Service Manual

(Serial Number Above 310000000)

Multi Pro® 1200/1250

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 Multi Pro 1200 and Multi Pro 1250 sprayers with a serial number above 310000000.

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

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Safety Instructions

The Multi Pro 1200 and Multi Pro 1250 Turf Sprayers 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 machine, these factors are also dependent upon the awareness, concern and proper training of the personnel involved in the operation, transport, maintenance and storage of the machine. Improper use or maintenance of the machine can result in injury or death. To reduce the potential for injury or death, comply with the following safety instructions.

WARNING

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

Before Operating

1. Read and understand the contents of the Operator's Manual before starting and operating the machine. Become familiar with the controls and know how to stop the machine and engine quickly. 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 machine. Also tighten any loose nuts, bolts or screws to ensure machine is in safe operating condition.

3. Assure interlock switches are adjusted correctly so engine cannot be started unless range selector is in NEUTRAL.

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

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

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

   C. Do not smoke while handling fuel.

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

   E. Wipe up any spilled fuel.

While Operating

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

2. Before starting the engine:

   A. Engage the parking brake.

   B. Make sure range selector is in NEUTRAL and the pump switch is OFF.

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

4. Do not touch engine, muffler, exhaust pipe or drive system components 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 range selector is in neutral.

   B. Set parking brake.

   C. Turn pump switch OFF.

   D. Stop engine and remove key from ignition switch.

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

6. Follow chemical manufacturer's recommendations for handling precautions, necessary protective equipment, mixing proportions and clean up procedures.

Maintenance and Service

1. Before servicing or making adjustments, turn spray pump off, put range selector in neutral, stop engine, set parking brake and remove key from the switch.

2. Prior to servicing sprayer components, determine what chemical(s) have been used in the sprayer. Follow precautions and recommendations printed on chemical container labels or Material Safety Data Sheets when servicing sprayer components. Use appropriate protective equipment: protective clothing, chemical resistant gloves and eye protection.

3. Make sure machine is in safe operating condition by keeping all nuts, bolts and screws tight.

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

5. Make sure all hydraulic line connectors are tight and 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 system must be relieved. To relieve system pressure, rotate steering wheel in both directions after the key 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. Clean protective screen on machine frequently.

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

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

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

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

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

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

16. To assure optimum performance and continued safety of the machine, use genuine Toro replacement parts and accessories. Replacement parts and accessories made by other manufacturers may result in nonconformance with the safety standards and the warranty may be voided.

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

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 Instructions

CAUTION

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

IMPORTANT: Before raising the sprayer, it is recommended to empty the spray tank. If the spray tank is not emptied, consider the extra weight of spray tank contents when choosing appropriate jacks, hoists and jack stands for raising and supporting the machine.

Jacking the Front End

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

2. Position jack securely under the A–arms, just to the inside of the front tire (Fig. 1).

3. Jack front of machine off the ground.

4. Position jack stands under the A–arms as close to the wheel as possible to support the machine.

Jacking the Rear End

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

2. Place jack securely under the rear most frame supports between the angle welds (Fig. 2).

3. Jack rear of machine off the ground.

4. Position jack stands under the frame to support the machine.

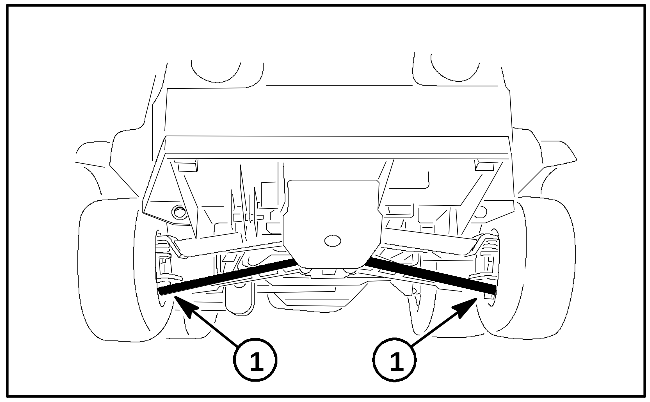

Figure 1

1. Front jacking points

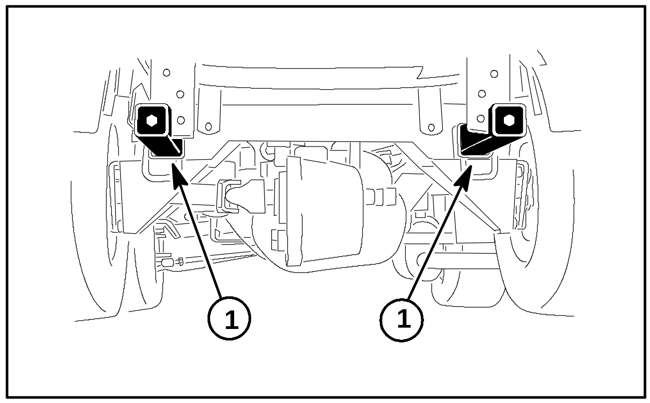

Figure 2

1. Rear jacking points

Safety and Instruction Decals

Numerous safety and instruction decals are affixed to the Multi Pro 1200 and Multi Pro 1250. If any decal becomes illegible or damaged, install a new decal. Decal part numbers are listed in your Parts Catalog. Order replacement decals from your Authorized Toro Distributor.

Chapter 2

Product Records and Maintenance

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Product Records

Insert Operator's Manual and Parts Catalog for your Multi Pro 1200 and 1250 at the end of this chapter. Refer to Operator's Manual for recommended maintenance intervals. Additionally, insert Installation Instructions, Operator's Manuals and Parts Catalogs for any accessories that have been installed on your Multi Pro at the end of this chapter.

Maintenance

Maintenance procedures and recommended service intervals for the Multi Pro 1200 and Multi Pro 1250 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. Subract 32° 2. Multiply by 5/9

Torque Specifications

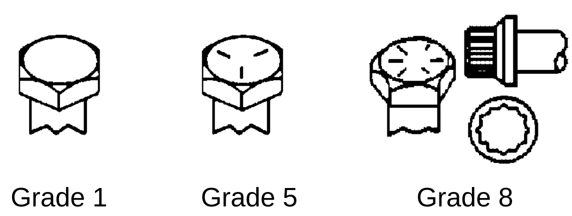
Recommended fastener torque values are listed in the following tables. For critical applications, as determined by Toro, either the recommended torque or a torque that is unique to the application is clearly identified and specified in this Service Manual.

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

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

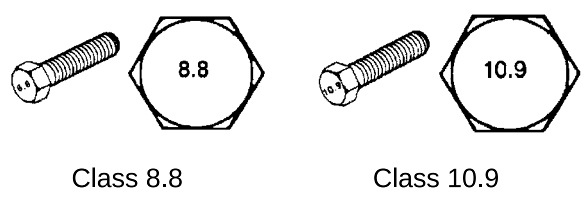
The standard method of verifying torque shall be performed by marking a line on the fastener (head or nut) and mating part, then back off fastener 1/4 of a turn. Measure the torque required to tighten the fastener until the lines match up.

Fastener Identification



Inch Series Bolts and Screws

Figure 1



Metric Bolts and Screws

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.

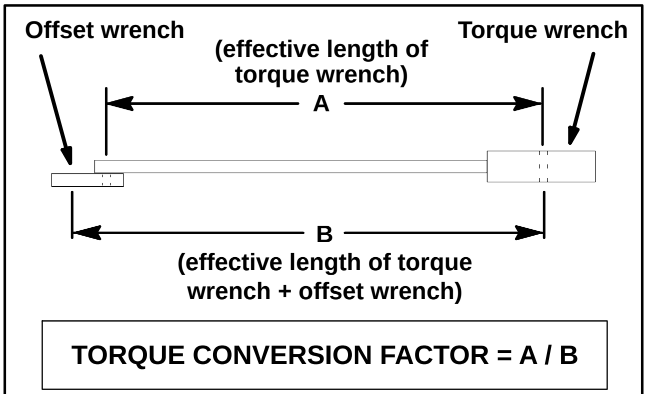


Figure 3

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 ± 2	13 ± 2	147 ± 23	15 ± 2	170 ± 20	23 ± 2	260 ± 20
# 6 – 40 UNF				17 ± 2	190 ± 20	25 ± 2	280 ± 20
# 8 – 32 UNC	13 ± 2	25 ± 5	282 ± 30	29 ± 3	330 ± 30	41 ± 4	460 ± 45
# 8 – 36 UNF				31 ± 3	350 ± 30	43 ± 4	485 ± 45
# 10 – 24 UNC	18 ± 2	30 ± 5	339 ± 56	42 ± 4	475 ± 45	60 ± 6	675 ± 70
# 10 – 32 UNF				48 ± 4	540 ± 45	68 ± 6	765 ± 70
1/4 – 20 UNC	48 ± 7	53 ± 7	599 ± 79	100 ± 10	1125 ± 100	140 ± 15	1580 ± 170
1/4 – 28 UNF	53 ± 7	65 ± 10	734 ± 113	115 ± 10	1300 ± 100	160 ± 15	1800 ± 170
5/16 – 18 UNC	115 ± 15	105 ± 17	1186 ± 169	200 ± 25	2250 ± 280	300 ± 30	3390 ± 340
5/16 – 24 UNF	138 ± 17	128 ± 17	1446 ± 192	225 ± 25	2540 ± 280	325 ± 30	3670 ± 340
	ft-lb	**ft-lb**	**N-m**	**ft-lb**	**N-m**	**ft-lb**	**N-m**
3/8 – 16 UNC	16 ± 2	16 ± 2	22 ± 3	30 ± 3	41 ± 4	43 ± 4	58 ± 5
3/8 – 24 UNF	17 ± 2	18 ± 2	24 ± 3	35 ± 3	47 ± 4	50 ± 4	68 ± 5
7/16 – 14 UNC	27 ± 3	27 ± 3	37 ± 4	50 ± 5	68 ± 7	70 ± 7	95 ± 9
7/16 – 20 UNF	29 ± 3	29 ± 3	39 ± 4	55 ± 5	75 ± 7	77 ± 7	104 ± 9
1/2 – 13 UNC	30 ± 3	48 ± 7	65 ± 9	75 ± 8	102 ± 11	105 ± 10	142 ± 14
1/2 – 20 UNF	32 ± 3	53 ± 7	72 ± 9	85 ± 8	115 ± 11	120 ± 10	163 ± 14
5/8 – 11 UNC	65 ± 10	88 ± 12	119 ± 16	150 ± 15	203 ± 20	210 ± 20	285 ± 27
5/8 – 18 UNF	75 ± 10	95 ± 15	129 ± 20	170 ± 15	230 ± 20	240 ± 20	325 ± 27
3/4 – 10 UNC	93 ± 12	140 ± 20	190 ± 27	265 ± 25	359 ± 34	375 ± 35	508 ± 47
3/4 – 16 UNF	115 ± 15	165 ± 25	224 ± 34	300 ± 25	407 ± 34	420 ± 35	569 ± 47
7/8 – 9 UNC	140 ± 20	225 ± 25	305 ± 34	430 ± 45	583 ± 61	600 ± 60	813 ± 81
7/8 – 14 UNF	155 ± 25	260 ± 30	353 ± 41	475 ± 45	644 ± 61	660 ± 60	895 ± 81

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

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

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

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

Thread Size	Class 8.8 Bolts, Screws and Studs with Regular Height Nuts (Class 8 or Stronger Nuts)		Class 10.9 Bolts, Screws and Studs with Regular Height Nuts (Class 10 or Stronger Nuts)	
M5 X 0.8	57 ± 5 in–lb	640 ± 60 N–cm	78 ± 7 in–lb	885 ± 80 N–cm
M6 X 1.0	96 ± 9 in–lb	1018 ± 100 N–cm	133 ± 13 in–lb	1500 ± 150 N–cm
M8 X 1.25	19 ± 2 ft–lb	26 ± 3 N–m	27 ± 2 ft–lb	36 ± 3 N–m
M10 X 1.5	38 ± 4 ft–lb	52 ± 5 N–m	53 ± 5 ft–lb	72 ± 7 N–m
M12 X 1.75	66 ± 7 ft–lb	90 ± 10 N–m	92 ± 9 ft–lb	125 ± 12 N–m
M16 X 2.0	166 ± 15 ft–lb	225 ± 20 N–m	229 ± 22 ft–lb	310 ± 30 N–m
M20 X 2.5	325 ± 33 ft–lb	440 ± 45 N–m	450 ± 37 ft–lb	610 ± 50 N–m

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

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

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

Other Torque Specifications

SAE Grade 8 Steel Set Screws

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

Wheel Bolts and Lug Nuts

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

** For steel wheels and non–lubricated fasteners.

Thread Cutting Screws (Zinc Plated Steel)

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

Thread Cutting Screws (Zinc Plated Steel)

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

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

Conversion Factors

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

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

Chapter 3

Kohler Gasoline Engine

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Introduction

This chapter gives information about specifications and repair of the Kohler Command engine used in the Multi Pro 1200 and 1250.

General maintenance procedures are described in your Operator's Manual. Information on engine troubleshooting, testing, disassembly and reassembly is identified in the Kohler Command Engine 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 Command Engine 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 Toro Distributor or a local Kohler Dealer.

Specifications

Item	Description
Make / Designation	Kohler, CH640, 4-stroke, V-Twin Air Cooled, OHV
Number of Cylinders	2
Bore x Stroke	3.03 in x 2.64 in (77 mm x 67 mm)
Total Displacement	38 in^3 (624 cc)
Compression Ratio	8.5:1
Fuel	Unleaded, Regular Gasoline (Minimum 87 Octane)
Fuel Tank Capacity	5 U.S. gal (18.9 liters)
Governor	Mechanical
Low Idle Speed (no load)	800 to 950 RPM
High Idle Speed (no load)	3275 to 3425 RPM
Engine Oil	API SF or SG (see Operator’s Manual for viscosity)
Oil Pump	Gear driven trochoid type
Crankcase Oil Capacity	2 U.S. qt (1.9 liters) with filter
Starter	12 VDC
Alternator/Regulator	12 VDC 25 AMP
Dry Weight (approximate)	90 lb (41 kg)

Adjustments

Adjust Engine Speed

1. Allow engine to reach operating temperature before checking or adjusting engine speed. Park machine on a level surface, shift range selector to neutral and engage parking brake.

2. Raise seat to gain access to engine speed control (Fig. 1).

3. With engine running, move accelerator pedal to **FAST** position.

4. Using a tachometer, check that engine is operating from **3275 to 3425 RPM**.

5. If high idle speed is incorrect, adjust high speed screw on control bracket (Fig. 2).

   A. Loosen jam nut on high speed screw.

   B. Adjust high speed screw to obtain **3275 to 3425 RPM**.

   C. Tighten lock nut. Recheck high speed.

6. Allow accelerator pedal to return to **SLOW** position.

7. Using a tachometer, check that engine is operating at **800 to 950 RPM**.

8. If low speed is incorrect, adjust low speed screw (Fig. 2).

   A. Loosen jam nut on slow speed screw.

   B. Adjust slow speed screw to obtain **800 to 950 RPM**.

   C. Tighten jam nut. Recheck low speed.

   NOTE: When the engine returns to idle speed, the drive clutch should fully disengage. Idle speed may have to be reduced to ensure complete clutch disengagement.

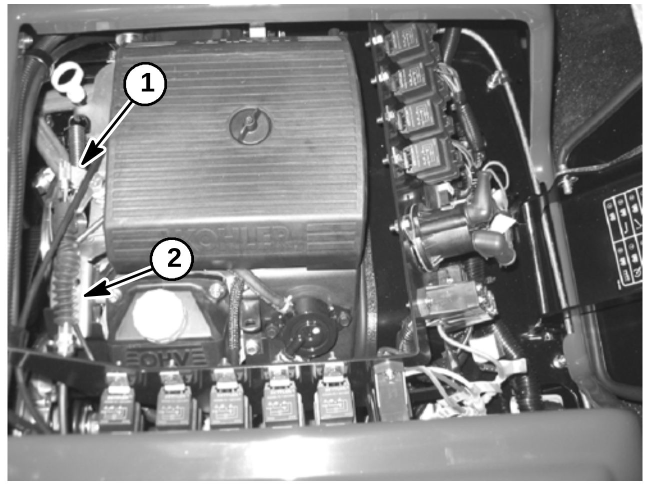

Figure 1

1. **Engine speed control**
2. **Accelerator cable**

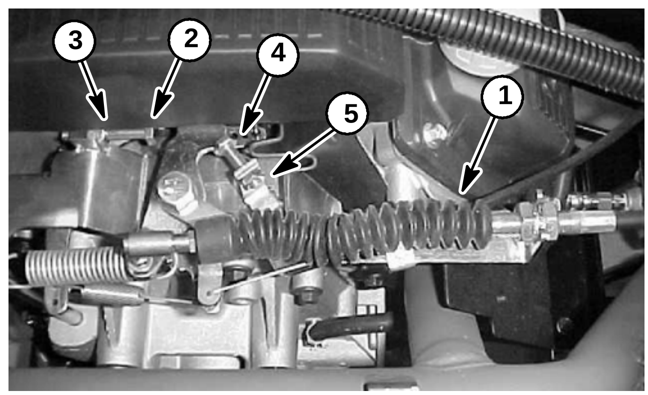

Figure 2

1. **Accelerator cable**
2. **High speed screw**
3. **Jam nut**
4. **Low speed screw**
5. **Jam nut**

Kohler Gasoline Engine

Adjust Choke Cable

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

2. Remove air cleaner cover and air filter from engine (see Operator's Manual).

3. Move choke control on control panel while watching choke plate in carburetor.

   A. Choke plate should be fully open when choke control is pushed in.

   B. Choke plate should be fully closed when choke control is pulled out.

4. If cable adjustment is needed, loosen cap screw and nut that secure choke cable clamp. Reposition cable to allow correct choke operation. Secure choke cable clamp.

5. Reassemble air cleaner.

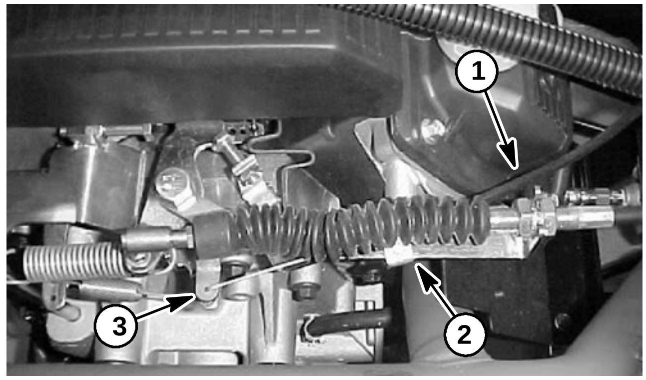

Figure 3

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

Service and Repairs

Cooling System

To ensure proper engine cooling, make sure the grass screen, cooling fins and other external surfaces of the engine are kept clean at all times.

NOTE: Perform this maintenance procedure at the interval specified in the Operator's Manual.

IMPORTANT: The engine that powers the Multi Pro is air-cooled. Operating the engine with dirty or plugged cooling fins, a blocked grass screen, or a dirty or plugged blower housing will result in engine overheating and engine damage.

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

IMPORTANT: Never clean engine with pressurized water. Water could enter and contaminate the fuel system.

2. Clean cooling fins on both cylinder heads.

3. Clean grass screen and blower housing of dirt and debris (Fig. 4). Remove screen and housing if necessary.

IMPORTANT: Never operate engine without the blower housing installed. Overheating and engine damage will result.

4. Make sure grass screen and blower housing are reinstalled to the engine if removed.

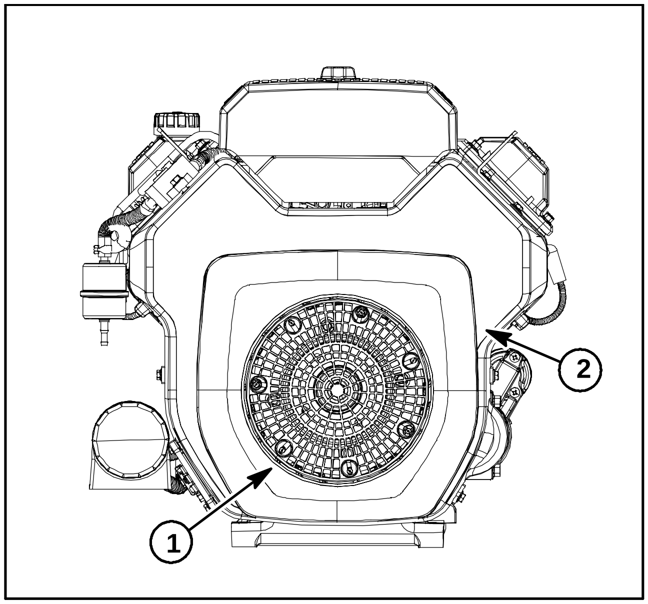

Figure 4

1. **Grass screen**
2. **Blower housing**

Kohler Gasoline Engine

Fuel System

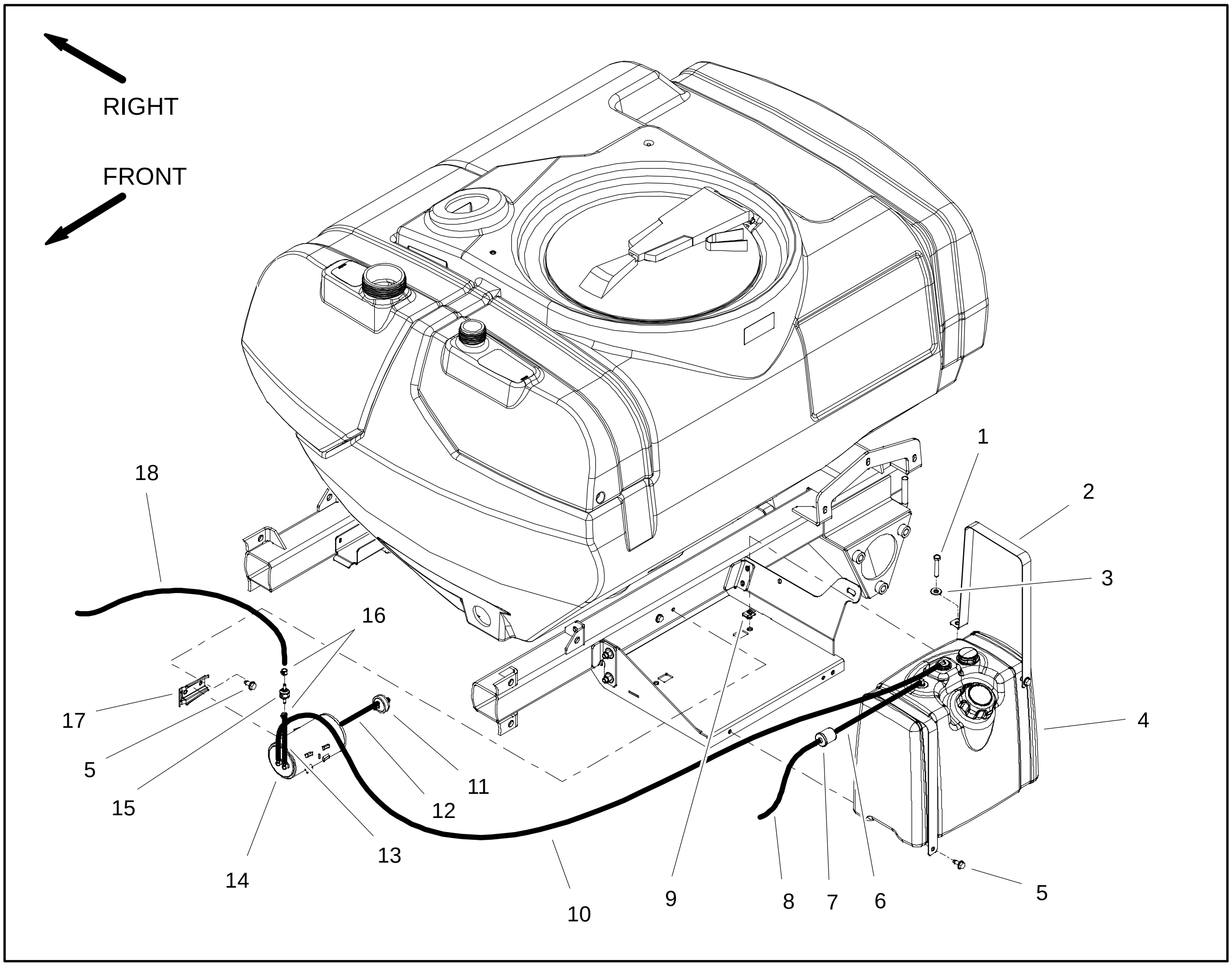

Figure 5

1. **Cap screw (2 used)**
2. **Fuel tank strap (2 used)**
3. **Flat washer (2 used)**
4. **Fuel tank assembly**
5. **Flange head screw (4 used)**
6. **Fuel supply hose (filter to tank)**
7. **Fuel filter**
8. **Fuel supply hose (fuel pump to filter)**
9. **U-nut (2 used)**
10. **Fuel hose**
11. **Fuel filter**
12. **Fuel hose**
13. **Fuel hose**
14. **Carbon cannister**
15. **Vacuum check valve**
16. **Hose clamp (8 used)**
17. **Cannister bracket**
18. **Fuel hose**

DANGER

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

Check Fuel Lines and Connections

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

Drain and Clean Fuel Tank

Drain and clean the fuel tank if the fuel system becomes contaminated or if the machine is to be stored for an extended period.

To clean fuel tank, flush tank out with clean solvent. Make sure tank is free of contaminates and debris.

Fuel Tank Removal

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

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

3. Note routing of fuel hoses for installation purposes. Disconnect fuel hoses from fuel standpipe and rollover valve. Plug fuel hoses to prevent leakage or contaminant entry.

4. Remove fuel tank from machine using Figure 5 as a guide.

5. Remove components from fuel tank as needed using Figure 6 as a guide.

Fuel Tank Installation

1. Install all removed components to fuel tank using Figure 6 as a guide.

2. Install fuel tank to machine using Figure 5 as a guide.

3. Remove plugs placed in fuel hoses during fuel tank removal. Connect fuel hoses to fuel standpipe and rollover valve. Secure fuel hoses with hose clamps.

4. Fill fuel tank.

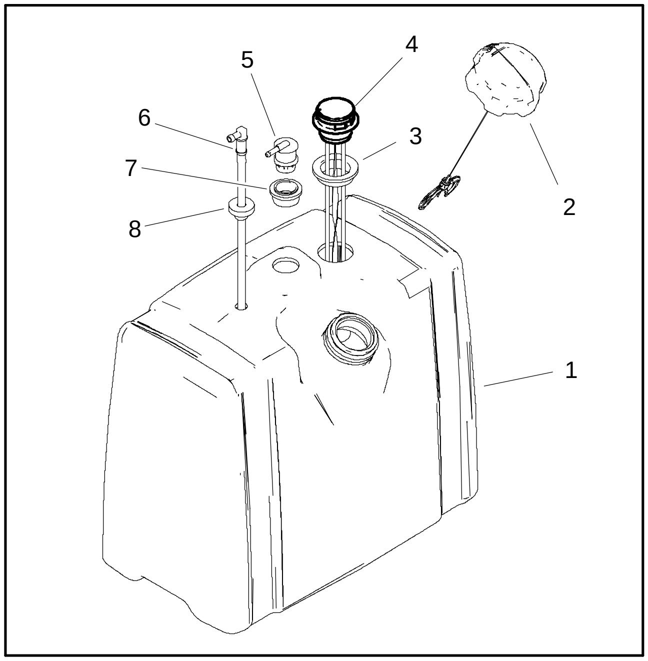

Figure 6

1. **Fuel tank**
2. **Fuel tank cap**
3. **Grommet**
4. **Fuel gauge**
5. **Rollover valve**
6. **Standpipe**
7. **Grommet**
8. **Bushing**

Kohler Gasoline Engine

Exhaust System

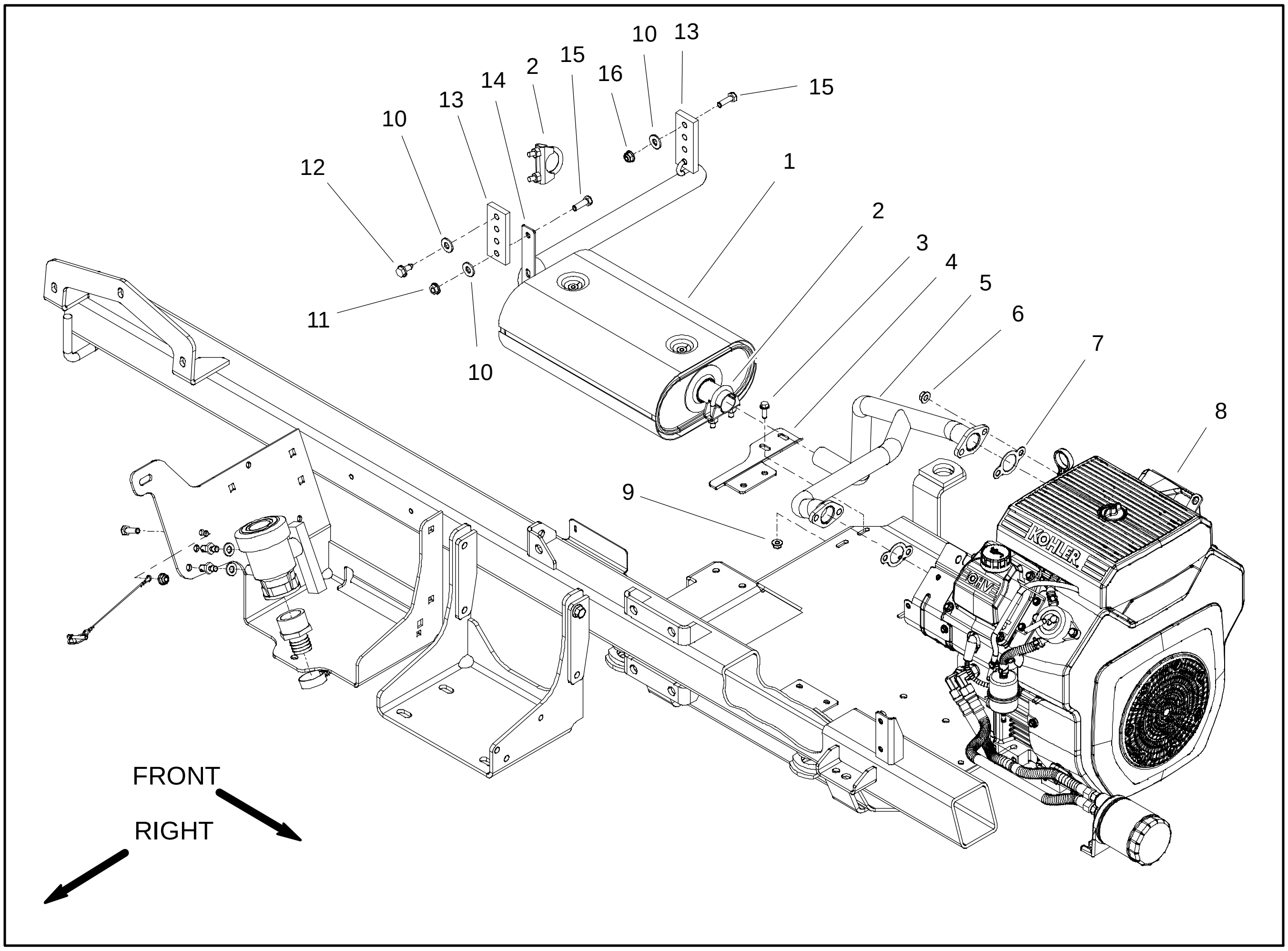

Figure 7

1. Muffler
2. Muffler clamp (2 used)
3. Flange head screw (2 used)
4. Exhaust support bracket
5. Exhaust manifold
6. Flange nut (4 used)
7. Exhaust gasket (2 used)
8. Engine
9. Flange nut (2 used)
10. Flat washer (3 used)
11. Flange nut
12. Flange head screw
13. Muffler hanger (2 used)
14. Muffler hanger bracket
15. Cap screw (2 used)
16. Flange nut

Removal (Fig. 7)

CAUTION

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

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

2. Gaining access from below machine, remove the muffler from the machine:

   A. Support muffler to prevent it from unexpectedly shifting.

   B. Remove muffler clamp (item 2) that secures muffler inlet to exhaust manifold and exhaust support bracket (item 4).

   C. Remove fasteners that secure two (2) muffler hangers (item 13) to machine frame.

   D. Slide muffler from exhaust manifold and remove from machine.

   E. If necessary, remove remaining mounting components from muffler using Figure 7 as a guide.

3. Remove four (4) flange nuts from the exhaust studs on engine. Remove exhaust manifold from the engine.

4. Remove and discard exhaust gaskets from engine.

Installation (Fig. 7)

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

IMPORTANT: Finger tighten all exhaust system fasteners before securing so there is no preload on exhaust components.

1. Place new exhaust gaskets on the exhaust studs on engine. Position exhaust manifold to the engine and install four (4) flange nuts.

2. Install the muffler:

   A. Install all removed mounting components to muffler using Figure 7 as a guide.

   B. Slide muffler inlet onto exhaust manifold.

   C. Secure muffler hangers (item 13) to machine frame with removed fasteners.

   D. Install muffler clamp (item 2) to muffler inlet and exhaust support bracket (item 4).

3. Tighten fasteners to secure exhaust system:

   A. Four (4) flange nuts to secure exhaust manifold to engine.

   B. Fasteners to secure muffler hangers (item 13) to machine frame. Muffler hangers should be perpendicular to frame after tightening.

   C. Two (2) nuts on muffler clamp to secure muffler inlet to exhaust support bracket and exhaust manifold.

Engine Mounting Plate Assembly

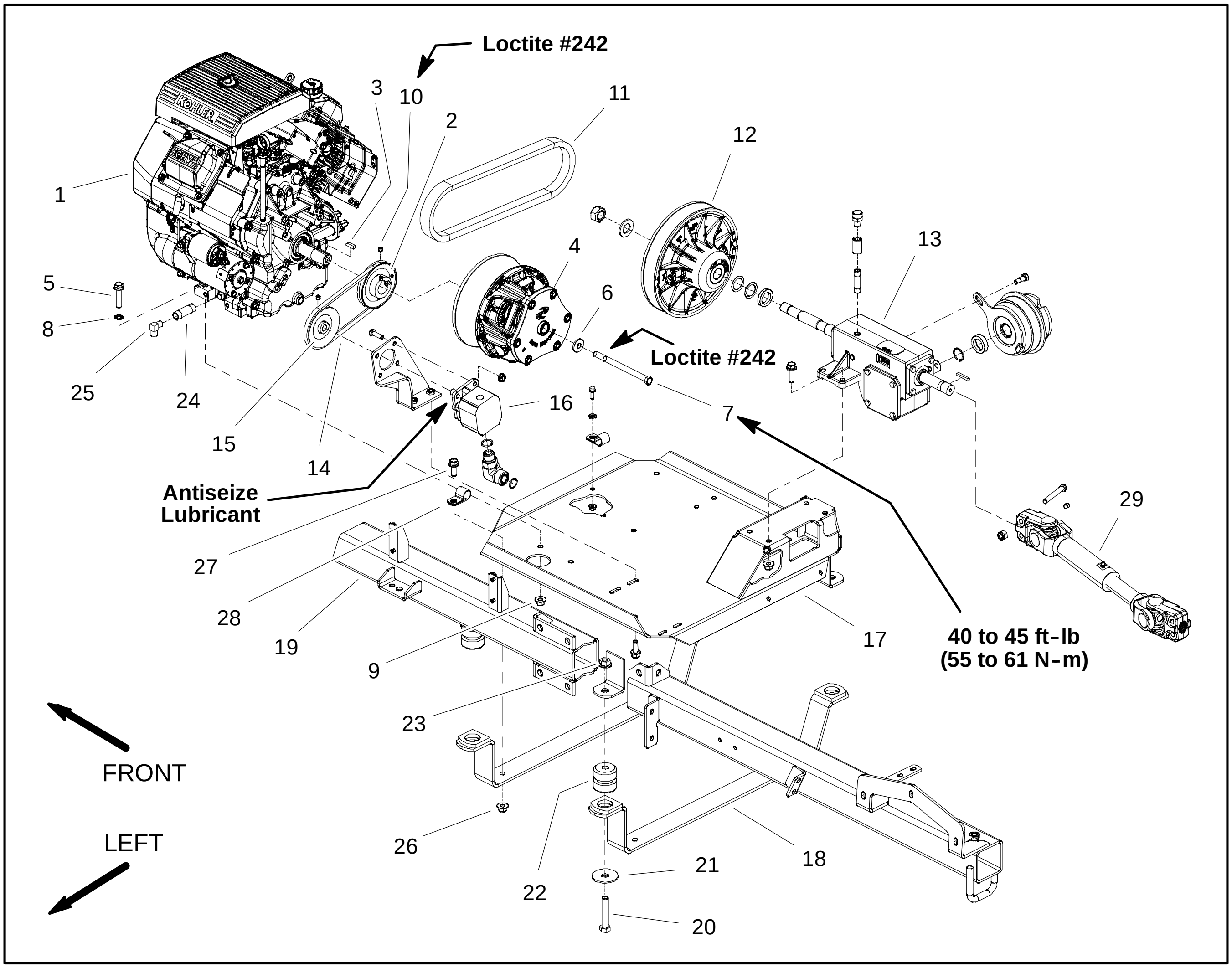

Figure 8

1. Engine
2. Pump pulley
3. Key
4. Drive clutch
5. Flange head screw (4 used)
6. Stepped washer
7. Cap screw
8. Lock washer
9. Flange nut (4 used)
10. Set screw (2 used)
11. CVT drive belt
12. Driven clutch
13. Pump drive gearbox
14. Steering pump drive belt
15. Steering pump pulley
16. Hydraulic steering pump
17. Engine mounting plate
18. Engine support strap (2 used)
19. Machine frame
20. Cap screw (4 used)
21. Washer (4 used)
22. Engine mount assembly (4 used)
23. Flange nut (4 used)
24. Oil drain nipple
25. Oil drain elbow
26. Flange nut (4 used)
27. Flange head screw (4 used)
28. R–clamp (3 used)
29. Transaxle driveshaft

NOTE: For easiest service access to the engine, removal of the spray tank is recommended (see Spray Tank Removal in the Service and Repairs section of Chapter 6 – Spray System). As an alternative, the engine mounting plate can be lowered from the machine to access the engine. The hydraulic hoses to the steering pump and the fuel hoses to the engine do not need to be disconnected unless the mounting plate is to be completely removed from the machine.

CAUTION

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

Removal (Fig. 8)

1. Park machine on a level surface, stop engine and remove key from the ignition switch. Chock wheels to keep the machine from moving.

2. Disconnect negative (–) and then positive (+) battery cables at the battery.

3. Remove muffler section of the exhaust system (see Exhaust System Removal in this section).

4. Remove accelerator cable from engine (Figs. 9 and 10).

A. Slide the sleeve back on the cable ball joint and lift accelerator cable from the ball stud.

B. Loosen one of the two cable jam nuts that secures accelerator cable to control bracket.

C. Remove accelerator cable from the engine speed control bracket and position away from the engine.

5. Remove choke cable from the engine speed control bracket (Figs. 9 and 10).

6. Gaining access from under operator seat, loosen two (2) flange head screws and flange nuts that secure oil filter adapter to right hand frame rail (Fig. 11). Slide adapter with oil filter away from frame.

7. Disconnect engine electrical connections. Position unplugged wires away from engine.

A. Unplug engine wire harness from machine wire harness.

B. Remove nut on starter solenoid stud. Remove fusible link connector and positive (+) battery cable from solenoid stud.

C. Remove flange head screw and nut under starter motor that secures engine and negative (–) cable to engine mounting plate (Fig. 12).

8. Remove transaxle drive shaft from pump drive gearbox (see Pump Drive Gearbox in the Service and Repairs Section of Chapter 7 – Drive Train). Locate and retrieve key.

9. Disconnect spray pump coupler from pump drive electric clutch. Unplug clutch wiring connector from machine harness (see Pump Drive Electric Clutch in the Service and Repairs Section of Chapter 6 – Spray System).

10. If the mounting plate is being removed from machine, disconnect fuel hose from fuel pump on engine. Pull fuel line from R–clamps on mount plate and position disconnected fuel line away from engine.

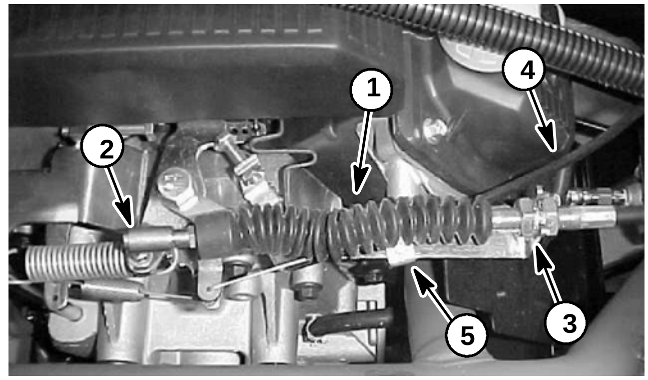

Figure 9

1. **Accelerator cable**
2. **Cable ball joint**
3. **Cable jam nut**
4. **Choke cable**
5. **Choke cable clamp**

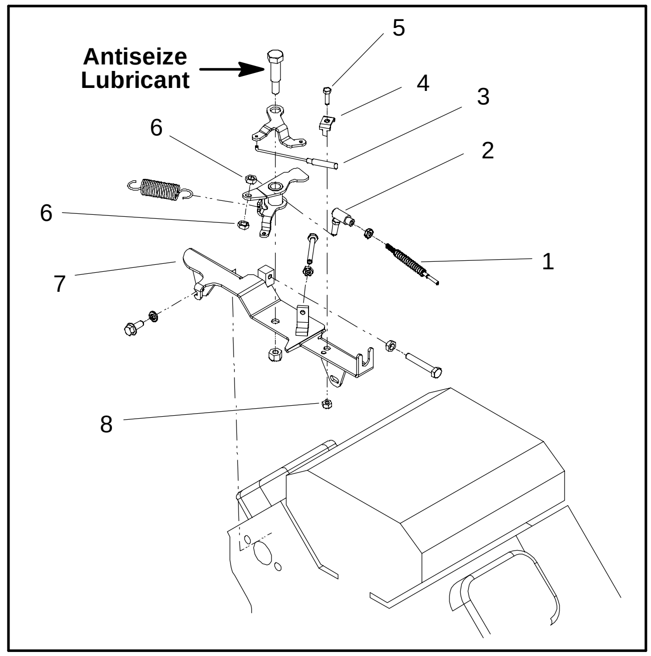

Figure 10

1. **Accelerator cable**
2. **Cable ball joint**
3. **Choke cable**
4. **Choke cable clamp**
5. **Cap screw**
6. **Ball joint jam nut**
7. **Speed control bracket**
8. **Hex nut**

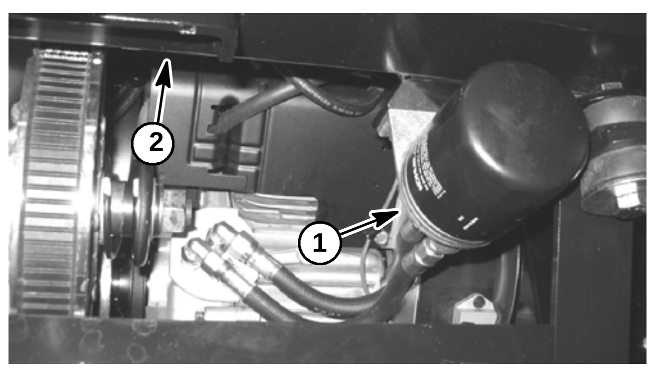

Figure 11

1. **Oil filter adapter**
2. **RH frame rail**

CAUTION

Rotate steering wheel to relieve hydraulic system pressure and avoid injury from pressurized hydraulic oil.

11. If the mounting plate assembly is being removed from machine, label all hydraulic connections for reassembly purposes. Clean hydraulic hose ends prior to disconnecting the hoses. Remove hydraulic hoses from steering pump. Cap or plug openings of pump and hoses to prevent contamination.

12. Remove engine mounting plate assembly from machine (Figs. 8 and 12):

A. Support the engine mounting plate assembly from below to prevent it from falling.

B. Remove four (4) cap screws, washers and flange nuts that secure the engine support straps to the frame.

IMPORTANT: Make sure to not damage the engine, fuel hoses, hydraulic lines, electrical harness or other parts while lowering the engine mounting plate assembly.

C. Carefully lower engine mounting plate assembly from machine.

Installation (Fig. 8)

1. Place machine on a level surface with key removed from the ignition switch. Chock wheels to keep the machine from moving.

2. Reinstall engine mounting plate assembly to machine (Figs. 8 and 12):

A. Make sure that engine mounts are correctly assembled to mounting straps (Fig. 13). Position engine mounting plate assembly under machine.

IMPORTANT: Make sure to not damage the engine, fuel hoses, hydraulic lines, electrical harness or other parts while raising the engine mounting plate assembly.

B. Carefully raise engine mounting plate assembly to machine frame.

C. Secure engine mounting plate assembly to frame with four (4) cap screws, washers and flange nuts.

3. Position key in pump drive gearbox shaft. Install transaxle drive shaft to pump drive gearbox (see Pump Drive Gearbox in the Service and Repairs Section of Chapter 7 – Drive Train).

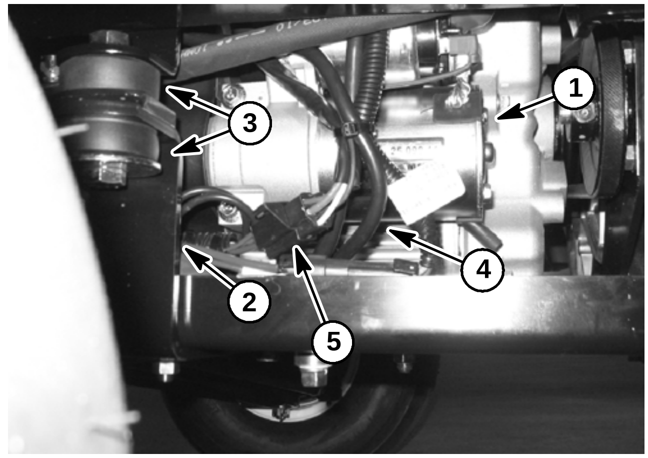

Figure 12

1. **Engine starter motor**
2. **Engine support strap**
3. **Engine mount**
4. **Negative battery cable**
5. **Engine wire harness**

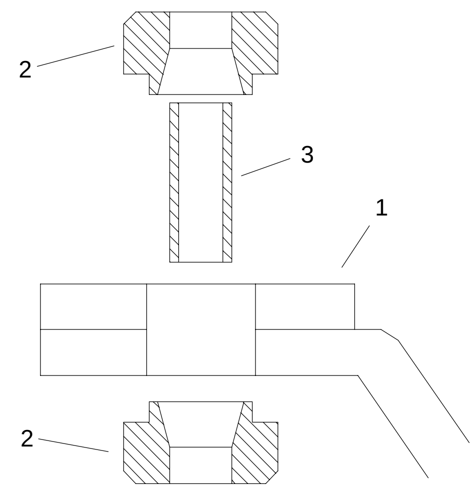

Figure 13

1. **Engine support strap**
2. **Engine mount cushion**
3. **Engine mount tube**

4. Connect spray pump coupler to pump drive electric clutch. Plug clutch wiring connector into machine harness (see Pump Drive Electric Clutch in the Service and Repairs Section of Chapter 6 – Spray System).

5. Reconnect engine electrical connections.

A. Pull wire harness into position, keeping harness away from any moving components.

B. Secure fusible link connector and positive (+) battery cable to starter solenoid stud with nut.

C. Connect engine wire harness to main wire harness.

D. From below, install flange head screw and nut under starter motor that secures engine and negative (–) cable (Fig. 12).

6. Install choke cable to engine and secure with cable clamp (Figs. 9 and 10). Check choke cable adjustment (see Adjust Choke Cable in the Adjustments Section of this chapter).

7. Reconnect accelerator cable to engine (Figs. 9 and 10).

A. Position accelerator cable to the engine speed control bracket.

B. Slide the sleeve back on the cable ball joint and place cable ball joint on ball stud. Release the sleeve so it slides over the stud to secure cable.

C. Tighten cable jam nuts that secure accelerator cable to control bracket.

8. If fuel line was removed, route fuel line through R–clamps on mounting plate. Connect fuel line to the fuel pump and secure with clamp.

9. Position oil filter adapter with oil filter to the right hand frame rail. Install two (2) flange head screws and flange nuts and secure oil filter adapter to machine (Fig. 11).

10. Reinstall the muffler section of the exhaust system (see Exhaust System Installation in this section).

11. If hydraulic hoses were disconnected, make sure hydraulic hoses and pump ports are clean. Remove plugs and caps from pump and hoses that were placed during disassembly. Install hydraulic hoses to steering pump.

12. Check engine oil level and transaxle/hydraulic fluid level (see Operator's Manual).

13. Connect positive (+) and then negative (–) battery cables to the battery.

14. Check engine speed (see Adjust Engine Speed in the Adjustments Section of this chapter).

Engine

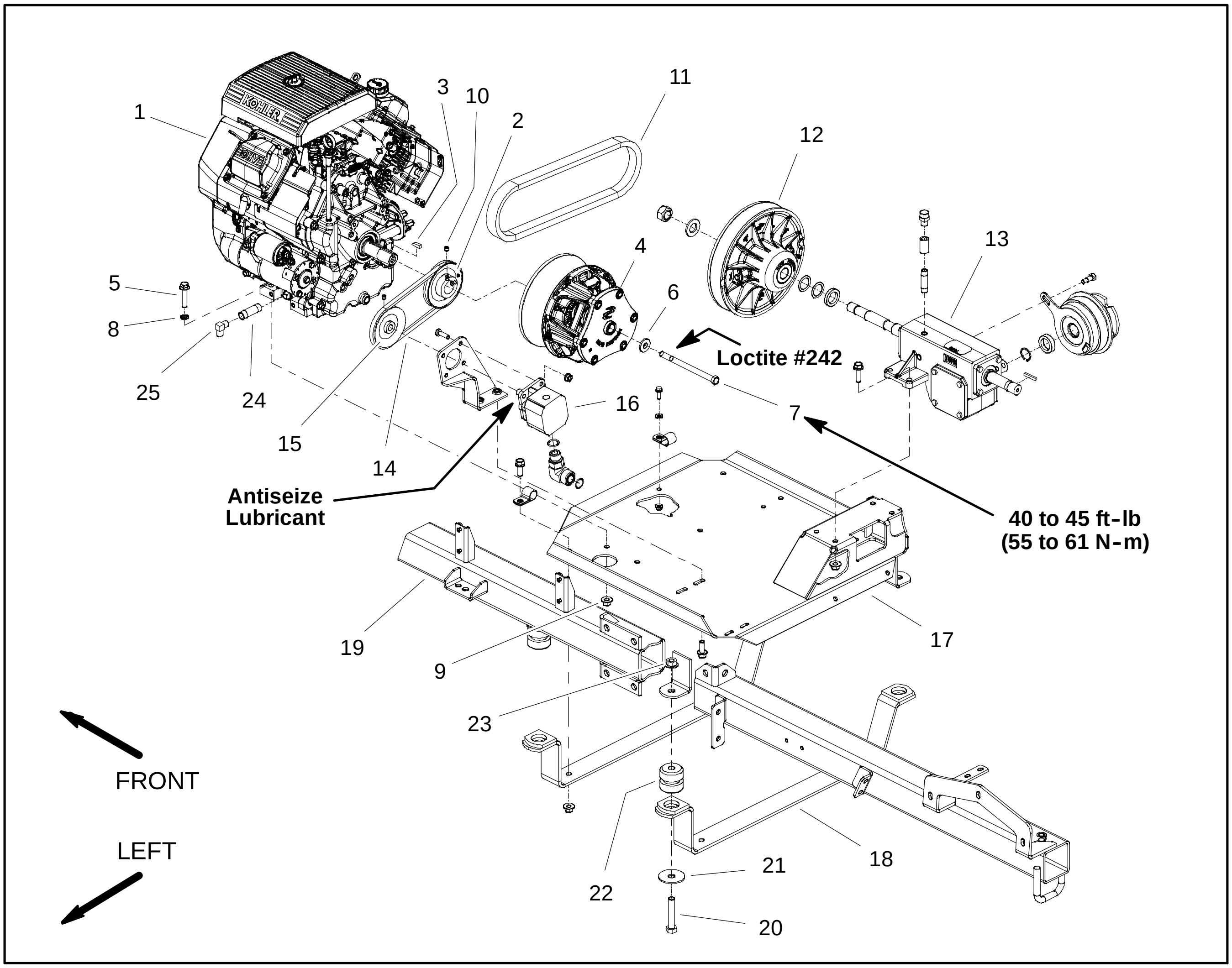

Figure 14

1. **Engine**
2. **Pump pulley**
3. **Key**
4. **Drive clutch**
5. **Flange head screw (4 used)**
6. **Stepped washer**
7. **Cap screw**
8. **Lock washer (for grounding)**
9. **Flange nut (4 used)**
10. **Set screw (2 used)**
11. **CVT drive belt**
12. **Driven clutch**
13. **Pump drive gearbox**
14. **Steering pump drive belt**
15. **Steering pump pulley**
16. **Hydraulic steering pump**
17. **Engine mounting plate**
18. **Engine support strap (2 used)**
19. **Machine frame**
20. **Cap screw (4 used)**
21. **Washer (4 used)**
22. **Engine mount assembly (4 used)**
23. **Flange nut (4 used)**
24. **Oil drain nipple**
25. **Oil drain elbow**

Engine Removal (Fig. 14)

CAUTION

The engine, exhaust system and drive components may be hot. To avoid possible burns, allow all components to cool before removing engine from the machine.

1. Park machine on a level surface, stop engine and remove key from the ignition switch. Chock wheels to keep the machine from moving.

2. Remove the spray tank from machine to access engine (see Spray Tank Removal in the Service and Repairs section of Chapter 6 – Spray System).

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

4. Remove exhaust system (see Exhaust System Removal in this section).

5. Disconnect fuel supply hose from fuel pump on engine and position disconnected fuel line away from engine.

6. Remove accelerator cable from engine (Figs. 15 and 16).

A. Slide the sleeve back on the cable ball joint and lift accelerator cable from the ball stud.

B. Loosen one of the two cable jam nuts that secures accelerator cable to control bracket.

C. Remove accelerator cable from the engine speed control bracket and position away from the engine.

7. Remove choke cable from the engine speed control bracket (Figs. 15 and 16).

8. Gaining access from under operator seat, loosen two (2) flange head screws and flange nuts that secure oil filter adapter to right hand frame rail (Fig. 17). Slide adapter with oil filter away from frame.

9. Disconnect engine electrical connections (Fig. 18). Position unplugged wires away from engine.

A. Unplug engine wire harness from machine wire harness.

B. Remove nut on starter solenoid stud. Remove fusible link connector and positive (+) battery cable from solenoid stud.

C. Remove flange head screw, lock washer and nut under starter motor that secures engine, wire harness ground connection and negative (–) cable to engine mounting plate.

10. Remove CVT drive belt from the drive clutch (see CVT Drive Belt Service in the Service and Repairs Section of Chapter 7 – Drive Train).

11. Loosen hydraulic steering pump and remove pump drive belt from pulleys.

12. Loosen and remove three (3) remaining flange head screws and flange nuts that secure engine to engine mounting plate.

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

13. Carefully lift engine from mounting plate and machine.

14. If needed, remove drive clutch from engine crankshaft (see Drive Clutch in the Service and Repairs Section of Chapter 7 – Drive Train).

15. If needed, loosen set screws and remove steering pump pulley from engine crankshaft. Locate and retrieve key.

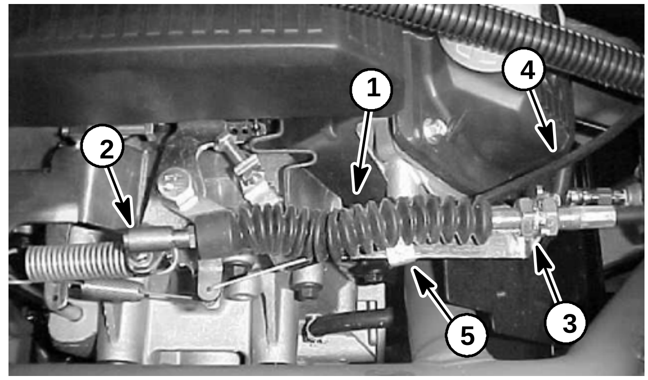

Figure 15

1. **Accelerator cable**
2. **Cable ball joint**
3. **Cable jam nut**
4. **Choke cable**
5. **Choke cable clamp**

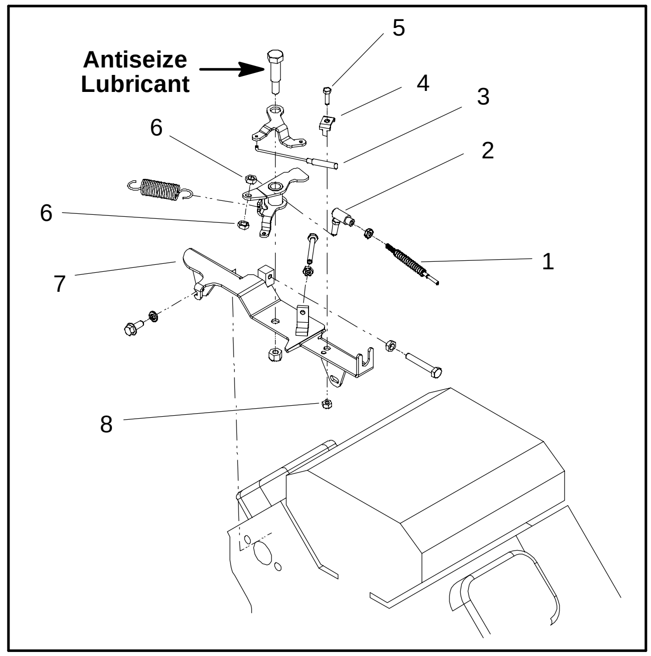

Figure 16

1. **Accelerator cable**
2. **Cable ball joint**
3. **Choke cable**
4. **Choke cable clamp**
5. **Cap screw**
6. **Ball joint jam nut**
7. **Speed control bracket**
8. **Hex nut**

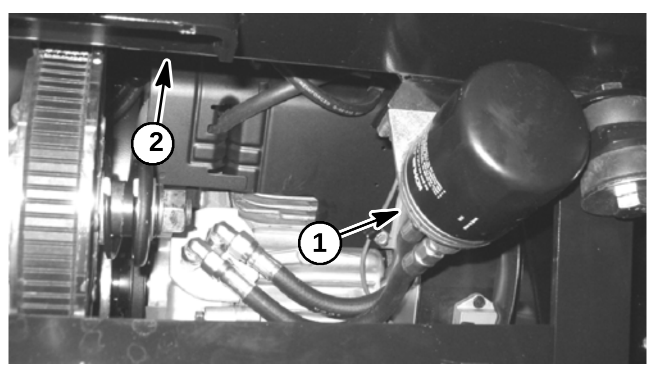

Figure 17

1. **Oil filter adapter**
2. **RH frame rail**

Engine Installation (Fig. 14)

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

2. If steering pump pulley was removed from engine, position key into keyway of engine shaft. Apply antiseize lubricant to shaft and key. Assemble pump pulley over key and shaft with hub on pulley away from engine.

3. If drive clutch was removed from engine, make sure that tapers of engine crankshaft and drive clutch bore are thoroughly clean. Reinstall clutch to engine (see Drive Clutch in the Service and Repairs Section of Chapter 7 – Drive Train).

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

4. Position engine to engine mounting plate. Secure engine to engine mounting plate with three (3) flange head screws and flange nuts. The flange head screw under the starter motor should not be installed at this time because it is also used to secure the wire harness ground and negative (–) cable.

5. Reconnect engine electrical connections (Fig. 18).

   A. Move wire harness into position, keeping harness away from any moving components.

   B. Secure fusible link connector and positive (+) battery cable to starter solenoid stud with nut.

   C. Connect engine wire harness to main wire harness.

   D. From below, insert final engine mounting flange head screw through lock washer, mounting plate, engine, wire harness ground and negative (–) cable. Secure screw with flange nut.

6. Install choke cable to engine and secure with cable clamp (Figs. 15 and 16). Check choke cable adjustment (see Adjust Choke Cable in the Adjustments Section of this chapter).

7. Reconnect accelerator cable to engine (Figs. 15 and 16).

   A. Position accelerator cable to the engine speed control bracket.

   B. Slide the sleeve back on the cable ball joint and place cable ball joint on ball stud. Release the sleeve so it slides over the stud to secure cable.

   C. Tighten cable jam nuts that secure accelerator cable to control bracket.

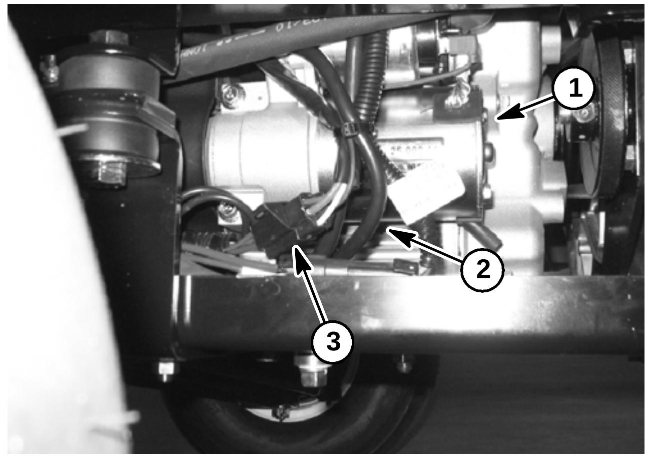

Figure 18

1. **Engine starter motor**
2. **Negative battery cable**
3. **Engine wire harness**

8. Connect fuel supply hose to the fuel pump and secure with clamp.

9. Position oil filter adapter with oil filter to the right hand frame rail. Install two (2) flange head screws and flange nuts and secure oil filter adapter to machine (Fig. 17).

10. Install the exhaust system (see Exhaust System Installation in this section).

11. Check engine oil level and adjust if necessary.

12. Connect positive (+) and then negative (–) battery cables to the battery.

13. Install steering pump drive belt to pump pulleys. Make sure that pump drive pulleys are aligned. Adjust pump drive belt tension. Make sure that hydraulic pump mounting bolts are tightened.

14. Start engine and check engine speed (see Adjust Engine Speed in the Adjustments Section of this chapter).

15. Place CVT drive belt around drive clutch. Rotate driven clutch while routing the belt onto the driven clutch (see CVT Drive Belt Service in the Service and Repairs Section of Chapter 7 – Drive Train).

16. Install the spray tank to the machine (see Spray Tank Installation in the Service and Repairs section of Chapter 6 – Spray System).

Kohler
Gasoline Engine

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Fuel Evaporative Control System

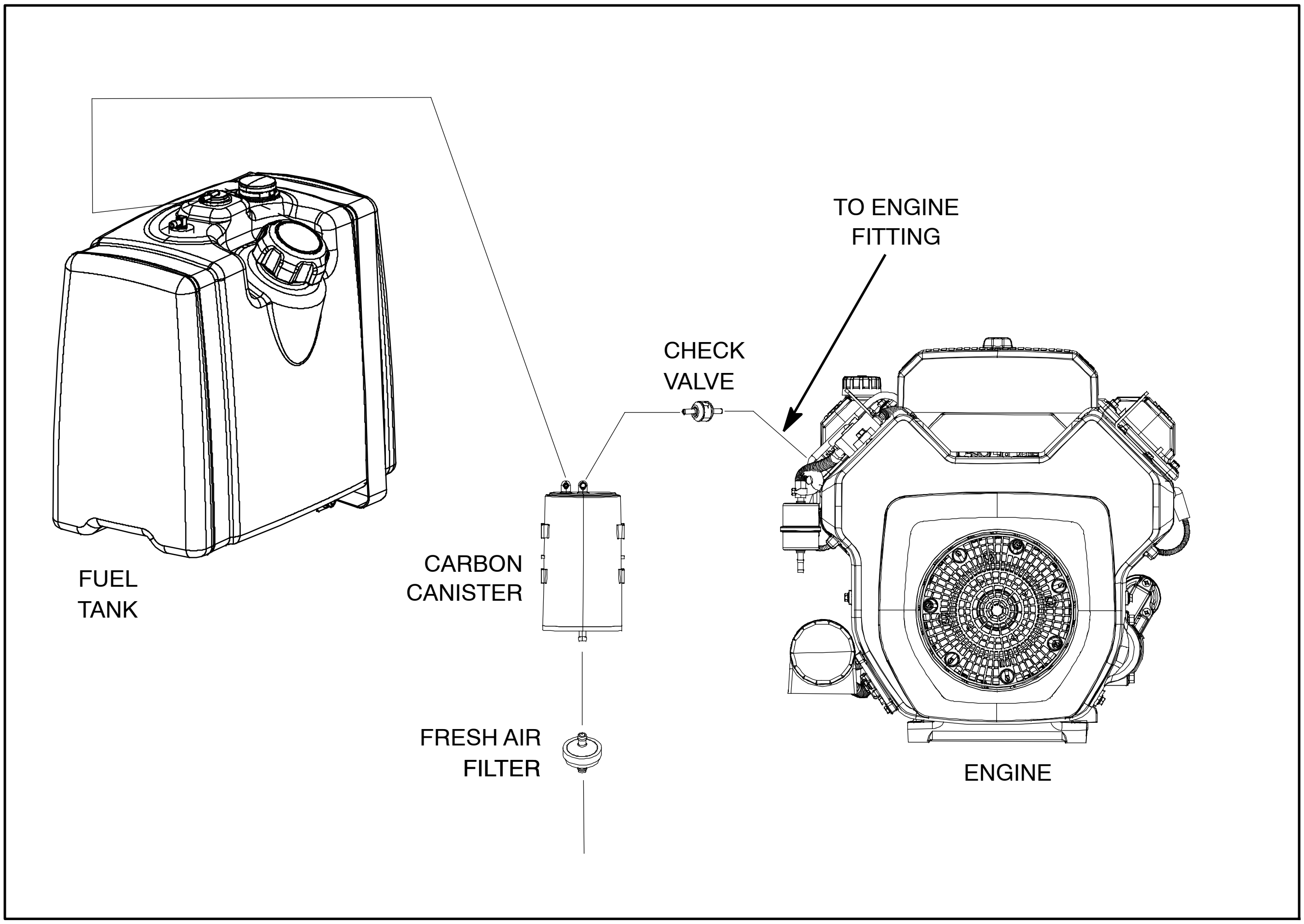

Figure 19

Multi Pro 1200 and 1250 sprayers are 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.

The fuel tank on these sprayers uses a non−vented fuel cap. To connect the tank to the evaporative control system, a fuel vent valve is positioned in the top of the tank that allows tank venting through the carbon canister.

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

Machines 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 inline check valve between the carbon canister and the engine fitting. Evaporative control system components for Multi Pro 1200 and 1250 sprayers are shown in Figure 19.

Disassembly

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

1. Inspect carbon canister and attached hoses for damage or obvious leaks. A damaged or leaking canister should be replaced.

2. Remove EVAP components as needed using Figure 19 as a guide.

   A. If check valve (item 7 in Fig. 19) is removed, note direction of arrow on valve body for assembly purposes.

   B. If hoses are removed from the carbon canister, note hose location for assembly purposes. Figure 20 identifies hose location.

Assembly

1. Install all removed components using Figure 19 as a guide.

   A. If check valve (item 7 in Fig. 19) 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.

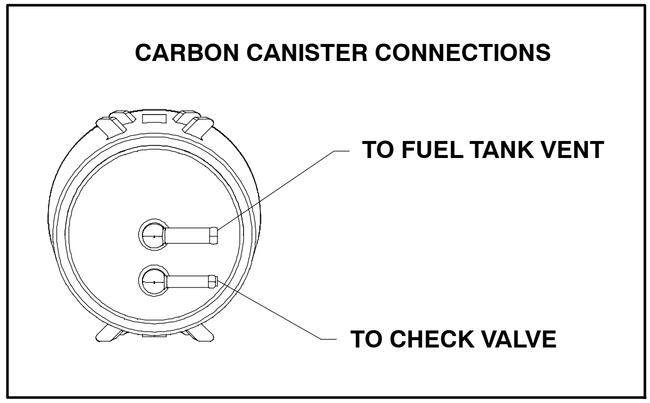

Figure 20

Kohler Gasoline Engine

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Chapter 4

Hydraulic System

Table of Contents

Hydraulic System

Specifications

Item	Description
Gear Pump Displacement (per revolution)	Positive displacement, gear type pump 0.194 in^3 (3.18 cc)
Steering Relief Pressure	1000 PSI (69.0 bar)
Hydraulic Filter	Spin–on cartridge type
Hydraulic Reservoir	In transaxle

Hydraulic 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 Multi Pro machine. Refer to that publication for additional information when servicing the machine.

Relieving Hydraulic System Pressure

Before disconnecting or performing any work on the hydraulic system, all pressure in the hydraulic system must be relieved. Park machine on a level surface, stop engine and engage parking brake. Once all moving parts have come to a complete stop, rotate steering wheel in both directions to relieve hydraulic system pressure.

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 when tightening a hose; hold the hose straight with one wrench and tighten the hose swivel nut onto the fitting with the second 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 components or performing any work on hydraulic system, all pressure in the system must be relieved by stopping the engine and rotating the steering wheel in both directions.

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

Hydraulic Hose and Tube Installation (O–Ring Face Seal Fitting)

1. Make sure threads and sealing surfaces of the hose/tube and the fitting are free of burrs, nicks, scratches or any foreign material.

2. As a preventative measure against leakage, it is recommended that the face seal O–ring be replaced any time the connection is opened. Make sure the O–ring is installed and properly seated in the fitting groove. Lightly lubricate the O–ring with clean hydraulic oil.

3. Place the hose/tube against the fitting body so that the flat face of the hose/tube sleeve fully contacts the O–ring in the fitting.

4. Thread the swivel nut onto the fitting by hand. While holding the hose/tube with a wrench, use a torque wrench to tighten the swivel nut to the recommended installation torque shown in Figure 3. This tightening process will require the use of an offset wrench (e.g. crowfoot wrench). Use of an offset wrench will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be lower than the listed installation torque (see Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 – Product Records and Maintenance).

5. If a torque wrench is not available or if space at the swivel nut prevents use of a torque wrench, an alternate method of assembly is the Flats From Wrench Resistance (F.F.W.R.) method (Fig. 2).

A. Using a wrench, tighten the swivel nut onto the fitting until light wrench resistance is reached (approximately 30 in–lb).

B. Mark the swivel nut and fitting body. Hold the hose/tube with a wrench to prevent it from turning.

C. Use a second wrench to tighten the nut to the correct Flats From Wrench Resistance (F.F.W.R.). The markings on the nut and fitting body will verify that the connection has been properly tightened.

Size	F.F.W.R.
4 (1/4 in. nominal hose or tubing)	1/2 to 3/4
6 (3/8 in.)	1/2 to 3/4
8 (1/2 in.)	1/2 to 3/4
10 (5/8 in.)	1/2 to 3/4
12 (3/4 in.)	1/3 to 1/2
16 (1 in.)	1/3 to 1/2

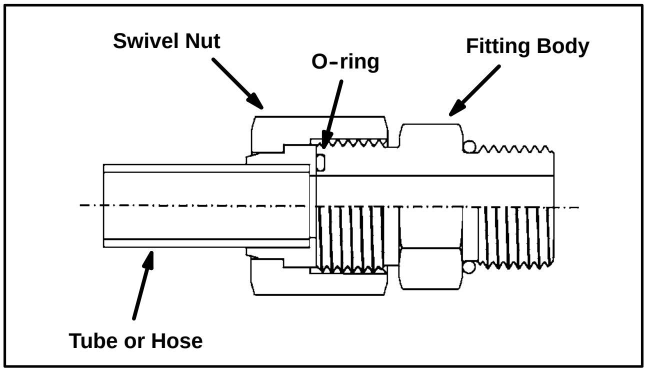


Figure 1

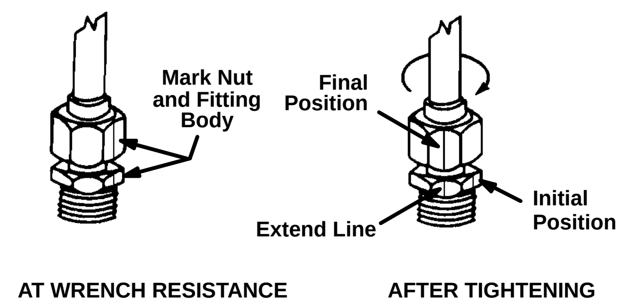


Figure 2

Fitting Dash Size	Hose/Tube Side Thread Size	Installation Torque
4	9/16 – 18	18 to 22 ft–lb (25 to 29 N–m)
6	11/16 – 16	27 to 33 ft–lb (37 to 44 N–m)
8	13/16 – 16	37 to 47 ft–lb (51 to 63 N–m)
10	1 – 14	60 to 74 ft–lb (82 to 100 N–m)
12	1 3/16 – 12	85 to 105 ft–lb (116 to 142 N–m)
16	1 7/16 – 12	110 to 136 ft–lb (150 to 184 N–m)
20	1 11/16 – 12	140 to 172 ft–lb (190 to 233 N–m)

Figure 3

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

Non–Adjustable Fitting (Fig. 4)

1. Make sure all threads and sealing surfaces of fitting and component port are free of burrs, nicks, scratches or any foreign material.

2. As a preventative measure against leakage, it is recommended that the O–ring be replaced any time the connection is opened.

3. Lightly lubricate the O–ring with clean hydraulic oil. Fitting threads should be clean with no lubricant applied.

IMPORTANT: Before installing fitting into port, determine port material. If fitting is to be installed into an aluminum port, installation torque is reduced.

4. Install the fitting into the port. Then, use a torque wrench and socket to tighten the fitting to the recommended installation torque shown in Figure 5.

NOTE: Use of an offset wrench (e.g. crowfoot wrench) will affect torque wrench calibration due to the effective length change of the torque wrench. Tightening torque when using a torque wrench with an offset wrench will be less than the recommended installation torque. See Using a Torque Wrench with an Offset Wrench in the Torque Specifications section of Chapter 2 – Product Records and Maintenance to determine necessary conversion information.

5. If a torque wrench is not available or if space at the port prevents use of a torque wrench, an alternate method of assembly is the Flats From Finger Tight (F.F.F.T.) method.

A. Install the fitting into the port and tighten it down full length until finger tight.

B. If port material is steel, tighten the fitting to the listed F.F.F.T. If port material is aluminum, tighten fitting to 60% of listed F.F.F.T.

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

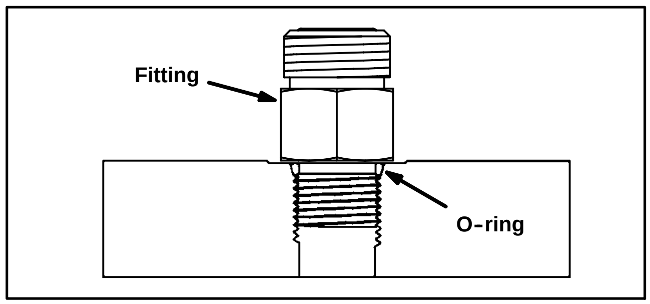


Figure 4

Fitting Dash Size	Fitting Port Side Thread Size	Installation Torque Into Steel Port	Installation Torque Into Aluminum Port
4	7/16 – 20	15 to 19 ft–lb (21 to 25 N–m)	9 to 11 ft–lb (13 to 15 N–m)
5	1/2 – 20	18 to 22 ft–lb (25 to 29 N–m)	11 to 15 ft–lb (15 to 20 N–m)
6	9/16 – 18	34 to 42 ft–lb (47 to 56 N–m)	20 to 26 ft–lb (28 to 35 N–m)
8	3/4 – 16	58 to 72 ft–lb (79 to 97 N–m)	35 to 43 ft–lb (48 to 58 N–m)
10	7/8 – 14	99 to 121 ft–lb (135 to 164 N–m)	60 to 74 ft–lb (82 to 100 N–m)
12	1 1/16 – 12	134 to 164 ft–lb (182 to 222 N–m)	81 to 99 ft–lb (110 to 134 N–m)
14	1 3/16 – 12	160 to 196 ft–lb (217 to 265 N–m)	96 to 118 ft–lb (131 to 160 N–m)
16	1 5/16 – 12	202 to 248 ft–lb (274 to 336 N–m)	121 to 149 ft–lb (165 to 202 N–m)
20	1 5/8 – 12	247 to 303 ft–lb (335 to 410 N–m)	149 to 183 ft–lb (202 to 248 N–m)

Figure 5

Adjustable Fitting (Fig. 6)

1. Make sure all threads and sealing surfaces of fitting and component port are free of burrs, nicks, scratches or any foreign material.

2. As a preventative measure against leakage, it is recommended that the O-ring be replaced any time the connection is opened.

3. Lightly lubricate the O-ring with clean hydraulic oil. Fitting threads should be clean with no lubricant applied.

4. Turn back the lock nut as far as possible. Make sure the back up washer is not loose and is pushed up as far as possible (Step 1 in Figure 7).

IMPORTANT: Before installing fitting into port, determine port material. If fitting is to be installed into an aluminum port, installation torque is reduced.

5. Install the fitting into the port and tighten finger tight until the washer contacts the face of the port (Step 2 in Figure 7). Make sure that the fitting does not bottom in the port during installation.

6. To put the fitting in the desired position, unscrew it by the required amount to align fitting with incoming hose or tube, but no more than one full turn (Step 3 in Figure 7).

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

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

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

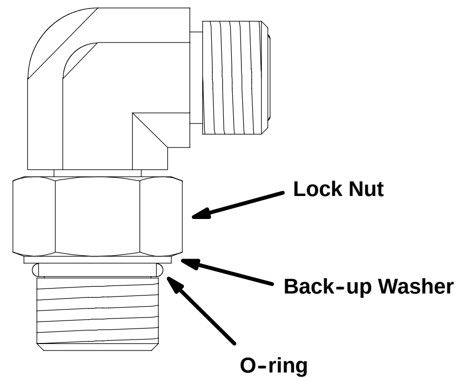


Figure 6

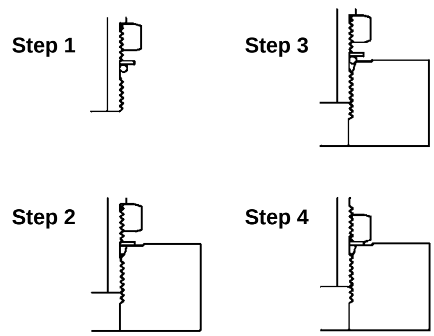
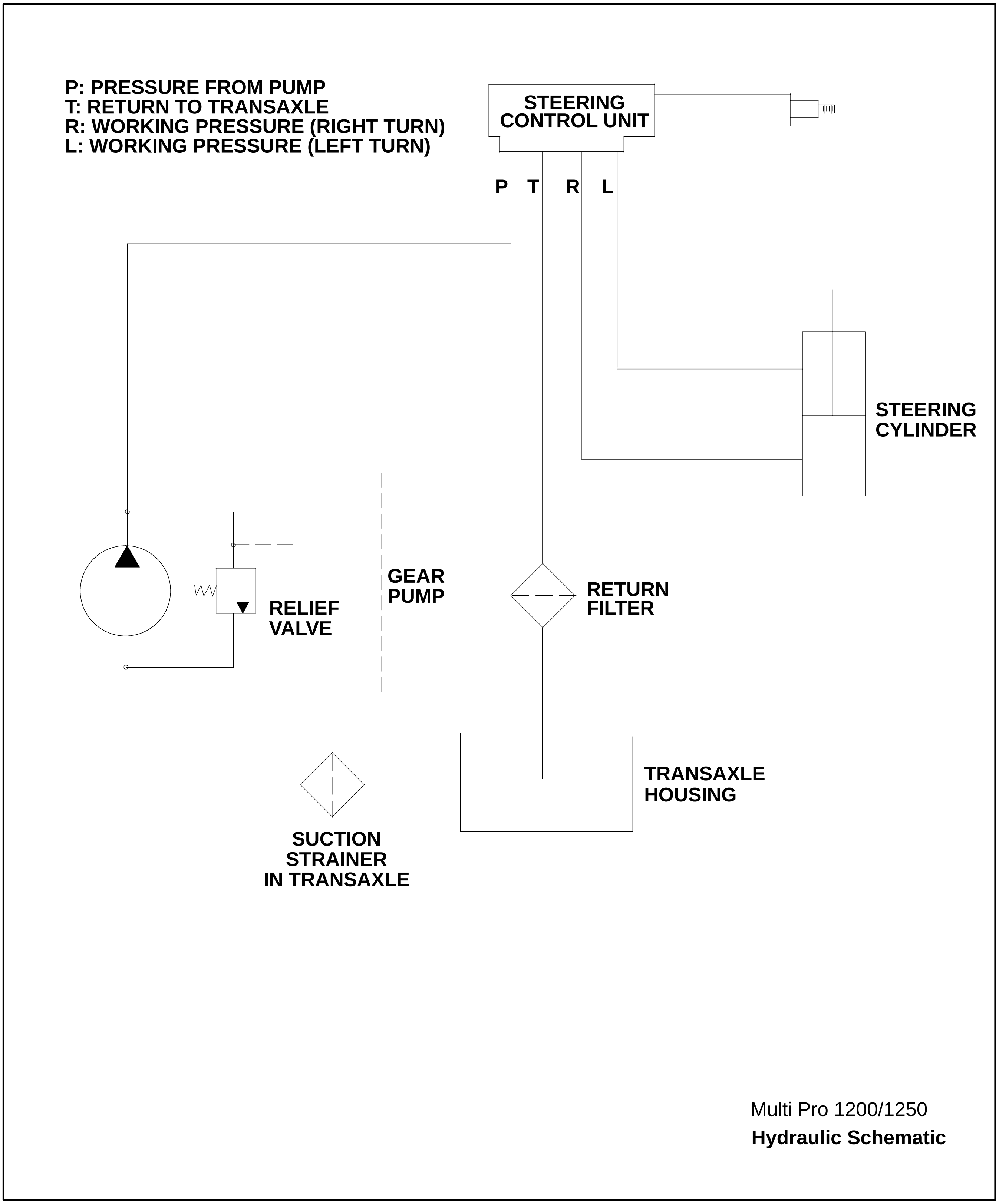


Figure 7

Hydraulic System

Hydraulic Schematic



Hydraulic Flow Diagrams

Steering Circuit

A single section, belt driven gear pump supplies hydraulic flow to the steering control valve and steering cylinder. The gear pump takes its suction from the transaxle. Steering circuit pressure is limited to 1000 PSI (69 bar) by a relief valve located in the gear pump.

Hydraulic flow and pressure to the steering control valve can be monitored at the outlet of the gear pump.

With the steering wheel in the neutral position and the engine running, flow enters the steering control valve and goes through the steering control spool valve, by–passing the rotary meter (V1) and steering cylinder. Flow leaves the control valve, to the oil filter and returns to the transaxle.

Left Turn

When a left turn is made with the engine running, the turning of the steering wheel positions the spool valve so that flow goes through the top of the spool. Flow entering the steering control valve from the pump goes through the spool, to the rotary meter (V1) and out the L port. Pressure contracts the steering cylinder piston for a left turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the steering control spool valve, then to the oil filter and returns to the transaxle.

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

Right Turn

When a right turn is made with the engine running, the turning of the steering wheel positions the spool valve so that flow goes through the bottom of the spool. Flow entering the steering control valve from the pump goes through the spool, to the rotary meter (V1) and out the R port. Pressure extends the steering cylinder piston for a right turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the steering control spool valve, then to the oil filter and returns to the transaxle.

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

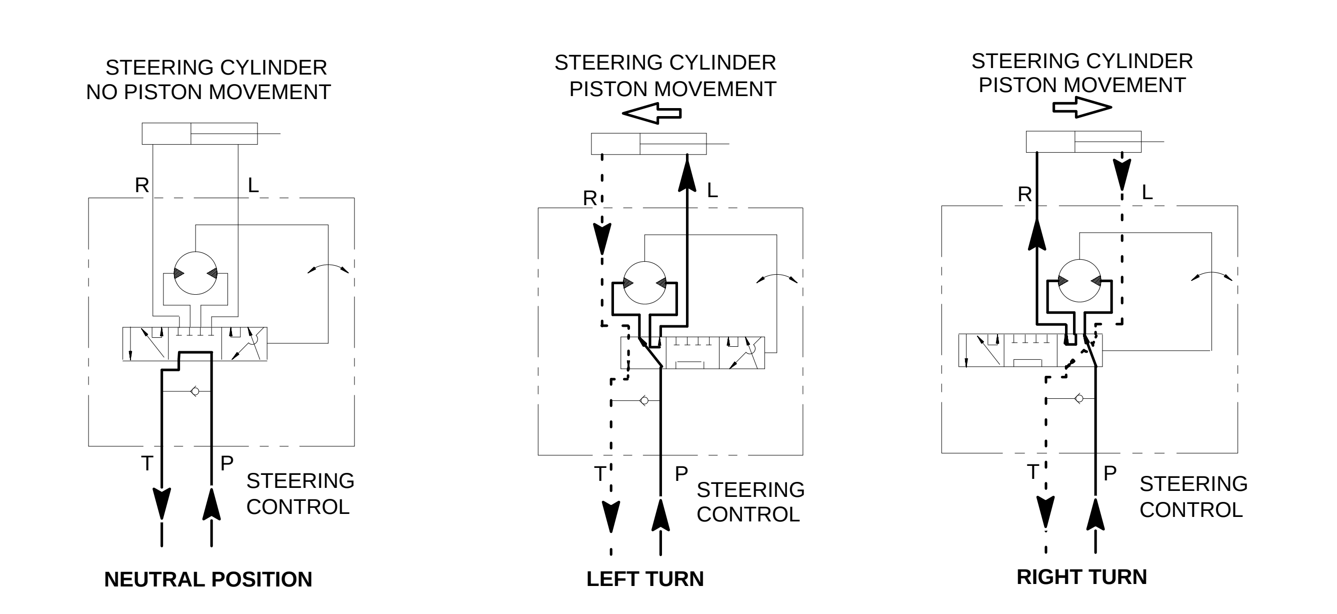


Figure 8

Hydraulic System

Special Tools

Order the following special tools from your Toro Distributor.

Hydraulic Pressure Test Kit

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

Toro Part Number: **TOR47009**

Figure 9

Hydraulic Tester (Pressure and Flow)

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

1. INLET HOSE: A 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 10

O–Ring Kit

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

Toro Part Number: **117–2727**

Figure 11

Hydraulic Test Fitting Kit

This kit includes a variety of O–ring Face Seal fittings to enable the connection of test gauges into the system.

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

Toro Part Number: **TOR4079**

TORO TEST FITTING KIT (TOR4079)

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
	Plug (2 ea.) Size / Toro No. No. 4 — TOR4079-13 No. 6 — TOR4079-14 No. 8 — TOR4079-15 No. 10 — TOR4079-16
	Cap (2 ea.) Size / Toro No. No. 4 — TOR4079-17 No. 6 — TOR4079-18 No. 8 — TOR4079-19 No. 10 — TOR4079-20

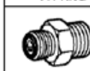
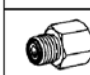
FITTING	TOOL NUMBER
	Union (1 ea.) Size / Toro No. No. 6 to No. 8 — TOR4079-8 No. 10 to No. 8 — TOR4079-2 No. 8 to No. 8 — TOR4079-9
	Reducer (1 ea.) Size / Toro No. No. 10 to No. 8 — TOR4079-7 No. 12 to No. 8 — TOR4079-6
	Test Cap Fitting (2 ea.) Size / Toro No. No. 4 — TOR4079-10 No. 6 — TOR4079-11 No. 8 — TOR4079-21 No. 10 — TOR4079-1
	Test Fitting (2 ea.) Size / Toro No. 7/16–20 ORB — TOR4079-22 1/8" Pipe Thd. — TOR4079-23

Figure 12

Hydraulic System

Troubleshooting

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

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

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

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

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

Problem	Possible Cause
Hydraulic oil leaks	Fitting(s), hose(s) or tube(s) are loose or damaged. O–ring(s) or seal(s) are missing or damaged.
Foaming hydraulic fluid	Oil level in transaxle is incorrect. Hydraulic system has wrong kind of oil. Hydraulic oil is contaminated. The steering pump suction line has an air leak.
Hydraulic system operates hot	Oil level in transaxle is incorrect. Hydraulic hose is kinked. Hydraulic oil is contaminated or incorrect viscosity. Suction screen in transaxle is loose or clogged. Oil constantly forced over relief. Steering pump is worn or damaged. Transaxle or drive train problem (see Drive Train – Chapter 7).
Steering inoperative or sluggish	Engine speed is too low. Oil level in transaxle is incorrect. Steering pump drive belt is loose. Steering cylinder is binding. Steering relief valve is stuck open. Steering control valve is worn or damaged. Pulley key (either on engine or pump) is sheared. Steering cylinder leaks internally. Steering pump is worn or damaged.

Testing

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

CAUTION

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

Before Performing Hydraulic Tests

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

Precautions For Hydraulic Testing

WARNING

Before disconnecting components or performing any work on hydraulic system, all pressure in the system must be relieved by stopping the engine and rotating the steering wheel in both directions.

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

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

2. Put caps or plugs on any hydraulic lines left open or exposed during testing or removal of components.

3. The engine must be in good operating condition. Use a tachometer when making a hydraulic test. Engine speed will affect the accuracy of the tester readings.

4. Because the hydraulic pump is belt driven, check for proper pump belt adjustment before performing any hydraulic test.

5. When using tester with pressure and flow capabilities, the inlet and the outlet hoses must be properly connected and not reversed to prevent damage to tester or components.

6. When using tester with pressure and flow capabilities, completely open load valve in hydraulic tester to minimize the possibility of damaging components.

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

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

9. Check and adjust the oil level in the transaxle 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 transaxle before returning the machine to service.

Steering Pump Flow and Relief Pressure (Using Tester With Pressure Gauges and Flow Meter)

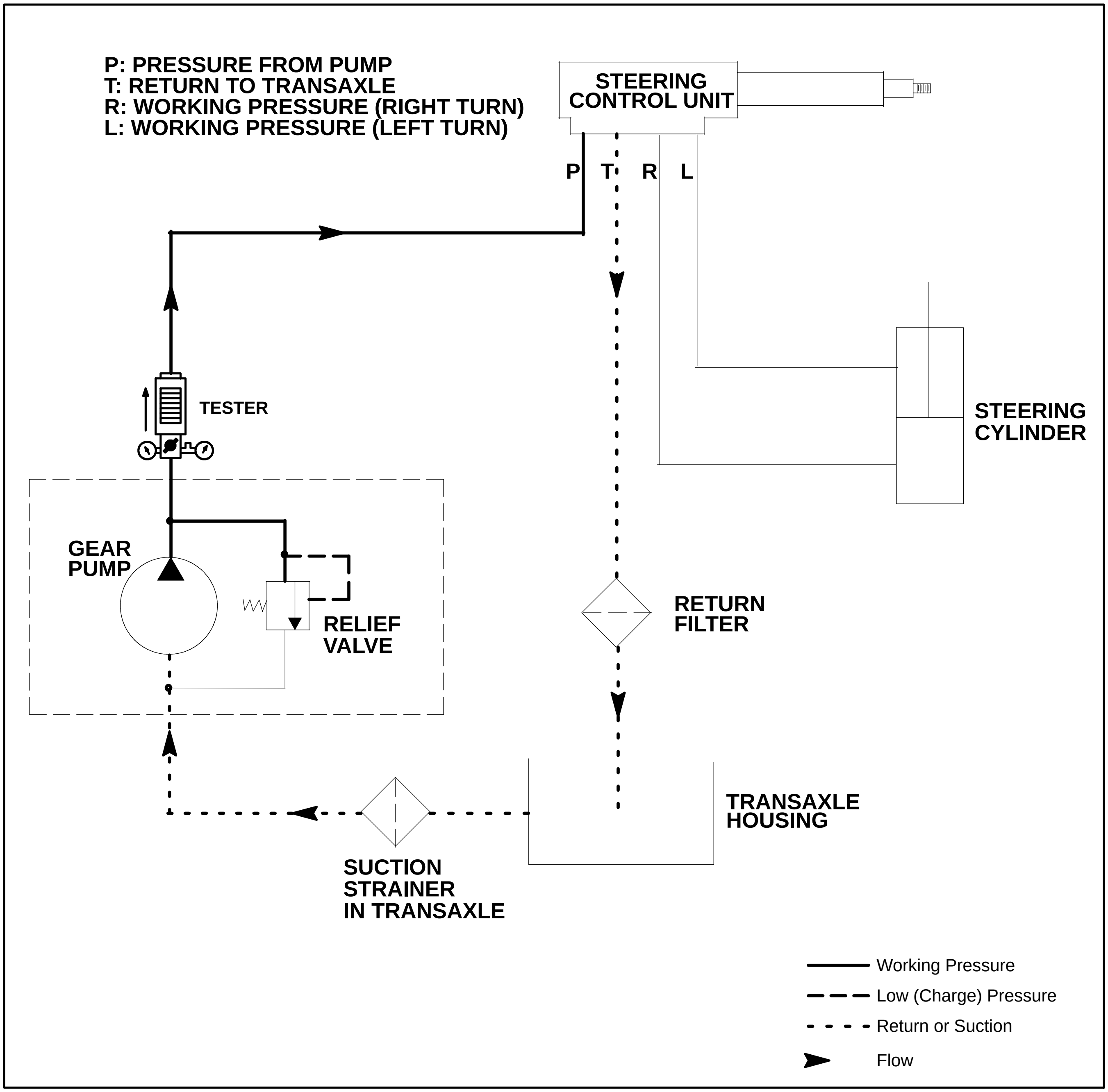


Figure 13

Procedure for Steering Pump Flow and Relief Pressure Test:

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

2. Park machine on a level surface with the spray system off. Apply parking brake and make sure range selector is in the neutral position.

3. Read Precautions For Hydraulic Testing.

4. Make sure that steering pump drive belt is adjusted properly (see Operator's Manual).

CAUTION

Before disconnecting components or performing any work on hydraulic system, all pressure in the system must be relieved by stopping the engine and rotating the steering wheel in both directions.

5. Clean hose fitting and disconnect pressure hose from the top of the steering pump (Fig. 14).

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

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

7. To test steering pump flow:

   A. Start engine and adjust engine speed with accelerator pedal so pump speed is **3450 RPM** (engine speed approximately 3000 RPM). Verify pump speed with a phototac.

   B. Close flow control valve on tester until pressure gauge reads **800 PSI (55 bar)**. Observe flow gauge.

   TESTER READING: Flow approximately **2.7 GPM**.

   C. Release accelerator pedal and turn off machine. Record test result.

8. If pump flow specification is not met, inspect for:

   A. Slipping steering pump drive belt.

   B. Worn, stuck or out of adjustment relief valve.

   C. Pump suction line restriction.

   D. Steering pump needs to be repaired or replaced.

9. To test steering pump 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 **(3275 to 3425 RPM)**.

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

   C. Watch pressure gauge carefully while turning the steering wheel completely in one direction (full steering lock) and holding.

   D. System pressure should be approximately **1000 PSI (69 bar)** as the relief valve lifts. Return steering wheel to the center position.

   E. Release accelerator pedal and turn off machine. Record test results.

10. If relief pressure is incorrect, inspect for:

    A. Slipping steering pump drive belt.

    B. Worn, stuck or out of adjustment relief valve in steering pump.

11. After testing is completed, disconnect tester from steering pump and hose. Reconnect hose to the pump.

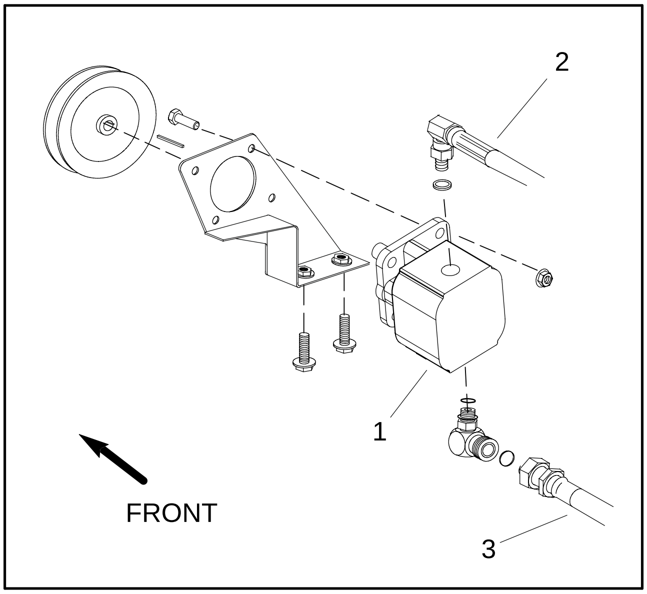


Figure 14

1. **Steering pump**
2. **Pressure hose**
3. **Suction hose**

Steering Control Valve and Steering Cylinder

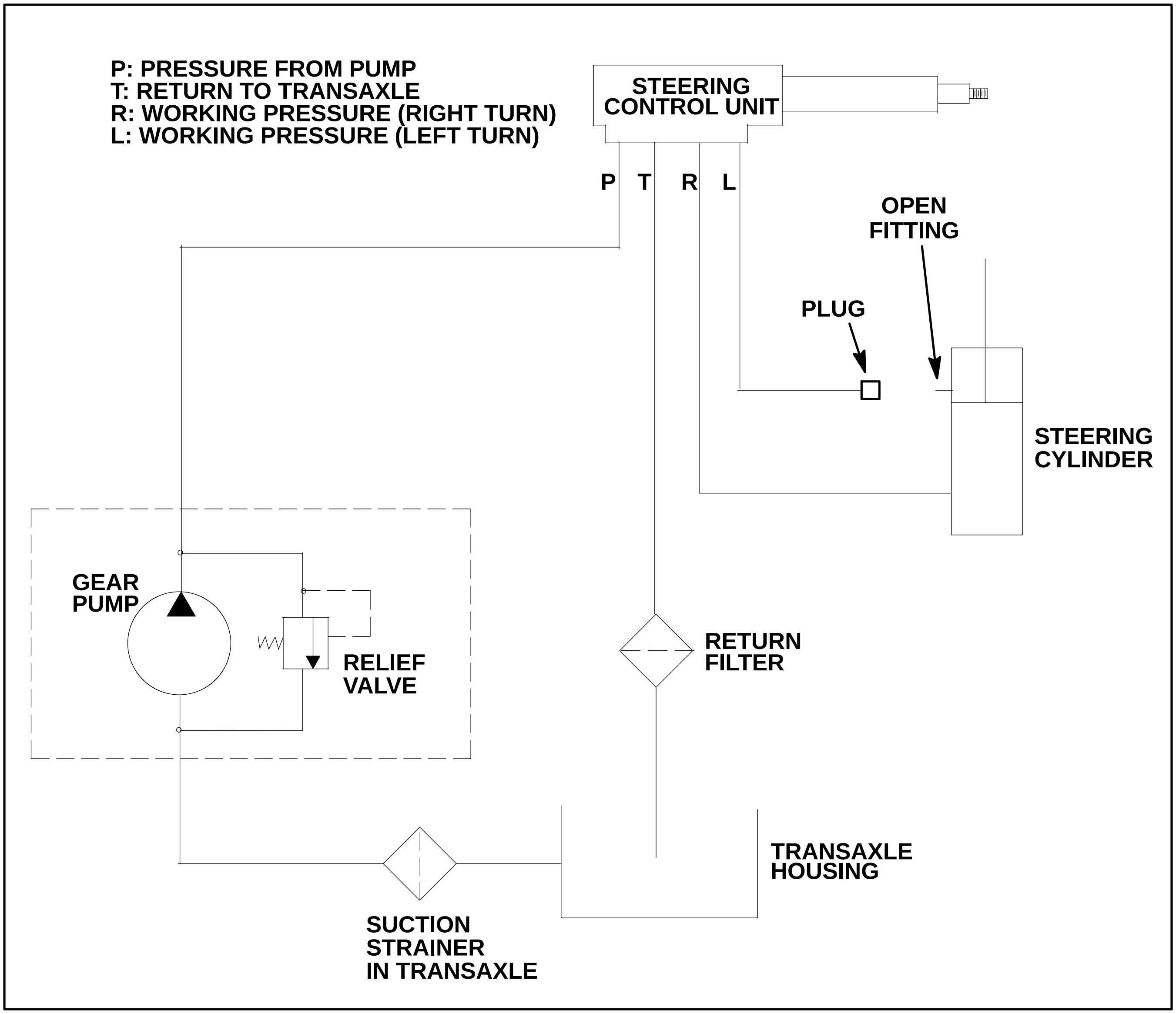


Figure 15

Procedure for Steering Control Valve and Steering Cylinder Test:

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

2. Perform the Steering Pump Relief Pressure and Steering Pump Flow tests to make sure that pump and relief valve are functioning correctly.

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, steering pivot). Make sure that these items are checked before proceeding with any hydraulic testing procedure.

3. Drive machine slowly in a figure eight on a flat level surface.

A. There should be no shaking or vibration in the steering wheel or 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 machine with the engine running. Turn steering wheel with small quick movements in both directions. Let go of the steering wheel after each movement.

A. The steering must immediately return to the neutral position.

B. The steering wheel or front wheels should **not** continue to turn.

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

A. Park machine on a level surface with the spray system turned off.

B. Turn the steering wheel all the way to the right (clockwise) so the steering cylinder rod is fully extended.

C. Turn engine off and engage the parking brake.

D. Read Precautions for Hydraulic Testing.

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

WARNING

Keep body and hands away from disconnected hose and fitting 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 hydraulic hose. Reconnect hose to the steering cylinder.

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

Service and Repairs

General Precautions for Removing and Installing Hydraulic System Components

Before Repair or Replacement of Components

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

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

CAUTION

Before disconnecting components or performing any work on hydraulic system, all pressure in the system must be relieved by stopping the engine and rotating the steering wheel in both directions.

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

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

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

After Repair or Replacement of Components

1. Check oil level in the transaxle and add correct oil if necessary. Drain and refill transaxle and change oil filter if component failure was severe or system is contaminated (see Flush Hydraulic System in this section).

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

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

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

5. After disconnecting or replacing any hydraulic components, operate machine functions slowly until air is out of system (see Hydraulic System Start Up in this section).

6. Check for hydraulic oil leaks. Shut off engine and correct leaks if necessary. Check oil level in transaxle 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 deterioration. Make all necessary repairs before operating machine.

Flush Hydraulic System

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

1. Park machine on a level surface. Stop engine, apply parking brake and remove key from ignition switch.

2. Clean area around filter mounting area (Fig. 16). Remove filter and drain filter into a suitable container. Discard filter.

3. Remove drain plug from transaxle (Fig. 17) and drain transaxle into a suitable container.

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

5. Make sure filter mounting surface is clean. Apply Dexron III ATF to gasket on new filter. Screw filter on until gasket contacts mounting plate, then tighten filter 3/4 turn further.

6. Install all hoses and components.

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

7. Fill transaxle with new hydraulic fluid (see Operator's Manual).

8. Disconnect and ground spark plug wires to prevent engine from starting.

9. Turn ignition key switch to start; engage starter for ten (10) seconds to prime hydraulic pump. Repeat this step again.

10. Connect spark plug wires.

11. Start engine and run at idle speed for a minimum of two (2) minutes.

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

13. Turn steering wheel in both directions several times.

14. Shut off engine and check for oil leaks. Check oil level in transaxle and add correct oil if necessary.

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

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

17. Resume normal operation and follow recommended maintenance intervals.

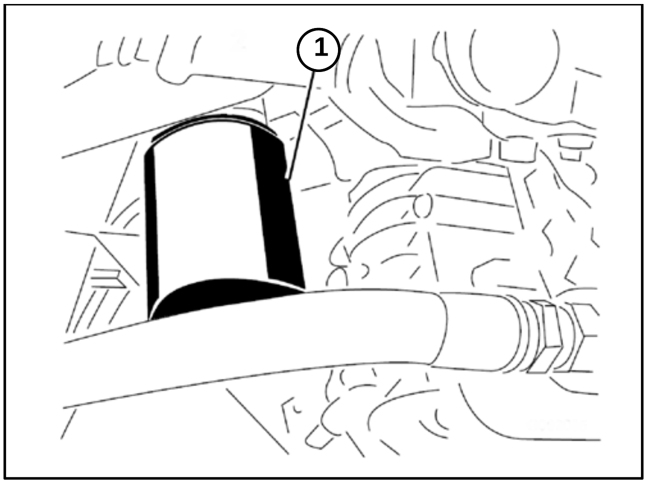


Figure 16

1. Hydraulic filter

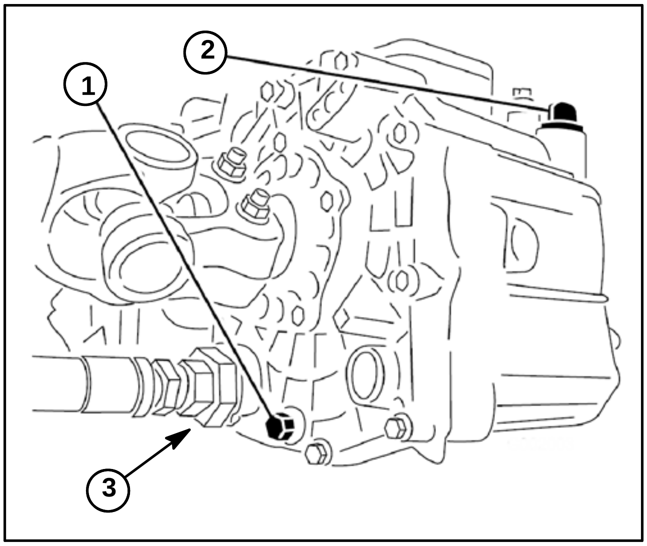


Figure 17

1. Transaxle drain plug
2. Dipstick/filler
3. Strainer

Hydraulic System

Steering Pump Drive Belt

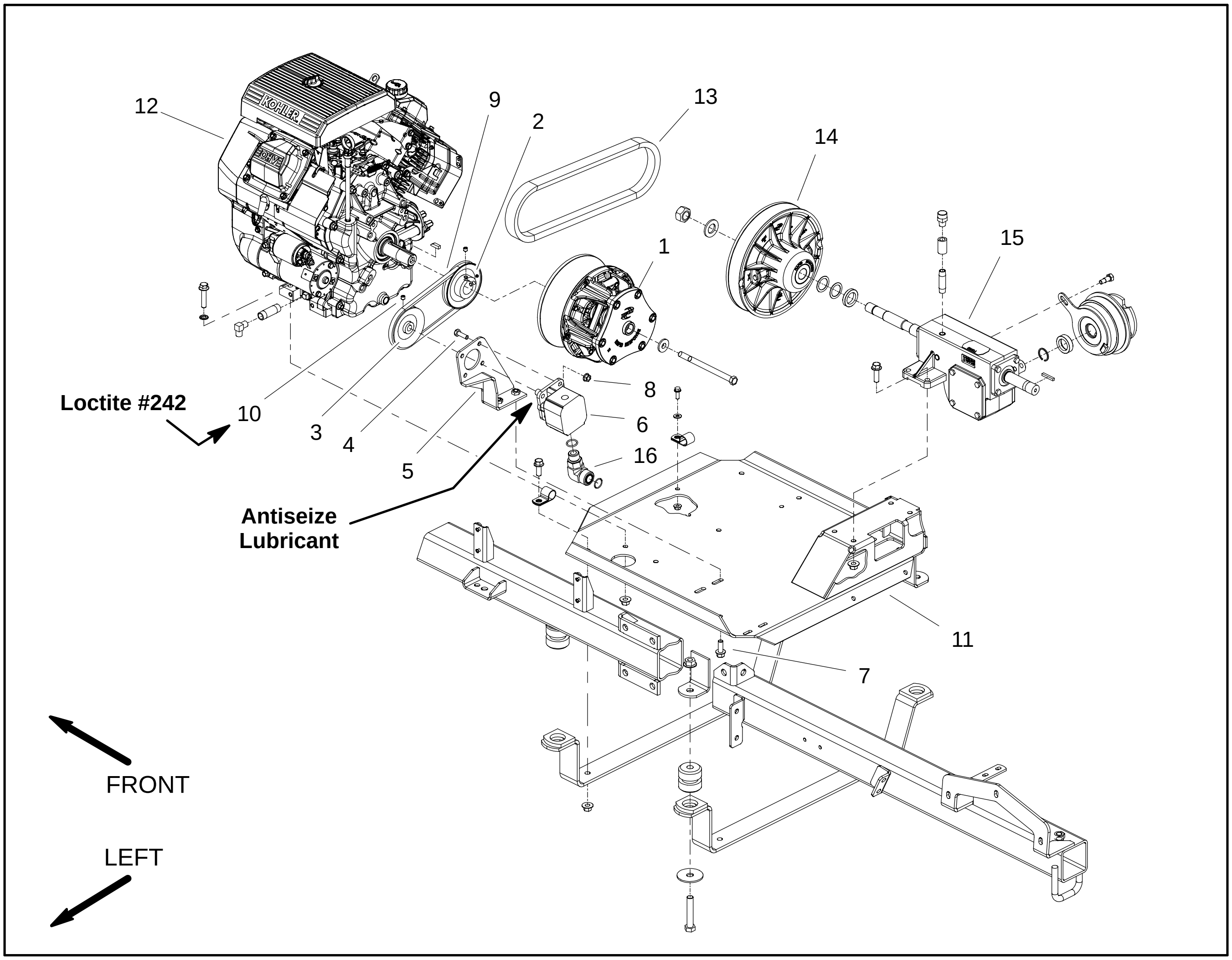


Figure 18

1. **Drive clutch**
2. **Pump drive pulley**
3. **Pump pulley**
4. **Cap screw (4 used)**
5. **Steering pump bracket**
6. **Steering pump**
7. **Flange head screw (2 used)**
8. **Flange nut (4 used)**
9. **Steering pump drive belt**
10. **Set screw (2 used)**
11. **Engine mounting plate**
12. **Engine**
13. **CVT drive belt**
14. **Driven clutch**
15. **Pump drive gearbox**
16. **Hydraulic fitting (suction)**

Steering Pump Drive Belt Removal (Fig. 18)

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

2. Remove CVT drive belt (see CVT Drive Belt Service in Service and Repairs Section of Chapter 7 – Drive Train).

3. From under left side of machine, locate and loosen two (2) flange head screws that secure steering pump bracket to engine mounting plate.

4. Slide pump and pump bracket toward engine crankshaft to allow steering pump drive belt to be removed from pulleys.

Steering Pump Drive Belt Installation (Fig. 18)

1. Install steering pump drive belt to pulleys.

2. Adjust steering pump belt tension (see Operator's Manual).

3. Install CVT drive belt (see CVT Drive Belt Service in Service and Repairs Section of Chapter 7 – Drive Train).

Hydraulic System

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Steering Pump

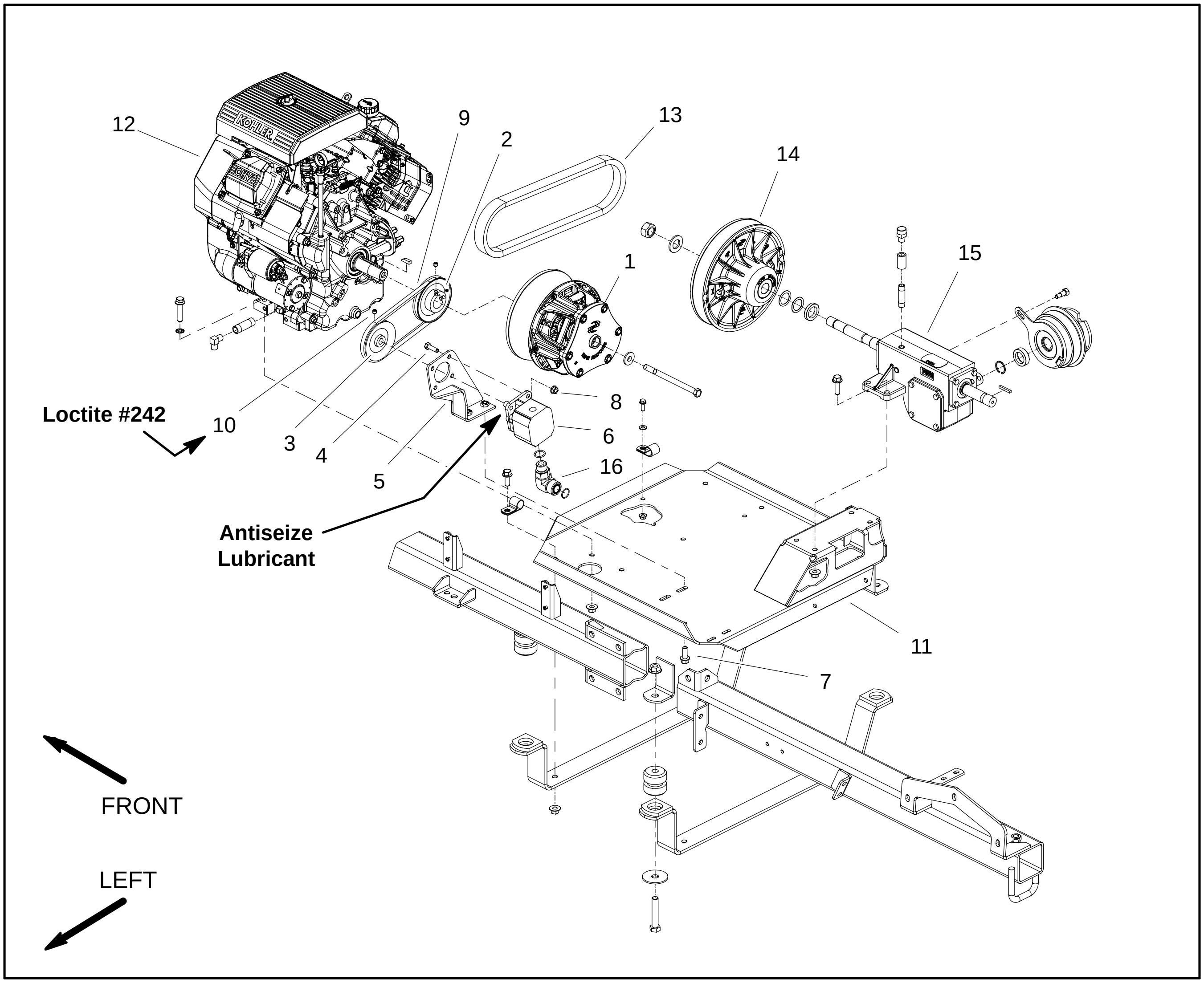

Figure 19

1. **Drive clutch**
2. **Pump drive pulley**
3. **Pump pulley**
4. **Cap screw (4 used)**
5. **Steering pump bracket**
6. **Steering pump**
7. **Flange head screw (2 used)**
8. **Flange nut (4 used)**
9. **Steering pump drive belt**
10. **Set screw (2 used)**
11. **Engine mounting plate**
12. **Engine**
13. **CVT drive belt**
14. **Driven clutch**
15. **Pump drive gearbox**
16. **Hydraulic fitting (suction)**

Removal (Figs. 19 and 20)

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

> **CAUTION**
>
> **Before disconnecting components or performing any work on hydraulic system, all pressure in the system must be relieved by stopping the engine and rotating the steering wheel in both directions.**

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

3. From under left side of machine, disconnect hydraulic hoses connected to the hydraulic pump. Allow hoses to drain into a suitable container. Cap or plug openings of pump and hoses to prevent contamination.

4. Loosen two (2) flange head screws that secure steering pump bracket to engine mounting plate.

5. Remove steering pump drive belt from the pump pulley.

6. Remove two (2) flange head screws from the steering pump bracket. Pull hydraulic pump with pulley and bracket from the machine.

7. Loosen and remove two (2) set screws (item 10) in pulley and remove pulley from the pump shaft. Locate and remove key from pump shaft.

8. Loosen and remove four (4) cap screws and flange nuts that secure pump to pump bracket. Remove pump from bracket.

Installation (Figs. 19 and 20)

1. Position steering pump to pump bracket. Install four (4) cap screws and flange nuts to secure pump to bracket.

2. Make sure the pulley bore and pump shaft are clean. Apply antiseize lubricant to both the pump shaft and the bore of the pulley. Position key to pump shaft.

3. Slide pulley onto shaft with the hub side of the pulley away from the pump. Align pulley with the end of the pump shaft.

4. Apply Loctite #242 to two (2) set screws (item 10). Secure pulley on the pump shaft with set screws.

5. Position hydraulic pump with pulley and bracket to the engine mounting plate. Install two (2) flange head screws through engine mounting plate into pump bracket.

