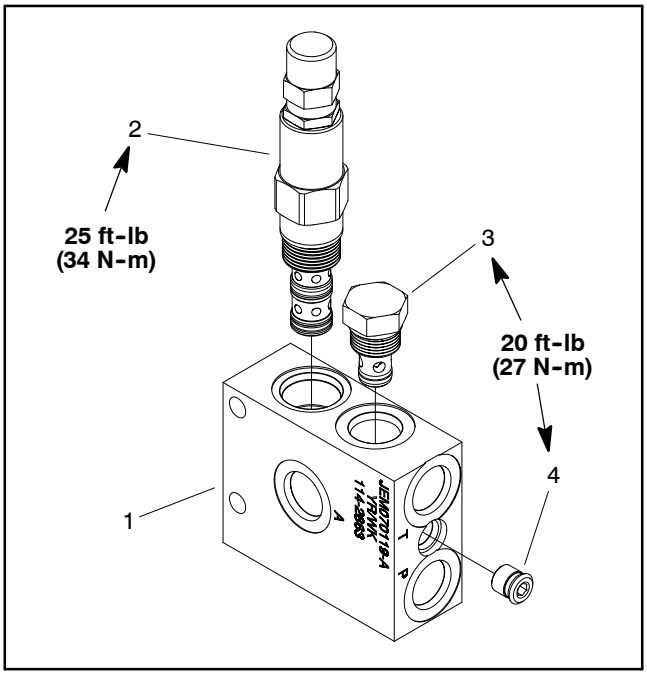

Figure 46

1. **Manifold**
2. **Counterbalance valve**
3. **Check valve**
4. **Plug**

Oil Cooler (Groundsmaster 3280-D)

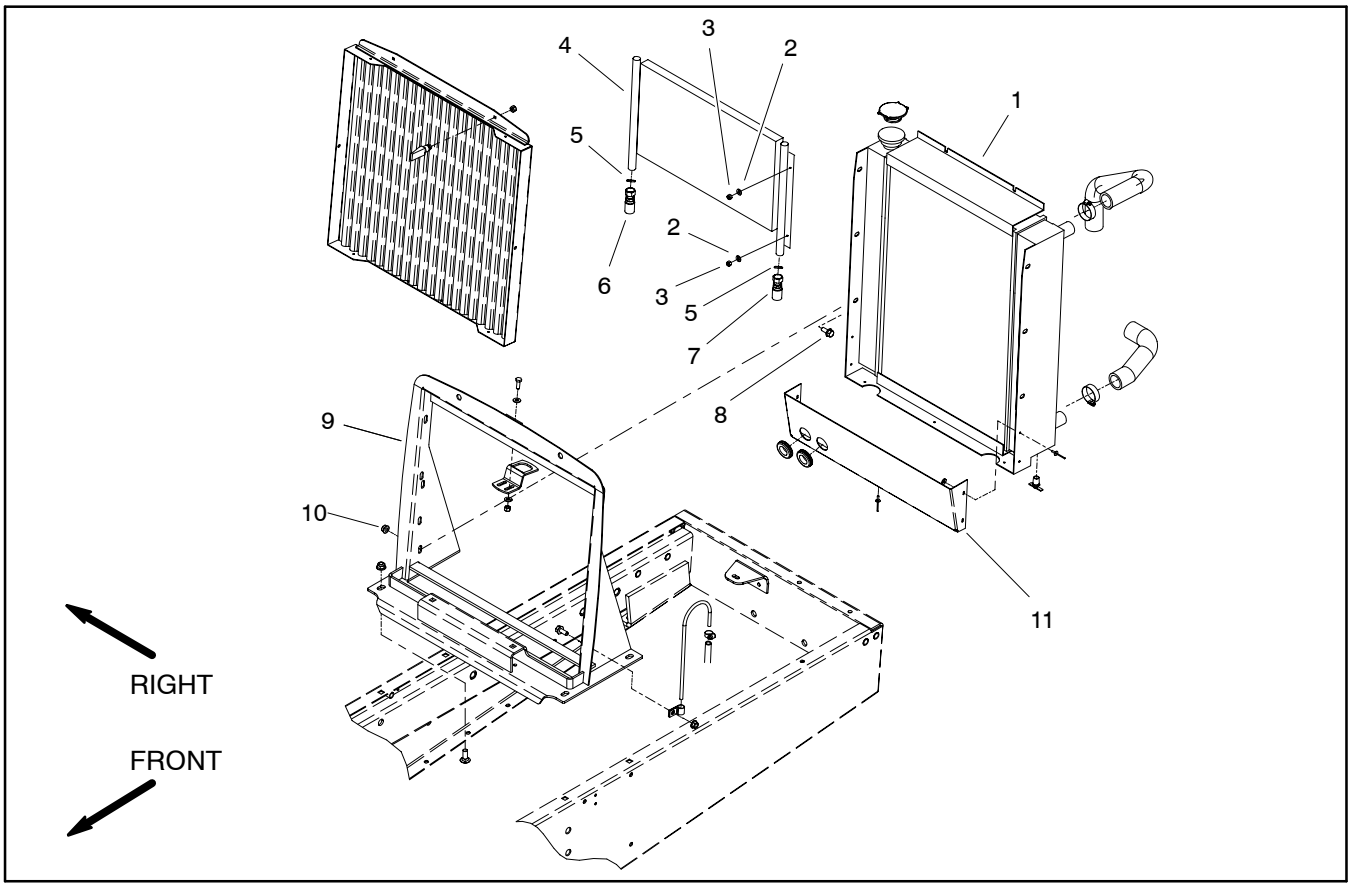

Figure 47

1. **Radiator**
2. **Lock washer**
3. **Hex nut**
4. **Oil cooler**
5. **O-ring**
6. **Hydraulic hose**
7. **Hydraulic hose**
8. **Flange head screw**
9. **Radiator support**
10. **Flange nut**
11. **Radiator shield**

Removal (Fig. 47)

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

2. Open hood (see Traction Unit Operator's Manual). Remove the radiator screen.

3. Loosen and remove hydraulic hoses from oil cooler. Remove and discard o-rings. Allow hoses to drain oil into a suitable container.

4. Remove hex nuts and lock washers that secure oil cooler to radiator.

5. Pull oil cooler from radiator.

Installation (Fig. 47)

1. Position and secure oil cooler to radiator with lock washers and hex nuts.

2. Coat new o-rings with hydraulic oil and position o-rings to hydraulic hose ends. Install hydraulic hoses to oil cooler.

3. Install radiator screen and close hood.

4. Check hydraulic fluid level in reservoir (front axle) and adjust as required (see Traction Unit Operator's Manual).

Chapter 6

Electrical System

Table of Contents

Electrical Diagrams

The electrical schematic, electrical circuit drawings and wire harness drawings for the Groundsmaster 3280−D and 3320 are located in Chapter 11 − 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. Obtain this tool locally.

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

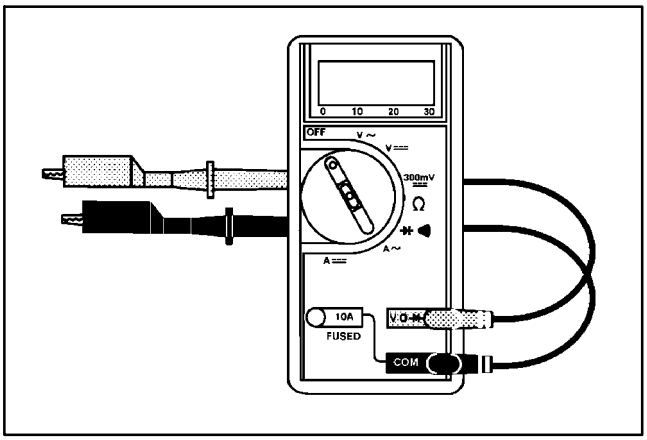

Figure 1

Skin−Over Grease

Special non−conductive grease (Toro Part Number 505−165) which forms a light protective skin to help waterproof electrical switches and contacts.

Figure 2

Battery Terminal Protector

Battery Terminal Protector (Toro Part No. 107−0392) is an aerosol spray that should be used on battery terminals to reduce corrosion problems. Apply terminal protector after battery cable has been secured to battery terminal.

Figure 3

Battery Hydrometer

Use the Battery Hydrometer when measuring specific gravity of battery electrolyte. Obtain this tool locally.

Figure 4

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 8 − Electrical Diagrams).

If the machine has any interlock switches by−passed, they must be reconnected for proper troubleshooting and safety.

NOTE: Use the Standard Control Module input and output LED's when troubleshooting a Groundsmaster 3505−D electrical problem.

Starting Problems

Problem	Possible Causes
Starter solenoid clicks, but starter will not crank (if solenoid clicks, problem is not in safety interlock system).	Battery charge is low. Battery cables are loose or corroded. Battery ground to frame is loose or corroded. Wiring at starter is faulty. Starter solenoid is faulty. Starter mounting bolts are loose or not supplying a sufficient ground for solenoid. Starter is faulty.
Engine cranks, but does not start.	Fuel tank empty. Engine run solenoid is faulty (Groundsmaster 3280−D). Glow plugs are faulty (Groundsmaster 3280−D). Engine and/or fuel may be too cold. Engine or fuel system is malfunctioning (see Chapter 3 − Engine or Chapter − Diesel Engine). Standard Control Module is faulty.
Engine cranks (but should not) with the traction pedal out of the neutral position.	Traction neutral switch is out of adjustment or faulty. Traction neutral switch wiring is faulty.

Starting Problems (continued)

Problem	Possible Causes
Nothing happens when start attempt is made (either seat switch OR parking brake must be engaged for successful start).	PTO switch is **ON** (pulled out) or is faulty. Traction pedal is not in neutral position. Interlock system has problem. Battery cables are loose or corroded. Battery ground to frame is loose or corroded. Battery is dead. Engine fuse (15 amp) is open. Fusible link is open. Wiring to start circuit components is loose, corroded or damaged (see Wiring Schematics). Traction neutral switch is out of adjustment or faulty. Ignition switch is faulty. Fuse block is faulty. High temperature shutdown switch is faulty. Starter solenoid is faulty. Standard Control Module is faulty.

General Run and Operating Problems

Problem	Possible Causes
Engine continues to run (but should not) when the traction pedal is depressed with no operator on the seat.	Seat switch is faulty. Seat switch wiring is loose, corroded or damaged. Traction neutral switch is out of adjustment or faulty.
Engine kills when the traction pedal is depressed or the P.T.O. switch is pulled **ON** with the operator in the seat.	Operator is lifting off the seat (seat switch not depressed fully). Parking brake is on. Seat switch is faulty. Seat switch wiring is loose, corroded or damaged.
Battery does not charge.	Wiring to the charging circuit components is loose, corroded or damaged (see Wiring Schematics in Chapter 11 − Electrical Diagrams). Alternator belt is loose or damaged. Fusible link to the battery is faulty. Alternator is faulty. Battery is faulty.
Engine kills during operation (operator sitting on seat).	Operator is lifting off the seat (seat switch not depressed fully). Seat switch is faulty. Seat switch wiring is loose, corroded or damaged. Engine is overheated. Ignition switch is faulty. Wiring to the run circuit components is damaged or disconnected (see Wiring Schematics in Chapter 11 − Electrical Diagrams). Standard Control Module is faulty.

General Run and Operating Problems (continued)

Problem	Possible Causes
Engine Continues to run (but should not) when the PTO switch is **ON** with no operator in the seat.	Seat switch is faulty. Seat switch wiring is loose, corroded or damaged. Traction neutral switch is out of adjustment or faulty.
P.T.O. clutch does not engage.	System fuse F1 (15 amp) or F3 (10 amp) is open. Logic power fuse F4 (2 amp) is open. Fuse block is faulty. P.T.O. switch is faulty. P.T.O. latch relay is faulty. Electric clutch wiring is loose, corroded or damaged. Electric clutch is out of adjustment or faulty.

Electrical System Quick Checks

Battery Test (Open Circuit Test)

Use a multimeter to measure the battery voltage.

Set the multimeter to the DC volts setting. The battery should be at a temperature of 60º to 100º F (16º to 38º C). The ignition key should be in the OFF position and all accessories turned off. Connect the positive (+) multimeter lead to the positive battery post and the negative (−) multimeter lead to the negative battery post. Record the battery voltage.

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

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

Charging System Test

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

Tool required: Digital multimeter set to DC volts.

Test instructions: Connect the positive (+) multimeter lead to the positive battery post and the negative (−) multimeter lead to the negative battery post. Keep the test leads connected to the battery posts and record the battery voltage.

NOTE: Upon starting the engine, the battery voltage will drop and then should increase once the engine is running.

NOTE: Depending upon the condition of the battery charge and battery temperature, the charging system voltage will increase at different rates as the battery charges.

Start the engine and run at high idle (3200 RPM). Allow the battery to charge for at least 3 minutes. Record the battery voltage.

Test results should be (example):

At least 0.50 volt over initial battery voltage.	
Initial Battery Voltage	= 12.30 v
Battery Voltage after 3 Minute Charge	= 12.85 v
Difference	= +0.55 v

Glow Plug System Test (Groundsmaster 3280−D)

This is a fast, simple test that can help to determine the integrity and operation of the Groundsmaster 3280−D glow plug system. The test should be run anytime hard starting (cold engine) is encountered on a diesel engine equipped with a glow plug system.

Tool(s) required: Digital multimeter and/or inductive Ammeter (AC/DC Current Transducer).

Test instructions: Properly connect the ammeter to the digital multimeter (refer to manufacturers' instructions). Set the multimeter to the correct scale. With the ignition switch in the OFF position, place the ammeter pickup around the main glow plug power supply wire and read the meter prior to activating the glow plug system. Adjust the meter to read zero (if applicable). Cycle the glow plug system at least two times (per instructions in Traction Unit Operator's Manual) and record the final results.

The Groundsmaster 3280−D glow plug system should have a reading of approximately 27 Amps. If low current reading is observed, one (or more) glow plugs is faulty.

Check Operation of Interlock Switches

CAUTION

Do not disconnect interlock 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. The Groundsmaster 3280−D and Groundsmaster 3320 are equipped with a Standard Control Module which monitors interlock switch operation. Information on this Module is described in the Traction Unit Operator's Manual and in the Component Testing section of this Chapter. Testing of individual interlock switches 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: Electrical troubleshooting of any 12 Volt power connection can be performed through voltage drop tests without disconnecting the component.

NOTE: See the Kubota Workshop Manual: 05 Series Engine (Groundsmaster 3280−D) or Briggs & Stratton/ Daihatsu Engine Repair Manual (Groundsmaster 3320) for additional electrical component repair information.

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, and START). The terminals are marked as shown in Figure 5. The circuit wiring of the ignition switch is shown in the chart below. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. Verify continuity between switch terminals.

POSITION	CIRCUIT
OFF	NONE
ON	B + C + F, D + E
START	A + B + C

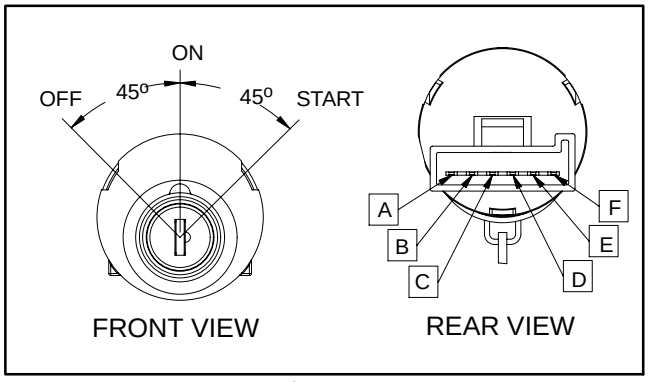

Figure 5

The Standard Control Module monitors the operation of the ignition switch. If the ignition switch is in the ON position, the Module Power input LED should be illuminated. If the ignition switch is in the START position, both the Module Power input and Start input LEDs should be illuminated.

Indicator Lights

Charge Indicator Light

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

Engine Oil Pressure Light

The engine oil pressure light should come on when the ignition switch is in the ON position with the engine not running. Also, it should illuminate with the engine running if the engine oil pressure drops to an unsafe level.

IMPORTANT: If the oil pressure indicator light is illuminated with the engine running, shut off the engine immediately.

To test the oil pressure light and circuit wiring, ground the wire attached to oil pressure switch located on the engine near the oil filter. Turn ignition switch to the ON position; the engine oil pressure light should come on indicating correct operation of the indicator light and circuit wiring.

High Temperature Warning Light

If the engine coolant temperature reaches 221ºF (105ºC) (approximate), the high temperature warning light should come on.

To test the high temperature warning light and circuit wiring, turn ignition switch to the ON position and ground the yellow wire attached to high temperature sender located on the engine water pump housing (see Temperature Sender in this Chapter). The indicator light should illuminate.

Glow Plug Indicator Light

The glow plug light on Groundsmaster 3280−D machines should come on when the ignition switch is placed in the ON position prior to placing the ignition switch in START. The light should stay lit for approximately 6 seconds while the ignition switch is left in the ON position.

Testing Indicator Lights

1. Apply 12 VDC to terminals 1A and 2A (Fig. 7).
2. Ground terminals 1B and 2B (Fig. 7).
3. Both indicator lights should illuminate.

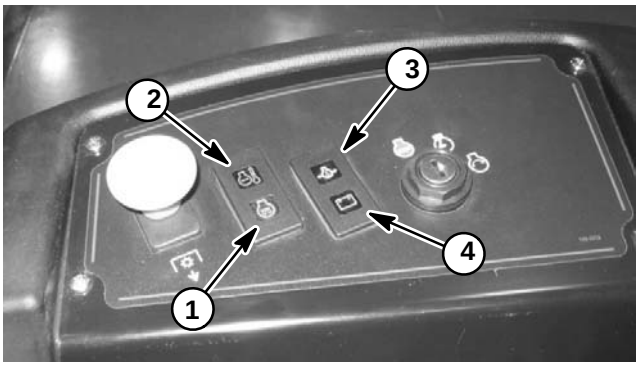

Figure 6

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

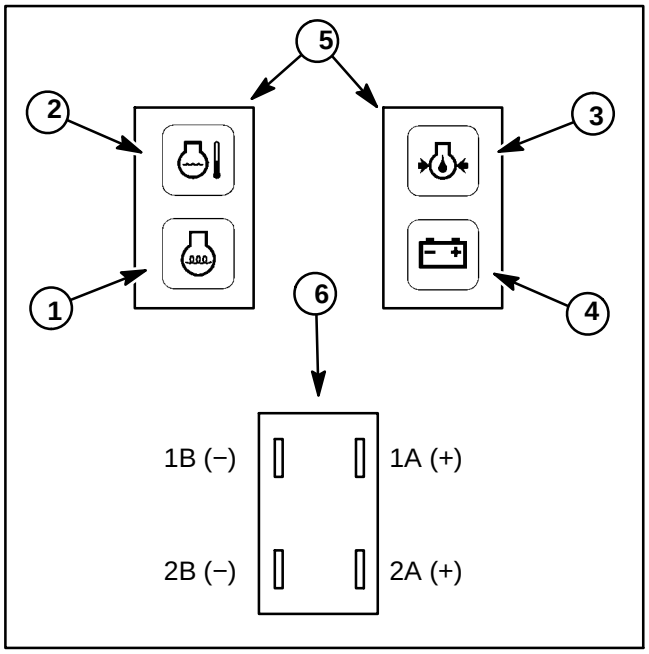

Figure 7

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

Hour Meter

1. Connect the positive (+) terminal of a 12 VDC source to the positive (+) terminal of the hour meter.

2. Connect the negative (−) terminal of the voltage source to the other terminal of the hour meter.

3. The hour meter should move a 1/10 of an hour in six minutes.

4. Disconnect the voltage source from the hour meter.

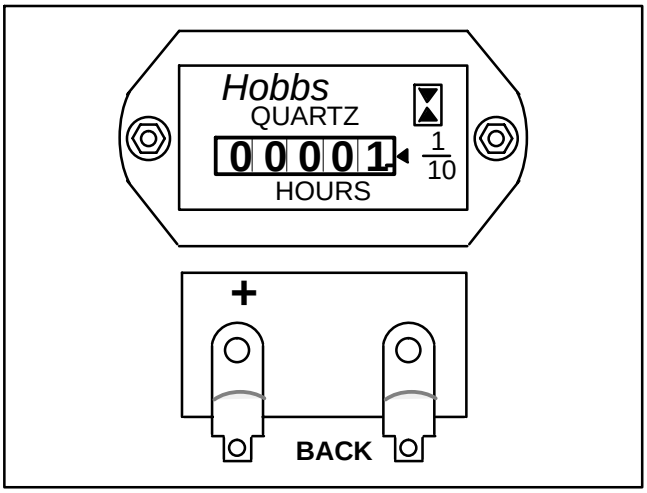

Figure 8

P.T.O. Switch

The P.T.O. switch is mounted on the control panel and is pulled to engage the P.T.O. electric clutch.

The Standard Control Module monitors the operation of the P.T.O. switch. If the ignition switch is in the ON position and the P.T.O. switch is pulled out, the Module P.T.O. switch input LED should be illuminated.

Testing

When the switch knob is pulled out to engage the P.T.O., the COM B and middle switch terminals should have continuity (Fig. 10). COM B and NC should not have continuity.

When the switch knob is pushed in, the outside switch terminals (COM B and NC) should have continuity (Fig. 10). COM B and middle switch terminals should not have continuity.

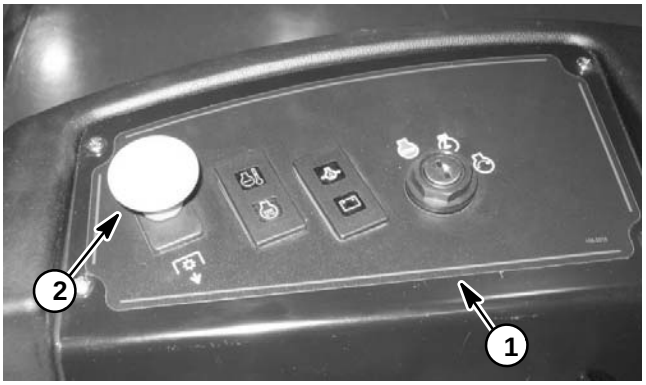

Figure 9

1. **Control panel**
2. **P.T.O. switch**

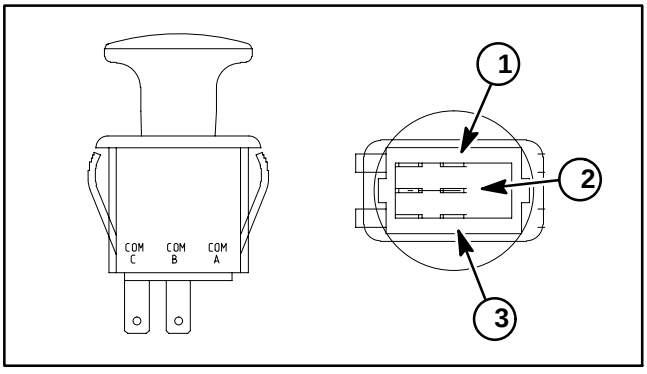

Figure 10

1. **COM B terminal**
2. **Middle terminal**
3. **NC terminal**

Temperature Sender

The temperature sender is attached to the water pump housing on the engine. There is a yellow wire attached to the temperature sender.

If the ignition switch is in the ON position and the temperature sender has reduced resistance due to high coolant temperature, the High Temperature Warning indicator light on the console and the Over Temperature Warning input LED on the Standard Control Module should be illuminated.

Testing

CAUTION

Make sure engine is cool before removing the temperature sender from engine.

1. Lower the coolant level in the engine and remove the temperature sender from the engine.

2. Put the end of the sender in a container of oil with a thermometer and slowly heat the oil (Fig. 13).

CAUTION

Handle the hot oil with extreme care to prevent personal injury or fire.

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

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 70ºF (21ºC).

   B. The meter should indicate approximately 460 ohms at 100ºF (38ºC).

   C. The meter should indicate from 54 to 78 ohms at 200ºF (93ºC).

   D. Replace sender if specifications are not met.

4. Install sender to the engine housing.

   A. Clean threads of housing and sender thoroughly. Apply thread sealant to the threads of the sender.

   B. Thread sender into the housing. Torque sender from 16 to 20 ft−lb (21.7 to 27.1 N−m).

   C. Reconnect wire to sender.

5. Fill engine cooling system (see Traction Unit Operator's Manual).

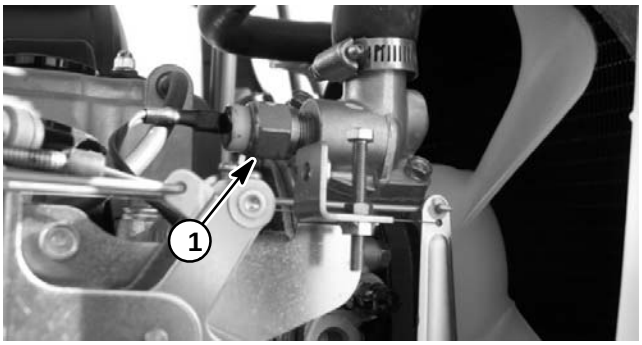

Figure 11

1. Temperature sender (gasoline engine)

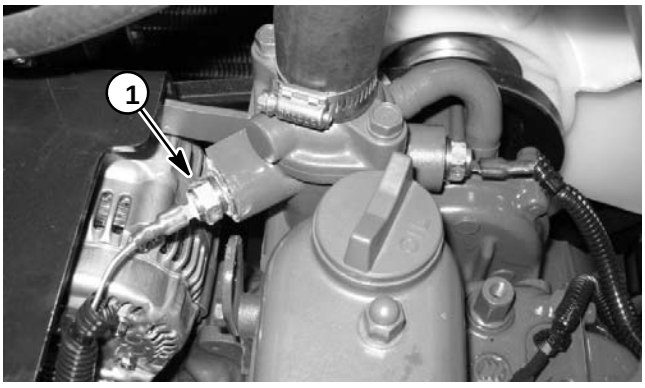

Figure 12

1. Temperature sender (diesel engine)

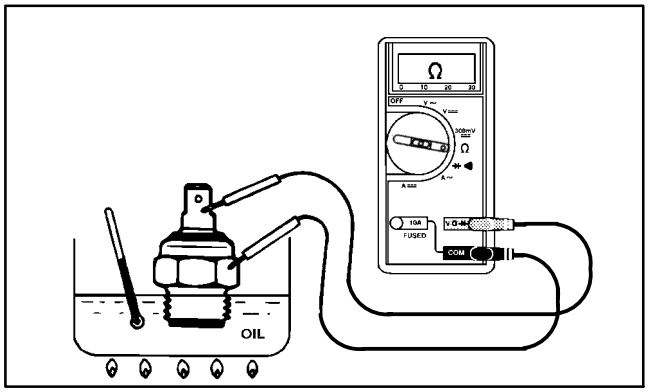

Figure 13

High Temperature Shutdown Switch

The high temperature shutdown switch is located on the water pump housing. There is a blue/white wire attached to the shutdown switch.

The Standard Control Module monitors the operation of the high temperature shutdown switch. If the ignition switch is in the ON position and the high temperature shutdown switch has closed due to excessive coolant temperature, the Module Over Temperature Shutdown input LED should be illuminated and the engine should shut down.

Testing

CAUTION

Make sure engine is cool before removing the temperature switch from engine.

1. Lower the coolant level in the engine and remove the high temperature shutdown switch from the engine.

2. Put the end of the switch in a container of oil with a thermometer and slowly heat the oil (Fig. 16).

CAUTION

Handle the hot oil with extreme care to prevent personal injury or fire.

3. Check resistance of the switch with a multimeter (ohms setting) as the oil temperature increases. The high temperature shutdown switch is normally open.

   A. On the Groundsmaster 3280−D (diesel engine), the high temperature shutdown switch should close between 225° and 235°F (107° and 113°C).

   B. On the Groundsmaster 3320 (gasoline engine), the high temperature shutdown switch should close at approximately 238°F (114°C).

4. Allow oil to cool while observing temperature.

   A. On the Groundsmaster 3280−D (diesel engine), the high temperature shutdown switch should open at approximately 219°F (104°C).

   B. On the Groundsmaster 3320 (gasoline engine), the high temperature shutdown switch should open at approximately 232°F (111°C).

5. Replace switch if specifications are not met.

6. After testing is complete, install switch to the engine housing.

   A. Clean threads of housing and switch thoroughly. Apply thread sealant to the threads of the switch.

   B. Thread switch into the housing. Torque switch from 16 to 20 ft−lb (21.7 to 27.1 N−m).

   C. Reconnect wire to switch.

7. Fill engine cooling system (see Traction Unit Operator's Manual).

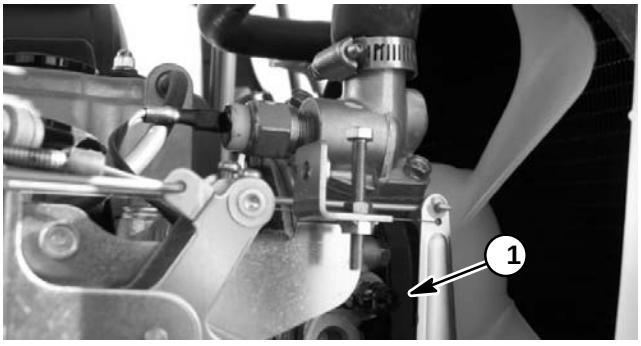

Figure 14

1. High temperature switch (gasoline engine)

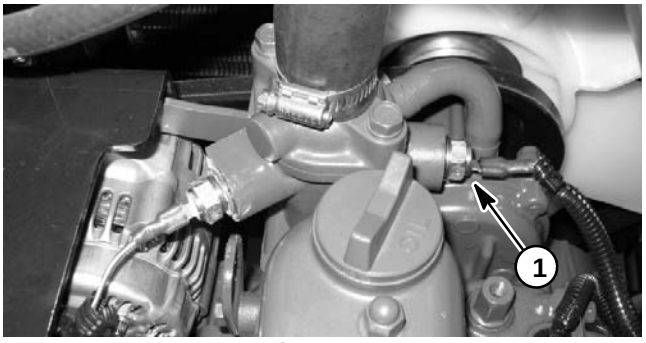

Figure 15

1. High temperature switch (diesel engine)

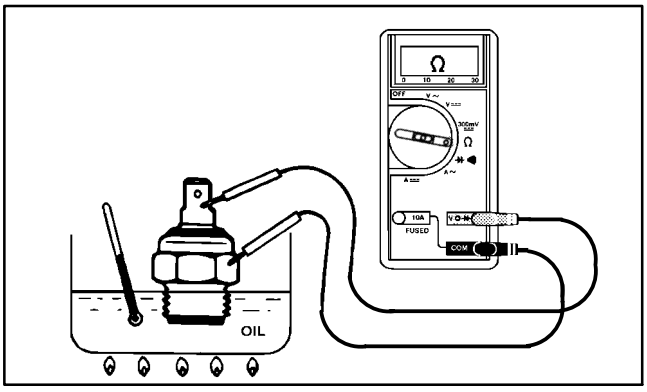

Figure 16

Oil Pressure Switch

The engine oil pressure switch is located on the engine near the oil filter (Figs.17 and 18). The oil pressure switch is a normally closed switch that opens with pressure.

On the Groundsmaster 3280−D (diesel engine), the oil pressure switch should open at approximately 8 PSI (0.56 kg/cm^2).

On the Groundsmaster 3320 (gasoline engine), the oil pressure switch should open between 2.9 to 5.7 PSI (0.2 to 0.4 kg/cm^2).

IMPORTANT: If the oil pressure indicator light is illuminated with the engine running, shut off the engine immediately. Check the indicator light, circuit wiring, pressure switch and engine lubrication system to identify the cause of the illuminated indicator light.

Testing

NOTE: Refer to engine service manual for information regarding engine lubrication system and testing.

1. Turn the ignition switch to the ON position. The oil pressure indicator light on the control panel should be illuminated.

2. If the light is not on, disconnect the wire from the oil pressure switch and ground the wire to the engine block.

3. If the light comes on, the oil pressure switch is faulty.

4. If the light does not come on after step 2, check the circuit wiring and indicator light (see Engine Oil Pressure Light in this section).

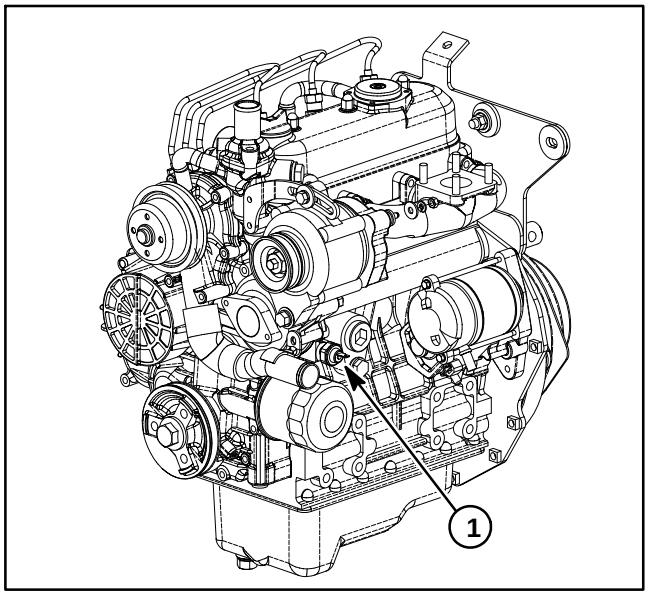

Figure 17

1. Oil pressure switch (diesel engine)

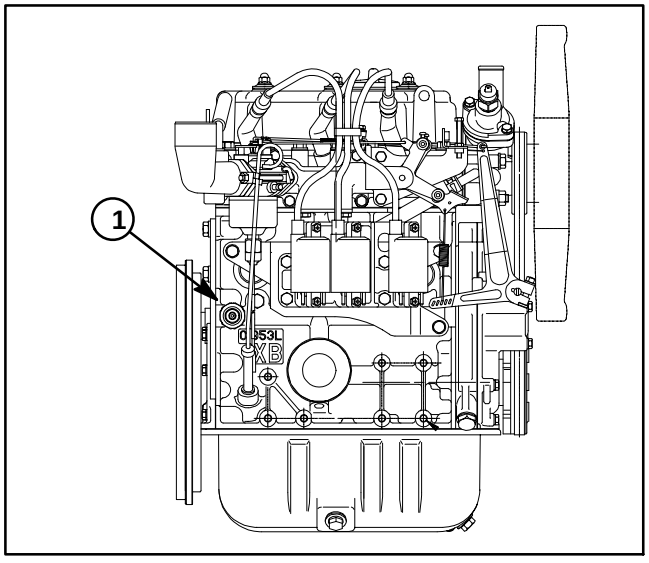

Figure 18

1. Oil pressure switch (gasoline engine)

Standard Control Module

The Groundsmaster 3280−D and Groundsmaster 3320 are equipped with a Standard Control Module to monitor and control electrical components required for safe operation. This Module is located under the control panel (Fig. 19).

Inputs from the ignition, neutral, parking brake, P.T.O., seat, temperature sender and high temperature shutdown switches are monitored by the Module. Current output to the P.T.O. (electric clutch), electric starter motor and engine components (fuel pump, diesel engine run solenoid and gasoline engine ignition) 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 Module LEDs. 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 ON position), testing of the switch and circuit wiring would be required.

Refer to the Traction Unit Operator's Manual for additional Standard Control Module information.

Control Module Inputs (Fig. 20)

The Power input LED should be illuminated when the ignition key switch is in the ON or START position.

The Start input LED should be illuminated when the ignition key switch is in the START position.

The Neutral input LED should be illuminated when the traction pedal is in the neutral position.

The Parking Brake Off input LED should be illuminated when the parking brake is not engaged.

The P.T.O. Switch input LED should be illuminated when the P.T.O. switch is engaged (pulled out).

The In Seat input LED should be illuminated when the operator is sitting in the seat.

The Over Temperature Shutdown input LED should be illuminated when excessive engine coolant temperature causes the high temperature shutdown switch to close.

The Over Temperature Warning input LED should be illuminated when the temperature sender has reduced resistance due to high engine coolant temperature.

The Backlap input LED is not used on the Groundsmaster 3280−D or 3320.

Control Module Outputs (Fig. 20)

The Start output LED should be illuminated when the ignition key switch is in the START position with the traction pedal in neutral, the P.T.O. switch off and either the seat occupied or parking brake engaged.

The Run output LED should be illuminated when the ignition key switch is in the ON position and inputs from the neutral, parking brake, P.T.O., seat and over temperature switches indicate safe engine operation (e.g. seat occupied and parking brake disengaged when traction pedal is depressed).

The P.T.O. output LED should be illuminated when the ignition key switch is in the ON position and the P.T.O. switch is pulled out. Note: If Module Over Temperature Warning input LED is illuminated, P.T.O. output LED will not be illuminated and P.T.O. will not be engaged regardless of P.T.O. switch position.

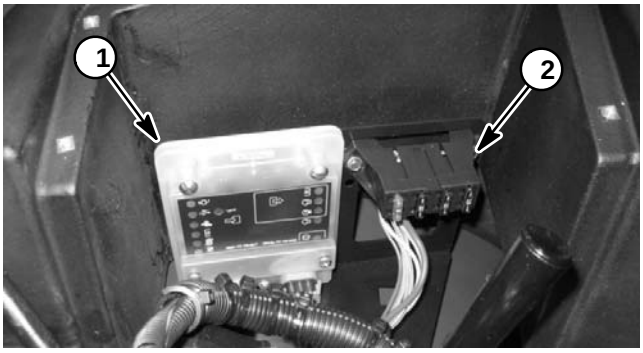

Figure 19

1. Standard Control Module **2. Fuse block**

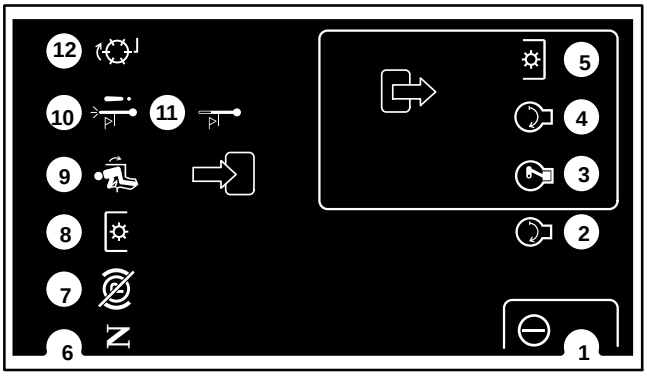

Figure 20

1. Power input LED
2. Start input LED
3. Engine run output LED
4. Start output LED
5. PTO output LED
6. Neutral input LED
7. Park brake off input LED
8. PTO switch input LED
9. In seat input LED
10. Temp shutdn input LED
11. Temp warning input LED
12. Backlap input LED

Traction Neutral Switch

The traction neutral switch is a normally open proximity switch that closes when the traction pedal is in the neutral position. A socket head screw threaded into the hydrostat neutral return arm acts as the sensing plate for the switch.

The Standard Control Module monitors the operation of the traction neutral switch. If the ignition switch is in the ON position and the traction pedal is in the neutral position, the Module Neutral input LED should be illuminated.

Testing

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

2. Disconnect the electrical connector from the neutral switch.

3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the connector terminals.

4. With the ignition switch in the OFF position, slowly push the traction pedal in the forward and reverse direction while watching the multimeter. Continuity should be broken in both the forward and reverse directions.

5. Allow the traction pedal to return to the neutral position. There should be continuity across the terminals.

6. Reconnect electrical connector to the neutral switch.

Adjustment

1. Before adjusting the traction neutral switch, check and adjust traction system neutral position (see Traction Unit Operator's Manual).

IMPORTANT: To prevent traction neutral switch damage, make sure that end of socket head screw does not contact switch.

2. Loosen jam nut on socket head screw.

3. Rotate socket head screw so the clearance between end of the socket head screw and neutral switch is .125" (3.2 mm) (Fig. 22).

4. Torque jam nut from 71 to 89 in−lb (8 to 10 N−m) to secure adjustment. After jam nut is tightened, make sure that clearance between socket head screw and neutral switch has not changed.

5. Check for proper switch operation (see Testing above).

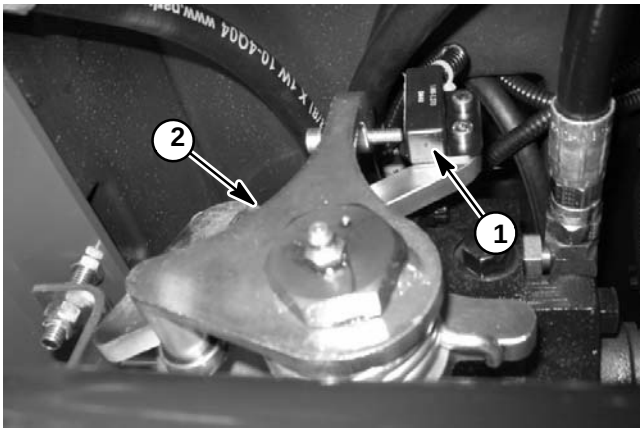

Figure 21

1. Neutral switch
2. Neutral return arm

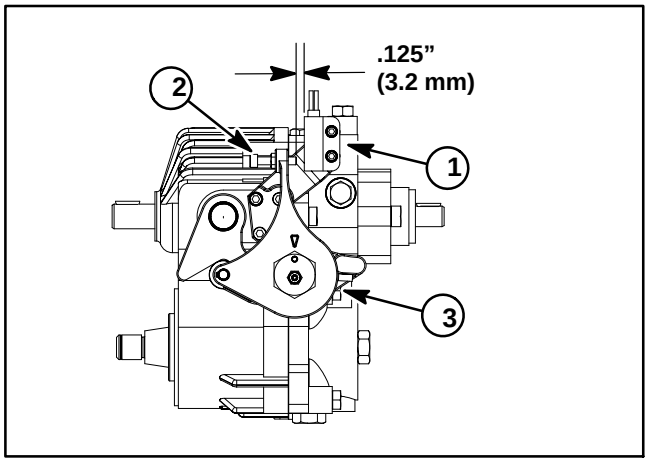

Figure 22

1. Neutral switch
2. Socket head screw
3. Neutral return arm

Seat Switch

The seat switch is normally open and closes when the operator is on the seat. If the traction system or P.T.O. switch is engaged when the operator raises out of the seat, the engine will stop. The seat switch (Fig. 23) 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.

The Standard Control Module monitors the operation of the seat switch. If the ignition switch is in the ON position and the seat is occupied, the Module in seat input LED should be illuminated.

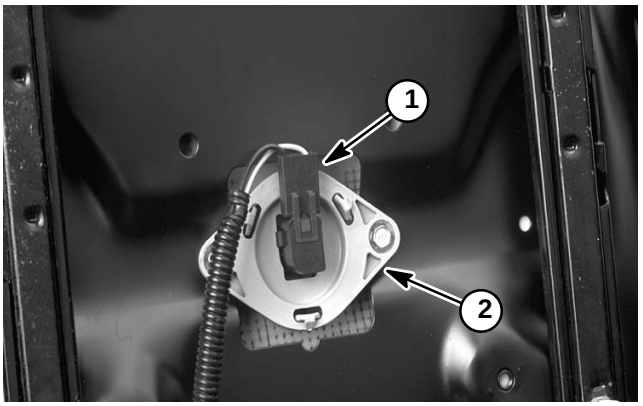

Figure 23

1. **Electrical connector**
2. **Standard seat switch**

Testing

1. Make sure the engine is off. Locate switch for testing.

2. Disconnect electrical connector from 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. Reconnect switch connector.

Parking Brake Switch

The switch used for the parking brake is a normally open switch. The switch closes when the parking brake is disengaged. The parking brake switch is located under the steering tower cover (Fig. 24).

The Standard Control Module monitors the operation of the parking brake switch. If the ignition switch is in the ON position and the parking brake is disengaged, the Module Parking Brake Off input LED should be illuminated.

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. When the switch plunger is extended there should not be continuity between the switch terminals.

5. When the switch plunger is depressed, there should be continuity between the switch terminals.

6. Reconnect switch connector.

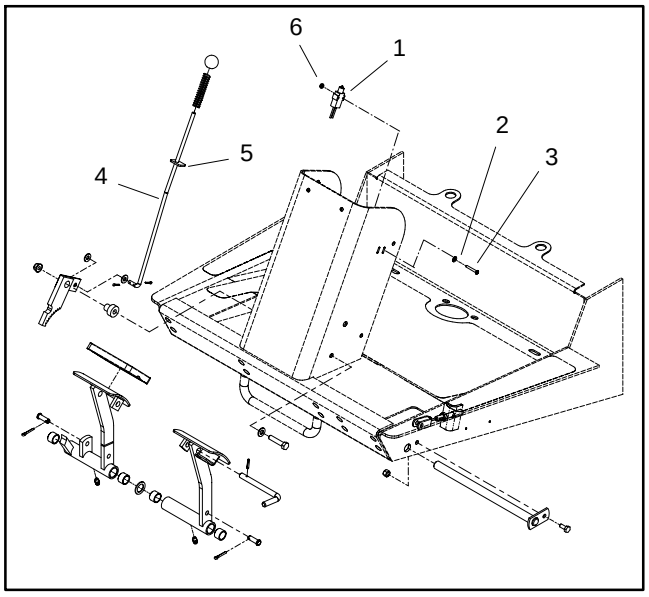

Figure 24

1. **Parking brake switch**
2. **Flat washer (2 used)**
3. **Phillips screw (2 used)**
4. **Parking brake rod**
5. **Switch actuator**
6. **Nut (2 used)**

P.T.O. Electric Clutch

An electric clutch is used to engage the P.T.O. The electric clutch is mounted on the engine crankshaft and engages when current is applied to the clutch. The clutch also incorporates a magnetic brake to stop clutch rotation when the clutch is de−energized.

Testing

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

2. Locate electric clutch on engine crankshaft (Fig. 25). Unplug clutch connector from machine wire harness.

3. For accurate clutch resistance measuring, clutch should be at approximately 70°F (21°C).

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

4. Using a multimeter (ohms setting), verify clutch coil resistance between the two terminals of the clutch wire connector. Coil resistance should be approximately 3.0 ohms. Additionally, check that there is no continuity between either of the clutch wire connector terminals and the clutch frame.

5. Using access slots in clutch cover, measure gap between clutch rotor and armature (Fig. 25). Gap should be from .012” to .024” (.3 to .6 mm) at all three access slots. If gap is incorrect, loosen or tighten three (3) lock nuts evenly to achieve correct, uniform gap.

6. As an additional test, apply 12 volts to the terminals of the clutch. The clutch should engage. If clutch does not engage when voltage is applied, replace clutch.

7. If clutch removal is necessary, see P.T.O. Electric Clutch in the Service and Repairs section of this chapter.

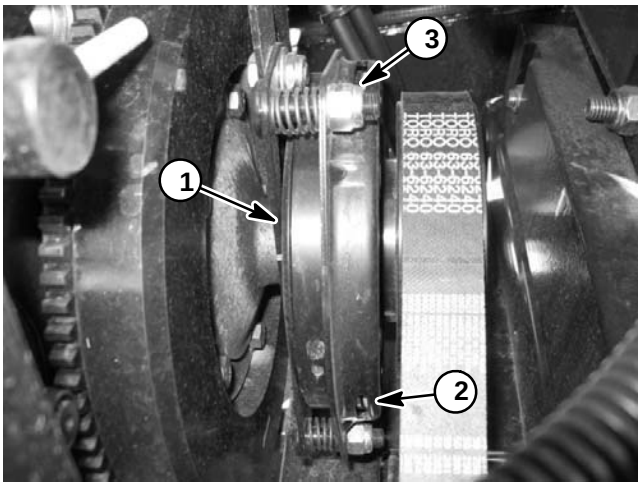

Figure 25

1. **P.T.O. clutch**
2. **Access slot**
3. **Lock nut**

Fuses

The fuse block is located under the control panel (Fig. 26).

Identification and Function

The fuses are held in the fuse block. Use Figure 27 to identify each individual fuse and its correct amperage. Each fuse holder has the following function.

Fuse 1 (15 Amp): Protects main power circuit to ignition switch terminal B

Fuse 2 (10 Amp): Protects power circuit from ignition switch terminal S.

Fuse 3 (10 Amp): Protects power circuit from ignition switch terminal I.

Fuse 4 (2 Amp): Protects power supply to Standard Control Module.

Testing

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

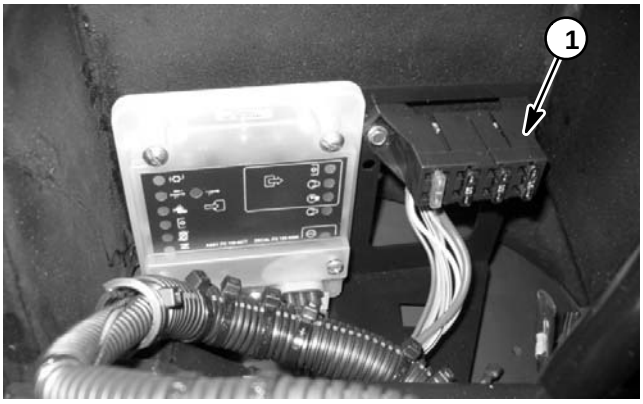

Figure 26

1. Fuse block

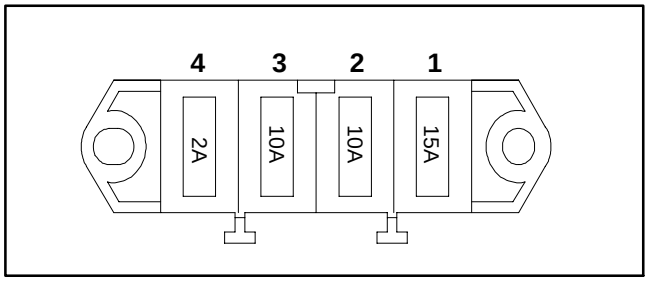

Figure 27

Fusible Link Harness

The Groundsmaster 3280−D and 3320−D use three (3) fusible links for circuit protection. These fusible links are located in a harness that connects the starter B+ terminal to the main wire harness (Fig. 28). If any of these links should fail, current to the protected circuit will cease. Refer to wire harness drawings in Chapter 11 − Electrical Diagrams for additional fusible link information.

Use a multimeter to make sure that continuity exists between each terminal pin in connector P1 and connector J1 at the starter (Fig. 29). If any of the fusible links are open, replace the complete harness.

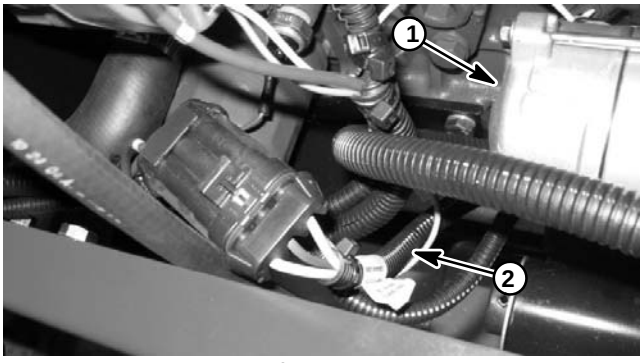

Figure 28

1. Starter motor **2. Fusible link harness**

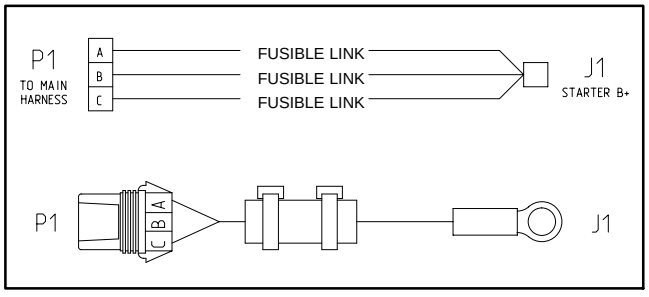

Figure 29

Fuel Stop Solenoid (Groundsmaster 3280−D)

The fuel stop solenoid used on the Groundsmaster 3280−D (diesel engine) must be energized for the diesel engine to run. The solenoid is mounted to the injection pump on the engine (Fig. 30).

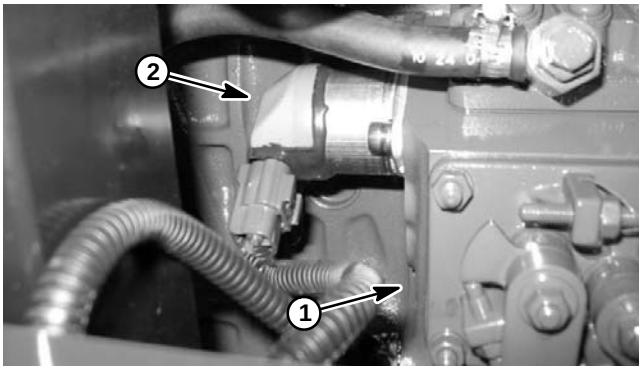

Figure 30

1. Injection pump
2. Fuel stop solenoid

In Place Testing

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

1. Disconnect wire harness connector from solenoid.

2. Using a digital multimeter, touch one test lead to the pull coil terminal and the other test lead to the fuel stop solenoid frame (ground) (Fig. 31). The resistance of the pull coil should be less than 1 ohm (but not zero).

3. Using a digital multimeter, touch one test lead to the hold coil terminal and the other test lead to the fuel stop solenoid frame (ground) (Fig. 31). The resistance of the hold coil should be approximately 15 ohms.

4. Connect solenoid to the wiring harness.

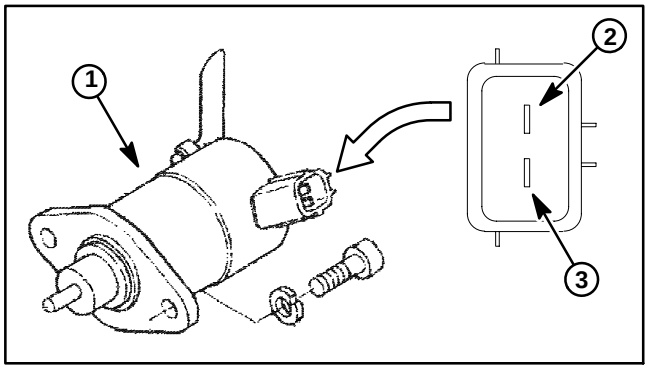

Figure 31

1. Fuel stop solenoid
2. Pull coil terminal
3. Hold coil terminal

Live testing

1. Disconnect wire harness connector from 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 plunger moves freely and is free of dirt, debris and corrosion.

NOTE: When testing run solenoid, use test leads with at least 14 gauge wire.

3. Connect a positive (+) test lead from a 12 VDC source to the pull coil and hold coil terminals.

4. Touch a negative (−) test lead from the 12 VDC source to the fuel stop solenoid frame (ground) (Fig. 31). The solenoid should engage, making an audible “click,” and the plunger should retract.

5. Remove positive (+) voltage from the pull coil terminal. The solenoid should stay engaged.

6. Remove positive (+) voltage from the hold coil terminal. The solenoid should release.

7. Reconnect the wires to the solenoid.

Glow Controller (Groundsmaster 3280−D)

The glow controller used on the Groundsmaster 3280−D (diesel engine) is located under the control panel.

NOTE: Refer to Chapter 11 − Electrical Diagrams when troubleshooting the glow controller circuit.

Controller Operation

1. When the ignition switch is placed in the RUN position, the controller energizes the glow plugs and lights up the glow lamp for approximately 6 seconds.

2. When the ignition switch is held in the START position, the glow plugs will energize while the switch is held in START and the glow lamp will **not** light.

3. When the ignition switch is released from START to RUN, the glow plugs will de−energize and the glow lamp will remain off.

