

TORO[®]

Count on it.

Service Manual

Workman[®] HDX Auto

Revision History

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NOTES



Service Manual

Workman® HDX Auto

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 Workman HDX Auto vehicles.

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

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



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

Safety

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Safety Instructions

The Workman HDX Auto vehicles are designed and tested to offer safe service when operated and maintained properly. Although hazard control and accident prevention are partially dependent upon the design and configuration of the vehicle, 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 vehicle. Improper use or maintenance of the vehicle can result in injury or death. To reduce the potential for injury or death, comply with the following safety instructions.

Before Operating

1. Review and understand the contents of the Operator's Manual and Operator's DVD before starting and operating the vehicle. Become familiar with the controls and know how to stop the vehicle and engine quickly. Additional copies of the Operator's Manual are available on the internet at www.Toro.com.
2. Keep all shields, safety devices and decals in place. If a shield, safety device or decal is defective, illegible or damaged, repair or replace it before operating the vehicle. Also tighten any loose nuts, bolts or screws to ensure vehicle is in safe operating condition.
3. Assure interlock switches are adjusted correctly so engine cannot be started unless brake pedal is depressed and hydraulic lever is in the neutral position.



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

While Operating

1. Sit on the operator seat when starting and operating the vehicle.
2. When starting the engine:
 - A. Sit on operator's seat and engage the parking brake.
 - B. Make sure that high flow hydraulics (if so equipped) are disengaged and hand throttle lever (if so equipped) is in OFF position.
 - C. Make sure that transmission lever is in the P (park) position.
 - D. Make sure that hydraulic lift lever is in the neutral position.
 - E. Press the brake pedal. Keep foot off accelerator pedal.
 - F. Turn ignition key to START. Release key when engine starts.
3. Do not run engine in a confined area without adequate ventilation. Exhaust fumes are hazardous and could possibly be deadly.
4. Do not touch engine, exhaust system components, transmission or radiator, while engine is running or soon after it is stopped. These areas could be hot enough to cause burns.
5. Before getting off the seat:
 - A. Ensure that the machine is completely stopped.
 - B. Move the transmission lever to the P (Park) position.
 - C. Set the parking brake.
 - D. Rotate the ignition switch to the OFF position and wait for all movement to stop.
 - E. Remove key from ignition switch.
6. Do not park on slopes unless wheels are chocked or blocked.

Maintenance and Service

1. Before servicing or making adjustments:
 - A. Ensure that the machine is stopped and all accessories are OFF.
 - B. Move the transmission lever to the P (Park) position and then set the parking brake.
 - C. Rotate the ignition switch to the OFF position and remove the key from the switch.
2. Make sure vehicle is in safe operating condition by keeping all nuts, bolts and screws tight.
3. Never store the vehicle or fuel container inside where there is an open flame, such as near a water heater or furnace.
4. Never work under a raised bed without placing the bed safety support on the fully extended lift cylinder rod.
5. Make sure all hydraulic line connectors are tight and that all hydraulic hoses and lines are in good condition, before applying pressure to the system.
6. Keep body and hands away from pin hole leaks in hydraulic lines that eject high pressure hydraulic fluid. Use cardboard or paper to find hydraulic leaks. Hydraulic fluid escaping under pressure can penetrate skin and cause injury. Fluid accidentally injected into the skin must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.
7. Before disconnecting or performing any work on the hydraulic system, all pressure in hydraulic system must be relieved. To relieve system pressure, push hydraulic lever forward and backward and rotate steering wheel in both directions after the ignition switch has been turned off.
8. If major repairs are ever needed or assistance is desired, contact an Authorized Toro Distributor.
9. To reduce potential fire hazard, keep engine area free of excessive grease, grass, leaves and dirt.
10. If engine must be running to perform maintenance or an adjustment, keep clothing, hands, feet and other parts of the body away from moving parts. Keep bystanders away.
11. Do not overspeed the engine by changing governor setting. To ensure safety and accuracy, check maximum engine speed.
12. Shut engine off before checking or adding oil to the engine crankcase.
13. Disconnect battery before servicing the vehicle. Disconnect negative (-) battery cable first and positive (+) cable last. If battery voltage is required for troubleshooting or test procedures, temporarily connect the battery. Connect 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 and clothing when working with a battery.
15. Battery gases can explode. Keep lit cigarettes, sparks and flames away from the battery.
16. To ensure optimum performance and continued safety of the vehicle, use genuine Toro replacement parts and accessories. Replacement parts and accessories made by other manufacturers may result in non-conformance with safety standards and the warranty may be voided.
17. When raising the vehicle to change tires or to perform other service, use correct jacks, hoists and jack stands. Make sure vehicle is parked on a solid level surface such as a concrete floor. Prior to raising the vehicle, remove any attachments that may interfere with the safe and proper raising of the vehicle. Always chock or block wheels. Use appropriate jack stands to support the raised vehicle. If the vehicle is not properly supported by jack stands, the vehicle may move or fall, which may result in personal injury (see Jacking Vehicle in this section).
18. Make sure to dispose of potentially harmful waste (e.g. fuel, oil, engine coolant, filters, battery) in an environmentally safe manner. Follow all local codes and regulations when recycling or disposing of waste.

Jacking Vehicle



WARNING

When changing attachments, tires or performing other service, use correct jacks, hoists and jack stands. Always chock or block the wheels and use jack stands to support the vehicle. If the vehicle is not properly supported by jack stands, the vehicle may move or fall resulting in personal injury.

1. Do not start engine while vehicle is on jack, because engine vibration or wheel movement could cause vehicle to slip off jack.
2. Do not work under vehicle without jack stands supporting it. The vehicle could slip off jack, injuring any one beneath it.
3. The jacking point at the front of the vehicle is under the front center frame support (Fig. 1). When jacking up front of vehicle, always place a wood block (or similar material) between jack and vehicle frame support.
4. The jacking point at the rear of the vehicle is under the axle (Fig. 2).

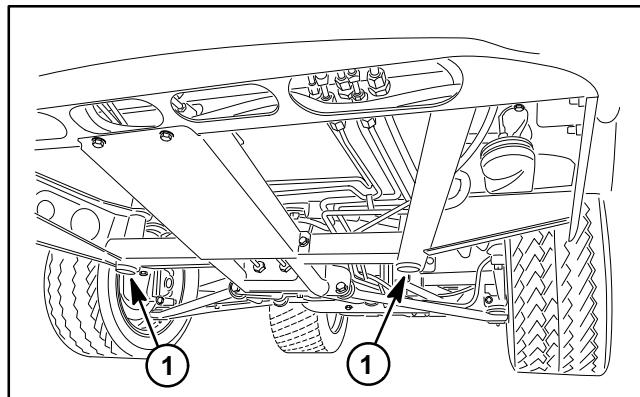


Figure 1

1. Front jacking point

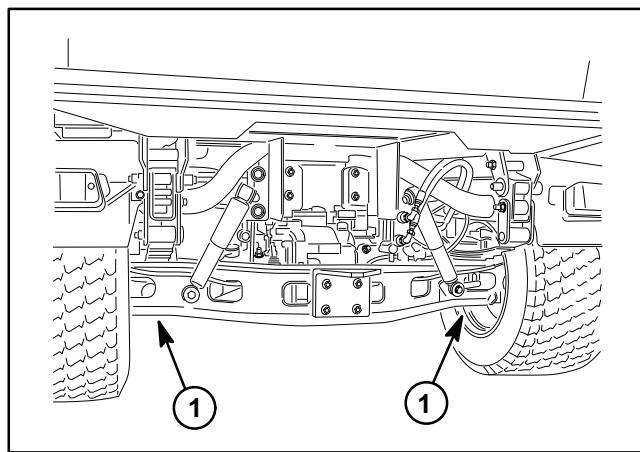


Figure 2

1. Rear jacking point

Using Bed Safety Support

Many of the procedures shown in this manual require raising and lowering the bed. The following precautions must be taken or serious injury or death could result.



WARNING

Before servicing or making adjustments to the vehicle, stop engine, engage parking brake and remove key from ignition switch. Any load material must be removed from bed or other attachment before working under raised bed. Never work under a raised bed without positioning bed safety support on a fully extended cylinder rod.

After work is completed, remove bed safety support, insert safety support into storage brackets on back of ROPS panel and lower bed.

1. Raise bed until lift cylinders are fully extended.
2. Remove bed safety support from storage brackets on back of ROPS panel.
3. Push bed safety support onto cylinder rod, making sure support end tabs rest on end of cylinder barrel and on cylinder rod end (Fig. 3).
4. To store bed safety support, remove support from lift cylinder and insert into storage brackets on back of ROPS panel.
5. Always install or remove bed safety support from outside of bed.
6. Do not try to lower bed with bed safety support on lift cylinder: cylinder and bed damage may occur.

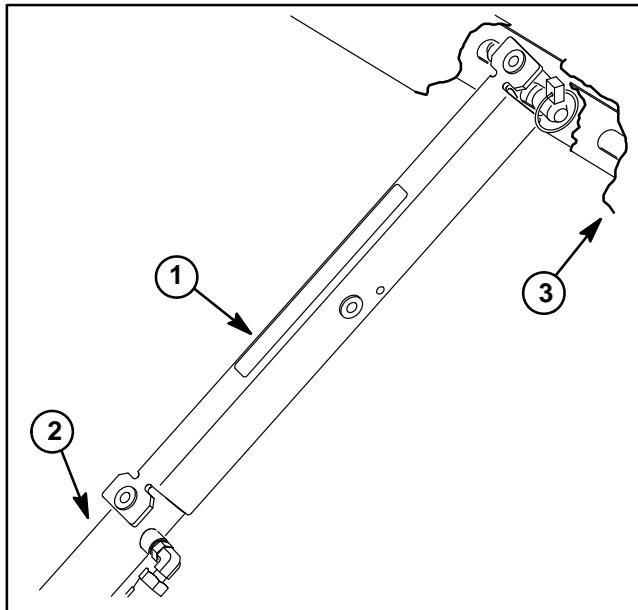


Figure 3

1. Bed safety support
2. Cylinder barrel
3. Bed

Safety and Instruction Decals

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



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Product Records

Insert Operator's Manual and Parts Catalog for your Workman HDX Auto vehicle at the end of this chapter. Refer to Operator's Manual for recommended maintenance intervals. Additionally, insert Installation Instructions, Operator's Manuals, Parts Catalogs and Service Manuals for any accessories that have been installed on your Workman at the end of this section.

Maintenance

Maintenance procedures and recommended service intervals for the Workman HDX Auto vehicles are covered in the Operator's Manual. Refer to that publication when performing regular equipment maintenance. Several maintenance procedures have break-in intervals identified in the Operator's Manual. Refer to the Engine Operator's Manual for additional engine specific maintenance procedures.

Equivalents and Conversions

Decimal and Millimeter Equivalents

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

U.S.to Metric Conversions

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

Torque Specifications

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

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

Fastener Identification

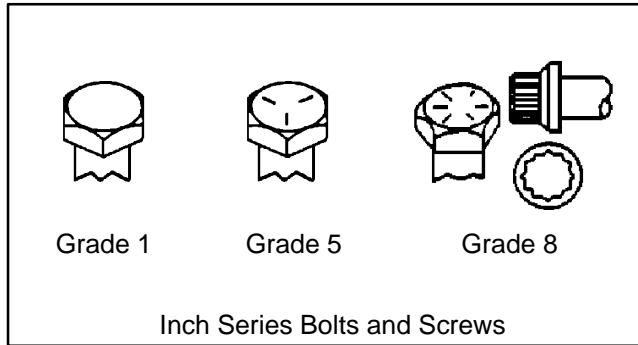


Figure 1

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.

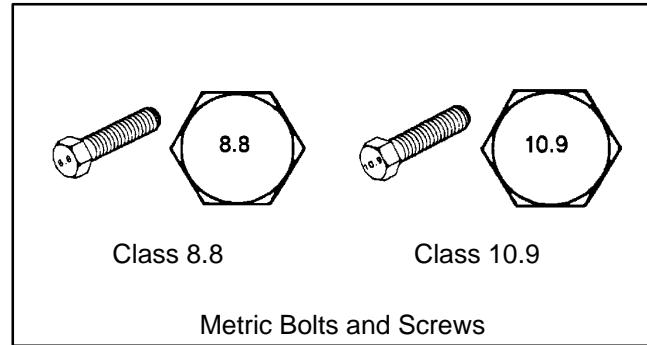


Figure 2

Using a Torque Wrench with an Offset Wrench

Use of an offset wrench (e.g. crowfoot wrench) will affect torque wrench calibration due to the effective change of torque wrench length. When using a torque wrench with an offset wrench, multiply the listed torque recommendation by the calculated torque conversion factor (Fig. 3) to determine proper tightening torque. Tightening torque when using a torque wrench with an offset wrench will be lower than the listed torque recommendation.

Example: The measured effective length of the torque wrench (distance from the center of the handle to the center of the square drive) is 18".

The measured effective length of the torque wrench with the offset wrench installed (distance from the center of the handle to the center of the offset wrench) is 19".

The calculated torque conversion factor for this torque wrench with this offset wrench would be $18 / 19 = 0.947$.

If the listed torque recommendation for a fastener is from 76 to 94 ft-lb, the proper torque when using this torque wrench with an offset wrench would be from 72 to 89 ft-lb.

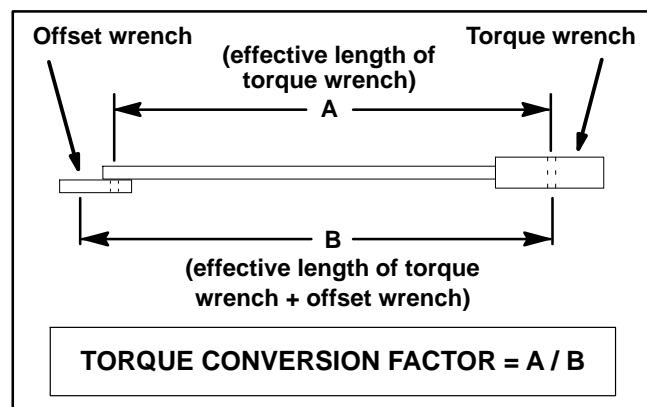


Figure 3

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

Thread Size	Grade 1, 5 & 8 with Thin Height Nuts	SAE Grade 1 Bolts, Screws, Studs & Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)	SAE Grade 5 Bolts, Screws, Studs & Sems with Regular Height Nuts (SAE J995 Grade 2 or Stronger Nuts)	SAE Grade 8 Bolts, Screws, Studs & Sems with Regular Height Nuts (SAE J995 Grade 5 or Stronger Nuts)			
	in-lb	in-lb	N-cm	in-lb	N-cm	in-lb	N-cm
# 6 – 32 UNC	10 \pm 2	13 \pm 2	147 \pm 23	15 \pm 2	169 \pm 23	23 \pm 3	262 \pm 34
# 6 – 40 UNF				17 \pm 2	192 \pm 23	25 \pm 3	282 \pm 34
# 8 – 32 UNC	13 \pm 2	25 \pm 5	282 \pm 30	29 \pm 3	328 \pm 34	41 \pm 5	463 \pm 56
# 8 – 36 UNF				31 \pm 4	350 \pm 45	43 \pm 5	486 \pm 56
# 10 – 24 UNC	18 \pm 2	30 \pm 5	339 \pm 56	42 \pm 5	475 \pm 56	60 \pm 6	678 \pm 68
# 10 – 32 UNF				48 \pm 5	542 \pm 56	68 \pm 7	768 \pm 79
1/4 – 20 UNC	48 \pm 7	53 \pm 7	599 \pm 79	100 \pm 10	1130 \pm 113	140 \pm 15	1582 \pm 169
1/4 – 28 UNF	53 \pm 7	65 \pm 10	734 \pm 113	115 \pm 12	1299 \pm 136	160 \pm 17	1808 \pm 192
5/16 – 18 UNC	115 \pm 15	105 \pm 15	1186 \pm 169	200 \pm 25	2260 \pm 282	300 \pm 30	3390 \pm 339
5/16 – 24 UNF	138 \pm 17	128 \pm 17	1446 \pm 192	225 \pm 25	2542 \pm 282	325 \pm 33	3672 \pm 373
	ft-lb	ft-lb	N-m	ft-lb	N-m	ft-lb	N-m
3/8 – 16 UNC	16 \pm 2	16 \pm 2	22 \pm 3	30 \pm 3	41 \pm 4	43 \pm 5	58 \pm 7
3/8 – 24 UNF	17 \pm 2	18 \pm 2	24 \pm 3	35 \pm 4	47 \pm 5	50 \pm 6	68 \pm 8
7/16 – 14 UNC	27 \pm 3	27 \pm 3	37 \pm 4	50 \pm 5	68 \pm 7	70 \pm 7	95 \pm 9
7/16 – 20 UNF	29 \pm 3	29 \pm 3	39 \pm 4	55 \pm 6	75 \pm 8	77 \pm 8	104 \pm 11
1/2 – 13 UNC	30 \pm 3	48 \pm 7	65 \pm 9	75 \pm 8	102 \pm 11	105 \pm 11	142 \pm 15
1/2 – 20 UNF	32 \pm 4	53 \pm 7	72 \pm 9	85 \pm 9	115 \pm 12	120 \pm 12	163 \pm 16
5/8 – 11 UNC	65 \pm 10	88 \pm 12	119 \pm 16	150 \pm 15	203 \pm 20	210 \pm 21	285 \pm 28
5/8 – 18 UNF	75 \pm 10	95 \pm 15	129 \pm 20	170 \pm 18	230 \pm 24	240 \pm 24	325 \pm 33
3/4 – 10 UNC	93 \pm 12	140 \pm 20	190 \pm 27	265 \pm 27	359 \pm 37	375 \pm 38	508 \pm 52
3/4 – 16 UNF	115 \pm 15	165 \pm 25	224 \pm 34	300 \pm 30	407 \pm 41	420 \pm 43	569 \pm 58
7/8 – 9 UNC	140 \pm 20	225 \pm 25	305 \pm 34	430 \pm 45	583 \pm 61	600 \pm 60	813 \pm 81
7/8 – 14 UNF	155 \pm 25	260 \pm 30	353 \pm 41	475 \pm 48	644 \pm 65	667 \pm 66	904 \pm 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 \pm 10% of the nominal torque value. Thin height nuts include jam nuts.

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

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

Other Torque Specifications

SAE Grade 8 Steel Set Screws

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

Wheel Bolts and Lug Nuts

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

** For steel wheels and non-lubricated fasteners.

Thread Cutting Screws (Zinc Plated Steel)

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

Thread Cutting Screws (Zinc Plated Steel)

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

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

Conversion Factors

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

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

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

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



Kohler Gasoline Engine

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KOHLER AEGIS SERVICE MANUAL	

Specifications

Item	Description
Make / Designation	Kohler, LH775, 4-stroke, V-Twin Liquid Cooled, OHV
Number of Cylinders	2
Bore x Stroke	3.27 in x 2.72 in (83 mm x 69 mm)
Total Displacement	45.6 in ³ (747 cc)
Compression Ratio	8.7:1
Fuel System	Electronic fuel injection
Fuel Pump	12 VDC, fuel tank mounted
Fuel	Unleaded, Regular Gasoline (Minimum 87 Octane)
Fuel Tank Capacity	6.5 U.S. gallons (24.6 liters)
Governor	Mechanical
Idle Speed (no load)	1250 to 1350 RPM
High Idle (no load)	3550 to 3650 RPM
Oil Pump	Gear driven trochoid type
Engine Oil	API Service Classification SJ or higher (see Operator's Manual for viscosity)
Crankcase Oil Capacity	2.1 U.S. quarts (2 liters) with filter
Cooling System Capacity	4.0 U.S. quarts (3.7 liters)
Starter	12 VDC, Solenoid Shift
Battery Charging System	12 VDC 25 Amp
Dry Weight (approximate)	116 pounds (52.6 kilograms)

General Information

This Chapter gives information about specifications and repair of the Kohler engine used in the Workman HDX Auto vehicle.

General engine maintenance procedures are described in your Operator's Manual. Information on engine troubleshooting, testing, disassembly and assembly is identified in the Kohler Aegis Service Manual that is included at the end of this section.

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

Service and repair parts for Kohler engines are supplied through your local Toro distributor. Be prepared to provide your distributor with both the Toro and Kohler model and serial numbers.

Operator's Manual

The Workman Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for your Workman HDX Auto vehicle. The Kohler Owner's Manual includes information specific to the engine used in your Workman. Refer to these publications for additional information when servicing the machine.

Kohler Aegis Service Manual

The engine that powers your Workman HDX Auto vehicle is a Kohler model LH775. The Kohler Aegis Service Manual should be used when servicing the engine on your Workman.

Engine Electronic Control Unit (ECU)

The Kohler Aegis engine that powers your Workman uses an electronic control unit (ECU) for engine management. All wire harness electrical connectors should be plugged into the ECU before the machine ignition switch is moved from the OFF position to either the RUN or START position.

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

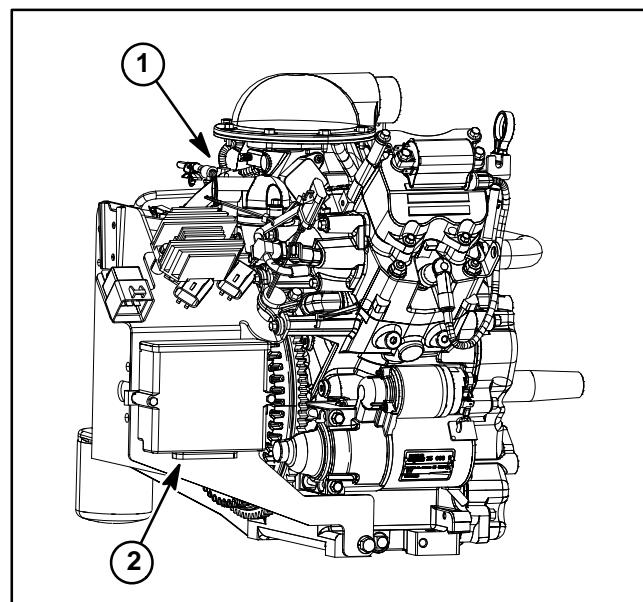


Figure 1

1. Engine

2. Engine ECU

Adjustments

Adjust Accelerator Control

Proper accelerator operation is dependent upon correct adjustment of the accelerator control. Make sure accelerator control is operating properly.

IMPORTANT: If the optional four wheel drive kit has been installed on your vehicle, additional information regarding accelerator control adjust is included in the Installation Instructions for that kit. When adjusting the accelerator control on a vehicle that is equipped with the four wheel drive kit, make sure to use these Instructions.

NOTE: Accelerator control for vehicles with serial numbers below 315000000 is shown in Figure 2 and accelerator control for vehicles with serial numbers above 315000000 is shown in Figure 3.

1. Park vehicle on a level surface and engage parking brake.
2. Raise or remove the cargo bed or other attachment(s). If bed is raised, place safety support on lift cylinder.
3. Start engine and allow it to reach operating temperature before checking or adjusting engine speed.
4. With engine running at low idle speed (accelerator pedal not depressed), use a tachometer to check that engine is operating at **1300 \pm 50 RPM**. When checking low idle speed, the engine governor spring should be at the end of the slot in the speed control bellcrank without being tensioned that would open the engine throttle. If low idle speed is incorrect, adjust engine idle speed screw so that idle speed is correct. The engine idle speed screw is located on the engine intake manifold/throttle body.
5. Make sure that transmission lever is in the park position and increase engine speed to high idle by fully depressing the accelerator pedal. Use a tachometer to check that engine is operating at **3600 \pm 50 RPM**.
6. If high idle speed is incorrect, adjust high speed screw on engine throttle bracket (Fig. 2).

A. Loosen jam nut on high speed screw.

B. Adjust high speed screw to obtain correct high idle speed of **3600 \pm 50 RPM**. Make sure that accelerator pedal is fully depressed when adjusting high speed screw position.

C. Tighten jam nut to secure adjustment of high speed screw.

7. Fully depress accelerator pedal to the **FAST** position. Accelerator pedal should have from **0.200" to 0.350" (5.1 to 8.9 mm)** clearance between bottom of pedal and floor plate when pedal is fully depressed.

A. If accelerator pedal clearance is incorrect, the accelerator cable can be adjusted by loosening cable jam nuts and repositioning accelerator cable at engine. When pedal clearance is correct, tighten cable jam nuts.

8. Recheck low idle and high idle speed after all adjustments have been made. Readjust if necessary.

9. Lower or install cargo bed or attachment(s).

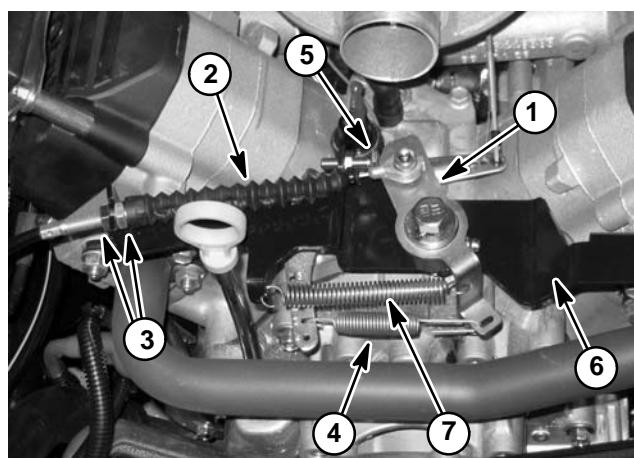


Figure 2

- | | |
|----------------------------|---------------------|
| 1. Speed control bellcrank | 5. High speed screw |
| 2. Accelerator cable | 6. Throttle bracket |
| 3. Jam nut (2) | 7. Governor spring |
| 4. Governor spring | |

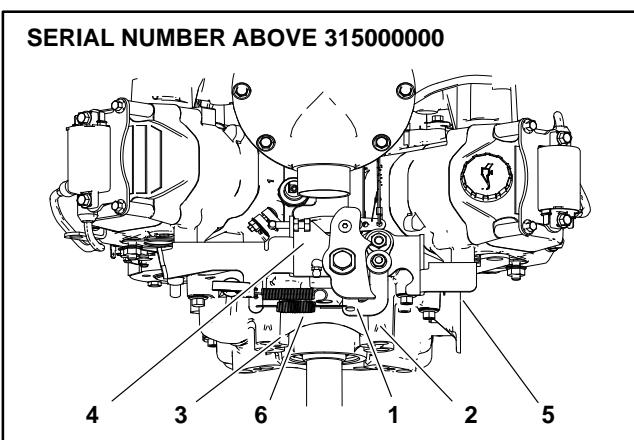


Figure 3

- | | |
|----------------------------|---------------------|
| 1. Speed control bellcrank | 4. High speed screw |
| 2. Throttle lever | 5. Throttle bracket |
| 3. Governor spring | 6. Governor spring |

Service and Repairs

Accelerator Control

Two styles of accelerator control have been used on Workman HDX Auto machines. On vehicles with serial numbers below 315000000 (Fig. 4), the accelerator control includes a bellcrank that is rotated by the accelerator cable to change engine speed. Vehicles with serial numbers above 315000000 (Fig. 5) use an accelerator control with additional components.

Disassembly (Fig. 4 or 5)

1. Park vehicle on a level surface and engage parking brake.
2. Raise or remove the cargo bed or other attachment(s). If bed is raised, place safety support on lift cylinder.
3. Make sure that the engine is stopped and the key is removed from ignition switch. Allow engine to cool.
4. Remove accelerator control components as needed using Figure 4 or 5 as a guide. If engine governor spring needs to be disconnected from bellcrank, note attachment points for assembly purposes.

Assembly (Fig. 4 or 5)

1. Install removed accelerator control components to engine using Figure 4 or 5 as a guide.
2. On vehicles with serial numbers above 315000000 (Fig. 5), make sure that ball bearing (item 15 in Fig. 5) is lightly contacting bellcrank. If necessary, loosen flange nut (item 5 in Fig. 5) and move throttle lever until ball bearing is in light contact with bellcrank. Tighten nut after adjustment.
3. Make sure that the engine governor spring is at the end of the slot in the bellcrank (item 3 in Fig. 4) or throttle lever (item 12 in Fig. 5) without being tensioned. If the governor spring is tensioned, the engine throttle will not be closed when the accelerator pedal is released.
4. After assembly is completed, make sure that bellcrank moves freely as accelerator pedal is depressed fully and released.
5. Lubricate grease fitting on bellcrank.
6. Check adjustment of accelerator control (see Adjust Accelerator Control in the Adjustments section of this chapter).
7. Lower or install cargo bed or attachment(s).

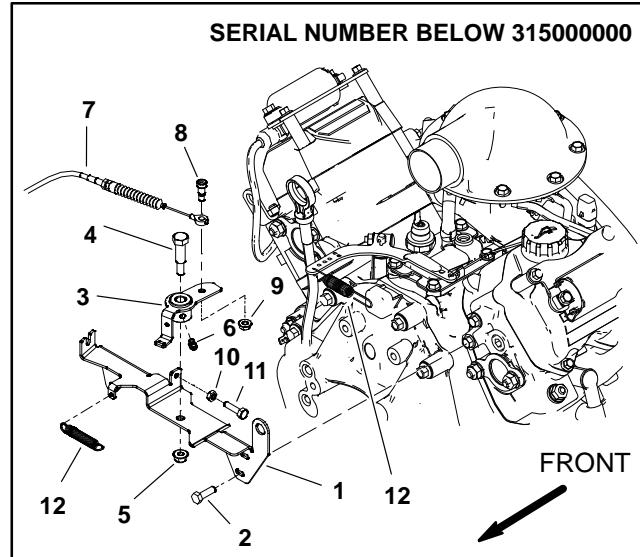


Figure 4

- | | |
|---------------------|----------------------|
| 1. Throttle bracket | 7. Accelerator cable |
| 2. Cap screw (4) | 8. Shoulder bolt |
| 3. Bellcrank | 9. Flange nut |
| 4. Shoulder screw | 10. Jam nut |
| 5. Flange nut | 11. Cap screw |
| 6. Grease fitting | 12. Governor spring |

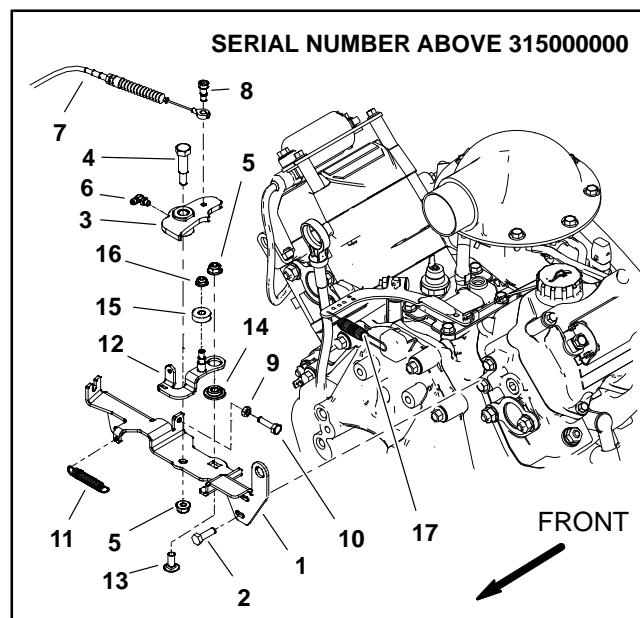


Figure 5

- | | |
|----------------------|----------------------|
| 1. Throttle bracket | 10. Cap screw |
| 2. Cap screw (4) | 11. Extension spring |
| 3. Bellcrank | 12. Throttle lever |
| 4. Shoulder screw | 13. Carriage screw |
| 5. Flange nut (2) | 14. Idle bushing |
| 6. Grease fitting | 15. Ball bearing |
| 7. Accelerator cable | 16. Flange nut |
| 8. Shoulder bolt | 17. Governor spring |
| 9. Jam nut | |

Air Cleaner System

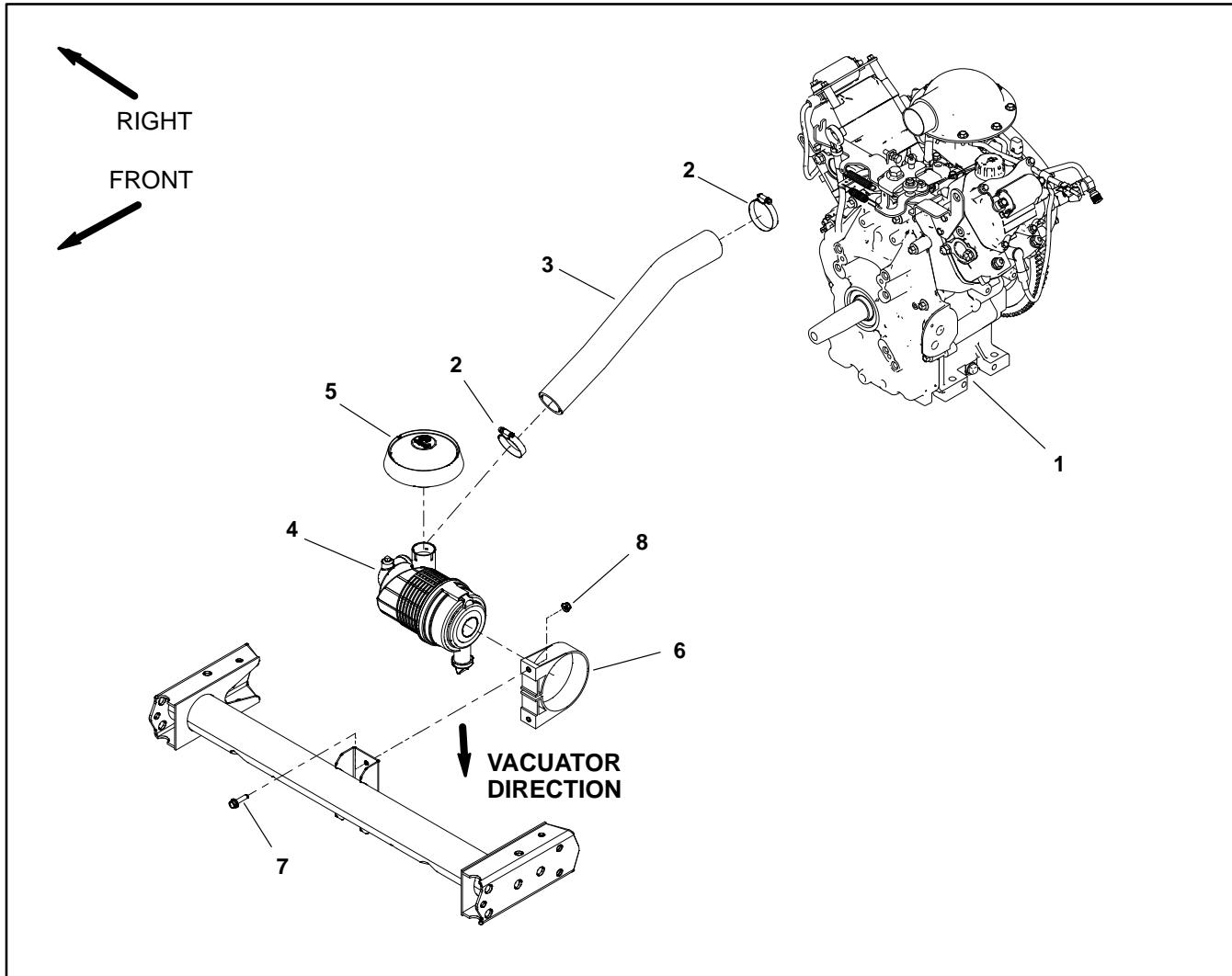


Figure 6

- | | | |
|-------------------|-------------------------|--------------------------|
| 1. Engine | 4. Air cleaner assembly | 7. Flange head screw (2) |
| 2. Hose clamp (2) | 5. Air inlet hood | 8. Flange nut (2) |
| 3. Intake hose | 6. Mounting bracket | |

Removal (Fig. 6)

1. Park vehicle on a level surface and engage parking brake.
2. Raise or remove the cargo bed or other attachment(s). If bed is raised, place safety support on lift cylinder.
3. Make sure that the engine is stopped and the key is removed from ignition switch. Allow engine to cool.
4. Remove air cleaner components as needed using Figures 6 and 7 as guides.

Installation (Fig. 6)

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

1. Assemble air cleaner system using Figures 6 and 7 as guides. The air inlet hood (item 5 in Fig. 6) should be positioned straight upward. The vacuator valve on the air cleaner assembly should be positioned downward.
2. Lower or install cargo bed or attachment(s).

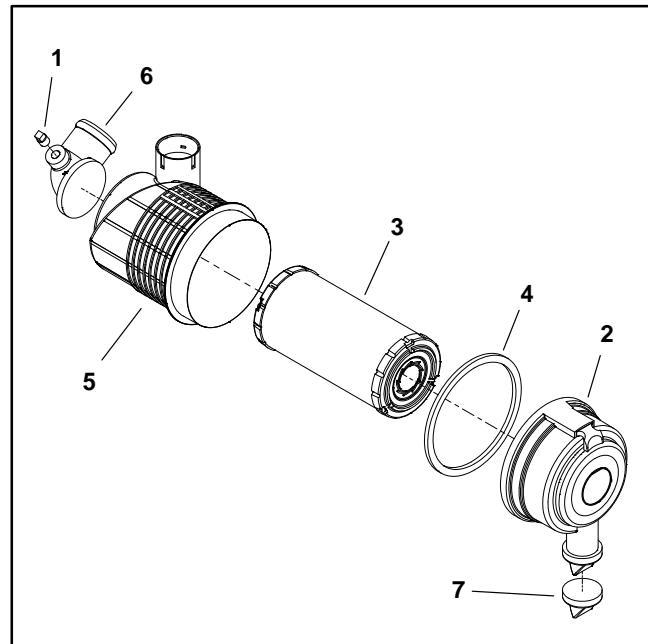


Figure 7

- | | |
|------------------|-------------------|
| 1. Plug | 5. Lower housing |
| 2. Upper housing | 6. Elbow |
| 3. Element | 7. Vacuator valve |
| 4. Gasket | |

Fuel Tank

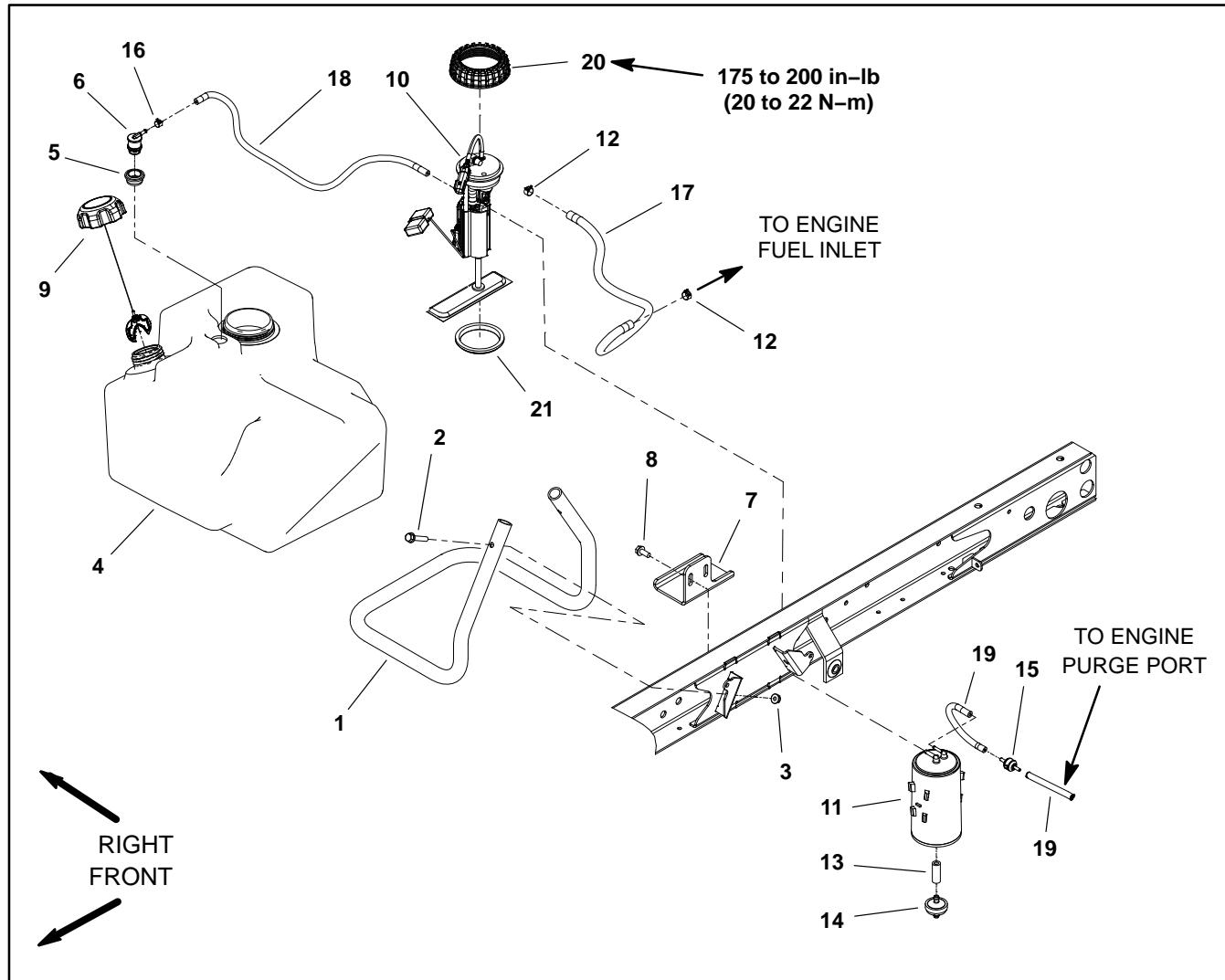


Figure 8

- | | | |
|--------------------------|--------------------------|------------------------|
| 1. Support tube | 8. Washer head screw (2) | 15. Vacuum check valve |
| 2. Washer head screw (2) | 9. Fuel tank cap | 16. Hose clamp |
| 3. Flange nut (2) | 10. Fuel pump assembly | 17. Fuel supply hose |
| 4. Fuel tank | 11. Carbon canister | 18. Tank vent hose |
| 5. Grommet | 12. Hose clamp (2) | 19. Fuel hose (2) |
| 6. Rollover valve | 13. Fuel hose | 20. Fuel pump retainer |
| 7. Retainer plate | 14. Fresh air filter | 21. Gasket |



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 vehicle 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 fuel for the engine only; not for any other purpose.

Check Fuel Lines and Connections

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

Fuel Tank Removal (Fig. 8)

1. Park vehicle on a level surface and engage parking brake.
2. Raise or remove the cargo bed or other attachment(s). If bed is raised, place safety support on lift cylinder.
3. Make sure that the engine is stopped and the key is removed from ignition switch. Allow engine to cool.
4. Disconnect wire harness connector from fuel pump assembly on fuel tank.
5. Note routing of fuel hoses for installation purposes (Fig. 9). Disconnect fuel hoses from fuel pump assembly and rollover valve. Plug fuel hoses to prevent leakage or contaminant entry.
6. Remove washer head screws (item 8) and retainer plate (item 7) that secure fuel tank to vehicle.
7. Remove fuel tank from vehicle.

Fuel Tank Installation (Fig. 8)

1. Position fuel tank to support tube.
2. Remove plugs placed in fuel hoses during fuel tank removal. Connect fuel hoses to fuel pump assembly and rollover valve (Fig. 9). Secure fuel hoses with hose clamps.
3. Connect wire harness connector to fuel pump assembly.
4. Position retainer plate (item 7) to tank and frame. Make sure that fuel hoses are correctly placed under retainer. While pressing down on retainer plate to best retain tank, install and tighten washer head screws (item 8) to secure fuel tank to vehicle.
5. Lower or install the cargo bed or other attachment(s).
6. Fill fuel tank. Check for fuel leakage and correct if found.

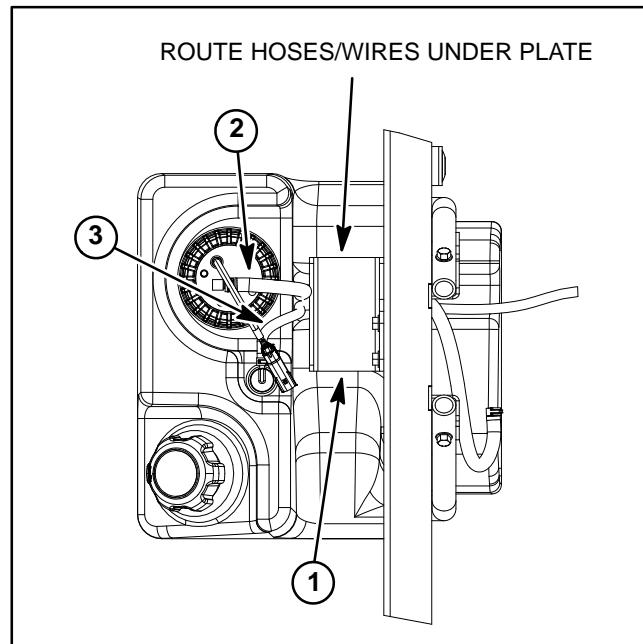


Figure 9

1. Retainer plate
2. Fuel supply hose
3. Tank vent hose

Fuel Evaporative Control System

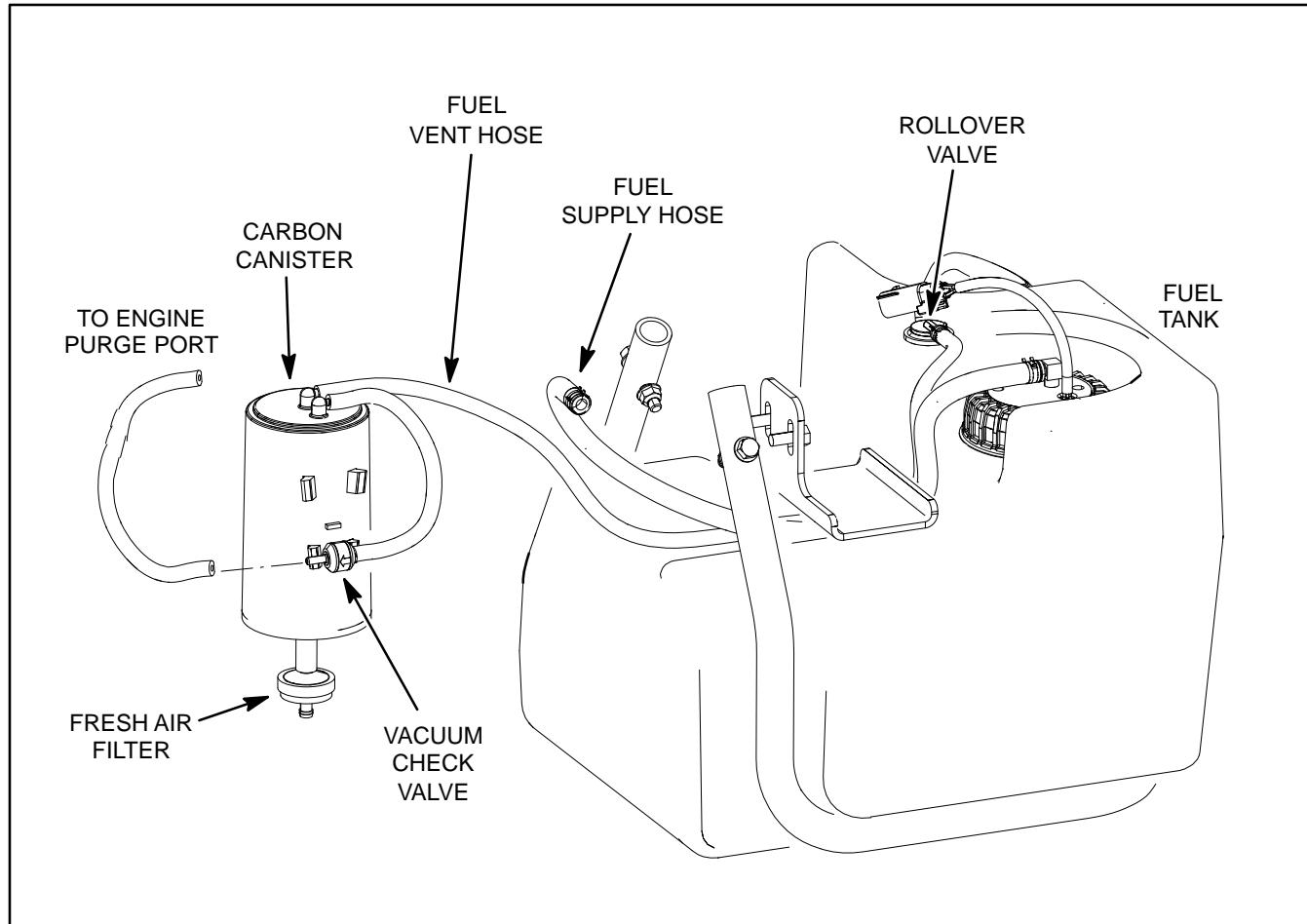


Figure 10

Your Workman vehicle is equipped with a fuel evaporative control system (EVAP) designed to collect and store evaporative emissions from the fuel tank. The EVAP uses a carbon canister to collect these evaporative emissions. Fuel vapors from the fuel tank are vented to the canister where they are stored. Vapors from the canister are consumed when the engine is running which purges the canister. Evaporative control system components for Workman vehicles are shown in Figure 10.

The fuel tank on your Workman uses a non-vented fuel cap. To connect the tank to the evaporative control system, a rollover valve is positioned in the top of the tank that allows tank venting through the carbon canister.

NOTE: If there is restriction in the carbon canister, the rollover valve or the fresh air filter connected to the bottom of the carbon canister, the fuel tank may distort due to venting issues. If the fuel tank returns to its normal shape when the fuel cap is removed, restriction in the evaporative control system is likely.

Workman vehicles with a carbon canister include a single engine connection to the engine intake system that is used to connect the evaporative system to the engine. These machines use an in-line check valve between the carbon canister and the engine fitting.

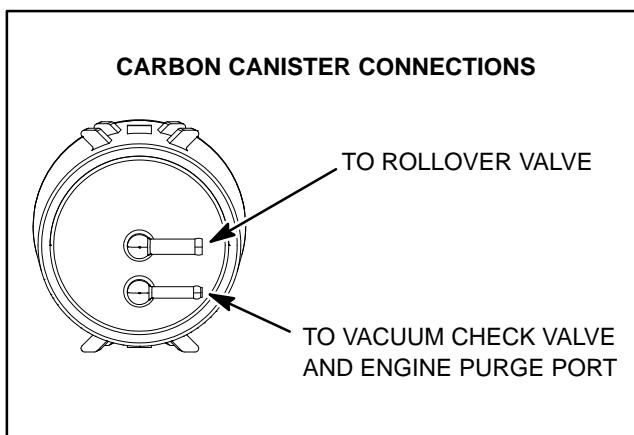


Figure 11

Disassembly



DANGER

Gasoline is flammable. Use caution when storing or handling it. Wipe up any spilled fuel before starting the engine.

1. Park vehicle on a level surface and engage parking brake.
2. Raise or remove the cargo bed or other attachment(s). If bed is raised, place safety support on lift cylinder.
3. Make sure that the engine is stopped and the key is removed from ignition switch. Allow engine to cool.
4. Inspect carbon canister and attached hoses for damage or obvious leaks. A damaged or leaking canister should be replaced.
5. Remove EVAP components as needed using Figures 11, 12 and 13 as guides.
 - A. If hoses are removed from the carbon canister, note hose location for assembly purposes. Figure 11 identifies hose location.
 - B. If vacuum check valve (item 11 in Fig. 12) is removed, note direction of arrow on valve body for assembly purposes.

IMPORTANT: A plugged carbon canister or fresh air filter can cause fuel pressure problems that result in poor engine performance and also can lead to failure of the fuel pump.

Assembly

1. Install all removed EVAP components using Figures 11, 12 and 13 as guides.
 - A. If vacuum check valve (item 11 in Fig. 12) was removed, make sure that arrow on valve body points toward engine.
 - B. Make sure that evaporative system fuel hoses are not kinked after installation. Also, secure all hoses with hose clamps.
2. Lower or install the cargo bed or other attachment(s).

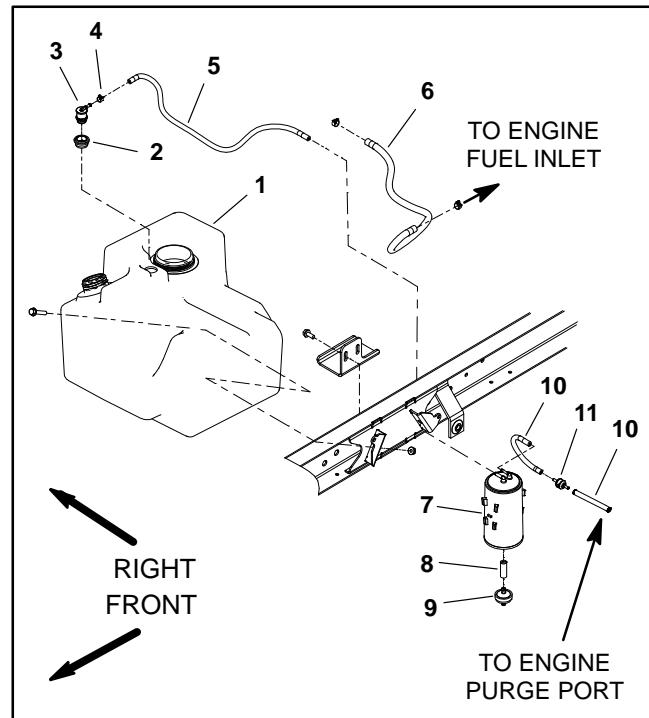


Figure 12

- | | |
|-----------------------|------------------------|
| 1. Fuel tank assembly | 7. Carbon canister |
| 2. Grommet | 8. Fuel hose |
| 3. Rollover valve | 9. Fresh air filter |
| 4. Hose clamp | 10. Fuel hose (2) |
| 5. Tank vent hose | 11. Vacuum check valve |
| 6. Fuel supply hose | |

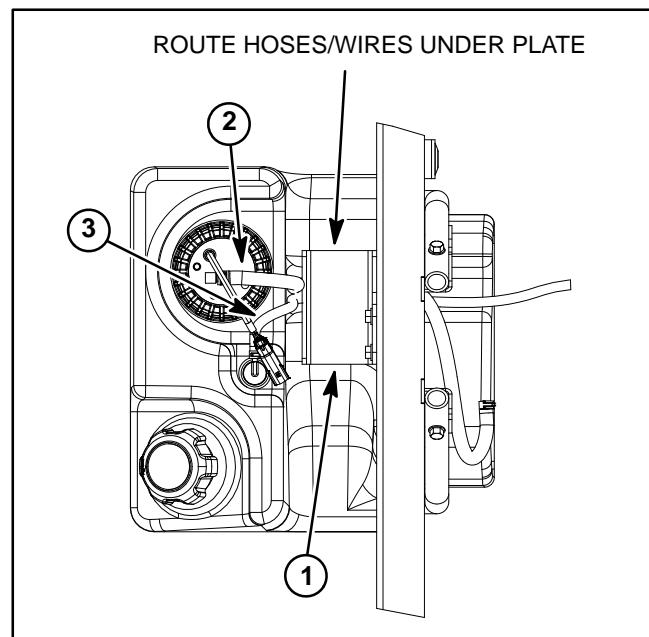


Figure 13

- | | |
|---------------------|-------------------|
| 1. Retainer plate | 3. Tank vent hose |
| 2. Fuel supply hose | |

Fuel Pump

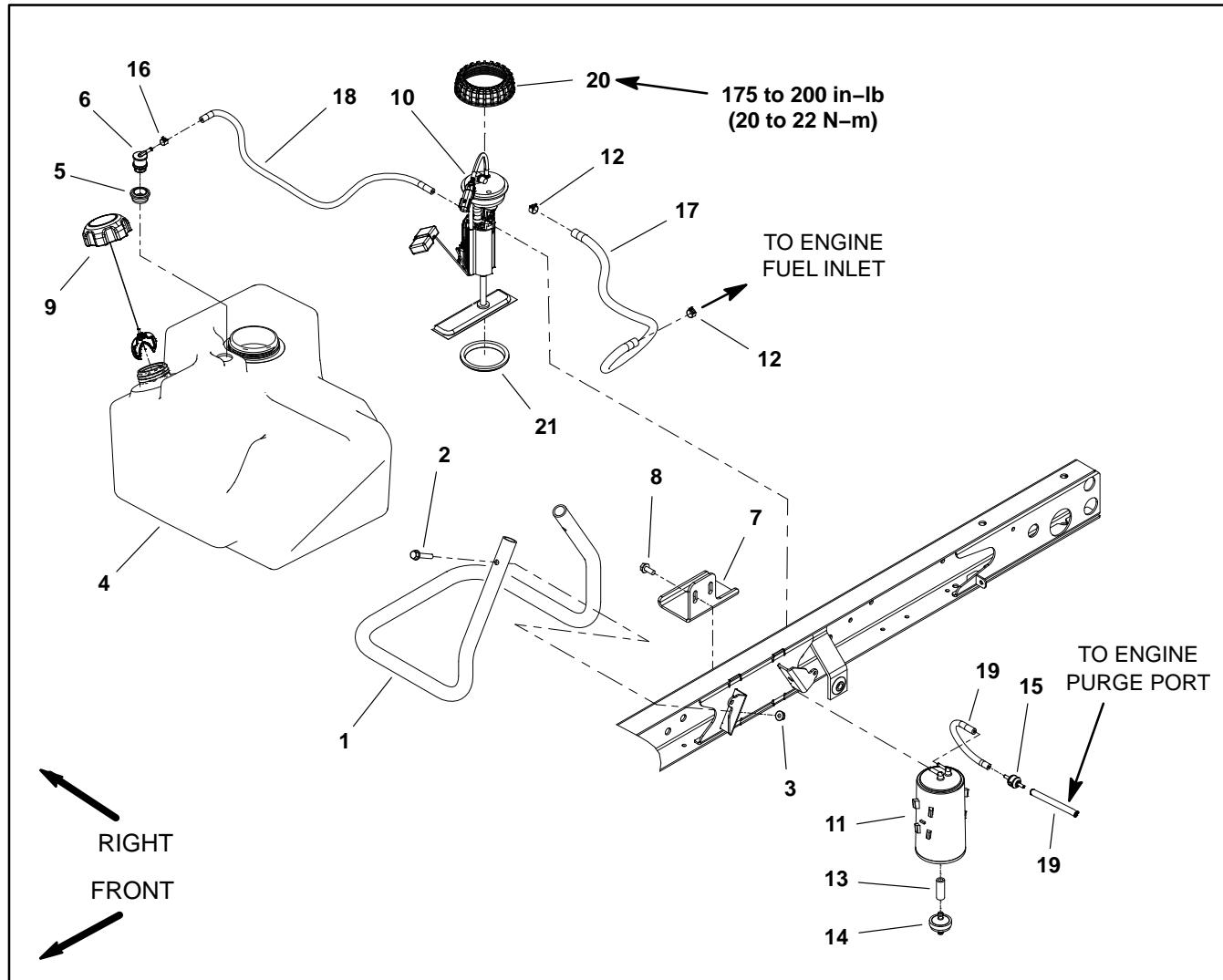


Figure 14

- | | | |
|--------------------------|--------------------------|------------------------|
| 1. Support tube | 8. Washer head screw (2) | 15. Vacuum check valve |
| 2. Washer head screw (2) | 9. Fuel tank cap | 16. Hose clamp |
| 3. Flange nut (2) | 10. Fuel pump assembly | 17. Fuel supply hose |
| 4. Fuel tank | 11. Carbon canister | 18. Fuel vent hose |
| 5. Grommet | 12. Hose clamp (2) | 19. Fuel hose (2) |
| 6. Rollover valve | 13. Fuel hose | 20. Fuel pump retainer |
| 7. Retainer plate | 14. Fresh air filter | 21. Gasket |



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 vehicle 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 fuel for the engine only; not for any other purpose.

NOTE: The fuel pump assembly includes the fuel pump, the fuel sender for the dash mounted fuel gauge and the fuel filter.

Fuel Pump Removal (Fig. 14)

1. Park vehicle on a level surface and engage parking brake.
2. Raise or remove the cargo bed or other attachment(s). If bed is raised, place safety support on lift cylinder.
3. Make sure that the engine is stopped and the key is removed from ignition switch. Allow engine to cool.
4. Disconnect vehicle wire harness connectors from fuel pump assembly on fuel tank.



CAUTION

The fuel supply hose will contain pressurized fuel. Be careful when disconnecting fuel supply hose. Wipe up any spilled fuel before starting the engine.

5. Disconnect fuel supply hose from fuel pump assembly fitting. Plug fuel hose to prevent leakage or contaminant entry.
6. Note orientation of fuel fitting on fuel pump for assembly purposes.
7. Remove fuel pump retainer (item 20) that secures fuel pump assembly in fuel tank.
8. Carefully remove fuel pump assembly and gasket (item 21) from tank.

Fuel Pump Installation (Fig. 14)

1. Make sure that fuel tank and fuel pump assembly gasket surfaces are thoroughly clean.
2. Position gasket (item 21) to sealing surface of fuel pump assembly.
3. Carefully insert fuel pump assembly and gasket into tank. Orientate fuel fitting so that it is pointing toward the vehicle frame (Fig. 15).

IMPORTANT: When securing the fuel pump assembly to the fuel tank, do not allow the fuel pump to rotate as the retainer is being tightened. If the pump assembly is allowed to rotate, damage to the fuel sender is possible.

4. Secure fuel pump assembly to fuel tank with retainer (item 20). Torque retainer from **175 to 200 in-lb (20 to 22 N·m)**.
5. Remove plug placed in fuel supply hose and connect supply hose to fuel pump fitting. Secure fuel hose with hose clamp.
6. Connect vehicle wire harness connectors to fuel pump assembly on fuel tank.
7. Lower or install the cargo bed or other attachment(s).

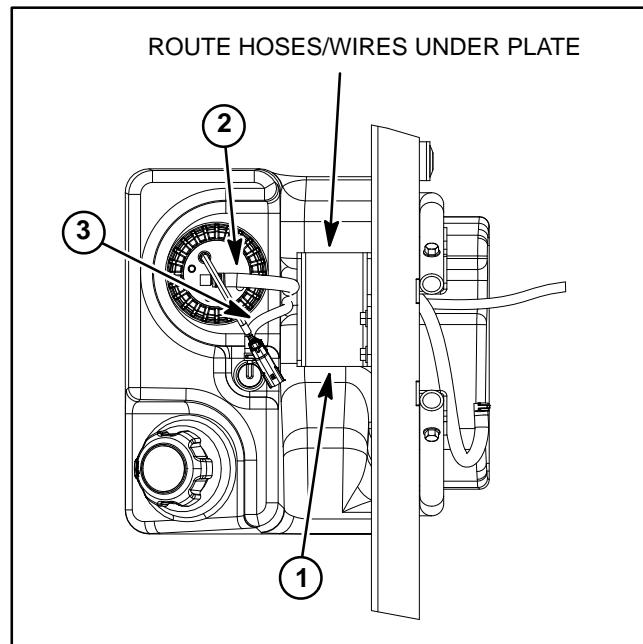


Figure 15

1. Retainer plate
2. Fuel supply hose

3. Tank vent hose

Exhaust System

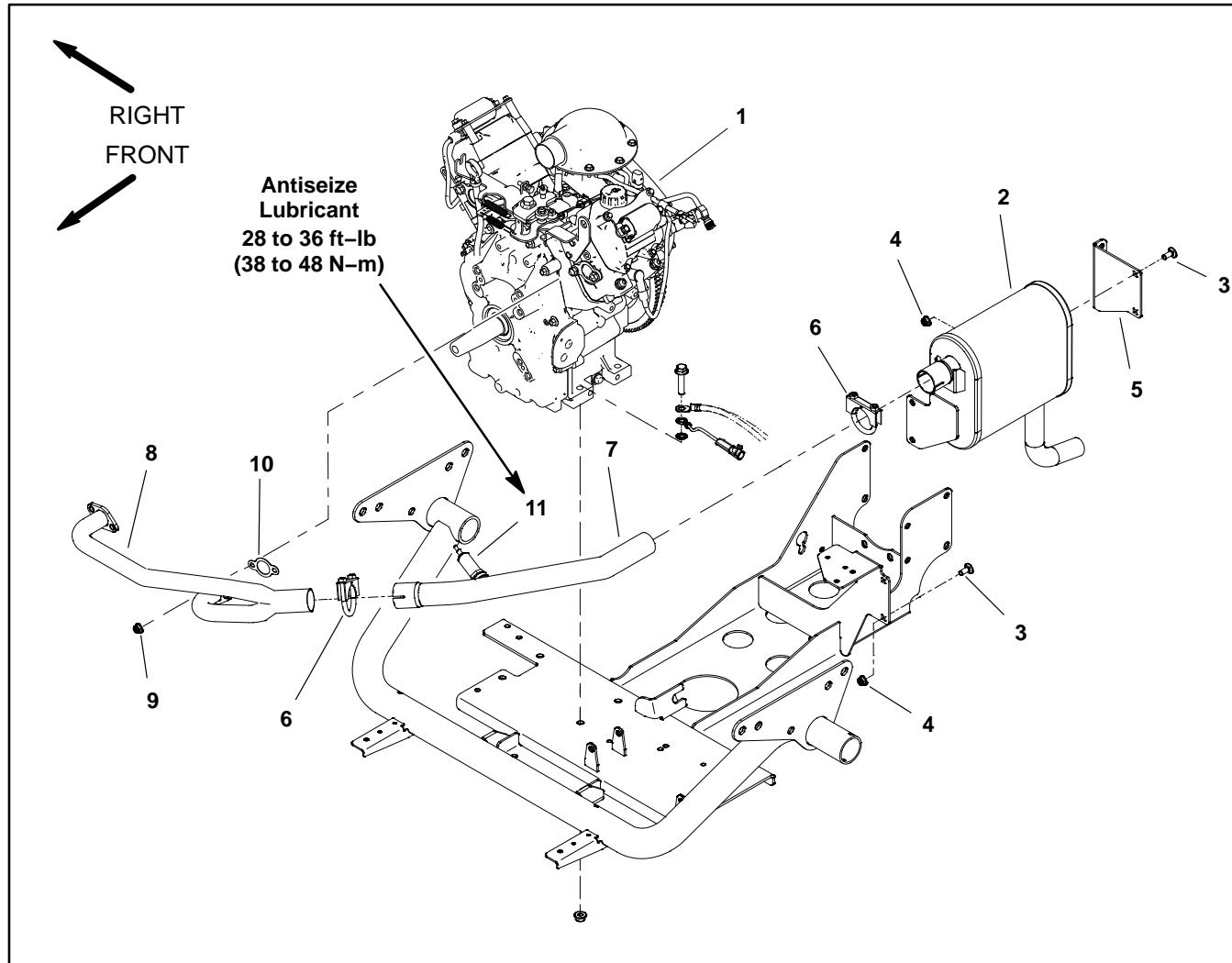


Figure 16

- 1. Engine
- 2. Muffler
- 3. Carriage screw (4)
- 4. Flange nut (4)

- 5. Muffler bracket
- 6. Clamp assembly (2)
- 7. Intermediate exhaust pipe
- 8. Exhaust manifold

- 9. Flange nut (4)
- 10. Exhaust gasket (2)
- 11. Oxygen sensor

Removal (Fig. 16)

1. Park vehicle on a level surface and engage parking brake.
2. Raise or remove the cargo bed or other attachment(s). If bed is raised, place safety support on lift cylinder.
3. Make sure that the engine is stopped and the key is removed from ignition switch. Allow engine to cool.
4. Remove exhaust system components as needed using Figure 16 as a guide.
5. Discard exhaust gaskets and thoroughly clean flange surfaces of exhaust manifold and muffler.

Installation (Fig. 16)

1. Replace any removed gaskets.
2. Using Figure 16 as a guide, fit all exhaust components to vehicle before tightening any fasteners.
 - A. If oxygen sensor (item 11) was removed from intermediate exhaust pipe, apply antiseize lubricant to threads of oxygen sensor before installation. Install and torque sensor from **28 to 36 ft-lb (38 to 48 N-m)**.
3. Lower or install the cargo bed or other attachment(s).

Radiator

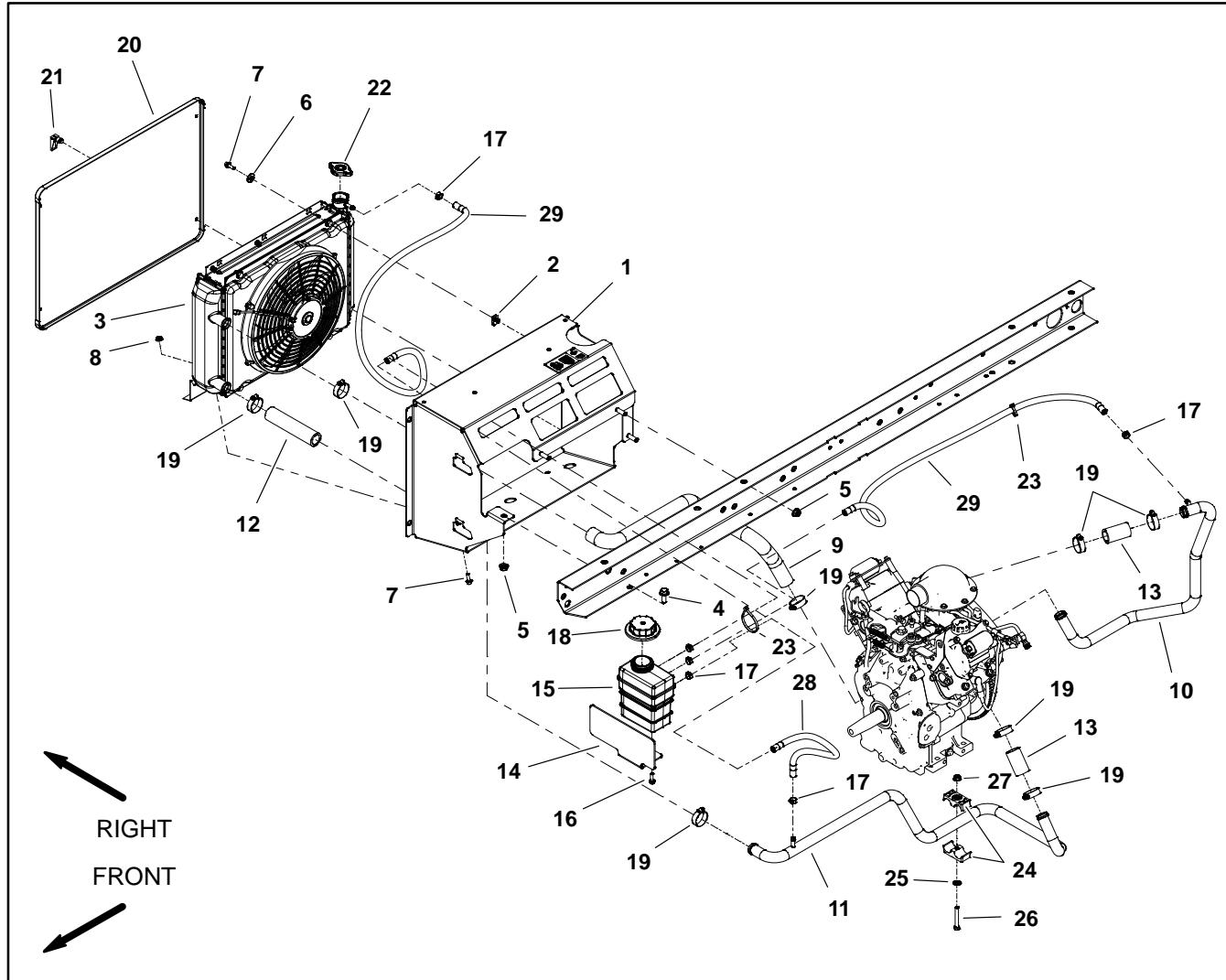


Figure 17

- | | | |
|------------------------------|---------------------------|----------------------|
| 1. Radiator mount | 11. Cold coolant pipe | 21. Swell latch (4) |
| 2. Clip (2) | 12. Straight hose | 22. Radiator cap |
| 3. Radiator and fan assembly | 13. Straight hose (2) | 23. Cable tie (2) |
| 4. Flange head screw | 14. Tank mount plate | 24. Tube clamp (2) |
| 5. Flange nut (4) | 15. Surge tank | 25. Flat washer |
| 6. Flat washer (2) | 16. Washer head screw (2) | 26. Cap screw |
| 7. Flange head screw (4) | 17. Hose clamp (6) | 27. Flange nut |
| 8. Flange nut (2) | 18. Tank cap | 28. Coolant hose |
| 9. Upper coolant hose | 19. Hose clamp (8) | 29. Coolant hose (2) |
| 10. Hot coolant pipe | 20. Radiator screen | |

Removal (Fig. 17)

1. Park vehicle on a level surface and engage parking brake.
2. Raise or remove the cargo bed or other attachment(s). If bed is raised, place safety support on lift cylinder.

3. Make sure that the engine is stopped and the key is removed from ignition switch. Allow engine to cool.
4. Unlatch and remove radiator screen from front of radiator.
5. If vehicle is equipped with high flow hydraulics kit, rotate oil cooler latches and place oil cooler away from radiator.



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. Remove the radiator cap.
 7. Drain radiator into a suitable container by disconnecting straight radiator hose (item 12) from the radiator.
 8. Disconnect upper coolant hose (item 9) from the radiator.
 9. Disconnect coolant hose (item 29) from the radiator filler neck.
 10. Disconnect wire harness connector from radiator fan.
 11. Detach radiator assembly (item 3) from radiator mount (item 1):
 - A. Remove two (2) flange head screws and flat washers that secure the top of the radiator assembly to the mount.
 - B. Remove two (2) flange head screws and flange nuts that secure the bottom of the radiator assembly to the mount.
 12. Carefully separate radiator assembly from mount and remove from vehicle.
 13. Plug all radiator and hose openings to prevent contamination.
 14. If necessary, remove components from radiator assembly using Figure 18 as a guide.
- Installation (Fig. 17)**
1. If radiator assembly was disassembled, install components to radiator using Figure 18 as a guide. Make sure that clearance exists between shroud and fan at all points.
 2. Remove plugs from radiator openings and hoses placed during the removal procedure.
 3. Position radiator assembly to the radiator mount. Secure radiator assembly to the vehicle with removed flange head screws, flat washers and flange nuts.
 4. Connect coolant hose (item 29) to the radiator filler neck. Secure hose with hose clamp.
 5. Connect upper coolant hose (item 9) and straight radiator hose (item 12) to the radiator. Secure hoses with hose clamps.
 6. Connect wire harness connector to radiator fan.
 7. Fill cooling system:
 - A. Slowly fill the radiator with a 50/50 mixture of water and permanent ethylene glycol anti-freeze. After the radiator is fully filled, install the radiator cap.
 - B. Slowly fill the surge tank until coolant level reaches the bottom of the filler neck. Install the cap on the surge tank.
 - C. Start the engine and operate it until it is warm.
 - D. Stop the engine, check the coolant level in the surge tank and replenish it, if required. Do not overfill coolant surge tank.
 8. If vehicle is equipped with high flow hydraulics kit, position oil cooler to radiator and secure in place.
 9. Install and latch the radiator screen.
 10. Lower or install cargo bed or other attachment(s).

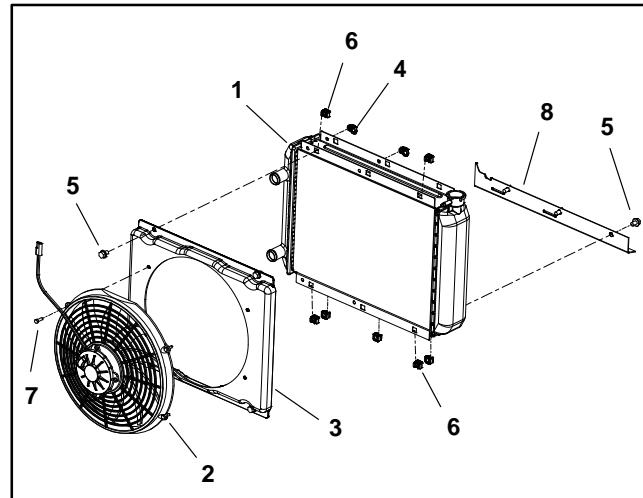


Figure 18

- | | |
|---------------------|----------------------|
| 1. Radiator | 5. Flange screw (7) |
| 2. Electric fan | 6. Nut (7) |
| 3. Shroud | 7. Screw (4) |
| 4. Spring latch (2) | 8. Lower mount plate |

Oil Filter Assembly

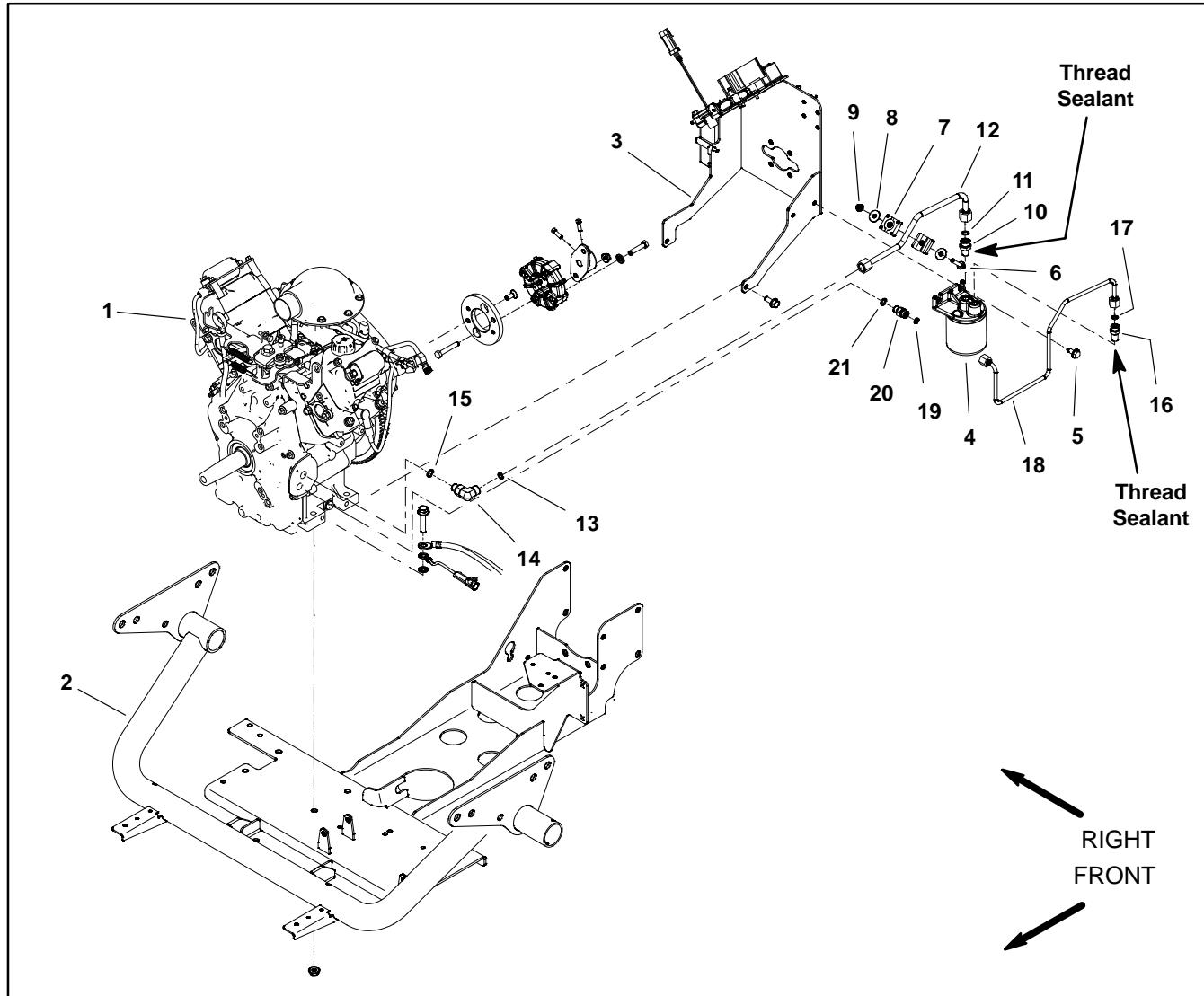


Figure 19

- | | | |
|--------------------------|---------------------------|-----------------------|
| 1. Engine | 8. Washer (2) | 15. O-ring |
| 2. Sub-frame assembly | 9. Flange nut | 16. Hydraulic fitting |
| 3. Pump mount | 10. Hydraulic fitting | 17. O-ring |
| 4. Oil filter assembly | 11. O-ring | 18. Hydraulic tube |
| 5. Washer head screw (2) | 12. Hydraulic tube | 19. O-ring |
| 6. Flange head screw | 13. O-ring | 20. Hydraulic fitting |
| 7. Tube clamp (2) | 14. 90° hydraulic fitting | 21. O-ring |

Removal (Fig. 19)

1. Park vehicle on a level surface and engage parking brake.
2. Raise or remove the cargo bed or other attachment(s). If bed is raised, place safety support on lift cylinder.
3. Make sure that the engine is stopped and the key is removed from ignition switch. Allow engine to cool.
4. To prevent contamination of engine lubrication system during adapter removal, thoroughly clean exterior of filter adapter, hoses and fittings.
5. Remove oil filter adapter components as needed using Figures 19 and 20 as guides.

Installation (Fig. 19)

1. Install removed oil filter adapter components using Figures 19 and 20 as guides. If hydraulic fittings were removed from oil filter adapter, apply thread sealant to threads of fittings before installing them into adapter.
2. Check and adjust engine oil level.
3. Lower or install the cargo bed or other attachment(s).

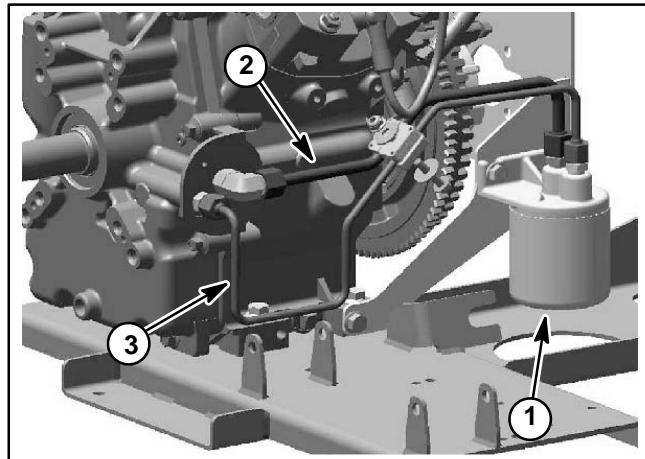


Figure 20

1. Oil filter assembly
2. Hydraulic tube
3. Hydraulic tube

Engine

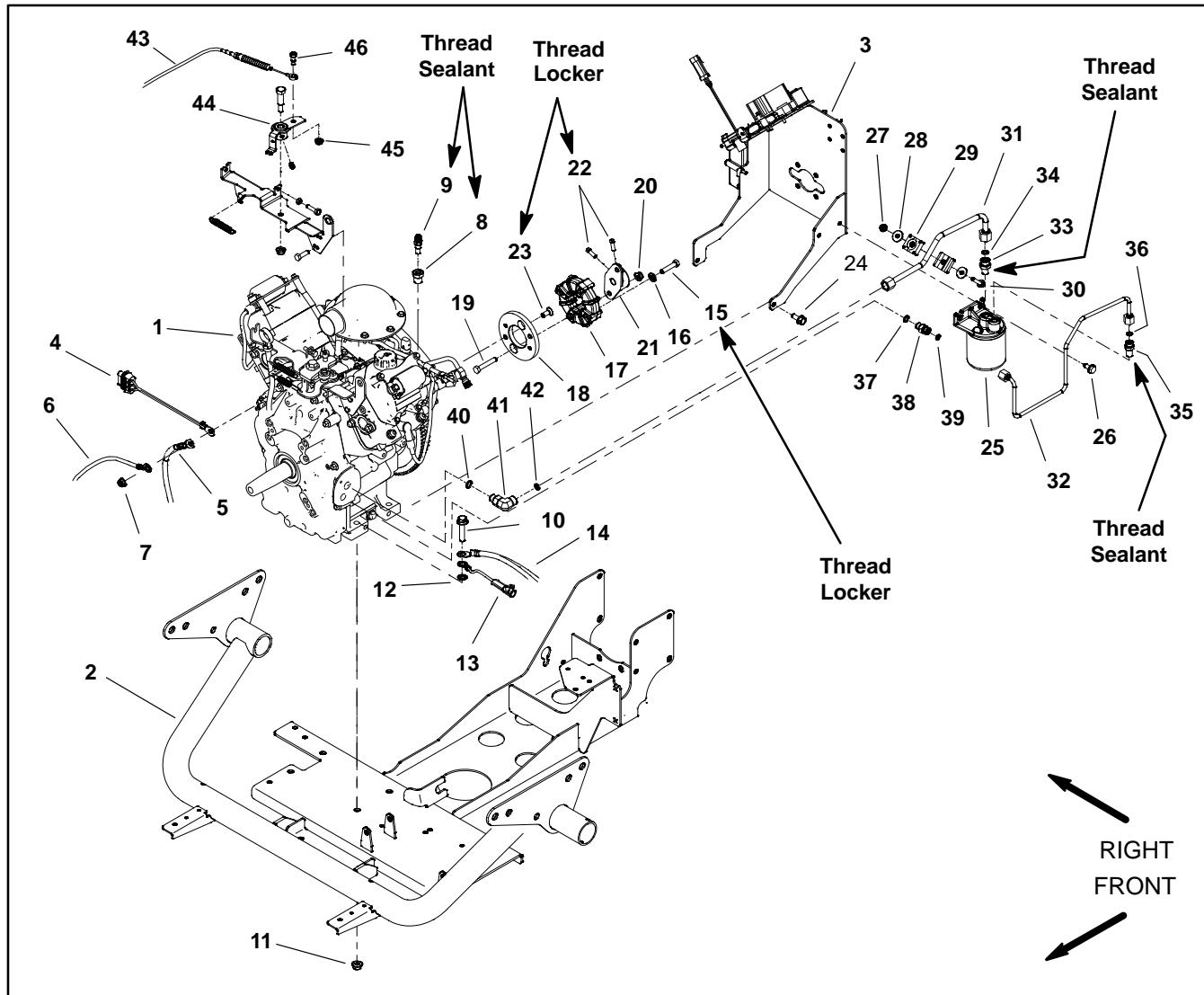


Figure 21

- | | | |
|----------------------------|---------------------------|---------------------------|
| 1. Engine | 17. Rubber coupler | 32. Hydraulic tube |
| 2. Sub-frame assembly | 18. Pump coupler adapter | 33. Hydraulic fitting |
| 3. Pump mount | 19. Cap screw (2) | 34. O-ring |
| 4. Fusible link harness | 20. Flange nut (2) | 35. Hydraulic fitting |
| 5. Positive battery cable | 21. Pump hub | 36. O-ring |
| 6. Regulator wire | 22. Set screw (2) | 37. O-ring |
| 7. Nut | 23. Socket head screw (2) | 38. Hydraulic fitting |
| 8. Straight fitting | 24. Flange head screw (2) | 39. O-ring |
| 9. Temperature sender | 25. Oil filter assembly | 40. O-ring |
| 10. Flange head screw (4) | 26. Washer head screw (2) | 41. 90° hydraulic fitting |
| 11. Flange nut (4) | 27. Flange nut | 42. O-ring |
| 12. Lock washer | 28. Washer (2) | 43. Accelerator cable |
| 13. Wire harness ground | 29. Tube clamp (2) | 44. Throttle bell crank |
| 14. Negative battery cable | 30. Flange head screw | 45. Flange nut |
| 15. Cap screw (2) | 31. Hydraulic tube | 46. Shoulder bolt |
| 16. Flat washer (2) | | |

NOTE: When removing the engine from the machine, it is recommended to leave the transmission and spanner plate attached to the machine. This will allow easier alignment of the engine and the transmission when the engine is installed back into the machine. Alignment of the engine and the transmission is critical for proper drive system operation.

Engine Removal (Fig. 21)

1. Park vehicle on a level surface and engage parking brake.
2. Raise or remove the cargo bed or other attachment(s). If bed is raised, place safety support on lift cylinder.
3. Make sure that the engine is stopped and the key is removed from ignition switch. Allow engine to cool.
4. Disconnect negative (–) and then positive (+) battery cables at the battery.
5. Remove the exhaust system (see Exhaust System in this section).
6. Remove air intake hose from engine and air cleaner assembly (see Air Cleaner System in this section).
7. Drain engine coolant from radiator and coolant pipes (see Radiator in this section). Disconnect radiator hoses from engine.
8. Remove carbon canister from pump mount (see Fuel Evaporative Control System in this section). Position canister away from engine.
9. Remove primary clutch from engine crankshaft (see Primary and Secondary Clutches in the Service and Repairs section of Chapter 4 – Drive Train).
10. Remove hydraulic pump from machine (see Gear Pump (Vehicles with Standard Hydraulics) or Gear Pump (Vehicles with High Flow Hydraulics) in the Service and Repairs section of Chapter 7 – Hydraulic System). Install plugs on disconnected hydraulic fittings and hoses to prevent system contamination.



CAUTION

The fuel supply hose will contain pressurized fuel. Be careful when disconnecting supply hose. Wipe up any spilled fuel before starting the engine.

11. Disconnect fuel supply hose from fuel fitting on engine. Plug end of fuel hose to prevent contamination and fuel spillage. Position disconnected fuel hose away from engine.

12. Label and disconnect wire harness connectors that attach to engine and engine accessories. Position wire harness leads away from the engine.

- A. The positive battery cable and fusible link harness from starter solenoid stud on starter motor.
- B. The machine wire harness spade connector from the starter solenoid start terminal.
- C. Two (2) machine wire harness connectors from engine wire harness connectors on starter side of engine.
- D. The machine wire harness connector from the engine temperature sender.
- E. The machine wire harness connector from the gear tooth sensor.

13. Disconnect accelerator cable ball joint from throttle bell crank on engine (Fig. 22). Loosen jam nuts on cable and remove cable from throttle bracket. Position accelerator cable away from engine.

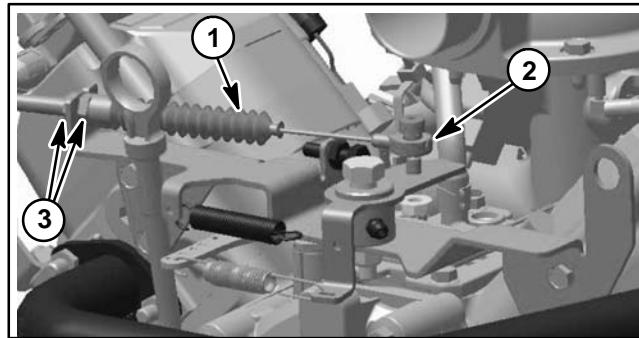


Figure 22

1. Accelerator cable
2. Ball joint
3. Jam nuts

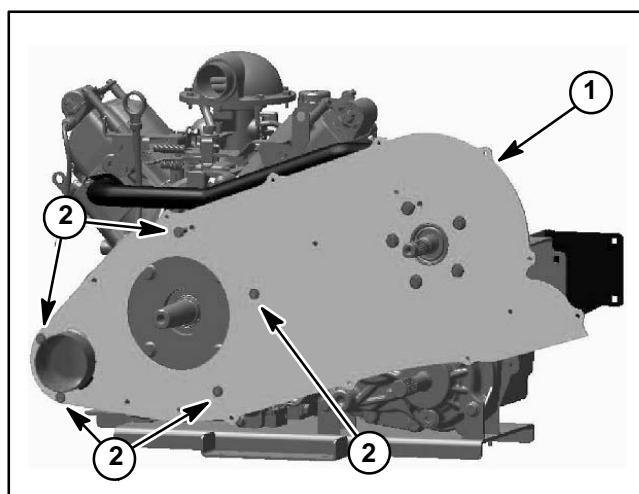


Figure 23

1. Spanner plate
2. Screw (5)

14. Remove all clamps and cable ties that attach wire harness, hoses and cables to the engine. Note locations of clamps and cable ties for assembly purposes.

15. Remove five (5) washer head screws that secure spanner plate to air inlet housing attached to engine (Fig. 23). For assembly purposes, note the locations of the five (5) removed screws. Two (2) holes in the spanner plate that align with holes in the air inlet housing are used to secure the CVT enclosure cover. Do not remove spanner plate from transmission so that the plate position can be used to align engine with transmission during engine installation.

16. Remove four (4) flange nuts and flange head screws that secure engine to engine mount. For assembly purposes, note that negative battery cable, wire harness ground connection and lock washer are secured with the left, front engine fastener.

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

17. Use lift or hoist to carefully remove engine from chassis. One person should operate hoist and a second person should help guide engine out of chassis. Move engine toward the rear of the machine before lifting to allow engine crankshaft to clear spanner plate that is attached to the transmission.

18. If necessary, remove air inlet housing from engine (Fig. 24).

19. If necessary, remove pump mount from engine:

A. Remove screws that secure oil filter adapter to pump mount to separate filter adapter from pump mount. Support oil filter assembly to prevent it from shifting during pump mount removal.

B. Either disconnect engine wire harness connectors from all electrical components on pump mount or remove electrical components from pump mount (Fig. 25).

C. Remove the two (2) screws that secure sensor mount and pump mount to engine (Fig. 25).

D. Support pump mount and remove flange head screws that secure mount to engine base. Remove pump mount from engine.

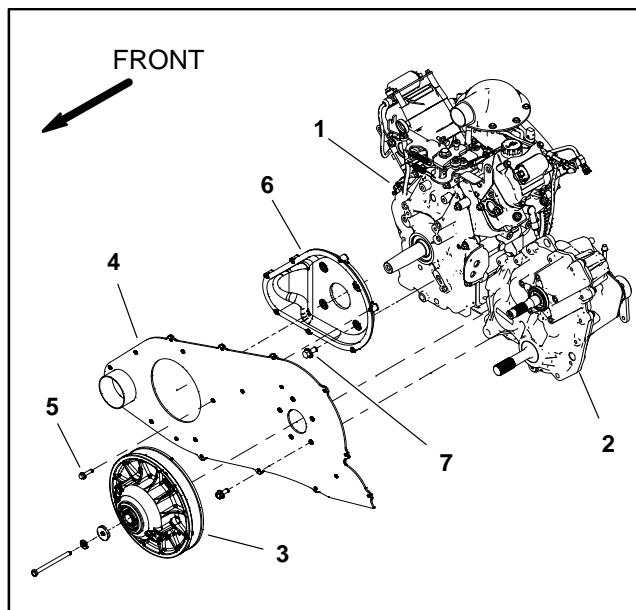


Figure 24

- | | |
|---------------------|----------------------|
| 1. Engine | 5. Washer head screw |
| 2. Transmission | 6. Air inlet housing |
| 3. Secondary clutch | 7. Flange head screw |
| 4. Spanner plate | |

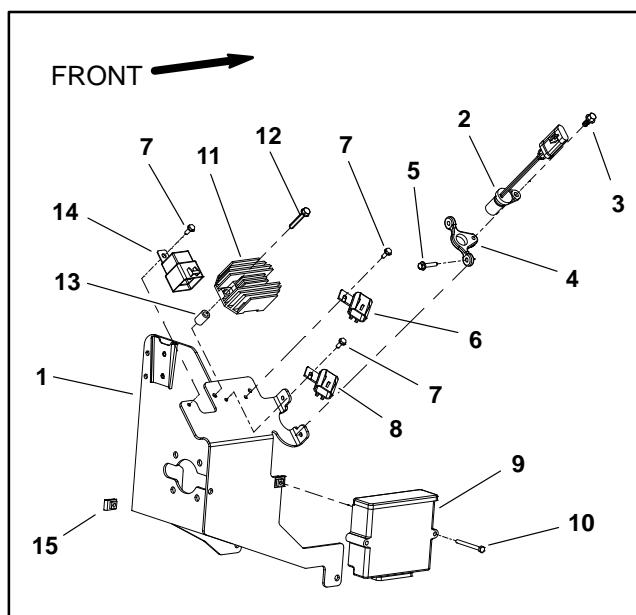


Figure 25

- | | |
|----------------------|-------------------------|
| 1. Pump mount plate | 9. Engine ECU |
| 2. Gear tooth sensor | 10. Cap screw (2) |
| 3. Flange screw | 11. Regulator/rectifier |
| 4. Sensor mount | 12. Flange screw (2) |
| 5. Flange screw (2) | 13. Spacer (2) |
| 6. Fuse | 14. Relay |
| 7. Flange screw (3) | 15. Clip nut (2) |
| 8. Fuse | |

20. If necessary, remove hydraulic pump coupler assembly from engine flywheel (Fig. 26):

- A. Remove cap screws and flat washers that secure rubber coupler to pump coupler adapter attached to flywheel. Remove coupler and pump hub assembly.
- B. Remove cap screws and flange nuts that secure pump hub to rubber coupler.
- C. If necessary, remove socket head screws that secure pump coupler adapter to flywheel and remove adapter.

Engine Installation (Fig. 21)

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

2. If removed, install hydraulic pump coupler assembly to engine flywheel (Fig. 26):

- A. If pump coupler adapter was removed from flywheel, apply medium strength thread locker to socket head screws and secure adapter to flywheel with screws.
- B. Secure pump hub to rubber coupler with two (2) cap screws and flange nuts. Make sure that nuts are located at pump hub.
- C. Apply medium strength thread locker to cap screws that retain rubber coupler to pump coupler adapter on flywheel. Secure rubber coupler and pump hub assembly to pump coupler with two (2) cap screws and flat washers.

3. If removed, secure pump mount to engine:

- A. Position pump mount to engine and loosely install two (2) flange head screws into engine base.
- B. Secure sensor mount and pump mount to engine with two (2) screws (Fig. 25). Then, fully tighten flange head screws to secure pump mount to engine base.
- C. Make sure that all electrical components are secured to pump mount and then connect engine wire harness connectors to all components (Fig. 25).
- D. Secure oil filter adapter to pump mount.

4. If removed, secure air inlet housing to engine (Fig. 24).

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

5. Use lift or hoist to carefully install engine to the chassis. One person should operate hoist and a second person should help guide engine to the machine. Lower engine and move it toward the front of the machine to allow engine crankshaft to clear spanner plate that is attached to the transmission.

6. Locate engine to engine mount with four (4) flange nuts and flange head screws. Make sure that negative battery cable, wire harness ground connection and lock washer are installed with the left, front engine fastener. Leave engine fasteners loose.

IMPORTANT: As the screws used to secure the spanner plate to the air inlet housing are tightened, move engine assembly to the spanner plate so that engine and transmission alignment can be accurate. Be careful to prevent spanner plate distortion as screws are tightened.

7. While moving the engine toward the spanner plate to prevent distortion of the spanner plate, secure spanner plate to air inlet housing with five (5) washer head screws (Fig. 24). Do not install screws in the two (2) holes closest to the air intake end of the spanner plate. These holes will be used to secure the CVT enclosure cover.

8. Secure the engine in place by fully tightening the flange nuts and flange head screws.

9. Connect accelerator cable ball joint to throttle bell-crank on engine (Fig. 22). Secure cable to throttle bracket with jam nuts.

