Part No. 96900SL (Rev. D)

Service Manual

Greensmaster® 3200/3200–D

Preface

The purpose of this publication is to provide the service technician with information for troubleshooting, testing, and repair of major systems and components on the Greensmaster 3200/3200–D.

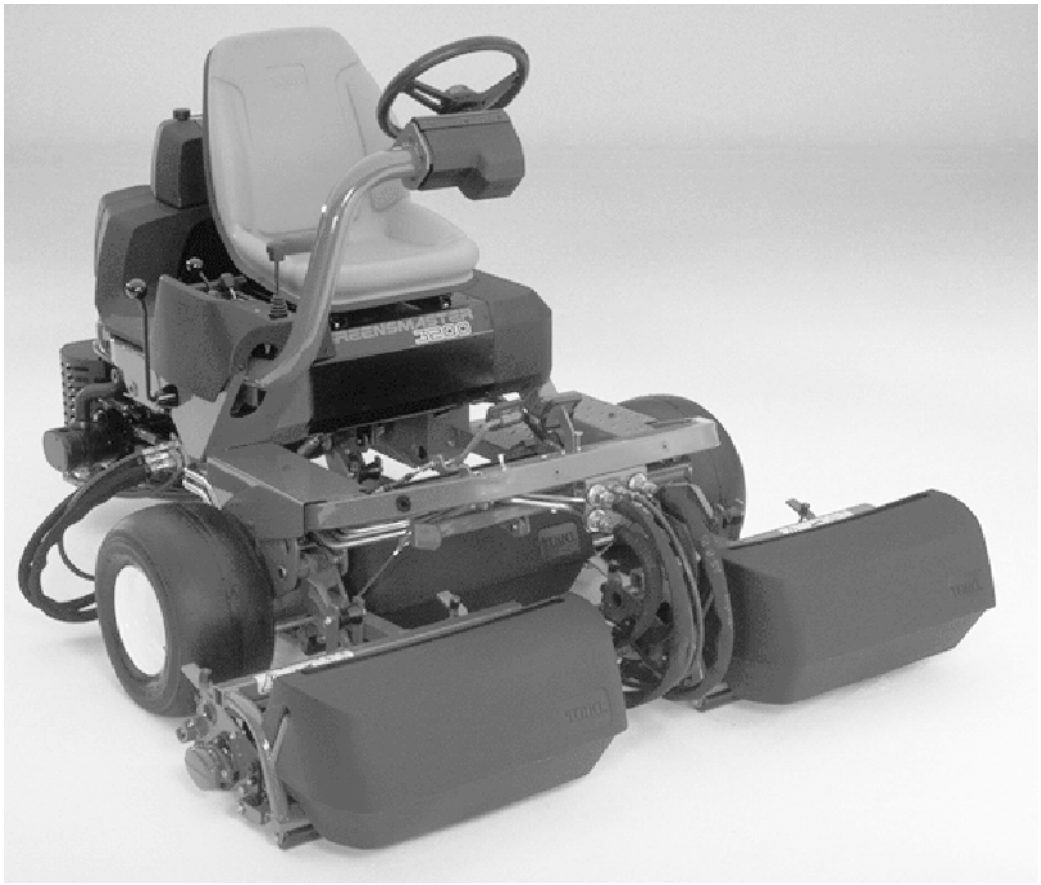
REFER TO THE TRACTION UNIT AND CUTTING UNIT OPERATOR'S MANUALS FOR OPERATING, MAINTENANCE AND ADJUSTMENT INSTRUCTIONS. Space is provided in Chapter 2 of this book to insert the Operator's Manuals and Parts Catalogs for your machine. Additional copies of the Operator's Manual and Parts Catalog are available 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 8 – Cutting Units

Chapter 1

Safety

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Safety Instructions

The GREENSMASTER 3200/3200–D was tested and certified by TORO for compliance with existing standards and specifications. Although hazard control and accident prevention partially are dependent upon the design and configuration of the machine, these factors are also dependent upon the awareness, concern, and proper training of the personnel involved in the operation, transport, maintenance, and storage of the machine. Improper use or maintenance of the machine can result in injury or death.

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

WARNING

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

Before Operating

1. Read and understand the contents of this Operator's Manual before starting and operating the machine. Become familiar with all controls and know how to stop quickly. Additional copies of the Operator's Manual are available on the internet at www.Toro.com.

2. Never allow children to operate the machine. Never allow adults to operate it without proper instructions.

3. Become familiar with the controls, and know how to stop the engine quickly.

4. 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.

5. Always wear substantial shoes. Do not operate machine while wearing sandals, tennis shoes or sneakers. Do not wear loose fitting clothing which could get caught in moving parts and cause personal injury.

6. Wearing safety glasses, safety shoes, long pants and a helmet is advisable and required by some local safety and insurance regulations.

7. Make sure work area is clear of objects which might be picked up and thrown by the reels.

8. Do not carry passengers on the machine. Keep everyone, especially children and pets, away from the areas of operation.

9. Gasoline and diesel fuel are highly flammable; handle it carefully.

   A. Use an approved gasoline container.

   B. Do not remove cap from fuel tank when engine is hot or running.

   C. Do not smoke while handling gasoline.

   D. Fill fuel tank outdoors and no higher than to the bottom of filter screen. **Do not overfill.**

   E. Wipe up any spilled gasoline.

While Operating

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

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

3. Check the operation of the interlock switches daily for proper operation (see Verify Interlock System Operation in Chapter 5 – Electrical System). Replace any malfunctioning switches before operating the machine.

4. To start the engine:

   A. Sit on the seat, make sure cutting units are disengaged.

   B. Verify that functional control lever is in neutral.

   C. Verify that parking brake is set.

   D. Proceed to start engine.

5. Using the machine demands attention, and to prevent loss of control:

   A. Mow only in daylight or when there is good artificial light.

   B. Watch for holes or other hidden hazards.

   C. Do not drive close to sand traps, ditches, creeks or other hazards.

   D. Reduce speed when making sharp turns. Avoid sudden stops and starts.

   E. Before backing up, look to the rear to be sure no one is behind the machine.

   F. Watch out for traffic when near or crossing roads. Always yield the right–of–way.

   G. Apply the service brakes when going downhill to keep forward speed slow and to maintain control of the machine.

6. Keep hands, feet and clothing away from moving parts and the reel discharge area. The grass baskets must be in place during operation of the reels or thatchers for maximum safety. Shut the engine off before emptying the baskets.

7. The GREENSMASTER 3200–D may exceed noise levels of 85 dB(A) at the operator position. Ear protectors are recommended, for prolonged exposure, to reduce the potential of permanent hearing damage.

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

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

10. If a cutting unit strikes a solid object or vibrates abnormally, stop immediately, turn engine off, wait for all motion to stop and inspect for damage. A damaged reel or bedknife must be repaired or replaced before operation is continued.

11. Before getting off the seat:

   A. Make sure cutting units are disengaged.

   B. Verify that functional control system is in neutral.

   C. Set the parking brake.

   D. Stop the engine and remove key from ignition switch.

12. Traverse slopes carefully. Do not start or stop suddenly when traveling uphill or downhill.

13. Operator must be skilled and trained in how to drive on hillsides. Avoid wet slopes. Failure to use caution on slopes or hills may cause loss of control and vehicle to tip or roll possibly resulting in personal injury or death.

14. If engine stalls or loses headway and cannot make it to the top of a slope, do not turn machine around. Always back slowly straight down the slope.

15. **DON'T TAKE AN INJURY RISK!** When a person or pet appears unexpectedly in or near the mowing area, **STOP MOWING.** Careless operation, combined with terrain angles, ricochets, or improperly positioned guards can lead to thrown object injuries. Do not resume mowing until area is cleared.

16. Whenever machine is left unattended, make sure cutting units are fully raised and reels are not spinning, key is removed from ignition switch and parking brake is set.

Maintenance and Service

1. Before servicing or making adjustments to the machine, stop the engine, remove key from switch to prevent accidental starting of the engine.

2. Be sure entire machine is in good operating condition. Keep all nuts, bolts, screws and hydraulic fittings tight.

3. Make sure all hydraulic line connectors are tight,and all hydraulic hoses and lines are in good condition before applying pressure to the system.

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

5. Before disconnecting or performing any work on the hydraulic system, all pressure in system must be relieved by stopping engine and lowering cutting units and attachments to the ground.

6. To reduce potential fire hazard, keep the engine area free of excessive grease, grass, leaves and accumulation of dirt. Never wash a warm engine or electrical connections with water.

7. Check all fuel lines for tightness and wear on a regular basis, and tighten or repair as needed.

8. If the engine must be running to perform a maintenance adjustment, keep hands, feet, clothing and any other parts of the body away from the cutting units, attachments and any moving parts. Keep everyone away.

9. Do not overspeed the engine by changing governor settings. To assure safety and accuracy, have an Authorized Toro Distributor check maximum engine speed with a tachometer. Maximum governed engine speed should be 3025 $\pm$50 RPM for the GR3200-D and 2800 RPM for the GR3200.

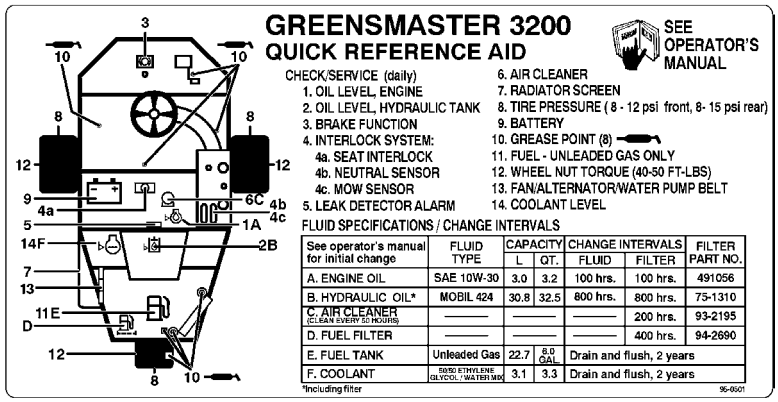
10. Engine must be shut off before checking oil or adding oil to the crankcase.

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

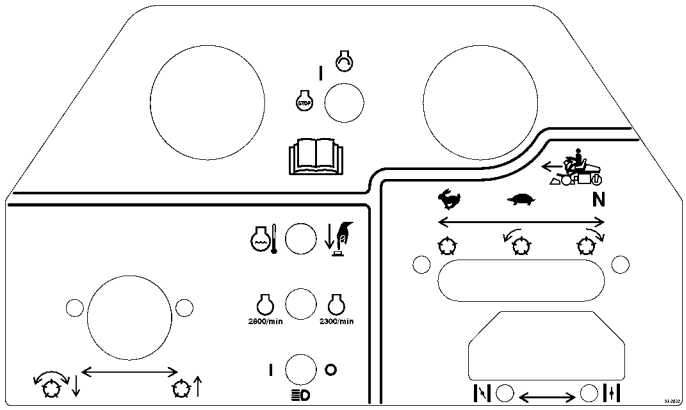
12. At the time of manufacture, the GREENSMASTER 3200/3200-D conformed to safety standards in effect for riding mowers. To make sure of optimum performance and continued safety certification of the machine, use genuine TORO replacement parts and accessories. Replacement parts and accessories made by other manufacturers could be dangerous, and such use could void the product warranty of The Toro Company.

Safety and Instruction Decals

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



On Seat Back
(Part No. 95–0501)



On Control Panel (GR3200)
(Part No. 93–2232)

Chapter 2

Product Records and Maintenance

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Product Records

Insert a copy of the Operator's Manual and Parts Catalog for your Greensmaster 3200 or 3200–D at the end of this chapter. Additionally, if any optional equipment or accessories have been installed to your machine, insert the Installation Instructions, Operator's Manuals and Parts Catalogs for those options at the end of this chapter.

Decimal and Millimeter Equivalents

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

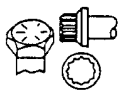
U.S to Metric Conversions

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

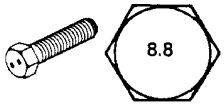
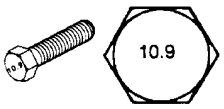
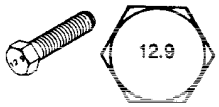
Torque Specifications

Use these torque values when specific torque values are not given. DO NOT use these values in place of specified values. Torque values listed are for lubricated threads. Plated threads are considered to be lubricated.

Capscrew Markings and Torque Values - U.S. Customary

SAE Grade Number	5				8			
Capscrew Head Markings								
Capscrew Body Size	Capscrew Torque - Grade 5				Capscrew Torque - Grade 8			
	Cast Iron		Aluminum		Cast Iron		Aluminum	
	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
1/4-20	7	9	6	8	11	15	9	12
-28	9	12	7	9	13	18	10	14
5/16-18	15	20	12	16	22	30	18	24
-24	17	23	14	19	24	33	19	25
3/8-16	30	40	20	25	40	55	30	40
-24	30	40	25	35	45	60	35	45
7/16-14	45	60	35	45	65	90	50	65
-20	50	65	40	55	70	95	55	75
1/2-13	70	95	55	75	95	130	75	100
-20	75	100	60	80	110	150	90	120
9/16-12	100	135	80	110	140	190	110	150
-18	110	150	85	115	155	210	125	170
5/8-11	135	180	110	150	190	255	150	205
-18	155	210	120	160	215	290	170	230
3/4-10	240	325	190	255	340	460	270	365
-16	270	365	210	285	380	515	300	410
7/8-9	360	490	280	380	550	745	440	600
-14	390	530	310	420	610	825	490	660
1-8	530	720	420	570	820	1100	660	890
-14	590	800	480	650	890	1200	710	960

Capscrew Markings and Torque Values – Metric

Commercial Steel Class	8.8				10.9				12.9			
Capscrew Head Markings												
Thread Diameter mm	Capscrew Torque - Class 8.8				Capscrew Torque - Class 10.9				Capscrew Torque - Class 12.9			
	Cast Iron		Aluminum		Cast Iron		Aluminum		Cast Iron		Aluminum	
	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
6	5	9	4	7	9	14	7	11	9	14	7	11
7	9	14	7	11	14	18	11	14	18	23	14	18
8	18	25	14	18	23	32	18	25	27	36	21	28
10	30	40	25	30	45	60	35	45	50	70	40	55
12	55	70	40	55	75	105	60	80	95	125	75	100
14	85	115	65	90	120	160	95	125	145	195	110	150
16	130	180	100	140	175	240	135	190	210	290	165	220
18	170	230	135	180	240	320	185	250	290	400	230	310

Single Point Adjust Cutting Unit

Each cutting unit has (7) grease fittings that must be lubricated regularly with No. 2 General Purpose Lithium Base Grease.

The grease fitting locations and quantities are: Bedknife pivot (1), Reel bearings (2), and front and rear rollers (2 ea.).

IMPORTANT: Lubricating cutting units immediately after washing helps purge water out of bearings and increases bearing life.

1. Wipe each grease fitting with a clean rag.
2. Apply grease until pressure is felt against handle.

IMPORTANT: Do not apply too much pressure or grease seals will be permanently damaged.

3. Wipe excess grease away.

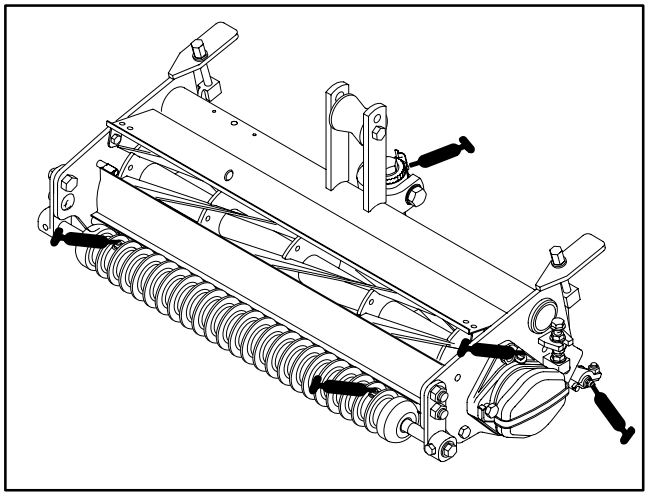


Figure 4

4 Bolt Cutting Unit

Each cutting unit has (6) grease fittings that must be lubricated regularly with No. 2 General Purpose Lithium Base Grease.

The grease fitting locations and quantities are: Reel bearings (2) and front and rear rollers (2 ea.).

IMPORTANT: Lubricating cutting units immediately after washing helps purge water out of bearings and increases bearing life.

1. Wipe each grease fitting with a clean rag.
2. Apply grease until pressure is felt against handle.

IMPORTANT: Do not apply too much pressure or grease seals will be permanently damaged.

3. Wipe excess grease away.

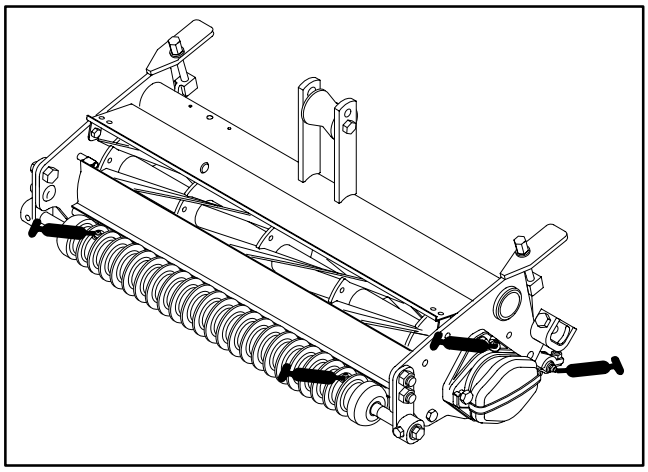


Figure 5

Maintenance

Maintenance procedures and recommended service intervals for the Greensmaster 3200 and 3200–D are covered in the Operator's Manuals. Refer to those publications when performing regular equipment maintenance.

Chapter 3

Vanguard 3/LC Gasoline Engine

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Introduction

This Chapter gives information about specifications, maintenance, troubleshooting, testing, and repair of the gasoline engine used in the Greensmaster 3200 mower.

Most repairs and adjustments require tools which are commonly available in many service shops. Special tools are described in the Briggs and Stratton Vanguard 3/LC Repair 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 Briggs and Stratton Vanguard Vanguard 3/LC engines are supplied through your local Briggs and Stratton dealer or distributor. If no parts list is available, be sure to provide your distributor with the Toro model and serial number.

Specifications

Item	Description
Make / Designation	Briggs and Stratton Vanguard 3/LC, Water–cooled, Gasoline, DM 700 G – 45
Number of Cylinders	3
Horse Power	Governed to 18.5 HP @ 2800 RPM
Torque kg–m (ft–lb)	4.91 (35.5) @ 2300 RPM
Bore x Stroke mm (in.)	68 x 64 (2.68 x 2.52)
Total Displacement cc (cu. in.)	677 (42.5)
Compression Ratio	8.6:1
Firing Order	1– 2–3
Dry Weight (approximate) kg (lb.)	85 (187)
Fuel	Unleaded Regular Grade Gasoline
Fuel Capacity liters (gallons)	22.7 (6.0)
Fuel Pump	Electric
Governor	Electronic
Low Idle (no load)	1500 $\pm$ 10 RPM
High Idle (no load)	2800 $\pm$ 10 RPM
Intake and Exhaust Valve Seat Angle	30°
Intake and Exhaust Valve Clearance mm (in.)	0.18 (0.007)
Carburetor	Single Barrel, Float Feed with Solenoid for After Fire Suppression
Engine Oil	SAE 10W–30 SG
Oil Pump	Gear Driven Trochoid Type
Crankcase Oil Capacity liters (U.S. qt.)	3.0 (3.2) with filter
Water Pump	Belt Driven Centrifugal Type
Cooling System Capacity liters (U.S. qt.)	1.8 (1.9)
Starter	12 VDC 0.8 KW
Alternator/Regulator	12 VDC 40 AMP
Spark Plug	Champion RC12YC or NGK BKR4E or Equivalent
Spark Plug Gap mm (in.)	0.76 (0.030)

Fuel Shutoff Valve

These valves should be shut when removing the engine or placing the unit in long term storage.

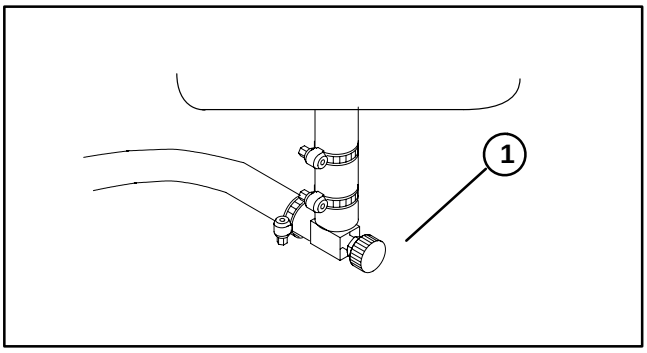


Figure 1

1. Fuel shut off (under the fuel tank)

Checking Engine Oil

IMPORTANT: Check level of oil every 5 operating hours or daily. Change oil after every 50 hours of operation.

Crankcase capacity is approximately 3.2 qts. (3.0 L) with filter.

1. Position machine on a level surface.

2. Remove dipstick and wipe it with a clean rag. Push dipstick down into the dipstick tube. Make sure stick is seated fully. Pull dipstick out and check oil level. If oil level is low, add enough oil to raise level to the FULL mark on the dipstick.

3. If oil level is low, remove oil fill cap (Fig. 3) and gradually add small quantities of oil. Check oil level frequently until level reaches the FULL mark on the dipstick.

4. The engine uses any high–quality 10W30 detergent oil having the American Petroleum Institute – API – "service classification" SG.

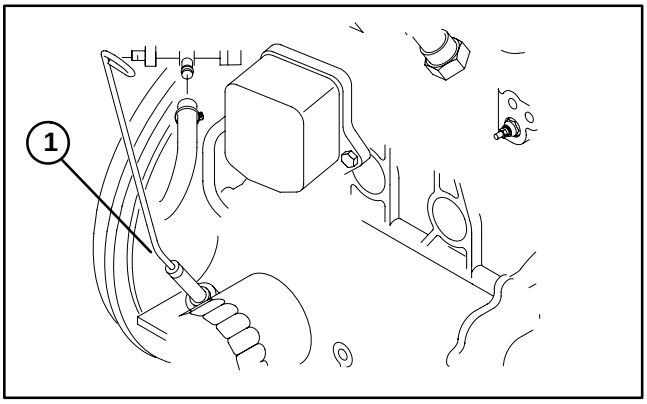


Figure 2

1. Dipstick

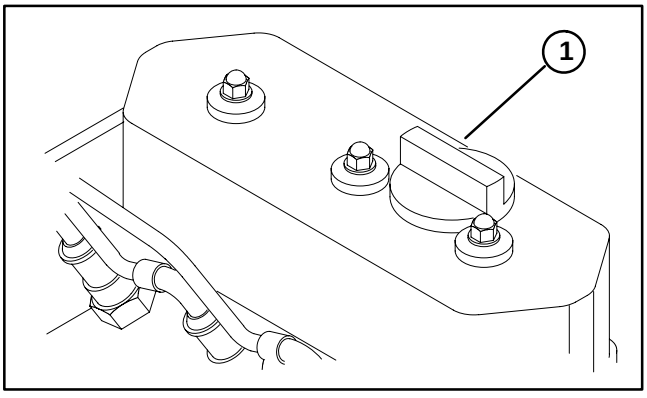


Figure 3

1. Oil fill cap

Fill Fuel Tank

The engine runs on unleaded regular grade gasoline. Fuel tank capacity is approximately 6.0 gallons (22.7 L).

The Toro Company strongly recommends the use of fresh, clean, **unleaded** regular grade gasoline in Toro gasoline powered products. **Unleaded** gasoline burns cleaner, extends engine life, and promotes good starting by reducing the build–up of combustion chamber deposits. Leaded gasoline can be used if unleaded is not available.

IMPORTANT: Never use methanol, gasoline containing methanol, gasoline containing more than 10% ethanol, gasoline additives, or white gas. Damage to the engine fuel system could result.

1. Clean area around fuel tank cap.

DANGER

Because gasoline is inflammable, caution must be used when storing or handling it. Do not fill fuel tank while the engine is running, hot, or when the machine is in an enclosed area. Vapors may build up and be ignited by a spark or flame source many feet away. DO NOT SMOKE while filling the fuel tank to prevent the possibility of an explosion. Always fill the fuel tank outside. Wipe up any spilled gasoline before starting the engine. Use a funnel or spout to prevent spilling gasoline, and fill tank to about 1 inch (25 mm) below the filler neck. Store gasoline in a clean, safety–approved container, and keep the cap in place on the container. Keep gasoline in a cool, well–ventilated place and never in an enclosed area such as a hot storage shed. To assure volatility, do not buy more than a 6 month supply. Gasoline is a fuel for internal combustion engines; do not use it for any other purpose. Since many children like the smell of gas, keep it out of their reach because the fumes are explosive and dangerous to inhale.

2. Remove fuel tank cap.

3. Fill tank to about one inch below the top of tank, (bottom of the filler neck). **Do not overfill.** Install cap.

4. Wipe up any fuel that may have spilled to prevent a fire hazard.

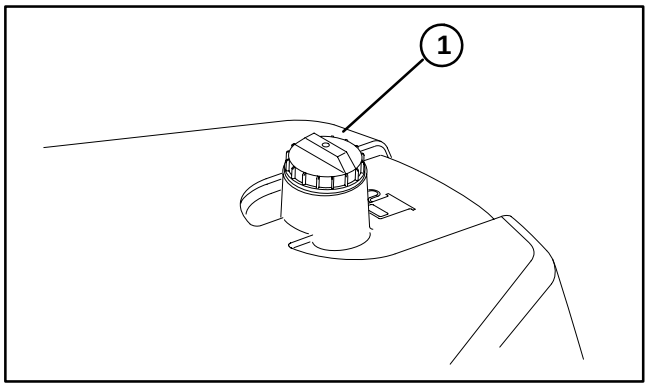


Figure 4

1. Fuel cap

Check Cooling System

The cooling system is filled with a 50/50 solution of water and ethylene glycol antifreeze. Check level of the coolant at the beginning of each day before starting the engine. Capacity of cooling system is approximately 3.6 qts. (3.4 L).

CAUTION

If engine has been running, pressurized hot coolant can escape when the radiator cap is removed and may cause burns.

1. Park machine on a level surface.

2. Check coolant level. Coolant should be between lines on the reserve tank when engine is cold.

3. If the coolant level is low, remove reserve tank cap and add a 50/50 mixture of water and permanent ethylene glycol antifreeze. **Do not overfill**.

4. Install reserve tank cap.

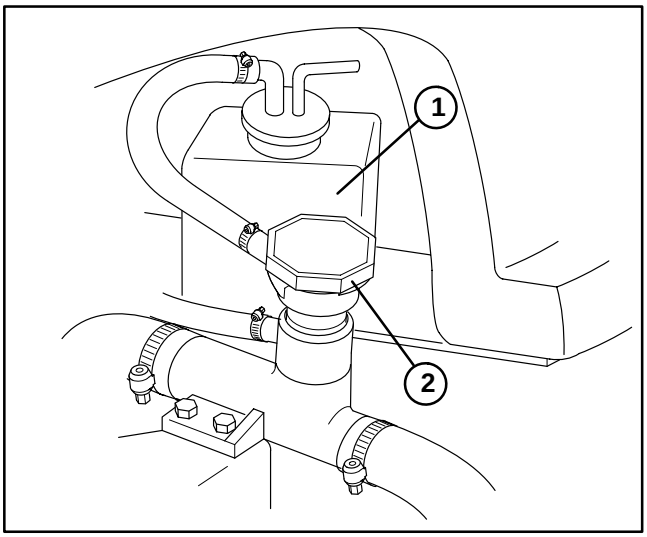


Figure 5

1. **Reserve tank**
2. **Radiator cap**

Adjustments

Alternator Belt Adjustment

Make sure belt is properly tensioned to assure the proper operation of the machine and prevent unnecessary wear. On new belts, check tension after 8 hours of operation.