6. Install steering pump belt to the pump pulley.

7. Adjust steering pump belt tension (see Operator's Manual).

8. Remove plugs and caps from pump and hoses that were placed during disassembly. Connect hydraulic hoses to pump.

9. Check fluid level in transaxle and adjust as required.

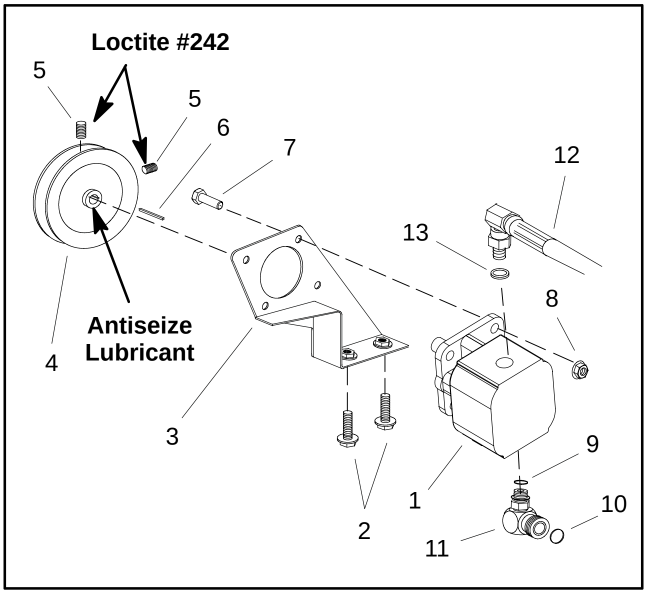

Figure 20

1. **Steering pump**
2. **Flange head screw**
3. **Pump bracket**
4. **Pump pulley**
5. **Set screw (2 used)**
6. **Key**
7. **Cap screw (4 used)**
8. **Flange nut (4 used)**
9. **O-ring**
10. **O-ring**
11. **Suction fitting**
12. **Pressure hose**
13. **O-ring**

Hydraulic System

Steering Pump Service

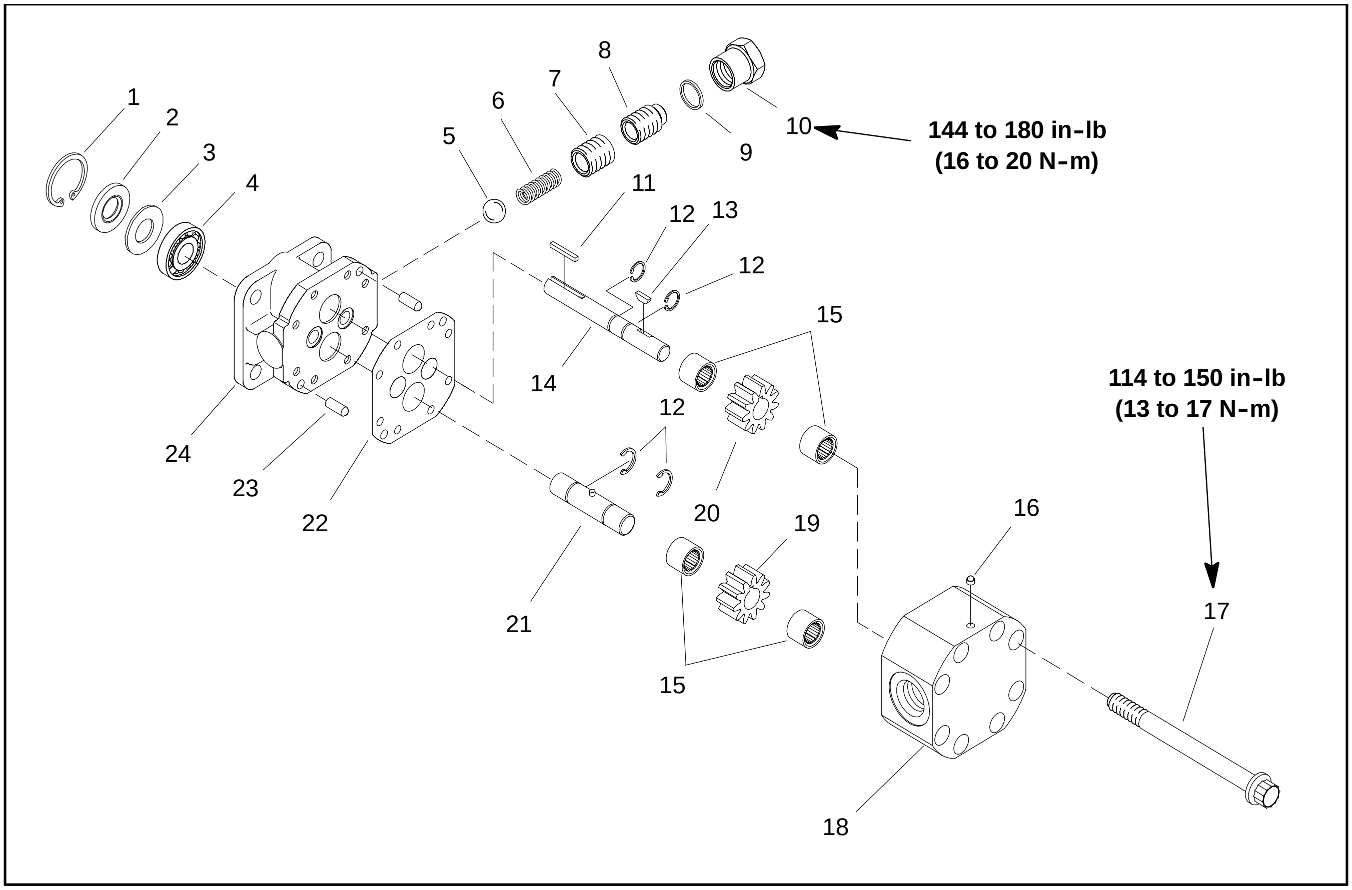

Figure 21

1. **Retaining ring**
2. **Shaft seal**
3. **Spacer**
4. **Ball bearing**
5. **Check ball**
6. **Spring**
7. **Spring**
8. **Adjusting screw**
9. **Gasket**
10. **Cap**
11. **Key**
12. **Crescent ring (4 used)**
13. **Woodruff key**
14. **Drive shaft**
15. **Needle bearing (4 used)**
16. **Plug**
17. **Screw (8 used)**
18. **Gear housing**
19. **Idler gear**
20. **Drive gear**
21. **Idler shaft**
22. **Gasket**
23. **Dowel pin (2 used)**
24. **Stator**

Before performing any service on gear pump, plug ports, wash exterior of pump with cleaning solvent and dry pump thoroughly.

Relief Valve Service (Fig. 21)

1. Remove cap (item 10). Remove and discard gasket (item 9) from cap.

NOTE: Count number of turns it takes to unthread adjusting screw so it can be reinstalled for the same approximate relief pressure setting.

2. Remove adjusting screw (item 8), springs (items 6 and 7) and check ball (item 5).

3. Inspect check ball for burrs or roughness. Inspect relief valve bore and seat inside pump stator (item 24). Inspect springs for damage. Replace any worn or damaged parts.

4. Clean and dry relief valve parts. Apply clean Dexron III ATF to valve parts.

NOTE: Install adjusting screw same number of turns as counted during removal for the same approximate relief pressure setting.

5. Install check ball (item 5), springs (item 6 and 7) and adjusting screw (item 8). Position small end of springs against check ball.

6. Install new gasket (item 9) and cap (item 10). Torque cap from **144 to 180 in-lb (16 to 20 N-m)**.

7. Check pump relief pressure (see Steering Pump Flow and Relief Pressure in the Testing section of this chapter). If adjustment is needed, tighten adjusting screw to increase relief pressure or loosen adjusting screw to reduce relief pressure.

Shaft Seal Replacement (Fig. 21)

IMPORTANT: Do not attempt to pry seal out of pump housing. This can damage the shaft seal bore so oil will leak past the seal.

1. Remove retaining ring (Item 1).

2. Punch two (2) holes in face of shaft seal (item 2), 180° apart, and install metal screws into seal. Remove shaft seal from gear pump by grasping and pulling on screws. Discard shaft seal.

3. Remove spacer (item 3).

4. Thoroughly clean seal bore and drive shaft of pump.

5. Install spacer (item 3) on driveshaft.

6. Apply grease or petroleum jelly to inside diameter of new seal.

7. Use a seal sleeve or tape on drive shaft to protect seal during installation.

8. Position new shaft seal (item 2) onto shaft with part number facing out. Use a seal installation tool to install new seal. Make sure seal is installed square with seal bore and that seal is pressed just below retaining ring groove.

9. Install retaining ring (item 1).

Pump Disassembly (Fig. 21)

1. Remove shaft seal (see Shaft Seal Replacement above) and spacer.

2. Remove relief valve (see Relief Valve Service above).

3. Matchmark the gear housing with the stator for proper orientation of these parts during assembly.

IMPORTANT: Use caution when using a vise to avoid distorting any pump components.

4. Secure flange end of pump in a vise with drive shaft facing down. Use of a vise with soft jaws is recommended to prevent pump damage.

5. Remove eight (8) screws.

6. Support gear housing (item 18) and gently tap housing with a soft face hammer to loosen from stator (item 24). Separate gear housing from stator. Be careful to not drop any parts or disengage gear mesh.

7. Before removing gears (items 19 and 20), apply marking dye to mating teeth to retain “timing” and location for assembly purposes.

8. Remove drive gear (item 20) and woodruff key (item 13) from drive shaft.

9. Remove idler shaft assembly (items 12, 19 and 21) from stator. Remove crescent rings and then idler gear (item 19) from idler shaft.

10. Locate and remove dowel pins (item 23) from stator or gear housing.

IMPORTANT: When removing gasket (item 22) from pump, note gasket color. Use new gasket of same color for assembly.

11. Remove gasket from between gear housing and stator.

12. Press drive shaft and bearing assembly (items 14, 12 and 4) out of stator.

IMPORTANT: When removing bearing and crescent rings from drive shaft, do not slide bearing or crescent rings over seal area of drive shaft.

13. Remove inner crescent ring, then remove bearing and second ring from drive shaft.

Inspection

1. Wash all parts in cleaning solvent.

2. Check all parts for burrs, scoring, nicks, etc.

3. Clean seal bore and drive shaft of pump so they are free of any foreign material.

4. Check needle bearings in stator and gear housing for excessive wear or damage. If gears (items 19 and 20), needle bearings (item 15), gear housing or stator are excessively worn, scored or damaged, replace pump.

5. Check bearing (item 4) for smooth operation. Replace bearing if loose on shaft or noisy when rotated.

6. Inspect woodruff key (item 13) and key slots in shaft for wear or damage and replace parts as necessary.

Pump Assembly (Fig. 21)

IMPORTANT: When installing bearing and crescent rings on drive shaft, do not slide bearing or crescent rings over seal area of drive shaft.

1. Install outer crescent ring on drive shaft (item 14), then install bearing (item 4) and second crescent ring. Slide drive shaft and bearing assembly into stator.

2. Install spacer (item 3) on drive shaft. Then install new seal (item 2) (see Shaft Seal Replacement above) and secure with retaining ring (item 1).

3. Install woodruff key (item 13), then apply clean Dexron III ATF to drive gear (item 20) and install to drive shaft.

4. Install one crescent ring to idler shaft (item 21), then install idler gear (item 19) and second crescent ring. Apply clean Dexron III ATF to gear and idler shaft assembly, then install into stator maintaining the original timing and locations.

5. Install new gasket (item 22) onto stator. Use same color gasket as the removed gasket.

6. Install dowel pins (item 23). Assemble gear housing to stator using the matchmark made during disassembly. Install screws and tighten in a crossing pattern from **114 to 150 in-lb (13 to 17 N-m)**.

7. Install relief valve (see Relief Valve Service above).

8. Place a small amount of Dexron III ATF in pump inlet and rotate pump one revolution. If binding is noted, disassemble pump and check for assembly problems.

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Steering Control Valve

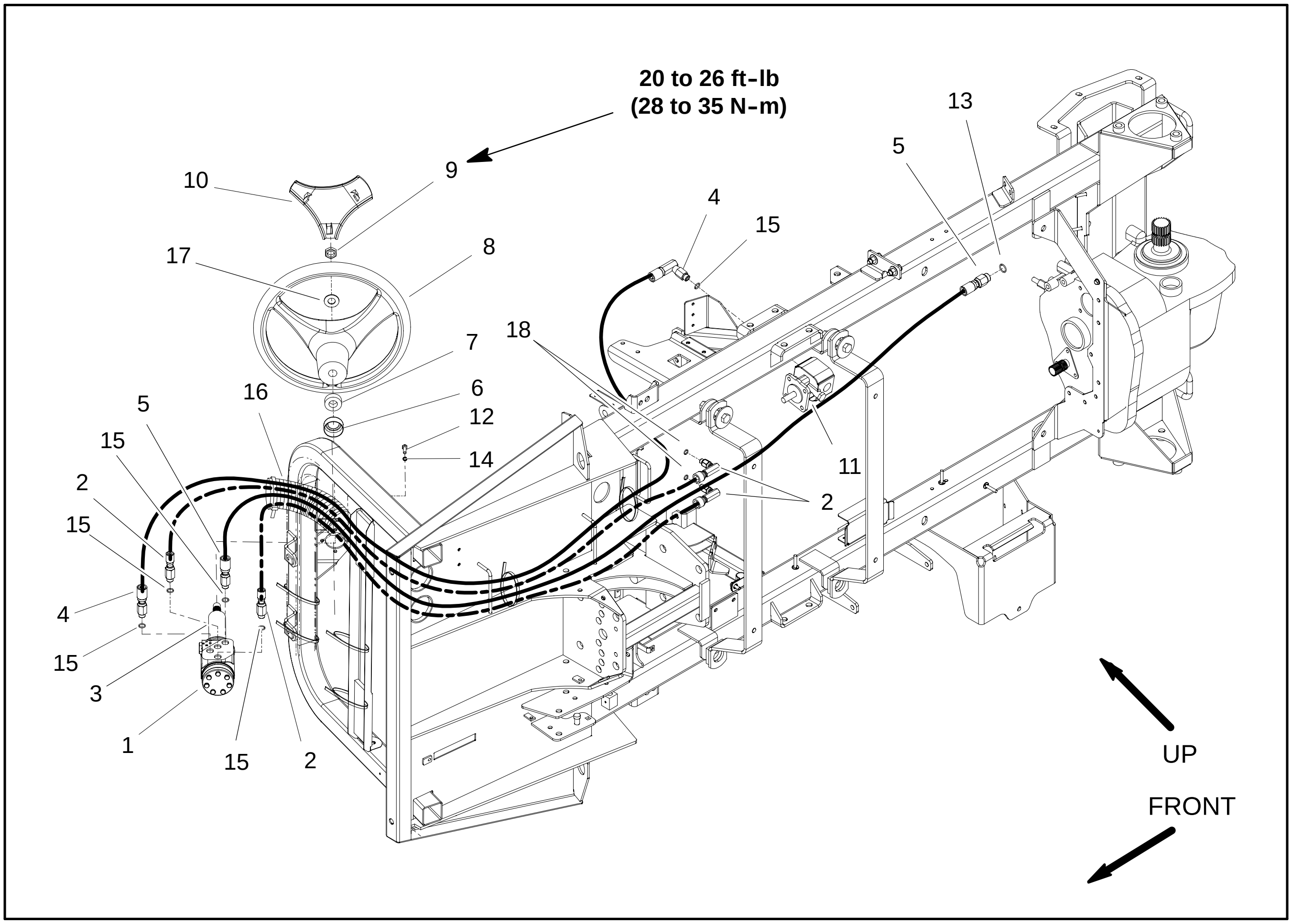

Figure 22

1. Steering control valve	**7. Dust cover**	**13. O-ring**
2. Hydraulic hose (2 used)	**8. Steering wheel**	**14. Lock washer (4 used)**
3. Steering column	**9. Hex nut**	**15. O-ring**
4. Hydraulic hose	**10. Steering wheel cover**	**16. Hose cover**
5. Hydraulic hose	**11. Steering pump**	**17. Flat washer**
6. Steering seal	**12. Cap screw (4 used)**	**18. O-ring**

Removal (Fig. 22)

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

2. Remove screws that secure dash panel to front hood (Fig. 23). Carefully slide dash panel up steering column to allow access to steering control valve.

CAUTION

Before disconnecting components or performing any work on hydraulic system, all pressure in the system must be relieved by stopping the engine and rotating the steering wheel in both directions.

3. Label all hydraulic hoses for assembly purposes (Fig. 24). Clean hydraulic hose ends prior to disconnecting the hoses from the steering control valve.

4. Disconnect hydraulic hoses connected to the steering control valve. Allow hoses to drain into a suitable container. Cap or plug openings of control valve and hoses to prevent contamination.

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

6. Loosen and remove four (4) cap screws and lock washers that secure steering column and steering control valve to machine frame.

7. Slide steering column from control valve. Remove control valve from machine.

Installation (Fig. 22)

1. Position steering control valve to frame. Slide steering column to control valve. Secure steering column and control valve to frame with four (4) cap screws and lock washers.

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

3. Using labels placed during removal, connect hydraulic hoses to steering control valve (Fig. 24). Tighten hose connections (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

4. Position dash panel to front hood and secure with removed fasteners (Fig. 23).

5. Check fluid level in transaxle and adjust as required (see Operator's Manual).

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

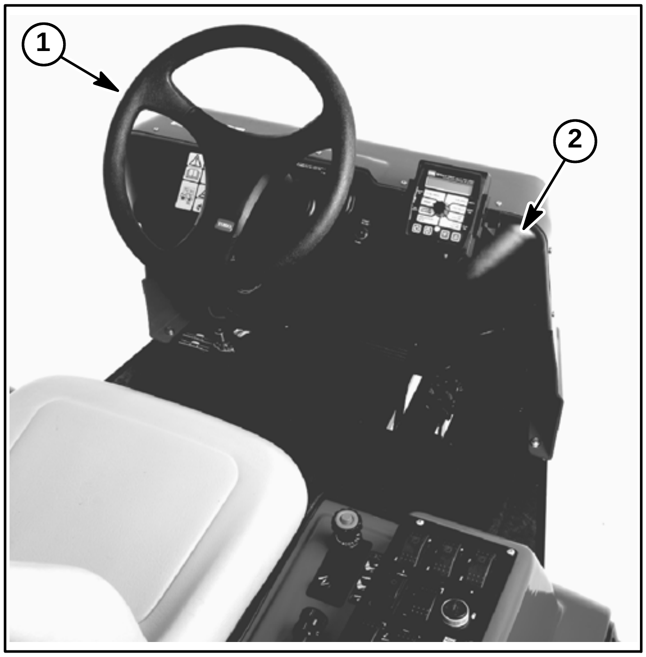

Figure 23

1. **Steering wheel**
2. **Dash panel**

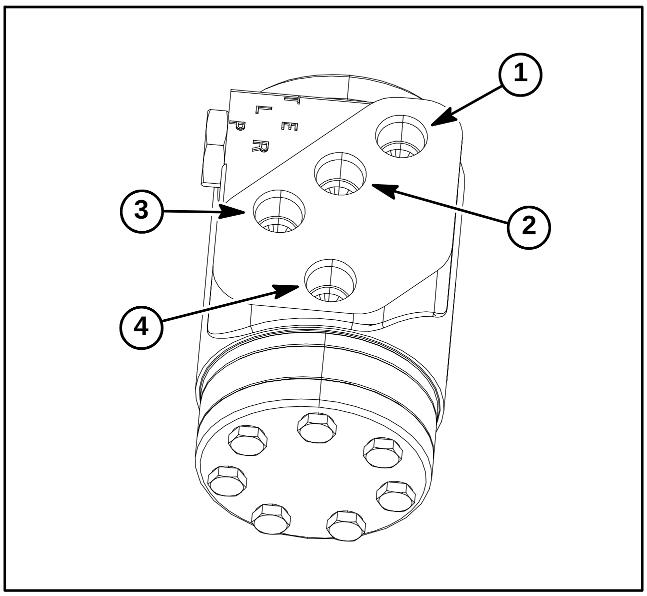

Figure 24

1. **T port (hose to oil filter)**
2. **L port (hose to rod end of steering cylinder)**
3. **P port (hose to steering pump)**
4. **R port (hose to barrel end of steering cylinder)**

Steering Control Valve Service

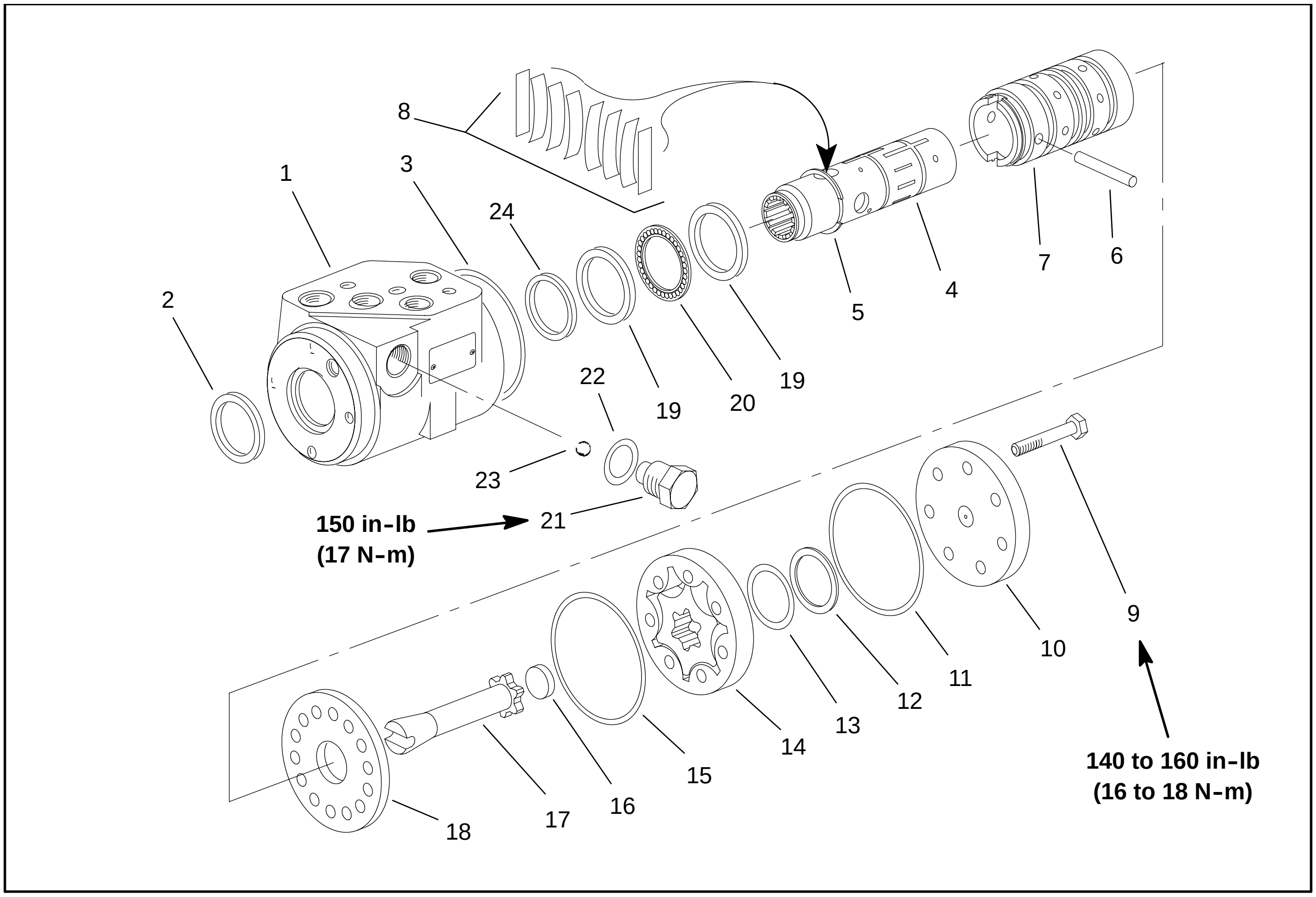

Figure 25

1. **Steering valve housing**
2. **Dust seal**
3. **O-ring**
4. **Spool**
5. **Spring retaining ring**
6. **Pin**
7. **Sleeve**
8. **Centering springs/spacers**
9. **Cap screw (7 used)**
10. **End cap**
11. **O-ring**
12. **Seal ring**
13. **O-ring**
14. **Geroter assembly**
15. **O-ring**
16. **Spacer**
17. **Geroter drive**
18. **Wear plate**
19. **Bearing race**
20. **Thrust bearing**
21. **Plug**
22. **O-ring**
23. **Check ball**
24. **Quad seal**

Control Valve Disassembly (Fig. 25)

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

1. Remove the seven cap screws from the steering valve assembly.

2. Remove end cap, geroter, spacer, geroter drive, wear plate, seal ring and O-rings (items 11, 13 and 15) from housing.

3. Remove the plug, O-ring and check ball from the housing.

4. Slide the spool and sleeve assembly from the housing.

5. Remove the thrust bearing and two (2) bearing races.

6. Remove the quad seal.

7. Use a small blade screwdriver to carefully pry the dust seal from the housing. Be careful to not damage the dust seal seat in the housing.

8. Remove the pin (item 6) that holds the spool and sleeve together.

9. Carefully slide the spool out of the sleeve. The centering springs and spring retaining ring will stay with the spool as it is removed.

CAUTION

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

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

Control Valve Assembly (Fig. 25)

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

NOTE: Always use new seals and O–rings when assembling the steering control valve.

IMPORTANT: During assembly, lubricate the new seals with petroleum jelly. Also, lubricate machined surfaces and bearings with clean Dexron III ATF.

1. Install the quad seal:

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

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

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

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

   E. Remove the sleeve and bearing race.

2. Lubricate and install the dust seal.

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

4. Fit the retaining ring over the centering springs.

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

6. Install the pin.

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

8. Put the thrust bearing and bearing races into the housing. The thrust bearing goes between the two bearing races (Fig. 26).

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

9. Apply a light coating of clean Dexron III ATF to the spool and sleeve assembly. Carefully slide the assembly into the housing.

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

11.Lubricate and install a new O-ring (item 3) in the groove in the housing.

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

NOTE: The holes in the wear plate are symmetrical.

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

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

15.Install the gerotor and align the screw holes.

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

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

18.Install the spacer.

19.Install the end cap and seven (7) cap screws. Tighten the cap screws, in a crossing pattern, from **140 to 160 in-lb (16 to 18 N–m)**.

20.Remove the steering control unit from the vise.

21.Install the check ball and plug with O–ring. Tighten the plug to **150 in-lb (17 N–m)**.

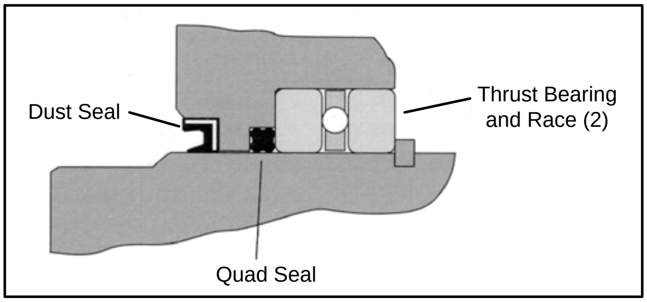

Figure 26

Hydraulic System

Steering Cylinder

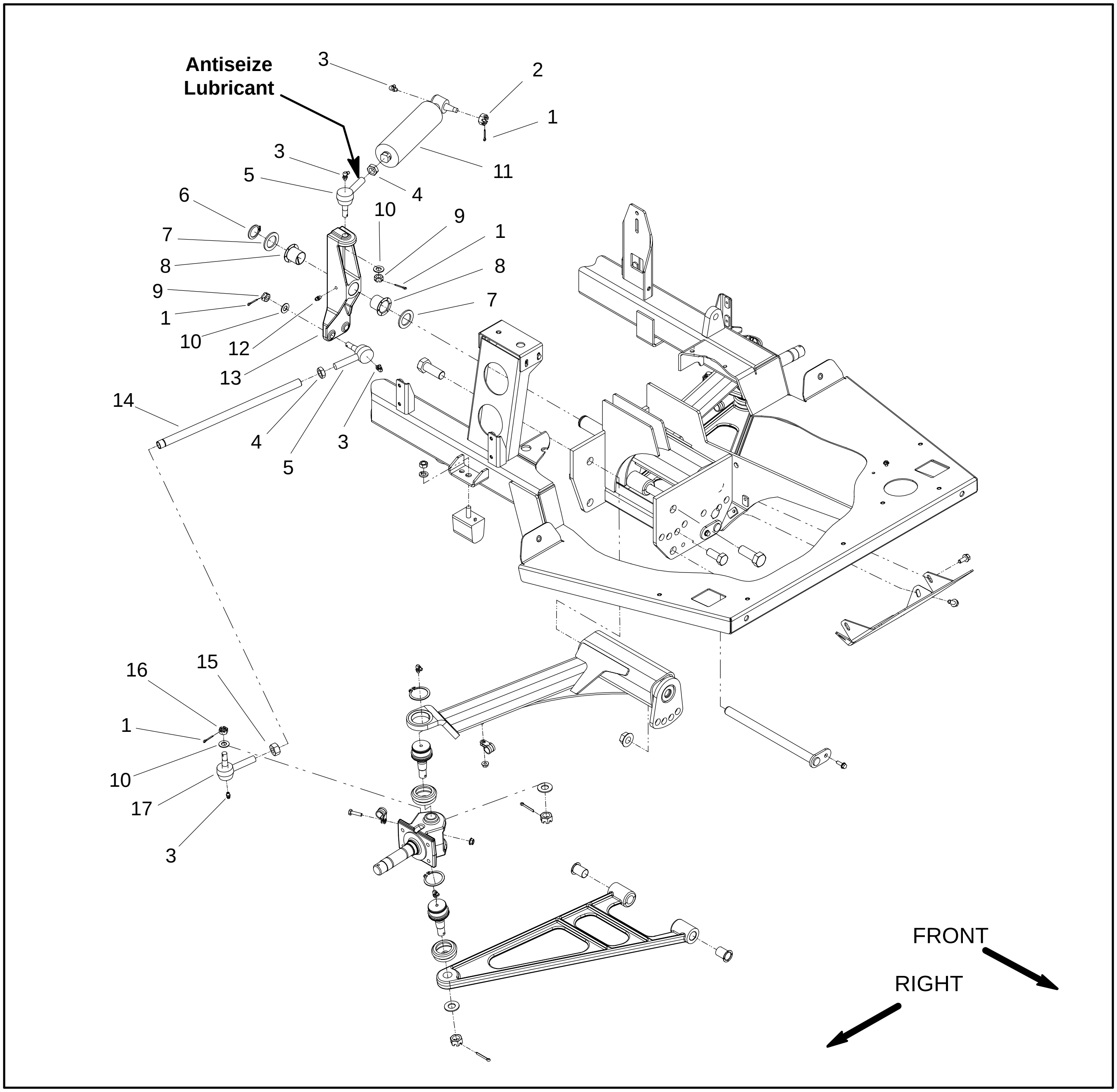

Figure 27

1. Cotter pin
2. Slotted hex nut
3. Grease fitting
4. Jam nut
5. Tie rod end
6. Retaining ring
7. Thrust washer
8. Bearing
9. Slotted hex nut
10. Flat washer
11. Steering cylinder
12. Grease fitting
13. Steering pivot
14. Tie rod (RH shown)
15. Jam nut (LH thread)
16. Slotted hex nut
17. Tie rod end (LH thread)

Removal (Fig. 27)

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

2. Lower the engine mounting plate assembly from machine (see Engine Mounting Plate Assembly Removal in the Service and Repairs Section of Chapter 3 – Kohler Gasoline Engine).

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

CAUTION

Before disconnecting components or performing any work on hydraulic system, all pressure in the system must be relieved by stopping the engine and rotating the steering wheel in both directions.

4. Disconnect hydraulic hoses from steering cylinder (Fig. 28). Allow hoses to drain into a suitable container.

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

6. Remove cotter pin and hex slotted nut that secure the barrel end of the steering cylinder to the frame.

7. Remove cotter pin, flat washer and hex slotted nut that secure the shaft end of the steering cylinder to the steering pivot.

8. Remove steering cylinder from machine.

9. If rod end is removed from cylinder shaft, count number of revolutions it takes to remove from shaft so rod end can be re–installed without affecting steering.

Installation (Fig. 27)

1. If rod end was removed from cylinder shaft, apply antiseize lubricant to threads of rod end. Install rod end onto shaft the same number of revolutions needed to remove rod end. Secure rod end with jam nut.

2. Position shaft end of cylinder to the steering pivot. Install flat washer and slotted hex nut finger tight to rod end.

3. Position barrel end of cylinder to the frame. Install slotted hex nut finger tight to barrel rod end.

4. Tighten slotted hex nuts to secure cylinder rod ends. Install cotter pins.

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

6. Connect hydraulic hoses to steering cylinder (Fig. 28). Tighten hose connections (see Hydraulic Hose and Tube Installation in the General Information section of this chapter).

7. Check fluid level in transaxle and adjust as required (see Operator's Manual).

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

9. Raise the engine mounting plate assembly to machine (see Engine Mounting Plate Assembly Installation in the Service and Repairs Section of Chapter 3 – Kohler Gasoline Engine).

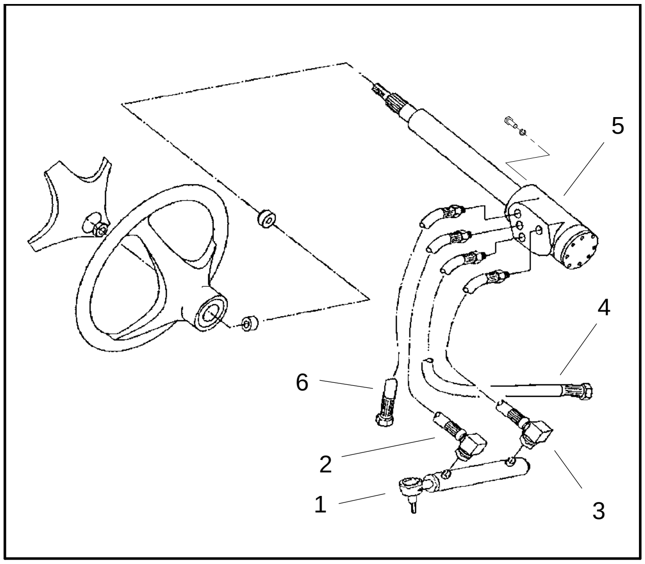

Figure 28

1. **Steering cylinder**
2. **Hyd hose (Left turn)**
3. **Hyd hose (Right turn)**
4. **Hyd hose (from pump)**
5. **Steering control valve**
6. **Hyd hose (to filter)**

Hydraulic System

Steering Cylinder Service

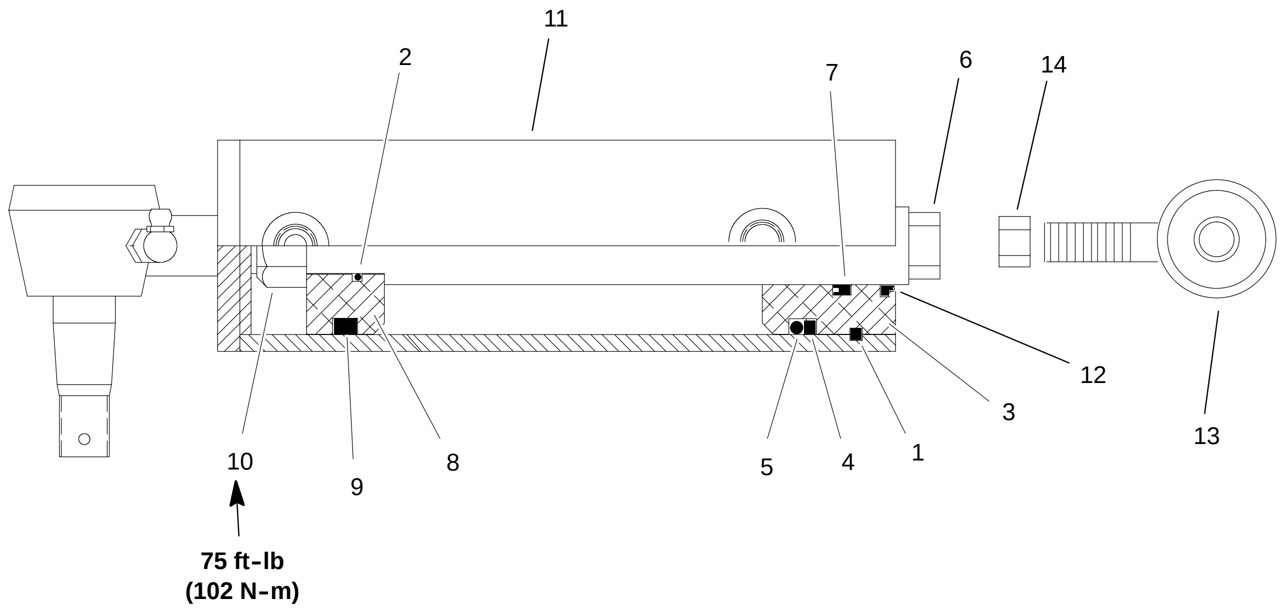

Figure 29

1. **Retaining ring**
2. **O-ring**
3. **Head**
4. **Backup ring**
5. **O-ring**
6. **Shaft**
7. **Rod seal**
8. **Piston**
9. **Uni-ring**
10. **Lock nut**
11. **Barrel**
12. **Dust seal**
13. **Ball joint**
14. **Jam nut**

Disassembly (Fig. 29)

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

IMPORTANT: Prevent damage when clamping the hydraulic cylinder into a vise. Do not close vise enough to distort the barrel.

2. Mount end of steering cylinder in a vise with soft jaws. Remove retaining ring.

   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.

3. Remove plugs from ports. Extract shaft, head and piston by carefully twisting and pulling on the shaft.

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

4. Mount shaft securely in a vise by clamping on the end of the shaft. Remove lock nut and piston from the shaft. Slide head off the shaft.

5. Remove Uni–ring and O–ring from the piston.

6. Remove O–ring, back–up ring, rod seal and dust seal from the head.

Assembly (Fig. 29)

1. Make sure all parts are clean before assembly.

2. Coat new O–rings, Uni–ring, rod seal and back–up ring with with clean Dexron III ATF.

   A. Install Uni–ring and O–ring to the piston.

   B. Install O–ring, back–up ring, rod seal and dust seal to the head.

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

3. Mount shaft securely in a vise by clamping on the end of the shaft.

   A. Coat shaft with a light coat of clean Dexron III ATF.

   B. Slide head assembly onto the shaft. Install piston and lock nut onto the shaft. Torque lock nut to **75 ft–lb (102 N–m)**.

   C. Remove shaft from the vise.

   IMPORTANT: Prevent damage when clamping the hydraulic cylinder into a vise. Do not close vise enough to distort the barrel.

4. Mount end of the barrel in a vise.

5. Coat all internal parts with a light coat of clean Dexron III ATF. Slide piston, shaft and head assembly into the barrel being careful to not damage the seals.

6. Secure head into the 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 barrel access slot.

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Chapter 5

Electrical System

Table of Contents

General Information

Operator’s Manual

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

Electrical Drawings

The electrical schematics and wire harness drawings for the Multi Pro 1200 and Multi Pro 1250 are located in Chapter 10 – Electrical Diagrams.

Special Tools

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

Multimeter

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

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

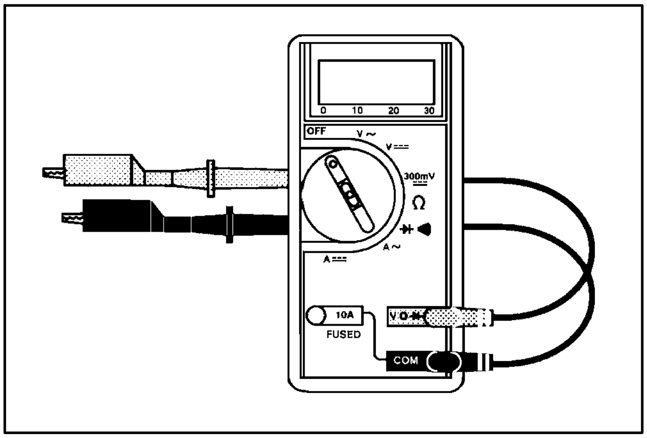


Figure 1

Skin–Over Grease

Special non–conductive grease which forms a light protective skin to help waterproof electrical switches and contacts.

Toro Part Number: **TOR50547**

Figure 2

Dielectric Gel

Dielectric gel should be used to prevent corrosion of 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 Connect harness connector to component. Connectors should be thoroughly packed with gel for effective results.

Toro Part Number: **107–0342**

Figure 3

Battery Terminal Protector

Aerosol spray that should be used on battery terminals to reduce corrosion problems. Apply terminal protector after the battery cable has been secured to the battery terminal.

Toro Part Number: **107–0392**

Figure 4

Spray Pro Monitor Tester

Used to test the inputs and power leads to the Spray Pro Monitor on Multi Pro 1200 and 1250 sprayers. Tests monitor functions by simulating sprayer operation.

Toro Part Number: **TOR6001**

Figure 5

Troubleshooting

> **CAUTION**
>
> **Remove all jewelry, especially rings and watches, before doing any electrical trouble-shooting or testing. Disconnect the battery cables unless the test requires battery voltage.**

For effective troubleshooting and repairs, you must have a good understanding of the electrical circuits and components used on this machine (see Chapter 10 – Electrical Diagrams).

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

Starting Problems

Problem	Possible Causes
Starter solenoid clicks, but starter will not crank (if solenoid clicks, problem is not in safety interlock system).	Battery is discharged. Battery cables are loose or corroded. Battery ground to frame is loose or corroded. Wiring at starter is faulty. Starter solenoid is faulty. Starter mounting bolts are loose or not supplying a sufficient ground for solenoid. Starter is faulty.
Nothing happens when start attempt is made.	Range selector lever is not in the neutral position. Battery cables are loose or corroded. Battery ground cable to frame is loose or corroded. Battery is discharged or faulty. Main fuse (30 amp) is faulty. Wiring to start circuit components is loose, corroded or damaged (see Chapter 10 – Electrical Diagrams). Neutral switch is faulty. Ignition switch is faulty. Fuse block is faulty. Starter solenoid is faulty.

Starting Problems (continued)

Problem	Possible Causes
Engine cranks, but does not start.	Ignition switch is faulty. Circuit wiring to engine magneto is grounded (see Chapter 10 – Electrical Diagrams). Circuit wiring to carburetor solenoid is loose, corroded or damaged (see Chapter 10 – Electrical Diagrams). Engine or fuel system is malfunctioning (see Chapter 3 – Kohler Gasoline Engine). Engine may be too cold.
Engine cranks (but should not) with the range selector lever out of the neutral position.	Neutral switch wiring is faulty (see Chapter 10 – Electrical Diagrams). Neutral switch is faulty.

General Run Problems

Problem	Possible Causes
Battery does not charge.	Wiring to the charging circuit components is loose, corroded or damaged (see Chapter 10 – Electrical Diagrams). Alternator components are faulty. Battery is faulty.
Engine stops during machine operation.	Ignition switch is faulty. Circuit wiring to engine magneto is damaged (see Chapter 10 – Electrical Diagrams). Circuit wiring to carburetor solenoid is loose, corroded or damaged (see Chapter 10 – Electrical Diagrams). Engine or fuel system is malfunctioning (see Chapter 3 – Kohler Gasoline Engine).

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^{o} to 100^{o} F (16^{o} to 38^{o} 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.

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

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

Charging System Test

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

Tool required: Digital multimeter set to DC volts.

Test instructions: 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 (3275 to 3425 RPM). Allow the battery to charge for at least three (3) minutes. Record the battery voltage.

Test results should be **at least 0.50 volt over initial battery voltage.** Example:

Initial Battery Voltage	= 12.30 v
Battery Voltage after 3 Minute Charge	= 12.95 v
Difference	= +0.65 v

NOTE: Typical battery voltage while the engine is running during this test should be 13.5 to 14.5 volts.

Check Operation of Neutral Switch

CAUTION

Do not disconnect neutral switch. It is for the operator's protection. Check the operation of the neutral switch daily for proper operation. Replace a malfunctioning switch before operating the machine.

Neutral switch operation is described in the Multi Pro 1200 and 1250 Operator's Manual. Testing of this switch is included in the Component Testing section of this chapter.

Component Testing

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

NOTE: For engine component testing information, see the Kohler Engine Service Manual at the end of Chapter 3 – Kohler Gasoline Engine.

CAUTION

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

Ignition Switch

The ignition (key) switch has three positions (OFF, RUN and START) (Fig. 6). The terminals are marked as shown in Figure 7.

Testing

The circuitry of the ignition switch is shown in the following chart. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each switch position.

Unplug wire harness connectors from switch and verify continuity between switch terminals. Connect the harness connectors to the switch after testing.

POSITION	CIRCUIT
OFF	G + M + A
RUN	B + L + A
START	B + L + S

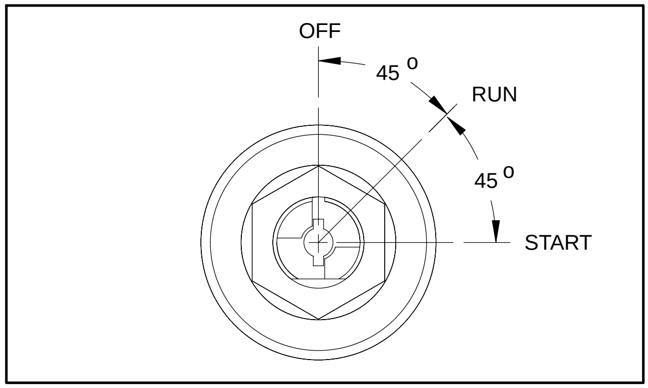


Figure 6

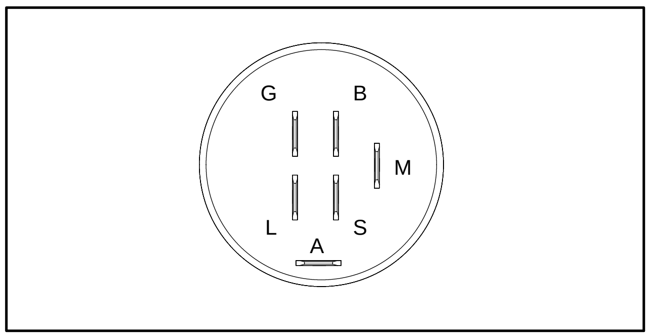


Figure 7

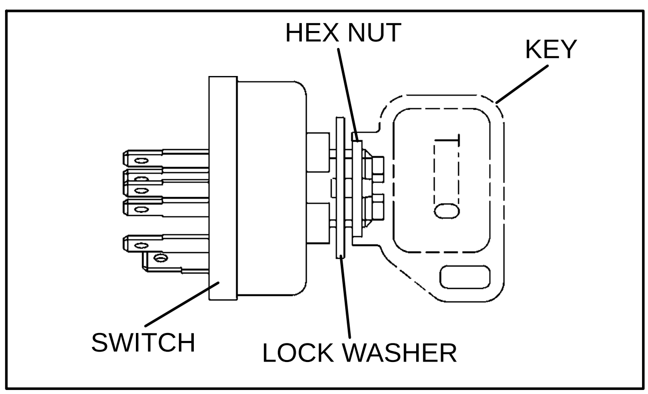


Figure 8

Start, Neutral Engine Speed Lock, Spray Pump Clutch, Boom Actuator and Spray Valve Relays

The start, neutral engine speed lock, spray pump clutch and boom actuator relays are used on both the Multi Pro 1200 and Multi Pro 1250. The Multi Pro 1250 uses an additional three (3) relays for the spray valve system. All of the relays are located under the operator seat (Fig. 9). The relays are all identical and can be identified by a tag at the relay wire harness connector.

Testing

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

2. Raise operator seat and locate the relay to be tested. Disconnect wire harness connector from relay and remove relay from panel.

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

3. Using a multimeter (ohms setting), measure coil resistance between terminals 85 and 86 (Fig. 10). Resistance should be between 70 and 90 ohms.

4. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay terminals 30 and 87 should have continuity as +12 VDC is applied to terminal 85. The relay terminals 30 and 87 should not have continuity as +12 VDC is removed from terminal 85.

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

6. Connect multimeter (ohms setting) leads to relay terminals 30 and 87A. With terminal 86 grounded, apply +12 VDC to terminal 85. The relay terminals 30 and 87A should not have continuity as +12 VDC is applied to terminal 85. The relay terminals 30 and 87A should have continuity as +12 VDC is removed from terminal 85.

7. When testing is completed, disconnect voltage and multimeter leads from the relay terminals. Replace relay if necessary.

8. Secure relay to machine panel and connect wire harness to relay. Lower operator seat.

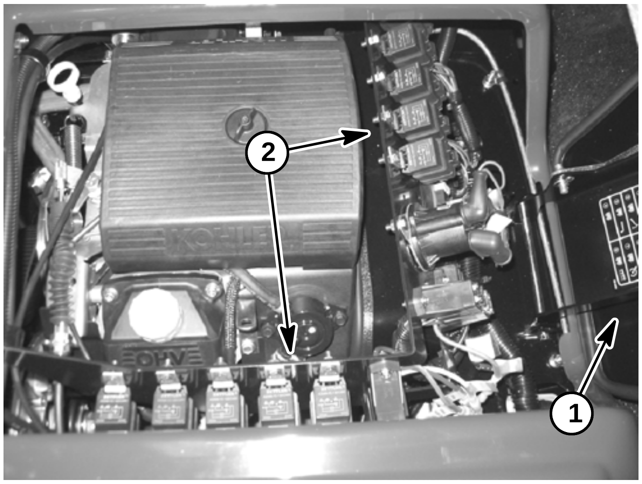


Figure 9

1. **Operator seat (raised)**
2. **Relay location**

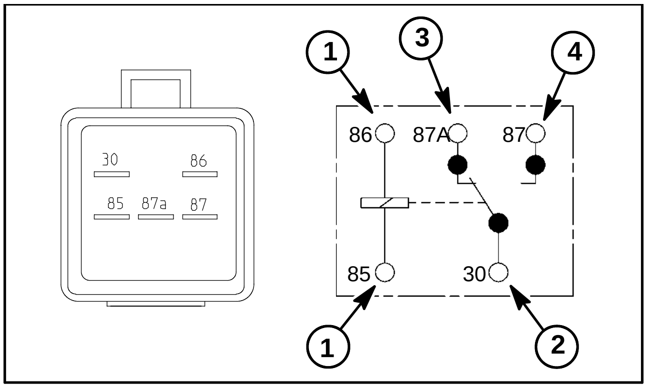


Figure 10

1. **Coil terminal**
2. **Common terminal**
3. **Normally closed term.**
4. **Normally open term.**

Electrical System

Neutral Switch

The neutral switch is attached to the shift lever assembly (Fig. 11). The switch is a normally open proximity switch that is closed when the shift lever is in the neutral position. The neutral switch allows engine cranking/starting only when the machine is in neutral.

Testing

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

2. Locate neutral switch on the shift lever assembly. If needed, remove air cleaner cover to ease access to switch. Disconnect the wire harness connector from the switch.

3. Check the continuity of the switch by connecting a multimeter (ohms setting) across the connector terminals.

4. With the shift lever in the neutral position, the neutral switch should be closed (continuity).

5. Depress the brake pedal to allow the shift lever to move. While watching the multimeter, move the shift lever out of the neutral position. Continuity of the neutral switch should be broken as the lever is moved and the interlock switch opens.

6. If necessary, replace switch.

7. Connect the wire harness connector to the switch.

8. If removed, install air cleaner cover.

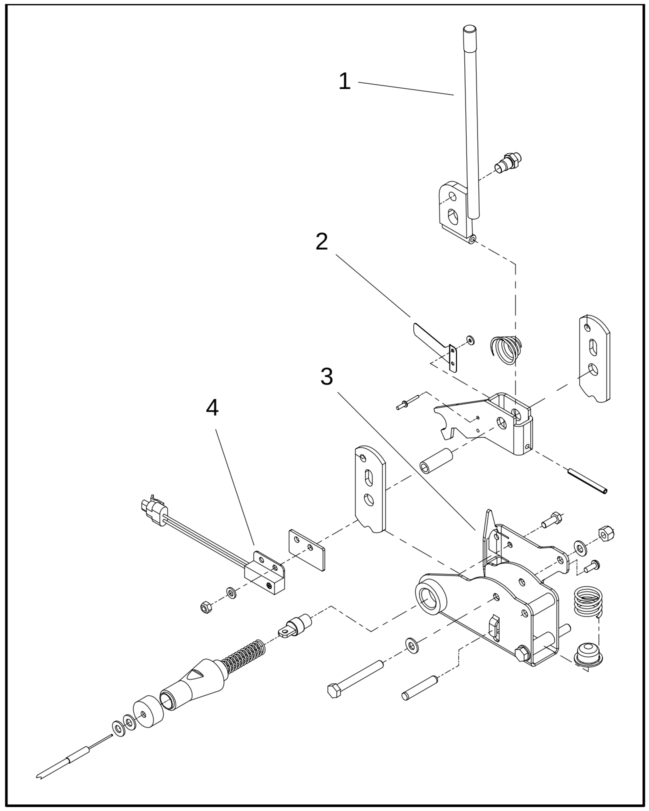


Figure 11

1. **Shift lever**
2. **Sensing tab**
3. **Shifter bracket**
4. **Neutral switch**

Hour Meter

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

Testing

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

2. Remove console panel. Disconnect the harness electrical connectors from the terminals on the hour meter.

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

4. Connect the negative (–) terminal of the voltage source to the other terminal of the hour meter.

5. The hour meter should move a 1/10 of an hour in six (6) minutes.

6. Disconnect voltage source from the hour meter.

7. Connect yellow/red harness wire to the positive (+) terminal of the hour meter and black harness wire to the other meter terminal. Install console panel.

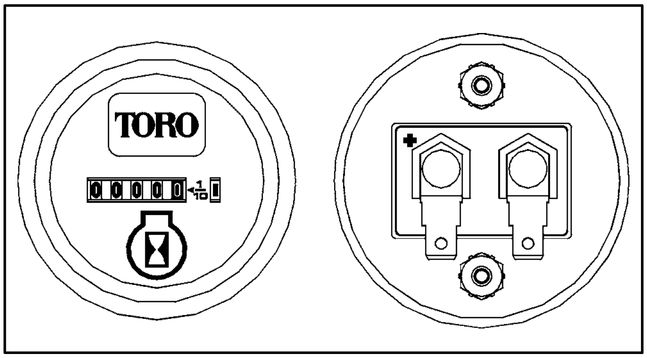


Figure 12

Headlight Switch

The headlight switch is located on the control console next to the operator seat (Fig. 13).

Testing

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

2. Remove console panel, locate headlight switch and unplug wire harness connector from switch.

3. The switch terminals are marked as shown in Figure 14. In the ON position, continuity should exist between the two terminals. In the OFF position, there should be no continuity between the switch terminals.

4. After testing, connect the harness connector to the switch. Install console panel to machine.

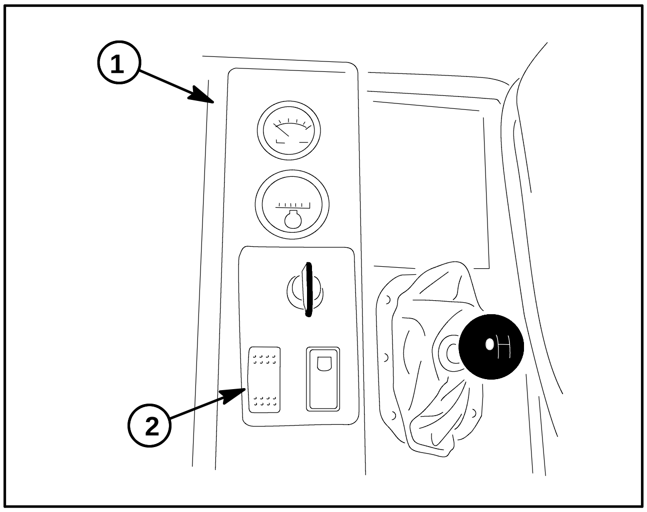


Figure 13

1. **Control console**
2. **Headlight switch**

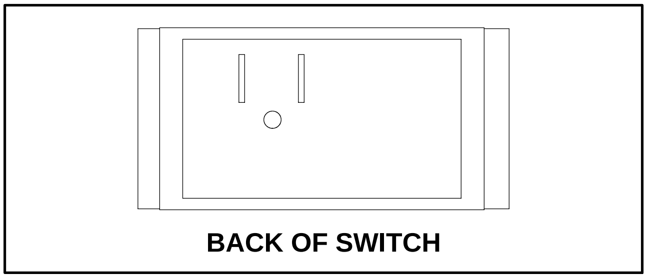


Figure 14

Electrical System

Pump Control and Neutral Engine Speed Control Switches

The pump control and neutral engine speed control switches are identical switches. The pump control switch is located on the sprayer (right side) console (Fig. 15). The neutral engine speed control switch is positioned on the control console (Fig. 16).

Testing

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

2. Locate switch, remove console panel and unplug machine wire harness connector from switch.

3. The switch terminals are marked as shown in Figure 17. In the ON position, continuity should exist between terminals 2 and 3. In the momentary SET position, continuity should exist between terminals 2 and 3 and also between terminals 5 and 6. In the OFF position, there should be no continuity between any switch terminals.

NOTE: When the switch is pressed to the momentary SET position, terminals 5 and 6 are used to initially energize the controlled component (pump drive clutch or cruise coil) and to set up a latch circuit through terminals 2 and 3. This latch circuit keeps the component energized through terminals 2 and 3 when the switch returns to the ON position. Pressing the switch to OFF opens this latch circuit and de–energizes the component.

4. Terminals 7 (–) and 8 (+) are used for the indicator light in the switch. The light should be illuminated when the switch is in the ON position while the controlled component is energized.

5. Connect the harness connector to the switch after testing. Install console panel to machine.

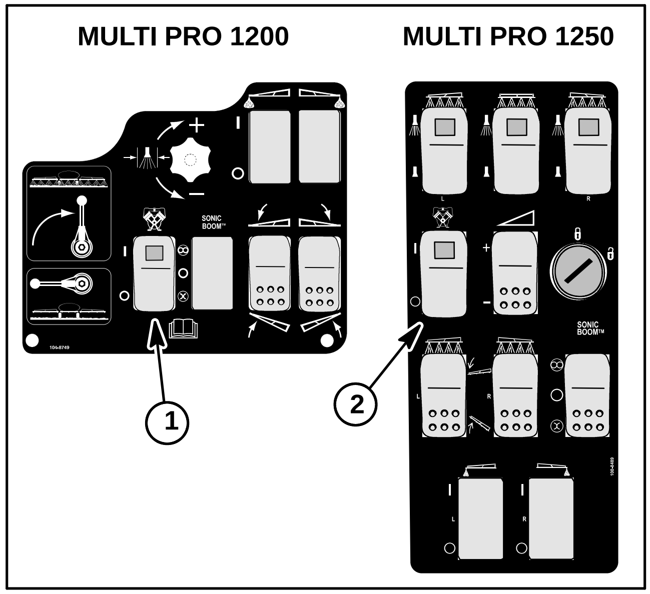


Figure 15

1. **Pump switch (MP 1200)**
2. **Pump switch (MP 1250)**

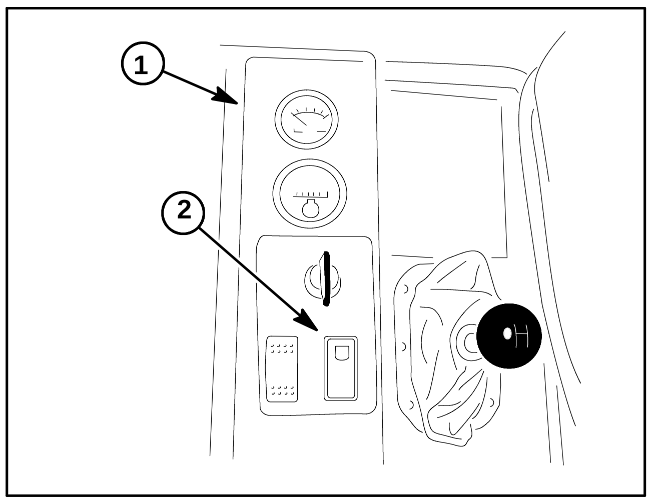


Figure 16

1. **Control console**
2. **Engine speed switch**

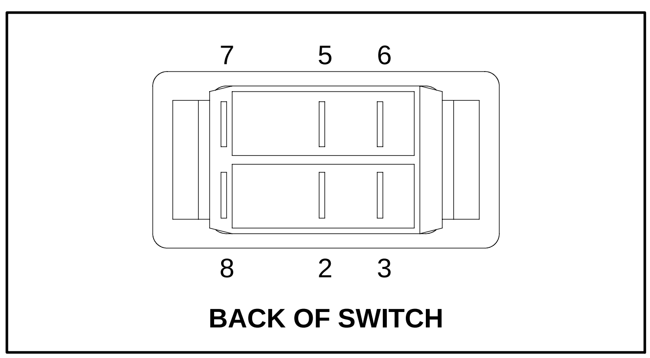


Figure 17

Traction Speed Sensor

The traction speed sensor is attached to the upper transaxle cover (Fig. 18). 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 positive lead, the black wire is the ground lead and the gray striped wire is the signal output.

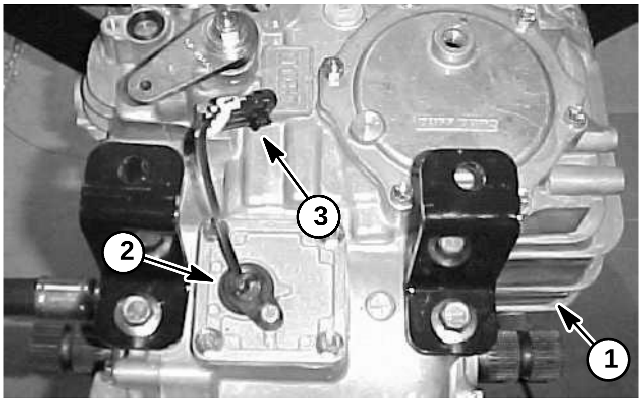


Figure 18

1. Transaxle
2. Traction speed sensor
3. Sensor connector

Testing

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

2. Locate traction speed sensor on the transaxle assembly. Disconnect the wire harness connector from the traction speed sensor.

3. Remove cap screw and lock washer that secure speed sensor to transaxle. Remove speed sensor from transaxle.

4. Connect positive multimeter test lead to the sensor connector gray striped wire terminal and the negative multimeter lead to the connector black wire terminal (Fig. 19). Set multimeter to ohms setting.

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 19 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. After testing is complete, remove jumper wires and multimeter leads from sensor connector. Install speed sensor into transaxle and secure with cap screw and lock washer. Connect speed sensor to wire harness.

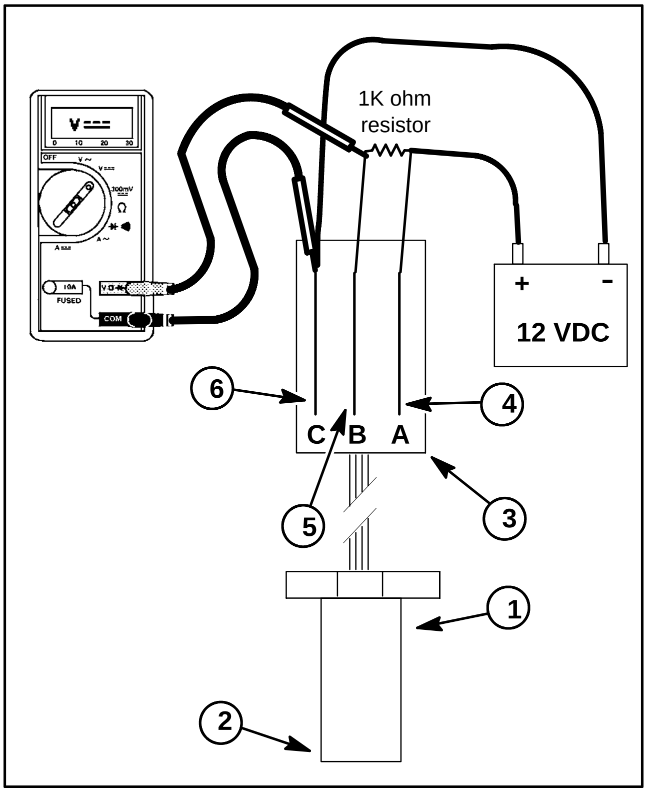


Figure 19

1. Speed sensor
2. Sensor tip
3. Sensor connector
4. Red striped wire
5. Gray striped wire
6. Black wire

Electrical System

Pump Drive Electric Clutch

An electric clutch is used to engage and drive the sprayer pump on the Multi Pro. Clutch operation is controlled by the pump control switch located on the spray console. The electric clutch is mounted on the pump drive gearbox output shaft and is coupled to the spray pump. The clutch engages when current is applied to the clutch.

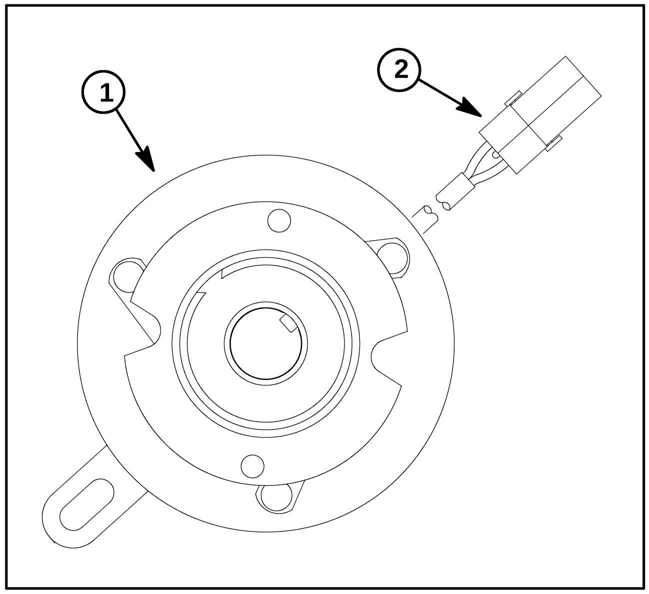


Figure 20

1. **Electric clutch**
2. **Clutch connector**

Testing

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

2. Locate clutch on pump drive gearbox shaft. Unplug clutch connector from machine wire harness (Fig. 20).

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

3. Using a multimeter (ohms setting), verify clutch coil resistance between the two terminals of the connector. Resistance should be 2.45 ohms.

4. If clutch does not engage when voltage is applied or coil resistance is incorrect, replace clutch.

5. See Pump Drive Electric Clutch in the Service and Repairs section of this chapter if clutch removal is necessary.

6. After testing, plug clutch connector into machine wire harness.

Neutral Engine Speed Control Coil

The neutral engine speed control coil is energized by the speed control switch and cruise module. The energized coil becomes a magnet to hold the accelerator lever in position and maintains engine speed for sprayer operation when the machine is stationary.

Testing

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

2. Locate control coil next to accelerator lever under the floorboard. Unplug coil connector from machine wire harness (Fig. 21).

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

3. Using a multimeter (ohms setting), verify control coil resistance between the two terminals of the connector. Resistance should be from 10.2 to 11.2 ohms.

4. If coil does not engage when voltage is applied or coil resistance is incorrect, replace control coil.

5. Connect the coil connector to the machine harness after testing.

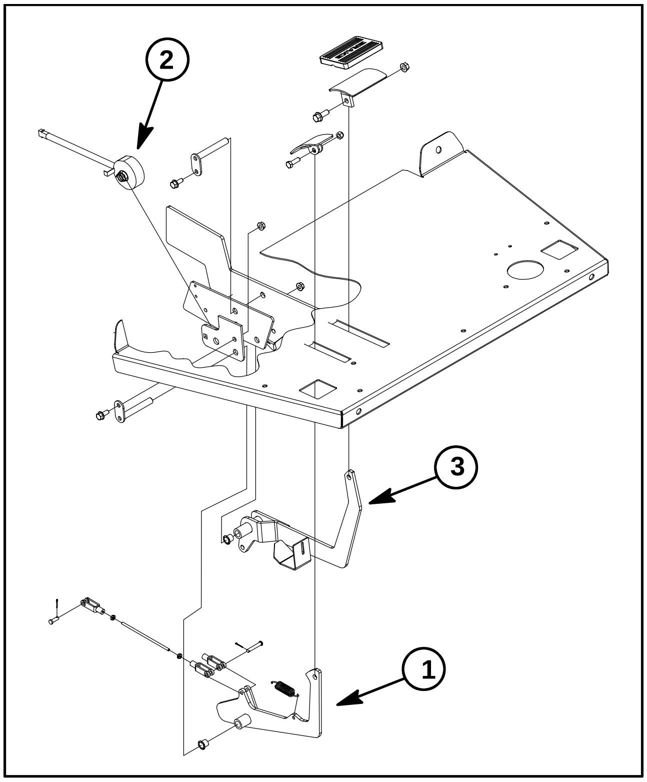


Figure 21

1. Accelerator lever
2. Speed control coil
3. Brake lever

Fusible Link Harness

The Multi Pro sprayer uses two (2) fusible links for circuit protection. These fusible links are located in a harness that connects the starter B+ terminal to the wire harness (Fig. 22). If either of these links should fail, current to the protected circuit will cease. Refer to wire harness drawings in Chapter 10 – Electrical Drawings for additional fusible link information.

Testing

Make sure that ignition switch is OFF. Disconnect negative battery cable from battery terminal and then disconnect positive cable from battery (see Battery Service in the Service and Repairs section of this chapter). Locate and unplug fusible link connector from machine wire harness. Use a multimeter to make sure that continuity exists between the fusible link terminals. If either fusible link is open, replace the fusible link harness.

After fusible link testing is complete, make sure that fusible link harness is securely attached to starter B+ terminal and wire harness. Connect positive battery cable to battery terminal first and then connect negative cable to battery.

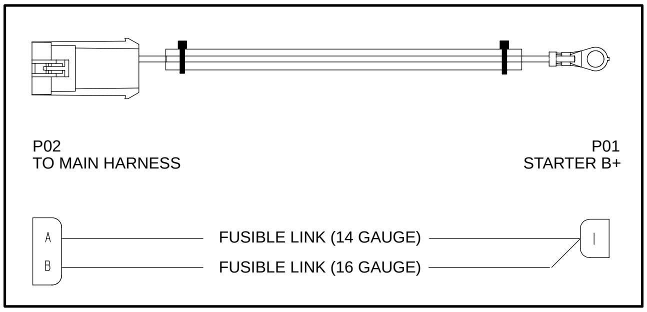


Figure 22

Accessory Solenoid

The accessory solenoid provides a current supply to the spray system, boom actuators and optional accessories (e.g. foam markers). The solenoid is energized when the ignition key switch is in the RUN position. The accessory solenoid is located under the operator seat (Fig. 23).

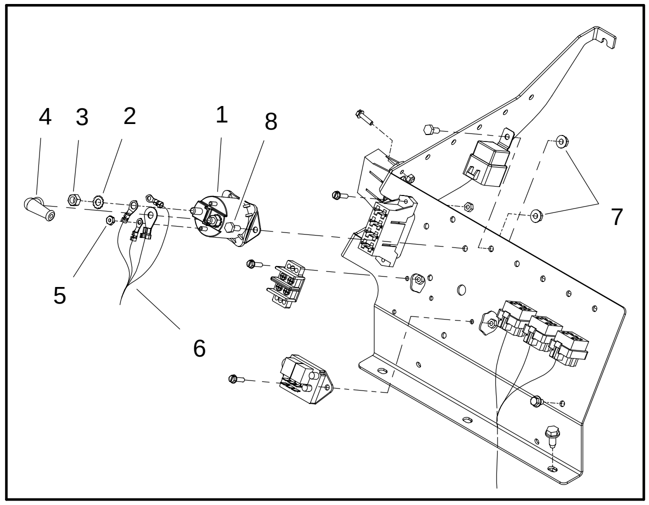


Figure 23

1. Accessory solenoid
2. Lock washer (2 used)
3. Jam nut (2 used)
4. Boot
5. Nut (2 used)
6. Harness connectors
7. Flange nut (2 used)
8. Cap screw (2 used)

Testing

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

2. Disconnect battery cables from battery. Make sure that negative (–) cable is removed from battery before positive (+) cable.

3. Raise operator seat and locate accessory solenoid. Put labels on wires for proper installation after repairs are completed. Disconnect machine wire harness connectors from solenoid.

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. Apply 12 VDC directly across the solenoid coil posts (steel). The solenoid should click as the solenoid coil is energized. Make sure resistance across the main contact posts (copper) is less than 1 ohm.

5. Remove voltage from solenoid coil posts. The solenoid should click as the solenoid coil is de–energized. Make sure resistance across the main contact posts is infinite ohms.

6. With no voltage to any of the solenoid coil posts, measure resistance of the coil across the solenoid coil posts (steel). Resistance should be approximately 13.5 ohms.

7. Replace accessory solenoid if necessary.

8. Using labels placed on wires before removal, connect electrical connections to solenoid.

9. Connect battery cables to battery. Make sure that positive (+) cable is secured to battery before negative (–) cable is attached to battery.

10. Lower operator seat.

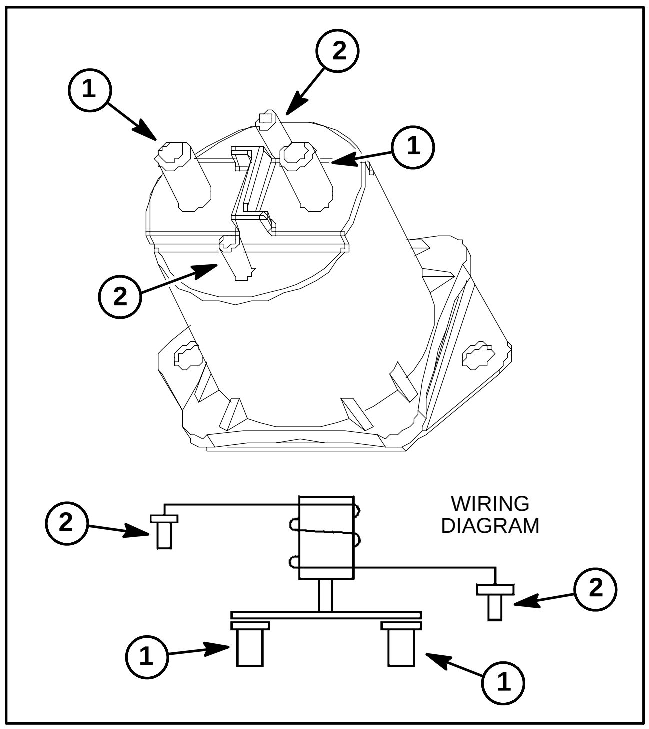


Figure 24

1. Main posts (copper)
2. Solenoid posts (steel)

Spray Pro Monitor

The Multi Pro 1200 and 1250 are equipped with a Spray Pro Monitor (Fig. 25) to provide the machine operator with spray system information. Operation, calibration and troubleshooting information for the Spray Pro Monitor is included in the Operator's Manual.

NOTE: Spray monitor operation on Multi Pro 1200 and 1250 machines can be checked with special tool TOR6001 (see Special Tools in this chapter).

Testing Flowmeter and Speed Sensor Input

The following procedure can be used to determine if inputs from the flowmeter and speed sensor are reaching the Spray Pro monitor.

1. Park machine on a level surface, stop engine and engage parking brake.

2. Locate and disconnect wire harness connector from component to be tested (flowmeter or speed sensor).

3. Turn ignition switch to RUN (do not start engine). Make sure that the pump control switch is in the ON position. On Multi Pro 1250 machines, turn all spray booms and master boom (foot) switch ON.

4. Set Spray Pro monitor as follows:

   A. If flowmeter input is being tested, turn monitor knob to the Calibration Volume setting on Multi Pro 1200 or Total Volume setting on Multi Pro 1250.

   B. If speed sensor input is being tested, turn monitor knob to the Calibration Distance setting on Multi Pro 1200 or Distance setting on Multi Pro 1250.

5. At the disconnected wire harness connector, use a small jumper wire to rapidly short ground terminal and signal terminal several times (Fig. 26). As the jumper wire makes contact with these two terminals, the Spray Pro Monitor display value should change.

6. Use a multimeter (DC volt setting) to measure the DC voltage between the disconnected flowmeter wire harness connector terminals (Fig. 26).

   A. There should be approximately 5 VDC between connector ground and power terminals.

   B. There should be approximately 5 VDC between connector ground and signal terminals.

7. Turn ignition switch to OFF. Record test results.

8. If testing results are correct, consider a faulty component (flowmeter or speed sensor).

9. If testing results are incorrect, check for wire harness problem between component (flowmeter or speed sensor) and Spray Pro Monitor. If wire harness is not damaged (open or shorted), suspect a faulty monitor.

10. After testing, connect wire harness connector to component. Repeat for second component if necessary.

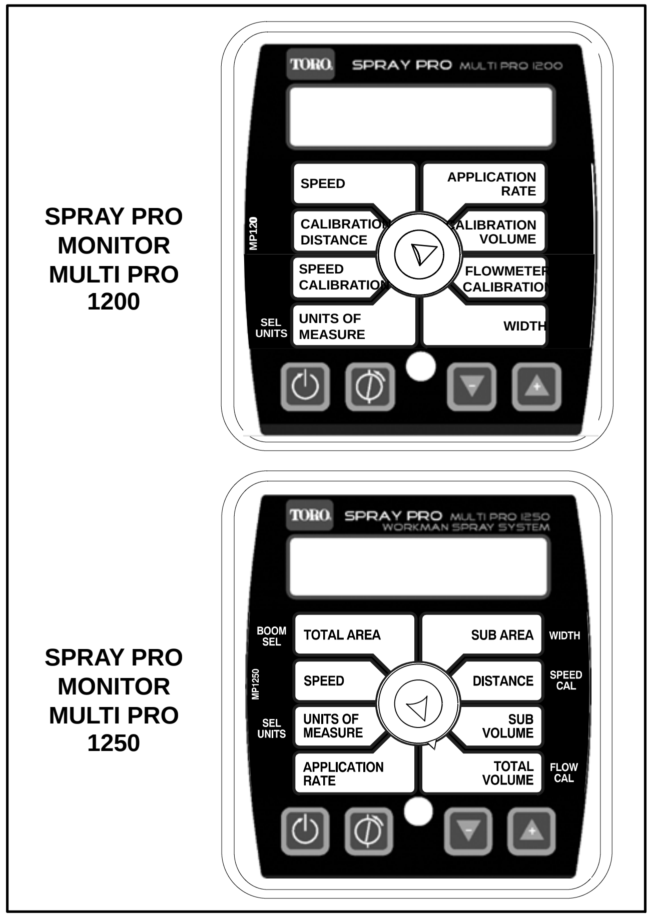


Figure 25

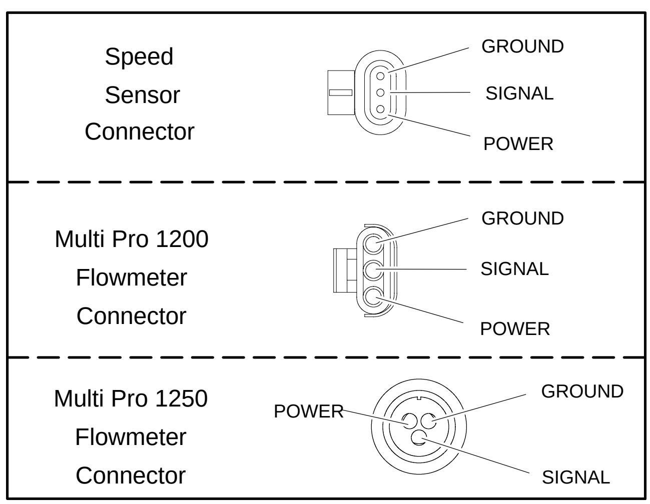


Figure 26

Boom Actuator and Application Rate (Multi Pro 1250 only) Switches

The right and left boom actuator switches used on both the Multi Pro 1200 and 1250 are located on the spray control console (Fig. 28). Pressing the front of a switch lowers the appropriate spray boom section. Pressing the rear of a switch raises the boom section.

The application rate switch on Multi Pro 1250 sprayers is also located on the spray control console (Fig. 28). Pressing the front of the switch increases spray system pressure. Pressing the rear of the switch decreases system pressure.

The boom actuator and application rate switches are all identical.

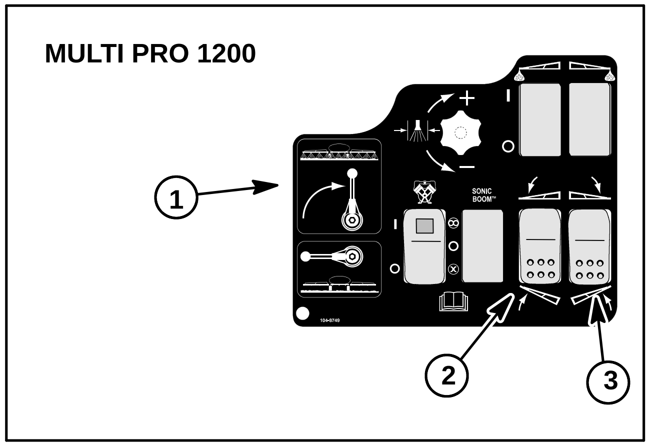


Figure 27

1. **Spray control console**
2. **LH boom switch**
3. **RH boom switch**

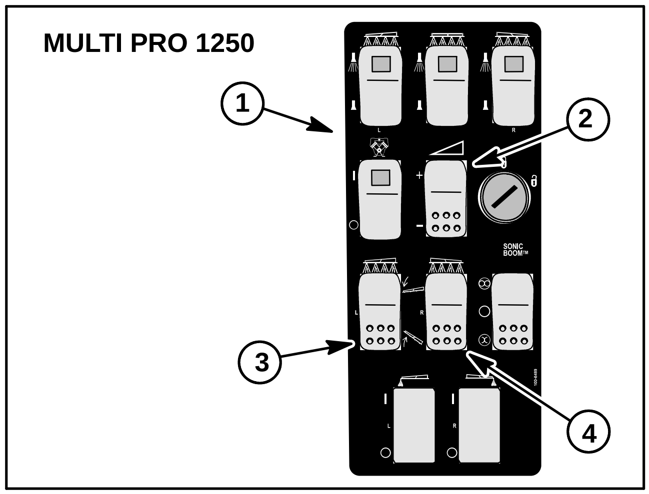


Figure 28

1. **Spray control console**
2. **Application rate switch**
3. **LH boom switch**
4. **RH boom switch**

Testing

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

2. Locate switch, remove console panel and unplug wire harness connector from switch.

3. The switch terminals are marked as shown in Figure 29. In the boom raise or pressure decrease position, continuity should exist between terminals 2 and 3 and also between terminals 5 and 6. In the neutral, center position, there should be no continuity between any switch terminals. In the boom lower or pressure increase position, continuity should exist between terminals 2 and 1 and also between terminals 5 and 4.

4. Connect the harness connector to the switch after testing. Install console panel to machine.

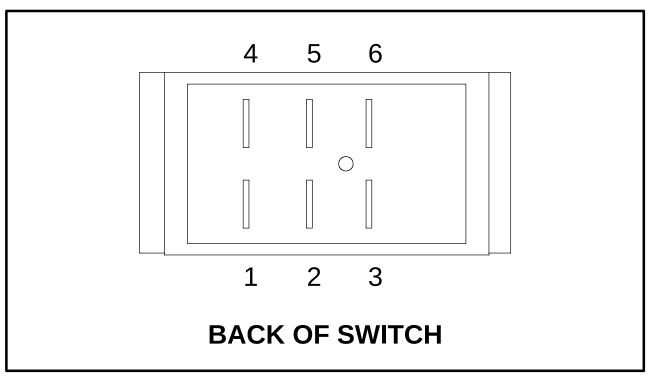


Figure 29

Rate Lockout Key Switch (Multi Pro 1250 only)

The rate lockout key switch on Multi Pro 1250 sprayers is located on the spray control console (Fig. 30). When the rate lockout switch is in the OFF (locked) position, the application rate switch is disabled.

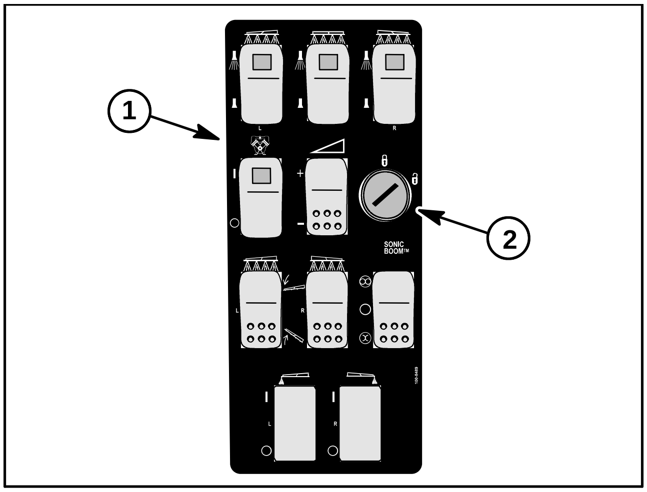


Figure 30

1. **Spray control console**
2. **Rate lockout switch**

Testing

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

2. Locate switch, remove console panel and remove wire harness connector from switch.

3. 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 31. The circuitry of the rate lockout key switch is shown in the chart below. Verify continuity between switch terminals.

SWITCH POSITION	NORMAL CIRCUITS	OTHER CIRCUITS
OFF (LOCKED)	NONE	B + C
ON (UNLOCKED)	A + D	B + C

NOTE: Only switch terminals A and D are used on Multi Pro 1250 machines.

4. After testing is completed, connect the harness connector to the switch. Install console panel to machine.

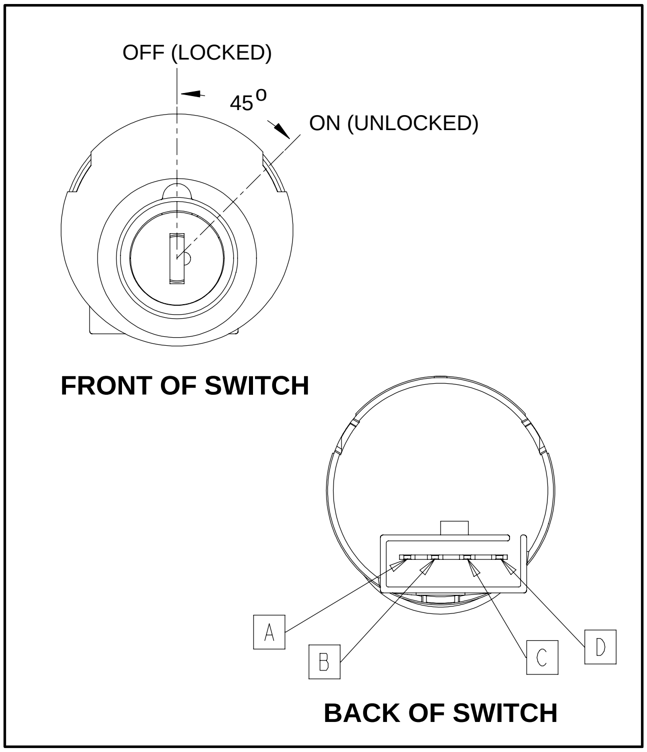


Figure 31

Electrical System

Master Boom (Foot) Switch (Multi Pro 1250 only)

The master boom switch on Multi Pro 1250 sprayers is located on the floorboard of the machine (Fig. 32).

Testing

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

2. Locate switch and unplug wire harness connector from switch.

3. The switch terminals are shown in Figure 33. Continuity should exist between the common terminal and only one of the side terminals. When the switch is depressed, continuity should exist between the common terminal and the other side terminal. Regardless of switch position, there should never be continuity between the two side terminals.

4. Connect the wire harness connector to the switch after testing.

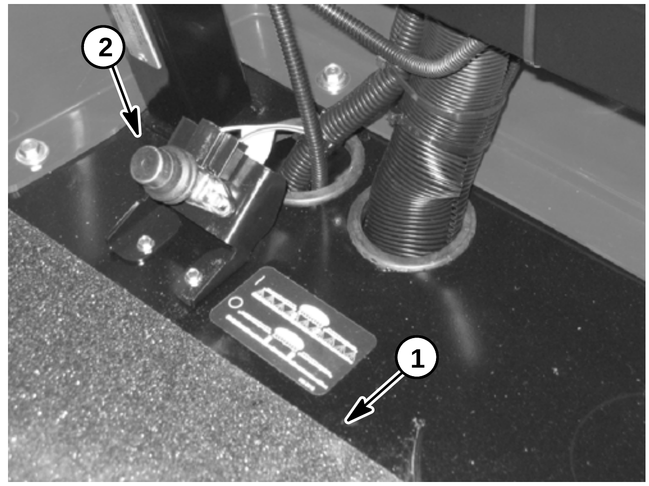


Figure 32

1. **Operator floorboard**
2. **Master boom switch**

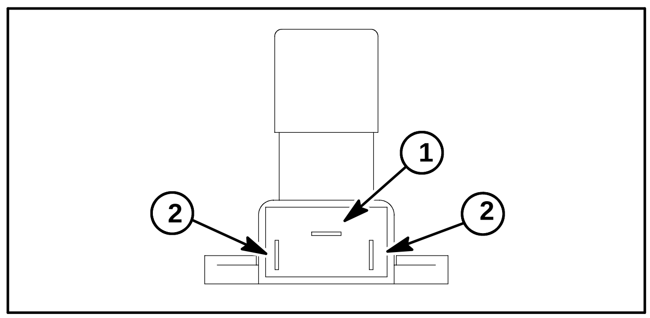


Figure 33

1. **Common terminal**
2. **Side terminal**

Spray Valve Switch (Multi Pro 1250 only)

The three (3) spray valve switches for the Multi Pro 1250 sprayers are located on the spray control console (Fig. 34). The switches are identical.

Testing

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

2. Locate spray valve switch, remove console panel and unplug machine wire harness connector from switch.

3. The switch terminals are marked as shown in Figure 35. In the ON position, continuity should exist between terminals 2 and 3 and also between terminals 5 and 6. In the OFF position, continuity should exist between terminals 1 and 2 and also between terminals 4 and 5.

4. Terminals 7 (–) and 8 (+) are used for the indicator light in the switch. The light should be illuminated when the switch is in the ON position.

5. Connect the harness connector to the switch after testing. Install console panel to machine.

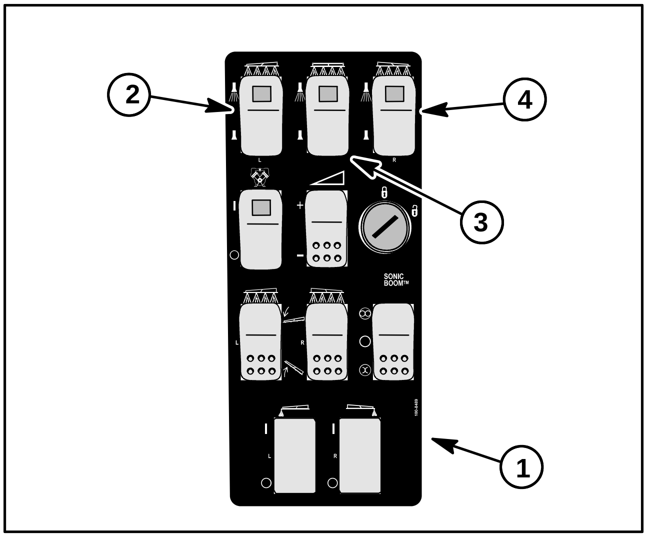


Figure 34

1. **Spray control console**
2. **LH spray valve switch**
3. **Center valve switch**
4. **RH spray valve switch**

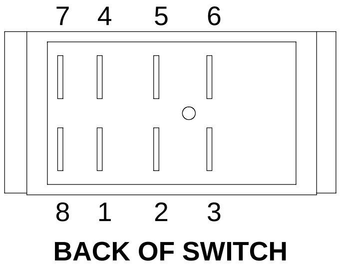


Figure 35

Service and Repairs

NOTE: For engine component testing information, see the Kohler Engine Repair Manual at the end of Chapter 3 – Kohler Gasoline Engine.

Pump Drive Electric Clutch

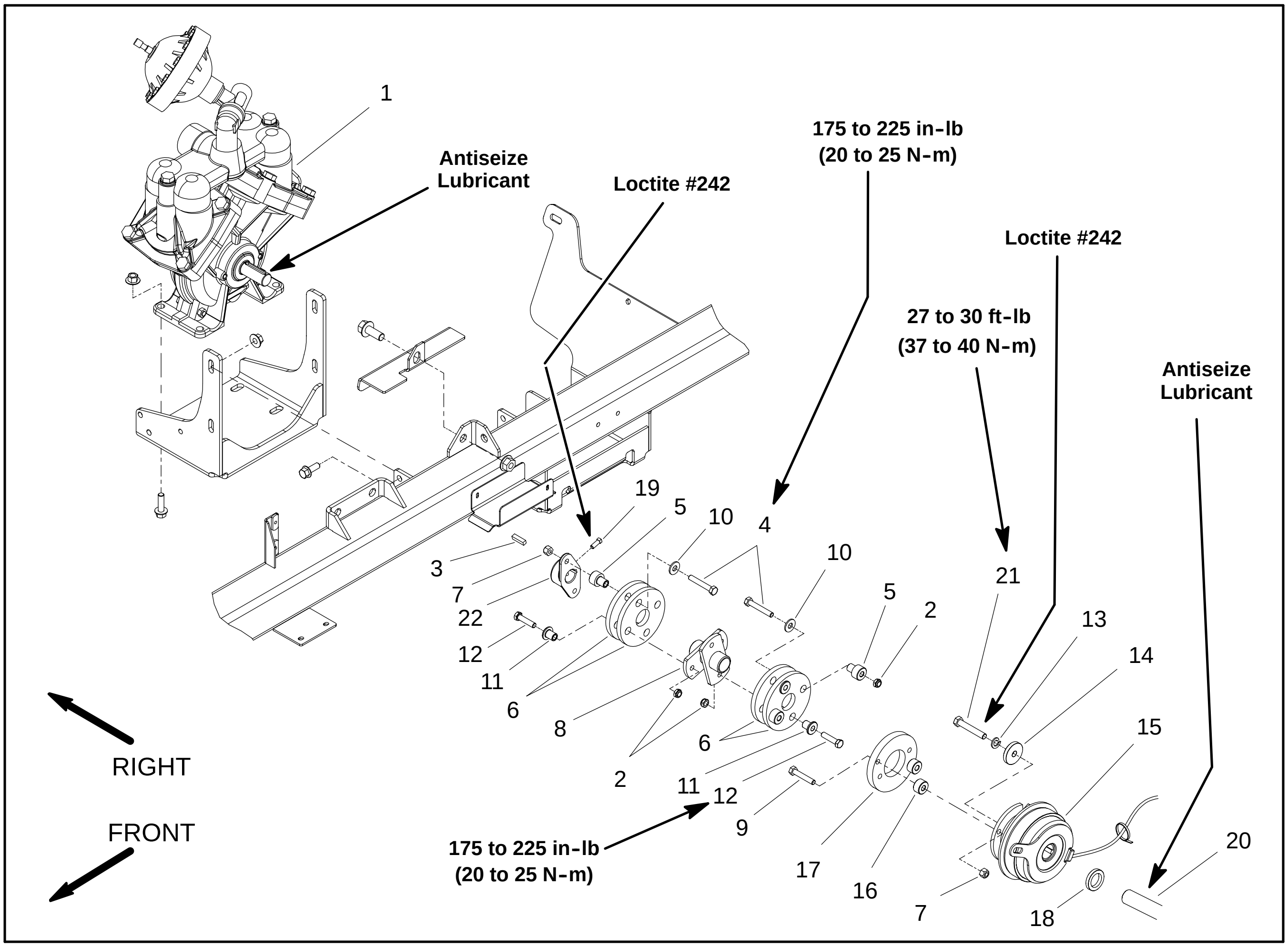


Figure 36

1. **Spray pump**
2. **Lock nut (6 used)**
3. **Key**
4. **Cap screw (4 used)**
5. **Coupling spacer (4 used)**
6. **Rubber coupling (4 used)**
7. **Lock nut (4 used)**
8. **Drive coupler**
9. **Cap screw (2 used)**
10. **Flat washer (4 used)**
11. **Spacer (4 used)**
12. **Cap screw (4 used)**
13. **Lock washer**
14. **Clutch retainer**
15. **Electric clutch**
16. **Spacer (2 used)**
17. **Clutch adapter**
18. **Spacer**
19. **Set screw (2 used)**
20. **Pump drive gearbox shaft**
21. **Cap screw**
22. **Pump hub**

Removal (Fig. 36)

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

2. Remove cap screws, flat washers, lock nuts and spacers that secure rubber couplings to pump hub (item 22).

3. Remove lock nuts that secure clutch adapter (item 17) to electric clutch.

4. Slide drive coupler, rubber couplings and clutch adapter from machine as an assembly. Locate and retrieve two (2) spacers (item 16) from between clutch adapter and electric clutch.

5. Unplug clutch wire connector from machine wire harness.

6. Remove cap screw, lock washer and clutch retainer that secure clutch to pump drive gearbox shaft.

7. Remove shoulder bolt that secures clutch leg to pump drive gearbox (Fig. 37).

8. Slide electric clutch from pump drive gearbox. Locate and remove spacer (item 18) from gearbox shaft. Note that spacer groove fits around retaining ring on gearbox shaft.

Installation (Fig. 36)

1. Apply antiseize lubricant to pump drive gearbox shaft. Make sure that retaining ring on gearbox shaft is fully seated in shaft groove.

2. Place spacer (item 18) onto gearbox shaft. Make sure that spacer groove fits around retaining ring on shaft.

3. Align key in clutch with key slot in gearbox shaft and align mounting leg of clutch to threaded hole in gearbox. Slide clutch onto gearbox shaft.

4. Install shoulder bolt through leg of clutch and into gearbox (Fig. 37). Tighten shoulder bolt. After shoulder bolt is tightened, make sure that leg of clutch does not bind on bolt.

5. Install cap screw, lock washer and clutch retainer to secure clutch to gearbox shaft. Torque screw from **27 to 30 ft-lb (37 to 40 N-m)**.

6. Connect clutch wire connector to machine wire harness.

IMPORTANT: If pump drive coupler components were disassembled, make sure that pump hub flanges and drive coupler are assembled at right angles (90 degrees) to each other (Fig. 38).

7. Position drive coupler assembly (with all rubber couplings and clutch adapter) between pump hub and electric clutch.

8. Make sure that two (2) spacers (item 16) are positioned between clutch adapter (item 17) and electric clutch. Secure clutch adapter to clutch with two (2) lock nuts.

9. Secure rubber coupling to pump hub (item 23) with spacers, flat washers, cap screws,and lock nuts. Make sure that cap screw threads extend fully through lock nuts.

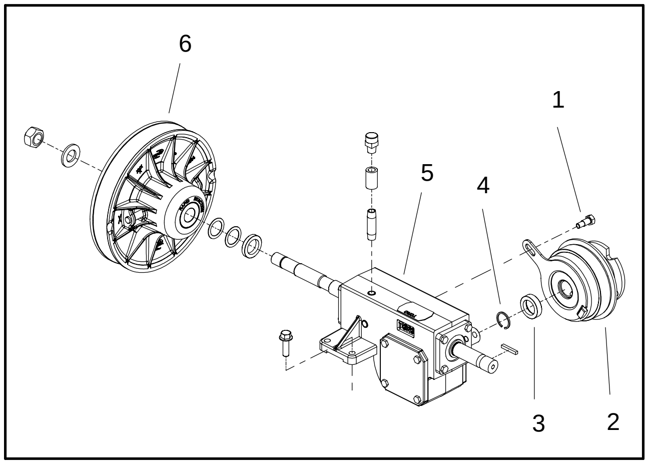


Figure 37

1. **Shoulder bolt**
2. **Electric clutch**
3. **Spacer**
4. **Retaining ring**
5. **Pump drive gearbox**
6. **Driven clutch**

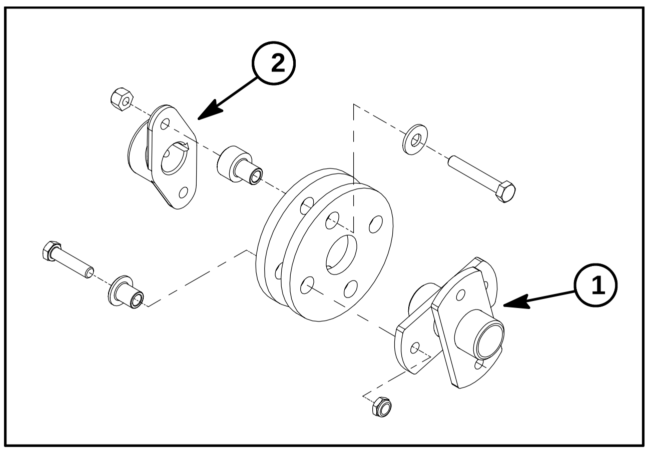


Figure 38

1. **Drive coupler**
2. **Pump hub**

Pump Drive Electric Clutch Service

NOTE: For clutch electrical testing information, see Pump Drive Electric Clutch in the Components section of this chapter.

The pump drive electric clutch used on the Multi Pro has sealed, non-serviceable bearings. If clutch bearing failure occurs, clutch replacement is necessary.

Headlights

Headlight Removal (Fig. 39)

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

2. Reach beneath dash and push headlight out of the hood.

3. Remove screws attaching the wire harness to the headlight.

4. Remove rubber seal from around the headlight. Discard headlight.

Headlight Installation (Fig. 39)

1. Align notch on the inside of the seal with the notch on the new headlight. Slide seal onto the headlight until the seal is firmly in place.

2. Attach headlight to the wire harness using the previously removed screws.

NOTE: Applying soapy water to the outside of the seal will aid in sliding the seal into the hood. Make sure to thoroughly dry headlights before turning lights on.

3. Align notch on the outside of the seal with the notch in the hood. Push headlight and seal into the hood until it is firmly in place.

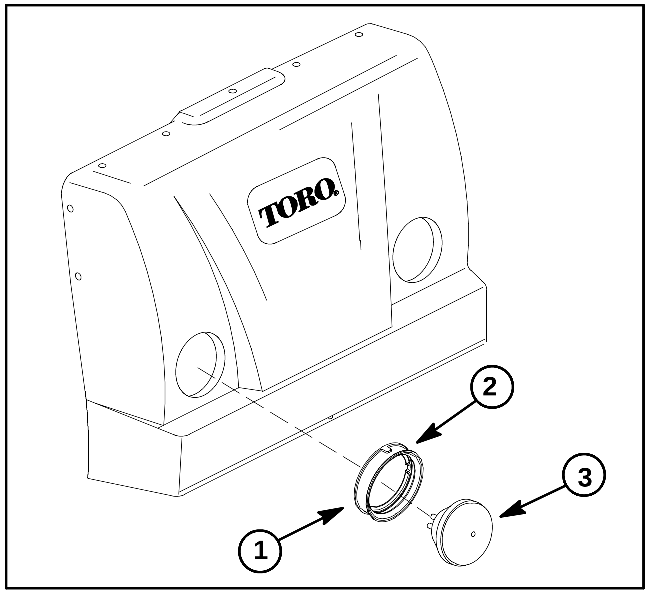


Figure 39

1. **Rubber seal**
2. **Outside notch**
3. **Headlight**

Battery Storage

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

1. Remove the battery and charge it fully (see Battery Service in this section).

2. Either store battery on a shelf or on the machine.

3. Leave cables disconnected if the battery is stored on the machine.

4. Store battery in a cool atmosphere to avoid quick deterioration of the battery charge.

5. To help prevent the battery from freezing, make sure it is fully charged (see Battery Service in this section).

Battery Care

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

WARNING

Wear safety goggles and rubber gloves when working with electrolyte. Charge battery in a well ventilated place so gases produced while charging can dissipate. Since these gases are explosive, keep open flames and electrical sparks away from the battery; do not smoke. Nausea may result if the gases are inhaled. Unplug charger from electrical outlet before connecting or disconnecting charger leads to or from battery posts.

IMPORTANT: Do not remove battery fill caps while cleaning.

2. Check battery condition weekly or after every 50 hours of operation. Keep terminals and entire battery case clean because a dirty battery will discharge slowly.

   A. Clean battery by washing entire case with a solution of baking soda and water. Rinse with clear water.

   B. Coat battery posts and cable connectors with Battery Terminal Protector (see Special Tools in this chapter) to prevent corrosion.

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

WARNING

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

4. If corrosion occurs at terminals, disconnect cables. Always disconnect negative (–) cable first. Clean clamps and terminals separately. Connect cables with positive (+) cable first. Coat battery posts and cable connectors with Battery Terminal Protector (see Special Tools in this chapter) to prevent corrosion.

5. Check electrolyte level every 25 operating hours and every 30 days if machine is in storage.

6. Maintain cell level with distilled water. Do not fill cells above the fill line.

Battery Service

The battery is the heart of the electrical system. With regular and proper service, battery life can be extended. Additionally, battery and electrical component failure can be prevented.

CAUTION

When working with batteries, use extreme caution to avoid splashing or spilling electrolyte. Electrolyte can destroy clothing and burn skin or eyes. Always wear safety goggles and a face shield when working with batteries.

Battery Specifications

BCI Group 26 Battery
540 Amp Cranking Performance at 0°F (–18°C)
80 minute Reserve Capacity at 80°F (27°C)
Electrolyte Specific Gravity (fully charged): from 1.250 to 1.280
Electrolyte Specific Gravity (discharged): 1.240

Battery Removal and Installation (Fig. 40)

See Operator's Manual for battery removal and installation information.

NOTE: Before connecting the negative (ground) cable, connect a digital multimeter (set to amps) between the negative battery post and the negative (ground) cable connector. The reading should be 0 amps. If the reading is 0.1 amp or more, the unit's electrical system should be tested and repaired.

Battery Inspection and Maintenance

1. Perform following inspections and maintenance:

   A. Replace battery if cracked or leaking.

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

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

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

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

   E. Check the electrolyte level in each cell. If the level is below the tops of the plates in any cell, fill all cells with **distilled water** between the minimum and maximum fill lines. Charge at 15 to 25 amps for 15 minutes to allow sufficient mixing of the electrolyte.

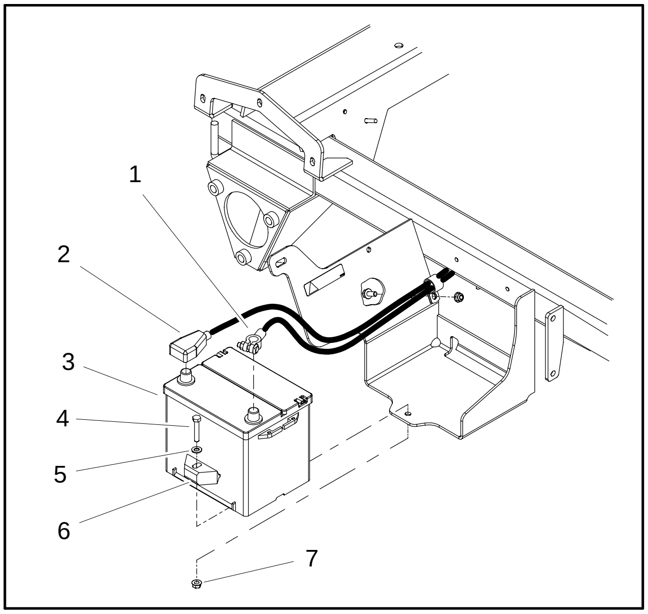


Figure 40

1. **Negative battery cable**
2. **Positive battery cable**
3. **Battery**
4. **Cap screw**
5. **Flat washer**
6. **Battery retainer**
7. **Flange nut**

Battery Testing

1. Conduct a hydrometer test of the battery electrolyte.

IMPORTANT: Make sure the area around the cells is clean before opening the battery caps.

A. Measure the specific gravity of each cell with a hydrometer. Draw electrolyte in and out of the hydrometer barrel prior to taking a reading to warm–up the hydrometer. At the same time take the temperature of the cell.

B. Temperature correct each cell reading. For each 10^{o}F (5.5^{o}C) above 80^{o}F (26.7^{o}C) add 0.004 to the specific gravity reading. For each 10^{o}F (5.5^{o}C) below 80^{o}F (26.7^{o}C) subtract 0.004 from the specific gravity reading.

Example: Cell Temperature	100^{o}F
Cell Gravity	1.245
100^{o}F minus 80^{o}F equals 20^{o}F	
(37.7^{o}C minus 26.7^{o}C equals 11.0^{o}C)	
20^{o}F multiply by 0.004/10^{o}F equals 0.008	
(11^{o}C multiply by 0.004/5.5^{o}C equals 0.008)	
ADD (conversion above)	0.008
Correction to 80^{o}F (27^{o}C)	1.253

C. If the difference between the highest and lowest cell specific gravity is 0.050 or greater or the lowest cell specific gravity is less than 1.225, charge the battery. Charge at the recommended rate and time given in **Charging** or until all cells specific gravity is 1.225 or greater with the difference in specific gravity between the highest and lowest cell less than 0.050. If these charging conditions can not be met, replace the battery.

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 tester.

A. Check the voltage across the battery terminals prior to testing the battery. If the voltage is less than 12.4 VDC, recharge the battery.

B. If the battery has been charged, apply a 150 amp load for 15 seconds to remove the surface charge. Use a battery load tester following the manufacturer's instructions.

C. Make sure battery terminals are free of corrosion.

D. Measure the temperature of the center cell.

E. Connect a battery load tester to the battery terminals **following the manufacturer's instructions**. Connect a digital multimeter to the battery terminals.

F. Apply a test load of one half the Cranking Performance (see Battery Specifications) rating of the battery for 15 seconds.

G. Take a voltage reading at 15 seconds, then remove the load.

H. Using the table below, determine the minimum voltage for the cell temperature reading:

Minimum Voltage	Battery Electrolyte Temperature	
9.6	70^{o}F (and up)	21^{o}C (and up)
9.5	60^{o}F	16^{o}C
9.4	50^{o}F	10^{o}C
9.3	40^{o}F	4^{o}C
9.1	30^{o}F	-1^{o}C
8.9	20^{o}F	-7^{o}C
8.7	10^{o}F	-12^{o}C
8.5	0^{o}F	-18^{o}C

I. If the test voltage is below the minimum, replace the battery. If the test voltage is at or above the minimum, return the battery to service.

Battery Charging

To minimize possible damage to the battery and allow the battery to be fully charged, the slow charging method is presented here. This charging method can be accomplished with a constant current battery charger which is available in most shops.

CAUTION

Follow the manufacturer's instructions when using a battery charger.

NOTE: Using specific gravity of the battery cells is the most accurate method of determining battery condition.

1. Determine the battery charge level from either its specific gravity or open circuit voltage.

Battery Charge Level	Specific Gravity	Open Circuit Voltage
100%	1.265	12.68
75%	1.225	12.45
50%	1.190	12.24
25%	1.155	12.06
0%	1.120	11.89

2. Determine the charging time and rate **using the manufacturer's battery charger instructions** or the following table.

Battery Reserve Capacity (Minutes)	Battery Charge Level (Percent of Fully Charged)			
	75%	**50%**	**25%**	**0%**
80 or less	**3.8 hrs @ 3 amps**	**7.5 hrs @ 3 amps**	**11.3 hrs @ 3 amps**	**15 hrs @ 3 amps**
81 to 125	5.3 hrs @ 4 amps	10.5 hrs @ 4 amps	15.8 hrs @ 4 amps	21 hrs @ 4 amps
126 to 170	5.5 hrs @ 5 amps	11 hrs @ 5 amps	16.5 hrs @ 5 amps	22 hrs @ 5 amps
171 to 250	5.8 hrs @ 6 amps	11.5 hrs @ 6 amps	17.3 hrs @ 6 amps	23 hrs @ 6 amps
above 250	6 hrs @ 10 amps	12 hrs @ 10 amps	18 hrs @ 10 amps	24 hrs @ 10 amps

CAUTION

Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 60°F (16°C) before connecting to a charger.

Charge the battery in a well–ventilated place to dissipate gases produced from charging. These gases are explosive; keep open flame and electrical spark away from the battery. Do not smoke. Nausea may result if the gases are inhaled. Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.

3. **Following the manufacturer's instructions**, connect the charger cables to the battery. Make sure a good connection is made.

4. Charge the battery **following the manufacturer's instructions**.

5. Occasionally check the temperature of the battery electrolyte. If the temperature exceeds 125°F (52°C) or the electrolyte is violently gassing or spewing, the charging rate must be lowered or temporarily stopped.

6. Three (3) hours prior to the end of the charging, measure the specific gravity of a battery cell once per hour. The battery is fully charged when the cells are gassing freely at a low charging rate and there is less than a 0.003 change in specific gravity for three (3) consecutive readings.

TORO

Chapter 6

Spray System

Table of Contents

Specifications

Item	Description
Spray Pump	Diaphragm Pump, 18 GPM @ 220 PSI (26 GPM @ 0 PSI)
Spray Pressure Relief Valve	Poppet Style, 220 PSI Maximum
Sprayer Tank	175 Gallon, Polyethylene
Suction Strainer	50 Mesh, Stainless Steel, Tank Mounted (30 Mesh and 80 Mesh Optional)

General Information

Precautions Concerning Chemicals Used in Spray System

Chemicals can injure persons, animals, plants, soil and other property. To eliminate environmental damage and personal injury:

1. Select the proper chemical for the job.

2. Carefully read the directions printed on the chemical manufacturer's labels before handling chemicals. Instructions on chemical manufacturer's container labels regarding mixing proportions should be read and strictly followed.

3. Keep spray material away from skin. If spray material comes in contact with a person, wash it off immediately in accordance with manufacturer's recommendations (refer to container labels and Material Safety Data Sheets).

4. Always wear protective clothing, chemical resistant gloves, eye protection and other personal protective equipment as recommended by the chemical manufacturer.

5. Properly dispose of chemical containers, unused chemicals and chemical solution.

Precautions for Removing or Adjusting Spray System Components

1. Stop the vehicle and set the parking brake.

2. Shut off the vehicle's engine and remove the key from the ignition switch.

3. Disengage all power and wait until all moving parts have stopped.

4. Remove chemicals from pump, hoses and other spray components. Thoroughly neutralize and rinse spray system before loosening or removing any spray system component(s).

5. Make sure system pressure is relieved before loosening any system component (e.g. spray valves, spray system hose).

Spray System Operation

The Multi Pro 1200 and 1250 spray systems use a positive displacement diaphragm pump to move spray solution from the spray tank to the boom nozzles. The spray pump is self–priming and has a dry crankcase. The pump is driven by the pump drive gearbox output shaft at a speed that is proportional to the ground speed of the vehicle. The pump is engaged with an electric clutch.

The downward stroke of the pump's connecting rods and diaphragms create suction to allow fluid to be drawn from the spray tank to the pump through the suction tube, suction strainer, hoses and connectors. A suction dampener placed in the suction line dampens suction pulses to smooth suction flow. Suction valves positioned in the pump valve chamber prevent fluid from being pumped back into the suction line when the connecting rods change direction. Leaks in the suction line will cause system problems and often will be indicated by erratic suction line jumping and pump noise.

Once to the pump, the fluid is pushed by the upward stroke of the pump's connecting rods and diaphragms to the pressure side of the spray system through hoses, connectors, control valves and spray nozzles. A pressure dampener at the pump outlet smooths system pressure pulsation. Pressure valves positioned in the pump head prevent fluid from being drawn back into the pump. Maximum pressure in the system is limited by a pressure relief valve located in the tank. A pressure gauge indicates system pressure.

Flow for tank agitation on both the Multi Pro 1200 and 1250 comes from flow that is bypassed by the pressure control valve. A manual agitation control valve directs flow to ten (10) agitation nozzles in the spray tank.

Battery current for spray system fuses, switches, relays and other components is provided by the accessory solenoid when the machine ignition switch is in the RUN position. For spray system electrical component information and test procedures, see Chapter 5 – Electrical System.

Multi Pro 1200 Spray Control

The spray control system on the Multi Pro 1200 consists of a main on/off valve, a pressure control valve and three (3) manual boom control valves. An adjustable boom bypass valve exists in each of the boom control valves to prevent system pressure changes when a boom section is shut off. Flow in excess of control valve settings is directed back to the spray tank or used for tank agitation.

An inline flowmeter in the pressure side of the system directly before the boom control valves measures flow to the spray booms. The Spray Pro Monitor displays information regarding application rate based on input from the flowmeter and the transaxle speed sensor.