Controller Checks

1. Make sure there is power from the battery.

2. Disconnect electrical connector to the fuel stop solenoid to prevent the engine from starting.

3. Place ignition switch in the RUN position. Verify the following while in the RUN position:

   A. Glow indicator lamp is on.

   B. Glow relay is energized.

   C. Glow plugs are energized.

   D. Glow indicator lamp goes out and glow plugs de−energize after approximately 6 seconds.

4. Place ignition switch in the START position. Verify the following while in the START position:

   A. Glow indicator lamp is out.

   B. Glow relay is energized.

   C. Glow plugs are energized.

   D. Power exists at terminal 1 of the glow controller.

NOTE: If there is no power to terminal 1 of the glow controller, verify continuity of the circuitry from the ignition switch to the glow controller and perform Step 4 again (see Chapter 11 − Electrical Diagrams).

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 11 − Electrical Diagrams).

   B. Verify continuity of the circuitry from the battery to ignition switch, glow controller, glow lamp, glow relay and ground (see Chapter 11 − Electrical Diagrams).

   C. Replace parts as necessary.

6. Connect electrical connector to the fuel stop solenoid.

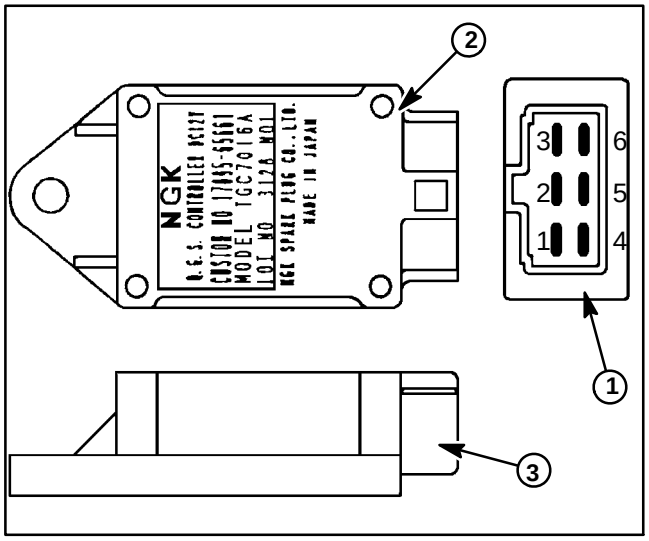

Figure 32

1. **Glow controller end view**
2. **Top view**
3. **Side view**

Glow Relay (Groundsmaster 3280−D)

The glow relay used on the Groundsmaster 3280−D (diesel engine) is attached to the support bracket inside the right side frame near the fuel/water filter (Fig. 33). When energized, the glow relay allows electrical current to the engine glow plugs.

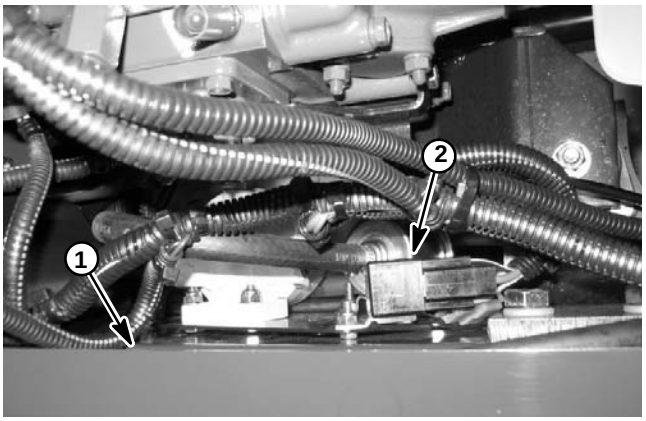

Figure 33

1. **Frame**
2. **Glow relay**

Testing

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

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

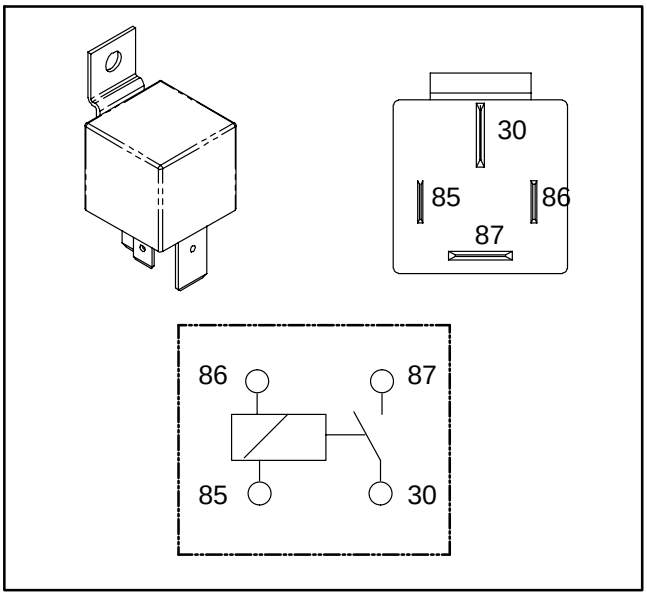

Figure 34

Fuel Pump (Groundsmaster 3280−D)

The fuel pump used on the Groundsmaster 3280−D (diesel engine) is attached to the support bracket inside the right side frame near the fuel/water filter (Fig. 35).

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

DANGER

Because diesel fuel is highly flammable, use caution when handling it. Do not smoke while testing the fuel pump. Do not test fuel pump while engine is hot. Make sure that there is adequate ventilation when testing. Always wipe up any spilled fuel before starting the engine.

Fuel Pump Capacity Test

1. Park machine on a level surface, lower cutting deck (or implement), stop engine and engage parking brake.

2. Disconnect electrical connector from the engine fuel stop solenoid to prevent the engine from firing.

3. Disconnect fuel pump discharge hose from the water separator inlet fitting (Fig. 35).

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).

IMPORTANT: When testing the fuel pump, DO NOT turn ignition switch to START.

6. Collect fuel in the graduated cylinder by turning ignition switch ON. Allow pump to run for 30 seconds, then turn 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 if 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).

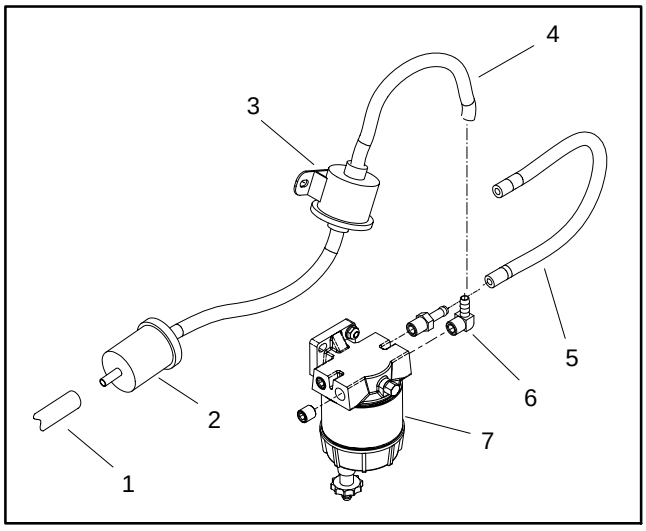

Figure 35

1. **Fuel hose (from tank)**
2. **Fuel filter**
3. **Fuel pump**
4. **Pump discharge hose**
5. **Fuel hose (to engine)**
6. **Inlet fitting**
7. **Water/fuel filter**

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

Fuel Pump (Groundsmaster 3320)

The fuel pump used on the Groundsmaster 3320 (gasoline engine) is attached to the support bracket inside the right side frame near the fuel filter (Fig. 36).

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

DANGER

Because gasoline is highly flammable, use caution when handling it. Do not smoke while testing the fuel pump. Do not test fuel pump while engine is hot. Make sure that there is adequate ventilation when testing. Always wipe up any spilled fuel before starting the engine.

Fuel Pump Capacity Test

1. Park machine on a level surface, lower cutting deck (or implement), stop engine and engage parking brake.

2. Disconnect fuel pump discharge hose from the carburetor inlet (Fig. 36).

3. Make sure fuel hoses attached to the fuel pump are free of obstructions.

4. Place disconnected pump discharge hose into a large, graduated cylinder sufficient enough to collect 1 quart (.95 liter).

IMPORTANT: When testing the fuel pump, DO NOT turn ignition switch to START.

5. Collect fuel in the graduated cylinder by turning ignition switch ON. Allow pump to run for 30 seconds, then release ignition switch to OFF.

6. The amount of fuel collected in the graduated cylinder should be approximately 13.5 fl oz (400 ml) after 30 seconds.

7. Replace fuel pump if necessary. Install fuel hose to carburetor inlet.

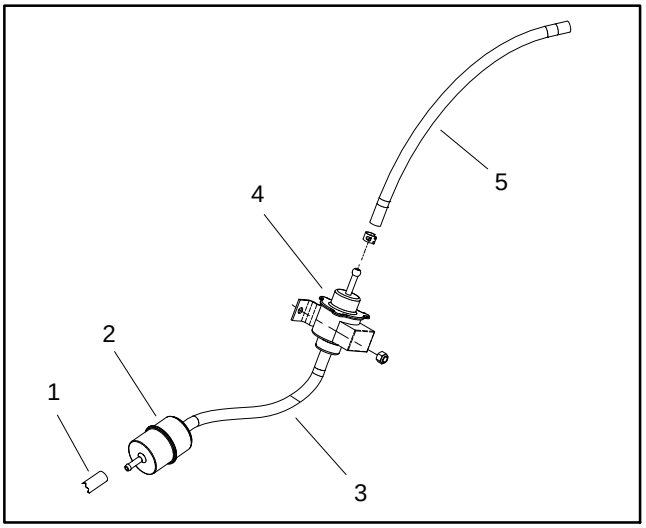

Figure 36

1. **Fuel hose (from tank)**
2. **Fuel filter**
3. **Fuel hose**
4. **Fuel pump**
5. **Fuel hose (to engine)**

Fuel Pump Specifications

Pump Capacity	27 fl oz/min (800 ml/min)
Pressure	2.8 − 4.3 psi (19.6 − 29.4 kPa)

Fuel Pump Relay (Groundsmaster 3320)

The Groundsmaster 3320 uses a relay to energize the fuel pump. The fuel pump relay is attached to the support bracket inside the right side frame near the fuel filter.

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. Locate relay and disconnect the machine wire harness connector from the relay.

2. Using a multimeter (ohms setting), measure coil resistance between terminals 85 and 86 (Fig. 37). Resistance should be between 70 and 90 ohms.

3. 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.

4. Disconnect voltage from terminal 85 and multimeter lead from terminal 87.

5. 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.

6. Disconnect voltage and multimeter leads from the relay terminals. Connect relay to machine wire harness.

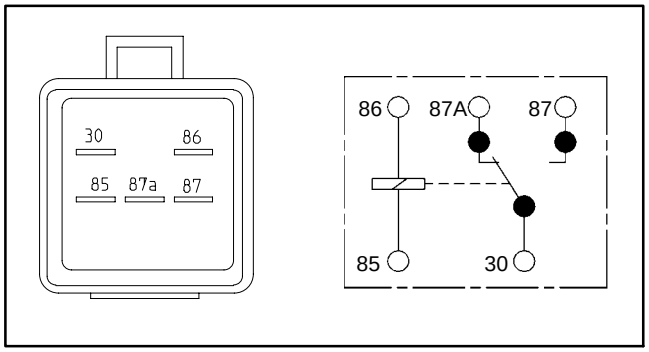

Figure 37

Service and Repairs

NOTE: See the Kubota Workshop Manual: 05 Series Engine (Groundsmaster 3280−D) or the Briggs & Stratton/Daihatsu Engine Repair Manual (Groundsmaster 3320) for additional component repair information.

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.

WARNING

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

IMPORTANT: Do not remove battery fill caps while cleaning.

2. Check battery condition weekly or after every 50 hours of operation. Keep terminals and entire battery case clean because a dirty battery will discharge slowly.

   A. Clean battery by washing entire case with a solution of baking soda and water. Rinse with clear water.

   B. Coat battery posts and cable connectors with Battery Terminal Protector (Toro Part No. 107−0392) or petroleum jelly to prevent corrosion.

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

WARNING

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

4. If corrosion occurs at terminals, disconnect cables. Always disconnect negative (−) cable first. Clean clamps and terminals separately. Reconnect cables with positive (+) cable first. Coat battery posts and cable connectors with Battery Terminal Protector (Toro Part No. 107−0392) or petroleum jelly to prevent corrosion.

5. Check electrolyte level every 25 operating hours, and every 30 days if machine is in storage.

6. Maintain cell level with distilled or demineralized water. Do not fill cells above the fill line.

Battery Service

The battery is the heart of the electrical system. With regular and proper service, battery life can be extended. Additionally, battery and electrical component failure can be prevented.

CAUTION

When working with batteries, use extreme caution to avoid splashing or spilling electrolyte. Electrolyte can destroy clothing and burn skin or eyes. Always wear safety goggles and a face shield when working with batteries.

Electrolyte Specific Gravity
Fully charged: 1.265 corrected to 80ºF (26.7ºC)
Discharged: less than 1.240

Battery Specifications
BCI Group Size 26
525 CCA at 0º F (−18º C)
Reserve Capacity of 80 minutes at 80ºF (27ºC)

Dimensions (including terminal posts)

Length	8.2 inches (20.8 cm)
Width	6.8 inches (17.3 cm)
Height	8.0 inches (20.3 cm)

Removal and Installation (Fig. 38)

1. Loosen and remove negative cable from battery. After negative cable is removed, loosen and remove positive cable.

2. Loosen cap screw that secures battery retainer.

3. Carefully remove battery from machine.

4. Install battery in reverse order making sure to connect and tighten positive cable to battery before connecting negative cable.

NOTE: Before connecting the negative (ground) cable to the battery, connect a digital multimeter (set to DC Amps) between the negative battery post and the negative (ground) cable connector. The reading should be less than 0.1 amp. If the reading is 0.1 amp or more, the machine's electrical system should be tested and repaired.

Inspection, Maintenance and Testing

1. Perform the following inspections and maintenance:

   A. Check for cracks. Replace battery if cracked or leaking.

   B. Check battery terminal posts for corrosion. Use wire brush to clean corrosion from posts.

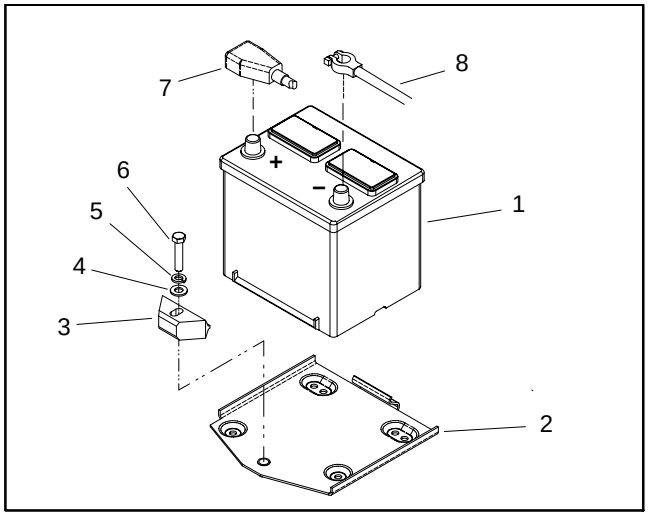

Figure 38

1. **Battery**
2. **Battery base**
3. **Retainer**
4. **Flat washer**
5. **Lock washer**
6. **Cap screw**
7. **Positive battery cable**
8. **Negative battery cable**

IMPORTANT: Before cleaning the battery, tape or block vent holes to the filler caps and make sure the caps are on tightly.

   C. Check for signs of wetness or leakage on the top of the battery which might indicate a loose or missing filler cap, overcharging, loose terminal post or overfilling. Also, check battery case for dirt and oil. Clean the battery with a solution of baking soda and water, then rinse it with clean water.

   D. Check that the cover seal is not broken away. Replace the battery if the seal is broken or leaking.

   E. Check the electrolyte level in each cell. If the level is below the tops of the plates in any cell, fill all cells with **distilled water** between the minimum and maximum fill lines. Charge at 15 to 25 amps for 15 minutes to allow sufficient mixing of the electrolyte.

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 10ºF (5.5ºC) above 80ºF (26.7ºC) add 0.004 to the specific gravity reading. For each 10ºF (5.5ºC) below 80ºF (26.7ºC) subtract 0.004 from the specific gravity reading.

Example: Cell Temperature	100ºF
Cell Gravity	1.245
100ºF minus 80ºF equals 20ºF	
(37.7ºC minus 26.7ºC equals 11.0ºC)	
20ºF multiply by 0.004/10ºF equals 0.008	
(11ºC multiply by 0.004/5.5ºC equals 0.008)	
ADD (conversion above)	0.008
Correction to 80ºF (26.7ºC)	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 load tester.

A. Check the voltage across the battery terminals prior to testing the battery. If the voltage is less than 12.4 VDC, recharge the battery.

B. If the battery has been charged, apply a 150 amp load for 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	70ºF (and up)	21.1ºC (and up)
9.5	60ºF	15.6ºC
9.4	50ºF	10.0ºC
9.3	40ºF	4.4ºC
9.1	30ºF	−1.1ºC
8.9	20ºF	−6.7ºC
8.7	10ºF	−12.2ºC
8.5	0ºF	−17.8ºC

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

CAUTION

Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 60^{o}F (15.5^{o} C) before connecting to a charger.

Charge the battery in a well−ventilated place to dissipate gases produced from charging. These gases are explosive; keep open flame and electrical spark away from the battery. Do not smoke. Nausea may result if the gases are inhaled. Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.

3. **Following the 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^{o}F (51.6^{o}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.

P.T.O. Electric Clutch

Removal (Figs. 39 and 40)

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

2. Unplug clutch connector from machine wire harness.

3. Remove P.T.O. belt from clutch and P.T.O. shaft pulley (see Traction Unit Operator's Manual).

4. Remove clutch stop components using Figure 39 (Groundsmaster 3280−D) or Figure 40 (Groundsmaster 3320) as a guide.

NOTE: Hold coupler on front of engine to prevent crankshaft from turning when removing cap screw that secures clutch to stub shaft.

5. Remove cap screw and spacer that secure clutch to stub shaft.

NOTE: It may be necessary to lower the rear frame and axle assembly to allow clutch removal (see Rear Frame and Axle Assembly Removal in the Service and Repairs section of Chapter 7 − Chassis).

6. Slide clutch from shaft. Locate and retrieve square key.

Installation (Figs. 39 and 40)

1. Apply antiseize lubricant to stub shaft.

2. Position square key in stub shaft. Slide clutch onto shaft making sure to engage clutch stop.

NOTE: Hold coupler on front of engine to prevent crankshaft from turning when installing cap screw that secures clutch to stub shaft.

3. Apply Loctite #242 (or equivalent) to threads of cap screw. Secure clutch to shaft with spacer and cap screw.

4. Install clutch stop components using Figure 39 (Groundsmaster 3280−D) or Figure 40 (Groundsmaster 3320) as a guide. Make sure that clutch stop is tight against clutch flange.

5. Check alignment between clutch pulley and P.T.O. shaft pulley (see Align P.T.O. Pulley to Electric Clutch Pulley in Service and Repairs section of Chapter 9 − P.T.O. System).

6. Install P.T.O. belt to clutch and P.T.O. shaft pulley and adjust P.T.O. belt tension (see Traction Unit Operator's Manual).

7. Connect clutch to machine wire harness.

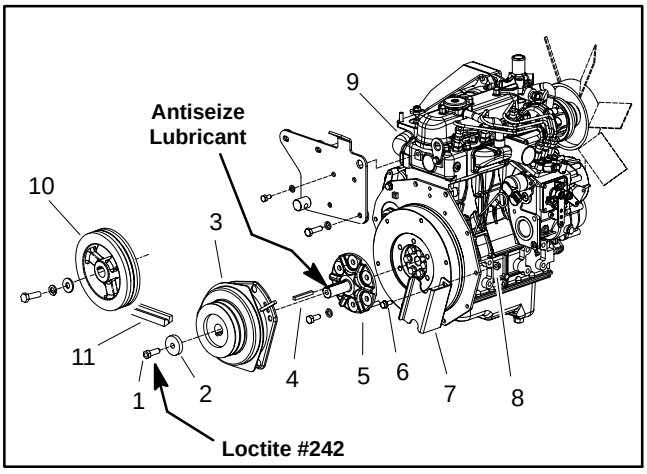

Figure 39

1. **Cap screw**
2. **Spacer**
3. **Electric clutch**
4. **Square key**
5. **Stub shaft**
6. **Flange head screw**
7. **Clutch stop**
8. **Flange nut**
9. **Diesel engine**
10. **PTO pulley**
11. **PTO belt**

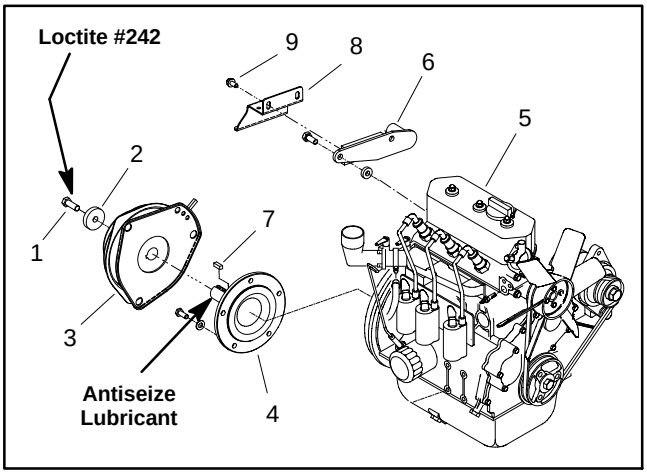

Figure 40

1. **Cap screw**
2. **Spacer**
3. **Electric clutch**
4. **Stub shaft**
5. **Gasoline engine**
6. **Mounting bracket**
7. **Square key**
8. **Clutch stop**
9. **Flange head screw**

Chapter 7

Chassis

Table of Contents

Specifications

Item	Description
Front Tire Pressure (23 x 9.50 − 12, 4 ply, tubeless)	20 PSI (1.38 bar)
Rear Tire Pressure (2 Wheel Drive Machines) (16 x 6.50 − 8, 4 ply, tubeless)	20 PSI (1.38 bar)
Rear Tire Pressure (4 Wheel Drive Machines) (18 x 6.50−8, 4 ply, tubeless)	20 PSI (1.38 bar)
Front Wheel Lug Nut Torque	75 to 80 ft−lb (102 to 108 N−m)
Rear Wheel Lug Nut Torque (2 Wheel Drive Machines)	75 to 80 ft−lb (102 to 108 N−m)
Rear Wheel Lug Nut Torque (4 Wheel Drive Machines)	70 to 90 ft−lb (95 to 122 N−m)

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Wheels

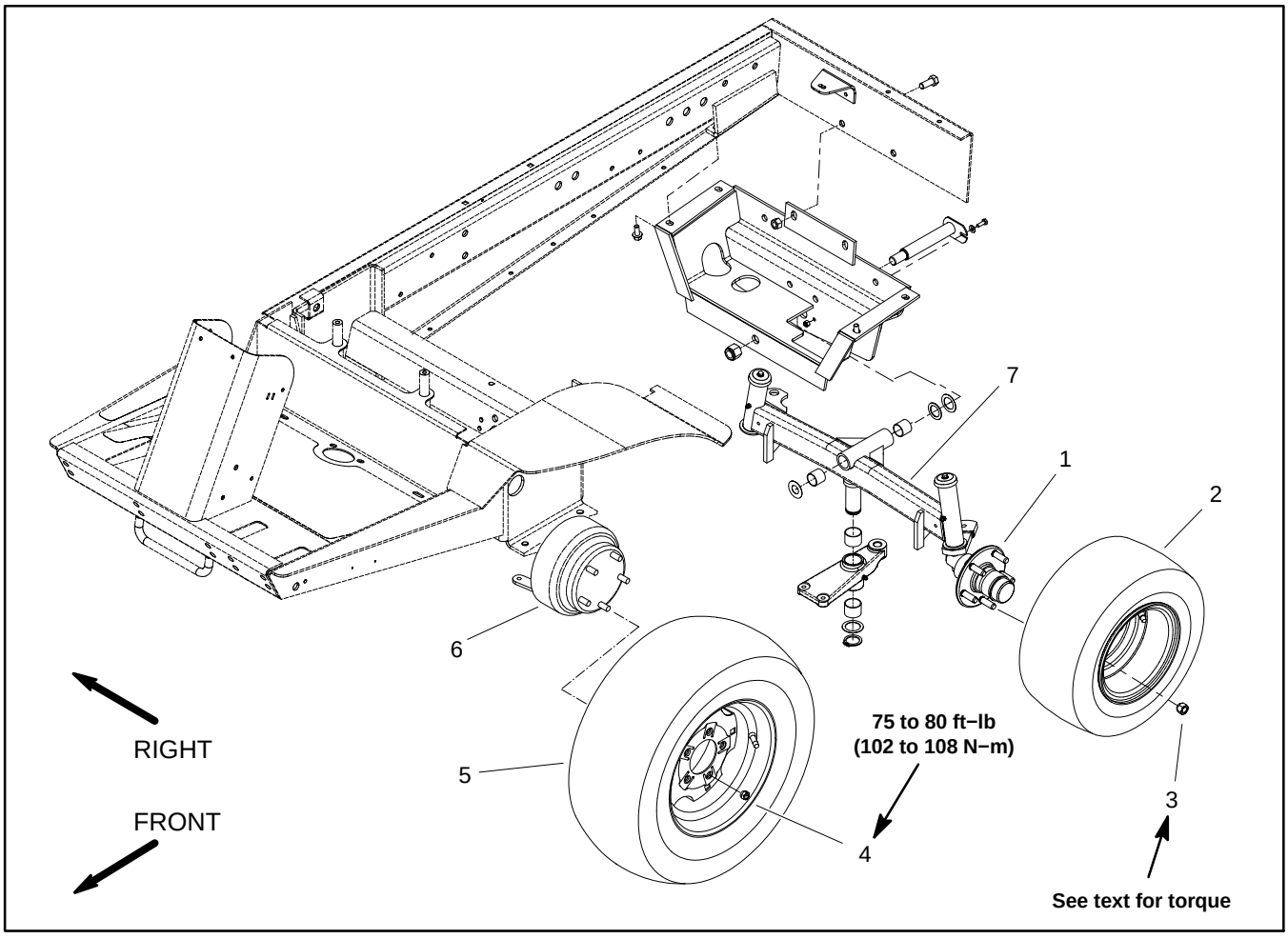

Figure 1

1. **Rear wheel hub**
2. **Rear wheel assembly**
3. **Rear wheel lug nut (5 per wheel)**
4. **Front wheel lug nut (5 per wheel)**
5. **Front wheel assembly**
6. **Front axle**
7. **Rear axle (2WD shown)**

Removal (Fig. 1)

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

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.

2. Chock wheels to prevent machine from shifting. Using a jack or hoist, raise machine so wheel is off ground. Support machine with jack stands or wooden blocking (see Jacking Instructions in Chapter 1 − Safety).

3. Remove lug nuts and remove wheel.

Installation (Fig. 1)

1. Install wheel and secure with five (5) lug nuts.

2. Tighten lug nuts evenly in a crossing pattern to the following torque specifications:

   A. Torque front lug nuts from 75 to 80 ft−lb (102 to 108 N−m).

   B. Torque rear lug nuts on 2 wheel drive machines from 75 to 80 ft−lb (102 to 108 N−m).

   C. Torque rear lug nuts on 4 wheel drive machines from 70 to 90 ft−lb (95 to 122 N−m).

3. Lower machine to ground.

Steering Tower Assembly

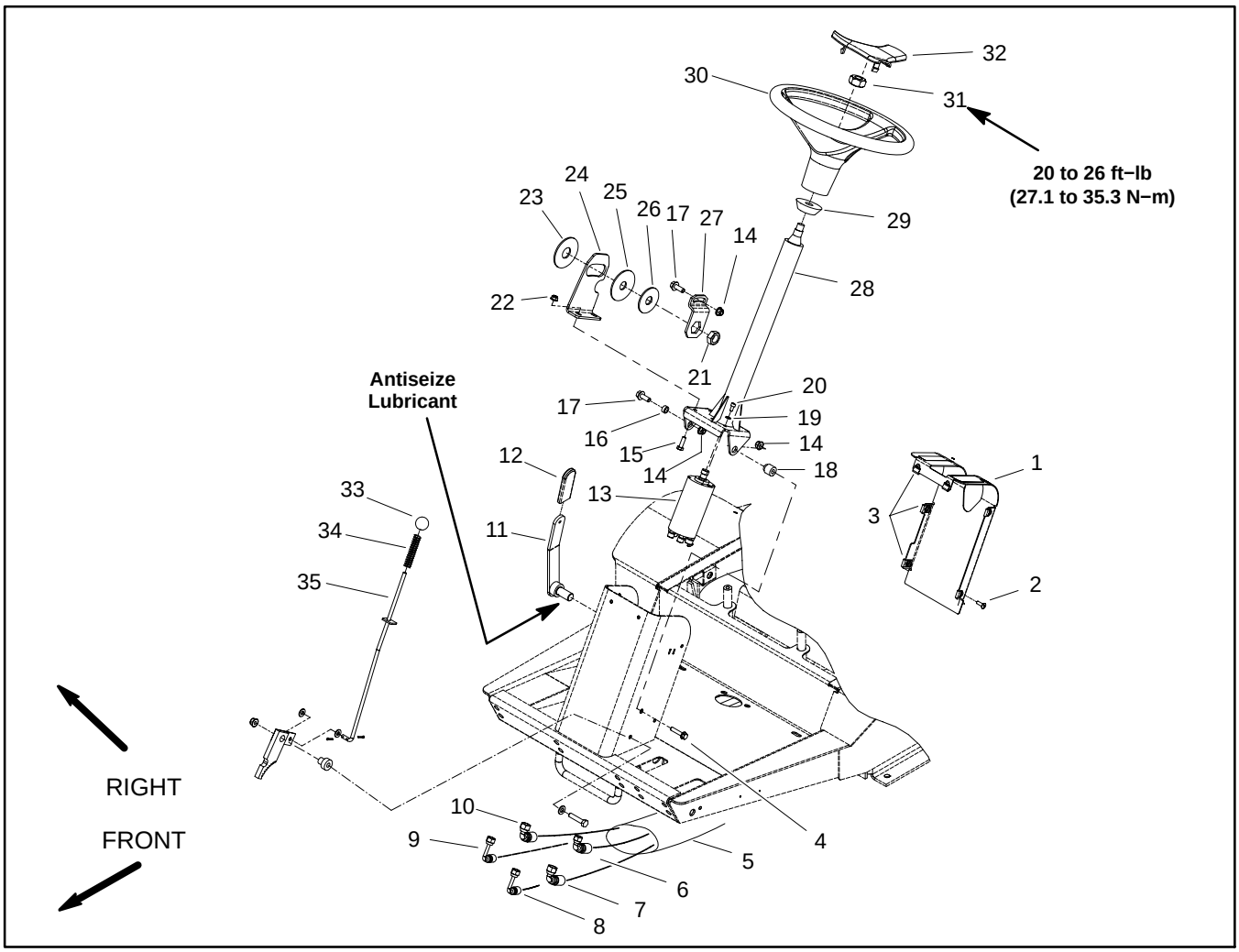

Figure 2

1. Tower panel
2. Phillips head screw (6 used)
3. Nut retainer (6 used)
4. Flange head screw
5. Sleeve protector
6. Hydraulic hose
7. Hydraulic hose
8. Hydraulic hose
9. Hydraulic hose
10. Hydraulic hose
11. Tilt steering lever
12. Grip
13. Steering control valve
14. Flange nut
15. Cap screw (2 used)
16. Spacer
17. Flange head screw
18. Spacer
19. Spring washer (4 used)
20. Socket head screw (4 used)
21. Jam nut
22. Flange nut (2 used)
23. Friction disc
24. Pivot plate
25. Friction disc
26. Flat washer
27. Tilt bracket
28. Steering column
29. Foam collar
30. Steering wheel
31. Hex nut
32. Steering wheel cover
33. Knob
34. Compression spring
35. Parking brake rod

Removal (Fig. 2)

1. Park the machine on a level surface, engage the parking brake, lower the cutting deck (or implement) and stop the engine. Remove the key from the ignition switch.

2. Carefully remove steering wheel cover from steering wheel.

3. Remove hex nut that secures steering wheel to steering column.

4. Pull steering wheel and foam collar from steering column.

5. Remove knob from end of parking brake rod.

6. Remove six (6) phillips head screws that secure tower panel to machine. Remove tower panel.

7. Remove flange head screw (item 17) and flange nut (item 14) that secure tilt bracket (item 27) to steering tower. Slide tilt bracket off jam nut.

8. Loosen and remove jam nut (item 21). Remove tilt steering lever from steering tower. Locate and retrieve friction washers (items 23 and 25) and flat washer (item 26).

9. Loosen and remove four (4) socket head screws (item 20) and spring washers (item 19) that secure steering control valve to steering column.

10. Loosen and remove flange screws (items 4 and 17) and flange nuts (item 14) that attach steering column to frame.

11. Slide steering column from steering control valve and remove from machine. Locate and retrieve two (2) spacers (items 16 and 18).

12. If necessary, remove two (2) cap screws (item 15) and flange nuts (item 22) that secure pivot plate (item 27) to steering column.

Installation (Fig. 2)

1. If removed, secure pivot plate (item 27) to steering column with two (2) cap screws (item 15) and flange nuts (item 22).

2. Slide steering column onto steering control valve. Position spacers (items 16 and 18) to steering column.

3. Attach steering column to frame with flange screws (items 4 and 17) and flange nuts (item 14).

4. Secure steering column to steering control valve with four (4) socket head screws (item 20) and spring washers (item 19).

5. Apply antiseize lubricant onto threads and rod of tilt steering lever (item 11). Position friction washer (item 23) between steering tower and pivot plate (item 24). Install tilt lever through steering tower boss, friction washer and pivot plate. Place friction washer (item 25) and flat washer (item 26) onto lever and thread jam nut (item 21) onto lever.

6. Torque jam nut from 20 to 23 ft−lb (27.1 to 31.2 N−m) so lever handle is secured in the up position ($90^o \pm 10^o$ from horizontal).

7. Position tilt bracket (item 27) onto jam nut and secure to steering tower with flange head screw (item 17) and flange nut (item 14).

8. Position tower panel to machine and secure with six (6) phillips head screws.

9. Install knob on end of parking brake rod.

10. Slide foam collar onto steering column.

11. Slide steering wheel onto steering column and secure with hex nut. Torque hex nut from 20 to 26 ft−lb (27.1 to 35.3 N−m).

12. Install steering wheel cover onto steering wheel.

Rear Frame and Axle Assembly

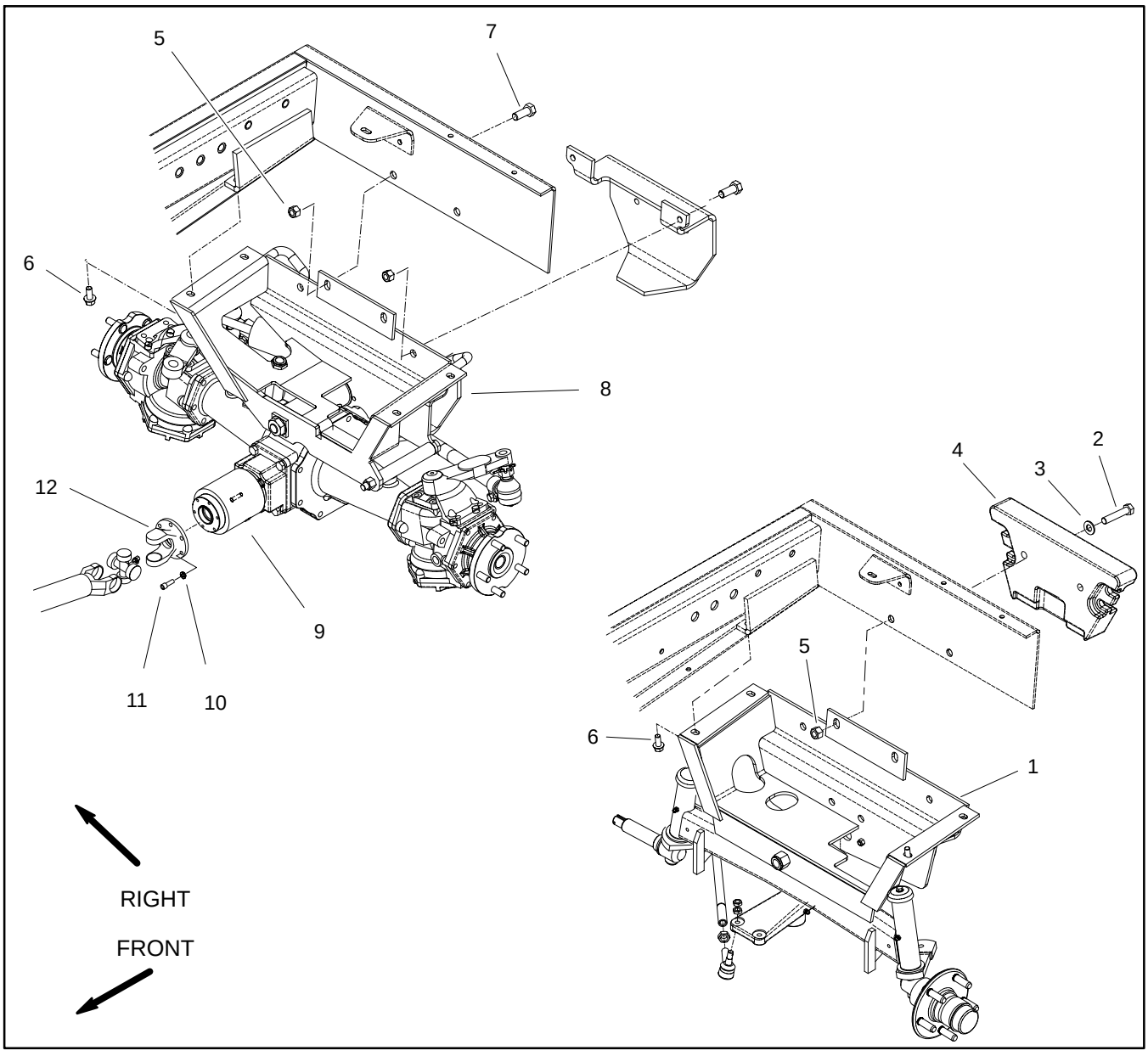

Figure 3

1. **Rear frame & axle assembly (2WD)**
2. **Cap screw (2 used)**
3. **Flat washer (2 used if equipped)**
4. **Rear weight (if equipped)**
5. **Lock nut (2 used)**
6. **Flange head screw (4 used)**
7. **Cap screw (2 used)**
8. **Rear frame & axle assembly (4WD)**
9. **Bidirectional clutch**
10. **Lock washer (6 used)**
11. **Socket head screw (6 used)**
12. **Drive shaft yoke**

Removal (Fig. 3)

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

2. Block front tires to prevent the machine from moving.

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

3. Disconnect the hydraulic hoses from the steering cylinder. Put caps or plugs on all fittings and hoses to prevent contamination.

4. On 4 wheel drive machines, remove six (6) socket head screws and lock washers that secure drive shaft to bidirectional clutch. Position drive shaft away from bidirectional clutch.

5. If machine has rear weight(s) attached to frame, remove weight(s).

6. Remove two (2) cap screws and lock nuts that secure rear of axle frame to machine frame.

7. Jack up the rear of the machine so that the tires are just off the ground. Support rear of machine frame with jack stands or appropriate blocking.

8. Remove four (4) flange head screws (item 6) that secure rear frame and axle assembly to machine frame.

9. Carefully move rear frame and axle assembly from machine.

Installation (Fig. 3)

1. Carefully position rear frame and axle assembly to machine frame.

NOTE: The flange head screws (item 6) used to secure the rear frame and axle assembly to the machine frame have a patch lock to prevent the screws from loosening. When installing rear frame and axle to machine, either replace flange head screws (item 6) or clean screw threads and apply Loctite #242 (or equivalent) to threads of screws.

2. Align mounting holes in rear frame and axle assembly. Install and tighten four (4) flange head screws (item 6) to secure rear frame and axle assembly. While tightening screws, make sure that mounting holes on the rear of the frame align with the axle frame holes.

3. Secure rear of axle frame to machine frame with two (2) cap screws and lock nuts.

4. If equipped with rear weight(s), attach weight(s) to rear of machine.

5. On 4 wheel drive machines, position drive shaft to bidirectional clutch. Secure drive shaft to bidirectional clutch with six (6) socket head screws and lock washers.

6. Remove all caps and plugs from hydraulic fittings and hoses. Correctly connect hydraulic hoses to the steering cylinder.

7. Lower machine to the ground.

8. Check hydraulic fluid level in reservoir (front axle) and adjust as required (see Traction Unit Operator's Manual).

9. Start engine and check for component interference as steering wheel is turned from lock to lock.

10. Check rear wheel toe−in and adjust if necessary (see Traction Unit Operator's Manual).

Rear Axle (2 Wheel Drive)

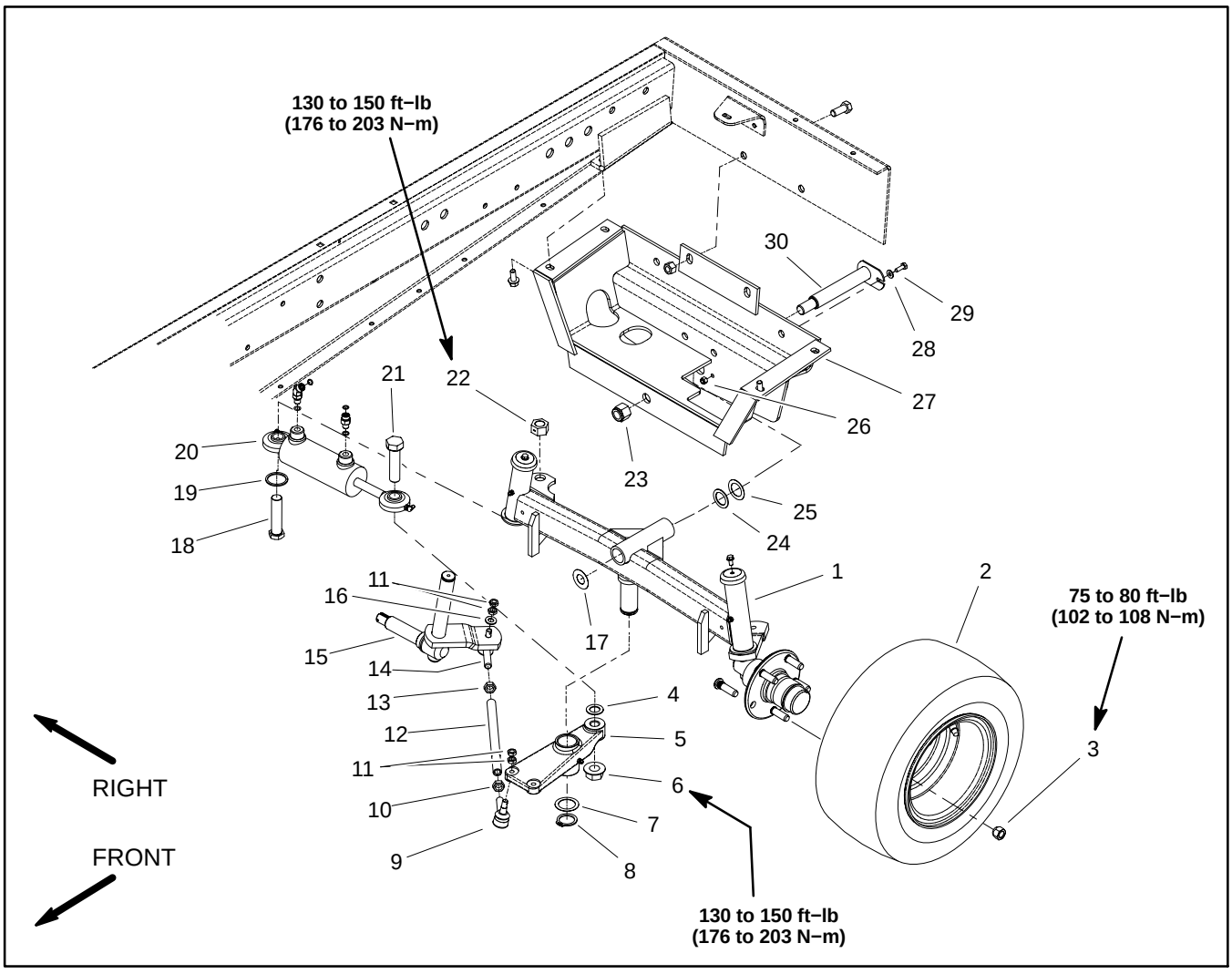

Figure 4

1. Rear axle
2. Rear wheel assembly
3. Lug nut (5 used per wheel)
4. Washer
5. Steering pivot
6. Lock nut
7. Thrust washer
8. Retaining ring
9. Ball joint (LH thread)
10. Jam nut (LH thread)
11. Jam nut
12. Tie rod
13. Jam nut (RH thread)
14. Ball joint (RH thread)
15. Spindle (RH shown)
16. Flat washer
17. Thrust washer (.766” ID)
18. Cap screw
19. Spacer
20. Steering cylinder
21. Cap screw
22. Lock nut
23. Lock nut
24. Thrust washer (1.030” ID)
25. Shim washer (1.060” ID)
26. Lock nut
27. Rear frame
28. Flat washer
29. Cap screw
30. Pivot pin

NOTE: For repair information regarding the rear axle on 4 wheel drive machines, refer to Chapter 8 − Drive Axles.

Removal (Fig. 4)

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

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

2. Disconnect the hydraulic hoses from the steering cylinder. Put caps or plugs on all fittings and hoses to prevent contamination.

3. Remove the lock nut (item 23) that secures the end of the axle pivot pin (item 29) to the rear frame.

4. Jack up the machine (just ahead of the rear wheels) until pressure is taken off the axle pivot pin. Support the machine with jack stands to prevent it from falling.

5. Remove lock nut (item 26), cap screw (item 28) and flat washer (item 27) that secure pivot pin to rear frame.

NOTE: Several washers (items 17, 24 and 25) are installed between the axle pivot tube and rear frame to adjust clearance between axle pivot tube and rear frame. Before removing axle pivot pin, note location of washers.

6. Pull the axle pivot pin out. This will release the rear axle and washer(s) from the frame. Carefully pull the entire axle and wheel assembly out from under the machine.

7. Locate and retrieve thrust washers (items 17 and 24) and shim washer(s) (item 25).

Installation (Fig. 4)

1. Thoroughly clean the rear axle pivot pin. Inspect the pin for wear or damage and replace if necessary.

2. Position the axle to the rear frame. Install small ID thrust washer (item 17) in front of axle tube and large ID thrust washer (item 24) directly behind axle tube. Place shim washer(s) (item 25) as required between large ID thrust washer and rear frame to allow .030” to .090” (.8 to 2.3 mm) axle tube end play. Slide pivot pin through rear frame, washers and axle.

3. Secure pivot pin to rear frame with cap screw (item 28), flat washer (item 27) and lock nut (item 26).

4. Tighten lock nut (item 23) until shoulder of pivot pin bottoms against the rear frame. Make sure that axle can still pivot freely after lock nut is tightened.

5. Remove the jackstands and lower the machine to the ground.

6. Install the hydraulic hoses to the steering cylinder.

7. Check oil level in hydraulic reservoir (front axle) (see Traction Unit Operator’s Manual).

8. Lubricate the rear axle pivot bushings through the grease fitting on the axle pivot tube (see Traction Unit Operator’s Manual).

9. Operate machine and check steering cylinder hydraulic connections for leaks.

Rear Axle Service (2 Wheel Drive)

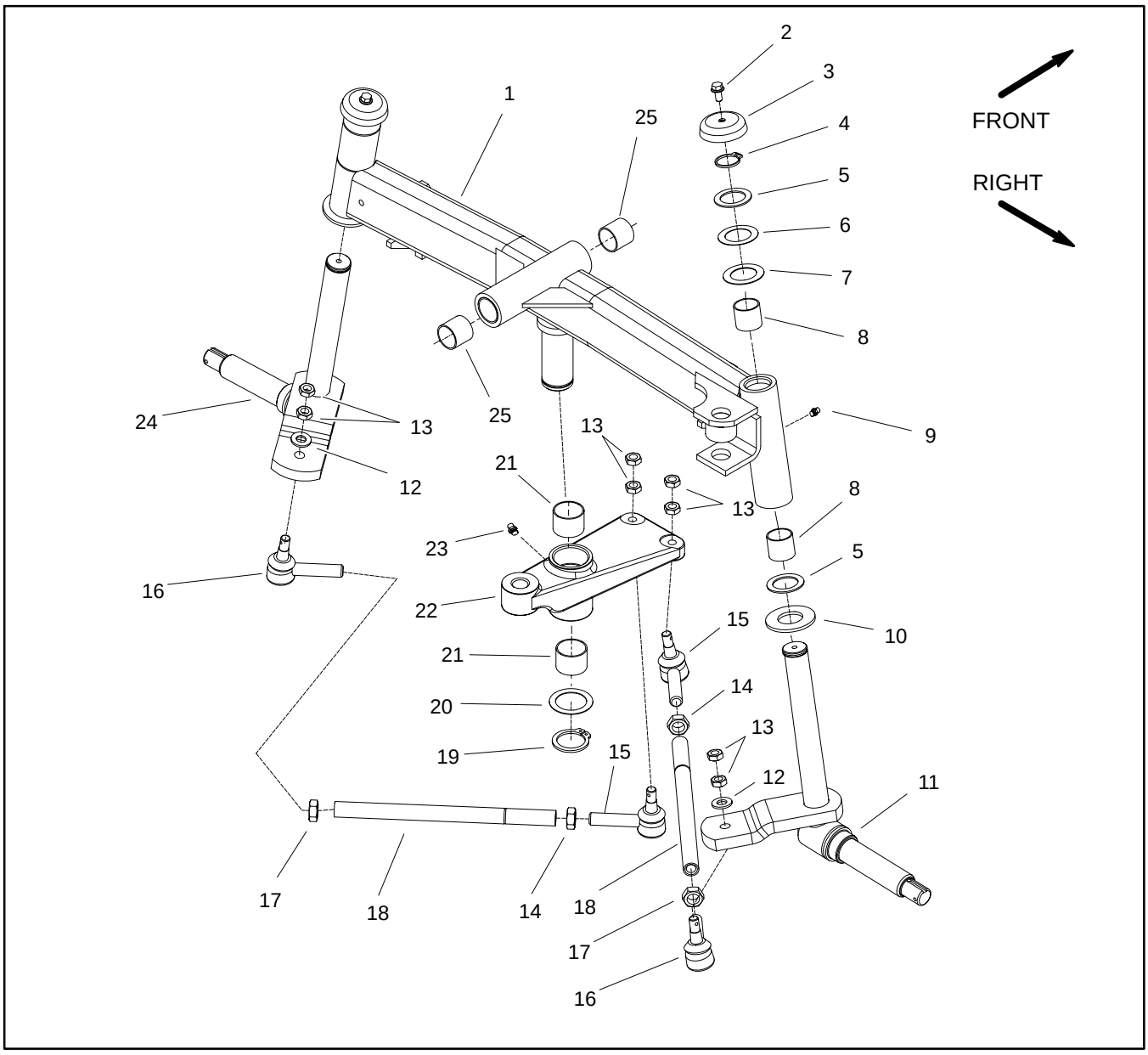

Figure 5

1. **Rear axle**
2. **Flange head screw**
3. **Spindle cap**
4. **Retaining ring**
5. **Thrust washer (.060” thick)**
6. **Flat washer (.018” thick)**
7. **Flat washer (.032” thick)**
8. **Spindle bushing**
9. **Grease fitting (3 used)**
10. **Thrust washer**
11. **RH spindle**
12. **Flat washer**
13. **Jam nut**
14. **Jam nut (LH thread)**
15. **Ball joint (LH thread)**
16. **Ball joint**
17. **Jam nut**
18. **Tie rod**
19. **Retaining ring**
20. **Thrust washer**
21. **Steering pivot bushing**
22. **Steering pivot plate**
23. **Grease fitting**
24. **LH spindle**
25. **Axle pivot bushing**

NOTE: For repair information regarding the rear axle on 4 wheel drive machines, refer to Chapter 8 − Drive Axles.

Axle Pivot Bushings (Fig. 5)

The rear axle must be held in place snugly by the axle pivot pin. Excessive movement of the axle, which is characterized by erratic steering, can indicate worn axle pivot bushings. To correct the problem, replace the axle pivot bushings (item 25).

1. Remove rear axle from machine (see Rear Axle Removal in this section).

2. Use a drift punch and hammer to drive both axle pivot bushings out of the axle pivot tube. Clean the inside of the tube to remove dirt and foreign material.

3. Apply grease to the inside and outside of the new bushings. Use an arbor press to install the bushings into the front and back of the axle pivot tube. Bushings must be flush with the axle tube.

4. Install rear axle to machine (see Rear Axle Installation in this section).

Steering Pivot Bushings (Fig. 5)

The steering pivot must fit snugly onto the mounting pin. Excessive movement of the steering pivot may indicate worn steering pivot bushings (item 21) or tie rod ball joints (items 14 and 15).

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

2. Remove the lock nut, cap screw and thrust washer that secure the steering cylinder rod end to the steering pivot plate (Fig. 6).

3. Remove four (4) jam nuts to allow both tie rod ends to be disconnected from the pivot plate. Inspect all tie rod end ball joints for wear or damage and replace as necessary.

4. Remove the retaining ring and thrust washer that secure steering pivot (item 22) to rear axle. Slide the steering pivot off of the mounting pin on the bottom of the axle.

5. Use a drift punch and hammer to drive both steering pivot bushings out of the steering pivot. Clean the inside of the steering pivot to remove dirt and foreign material. Also clean the mounting pin on the bottom of the rear axle.

6. Apply grease to the inside and outside of the new bushings. Use an arbor press to install the bushings into the top and bottom of the steering pivot. Bushings must be flush with the pivot plate.

7. Slide the steering pivot onto the axle mounting pin. Secure the pivot in place with the thrust washer and retaining ring.

8. Connect each tie rod end to the pivot with two (2) jam nuts. For each tie rod, tighten the first jam nut and then tighten the second jam nut against the first to secure tie rod end.

9. Install the thrust washer, cap screw and lock nut to secure the steering cylinder rod end to the steering pivot plate. Torque the nut from 130 to 150 ft-lb (176 to 203 N−m).

10. Lubricate the bushings through the grease fitting on the steering pivot plate.

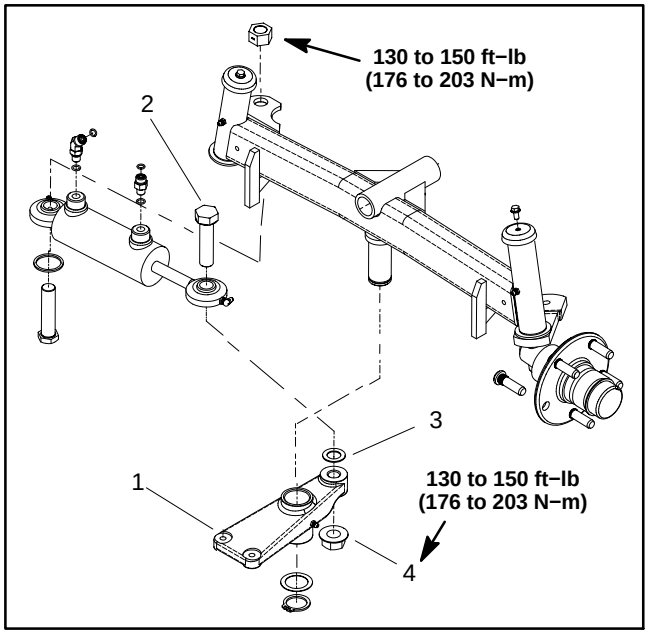

Figure 6

1. **Steering pivot plate**
2. **Cap screw**
3. **Thrust washer**
4. **Lock nut**

Rear Axle Spindle Bushings (Fig. 5)

The rear wheel spindles must fit snugly in the rear axle. Excessive movement of the spindle in the axle indicates that the spindle bushings (item 8) are probably worn and must be replaced.