The engine belt should be tensioned so it deflects 0.20 inch (5 mm) with a 2–3 pound (9 to 13 N) load applied midway between the crankshaft and alternator pulley.

1. Loosen bolts securing the alternator to the engine and adjusting bracket.

2. Adjust belt to proper tension and tighten bolts.

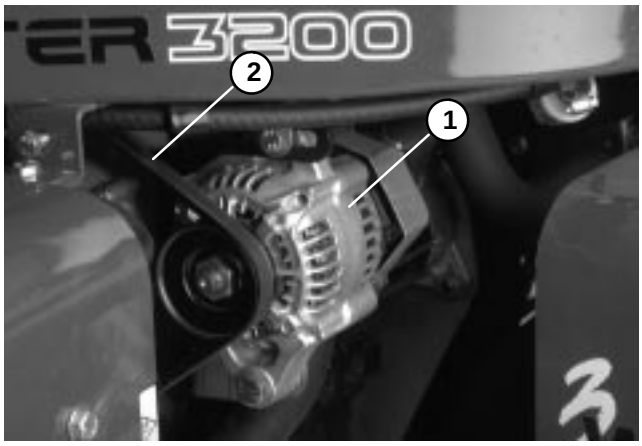


Figure 6

1. Alternator **2. Belt**

Valve Clearance Adjustment

Initially, adjust valves after the first 50 hours of operation and every 400 hours thereafter.

1. Remove cylinder head cover from the engine.

Note: Adjust valves when engine is cold.

2. Set No. 1 cylinder to the top dead center and adjust the clearances of intake and exhaust valves of No. 1 cylinder, exhaust valve of No. 2 cylinder, and the intake valve of No. 3 cylinder. Adjust clearances of both intake and exhaust valves to 0.007 inch (0.18mm).

3. Turn crankshaft clockwise 360_ (viewed from front) to adjust the clearance of intake valve of the No. 2 cylinder and exhaust valves of No. 3 cylinder. Adjust clearance of both intake and exhaust valves to 0.007 inch (0.18mm).

4. Install cylinder head cover and gasket. Torque cover screws to 60 in–lb (69 kg–cm).

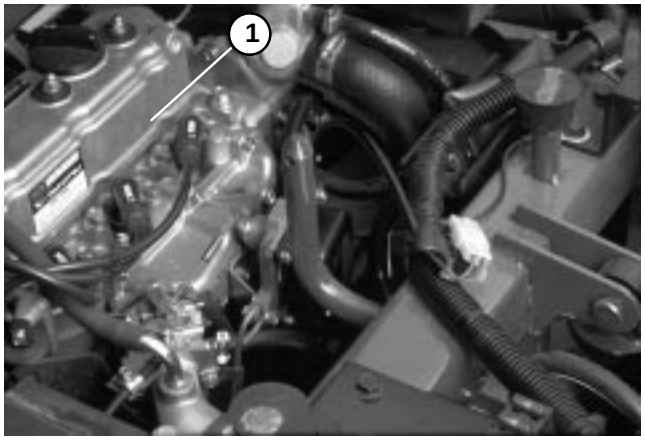


Figure 7

1. Cylinder head cover

Servicing Air Cleaner

Service air cleaner filter every 200 hours (more frequently in extreme dusty or dirty conditions).

1. Check air cleaner body and hoses for damage which could possibly cause an air leak. Replace air cleaner body if damaged.

2. Release latches securing the air cleaner cover to the air cleaner body. Separate cover from the body. Clean inside of air cleaner cover.

3. Gently slide filter out of the air cleaner body to reduce the amount of dust dislodged. Avoid knocking filter against the air cleaner body.

4. Inspect filter. Discard filter if damaged. Do not wash or reuse a damaged filter.

Washing Method

A. Prepare a solution of filter cleaner and water. Soak filter element for about 15 minutes. Refer to directions on the filter cleaner carton for complete information.

B. After soaking the filter for 15 minutes, rinse it with clear water. Maximum water pressure must not exceed 40 psi to prevent damage to the filter element. Rinse filter from the clean side to dirty to side.

C. Dry filter element using warm, flowing air that dose not to exceed 160°F (71°C), or allow element to air–dry. Do not use a light bulb to dry the filter element because damage could result.

Compressed Air Method

CAUTION

Use eye protection such as goggles when using compressed air

A. Blow compressed air from the inside to the outside of the dry filter element. Do not exceed 100 psi to prevent damage to the element.

B. Keep air hose nozzle at least 2 inches (5 cm) from the filter. Move nozzle up and down while rotating the filter element. Inspect for holes and tears by looking through the filter toward a bright light.

5. Inspect new filter for shipping damage. Check sealing end of the filter. Do not install a damaged filter.

6. Insert new filter properly into the air cleaner body. Make sure filter is sealed properly by applying pressure to the outer rim of the filter when installing. Do not press on the flexible center of the filter.

7. Reinstall cover and secure latches.

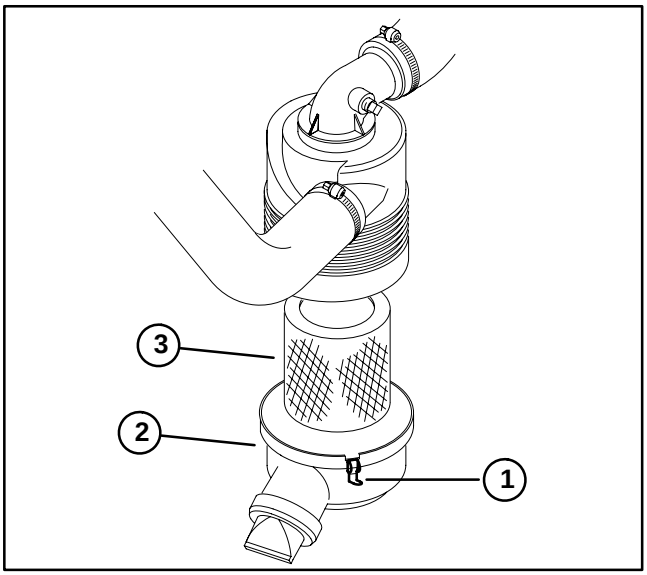


Figure 8

1. **Air cleaner latches**
2. **Dust cup**
3. **Filter**

Cleaning Radiator and Screen

To prevent the cooling system from overheating, the radiator screen and radiator must be kept clean. Check and clean screen and radiator daily. If necessary, clean any debris off these parts hourly. Clean these components more frequently in dusty and/or dirty conditions.

1. Release latches and remove radiator screen from the radiator support.

2. Remove fan shroud to access radiator corners.

CAUTION

Use eye protection such as goggles when using compressed air

IMPORTANT: Air pressure should not exceed 40 psi (2.8 bar) because damage to the radiator fins may result.

3. Working from the fan side of the radiator, blow out radiator with compressed air.

4. Clean screen. Reinstall fan shroud and screen to the radiator support. Secure latches.

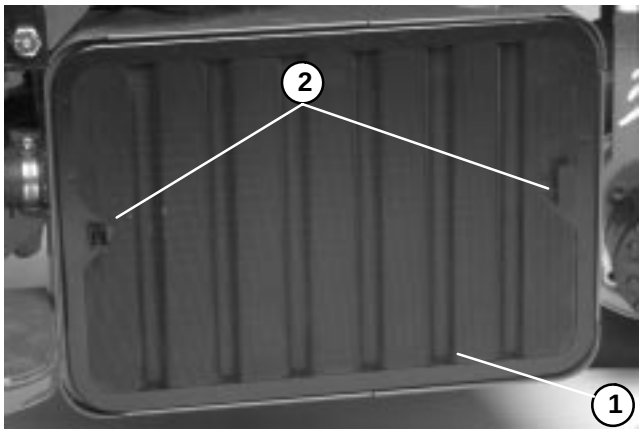


Figure 9

1. Screen **2. Latches**

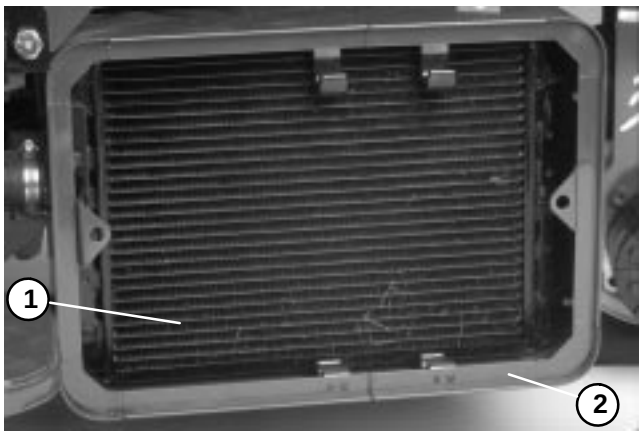


Figure 10

1. Radiator **2. Radiator support**

Torquing Cylinder Head bolts

Initially, check head bolt torque after first 50 hours of operation, and every 400 hours thereafter.

1. Remove cylinder head cover from the engine.

2. Using the sequence in Figure 11, torque head bolts to 25 ft–lb (3.5 kg–m).

3. Install cylinder head cover and gasket. Torque cover screws to 60 in–lb (69 kg–cm).

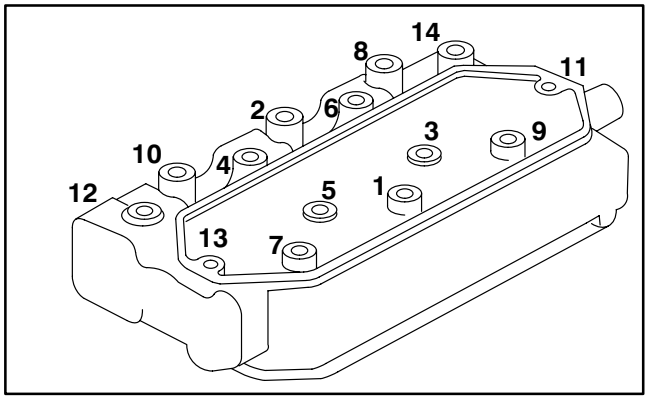


Figure 11

Changing Engine Oil and Filter

Change oil and filter initially after the first 8 hours of operation. Change oil every 50 hours and the filter every 100 hours thereafter.

1. Remove drain plug letting the oil flow into the drain pan. When the oil stops flowing, install drain plug.

2. Remove oil filter. Apply a light coat of clean oil to the new filter gasket.

3. Screw filter on by hand until the gasket contacts the filter adapter. Tighten filter from 1/2 to 3/4 of a turn further. **Do not overtighten.**

4. Add oil to crankcase, (see Check Engine Oil).

5. Dispose of oil properly.

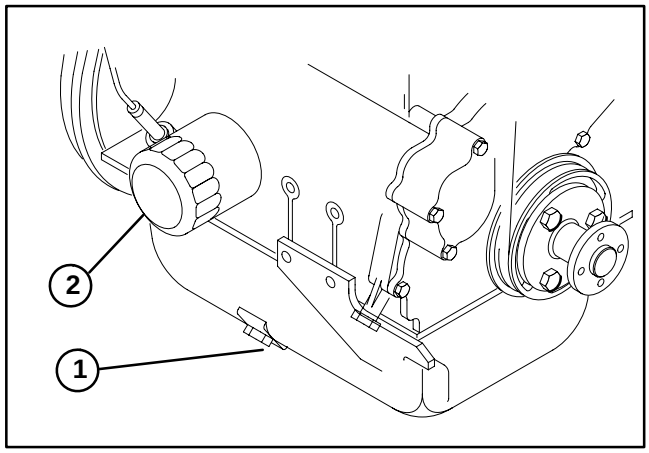


Figure 12

1. Drain plug **2. Oil filter**

Replacing Fuel Filter

An in–line filter is incorporated into the fuel line. Change filter every 800 hours. Use the following procedures when replacement becomes necessary:

1. Close fuel shut–off valve.

2. Clamp both fuel lines that connect to the fuel filter so gasoline cannot drain when lines are removed.

CAUTION

Since gasoline is highly flammable, drain it outdoors and make sure engine is cool to prevent a potential fire hazard. Wipe up any gasoline that may have spilled. Do not drain gasoline near any open flame or where gasoline fumes may be ignited by a spark. Do not smoke a cigar, cigarette, or a pipe when handling gasoline.

3. Loosen hose clamps at both ends of the filter. Pull fuel lines off the filter.

4. Slide hose clamps onto ends of the fuel lines. Push fuel lines onto fuel filter, and secure them with hose clamps. Make sure arrow on the side of the filter points towards the carburetor.

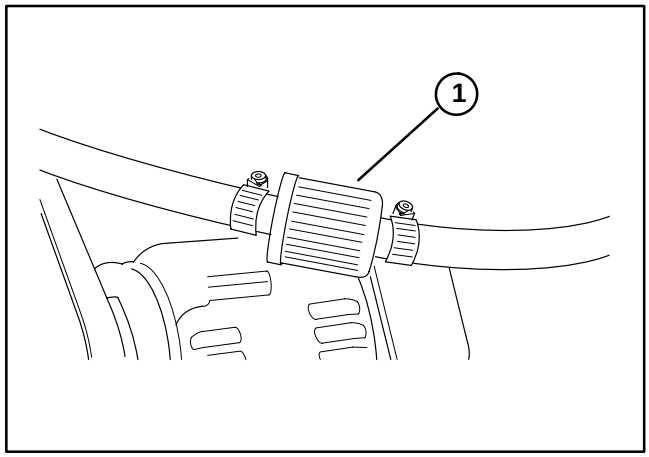


Figure 13

1. Fuel filter

Replacing Spark Plugs

Use a Briggs & Stratton Vanguard 3/LC #491053 or Champion RC12YC spark plug or equivalent. Correct air gap is 0.030 inch (0.76 mm). Remove plugs after every 100 operating hours and check condition.

1. Pull wires off the spark plugs.

2. Clean around spark plugs and remove plugs.

IMPORTANT: Replace any cracked, fouled, or dirty spark plug. Do not sand blast, scrape, or clean electrodes because engine damage could result from grit entering the cylinder.

3. Set air gap between 0.028 and 0.031 inch (0.71 and 0.79 mm). Install gapped spark plug and tighten firmly to 180 in–lb (207 kg–cm).

Figure 14

1. Spark plug wire

Muffler and Air Cleaner

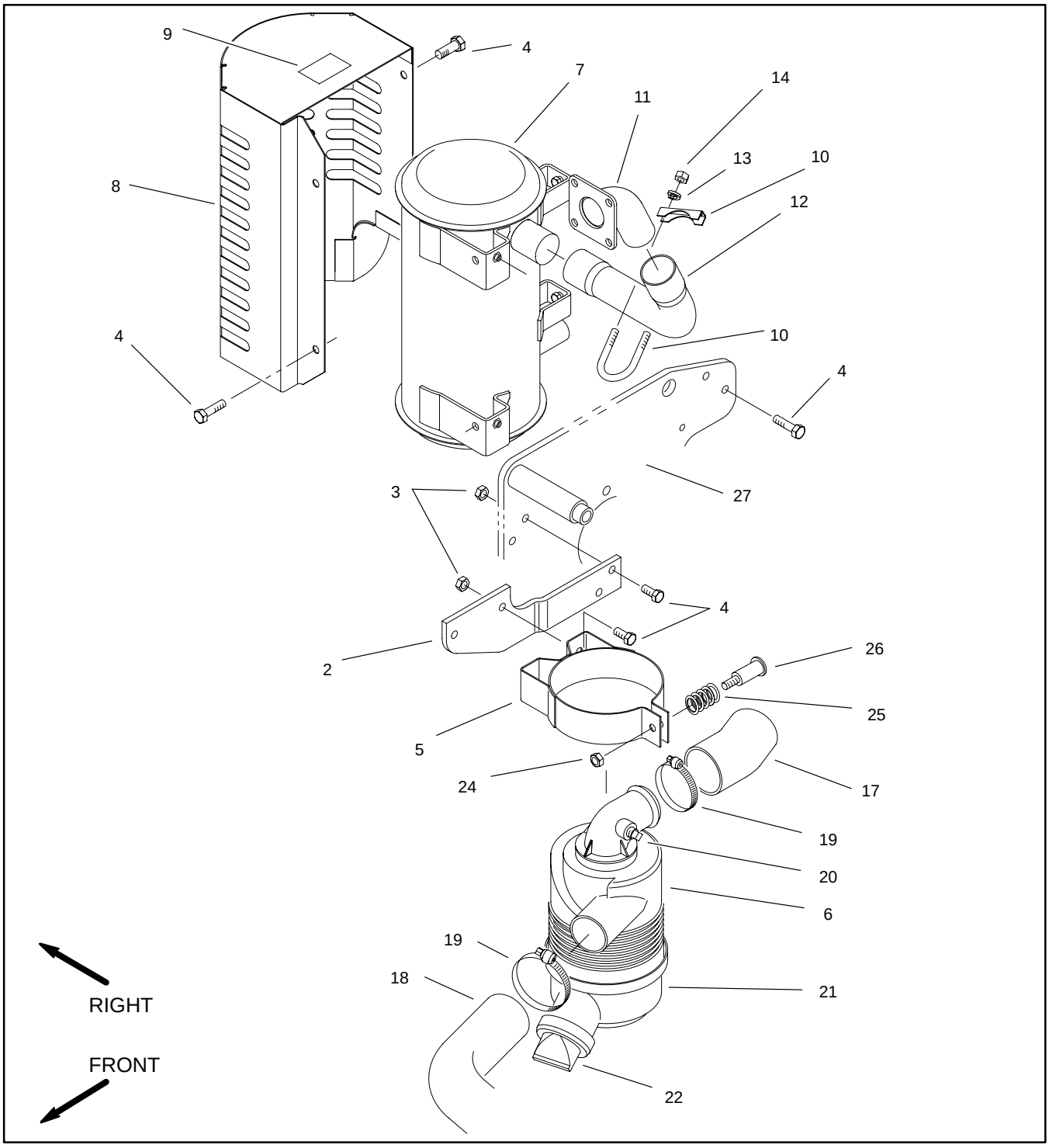


Figure 15

1. **Not used**
2. **Air cleaner bracket**
3. **Lock nut**
4. **Cap screw**
5. **Mounting band**
6. **Air cleaner**
7. **Muffler**
8. **Spark arrestor**
9. **Hot surface decal**
10. **Clamp**
11. **Exhaust bracket**
12. **Exhaust pipe**
13. **Lock nut**
14. **Nut**
15. **Not used**
16. **Not used**
17. **Air cleaner hose**
18. **Air cleaner hose**
19. **Hose clamp**
20. **Plug**
21. **Cover**
22. **Valve**
23. **Air Cleaner element**
24. **Lock nut**
25. **Compression spring**
26. **Bolt**
27. **Pump plate**

Muffler Removal (Fig. 15)

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

CAUTION

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

2. Remove muffler shield (8) from from the muffler (7) by removing the four cap screws (4) securing the shield to the muffler.

3. Remove nuts (14), lock washers (13), and clamp (10) securing the exhaust pipe (12) to the muffler (7).

4. Remove two cap screws (4) securing the muffler (7) to the rear of the pump plate (27). Carefully separate muffler from the pump plate and exhaust pipe (12).

5. Further disassemble muffler as necessary.

Muffler Installation (Fig. 15)

1. Make sure the engine is off.

2. If the exhaust bracket (11) was removed, install bracket to exhaust manifold with a new gasket. Secure bracket to the manifold with spring lock washers and cap screws.

3. If the exhaust pipe (12) was removed, install pipe to exhaust bracket (11) with clamp (10), lock washers (13), and nuts (14).

4. Carefully attach muffler (7) to the exhaust pipe (12). Secure muffler (7) to the pump plate (27) with two cap screws (4).

5. Secure exhaust pipe (12) to the muffler (7) with clamp (10), lock washers (13), and nuts (14).

6. Secure muffler shield (8) to the muffler (7) with four cap screws (4).

Air Cleaner Removal (Fig. 15)

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

2. Loosen hose clamps (19), and disconnect air cleaner hoses (17 and 18) from the air cleaner (6).

3. Remove lock nut (24) from bolt (26). Remove bolt and compression spring (25) from the mounting band (5).

4. Remove air cleaner (6) from the mounting band (5).

5. Further disassemble air cleaner as necessary.

Air Cleaner Installation (Fig. 15)

1. Make sure the engine is off.

2. If the air cleaner bracket (2) was removed, secure bracket to the pump plate (27) with two cap screws (13) and lock nuts (3).

3. If the mounting band (5) was removed, secure band to the air cleaner bracket (2) with two cap screws (13) and lock nuts (3).

4. Carefully place air cleaner (6) into the mounting band (5).

5. Reconnect air cleaner hoses (17 and 18) to the air cleaner (6) and secure with hose clamps (19).

6. Install bolt (26) and compression spring (25) to the mounting band (5). Secure bolt with lock nut (24).

Radiator

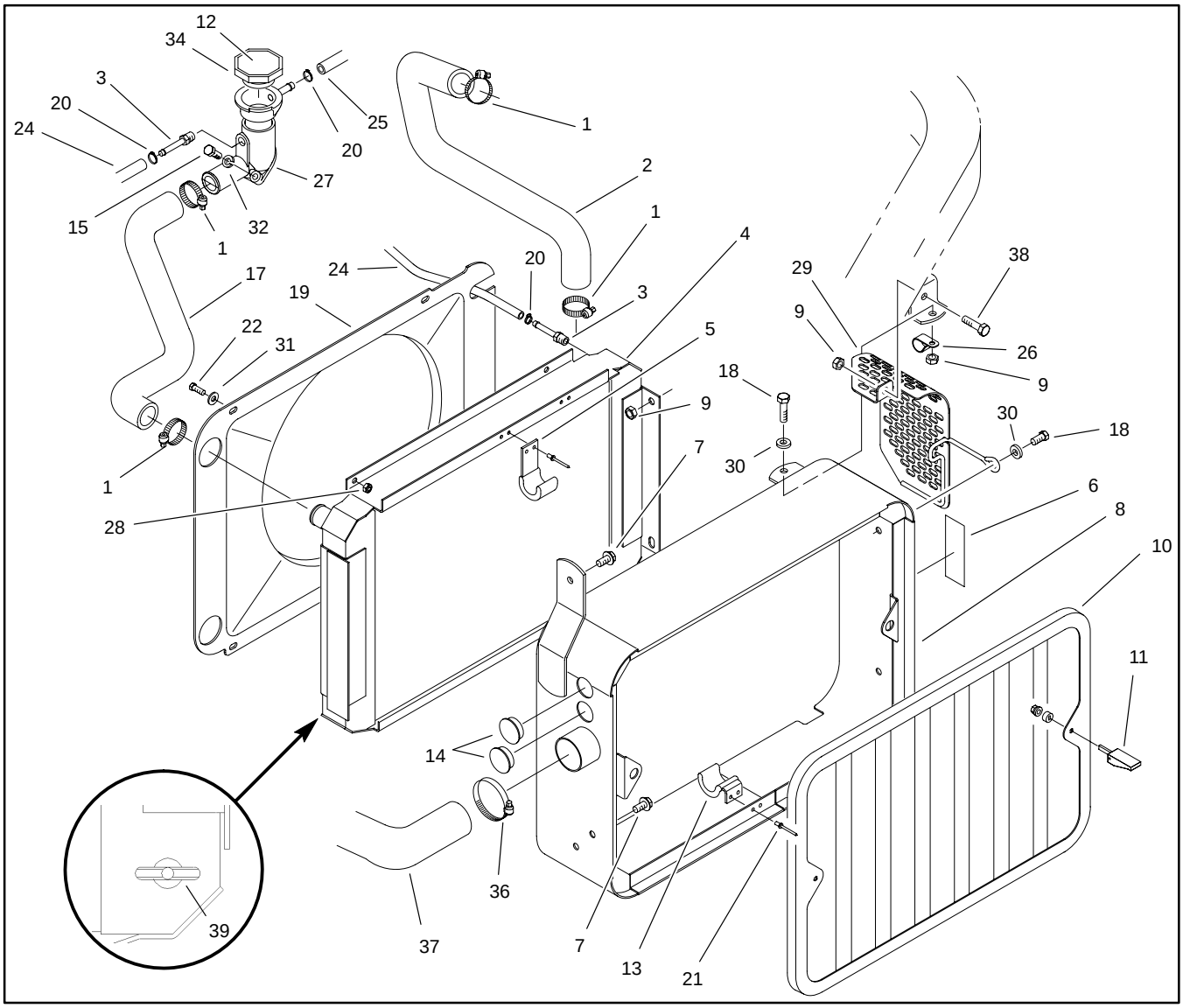


Figure 16

1. **Hose clamp**
2. **Radiator hose**
3. **Barb hose fitting**
4. **Radiator**
5. **Upper cooler bracket**
6. **Fan warning decal**
7. **Cap screw**
8. **Radiator support assembly**
9. **Lock nut**
10. **Screen**
11. **Swell latch**
12. **Radiator cap decal**
13. **Lower cooler bracket**
14. **Plug**
15. **Cap screw**
16. **Not used**
17. **Radiator hose**
18. **Cap screw**
19. **Fan shroud**
20. **Hose Clamp**
21. **Pop rivet**
22. **Cap screw**
23. **Not used**
24. **Breather hose**
25. **Expansion tank hose**
26. **R–clamp**
27. **Thermostat housing**
28. **Lock nut**
29. **Alternator guard**
30. **Washer**
31. **Flat washer**
32. **Spring lock washer**
33. **Not used**
34. **Radiator cap**
35. **Not used**
36. **Hose clamp**
37. **Air cleaner hose**
38. **Cap screw**
39. **Drain petcock**

Radiator Removal (Fig. 16)

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

CAUTION

DO NOT open radiator cap or drain coolant if the engine or radiator is hot. Pressurized hot coolant can escape and cause burns.

Ethylene–gycol antifreeze is poisonous. Dispose of it properly or store it in a properly labeled container away from children and pets.

2. Place a suitable container under the front end of the radiator. Open drain petcock (39) on the back of the radiator. Drain radiator completely and close petcock.

3. Remove screen (10) from radiator support (8).

4. If the hydraulic oil cooler is installed, drain the hydraulic reservoir and disconnect the oil cooler (see Engine Removal).

5. Remove the following hoses from the radiator:

   A. Loosen hose clamp (20) and disconnect breather hose (24).

   B. Loosen hose clamps (1) and disconnect radiator hoses (2 and 17).

   C. Loosen hose clamp (36) and disconnect air cleaner hose (37).

6. Remove the following fasteners to remove the radiator support (8) from the frame:

   A. Lock nut (9) and cap screw (38) securing the alternator guard (29) to the frame tab. Cap screw (7) securing the lower radiator support to the frame.

   B. Cap screw (7) securing the upper radiator support tab to the frame. Lock nut (9), cap screw (18), and flat washer (30) securing the rear radiator support tab and R–clamp (26) to the frame tab.

7. Remove the radiator support (8) from the frame and onto a workbench.

8. Remove four cap screws (18) and lock nuts (9) securing the radiator (4) to the radiator support (8). Slide radiator out of the support.

9. Remove four cap screws (22), lock nuts (28), and flat washers (15) securing the fan shroud (19) to the radiator (4). Separate the shroud from the radiator.

Radiator Installation (Fig. 16)

1. Secure fan shroud (19) to radiator (4) with four cap screws (22), lock nuts (28), and flat washers (15).

2. Slide radiator (4) into the radiator support (8). Secure radiator to support with four cap screws (18) and lock nuts (9). Also, install alternator guard (29) with washer (30) to the radiator support.