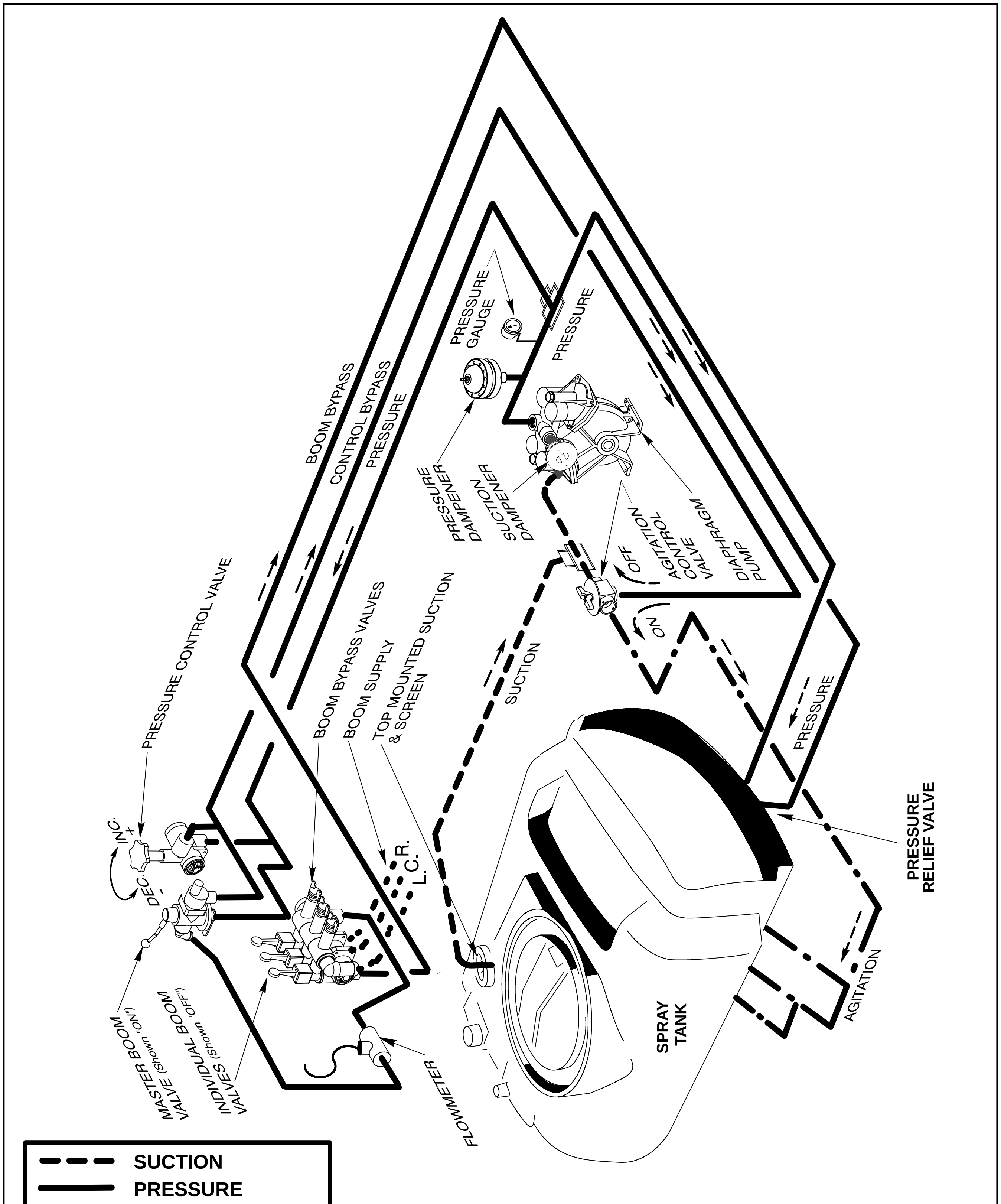
NOTE: On the Multi Pro 1200, make sure that all boom valves are on when calibrating the Spray Pro Monitor. The Multi Pro 1200 monitor cannot accurately display calibration volume when any of the boom valves are off.

Multi Pro 1250 Spray Control

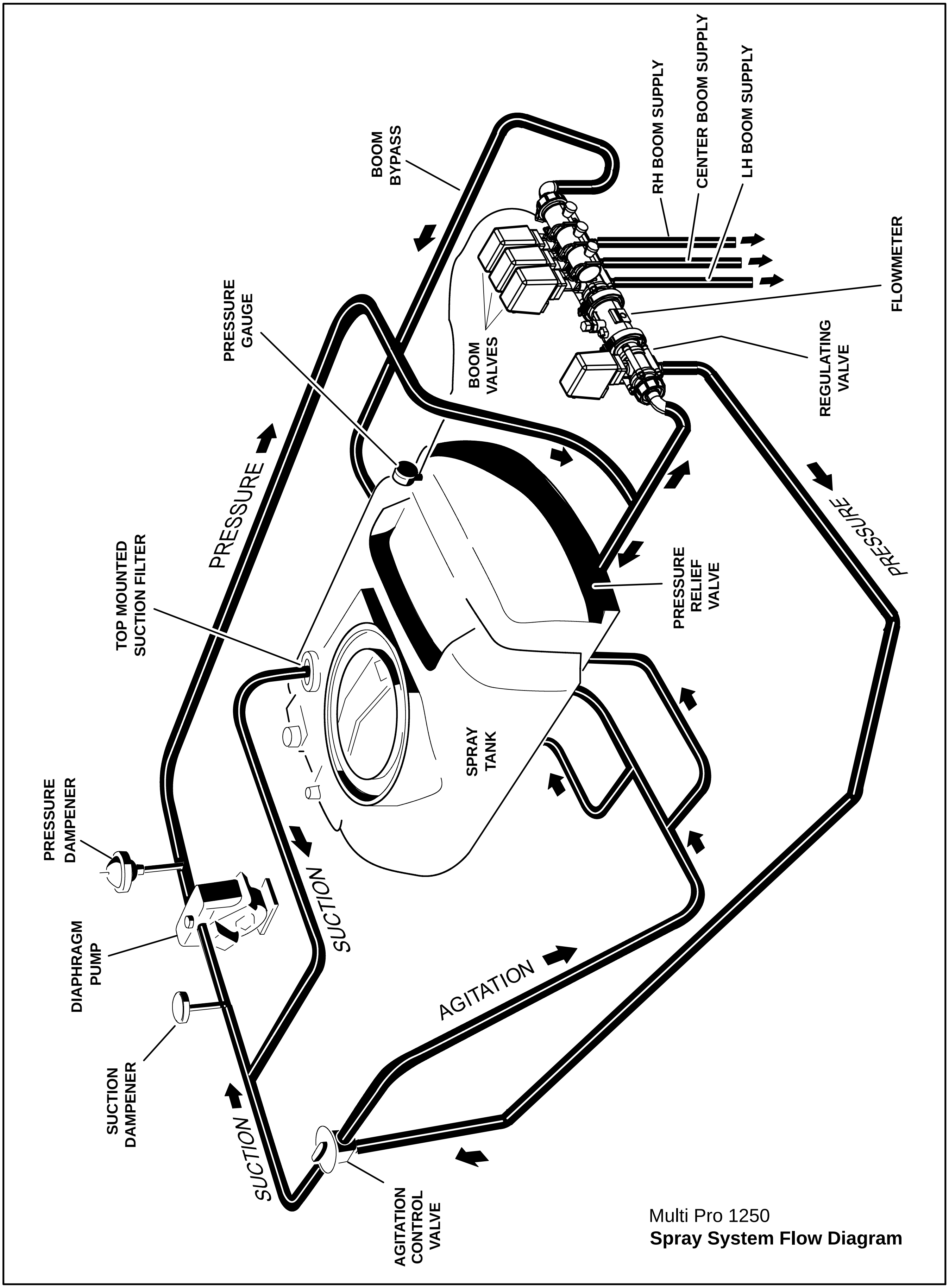
The spray system on the Multi Pro 1250 is controlled electrically and consists of a main control valve and three (3) boom control valves. An adjustable boom bypass valve exists in each of the boom control valves to prevent system pressure changes when a boom section is shut off. Flow in excess of control valve settings is directed back to the spray tank or used for tank agitation.

An inline flowmeter in the pressure side of the system directly before the boom control valves measures flow to the spray booms. The Spray Pro Monitor displays information regarding application rate based on input from the flowmeter and the transaxle speed sensor.

Spray System Flow Diagrams



Multi Pro 1200
Spray System Flow Diagram



Multi Pro 1250
Spray System Flow Diagram

Spray System

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Special Tools

Spray Pump Alignment Fixture

The spray pump alignment fixture should be used to ensure that the spray pump mounting bracket is positioned correctly to the machine frame to allow alignment between the pump drive gearbox output shaft and spray pump input shaft. Proper alignment of the pump prevents damage to the pump drive coupling assembly. Instructions for alignment fixture are included with the tool.

Toro Part Number: **104–8930**

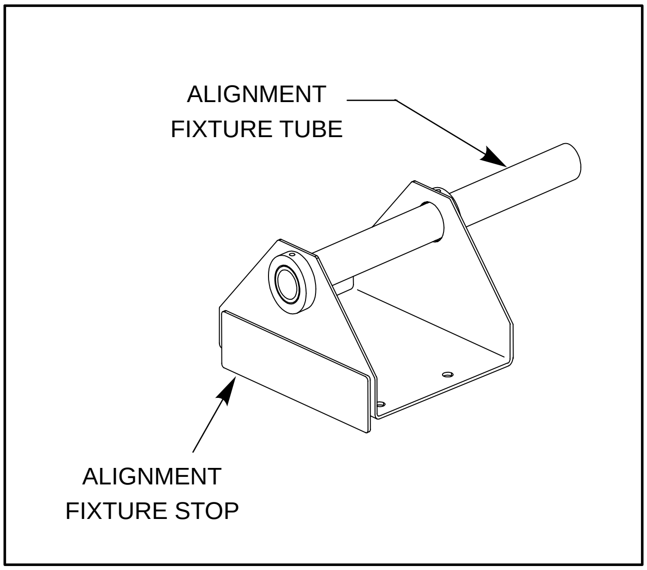


Figure 1

O–Ring Seal Kit

The O–Ring Seal Kit includes an assortment of O–rings used for sealing Multi Pro 1200 spray control valves. It is recommended that O–rings be replaced every two (2) years or whenever a valve is loosened.

Toro Part Number: **106–4846**

Figure 2

Spray System

Troubleshooting

Problem	Possible Cause
Spray system leaks fluid.	Fitting(s), hose(s) or tube(s) are loose or damaged. O–ring(s) or seal(s) are missing or damaged.
Fluid leaking from bottom of spray pump.	Faulty diaphragm(s) exist in spray pump.
Excessive suction hose vibration.	Suction screen in tank is plugged. Spray pump suction line has an air leak. Suction tube in spray tank has air leak. Suction line is restricted. Suction dampener diaphragm is damaged.
Spray pressure is low.	Suction line is restricted. Suction screen in tank is plugged. Spray nozzles are worn or damaged. Pressure line or component is loose or leaking. Engine speed is low. Pressure relief valve in tank is not seating. Pressure control valve is damaged or incorrectly adjusted (Multi Pro 1200) CVT drive belt is slipping (Ground speed also affected: see Drive Train – Chapter 7). Spray pump is damaged.
Nozzles on one spray boom leak when boom is switched off.	Diaphragm in turret body is leaking or damaged. Distribution valve for affected boom not seating (Multi Pro 1200). Boom valve motor for affected boom not seating (Multi Pro 1250).
All spray boom nozzles leak when boom is turned off.	Master boom valve is not seating (Multi Pro 1200). Regulating valve is not seating (Multi Pro 1250). All distribution valves are not seating (Multi Pro 1200). All boom valve motors are not seating (Multi Pro 1250).

Spray pump doesn't rotate.	Spray pump switch is off or faulty. Foot switch is off or damaged (Multi Pro 1250). Key on spray pump shaft is sheared. Spray pump coupler is damaged. Pump drive electric clutch is not engaged or is faulty (see Chapter 5 – Electrical System).
Erratic spray operation from booms.	Clogged strainer. Suction dampener is damaged. Pressure dampener is damaged. Leak in suction line exists. Boom bypass valve on distribution valve is damaged (Multi Pro 1200). Master boom valve is damaged (Multi Pro 1200). Console boom switch(es) is dirty, corroded or damaged (Multi Pro 1250). Regulating valve is worn or sticking (Multi Pro 1250). Boom valve motor seat is loose or damaged (Multi Pro 1250). Boom valve motor actuating cam is worn or sticking (Multi Pro 1250).
No spray output from one spray boom.	Hoses on boom are pinched or kinked. Distribution valve for affected boom is not open (Multi Pro 1200). Boom valve motor for affected boom is not opening (Multi Pro 1250). Console boom switch is dirty, corroded or damaged (Multi Pro 1250). Check for 12 volts at affected boom valve motor (Multi Pro 1250).
Low spray rate from one nozzle.	Spray nozzle(s) are clogged or damaged. Spray nozzles are different sizes. Distribution valve for affected boom is not seating (Multi Pro 1200). Boom valve motor for affected boom is not seating (Multi Pro 1250).

Service and Repairs

Suction Dampener

The suction dampener is mounted to the suction line at the spray pump (Fig. 3) and is used to dampen suction pulses and smooth suction flow. During pump operation, the suction dampener diaphragm will move.

IMPORTANT: Make sure to neutralize and remove chemicals from pump and hoses before loosening and removing spray system components. Wear protective clothing, chemical resistant gloves, and eye protection during repair.

A damaged suction dampener diaphragm will allow a suction leak and will cause improper pump operation. If the diaphragm is damaged, remove diaphragm from dampener housing and replace it (Fig. 4).

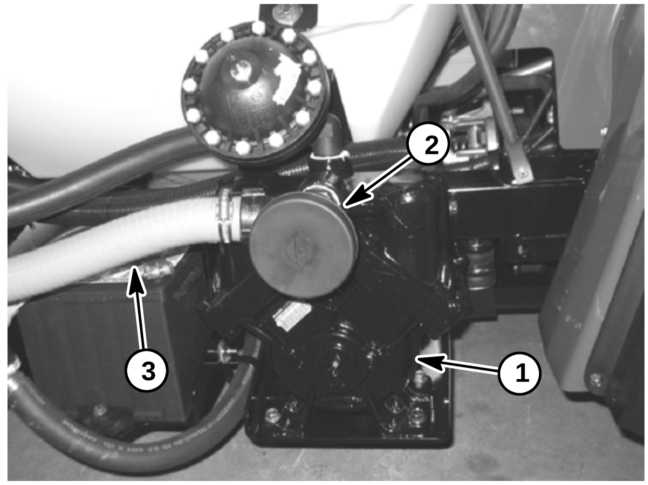
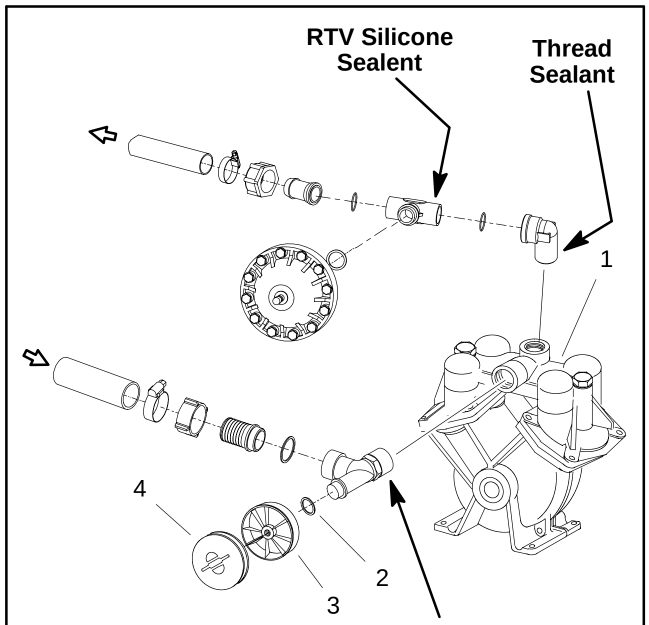


Figure 3

1. **Spray pump**
2. **Suction dampener**
3. **Suction hose**



NOTE: ARROWS SHOW FLUID FLOW DIRECTION

Figure 4

1. **Spray pump**
2. **O-ring**
3. **Dampener housing**
4. **Diaphragm**

Pressure Dampener

The pressure dampener is mounted to the pressure line at the spray pump (Fig. 5) and is used to smooth system pressure pulsation. Adjust air pressure on the pressure dampener to approximately 1/3 of the spraying pressure (e.g. if the spraying pressure is 45 PSI (3.1 bar), the dampener pressure should be 15 PSI (1 bar)). If fluid is present when pressure in the dampener is checked, the diaphragm in the pressure dampener is damaged and should be replaced.

Dampener Service (Fig. 6)

IMPORTANT: Make sure to neutralize and remove chemicals from pump and hoses before loosening and removing spray system components. Wear protective clothing, chemical resistant gloves, and eye protection during repair.

1. Loosen and remove cap screws and nuts that secure diaphragm between housings.

2. Remove diaphragm from dampener.

3. Replace diaphragm and reassemble dampener.

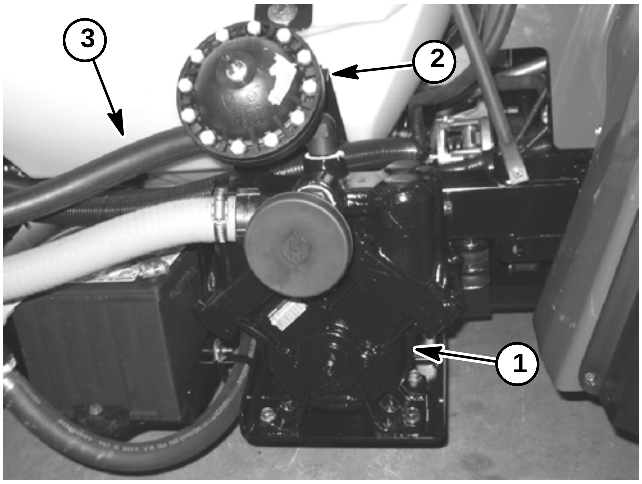


Figure 5

1. **Spray pump**
2. **Pressure dampener**
3. **Pressure hose (1")**

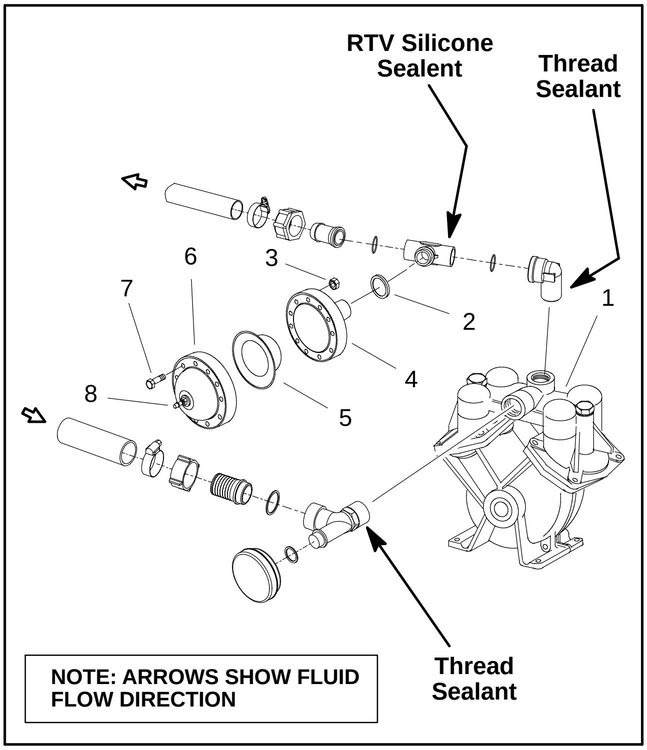


Figure 6

1. **Spray pump**
2. **O-ring**
3. **Hex nut (12 used)**
4. **Rear housing**
5. **Diaphragm**
6. **Front housing**
7. **Cap screw (12 used)**
8. **Air valve**

Spray System

Spray Pump

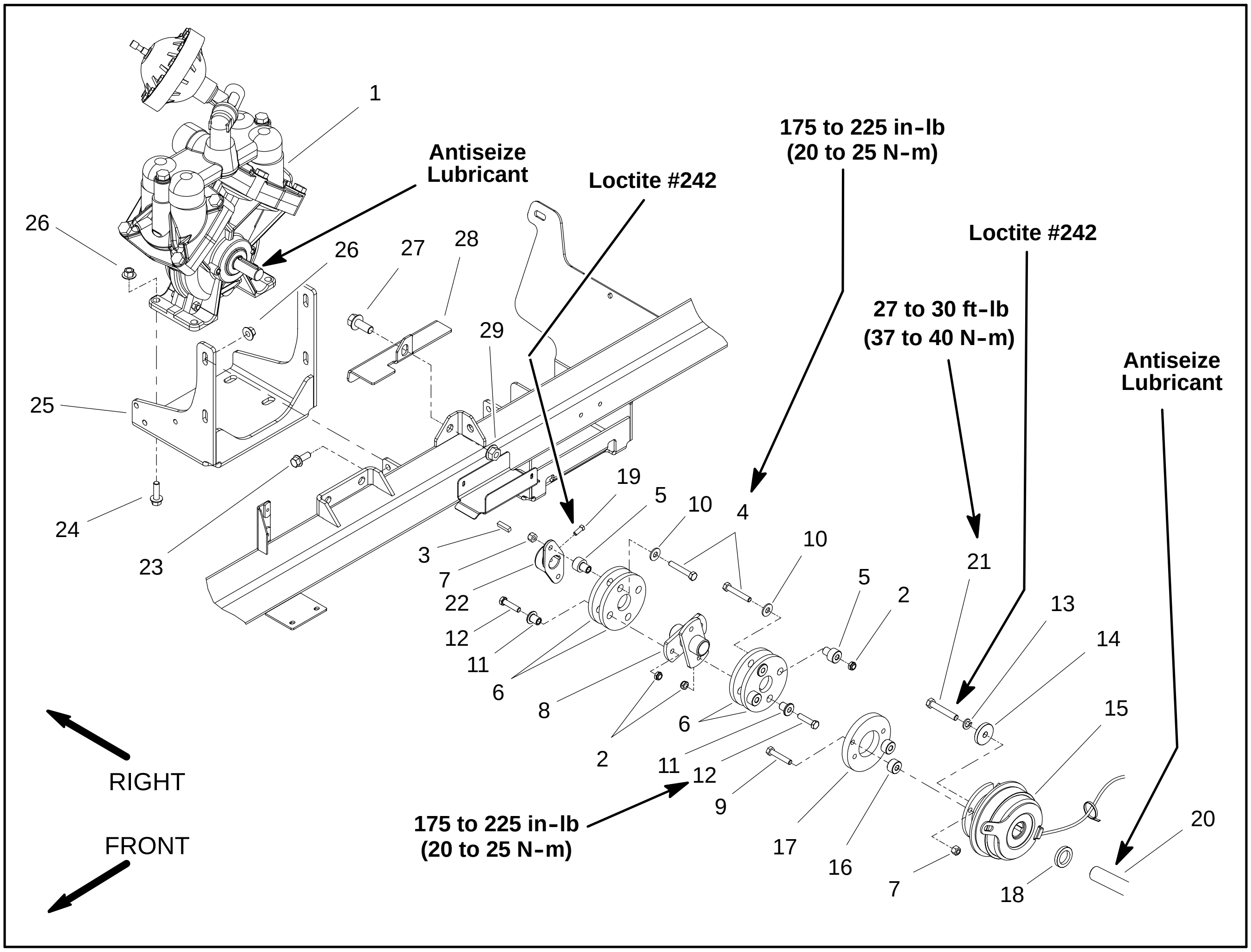


Figure 7

1. **Spray pump**
2. **Lock nut (6 used)**
3. **Key**
4. **Cap screw (4 used)**
5. **Coupling spacer (4 used)**
6. **Rubber coupling (4 used)**
7. **Lock nut (4 used)**
8. **Drive coupler**
9. **Cap screw (2 used)**
10. **Flat washer (4 used)**
11. **Spacer (4 used)**
12. **Cap screw (4 used)**
13. **Lock washer**
14. **Clutch retainer**
15. **Electric clutch**
16. **Spacer (2 used)**
17. **Clutch adapter**
18. **Spacer**
19. **Set screw (2 used)**
20. **Pump drive gearbox shaft**
21. **Cap screw**
22. **Pump hub**
23. **Flange head screw (4 used)**
24. **Flange head screw (4 used)**
25. **Pump mount bracket**
26. **Flange nut (8 used)**
27. **Flange head screw**
28. **Pump guard**
29. **Flange nut**

Removal (Fig. 7)

IMPORTANT: Make sure to neutralize and remove chemicals from pump and hoses before loosening and removing spray system components. Wear protective clothing, chemical resistant gloves, and eye protection during repair.

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

2. Loosen hose clamps that secure suction and pressure hoses to hose barbs on pump fittings. Pull suction and pressure hoses from hose barbs.

3. Remove lock nuts, flat washers, cap screws and coupling spacers that secure rubber couplings to pump hub (item 22).

4. Remove flange head screws and flange nuts that secure pump to pump mount bracket.

5. Remove spray pump from machine.

6. Loosen set screws in pump hub. Pull hub from pump shaft. Locate and remove key from pump shaft.

7. For assembly purposes, matchmark fittings at pump inlet and outlet to make sure that the fittings will be properly aligned during pump installation. Also, matchmark position of tee fitting (pressure) (item 4 in Fig. 9) at elbow (pressure).

8. Remove pressure dampener, tee fitting (pressure) and elbow (pressure) from pump outlet (Fig. 9). Discard removed gasket.

9. Remove suction dampener and tee fitting (suction) from pump inlet (Fig. 9). Discard removed O–ring and seal.

Installation (Fig. 7)

NOTE: Coat all O–rings with vegetable oil before installation to reduce the chance of damage during assembly.

1. Apply thread sealant to threads of elbow (pressure) and install elbow into pump outlet (Fig. 9). Use matchmark made during pump removal to properly orientate elbow.

2. Apply RTV silicone sealant to threads of tee fitting (pressure) that will thread into elbow (pressure) and install fitting into elbow (Fig. 9). Use matchmark made during pump removal to properly orientate tee fitting. Install pressure dampener (with new O–ring) and hosebarb (with new gasket) to tee fitting.

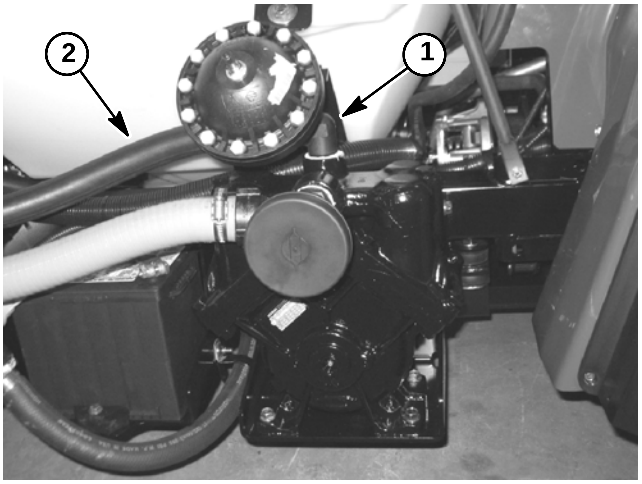


Figure 8

1. Elbow (pressure)
2. Suction hose

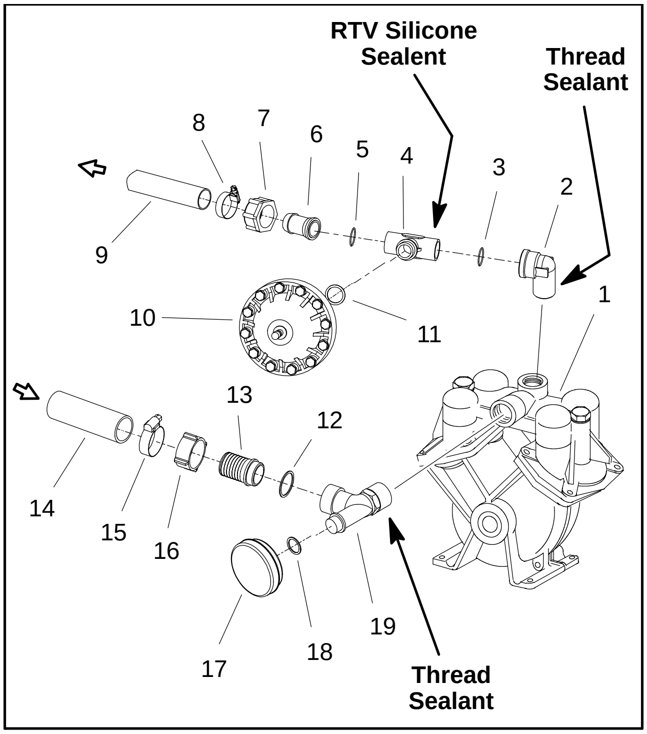


Figure 9

1. Spray pump
2. Elbow (pressure)
3. O–ring
4. Tee fitting (pressure)
5. Gasket
6. Hosebarb
7. Nut
8. Hose clamp
9. Pressure hose
10. Pressure dampener
11. O–ring
12. Seal
13. Hosebarb
14. Suction hose
15. Hose clamp
16. Nut
17. Suction dampener
18. O–ring
19. Tee fitting (suction)

Spray System

3. Apply thread sealant to threads of tee fitting (suction) and install fitting into pump inlet (Fig. 9). Use matchmark made during pump removal to properly orientate tee fitting. Install suction dampener (with new O–ring) and hosebarb (with new seal) to tee fitting.

IMPORTANT: If pump drive coupler components were disassembled, make sure that pump hub flanges and drive coupler are installed at right angles (90 degrees) to each other (Fig. 10).

4. Remove set screws from pump hub. Clean threads of set screws and hub.

5. Apply antiseize lubricant to pump shaft. Install key in shaft and slide pump hub onto shaft.

6. Position pump on pump mounting bracket. Install flange head screws and flange nuts to pump and mounting bracket. Leave fasteners loose.

7. Place coupling spacers into rubber coupling. Install cap screws, flat washers and lock nuts to secure rubber couplings to pump hub. Make sure that cap screw threads extend fully through lock nut.

IMPORTANT: Before securing spray pump to mounting bracket, make sure that the pump shaft, coupler assembly and electric clutch are properly aligned. There should not be distortion of the rubber couplings. Failure to properly align the pump may result in coupler failure. The spray pump alignment fixture (see Special Tools in this chapter) can be used to properly locate pump mounting bracket to machine frame and ensure coupler alignment.

8. Position pump on mounting bracket so that rubber couplings are not distorted. Secure pump to mounting bracket by tightening flange head screws and flange nuts.

9. Apply Loctite #242 (or equivalent) to threads of pump hub set screws. Install set screws into pump hub to secure hub to pump shaft.

10. Install pressure and suction hoses to correct barb fittings. Secure hoses with hose clamps.

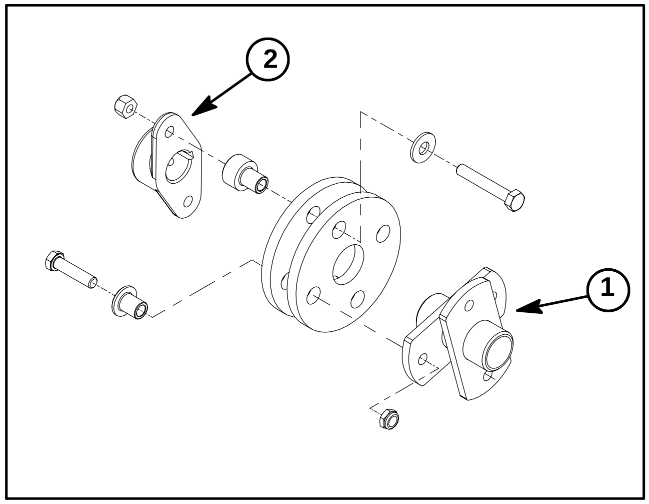


Figure 10

1. Drive coupler **2. Pump hub**

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Spray Pump Service

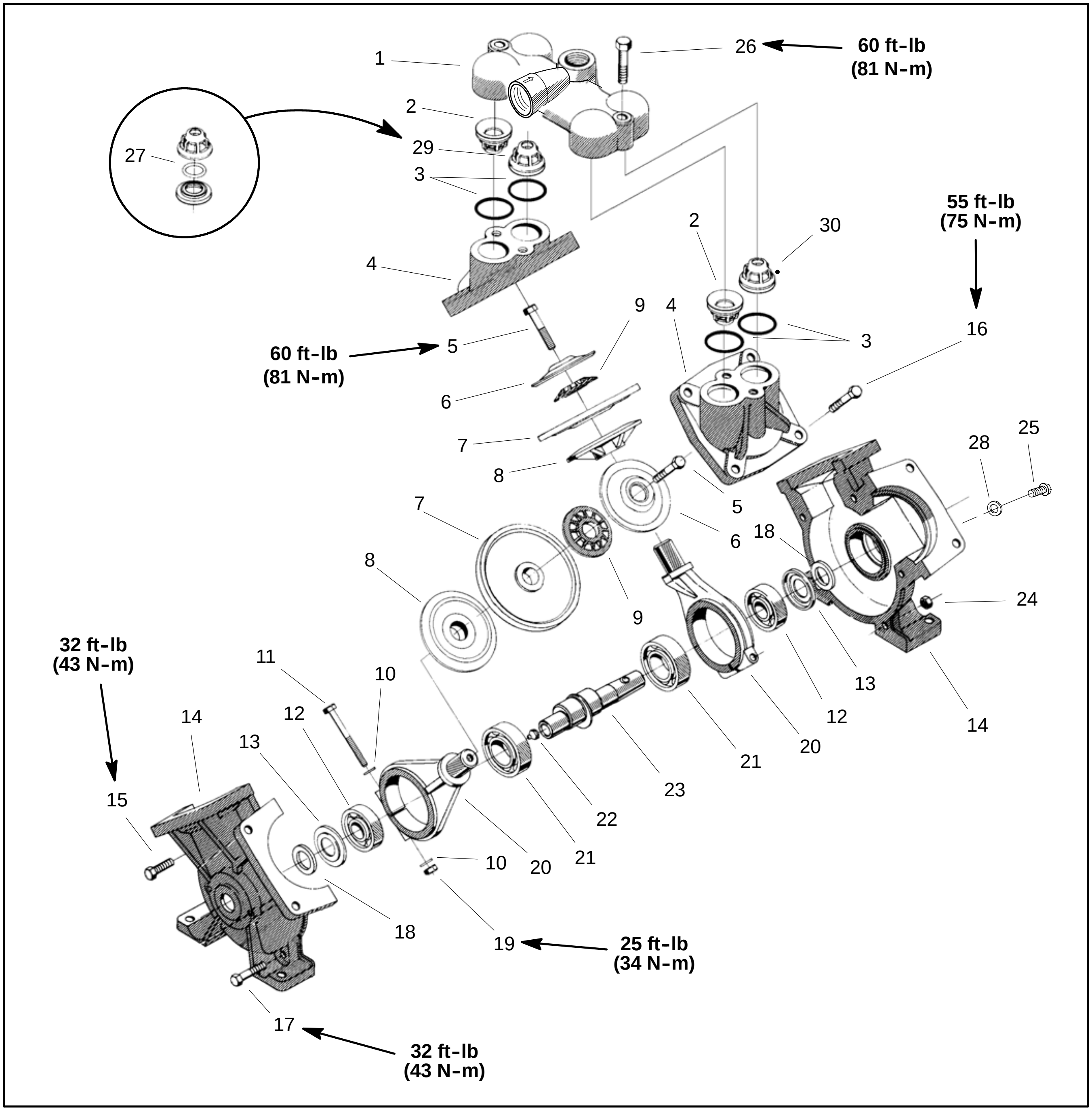

Figure 11

1. **Valve chamber**
2. **Valve (inlet position)**
3. **O-ring**
4. **Diaphragm cover**
5. **Hex bolt**
6. **Washer**
7. **Diaphragm**
8. **Diaphragm back disc**
9. **Nylon washer**
10. **Lock washer**
11. **Hex bolt (M8)**
12. **Ball bearing (crankshaft)**
13. **Dust plate**
14. **Pump casing**
15. **Hex bolt (30 mm long) (3 used)**
16. **Hex bolt (M12) (4 used per cover)**
17. **Hex bolt (55 mm long) (2 used)**
18. **Felt seal**
19. **Hex nut (M8)**
20. **Connecting rod**
21. **Ball bearing (connecting rod)**
22. **Grease fitting**
23. **Crankshaft**
24. **Hex nut (5 used)**
25. **Hex bolt**
26. **Hex bolt (2 used)**
27. **Poly O-ring**
28. **Lock washer**
29. **Valve (outlet position)**

Disassembly (Fig. 11)

IMPORTANT: Make sure to remove and neutralize chemicals from pump before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during pump repair.

1. Remove two (2) hex bolts that retain valve chamber to pump. Separate valve chamber from pump.

2. Remove inlet and outlet valves and O–rings from each diaphragm cover. Note orientation of valves. Discard valves and O–rings. Clean valve and O–ring seats in the valve chambers and diaphragm covers.

3. Remove hex bolts that secure diaphragm covers to pump. Remove diaphragm covers.

4. Remove hex bolt, washer, nylon washer, diaphragm and diaphragm back disc from each connecting rod. Discard diaphragms.

5. Remove five (5) hex bolts and nuts that secure pump casing halves together. Note location of two (2) longer hex bolts. Carefully separate pump casing halves.

6. Clean grease from bottom of housing and check condition of bearings on crankshaft. If bearings require replacement, remove and disassemble crankshaft:

A. Remove crankshaft assembly from pump casing.

B. Slide felt seal and dust plate from both ends of crankshaft.

C. Loosen bolt and hex nut that secure connecting rods to crankshaft. Slide connecting rods from crankshaft.

D. Press ball bearings from crankshaft.

Assembly (Fig. 11)

1. If crankshaft was disassembled, reassemble crankshaft:

A. Hand pack new bearings with #2 general purpose lithium base grease.

B. Pressing on bearing inner race, install two connecting rod and two crankshaft ball bearings onto crankshaft.

C. Slide connecting rods onto rod bearings. Offsets of the connecting rods should face each other. Install hex bolt, flat washers and hex nut to connecting rod. Torque hex nuts to **25 ft–lb (34 N–m)** to secure connecting rod to crankshaft.

D. Position dust plate and felt seal on both ends of crankshaft.

IMPORTANT: If connecting rod position is incorrect, pump will not operate properly.

E. Slide crankshaft assembly into pump casing. The rear connecting rod should be positioned to the left side and the connecting rod closest to you to the right side (Fig. 12).

2. Place second pump casing onto assembly. Pump casing surfaces should mate together.

3. Install three (3) shorter (30 mm) and two (2) longer (55 mm) bolts into pump casing assembly (Fig. 13). Thread hex nuts onto bolts but do not fully tighten. Check that crankshaft turns freely.

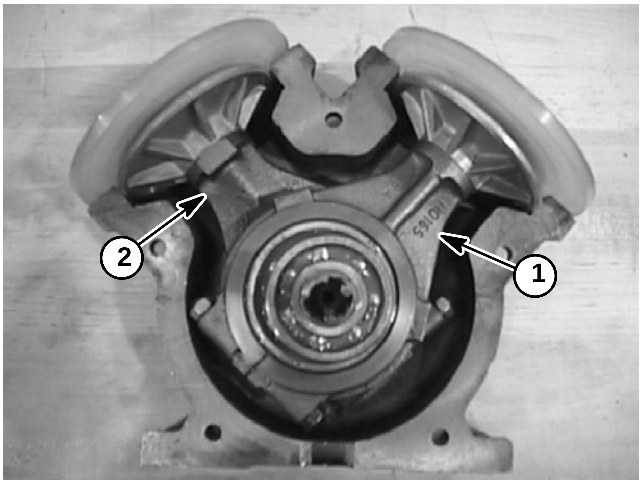

Figure 12

1. **Closest connecting rod (to right side)**
2. **Rear connecting rod (to left side)**

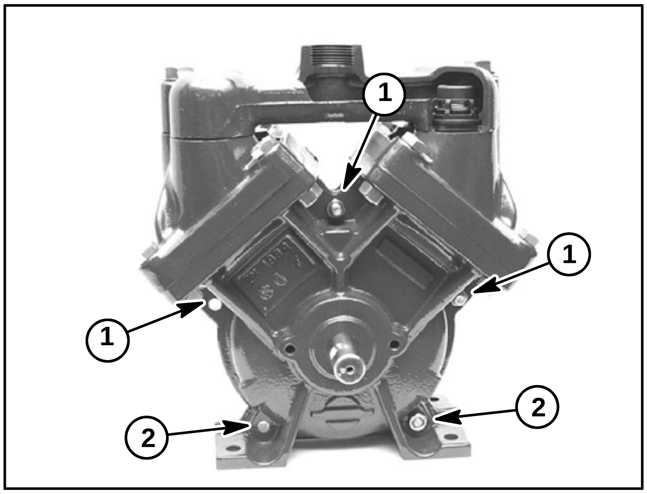

Figure 13

1. **Hex bolt (30 mm long)**
2. **Hex bolt (55 mm long)**

Spray System

4. Place diaphragm back disc and new diaphragm onto each connecting rod. The connecting rods should extend above the diaphragms when correctly installed (Fig. 14). Position nylon washer and washer on each connecting rod and then thread hex bolt into connecting rod. Torque bolt to **60 ft–lb (81 N–m)**.

5. Make sure that pump casings align and then secure pump casing assembly by torquing five (5) bolts to **32 ft–lb (43 N–m)**.

6. Secure diaphragm covers to pump with hex bolts (4 per cover). Torque bolts to **55 ft–lb (75 N–m)**.

7. Place new O–rings and valves into diaphragm cover openings (Fig. 15). Inlet valves should be installed with the spring down into the cover. Outlet valves should be installed in with the spring up and away from cover.

8. Place valve chamber over valves noting orientation of chamber inlet and outlet. Secure valve chamber with two (2) hex bolts. Torque bolts **60 ft–lb (81 N–m)**.

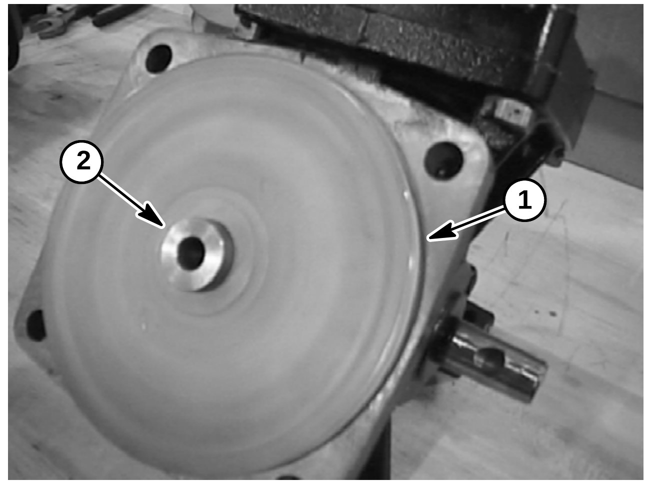

Figure 14

1. **Diaphragm**
2. **Connecting rod**

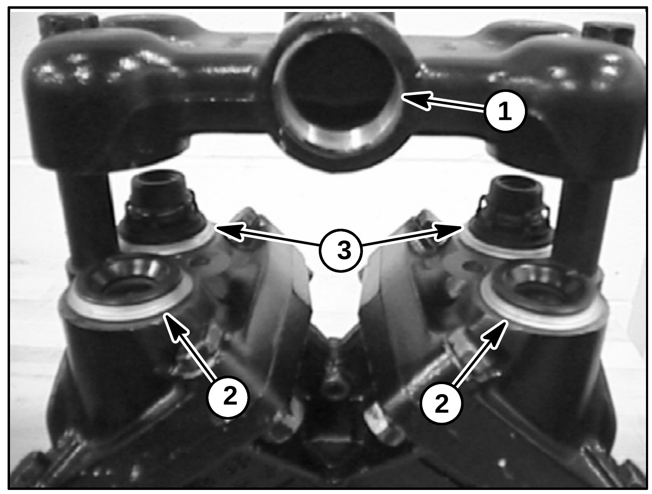

Figure 15

1. **Inlet (suction)**
2. **Inlet valve**
3. **Outlet valve**

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Spray System

Agitation Control Valve

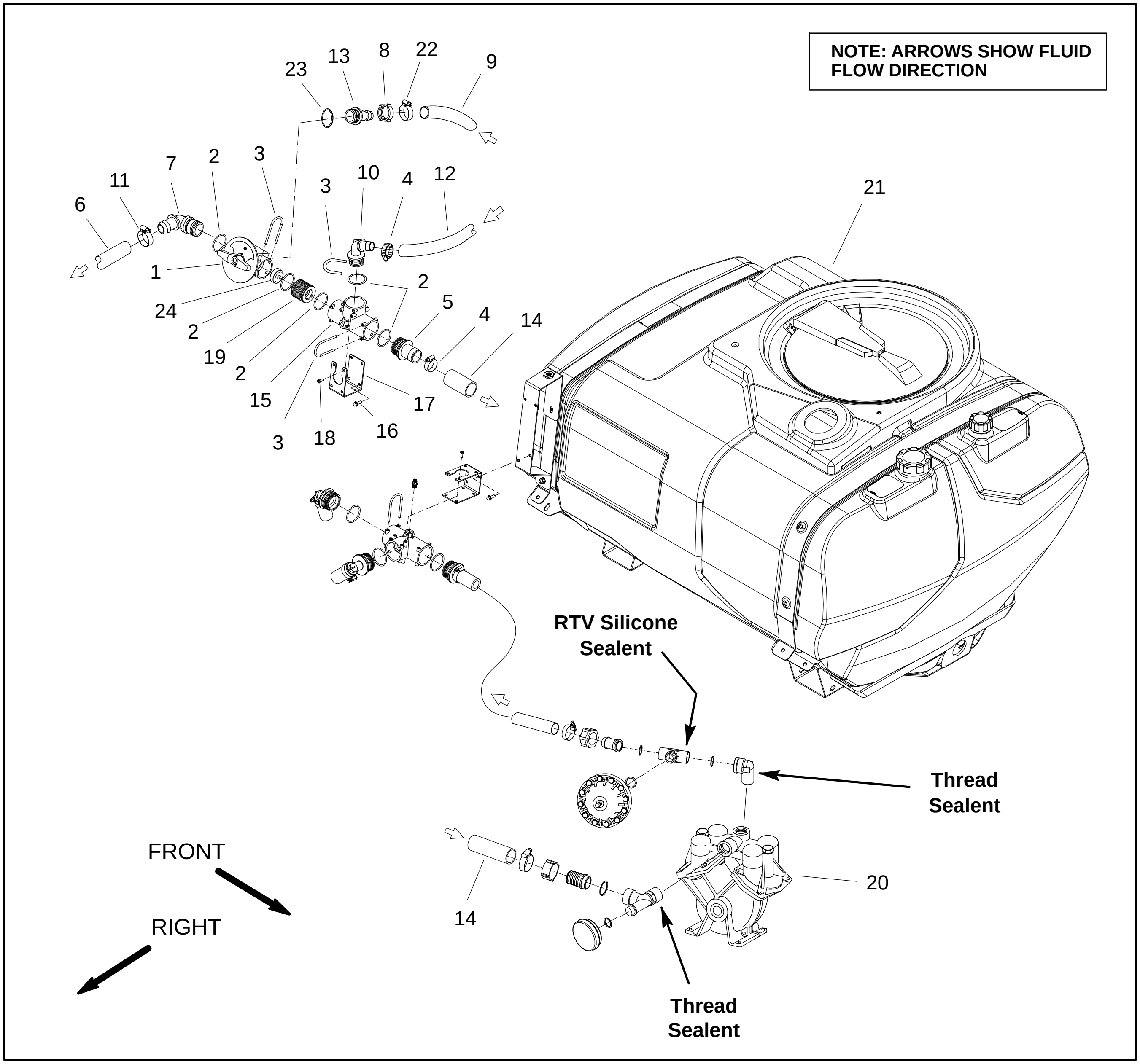

Figure 16

1. Agitation control valve
2. O-ring
3. Fork
4. Hose clamp
5. Hosebarb
6. Hose: agitation supply (1”)
7. Hosebarb
8. Nut
9. Hose: control bypass (1”)
10. Hosebarb
11. Hose clamp
12. Hose: tank suction (1 1/2”)
13. Hosebarb
14. Suction hose (1 1/2”)
15. Tee
16. Flange head screw (2 used)
17. Tee bracket
18. Screw (4 used)
19. Connector
20. Spray pump
21. Spray tank
22. Hose clamp
23. O-ring
24. Agitation reducer

Removal (Fig. 16)

IMPORTANT: Make sure to remove and neutralize chemicals from spray components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

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

2. Label hoses to allow proper installation after repairs are completed. Loosen hose clamps and remove hoses from hosebarbs that are to be disassembled.

3. Remove agitation control valve using Figures 16 and 17 as guides. If agitation reducer (item 24) is removed, note direction of chamfer on reducer for assembly purposes.

4. Disassemble agitation valve as required (Fig 18).

Installation (Fig. 16)

NOTE: Coat all O-rings with vegetable oil before installation to reduce the chance of damage during assembly.

1. Assemble agitation control valve (Fig 18). Align arrow on valve handle with large hole in valve ball during assembly (Fig. 19).

2. Install agitation valve using Figures 16 and 17 as guides.

3. Using labels placed during disassembly, install hoses to hosebarbs and secure with hose clamps.

4. Check spray system for leaks. Repair all leaks before returning the sprayer to service.

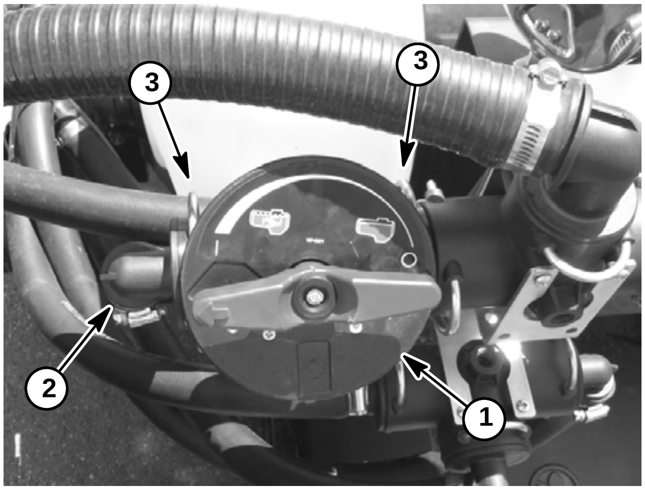

Figure 17

1. **Agitation control valve**
2. **Agitation supply hose**
3. **Fork**

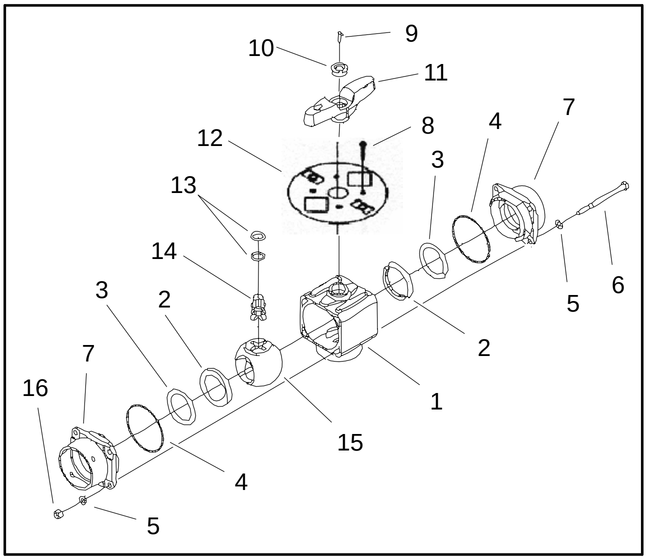

Figure 18

1. **Valve housing**
2. **Ball seat**
3. **O-ring**
4. **O-ring**
5. **Washer (8 used)**
6. **Cap screw (4 used)**
7. **End cover**
8. **Screw (4 used)**
9. **Screw**
10. **Button**
11. **Valve handle**
12. **Disc**
13. **O-ring**
14. **Spindle**
15. **Valve ball**
16. **Lock nut (4 used)**

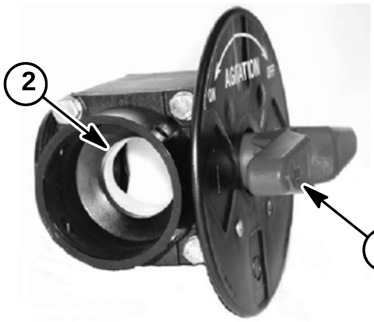

Figure 19

1. **Valve handle arrow**
2. **Valve ball large hole**

Agitation Components (Tank mounted)

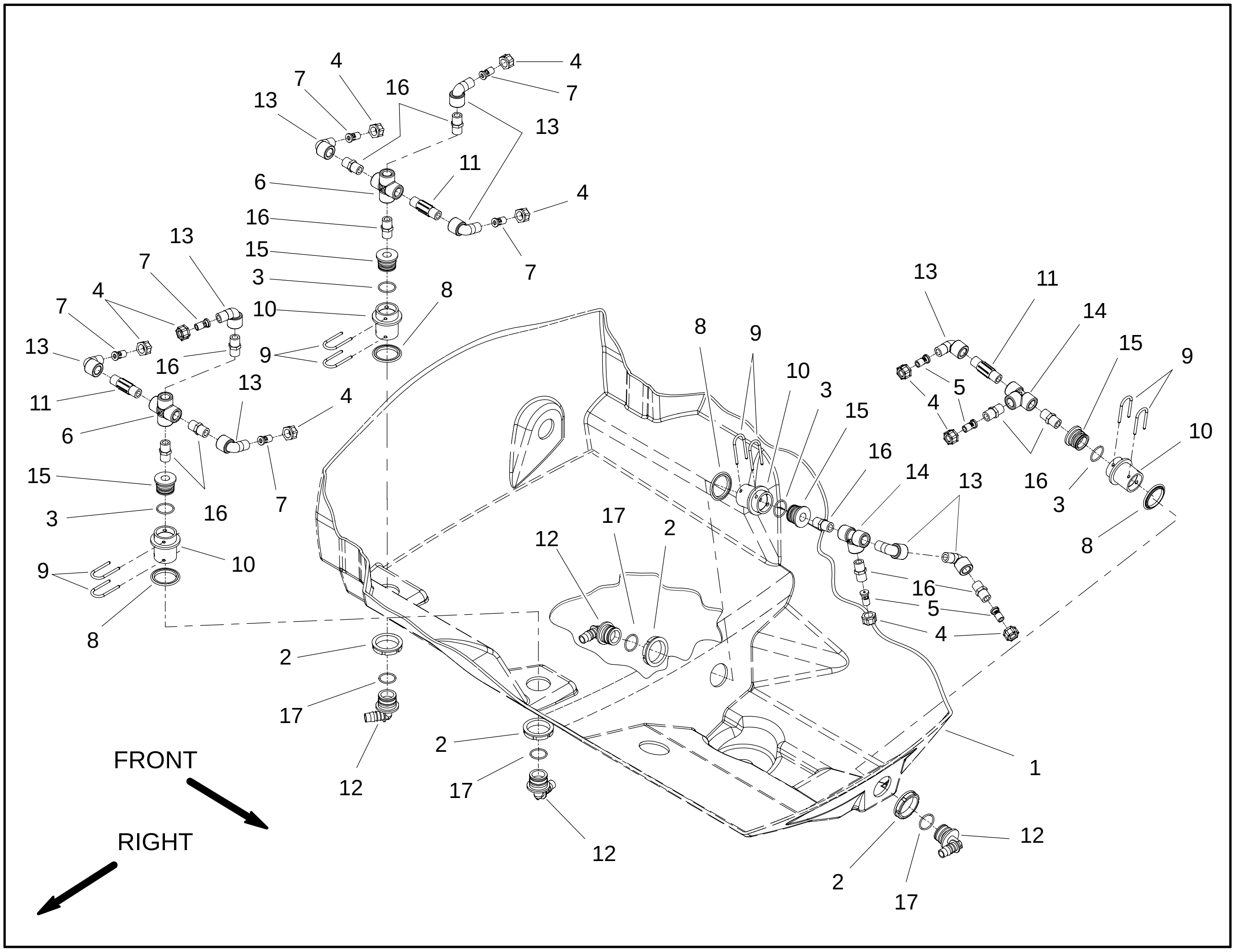

Figure 20

1. **Spray Tank**
2. **Bulkhead nut**
3. **O-ring**
4. **Nut**
5. **Agitation nozzle**
6. **Cross**
7. **Agitation nozzle**
8. **Bulkhead gasket**
9. **Fork**
10. **Bulkhead fitting**
11. **Nipple**
12. **Hosebarb**
13. **Elbow**
14. **Tee**
15. **Adapter**
16. **Nipple**
17. **O-ring**

Disassembly (Fig. 20)

IMPORTANT: Make sure to remove and neutralize chemicals from tank and other components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

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

2. Drain spray tank (see Operator's Manual).

3. Label hoses to allow proper installation after repairs are completed. Loosen hose clamps and remove hoses from all hosebarbs that are to be disassembled.

4. Remove agitation components as required using Figure 20 as a guide. Discard all removed O–rings and gaskets.

Assembly (Fig. 20)

NOTE: Coat all O–rings with vegetable oil before installation to reduce the chance of damage during assembly.

1. Install agitation components using Figure 20 as a guide. Replace all removed O–rings and gaskets.

2. Using labels placed during disassembly, install hoses to hosebarbs and secure with hose clamps.

3. Check spray system for leaks. Repair all leaks before returning the sprayer to service.

Pressure Relief Valve (Tank Mounted)

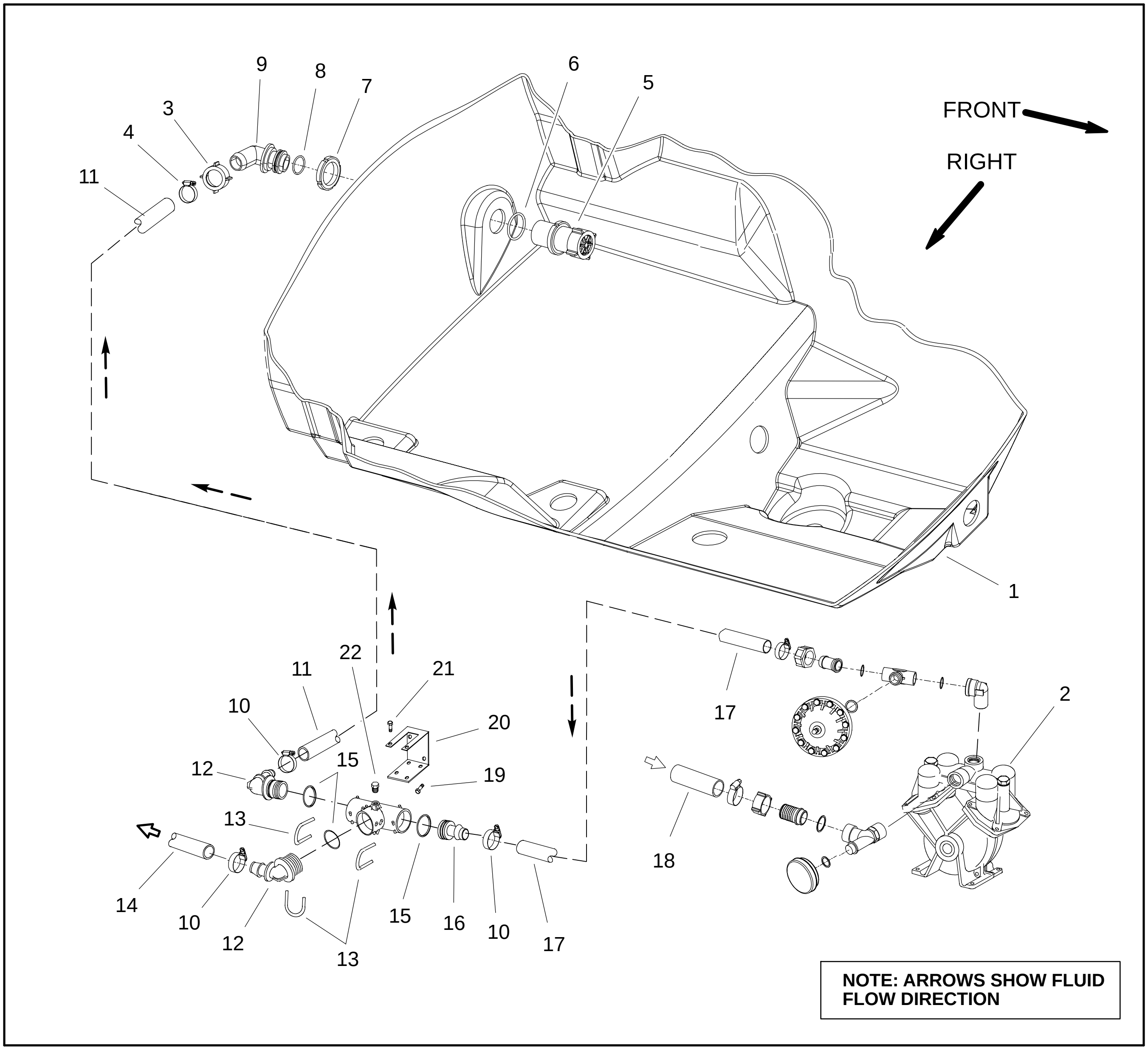

Figure 21

1. **Spray tank**
2. **Spray pump**
3. **Ring nut**
4. **Hose clamp**
5. **Relief valve assembly**
6. **Gasket**
7. **Ringnut**
8. **O–ring**
9. **Hosebarb**
10. **Hose clamp**
11. **Hose: pressure relief valve (1”)**
12. **Hosebarb**
13. **Fork**
14. **Hose: control supply (1”)**
15. **O–ring**
16. **Hosebarb**
17. **Pressure supply hose (1”)**
18. **Suction hose (1 1/2”)**
19. **Flange head screw (2 used)**
20. **Tee bracket**
21. **Phillips head screw (4 used)**
22. **Coupler (MP 1200)**

Removal (Fig. 21)

IMPORTANT: Make sure to remove and neutralize chemicals from tank and other components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

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

2. Drain spray tank (see Operator's Manual).

3. Label hoses to allow proper installation after repairs are completed. Loosen hose clamps and remove hoses from hosebarbs that are to be disassembled.

4. Remove pressure relief valve from spray tank using Figures 21 and 22 as guides. Discard all removed O–rings and gaskets.

5. Disassemble relief valve using Fig. 23 as a guide.

Assembly (Fig. 21)

1. Assemble relief valve using Fig. 23 as a guide.

NOTE: Coat all O–rings with vegetable oil before installation to reduce the chance of damage during assembly.

2. Install pressure relief valve using Figures 21 and 22 as guides. Replace all removed O–rings and gaskets.

3. Using labels placed during disassembly, install hoses to hosebarbs and secure with hose clamps.

4. Check spray system for leaks. Repair all leaks before returning the sprayer to service.

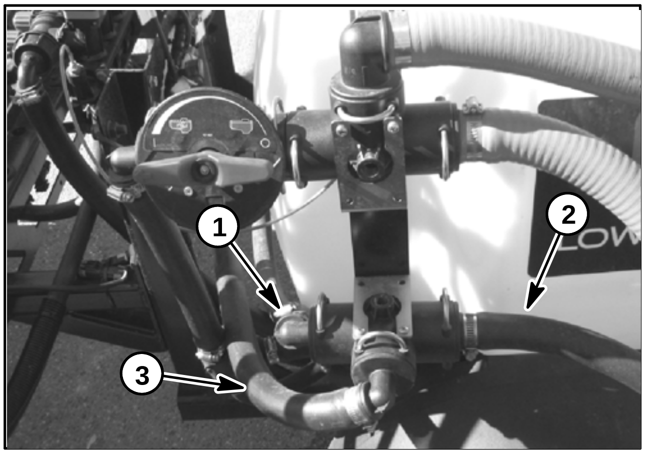

Figure 22

1. Hose to pressure relief
2. Hose from spray pump
3. Control supply hose

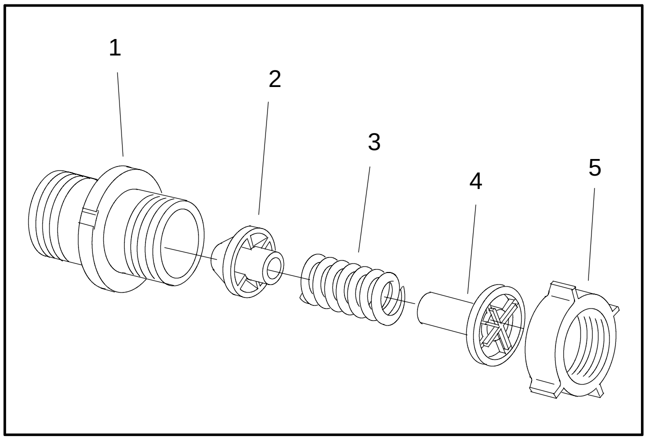

Figure 23

1. Housing
2. Relief valve cone
3. Spring
4. Relief valve seat
5. Nut

Spray System

Spray Control (Multi Pro 1200)

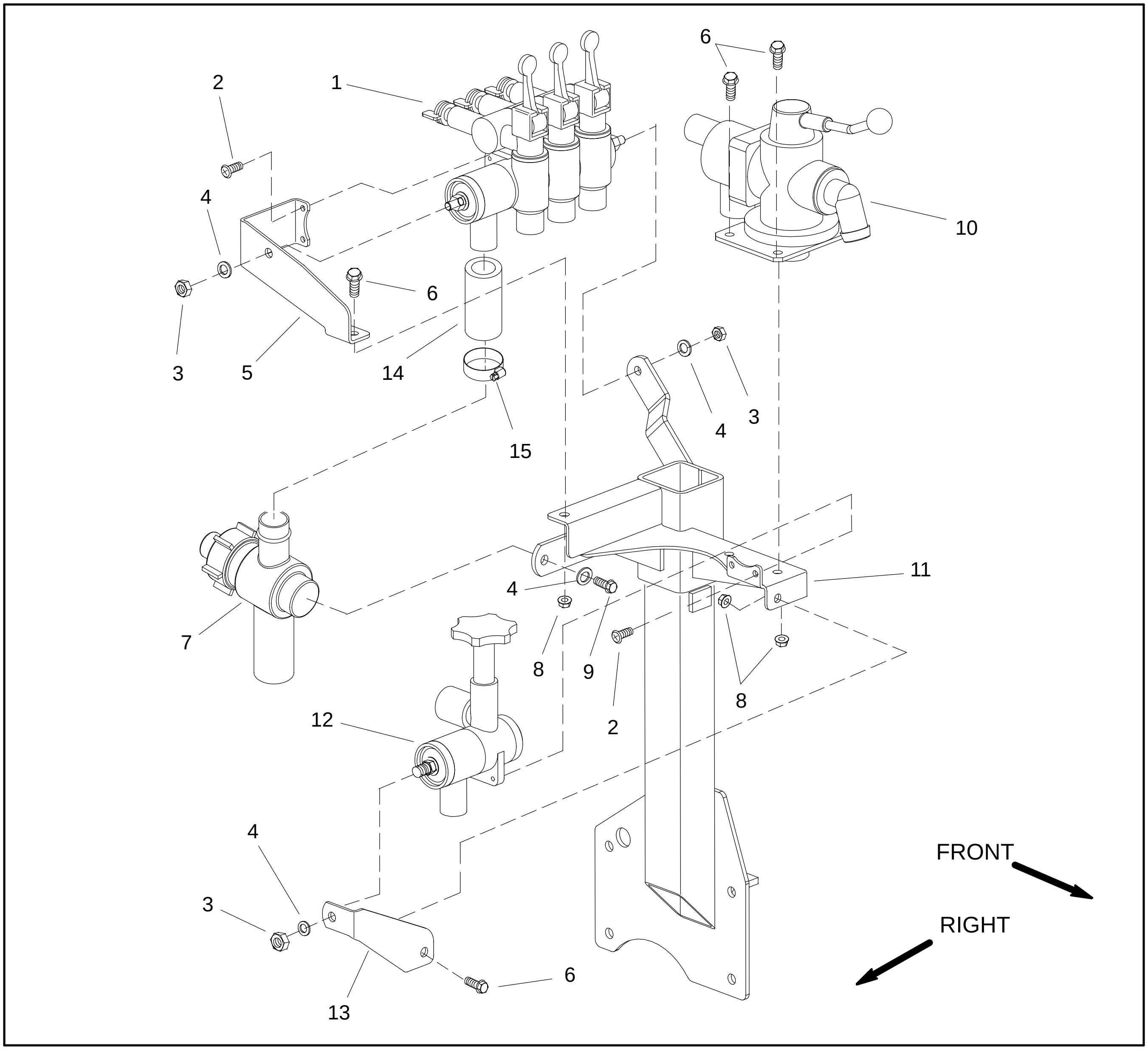

Figure 24

1. **Boom distribution valves**
2. **Screw**
3. **Hex nut**
4. **Washer**
5. **Bracket**
6. **Flange head screw**
7. **Flowmeter**
8. **Flange nut**
9. **Hex bolt**
10. **Master boom valve**
11. **Valve mount**
12. **Pressure control valve**
13. **Pressure control valve bracket**
14. **Pressure hose**
15. **Hose clamp**

Removal (Fig. 24)

IMPORTANT: Make sure to remove and neutralize chemicals from spray components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

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

2. Remove master boom valve handle, spray console panel and spray console from machine (Fig. 25).

3. Label hoses to allow proper installation after repairs are completed. Loosen hose clamps and remove hoses from hosebarbs that are to be disassembled.

4. Remove spray control components as required using Figures 24 and 26 as guides.

Assembly (Fig. 24)

1. Install spray control components using Figures 24 and 26 as guides.

2. Using labels placed during disassembly, install hoses to hosebarbs and secure with hose clamps.

3. Operate spray system and check for leaks. Repair all leaks before returning the sprayer to service.

4. Install spray console, spray control panel and master boom valve handle to machine (Fig. 25).

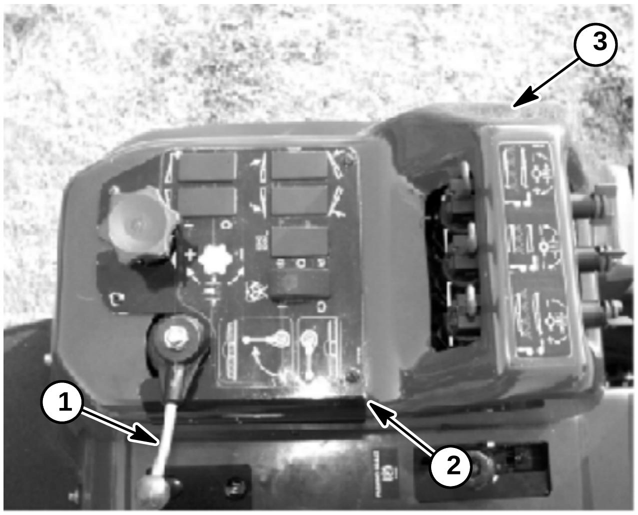

Figure 25

1. **Boom valve handle**
2. **Spray console panel**
3. **Spray console**

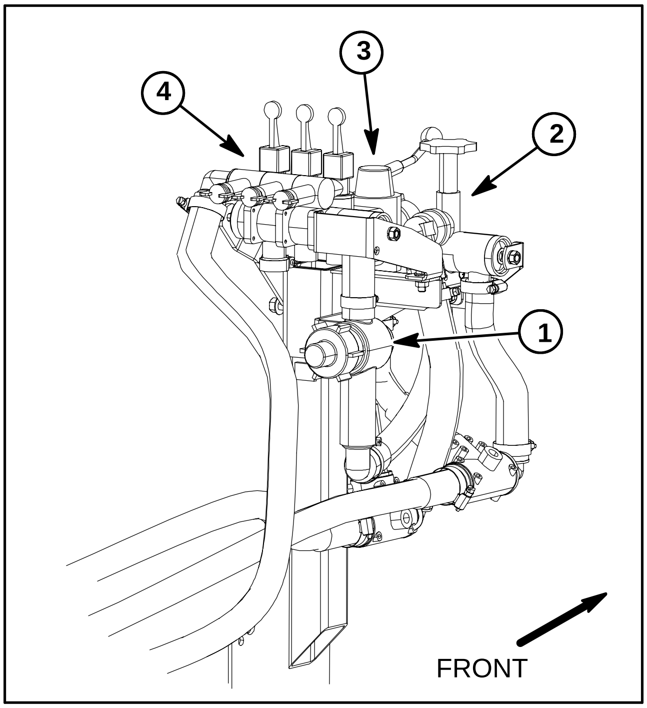

Figure 26

1. **Flowmeter**
2. **Pressure control valve**
3. **Master boom valve**
4. **Boom distribution valves**

Spray System

Flowmeter (Multi Pro 1200)

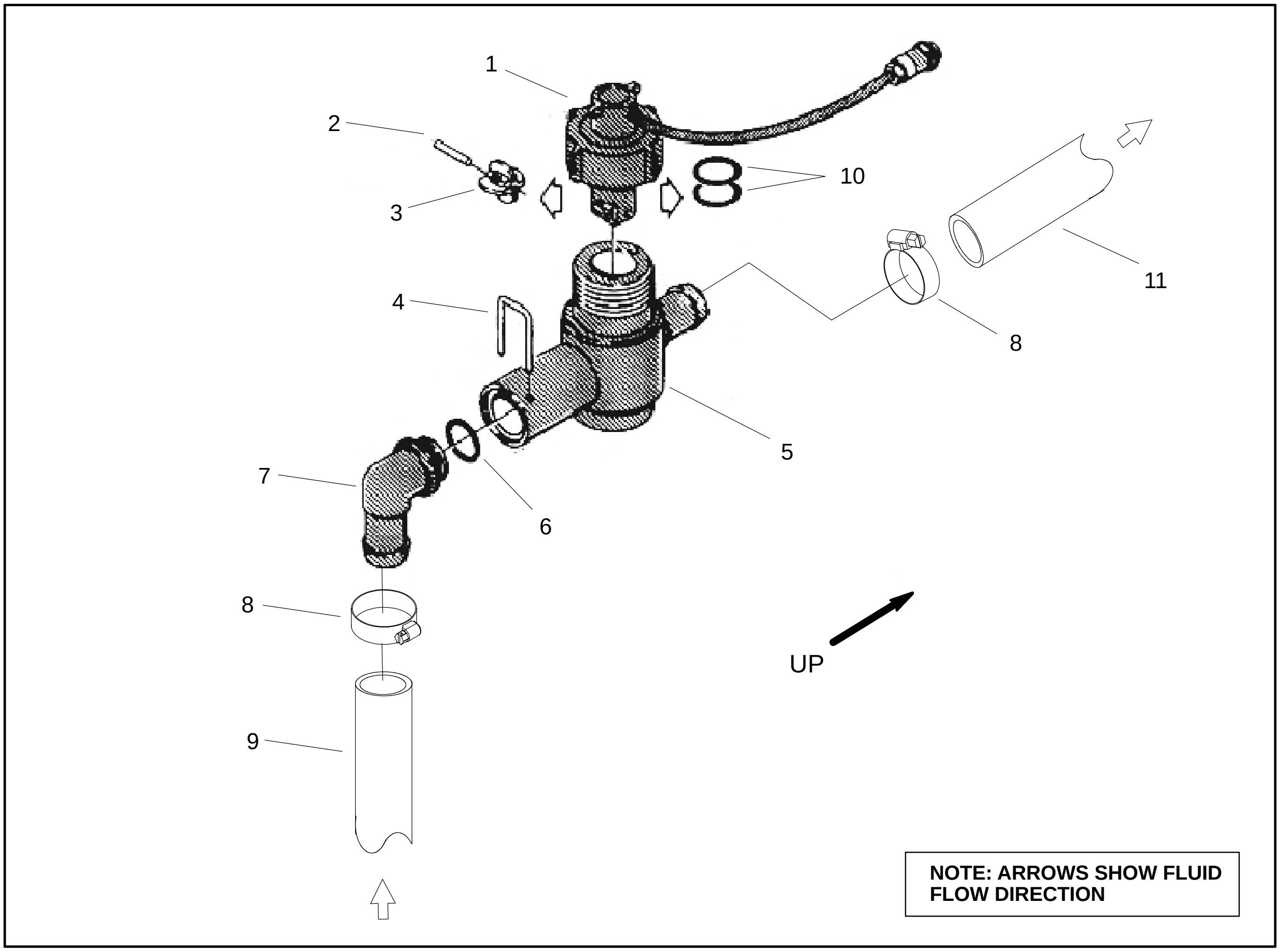

Figure 27

1. **Flow sensor with nut**
2. **Flowmeter rotor shaft**
3. **Flowmeter rotor**
4. **Fork**
5. **Flowmeter housing**
6. **O-ring**
7. **Hosebarb**
8. **Hose clamp**
9. **Hose: from master boom valve (1")**
10. **O-ring**
11. **Hose: to distribution valves (1")**

Removal and Inspection (Fig. 27)

IMPORTANT: Make sure to remove and neutralize chemicals from spray components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

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

2. Remove master boom valve handle, spray control panel and spray console from machine (Fig. 28).

3. Loosen and remove nut that secures flow sensor to housing (Fig. 29). Carefully remove flow sensor from flowmeter housing.

4. Clean rotor, rotor shaft and flowmeter sensor if required (see Operator's Manual).

5. With the flow sensor harness connected to the machine and the ignition key in the ON position, slowly spin the flowmeter rotor. The LED on the flowmeter should illuminate as a rotor magnet passes the flow sensor and should go out as the next rotor magnet passes the sensor.

NOTE: When using a magnet to check the flowmeter, make sure to alternately use both north and south poles of the magnet.

6. If the flowmeter LED does not flash, remove rotor and rotor shaft from sensor. With the flowmeter harness connected to the machine and the ignition key in the ON position, slowly pass alternate poles of a magnet past the flow sensor. If the flowmeter LED flashes as the magnet poles pass the sensor, replace the rotor and rotor shaft. If the flowmeter LED does not flash as the magnet poles pass the sensor, replace the flow sensor.

7. If necessary, remove flowmeter housing using Figures 27 and 29 as guides (also see Spray Control (Multi Pro 1200) in this section). Discard all removed O–rings and gaskets.

Assembly (Fig. 27)

NOTE: Coat all O–rings with vegetable oil before installation to reduce the chance of damage during assembly.

NOTE: When installing flow sensor into housing, make sure to align locating pin on sensor with hole in housing.

1. Assemble flowmeter using Figures 27 and 29 as guides. Replace all removed O–rings and gaskets.

2. Operate spray system and check for leaks. Repair all leaks before returning the sprayer to service.

3. Install spray console, spray control panel and master boom valve handle to machine (Fig. 28).

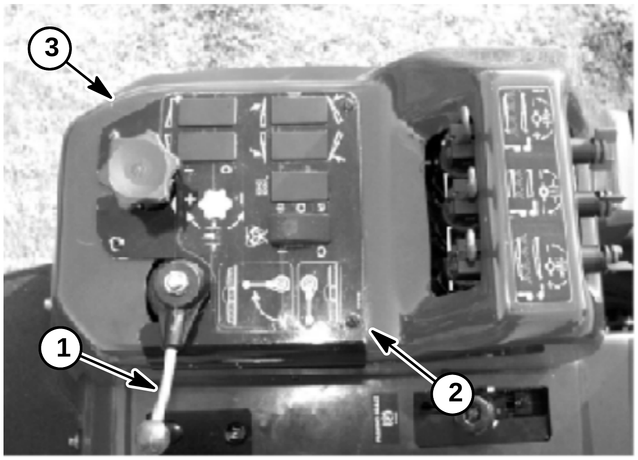

Figure 28

1. **Boom valve handle**
2. **Spray console panel**
3. **Spray console**

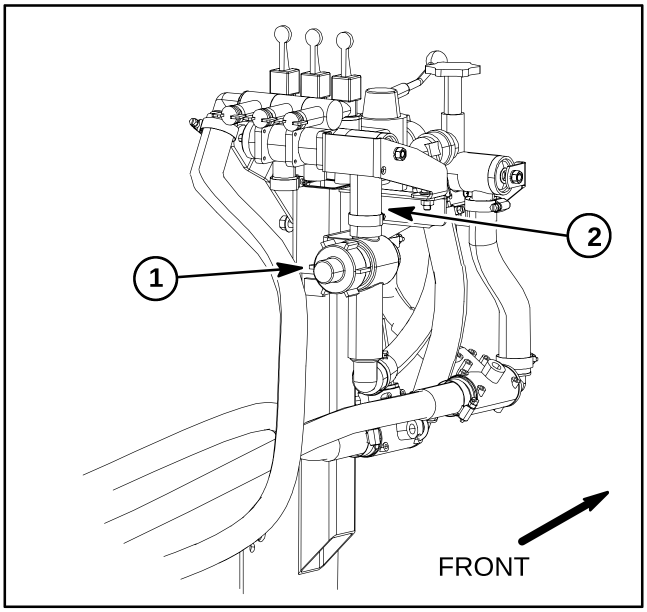

Figure 29

1. **Flowmeter assembly**
2. **Hose to boom valves**

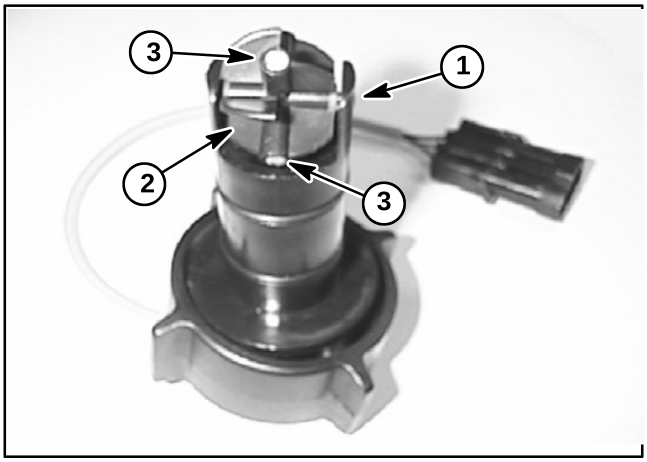

Figure 30

1. **Rotor shaft**
2. **Rotor**
3. **Rotor magnet**

Spray System

Master Boom Valve (Multi Pro 1200)

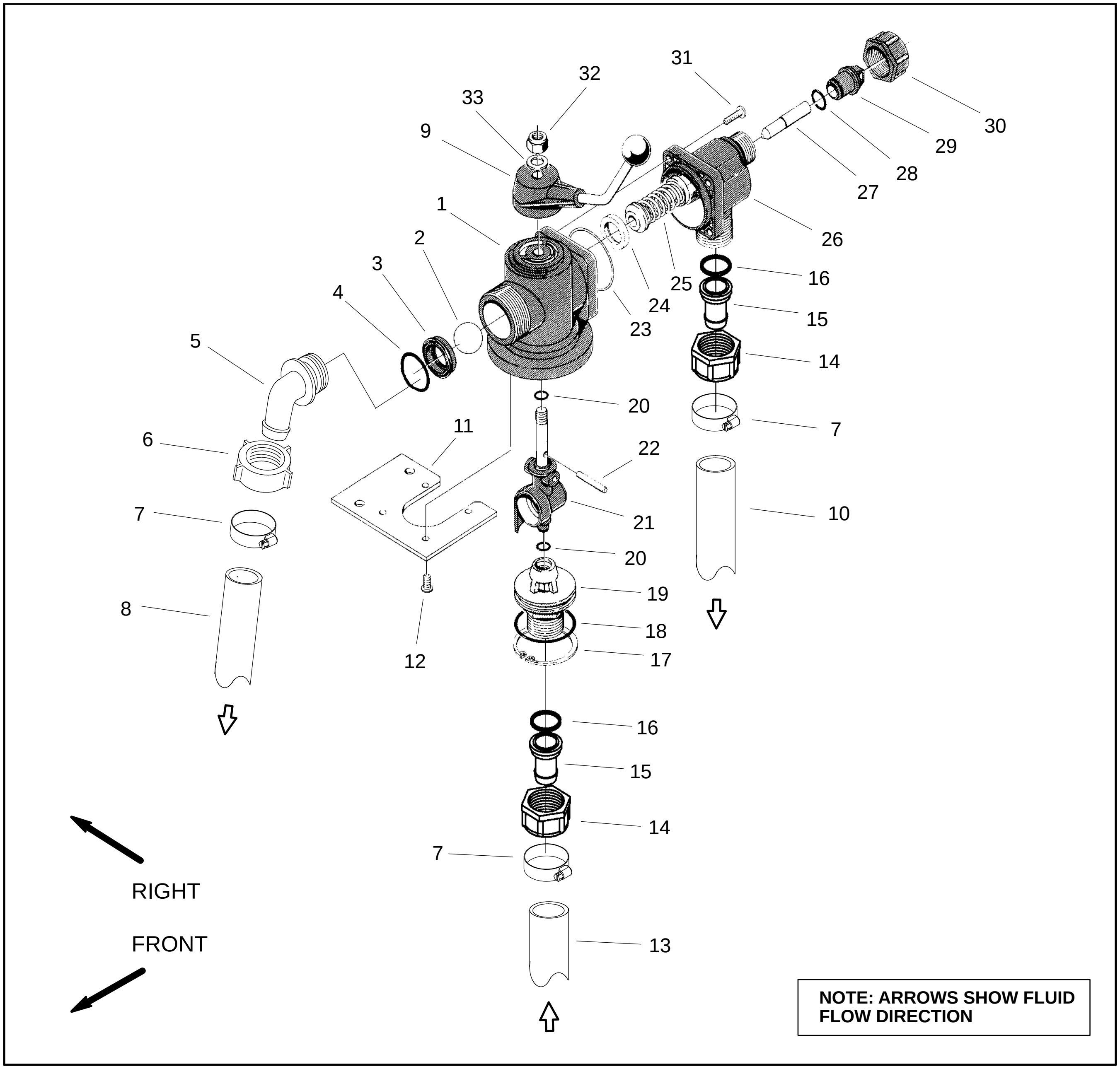

Figure 31

1. **Housing**
2. **Ball**
3. **Seat**
4. **O-ring**
5. **Hosebarb**
6. **Nut**
7. **Hose clamp**
8. **Hose: to flowmeter (1")**
9. **Handle**
10. **Hose: control bypass (1")**
11. **Plate**
12. **Screw (4 used)**
13. **Hose: pressure supply (1")**
14. **Nut**
15. **Hose barb**
16. **Seal**
17. **Retaining ring**
18. **O-ring**
19. **Adapter**
20. **O-ring**
21. **Stem**
22. **Roll pin**
23. **O-ring**
24. **Seat**
25. **Valve assembly**
26. **Pressure valve housing**
27. **Pin**
28. **O-ring**
29. **Fitting**
30. **Nut**
31. **Screw (4 used)**
32. **Hex nut**
33. **Washer**

Disassembly (Fig. 31)

IMPORTANT: Make sure to remove and neutralize chemicals from spray components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

1. Remove master boom valve from machine (see Spray Control (Multi Pro 1200) in this section).

2. Disassemble master boom valve using Figure 31 as a guide. Discard all removed O–rings.

Assembly (Fig. 31)

NOTE: Coat all O–rings with vegetable oil before installation to reduce the chance of damage during assembly.

1. Assemble master boom valve using Figure 31 as a guide. Replace all removed O–rings.

2. Install master boom valve to machine (see Spray Control (Multi Pro 1200) in this section).

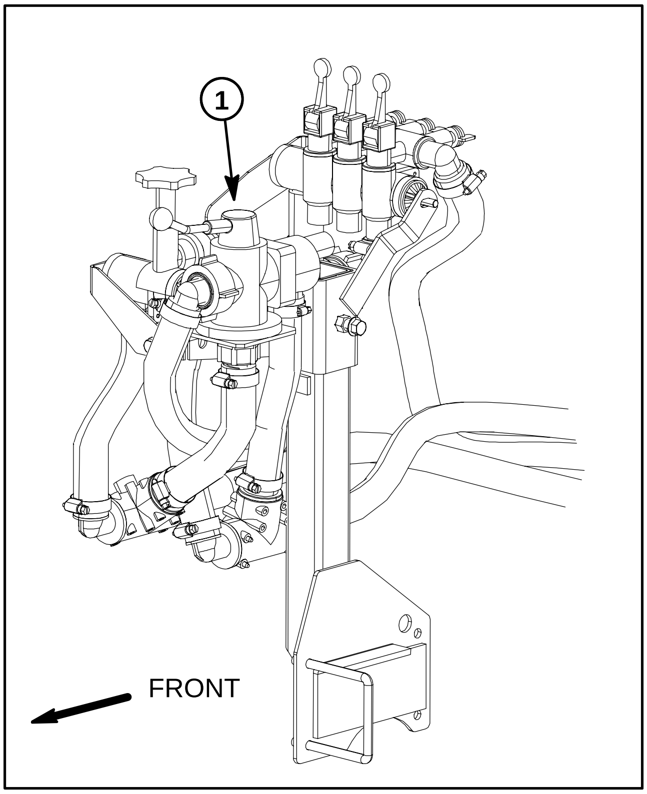

Figure 32

1. **Master boom valve**

Spray System

Pressure Control Valve (Multi Pro 1200)

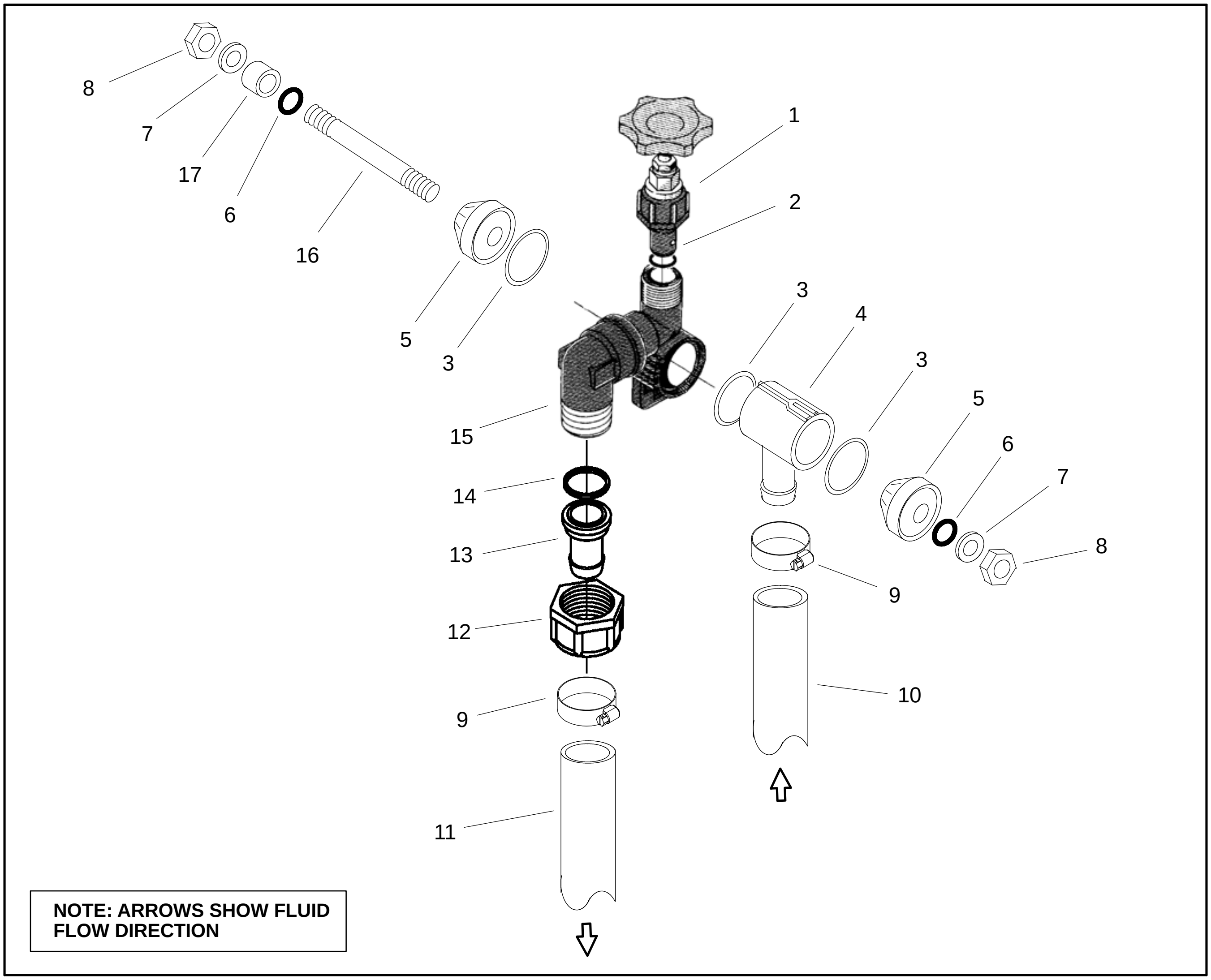

Figure 33

1. **Pressure control valve**
2. **O–ring**
3. **O–ring**
4. **Tee piece**
5. **Cap**
6. **O–ring**
7. **Washer**
8. **Hex nut**
9. **Hose clamp**
10. **Hose: pressure supply (1”)**
11. **Hose: control bypass (1”)**
12. **Nut**
13. **Hosebarb**
14. **Seal**
15. **Pressure control housing**
16. **Threaded rod**
17. **Bushing**

Disassembly (Fig. 33)

IMPORTANT: Make sure to remove and neutralize chemicals from spray components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

1. Remove pressure control valve from machine (see Spray Control (Multi Pro 1200) in this section).

2. Disassemble pressure control valve using Figure 33 as a guide. Discard all removed O–rings.

Assembly (Fig. 33)

NOTE: Coat all O–rings with vegetable oil before installation to reduce the chance of damage during assembly.

1. Assemble pressure control valve using Figure 33 as a guide. Replace all removed O–rings.

2. Install pressure control valve to machine (see Spray Control (Multi Pro 1200) in this section).

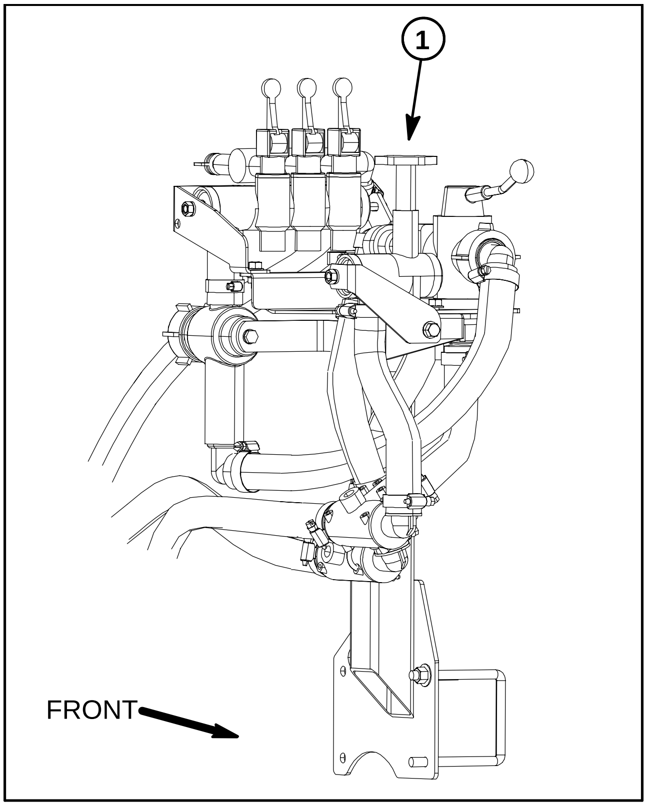

Figure 34

1. **Pressure control valve**

Spray System

Boom Distribution Valves (Multi Pro 1200)

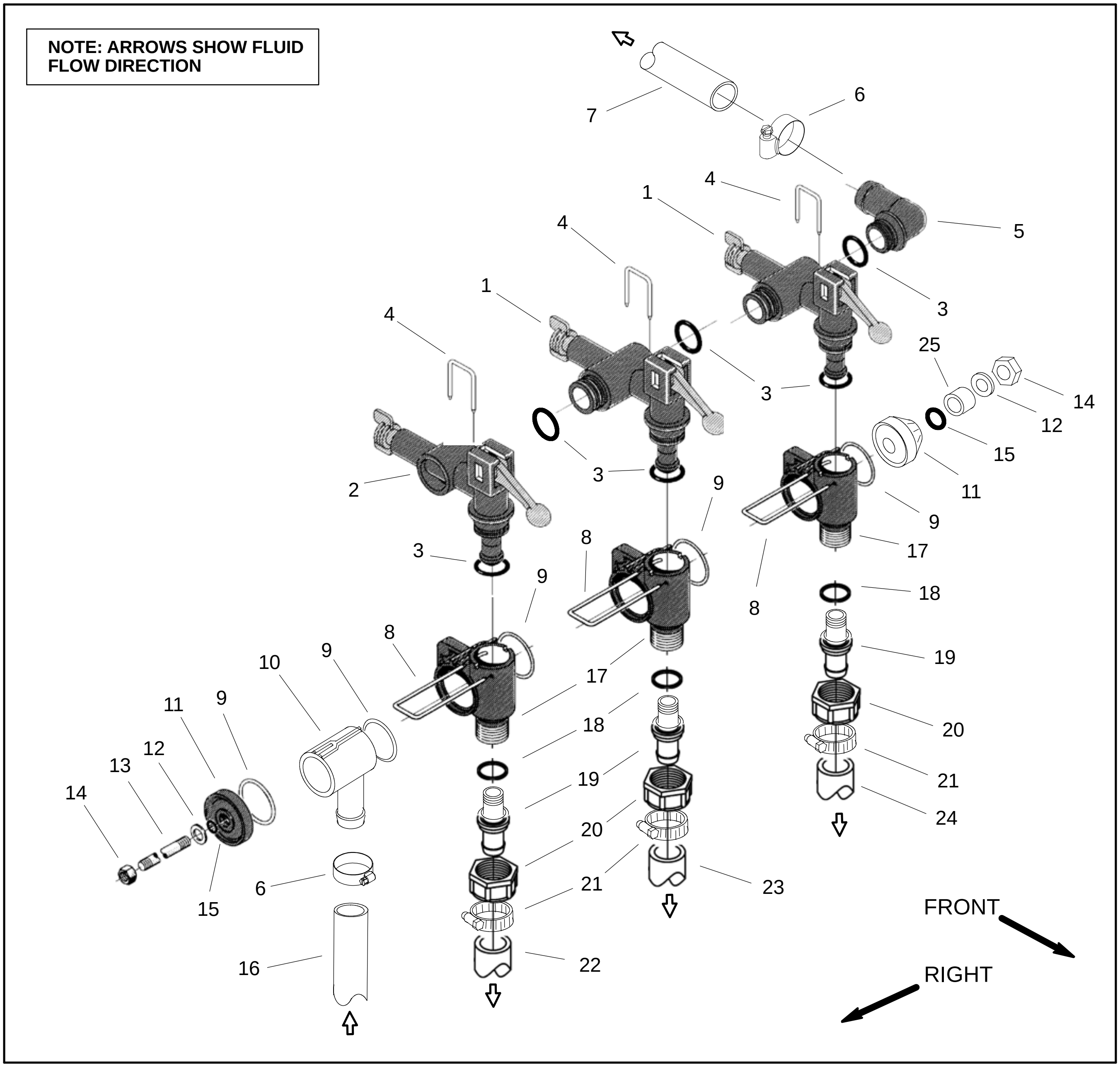

Figure 35

1. **Distribution valve (center/LH boom)**
2. **Distribution valve (RH boom)**
3. **O-ring**
4. **Fork**
5. **Elbow**
6. **Hose clamp**
7. **Hose: boom bypass (1”)**
8. **Fork**
9. **O-ring**
10. **Tee fitting**
11. **Cover**
12. **Washer**
13. **Threaded rod**
14. **Hex nut**
15. **O-ring**
16. **Hose: from flowmeter (1”)**
17. **Housing**
18. **Seal**
19. **Hosebarb**
20. **Nut**
21. **Hose clamp**
22. **Hose: RH boom (3/4”)**
23. **Hose: Center boom (3/4”)**
24. **Hose: LH boom (3/4”)**
25. **Bushing**

IMPORTANT: Make sure to remove and neutralize chemicals from spray components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

Disassembly (Fig. 35)

1. Remove boom distribution valve assembly (see Spray Control (Multi Pro 1200) in this section).

2. Separate boom distribution valves:

A. Remove forks (item 4) that secure distribution valves together.

B. Remove hex nut from one end of threaded rod.

C. Pull threaded rod from assembly and separate components.

3. Remove fork (item 8) to separate individual distribution valves from housings.

4. Remove and discard O–rings and seals.

Distribution Valve Service (Figs. 37 and 38)

1. Remove cap screw and washer to allow seat assemblies to be removed from shaft. Each seat assembly includes two (2) O–rings.

2. The seat assemblies allow the spindle to shut off flow to the spray boom. If boom nozzles leak when the boom is shut off, the seat and seat O–rings should be inspected carefully. The seats should be free of nicks or worn spots.

3. Press pin from handle to remove handle from shaft.

4. Take note of washer, spring, retaining ring (not pictured) and O–ring locations as shaft is removed from housing.

5. Assemble valve in reverse order of disassembly. Apply Loctite #243 (or equivalent) to threads of cap screw and torque cap screw to **45 in–lb (5 N–m)**.

Assembly (Fig. 35)

NOTE: Coat all O–rings with vegetable oil before installation to reduce the chance of damage during assembly.

1. Replace O–rings and seals that were removed during disassembly.

2. Secure distribution valves to housings with fork (item 8).

3. Position distribution valves, tee fitting, O–rings and covers together. Slide threaded rod with O–rings, bushing and washers through distribution valves and secure with hex nuts.

4. Install forks (item 4) to secure distribution valves together.

5. Install boom distribution valve assembly to machine (see Spray Control (Multi Pro 1200) in this section).

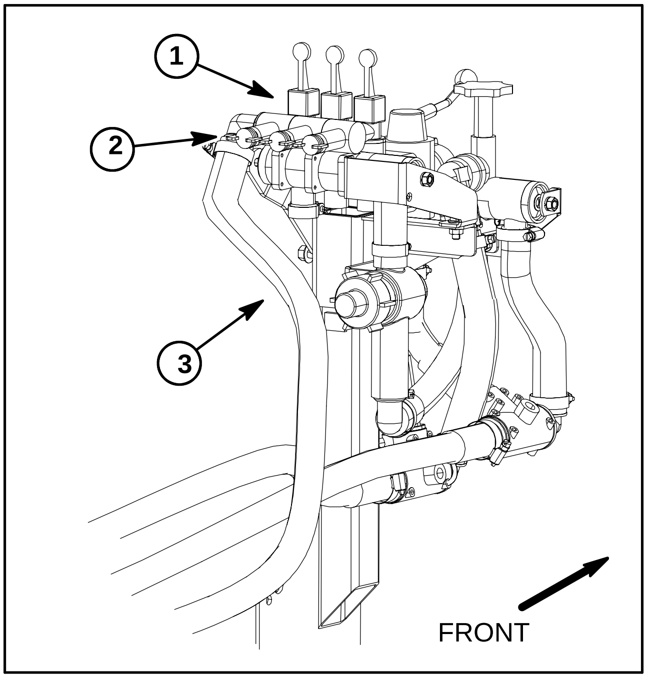

Figure 36

1. **Boom distribution valves**
2. **Boom bypass valve**
3. **Boom bypass hose**

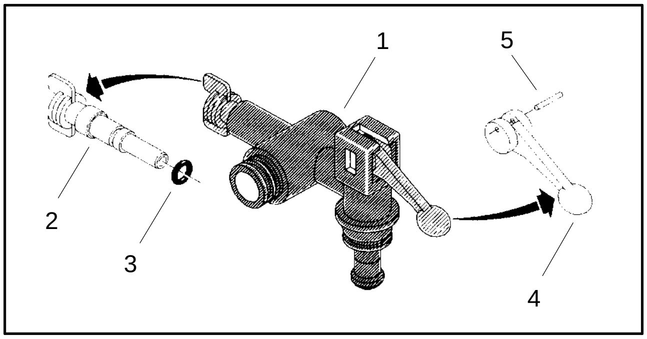

Figure 37

1. **Distribution valve**
2. **Bypass valve**
3. **O–ring**
4. **Handle**
5. **Pin**

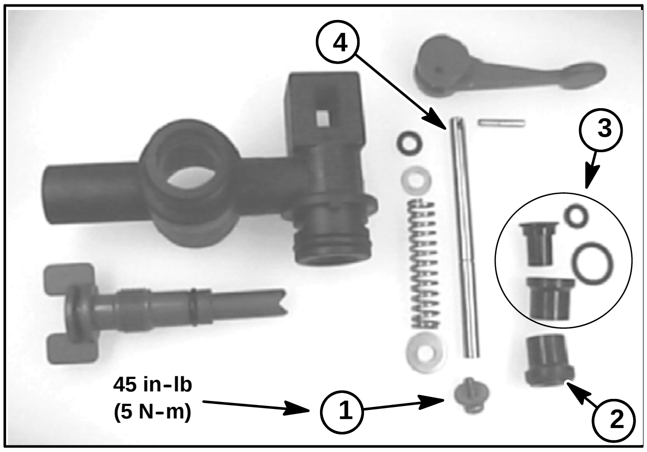

Figure 38

1. **Cap screw and washer**
2. **Seat assembly (2 used)**
3. **Seat components**
4. **Retaining ring location**

Spray System

Spray Control Assembly (Multi Pro 1250)

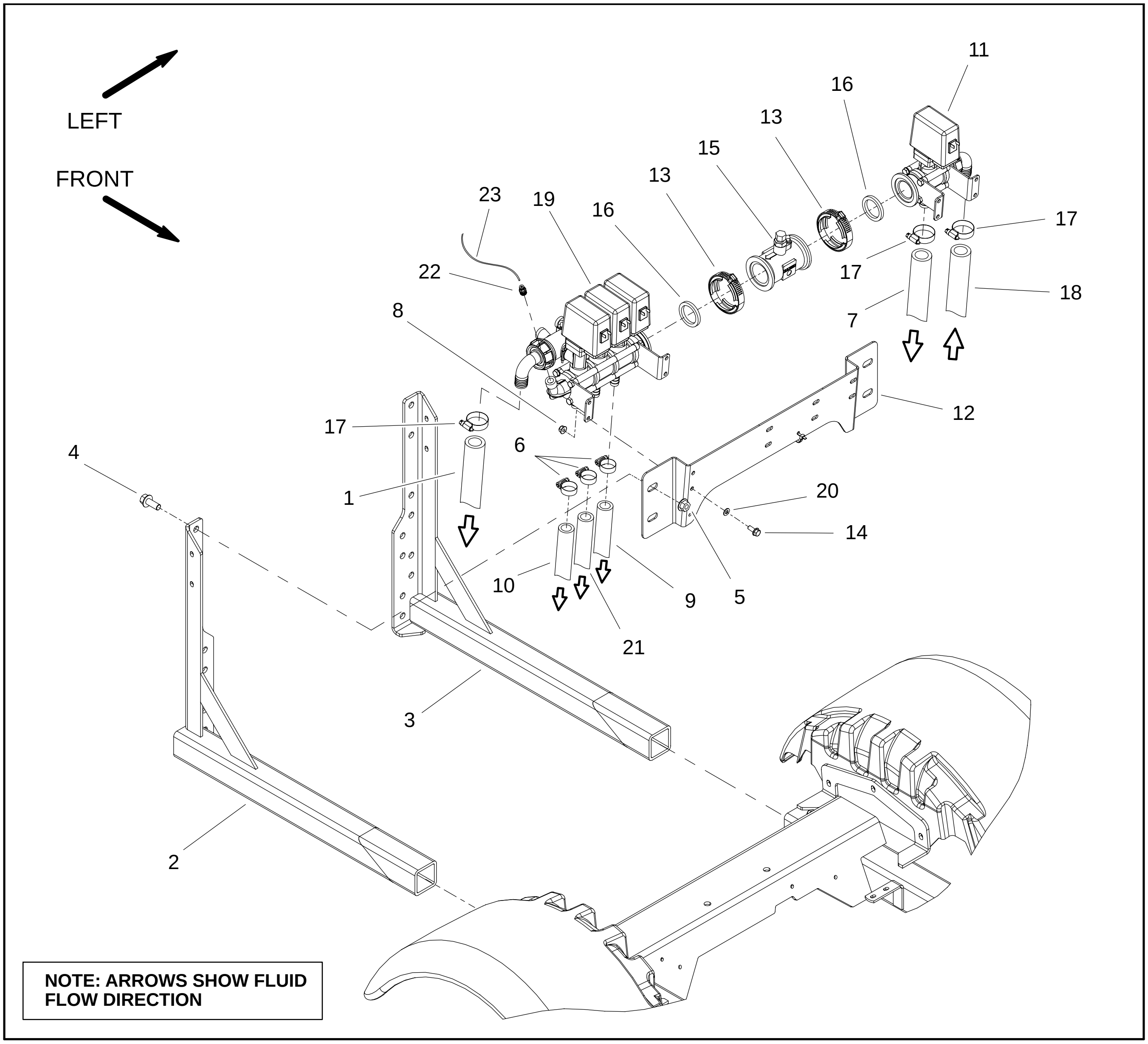

Figure 39

1. Boom bypass hose
2. RH boom mount
3. LH boom mount
4. Cap screw (4 used)
5. Flange nut (4 used)
6. Hose clamp (3 used)
7. Agitation bypass hose
8. Flange nut (8 used)
9. LH boom supply hose
10. RH boom supply hose
11. Regulating valve assembly
12. Valve mount
13. Worm clamp (2 used)
14. Flange head screw (8 used)
15. Flowmeter assembly
16. Gasket (2 used)
17. Hose clamp
18. Tee controls hose
19. Boom valve manifold assembly
20. Flat washer (8 used)
21. Center boom supply hose
22. Coupler
23. Pressure gauge tube

IMPORTANT: The regulating valve and all boom valve motors each have a 5 amp fuse for circuit protection. Make sure that the correct fuse is installed in the in-line fuse holder located near the spray control motors.

IMPORTANT: Make sure to remove and neutralize chemicals from spray components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

Removal (Fig. 39)

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

2. Label all spray control assembly hoses for proper installation after repairs are completed. Loosen hose clamps and disconnect hoses from spray control.

3. Label all wire harness leads for assembly purposes. Disconnect wire harness connectors from regulating valve, flowmeter and three (3) boom valve motors.

4. Remove pressure gauge tube from coupler on pressure gauge port on right side of boom valve manifold assembly (Fig. 40).

5. Support spray control assembly to prevent it from falling.

6. Remove eight (8) flange head screws, flat washers and flange nuts that secure spray control assembly to valve mount. Remove spray control assembly from machine.

IMPORTANT: Before removing flowmeter from spray control assembly, note direction of arrow on top of flowmeter (Fig. 41). The arrow should point toward boom valve manifold assembly.

7. Separate spray control assembly as required using Figure 39 as a guide. Discard all removed gaskets.

Installation (Fig. 39)

NOTE: Coat gaskets with vegetable oil before installation to reduce the chance of damage during assembly.

1. Assemble spray control using Figure 39 as a guide. Replace all removed gaskets. Make sure that arrow on flowmeter body points toward boom valve manifold assembly (Fig. 41).

2. Position spray control assembly to valve mounting bar and secure with eight (8) flange head screws, flat washers and flange nuts.

3. Using labels placed during disassembly, install hoses to correct locations on spray control assembly. Secure hoses with hose clamps.

4. Install pressure gauge tube to coupler on pressure gauge port on right side of boom valve manifold assembly (Fig. 40).

5. Using labels placed during disassembly, secure wire harness connectors to regulating valve, flowmeter and three (3) boom valve motors.

6. Operate spray system and check for leaks. Repair all leaks before returning the sprayer to service.

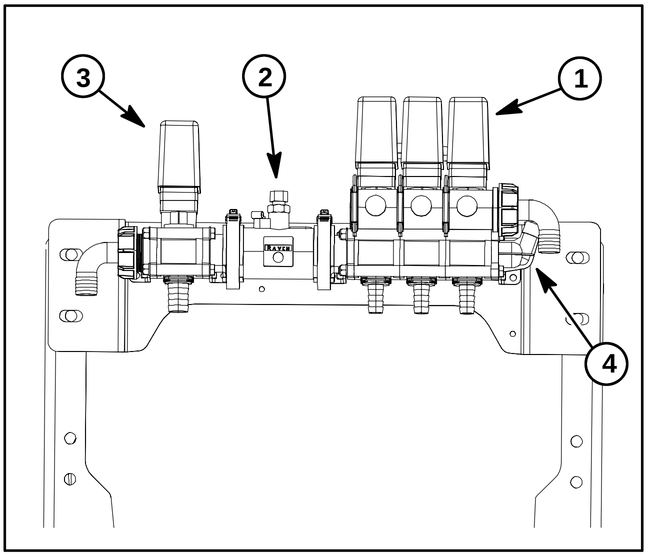

Figure 40

1. Boom valve manifold
2. Flowmeter
3. Regulating valve
4. Pressure gauge port

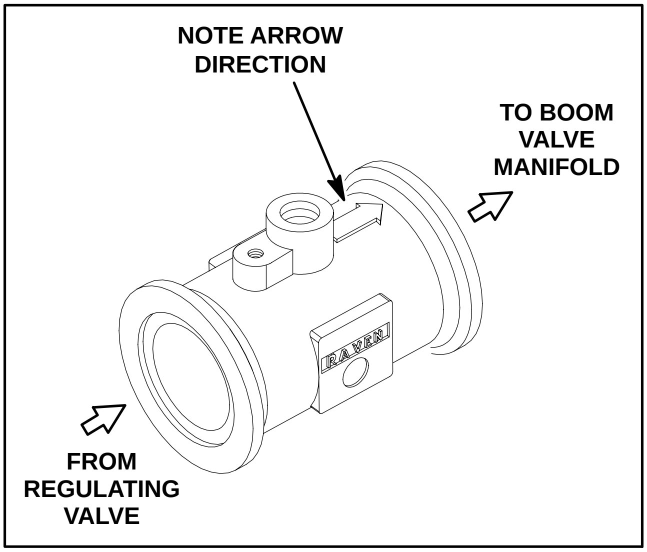

Figure 41

Spray System

Flowmeter (Multi Pro 1250)

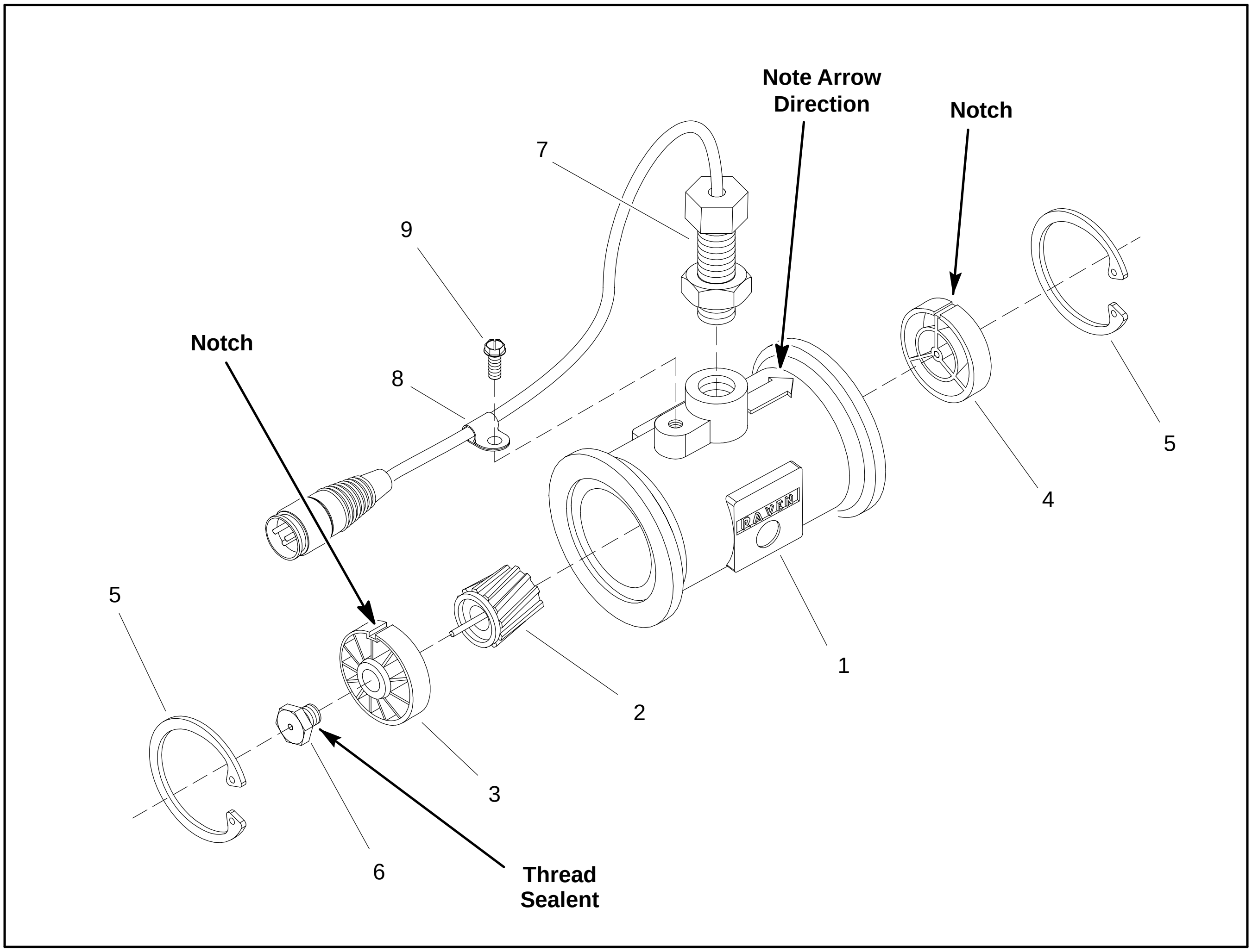

Figure 42

1. Flowmeter body
2. Rotor/magnet assembly
3. Upstream hub with bearing
4. Downstream hub
5. Retaining ring (2 used)
6. Turbine stud with bearing
7. Sensor assembly
8. Cable clamp
9. Screw

Disassembly (Fig. 42)

IMPORTANT: Make sure to remove and neutralize chemicals from spray components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

1. Remove spray control assembly from machine and separate flowmeter from spray control (see Spray Control Assembly (Multi Pro 1250) Removal in this section).