10. Connect wire harness connectors to all engine and engine accessories.

11. Connect fuel supply hose to fuel fitting on engine and secure with hose clamp.

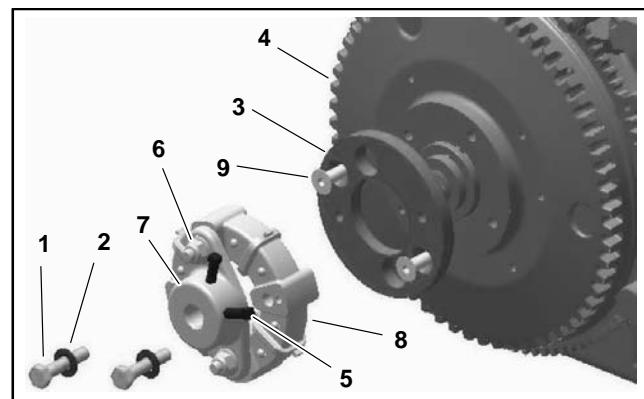


Figure 26

- | | |
|-------------------------|-------------------------|
| 1. Cap screw | 6. Screw and flange nut |
| 2. Flat washer | 7. Pump hub |
| 3. Pump coupler adapter | 8. Rubber coupler |
| 4. Engine flywheel | 9. Socket head screw |
| 5. Set screw (2) | |

12. Install hydraulic pump to machine (see Gear Pump (Vehicles with Standard Hydraulics) or Gear Pump (Vehicles with High Flow Hydraulics) in the Service and Repairs section of Chapter 7 – Hydraulic System).
13. Install primary clutch to engine crankshaft. Make sure that CVT drive belt and enclosure cover are properly installed (see Primary and Secondary Clutches in the Service and Repairs section of Chapter 4 – Drive Train).
14. Secure carbon canister to pump mount (see Fuel Evaporative Control System in this section).
15. Connect radiator hoses to engine and secure hoses with hose clamps. Fill cooling system (see Radiator in this section).
16. Secure wire harness, hoses and cables to the engine with clamps and cable ties in locations noted during engine removal.
17. Install the exhaust system (see Exhaust System in this section).
18. Install air intake hose from engine to air cleaner assembly and secure hose with hose clamps (see Air Cleaner System in this section).
19. Install a new engine oil filter. Fill engine with new engine oil.
20. Connect positive (+) and then negative (–) battery cables to the battery.
21. Check operation of accelerator cable and adjust if necessary (see Adjust Accelerator Control in the Adjustments section of this chapter).
22. Lower cargo bed or install bed or attachment(s).



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Specifications

Item	Specification
Clutch System Primary Clutch Secondary Clutch	Continuously Variable Speed Transmission with Enclosed CVT Belt Drive and Speed Control Override Speed Sensing with Mechanical Flyweights Torque Sensing with Spring Loaded Cam
Speed Control System Fluid	DOT 3 Brake Fluid
Speed Control System Fluid Capacity	16 fluid ounces (470 milliliter) System Capacity (approximate)
Transmission	Two-Speed Forward (Drive and Low), Reverse, Neutral and Park
Transmission Oil	Dexron VI Transmission Fluid
Transmission Oil Capacity	23.7 fluid ounces (700 milliliter) System Capacity (approximate)
Rear Differential	Open Differential with Electric Solenoid Locking Feature
Rear Differential Oil	80W90 API GLI-5
Rear Differential Oil Capacity	18.6 fluid ounces (550 milliliter) System Capacity (approximate)
Front Differential (Optional Kit)	See Chapter 8 – Four Wheel Drive (Optional Kit)

General Information

Operator's Manual

The Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for your Workman vehicle. Refer to the Operator's Manual for additional information when servicing the vehicle.

Drive Train

Drive Train Operation

Drive Train Operation

Workman HDX Auto vehicles have a variable speed drive system with positions for neutral, forward high and low range, reverse and park. Drive system components include an engine driven primary clutch, a secondary clutch, a CVT drive belt, a transmission, a drive shaft driven rear differential and two (2) CV (constant velocity) axles to drive the rear wheels. On vehicles with optional four wheel drive, a second drive shaft, a front differential and two (2) additional CV (constant velocity) axles are used to drive the front wheels. The vehicle must be fully stopped before shifting to reverse from a forward gear (either low forward or drive position) or to a forward gear from reverse.

Power is transferred from the engine to the transmission by a variable clutch system that consists of two (2) clutches connected by a drive belt. The primary clutch is mounted to the engine crankshaft and the secondary clutch is mounted to the transmission input shaft. The transmission has positions for park, reverse, neutral, low speed forward and drive speed forward operation.

The drive system features Speed Control that delivers precise speed range control to limit the maximum ground speed of the machine for operations that require a constant speed like spraying and topdressing. The speed range lever mounted to the seat base console (Fig. 2) is used to select one of four (4) work speed ranges that are used to limit maximum ground speed or a transport speed range that is used when the machine is moved between job sites. The accelerator pedal must be released before shifting between speed ranges but the vehicle does not need to be stopped.

A rear output shaft in the transmission transfers power from the transmission to the rear differential and then to the rear wheels. Two (2) identical CV (constant velocity) axles transfer power from the rear differential to the rear wheels. A dash mounted switch allows the operator to engage the rear differential lock for increased traction at slow speeds. A fully independent rear suspension and Dedion type rear axle isolates the engine, transmission and main frame from all vehicle load forces, eliminating stress to these main components.

On units equipped with optional four wheel drive, a front output shaft in the transmission transfers power from the transmission to the front differential and then to the front wheels. For information on the front wheel drive system, see Chapter 8 – Four Wheel Drive (Optional Kit).

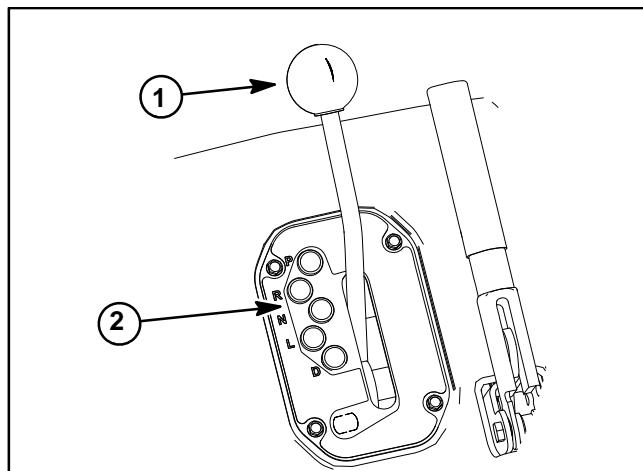


Figure 1

1. Transmission lever

2. Transmission positions

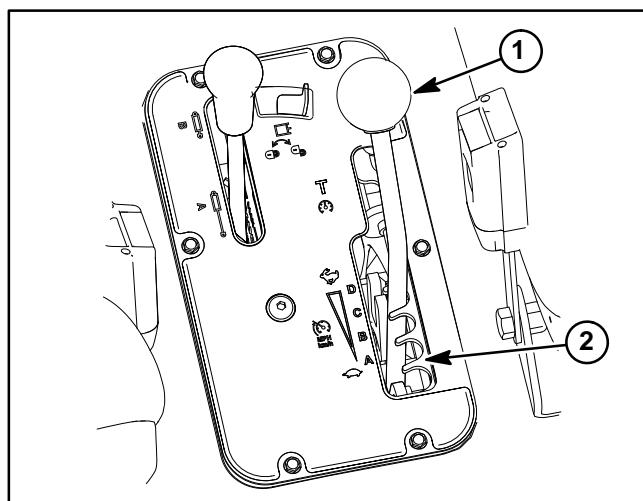


Figure 2

1. Speed range lever

2. Speed range positions

Clutch System Operation

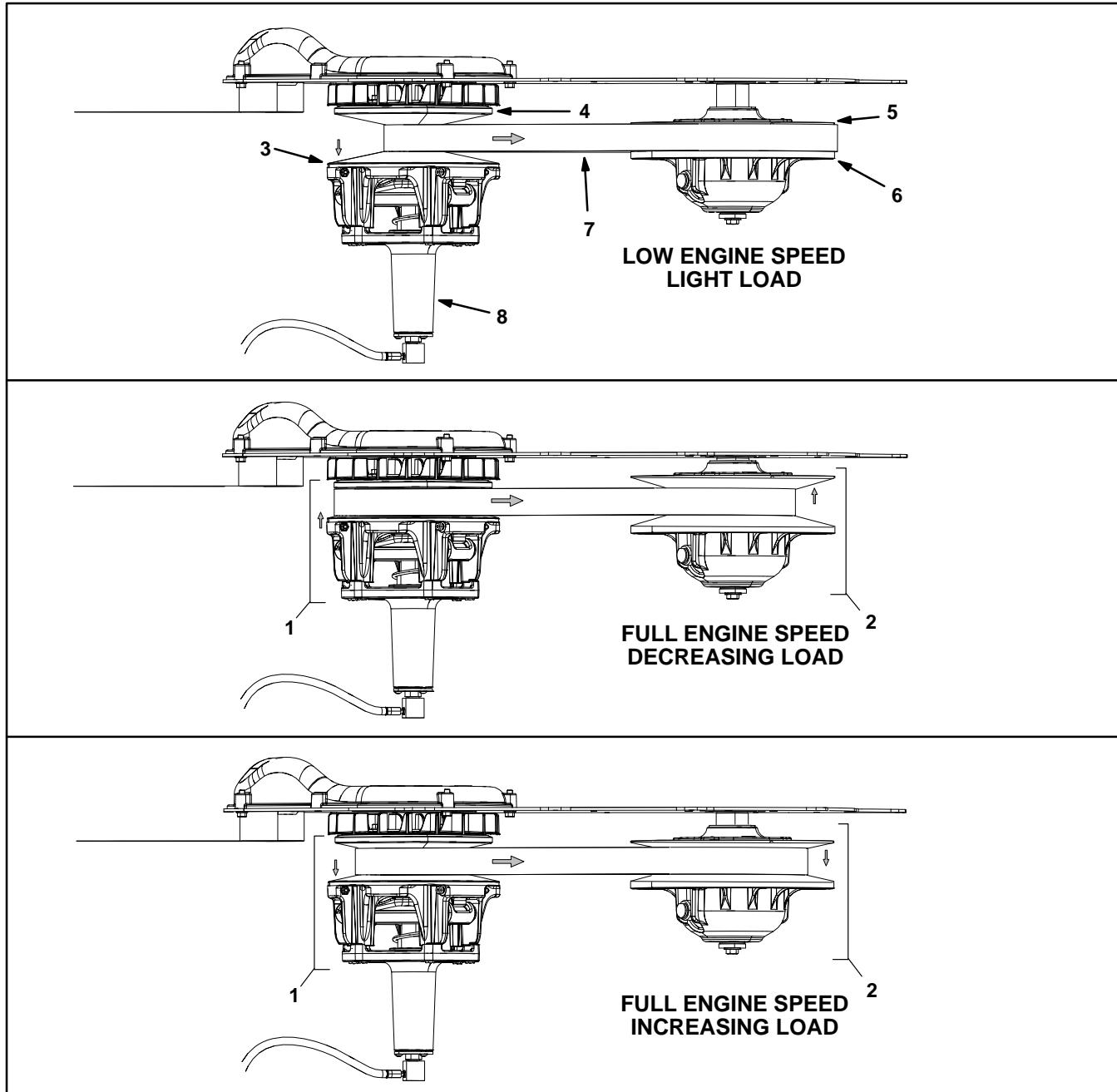


Figure 3

- | | | |
|-------------------------------------|---|---------------------------|
| 1. Primary clutch | 4. Stationary sheave (primary clutch) | 7. CVT drive belt |
| 2. Secondary clutch | 5. Moveable sheave (secondary clutch) | 8. Speed limiter assembly |
| 3. Moveable sheave (primary clutch) | 6. Stationary sheave (secondary clutch) | |

Power is transferred from the engine to the transmission by a variable clutch system that consists of two (2) clutches connected by a drive belt. The primary clutch is mounted to the engine crankshaft and responds to engine speed. The secondary clutch is mounted to the transmission input shaft and responds to changes in drive system load.

The two (2) clutches work together to automatically up-shift and back-shift as changes in load and speed occur. This shifting changes the turning ratio between the primary and secondary clutches and allows the engine to operate at optimum efficiency.

Primary Clutch Operation

The operation of the primary clutch is affected by engine shaft speed. With the engine not turning, the CVT drive belt rests low within the primary clutch sheaves as the pressure of the clutch spring holds the sheaves apart. As the engine increases in speed, the clutch weights attached to the moveable sheave move outward as they spin about the engine crankshaft. The outward movement of the clutch weights presses against the clutch rollers and overcomes spring pressure through the spider assembly, which forces the moveable sheave closer to the stationary sheave. This inward movement of the sheave engages the drive belt to drive the secondary clutch.

With increasing engine speed, the moveable sheave continues to move inward, which forces the drive belt to ride towards the outer diameter of the primary clutch sheaves.

When engine speed is decreased, the clutch weights exert less force on the rollers and thus the spring. The spring pressure overcomes the force of the clutch weights and shifts the moveable sheave away from the stationary sheave. The drive belt disengages from the primary clutch sheaves at a point where the force of the spring is greater than that of the clutch weights.

Speed Control System Operation

Toro's proprietary Speed Control insures precise ground speed to engine speed critical for accurate application rates with bed mounted topdressers and sprayers. The speed range of the vehicle can easily be adjusted with the speed range lever to limit the maximum-ground speed of the vehicle. The speed range lever (Fig. 22) is used to select one of four (4) work-speed ranges that are used to limit maximum ground speed or a transport-speed range that is used when the machine is moved between job sites.

The speed limiter cover assembly is used on the Workman Auto vehicle to adjust the maximum opening of the primary clutch moveable sheave. The speed limiter control uses a manually operated hydraulic cylinder to change the location of the piston in the speed limiter cover assembly. The piston location determines the maximum primary clutch opening.

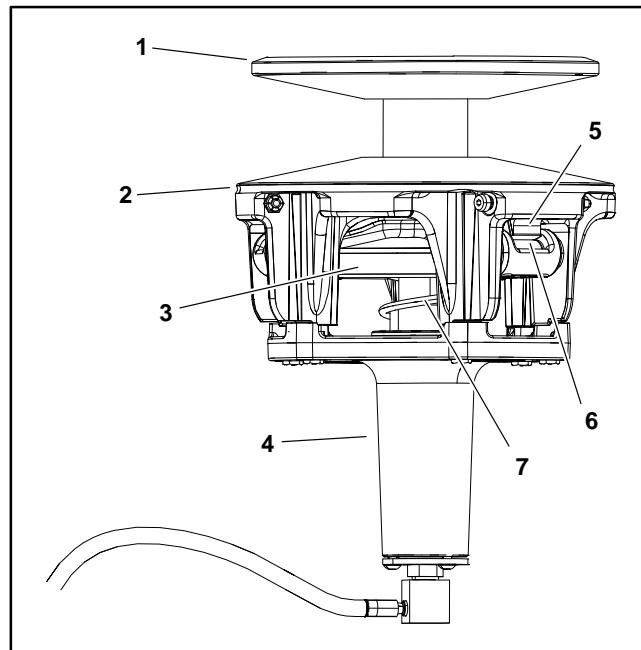


Figure 4

- | | |
|------------------------|----------------------|
| 1. Stationary sheave | 5. Clutch weight (3) |
| 2. Moveable sheave | 6. Roller (3) |
| 3. Spider assembly | 7. Spring |
| 4. Speed limiter cover | |

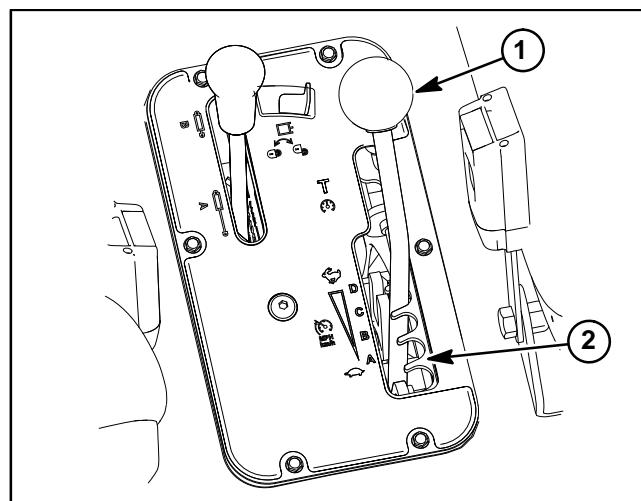


Figure 5

- | | |
|----------------------|-------------------------|
| 1. Speed range lever | 2. Speed range settings |
|----------------------|-------------------------|

Secondary Clutch Operation

The operation of the secondary clutch (Fig. 6) is affected by traction load. When the vehicle is stopped, the drive belt is held at the outer diameter of the secondary clutch sheaves from the pressure of the clutch spring pushing the moveable sheave against the stationary sheave and away from the fixed cam.

Once the drive belt starts rotating, the secondary clutch also starts to rotate. With increasing speed of the primary clutch on the engine, the drive belt begins to climb to the outer diameter of the primary clutch sheaves. This increases the tension on the drive belt and forces the moveable sheave of the secondary clutch to move away from the stationary sheave against the pressure of the secondary clutch spring. As the belt tightens and the secondary clutch sheaves open up, the drive belt rides lower in the secondary clutch sheaves.

With increased load to the transmission, the secondary clutch fixed cam resists forward movement relative to the moveable sheave and drive belt. Torque from the drive belt along with spring pressure moves the moveable sheave up the ramp of the fixed cam. The drive belt becomes positioned closer to the outer diameter of the secondary clutch sheaves.

The fixed cam on the secondary clutch moveable sheave rotates on a pair of rollers in the stationary sheave base to allow low friction movement of the moveable sheave.

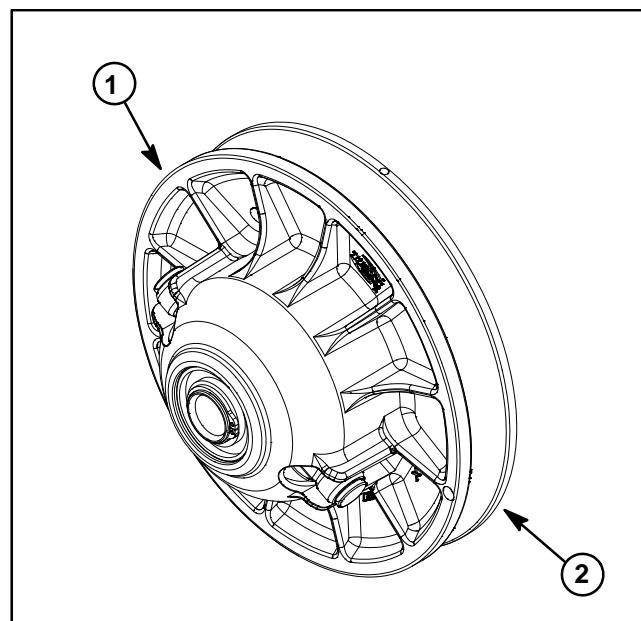


Figure 6

1. Stationary sheave

2. Moveable sheave

Special Tools

Order the following special tools from your Authorized Toro Distributor.

Clutch Removal Tools

The clutch removal tool is required to remove the primary clutch from the tapered drive shaft of the engine. It is threaded into the primary clutch after the clutch retaining screw is removed.

The clutch removal tool can also be used to remove the secondary clutch from the transmission input shaft. An adapter is required to allow the clutch removal tool to be used to remove the secondary clutch.

Clutch Removal Tool: **TOR6032**
Secondary Clutch Adapter: **TOR6033**

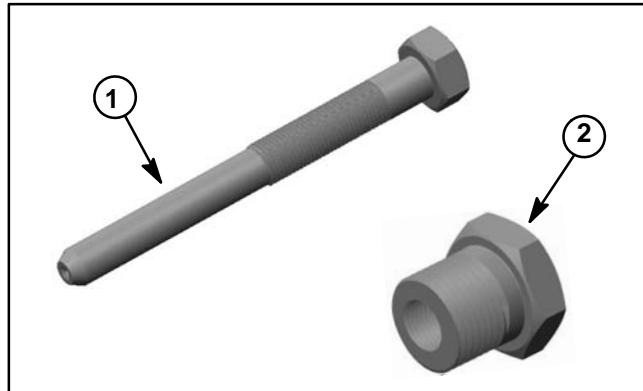


Figure 7

1. Clutch removal tool 2. Adapter

Piston Installation Tool

The piston installation tool is used to install the piston into the speed limiter assembly.

Toro Part Number: **TOR6034**



Figure 8

Secondary Clutch Press Tool

The secondary clutch press tool is used to compress the compression spring in the secondary clutch to allow removal of the retaining ring and separation of the clutch sheaves.

Toro Part Number: **TOR6027**



Figure 9

Troubleshooting

Clutch

Problem	Possible Cause
Poor up-shifting.	Engine speed is too low. Primary and/or secondary clutch assemblies have accumulation of dirt or debris. CVT drive belt is worn. Primary and/or secondary clutch sheaves are worn or damaged.
Poor downshifting.	Primary and/or secondary clutch assembly have accumulation of dirt or debris. CVT drive belt is worn. Primary and/or secondary clutch sheaves are worn or damaged.
Vehicle creeps at low idle.	Engine low idle speed is excessive. Primary clutch has accumulation of dirt or debris preventing full back-shifting. Primary and secondary clutches are not aligned.
Rough clutch engagement.	Engine low idle speed is adjusted too low. Primary clutch assembly has accumulation of dirt or debris. CVT drive belt is worn. Primary and/or secondary clutch sheaves are worn or damaged.
Noisy clutch operation.	Primary clutch roller or weight bushings are worn. Worn primary clutch spider slides (primary clutch replacement is necessary if spider slides are worn).

Transmission

Problem	Possible Cause
Noisy transmission operation.	<p>Low oil level in transmission.</p> <p>Damaged or worn bearings in transmission.</p> <p>Transmission gears are worn, scuffed or broken.</p> <p>Gears are loose on transmission shaft(s).</p> <p>Excessive wear of transmission chain(s).</p>
Difficult transmission shifting.	<p>Engine speed is not reduced fully when shifting is attempted.</p> <p>Shift cable is out of adjustment.</p> <p>Shift cable is damaged.</p> <p>Shift lever on transmission is loose.</p> <p>Cable clamp securing shift cable near shift lever is loose.</p> <p>Transmission shift shaft, sector gears, detent star and/or detent pawl are worn or damaged.</p> <p>Transmission sliding gear(s) is/are tight on shaft or splines.</p> <p>Transmission gear teeth damaged.</p> <p>Transmission shift forks are worn or damaged.</p> <p>Damaged or worn shift drum.</p>
Gears make clashing noise when shifting.	<p>Shift forks are bent, worn or damaged.</p> <p>Damaged or worn bearings in transmission.</p> <p>Excessive wear of transmission shaft(s).</p>
Transmission sticks in gear.	<p>Shift fork compression spring(s) are weak or broken.</p> <p>Shift engagement dog is tight on shaft splines.</p> <p>Shift forks are bent, worn or damaged.</p>
Transmission slips out of gear.	<p>Shift cable is out of adjustment.</p> <p>Transmission gear(s) are loose on shaft.</p> <p>Transmission gear teeth are excessively worn.</p> <p>Excessive end play in gears.</p> <p>Shift forks are worn or damaged.</p> <p>Excessive wear of transmission bearings.</p>

Adjustments

Shift Cable Adjustment

For correct vehicle operation, shift cable adjustment should allow the transmission lever on the seat base console (Fig. 10) to move fully between all transmission positions.

1. Park vehicle on a level surface, raise and support vehicle cargo bed (if installed), shut engine off and engage the parking brake. Remove key from the ignition switch.
2. Adjust jam nuts on shift cable (item 6 in Fig. 11) to allow full range of motion between PARK and DRIVE at transmission lever. If necessary, additional cable adjustment can be made with jam nuts on cable clevis (item 7 in Fig. 11) at transmission lever.
3. Make sure that jam nuts are properly tightened after adjustment.
4. Remove bed support from cargo bed lift cylinder and lower bed after shift cable adjustment is completed.

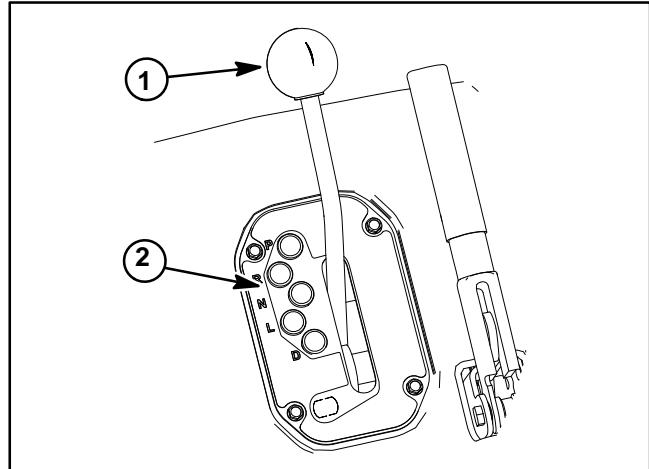


Figure 10

1. Transmission lever

2. Transmission positions

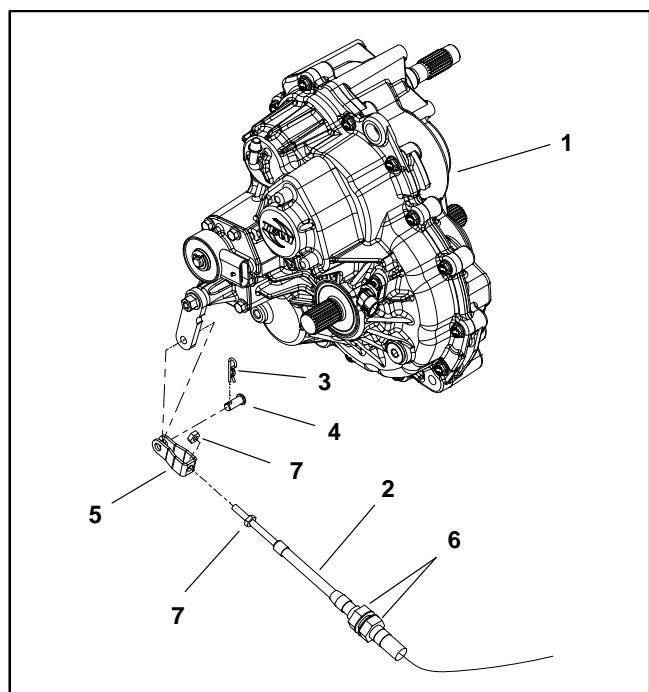


Figure 11

1. Transmission

2. Shift cable

3. Hairpin

4. Clevis pin

5. Cable clevis

6. Jam nut (2)

7. Jam nut (2)

Service and Repairs

Shift Cable

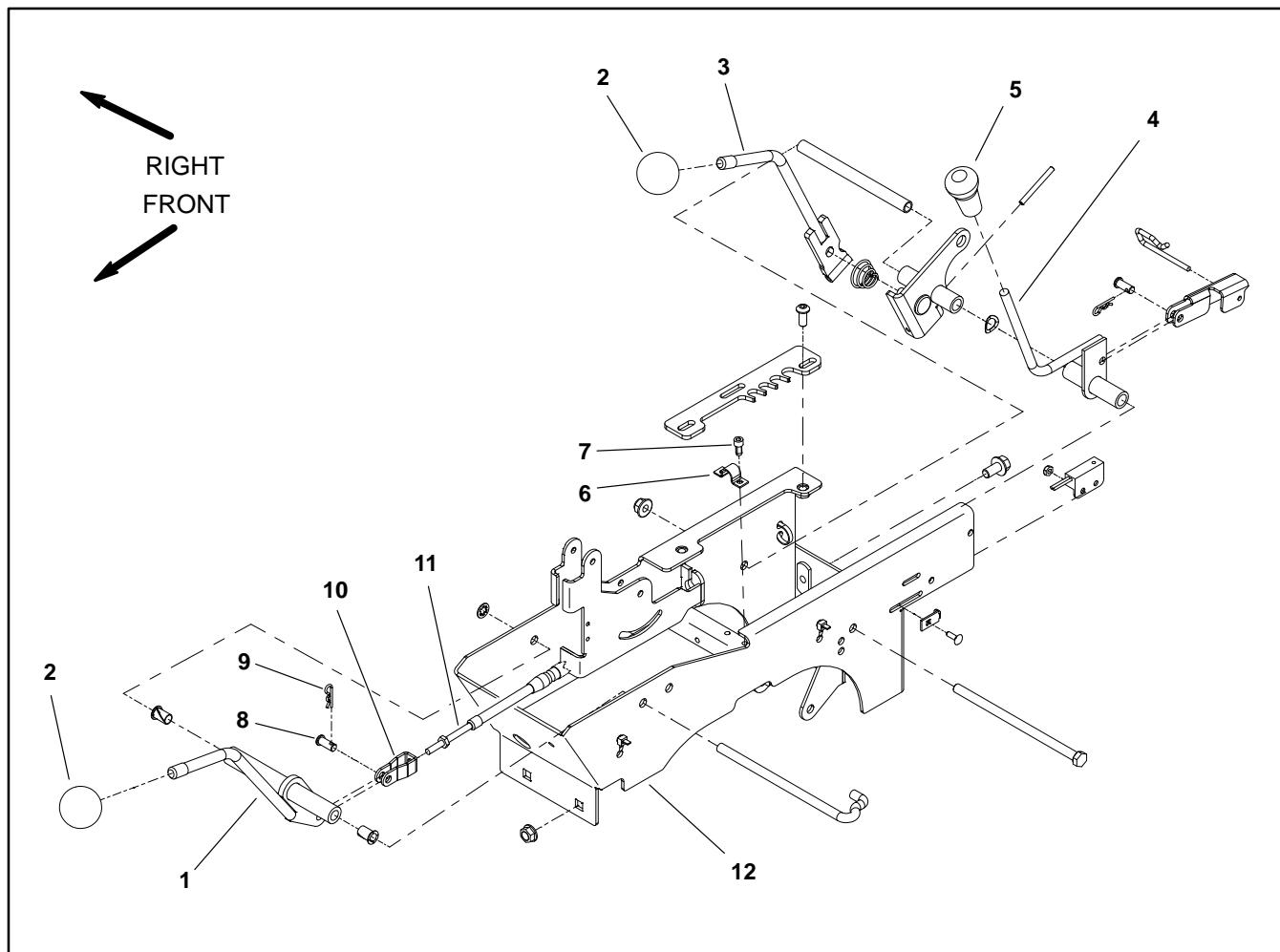


Figure 12

- | | | |
|-----------------------|----------------|----------------------------|
| 1. Transmission lever | 5. Knob | 9. Hairpin |
| 2. Knob (2) | 6. Cable clamp | 10. Shift cable clevis |
| 3. Speed range lever | 7. Screw (2) | 11. Shift cable |
| 4. Hydraulic lever | 8. Clevis pin | 12. Lever support assembly |

Shift Cable Removal (Fig. 12)

1. Park vehicle on a level surface, raise and support vehicle cargo bed (if installed), shut engine off and engage the parking brake. Remove key from the ignition switch.
2. Remove knobs from control levers, then remove shift and control plates from seat base (Fig. 13).
3. Remove two (2) screws (item 7) and cable clamp (item 6) that secure shift cable to lever support.
4. Remove hair pin and clevis pin that secure shift cable clevis (item 10) to transmission lever (item 1) in shift plate opening of seat base.

5. Remove shift cable from transmission shift lever (Fig. 14):

- A. Remove hair pin and clevis pin that secure shift cable to shift lever on transmission.
- B. Loosen jam nuts (item 6 in Fig. 14) that secure shift cable to shift cable mount bracket on engine/transmission mount.
- C. Disconnect cable from transmission shift lever.

6. Note routing of shift cable and location of cable ties used to secure cable to vehicle. Remove shift cable from vehicle.

7. If necessary, remove jam nut and clevis from ends of shift cable.

Shift Cable Installation (Fig. 12)

1. If clevis was removed from ends of shift cable, install clevis and secure with jam nut. Center jam nuts on threaded area of shift cable during assembly.

2. Route shift cable in same location as noted during cable removal.

3. Connect shift cable to transmission lever in seat base console by inserting clevis pin (item 8) from the passenger side, then install hair pin.

4. Secure shift cable to lever support using cable clamp (item 6) and two (2) screws (item 7). Make sure that rib in clamp and groove in cable align correctly.

5. With shift cable properly routed to transmission, secure cable to shift lever and bracket on engine/transmission mount:

A. Install clevis pin and hair pin to secure shift cable to shift lever on transmission.

B. Secure shift cable to shift cable mount bracket on engine/transmission mount with cable jam nuts (item 6 in Fig. 14). Center jam nuts on threaded area of shift cable during assembly.

6. Install cable ties in the original locations to secure shift cables to vehicle.

7. Adjust shift cable to allow full range of motion between PARK and DRIVE at transmission lever on console (see Shift Cable Adjustment in the Adjustments section of this chapter).

8. Install shift and control plates to seat base and then secure knobs to control levers (Fig. 13).

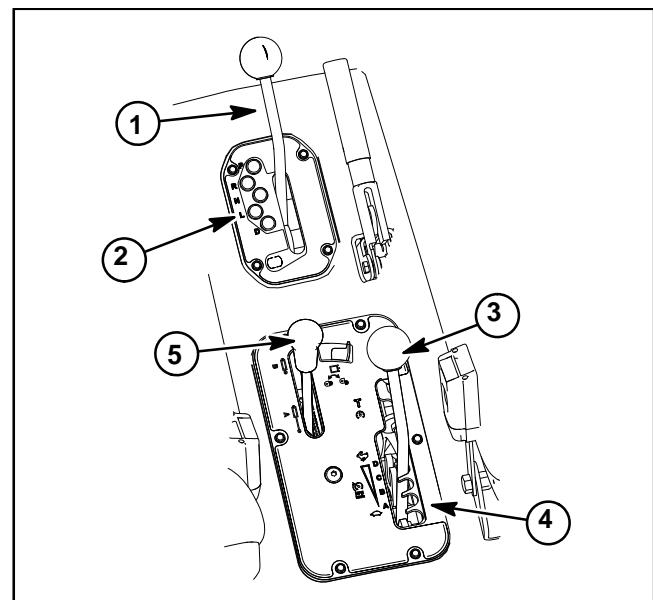


Figure 13

- | | |
|-----------------------|--------------------|
| 1. Transmission lever | 4. Control plate |
| 2. Shift plate | 5. Hydraulic lever |
| 3. Speed range lever | |

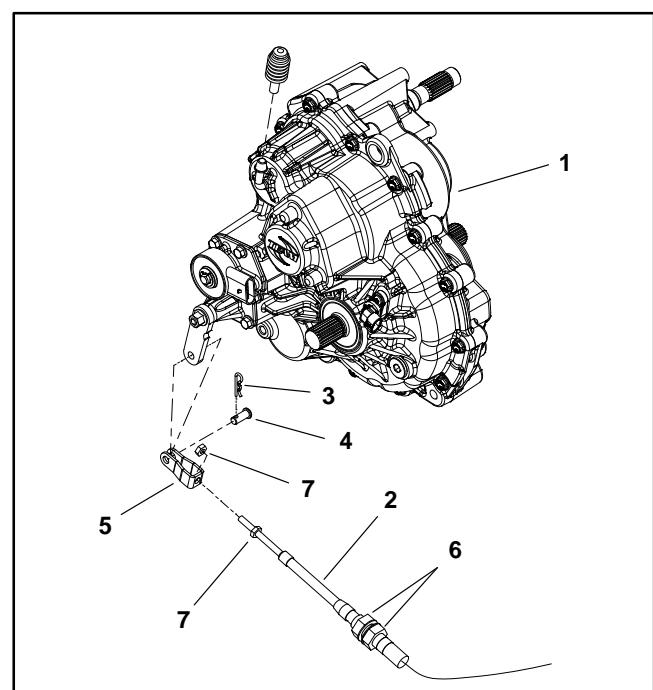


Figure 14

- | | |
|-----------------|-----------------|
| 1. Transmission | 5. Cable clevis |
| 2. Shift cable | 6. Jam nut (2) |
| 3. Hairpin | 7. Jam nut (2) |
| 4. Clevis pin | |

Bleed Speed Control System

The speed limiter cover assembly is used on the Workman Auto vehicle to adjust the maximum opening of the primary clutch moveable sheave. The speed limiter control uses a manually operated hydraulic cylinder to change the location of the piston in the speed limiter cover assembly. The piston location determines the maximum primary clutch opening. If the speed limiter cover assembly is removed or disassembled, use the following procedure to bleed the speed control system for proper operation.

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake.
 2. Remove knobs from speed range lever and hydraulic lift lever on seat base console (Fig. 15).
 3. Remove six (6) washer head screws that secure control plate to seat base console. Lift control plate from seat base to access the speed control system reservoir (Fig. 16).

IMPORTANT: Use DOT 3 brake fluid in the speed control system.

- #### 4. Bleed speed control system:

NOTE: Make sure fluid level is maintained in speed control reservoir at all times during bleeding process. Also, clean reservoir around cap area before removing cap from reservoir.

- A. Move speed range lever between all positions (A through D and T) three (3) or four (4) times which will cause piston in speed limiter assembly to move and properly fill speed control system with fluid.
 - B. After bleeding the speed control system, make sure that fluid level in reservoir is correct.

5. After speed control system bleeding, install control plate to seat base and secure with six (6) washer head screws. Install knobs to speed range lever and hydraulic lift lever.

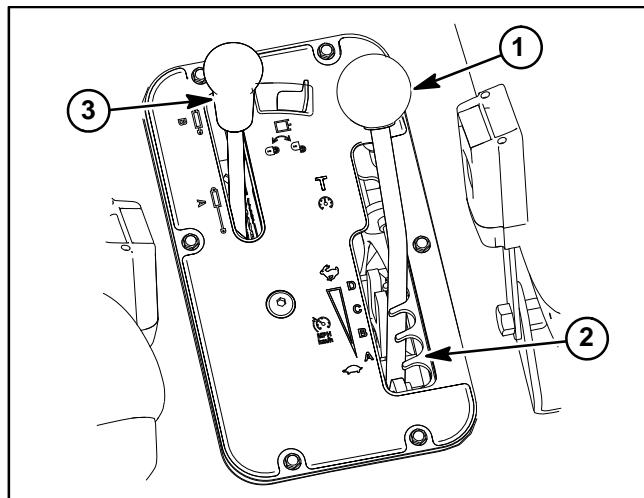


Figure 15

- | | |
|-------------------------|-------------------------|
| 1. Speed range lever | 3. Hydraulic lift lever |
| 2. Speed range settings | |

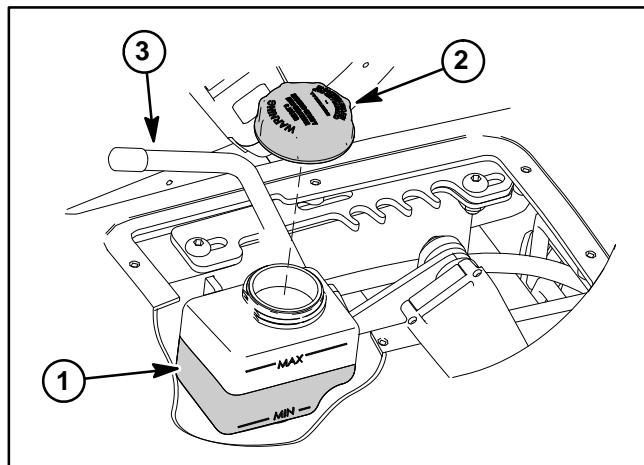


Figure 16

- | | |
|----------------------------|----------------------|
| 1. Speed control reservoir | 3. Speed range lever |
| 2. Reservoir cap | |

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Speed Control System

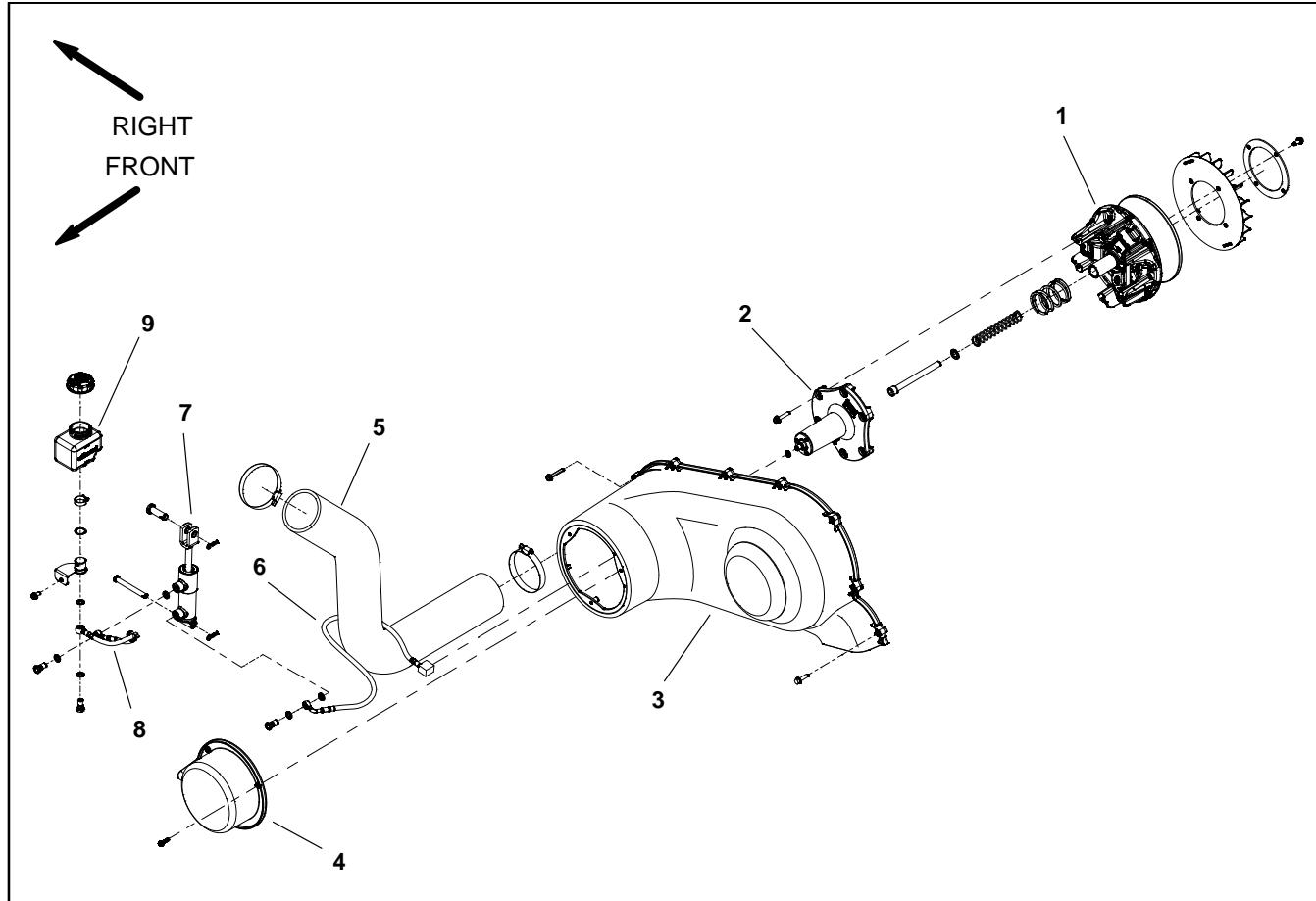


Figure 17

- | | | |
|---------------------------|------------------------|--------------|
| 1. Primary clutch | 4. Speed limiter cover | 7. Cylinder |
| 2. Speed limiter assembly | 5. CVT intake hose | 8. Hose |
| 3. CVT enclosure cover | 6. Speed control hose | 9. Reservoir |

The Workman Auto speed control system includes the speed limiter assembly, cylinder, reservoir, speed range lever and connecting hoses.

Disassembly (Fig. 17)

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake.
2. Move speed range lever to the transport (T) position to remove pressure in the speed control system.
3. Remove control plate from seat base to access speed control system components (Fig. 18):
 - A. Remove knobs from speed range lever and hydraulic lift lever.
 - B. Remove six (6) washer head screws that secure control plate to seat base.
 - C. Lift control plate from seat base.

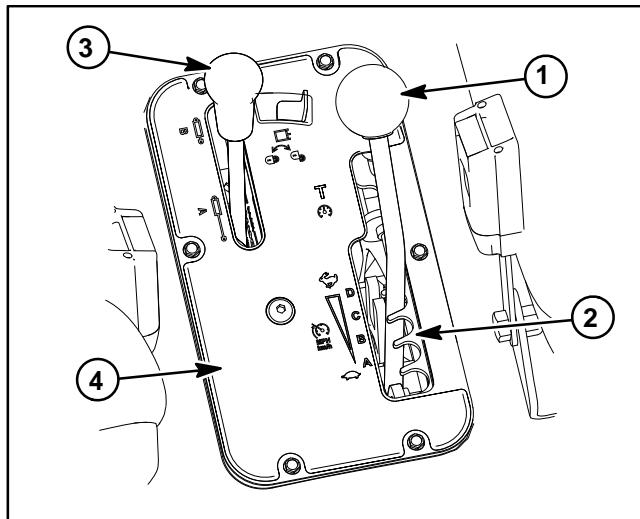


Figure 18

- | | |
|-------------------------|-------------------------|
| 1. Speed range lever | 3. Hydraulic lift lever |
| 2. Speed range settings | 4. Control plate |

IMPORTANT: To prevent speed control system contamination, clean components before disassembly.

4. Remove speed control components as needed using Figures 17, 19 and 20 as guides. If hydraulic hoses are removed, discard banjo washers and replace during assembly.

NOTE: If speed limiter assembly (item 2 in Fig. 17) needs to be removed or disassembled, see Speed Limiter Assembly and Speed Limiter Cover Service in this section.

Assembly (Fig. 17)

1. Install all removed speed control components using Figures 17, 19 and 20 as guides.

A. If banjo bolts (item 7 in Fig. 20) were removed from reservoir fitting cylinder, use new banjo washers (item 6 in Fig. 20) on both sides of hose fitting and torque banjo bolt from **108 to 132 in-lb (12.3 to 14.9 N-m)** during assembly.

2. If hydraulic system was opened during disassembly, bleed speed control system (see Bleed Speed Control System in this section).

IMPORTANT: Use DOT 3 brake fluid in the speed control system.

3. Make sure that fluid level in speed control reservoir is correct. Add DOT 3 brake fluid to reservoir as needed to adjust level.

4. Install control plate to seat base and secure with six (6) washer head screws. Install knobs to speed range lever and hydraulic lift lever.

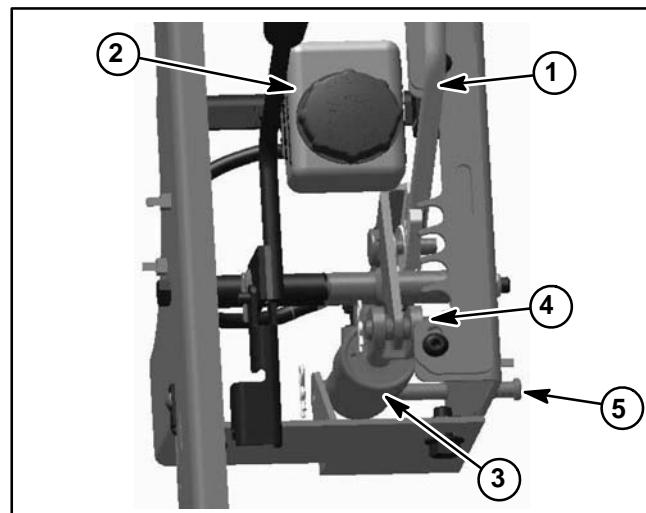


Figure 19

- | | |
|----------------------|---------------|
| 1. Speed range lever | 4. Clevis pin |
| 2. Reservoir | 5. Clevis pin |
| 3. Cylinder | |

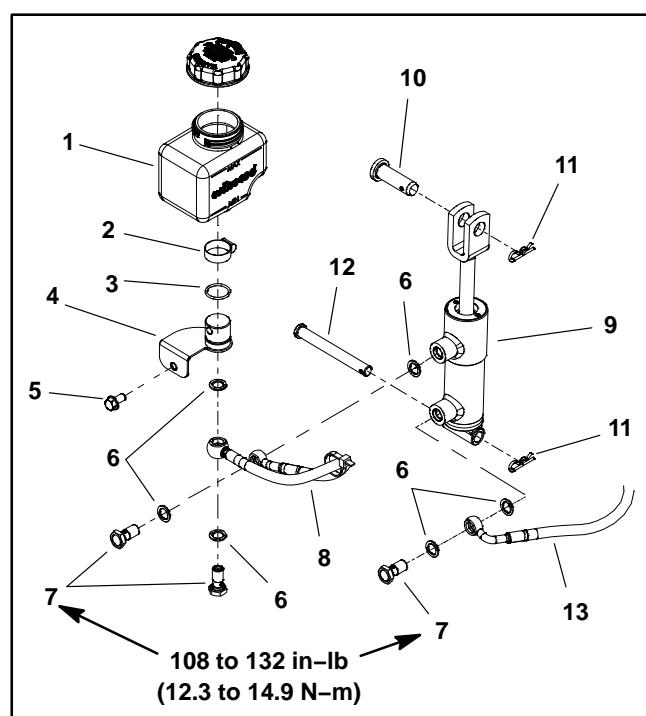


Figure 20

- | | |
|----------------------|------------------------|
| 1. Reservoir | 8. Hose |
| 2. Worm clamp | 9. Cylinder |
| 3. O-ring | 10. Clevis pin |
| 4. Reservoir fitting | 11. Hair pin |
| 5. Washer head screw | 12. Clevis pin |
| 6. Banjo washer | 13. Speed control hose |
| 7. Banjo bolt | |

Speed Limiter Assembly

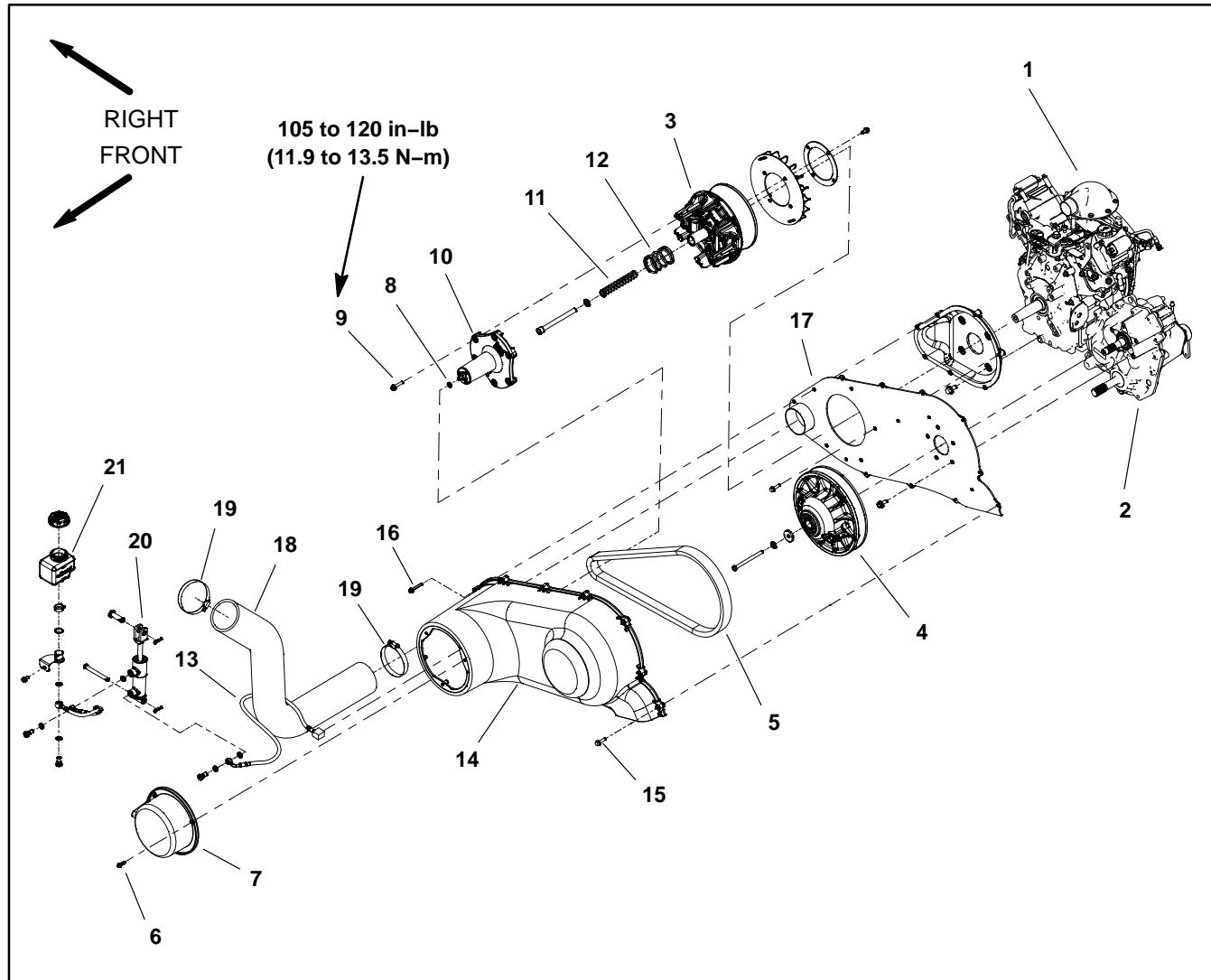


Figure 21

- | | | |
|--------------------------|----------------------------|---------------------------|
| 1. Engine | 8. Banjo washer | 15. Washer head screw (9) |
| 2. Transmission | 9. Flange head screw (6) | 16. Washer head screw (2) |
| 3. Primary clutch | 10. Speed limiter assembly | 17. Spanner plate |
| 4. Secondary clutch | 11. Compression spring | 18. CVT intake hose |
| 5. CVT drive belt | 12. Compression spring | 19. Hose clamp (2) |
| 6. Washer head screw (3) | 13. Speed control hose | 20. Cylinder |
| 7. Speed limiter cover | 14. CVT enclosure cover | 21. Reservoir |

The speed limiter assembly is used on the Workman Auto vehicle to adjust the maximum opening of the primary clutch moveable sheave. The vehicle speed range can easily be adjusted with the speed range lever to limit the maximum ground speed for operations that require a constant speed (e.g. spraying or topdressing). The speed range lever (Fig. 22) is used to select one of the four (4) work-speed ranges that are used to limit maximum ground speed or a transport speed range that is used when the machine is moved between job sites.

The speed limiter control uses a manually operated hydraulic cylinder to change the location of the piston in the speed limiter cover attached to the primary clutch. The piston location determines the maximum opening of the primary clutch.



CAUTION

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

Removal (Fig. 21)

1. Park vehicle on a level surface, raise and support vehicle cargo bed (if installed), shut engine off and engage the parking brake. Remove key from the ignition switch.
2. Move speed range lever to the transport (T) position to remove pressure in the speed control system (Fig. 22).
3. Remove three (3) washer head screws (item 6) that secure speed limiter cover (item 7) to CVT enclosure cover (item 13). Separate speed limiter cover from CVT enclosure cover and remove from vehicle.
4. Remove speed limiter assembly (item 9) with attached hydraulic hose from primary clutch (Fig. 23):



CAUTION

Loosen the flange head screws that secure speed limiter assembly slowly. The limiter assembly is under pressure from the primary clutch compression springs.

- A. Using a crossing pattern, evenly loosen and remove six (6) flange head screws (item 8) that secure the speed limiter assembly (item 9) to the primary clutch.
- B. Separate speed limiter assembly (item 9) with attached hydraulic hose from primary clutch.
- C. Carefully route speed limiter assembly with attached hydraulic hose out of CVT enclosure cover and position away from cover.

Installation (Fig. 21)

1. Position speed limiter assembly to the primary clutch. Make sure that compression springs (items 10 and 11) are properly placed onto primary clutch.

2. Secure speed limiter assembly (item 9) to the primary clutch with six (6) flange head screws (item 8) in a crossing pattern and in three (3) equal steps. Final torque on screws should be from **105 to 120 in-lb (11.9 to 13.5 N·m)**.

3. Install speed limiter cover (item 7) to CVT enclosure cover. Make sure that speed control hose (item 13) is routed through slot in limiter cover. Secure cover with three (3) washer head screws (item 6).
4. Bleed speed control system (see Bleed Speed Control System in this section).
5. Remove bed support from cargo bed lift cylinder and lower bed.

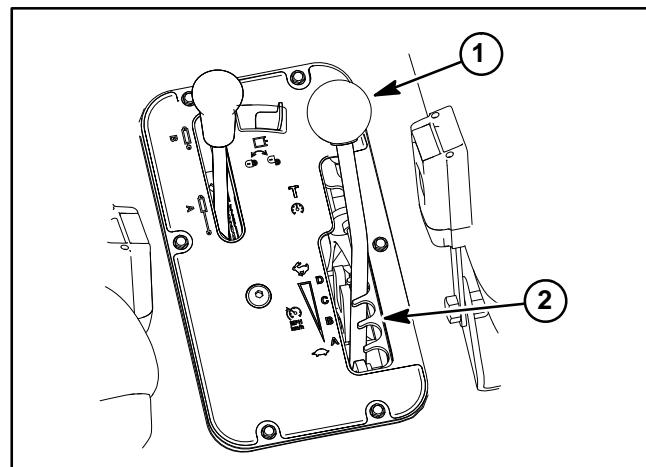


Figure 22

1. Speed range lever

2. Speed range settings

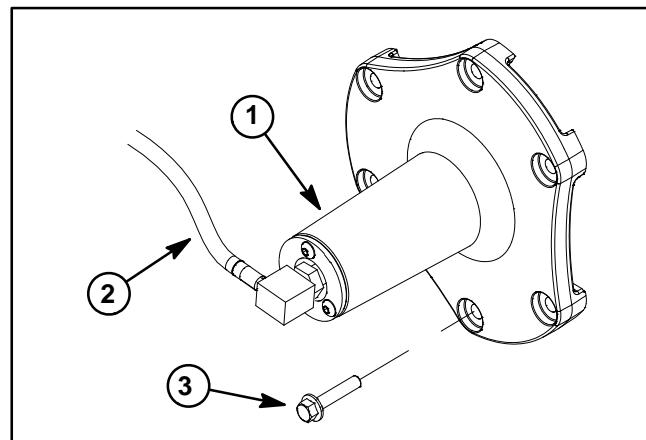


Figure 23

1. Speed limiter assembly

2. Speed control hose

3. Screw (6)

Speed Limiter Cover Service

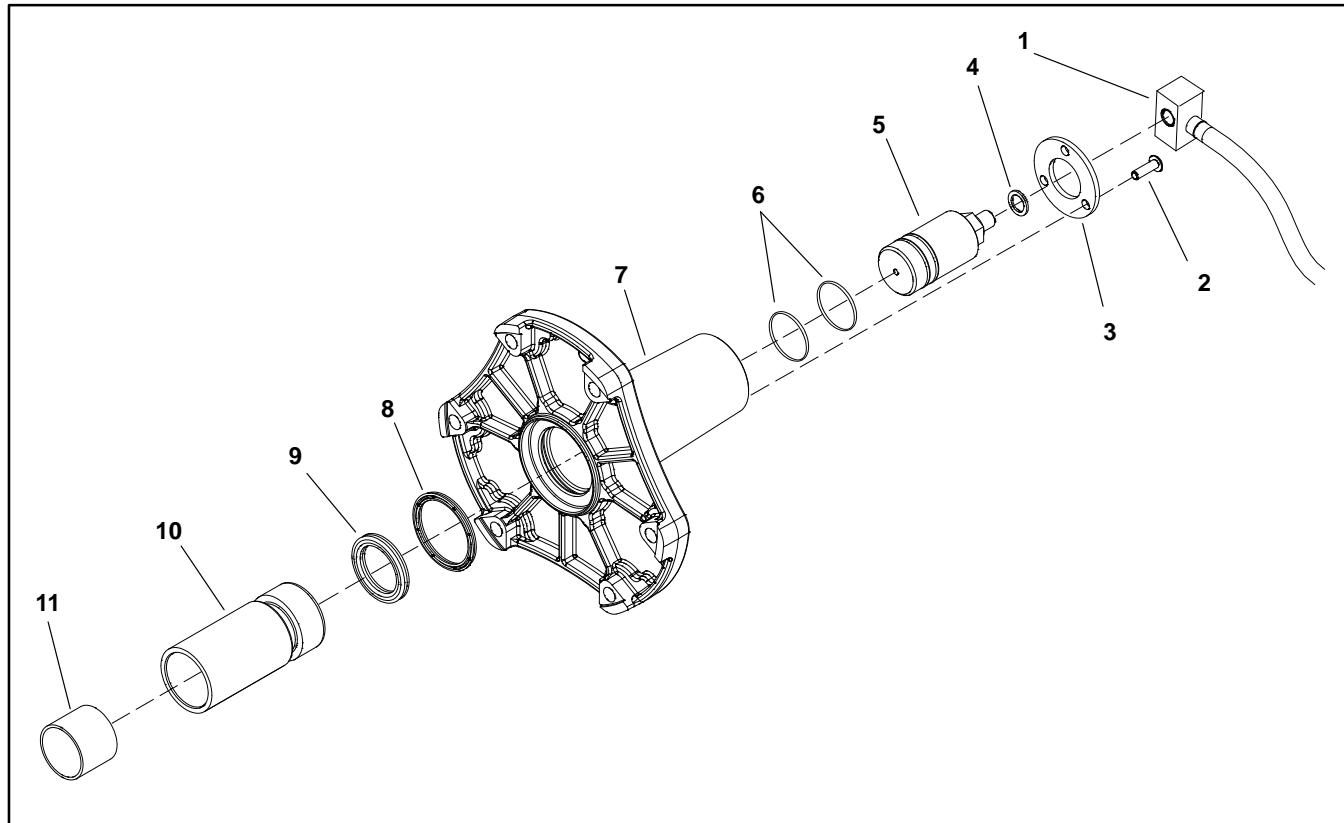


Figure 24

- | | | |
|--------------------------|--------------------------------|----------------------|
| 1. Speed control hose | 5. Rotary union | 9. Quad ring |
| 2. Button head screw (3) | 6. O-ring (2) | 10. Hydraulic piston |
| 3. Retainer | 7. Speed limiter control cover | 11. Sleeve bushing |
| 4. Banjo washer | 8. U-cup | |

Disassembly (Fig. 24)

1. Remove speed limiter assembly with attached hydraulic hose from primary clutch (see Speed Limiter Assembly in this section).
2. Thoroughly clean speed limiter control cover before disassembly.
3. Move speed range lever on seat base console out of the transport position to reduce fluid leakage from speed control system.

NOTE: If only replacing rotary union O-rings, the rotary union can be removed without disconnecting speed control hose. Remove three (3) button head screws (item 2) and slide rotary union with attached hose and retainer from control cover (Fig. 25).

4. Separate speed control hose (item 1) from rotary union (item 5) by holding fitting on speed control hose and loosening hex on rotary union. Discard banjo washer (item 4).
5. Remove three (3) button head screws that secure retainer (item 3) to speed limiter control cover. Remove retainer.
6. Slide rotary union (item 5) and hydraulic piston (item 10) out of speed limiter control cover.
7. Remove and discard quad ring (item 9) from piston, U-cup (item 8) from control cover and O-rings (item 6) from rotary union.
8. Thoroughly clean and inspect all speed limiter control cover components.

Assembly (Fig. 24)

1. Lubricate quad ring (item 9), U-cup (item 8) and O-rings (item 6) with clean DOT 3 brake fluid. Carefully install quad ring onto piston, U-cup into cover and O-rings onto rotary union. Make sure that seals are completely seated into component grooves.
2. Lubricate piston with clean DOT 3 brake fluid.
3. Place piston installation tool (see Special Tools in this chapter) in bore of speed limiter control cover. Using finger pressure, slide lubricated piston through piston guide and insert piston into control cover.

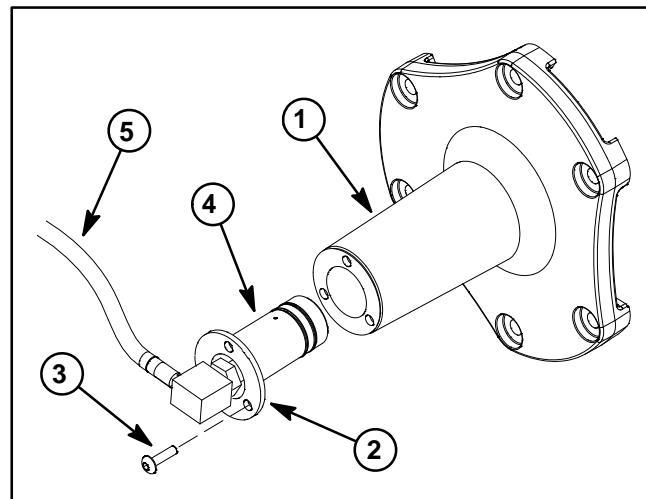


Figure 25

1. Speed limiter cover
2. Retainer
3. Screw (3)
4. Rotary union
5. Speed control hose

4. Put small amount of clean DOT 3 brake fluid into bore of speed limiter control cover before installing rotary union.
5. Slide lubricated rotary union into speed limiter control cover.
6. Position retainer (item 3) onto speed limiter control cover and secure with three (3) button head screws (item 2). Tighten screws evenly so the retainer has a uniform gap all the way around.
7. Position new banjo washer onto rotary union fitting.
- NOTE:** Proper torque of rotary union fitting will require the use of an offset wrench (e.g. crowfoot wrench). Use of an offset wrench will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be lower than the listed installation torque (see Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 – Product Records and Maintenance).
8. Thread rotary union into speed control hose fitting and tighten. Torque rotary union hex from **108 to 132 in-lb (12.3 to 14.9 N·m)**.
9. Bleed speed control system (see Bleed Speed Control System in this section).
10. Install speed limiter assembly with attached hydraulic hose to primary clutch (see Speed Limiter Assembly in this section).

CVT Enclosure Cover

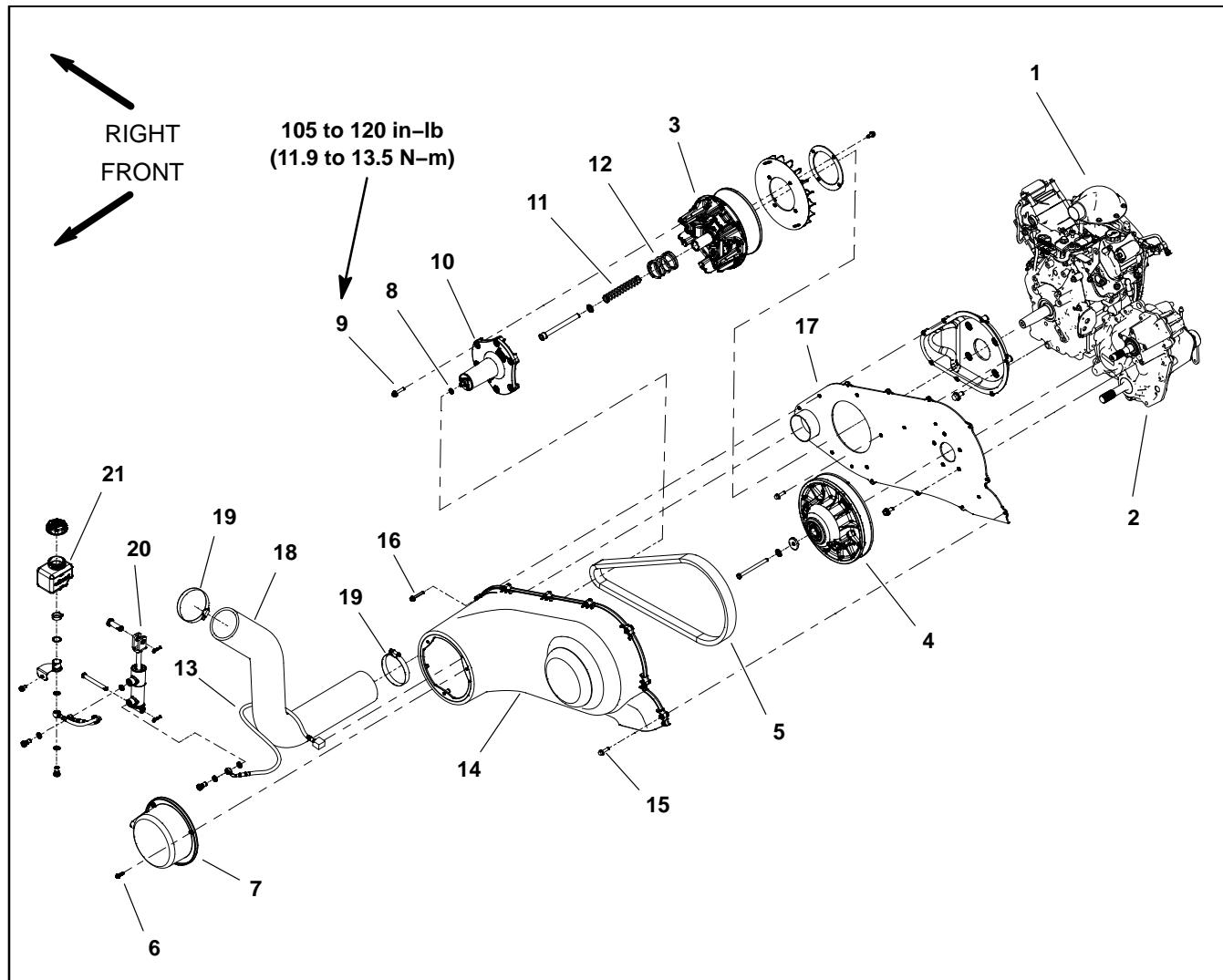


Figure 26

- | | | |
|--------------------------|----------------------------|---------------------------|
| 1. Engine | 8. Banjo washer | 15. Washer head screw (9) |
| 2. Transmission | 9. Flange head screw (6) | 16. Washer head screw (2) |
| 3. Primary clutch | 10. Speed limiter assembly | 17. Spanner plate |
| 4. Secondary clutch | 11. Compression spring | 18. CVT intake hose |
| 5. CVT drive belt | 12. Compression spring | 19. Hose clamp (2) |
| 6. Washer head screw (3) | 13. Speed control hose | 20. Cylinder |
| 7. Speed limiter cover | 14. CVT enclosure cover | 21. Reservoir |



CAUTION

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

Removal (Fig. 26)

1. Park vehicle on a level surface, raise and support vehicle cargo bed (if installed), shut engine off and engage the parking brake. Remove key from the ignition switch.
2. Place speed range lever in the transport (T) position to remove pressure in the speed control system.
3. Remove speed limiter assembly (item 9) with attached speed control hose from primary clutch to allow removal of CVT enclosure cover (see Speed Limiter Assembly in this section).
4. Remove washer head screws (items 14 and 15) that secure CVT enclosure cover (item 13) to spanner plate (item 16). Note that two (2) longer screws are installed on the air intake end of the cover (Fig. 27).
5. Separate CVT enclosure cover from spanner plate and remove from vehicle.

Installation (Fig. 26)

1. Position CVT enclosure cover to spanner plate and secure with washer head screws (items 14 and 15). Make sure that two (2) longer screws are installed on the air intake end of the cover.
2. Install and secure speed limiter assembly (item 9) with attached speed control hose to the primary clutch (see Speed Limiter Assembly in this section).
3. Install speed limiter cover (item 7) to CVT enclosure cover. Make sure that speed control hose (item 12) is routed through slot in limiter cover. Secure cover with three (3) washer head screws (item 6).
4. Bleed speed control system (see Bleed Speed Control System in this section).
5. Remove bed support from cargo bed lift cylinder and lower bed.

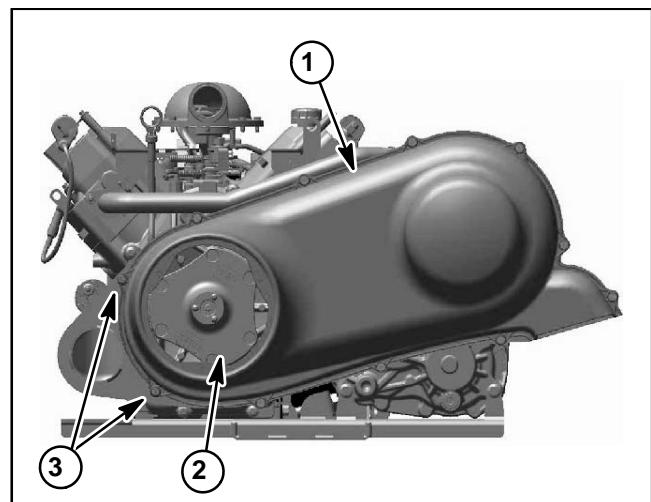


Figure 27

- | | |
|------------------------|---------------------|
| 1. CVT enclosure cover | 3. Longer screw (2) |
| 2. Speed limiter cover | |

CVT Drive Belt

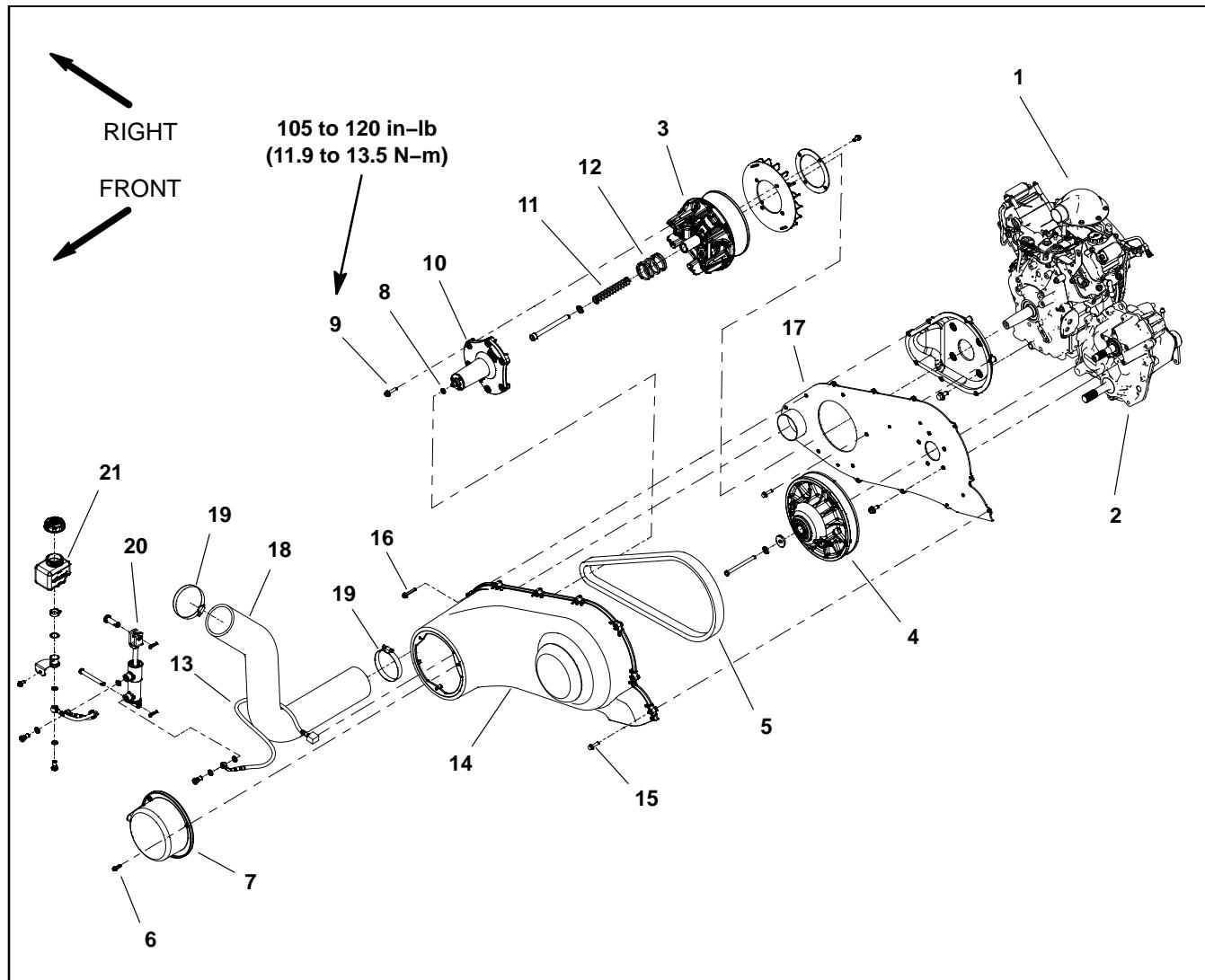


Figure 28

- | | | |
|--------------------------|----------------------------|---------------------------|
| 1. Engine | 8. Banjo washer | 15. Washer head screw (9) |
| 2. Transmission | 9. Flange head screw (6) | 16. Washer head screw (2) |
| 3. Primary clutch | 10. Speed limiter assembly | 17. Spanner plate |
| 4. Secondary clutch | 11. Compression spring | 18. CVT intake hose |
| 5. CVT drive belt | 12. Compression spring | 19. Hose clamp (2) |
| 6. Washer head screw (3) | 13. Speed control hose | 20. Cylinder |
| 7. Speed limiter cover | 14. CVT enclosure cover | 21. Reservoir |



CAUTION

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

Removal (Fig. 28)

1. Park vehicle on a level surface, raise and support vehicle cargo bed (if installed), shut engine off and engage the parking brake. Remove key from the ignition switch.
2. Remove CVT enclosure cover to allow access to CVT drive belt (see CVT Enclosure Cover in this section).
3. Use 1" open end wrench or equivalent in opening of secondary clutch (Fig. 29) to pry clutch sheaves apart and allow drive belt to drop down between secondary clutch sheaves. This will allow slack in drive belt.
4. Remove drive belt from primary clutch and then from secondary clutch.

Installation (Fig. 28)

1. Use 1" open end wrench or equivalent in opening of secondary clutch (Fig. 29) to pry clutch sheaves apart.
2. Place drive belt between secondary clutch sheaves and allow drive belt to drop down between secondary clutch sheaves.
3. Route drive belt onto primary clutch.
4. Remove wrench from secondary clutch.
5. After installation of drive belt, check that belt is centered between the stationary and moveable sheaves of both clutches. If transmission or engine has moved in machine for some reason, belt alignment may be incorrect. Repositioning transmission and/or engine location on frame may be required to center drive belt.
6. Install CVT enclosure cover (see CVT Enclosure Cover in this section).
7. Remove bed support from cargo bed lift cylinder and lower bed.

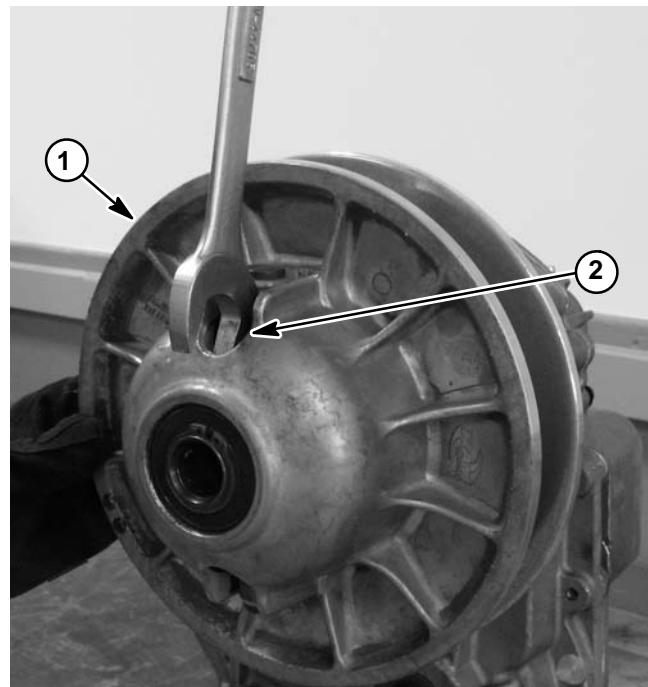


Figure 29

1. Secondary clutch

2. Clutch opening

Primary and Secondary Clutches

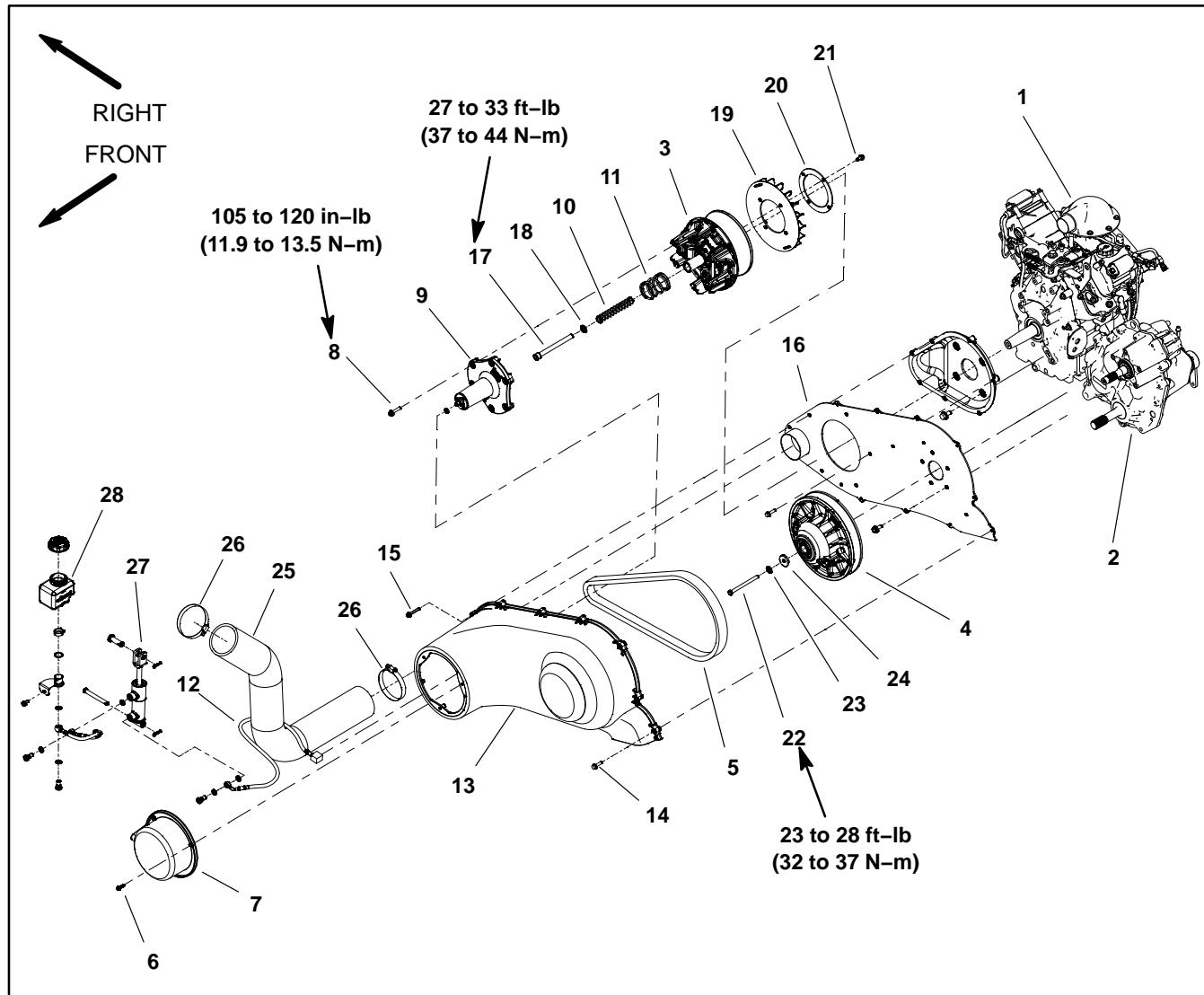


Figure 30

- | | | |
|---------------------------|---------------------------|-----------------------------|
| 1. Engine | 11. Compression spring | 20. Fan stiffener |
| 2. Transmission | 12. Speed control hose | 21. Washer head screw (4) |
| 3. Primary clutch | 13. CVT enclosure cover | 22. Cap screw |
| 4. Secondary clutch | 14. Washer head screw (9) | 23. Lock washer |
| 5. CVT drive belt | 15. Washer head screw (2) | 24. Flat washer |
| 6. Washer head screw (3) | 16. Spanner plate | 25. CVT intake hose |
| 7. Speed limiter cover | 17. Socket head screw | 26. Hose clamp (2) |
| 8. Flange head screw (6) | 18. Flat washer | 27. Speed control cylinder |
| 9. Speed limiter assembly | 19. CVT fan | 28. Speed control reservoir |
| 10. Compression spring | | |



CAUTION

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

Removal (Fig. 26)

1. Park vehicle on a level surface, raise and support vehicle cargo bed (if installed), shut engine off and engage the parking brake. Remove key from the ignition switch.
2. Remove CVT enclosure cover to gain access to primary and secondary clutches (see CVT Enclosure Cover in this section).
3. Remove CVT drive belt from primary and secondary clutches (see CVT Drive Belt in this section).
4. Remove primary clutch, if necessary:
 - A. Remove socket head screw (item 17) and flat washer (item 18) that secure primary clutch to engine crankshaft.

IMPORTANT: Lightly grease end of clutch removal tool to prevent wear or damage to removal tool and engine crankshaft. Prevent damage to clutch threads; thread tool into primary clutch only enough to remove the clutch.

- B. Thread clutch removal tool (see Special Tools in this chapter) into threads in primary clutch and then tighten tool to remove clutch from the engine tapered crankshaft.
 - C. If necessary, remove fan stiffener (item 20) and CVT fan (item 19) from primary clutch.
5. Remove secondary clutch, if necessary:
 - A. Remove cap screw (item 22), lock washer (item 23) and flat washer (item 24) that secure secondary clutch to transmission input shaft.
 - B. Remove secondary clutch from transmission input shaft. Use of clutch removal tool and secondary clutch adapter (see Special Tools in this chapter) may be needed to loosen clutch from shoulder on input shaft.

Installation (Fig. 26)

1. If removed, install primary clutch to engine crankshaft:
 - A. If removed, secure CVT fan (item 19) and fan stiffener (item 20) to primary clutch with removed fasteners.
 - B. Thoroughly clean the tapered surfaces of the engine crankshaft and primary clutch.
 - C. Slide primary clutch onto the engine shaft.
 - D. Secure primary clutch to engine shaft with socket head screw (item 17) and flat washer (item 18). Torque screw from **27 to 33 ft-lb (37 to 44 N·m)**.
2. If removed, install secondary clutch to transmission input shaft:
 - A. Apply antiseize lubricant to transmission input shaft.
 - B. Slide secondary clutch onto the transmission shaft.
 - C. Secure secondary clutch to transmission shaft with cap screw (item 22), lock washer (item 23) and flat washer (item 24). Torque cap screw from **23 to 28 ft-lb (32 to 37 N·m)**.
3. Install CVT drive belt to primary and secondary clutches (see CVT Drive Belt in this section).
4. Install CVT enclosure cover (see CVT Enclosure Cover in this section).
5. Remove bed support from cargo bed lift cylinder and lower bed.

Primary Clutch Service

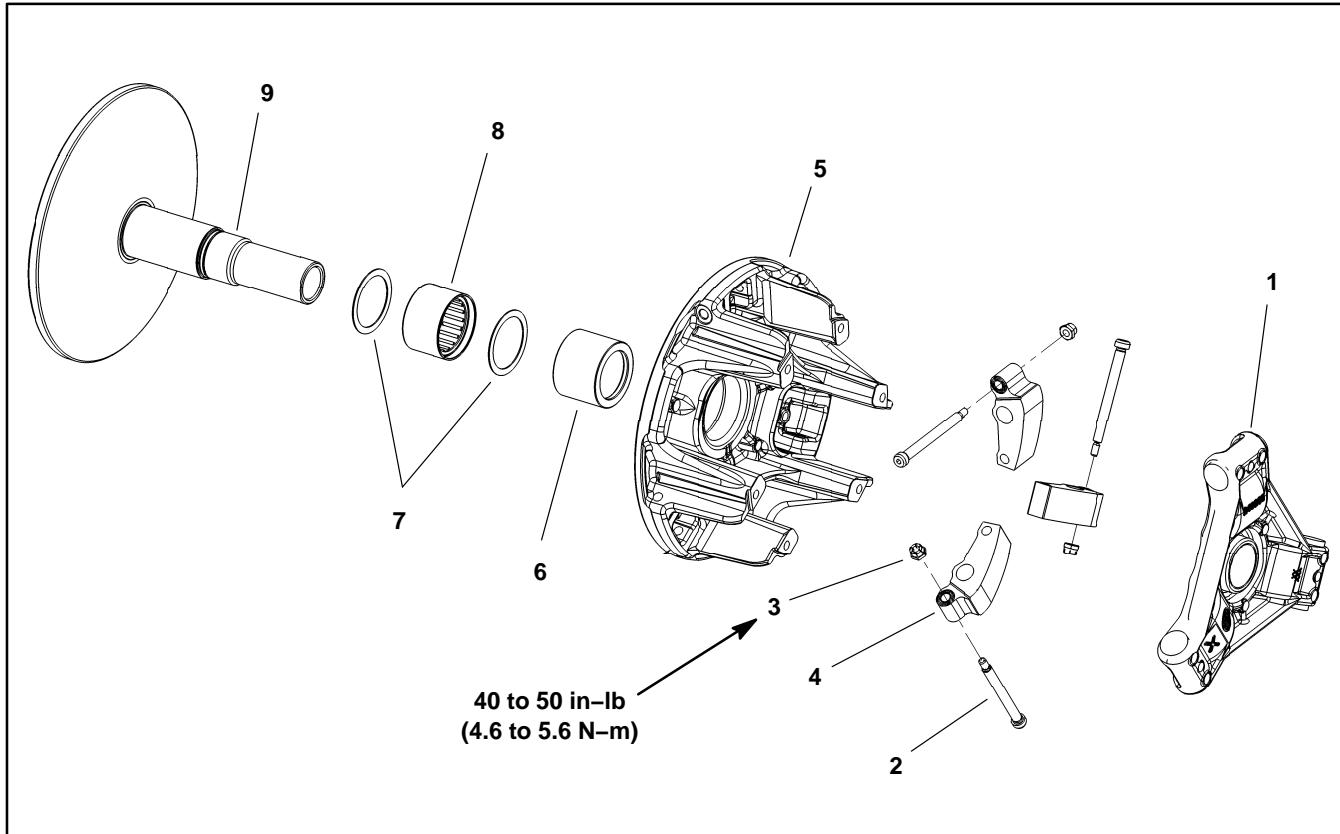


Figure 31

- 1. Spider assembly
- 2. Shoulder screw (3)
- 3. Lock nut (3)

- 4. Clutch weight (3)
- 5. Moveable sheave
- 6. Cap

- 7. Thrust washer (2)
- 8. Bearing
- 9. Stationary sheave

Disassembly (Fig. 31)

1. Remove lock nut (item 3) from each of the shoulder screws (item 2). Discard lock nuts after removal.
2. Slide shoulder screw from each of the clutch weights (item 4) and then remove weights from clutch.
3. Clean all dust and debris from clutch components with a soft bristle brush. If necessary, use water to remove dirt and dry immediately with compressed air to remove all dirt and water. Remove any remaining debris with a fast drying contact or brake parts cleaner. Focus debris removal on and around moving components.

Inspection

NOTE: If primary clutch wear or damage occurs, clutch replacement may be necessary. Refer to your parts catalog to identify individual primary clutch components that are available.

1. Inspect the tapered ends of the engine crankshaft and stationary sheave of primary clutch. If either is severely damaged, replace component as damage to the taper will allow loosening of the clutch during operation.
2. Clean and inspect shoulder screws (item 2). If the shoulder area of the screws is worn or if the threads are damaged, replace the screws.
3. Check the contact surface of the clutch weights (Fig. 4). If surface is worn or damaged, replace all three (3) clutch weights as a set.
4. Check the rollers in the spider assembly for binding or wear (Fig. 33). If binding or uneven wear is found, replace primary clutch assembly.
5. Check the belt contact surfaces of the movable and stationary sheaves. Remove any belt material from sheave faces with a fine abrasive pad or fine steel wool. If sheave surfaces are worn, replace primary clutch.

Assembly (Fig. 31)

IMPORTANT: For proper clutch operation, DO NOT lubricate clutch components during assembly.

IMPORTANT: To maintain the balance of the clutch, all shoulder screws must be installed with their threads pointing in a clockwise direction (Fig. 34).

1. Position clutch weights to moveable sheave and slide shoulder screw into sheave and weight. Make sure that screw threads are pointing in a clockwise direction.
2. Install new lock nuts on the shoulder screws. DO NOT reuse removed lock nuts. Tighten nuts until they contact screw shoulder and then torque nuts from **40 to 50 in-lb (4.6 to 5.6 N·m)**.

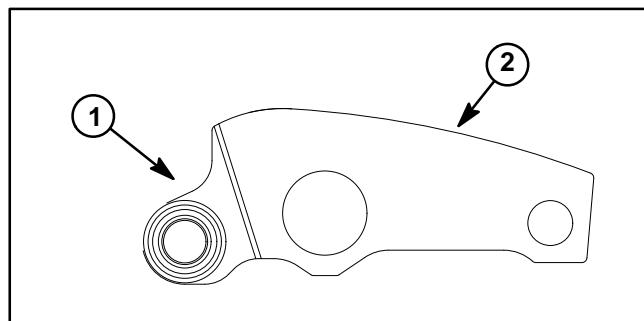


Figure 32

1. Clutch weight

2. Contact surface

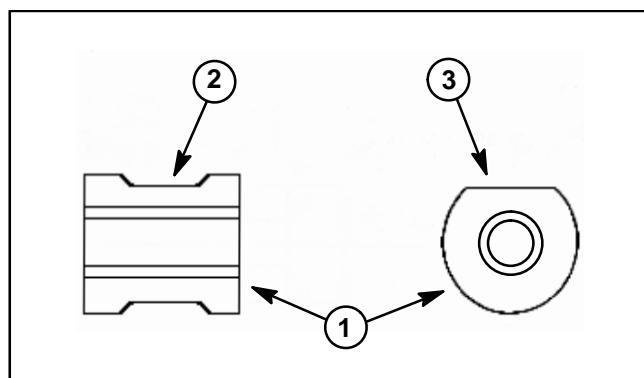


Figure 33

1. Roller

2. Weight contact surface

3. Roller uneven wear

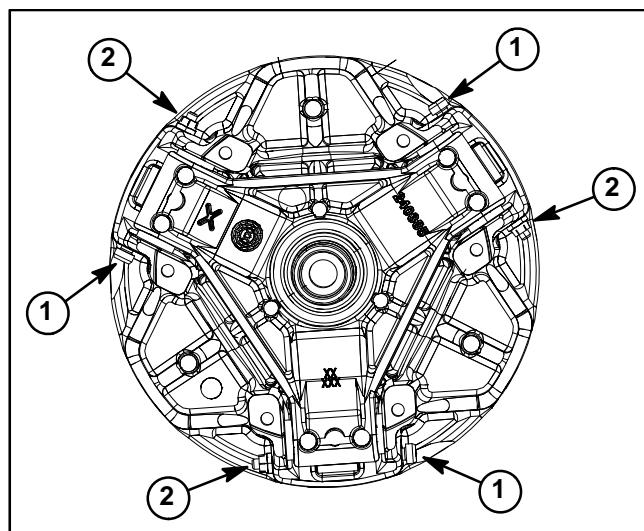


Figure 34

1. Shoulder screw head

2. Lock nut

Secondary Clutch Service

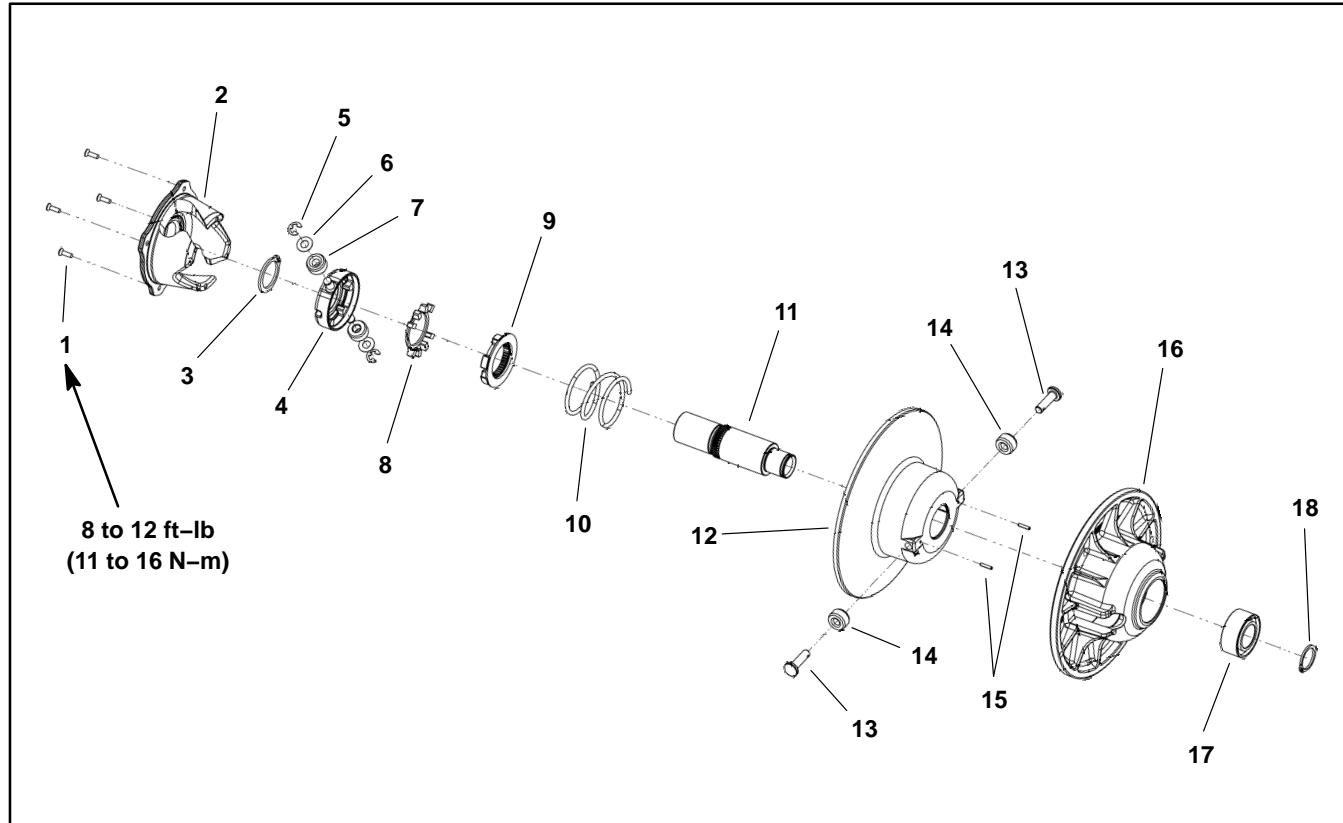


Figure 35

- | | | |
|--------------------------------|------------------------|-----------------------|
| 1. Torx screw (4) | 7. Clutch roller (2) | 13. Roller pin (2) |
| 2. Cam assembly | 8. Spider dampener | 14. Clutch roller (2) |
| 3. Retaining ring | 9. Spider insert | 15. Spring pin (2) |
| 4. Outer dampered spider | 10. Compression spring | 16. Stationary sheave |
| 5. External retaining ring (2) | 11. Clutch shaft | 17. Ball bearing |
| 6. Thrust washer (2) | 12. Moveable sheave | 18. Retaining ring |

Disassembly (Fig. 35)

1. For clutch assembly purposes, use a marker to make alignment marks on the cam assembly, moveable sheave and stationary sheave (Fig. 36).