3. Position radiator support (8) to the frame.

   A. Secure rear radiator support tab and R–clamp (26) to the frame with cap screw (18), flat washer (30), and lock nut (9). Secure upper radiator support tab to frame with cap screw (7).

   B. Secure lower portion of the radiator support to the frame with cap screw (7). Secure alternator guard (29) to the frame tab with cap screw (38) and lock nut (9).

4. Connect the following hoses to the radiator:

   A. Air cleaner hose (37) with hose clamp (36)

   B. Radiator hoses (2 and 17) with hose clamps (1).

   C. Breather hose (24) with hose clamp (20).

5. If the hydraulic oil cooler was installed, connect the oil cooler (see Engine Installation). Fill the hydraulic reservoir (see Check Hydraulic System Fluid in Chapter 5 – Hydraulic System).

6. Install screen (10) to radiator support (8).

7. Fill radiator (4) with coolant (see Check Cooling System).

Fuel Tank

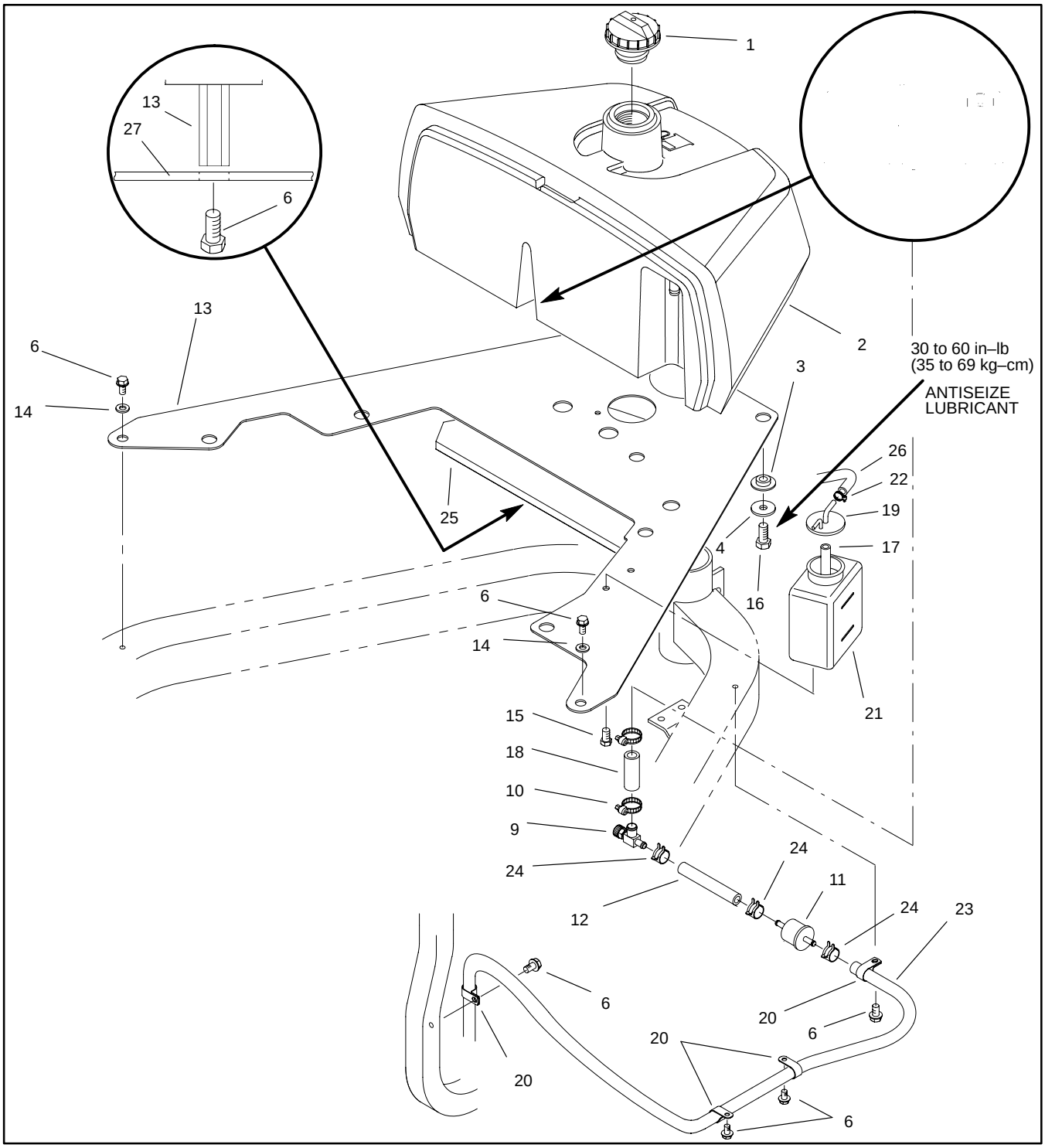


Figure 17

1. **Fuel cap**
2. **Gasoline fuel tank**
3. **Grommet**
4. **Flat washer**
5. **Not used**
6. **Cap screw**
7. **Not used**
8. **Not used**
9. **Fuel shut–off fitting**
10. **Hose clamp**
11. **Fuel filter**
12. **Fuel hose**
13. **Mounting plate**
14. **Flat washer**
15. **Cap screw**
16. **Cap screw**
17. **Over flow tank hose**
18. **Fuel hose**
19. **Over flow tank cap**
20. **R–clamp**
21. **Overflow tank**
22. **Hose clamp**
23. **Fuel hose**
24. **Hose clamp**
25. **Thermal pad**
26. **Over flow tank hose**
27. **Support bracket**

Fuel Tank Removal (Fig. 17)

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

DANGER

Because gasoline is inflammable, caution must be used when storing or handling it. Do not drain fuel tank while the engine is running, hot, or when the machine is in an enclosed area. Vapors may build up and be ignited by a spark or flame source many feet away. DO NOT SMOKE while draining the fuel tank to prevent the possibility of an explosion. Always drain fuel tank outside. Wipe up any spilled gasoline. Store gasoline in a clean, safety–approved container, and secure cap on the container. Keep gasoline in a cool, well–ventilated place and never in an enclosed area such as a hot storage shed. Since many children like the smell of gas, keep it out of their reach because the fumes are explosive and dangerous to inhale.

2. Drain fuel tank (2) as follows:

   A. Close fuel shut–off valve (9) below the fuel tank.

   B. Separate hose (12) from the frame by removing cap screw (6) and R–clamp (20) from the frame and hose.

   C. Disconnect fuel hose (12) from the fuel filter (11). Use funnel and hose to drain the fuel tank into a suitable container for storage.

   D. Drain fuel tank completely by opening the fuel shut off valve. Close fuel shutoff valve when tank is drained.

3. Gain access to the fasteners securing the fuel tank (2) to the mounting plate (13) as follows:

   A. Remove three cap screws (6) and two flat washers (14) securing mounting plate to the frame and support bracket (27).

   B. Lift and support the mounting plate up from the rear of the machine.

4. Loosen hose clamp (10) and disconnect fuel hose (18) from fuel tank (2).

5. Remove three cap screws (16) and flat washers (4) securing the fuel tank (2) to the mounting plate (13). Remove the tank from the mounting plate.

Fuel Tank installation (Fig. 17)

1. Position fuel tank (2) to the mounting plate (13).

   A. Apply antiseize lubricant to the threads of the three cap screws (16).

   B. Secure fuel tank to the plate with three flat washers (4) and cap screws.

   C. Torque cap screws from 30 to 60 in–lb (35 to 69 kg–cm).

2. Install mounting plate (13) to the frame as follows:

   A. Position mounting plate to the frame. Make sure to align plate holes with holes on the frame and support bracket (27).

   B. Secure mounting plate to the frame and support bracket with two flat washers (14) and three cap screws (6).

3. Connect fuel hose (18) to the fuel tank with hose clamp (10).

4. Attach hose (12) to the frame with cap screw (6) and R–clamp (20).

5. Connect fuel hose (12) to the fuel filter (11) with hose clamp (24).

6. Open fuel shut–off valve (9) below the fuel tank.

7. Fill fuel tank with fuel (see Fill fuel Tank). Check fuel lines and tank for leaks.

Engine

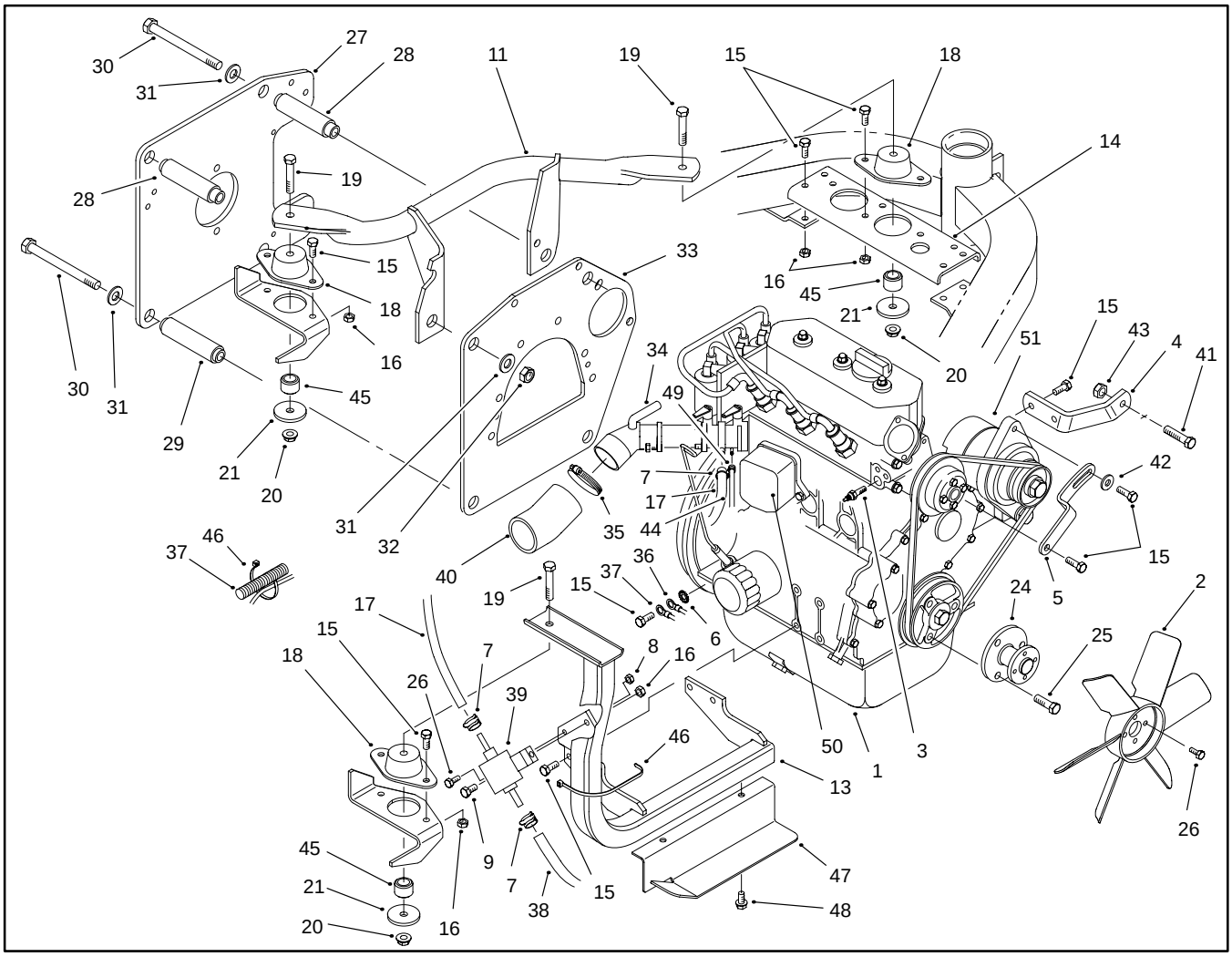


Figure 18

1. Daihatsu engine
2. Engine fan
3. Temperature sender
4. Lower alternator bracket
5. Upper alternator bracket
6. Lock washer
7. Hose clamp
8. Lock nut
9. Cap screw
10. Not used
11. Rear engine mount
12. Not used
13. Front engine mount
14. Support bracket
15. Flange screw
16. Lock nut
17. Fuel hose
18. Engine mount
19. Cap screw
20. Flange nut
21. Washer plate
22. Not used
23. Not used
24. Fan adapter
25. Screw
26. Cap screw
27. Pump plate
28. Upper spacer
29. Lower spacer
30. Cap screw
31. Flat washer
32. Lock washer
33. Backing plate
34. Carburetor adapter
35. Hose clamp
36. Negative battery cable
37. Wire harness
38. Fuel hose
39. Fuel pump
40. Air cleaner
41. Cap screw
42. Flat washer
43. Lock nut
44. Fuel hose
45. mount spacer
46. Cable tie
47. Dust shield
48. Whiz screw
49. Hose clamp
50. Electric governor
51. Alternator

Engine Removal

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

2. Release lockup handle, and pivot steering arm and steering wheel all the way forward. Lift seat forward to gain access to the engine.

3. Remove console shroud from the control panel.

4. Drain fuel tank (see Fuel Tank Removal):

CAUTION

The hydraulic fluid may be hot. To avoid possible burns, allow the hydraulic system to cool before disconnecting hoses.

5. Drain hydraulic reservoir as follows (Fig 19):

   A. Clamp pump inlet hose to prevent hydraulic tank from inadvertently draining.

   B. Loosen hose clamp, and remove pump inlet hose from the gear pump.

   C. Drain hydraulic tank completely into a suitable container by releasing the clamp from the hose. Plug hose and pump to prevent contamination.

CAUTION

DO NOT open radiator cap or drain coolant if the engine or radiator is hot. Pressurized hot coolant can escape and cause burns.

Ethylene–gycol antifreeze is poisonous. Dispose of it properly or store it in a properly labeled container away from children and pets.

6. Drain radiator (4) as follows (Fig. 16):

   A. Place a suitable container under the radiator.

   B. Open drain petcock (39) on the back of the radiator. Drain radiator completely and close petcock.

7. Disconnect hydraulic oil cooler if installed (Fig. 20).

   A. Disconnect tube and O–ring from hydraulic fitting on the hydraulic reservoir.

   B. Disconnect tube and O–ring from hydraulic fitting on the oil filter.

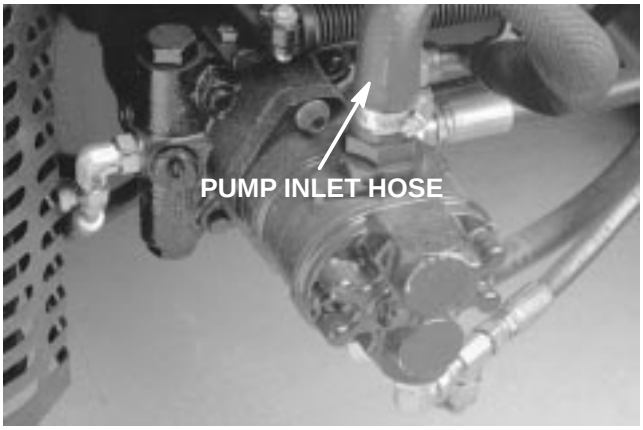


Figure 19

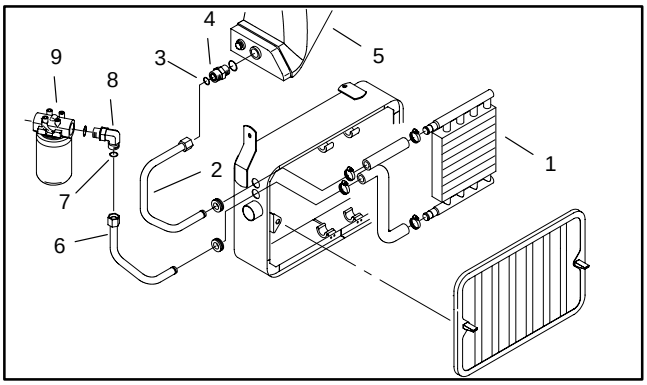


Figure 20

1. **Hydraulic oil cooler**
2. **Tube**
3. **O–ring**
4. **Hydraulic fitting**
5. **Hydraulic reservoir**
6. **Tube**
7. **O–ring**
8. **Hydraulic fitting**
9. **Oil filter**

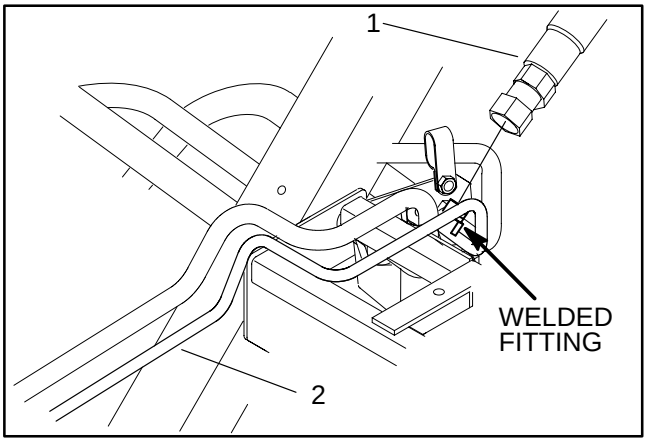


Figure 21

1. **Hose assembly**
2. **Tube**

8. Remove fuel tank and hydraulic reservoir as follows:

A. Remove three cap screws (6) and two flat washers (14) securing tank mounting plate (13) to the support bracket (27) and frame (Fig. 17).

B. Disconnect expansion tank hose (25) from the radiator elbow (27) (Fig. 16).

C. Disconnect hydraulic hose from welded fitting on the tube leading into rear bulkhead (Fig. 21).

D. If the oil cooler is **not** installed, disconnect hydraulic hose from the hydraulic oil filter (Fig. 22).

E. Make sure cable ties and hose clamps securing hoses to the frame and supports are removed.

F. Disconnect leak detector harness.

G. Lift mounting plate and tanks from the machine.

9. Remove air cleaner as follows (Fig. 23):

A. Disconnect air cleaner hose (40) from the carburetor adapter (34) (Fig. 18).

B. Disconnect hose leading to the radiator from the cleaner.

C. Disconnect air cleaner bracket from the pump mount. Remove air cleaner and bracket from the machine.

CAUTION

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

10. Remove muffler as follows (Fig. 24):

A. Remove four cap screws and lock washers securing the exhaust plate to the engine exhaust manifold.

B. Remove muffler shield from the muffler and pump plate by removing four cap screws.

C. Remove two cap screws securing the muffler to the pump plate. Remove muffler from the machine.

11. Remove fuel filter (39) to the front engine mount (13) (Fig. 18).

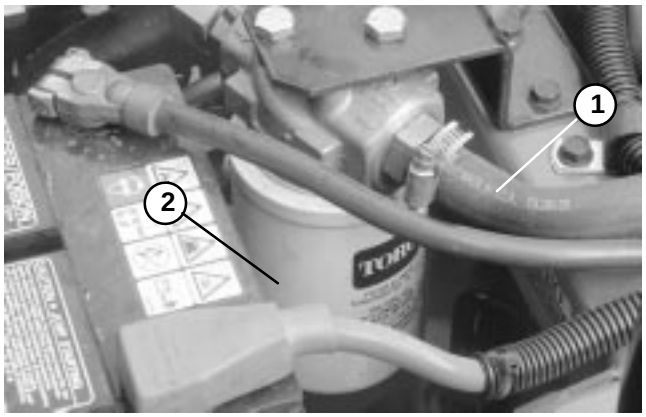


Figure 22

1. **Hydraulic hose**
2. **Hydraulic oil filter**

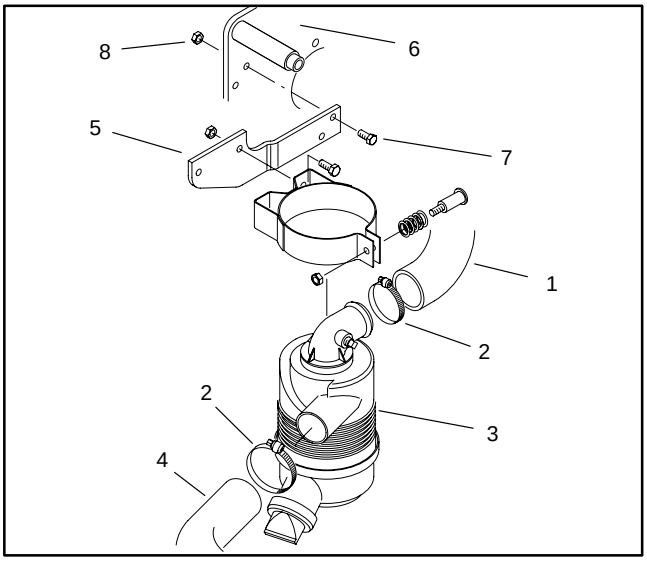


Figure 23

1. **Hose (to carburetor)**
2. **Hose clamp**
3. **Air cleaner**
4. **Hose (to radiator)**
5. **Air cleaner bracket**
6. **Pump plate**
7. **Cap screw**
8. **Lock nut**

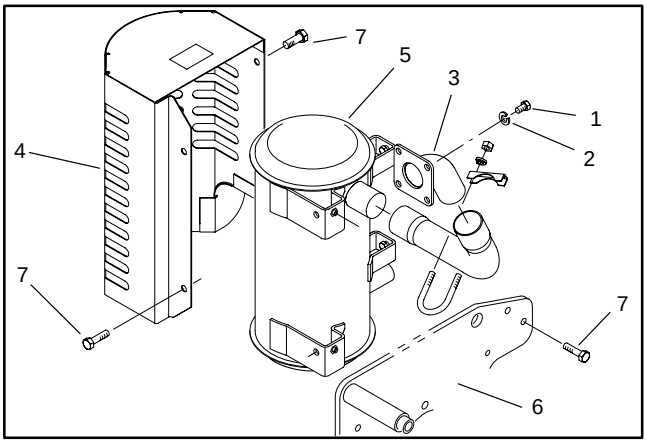


Figure 24

1. **Cap screw**
2. **Lock washer**
3. **Exhaust plate**
4. **Muffler shield**
5. **Muffler**
6. **Pump plate**
7. **Cap screw**

12. Remove radiator as follows (Fig. 16):

A. Remove alternator guard (29) from radiator support (8) and frame bracket.

B. Disconnect breather hose (24) and radiator hose (17) from the radiator elbow (27).

C. Disconnect radiator hose (2) from the bottom of the water pump.

D. Disconnect hose (37) from air cleaner at the radiator support (8). Remove hose from the machine

E. Remove screen (10) from the radiator support.

F. Remove both cap screws (7) from radiator support and frame. Remove cap screw (18), flat washer (30) and lock nut (9) securing the radiator support and R–clamp (26) to the frame tab.

G. Make sure cable ties and clamps securing hoses to the frame and supports are removed.

H. Pull radiator and hoses from the machine.

13. Separate relief valve from the pump plate by removing both cap screws flat washers, and lock nuts (Fig. 25).

14. Separate hydrostat from the pump plate as follows:

A. Loosen set screw securing the hydrostat shaft to the hub (Fig. 26).

CAUTION

Use caution when removing the lock nut from the pin. The extension spring is under tension and may cause personal injury during removal.

B. Remove lock nut securing the pin and extension spring to the spring bracket. Do not unscrew jam nut from the pin. Release pin from the bracket. Remove spring from neutral arm (Fig. 27).

C. Remove spring bracket from the pump plate (Fig. 27).

D. Remove both locknuts, cap screws, and flat washers securing the hydrostat to the pump plate. Be careful not to lose the key (Fig. 26).

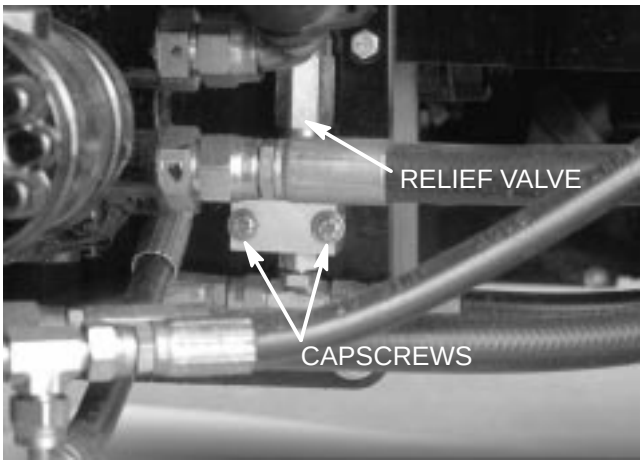


Figure 25

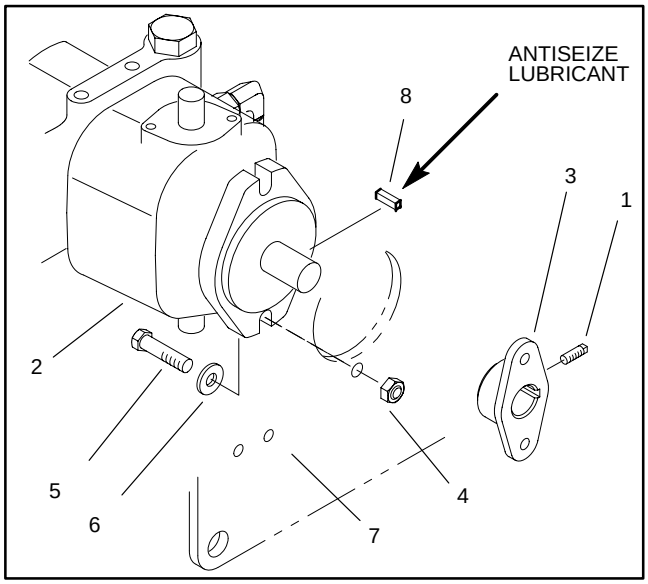


Figure 26

1. **Set screw**
2. **Hydrostat**
3. **Hub**
4. **Lock nut**
5. **Cap screw**
6. **Flat washer**
7. **Pump plate**
8. **Key**

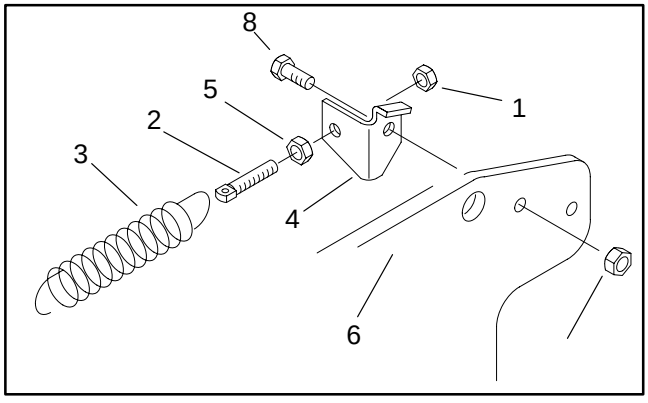


Figure 27

1. **Lock nut**
2. **Pin**
3. **Extension spring**
4. **Spring bracket**
5. **Jam nut**
6. **Pump plate**
7. **Lock nut**
8. **Cap screw**

15. Loosen cable clamp and remove choke cable from the clamp. Disconnect choke link from the choke lever (Fig. 28)

16. Disconnect the following electrical connections (Fig. 18):

A. The black (negative) battery cable (36) and black wire harness ground (37) from below the oil filter.

B. The red (positive) battery cable and red wires and connector on the starter solenoid.

C. Red/violet and red wires and connector on the starter solenoid.

D. The blue and green wires and connector to the speed sensor near the water pump.

E. The red/white wire and connector for the fuel shut off solenoid near on the main harness near the ECU.

F. The blue wire on the water temperature sender (3).

G. The green/blue wire on the oil pressure switch.

H. The black and white/black wires and connector for the fuel pump (39).

I. The connector from the electric governor. Remove R–clamps securing the main electrical harness to the frame (Fig. 29).