2. Disassemble flowmeter as required using Figures 42 and 44 as guides.

3. Clean rotor (item 2), both hubs (items 3 and 4) and flowmeter body to remove any metal filings, spray chemicals or other materials.

Assembly (Fig. 42)

1. Assemble flowmeter using Figures 42 and 44 as guides. Check the following items during flowmeter assembly.

A. If turbine stud was removed from upstream hub, apply thread sealant to threads of stud before installation.

B. Check that rotor spins freely with very little drag. If necessary, loosen the turbine stud 1/16 of a turn and check rotor drag. Continue the process of loosening stud until rotor spins freely.

C. When installing hubs (items 3 and 4) into housing, make sure to align locating notch on each hub with boss in housing bore.

D. If sensor (item 7) was removed from flowmeter body, thread sensor into housing so it lightly bottoms in housing. Secure sensor in position by tightening jam nut.

E. Make sure that retaining rings are fully seated in grooves of flowmeter housing.

2. Attach flowmeter assembly to spray control and then install spray control assembly to machine (see Spray Control Assembly (Multi Pro 1250) Installation in this section).

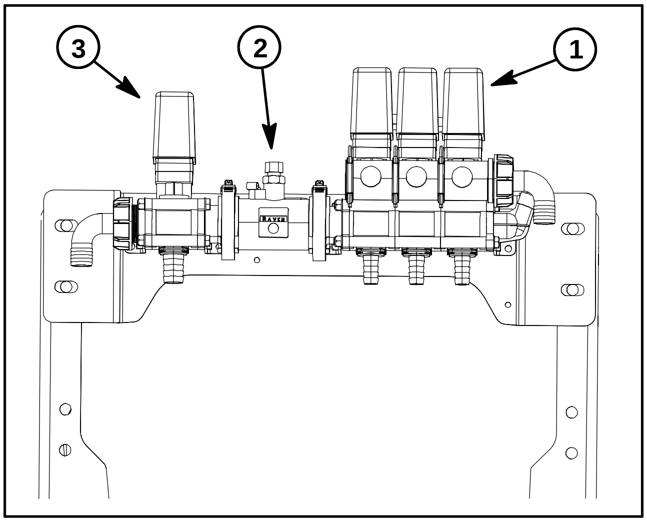

Figure 43

1. **Boom valve manifold**
2. **Flowmeter**
3. **Regulating valve**

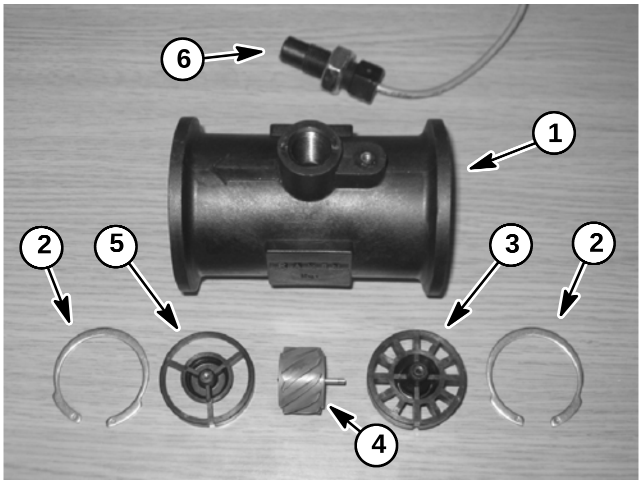

Figure 44

1. **Flowmeter body**
2. **Retaining ring**
3. **Upstream hub**
4. **Rotor**
5. **Downstream hub**
6. **Sensor**

Spray System

Regulating Valve Assembly (Multi Pro 1250)

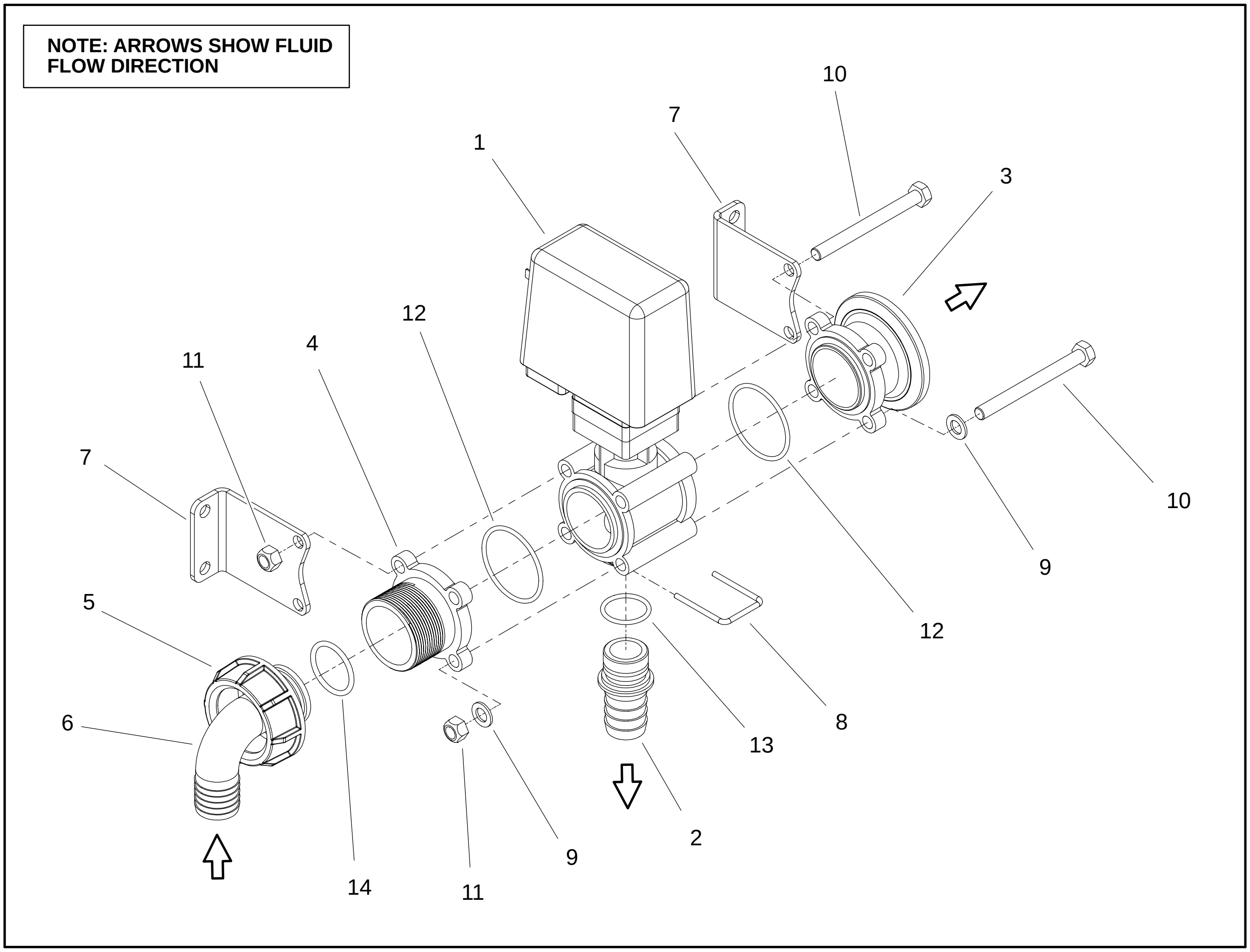

Figure 45

1. Regulating valve motor
2. Hose barb (agitation supply)
3. Flange
4. Adaptor
5. Flynut
6. Elbow fitting (supply)
7. Mounting bracket (2 used)
8. Fork
9. Washer (4 used)
10. Cap screw (4 used)
11. Lock nut (4 used)
12. O-ring (2 used)
13. O-ring
14. O-ring

The regulating valve allows the operator to vary the spray application rate. The pressure increase/decrease switch on the spray console energizes the regulating valve motor which adjusts the valve opening and allows some flow to bypass the spray booms.

NOTE: The regulating valve affects flow to all spray booms so a problem with the regulating valve will affect all booms and nozzles.

Disassembly (Fig. 45)

IMPORTANT: Make sure to remove and neutralize chemicals from spray components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

1. Remove spray control assembly from machine and separate regulating valve assembly from spray control (see Spray Control Assembly (Multi Pro 1250) Removal in this section).

2. Disassemble regulating valve assembly as needed using Figure 45 as a guide. Discard all removed O–rings and gaskets.

3. See Boom and Agitation Valve Motor Service in this section for disassembly and assembly information of the agitation valve motor.

Assembly (Fig. 45)

NOTE: Coat all O–rings with vegetable oil before installation to reduce the chance of damage during assembly.

1. Assemble regulating valve assembly using Figure 45 as a guide.

2. Attach regulating valve assembly to spray control and then install spray control assembly to machine (see Spray Control Assembly (Multi Pro 1250) Installation in this section).

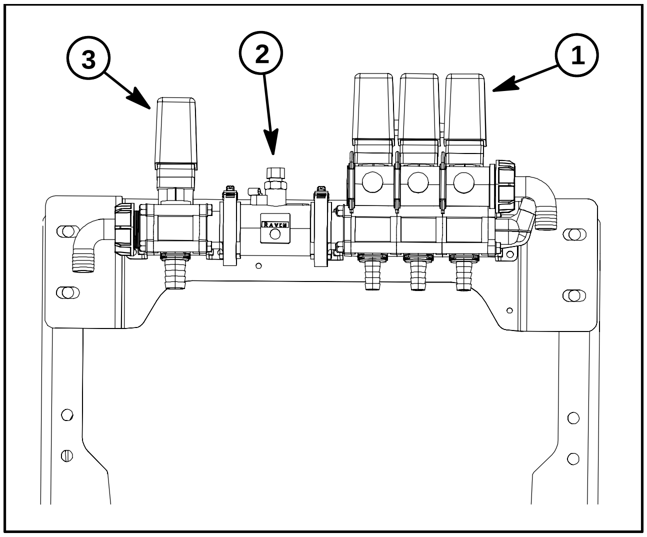

Figure 46

1. Boom valve manifold
2. Flowmeter
3. Regulating valve

Spray System

Boom Valve Manifold Assembly (Multi Pro 1250)

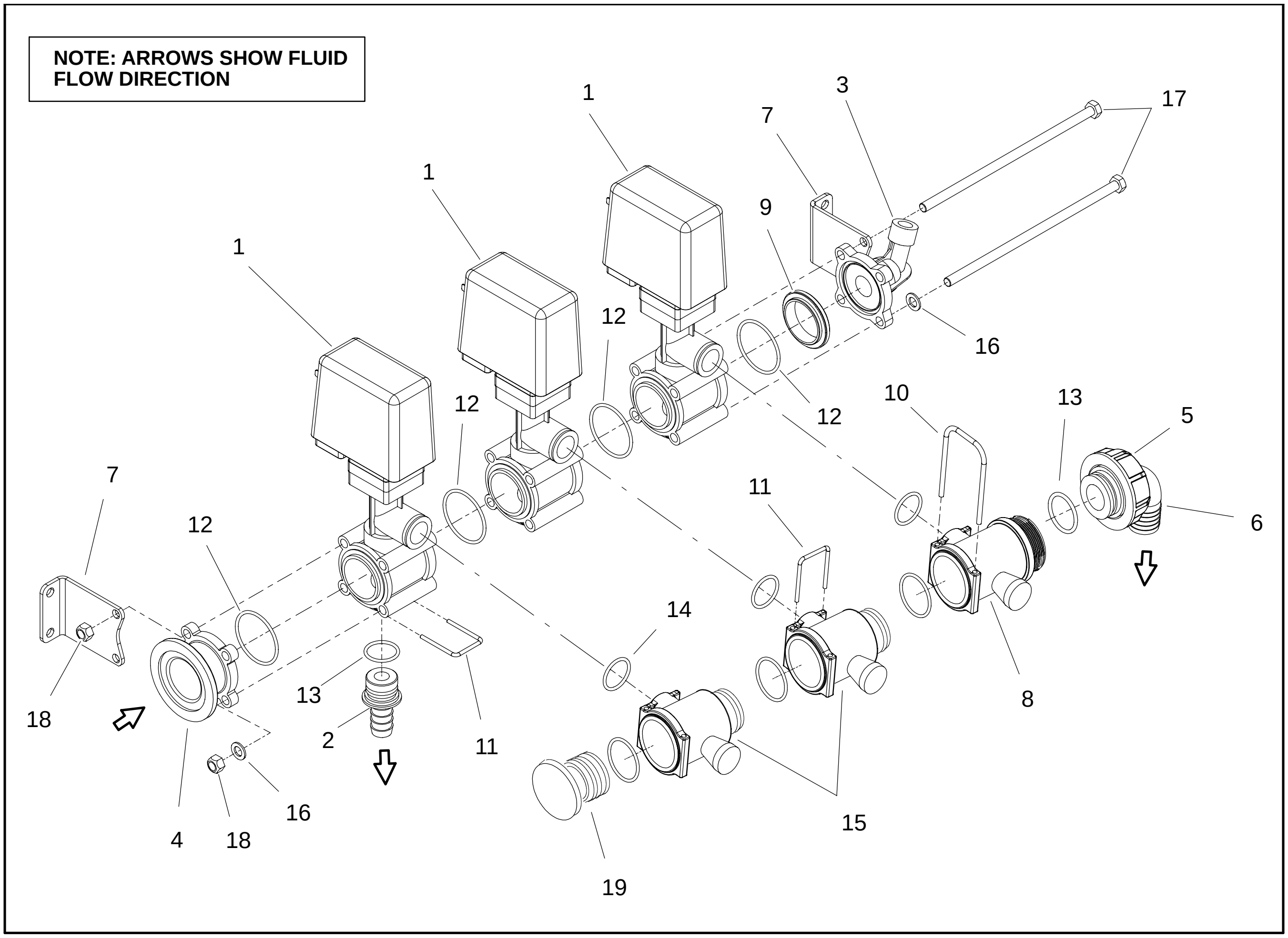

Figure 47

1. Boom valve motor (3 used)
2. Hose barb (boom supply) (3 used)
3. Pressure gauge port
4. Flange
5. Flynut
6. Elbow fitting (boom bypass)
7. Mounting bracket (2 used)
8. Balancing valve assembly
9. Flange
10. Fork (3 used)
11. Fork (6 used)
12. O-ring (4 used)
13. O-ring (4 used)
14. O-ring (3 used)
15. Balancing valve assembly (2 used)
16. Washer (4 used)
17. Cap screw (4 used)
18. Lock nut (4 used)
19. Cap

The Multi Pro 1250 uses three (3) boom valve motor assemblies to control the spray booms. Each boom valve motor assembly includes a motor section and a balancing valve assembly.

The boom control switches on the operator spray console are used to energize the boom valve motors and open the boom valves. The open boom valves allow system flow to reach the appropriate boom section (right, center or left).

Disassembly (Fig. 47)

IMPORTANT: Make sure to remove and neutralize chemicals from spray components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

1. Remove spray control assembly from machine and separate boom valve manifold assembly from spray control (see Spray Control Assembly (Multi Pro 1250) Removal in this section).

2. Disassemble boom valve manifold assembly as needed using Figure 47 as a guide. Discard all removed O–rings and gaskets.

3. See Boom and Agitation Valve Motor Service in this section for disassembly and assembly information of the agitation valve motor.

Assembly (Fig. 47)

NOTE: Coat all O–rings with vegetable oil before installation to reduce the chance of damage during assembly.

1. Assemble boom valve manifold assembly using Figure 47 as a guide.

2. Attach boom valve manifold assembly to spray control and then install spray control assembly to machine (see Spray Control Assembly (Multi Pro 1250) Installation in this section).

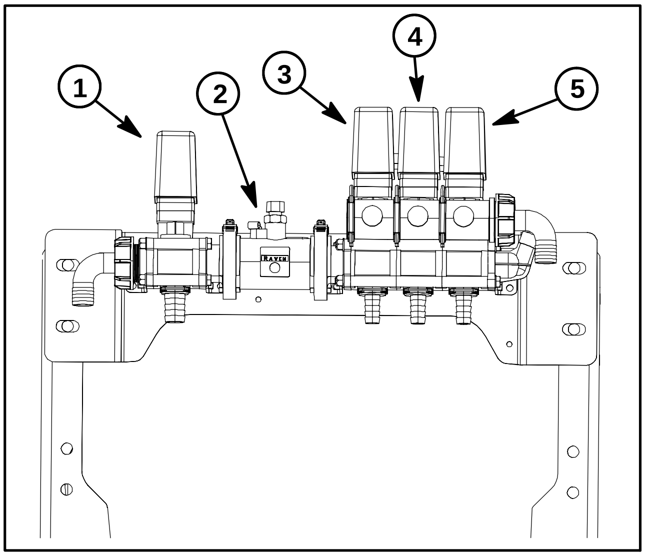

Figure 48

1. **Regulating valve**
2. **Flowmeter**
3. **LH boom valve motor**
4. **Center boom valve motor**
5. **RH boom valve motor**

Spray System

Regulating and Boom Valve Motor Service

IMPORTANT: Make sure to remove and neutralize chemicals from spray components before valve motor disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

NOTE: There are limited replacement parts available for agitation and boom valve motor assemblies. Check your parts catalog for parts that are available.

Valve Motor Cover Removal (Fig. 49)

1. Loosen three (3) screws that secure valve motor cover to valve motor assembly.

2. Carefully lift and rotate cover from valve motor.

3. Unplug wire connections and remove cover.

4. Make sure that all screws that secure valve motor are tight.

Valve Motor Cover Installation (Fig. 49)

1. Connect cover wires to motor wires. Make sure that cover wire color is the same as the motor wire color when connecting wires.

2. Carefully rotate cover onto valve motor taking care to not damage wires.

3. Tighten screws to secure cover to valve motor.

Piston Valve Service (Fig. 50)

1. Remove hosebarb from bottom of valve motor to allow access to piston valve.

2. Make sure that valve is closed. If valve is not closed, spring above piston valve will be under compression and may damage valve motor or piston valve during disassembly. End of piston valve will extend into bottom of valve motor housing when valve is closed. If necessary, reconnect motor to machine wire harness and close valve before removing piston valve.

3. Use 3mm allen wrench to loosen and remove piston valve assembly from valve motor. Locate and retrieve spring from above piston valve.

4. Inspect seals on piston valve assembly. O–ring in top groove of piston valve assembly is available separately. If lower two (2) seals in piston valve are worn or damaged, replace piston valve assembly. The piston valve is not designed to be disassembled.

5. Apply silicone grease to seals on piston valve assembly.

6. Position spring into valve motor housing. Use 3mm allen wrench to secure piston valve assembly to valve motor.

7. Secure hosebarb to bottom of valve motor.

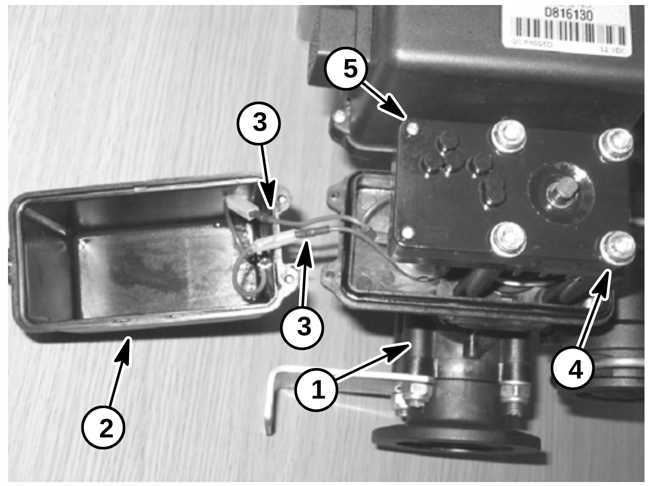

Figure 49

1. **Valve motor assembly**
2. **Valve motor cover**
3. **Wire connector**
4. **Socket screw (4 used)**
5. **Phillips screw (2 used)**

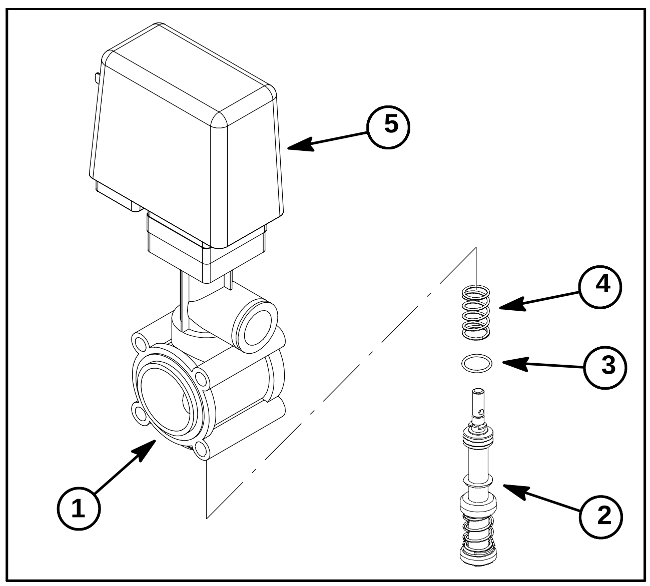

Figure 50

1. **Valve motor assembly**
2. **Piston valve assembly**
3. **Valve seal**
4. **Spring**
5. **Valve motor cover**

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Boom Bypass

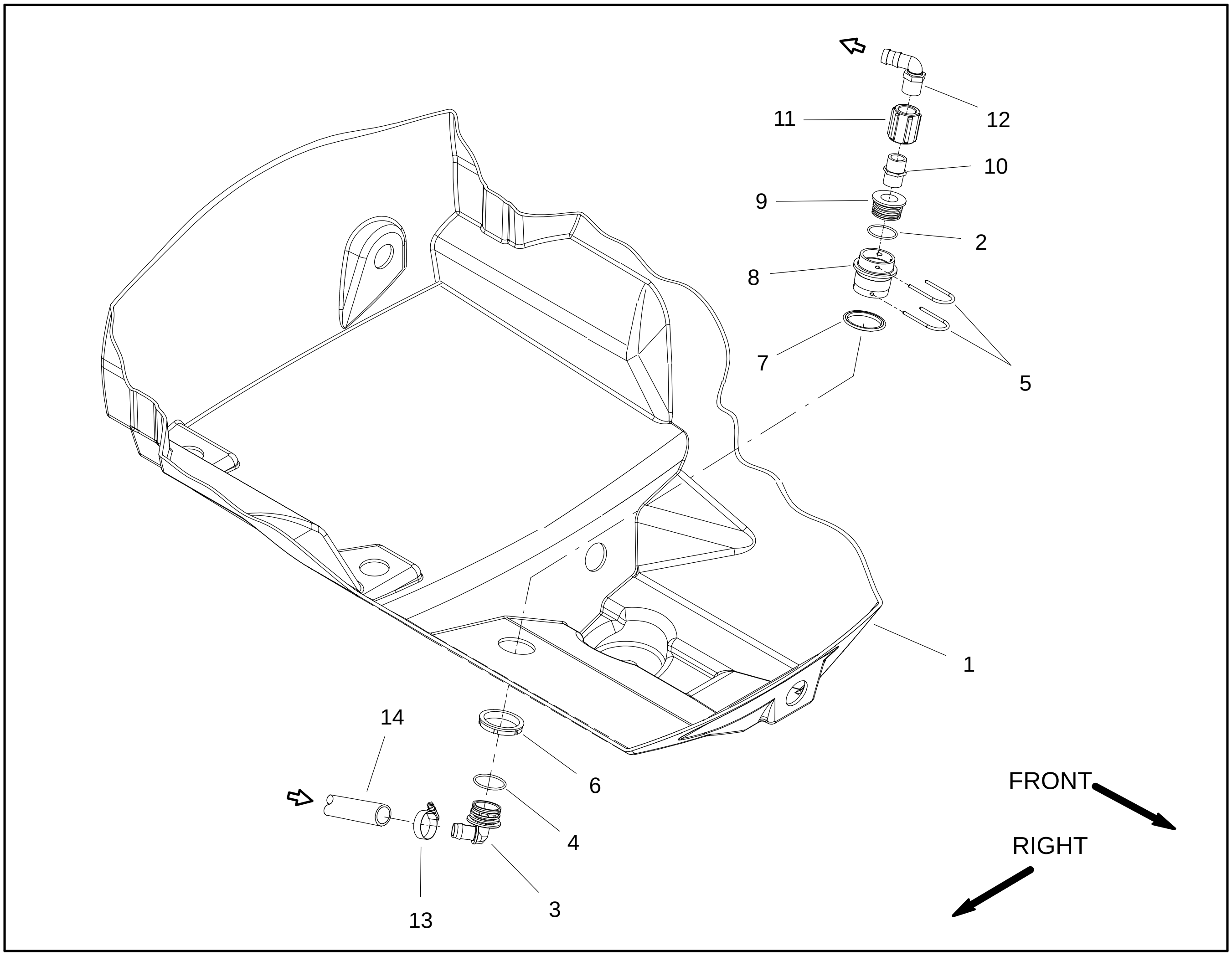

Figure 51

1. Spray tank
2. O-ring
3. Hosebarb
4. O-ring
5. Fork
6. Bulkhead nut
7. Bulkhead gasket
8. Bulkhead fitting
9. Adapter
10. Nipple
11. Union
12. Elbow
13. Hose clamp
14. Boom bypass hose

Disassembly (Fig. 51)

IMPORTANT: Make sure to remove and neutralize chemicals from tank and spray components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

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

2. Drain spray tank (see Operator's Manual).

NOTE: The boom bypass hose on the Multi Pro 1200 is routed between the spray tank hosebarb (item 3) and the boom distribution valves. On the Multi Pro 1250, the boom bypass hose is routed between the spray tank hosebarb (item 3) and the spray control assembly.

3. Label hoses to allow proper installation after repairs are completed. Loosen hose clamps and remove hoses from hosebarbs that are to be disassembled.

4. Disassemble boom bypass using Figure 51 as a guide. Discard all removed O–rings and gaskets.

Assembly (Fig. 51)

NOTE: Coat all O–rings with vegetable oil before installation to reduce the chance of damage during assembly.

1. Assemble boom bypass using Figure 51 as a guide. Replace all removed O–rings and gaskets.

2. Using labels placed during disassembly, install hoses to hosebarbs and secure with hose clamps.

3. Check spray tank for leaks. Repair all leaks before returning the sprayer to service.

Tank Suction

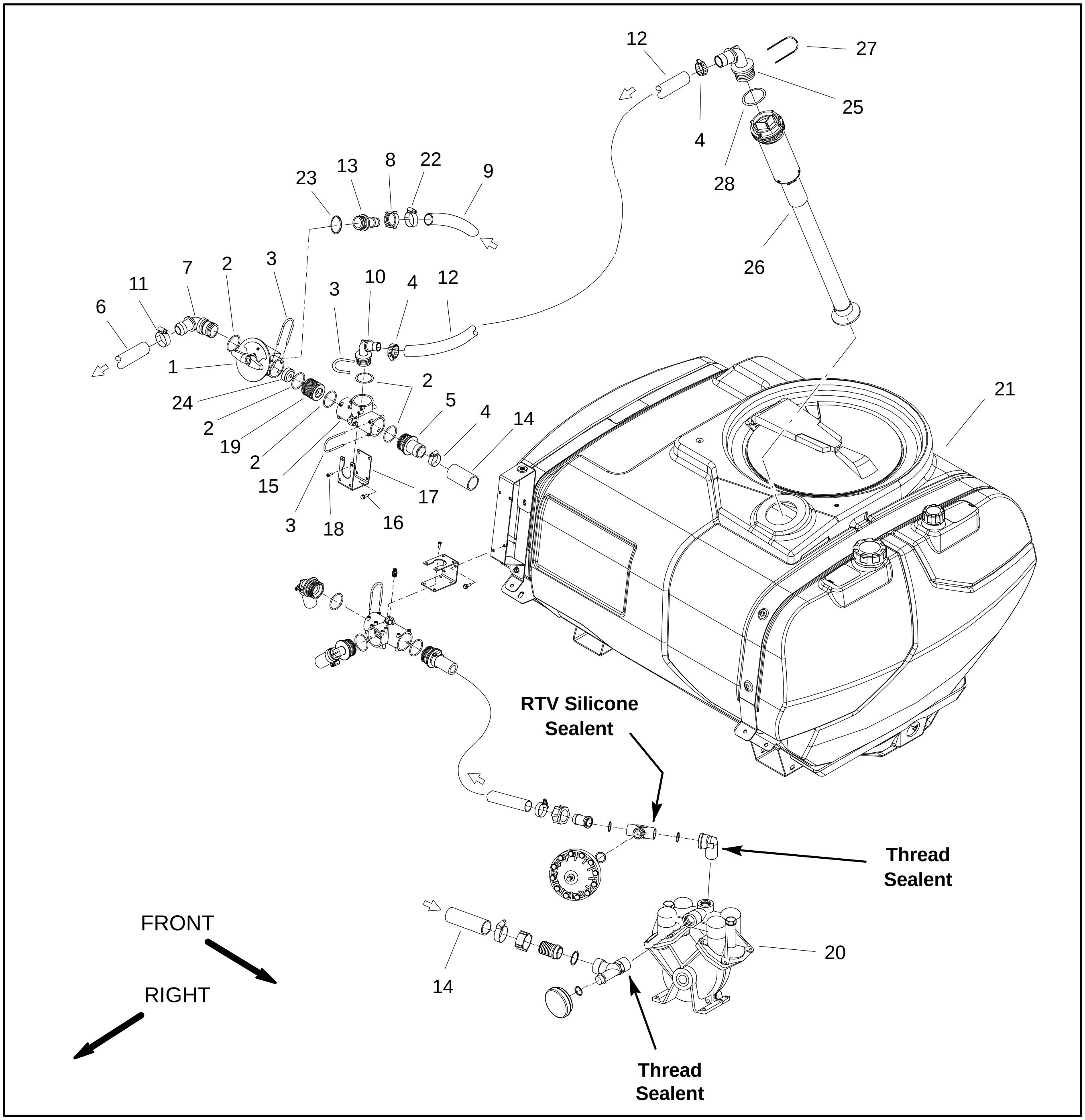

Figure 52

1. Agitation control valve
2. O-ring
3. Fork
4. Hose clamp
5. Hosebarb
6. Hose: agitation supply (1")
7. Hosebarb
8. Nut
9. Hose: control bypass (1")
10. Hosebarb
11. Hose clamp
12. Hose: tank suction (1 1/2")
13. Hosebarb
14. Suction hose (1 1/2")
15. Tee
16. Flange head screw (2 used)
17. Tee bracket
18. Screw (4 used)
19. Connector
20. Spray pump
21. Spray tank
22. Hose clamp
23. O-ring
24. Agitation reducer
25. Hosebarb
26. Suction assembly
27. Fork
28. O-ring

NOTE: If suction tube in tank develops an air leak, spray performance will diminish when tank level reaches the leak point.

Removal (Fig. 52)

IMPORTANT: Make sure to remove and neutralize chemicals from tank and spray components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

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

2. Label hoses to allow proper installation after repairs are completed. Loosen hose clamps and remove hoses from hosebarbs that are to be disassembled.

3. Remove suction strainer from spray tank (see Operator's Manual).

4. Raise tank lid and remove strainer basket to gain access to suction tube inside spray tank.

5. Remove suction tube assembly from spray tank using Figure 52 as a guide. Discard all removed O–rings and gaskets.

6. For assembly purposes, measure and record length of suction tube from filter housing flange to foot (Fig. 54).

7. Disassemble suction tube as needed using Figure 53 as a guide.

Installation (Fig. 52)

NOTE: Coat all O–rings with vegetable oil before installation to reduce the chance of damage during assembly.

1. Assemble suction tube assembly using Figure 53 as a guide. Make sure that assembled length is the same as the length measured before disassembly (Fig. 54).

2. Install suction tube assembly into spray tank using Figure 52 as a guide. Replace all removed O–rings and gaskets. The foot of the suction tube foot should be less than 1/2 inch (12.7 mm) from floor of spray tank after assembly.

3. Using labels placed during disassembly, install hoses to hosebarbs and secure with hose clamps.

4. Check spray tank for leaks. Repair all leaks before returning the sprayer to service.

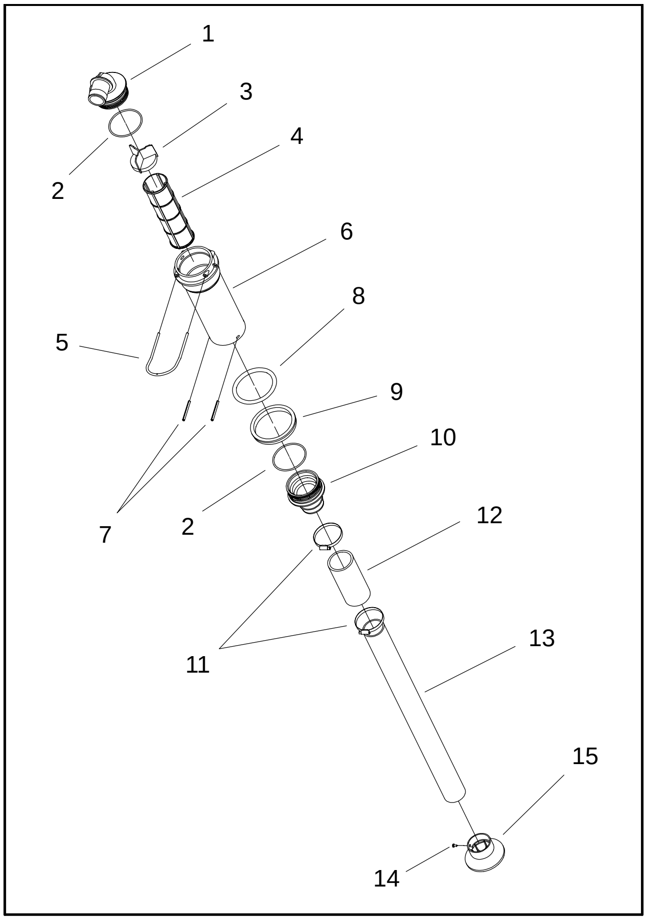

Figure 53

1. **Hosebarb**
2. **O–ring (2 used)**
3. **Screen vane**
4. **Filter**
5. **Fork**
6. **Filter housing**
7. **Expansion pin (2 used)**
8. **Bulkhead gasket**
9. **Bulkhead nut**
10. **Hosebarb**
11. **Hose clamp (2 used)**
12. **Suction hose**
13. **Suction tube**
14. **Screw**
15. **Foot**

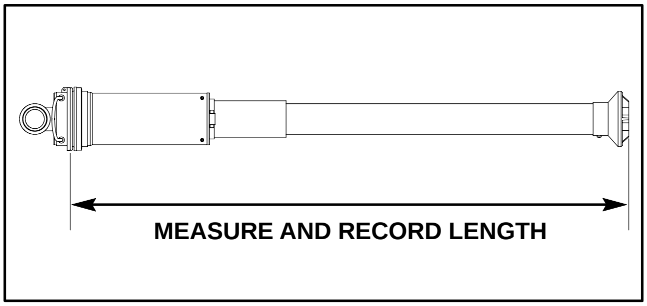

Figure 54

Spray System

Tank Drain Assembly

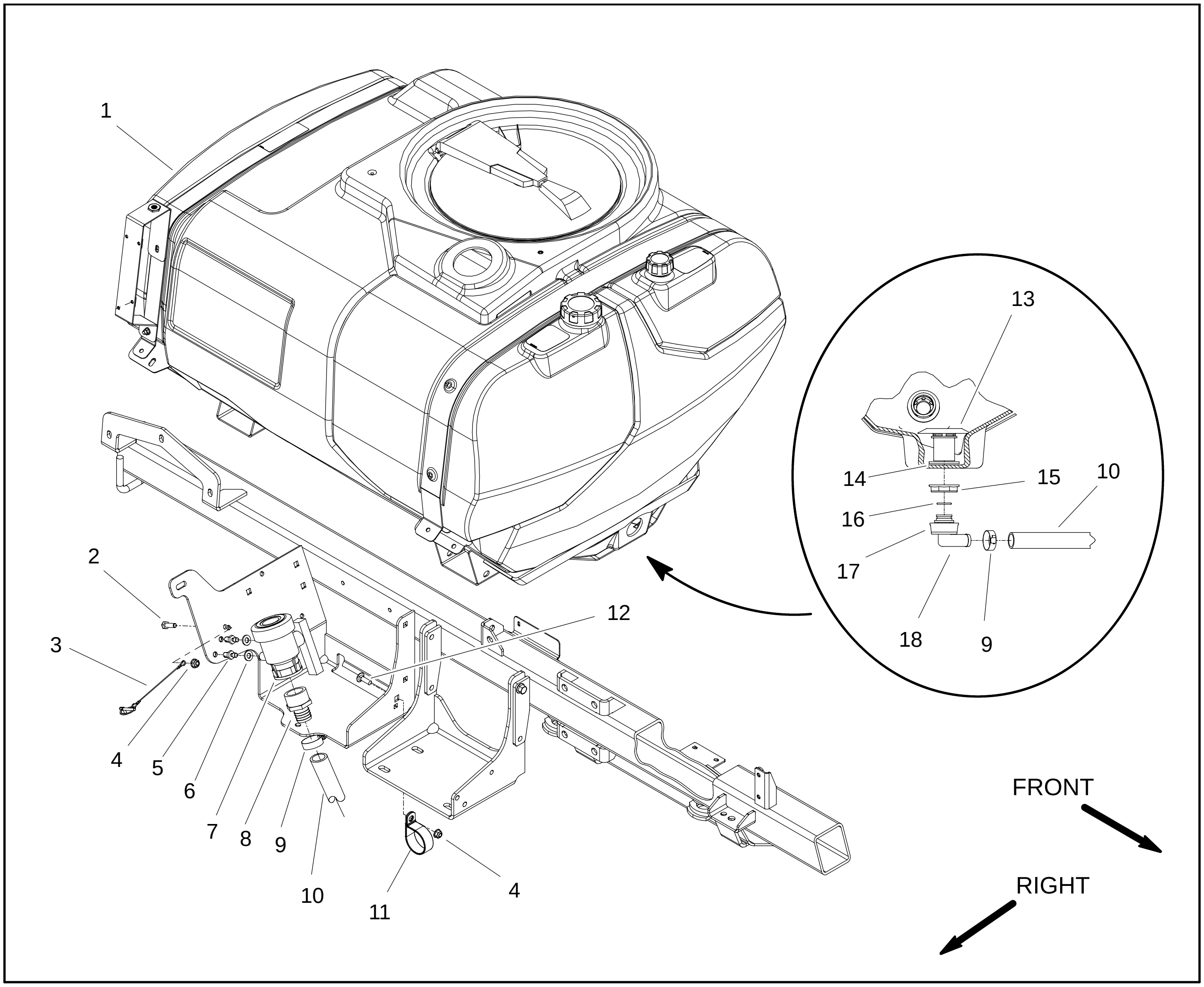

Figure 55

1. **Spray tank**
2. **Cap screw**
3. **Lynch pin assembly**
4. **Flange nut (2 used)**
5. **Peg mount (2 used)**
6. **Rubber washer (2 used)**
7. **Drain valve**
8. **Barbed fitting**
9. **Hose clamp (2 used)**
10. **Hose**
11. **R-clamp**
12. **Carriage bolt**
13. **Drain outlet**
14. **Plastic seal**
15. **Ring nut**
16. **O-ring**
17. **Bulkhead nut**
18. **Elbow fitting**

Disassembly (Fig. 55)

IMPORTANT: Make sure to remove and neutralize chemicals from tank and spray components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

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

2. Drain spray tank (see Operator's Manual and Fig. 56).

3. Label hoses to allow proper installation after repairs are completed. Loosen hose clamps and remove hoses from hosebarbs that are to be disassembled.

4. Disassemble drain assembly using Figure 55 as a guide. Discard all removed O–rings and gaskets.

Assembly (Fig. 55)

NOTE: Coat all O–rings with vegetable oil before installation to reduce the chance of damage during assembly.

1. Assemble drain assembly using Figure 55 as a guide. Replace all removed O–rings and gaskets.

2. Using labels placed during disassembly, install hoses to hosebarbs and secure with hose clamps.

3. Make sure that drain valve is closed and secured to sprayer with lynch pin.

4. Check spray tank for leaks. Repair all leaks before returning the sprayer to service.

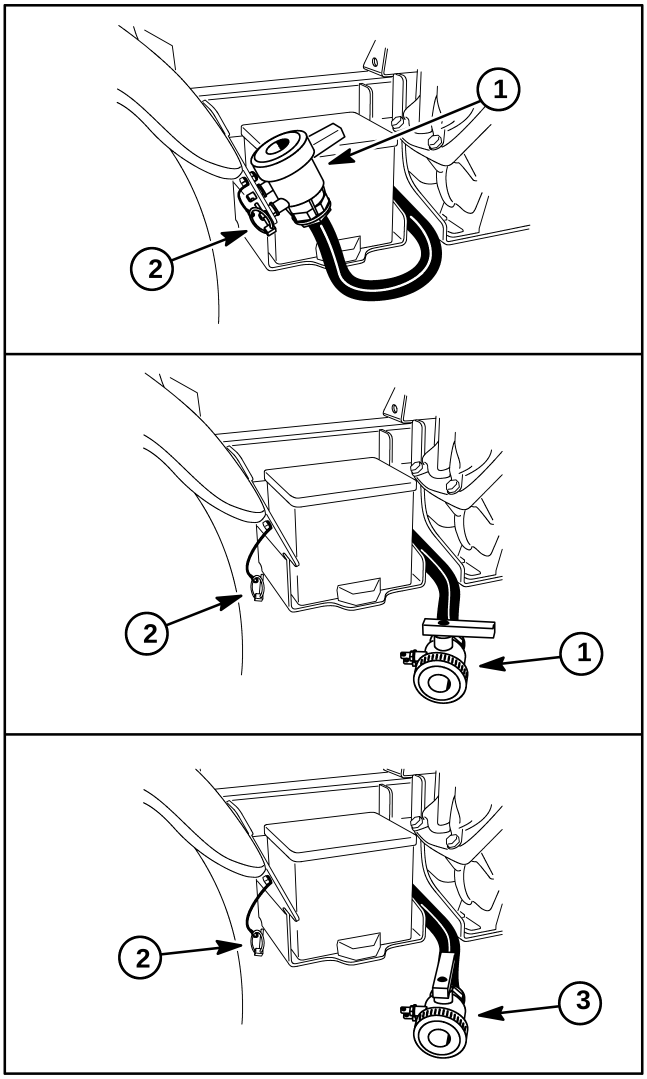

Figure 56

1. **Drain valve (closed)**
2. **Lynch pin**
3. **Drain valve (open)**

Spray System

Spray Tank

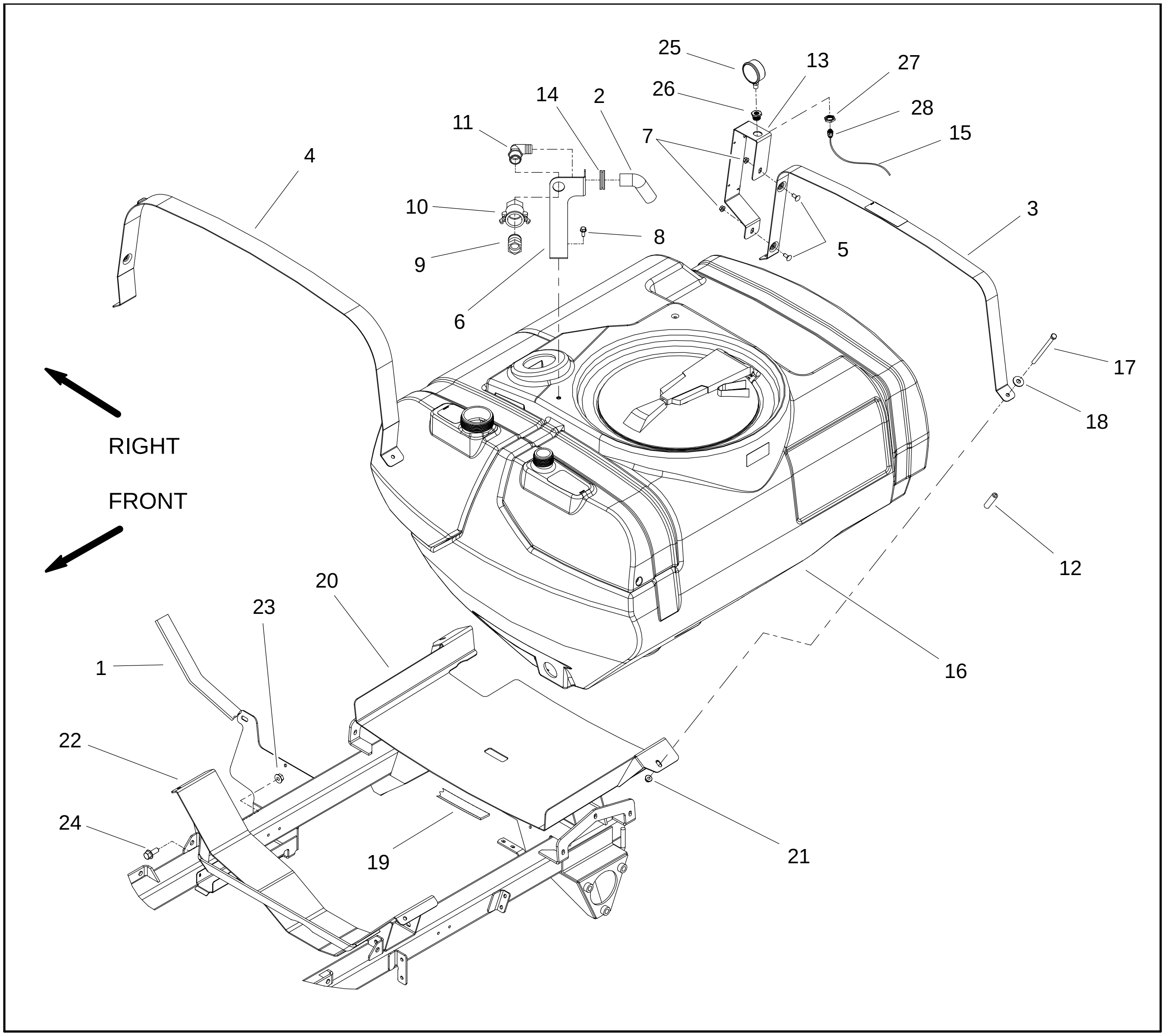

Figure 57

1. **Front saddle foam (2 used)**
2. **Hose fill**
3. **Rear tank band**
4. **Front tank band**
5. **Carriage bolt (2 used)**
6. **Anti–siphon bracket**
7. **Flange nut (2 used)**
8. **Flange head screw**
9. **Adapter**
10. **Female coupling**
11. **Elbow**
12. **Rubber spacer (RH rear position)**
13. **Mounting bracket**
14. **Grommet**
15. **Pressure gauge tubing**
16. **Spray tank assembly**
17. **Cap screw (4 used)**
18. **Hardened washer (4 used)**
19. **Rear saddle foam (3 used)**
20. **Rear saddle**
21. **Flange nut (4 used)**
22. **Front saddle**
23. **Flange nut (4 used)**
24. **Flange head screw (4 used)**
25. **Pressure gauge**
26. **Reducer**
27. **Nut**
28. **Coupler**

NOTE: For easiest service access to the engine, drive clutch, driven clutch and spray pump drive gearbox, removal of the spray tank is recommended using the following procedure.

Removal (Fig. 57)

IMPORTANT: Make sure to remove and neutralize chemicals from tank and spray components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

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

2. Drain spray tank (see Operator's Manual).

3. Label all hoses that are connected to spray tank fittings to allow proper installation after repairs are completed. Loosen hose clamps and disconnect all hoses from spray tank hosebarbs.

NOTE: A rubber spacer (item 12) is used between the rear tank band and saddle on the right side of the machine.

4. Remove cap screws (item 17), hardened washers (item 18) and flange nuts (item 21) that secure front and rear tank bands (items 4 and 3) to saddles.

5. Remove front tank band from machine.

6. Carefully position rear tank band with attached mounting bracket (item 13) and spray components away from spray tank.

7. Raise spray tank assembly from machine.

8. Remove tank saddles from machine frame if necessary.

Installation (Fig. 57)

1. Make sure that foam cushions on front and rear saddles are in good condition. Install new cushions if needed.

2. If tank saddles were removed from frame, position saddles to frame and secure with flange head screws and flange nuts.

3. Carefully lower spray tank assembly onto machine.

4. Position tank bands to front and rear of tank.

NOTE: A rubber spacer (item 12) is used between the rear tank band and saddle on the right side of the machine.

5. Install cap screws (item 17), hardened washers (item 18) and flange nuts (item 21) to secure front and rear tank bands (items 4 and 3) to saddle. On RH rear tank band, make sure that rubber spacer is placed between the tank band and saddle.

6. Using labels placed during tank removal, correctly connect hoses to spray tank fittings. Secure hoses with hose clamps.

7. Make sure that drain valve is closed and secured to sprayer with lynch pin.

8. After spray tank installation, make sure that spray hoses do not contact any moving parts on machine.

9. Check spray tank for leaks. Repair all leaks before returning the sprayer to service.

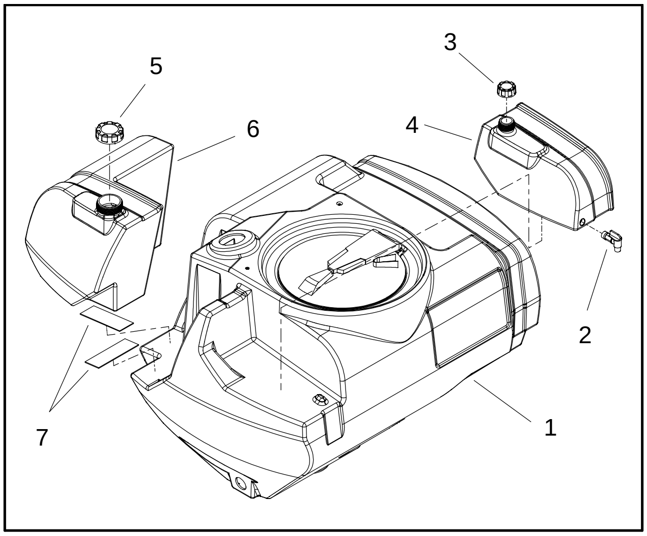

Figure 58

1. **Spray tank**
2. **Spigot assembly**
3. **Cap**
4. **Fresh water tank**
5. **Cap**
6. **Rinse tank**
7. **Rubber pad**

Spray System

Turret Bodies

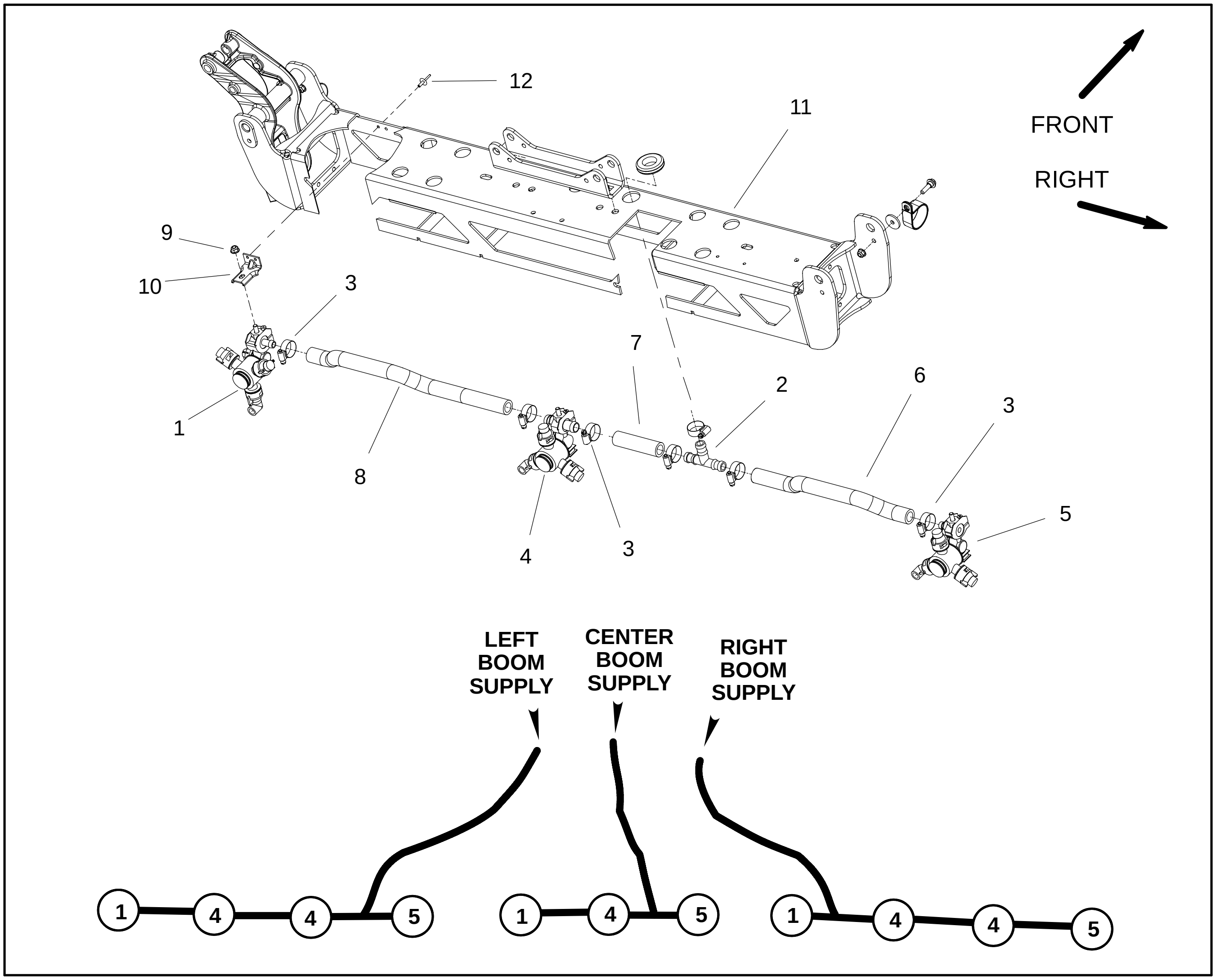

Figure 59

1. **Turret body (single LH barb)**
2. **Tee fitting (1 used per boom section)**
3. **Hose clamp**
4. **Turret body (double hose barb)**
5. **Turret body (single RH barb)**
6. **Hose**
7. **Hose**
8. **Hose**
9. **Flange nut**
10. **Mount bracket**
11. **Boom frame**
12. **Pop rivet (2 used per bracket)**

Removal (Fig. 59)

IMPORTANT: Make sure to remove and neutralize chemicals from spray components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

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

2. Loosen hose clamp(s) and remove supply hose(s) from turret body.

3. Remove flange nut that secures turret body to mount bracket. Remove turret body from machine.

Installation (Fig. 59)

NOTE: The type of hose barb on turret body determines turret location on spray boom. Refer to Figure 59 for turret position on booms.

1. Position turret body clamp halves to spray boom and turret body. Slide clamp halves together. Level turret and tighten flange nut to secure turret body.

2. Install supply hose(s) to turret body. Tighten hose clamp(s).

Turret Body Service

Disassembly (Fig. 60)

1. Pull e–clip from body and slide plug with O–ring from body.

2. Disassemble turret body using Figure 60 as a guide.

3. Discard all removed seals, gaskets, O–rings and diaphragms.

Assembly (Fig. 60)

NOTE: Coat all O–rings with vegetable oil before installation to reduce the chance of damage during assembly.

1. Replace all removed seals, gaskets, O–rings and diaphragms.

2. Assemble turret body using Figure 60 as a guide.

   A. The turret (item 8) end with slightly larger bore and detent grooves needs to be orientated toward detent posts on body (item 4) (Fig. 61).

   B. Make sure to align notch on plug (item 10) with groove in body (item 4) as plug is installed.

   C. Install e–clip (item 5) into body to secure assembly.

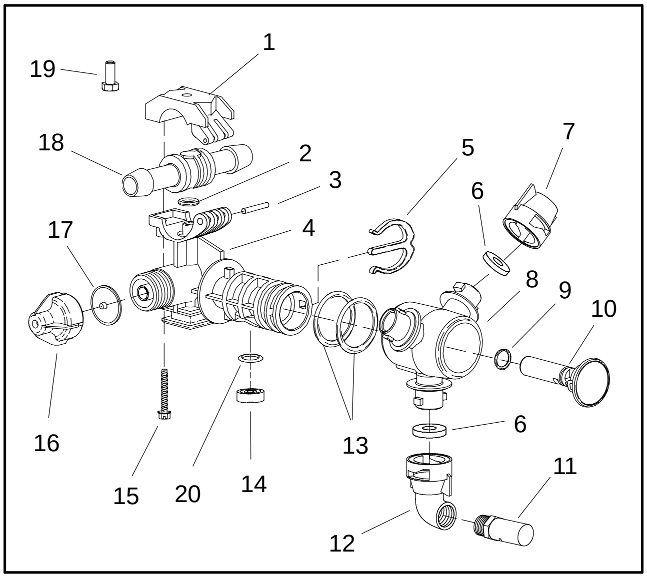

Figure 60

1. **Upper clamp**
2. **O–ring**
3. **Pivot pin**
4. **Body**
5. **E–clip**
6. **Gasket (3 used)**
7. **Dust cap (2 used)**
8. **Turret**
9. **O–ring**
10. **Plug**
11. **Nozzle**
12. **Nozzle cap**
13. **O–ring**
14. **Seal**
15. **Screw**
16. **End cap**
17. **Diaphragm**
18. **Hose barb**
19. **Cap screw**
20. **O–ring**

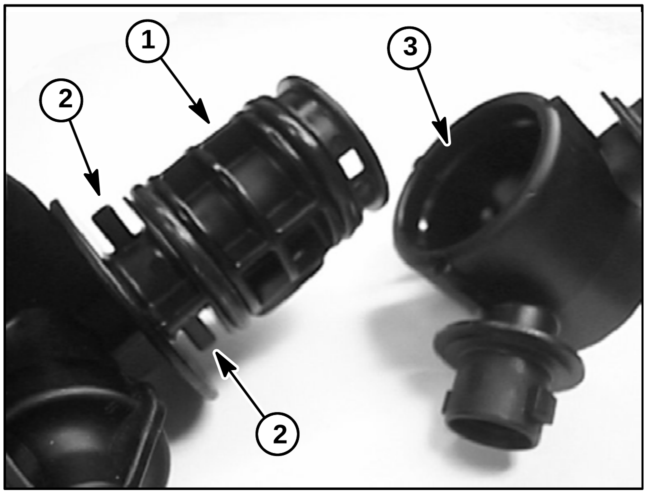

Figure 61

1. **Body**
2. **Detent post**
3. **Detent groove**

Spray System

Spray Boom Hinge

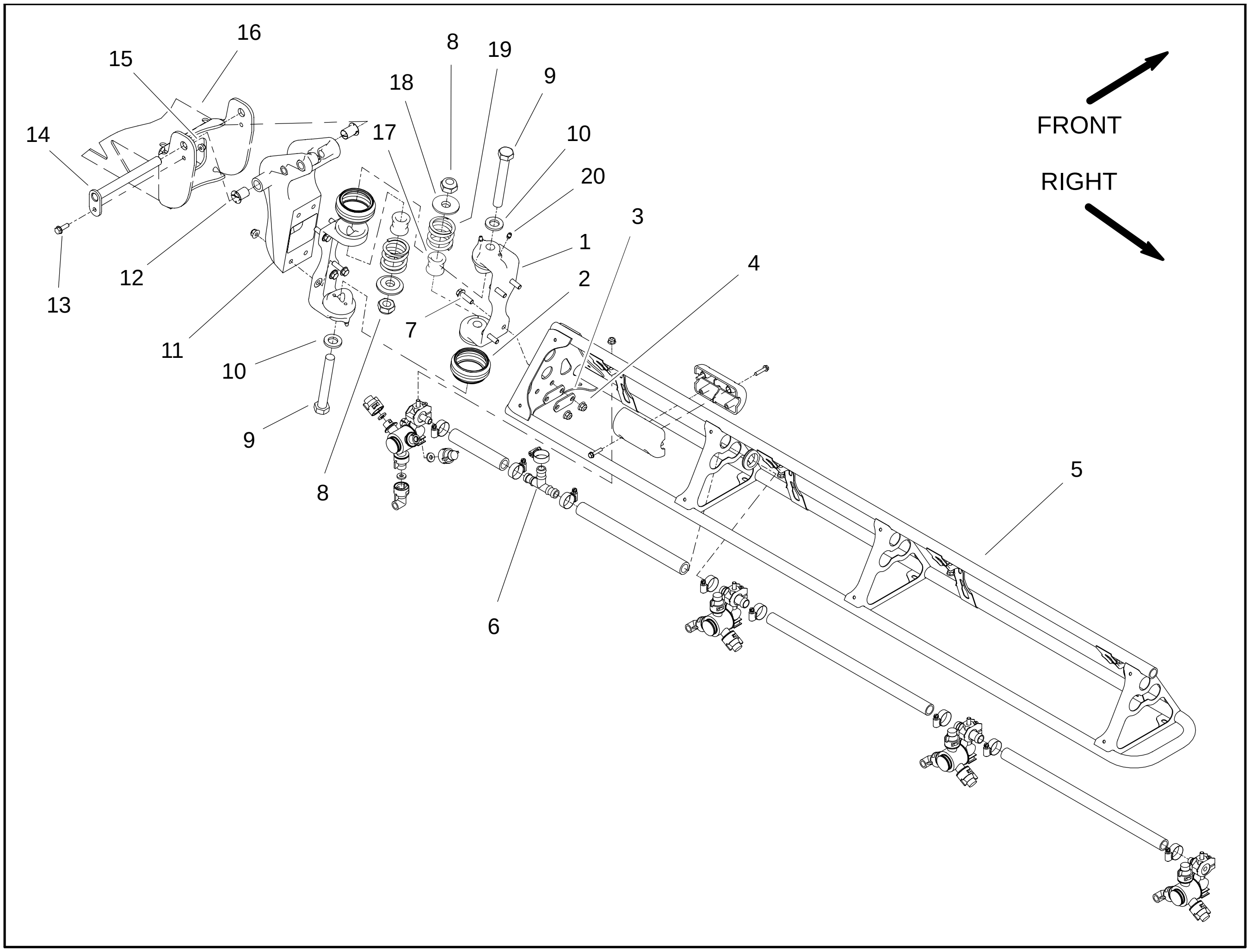

Figure 62

1. Hinge (2 used per boom)
2. Rubber boot (2 used per hinge)
3. Backing plate (4 used per hinge)
4. Flange nut (4 used per hinge)
5. Boom (RH shown)
6. Tee fitting
7. Flange hd screw (4 used per hinge)
8. Lock nut
9. Cap screw
10. Flat washer
11. Pivot bracket
12. Bushing (2 used per pivot bracket)
13. Flange head screw
14. Pivot pin
15. Flange nut
16. Boom frame
17. Tube (2 used per boom)
18. Spring retainer (2 used per boom)
19. Breakaway spring (2 used per boom)
20. Grease fitting (2 used per hinge)

Disassembly (Fig. 62)

IMPORTANT: Make sure to remove and neutralize chemicals from spray components before disassembly. Wear protective clothing, chemical resistant gloves and eye protection during repair.

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

2. Loosen hose clamp and remove supply hose from tee fitting (item 6) on spray boom.

3. Support spray boom to prevent it from falling.

4. Loosen two (2) cap screws (item 9) and lock nuts (item 8) to allow breakaway springs (item 19) to fully extend.

5. Complete boom hinge disassembly as required using Figure 62 as a guide. If pivot bracket (item 11) is to be removed from machine, disconnect boom actuator (not shown) from pivot bracket (see Boom Actuator Removal) in this section).

6. Clean all removed components. If pivot bracket was removed, inspect bushings and pivot pin for damage or wear.

Assembly (Fig. 62)

1. If pivot bracket (item 11) was removed from machine, lightly lubricate bushings (item 12) with motor oil before assembly. Connect boom actuator (not shown) to pivot bracket (see Boom Actuator Installation in this section).

2. Make sure that hinges (item 1) are securely fastened to pivot bracket (item 11) and boom (item 5). The boom hinge uses four (4) backing plates between the boom and flange nuts.

3. Position boom hinge to pivot bracket hinge. Make sure that rubber boots (item 2) are placed at hinge junctions and that rib on boots are toward the top of the boom (Fig. 63).

4. Insert two (2) cap screws (item 9) through flat washers (item 10) and hinges. Place tube (item 17), breakaway spring (item 19), spring retainer (item 18) and lock nut (item 8) on each cap screw. Make sure that shoulder on spring retainer fits into breakaway spring.

5. Tighten lock nuts so there is 1.560” (39.6 mm) between the face of the spring retainer and the hinge casting (Fig. 64).

6. Connect supply hose to tee fitting on spray boom and secure with hose clamp.

7. Lubricate grease fittings on boom hinge.

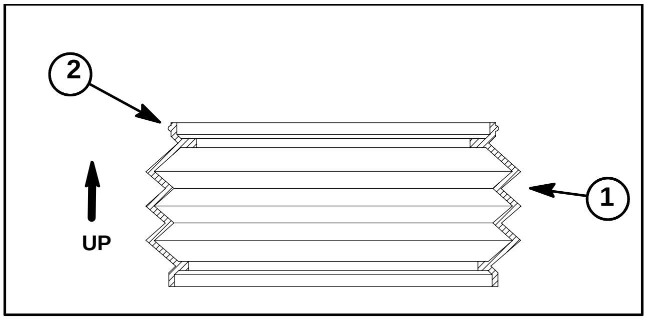

Figure 63

1. **Rubber boot**
2. **Rib**

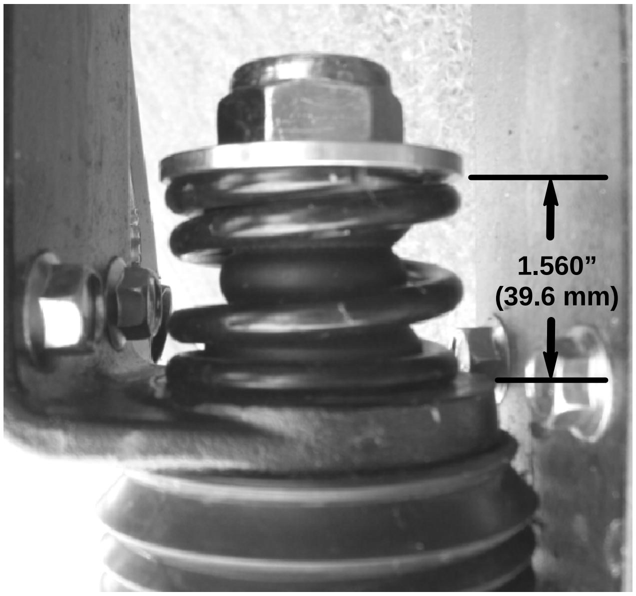

Figure 64

Boom Actuator

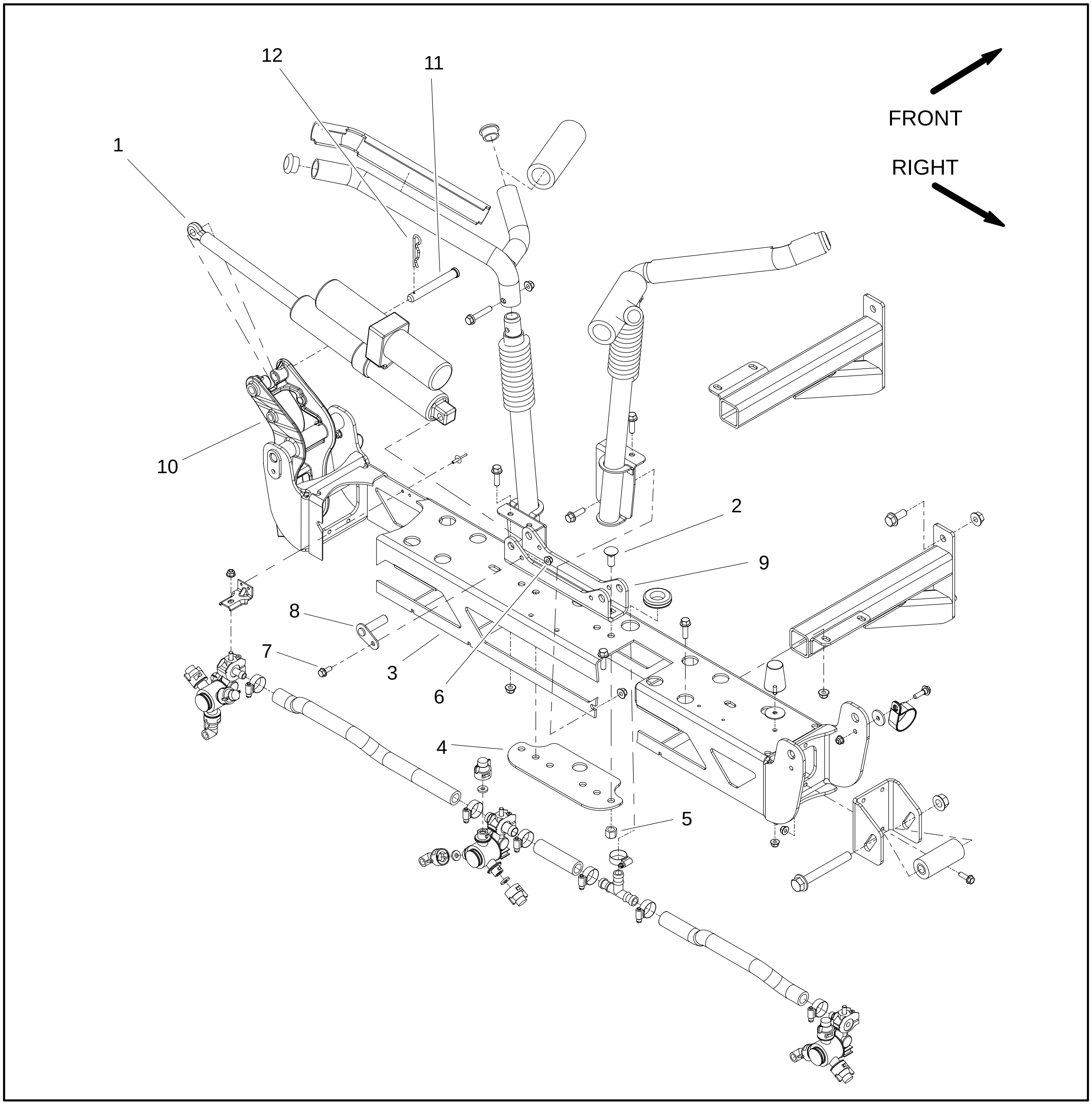

Figure 65

1. Boom actuator (2 used)
2. Carriage screw (4 used)
3. Boom frame
4. Washer plate
5. Lock nut (4 used)
6. Flange nut (2 used)
7. Flange head screw (2 used)
8. Pivot pin (2 used)
9. Clevis strap (2 used)
10. Boom pivot bracket
11. Clevis pin (2 used)
12. Cotter pin (2 used)

Removal (Fig. 65)

1. Park machine on a level surface, place spray booms in the transport (raised) position, stop engine, engage parking brake and remove key from the ignition switch.

2. Disconnect boom actuator from machine wire harness.

3. Remove pivot pin (item 8) that secures actuator to clevis strap (item 9) on boom frame.

4. Remove cotter pin (item 12) from clevis pin (item 11). Support boom actuator and slide clevis pin from boom pivot bracket. Remove actuator from machine.

Installation (Fig. 65)

1. Position boom actuator to boom frame and boom pivot bracket.

2. Secure actuator to boom pivot bracket with clevis pin and cotter pin.

3. Secure actuator to clevis strap on boom frame with pivot pin.

4. Connect boom actuator to machine wire harness.

Boom Actuator Service

IMPORTANT: Do not dismantle, repair or modify the boom actuator. Internal components are not available for the actuator. If an actuator is damaged or worn, replace actuator.

CAUTION

During and after operation, the actuator may be very hot. To avoid possible burns, allow the actuator to cool before working on it.

Actuator Circuit Protection

Each boom actuator is protected internally by a thermal circuit breaker. In case of actuator overheating, the thermal breaker will trip, causing the actuator to cease functioning. Once the actuator cools to appropriate operating temperature, the actuator thermal breaker will reset to allow actuator operation to resume.

A separate 30 amp thermal breaker also protects each boom actuator circuit. These thermal breakers are located at the machine fuse panel and will prevent circuit operation if overloaded. The thermal breakers reset automatically.

Actuator Freeplay Inspection

Over time, actuator operation may be affected by air captured in the reservoir oil. An excessive amount of air in the actuator oil will allow excessive actuator freeplay. Excessive freeplay will allow spray boom bouncing when driving over severe terrain.

Measure actuator freeplay using the following procedure:

1. Move the vehicle to an open area and lower the spray booms to the spray position.

2. Lift up on the boom at the last triangular gusset with a 25 pound (11.4 kg) force. Support boom in that position.

3. Using a non–permanent felt tipped marker, mark the cylinder rod at the outside of the cylinder seal.

4. Release the spray boom and allow it to return to the spray (fully lowered) position.

5. Determine the actuator freeplay by measuring the distance from the mark on the cylinder rod to the cylinder seal. The freeplay should be less than 0.100” (2.5 mm). If excessive freeplay is found, bleed air from actuator.

Actuator Air Bleeding

If actuator freeplay is excessive, air bleeding of the actuator should be performed using the following procedure:

1. Make sure that the exterior of the actuator is thoroughly clean to prevent contaminates from entering the actuator.

2. Make sure that the actuator cylinder is fully retracted.

IMPORTANT: To prevent actuator damage, use vise with protective jaws when clamping actuator.

3. Place the actuator in a vise making sure that actuator is clamped in the area identified in Figure 66. Use just enough clamping force to hold the housing securely. Make sure that the reservoir plug is orientated up.

CAUTION

The actuator reservoir is pressurized. If the reservoir plug is removed too quickly, oil under pressure can be ejected from the actuator.

4. Slowly loosen and remove the reservoir plug at the top of the reservoir.

5. Using a light through the plug hole, confirm that the reservoir oil is clear. If the oil appears milky, air is entrained in the reservoir oil. Keep the actuator vertical with the plug removed for approximately fifteen (15) minutes to allow the air to separate from the oil.

6. When oil appears clear, use a 12 volt DC power supply to power the actuator and extend the cylinder completely.

IMPORTANT: To ensure proper reservoir pressure, make sure that cylinder is extended before installing reservoir plug.

7. Install the reservoir plug and torque from **45 to 60 in–lb (5.1 to 6.8 N–m)**.

8. If reservoir oil was milky, use power supply to contract and extend the actuator cylinder three (3) times. Repeat steps 2 through 7 until oil is clear.

9. When actuator oil is clear and plug has been installed, use power supply to fully contract the actuator cylinder. Remove actuator from vise and install on machine.

Actuator Oil Level

Under normal conditions, actuator oil level should remain constant. If any oil is spilled from the reservoir during air bleeding, the oil level in the actuator should be checked and adjusted.

1. Make sure that the exterior of actuator is thoroughly clean to prevent contaminates from entering the actuator.

2. Make sure that the actuator cylinder is fully retracted.

IMPORTANT: To prevent actuator damage, use vise with protective jaws when clamping actuator.

3. Place the actuator in a vise making sure that actuator is clamped in the area identified in Figure 66. Use just enough clamping force to hold the housing securely. Make sure that the reservoir plug is orientated up.

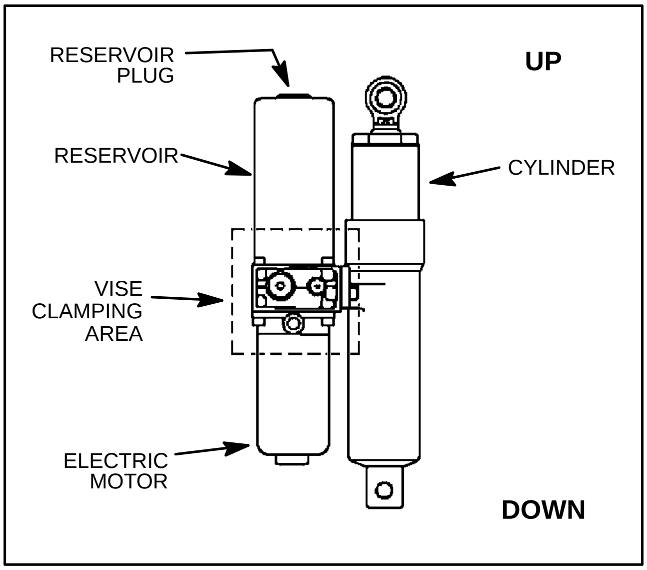

Figure 66

CAUTION

The actuator reservoir is pressurized. If the reservoir plug is removed too quickly, oil under pressure can be ejected from the actuator.

4. Slowly loosen and remove the reservoir plug at the top of the reservoir.

5. Using a light through the plug hole, confirm that the reservoir oil is clear. If the oil appears milky, perform actuator air bleeding procedure.

6. Use a clean rod to identify the level of oil in reservoir. Distance from plug fitting to oil level should be 0.984” (25 mm). If necessary, add ISO VG 32 mineral oil to actuator reservoir to adjust oil level.

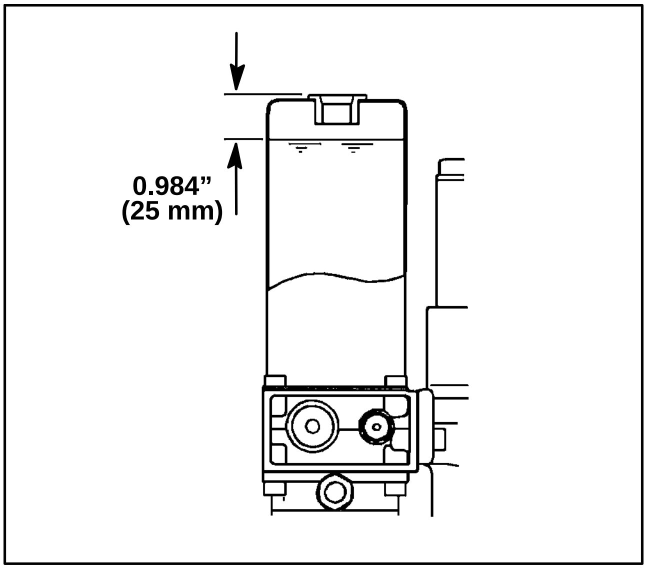

Figure 67

7. When oil level is correct, use a 12 volt DC power supply to power the actuator and extend the cylinder completely.

IMPORTANT: To ensure proper reservoir pressure, make sure that cylinder is extended before installing reservoir plug.

8. Install the reservoir plug and torque from **45 to 60 in–lb (5.1 to 6.8 N–m)**.

Actuator Disposal

If actuator disposal is necessary, remove hydraulic oil from actuator before disposal.

1. Open actuator reservoir (see Steps 1 through 4 in Actuator Air Bleeding above).

2. Drain oil from actuator.

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Chapter 7

Drive Train

Table of Contents

Specifications

Item	Description
Transmission Fluid Capacity Fluid Type	Integrated Transaxle with 3 Forward Speed Ranges and Reverse 7.5 quarts (7.1 liters) Dexron III ATF
Clutch System Drive Clutch Driven Clutch	Centrifugally Engaged Variable Belt Drive Speed Sensing With Mechanical Fly–Weights Torque Sensing With Spring Loaded Cam
Pump Drive Gearbox Fluid Capacity Fluid Type	Reducing Worm Gear for Pump Drive and Through Shaft for Transaxle Drive 0.6 quarts (0.57 liters) Mobil SHC 634 Synthetic Lubricant (Toro Part No. 104–8772)

General Information

Clutch System Operation

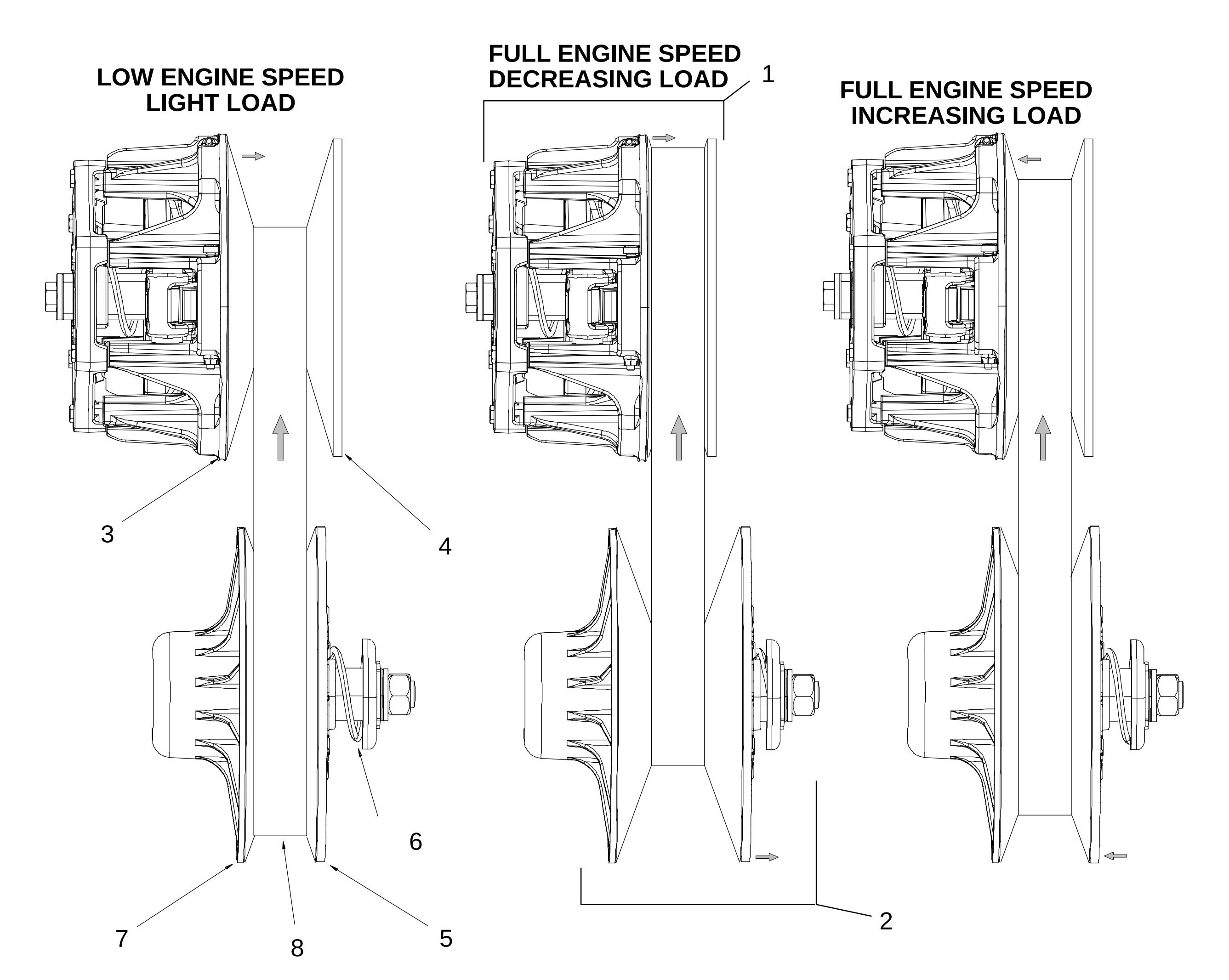

Figure 1

1. **Drive clutch**
2. **Driven clutch**
3. **Moveable sheave (drive clutch)**
4. **Fixed sheave (drive clutch)**
5. **Moveable sheave (driven clutch)**
6. **Spring**
7. **Fixed sheave (driven clutch)**
8. **CVT drive belt**

Two Clutch System (Fig. 1)

Power is transferred from the engine to the transaxle and spray pump by a variable clutch system that consists of two clutches connected by a drive belt. The drive clutch responds to engine speed and is mounted to the engine driveshaft. The driven clutch responds to changes in load from the transaxle and spray pump and is mounted to the pump drive gearbox input shaft.

The two 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 drive and driven clutches and allows the engine to operate at optimum efficiency.

Drive Clutch

Principles of Operation (Fig. 2)

The operation of the drive clutch is affected by engine shaft speed. With the engine not turning, the CVT drive belt rests low within the drive clutch sheaves as the pressure of the 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 driveshaft. The outward movement of the clutch weights presses against the rollers and overcomes spring pressure through the spider assembly, which forces the moveable sheave closer to the fixed sheave. This inward movement of the sheave engages the drive belt to drive the driven 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 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 fixed sheave. The drive belt disengages from the clutch sheaves at a point where the force of the spring is greater than that of the clutch weights.

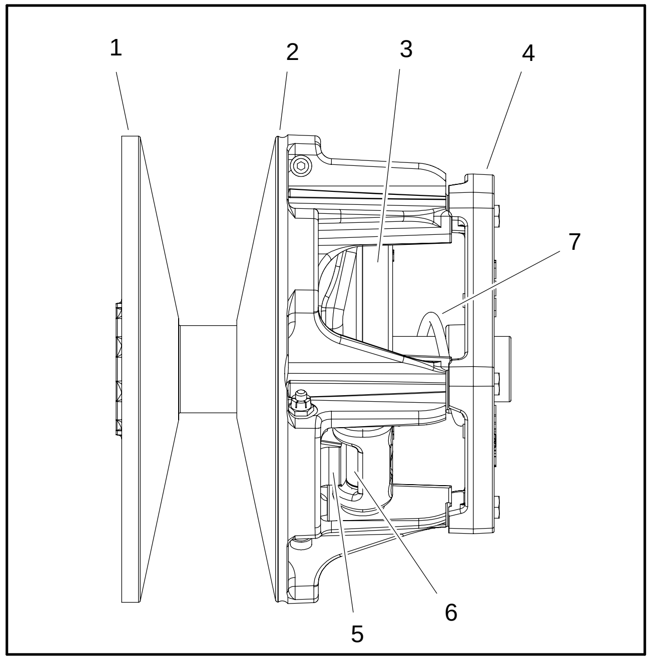

Figure 2

1. **Fixed sheave**
2. **Moveable sheave**
3. **Spider assembly**
4. **Cover**
5. **Clutch weight (3 used)**
6. **Roller (3 used)**
7. **Spring**

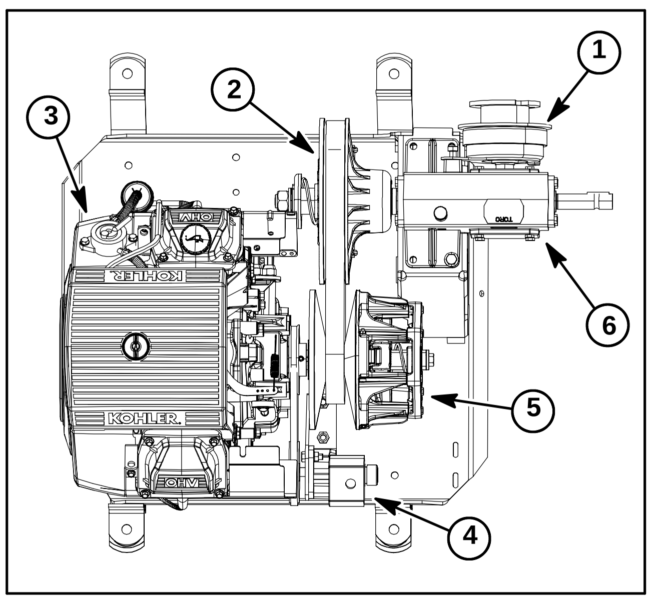

Figure 3

1. **Pump drive clutch**
2. **Driven clutch**
3. **Engine**
4. **Steering pump**
5. **Drive clutch**
6. **Pump drive gearbox**

Driven Clutch

Principles of Operation (Fig. 4)

The operation of the driven clutch is affected by load. When the vehicle is stopped, the CVT drive belt is held at the outer diameter of the driven clutch sheaves from the pressure of the spring pushing the moveable sheave against the fixed sheave and away from the fixed cam. A fixed cam on the moveable sheave rotates on a pair of rollers in the fixed sheave base to allow a low friction movement of the moveable sheave.

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

With increased load from the transaxle and/or spray pump, the cam resists forward movement relative to the moveable sheave and drive belt. Torque from the drive belt and spring pressure moves the movable sheave up the ramp of the fixed cam. The drive belt becomes positioned closer to the outer diameter of the driven clutch sheaves to respond to the load increase.

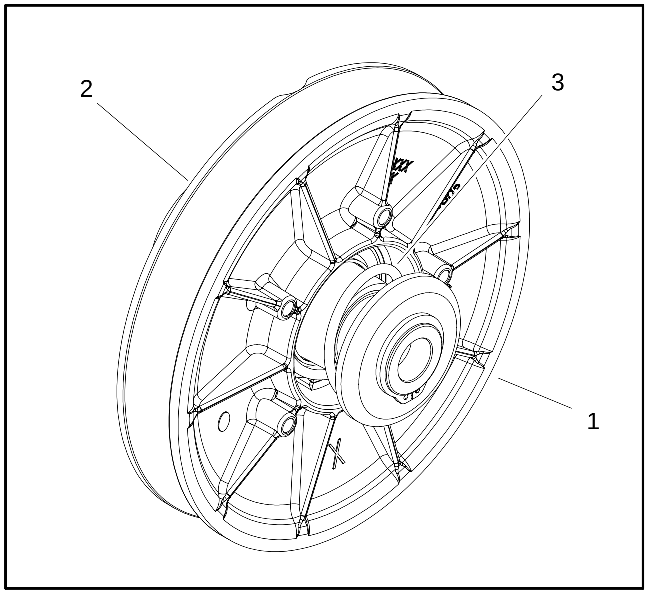

Figure 4

1. **Moveable sheave**
2. **Fixed sheave**
3. **Spring**

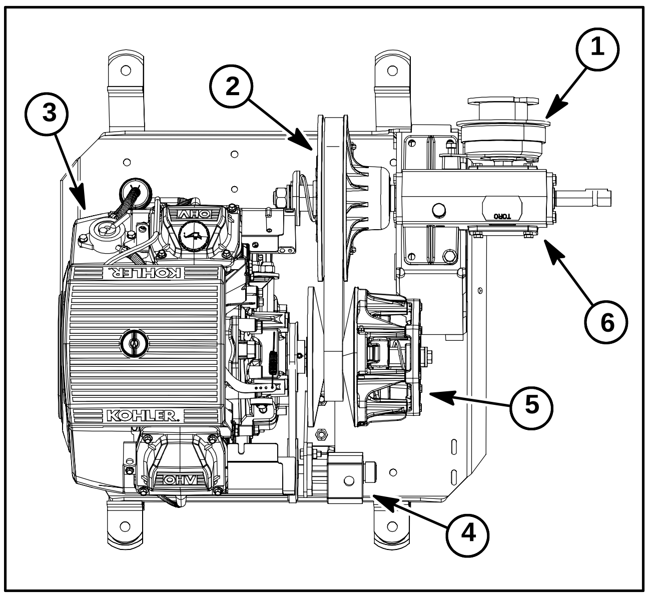

Figure 5

1. **Pump drive clutch**
2. **Driven clutch**
3. **Engine**
4. **Steering pump**
5. **Drive clutch**
6. **Pump drive gearbox**

Drive Train

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Special Tools

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

Drive Clutch Removal Tool

This tool is required to remove the drive clutch from the tapered crankshaft of the engine. It is placed in the threaded hole of the fixed clutch sheave after the clutch retaining cap screw has been removed.

Toro Part Number: **TOR6014**

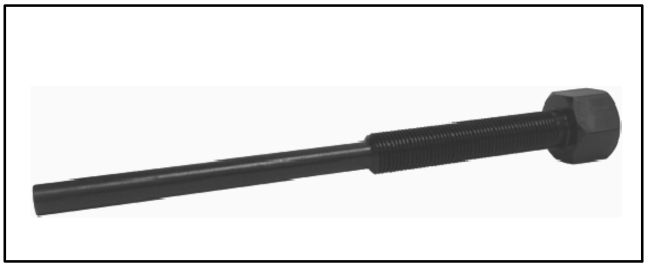

Figure 6

Drive Train

Troubleshooting

Transaxle

Symptom	Possible Causes
Noisy operation.	Low oil level in transaxle. Damaged or worn transaxle bearings. Transaxle gears worn, scuffed or broken. Excessive end play in transaxle countershaft. Gears loose on transaxle shaft. Excessive wear of differential side gear liners and pinion liners. Excessive wear of splined slider on axle drive joints.
Difficult shifting.	Shift cable out of adjustment. Shift cable damaged. Shifter cap screw loose (at operator position). Loose shift lever on transaxle. Cable clamp securing cables near shifter is loose. Sliding gear tight on transaxle shaft or splines. Transaxle synchronizing unit damaged. Transaxle sliding gear teeth damaged. Transaxle synchro keys damaged.

Transaxle (continued)

Symptom	Possible Causes
Gears make clashing noise when shifting.	Shifting too fast. Excessive wear of transaxle synchro rings. Excessive wear of differential side gear thrust washers and/or pinion gear washers. Damaged transaxle synchro springs and/or keys. Transaxle main gear needle bearings worn or damaged. Excessive wear of driveshaft(s).
Transaxle sticks in gear.	Transaxle shift fork detent ball stuck. Shift linkage damaged, loose or out of adjustment. Transaxle sliding gears tight on shaft splines. Transaxle synchro shift keys damaged.
Transaxle slips out of gear.	Shift linkage out of adjustment. Gear loose on transaxle shaft. Transaxle gear teeth worn. Excessive end play in transaxle gears. Lack of spring pressure on transaxle shift fork detent ball. Badly worn transaxle bearings.
Overheating of transaxle.	Oil level too high in transaxle. Excessive hydraulic load (see Chapter 8 – Hydraulic System).

Adjustments

Shift Cable Adjustment (Fig. 7)

1. Park machine on a level surface, stop engine, engage parking brake and remove key from the ignition switch. Place the shift lever in the neutral position.

2. Remove cotter pins and clevis pins that secure cable clevis to shift levers.

3. Check that the threads of the shift cables are centered in the mounting brackets. If needed, readjust shift cable jam nuts.

4. Adjust cable clevis with clevis jam nuts so that forward and backward free play of clevis is equal relative to the hole in the transaxle shift lever. Tighten clevis jam nuts.

5. Secure cable clevis to shift levers with clevis pins and cotter pins.

6. Check shift lever for proper operation.

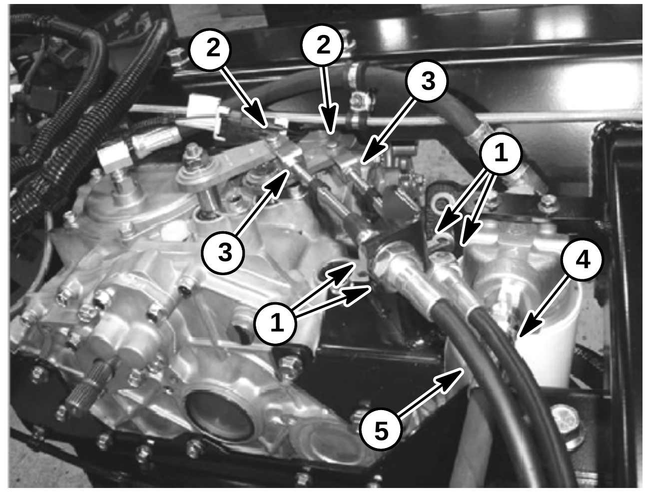

Figure 7

1. **Shift cable jam nut**
2. **Clevis pin**
3. **Clevis jam nut**
4. **Shift cable (1/reverse)**
5. **Shift cable (2/3)**

Service and Repairs

CVT Drive Belt Service

CVT Drive Belt Inspection

NOTE: Perform this maintenance procedure at the interval specified in the Operator's Manual.

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

2. Put vehicle transmission in neutral.

3. Rotate and inspect CVT drive belt for excessive wear or damage. Replace belt as necessary.

CVT Drive Belt Replacement (Fig. 8)

1. To remove CVT drive belt:

   A. While rotating the driven clutch, route belt over the clutch.

   B. Remove belt from the drive clutch.

2. To install CVT drive belt:

   A. Place new belt around drive clutch.

   B. Position belt to driven clutch. While rotating the driven clutch, route belt into position on driven clutch.

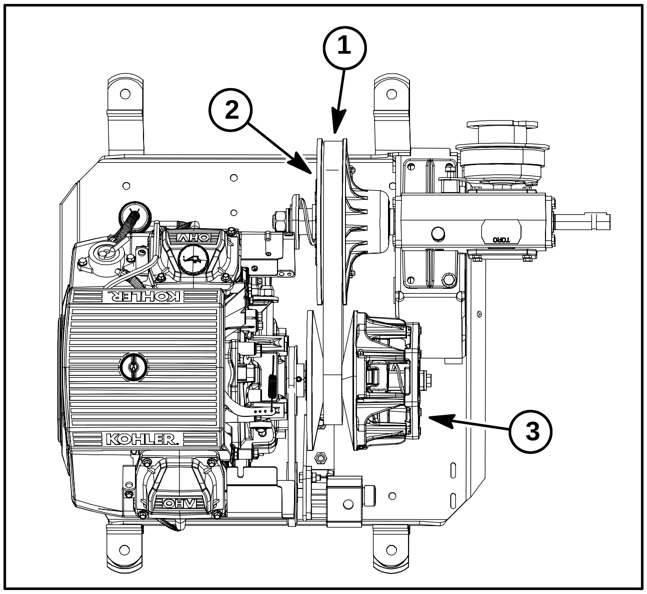

Figure 8

1. **CVT drive belt**
2. **Driven clutch**
3. **Drive clutch**

Drive Clutch

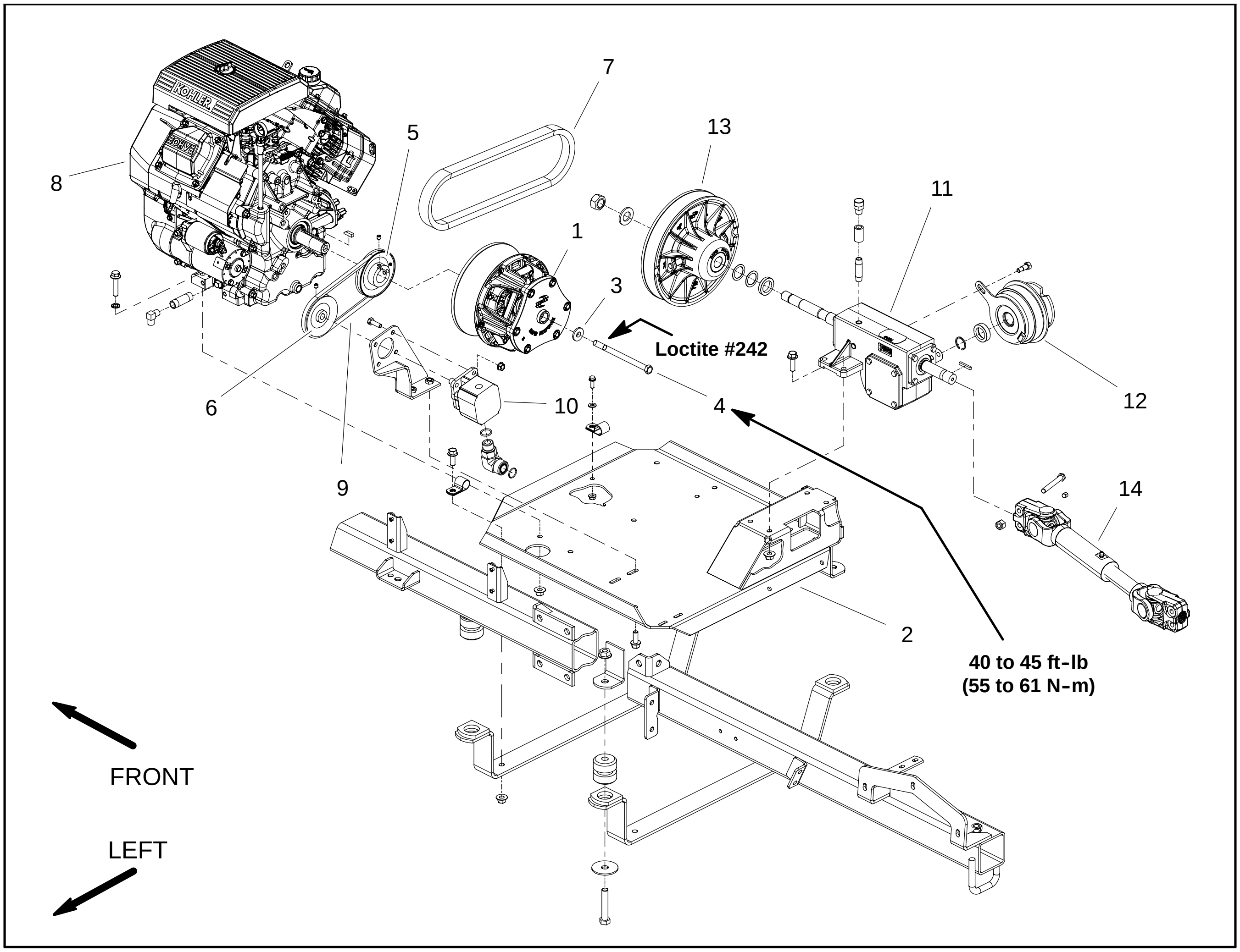

Figure 9

1. **Drive clutch**
2. **Engine mounting plate**
3. **Stepped washer**
4. **Cap screw**
5. **Pump drive pulley**
6. **Pump pulley**
7. **CVT drive belt**
8. **Engine**
9. **Steering pump belt**
10. **Steering pump**
11. **Pump drive gearbox**
12. **Pump drive electric clutch**
13. **Driven clutch**
14. **Transaxle driveshaft**

NOTE: For easiest service access to the drive clutch, removal of the spray tank is recommended in the following procedure. As an alternative, the engine mounting plate can be lowered from the machine to access the clutch (see Engine Mounting Plate Assembly in the Service and Repairs section of Chapter 3 – Kohler Gasoline Engine).

CAUTION

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

Removal (Fig. 9)

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

2. Remove the spray tank from machine to access drive clutch (see Spray Tank Removal in the Service and Repairs section of Chapter 6 – Spray System).

3. Remove CVT drive belt from the drive clutch (see CVT Drive Belt Service in this section).

4. Remove cap screw and stepped washer securing the drive clutch to the engine tapered crankshaft.

IMPORTANT: Lightly grease end of clutch removal tool to prevent damage to removal tool. To prevent clutch damage, thread tool into clutch threads only enough to remove the clutch.

5. Use clutch removal tool (see Special Tools in this chapter) to remove drive clutch from the engine tapered shaft.

Installation (Fig. 9)

1. Make sure that tapers of engine crankshaft and drive clutch bore are thoroughly clean.

2. Slide drive clutch onto engine shaft.

3. Apply Loctite #242 (or equivalent) to the threads of the cap screw used to secure clutch to crankshaft. Install cap screw and stepped washer to crankshaft. Torque cap screw **40 to 45 ft–lb (55 to 61 N–m)** to secure drive clutch.

4. Install CVT drive belt to the drive clutch (see CVT Drive Belt Service in this section).

5. Install the spray tank to the machine (see Spray Tank Installation in the Service and Repairs section of Chapter 6 – Spray System).

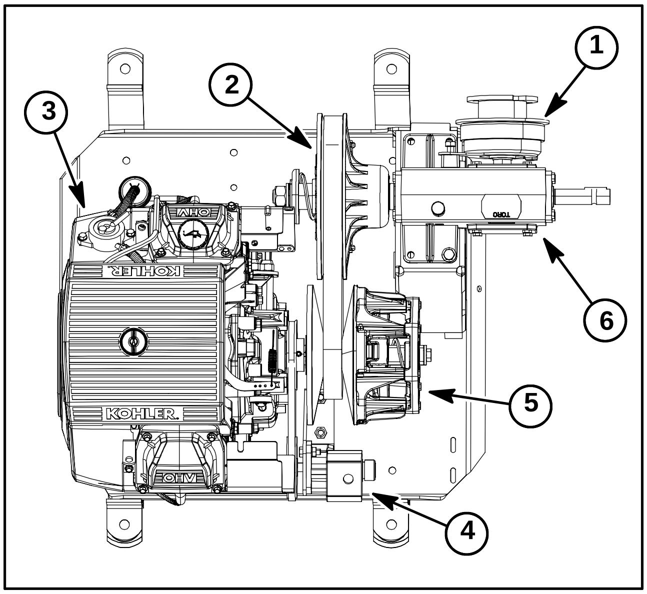

Figure 10

1. **Pump drive clutch**
2. **Driven clutch**
3. **Engine**
4. **Steering pump**
5. **Drive clutch**
6. **Pump drive gearbox**

Drive Train

Drive Clutch Service

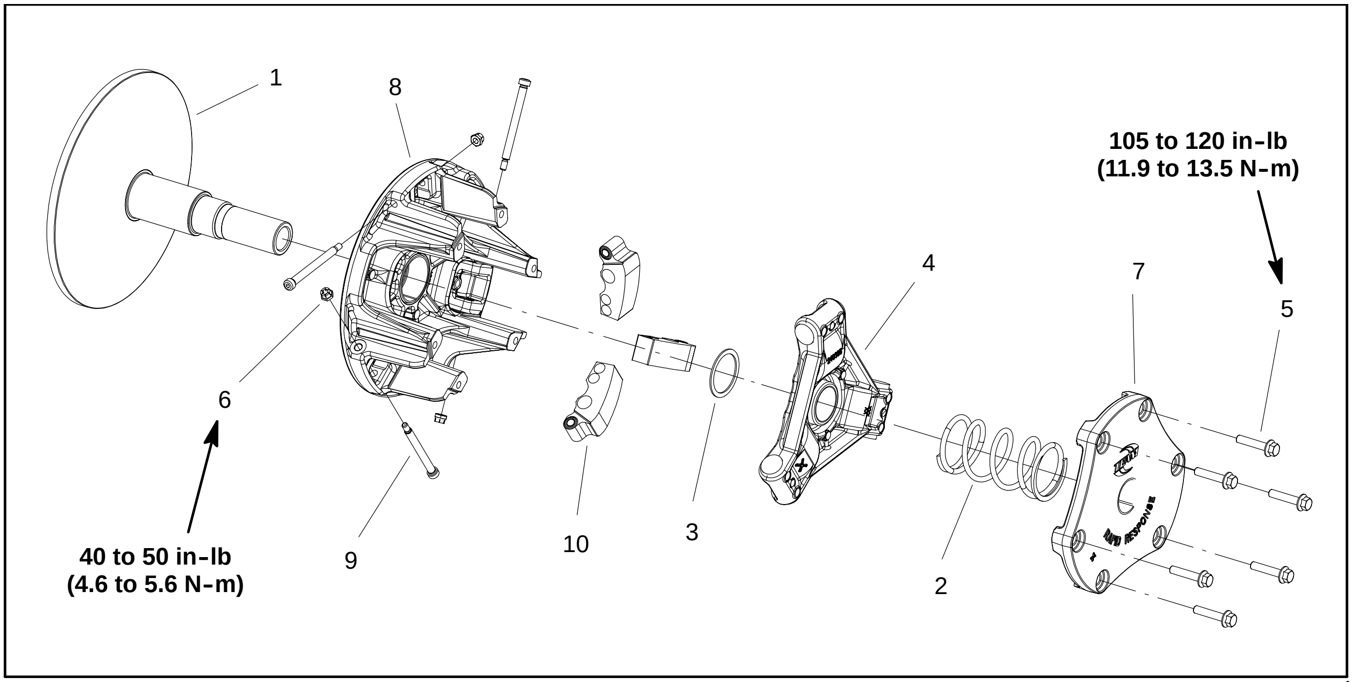

Figure 11

1. **Fixed sheave**
2. **Compression spring**
3. **Shim**
4. **Spider assembly**
5. **Flange head screw (6 used)**
6. **Lock nut (3 used)**
7. **Cover**
8. **Moveable sheave**
9. **Shoulder screw (3 used)**
10. **Clutch weight (3 used)**

Disassembly (Fig. 11)

1. Make note of the "X" mark cast into the cover and spider before clutch disassembly (Fig. 12). These marks must be aligned during assembly for proper clutch operation.

CAUTION

Loosen flange screws that secure cover slowly. The cover is under pressure from the compression spring.

2. Using a crossing pattern, loosen and remove six (6) flange head screws (item 5) that secure the cover to the movable sheave.

3. Carefully remove cover and compression spring from clutch.

4. Remove lock nut (item 6) from each of the shoulder screws (item 9). Discard lock nuts after removal.

5. Slide shoulder screw from each of the clutch weights (item 10) and then remove weights from clutch.

6. 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.

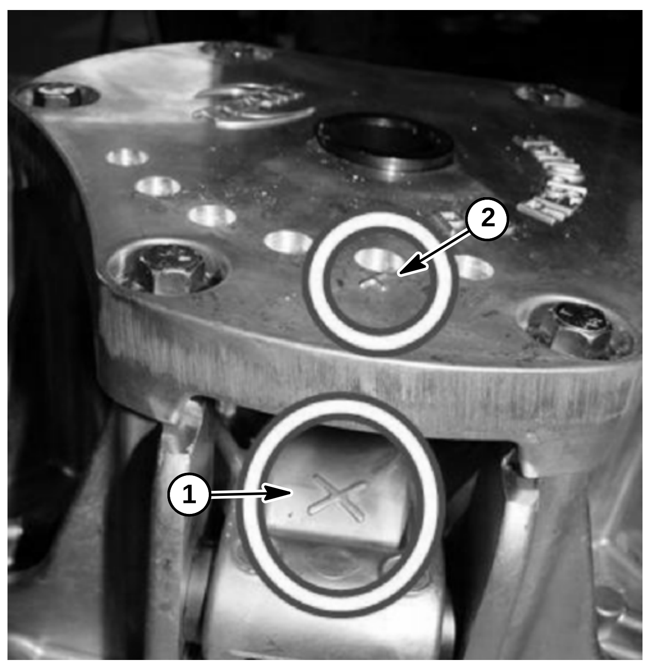

Figure 12

1. **Spider**
2. **Cover**

Inspection

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

1. Inspect the tapered ends of the engine crankshaft and fixed sheave of drive clutch. If either is severely damaged, replace component as damage to the taper will allow loosening of the clutch during machine operation.

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

3. Clean and inspect shoulder screws (item 9). If the shoulder area of the screws is worn or if the threads are damaged, replace the screws.

4. Check the contact surface of the clutch weights (Fig. 13). If surface is worn or damaged, replace all three (3) clutch weights as a set.

5. Check the rollers in the spider assembly for binding or wear (Fig. 14). If binding or uneven wear is found, replace clutch assembly.

6. Check the contact surface of the movable sheave for wear and/or fraying. If surface is worn/frayed, replace clutch assembly.

Assembly (Fig. 11)

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

IMPORTANT: To maintain the balance of the clutch, all shoulder screws must be installed with their threads pointing in a clockwise direction (Fig. 15).

1. Position clutch weights to moveable sheave and slide shoulder screw into sheave and weight. Make sure that shoulder 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)**.

3. Position compression spring and cover to clutch. Make sure that the “X” mark cast into the cover and spider are aligned.

4. Secure cover to the movable sheave with six (6) flange head screws in a crossing pattern and in three (3) steps. Final torque on screws should be from **105 to 120 in–lb (11.9 to 13.5 N–m)**.

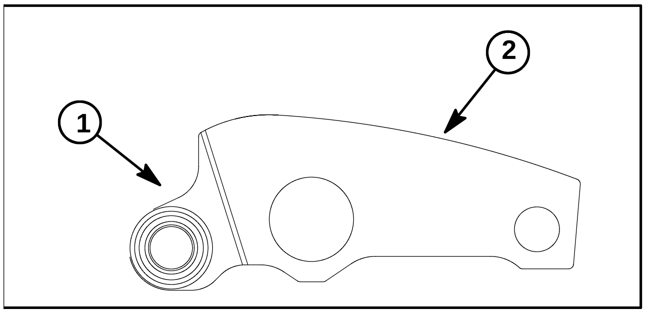

Figure 13

1. **Clutch weight**
2. **Contact surface**

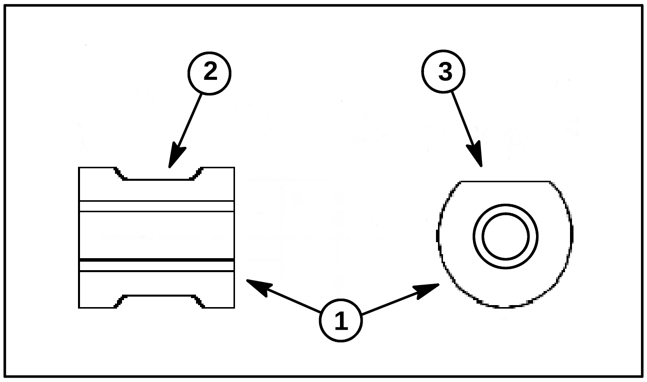

Figure 14

1. **Roller**
2. **Weight contact surface**
3. **Roller uneven wear**

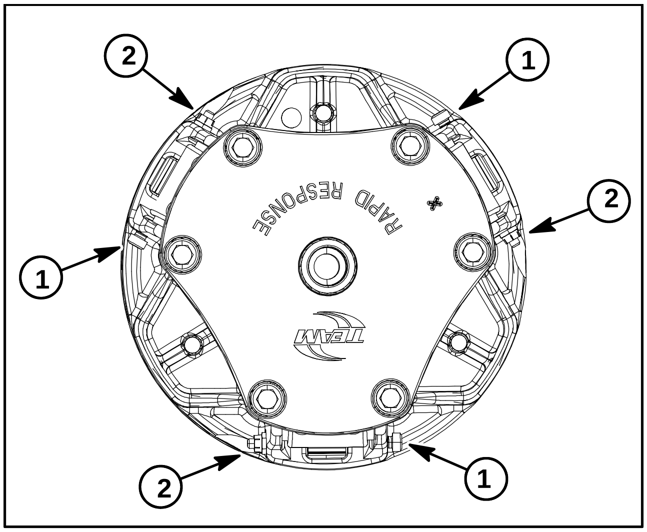

Figure 15

1. **Shoulder screw**
2. **Lock nut**

Driven Clutch

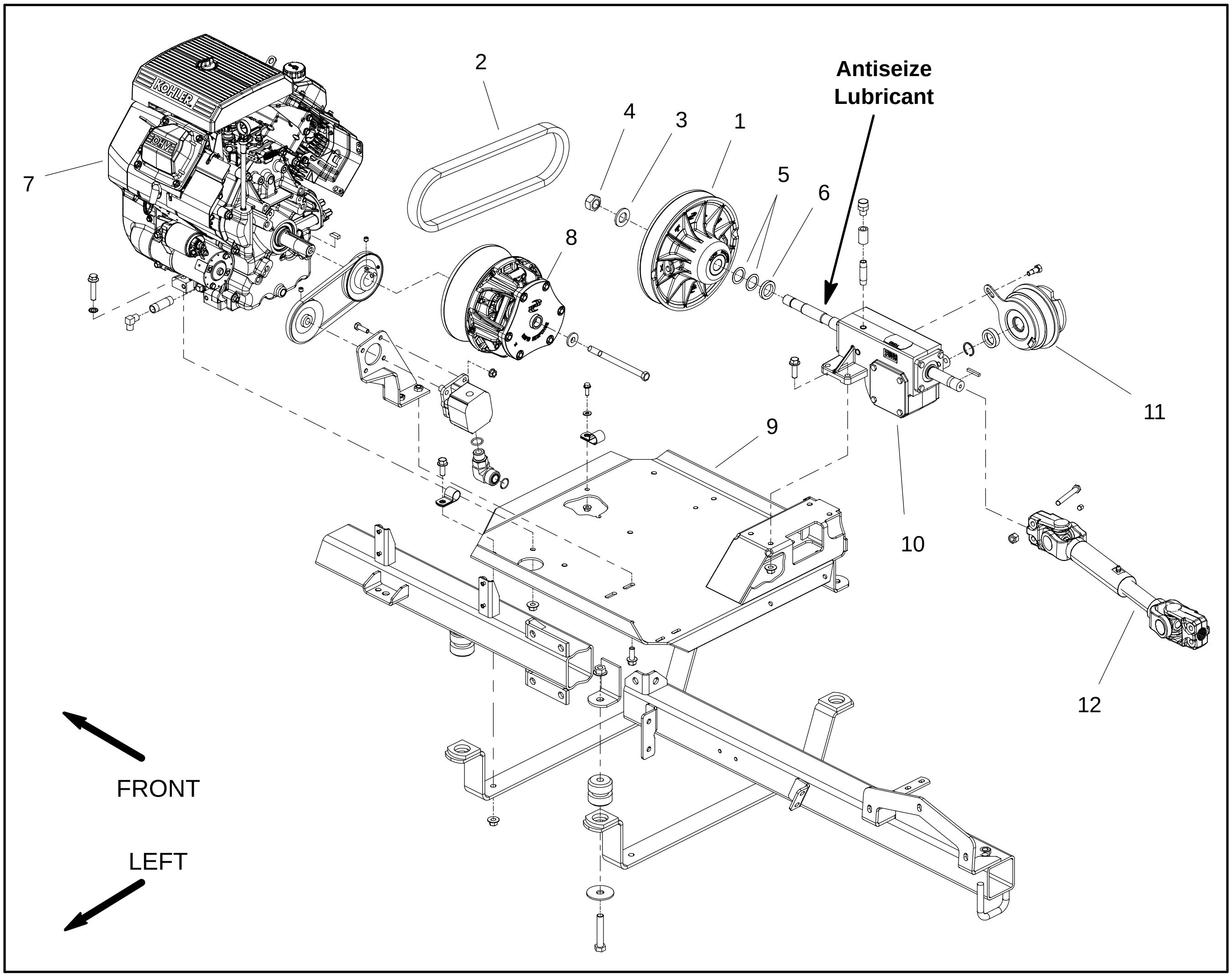

Figure 16

1. Driven clutch
2. CVT drive belt
3. Flat washer
4. Lock nut (LH thread)
5. Washer
6. Spacer
7. Engine
8. Drive clutch
9. Engine mounting plate
10. Pump drive gearbox
11. Pump drive electric clutch
12. Transaxle driveshaft

NOTE: For easiest service access to the driven clutch, removal of the spray tank is recommended in the following procedure. As an alternative, the engine mounting plate can be lowered from the machine to access the clutch (see Engine Mounting Plate Assembly in the Service and Repairs section of Chapter 3 – Kohler Gasoline Engine).