2. Remove cam assembly from secondary clutch.

A. Remove four (4) torx screws (item 1) that secure cam assembly to moveable sheave.

B. To remove cam from clutch, pull cam straight out or turn the sheaves relative to each other to twist the cam out of clutch. If cam resists removal, place clutch assembly on a flat surface with the cam side facing down. Press down on moveable sheave belt face with both hands and cam should release from moveable sheave.

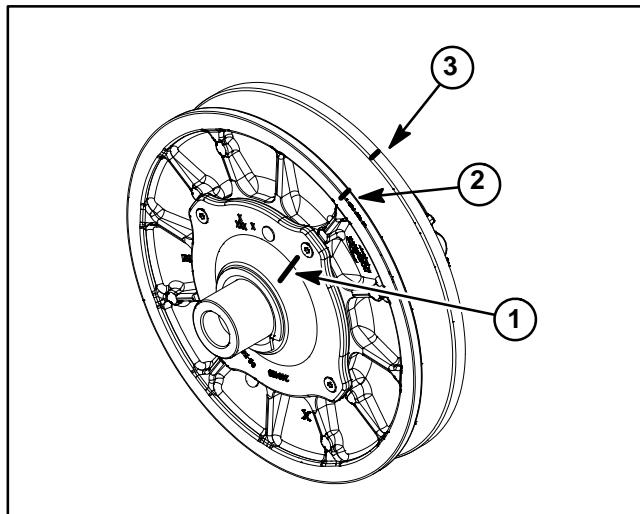


Figure 36

- | | |
|-------------------------|---------------------------|
| 1. Cam assembly mark | 3. Stationary sheave mark |
| 2. Moveable sheave mark | |

3. Use secondary clutch press tool (see Special Tools in this chapter) to compress the compression spring enough to allow removal of the retaining ring (item 3) that secures internal clutch components. Remove retaining ring (item 3).

4. Carefully, release clutch press tool to allow the compression spring to extend fully.

5. Remove outer damped spider assembly (items 4, 5, 6 and 7), spider dampener (item 8), spider insert (item 9), compression spring (item 10) and moveable sheave assembly (items 12, 13 and 14) from stationary sheave.

6. If bearing (item 17) replacement is necessary, remove clutch shaft (item 11) with bearing from stationary sheave (item 16). Remove retaining ring and bearing from clutch shaft. Discard removed bearing.

Inspection

NOTE: If secondary clutch wear or damage occurs, clutch replacement may be necessary. Refer to your parts catalog to identify individual secondary clutch components that are available.

1. Clean all dust and debris from clutch components. If necessary, use contact or brake cleaner to remove any oil or other lubricants from clutch components. Make sure that belt contact surfaces of sheaves are thoroughly cleaned.

2. Inspect the compression spring and replace if damaged or fatigued.

3. Check the rollers attached to the spider and moveable sheave for binding or wear. If binding or uneven wear is found, replace faulty rollers.

4. Check the contact surface of the sheaves for wear and/or fraying. If wear or damage is found, replace secondary clutch assembly.

Assembly (Fig. 35)

IMPORTANT: For proper clutch operation, DO NOT lubricate clutch components during assembly.

IMPORTANT: When assembling the secondary clutch, check the marker lines made during clutch disassembly to make sure the cam assembly, moveable sheave and stationary sheave are properly aligned (Fig. 36).

1. If bearing (item 17) was removed from clutch shaft, install new bearing onto clutch shaft and secure with retaining ring. Install clutch shaft (item 11) with bearing into stationary sheave (item 16).

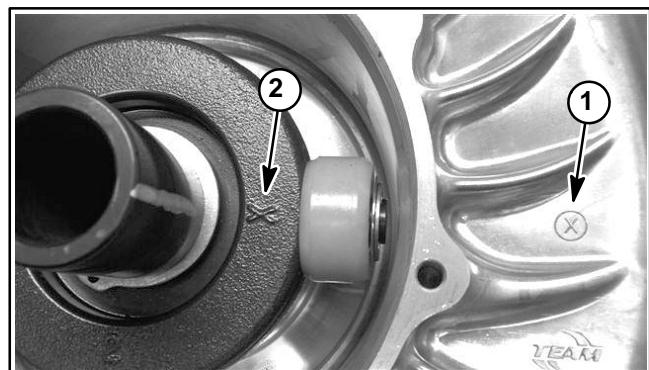


Figure 37

1. Moveable sheave alignment mark
2. Spider alignment mark

2. Install moveable sheave assembly (items 12, 13 and 14), compression spring (item 10), spider insert (item 9), spider dampener (item 8) and outer damped spider assembly (items 4, 5, 6 and 7) to clutch shaft and stationary sheave.

3. Use secondary clutch press tool (see Special Tools in this chapter) to compress the compression spring enough to allow installation of the retaining ring (item 3) that secures internal clutch components. While compressing spring, align the "X" mark cast on spider and "X" mark cast on moveable sheave during the last $\frac{1}{2}$ " of spring compression.

4. Secure the clutch assembly with retaining ring (item 3). Make sure that retaining ring is fully seated in groove before releasing the clutch press tool.

5. Align cam assembly with rollers on outer damped spider and slide the cam down over the rollers. If the cam assembly is difficult to install, align clutch sheaves by rocking the moveable sheave while inserting the cam.

6. Apply medium strength thread locker to threads of torx screws (item 1). Secure cam assembly to moveable sheave with four (4) torx screws. Torque screws from 8 to 12 ft-lb (11 to 16 N-m).

Rear CV (Constant Velocity) Axles

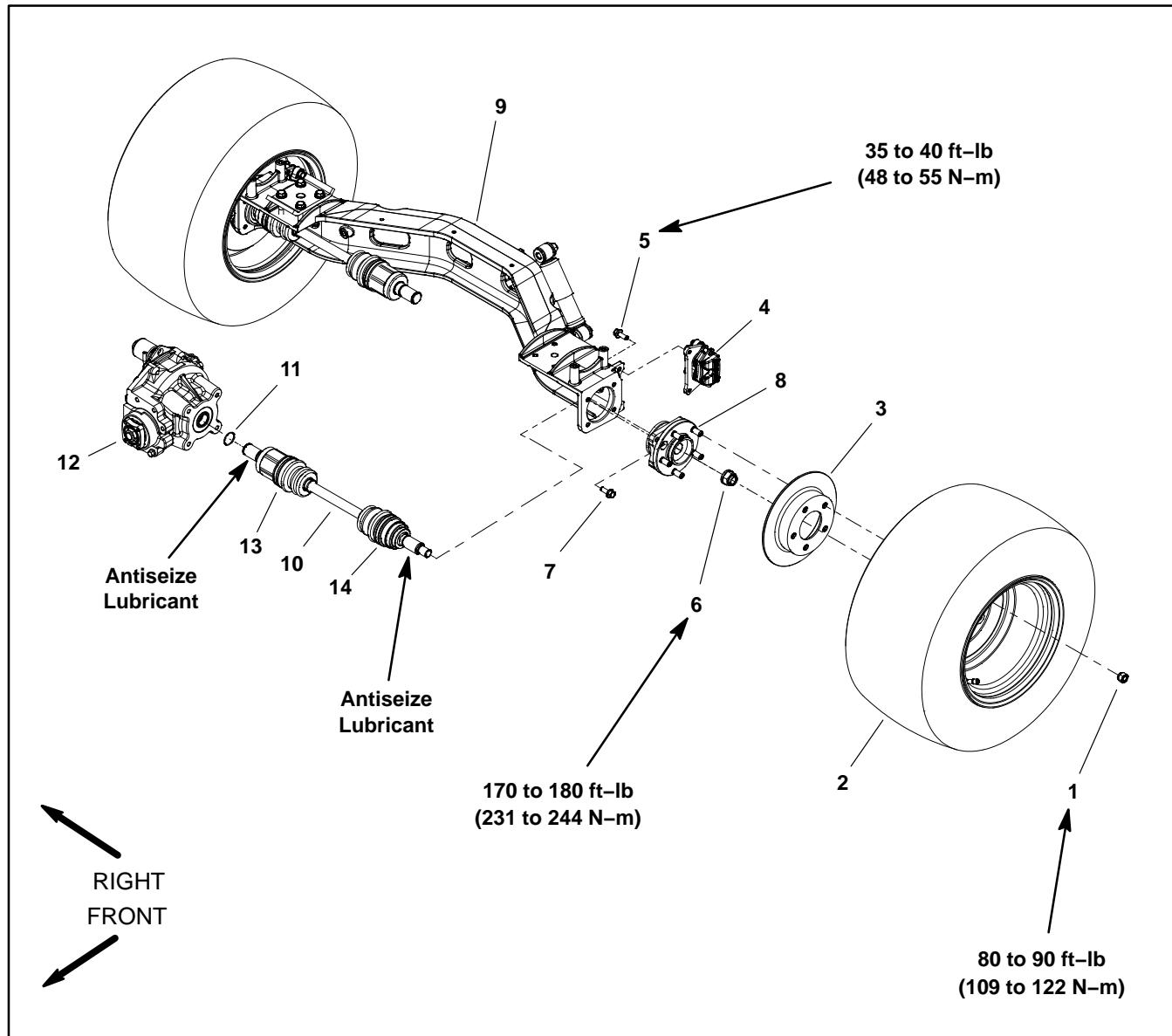


Figure 38

- | | | |
|--------------------------------------|----------------------------------|-----------------------|
| 1. Lug nut (5 per wheel) | 6. Spindle nut(2) | 11. O-ring (2) |
| 2. Rear wheel assembly (2) | 7. Flange head screw (4 per hub) | 12. Rear differential |
| 3. Brake rotor (2) | 8. Wheel bearing hub (2) | 13. Inboard boot (2) |
| 4. Brake caliper (2) | 9. Rear axle | 14. Outboard boot (2) |
| 5. Flange head screw (2 per caliper) | 10. CV axle assembly (2) | |

Test Rear CV Axle

NOTE: A worn and noisy CV axle joint with the boot in good condition and filled with grease is not uncommon. Potholes, curb contact or collision damage can damage CV axle bearing components and initiate worn conditions.

1. Test drive vehicle on a smooth surface to verify CV axle joint problem.
2. Accelerate or back-up vehicle slowly with the front wheels turned. Listen for snapping or clicking noise at the wheel, then drive straight ahead.
 - A. If the noise remains constant, the wheel bearing is the likely problem and, if so, the wheel hub assembly must be replaced.
 - B. If the noise gets louder when turning, the out-board CV axle joint is likely worn. A badly worn joint will snap or click when driving straight ahead, however the noise will increase when accelerating or backing up into a turn.
3. Accelerate vehicle quickly and straight ahead. Vibration or shudder often indicates a worn or sticking inboard CV axle joint.
4. Accelerate vehicle at an angle over a ramp or up a hill. A clunking noise may indicate a worn inboard CV axle joint.
5. If any CV axle components other than the boots are worn or damaged, the CV axle assembly must be replaced.

Disassembly (Fig. 38)

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake.
2. For CV axle to be removed, remove rear wheel assembly, brake caliper and brake rotor (see Brake System in the Service and Repairs section of Chapter 5 – Chassis).

IMPORTANT: If staked-in portion of spindle nut (item 6) is not released before nut removal, CV axle may be damaged. Follow spindle nut removal procedure listed in Wheel Hub in the Service and Repairs section of Chapter 5 – Chassis.

3. Remove rear wheel bearing hub (item 8) from axle (see Wheel Hub in the Service and Repairs section of Chapter 5 – Chassis).

IMPORTANT: Make sure to not damage the oil seal on the differential with the pry bars when removing the CV axle.

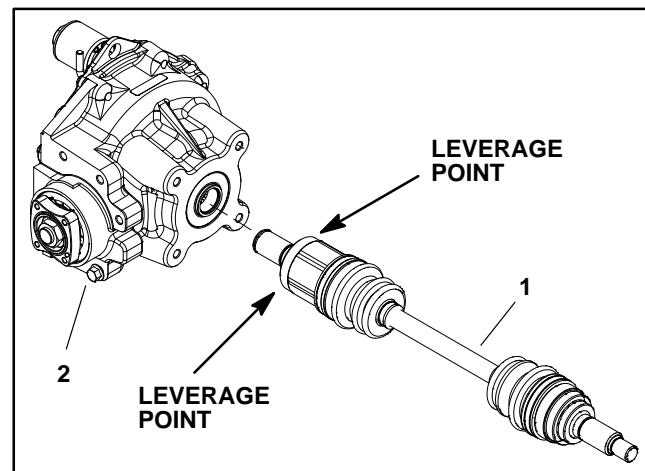


Figure 39

1. CV axle (LH shown) 2. Differential assembly

4. Use two small pry bars (180° apart) to leverage the CV axle out of the differential. Use even pressure on both pry bars (Fig. 39).
5. Pull CV axle through opening in rear axle and remove from vehicle.

Assembly (Fig. 38)

NOTE: The inner end of the CV axle has an O-ring and the outer end of the axle has threads for the spindle nut.

1. Apply antiseize lubricant to splines on inner end of CV axle.
2. Insert inner end of CV axle through rear axle opening and into the rear differential. Press axle into differential until a snap is heard.

IMPORTANT: After CV axle installation into differential, pull outward on CV axle as close as possible to the differential to make sure that the axle is properly secured into the differential.

3. Apply antiseize lubricant to splines on outer end of CV axle and slide wheel bearing hub (item 8) onto CV axle making sure to align hub and axle splines. Loosely install four (4) flange head screws (item 7) to locate wheel hub to rear axle. Do not fully tighten screws.
4. Install new spindle nut (item 6) onto CV axle. Torque spindle nut from **170 to 180 ft-lb (231 to 244 N·m)**. After tightening nut, stake nut extension into slot in CV axle.
5. Fully tighten flange head screws to secure wheel hub to rear axle. Torque screws from **35 to 40 ft-lb (48 to 55 N·m)**.
6. Install brake rotor, brake caliper and wheel assembly (see Brake System and Wheel Assembly in the Service and Repairs section of Chapter 5 – Chassis).

CV Axle Boots

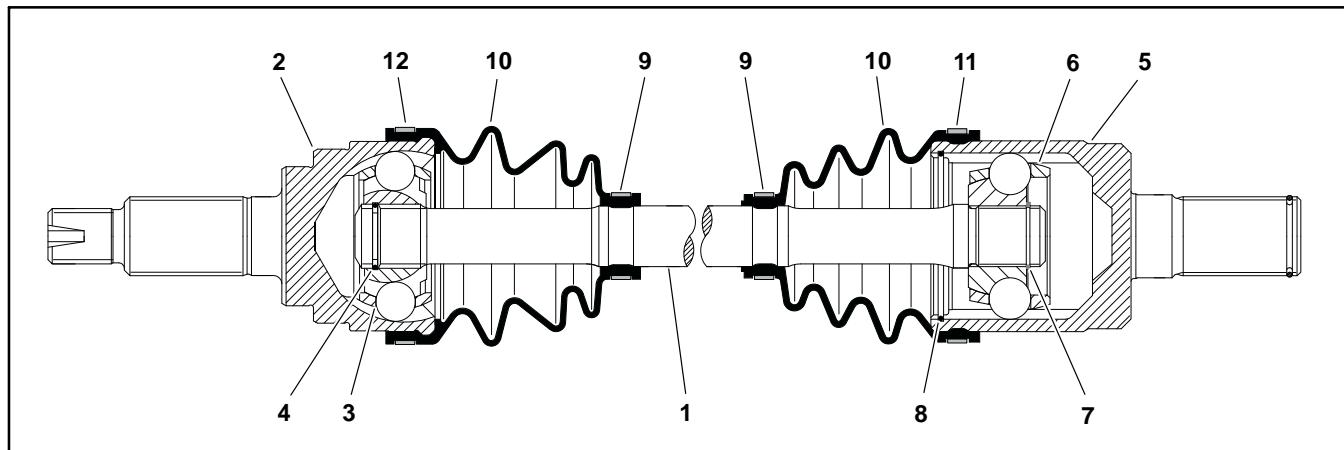


Figure 40

- | | | |
|---------------------------|--------------------------|---------------------------------|
| 1. Center shaft | 5. Inboard joint housing | 9. Boot clamp - small (2) |
| 2. Outboard joint housing | 6. Inboard CV joint | 10. Boot (2) |
| 3. Outboard CV joint | 7. Inner retaining ring | 11. Boot clamp - inboard large |
| 4. Spring clip | 8. Outer retaining ring | 12. Boot clamp - outboard large |

A torn CV axle boot is the most common cause of CV axle failures. Look for grease on front suspension components, inner tire sidewall or fender to indicate a possible torn boot. Inspect boots for cracks, holes, tears or loose clamps. Dirty grease within the boot may indicate damage to the CV axle joint. Replace the boot if it is cracked or torn, has any holes or has loose clamps.

1. Remove CV axle assembly (see CV Axle Assembly in this section).

2. Clamp the un-splined center section of the axle in a vise.

3. Cut, remove, and discard damaged boot and boot clamps.

4. Replace outboard boot as follows:

A. Use a soft brass or plastic hammer against the CV joint and carefully drive the joint from the center shaft.

B. Clean old grease from CV joint and center axle.

C. Fit small clamp and boot over center axle.

D. Fill CV joint with approximately 1.5 oz (44 ml) of Shell Gadus 1452 or equivalent low friction CV joint grease.

E. Align CV joint with center axle splines and slide against spring clip on shaft. Start the joint over the spring clip by using a small screwdriver to collapse the spring clip while pushing the joint onto the center shaft.

F. Use a soft brass or plastic hammer against the outboard joint housing and carefully drive the joint onto the center shaft until spring clip is seated.

5. Replace inboard boot as follows:

A. Remove the outer retaining ring and pull the joint housing from the CV joint.

B. Remove the inner retaining ring and pull the CV joint from the center axle.

C. Clean old grease from CV joint, center axle and joint housing.

D. Fit small clamp and boot over center axle.

E. Align CV joint with center axle splines and install joint onto center axle. Install inner retaining ring.

F. Fill CV joint with approximately 1 oz (30 ml) of Shell Gadus 1452 or equivalent low friction CV joint grease.

G. Fit CV joint into joint housing and install outer retaining ring.

6. Fill boot with approximately 1.5 oz (44 ml) of Shell Gadus 1452 or equivalent low friction CV joint grease.

7. Fit boot over grooves in center shaft and joint housing. Secure boot with clamps.

8. Install CV axle assembly (see CV Axle Assembly in this section).

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Rear Driveshaft

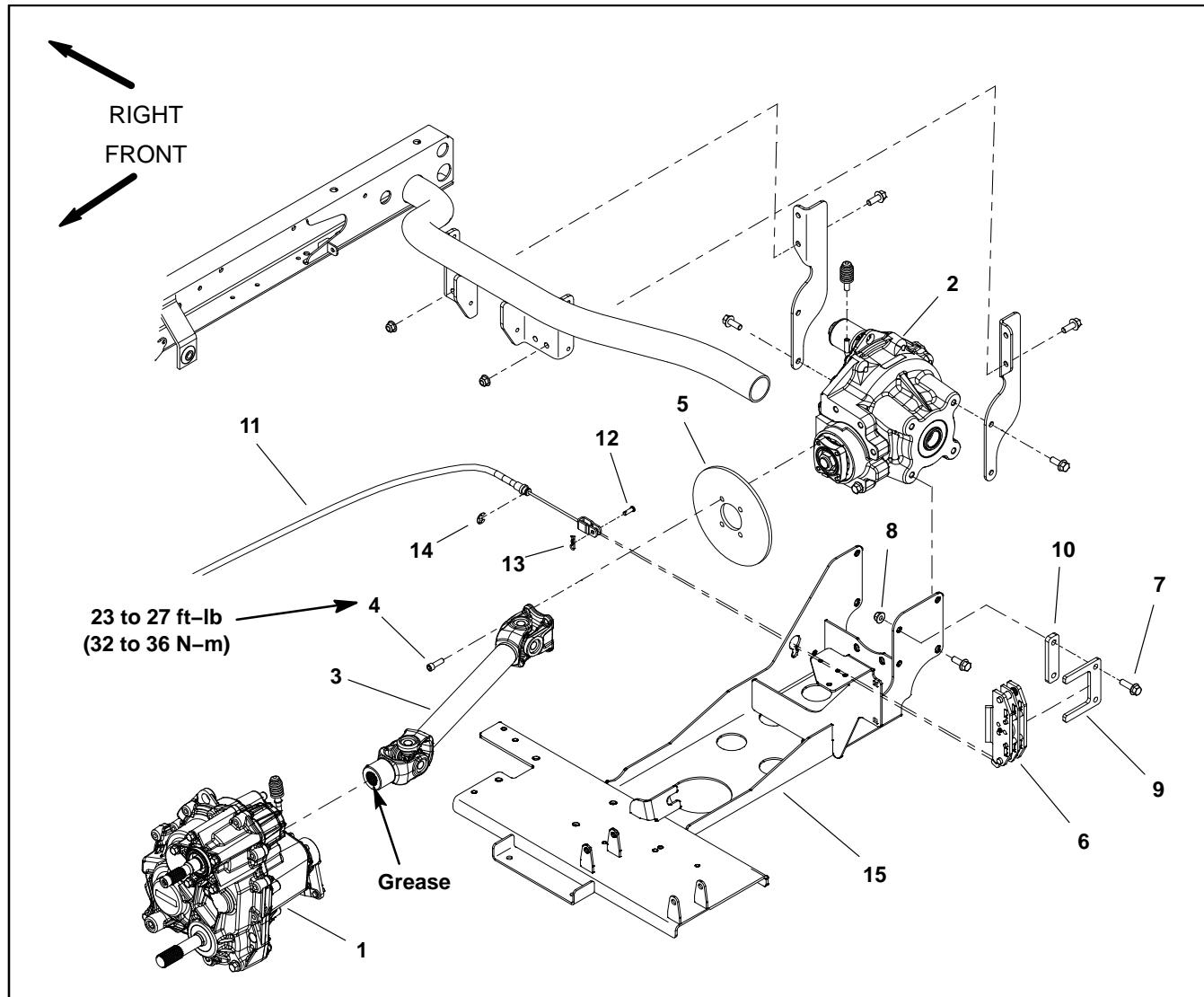


Figure 41

- | | | |
|--------------------------|--------------------------|-------------------------------|
| 1. Transmission | 6. Parking brake caliper | 11. Parking brake cable |
| 2. Rear differential | 7. Flange head screw (2) | 12. Clevis pin |
| 3. Rear driveshaft | 8. Lock nut (2) | 13. Hair pin |
| 4. Socket head screw (4) | 9. Brake mount plate | 14. Retaining ring |
| 5. Parking brake rotor | 10. Spacer | 15. Engine/transmission mount |

Removal (Fig. 41)

1. Park vehicle on a level surface, raise and support vehicle cargo bed (if installed), shut engine off and engage the parking brake. Remove key from the ignition switch.
2. Support driveshaft to prevent it from shifting or falling.
3. Loosen and remove four (4) socket head screws that secure driveshaft and parking brake rotor to rear differential input shaft (Fig. 42). The center of the parking brake rotor is fitted to shoulder on differential input shaft and, with parking brake applied, the rotor can remain in place during driveshaft removal.
4. Move driveshaft flange yoke away from differential input shaft and slide driveshaft slip yoke from transmission output shaft. Remove driveshaft from vehicle.

Installation (Fig. 41)

1. Apply grease to splined shaft of transmission.
2. Make sure that mounting holes in parking brake rotor and differential input shaft are aligned.
3. Make sure that flange of driveshaft is thoroughly cleaned before installation. Also, clean rotor thoroughly at driveshaft flange mounting location.
4. Slide driveshaft yoke onto transmission shaft. Align driveshaft flange yoke to parking brake rotor and differential input shaft.
5. Secure driveshaft and parking brake rotor to rear differential with four (4) socket head screws. Torque screws from **23 to 27 ft-lb (32 to 36 N·m)**.
6. Lubricate driveshaft grease fittings.
7. Check that parking brake requires a force of 45 to 50 lb (20 to 22 kg) to actuate the brake lever. If necessary, adjust parking brake lever (see Parking Brake in the Adjustments section of Chapter 5 – Chassis).
8. Remove bed support from cargo bed lift cylinder and lower bed.

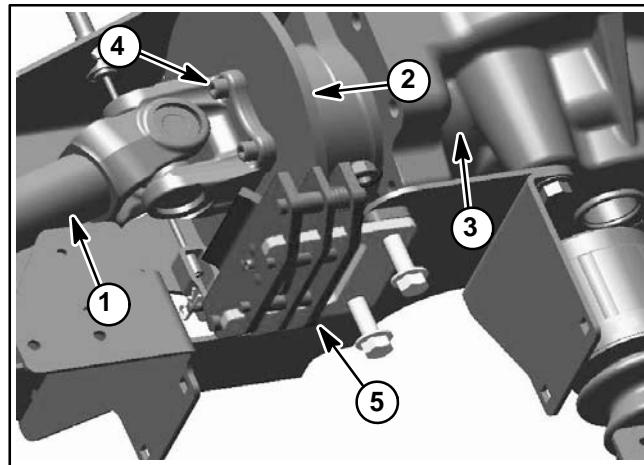


Figure 42

1. Driveshaft
2. Parking brake rotor
3. Rear differential
4. Socket screw (4)
5. Parking brake caliper

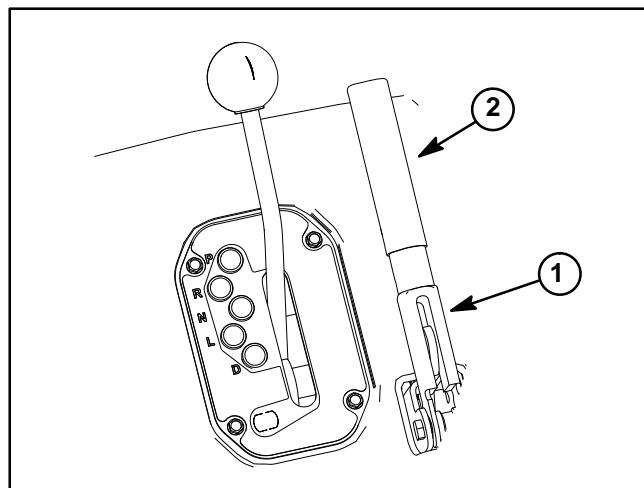


Figure 43

1. Parking brake lever
2. Brake handle

Rear Driveshaft Cross and Bearing Service

1. Remove driveshaft from vehicle (see Rear Driveshaft in this section).

IMPORTANT: When placing yoke in vise, clamp lightly on the solid part of the yoke to prevent yoke damage. Also, the use of a vise with soft jaws is recommended.

2. Lightly clamp yoke in vise. Remove snap rings that secure bearings at the inside of each yoke. Remove yoke from vise.

IMPORTANT: Yokes must be supported when removing and installing bearings to prevent damage.

3. Use a press to remove cross and bearings from yokes:

- A. Place a small socket against one bearing and a large socket against the yoke on the opposite side.
- B. While supporting the large socket, apply pressure on small socket to partially push the opposite bearing into the large socket.
- C. Remove yoke from press, grasp partially removed bearing and tap on yoke to completely remove the bearing.
- D. Repeat process for remaining bearings.
- E. Thoroughly clean and inspect all components.

4. To install new cross and bearings:

- A. Apply a coating of grease to bearing bores of end yoke (slip yoke or flange yoke) and driveshaft yoke. Also, apply grease to bearings and seal of bearing assembly. Make sure that all bearing rollers are properly seated in bearing cage.
- B. Press one bearing partially into yoke.
- C. Carefully insert cross into bearing and yoke.
- D. Hold cross in alignment and press bearing in until it hits the yoke.
- E. Carefully place second bearing into yoke bore and onto cross shaft. Press bearing into yoke.
- F. Install snap rings into yokes to secure bearings in place. Make sure that snap rings are fully seated in grooves in yokes.

- G. Repeat procedure for remaining yoke.

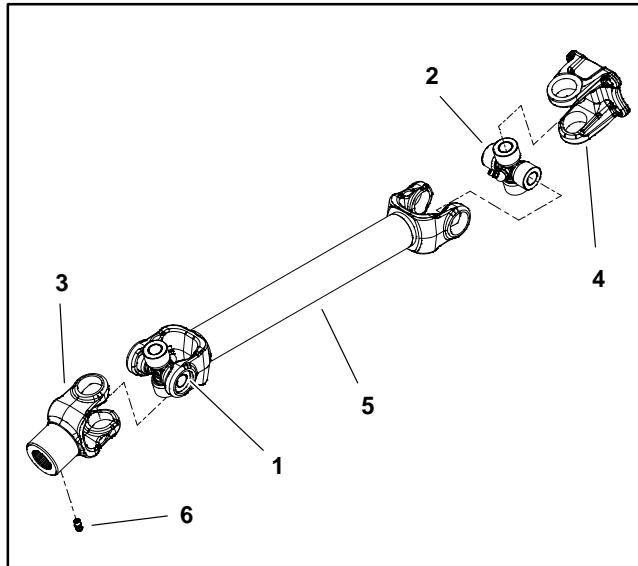


Figure 44

- | | |
|-----------------------|-------------------|
| 1. Snap ring | 4. Flange yoke |
| 2. Cross and bearings | 5. Driveshaft |
| 3. Slip yoke | 6. Grease fitting |

5. Lubricate grease fittings until grease purges from bearing cups. Make sure to grease all cross fittings.
6. 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.
7. Install driveshaft to vehicle (see Rear Driveshaft in this section).

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Rear Differential

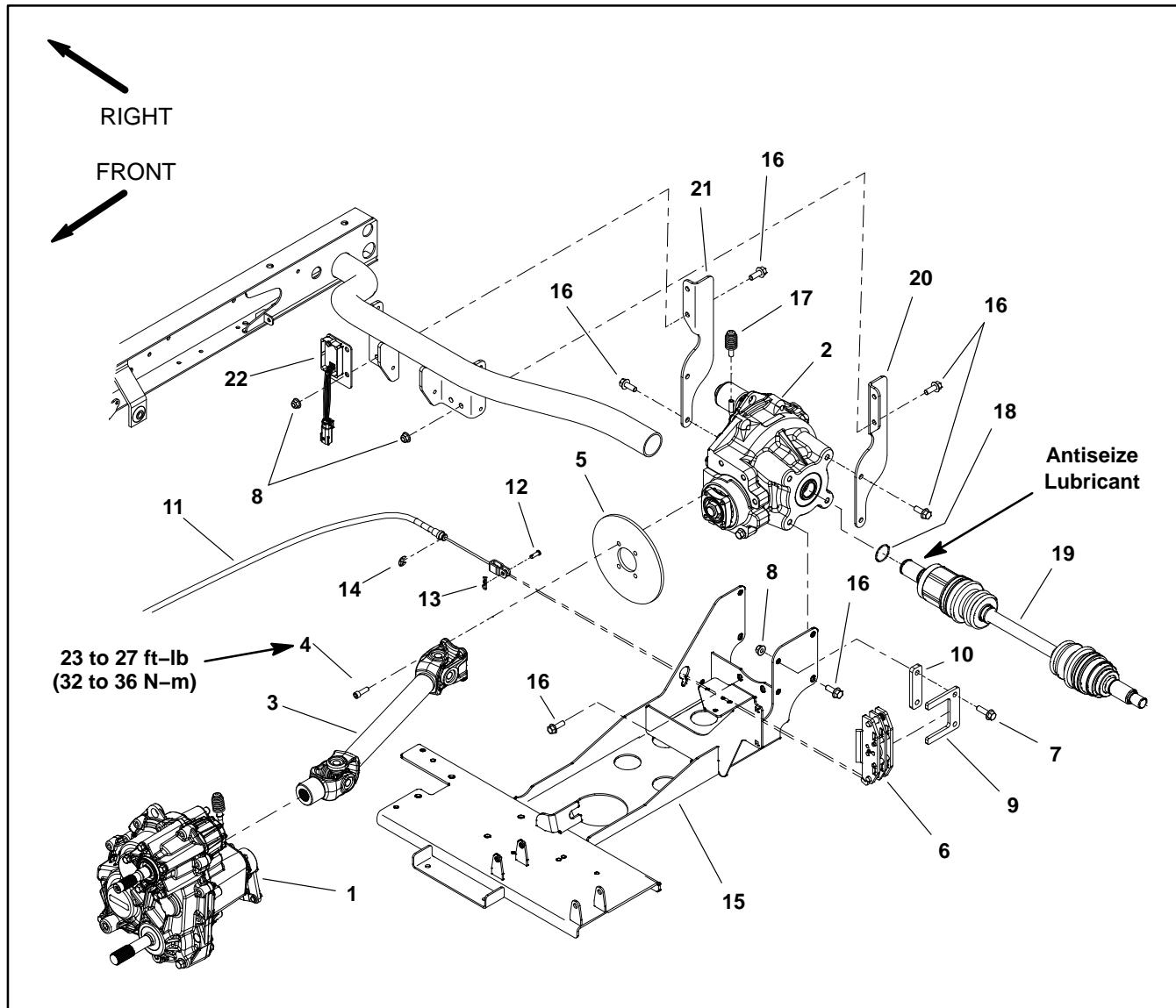


Figure 45

- | | | |
|--------------------------|-------------------------------|----------------------------------|
| 1. Transmission | 9. Brake mount plate | 16. Flange head screw (14) |
| 2. Rear differential | 10. Spacer | 17. Breather |
| 3. Rear driveshaft | 11. Parking brake cable | 18. O-ring (2) |
| 4. Socket head screw (4) | 12. Clevis pin | 19. CV axle (2) |
| 5. Parking brake rotor | 13. Hair pin | 20. LH rear differential mount |
| 6. Parking brake caliper | 14. Retaining ring | 21. RH rear differential mount |
| 7. Flange head screw (2) | 15. Engine/transmission mount | 22. Solenoid controller assembly |
| 8. Lock nut (6) | | |



CAUTION

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

Removal (Fig. 45)

- Park vehicle on a level surface, raise and support vehicle cargo bed (if installed), shut engine off and engage the parking brake. Remove key from the ignition switch.
- If rear differential is to be disassembled, drain lubricant from rear differential.
- Jack up and support rear of vehicle (see Jacking Vehicle in the Safety Instructions section of Chapter 1 – Safety). Once the machine is raised, support rear of engine/transmission mount to prevent it from moving or shifting during rear differential removal.
- Remove parking brake caliper, driveshaft and parking brake rotor from rear differential (see Parking Brake Caliper in the Service and Repairs section of Chapter 5 – Chassis). Position and support disconnected rear driveshaft away from rear differential.
- Disconnect wire harness connector from rear differential lock solenoid on right side of differential.
- Remove rear wheel assembly, brake caliper and brake rotor from both sides of machine (see Brake System in the Service and Repairs section of Chapter 5 – Chassis).
- Remove both CV axle assemblies from machine:
 - Using wheel hub hole to access flange head screws, remove screws that secure wheel hub assembly to rear axle (Fig. 46). It is not necessary to remove wheel hub assembly from CV axle so spindle nut does not have to be loosened.

IMPORTANT: Make sure to not damage the oil seal on the rear differential with the pry bars when removing the CV axle assemblies.

 - Use two small pry bars (180° apart) to carefully leverage the CV axle out of the differential. Use even pressure on both pry bars (Fig. 47).
 - Carefully pull wheel hub assembly with attached CV axle through opening in rear axle and remove from vehicle.
 - Repeat procedure for second CV axle assembly.

IMPORTANT: Before loosening fasteners that secure rear differential, support differential to prevent it from falling during removal.

- Remove fasteners that secure the LH and RH rear mounts to machine frame and rear differential. Remove rear mounts. For assembly purposes, note that solenoid controller assembly (item 22) is secured to the machine frame with fasteners for the RH rear mount.
- On the front of the rear differential, remove two (2) flange head screws that secure the differential to the engine/transmission mount.
- On the sides of the rear differential, remove flange head screws that secure the differential to the engine/transmission mount.

IMPORTANT: Weight of rear differential is approximately 46 pounds (21 kg). Take care when removing the differential from machine.

- Carefully lower rear differential from machine and remove toward the rear of the machine.

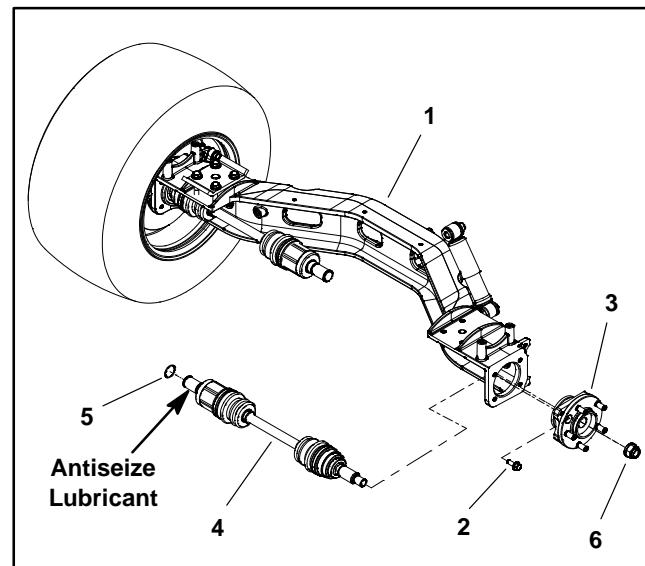


Figure 46

- | | |
|-----------------------|---------------------|
| 1. Rear axle | 4. CV axle assembly |
| 2. Flange screw (4) | 5. O-ring |
| 3. Wheel hub assembly | 6. Spindle nut |

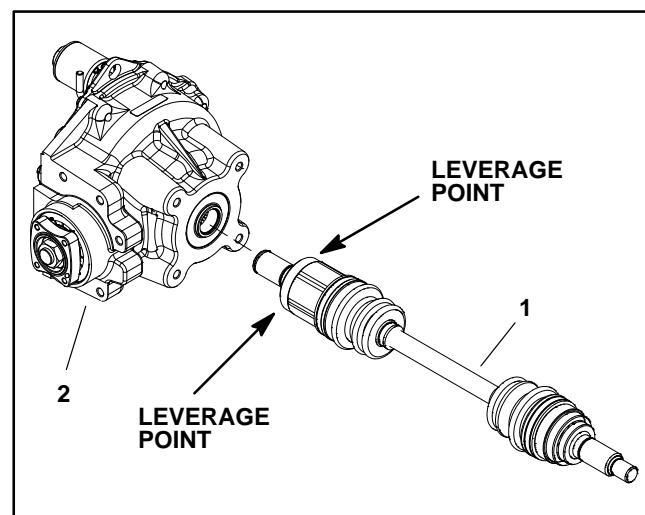


Figure 47

- | | |
|-----------------------|--------------------------|
| 1. CV axle (LH shown) | 2. Differential assembly |
|-----------------------|--------------------------|

Installation (Fig. 45)

1. Carefully raise rear differential into machine from the rear of the machine. Support differential in position to prevent it from shifting or falling.

NOTE: When securing the rear differential to the machine, loosely install all fasteners before fully tightening any of the fasteners.

2. On the sides of the rear differential, install flange head screws that secure the differential to the engine/transmission mount.
3. On the front of the rear differential, install two (2) flange head screws that secure the differential to the engine/transmission mount.
4. Position LH and RH rear mounts to machine frame and rear differential and install removed fasteners to secure the mounts. Make sure that solenoid controller assembly (item 22) is secured to the machine frame with fasteners for the RH rear mount.
5. Tighten all fasteners to secure rear differential to machine.
6. Install both CV axle assemblies with attached wheel hubs to machine (see Rear CV (Constant Velocity) Axles in this section). Make sure that flange head screws that secure wheel hub to rear axle are torqued from **35 to 40 ft-lb (48 to 55 N-m)**.
7. Install rear brake rotor, brake caliper and wheel assembly to both sides of machine (see Brake System in the Service and Repairs section of Chapter 5 – Chassis).



WARNING

Failure to maintain proper wheel lug nut torque could result in failure or loss of wheel and may result in personal injury. Torque wheel lug nuts from 80 to 90 ft-lb (109 to 122 N-m).

8. Make sure that rear wheel lug nuts are properly tightened.
9. Connect wire harness connector to rear differential lock solenoid on right side of differential.
10. Install parking brake rotor, rear driveshaft and parking brake caliper to rear differential (see Parking Brake Caliper in the Service and Repairs section of Chapter 5 – Chassis).
11. Make sure that all supports under the machine used for the rear differential and engine/transmission mount are removed before lowering the machine.
12. Lower rear of vehicle to ground.
13. Properly fill rear differential with 80W90 API GLI-5 lubricant. Torque drain and fill plugs from **10 to 14 ft-lb (14 to 19 N-m)**.
14. Lower cargo bed (if installed).

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Rear Differential Service

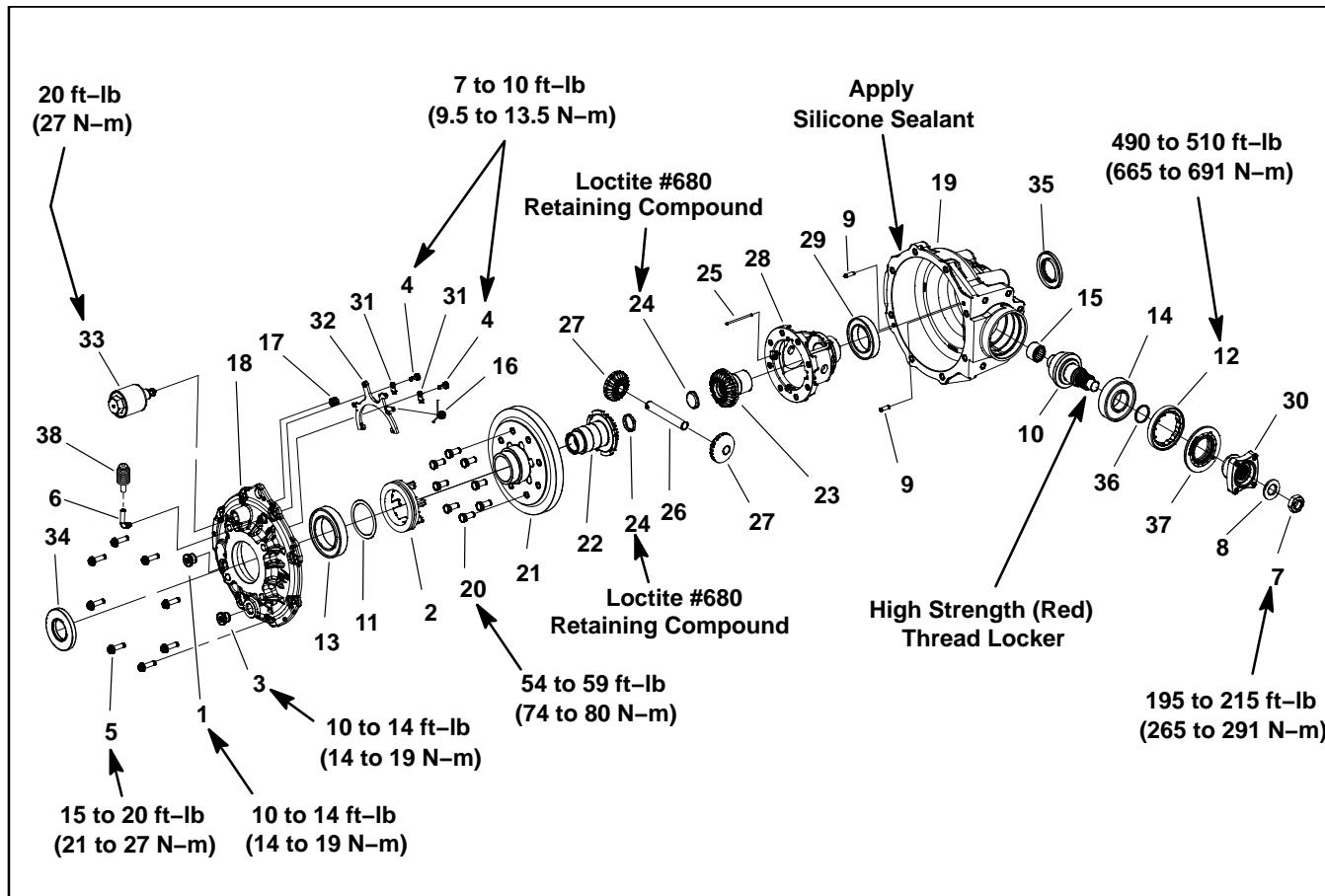


Figure 48

- | | | |
|-------------------------------|---------------------------|----------------------------------|
| 1. Fill plug | 14. Ball bearing | 27. Differential pinion gear (2) |
| 2. Engagement dog | 15. Caged needle bearing | 28. Differential housing |
| 3. Drain plug | 16. Torsion return spring | 29. Ball bearing |
| 4. Torx screw (2) | 17. Compression spring | 30. Coupler |
| 5. Flange head screw (8) | 18. Output cover | 31. Fork retainer (2) |
| 6. Vent tube | 19. Gear case | 32. Shift fork |
| 7. Hex nut | 20. Cap screw (8) | 33. Solenoid |
| 8. Lock washer set (2 halves) | 21. Spiral gear | 34. Seal |
| 9. Dowel pin (2) | 22. Output gear | 35. Seal |
| 10. Pinion gear | 23. Output gear | 36. O-ring |
| 11. Shim | 24. Expansion plug (2) | 37. Seal |
| 12. Lock collar | 25. Dowel pin | 38. Breather bellows |
| 13. Ball bearing | 26. Differential gear pin | |

Rear Differential Disassembly (Fig. 48)

1. Clean the outside of the differential assembly.
2. Remove the solenoid (item 33) from the differential cover. Then, remove compression spring (item 17) from cover.
3. Support the differential assembly with the output cover side facing up.
4. Remove the eight (8) flange head screws that secure the output cover (item 18) to the gear case.

IMPORTANT: Do not use a pry bar or screw driver on the differential output cover and gear case mating surfaces when separating the cover from the gear case. Damage to the sealing surfaces of the components may result.

5. Using pry point areas as shown in Figure 49, carefully separate the output cover from the gear case and then remove the output cover. Locate and retrieve the shim (item 11) and engagement dog (item 2).
6. For assembly purposes, note location of dowel pins (item 9) in the cases. Remove pins to prevent them from falling out unexpectedly.

7. Remove differential assembly (items 20 to 29) from the gear case.

8. Remove eight (8) cap screws that secure spiral gear (item 21) to the differential housing. Remove gear from housing.

9. Remove dowel pin (item 25) that retains differential gear pin in the differential housing. Discard the removed pin.

10. Remove differential gear pin (item 26), pinion gears (item 27) and output gear (item 23) from the differential housing. Also, remove output gear (item 22) from spiral gear.

11. Remove oil seals from output cover and gear case taking care to not damage bores in cases during seal removal. Discard removed seals.

12. If necessary, remove shift fork from cover (Fig. 50):

A. Remove Torx screws and fork retainers that secure shift fork to output cover.

B. Lift shift fork and torsion spring from cover.

IMPORTANT: Use appropriate puller or press to remove bearings from differential components. Discard all bearings that have been removed and replace with new bearings during assembly.

13. If necessary, remove bearings (item 12 and 13) from the output cover and/or differential housing. Discard bearings after removal.

14. If necessary, remove expansion plugs (item 24) from output gears.

15. If necessary, remove coupler (item 30) and seal (item 37) from pinion gear:

A. Use a suitable wrench on coupler to prevent the coupler and pinion gear from rotating. Remove hex nut (item 7) that secures coupler to pinion gear.

B. Remove lock washer set (item 8) from pinion gear (Shown in Fig. 51). For assembly purposes, note that the wider serrations on the washer halves are orientated against each other.

C. Use suitable puller to remove coupler from pinion gear.

D. Remove and discard seal from gear case taking care to not damage case bore during seal removal.

E. Remove O-ring (item 36) from pinion gear. Discard removed O-ring.

NOTE: If the pinion gear (item 10) or bearings (items 14 and 15) are worn or damaged, there probably is considerable damage to other differential components as well. Replacement of the complete rear differential assembly would be required.

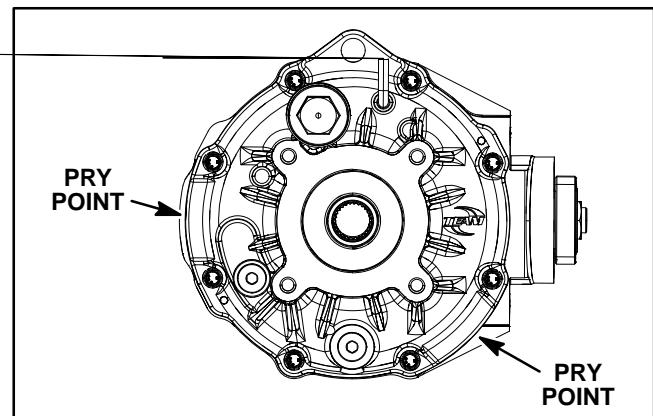


Figure 49

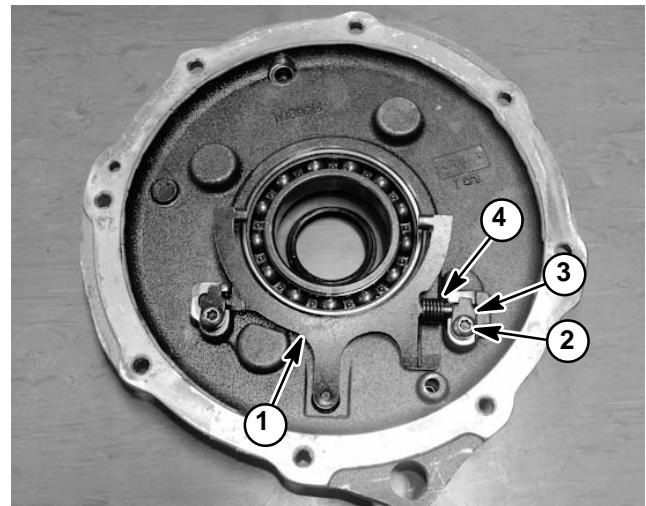


Figure 50

1. Shift fork
2. Torx screw (2)
3. Retainer (2)
4. Return spring

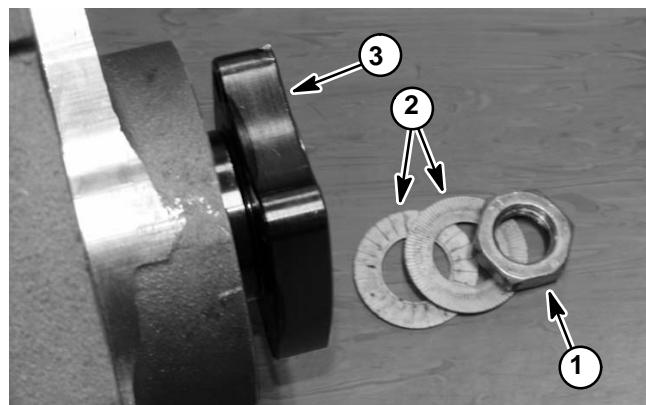


Figure 51

1. Hex nut
2. Lock washer
3. Coupler

Differential Inspection

1. Thoroughly clean and dry all internal rear differential parts.
2. Use emery cloth to remove nicks and burrs from all differential components.
3. Inspect all gear teeth for roughness, material transfer or other damage. Cracked, broken, missing or chipped gear teeth are not acceptable. Replace gears if worn or damaged.
4. Inspect splines on pinion gear (item 10) and output gears (items 22 and 23). If cracked, broken, chipped or missing splines are found, replace shaft.
5. Inspect I.D. of all gears for excessive wear or scoring. Gears should fit snugly on shafts.
6. Inspect all shaft bearing surfaces for wear or damage. Replace worn components.
7. Inspect oil seal surfaces of shafts for wear or damage and replace shafts if necessary.
8. Inspect shift fork (item 32) and engagement dog (item 2):
 - A. The shift fork should move freely in the groove of the pin clutch. The fork should also pivot easily between the output cover and fork retainers.
 - B. The engagement tabs of the shift fork should not have excessive scoring at surfaces that contact the engagement dog groove.
 - C. The tabs on the engagement dog should not be worn or damaged.
9. Inspect differential gear case for wear in the pinion shaft area. Replace the case (or complete differential assembly) if machined surfaces are scored or if the pinion shaft bearing fits loosely in the gear case bearing bore.

Rear Differential Assembly (Fig. 48)

1. Clean sealant material from differential output cover and gear case mating surfaces before differential assembly. Make sure all differential parts are clean.
2. If bearing (item 13) was removed from output cover, install new bearing into output cover bore fully to shoulder of bore. Press only on outer race of bearing during installation.
3. If bearing (item 29) was removed from differential housing, install new bearing onto housing fully to shoulder of housing. Press only on inner race of bearing during installation.

4. Make sure that expansion plugs (item 24) are secure in output gears (items 22 and 23). If new expansion plugs are being installed into gears, thoroughly clean inside of gears and apply Loctite #680 retaining compound to OD of new plug before installation. Press plugs fully to internal shoulder of output gears.
5. If removed, install seal (item 37) and coupler (item 30) onto pinion gear:
 - A. Apply grease to O-ring (item 36) and install onto pinion.
 - B. Apply multi-purpose grease to lips on new seal and area between them. Install seal into gear case taking care to not damage case bore during seal removal.
 - C. Install lock washer set (item 8) onto pinion gear (Shown in Fig. 51). Make sure that the wider serrations on the washer halves are orientated against each other.
 - D. Apply high strength thread locker (red) to threads of pinion gear.
 - E. Use a suitable wrench on coupler to prevent the coupler and pinion gear from rotating. Secure coupler to pinion gear with hex nut (item 7). Torque nut from **195 to 215 ft-lb (265 to 291 N-m)**.
6. If the shift fork (item 32) was removed from output cover, install shift fork (shown in Fig. 50):
 - A. Slide torsion spring onto shift fork peg.
 - B. Position shift fork with attached torsion spring onto output cover.
- IMPORTANT: The Torx screws (item 4) used to secure the shift fork to the output cover have a patch lock on the threads to prevent loosening of the screws. Either replace screws or apply medium strength thread locker to threads of original screws before assembly.**
- C. Secure shift fork to output cover with fork retainers and Torx screws. Fork retainers should rest flush onto cover surface. Torque screws from **7 to 10 ft-lb (9.5 to 13.5 N-m)**.
- D. After installation, make sure that shift fork pivots freely and torsion spring presses shift fork tab against solenoid hole in output cover.

7. Install all components to differential assembly (items 20 to 29):
 - A. Apply a coating of 80W90 API GLI-5 gear oil to all surfaces of pinion and output gears.
 - B. Slide output gear (item 23) into differential housing and then position both pinion (item 27) gears into housing making sure that pinion gears mesh properly with output gear.
 - C. Slide differential gear pin (item 26) into differential housing and pinion gears. Make sure that dowel pin holes in gear pin and differential housing align.
 - D. Secure differential gear pin into the differential housing with new dowel pin (item 25).
 - E. Slide output gear (item 22) into spiral gear bore.

IMPORTANT: The cap screws (item 20) used to secure the spiral gear to the differential housing have a patch lock on the threads to prevent loosening of the screws. Either replace screws or apply medium strength thread locker to threads of original screws before assembly.

- F. Position spiral gear (item 21) to the differential housing making sure that output gear meshes properly with pinion gears. Secure spiral gear with eight (8) cap screws. Torque screws in a crossing pattern from **54 to 59 ft-lb (74 to 80 N-m)**.

NOTE: To make sure that shift fork (item 32) and shim (item 11) are properly positioned, assembly of the differential is easiest if components are assembled onto the output cover.

8. Install gear case to output cover:

- A. Support output cover on work bench with the shift fork facing up.

- B. Place shim (item 11) and then engagement dog (item 2) on cover centered on bearing. Make sure that shift fork engagement tabs are positioned in engagement dog groove.
- C. Slide differential assembly onto the pins on the engagement dog. Make sure that shim, engagement dog and differential assembly stay centered over bearing in output cover.
- D. Make sure gasket sealing surfaces of output cover and gear case are thoroughly cleaned. Install both dowel pins (item 9) to the supported output cover.
- E. Apply silicone sealant to mating surfaces of output cover
- F. Lower gear case onto the output cover and align dowel pins to locate gear case.
- G. Secure output cover to gear case with eight (8) flange head screws. Torque screws from **15 to 20 ft-lb (21 to 27 N-m)**.
9. Apply multi-purpose grease to seal lips and the area between the seal lips on output shaft seals (items 34 and 35). Carefully install output shaft seals into output cover and gear case. The seals should fully seat past the chamfer on the casting.
10. By inserting a clean screwdriver into solenoid hole in output cover, make sure that shift fork pivots freely. Then, install compression spring (item 17) and solenoid (item 33) into cover. Torque solenoid to **20 ft-lb (27 N-m)**.
11. Make sure that **18.6 fluid ounces (550 milliliter)** (approximate) of new 80W90 API GLI-5 gear oil is added to rear differential before vehicle operation.
12. Install and torque fill and drain plugs from **16 to 19 ft-lb (21 to 25 N-m)**.

Transmission

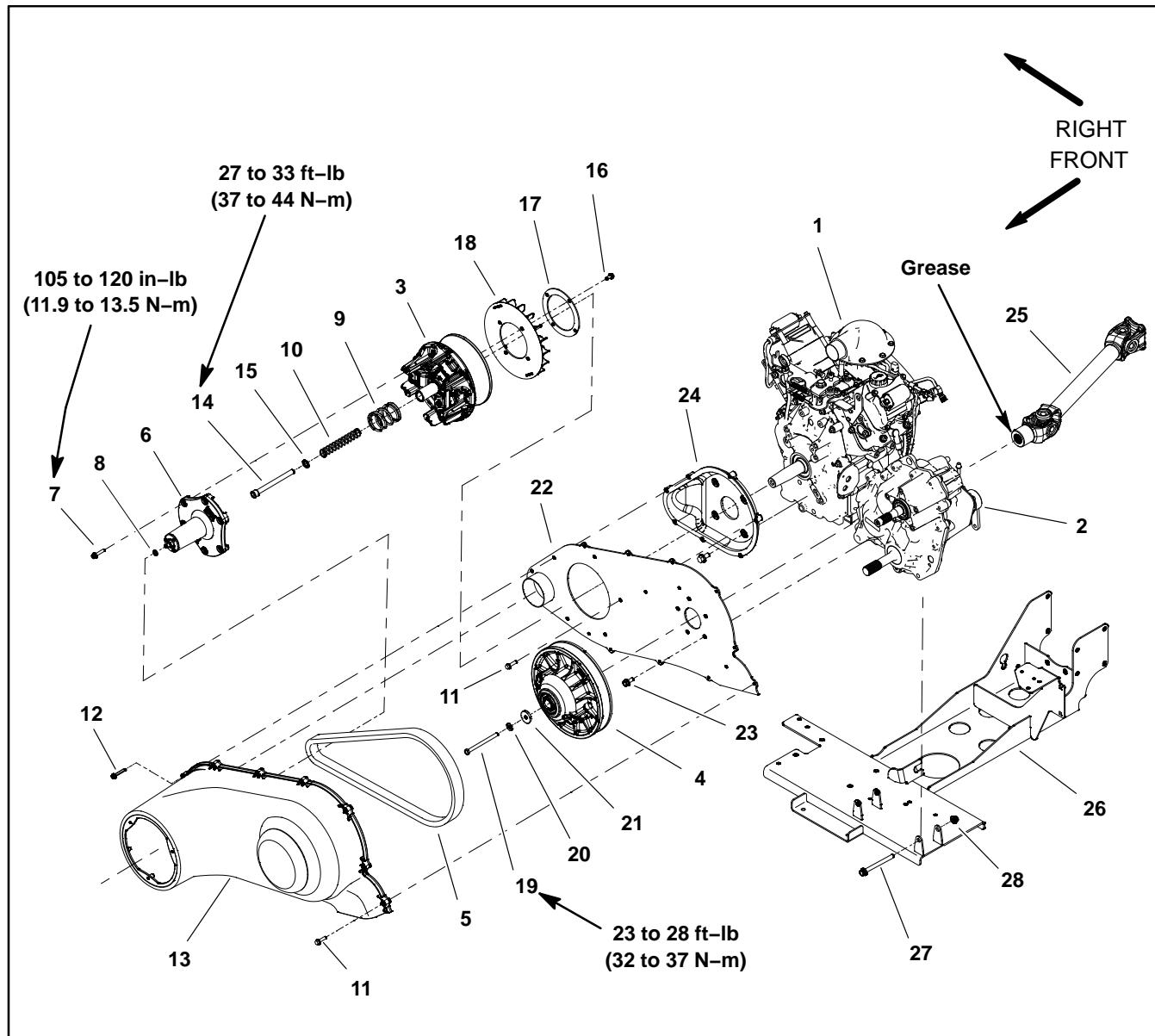


Figure 52

- | | | |
|---------------------------|----------------------------|-------------------------------|
| 1. Engine | 11. Washer head screw (14) | 20. Lock washer |
| 2. Transmission | 12. Washer head screw (2) | 21. Flat washer |
| 3. Primary clutch | 13. CTV enclosure cover | 22. Spanner plate |
| 4. Secondary clutch | 14. Socket head screw | 23. Flange head screw (5) |
| 5. CVT drive belt | 15. Washer | 24. Air inlet housing |
| 6. Speed limiter assembly | 16. Washer head screw (4) | 25. Driveshaft |
| 7. Flange head screw (6) | 17. Fan stiffener | 26. Engine/transmission mount |
| 8. Banjo washer | 18. CVT fan | 27. Flange head screw (2) |
| 9. Compression spring | 19. Cap screw | 28. Flange nut (2) |
| 10. Compression spring | | |

IMPORTANT: Proper alignment of the engine and transmission is crucial for operation of the Workman Auto drive system. Do not loosen engine if transmission is to be removed from machine. Engine location will be used to align engine and transmission during transmission installation.



CAUTION

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

Transmission Removal (Fig. 52)

1. Park vehicle on a level surface, raise and support vehicle cargo bed (if installed), shut engine off and engage the parking brake. Remove key from the ignition switch.
2. If transmission is to be disassembled, drain lubricant from transmission.
3. Remove rear driveshaft from machine (see Rear Driveshaft in this section).
4. Remove primary clutch from engine and secondary clutch from transmission (see Primary and Secondary Clutches in this section).
5. Remove spanner plate from engine and transmission (Fig. 54):
 - A. Remove five (5) washer head screws that secure spanner plate to air inlet housing on engine.
 - B. Remove five (5) flange head that secure plate to transmission.
- IMPORTANT: Do not bend or distort spanner plate during removal because it is used to ensure proper alignment of engine and transmission.**
- C. Carefully remove spanner plate from vehicle.
6. Disconnect wire harness connectors from rotary switch and speed sensor on front of transmission (Fig. 53).
7. Remove hairpin and clevis pin that secure shift cable to transmission lever. Remove shift cable clevis from lever (Fig. 53).
8. On vehicles equipped with four wheel drive kit, remove front differential driveshaft from the front of the transmission (see Differential Driveshaft in the Service and Repairs section of Chapter 8 – Four Wheel Drive Kit). Position and support driveshaft away from transmission.
9. Remove two (2) flange head screws and flange nuts that secure transmission to tabs on engine/transmission mount.

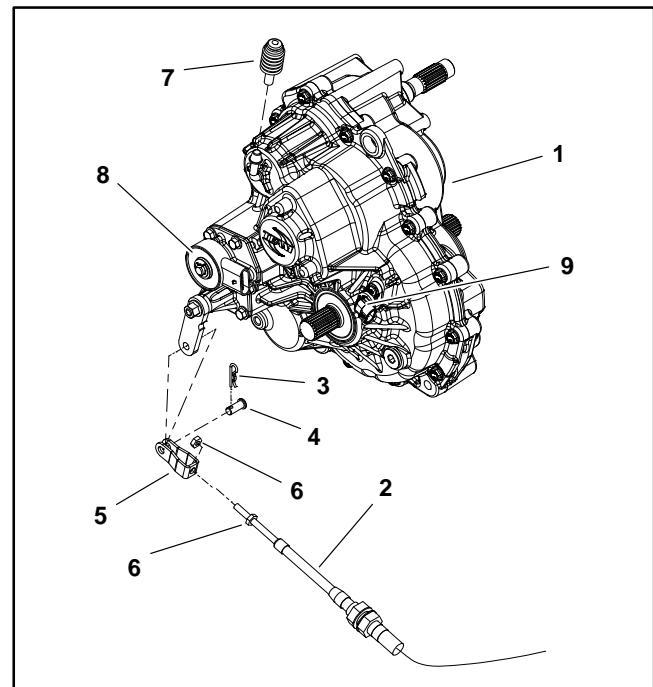


Figure 53

- | | |
|-----------------|---------------------|
| 1. Transmission | 6. Jam nut (2) |
| 2. Shift cable | 7. Breather bellows |
| 3. Hairpin | 8. Rotary switch |
| 4. Clevis pin | 9. Speed sensor |
| 5. Cable clevis | |

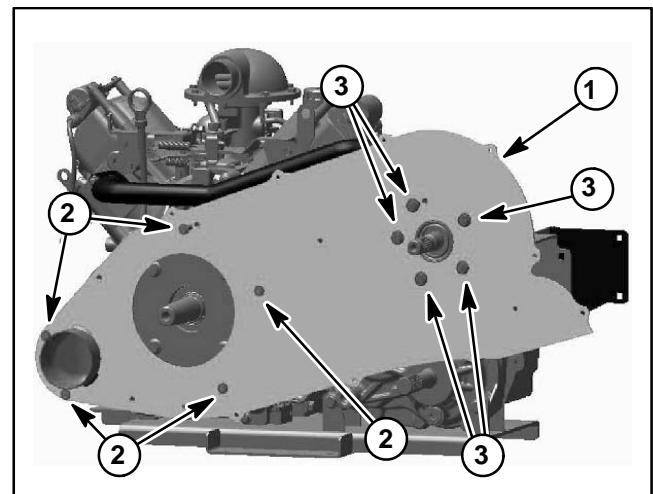


Figure 54

- | | |
|------------------|--------------|
| 1. Spanner plate | 3. Screw (5) |
| 2. Screw (5) | |

IMPORTANT: Weight of transmission is approximately 42 pounds (19 kg). Take care when removing the transmission from machine.

10. Carefully raise and rotate transmission to allow it to clear engine and tabs on engine/transmission mount. Remove transmission from vehicle.

Transmission Installation (Fig. 52)

1. Carefully lower and rotate transmission to allow it to clear engine and tabs on engine/transmission mount. Support transmission in position.
2. Loosely secure transmission to tabs on engine/transmission mount with two (2) flange head screws and flange nuts. Tighten fasteners only enough so that transmission can be moved for alignment purposes.
3. Carefully position spanner plate to air inlet housing on engine and transmission. Secure spanner plate to air inlet housing with five (5) washer head screws (Fig. 23). Do not install screws in the two (2) holes closest to the air intake end of the spanner plate. These holes will be used to secure the CVT enclosure cover.
- IMPORTANT: As the screws used to secure the spanner plate to the transmission are installed, move transmission so the mounting holes of the spanner plate align with the transmission. Be careful to prevent spanner plate distortion as screws are installed and tightened.**
4. Align the transmission to the spanner plate so that the mounting holes align. Secure spanner plate to transmission with five (5) flange head screws (Fig. 23).
5. Secure the transmission in place by fully tightening the two (2) flange nuts and flange head screws.

6. On vehicles equipped with four wheel drive kit, secure front differential driveshaft to the front of the transmission (see Differential Driveshaft in the Service and Repairs section of Chapter 8 – Four Wheel Drive Kit).
7. Install shift cable clevis to transmission lever and secure with clevis pin and hairpin (Fig. 53).
8. Connect wire harness connectors to rotary switch and speed sensor on front of transmission (Fig. 53).
9. Install primary clutch to engine and secondary clutch to transmission (see Primary and Secondary Clutches in this section).
10. Install rear driveshaft to machine (see Rear Driveshaft in this section).
11. Make sure that the transmission lever on the seat base console moves fully between all transmission positions. If necessary, adjust shift cable to allow correct lever movement (see Shift Cable Adjustment in the Adjustments section of this chapter).
12. Properly fill transmission with Dexron VI transmission fluid.
13. Lubricate grease fittings on driveshaft(s).
14. Lower cargo bed (if installed).

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Transmission Service

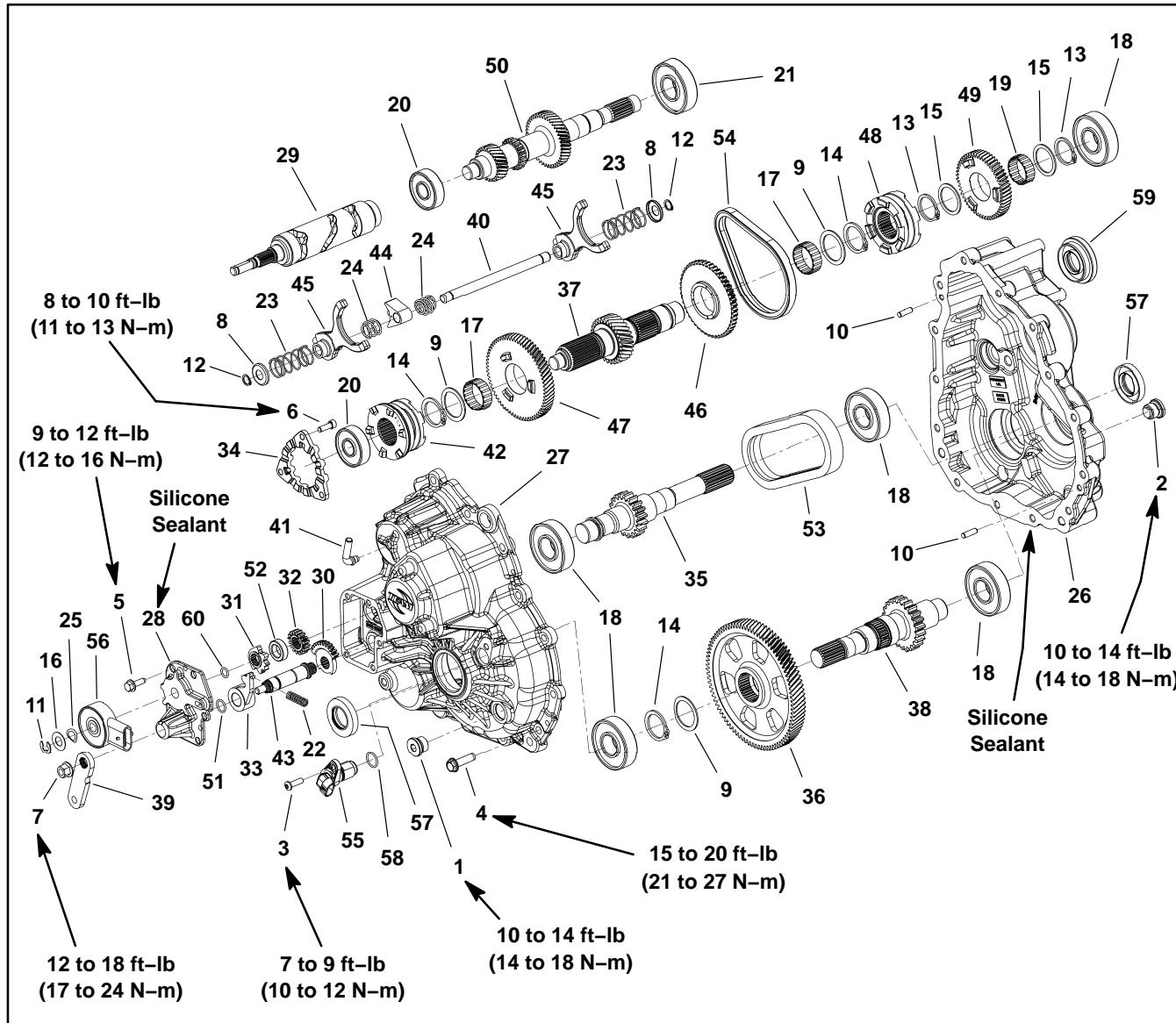


Figure 55

- | | | |
|---------------------------|----------------------------|--------------------|
| 1. Plug | 21. Ball bearing | 41. Vent tube |
| 2. Plug | 22. Compression spring | 42. Park shift dog |
| 3. Button head screw | 23. Compression spring (2) | 43. Shift shaft |
| 4. Flange head screw (14) | 24. Compression spring (2) | 44. Shift collar |
| 5. Flange head screw (5) | 25. Spring washer | 45. Shift fork (2) |
| 6. Socket head screw (3) | 26. Front gear case | 46. Sprocket (48T) |
| 7. Lock nut | 27. Rear gear case | 47. Low gear (67T) |
| 8. Cup washer (2) | 28. Sector gear cover | 48. Engagement dog |
| 9. Washer (3) | 29. Shift drum | 49. Gear (53T) |
| 10. Dowel pin (2) | 30. Sector gear (31T) | 50. Input shaft |
| 11. Snap ring | 31. Detent star | 51. O-ring |
| 12. Retaining ring (2) | 32. Sector gear (16T) | 52. Spacer |
| 13. Retaining ring (2) | 33. Detent pawl | 53. Silent chain |
| 14. Retaining ring (3) | 34. Park plate | 54. Silent chain |
| 15. Thrust washer (2) | 35. Front output shaft | 55. Speed sensor |
| 16. Thrust washer | 36. Helical gear (88T) | 56. Rotary switch |
| 17. Needle bearing (2) | 37. Reverse shaft | 57. Seal (2) |
| 18. Ball bearing (5) | 38. Rear output shaft | 58. O-ring |
| 19. Needle bearing | 39. Shift lever | 59. Seal |
| 20. Ball bearing (2) | 40. Shift shaft rail | 60. O-ring |

Transmission Disassembly (Fig. 55)

1. Clean exterior of transmission assembly.
2. Use suitable blocks to support the transmission with the rear gear case side orientated upwards.
3. Remove rotary switch (Fig. 55 item 56) from transmission:
 - A. Remove snap ring, thrust washer and spring washer that secure rotary switch to shift drum shaft.
 - B. Slide rotary switch from shift drum shaft. For assembly purposes, note alignment post on switch that locates in slot of sector gear cover (Fig. 56).
4. Remove lock nut that secures shift lever (Fig. 55 item 39) to shift shaft. Slide shift lever from shaft. Note missing tooth in shift lever for assembly purposes.
5. Remove five (5) flange head screws that secure sector gear cover (Fig. 55 item 28) to transmission. Carefully separate and remove cover from gear case taking care to not damage sealing surfaces of cover and gear case.
6. Note location of shift assembly components for assembly purposes (Fig. 57).
7. Remove shift assembly components from rear gear case noting the following for assembly purposes:
 - A. End of compression spring (Fig. 55 item 22) fits around pin on detent pawl.
 - B. Detent pawl (Fig. 55 item 33) has a recess on one face which allows the shift shaft shoulder to be fully installed into the pawl.
 - C. Shift shaft (Fig. 55 item 43) splines have a missing tooth for alignment of both shift lever (removed in step 4 above) and sector gear (Fig. 55 item 30).
 - D. Shift drum shaft splines have a missing tooth for alignment of both detent star and sector gear (Fig. 55 item 31 and 32).
 - E. To ensure alignment of shift drum and shift shaft, the shift drum sector gear (Fig. 55 item 32) has an alignment mark that should be positioned between the two (2) marks on the shift shaft sector gear (Fig. 55 item 30) (Fig. 58).

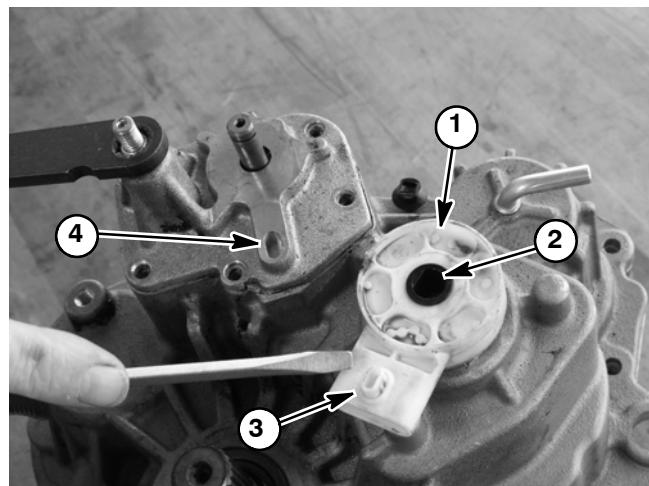


Figure 56

1. Rotary switch
2. Drum shaft
3. Switch alignment post
4. Slot in sector gear cover

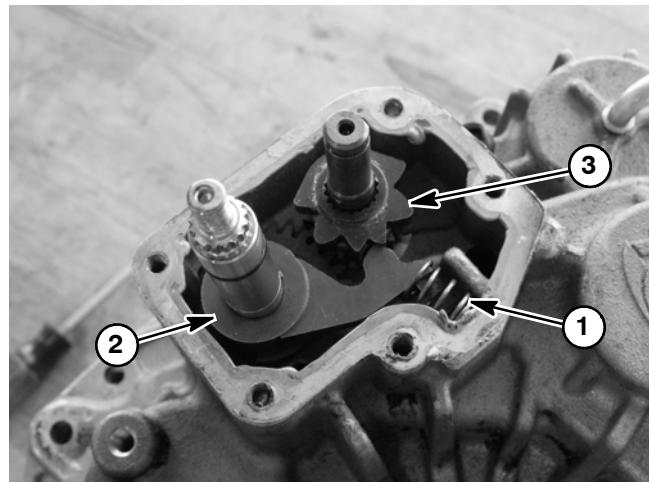


Figure 57

1. Compression spring
2. Detent pawl
3. Detent star

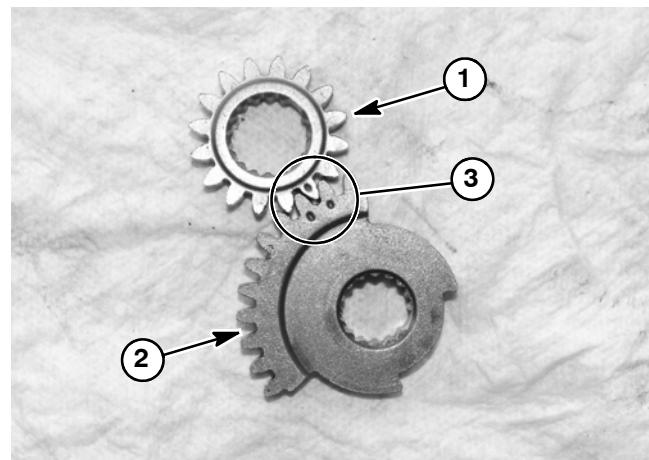


Figure 58

1. Shift drum sector gear
2. Shift shaft sector gear
3. Alignment marks

8. Remove flange head screws that secure transmission gear cases. Carefully separate and remove rear gear case taking care to not damage sealing surfaces of the gear cases (Fig. 59).

9. Note location of two (2) dowel pins (Fig. 55 item 10) and remove pins from gear case.

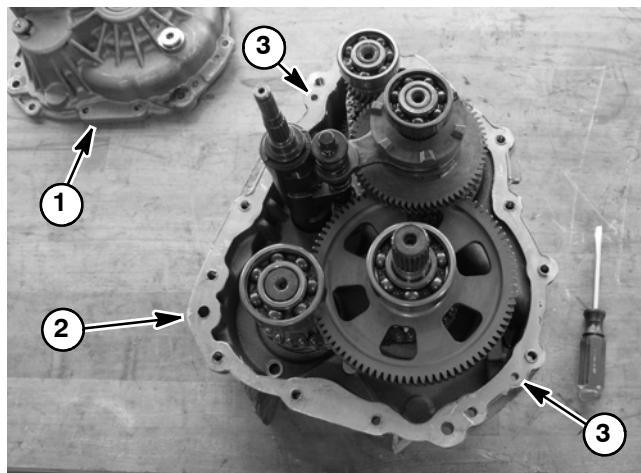


Figure 59

1. Rear gear case
2. Front gear case

3. Dowel pin location (2)

10. Carefully rotate shift drum (Fig. 55 item 29) to separate the drum from the shift fork pins. Lift shift drum from transmission. Lift shift shaft rail (Fig. 55 item 40) with attached shift forks from transmission (Fig. 60).

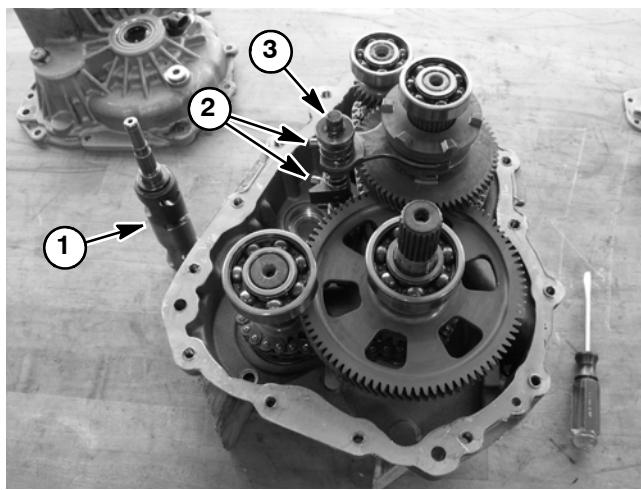


Figure 60

1. Shift drum
2. Shift fork pins

3. Shift shaft rail

11. With the help of a second person, carefully remove front and rear output shafts (items 35 and 38) along with reverse and input shafts (Fig. 55 items 37 and 50) as a complete assembly. The silent chains (Fig. 55 items 53 and 54) will keep the paired shaft assemblies together (Fig. 61 and 62).

12. Carefully remove and discard all seals from front and rear gear cases. Make sure that bores in cases are not damaged during seal removal.

13. If necessary, remove button head screw that secures speed sensor (Fig. 55 item 55) to rear gear case and slide sensor from gear case. Remove and discard O-ring from sensor.

14. Clean all sealant from mating surfaces of front gear case, rear gear case and sector gear (Fig. 55 item 26, 27 and 28).

15. Remove and discard O-rings (Fig. 55 items 60 and 51) from grooves in shift drum shaft and shift shaft.

16. Inspect park plate (item 34) that is secured to inside of rear gear case. If plate is worn or damaged, remove park plate from gear case and replace it.

17. Inspect shift drum (Fig. 55 item 29) for wear or damage to bearing surfaces and to slots for shift fork pins. Also, inspect threads and splines on shift drum shaft. Replace shift drum if worn or damaged.

18. Inspect shift forks (Fig. 55 item 45) for any evidence of wear or damage. Also, inspect shift shaft rail (Fig. 55 item 40) for evidence of bending or wear. Replace shift fork(s) or shift shaft rail if necessary.

19. Carefully inspect all transmission shaft bearings, gear teeth and shaft splines for wear or damage. If inspection identifies the need to replace any transmission shaft components, proceed as follows:

NOTE: Use a press to remove bearings from transmission shafts. Discard and replace all removed bearings.

A. Front and rear output shafts can be separated by removing the silent chain from the two (2) shafts. Once these shafts are separated, shaft components can be removed using Figure 55 as a guide.

B. To separate reverse and input shafts, the bearing, park shift dog and 67 tooth gear (Fig. 55 items 20, 42 and 47) need to be removed from the reverse shaft to provide needed clearance for removal of the silent chain from the two (2) shafts (Fig. 63). Once these shafts are separated, shaft components can be removed using Figure 55 as a guide.

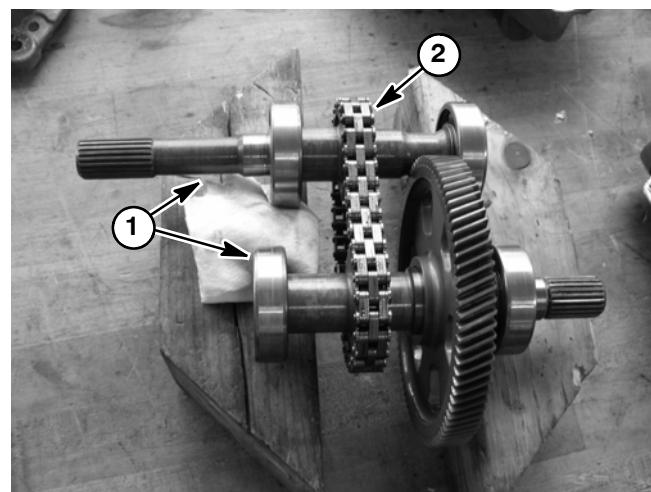


Figure 61

1. Front and rear output shaft assembly

2. Silent chain

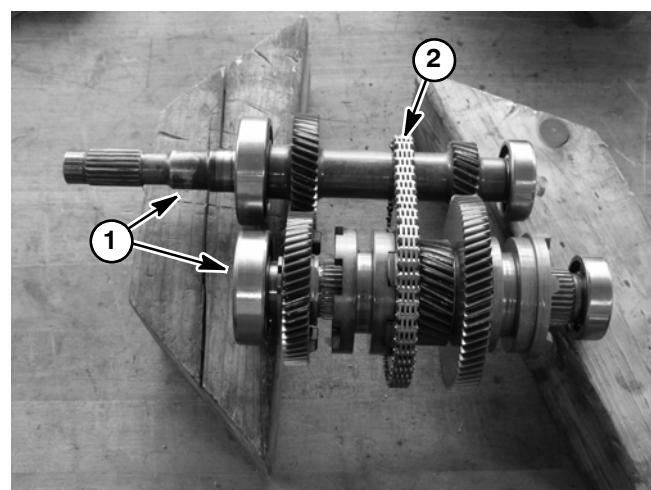


Figure 62

1. Reverse and input shaft assembly

2. Silent chain

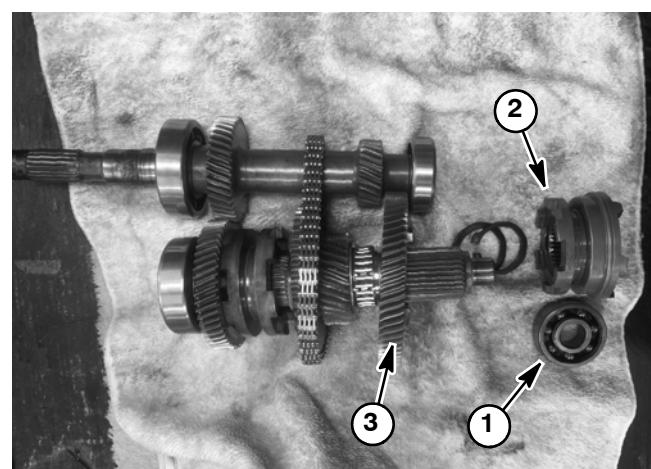


Figure 63

1. Bearing
2. Park shift dog

3. 67 tooth gear

Transmission Assembly (Fig. 55)

1. Make sure that all internal transmission components are thoroughly cleaned before transmission assembly. Lubricate all transmission components with clean Dexron VI automatic transmission fluid before installing them into the transmission.

NOTE: Use a press to install new bearings onto transmission shafts. All shaft bearings should be pressed only on the inner bearing race during installation onto the shaft. Also, make sure that bearings are pressed fully to the shaft shoulder.

2. If any of the transmission shafts were disassembled, install removed components onto the shafts in the reverse order of disassembly. During assembly, make sure that retaining rings are installed fully into the grooves of the shafts. Also, if the reverse and input shafts were separated, make sure that the silent chain is installed on these shafts before the 67 tooth gear, park shift dog and bearing are installed on the reverse shaft (Fig. 64).

3. Install new seals into transmission bores. The two (2) output shaft seals (Fig. 55 item 57) should be installed so they are flush with the cases. The input shaft seal (Fig. 55 item 59) should be installed fully into the front gear case so that the seal shoulder is flush to the case. After seal installation, apply a light coating of multi-purpose lithium grease onto seal lips and the area between the seal lips.

4. Use suitable blocks to support the front gear case for transmission assembly.

5. Position the front and rear output shaft assembly (Fig. 55 items 35 and 38) to the reverse and input shaft assembly (Fig. 55 items 37 and 50). Make sure that gears on rear output and reverse shafts are properly meshed.

6. With the help of a second person, carefully install front and rear output shafts (Fig. 55 items 35 and 38) along with reverse and input shafts (Fig. 55 items 37 and 50) as a complete assembly into the front gear case. During installation, take care to not damage seals in gear case. After installation, make sure that shafts rotate without binding (Fig. 65).

7. Install shift shaft rail (Fig. 55 item 40) with attached shift forks into transmission. Make sure that shift forks are properly placed in grooves on park shift and engagement dogs (Fig. 55 items 42 and 48) on reverse shaft (Fig. 66).

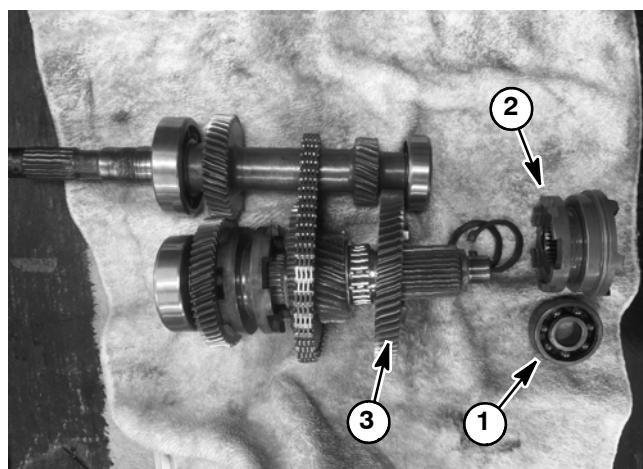


Figure 64

- 1. Bearing
- 2. Park shift dog
- 3. 67 tooth gear

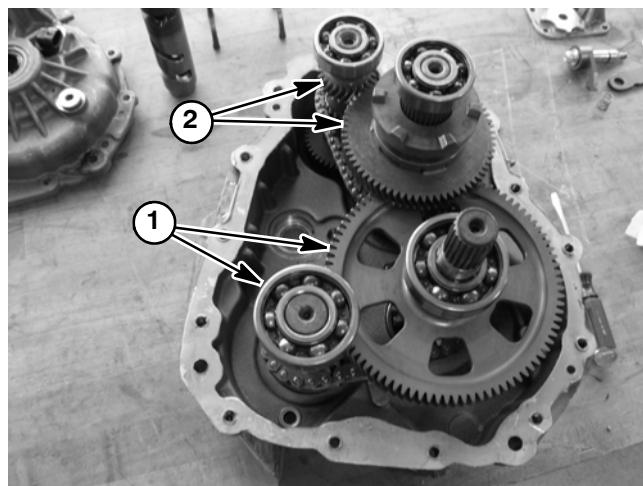


Figure 65

- 1. Front and rear output shaft assembly
- 2. Reverse and input shaft assembly

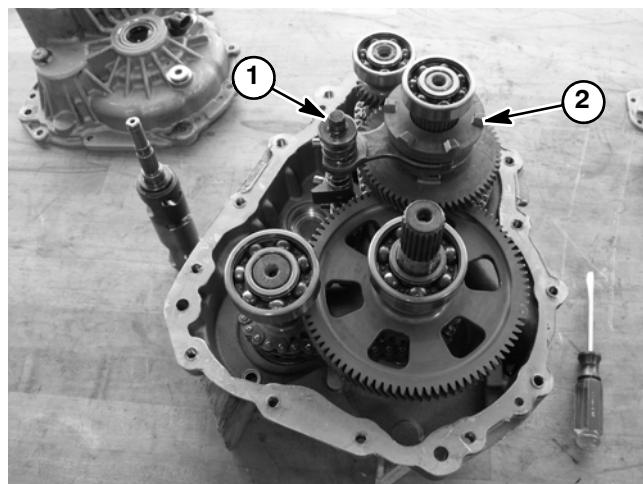


Figure 66

- 1. Shift shaft rail
- 2. Reverse shaft

8. Carefully lower shift drum (Fig. 55 item 29) into transmission while engaging the drum slots to the shift fork pins (Fig. 67).

9. Make sure that mating surfaces of front and rear gear case are clean. Apply silicone sealant to mating surface of front gear case.

10. Install two (2) dowel pins (Fig. 55 item 10) into gear case locations.

11. Carefully install rear gear case taking care to not damage seal in gear case.

12. Secure transmission gear cases with flange head screws. Tighten screws in three (3) steps in a crossing pattern from **15 to 20 ft-lb (21 to 27 N-m)**. Make sure that there is no shaft binding after assembly.

13. Apply a light coating of multi-purpose lithium grease onto new O-ring (Fig. 55 item 60) for shift drum shaft. Install lubricated O-ring into shaft groove.

14. Install shift components into rear gear case:

A. Noting location of missing tooth, slide sector gear (Fig. 55 item 32) onto shift drum shaft. If necessary, rotate shift drum so that the sector gear identification mark is toward the location of the shift shaft (Fig. 55 item 43).

B. Noting location of missing tooth, slide sector gear (Fig. 55 item 30) onto lower end of shift shaft. Lower shaft with gear into rear case and align the identification marks on the two (2) sector gears (Fig. 68).

C. Slide spacer and then detent star (Fig. 55 item 52 and 31) onto shift drum shaft. The detent star has a missing tooth for alignment purposes.

D. Slide detent pawl (Fig. 55 item 33) onto shift shaft making sure that recess on pawl face fully engages the shift shaft shoulder.

E. Install compression spring (Fig. 55 item 22) into case recess and onto the detent pawl pin.

F. Apply a light coating of multi-purpose lithium grease onto new O-ring (Fig. 55 item 51) for shift shaft. Install lubricated O-ring into shaft groove (Fig. 69).

15. Make sure that mating surfaces of rear gear case and sector gear cover (Fig. 55 item 28) are clean. Apply silicone sealant to mating surface of rear gear case.

16. Install sector gear cover and secure with flange head screws. Tighten screws in two (2) steps in a crossing pattern and to a final torque of **9 to 12 ft-lb (12 to 16 N-m)**.

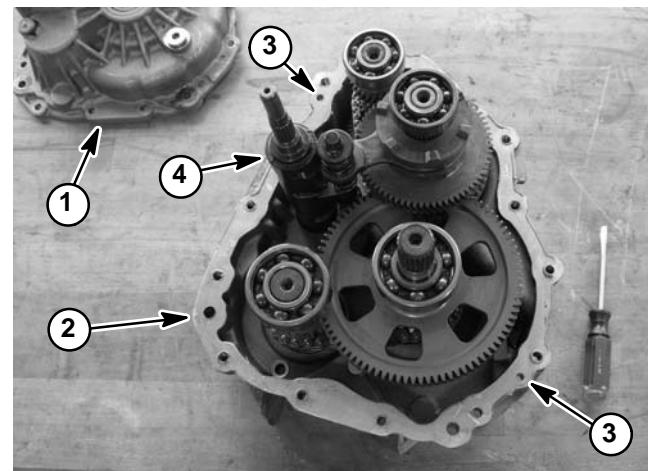


Figure 67

- 1. Rear gear case
- 2. Front gear case
- 3. Dowel pin location (2)
- 4. Shift drum

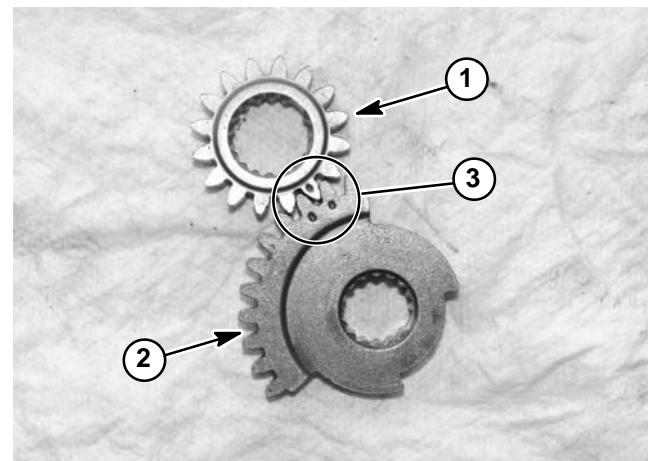


Figure 68

- 1. Shift drum sector gear
- 2. Shift shaft sector gear
- 3. Alignment marks

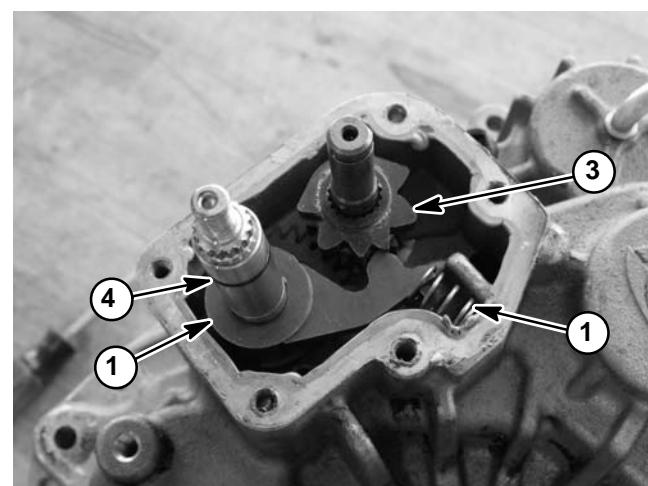


Figure 69

- 1. Compression spring
- 2. Detent pawl
- 3. Detent star
- 4. O-ring

17. Slide rotary switch (Fig. 55 item 56) onto shift drum shaft and align tab on switch with slot in sector gear cover. Secure switch with spring washer, thrust washer and snap ring.

18. Noting location of missing tooth, slide shift lever (item 39) onto shift shaft. Secure lever with lock nut. Torque lock nut from **12 to 18 ft-lb (17 to 24 N-m)**.

19. If speed sensor (Fig. 55 item 55) was removed, apply a light coating of multi-purpose lithium grease onto new O-ring (Fig. 55 item 58) and install onto sensor. Slide sensor into gear case bore and secure with button head screw. Torque screw from **7 to 9 ft-lb (10 to 12 N-m)**.



Chapter 5

Chassis

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Chassis

Specifications

Item	Specification
Front tire	20" x 9" – 12, 6 ply
Maximum front tire pressure	32 PSI (220 kPa)
Front wheel alignment	0 \pm 0.120 in. (0 \pm 3 mm)
Rear tire	24" x 12" – 12, 6 ply
Maximum rear tire pressure	18 PSI (124 kPa)
Wheel nut torque (all wheels)	80 to 90 ft-lb (109 to 122 N-m)
Brake fluid	DOT 3

General Information

Operator's Manual

The Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for your Workman vehicle. Refer to the Operator's Manual for additional information when servicing the vehicle.

Tire Pressure

1. Tire pressure should be determined by the payload carried.
 - A. The lower the tire pressure, the less the compaction and tire marks are minimized. Lower pressure should not be used for heavy payloads at higher speeds. Tire damage may result.
 - B. Higher tire pressure should be used for heavier payloads at higher speeds. Do not exceed maximum tire pressure listed in the Specifications section of this chapter.
2. If the tires are not inflated to the correct pressure, the tires will wear prematurely.
3. See Operator's Manual for additional tire pressure information.

Chassis

Special Tools

Compression Spring Tool

Use to remove and install the two (2) front suspension compression springs.