IMPORTANT: Label wires on the ignition coils for assembly purposes.

J. The yellow/blue and yellow/red wires on the ignition coils

K. The green, green/blue, and red/blue wires and connector to the alternator. The red wire and connector to the alternator.

17. Remove both cap screws securing the ECU to the frame. Position ECU away from the engine.

18. Remove both whiz screws (48) securing the dust shield (47) to the front engine mount (13) (Fig. 18).

19. Remove alternator (51) and fan adapter (24) from the engine for better clearance (Fig. 18).

20. Remove three whiz nuts (20), plate washers (21), and cap screws (19) securing the front engine mount (13) and rear engine mount (11) to the rubber mounts (18) (Fig. 18).

21. Disconnect fuel hose (17) from the carburetor on the engine (1) (Fig. 18).

CAUTION

One person should operate the chain fall or hoist while the other person guides the engine out of the frame.

22. Remove engine from the frame.

A. Connect a hoist or chain fall to the engine mounts.

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

B. Slowly remove the engine and mounts from the machine.

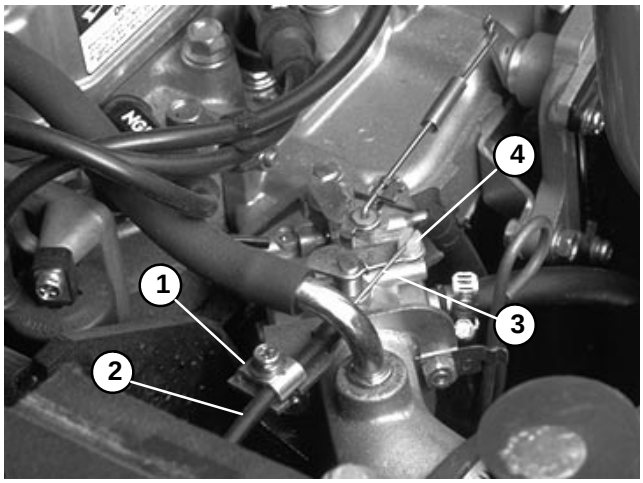


Figure 28

1. Cable clamp
2. Choke cable
3. Choke link
4. Choke lever

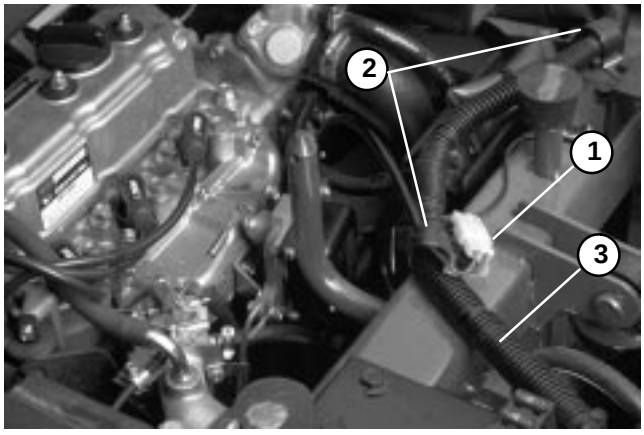


Figure 29

1. Connector (governor)
2. R–clamps
3. Main electrical harness

Engine Installation

1. If the pump plate, backing plate, or engine mounts were removed from the engine, install them to the engine using Figure 18 as a guide.

CAUTION

One person should operate the chain fall or hoist while the other person guides the engine into the frame.

2. Install engine to the frame.

A. Attach a hoist or chain fall to the engine mounts.

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

B. Lower engine and mounts into the machine.

3. Secure front engine mount (13) and rear engine mount (11) to the rubber mounts (18) with three cap screws (19), plate washers (21), and whiz nuts (20). Align mounts and tighten fasteners before releasing the engine from the chain fall or hoist (Fig. 18).

4. Install alternator (5) and fan adapter (24) to the engine (Fig. 18).

5. Adjust alternator belt (see Alternator Belt Adjustment).

6. Secure dust shield (43) to the front engine mount (13) with both whiz screws (44) (Fig. 18).

7. Secure ECU to the frame with both cap screws.

8. Connect following electrical connections (Fig. 18):

A. The black (negative) battery cable (36) and black wire harness ground (37) to the engine.

B. The red (positive) battery cable and red wires and connector to the starter solenoid.

C. Red/violet and red wires and connector to the starter solenoid.

D. The blue and green wires and connector to the speed sensor near the water pump.

E. The red/white wire and connector to the fuel shut off solenoid near on the main harness near the ECU.

F. The blue wire to the water temperature sender (3).

G. The green/blue wire to the oil pressure switch.

H. The black and white/black wires and connector to the fuel pump (39).

I. The connector to the electric governor. .Secure main electrical harness to the frame with R–clamps (Fig. 29).

J. The blue and white wires and connector to the alternator.

9. Connect choke link to the choke lever. Secure choke cable to the cable clamp (Fig. 28).

10. Install hydrostat to the pump plate as follows:

CAUTION

Use caution when installing the lock nut to the pin. The extension spring is under tension and may cause personal injury during removal.

A. Apply antiseize lubricant to the key and install into hydrostat shaft. Slide shaft and key into hub (Fig. 26).

B. Secure spring bracket to the pump plate with cap screw and lock nut (Fig. 27).

C. Install spring to neutral arm and pin. Insert pin into the spring bracket. Secure pin and to the spring bracket with lock nut (Fig. 27).

D. Secure hydrostat shaft to the hub by tightening set screw (Fig. 26).

11. Secure relief valve to the pump plate with both cap screws, flat washers, and lock nuts (Fig. 25).

12. Install radiator as follows (Fig. 16):

A. Position radiator to the machine and route hoses.

B. Secure radiator support (8) to the frame with cap screws (7). Secure radiator support, and R–clamp (31) to the frame tab with cap screw (18), flat washer (30), and lock nut (9).

C. Connect hose (3) from air cleaner to the radiator support (8).

D. Connect radiator hose (2) to the bottom of the water pump.

E. Connect breather hose (24) and radiator hose (17) to the radiator elbow (26).

F. Install alternator guard (29) to the radiator support (8) and frame bracket.

G. Make sure hoses are clear of rotating parts. Make sure cable ties and clamps securing hoses to the frame and supports are installed.

13. Install fuel filter (39) to the front engine mount (13). Connect fuel hose (17) to the carburetor on the engine (1) (Fig. 18).

14. Disconnect fuel hose (17) from the carburetor on the engine (1) (Fig. 18).

15. Install muffler as follows (Fig. 24):

A. Secure muffler to the pump plate with two cap screws.

B. Install muffler shield to the muffler and pump plate with four cap screws.

C. Secure exhaust plate to the engine exhaust manifold with four cap screws and flat washers.

16. Install air cleaner as follows (Fig. 23):

A. Secure air cleaner and bracket to the pump plate.

B. Connect hose leading to the radiator to the cleaner.

C. Route and connect hose, leading from the cleaner to the engine valve cover, to the valve cover and cleaner.

17. Install fuel tank and hydraulic reservoir as follows:

A. Position mounting plate and tanks onto the frame.

B. If the oil cooler is **not** installed, Connect hydraulic hose to the hydraulic oil filter (Fig. 22).

C. Connect hydraulic hose to the welded fitting on the tube leading into rear bulkhead (Fig. 21).

D. Remove plug from the pump inlet hose and gear pump. Install pump inlet hose to the gear pump with hose clamp (Fig 19).

E. Connect expansion tank hose (25) to the radiator elbow (27) (Fig. 16).

F. Make sure hoses are secured to the frame and supports with cable ties and hose clamps.

G. Secure tank mounting plate (13) to the support bracket (28) and frame with three cap screws (6) and two flat washers (14) (Fig. 17).

18. Connect hydraulic oil cooler if installed (Fig. 20).

A. Connect tube and O–ring to hydraulic fitting on the hydraulic reservoir.

B. Connect tube and O–ring to hydraulic fitting on the oil filter.

19. Install screen (10) into the radiator support (8) (Fig. 16).

20. Install console shroud to the control panel.

21. Make sure fuel shutoff valve is open (see Fuel Shutoff Valves). Fill fuel tank with fuel (see Fill Fuel Tank). Check tank and hoses for leaks.

22. Fill cooling system with coolant (see Check Cooling System). Check radiator and hoses for leaks.

23. Fill hydraulic reservoir with hydraulic oil (see Check Hydraulic System Fluid in Chapter 5 – Hydraulic System). Check reservoir and hoses for leaks.

Chapter 4

Perkins Diesel Engine

Table of Contents

Introduction

This Chapter gives information about specifications, maintenance, troubleshooting, testing, and repair of the diesel engine used in the Greensmaster 3200–D mower.

Most repairs and adjustments require tools which are commonly available in many service shops. Special tools are described in the Special Tools section. 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 Perkins engines are supplied through your local Toro Distributor. If no parts list is available, be sure to provide your dealer or distributor with the Perkins model and serial number.

Specifications

Item	Description
Make / Designation	Perkins, vertical in–line, 4–stroke, water–cooled Diesel, 103–07 KL 70373
Combustion Chamber	IDI special swirl–combustion type
Number of Cylinders	3
Horse Power	17.0 HP @ 3600 RPM
Torque kg–cm (in–lb)	392 (340) @ 3600 RPM
Bore x Stroke mm (in.)	67 x 64 (2.64 x 2.52)
Total Displacement cc (cu. in.)	676 (41.23)
Compression Ratio	24:1
Firing Order	1– 2–3
Dry Weight (approximate) kg (lb.)	64 (141)
Fuel	Grade No. 2D diesel fuel (ASTM specification)
Fuel Capacity liters (gallons)	22.7 (6.0)
Fuel Injection Pump	Bosch type plunger
Governor	Mechanical
Idle Speed (no load)	1500 $\pm$ 50 RPM
High Idle (no load)	3025 $\pm$ 50 RPM
Fuel Injector Nozzle	Bosch throttle type
Fuel Injection Working Pressure kg/cm^2 (psi)	115 to 125 (1636 to 1778)
Injection Timing	28.5 to 30.5° B.T.D.C.
Engine Oil	SAE 10W30 SF, CD
Oil Pump	Gear driven trochoid type
Crankcase Oil Capacity liters (U.S. qt.)	2.8 (3.0) with filter
Water Pump	Belt driven centrifugal type
Cooling System Capacity liters (U.S. qt.)	4.7 (5.0)
Starter	12 VDC 1.2 KW
Alternator/Regulator	12 VDC 27 AMP
Glow Plug	Sheathed type

Special Tools

Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (Commercial Products*).

Some tools may be listed in the Greensmaster 3200–D Parts Catalog. Tools may also be available from a local supplier.

Filter Cleaner

Mix cleaner with water, and use solution to wash the Donaldson air cleaner element.

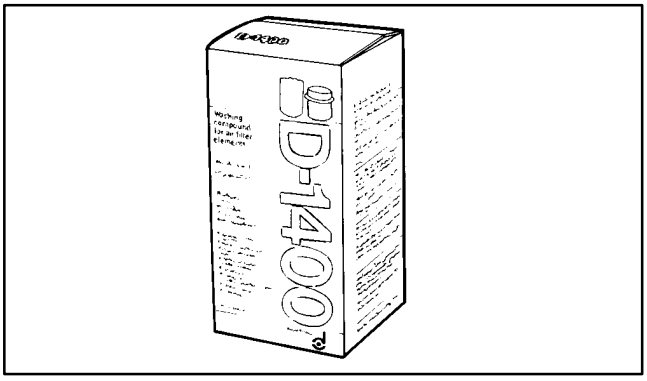


Figure 1

Diesel Engine Compression Test Kit

This 0 to 1000 PSI gauge allows testing and checking the general operating condition of the engine. The kit includes a case, gauge with hose, glow plug hole adapters, and instructions.

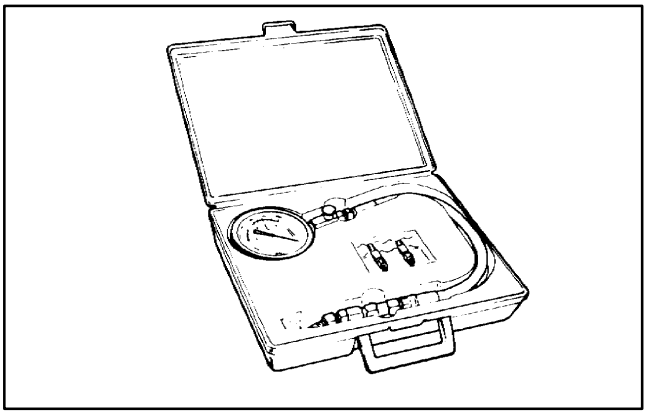


Figure 2

Nozzle Tester

This tests the condition and opening pressure of fuel injection nozzles.

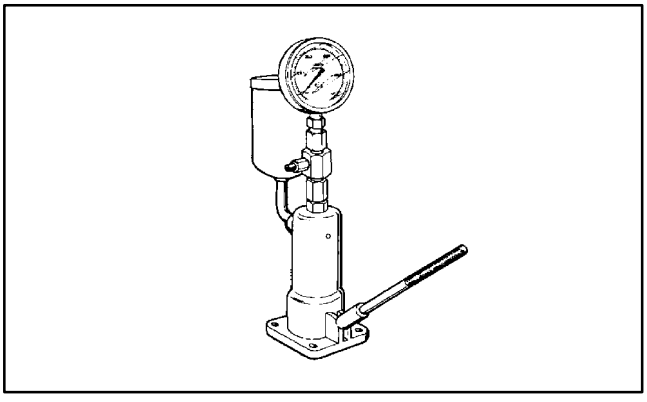


Figure 3

Nozzle Test Adapter

This adapter is required to test the fuel injection nozzles in conjunction with the spray tester.

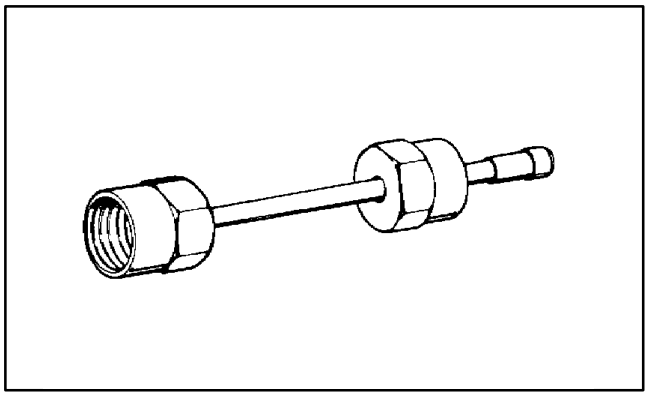


Figure 4

Fuel Shutoff Valves

These valves should be shut when removing the engine or placing the unit in long term storage.

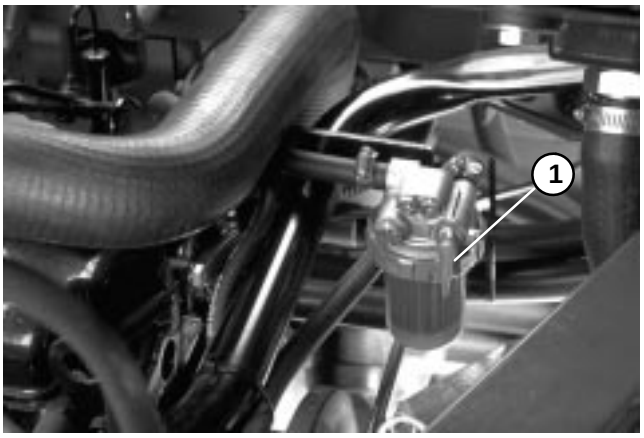


Figure 5

1. Fuel shut off valve (on the fuel filter)

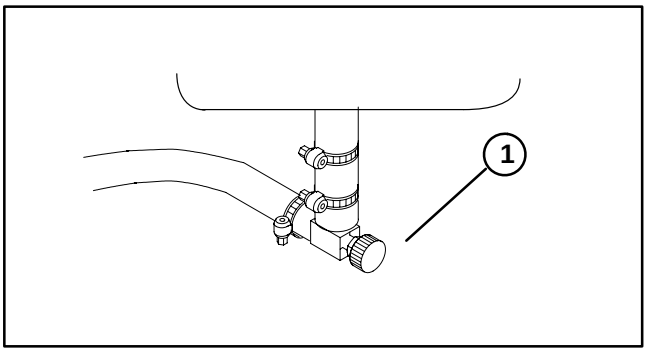


Figure 6

1. Fuel shut off (under the fuel tank)

Filling Fuel Tank

The engine runs on No. 2 diesel fuel. The fuel tank capacity is approximately 6 gallons (22.7 L)

1. Clean area around fuel tank cap.

DANGER

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

2. Remove fuel tank cap.

3. Fill tank to about one inch below the top of the tank, (bottom of filler neck). **Do not overfill.** Then install cap.

4. Wipe up any fuel that may have spilled to prevent a fire hazard.

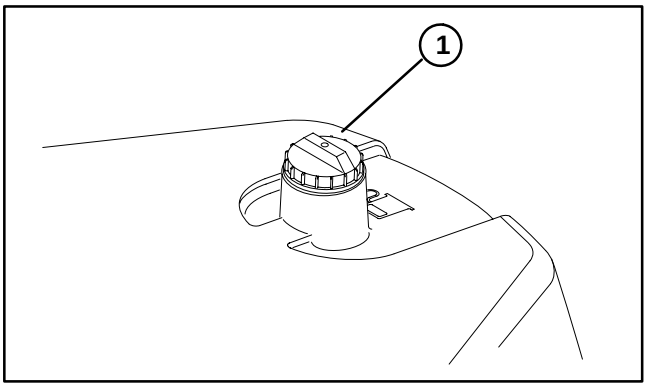


Figure 7

1. Fuel cap

Checking Engine Oil

IMPORTANT: Check level of oil every 5 operating hours or daily. Change oil after every 50 hours of operation.

Crankcase capacity is approximately 3.2 qts. (3.0 L) with filter.

1. Park machine on a level surface, engage parking brake, and lower cutting units. Allow engine to run for at least ten minutes to bring it to operating temperature, then shut off the engine.

2. Remove dipstick and wipe it with a clean rag. Push dipstick down into dipstick tube and make sure it is seated fully. Pull dipstick out and check level of oil. If oil level is low, add enough oil to raise level to FULL mark on dipstick (Fig. 8).

3. If oil level is low, remove oil fill cap (Fig. 9) and gradually add small quantities of oil, checking level frequently, until level reaches FULL mark on dipstick.

4. The engine uses any high–quality 10W30 detergent oil having the American Petroleum Institute – API – "service classification" CD.

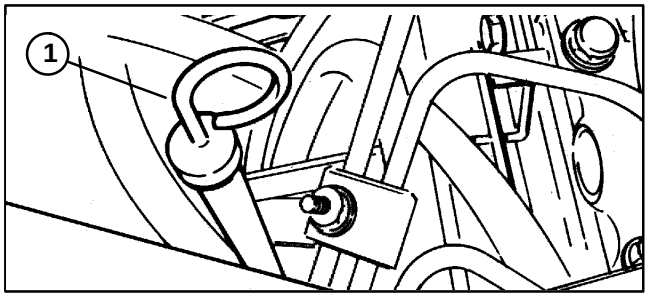


Figure 8

1. Dipstick

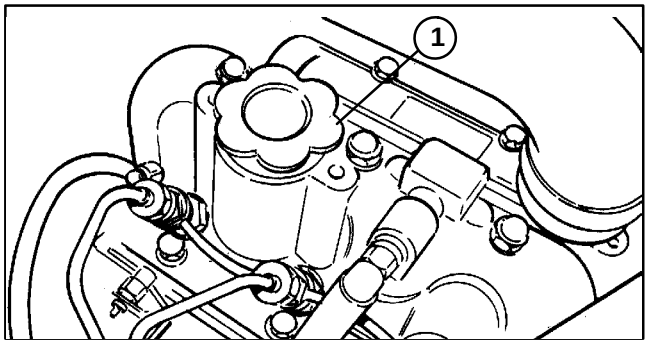


Figure 9

1. Oil fill cap

Checking Cooling System

The cooling system is filled with a 50/50 solution of water and permanent ethylene glycol antifreeze. Check level of coolant at beginning of each day before starting the engine. Capacity of cooling system is approximately 3.6 qts. (3.4 L).

CAUTION

If engine has been running, pressurized hot coolant can escape when radiator cap is removed and cause burns.

1. Park machine on a level surface.

2. Check coolant level. Coolant should be between lines on reserve tank, when engine is cold.

3. If coolant is low, remove reserve tank cap and add a 50/50 mixture of water and permanent ethylene glycol antifreeze. **Do not overfill**.

4. Install reserve tank cap.

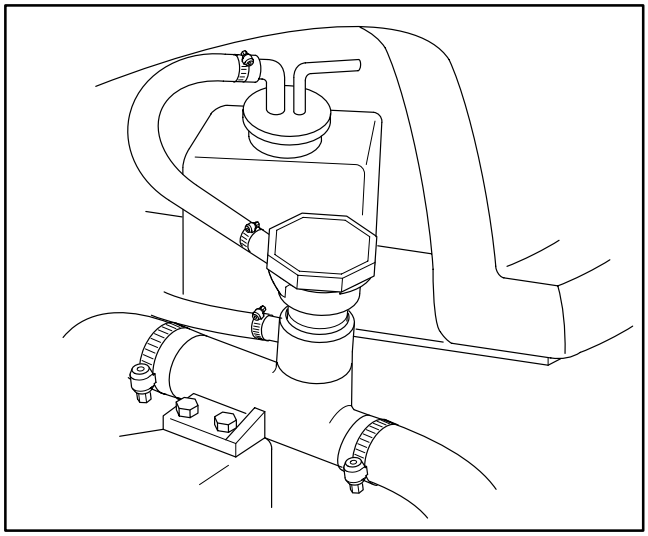


Figure 10

1. Reserve tank **2. Radiator cap**

Adjustments

Alternator Belt Adjustment

Make sure belt is properly tensioned to assure proper operation of the machine and prevent unnecessary wear. On new belts, check tension after 8 hours operation.

The alternator belt should be tensioned so it deflects 0.20 inch (0.51 cm) with a 2 to 3 pound (8.9 to 13.3 N) load applied midway between the crankshaft and alternator pulley.

1. Loosen bolts securing alternator to engine and adjusting strap.

2. Adjust belt to proper tension and tighten bolts.

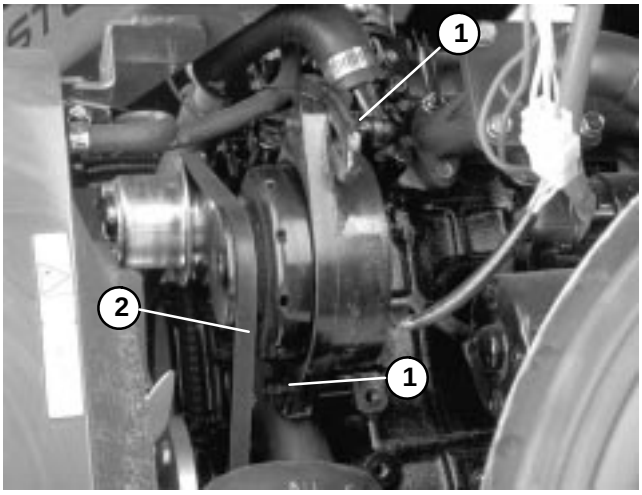


Figure 11

1. Adjustment bolt **2. Alternator belt**

Valve Clearance Adjustment

Initially, adjust valves after the first 50 hours of operation, and every 400 hours thereafter.

1. Remove breather hose and cylinder head cover from the engine.

Note: Adjust valves when the engine is cold. Set the No. 1 cylinder to top dead center. Adjust clearances of the intake/exhaust valves of No. 1 cylinder and exhaust valve of No. 2 cylinder. Then, turn the crankshaft counterclockwise 240° (viewed from front) to adjust clearance of intake valve of No. 2 cylinder and intake/exhaust valves of No. 3 cylinder.

2. Loosen nut and adjust clearance of both intake and exhaust valves to 0.0078 inch (0.2mm).

3. Install cylinder head cover and gasket. Torque screws to 7 to 9 ft–lb (0.97 to 1.24 kg–m). Install breather hose.

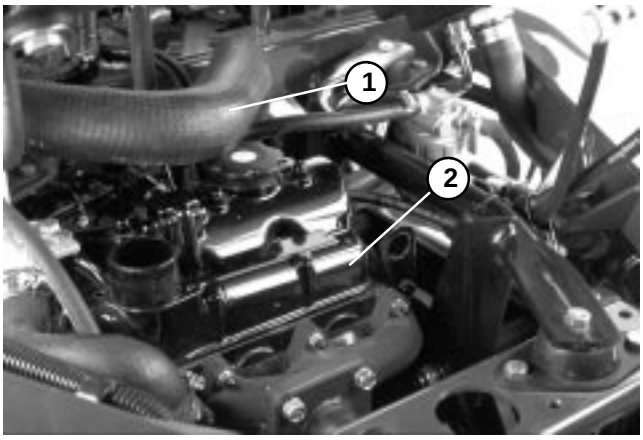


Figure 12

1. Breather hose **2. Cylinder head cover**

Throttle Adjustment

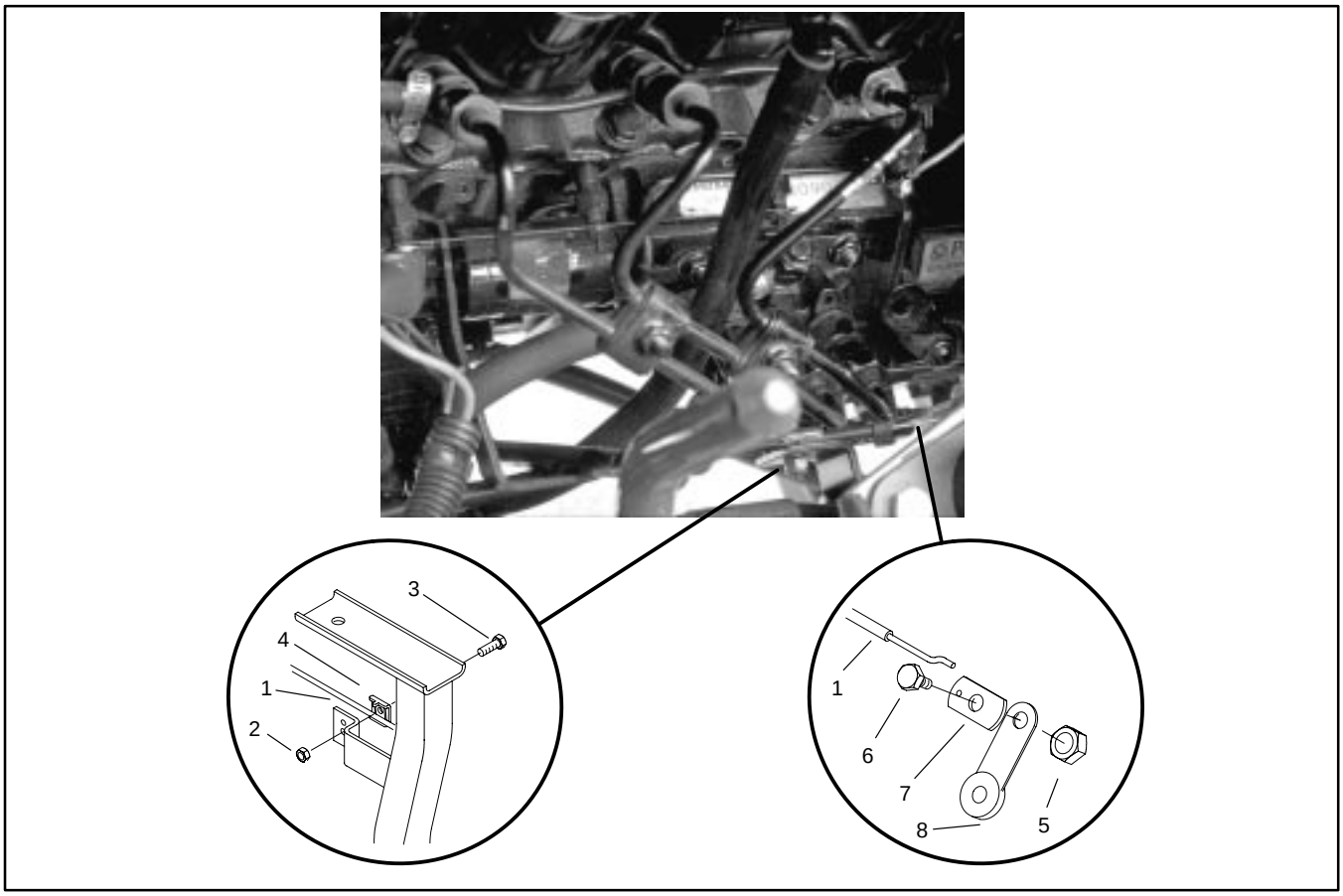


Figure 13

1. **Throttle control cable**
2. **Lock nut**
3. **Cap screw**
4. **Throttle cable clamp**
5. **Lock nut**
6. **Shoulder screw**
7. **Throttle tab**
8. **Governor lever**

Normally, adjustments to the engine speed settings are not necessary unless the throttle control cable, injection pump, or governor have been repaired, rebuilt, or replaced; or are they are not operating correctly.