1. Remove rear axle from machine (see Rear Axle Removal in this section).

2. Remove two (2) jam nuts and flat washer that secure the tie rod end to the spindle arm. Disconnect the tie rod end from the spindle arm.

3. Remove the flange screw, spindle cap, retaining ring and washers that secure the wheel spindle into the axle tube. Slide the spindle, washers and wheel assembly out of the axle tube to expose the spindle bushings.

4. Use a punch and hammer to drive both bushings out of the axle tube. Take care not to damage the inside of the axle tube. Clean the inside of the axle tube to remove any dirt or foreign material.

5. Apply grease to the inside and outside of the new bushings. Use an arbor press to install the bushings into the top and bottom of the axle tube. The bushings must be flush with the axle tube.

6. Thoroughly clean the spindle shaft. Inspect the spindle for wear and replace if worn or damaged.

7. Install two thrust washers (items 10 and 5) onto the spindle shaft and slide the shaft up through the axle tube. Hold the wheel and spindle shaft assembly in place and install the flat washer(s) (items 7 and 6), thrust washer (item 5) and retaining ring (item 4) onto the end of the spindle shaft.

8. End play of spindle should be .030” to .090” (.8 to 2.3 mm) after assembly. If necessary, adjust end play by adding or removing flat washers (items 6 and 7).

9. Install the spindle cap and cap screw.

10. Connect the tie rod end to the spindle bracket with flat washer and two (2) jam nuts. Tighten the first jam nut and then tighten the second jam nut against the first to secure tie rod end to spindle.

11. Install rear axle to machine (see Rear Axle Installation in this section).

12. Lubricate the steering spindles through the grease fittings on the rear axle (see Traction Unit Operator’s Manual).

13. Check rear wheel toe−in (see Traction Unit Operator’s Manual).

14. After all adjustments have been made, make sure that no contact is made between any steering components as the wheels are moved from lock to lock. Readjust if necessary.

Rear Wheel Bearings (2 Wheel Drive)

NOTE: For repair information regarding the rear axle on 4 wheel drive machines, refer to Chapter 8 − Drive Axles.

Disassembly (Fig. 7)

1. Jack up the rear of the machine until the tire is off the floor. Support the machine with jack stands or blocks to prevent it from falling.

2. Remove the rear wheel (see Wheels in this section).

3. Remove the dust cap from the wheel hub.

4. Remove the cotter pin, retainer, jam nut and tab washer. Slide the wheel hub from the spindle shaft.

5. Pull the seal out of the wheel hub. Discard seal.

6. Remove the bearing cones from both sides of the wheel hub. Clean the bearings in solvent. Make sure the bearings are in good operating condition. Clean the inside of the wheel hub. Check the bearing cups for wear, pitting or other noticeable damage. Replace worn or damaged parts.

Assembly (Fig. 7)

1. If bearing cups were removed from the wheel hub, press them into the hub until they seat against the shoulder of the hub.

IMPORTANT: The seal must be pressed in so it is flush with the end of the wheel hub. The lip of the seal must be toward the bearing.

2. Pack both bearings with grease. Install one bearing into the cup on inboard side of the wheel hub. Lubricate the inside of the new seal and press it into the wheel hub.

3. Pack inside of wheel hub with some grease (not full). Position remaining bearing into the outer bearing cup.

4. Slide the wheel hub assembly onto the spindle shaft and secure it in place with the tab washer and jam nut. DO NOT tighten the nut or install the cotter pin.

5. Rotate the wheel hub by hand and tighten the jam nut from 75 to 100 in-lb (8.5 to 11.3 N−m) to set the bearings. Then, loosen the nut until the hub has endplay.

6. Rotate the wheel hub by hand and tighten the jam nut from 15 to 20 in-lb (1.7 to 2.3 N−m). After final tightening, make sure that the wheel hub does not have any free play.

7. Install retainer with slot aligned to cotter pin hole in spindle. Install cotter pin.

8. Install dust cap.

9. Install rear wheel (see Wheels in this section).

10. Remove jack stands or blocks and lower machine to floor.

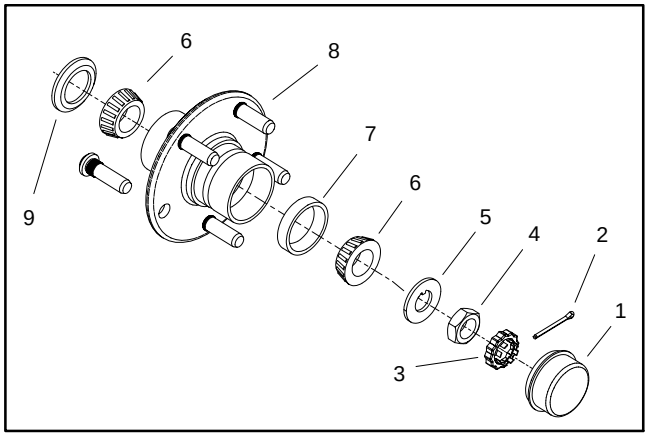

Figure 7

1. **Dust cap**
2. **Cotter pin**
3. **Retainer**
4. **Jam nut**
5. **Tab washer**
6. **Bearing cone**
7. **Bearing cup (2 used)**
8. **Wheel hub**
9. **Seal**

Operator Seat

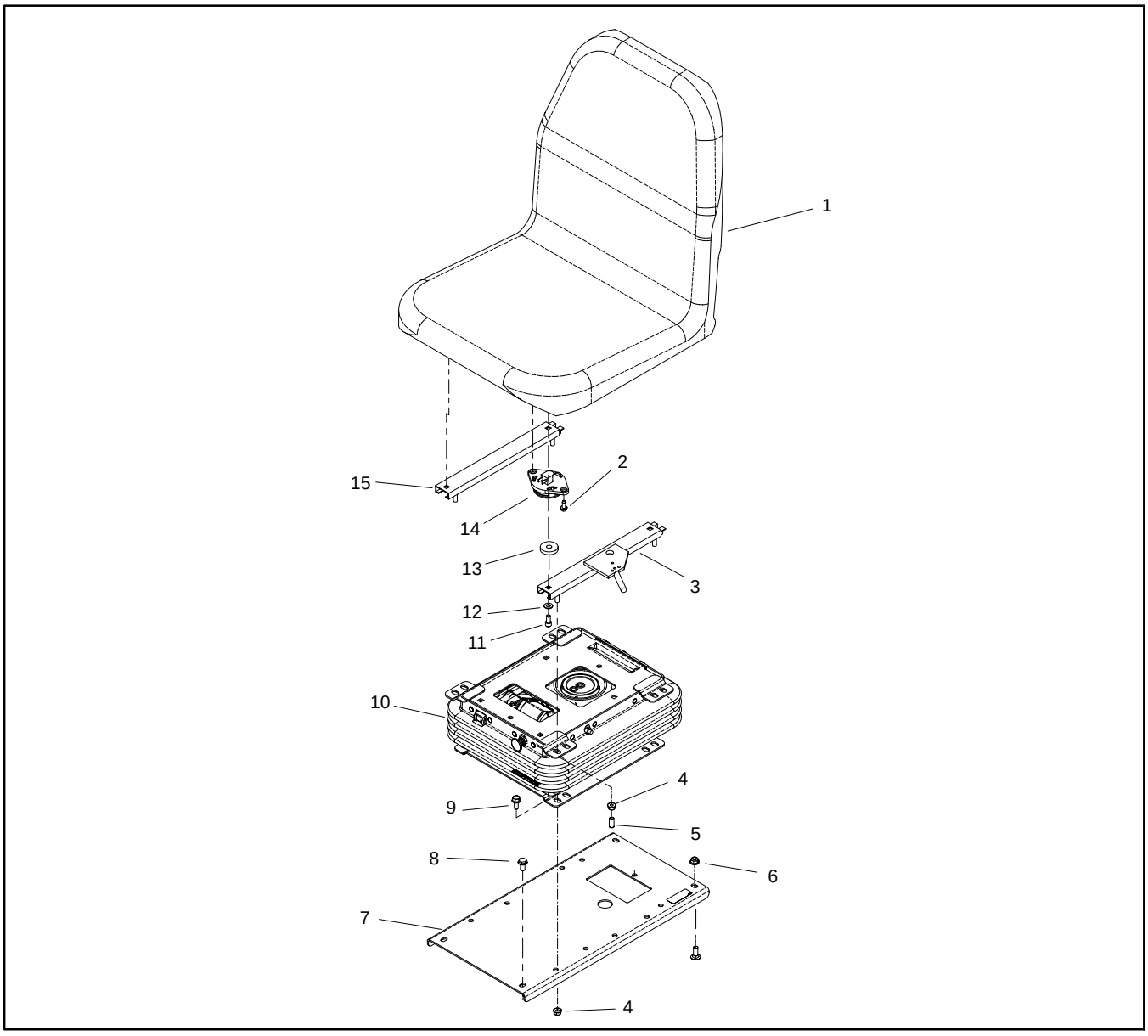

Figure 8

1. **Seat**
2. **Washer head screw (2 used)**
3. **Seat adjuster with latch**
4. **Flange nut (4 used)**
5. **Cap (4 used)**
6. **Flange nut (2 used)**
7. **Seat Base**
8. **Flange head screw (2 used)**
9. **Screw (4 used)**
10. **Seat suspension**
11. **Socket head screw (4 used)**
12. **Flat washer (4 used)**
13. **Spacer (2 used) (pneumatic seat)**
14. **Seat switch**
15. **Seat adjuster**

Removal (Fig. 8)

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

2. Disconnect electrical connector from the seat switch. On pneumatic seat suspension systems, disconnect electrical connector from the suspension.

3. Remove two (2) flange head screws (item 8) and two (2) flange nuts (item 6) that secure seat base to machine.

4. Remove seat and seat base from machine.

5. Remove seat components as necessary using Figure 8 as a guide.

Installation (Fig. 8)

1. Install seat components using Figure 8 as a guide.

2. Position seat and seat base to machine.

3. Secure seat base to machine with two (2) flange head screws (item 8) and two (2) flange nuts (item 6).

4. Connect electrical connector to the seat switch. On pneumatic seat suspension systems, connect electrical connector to the suspension.

Mechanical Seat Suspension

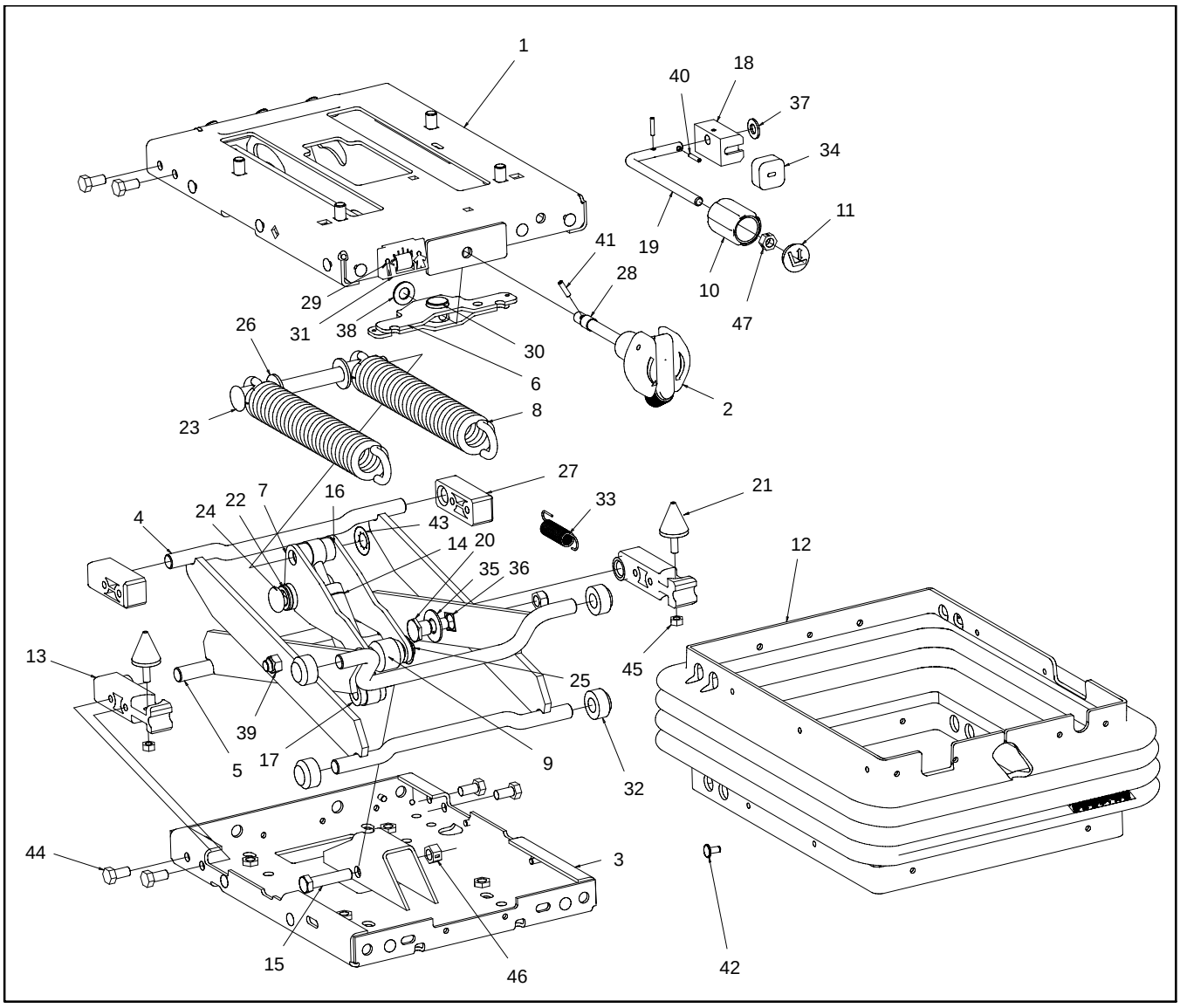

Figure 9

1. Upper housing
2. Weight adjust knob
3. Lower housing
4. Outer scissor arm
5. Inner scissor arm
6. Weight adjust
7. Drive arm
8. Extension spring (2 used)
9. Roller guide
10. Weight adjust knob
11. Cap
12. Suspension boot
13. Pivot block (2 used)
14. Damper
15. Lower shock bolt
16. Upper shock bushing (2 used)
17. Lower shock bushing (2 used)
18. Stop bumper
19. Height adjust rod
20. Cross pivot bolt (2 used)
21. Stop bumper (2 used)
22. Bearing tube (2 used)
23. Spring shaft
24. Pivot pin
25. Roller pin
26. Spring bushing (2 used)
27. Shaft block (2 used)
28. Weight adjust spacer
29. Weight adjust tape
30. Weight adjust nut
31. Weight tape guide
32. Roller (4 used)
33. Extension spring
34. Bumper
35. Spacer washer (2 used)
36. Cross pivot bearing (2 used)
37. Flat washer
38. Flat washer
39. Lock nut (2 used)
40. Roll pin (2 used)
41. Roll pin
42. Clip (20 used)
43. Retainer (3 used)
44. Thread forming screw (8 used)
45. Hex nut (2 used)
46. Lock nut
47. Lock nut

Removal (Fig. 9)

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

2. Remove seat and seat suspension from machine (see Operator Seat in this section).

3. Remove mechanical seat suspension components as needed using Figures 9 and 10 as guides.

Installation (Fig. 9)

1. Install mechanical seat suspension components using Figure 9 and 10 as guides.

2. Install seat and seat suspension to machine (see Operator Seat in this section). Make sure to connect electrical connector to the seat switch.

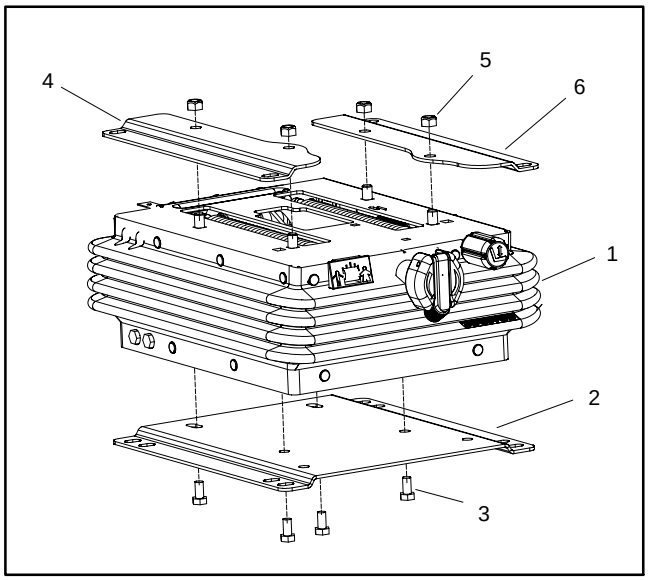

Figure 10

1. Suspension assembly
2. Mounting bracket
3. Cap screw (4 used)
4. RH slide bracket
5. Lock nut (4 used)
6. LH slide bracket

Pneumatic Seat Suspension

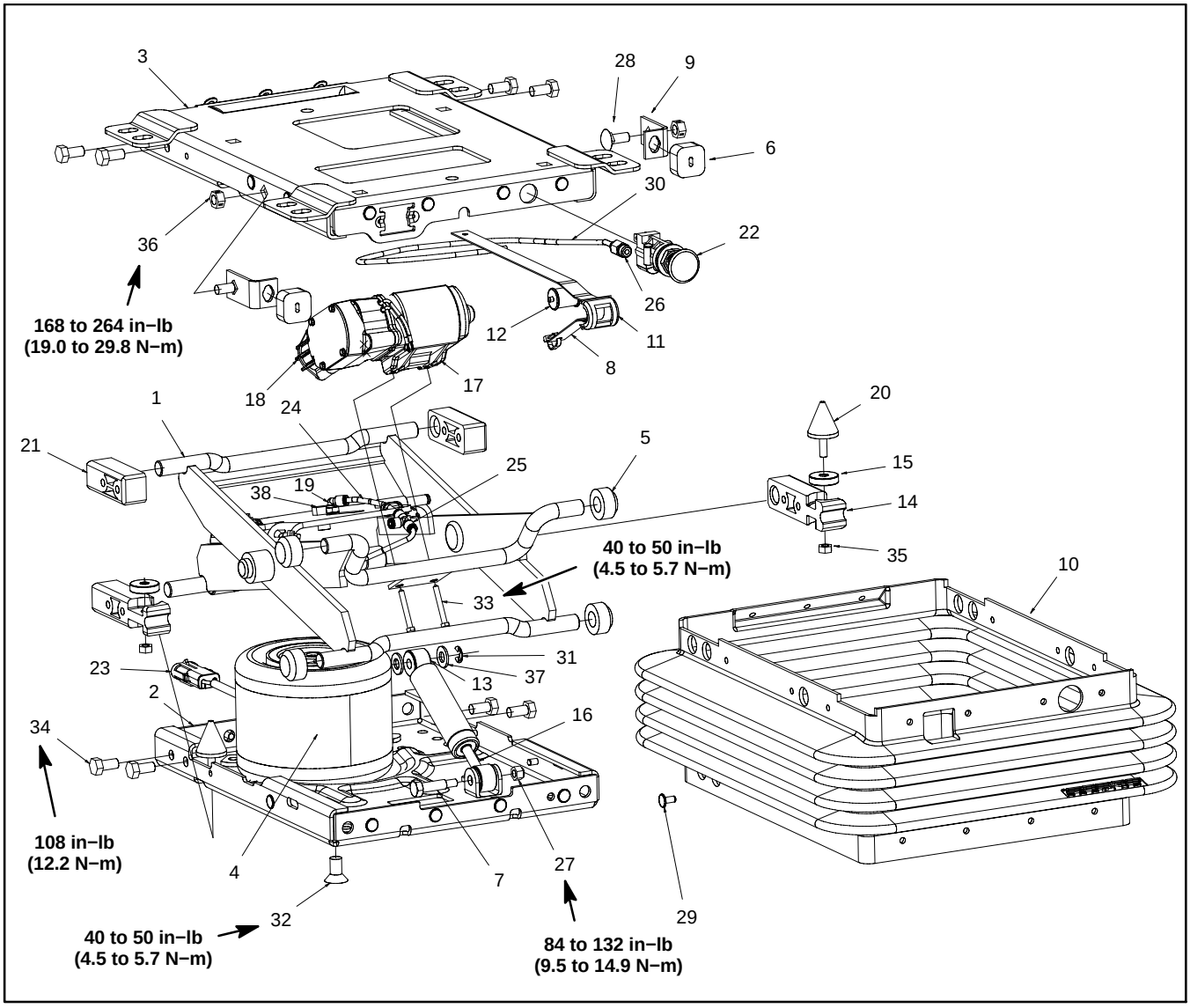

Figure 11

1. Scissor assembly
2. Lower housing
3. Upper housing
4. Air spring
5. Roller (4 used)
6. Bumper (2 used)
7. Shock mount bolt
8. Weight tape adjuster
9. Up stop bracket (2 used)
10. Suspension boot
11. Weight tape guide
12. Weight tape roller
13. Shock bushing (4 used)
14. Scissor pivot block (2 used)
15. Bumper spacer (2 used)
16. Damper
17. Compression clamp
18. Compressor
19. Elbow stud
20. Down stop bumper (2 used)
21. Shaft block (2 used)
22. Air control valve
23. Wire harness
24. Tubing (2 used)
25. Tee fitting
26. Connector
27. Lock nut
28. Carriage bolt (2 used)
29. Clip (25 used)
30. Tubing
31. Retaining ring
32. Screw
33. Flange head screw (2 used)
34. Thread forming screw (8 used)
35. Hex nut (2 used)
36. Lock nut (2 used)
37. Flat washer (2 used)
38. Cap screw

Removal (Fig. 11)

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

2. Remove seat and seat suspension from machine (see Operator Seat Removal in this section).

3. Remove pneumatic seat suspension components as necessary using Figures 11 and 12 as guides.

Installation (Fig. 11)

1. Install pneumatic seat suspension components using Figures 11 and 12 as guides. Refer to Figure 11 for fastener torque values for assembly purposes.

2. Install seat and seat suspension to machine (see Operator Seat Installation in this section). Make sure to connect electrical connector to the seat switch.

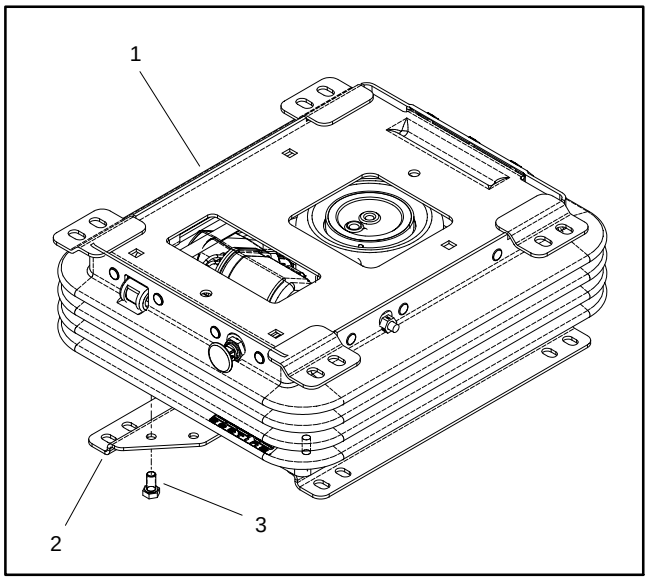

Figure 12

1. Suspension assembly
2. Bracket (2 used)
3. Cap screw (4 used)

Lift Arms

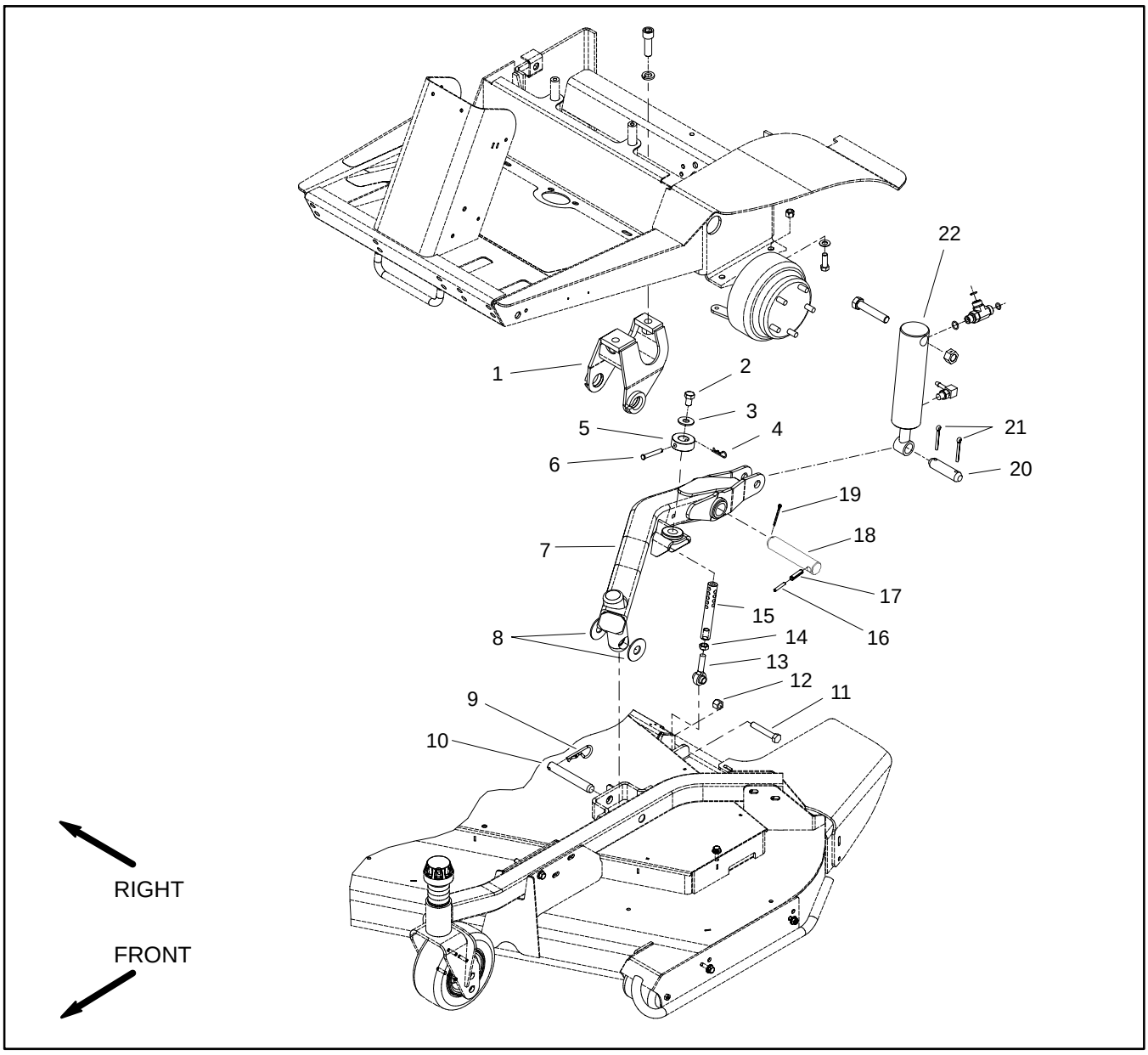

Figure 13

1. **Carrier bracket**
2. **Cap screw**
3. **Flat washer**
4. **Hair pin**
5. **Height of cut collar**
6. **Clevis pin**
7. **Lift arm (LH shown)**
8. **Thrust washer**
9. **Hair pin**
10. **Clevis pin**
11. **Cap screw**
12. **Lock nut**
13. **Rod end**
14. **Jam nut**
15. **Height of cut tube**
16. **Roll pin**
17. **Roll pin**
18. **Pivot pin**
19. **Cotter pin**
20. **Cylinder pin**
21. **Cotter pin**
22. **Lift cylinder**

Removal (Fig. 13)

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

2. Remove cutting deck (or implement) from lift arm (see Cutting Unit Operator's Manual).

3. Disconnect brake return spring from lift arm.

4. Remove front lift arm components from machine using Figure 13 as a guide.

5. If necessary, disassemble lift arm using Figure 14 as a guide.

Installation (Fig. 13)

1. If lift arm was disassembled, install lift arm components using Figure 14 as a guide.

2. Install front lift arm components to machine using Figure 13 as a guide.

   A. If roll pins (items 13 and 14) were removed from pivot pin (item 15), install roll pins so that one end is flush with pivot pin. Also, inner roll pin split should be opposite outer roll pin split (Fig. 15).

3. Connect brake return spring to lift arm.

4. Mount cutting deck(or implement) to lift arm (see Cutting Unit Operator's Manual).

5. See Cutting Unit Operator's Manual for lift arm adjustment procedures.

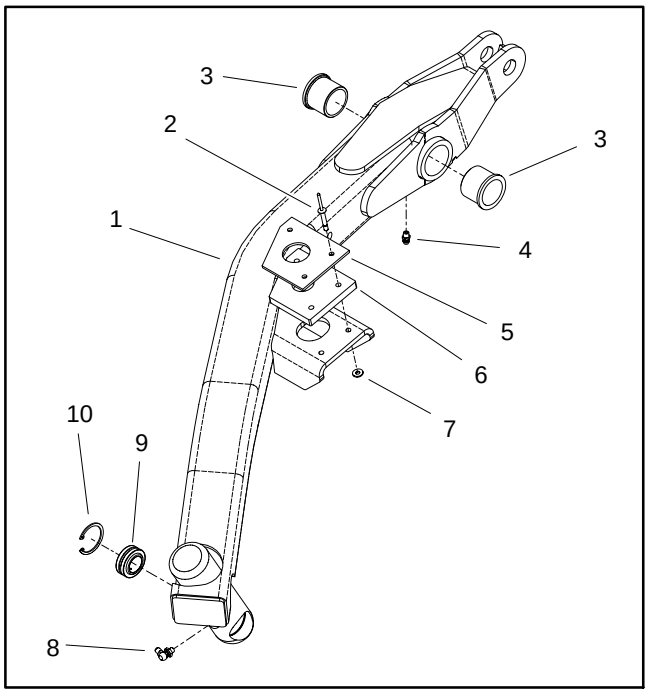

Figure 14

1. **Lift arm (LH shown)**
2. **Rivet (3 used)**
3. **Flange bushing**
4. **Grease fitting**
5. **Plastic pad**
6. **Rubber pad**
7. **Washer (3 used)**
8. **Grease fitting**
9. **Spherical bearing**
10. **Retaining ring**

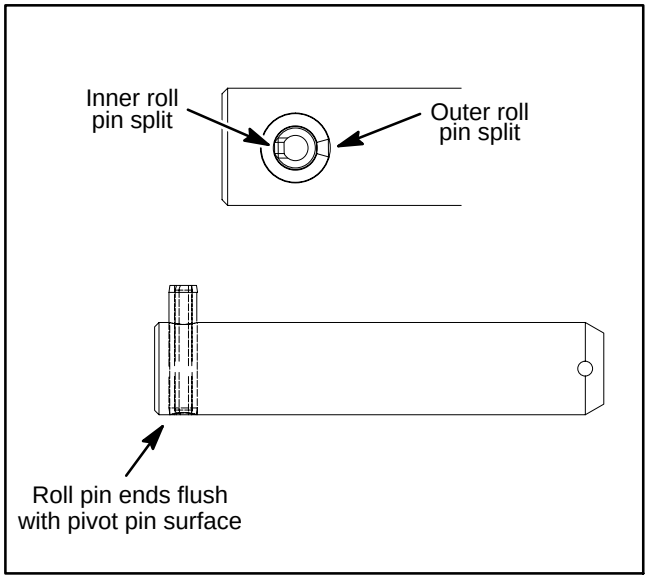

Figure 15

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Chapter 8

Drive Axles

Table of Contents

Specifications

Item	Description
Front Axle (Hydraulic Reservoir) Oil	See Traction Unit Operator's Manual
Front Axle (Hydraulic Reservoir) Capacity	6 Qts. U.S. (5.7 L) (see Traction Unit Operator's Manual for checking procedure)
4WD Rear Axle Lubricant	GL−5 API, SAE 80W−90 gear lube
4WD Rear Axle Lubricant Capacity	3.1 quarts (2.9 liters) (see Traction Unit Operator's Manual for checking procedure)
4WD Bidirectional Clutch Lubricant	Mobil Fluid 424
4WD Bidirectional Clutch Capacity	1.2 fl.ounces (35 ml) (see Traction Unit Operator's Manual for checking procedure)

General Information

Front Axle

The Groundsmaster 3280−D and 3320 use a Dana Axle, model GT-20. The differential and axle form the final drive of the power train (Fig. 1).

The differential has a heavy duty case with automotive type, cut gears that rotate on tapered roller bearings. Single-row, pre-set, tapered roller bearings are used on the outside ends of the axle shafts.

The entire drive line of the axle assembly is made of alloy steel. The axle has a die-cast aluminum housing that also serves as the hydraulic oil reservoir.

Power is transmitted from the hydrostatic transmission output gear to the axle pinion spur gear. The pinion spur gear transmits power directly to the differential drive gears, to turn the axles and the front wheels.

The differential axle has a one-piece axle shaft with the flange being part of the axle stem.

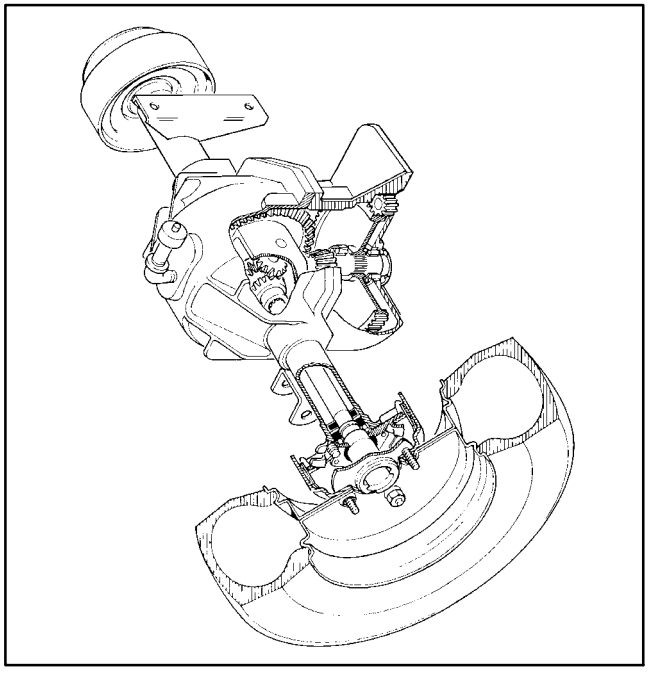

Figure 1

4 Wheel Drive Rear Axle

The 4WD rear axle used on the Groundsmaster 3280−D is a steerable, mechanical drive axle. A drive shaft connected to the front axle output shaft provides power to the 4WD rear axle. The drive shaft incorporates a bidirectional clutch that transfers power from the drive shaft to the 4WD rear axle input shaft (Fig. 2).

Any time the front wheels change speed (e.g. initially depressing the traction pedal, climbing an incline, tires slipping), the rear axle drive shaft speed also changes. As soon as the drive shaft and the rear axle input shaft turn at slightly different speeds, the bidirectional clutch will engage and power is transferred to the rear axle (Fig. 3). The result is automatic four wheel drive. The clutch engages in either forward or reverse direction.

NOTE: The bidirectional clutch may not operate properly if different size tires are used or if correct tire pressure is not maintained.

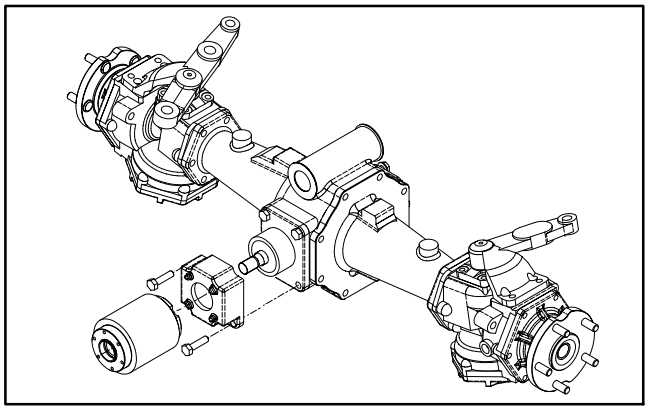

Figure 2

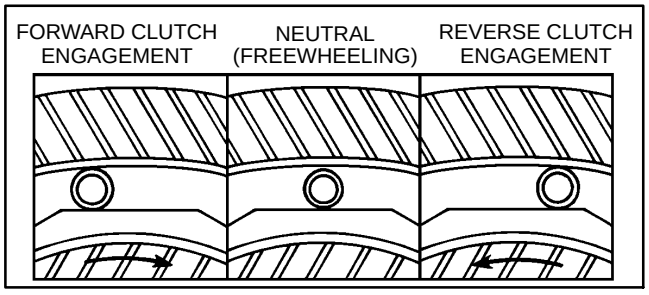

Figure 3

Special Tools

Order special tools from your Toro Distributor.

Differential Gear Holder (TOR4027)

Remove gear cover from right hand side of differential and bolt this tool in place to lock spur gear in position when removing nut that secures pinion coupler.

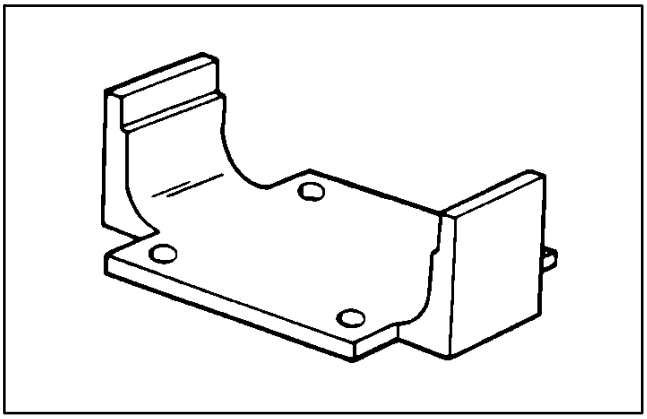

Figure 4

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Brake Service

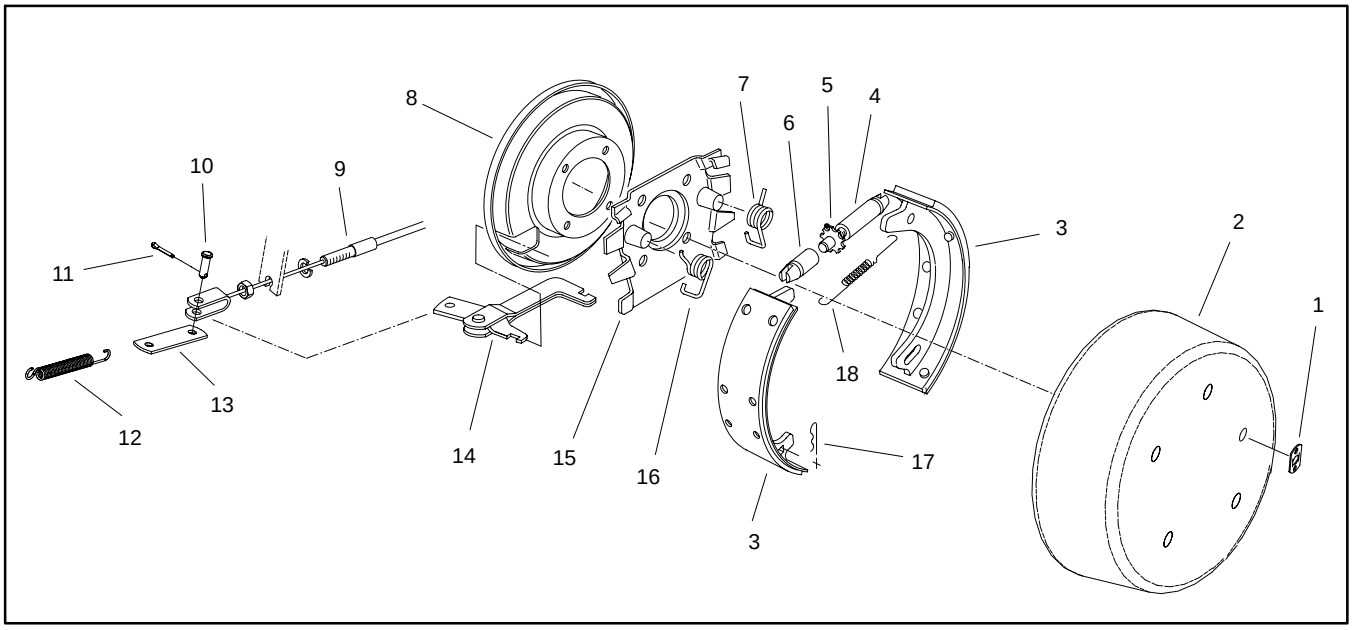

Figure 5

1. **Lock nut**
2. **Brake drum**
3. **Brake shoe set**
4. **Pivot nut**
5. **Star wheel adjuster**
6. **Star wheel socket**
7. **Return spring**
8. **Dust shield**
9. **Brake cable**
10. **Clevis pin**
11. **Cotter pin**
12. **Brake return spring**
13. **Brake cable link**
14. **Brake lever**
15. **Brake spider**
16. **Return spring**
17. **Brake lever retainer**
18. **Adjuster spring**

Disassembly

1. Park machine on a level surface, lower cutting deck (or implement), stop engine and remove key from the ignition switch.

CAUTION

When removing wheels, 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.

2. 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.

3. Remove wheel lug nuts and slide wheel assembly from front axle.

4. Remove brake return spring (item 12) from brake cable link (item 13). Disconnect brake cable from brake lever by removing cotter pin (item 11) and clevis pin (item 10).

NOTE: If the brake drum is severely worn, it may be necessary to loosen the brake shoes before removing the brake drum. Loosen the brake shoes by turning the star wheel adjuster inside the brake drum assembly.

5. Remove the lock nut (item 1) that retains the brake drum. Pull the brake drum from the machine.

6. Inspect braking surface of brake drum. If excessive wear or scoring exist, replace brake drum.

CAUTION

Be careful when removing adjuster and brake return springs. The springs are under tension and could possibly slip during removal.

7. Remove adjuster spring (item 13).

8. Spread the upper ends of the brake shoes and remove star wheel assembly (items 4, 5 and 6).

9. Remove brake lever retainers (cotter pins) (item 12).

10. Pull brake lever from brake shoes.

11. Remove brake shoe return springs (Items 7 and 11) by prying the end of the spring up and out of the brake shoe. Use a brake spring pliers or flat blade screwdriver.

12. Remove brake shoes by sliding them both down from brake spider.

Assembly

1. Slide brake shoes up onto brake spider.

CAUTION

Be careful when installing brake return and adjuster springs. The springs are under tension and could possibly slip during installation.

2. Position brake return springs (Items 7 and 11) to brake shoes.

3. Position brake lever to brake shoes. Secure brake lever to shoes with retainers (item 12).

4. Spread the upper ends of the brake shoes and install star wheel assembly (items 4, 5 and 6).

5. Install adjuster spring (item 13).

6. Install brake drum on wheel studs. Install lock nut (item 1).

7. Install wheel assembly on studs and secure with five (5) lug nuts. Torque lug nuts in a crossing pattern from 75 to 80 ft-lb (102 to 108 N−m).

8. Secure brake cable to brake lever with clevis pin (item 10) and cotter pin (item 11). Attach brake return spring (item 12) to brake cable link (item 13).

9. Remove jack stands or blocking and lower machine to the floor.

10. Adjust brakes (see Traction Unit Operator's Manual).

Front Axle Shafts and Bearings

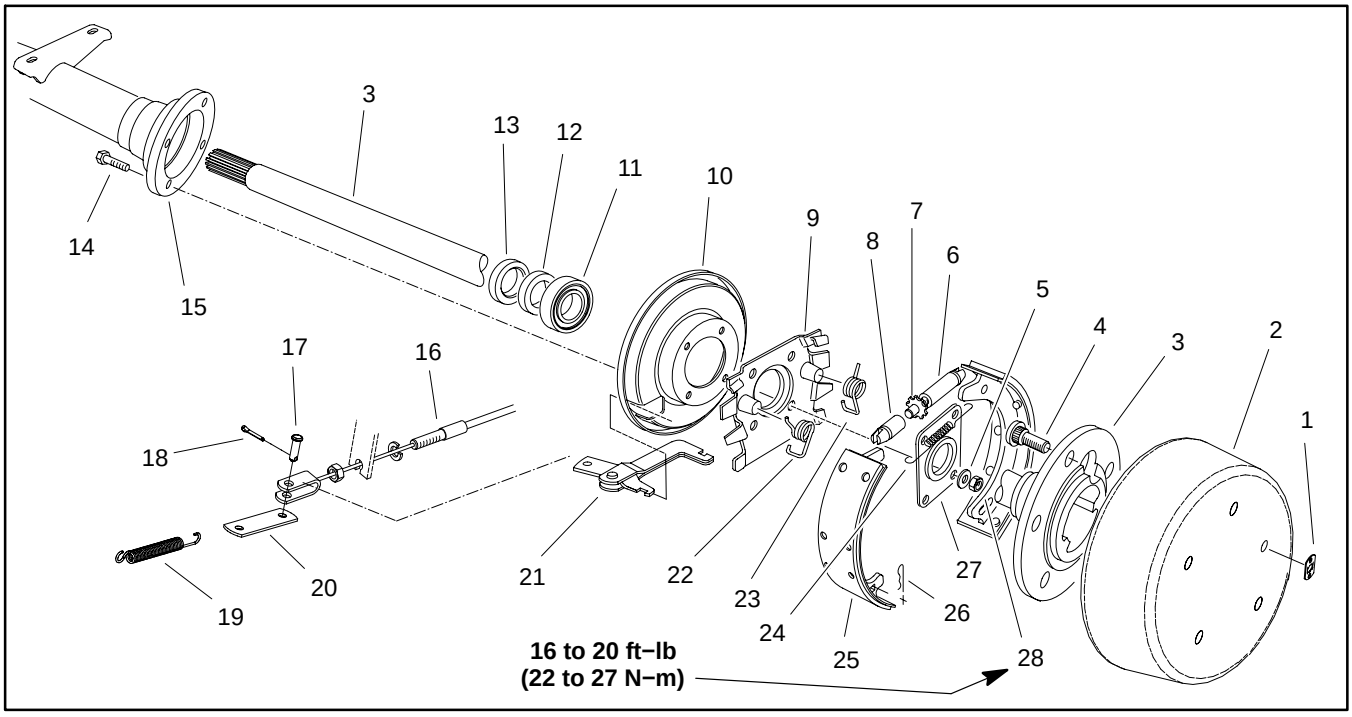

Figure 6

1. **Lock nut**
2. **Brake drum**
3. **Axle shaft**
4. **Wheel stud (5 used per wheel)**
5. **Hardened washer (4 used per wheel)**
6. **Pivot nut**
7. **Star wheel adjuster**
8. **Star wheel socket**
9. **Brake spider**
10. **Dust shield**
11. **Bearing**
12. **Bearing retainer**
13. **Inner axle oil seal**
14. **Socket head screw (4 used per wheel)**
15. **Front axle housing**
16. **Brake cable**
17. **Clevis pin**
18. **Cotter pin**
19. **Brake return spring**
20. **Brake cable link**
21. **Brake lever**
22. **Brake return spring**
23. **Brake return spring**
24. **Adjuster spring**
25. **Brake shoe**
26. **Brake lever retainer**
27. **Outer seal plate**
28. **Lock nut (4 used per wheel)**

NOTE: It is not necessary to remove the front axle assembly from machine when servicing front axle shafts.

Disassembly (Fig. 6)

1. Park machine on a level surface, lower cutting deck (or implement), stop engine and remove key from the ignition switch.

2. Remove brake return spring (item 19) from brake cable link (item 20). Disconnect brake cable from brake lever by removing cotter pin (item 18) and clevis pin (item 17).

CAUTION

When removing wheels, 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 lug nuts and slide wheel assembly from front axle.

5. Remove the lock nut (item 1) that retains the brake drum. Slide the brake drum from machine (Fig. 7).

NOTE: If the brake drum is severely worn, it may be necessary to loosen the brake shoes before removing the brake drum. Loosen the brake shoes by turning the star wheel adjuster (item 7) inside the brake drum assembly.

Figure 7

6. Remove the four (4) lock nuts, hardened washers and socket head screws that secure brake assembly and outer seal plate to axle housing (Fig. 8). Use the hole in the axle shaft flange to gain access to the lock nuts.

IMPORTANT: Hold the socket head screws with a wrench to prevent the screw head from rotating and damaging the axle tube.

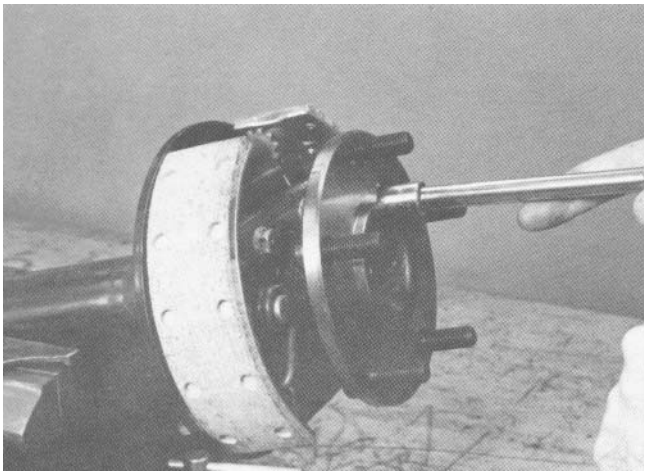

Figure 8

7. Pull the axle shaft and brake assembly out of the axle housing (Fig 9).

NOTE: Remove the bearing race from the axle housing with a bearing puller if necessary.

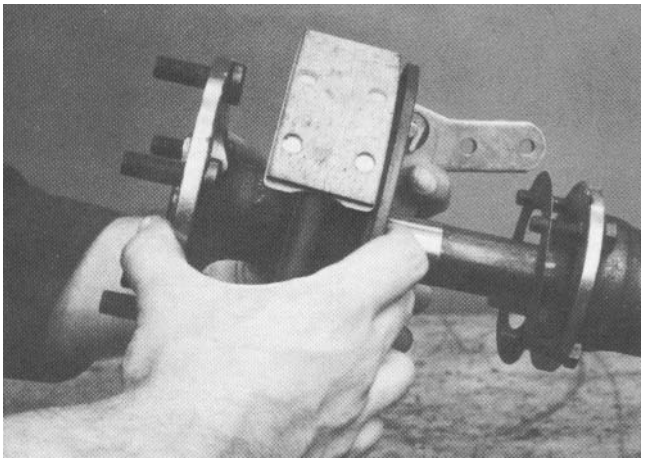

Figure 9

8. Remove and discard the inner axle shaft seal (Fig. 10).

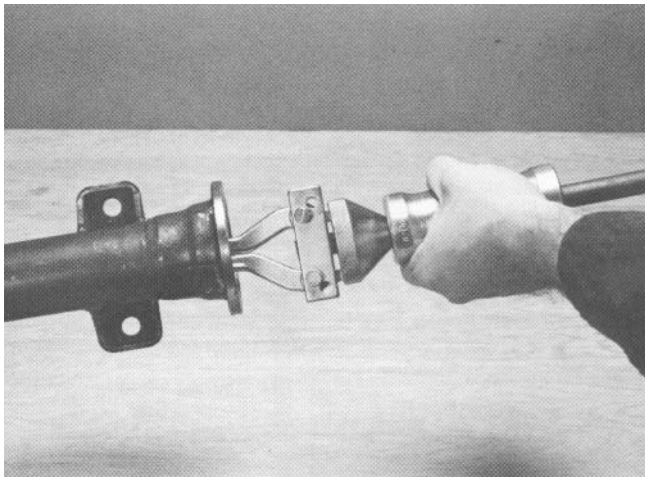

Figure 10

9. Center punch and drill a 1/4 inch (6 mm) hole (approximate) into the outside of the bearing retainer to a depth of about 3/4 the thickness of the retainer (Fig. 11).

IMPORTANT: Drilling completely through the retainer ring will damage the axle shaft.

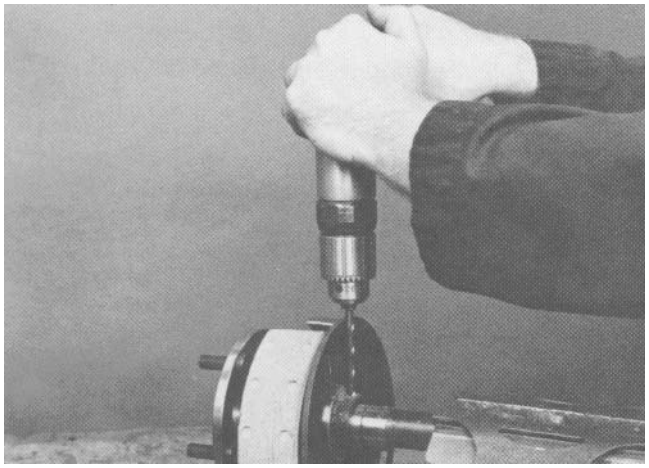

Figure 11

10. Place a chisel in position across the drilled hole and strike sharply to break the retainer (Fig. 12). Remove and discard the retainer.

WARNING

Wear protective safety goggles when breaking the retaining ring. Personal injury could result from flying metal particles. Keep bystanders away during this procedure.

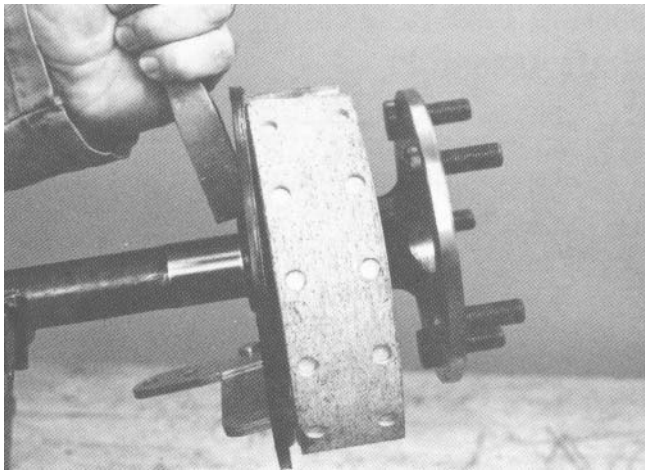

Figure 12

11. Remove the bearing from axle shaft.

12. Remove and discard the outer seal plate.

13. Inspect all components for wear and damage (Fig. 13). Replace the axle shaft if the seal has grooved the axle surface more that 1/64 inch (0.40 mm).