Quantity	Item
2	1/2" x 20" threaded steel rods
4	1/2" nuts
4	1/2" flat washers

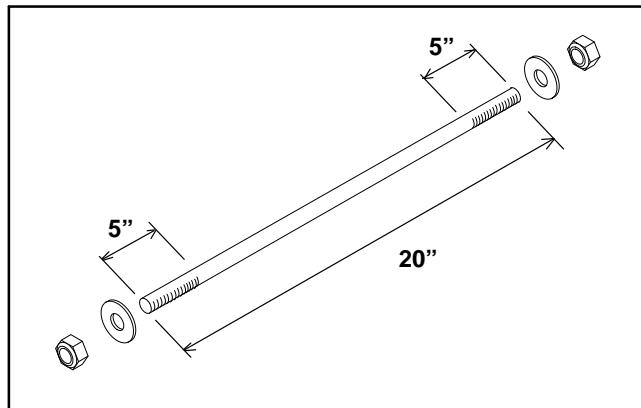


Figure 1

Troubleshooting

Suspension and Steering

Problem	Possible Causes
Excessive front end noise.	Loose or worn front wheel bearings. Worn front shock absorbers. Worn stabilizer link bushings. Loose steering components (e.g. tie rods, steering cylinder). Worn control arm bushings. Tire pressure low (4WD vehicles). Worn tires (4WD vehicles).
Excessive rear end noise.	Worn or brinelled rear wheel bearings. Worn rear shock absorbers. Worn leaf spring bushings. Rear differential or CV axle problem (see Chapter 4 – Drive Train).
Excessive steering play.	Loose or worn front wheel bearings. Loose or worn steering linkage. Worn tie rod ends.
Front wheel shimmy.	Loose or worn front wheel bearings. Tires out of round or uneven tire wear. Worn tie rod ends. Incorrect front wheel alignment (toe-in). Worn shock absorbers.
Instability (wander).	Low or uneven tire pressure. Worn or loose wheel bearings. Worn steering linkage bushings. Broken or loose rear leaf spring. Worn shock absorber(s). Incorrect front wheel alignment (toe-in). Worn or loose ball joints.

Suspension and Steering (Continued)

Problem	Possible Causes
Hard steering.	Binding or damaged steering linkage. Low or uneven tire pressure. Incorrect front wheel alignment. Binding or damaged steering cylinder. Low hydraulic pressure (see Chapter 7 – Hydraulic System). Worn or damaged steering control valve (see Chapter 7 – Hydraulic System).
Vehicle pulls to one side when not braking.	Low or uneven tire pressure. Broken or weak rear leaf spring. Incorrect front wheel alignment. Damaged or bent suspension or steering component. Worn or damaged brake components.

Brakes

Problem	Possible Causes
Brake pedal goes to floor.	Low brake fluid level. Air in brake system. Leaking wheel caliper(s). Loose or broken brake lines. Leaking or worn brake master cylinder. Worn wheel bearings. Excessively worn brake pads or rotors.
Spongy brake pedal.	Air in brake system. Excessively worn brake pads or rotors. Broken or worn brake pedal pivot bushing.
Squealing brakes.	Glazed, saturated or worn brake pads. Contaminants on brake pads and/or rotors. Scored or bent brake rotors.

Brakes (Continued)

Problem	Possible Causes
Brakes pulling.	Incorrect tire pressure. Contaminated brake pads. Incorrect front wheel alignment. Bent or damaged brake rotors. Damaged brake hoses. Parking brake caliper or cable is sticking or damaged. Unmatched tires on same axle.
Dragging brakes.	Parking brake is engaged or sticking. Improper parking brake adjustment. Weak or broken parking brake return spring. Binding brake pedal. Sticking brake caliper(s). Sticking brake master cylinder. Saturated brake pads. Scored or bent brake rotors.
Hard brake pedal.	Incorrect brake pad material. Damaged brake hoses. Brake pedal linkage is binding.
Wheel locks.	Contaminated brake pads. Loose or damaged brake pads. Wheel caliper is sticking. Sticking brake master cylinder. Wheel bearing is seized.
Brakes fade.	Overheated brake rotors. Saturated brake pads.
Brakes surge at slow speeds and chatter at fast speeds.	Warped or unevenly worn brake rotors.

Adjustments

Parking Brake Adjustment

1. Park vehicle on a level surface, shut engine off and remove key from ignition switch.
2. Remove brake lever handle from parking brake lever. Loosen set screw on end of parking brake lever knob.
3. Adjust parking brake with knob on parking brake lever until a force of 45 to 50 lb (20 to 22 kg) is required to actuate the brake lever.
4. After adjustment, tighten set screw in knob to secure parking brake adjustment and then install brake lever handle.

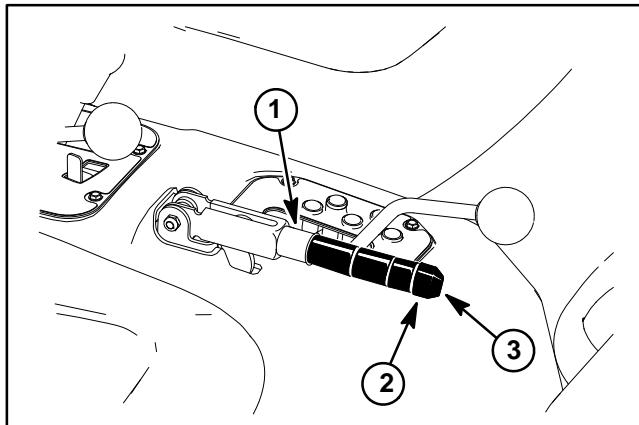


Figure 2

1. Parking brake lever
2. Knob
3. Set screw

Front Wheel Alignment

1. Rotate steering wheel to center the pitman arm with the vehicle to ensure correct front wheel alignment measurement.
2. With the pitman arm centered, measure center to center distance (at axle height) between the front wheels at both front and rear of the wheels (Fig. 3). The front and rear measurements should be equal with a tolerance of 0.120" (3 mm). Rotate tires 90° and make a second measurement.
3. If measurements determine that an adjustment is needed, loosen jam nuts on front tie rod ends and rotate tie rods equally to change wheel alignment. Torque jam nuts from **45 to 55 ft-lb (61 to 74 N·m)** after adjustment is complete.
4. After alignment has been checked and/or adjusted, check for component interference as steering wheel is turned from lock to lock. If necessary, adjust tie rods equally to center steering components and then re-check front wheel alignment.
5. Make sure that all jam nuts are properly torqued.

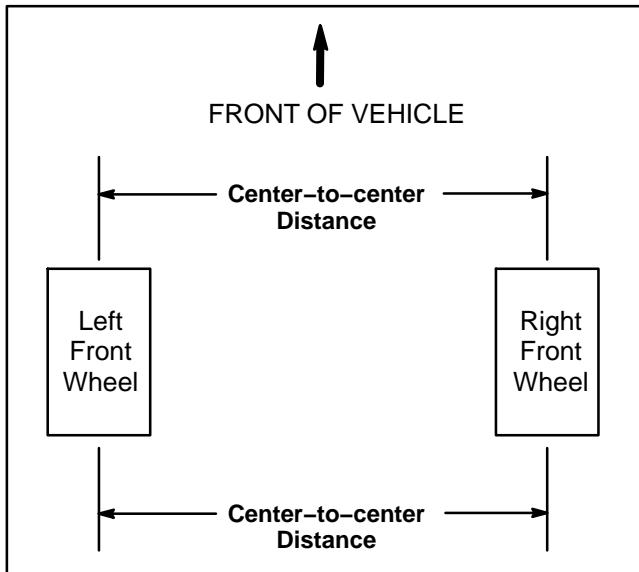


Figure 3

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Chassis

Service and Repairs

Wheel Assembly

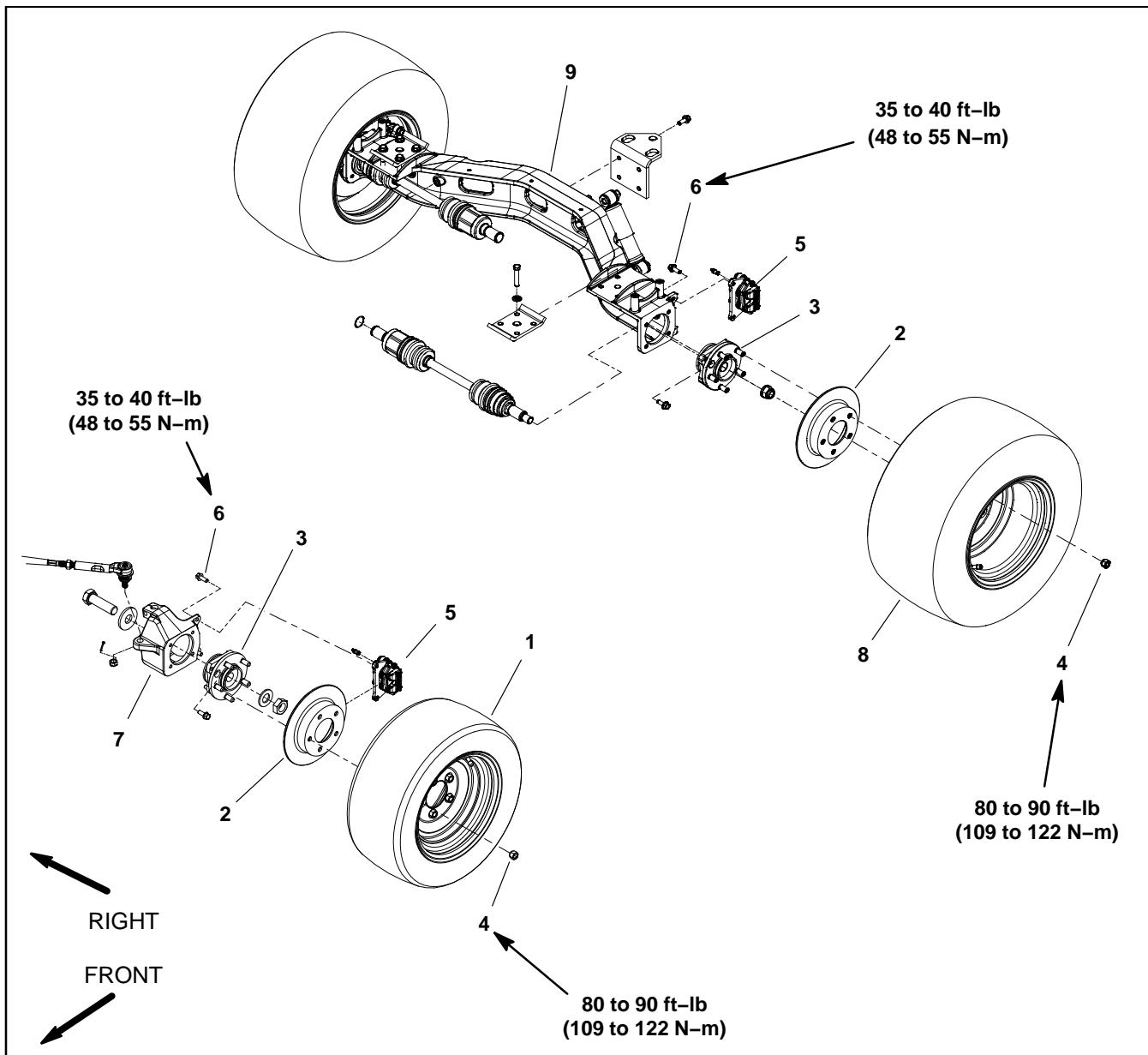


Figure 4

- | | | |
|-------------------------|--------------------------------------|-----------------------------|
| 1. Front wheel assembly | 4. Lug nut (5 per wheel) | 7. Front knuckle (LH shown) |
| 2. Brake rotor | 5. Brake caliper | 8. Rear wheel assembly |
| 3. Wheel hub assembly | 6. Flange head screw (2 per caliper) | 9. Rear axle |

Removal (Fig. 4)

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake.
2. Partially loosen wheel lug nuts that secure wheel to be removed, then jack up and support vehicle (see Jacking Vehicle in the Safety Instructions section of Chapter 1 – Safety).
3. Remove lug nuts and then remove wheel assembly from vehicle.

Installation (Fig. 4)

1. Install wheel. Secure with five (5) lug nuts.
2. Lower vehicle to ground.



WARNING

Failure to maintain proper wheel lug nut torque could result in failure or loss of wheel and may result in personal injury. Torque wheel lug nuts from 80 to 90 ft-lb (109 to 122 N-m).

3. Wheel lug nuts should be tightened in a star pattern (Fig. 5) and in two (2) steps. First, tighten all lug nuts to **40 ft-lb (55 N-m)** and then torque all lug nuts to a final torque from **80 to 90 ft-lb (109 to 122 N-m)**.

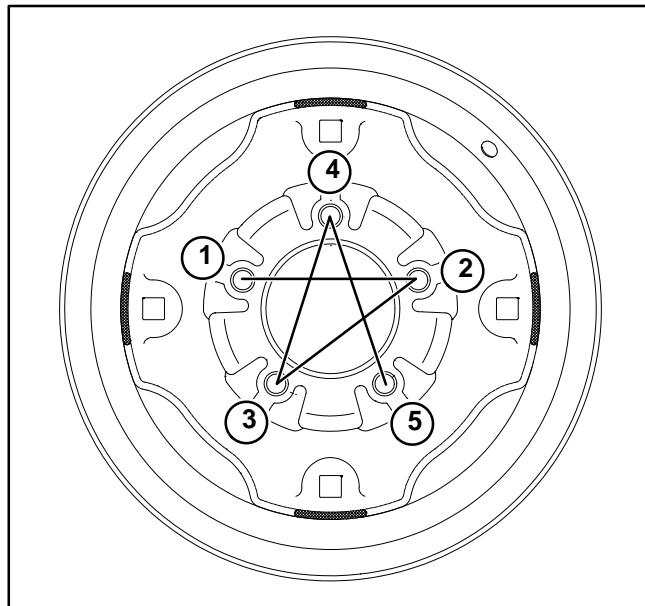


Figure 5

Brake System

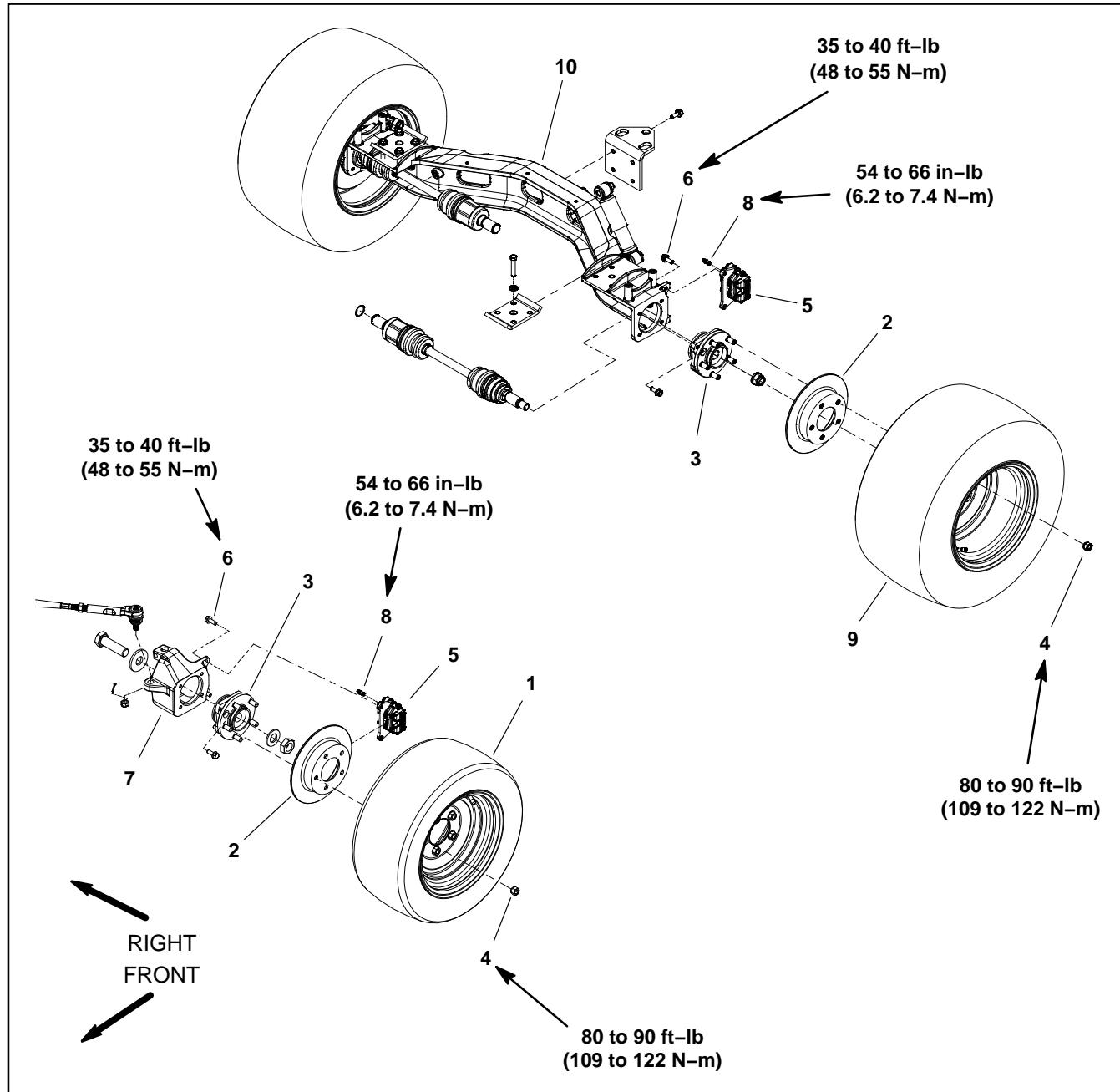


Figure 6

- | | | |
|--------------------------|--------------------------------------|------------------------|
| 1. Front wheel assembly | 5. Brake caliper | 8. Bleed screw |
| 2. Brake rotor | 6. Flange head screw (2 per caliper) | 9. Rear wheel assembly |
| 3. Wheel hub assembly | 7. Front knuckle (LH shown) | 10. Rear axle |
| 4. Lug nut (5 per wheel) | | |

Disassembly (Fig. 6)

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake.



WARNING

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

2. Chock wheels not being jacked up. For brake that is to be serviced, jack wheel off the ground and place appropriate jack stand beneath the frame to support vehicle.
3. Remove wheel from vehicle (see Wheel Assembly in this section).
4. Disconnect brake line from caliper (Fig. 7):
 - A. Clean hydraulic brake line area of brake caliper to prevent contamination.
 - B. Remove banjo bolt from caliper brake line from caliper.
 - C. Carefully separate brake line from caliper. Locate and retrieve two (2) banjo washers from sides of brake line fitting.
 - D. Plug brake line and position it away from caliper.
5. Remove two (2) flange head screws that secure the brake caliper to the machine.
6. Slide brake caliper from brake rotor and remove caliper from vehicle.

Assembly (Fig. 6)

1. Slide brake caliper onto brake rotor. Make sure that rotor is between brake pads.
2. Align caliper with mounting holes. Secure caliper with two (2) flange head screws. Torque screws from **35 to 40 ft-lb (48 to 55 N-m)**.
3. Connect brake line to caliper (Fig. 7):
 - A. Position brake line to caliper.
 - B. Place banjo washer on each side of brake line fitting.
 - C. Install banjo bolt through brake line fitting and banjo washers and then thread into caliper. Torque banjo bolt from **108 to 132 in-lb (12.3 to 14.9 N-m)**.
4. Install wheel to vehicle (see Wheel Assembly in this section).
5. Lower machine to ground.



WARNING

Failure to maintain proper wheel lug nut torque could result in failure or loss of wheel and may result in personal injury. Torque wheel lug nuts from 80 to 90 ft-lb (109 to 122 N-m).

6. Torque wheel lug nuts in a crossing pattern from **80 to 90 ft-lb (109 to 122 N-m)**.

IMPORTANT: Use DOT 3 brake fluid in the brake system.

7. Check and adjust fluid level in brake master cylinder.
8. Bleed brakes (see Bleed Brake System in this section).



CAUTION

After servicing brake system components, always check the brakes in a wide open, level area that is free of other persons and obstructions.

9. After assembly is completed, check brake operation.

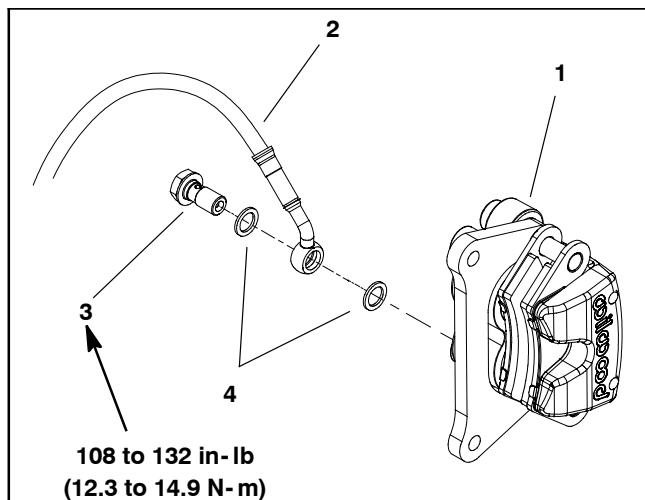


Figure 7

1. Brake caliper
2. Brake line
3. Banjo bolt
4. Banjo washer (2)

Burnish Brake Pads

After brake pad replacement, burnish (break-in) the brakes before use.

1. Bring the machine to full speed and apply the brakes to rapidly stop the machine without skidding or locking up the wheels.
2. Repeat this procedure 10 times. To avoid overheating the brakes, wait 1 minute between each stop.

Brake Caliper Service

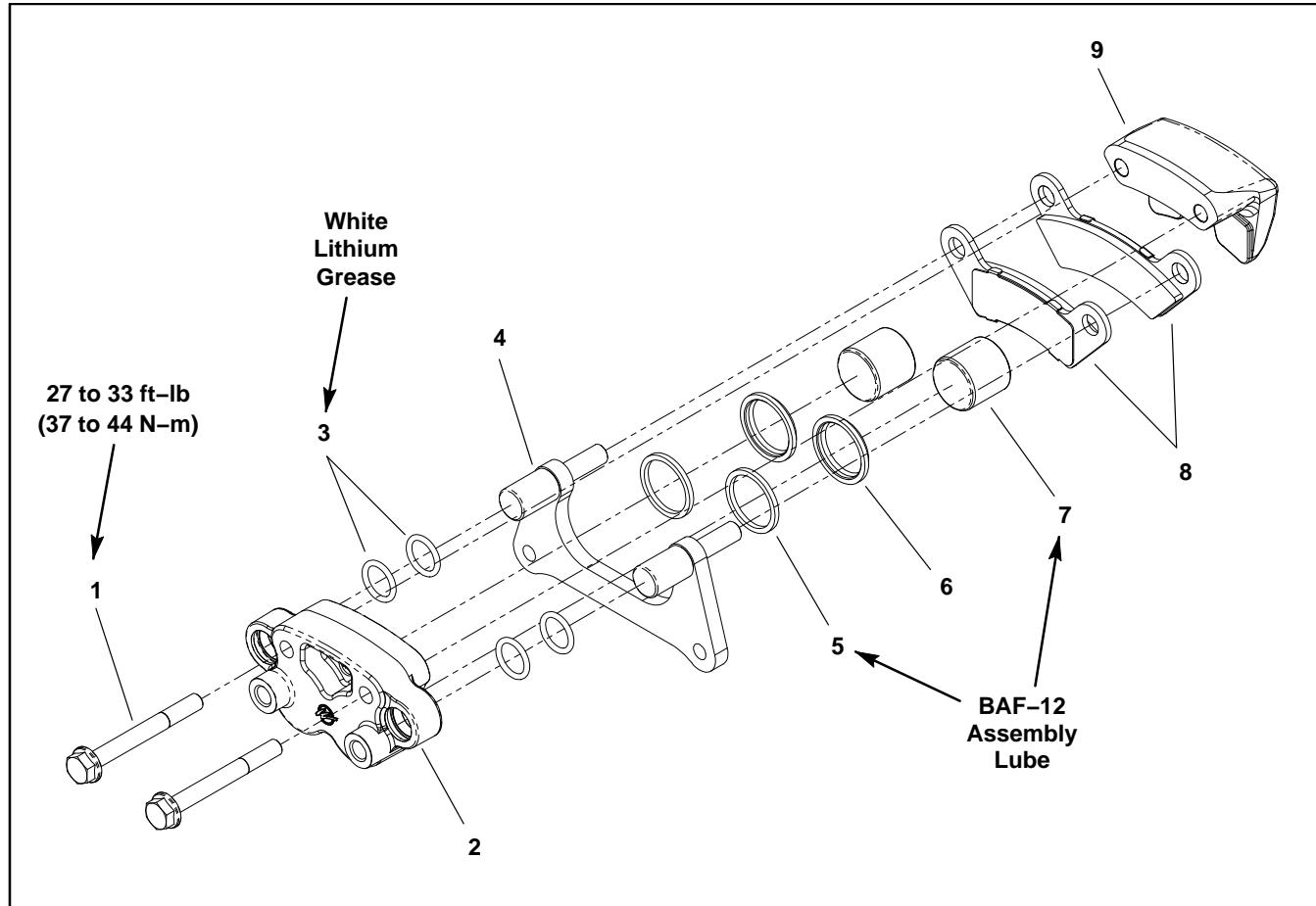


Figure 8

- | | | |
|-----------------|--------------------|------------------|
| 1. Bolt (2) | 4. Caliper bracket | 7. Piston (2) |
| 2. Caliper body | 5. Square seal (2) | 8. Brake pad (2) |
| 3. O-ring (4) | 6. Dust seal (2) | 9. Caliper anvil |

Disassembly (Fig. 8)

1. Remove two (2) bolts that secure brake caliper assembly.
2. Remove caliper anvil and then slide brake pads from pins on caliper bracket.
3. Slide caliper body assembly from caliper bracket.
4. If necessary, remove remaining components from caliper body:
 - A. Carefully remove pistons from caliper body making sure that outer surface of pistons are not damaged during removal.
 - B. Carefully, remove and discard O-rings, dust seals and square seals from caliper body. Make sure that caliper body is not damaged during removal of O-rings and seals.
5. Clean caliper components with brake cleaner.

Inspection

1. Check brake pads for uneven wear that would indicate binding in the caliper assembly. Replace the brake pads if the friction material is worn to less than 1/16" (1.6 mm). Also, if pads are contaminated with grease or oil, they must be replaced.
2. Inspect brake pistons and piston bores in caliper body for damage or wear. Replace brake pistons or complete brake caliper assembly if necessary.
3. Check that pins on caliper bracket are not worn or damaged. Wear on the pins will prevent smooth brake operation.

Assembly (Fig. 8)

1. If caliper body was disassembled, install components in caliper body:
 - A. Apply hydraulic brake cylinder assembly lube (BAF-12 or equivalent) to square seals and pistons before installation.
 - B. Fit lubricated square seals into grooves of caliper body. Make sure that seals are not twisted in groove after installation.
 - C. Install lubricated pistons into caliper body bores. Pistons should slide into bores with light resistance.
 - D. Install dust seals into caliper body.
 - E. Lubricate O-rings with white lithium grease and install into grooves in caliper body.
 - F. Slide caliper body assembly onto pins on caliper bracket.

NOTE: If brake pads are being replaced, it will be necessary to push caliper pistons back into the caliper bore before installing new pads.

2. Slide brake pads onto pins on caliper bracket. Make sure that friction material on pads is toward brake rotor position.
3. Fit caliper anvil to assembly and secure caliper components with two (2) bolts. Torque bolts from **27 to 33 ft-lb (37 to 44 N·m)**.

Chassis

Bleed Brake System

IMPORTANT: Use DOT 3 brake fluid in the brake system.

1. Remove hood to access brake master cylinder (see Hood in this section). Make sure that brake fluid level is correct.
2. Connect a suitable transparent hose to bleeder valve on left rear wheel caliper and submerge other end of hose in a clean glass container partially filled with clean brake fluid.
3. Have a second person pump brake pedal several times, then hold pedal down firmly.
4. With pedal firmly depressed, open bleeder valve of left rear brake until pedal fades to floor, then close bleeder valve.
5. Repeat procedure until a continuous flow of brake fluid, with no air bubbles, is released from bleeder valve. **Make sure fluid level is maintained in brake fluid reservoir at all times.**
6. Torque bleeder valve from **54 to 66 in-lb (6.2 to 7.4 N-m)**.
7. Complete steps 2 through 6 for right rear, left front and then right front brake calipers.
8. Install hood (see Hood in this section).



9. After bleeding of brakes is completed, test vehicle to make sure brakes are operating correctly and brake pedal is solid.

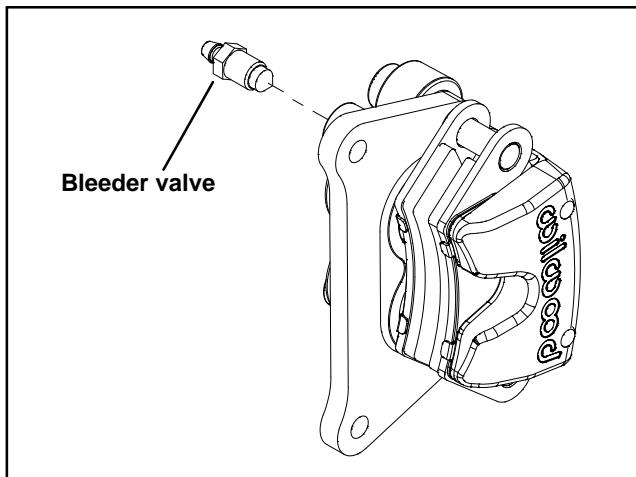


Figure 9

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Chassis

Brake Master Cylinder

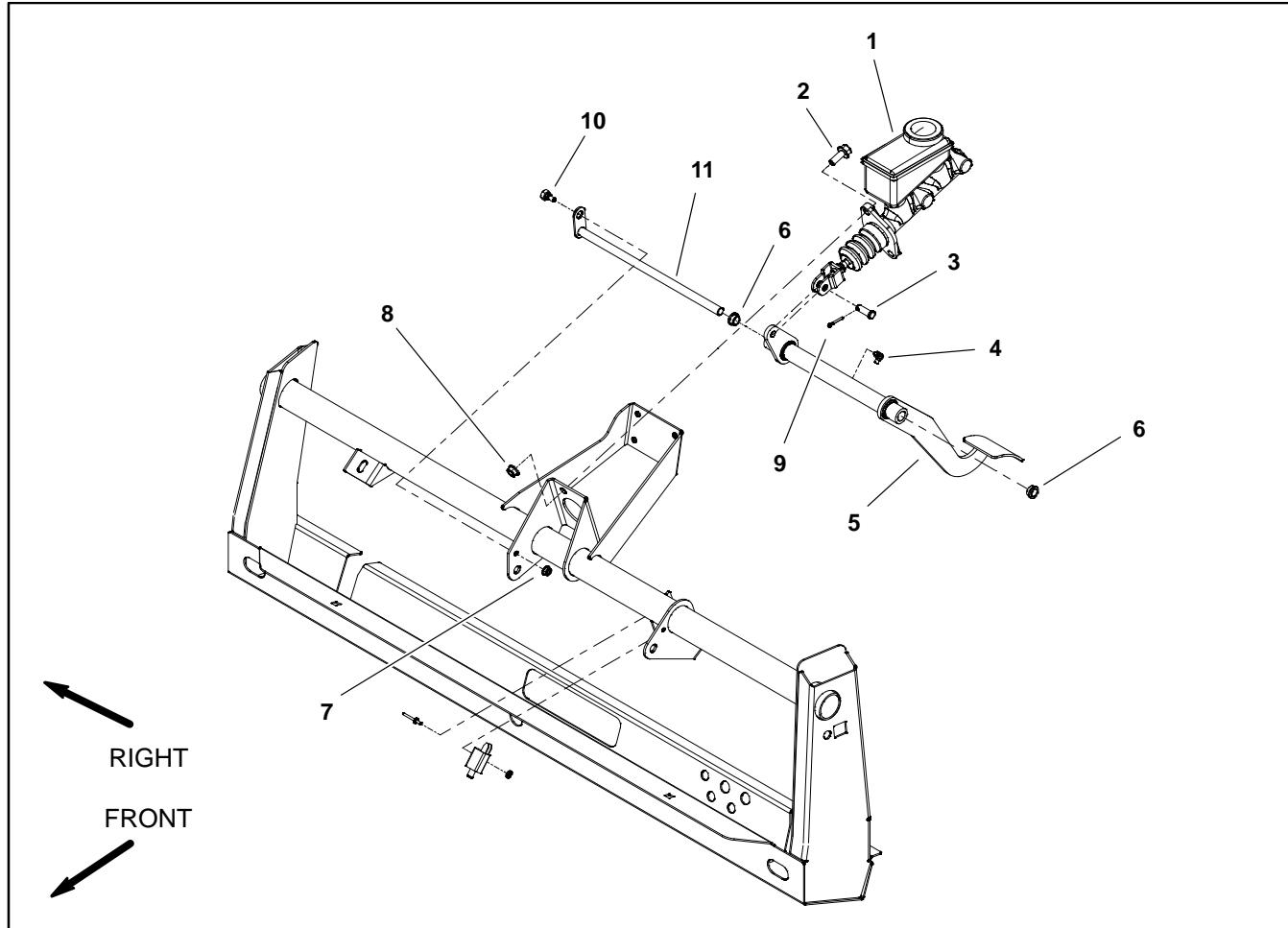


Figure 10

- | | | |
|--------------------------|-------------------|--------------------|
| 1. Brake master cylinder | 5. Brake pedal | 9. Cotter pin |
| 2. Flange head screw (2) | 6. Flange bushing | 10. Shoulder screw |
| 3. Clevis pin | 7. Flange nut | 11. Brake shaft |
| 4. Grease fitting | 8. Flange nut (2) | |

Removal (Fig. 10)

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake.
2. Remove hood to access brake master cylinder (see Hood in this section).
3. Remove cotter pin from the clevis pin that connects master cylinder to brake pedal.
4. Clean hydraulic brake line area of master cylinder to prevent system contamination. Remove both brake lines from master cylinder. Cap ends of brake lines and position them away from master cylinder.
5. Remove two (2) flange head screws and flange nuts that secure master cylinder to vehicle frame.
6. Remove master cylinder from vehicle.

Installation (Fig. 10)

1. Position master cylinder to vehicle frame and secure with two (2) flange head screws and flange nuts.
2. Remove plugs from brake lines. Install brake lines to master cylinder. Make sure that brake lines are properly connected to master cylinder (Fig. 11).
3. Make sure that master cylinder push rod is fully extended. Connect push rod clevis to brake pedal with clevis pin and cotter pin.
4. Bleed brakes (see Bleed Brake System in this section).
5. Install hood (see Hood in this section).

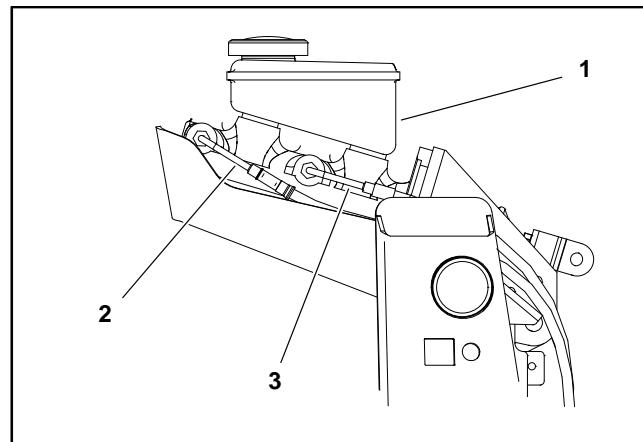


Figure 11

1. Brake master cylinder 3. Rear brake line
2. Front brake line

Chassis



CAUTION

After servicing the brakes, always check the brakes in a wide open, level area that is free of other persons and obstructions.

6. Check brake operation.

Brake Master Cylinder Service

Disassembly (Fig. 12)

1. Thoroughly clean outside of master cylinder before disassembly.
2. Remove reservoir and flange seal. Push in on the push rod (item 8) so the stop pin (item 3) can be removed.
3. Disconnect lower end of the dust cover from the housing.
4. Push in on the push rod and remove circlip (item 9) from cylinder housing, then remove push rod with dust cover and clevis. Remove retainer washer.
5. Remove primary piston assembly and secondary piston assembly from cylinder housing.

Inspection



CAUTION

Use eye protection such as goggles when using compressed air for master cylinder service.

1. Clean all metal parts with isopropyl alcohol, then clean out and dry grooves and passageways with compressed air. Make sure cylinder bore and component pieces are thoroughly clean.

2. Check cylinder bore, pistons and springs for damage or excessive wear. Replace brake cylinder assembly if signs of pitting, scoring or cracks are evident in cylinder bore.

Assembly (Fig. 12)

1. Apply a film of clean DOT 3 brake fluid to cylinder bore and piston assemblies.
2. Install secondary piston assembly and primary piston assembly into cylinder.
3. Install retainer washer.
4. Install push rod and secure in place with circlip. Install lower end of dust cover to housing.
5. Push in on push rod so stop pin can be installed to retain secondary piston assembly, then install flange seal and reservoir.

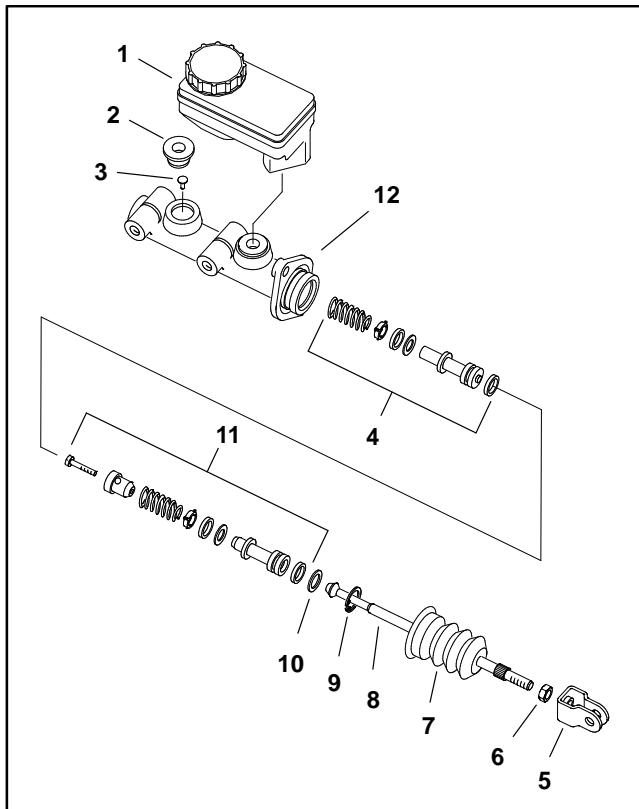


Figure 12

- | | |
|--------------------------|-------------------------|
| 1. Reservoir | 7. Dust cover |
| 2. Flange seal (2) | 8. Push rod |
| 3. Stop pin | 9. Circlip |
| 4. Secondary piston assy | 10. Retainer washer |
| 5. Clevis | 11. Primary piston assy |
| 6. Jam nut | 12. Cylinder housing |

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Chassis

Parking Brake Cable

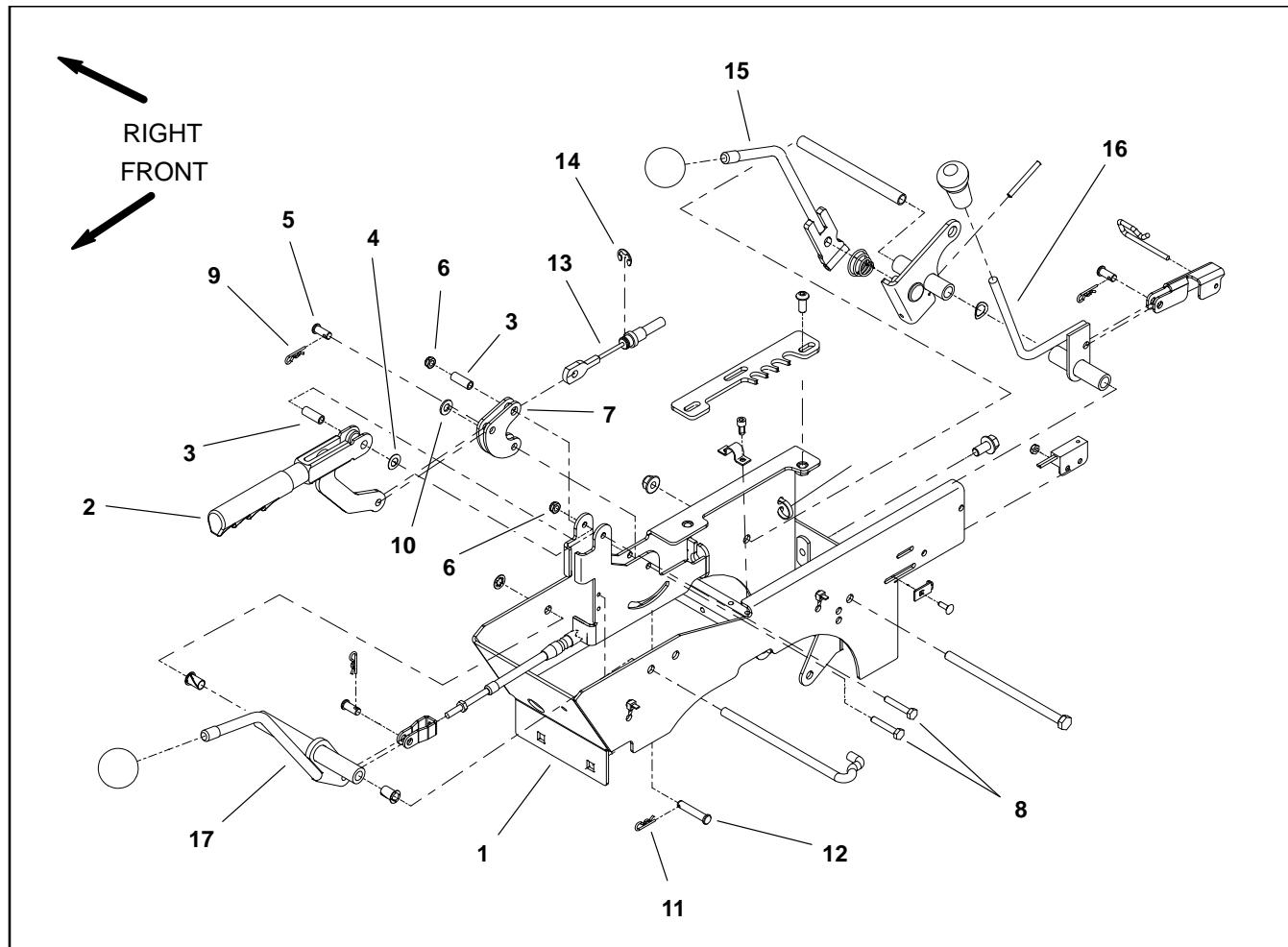


Figure 13

- | | | |
|---------------------------|------------------|-------------------------|
| 1. Lever support assembly | 7. Bellcrank (2) | 13. Parking brake cable |
| 2. Parking brake lever | 8. Cap screw (2) | 14. Retaining ring |
| 3. Spacer (2) | 9. Hair pin | 15. Speed control lever |
| 4. Curved washer | 10. Flat washer | 16. Hydraulic lever |
| 5. Clevis pin | 11. Hair pin | 17. Shift lever |
| 6. Lock nut (2) | 12. Clevis pin | |

Removal (Fig. 13)

1. Park vehicle on a level surface, raise and support vehicle cargo bed (if installed), shut engine off and engage the parking brake. Remove key from the ignition switch.
2. Remove brake lever handle from parking brake lever and loosen set screw on parking brake lever knob (Fig. 14). Turn knob on parking brake lever counter-clockwise all the way to loosen brake cable adjustment.
3. Remove knobs from control levers and then remove center console control plate to gain access to parking brake cable in console.

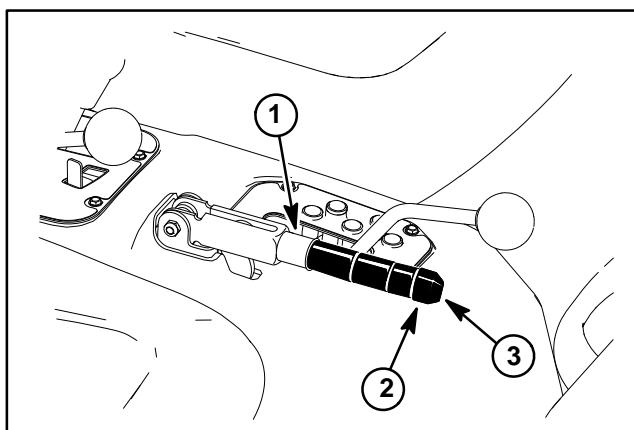


Figure 14

- | | |
|------------------------|--------------|
| 1. Parking brake lever | 3. Set screw |
| 2. Knob | |

4. Disconnect parking brake cable from parking brake caliper at rear differential (Fig. 15):

A. Remove retaining ring that secures parking brake cable to engine mount.

B. Remove hair pin and clevis pin that secure parking brake cable clevis to parking brake caliper lever.

C. Disconnect brake cable from caliper lever and remove cable from engine mount.

5. Remove retaining ring (item 14) that secures brake cable to lever support assembly.

6. Remove hair pin (item 11), flat washer (item 10) and clevis pin (item 12) that secure parking brake cable end to brake lever and lever support.

7. Note routing of parking brake cable and location of cable ties used to secure brake cable to vehicle frame. Remove brake cable from vehicle.

Installation (Fig. 13)

1. Route new parking brake cable in same location as before and secure with cable ties. Start from rear of vehicle and work towards front.

2. Install brake cable end to brake equalizer on parking brake lever. Secure brake cable to lever support assembly with retaining ring.

3. Connect parking brake cable to parking brake caliper at rear differential (Fig. 15 and 16).

A. Route parking brake cable through hole in engine mount.

B. Connect parking brake cable clevis to parking brake caliper lever and secure with clevis pin and hair pin.

C. Secure parking brake cable to engine mount with retaining ring.

4. Secure center console control plate to seat base with removed screws. Torque screws a maximum of **12 in-lb (1.3 N·m)**.

5. Install control lever knobs.

6. Remove bed support from cargo bed lift cylinder and lower bed.

7. Adjust parking brake (see Parking Brake in the Adjustments section of this chapter).

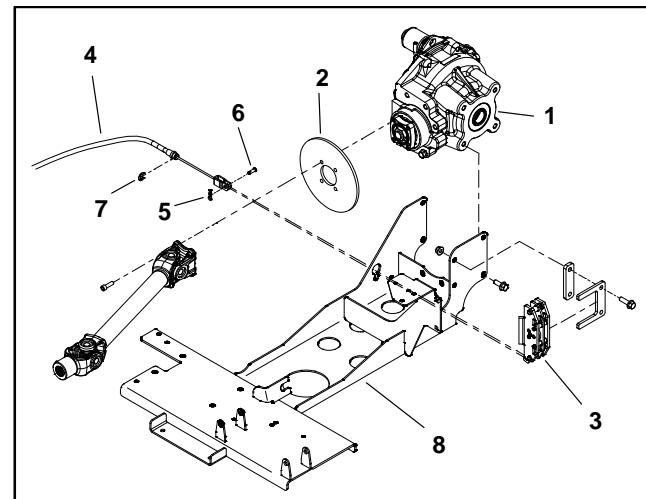


Figure 15

- | | |
|--------------------------|-------------------|
| 1. Rear differential | 5. Hairpin |
| 2. Parking brake rotor | 6. Clevis pin |
| 3. Parking brake caliper | 7. Retaining ring |
| 4. Parking brake cable | 8. Engine mount |

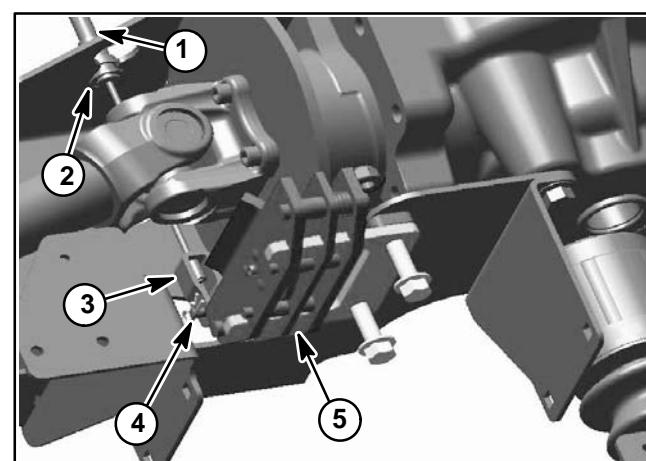


Figure 16

- | | |
|------------------------|--------------------------|
| 1. Parking brake cable | 4. Clevis pin/hairpin |
| 2. Retaining ring | 5. Parking brake caliper |
| 3. Brake cable clevis | |

Parking Brake Caliper

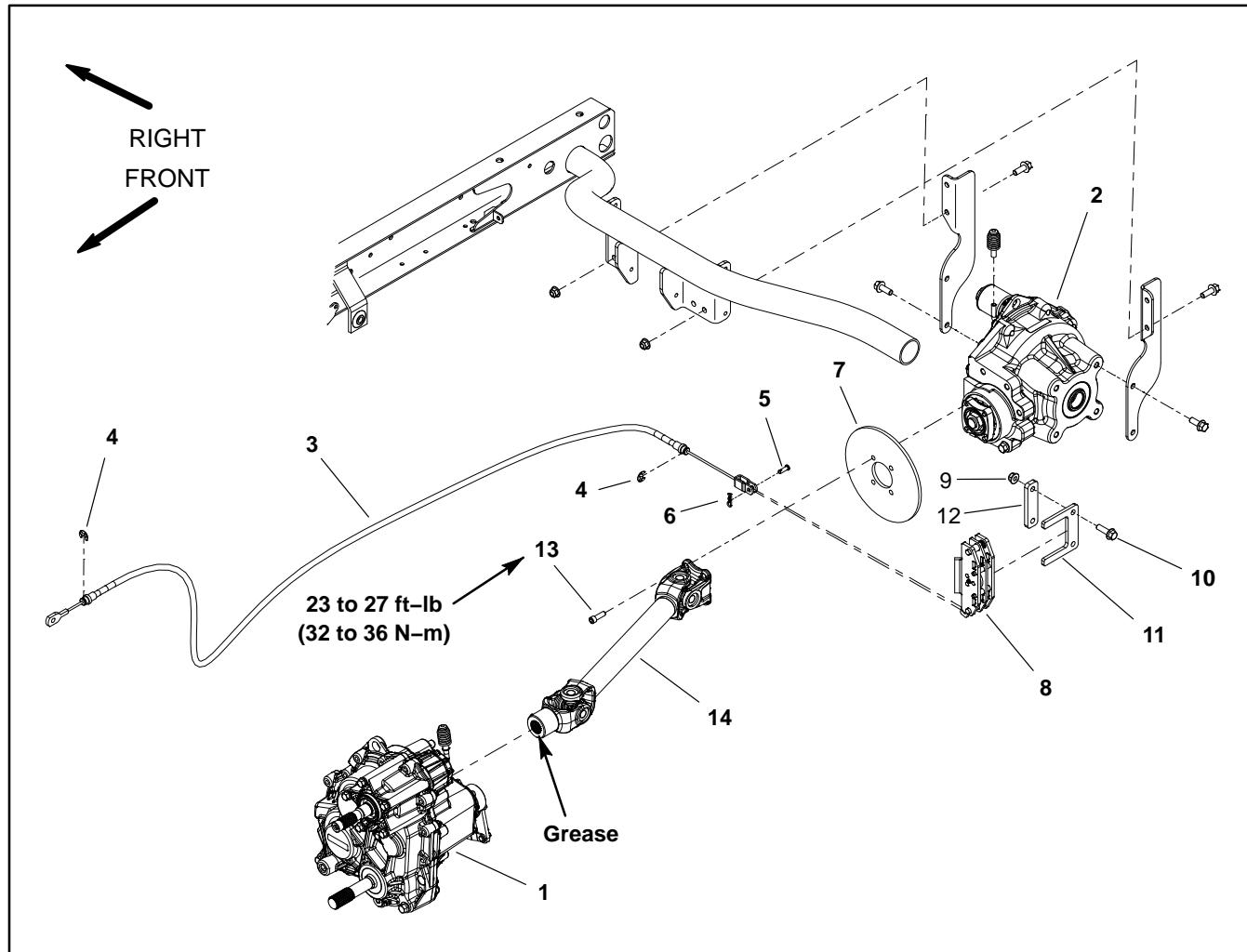


Figure 17

- | | | |
|------------------------|---------------------------|---------------------------|
| 1. Transmission | 6. Hairpin | 11. Brake mount plate |
| 2. Rear differential | 7. Parking brake rotor | 12. Parking brake spacer |
| 3. Parking brake cable | 8. Parking brake caliper | 13. Socket head screw (4) |
| 4. Retaining ring (2) | 9. Flange nut (2) | 14. Rear driveshaft |
| 5. Clevis pin | 10. Flange head screw (2) | |

Disassembly (Fig. 17)

1. Park vehicle on a level surface, raise and support vehicle cargo bed (if installed), shut engine off and engage the parking brake. Remove key from the ignition switch.
2. Remove brake lever handle from parking brake lever. Loosen set screw in parking brake lever knob (Fig. 18). Turn knob on parking brake lever counter-clockwise all the way to loosen brake cable adjustment.
3. Jack up and support rear of vehicle (see Jacking Vehicle in the Safety Instructions section of Chapter 1 – Safety).

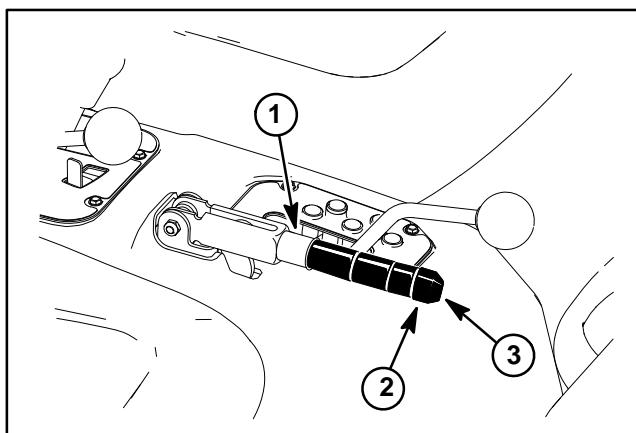


Figure 18

- | | |
|------------------------|--------------|
| 1. Parking brake lever | 3. Set screw |
| 2. Knob | |

4. Remove parking brake caliper from vehicle:

- A. Remove flange nuts (item 9) and flange head screws (item 10) that secure brake mount plate (item 11) to frame. Locate and retrieve parking brake spacer (item 12).
- B. Slide parking brake caliper with attached brake cable and brake mount plate from parking brake rotor.
- C. Remove hairpin (item 6) and clevis pin (item 5) that secure parking brake cable to parking brake caliper. Separate cable from caliper.
- D. Remove brake caliper from vehicle. Slide brake mount plate from caliper.
- 5. If wear or damage is evident with parking brake caliper, replace caliper. Component parts for the parking brake caliper are not available separately.
- 6. Inspect parking brake rotor (item 7) for wear or damage. If necessary, remove brake rotor:

- A. Support rear driveshaft to prevent it from falling.
- B. Remove four (4) socket head screws (item 13) that secure driveshaft and parking brake rotor to rear differential.
- C. Remove driveshaft flange and brake rotor from differential.

Assembly (Fig. 17)

- 1. If parking brake rotor was removed from vehicle, install rotor:
 - A. Make sure that flanges of differential and driveshaft are thoroughly cleaned before installing brake rotor. Also, clean rotor thoroughly.
 - B. Position brake rotor and driveshaft flange to differential.
 - IMPORTANT: Socket head screws used to secure driveshaft and parking brake rotor to rear differential have a patch-lock applied. If these screws are being reused, apply medium strength thread locker to screw threads before installation.**
 - C. Secure driveshaft and parking brake rotor to rear differential with four (4) socket head screws. Torque screws from **23 to 27 ft-lb (32 to 36 N·m)**.

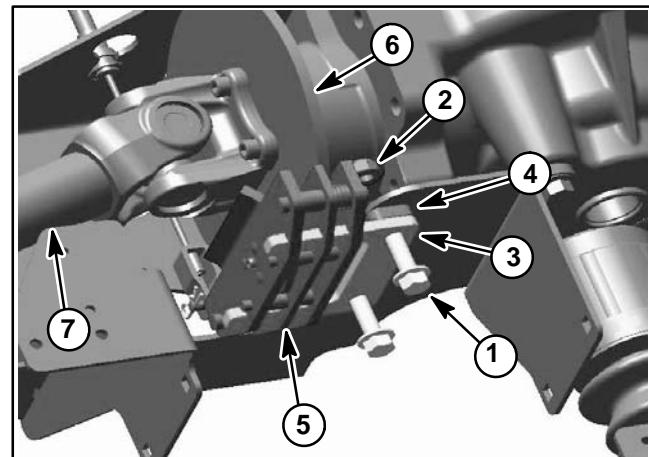


Figure 19

- | | |
|--------------------------|--------------------------|
| 1. Flange head screw (2) | 5. Parking brake caliper |
| 2. Flange nut (2) | 6. Parking brake rotor |
| 3. Brake mount plate | 7. Driveshaft |
| 4. Spacer | |

2. Install parking brake caliper to vehicle:

- A. Secure parking brake cable to brake caliper with clevis pin and hairpin.
- B. Slide brake mount plate into caliper.
- C. Slide parking brake caliper with attached brake cable and brake mount plate onto parking brake rotor. Make sure that rotor is between brake pads.
- D. Position parking brake spacer (item 12) between frame bracket and brake mount plate. Secure assembly with flange nuts (item 9) and flange head screws (item 10).
- 3. Remove bed support from cargo bed lift cylinder and lower bed.
- 4. Adjust parking brake (see Parking Brake in the Adjustments section of this chapter).

Wheel Hub

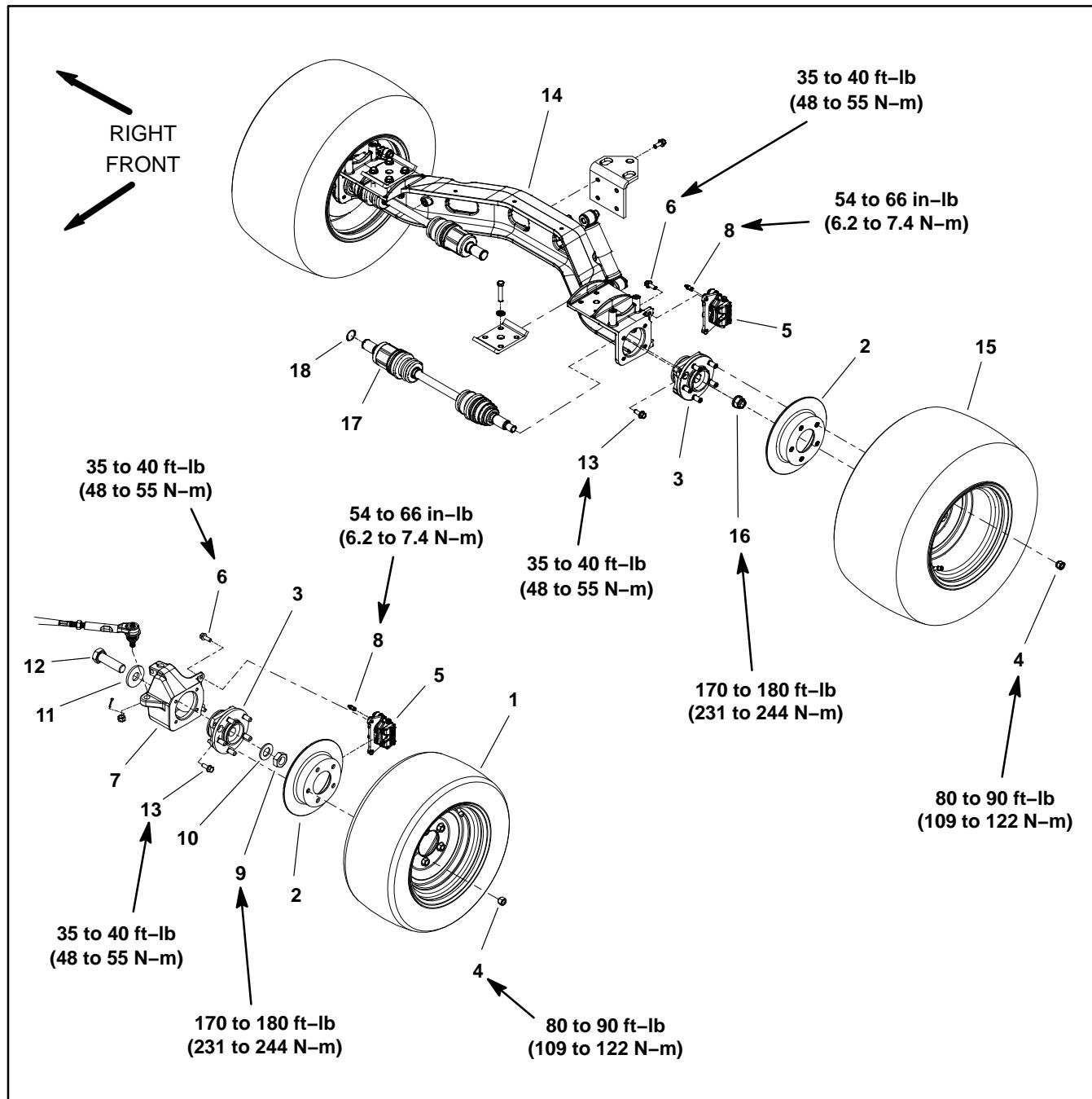


Figure 20

- | | | |
|--------------------------------------|-----------------------------|-----------------------------------|
| 1. Front wheel assembly | 7. Front knuckle (LH shown) | 13. Flange head screw (4 per hub) |
| 2. Brake rotor | 8. Bleed screw | 14. Rear axle |
| 3. Wheel hub assembly | 9. Lock nut | 15. Rear wheel assembly |
| 4. Lug nut (5 per wheel) | 10. Flat washer | 16. Spindle nut |
| 5. Brake caliper | 11. Hardened washer | 17. CV axle assembly |
| 6. Flange head screw (2 per caliper) | 12. Cap screw | 18. O-ring |

NOTE: If vehicle is equipped with optional four wheel drive kit, see CV Axle Assembly in the Service and Repairs section of Chapter 8 – Four Wheel Drive (Optional Kit) for front wheel hub removal and installation procedure.

Removal (Fig. 20)

1. Park vehicle on a level surface, shut engine off and remove key from ignition switch.
2. For wheel hub to be serviced, remove wheel, brake caliper and brake rotor (see Brake System in this section).
3. If rear wheel hub is to be removed, remove spindle nut (item 16) that secures splined shaft on CV axle assembly to wheel hub:

IMPORTANT: If staked-in portion of spindle nut (item 16) is not released before nut removal, CV axle may be damaged.

- A. Align a flat punch with the staked-in portion of the spindle nut. Use a hammer to carefully drive the punch into the nut to release the staking.
 - B. Remove the spindle nut from the CV axle. Discard spindle nut after removal.
4. Using wheel hub hole to access flange head screws (item 13), remove screws that secure wheel hub to vehicle. Remove wheel hub from vehicle.
 5. Inspect wheel studs in hub and replace studs if damage is identified. Use press to extract stud(s) from hub.
- NOTE:** If wheel hub wear or damage exists, replacement of the wheel hub assembly is necessary. Wheel hubs are not rebuildable.
6. If front wheel hub replacement is necessary, remove cap screw (item 12), washers (items 11 and 10) and lock nut (item 9) from wheel hub assembly so that these components can be installed on replacement hub.

Installation (Fig. 20)

1. If front wheel hub is being replaced, install cap screw (item 12), washers (items 11 and 10) and lock nut (item 9) to new hub. Torque lock nut from **170 to 180 ft-lb (231 to 244 N-m)**.
2. If any wheel studs were removed from hub, press new stud(s) fully into hub making sure that stud shoulder is tight against hub.
3. If rear wheel hub was removed, apply antiseize lubricant to splined shaft on CV axle assembly.
4. Position wheel hub to vehicle and secure with four (4) flange head screws. Torque screws from **35 to 40 ft-lb (48 to 55 N-m)**.
5. If rear wheel hub was removed, secure wheel hub to CV axle splined shaft with **new** spindle nut (item 17). Torque spindle nut from **170 to 180 ft-lb (231 to 244 N-m)**. After properly torquing spindle nut, stake the end of the spindle nut into slot in CV axle splined shaft.
6. Install brake rotor, brake caliper and wheel (see Brake System in this section). Make sure that wheel lug nuts are properly torqued from **80 to 90 ft-lb (109 to 122 N-m)**.

Steering Assembly

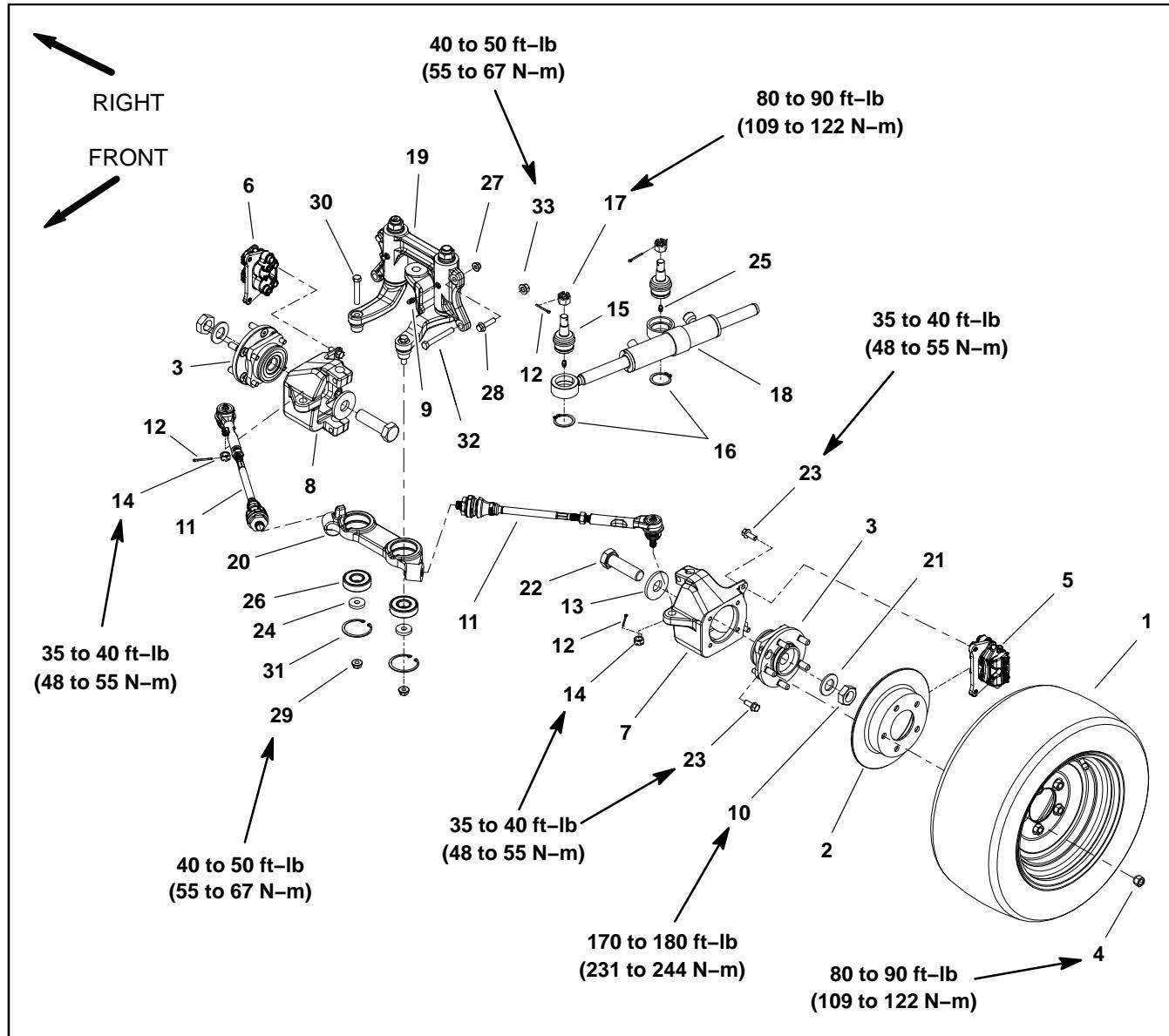


Figure 21

- | | | |
|-------------------------------|-------------------------------|----------------------------|
| 1. Front wheel assembly | 12. Cotter pin (4) | 23. Flange head screw (12) |
| 2. Brake rotor | 13. Hardened washer (2) | 24. Washer (2) |
| 3. Wheel hub assembly | 14. Slotted hex nut | 25. Grease fitting (2) |
| 4. Lug nut (5 used per wheel) | 15. Ball joint (2) | 26. Ball bearing (2) |
| 5. LH brake caliper | 16. Retaining ring | 27. Flange nut (2) |
| 6. RH brake caliper | 17. Slotted hex nut (2) | 28. Flange head bolt (2) |
| 7. LH knuckle | 18. Steering cylinder | 29. Flange nut (2) |
| 8. RH knuckle | 19. Steering linkage assembly | 30. Cap screw (2) |
| 9. Grease fitting (2) | 20. Center link | 31. Snap ring (2) |
| 10. Lock nut (2) | 21. Flat washer (2) | 32. Cap screw (2) |
| 11. Tie rod assembly (2) | 22. Cap screw (2) | 33. Lock nut (2) |

Disassembly (Fig. 21)

- Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake.
- Remove front wheel assembly to access steering components that are to be serviced (see Wheel Assembly in this section).
- To remove tie rod (item 11) from vehicle (Fig. 22):
 - Remove cotter pin and slotted hex nut that secure outer tie rod ball joint stud to knuckle.
 - Use puller to separate ball joint from knuckle.
 - Unscrew inner tie rod end from center link and remove tie rod from vehicle.
 - If necessary, loosen jam nut and remove outer tie rod end from inner tie rod. Count the number of revolutions it takes to remove outer rod end so new rod end can be installed without changing the wheel alignment.

4. To remove steering linkage (item 19) and center link (item 20) assembly from vehicle:

- Remove tie rods from center link (see above).
- Remove seat base from vehicle (see Seat Base in this section).
- Remove cotter pin and slotted hex nut that secure steering cylinder ball joint to steering linkage. Separate steering cylinder from steering linkage.
- Remove fasteners (items 27, 28, 32 and 33) that secure steering linkage and center link assembly to frame. Remove assembly from frame.
- If removed, disassemble steering linkage and center link assembly as required using Figures 21 and 23 as guides.

IMPORTANT: If staked-in portion of spindle nut (item 8 in Fig. 23) is not released before nut removal, steering linkage arms may be damaged.

- If spindle nut (item 8 in Fig. 23) is to be removed from idler or pitman arm, align a flat punch with the staked-in portion of the spindle nut. Use a hammer to carefully drive the punch into the nut to release the staking. Remove the spindle nut from the steering linkage arms. Discard spindle nut after removal.

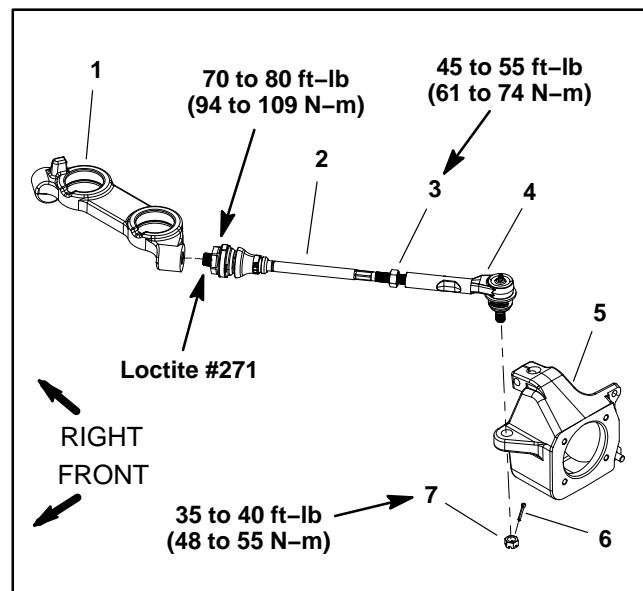


Figure 22

- | | |
|----------------------|-----------------------|
| 1. Center link | 5. Knuckle (LH shown) |
| 2. Inner tie rod end | 6. Cotter pin |
| 3. Jam nut | 7. Slotted hex nut |
| 4. Outer tie rod end | |

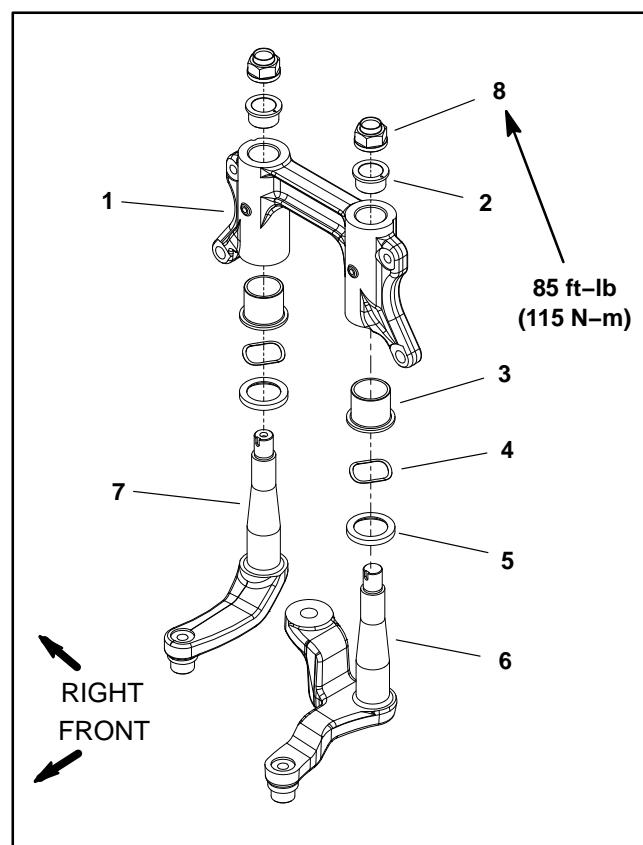


Figure 23

- | | |
|-----------------------|----------------------|
| 1. Pivot mount | 5. Thrust washer (2) |
| 2. Flange bushing (2) | 6. Pitman arm |
| 3. Flange bushing (2) | 7. Idler arm |
| 4. Wave washer (2) | 8. Spindle nut (2) |

Assembly (Fig. 21)

1. If steering linkage and center link assembly were disassembled, use Figures 21 and 23 as guides for assembly.

A. If flange bushings (items 2 and 3 in Fig. 23) were removed from pivot mount, make sure that new bushings are pressed fully into the pivot mount.

B. Install and torque **new** spindle nut (item 8 in Fig. 23) to **85 ft-lb (115 N-m)**. Deform spindle nut into slot in idler arm or pitman arm after torquing nut.

C. If bearings were removed from center link, press new bearings fully to the shoulder of the bearing bore in the center link. Secure bearings with retaining ring.

D. Secure center link to steering linkage with cap screws, washers and flange nuts. Torque flange nuts from **40 to 50 ft-lb (55 to 67 N-m)**.

2. If steering linkage (item 19) and center link (item 20) assembly was removed from vehicle:

A. Position assembly to frame and secure with removed fasteners. Torque lock nuts (item 33) from **40 to 50 ft-lb (55 to 67 N-m)**.

B. Secure steering cylinder ball joint to steering linkage with slotted hex nut. Torque slotted hex nut from **80 to 90 ft-lb (109 to 122 N-m)**. If necessary, tighten nut further until slot in nut aligns with hole in ball joint stud. Install cotter pin.

C. Install tie rods to center link (see below).

D. Install seat base to vehicle (see Seat Base in this section).

3. To install tie rod (item 11) to vehicle:

A. If tie rod was separated, make sure that jam nut is on inner tie rod threads. Thread outer tie rod end onto inner tie rod the same number of revolutions as the old one took to remove.

B. Apply Loctite #271 (or equivalent) to threads of inner tie rod end. Thread tie rod into center link and torque from **70 to 80 ft-lb (94 to 109 N-m)**.

C. Clean tapers of knuckle and outer tie rod end ball joint stud.

D. Insert outer tie rod end ball joint stud into knuckle and secure with slotted hex nut. Torque slotted hex nut from **35 to 40 ft-lb (48 to 55 N-m)**. If necessary, tighten nut further until slot in nut aligns with hole in tie rod ball joint stud. Install cotter pin.

4. Lubricate all grease fittings in steering assembly.

5. Install removed front wheel (see Wheel Assembly in this section). Make sure that wheel lug nuts are properly torqued from **80 to 90 ft-lb (109 to 122 N-m)**.

6. Check front wheel alignment and adjust if necessary (see Front Wheel Alignment in this section).

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Chassis

Front Control Arms

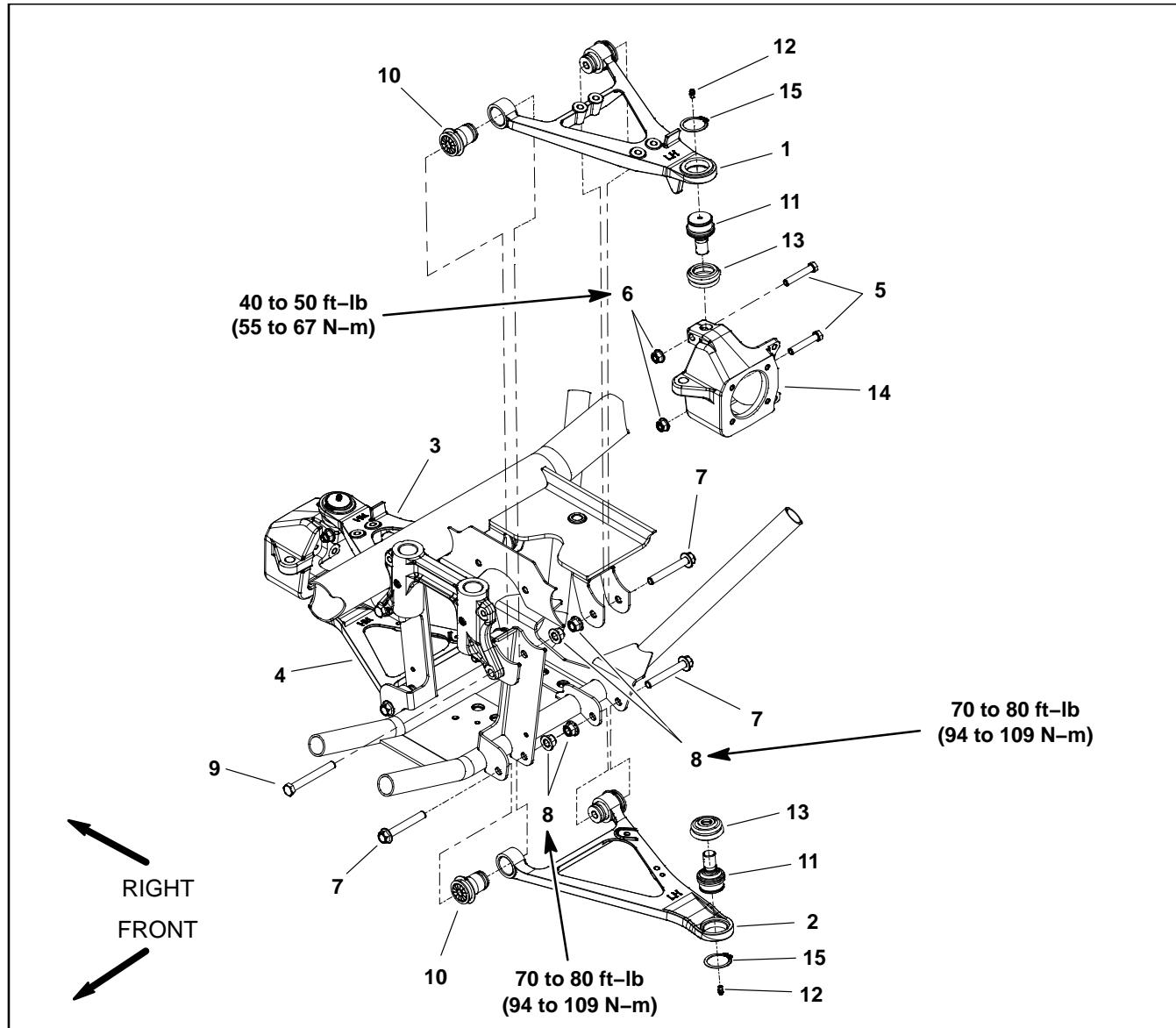


Figure 24

- | | | |
|-------------------------|-------------------------------------|------------------------|
| 1. LH upper control arm | 6. Flange nut (4) | 11. Ball joint |
| 2. LH lower control arm | 7. Flange head screw (6) | 12. Grease fitting |
| 3. RH upper control arm | 8. Lock nut (8) | 13. Ball joint seal |
| 4. RH lower control arm | 9. Cap screw (2) | 14. Knuckle (LH shown) |
| 5. Cap screw (4) | 10. Flange bushing (2 used per arm) | 15. Retaining ring |

Removal (Fig. 24)



WARNING

FRONT SUSPENSION IS SPRING LOADED! To prevent possible personal injury, use special tool to remove compression springs before disassembling the front suspension.

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake.

NOTE: Front compression springs do not need to be removed if servicing only the lower control arm.

2. If servicing upper control arm, remove front compression springs (see Front Compression Spring Service in this section).
3. Remove cap screw and flange nut that secure affected control arm ball joint to knuckle. Separate ball joint from knuckle. Inspect ball joint seal and replace if damaged.
4. Remove control arm from vehicle frame.
5. Disassemble control arm as needed.
 - A. Remove retaining ring and press ball joint out of control arm.
 - B. Press flange bushings from control arm.

Installation (Fig. 24)

1. Assemble control arm.

A. Press ball joint into control arm and secure with retaining ring. Make sure that grease fitting is in ball joint.

B. Lightly oil flange bushings and press bushings fully into control arm.

2. Install ball joint seal over shaft on ball joint. Edge of seal must be inserted into ball joint slot.

3. Install and secure control arm to vehicle with removed fasteners. Tighten lock nuts from **70 to 80 ft-lb (94 to 109 N·m)**.

4. Align recess in ball joint stud with hole in knuckle. Slide ball joint stud into knuckle and secure with cap screw and flange nut. Torque nut from **40 to 50 ft-lb (55 to 67 N·m)**.

5. If removed, install front compression springs (see Front Compression Spring Service in this section).

6. Grease ball joint.

Chassis

Front Compression Spring Service

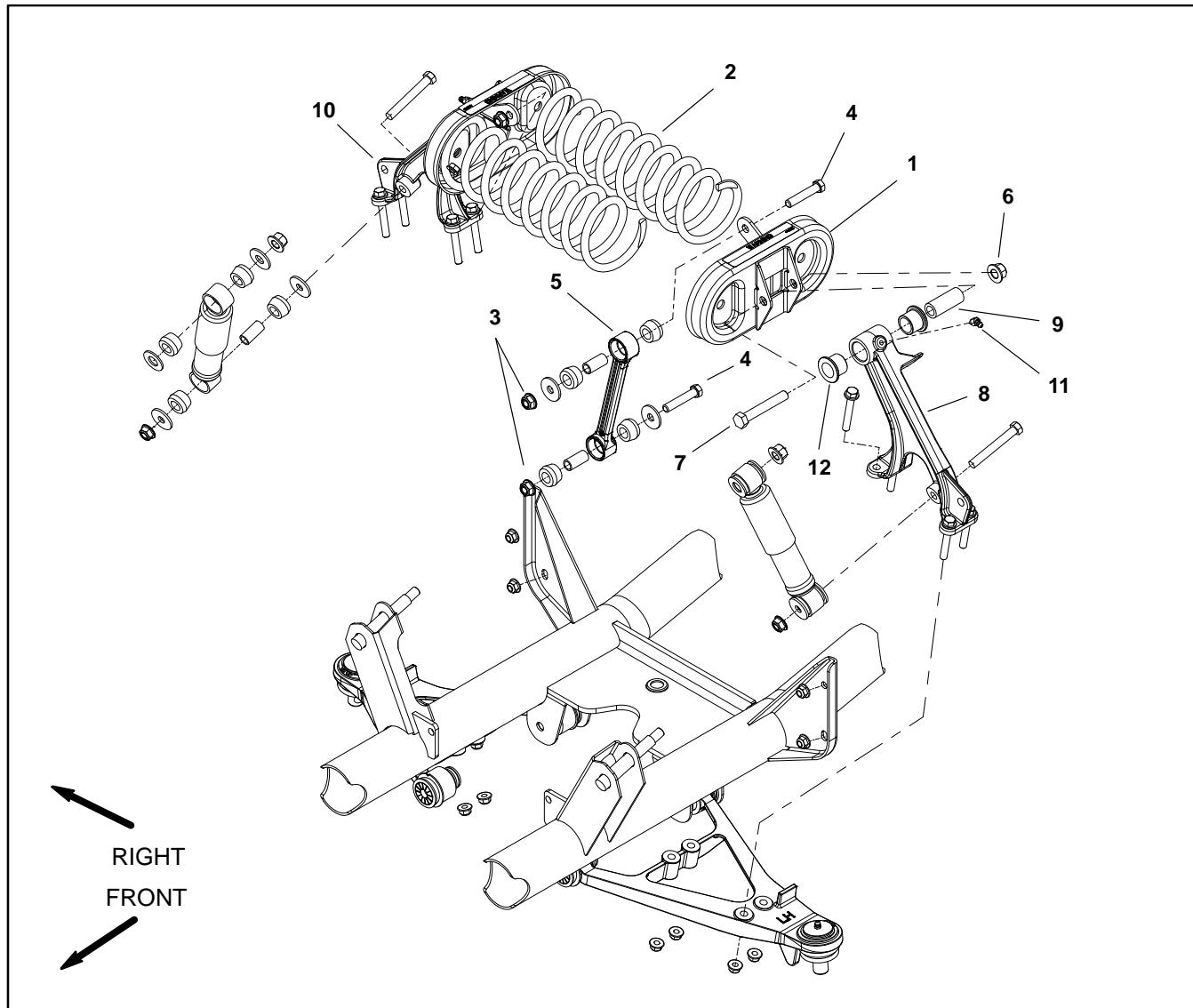
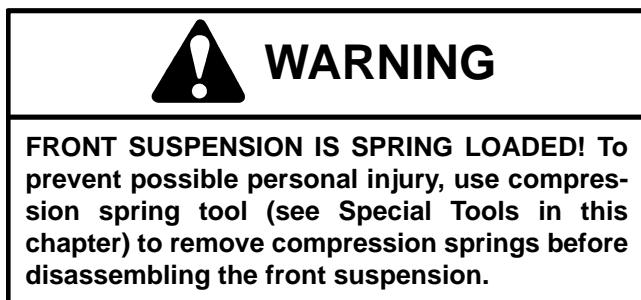


Figure 25

- | | | |
|---------------------------|--------------------|--------------------------|
| 1. Spring cradle (2) | 5. Stabilizer link | 8. LH control arm tower |
| 2. Compression spring (2) | 6. Lock nut | 9. Spring pivot sleeve |
| 3. Flange nut | 7. Cap screw | 10. RH control arm tower |
| 4. Cap screw | | |

Disassembly (Fig. 25)

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake.
 2. Remove seat base to gain access to front suspension assembly (see **Seat Base** in this section).
 3. Jack up front of vehicle and secure with jack stands (see **Jacking Vehicle** in the **Safety Instructions** section of Chapter 1 – **Safety**). Remove front wheels.
 4. Remove front shock absorbers (see **Front Shock Absorber** in this section).



NOTE: Extended portion of each compression spring tool must be on opposite ends so cap screws (item 7) that secure spring cradles to control arm towers can be removed (Fig. 27).

5. Install a compression spring tool rod (see Special Tools) through holes in each spring cradle (item 1), then install nuts and washers on both ends of each rod. Tighten one nut on each rod to secure compression springs (item 2).
 6. Remove flange nut (item 3) and cap screw (item 4) from lower end of each stabilizer link (item 5).
 7. Remove lock nut (item 6) and cap screw (item 7) securing each spring cradle to control arm towers (item 8), then remove springs and cradles along with the stabilizer links.
 8. Carefully loosen compression spring tool rods to allow disassembly of compression springs, spring cradles and stabilizer links.

Assembly (Fig. 25)

1. Reverse the disassembly procedure to install compression springs.

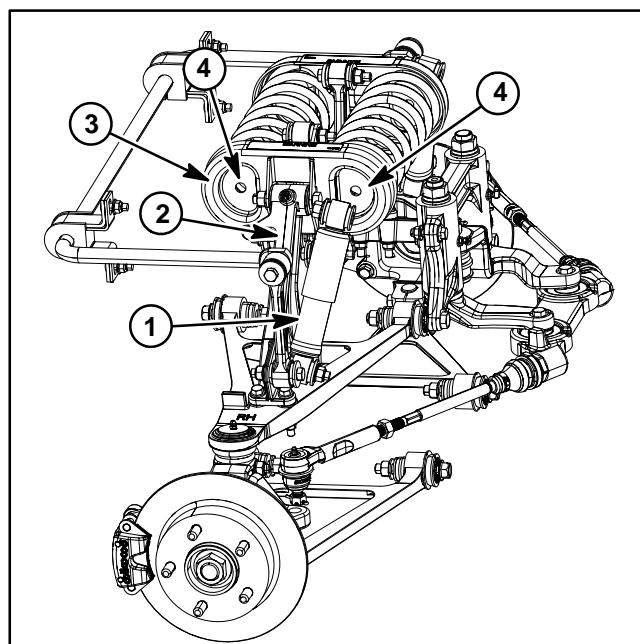


Figure 26

- 1. Shock absorber
 - 2. Control arm tower
 - 3. Spring cradle
 - 4. Spring cradle hole

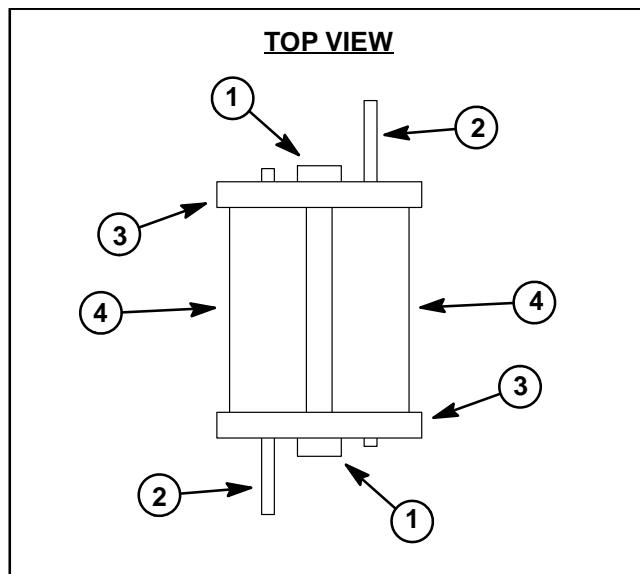


Figure 27

- | | |
|----------------------|-----------------------|
| 1. Control arm tower | 3. Spring cradle |
| 2. Spring tool rod | 4. Compression spring |

Front Shock Absorber

Removal (Fig. 28)

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake.
2. Remove lower and upper lock nuts, then remove shock absorber and washers. Note that washers on upper end of shock absorber are different. Washers on lower end of shock are identical.

Installation (Fig. 28)

1. If necessary (e.g. shock absorber is being replaced or bushings are worn), insert two (2) new rubber bushings into each end of new shock absorber. Insert spacer into ram (lower) end of shock absorber.
2. Install inner washer (item 3) onto frame stud above control arm.
3. Install upper end of shock absorber onto frame stud. Secure shock end to frame stud with outer washer (item 5) and lock nut.
4. Insert cap screw down through angled hole in control arm tower. Install washer onto cap screw and then slide lower end of shock absorber onto cap screw. Install second washer onto cap screw and secure shock end with lock nut.

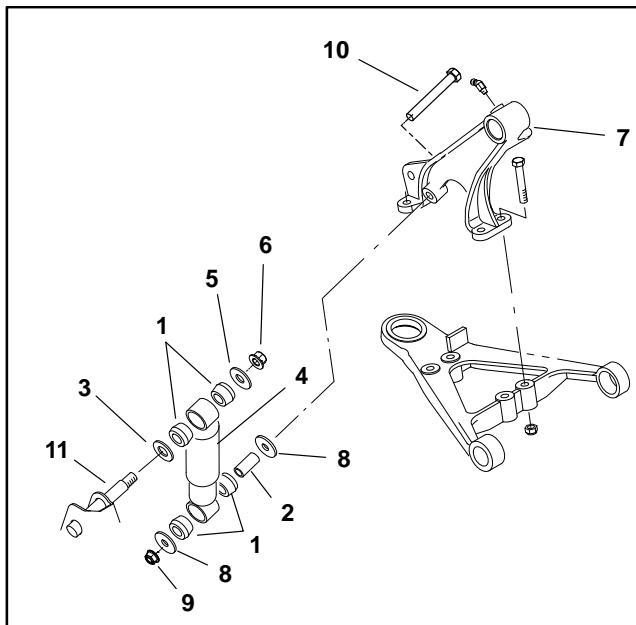


Figure 28

- | | |
|-----------------------------|-----------------------|
| 1. Rubber bushing | 7. Control arm tower |
| 2. Spacer | 8. Washer (0.445" ID) |
| 3. Inner washer (0.656" ID) | 9. Flange nut |
| 4. Shock absorber | 10. Cap screw |
| 5. Outer washer (0.563" ID) | 11. Frame stud |
| 6. Lock nut | |

Rear Shock Absorber

Removal (Fig. 30)

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake.

NOTE: The three (3) flat washers used to retain shock absorber to vehicle are different. Note location of each washer during removal.

2. Remove lock nut and flat washer that secure top of shock absorber to frame.
3. Remove cap screw, flat washer and flange nut that secure bottom of shock absorber to axle.
4. Remove shock absorber and washer (item 4) from vehicle.

Installation (Fig. 30)

1. If necessary (e.g. shock absorber is being replaced or bushings are worn), insert two (2) new rubber bushings into each end of shock absorber. Insert spacer into ram (lower) end of shock absorber.
2. Install washer (item 4) onto shock absorber mounting stud on frame.
3. Slide upper end of shock absorber onto stud on frame. Install flat washer and lock nut onto stud. Tighten lock nut.
4. Place flat washer (item 7) onto cap screw. Insert cap screw through lower end of shock absorber and axle. Install flange nut onto cap screw. Torque nut from **40 to 50 ft-lb (55 to 67 N·m)**.

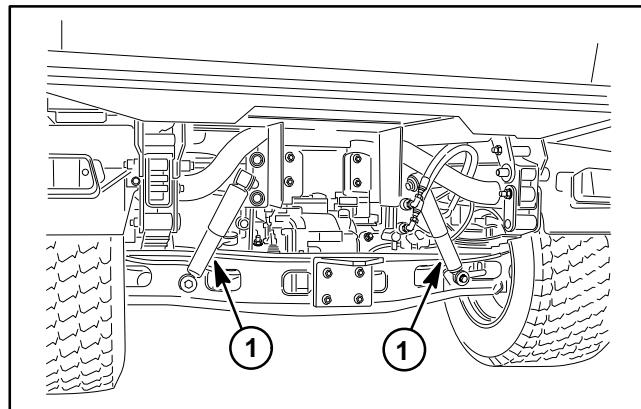


Figure 29

1. Rear shock absorber

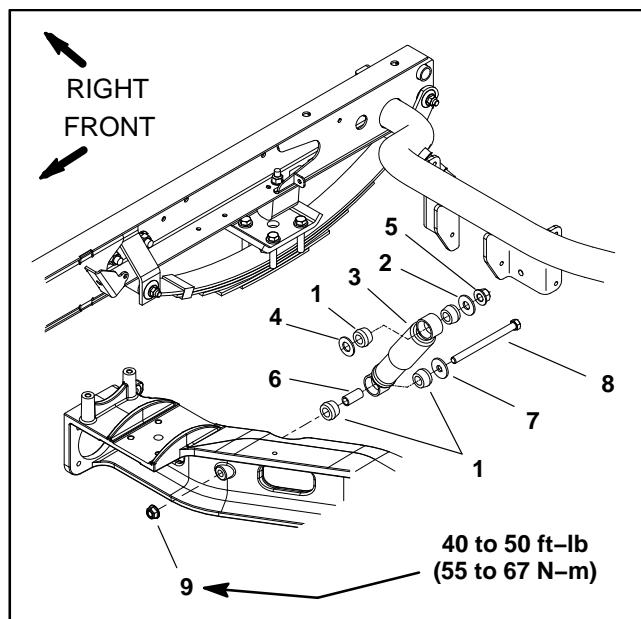


Figure 30

- | | |
|----------------------------|----------------------------|
| 1. Rubber bushing (4) | 6. Spacer |
| 2. Flat washer (0.563" ID) | 7. Flat washer (0.445" ID) |
| 3. Shock absorber | 8. Cap screw |
| 4. Flat washer (0.656" ID) | 9. Flange nut |
| 5. Lock nut | |

Rear Leaf Spring

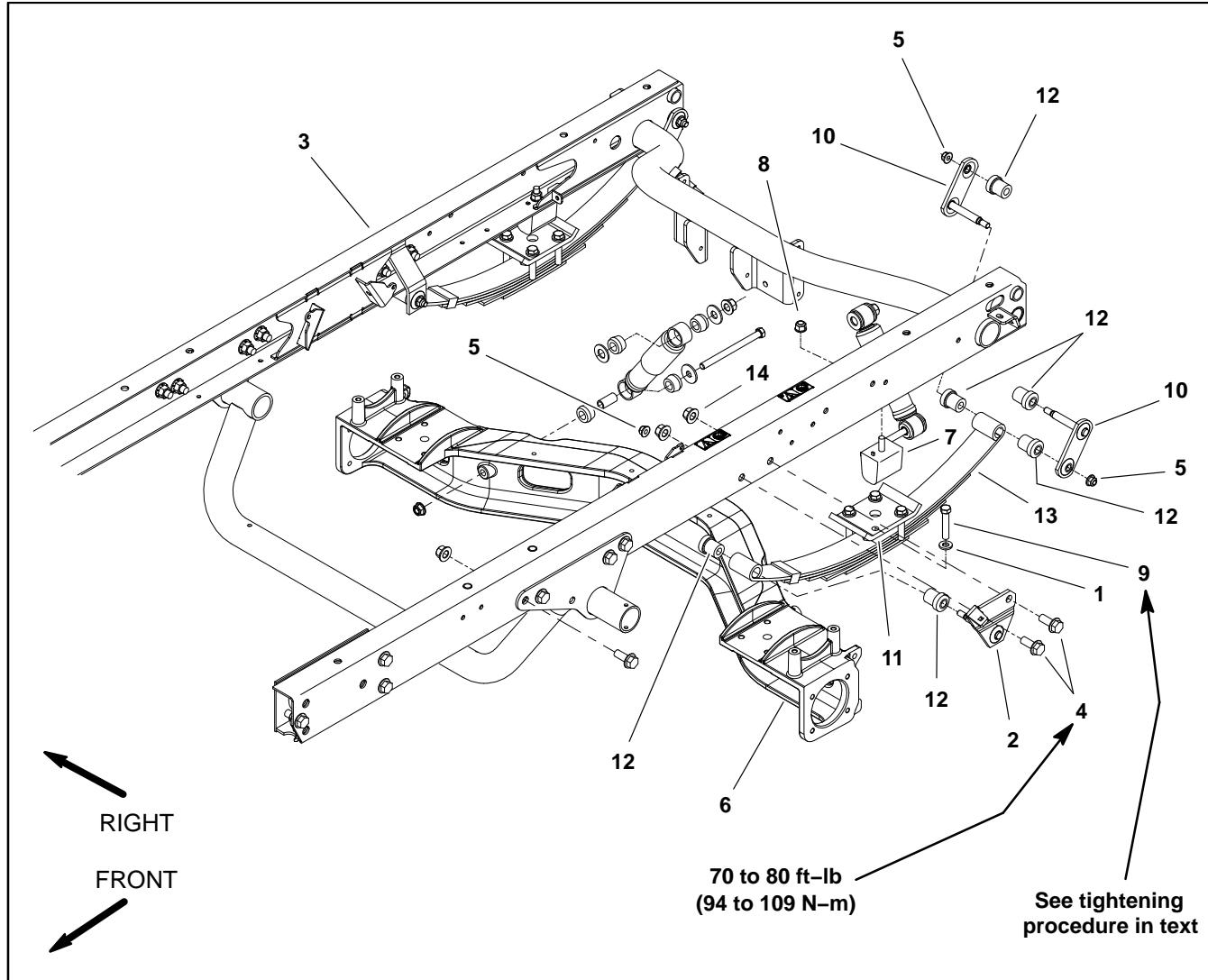


Figure 31

- | | | |
|------------------------------|--|--|
| 1. Washer (4 used per plate) | 6. Rear axle | 11. Spring plate (2) |
| 2. Spring mount (LH shown) | 7. Axle bumper (2) | 12. Rubber bushing (6 used per spring) |
| 3. Rear frame | 8. Lock nut | 13. Leaf spring (2) |
| 4. Flange head screw | 9. Bolt (4 used per plate) | 14. Lock nut |
| 5. Flange nut | 10. Spring shackle (2 used per spring) | |

IMPORTANT: For proper vehicle performance, always replace the springs on both sides of the vehicle.