Use a vibration type tachometer or a digital photo tachometer to set engine speed.

High–Speed Adjustment (Fig. 14)

1. Park machine on a level surface, engage parking brake, and lower cutting units. Allow engine to run for at least ten minutes to bring it to operating temperature.

2. Lift up seat to access the engine.

3. Remove wire and lead seal from the high–speed set bolt. Loosen lock nut on the high–speed set bolt.

4. Adjust maximum engine speed between **2975 and 3075 RPM** by rotating the high–speed set bolt. Tighten lock nut.

5. Install new wire and lead seal no the high–speed set bolt.

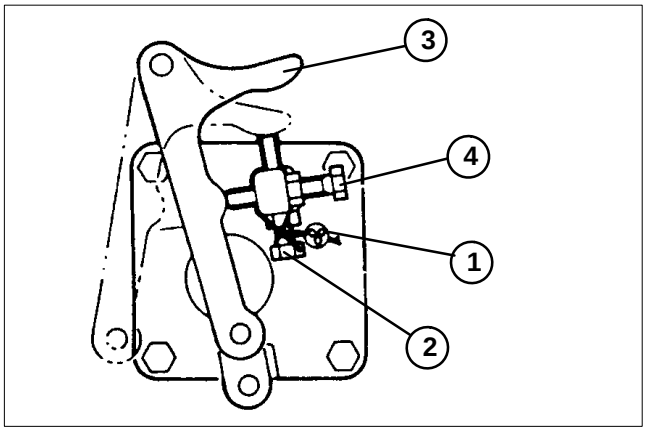


Figure 14

1. **Wire and lead seal**
2. **High–speed set bolt**
3. **Governor lever**
4. **Low–speed set bolt**

Low–Speed Adjustment (Fig. 13 and 14)

1. Make sure machine is parked on a level surface with the parking brake engaged and the cutting units lowered. Allow engine to run for at least ten minutes to bring it to operating temperature.

2. Position throttle control lever to the low idle position (against the stop plate).

3. Lift up seat to access the engine.

4. Loosen cap screw and lock nut securing the throttle cable clamp to the throttle control cable and front engine mount.

5. Loosen lock nut on the low–speed set bolt.

6. Adjust engine speed between **1450 and 1550 RPM** by rotating the low–speed set bolt. Make sure throttle control lever is against the stop plate. Tighten lock nut.

7. Tighten cap screw and lock nut securing the throttle cable clamp to the throttle control cable and front engine mount.

Inspecting Fuel Filter

Inspect fuel filter bowl daily for water or other contaminants. If water or other contaminants are present, they must be removed before commencing operation.

1. Close fuel shutoff valve above the filter.

DANGER

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

2. Unscrew nut securing bowl to filter head. Remove water or other contaminants from bowl.

3. Inspect fuel filter and replace if dirty. Refer to Replacing Fuel Filter.

4. Reinstall bowl to filter head. Make sure O–ring is positioned properly between bowl mounting nut and filter head.

5. Open fuel shutoff valve above filter.

6. Open bleed screw on filter mounting allowing bowl to refill with fuel. Close bleed screw.

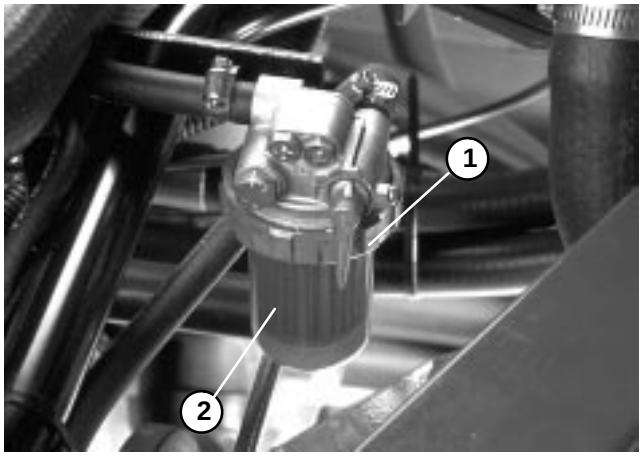


Figure 15

1. **Fuel shut–off valve**
2. **Fuel filter**

Bleeding Fuel System

1. Park the machine on a level surface. Make sure fuel tank is at least half full.

DANGER

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

2. Open fuel shutoff valve under fuel tank and on fuel filter.

3. Open (2) bleed screws on side of fuel filter mounting head. Allow bowl to refill with fuel. Close bleed screws when bowl is filled.

4. Locate transfer pump inlet screw on the front of the engine (by oil filter). Note angle of the fitting on transfer pump inlet screw, and loosen screw (left screw only).

5. When a steady stream of fuel flows out of transfer pump screw, tighten screw. Retain angle of the fitting before loosening.

6. Loosen injection pump inlet screw on the front of engine.

7. Pump priming lever until a steady stream of fuel flows out of injection pump inlet screw, then tighten screw.

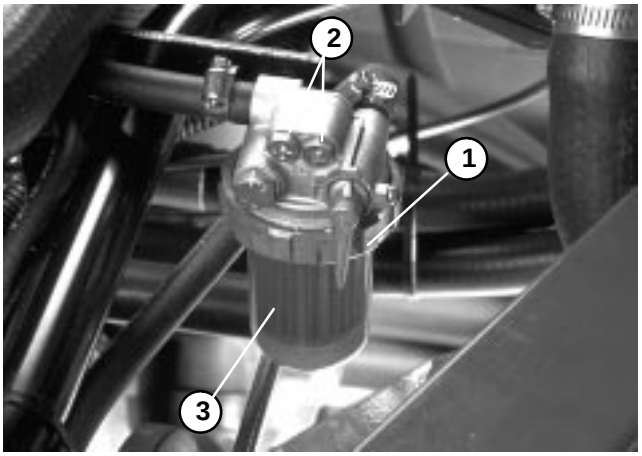


Figure 16

1. **Fuel shut–off valve**
2. **Bleed screws**
3. **Fuel filter**

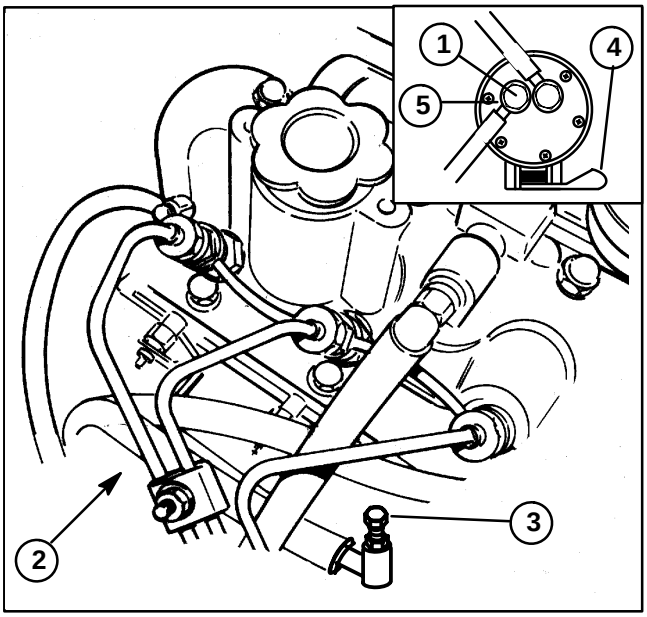


Figure 17

1. **Transfer pump screw**
2. **Transfer pump inlet screw location**
3. **Injection pump inlet screw**
4. **Priming lever**
5. **Fitting angle**

Servicing Air Cleaner

Service air cleaner filter every 200 hours (more frequently in extreme dusty or dirty conditions).

1. Check air cleaner body for damage which could possibly cause an air leak. Replace cleaner body if damaged.

2. Release latches securing the air cleaner cover to the air cleaner body. Separate cover from the body. Clean inside of the air cleaner cover.

3. Gently slide filter out of the air cleaner body to reduce the amount of dust dislodged. Avoid knocking filter against the air cleaner body.

4. Inspect filter and discard it if damaged. Do not wash or reuse a damaged filter.

Washing Method

A. Prepare a solution of filter cleaner and water a nd soak filter element about 15 minutes. Refer to directions on filter cleaner carton for complete information.

B. After soaking the filter for 15 minutes, rinse it with clear water. Maximum water pressure must not exceed 40 psi to prevent damage to the filter element. Rinse filter from the clean side to the dirty side.

C. Dry filter element using warm, flowing air that dose not to exceed 160_F (71_C), or allow element to air–dry. Do not use a light bulb to dry the filter element because damage could result.

Compressed Air Method

CAUTION

Use eye protection such as goggles when using compressed air

A. Blow compressed air from the inside to the outside of the dry filter element. Do not exceed 100 psi to prevent damage to the element.

B. Keep air hose nozzle at least 2 inches (5 cm) from the filter. Move nozzle up and down while rotating the filter element. Inspect for holes and tears by looking through the filter toward a bright light.

5. Inspect new filter for shipping damage. Check sealing end of filter. Do not install a damaged filter.

6. Insert new filter properly into air cleaner body. Make sure filter is sealed properly by applying pressure to outer rim of filter when installing. Do not press on flexible center of filter.

7. Reinstall cover and secure latches.

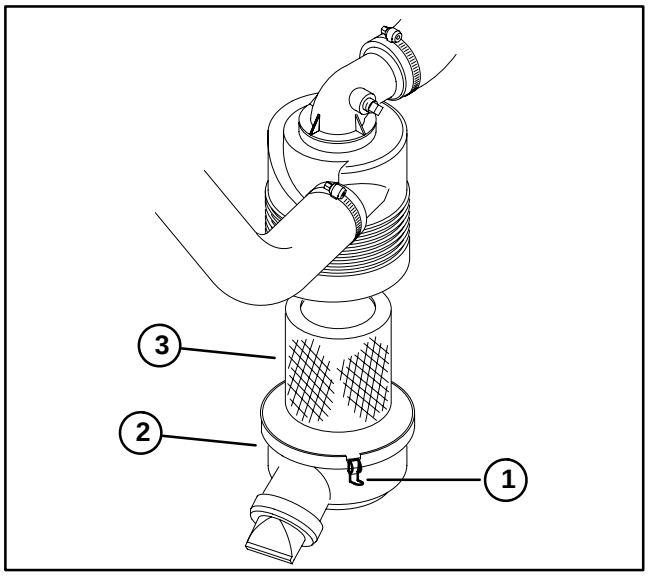


Figure 18

1. **Air cleaner latches**
2. **Dust cup**
3. **Filter**

Cleaning Radiator and Screen

Keep radiator screen and radiator clean to prevent the cooling system from overheating. Check and clean both the screen and radiator daily. If necessary, clean any debris off these parts hourly. Clean these components more frequently in dusty and/or dirty conditions.

1. Release latches and remove radiator screen from the support.

2. Remove fan shroud to access radiator corners.

CAUTION

Use eye protection such as goggles when using compressed air

IMPORTANT: Air pressure should not exceed 40 psi (2.8 bar) because damage to the radiator fins may result.

3. Working from fan side of radiator, blow out the radiator with compressed air.

4. Clean screen. Reinstall fan shroud and screen to the radiator support. Secure latches.

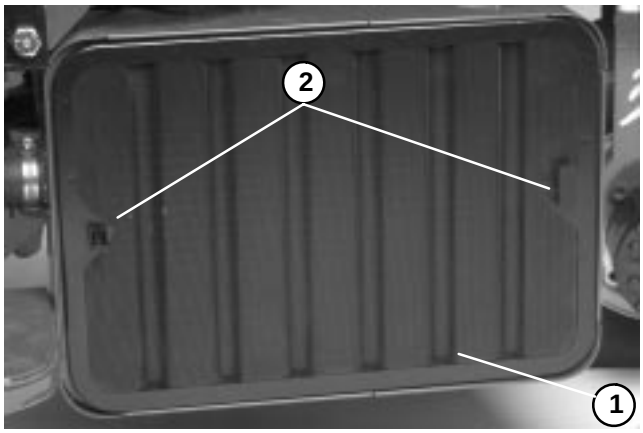


Figure 19

1. **Screen** 2. **Latches**

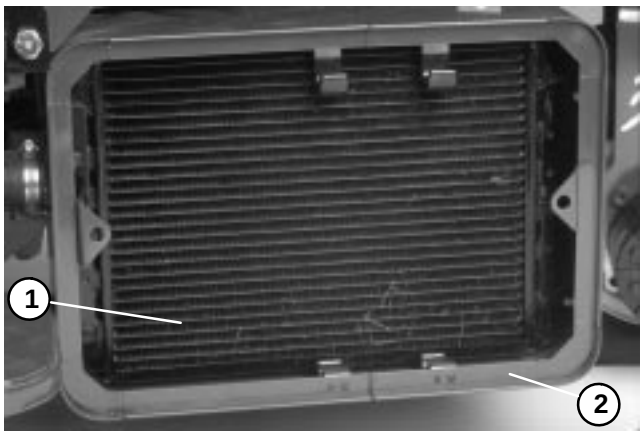


Figure 20

1. **Radiator** 2. **Radiator support**

Changing Engine Oil and Filter

Change oil and filter initially after the first 8 hours of operation, thereafter change oil every 50 hours and filter every 100 hours.

1. Remove drain plug and let oil flow into drain pan. When oil stops, install drain plug.

2. Remove oil filter.

3. Apply a light coat of clean oil to the new filter gasket.

4. Screw filter on by hand until gasket contacts filter adapter, then tighten 1/2 to 3/4 turn further. **Do not overtighten.**

5. Add oil to crankcase, (see Check Engine Oil).

6. Dispose of oil properly.

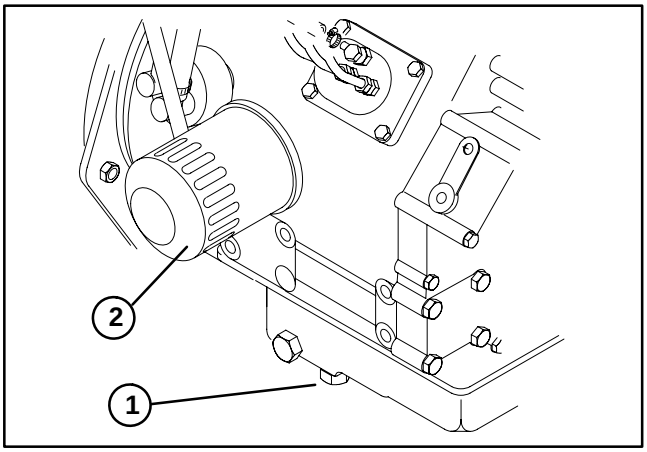


Figure 21

1. **Drain plug** 2. **Oil filter**

Torque Cylinder Head Bolts

Check head bolt torque after the first 50 hours of operation, and every 400 hours thereafter.

1. Remove breather hose and cylinder head cover from engine.

2. Torque head bolts from 25 to 29 ft–lb (3.5 to 4.0 kg–m) using the sequence in Figure 23.

3. Install cylinder head cover and gasket. Torque cover screws from 7 to 9 ft–lb (1.0 to 1.2 kg–m). Install breather hose.

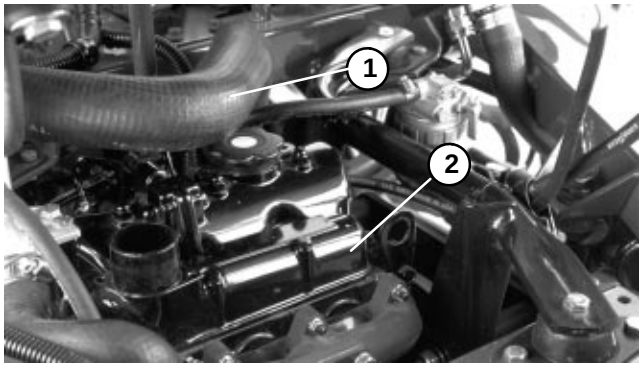


Figure 22

1. Breather hose **2. Cylinder head cover**

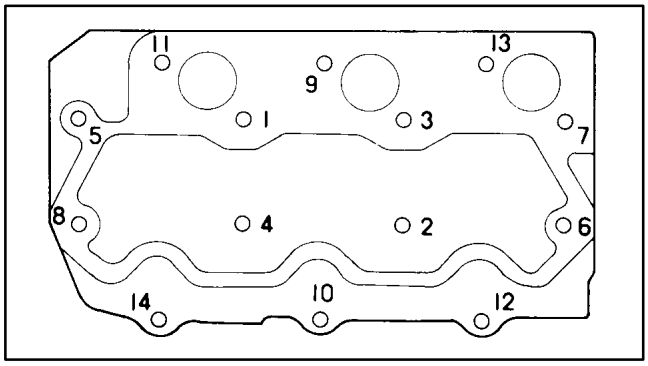


Figure 23

Replacing Fuel Filter

Inspect fuel filter bowl daily for water or other contaminants. If water or other contaminants are present, they must be removed before commencing operation.

1. Close fuel shutoff valve above filter.

DANGER

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

2. Unscrew nut securing the bowl to the filter head. Remove water or other contaminants from the bowl. Remove and inspect fuel filter. Replace filter if dirty.

3. Reinstall bowl to the filter head. Make sure O–ring is positioned properly between the bowl mounting nut and the filter head.

4. Open fuel shutoff valve above the filter. Open bleed screw on the filter mounting head to refill the bowl with fuel. Close bleed screw.

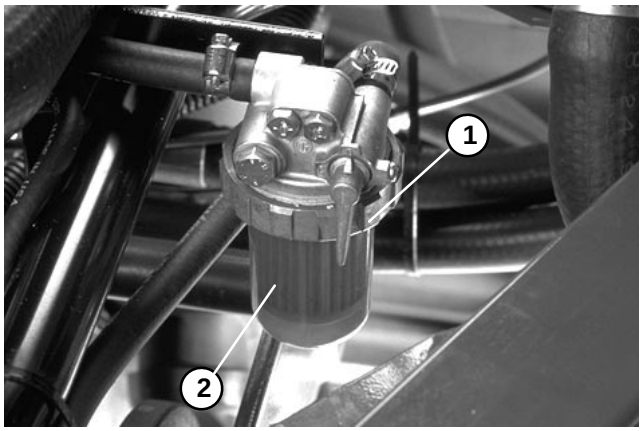


Figure 24

1. Fuel shut–off valve **2. Fuel filter**

Muffler and Air Cleaner

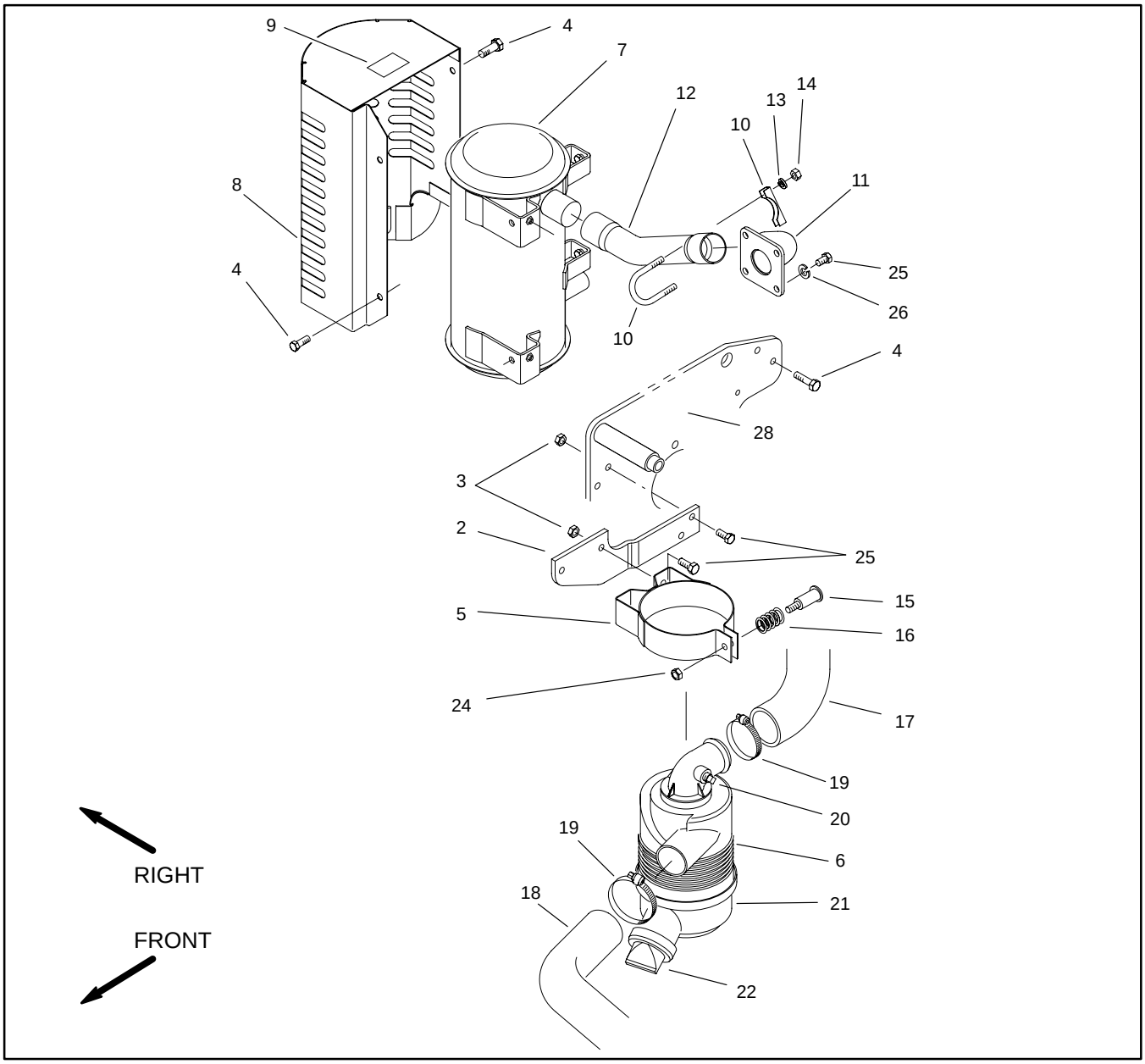


Figure 25

1. **Not used**
2. **Air cleaner bracket**
3. **Lock nut**
4. **Cap screw**
5. **Mounting band**
6. **Air cleaner**
7. **Muffler**
8. **Muffler shield**
9. **Hot surface decal**
10. **Clamp**
11. **Exhaust bracket (to engine)**
12. **Exhaust pipe**
13. **Lock washer**
14. **Nut**
15. **Bolt**
16. **Compression spring**
17. **Air cleaner hose (to engine)**
18. **Air cleaner hose (to radiator)**
19. **Hose clamp**
20. **Plug**
21. **Cover assembly**
22. **Valve**
23. **Air cleaner element (not shown)**
24. **Lock nut**
25. **Cap screw**
26. **Spring lock washer**
27. **Cap screw**
28. **Pump plate**

Muffler Removal

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

CAUTION

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

2. Remove muffler shield (8) from from the muffler (7) by removing the four cap screws (4) securing the shield to the muffler.

3. Remove nuts (14), lock washers (13), and clamp (10) securing the exhaust pipe (12) to the muffler (7).

4. Remove two cap screws (4) securing the muffler (7) to the rear of the pump plate (28). Carefully separate muffler from the pump plate and exhaust pipe (12).

5. Further disassemble muffler as necessary.

Muffler Installation

1. Make sure the engine is off.

2. If the exhaust bracket (11) was removed, install bracket to exhaust manifold with a new gasket. Secure bracket to the manifold with spring lock washers (26) and cap screws (25).

3. If the exhaust pipe (12) was removed, install pipe to exhaust bracket (11) with clamp (10), lock washers (13), and nuts (14).

4. Carefully attach muffler (7) to the exhaust pipe (12). Secure muffler (7) to the pump plate (28) with two cap screws (4).

5. Secure exhaust pipe (12) to the muffler (7) with clamp (10), lock washers (13), and nuts (14).

6. Secure muffler shield (8) to the muffler (7) with four cap screws (4).

Air Cleaner Removal

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

2. Loosen hose clamps (19), and disconnect air cleaner hoses (17 and 18) from the air cleaner (6).

3. Remove lock nut (24) from bolt (15). Remove bolt and compression spring (16) from the mounting band (5).

4. Remove air cleaner (6) from the mounting band (5).

5. Further disassemble air cleaner as necessary.

Air Cleaner Installation

1. Make sure the engine is off.

2. If the air cleaner bracket (2) was removed, secure bracket to the pump plate (28) with two cap screws (25) and lock nuts (3).

3. If the mounting band (5) was removed, secure band to the air cleaner bracket (2) with two cap screws (25) and lock nuts (3).