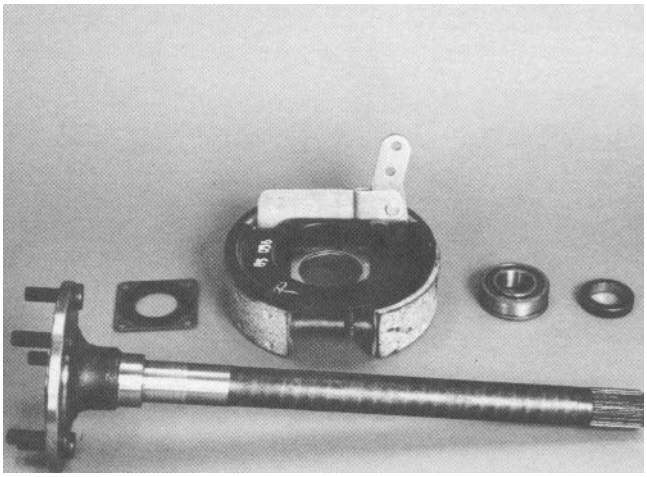

Figure 13

Assembly (Fig. 6)

1. Coat a new outer seal plate with a thin film of oil and place the outer seal plate, brake assembly and dust shield in position on the axle shaft.

2. Pack the bearing with grease and press it onto the axle shaft (Fig. 14).

IMPORTANT: Drive the bearing onto the axle shaft by pressing on the inner race of the bearing only.

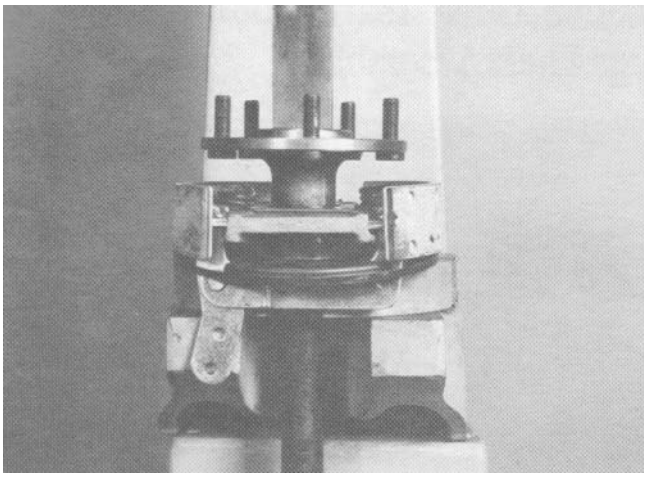

Figure 14

3. Slide a new bearing retainer on the axle shaft. Support the shaft and retainer in a suitable press and press the bearing retainer firmly against the bearing (Fig. 15).

IMPORTANT: Do not heat the bearing retainer to install. Heat will destroy the close tolerance press fit.

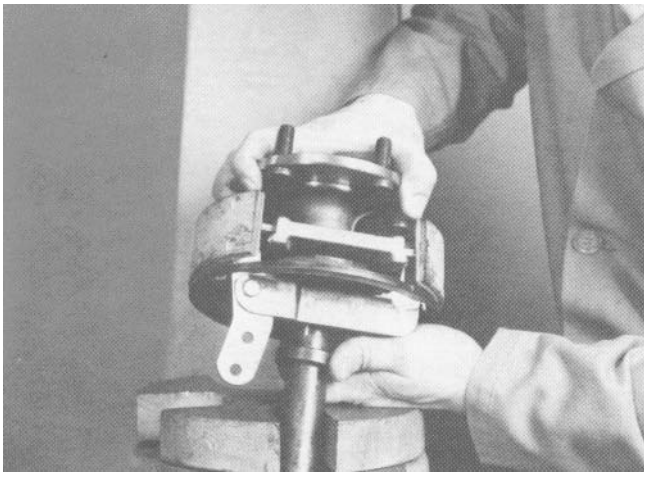

Figure 15

4. Prepare a new inner shaft seal for assembly. Put a light coat of No. 1 Permatex (or equivalent) on the outside diameter (surface that contacts the axle housing), and a thin film of oil on the inside diameter (surface that contacts the axle shaft). Install the new seal to a depth of 1.218 in. (30.90 mm) into the axle housing (Fig. 16).

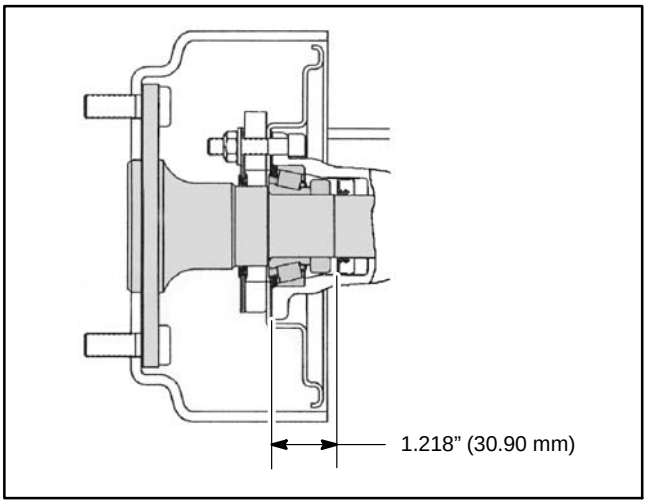

Figure 16

5. Apply a 1/16” (1.60 mm) bead of Loctite® Ultra Gray Silicone (gasket eliminator) to the axle housing flange. Align the dust shield and brake assembly with axle housing flange and push the axle shaft assembly all the way into the axle housing. Be careful not to damage the oil seal and bearing (Fig. 17).

NOTE: Liquid Gasket Kit (Toro P/N 92-8775) includes Loctite® Ultra Gray Silicone (gasket eliminator) and application instructions.

Figure 17

6. Install socket head screws, hardened washers and lock nuts. Tighten the nuts in an alternating pattern so the bearing is drawn into the axle housing evenly (Fig. 18). Torque the nuts from 16 to 20 ft-lb (22 to 27 N−m).

IMPORTANT: When tightening the lock nuts, hold the socket head screws with a wrench to prevent the screw head from damaging the axle tube.

7. Slide the brake drum onto wheel studs. Retain brake drum with lock nut (item 1).

8. Install wheel assembly on studs and secure with five (5) lug nuts. Torque lug nuts in a crossing pattern from 75 to 80 ft-lb (102 to 108 N−m).

9. Secure brake cable to brake lever with clevis pin (item 17) and cotter pin (item 18). Attach brake return spring (item 19) to brake cable link (item 20).

10. Remove jack stands or blocking and lower machine to the floor.

11. Adjust brakes (see Traction Unit Operator’s Manual).

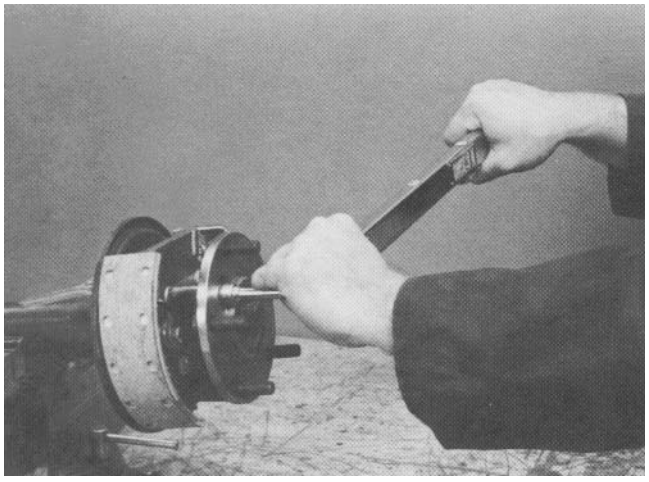

Figure 18

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Front Axle

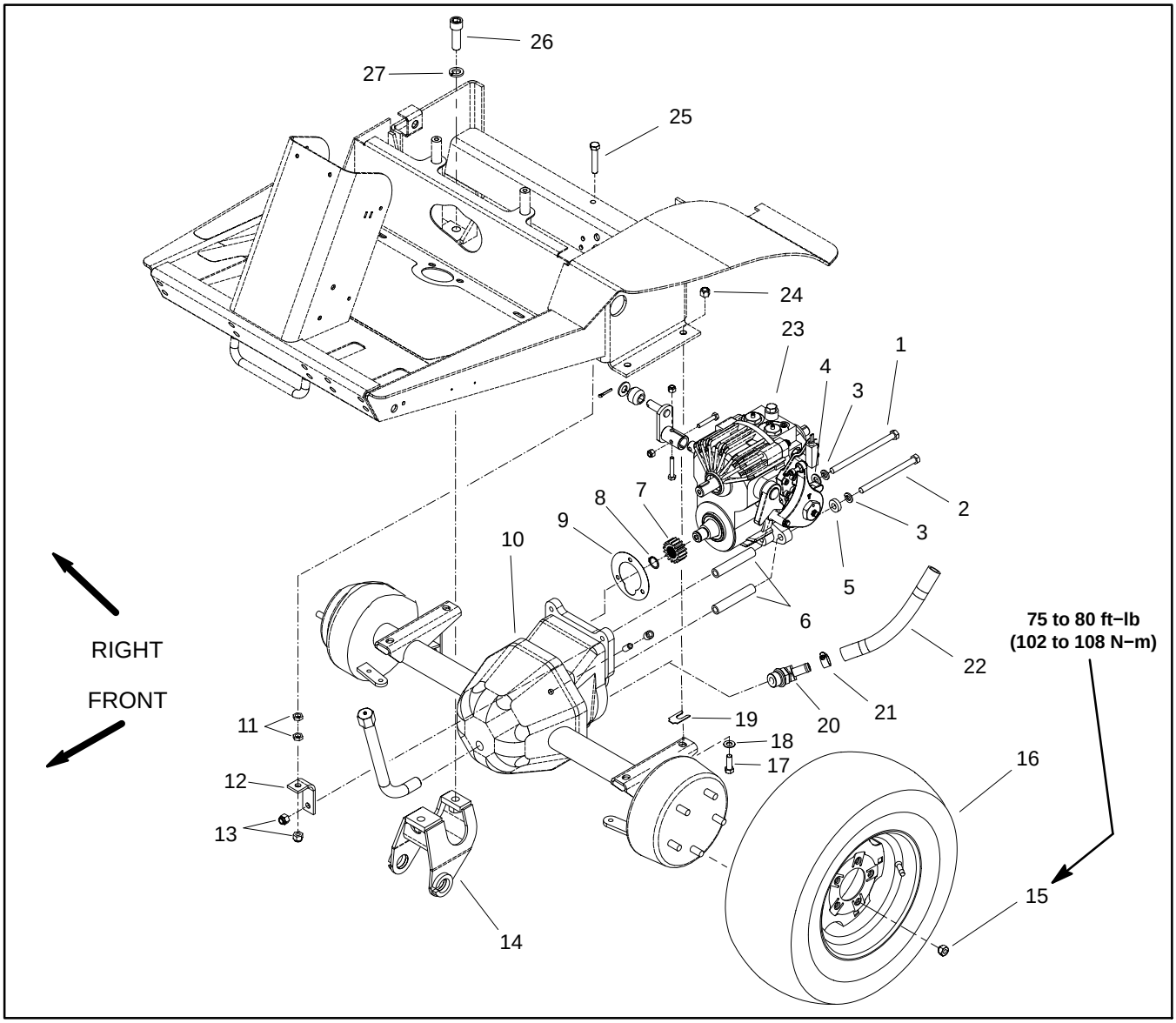

Figure 19

1. **Cap screw**
2. **Cap screw (3 used)**
3. **Lock washer (4 used)**
4. **Flat washer**
5. **Spacer**
6. **Mounting spacer (4 used)**
7. **Pinion Gear**
8. **Snap ring**
9. **Gasket**
10. **Front axle assembly**
11. **Jam nut**
12. **Transmission anchor**
13. **Lock nut**
14. **Carrier bracket (2 used)**
15. **Lug nut (5 used per wheel)**
16. **Tire and wheel assembly**
17. **Cap screw (4 used)**
18. **Flat washer (4 used)**
19. **Axle shim (as needed)**
20. **Hydraulic fitting**
21. **Hose clamp**
22. **Hydraulic hose**
23. **Transmission**
24. **Lock nut (4 used)**
25. **Cap screw**
26. **Socket head screw (4 used)**
27. **Lock washer (4 used)**

Removal (Fig. 19)

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

2. Remove the cutting deck (or implement) (See Cutting Unit Operator's Manual).

3. To prevent contamination of the hydraulic system, thoroughly clean transmission and front axle.

4. Drain oil from front axle (see Traction Unit Operator's Manual).

5. Loosen hose clamp (item 21) and pull hydraulic hose (item 22) from fitting (item 20) on axle.

6. Remove lift arms from machine (See Lift Arm Removal in the Service and Repairs section of Chapter 7 − Chassis).

7. Remove fuel tank (See Fuel Tank Removal in the Service and Repairs section of Chapter 3 − Gasoline Engine or Chapter 4 − Diesel Engine).

8. Remove carrier brackets (item 14) from machine frame.

CAUTION

When removing wheels, 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.

9. 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. Release parking brake.

10. Remove front wheel lug nuts and pull front wheels from front axle.

11. Remove hydrostatic transmission from machine (See Hydrostatic Transmission Removal in the Service and Repairs section of Chapter 5 − Hydraulic System).

12. Remove the cotter pin and clevis pin to disconnect the brake cable from brake actuating lever on each brake (Fig. 20). Loosen jam nut to remove brake cable from each end of axle bracket.

13. Put a jack or blocking under front axle to prevent it from falling. Remove cap screws, flat washers and lock nuts that secure axle mounting pads to frame. Retrieve and note location of axle shims (item 19).

14. Carefully lower front axle and remove from machine.

Installation (Fig. 19)

1. Position front axle to machine frame and support axle in place.

2. Place axle shims in location noted during disassembly. Install cap screws, flat washers and lock nuts that secure axle mounting pads to frame. Leave fasteners loose to allow alignment of transmission.

3. Connect the brake cables to the brake actuating levers on each brake (Fig. 20). Secure brake cables to axle brackets with jam nuts.

IMPORTANT: When installing hydrostatic transmission, make sure that transmission drive shaft alignment is checked and adjusted if necessary.

4. Install hydrostatic transmission to machine (See Hydrostatic Transmission Installation in the Service and Repairs section of Chapter 5 − Hydraulic System).

5. Install front wheels to axle and secure with lug nuts. Torque lug nuts in a crossing pattern from 75 to 80 ft−lb (102 to 108 N−m).

6. Install carrier brackets (item 14) to machine frame.

7. Install lift arms to machine (See Lift Arm Installation in the Service and Repairs section of Chapter 7 − Chassis).

8. Install fuel tank (See Fuel Tank Installation in the Service and Repairs section of Chapter 3 − Gasoline Engine or Chapter 4 − Diesel Engine).

9. Install hydraulic hose (item 22) to fitting (item 20) on axle and secure with hose clamp (item 21).

10. Lower machine to ground.

11. Fill hydraulic reservoir (front axle) with oil (see Traction Unit Operator's Manual).

12. Install the cutting deck (or implement) (See Cutting Unit Operator's Manual).

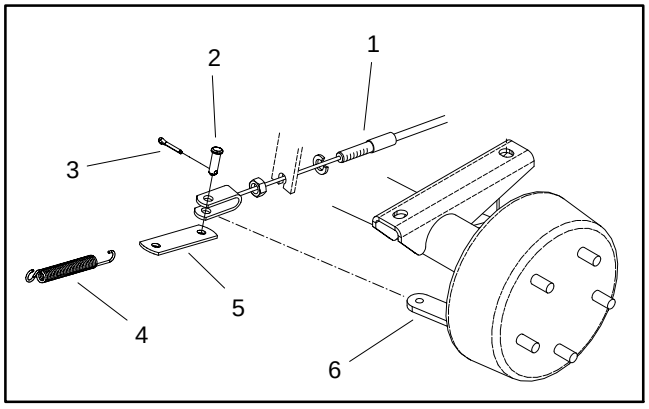

Figure 20

1. **Brake cable**
2. **Clevis pin**
3. **Cotter pin**
4. **Brake return spring**
5. **Brake cable link**
6. **Brake actuating lever**

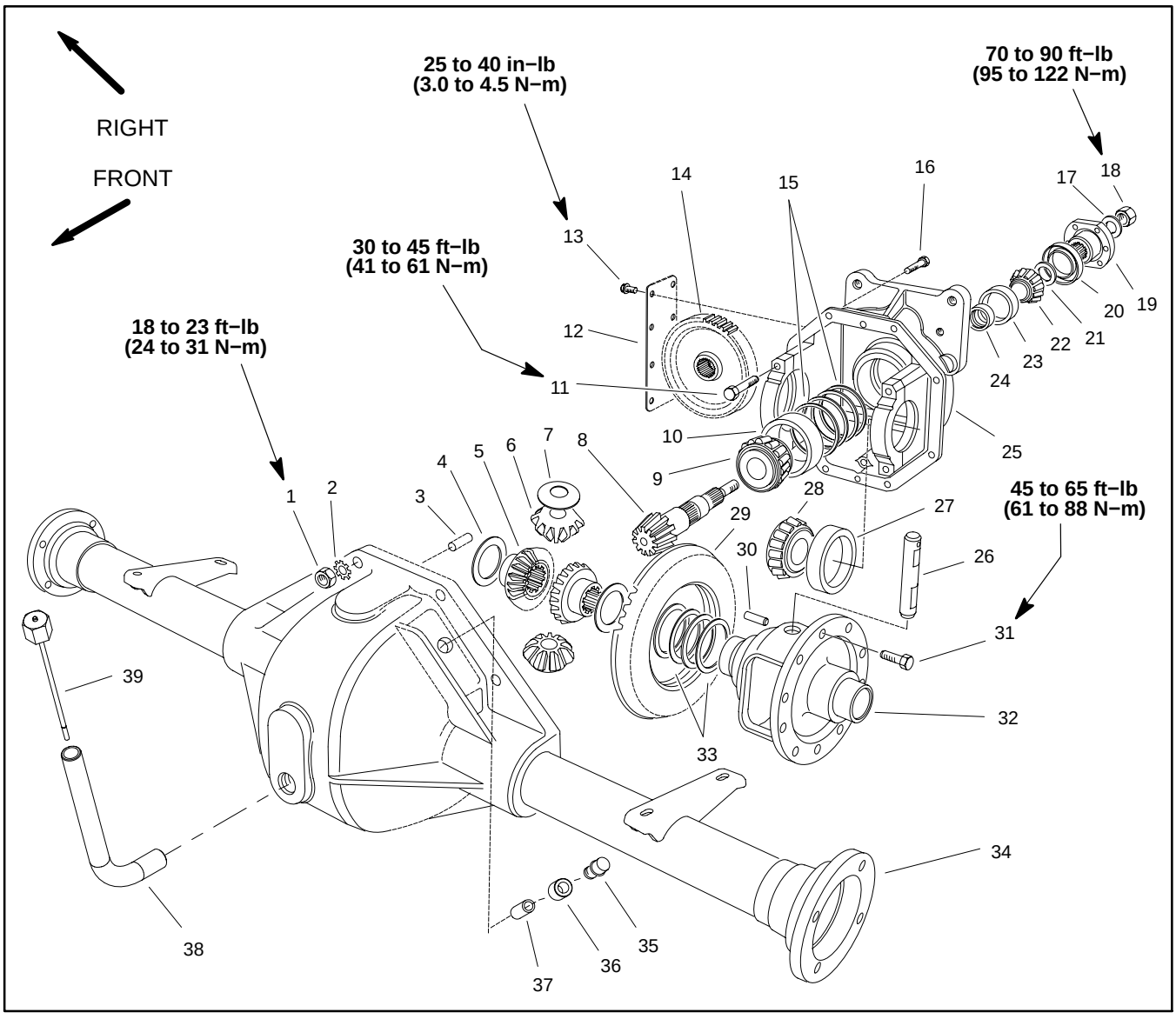

Figure 21

1. Hex nut (8 used)
2. Lock washer (8 used)
3. Dowel pin (2 used)
4. Thrust washer (2 used)
5. Side bevel gear (2 used)
6. Pinion mate bevel gear (2 used)
7. Spherical thrust washer (2 used)
8. Drive pinion
9. Bearing cone
10. Bearing cup
11. Cap screw (4 used)
12. Gear cover
13. Screw (8 used)
14. Spur gear
15. Shims
16. Cap screw (8 used)
17. Washer
18. Nut
19. Flange coupler
20. Seal
21. Shim pack
22. Outer bearing cone
23. Outer bearing cup
24. Bearing spacer
25. Rear axle (carrier) housing
26. Pinion mate shaft
27. Differential bearing cup (2 used)
28. Differential bearing cone (2 used)
29. Ring gear
30. Lock pin
31. Cap screw (5 used)
32. Differential case
33. Shim pack
34. Front axle housing
35. Vent
36. Fitting
37. Pipe nipple
38. Oil fill tube
39. Dipstick

Disassembly (Fig. 21)

1. Remove the right and left-hand axle assemblies. (See Front Axle Shafts and Bearings Disassembly in this section).

2. Remove the eight (8) housing cap screws, hex nuts and lock washers that secure axle housings. Separate the front and rear axle housings (Fig. 22). Clean all gasket material from the housing mating surfaces.

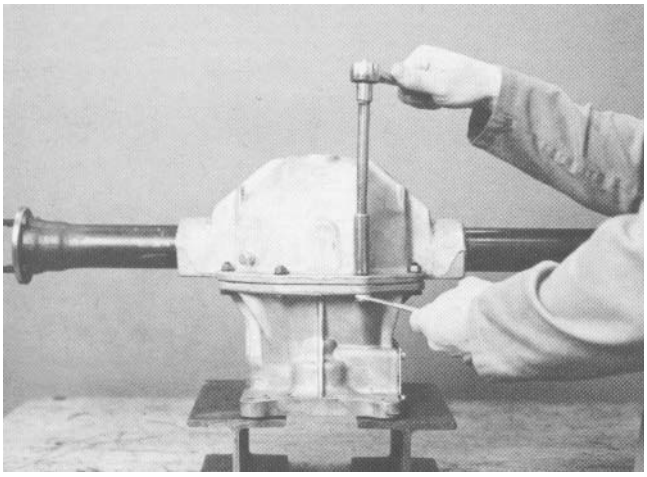

Figure 22

3. Remove the four bearing cap screws and remove the caps. Place the caps in a safe place to avoid damaging their machined surfaces (Fig. 23).

IMPORTANT: The bearing caps are marked for identification. The letters or numbers are in horizontal and vertical positions. Record them for reference during assembly. Always reinstall them in the same position.

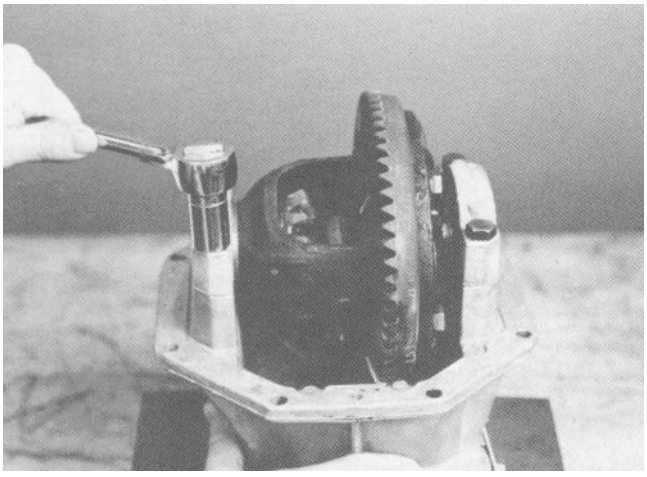

Figure 23

4. To remove the differential assembly, place two wooden devices (e.g. hammer handles) under the differential case and pry firmly upward. Mark the bearing cups and cones, they must be reinstalled in matched sets (Fig. 24).

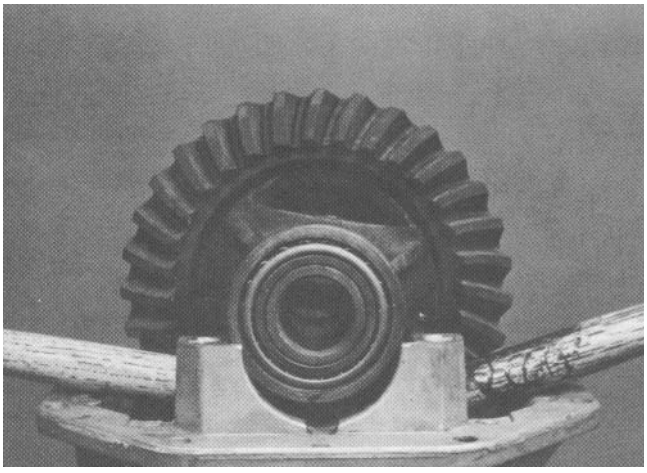

Figure 24

5. Remove the ring gear cap screws. Using a hard wooden block and a hammer, drive the ring gear from the differential case. Be prepared to protect the ring gear when removing it from the differential case; this will avoid damage of the ring gear teeth (Fig. 25).

NOTE: It is recommended that whenever the ring gear cap screws are removed, they are to be replaced with new screws.

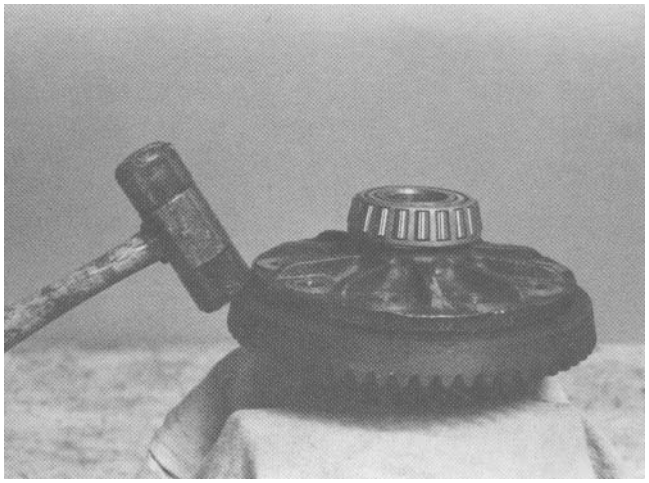

Figure 25

6. Do not remove the bearings from the differential case unless bearing failure is evident. It is recommended that whenever bearings are removed (regardless of usage) they must be replaced with new ones. Remove the case side bearing with a puller as shown (Fig. 26).

If bearings are removed from differential case, locate and retrieve shims from case. Note shim location to assist in assembly.

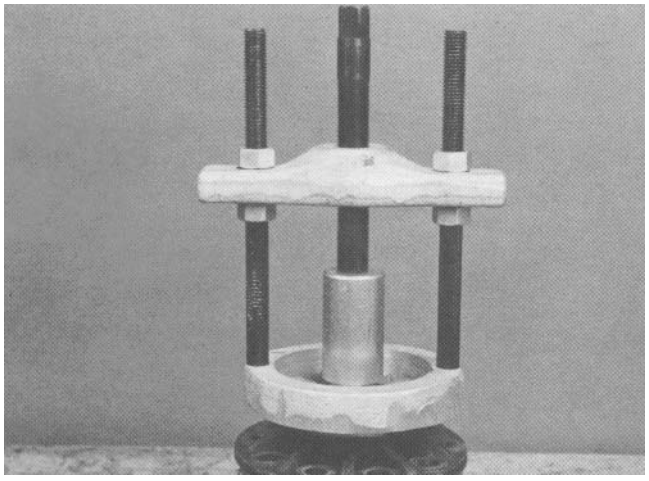

Figure 26

7. Put the case in a vise. Drive the lock pin out of the pinion mate shaft (Fig. 27). Use a small drift punch as shown.

WARNING

To prevent personal injury, always wear a face shield or safety goggles when striking a drift punch with a hammer.

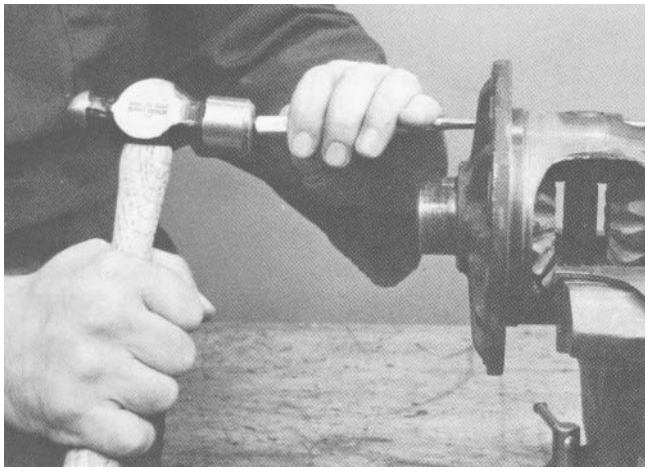

Figure 27

8. While supporting the differential in a vise, drive the pinion mate shaft from the differential with a long drift punch (Fig. 28).

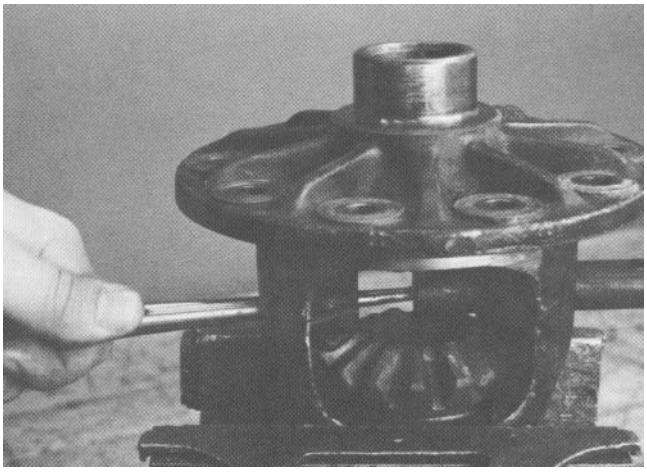

Figure 28

9. To remove the side gears and pinion mate gears, rotate the side gears. This will allow the pinion mate gears to turn to the opening of the case (Fig. 29). Remove the pinion mate gears and the spherical washers behind the gears.

Inspect all differential components including the machined surfaces of the case. If gear damage is identified, replace the entire gear set as damage to one gear will most likely damage other gears as well. If necessary, replace the complete differential assembly.

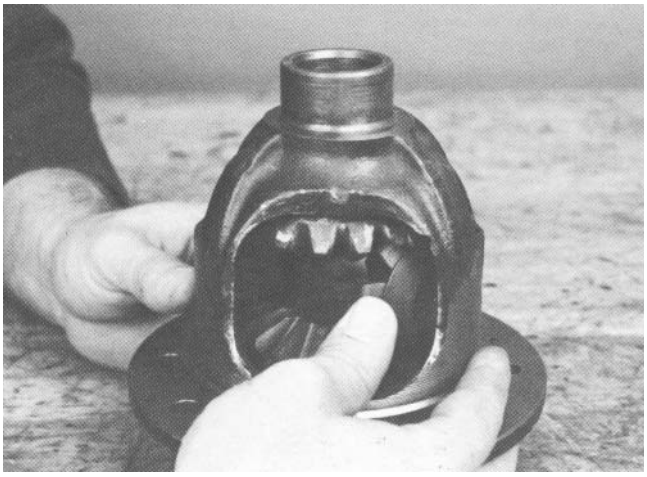

Figure 29

10. Remove the eight side cover capscrews. Remove the the side cover from the carrier assembly (Fig. 30). Clean the gasket material from the mating surfaces before reassembly.

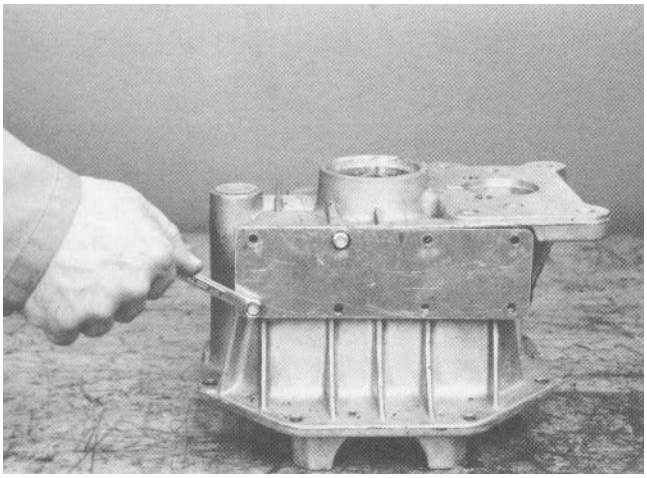

Figure 30

11. Install differential gear holder to carrier to retain spur gear (see Special Tools). Remove nut, washer, flange coupler and seal from the pinion shaft (Fig. 31).

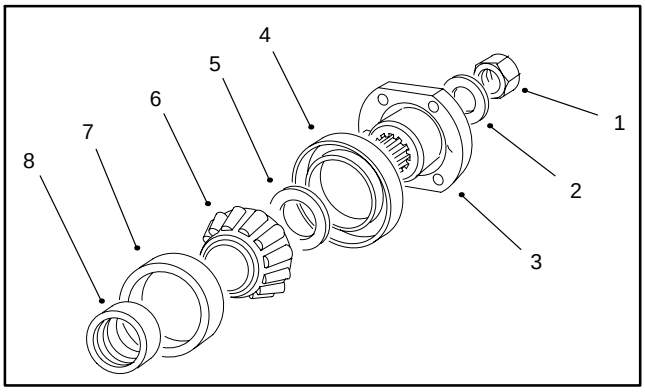

Figure 31

1. **Nut**
2. **Washer**
3. **Flange coupler**
4. **Seal**
5. **Shim**
6. **Outer bearing cone**
7. **Outer bearing cup**
8. **Bearing spacer**

12. Position the housing assembly on a suitable press. Place a 1/8 inch (3 mm) piece of steel or a screwdriver blade under the edge of the spur gear. This will prevent the spur gear from cocking and possibly cracking the housing (Fig. 32).

IMPORTANT: DO NOT allow the pinion shaft to drop on the floor during removal as damage will result.

Carefully press drive pinion shaft from housing. When the pinion is close to being pressed completely out of the bearing, reach under the housing and catch the pinion in your hand to prevent any damage to the pinion.

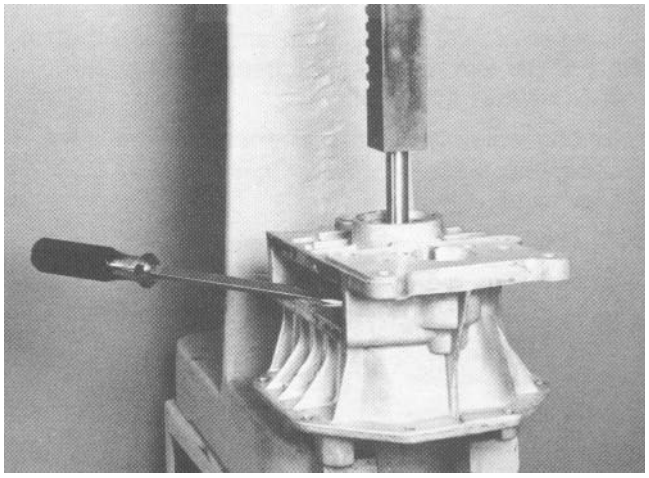

Figure 32

13. Removing the drive pinion releases the spur gear (Fig. 33).

14. Remove oil seal from housing. Then remove the bearing shim, outer pinion bearing cone and bearing spacer from the housing (Fig. 31).

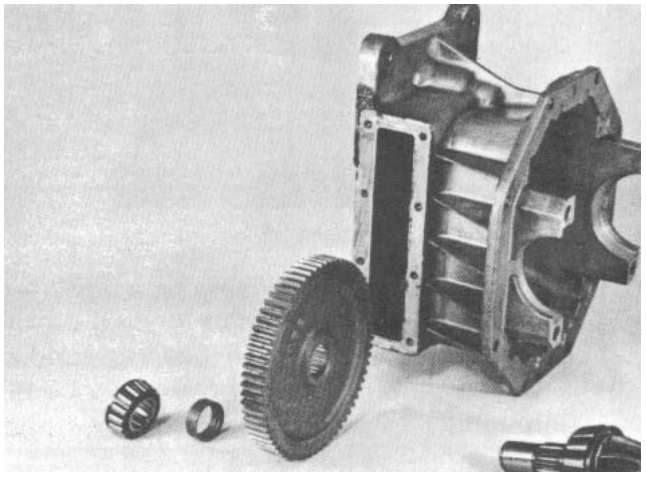

Figure 33

15. Clamp the inner pinion bearing with a universal bearing remover (Fig. 34). Position the unit in a press and carefully push the drive pinion out of the bearing.

IMPORTANT: DO NOT allow the pinion to drop on the floor during removal as damage will result.

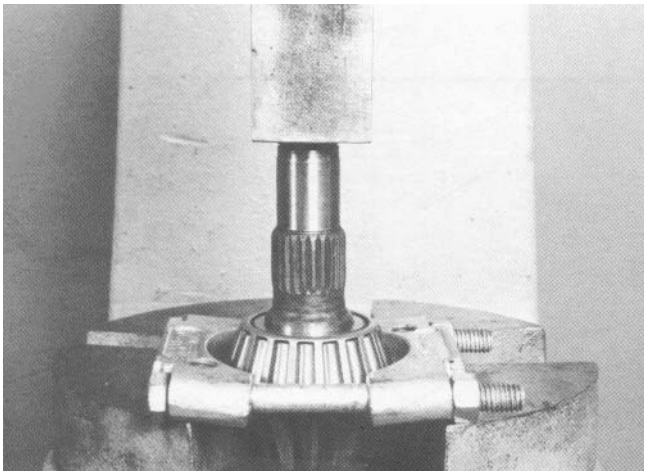

Figure 34

16. To remove the outer pinion bearing cup, position the housing in a press. Place a press plate of the proper size against the cup. Press the cup out of the housing (Fig. 35).

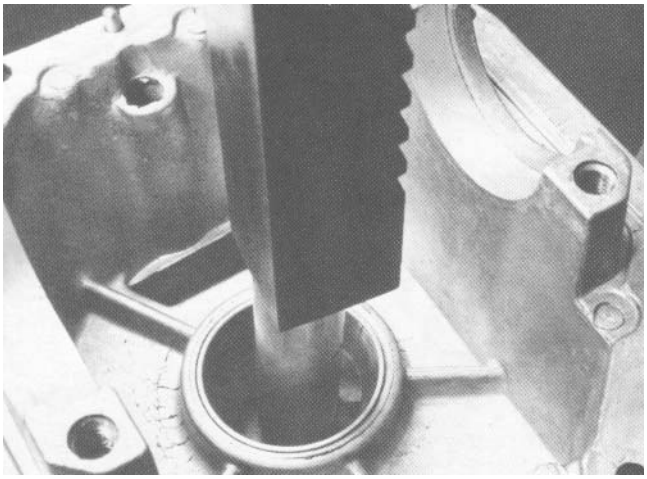

Figure 35

17. Position the front housing on a press bed with the bearing saddles resting on the press bed. Protect the bearing saddles with a piece of wood if the press bed is rough.

Insert a press plate of the proper size and press the inner bearing cup toward the inside of the housing. Retain the shims located under the bearing cup (Fig. 36). If the shims are damaged, replace with new shims of the same thickness.

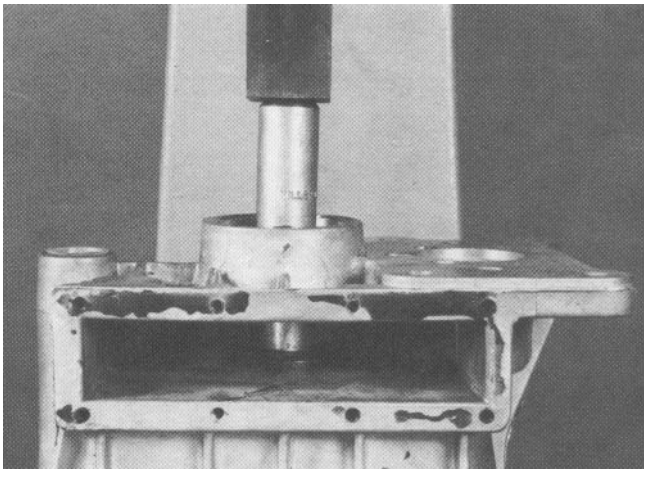

Figure 36

Assembly (Fig. 21)

1. Inspect the differential parts for damage before assembling.

   A. If any bearings are damaged they must be replaced with new ones. Replace all removed bearings.

   B. Check the ring, pinion and spur gear for abnormal wear or damage; replace worn components.

   C. Inspect the housings for cracks and external damage that could affect the operation of the axle assembly.

   D. Inspect the differential case for wear in the side gear and pinion mate area. Replace the case if its machined areas are scored or if the pinion mate shaft fits loosely in the bore.

2. Press new pinion inner bearing cone onto the pinion drive gear. Support the bearing on the inner cup of the bearing ONLY WHEN INSTALLING (Fig. 37).

3. Put the front housing on a press. Using a press plate, push new pinion outer bearing cup into the housing until it bottoms in the housing (Fig. 38).

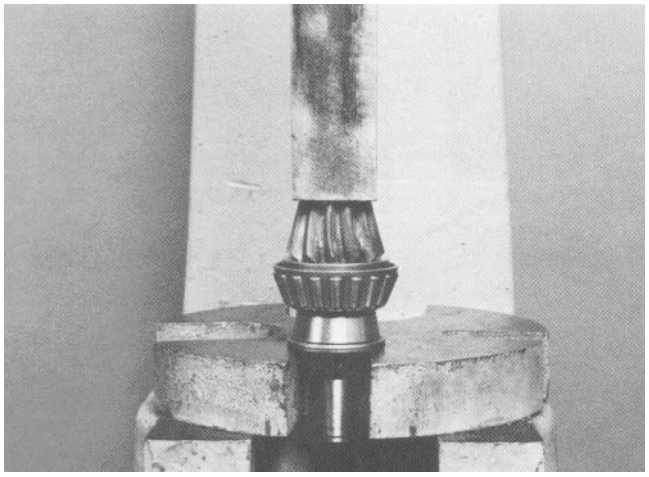

Figure 37

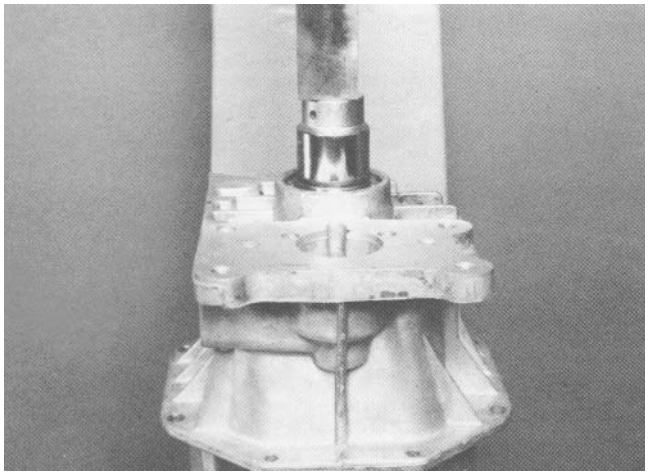

Figure 38

IMPORTANT: Correct engagement between ring gear and pinion gear is critical to axle performance and durability.

NOTE: A complete Upper Housing Assembly for Differential repairs is available. Using this assembly eliminates the need for shimming to establish the correct contact pattern between the ring and pinion gears.

4. Determine the correct inner bearing shims for use with ring and pinion gear sets:

A. When reinstalling the ORIGINAL ring and pinion gears, the original bearing shims or new shims of the same thickness should be used. In this case, proceed directly to step 5.

B. When installing NEW ring and pinion gears (supplied in matched sets only) make sure the numbers etched on both the pinion and ring gear match (Fig. 39).

Compare the +, - or 0 markings of the old and new pinions. Adjust the thickness of a new shim pack to compensate for the difference in these two numbers.

For example: If the old pinion reads +2 and the new pinion reads -2, add 0.004 in. of bearing shims to the original shim pack thickness.

NOTE: The following information is provided to help you understand the adjustment required for proper engagement of NEW ring and pinion gears.

To ensure proper engagement, an additional number is etched into the button end of each pinion gear. This number indicates modifications that must be made to the “pinion to ring gear distance” for each particular gear set. This distance is controlled by adding or removing shims behind the inner bearing cup.

A pinion gear etched 0 is considered standard, and has a 1.210 in. pinion to ring gear distance.

A pinion gear etched +3 requires a pinion to ring gear distance of 1.213 in. (+0.003 in. from standard). Removing 0.003 in. of bearing shims moves the pinion gear away from the ring gear, increasing the pinion to ring gear distance.

A pinion gear etched -3 requires a pinion to ring gear distance of 1.207 in. (-0.003 in. from standard). Adding 0.003 in. of bearing shims moves the pinion gear closer to the ring gear, decreasing the pinion to ring gear distance.

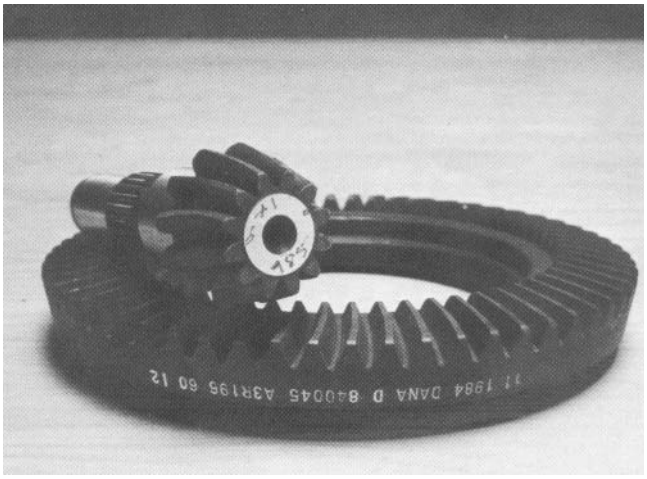

Figure 39

5. Install the correct bearing shims and a new inner bearing cup using a press plate of proper diameter. Push the bearing into the housing until it bottoms out against the shims (Fig. 40).

NOTE: Pinion bearing shims are available in 0.003 in. (0.08 mm), 0.005 in. (0.13 mm), 0.010 in. (0.25 mm) and 0.030 in. (0.76 mm) thickness.

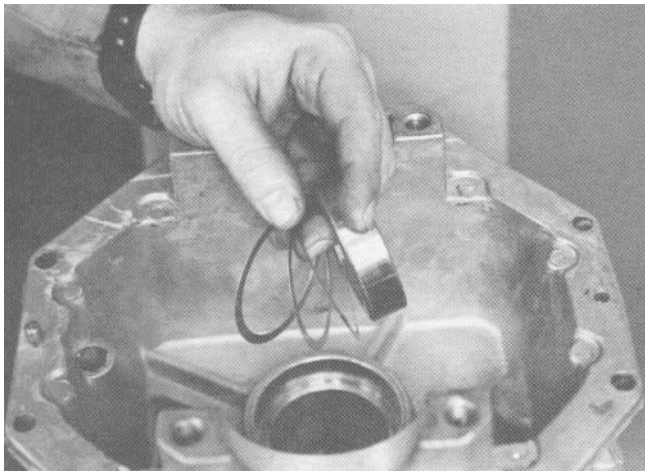

Figure 40

6. Insert the spur gear into the front housing with the chamfered area of the center spline toward the pinion gear. Tap the pinion gear with a soft mallet to engage the splines in the spur gear (Fig. 41).

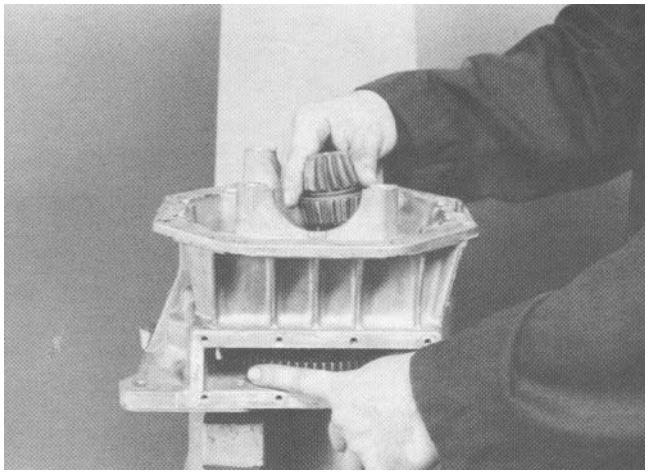

Figure 41

7. Support the drive pinion in a suitable press (Fig. 42).

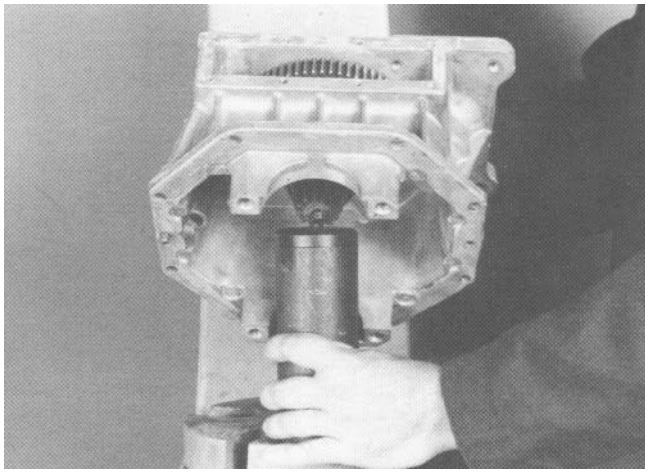

Figure 42

8. Install the outer bearing spacer with the chamfer towards the pinion splines and position the new outer bearing cone on the pinion shaft (Fig. 43).

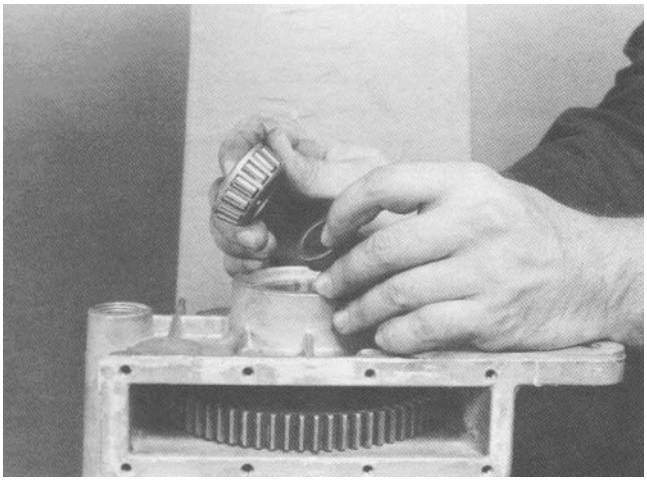

Figure 43

9. With a hollow press sleeve of proper diameter, press on the outer bearing cone race until the drive pinion seats in the carrier and a slight drag is felt when the gear is rotated by hand (Fig. 44). If more than 2 to 13 in-lb (.2 to 1.5 N−m) torque is required to rotate the pinion and spur gear, tap the pinion shaft with a soft mallet until the drag is reduced.

10. Apply Permatex No. 2 (or equivalent) to outer diameter of seal, external splines of pinion shaft and internal splines of pinion coupler. Install differential gear holder to carrier to retain spur gear (see Special Tools).

11. Install seal into housing. Install shim, flange coupler, washer and nut onto end of the pinion shaft (Fig. 45). Torque nut securing pinion coupler from 70 to 90 ft-lbs (95 to 122 N−m).

12. Check pinion shaft end play.

PINION SHAFT END PLAY:
0.000 to 0.005 in. (0.00 to 0.13 mm)

If end play is incorrect, remove nut, washer and flange coupler. Replace shim with appropriate thicker or thinner shim and reassemble. Make sure that pinion shaft end play is correct before continuing with assembly procedure.

NOTE: Pinion shaft shims are available in 0.094 in. (2.39 mm) to 0.120 in. (3.05 mm) thickness, and in 0.125 in. (3.18 mm) to 0.151 in. (3.84 mm) thickness in 0.002 (0.05 mm) increments.

13. Remove differential gear holder from carrier.

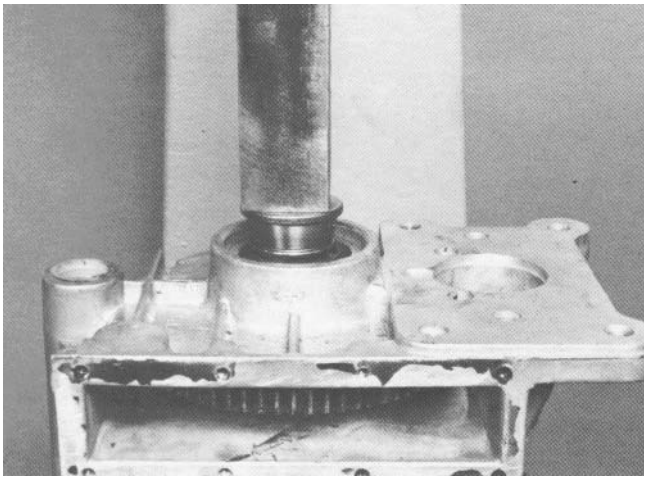

Figure 44

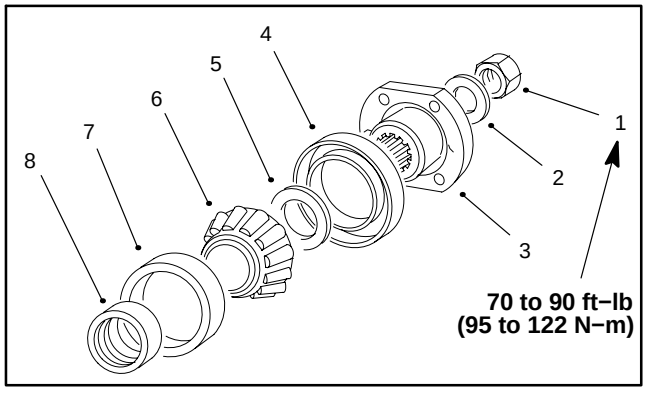

Figure 45

1. **Nut**
2. **Washer**
3. **Flange coupler**
4. **Seal**
5. **Shim**
6. **Outer bearing cone**
7. **Outer bearing cup**
8. **Bearing spacer**

14. Make sure that all gasket material has been removed from the mating surfaces of the spur gear cover and the carrier before assembly.

Apply Permatex No. 2 or silicone sealant to mating surface of spur gear cover and carrier. Install the spur gear cover (Fig. 46). Torque cap screws from 25 to 40 in-lb (3 to 4.5 N−m).

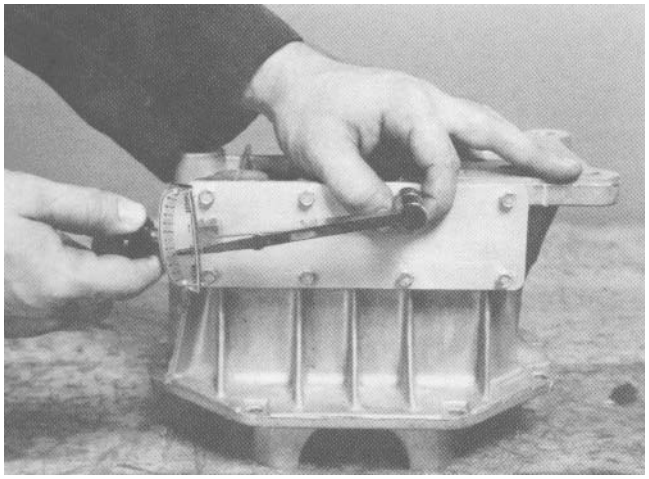

Figure 46

15. Place the differential case in a vise as shown (Fig. 47). Apply grease to new side gear thrust washers and hubs of the side gears. Apply grease to new pinion mate spherical washers and pinion mate gears. Place the side gears and thrust washers in the case. Install the pinion gears while holding the side gears in place.

Rotate the side gears until the holes of the washers and pinion gears line up with the holes of the case. If the gears cannot be rotated by hand, install one of the axle shafts into the side gear spline and use a pipe wrench to turn the shafts.