CAUTION

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

Driven Clutch Removal (Fig. 16)

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

2. Remove the spray tank from machine to access drive clutch (see Spray Tank Removal in the Service and Repairs section of Chapter 6 – Spray System).

3. Remove CVT drive belt from the driven clutch (see CVT Drive Belt Service in this section).

IMPORTANT: The gearbox input shaft and lock nut that secures the driven clutch have left hand threads.

4. Remove lock nut and flat washer securing the driven clutch to the input shaft of the pump drive gearbox.

IMPORTANT: When removing driven clutch, note quantity of washers (item 5) that exist on gearbox shaft. Washers are used to align drive and driven clutch pulleys.

5. Pull driven clutch from the pump drive gearbox input shaft. Locate and retrieve washer(s) (item 5) and spacer (item 6) from input shaft.

Driven Clutch Service (Fig. 17)

1. Use a suitable press to compress the clutch spring enough to allow removal of the retaining ring.

2. Remove retaining ring.

3. Carefully, allow the spring to extend fully.

4. Remove outer spring retainer, spring and inner spring retainer from clutch.

5. Make note of the "X" mark cast into the fixed sheave and moveable sheave before removing the moveable sheave. These marks must be aligned during assembly for proper clutch operation.

6. Separate the clutch sheaves. Locate and retrieve thrust washer.

7. Clean and inspect driven clutch components:

   A. 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.

   B. Inspect the spring and replace if damaged or fatigued.

   C. Check the rollers in the fixed sheave for binding or wear. If binding or uneven wear is found, replace driven clutch assembly.

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

8. Assemble the driven clutch in the reverse order of disassembly. Make sure that the "X" mark cast into the fixed and moveable sheaves are aligned. Also, make sure that the retaining ring is fully seated in groove after installation.

Driven Clutch Installation (Fig. 16)

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

1. Apply antiseize lubricant to gearbox input shaft.

2. Place spacer (item 6) and then washer(s) (item 5) onto input shaft. Make sure that number of washers used during clutch installation is the same as number of washers that were removed.

3. Position driven clutch to the gearbox input shaft. Make sure pulley side of the clutch faces away from the gearbox case.

IMPORTANT: The gearbox input shaft and lock nut that secures the driven clutch have left hand threads.

4. Secure driven clutch to the gearbox input shaft with lock nut and flat washer.

5. Install CVT drive belt to the driven clutch (see CVT Drive Belt Service in this section).

6. Install the spray tank to the machine (see Spray Tank Installation in the Service and Repairs section of Chapter 6 – Spray System).

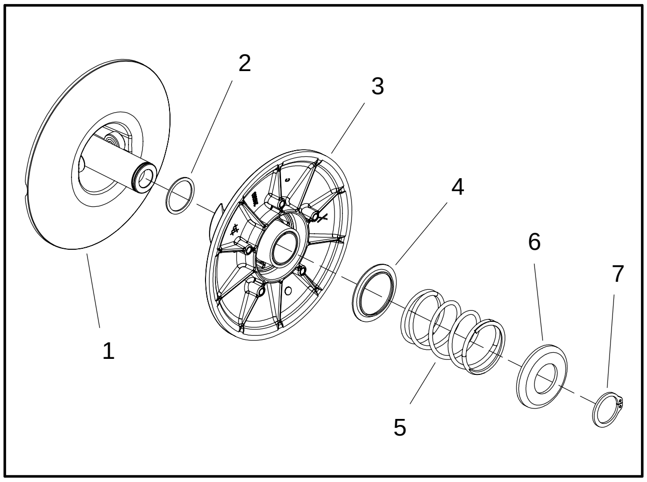

Figure 17

1. **Fixed sheave**
2. **Thrust washer**
3. **Moveable sheave**
4. **Inner spring retainer**
5. **Spring**
6. **Outer spring retainer**
7. **Retaining ring**

Pump Drive Gearbox

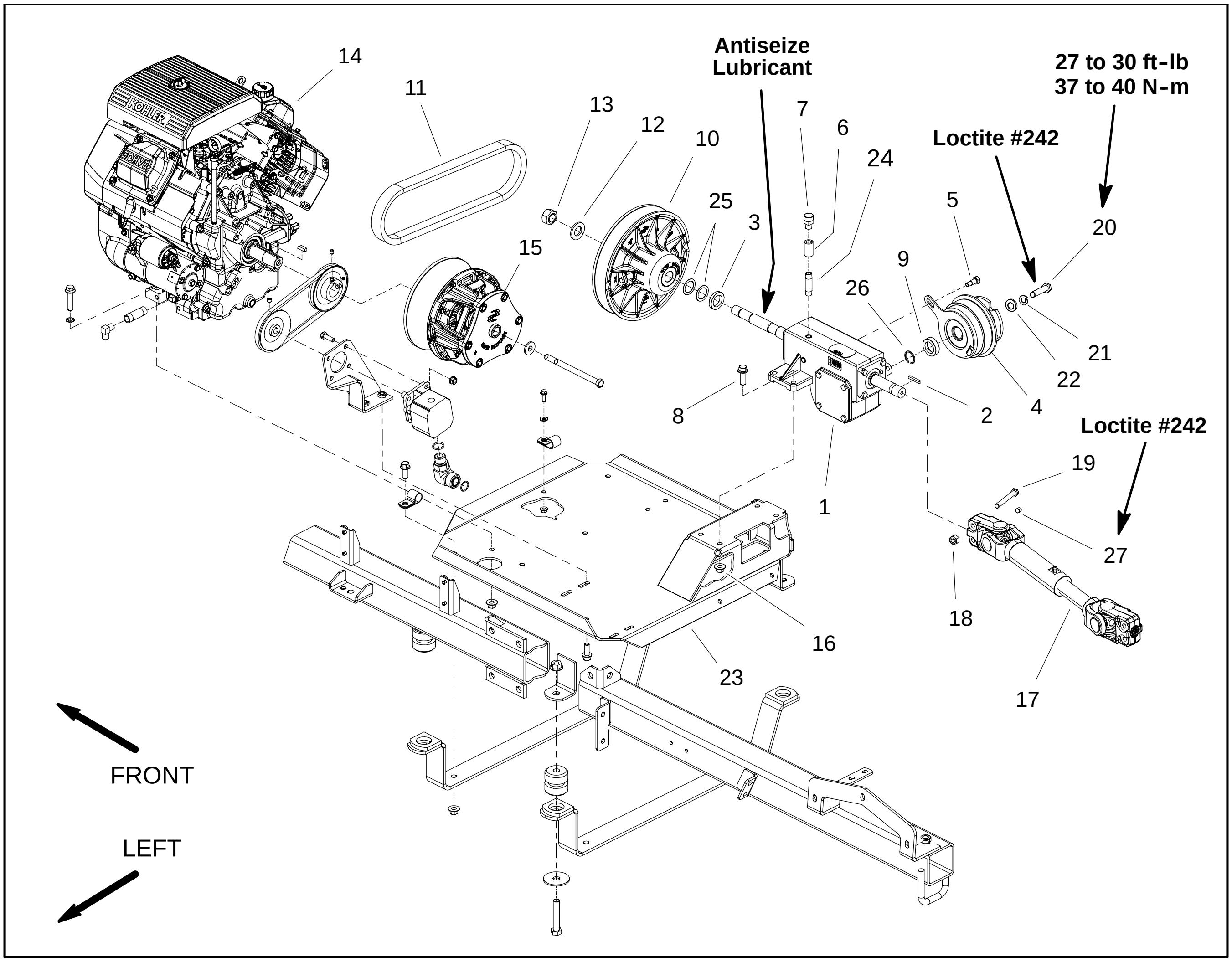

Figure 18

1. Pump drive gearbox
2. Key
3. Spacer
4. Pump drive electric clutch
5. Shoulder bolt
6. Coupling
7. Breather
8. Flange head screw (4 used)
9. Spacer
10. Driven clutch
11. CVT drive belt
12. Flat washer
13. Lock nut (LH thread)
14. Engine
15. Drive clutch
16. Flange nut (4 used)
17. Transaxle driveshaft
18. Lock nut (2 used)
19. Cap screw (2 used)
20. Cap screw
21. Lock washer
22. Clutch retainer
23. Engine mounting plate
24. Pipe nipple
25. Washer (as needed for alignment)
26. Retaining ring
27. Socket head screw

NOTE: For easiest service access to the pump drive gearbox, removal of the spray tank is recommended in the following procedure. As an alternative, the engine mounting plate can be lowered from the machine to access the gearbox (see Engine Mounting Plate Assembly in the Service and Repairs section of Chapter 3 – Kohler Gasoline Engine).

CAUTION

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

Removal (Fig. 18)

1. Park vehicle on a level surface, stop engine, set parking brake and remove key from the ignition switch.

2. Remove the spray tank from machine to access drive clutch (see Spray Tank Removal in the Service and Repairs section of Chapter 6 – Spray System).

3. Disconnect transaxle driveshaft from pump drive gearbox shaft:

A. Remove two (2) cap screws and lock nuts that secure transaxle driveshaft yoke to pump drive gearbox shaft.

B. Loosen socket head screw (item 27) in driveshaft yoke.

C. Slide transaxle driveshaft yoke from pump drive gearbox shaft.

IMPORTANT: When removing driven clutch, note quantity of washers (item 25) that exist on gearbox shaft. Washers are used to align drive and driven clutch pulleys.

4. Remove driven clutch from pump drive gearbox (see Driven Clutch in this section).

5. Remove electric clutch from pump drive gearbox (see Electric Clutch (Pump Drive) in the Service and Repairs Section of Chapter 6 – Spray System). Locate and remove spacer from gearbox input shaft.

6. Remove four (4) flange head screws and lock nuts that secure gearbox to engine mounting plate. Remove gearbox from machine.

Installation (Fig. 18)

1. Position gearbox to engine mounting plate. Secure gearbox to mounting plate with four (4) flange head screws and lock nuts.

2. Install electric clutch to gearbox shaft (see Electric Clutch (Pump Drive) in the Service and Repairs Section of Chapter 6 – Spray System). Make sure that spacer is installed so that spacer groove is positioned over the retaining ring in gearbox shaft.

3. Install driven clutch to gearbox (see Driven Clutch in this section). Make sure that spacer (item 3) and washer(s) (item 25) are installed on gearbox input shaft.

4. Connect transaxle driveshaft to pump drive gearbox shaft:

A. Slide transaxle driveshaft yoke onto pump drive gearbox shaft.

B. Align mounting holes in driveshaft with relief in gearbox shaft.

C. Install and tighten two (2) cap screws and lock nuts to secure driveshaft to transaxle shaft.

D. Remove socket head screw (item 27) from driveshaft yoke. Clean threads of screw and yoke. Apply Loctite #242 (or equivalent) to threads of screw. Install and tighten screw into yoke.

IMPORTANT: Make sure that correct gearbox lubricant is used when filling gearbox. Recommended gearbox lubricant is Mobil SHC 634 Synthetic Lubricant (Toro Part No. 104–8772).

5. Check and adjust gearbox lubricant level (see Operator's Manual). The oil level should be checked using the plug on the side of the gearbox.

6. Install the spray tank to the machine (see Spray Tank Installation in the Service and Repairs section of Chapter 6 – Spray System).

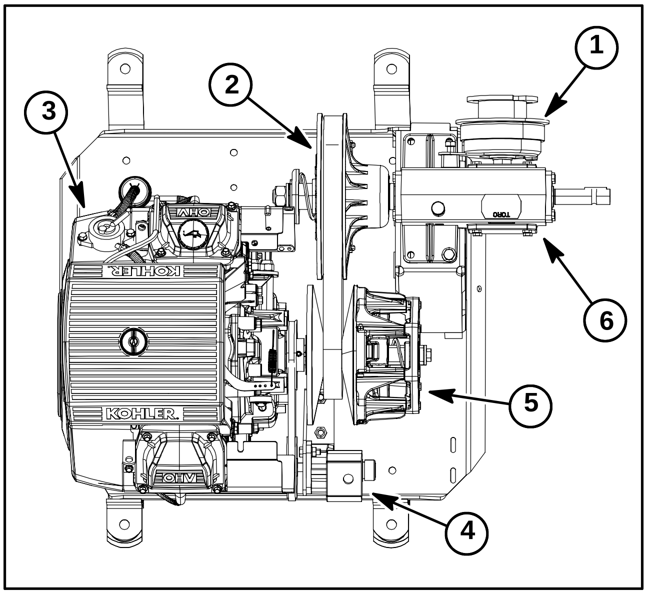

Figure 19

1. **Pump drive clutch**
2. **Driven clutch**
3. **Engine**
4. **Steering pump**
5. **Drive clutch**
6. **Pump drive gearbox**

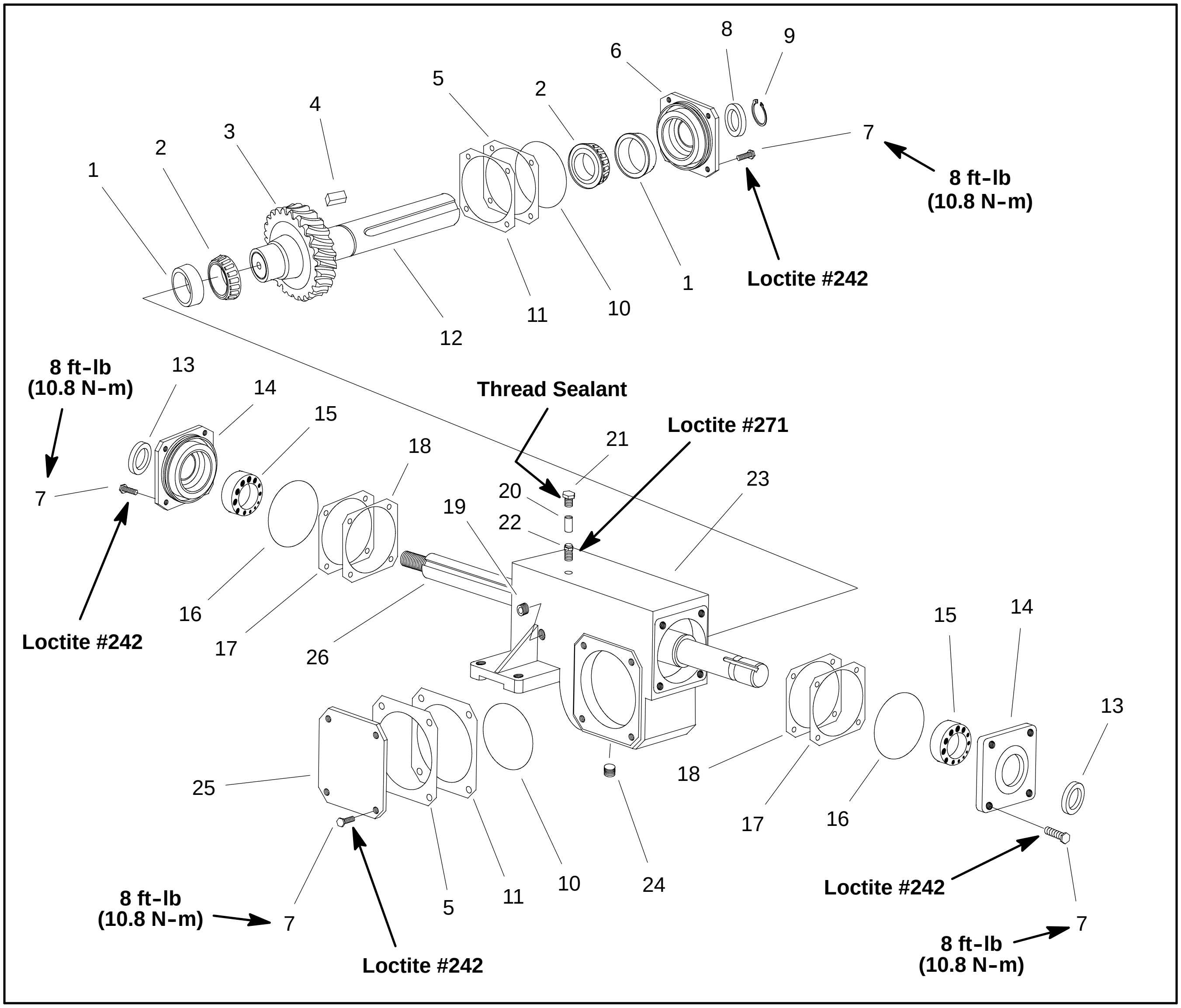

Figure 20

1. **Bearing cup**
2. **Bearing cone**
3. **Worm gear**
4. **Key**
5. **Red shim (0.002")**
6. **Open output cap**
7. **Cap screw (4 per cap)**
8. **Output shaft seal**
9. **Retaining ring**
10. **O-ring**
11. **Blue shim (0.005")**
12. **Output shaft**
13. **Input shaft seal**
14. **Open input cap**
15. **Ball bearing**
16. **O-ring**
17. **Red shim (0.002")**
18. **Blue shim (0.005")**
19. **Oil level plug**
20. **Coupling**
21. **Breather**
22. **Nipple**
23. **Gearbox housing**
24. **Drain plug**
25. **Closed output cap**
26. **Worm (input) shaft**

Disassembly (Fig. 20)

1. Drain lubricant from gearbox.

2. Remove retaining ring (item 9) from output shaft.

3. Loosen and remove cap screws that secure output caps (item 6 and 25) to gearbox housing. Remove caps with bearing cups and O-rings. Remove shims. Note shim location for assembly purposes.

4. Carefully remove output shaft (item 12) with worm gear and bearing cones from housing.

5. Loosen and remove cap screws that secure both open input caps (item 14) to gearbox housing. Remove caps and O-rings from housing. Remove shims. Note shim location for assembly purposes.

6. Carefully pull worm (input) shaft (item 26) with bearings from housing.

7. Remove seals from open caps taking care not to damage seal bores. Clean seal bore in caps. Remove and discard O-rings from caps.

8. If required, press bearings from worm (input) shaft (item 26).

9. If necessary, remove bearing cups from output caps. Make sure to remove bearing cups evenly to prevent damage to output caps.

IMPORTANT: Do not attempt to remove both bearing cones and gear from output shaft at the same time. The key (item 4) will cause severe damage to gear, shaft and bearings.

10. If worm gear (item 3) and bearing cones (item 2) are to be removed from output shaft, support bottom side of gear and press shaft down through one bearing cone and gear (Fig. 21). Remove key from shaft. Second bearing cone can then be pressed from shaft.

11. Thoroughly clean all gearbox components and inspect for evidence of wear or damage. Replace internal components as needed.

Assembly (Fig. 20)

1. If removed, install bearings onto worm (input) shaft. Press on the inner bearing race until the bearing is tight against the shaft shoulder.

2. If removed, press bearing cups into output caps.

3. If worm gear and bearing cones were removed from output shaft, fit key into output shaft and position gear to shaft. Press gear onto shaft until the gear is centered on the key (Fig. 22). Pressing on the inner bearing race, install bearing cones until they are tight against the gear.

4. Slide worm (input) shaft with bearings into housing noting correct orientation of shaft ends.

5. Adjust worm (input) shaft end play.

A. Position new shims to gearbox housing.

B. Install both open caps (item 14) (O-ring and seal not installed on cap) to gearbox housing. Torque cap screws **8 ft-lb (10.8 N-m)** while checking for binding of shaft. If shaft binds as screws are tightened, add additional shims.

C. After both input caps are installed, check end play of worm (input) shaft. Shaft end play should be from 0.001” to 0.003” (0.025 to 0.076 mm). End play can be adjusted by adding or removing shims from between input caps and gearbox housing. Total shim thickness at one input cap should be within 0.005” (0.13 mm) of the total shim thickness of the other cap.

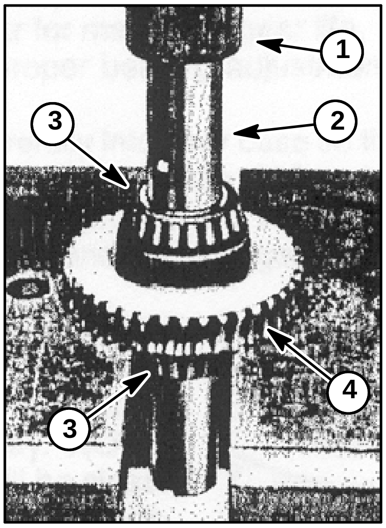

Figure 21

1. **Press**
2. **Output shaft**
3. **Bearing cone**
4. **Worm gear**

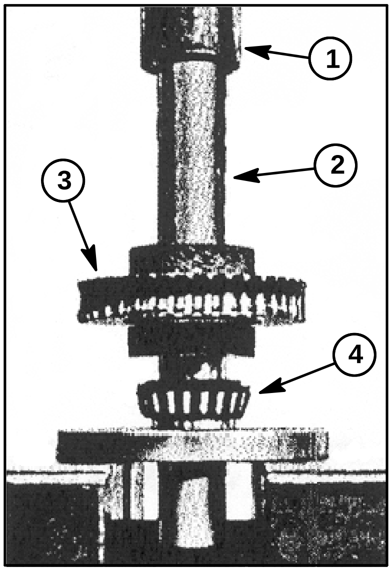

Figure 22

1. **Press**
2. **Output shaft**
3. **Worm gear**
4. **Bearing cone**

6. Once correct quantity of shims has been determined, make final assembly of input caps to gearbox housing.

A. Remove open input caps from housing.

B. Install new O-ring into groove of input cap. Apply light coat of grease on O-ring and gearbox housing bore.

C. Taking care to not damage O-ring or shims, install input cap over input shaft and into housing.

D. Apply Loctite #242 to cap screw threads. Install and torque cap screws **8 ft-lb (10.8 N-m)**.

Drive Train

7. Slide output shaft with worm gear and bearing cones into housing. Align output shaft worm gear with input shaft gear.

8. Adjust output shaft end play.

A. Position one red (0.002”) and one blue (0.005”) shim to both openings of gearbox housing.

B. Install both output caps (items 6 and 25) (O–rings and seals not installed on caps) to gearbox housing. Torque cap screws **8 ft–lb (10.8 N–m)** while checking for binding of shaft. If shaft binds as screws are tightened, add additional shims.

C. After both output caps are installed, check end play of output shaft. Shaft end play should be from 0.001” to 0.003” (0.025 to 0.076 mm). End play can be adjusted by adding or removing shims from between output caps and gearbox housing. Total shim thickness at one output cap should be within 0.005” (0.13 mm) of the total shim thickness of the other cap.

D. Check gear contact by applying bluing compound to worm gear (item 3) teeth. Turn worm (input) shaft while putting a slight load on output shaft. Inspect contact on gear by viewing through drain plug opening in gear housing. Worm contact should be centered on both sides of the gear (Fig. 23). To adjust gear contact while maintaining shaft end play, move shim(s) from one side of the gear housing to the other.

9. Once correct quantity of shims has been determined and gear contact has been adjusted, make final assembly of output caps to gearbox housing.

A. Remove output caps from gearbox housing.

B. Install new O–rings into groove of output caps. Apply light coat of grease on O–rings and gearbox housing bores.

C. Taking care not to damage O–rings or shims, install caps over output shaft and into housing.

D. Apply Loctite #242 to cap screw threads. Install and torque cap screws **8 ft–lb (10.8 N–m)**.

10. Install seals into input and output caps.

A. Apply a light coat of Permatex to outside diameter of new shaft seal.

B. To prevent seal damage, cover shaft keyway with seal protector, cellophane tape or other thin material. Apply light coat of grease on seal lip and place seal on the shaft with the seal lip facing in.

C. Press seal evenly into cap bore. Seal in output cap should be flush to the cap face. Seals in input caps should be recessed 0.040” (1.0 mm) into cap.

11. Install retaining ring to output shaft. Make sure that retaining ring is fully seated in shaft groove.

12. If breather assembly was removed from gearbox, apply Loctite #271 (or equivalent) to threads on each end of nipple. Install nipple into gearbox housing and then thread coupling onto nipple. Apply thread sealant onto threads of breather and install breather onto coupling.

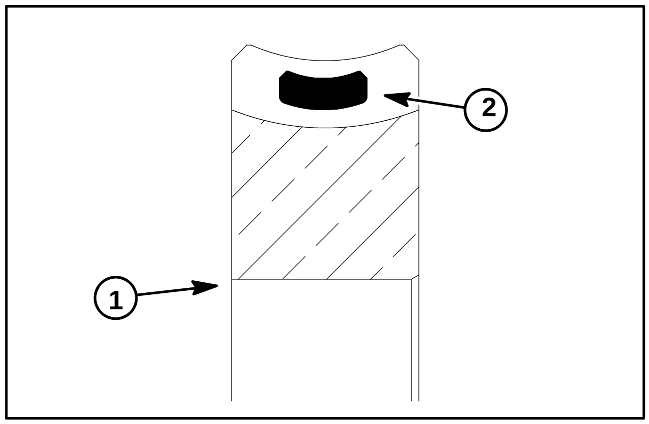

Figure 23

1. Worm gear (output shaft) **2. Gear pattern**

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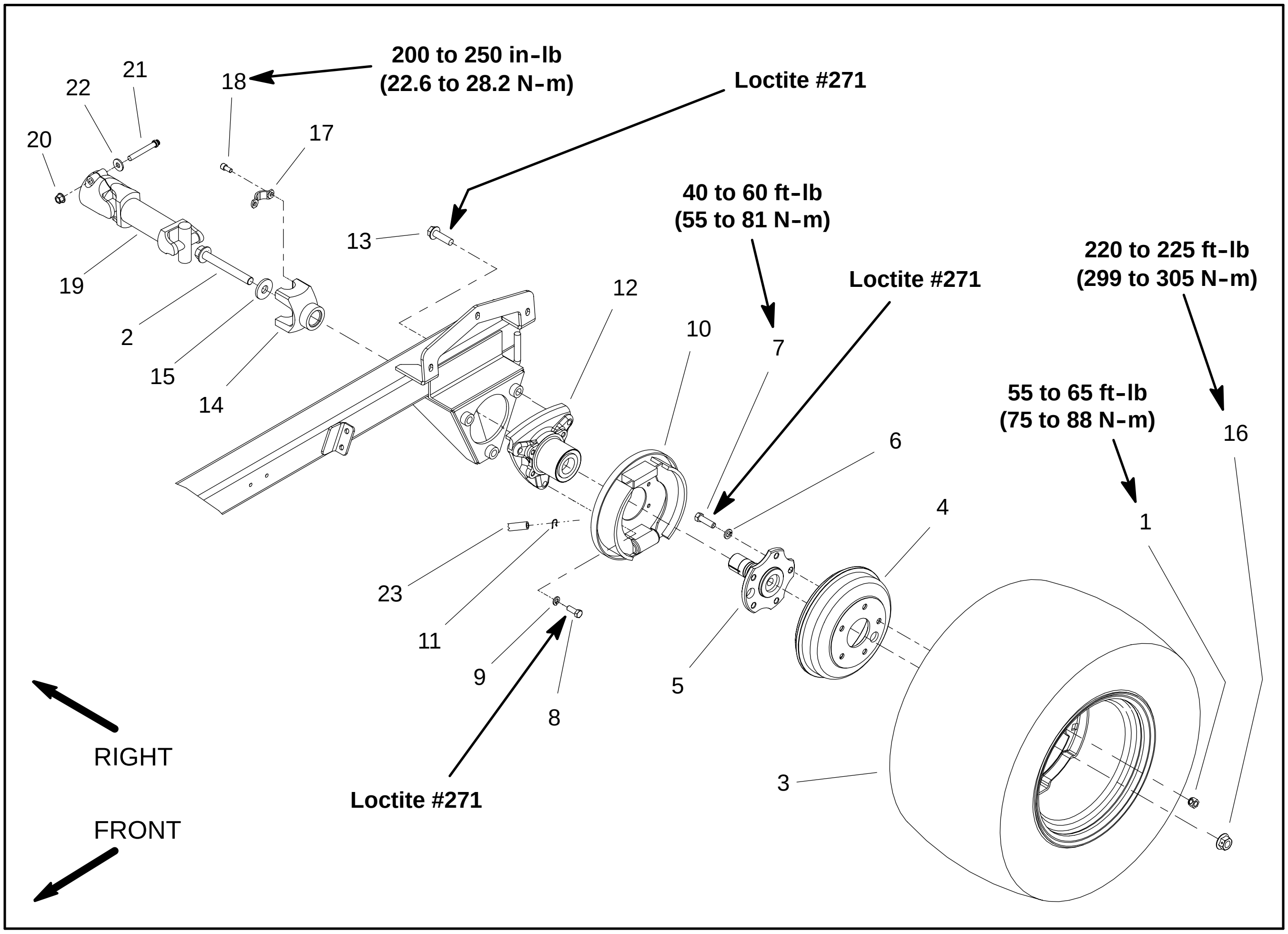

Figure 24

1. **Lug nut (5 used per wheel)**
2. **Flange head screw**
3. **Wheel assembly**
4. **Brake drum**
5. **Stub axle**
6. **Lock washer (5 used per wheel)**
7. **Drive stud (5 used per wheel)**
8. **Cap screw (4 used per wheel)**
9. **Lock washer (4 used per wheel)**
10. **Brake assembly**
11. **Brake cable clip**
12. **Axle housing assembly**
13. **Flange head screw (3 used per wheel)**
14. **End yoke**
15. **Flat washer**
16. **Flange lock nut**
17. **Yoke strap (2 used per yoke)**
18. **Bolt (4 used per yoke)**
19. **Driveshaft assembly**
20. **Lock nut (2 used per driveshaft)**
21. **Cap screw (2 used per driveshaft)**
22. **Hardened washer (2 per driveshaft)**
23. **Parking brake cable**

Removal (Fig. 24)

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

2. Chock front wheels. Raise rear wheel using a jack or hoist (see Jacking Instructions in Chapter 1 – Safety). Support rear of machine with jack stands.

3. Loosen and remove lug nuts. Remove rear wheel. Remove brake drum (see Rear Wheels and Brakes in the Service and Repairs Section of Chapter 8 – Chassis).

NOTE: Loosening driveshaft at transaxle will allow easier driveshaft removal from end yoke.

4. Remove the straps securing driveshaft bearing cross to the end yoke, then disconnect driveshaft from the end yoke.

5. Loosen flange lock nut that secures end yoke to stub axle. Remove flange lock nut, flat washer and flange head screw. Pull end yoke from stub axle.

6. Carefully slide stub axle from axle housing.

7. To remove driveshaft from transaxle, loosen and remove lock nuts, cap screws and hardened washers securing driveshaft to splined axle shaft of transaxle. Slide driveshaft outward and remove from transaxle.

8. To remove axle housing from machine:

A. Remove brake assembly from axle housing (see Rear Wheels and Brakes in the Service and Repairs Section of Chapter 8 – Chassis).

B. Remove three (3) flange head screws that secure axle housing to machine frame. Remove axle housing.

Bearing Service (Fig. 25)

1. Inspect bearings and replace if necessary. If outer bearing cone is removed from stub axle, bearing set must be replaced.

IMPORTANT: Bearings, with bearing cups and thin bearing spacer, are a MATCHED SET. Use one bearing set for each axle housing. Bearing set components are NOT INTERCHANGEABLE.

2. Remove seal from back of axle housing.

3. Remove inner bearing cone. Slide bearing spacers from axle housing noting orientation of step in large bearing spacer (toward seal location).

4. Press inner and outer bearing cups from housing. Press outer bearing cone from stub axle.

5. Clean all parts thoroughly before reassembly.

6. Position inner and outer bearing cups to axle housing. Press bearing cups into housing until they seat against the housing shoulder.

7. Pack bearings with lithium based grease.

8. Position larger bearing cone (item 1), wide end first, onto stub axle. Press bearing onto stub axle putting pressure on inner race of bearing. Slide thin bearing spacer onto stub axle.

9. Insert stub axle with bearing and thin spacer into axle housing.

10. Fill axle housing with grease.

11. Insert large bearing spacer onto stub axle inside housing. Orientate the stepped end of the spacer toward the seal location.

12. Insert smaller, greased bearing cone, small end first, onto stub axle inside housing.

IMPORTANT: The seal must be pressed in so it is flush with the end of the axle housing. The lip of the seal must be toward the bearing.

13. Install new seal over shaft and into housing. Be careful to not damage the seal during installation.

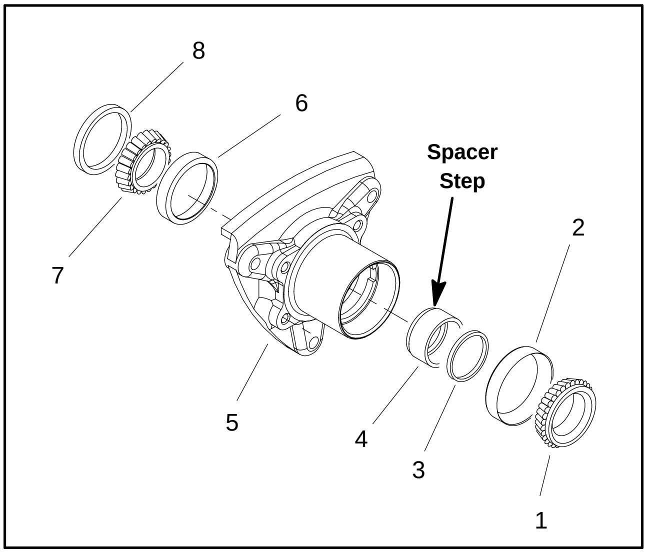

Figure 25

1. **Outer bearing cone**
2. **Outer bearing cup**
3. **Thin bearing spacer**
4. **Large bearing spacer**
5. **Axle housing**
6. **Inner bearing cup**
7. **Inner bearing cone**
8. **Seal**

Installation (Fig. 24)

1. If removed, install axle housing to frame:

A. Apply Loctite #271 (or equivalent) to the threads of three (3) flange head screws that mount axle housing to machine.

B. Position axle housing to frame and install three (3) flange head screws to secure axle housing to machine frame.

C. Install brake assembly to axle housing (see Rear Wheels and Brakes in the Service and Repairs Section of Chapter 8 – Chassis).

2. If driveshaft was removed from transaxle:

A. Apply antiseize lubricant to transaxle shaft. Slide driveshaft clamp end onto splined transaxle shaft.

B. Apply Loctite #242 (or equivalent) to threads of cap screws that secure driveshaft to transaxle shaft.

C. Align mounting holes in driveshaft with relief in transaxle shaft.

D. Install cap screws, hardened washers and lock nuts to secure driveshaft to transaxle shaft.

3. If wheel studs were removed from stub axle, apply Loctite #271 (or equivalent) to threads near head of stud. Install stud with lock washer into stub axle and torque from **40 to 60 ft–lb (55 to 81 N–m)**.

4. Insert stub axle with greased bearing and thin spacer into axle housing. Be careful to not damage the bearing seal during installation.

5. Apply antiseize lubricant to splines of stub axle.

6. Slide end yoke onto stub axle shaft.

7. Insert cap screw through flat washer, end yoke and stub axle. Install flange nut onto cap screw. Torque flange nut from **220 to 225 ft–lb (299 to 305 N–m)**.

8. Position driveshaft cross to the end yoke. Install the straps to secure driveshaft bearing cross to the end yoke. Torque bolts from **200 to 250 in–lb (22.6 to 28.2 N–m)**.

9. Lubricate driveshaft grease fittings.

10. Install brake drum and wheel. Tighten wheel nuts to a torque of **55 to 65 ft–lb (75 to 88 N–m)** (see Rear Wheels and Brakes in the Service and Repairs Section of Chapter 8 – Chassis).

11. Lower machine to ground.

Driveshaft Universal Joint Service

1. Remove driveshaft from machine:

   A. For transaxle driveshaft (Fig. 26) removal, see Pump Drive Gearbox Removal in this section.

   B. For rear axle driveshaft (Fig. 27) removal, see Stub Axle and Driveshaft Removal in this section.

2. Remove snap rings that secure bearings.

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

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

4. To install new cross and bearings:

   A. Apply a coating of grease to all bearing bores.

   B. Press one bearing partially into yoke.

   C. Insert cross into yoke and bearing.

   D. Hold cross in alignment and press bearing in until it hits the yoke.

   E. Install snap ring into yoke groove to secure installed bearing.

   F. Place second bearing into yoke bore and onto cross shaft. Press bearing into yoke and secure with snap ring.

   G. Repeat procedure for other yoke.

   H. Grease cross until grease comes out of all four (4) cups.

5. Install driveshaft to machine:

   A. For transaxle driveshaft installation, see Pump Drive Gearbox Installation in this section.

   B. For rear axle driveshaft installation, see Stub Axle and Driveshaft Installation in this section.

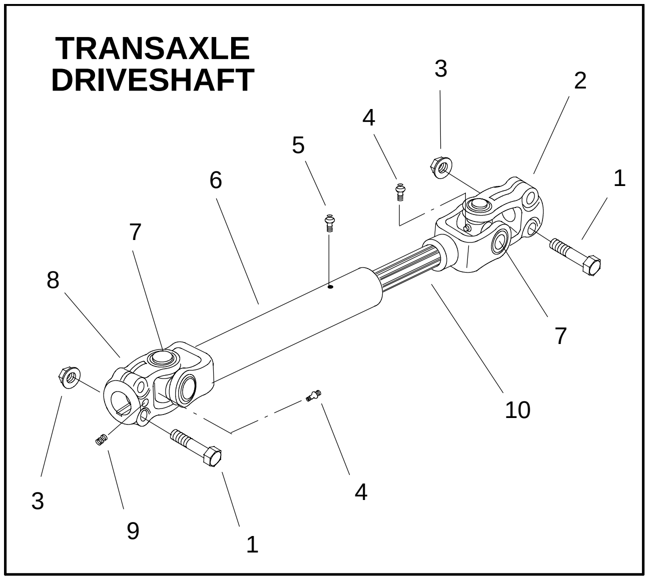

Figure 26

1. **Cap screw (2 per yoke)**
2. **Splined yoke**
3. **Lock nut (2 per yoke)**
4. **Grease fitting**
5. **Grease fitting**
6. **Yoke and tube**
7. **Cross and bearing kit**
8. **Keyed yoke**
9. **Set screw**
10. **Yoke and shaft**

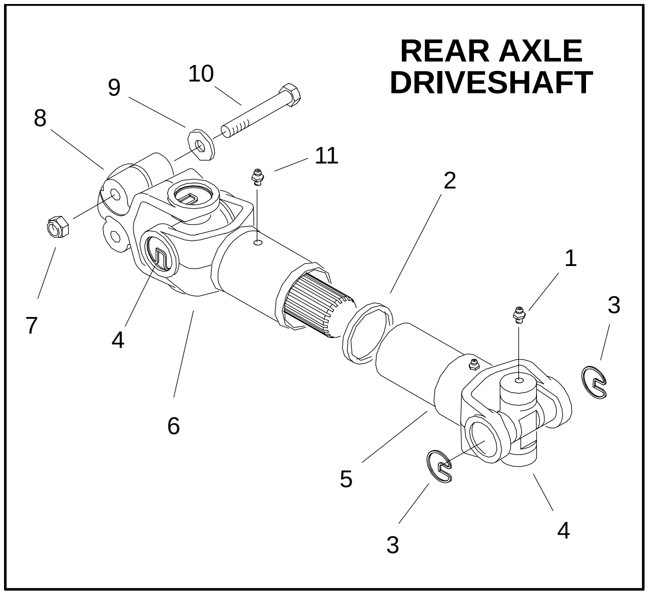

Figure 27

1. **Grease fitting**
2. **Seal**
3. **Snap ring**
4. **Cross and bearing kit**
5. **Yoke and hub**
6. **Shaft and tube yoke**
7. **Lock nut (2 per yoke)**
8. **Clamp yoke**
9. **Hardened washer**
10. **Cap screw (2 per yoke)**

Drive Train

Transaxle

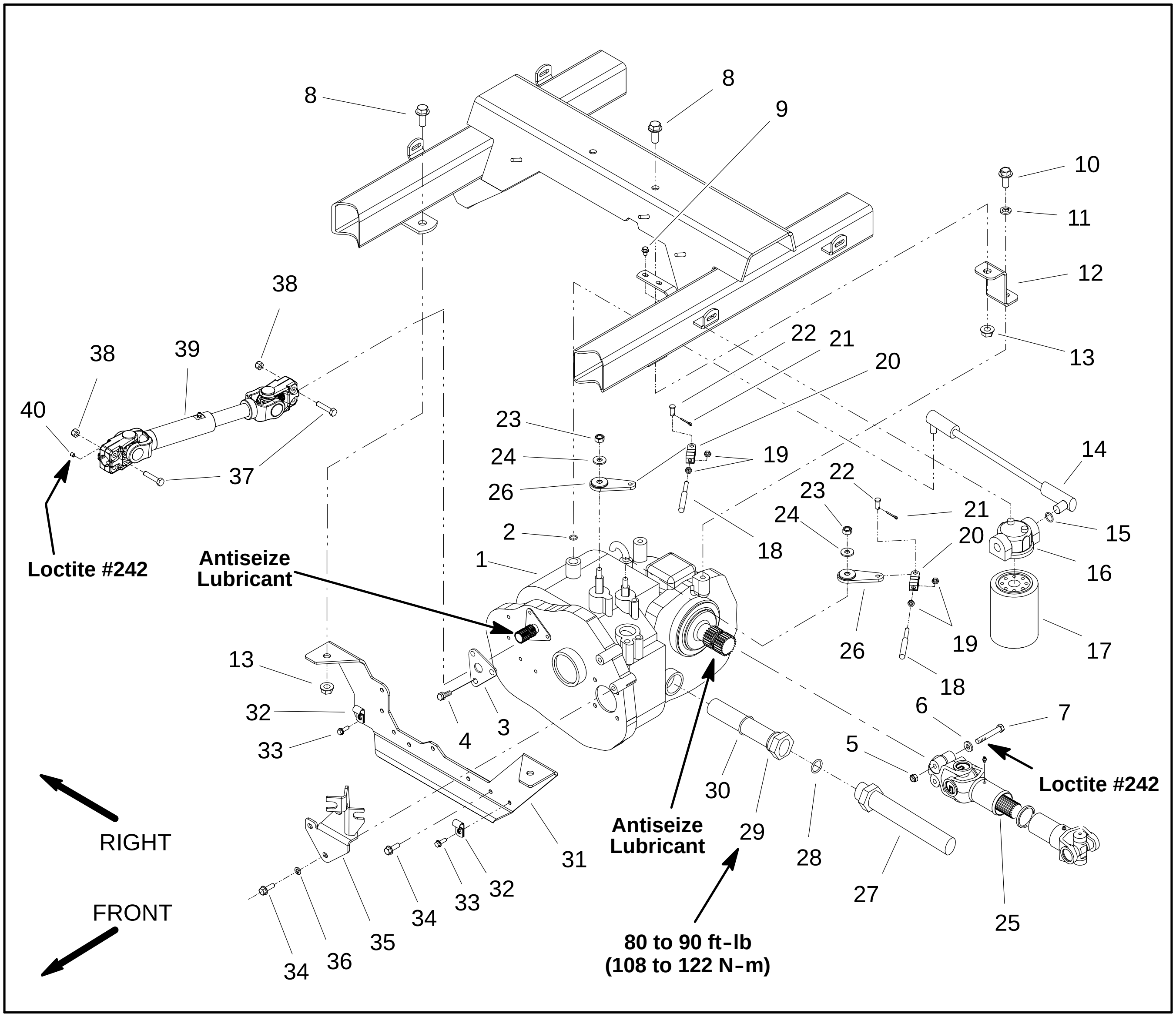

Figure 28

1. Transaxle assembly
2. O-ring
3. Input shaft cover plate
4. Cap screw (3 used)
5. Lock nut
6. Hardened washer
7. Cap screw (2 used per driveshaft)
8. Flange head screw (4 used)
9. Flange head screw (2 used)
10. Flange head screw (2 used)
11. Lock washer (2 used)
12. Transaxle strap mount (2 used)
13. Flange nut (4 used)
14. Hydraulic return hose
15. O-ring
16. Oil filter head
17. Oil filter
18. Shift cable
19. Jam nut
20. Cable clevis
21. Cotter pin
22. Clevis pin
23. Lock nut
24. Hardened washer
25. Driveshaft assembly (2 used)
26. Shift lever
27. Suction hose
28. O-ring
29. Strainer
30. O-ring
31. Front transaxle mount
32. R-clamp (2 used)
33. Flange head screw (2 used)
34. Flange head screw (10 used)
35. Shift cable mount
36. Lock washer
37. Cap screw (2 used per yoke)
38. Lock nut
39. Transaxle driveshaft
40. Socket head screw

Transaxle Removal (Fig. 28)

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

2. Drain oil from transaxle into a suitable container.

3. Disconnect negative (–) cable from battery first and then positive (+) cable.

4. Block front wheels. Raise rear of machine and secure machine with jack stands so transaxle can be removed by sliding out under rear of machine (see Jacking Instructions in Chapter 1 – Safety).

5. Unplug speed sensor connector from machine wire harness (Fig. 29).

6. Label shift cables to ease reassembly. Loosen shift cable jam nuts at cable mount (Fig. 30). Remove cotter pin and clevis pin that attach shift cable ends to transaxle shift arm levers. Pull shift cables free from mount.

7. Disconnect hydraulic return hose from top of transaxle (Fig. 30). Locate, remove and discard hose O–ring.

8. Disconnect suction hose from transaxle (Fig. 29). Locate, remove and discard suction hose O–ring. Position suction hose away from transaxle.

9. Put caps or plugs on all open hoses and fittings to prevent contamination.

10. Remove two (2) R–clamps that secure LH parking brake cable to front transaxle mount.

11. Remove the straps securing driveshaft bearing cross to the end yoke at both rear wheel hubs (Fig. 31).

12. Loosen and remove cap screws, hardened washers and lock nuts that secure driveshafts (both right and left sides) to transaxle axle shafts (Fig. 32). Remove both driveshafts from machine.

13. Loosen and remove cap screws and lock nuts that secure universal joint of transaxle driveshaft to input shaft of transaxle (Fig. 33). Disconnect driveshaft from transaxle input shaft.

14. Support transaxle to prevent it from shifting or falling. Remove four (4) flange nuts that secure transaxle mounts to machine frame. Lower transaxle with mounts from machine.

15. If required, remove front transaxle mount, shift cable mount and transaxle strap mounts from transaxle.

16. Remove oil strainer from transaxle. Locate, remove and discard strainer O–ring.

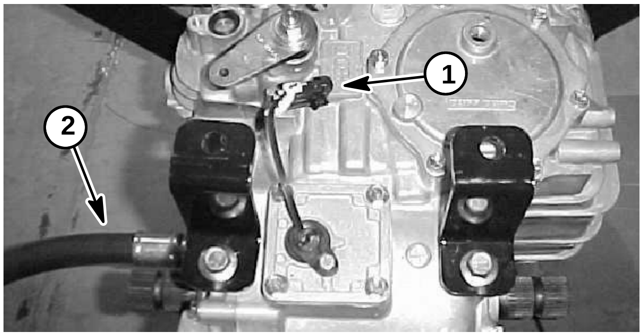

Figure 29

1. Speed sensor connector
2. Suction hose

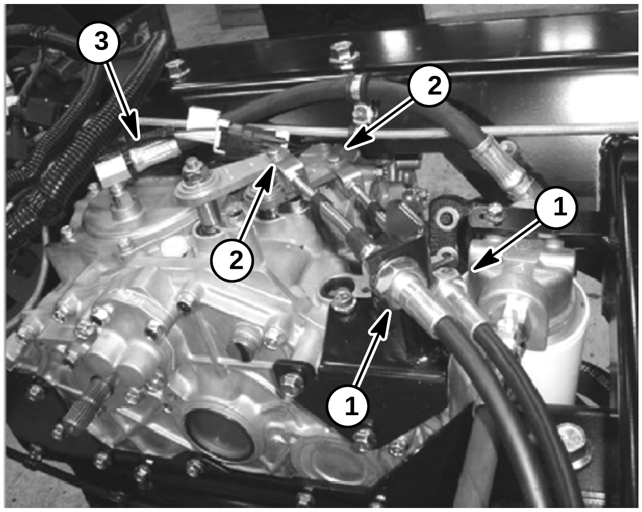

Figure 30

1. Shift cable jam nut
2. Clevis pin
3. Hydraulic return hose

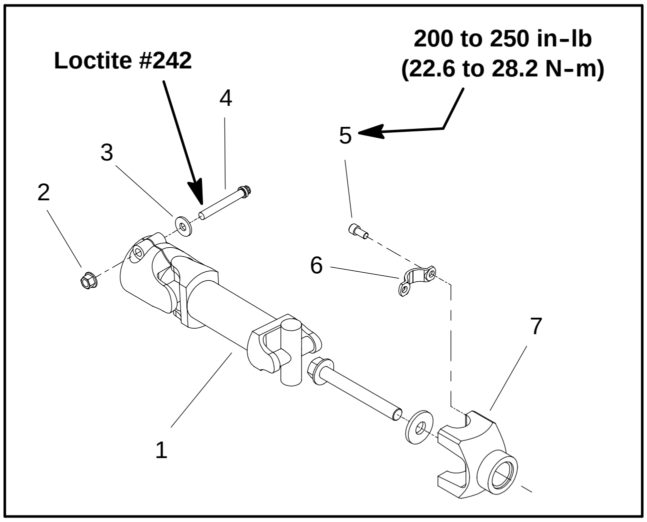

Figure 31

1. Driveshaft assembly
2. Lock nut
3. Hardened washer
4. Cap screw (2 per shaft)
5. Bolt (2 per strap)
6. Yoke strap (2 per yoke)
7. End yoke

Drive Train

Transaxle Installation (Fig. 28)

1. Lubricate new oil strainer O–ring with Dexron III ATF oil and position on strainer. Install strainer into transaxle and torque from **80 to 90 ft–lb (108 to 122 N–m)**.

2. If removed, install front transaxle mount, shift cable mount and transaxle strap mounts to transaxle.

3. Apply antiseize lubricant to transaxle shafts.

4. Position transaxle to machine. Slide universal joint of transaxle driveshaft onto input shaft of transaxle. Slide both driveshafts onto transaxle axle shafts. Position driveshaft bearing cross to the end yoke at both rear wheel hubs and loosely install straps.

5. Secure transaxle to machine by installing and tightening four (4) flange nuts onto cap screws.

6. Secure driveshafts to transaxle:

   A. Tighten the strap bolts to secure driveshaft bearing cross to the end yoke at wheel hubs (Fig. 31). Torque bolts from **200 to 250 in–lb (22.6 to 28.2 N–m)**.

   B. Align mounting holes in driveshafts with reliefs in transaxle shafts.

   C. Apply Loctite #242 (or equivalent) to threads of cap screws used to secure driveshafts to transaxle shafts.

   D. Install cap screws and lock nuts to secure driveshaft to transaxle input shaft (Fig. 33).

   E. Install cap screws, hardened washers and lock nuts to secure driveshafts to transaxle axle shafts (Fig. 32).

7. Secure LH parking brake cable to front transaxle mount with two (2) R–clamps.

8. Remove all caps or plugs placed on hydraulic hoses and fittings during disassembly.

9. Lubricate new suction and return hose O–rings with Dexron III ATF oil. Install suction and return hoses to transaxle.

10. Position shift cables to cable mount noting cable identification made during disassembly. Center the cable threads to the cable mounts and secure cables with jam nuts (Fig. 30).

11. Check and adjust shift cables as needed (see Shift Cable Adjustment in the Adjustments section of this chapter).

12. Secure shift cable ends to shift arm levers of transaxle with clevis pins and cotter pins.

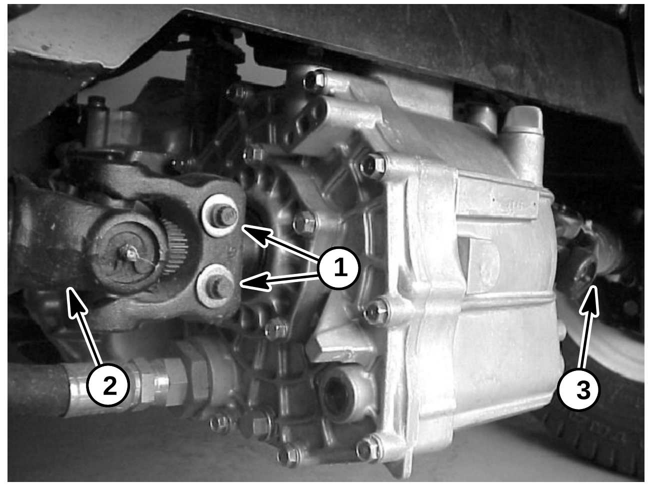

Figure 32

1. **Cap screw w/washer**
2. **Driveshaft (LH)**
3. **Driveshaft (RH)**

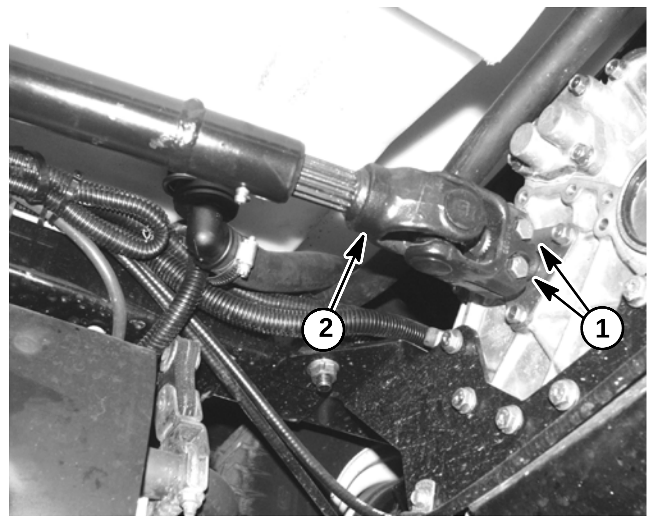

Figure 33

1. **Cap screw**
2. **Driveshaft**

13. Plug speed sensor connector into wire harness (Fig. 29).

14. Lower machine to ground.

WARNING

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

15. Connect positive (+) cable to battery first and then negative (–) cable.

16. Fill transaxle with Dexron III ATF oil (see Operator's Manual).

Transaxle Service

Transaxle Disassembly

1. Thoroughly clean outside surface of transaxle.

NOTE: Item numbers in figures are shown in order of disassembly; for example, remove item 1 first, then item 2, etc. Assemble in reverse order; for example, install item 1 last.

2. Loosen four (4) cap screws (items 1 and 2) and remove fork shaft cap (item 3) from center plate. Note location of longer cap screw. Be careful when removing cap as steel balls inside are spring loaded.

3. Inspect fork shaft cap for cracks or damage and replace if necessary.

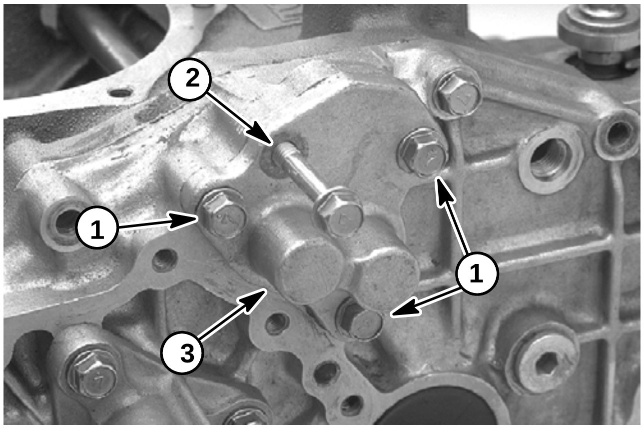

Figure 34

1. **Cap screw**
2. **Longer cap screw**
3. **Fork shaft cap**

4. Hold hand over the area and shift R–1 and 2–3 levers to move shafts outward so two (2) balls (item 3), two (2) springs (item 2) and spindle lock (item 1) can be removed from center plate.

5. Remove three (3) cap screws that secure input shaft cover plate to transaxle. Remove cover plate.

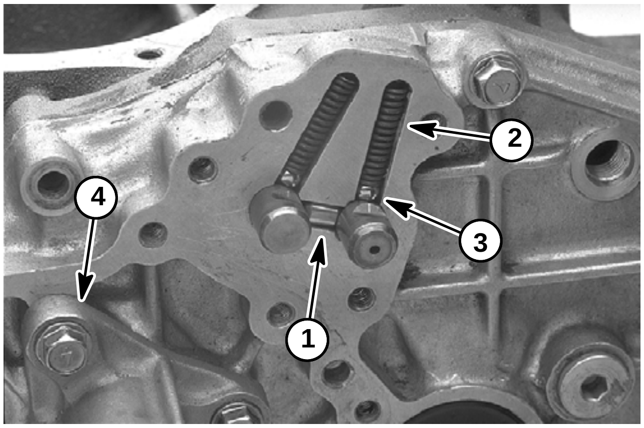

Figure 35

IMPORTANT: The center plate has one (1) tabbed shim (item 4) <u>with</u> three (3) tabless shims (item 2) (Fig. 36).

6. Loosen cap screws and separate center plate from transaxle case. Note dowel pin locations in transaxle case. Remove seal cap (item 1), shims (items 2 and 4) and snap ring (item 3) from center plate.

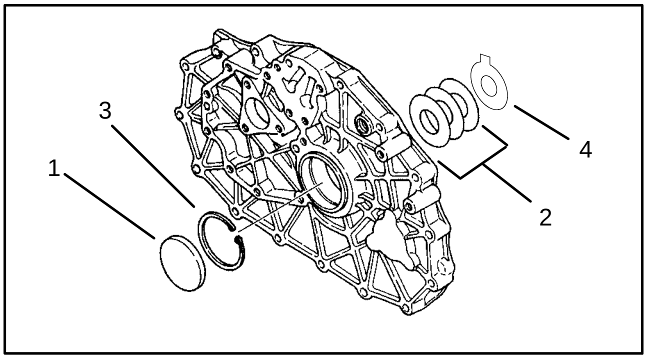

Figure 36

Drive Train

7. Remove reverse shaft (item 1) from transaxle case.

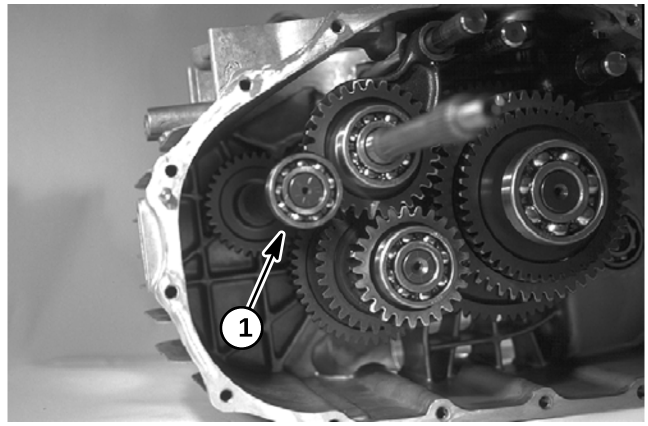

Figure 37

8. Remove main shaft assembly (item 1) together with 2nd–3rd fork shaft assembly (item 2) from transaxle case.

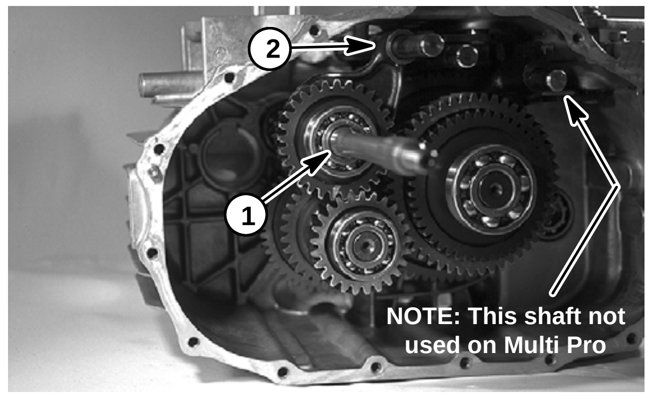

Figure 38

9. Remove, all at the same time, reduction shaft assembly (item 1), 1st–reverse fork shaft assembly (item 2) and countershaft assembly (item 3)

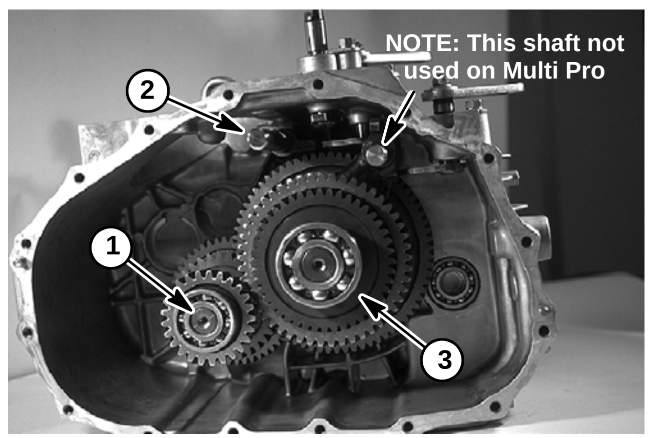

Figure 39

10. Loosen five (5) cap screws (item 1) and remove differential carrier with L.H. axle shaft assembly (item 2) and shims (item 3) from side cover (item 4).

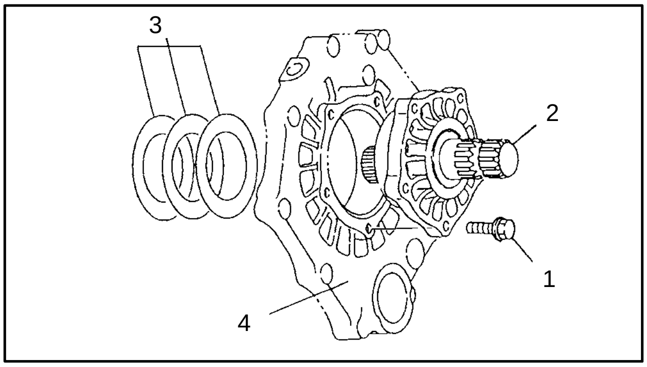

Figure 40

11. Loosen cap screws (item 1) and remove side cover (item 2) from transaxle case. Note locations of two (2) dowel pins (item 3) in transaxle case.

12. Inspect side cover for cracks or damage and replace if necessary.

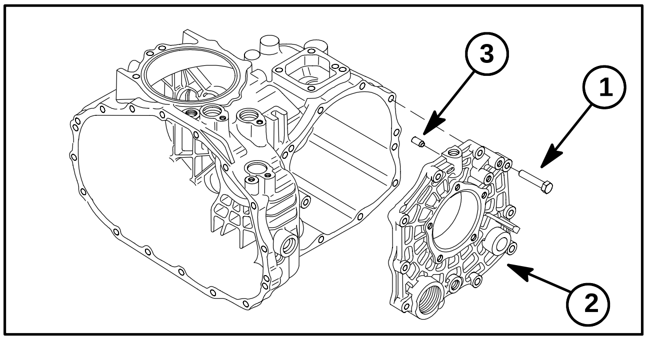

Figure 41

13. Loosen cap screws (item 1) and remove R.H. axle shaft assembly (item 2) from transaxle case.

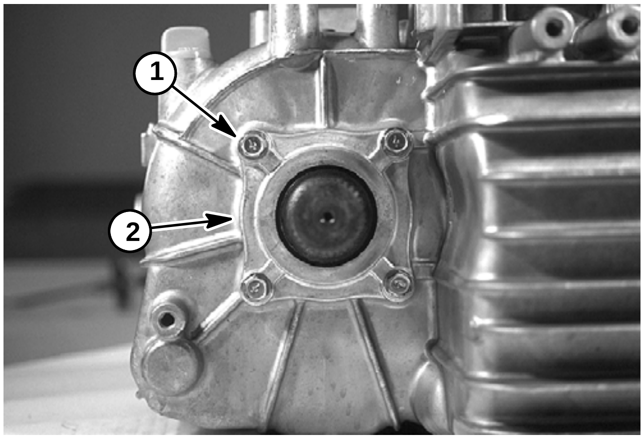

Figure 42

14. Slide differential gear assembly (item 1) from transaxle case.

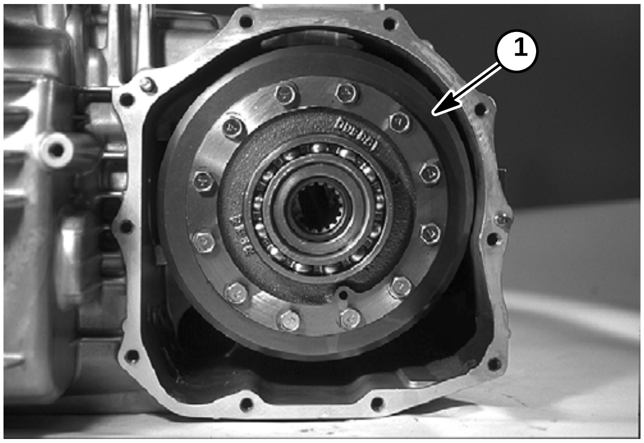

Figure 43

Drive Train

15. To remove shift arms:

A. Loosen and remove lock nuts (item 3) that secure shift arms (items 1 and 4). Remove flat washers (item 2) and shift arms.

B. Loosen and remove cap screws (item 5). Remove lock washers (item 6) and keeper plates (item 7).

C. Remove oil seals (item 8) from transaxle case.

D. Inspect shift arms and keeper plates for bending or damage and replace if necessary.

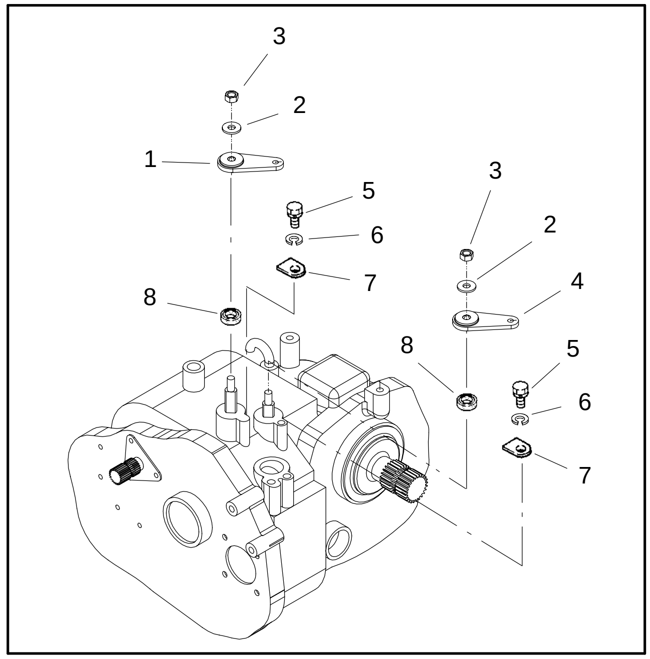

Figure 44

1. Shift arm (2-3)
2. Flat washer
3. Lock nut
4. Shift arm lever (1-R)
5. Cap screw
6. Lock washer
7. Keeper plate
8. Oil seal

16. Loosen five (5) cap screws (item 1) and remove nut with washer (item 2). Separate P.T.O. cover (item 3) and O-ring from transaxle case. Inspect P.T.O. cover for cracks or damage and replace if necessary.

17. If necessary, remove oil cap (item 4) with O-ring from transaxle case.

18. If necessary, remove air breather (item 5) from transaxle case.

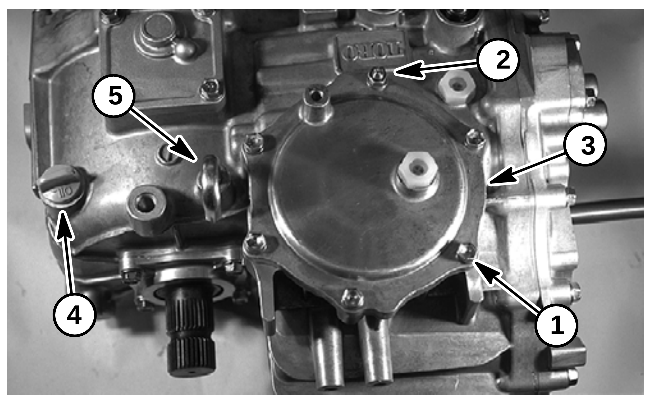

Figure 45

19. If necessary, remove cap screw with lock washer (item 1) and slide speed sensor (item 2) from upper cover (item 4).

20. Loosen and remove cap screws (item 3) that secure upper cover to transaxle case. Remove upper cover (item 4) from case.

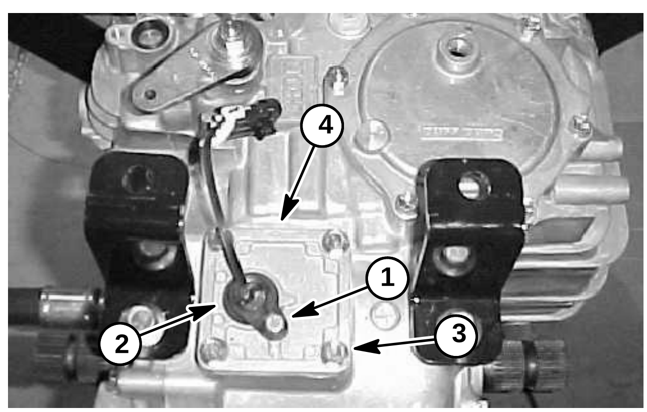

Figure 46

21. Disassemble main shaft assembly:

A. Use a bearing puller to remove bearing (item 1) from main shaft.

B. Remove snap ring (item 2) and thrust washer (item 3). Measure thickness of thrust washer. Replace washer if it is less than 0.0709" (1.8 mm) thick.

C. Remove 36T gear (item 4) and two (2) needle bearings (item 5). Inspect needle bearings and replace if necessary.

D. Remove synchro ring (item 6).

E. Remove retaining ring (item 7).

F. Remove synchro shifter (item 8) together with springs, hub and three (3) keys.

G. Remove key (item 9).

H. Remove retaining ring (item 10).

I. Remove synchro ring (item 6), 22T gear (item 11), two (2) needle bearings (item 12) and thrust washer (item 13). Inspect needle bearings and replace if necessary.

J. Use a bearing puller to remove bearing (item 14).

K. Remove 14T gear (item 15), retaining ring (item 16) and 20T gear (item 17).

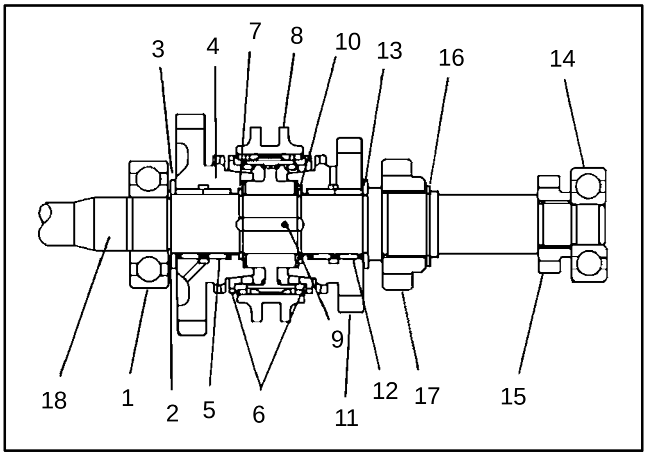

Figure 47

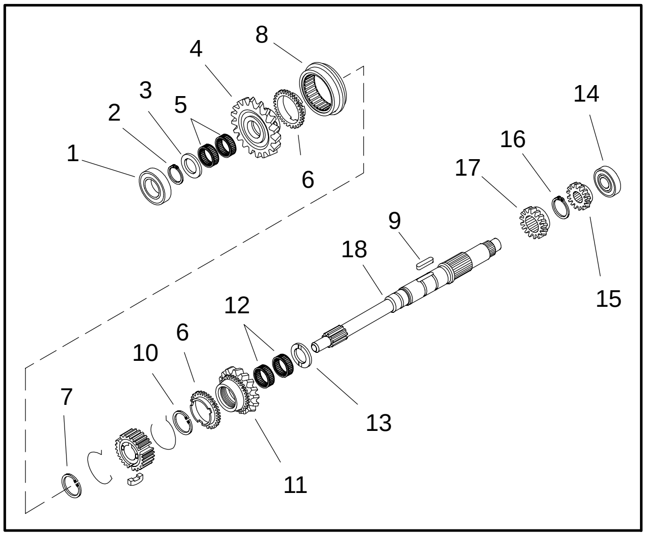

Figure 48

22. Disassemble reduction shaft assembly:

A. Use a bearing puller to remove bearing (item 1) from reduction shaft.

B. Remove 25T gear (item 2), collar (item 4) and 32T gear (item 5).

C. Use a bearing puller to remove bearing (item 6).

D. Remove thrust washer (item 7), 40T gear (item 8) and needle bearing (item 9).

E. Remove retaining ring (item 10).

F. Remove synchro shifter (item 11) together with springs, hub and three (3) keys.

G. Remove key (item 12) from reduction shaft.

H. Remove synchro ring (item 13) from 47T gear (item 14).

I. Remove 47T gear (item 14), needle bearings (item 15) and thrust washer (item 16). Inspect needle bearings and replace if necessary. Measure thickness of thrust washer. Replace thrust washer if thickness is less than 0.0709” (1.8 mm).

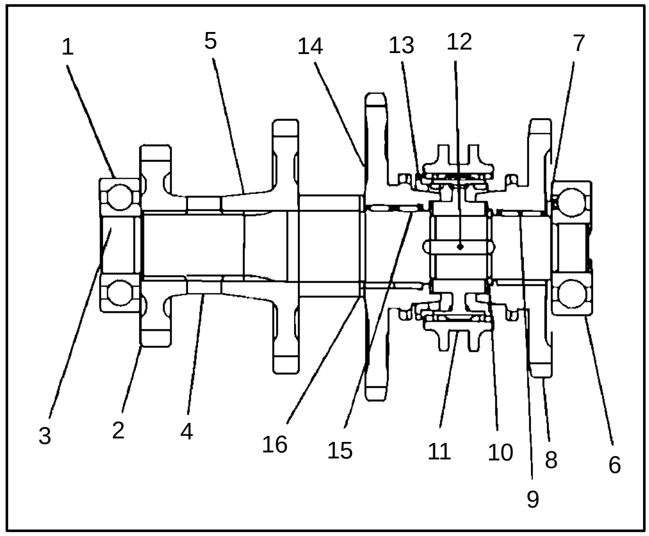

Figure 49

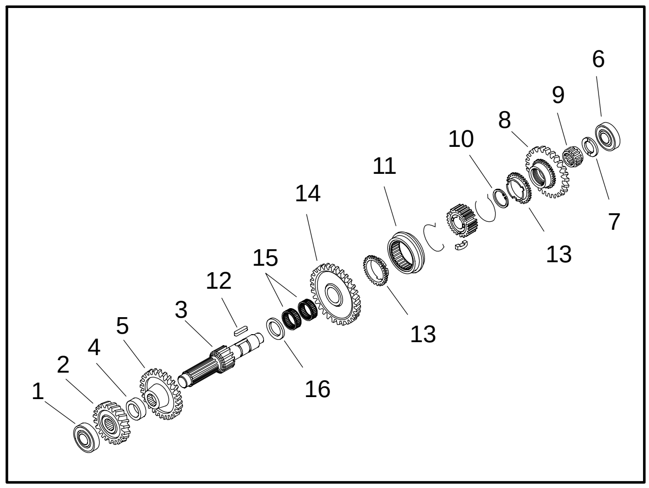

Figure 50

23. Disassemble reverse shaft assembly:

A. Use a bearing puller to remove bearing (item 1) from reverse shaft.

B. Remove 33T gear (item 2).

C. Use a bearing puller to remove bearing (item 3) from reverse shaft.

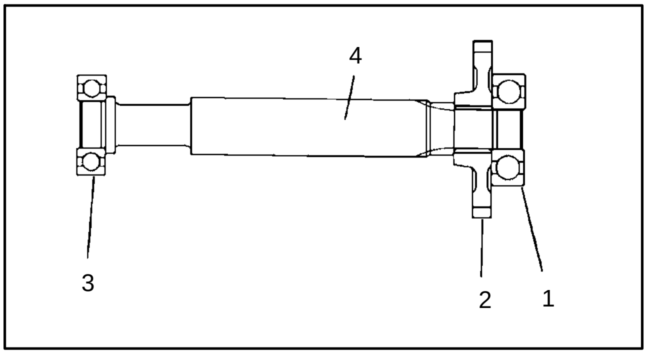

Figure 51

24. Disassemble countershaft assembly:

A. Use a bearing puller to remove bearing (item 1) from countershaft.

B. Remove collar (item 2) and retaining ring (item 5).

C. Remove countershaft gear (item 3).

D. Remove retaining ring (item 6) and collar (item 4) from shaft.

E. Use a bearing puller to remove two (2) bearings (item 8) from shaft.

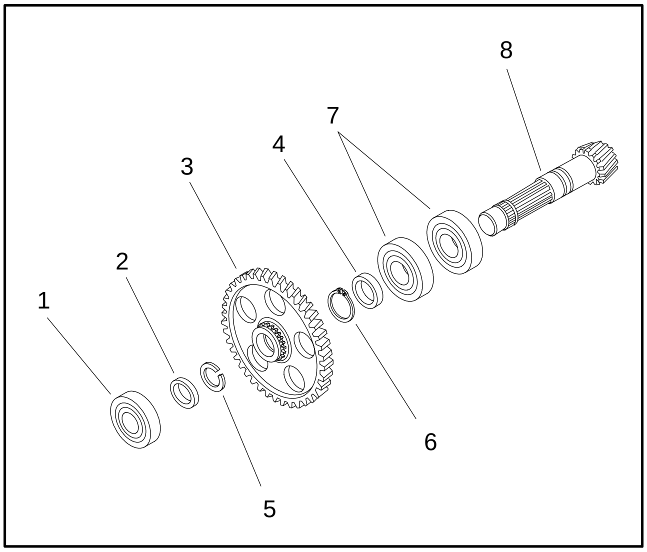

Figure 52

Drive Train

25. Disassemble fork shaft assemblies:

A. Remove spring pin (item 1) from 2nd–3rd fork shaft assembly.

B. Remove shift fork (item 2) from fork shaft (item 3).

C. Remove spring pin (item 4) from 1st–Reverse fork shaft assembly.

D. Remove fork (item 5) from fork shaft (item 5).

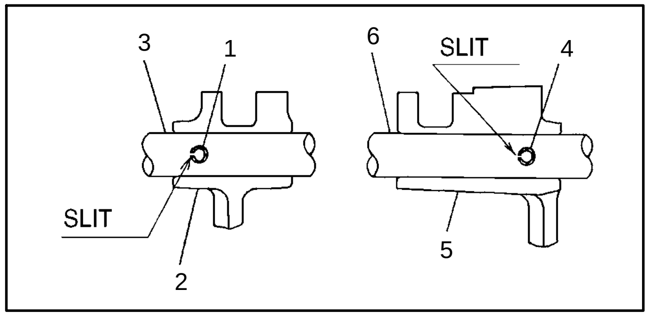

Figure 53

26. Disassemble differential gear assembly:

A. Use a bearing puller to remove bearing (item 1) from differential case.

B. Remove retaining ring (item 2).

C. Use a bearing puller to remove bearing (item 3).

D. Loosen and remove twelve (12) flange head screws (item 4) that secure ring gear (item 5) to differential case.

E. Remove ring gear (item 5) from differential case and remove two (2) alignment pins (item 6).

F. Drive spring pin (item 7) out of pinion shaft (item 8).

G. Remove pinion shaft (item 8) from differential case.

H. Remove two (2) differential pinion gears (item 9) and two (2) washers (item 10).

I. Remove L.H. side gear (item 11), R.H. side gear (item 12) and two (2) thrust washers (item 13).

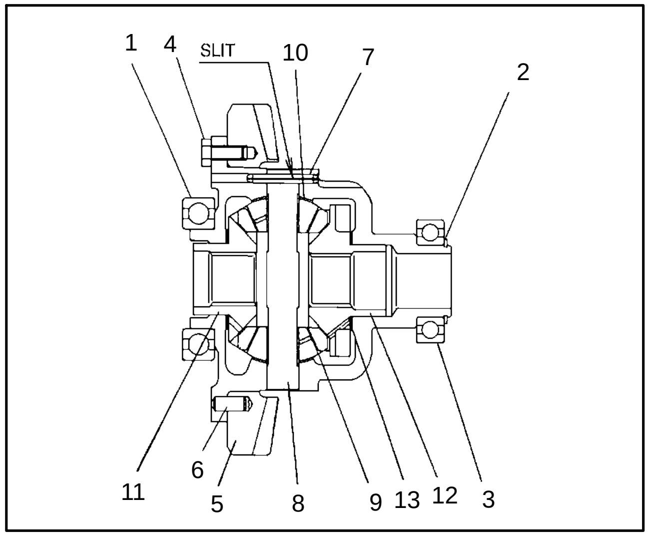

Figure 54

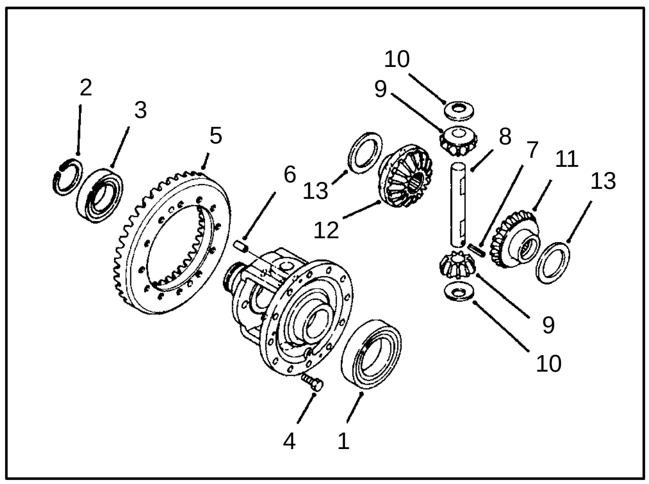

Figure 55

27. Disassemble differential carrier (L.H. axle shaft) assembly:

A. Remove O–ring (item 1) from differential carrier (item 8).

B. Remove retaining ring (item 2) from carrier.

C. Remove L.H. axle shaft assembly (item 3) from carrier.

D. Remove retaining ring (item 4) and washer (item 5) from axle shaft.

E. Use a bearing puller to remove bearing (item 6) from axle shaft.

F. Remove oil seal (item 7) from carrier (item 8).

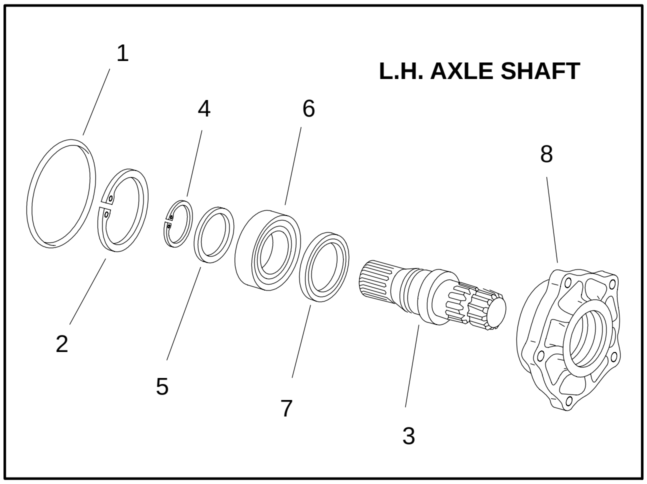

Figure 56

28. Disassemble R.H. axle shaft assembly:

A. Remove R.H. axle shaft assembly (item 1) from seal cover (item 7).

B. Remove retaining ring (item 2) and washer (item 3) from axle shaft.

C. Use a bearing puller to remove bearing (item 4) from axle shaft. Locate and remove washer (item 6).

D. Remove oil seal (item 5) from seal cover.

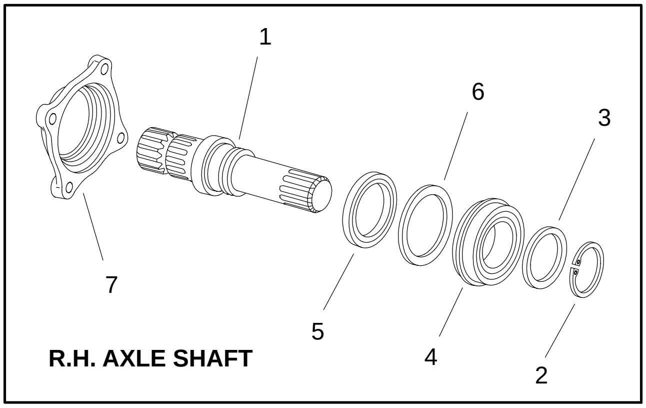

Figure 57

Drive Train

Transaxle Inspection

1. Thoroughly clean and dry all parts.

2. Use emery cloth to remove nicks and burrs from all parts.

3. Inspect synchronizer ring:

   A. Inspect the chamfer for excessive wear or damage.

   B. Inspect inner tapered area for excessive wear or damage.

   C. Measure the clearance between synchronizer ring and synchro gear in three equally spaced points. If clearance is less than 0.0197" (0.5 mm) replace the synchronizer ring.

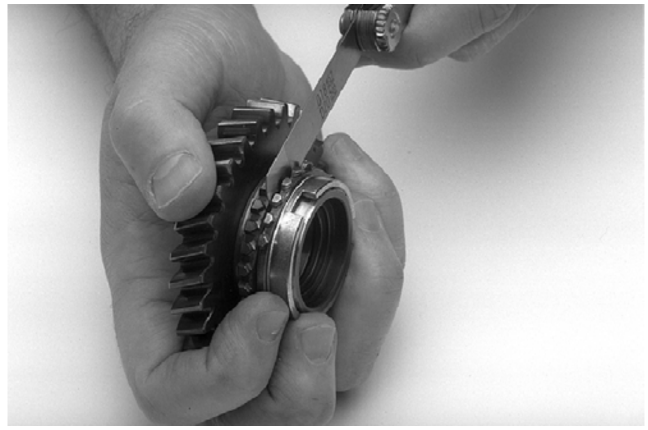

Figure 58

4. Inspect synchro gears:

   A. Inspect the cone surface for roughness, material transfer (brass color material) or damage.

   B. Inspect the spline chamfer for excessive chipping or damage.

   C. Inspect I.D. of synchro gears on main shaft for excessive wear or scoring (Fig. 59). If synchro gear has the following I.D., replace the synchro gear:

      22T I.D. exceeds 1.027" (26.08 mm)
      36T I.D. exceeds 1.027" (26.08 mm)

   D. Inspect I.D. of synchro gears on reduction shaft for excessive wear or scoring (Fig. 60). If synchro gear has the following I.D., replace the synchro gear:

      40T I.D. exceeds 1.027" (26.08 mm)
      47T I.D. exceeds 1.145" (29.08 mm)

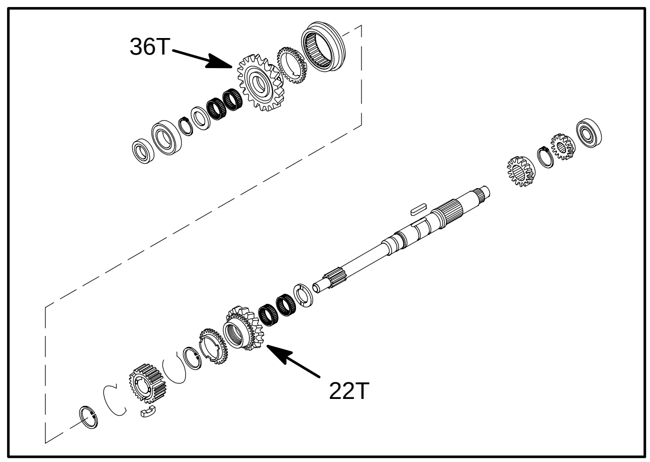

Figure 59

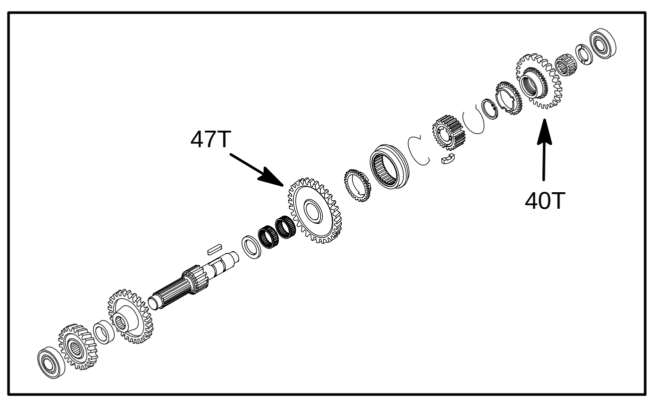

Figure 60

5. Inspect hub, shifter, synchro keys and synchro springs:

A. Inspect hub for worn or damaged spline.

B. Inspect shifter for chipping or damaged chamfer.

C. Inspect synchro keys for wear or damage.

D. Inspect synchro springs for wear or damage.

E. The shifter should move freely on the hub.

F. Measure the clearance between shifter groove and fork. Replace shift fork if the clearance exceeds 0.039” (1.0 mm).

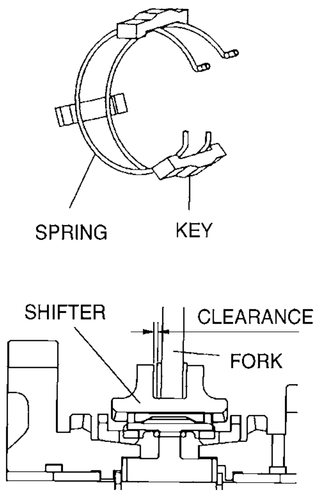

Figure 61

6. Inspect main shaft:

A. Inspect main shaft for worn or damaged surfaces. If O.D. of needle bearing surface is less than 0.864” (21.95 mm), replace the main shaft.

B. Inspect lip portion of oil seal for wear or damage.

C. Inspect main shaft input spline for wear or damage.

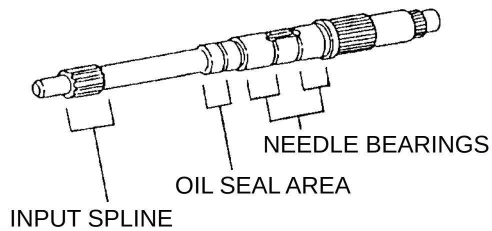

Figure 62

IMPORTANT: The center plate has one (1) tabbed shim (item 4) <u>with</u> three (3) tabless shims (item 2) (Fig. 63).

7. Inspect retaining ring (item 3) and shims (items 2 and 4) for damage (Fig. 63). Replace all parts if any component is cracked or broken.

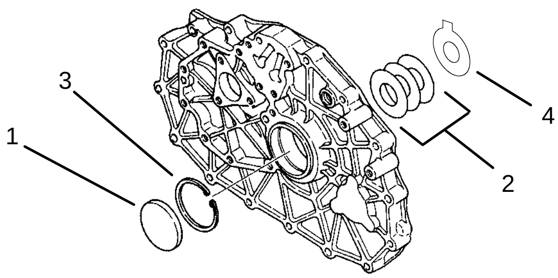

Figure 63

8. Inspect center plate for cracks and damage. Replace center plate if the retaining ring groove has more than 15% of its edges damaged due to nicks, rounding, cracks or dents (Fig. 64 and 65).

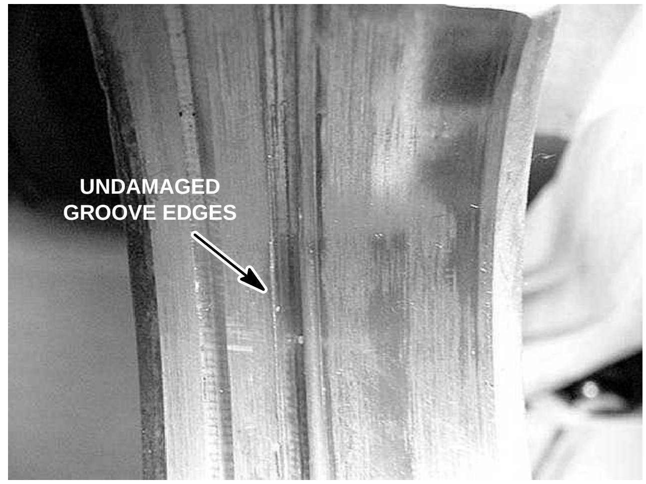

Figure 64

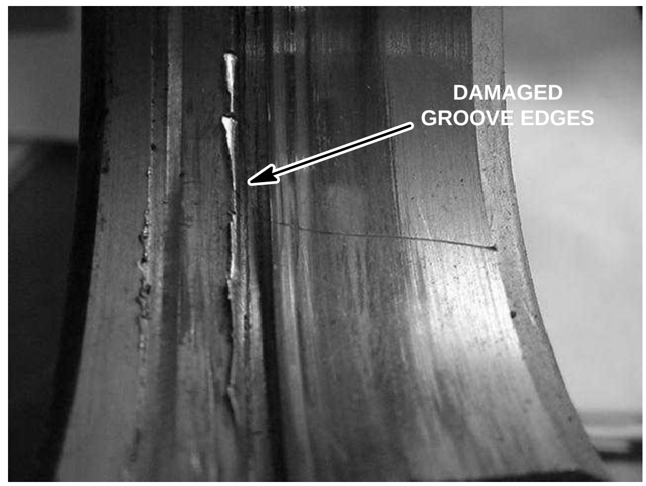

Figure 65

9. Inspect reduction shaft:

A. Inspect reduction shaft for wear or damage. If O.D. of needle bearing area is less than reject size specified in Figure 66, replace the reduction shaft.

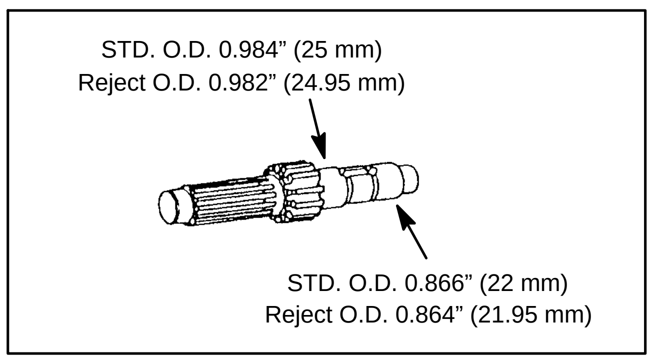

Figure 66

10. Inspect countershaft:

A. Inspect countershaft for wear or damage. If O.D. of inner portion is less than 1.100” (27.95 mm) or 71T gear portion is less than 1.179” (29.95 mm), replace the countershaft.

B. Inspect the gear contact condition of the bevel gear.

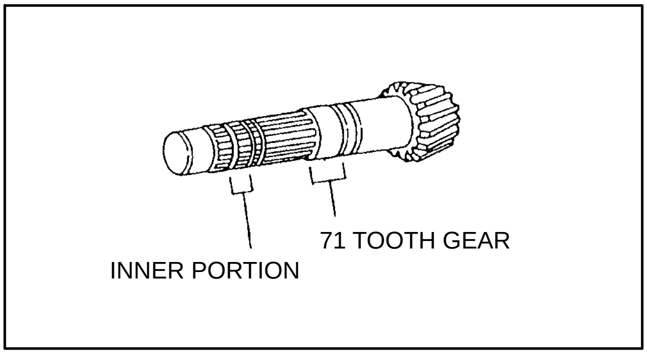

Figure 67

11. Inspect differential:

A. Inspect pinion shaft for excessive wear or damage. If O.D. is less than 0.707” (17.95 mm), replace the pinion shaft.

B. Measure thickness of pinion shaft washers. If thickness is less than 0.035” (0.9 mm), replace the washers.

C. Measure thickness of side gear thrust washers. If thickness is less than 0.043” (1.1 mm), replace the thrust washers.

D. Inspect the gear contact condition of the ring gear.

E. Inspect differential case for wear in side gears and pinion shaft mating area. Replace the case if machined surfaces are scored or if the pinion shaft fits loosely in the bore.

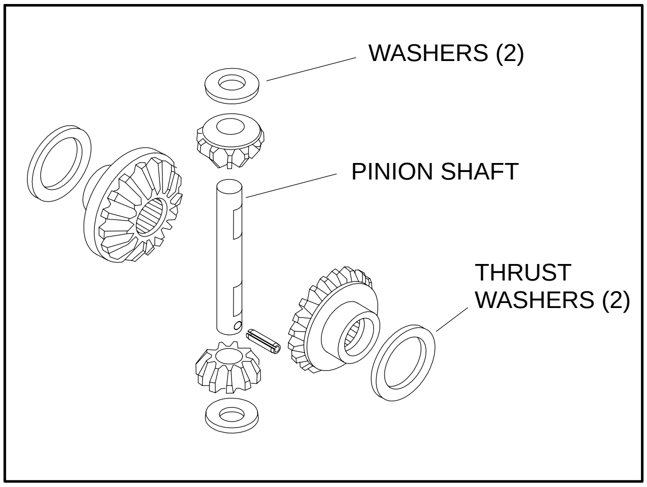

Figure 68

Drive Train

Transsaxle Assembly

NOTE: Item numbers in figures are shown in reverse order of assembly; for example, when reassembling, install item 1 last.

IMPORTANT: Be careful not to damage mating surfaces when removing gasket material.

1. Clean gasket material from all transaxle mating surfaces before reassembling. Make sure all parts are clean and free of dirt and dust.

2. Assemble differential carrier (L.H. axle shaft) assembly (Fig. 69):

   A. Apply multi–purpose grease on new oil seal (item 7) and install seal into differential carrier (item 8).

   B. Use a press to install bearing (item 6) onto L.H. axle shaft (item 3).

   C. Install washer (item 5) and retaining ring (item 4) onto L.H. axle shaft. Make sure that retaining ring is fully seated in axle groove.

   D. Install L.H. axle shaft assembly into carrier.

   E. Install retaining ring (item 2) into groove in carrier. Make sure that retaining ring is fully seated in carrier groove.

   F. Apply multi–purpose grease onto O–ring (item 1) and install O–ring onto carrier.

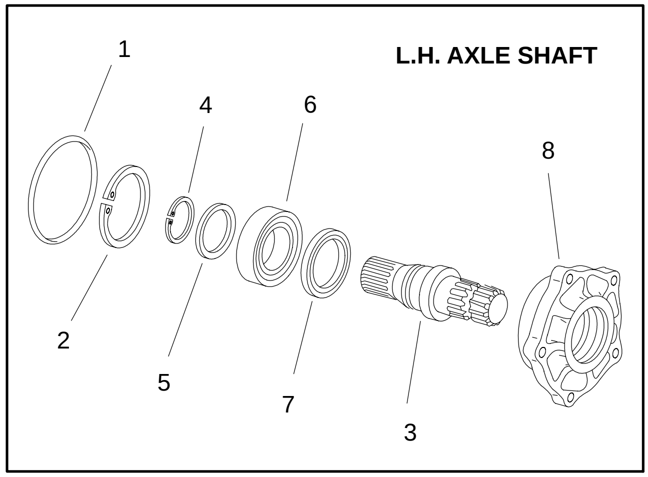

Figure 69

3. Assemble R.H. axle shaft (Fig. 69):

   A. Apply multi–purpose grease on oil seal (item 5) and install seal into seal cover (item 7).

   B. Use a press to install bearing (item 4) onto R.H. axle shaft.

   C. Install washer (item 3) and retaining ring (item 2) onto R.H. axle shaft. Make sure that retaining ring is fully seated in axle groove.

   D. Insert washer (item 6) into seal cover.

   E. Install R.H. axle shaft assembly into seal cover.

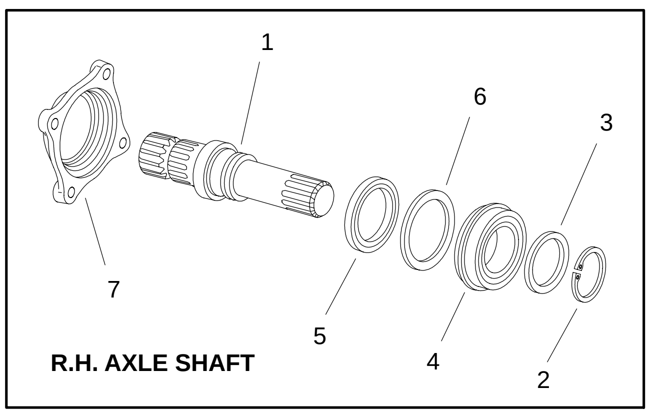

Figure 70

4. Assemble differential gears:

A. Apply moly disulfide grease on washers (item 10), holes of pinion gears (item 9), side gear thrust washers (item 13) and hubs of side gears (item 11 and 12).

B. Install side gear thrust washers (item 13), side gears (item 11 and 12), washers (item 10) and differential pinion gears (item 9) into differential case.

C. Rotate side gears until holes of pinion gears and washers line up with holes of differential case.

D. Grease the pinion shaft (item 8) and insert it into the differential case.

E. Assemble lock pin (item 7). Drive the pin to the approximate center location of the pinion shaft. Pay attention to direction of slit in lock pin (Fig. 73).

F. Check for smooth revolution of pinion gears and side gears.

G. Completely clean oil from fastener threads in ring gear (item 5).

NOTE: Ring gear and countershaft are supplied in matched sets only.

H. Insert two (2) dowel pins (item 6) onto ring gear (item 5).

I. Completely clean oil from threads of cap screws (item 4).

J. Clean oil from contact surface of differential case and ring gear.

K. Drive ring gear onto differential case.

NOTE: It is recommended that whenever the ring gear screws are removed that they be replaced with new screws.

L. Apply thread locking compound (e.g. Loctite) to threads of cap screws (item 4).

M. Install cap screws into ring gear. Torque cap screws from **18 to 22 ft-lb (24.5 to 29.5 N-m)**.

N. Use a press to install bearing (item 1) onto differential case.

O. Use a press to install bearing (item 3) onto differential case.

P. Install retaining ring (item 2) to secure bearing.

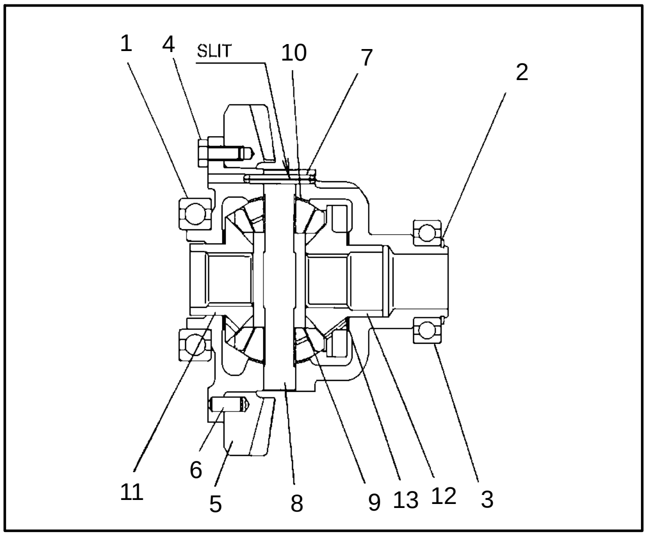

Figure 71

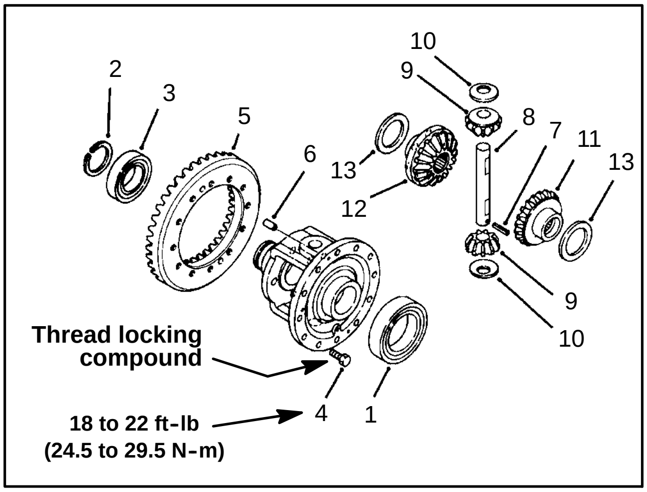

Figure 72

Figure 73

Drive Train

5. Assemble 1st–reverse and 2nd–3rd fork shaft:

   A. Insert 1st–reverse fork shaft (item 3) into 1st–reverse fork (item 2).

   B. Drive spring pin (item 1) into fork and fork shaft. Pay attention to direction of slit in spring pin.

   C. Insert 2nd–3rd fork shaft (item 6) into 2nd–3rd fork (item 5).

   D. Drive spring pin (item 4) into fork and fork shaft. Pay attention to direction of slit in spring pin.

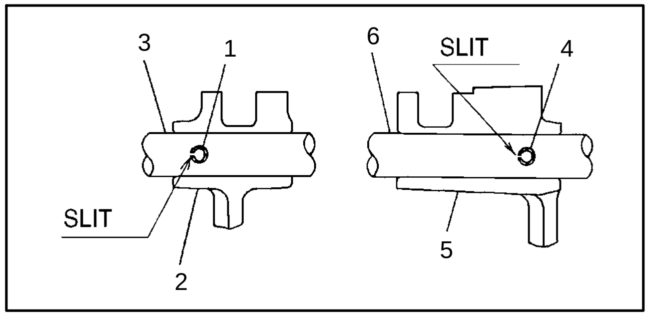

Figure 74

6. Assemble countershaft:

   A. Use a press to install two (2) new bearings (item 8) onto countershaft.

   B. Install collar (item 4) and retaining ring (item 6).

   C. Install countershaft gear (item 3) onto shaft.

   D. Install retaining ring (item 5).

   E. Slide collar (item 2) onto shaft.

   F. Use a press to install new bearing (item 1).

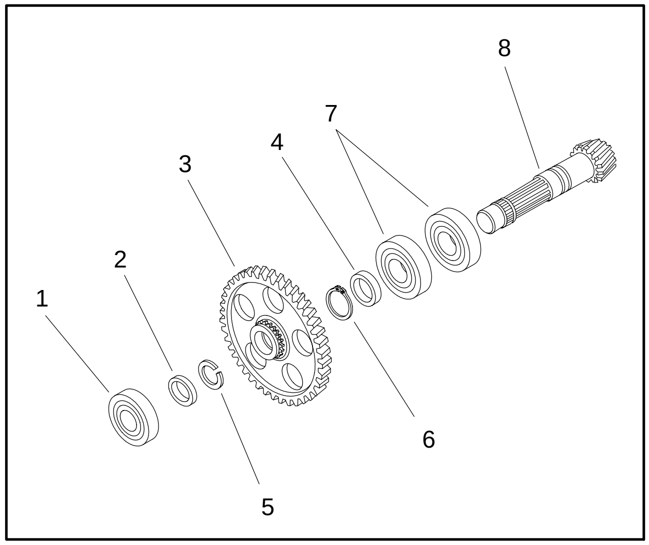

Figure 75

7. Assemble synchro hub:

A. Install three (3) keys (item 1) into grooves of hub (item 2).

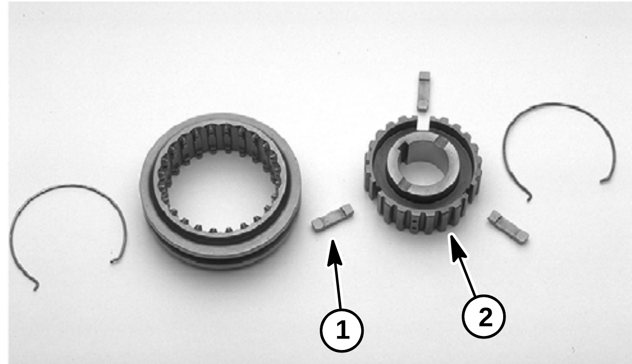

Figure 76

B. Install shifter (item 1) onto hub assembly (item 2).

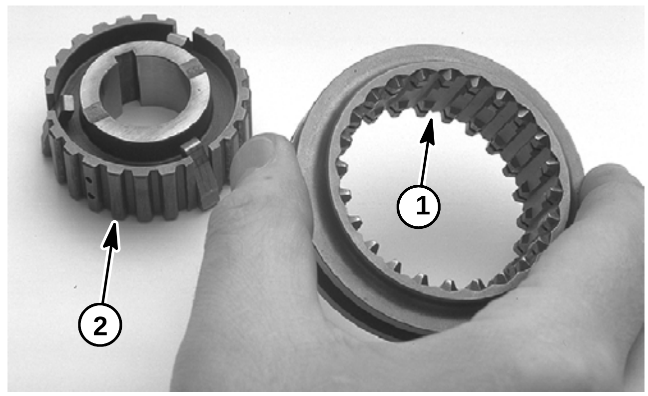

Figure 77

C. Insert two (2) springs (item 1) into hub to secure hub assembly. Pay attention to direction of spring.

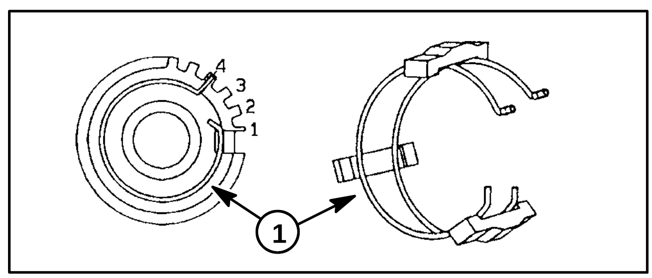

Figure 78

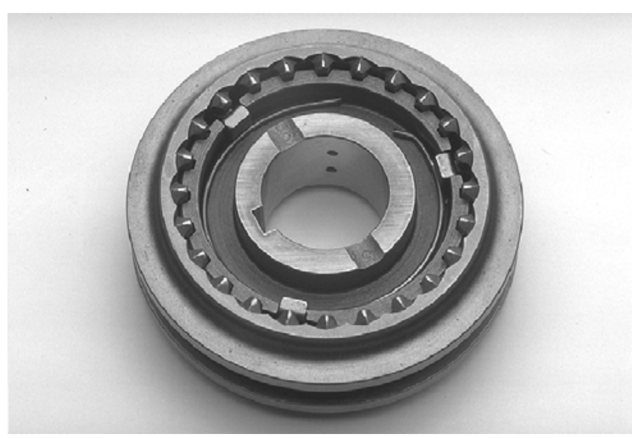

Figure 79

8. Assemble reduction shaft:

   A. Apply moly disulfide grease to thrust washer (item 16) and two (2) needle bearings (item 15). Install washer, needle bearings and 47T gear (item 14) onto reduction shaft (item 3). Oil groove on washer must face the gear.

   B. Apply Dexron III ATF oil on cone face of gear (item 14). Install synchro ring (item 13) onto gear.

   C. Insert key (item 12) into reduction shaft slot.

   D. Install synchro hub sub-assembly (item 11).

   E. Install retaining ring (item 10).

   F. Insert needle bearing (item 9) into 40T gear (item 8). Slide gear and bearing assembly onto shaft.

   G. Install thrust washer (item 7). Oil groove on washer must face the gear.

   H. Use a press to install bearing (item 6) onto shaft.

   I. Install 32T gear (item 5), collar (item 4) and 25T gear (item 2) onto shaft.

   J. Use a press to install bearing (item 1) onto shaft.

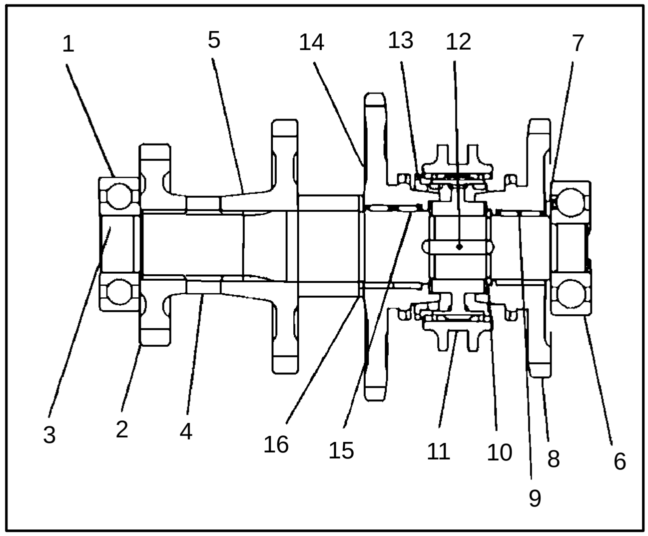

Figure 80

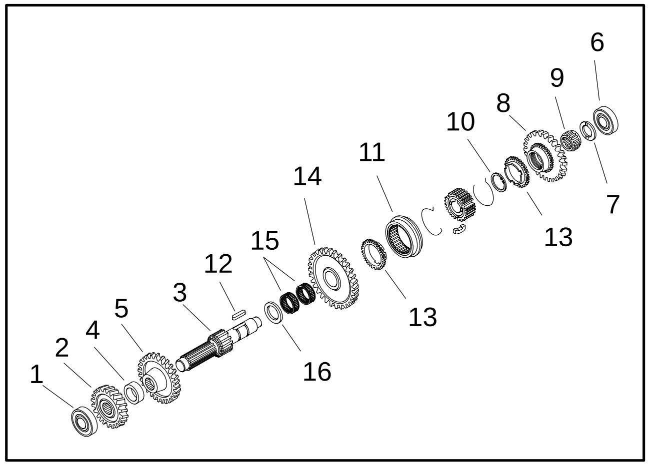

Figure 81

9. Assemble reverse shaft:

   A. Install 33T gear (item 2) onto reverse shaft (item 4).

   B. Use a press to install bearings (item 3 and 1).

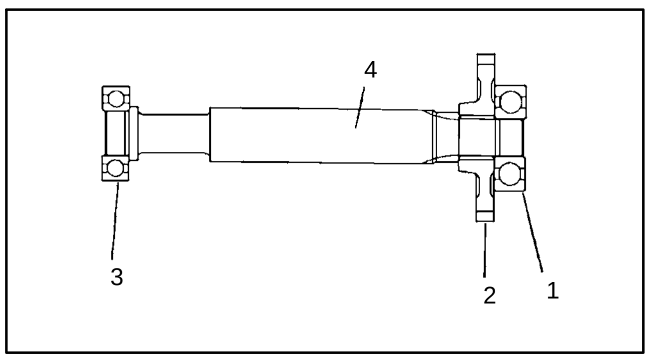

Figure 82

10. Assemble main shaft:

A. Install 20T gear (item 17) and retaining ring (item 16).

B. Install 14T gear (item 15).

C. Use a press to install bearing (item 14) onto shaft.

D. Apply moly disulfide grease onto thrust washer (item 13) and two (2) needle bearings (item 12). Install washer and needle bearings onto main shaft. Oil groove on washer must face the gear.