4. Carefully place air cleaner (6) into the mounting band (5).

5. Reconnect air cleaner hoses (17 and 18) to the air cleaner (6) and secure with hose clamps (19).

6. Install bolt (15) and compression spring (16) to the mounting band (5). Secure bolt with lock nut (24).

Radiator

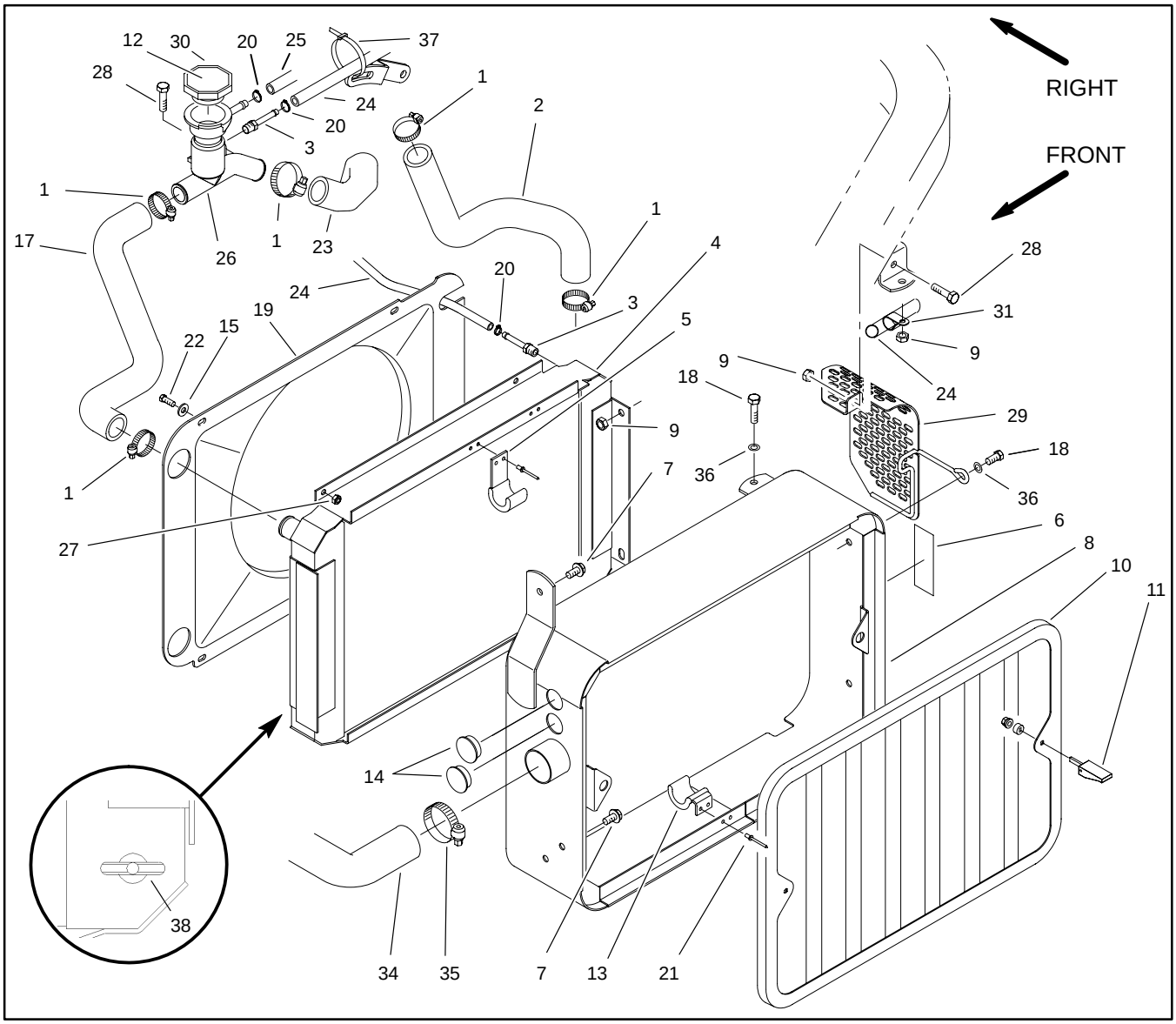


Figure 26

1. **Hose clamp**
2. **Radiator hose (to water pump)**
3. **Hydraulic barb fitting**
4. **Radiator**
5. **Upper cooler bracket**
6. **Lower cooler bracket**
7. **Cap screw**
8. **Radiator support**
9. **Lock nut**
10. **Screen**
11. **Swell latch**
12. **Radiator cap decal**
13. **Cooler lower bracket**
14. **Plug**
15. **Flat washer**
16. **Not used**
17. **Radiator hose**
18. **Cap screw**
19. **Fan shroud**
20. **Hose clamp**
21. **Pop rivet**
22. **Cap screw**
23. **Radiator hose**
24. **Breather hose**
25. **Expansion tank hose**
26. **Radiator elbow**
27. **Lock nut**
28. **Cap screw**
29. **Alternator guard**
30. **Radiator cap**
31. **R–clamp**
32. **Not used**
33. **Not used**
34. **Air cleaner hose**
35. **Hose clamp**
36. **Flat washer**
37. **Cable tie**
38. **Petcock**

Radiator Removal (Fig. 26)

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

CAUTION

DO NOT open radiator cap or drain coolant if the engine or radiator is hot. Pressurized hot coolant can escape and cause burns.

Ethylene–gycol antifreeze is poisonous. Dispose of it properly or store it in a properly labeled container away from children and pets.

2. Place a suitable container under the front end of the radiator. Open drain petcock (38) on the back of the radiator. Drain radiator completely and close petcock.

3. Remove screen (10) from radiator support (8).

4. If the hydraulic oil cooler is installed, drain the hydraulic reservoir and disconnect the oil cooler (see Engine Removal).

5. Remove the following hoses from the radiator:

   A. Loosen hose clamp (20) and disconnect breather hose (24).

   B. Loosen hose clamps (1) and disconnect radiator hoses (2 and 17).

   C. Loosen hose clamp (35) and disconnect air cleaner hose (34).

6. Remove the following fasteners to remove the radiator support (8) from the frame:

   A. Lock nut (9) and cap screw (28) securing the alternator guard (29) to the frame tab. Cap screw (7) securing the lower radiator support to the frame.

   B. Cap screw (7) securing the upper radiator support tab to the frame. Lock nut (9), cap screw (18), and flat washer (36) securing the rear radiator support tab and R–clamp (31) to the frame tab.

7. Remove the radiator support (8) from the frame and onto a workbench.

8. Remove four cap screws (18) and lock nuts (9) securing the radiator (4) to the radiator support (8). Slide radiator out of the support.

9. Remove four cap screws (22), lock nuts (27), and flat washers (15) securing the fan shroud (19) to the radiator (4). Separate the shroud from the radiator.

Radiator Installation (Fig. 26)

1. Secure fan shroud (19) to radiator (4) with four cap screws (22), lock nuts (27), and flat washers (15).

2. Slide radiator (4) into the radiator support (8). Secure radiator to support with four cap screws (18) and lock nuts (9). Also, install alternator guard (29) with washer (36) to the radiator support.

3. Position radiator support (8) to the frame.

   A. Secure rear radiator support tab and R–clamp (31) to the frame with cap screw (18), flat washer (36), and lock nut (9). Secure upper radiator support tab to frame with cap screw (7).

   B. Secure lower portion of the radiator support to the frame with cap screw (7). Secure alternator guard (29) to the frame tab with cap screw (28) and lock nut (9).

4. Connect the following hoses to the radiator:

   A. Air cleaner hose (34) with hose clamp (35)

   B. Radiator hoses (2 and 17) with hose clamps (1).

   C. Breather hose (24) with hose clamp (20).

5. If the hydraulic oil cooler was installed, connect the oil cooler (see Engine Installation). Fill the hydraulic reservoir (see Check Hydraulic System Fluid in Chapter 5 – Hydraulic System).

6. Install screen (10) to radiator support (8).

7. Fill radiator (4) with coolant (see Check Cooling System).

Fuel Tank

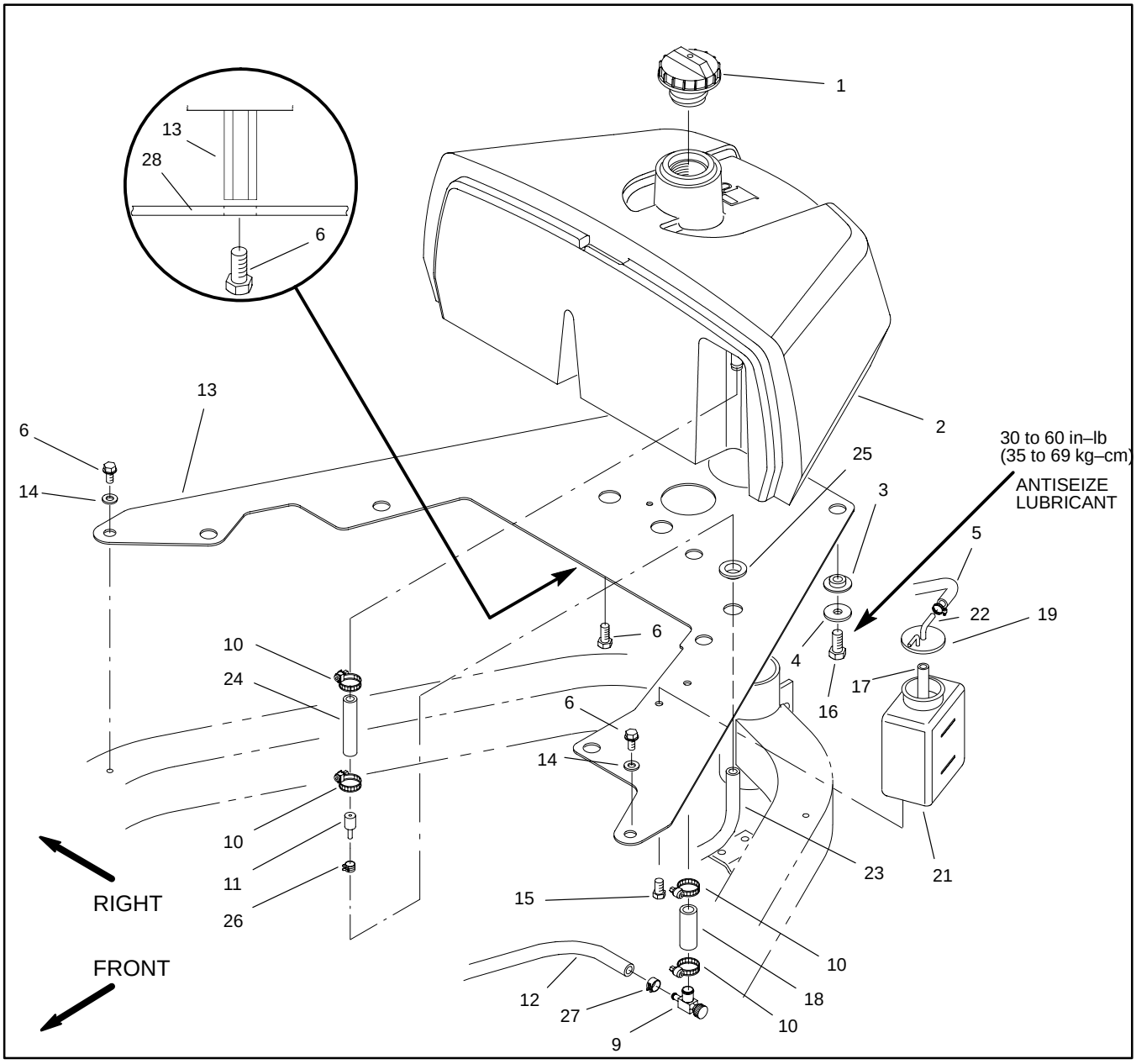


Figure 27

1. **Diesel fuel cap**
2. **Fuel tank**
3. **Grommet**
4. **Flat washer**
5. **Expansion tank hose (from radiator)**
6. **Cap screw**
7. **Not used**
8. **Not used**
9. **Fuel shut–off fitting**
10. **Hose clamp**
11. **Fuel fitting**
12. **Fuel hose (to fuel filter)**
13. **Mounting plate**
14. **Flat washer**
15. **Cap screw**
16. **Cap screw**
17. **Tank hose**
18. **Fuel hose**
19. **Overflow tank cap**
20. **Not used**
21. **Expansion tank**
22. **hose clamp**
23. **Fuel hose (from fuel injectors)**
24. **Fuel hose**
25. **Grommet**
26. **Hose clamp**
27. **Hose clamp**
28. **Support bracket**

Fuel Tank Removal (Fig. 27)

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

DANGER

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

2. Drain fuel tank (2) as follows:

   A. Close fuel shut–off valve (9) below the fuel tank.

   B. Close fuel shutoff valve on the fuel filter (49). Disconnect fuel hose (36) from the fuel filter. Place hose into a suitable container for draining the tank (Fig. 27)

   C. Drain fuel tank completely by opening the fuel shut off valve.

3. Gain access to the fasteners securing the fuel tank (2) to the mounting plate (13) as follows:

   A. Remove three cap screws (6) and two flat washers (14) securing mounting plate to the frame and support bracket (28).

   B. Lift and support the mounting plate up from the rear of the machine.

4. Loosen hose clamp (26) and disconnect fuel hose (23) from fuel fitting (11).

5. Loosen hose clamp (10) and disconnect fuel hose (18) from fuel tank (2).

6. Remove three cap screws (16) and flat washers (4) securing the fuel tank (2) to the mounting plate (13). Remove the tank from the mounting plate being careful not to damage any fuel hoses.

Fuel Tank installation (Fig. 27)

1. Position fuel tank (2) to the mounting plate (13). Be careful not to damage any fuel hoses.

   A. Apply antiseize lubricant to the threads of the three cap screws (16).

   B. Secure fuel tank to the plate with three flat washers (4) and cap screws.

   C. Torque cap screws from 30 to 60 in–lb (35 to 69 kg–cm).

2. Connect fuel hose (18) to the fuel tank with hose clamp (10).

3. Connect fuel hose (23) to fuel fitting (11) with hose clamp (26).

4. Install mounting plate (13) to the frame as follows:

   A. Position mounting plate to the frame. Make sure to align plate holes with frame holes and support bracket (28).

   B. Secure mounting plate to the frame and support bracket with two flat washers (14) and three cap screws (6).

5. Connect fuel hose (36) to the fuel filter (49).

6. Open fuel shut–off valve (9) below the fuel tank.

7. Fill fuel tank with fuel (see Fill fuel Tank). Check fuel lines and tank for leaks.

Engine

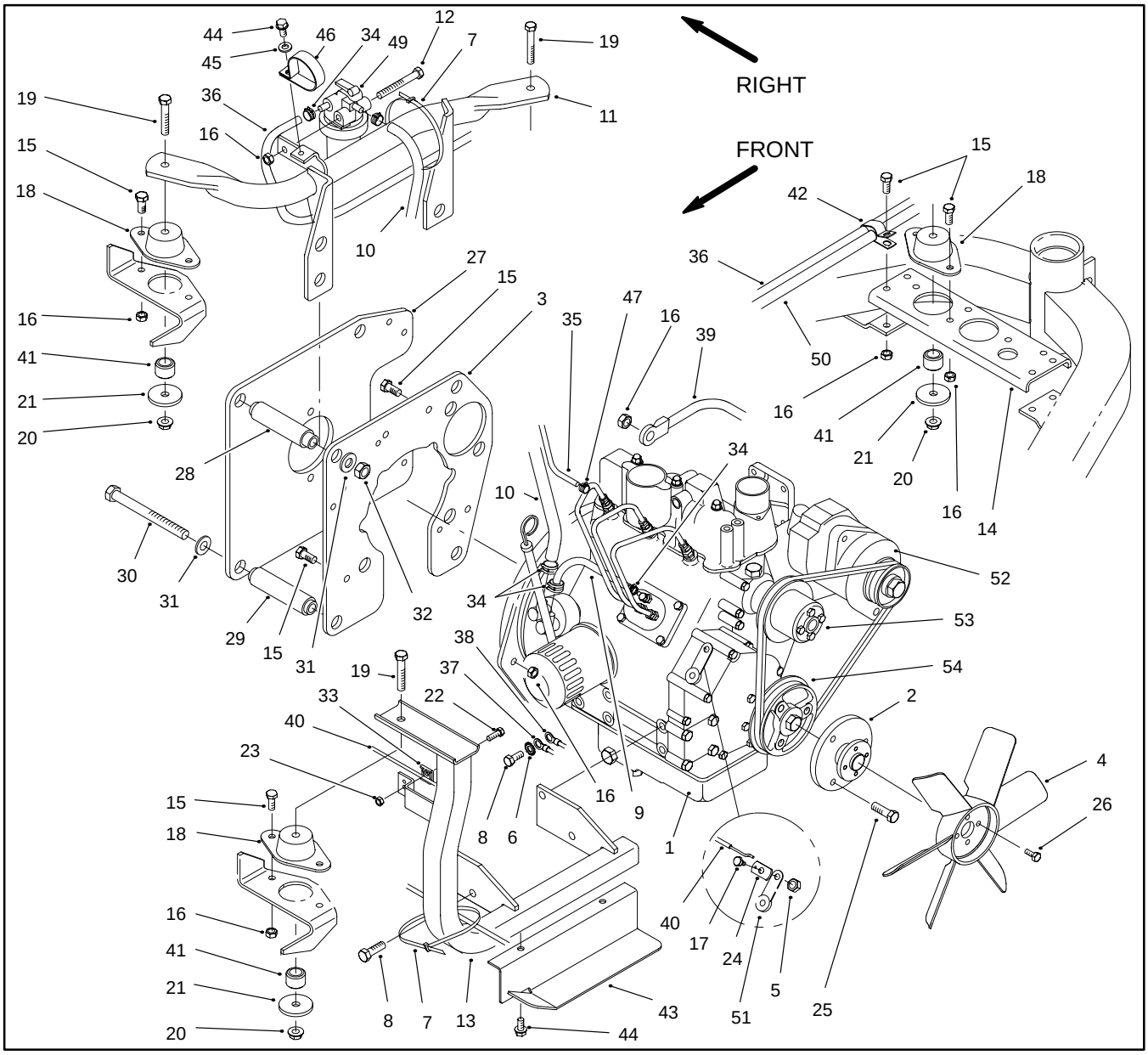


Figure 28

1. Perkins engine
2. Fan adapter
3. Backing plate
4. Fan
5. Lock nut
6. Lock washer
7. Cable tie
8. Cap screw
9. Fuel hose
10. Fuel hose
11. Rear engine mount
12. Cap screw
13. Front engine mount
14. Support bracket
15. Cap screw
16. Lock nut
17. Shoulder screw
18. Engine mount
19. Cap screw
20. Flange lock nut
21. Plate washer
22. Cap screw
23. Lock nut
24. Throttle
25. Cap screw
26. Cap screw
27. Pump plate
28. Upper spacer
29. Lower spacer
30. Cap screw
31. Flat washer
32. Lock nut
33. Throttle cable clamp
34. Hose clamp
35. Fuel hose (to fuel tank)
36. Fuel hose (to fuel shut–off valve)
37. Negative battery cable
38. Wire harness
39. Positive battery cable
40. Throttle control cable
41. Mount spacer
42. Double hose clamp
43. Dust shield
44. Whiz screw
45. Flat washer
46. R–clamp
47. Hose clamp
48. Flat washer
49. Fuel filter
50. Expansion tank hose
51. Governor lever
52. Alternator
53. Water pump pulley
54. Crank shaft pulley

Engine Removal

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

2. Release lockup handle, and pivot steering arm and steering wheel all the way forward. Lift seat forward to gain access to the engine.

3. Remove console shroud from the control panel.

4. Drain fuel tank (see Fuel Tank Removal):

CAUTION

The hydraulic fluid may be hot. To avoid possible burns, allow the hydraulic system to cool before disconnecting hoses.

5. Drain hydraulic reservoir as follows (Fig 29):

   A. Clamp pump inlet hose to prevent hydraulic tank from inadvertently draining.

   B. Loosen hose clamp, and remove pump inlet hose from the gear pump.

   C. Drain hydraulic tank completely into a suitable container by releasing the clamp from the hose. Plug hose and pump to prevent contamination.

CAUTION

DO NOT open radiator cap or drain coolant if the engine or radiator is hot. Pressurized hot coolant can escape and cause burns.

Ethylene–gycol antifreeze is poisonous. Dispose of it properly or store it in a properly labeled container away from children and pets.

6. Drain radiator (4) as follows (Fig. 26):

   A. Place a suitable container under the radiator.

   B. Open drain petcock (38) on the back of the radiator. Drain radiator completely and close petcock.

7. Disconnect hydraulic oil cooler if installed (Fig. 30).

   A. Disconnect tube and O–ring from hydraulic fitting on the hydraulic reservoir.

   B. Disconnect tube and O–ring from hydraulic fitting on the oil filter.

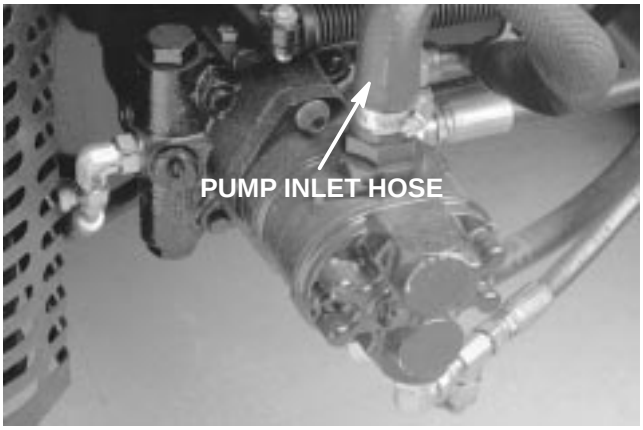


Figure 29

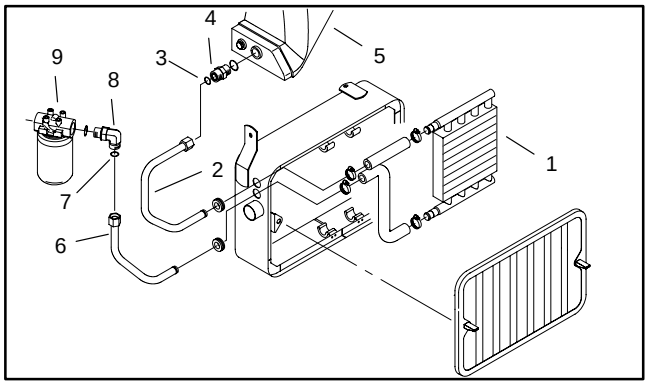


Figure 30

1. **Hydraulic oil cooler**
2. **Tube**
3. **O–ring**
4. **Hydraulic fitting**
5. **Hydraulic reservoir**
6. **Tube**
7. **O–ring**
8. **Hydraulic fitting**
9. **Oil filter**

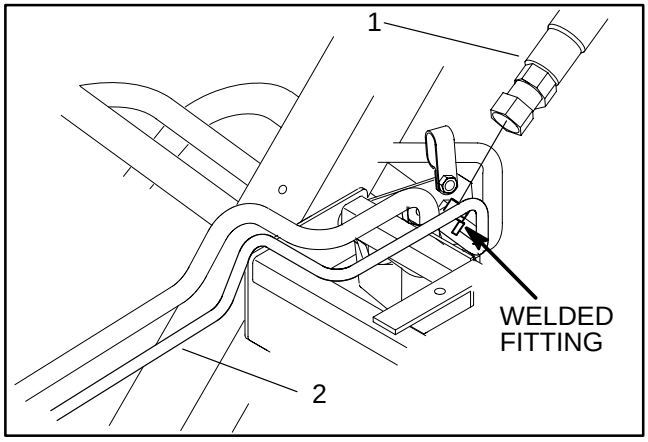


Figure 31

1. **Hose assembly**
2. **Tube**

8. Remove fuel tank and hydraulic reservoir as follows:

A. Remove three cap screws (6) and two flat washers (14) securing tank mounting plate (13) to the support bracket (28) and frame (Fig. 27).

B. Disconnect fuel hose (36) and expansion tank hose (50) from the support bracket (14). Disconnect fuel hose (35) from the number three fuel injector (Fig. 28).

C. Disconnect expansion tank hose (25) from the radiator elbow (26) (Fig. 26).

D. Disconnect hydraulic hose from welded fitting on the tube leading into rear bulkhead (Fig. 31).

E. If the oil cooler is **not** installed, disconnect hydraulic hose from the hydraulic oil filter (Fig. 32).

F. Make sure cable ties and hose clamps securing hoses to the frame and supports are removed.

G. Lift mounting plate and tanks from the machine.

9. Remove air cleaner as follows (Fig. 33):

A. Disconnect and remove hose leading from the cleaner to the engine valve cover at the engine and cleaner.

B. Disconnect hose leading to the radiator from the cleaner.

C. Disconnect air cleaner bracket from the pump mount. Remove air cleaner and bracket from the machine.

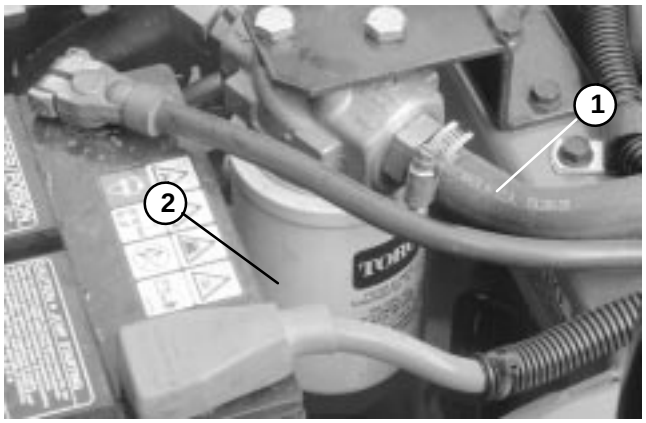


Figure 32

1. **Hydraulic hose**
2. **Hydraulic oil filter**

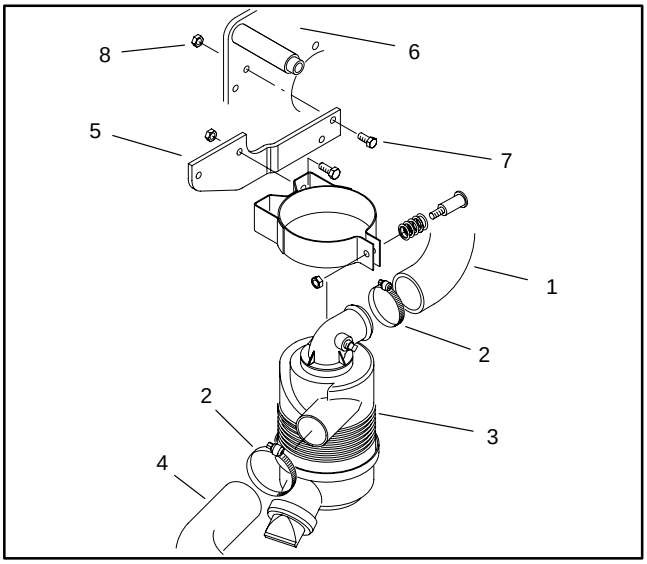


Figure 33

1. **Hose (to engine)**
2. **Hose clamp**
3. **Air cleaner**
4. **Hose (to radiator)**
5. **Air cleaner bracket**
6. **Pump plate**
7. **Cap screw**
8. **Lock nut**

10. Remove muffler as follows (Fig. 34):

A. Remove four cap screws and flat washers securing the exhaust plate to the engine exhaust manifold.

B. Remove muffler shield from the muffler and pump plate by removing four cap screws.

C. Remove two cap screws securing the muffler to the pump plate.

CAUTION

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

11. Remove radiator as follows (Fig. 26):

A. Remove alternator guard (29) from radiator support (8) and frame bracket.

B. Remove cable tie (37) from the breather hose (24). Disconnect breather hose and radiator hose (17) from the radiator elbow (26).

C. Disconnect radiator hose (2) from the bottom of the water pump.

D. Disconnect hose (34) from air cleaner at the radiator support (8). Remove hose from the machine

E. Remove screen (10) from the radiator support.

F. Remove cap screws (7) from radiator support and frame. Remove cap screw (18), flat washer (36) and lock nut (9) securing the radiator support to the frame tab.

G. Make sure cable ties and clamps securing hoses to the frame and supports are removed.

H. Pull radiator and hoses from the machine.

12. Loosen cap screw (22) and lock nut (23) securing the throttle tab (33) and throttle control cable (40) to the front engine mount (13). Disconnect the cable from the governor lever (51) (Fig. 28).