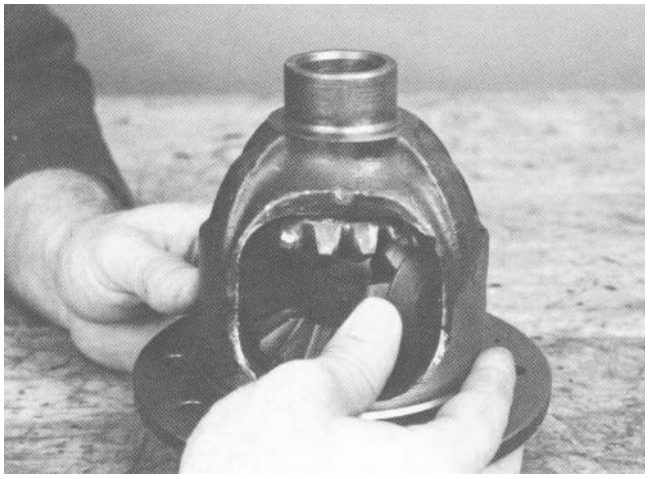

Figure 47

16. Install the pinion shaft. Grease the shaft to aid assembly. Be sure the hole in the pinion shaft lines up with the hole in the differential case (Fig. 48).

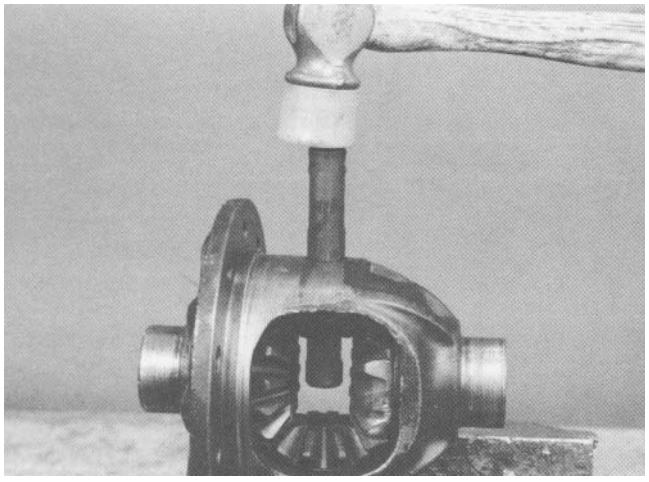

Figure 48

17. Assemble the lock pin. Drive the pin to the approximate center location of the pinion mate shaft. Peen the metal of the case to lock the pin in place (Fig. 49).

Figure 49

18. Position the ring gear onto the differential case and thread new cap screws into the ring gear. Tighten the screws, alternating back and forth across the gear to allow the gear to be pulled evenly into place. Torque cap screws from 45 to 65 ft-lb (61 to 88 N−m) to secure assembly (Fig. 50).

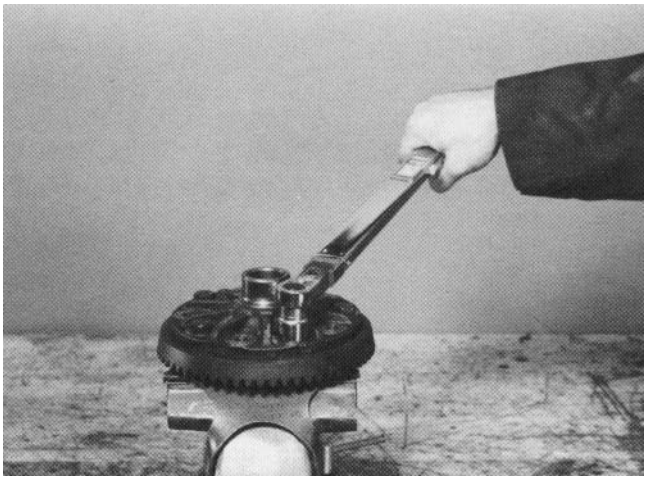

Figure 50

19. When installing new differential bearings, reuse the original shims or use new shims of the same thickness. Press the new differential bearings onto the differential case. If a new differential case is being installed, start with a 0.020 inch (0.50 mm) pack of shims under each differential bearing (Fig. 51).

NOTE: Shims are available in 0.003 in. (0.08 mm), 0.005 in. (0.13 mm), 0.010 in. (0.25 mm) and 0.030 in. (0.76 mm) thickness.

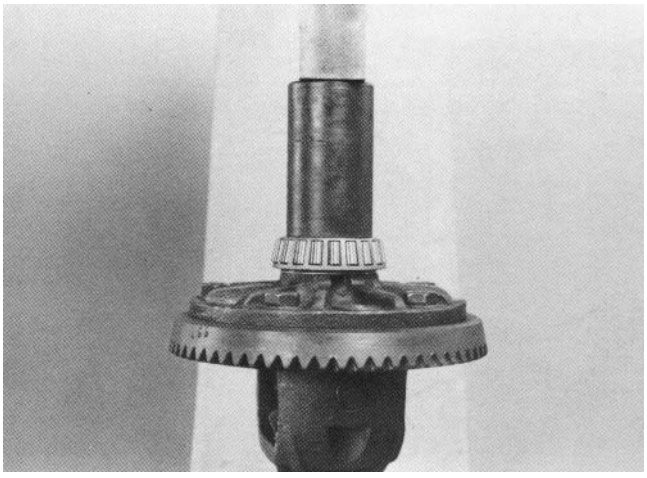

Figure 51

20. Assemble new differential bearing cups onto differential bearing cones. Seat differential assembly with drive gear on proper side of carrier into carrier bearing cradles.

NOTE: This application requires that the ring gear teeth face toward the spur gear cover.

21. The bearing cradles are designed to apply a slight preload to the bearings. It is important to push both of the bearing assemblies simultaneously into their saddles.

Install the bearing caps into their original position as marked during disassembly. Tighten the cap screws to a torque from 30 to 45 ft-lb (41 to 61 N−m) (Fig. 52).

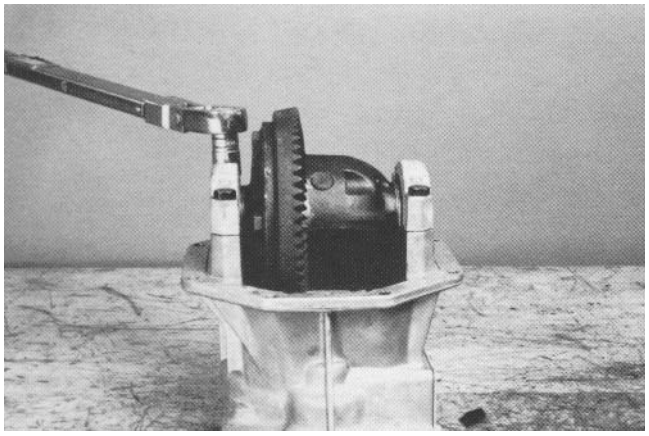

Figure 52

22. Using a dial indicator, check the ring gear backlash in three equally spaced points. Ring gear backlash should be .003 to .007 in. (.076 to .178 mm) and must not vary more than .002 in. (.05 mm) between points checked (Fig. 53).

If the backlash is not in this range, move the shims which are located beneath the differential bearings, from one side to the other until the correct backlash is attained.

23. Check ring to pinion gear engagement (see Ring and Pinion Gear Engagement in this chapter).

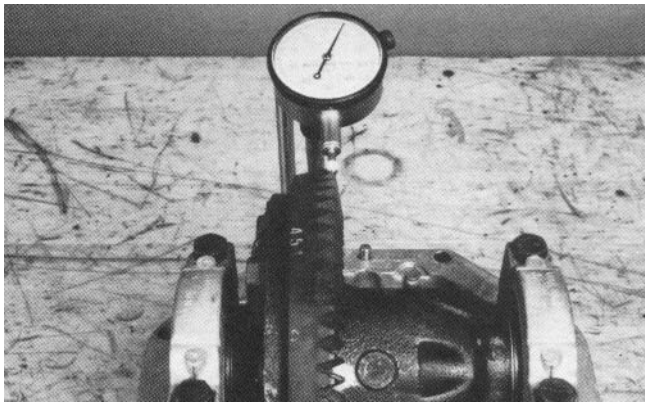

Figure 53

24. Apply silicone sealant between the front and rear axle housings and install the eight (8) housing cap screws. Tighten the cap screws to a torque from 18 to 23 ft-lb (24 to 31 N−m) (Fig. 54).

25. Install the right and left-hand axle assemblies (See Front Axle Shafts and Bearings Assembly in this section).

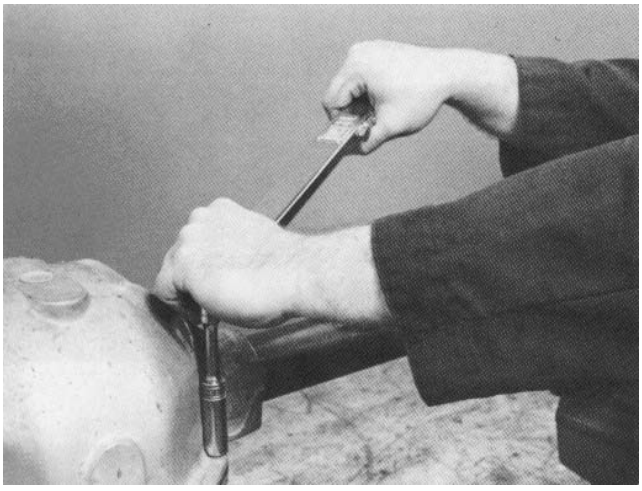

Figure 54

Ring to Pinion Gear Engagement (Front Axle)

Final position of front axle pinion is verified by using the gear contact pattern method as described in the following procedure.

GEAR TOOTH DEFINITIONS (Fig. 55):

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. While applying a light load to the ring gear, rotate the pinion gear until the ring gear has made one complete revolution. The drive side pattern should be located at the toe portion of the tooth. The coast pattern should also be at the toe portion of the tooth (Fig. 56).

Study the patterns in the following illustrations and correct engagement as necessary.

NOTE: When making changes, note that two variables are involved. Example: If you have the backlash set correctly to specifications and you change the pinion position shim, you may have to readjust backlash to the correct specification before checking the pattern.

Every gear has a characteristic pattern. The illustrations show typical patterns only and explain how patterns shift as gear location is changed. When making pinion position changes, shims should be changed in the range of .002 to .004 in. (.05 to .10 mm) until a correct pattern has been obtained.

When a change in backlash is required, backlash shims should be changed in the range of 1-1/2 times the amount of backlash required to bring the gears into specification. For example, if the backlash needed to be changed by .004 in. (.10 mm), the shim pack should be changed by .006 in. (.15 mm) as a starting point.

High backlash is corrected by moving the ring gear closer to the pinion. Low backlash is corrected by moving the ring gear away from the pinion. These corrections are made by switching shims from one side of the differential case to the other.

Example 1: Backlash correct. Thicker pinion position shims required (Fig. 57).

Example 2: Backlash correct. Thinner pinion position shims required (Fig. 58).

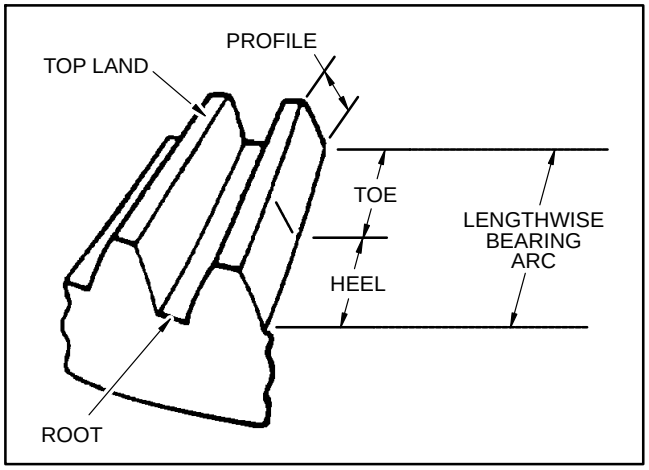

Figure 55

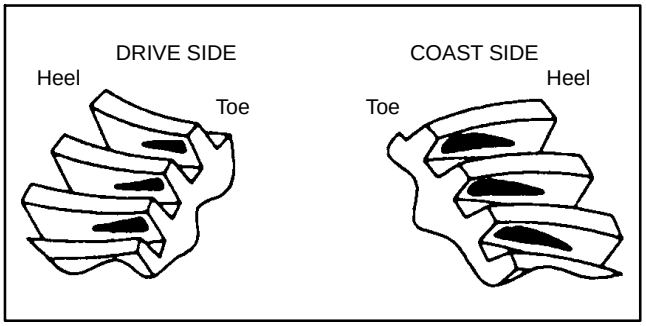

Figure 56

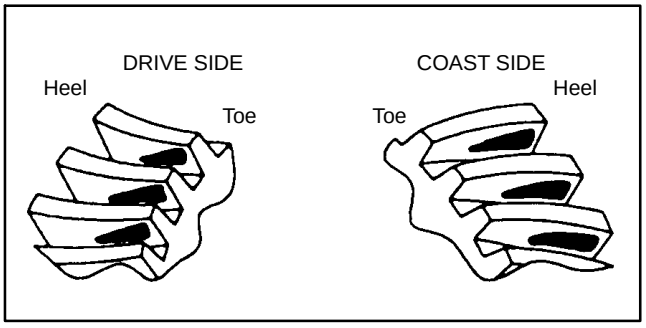

Figure 57

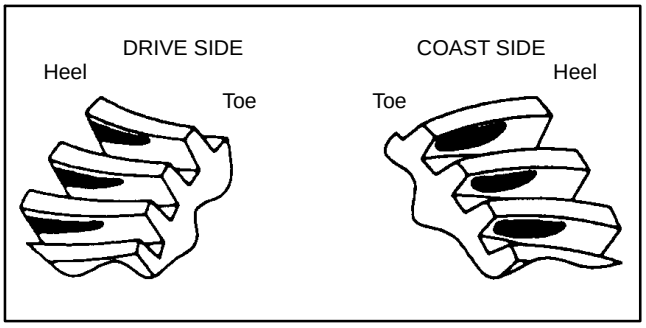

Figure 58

Example 3: Backlash incorrect. Thinner pinion position shim required. Adjust backlash to match (Fig. 59).

GEAR PATTERN MOVEMENT SUMMARY:

A. Decreasing backlash moves the ring gear closer to the pinion.

Drive pattern (convex side of gear) moves lower and toward the toe.

Coast pattern (concave side of gear) moves slightly higher and toward the heel.

B. Increasing backlash moves the ring gear away from the pinion.

Drive pattern (convex side of gear) moves higher and toward the heel.

Coast pattern (concave side of gear) moves slightly lower and toward the toe.

C. Thicker pinion position shim with the backlash constant moves the pinion closer to the ring gear.

Drive pattern (convex side of gear) moves deeper on the tooth (flank contact) and slightly toward the toe.

Coast pattern (concave side of gear) moves deeper on the tooth and toward the heel.

D. Thinner pinion position shim with backlash constant moves the pinion further from the ring gear.

Drive pattern (convex side of gear) moves toward the top of the tooth (face contact) and toward the heel.

Coast pattern (concave side of gear) moves toward the top of the tooth (face contact) and toward the heel.

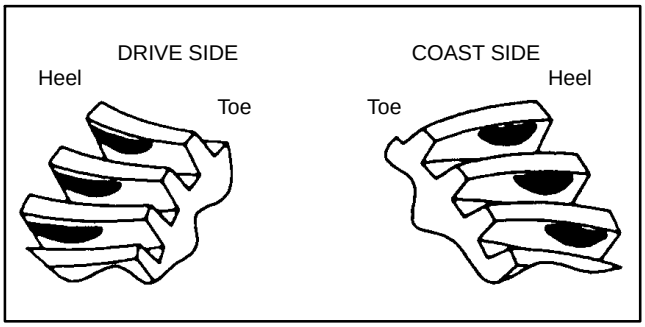

Figure 59

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Rear Axle Drive Shaft (4 Wheel Drive)

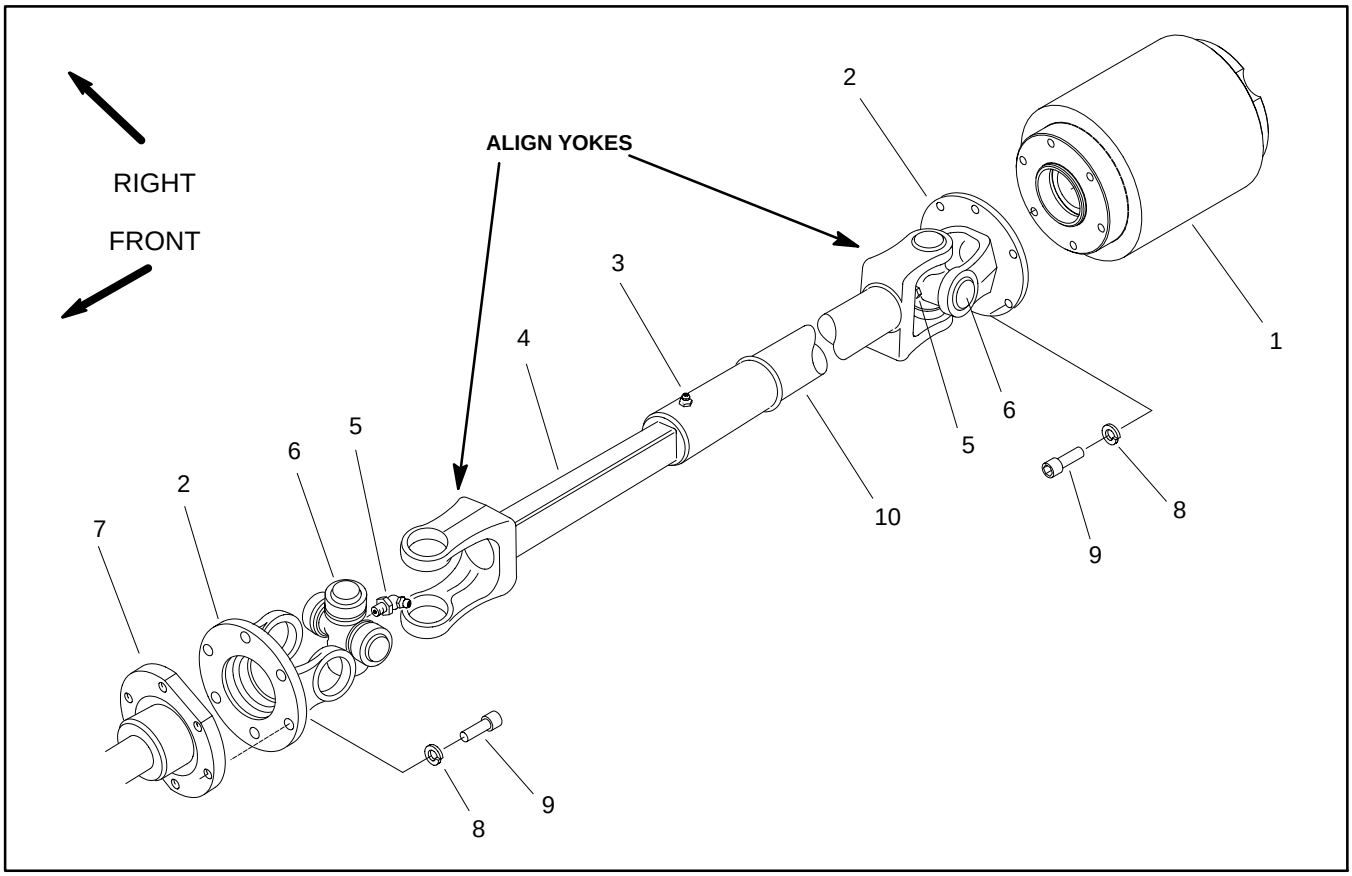

Figure 60

1. **Bidirectional clutch**
2. **Yoke flange**
3. **Grease fitting**
4. **Yoke and shaft**
5. **Grease fitting**
6. **Cross and bearing kit**
7. **Front axle flange**
8. **Lock washer (6 per flange)**
9. **Socket head screw (6 per flange)**
10. **Yoke and tube**

Removal (Fig. 60)

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

2. Support drive shaft to prevent it from falling.

3. Disconnect front yoke flange of drive shaft from front axle flange by removing six (6) socket head screws and lock washers.

4. Disconnect rear yoke flange of drive shaft from bidirectional clutch by removing six (6) socket head screws and lock washers.

5. Remove rear axle drive shaft from machine.

Installation (Fig. 60)

IMPORTANT: If the drive shaft tube and shaft were separated, make sure that the drive shaft yokes are aligned when the tube and shaft are assembled (Fig. 60). Misalignment of the yokes will result in shortened drive shaft life and will cause unnecessary vibration.

1. Position rear axle drive shaft to machine. Make sure that drive shaft tube (item 10) is toward rear axle.

2. Secure yokes of drive shaft to front axle flange and bidirectional clutch with removed fasteners.

3. Lubricate drive shaft grease fittings (see Traction Unit Operator's Manual).

Rear Axle Drive Shaft Cross and Bearing Service (4 Wheel Drive)

1. Remove rear axle drive shaft from vehicle (see Rear Axle Drive Shaft (4 Wheel Drive) Removal in this section).

2. Remove snap rings that secure bearings in yokes.

IMPORTANT: Yokes must be supported when removing and installing bearings to prevent damage.

3. Use a press to remove cross and bearings from yokes. Thoroughly clean drive shaft yokes.

4. To install new cross and bearings:

   A. Apply a coating of grease to bearing bores in end yoke and shaft yoke.

   B. Press one bearing partially into yoke.

   C. Insert cross into yoke and bearing.

   D. Hold cross in alignment and press bearing in until it hits the yoke.

   E. Install snap ring into yoke groove to secure installed bearing.

   F. Place second bearing into yoke bore and onto cross shaft. Press bearing into yoke and secure with snap ring.

   G. Repeat procedure for other yoke.

   H. Grease cross until grease comes out of all four (4) cups.

5. Make sure that assembled joint moves without binding. Slight binding can usually be eliminated by lightly rapping the yoke lugs with a soft faced hammer. If binding continues, disassemble joint to identify source of binding.

6. Install drive shaft to vehicle (see Rear Axle Drive Shaft (4Wheel Drive) Installation in this section).

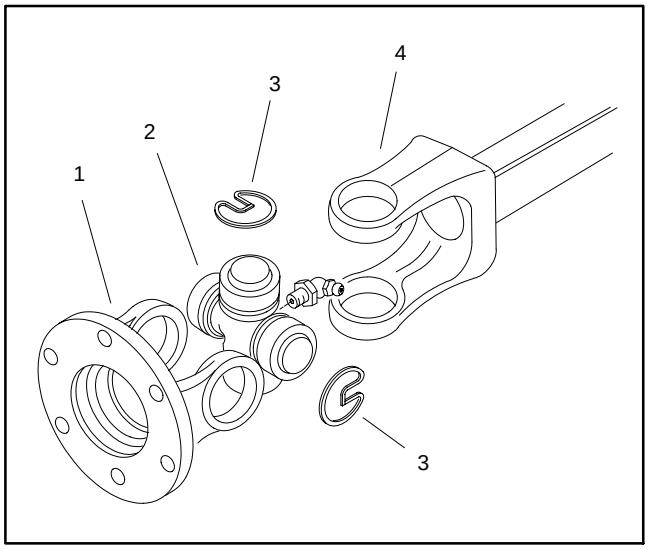

Figure 61

1. End yoke
2. Cross and bearing kit
3. Snap ring (4 used)
4. Shaft yoke

Rear Axle (4 Wheel Drive)

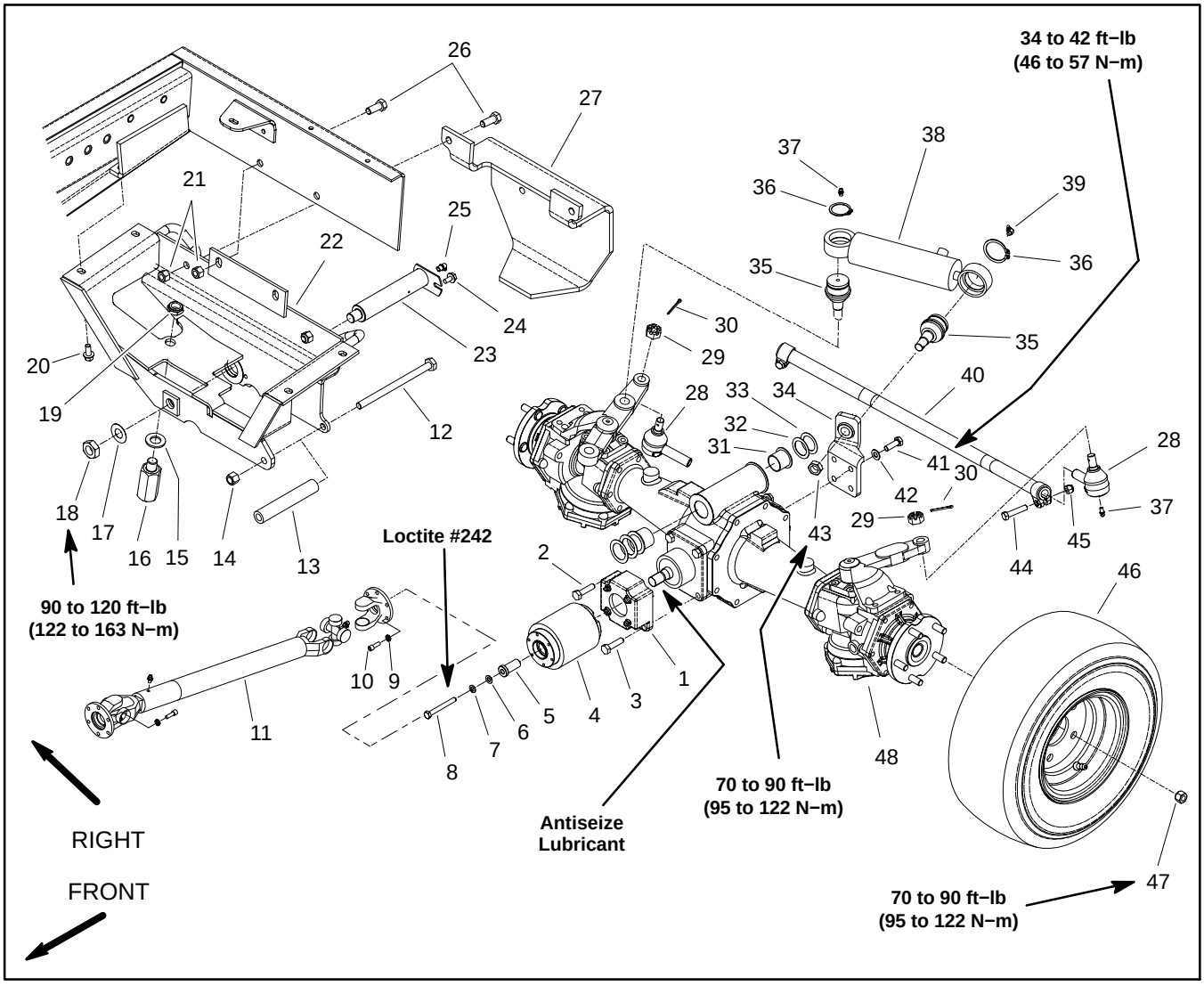

Figure 62

1. Clutch locator adapter
2. Cap screw (2 used)
3. Cap screw (2 used)
4. Bidirectional clutch
5. Spacer
6. Flat washer
7. Lock washer
8. Cap screw
9. Lock washer (6 used)
10. Socket head screw (6 used)
11. Driveshaft assembly
12. Cap screw
13. Axle stop
14. Lock nut
15. Flat washer
16. Oscillation stop
17. Thrust washer
18. Jam nut
19. Lock nut
20. Flange head screw (4 used)
21. Lock nut (4 used)
22. Axle support
23. Axle pin
24. Washer head screw
25. Grease fitting
26. Cap screw (4 used)
27. Rear bumper
28. Tie rod end
29. Slotted hex nut
30. Cotter pin
31. Flange bushing (2 used)
32. Thrust washer (as needed)
33. Thrust washer (as needed)
34. Steering cylinder support bracket
35. Steering cylinder ball joint
36. Retaining ring
37. Grease fitting
38. Steering cylinder
39. Grease fitting
40. Tie rod
41. Cap screw (4 used)
42. Washer (4 used)
43. Jam nut (4 used)
44. Cap screw (2 used)
45. Lock nut (2 used)
46. Wheel assembly
47. Lug nut
48. Rear axle assembly

NOTE: For repair information regarding the rear axle on 2 wheel drive machines, refer to Chapter 7 − Chassis.

Removal (Fig. 62)

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

2. Drain oil from rear axle (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 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 six (6) socket head screws (item 10) and lock washers (item 9) that secure driveshaft to bidirectional clutch on rear axle. Position end of driveshaft away from clutch.

6. Remove steering cylinder from rear axle (see Steering Cylinder Removal in Service and Repairs section of Chapter 5 − Hydraulic System).

7. If machine has rear weight(s) attached to frame, remove weight(s).

8. Support rear axle to prevent it from falling. Remove two (2) cap screws (item 26) with lock nuts (item 21) and then four (4) flange head screws (item 20) that secure rear axle support to equipment frame. Lower rear axle and rear axle support from machine.

9. Remove jam nut (item 18) and thrust washer (item 17) from axle pin (item 23) that attaches rear axle to rear axle support. Remove washer head screw (item 24) that secures flange of axle pin to rear axle support.

10. Remove axle pin. Separate rear axle support from rear axle. Note location of thrust washers on both ends of axle mounting boss.

Installation (Fig. 62)

1. Position rear axle support to axle. Install thrust washers (items 32 and 33) between axle boss and axle support to minimize clearance.

2. Install axle pin (item 23) to secure axle to rear axle support. Install thrust washer (item 17) and jam nut (item 18) onto pivot pin. Torque jam nut from 90 to 120 ft−lb (122 to 163 N−m). Secure pivot pin to axle support with washer head screw (item 24).

3. Position axle and axle support under machine with a jack. Raise assembly to machine frame and align mounting holes of axle support and machine frame.

4. Secure rear axle support to frame with four (4) flange head screws (item 20) and two (2) cap screws (item 26) with lock nuts (item 21).

5. Install steering cylinder to axle assembly (see Steering Cylinder Installation in Service and Repairs section of Chapter 5 − Hydraulic System).

6. Position end of driveshaft to bidirectional clutch on rear axle. Secure driveshaft to clutch with six (6) socket head screws (item 10) and lock washers (item 9).

WARNING

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

7. Install wheels to axle. Torque wheel lug nuts from 70 to 90 ft−lb (95 to 122 N−m).

8. Lower machine to ground.

9. If equipped with rear weight(s), attach weight(s) to rear of machine.

10. Fill axle and input gearbox with SAE 80W−90 weight gear lube (see Traction Unit Operator's Manual).

11. Start engine and check for component interference as steering wheel is turned from lock to lock.

12. Check rear wheel toe−in and adjust if necessary (see Traction Unit Operator's Manual).

13. Check steering stop bolt adjustment on both sides of axle. At full RH and LH turns, a gap of 0.088" (2.2 mm) should exist between bevel gear case casting and stop bolt on axle case.

Bevel Gear Case and Axle Case (4 Wheel Drive Axle)

The following procedures assume the 4WD 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. 63).

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.

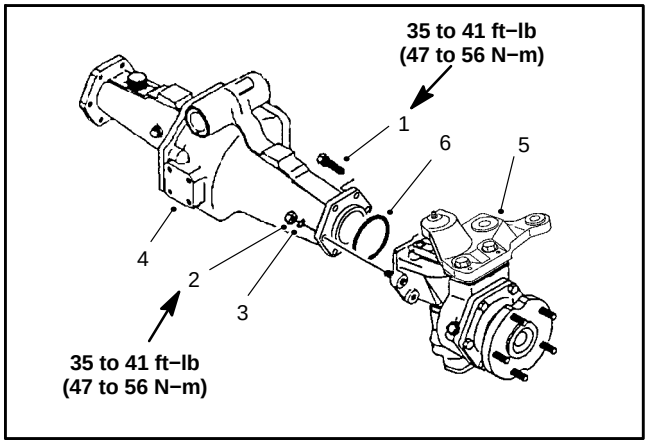

Figure 63

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

3. Remove the axle cover mounting screws. Remove the axle cover from the axle case as an assembly (Fig. 64).

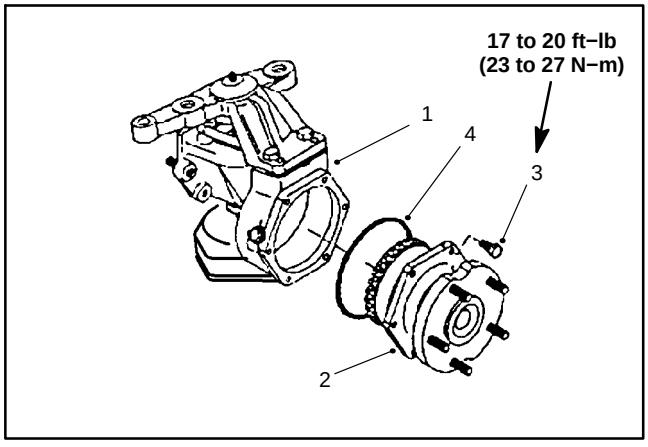

Figure 64

1. Axle case
2. Axle cover assembly
3. Mounting screw
4. O-ring

4. Remove the axle case support mounting screws, the axle case support and the support shims (Fig. 65).

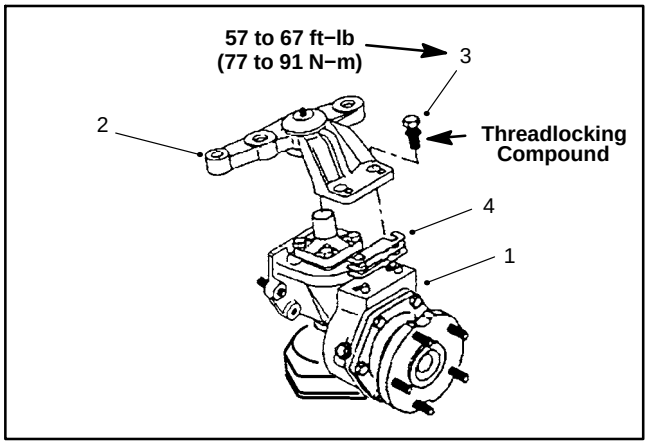

Figure 65

1. Axle case
2. Axle case support
3. Mounting screw
4. Support shim

5. Remove the knuckle pin mounting screws and the knuckle pin. Remove and discard o−ring (Fig. 66).

6. While holding the bevel gear case, lightly 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, collar, spacer and thrust washer from the gear case.

8. Remove the axle case cover screws, cover and O-ring from the axle case.

9. Remove the plug and sealing washer (not shown) 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 seals from bevel gear case and axle case (Fig. 66).

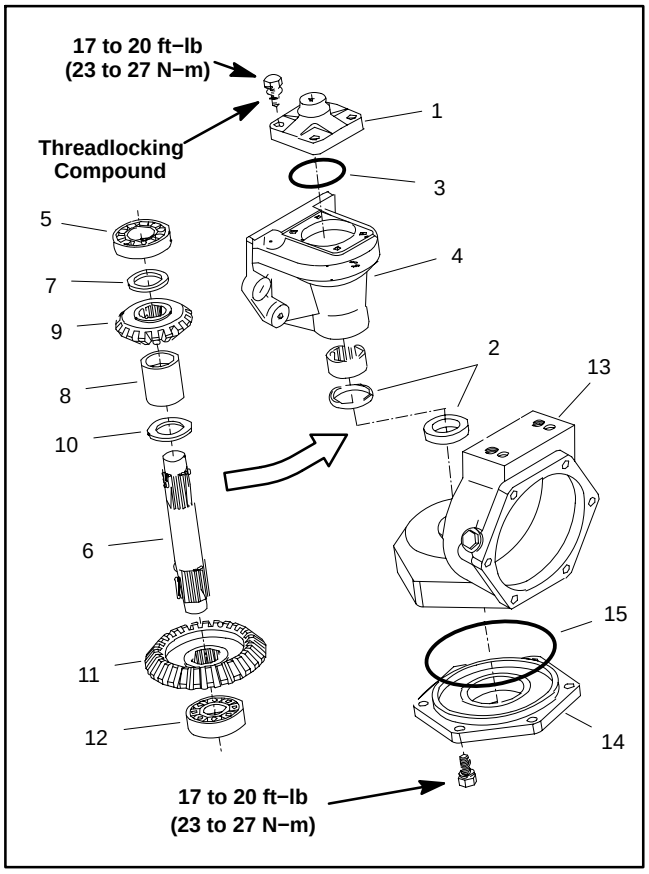

Figure 66

1. Knuckle pin
2. Shaft seals
3. O−ring
4. Bevel gear case
5. Upper bearing
6. Bevel gear shaft
7. Collar
8. Spacer
9. Upper bevel gear
10. Thrust washer
11. Lower bevel gear
12. Lower bearing
13. Axle case
14. Axle case cover
15. O-ring

Inspection

1. Measure the knuckle pin O.D. and the axle case support bushing I.D. to determine the bushing to pin clearance (Fig. 67). 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.

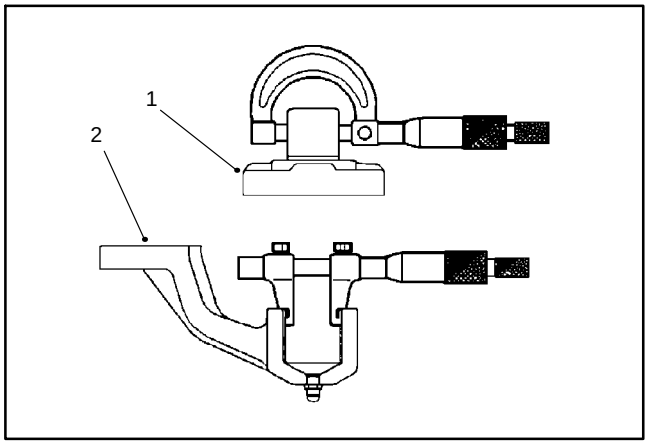

Figure 67

1. Knuckle pin
2. Axle case support

Installation

1. Coat new shaft seals with grease and install in axle case and bevel gear case as shown (Fig. 68).

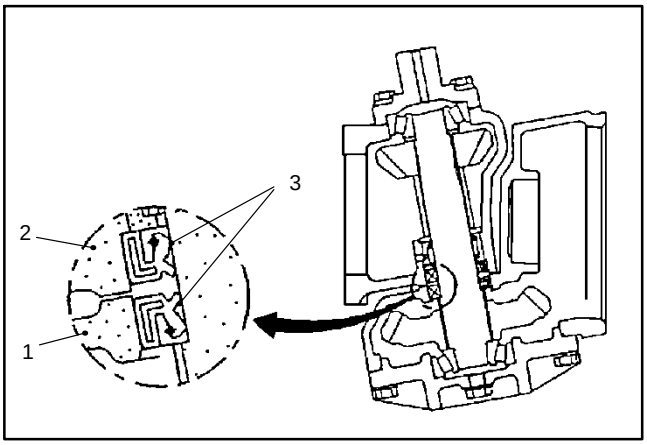

Figure 68

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. 69). 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 thrust washer, spacer, bevel gear and collar. Make sure the bevel gear shaft is completely seated in the upper and lower bearings (Fig. 69).

4. Install new o−ring and then knuckle pin. Use medium strength Loctite thread locker and tighten the knuckle pin mounting screws from 17 to 20 ft-lb (23 to 27 N−m).

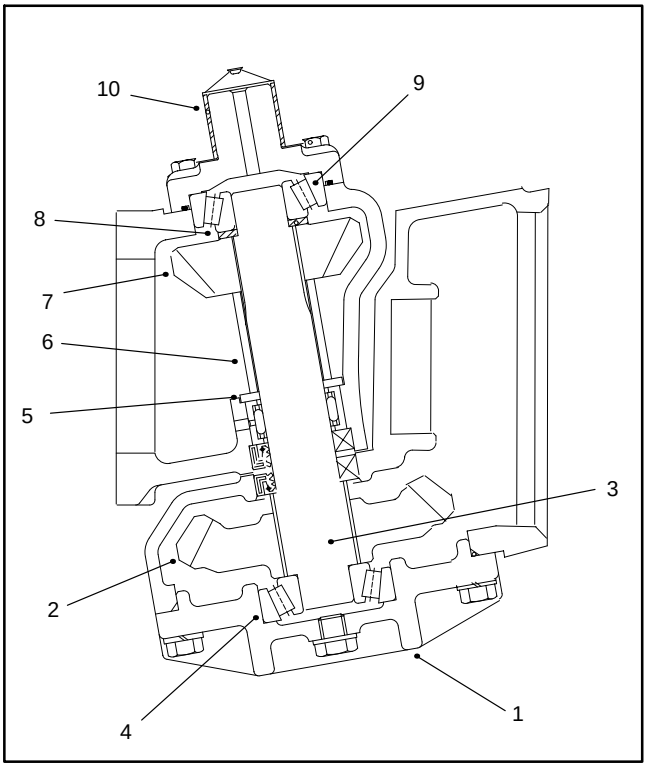

Figure 69

1. **Axle case cover**
2. **Lower bevel gear**
3. **Bevel gear shaft**
4. **Lower bearing**
5. **Thrust washer**
6. **Spacer**
7. **Upper bevel gear**
8. **Collar**
9. **Upper bearing**
10. **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. 70).

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. (0.10 mm), 0.008 in. (0.20 mm) and 0.016 in. (0.40 mm) thickness.

6. After correct support shims have been determined, remove mounting screws and apply heavy strength thread−locking compound to screw threads. Reinstall screws and torque from 57 to 67 ft−lb (77 to 91 N−m).

IMPORTANT: Correct engagement between bevel gears is critical to axle performance and durability.

7. Temporarily install the bevel gear case/axle case assembly on the axle support. Position a dial indicator at the tooths center. Prevent the axle from turning and measure the upper bevel gear to differential shaft gear backlash (Fig. 71).

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. (0.10 mm), 0.008 in. (0.20 mm) and 0.020 in. (0.50 mm) thickness.

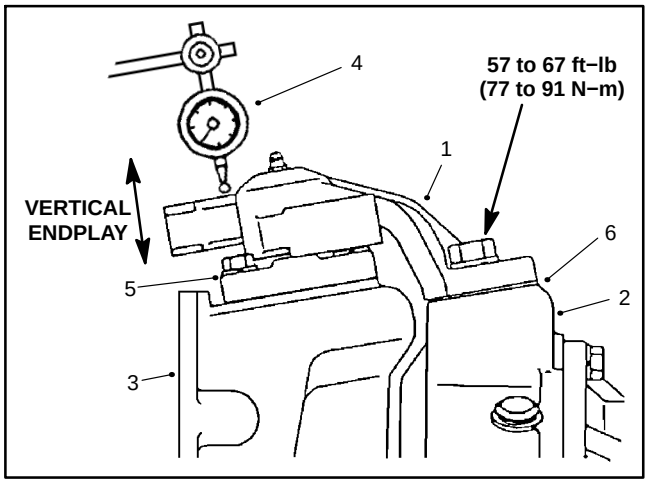

Figure 70

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

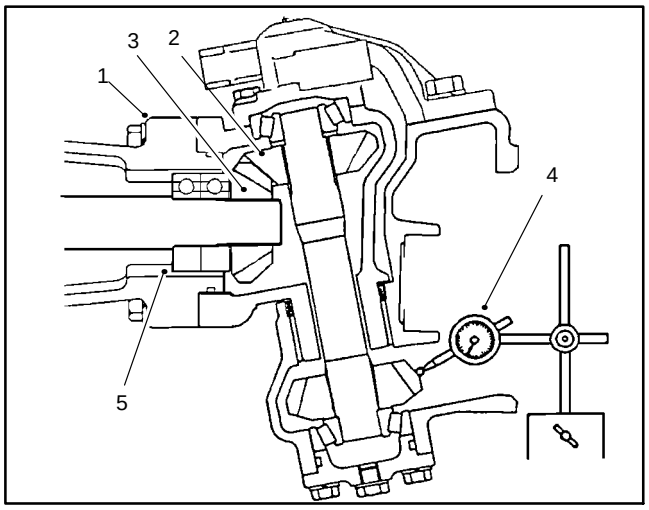

Figure 71

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

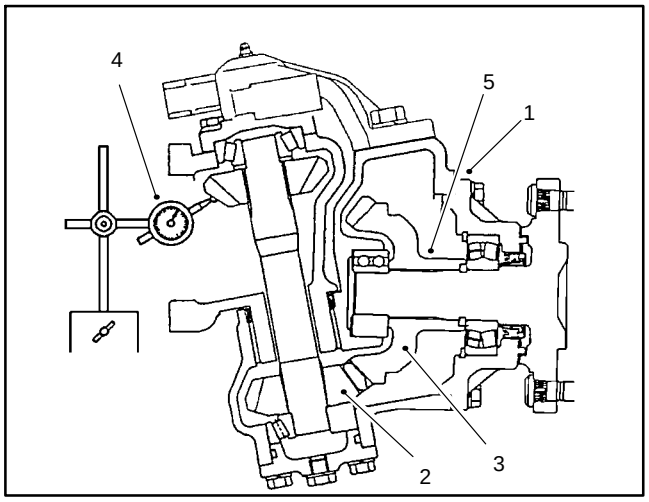

Figure 72

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

9. Remove the bevel gear case/axle case assembly from the axle support. Coat a new O-ring with grease and temporarily install the axle cover assembly. Position a dial indicator at the tooths center. Prevent the axle from turning and measure the lower bevel gear to axle gear backlash (Fig. 72).

LOWER BEVEL GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

10. Adjust backlash by increasing or reducing axle bearing shim thickness (see Axle Shafts in this section of this manual).

NOTE: Axle bearing shims are available in 0.008 in. (0.20 mm), 0.012 in. (0.30 mm) and 0.020 in. (0.50 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. 73).

Differential Shafts (4 Wheel Drive Axle)

The following procedures assume the 4WD rear axle assembly has been removed from the machine.

Removal

IMPORTANT: Do not interchange right and left differential shafts assemblies. Mark right and left shafts before disassembly.

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. 73).

2. Mark and pull the differential shaft assembly from the axle support.

3. Remove the retaining ring and bevel gear (Fig 74).

4. Drive the differential shaft out of the bearings. Remove the bearings and bearing shims.

5. Inspect all gears, shafts, bearings and cases for damage and wear. Replace components as necessary.

Installation

1. Press bearings onto differential shaft. Place correct combination of bearing shims in axle support and drive differential shaft and bearing assembly into axle support.

2. Install bevel gear and retaining ring.

3. Coat new O-ring with grease. Align differential shaft splines with differential gear assembly and slide differential shaft assembly onto axle support.

4. Install bevel gear case/axle case assembly (see Bevel Gear Case/Axle Case Assembly in this section of this manual).

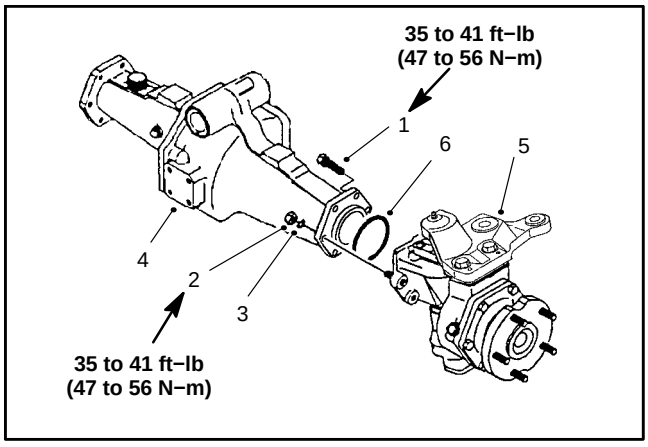

Figure 73

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

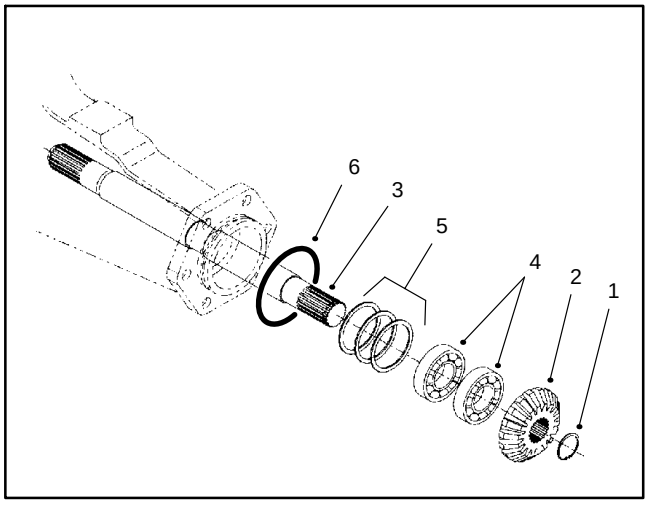

Figure 74

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

Axle Shafts (4 Wheel Drive Axle)

The following procedures assume the 4WD 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. 75).

2. Use a bearing puller to remove the bearing and bevel gear as shown (Fig. 76).

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. 77).

2. Press the axle cover and bearing assembly onto the axle shaft. Press only on the inner race of the cover bearing (Fig. 77).

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).

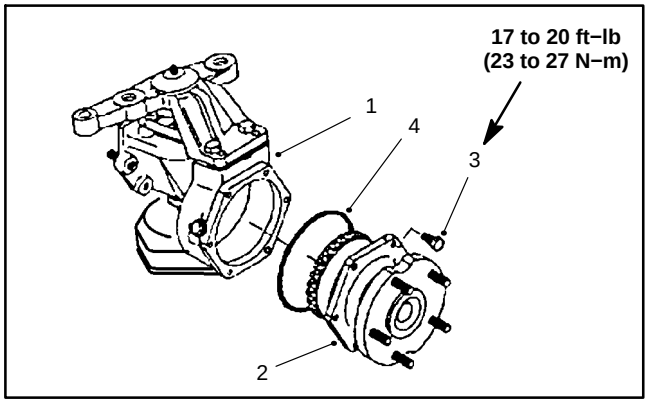

Figure 75

1. **Axle case**
2. **Axle cover assembly**
3. **Mounting screw**
4. **O-ring**

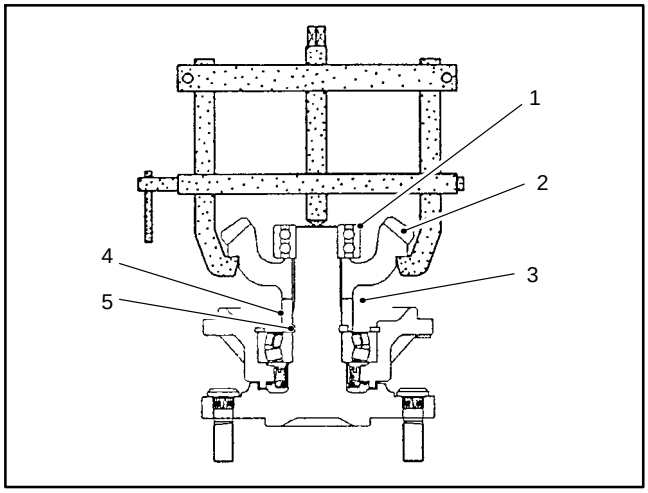

Figure 76

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

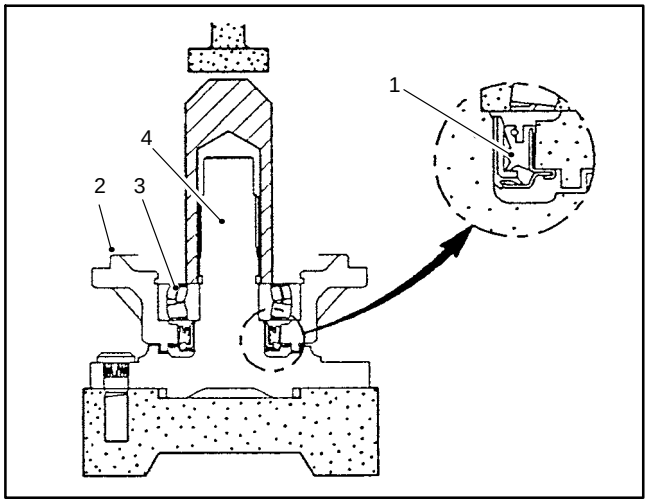

Figure 77

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

Input Shaft/Pinion Gear (4 Wheel Drive Axle)

The following procedures assume the 4WD rear axle assembly has been removed from the machine.

Removal (Fig. 78)

1. Remove input shaft/pinion gear assembly from the axle support. Remove the shims and bearing case O-ring.

2. Release the stake washer and remove the lock nut. Remove and discard the stake washer.

3. Drive the input shaft/pinion gear out from the outer bearing cone and bearing case. Remove and discard the oil seal and O-ring.

4. Inspect all gears, shafts, bearings, spacers and cases for damage and wear. Replace components as necessary.

NOTE: Replacement input shaft/pinion gears are only available in matched ring and pinion sets.

Installation (Fig. 78)

NOTE: When installing new bearing cones, press only on the inner race of the bearing cone.

1. If the inner bearing cone was removed, press a new bearing cone all the way onto the input shaft/pinion gear.

2. Place the shaft and bearing assembly in the bearing case and install the outer bearing cone.

NOTE: The bearings must be completely seated. There should be no input shaft/pinion gear end play.

3. Coat a new oil seal with grease and install as shown in Figure 79.

4. Coat a new O-ring with grease. Install O-ring in the 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.

7. Slowly tighten the lock nut until 4.0 to 6.0 in-lb (0.4 to 0.7 N−m) of force is required to rotate the input shaft/pinion gear in the bearing case.

8. Secure the lock nut with the stake washer.

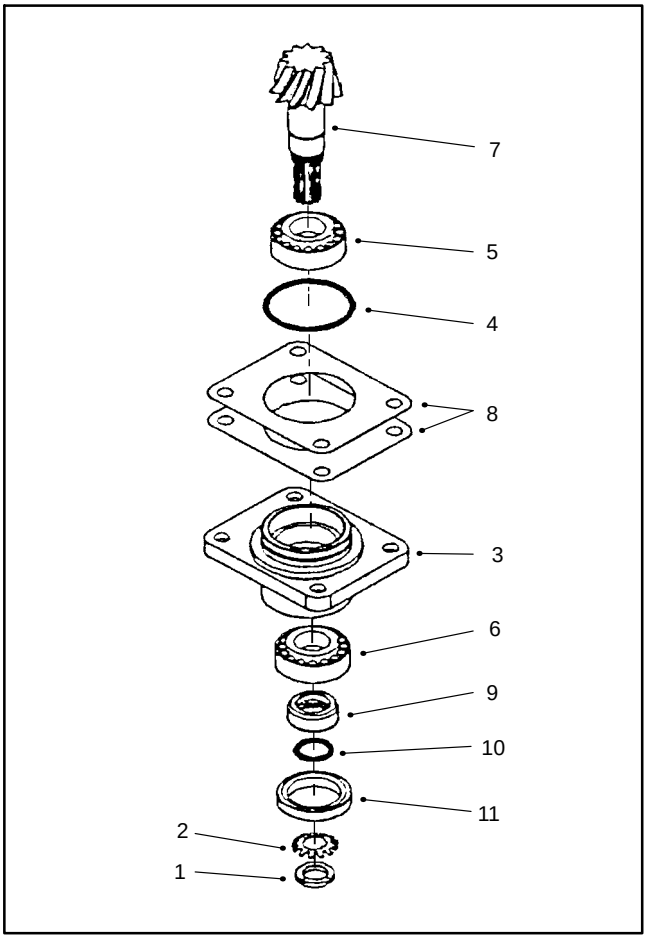

Figure 78

1. **Lock nut**
2. **Stake washer**
3. **Bearing case**
4. **Bearing case O-ring**
5. **Inner bearing**
6. **Outer bearing**
7. **Input shaft/pinion gear**
8. **Bearing case shims**
9. **Seal collar**
10. **O-ring**
11. **Oil seal**

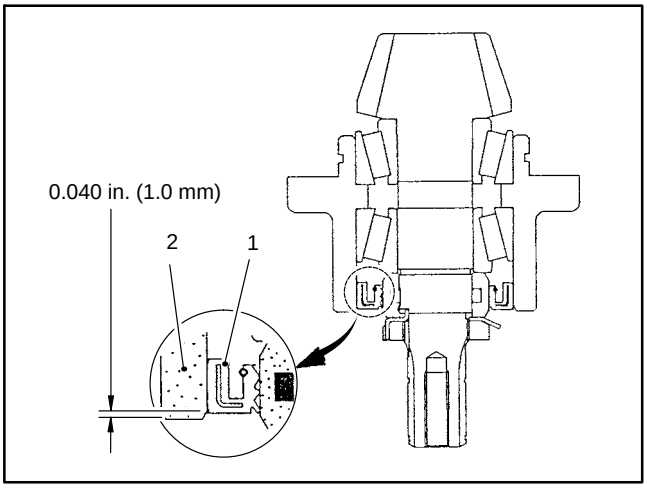

Figure 79

1. **Oil seal**
2. **Bearing case**

9. 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. NO TAG).