E. Install 22T gear (item 11) and retaining ring (item 10).

F. Apply Dexron III ATF oil on cone face of gear (item 11). Install synchro ring (item 6) onto gear.

G. Insert key (item 9) into main shaft slot.

H. Install synchro hub sub–assembly (item 8).

I. Install retaining ring (item 7).

J. Apply Dexron III ATF oil to cone face of 36T gear (item 4). Install synchro ring (item 6) onto gear.

K. Apply moly disulfide grease onto two (2) needle bearings (item 5). Insert needle bearings into gear (item 4).

L. Install gear (item 4) with synchro ring and needle bearings onto main shaft.

M. Apply moly disulfide grease to thrust washer (item 3). Install washer and snap ring (item 2) to shaft. Oil groove on washer must face the gear.

N. Use a press to install bearing (item 1) onto shaft.

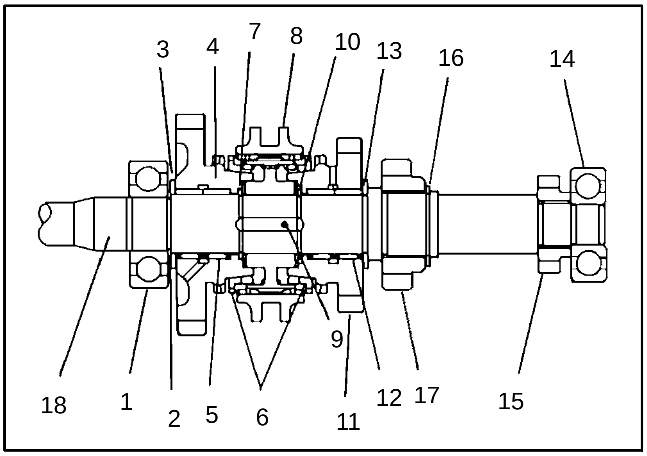

Figure 83

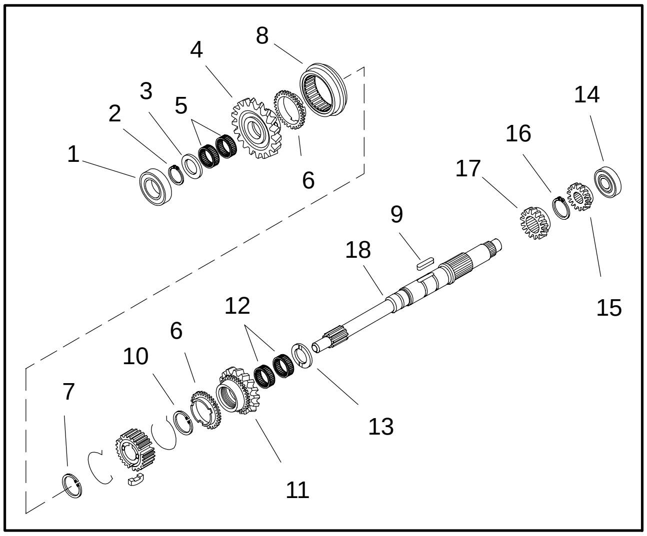

Figure 84

11. Assemble shift arms:

A. Apply multi–purpose grease on lips of new oil seals (item 14). Install oil seals into transaxle case.

B. Position keeper plates (item 13) and secure with cap screws (item 12). Torque cap screws from **11 to 13 ft–lb (15 to 17 N–m)**.

C. Apply Loctite #680 (or equivalent) to threads and tapers of shift fork shafts.

D. Install 1st–reverse shift arm lever (item 9).

E. Install 2nd–3rd shift arm lever (item 1).

F. Install flat washers (item 2) and lock nuts (item 3) to secure shift arms. Torque shift arm retaining lock nuts from **18 to 22 ft–lb (24.5 to 29.5 N–m)**.

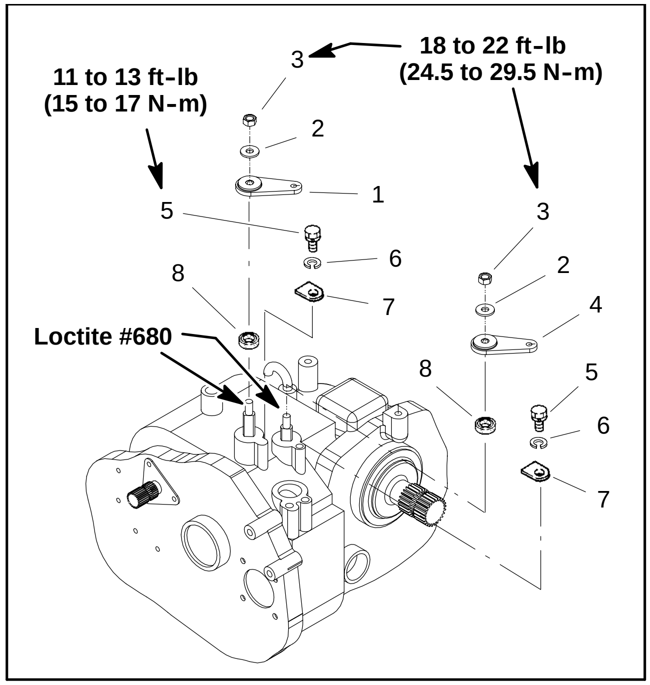

Figure 85

1. **Shift arm (2–3)**
2. **Flat washer**
3. **Lock nut**
4. **Shift arm lever (1–R)**
5. **Cap screw**
6. **Lock washer**
7. **Keeper plate**
8. **Oil seal**

12. Install reduction shaft and countershaft together with 1st–reverse fork shaft. Insert head of shift arm into groove of fork (item 1) when installing assembly.

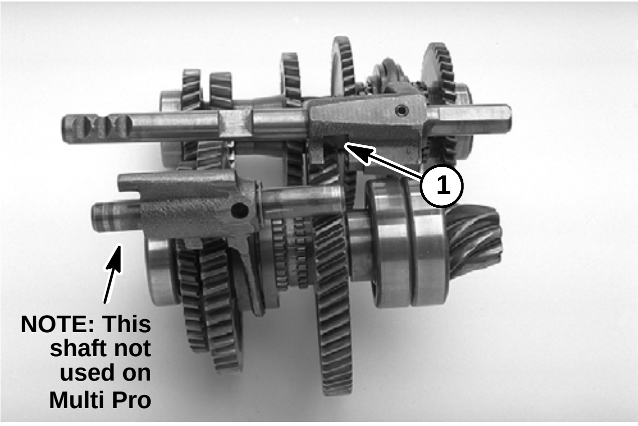

Figure 86

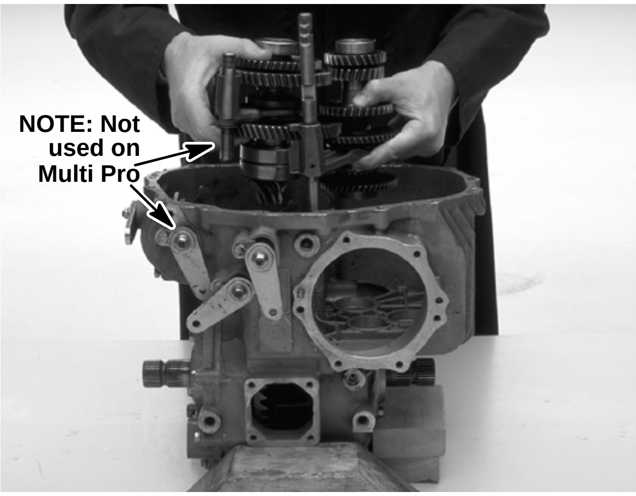

Figure 87

13. Install main shaft together with 2nd–3rd fork shaft. Insert head of shift arm into groove of fork (item 1) while installing.

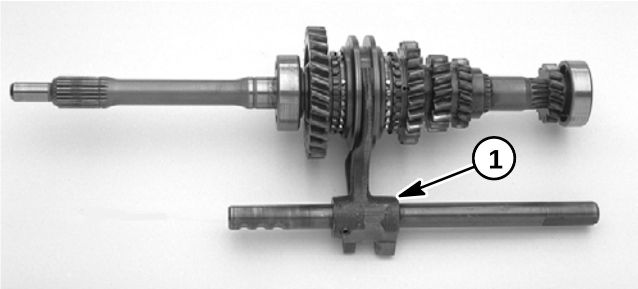

Figure 88

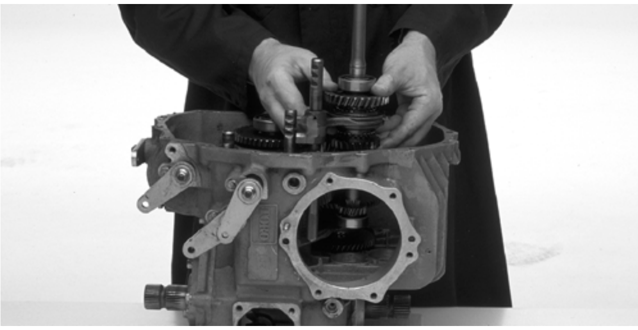

Figure 89

Drive Train

14. Install reverse shaft (item 1) into transaxle case. Rotate main shaft and reverse shaft gears to mesh gears when installing.

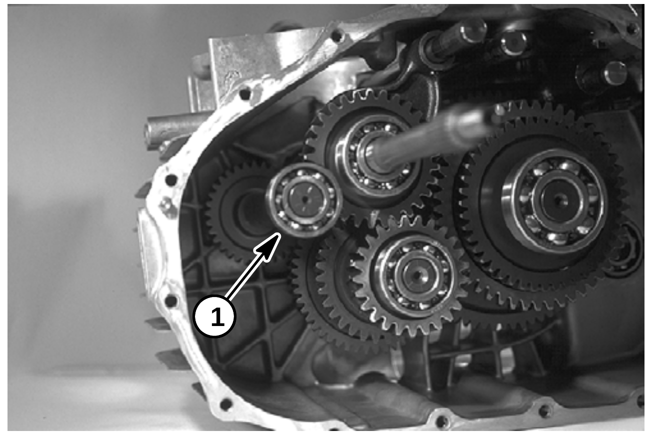

Figure 90

15. Install center plate onto transaxle:

A. Thoroughly clean mating surfaces of transaxle case and center plate. Insert two (2) dowel pins into transaxle case.

B. Apply silicone sealant onto mating surface of center plate. Carefully install center plate onto transaxle case.

C. Install and tighten cap screws to a torque of **18 to 22 ft–lb (24.5 to 29.5 N–m)** to secure center plate.

D. Apply multi–purpose grease onto lips of main shaft oil seal. Insert oil seal into center plate flush with face of housing.

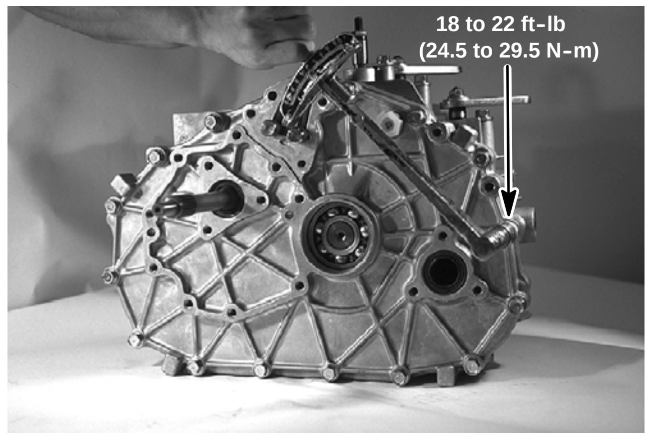

Figure 91

IMPORTANT: The center plate uses one (1) tabbed shim (item 4) with three (3) tabless shims (item 3) (Fig. 92).

NOTE: The thickest shim of the shim set (item 3) should be positioned against the retaining ring (Fig. 92).

16. Insert tabbed shim (item 4) against the bearing. Insert shim set (item 3) against the tabbed shim. Use thickest shims in set possible, that will permit installation of the snap ring (Fig. 92 and 93).

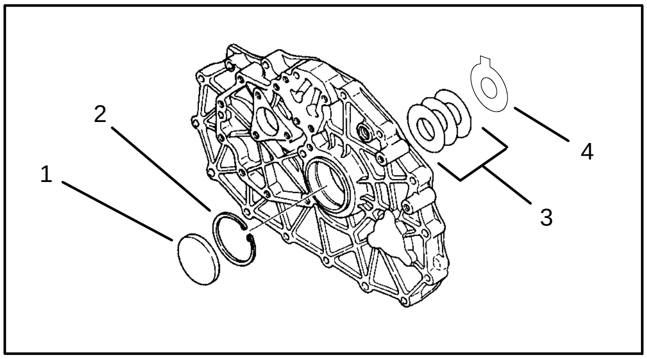

Figure 92

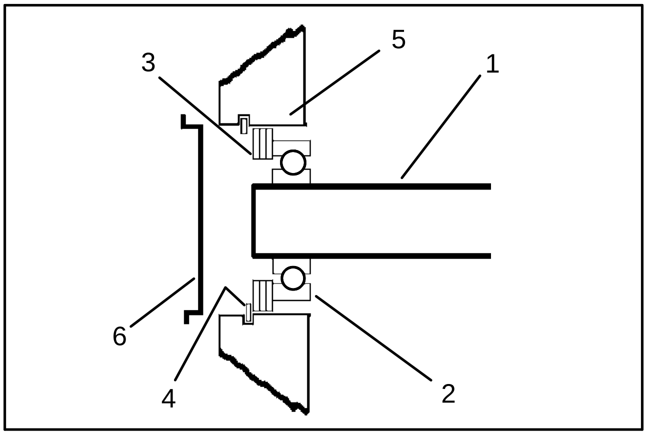

Figure 93

1. **Countershaft**
2. **Bearing**
3. **Shims**
4. **Retaining ring**
5. **Center plate**
6. **Sealing cap**

17. Install retaining ring into the groove of the center plate (Fig. 93 and 94).

Figure 94

18.Measure countershaft end play. Rotate one of the axle shafts back and forth to take up all back lash. Rotating the shaft in one direction will pull the shaft and bearing away from the snap ring. Rotate axle shaft in this direction, then measure space between the retaining ring and shim (set) with a feeler gauge. Make sure shim set is pressed against the bearing during the measurement. End play should be 0.000” to 0.0039” (0.0 to 0.10 mm) (Fig. 95).

IMPORTANT: If end play is too great, replace shim/ shim set (item 2) with thicker shims to allow correct end play.

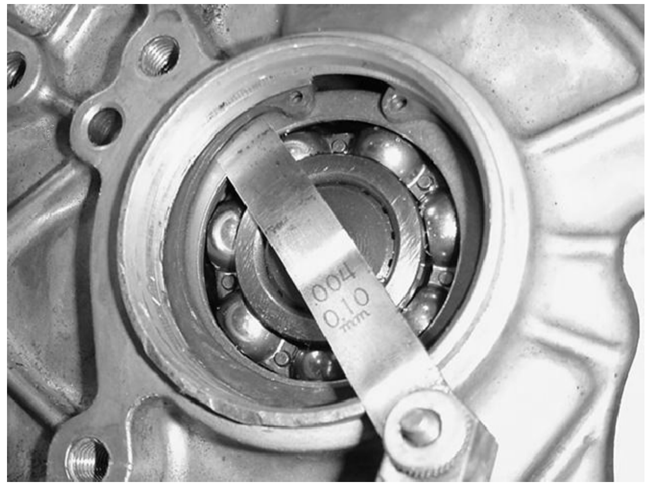

Figure 95

19.Insert sealing cap (item 1) flush with face of center plate. Make sure not to insert sealing cap too far. Pay attention to direction of sealing cap.

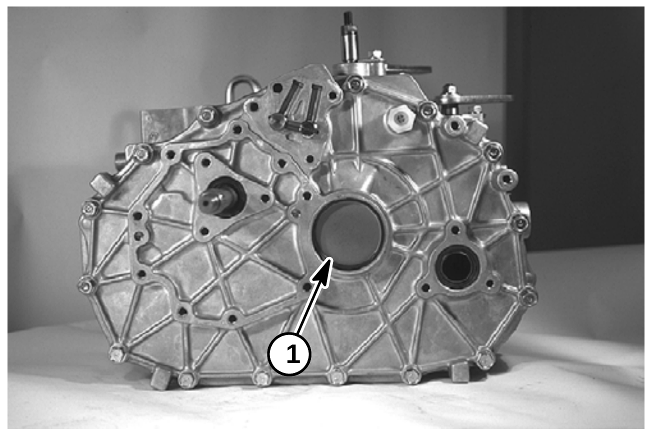

Figure 96

20. Install fork shaft case:

A. Thoroughly clean mating surface of transaxle case and fork shaft case.

B. Insert spindle lock (item 1) between fork shafts.

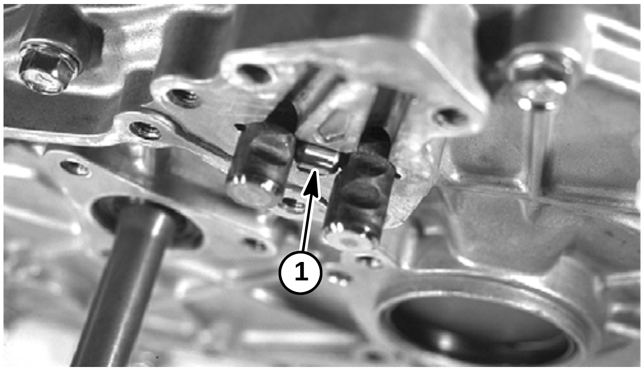

Figure 97

C. Insert two (2) steel balls (item 2) and two (2) springs (item 1) into the grooves of the center plate.

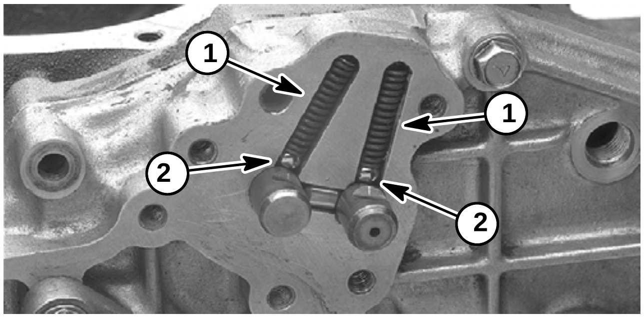

Figure 98

D. Apply silicone sealant to mating surface of fork shaft case. Install fork shaft case (item 3). Install cap screws (items 2 and 1) noting location of longer screw (item 1). Tighten cap screws to a torque of **18 to 22 ft-lb (24.5 to 29.5 N-m)**. Check operation of shifters and detent.

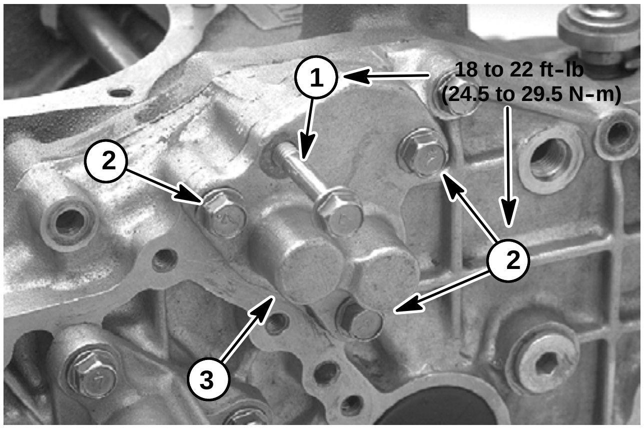

Figure 99

Drive Train

21. Install differential gear assembly (item 2) into transaxle case.

22. Insert two (2) dowel pins (item 1) into transaxle case.

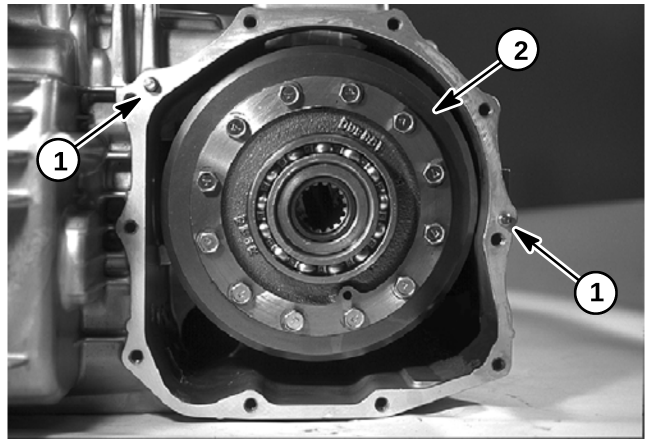

Figure 100

23. Install side cover:

A. Thoroughly clean mating surfaces of transaxle case and side cover. Apply silicone sealant onto mating surface of side cover.

B. Install side cover and secure with cap screws. Torque cap screws from **18 to 22 ft-lb (24.5 to 29.5 N-m)**.

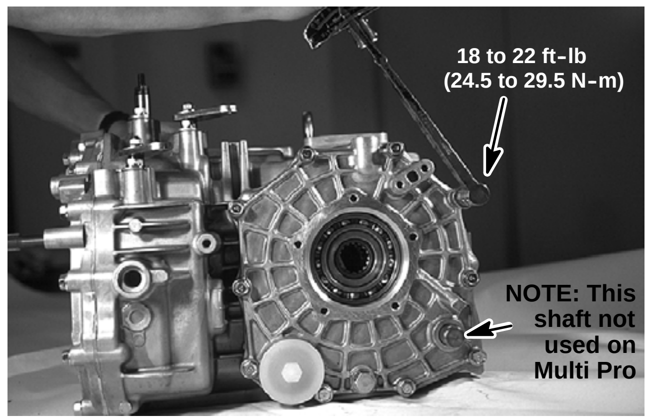

Figure 101

24. Install R.H. axle shaft assembly:

A. Thoroughly clean mating surface of transaxle case and seal cover of R.H. axle shaft assembly. Apply silicone sealant onto mating surface of seal cover.

B. Install axle shaft assembly (item 2) and secure with cap screws. Torque cap screws (item 1) from **18 to 22 ft-lb (24.5 to 29.5 N-m)**.

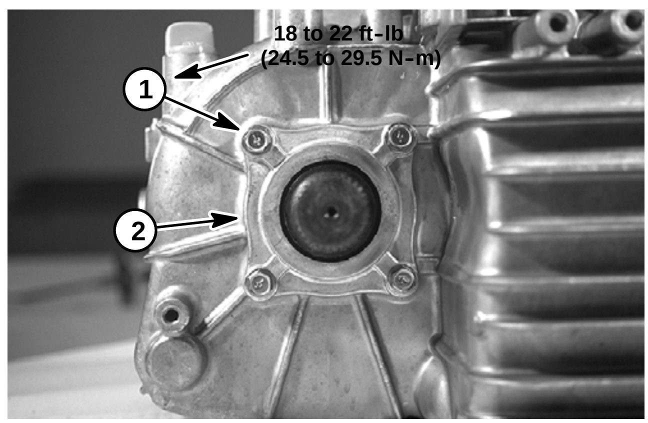

Figure 102

25. Install L.H. axle shaft assembly:

A. Thoroughly clean mating surface of differential carrier and side cover (item 2).

B. Insert selected shims (item 1) into housing of side cover.

NOTE: The thickest shim should be installed against the bearing.

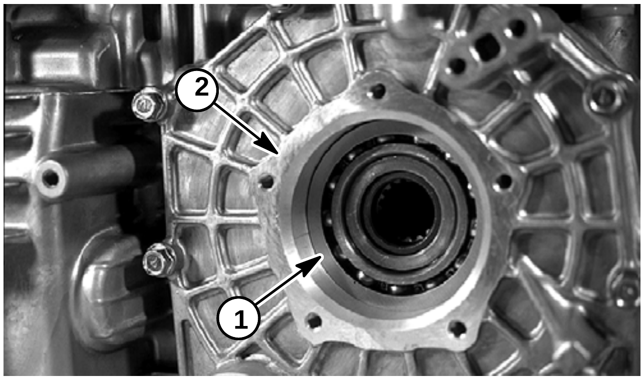

Figure 103

C. Install axle shaft assembly and secure with cap screws (item 1). Torque cap screws from **18 to 22 ft–lb (24.5 to 29.5 N–m)**.

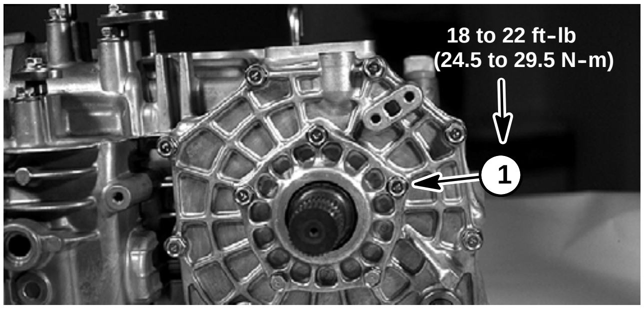

Figure 104

26. Measure backlash of ring gear through P.T.O. cover opening on top of transaxle. Using a dial indicator, check ring gear backlash in three equally spaced points. Backlash should be 0.0031" to 0.0071" (0.08 to 0.18 mm) and must not vary more than 0.002" (0.05 mm) at the points checked. If backlash is not in this range, replace shim set in end of differential carrier:

A. If backlash is less than target range, decrease total thickness of shim set until correct backlash is achieved.

B. If backlash exceeds the target range, increase total thickness of shim set until correct backlash is achieved.

NOTE: The thickest shim should be installed against the bearing.

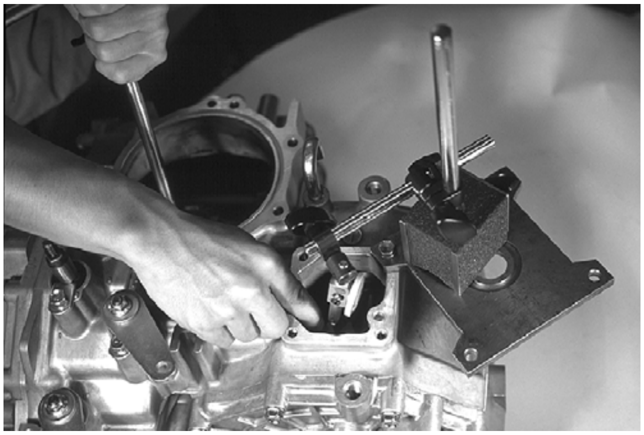

Figure 105

Drive Train

27.Apply multi–purpose grease to P.T.O. cover O–ring and insert O–ring into groove of transaxle case. Position P.T.O. cover (item 5) to transaxle case. Install five (5) cap screws (item 4) and nut with lock washer (item 3). Tighten cap screws and nut to a torque of **11 to 13 ft–lb (15 to 17 N–m)**.

28.If removed, install oil cap (item 2) with O–ring to transaxle case.

29.If removed, apply sealing tape to threads of air breather (item 1) and install air breather.

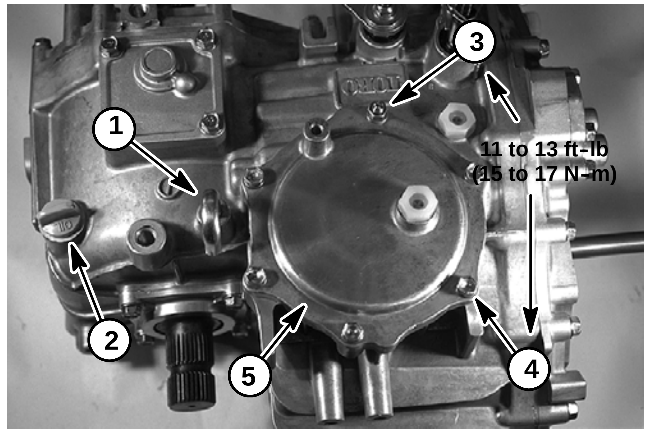

Figure 106

30.Apply silicone sealant to mating surface of upper cover (item 4). Pay attention to direction of cover and install. Torque cap screws (item 3) from **18 to 22 ft–lb (24.5 to 29.5 N–m)**.

31.If removed, slide speed sensor (item 2) into upper cover (item 4). Install cap screw (item 1) with lock washer to secure sensor.

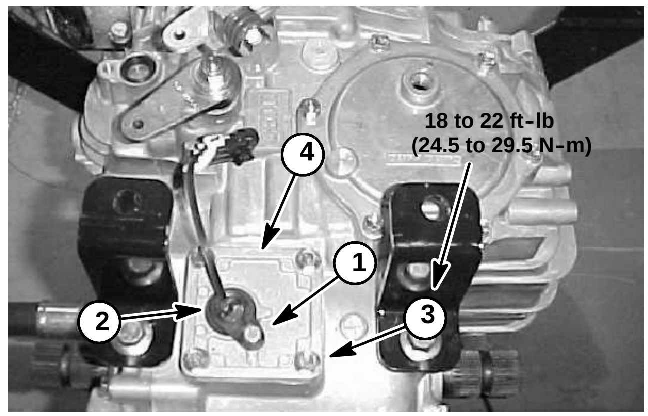

Figure 107

32.Position input shaft cover plate (item 2) to transaxle and secure it with three (3) cap screws (item 1).

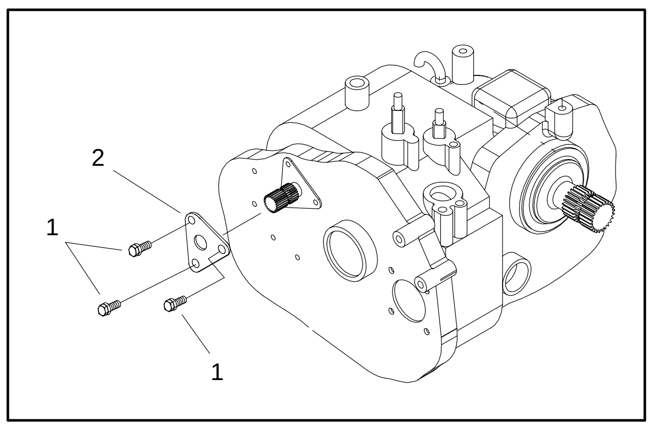

Figure 108

Chapter 8

Chassis

Table of Contents

Chassis

Specifications

Item	Description
Front tire pressure (18 x 9.5 – 8, 4 ply, tubeless)	18 PSI (124 kPa) Maximum
Rear tire pressure (24 x 13 – 12, 4 ply, tubeless)	18 PSI (124 kPa) Maximum
Front wheel lug nut torque	55 to 65 ft–lb (75 to 88 N–m)
Rear wheel lug nut torque	55 to 65 ft–lb (75 to 88 N–m)
Front wheel toe–in	0 to 1/4 inch (0 to 6 mm)

Adjustments

Front Suspension

Any time the front wheel toe–in is checked, the front suspension should be checked as well. Incorrect suspension setting can affect steering and can cause accelerated tire wear and scuffing.

IMPORTANT: When checking suspension, vehicle spray tank should be approximately half full and operator should be in seat.

IMPORTANT: Prior to checking front suspension, drive the machine straight forward at least fifteen (15) feet to allow the suspension to relax. Do not turn steering wheel.

1. Drive machine straight ahead at least fifteen (15) feet and stop on a level surface. Stop engine and remove key from ignition switch.

2. Check attitude of both right and left A–arms (Fig. 1). Both A–arms should be level and parallel to the ground.

3. If either A–arm is not level, check all suspension and steering components for wear or damage. If no component wear or damage is detected, adjust suspension:

   A. Chock rear wheels to prevent vehicle from shifting. Lift front of machine using a jack or hoist to allow front suspension to relax (see Jacking Instructions in Chapter 1 – Safety). Support raised machine with jack stands.

   B. Loosen and remove lock nut and cap screw that secure axle assembly position to the frame (Fig. 2).

   C. Rotate axle assembly to allow different cap screw position. Rotating axle toward ground increases tension on suspension.

   D. Reinstall cap screw in new position and secure with lock nut. Torque from **130 to 150 ft–lb (176 to 203 N–m)**.

   E. Lower machine to ground and repeat steps 1 to 3 as needed.

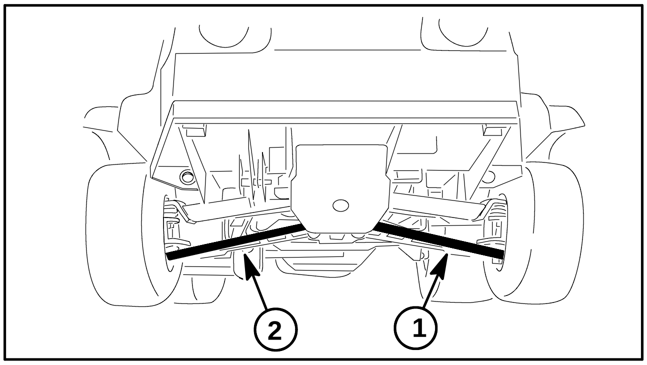

Figure 1

1. LH A–arm **2. RH A–arm**

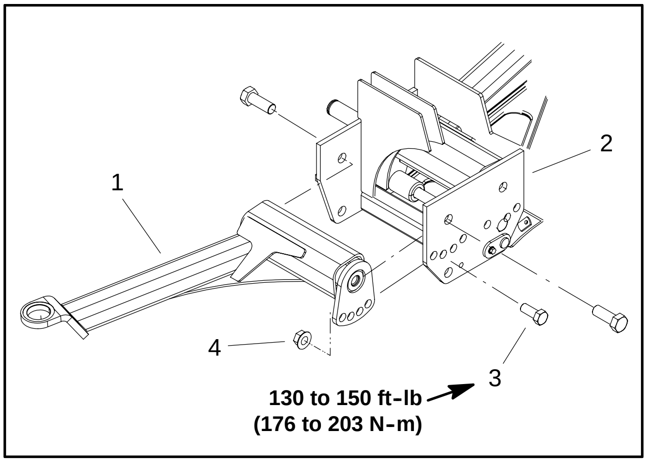

Figure 2

1. Axle assembly (RH)
2. Frame
3. Cap screw
4. Lock nut

Chassis

Front Wheels and Brakes

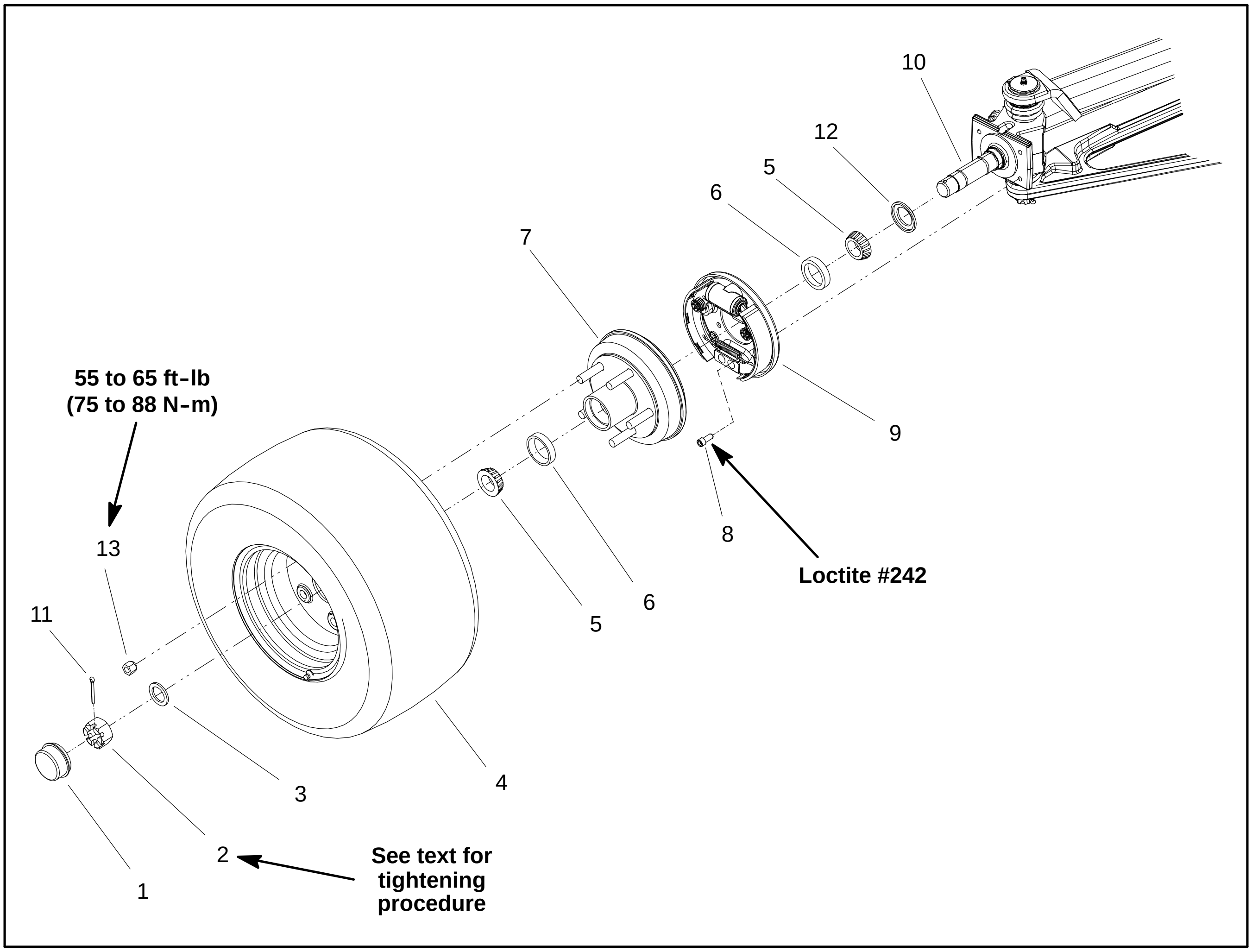

Figure 3

1. **Dust cap**
2. **Slotted hex nut**
3. **Washer**
4. **Wheel and tire assembly**
5. **Wheel bearing cone**
6. **Wheel bearing cup**
7. **Wheel hub/drum**
8. **Socket head screw (4 per wheel)**
9. **Front brake assembly**
10. **Front spindle**
11. **Cotter pin**
12. **Seal**
13. **Lug nut (5 per wheel)**

Removal (Fig. 3)

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

2. Jack front wheel off the ground (see Jacking Instructions in Chapter 1 – Safety). Chock front and rear of other wheels. Support raised machine with jack stands.

3. Remove lug nuts and wheel assembly.

4. Carefully pry dust cap from wheel hub.

5. Remove cotter pin from front spindle.

6. Remove slotted hex nut and washer that secures wheel hub/drum to spindle. Slide wheel hub with bearings from spindle.

7. If required, disassemble wheel hub/drum:

A. Pull seal out of the wheel hub.

B. Remove bearings from both sides of wheel hub. Clean bearings in solvent. Clean inside of the hub.

8. Inspection and service of front brakes can be completed with brake assembly on machine (see Front Brake Service in this section). If required, brake assembly can be removed from machine as follows:

A. Clean hydraulic brake line area of brake assembly to prevent contamination.

B. Loosen and remove banjo bolt from wheel cylinder and brake line. Locate and retrieve two (2) washers from brake line fitting. Cap brake line and position it away from brake assembly.

C. Remove four (4) socket head screws that secure the brake assembly to the front spindle.

D. Remove brake assembly from spindle.

Inspection

1. Inspect brake drums.

IMPORTANT:Brake drum machining is not recommended. Replace front brake drums as a set to maintain equal braking forces.

A. Clean drums with denatured alcohol.

B. Replace drums that are cracked, deeply grooved, tapered, significantly out–of–round, scored, heat spotted or excessively rusted. Minor scoring in brake drum can be removed with sandpaper.

2. If removed, inspect wheel bearings. Make sure bearing cones are in good operating condition. Check the bearing cups for wear, pitting or other noticeable damage. Replace worn or damaged parts.

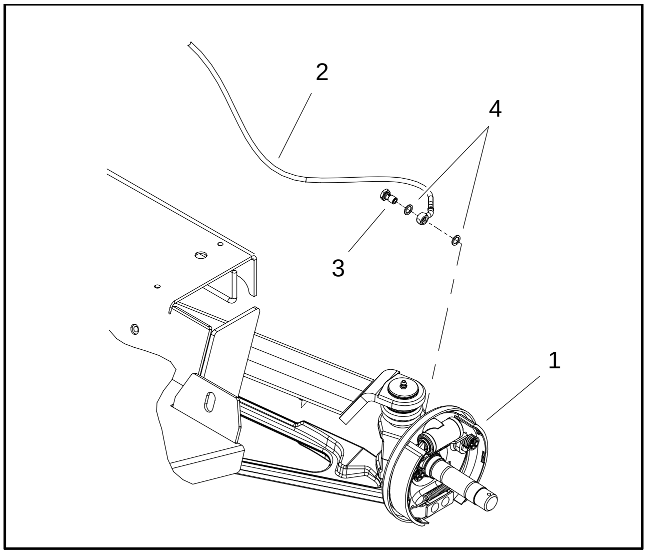

Figure 4

1. **Brake assembly**
2. **Brake line**
3. **Banjo bolt**
4. **Banjo washer (2 used)**

Installation (Fig. 3)

1. Clean all parts thoroughly before assembly.

2. If removed, position brake assembly to the front spindle.

A. Apply Loctite #242 (or equivalent) to threads of socket head screws that secure brake assembly to spindle.

B. Secure backing plate of the brake assembly to the spindle with four (4) socket head screws.

C. Position two (2) new banjo washers on sides of brake line fitting.

D. Secure brake line to wheel cylinder with banjo bolt.

3. If wheel bearings were removed from wheel hub/ drum, assemble wheel hub:

A. If bearing cups were removed from the wheel hub, press inner and outer cups into the hub until they seat against the hub shoulder.

B. Pack both bearings with grease. Install greased inner bearing into the cup on inboard side of the wheel hub.

IMPORTANT: The lip seal must be pressed in so it is flush with the end of the hub. The lip of the seal must be toward the bearing.

C. Lubricate the inside of the new lip seal and press it into the wheel hub.

4. Install the wheel hub/drum onto the spindle shaft taking care to not damage seal in the wheel hub.

5. Install greased outer bearing cone, washer and slotted hex nut onto spindle shaft.

6. Rotate the wheel hub/drum by hand and tighten the slotted hex nut from **75 to 100 in-lb (8.5 to 11.3 N–m)** to set the bearings. Then, loosen the nut until the wheel hub has end play.

7. Rotate the wheel hub/drum by hand and re-tighten the slotted hex nut from **15 to 20 in-lb (1.7 to 2.3 N–m)**. If necessary, nut can be tightened slightly to align cotter pin position in spindle and nut.

8. Install cotter pin through spindle shaft hole. Install dust cap to hub.

9. Install wheel assembly with valve stem facing out and secure with lug nuts. Torque lug nuts evenly in a crossing pattern from **55 to 65 ft–lb (75 to 88 N–m)**.

10. Lower machine to ground.

11. Bleed brakes (see Bleed Brake System in this section).

12. Align steering, adjust toe–in (see Operator's Manual) and check front suspension (see Front Suspension in the Adjustments section of this chapter).

13. Lubricate tie rod ball joints.

CAUTION

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

14. Check brake operation.

Burnish Brake Shoes

Sintered metal linings may not provide maximum brake stopping distance after brake shoes are replaced. It may be necessary to burnish new brake shoe linings.

IMPORTANT: Do not drive machine with the brakes applied. The brake shoe linings will overheat.

IMPORTANT: Do not allow the brakes to lock up. Allow brakes to cool between applications.

Drive machine while making 6 to 7 normal stops at about 200 ft (60 m) intervals while traveling at moderate speed.

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Front Brake Service

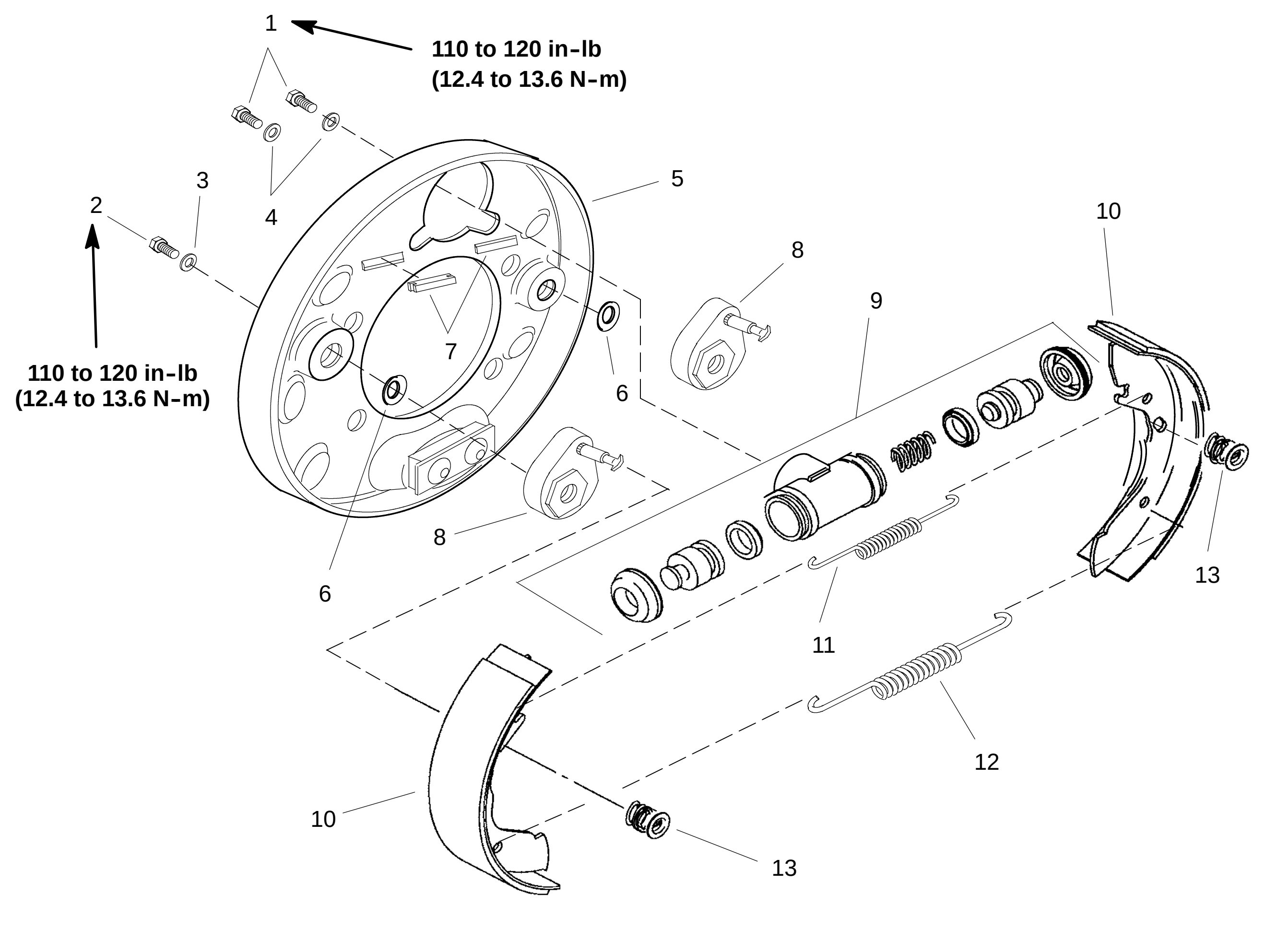

Figure 5

1. **Flange head screw**
2. **Cap screw (2 used per wheel)**
3. **Flat washer (2 used per wheel)**
4. **Lock washer**
5. **Brake backing plate**
6. **Belleville washer**
7. **Dust cover**
8. **Adjuster lever**
9. **Wheel cylinder**
10. **Brake shoe**
11. **Upper spring**
12. **Lower spring**
13. **Shoe hold down cup and spring**

Disassembly (Fig. 5)

1. Remove front wheel and brake hub/drum and, if necessary, remove brake assembly from machine (see Front Wheels and Brakes in this section).

CAUTION

Be careful when removing springs from brake shoes. The springs are under heavy tension and may cause personal injury.

2. Remove upper and lower springs from brake shoes.

3. Remove shoe hold down cups and springs that secure the brake shoes to the backing plate.

4. Remove brake shoes from backing plate.

5. If brake assembly is still on machine and wheel cylinder removal is necessary:

A. Clean hydraulic brake line area of wheel cylinder to prevent contamination.

B. Loosen and remove banjo bolt from wheel cylinder and brake line. Locate and retrieve two (2) washers from brake line fitting. Cap brake line and position it away from brake assembly.

C. Remove two (2) flange head screws that secure wheel cylinder to backing plate. Remove wheel cylinder from backing plate.

6. If necessary, remove cap screws and washers to allow adjuster levers to be separated from backing plate. Locate and remove belleville washers from between adjuster levers and backing plate.

Inspection

1. Inspect brake shoes.

IMPORTANT:Replace front brake shoes as a set (all four shoes on both wheels) to maintain equal braking forces.

A. Replace brake shoes if damaged or if lining is worn to 1/16” (1.6 mm). Replace shoes if lining is contaminated by oil, grease or other fluids.

NOTE: Overheated springs lose their tension and can cause brake linings to wear out prematurely.

B. Inspect brake shoe webbing, upper and lower springs and shoe hold down springs for overheating and stretching. Overheating is indicated by a slight blue color. Inspect brake shoe webbing for deformation. Replace parts as necessary.

C. Inspect hold down pins on adjuster levers for bends, rust or corrosion. Replace as necessary.

2. Inspect backing plate surfaces which contact with the brake shoes for grooves that may restrict shoe movement. Replace backing plate if grooves can not be removed by light sanding with emery cloth or other suitable abrasive. Replace backing plate if cracked, warped or excessively rusted.

3. Inspect adjuster levers. Replace levers if deformation or excessive rust is found.

Assembly (Fig. 5)

IMPORTANT:Brake shoe lining surfaces must be free of grease, oil and other foreign matter.

1. Apply a light film of lubricant to the following:

A. Ledges on which the brake shoes rest.

B. Pin surfaces on adjuster levers.

C. Anchor block surfaces that contact shoe webs.

D. Both surfaces of belleville washers that are positioned between adjuster levers and backing plate (if removed).

2. If removed, position lubricated belleville washer between adjuster lever and backing plate. Secure adjuster to backing plate with washer and cap screw. Torque bolt from **110 to 120 in-lb (12.4 to 13.6 N-m)**.

3. If removed, install wheel cylinder:

A. Secure wheel cylinder to backing plate with two flange head screws. Torque screws from **110 to 120 in-lb (12.4 to 13.6 N-m)**.

B. If brake assembly is still on machine, position two (2) new banjo washers on sides of brake line fitting. Secure brake line to wheel cylinder with banjo bolt.

4. If removed from backing plate, install dust covers in backing plate.

5. Position brake shoes to backing plate. Make sure that each shoe is properly positioned at anchor block, wheel cylinder and pin on adjuster lever. Secure shoes to adjuster levers with shoe hold down cups and springs.

CAUTION

Be careful when installing springs to brake shoes. The springs are under heavy tension and may cause personal injury.

6. Secure brake shoes with upper and lower springs.

7. Assemble front wheel (see Front Wheels and Brakes in this section).

Rear Wheels and Brakes

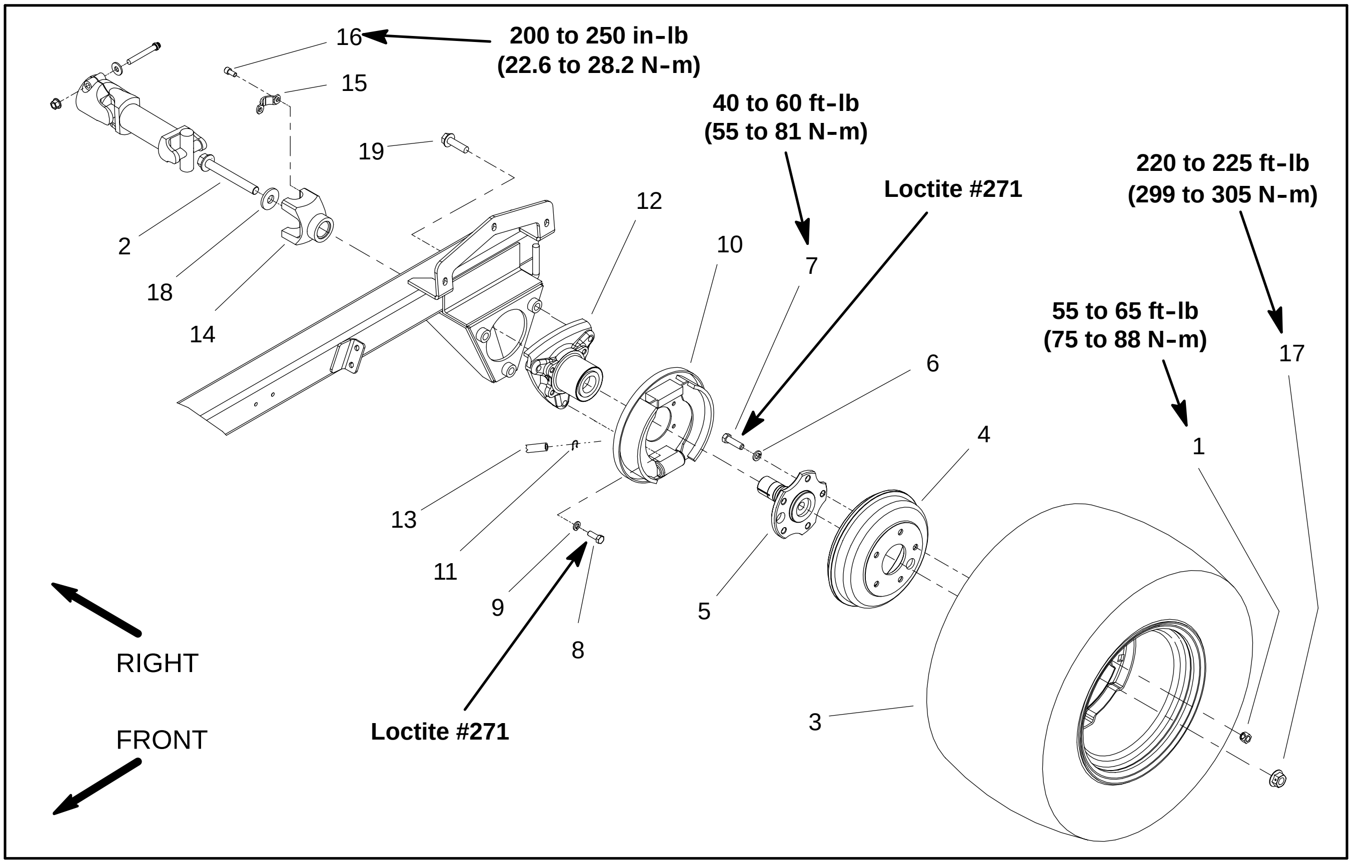

Figure 6

1. **Lug nut (5 used per wheel)**
2. **Flange head screw**
3. **Wheel assembly**
4. **Brake drum**
5. **Stub axle**
6. **Lock washer (5 used per wheel)**
7. **Drive stud (5 used per wheel)**
8. **Cap screw (4 used per wheel)**
9. **Lock washer (4 used per wheel)**
10. **Brake assembly**
11. **Brake cable clip**
12. **Axle housing assembly**
13. **Parking brake cable**
14. **End yoke**
15. **Yoke strap (2 used per yoke)**
16. **Bolt (4 used per yoke)**
17. **Flange lock nut**
18. **Flat washer**
19. **Flange head screw (3 per housing)**

Removal (Fig. 6)

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

2. Chock front wheels. Raise rear wheel using a jack or hoist (see Jacking Instructions in Chapter 1 – Safety). Support raised machine with jack stands.

3. Loosen and remove lug nuts that secure rear wheel. Remove rear wheel.

4. Loosen set screw on parking brake control lever knob (Fig. 7). Turn knob on parking brake lever counterclockwise all the way to loosen brake cables.

5. To remove brake drum, it may be necessary to back off parking brake adjuster. To back off adjuster, rotate brake drum until access hole lines up with star wheel. Use a hooked piece of wire to pull pawl away from star wheel, then turn star wheel. Pull brake drum from machine.

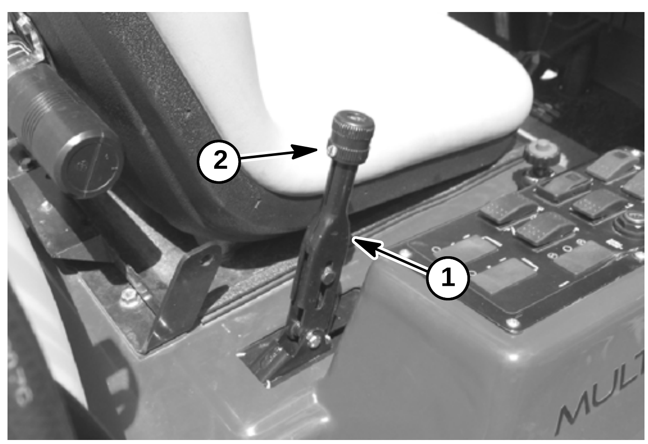

Figure 7

1. **Parking brake lever**
2. **Set screw**

6. Inspection and service of rear brakes can be completed with brake assembly on machine (see Rear Brake Service in this section). If required, brake assembly can be removed from machine as follows:

A. Remove parking brake cable from brake assembly (see Parking Brake Cable Removal in this section).

A. Clean hydraulic brake line area of wheel cylinder to prevent contamination.

B. Loosen and remove banjo bolt from wheel cylinder and brake line. Locate and retrieve two (2) washers from brake line fitting. Cap brake line and position it away from brake assembly.

C. Remove stub axle from machine (see Stub Axle and Driveshaft in the Service and Repairs section of Chapter 7 – Drive Train).

D. Remove four (4) cap screws and lock washers that secure the brake assembly to the axle housing.

E. Remove brake assembly from machine.

Inspection

1. Inspect brake drums.

IMPORTANT:Brake drum machining is not recommended. Replace rear brake drums as a set to maintain equal braking forces.

A. Clean drums with denatured alcohol. Check braking surface diameter in at least three places. If the diameter exceeds 8.071" (205.0 mm), replace both brake drums.

B. Replace drums that are cracked, deeply grooved, tapered, significantly out–of–round, scored, heat spotted or excessively rusted.

C. Minor scoring in brake drum can be removed with sandpaper.

Installation (Fig. 6)

1. Clean all parts thoroughly before assembly.

2. If removed, position brake assembly to the machine.

A. Apply Loctite #271 (or equivalent) to four (4) cap screws (item 8). Secure backing plate of the brake assembly to the axle housing with cap screws and lock washers.

B. Install stub axle (see Stub Axle and Driveshaft in the Service and Repairs section of Chapter 7 – Drive Train).

C. Position two (2) new banjo washers on sides of brake line fitting. Secure brake line to wheel cylinder with banjo bolt.

D. Install parking brake cable to brake assembly (see Parking Brake Cable Installation in this section).

3. Position brake drum so access hole in drum aligns with hole in stub axle flange. Slide brake drum onto machine.

4. Adjust brake shoes:

A. Align access hole in brake drum with star wheel on brake adjuster assembly.

B. Rotate star wheel to increase adjuster length until brake shoes contact brake drum.

C. Back off star wheel until drum rotates freely.

5. Install wheel and secure with lug nuts. Torque lug nuts evenly in a crossing pattern from **55 to 65 ft–lb (75 to 88 N–m)**.

6. Lower machine to ground.

7. Bleed brakes (see Bleed Brake System in this section).

CAUTION

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

8. Check brake operation. To adjust the brakes, stop several times while vehicle is moving in reverse.

9. Adjust parking brake (see Operator's Manual).

Burnish Brake Shoes

Brake linings may not provide maximum brake stopping distance after brake shoes are replaced. It is necessary to burnish new brake shoe linings.

IMPORTANT:Do not drive machine with the brakes applied. The brake shoe linings will overheat.

IMPORTANT:Do not allow the brakes to lock up. Allow brakes to cool between applications.

Drive machine while making 6 to 7 normal stops at about 200 ft (60 m) intervals while traveling at moderate speed.

Rear Brake Service

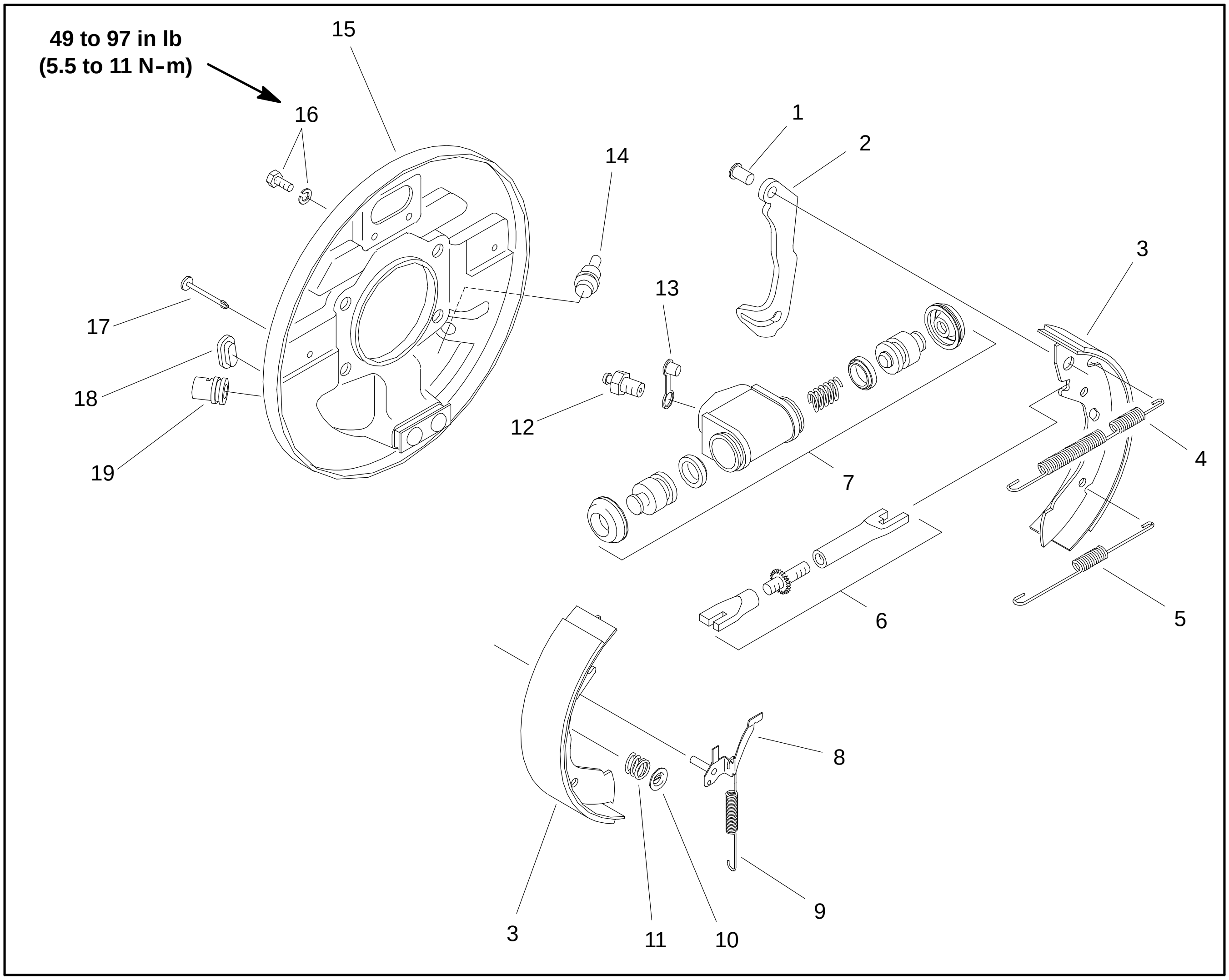

Figure 8

1. Pin
2. Parking brake lever
3. Brake shoe
4. Upper spring
5. Lower spring
6. Brake adjuster assembly
7. Brake cylinder assembly
8. Parking brake pawl with pin
9. Adjuster spring
10. Hold down washer (2 used per wheel)
11. Hold down spring (2 used per wheel)
12. Bleed screw
13. Cap
14. Plug
15. Brake back plate
16. Bolt set (2 used per wheel)
17. Hold down pin (2 used per wheel)
18. Inspection plug
19. Cable guide

Disassembly (Fig. 8)

1. If brake assembly is still on machine, remove parking brake cable (see Parking Brake Cable Removal in this section).

CAUTION

Be careful when removing springs from brake shoes. The springs are under heavy tension and may cause personal injury.

2. Remove upper and lower springs from brake shoes.

3. Remove shoe hold down washers and springs that secure the brake shoes to the backing plate.

4. Remove brake shoes from backing plate.

5. If brake assembly is still on machine and wheel cylinder removal is necessary:

   A. Clean hydraulic brake line area of wheel cylinder to prevent contamination.

   B. Loosen and remove banjo bolt from wheel cylinder and brake line. Locate and retrieve two (2) washers from brake line fitting. Cap brake line and position it away from brake assembly.

   C. Remove two (2) bolts and washers that secure wheel cylinder to backing plate. Remove wheel cylinder from backing plate.

Inspection

1. Inspect brake shoe linings.

   IMPORTANT:Replace rear brake shoes as a set (all four shoes) to maintain equal braking forces.

   A. Replace brake shoes if damaged or if lining is worn to 1/16” (1.6 mm). Replace if lining is contaminated by oil, grease or other fluids.

   NOTE: Overheated springs lose their tension and can cause brake linings to wear out prematurely.

   B. Inspect brake shoe webbing, upper and lower springs and shoe hold down springs for overheating. Overheating is indicated by a slight blue color. Inspect brake shoe webbing for deformation. Replace parts as necessary.

   C. Inspect hold down pins for damage. Replace as necessary.

2. Inspect brake adjuster, parking brake lever and parking brake pawl for damage or wear. Replace components as necessary.

Assembly (Fig. 8)

IMPORTANT:Brake shoe lining surfaces must be free of grease, oil and other foreign matter.

1. Apply a light film of lubricant to the following:

   A. Ledges on which the brake shoes rest.

   B. Hold down pins.

   C. Anchor block surfaces that contact shoe webs.

2. If removed, install wheel cylinder:

   A. Secure wheel cylinder to backing plate with two (2) bolts and washers. Torque bolts from **49 to 97 in–lb (5.5 to 11 N–m)**.

   B. If brake assembly is still on machine, position two (2) new banjo washers on sides of brake line fitting. Secure brake line to wheel cylinder with banjo bolt.

3. If removed from backing plate, install dust covers in backing plate.

4. Position brake shoes to backing plate. Make sure that each shoe is properly positioned at anchor block, wheel cylinder and hold down pin. Secure shoes to pins with hold down springs and washers.

CAUTION

Be careful when installing springs to brake shoes. The springs are under heavy tension and may cause personal injury.

5. Install lower spring to brake shoes.

6. Install brake adjuster assembly to slots on brake shoes, then the parking brake pawl with pin. Install adjuster spring.

7. Install upper spring.

8. If brake assembly is still on machine, install parking brake cable (see Parking Brake Cable Installation in this section).

9. Assemble rear wheel (see Rear Wheels and Brakes Installation in this section).

Brake Lines

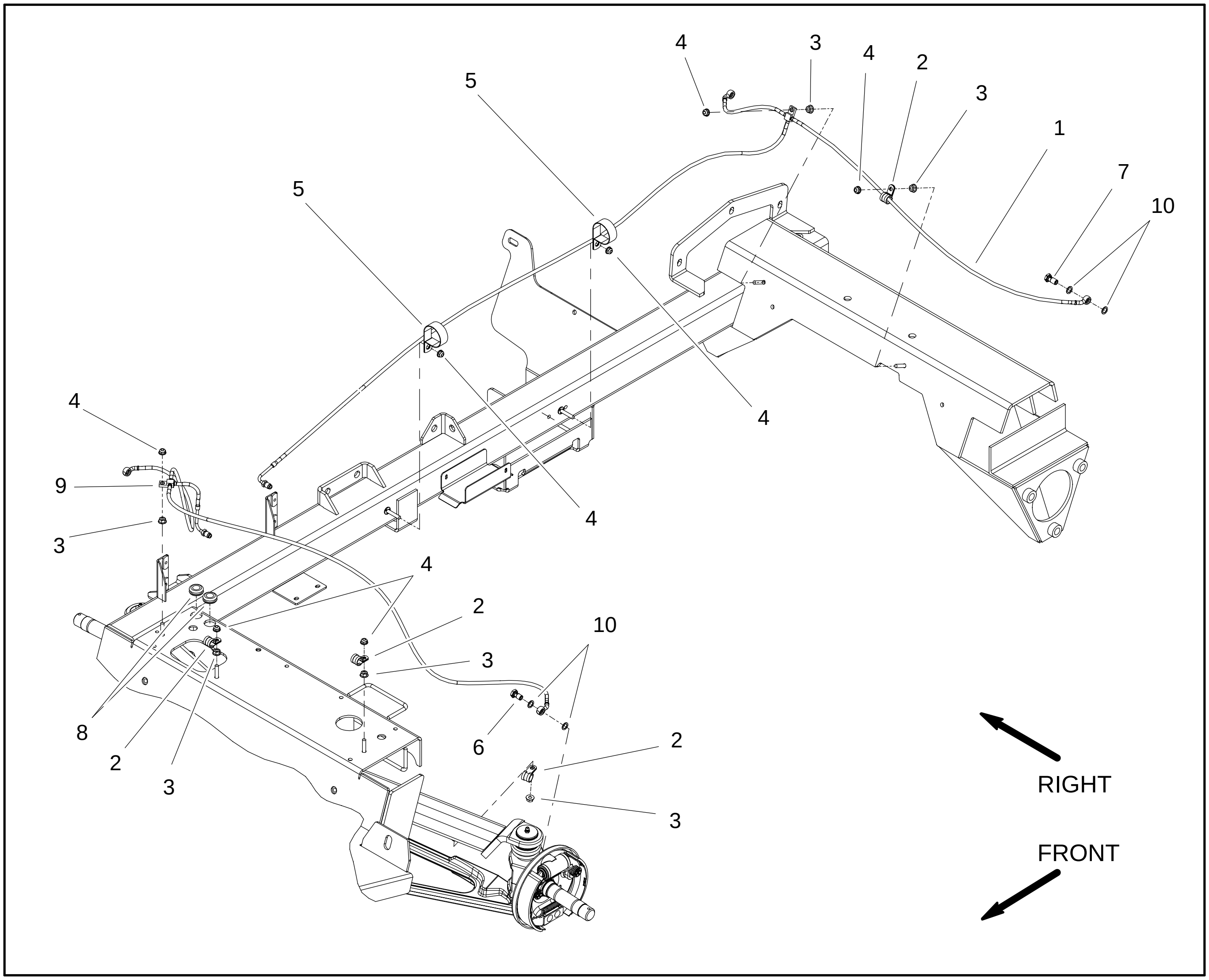

Figure 9

1. **Rear brake line**
2. **R-clamp (5 used)**
3. **Flange nut (8 used)**
4. **Flange nut (8 used)**
5. **R-clamp (2 used)**
6. **Front brake banjo bolt (2 used)**
7. **Rear brake banjo bolt (2 used)**
8. **Grommet (2 used)**
9. **Front brake line**
10. **Banjo washer (2 per banjo bolt)**

When performing service work on the Multi Pro brake lines, make sure to clean brake components before disassembly. Use Figure 9 as a guide for removal and installation of hydraulic brake lines.

Parking Brake Cables

Removal

1. Loosen set screw on parking brake lever knob (Fig. 10). Turn knob on parking brake lever counterclockwise fully to loosen cable adjustment.

2. Raise seat to allow access to cable connection at parking brake lever.

3. Remove cotter pin, flat washer and clevis pin that secure brake equalizer to parking brake lever (Fig. 11).

4. Remove retaining rings that secure brake cables to frame. Remove cable ends from equalizer plate (Fig. 11).

5. Jack up and support rear of machine (see Jacking Instructions in Chapter 1 – Safety). Remove both rear wheels and brake drums (see Rear Wheels and Brakes in this section).

6. Remove cable clip that holds each brake cable into brake backing plate. Remove cable end from parking brake lever (Fig. 12). Pull cable from rear brake assembly.

7. Note routing of cables and location of cable ties and r–clamps before removing cables from machine.

Installation

1. Install new cables to brake equalizer. Attach equalizer to parking brake lever with clevis pin, flat washer and cotter pin.

2. Position cables to frame and secure with retaining rings.

3. Route cables to rear brakes and secure with cable ties and r–clamps.

4. Insert cables through cable guide on appropriate rear brake. Connect cable end to parking brake lever. Install cable clip to secure cable to brake backing plate.

5. After installing cable to each rear brake, check to make sure that the bottoms of the brake shoes are seated in grooves at bottom of backing plate.

6. Install brake drums and rear wheels (see Rear Wheels and Brakes in this section). Lower machine to ground.

7. Lower seat.

8. Adjust parking brake (see Operator's Manual). Check operation of brakes before returning machine to regular service.

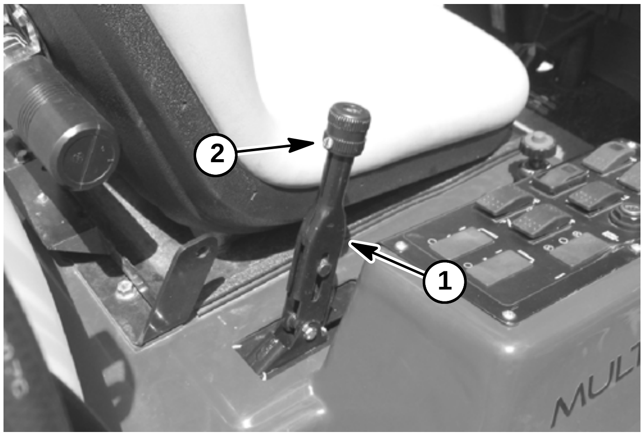

Figure 10

1. **Parking brake lever**
2. **Set screw**

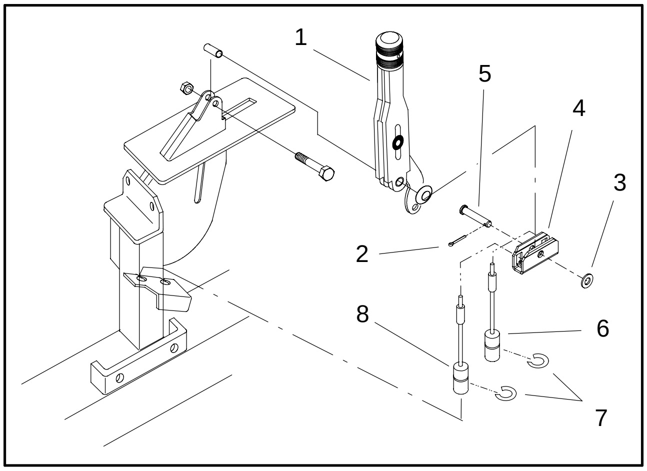

Figure 11

1. **Parking brake lever**
2. **Cotter pin**
3. **Flat washer**
4. **Equalizer plate**
5. **Clevis pin**
6. **LH brake cable**
7. **Retaining ring**
8. **RH brake cable**

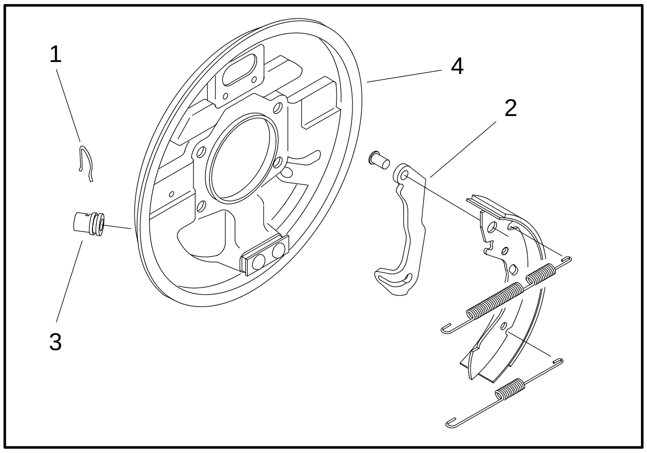

Figure 12

1. **Cable clip**
2. **Parking brake lever**
3. **Cable guide**
4. **Brake backing plate**

Chassis

Brake Master Cylinder Service

Testing

1. Insure that brake system is properly adjusted and bled.

2. Apply light pressure to brake pedal.

3. If brake pedal fades or falls away while applying light pressure to pedal, the master cylinder should be serviced.

Disassembly (Fig. 13)

1. Remove reservoir and flange seal. Push in on the push rod so the stop pin can be removed.

2. Disconnect lower end of the dust cover from the housing.

3. Push in on the push rod and remove circlip, then remove push rod with dust cover and clevis. Remove retainer washer.

4. Remove primary piston assembly and secondary piston assembly from cylinder housing.

Inspection

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. **Note:** Do not hone bore of brake cylinder.

Assembly (Fig. 13)

1. Apply a film of clean 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.

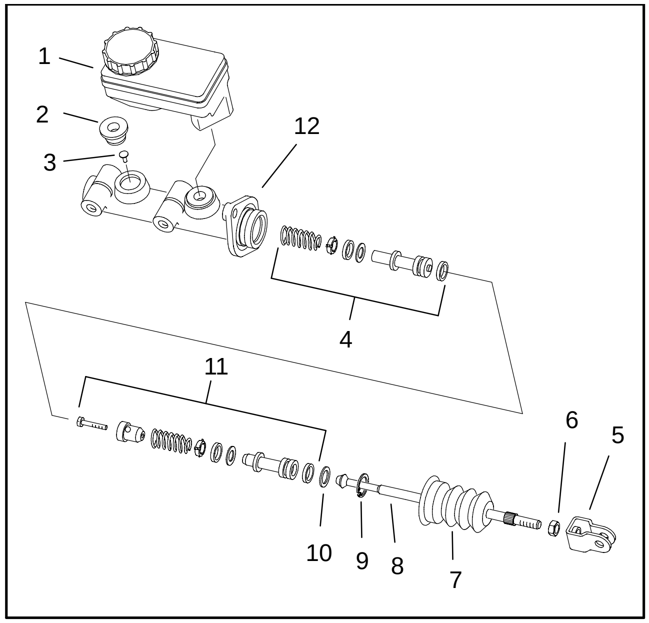

Figure 13

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

Bleed Brake System

After loosening or removing any hydraulic brake component, the brake system should be bled to insure proper brake operation.

NOTE: A power/vacuum brake bleeding tool will provide faster and more effective brake bleeding than manual bleeding.

1. Connect a suitable transparent hose to bleeder valve on wheel cylinder and submerge other end of hose in a glass container partially filled with clean brake fluid.

2. Have a second person pump brake pedal several times, then hold pedal down firmly.

3. With pedal firmly depressed, open bleeder valve of wheel cylinder until pedal fades to floor. Close bleeder valve before releasing pedal.

4. 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**.

5. Repeat steps 1 to 4 for other wheel cylinders.

CAUTION

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

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

Front Suspension

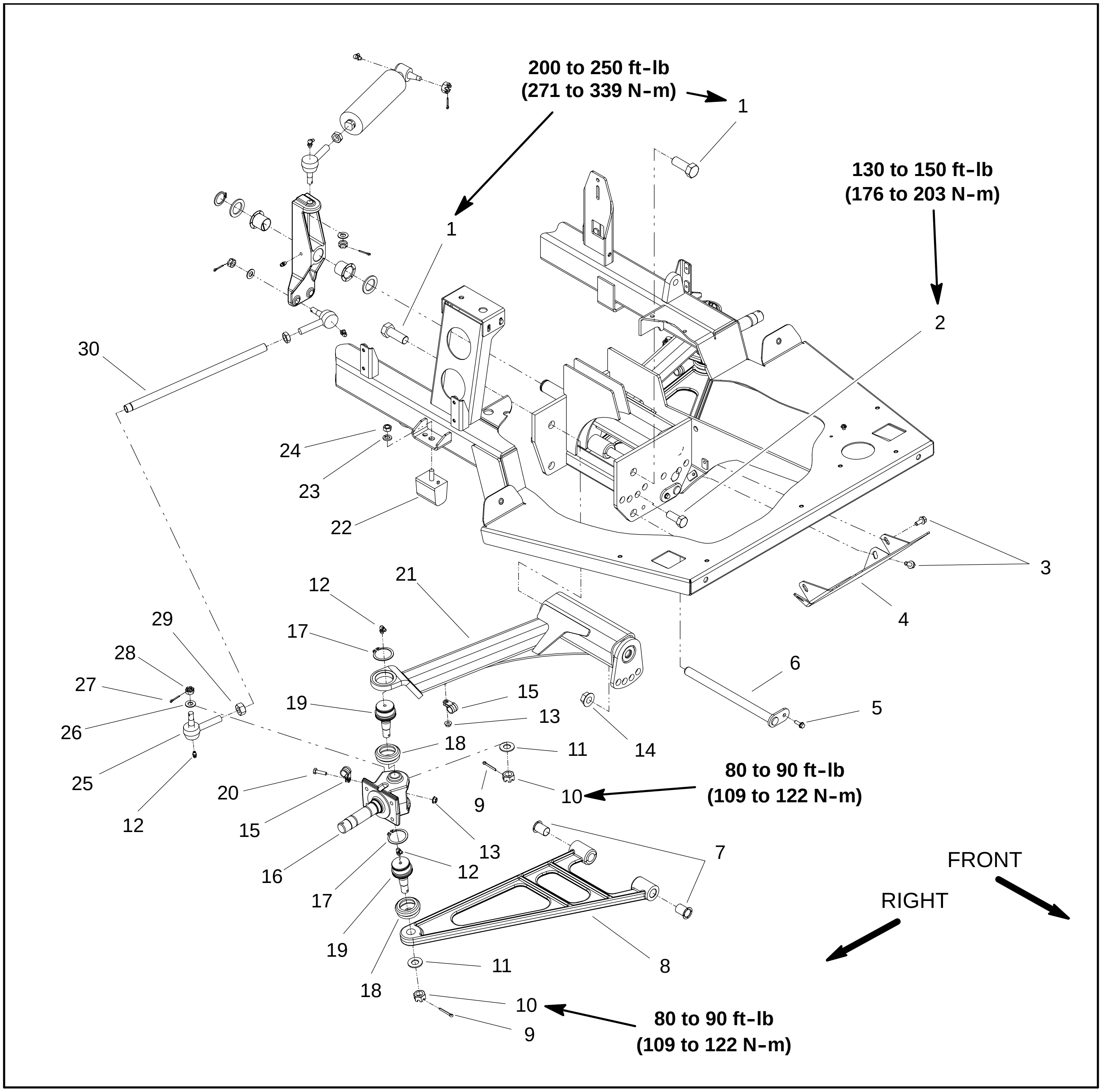

Figure 14

1. **Cap screw**
2. **Cap screw**
3. **Flange head screw (4 used)**
4. **Skid plate**
5. **Flange head screw**
6. **Pivot pin**
7. **Flange bushing**
8. **A-arm**
9. **Cotter pin**
10. **Slotted hex nut**
11. **Flat washer**
12. **Grease fitting**
13. **Flange nut**
14. **Flange nut**
15. **R-clamp**
16. **Spindle**
17. **Retaining ring**
18. **Ball joint seal**
19. **Ball joint**
20. **Cap screw**
21. **Axle assembly (RH shown)**
22. **Axle bumper**
23. **Lock washer**
24. **Hex nut**
25. **Ball joint (LH thread)**
26. **Flat washer**
27. **Cotter pin**
28. **Slotted hex nut**
29. **Jam nut (LH thread)**
30. **Tie rod**

Disassembly (Fig. 14)

1. Park machine on a level surface, stop engine, engage parking brake and remove key.

2. Lift front of machine using a jack or hoist to allow front suspension to hang freely from machine. Chock rear wheels to prevent vehicle from shifting.

3. Remove front wheel assembly (see Front Wheels and Brakes in this section).

4. Support brake and spindle assembly to prevent them from falling during disassembly. If necessary, remove front brake assembly from spindle (see Front Wheels and Brakes in this section).

5. Disassemble suspension as needed using Figure 14 as a guide.

A. During disassembly, note position of cap screw in torque arm of axle assembly for assembly purposes (Fig. 15).

Assembly (Fig. 14)

1. Assemble suspension using Figure 14 as a guide.

A. Loosely install cap screws (item 1) that secure axle assembly to machine frame.

B. Install cap screw (item 2) in noted location of axle assembly torque arm (Fig. 15). Torque cap screw from **130 to 150 ft–lb (176 to 203 N–m)**.

C. Torque cap screws (item 1) that secure axle assembly to machine frame from **200 to 250 ft–lb (271 to 339 N–m)**.

D. If ball joints were loosened or removed from spindle, tighten slotted hex nut to a minimum of **80 to 90 ft–lb (109 to 122 N–m)**. If necessary for cotter pin installation, tighten slotted hex nut further until cotter pin can be installed.

2. After assembly is complete, make sure that components do not contact hoses and/or wires.

3. Lubricate suspension grease fittings.

4. Install wheel and secure with lug nuts. Torque lug nuts evenly in a crossing pattern from **55 to 65 ft–lb (75 to 88 N–m)**.

5. Lower machine to ground.

NOTE: Right and left tie rods should be identical length.

6. Check and adjust front wheel toe–in (see Operator's Manual). Check front suspension (see Front Suspension in the Adjustments section of this chapter).

IMPORTANT: If axle assembly has been replaced, front wheel toe–in should be rechecked after machine has been used for several hours.

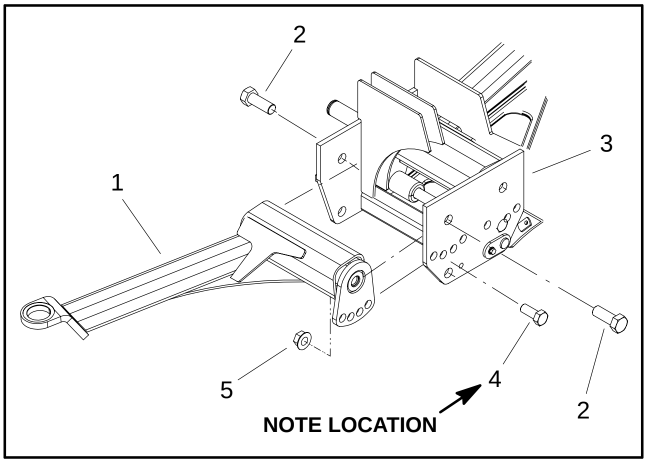

Figure 15

1. **Axle assembly (RH)**
2. **Cap screw**
3. **Frame**
4. **Cap screw**
5. **Lock nut**

Chassis

Steering Assembly

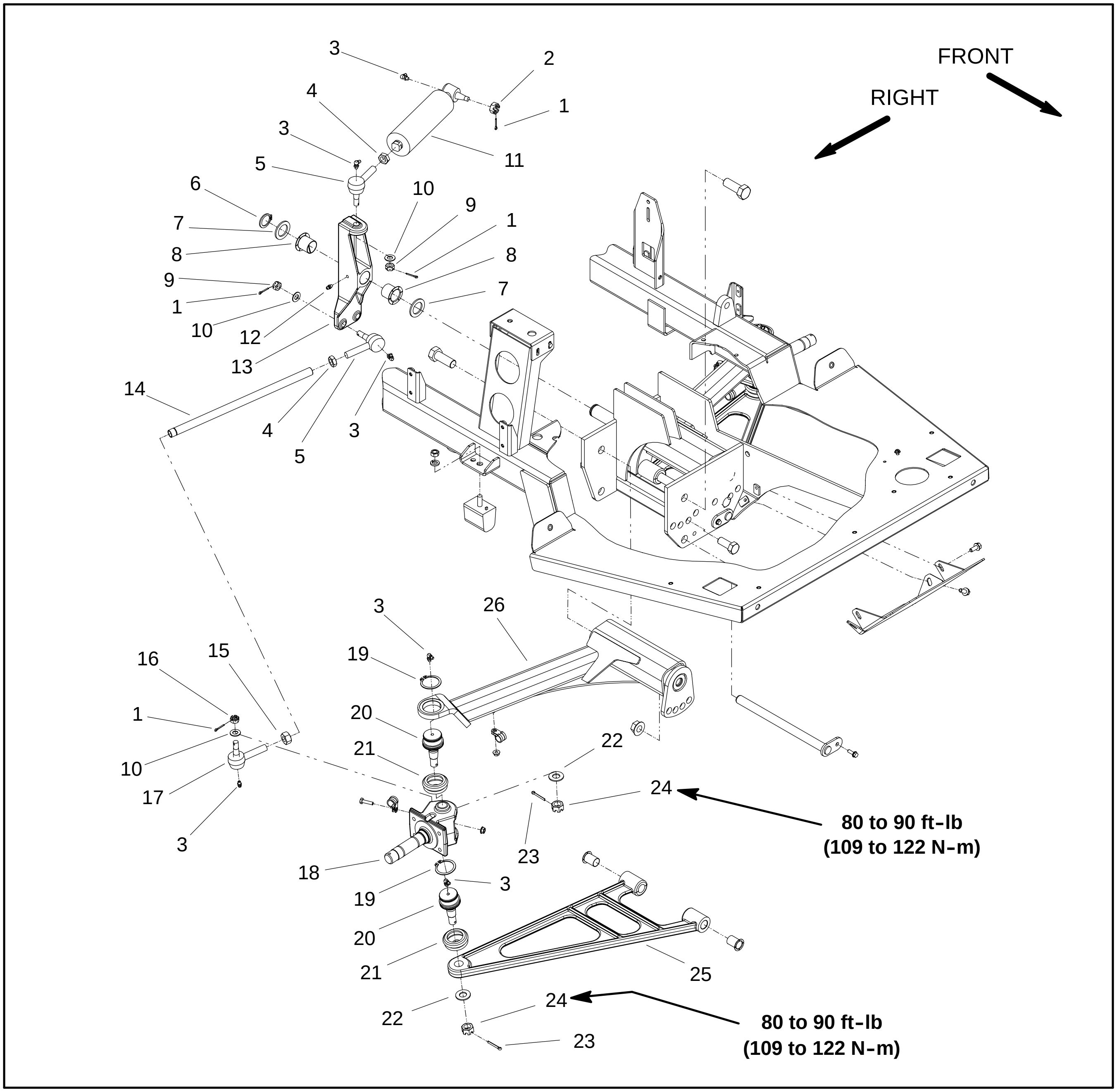

Figure 16

1. **Cotter pin**
2. **Slotted hex nut**
3. **Grease fitting**
4. **Jam nut**
5. **Tie rod end**
6. **Retaining ring**
7. **Thrust washer**
8. **Bearing**
9. **Slotted hex nut**
10. **Flat washer**
11. **Steering cylinder**
12. **Grease fitting**
13. **Steering pivot**
14. **Tie rod**
15. **Jam nut (LH thread)**
16. **Slotted hex nut**
17. **Tie rod end (LH thread)**
18. **Spindle**
19. **Retaining ring**
20. **Ball joint**
21. **Ball joint seal**
22. **Flat washer**
23. **Cotter pin**
24. **Slotted hex nut**
25. **A-arm (RH shown)**
26. **Axle (RH shown)**

Disassembly (Fig. 16)

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

2. Jack front of machine off ground (see Jacking Instructions in Chapter 1 – Safety). Front of machine should be lifted enough to allow front suspension to hang freely from machine. Support raised machine with jack stands.

3. Remove front wheel assembly (see Front Wheels and Brakes in this section).

4. Support brake and spindle assembly to prevent them from falling during disassembly. If necessary, remove front brake assembly from spindle (see Front Wheels and Brakes in this section).

5. If steering pivot requires removal, lower engine mounting plate from machine (see Engine Mounting Plate Assembly Removal in the Service and Repairs section of Chapter 3 – Kohler Gasoline Engine).

6. Disassemble steering components as needed using Figure 16 as a guide.

Assembly (Fig. 16)

1. Assemble steering components using Figure 16 as a guide.

2. If engine mounting plate was lowered from machine, raise mounting plate assembly to machine (see Engine Mounting Plate Installation in the Service and Repairs section of Chapter 3 – Kohler Gasoline Engine).

3. After assembly is complete, make sure that steering components do not contact hoses and/or wires.

4. Lubricate suspension grease fittings.

5. Install wheel and secure with lug nuts. Torque lug nuts evenly in a crossing pattern from **55 to 65 ft–lb (75 to 88 N–m)**.

6. Lower machine to ground.

NOTE: Right and left tie rods should have identical length.

7. Check and adjust front wheel toe–in (see Operator's Manual). Check front suspension (see Front Suspension in the Adjustments section of this chapter).

Tie Rod End Replacement

Removal (Fig. 17)

1. Loosen jam nut on tie rod end. Note: outside tie rod end that is attached to spindle has left hand threads.

2. Remove cotter pin and slotted hex nut from tie rod end to be removed.

3. Use a suitable puller to separate tie rod end from spindle (outside tie rod end) or steering pivot (inside tie rod end).

4. When removing tie rod end from tie rod, count the number of revolutions it takes to remove so new tie rod end can be installed without changing the front wheel toe–in.

Installation (Fig. 17)

1. Install new tie rod end to tie rod. Thread in new rod end the same number of revolutions as the old one took to remove.

2. Install grease fitting into tie rod end.

3. Insert tie rod end shaft into spindle (outside tie rod end) or steering pivot (inside tie rod end) and secure with flat washer and slotted hex nut. Install cotter pin.

4. Grease tie rod end.

NOTE: Right and left tie rods should be identical length.

5. Check and adjust front wheel toe–in (see Operator's Manual) and front suspension (see Front Suspension in the Adjustments section of this chapter).

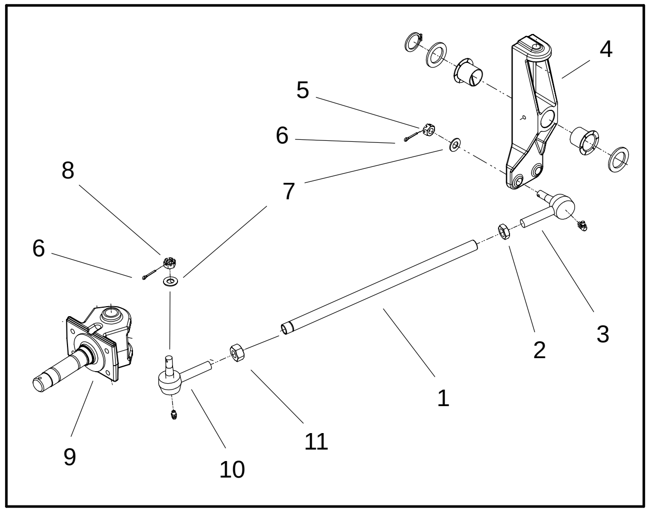

Figure 17

1. **Tie rod**
2. **Jam nut**
3. **Tie rod end**
4. **Steering pivot**
5. **Slotted hex nut**
6. **Cotter pin**
7. **Flat washer**
8. **Slotted hex nut**
9. **Spindle**
10. **Tie rod end (LH thread)**
11. **Jam nut (LH thread)**

Ball Joint Replacement

Removal (Fig. 18)

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

2. Lift front wheel off the ground using a jack (see Jacking Instructions in Chapter 1 – Safety). Block front and rear of other wheels.

3. Remove lug nuts and wheel assembly.

4. Support axle, spindle and a–arm to prevent them from falling during disassembly.

5. Remove cotter pin from ball joint to be removed, then remove slotted hex nut and flat washer.

6. Using fork or suitable press, separate upper ball joint from spindle or lower ball joint from A–arm.

7. Remove ball joint seal.

8. Remove retaining ring that secures ball joint. Press upper ball joint from axle or lower ball joint from spindle. Note: Ball joint removal may be easier if affected A–arm or spindle is removed from machine.

Installation (Fig. 18)

1. Press new upper ball joint into axle or lower ball joint into spindle. Install retaining ring to secure ball joint. Use punch and hammer to seat retaining ring if needed. Make sure that retaining ring is fully seated in groove after installation.

2. If removed, install A–arm or spindle to machine.

3. Install grease fitting into ball joint. Install ball joint seal over shaft on ball joint. Edge of seal must be inserted into ball joint slot.

4. Position upper ball joint to spindle or lower ball joint to A–arm.

5. Secure ball joint with flat washer and slotted hex nut. Torque slotted hex nut from **80 to 90 ft–lb (109 to 122 N–m)** and until cotter pin can be installed. Secure with cotter pin.

6. Grease ball joint.

7. Install wheel and secure with lug nuts. Torque lug nuts evenly in a crossing pattern from **55 to 65 ft–lb (75 to 88 N–m)**.

8. Lower machine to ground.

9. Check and adjust front wheel toe–in (see Operator's Manual) and front suspension (see Front Suspension in the Adjustments section of this chapter).

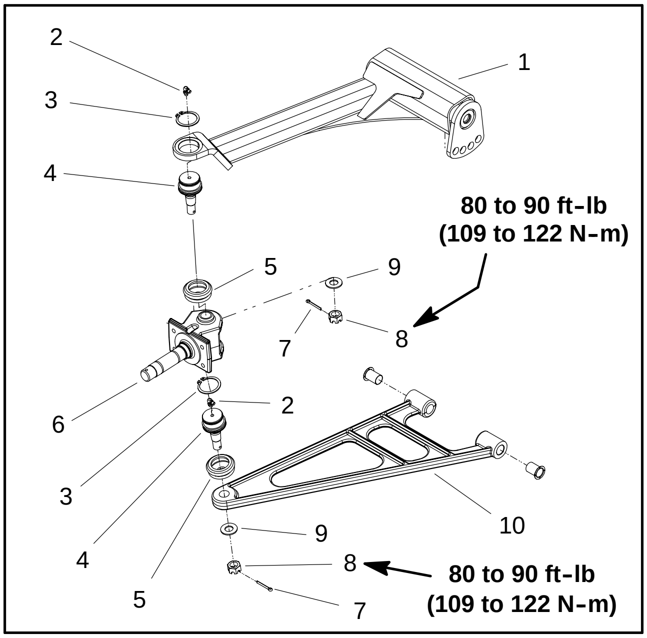

Figure 18

1. **Axle (RH shown)**
2. **Grease fitting**
3. **Retaining ring**
4. **Ball joint**
5. **Ball joint seal**
6. **Spindle**
7. **Cotter pin**
8. **Slotted hex nut**
9. **Flat washer**
10. **A–arm (RH shown)**

Chassis

Seat Base (Multi Pro 1200)

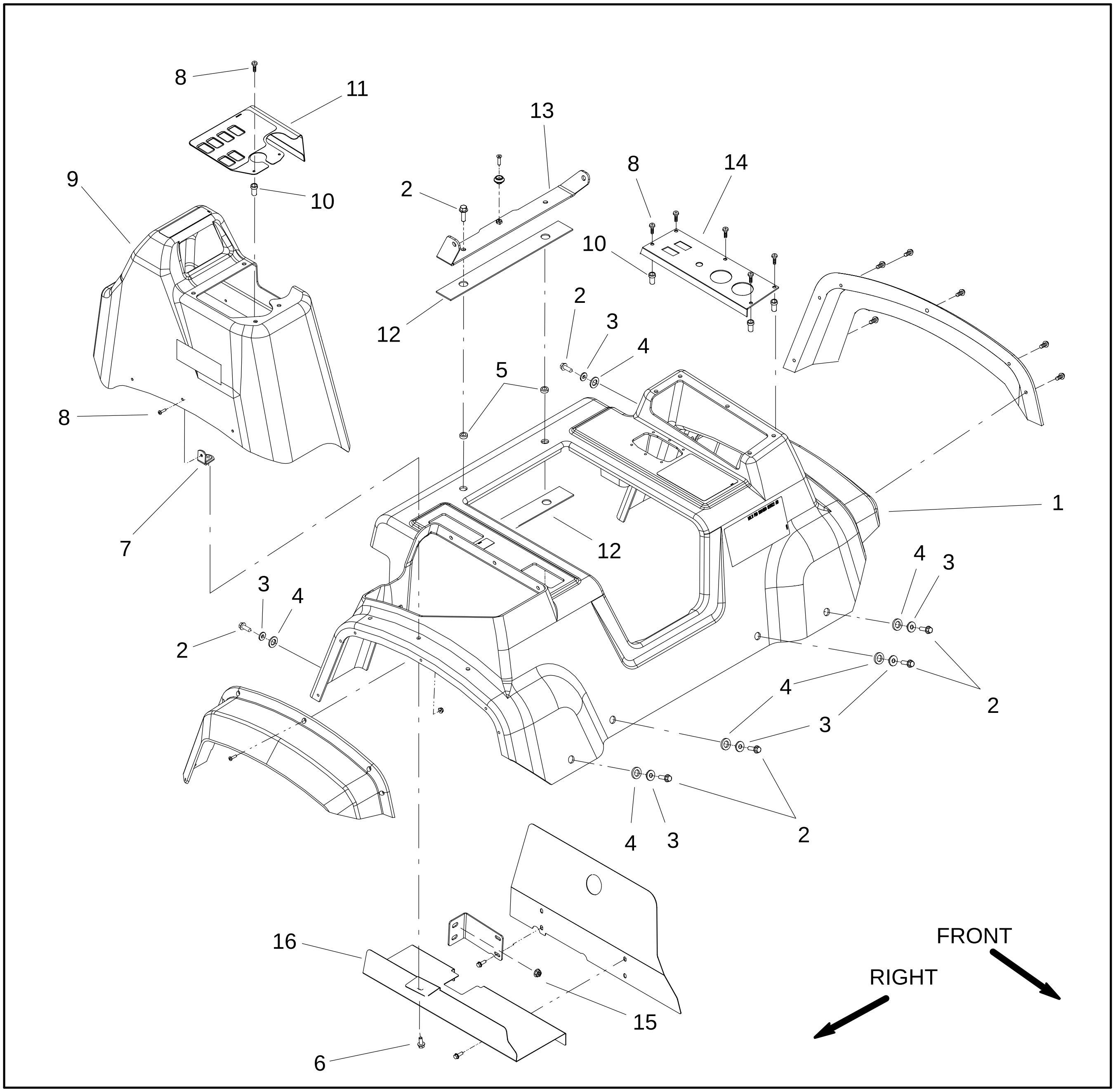

Figure 19

1. **Seat base**
2. **Flange head screw (8 used)**
3. **Spacer (6 used)**
4. **Rubber washer (6 used)**
5. **Spacer (2 used)**
6. **Flange head screw (3 used)**
7. **L bracket (3 used)**
8. **Phillips head screw**
9. **Console**
10. **Well nut**
11. **Spray control panel**
12. **Seal (2 used)**
13. **Seat belt bracket**
14. **Control panel**
15. **Flange nut (2 used)**
16. **RH inner fender**

Removal (Fig. 19)

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

2. Disconnect negative (–) cable and then positive (+) cable from battery.

3. Remove seat assembly by tilting seat forward and removing hitch pin and clevis pin (Fig. 20).

4. Remove screws that secure control panels to seat base. Carefully place control panels into seat base openings.

5. Remove knob from shift lever.

6. Remove flange head screw (item 6) that secures right hand inner panel (item 16) to L bracket (item 7).

7. Remove eight (8) flange head screws that fasten seat base to machine. During screw removal, locate and remove washers and spacers. The two (2) screws directly behind the front wheels are secured with flange nuts (item 15).

8. Carefully lift seat base from machine.

Installation (Fig. 19)

1. Position seat base on machine.

2. Carefully pull control panels through openings in seat base.

3. Install flange head screw (item 6) to secure right hand inner panel (item 16) to L bracket (item 7).

4. Secure seat base to machine using washers, spacers, flange nuts and eight (8) flange head screws. Install all fasteners before tightening.

5. Install knob on shift lever.

6. Secure control panels to seat base.

7. Secure seat assembly to machine with clevis pin and hitch pin.

8. Connect positive (+) cable and then negative (–) cable to battery.

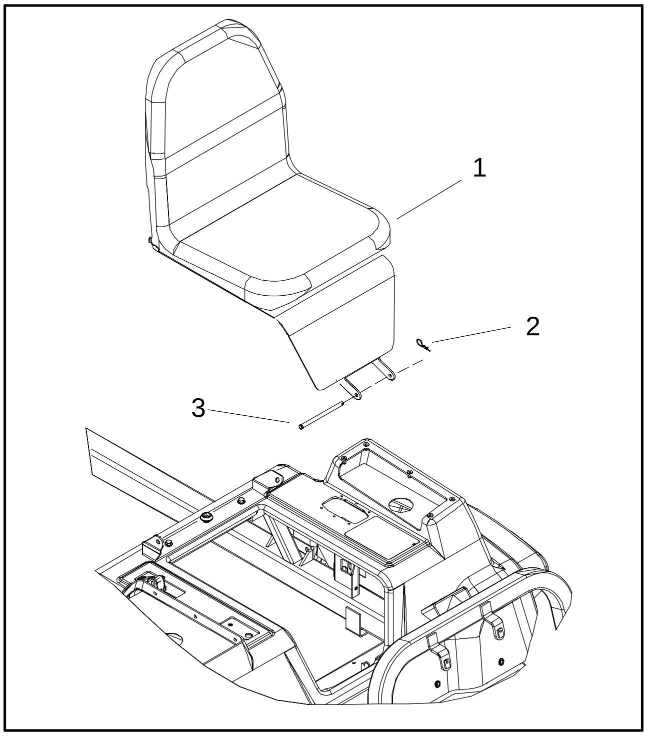

Figure 20

1. **Seat assembly**
2. **Hitch pin**
3. **Clevis pin**

Seat Base (Multi Pro 1250)

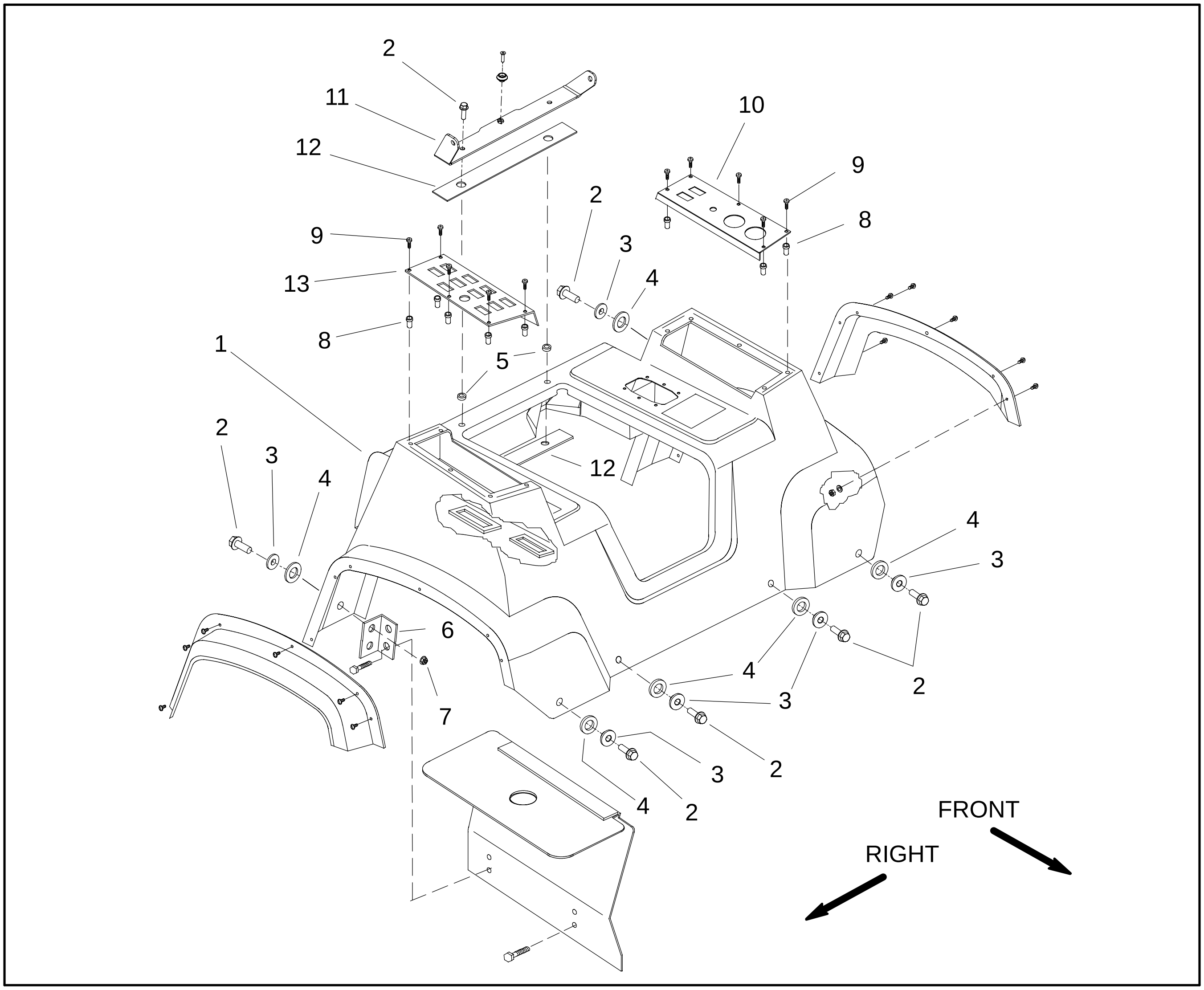

Figure 21

1. **Seat Base**
2. **Flange head screw (8 used)**
3. **Spacer (6 used)**
4. **Rubber washer (6 used)**
5. **Spacer (2 used)**
6. **Support bracket (2 used)**
7. **Flange nut (2 used)**
8. **Well nut**
9. **Phillips head screw**
10. **Control panel**
11. **Seat belt bracket**
12. **Seal (2 used)**
13. **Spray control panel**

Removal (Fig. 21)

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

2. Disconnect negative (–) cable and then positive (+) cable from battery.

3. Remove seat assembly by tilting seat forward and removing hitch pin and clevis pin (Fig. 22).

4. Remove screws that secure control panels to seat base. Carefully place control panels into seat base openings.

5. Remove knob from shift lever.

6. Remove eight (8) flange head screws that fasten seat base to machine. During screw removal, locate and remove washers and spacers. The two (2) screws directly behind the front wheels are secured with flange nuts (item 7).

7. Carefully lift seat base from machine.

Installation (Fig. 21)

1. Position seat base on machine.

2. Carefully pull control panels through openings in seat base.

3. Secure seat base to machine using washers, spacers, flange nuts and eight (8) flange head screws. Install all fasteners before tightening.

4. Install knob on shift lever.

5. Secure control panels to seat base.

6. Secure seat assembly to machine with clevis pin and hitch pin.

7. Connect positive (+) cable and then negative (–) cable to battery.

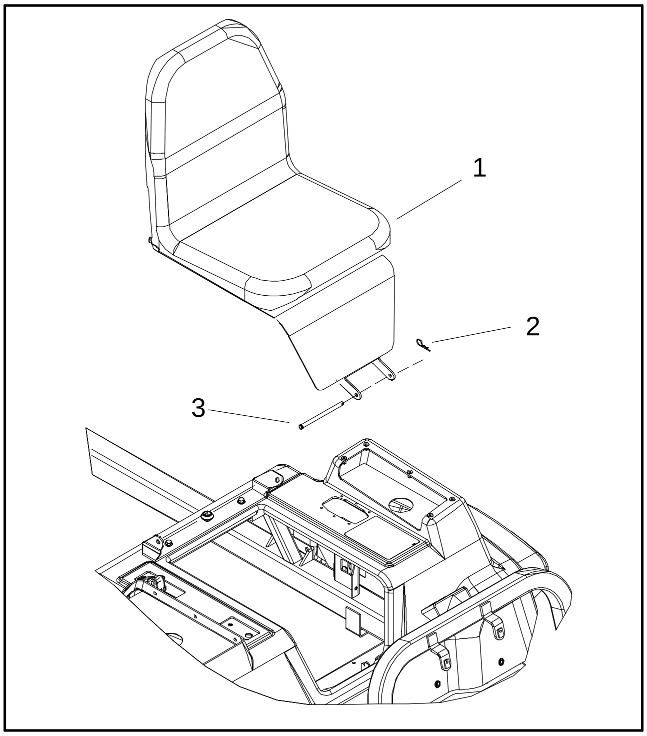

Figure 22

1. Seat assembly
2. Hitch pin
3. Clevis pin

Chassis

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TORO®

Chapter 9

Sonic Boom System (Optional Kit)

Table of Contents

General Information

Installation Instructions

The Sonic Boom Kit Installation Instructions provides information regarding the installation, operation and general maintenance for your Sonic Boom System. Refer to that publication for additional information when servicing the machine.

Precautions Concerning Chemicals Used in Spray System

Chemicals can injure persons, animals, plants, soil and other property. To eliminate environmental damage and personal injury:

1. Select the proper chemical for the job.

2. Carefully read the directions printed on the chemical manufacturer's labels before handling chemicals. Instructions on chemical manufacturer's container labels regarding mixing proportions should be read and strictly followed.

3. Keep spray material away from skin. If spray material comes in contact with a person, wash it off immediately in accordance with manufacturer's recommendations (refer to container labels and Material Safety Data Sheets).

4. Always wear protective clothing, chemical resistant gloves, eye protection and other personal protective equipment as recommended by the chemical manufacturer.

5. Properly dispose of chemical containers, unused chemicals and chemical solution.

Precautions for Removing or Adjusting Spray System Components

1. Park vehicle on a level surface and apply the parking brake.

2. Shut off the vehicle's engine and remove the key from the ignition switch.

3. Disengage all power and wait until all moving parts have stopped.

4. Remove chemicals from pump, hoses and other spray components. Thoroughly neutralize and rinse spray system before loosening or removing any spray system component(s).

5. Make sure spray system pressure is relieved before loosening any system component.

Special Tools

Diagnostic Display

The Diagnostic Display (Fig. 1) can be connected to the Sonic Boom wire harness communication connector to verify correct electrical functions of the Sonic Boom System. Electronic control unit (ECU) inputs and outputs for the Sonic Boom System can be checked using the Diagnostic Display.

Toro Part Number for Diagnostic Display: **85-4750**

Toro Part Number for Overlay (English)**: 94-8604**

IMPORTANT: The Diagnostic Display must not be left connected to the machine. It is not designed to withstand the environment of the machine's every day use. When use of Diagnostic Display is completed, disconnect it from the machine and reconnect loopback connector to wire harness communication connector. Machine will not operate without loopback connector installed on wire harness. Store Diagnostic Display in a dry, secure, indoor location and not on machine.