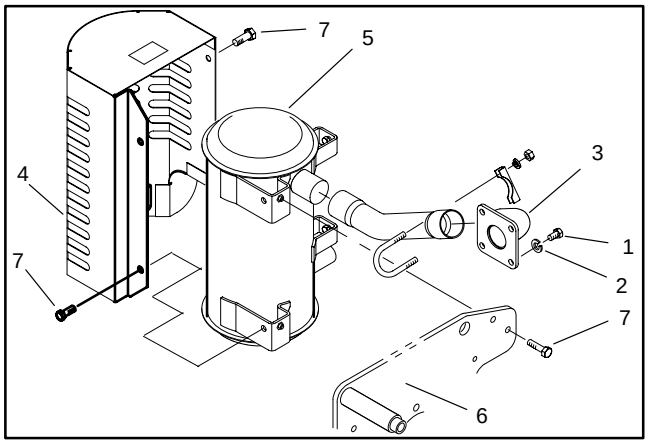


Figure 34

1. **Cap screw**
2. **Lock washer**
3. **Exhaust plate**
4. **Muffler shield**
5. **Muffler**
6. **Pump plate**
7. **Cap screw**

13. Separate relief valve from the pump plate by removing both cap screws flat washers, and lock nuts (Fig. 35).

14. Separate hydrostat from the pump plate as follows:

A. Loosen set screw securing the hydrostat shaft to the hub (Fig. 36).

CAUTION

Use caution when removing the lock nut from the pin. The extension spring is under tension and may cause personal injury during removal.

B. Remove lock nut securing the pin and extension spring to the spring bracket. Do not unscrew jam nut from the pin. Release pin from the bracket. Remove spring from neutral arm (Fig. 37).

C. Remove spring bracket from the pump plate (Fig. 37).

D. Remove both locknuts, cap screws, and flat washers securing the hydrostat to the pump plate. Be careful not to lose the key (Fig. 36).

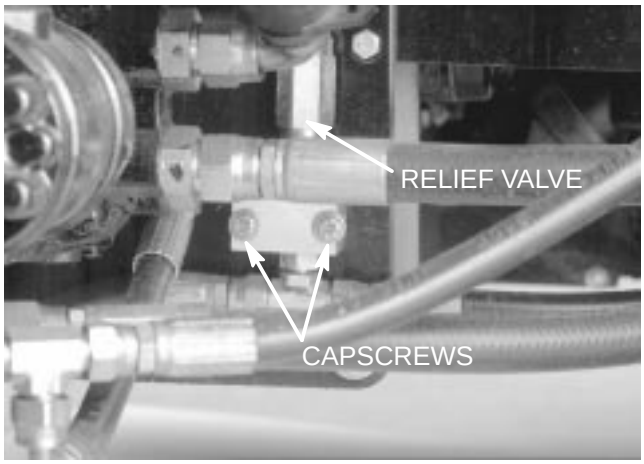


Figure 35

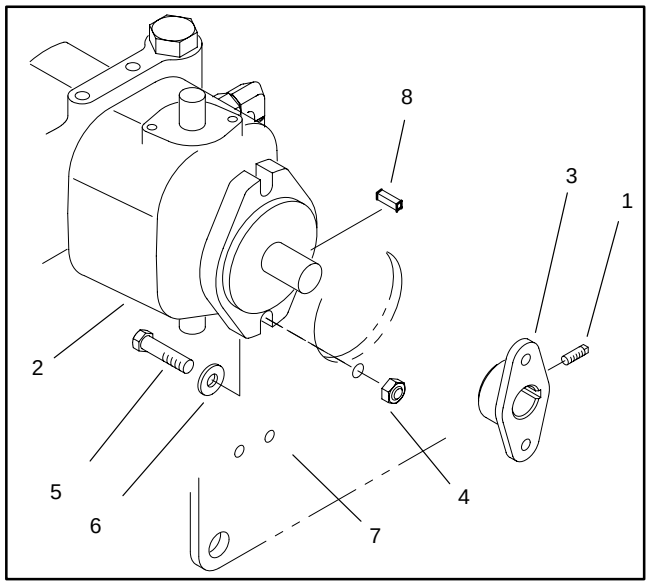


Figure 36

1. **Set screw**
2. **Hydrostat**
3. **Hub**
4. **Lock nut**
5. **Cap screw**
6. **Flat washer**
7. **Pump plate**
8. **Key**

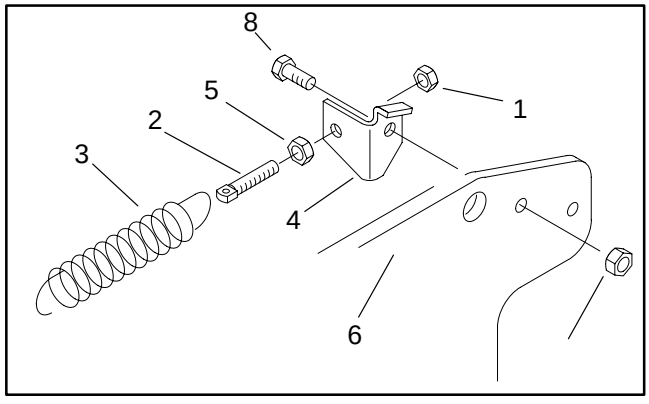


Figure 37

1. **Lock nut**
2. **Pin**
3. **Extension spring**
4. **Spring bracket**
5. **Jam nut**
6. **Pump plate**
7. **Lock nut**
8. **Cap screw**

15. Disconnect electrical connections from the following engine components (Fig. 28):

A. The black (negative) battery cable (37) and Black wire harness ground (38) on the lower engine block.

B. The red (positive) battery cable (39) and red wires and connector on the starter solenoid.

C. The orange wire and connector on the glow plug bus.

D. The blue and blue/white wires and connector on the ETR solenoid.

E. The blue wire on the water temperature switch.

F. The green/blue wire on the oil pressure switch.

G. The blue and white wires and connector to the alternator.

16. Remove both whiz screws (44) securing the dust shield (43) to the front engine mount (13) (Fig. 28).

17. Remove alternator (52), water pump pulley (53), fan adapter (2), and crank shaft pulley (54) from the engine for better clearance (Fig. 28).

18. Remove three whiz nuts (20), plate washers (21), and cap screws (19) securing the front engine mount (13) and rear engine mount (11) to the rubber mounts (18) (Fig. 28).

CAUTION

One person should operate the chain fall or hoist while the other person guides the engine out of the frame.

19. Remove engine from the frame.

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

B. Connect a hoist or chain fall at the center of the short section of chain.

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

C. Slowly remove the engine and mounts from the machine.

20. Remove engine mounts, backing plate, and pump plate as necessary to repair the engine.

Engine Installation

1. If the pump plate, backing plate, or engine mounts were removed from the engine, install them to the engine using Figure 28 as a guide.

CAUTION

One person should operate the chain fall or hoist while the other person guides the engine into the frame.

2. Install engine to the frame.

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

B. Connect a hoist or chain fall at the center of the short section of chain.

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

C. Lower engine and mounts into the machine.

3. Secure front engine mount (13) and rear engine mount (11) to the rubber mounts (18) with three cap screws (19), plate washers (21), and whiz nuts (20). Align mounts and tighten fasteners before releasing the engine from the chain fall (Fig. 28).

4. Install alternator (52), water pump pulley (53), fan adapter (2), and crank shaft pulley (54) to the engine (Fig. 28).

5. Adjust alternator belt (see Alternator Belt Adjustment).

6. Secure dust shield (43) to the front engine mount (13) with both whiz screws (44) (Fig. 28).

7. Connect electrical connections to the following engine components (Fig. 28):

A. The black (negative) battery cable (37) and Black wire harness ground (38) to the lower engine.

B. The red (positive) battery cable (39) and red wires and connector to the starter solenoid.

C. The orange wire and connector to the glow plugs.

D. The blue and blue/white wires and connector to the ETR solenoid.

E. The blue wire to the water temperature switch.

F. The green/blue wire to the oil pressure switch.

G. The blue and white wires and connector to the alternator.

8. Install hydrostat to the pump plate as follows:

CAUTION

Use caution when installing the lock nut to the pin. The extension spring is under tension and may cause personal injury during removal.

A. Apply antiseize lubricant to the key and install into hydrostat shaft. Slide shaft and key into hub (Fig. 36).

B. Secure spring bracket to the pump plate with cap screw and lock nut (Fig. 37).

C. Install spring to neutral arm and pin. Insert pin into the spring bracket. Secure pin and to the spring bracket with lock nut (Fig. 37).

D. Secure hydrostat shaft to the hub by tightening set screw (Fig. 36).

9. Secure relief valve to the pump plate with both cap screws, flat washers, and lock nuts (Fig. 35).

10. Connect throttle control cable (40) to the governor lever (51). Secure control cable with throttle tab (33) to the front engine mount (13). Tighten cap screw (22) and lock nut (23) to secure cable to the mount (Fig. 28).

11. Install radiator as follows (Fig. 26):

A. Position radiator to the machine and route hoses.

B. Secure radiator support (8) to the frame with cap screws (7). Secure radiator support, breather hose (24), and R–clamp (31) to the frame tab with cap screw (18), flat washer (36), and lock nut (9).

C. Connect hose (34) from air cleaner to the radiator support (8).

D. Connect radiator hose (2) to the bottom of the water pump.

E. Connect breather hose (24) and radiator hose (17) to the radiator elbow (26). Install new cable tie (37) to the breather hose and bracket.

F. Install alternator guard (29) to the radiator support (8) and frame bracket.

G. Make sure hoses are clear of rotating parts. Make sure cable ties and clamps securing hoses to the frame and supports are installed.

12. Install muffler as follows (Fig. 34):

    A. Secure muffler to the pump plate with two cap screws.

    B. Install muffler shield to the muffler and pump plate with four cap screws.

    C. Secure exhaust plate to the engine exhaust manifold with four cap screws and flat washers.

13. Install air cleaner as follows (Fig. 33):

    A. Secure air cleaner and bracket to the pump plate.

    B. Connect hose leading to the radiator to the cleaner.

    C. Route and connect hose, leading from the cleaner to the engine valve cover, to the valve cover and cleaner.

14. Install fuel tank and hydraulic reservoir as follows:

    A. Position mounting plate and tanks onto the frame.

    B. If the oil cooler is **not** installed, Connect hydraulic hose to the hydraulic oil filter (Fig. 32).

    C. Connect hydraulic hose to the welded fitting on the tube leading into rear bulkhead (Fig. 31).

    D. Remove plug from the pump inlet hose and gear pump. Install pump inlet hose to the gear pump with hose clamp (Fig 29).

    E. Connect expansion tank hose (25) to the radiator elbow (26) (Fig. 26).

    F. Connect fuel hose (36) and expansion tank hose (50) to the support bracket (14). Connect fuel hose (35) to the number three fuel injector (Fig. 28).

    G. Make sure hoses are secured to the frame and supports with cable ties and hose clamps.

    H. Connect fuel hose (36) to fuel filter (49) (Fig. 28).

    I. Secure tank mounting plate (13) to the support bracket (28) and frame with three cap screws (6) and two flat washers (14) (Fig. 27).

15. Connect hydraulic oil cooler if installed (Fig. 30).

    A. Connect tube and O–ring to hydraulic fitting on the hydraulic reservoir.

    B. Connect tube and O–ring to hydraulic fitting on the oil filter.

16. Install screen (10) into the radiator support (8) (Fig. 26).

17. Install console shroud to the control panel.

18. Make sure both fuel shutoff valves are open (see Fuel Shutoff Valves). Fill fuel tank with fuel (see Fill Fuel Tank). Check tank and hoses for leaks.

19. Fill cooling system with coolant (see Check Cooling System). Check radiator and hoses for leaks.

20. Fill hydraulic reservoir with hydraulic oil (see Check Hydraulic System Fluid in Chapter 5 – Hydraulic System). Check reservoir and hoses for leaks.

21. Bleed fuel system (see Bleeding Fuel System).

22. Adjust throttle control lever and cable (see Throttle Adjustment).

Chapter 5

Hydraulic System

Table of Contents

Specifications

Item Description	
Hydrostatic Transmission Maximum Operating Pressure Maximum Intermittent Pressure Maximum Rated Speed Rated Flow @ Maximum Rated Speed and Operating Pressure Charge Pressure	Variable displacement piston pump 3000 PSI (207 bar) 5000 PSI (345 bar) 3600 RPM 17 GPM (64 LPM) 100 to 150 PSI (6.9 to 10.0 bar)
Gear Pump Front Section to Reel Circuit Maximum Operating Pressure Maximum Intermittent Pressure Maximum Rated Speed Rated Flow @ Maximum Rated Speed and Operating Pressure Rear Section to Steering and Lift Circuits Maximum Operating Pressure Maximum Intermittent Pressure Maximum Rated Speed Rated Flow @ Maximum Rated Speed and Operating Pressure	2 stage positive displacement gear type pump 3000 PSI (207 bar) 3500 PSI (241 bar) 3600 RPM 7.8 GPM (30 LPM) 3000 PSI (207 bar) 3500 PSI (241 bar) 3600 RPM 4.8 GPM (18 LPM)
Wheel Motors (Front) Maximum Operating Pressure Maximum Intermittent Pressure Rated Flow @ Rated Speed and Maximum Operating Pressure Rated Speed @ Maximum Operating Pressure and Rated Flow	Orbital rotor motor 2000 PSI (138 bar) 3000 PSI (207 bar) 15 GPM (57 LPM) 309 RPM
Wheel Motor (Optional Rear) Maximum Operating Pressure Maximum Intermittent Pressure Rated Flow @ Rated Speed and Maximum Operating Pressure Rated Speed @ Maximum Operating Pressure and Rated Flow	Orbital rotor motor 3000 PSI (207 bar) 4000 PSI (276 bar) 20 GPM (76 LPM) 182 RPM
Reel Motor Maximum Operating Pressure Maximum Intermittent Pressure Rated Flow @ Maximum Rated Speed and Pressure Rated Speed @ Maximum Operating Pressure and Rated Flow	Gear motor 2000 PSI (138 bar) 2500 PSI (173 bar) 12.7 GPM (48.0 LPM) 4000 RPM
Steering Control Valve Displacement	Distributor valve with rotary meter 4.9 cubic inch/rev (80 cc/rev)
Implement (Steering and Lift) Relief Valve Relief Pressure (R5)	Differential area relief valve 1000 PSI (69.0 bar)
Hydraulic Manifold Relief Valves Cutting Circuit Relief Pressure (R2) Lift Circuit Relief Pressure (R1)	Differential area relief valve 2400 PSI (166 bar) 150 PSI (10.4 bar)
Hydraulic Filter	5 Micron spin–on cartridge type
Hydraulic Oil	See Check Hydraulic System Fluid in General section
Hydraulic Reservoir	Reservoir (without leak detector) capacity 5.5 gal. U.S. (20.8 L) Reservoir (with leak detector) capacity 8.1 gal. U.S. (30.7 L)

General Information

Hydraulic Hoses

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

When replacing a hydraulic hose, be sure that the hose is straight (not twisted) before tightening the fittings. This can be done by observing the imprint on the hose. Use two wrenches; hold the hose straight with one and tighten the hose swivel nut onto the fitting with the other.

WARNING

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

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

Hydraulic Fitting Installation

O–Ring Face Seal

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.

2. Make sure the O–ring is installed and properly seated in the groove. It is recommended that the O–ring be replaced any time the connection is opened.

3. Lubricate the O–ring with a light coating of oil.

4. Put the tube and nut squarely into position on the face seal end of the fitting and tighten the nut until finger tight.

5. Mark the nut and fitting body. Hold the body with a wrench. Use another wrench to tighten the nut to the correct flats from finger tight (F.F.F.T.). The markings on the nut and fitting body will verify that the connection has been tightened.

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	.75 ± .25
6 (3/8 in.)	.75 ± .25
8 (1/2 in.)	.75 ± .25
10 (5/8 in.)	1.00 ± .25
12 (3/4 in.)	.75 ± .25
16 (1 in.)	.75 ± .25

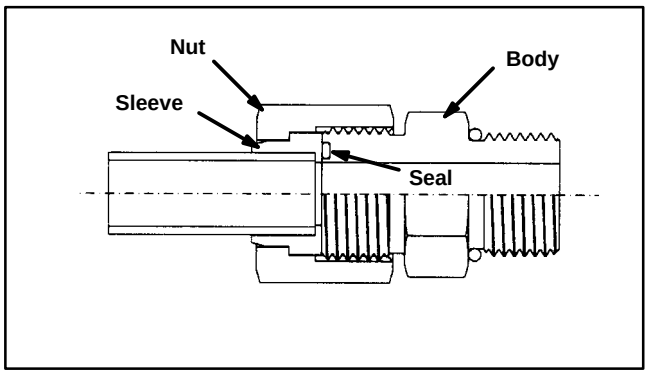


Figure 1

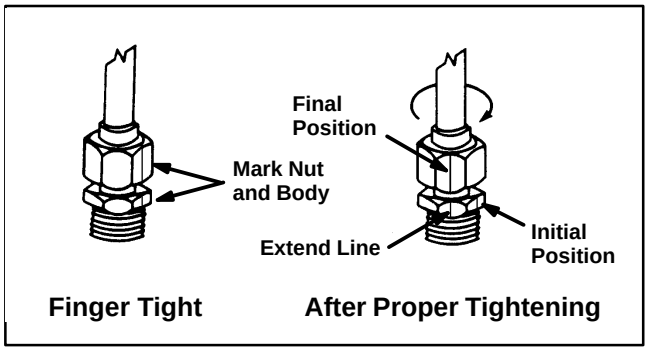


Figure 2

SAE Straight Thread O–Ring Port – Non–adjustable

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.

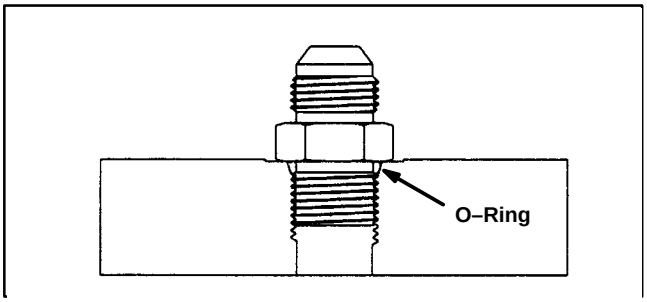
2. Always replace the O–ring seal when this type of fitting shows signs of leakage.

3. Lubricate the O–ring with a light coating of oil.

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

5. Tighten the fitting to the correct flats from finger tight (F.F.F.T.).

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± .25
6 (3/8 in.)	1.50 ± .25
8 (1/2 in.)	1.50 ± .25
10 (5/8 in.)	1.50 ± .25
12 (3/4 in.)	1.50 ± .25
16 (1 in.)	1.50 ± .25



SAE Straight Thread O–Ring Port – Adjustable

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.

2. Always replace the O–ring seal when this type of fitting shows signs of leakage.

3. Lubricate the O–ring with a light coating of oil.

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

5. Install the fitting into the port and tighten finger tight until the washer contacts the face of the port (Step 2).

6. To put the fitting in the desired position, unscrew it by the required amount, but no more than one full turn (Step 3).

7. Hold the fitting in the desired position with a wrench and turn the jam nut with another wrench to the correct flats from finger tight (F.F.F.T.) (Step 4).

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± .25
6 (3/8 in.)	1.50 ± 25
8 (1/2 in.)	1.50 ± .25
10 (5/8 in.)	1.50 ± .25
12 (3/4 in.)	1.50 ± .25
16 (1 in.)	1.50 ± .25

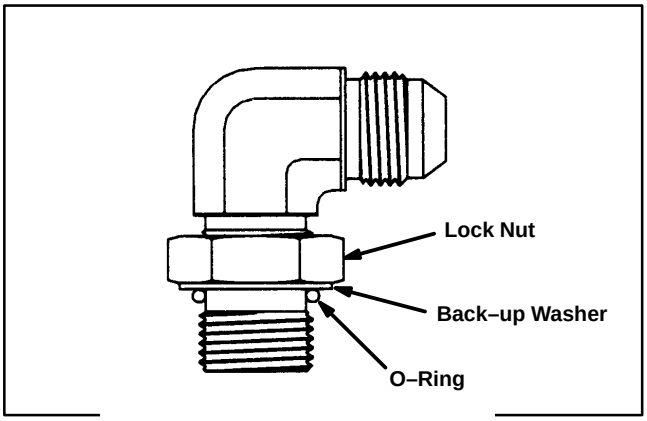


Figure 4

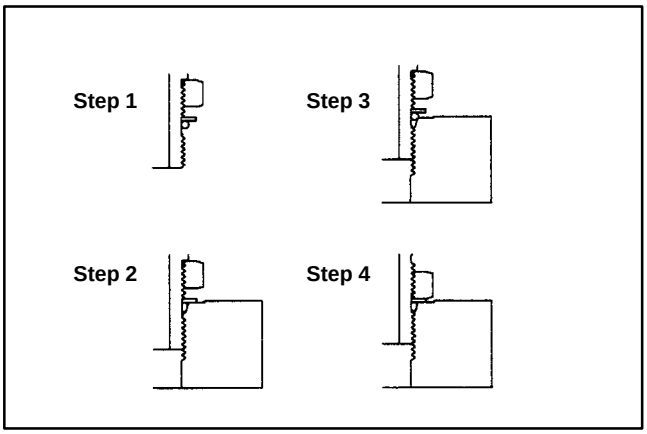


Figure 5

Check Hydraulic System Fluid

The hydraulic system is designed to operate on antiwear hydraulic fluid. The machine's reservoir is filled at the factory with Mobil 424 hydraulic fluid. **Check level of hydraulic fluid before engine is first started and daily thereafter (see Specifications for capacity).**

IMPORTANT: Two groups of hydraulic fluid are specified to allow optimal operation of the machine in a wide range of temperatures encountered. The group 1 fluids are a multiviscosity hydraulic fluids which allows operation at lower temperatures without the increased viscosity, which is associated with straight viscosity fluids.

Note: The fluids in this Group 1 are interchangeable.

Group 1 Hydraulic Fluid (Recommended for ambient temperatures consistently below 100° F.):

ISO type 46/68 antiwear hydraulic fluid

Mobil	Mobil Fluid 424
Amoco	Amoco 1000
International Harvester	Hy–Tran
Texaco	TDH
Shell	Donax TD
Union OIl	Hydraulic/Tractor Fluid
Chevron	Tractor Hydraulic Fluid
BP Oil	BP HYD TF
Boron OIl	Eldoran UTH
Exxon	Torque Fluid
Conoco	Power–Tran 3
Kendall	Hyken 052
Phillips	HG Fluid

Note: The fluids in Group 2 are interchangeable.

Group 2 Hydraulic Fluid (Recommended for ambient temperatures consistently above 70° F.):

ISO type 68 antiwear hydraulic fluid

Mobil	DTE 26 or DTE 16
Shell	Tellus 68
Amoco	Rykon Oil 68
Arco	Duro AW S–315
Boron	Industron 53
BP Oil	Energol HLP68
Castrol	Hyspin AWS68
Chevron	Chevron EP68
Citgo	Citgo A/W68
Conoco	Super Hydraulic Oil 31
Exxon	Nuto H68
Gulf	68AW
Pennzoi	lAW Hyd Oil 68
Phillips	Magnus A315
Standard	Industron 53
Texaco	Rando HD68
Union	Unax AW 315

Using the Mobil 424 type fluids in the higher ambient temperatures may result in decreased efficiency in some of the hydraulic components compared to using the Mobil DTE 26 type fluids.

The Mobil DTE 26 type fluids are straight viscosity fluids which remain slightly more viscous at higher temperatures than the multiviscosity fluids.

Using the Mobil DTE 26 type fluids in the lower ambient temperatures may result in harder starting, increased engine laboring while cold, sluggish or malfunctioning valve spools while cold and increase filter back pressure due to the higher fluid viscosity.

It is recommended that you select which set of conditions (either ambient temperatures above 70° F. or below 100° F.), and use that type of fluid throughout the year, rather than changing fluid types several times per year.

Group 3 Hydraulic Fluid (Biodegradable):

ISO VG 32/46 antiwear hydraulic fluid

Mobil	EAL 224 H

Note: This biodegradable hydraulic fluid in this group is not compatible with the fluids in group 1 or 2.

Note: Using biodegradable hydraulic fluid requires the installation of a Oil Cooler Kit, Toro Model No. 04499 to traction unit.

IMPORTANT: When changing from one type of hydraulic fluid to the other, be certain to remove all the old fluid from the system, because some brands of one type are not completely compatible with some brands of the other type of hydraulic fluid.

IMPORTANT: Use only types of hydraulic fluids specified. Other fluids could cause system damage.

Note: A red dye additive for the hydraulic system fluid is available in 2/3 oz. bottles. One bottle is sufficient for 4 to 6 gal of hydraulic fluid. Order Part No. 44–2500 from your Authorized Toro Distributor.

Checking Fluid Level

1. Position machine on a level surface. Make sure machine has cooled down so fluid is cold.

2. Remove cap from reservoir and check level of fluid. The fluid should be up to bottom of screen in filler neck.

3. If fluid level is low, slowly fill reservoir with appropriate hydraulic fluid until level reaches bottom of screen. **DO NOT OVERFILL.**

IMPORTANT: To prevent system contamination, clean top of hydraulic fluid containers before puncturing. Make sure pour spout and funnel are clean.

4. Install reservoir cap. Wipe up any fluid that may have spilled.

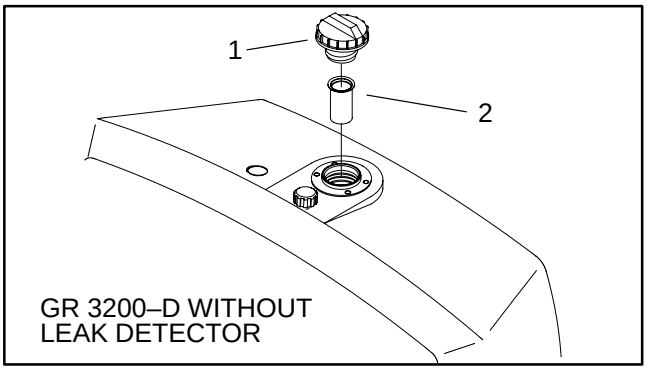


Figure 6

1. Hydraulic oil cap **2. Filler screen**

Towing Traction Unit

In case of emergency, the Greensmaster 3200/3200–D can be towed for a short distance. However, Toro does not recommend this as a standard procedure.

IMPORTANT: Do not tow the machine faster than 2 to 3 mph because drive system may be damaged. If machine must be moved a considerable distance, transport it on a truck or trailer.