Removal (Fig. 31)

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake.
2. Jack up and support rear of vehicle with jack stands (See Jacking Vehicle in the Safety Instructions section of Chapter 1 – Safety).
3. Remove rear wheels (see Wheel Assembly in this section).
4. Support rear axle to prevent it from moving during leaf spring removal.
5. Remove four (4) bolts (item 9) and washers (item 1) securing leaf spring to rear axle.
6. Remove two (2) flange nuts (item 5) from spring shackles (item 10). Remove spring shackles from leaf spring and frame.
7. Remove two (2) lock nuts (item 14) and flange head screws (item 4) securing spring mount (item 2) to frame rail, then remove leaf spring assembly.

8. Remove flange nut that secures spring mount to leaf spring and remove mount from spring.
9. Remove rubber bushings (item 12) from leaf spring and frame side rails.

Installation (Fig. 31)

1. Make sure that four (4) rubber bushings (item 12) are positioned in leaf spring and two (2) rubber bushings are fitted in frame side rail.
2. Insert one (1) spring shackle (item 10), from inside/out, into rear of leaf spring. Insert spring mount (item 2), from outside/in, to front of leaf spring and secure, finger tight, with flange nut (item 5).
3. Install leaf spring assembly to frame and rear axle. Secure spring mount to frame with two (2) flange head screws (item 4) and lock nuts (item 14) and tighten finger tight. Tighten flange nuts (item 5). Leave lock nuts (item 14) that secure spring mount to frame rail finger tight.
4. Insert second spring shackle (item 10) through rubber bushings in frame rail and onto spring shackle already placed in leaf spring. Install flange nuts (item 5) to spring shackles and tighten finger tight.

NOTE: During leaf spring installation, make sure axle and spring plate are centered on leaf spring knob.

5. Install spring plate (item 11) to top of leaf spring, then secure spring to axle with bolts (item 9) and washers (item 1). Tighten bolts (item 9) in a crossing pattern until spring plate, leaf spring and axle contact.
6. Fully tighten flange head screws (item 4) and lock nuts (item 14) securing spring mount to frame rail. Torque flange head screws (item 4) from **70 to 80 ft-lb (94 to 109 N·m)**. Also, fully tighten flange nuts (item 5).
7. Tighten bolts (item 9) securing spring plate and leaf spring to axle using a crossing pattern and the following torque values:
 - A. Tighten bolts to **25 ft-lb (33 N·m)** in a crossing pattern.
 - B. Tighten bolts from **50 to 60 ft-lb (67 to 81 N·m)** in a crossing pattern.
 - C. Retighten bolts from **50 to 60 ft-lb (67 to 81 N·m)**.
8. Install rear wheels (see Wheel Assembly in this section).
9. Lower vehicle to ground. Make sure that wheel lug nuts are properly torqued from **80 to 90 ft-lb (109 to 122 N·m)**.

Steering Wheel

Removal (Fig. 32)

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake.
2. Carefully remove steering wheel cover from steering wheel.
3. Remove hex nut and flat washer that secure steering wheel to steering control valve.
4. Pull steering wheel from control valve. If necessary, use suitable puller to remove steering wheel.

Installation (Fig. 32)

1. Apply antiseize lubricant to taper and spline on steering control valve shaft.
2. Slide steering wheel onto control valve shaft.
3. Secure steering wheel with flat washer and hex nut. Torque hex nut from **20 to 25 ft-lb (28 to 33 N·m)**.
4. Install steering wheel cover.

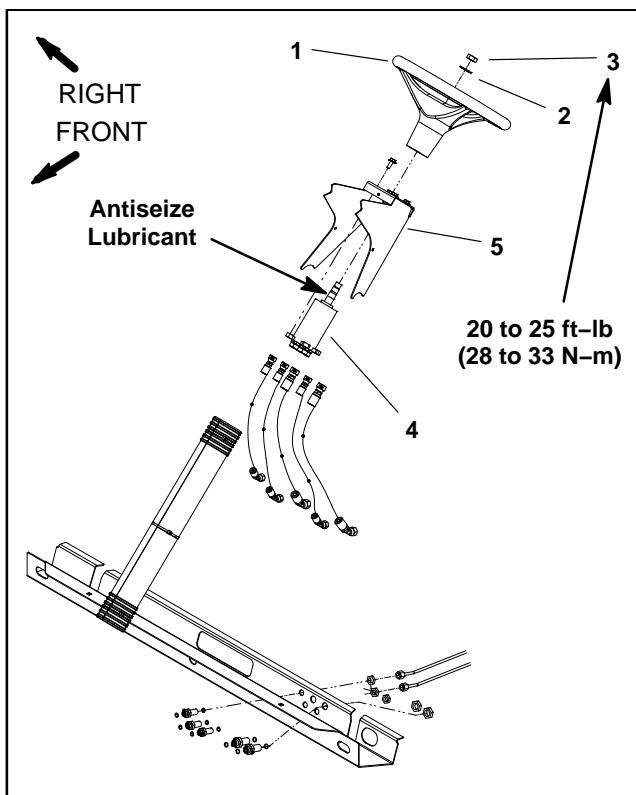


Figure 32

- | | |
|-------------------|---------------------------|
| 1. Steering wheel | 4. Steering control valve |
| 2. Flat washer | 5. Frame |
| 3. Hex nut | |

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Chassis

Seat Base

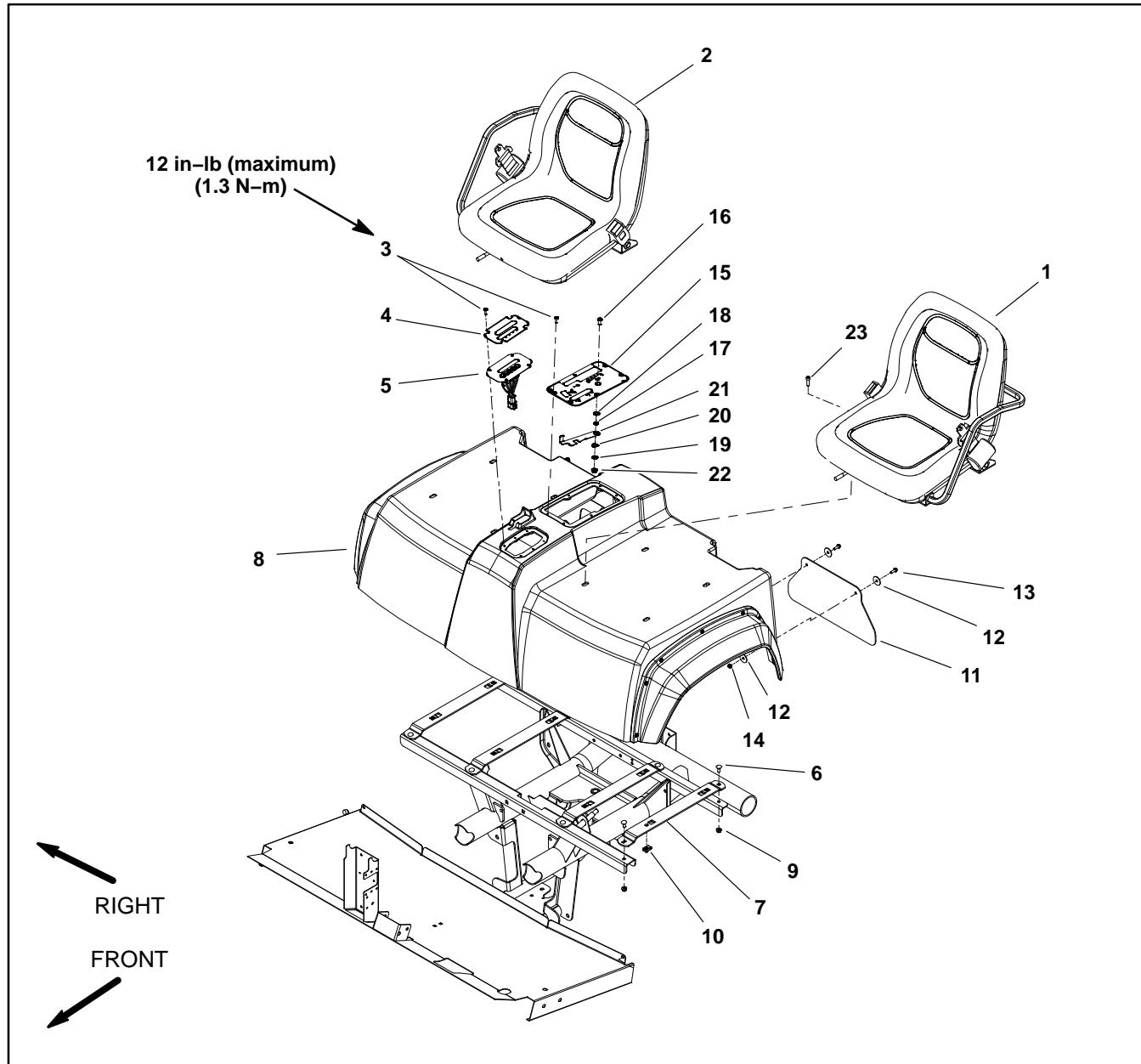


Figure 33

- | | | |
|---------------------------|---------------------------|---------------------------|
| 1. LH (operator) seat | 9. Flange nut (8) | 17. Spacer |
| 2. RH (passenger) seat | 10. U-clip nut (8) | 18. Nylon washer |
| 3. Washer head screw (10) | 11. Mudflap (2) | 19. Flat washer |
| 4. Shift decal | 12. Flat washer (8) | 20. Spring washer |
| 5. Shift plate | 13. Flange head screw (4) | 21. Detent lever |
| 6. Carriage bolt (8) | 14. Flange nut (4) | 22. Flange head screw |
| 7. Seat bracket (4) | 15. Control plate | 23. Socket head screw (8) |
| 8. Seat base | 16. Socket head screw | |

Removal (Fig. 33)

- Park vehicle on a level surface, raise and support bed (if installed), shut engine off and apply the parking brake. Remove key from ignition switch.
- Loosen hose clamps and remove CVT intake hose from ROPS cover and CVT enclosure cover (Fig. 34).

3. Lift engine coolant overflow tank from slots in rear of ROPS cover. Position overflow tank away from seat base.

4. Remove six (6) carriage screws and flange nuts that secure ROPS cover to ROPS frame. Remove cover from vehicle (Fig. 35).

5. Remove knobs from control levers (Fig. 36).
6. Remove six (6) washer head screws that secure center console control plate assembly to seat base. Remove center console control plate assembly.
7. Remove four (4) washer head screws that secure shift plate (item 5) to seat base. Lift shift plate from seat base, carefully unplug plate connector from vehicle wire harness and remove shift plate.
8. Remove four (4) socket head screws that secure each seat to vehicle. Lift both seats from vehicle.
9. Carefully lift seat base from vehicle.

Installation (Fig. 33)

1. Lower seat base to vehicle while guiding control levers through seat base opening.
2. Secure seats to vehicle with removed fasteners.
3. Secure center console control plate to seat base with removed screws. Torque screws a maximum of **12 in-lb (1.3 N·m)**. Make sure that lift lever can be moved in control plate slot to allow correct operation of lift lock.
4. Plug shift plate (item 5) connector into vehicle wire harness. Position shift plate to seat base and secure with four (4) washer head screws. Torque screws a maximum of **12 in-lb (1.3 N·m)**.
5. Install knobs on control levers.
6. Install ROPS cover to vehicle (Fig. 35).
7. Secure engine coolant overflow tank into slots in rear of ROPS cover.
8. Install CVT intake hose to ROPS cover and CVT enclosure cover (Fig. 34). Secure intake hose with hose clamps.
9. Lower bed (if installed).

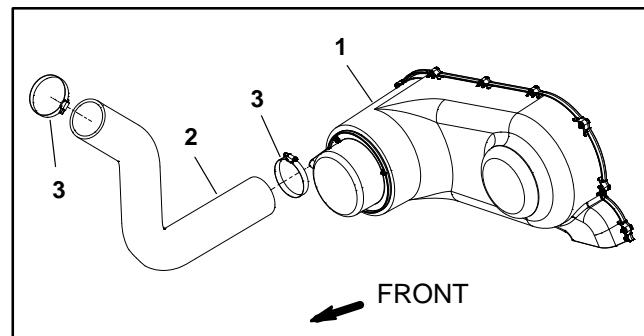


Figure 34

1. CVT enclosure cover 3. Hose clamp
2. CVT intake hose

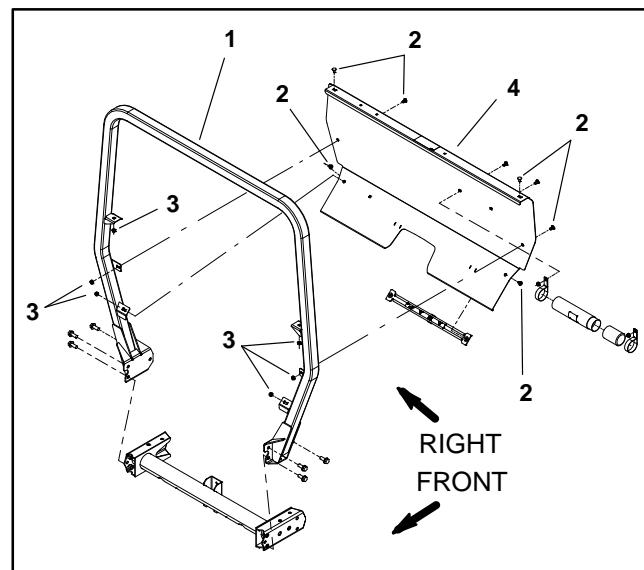


Figure 35

1. ROPS frame 3. Flange nut (6)
2. Carriage screw (6) 4. ROPS cover

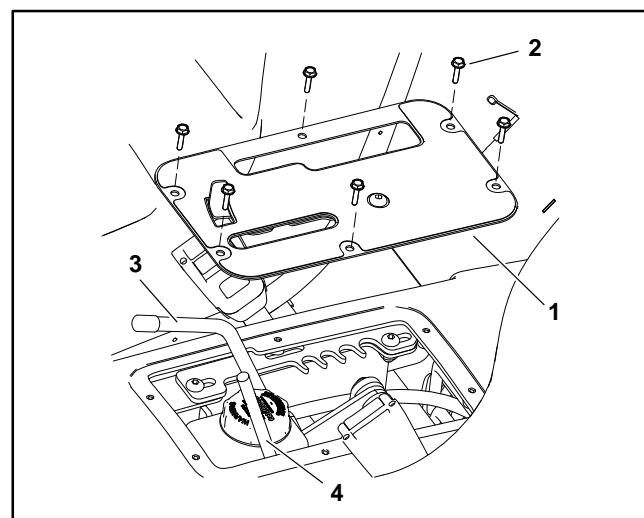


Figure 36

1. Control plate 3. Speed range lever
2. Screw (6) 4. Hydraulic lift lever

Hood

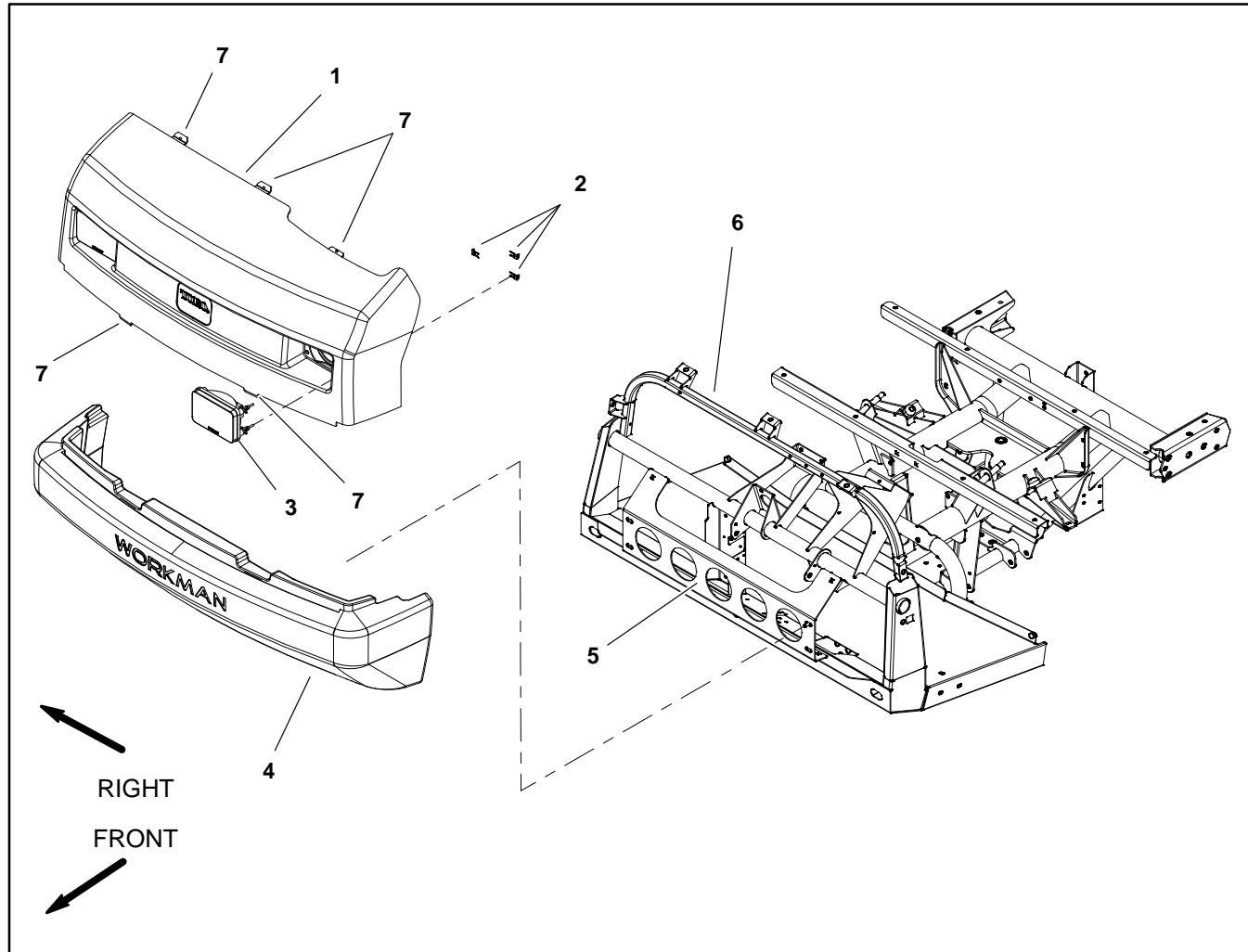


Figure 37

1. Hood
2. Clip (3 used per headlight)
3. Headlight (2)

4. Bumper
5. Bumper bracket

6. Operator frame
7. Hood mounting tab

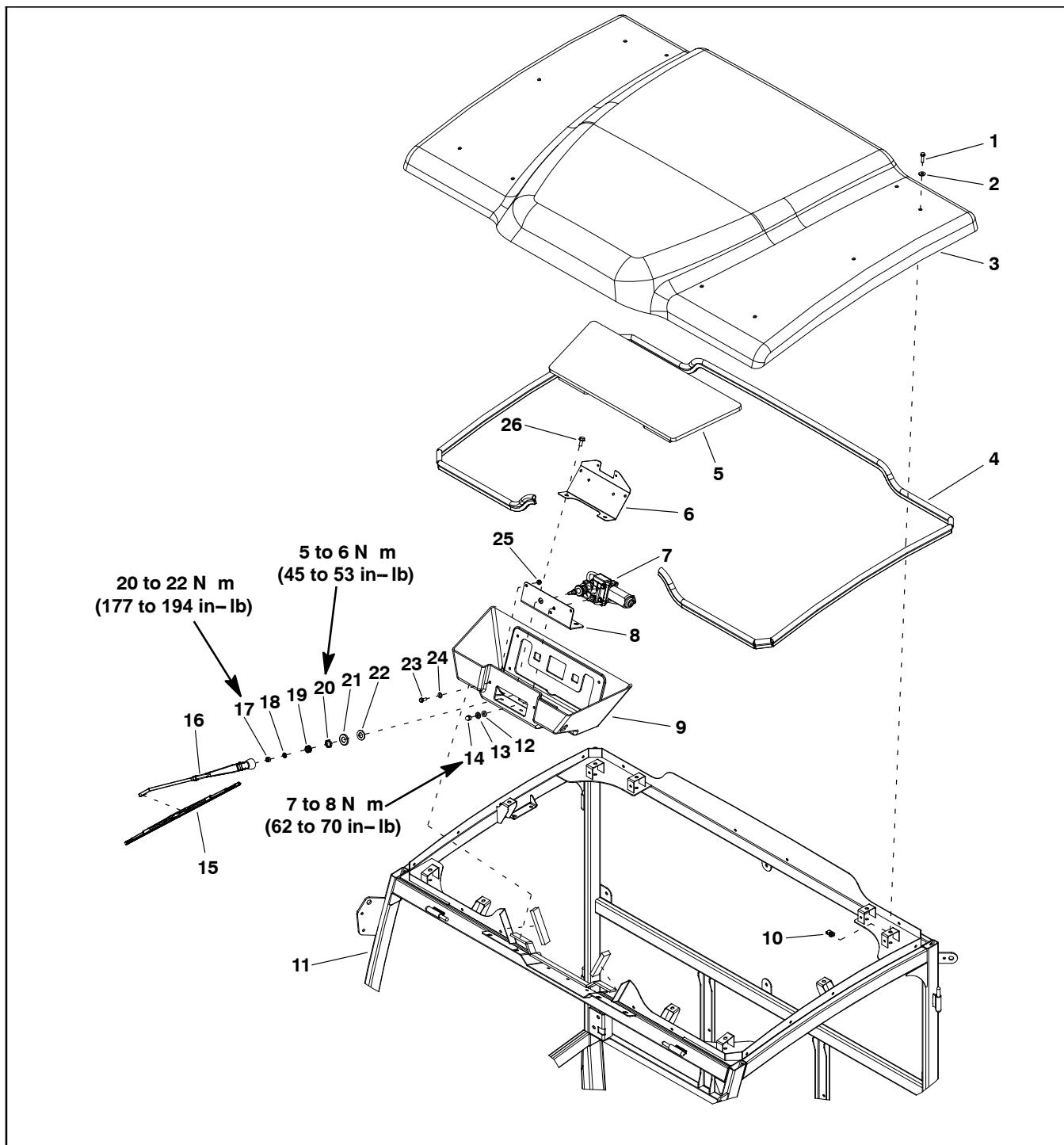
Removal (Fig. 37)

1. Park vehicle on a level surface, shut engine off and apply the parking brake. Remove key from ignition switch.
2. While grasping the hood in the headlight openings, lift up on the hood to release the lower mounting tabs from the frame slots.
3. Pivot the bottom of the hood upward until the top mounting tabs can be pulled from the frame slots.
4. Pivot the top of hood forward and unplug the wire harness connectors from the head lights.
5. Remove hood from vehicle.

Installation (Fig. 37)

1. Position hood to operator frame.
2. Plug the wire harness connector to the two (2) headlights. Insert the top mounting tabs into the frame slots.
3. Insert the lower mounting tabs (item 7) into the frame slots.
4. Ensure that the hood tabs are fully engaged in the top, side and bottom frame slots.

Windshield Wiper Assembly (Machines with Operator Cab)



Chassis

Figure 38

- | | | |
|--------------------------------|-----------------------------|--------------------------------|
| 1. Flange-head screw (10 each) | 10. Clip (10 each) | 19. Stud cover |
| 2. Sealing washer (10 each) | 11. Cab frame | 20. Wiper nut (2 each) |
| 3. Cab roof | 12. Seal washer (2 each) | 21. Cup cover (2 each) |
| 4. Bulb trim seal | 13. Cup cover (2 each) | 22. Seal washer (2 each) |
| 5. Console foam | 14. Wiper acorn nut | 23. Washer-head screw (2 each) |
| 6. Fuse block mount | 15. Wiper blade | 24. Flat washer (2 each) |
| 7. Wiper motor | 16. Wiper arm | 25. Flange nut (2 each) |
| 8. Wiper motor bracket | 17. Wiper stud nut (2 each) | 26. Washer-head screw (3 each) |
| 9. Roof console | 18. Lock washer | |

Removal (Fig. 38)

1. Park the machine on a level surface, shut off the engine, set the parking brake, and remove the key from the key switch.
2. Remove the wiper blade (item 15 in Fig. 38) from the wiper arm.
3. If necessary, remove the wiper arm as follows:
 - A. Disconnect the washer hose from the wiper arm.
 - B. Lift the cap at the top of the wiper arm and remove the wiper stud nut that secure the wiper arm to the wiper motor.
 - C. Use a suitable puller to remove the tapered wiper arm socket from the wiper motor shaft.
4. If access to the wiper motor is necessary, do as follows:
 - A. Remove the 10 clips, 10 sealing washers, and 10 flange- head screws that secure the roof to the cab frame, and remove the roof.
 - B. Remove the console foam.
5. Remove the wiper motor components as shown in Figure 38.

Installation (Fig. 38)

1. Locate the nuts on the studs at the dimensions shown before assembling the wiper motor into the console (Fig. 39).
2. Install the wiper motor components that were removed (Fig. 38) and do the following:
 - A. Ensure that the wiper motor electrical connector is secured to the cab wire harness.
 - B. Position the console foam. Secure the roof to the cab frame with the 10 clips, 10 sealing washers, and 10 flange- head screws.

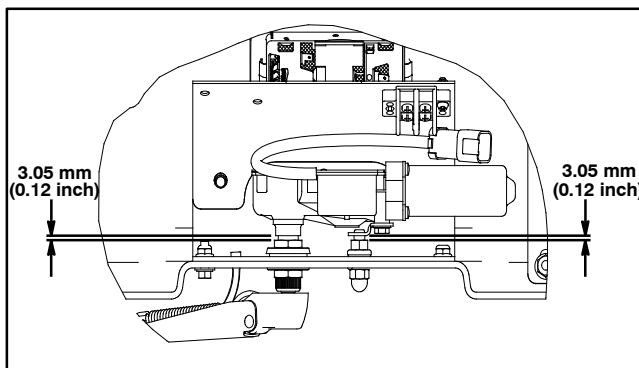


Figure 39

3. If the wiper arm was removed, do the following:
 - A. Clean the tapered wiper arm socket and wiper motor shaft.
 - B. Slide the wiper arm socket onto the wiper motor shaft and secure the wiper arm socket with the wiper stud nut. Install the wiper arm cap over the wiper stud nut.
4. If the wiper blade was removed, secure the blade to the wiper arm.



Chapter 6

Electrical System

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General Information

Operator's Manual

The Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for your Workman vehicle. Refer to the Operator's Manual for additional information when servicing the vehicle.

Electrical Drawings

The electrical schematics and other electrical drawings for Workman HDX Auto vehicles are located in Chapter 9 – Electrical Drawings.

Special Tools

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

Digital Multimeter

The digital multimeter can test electrical components and circuits for current (amps), resistance (ohms) or voltage. Obtain this tool locally.

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

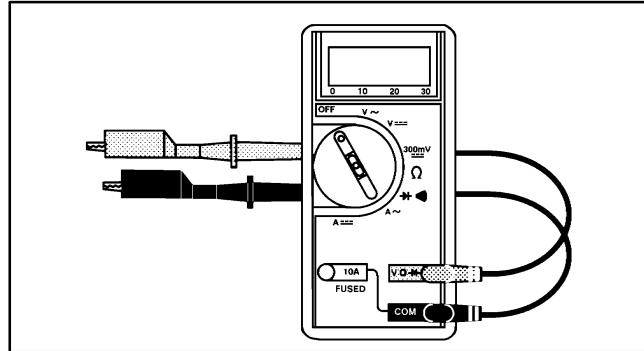


Figure 1

Dielectric Gel

Dielectric gel should be used to prevent corrosion of unsealed connection terminals. To ensure complete coating of terminals, liberally apply gel to both component and wire harness connector, plug connector to component, unplug connector, reapply gel to both surfaces and reconnect harness connector to component. Connectors should be thoroughly packed with gel for effective results.

Do not use dielectric gel on sealed connection terminals as the gel can unseat connector seals during assembly.

Toro Part Number: **107-0342**

Battery Hydrometer

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



Figure 2



Figure 3

Battery Terminal Protector

Aerosol spray that should be used on battery terminals, ring terminals and fork terminals to reduce corrosion problems. Apply terminal protector to the connection after the battery cable, ring terminal or fork terminal has been secured.

Toro Part Number: **107-0392**



Figure 4

Spark Tester

The spark tester can be used to test magneto ignitions on gasoline engines. The spark tester determines if ignition is present.

Toro Part Number: **TOR4036**



Figure 5

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 vehicle (see electrical schematics and drawings in Chapter 9 – Electrical Drawings).

If the vehicle has any interlock switches bypassed, they must be reconnected for proper troubleshooting and safety.

Condition	Possible Cause
Nothing happens when start attempt is made.	<p>Brake pedal is not depressed when attempting to start – instruct operator.</p> <p>Hydraulic lift lever is not in neutral position when attempting to start – instruct operator.</p> <p>Fuse A1 (10 amp) is faulty.</p> <p>Battery cables are loose or corroded.</p> <p>Ground connection(s) is loose or corroded.</p> <p>Battery is discharged.</p> <p>Fusible link is faulty.</p> <p>Lift lever interlock switch is out of adjustment or faulty.</p> <p>Lift lever interlock switch wiring is loose, corroded or damaged.</p> <p>Ignition switch is faulty.</p> <p>Ignition switch wiring is loose, corroded or damaged.</p> <p>Main power relay is faulty.</p> <p>Main power relay wiring is loose, corroded or damaged.</p> <p>Start relay is faulty.</p> <p>Start relay wiring is loose, corroded or damaged.</p> <p>Starter solenoid wiring is loose, corroded or damaged.</p> <p>Starter solenoid is faulty.</p>
Starter cranks, but should not, with brake pedal released.	Brake switch or circuit wiring is faulty.
Starter cranks, but should not, with hydraulic lift lever out of the neutral position.	Lift lever interlock switch is out of adjustment.

Condition	Possible Cause
Starter solenoid clicks, but starter will not crank. (If solenoid clicks, problem is not in interlock system.)	<p>Battery cables are loose or corroded.</p> <p>Ground connection(s) is loose or corroded.</p> <p>Battery is discharged or faulty.</p> <p>Cable connection at starter motor is faulty.</p> <p>Starter mounting fasteners are loose or not supplying a sufficient ground for starter operation.</p> <p>Starter solenoid is faulty.</p> <p>Starter motor is faulty.</p>
Starter cranks but engine will not start.	<p>Fuel tank is empty.</p> <p>Fuse B1 (10 Amp) is faulty.</p> <p>Wiring to interlock components is loose, corroded or damaged (see electrical schematic and wire harness drawings in Chapter 9 – Electrical Drawings).</p> <p>Fuel pump or circuit wiring is faulty.</p> <p>Engine or fuel system problem (see Chapter 3 – Kohler Gasoline Engine and/or Kohler Aegis Service Manual).</p>
Battery does not charge.	<p>Battery is faulty.</p> <p>Engine alternator or circuit wiring is faulty.</p>
Radiator fan never comes on.	<p>Fan fuse (30 Amp) is faulty.</p> <p>Fusible link is faulty.</p> <p>Fan relay or circuit wiring is faulty.</p> <p>Excessive temperature output from engine controller has not energized fan relay (see Kohler Aegis Service Manual).</p>

Electrical System Quick Checks

Battery Test (Open Circuit Test)

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

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

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 (or lower)	0% charged

NOTE: This test provides a relative condition of the battery. Load testing of the battery will provide additional and more accurate information (see Battery Service in the Service and Repairs section of this Chapter).

Charging System Test

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

Use a multimeter set to the DC volts setting. Connect the positive (+) meter lead to the positive battery post and the negative (−) meter lead to the negative battery post. Leave the test leads connected and record the battery voltage.

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

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

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

An example of a charging system that is functioning:

At least 0.50 volt over initial battery voltage.	
Initial Battery Voltage	= 12.30 v
Battery Voltage after 3 Minute Charge	= 12.95 v
Difference	= +0.65 v

Verify Interlock System Operation

The purpose of the interlock system is to prevent the engine from cranking or starting unless the brake pedal is depressed and the hydraulic lift lever is in the neutral position.



CAUTION

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

To verify brake interlock switch operation:

1. Sit on operator's seat and engage parking brake. Move transmission lever to NEUTRAL or PARK position. Make sure that hydraulic lift lever is in neutral position.
2. Without depressing the brake pedal, rotate ignition switch to START position.
3. If engine cranks or starts, there is a malfunction in the interlock system that must be repaired before operating vehicle.

To verify operation of hydraulic lift lever interlock switch:

1. Sit on operator's seat and engage parking brake. Move transmission lever to NEUTRAL or PARK position.
2. Move hydraulic lift lever out of neutral position.
3. Depress brake pedal and rotate ignition switch to START position.
4. If engine cranks or starts, there is a malfunction in the interlock system that must be repaired before operating vehicle.

NOTE: Refer to Installation Instructions and Operator's Manuals for any attachments on your Workman for procedures on checking the attachment interlock system.

Component Testing

This section will define electrical component operation and supply test procedures that can be performed on those components.

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

NOTE: Electrical troubleshooting of any 12 volt power connection can also be performed through voltage drop tests without disconnecting the component.



CAUTION

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

Ignition (Key) Switch

The ignition (key) switch has three (3) positions: OFF, RUN and START. The ignition switch is located on the dash (Fig. 6).

Testing

1. Park machine on a level surface, stop engine, apply parking brake and remove key from ignition switch.
2. To ease access to ignition switch, remove hood of vehicle (see Hood in the Service and Repairs section of Chapter 5 – Chassis).
3. Locate ignition switch on dash and disconnect wire harness electrical connector from the switch.
4. With the use of a multimeter (ohms setting), the ignition switch functions may be tested to determine whether continuity exists between the various terminals for each switch position. The switch terminals are marked as shown in Figure 7. The circuitry of this switch is shown in the chart below. Verify continuity between ignition switch terminals for each switch position.

POSITION	CIRCUITS
OFF	NONE
RUN	B + C + F, D + E
START	A + B + C

5. Replace ignition switch if testing proves it to be faulty.
6. After testing, connect wire harness electrical connector to the ignition switch.
7. Install hood if it was removed (see Hood in the Service and Repairs section of Chapter 5 – Chassis).

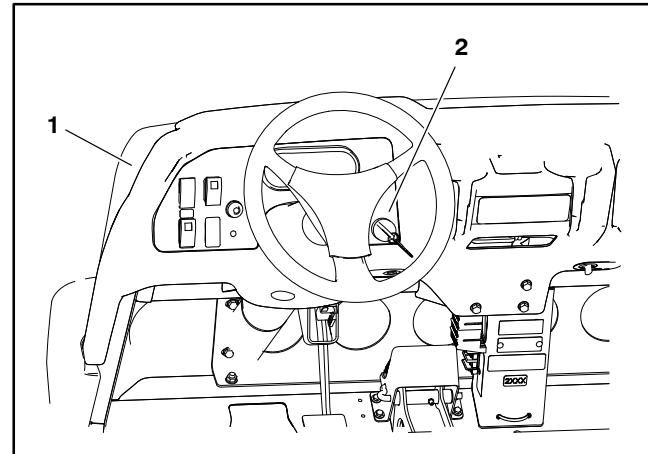


Figure 6
1. Dash
2. Ignition switch

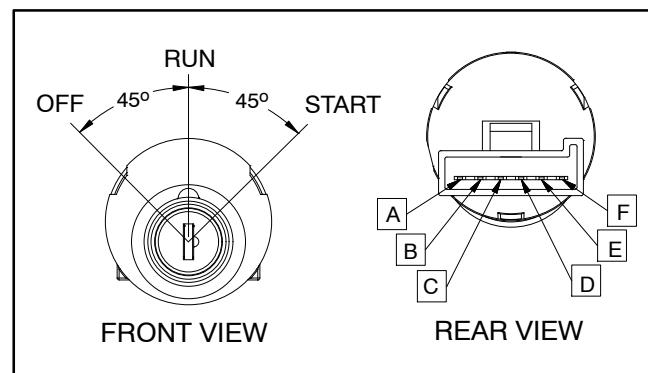


Figure 7

Gauge Cluster

Hourmeter

The hourmeter should move 1/10 of an hour for every six (6) minutes that the ignition switch is in the RUN position.

Fuel Level Gauge

The fuel level gauge displays the approximate amount of fuel remaining in the fuel tank. Additionally, a red LED will illuminate when the fuel tank is low and the LED will flash when the tank is near empty.

Oil Pressure Warning Light

The oil pressure LED should come on when the ignition key switch is in the RUN position with the engine not running or if the engine oil pressure switch closes during engine operation due to low oil pressure.

IMPORTANT: If the oil pressure warning light flickers or remains on, stop the vehicle, turn off the engine and check the engine oil level. If the oil level was low, but adding oil does not cause the light to go out when the engine is restarted, turn the engine off immediately and contact your Toro distributor for assistance.

Speedometer

The speedometer displays the vehicle ground speed. Speed is shown in miles per hour (MPH) but can be converted to kilometers per hour (KPH) by changing the status of the wire harness MPH/KPH shunt.

Engine Coolant Temperature Gauge

The temperature gauge displays the engine coolant temperature. If the coolant temperature exceeds 230F (110C), the temperature gauge will display a blinking red LED.

Tachometer

The tachometer displays the engine speed.

Check Engine Light

The check engine LED will illuminate if an engine fault is detected by the engine electronic controller. For additional information, see Chapter 3 - Kohler Engine and Kohler Aegis Service Manual.

Charging Light

The charging light LED should come on when the ignition key switch is in the ON position with the engine not running or if the charging circuit is not operating properly during the engine operation.

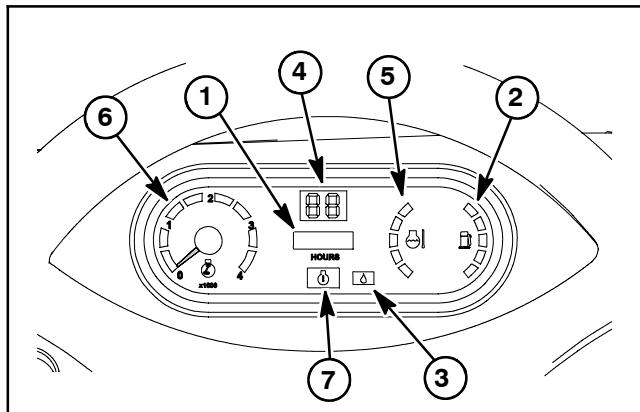


Figure 8A (Serial below 403430001)

- | | |
|-----------------------|----------------------|
| 1. Hourmeter | 5. Temperature gauge |
| 2. Fuel level gauge | 6. Tachometer |
| 3. Oil pressure light | 7. Engine light |
| 4. Speedometer | |

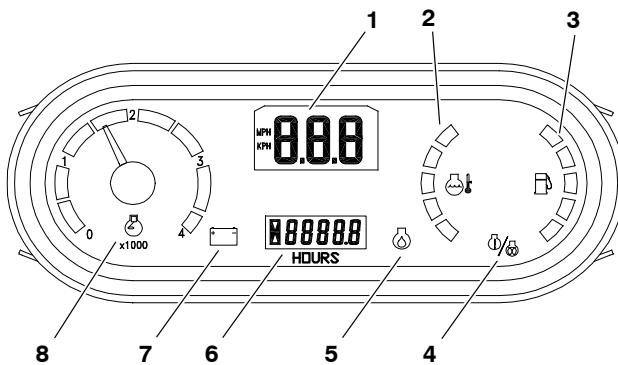


Figure 8B (Serial below 403430001)

- | | |
|---------------------------------|-----------------------|
| 1. Speedometer | 5. Oil pressure light |
| 2. Temperature gauge | 6. Hourmeter |
| 3. Fuel level gauge | 7. Charging light |
| 4. Glow plug/Check engine light | 8. Tachometer |

Fuses

The fuse block is located below the center of the dash panel (Fig. 9).

Identification and Function (Fig. 10)

Top Row Position A2 (15 amp): Protects power point circuit.

Top Row Position A1 (10 amp): Protects engine start circuit.

Second Row Position B2 (10 amp): Protects power supply circuit for hazard lights (if equipped).

Second Row position B1 (10 amp): Protects power supply circuit for ignition switch ON.

Third Row Position C2 (15 amp): Protects power supply circuit for differential lock.

Third Row Position C1 (10 amp): Protects power supply circuit for speedometer and engine tachometer.

Fourth Row Position D2 (15 amp): Protects power supply circuit for headlights and rear lights.

Fourth Row Position D1 (30 amp): Protects power supply circuit for horn.

NOTE: Fuse positions A3, B3, C3 and D3 may be used for accessory kits on your Workman.

A 30 amp fuse is located in an in-line fuse holder near the cooling fan. This fuse protects the power supply for the radiator fan.

A 15 amp fuse is located in an in-line fuse holder near the engine starter motor. This fuse protects the power supply for the engine starter solenoid circuit.

Fuse Testing

1. Make sure that ignition switch is OFF and key is removed from switch.
2. Remove fuse from fuse block for testing.
3. Fuse should have continuity across the terminals.

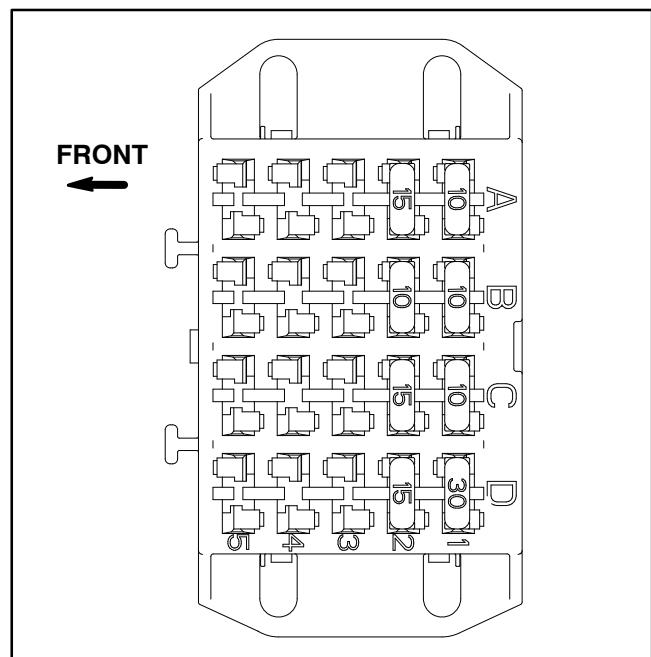


Figure 9

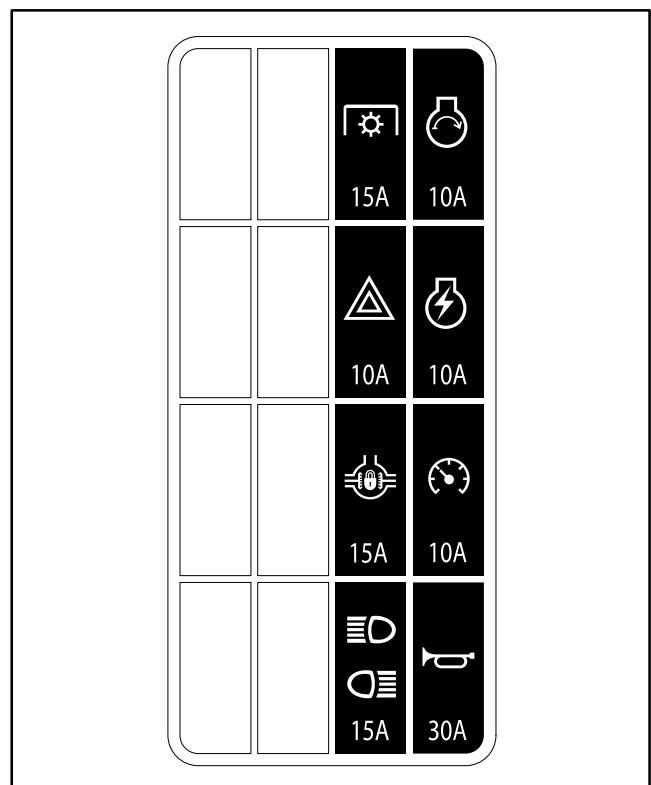


Figure 10

Headlight Switch

This headlight switch allows the headlights to be turned on and off. The headlight switch is located on the dash (Fig. 11).

Testing

1. Park machine on a level surface, stop engine, apply parking brake and remove key from ignition switch.
2. To ease access to headlight switch, remove hood of vehicle (see Hood in the Service and Repairs section of Chapter 5 – Chassis).
3. Locate headlight switch on dash and disconnect wire harness electrical connector from the switch.
4. With the use of a multimeter (ohms setting), the headlight switch functions may be tested to determine whether continuity exists between the various terminals for each switch position. The switch terminals are marked as shown in Figure 12. The circuitry of this switch is shown in the chart below. Verify continuity between switch terminals for each switch position.

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

5. Replace headlight switch if testing proves it to be faulty.
6. After testing, connect wire harness electrical connector to the headlight switch.
7. Install hood if it was removed (see Hood in the Service and Repairs section of Chapter 5 – Chassis).

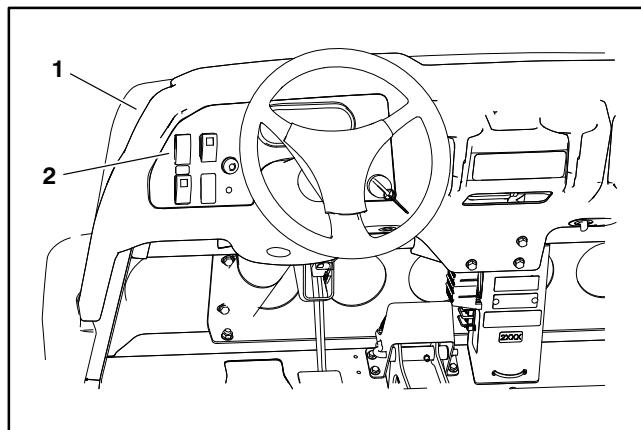


Figure 11

1. Dash

2. Headlight switch

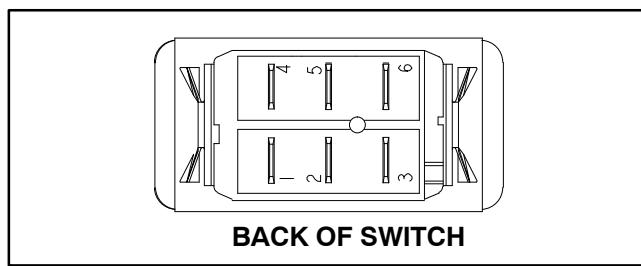


Figure 12

Rear Differential Lock Switch

The rear differential lock switch allows the rear axle differential to be locked for increased traction or un-locked for normal differential operation. The rear differential lock switch is located on the dash (Fig. 13). An indicator light on the differential lock switch identifies when the rear differential is locked.

The differential lock mechanism is in the locked position when the differential solenoid is de-energized. During vehicle operation with the rear differential lock switch in the normal position, the rear differential solenoid will be energized by the circuit made through the switch and the de-energized rear differential relay. This will allow the rear wheels to rotate individually (unlocked). The indicator on the differential lock switch will not be illuminated when the switch is in the normal position.

When the rear differential lock switch is held in the momentary (locked) position, the circuit through the switch and the de-energized rear differential relay will open. This will cause the rear differential solenoid to de-energize, locking the rear differential and thus the rear wheels. The indicator on the differential lock switch will be illuminated when the switch is in the momentary position.

NOTE: The rear differential lock switch can be used to lock or unlock the differential while the vehicle is in motion.

If the parking brake is applied or the transmission is in the neutral or park position while operating the vehicle (ignition key in the RUN or START position), the rear differential relay will be energized, opening the circuit and de-energizing the rear differential solenoid and locking the differential. This will ensure that the rear wheels are locked when the vehicle is parked while running.

When the ignition switch is set to the OFF position, no power is available to the circuit and the rear differential solenoid will be de-energized, locking the differential. This will ensure that the rear wheels are locked when the vehicle is parked while OFF.

Testing

1. Park machine on a level surface, stop engine, apply parking brake and remove key from ignition switch.
2. To ease access to differential lock switch, remove hood of vehicle (see Hood in the Service and Repairs section of Chapter 5 – Chassis).
3. Locate rear differential lock switch on dash and disconnect wire harness electrical connector from the switch.

4. With the use of a multimeter (ohms setting), the rear differential lock switch functions may be tested to determine whether continuity exists between the various terminals for each switch position. The switch terminals are marked as shown in Figure 14. The circuitry of this switch is shown in the chart below. Verify continuity between switch terminals for each switch position.

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

5. Replace rear differential lock switch if testing proves it to be faulty.
6. After testing, connect wire harness electrical connector to the rear differential lock switch.
7. Install hood if it was removed (see Hood in the Service and Repairs section of Chapter 5 – Chassis).

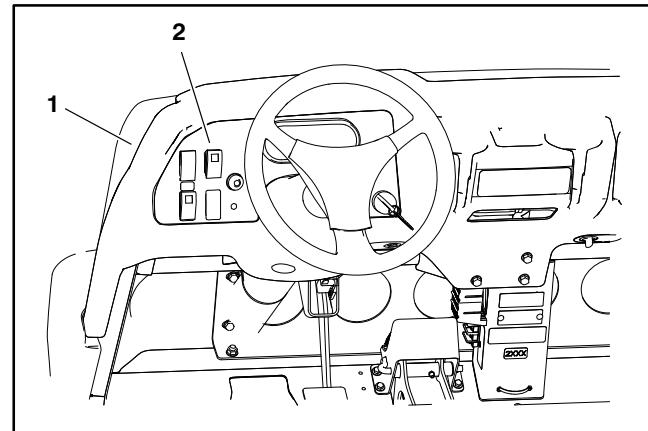


Figure 13

1. Dash

2. Rear differential switch

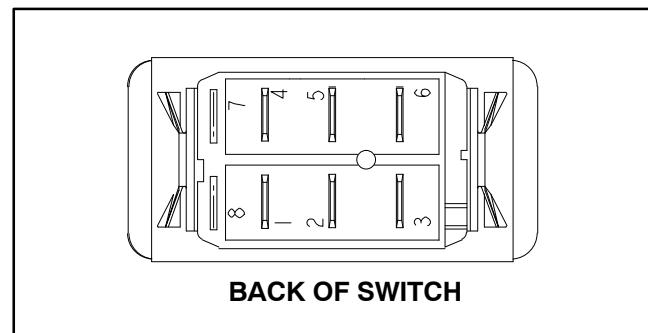


Figure 14

Brake Switch

The brake switch is a normally closed switch that is attached to the frame under the dash (Fig. 15). When the brakes are not applied, the brake pedal presses the brake switch plunger to open the switch. When the brakes are applied, the pedal moves away from the brake switch plunger to allow the switch to be in the normally closed state. This will allow a current path to energize the start enable relay and also to illuminate the stop lights.

Testing

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake. Locate the brake switch (Fig. 15).
2. To ease access to brake switch, remove hood of vehicle (see Hood in the Service and Repairs section of Chapter 5 – Chassis).
3. Disconnect the wire harness connector from the brake switch.
4. With the use of a multimeter (ohms setting), test for continuity across the two (2) switch terminals. There **should be** continuity (zero ohms) when the brake pedal is depressed (switch plunger extended). There **should not be** continuity (infinite ohms) when the brake pedal is released (switch plunger depressed).
5. Replace brake switch if testing proves it to be faulty.
6. After switch testing is completed, connect the wire harness connector to the brake switch.
7. Install hood if it was removed (see Hood in the Service and Repairs section of Chapter 5 – Chassis).

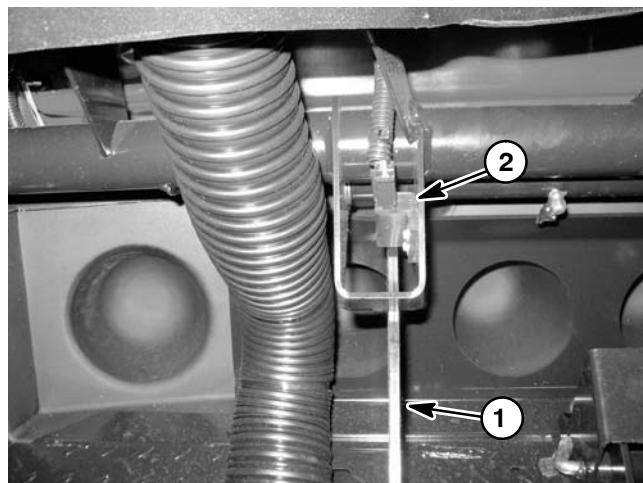


Figure 15

1. Brake pedal

2. Brake switch

Parking Brake Switch

The parking brake switch is a normally closed proximity switch that is attached to the control lever support (Fig. 16). The switch is in its normal closed position when the parking brake **is applied**. When the parking brake **is not** applied, the parking brake lever is positioned close to the brake switch causing the switch to open. The closed brake switch is used in the starting interlock system to make sure that the drive system is disengaged during engine starting.

NOTE: When the parking brake is applied, the rear differential relay is energized which opens the circuit to the rear differential locking solenoid. The de-energized solenoid locks the rear differential while the vehicle is stationary with the parking brake applied.

Testing

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake. Locate the parking brake switch (Fig. 16).
2. Remove seat base to gain access to parking brake switch (see Seat Base in the Service and Repairs section of Chapter 5 – Chassis).
3. Disconnect the wire harness connector from the parking brake switch.
4. With the use of a multimeter (ohms setting), test for continuity across the two (2) switch terminals. There **should be** continuity (zero ohms) when the parking brake is applied and there **should not be** continuity (infinite ohms) when the parking brake is released.
5. Replace parking brake switch if testing proves it to be faulty.
6. After switch testing is completed, connect the wire harness connector to the parking brake switch.
7. Install seat base to machine (see Seat Base in the Service and Repairs section of Chapter 5 – Chassis).

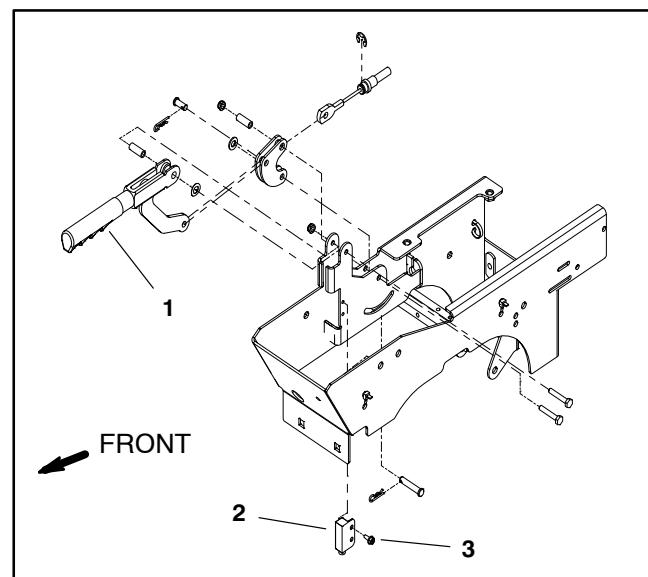


Figure 16

1. Parking brake lever
2. Parking brake switch
3. Screw (2)

Hydraulic Lift Lever Interlock Switch

The lift lever interlock switch is a normally open proximity switch that is attached to the control lever support (Fig. 17). The interlock switch is in its normal open position whenever the hydraulic lift lever is moved away from the neutral position. When the lift lever is in the neutral position, the retainer pin that attaches the lift lever link to the lift valve is positioned close to the interlock switch causing the switch to close. The closed lift lever switch is used in the starting interlock system to make sure that the hydraulic lift circuit is disengaged during engine starting.

Testing

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake.
2. Remove knobs from control levers, then remove control plate assembly from seat base (Fig. 18).
3. Locate the hydraulic lift lever interlock switch (Fig. 17).
4. Disconnect the wire harness connector from the lift lever interlock switch.
5. With the use of a multimeter (ohms setting), test for continuity across the two (2) switch terminals. There **should be** continuity (zero ohms) when the lift lever is in the neutral position and there **should not be** continuity (infinite ohms) when the lever is not in the neutral position.
6. Replace lift lever interlock switch if testing proves it to be faulty.
7. After switch testing is completed, connect the wire harness connector to the lift lever interlock switch.
8. Secure center console control plate to seat base with removed screws. Torque screws a maximum of **12 in-lb (1.3 N-m)**. Install knobs on control levers.

Adjustment

The hydraulic lift lever interlock switch should be adjusted so that the engine will not crank if the hydraulic lift lever is locked in the forward position by the detent lever. The engine should crank if the hydraulic lift lever is in any other position when the interlock switch is adjusted correctly.

NOTE: Remove seat base if hydraulic lift lever interlock switch needs to be adjusted (see Seat Base in the Service and Repairs section of Chapter 5 – Chassis).

Adjust interlock switch position by loosening lock nut and moving switch for proper operation (Fig. 19). Tighten lock nut after adjustment.

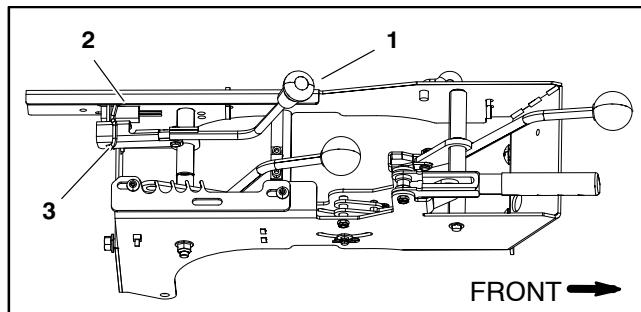


Figure 17

1. Lift lever
2. Interlock switch
3. Retainer pin

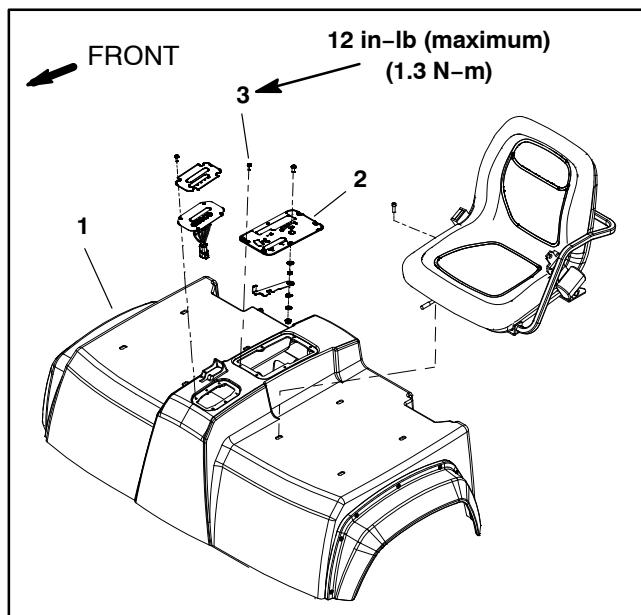


Figure 18

1. Seat base
2. Control plate
3. Screw (6)

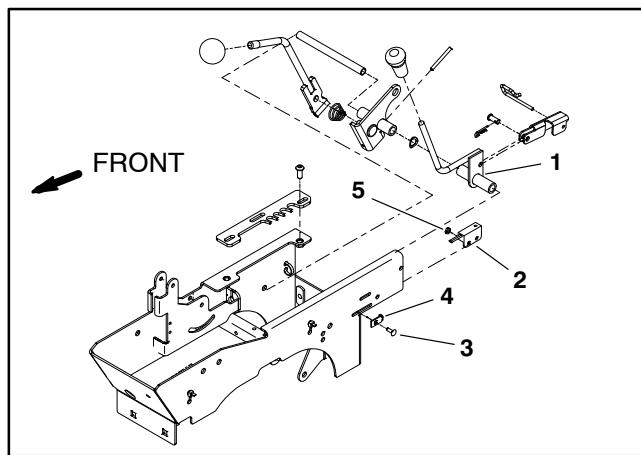


Figure 19

1. Lift lever
2. Switch
3. Carriage screw
4. Switch plate
5. Lock nut

High Flow Hydraulics Switch (Vehicles with High Flow Hydraulics)

On vehicles equipped with the high flow hydraulics kit, the switch to engage the high flow hydraulic circuit is mounted on the dash (Fig. 20). When the high flow hydraulics kit switch is ON, the solenoid coil on the control manifold is energized to allow hydraulic flow to the attachment. An indicator light on the high flow hydraulics switch identifies when the switch is ON.

Testing

1. Park machine on a level surface, stop engine, apply parking brake and remove key from ignition switch.
2. To ease access to high flow switch, remove hood of vehicle (see Hood in the Service and Repairs section of Chapter 5 – Chassis).
3. Locate high flow hydraulics switch on dash and disconnect wire harness electrical connector from the switch.
4. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each switch position. The switch terminals are marked as shown in Figure 21. The circuitry of this switch is shown in the chart below. Verify continuity between switch terminals for each switch position. Replace switch if testing proves it to be faulty.

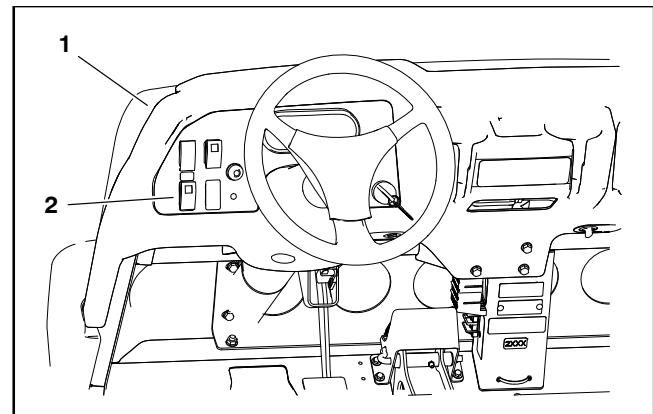


Figure 20

1. Dash

2. High flow switch

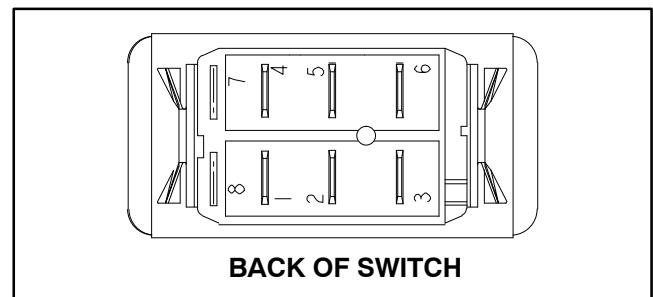


Figure 21

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

5. Replace high flow hydraulics switch if testing proves it to be faulty.
6. After testing, connect wire harness electrical connector to the high flow hydraulics switch.
7. Install hood if it was removed (see Hood in the Service and Repairs section of Chapter 5 – Chassis).

Front Differential Interrupter Switch (Vehicles with 4WD)

The front differential interrupter switch is a normally closed switch that opens when the accelerator pedal **is not** depressed. When the accelerator pedal **is** depressed for vehicle acceleration, the flange on the accelerator pedal moves away from the switch plunger to allow the switch to be in its normally closed state. The differential interrupter switch is attached to the pedal support frame under the dash panel (Fig. 22).

Testing

1. Park machine on a level surface, stop engine, apply parking brake and remove key from ignition switch.
2. To ease access to interrupter switch, remove hood of vehicle (see Hood in the Service and Repairs section of Chapter 5 – Chassis).
3. Locate front differential interrupter switch for testing. Disconnect vehicle wire harness electrical connector from the interrupter switch.
4. Check the continuity of the switch by connecting a multimeter (ohms setting) across the connector terminals.
5. When the switch plunger is extended (accelerator pedal **is** depressed), there should be continuity (closed) between the switch terminals.
6. When the switch plunger is depressed (accelerator pedal **is not** depressed), there should not be continuity (open) between the switch terminals.
7. Replace interrupter switch if testing determines that it is faulty. When installing switch, make sure that the brake pedal does not bottom switch when the pedal is released.
8. If the interrupter switch tests correctly and a circuit problem still exists, check wire harness (see Electrical Schematic and Circuit Drawings in Chapter 7 – Electrical Drawings).
9. When interrupter switch testing is completed, connect switch connector to vehicle wire harness.
10. Install hood of vehicle if it was removed (see Hood in the Service and Repairs section of Chapter 5 – Chassis).

Adjustment

Make sure that the flange of the accelerator pedal is against the stop. The plunger of the switch should be bottomed out in the switch. If necessary, loosen switch fasteners and reposition switch. Tighten fasteners after adjustment.

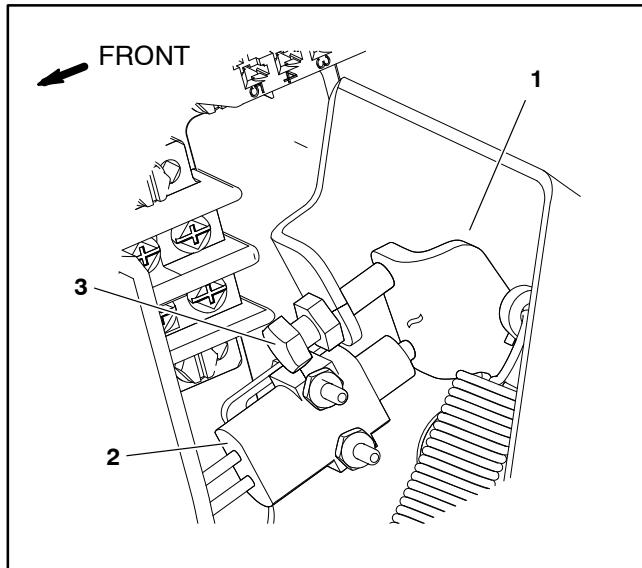


Figure 22

1. Accelerator pedal flange 3. Accelerator pedal stop
2. Interrupter switch

Main Power Relay (Four Terminals)

The main power relay is used to provide electrical power to the majority of the Workman circuits. When the ignition key is in either the RUN or START position, the main power relay is energized. The main power relay is attached to the relay bracket under the right side of the bed near the engine (Fig. 23).

Testing

1. Park machine on a level surface, raise bed, stop engine, apply parking brake and remove key from ignition switch.
2. Install bed support on bed lift cylinder to prevent bed from lowering.
3. Locate main power relay and disconnect the machine wire harness connector from the relay. Remove relay from machine for easier testing.

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

4. Verify coil resistance between main power terminals 85 and 86 with a multimeter (ohms setting) (Fig. 24). Resistance should be approximately **72 ohms**.
5. Connect multimeter (ohms setting) leads to main power relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay should have continuity between terminals 30 and 87 as +12 VDC is applied to terminal 85. The relay should not have continuity between terminals 30 and 87 as +12 VDC is removed from terminal 85.
6. Replace main power relay if testing determines that relay is faulty.
7. After testing is complete, install main power relay to relay bracket and connect wire harness connector to relay.
8. Remove bed support from cargo bed lift cylinder and lower bed.

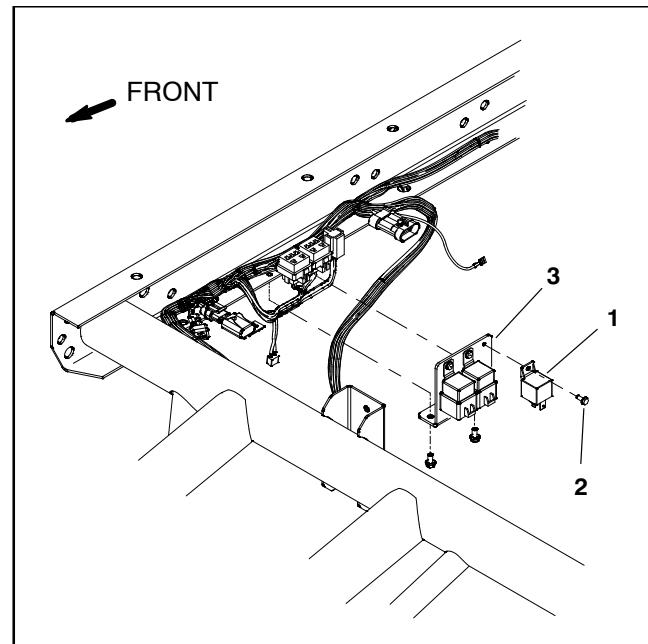


Figure 23

1. Main power relay
2. Screw
3. Relay bracket

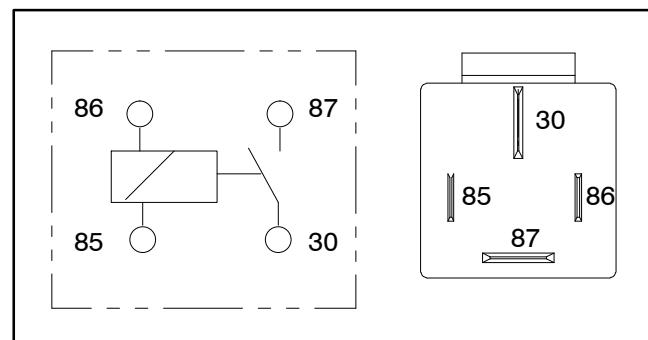


Figure 24

Relays with Five (5) Terminals

Workman HDX Auto vehicles use a number of relays that have five (5) terminals:

The start relay ensures that the hydraulic lift lever is in neutral before the engine starter solenoid can be energized. The start relay also prevents starting if the high flow hydraulics system (if equipped) is engaged.

The fan relay allows powers to the engine cooling fan when the relay is energized.

The start enable relay ensures that the brake pedal is depressed before the engine starter motor can be engaged.

The rear differential relay is used to make sure that the rear differential solenoid is not energized when the parking brake is applied or if the transmission is in the neutral or park position. This will ensure that the rear wheels are locked when the vehicle is parked.

The front differential relay on vehicles equipped with 4WD is used to disengage the front wheel drive differential solenoid. If the front differential interrupter switch is pressed or the transmission is in the neutral or park position, the front differential relay will be de-energized to ensure that front wheel drive is disengaged.

The start and fan relays are attached to the relay bracket under the right side of the bed near the engine (Fig. 25). The other relays are located behind the dash panel (Fig. 26).

Testing

1. Park machine on a level surface and apply parking brake.
2. If relay is located on relay bracket (Fig. 25), raise bed and install bed support on bed lift cylinder to prevent bed from lowering. Stop engine and remove key from ignition switch.
3. If relay is located behind the dash panel (Fig. 26), remove hood to access relay (see Hood in the Service and Repairs section of Chapter 5 – Chassis).
4. Locate relay that is to be tested and disconnect the wire harness connector from the relay. Remove relay from machine for easier testing.

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

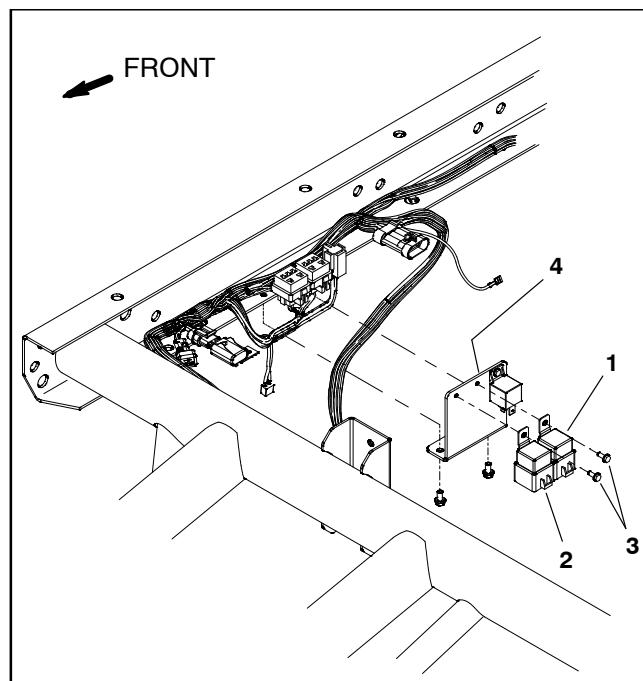


Figure 25

- 1. Start relay
- 2. Fan relay
- 3. Screw (2)
- 4. Relay bracket

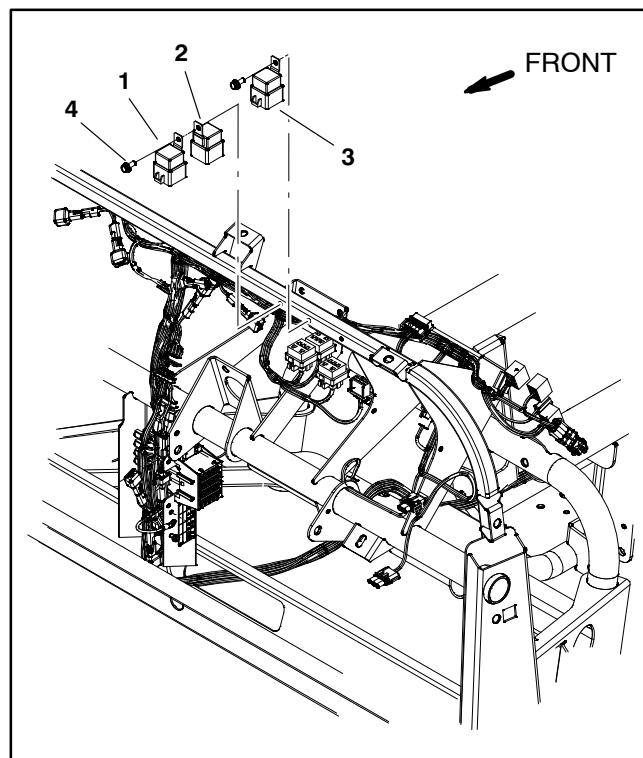


Figure 26

- 1. Start enable relay
- 2. Rear differential relay
- 3. Front differential relay
- 4. Screw

5. Using a multimeter (ohms setting), measure coil resistance between terminals 85 and 86 (Fig. 27). Resistance should be between **70 and 90 ohms**.

6. Connect multimeter (ohms setting) leads to relay terminals 30 and 87 (Fig. 27). Ground terminal 86 and apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87 as +12 VDC is applied and removed from terminal 85.

7. Disconnect voltage from terminal 85 and multimeter lead from terminal 87.

8. Connect multimeter (ohms setting) leads to relay terminals 30 and 87A. Apply +12 VDC to terminal 85. The relay should make and break continuity between terminals 30 and 87A as +12 VDC is applied and removed from terminal 85.

9. Disconnect voltage and multimeter leads from the relay terminals.

10. Replace relay if testing determines that relay is faulty.

11. After testing is complete, secure relay to machine and connect wire harness connector to relay.

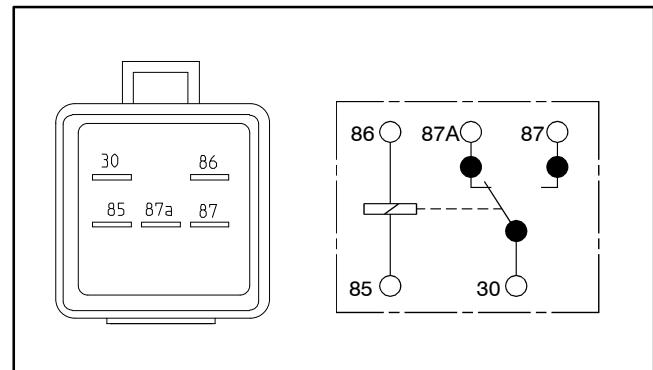


Figure 27

Diode Assemblies

The protection diode assembly is used for starting circuit protection from voltage spikes that occur when the starter solenoid is de-energized. This diode plugs into the rear wire harness under the right side of the bed near the engine.

Four (4) diode assemblies are used for circuit logic in the transmission gear selection system. The park, reverse low and high diode assemblies plug into the front wire harness behind the dash.

If a vehicle is equipped with the optional light kit that includes flashers, two (2) additional diode assemblies are used for flasher circuit logic. These diodes plug into the front wire harness behind the dash. The LH diode (GREEN harness wire) and RH diode (BROWN harness wire) can be identified by the color of the wire harness conductor at the harness connector for the diode.

The diode assemblies can be identified by a black color and a diode symbol on the end of the diode assembly body (Fig. 28). Refer to the appropriate wire harness drawings in Chapter 9 – Electrical Drawings for additional information on diode assembly location.

Testing

1. Park vehicle on a level surface, engage parking brake. Stop the engine and remove key from ignition switch. Allow engine to cool.

2. Locate diode assembly that is to be tested:

A. For protection diode testing, raise and support the cargo bed. Make sure engine is off and key is removed from switch after raising bed. Locate protection diode in rear wire harness.

B. For other diodes, remove hood from machine to access front wire harness behind the dash (see Hood in the Service and Repairs section of Chapter 5 – Chassis).

3. Remove cable tie that secures diode to wire harness. Unplug the diode from the wire harness for testing.

4. A diode assembly can be tested using a digital multimeter (diode test or ohms setting) and the table **below**.

Multimeter Red Lead (+) on Terminal	Multimeter Black Lead (-) on Terminal	Continuity
Female	Male	YES
Male	Female	NO

5. If testing determines that a diode assembly is faulty, replace diode assembly.

6. After diode testing is complete, make sure that diode assembly is fully installed into wire harness connector and secured to harness with cable tie.

7. If cargo bed was raised, remove bed support from bed lift cylinder and lower bed. If hood was removed, install hood to machine.

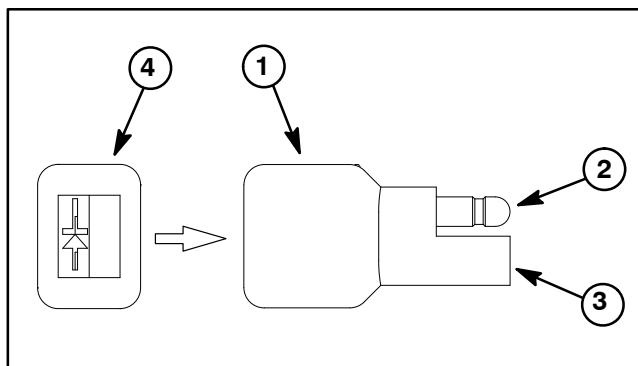


Figure 28

1. Diode assembly
2. Male terminal
3. Female terminal
4. End of diode body

Fusible Link

A Workman HDX Auto vehicle uses three (3) fusible links for circuit protection. These fusible links are located in a harness that connects the engine starter motor B+ terminal to the vehicle rear wire harness (Fig. 29). If any of these links should fail, current to the protected circuit will cease. Refer to electrical schematics and wire harness drawings in Chapter 9 – Electrical Drawings for additional fusible link information.

Testing

1. Park machine on a level surface, raise bed, stop engine, apply parking brake and remove key from ignition switch.
2. Install bed support on bed lift cylinder to prevent bed from lowering.
3. Disconnect negative battery cable from battery terminal and then disconnect positive cable from battery (see Battery Service in the Service and Repairs section of this chapter).
4. Locate and unplug fusible link connector P1 from vehicle wire harness.
5. Use a multimeter to make sure that continuity (zero ohms) exists between each terminal pin in connector P1 and connector J1 at the starter (Fig. 30). If any of the fusible links are open (infinite ohms), replace the fusible link harness.
6. After testing is complete, make sure that fusible link harness connectors are securely attached to starter and vehicle wire harness.
7. Connect positive battery cable to battery terminal first and then connect negative cable to battery.
8. Remove bed support from cargo bed lift cylinder and lower bed.

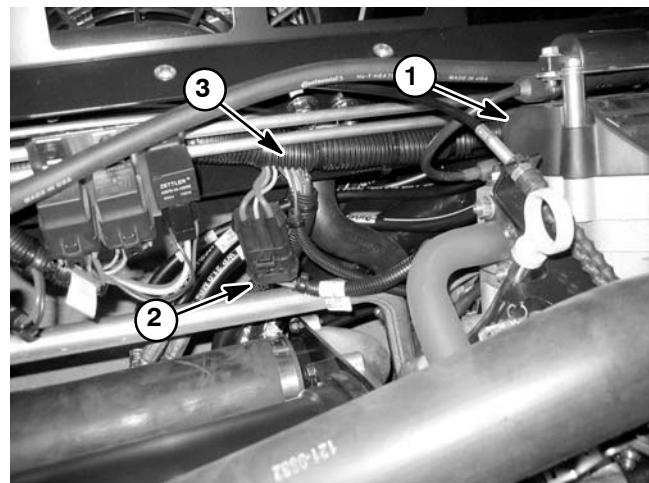


Figure 29

1. Engine
2. Fusible link harness
3. Rear wire harness

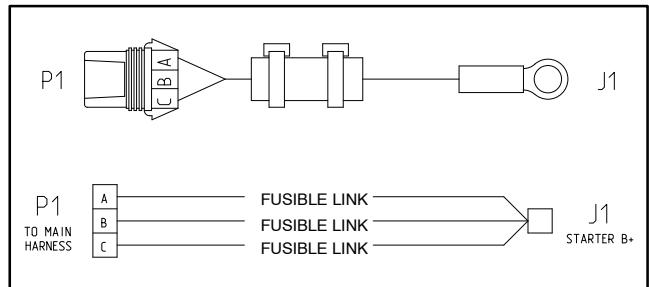


Figure 30

Fuel Gauge Sender

The fuel gauge sender on Workman HDX Auto vehicles is included with the fuel pump assembly that fits into the fuel tank (Fig. 31).

Testing

1. Park machine on a level surface, raise bed, stop engine, apply parking brake and remove key from ignition switch. Install bed support on bed lift cylinder to prevent bed from lowering.
2. Disconnect the wire harness connector from the fuel pump assembly.



CAUTION

When testing circuit wiring and fuel gauge sender, make sure wire connections are secure before turning ignition switch to RUN to prevent an explosion or fire from sparks.

3. To test the circuit wiring and fuel gauge on the dash, use a jumper wire to connect the two (2) terminals in the fuel pump assembly wire harness connector. Make sure that jumper wire connections are secure. Turn ignition switch to ON. Fuel gauge should indicate a full fuel tank. Turn ignition switch OFF and continue testing fuel sender if circuit wiring and gauge are acceptable.

4. Remove fuel pump assembly from the fuel tank (see Fuel Pump in the Service and Repairs section of Chapter 3 – Kohler Gasoline Engine). Clean all fuel from the pump assembly.



CAUTION

Make sure sending unit is completely dry (no fuel on it) before testing. Perform test away from the tank to prevent an explosion or fire from sparks.

5. Using a multimeter, check that there is a change in resistance of the sender as the float is moved from the empty (completely down) to the full (completely up) position (Fig. 32).

6. Replace fuel pump assembly if the fuel sender is faulty.

7. After testing, install pump assembly into fuel tank and secure with gasket and fuel pump cap (see Fuel Pump in the Service and Repairs section of Chapter 3 – Kohler Gasoline Engine). Secure fuel hose to pump fitting and connect fuel pump assembly connector to vehicle wire harness.
8. Remove bed support from cargo bed lift cylinder and lower bed.

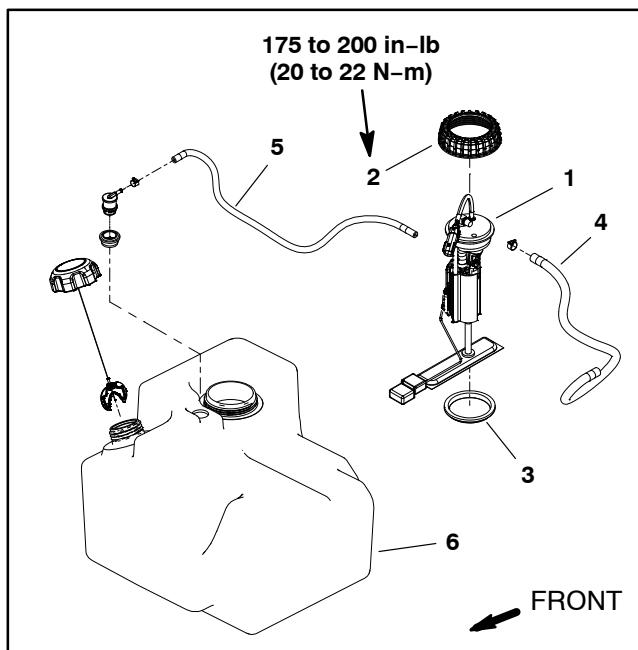


Figure 31

- | | |
|-----------------------|---------------------|
| 1. Fuel pump assembly | 4. Fuel supply hose |
| 2. Fuel pump cap | 5. Fuel vent hose |
| 3. Gasket | 6. Fuel tank |

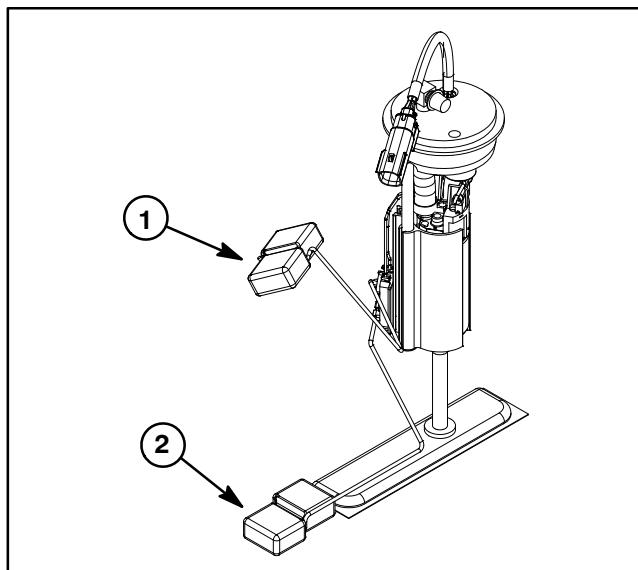


Figure 32

- | | |
|-------------------------|--------------------------|
| 1. Sender full position | 2. Sender empty position |
|-------------------------|--------------------------|

Fuel Pump

The fuel pump used on Workman HDX Auto vehicles is a positive displacement electric pump that provides pressurized fuel to the engine fuel rail in a return-less system. The fuel pump assembly includes the fuel pump, the fuel sender for the dash mounted fuel gauge and the fuel filter. The fuel pump assembly is mounted in the fuel tank. The fuel pump assembly includes a regulator to maintain fuel pressure of approximately 40 PSI (276 kPa).

Electrical power for the fuel pump is available when the fuel pump relay is energized by the engine ECU and when the transaxle lockout switches are properly positioned (e.g. transaxle is in 2nd gear, low range with lockout key switch in slow position).

NOTE: When the ignition switch is turned to RUN, the engine ECU energizes the engine relay for approximately three (3) seconds which allows the fuel system to be pressurized. If the engine does not start for some reason, the ECU switches off the relay preventing the continued delivery of fuel. Once the engine is running, the relay and fuel pump remain energized.

Fuel Pump Testing

1. Park vehicle on a level surface, raise bed and engage parking brake. Stop the engine and remove key from ignition switch. Allow engine to cool.
2. Install bed support on bed lift cylinder to prevent bed from lowering.



CAUTION

The fuel supply hose will contain pressurized fuel. Be careful when disconnecting fuel supply hose. Wipe up any spilled fuel before starting the engine.

3. Disconnect fuel supply hose from fuel rail inlet on engine (Fig. 34).
4. Install a fuel pressure gauge capable of measuring 50 PSI (350 kPa) to the disconnected hose.

NOTE: If pressure gauge is connected to a tee fitting, fuel rail and injectors can be checked for potential leakage while measuring fuel pump pressure.

5. While monitoring fuel pressure gauge, turn ignition switch to RUN so that engine relay and fuel pump are energized. Fuel pressure displayed on the gauge should rise. After pump relay is de-energized (approximately 3 seconds), turn ignition switch to OFF and then back to RUN to re-energize the engine relay and fuel pump. Fuel pump pressure should be approximately 40 PSI (276 kPa).

6. If fuel pump pressure is low, make sure that electrical power is available to pump and then consider a clogged fuel filter or faulty fuel pump (see Fuel Pump in the Service and Repairs section of Chapter 3 – Kohler Gasoline Engine).
7. After testing is completed, make sure that key is removed from ignition switch. Remove pressure gauge from fuel supply hose. Connect fuel supply hose to fuel rail inlet on engine and secure with hose clamp.
8. Remove bed support from cargo bed lift cylinder and lower bed.

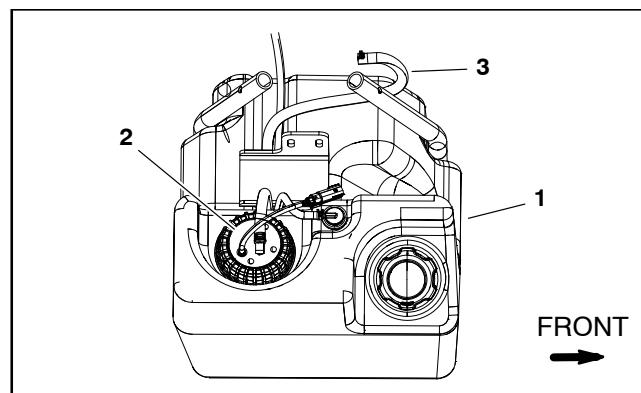


Figure 33

1. Fuel tank
2. Fuel pump assembly
3. Fuel supply hose

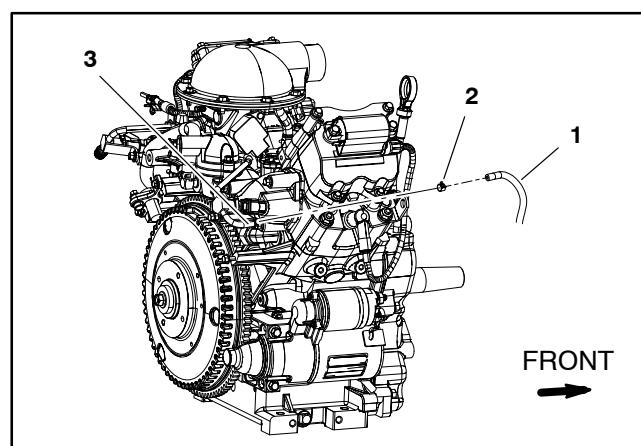


Figure 34

1. Fuel supply hose
2. Hose clamp
3. Fuel rail inlet

Temperature Sender

The temperature sender is threaded into a fitting in the top of the engine cylinder casting (Fig. 35). The resistance of the temperature sender reduces as the engine coolant temperature increases. This resistance change is used by the instrument cluster to display engine operating temperature. There is a violet wire attached to the sender.

Testing

1. Park machine on a level surface, raise bed, stop engine, apply parking brake and remove key from ignition switch.
2. Install bed support on bed lift cylinder to prevent bed from lowering.



CAUTION

Make sure engine is cool before removing the temperature switch.

3. Lower the coolant level in the engine, remove wire harness connector from temperature sender and remove the sender from the engine.
4. Put switch in a container of oil with a thermometer and slowly heat the oil (Fig. 36).



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 the measured value of the component you are testing.

5. Check resistance of the sender with a multimeter (ohms setting) as the oil temperature increases. Replace sender if specifications are not met.

COOLANT TEMP	TEMP SENDER RESISTANCE
100F (38C)	460 ohms (approximate)
160F (71C)	140 ohms (approximate)
200F (93C)	54 to 78 ohms
220F (105C)	50 ohms (approximate)

6. Install temperature sender to the water pump housing.

A. Clean threads of water pump housing and switch thoroughly. Apply thread sealant to the threads of the switch.

B. Install sender into the water pump housing and tighten. Torque from **16 to 20 ft-lb (22 to 27 N·m)**.

C. Connect harness violet wire to switch.

7. Fill engine cooling system.

8. Remove bed support from cargo bed lift cylinder and lower bed.

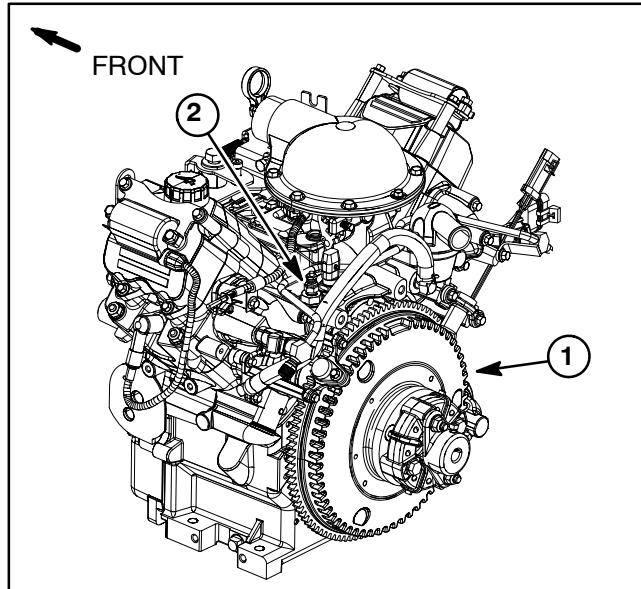


Figure 35

1. Engine flywheel

2. Temp sender

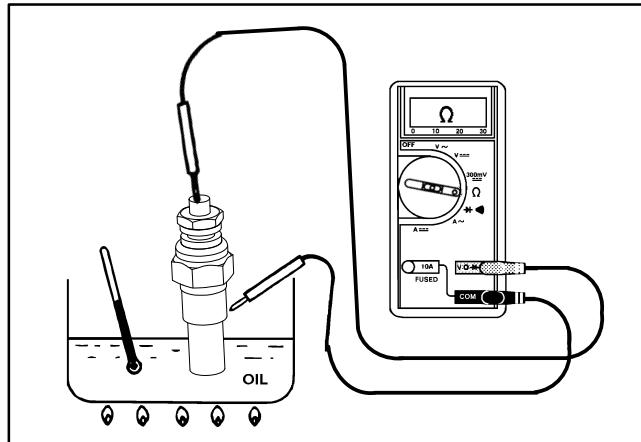


Figure 36

Speed Sensor

The speed sensor is attached to the upper transaxle cover (Fig. 37). It uses a magnetically based, Hall Effect integrated circuit. As the differential in the transaxle turns, the sensor accurately senses the movement of the differential ring gear teeth passing by the sensor. The red striped connector wire is the sensor positive lead, the black wire is the ground lead and the gray striped wire is the signal output.

Testing

1. Park machine on a level surface, raise bed, stop engine, apply parking brake and remove key from ignition switch.
2. Install bed support on bed lift cylinder to prevent bed from lowering.
3. Locate traction speed sensor on the transaxle assembly. Disconnect the wire harness connector from the traction speed sensor.
4. Remove flange head screw that secures speed sensor to transaxle. Remove speed sensor from transaxle.

IMPORTANT: Incorrect jumper wire connections during testing can damage the sensor.

5. Using a +12 VDC battery, a multimeter, a 1K ohm resistor and appropriate jumper wires, connect the battery and multimeter to the speed sensor using Figure 38 as a guide.
6. Set multimeter to DC volts setting.
7. The multimeter should display very low voltage when a metal object is held near the sensor tip. The multimeter should display battery voltage when the metal object is moved away from the sensor tip.
8. After testing is complete, remove jumper wires, resistor and multimeter leads from sensor connector.
9. Replace speed sensor if necessary.
10. Install speed sensor into transaxle and secure with flange head screw. Reconnect speed sensor to wire harness.
11. Remove bed support from cargo bed lift cylinder and lower bed.

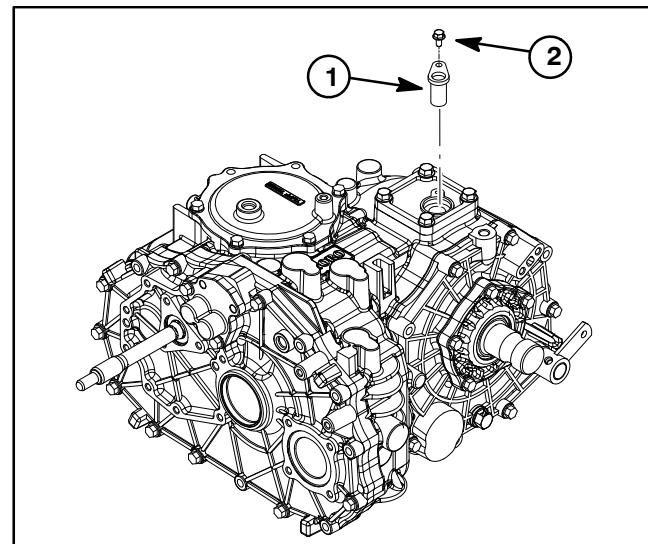


Figure 37

1. Speed sensor

2. Flange head screw

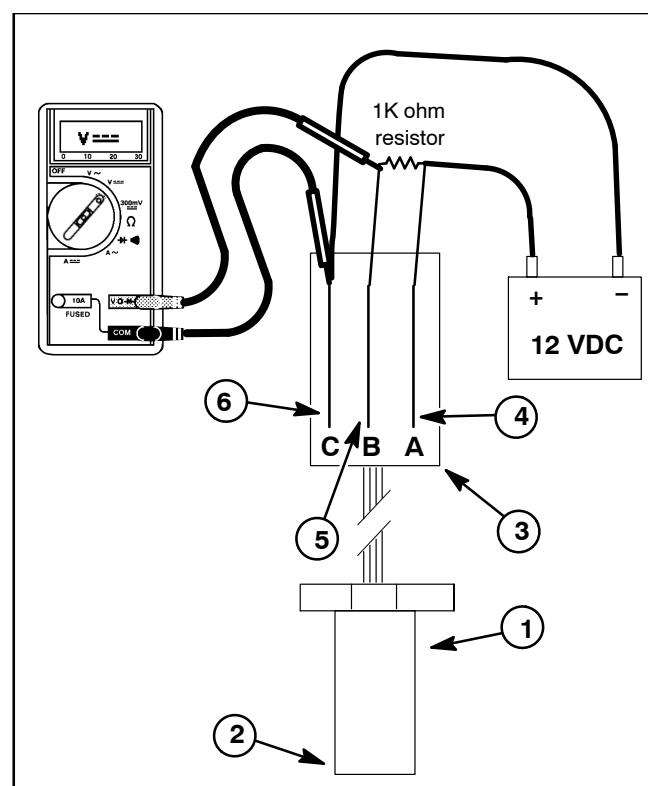


Figure 38

1. Speed sensor

2. Sensor tip

3. Sensor connector

4. Red striped wire

5. Gray striped wire

6. Black wire

Hydraulic Solenoid Valve Coil (Vehicles with High Flow Hydraulics Kit)

Vehicles equipped with the High Flow Hydraulics Kit use a hydraulic solenoid valve coil for system control (Fig. 39). When the solenoid coil is energized, hydraulic valve shift occurs to provide hydraulic flow for the attachment. Testing of the coil can be done with the coil installed on the hydraulic manifold valve.