Figure 1

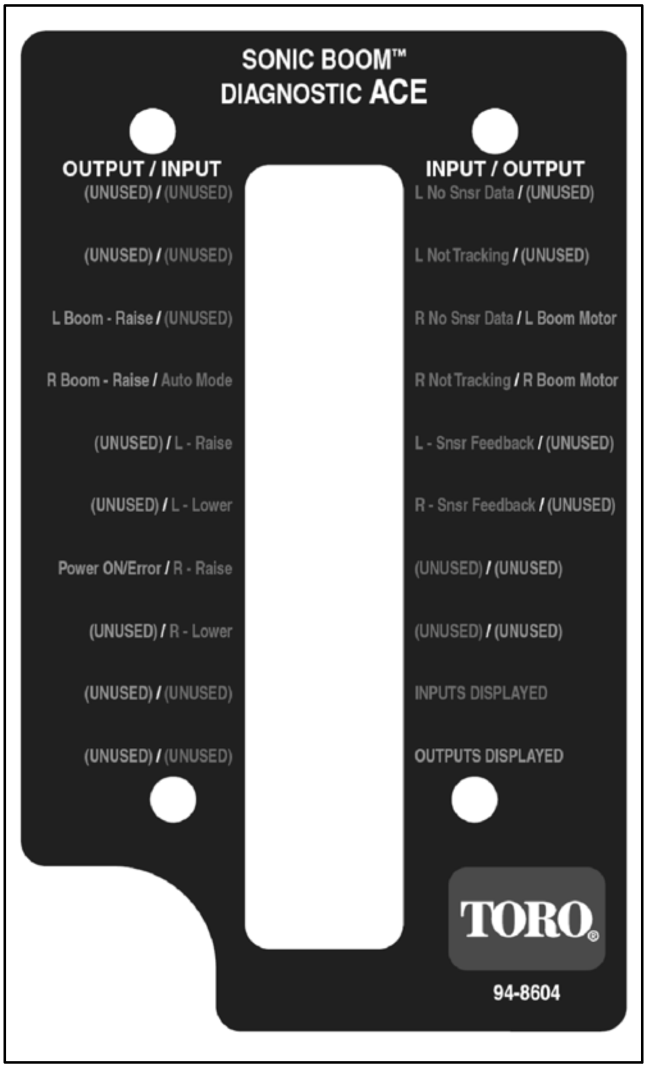
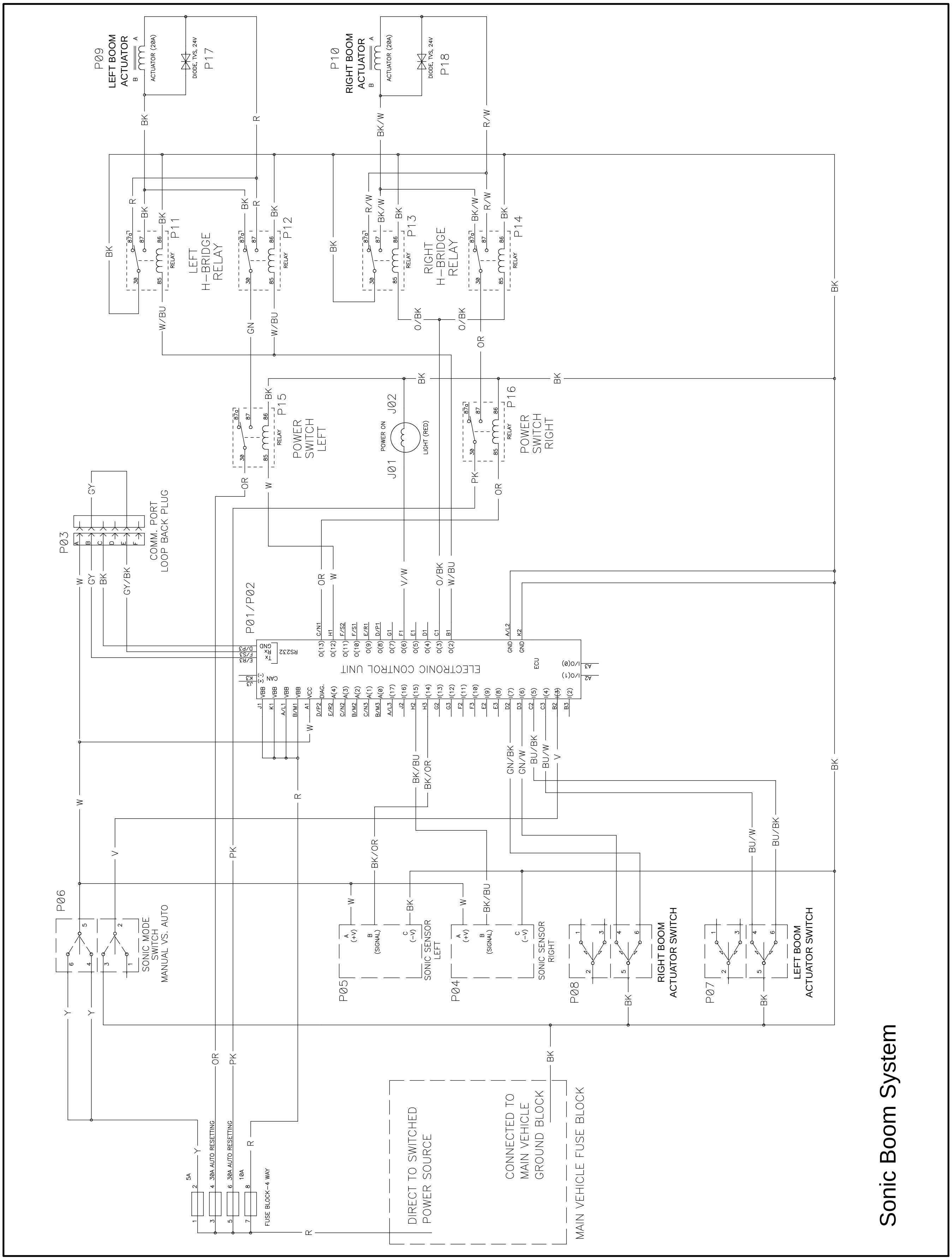


Figure 2

Electrical Schematic



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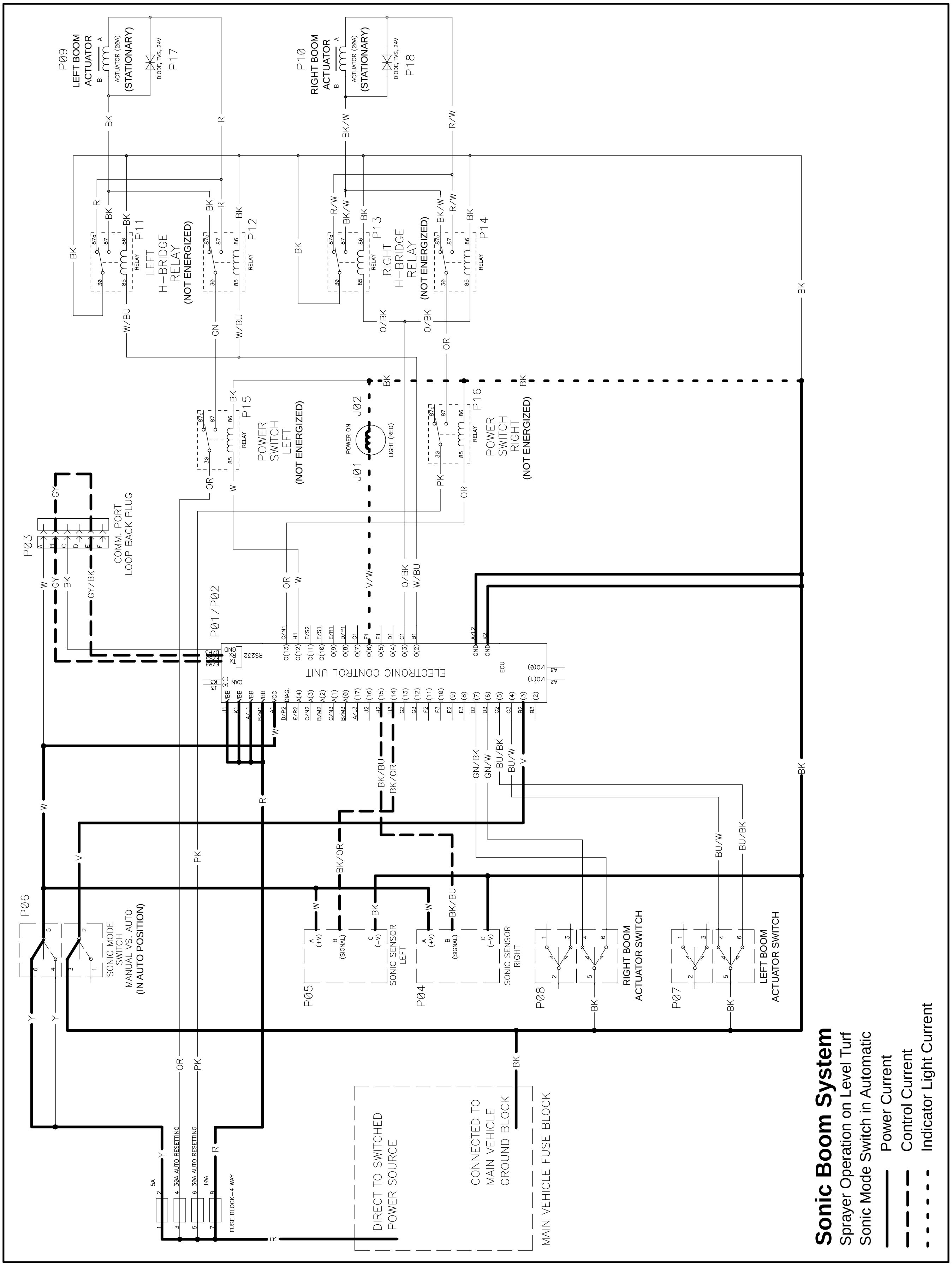
Sonic Boom System Operation



Sprayer Operation on Level Turf

During sprayer operation with the sonic boom switch in the automatic position (sonic boom light is illuminated), the boom mounted sonic boom sensors continually send impulse signals and then receive echos as the signals bounce off the turf. The electronic control unit (ECU) determines the sensor distance from the ground based on the elapsed time between the sensor signal generation and the received echo. As long as the sensor height remains the same as the calibrated height, the spray boom will remain at a fixed height from the ground for spraying accuracy.

On level turf, the boom sensors continually send signals and receive echoes that determine that the booms sections are at the calibrated height. Thus, there is no need to change boom height. The boom actuators will not be energized and the boom sections remain at the correct, level position.

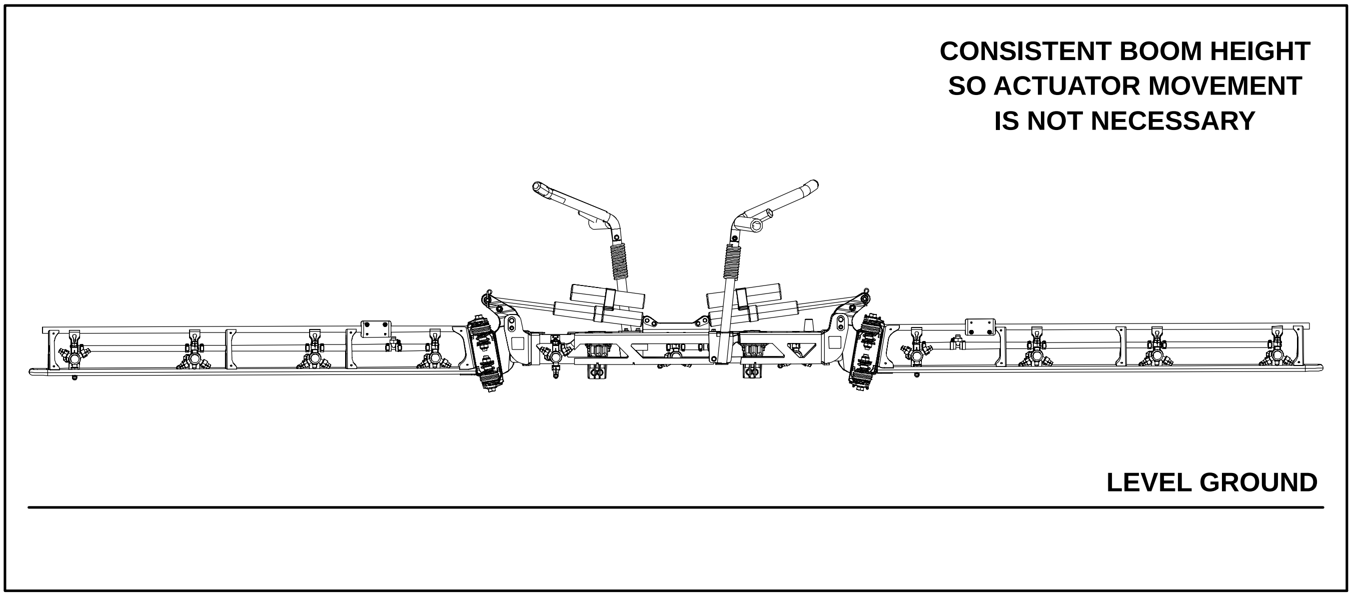
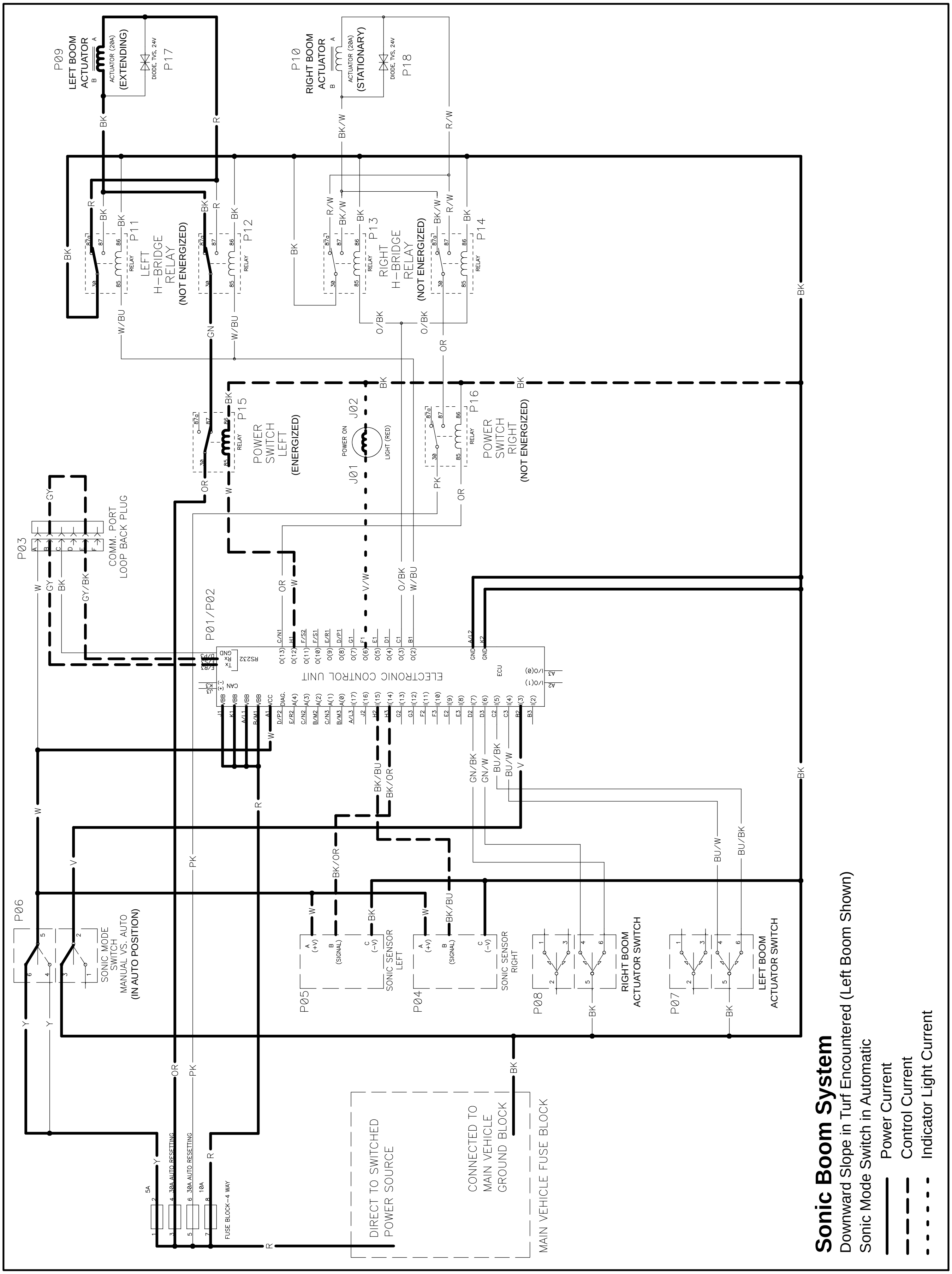


Figure 3


Sonic Boom System
Downward Slope in Turf Encountered (Left Boom Shown)
Sonic Mode Switch in Automatic
Power Current
Control Current
Indicator Light Current
P09
LEFT BOOM ACTUATOR
ACTUATOR (20A) (EXTENDING)
DIODE, TVS, 24V
P17
P10
RIGHT BOOM ACTUATOR
ACTUATOR (20A) (STATIONARY)
P18
P11
LEFT H-BRIDGE RELAY (NOT ENERGIZED)
P12
P13
RIGHT H-BRIDGE RELAY (NOT ENERGIZED)
P14
P15
POWER SWITCH LEFT (ENERGIZED)
P16
POWER SWITCH RIGHT (NOT ENERGIZED)
J01
J02
POWER ON
LIGHT (RED)
P03
COMM. PORT LOOP BACK PLUG
P01/P02
ELECTRONIC CONTROL UNIT
ECU
RS232
CAN
P06
SONIC MODE SWITCH MANUAL VS. AUTO (IN AUTO POSITION)
P05
SONIC SENSOR LEFT
P04
SONIC SENSOR RIGHT
P08
RIGHT BOOM ACTUATOR SWITCH
P07
LEFT BOOM ACTUATOR SWITCH
FUSE BLOCK-4 WAY
5A
30A AUTO RESETTING
30A AUTO RESETTING
10A
DIRECT TO SWITCHED POWER SOURCE
CONNECTED TO MAIN VEHICLE GROUND BLOCK
MAIN VEHICLE FUSE BLOCK

Downward Slope in Turf Encountered

During sprayer operation with the sonic boom switch in the automatic position (sonic boom light is illuminated), the boom mounted sonic boom sensors continually send impulse signals and then receive echos as the signals bounce off the turf. The electronic control unit (ECU) determines the sensor distance from the ground based on the elapsed time between the sensor signal generation and the received echo. As long as the sensor height remains the same as the calibrated height, the spray boom section will remain at a fixed distance from the ground for spraying accuracy.

When a spray boom section encounters a downward slope in the turf, the time necessary for the sensor to receive the signal echo is longer than the calibrated timeframe. This change in time causes the ECU to energize the appropriate power switch relay. The energized relay provides a current path to the boom actuator causing the actuator to extend and the boom section to lower. This maintains the boom height at the calibrated distance from the ground. Once the boom section is lowered to the calibrated distance, the elapsed time between the sensor signal generation and the received echo returns to the correct timeframe and the boom stops lowering.

The boom sensor target distance is initiated during initial sonic boom calibration and is typically set at twenty (20) inches. When in automatic mode, the booms will not move if the target distance change is three (3) inches or less (inner dead band). Once the target distance exceeds five (5) inches (outer dead band), the ECU will energize the appropriate power switch relay. The energized relay will lead to a change in boom actuator length and ultimately a change in boom height.

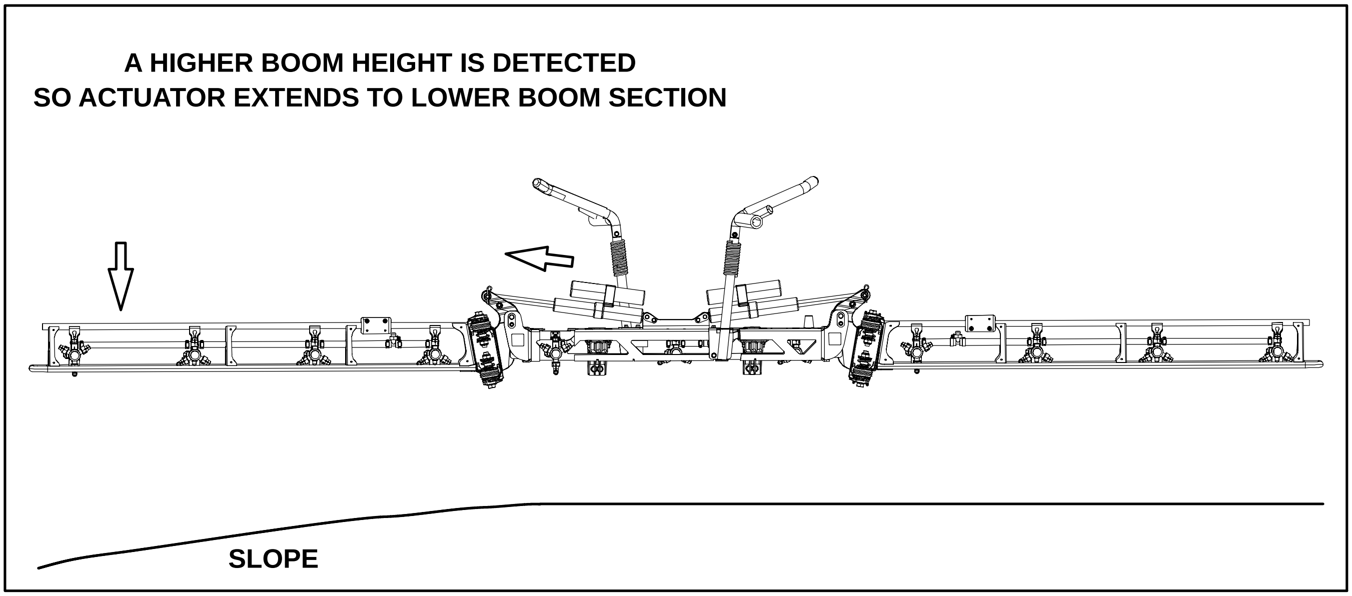
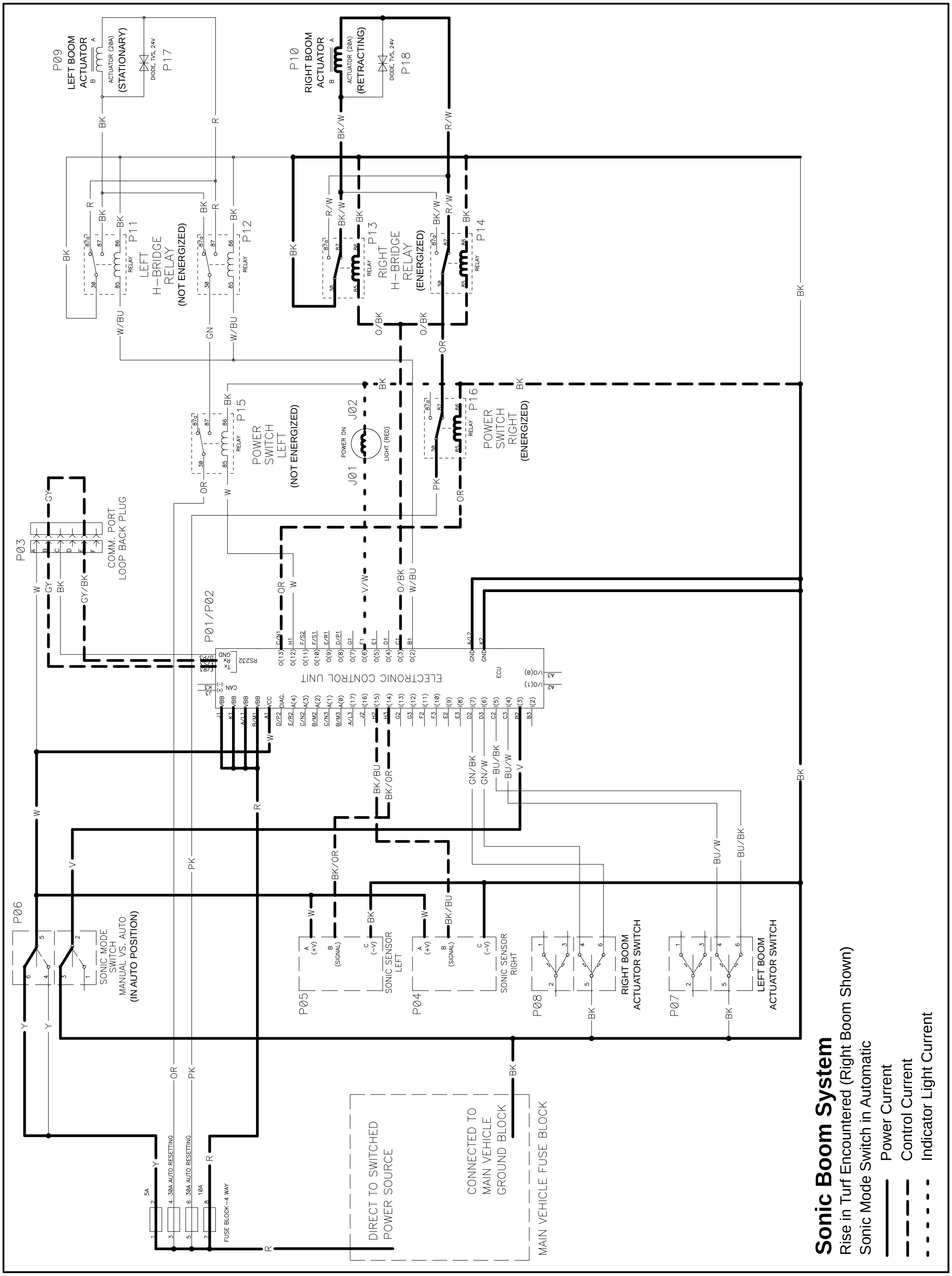


Figure 4


Sonic Boom System
Rise in Turf Encountered (Right Boom Shown)
Sonic Mode Switch in Automatic
Power Current
Control Current
Indicator Light Current
P09 LEFT BOOM ACTUATOR
ACTUATOR (20A) (STATIONARY)
DIODE, TVS, 24V P17
P10 RIGHT BOOM ACTUATOR
ACTUATOR (20A) (RETRACTING)
DIODE, TVS, 24V P18
P11 LEFT H-BRIDGE RELAY (NOT ENERGIZED) P12
P13 RIGHT H-BRIDGE RELAY (ENERGIZED) P14
P15 POWER SWITCH LEFT (NOT ENERGIZED)
P16 POWER SWITCH RIGHT (ENERGIZED)
J01 POWER ON LIGHT (RED) J02
P03 COMM. PORT LOOP BACK PLUG
P01/P02
ELECTRONIC CONTROL UNIT
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RS232
CAN
P06 SONIC MODE SWITCH MANUAL VS. AUTO (IN AUTO POSITION)
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P04 SONIC SENSOR RIGHT
P08 RIGHT BOOM ACTUATOR SWITCH
P07 LEFT BOOM ACTUATOR SWITCH
FUSE BLOCK-4 WAY
5A
30A AUTO RESETTING
30A AUTO RESETTING
10A
DIRECT TO SWITCHED POWER SOURCE
CONNECTED TO MAIN VEHICLE GROUND BLOCK
MAIN VEHICLE FUSE BLOCK

Rise in Turf Encountered

During sprayer operation with the sonic boom switch in the automatic position (sonic boom light is illuminated), the boom mounted sonic boom sensors continually send impulse signals and then receive echos as the signals bounce off the turf. The electronic control unit (ECU) determines the sensor distance from the ground based on the time between the sensor signal generation and the received echo. As long as the sensor height remains the same as the calibrated height, the spray boom section will remain at a fixed distance from the ground for spraying accuracy.

When a spray boom section encounters a rise in the turf, the time necessary for the sensor to receive the signal echo is shorter than the calibrated timeframe. This change in time causes the ECU to energize the appropriate power switch relay and H–bridge relays. These energized relays provide a current path to the boom actuator causing the actuator to retract and the boom section to raise. This maintains the boom height at the calibrated distance from the ground. Once the boom section is raised to the calibrated distance, the elapsed time between the sensor signal generation and the received echo returns to the correct timeframe and the boom stops raising.

The boom sensor target distance is initiated during initial sonic boom calibration and is typically set at twenty (20) inches. When in automatic mode, the booms will not move if the target distance change is three (3) inches or less (inner dead band). Once the target distance exceeds five (5) inches (outer dead band), the ECU will energize the appropriate power switch relay. The energized relay will lead to a change in boom actuator length and ultimately a change in boom height.

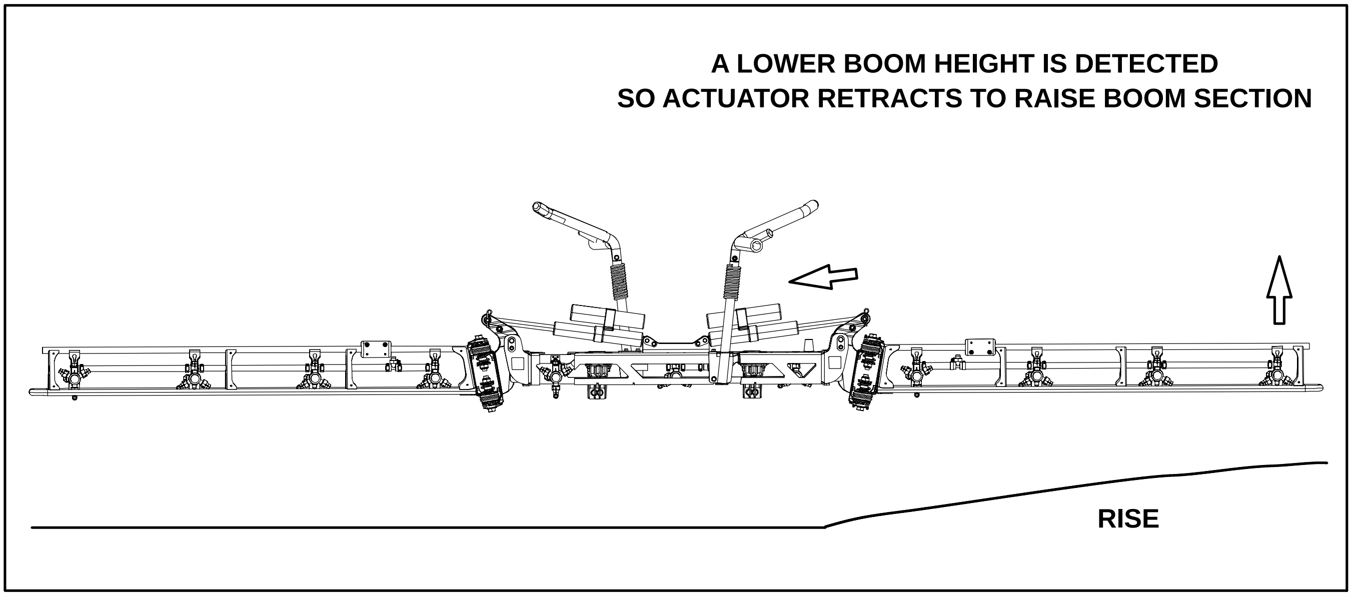
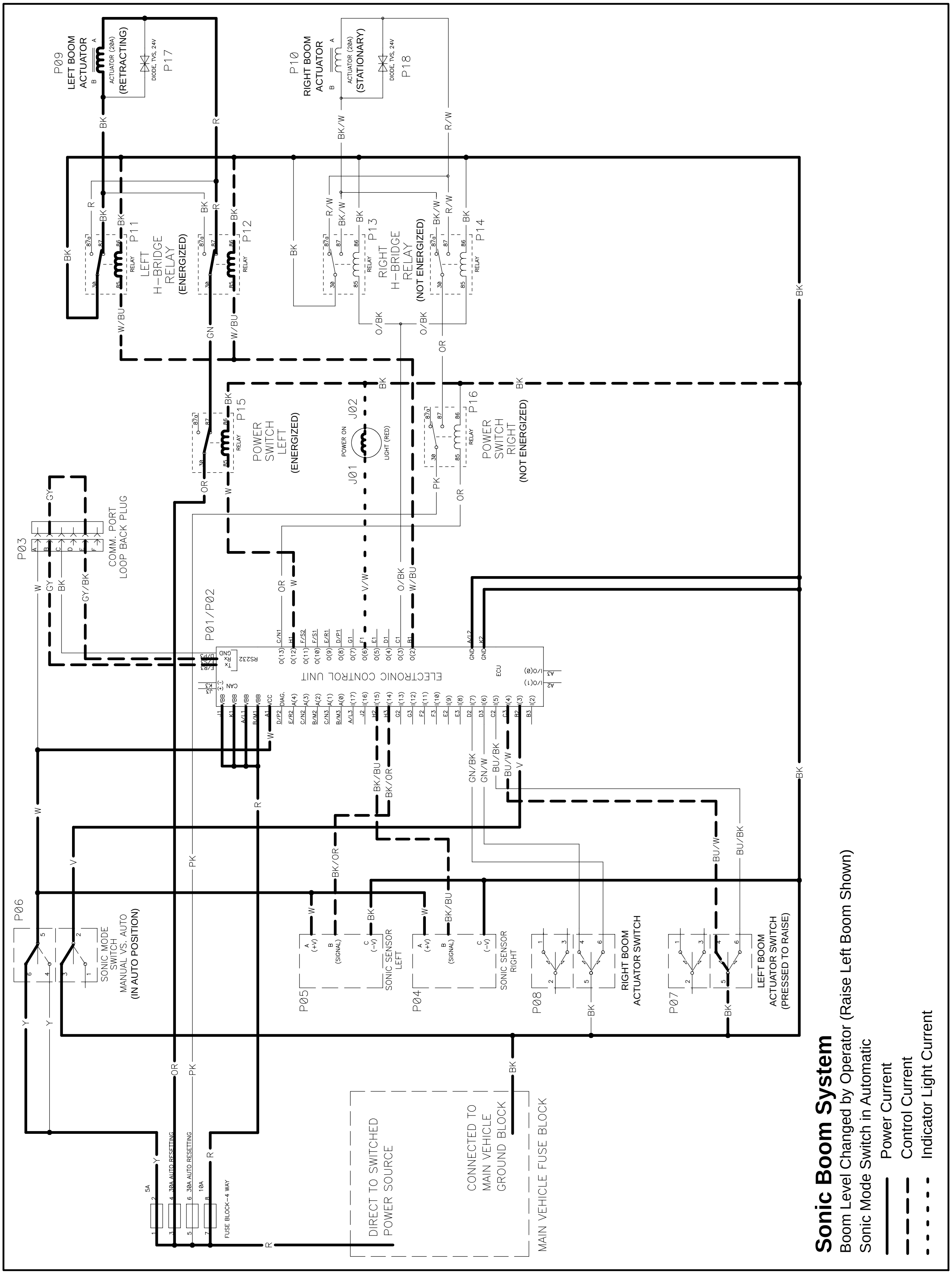


Figure 5

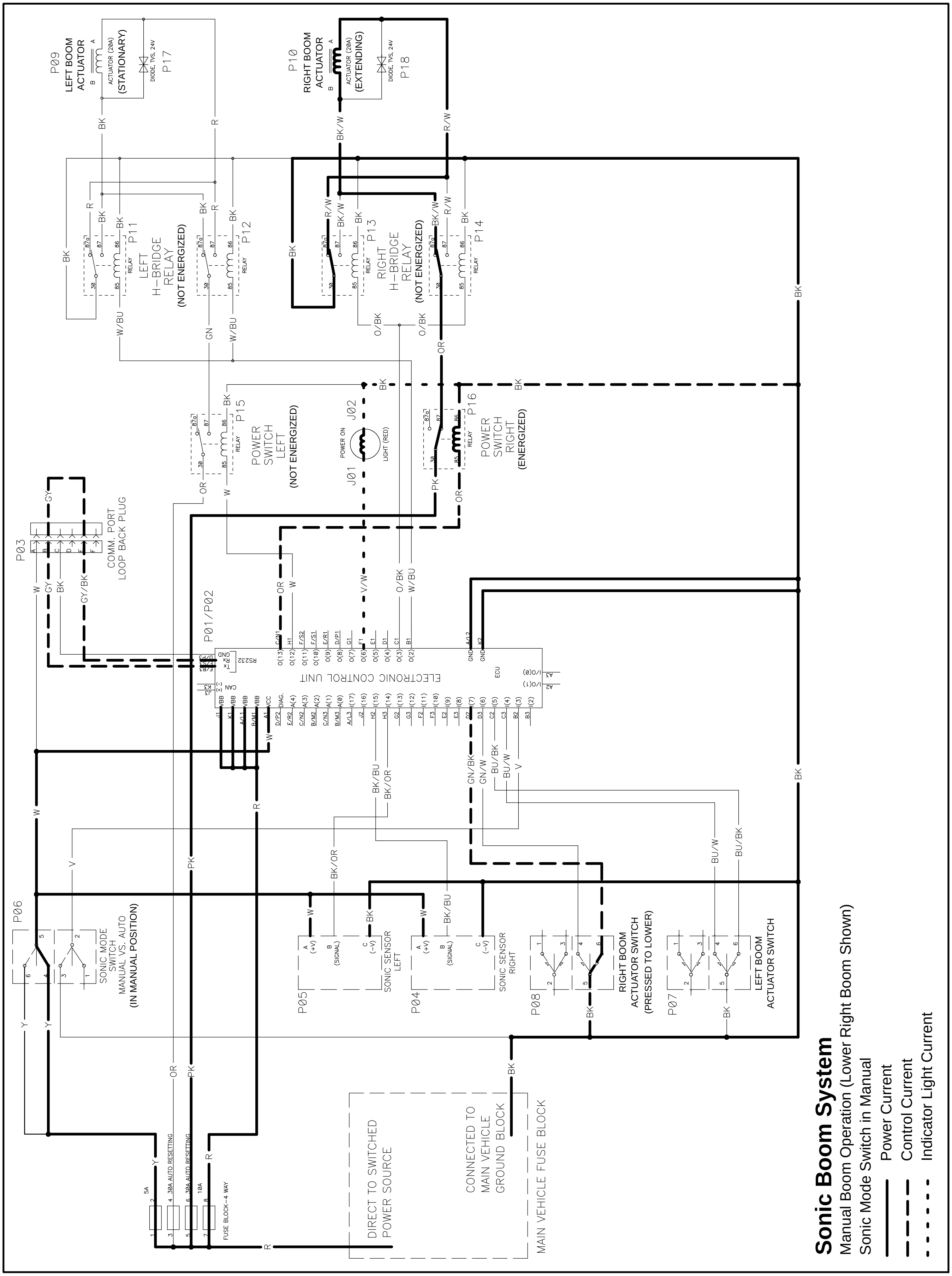

Sonic Boom System
Boom Level Changed by Operator (Raise Left Boom Shown)
Sonic Mode Switch in Automatic
Power Current
Control Current
Indicator Light Current
ELECTRONIC CONTROL UNIT
MAIN VEHICLE FUSE BLOCK
DIRECT TO SWITCHED POWER SOURCE
CONNECTED TO MAIN VEHICLE GROUND BLOCK
LEFT BOOM ACTUATOR SWITCH (PRESSED TO RAISE)
RIGHT BOOM ACTUATOR SWITCH
SONIC SENSOR LEFT
SONIC SENSOR RIGHT
SONIC MODE SWITCH MANUAL VS. AUTO (IN AUTO POSITION)
COMM. PORT LOOP BACK PLUG
POWER SWITCH LEFT (ENERGIZED)
POWER SWITCH RIGHT (NOT ENERGIZED)
LEFT H-BRIDGE RELAY (ENERGIZED)
RIGHT H-BRIDGE RELAY (NOT ENERGIZED)
LEFT BOOM ACTUATOR
RIGHT BOOM ACTUATOR

Boom Level Changed by Operator During Automatic Operation

During sprayer operation with the sonic boom switch in the automatic position (sonic boom light is illuminated), the boom mounted sonic boom sensors continually send impulse signals and then receive echos as the signals bounce off the turf. The electronic control unit (ECU) determines the sensor distance from the ground based on the time between the sensor signal generation and the received echo. As long as the sensor height remains the same as the calibrated height, the spray boom will remain at a fixed distance from the ground for spraying accuracy.

If the sprayer operator should press a boom actuator switch while in automatic operation, the ECU energizes the necessary power switch relay and H–bridge relays to raise or lower the appropriate boom. The energized relay(s) provides a current path to the requested boom actuator to raise or lower the boom. The boom actuator will stay energized as long as the operator keeps the boom actuator switch pressed. The sonic boom light will flash as long as the boom actuator switch is pressed.

If a boom is raised by the operator while the Sonic Boom System is in automatic operation, the boom will remain in the raised position until it is lowered halfway with the boom actuator switch to re–engage automatic sonic boom operation. If one boom is moved by the operator, the other boom continues to function automatically.


Sonic Boom System
Manual Boom Operation (Lower Right Boom Shown)
Sonic Mode Switch in Manual
Power Current
Control Current
Indicator Light Current
P09 LEFT BOOM ACTUATOR
ACTUATOR (20A) (STATIONARY)
DIODE, TVS, 24V
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P10 RIGHT BOOM ACTUATOR
ACTUATOR (20A) (EXTENDING)
DIODE, TVS, 24V
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P11 P12 LEFT H–BRIDGE RELAY (NOT ENERGIZED)
P13 P14 RIGHT H–BRIDGE RELAY (NOT ENERGIZED)
P15 POWER SWITCH LEFT (NOT ENERGIZED)
P16 POWER SWITCH RIGHT (ENERGIZED)
J01 J02 POWER ON LIGHT (RED)
P03 COMM. PORT LOOP BACK PLUG
P01/P02
ELECTRONIC CONTROL UNIT
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RS232
CAN
P06 SONIC MODE SWITCH MANUAL VS. AUTO (IN MANUAL POSITION)
P05 SONIC SENSOR LEFT
P04 SONIC SENSOR RIGHT
P08 RIGHT BOOM ACTUATOR SWITCH (PRESSED TO LOWER)
P07 LEFT BOOM ACTUATOR SWITCH
FUSE BLOCK–4 WAY
5A
30A AUTO RESETTING
30A AUTO RESETTING
10A
DIRECT TO SWITCHED POWER SOURCE
CONNECTED TO MAIN VEHICLE GROUND BLOCK
MAIN VEHICLE FUSE BLOCK

Manual Boom Operation

During sprayer operation with the sonic boom switch in the manual position, the spray booms will remain in position unless the operator presses a boom actuator switch. When the sonic boom switch is in the manual position, the sonic boom light should be illuminated. The operator will control the boom position with the boom actuator switches.

Raise Boom

When a boom actuator switch is pressed to raise a boom section, the electronic control unit (ECU) energizes the power switch relay and both H–bridge relays for the requested boom section. The energized relays provide a current path to the boom actuator causing the actuator to retract which will raise the boom section. The boom will continue to rise until the operator releases the boom actuator switch.

Lower Boom

When a boom actuator switch is pressed to lower a boom section, the electronic control unit (ECU) energizes the power switch relay for the requested boom section. The energized relay provides a current path to the boom actuator causing the actuator to extend which will lower the boom section. The boom will continue to lower until the operator releases the boom actuator switch.

Troubleshooting

For effective troubleshooting and repairs, there must be a good understanding of the electrical circuits and components used on the Sonic Boom System (see Sonic Boom System Operation in this chapter).

NOTE: When troubleshooting an electrical problem on your Sonic Boom System, refer to information regarding the sonic boom light in this section. Also, use the Diagnostic Display (see Special Tools in this chapter) to test electronic control unit (ECU) inputs and outputs.

Sonic Boom Light

The Sonic Boom System is designed to automatically adjust the sprayer boom height if changes in the turf surface are detected. The sonic boom light should be illuminated whenever the vehicle ignition switch is ON and the sonic boom switch is in either the automatic or manual position.

The sonic boom light flashing quickly indicates that the Sonic Boom System is in the calibration mode. This mode allows the spray booms to be adjusted for the desired boom height. The calibration mode lasts for twenty (20) seconds after which the boom light should quit flashing.

NOTE: A sequence of switch movements is necessary to engage the calibration mode. Refer to the Sonic Boom Kit Installation Instructions for this sequence.

The sonic boom light flashing slowly indicates that a system error has been encountered. If the boom light is flashing slowly, lower the affected boom(s) with the boom actuator switch(es) to clear the error. If the error continues, there may be an issue with the Sonic Boom System electronic control unit (ECU). If this occurs, see Diagnostic Display and Troubleshooting Chart in this section.

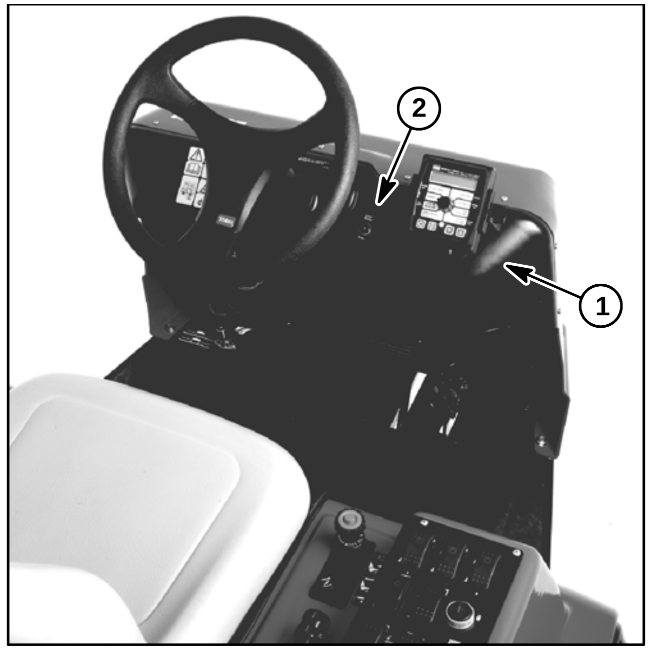

Figure 6

1. **Dash panel**
2. **Boom light location**

Sonic Boom Calibration

The Sonic Boom sensor calibration process is critical to the correct operation of the Sonic Boom system. The calibration process establishes the sensor target distance between the boom and the turf surface. Typically, this distance is approximately twenty (20) inches. Steps needed for proper calibration are identified in the Sonic Boom Kit Installation Instructions.

While calibrating the Sonic Boom sensors, it is best to perform the calibration process on turf. A shiny surface (e.g. cement shop floor) can skew sensor signals. Also, ensure the calibration area is free of buildings, trees, underground plumbing and other machines that could interfere with sensor signals.

Diagnostic Display

The Sonic Boom System is equipped with an electronic control unit (ECU) which controls machine sonic boom electrical functions. The ECU monitors various input switches (e.g. boom actuator switches, sonic boom sensors) and energizes outputs to actuate relays for appropriate machine functions.

For the ECU to control the machine as desired, each of the inputs (switches and sensors) and outputs (relays) must be connected and functioning properly.

The Diagnostic Display (see Special Tools in this chapter) is a tool to help the technician verify correct electrical functions of the machine.

IMPORTANT: The Diagnostic Display must not be left connected to the machine. It is not designed to withstand the environment of the machine's every day use. When use of the Diagnostic Display is completed, disconnect it from the machine and reconnect loopback connector to harness connector. The machine will not operate without the loopback connector installed on the harness. Store the Diagnostic Display in a dry, secure, indoor location and not on machine.

Verify Diagnostic Display Input Functions

1. Park vehicle on a level surface, stop the engine and apply the parking brake.

2. Locate Sonic Boom wire harness communication port and loopback connector under the vehicle dash panel. Carefully unplug loopback connector from harness connector.

3. Connect the Diagnostic Display connector to the wire harness connector. Make sure correct overlay decal is positioned on the Diagnostic Display (Fig. 7).

4. Turn the vehicle ignition switch to the ON position, but do not start vehicle.

NOTE: The **red** text on the Diagnostic Display overlay decal refers to input switches and the **green** text refers to ECU outputs.

5. Make sure that the "INPUTS DISPLAYED" LED, on lower right column of the Diagnostic Display, is illuminated. If "OUTPUTS DISPLAYED" LED is illuminated, press the toggle button on the Diagnostic Display to change to "INPUTS DISPLAYED" LED.

CAUTION

When testing ECU inputs with the Diagnostic Display, boom actuators may be energized causing the spray booms to move. Be cautious of potential sprayer component movement while verifying inputs with the Diagnostic Display.

6. The Diagnostic Display will illuminate the LED associated with each of the inputs when that input switch is closed. Individually, change each of the switches from open to closed (e.g. toggle sonic mode switch), and note that the appropriate LED on the Diagnostic Display will illuminate when the corresponding switch is closed. Repeat on each switch that is possible to be changed by hand (see Inputs and LED Operation chart on following page).

7. If appropriate LED does not toggle on and off when switch state is changed, check all wiring and connections to that switch and/or test switch. Replace any defective switches and repair any damaged wiring.

8. After input functions testing is complete, disconnect the Diagnostic Display connector from the harness connector and plug loopback connector into wire harness.

Figure 7

Diagnostic Display Inputs	**Diagnostic Display LED Operation**
AUTO MODE	Sonic mode switch in auto position: LED ON Sonic mode switch not in auto position: LED OFF
L RAISE	Left boom actuator switch in raise position: LED ON Left boom actuator switch not in raise position: LED OFF
L LOWER	Left boom actuator switch in lower position: LED ON Left boom actuator switch not in lower position: LED OFF
R RAISE	Right boom actuator switch in raise position: LED ON Right boom actuator switch not in raise position: LED OFF
R LOWER	Right boom actuator switch in lower position: LED ON Right boom actuator switch not in lower position: LED OFF
L NO SNSR DATA	ECU has detected an invalid reading from left sensor: LED ON Left sensor operating normally: LED OFF
L NOT TRACKING	Left boom not tracking to target within 5 seconds: LED ON Left sensor operating normally: LED OFF
R NO SNSR DATA	ECU has detected an invalid reading from right sensor: LED ON Right sensor operating normally: LED OFF
R NOT TRACKING	Right boom not tracking to target within 5 seconds: LED ON Right sensor operating normally: LED OFF
L – SNSR FEEDBACK	ECU receiving signal from left sensor: LED ON ECU not receiving signal from left sensor: LED OFF
R – SNSR FEEDBACK	ECU receiving signal from right sensor: LED ON ECU not receiving signal from right sensor: LED OFF

NOTE: When the vehicle ignition switch is in the OFF position, all Diagnostic Display LED's should be OFF.

NOTE: Initial calibration of the Sonic Boom sensors is required for proper operation of ECU inputs. Refer to your Sonic Boom Kit Installation Instructions for information on initial sensor calibration.

NOTE: Right and left side Sonic Boom sensors are identical so they can be exchanged to assist in troubleshooting. If a problem follows the exchanged sensor, an electrical problem likely exists with the sensor. If the problem remains unchanged, something other than the sensor is the problem source (e.g. switch, circuit wiring).

Verify Diagnostic Display Output Functions

The Diagnostic Display also has the ability to detect which output solenoids or relays are energized by the electronic control unit (ECU). This is a quick way to determine which electrical component is malfunctioning.

NOTE: An open output (e.g. an unplugged connector or a broken wire) cannot be detected with the Diagnostic Display.

1. Park vehicle on a level surface, stop the engine and engage the parking brake.

2. Locate Sonic Boom System wire harness and loopback connector under the vehicle dash panel. Carefully unplug loopback connector from harness connector.

3. Connect the Diagnostic Display connector to the harness connector. Make sure correct overlay decal is positioned on the Diagnostic Display (see Special Tools in this chapter).

4. Turn the ignition switch to the ON position.

NOTE: The **red** text on the Diagnostic Display overlay decal refers to input switches and the **green** text refers to ECU outputs.

5. Make sure that the “OUTPUTS DISPLAYED” LED, on lower right column of the Diagnostic Display, is illuminated. If “INPUTS DISPLAYED” LED is illuminated, press the toggle button on the Diagnostic Display to change the LED to “OUTPUTS DISPLAYED”.

NOTE: It may be necessary to toggle between “INPUTS DISPLAYED” and “OUTPUTS DISPLAYED” several times to perform the following step. To change from inputs to outputs, press toggle button once. This may be done as often as required. **Do not press and hold toggle button**.

6. Attempt to operate the desired function of the machine. The appropriate output LED’s should illuminate on the Diagnostic Display to indicate that the ECU is turning on that function. The outputs can be checked with the vehicle ignition switch in the ON position and the engine not running.

A. If the correct output LED’s do not illuminate, verify that the required input switches are in the necessary positions to allow that function to occur.

B. If the output LED’s are on as specified, but the booms do not function properly, suspect a failed electrical component, an open in the tested circuit or a non-electrical problem (e.g. binding of the boom hinge). Repair as necessary.

C. If each input switch is in the correct position and functioning correctly, but the output LED’s are not correctly illuminated, this indicates an ECU problem. If this occurs, contact your Toro Distributor for assistance.

7. After output functions testing is complete, disconnect the Diagnostic Display connector from the harness connector and plug loopback connector into wire harness.

Diagnostic Display Outputs	Diagnostic Display LED Operation
L BOOM – RAISE	Left boom is rising: LED ON Left boom is stationary: LED OFF
R BOOM – RAISE	Right boom is rising: LED ON Right boom is stationary: LED OFF
POWER ON/ERROR	Power to ECU: LED ON No power to ECU: LED OFF System error: LED flashing slowly
L BOOM MOTOR	ECU output exists to energize left power switch relay: LED ON No ECU output to left power switch relay: LED OFF
R BOOM MOTOR	ECU output exists to energize right power switch relay: LED ON No ECU output to right power switch relay: LED OFF

Troubleshooting Chart

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

NOTE: When troubleshooting an electrical problem on your Sonic Boom System, refer to information regarding the sonic boom light in this section. Also, use the Diagnostic Display (see Special Tools in this chapter) to test electronic control unit (ECU) inputs and outputs.

Problem	Possible Cause
Sonic boom light is not illuminated.	Sonic mode switch is in the OFF position. 5 amp or 10 amp fuse in sonic boom fuse block is faulty. Electrical power from vehicle is not available (all sonic boom functions are affected). Sonic boom light or circuit wiring is faulty. Sonic mode switch or circuit wiring is faulty.
LED on one of the sonic boom sensors is not illuminated.	Sonic boom sensor or circuit wiring is faulty.
LED on both of the sonic boom sensors is not illuminated.	Sonic mode switch is in the OFF position. 5 amp fuse in sonic boom fuse block is faulty. Sonic mode switch or circuit wiring is faulty.
One of the boom actuators will not retract.	30 amp auto resetting fuse for affected boom actuator is faulty. Power switch relay or circuit wiring for affected boom actuator is faulty. One or both of the H–bridge relays or circuit wiring for the affected boom actuator is faulty. Boom actuator switch or circuit wiring for affected boom actuator is faulty. Affected boom actuator or circuit wiring is faulty.
Neither of the boom actuators will retract.	Loop back connector is unplugged from wire harness connector. 5 amp or 10 amp fuse in sonic boom fuse block is faulty. Electrical power from vehicle is not available (all sonic boom functions are affected). Both of the boom actuator 30 amp auto resetting fuses are faulty. ECU or circuit wiring is faulty.

Problem	Possible Cause
One of the boom actuators will not extend.	30 amp auto resetting fuse for affected boom actuator is faulty. Power switch relay or circuit wiring for affected boom actuator is faulty. Boom actuator switch or circuit wiring for affected boom actuator is faulty. Affected boom actuator or circuit wiring is faulty.
Neither of the boom actuators will extend.	Loop back connector is unplugged from wire harness connector. 5 amp or 10 amp fuse in sonic boom fuse block is faulty. Electrical power from vehicle is not available (all sonic boom functions are affected). 30 amp auto resetting fuse is faulty in both boom actuators. ECU or circuit wiring is faulty.
One of the booms does not automatically follow ground irregularities. Boom can be controlled with boom actuator switch.	On affected boom, the sonic boom sensor cover is on sensor or is hanging in sensor path. On affected boom, the sensor filter is dirty or damaged. Calibration of the Sonic Boom sensors is incorrect. On affected boom, the sonic sensor angle needs adjustment. Sonic sensor or circuit wiring for affected boom is faulty. ECU or circuit wiring is faulty.
Neither boom automatically follows ground irregularities. Booms can be controlled with boom actuator switches.	Sonic mode switch is not in the AUTO position. Sonic boom sensor covers are on both sensors or are hanging in sensor path. The filters on both sensors are dirty or damaged. Calibration of the Sonic Boom sensors is incorrect. The sonic sensor angle on both booms need adjustment. Both sonic sensors or circuit wiring are faulty. ECU or circuit wiring is faulty.

Service and Repairs

Sonic Mode Switch

The sonic mode switch is used as an input for the ECU to activate the Sonic Boom System. This switch has three (3) positions: automatic, manual and off. The sonic mode switch is located on the console.

If the sonic mode switch is in the automatic position, the sonic sensors will be activated to allow automatic movement of the boom. The tips of the booms will remain at a constant distance from the ground. The boom switches can be used to raise/lower the booms when the sonic mode switch is in the automatic position.

If the sonic mode switch is in the manual position, the sonic sensors are disabled. The boom switches are used to raise/lower the booms when the sonic mode switch is in the manual position.

If the sonic mode switch is in the OFF position, the booms will remain in position. The boom actuators will not be energized regardless of sonic boom sensor activity or change in boom switch position.

Testing

1. Before disconnecting the sonic mode switch for testing, the switch and its circuit wiring should be tested as a ECU input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the sonic mode switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, the Display determines that the sonic mode switch and circuit wiring **are not** functioning correctly, proceed with test.

2. Park vehicle on a level surface, stop engine, engage parking brake and remove key from ignition switch.

3. Disassemble console to gain access to sonic mode switch.

4. Disconnect harness electrical connector from the sonic mode switch.

5. The switch terminals are marked as shown in Figure 9. The circuit logic of the sonic mode switch is shown in the chart to the right. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each switch position. Verify continuity between switch terminals. Replace switch if testing identifies a faulty switch.

6. If the sonic mode switch tests correctly and circuit problem still exists, check wire harness (see Electrical Schematic and Wire Harness Drawings in this chapter).

7. After testing is completed, connect wire harness connector to the sonic mode switch.

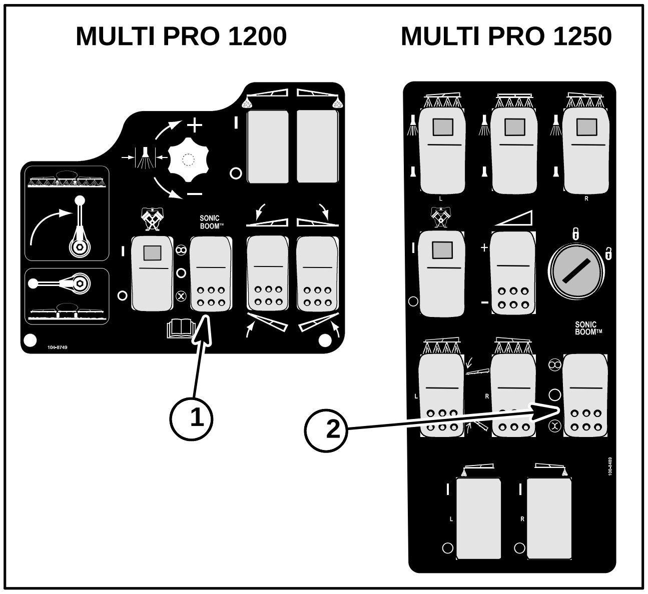

Figure 8

1. **Mode switch (MP 1200)**
2. **Mode switch (MP 1250)**

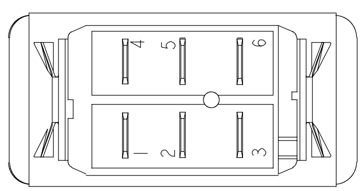

Figure 9

SWITCH POSITION	CLOSED CIRCUITS	OPEN CIRCUITS
AUTOMATIC	2 + 3 5 + 6	2 + 1 5 + 4
OFF	NONE	ALL
MANUAL	2 + 1 5 + 4	2 + 3 5 + 6

Relays

The Sonic Boom System uses six (6) identical relays to control the boom actuators and ultimately the boom height. Three (3) of the relays control the right actuator and the other three (3) relays control the left actuator. The electronic control unit (ECU) controls the operation of the relays. The relays are located on a mounting plate under the vehicle dash panel (Fig. 10) and can be identified by a label on the wire harness connector.

For each actuator, a power switch relay and two (2) H–bridge relays are used. The power switch relay is energized by the ECU whenever the actuator is to be energized to change boom height (either lowered or raised). Both H–bridge relays are energized by the ECU when a boom is to be raised. The energized bridge relays provide current flow to the actuator so the actuator retracts. The H–bridge relays are not energized when a boom is to be lowered. The non–energized bridge relays provide current flow to the actuator so the actuator extends.

Testing

1. Park vehicle on a level surface, stop engine, engage parking brake and remove key from ignition switch.

2. Locate relay to be tested and disconnect wire harness connector from relay. Remove relay from mount plate for testing.

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

3. Using a multimeter, verify that coil resistance between terminals 85 and 86 is from 71 to 88 ohms.

4. Connect multimeter (ohms setting) leads to relay terminals 30 and 87. Ground terminal 86 and apply +12 VDC to terminal 85. The relay terminals 30 and 87 should have continuity as +12 VDC is applied to terminal 85. The relay terminals 30 and 87 should not have continuity as +12 VDC is removed from terminal 85.

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

6. Connect multimeter (ohms setting) leads to relay terminals 30 and 87A. With terminal 86 grounded, apply +12 VDC to terminal 85. The relay terminals 30 and 87A should not have continuity as +12 VDC is applied to terminal 85. The relay terminals 30 and 87A should have continuity as +12 VDC is removed from terminal 85.

7. Disconnect voltage and multimeter test leads from the relay terminals. Replace relay if necessary.

8. Secure relay to mount plate and connect wire harness connector to relay.

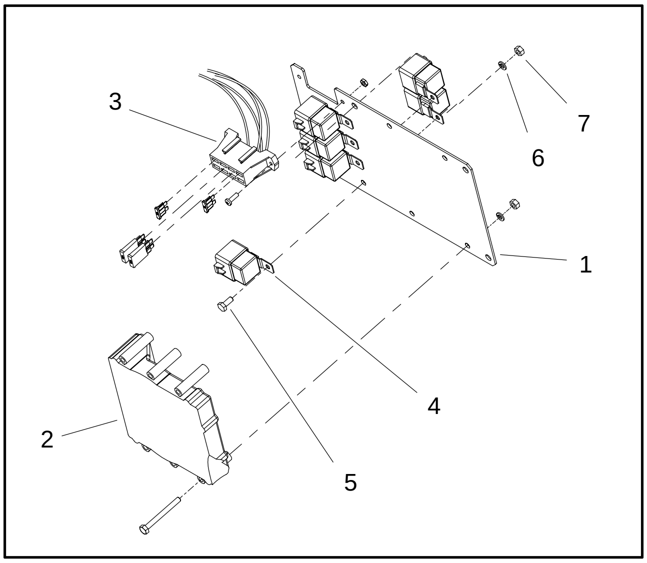

Figure 10

1. **Mount plate**
2. **Electronic control unit**
3. **Sonic boom fuse block**
4. **Relay (6 used)**
5. **Cap screw (4 used)**
6. **Lock washer (4 used)**
7. **Nut (4 used)**

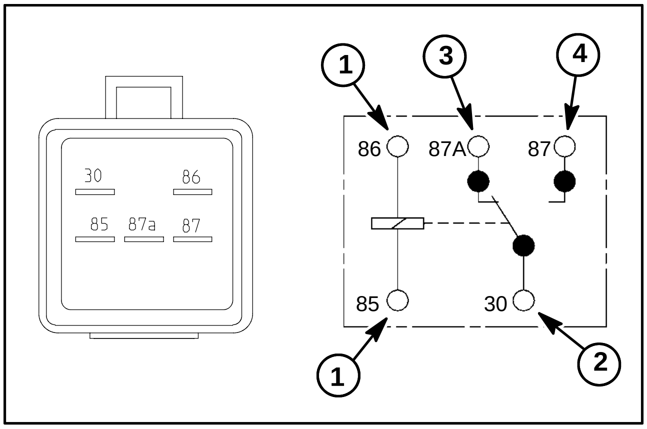

Figure 11

1. **Coil terminal**
2. **Common terminal**
3. **Normally closed term.**
4. **Normally open term.**

Electronic Control Unit (ECU)

The Sonic Boom System uses an electronic control unit (ECU) to control electrical system operation. The ECU is attached to a mounting plate under the vehicle dash panel (Fig. 12).

Power is provided to the ECU when the vehicle ignition switch is ON. A 5 amp fuse provides circuit protection for this logic power to the ECU. The fuse is located in the Sonic Boom System fuse block.

The ECU monitors the states of the following components as inputs: the sonic mode switch, the two (2) boom actuator switches and the two (2) boom sonic sensors.

The ECU controls electrical output to the sonic boom light and the six (6) relays that are part of the Sonic Boom System. Circuit protection for the ECU outputs is provided by a 10 amp fuse located in the Sonic Boom System fuse block.

Because of the solid state circuitry built into the ECU, there is no method to test it directly. The ECU may be damaged if an attempt is made to test it with an electrical test device (e.g. digital multimeter or test light).

IMPORTANT: Before performing welding on the machine, disconnect both cables from the battery and disconnect wire harness connector from the ECU. These steps will prevent damage to the machine electrical system.

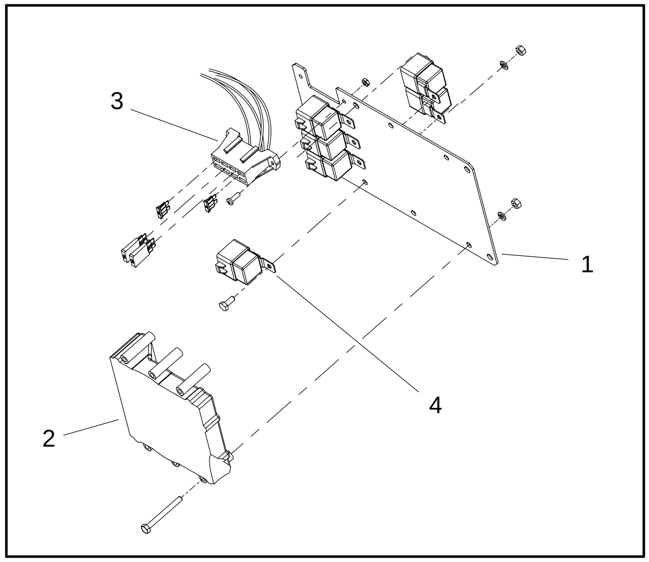

Figure 12

1. **Mount plate**
2. **Electronic control unit**
3. **Sonic boom fuse block**
4. **Relay (6 used)**

Sonic Sensor

Two (2) identical sonic sensors are used in the Sonic Boom System. The sensors are mounted to the spray booms (Fig. 13). During sprayer operation with the sonic mode switch in the automatic position, the sonic sensors will provide inputs for the electronic control unit (ECU) to keep the booms at a constant distance from the ground.

During sprayer operation, the sonic boom sensor continually sends an impulse signal and then receives an echo as the signal bounces off the turf. The ECU establishes the sensor distance from the ground based on the time between the sensor signal generation and the received echo. The ECU then determines if the boom height is different than the calibrated height and, if necessary, energizes the appropriate boom actuator to change the boom height.

Sensors and protection tubes should be rotated above parallel with the ground for proper sonic sensor operation. Refer to the Sonic Boom Kit Installation Instructions for sonic sensor setup information.

The sonic sensor includes a LED that should be illuminated during sprayer operation regardless of whether the sonic mode switch is in manual or automatic mode. The intensity of the LED can be used to assure that the sensor is properly adjusted on the spray boom.

The sonic sensors and their circuit wiring can be tested as ECU inputs with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). Because of the solid state circuitry built into the sensors, there is no method to test them directly. The sensors may be damaged if an attempt is made to test them with an electrical test device (e.g. digital multimeter or test light)

IMPORTANT: Do not spray water at or on the sensors. Water sprayed under even household pressure can damage the sensor. Always install sensor cover (item 7) on sensor before washing the sprayer. Also, install cover when sprayer is not in use.

As required, use a damp cloth to clean the sensors. Make sure that the sensor covers (item 7) are clean and dry before installing them on sensors.

The patch (item 13) that is adhered to the sensor is designed to allow moisture to escape from inside the sensor housing. The patch should be replaced if it is deteriorated or has loosened from the sensor.

Inspect the foam sensor filter (item 11) for damage or excessive debris buildup. Replace filter if necessary.

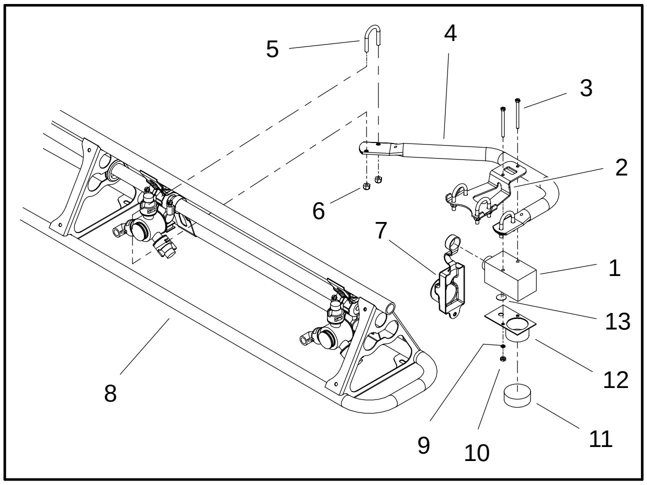

Figure 13

1. **Sonic sensor**
2. **Sensor bracket**
3. **Screw (2 used)**
4. **Protection tube**
5. **U-bolt (2 used)**
6. **Lock nut (4 used)**
7. **Sensor cover**
8. **Spray boom (RH shown)**
9. **Lock washer (2 used)**
10. **Nut (2 used)**
11. **Foam sensor filter**
12. **Sensor shield**
13. **Patch**

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Chapter 9.1

Ultra Sonic Boom System (Optional Kit)

Table of Contents

General Information

Installation Instructions

The Ultra Sonic Boom Kit Installation Instructions provides information regarding the installation, operation and general maintenance for your Ultra Sonic Boom System. Refer to that publication for additional information when servicing the machine.

Precautions Concerning Chemicals Used in Spray System

Chemicals can injure persons, animals, plants, soil and other property. To eliminate environmental damage and personal injury:

1. Select the proper chemical for the job.

2. Carefully read the directions printed on the chemical manufacturer's labels before handling chemicals. Instructions on chemical manufacturer's container labels regarding mixing proportions should be read and strictly followed.

3. Keep spray material away from skin. If spray material comes in contact with a person, wash it off immediately in accordance with manufacturer's recommendations (refer to container labels and Material Safety Data Sheets).

4. Always wear protective clothing, chemical resistant gloves, eye protection and other personal protective equipment as recommended by the chemical manufacturer.

5. Properly dispose of chemical containers, unused chemicals and chemical solution.

Precautions for Removing or Adjusting Spray System Components

1. Park vehicle on a level surface and apply the parking brake.

2. Shut off the vehicle's engine and remove the key from the ignition switch.

3. Disengage all power and wait until all moving parts have stopped.

4. Remove chemicals from pump, hoses and other spray components. Thoroughly neutralize and rinse spray system before loosening or removing any spray system component(s).

5. Make sure spray system pressure is relieved before loosening any system component.

Special Tools

Diagnostic Display

The Diagnostic Display (Fig. 1) can be connected to the Ultra Sonic Boom wire harness communication connector to verify correct electrical functions of the Ultra Sonic Boom System. Toro electronic controller (TEC) inputs and outputs for the Ultra Sonic Boom System can be checked using the Diagnostic Display.

Toro Part Number for Diagnostic Display: **85-4750**

Toro Part Number for Overlay (English)**: 119-9431**

IMPORTANT: The Diagnostic Display must not be left connected to the machine. It is not designed to withstand the environment of the machine's every day use. When use of Diagnostic Display is completed, disconnect it from the machine and reconnect loopback connector to wire harness communication connector. Machine will not operate without loopback connector installed on wire harness. Store Diagnostic Display in a dry, secure, indoor location and not on machine.

Figure 1

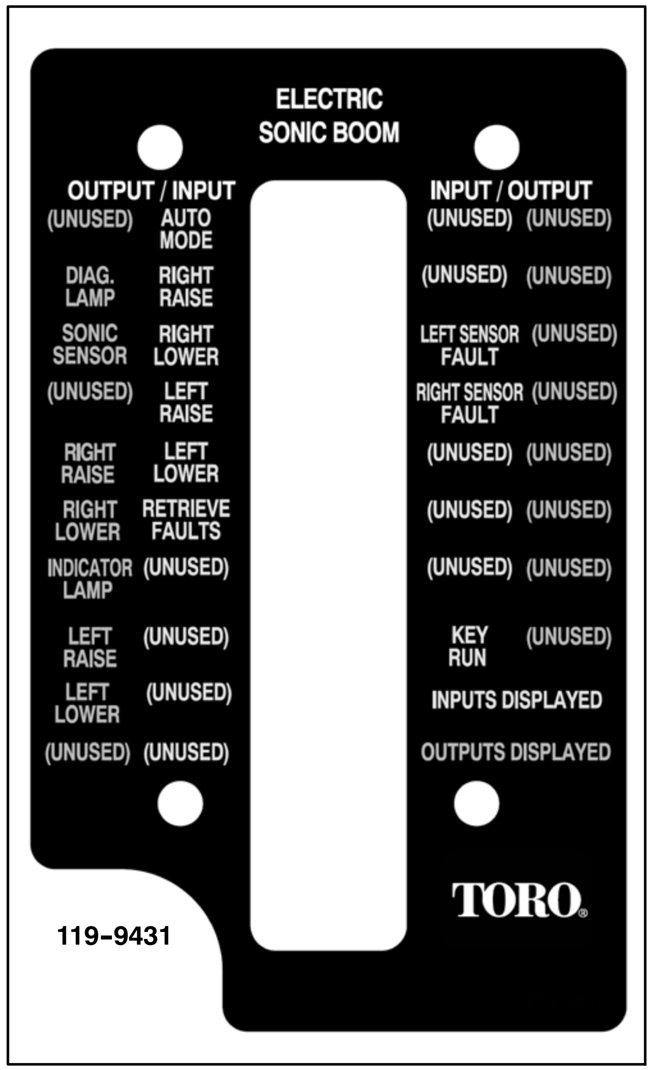
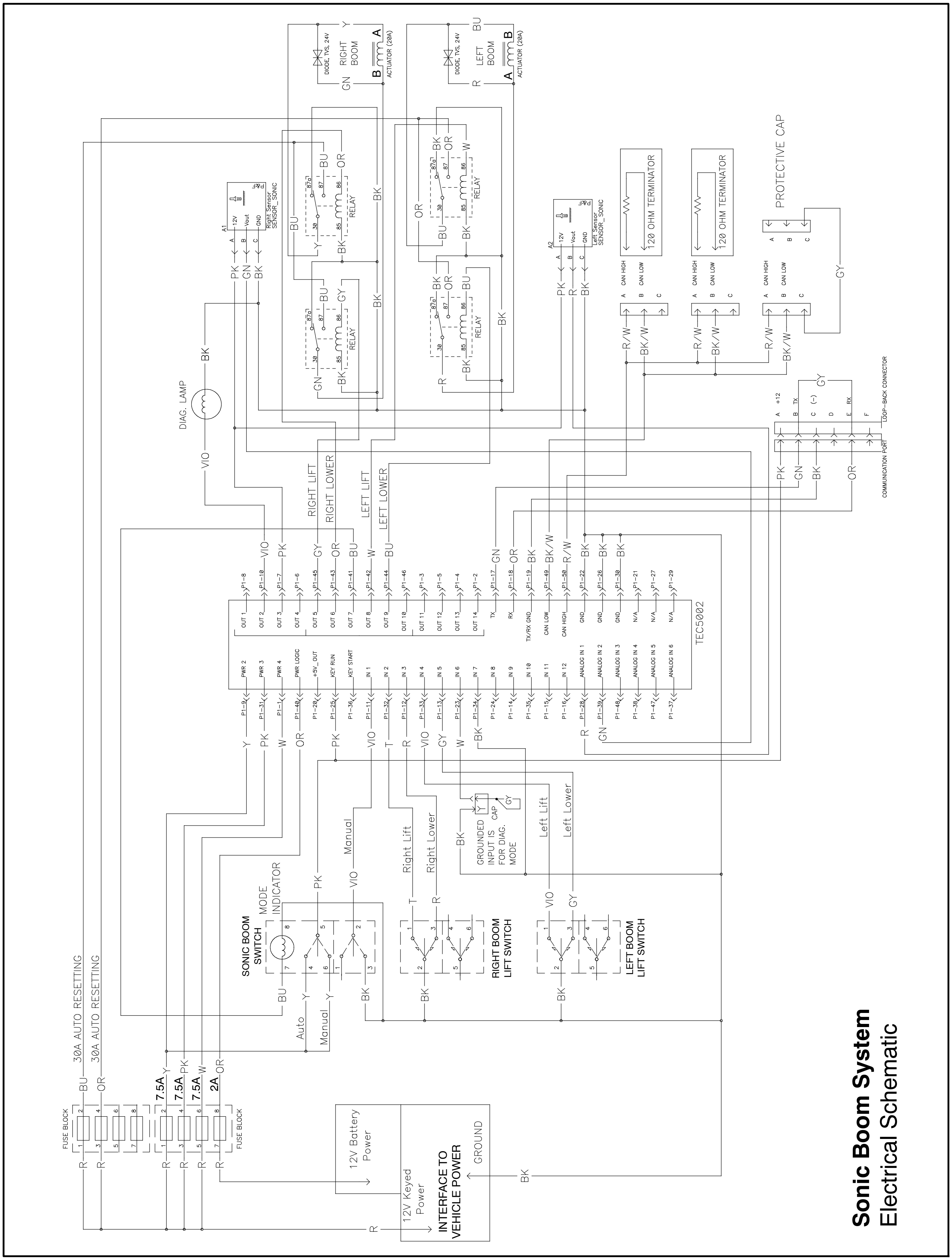


Figure 2

Electrical Schematic



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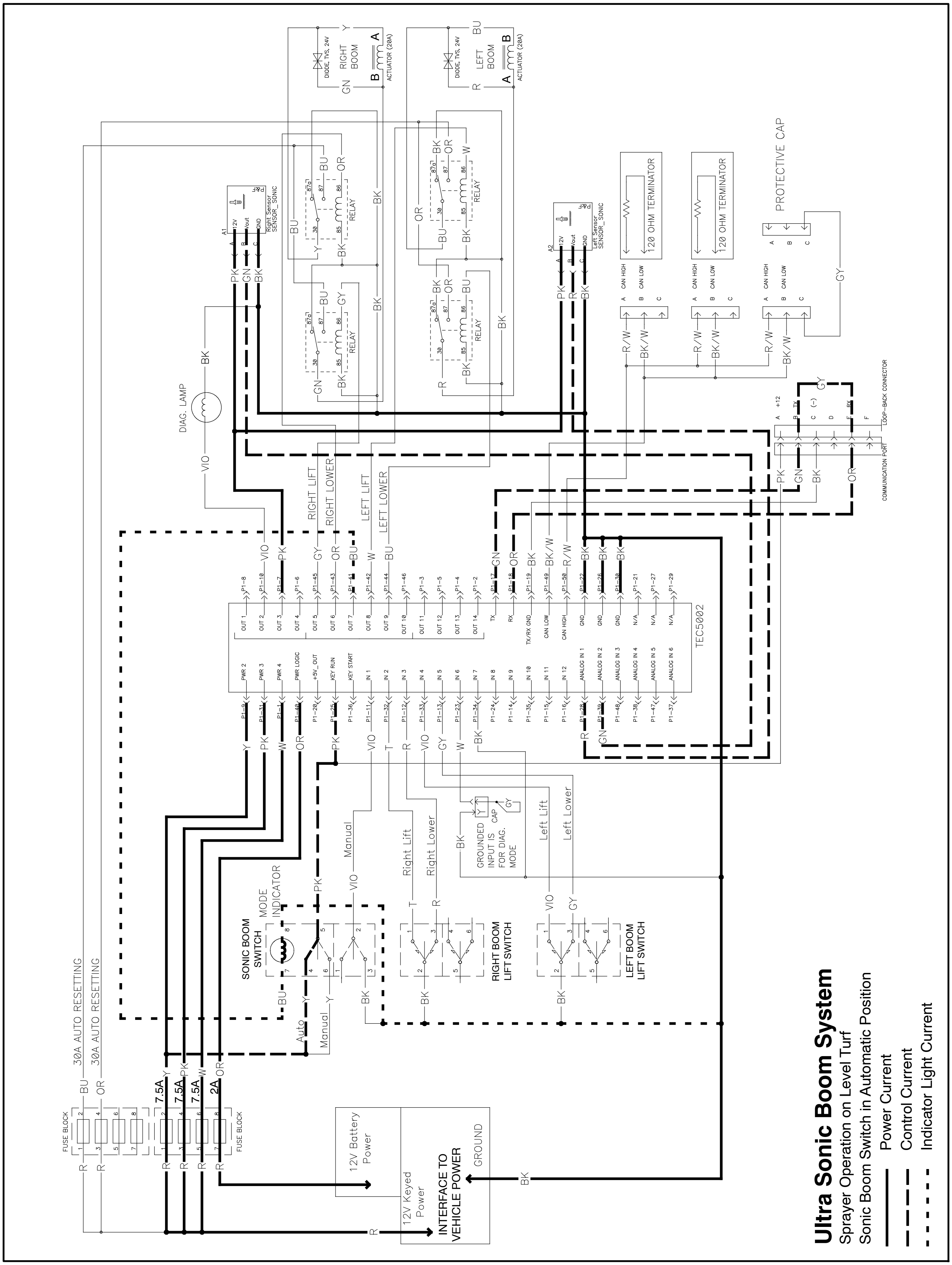
Ultra Sonic Boom System Operation



Sprayer Operation on Level Turf

During sprayer operation with the sonic boom switch in the automatic position (sonic boom light is illuminated), the boom mounted sonic boom sensors continually send impulse signals and then receive echoes as the signals bounce off the turf. The Toro electronic controller (TEC) determines the sensor distance from the ground based on the elapsed time between the sensor signal generation and the received echo. As long as the sensor height remains the same as the calibrated height, the spray boom will remain at a fixed height from the ground for spraying accuracy.

NOTE: During normal Ultra Sonic Boom system operation, there may be some slight movement of the booms.

On level turf, the boom sensors continually send signals and receive echoes that determine that the boom sections are at the calibrated height. Thus, there is no need to change boom height and the boom sections will remain at the correct, level position.

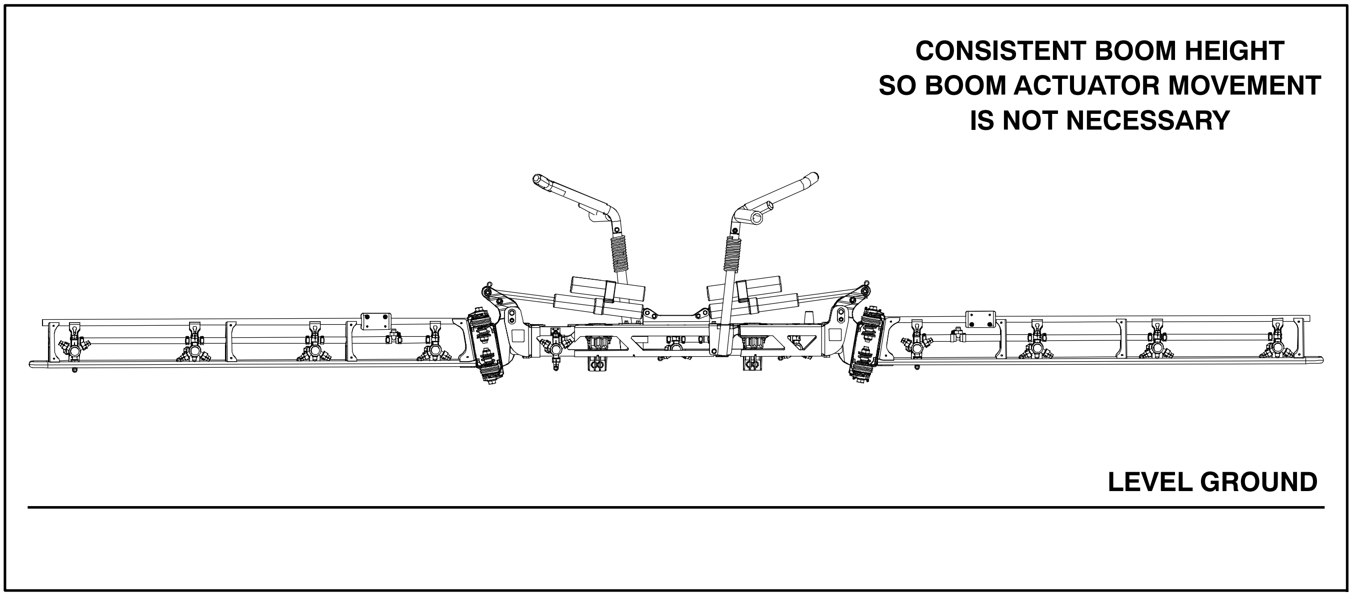
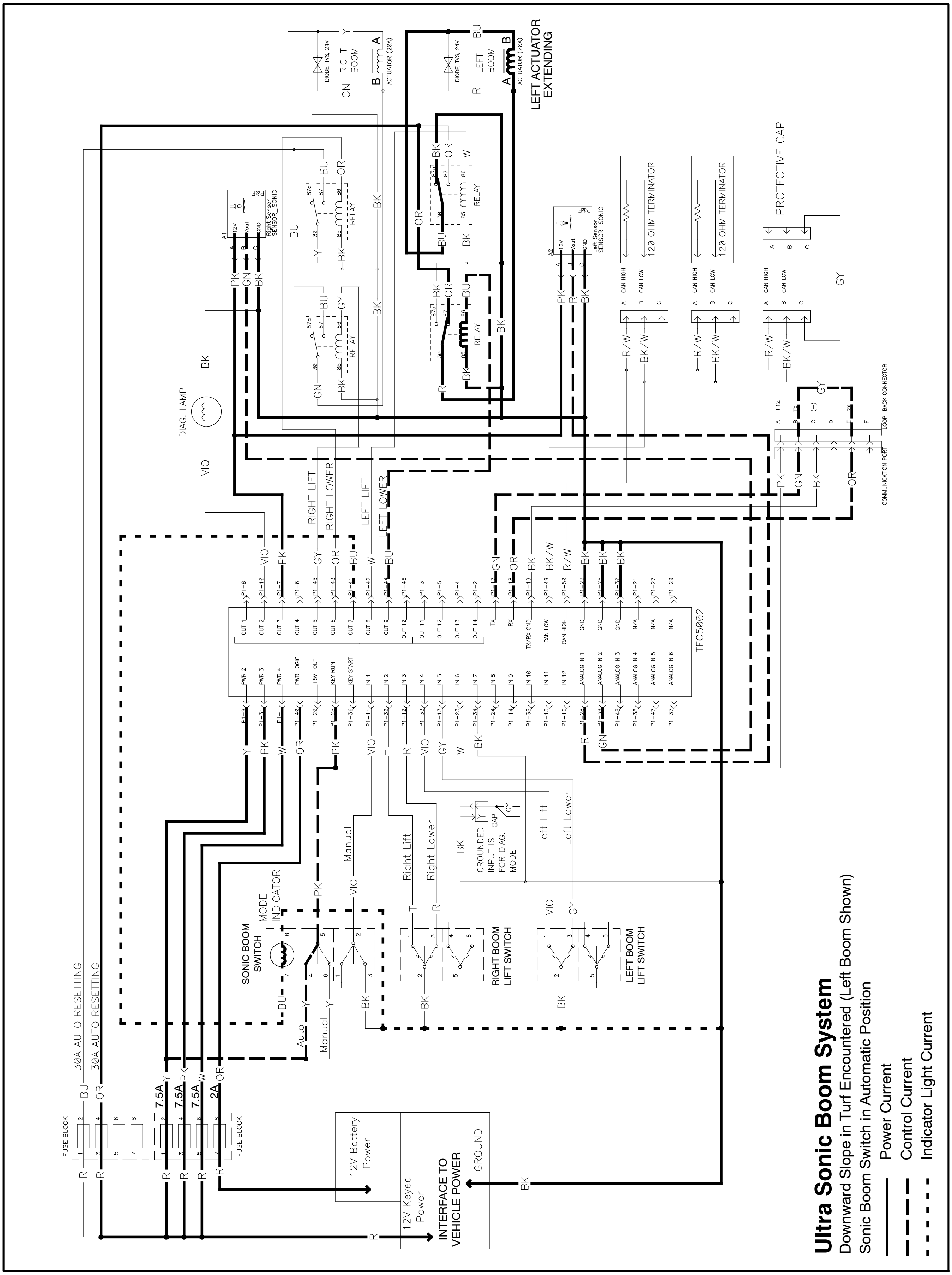


Figure 3


Ultra Sonic Boom System
Downward Slope in Turf Encountered (Left Boom Shown)
Sonic Boom Switch in Automatic Position
Power Current
Control Current
Indicator Light Current
LEFT ACTUATOR EXTENDING
RIGHT BOOM
LEFT BOOM
ACTUATOR (20A)
DIODE, TVS, 24V
RELAY
Right Sensor SENSOR_SONIC
Left Sensor SENSOR_SONIC
DIAG. LAMP
120 OHM TERMINATOR
PROTECTIVE CAP
CAN HIGH
CAN LOW
LOOP–BACK CONNECTOR
COMMUNICATION PORT
TEC5002
RIGHT LIFT
RIGHT LOWER
LEFT LIFT
LEFT LOWER
GROUNDED INPUT IS FOR DIAG. MODE
CAP
Manual
Auto
Right Lift
Right Lower
Left Lift
Left Lower
SONIC BOOM SWITCH
MODE INDICATOR
RIGHT BOOM LIFT SWITCH
LEFT BOOM LIFT SWITCH
30A AUTO RESETTING
30A AUTO RESETTING
FUSE BLOCK
7.5A
7.5A
7.5A
2A
12V Battery Power
12V Keyed Power
GROUND
INTERFACE TO VEHICLE POWER

Downward Slope in Turf Encountered

During sprayer operation with the sonic boom switch in the automatic position (sonic boom light is illuminated), the boom mounted sonic boom sensors continually send impulse signals and then receive echoes as the signals bounce off the turf. The Toro electronic controller (TEC) determines the sensor distance from the ground based on the elapsed time between the sensor signal generation and the received echo. As long as the sensor height remains the same as the calibrated height, the spray boom section will remain at a fixed distance from the ground for spraying accuracy.

When a spray boom section encounters a downward slope in the turf, the time necessary for the sensor to receive the signal echo is longer than the calibrated timeframe. This change in time causes the TEC to energize the appropriate electrical relays causing the controlled boom actuator to extend and the boom section to lower. Once the boom section is lowered to the calibrated distance, the elapsed time between the sensor signal generation and the received echo returns to the correct timeframe, relays are de-energized and the boom stops lowering. This maintains the boom height at the calibrated distance from the ground.

The boom sensor target distance is initiated during initial sonic boom calibration and is typically set at twenty (20) inches. If the boom target distance changes when in automatic mode, the TEC will energize the appropriate electrical relays. The energized relays will lead to a change in boom actuator length and ultimately a change in boom height.

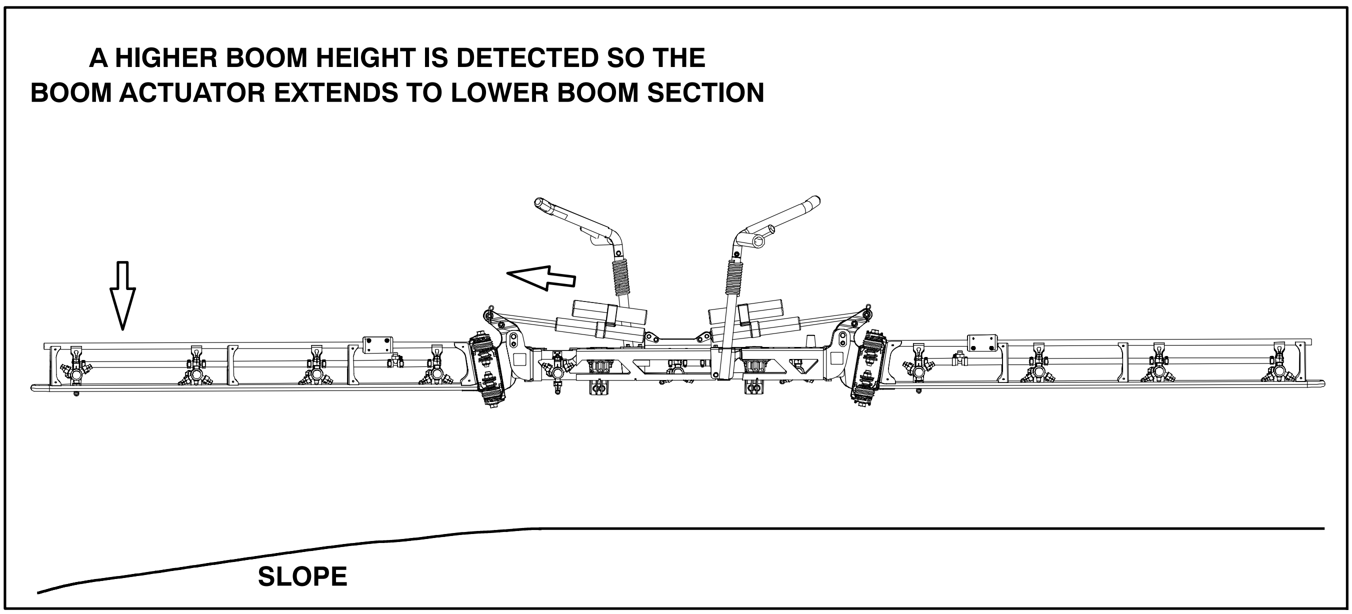
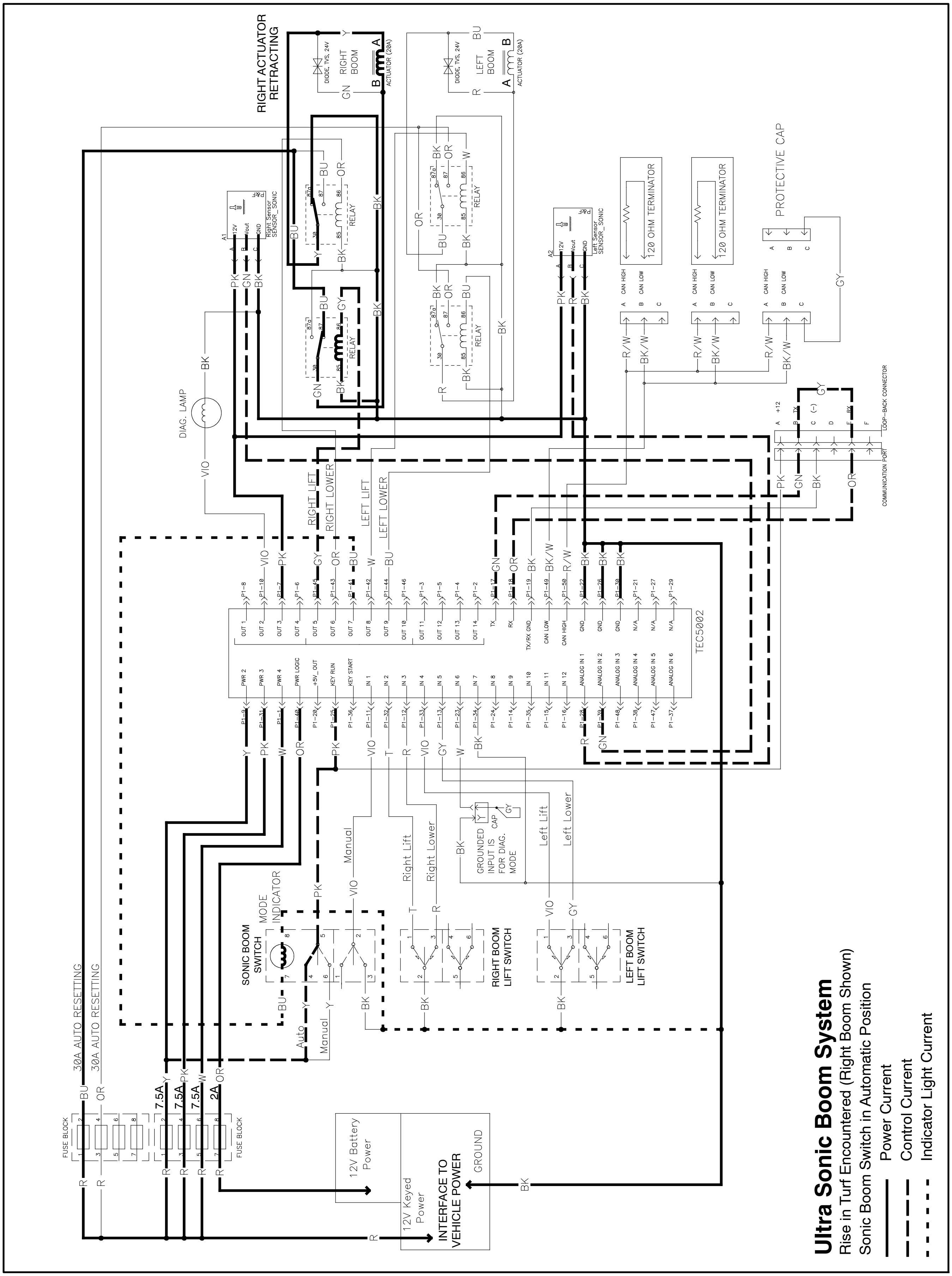


Figure 4


Ultra Sonic Boom System
Rise in Turf Encountered (Right Boom Shown)
Sonic Boom Switch in Automatic Position
Power Current
Control Current
Indicator Light Current
RIGHT ACTUATOR RETRACTING
TEC5002
PROTECTIVE CAP
120 OHM TERMINATOR
120 OHM TERMINATOR
LOOP-BACK CONNECTOR
COMMUNICATION PORT
DIAG. LAMP
RIGHT LIFT
RIGHT LOWER
LEFT LIFT
LEFT LOWER
30A AUTO RESETTING
30A AUTO RESETTING
FUSE BLOCK
FUSE BLOCK
12V Battery Power
12V Keyed Power
GROUND
INTERFACE TO VEHICLE POWER
SONIC BOOM SWITCH
MODE INDICATOR
RIGHT BOOM LIFT SWITCH
LEFT BOOM LIFT SWITCH
GROUNDED INPUT IS FOR DIAG. MODE
CAP
Manual
Auto
Right Lift
Right Lower
Left Lift
Left Lower
Right Sensor SENSOR_SONIC
Left Sensor SENSOR_SONIC
RELAY
RIGHT BOOM
LEFT BOOM
ACTUATOR (20A)
DIODE, TVS, 24V

Rise in Turf Encountered

During sprayer operation with the sonic boom switch in the automatic position (sonic boom light is illuminated), the boom mounted sonic boom sensors continually send impulse signals and then receive echoes as the signals bounce off the turf. The Toro electronic controller (TEC) determines the sensor distance from the ground based on the time between the sensor signal generation and the received echo. As long as the sensor height remains the same as the calibrated height, the spray boom section will remain at a fixed distance from the ground for spraying accuracy.

When a spray boom section encounters a rise in the turf, the time necessary for the sensor to receive the signal echo is shorter than the calibrated timeframe. This change in time causes the TEC to energize the appropriate electrical relays causing the controlled boom actuator to retract and the boom section to raise. Once the boom section is raised to the calibrated distance, the elapsed time between the sensor signal generation and the received echo returns to the correct timeframe, relays are de-energized and the boom stops raising. This maintains the boom height at the calibrated distance from the ground.

The boom sensor target distance is initiated during initial sonic boom calibration and is typically set at twenty (20) inches. If the boom target distance changes when in automatic mode, the TEC will energize the appropriate electrical relays. The energized relays will lead to a change in boom actuator length and ultimately a change in boom height.

Ultra Sonic Boom System

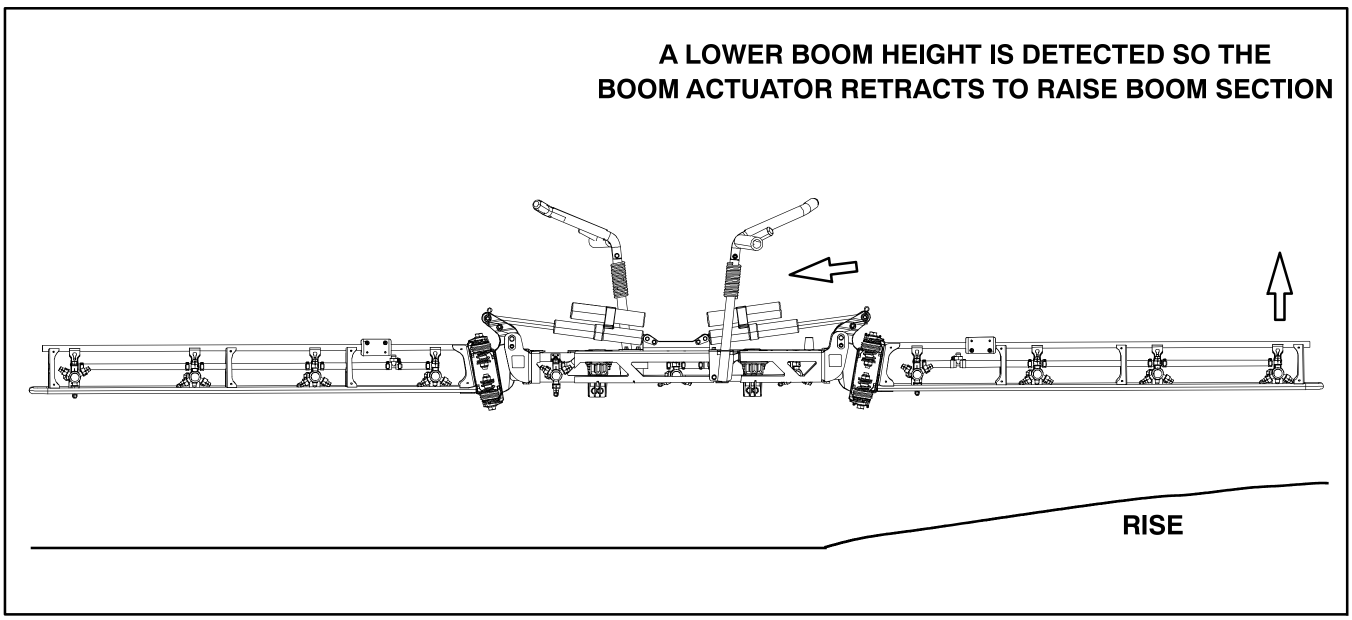
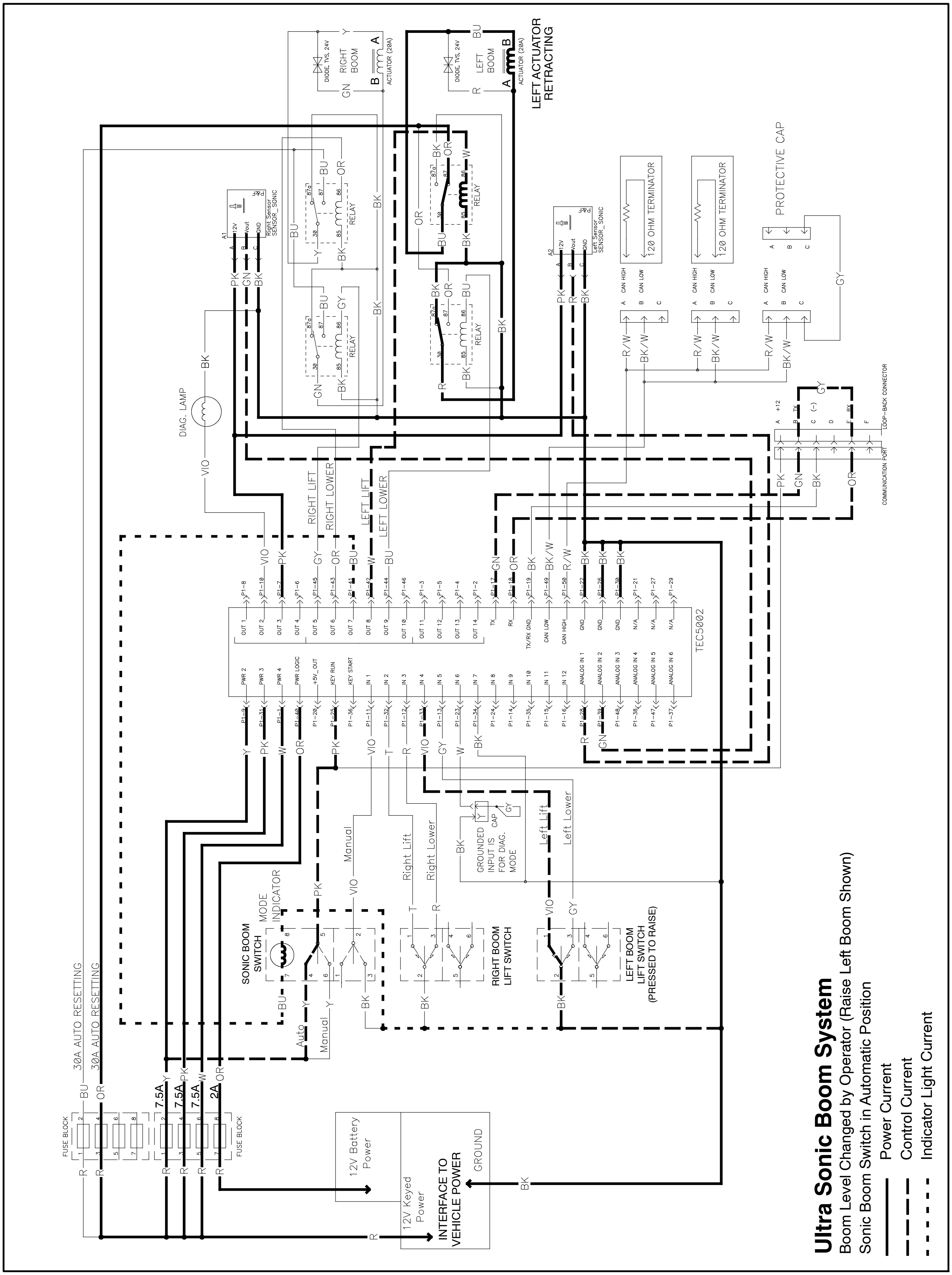


Figure 5



Ultra Sonic Boom System
Boom Level Changed by Operator (Raise Left Boom Shown)
Sonic Boom Switch in Automatic Position
Power Current
Control Current
Indicator Light Current
LEFT ACTUATOR RETRACTING
RIGHT BOOM
LEFT BOOM
ACTUATOR (20A)
DIODE, TVS, 24V
RELAY
Right Sensor SENSOR_SONIC
Left Sensor SENSOR_SONIC
120 OHM TERMINATOR
PROTECTIVE CAP
LOOP-BACK CONNECTOR
COMMUNICATION PORT
DIAG. LAMP
RIGHT LIFT
RIGHT LOWER
LEFT LIFT
LEFT LOWER
TEC5002
MODE INDICATOR
SONIC BOOM SWITCH
RIGHT BOOM LIFT SWITCH
LEFT BOOM LIFT SWITCH (PRESSED TO RAISE)
GROUNDED INPUT IS FOR DIAG. MODE
30A AUTO RESETTING
FUSE BLOCK
12V Battery Power
12V Keyed Power
GROUND
INTERFACE TO VEHICLE POWER

Boom Level Changed by Operator During Automatic Operation

During sprayer operation with the sonic boom switch in the automatic position (sonic boom switch light is illuminated), the boom mounted sonic boom sensors continually send impulse signals and then receive echoes as the signals bounce off the turf. The Toro electronic controller (TEC) determines the sensor distance from the ground based on the time between the sensor signal generation and the received echo. As long as the sensor height remains the same as the calibrated height, the spray boom will remain at a fixed distance from the ground for spraying accuracy.

If the sprayer operator should press a boom lift switch while in automatic operation, the TEC energizes the appropriate boom lift control electrical relays. The energized relays cause the boom actuator to raise or lower the boom section. The relays will stay energized as long as the operator keeps the boom lift switch pressed. The sonic boom light will flash while the boom lift switch is being depressed. If one boom is moved by the operator, the other boom continues to function automatically.

If a boom is raised by the operator while the Ultra Sonic Boom System is in automatic operation, that boom will remain in the raised position until the boom lift switch is pressed to lower and released which will re-engage automatic sonic boom operation on that boom section.

If a boom is lowered by the operator while the Ultra Sonic Boom System is in automatic operation, that boom will lower until the boom lift switch is released. The automatic sonic boom operation will be re-engaged as soon as the lift switch is released from lower.

NOTE: To re-engage automatic sonic boom operation, the boom lift switch must be pressed to lower and released. Pressing the boom lift switch to raise will not re-engage automatic operation.

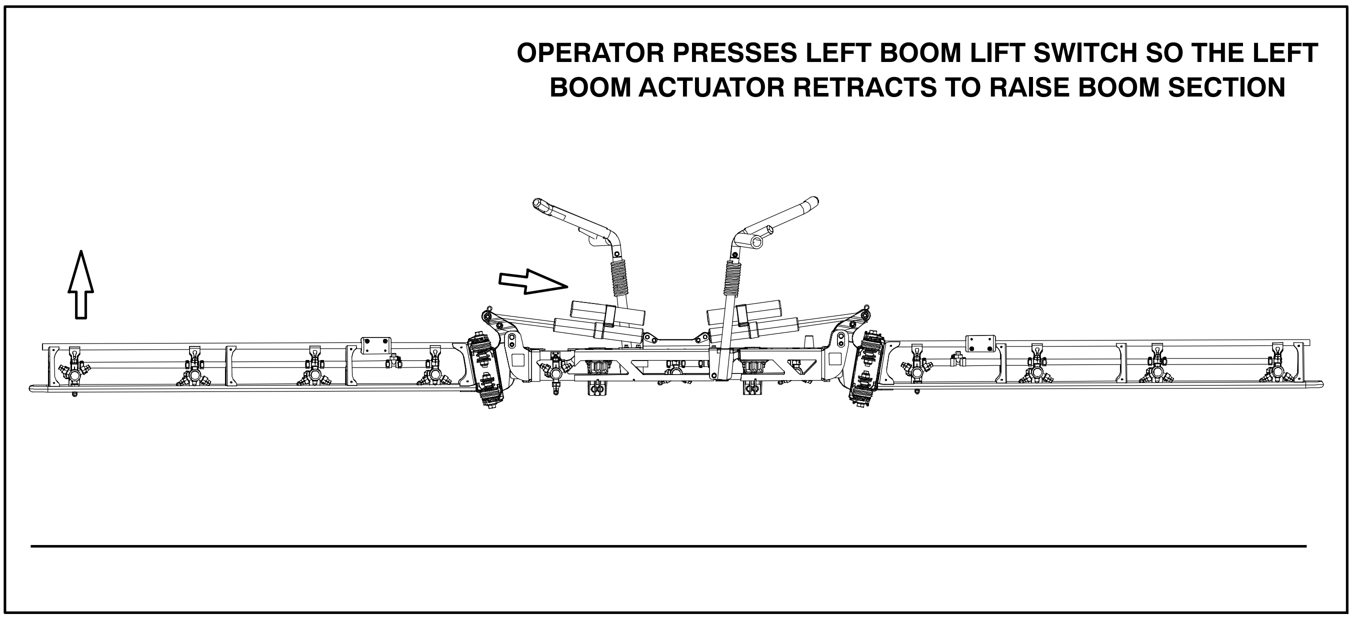
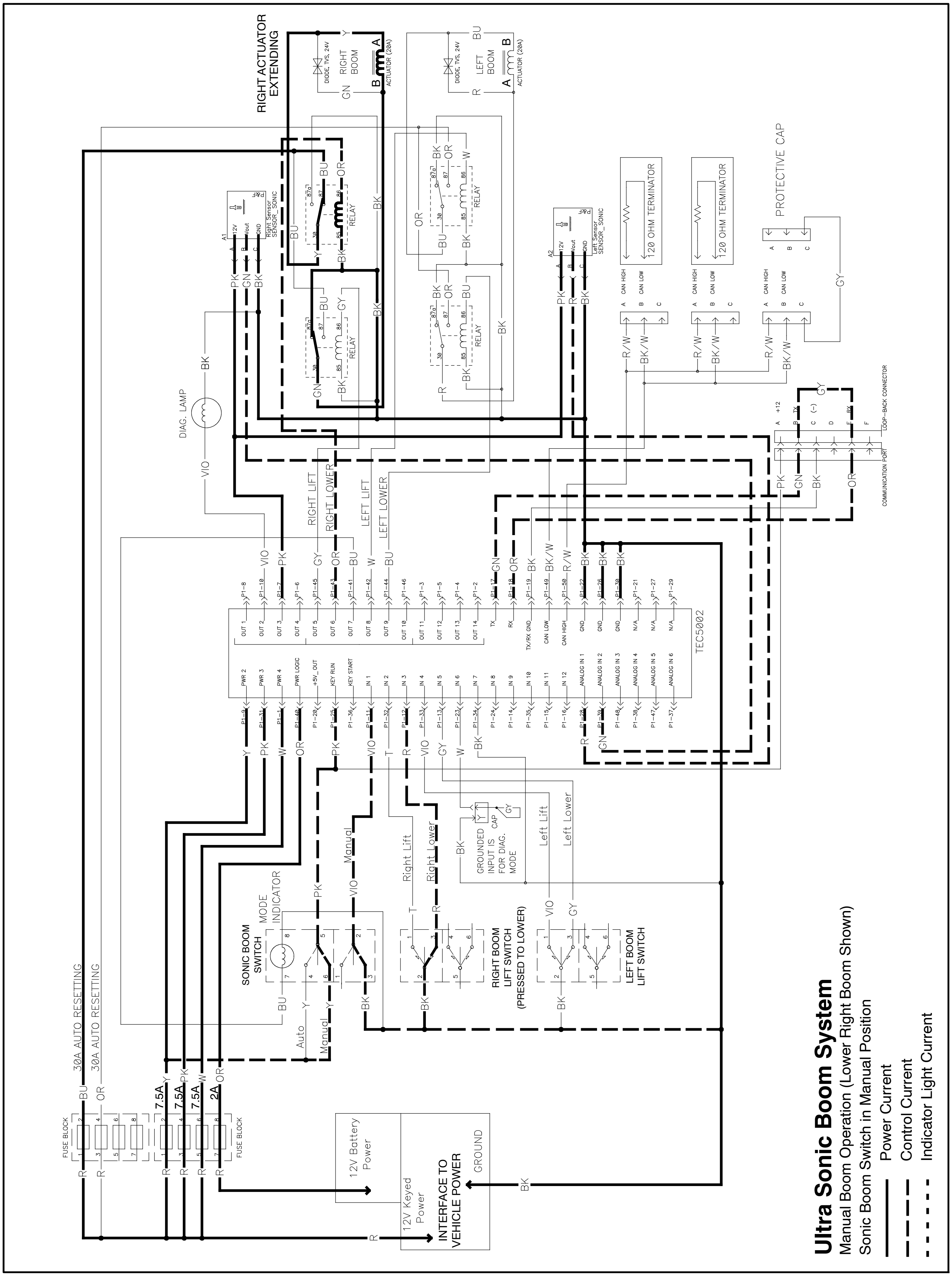


Figure 6


Ultra Sonic Boom System
Manual Boom Operation (Lower Right Boom Shown)
Sonic Boom Switch in Manual Position
Power Current
Control Current
Indicator Light Current
RIGHT ACTUATOR EXTENDING
TEC5002
PROTECTIVE CAP
120 OHM TERMINATOR
COMMUNICATION PORT
LOOP-BACK CONNECTOR
DIAG. LAMP
SONIC BOOM SWITCH
MODE INDICATOR
RIGHT BOOM LIFT SWITCH (PRESSED TO LOWER)
LEFT BOOM LIFT SWITCH
GROUNDED INPUT IS FOR DIAG. MODE
30A AUTO RESETTING
FUSE BLOCK
12V Battery Power
12V Keyed Power
GROUND
INTERFACE TO VEHICLE POWER

Manual Boom Operation

During sprayer operation with the sonic boom switch in the manual position, the spray booms will remain in position unless the operator presses a boom lift switch. The sonic boom light should not be illuminated when in the manual position. The operator will control the boom position with the boom lift switches.

Lower Boom

When a boom lift switch is pressed to lower a boom section, the Toro electronic controller (TEC) energizes the appropriate electrical relays causing the controlled boom actuator to extend and the boom section to lower. The boom will continue to lower until the operator releases the boom actuator switch.

Raise Boom

When a boom lift switch is pressed to raise a boom section, the Toro electronic controller (TEC) energizes the appropriate electrical relays causing the controlled boom actuator to retract and the boom section to raise. The boom will continue to rise until the operator releases the boom lift switch.

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Troubleshooting

For effective troubleshooting and repairs, there must be a good understanding of the electrical circuits and components used on the Ultra Sonic Boom System (see Ultra Sonic Boom System Operation in this chapter).

NOTE: When troubleshooting an electrical problem on your Ultra Sonic Boom System, refer to information regarding the sonic boom light and diagnostic lamp in this section. Also, use the Diagnostic Display (see Special Tools in this chapter) to test Toro electronic controller (TEC) inputs and outputs.

Sonic Boom Light

The sonic boom light is included in the sonic boom switch on the spray control console (Fig. 7 or 8). This light should be illuminated whenever the vehicle ignition switch is ON and the sonic boom switch is in the automatic position.

The sonic boom light flashing quickly indicates that the Ultra Sonic Boom System is in the calibration mode. This mode allows the spray booms to be adjusted for the desired boom height and continues for approximately twenty (20) seconds. The sonic boom light will then flash slowly for approximately two (2) minutes to finalize the calibration settings.