DESIGN CONE CENTER DISTANCE
(distance from mating surface of axle support to end face of pinion gear):
1.870 ± 0.002 in. (47.50 ± 0.05 mm)

NOTE: Bearing case shims are available in 0.004 in. (0.10 mm) and 0.008 in. (0.20 mm) thickness.

10. Coat a new O-ring with grease. Place shims on the bearing case and temporarily install input shaft/pinion gear assembly into axle case. Tighten mounting screws from 35 to 41 ft-lb (47 to 56 N−m).

11. Insert a screwdriver through the drain plug hole to hold ring gear and measure the pinion gear to ring gear backlash (Fig. 81).

PINION GEAR TO RING GEAR BACKLASH:
0.004 to 0.016 in. (0.10 to 0.40 mm)

12. Adjust backlash by increasing or reducing bearing case shim thickness.

13. Check pinion gear to ring gear engagement (see Pinion Gear to Ring Gear Engagement in this section of this manual).

14. Place the correct combination of shims on the bearing case. Tighten mounting screws from 35 to 41 ft-lb (47 to 56 N−m).

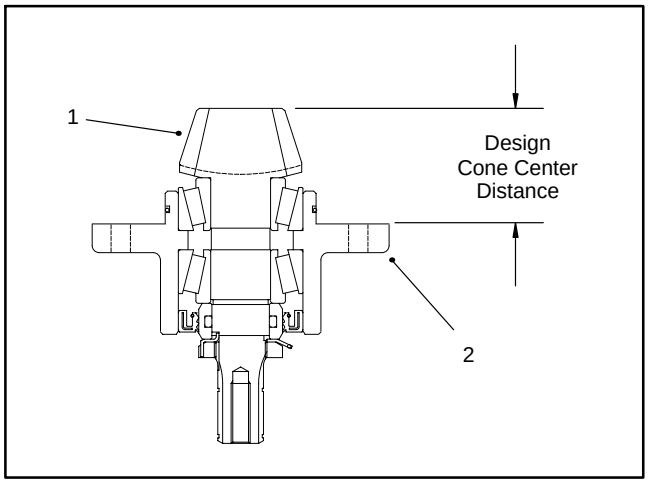

Figure 80

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

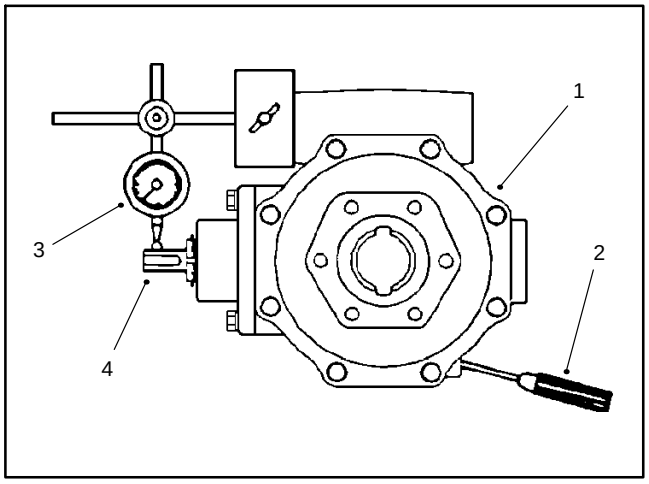

Figure 81

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

Differential Gear Assembly (4 Wheel Drive Axle)

The following procedures assume the 4WD rear axle assembly has been removed from the machine.

Removal

1. Remove bevel gear case/axle case assemblies (see Bevel Gear Case/Axle Case Assembly in this section of this manual).

IMPORTANT: Do not interchange right and left differential shafts assemblies.

2. Mark the differential shaft assemblies for assembly purposes. 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. 82).

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. 83).

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. 84).

NOTE: Replacement ring gears are only available in matched ring and pinion sets.

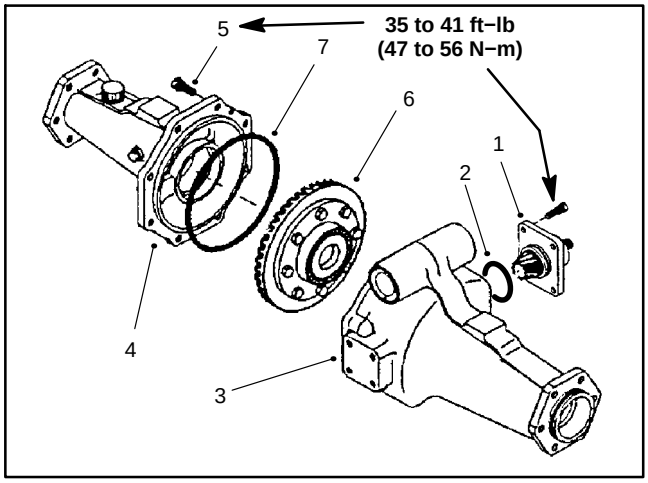

Figure 82

1. **Pinion gear assembly**
2. **O-ring**
3. **Axle support (right)**
4. **Axle support (left)**
5. **Case screws**
6. **Differential gear assy.**
7. **O-ring**

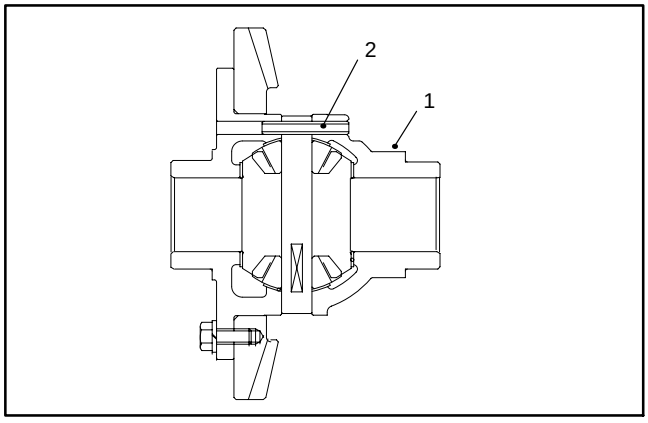

Figure 83

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

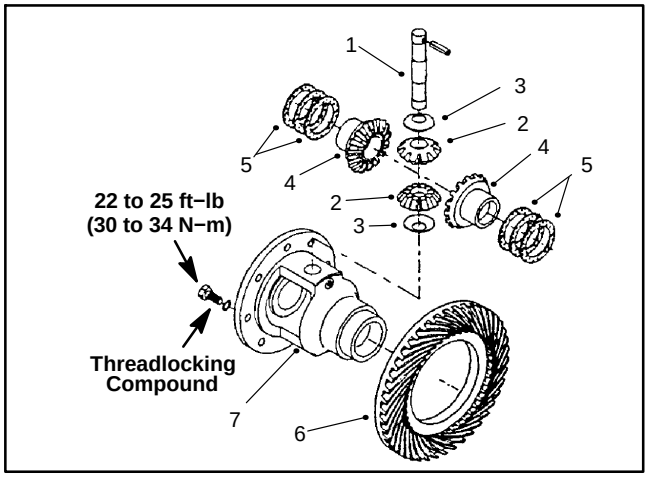

Figure 84

1. **Differential pinion shaft**
2. **Pinion gear**
3. **Pinion washer**
4. **Side gear**
5. **Side gear shims**
6. **Ring gear**
7. **Differential case**

Inspection

1. Measure the differential side gear O.D. and the differential case I.D. to determine the side gear to case clearance (Fig. 85). 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. 86). 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 13.98 mm)

PINION GEAR I.D. (Factory Spec.):
0.551 to 0.552 in. (14.00 to 14.02 mm)

3. Inspect all gears, shafts, bearings, cases and covers for damage and wear. Replace components as necessary.

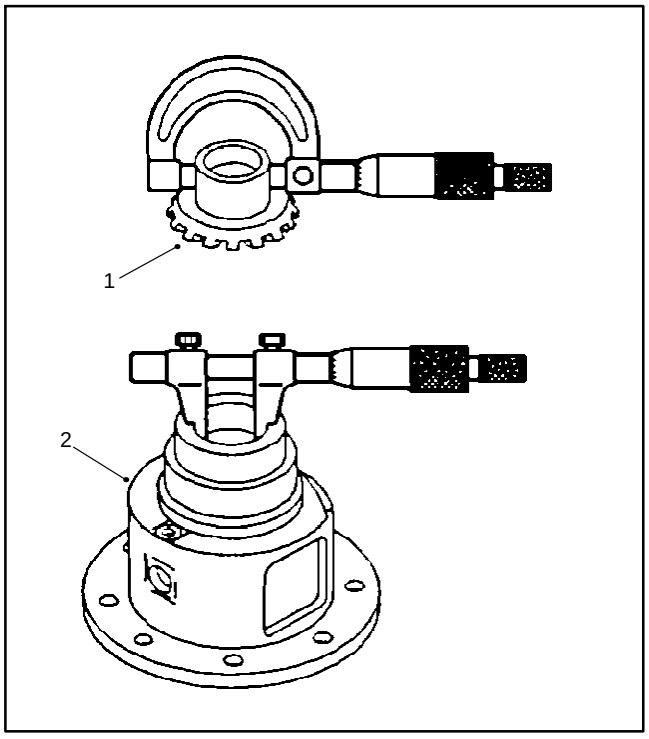

Figure 85

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

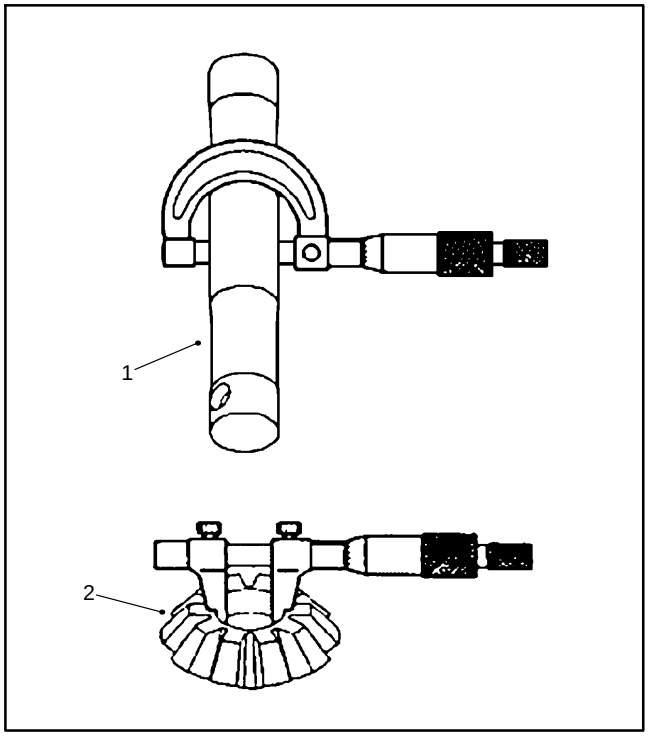

Figure 86

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. 87).

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. 88).

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.

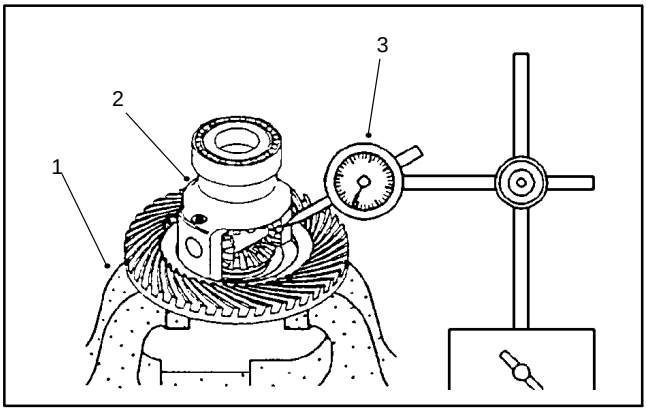

Figure 87

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

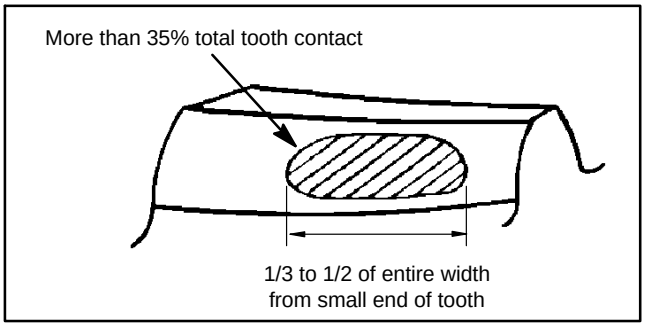

Figure 88

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 (4 Wheel Drive Axle)

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. 89):

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. 90).

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. 91).

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. 92 and 93) 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.

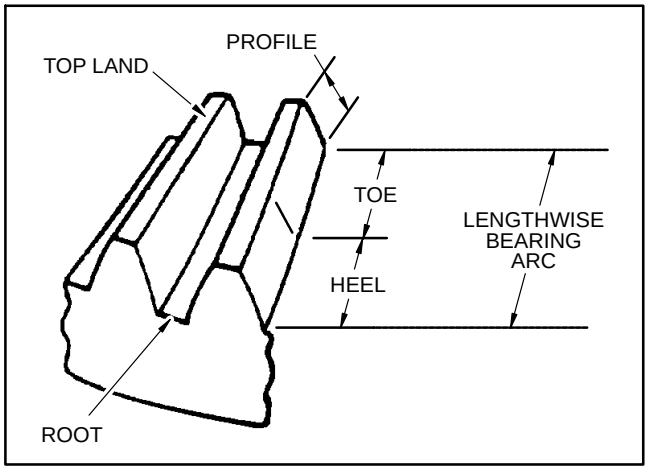

Figure 89

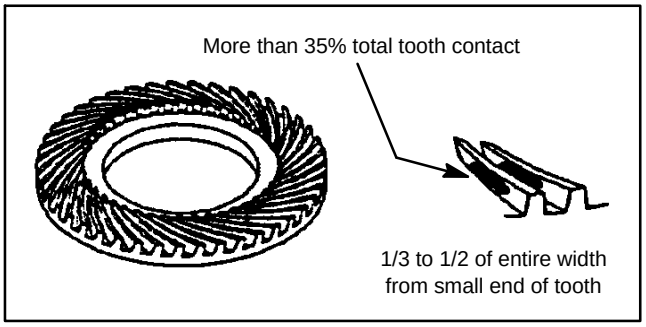

Figure 90

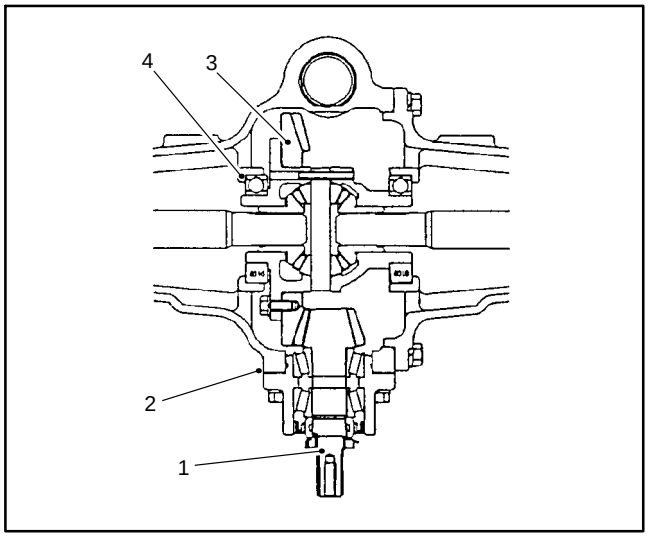

Figure 91

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

Gear Pattern Movement Summary

Every gear has a characteristic pattern. The illustrations show typical patterns only and explain how patterns shift as gear location is changed.

1. If contact is toward the heel or base of the gear (Fig. 92):

   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. 93):

   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.

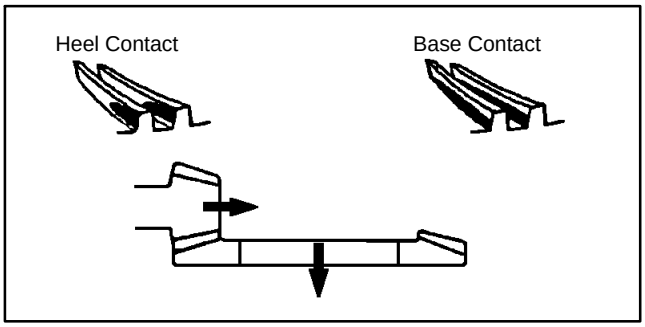

Figure 92

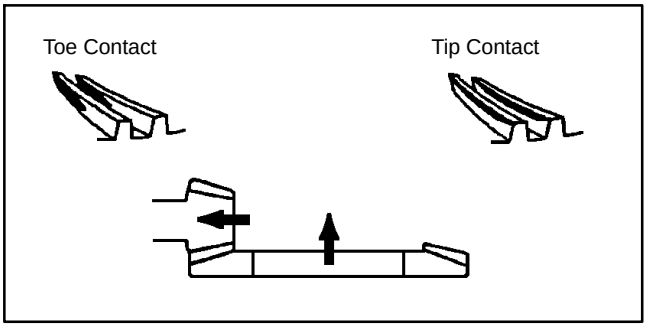

Figure 93

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Bidirectional Clutch (4 Wheel Drive)

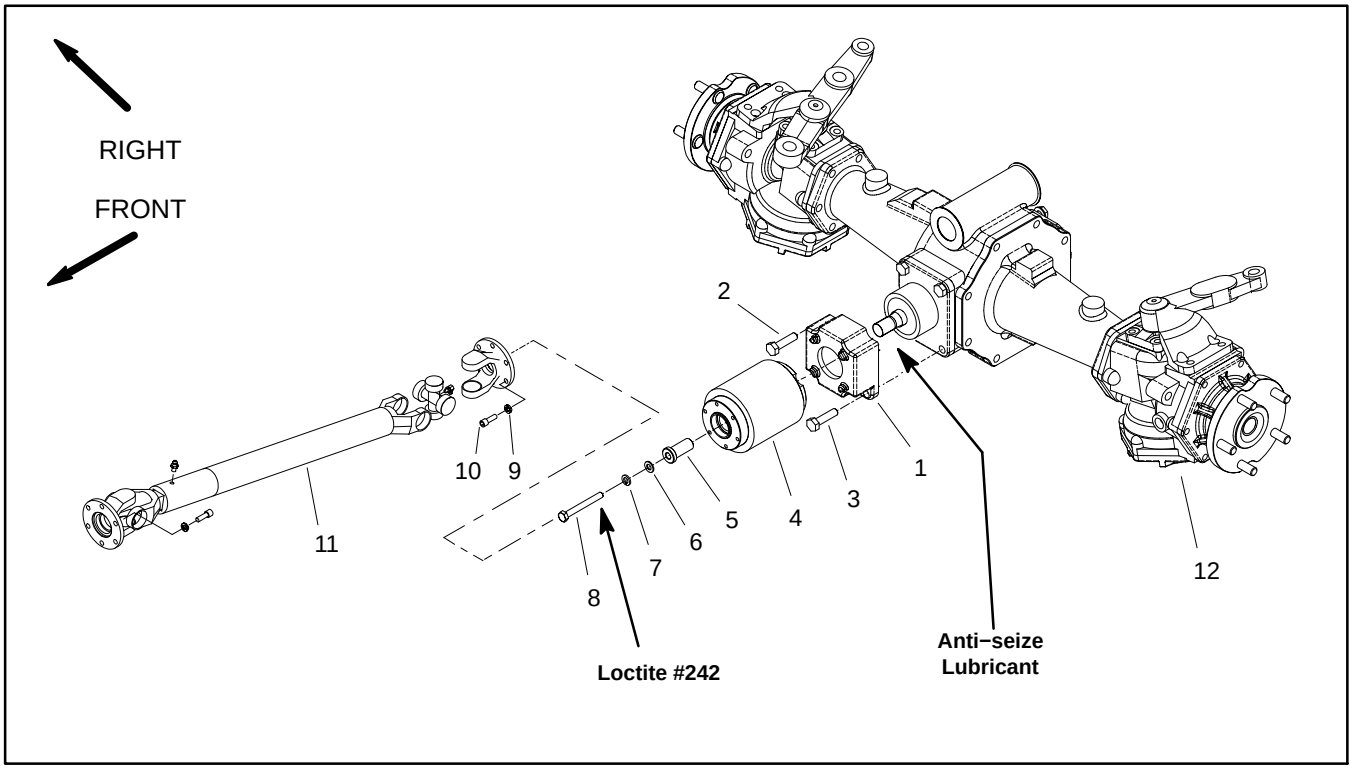

Figure 94

1. **Clutch locator adapter**
2. **Cap screw (2 used)**
3. **Cap screw (2 used)**
4. **Bidirectional clutch**
5. **Spacer**
6. **Flat washer**
7. **Lock washer**
8. **Cap screw**
9. **Lock washer (6 used)**
10. **Socket head screw (6 used)**
11. **Drive shaft assembly**
12. **Rear axle assembly**

Removal (Fig. 94)

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

2. Drain oil from bidirectional clutch (see Traction Unit Operator's Manual).

3. Remove six (6) socket head screws (item 10) and lock washers (item 9) that secure driveshaft to bidirectional clutch on rear axle. Position end of driveshaft away from clutch.

4. Remove cap screw (item 8), lock washer (item 7) and flat washer (item 6) that secure clutch to rear axle. Locate and retrieve spacer (item 5).

5. Pull bidirectional clutch from rear axle input shaft.

Installation (Fig. 94)

1. Apply anti−seize lubricant to splines of rear axle input shaft.

2. Slide bidirectional clutch onto rear axle input shaft. Align notches in clutch housing with cap screw heads on axle clutch locator adapter.

3. Apply Loctite #242 (or equivalent) to threads of cap screw (item 8) that secures clutch to rear axle shaft.

4. Secure clutch to axle shaft with cap screw, lock washer (item 7), flat washer (item 6) and spacer (item 5).

5. Position end of driveshaft to bidirectional clutch on rear axle. Secure driveshaft to clutch with six (6) socket head screws (item 10) and lock washers (item 9).

6. Fill clutch with oil to the proper level (see Traction Unit Operator's Manual).

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Bidirectional Clutch Service (4 Wheel Drive)

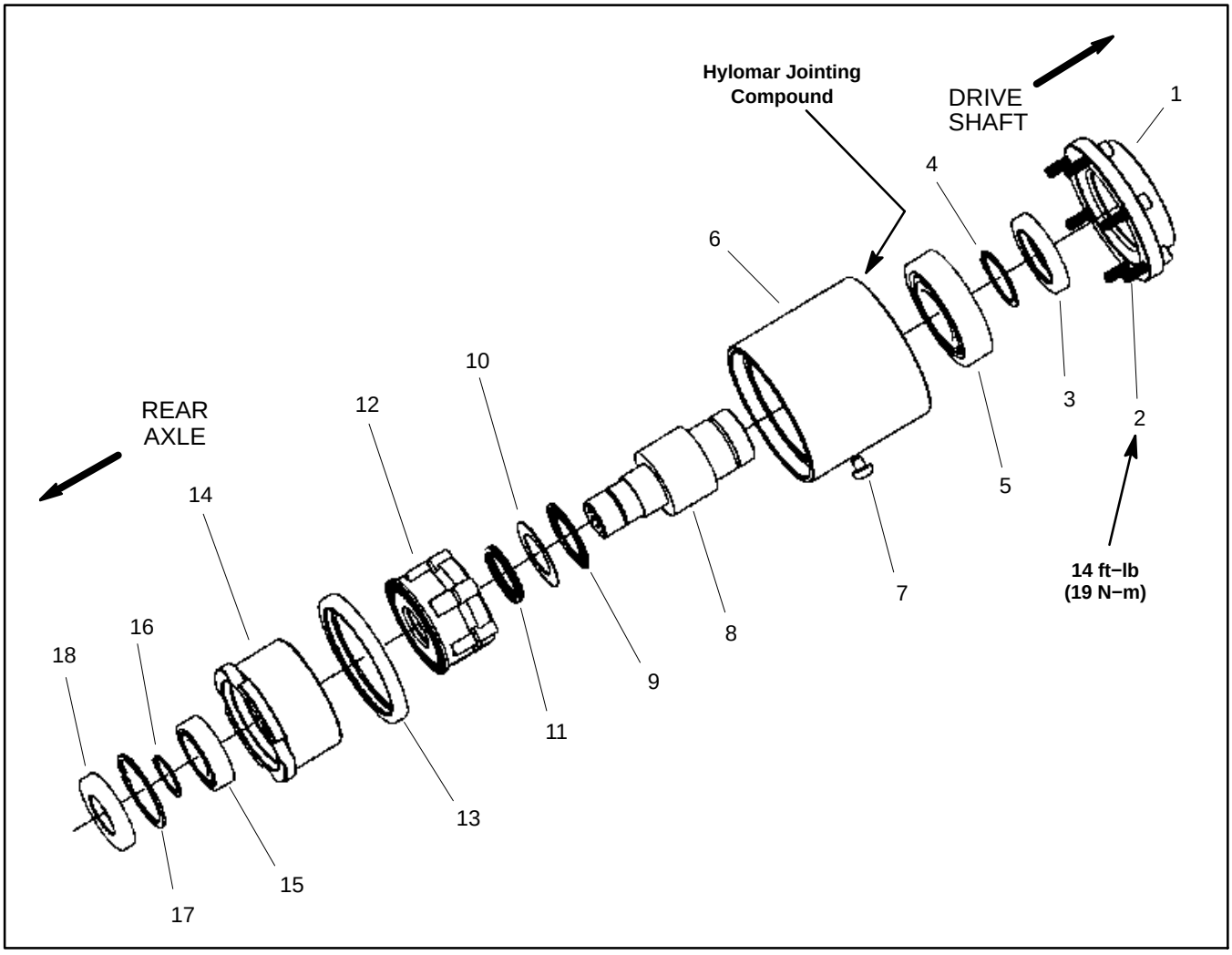

Figure 95

1. **End plate**
2. **Socket head screw (6 used)**
3. **Oil seal**
4. **Snap ring**
5. **Bearing**
6. **Housing**
7. **Phillips head screw w/o−ring**
8. **Hub**
9. **Needle bearing**
10. **Thrust washer**
11. **Wave spring**
12. **Roller cage assembly**
13. **Oil seal**
14. **Bearing Housing**
15. **Bearing**
16. **Snap ring**
17. **Retaining ring**
18. **Oil seal**

Disassembly (Fig. 95)

1. Thoroughly clean exterior of clutch before disassembly.

2. Disassemble clutch using Figure 95 as a guide.

Assembly (Fig. 95)

1. Lightly lubricate clutch components with clean Mobil Fluid 424 before assembly.

2. Assemble clutch using Figure 95 as a guide.

3. When installing oil seals, make sure that seal lips are facing in.

4. Apply Hylomar Jointing Compound (or equivalent) to end plate (item 1) mating surface before installing end plate.

5. Secure end plate with six (6) socket head cap screws. Torque screws 14 ft−lb (19 N−m).

Chapter 9

P.T.O. System

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P.T.O. Drive Belt

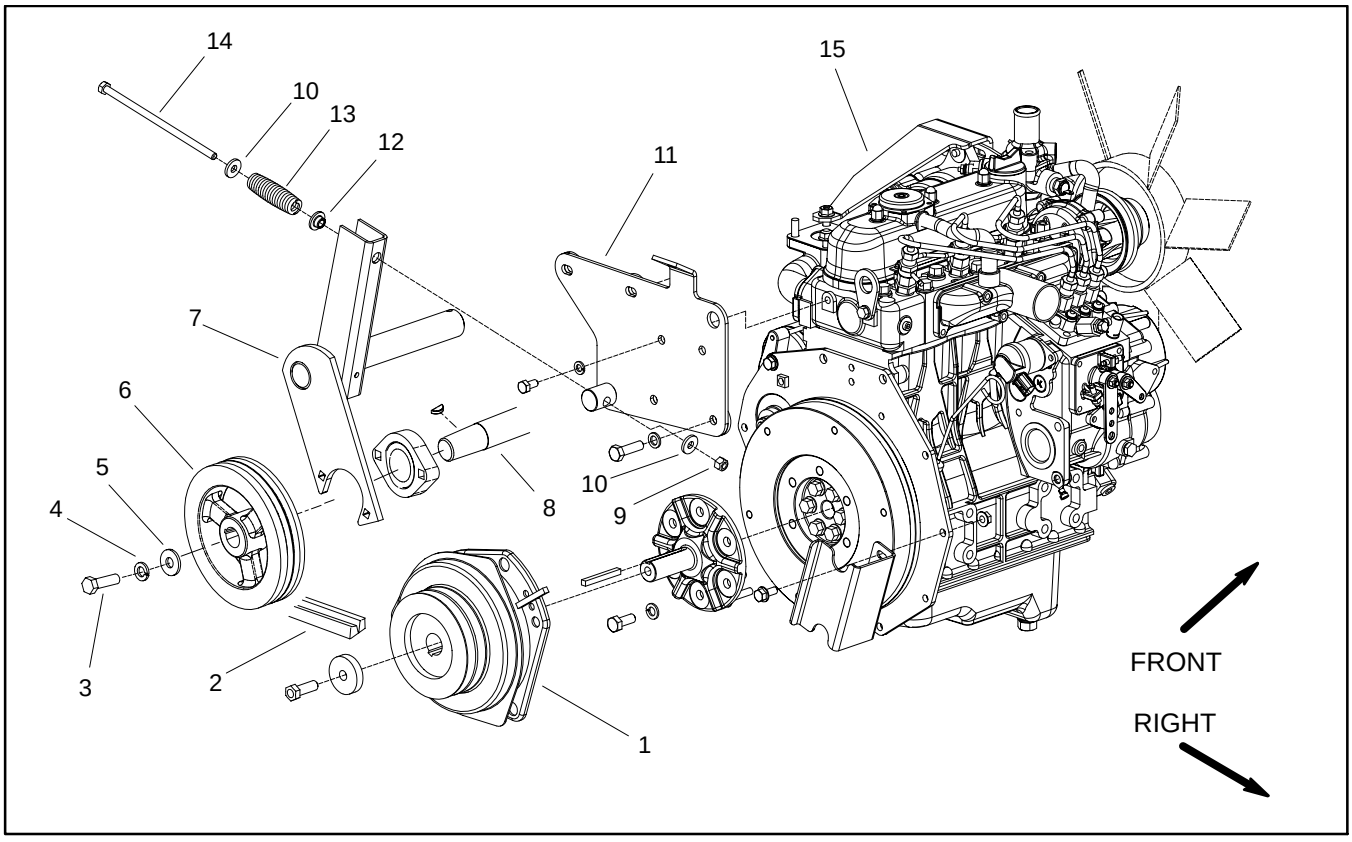

Figure 1

1. **Electric clutch**
2. **P.T.O. drive belt**
3. **Cap screw**
4. **Lock washer**
5. **Flat washer**
6. **P.T.O. shaft pulley**
7. **P.T.O. tension shaft**
8. **P.T.O. shaft**
9. **Lock nut**
10. **Flat washer**
11. **Mounting bracket**
12. **Spacer**
13. **Compression spring**
14. **Cap screw**
15. **Engine (diesel engine shown)**

NOTE: Refer to Traction Unit Operator's Manual for information regarding P.T.O. Belt Adjustment and Installation.

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P.T.O. Drive Shaft

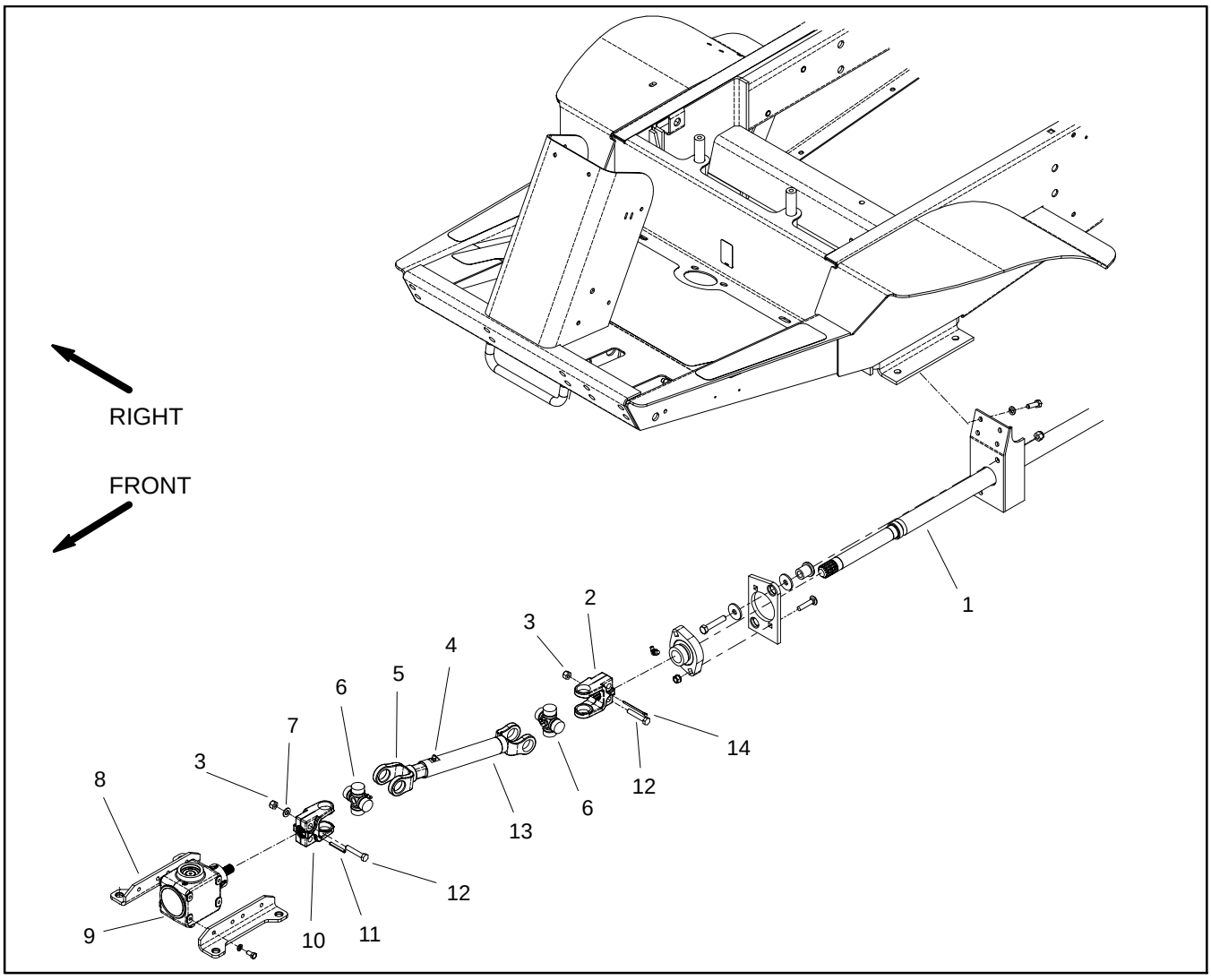

Figure 2

1. P.T.O. shaft
2. End yoke
3. Lock nut (2 used per end yoke)
4. Grease fitting
5. Slip shaft yoke
6. U−joint kit (cross and bearings)
7. Flat washer (2 used)
8. Gearbox bracket (2 used)
9. Cutting deck gearbox
10. End yoke
11. Roll pin
12. Cap screw (2 used per end yoke)
13. Slip tube yoke
14. Cotter pin

WARNING

Do not start the engine and engage the P.T.O. switch when the P.T.O. drive shaft is disconnected from the cutting deck (or implement). If the engine is started and the P.T.O. shaft is allowed to rotate, serious personal injury and machine damage could result. Disconnect the P.T.O. electric clutch electrical connector whenever the P.T.O. drive shaft is disconnected from the cutting deck (or implement).

Removal (Fig. 5)

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

2. Disconnect end yoke of P.T.O. drive shaft (item 2) from P.T.O. shaft:

   A. Straighten cotter pin (item 14) and remove cotter pin from end yoke.

   B. Loosen two (2) cap screws and lock nuts.

   C. Slide drive shaft end yoke from P.T.O. shaft.

3. Disconnect end yoke of P.T.O. drive shaft (item 10) from cutting deck gearbox shaft:

   A. Remove roll pin (item 11) from end yoke and gearbox shaft.

   B. Loosen two (2) cap screws and lock nuts.

   C. Slide drive shaft end yoke from gearbox shaft.

4. Remove P.T.O. drive shaft from machine.

Installation (Fig. 5)

IMPORTANT: If the drive shaft tube and shaft were separated, make sure that the slip shaft yoke and slip tube yoke are aligned when the tube and shaft are assembled (Fig. 3). Misalignment of the yokes will result in shortened drive shaft life and will cause unnecessary vibration when the cutting deck (or implement) is operated.

1. Position P.T.O. drive shaft to machine. Make sure that drive shaft slip shaft yoke (item 5) is toward cutting deck gearbox shaft.

2. Align splines and slide P.T.O. drive shaft end yokes onto P.T.O. shaft and gearbox shaft.

3. Secure end yokes of P.T.O. drive shaft.

   A. Install cotter pin (item 14) in end yoke (item 2) and P.T.O. shaft.

   B. Install roll pin (item 11) in end yoke (item 10) and gearbox shaft.

   C. Tighten lock nuts to secure end yokes to gearbox shaft and P.T.O. shaft.

4. Lubricate P.T.O. drive shaft grease fittings (see Traction Unit Operator's Manual).

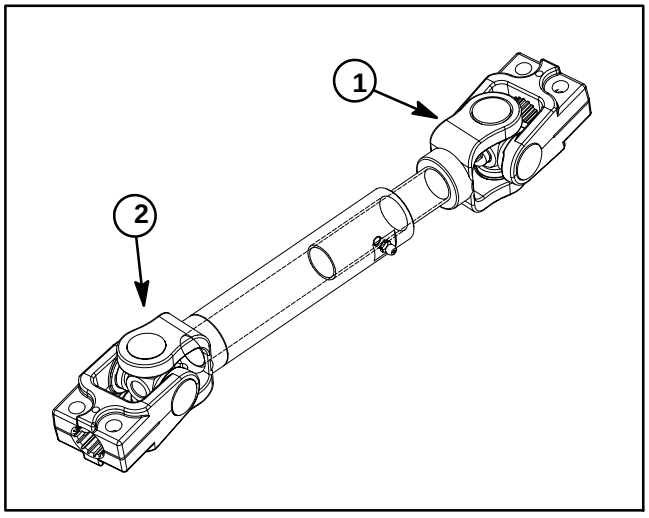

Figure 3

1. **Slip shaft yoke**
2. **Slip tube yoke**

P.T.O. Drive Shaft Cross and Bearing Service

1. Remove P.T.O. drive shaft from vehicle (see P.T.O. Drive Shaft Removal in this section).

2. Remove snap rings that secure bearings in yokes.

IMPORTANT: Yokes must be supported when removing and installing bearings to prevent damage.

3. Use a press to remove cross and bearings from yokes. Thoroughly clean drive shaft yokes.

4. To install new cross and bearings:

   A. Apply a coating of grease to bearing bores to end yoke and shaft yoke.

   B. Press one bearing partially into yoke.

   C. Insert cross into yoke and bearing.

   D. Hold cross in alignment and press bearing in until it hits the yoke.

   E. Install snap ring into yoke groove to secure installed bearing.

   F. Place second bearing into yoke bore and onto cross shaft. Press bearing into yoke and secure with snap ring.

   G. Repeat procedure for other yoke.

   H. Grease cross until grease comes out of all four (4) cups.

5. Make sure that assembled joint moves without binding. Slight binding can usually be eliminated by lightly rapping the yoke lugs with a soft faced hammer. If binding continues, disassemble joint to identify source of binding.

6. Reinstall drive shaft to vehicle (see P.T.O. Drive Shaft Installation in this section).

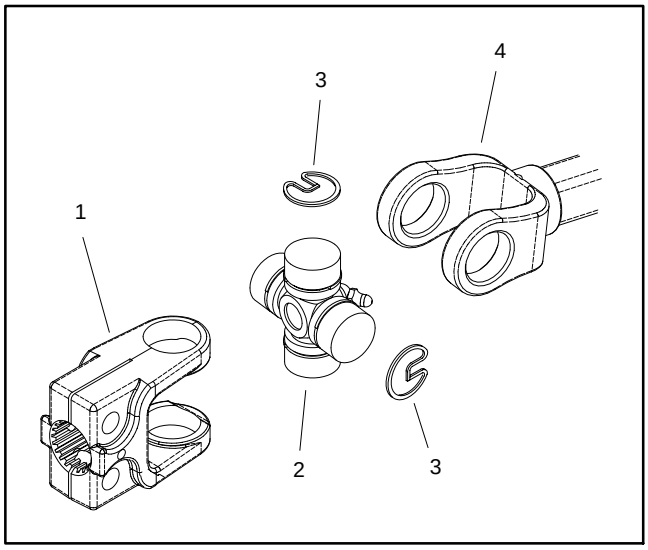

Figure 4

1. End yoke
2. Cross and bearing kit
3. Snap ring (4 used)
4. Shaft yoke

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P.T.O. Shaft

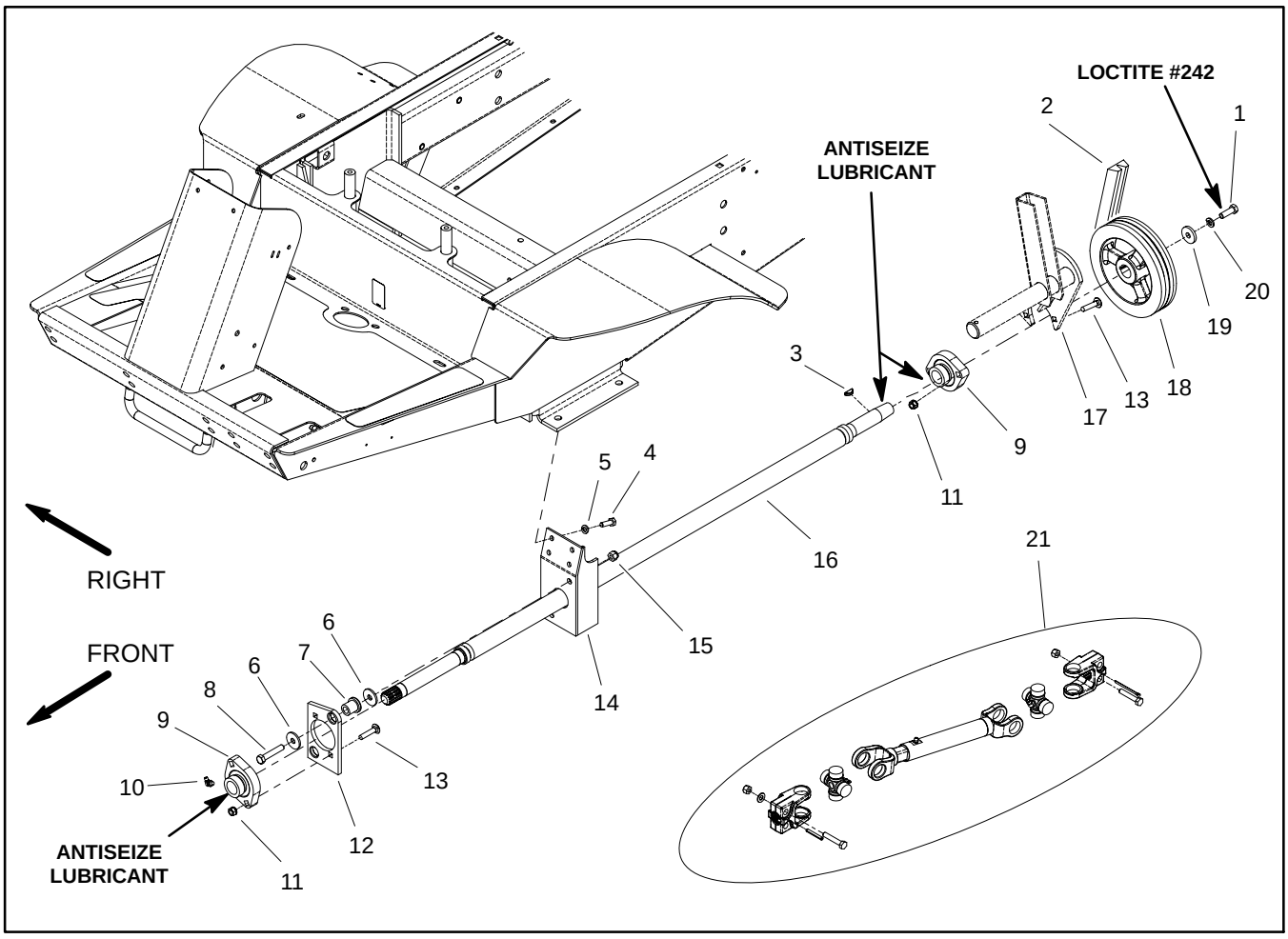

Figure 5

1. Cap screw
2. P.T.O. drive belt
3. Woodruff key
4. Cap screw (4 used)
5. Lock washer (4 used)
6. Washer (4 used)
7. Rubber mount (2 used)
8. Cap screw (2 used)
9. Flange bearing
10. Grease fitting
11. Hex nut
12. Bushing support plate
13. Carriage screw
14. P.T.O. bearing bracket
15. Lock nut (2 used)
16. P.T.O. shaft
17. P.T.O. tension shaft
18. P.T.O. pulley
19. Flat washer
20. Lock washer
21. P.T.O. drive shaft

WARNING

Do not start the engine and engage the P.T.O. switch when the P.T.O. drive shaft is disconnected from the cutting deck (or implement). If the engine is started and the P.T.O. shaft is allowed to rotate, serious injury could result. Disconnect the P.T.O. electric clutch electrical connector whenever the P.T.O. drive shaft is disconnected from the cutting deck (or implement).

Removal (Fig. 5)

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

2. Remove P.T.O. drive shaft from machine (see P.T.O. Drive Shaft Removal in this section).

3. Remove P.T.O. drive belt from machine (see Traction Unit Operator's Manual).

4. Remove rear frame and axle assembly from machine (see Rear Frame and Axle Assembly Removal in the Service and Repairs section of Chapter 7 − Chassis).

5. Remove cap screw and washer that secure pulley to P.T.O. shaft. Using a puller, remove pulley from P.T.O. shaft. Locate and retrieve woodruff key.

6. Loosen set screws that secure front and rear flange bearing locking collars to P.T.O. shaft. Using the blind hole in each bearing collar as a striking point, unlock collars from P.T.O. shaft with a punch by rotating the collars clockwise as viewed while facing forward.

7. Support P.T.O. shaft to prevent it from falling.

8. Remove two (2) carriage screws and lock nuts that secure rear bearing flange to the P.T.O. pivot shaft.

9. Remove four (4) cap screws and lock washers that secure P.T.O. bearing bracket to frame (Fig. 6).

IMPORTANT: Make sure not to damage hydraulic lines or other parts while removing the P.T.O. shaft from machine.

10. Carefully lower P.T.O. shaft and remove from machine.

11. Slide flange bearings, bearing bracket and support plate from P.T.O. shaft.

12. If required, disassemble front flange bearing, bearing bracket and support plate using Figure 5 as a guide.

Installation (Fig. 5)

1. If separated, assemble front front flange bearing, bearing bracket and support plate:

   A. Secure flange bearing to support plate with two (2) carriage screws and hex nuts.

   B. Lubricate rubber mounts with soapy water and install mounts into support plate. Make sure that mounts slide completely into support plate.

   C. Secure support plate to bearing bracket with cap screws, washers and lock nuts. Make sure that washers are placed on both sides of rubber mounts.

   D. Make sure that bearing support plate is fully seated against shoulders of rubber mounts and also is parallel within .120” (3.0 mm) to bearing bracket.

2. Apply antiseize lubricant to flange bearing bores. Install flange bearings onto P.T.O. shaft with locking collars orientated toward front of shaft.

IMPORTANT: Make sure not to damage hydraulic lines or other parts while installing the P.T.O. shaft to machine.

3. Carefully raise P.T.O. shaft to machine.

4. Secure P.T.O. bearing bracket to frame with four (4) cap screws and lock washers (Fig. 6).

5. Secure rear bearing flange to P.T.O. pivot shaft with two (2) carriage screws and lock nuts.

6. Thoroughly clean tapers of P.T.O. shaft and pulley. Apply antiseize lubricant to P.T.O. shaft taper. Position woodruff key into shaft slot. Install pulley onto P.T.O. shaft.

7. Apply Loctite #242 (or equivalent) to threads of cap screw that secures pulley to P.T.O. shaft. Secure pulley to P.T.O. shaft with cap screw and washer.

8. Install P.T.O. drive belt to machine (see Traction Unit Operator’s Manual). Do not fully tension belt.

9. Align P.T.O. pulley to electric clutch pulley (see Align P.T.O. Pulley to Electric Clutch Pulley in this section).

10. After pulleys are aligned properly, make sure that flange bearing locking collars are locked to P.T.O. shaft and secured with set screws. Torque set screws from 85 to 100 in−lb (9.6 to 11.3 N−m). Also, make sure that P.T.O. drive belt is properly tensioned (see Traction Unit Operator’s Manual).

11. Install rear frame and axle assembly to machine (see Rear Frame and Axle Assembly Installation in the Service and Repairs section of Chapter 7 − Chassis).

12. Install P.T.O. drive shaft to machine (see P.T.O. Drive Shaft Installation in this section).

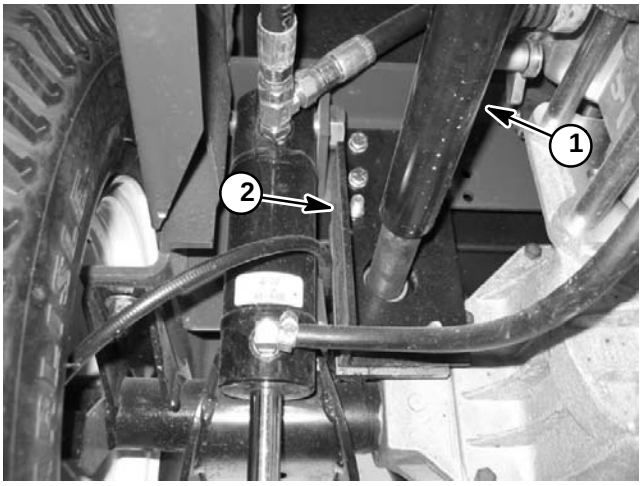

Figure 6

1. P.T.O. shaft
2. P.T.O. bearing bracket

Align P.T.O. Pulley to Electric Clutch Pulley

Check Pulley Alignment

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

NOTE: Because the clutch pulley and P.T.O. pulley have different thicknesses, check pulley alignment at pulley grooves.

2. Measuring at the bottom of the pulleys, check that the clutch and P.T.O. pulley grooves are aligned within .060” (1.5 mm).

3. If the pulley grooves are not aligned within .060” (1.5 mm), the P.T.O. bearing locking collars must be loosened and the P.T.O. shaft moved to get proper pulley alignment.

Adjust Pulley Alignment

1. With the P.T.O. belt installed, adjust the belt tension screw until the compression spring begins to compress.

2. Loosen and remove set screws that secure front and rear flange bearing locking collars to P.T.O. shaft. Using the blind hole in each bearing collar as a striking point, unlock collars from P.T.O. shaft with a punch by rotating the collars clockwise as viewed while facing forward.

3. Shift the position of the P.T.O. shaft and pulley until the P.T.O. pulley groove is aligned with the clutch pulley groove.

4. Using the blind hole in each bearing collar as a striking point, lock collars to P.T.O. shaft with a punch by rotating the collars counterclockwise as viewed while facing forward.

5. After tightening locking collars on P.T.O. flange bearings, recheck pulley alignment to ensure that alignment did not change.

6. Apply Loctite #242 to locking collar set screws. Install set screws into collars and torque from 85 to 100 in−lb (9.6 to 11.3 N−m).

7. Adjust P.T.O. drive belt tension (see Traction Unit Operator’s Manual).

Chapter 10

Cutting Units

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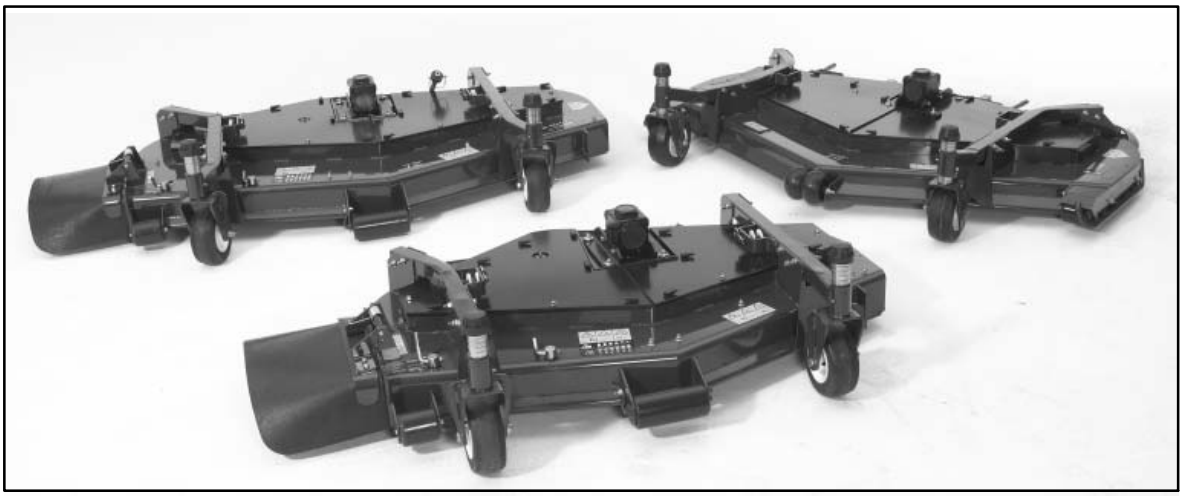
General Information



Several cutting units are available for the Groundsmaster 3280−D and 3320. Refer to the Cutting Unit Operator's Manual for specifications and optional accessories for the cutting unit used on your Groundsmaster.