Testing

1. Park machine on a level surface, raise bed, stop engine, apply parking brake and remove key from ignition switch.
2. Install bed support on bed lift cylinder to prevent bed from lowering.
3. Disconnect wire harness connector from hydraulic solenoid valve coil.

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

4. Using a multimeter (ohms setting), measure resistance between the two connector terminals on the solenoid coil. The resistance for the coil should be approximately **7.1 ohms**.
5. After testing is complete, connect wire harness connector to the solenoid coil.
6. Remove bed support from cargo bed lift cylinder and lower bed.

Solenoid Coil Replacement

1. Remove nut that secures solenoid coil to cartridge valve.
2. Carefully slide coil from valve.
3. When installing coil on cartridge valve, torque nut to **5 ft-lb (6.8 N·m)**.

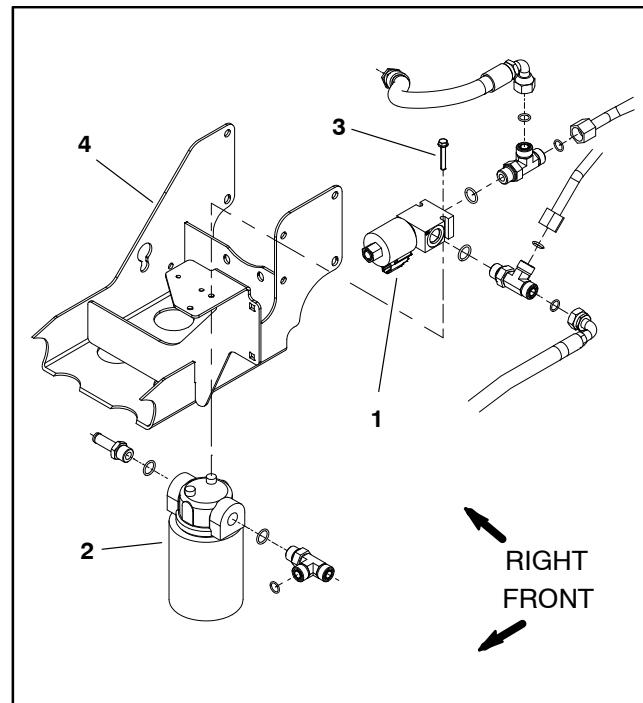


Figure 39

1. Hydraulic manifold
2. Oil filter
3. Screw (2)
4. Engine mount assembly

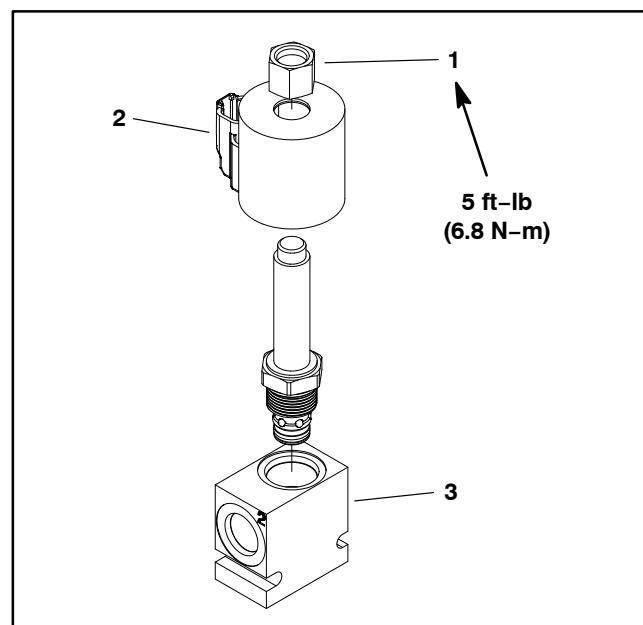


Figure 40

1. Nut
2. Solenoid coil
3. Manifold body

Windshield Washer/Wiper Switch (Machines with Operator Cab)

The windshield washer/wiper switch controls the operation of the windshield wiper and washer pump. The switch is located in the roof console (Fig. 41).

Testing

1. Park the machine on a level surface, lower the cutting deck, set the parking brake, and shut off the engine.
2. To access the switch, do as follows:
 - A. Remove the 10 clips, 10 sealing washers, and 10 flange-head screws that secure the roof to the cab frame, and remove the roof.
 - B. Remove the console foam.
 - C. Remove the console panel from the roof console.
3. Disconnect the wire harness electrical connector from the windshield wiper/washer switch.
4. With the use of a multimeter (ohms setting), test the switch functions to determine if continuity exists between the various terminals for each switch position. Check the continuity between the switch terminals. The windshield wiper/washer switch terminals are identified in Figure 42 and the circuitry of the switch is shown in below table:

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
OFF	2 + 1	None
WIPER ON	2 + 3	None
WASHER ON	2 + 3	5 + 6

5. Replace the windshield wiper/washer switch if testing determines that the switch is damaged.
6. If the windshield wiper/washer switch testing is correct and a circuit problem still exists, check the wire harness; refer to the Chapter 9 – Electrical Drawings.

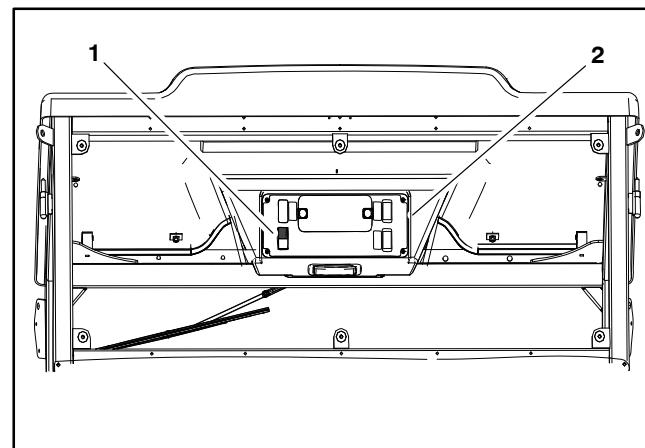


Figure 41

1. Washer/wiper switch 2. Console panel

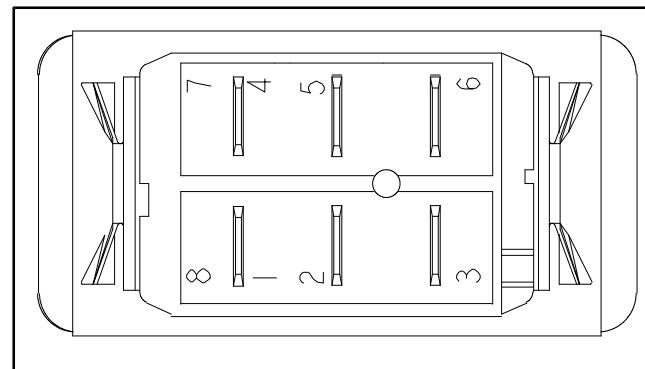


Figure 42

7. After you complete the testing, connect the wire harness connector to the windshield wiper/washer switch.
8. Position the console foam. Secure the roof to the cab frame with the 10 clips, 10 sealing washers, and 10 flange-head screws.

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Service and Repairs

NOTE: Refer to the Kohler Aegis Service Manual for engine electrical component repair information.

Battery Storage

If the machine will be stored for more than thirty (30) days:

1. Remove the battery from the machine and charge it fully (see Battery Service in this section).
2. Either store battery on a shelf or on the machine.
3. Leave battery cables disconnected if the battery is stored on the machine.
4. Store battery in a cool atmosphere to avoid quick deterioration of the battery charge.
5. To help prevent the battery from freezing, make sure it is fully charged (see Battery Service in this section).

Battery Care

1. Battery electrolyte level must be properly maintained. The top of the battery must be kept clean. If the machine is stored in a location where temperatures are extremely high, the battery will discharge more rapidly than if the machine is stored in a location where temperatures are cool.

3. Battery cables must be tight on terminals to provide good electrical contact.



CAUTION

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 battery charger from electrical outlet before connecting or disconnecting charger leads to or from battery posts.

IMPORTANT: Do not remove battery fill caps while cleaning battery.

2. Check battery condition weekly or after every fifty (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.



Connecting battery cables to the wrong battery post could result in personal injury and/or damage to the electrical system.

4. If corrosion occurs at battery terminals, disconnect cables. Always disconnect negative (-) cable first. Clean clamps and terminals separately. Connect cables to battery 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. Periodically (at least every fifty (50) operating hours) check battery electrolyte level. Check electrolyte level every thirty (30) days if machine is in storage.

6. Maintain battery cell level with distilled water. Do not fill battery 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 and eyes. Always wear safety goggles and a face shield when working with batteries.

Battery Specifications

BCI Group 26 Battery

540 Amp Cranking Performance at 0F (-18C)

80 minute Reserve Capacity at 80F (27C)

Electrolyte Specific Gravity (fully charged): from 1.250 to 1.280

Electrolyte Specific Gravity (discharged): 1.240

Battery Removal and Installation (Fig. 43)

1. Make sure that ignition switch is in the OFF position.
2. Squeeze the battery cover to release cover tabs from battery tray. Remove battery cover from the frame. Loosen battery retainer that secures battery to battery tray.
3. Loosen and remove negative (-) cable from battery. After negative cable has been removed, loosen and remove positive (+) cable.
4. Carefully remove battery from machine.
5. Install battery in reverse order making sure to connect and tighten positive (+) cable to battery before connecting negative (-) cable.

NOTE: Before connecting the negative (-) cable to the battery, connect a digital multimeter (set to DC Amps) between the negative battery post and the negative (-) cable connector. The reading should be less than 0.1 amp. If the reading is 0.1 amp or more, the machine's electrical system should be tested for short circuits or faulty components and repaired.

6. Coat battery posts and cable connectors with Battery Terminal Protector (Toro Part No. 107-0392) or petroleum jelly to prevent corrosion.
7. Make sure that battery retainer secures battery in place. Install battery cover to battery tray.

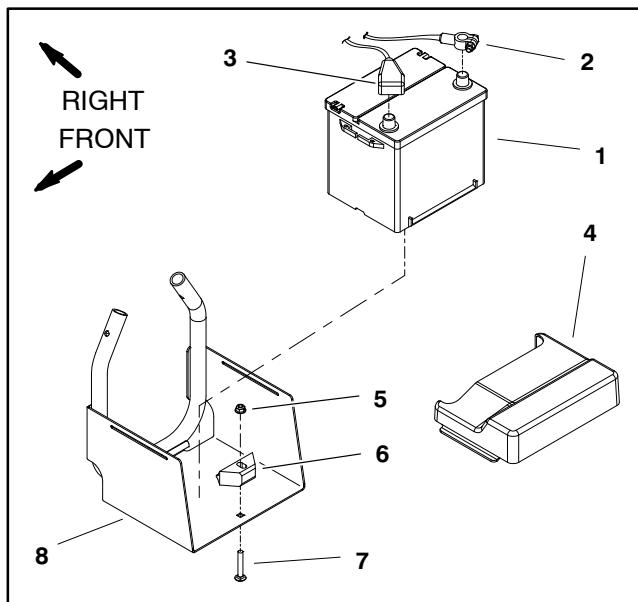


Figure 43

- | | |
|-------------------|---------------------|
| 1. Battery | 5. Flange nut |
| 2. Negative cable | 6. Battery retainer |
| 3. Positive cable | 7. Carriage screw |
| 4. Battery cover | 8. Battery tray |

Battery Inspection and Maintenance

1. Check battery case for cracks. Replace battery if cracked or leaking.

2. Check battery terminal posts for corrosion. Use wire brush to clean corrosion from posts.

IMPORTANT: Before cleaning the battery, tape or block vent holes to the filler caps and make sure the caps are on tightly.

3. Check for signs of wetness or leakage on the top of the battery which might indicate a loose filler cap, overcharging, a loose terminal post or overfilling. Also, check battery case for dirt and oil. Clean the battery with a solution of baking soda and water, then rinse it with clean water.

4. Check that the cover seal is not broken. Replace the battery if the seal is broken or leaking.

Battery Testing

1. If battery filler caps are removable, conduct a hydrometer test of the battery electrolyte.

IMPORTANT: Make sure the area around the cells is clean before opening the battery caps.

A. Measure the specific gravity of each cell with a hydrometer. Draw electrolyte in and out of the hydrometer barrel prior to taking a reading to warm-up the hydrometer. At the same time take the temperature of the cell.

B. Temperature correct each cell reading. For each 10F (6C) above 80F (27C) add 0.004 to the specific gravity reading. For each 10F (6C) below 80°F (27C) subtract 0.004 from the specific gravity reading.

Example: Cell Temperature	100F
Cell Specific Gravity	1.245
100F minus 80F equals 20F	
(38C minus 27C equals 11C)	
20F multiply by 0.004/10F equals 0.008	
(11C multiply by 0.004/6C equals 0.008)	
ADD (conversion above)	<u>0.008</u>
Correction to 80F (27C)	1.253

C. If the difference between the highest and lowest cell specific gravity is 0.050 or greater or the lowest cell specific gravity is less than 1.225, charge the battery. Charge at the recommended rate and time given in **Charging** or until all cells specific gravity is 1.225 or greater with the difference in specific gravity between the highest and lowest cell less than 0.050. If these charging conditions can not be met, replace the battery.

2. Perform a high-discharge test with an adjustable load tester.

This is one of the most reliable means of testing a battery as it simulates the cold-cranking test. A commercial battery load tester is **required** to perform this test.



CAUTION

Follow the manufacturer's instructions when using a battery load tester.

A. Check the voltage across the battery terminals prior to testing the battery. If the voltage is less than 12.4 VDC, charge the battery.

B. If the battery has been charged, apply a 150 amp load for fifteen (15) seconds to remove the surface charge. Use a battery load tester **following the manufacturer's instructions**.

C. Make sure battery terminals are free of corrosion.

D. If battery filler caps are removable, 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 270 amps (one half the Cranking Performance rating of the battery) for fifteen (15) seconds.

G. Take a battery voltage reading at fifteen (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	70F (and up)	21C (and up)
9.5	60F	16C
9.4	50F	10C
9.3	40F	4C
9.1	30F	-1C
8.9	20F	-7C
8.7	10F	-12C
8.5	0F	-18C

I. If the measured battery voltage is below the minimum voltage shown in the table, replace the battery. If the measured voltage is at or above the minimum voltage shown in the table, return the battery to service.

Battery Charging

To minimize possible damage to the battery and to 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.



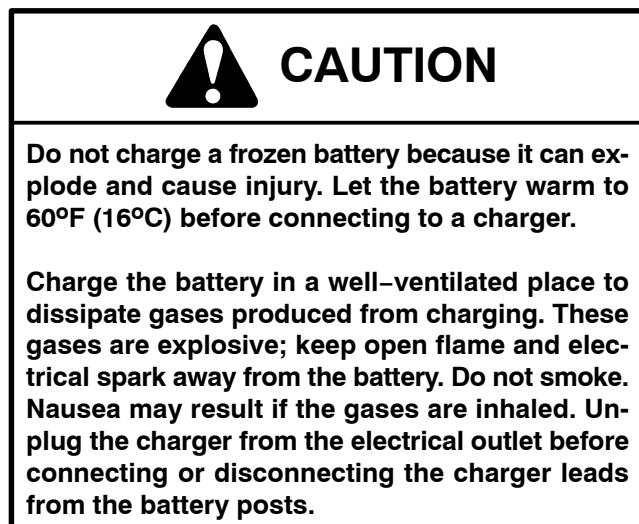
NOTE: Using specific gravity of the battery cells is the most accurate method of determining battery condition.

1. If battery filler caps are removable, 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 so that plates are just covered with electrolyte.
2. Determine the battery charge level from either its open circuit voltage or specific gravity (if filler caps are removable).

Battery Charge Level	Open Circuit Voltage	Specific Gravity
100%	12.68	1.265
75%	12.45	1.225
50%	12.24	1.190
25%	12.06	1.155
0%	11.89	1.120

3. Determine the charging time and rate **using the battery charger manufacturer's instructions** or the following table.

Battery Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	50%	25%	0%
80 or less	3.8 hrs @ 3 amps	7.5 hrs @ 3 amps	11.3 hrs @ 3 amps	15 hrs @ 3 amps
81 to 125	5.3 hrs @ 4 amps	10.5 hrs @ 4 amps	15.8 hrs @ 4 amps	21 hrs @ 4 amps
126 to 170	5.5 hrs @ 5 amps	11 hrs @ 5 amps	16.5 hrs @ 5 amps	22 hrs @ 5 amps
171 to 250	5.8 hrs @ 6 amps	11.5 hrs @ 6 amps	17.3 hrs @ 6 amps	23 hrs @ 6 amps
above 250	6 hrs @ 10 amps	12 hrs @ 10 amps	18 hrs @ 10 amps	24 hrs @ 10 amps



4. **Following the battery charger manufacturer's instructions**, connect the charger cables to the battery. Make sure a good connection is made.
5. Charge the battery **following the battery charger manufacturer's instructions**.
6. Occasionally check the temperature of the battery electrolyte. If the temperature exceeds 125°F (52°C) or the electrolyte is violently gassing or spewing, the charging rate must be lowered or temporarily stopped.
7. 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 (3) consecutive readings.
8. If battery filler caps are removable, check the electrolyte level in each cell. Adjust electrolyte level if needed.

Headlights



CAUTION

The Workman headlights use a halogen bulb that becomes extremely hot when in operation. Handling a hot headlight bulb can cause severe burns and personal injury. Allow enough time for bulb to cool before handling.



CAUTION

Any surface contamination can damage the headlight bulb and lead to its failure or explosion creating a serious safety hazard.

Headlight bulbs should be handled without touching the clear bulb surface. Handle the bulb by holding onto the base.

Headlight Disassembly (Fig. 44)

1. Park machine on a level surface, stop engine, apply parking brake and remove key from ignition switch.
2. Remove hood (see Hood in the Service and Repairs section of Chapter 7 – Chassis).
3. If bulb removal is necessary, loosen the bulb from the headlight by rotating it 1/4 turn counter-clockwise. Then, grasp bulb base and remove bulb from the headlight.
4. If necessary, remove headlight from hood.
 - A. Remove three (3) clips that secure headlight to hood.
 - B. Remove headlight from hood.

Headlight Assembly (Fig. 44)

1. If headlight was removed from hood, insert headlight into hood opening and secure light with three (3) clips.
2. If bulb was removed from headlight, align tabs on bulb with notches in headlight opening. Insert bulb into back of headlight without touching the clear bulb surface. Secure bulb to headlight by rotating it 1/4 turn clockwise.

3. Install hood (see Hood in the Service and Repairs section of Chapter 7 – Chassis). Make sure to connect the wire harness connector to the headlight during hood installation.

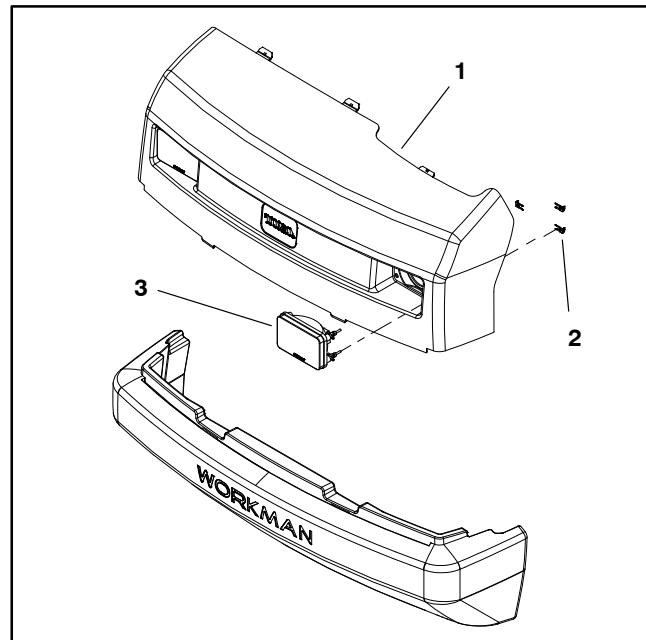


Figure 44

1. Front hood
2. Clips (3 used per light)
3. Headlight (2)

Tail Lights

Disassemble and assemble tail light using Fig. 45 as a guide.

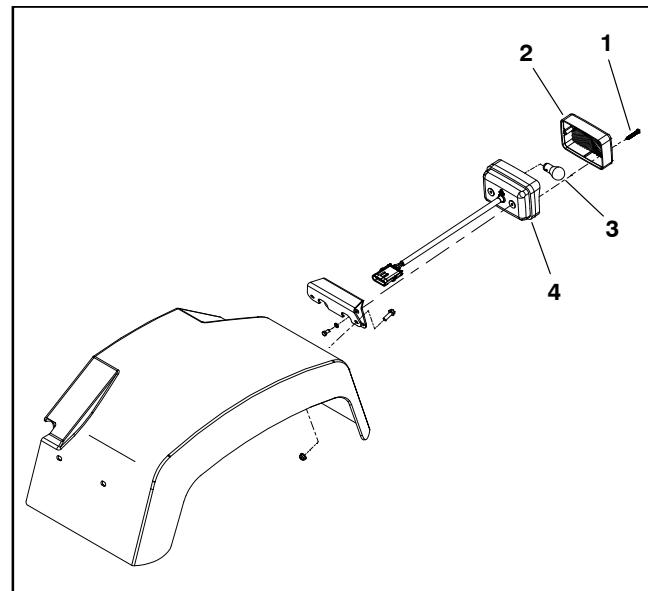


Figure 45

- | | |
|--------------|------------------------|
| 1. Screw (2) | 3. Bulb |
| 2. Lens | 4. Tail light assembly |



Chapter 7

Hydraulic System

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Specifications

Item	Description
Hydraulic Pump Displacement (per revolution)	Casappa positive displacement gear type pump 0.326 in ³ (5.3 cc)
System Relief Pressure	1800 PSI (124 Bar)
Steering Control Valve	Sauer Danfoss Steering Unit, Series OSPM
Lift Control Valve	Three (3) position control valve Spring return to neutral Ball checks to maintain load
Hydraulic Oil	Mobil M15
Reservoir System Capacity	8 U.S. quart (7.5 Liter)
Hydraulic Filter	Spin-on cartridge type 100 mesh strainer in hydraulic reservoir
High Flow Hydraulics Pump (If Equipped) Front section displacement (per revolution) Rear section displacement (per revolution)	Casappa positive displacement gear type pump, 2 section 0.326 in ³ (5.3 cc) 0.519 in ³ (8.5 cc)
High Flow Hydraulics System Relief Pressure	2000 PSI (137 Bar)
High Flow Hydraulics Hydraulic Filter	Spin-on cartridge type 100 mesh strainer in reservoir

General Information

Operator's Manual

The Operator's Manual provides information regarding the operation, general maintenance and maintenance intervals for your Workman vehicle. Refer to the Operator's Manual for additional information when servicing the vehicle.

Check Hydraulic Oil

The hydraulic system on your Workman is designed to operate on Mobil M15 hydraulic oil. **Check level of hydraulic fluid daily.** See Operator's Manual for fluid level checking procedure and hydraulic oil recommendations.

IMPORTANT: Vehicles with standard hydraulics use a different reservoir oil level than vehicles with high flow hydraulics. To prevent hydraulic system problems with your Workman, make sure that the correct hydraulic oil level is used.

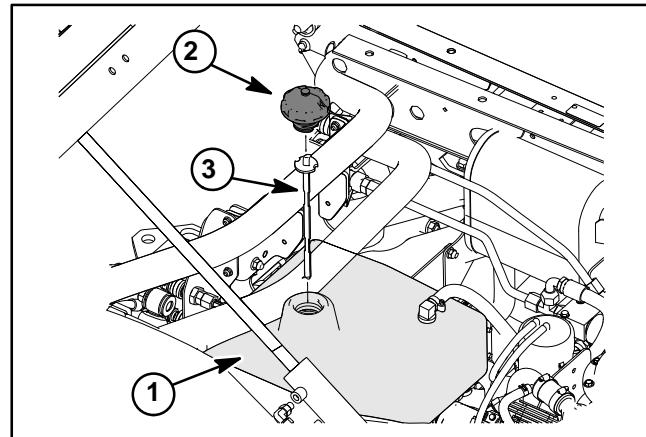


Figure 1

1. Hydraulic reservoir
 2. Reservoir cap
 3. Dipstick

Relieving Hydraulic System Pressure

Before disconnecting or performing any work on the hydraulic system, all pressure in the hydraulic system must be relieved. Park vehicle on a level surface, stop engine and engage parking brake.

System pressure in lift circuit is relieved when the cargo bed is fully lowered. Hold the lever in the forward position for one (1) or two (2) seconds after the bed contacts the frame to ensure that system pressure is fully relieved.

To relieve hydraulic pressure in steering circuit, rotate steering wheel in both directions.

If vehicle is equipped with the High Flow Hydraulics system, move high flow hydraulics switch to the OFF position to relieve hydraulic pressure in the high flow hydraulic circuit.

After all hydraulic system pressures have been relieved, remove key from ignition switch.

Hydraulic Hoses

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

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

Kinked, crushed, flattened or twisted hose.

Blistered, soft, degraded or loose hose cover.

Cracked, damaged or badly corroded hose fittings.

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

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



WARNING

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

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

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

1. Make sure threads and sealing surfaces of the hose/tube and the fitting are free of burrs, nicks, scratches or any foreign material.
2. As a preventative measure against leakage, it is recommended that the face seal O-ring be replaced any time the connection is opened. Make sure the O-ring is installed and properly seated in the fitting groove. Lightly lubricate the O-ring with clean hydraulic oil.
3. Place the hose/tube against the fitting body so that the flat face of the hose/tube sleeve fully contacts the O-ring in the fitting.
4. Thread the swivel nut onto the fitting by hand. While holding the hose/tube with a wrench, use a torque wrench to tighten the swivel nut to the recommended installation torque shown in Figure 4. This tightening process will require the use of an offset wrench (e.g. crowfoot wrench). Use of an offset wrench will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be lower than the listed installation torque (see Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 – Product Records and Maintenance).
5. If a torque wrench is not available or if space at the swivel nut prevents use of a torque wrench, an alternate method of assembly is the Flats From Wrench Resistance (F.F.W.R.) method (Fig. 2).
 - A. Using a wrench, tighten the swivel nut onto the fitting until light wrench resistance is reached (approximately 30 in-lb).
 - B. Mark the swivel nut and fitting body. Hold the hose/tube with a wrench to prevent it from turning.

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

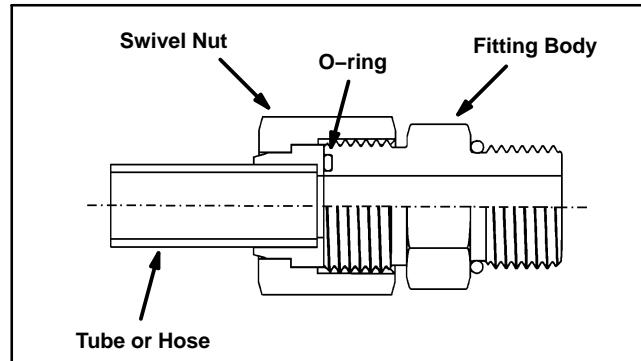


Figure 2

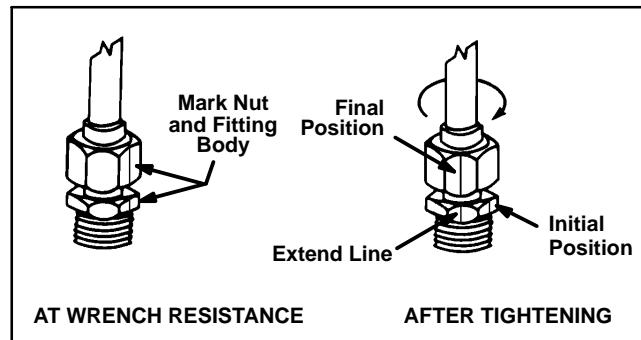


Figure 3

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

Figure 4

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

Non-Adjustable Fitting (Fig. 5)

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

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

4. Install the fitting into the port. Then, use a torque wrench and socket to tighten the fitting to the recommended installation torque shown in Figure 6.

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

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

- A. Install the fitting into the port and tighten it down full length until finger tight.
- B. If port material is steel, tighten the fitting to the listed F.F.F.T. If port material is aluminum, tighten fitting to 60% of listed F.F.F.T.

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

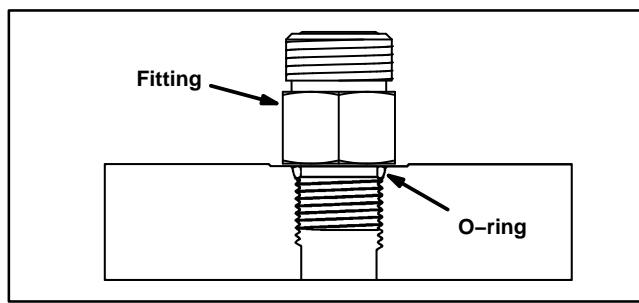


Figure 5

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

Figure 6

Adjustable Fitting (Fig. 7)

1. Make sure all threads and sealing surfaces of fitting and component port are free of burrs, nicks, scratches or any foreign material.
2. As a preventative measure against leakage, it is recommended that the O-ring be replaced any time the connection is opened.
3. Lightly lubricate the O-ring with clean hydraulic oil. Fitting threads should be clean with no lubricant applied.
4. Turn back the lock nut as far as possible. Make sure the back up washer is not loose and is pushed up as far as possible (Step 1 in Figure 8).

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

5. Install the fitting into the port and tighten finger tight until the washer contacts the face of the port (Step 2).
6. To put the fitting in the desired position, unscrew it by the required amount, but no more than one full turn (Step 3).
7. Hold the fitting in the desired position with a wrench and use a torque wrench to tighten the fitting to the recommended installation torque shown in Figure 6. This tightening process will require the use of an offset wrench (e.g. crowfoot wrench). Use of an offset wrench will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be lower than the listed installation torque (see Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 – Product Records and Maintenance).
8. If a torque wrench is not available, or if space at the port prevents use of a torque wrench, an alternate method of assembly is the Flats From Finger Tight (F.F.F.T.) method. Hold the fitting in the desired position with a wrench and, if port material is steel, tighten the lock nut with a second wrench to the listed F.F.F.T (Step 4). If port material is aluminum, tighten fitting to 60% of listed F.F.F.T.

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

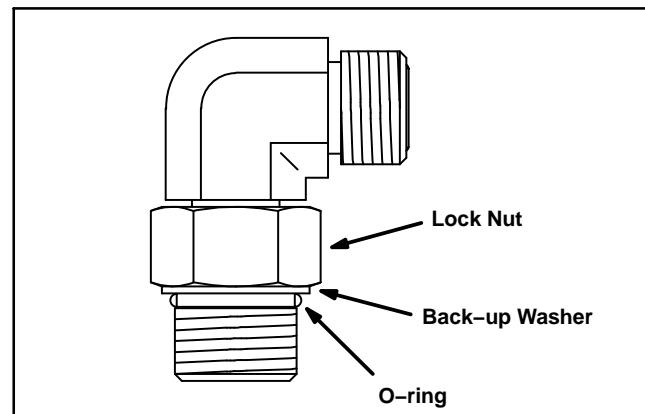


Figure 7

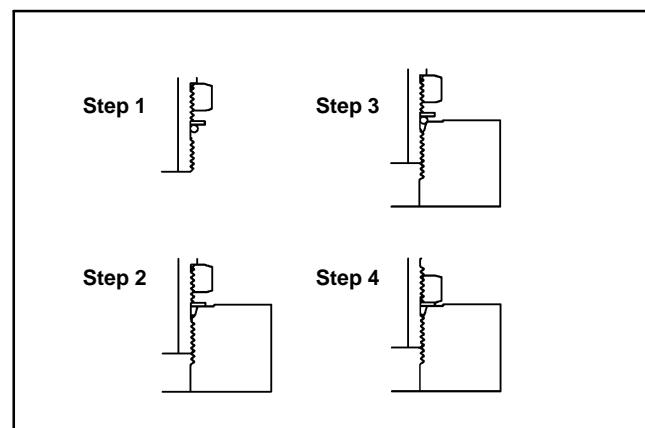
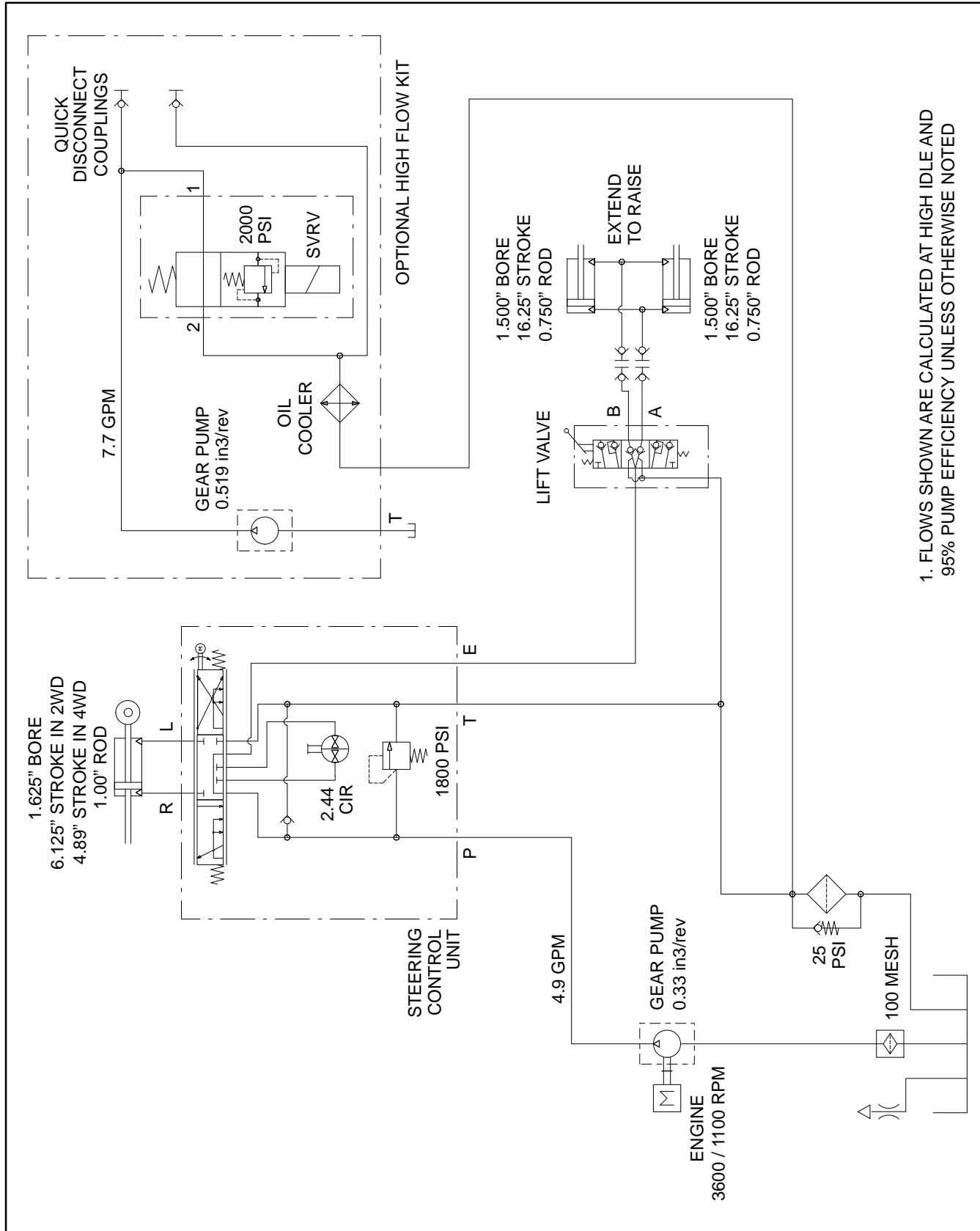


Figure 8

Hydraulic Schematic



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Hydraulic
System

Hydraulic Circuit Operation

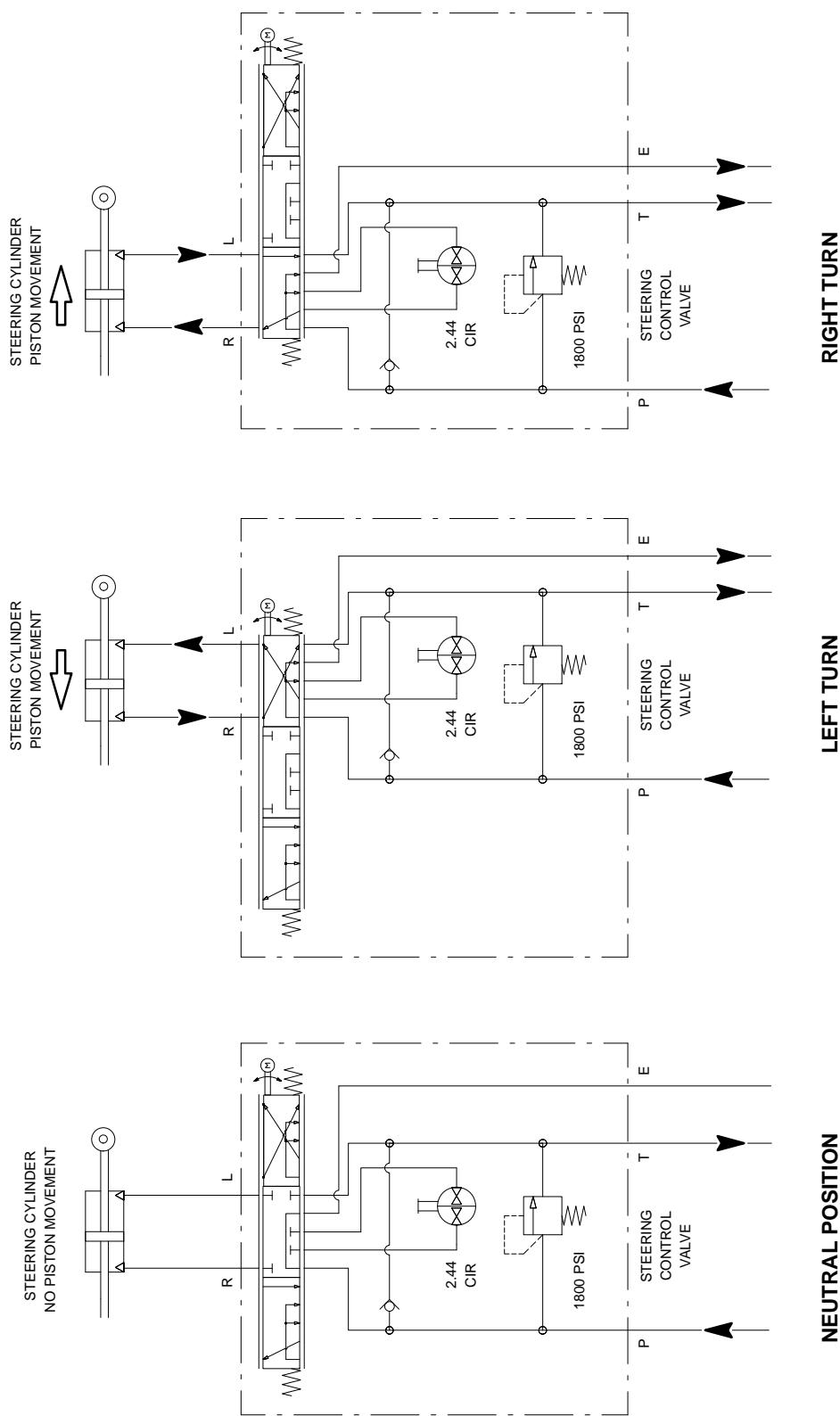


Figure 9

Steering Circuit

The hydraulic gear pump supplies flow for the steering circuit and for raising and lowering the bed. Pump output flows to the steering control valve before reaching the lift valve so the steering circuit has priority. Circuit pressure is limited by a relief valve located in the steering control valve.

NOTE: On vehicles with High Flow Hydraulics, a two (2) section gear pump is used. The front gear pump section supplies oil for steering and raising/lowering the bed. The rear pump section on these vehicles provides system flow for accessories.

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

Left Turn (Fig. 9)

When a left turn is made with the engine running, the turning of the steering wheel positions the spool valve so that flow goes through the top of the spool. Flow entering the steering control valve at the P port 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.

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

Right Turn (Fig. 9)

When a right turn is made with the engine running, the turning of the steering wheel positions the spool valve so that flow goes through the bottom of the spool. Flow entering the steering control valve at the P port 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.

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

Raise and Lower Bed

The hydraulic gear pump supplies flow for the steering circuit and for raising and lowering the bed. Pump output flows through the steering control valve and then to the lift valve for raising and lowering the bed (flow priority to the steering circuit). Circuit pressure is limited by a relief valve located in the steering control valve.

NOTE: On vehicles with High Flow Hydraulics, a two (2) section gear pump is used. The front gear pump section on these vehicles supplies oil for steering and raising/lowering the bed. The rear pump section on these vehicles provides system flow for accessories.

When the lift valve is in the center position, flow from the gear pump by-passes the lift valve and returns through the hydraulic oil filter and to the reservoir.

Raise Bed (Fig. 10)

When the bed is to be raised (lift lever pulled rearward), the lift valve spool directs flow out the A port of the lift valve to the barrel end of the lift cylinders. Hydraulic pressure against the cylinder pistons extends the cylinder shafts. At the same time, the lift valve spool cam pin opens the return direction check ball which allows the cylinder pistons to push the hydraulic fluid out the rod end of the lift cylinders. Fluid leaving the cylinders is routed through the lift valve to the reservoir.

When the control valve lever is released, spring action returns the lift valve spool to the center position and lift cylinder movement is stopped. The cylinder position is locked in place since there is no complete circuit of flow to and from the lift cylinders.

Lower Bed (Fig. 10)

Circuit operation for lowering the bed (lift lever pushed forward) is similar to raising the bed. However, the lift valve spool directs flow from the B port of the lift valve to the rod end of the lift cylinders. Hydraulic pressure against the cylinder pistons retracts the cylinder shafts to lower the bed.

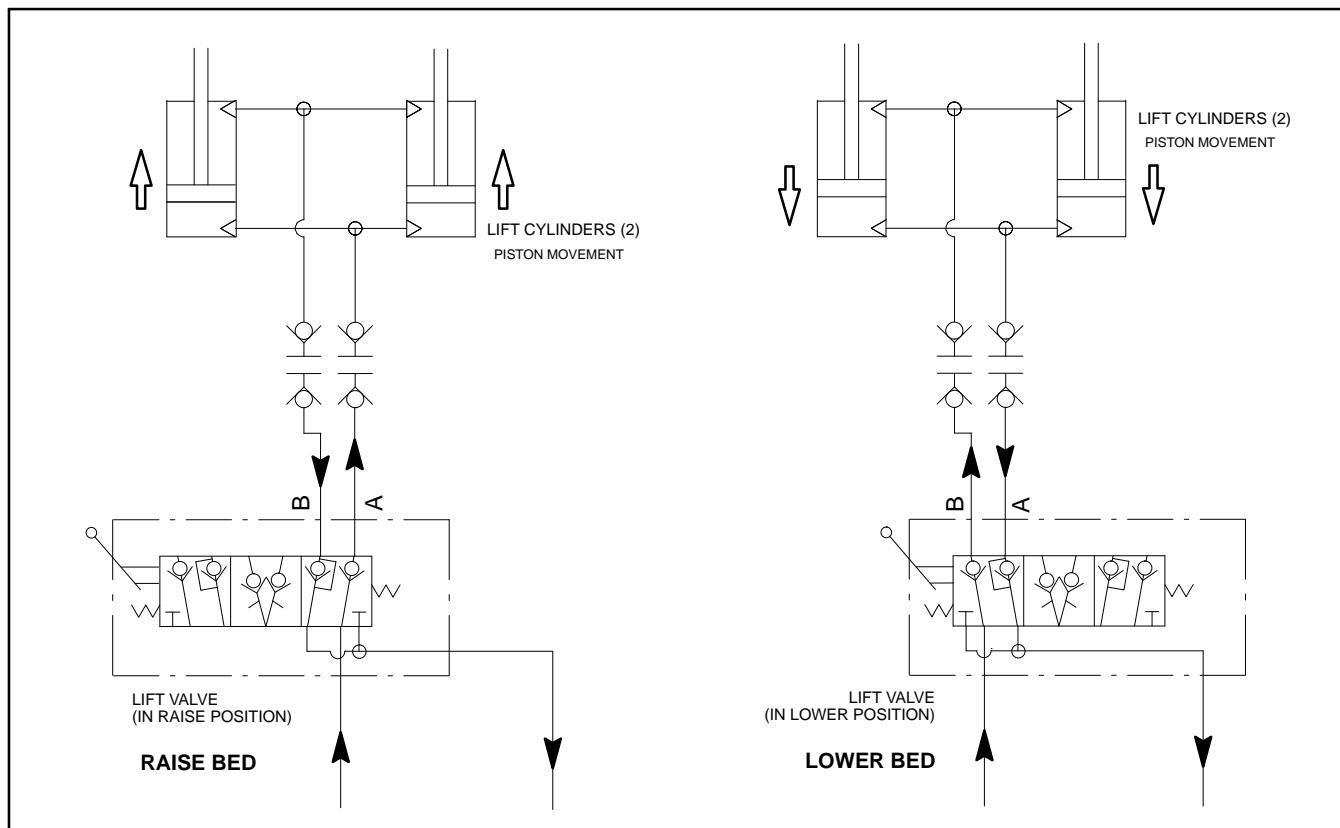


Figure 10

High Flow Hydraulic Circuit

On Workman HDX Auto vehicles that are equipped with high flow hydraulics, a second gear pump section is directly coupled to the standard gear pump. This second pump section provides hydraulic system flow for the high flow circuit that is designed to power hydraulic attachments. A hydraulic manifold equipped with a solenoid operated relief valve (SVRV) is used to control the accessory circuit and when energized, also provides circuit relief. A dash mounted rocker switch is used to energize the solenoid to engage the circuit. The high flow circuit includes quick disconnect couplers for attachment connection and an oil cooler. Vehicles with high flow hydraulics require more hydraulic oil in the reservoir for correct system operation.

High Flow Circuit OFF (Fig. 11)

When the rocker switch is in the OFF position, the hydraulic manifold solenoid operated relief valve (SVRV) is not energized. Flow from the gear pump is routed through the manifold, the oil cooler, the oil filter and then returns to the reservoir.

High Flow Circuit ON (Fig. 11)

When the rocker switch is in the ON position, the manifold solenoid operated relief valve (SVRV) is energized. The energized solenoid valve directs gear pump oil flow to the hydraulic attachment. Circuit pressure is limited to 2000 PSI (138 bar) by the manifold solenoid relief valve (SVRV). Return oil from the attachment is routed through the oil cooler, the oil filter and then returns to the reservoir.

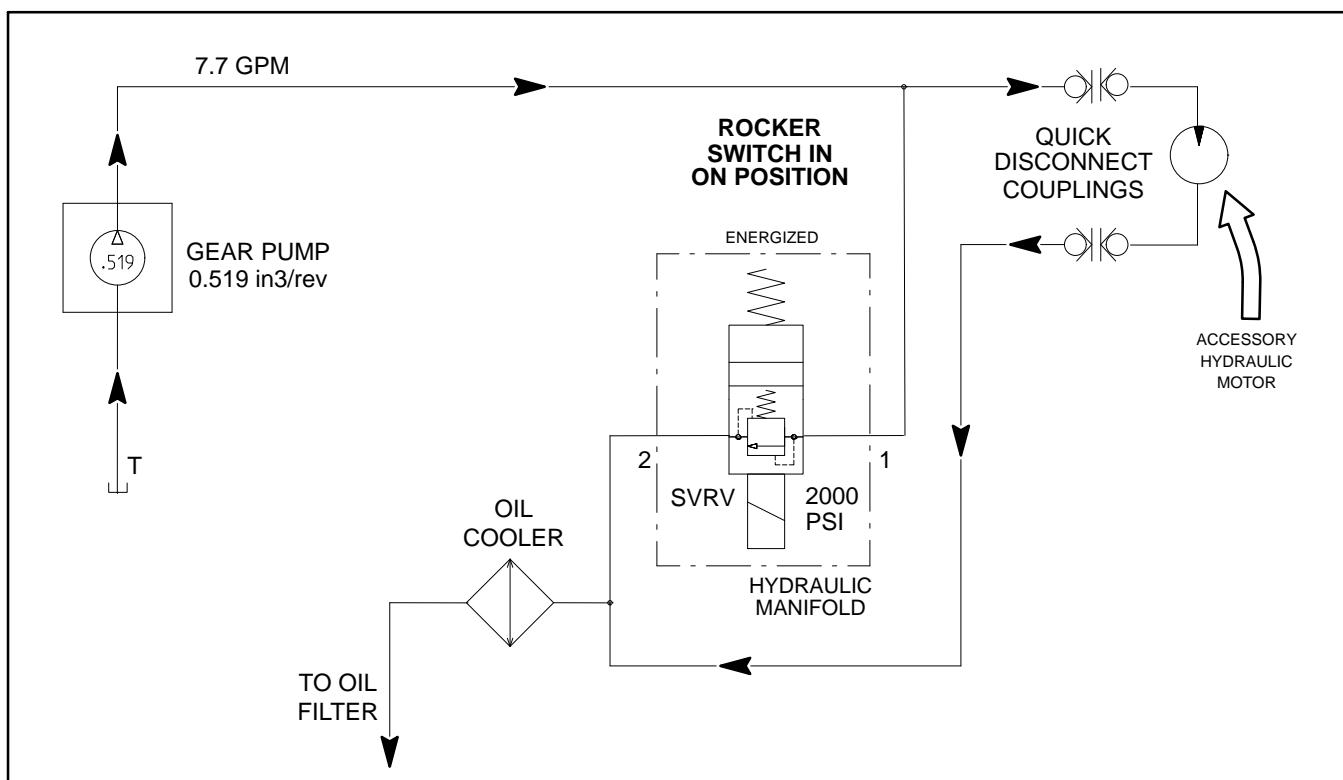


Figure 11

Special Tools

Order these special tools from your Toro Distributor.

Hydraulic Pressure Test Kit

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

Toro Part Number: **TOR47009**



Figure 12

Hydraulic Tester (Pressure and Flow)

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

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

Toro Part Number: **TOR214678**



Figure 13

Hydraulic Test Fitting Kit

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

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

Toro Part Number: **TOR4079**

TORO TEST FITTING KIT			
FITTING	TOOL NUMBER	FITTING	TOOL NUMBER
	Swivel Nut Run Tee (2 ea.) Size Toro No. No. 4 TOR4079-3 No. 6 TOR4079-12 No. 8 TOR4079-4 No. 10 TOR4079-5		Union (1 ea.) Size Toro No. No. 6 to No. 8 TOR4079-3 No. 6 to No. 8 TOR4079-2 No. 6 to No. 8 TOR4079-9
	Plug (2 ea.) Size Toro No. No. 4 TOR4079-13 No. 6 TOR4079-14 No. 8 TOR4079-15 No. 10 TOR4079-16		Reducer (1 ea.) Size Toro No. No. 10 to No. 8 TOR4079-7 No. 12 to No. 8 TOR4079-6
	Cap (2 ea.) Size Toro No. No. 4 TOR4079-17 No. 6 TOR4079-18 No. 8 TOR4079-19 No. 10 TOR4079-20		Test Cap Fitting (2 ea.) Size Toro No. No. 4 TOR4079-19 No. 6 TOR4079-11 No. 8 TOR4079-21 No. 10 TOR4079-1
			Test Fitting (2 ea.) Size Toro No. 7/16-20 ORB TOR4079-22 1/2" Pipe Thd. TOR4079-23

Figure 14

O-ring Kit

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

Toro Part Number: **117-2727**



Figure 15

Male Coupler (For High Flow Hydraulics)

Male coupler that fits into the High Flow Hydraulics female coupler. Male coupler can be used when testing hydraulic components of the High Flow Hydraulics system. Two (2) couplers are required for testing.

Toro Part Number: **105-4170**

NOTE: Dust cap (part number 105-7963) for male coupler is available separately.

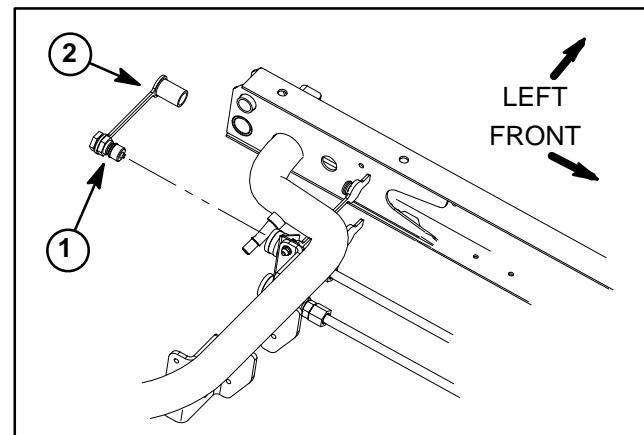


Figure 16

1. Male coupler

2. Dust cap

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 is a potential failure. Should either of these conditions be noticed, immediately stop the vehicle, turn off the engine, locate the cause of the trouble and correct it before allowing the vehicle to be used again. Contin-

ued 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 vehicle malfunction.

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

Problem	Possible Cause
Hydraulic oil leaks.	Hydraulic fitting(s), hose(s) or tube(s) are loose or damaged. O-ring(s) or seal(s) are missing or damaged.
Squealing noise.	Hydraulic lift valve is being held in raise or lower position (hydraulic oil flowing over relief valve).
Hydraulic oil is overheating.	Oil level in reservoir is incorrect. Hydraulic oil is contaminated. Incorrect oil in system (see oil recommendations in Operator's Manual). Hydraulic hose or tube is kinked or severely bent. Hydraulic oil is going over relief valve excessively (e.g. too heavy a load on hydraulic system or quick coupler disconnected with lift valve engaged). Strainer in reservoir is loose or clogged. Hydraulic gear pump is worn or damaged NOTE: Entire hydraulic system is affected.
Lift cylinders extend with lift valve in neutral position.	Load checks in hydraulic lift valve are leaking. Lift valve lever is sticking. Lift valve control handle is not in correct location. Hydraulic relief valve is stuck or damaged (see Gear Pump Flow and System Relief Pressure Test in the Testing section of this chapter).
Bed drops from raised position with lift valve in centered position.	Improperly positioned lift valve lever. Lift valve is worn or damaged. Lift cylinder(s) is (are) leaking externally. Lift cylinder hydraulic lines or fittings are leaking.

Problem	Possible Cause
Bed does not lift or lifts very slowly.	<p>Excessive load in bed.</p> <p>Oil level in reservoir is low.</p> <p>Engine RPM is low.</p> <p>Incorrect oil in system (see oil recommendations in Operator's Manual).</p> <p>Lift cylinder pivots or bed pivots are binding or damaged.</p> <p>Lift cylinder(s) is (are) worn or damaged.</p> <p>Gear pump key is sheared or missing</p> <p>NOTE: Entire hydraulic system is affected.</p> <p>Gear pump flow or pressure is low</p> <p>NOTE: Entire hydraulic system is affected (see Gear Pump Flow and System Relief Pressure Test in the Testing section of this chapter).</p>
Steering inoperative or sluggish	<p>NOTE: On a smooth surface with a heavily loaded, stationary vehicle, hydraulic circuit pressure to steering control valve may be near relief pressure.</p> <p>Engine RPM is low.</p> <p>Oil level in reservoir is low.</p> <p>Steering components (e.g. pitman arm, tie rods, steering cylinder rod ends) are worn or binding.</p> <p>Steering cylinder is binding.</p> <p>Hydraulic relief valve is stuck or damaged (see Gear Pump Flow and System Relief Pressure Test in the Testing section of this chapter).</p> <p>Steering control valve is worn or damaged.</p> <p>Steering cylinder leaks internally.</p> <p>Gear pump key is sheared or missing</p> <p>NOTE: Entire hydraulic system is affected.</p> <p>Gear pump flow or pressure is low</p> <p>NOTE: Entire hydraulic system is affected (see Gear Pump Flow and System Relief Pressure Test in the Testing section of this chapter).</p> <p>Gear pump is worn or damaged</p> <p>NOTE: Entire hydraulic system is affected.</p>

Problem	Possible Cause
Difficulty in connecting or disconnecting quick couplers.	<p>Hydraulic pressure is not relieved (coupler under pressure – engine running).</p> <p>Hydraulic lift valve is not in neutral (centered) position.</p>
Hydraulic attachment does not function.	<p>Quick couplers are not fully engaged.</p> <p>Quick couplers are interchanged.</p> <p>Oil level in reservoir is low.</p> <p>Engine RPM is low.</p> <p>Excessive load is applied to attachment.</p> <p>Gear pump key is sheared or missing</p> <p>NOTE: Entire hydraulic system is affected.</p> <p>Gear pump flow or pressure is low (see Gear Pump Flow and System Relief Pressure Test in the Testing section of this chapter).</p> <p>Hydraulic relief valve is stuck or damaged (see Gear Pump Flow and System Relief Pressure Test in the Testing section of this chapter).</p> <p>Hydraulic lift valve is worn or damaged.</p> <p>Hydraulic component(s) on attachment is malfunctioning or damaged.</p>

Testing

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



CAUTION

Failure to use gauge with recommended pressure (psi/bar) 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, rotating the steering wheel in both directions, lowering the bed and operating other hydraulic accessories.

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.



CAUTION

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

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

2. Review all test steps before starting the test procedure.

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

4. The engine must be in good operating condition. Use a tachometer to identify engine speed when making a hydraulic test. Engine speed will affect the accuracy of the tester readings.

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

6. To minimize the possibility of damaging components when using tester with pressure and flow capabilities, completely open load valve in hydraulic tester before starting engine.

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

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

9. Check and adjust the oil level in the hydraulic reservoir after connecting hydraulic test equipment.

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

11. After testing is completed, check and adjust the oil level in the hydraulic reservoir before returning the vehicle to service.

Gear Pump Flow and System Relief Pressure

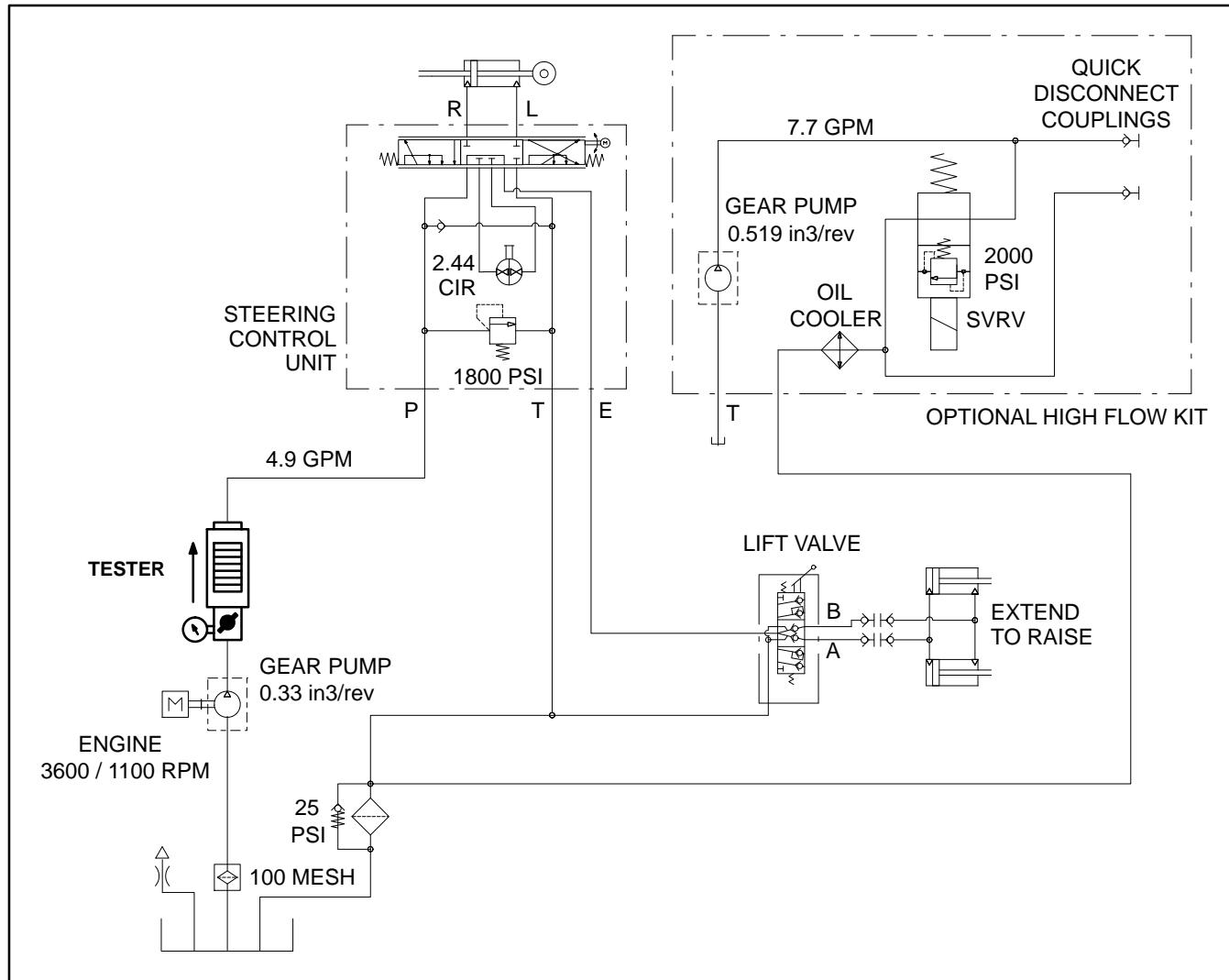


Figure 17

NOTE: This test procedure is for the single section gear pump used on vehicles with standard hydraulics. If vehicle is equipped with High Flow Hydraulics, use this test for the front pump section and refer to the High Flow Hydraulics Gear Pump Flow and Relief Pressure Test for testing of the rear pump section.

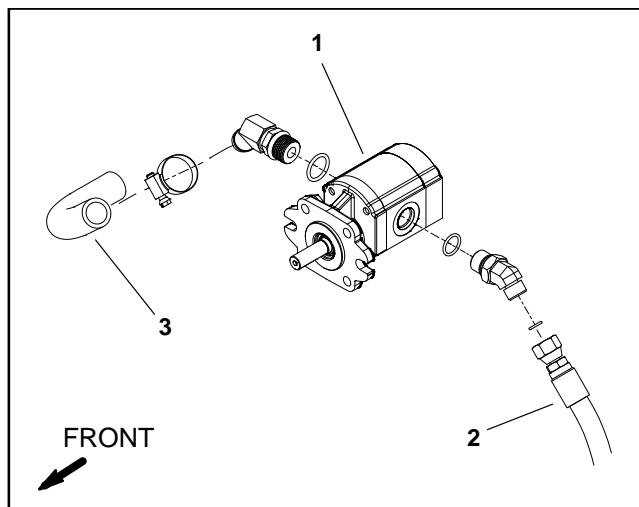


Figure 18

Procedure for Gear Pump Flow and System Relief Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the vehicle for approximately ten (10) minutes.
2. Park vehicle on a level surface, raise and support cargo bed (if installed), shut engine off and engage the parking brake. After turning engine off, operate all hydraulic controls to relieve hydraulic system pressure.



CAUTION

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

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 into the hydraulic hose.

3. With the engine off, clean hose fitting and disconnect the pressure hose from the gear pump (Fig. 18). Install tester with pressure gauges and flow meter in series between the gear pump and the disconnected hose. **Make sure the tester flow control valve is open.**
4. Make sure the hydraulic reservoir is full after connecting the tester.



CAUTION

The engine must be running to perform hydraulic tests. To guard against possible personal injury, engage parking brake and keep clothing, hands, feet, face and other parts of the body away from fan and other moving parts.

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

IMPORTANT: In this test, the flow tester is positioned before the relief valve. Pump damage can occur if the oil flow is fully restricted.

6. Fully depress and hold accelerator pedal. Check that engine speed is **3600 RPM**. Verify engine speed with a phototac.

7. While watching tester pressure gauges, slowly close flow control valve on the tester until **1500 PSI (103 bar)** is obtained on gauge. Verify that engine speed continues to be correct (**3600 RPM**). Record flow meter reading.

GAUGE READING TO BE: For a pump in good condition, flow should be approximately **4.5 GPM (17.0 LPM)** at **1500 PSI (103.4 bar)**.

8. Open tester flow control valve, release accelerator pedal and stop engine.
9. If measured flow is **less than 3.8 GPM** or a pressure of **1500 PSI (103 bar)** cannot be obtained, inspect for:
 - A. Pump suction line restriction.
 - B. Gear pump needs to be repaired or replaced.

10. To test system relief pressure:

- A. Make sure flow control valve on tester is fully open.
- B. Start engine and depress accelerator pedal so engine is running at high idle (**3600 RPM**).
- C. Watch pressure gauge carefully while turning the steering wheel completely in one direction (full steering lock) and holding momentarily.
- D. System pressure should be approximately **1800 PSI (124 bar)** as the relief valve lifts. Return steering wheel to the center position.
- E. Release accelerator pedal to allow engine to return to low idle and turn off vehicle. Record test results.

11. If relief pressure is incorrect, inspect for a worn or stuck relief valve in steering control valve (see Steering Control Valve Service in the Service and Repairs section of this chapter).

12. After testing is completed, remove tester and reinstall disconnected hose.

Steering Control Valve and Steering Cylinder

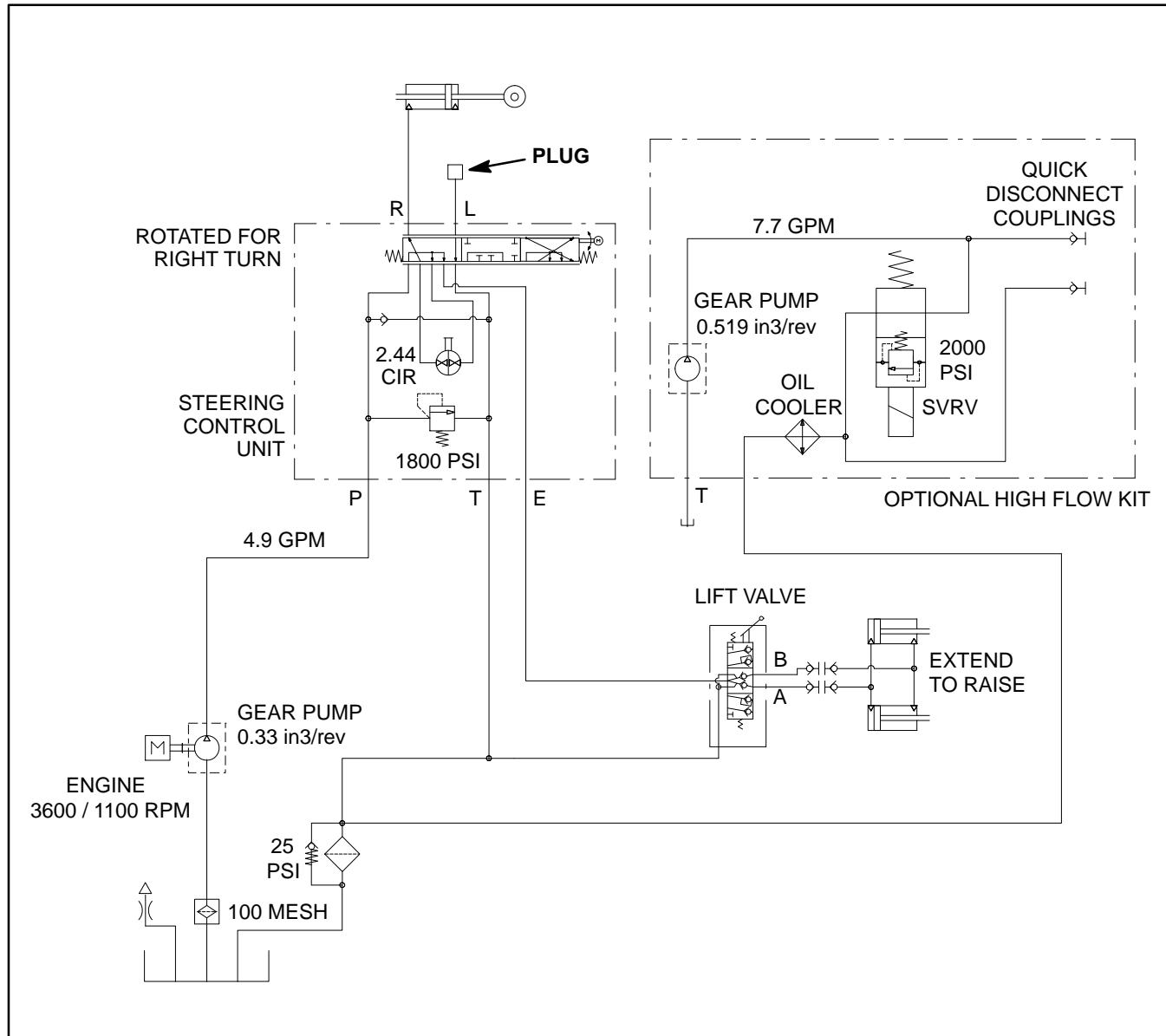


Figure 19

Procedure for Steering Control Valve and Steering Cylinder Test

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

NOTE: This steering test procedure will be affected by incorrect tire pressure, binding of the hydraulic steering cylinder, excessive weight on the vehicle and/or binding of the steering assembly (e.g. wheel spindles, tie rods). Make sure that these items are checked before proceeding with any hydraulic testing procedure.

2. Perform the Gear Pump Flow and System Relief Pressure Tests to make sure that gear pump and relief valve are functioning correctly.

3. Drive vehicle slowly in a figure eight on a flat level surface.

A. There should be no shaking or vibration in the steering wheel or front wheels.

B. Steering wheel movements should be followed **immediately** by a corresponding front wheel movement **without** the steering wheel continuing to turn.

4. Stop vehicle with the engine running. Turn steering wheel with small quick movements in both directions. Let go of the steering wheel after each movement. The steering wheel or front wheels should **not** continue to turn.



WARNING

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

IMPORTANT: Do not turn steering wheel to the left (counterclockwise) as system damage may occur.

F. With the engine off, continue turning the steering wheel to the right (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.

G. Remove plug from the disconnected hydraulic hose. Reconnect hose to the steering cylinder.

6. If steering problem exists and the steering cylinder, gear pump flow and system relief pressure (see Gear Pump Flow and System Relief Pressure Tests in this section) tested acceptably, steering control valve requires service (see Steering Control Valve and Steering Control Valve Service in the Service and Repairs section of this chapter).



CAUTION

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

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

A. Park vehicle on a level surface.

B. With the engine running, turn the steering wheel to the right (clockwise) until the steering cylinder rod is fully extended.

C. Turn engine off and engage the parking brake.

D. Read **Precautions for Hydraulic Testing** in this section.

E. Clean and remove hydraulic hose from the fitting on the rod end of the steering cylinder. Plug the end of the disconnected hose (Fig. 19).

Lift Cylinder Internal Leakage

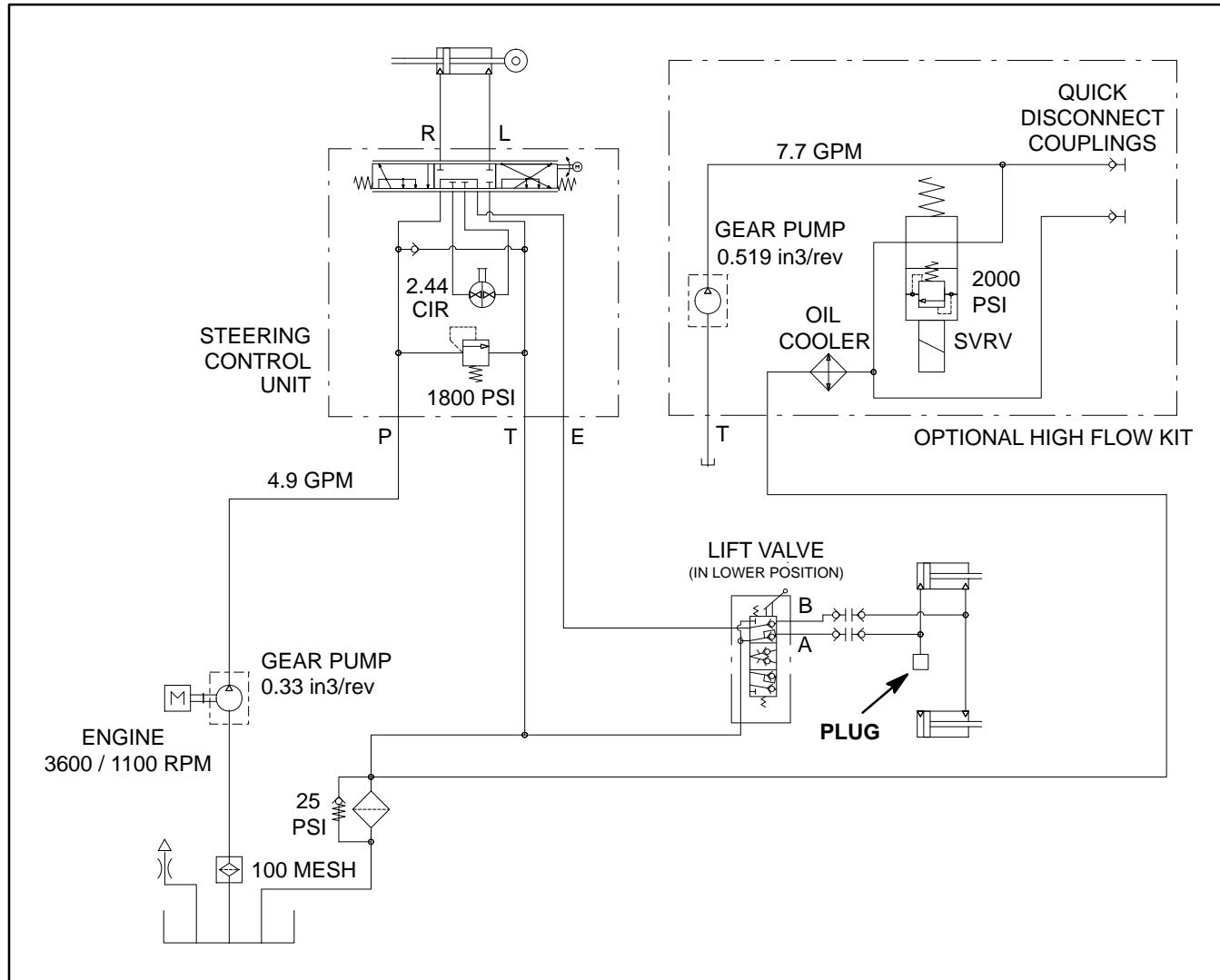


Figure 20

Procedure for Lift Cylinder Internal Leakage Test

1. Shut off engine and engage parking brake.



CAUTION

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

2. Remove all pressure from lift cylinder by fully retracting it (i.e. put hydraulic lift lever in LOWER position).
3. Read Precautions for Hydraulic Testing in this section.
4. Disconnect hydraulic hose from base end of lift cylinder that is to be tested and install a steel plug with O-ring seal in the hose (Fig. 21). Clean any remaining oil from cylinder port.
5. Start engine and apply pressure to rod end of cylinder (i.e. put hydraulic lift lever in LOWER position).
6. If any oil comes out of open cylinder port, cylinder has an internal leak. Repair or replace cylinder.
7. When testing is complete, reconnect hose that was disconnected in step 3.
8. Repeat test for second lift cylinder if necessary.

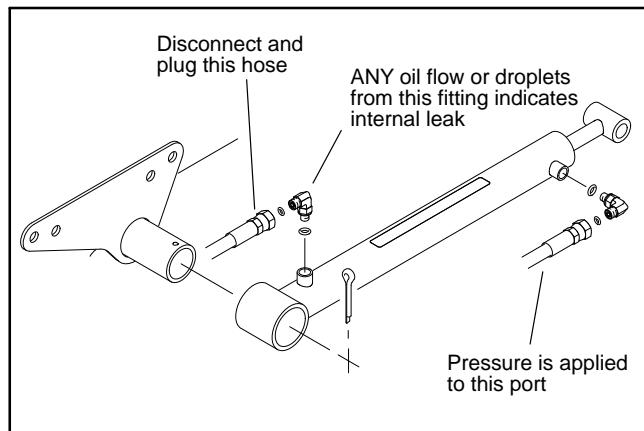


Figure 21

High Flow Hydraulics Gear Pump Flow and System Relief Pressure

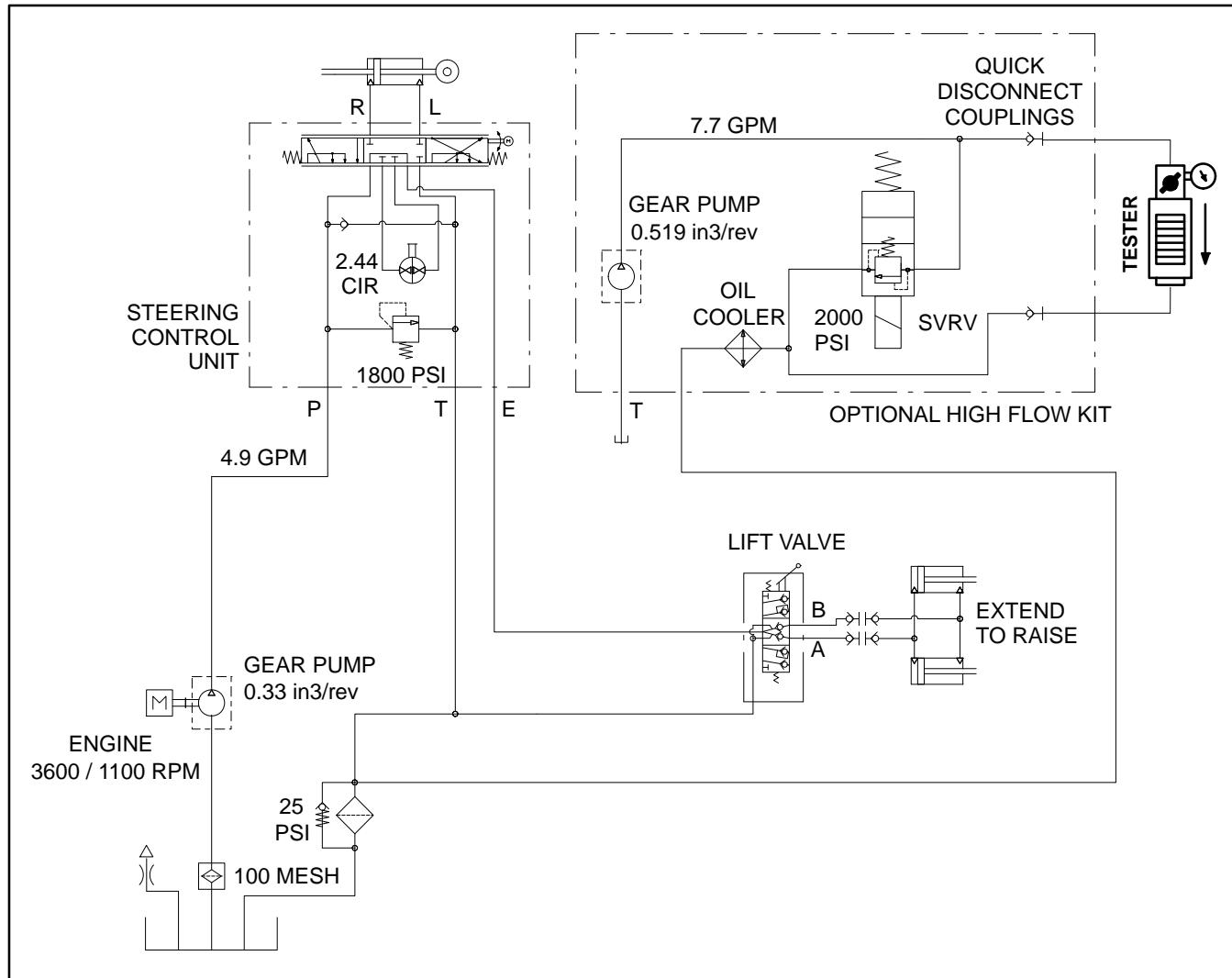


Figure 22

NOTE: This test procedure is for the rear gear pump section on Workman vehicles that are equipped with High Flow Hydraulics. For testing the front pump section on vehicles with this system, refer to the Gear Pump Flow and System Relief Pressure Test in this section.

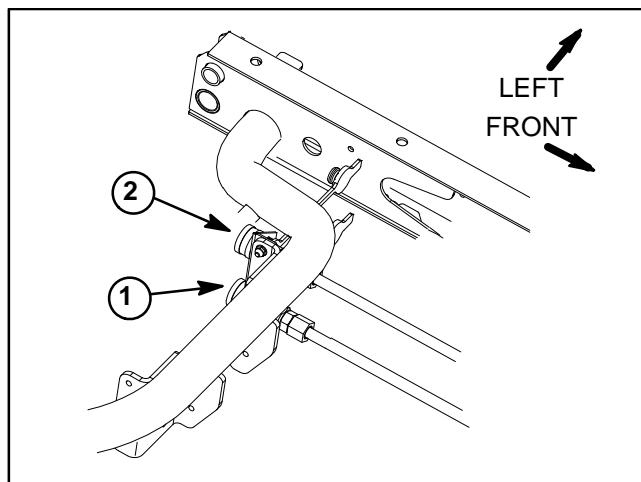


Figure 23

1. Pressure coupler (lower) 2. Return coupler (upper)

Procedure for High Flow Hydraulics Gear Pump Flow and System Relief Pressure Test

1. Make sure hydraulic oil is at normal operating temperature by operating the vehicle for approximately ten (10) minutes.
2. Park vehicle on a level surface, raise and support cargo bed (if installed), shut engine off and apply the parking brake. After turning engine off, operate all hydraulic controls to relieve hydraulic system pressure.



CAUTION

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

IMPORTANT: Make sure that the oil flow indicator arrow on the flow meter is showing that the oil will flow from the pressure (P) coupler, through the tester and into the return (T) coupler (Fig. 23).

3. With the engine off, install tester with pressure gauges and flow meter in series between the quick disconnect couplings at the rear of the vehicle. **Make sure the tester flow control valve is open.**
4. Make sure the hydraulic reservoir is full after connecting the tester.



CAUTION

The engine must be running to perform hydraulic tests. To guard against possible personal injury, engage parking brake and keep clothing, hands, feet, face and other parts of the body away from moving vehicle parts while testing.

5. After installing tester, start engine and run at idle speed. Turn high flow hydraulics switch ON and check for hydraulic leakage from connections. Correct before proceeding with test.
6. Depress accelerator pedal so engine speed is **3600 RPM**. Verify speed with a phototac.
7. With high flow hydraulics switch still in the ON position, watch tester pressure gauges while slowly closing flow control valve on the tester until **1500 PSI (103.4 bar)** is obtained on gauge. Verify that engine speed continues to be **3600 RPM**. Record flow meter reading.

GAUGE READING TO BE: A pump in good condition should have a flow of approximately **7.3 GPM (27.6 LPM)** at **1500 PSI (103 bar)**.

8. Open tester flow control valve, release accelerator pedal to allow engine to return to low idle, turn high flow hydraulics switch OFF and stop engine.
9. If the measured pump flow is lower than **6.1 GPM (23.1 LPM)** or a pressure of **1500 PSI (103 bar)** could not be obtained, inspect for:

- A. Worn or stuck relief valve (SVRV).
- B. Pump suction line restriction.
- C. Gear pump needs to be repaired or replaced.

10. To test high flow hydraulics system relief pressure:

- A. Make sure flow control valve on tester is fully open.
- B. Start engine and depress accelerator pedal so engine is running at high idle (**3600 RPM**). Turn high flow hydraulics switch ON.
- IMPORTANT: Close flow control valve on tester only enough to get a system relief pressure reading.**
- C. Watch pressure gauge carefully while slowly closing the tester flow control valve until the relief valve opens.
- D. System pressure should be approximately **2000 PSI (137.9 bar)** as the relief valve lifts.

- E. Open tester flow control valve, release accelerator pedal to allow engine to return to low idle, turn high flow hydraulics switch OFF and stop engine. Record test results.

11. If relief pressure is incorrect, inspect for a worn, stuck or damaged relief valve (SVRV) in control manifold (see Hydraulic Manifold (Vehicles with High Flow Hydraulics) in the Service and Repairs section of this chapter).

12. When testing is completed, remove tester from quick disconnect couplings.

Service and Repairs

General Precautions for Removing and Installing Hydraulic System Components

Before Repair or Replacement of Components

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



CAUTION

Before performing any service or repair on hydraulic system components, relieve system pressure to avoid injury from pressurized hydraulic oil. Stop the engine, remove key from the ignition switch, rotate the steering wheel in both directions, lower or support the bed and operate other hydraulic accessories.

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

After Repair or Replacement of Components

1. Check oil level in the hydraulic reservoir and add correct oil if necessary. Drain and refill reservoir and change oil filter if component failure was severe or system is contaminated.
2. Lubricate O-rings and seals with clean hydraulic oil before installing hydraulic components.
3. Make sure caps or plugs are removed from the hydraulic lines, hydraulic fittings and components before reconnecting.
4. Use proper tightening methods when installing hydraulic hoses and fittings (see Hydraulic Hose and Tube Installation and Hydraulic Fitting Installation in the General Information section of this chapter).
5. After disconnecting or replacing any hydraulic components, operate vehicle functions slowly until air is out of system.
6. Check for hydraulic oil leaks. Shut off engine and correct leaks if necessary. Check oil level in reservoir and add correct oil if necessary.

Check Hydraulic Lines and Hoses



WARNING

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

Check hydraulic lines and hoses daily for leaks, kinked lines, loose mounting supports, wear, loose fittings or general deterioration. Make all necessary repairs before vehicle operation.

Hydraulic Reservoir

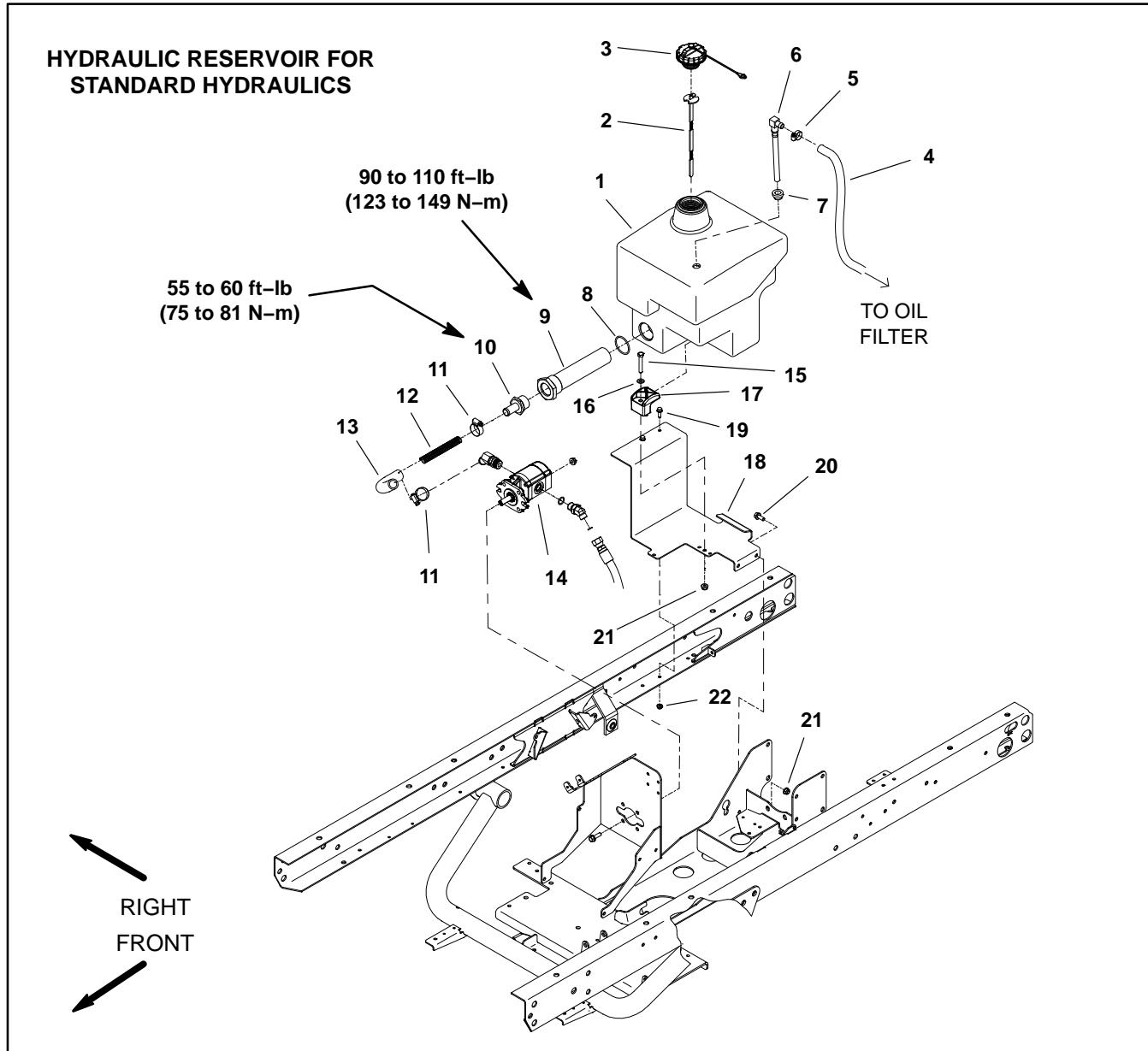


Figure 24

- | | | |
|------------------------|--------------------------------|---------------------------|
| 1. Hydraulic reservoir | 9. Strainer | 16. Flat washer |
| 2. Dipstick | 10. Barbed fitting with O-ring | 17. Clamp |
| 3. Reservoir cap | 11. Hose clamp (2) | 18. Reservoir mount |
| 4. Hydraulic hose | 12. Spring | 19. Flange head screw (2) |
| 5. Hose clamp | 13. Suction hose | 20. Flange head screw (2) |
| 6. Standpipe | 14. Gear pump | 21. Flange nut (3) |
| 7. Bushing | 15. Cap screw | 22. Flange nut (2) |
| 8. O-ring | | |

The hydraulic reservoir on all Workman HDX Auto vehicles is the same. Vehicles with standard hydraulics use a single section gear pump and single suction hose (shown in Fig. 24). Vehicles with high flow hydraulics use a two (2) section gear pump with two (2) suction hoses (shown in Fig. 25).

NOTE: Refer to your Operator's Manual for checking hydraulic fluid level in the reservoir.

Hydraulic Reservoir Removal

1. Park vehicle on a level surface, raise and support cargo bed (if installed), shut engine off and engage parking brake. Remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of this section.



CAUTION

Before performing any service or repair on hydraulic system components, relieve system pressure to avoid injury from pressurized hydraulic oil. Stop the engine, remove key from the ignition switch, rotate the steering wheel in both directions, lower the bed onto the bed support and operate other hydraulic accessories.

3. Use siphoning equipment to remove hydraulic oil from hydraulic tank and into a suitable container.

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

4. Label all hydraulic hoses and fittings for assembly purposes. Remove hydraulic hoses from fittings on hydraulic reservoir (Fig. 24 or 25). Drain hoses into a suitable container.
5. Put clean plugs in disconnected hydraulic hoses and fittings to prevent system contamination.
6. Remove clamp (item 17 in Fig. 24) that secures hydraulic reservoir to bracket.
7. Carefully remove hydraulic reservoir from vehicle.
8. As needed, remove fittings and strainer from hydraulic reservoir using Figure 24 or 25 as a guide. Discard and replace any removed O-rings.

Hydraulic Reservoir Inspection

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

Hydraulic Reservoir Installation

1. Install removed strainer and hydraulic fittings with new, lubricated O-rings to hydraulic reservoir using Figure 24 or 25 as a guide (see Hydraulic Fitting Installation in the General Information section of this chapter). Torque fittings to values identified in illustration.
2. Position hydraulic reservoir to bracket. Secure reservoir to frame with clamp (item 17 in Fig. 24) and removed fasteners.
3. Remove plugs that were installed in hydraulic hoses and fittings during the removal procedure.
4. Using labels placed during removal, attach hydraulic hoses to fittings on hydraulic reservoir (Fig. 24 or 25) (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).
5. Properly fill hydraulic reservoir with **new** hydraulic fluid.
6. Remove bed support and lower bed (if installed).
7. Operate machine. Check hydraulic oil level and adjust if necessary. Check hydraulic components for leaks. Tighten any loose connections.

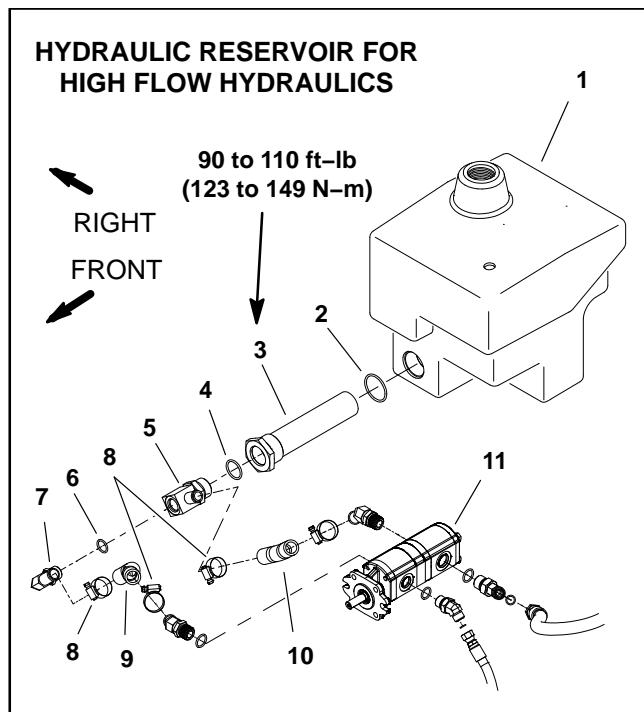


Figure 25

- | | |
|------------------------|--------------------|
| 1. Hydraulic reservoir | 7. Fitting |
| 2. O-ring | 8. Hose clamp (3) |
| 3. Strainer | 9. Hydraulic hose |
| 4. O-ring | 10. Hydraulic hose |
| 5. Tee fitting | 11. Gear pump |
| 6. O-ring | |

Gear Pump (Vehicles with Standard Hydraulics)

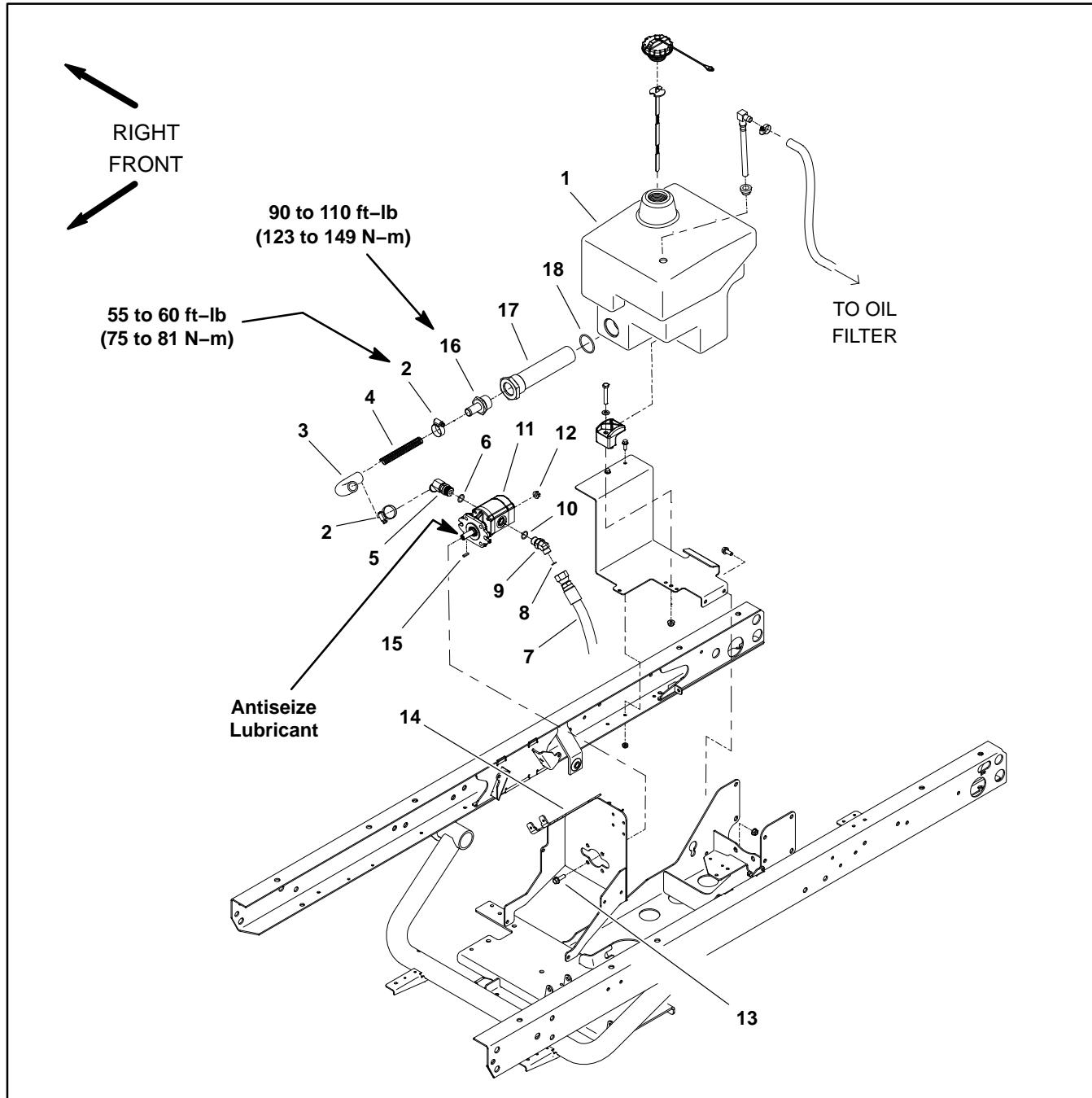


Figure 26

- | | | |
|--------------------------|--------------------------|--------------------------------|
| 1. Hydraulic reservoir | 7. Hydraulic hose | 13. Flange head screw (4) |
| 2. Hose clamp (2) | 8. O-ring | 14. Pump mount |
| 3. Suction hose | 9. 45° hydraulic fitting | 15. Square key |
| 4. Spring | 10. O-ring | 16. Barbed fitting with O-ring |
| 5. 45° hydraulic fitting | 11. Gear pump | 17. Strainer |
| 6. O-ring | 12. Flange nut (4) | 18. O-ring |

NOTE: The standard gear pump used on Workman HDX Auto vehicles is a single gear pump. If your vehicle is equipped with High Flow Hydraulics, a second pump section is added to the standard gear pump (see Gear Pump (Vehicles with High Flow Hydraulics) in this section).