NOTE: A sequence of switch movements is necessary to engage the calibration mode. Refer to the Sonic Boom Kit Installation Instructions for this sequence.

The sonic boom light flashes slowly when the sonic boom switch is in the automatic position and a boom lift switch is pressed to manually change the boom height. The flashing light will return to being constantly ON and automatic operation will be re-engaged once the boom switch is manually pressed to the lower position.

A slowly flashing sonic boom light may also indicate that a system fault has been encountered. In the event that there is a fault in the Ultra Sonic Boom System (e.g. there is no signal coming from a boom sensor), the affected boom will raise briefly and then stop. The sonic boom light will begin to flash slowly and the diagnostic lamp on the console will also flash. If this occurs, refer to Diagnostic Lamp, Diagnostic Display and Troubleshooting Chart in this section.

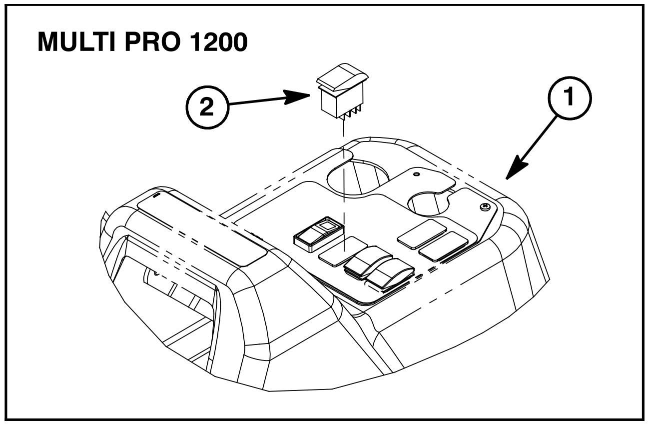

Figure 7

1. **Spray control console**
2. **Sonic boom switch**

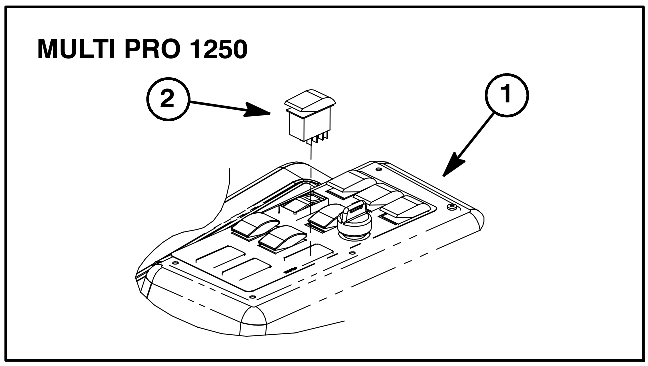

Figure 8

1. **Spray control console**
2. **Sonic boom switch**

Ultra Sonic Boom Calibration

The sensor calibration process is critical to the correct operation of the Ultra Sonic Boom System. The calibration process establishes the sensor target distance between the boom and the turf surface. Typically, this distance is approximately twenty (20) inches. Steps needed for proper calibration are identified in the Ultra Sonic Boom Kit Installation Instructions.

While calibrating the Ultra Sonic Boom sensors, it is best to perform the calibration process on turf. A shiny surface (e.g. cement shop floor) can skew sensor signals. Also, ensure the calibration area is free of buildings, trees, underground plumbing and other machines that could interfere with sensor signals.

Diagnostic Lamp

The Ultra Sonic Boom System includes a diagnostic lamp that displays the status of the sonic boom system. The diagnostic lamp is located on the dash panel (Fig. 9).

When the ignition switch is moved to the ON position and the Ultra Sonic Boom System electrical system is functioning properly, the diagnostic lamp will be illuminated for approximately three (3) seconds and then will turn off. The diagnostic lamp should remain off during normal sonic boom operation.

If the sonic boom system TEC controller detects an electrical system malfunction (fault) during operation (e.g. there is no signal coming from a boom sensor), the affected boom will raise briefly and then stop. The sonic boom light (in sonic boom switch) will begin to flash slowly and the diagnostic lamp will flash rapidly. The diagnostic lamp will stop flashing and will automatically reset when the ignition switch is turned to the OFF position. The fault, however, will be retained in controller memory and can be retrieved at a future time (see Retrieving Fault Codes below).

If the diagnostic lamp does not illuminate when the ignition switch is turned to the ON position, possible causes are:

- The loopback connector (6 pin connector) is not connected to the machine wire harness (Fig. 10). The loopback connector is near the TEC controller on the mounting plate under the dash panel.
- The diagnostic lamp (or circuit wiring) is faulty.
- TEC controller fuse(s) are faulty.
- The TEC controller is faulty.

Check electrical connections, controller fuses and the diagnostic lamp to determine malfunction. Make sure that the loopback connector is secured to the wire harness connector during machine operation.

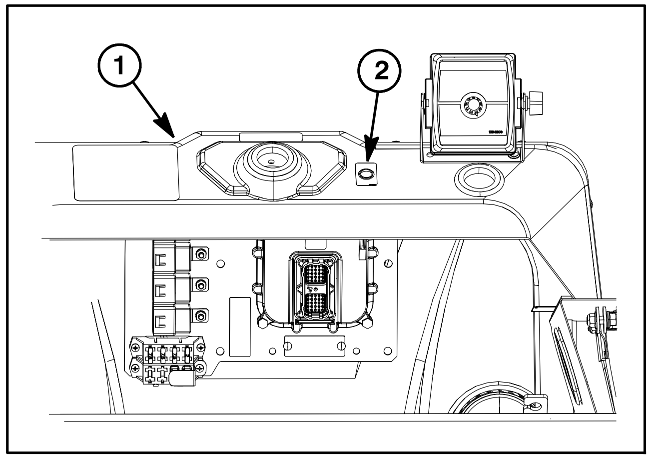

Figure 9

1. **Dash panel**
2. **Diagnostic lamp**

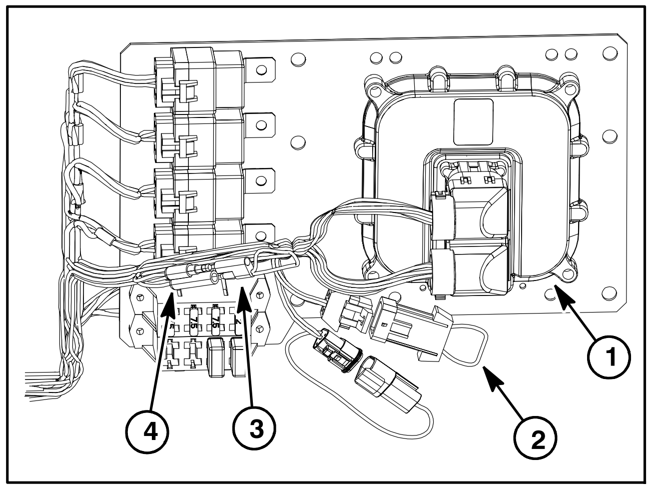

Figure 10

1. **TEC controller location**
2. **Loopback connector**
3. **Diagnostic tether cap**
4. **Diagnostic shunt wires**

Retrieving Fault Codes

All Ultra Sonic Boom System fault codes are retained in the TEC controller memory. The three (3) most recent fault codes that have occurred within the last forty (40) hours of operation can be retrieved using the diagnostic lamp. To retrieve these fault codes from the controller memory, perform the following steps:

1. Make sure that ignition switch is OFF.

2. Locate diagnostic tether cap that connects the two (2) diagnostic shunt wires located near the TEC controller on the mounting plate under the dash panel (Fig. 10).

3. Remove diagnostic tether cap from diagnostic shunt wires and connect the two (2) shunt wires together.

4. Turn ignition switch to the ON position.

5. Monitor the diagnostic lamp for fault code(s).

Fault codes displayed by the diagnostic lamp are two (2) digit numbers with no digit larger than five (5). Fault codes are listed in the chart below. There will be a one (1) second pause between the first and second digit of a code. Up to three (3) fault codes retained in controller memory will be displayed by the diagnostic lamp in order from the most recent fault to the oldest fault. If there are multiple faults in controller memory, there will be a three (3) second pause between codes. The fault codes will continually repeat after a five (5) second pause until the ignition key is turned OFF.

If there are no faults that have occurred within the last forty (40) hours of operation, the diagnostic lamp will flash continuously after performing the above steps.

If a fault code is not retrieved from the controller memory within forty (40) hours of machine operating time, the fault cannot be retrieved from controller memory using this procedure. If necessary, contact your Toro distributor to retrieve older fault codes.

After necessary service has been performed, disconnect diagnostic shunt wires and insert shunt leads into diagnostic tether cap. Lower operator seat.

Fault Code (Lamp Flashes)	Fault Description
1 – 2	Left sonic boom sensor fault occurred
1 – 3	Right sonic boom sensor fault occurred
1 – 6	TEC inputs are out of range (sonic boom operation will stop)
2 – 1	The extreme right 7.5 Amp fuse in boom supply fuse block is faulty
2 – 2	The middle right 7.5 Amp fuse in boom supply fuse block is faulty
2 – 3	The middle left 7.5 Amp fuse in boom supply fuse block is faulty
2 – 4	Main electrical power to sonic boom system was interrupted
3 – 4	Left boom raise function (output) is grounded or faulty
4 – 1	Right boom raise function (output) is grounded or faulty
4 – 2	Right boom lower function (output) is grounded or faulty
4 – 5	Left boom lower function (output) is grounded or faulty

Clearing Fault Codes

After fault codes have been retrieved, clearing of those faults can be completed using the following switch sequence:

1. Place sprayer in fault retrieval mode (see above). The diagnostic lamp should be displaying the fault codes.

2. At the same time, press the left boom switch to lower and the right boom switch to raise.

3. Monitor the diagnostic lamp for continuous flashing indicating that all faults have been cleared from the controller memory.

Diagnostic Display

The Ultra Sonic Boom System is equipped with the Toro electronic controller (TEC) which controls machine sonic boom electrical functions. The TEC monitors various input switches (e.g. sonic boom switch, boom lift switches, sonic boom sensors) and energizes outputs (e.g. boom actuators, diagnostic lamp) for appropriate machine functions.

For the TEC to control the machine as desired, each of the inputs (switches and sensors) and outputs (e.g. boom actuators) must be connected and functioning properly.

The Diagnostic Display (see Special Tools in this chapter) is a tool to help the technician verify correct electrical functions of the machine.

IMPORTANT: The Diagnostic Display must not be left connected to the machine. It is not designed to withstand the environment of the machine's every day use. When use of the Diagnostic Display is completed, disconnect it from the machine and reconnect loopback connector to harness connector. The machine will not operate without the loopback connector installed on the harness. Store the Diagnostic Display in a dry, secure, indoor location and not on machine.

Verify Diagnostic Display Input Functions

1. Park machine on a level surface, stop the engine and apply the parking brake.

2. Locate Ultra Sonic Boom wire harness communication port and loopback connector (6 pin connector) located near the TEC controller on the mounting plate under the dash panel (Fig. 11). Carefully unplug loopback connector from harness connector.

3. Connect the Diagnostic Display connector to the wire harness communication port connector. Make sure correct overlay decal is positioned on the Diagnostic Display (Fig. 12).

4. Turn the machine ignition switch to the ON position, but do not start engine.

NOTE: The **red** text on the Diagnostic Display overlay decal refers to input switches and the **green** text refers to TEC outputs.

5. Make sure that the "INPUTS DISPLAYED" LED, on lower right column of the Diagnostic Display, is illuminated. If "OUTPUTS DISPLAYED" LED is illuminated, press the toggle button on the Diagnostic Display to change to "INPUTS DISPLAYED" LED.

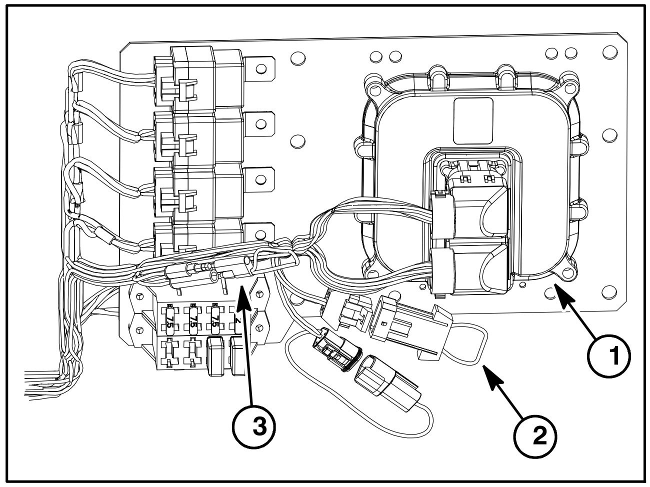

Figure 11

1. **TEC controller location**
2. **Loopback connector**
3. **Diagnostic tether cap**

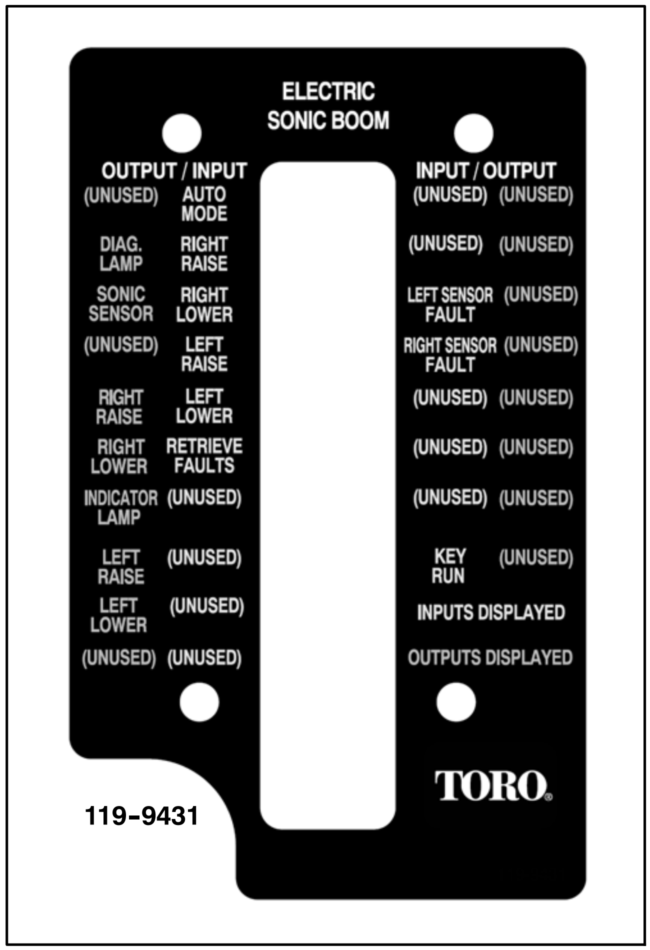

Figure 12

CAUTION

When testing TEC inputs with the Diagnostic Display, boom actuators may be energized causing the spray booms to move. Be cautious of potential sprayer component movement while verifying inputs with the Diagnostic Display.

6. The Diagnostic Display will illuminate the LED associated with each of the inputs when that input switch is closed. Individually, change each of the switches from open to closed (e.g. toggle sonic boom switch), and note that the appropriate LED on the Diagnostic Display will illuminate when the corresponding switch is closed. Repeat on each switch that is possible to be changed by hand (see Inputs and LED Operation chart below).

7. If appropriate LED does not toggle on and off when switch state is changed, perform test of switch and/or check all wiring and connections to that switch. Replace any defective switches and repair any damaged wiring.

8. After input functions testing is complete, disconnect the Diagnostic Display connector from the harness connector. Plug loopback connector into wire harness.

Diagnostic Display Inputs	Diagnostic Display LED Operation
AUTO MODE	Sonic boom switch in auto position: LED ON Sonic boom switch not in auto position: LED OFF
RIGHT RAISE	Right boom lift switch in raise position: LED ON Right boom lift switch not in raise position: LED OFF
RIGHT LOWER	Right boom lift switch in lower position: LED ON Right boom lift switch not in lower position: LED OFF
LEFT RAISE	Left boom lift switch in raise position: LED ON Left boom lift switch not in raise position: LED OFF
LEFT LOWER	Left boom lift switch in lower position: LED ON Left boom lift switch not in lower position: LED OFF
RETRIEVE FAULTS	Diagnostic shunt wires are connected for fault retrieval: LED ON Diagnostic shunt wires are not connected: LED OFF
LEFT SENSOR FAULT	The TEC has detected an invalid reading from left sensor: LED ON Left sensor operating normally: LED OFF
RIGHT SENSOR FAULT	The TEC has detected an invalid reading from right sensor: LED ON Right sensor operating normally: LED OFF
KEY RUN	Ignition key is in ON position: LED ON Ignition key is in OFF position: LED OFF

NOTE: When the vehicle ignition switch is in the OFF position, all Diagnostic Display LED's should be OFF.

NOTE: Initial calibration of the Ultra Sonic Boom sensors is required for proper operation of TEC inputs. Refer to your Sonic Boom Kit Installation Instructions for information on initial sensor calibration.

NOTE: Right and left side Ultra Sonic Boom sensors are identical so they can be exchanged to assist in troubleshooting. If a problem follows the exchanged sensor, an electrical problem likely exists with the sensor. If the problem remains unchanged, something other than the sensor is the problem source (e.g. switch, circuit wiring).

Verify Diagnostic Display Output Functions

The Diagnostic Display also has the ability to detect which output boom actuators or lights (sonic boom or diagnostic) are energized by the Toro electronic controller (TEC). This is a quick way to determine which electrical component is malfunctioning.

NOTE: An open output (e.g. an unplugged connector or a broken wire) cannot be detected with the Diagnostic Display.

1. Park machine on a level surface, stop the engine and engage the parking brake.

2. Locate Ultra Sonic Boom wire harness communication port and loopback connector (6 pin connector) located near the TEC controller on the mounting plate under the dash panel (Fig. 13). Carefully unplug loopback connector from harness connector.

3. Connect the Diagnostic Display connector to the harness communication port connector. Make sure correct overlay decal is positioned on the Diagnostic Display (see Special Tools in this chapter).

4. Turn the ignition switch to the ON position.

NOTE: The **red** text on the Diagnostic Display overlay decal refers to input switches and the **green** text refers to TEC outputs.

5. Make sure that the "OUTPUTS DISPLAYED" LED, on lower right column of the Diagnostic Display, is illuminated. If "INPUTS DISPLAYED" LED is illuminated, press the toggle button on the Diagnostic Display to change the LED to "OUTPUTS DISPLAYED".

NOTE: It may be necessary to toggle between "INPUTS DISPLAYED" and "OUTPUTS DISPLAYED" several times to perform the following step. To change from inputs to outputs, press toggle button once. This may be done as often as required. **Do not press and hold toggle button**.

CAUTION

When testing TEC inputs with the Diagnostic Display, boom actuators may be energized causing the spray booms to move. Be cautious of potential sprayer component movement while verifying inputs with the Diagnostic Display.

6. Attempt to operate the desired function of the machine. The appropriate output LED's should illuminate on the Diagnostic Display to indicate that the TEC is turning on that function (see Outputs and LED Operation chart on next page). The outputs can be checked with the ignition switch in the ON position and the engine not running.

A. If the correct output LED's do not illuminate, verify that the required input switches are in the necessary positions to allow that function to occur.

B. If the output LED's are on as specified, but the booms do not function properly, suspect a failed electrical component, an open in the tested circuit or a non-electrical problem (e.g. binding of the boom hinge). Repair as necessary.

C. If each input switch is in the correct position and functioning correctly, but the output LED's are not correctly illuminated, this may indicate a TEC problem. If this occurs, contact your Toro Distributor for assistance.

7. After output functions testing is complete, disconnect the Diagnostic Display connector from the harness connector and plug loopback connector into wire harness.

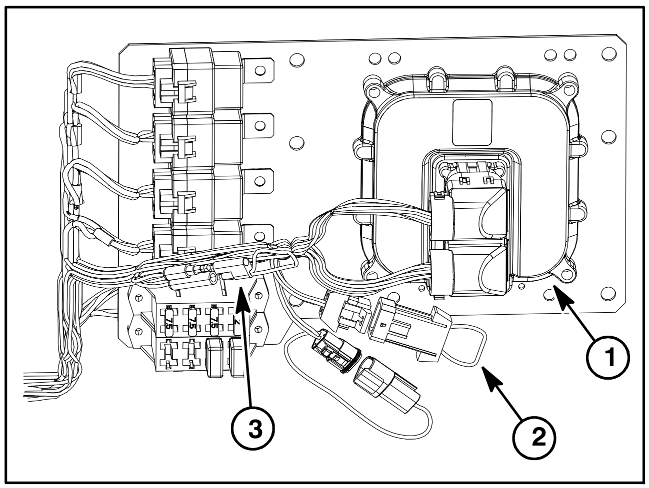

Figure 13

1. **TEC controller location**
2. **Loopback connector**
3. **Diagnostic tether cap**

Diagnostic Display Outputs	Diagnostic Display LED Operation
DIAG LAMP	Diagnostic lamp is ON or FLASHING: LED ON or FLASHING Diagnostic lamp is not ON or FLASHING: LED OFF
SONIC SENSOR	TEC output exists to sonic sensors: LED ON No TEC output to sonic sensors: LED OFF
RIGHT RAISE	TEC output exists to energize relays to raise right boom: LED ON No TEC output to energize relays to raise right boom: LED OFF
RIGHT LOWER	TEC output exists to energize relays to lower right boom: LED ON No TEC output to energize relays to lower right boom: LED OFF
INDICATOR LAMP	Sonic boom switch is in automatic position: LED ON Sonic boom switch is in manual position: LED OFF
LEFT RAISE	TEC output exists to energize relays to raise left boom: LED ON No TEC output to energize relays to raise left boom: LED OFF
LEFT LOWER	TEC output exists to energize relays to lower left boom: LED ON No TEC output to energize relays to lower left boom: LED OFF

Troubleshooting Chart

The chart that follows contains suggestions that can be used to assist in diagnosing Ultra Sonic Boom System performance issues. These suggestions are not all–inclusive. Also, consider that there may be more than one cause for a machine problem.

NOTE: When troubleshooting an electrical problem on your Ultra Sonic Boom System, refer to information regarding the sonic boom light in this section. Also, use the Diagnostic Display (see Special Tools in this chapter) to test Toro electronic controller (TEC) inputs and outputs.

Problem	**Possible Cause**
Light in sonic boom switch is not illuminated.	Sonic boom switch is in the MANUAL position. 2 Amp fuse in sonic boom fuse block is faulty (all sonic boom functions are affected). Upper, middle right fuse (7.5 Amp) in sonic boom fuse block is faulty. Loopback connector is unplugged from wire harness connector (all sonic boom functions are affected). Electrical power from vehicle is not available (all sonic boom functions are affected). Sonic boom switch or circuit wiring is faulty.
One of the boom actuators will not extend or retract.	Boom lift switch or circuit wiring for affected boom actuator is faulty. A problem exists with the affected boom actuator.
Neither of the boom actuators will extend or retract.	Loopback connector is unplugged from wire harness connector (all sonic boom functions are affected). Fuse(s) in sonic boom fuse block is faulty. Electrical power from vehicle is not available (all sonic boom functions are affected). A problem exists with both boom actuators. The Toro electronic controller (TEC) or circuit wiring is faulty.
The LED's on one of the sonic boom sensors are not illuminated.	Sonic boom sensor or circuit wiring is faulty.
The LED's on both of the sonic boom sensors are not illuminated.	Sonic boom switch is in the MANUAL position. Upper, middle left fuse (7.5 Amp) in sonic boom fuse block is faulty (diagnostic lamp also affected). Sonic boom switch or circuit wiring is faulty.

Problem	Possible Cause
One of the booms does not automatically follow ground irregularities. Boom can be controlled with boom lift switch.	On affected boom, the sonic boom sensor cover is on sensor. On affected boom, calibration of the sonic boom sensors is incorrect. The sonic boom sensor is incorrectly installed. Sonic boom sensor or circuit wiring for affected boom is faulty. The Toro electronic controller (TEC) or circuit wiring is faulty.
Neither boom automatically follows ground irregularities. Booms can be controlled with boom lift switches.	Sonic boom switch is not in the AUTOMATIC position. Sonic boom sensor covers are on both sensors. Calibration of the sonic boom sensors is incorrect. Both sonic boom sensors or circuit wiring are faulty. The Toro electronic controller (TEC) or circuit wiring is faulty.

Sonic Boom Fuses

Fuses for the Ultra Sonic Boom system are included in the fuse blocks attached to the mounting plate under the dash panel (Fig. 14).

Fuse Identification and Function

The upper row of fuses protect circuits as follows:

1. The upper, extreme left 2 Amp fuse protects power supply for TEC logic.

2. The upper, middle left 7.5 Amp fuse is not used.

3. The upper, middle right 7.5 Amp fuse protects TEC output circuits (sonic boom switch light and boom actuator power supply).

4. The upper, extreme right 7.5 Amp fuse protects TEC output circuits (diagnostic light and sonic sensor power supply).

The lower row of fuses protect circuits as follows:

1. The lower, extreme left fuse position is not used.

2. The lower, middle left fuse position is not used.

3. The lower, middle right 30 Amp fuse (auto resetting) protects the left boom actuator circuit.

4. The extreme right 30 Amp fuse (auto resetting) protects the right boom actuator circuit.

Fuse Testing

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

NOTE: The auto resetting fuses should only be removed if they are faulty.

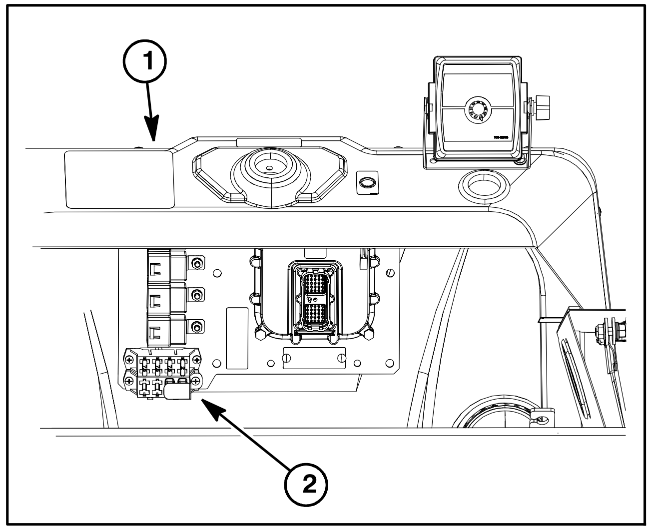

Figure 14

1. **Dash panel**
2. **Fuse blocks**

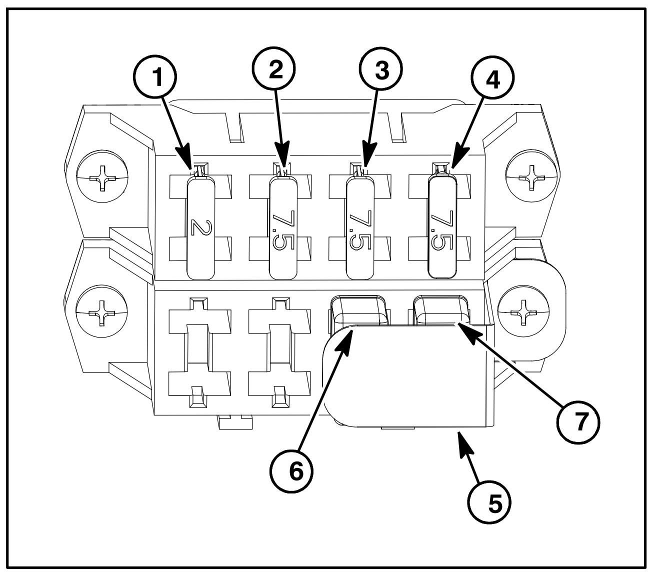

Figure 15

1. **Upper, extreme left fuse**
2. **Upper middle left fuse**
3. **Upper, middle right fuse**
4. **Upper right fuse**
5. **Auto resetting fuse**
6. **Auto resetting fuse**

Sonic Boom Switch

The sonic boom switch is used as an input for the Toro electronic controller (TEC) to activate the Ultra Sonic Boom System. This switch has two (2) positions: automatic and manual. The sonic boom switch is located on the spray control console (Figs. 16 and 17).

If the sonic boom switch is in the automatic position, the sonic sensors will be activated to allow automatic movement of the booms. The tips of the booms will remain at a constant distance from the ground. The boom lift switches can be used to raise/lower the booms when the sonic boom switch is in the automatic position. The light in the switch should be illuminated when the switch is in the automatic position.

If the sonic boom switch is in the manual position, the sonic sensors are disabled. The boom lift switches are used to raise/lower the booms when the sonic boom switch is in the manual position.

Testing

NOTE: Before disconnecting sonic boom switch for testing, the switch and its circuit wiring should be tested as a TEC input with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). If the Diagnostic Display verifies that the sonic boom switch and circuit wiring **are** functioning correctly, no further switch testing is necessary. If, however, the Display determines that the sonic boom switch and circuit wiring **are not** functioning correctly, proceed with switch test.

1. Park vehicle on a level surface, stop engine, engage parking brake and remove key from ignition switch.

2. Locate sonic boom switch, remove console panel and unplug wire harness connector from switch.

3. The switch terminals are shown in Figure 18. The circuit logic of the sonic boom switch is shown in the chart to the right. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each switch position. Verify continuity between switch terminals. Replace switch if testing identifies a faulty switch.

4. To test switch light, apply 12 VDC to terminal 8 (+) and ground terminal 7 (–). The light should illuminate.

5. If the sonic boom switch tests correctly and circuit problem still exists, check sonic boom system wire harness.

6. After testing is completed, connect wire harness connector to the sonic boom switch. Install console panel to machine.

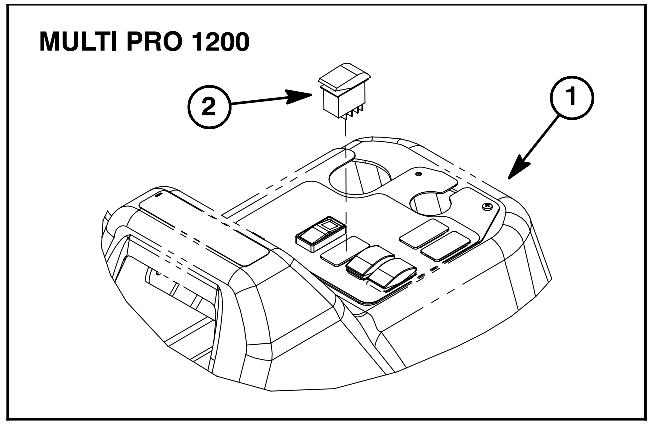

Figure 16

1. **Spray control console** 2. **Sonic boom switch**

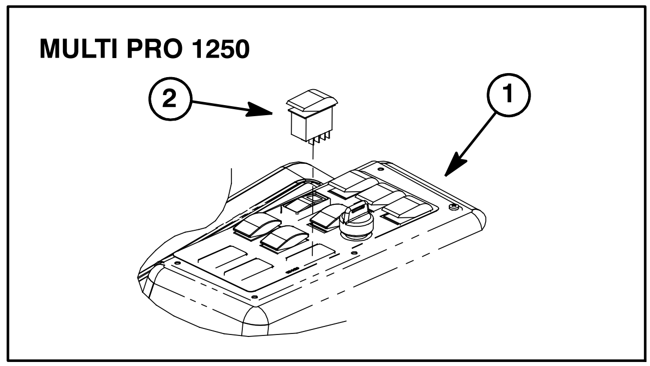

Figure 17

1. **Spray control console** 2. **Sonic boom switch**

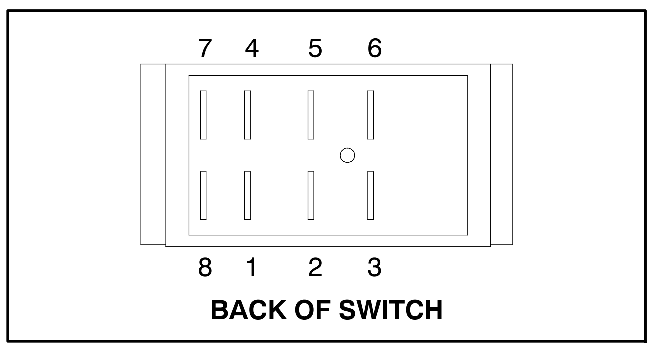

Figure 18

SWITCH POSITION	CLOSED CIRCUITS	OPEN CIRCUITS
MANUAL	2 + 3 5 + 6	2 + 1 5 + 4
AUTOMATIC	2 + 1 5 + 4	2 + 3 5 + 6

Sonic Sensors

Two (2) identical sonic sensors are used in the Ultra Sonic Boom System. The sensors are mounted to the spray booms (Figs. 19, 20 and 21). During sprayer operation with the sonic boom switch in the automatic position, the sonic sensors will provide inputs for the Toro electronic controller (TEC) to keep the booms at a constant distance from the ground.

During sprayer operation, the sonic boom sensor continually sends an impulse signal and then receives an echo as the signal bounces off the turf. The TEC establishes the sensor distance from the ground based on the time between the sensor signal generation and the received echo. The TEC then determines if the boom height is different than the calibrated height and, if necessary, energizes the appropriate boom actuator(s) to change the boom height.

Sensors should be secured to the spray booms correctly for proper sonic sensor operation. Refer to the Ultra Sonic Boom Kit Installation Instructions for sonic sensor installation and setup information.

The sonic sensors and their circuit wiring can be tested as TEC inputs with the Diagnostic Display (see Diagnostic Display in the Troubleshooting section of this chapter). Because of the solid state circuitry built into the sensors, there is no method to test them directly. The sensors may be damaged if an attempt is made to test them with an electrical test device (e.g. digital multimeter or test light).

IMPORTANT: Do not spray water at or on the sensors. Water sprayed even under household pressure can damage the sensor. Always install sensor cap on sensor before washing the sprayer. Also, install cap when sprayer is not in use.

As required, use a damp cloth to clean the sensors. Make sure that the sensor covers and caps are clean and dry before installing them on sensors. When the sprayer is not being used, it is recommended to have the caps installed on the sensors for sensor protection.

Each of the sonic sensor assemblies includes a programming plug for sensor accuracy. If a programming plug is removed from the sensor, make sure that the arrow below the sideways T on the plug is aligned with the notch on the top edge of the sensor (Fig. 22).

NOTE: The two (2) sonic sensors are identical. To assist in troubleshooting, sensors can be exchanged. If the problem follows the exchanged sensor, an electrical problem likely exists with the sensor. If the problem remains unchanged, something other than the sensor is the problem source.

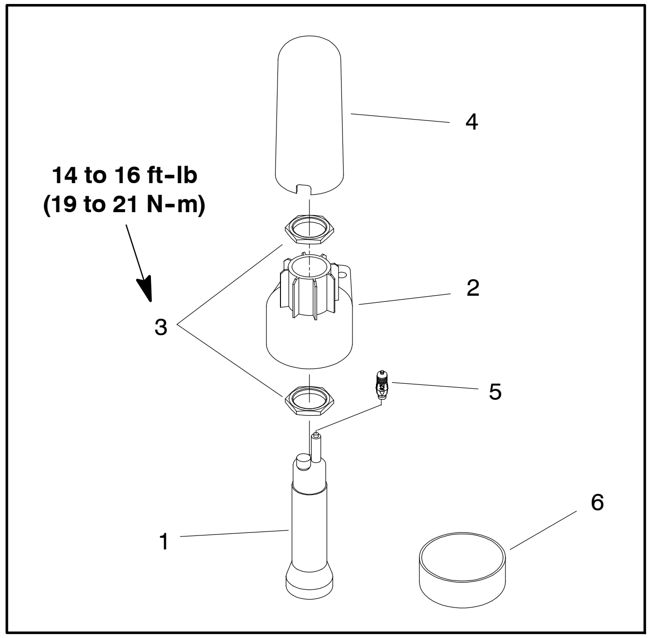

Figure 19

1. **Sonic sensor**
2. **Lower housing**
3. **Nut (2 used)**
4. **Cover**
5. **Programming plug**
6. **Cap**

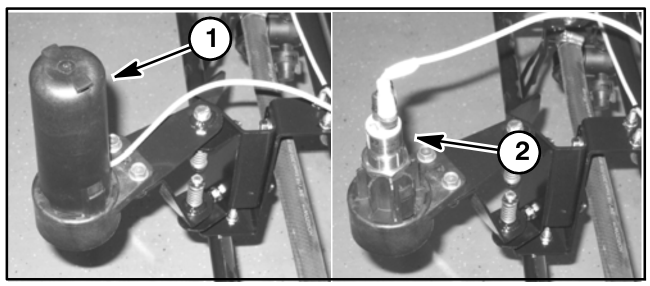

Figure 20

1. **Sensor with cover**
2. **Sensor without cover**

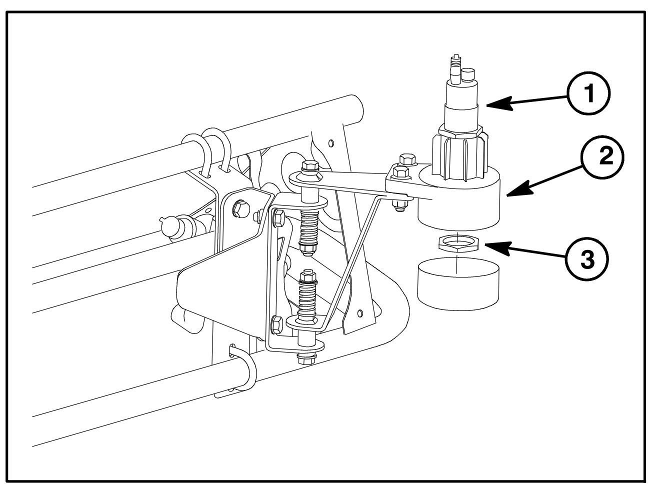

Figure 21

1. **Sonic sensor**
2. **Lower housing**
3. **Nut (2 used)**

Sonic Sensor LED Window

The sonic sensor includes a LED window that identifies sensor status during sprayer operation during operation of the Ultra Sonic Boom system (Fig. 23). To view the LED window, carefully remove cover from sonic sensor. The LED window includes four (4) LED's.

During normal operation, the green LED and both yellow LED's should be illuminated. The red LED will be off.

If there is some interference with normal sensor operation, the red LED will be flashing. The green LED will be off. The yellow LED's may flash, be illuminated or be off.

If the sensor programming plug is removed or is faulty, the red LED will be illuminated. The green LED will be off. The yellow LED's may flash, be illuminated or be off.

The status of the LED's on the sensors can be used to identify a faulty or unplugged programming plug. The LED's also can be used to identify the presence of interference that can affect Ultra Sonic Boom system operation. If the LED's do not illuminate correctly, a problem may exist with circuit wiring to the sensor or with the sensor itself.

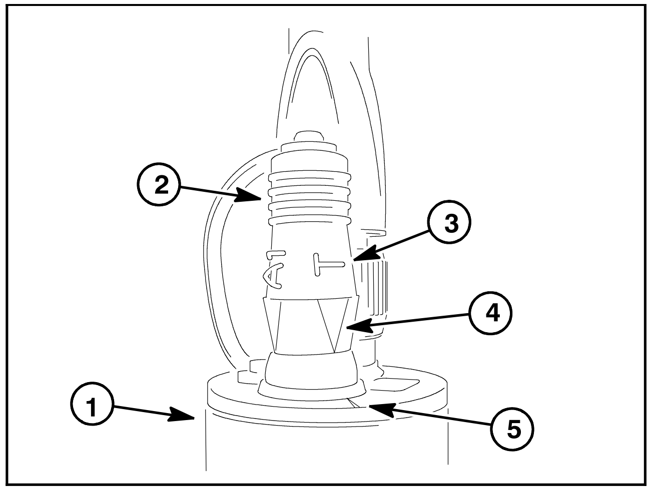

Figure 22

1. **Sonic sensor**
2. **Programming plug**
3. **Letter T**
4. **Plug arrow**
5. **Sensor notch**

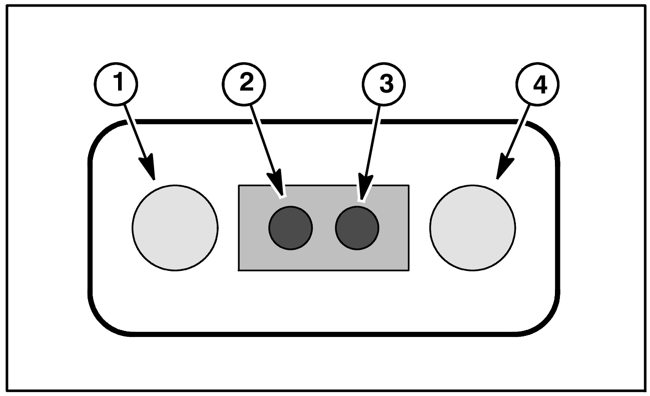

Figure 23

1. **Yellow LED**
2. **Green LED**
3. **Red LED**
4. **Yellow LED**

Relays

The Ultra Sonic Boom System uses four (4) identical relays to control the boom actuators and ultimately the boom height. Two (2) of the relays control the right boom actuator and the other two (2) relays control the left boom actuator. The Toro electronic controller (TEC) controls the operation of the relays. The appropriate relay is energized by the TEC to allow current flow to the boom actuators in the proper direction so that the actuator extends (boom raise) or retracts (boom lower).

The relays are located on a mount plate under the vehicle dash panel (Fig. 24) and can be identified by a label on the wire harness connector.

Testing

1. Park vehicle on a level surface, stop engine, engage parking brake and remove key from ignition switch.

2. Remove mount plate from under dash panel to allow easier relay access.

3. Locate relay to be tested and disconnect wire harness connector from relay. Remove relay from mount plate for testing.

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

4. Using a multimeter, verify that coil resistance between terminals 85 and 86 is from 71 to 88 ohms.

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

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

7. 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.

8. Disconnect voltage and multimeter test leads from the relay terminals. Replace relay if necessary.

9. Secure relay to mount plate and connect wire harness connector to relay. Secure mount plate to machine frame.

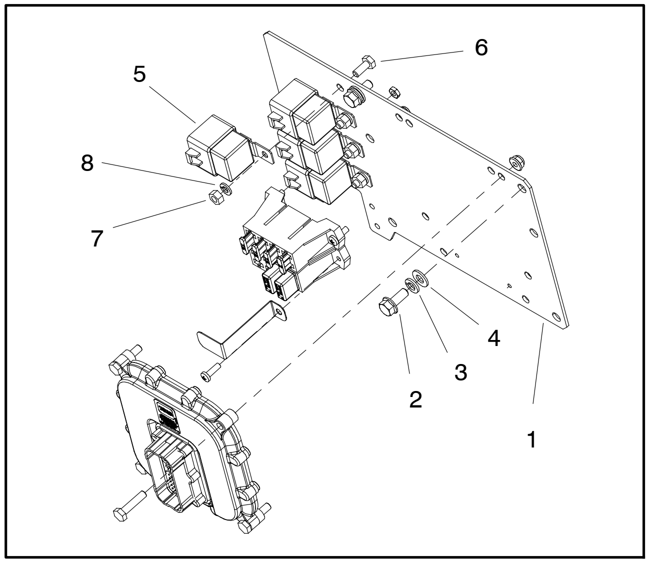

Figure 24

1. **Mount plate**
2. **Flange screw (2 used)**
3. **Lock washer (2 used)**
4. **Flat washer (2 used)**
5. **Relay (4 used)**
6. **Cap screw (4 used)**
7. **Lock washer (4 used)**
8. **Nut (4 used)**

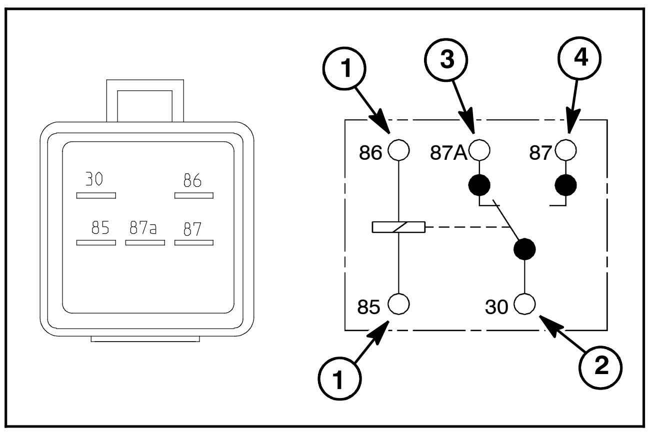

Figure 25

1. **Coil terminal**
2. **Common terminal**
3. **Normally closed term.**
4. **Normally open term.**

Toro Electronic Controller (TEC)

The Ultra Sonic Boom System uses the Toro Electronic Controller (TEC) to control electrical system operation. The TEC is attached to a mounting plate under the dash panel (Fig. 26).

Power is provided to the TEC when the vehicle ignition switch is ON. A 2 Amp fuse provides circuit protection for this logic power to the TEC. The fuse is located in the Ultra Sonic Boom System fuse block under the dash panel.

The TEC monitors the states of the following components as inputs: the sonic boom switch, the two (2) boom lift switches, the two (2) sonic boom sensors and the diagnostic shunt wires.

The TEC controls electrical output to the sonic boom light, the diagnostic lamp, the four (4) relays used to control the sonic boom system and the two (2) sonic boom sensors. Circuit protection for the TEC outputs is provided by three (3) 7.5 Amp fuses located in the Ultra Sonic Boom System fuse block.

Testing of the TEC inputs and outputs can be completed with the use of the Diagnostic Display (see the Special Tools and Troubleshooting sections of this chapter).

Because of the solid state circuitry built into the TEC, there is no method to test it directly. The TEC may be damaged if an attempt is made to test it with an electrical test device (e.g. digital multimeter or test light).

IMPORTANT: Before performing welding on the machine, disconnect both cables from the battery and disconnect wire harness connector from the TEC. These steps will prevent damage to the machine electrical system.

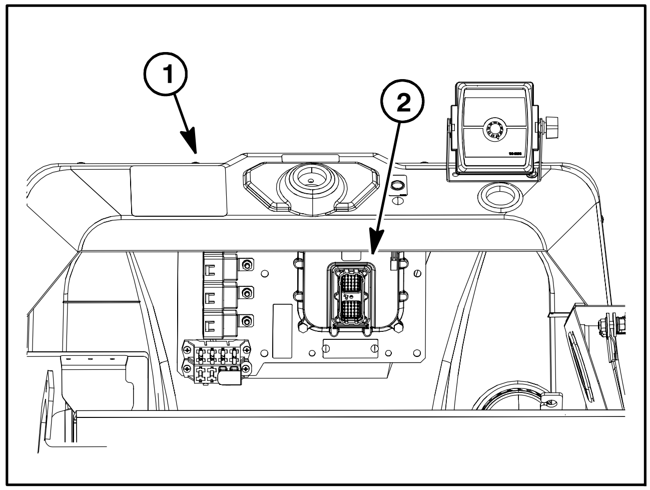

Figure 26

1. **Dash panel**
2. **TEC controller**

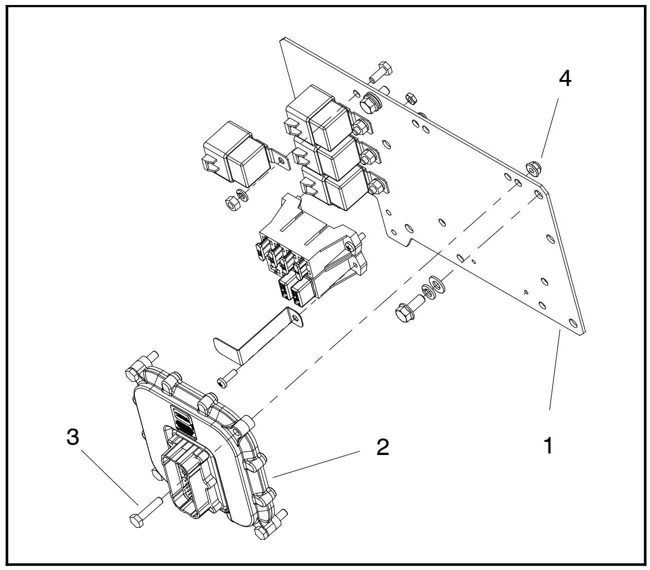

Figure 27

1. **Mount plate**
2. **TEC controller**
3. **Cap screw (4 used)**
4. **Flange nut (4 used)**

Ultra Sonic Boom System

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Chapter 10

Electrical Drawings

Table of Contents

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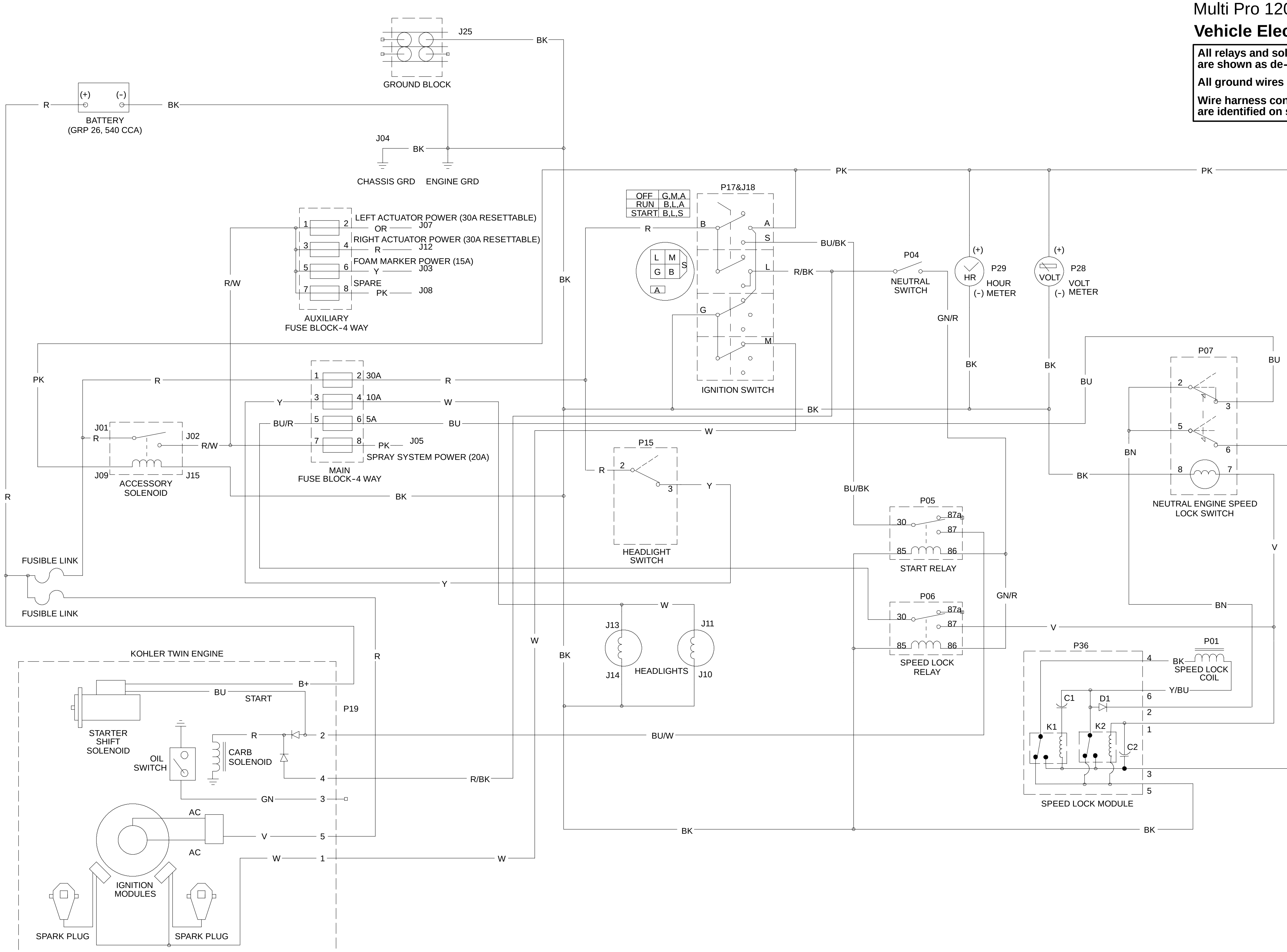
Multi Pro 1200/1250
Vehicle Electrical Schematic

All relays and solenoids are shown as de-energized.

All ground wires are black.

Wire harness connector numbers are identified on schematic.

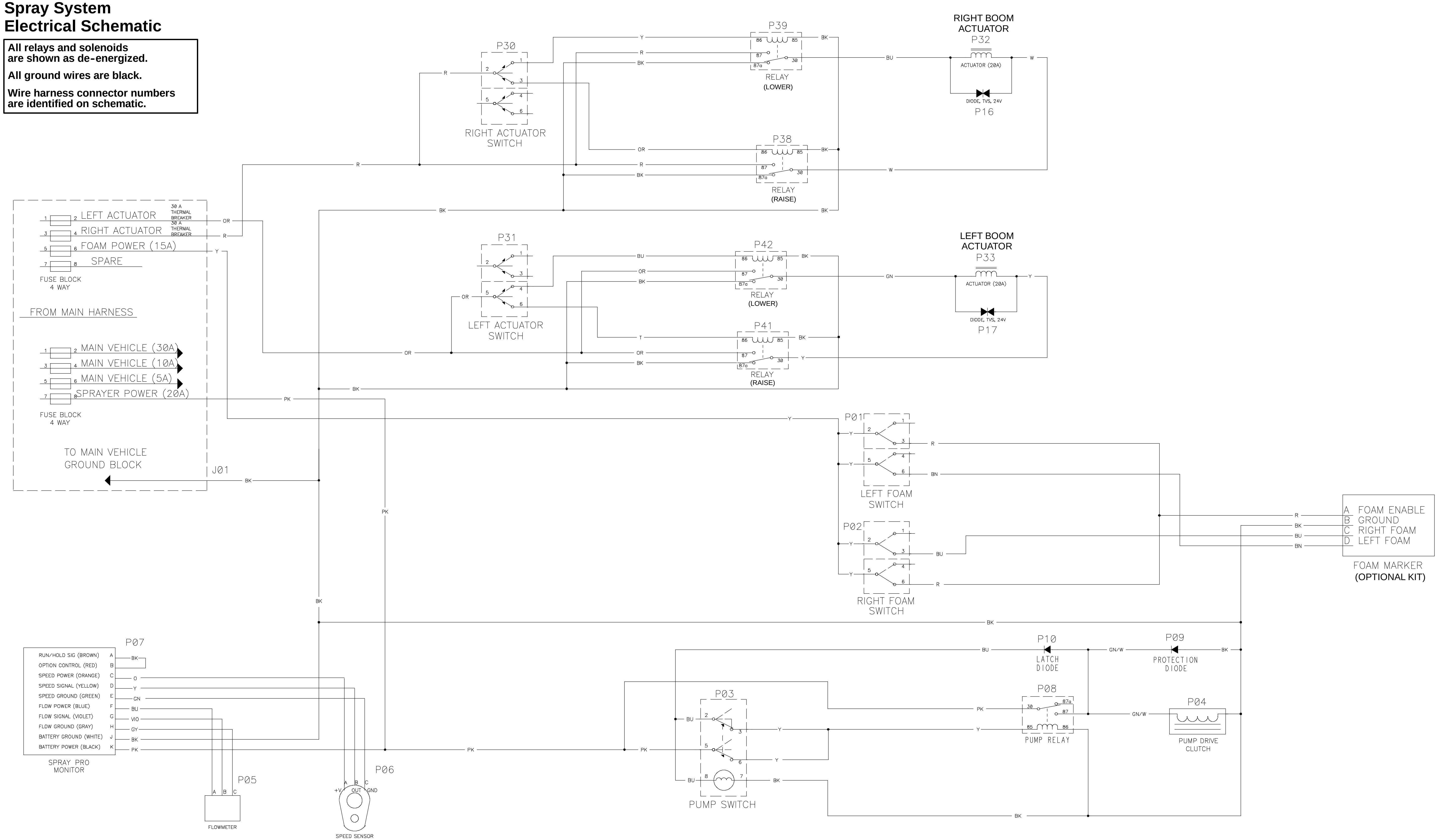


Multi Pro 1200
Spray System
Electrical Schematic

All relays and solenoids are shown as de-energized.

All ground wires are black.

Wire harness connector numbers are identified on schematic.

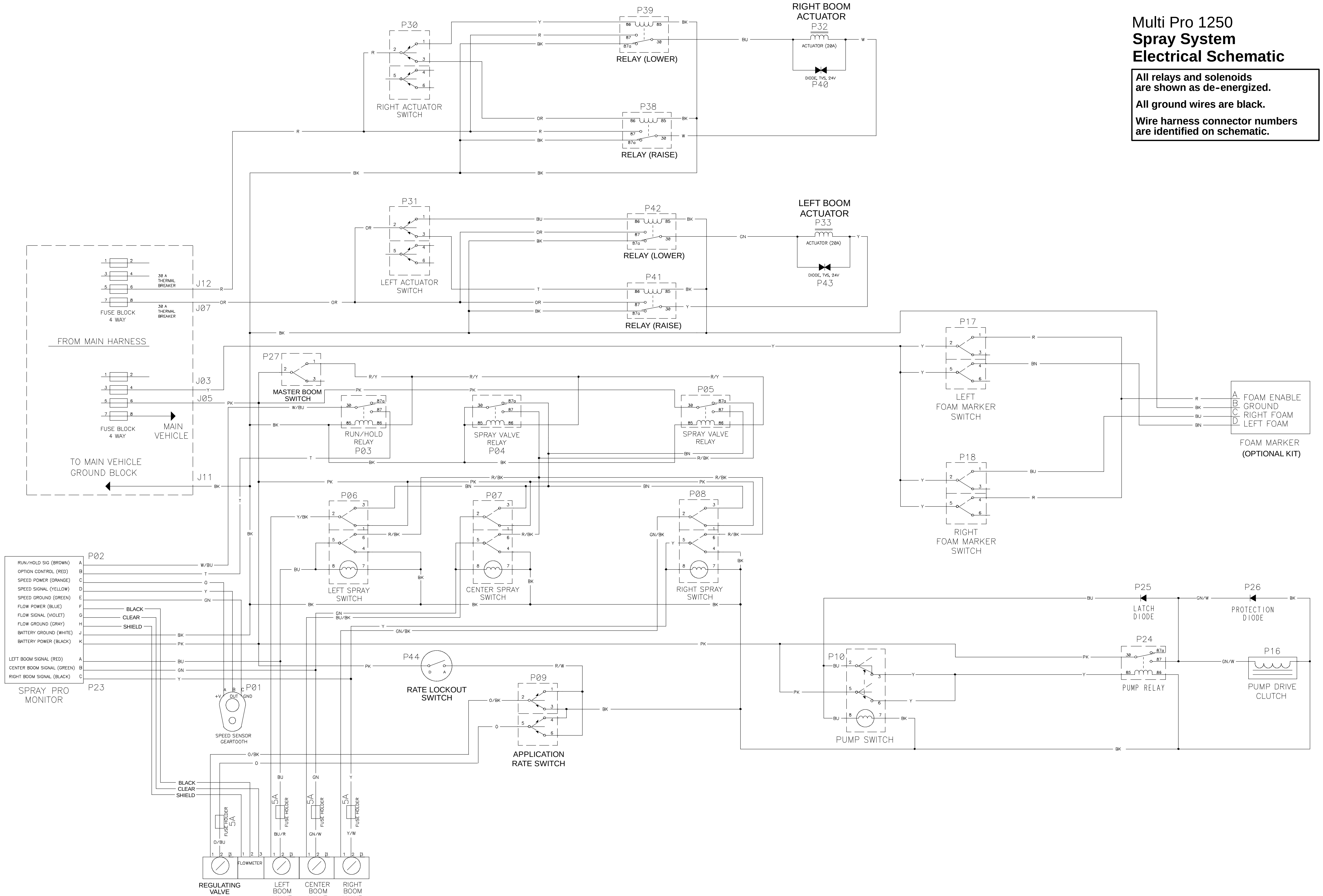


Multi Pro 1250
Spray System
Electrical Schematic

All relays and solenoids are shown as de-energized.

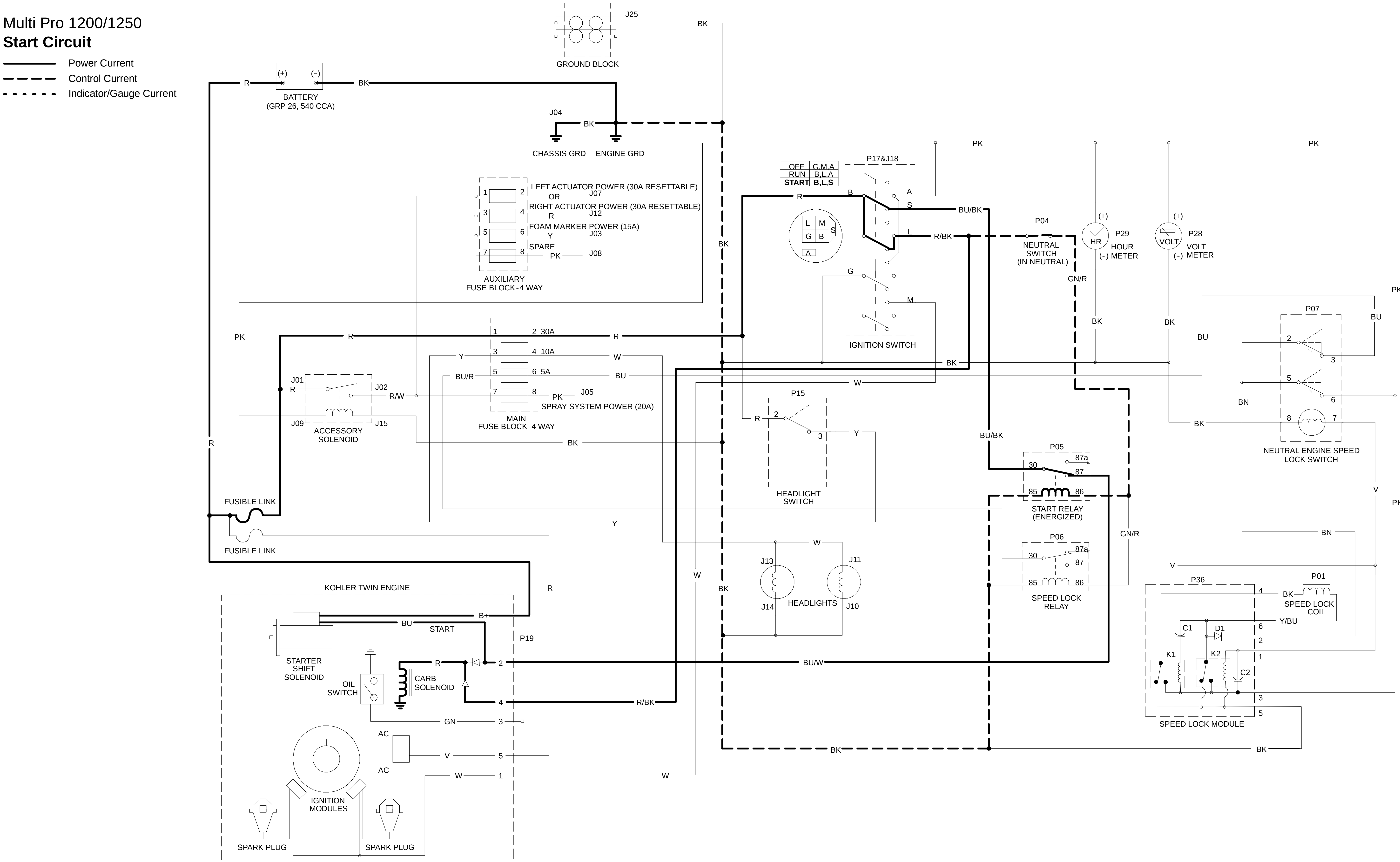
All ground wires are black.

Wire harness connector numbers are identified on schematic.

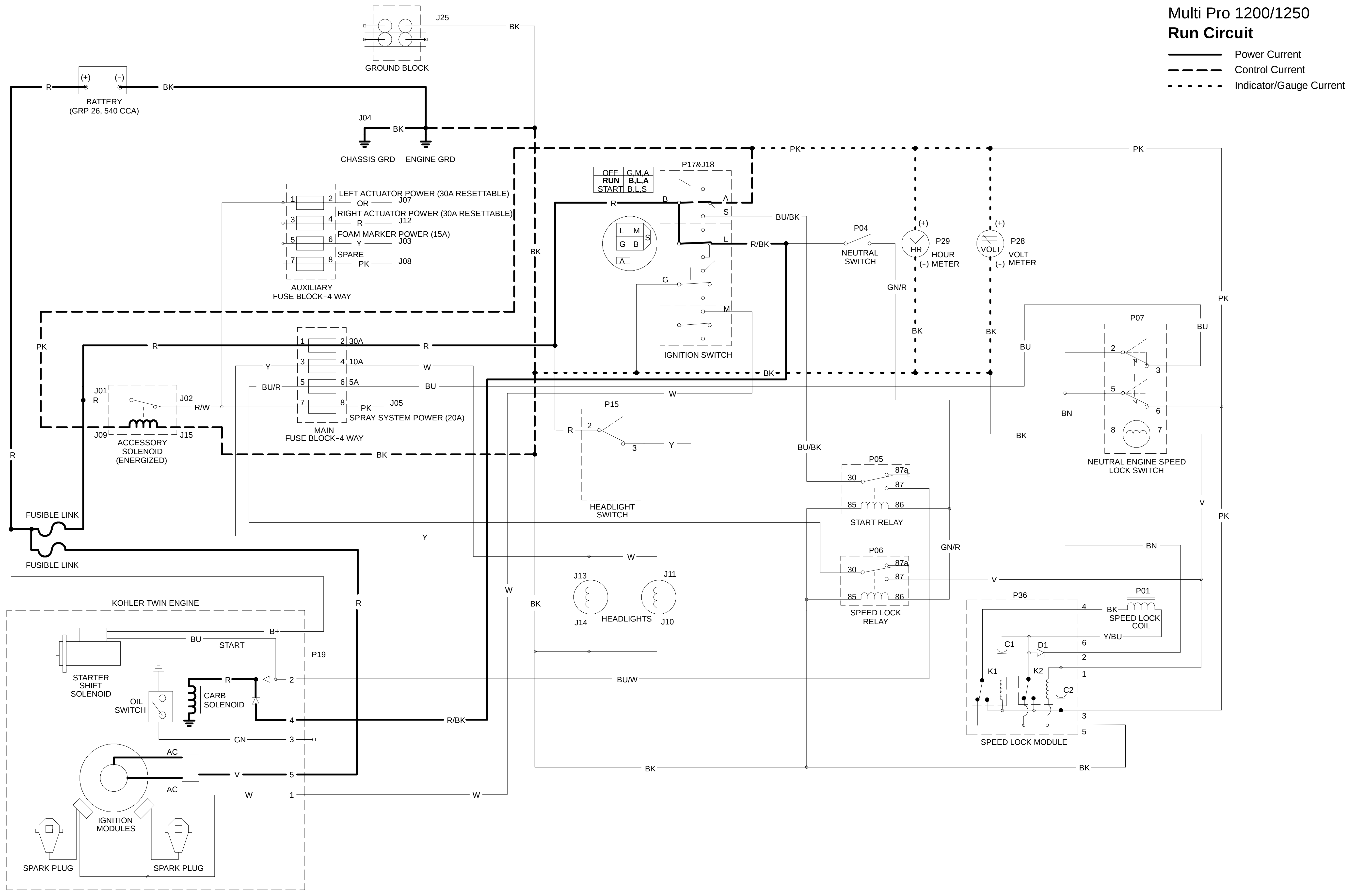


Multi Pro 1200/1250

Start Circuit

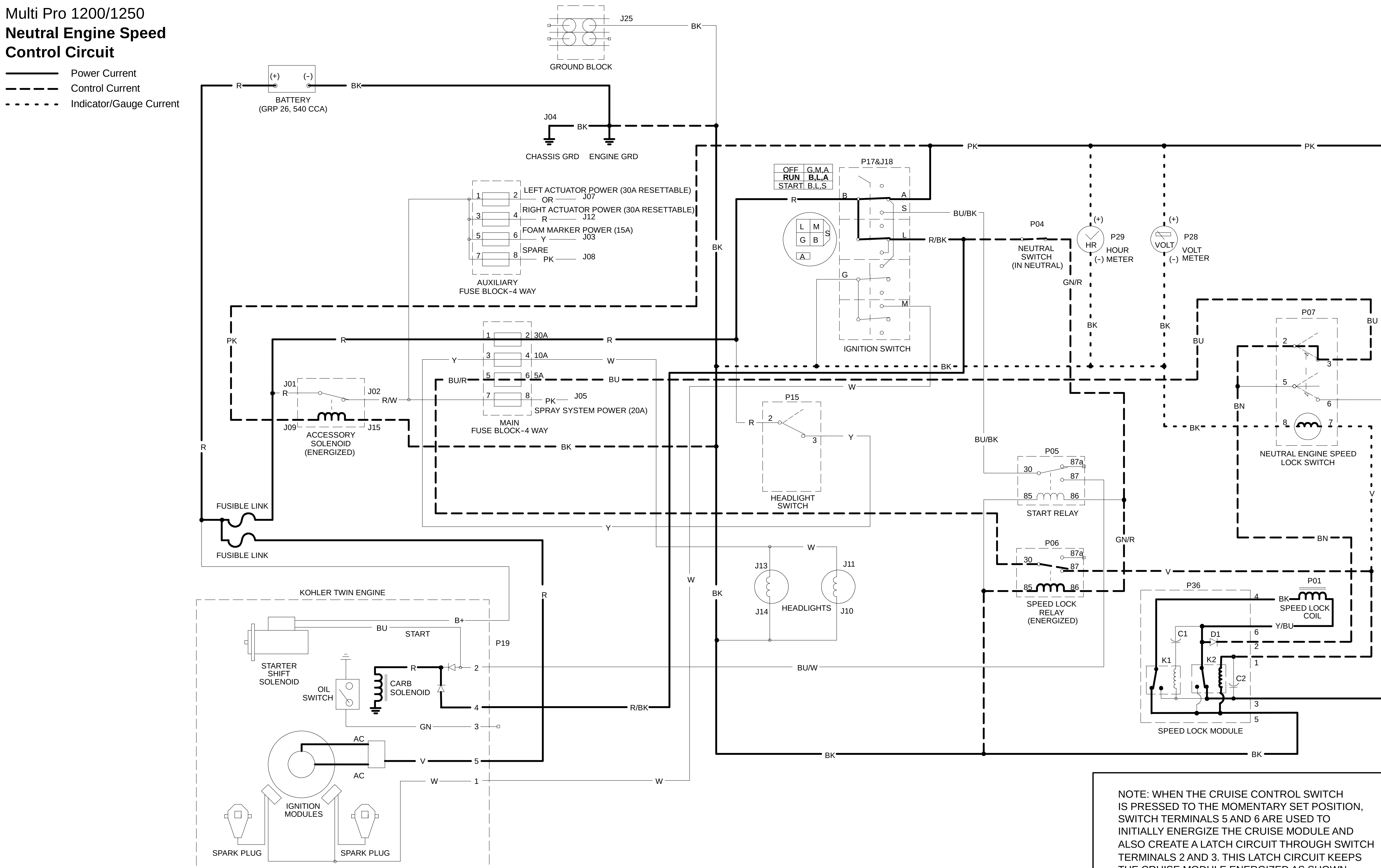


Multi Pro 1200/1250
Run Circuit



Multi Pro 1200/1250

Neutral Engine Speed Control Circuit



NOTE: WHEN THE CRUISE CONTROL SWITCH IS PRESSED TO THE MOMENTARY SET POSITION, SWITCH TERMINALS 5 AND 6 ARE USED TO INITIALLY ENERGIZE THE CRUISE MODULE AND ALSO CREATE A LATCH CIRCUIT THROUGH SWITCH TERMINALS 2 AND 3. THIS LATCH CIRCUIT KEEPS THE CRUISE MODULE ENERGIZED AS SHOWN.

Multi Pro 1200

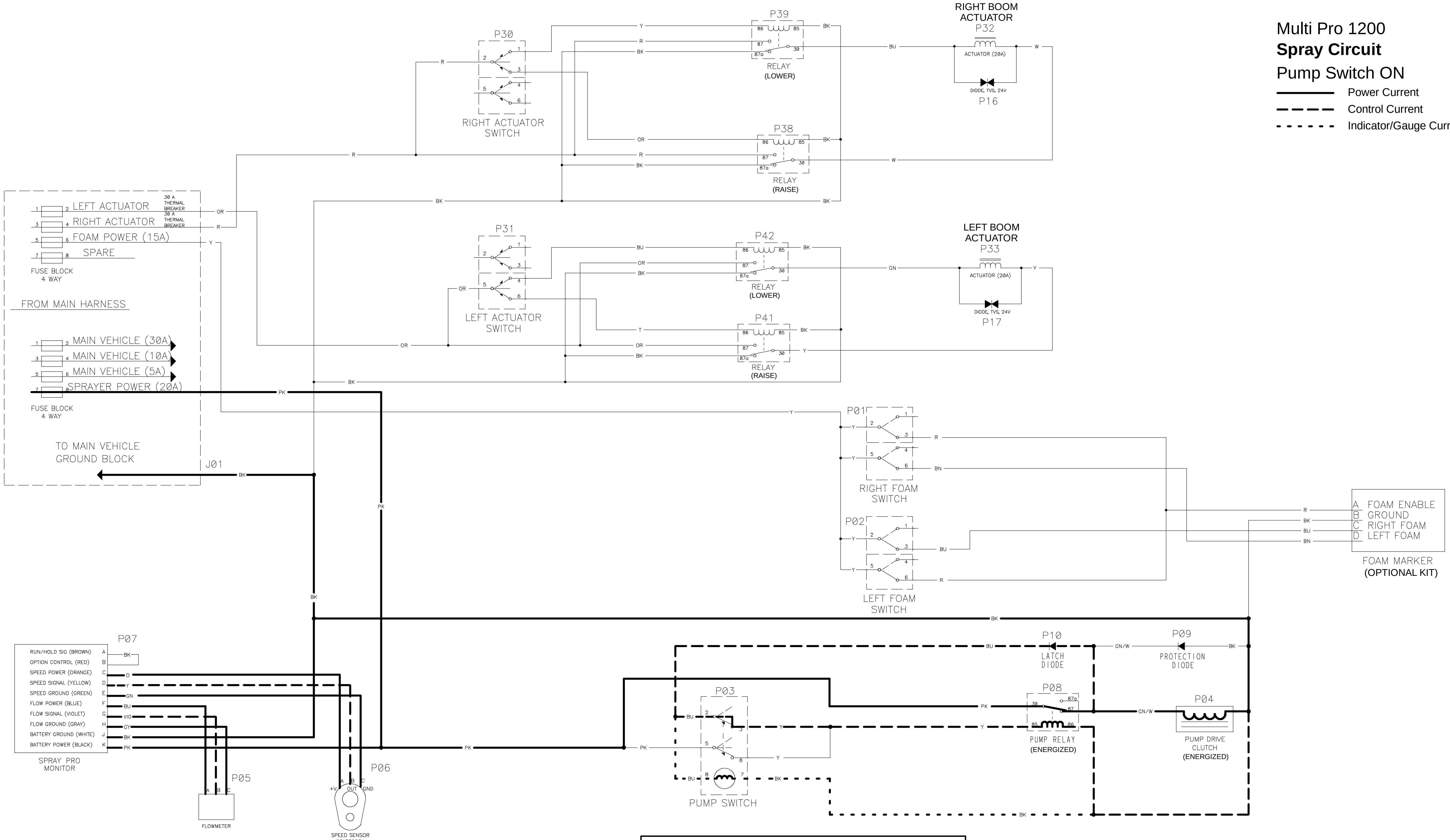
Spray Circuit

Pump Switch ON

Power Current

Control Current

Indicator/Gauge Current



NOTE: WHEN THE PUMP SWITCH IS PRESSED TO THE MOMENTARY ON POSITION, SWITCH TERMINALS 5 AND 6 ARE USED TO INITIALLY ENERGIZE THE PUMP RELAY AND ALSO TO CREATE A LATCH CIRCUIT THROUGH SWITCH TERMINALS 2 AND 3. THIS LATCH CIRCUIT KEEPS THE PUMP RELAY ENERGIZED AS SHOWN.

Multi Pro 1250

Spray Circuit

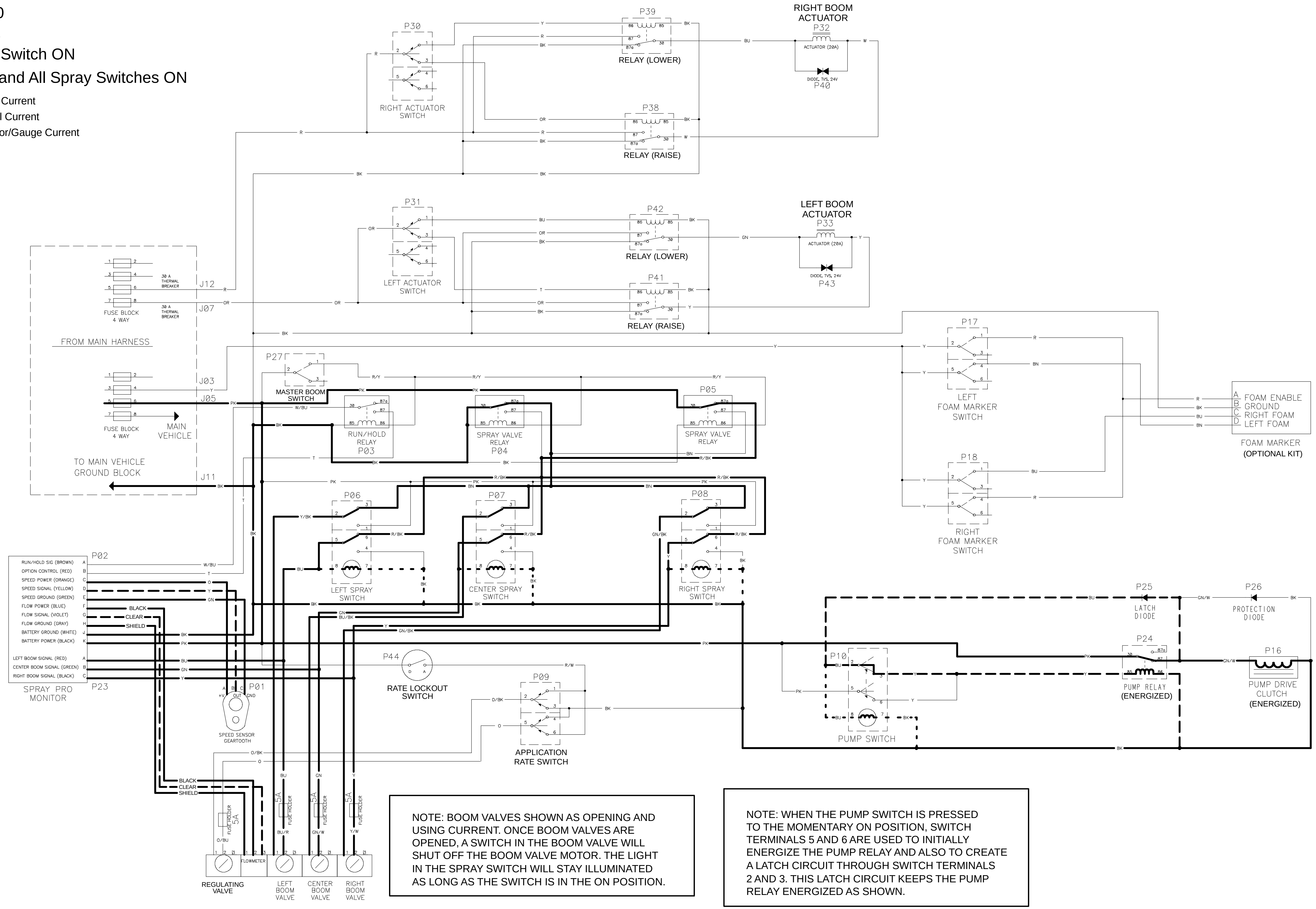
Master Boom Switch ON

Pump Switch and All Spray Switches ON

Power Current

Control Current

Indicator/Gauge Current



NOTE: BOOM VALVES SHOWN AS OPENING AND USING CURRENT. ONCE BOOM VALVES ARE OPENED, A SWITCH IN THE BOOM VALVE WILL SHUT OFF THE BOOM VALVE MOTOR. THE LIGHT IN THE SPRAY SWITCH WILL STAY ILLUMINATED AS LONG AS THE SWITCH IS IN THE ON POSITION.

NOTE: WHEN THE PUMP SWITCH IS PRESSED TO THE MOMENTARY ON POSITION, SWITCH TERMINALS 5 AND 6 ARE USED TO INITIALLY ENERGIZE THE PUMP RELAY AND ALSO TO CREATE A LATCH CIRCUIT THROUGH SWITCH TERMINALS 2 AND 3. THIS LATCH CIRCUIT KEEPS THE PUMP RELAY ENERGIZED AS SHOWN.

Multi Pro 1250

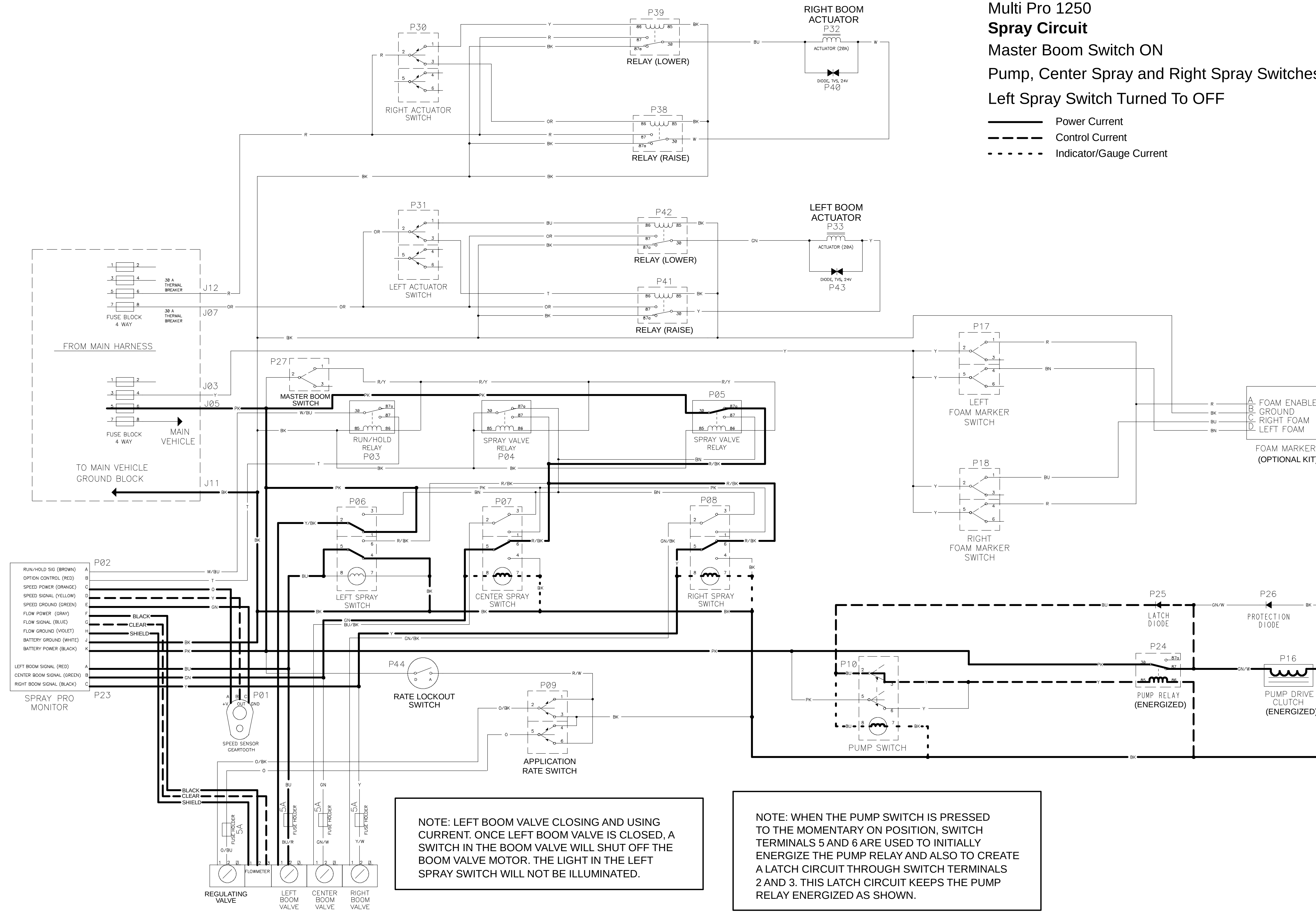
Spray Circuit

Master Boom Switch ON

Pump, Center Spray and Right Spray Switches ON

Left Spray Switch Turned To OFF

- Power Current (solid line)
- Control Current (long dash line)
- Indicator/Gauge Current (short dash line)



NOTE: LEFT BOOM VALVE CLOSING AND USING CURRENT. ONCE LEFT BOOM VALVE IS CLOSED, A SWITCH IN THE BOOM VALVE WILL SHUT OFF THE BOOM VALVE MOTOR. THE LIGHT IN THE LEFT SPRAY SWITCH WILL NOT BE ILLUMINATED.

NOTE: WHEN THE PUMP SWITCH IS PRESSED TO THE MOMENTARY ON POSITION, SWITCH TERMINALS 5 AND 6 ARE USED TO INITIALLY ENERGIZE THE PUMP RELAY AND ALSO TO CREATE A LATCH CIRCUIT THROUGH SWITCH TERMINALS 2 AND 3. THIS LATCH CIRCUIT KEEPS THE PUMP RELAY ENERGIZED AS SHOWN.

Multi Pro 1250

Spray Circuit

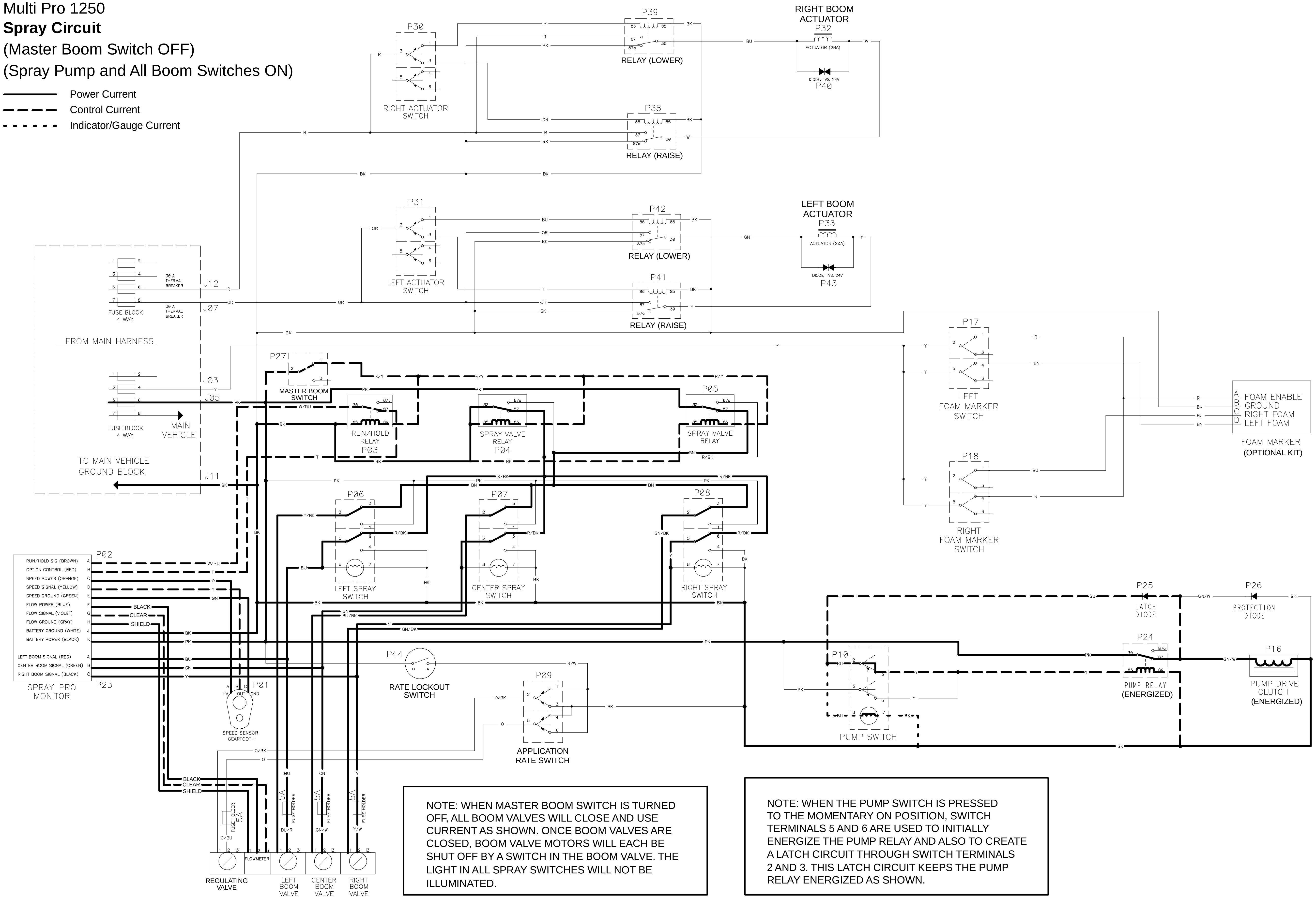
(Master Boom Switch OFF)

(Spray Pump and All Boom Switches ON)

Power Current

Control Current

Indicator/Gauge Current

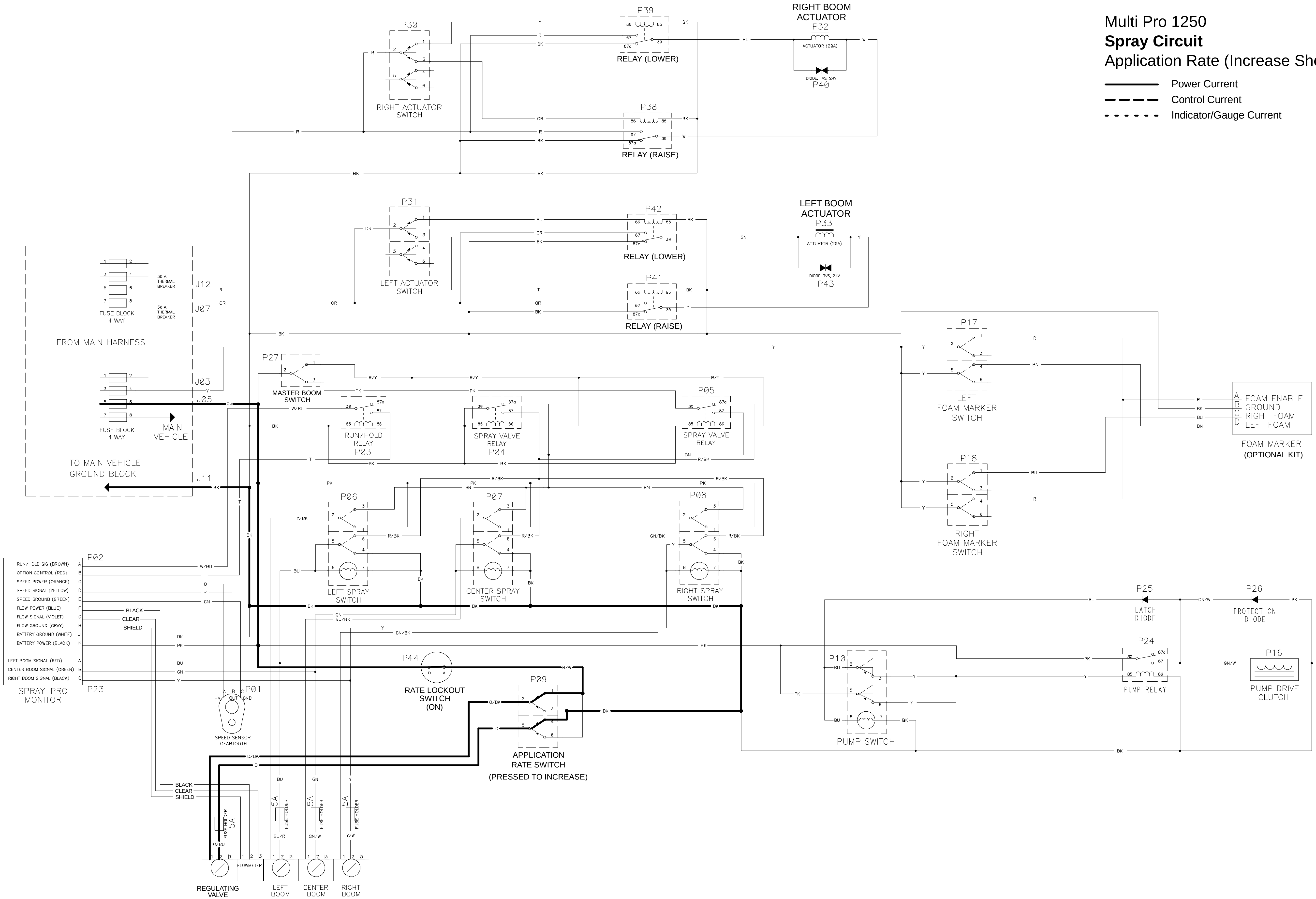


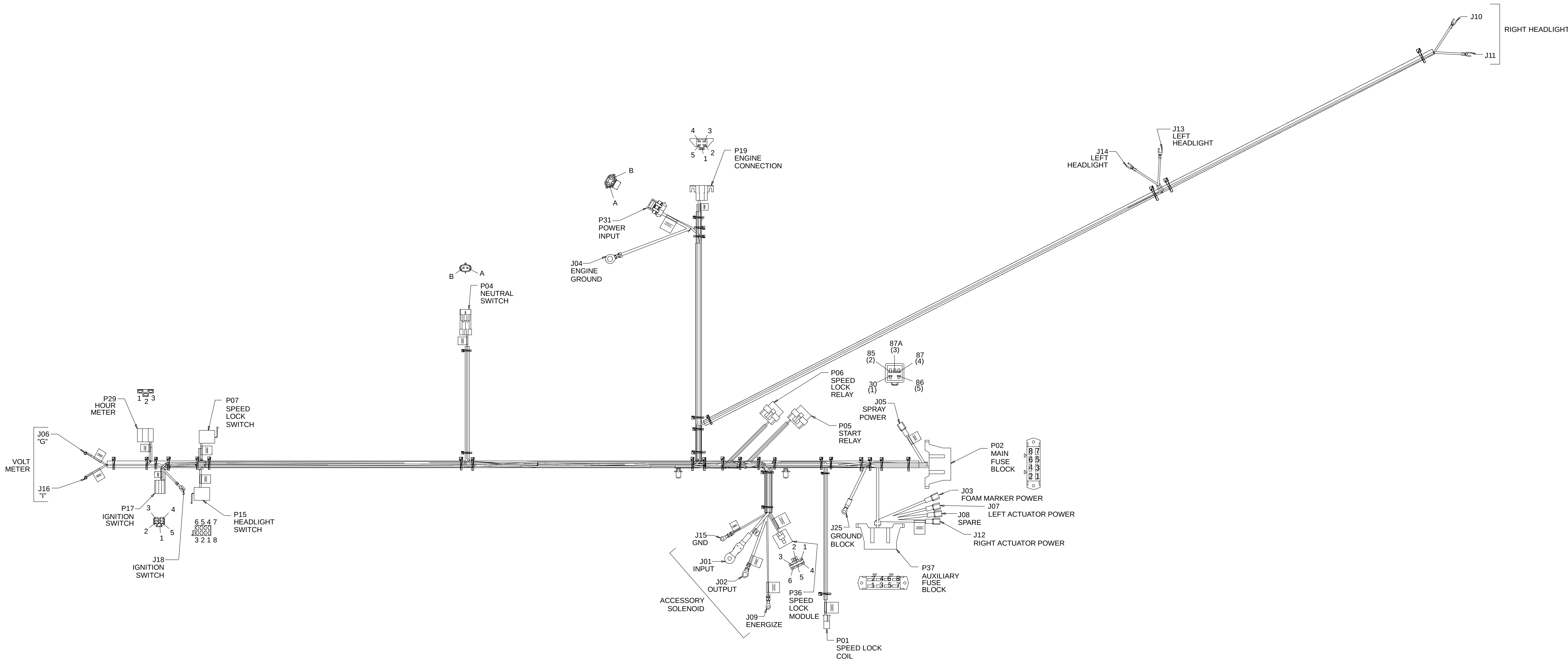
NOTE: WHEN MASTER BOOM SWITCH IS TURNED OFF, ALL BOOM VALVES WILL CLOSE AND USE CURRENT AS SHOWN. ONCE BOOM VALVES ARE CLOSED, BOOM VALVE MOTORS WILL EACH BE SHUT OFF BY A SWITCH IN THE BOOM VALVE. THE LIGHT IN ALL SPRAY SWITCHES WILL NOT BE ILLUMINATED.

NOTE: WHEN THE PUMP SWITCH IS PRESSED TO THE MOMENTARY ON POSITION, SWITCH TERMINALS 5 AND 6 ARE USED TO INITIALLY ENERGIZE THE PUMP RELAY AND ALSO TO CREATE A LATCH CIRCUIT THROUGH SWITCH TERMINALS 2 AND 3. THIS LATCH CIRCUIT KEEPS THE PUMP RELAY ENERGIZED AS SHOWN.

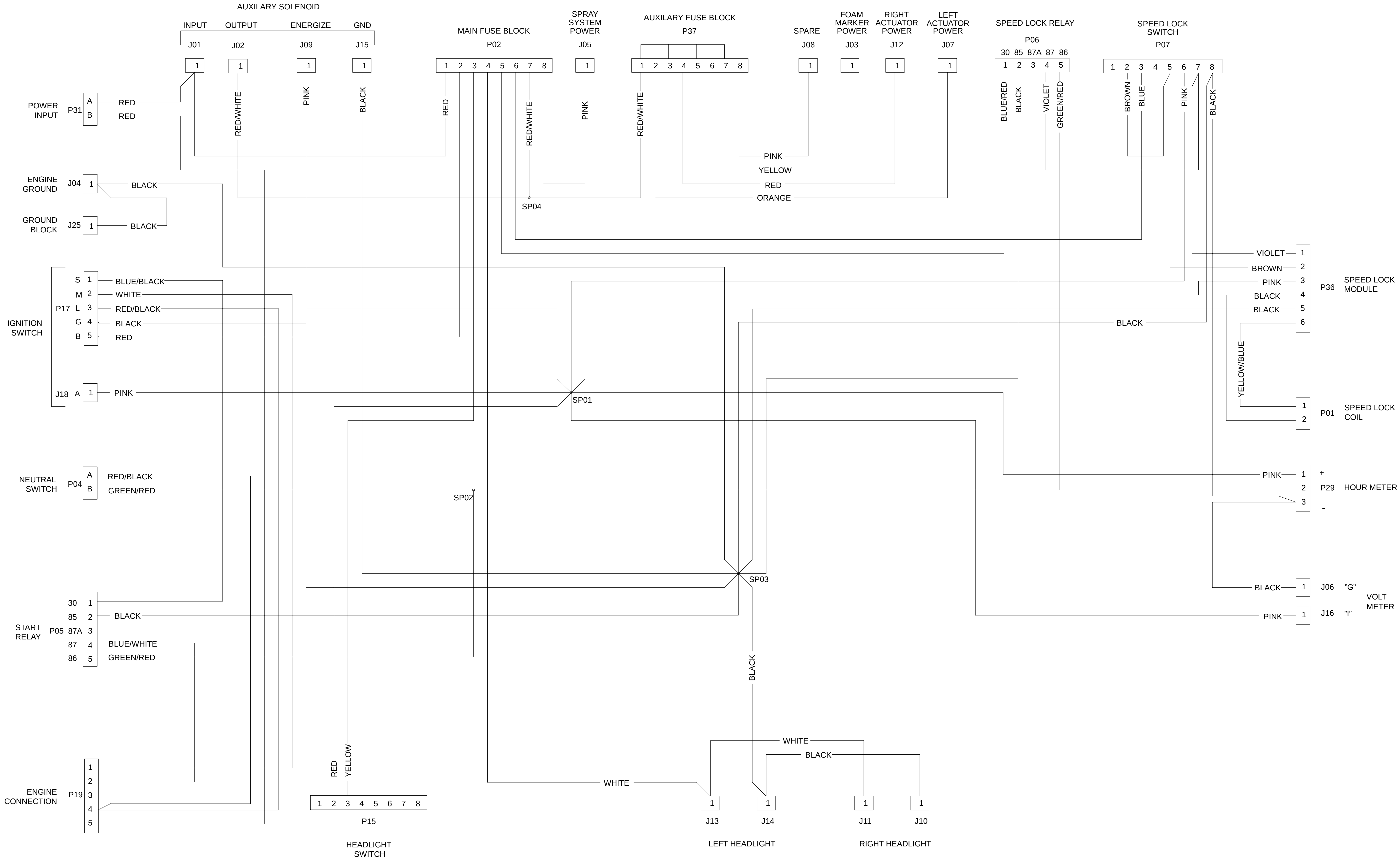
Multi Pro 1250
Spray Circuit
Application Rate (Increase Shown)

Power Current
Control Current
Indicator/Gauge Current

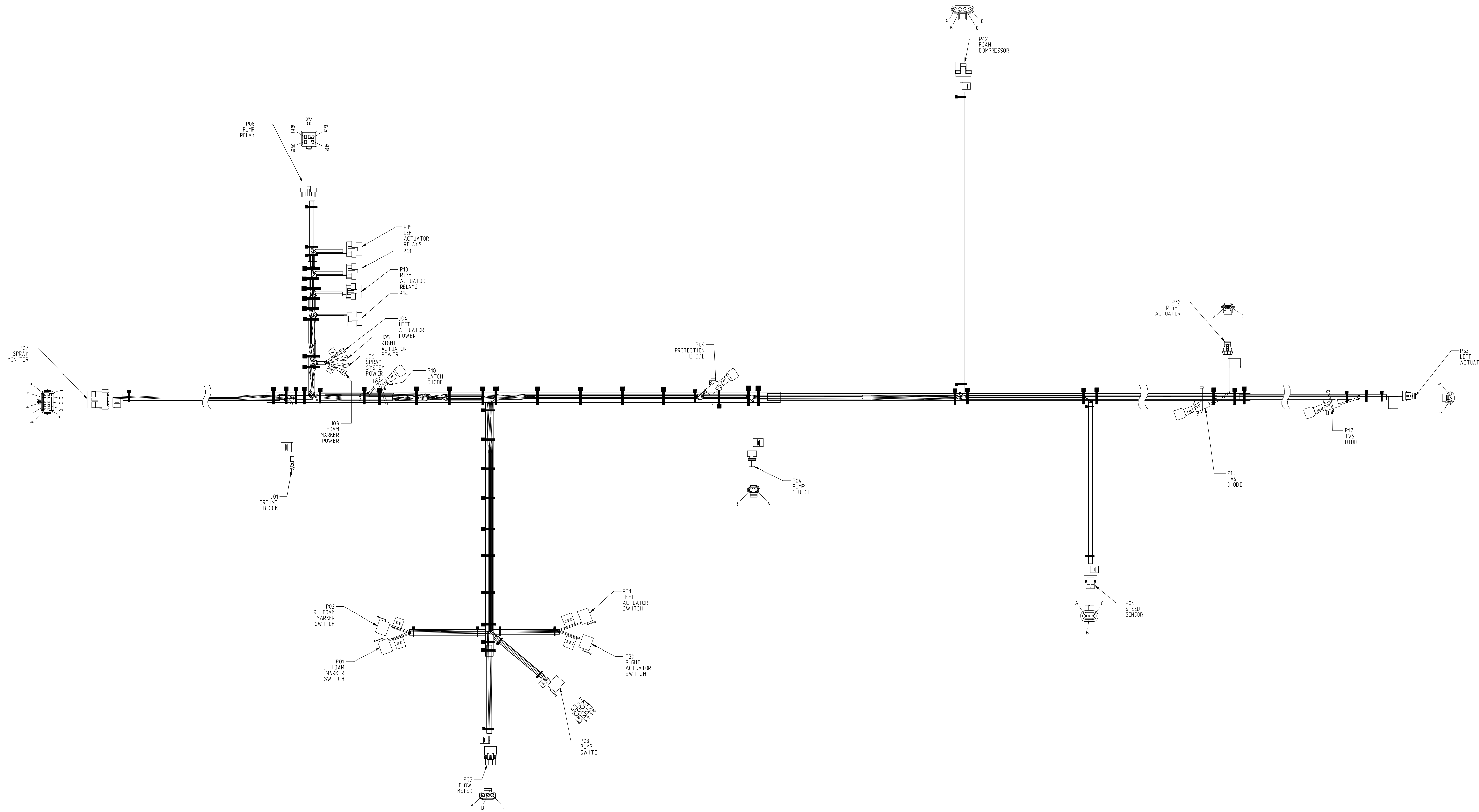




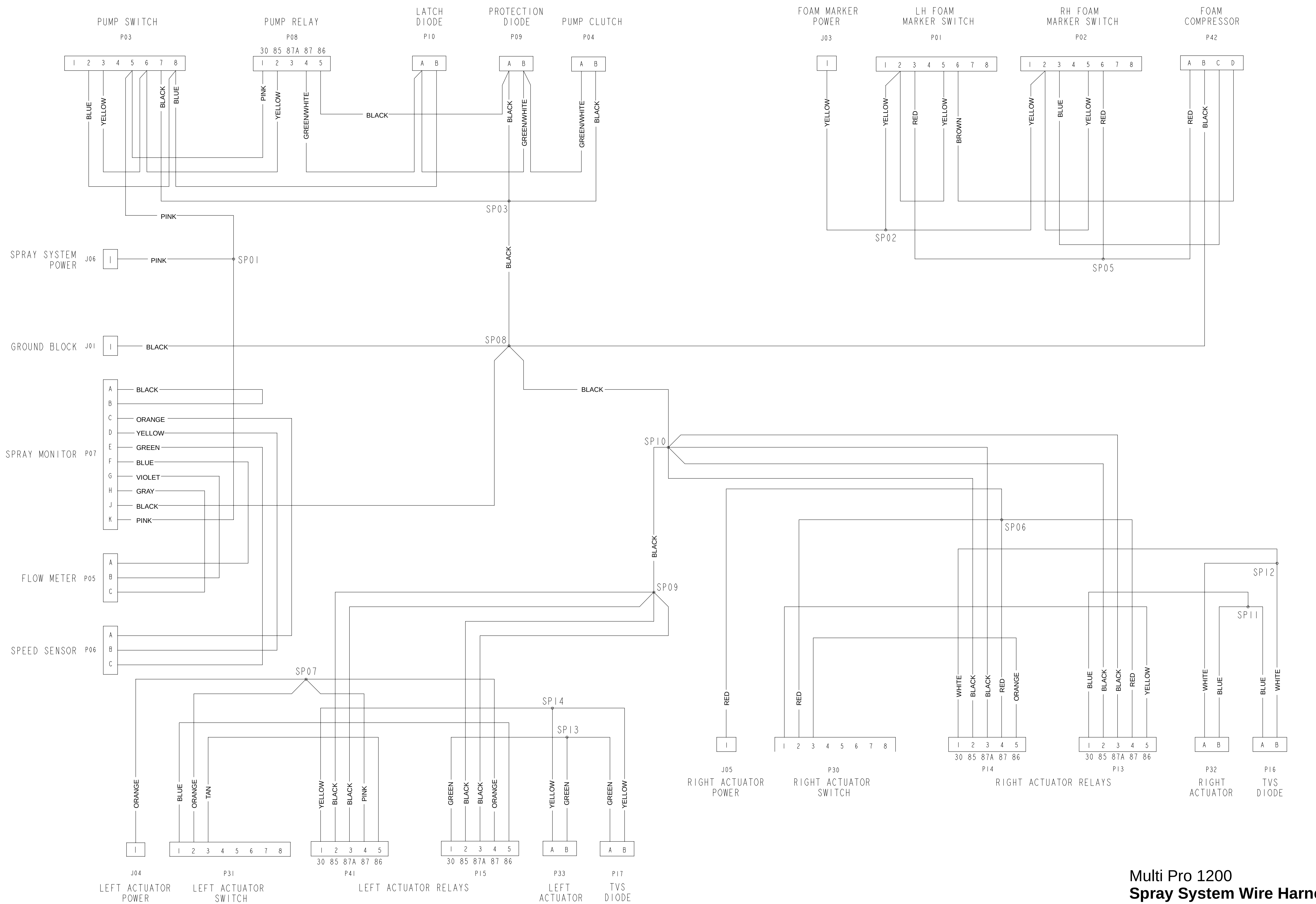
Multi Pro 1200/1250
Main Wire Harness



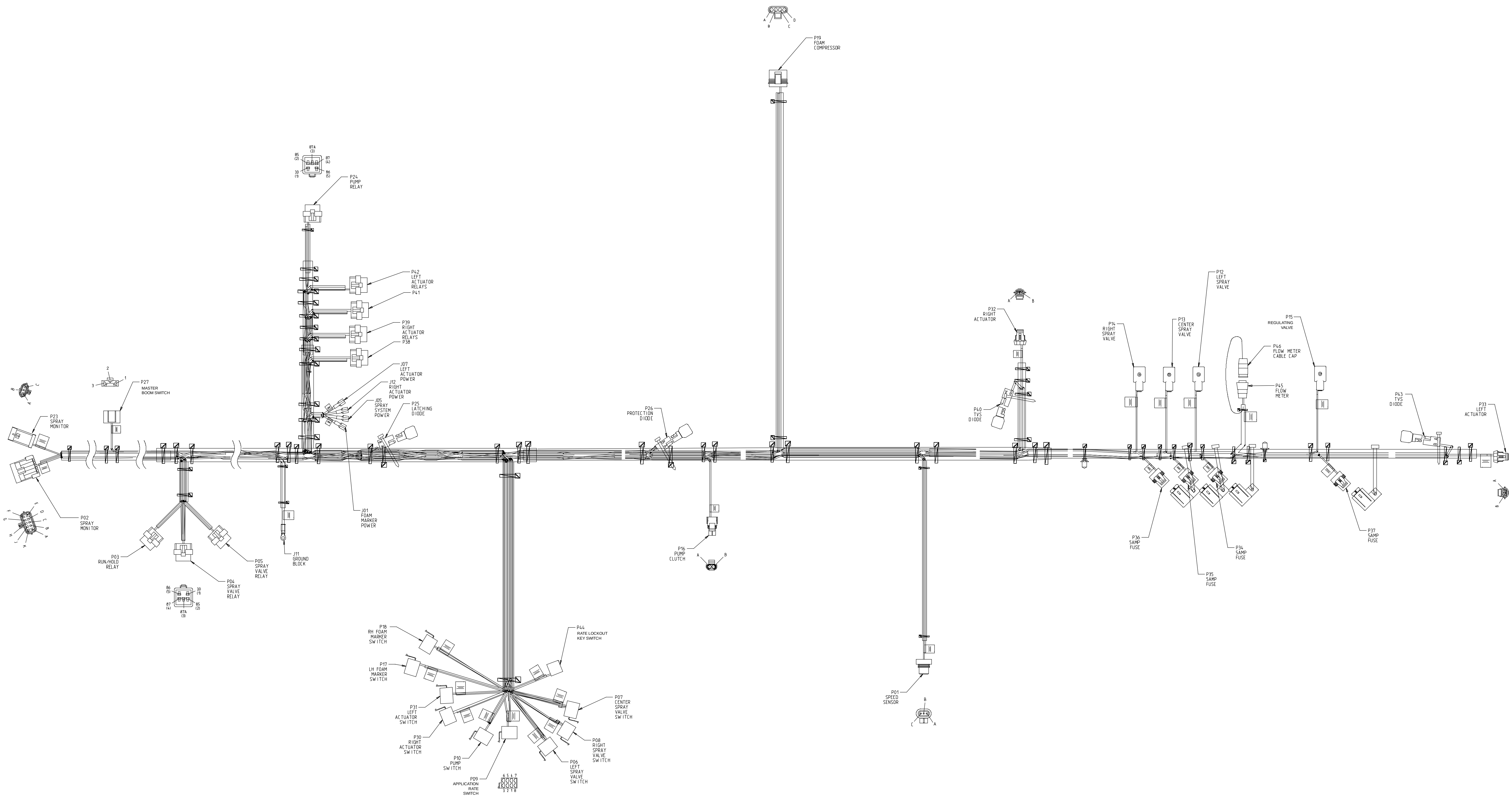
Multi Pro 1200/1250
Main Wire Harness



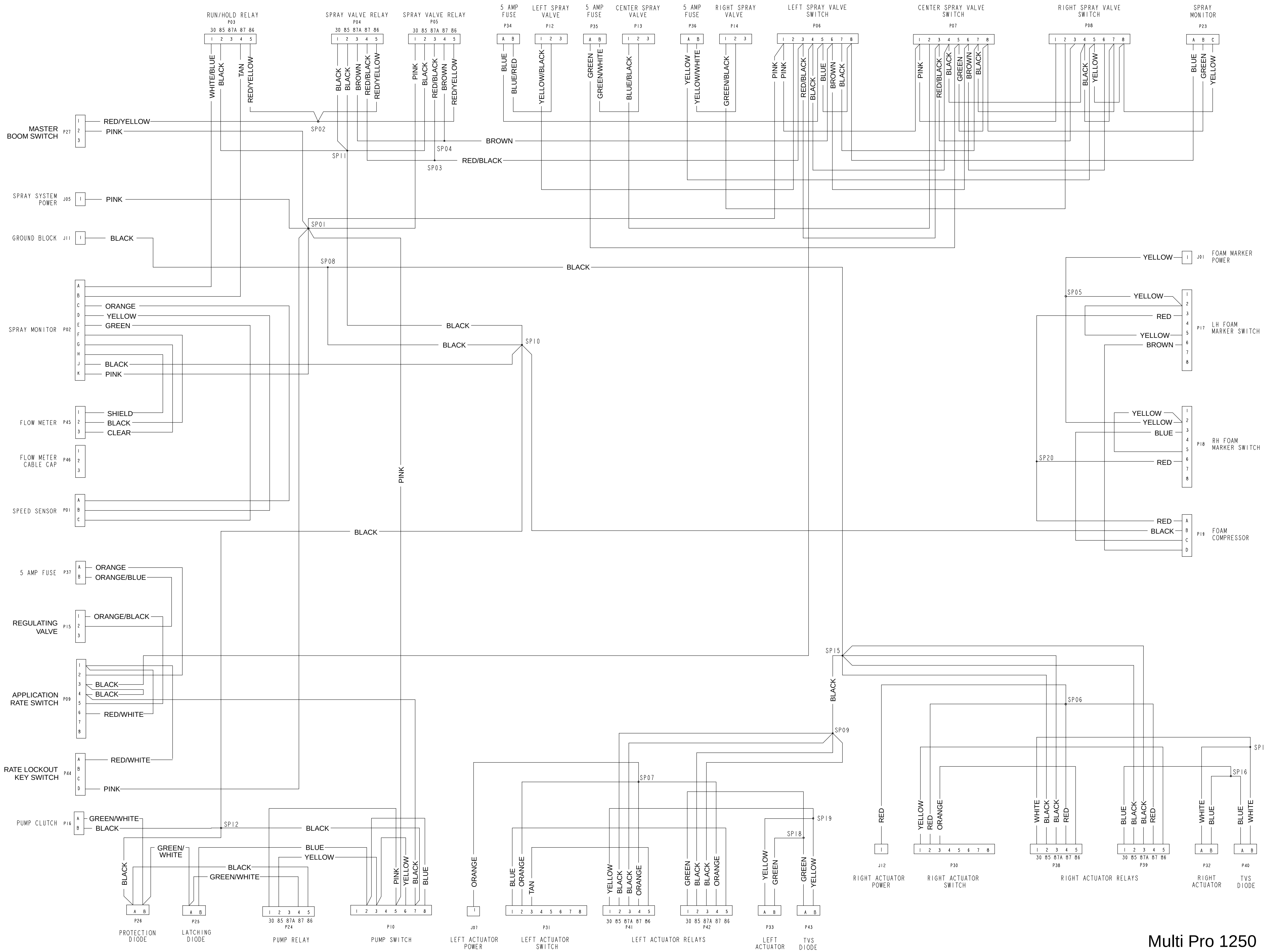
Multi Pro 1200
Spray System Wire Harness



Multi Pro 1200
Spray System Wire Harness



Multi Pro 1250
Spray System Wire Harness



Multi Pro 1250
Spray System Wire Harness

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