Troubleshooting

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. Turf conditions such as excessive thatch, uneven ground conditions, “sponginess” or attempting to cut off too much grass height may not always be overcome by adjusting the cutting deck or machine.

Remember that the “effective” or actual height−of−cut depends on cutting unit weight, tire pressures, hydraulic counterbalance settings and turf conditions. Effective height−of−cut will be different than the bench set height−of−cut.

Factors That Can Affect Quality of Cut

Factor	Possible Problem/Correction
1. Maximum governed engine speed.	Check maximum governed engine speed. Adjust engine speed to specifications if necessary (see Chapter 3 − Gasoline Engine or Chapter 4 − Diesel Engine).
2. Blade speed.	All cutting deck blades should rotate at the same speed.
3. Tire pressure.	Check air pressure of all tires including castor tires. Adjust to pressures specified in Operator’s Manual.
4. Blade condition.	Sharpen blades if their cutting edges are dull or nicked. Inspect blade sail for wear or damage. Replace blade if needed.
5. Mower housing condition.	Make sure that cutting chamber is in good condition. Keep underside of deck clean. Debris buildup will reduce cutting performance.
6. Height−of−cut.	Make sure all cutting deck height−of−cut adjustments are the same. Adjust deck as specified in the Cutting Unit Operator’s Manual.
7. Cutting deck alignment and ground following.	Check lift arms for wear, damage or binding. Also, inspect for bent or damaged pivot shafts.
8. Roller and castor wheel condition.	All rollers and caster wheels should rotate freely. Replace bearings if worn or damaged.
9. Grass conditions.	Mow when grass is dry for best cutting results. Also, remove only 1” (2.5 cm) or 1/3 of the grass blade when cutting.

Adjustments

CAUTION

Never install or work on the cutting deck or lift arms with the engine running. Always stop engine and remove ignition key first.

See the Cutting Unit Operator's Manual for adjustment procedures for the cutting unit on the Groundsmaster 3280−D and 3320.

Castor Wheel Tire Pressure

Castor tires on the cutting deck should be inflated to 50 psi (3.5 bar).

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Service and Repairs

WARNING

Do not start the engine and engage the P.T.O. switch when the P.T.O. drive shaft is disconnected from the cutting deck (or implement). If the engine is started and the P.T.O. shaft is allowed to rotate, serious personal injury and machine damage could result. Disconnect the P.T.O. electric clutch electrical connector whenever the P.T.O. drive shaft is disconnected from the cutting deck (or implement).

CAUTION

Never install or work on the cutting deck or lift arms with the engine running. Always stop engine and remove ignition key first.

Idler Assembly

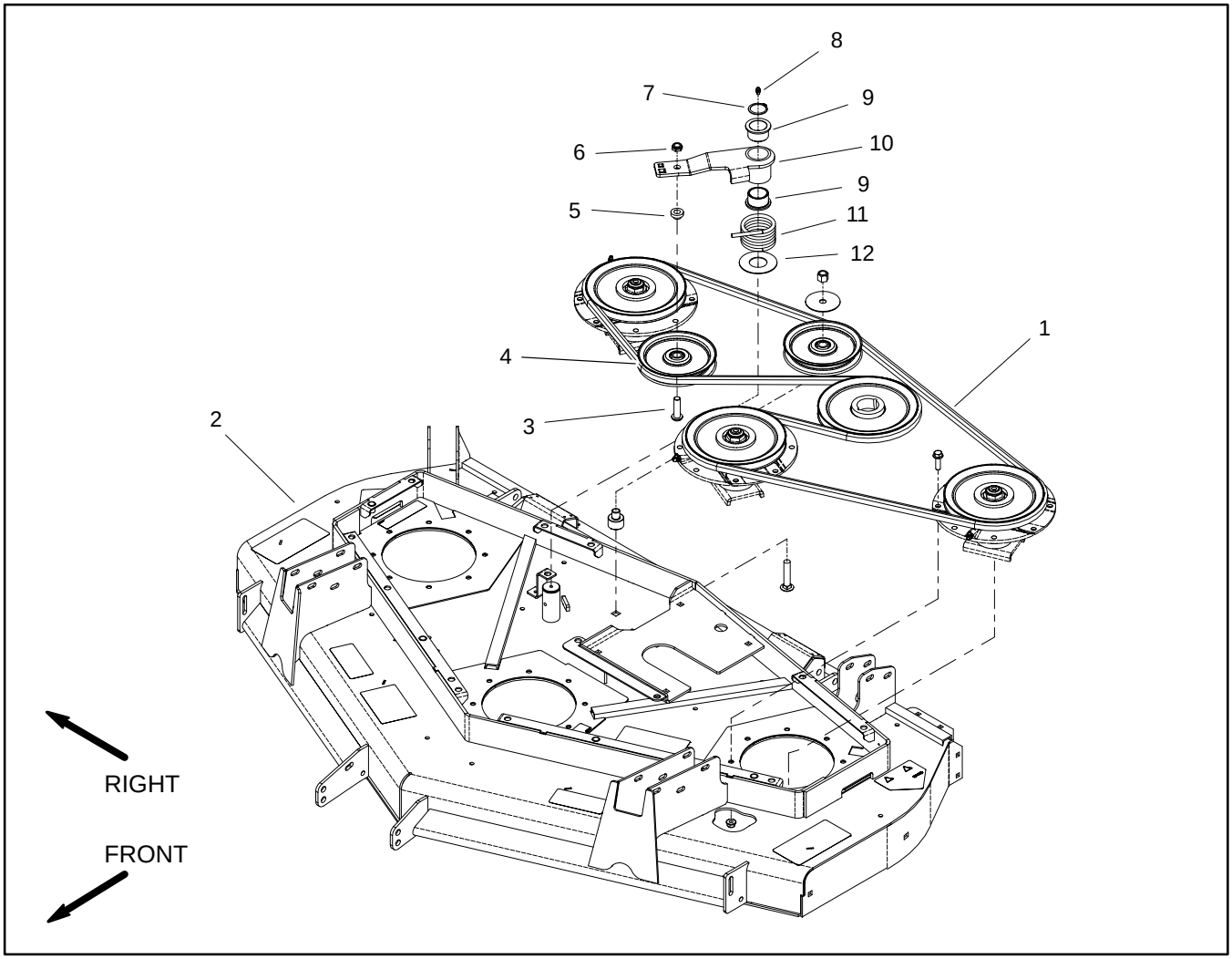

Figure 1

1. **Drive belt**
2. **Cutting deck**
3. **Socket head screw**
4. **Idler pulley**
5. **Idler spacer**
6. **Lock nut**
7. **Snap ring**
8. **Grease fitting**
9. **Flange bushing**
10. **Idler arm**
11. **Torsion spring**
12. **Washer**

Removal (Fig. 1)

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

2. Remove belt covers from top of cutting deck. Remove drive belt from deck pulleys (see Cutting Unit Operator's Manual).

3. Insert nut driver or small piece of pipe onto the end of the torsion spring for the idler arm.

CAUTION

Be careful when removing tension from the idler arm torsion spring. The spring is under heavy load and may cause personal injury.

4. Carefully push the torsion spring end down and away from the idler arm to unhook the spring from the arm.

5. Remove snap ring that retains idler arm assembly to cutting deck.

6. Remove idler components as needed using Figure 1 as a guide.

Installation (Fig. 1)

1. Install removed idler components using Figure 1 as a guide. Secure idler arm assembly to cutting deck with snap ring.

2. Insert nut driver or small piece of pipe onto the end of the torsion spring for the idler arm.

CAUTION

Be careful when applying tension to the idler arm torsion spring. The spring is under heavy load and may cause personal injury.

3. Carefully push down on the torsion spring end to get the spring under the idler arm mounting plate. Then release the spring slowly to lock it into place.

4. Install drive belt to pulleys (see Cutting Unit Operator's Manual).

5. Install belt covers to cutting deck (see Cutting Unit Operator's Manual).

Blade Spindle

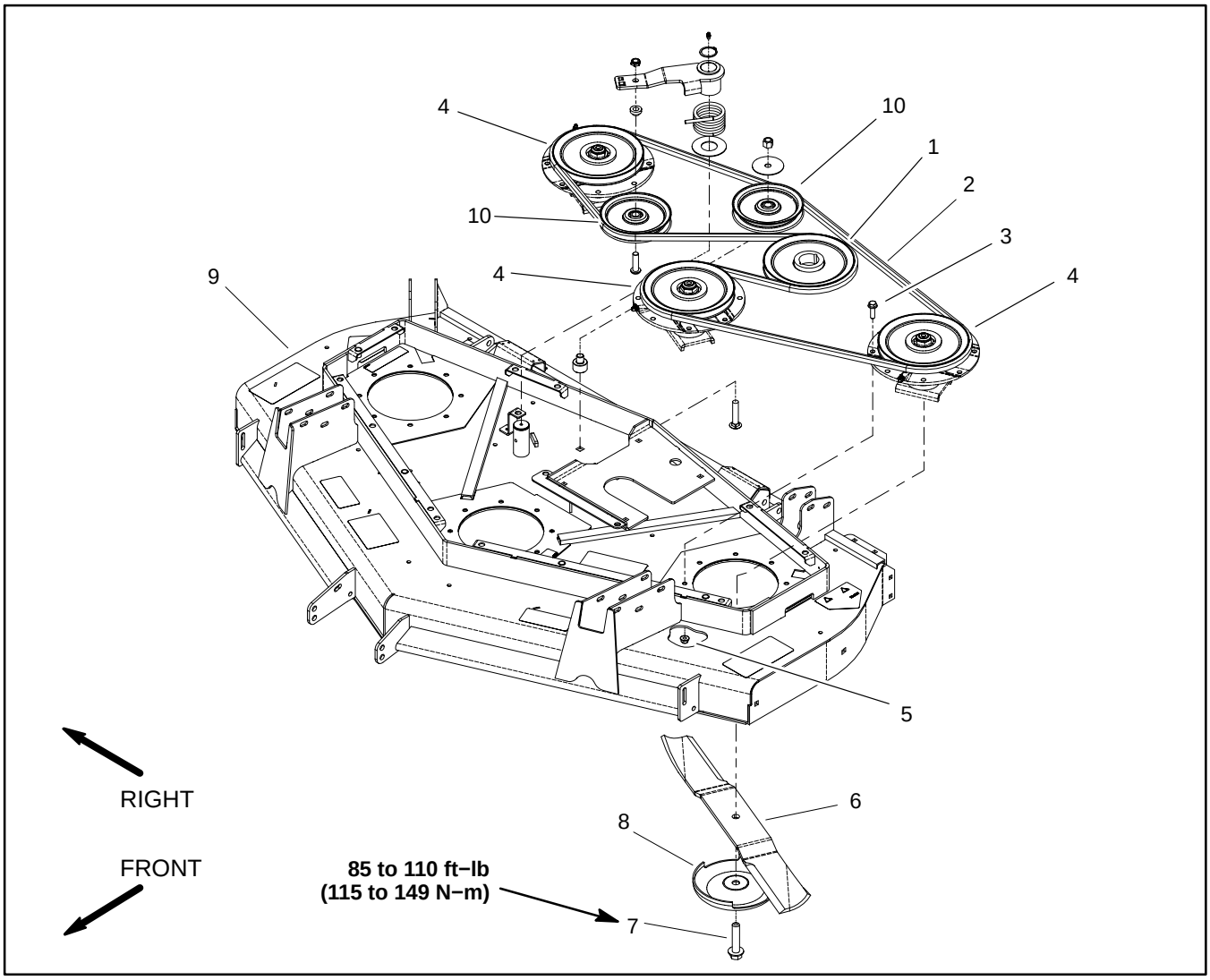

Figure 2

1. **Drive pulley**
2. **Drive belt**
3. **Flange head screw (8 per spindle)**
4. **Drive spindle assembly**
5. **Flange nut (8 per spindle)**
6. **Cutting blade**
7. **Blade bolt**
8. **Anti−scalp cup**
9. **Cutting deck**
10. **Idler pulley**

Removal (Fig. 2)

1. Park machine on a level surface with cutting deck raised. Stop engine, engage parking brake and remove key from the ignition switch. Support the cutting deck so it cannot fall accidentally.

2. Remove belt covers from top of cutting deck. Remove drive belt from deck pulleys (see Cutting Unit Operator's Manual).

3. Remove cutting blade, anti−scalp cup and blade bolt from spindle to be serviced (see Cutting Unit Operator's Manual).

4. Remove eight (8) flange head screws and flange nuts that secure spindle assembly to deck. Remove spindle assembly from deck.

Installation (Fig. 2)

1. Position spindle on cutting deck noting orientation of grease fitting (Fig. 3). Secure spindle assembly to deck with eight (8) flange head screws and flange nuts.

2. Install cutting blade, anti−scalp cup and blade bolt (see Cutting Unit Operator's Manual). Tighten blade bolt from 85 to 110 ft−lb (115 to 149 N−m).

3. Slowly rotate cutting blades to verify that blades do not contact any deck component(s).

4. Install drive belt to pulleys (see Cutting Unit Operator's Manual).

5. Install belt covers to cutting deck (see Cutting Unit Operator's Manual).

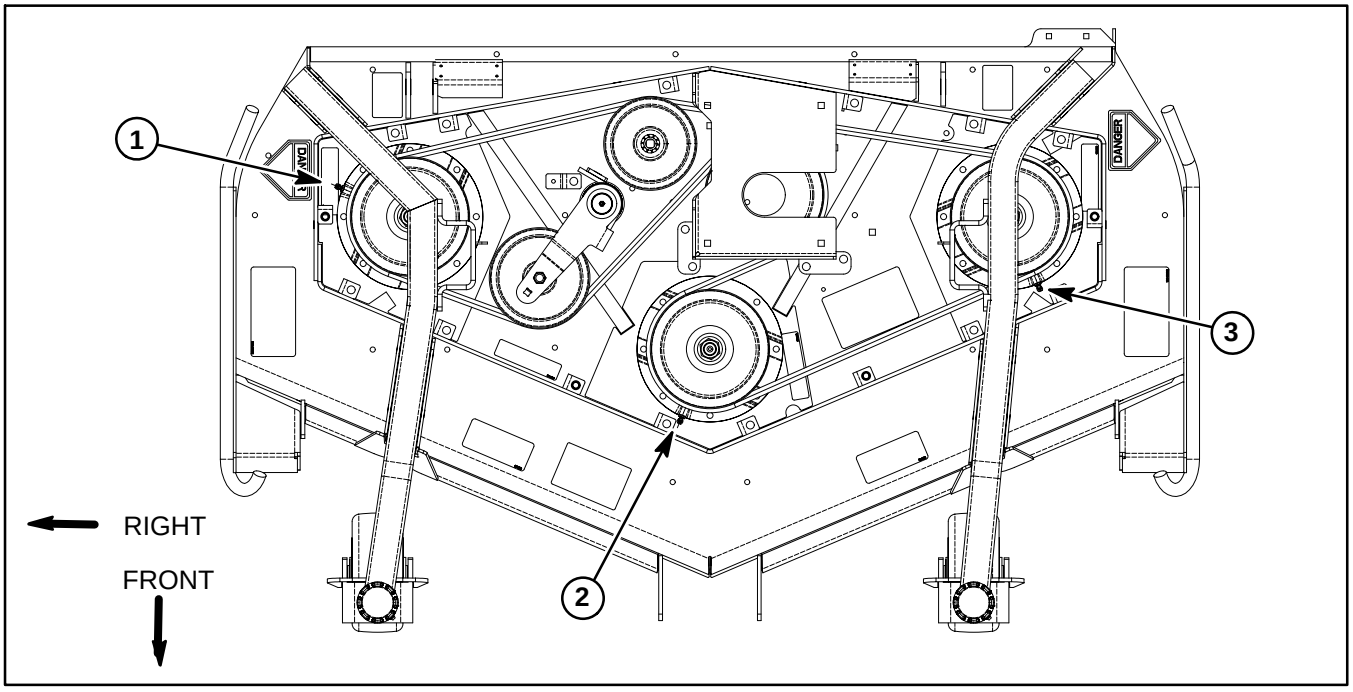

Figure 3

1. **RH spindle grease fitting**
2. **Center spindle grease fitting**
3. **LH spindle grease fitting**

Blade Spindle Service

Disassembly (Fig. 4)

1. Loosen and remove lock nut from top of spindle shaft.

NOTE: Early production spindle assemblies included a v−ring seal (item 4) which has been found to be unnecessary. Discard v−ring seal if found in spindle assembly.

2. Remove flat washer and pulley from shaft. If spindle is equipped with a v−ring seal, remove and discard v−ring seal.

3. Remove the spindle shaft from the spindle housing which may require the use of an arbor press. The spindle shaft spacer should remain on the spindle shaft as the shaft is being removed.

4. Remove oil seals from spindle housing.

5. Allow the bearing cones, inner bearing 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. Remove the outer bearing spacer from the housing.

7. The large snap ring can remain inside the spindle housing. Removal of this snap ring is very difficult.

Assembly (Fig. 4)

NOTE: A replacement spindle bearing set contains two (2) bearings, a spacer ring and a large snap ring (Fig. 5). These parts cannot be purchased separately. A replacement spacer set includes the inner spacer and outer spacer.

IMPORTANT: If new bearings are installed into a used spindle housing, it may not be necessary to replace the original large snap ring. If the original snap ring is in good condition with no evidence of damage (e.g. spun bearing), leave the snap ring in the housing and discard the snap ring that comes with the new bearings. If the large snap ring is found to be damaged, replace the snap ring. Replacement bearings are sold only with a matched spacer ring and large snap ring (Fig. 5). These parts cannot be purchased separately.

1. If large snap ring was removed from spindle housing, install snap ring into housing groove. Make sure snap ring is fully seated in housing groove.

2. Install outer bearing spacer into top of spindle housing. The spacer should fit against the snap ring.

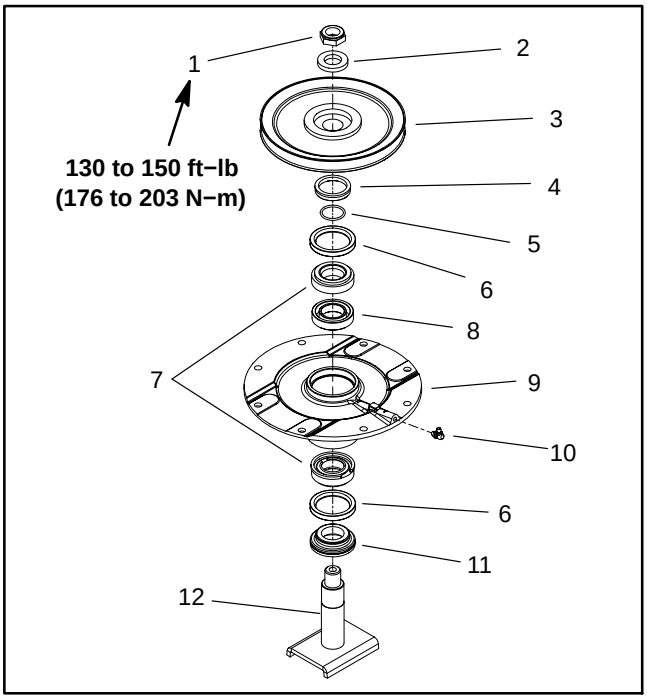

Figure 4

1. **Lock nut**
2. **Flat washer**
3. **Pulley**
4. **V−ring seal (if equipped)**
5. **O−ring**
6. **Oil seal**
7. **Bearing set**
8. **Spacer set**
9. **Spindle housing**
10. **Grease fitting**
11. **Shaft spacer**
12. **Spindle shaft**

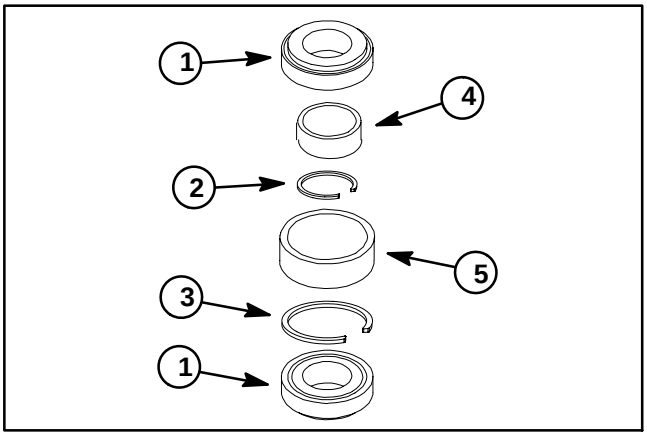

Figure 5

1. **Bearing**
2. **Spacer ring**
3. **Large snap ring**
4. **Inner spacer**
5. **Outer spacer**

3. Using an arbor press, push the bearing cups into the top and bottom of the spindle housing. The top bearing cup must contact the outer spacer previously installed, and the bottom bearing cup must contact the snap ring. Make sure that the assembly is correct by supporting the first bearing cup and pressing the second against it (Fig 6).

4. Pack the bearing cones with grease. Apply a film of grease on lips of oil seals and o−ring.

5. Install lower bearing cone and oil seal into bottom of spindle housing. **Note:** The bottom seal must have the lip facing out (down) (Fig. 7).

IMPORTANT: If bearings are being replaced, make sure to use the spacer ring that is included in bearing set.

6. Slide spacer ring and inner bearing spacer into spindle housing, then install upper bearing cone and oil seal into top of housing. **Note:** The upper seal must have the lip facing in (down) (Fig. 7). When properly installed, the upper seal should be recessed .095” (2.4 mm) into the housing.

7. Inspect the spindle shaft and shaft spacer to make sure they are free of burrs or nicks that could possibly damage the oil seals. Lubricate the shaft with grease.

8. Install spindle shaft spacer onto shaft. Carefully slide spindle shaft with spacer up through spindle housing. The bottom oil seal and spindle spacer fit together when the spindle is installed fully.

9. Install greased o−ring to top of spindle shaft (Fig. 8).

NOTE: Early production spindle assemblies included a v−ring seal which has been found to be unnecessary. **Do not** install a v−ring seal when assembling the spindle.

10. Install pulley (hub down), flat washer and lock nut to spindle shaft. Tighten lock nut from 130 to 150 ft−lb (176 to 203 N−m).

IMPORTANT: Pneumatic grease guns can produce air pockets when filling large cavities and therefore, are not recommended to be used for proper greasing of spindle housings.

11. Attach a hand pump grease gun to grease fitting on housing and fill housing cavity with grease until grease starts to come out of lower seal.

12. Rotate spindle shaft to make sure that it turns freely.

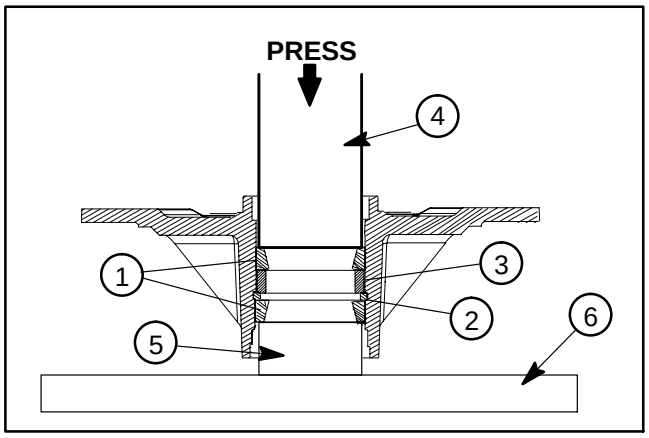

Figure 6

1. **Bearing cup**
2. **Large snap ring**
3. **Outer spacer**
4. **Arbor press**
5. **Support**
6. **Arbor press base**

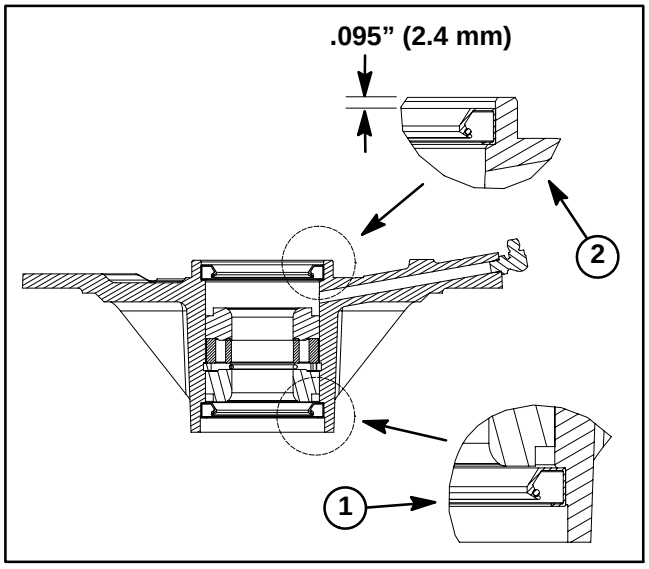

Figure 7

1. **Bottom seal installation**
2. **Upper seal installation**

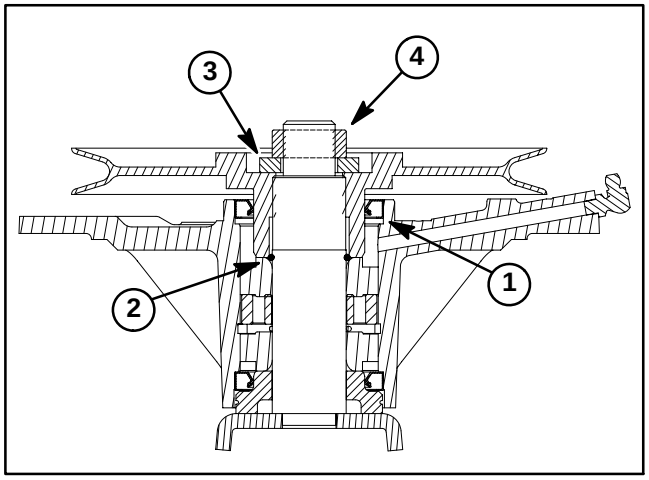

Figure 8

1. **Upper seal**
2. **O−ring**
3. **Flat washer**
4. **Lock nut**

Gearbox

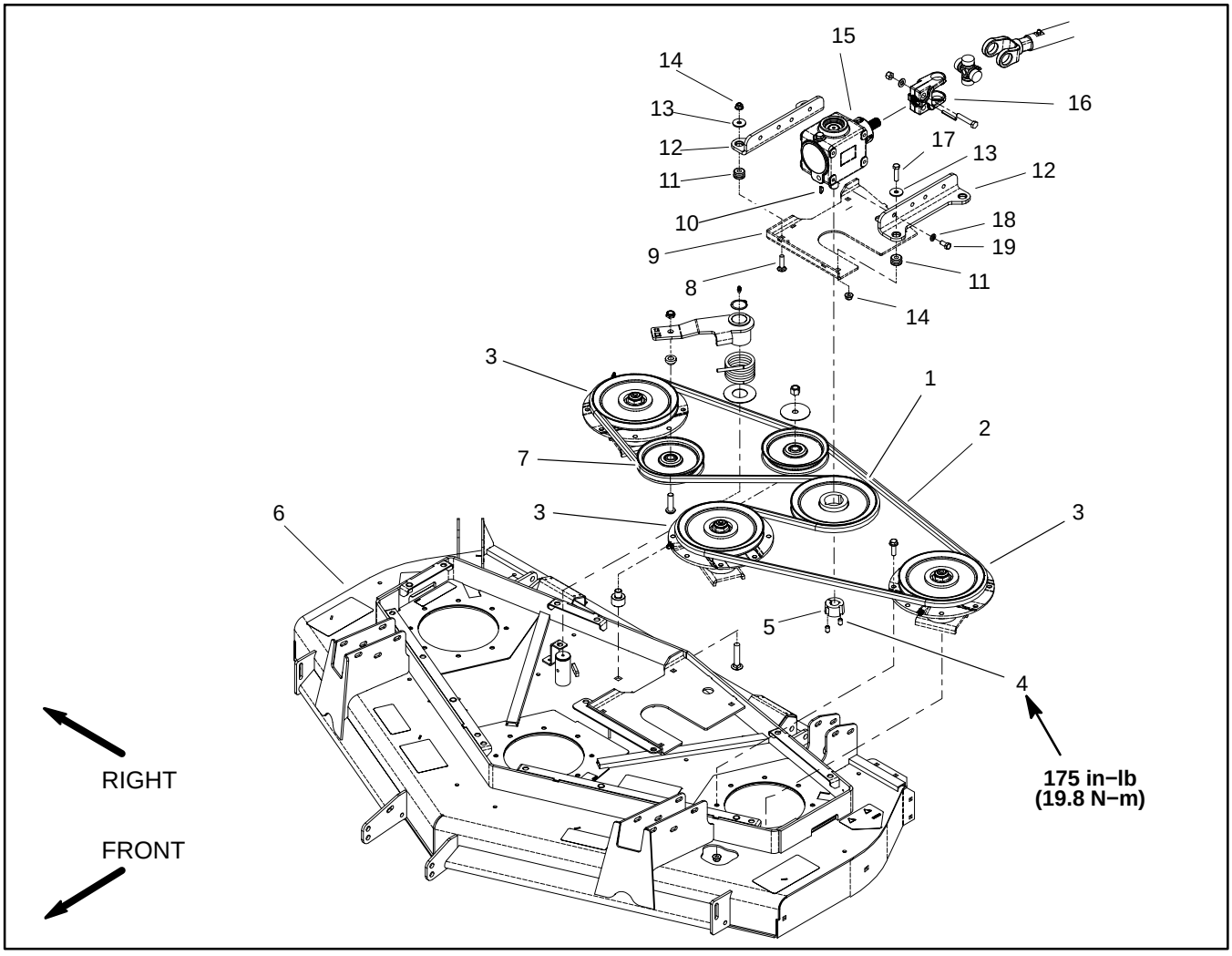

Figure 9

1. **Drive pulley**
2. **Drive belt**
3. **Spindle assembly**
4. **Set screw (2 used)**
5. **Taper lock bushing**
6. **Cutting deck**
7. **Idler pulley**
8. **Carriage screw (3 used)**
9. **Deck gearbox mounting plate**
10. **Woodruff key**
11. **Mount (4 used)**
12. **Gearbox bracket (2 used)**
13. **Flat washer (4 used)**
14. **Flange nut**
15. **Gearbox assembly**
16. **P.T.O. drive shaft end yoke**
17. **Cap screw**
18. **Lock washer (4 used)**
19. **Cap screw (4 used)**

Removal (Fig. 9)

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

2. Remove belt covers from top of cutting deck (see Cutting Unit Operator's Manual).

3. Remove drive belt from deck pulleys (see Cutting Unit Operator's Manual).

WARNING

Do not start the engine and engage the P.T.O. switch when the P.T.O. drive shaft is disconnected from the cutting deck (or implement). If the engine is started and the P.T.O. shaft is allowed to rotate, serious injury could result. Disconnect the P.T.O. electric clutch electrical connector whenever the P.T.O. drive shaft is disconnected from the cutting deck (or implement).

4. Disconnect P.T.O. drive shaft from gearbox (see P.T.O. Drive Shaft Removal in Service and Repairs section of Chapter 9 − P.T.O. System).

5. Remove four (4) cap screws (item 17) and lock washers (item 16) that secure gearbox assembly to gearbox brackets.

6. Remove fasteners that secure left side gearbox bracket (item 12) to deck mounting plate. Remove bracket from deck.

7. Remove gearbox assembly with drive pulley attached from deck. Drain lubricant from gearbox.

8. Remove two (2) set screws that secure taper lock bushing to drive pulley on gearbox shaft.

9. Thread one of the removed set screws into threaded hole of bushing (Fig. 10). Tighten set screw to loosen bushing from pulley hub.

10. Slide bushing and pulley from gearbox shaft. Locate and retrieve woodruff key.

11. If necessary, remove and replace oil seals and oil caps in gearbox (Fig. 11).

NOTE: If internal gearbox wear or damage occurs, gearbox replacement is necessary. Internal gearbox components are not available.

Installation (Fig. 9)

1. If oil seals or seal caps were removed, use a press to install seals or caps so they are flush with the gearbox housing. With seals installed, rolling torque for gearbox input shaft should be 5 to 10 in−lb (.56 to 1.13 N−m).

2. Clean gearbox output shaft, pulley ID and taper lock bushing thoroughly.

3. Position woodruff key, pulley and then taper lock bushing to gearbox output shaft. Slide bushing to shoulder on shaft. Align threaded holes of pulley with non−threaded holes of bushing.

4. Lightly oil threads of set screws and install screws into threads of pulley (Fig. 10). Alternately and evenly tighten set screws to a torque of 175 in−lb (19.8 N−m).

5. Fill allen recess in set screws and bushing threads with grease to prevent dirt from packing into crevices.

6. Position gearbox assembly with drive pulley attached to deck.

7. Position and secure left side gearbox bracket (item 12) to deck mounting plate.

8. Secure gearbox assembly to gearbox brackets with four (4) cap screws (item 17) and lock washers (item 16).

9. Connect P.T.O. drive shaft to gearbox (see P.T.O. Drive Shaft Installation in Service and Repairs section of Chapter 9 − P.T.O. System).

10. Install drive belt and belt covers to cutting deck (see Cutting Unit Operator's Manual).

11. Torque plug in gearbox to 175 in−lb (19.8 N−m). Fill gearbox with lubricant (see Cutting Unit Operator's Manual). Install dipstick in gearbox and torque to 175 in−lb (19.8 N−m).

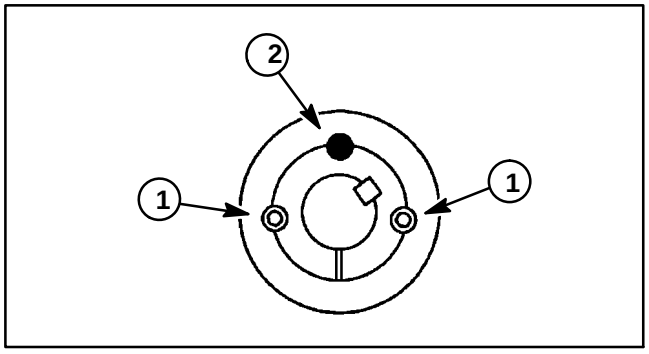

Figure 10

1. **Set screw installation position**
2. **Set screw removal position**

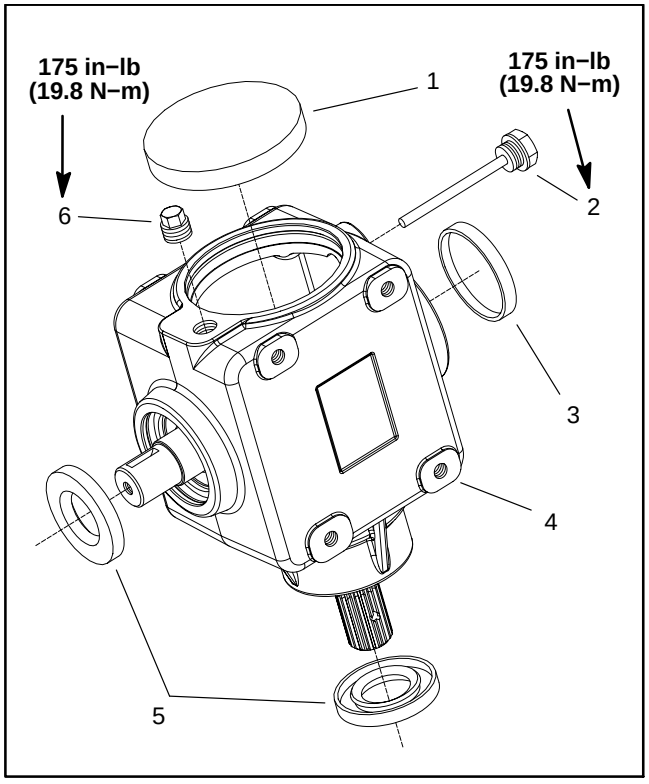

Figure 11

1. **Oil cap**
2. **Dipstick**
3. **Oil cap**
4. **Gearbox**
5. **Oil seal**
6. **Plug**

Castor Forks and Wheels

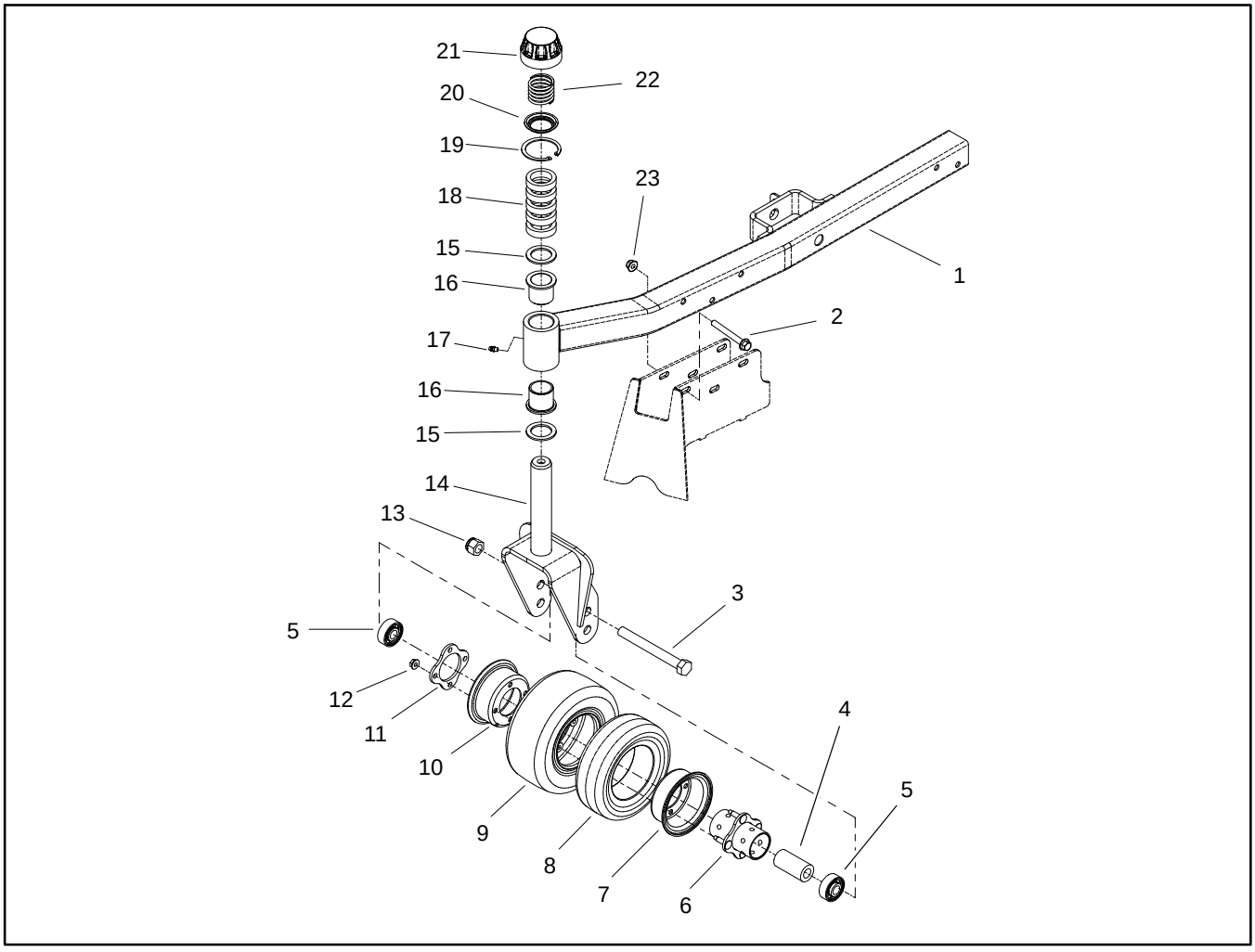

Figure 12

1. **Castor arm (RH shown)**
2. **Cap screw (5 used per arm)**
3. **Cap screw**
4. **Inner bearing spacer**
5. **Bearing**
6. **Wheel hub**
7. **Wheel rim half**
8. **Inner tube**
9. **Castor tire**
10. **Wheel rim half**
11. **Plate**
12. **Flange nut (4 used)**
13. **Lock nut**
14. **Castor fork**
15. **Thrust washer**
16. **Flange bushing**
17. **Grease fitting**
18. **Spacer**
19. **Retaining ring**
20. **Cap washer**
21. **Cap**
22. **Compression spring**
23. **Flange nut (5 used per arm)**

Disassembly (Fig. 12)

1. Disassemble castor forks and wheels as required using Figure 12 as a guide.

Assembly (Fig. 12)

1. Assemble castor forks and wheels using Figure 12 as a guide. Make sure that thrust washers (item 15) are positioned directly above and below castor arm bushings.

2. If bearings were removed from wheel hub:

   A. Press first bearing into hub until it contacts shoulder of hub.

   B. Place inner bearing spacer in hub and then press second bearing into hub.

   C. Check that spacer fits tightly between bearings after hub assembly.

3. If castor fork was removed from castor arm, lubricate grease fitting.

4. See Cutting Unit Operator's Manual for castor wheel adjustment.

Cutting Deck Rollers and Skids

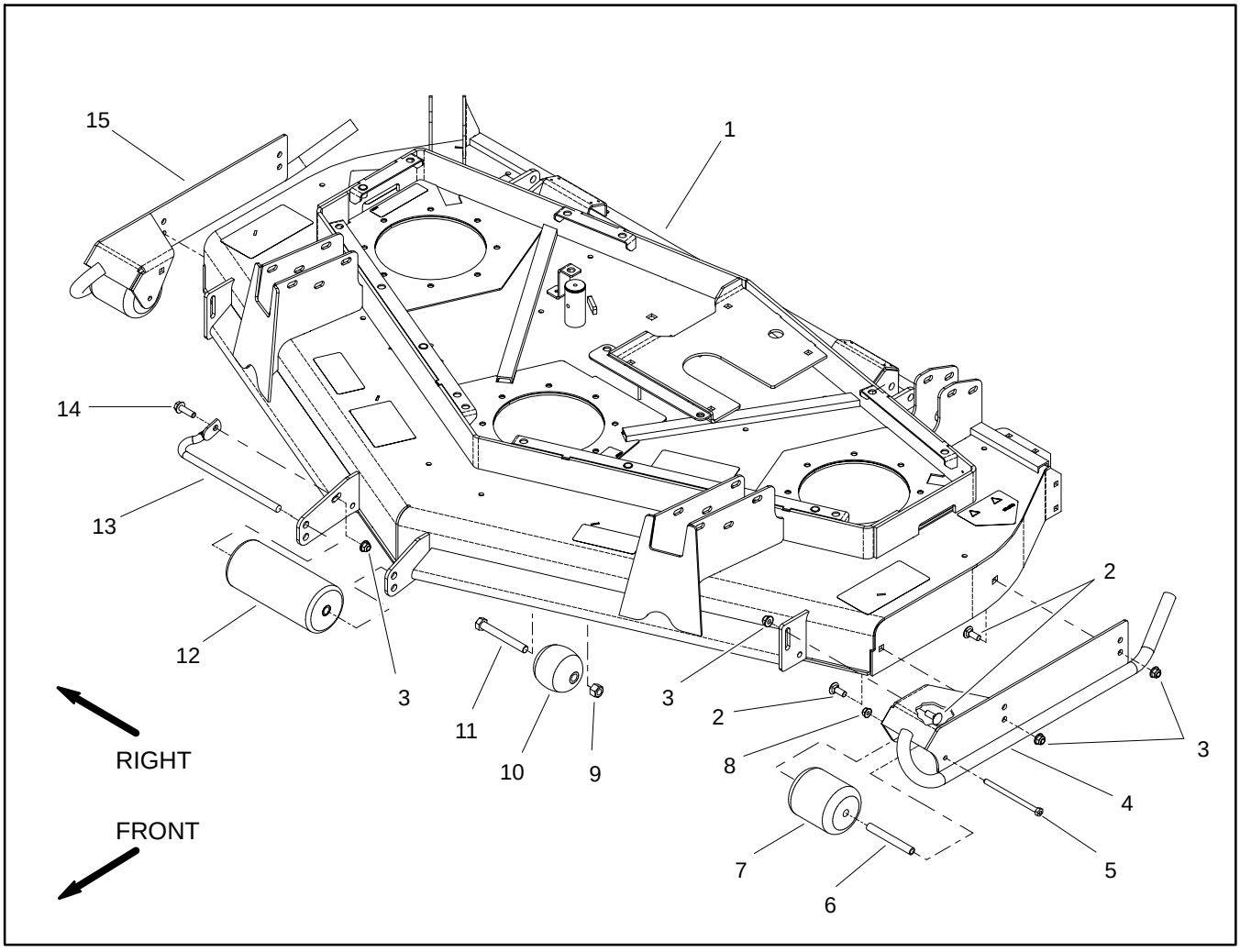

Figure 13

1. **Cutting deck**
2. **Carriage screw**
3. **Flange nut**
4. **LH skid**
5. **Cap screw**
6. **Roller spacer**
7. **Roller**
8. **Flange nut**
9. **Lock nut**
10. **Roller (2 used)**
11. **Cap screw**
12. **Roller**
13. **Roller shaft**
14. **Flange head screw**
15. **RH skid**

Removal (Fig. 13)

1. Remove skids and rollers from cutting deck using Figure 13 as a guide.

Installation (Fig. 13)

1. Install skids to cutting deck using Figure 13 as a guide. Make sure to install skids in the same mounting hole height position (lower or upper).

2. When installing rollers to deck, tighten nut until roller will not rotate, then loosen nut only enough to allow roller to rotate freely. Make sure to install all cutting deck rollers in the same mounting hole height position (lower or upper).

Chapter 11

Electrical Diagrams

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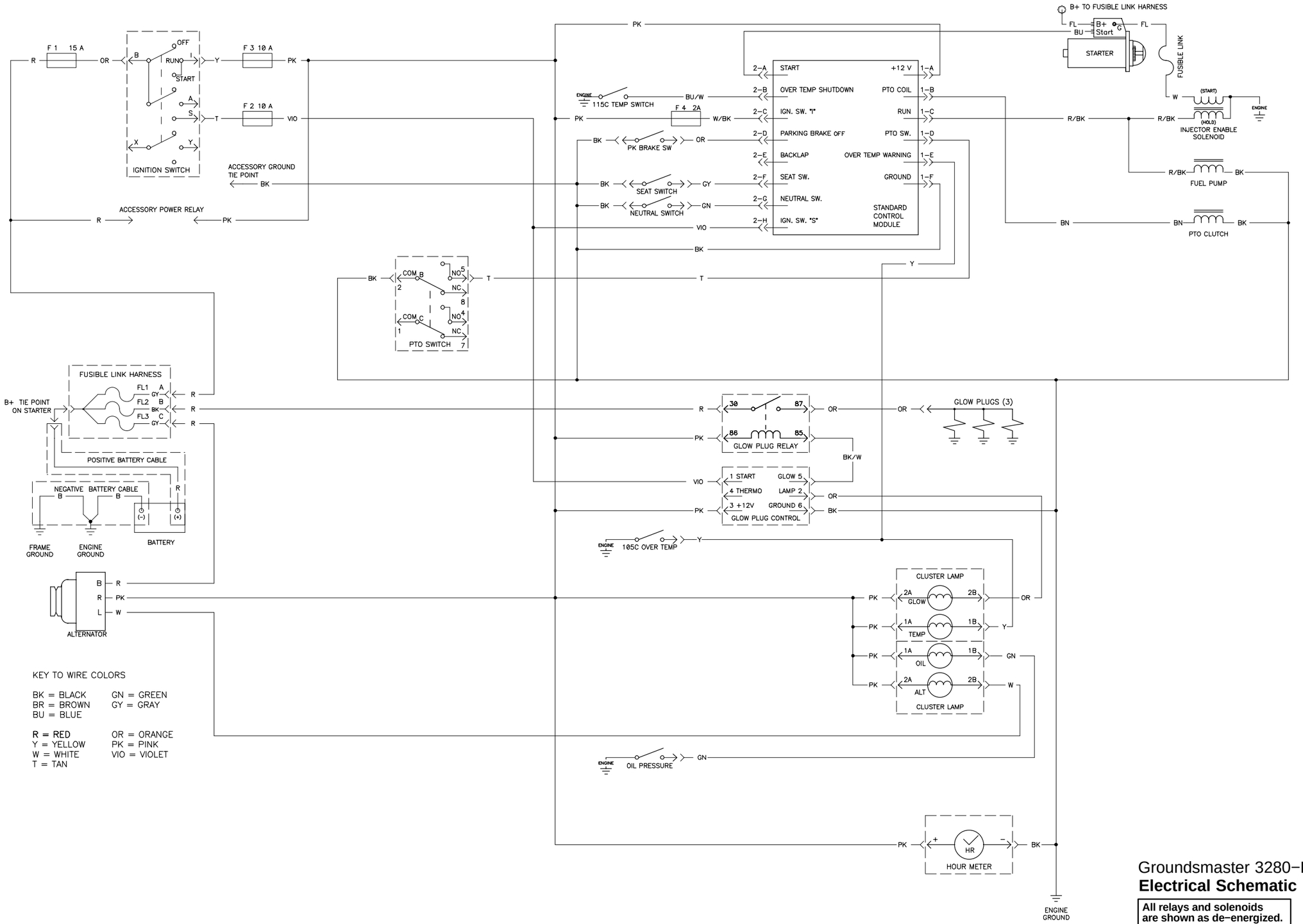


KEY TO WIRE COLORS

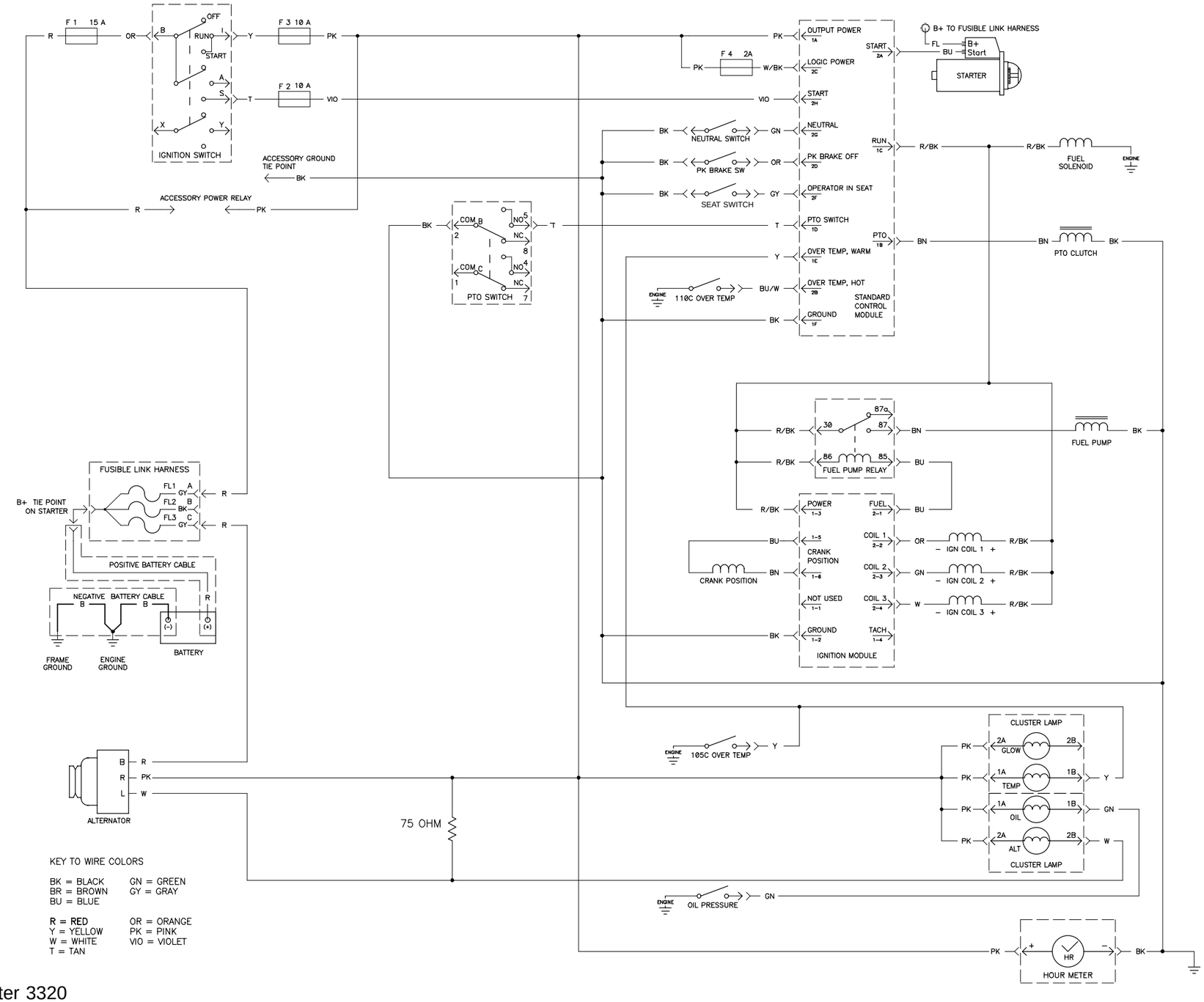
BK = BLACK	GN = GREEN
BR = BROWN	GY = GRAY
BU = BLUE	
R = RED	OR = ORANGE
Y = YELLOW	PK = PINK
W = WHITE	VIO = VIOLET
T = TAN	

Groundsmaster 3280−D

Electrical Schematic

All relays and solenoids are shown as de−energized.

All ground wires are black.



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Groundsmaster 3320

Electrical Schematic

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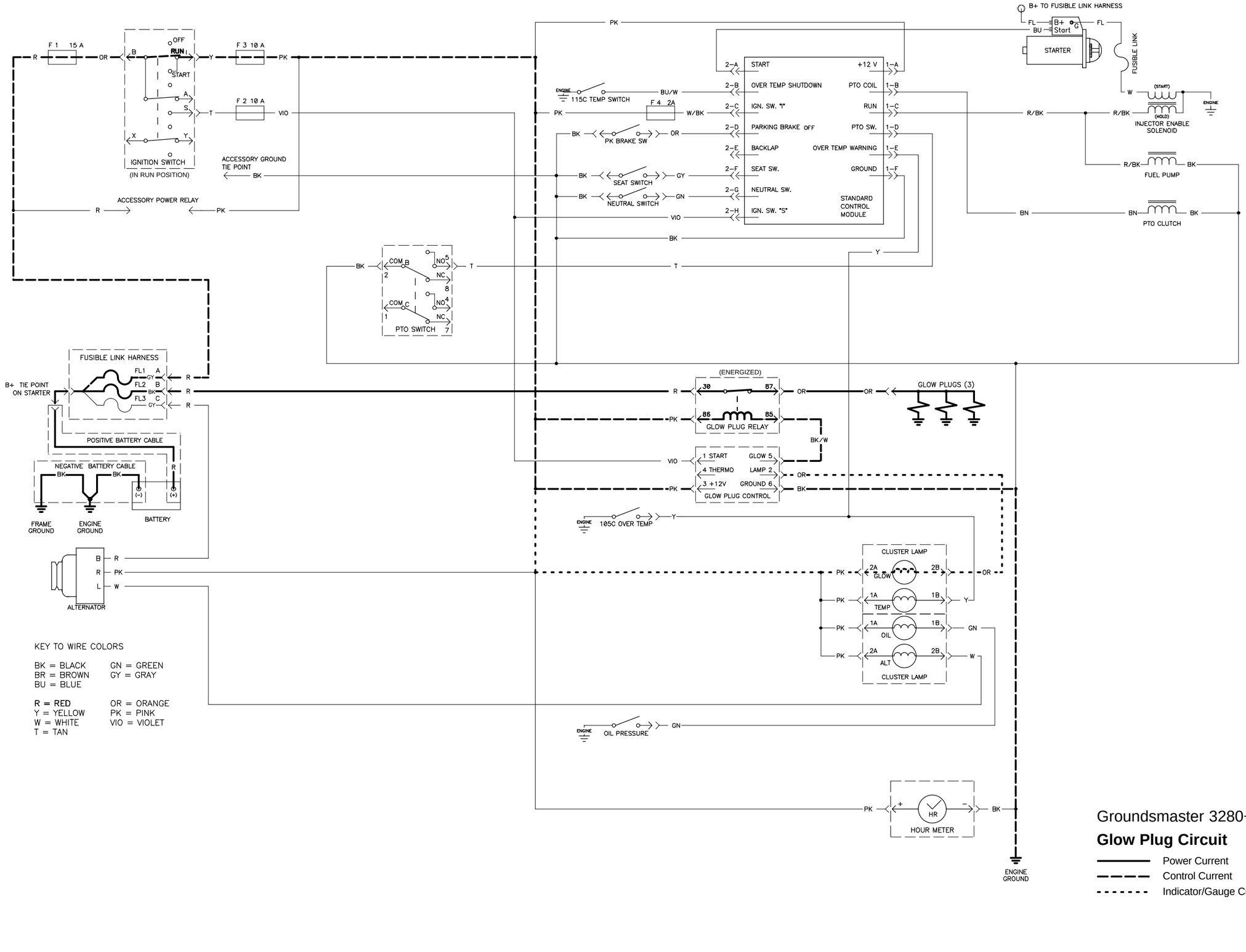
All ground wires are black.