Removal (Fig. 26)

1. Park vehicle on a level surface, raise and support cargo bed (if installed), shut engine off and engage parking brake. Remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of this section.



CAUTION

Before performing any service or repair on hydraulic system components, relieve system pressure to avoid injury from pressurized hydraulic oil. Stop the engine, remove key from the ignition switch, rotate the steering wheel in both directions, lower the bed onto the bed support and operate other hydraulic accessories.

3. Thoroughly clean junction of hydraulic hoses and gear pump fittings. Disconnect hydraulic hoses from pump fittings. Install caps or plugs in hoses and pump fittings to prevent contamination and leakage of hydraulic oil.
4. Remove two (2) set screws (item 3 in Fig. 27) on the pump hub to allow gear pump shaft removal from pump hub.
5. Support gear pump to prevent it from falling during removal.
6. Remove four (4) flange nuts and flange head screws that secure gear pump to mount.
7. Slide gear pump shaft out of pump hub and remove gear pump from vehicle. Locate and retrieve square key from the pump shaft.
8. If hydraulic fittings are to be removed from gear pump, mark fitting orientation to allow correct assembly. Remove fittings from pump and discard O-rings.

Installation (Fig. 26)

1. If fittings were removed from gear pump, lubricate and place new O-rings onto fittings. Install fittings into pump openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).
2. Install square key to the pump shaft. Apply antiseize lubricant to gear pump shaft.
3. Align pump shaft to pump hub. Slide pump shaft into hub until pump flange holes align with holes in mount. Take care to not damage the pump coupling.

4. Install four (4) flange head screws and flange nuts to secure pump to mount. Do not fully tighten fasteners.

5. Position pump hub on pump shaft so that rubber coupling is not distorted.

6. Apply Loctite #243 (or equivalent) to threads of pump hub set screws (item 3 in Fig. 27). Install and tighten both set screws to the pump hub to secure hub to the gear pump shaft.

7. Allow coupler assembly to locate gear pump making sure that no deflection of coupler components exists. Fully tighten fasteners to secure gear pump to mount.

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

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

10. Start the engine and operate at idle speed until air is out of hydraulic system.

11. Stop the engine and recheck oil level in hydraulic reservoir. Add correct oil if necessary.

12. Remove bed support from cargo bed lift cylinder and lower bed.

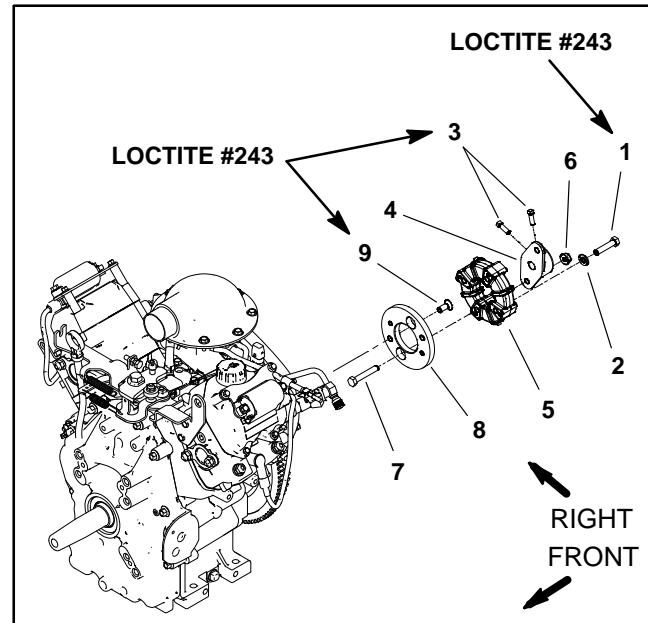


Figure 27

1. Cap screw (2)
2. Flat washer (2)
3. Set screw (2)
4. Pump hub
5. Rubber coupler
6. Flange nut (2)
7. Cap screw (2)
8. Coupler adapter
9. Socket screw (2)

Gear Pump Service (Vehicles with Standard Hydraulics)

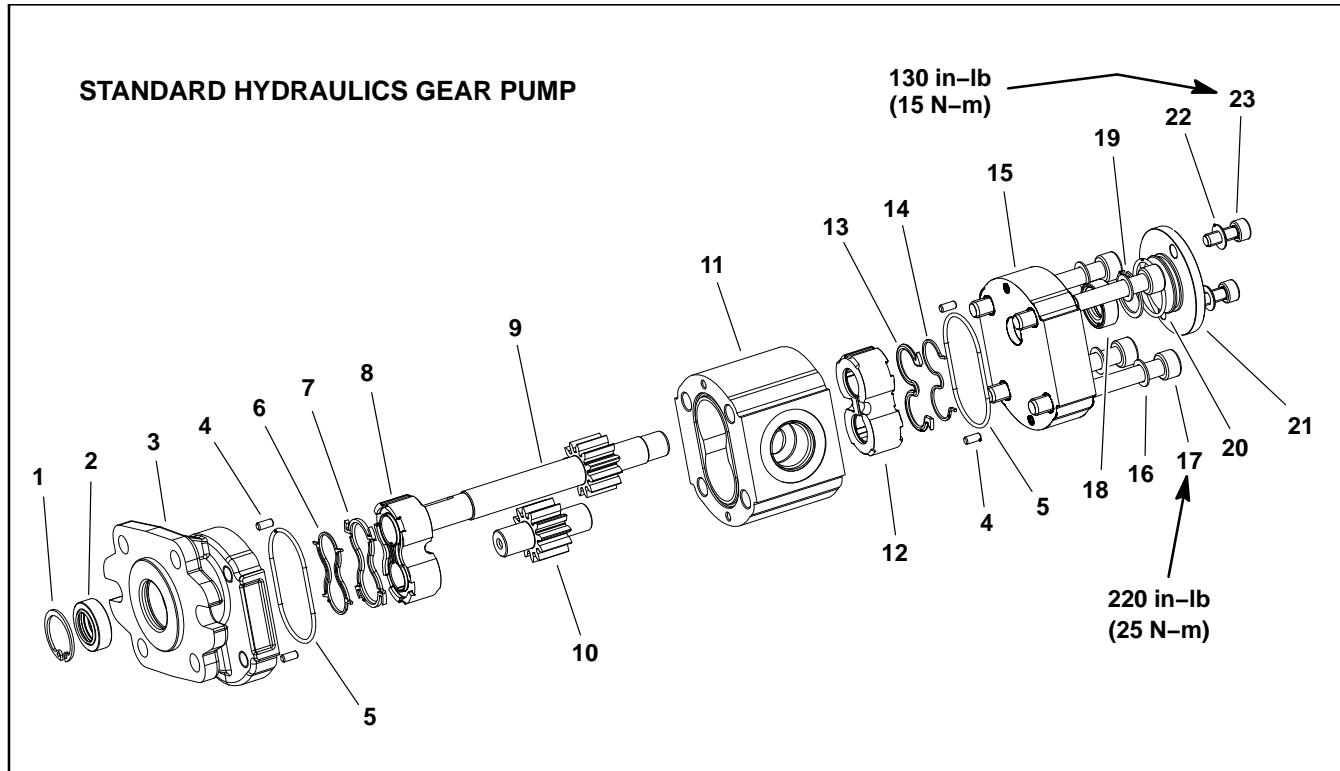


Figure 28

- | | | |
|-----------------------|-----------------------|---------------------------|
| 1. Retaining ring | 9. Drive shaft | 17. Screw (4) |
| 2. Shaft seal | 10. Idler shaft | 18. Shaft seal |
| 3. Front cover | 11. Body | 19. Retaining ring |
| 4. Dowel pin | 12. Rear thrust plate | 20. O-ring |
| 5. O-ring (2) | 13. Pressure seal | 21. Cover |
| 6. Back-up seal | 14. Back-up seal | 22. Washer (2) |
| 7. Pressure seal | 15. Rear flange | 23. Socket head screw (2) |
| 8. Front thrust plate | 16. Lock washer (4) | |

NOTE: If vehicle is equipped with High Flow Hydraulics, refer to High Flow Hydraulics Gear Pump Service later in this section.

NOTE: The Workman HDX Auto gear pump includes a rear flange that will allow the installation of a second pump section for the High Flow Hydraulics system.

Disassembly (Fig. 28)

1. Plug pump ports and clean the outside of the pump thoroughly. After cleaning, remove plugs and drain any oil out of the pump.
2. Use a marker to make a **diagonal** line across the front thrust plate, body and rear flange for assembly purposes (Fig. 29).

IMPORTANT: Prevent damage when clamping the gear pump in a vise; clamp on the front thrust plate only. Also, use a vise with soft jaws.

3. Clamp front thrust plate of pump in a vise with soft jaws with the shaft end down.

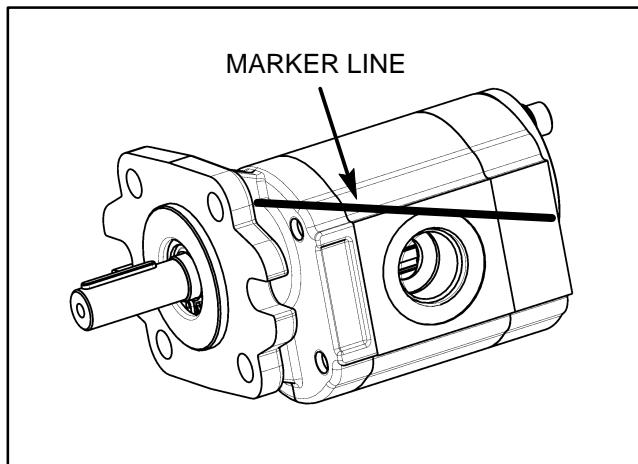


Figure 29

4. Remove socket head screws (item 23), washers (item 22) and cover (item 21) from rear flange.
5. Loosen, but do not remove, screws that secure rear flange to pump.

6. Remove pump from the vise and position pump so that the shaft end is facing down. Remove screws.

7. Carefully lift rear flange from body.

8. Carefully remove body. Lift body straight up to remove. Make sure the rear thrust plate remains on the drive and idler gear shafts. Locate and retrieve dowel pins.

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

9. Carefully remove rear thrust plate, idler shaft, drive shaft and front thrust plate from the front cover.

10. Remove and discard O-rings, back-up seals and pressure seals from pump.

IMPORTANT: Make sure to not damage the seal bores when removing the seal from the front cover and rear flange.

11. Carefully remove retaining ring and shaft seal from both the front cover and rear flange. Discard seals.

Inspection

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



CAUTION

Use eye protection such as goggles when using compressed air.

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

3. Inspect drive and idler shafts for the following (Fig. 30):

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

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

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

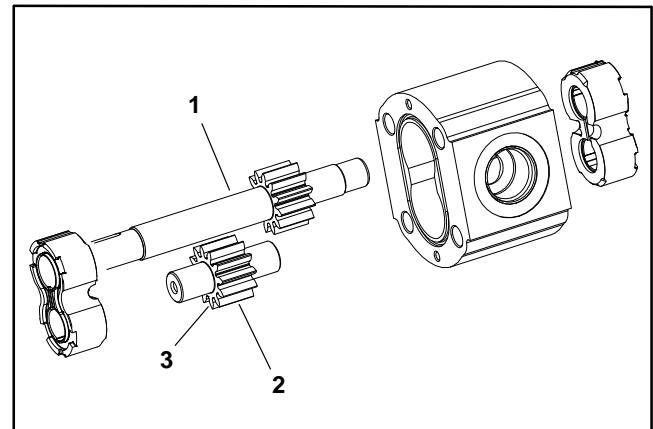


Figure 30

1. Gear shaft
2. Gear teeth

3. Gear face edge

4. Inspect thrust plates for the following:

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

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

C. Thickness of thrust plates should be equal.

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

Assembly (Fig. 28)

NOTE: When assembling the pump, check the marker line on each part to make sure the pump components are properly aligned during assembly (Fig. 29).

1. Lubricate O-rings, pressure seals, back-up seals and thrust plate grooves with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic oil.

2. Install new seal into front cover and rear flange:

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

B. Install retaining ring into the groove of the cover.

3. Install the lubricated pressure and backup seals into the grooves in the front and rear thrust plates. Install lubricated O-rings to the body.

4. Place front cover, seal side down, on a flat surface. Apply a light coating of petroleum jelly to the exposed side of the front cover.

5. Lubricate the drive shaft with clean hydraulic oil. Carefully insert the drive end of the drive shaft through the front thrust plate with the pressure seal side down.

IMPORTANT: When installing drive shaft into front cover, make sure that shaft seal (item 2) is not damaged.

6. Carefully install shaft with front thrust plate into front cover taking care to not damage shaft seal.

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

8. Install rear thrust plate with pressure seal side up and open side of the seals pointing to the inlet side of the pump.

9. Install two (2) dowel pins into front cover. Align marker line on the body and front cover.

IMPORTANT: Do not dislodge seals during installation.

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

11. Install two (2) dowel pins into body.

12. Align marker line on the body and rear flange.

IMPORTANT: When installing rear flange on, make sure that shaft seal (item 18) is not damaged.

13. Carefully install rear flange onto pump assembly.

14. Install the four (4) screws (item 17) with lock washers and hand tighten.

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

15. Place front cover of the pump into a vise with soft jaws and alternately torque the cap screws **220 in-lb (25 N-m)**.

16. Lubricate O-ring (item 20) with a thin coat of petroleum jelly and install on cover. Install cover to rear flange and secure with two (2) socket head screws. Torque screws **130 in-lb (15 N-m)**.

17. Remove pump from vise.

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

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Hydraulic
System

Gear Pump (Vehicles with High Flow Hydraulics)

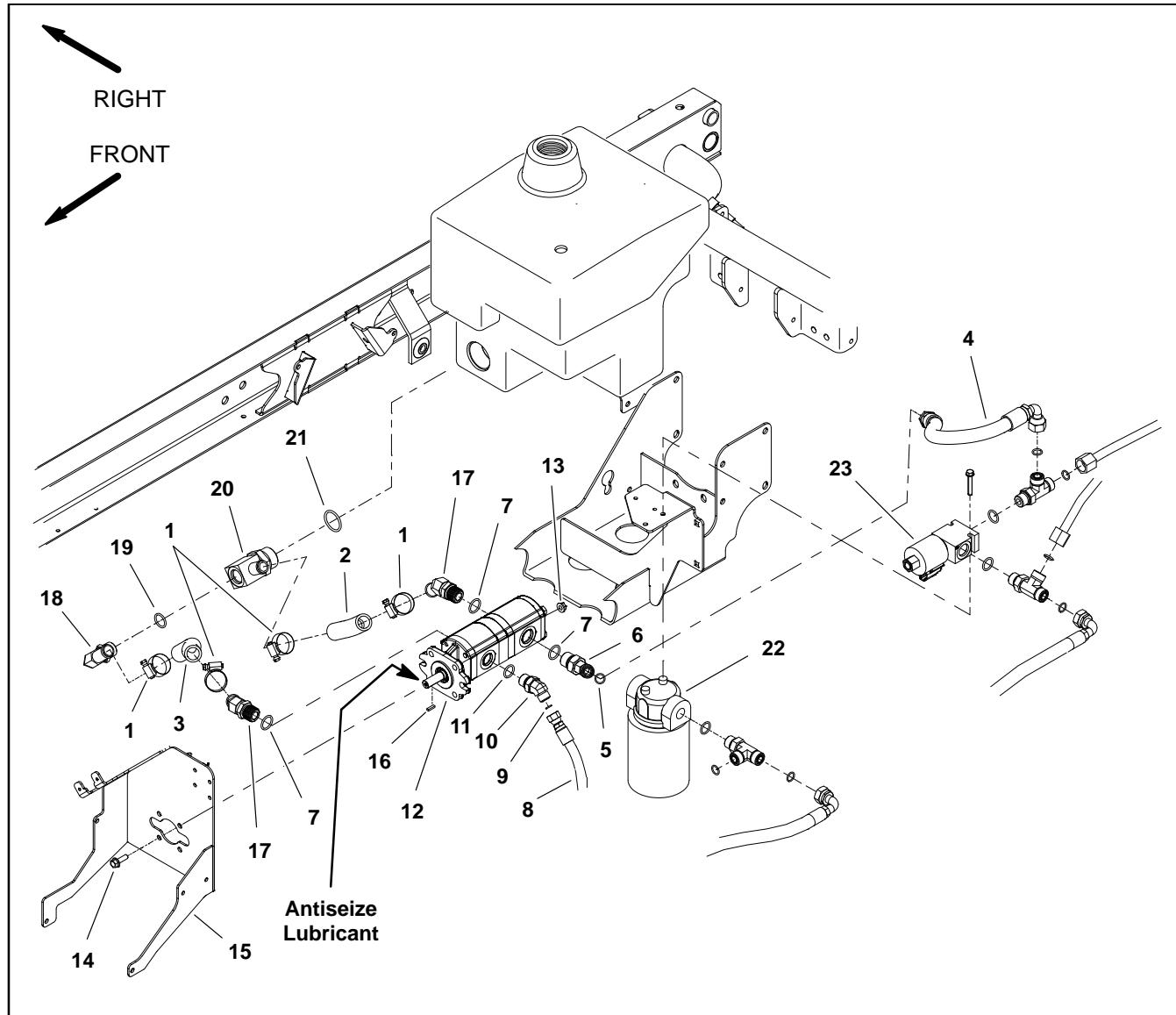


Figure 31

- | | | |
|--------------------------|---------------------------|-------------------------------|
| 1. Hose clamp (4) | 9. O-ring | 17. 45° hydraulic fitting (2) |
| 2. Hydraulic hose | 10. 45° hydraulic fitting | 18. Hydraulic fitting |
| 3. Hydraulic hose | 11. O-ring | 19. O-ring |
| 4. Hydraulic hose | 12. Gear pump | 20. Tee fitting |
| 5. O-ring | 13. Flange nut (4) | 21. O-ring |
| 6. 45° hydraulic fitting | 14. Flange head screw (4) | 22. Oil filter assembly |
| 7. O-ring | 15. Pump mount | 23. Hydraulic manifold |
| 8. Hydraulic hose | 16. Square key | |

NOTE: Workman HDX automatic vehicles equipped with High Flow Hydraulics use a two (2) section gear pump as shown in Figure 31.

Removal (Fig. 31)

1. Park vehicle on a level surface, raise and support cargo bed (if installed), shut engine off and engage parking brake. Remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of this section.



CAUTION

Before performing any service or repair on hydraulic system components, relieve system pressure to avoid injury from pressurized hydraulic oil. Stop the engine, remove key from the ignition switch, rotate the steering wheel in both directions, lower the bed onto the bed support and operate other hydraulic accessories.

3. Thoroughly clean junction of hydraulic hoses and gear pump fittings. Disconnect hydraulic hoses from pump fittings. Install caps or plugs in hoses and pump fittings to prevent contamination and leakage of hydraulic oil.
4. Remove two (2) set screws (item 3 in Fig. 32) on the pump hub to allow gear pump shaft removal from pump hub.
5. Support gear pump to prevent it from falling during removal.
6. Remove four (4) flange nuts and flange head screws that secure gear pump to mount.
7. Slide gear pump shaft out of pump hub and remove gear pump from vehicle. Locate and retrieve square key from the pump shaft.
8. If hydraulic fittings are to be removed from gear pump, mark fitting orientation to allow correct assembly. Remove fittings from pump and discard O-rings.

Installation (Fig. 31)

1. If fittings were removed from gear pump, lubricate and place new O-rings onto fittings. Install fittings into pump openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).
2. Install square key to the pump shaft. Apply antiseize lubricant to gear pump shaft.
3. Align pump shaft to pump hub. Slide pump shaft into hub until pump flange holes align with holes in mount. Take care to not damage the pump coupling.

4. Install four (4) flange head screws and flange nuts to secure pump to mount. Do not fully tighten fasteners.

5. Position pump hub on pump shaft so that rubber coupling is not distorted.

6. Apply Loctite #243 (or equivalent) to threads of pump hub set screws (item 3 in Fig. 32). Install and tighten both set screws to the pump hub to secure hub to the gear pump shaft.

7. Allow coupler assembly to locate gear pump making sure that no deflection of coupler components exists. Fully tighten fasteners to secure gear pump to mount.

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

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

10. Start the engine and operate at idle speed until air is out of hydraulic system.

11. Stop the engine and recheck oil level in hydraulic reservoir. Add correct oil if necessary.

12. Remove bed support from cargo bed lift cylinder and lower bed.

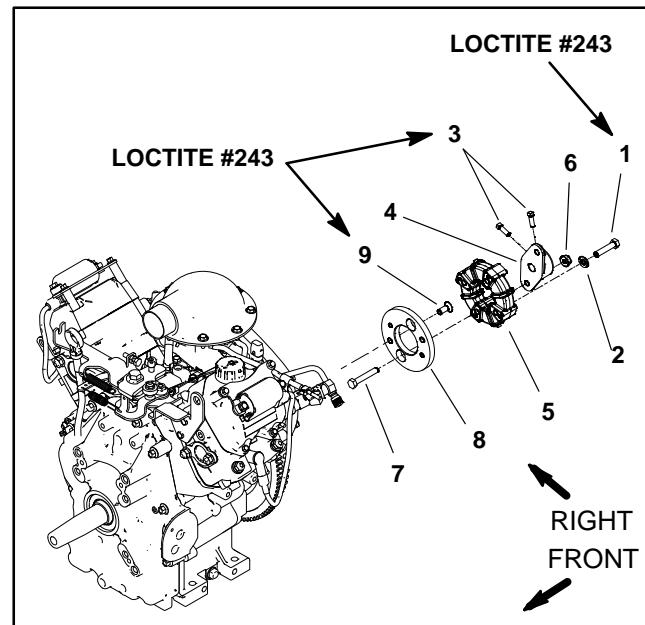


Figure 32

- | | |
|--------------------|---------------------|
| 1. Cap screw (2) | 6. Flange nut (2) |
| 2. Flat washer (2) | 7. Cap screw (2) |
| 3. Set screw (2) | 8. Coupler adapter |
| 4. Pump hub | 9. Socket screw (2) |
| 5. Rubber coupler | |

Gear Pump Service (Vehicles with High Flow Hydraulics)

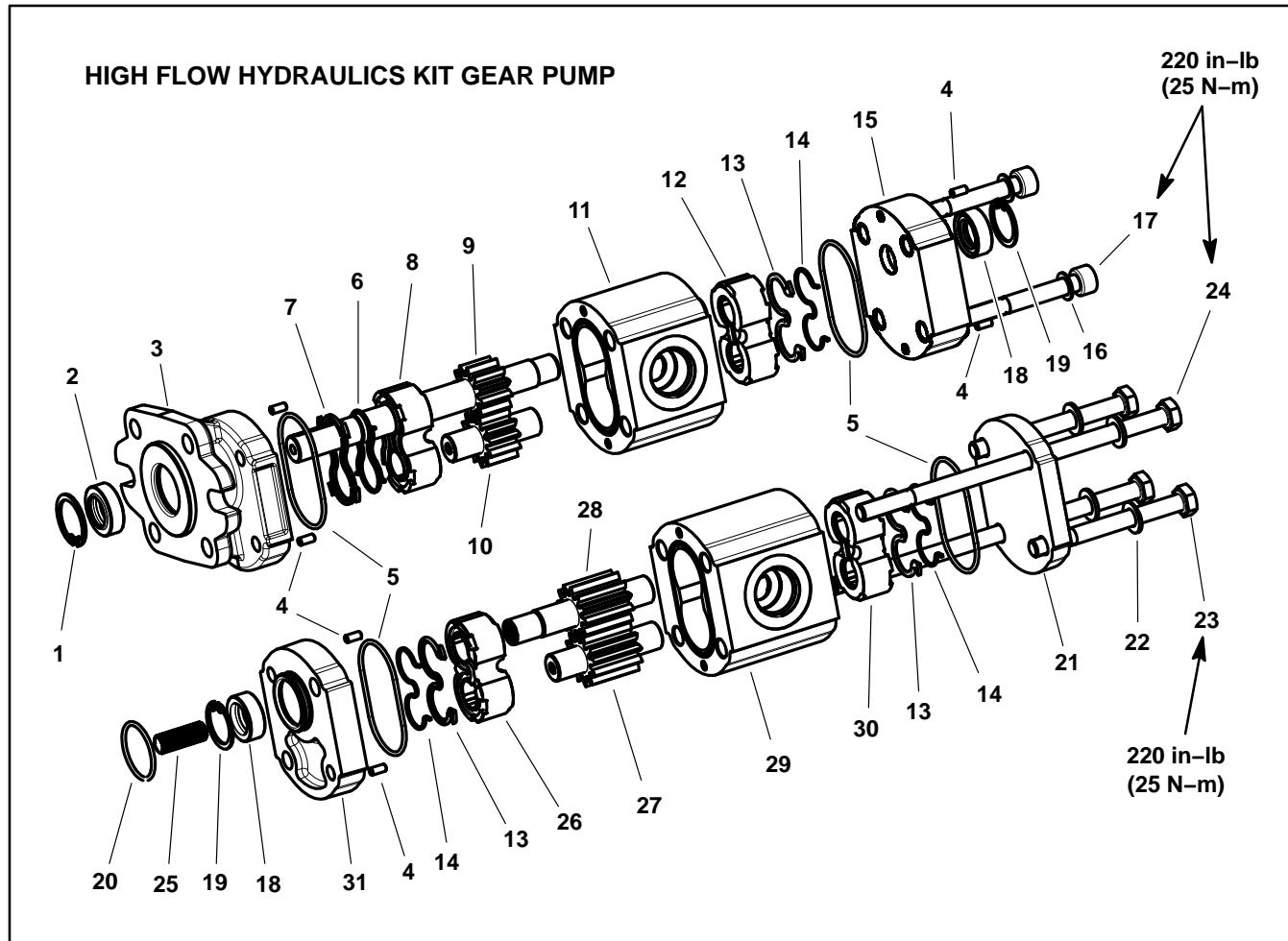


Figure 33

- | | | |
|-----------------------------|---------------------------|----------------------------|
| 1. Retaining ring | 12. Thrust plate | 22. Washer (4) |
| 2. Shaft seal | 13. Pressure seal | 23. Cap screw (2) |
| 3. Front cover | 14. Back-up seal | 24. Cap screw (2) |
| 4. Dowel pin (6) | 15. Rear flange | 25. Coupler |
| 5. O-ring (4) | 16. Lock washer (2) | 26. Thrust plate |
| 6. Back-up seal | 17. Socket head screw (2) | 27. Idler shaft |
| 7. Pressure seal | 18. Shaft seal | 28. Drive shaft |
| 8. Thrust plate | 19. Retaining ring | 29. Rear pump section body |
| 9. Drive shaft | 20. O-ring | 30. Thrust plate |
| 10. Idler shaft | 21. Rear cover | 31. Front flange |
| 11. Front pump section body | | |

The gear pump assembly used on Workman HDX Auto vehicles equipped with High Flow Hydraulics is shown in Figure 33. When servicing this gear pump, follow the procedure for Gear Pump Service (Vehicles with Standard Hydraulics) in this section and the following:

1. Use Figure 33 as a guide when servicing High Flow Hydraulics gear pump.
2. Do not mix components from one pump section to the other.

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Hydraulic
System

Lift Valve

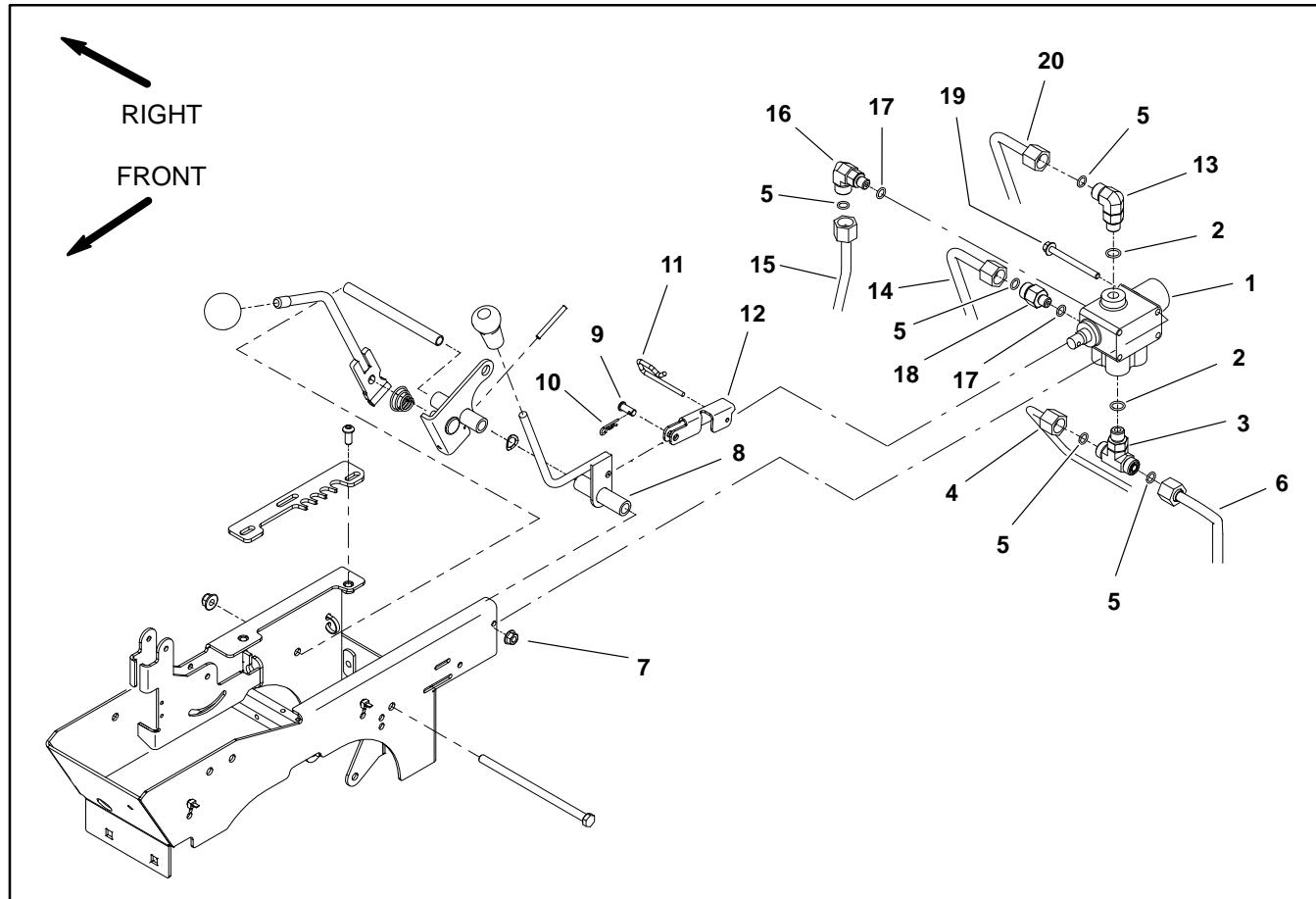


Figure 34

- | | | |
|---|---------------------------------------|---|
| 1. Lift valve | 8. Lift lever | 15. Hyd. tube (to female quick fitting) |
| 2. O-ring | 9. Clevis pin | 16. 90° hydraulic fitting |
| 3. Tee fitting | 10. Hairpin | 17. O-ring |
| 4. Hyd. tube (steering circuit return) | 11. Retainer pin | 18. Hydraulic adapter |
| 5. O-ring | 12. Link | 19. Flange head screw (2) |
| 6. Hyd. tube (return to hydraulic filter) | 13. 90° hydraulic fitting | 20. Hyd. tube (pressure supply) |
| 7. Flange nut (2) | 14. Hyd. tube (to male quick fitting) | |

Removal (Fig. 34)

1. Park vehicle on a level surface, raise and support bed (if installed), shut engine off and engage the parking brake. Remove key from the ignition switch.
2. Remove seat base from vehicle (see Seat Base in the Service and Repairs section of Chapter 7 – Chassis).
3. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of this section.



CAUTION

Before performing any service or repair on hydraulic system components, relieve system pressure to avoid injury from pressurized hydraulic oil. Stop the engine, remove key from the ignition switch, rotate the steering wheel in both directions, lower or support the bed and operate other hydraulic accessories.

4. Label and disconnect hydraulic tubes from lift valve. Install caps or plugs in tubes to prevent contamination and leakage of hydraulic oil. Install plugs in valve ports.
5. Remove lift valve from vehicle using Figure 34 as a guide.
6. If hydraulic fittings are to be removed from lift valve, mark fitting orientation to allow correct assembly. Remove fittings from valve and discard O-rings.

Installation (Fig. 34)

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

2. Install lift valve to vehicle using Figure 34 as a guide.

3. Replace O-rings on hydraulic lines and fittings. Remove caps and plugs from tubes and fittings. Connect hydraulic tubes to lift valve (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

4. Install seat base to vehicle (see Seat Base in the Service and Repairs section of Chapter 7 – Chassis). Make sure that lift lever can be moved in control plate slot to allow correct operation of lift lock.

5. Check oil level in hydraulic reservoir. Add hydraulic oil to reservoir if necessary.

6. Start the engine, operate at idle speed and operate the lift lever in both directions until air is out of hydraulic system.

7. Stop the engine and recheck oil level in hydraulic reservoir. Add hydraulic oil to reservoir if necessary.

8. On TC models, verify correct operation of lift lever interlock switch.

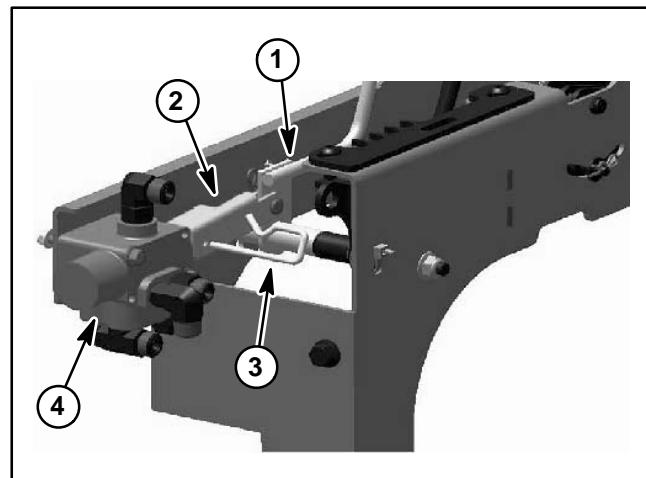


Figure 35

1. Lift lever
2. Link

3. Retainer pin
4. Lift valve

Lift Valve Service

Disassembly (Fig. 36)

1. After removing lift valve from vehicle, wash valve in solvent and dry thoroughly.
2. Carefully mount lift valve in a vise so that mounting pads are against jaws of vise. Lift valve spool retaining ring (item 14) should be facing up.
3. Remove two (2) hex cap plugs (item 1) from side of valve body. Inside valve body, behind each hex cap plug, there is a spring (item 3), ball (item 4) and cam pin (item 6); remove these parts.

NOTE: Remove check ball seats (item 5) only if they need replacement; the seats are press fit into the valve body.

4. Remove retaining ring (item 14) from spool (item 8). Remove spool retaining ring (item 13), spring retainer (item 10), spacer (item 12), spring (item 11) and second spool retaining ring (item 13). Carefully push and twist spool to remove spool from valve body.

IMPORTANT: When removing O-rings from valve body, be very careful to not scratch valve bore finish.

5. Use a hooked scribe or thin screwdriver to remove O-rings (item 9) from inside bore of valve body. These O-rings are the seals for the spool.
6. Inspect all components for wear, paying special attention to the spool. Signs of wear on one side of the spool may indicate a bent spool. Inspect the spool for flatness and replace if necessary.

Assembly (Fig. 36)

1. Clean all components thoroughly before assembly. Use new O-rings when assembling lift valve.
2. Coat all O-rings and spool with clean hydraulic oil before installation into valve body. Assemble components in reverse order of disassembly. Install spool into valve body before inserting cam pins, balls, springs and hex cap plugs.

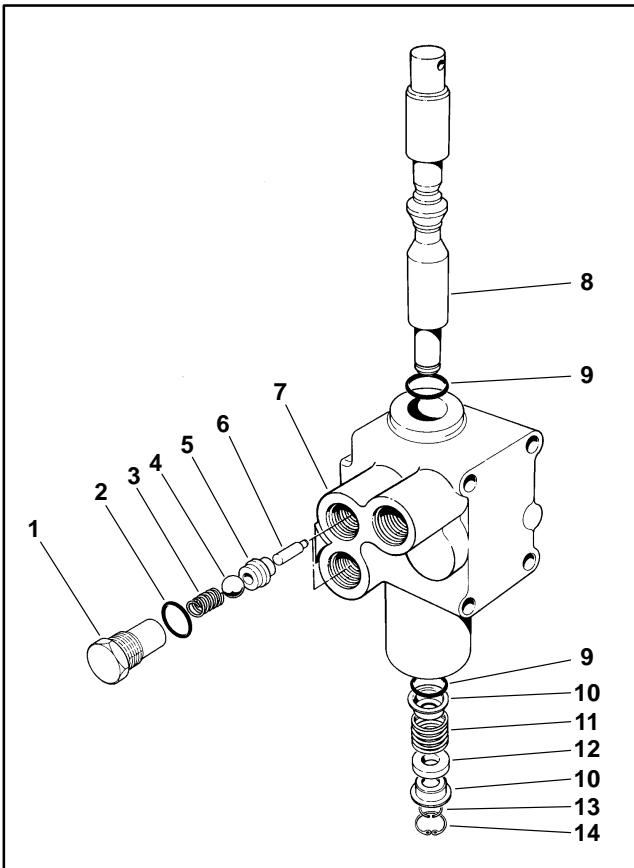


Figure 36

- | | |
|------------------------|--------------------------|
| 1. Hex cap plug (2) | 8. Spool |
| 2. O-ring (2) | 9. O-ring |
| 3. Spring (2) | 10. Spring retainer |
| 4. Check ball (2) | 11. Spring |
| 5. Check ball seat (2) | 12. Spacer |
| 6. Cam pin (2) | 13. Spool retaining ring |
| 7. Valve body | 14. Retaining ring |

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Hydraulic
System

Steering Control Valve

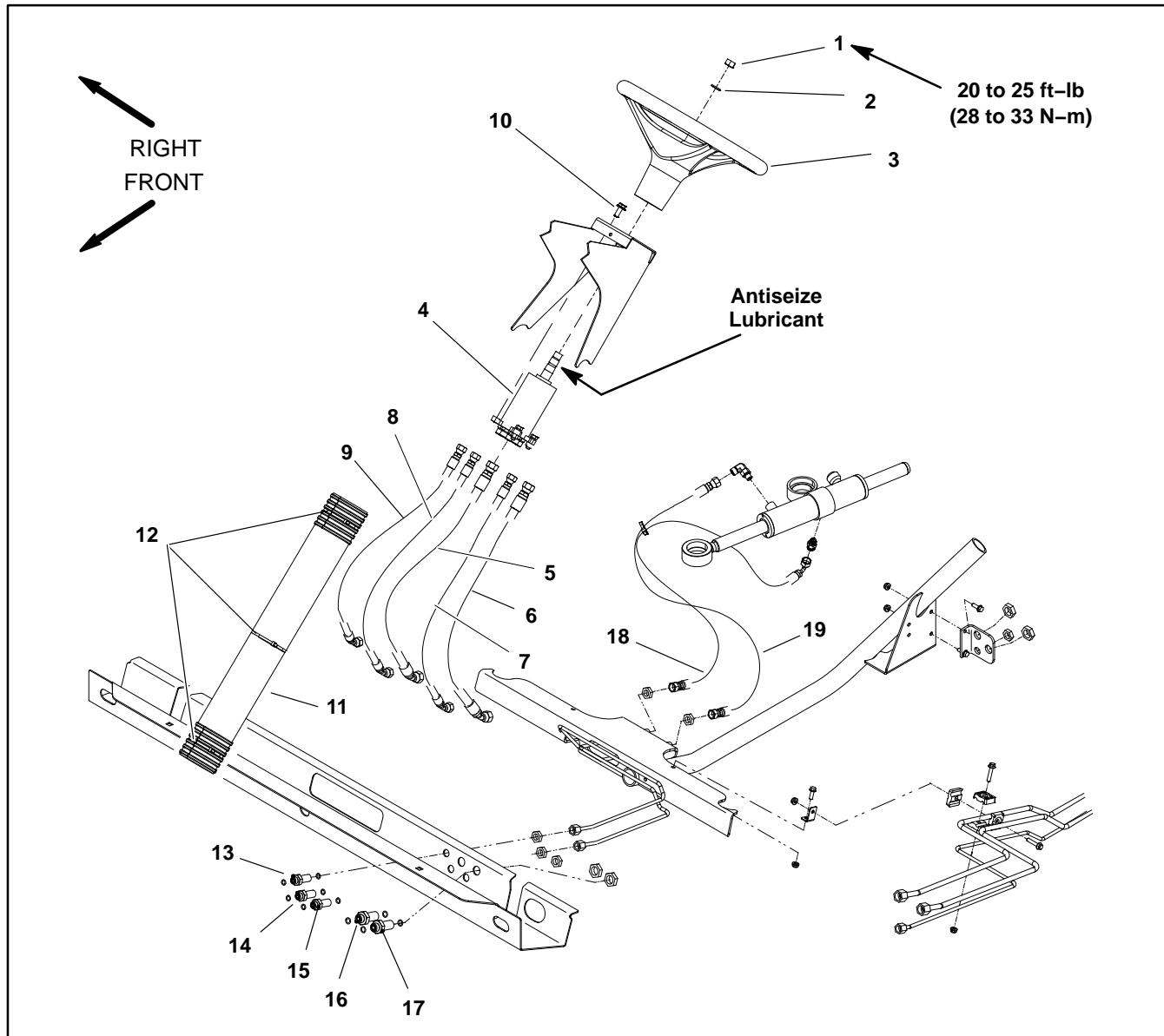


Figure 37

- | | | |
|---------------------------------------|--|--|
| 1. Lock nut | 8. Hyd hose (to control valve R port) | 14. Bulkhead fitting (to valve R port) |
| 2. Flat washer | 9. Hyd hose (to control valve L port) | 15. Bulkhead fitting (to valve T port) |
| 3. Steering wheel | 10. Flange head screw (4) | 16. Bulkhead fitting (to valve P port) |
| 4. Steering control valve | 11. Steering hose cover | 17. Bulkhead fitting (to valve E port) |
| 5. Hyd hose (to control valve P port) | 12. Cable tie | 18. Hyd hose (to steer cyl shaft end) |
| 6. Hyd hose (to control valve E port) | 13. Bulkhead fitting (to valve L port) | 19. Hyd hose (to steer cyl barrel end) |
| 7. Hyd hose (to control valve T port) | | |

Removal (Fig. 37)

- Park vehicle on a level surface, shut engine off and engage the parking brake. Remove key from the ignition switch.
- Remove steering wheel (see Steering Wheel in the Service and Repairs section of Chapter 7 – Chassis).
- Remove cable ties that secure steering hose cover to hydraulic hoses. Remove cover from hoses.

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

5. Remove hood to gain access to steering control (see Hood in the Service and Repairs section of Chapter 7 – Chassis).



CAUTION

Before performing any service or repair on hydraulic system components, relieve system pressure to avoid injury from pressurized hydraulic oil. Stop the engine, remove key from the ignition switch, rotate the steering wheel in both directions, lower or support the bed and operate other hydraulic accessories.

6. Remove four (4) flange head screws that secure steering control valve to vehicle frame. Move steering valve (with hydraulic hoses attached) away from vehicle frame.
7. Label and disconnect hydraulic hoses from steering control valve (refer to Figures 38 and 39). Install caps or plugs in hoses and valve fittings to prevent contamination and leakage of hydraulic oil.

Installation (Fig. 37)

1. Replace O-rings on hydraulic fittings. Remove caps and plugs from hoses. Connect hydraulic hoses to correct steering control valve ports (refer to Figures 38 and 39) (see Hydraulic Hose and Tube Installation in the General Information section of this chapter). Make sure that hoses are not twisted while tightening.
2. Position steering control valve to vehicle frame with port R toward front of vehicle (Fig. 38). Secure steering control valve to vehicle with four (4) flange head screws.
3. Install hydraulic hose cover over hoses and secure with cable ties.
4. Install hood to frame (see Hood in the Service and Repairs section of Chapter 7 – Chassis).
5. Install steering wheel (see Steering Wheel in the Service and Repairs section of Chapter 7 – Chassis).
6. Check oil level in hydraulic reservoir and add hydraulic oil if necessary.
7. Start the engine, operate at idle speed and rotate the steering wheel in both directions until air is out of hydraulic system.
8. Stop the engine and check oil level in reservoir. Fill reservoir if necessary.

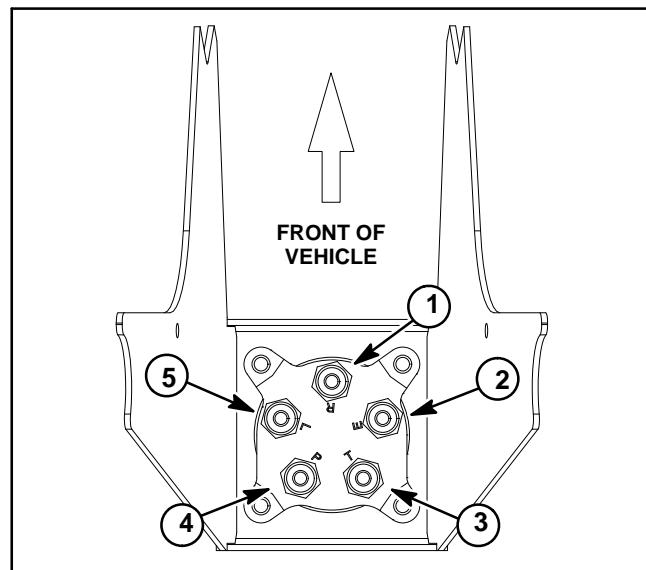


Figure 38

1. R port
2. E port
3. T port
4. P port
5. L port

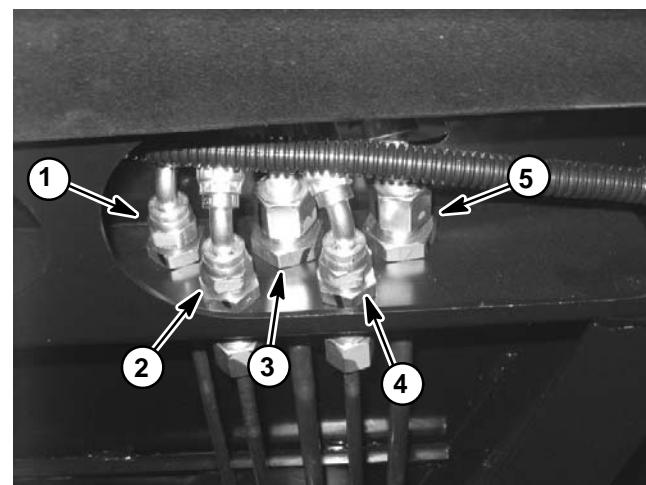


Figure 39

1. Hyd hose to L port
2. Hyd hose to R port
3. Hyd hose to T port
4. Hyd hose to P port
5. Hyd hose to E port

Steering Control Valve Service

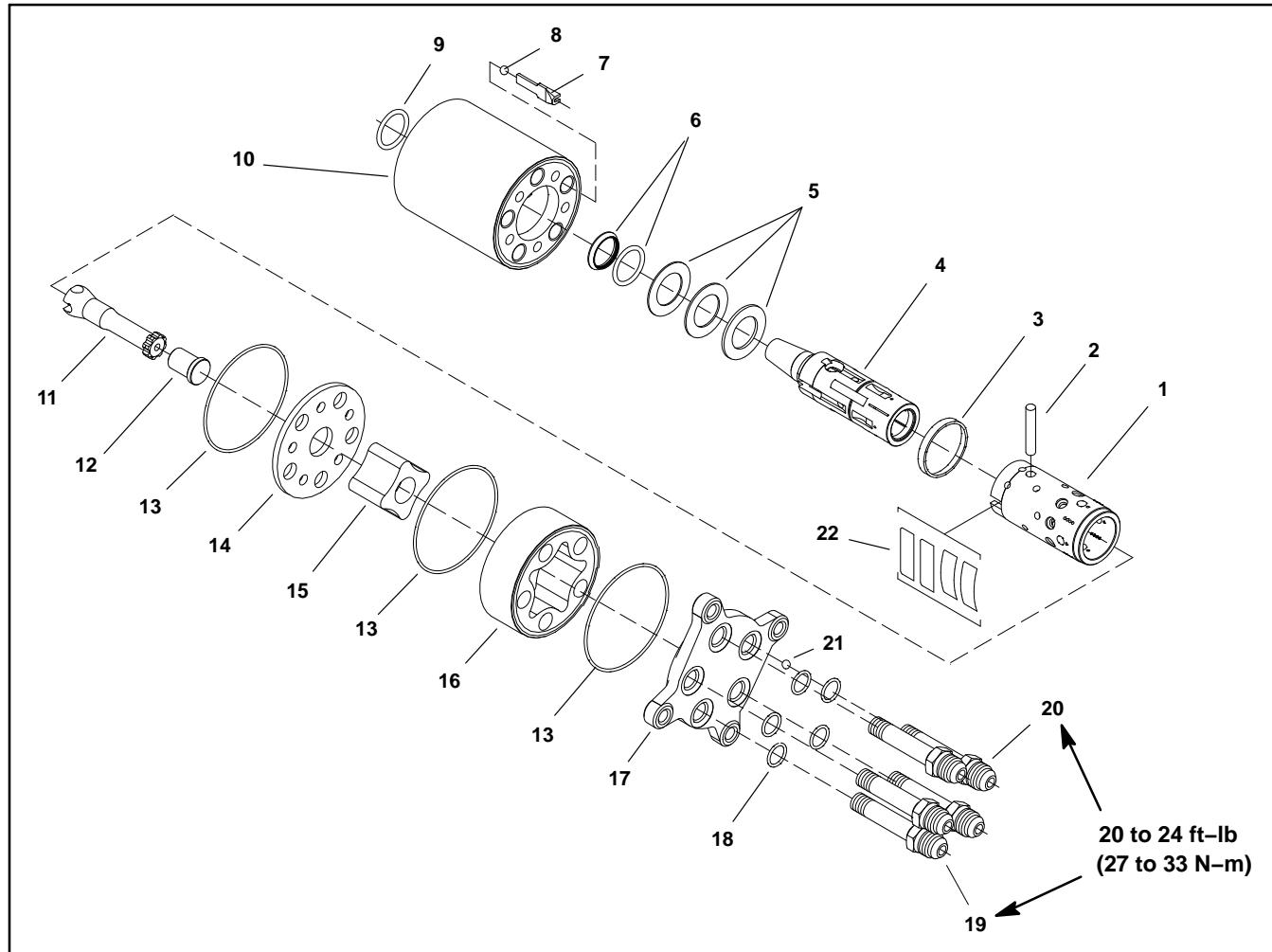


Figure 40

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

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

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Hydraulic
System

Steering Cylinder

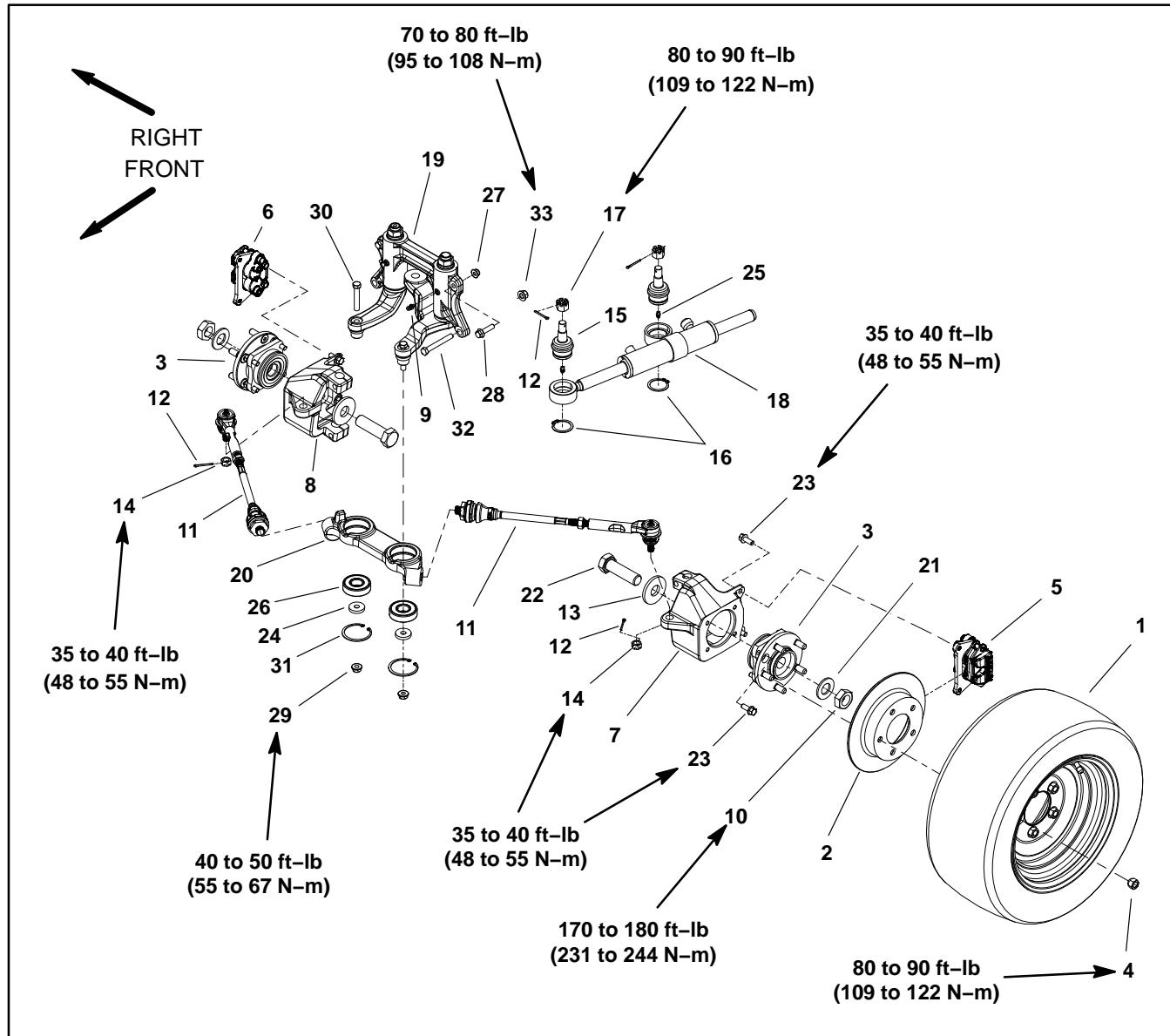


Figure 41

- | | | |
|-------------------------------|-------------------------------|----------------------------|
| 1. Front wheel assembly | 12. Cotter pin (4) | 23. Flange head screw (12) |
| 2. Brake rotor | 13. Hardened washer (2) | 24. Washer (2) |
| 3. Wheel hub assembly | 14. Slotted hex nut (2) | 25. Grease fitting (2) |
| 4. Lug nut (5 used per wheel) | 15. Ball joint (2) | 26. Ball bearing (2) |
| 5. LH brake caliper | 16. Retaining ring (2) | 27. Flange nut (2) |
| 6. RH brake caliper | 17. Slotted hex nut (2) | 28. Flange head bolt (2) |
| 7. LH knuckle | 18. Steering cylinder | 29. Flange nut (2) |
| 8. RH knuckle | 19. Steering linkage assembly | 30. Cap screw (2) |
| 9. Grease fitting (2) | 20. Center link | 31. Snap ring (2) |
| 10. Lock nut (2) | 21. Flat washer (2) | 32. Cap screw (2) |
| 11. Tie rod assembly | 22. Cap screw (2) | 33. Lock nut (2) |

Removal (Fig. 41)

1. Park vehicle on a level surface, shut engine off and engage the parking brake. Remove key from the ignition switch.
2. Remove seat base from vehicle (see Seat Base in the Service and Repairs section of Chapter 7 – Chassis).
3. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of this section.



CAUTION

Before performing any service or repair on hydraulic system components, relieve system pressure to avoid injury from pressurized hydraulic oil. Stop the engine, remove key from the ignition switch, rotate the steering wheel in both directions, lower or support the bed and operate other hydraulic accessories.

4. Label and disconnect hydraulic hoses from fittings in steering cylinder ports. Install caps or plugs in hoses to prevent contamination and leakage of hydraulic oil. Install plugs in fittings.
5. Remove steering cylinder from vehicle using Figure 19 as a guide.
6. If hydraulic fittings are to be removed from steering cylinder, mark fitting orientation to allow correct assembly. Remove fittings from cylinder and discard O-rings (Fig. 42).

Installation (Fig. 41)

1. If fittings were removed from steering cylinder, lubricate and place new O-rings onto fittings. Install fittings into cylinder openings using marks made during the removal process to properly orientate fittings. Tighten fittings (see Hydraulic Fitting Installation in the General Information section of this chapter).
2. Install steering cylinder to vehicle using Figure 19 as a guide.

3. Remove caps and plugs from hoses and fittings. Install new O-rings on hydraulic fittings. Connect hydraulic hoses to fittings in steering cylinder ports (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

4. Install seat base to vehicle (see Seat Base in the Service and Repairs section of Chapter 7 – Chassis).
5. Check oil level in hydraulic reservoir and add oil if necessary.
6. Start the engine, operate at idle speed and rotate the steering wheel in both directions until air is out of hydraulic system.
7. Stop the engine and check oil level in hydraulic reservoir. Fill reservoir if necessary.
8. Check front wheel alignment and adjust as needed (see Front Wheel Alignment in the Service and Repair section of Chapter 7 – Chassis).

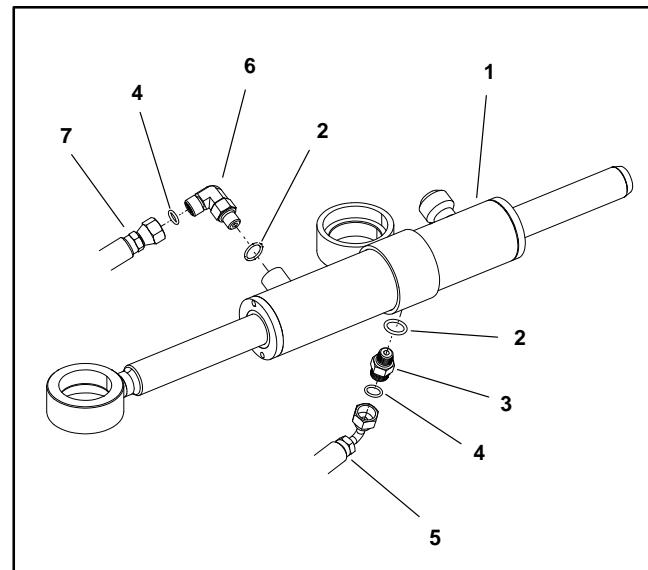


Figure 42

- | | |
|----------------------|--------------------------|
| 1. Steering cylinder | 5. Hydraulic hose |
| 2. O-ring | 6. 90° hydraulic fitting |
| 3. Hydraulic fitting | 7. Hydraulic hose |
| 4. O-ring | |

Steering Cylinder Service

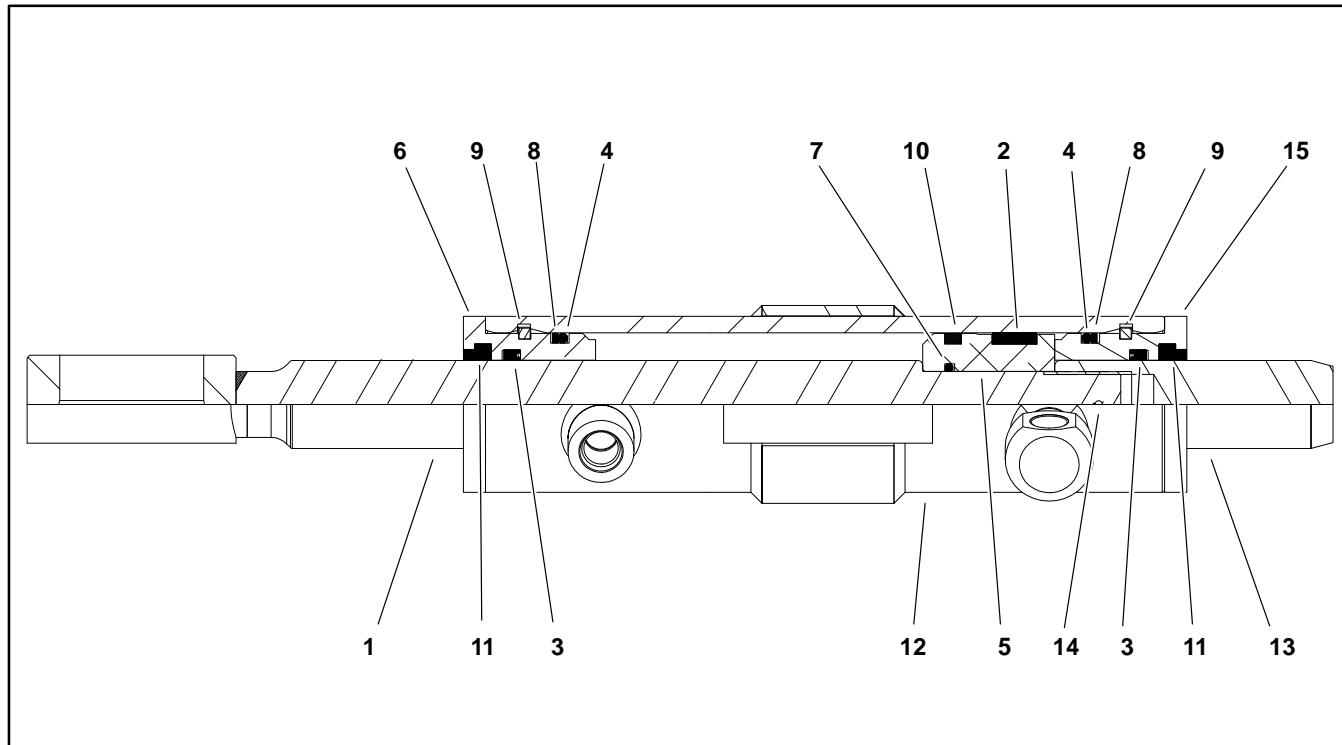


Figure 43

- 1. Rear shaft
- 2. Wear ring
- 3. Seal
- 4. O-ring
- 5. Piston
- 6. Rear head
- 7. O-ring
- 8. Back-up ring
- 9. Retaining ring
- 10. Seal

- 11. Dust seal
- 12. Barrel
- 13. Front shaft
- 14. Roll pin
- 15. Front head

Disassembly (Fig. 43)

1. Pump oil out of cylinder into a drain pan by slowly moving piston back and forth.
2. Before disassembling cylinder, plug ports, wash exterior with cleaning solvent and dry thoroughly.

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

3. Mount steering cylinder in a vise equipped with soft jaws by clamping on the barrel clevis.
4. Remove retaining rings that secure both heads in barrel.

- A. Use a spanner wrench to rotate head clockwise until the edge of the retaining ring appears in the barrel opening.
- B. Insert a screwdriver under the beveled edge of the retaining ring to start the retaining ring through the opening.

C. Rotate the head counter-clockwise to remove retaining ring from barrel and head.

5. Use a twisting and pulling motion to carefully extract the front head assembly from the barrel.
6. Grasp end of rear shaft and use a twisting and pulling motion to carefully extract the rear shaft, rear head, front shaft and piston assembly from the barrel.
7. Remove cylinder from vise.

IMPORTANT: When removing roll pin from front and rear shafts, make sure that shaft surfaces are not damaged.

8. Remove roll pin (item 14) that secures front shaft to rear shaft, then remove front shaft (item 13), piston (item 5) and rear head (item 6) from rear shaft. Discard roll pin.
9. Remove and discard seals, O-rings and wear ring from piston and heads.

Inspection

1. Wash all cylinder parts in clean solvent. Dry parts with compressed air. Do not wipe parts dry with paper towels or cloth. Lint in the hydraulic system will cause damage.
2. Carefully inspect internal surface of barrel for damage (deep scratches, out-of-round, etc.).
3. Inspect shaft and piston for evidence of excessive scoring, pitting or wear.
4. Replace steering cylinder if internal components are found to be worn or damaged.

Assembly (Fig. 43)

1. Use a new seal kit to replace all seals, O-rings and wear ring to piston and heads. Apply clean Dexron III ATF to all seal kit components before installing.
2. Install rear head (item 6) with new seals onto rear shaft (item 1).
3. Install piston (item 5) with new seals and back-ups onto rear shaft.

IMPORTANT: Make sure to not damage O-ring (item 7) as piston is installed over roll pin hole in rear shaft.

IMPORTANT: When installing roll pin into front and rear shafts, make sure that shaft surfaces are not damaged.

4. Slide front shaft onto rear shaft and align roll pin holes in shafts. Install new roll pin to secure shafts.

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

5. Mount steering cylinder in a vise equipped with soft jaws by clamping on the barrel clevis.
6. Coat all cylinder components with clean Dexron III ATF. Slide shaft assembly into barrel, being careful to not damage seals during installation.
7. Insert front head assembly into the barrel being careful to not damage head seals during installation.
8. Secure front and rear heads in barrel with retaining rings.
 - A. Align retaining ring hole in the head with the access slot in the barrel.
 - B. Insert the retaining ring hook into the hole and rotate head clockwise until the retaining ring is completely pulled into the barrel and the ring ends are covered.
 - C. Apply silicone sealer to tube access slot.

Lift Cylinder

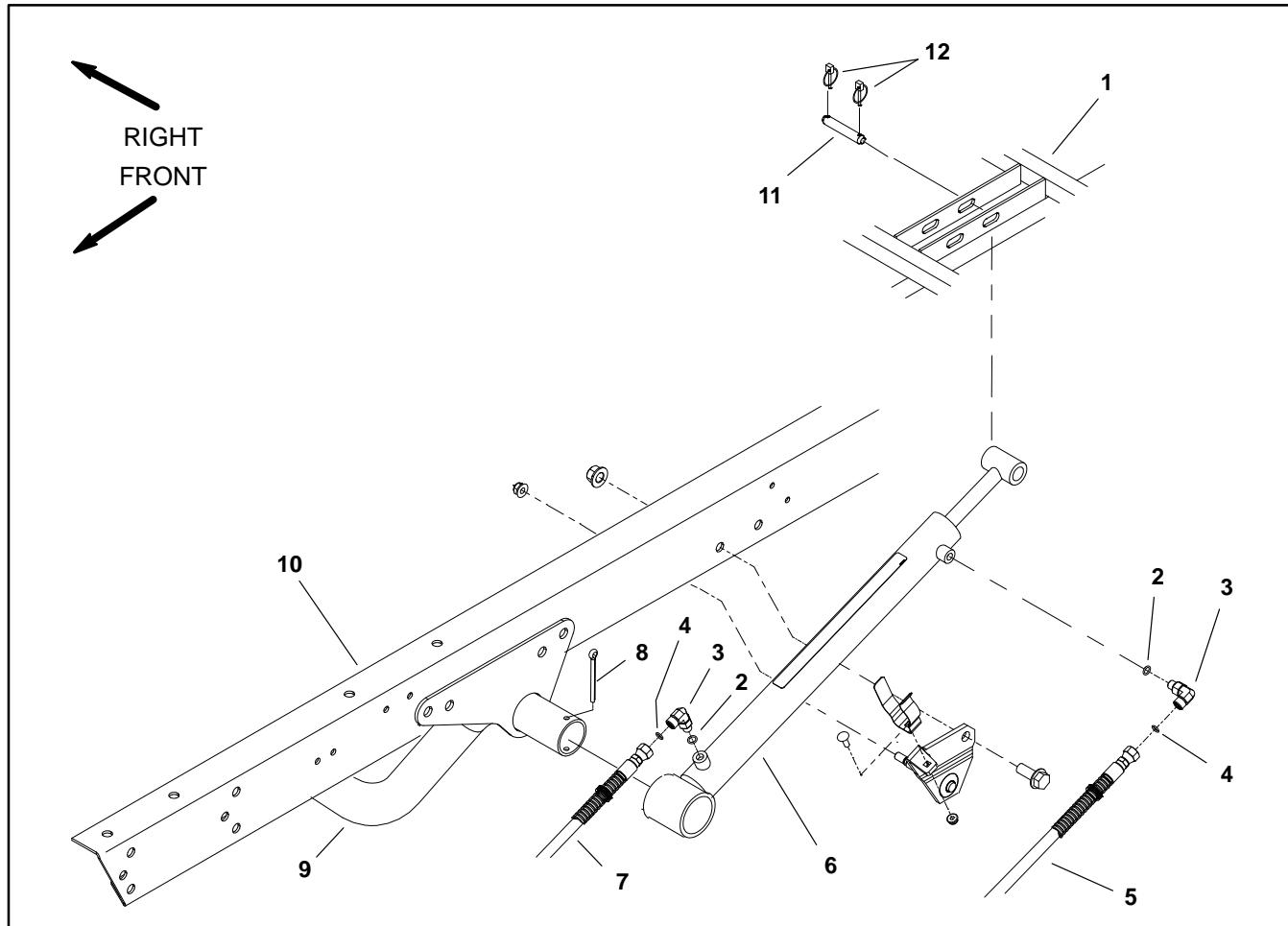


Figure 44

- | | | |
|--------------------------|-----------------------------|---------------------------|
| 1. Bed frame | 5. Hydraulic hose | 9. Frame engine support |
| 2. O-ring | 6. Lift cylinder (LH shown) | 10. Frame rail (LH shown) |
| 3. 90° hydraulic fitting | 7. Hydraulic hose | 11. Clevis pin |
| 4. O-ring | 8. Cotter pin | 12. Lynch pin |

Removal (Fig. 44)

1. Park vehicle on a level surface, lower bed until clevis pins that secure lift cylinder to bed are loose in the bed slots. Shut engine off and engage the parking brake. Remove key from the ignition switch.

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



CAUTION

Before performing any service or repair on hydraulic system components, relieve system pressure to avoid injury from pressurized hydraulic oil. Stop the engine, remove key from the ignition switch, rotate the steering wheel in both directions, lower or support the bed and operate other hydraulic accessories.

3. Disconnect hydraulic hoses from lift cylinder. Install caps or plugs in hydraulic hoses and cylinder fittings to prevent contamination and leakage of hydraulic oil.

4. Remove lynch pin and clevis pin that secure lift cylinder to bed.

5. Remove cotter pin that secures lift cylinder to frame engine support.

6. Remove lift cylinder from vehicle.

7. If hydraulic fittings are to be removed from lift cylinder, mark fitting orientation to allow correct assembly. Remove fittings from cylinder and discard O-rings.

Installation (Fig. 44)

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

2. Make sure that lift cylinder is fully retracted.

3. Position lift cylinder to vehicle. Secure lift cylinder to bed with clevis pin and lynch pins and to frame engine support with cotter pin.

4. Remove plugs and/or caps from hydraulic hoses and cylinder fittings. Connect hydraulic hoses to lift cylinder (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

5. Start the engine, operate at idle speed and raise and lower bed until air is out of hydraulic system.

6. Stop the engine and check oil level in hydraulic reservoir. Fill reservoir if necessary.

Lift Cylinder Service

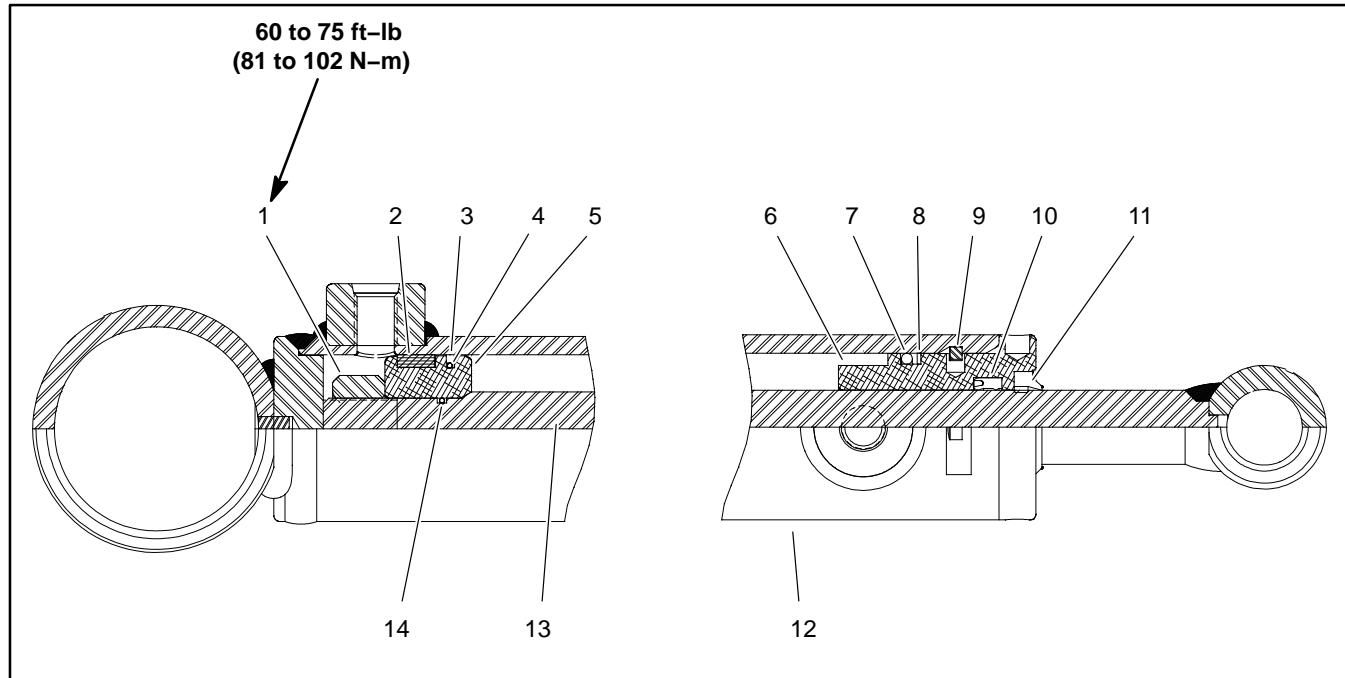


Figure 45

- 1. Lock nut
- 2. Wear ring
- 3. Seal
- 4. O-ring
- 5. Piston
- 6. Head
- 7. O-ring
- 8. Back-up seal
- 9. Retaining ring
- 10. Seal

- 11. Wiper
- 12. Barrel
- 13. Shaft
- 14. O-ring

Disassembly (Fig. 45)

1. Pump oil out of cylinder into a drain pan by slowly moving piston back and forth.

2. Before disassembling cylinder, plug ports, wash exterior with cleaning solvent and dry thoroughly.

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

3. Mount lift cylinder in a vise equipped with soft jaws by clamping on the barrel clevis.

4. Remove retaining ring that secures head in barrel.

A. Use a spanner wrench to rotate head clockwise until the edge of the retaining ring appears in the barrel opening.

B. Insert a screwdriver under the beveled edge of the retaining ring to start the retaining ring through the opening.

C. Rotate the head counter-clockwise to remove retaining ring from barrel and head.

5. Extract shaft with head and piston by carefully twisting and pulling on the shaft.

IMPORTANT: When securing shaft in vise, clamp on shaft clevis only. Do not clamp vise jaws against the shaft surface.

6. Mount shaft securely in a vise by clamping on the clevis of the shaft. Remove lock nut and piston from the shaft. Slide head from the shaft.

7. Remove piston seal, O-rings and wear ring from the piston. Remove O-ring, back-up seal, seal and wiper from the head.

Inspection

1. Wash parts in clean solvent. Dry parts with compressed air. Do not wipe parts dry with paper towels or cloth. Lint in the hydraulic system will cause damage.

2. Carefully inspect internal surface of barrel for damage (deep scratches, out-of-round, etc.).

3. Inspect shaft and piston for evidence of excessive scoring, pitting or wear.

4. Replace lift cylinder if internal components are found to be worn or damaged.

Assembly (Fig. 45)

1. Make sure all parts are clean before assembly.
 2. Coat new O-rings, piston seal, wear ring, shaft seal, back-up ring and dust seal with clean hydraulic oil.
 - A. Install lubricated piston seal, O-rings and wear ring to the piston.
 - B. Install lubricated O-ring, back-up seal, seal and wiper to the head.
- IMPORTANT: When securing shaft in vise, clamp on shaft clevis only. Do not clamp vise jaws against the shaft surface.**
3. Mount shaft securely in a vise equipped with soft jaws by clamping on the shaft clevis.
 - A. Coat shaft with clean hydraulic oil.
 - B. Slide head and piston onto the shaft.
 - C. Secure piston to shaft with lock nut. Torque lock nut from **60 to 75 ft-lb (81 to 102 N-m)**.
 4. Lubricate head and piston with clean hydraulic oil. Slide shaft assembly carefully into cylinder barrel.
- IMPORTANT: Prevent damage when clamping the cylinder's barrel into a vise; clamp on the clevis only. Do not close vise on barrel.**
5. Mount lift cylinder in a vise equipped with soft jaws by clamping on the barrel clevis.
 6. Secure head in barrel with retaining ring.
 - A. Align retaining ring hole in the head with the access slot in the barrel.
 - B. Insert the retaining ring hook into the hole and rotate head clockwise until the retaining ring is completely pulled into the barrel and the ring ends are covered.
 - C. Apply silicone sealer to tube access slot.

Hydraulic Manifold (Vehicles with High Flow Hydraulics)

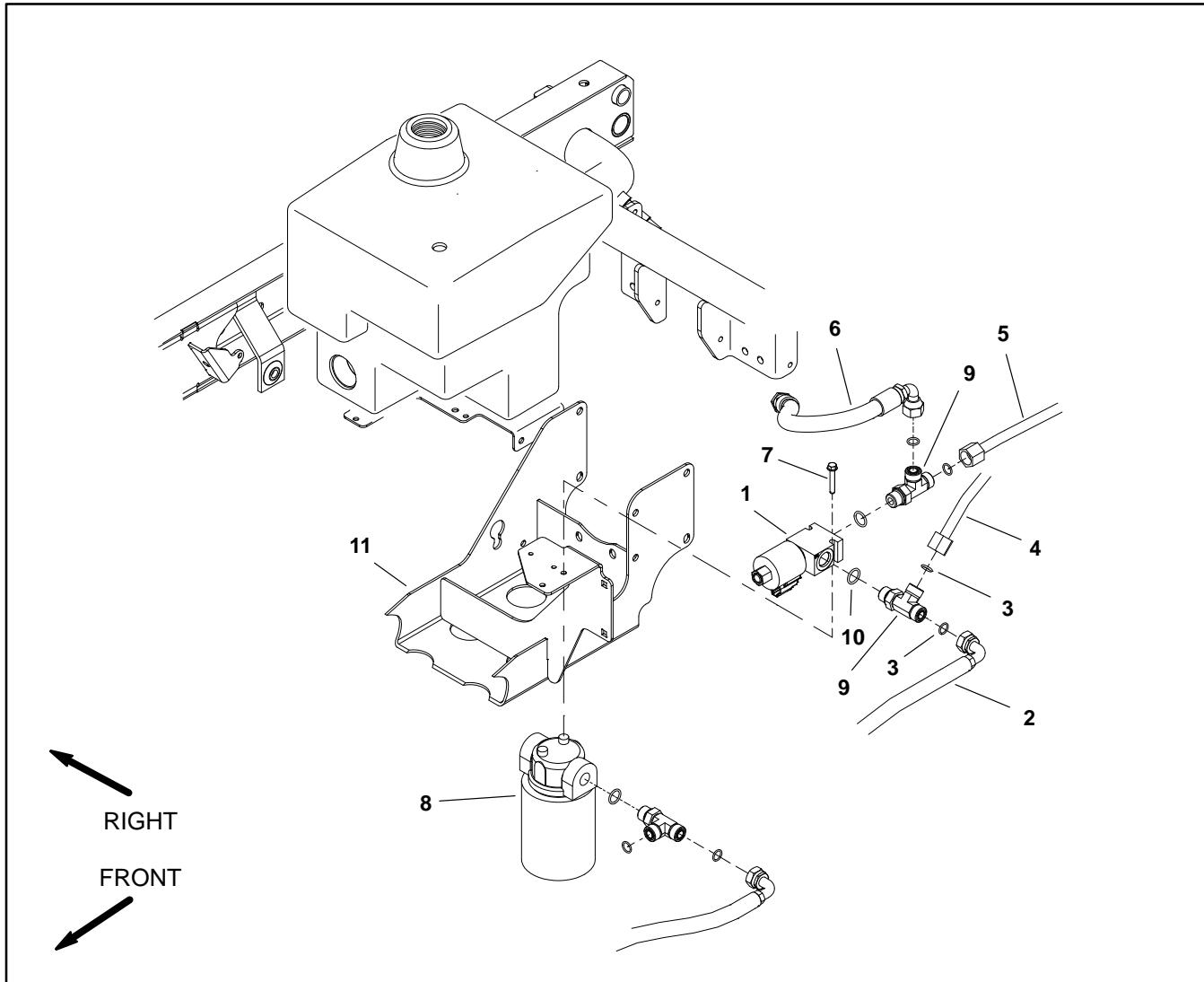


Figure 46

- | | | |
|--------------------------------|------------------------|---------------------------|
| 1. Hydraulic manifold assembly | 5. Hydraulic tube | 9. Tee fitting |
| 2. Hydraulic hose | 6. Hydraulic hose | 10. O-ring |
| 3. O-ring | 7. Cap screw (2) | 11. Engine mount assembly |
| 4. Hydraulic tube | 8. Oil filter assembly | |

Workman HDX automatic vehicles equipped with High Flow Hydraulics use a hydraulic manifold mounted solenoid valve to engage the accessory hydraulic circuit. The hydraulic manifold is attached to the vehicle above the hydraulic oil filter assembly (Fig. 47).

Removal (Fig. 46)

1. Park vehicle on a level surface, raise and support cargo bed (if installed), shut engine off and engage the parking brake. Remove key from the ignition switch.
2. Read the General Precautions for Removing and Installing Hydraulic System Components at the beginning of the Service and Repairs section of this chapter.



CAUTION

Before performing any service or repair on hydraulic system components, relieve system pressure to avoid injury from pressurized hydraulic oil. Stop the engine, remove key from the ignition switch, rotate the steering wheel in both directions, lower or support the bed and operate other hydraulic accessories.

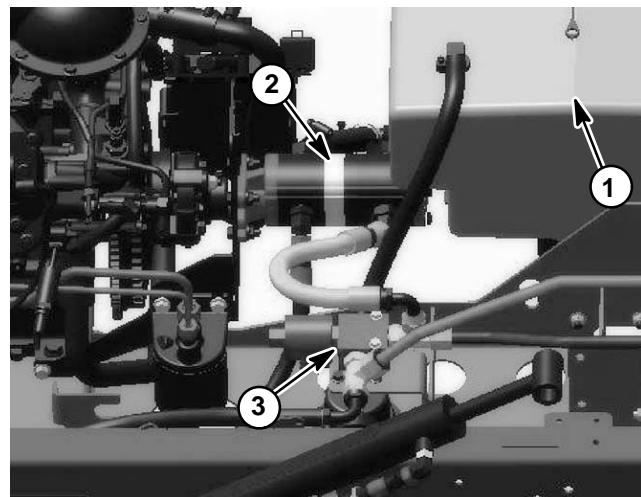


Figure 47

1. Hydraulic reservoir
2. Gear pump
3. Hydraulic manifold

3. Label and disconnect hydraulic hoses and tubes at hydraulic manifold. Install caps or plugs in open hoses, tubes and fittings to prevent contamination and leakage of hydraulic oil.
4. Remove manifold from vehicle using Figure 46 as a guide.
5. If hydraulic tee fittings are to be removed from manifold, mark fitting orientation to allow correct assembly. Remove fittings from manifold and discard O-rings.

Valve Cartridge Service (Fig. 46)

1. Make sure the entire outer surface of the manifold is clean before removing the cartridge valve.
2. Remove nut securing solenoid coil to the cartridge valve. Carefully slide solenoid off the valve.

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

3. Remove cartridge valve with a deep socket wrench. Note correct location of O-rings, sealing rings and back-up rings on valve. Remove and discard seal components.
4. Visually inspect the port in the manifold for damage to the sealing surfaces, damaged threads or contamination.

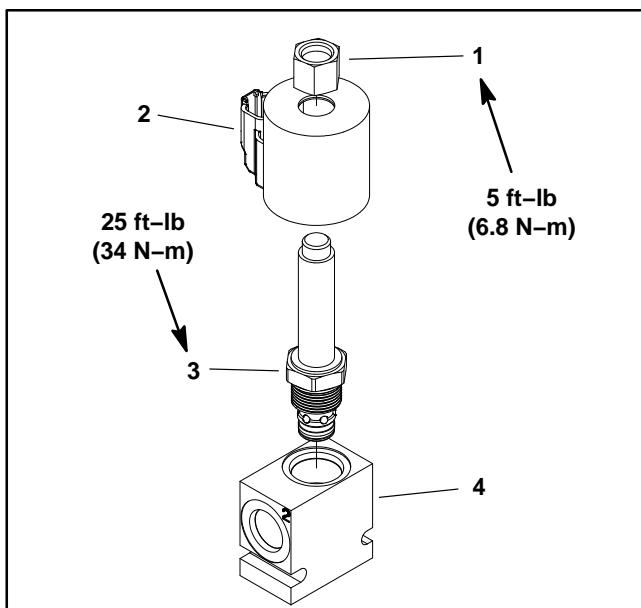


Figure 48

1. Nut
2. Solenoid coil
3. Solenoid cartridge valve
4. Manifold body

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



CAUTION

Use eye protection such as goggles when using compressed air.

6. Clean cartridge valve using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. If cartridge design allows, use a wood or plastic probe to push the internal spool in and out 20 to 30 times to flush out contamination. Be extremely careful to not damage cartridge. Use compressed air for cleaning.

7. Reinstall the cartridge valve into the manifold:

A. Lubricate new seal kit components with clean hydraulic oil and install on valve. The O-rings, sealing rings and backup rings must be arranged properly on the cartridge valve for proper operation and sealing.

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

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

C. Using a deep socket, torque cartridge valve **25 ft-lb (34 N·m)**.

D. Slide solenoid coil onto the cartridge valve. Install nut and torque **5 ft-lb (6.8 N·m)**. Over-tightening may damage the solenoid or cause the valve to malfunction.

8. If hydraulic problems still exist with vehicle, remove cartridge valve and clean again or replace valve.

Installation (Fig. 46)

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

2. Install manifold to vehicle using Figure 46 as a guide.

3. Replace O-rings on hydraulic hoses and fittings. Remove caps and plugs from hydraulic lines and fittings. Connect hydraulic lines to manifold (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

4. Check oil level in hydraulic reservoir. Add correct oil if necessary.

5. Remove bed support from cargo bed lift cylinder and lower bed.



Four Wheel Drive (Optional Kit)

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HILLIARD FRONT DRIVE SYSTEM DIFFERENTIAL
PARTS and SERVICE MANUAL

Specifications

Item	Description
Front Differential (Optional Kit)	Ring and Pinion with Dual Bi-Directional Clutches
Front Differential Oil	Mobil 424
Front Differential Oil Capacity	6 fluid ounces (180 milliliter) system capacity

General Information

Front Wheel Drive Operation

The Automatic on Demand front wheel drive feature on Workman HDX Auto vehicles equipped with the optional four wheel drive kit does not require operator activation. The front differential on Workman Auto vehicles equipped with the optional four wheel drive kit is an electro-mechanically activated bi-directional overrunning clutch system. Front differential engagement is available when the ignition switch is in the ON position, the transmission is in the low forward, high forward or reverse speed position and the accelerator pedal is depressed. The front differential is dis-engaged when the accelerator pedal is not depressed or when the transmission is in the park or neutral position.

If a vehicle is equipped with the four wheel drive kit, power is not delivered to the front wheels until the rear wheels begin to lose traction. When the rear wheels do lose traction, the dual bi-directional clutches in the

front differential sense the rear wheels slipping and engage the front wheel drive instantaneously to deliver power to the front wheels. The front wheel drive system continues to deliver power to the front wheels until the rear wheels have enough traction to move the vehicle without slipping. Once this occurs, the system stops delivering power to the front wheels and the handling characteristics become similar to that of a two wheel drive vehicle. The front wheel drive system functions in both forward and reverse. When the front wheels are turned for steering, the rear wheels will slip slightly more before power is delivered to the front wheels.

When the accelerator pedal is released during vehicle operation, the front differential relay is de-energized which removes electrical current to the front differential to disengage the differential (no power delivered to front wheels).

Installation Instructions

The Four Wheel Drive Kit Installation Instructions provide information regarding the operation, general maintenance and maintenance intervals for the front wheel drive system on your Workman Auto vehicle. Refer to this publication for additional information when servicing the front wheel drive system on your vehicle.

Service and Repairs

CV (Constant Velocity) Axle Assembly

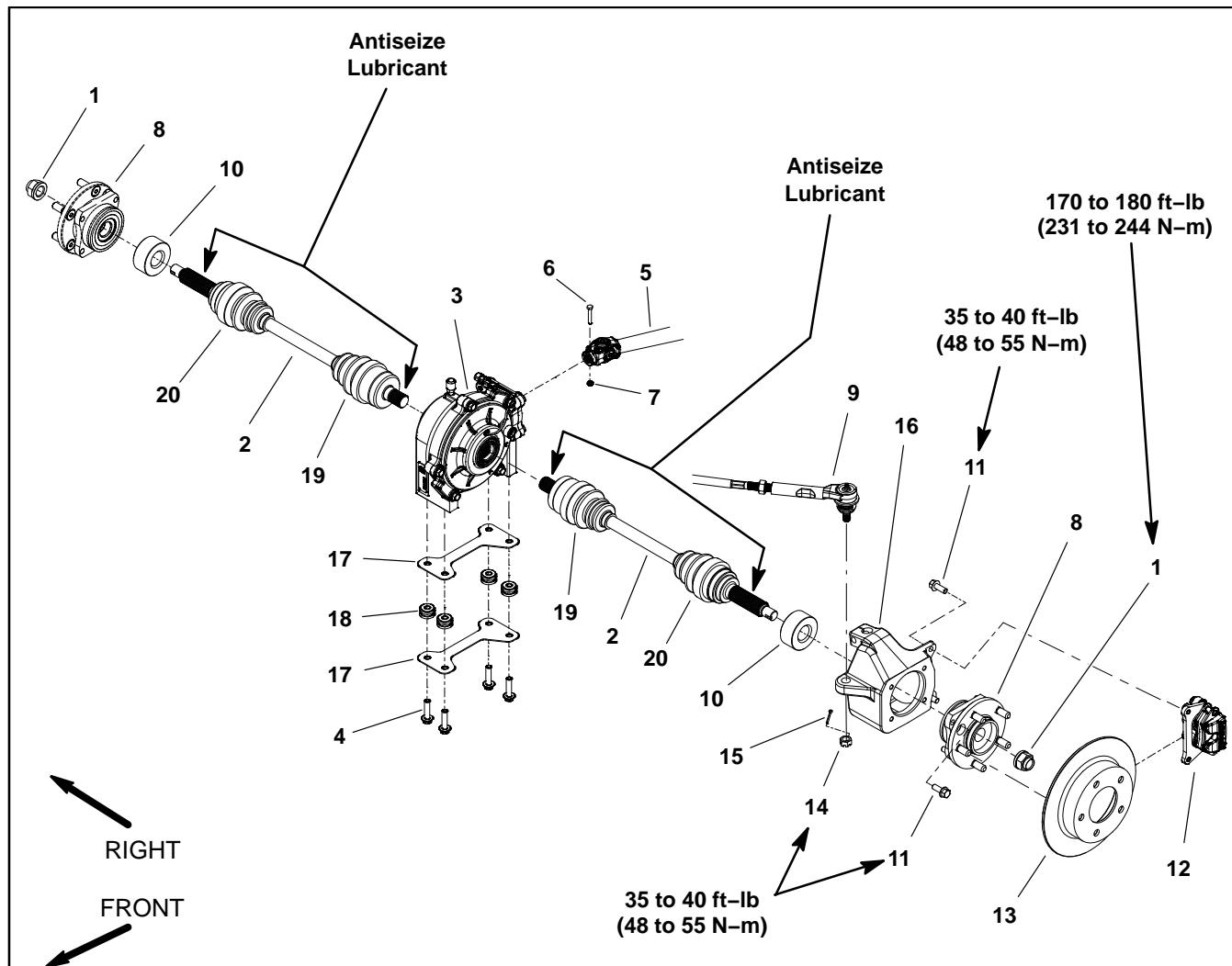


Figure 1

- | | | |
|--------------------------|------------------------------|--------------------------------|
| 1. Spindle nut | 8. Wheel hub assembly (2) | 15. Cotter pin (4) |
| 2. CV axle assembly (2) | 9. Tie rod assembly (2) | 16. Knuckle (LH shown) |
| 3. Differential assembly | 10. Axle spacer (2) | 17. Differential plate (2) |
| 4. Flange head screw (4) | 11. Flange head screw (8) | 18. Mount (4) |
| 5. Driveshaft | 12. Brake caliper (LH shown) | 19. Inboard boot (1 per axle) |
| 6. Cap screw | 13. Brake rotor (2) | 20. Outboard boot (1 per axle) |
| 7. Lock nut | 14. Slotted hex nut (2) | |

Test CV Axle

NOTE: A worn and noisy CV axle joint with the boot in good condition and filled with grease is not uncommon. Potholes, curb contact or collision damage can damage bearing components and initiate worn conditions.

1. Test drive vehicle on a smooth surface to verify CV axle joint problem.
2. Accelerate or back-up vehicle slowly with the front wheels turned. Listen for snapping or clicking noise at the wheel, then drive straight ahead.
 - A. If the noise remains constant, the wheel bearing is the likely problem and, if so, the wheel hub assembly must be replaced.
 - B. If the noise gets louder when turning, the outboard CV axle joint is likely worn. A badly worn joint will snap or click when driving straight ahead, however the noise will increase when accelerating or backing up into a turn.
3. Accelerate vehicle straight ahead quickly. Vibration or shudder often indicates a worn or sticking inboard CV joint.
4. Accelerate vehicle over a ramp or up a hill. A clunking noise indicates a worn inboard CV joint.
5. If any CV axle components other than the boots are worn or damaged, the CV axle assembly must be replaced.

Disassembly (Fig. 1)

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake.
2. For CV axle to be removed, remove wheel assembly, brake caliper and brake rotor (see Brake System Disassembly in the Service and Repairs section of Chapter 7 – Chassis).
3. Remove and discard spindle nut (item 1).
4. Using access hole in wheel hub (item 11), remove screws that secure wheel hub to knuckle. Slide wheel hub assembly from CV axle.
5. Remove axle spacer (item 10) from CV axle.

IMPORTANT: Make sure to not damage the oil seal on the differential with the pry bars when removing the CV axle.

6. Apply even pressure to two (2) small pry bars (180° apart) to leverage the CV axle out of the differential (Fig. 2).
7. Pull CV axle through opening in knuckle and remove from vehicle.

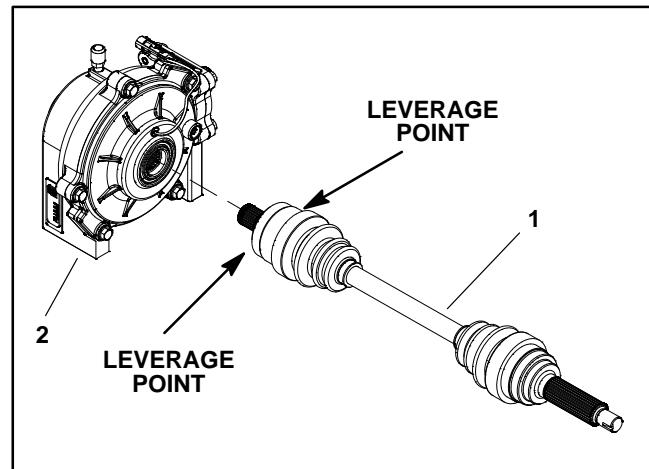


Figure 2

1. CV axle (LH shown) 2. Differential assembly

Assembly (Fig. 1)

NOTE: The inner end of the CV axle has a retaining ring to keep axle engaged in differential. The outer end of the axle has threads for the spindle nut (item 1).

1. Apply antiseize lubricant to splines on inner end of CV axle.

2. Insert inner end of CV axle through knuckle and into the differential. Press axle into differential until a snap is heard.

IMPORTANT: After CV axle installation into differential, pull outward on CV axle as close as possible to the differential to make sure that the axle is properly secured into the differential.

3. Place wheel spacer (item 10) onto CV axle.

4. Apply antiseize lubricant to splines on outer end of CV axle.

5. Slide wheel hub onto CV axle. Loosely install four (4) flange head screws (item 11) to locate wheel hub to knuckle. Do not fully tighten screws.

6. Install new spindle nut (item 1) onto CV axle. Torque spindle nut from **170 to 180 ft-lb (231 to 244 N·m)**. After tightening nut, stake nut extension into slot in axle.

7. Fully tighten flange head screws to secure wheel hub to knuckle. Torque screws from **35 to 40 ft-lb (48 to 55 N·m)**.

8. Install brake rotor, brake caliper and wheel assembly (see Brake System Assembly in the Service and Repairs section of Chapter 7 – Chassis).

9. Make sure that wheel lug nuts are properly tightened.

CV Axle Boots

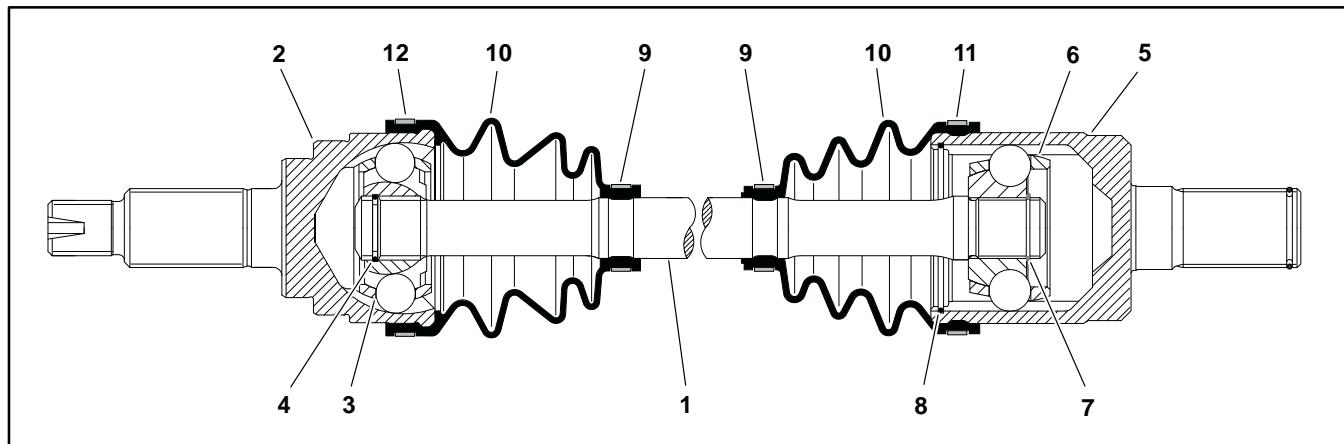


Figure 3

- | | | |
|---------------------------|--------------------------|---------------------------------|
| 1. Center shaft | 5. Inboard joint housing | 9. Boot clamp – small (2) |
| 2. Outboard joint housing | 6. Inboard CV joint | 10. Boot (2) |
| 3. Outboard CV joint | 7. Inner retaining ring | 11. Boot clamp – inboard large |
| 4. Spring clip | 8. Outer retaining ring | 12. Boot clamp – outboard large |

A torn CV axle boot is the most common cause of CV axle failures. Look for grease on front suspension components, inner tire sidewall or fender to indicate a possible torn boot. Inspect boots for cracks, holes, tears or loose clamps. Dirty grease within the boot may indicate damage to the CV axle joint. Replace the boot if it is cracked or torn, has any holes or has loose clamps.

1. Remove CV axle assembly (see CV Axle Assembly in this section).

2. Clamp the un-splined center section of the axle in a vise.

3. Cut, remove, and discard damaged boot and boot clamps.

4. Replace outboard boot as follows:

A. Use a soft brass or plastic hammer against the CV joint and carefully drive the joint from the center shaft.

B. Clean old grease from CV joint and center axle.

C. Fit small clamp and boot over center axle.

D. Fill CV joint with approximately 1.5 oz (44 ml) of Shell Gadus 1452 or equivalent low friction CV joint grease.

E. Align CV joint with center axle splines and slide against spring clip on shaft. Start the joint over the spring clip by using a small screwdriver to collapse the spring clip while pushing the joint onto the center shaft.

F. Use a soft brass or plastic hammer against the outboard joint housing and carefully drive the joint onto the center shaft until spring clip is seated.

5. Replace inboard boot as follows:

A. Remove the outer retaining ring and pull the joint housing from the CV joint.

B. Remove the inner retaining ring and pull the CV joint from the center axle.

C. Clean old grease from CV joint, center axle and joint housing.

D. Fit small clamp and boot over center axle.

E. Align CV joint with center axle splines and install joint onto center axle. Install inner retaining ring.

F. Fill CV joint with approximately 1 oz (30 ml) of Shell Gadus 1452 or equivalent low friction CV joint grease.

G. Fit CV joint into joint housing and install outer retaining ring.

6. Fill boot with approximately 1.5 oz (44 ml) of Shell Gadus 1452 or equivalent low friction CV joint grease.

7. Fit boot over grooves in center shaft and joint housing. Secure boot with clamps.

8. Install CV axle assembly (see CV Axle Assembly in this section).

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Four Wheel Drive
(Optional Kit)

Front Differential Driveshaft

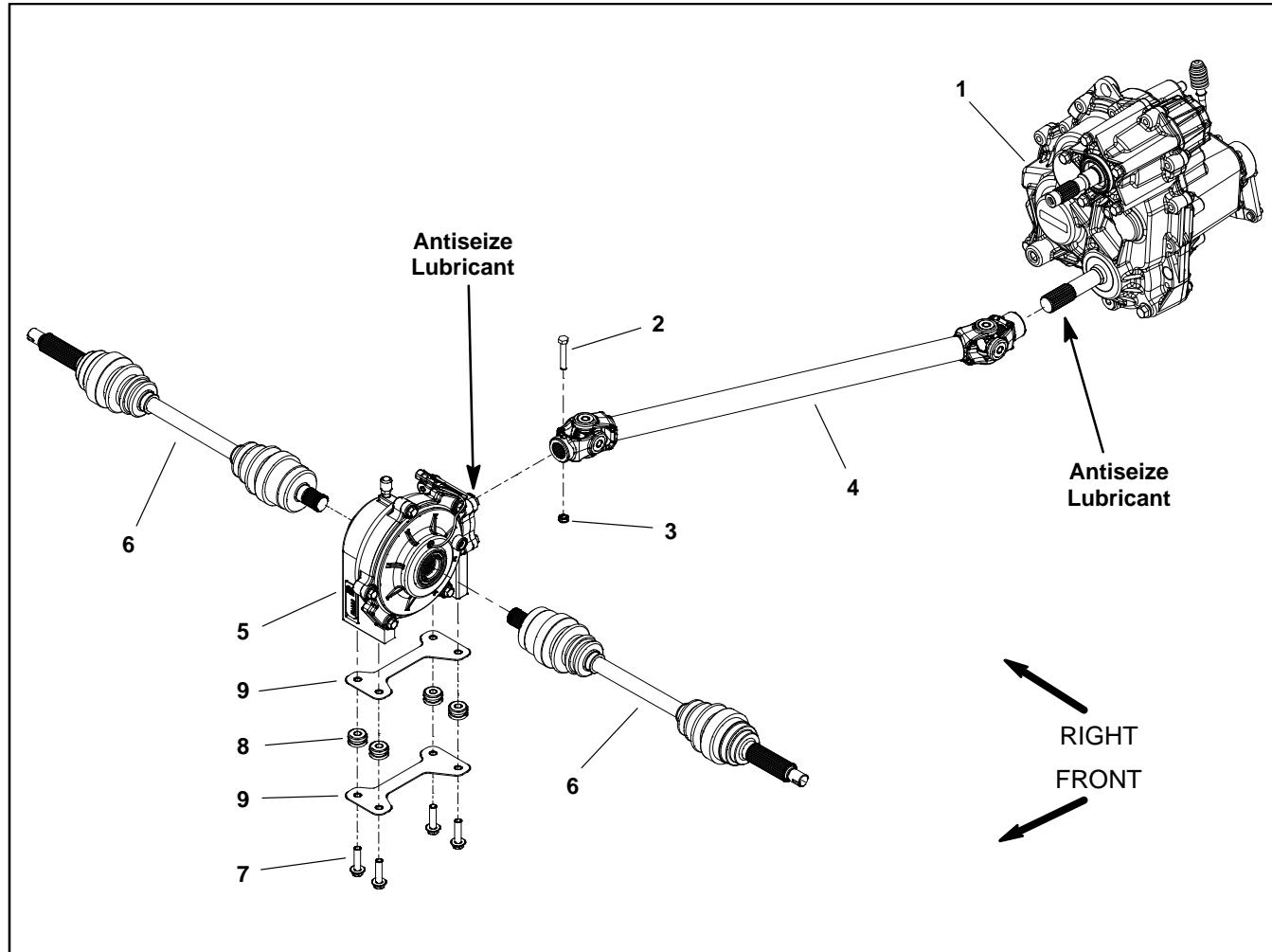


Figure 4

- 1. Transmission
- 2. Cap screw
- 3. Lock nut

- 4. Front differential driveshaft
- 5. Front differential assembly
- 6. CV axle assembly (2)

- 7. Flange head screw (4)
- 8. Mount (4)
- 9. Differential plate (2)

Removal (Fig. 4)

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake.
2. Remove cap screw (item 2) and lock nut (item 3) that secure the front driveshaft yoke to front differential input shaft.
3. Remove four (4) flange head screws (item 4) and lower differential plate (item 17) that secure the front differential to the frame.



4. Support front differential driveshaft to prevent it from falling.
5. Slide front differential assembly forward to allow removal of front differential driveshaft.
6. Slide front differential driveshaft yokes from the front differential input shaft and the transmission output shaft.
7. Lower rear of driveshaft and remove shaft from vehicle.

Installation (Fig. 4)

1. Apply antiseize lubricant to front differential input shaft and transmission output shaft.
2. Position front differential driveshaft to vehicle frame, front differential assembly and transmission.
3. Rotate input shaft of front differential until the hole in the input shaft is aligned with the hole in the differential yoke.

4. Align splines in driveshaft yokes with shaft splines. Slide driveshaft yokes onto front differential input shaft and transmission output shaft.

5. Move the front differential rearward so that the differential mounting holes align with the upper mount plate (item 9) and the mounts (item 8) in the frame supports.

6. Insert cap screw (item 2) through driveshaft yoke and front differential input shaft. Install and tighten lock nut (item 3) to secure front driveshaft yoke to front differential input shaft.

7. Secure the front differential to the frame supports with lower mount plate (item 9) and four (4) flange head screws (item 7).

8. Lubricate front differential driveshaft grease fittings.

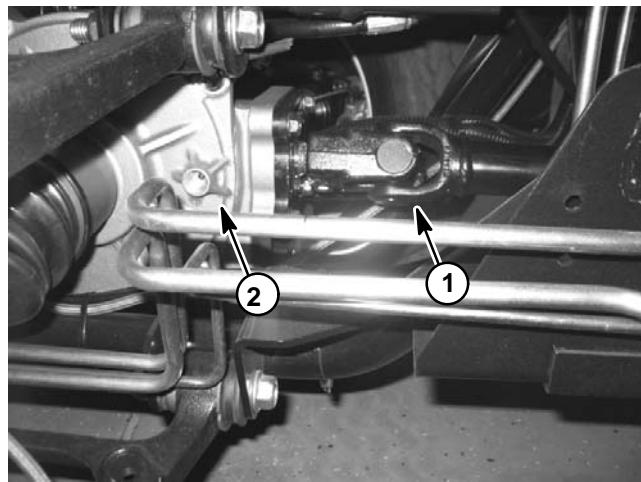


Figure 5

1. Driveshaft flange yoke 2. Differential assembly

Driveshaft Cross and Bearing Service

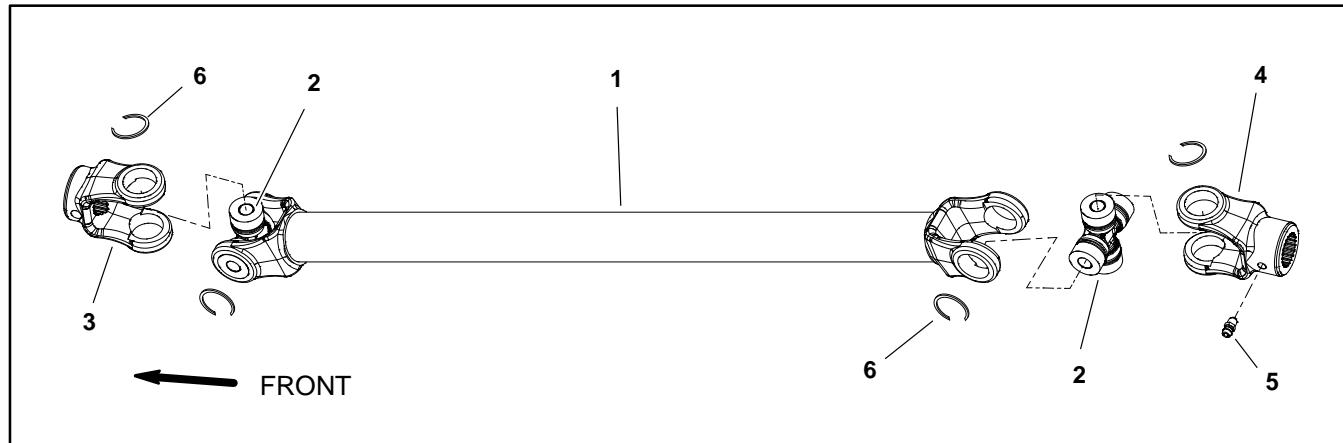


Figure 6

- | | | |
|------------------------------|---|---------------------------------|
| 1. Drive shaft | 3. Connect yoke (to front differential) | 5. Grease fitting |
| 2. Cross and bearing kit (2) | 4. Slip yoke (to transmission) | 6. Snap ring (4 used per cross) |

Disassembly (Fig. 6)

1. Remove front differential driveshaft from vehicle (see Front Differential Driveshaft in this section).

IMPORTANT: When placing yoke in vise, clamp lightly on the solid part of the yoke to prevent yoke damage. Also, the use of a vise with soft jaws is recommended.

2. Lightly clamp yoke in vise. Use two (2) screwdrivers to carefully remove snap rings that secure bearings at the inside of each yoke. Remove yoke from vise.

IMPORTANT: Yokes must be supported when removing and installing bearings to prevent damage.

3. Use a press to remove cross and bearings from yokes:

A. Place a small socket against one bearing and a large socket against the yoke on the opposite side.

B. While supporting the large socket, apply pressure on small socket to partially push the opposite bearing into the large socket.

C. Remove yoke from press, grasp partially removed bearing and tap on yoke to completely remove the bearing.

D. Repeat process for remaining bearings.

E. Thoroughly clean and inspect all components.

Assembly (Fig. 6)

1. To install new cross and bearings:

A. Apply a coating of grease to bearing bores of connect yoke and slip yoke. Also, apply grease to bearings and seal of bearing assembly. Make sure that all bearing rollers are properly seated in bearing cage.

B. Press one bearing partially into yoke.

IMPORTANT: Take care when installing cross into bearing to avoid damaging bearing seal.

C. Carefully insert cross into bearing and yoke.

D. Hold cross in alignment and press bearing in until it hits the yoke.

E. Carefully place second bearing into yoke bore and onto cross shaft. Press bearing into yoke.

F. Install snap rings to bearings to secure bearings in place.

G. Repeat procedure for other yoke.

H. Grease cross until grease comes out of all four (4) bearing cups.

2. 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.

3. Install front differential driveshaft to vehicle (see Front Differential Driveshaft in this section).

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Four Wheel Drive
(Optional Kit)

Front Differential

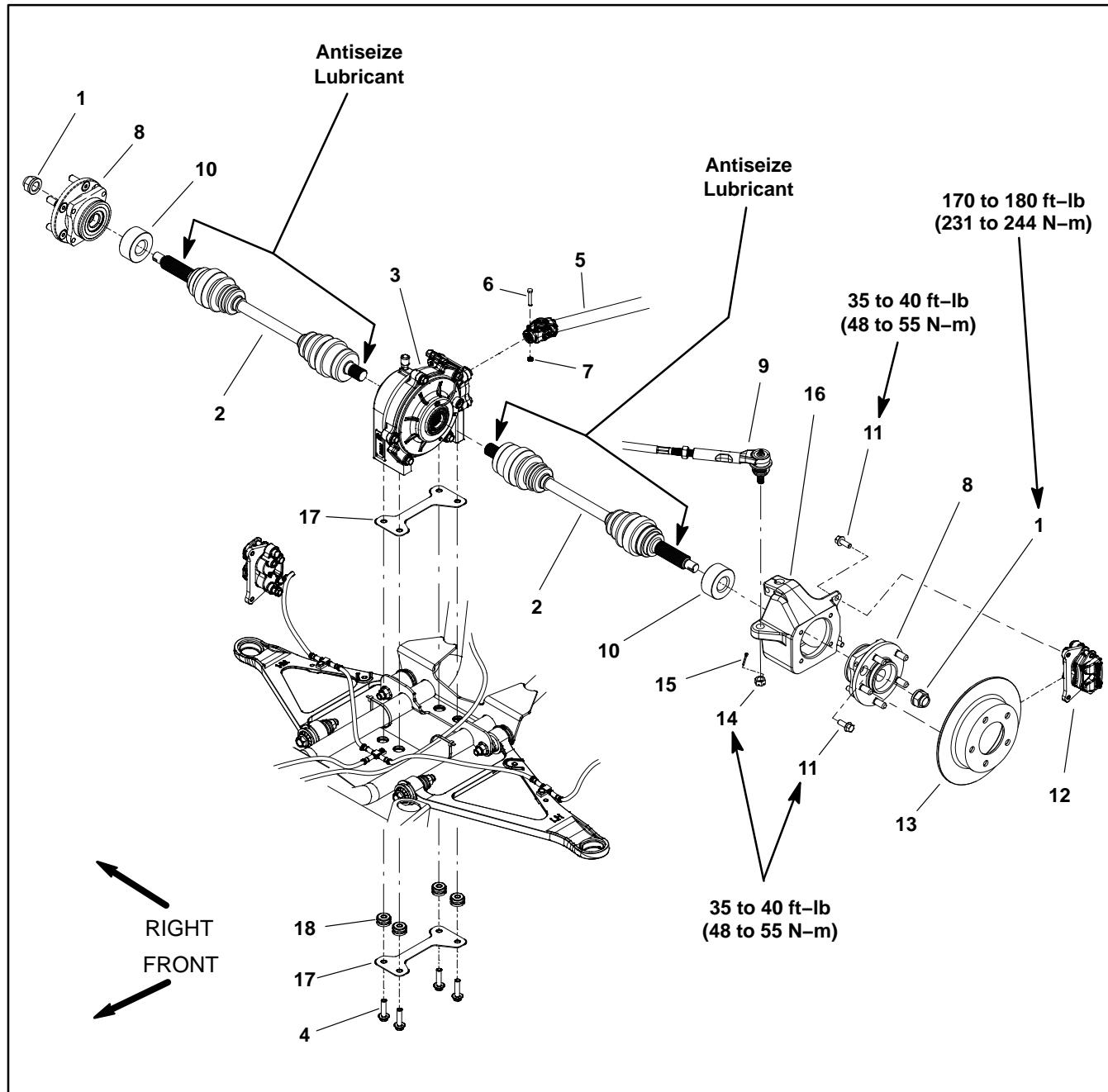


Figure 7

- | | | |
|--------------------------|------------------------------|----------------------------|
| 1. Spindle nut (2) | 7. Lock nut | 13. Brake rotor (2) |
| 2. CV axle assembly (2) | 8. Wheel hub assembly (2) | 14. Slotted hex nut (2) |
| 3. Differential assembly | 9. Tie rod assembly (2) | 15. Cotter pin (4) |
| 4. Flange head screw (4) | 10. Axle spacer (2) | 16. Knuckle (LH shown) |
| 5. Driveshaft | 11. Flange head screw (8) | 17. Differential plate (2) |
| 6. Cap screw | 12. Brake caliper (LH shown) | 18. Mount (4) |

Removal (Fig. 7)

1. Park vehicle on a level surface, shut engine off, remove key from ignition switch and apply parking brake. Block rear wheels to prevent the vehicle from moving unexpectedly.
2. Drain front differential oil into a suitable container by removing the drain plug. Install drain plug after draining.
3. Unplug wire harness connector from front differential.
4. Remove both CV axle assemblies from the front differential (see CV (Constant Velocity) Axle Assembly in this section).
5. Remove cap screw and lock nut that secure driveshaft yoke to the front differential input shaft. Separate differential driveshaft yoke from the differential input shaft (see Front Differential Driveshaft in this section).



CAUTION

Support front differential during removal to prevent personal injury from falling and damage to the differential.

6. Remove four (4) flange head screws (item 4) and lower differential plate (item 17) that secure the differential to the frame.
7. Slide front differential assembly forward to allow removal of front differential driveshaft yoke from differential input shaft. Slide driveshaft yoke from input shaft and position driveshaft away from differential.

IMPORTANT: Make sure to not damage brake lines, electrical harness, control cables or other parts while removing the differential.

8. Tip differential toward left side (driver side) of vehicle. Remove differential assembly toward the right side (passenger side) of the vehicle.

Installation (Fig. 7)

IMPORTANT: Make sure to not damage brake lines, electrical harness, control cables or other parts while installing the differential to the vehicle.

1. Make sure that all mounts (item 18) are installed in frame and that upper differential plate (item 17) is placed onto mounts.
2. Position front differential assembly to the vehicle frame from the right side (passenger side) of the vehicle. Make sure that larger offset in differential plate is placed to allow access to the differential drain plug.
3. Apply antiseize lubricant to input shaft of differential. Slide driveshaft yoke onto differential input shaft.
4. Move differential toward rear of vehicle and align holes in frame, mounts, upper differential plate and differential.
5. Secure front differential to the frame with lower differential plate (item 17) and four (4) flange head screws (item 4).
6. Secure driveshaft yoke to the differential with cap screw and lock nut (see Front Differential Driveshaft in this section).
7. Install both CV axles to the front differential (see CV (Constant Velocity) Axle Assembly in this section).
8. Connect wire harness connector to front differential.
9. Make sure differential drain plug is installed properly. Fill front differential with oil.

Front Differential Service

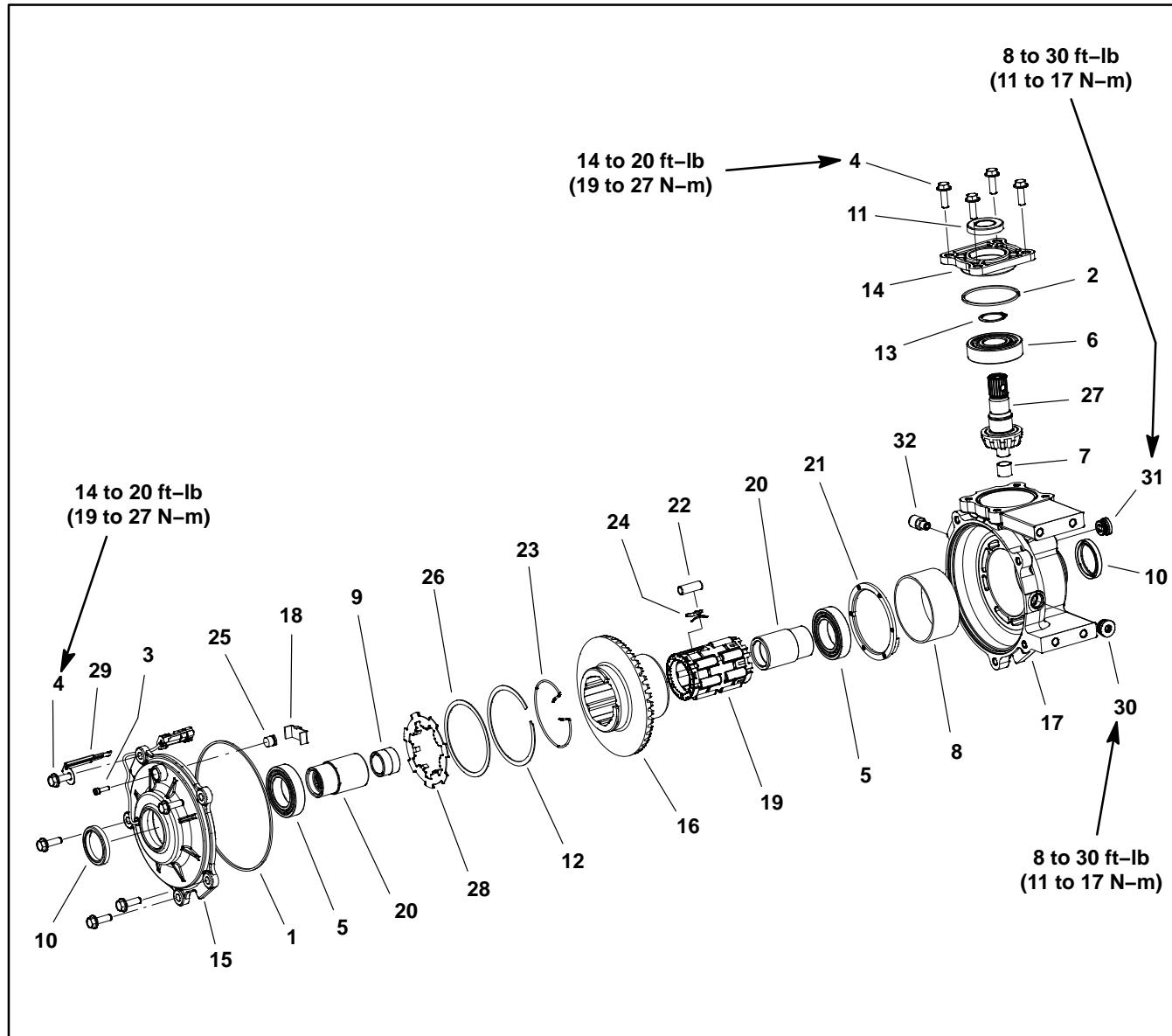


Figure 8

- | | | |
|--------------------------|-----------------------------|------------------------|
| 1. O-ring | 12. Internal retaining ring | 23. Torsion spring |
| 2. O-ring | 13. Retaining ring | 24. H-clip spring (14) |
| 3. Set screw | 14. Input cover | 25. Thrust button |
| 4. Flange head screw (9) | 15. Cover plate assembly | 26. Gear spacer |
| 5. Bearing (2) | 16. Ring gear | 27. Pinion gear |
| 6. Bearing | 17. Gear case | 28. Armature plate |
| 7. Bushing | 18. Thrust bearing | 29. Plug clip |
| 8. Bushing | 19. Roller cage assembly | 30. Drain plug |
| 9. Bushing | 20. Output hub (2) | 31. Fill plug |
| 10. Oil seal (2) | 21. Gear shim | 32. Vent |
| 11. Oil seal | 22. Roller (14) | |

Disassembly of Front Differential

1. Make sure that the oil is drained from the front differential assembly.
2. Remove the four (4) flange head screws from the input cover (Fig. 9). Remove the cover.

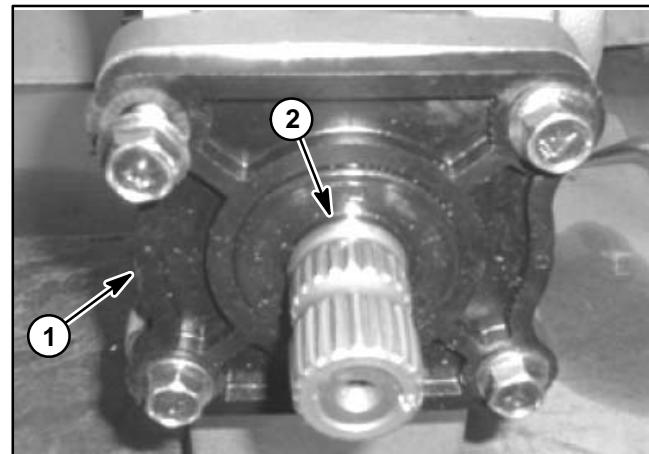


Figure 9

1. Input cover

2. Pinion gear shaft

3. Remove the pinion gear with bearing from housing by pulling it out of the gear case by hand (Fig. 10).

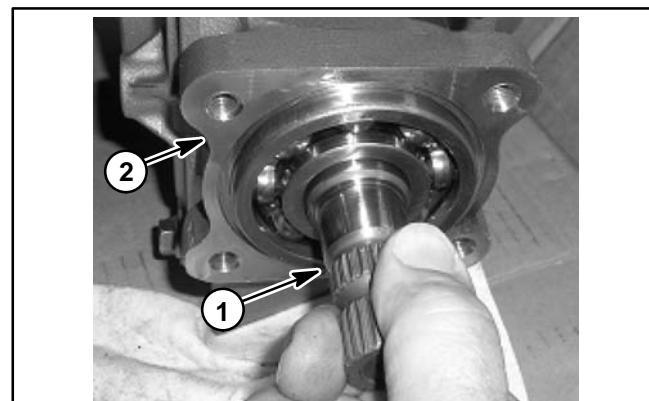


Figure 10

1. Pinion gear shaft

2. Gear case

4. Inspect the inner pinion bushing in the gear case (Fig. 11). If the bushing is excessively worn, the gear case must be replaced. The bushing is not serviced separately.

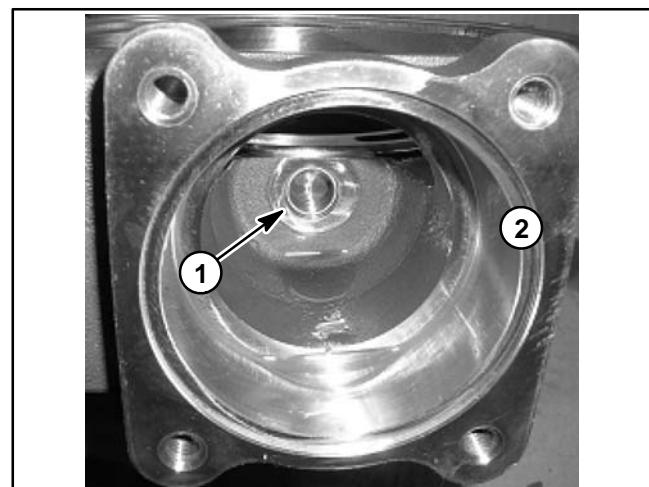


Figure 11

1. Pinion bushing

2. Gear case

5. Place the differential assembly on workbench with the cover plate facing up.

6. Remove the five (5) flange head screws that secure cover plate assembly to gear case. Note location of plug clip for assembly purposes (Fig. 12). Carefully remove the cover plate from the gear case by lifting straight up.

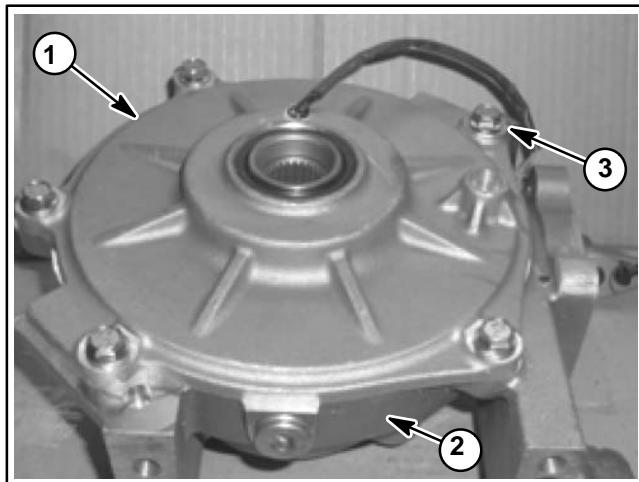


Figure 12

1. Cover plate
2. Gear case

3. Plug clip

7. Remove the thrust bearing from the cover plate and inspect for wear (Fig. 13). Replace the thrust bearing if the red coating is worn completely off the bearing surface. The thrust bearing is used to set the backlash of the ring gear and pinion.

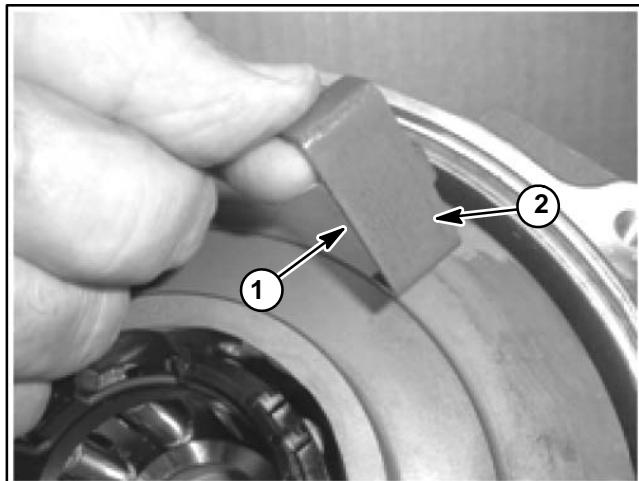


Figure 13

1. Thrust bearing

2. Thrust surface

8. Lift the roller cage assembly from the center of the ring gear (Fig. 14). Note: the rollers are loose in the cage and may fall out when removed.

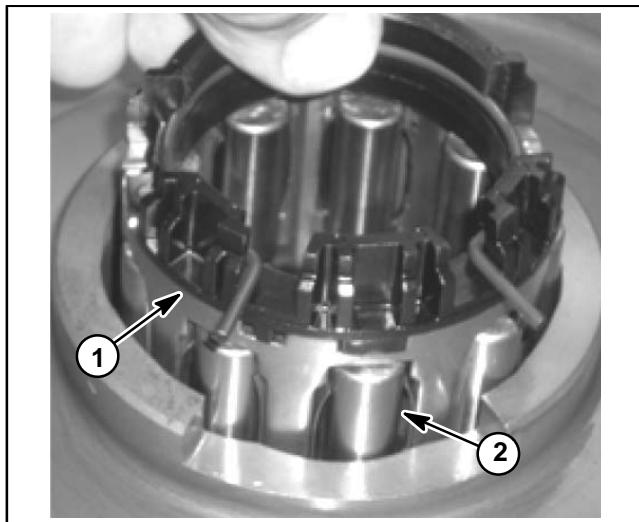


Figure 14

1. Roller cage assembly

2. Roller

9. Carefully lift the ring gear out of the gear case (Fig. 15). Inspect ring gear teeth for any damage or abnormal wear. Also, inspect inner surface of ring gear for excessive wear caused by the rollers.

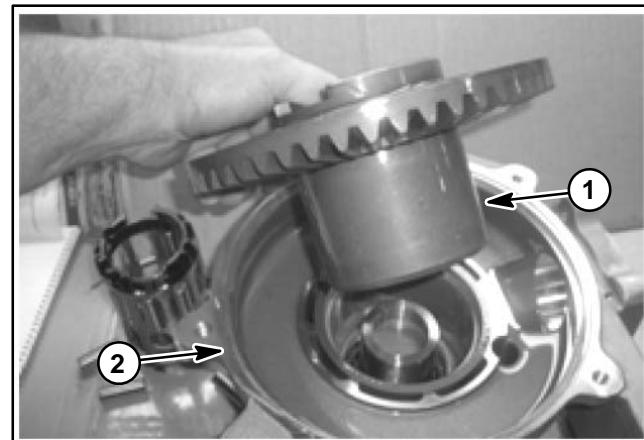


Figure 15

1. Ring gear

2. Gear case

10. Remove the gear shim from between the gear case and the ring gear location (Fig. 16).

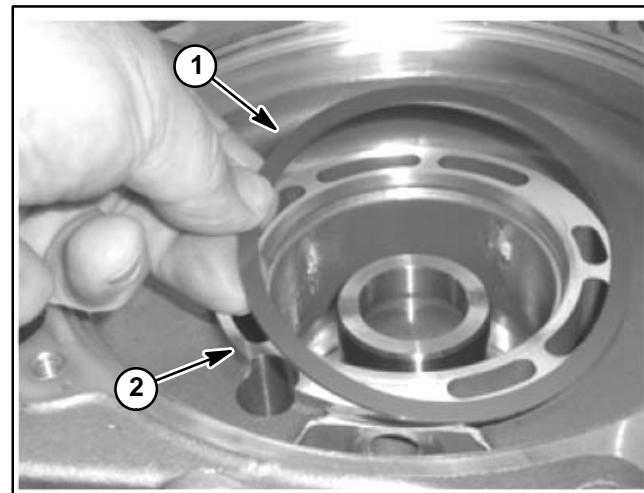


Figure 16

1. Gear spacer

2. Gear case

IMPORTANT: When removing output hub from gear case, be careful to not damage the seal in the gear case. The seal cannot be serviced separately.

11. Turn the gear case over. Using a hammer and a suitable drift, carefully remove the output hub and bearing by driving it in toward the center of the gear case (Fig. 17). The bearing has a slight interference fit to the bore of the gear case. Take care to not damage the oil seal in the gear case during hub removal.

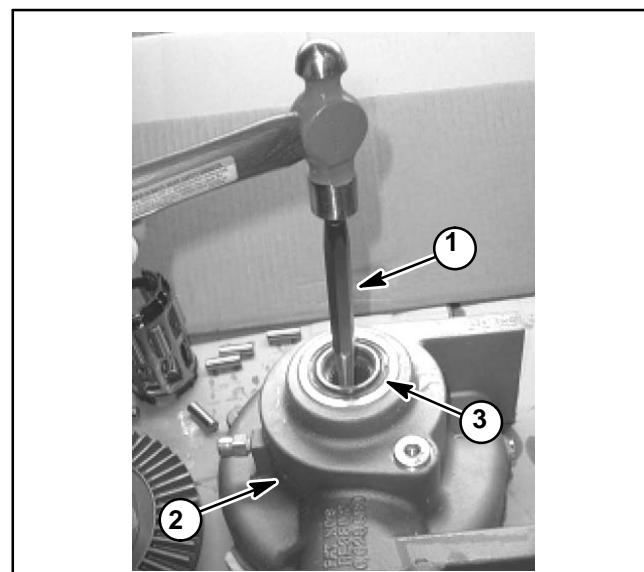


Figure 17

1. Drift

2. Gear case

3. Oil seal

12. Place the cover plate on the workbench with the output hub facing up.

13. Using a screwdriver, carefully remove the internal retaining ring from the cover plate (Fig. 18).

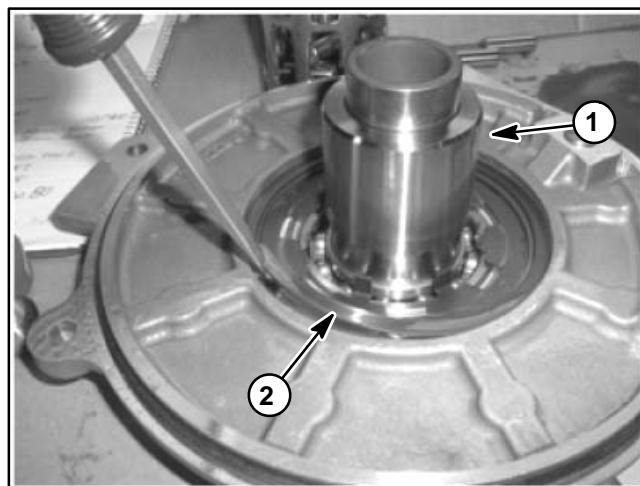


Figure 18

1. Output hub

2. Retaining ring

14. Remove the gear spacer from the cover plate (Fig. 19).

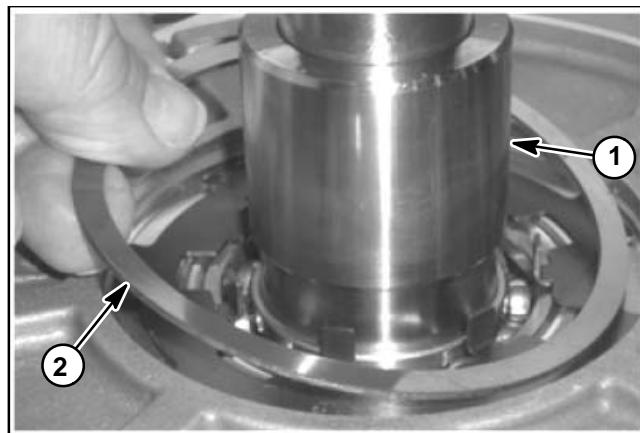


Figure 19

1. Output hub

2. Gear spacer

15. Remove the armature plate from the cover plate (Fig. 20).

IMPORTANT: When removing output hub from cover plate, be careful to not damage the seal in the cover plate. The seal cannot be serviced separately.

16. Turn the cover plate over and place it on blocking or in a vise. Using a hammer and suitable drift, carefully remove the output hub and bearing from the cover plate by driving the hub down. The bearing has a slight interference fit to the bore of the cover plate. Be careful to not damage the seal in the cover plate.

17. Discard the removed hub assemblies. Clean and inspect all removed parts.

NOTE: For additional front differential information, see the Hilliard Front Drive System Differential Parts and Service Manual at the end of this chapter.

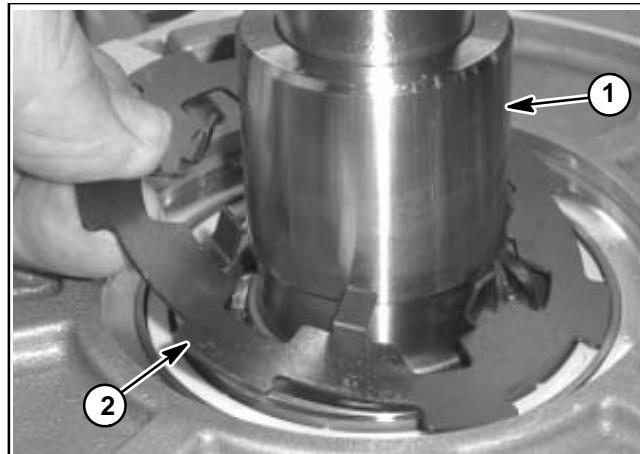


Figure 20

1. Output hub

2. Armature plate

Assembly of Front Differential

1. Be sure that all parts are clean and free of any dirt or debris. Make sure that all residual oil has been removed from differential components.

2. Carefully install new square sectioned O-ring into the groove in the cover plate.

IMPORTANT: When installing output hub assembly into cover plate, be careful to not damage the seal in the cover plate. The seal cannot be serviced separately.

NOTE: The output hub that is installed in the cover plate has an extended bushing.

3. Press the new output hub/bearing assembly into the cover plate assembly. The bearing has a slight interference fit to the bore, so it should not take much force to install (Fig. 21). Take care to not damage the seal in the cover plate during installation of the hub assembly.

4. Set the armature plate onto the coil located in the cover plate (Fig. 22). The internal tangs of the armature plate should face up as shown.

5. Place the gear spacer on top of the armature plate and secure with retaining ring (Fig. 23). Make sure that retaining ring is fully seated into groove in cover plate.

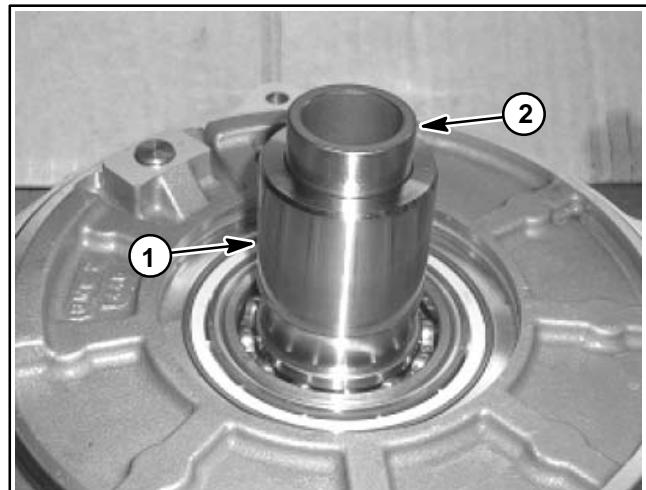


Figure 21

1. Output hub

2. Extended bushing

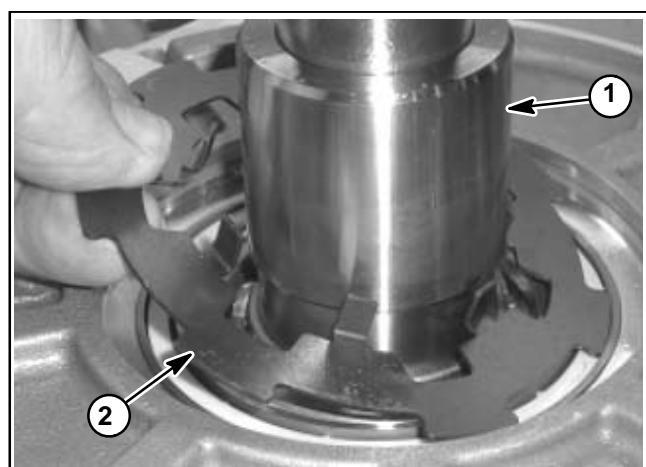


Figure 22

1. Output hub

2. Armature plate

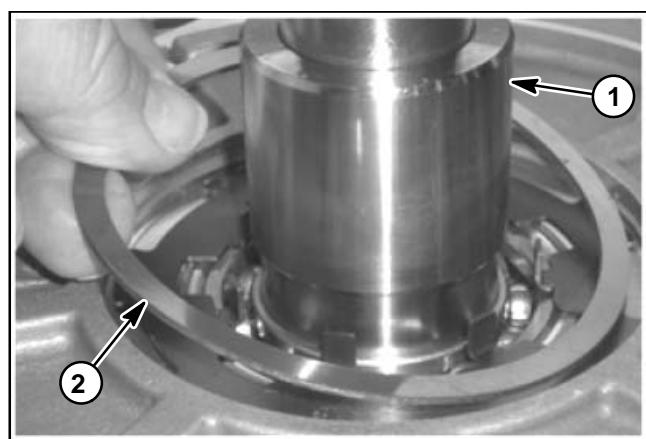


Figure 23

1. Output hub

2. Gear spacer

IMPORTANT: When installing output hub assembly into gear case, be careful to not damage the seal in the gear case. The seal cannot be serviced separately.

6. Press the new output hub/bearing assembly into the gear case from the inside. The bearing has a slight interference fit to the bore, so it should not take much force to install. Take care to not damage the seal during installation of the output hub assembly.

7. Place the gear shim to the gear case and then install the ring gear into the gear case (Fig. 24).

NEED NEW PICTURE OF GEAR SHIM

8. Set the roller cage on a flat surface with the torsion spring end facing up (Fig. 25). Install nine (9) rollers into the slots on the bottom row of the cage. If needed, use grease or petroleum jelly to help hold the rollers in place.

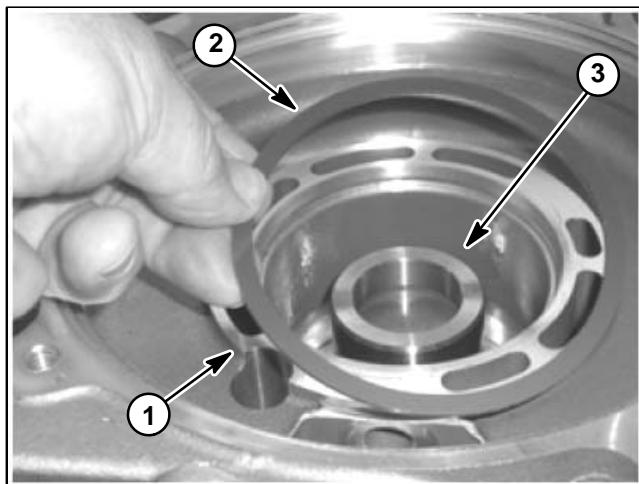


Figure 24

1. Gear case
2. Gear spacer
3. Output hub

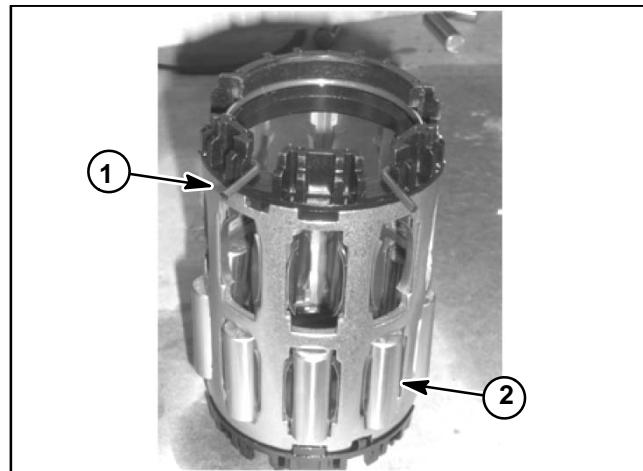


Figure 25

1. Torsion spring
2. Lower roller

9. Align torsion spring on roller cage with the slot in the ring gear and then carefully lower the cage assembly into the ring gear bore (Fig. 26). The torsion spring must align and fit into the notch cut into the ring gear.

10. Install remaining nine (9) rollers into the top row of the roller cage assembly. Place the rollers into the roller cage slots and press them out toward the ring gear bore.

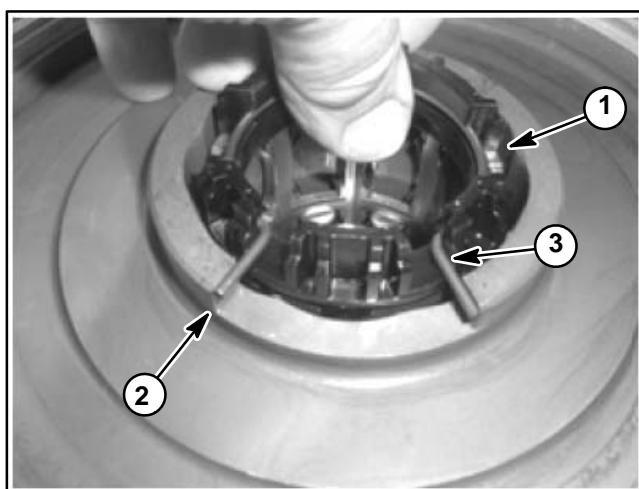


Figure 26

1. Roller cage assembly
2. Ring gear notch
3. Torsion spring

11. Install the thrust bearing onto the thrust button in the cover plate (Fig. 27). Make sure that the tang on the side of the thrust bearing is located toward the outer edge of the cover plate. Use grease or petroleum jelly on the back side of the thrust plate to keep the bearing in position while assembling the cover plate assembly to the gear case.

IMPORTANT: When installing the cover plate, make sure that the tangs on the armature plate are properly aligned into the slots on the roller cage. Improper assembly can cause damage to the armature plate and will prevent 4WD from engaging.

12. Place the cover plate onto the gear case assembly. Make sure to line up the tangs on the armature so they will insert into the mating slots on the roller cage. Also, make sure to align the cover plate bolt holes with the threaded holes in the gear case.

13. Position plug clip to correct location on cover plate and secure cover plate to gear case with five (5) flange head screws. Torque screws from **14 to 17 ft-lbs (19 to 27 N-m)**.

14. Install the pinion gear and then the input cover (Fig. 28). Secure cover with four (4) flange head screws. Torque screws from **14 to 17 ft-lbs (19 to 27 N-m)**.

15. Remove the oil fill plug and fill the unit with 6 oz. (180 ml.) of Mobil 424 hydraulic oil (or equivalent).

16. Adjust differential gear backlash as follows:

A. Locate backlash adjustment set screw inside round boss on cover plate (Fig. 29).

B. Using a 5/32" allen wrench, turn the set screw clockwise until it is snug (do not over-tighten the set screw). At this point, you should not be able to turn the pinion gear shaft.

C. Slowly turn the set screw counter-clockwise until the pinion gear shaft can just be turned.

D. Continue to slowly turn the set screw counter-clockwise until the pinion gear shaft can freely rotate six (6) times (one (1) revolution of the ring gear) without any tight spots. This proper backlash should be achieved by the time that the set screw has been turned counter-clockwise one (1) complete rotation.

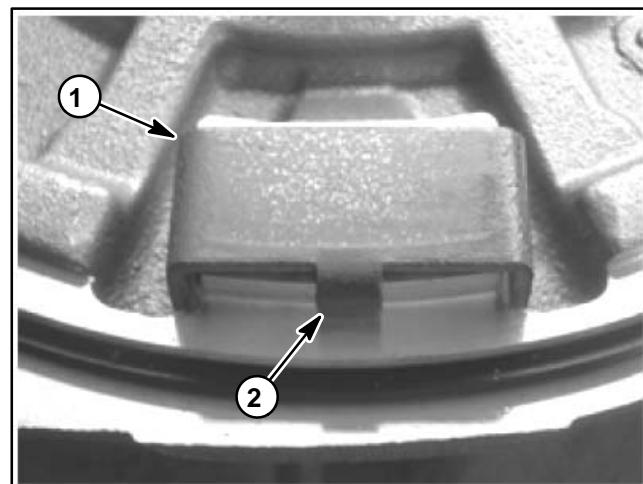


Figure 27

1. Thrust bearing

2. Bearing tang

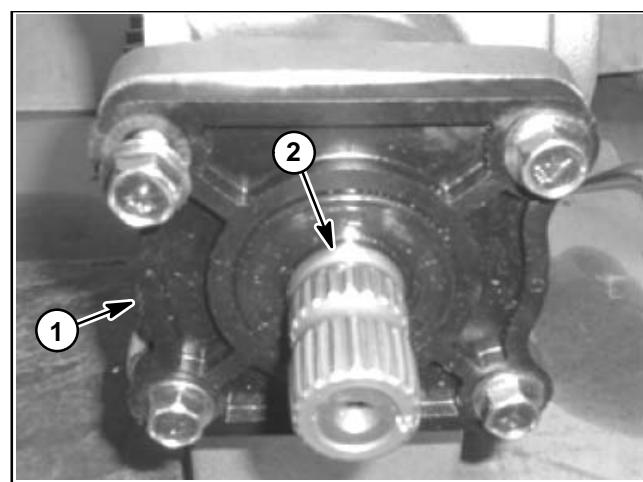


Figure 28

1. Input cover

2. Pinion gear shaft

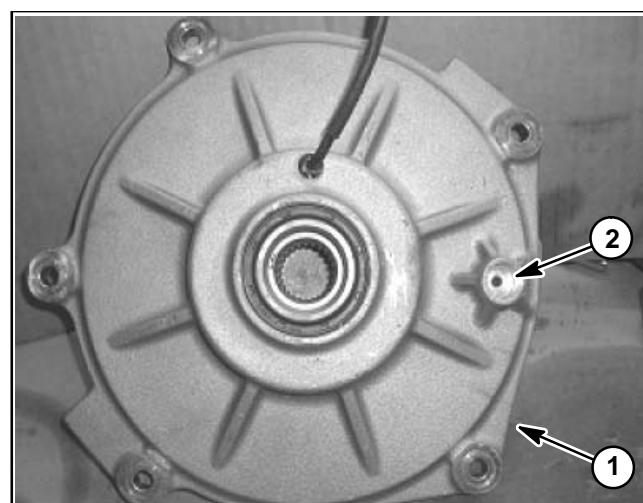


Figure 29

1. Cover plate

2. Set screw

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Electrical Drawings

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Below 316000000)	5
Front Wire Harness (Serial Numbers	
316000001 to 403430000)	7
Front Wire Harness (Serial Numbers	
Above 403430001)	9
Rear Wire Harness	11
Rear Differential Solenoid Controller	
Wire Harness	13
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Electrical Drawing Designations

NOTE: A splice used in a wire harness will be identified on the wire harness diagram by SP. The manufacturing number of the splice is also identified on the wire harness diagram (e.g. SP01 is splice number 1).

Wire Color

The following abbreviations are used for wire harness colors on the electrical schematics and wire harness drawings in this chapter.

<u>ABBREVIATION</u>	<u>COLOR</u>
BK	BLACK
BR or BN	BROWN
BU	BLUE
GN	GREEN
GY	GRAY
OR	ORANGE
PK	PINK
R or RD	RED
T	TAN
VIO	VIOLET
W or WH	WHITE
Y or YE	YELLOW

Numerous harness wires used on Toro machines include a line with an alternate color. These wires are identified with the wire color and line color with either a / or _ separating the color abbreviations listed above (e.g. R/BK is a red wire with a black line, OR_BK is an orange wire with a black line).

Wire Size

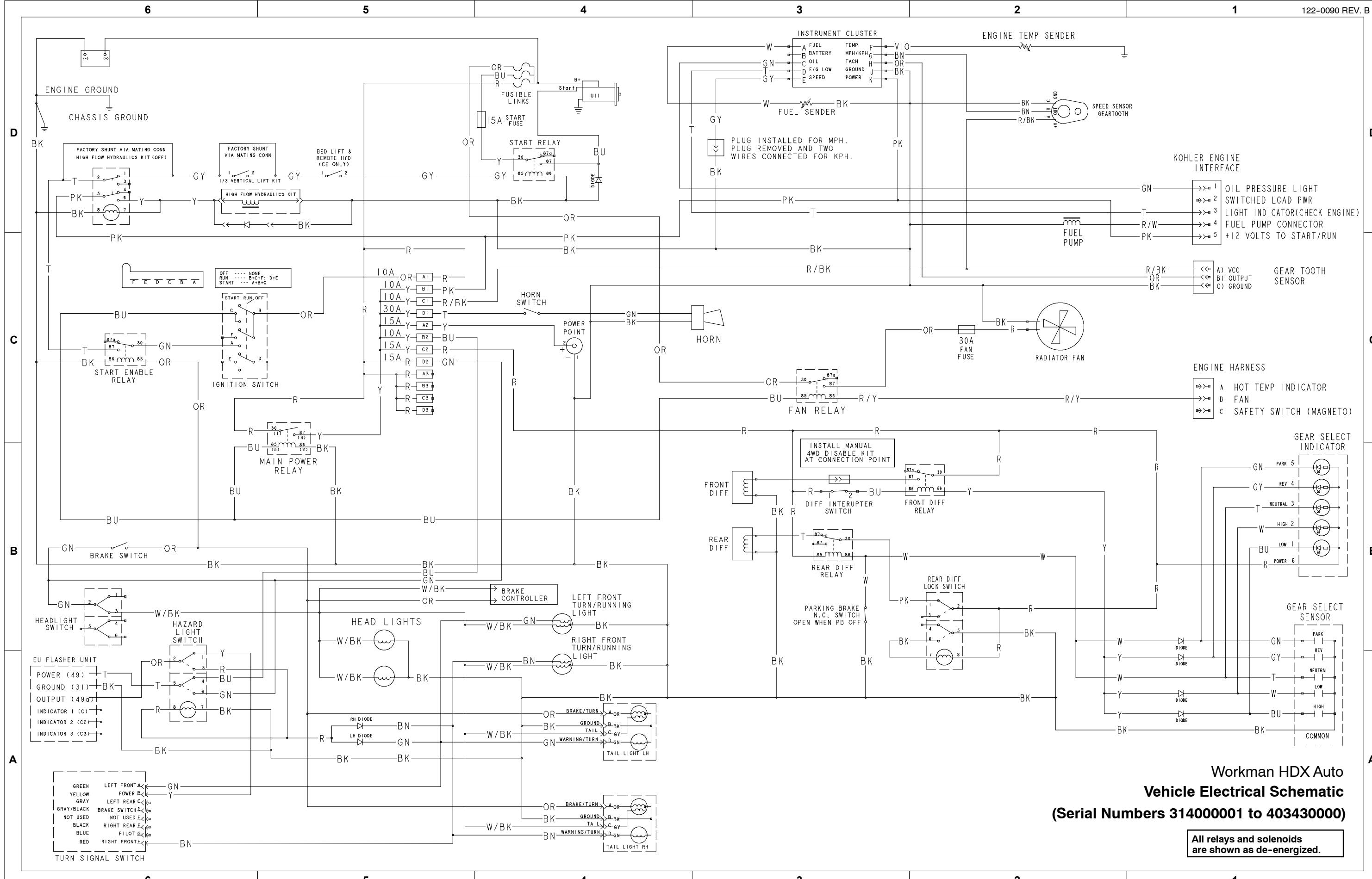
The individual wires of the electrical harness diagrams in this chapter identify both the wire color and the wire size.

Examples:

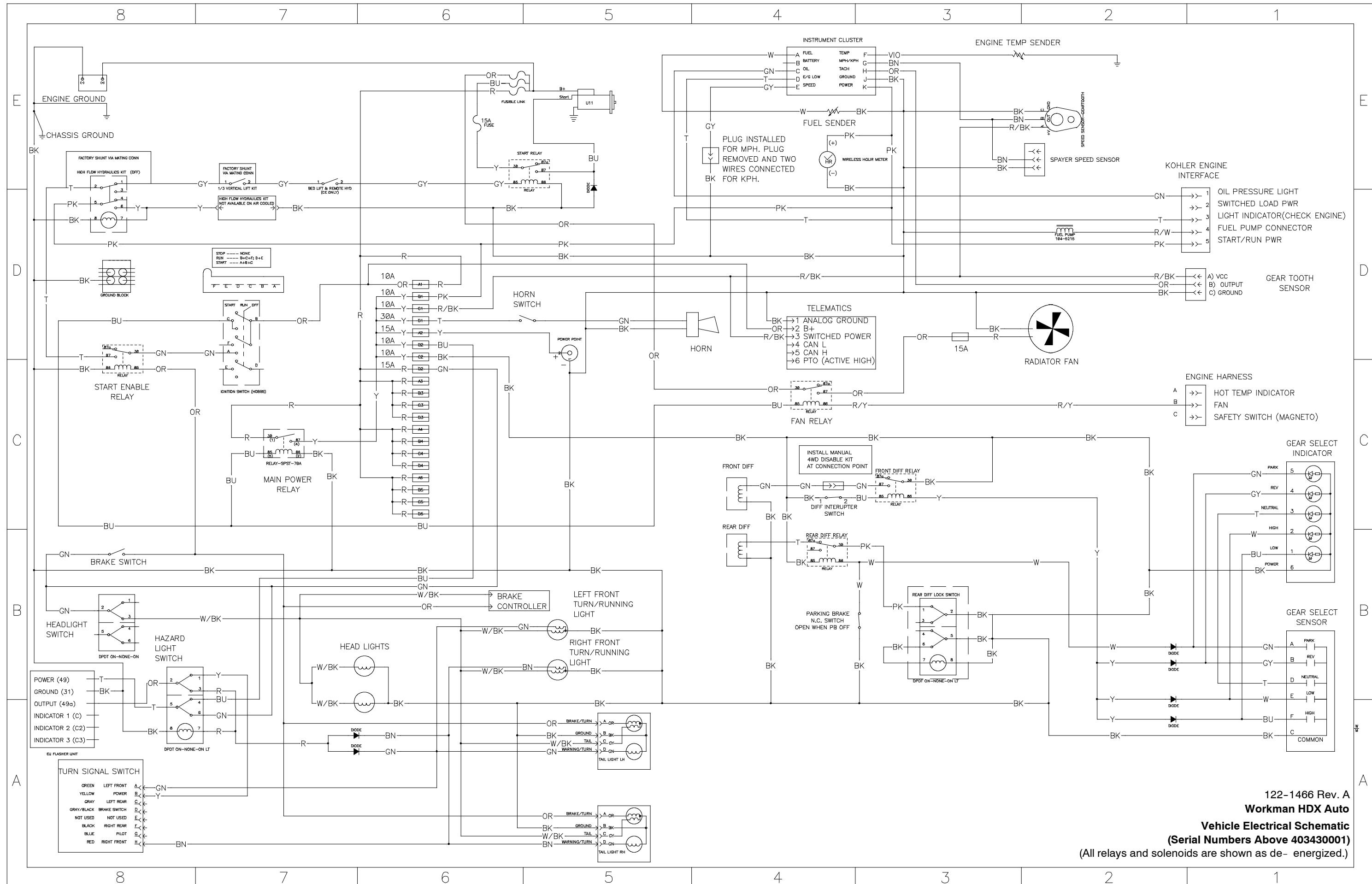
16 BK = 16 AWG (American Wire Gauge) wire that has a black insulator

050 R = 0.5 mm metric wire that has a red insulator (AWG equivalents for metric wire appear in the following table)

AWG EQUIVALENTS FOR METRIC WIRE		
DIAGRAM LABEL	METRIC SIZE	AWG EQUIVALENT
050	0.5 mm	20 GA
175	0.75 mm	18 GA
100	1.0 mm	16 GA
150	1.5 mm	14 GA



All relays and solenoids
are shown as de-energized.



D

D

C

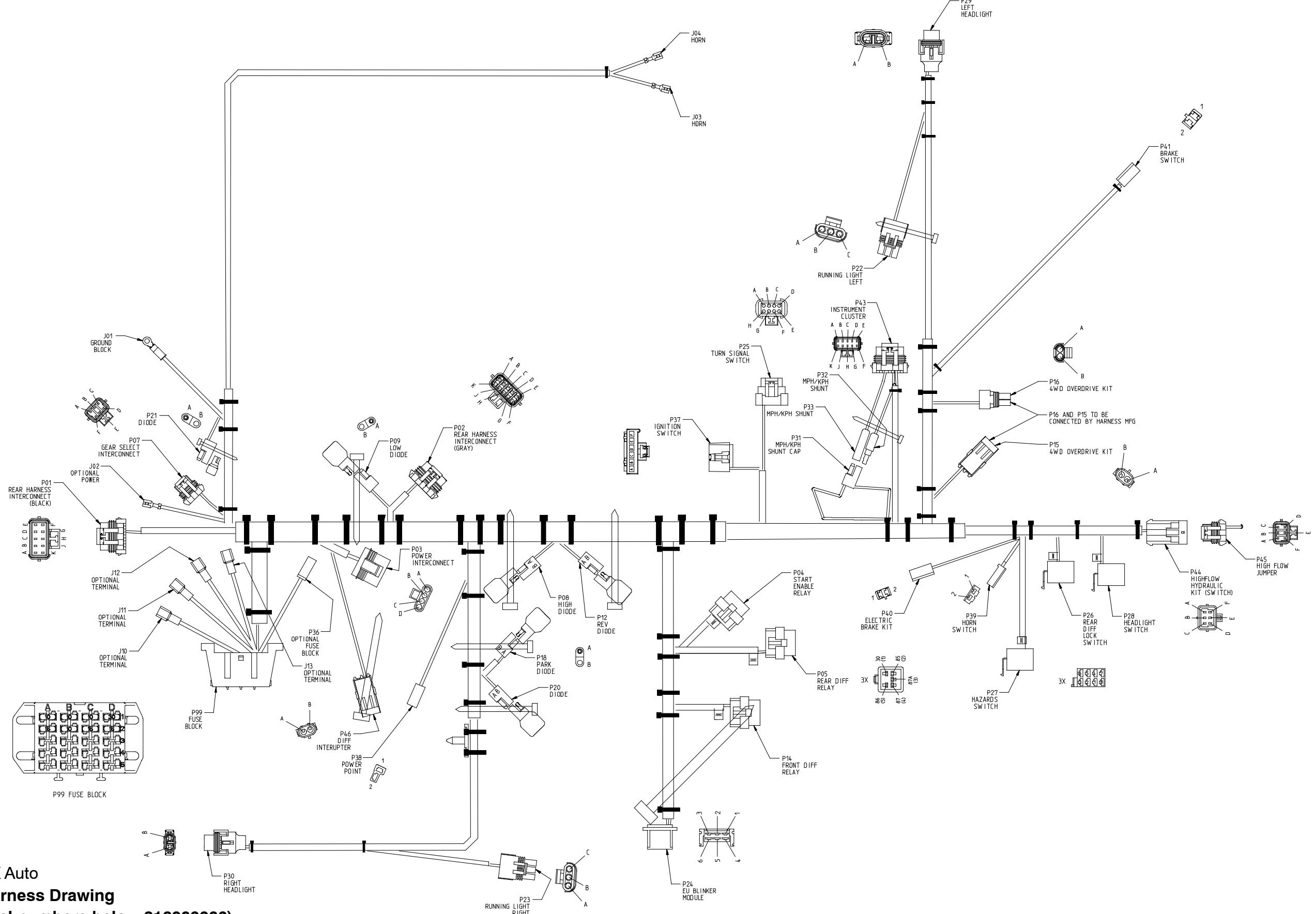
C

B

B

A

A



D

D

C

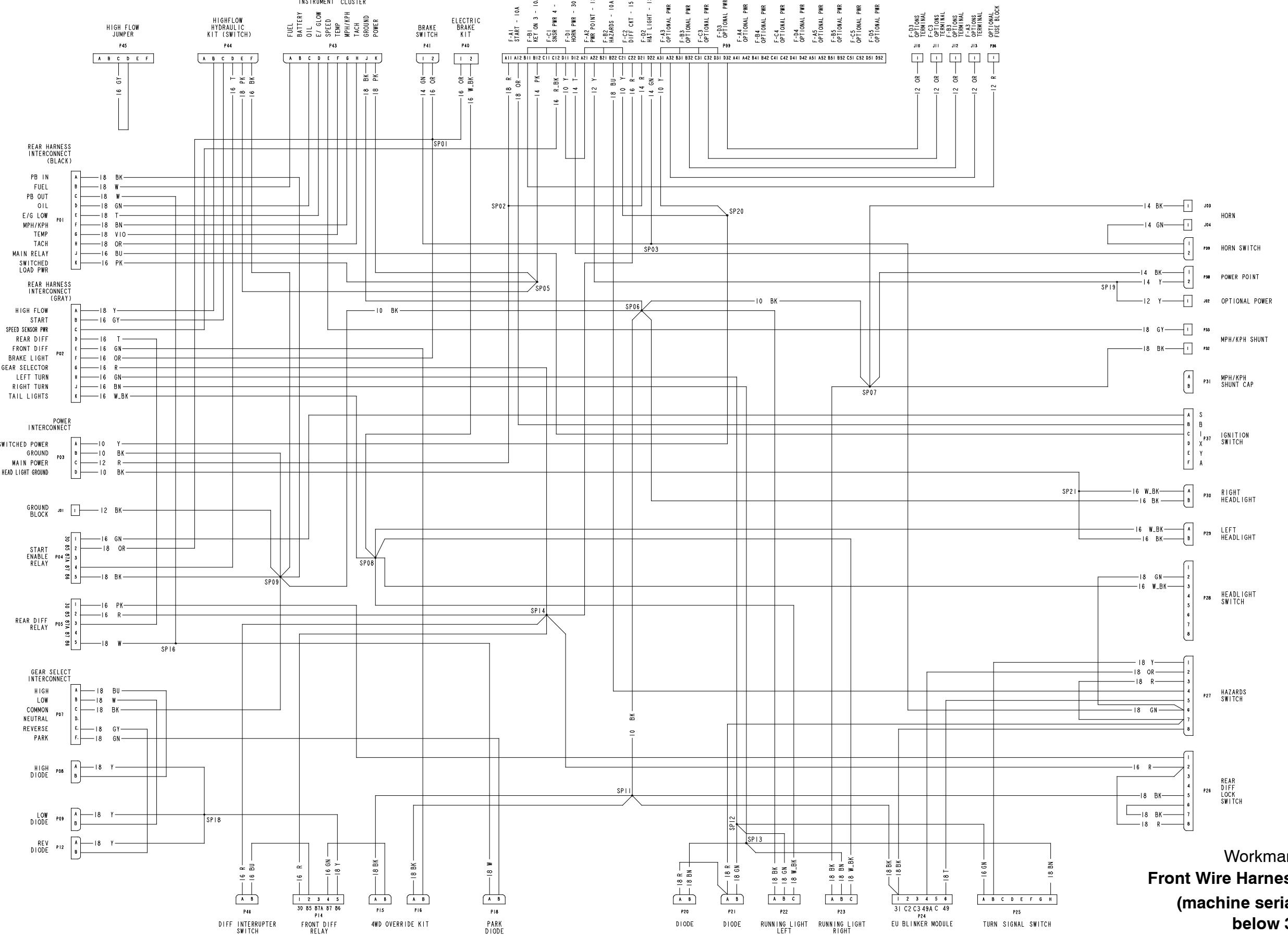
C

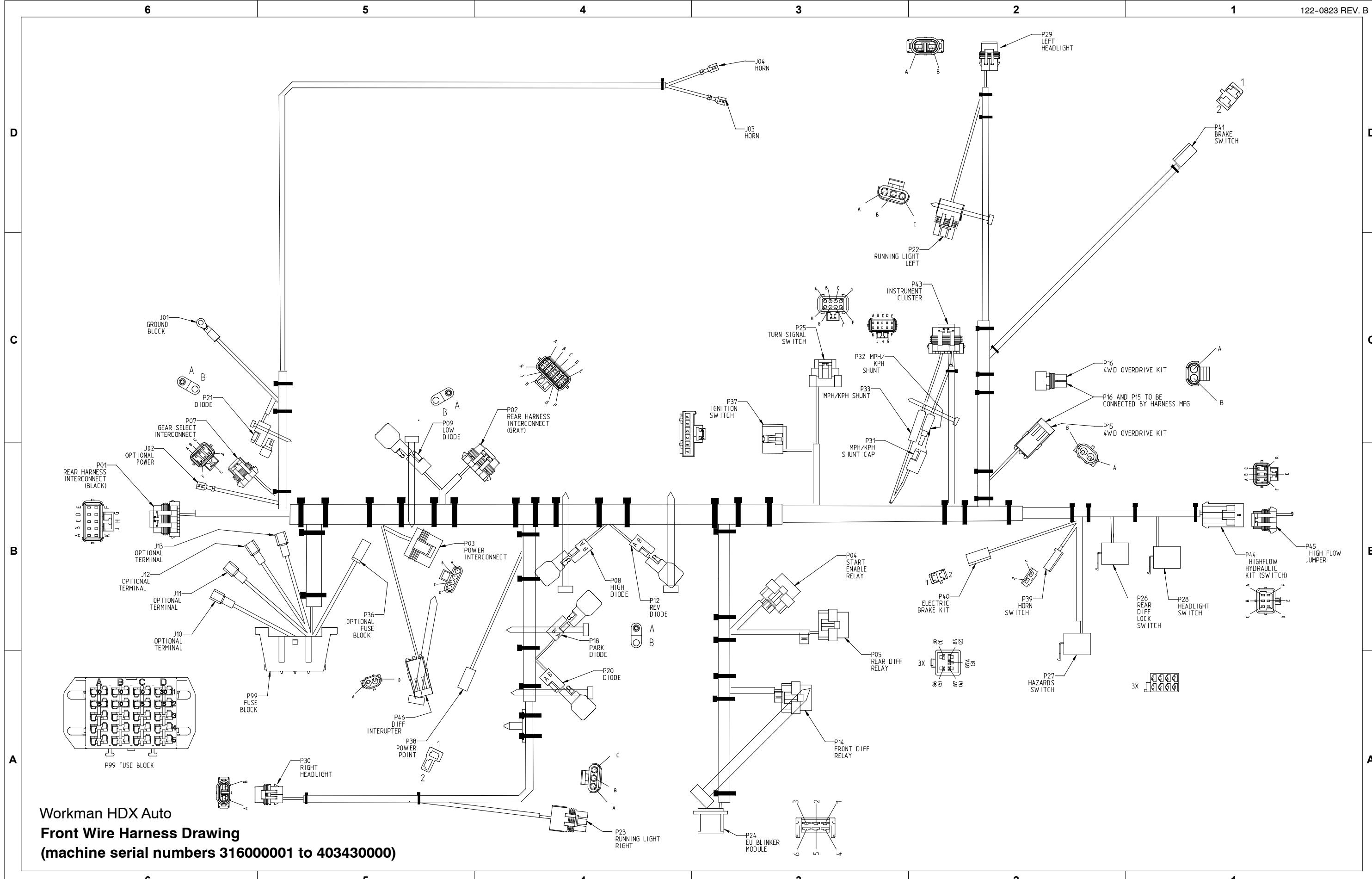
B

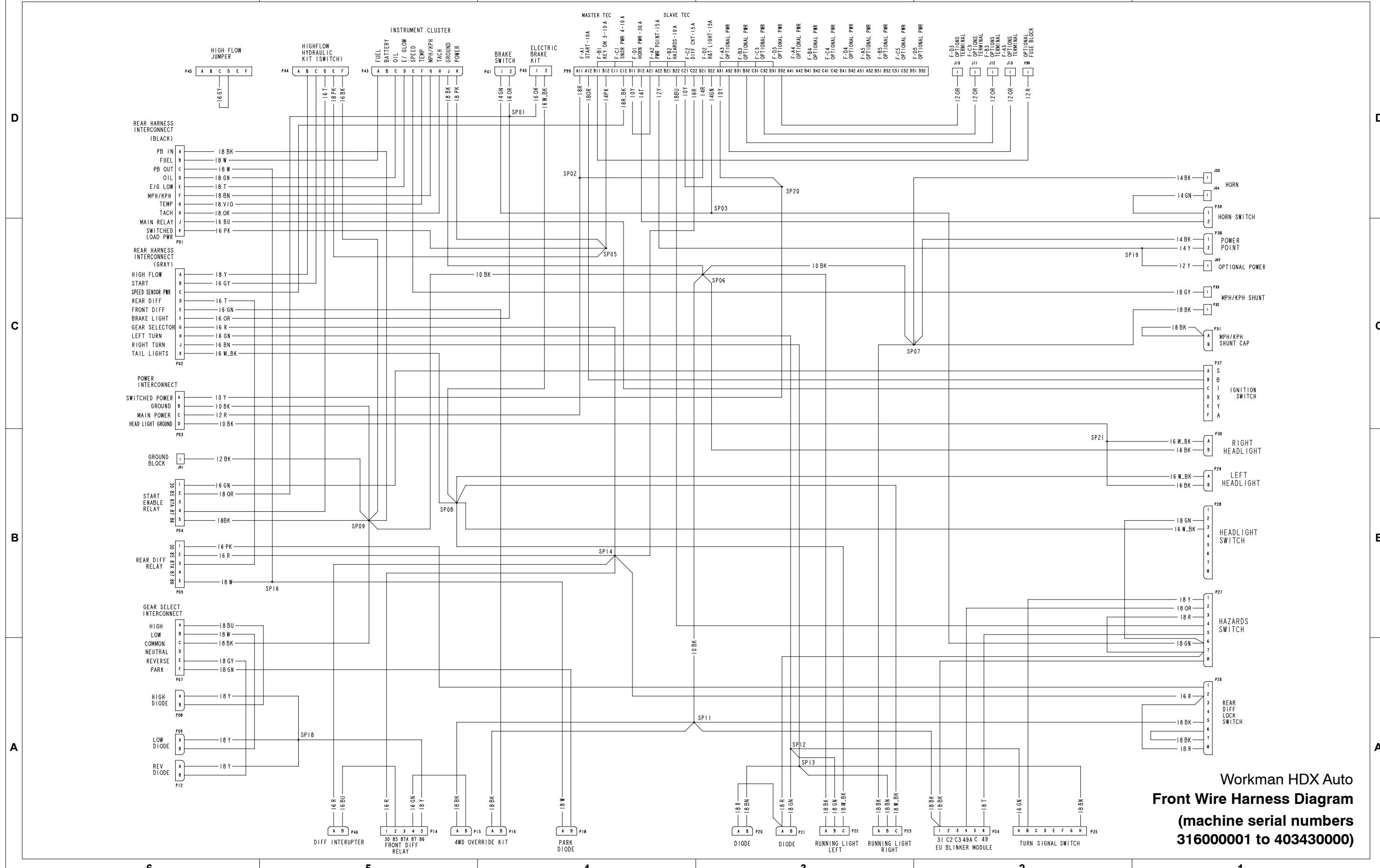
B

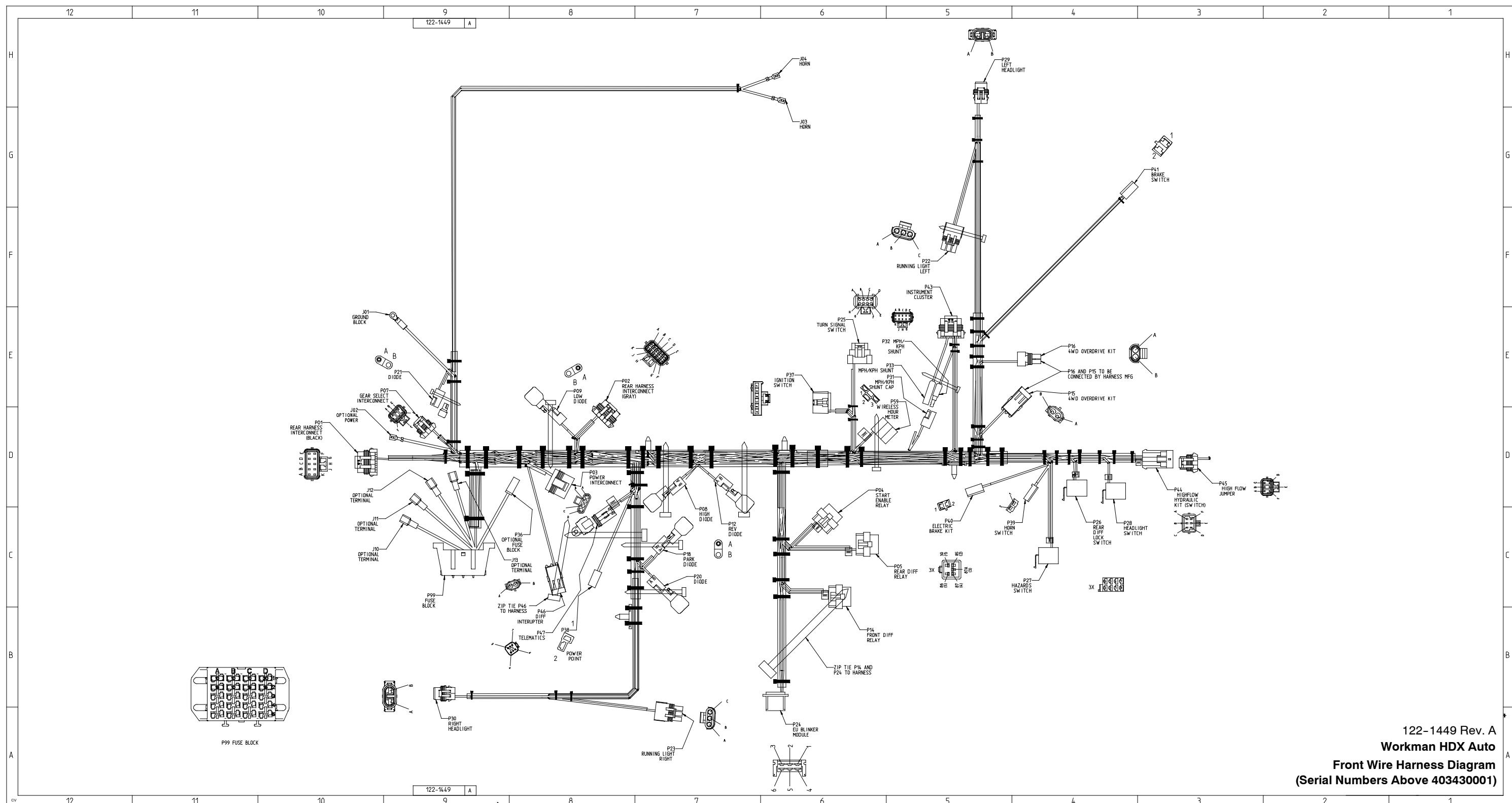
A

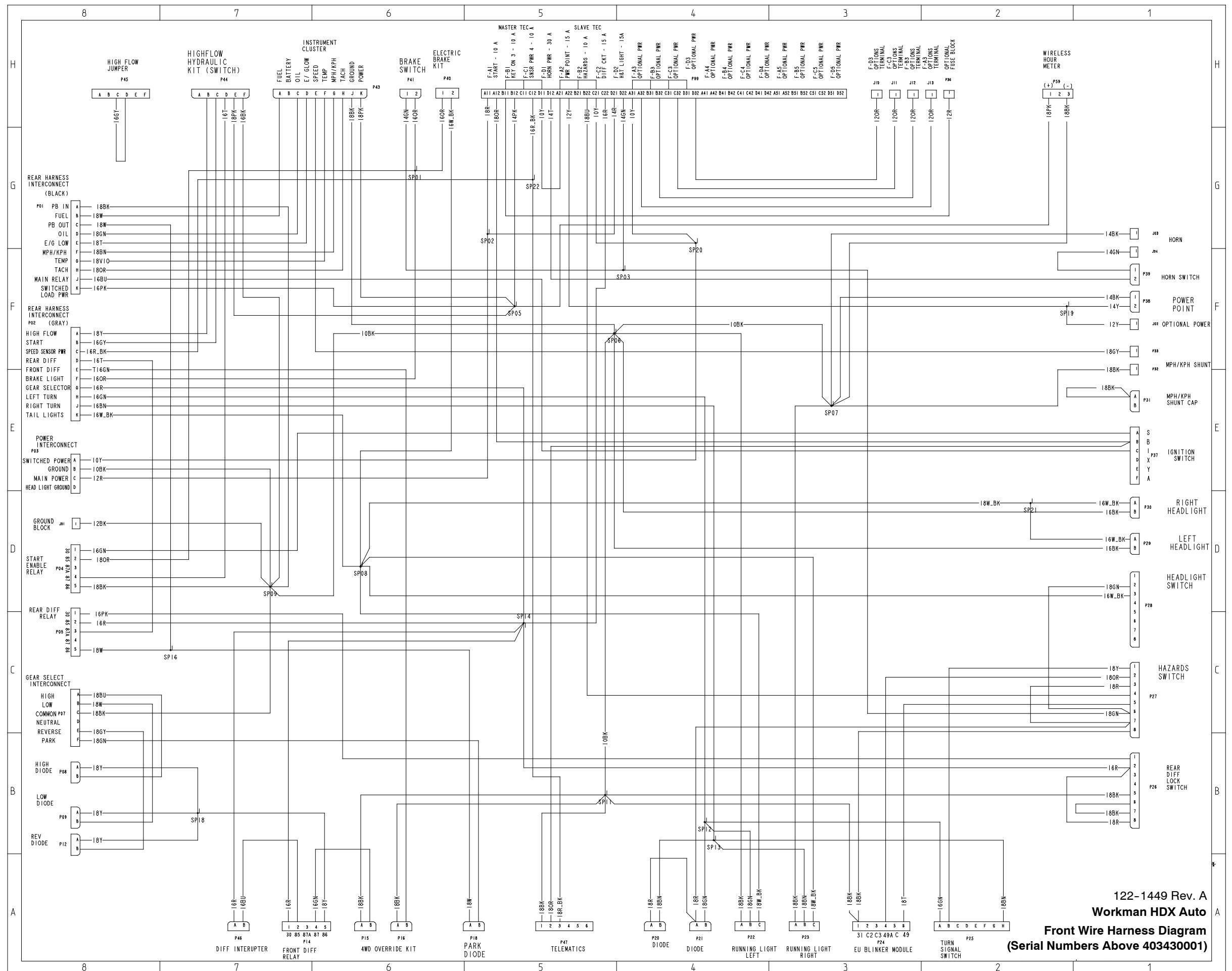
A



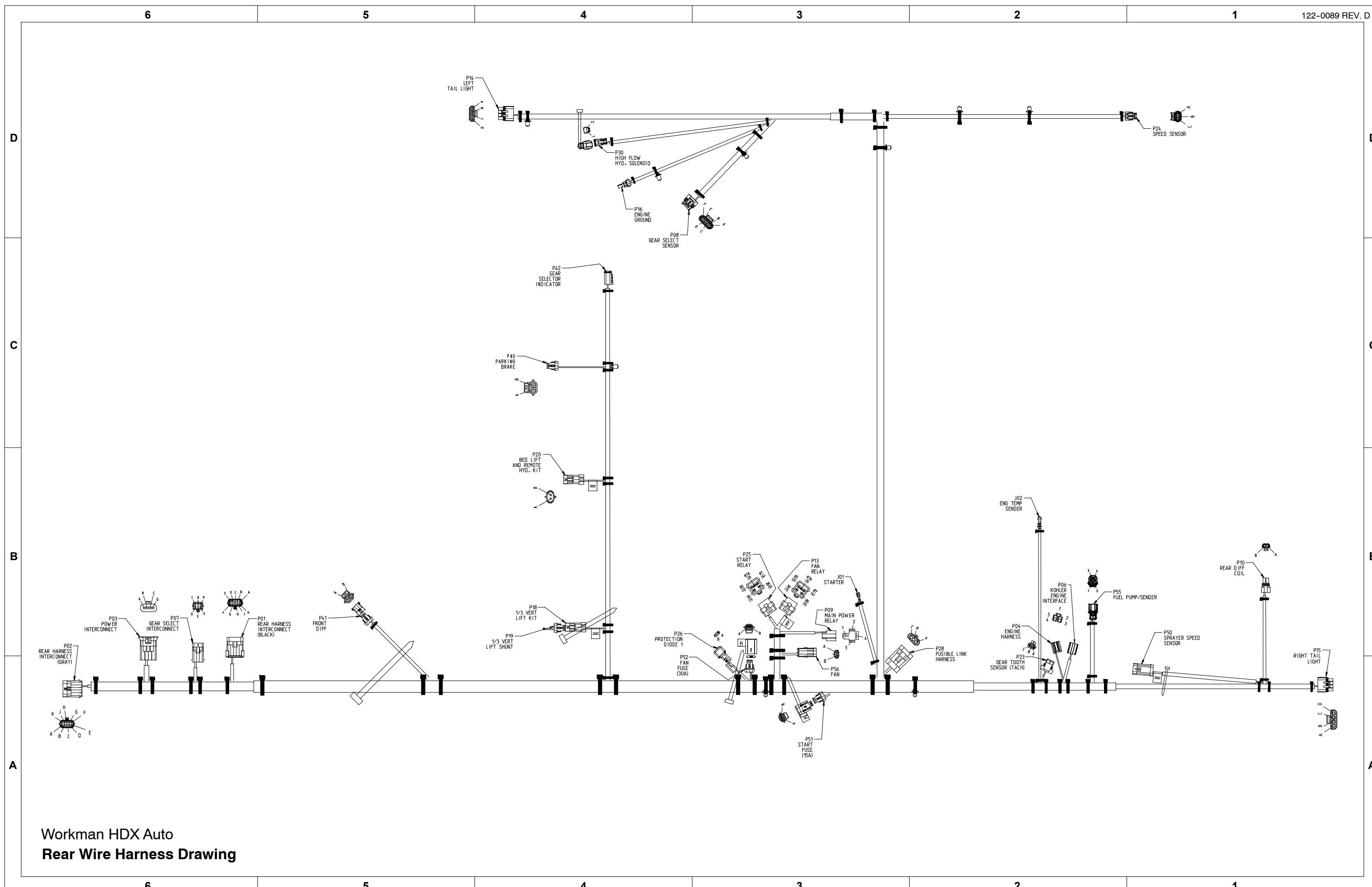




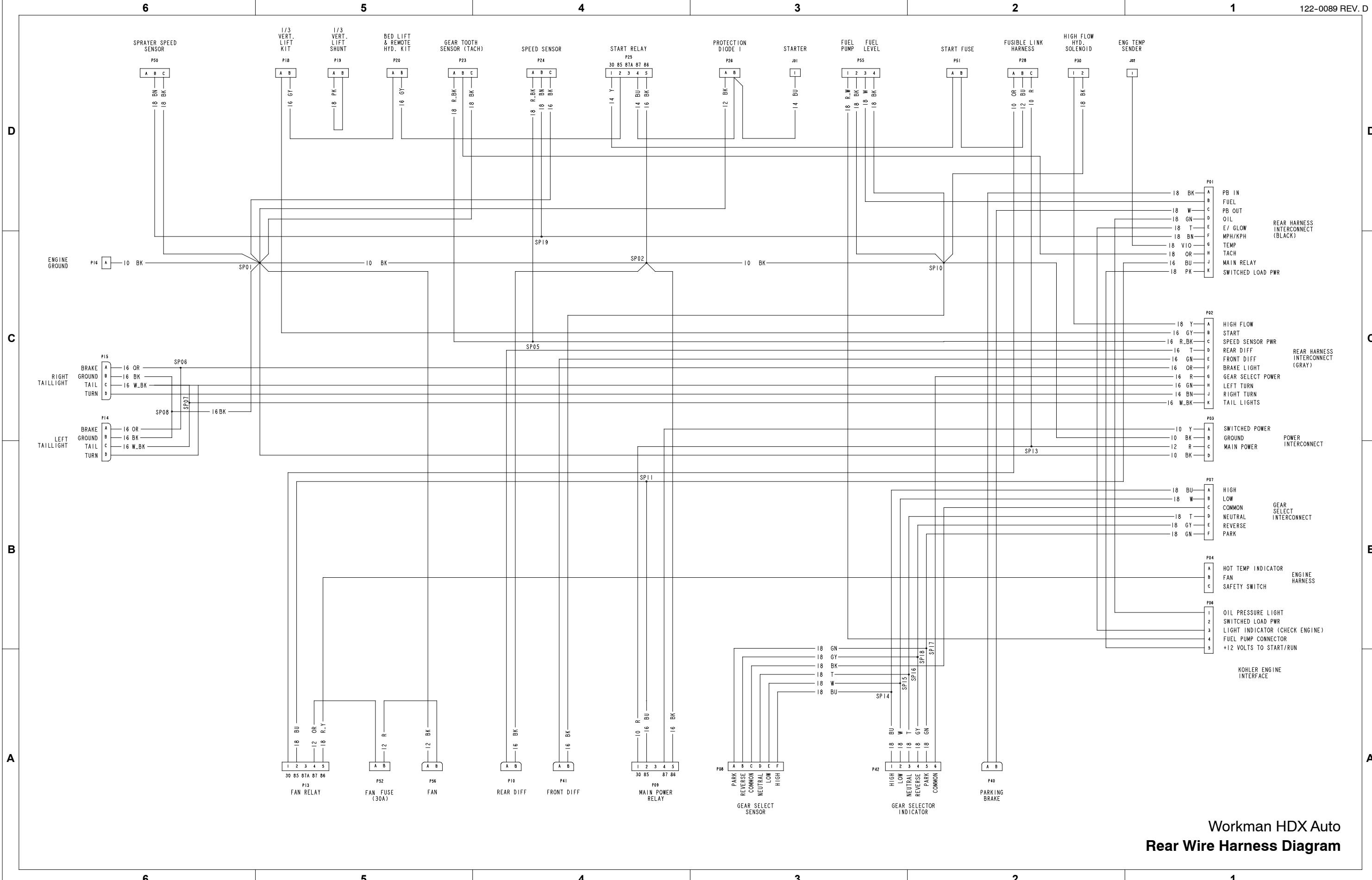


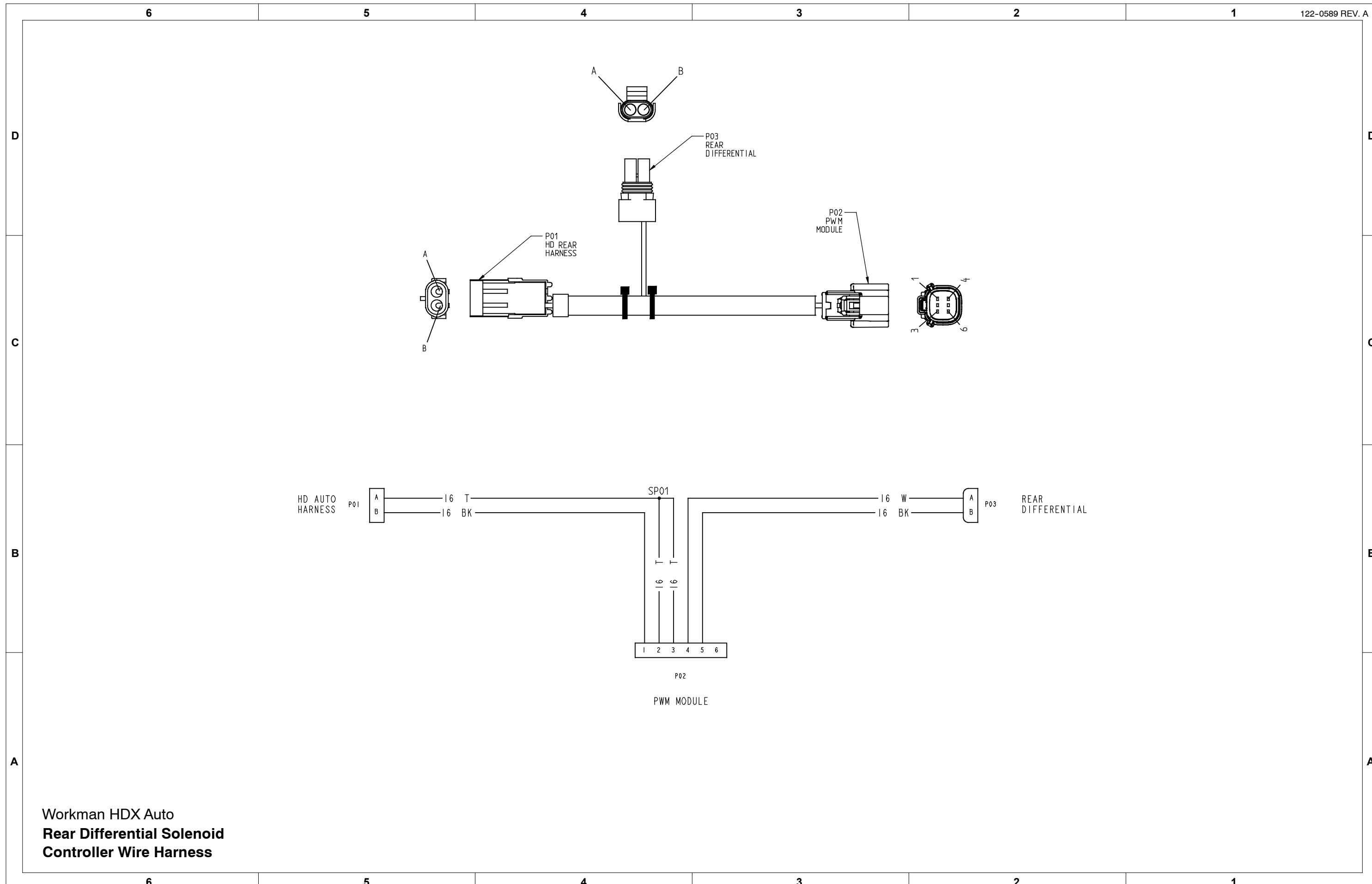


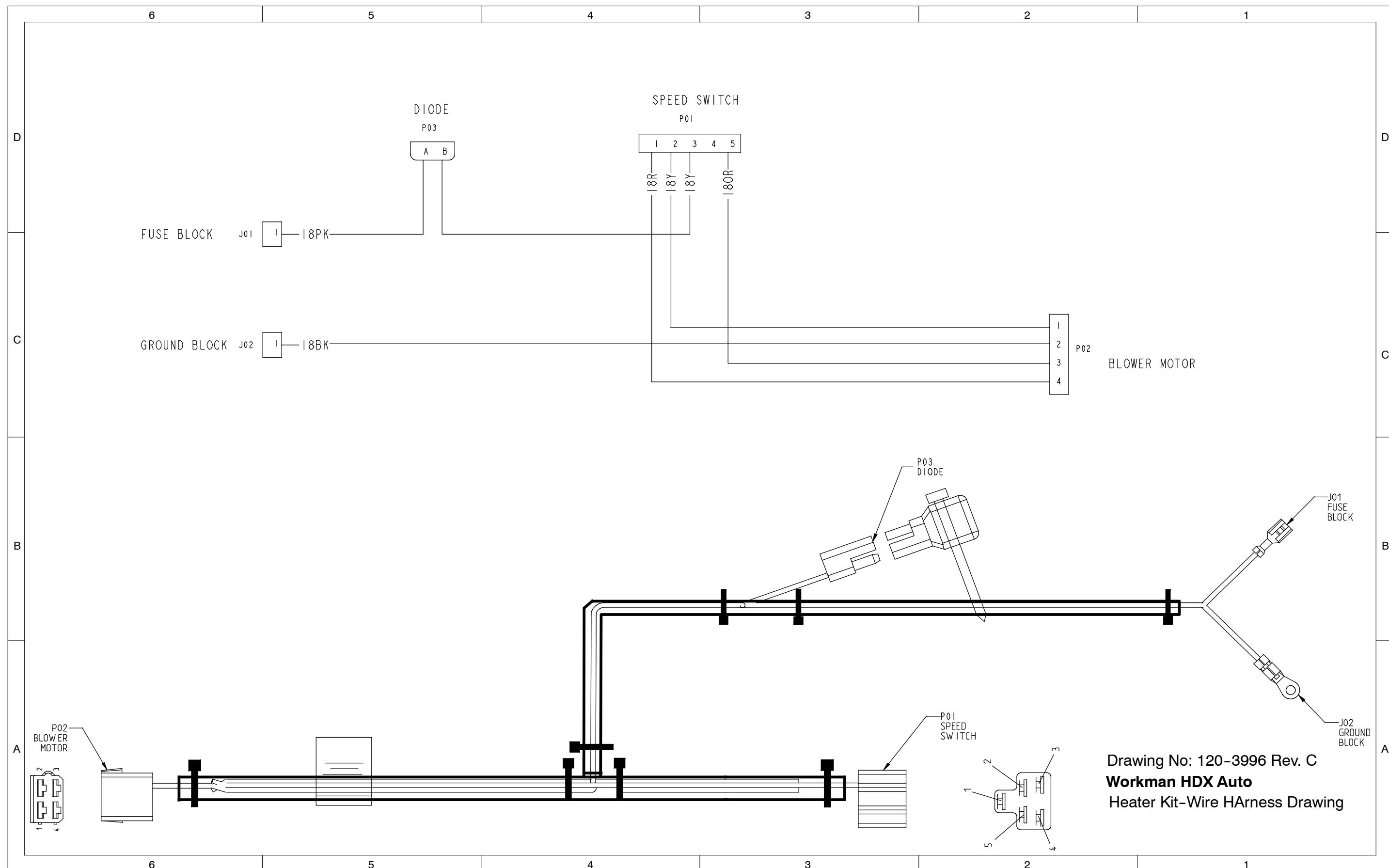
122-1449 Rev. A
Workman HDX Auto A



Workman HDX Auto
Rear Wire Harness Drawing







Drawing No: 120-3996 Rev. C
Workman HDX Auto
 Heater Kit-Wire HARNESS Drawing