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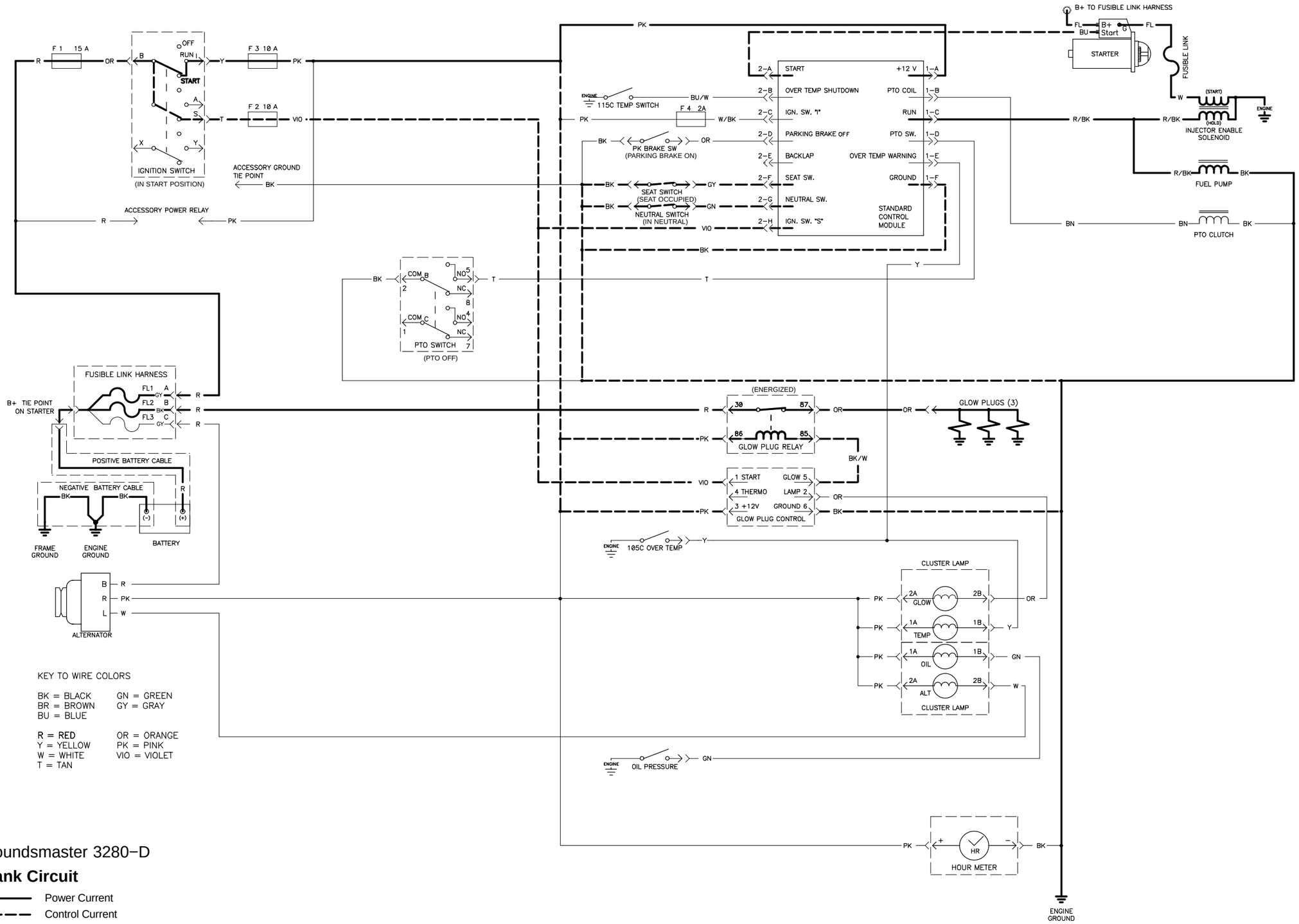
Groundsmaster 3280−D

Glow Plug Circuit

Power Current

Control Current

Indicator/Gauge Current



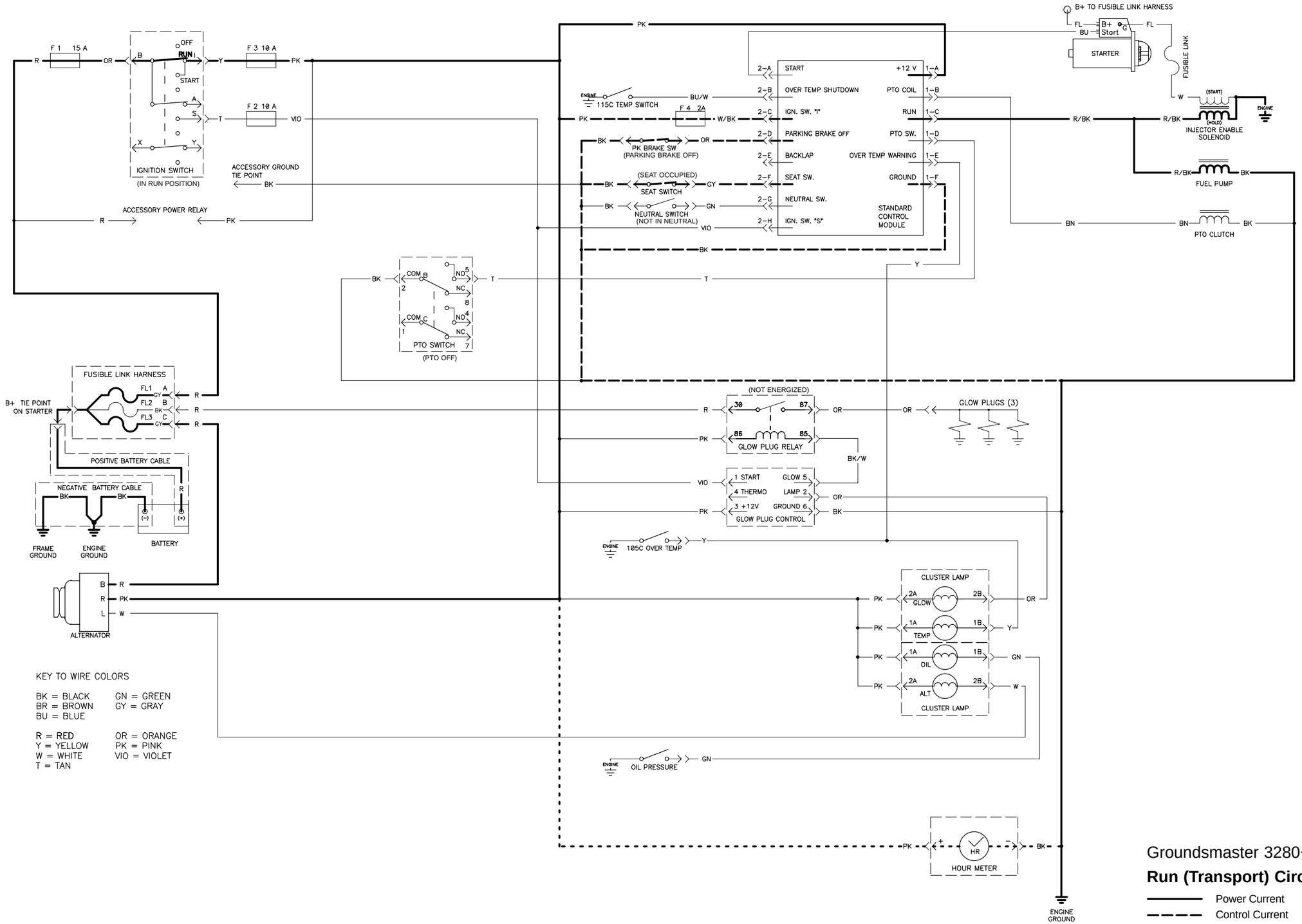
Groundsmaster 3280−D

Crank Circuit

Power Current

Control Current

Indicator/Gauge Current



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Y = YELLOW	PK = PINK
W = WHITE	VIO = VIOLET
T = TAN	

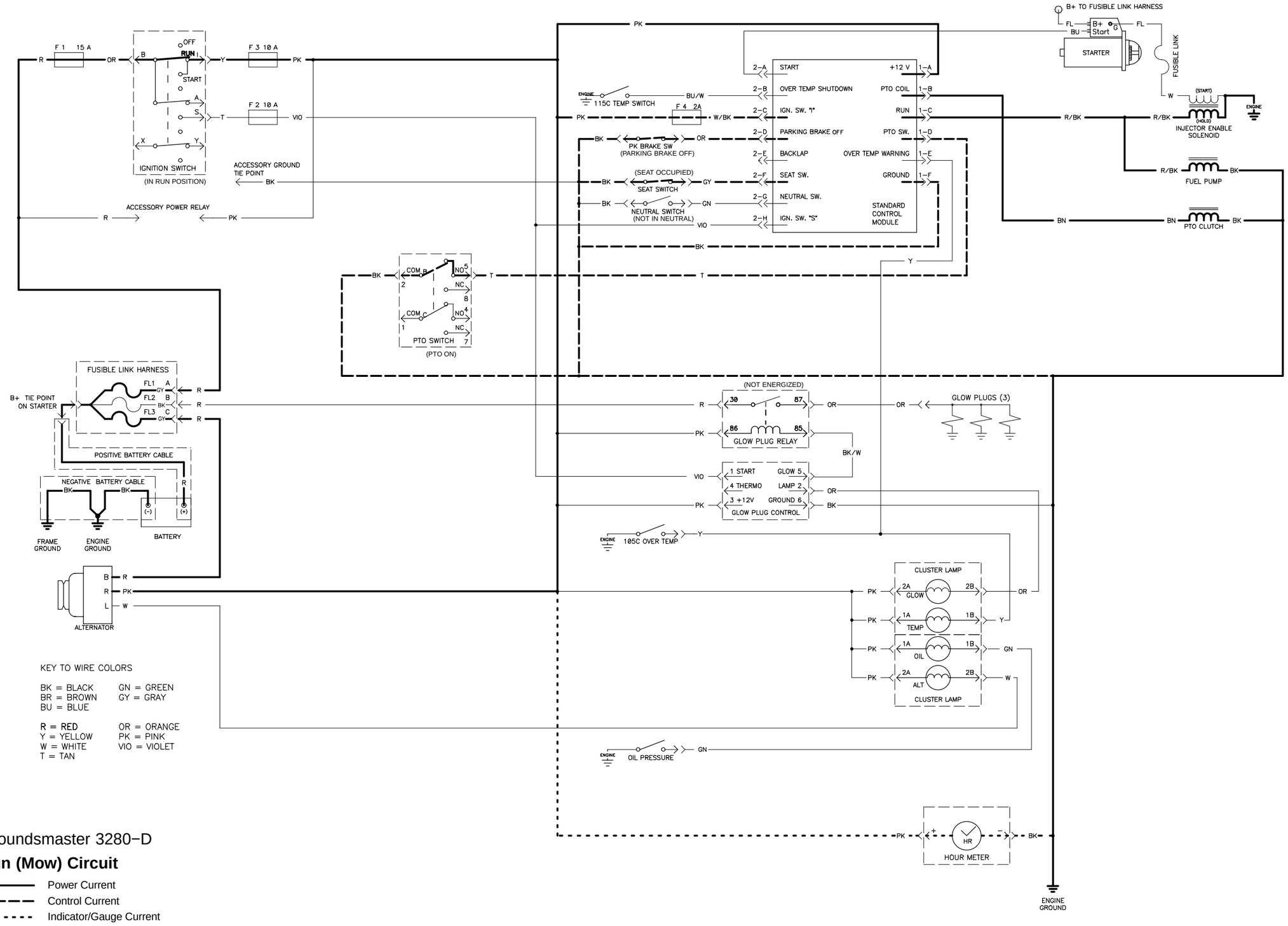
Groundsmaster 3280−D

Run (Transport) Circuit

Power Current

Control Current

Indicator/Gauge Current



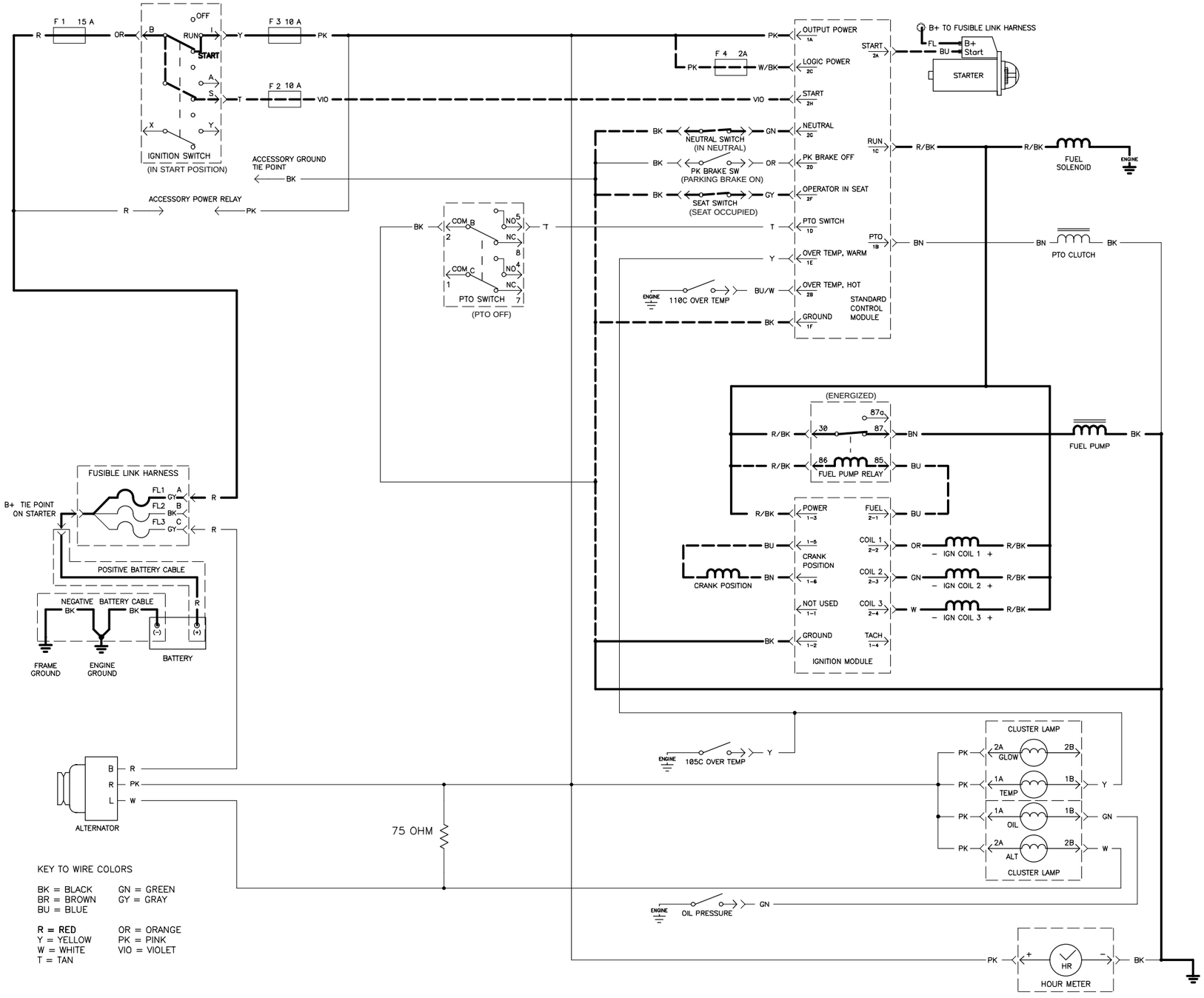
Groundsmaster 3280−D

Run (Mow) Circuit

Power Current

Control Current

Indicator/Gauge Current



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BU = BLUE	
R = RED	OR = ORANGE
Y = YELLOW	PK = PINK
W = WHITE	VIO = VIOLET
T = TAN	

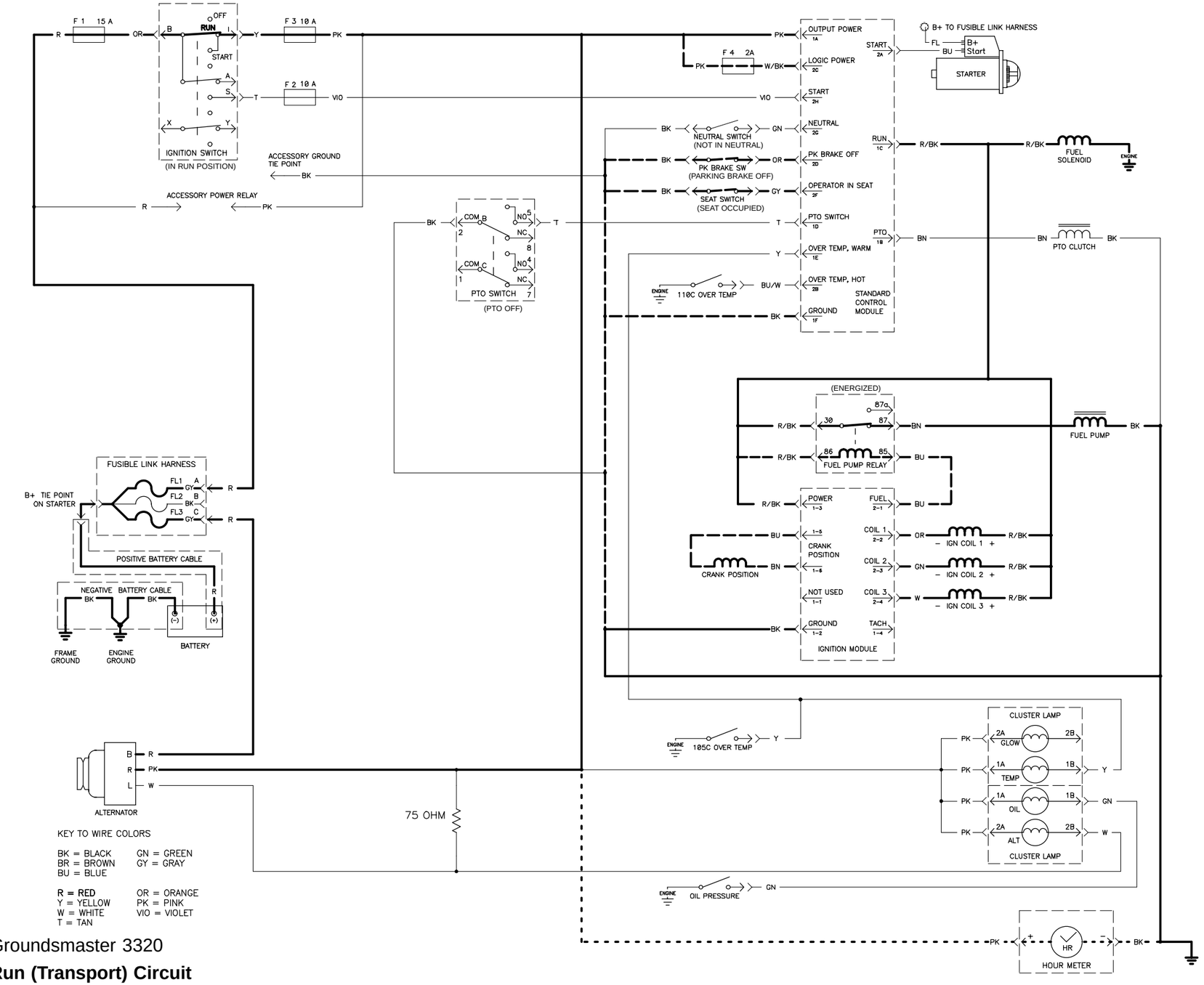
Groundsmaster 3320

Crank Circuit

Power Current

Control Current

Indicator/Gauge Current



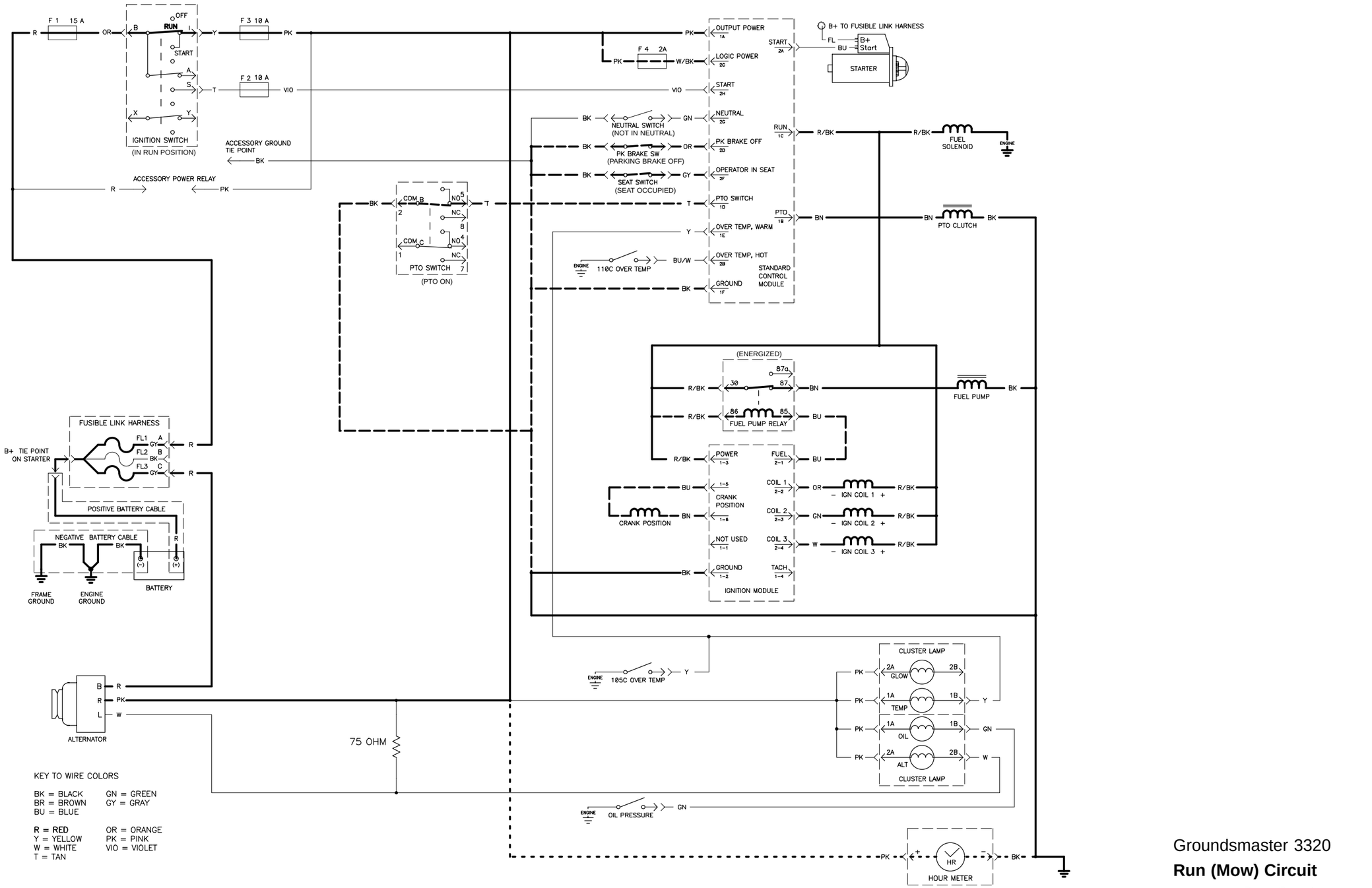
Groundsmaster 3320

Run (Transport) Circuit

Power Current

Control Current

Indicator/Gauge Current



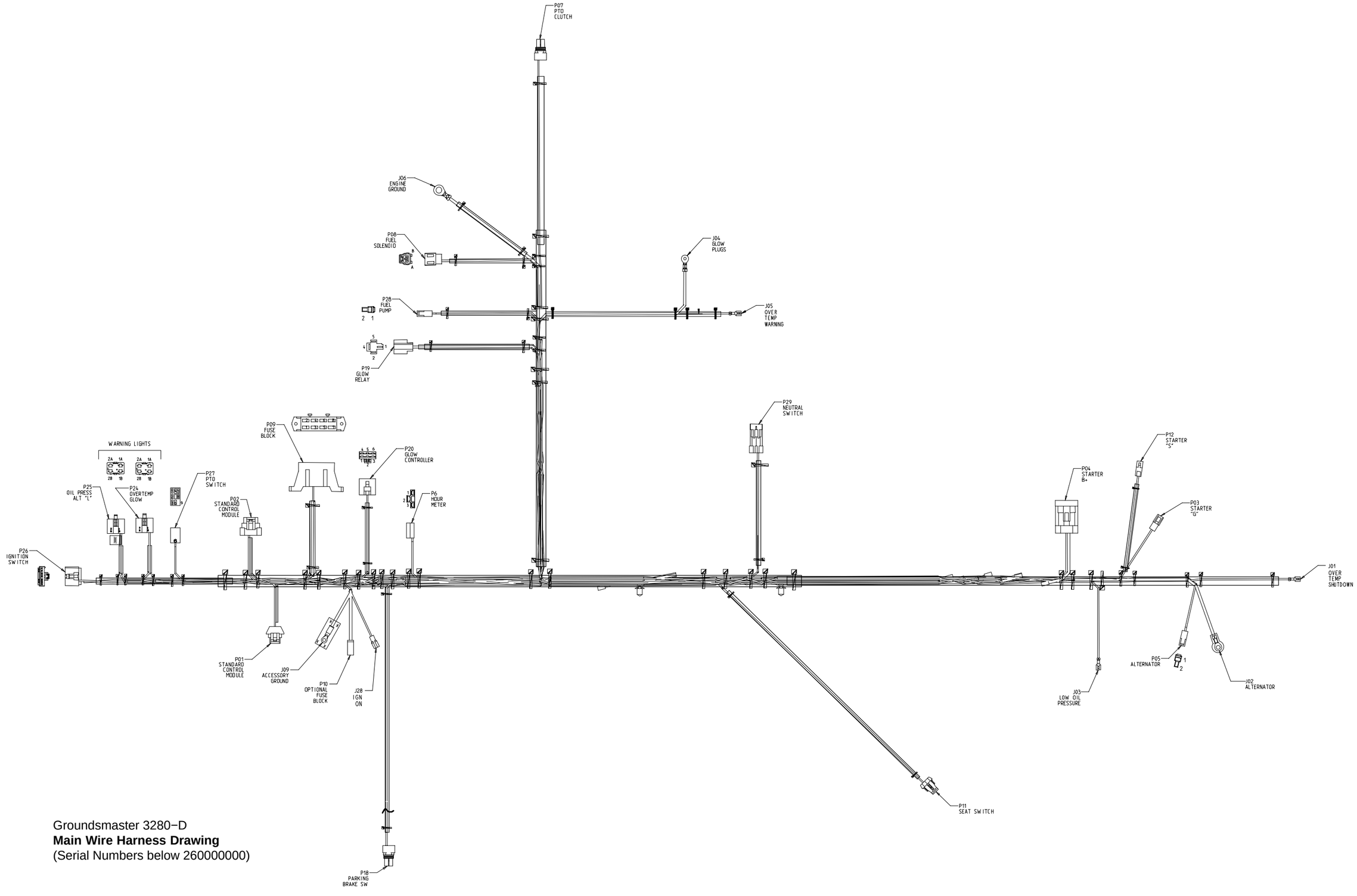
Groundsmaster 3320

Run (Mow) Circuit

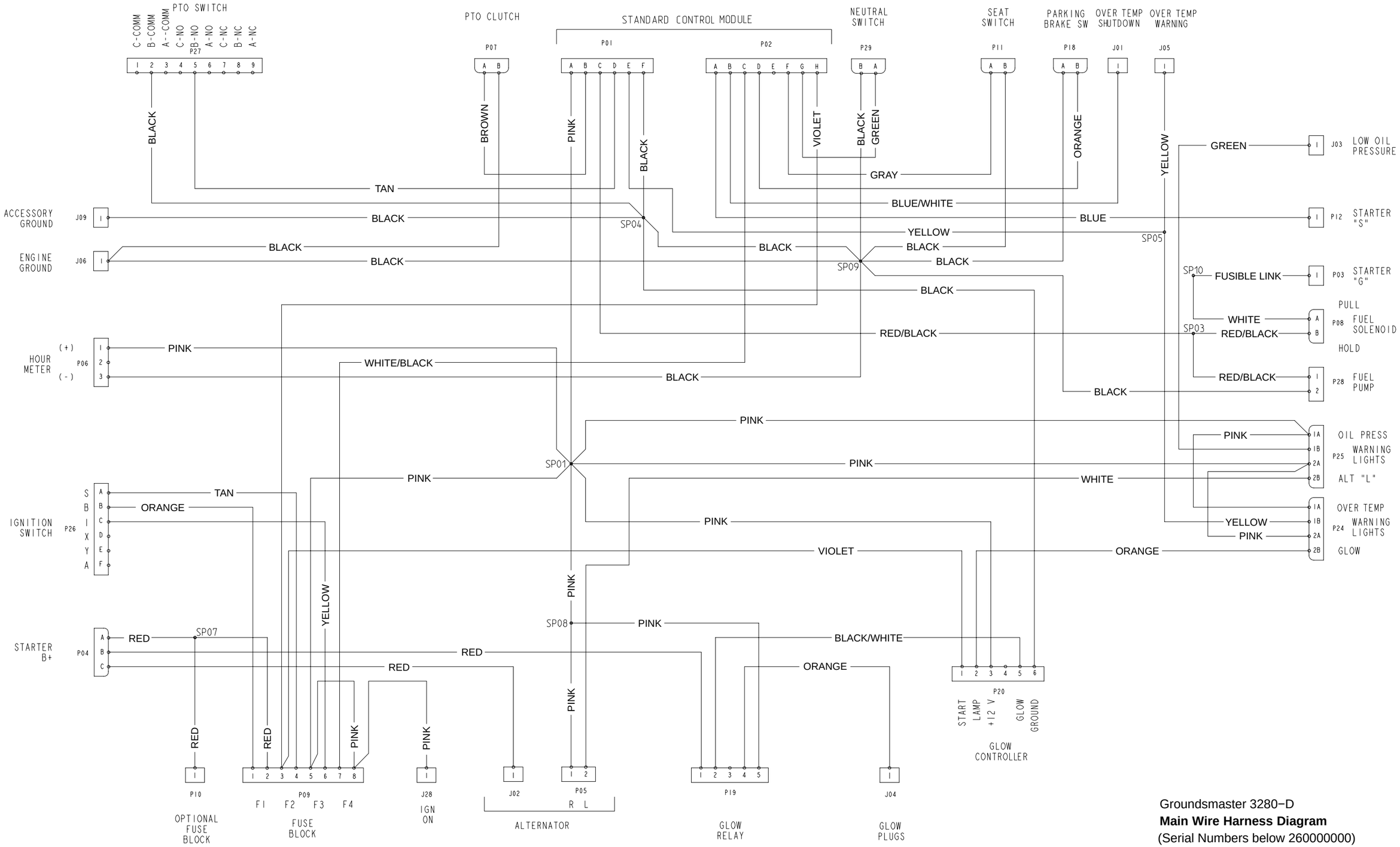
Power Current

Control Current

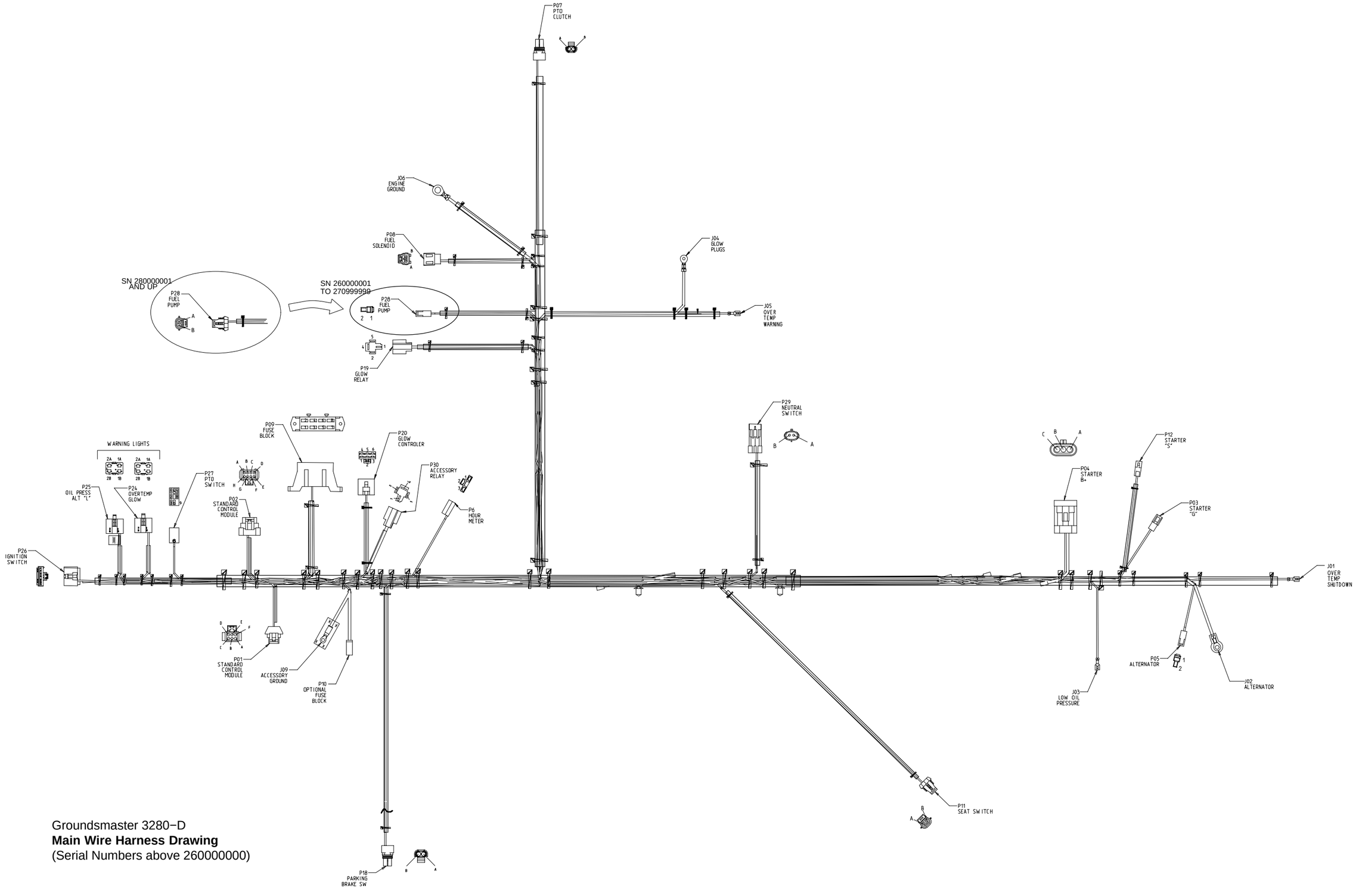
Indicator/Gauge Current



Groundsmaster 3280−D
Main Wire Harness Drawing
(Serial Numbers below 260000000)



Groundsmaster 3280−D
Main Wire Harness Diagram
(Serial Numbers below 260000000)



Groundsmaster 3280−D
Main Wire Harness Drawing
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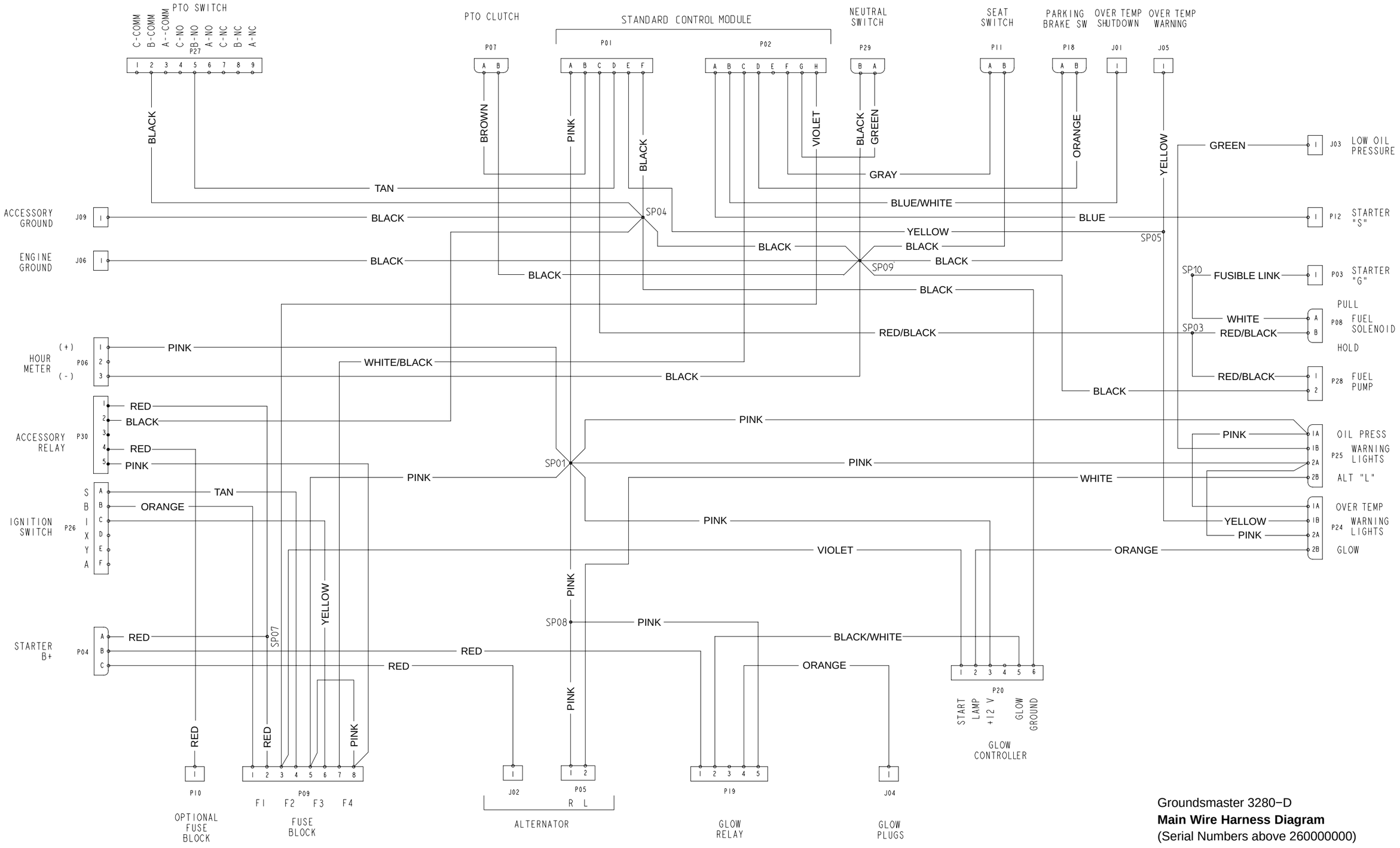

Groundsmaster 3280−D
Main Wire Harness Diagram
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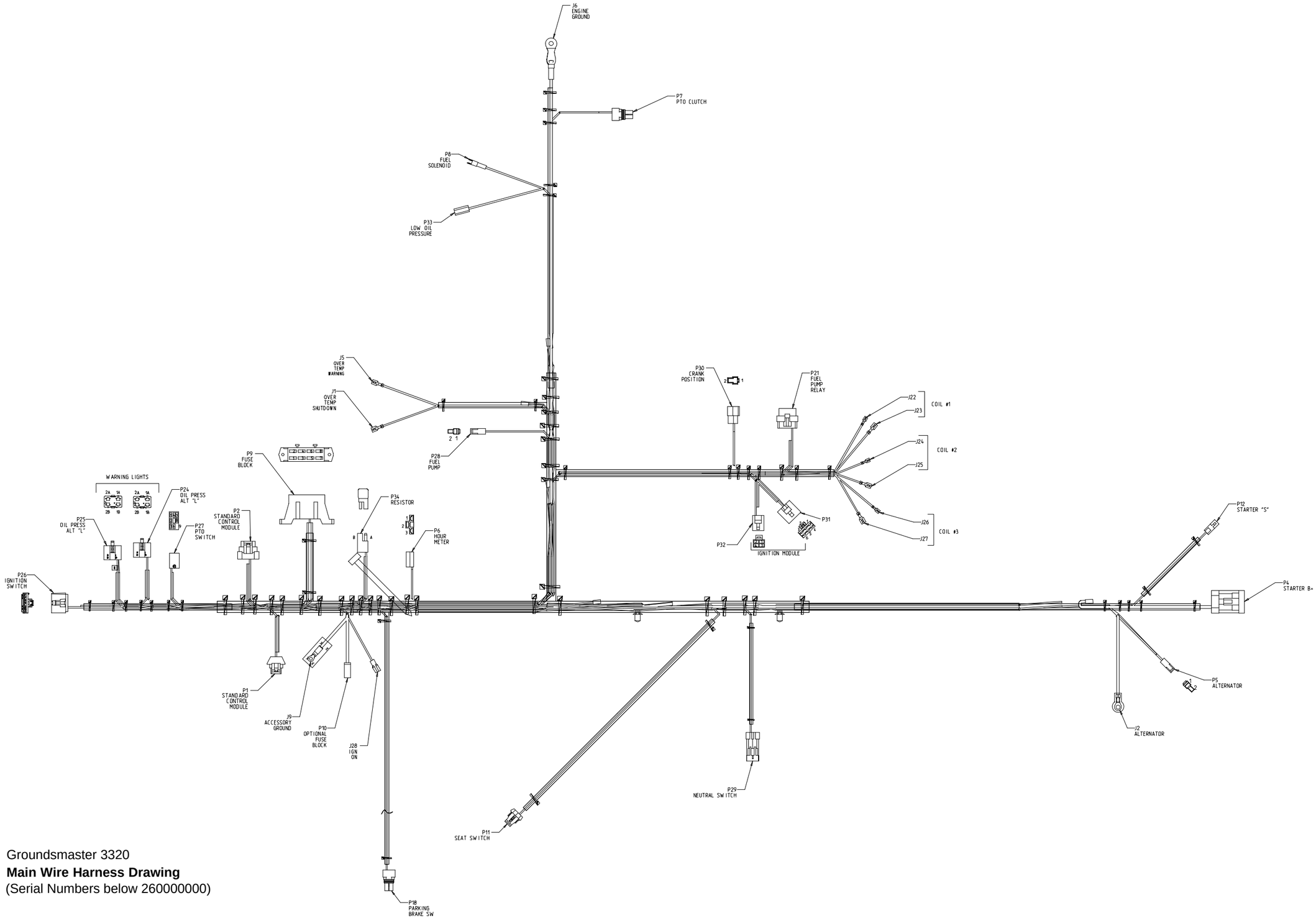

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Main Wire Harness Drawing
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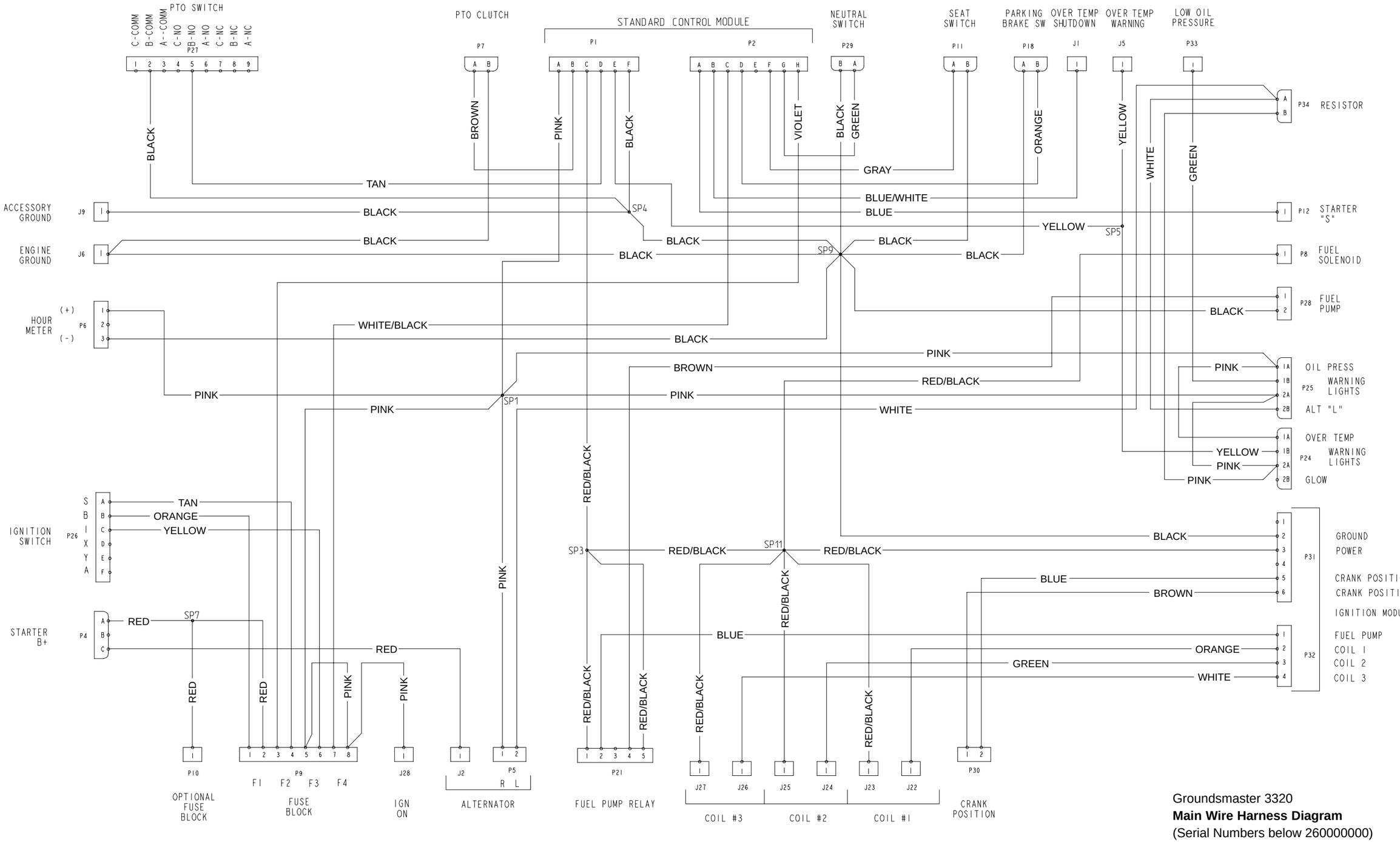

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Main Wire Harness Diagram
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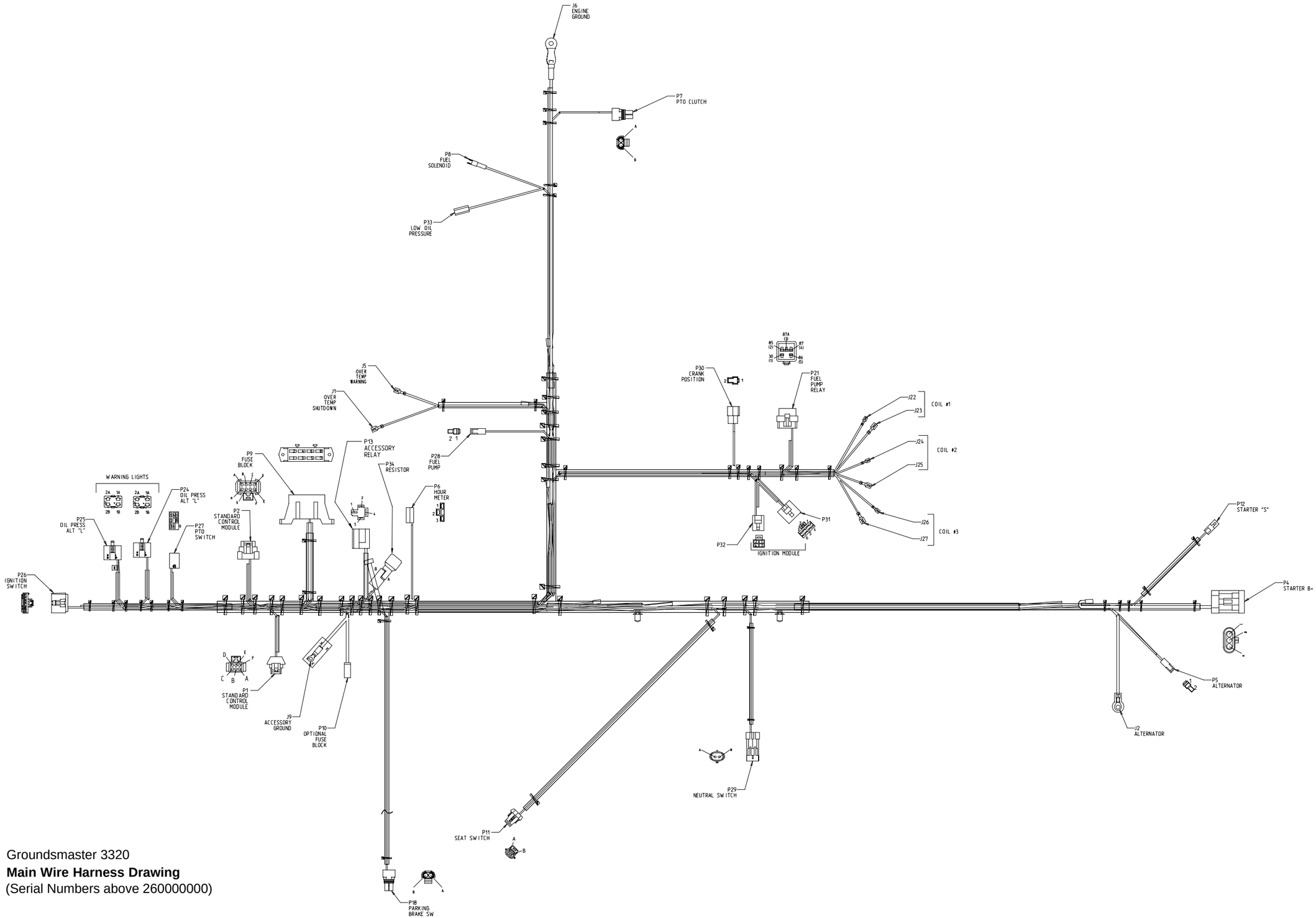

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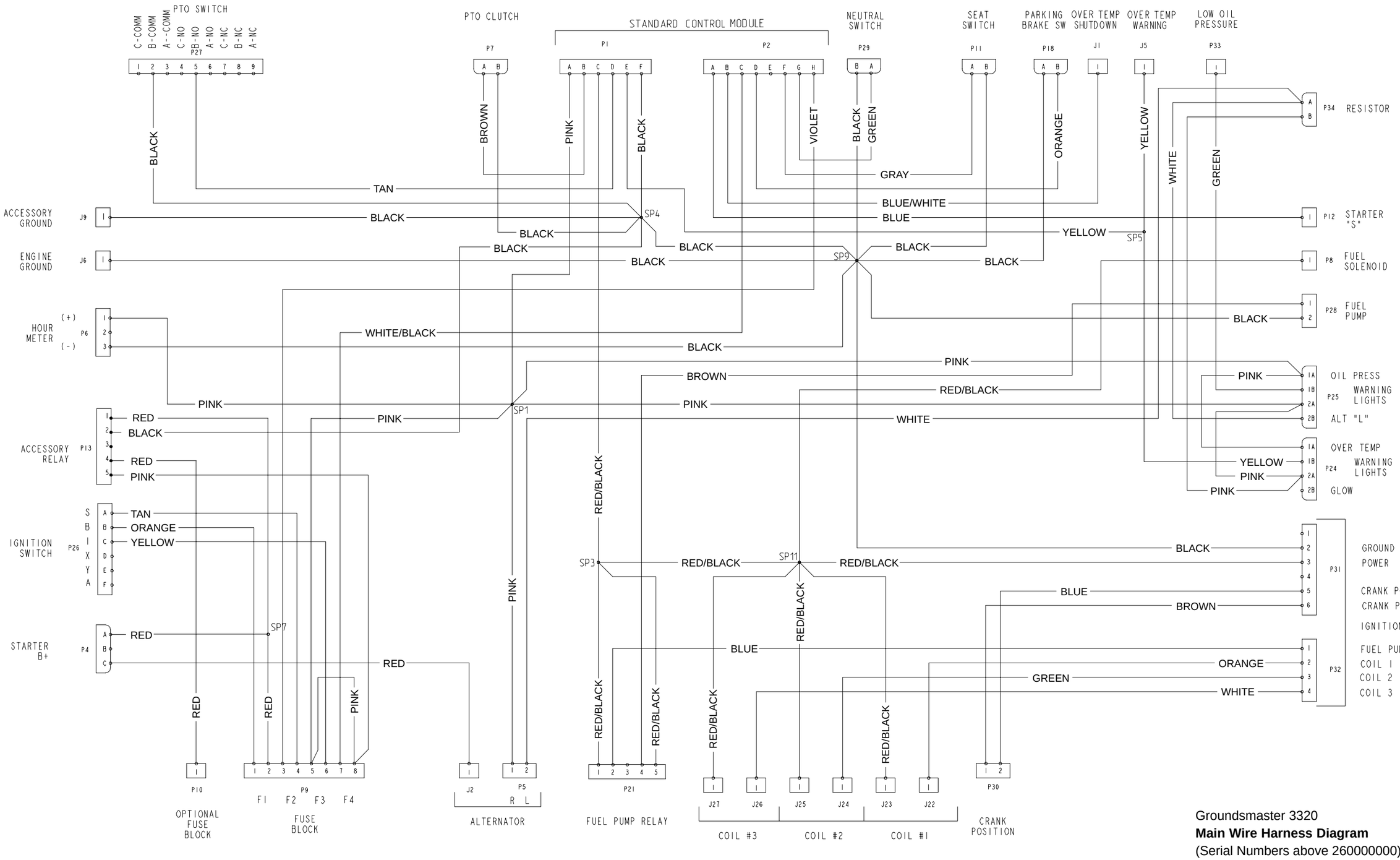

Groundsmaster 3320
Main Wire Harness Diagram
(Serial Numbers above 260000000)