1. Locate by–pass valve on hydrostat and rotate it 90°.

2. Before starting engine, close by–pass valve by rotating it 90°. Do not start engine when valve is open.

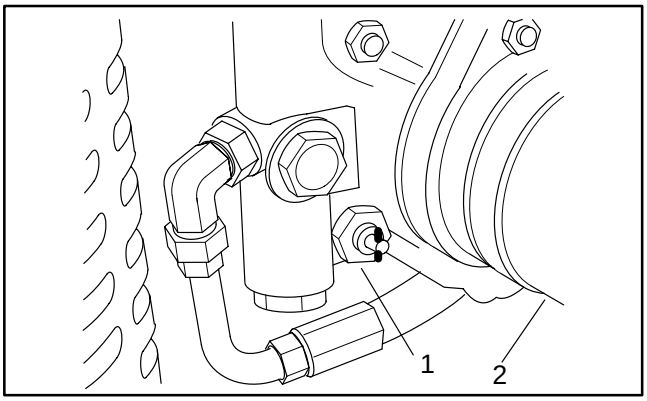


Figure 7

1. By–pass valve **2. Hydrostat**

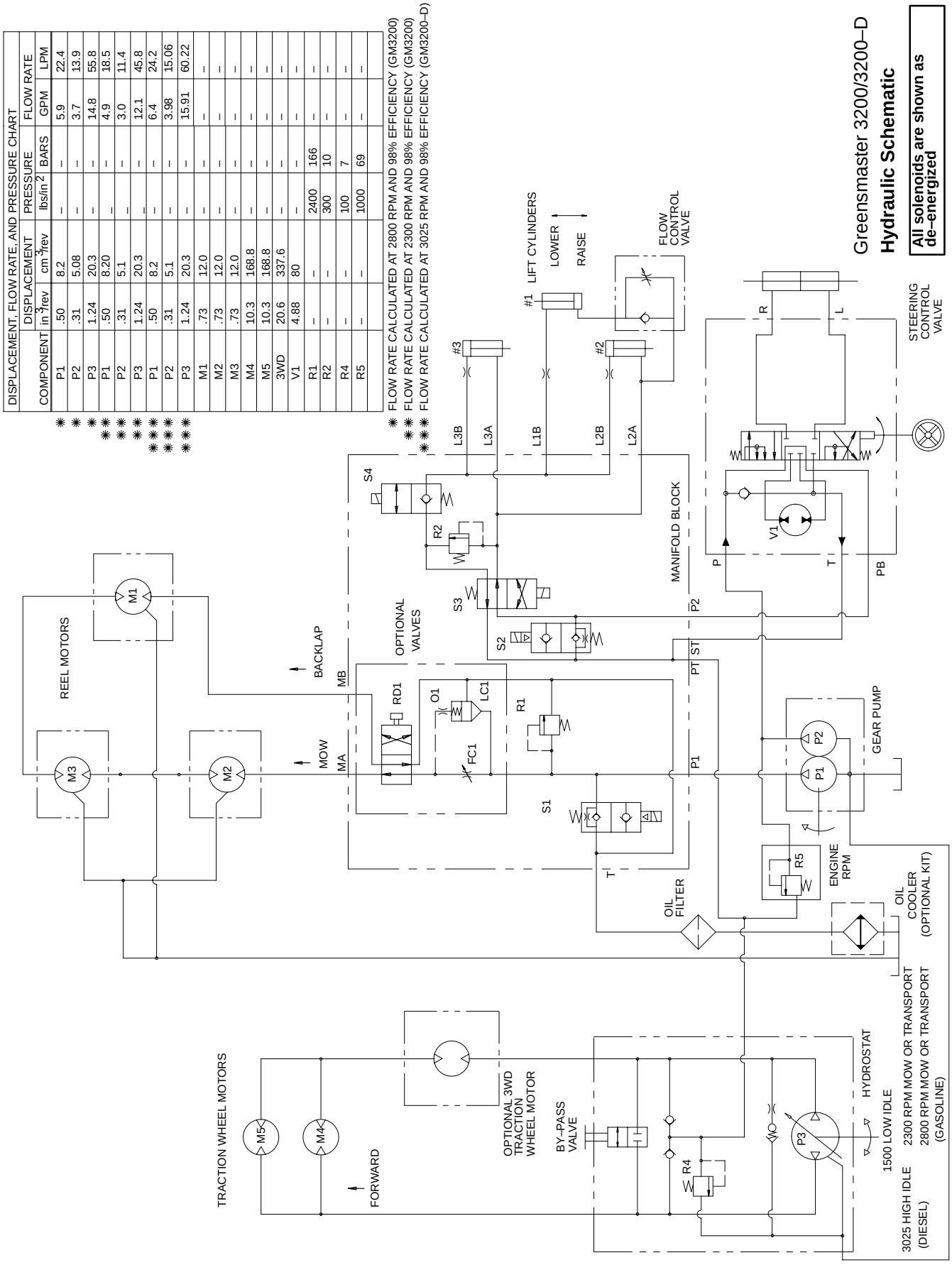
Check Hydraulic Lines and Hoses

WARNING

Keep body and hands away from pin hole leaks or nozzles 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.

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

Hydraulic Schematic



Hydraulic Flow Diagrams

Traction Forward and Reverse

Forward

The hydrostat is driven directly by the engine. The traction circuit of the hydraulic system acts essentially as a closed loop. Taking its suction directly from the return side of the wheel motors of the traction circuit, the hydrostat supplies oil flow to the wheel motors through the supply side of the traction circuit.

With the engine running and traction pedal in the neutral position, the hydrostat supplies no flow to the wheel motors. When the traction pedal is pressed to the forward position, the linkage from the pedal positions the swash plate in the hydrostat so oil flows out the bottom port of the pump. Oil flow out of the bottom port goes to the wheel motors and turns them in the forward direction.

Oil flowing out of the wheel motors returns to the top port of the hydrostat and is continuously pumped out the bottom port.

Hydraulic oil is supplied to the traction circuit from the gear pump (P2) though the steering control valve and back through the charge circuit check valves. This oil replaces oil losses from flow through the case drains and small amounts of leakage.

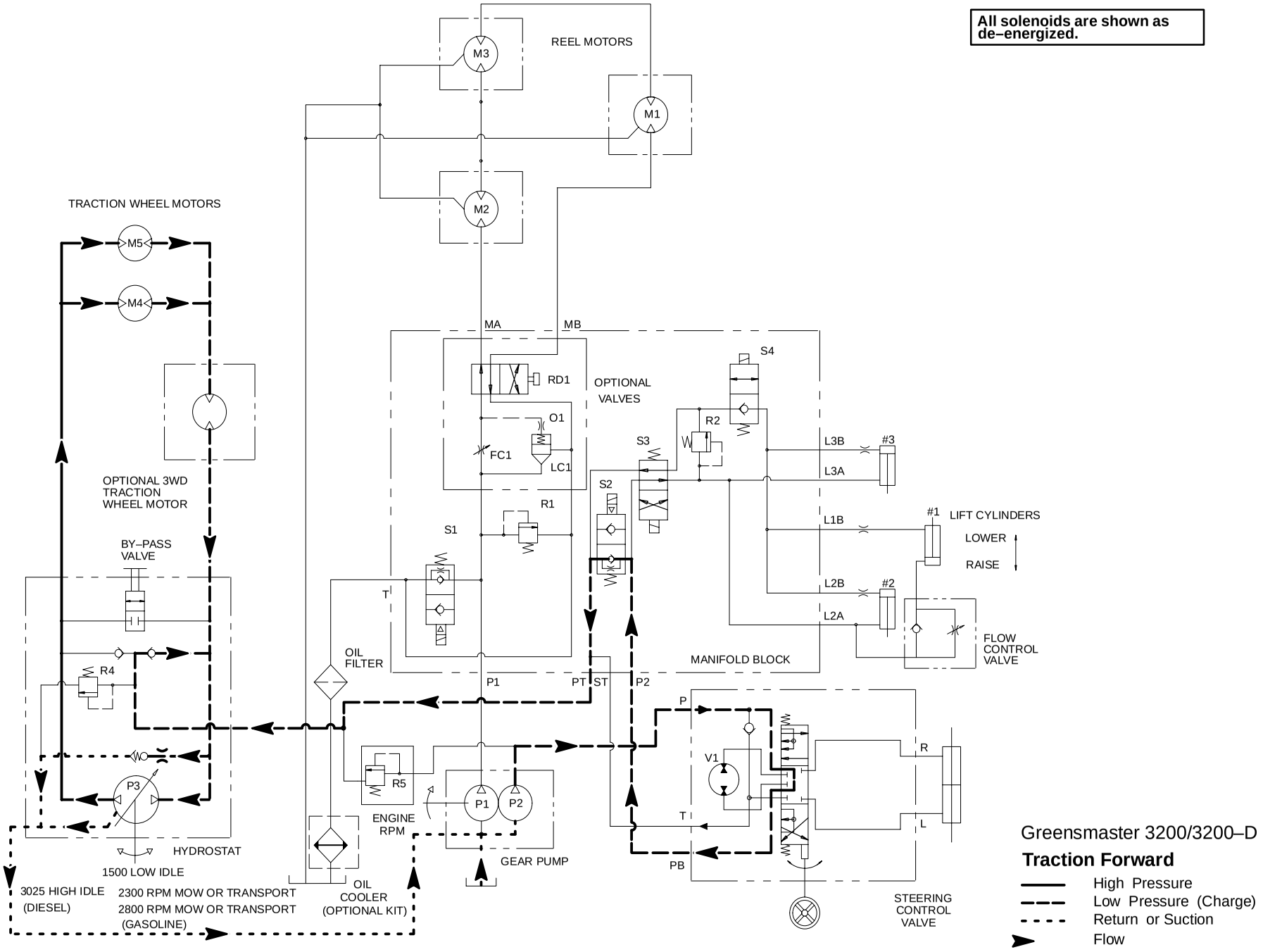
Reverse

The traction circuit operates essentially the same in reverse as it does in the forward direction. However, the flow through the circuit is reversed.

With the engine running and traction pedal in the neutral position, the hydrostat supplies no flow to the wheel motors. When the traction pedal is pressed to the reverse position, the linkage from the pedal positions the swash plate in the hydrostat so oil flows out the top port of the pump. Oil flow out of the top port goes to the wheel motors and turns them in the reverse direction.

Oil flowing out of the wheel motors returns to the bottom port of the hydrostat and is continuously pumped out the bottom port.

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



Hydraulic System

Raise and Lower Cutting Units

Raise

The gear pump (P2) is directly coupled to the hydrostat through gear pump (P1). It supplies hydraulic pressure for raising and lowering cutting units and maintaining 100 to 150 PSI (6.9 to 10.0 bar) to the low pressure side of the traction circuit (charge pressure). The pump takes its suction from the hydraulic reservoir.

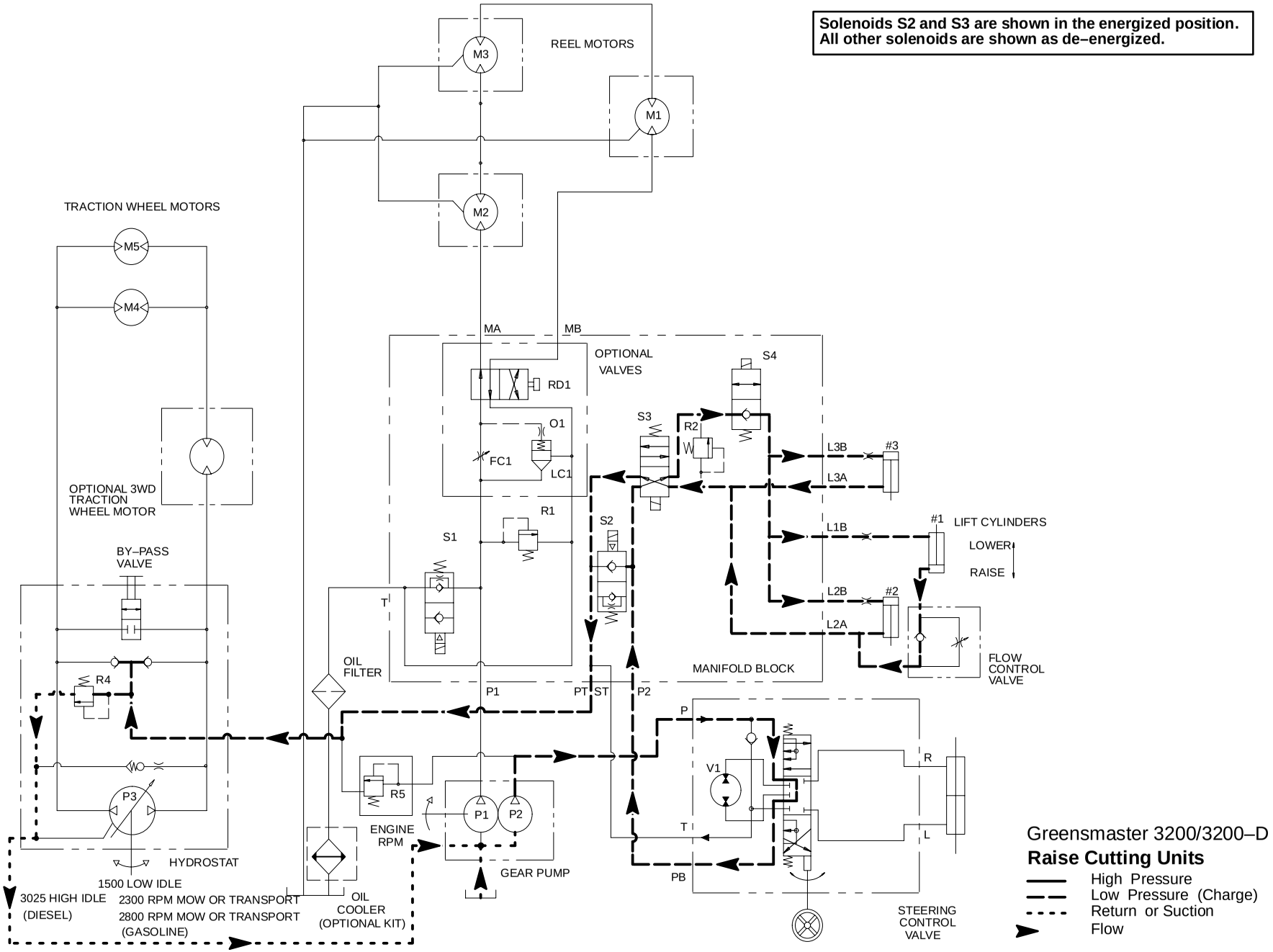
During conditions of not lifting or lowering cutting units, flow from the gear pump is by–passed through the steering control valve and solenoid valve (S2) directly to the hydrostat and the charge relief valve(R4). Flow then returns to the hydraulic reservoir.

When the cutting units are to be raised, solenoid valve (S2) is energized and blocks flow directly to the hydrostat. Flow is directed to energized solenoid valve (S3), which directs flow to de–energized solenoid valve (S4) and the lift cylinders. Hydraulic pressure against the cylinder pistons moves their shafts causing the cutting units to raise. At the same time, the pistons push the hydraulic fluid out of the lift cylinders and back through solenoid valves (S4 and S3) to the hydrostat. When the solenoid valves de–energize, spring action returns the valves to their original position and by–passes flow back to the hydrostat stopping lift cylinder movement. The cylinder position is locked in place since there is no complete circuit of flow to and from the lift cylinders.

Lower

Circuit operation for lowering the lift cylinders is similar to raising them. However, the solenoid valve (S3) remains de–energized and in the down position and solenoid valve (S4) is energized and shifts down. Flow is reversed to and from the lift cylinders, thus moving the cutting units down.

When the cutting units are to be lowered, solenoid valve (S2) is energized and blocks flow directly to the hydrostat. Flow is directed to de–energized solenoid valve (S3), which directs flow to energized solenoid valve (S4) and the lift cylinders. Hydraulic pressure against the cylinder pistons moves their shafts causing the cutting units to lower. At the same time, the pistons push the hydraulic fluid out of the lift cylinders and back through solenoid valves (S4 and S3) to the hydrostat. Flow into the flow control valve is slowed by the variable orifice to allow the rear cutting unit to lower after the front units. When the solenoid valves de–energize, spring action returns the valves to their original position and by–passes flow back to the hydrostat stopping lift cylinder movement.



Hydraulic System

Mow and Backlap

Mow

The gear pump (P1) is directly coupled to the the hydrostat which is driven directly by the engine. Taking its suction directly from the hydraulic reservoir, the gear pump supplies oil flow to the manifold block and to the reel motors.

With the engine running and the Functional Control and Raise/Lower/Mow levers positioned so the reels **will not** turn (see Operator's Manual), solenoid valve (S1) is de–energized. S1 by–passes flow from the reel motors directly to the hydraulic reservoir.

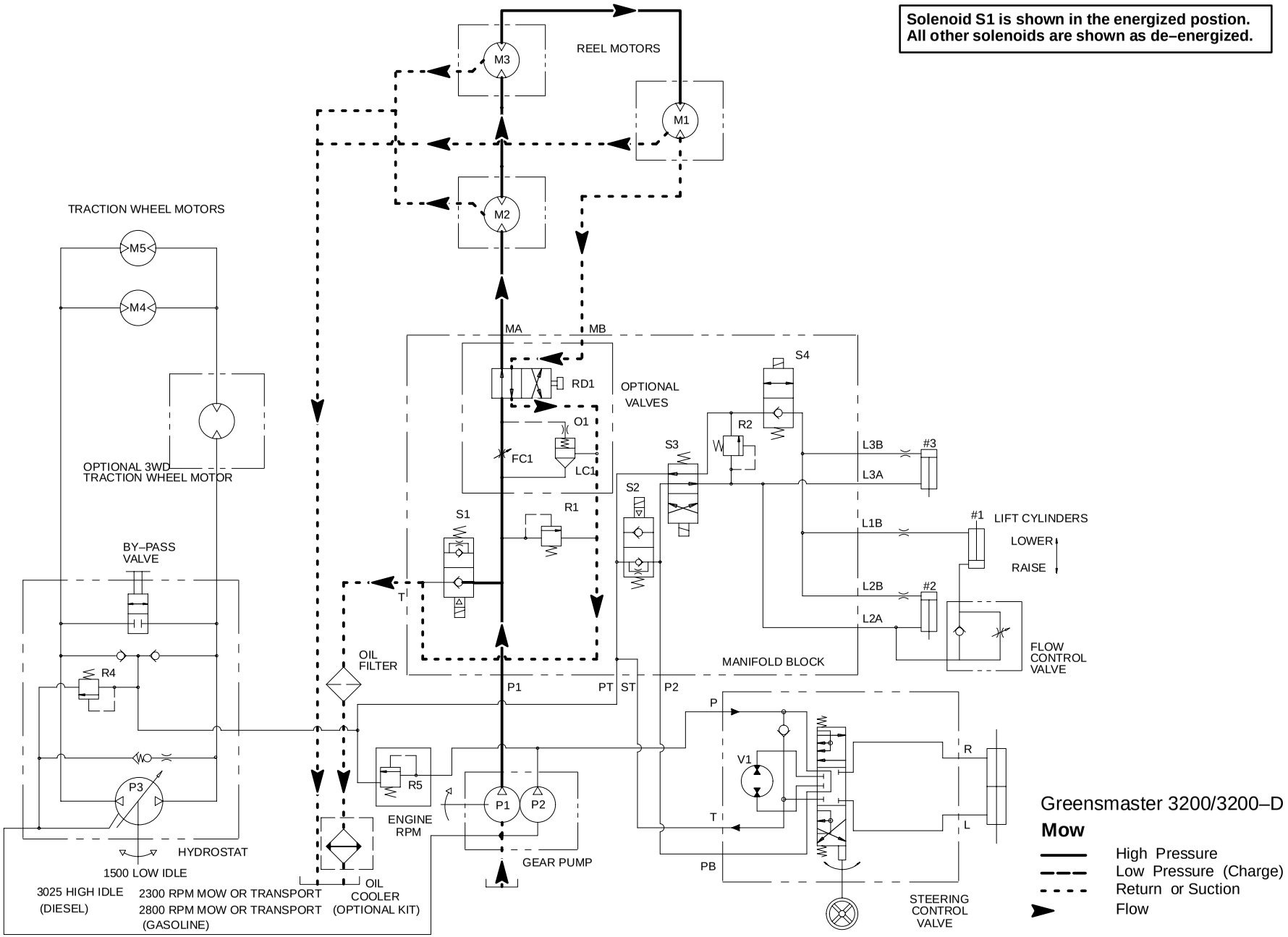
When the engine running and the Functional Control and Raise/Lower/Mow levers positioned so the reels **will** turn (see Operator's Manual), solenoid valve (S1) is energized. Flow is diverted to the reel motors.

On units with the optional backlap kit installed, flow through the manifold block is different. Oil flow from port (P1) flows through the 11 position reel speed control valve (FC1). Flow across the speed control valve is pressure compensated by the logic cartridge valve (LC1). The logic cartridge valve maintains a pressure differential of 75 PSI (5.2 bar) across the speed control valve. Any excess flow above what the speed control valve is set for is by–passed to the reservoir through the logic cartridge valve. With the backlap valve (RD1) in the **mow** position, oil flows through the valve, out port (MA), and reel motors that are connected in series.

Oil flows through the left (M2), right (M3), and then rear reel motor (M1) as it turns the motors in the mow direction. The oil then returns through the manifold block to the reservoir.

Backlap

Backlapping operation is the same as mowing operation, except for the position of the backlap valve (RD1). The backlap valve is in the **backlap** position allowing oil flow through the rear (M1), right (M3), and then left (M2) reel motor as it turns the motors in the backlap direction.


Solenoid S1 is shown in the energized postion.
All other solenoids are shown as de–energized.
REEL MOTORS
M3
M1
M2
TRACTION WHEEL MOTORS
M5
M4
OPTIONAL 3WD
TRACTION WHEEL MOTOR
MA
MB
RD1
O1
FC1
LC1
OPTIONAL
VALVES
S4
R2
S3
S2
S1
R1
L3B
L3A
L1B
L2B
L2A
#3
#2
#1
LIFT CYLINDERS
LOWER
RAISE
FLOW
CONTROL
VALVE
BY–PASS
VALVE
T
OIL
FILTER
MANIFOLD BLOCK
R4
P1
PT
ST
P2
P
V1
R
T
L
PB
P3
R5
P1
P2
ENGINE
RPM
GEAR PUMP
HYDROSTAT
1500 LOW IDLE
3025 HIGH IDLE
(DIESEL)
2300 RPM MOW OR TRANSPORT
2800 RPM MOW OR TRANSPORT
(GASOLINE)
OIL
COOLER
(OPTIONAL KIT)
STEERING
CONTROL
VALVE
Greensmaster 3200/3200–D
Mow
High Pressure
Low Pressure (Charge)
Return or Suction
Flow

Right and Left Turn

Right

The gear pump (P2) is directly coupled to the hydrostat through gear pump (P1). It supplies hydraulic pressure to the steering control valve for turning the rear wheel and maintaining 100 to 150 PSI (6.9 to 10.0 Bar) to the low pressure side of the traction circuit. The pump takes its suction from the hydraulic reservoir.

With the steering wheel in the neutral position (rear wheel positioned straight ahead) and the engine running, the spool valve is in the center position. Flow enters the steering control valve at Port (P) and goes through the spool valve by–passing the steering cylinder. Flow leaves the control valve out port (PB) and continues through solenoid valve (S2) to the hydrostat.

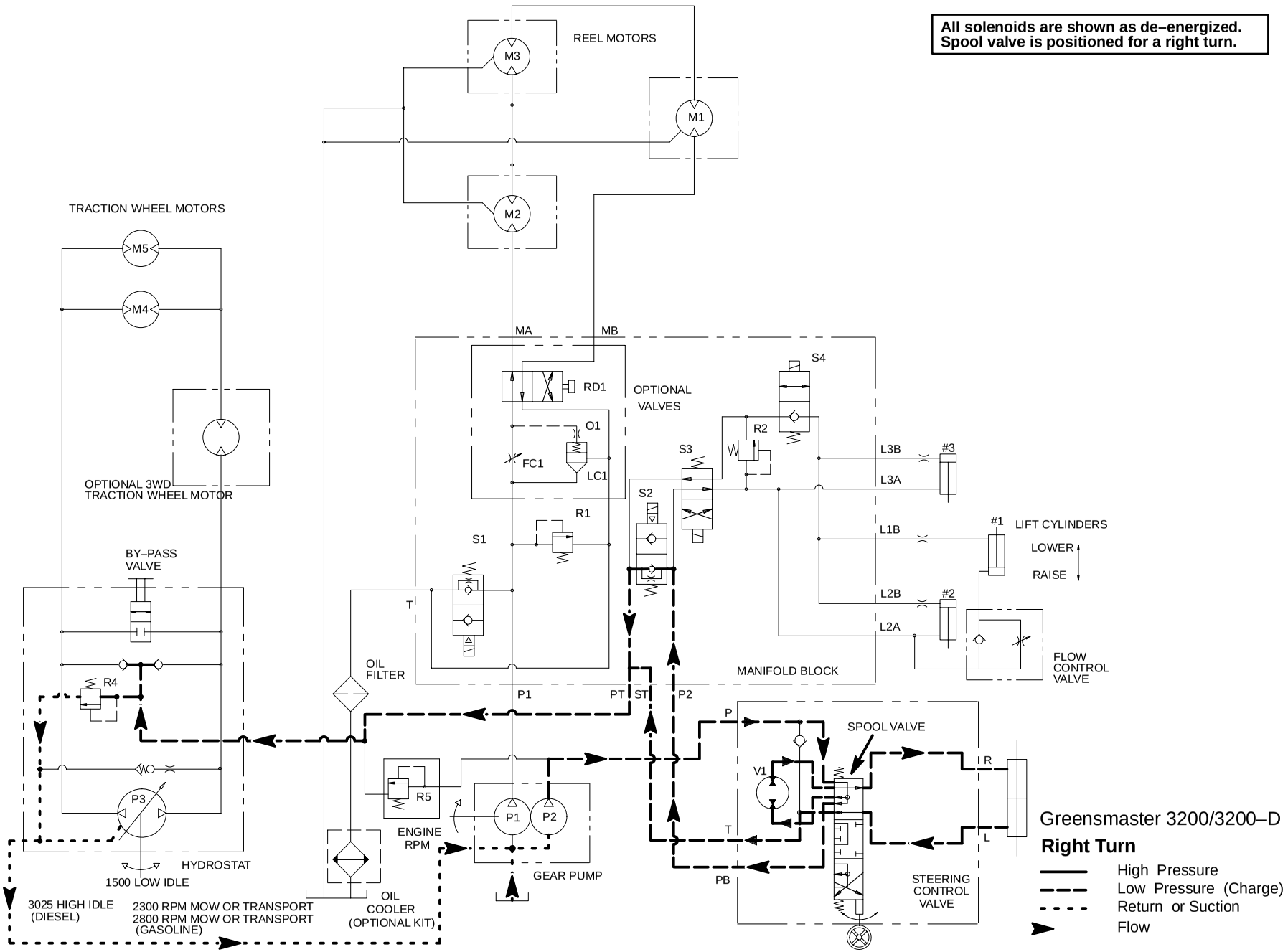
When a right turn is made with the engine running, the turning of the steering wheel positions the spool valve so that flow goes through the top of the spool. Flow entering the steering control valve at Port (P) goes through the spool and is routed to two places. First, most of the flow through the valve is by–passed out port (PB) back through solenoid valve (S2) to the hydrostat. Second, the remainder of the flow is drawn through rotary meter (V1) and out port (R). Pressure moves the piston in the direction for a right turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve then out port (T) and to the hydrostat.

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

Left

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 bottom of the spool. Flow entering the steering control valve at Port (P) goes through the spool and is routed to two places. First, most of the flow through the valve is by–passed out port (PB) back through solenoid valve (S2) to the hydrostat. Second, the remainder of the flow is drawn through rotary meter (V1) and out port (L). Pressure moves the piston in the direction for a left turn. The rotary meter ensures that the oil flow to the cylinder is proportional to the amount of the turning on the steering wheel. Fluid leaving the cylinder flows back through the spool valve then out port (T) and to the hydrostat.

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


All solenoids are shown as de–energized.
Spool valve is positioned for a right turn.
REEL MOTORS
M3
M1
M2
TRACTION WHEEL MOTORS
M5
M4
OPTIONAL 3WD
TRACTION WHEEL MOTOR
MA
MB
RD1
OPTIONAL
VALVES
O1
FC1
LC1
S4
R2
S3
S2
R1
S1
L3B
#3
L3A
L1B
#1
LIFT CYLINDERS
LOWER
RAISE
L2B
#2
L2A
FLOW
CONTROL
VALVE
MANIFOLD BLOCK
BY–PASS
VALVE
T
OIL
FILTER
R4
P1
PT
ST
P2
P
SPOOL VALVE
V1
R
T
L
R5
P3
P1
P2
ENGINE
RPM
GEAR PUMP
PB
STEERING
CONTROL
VALVE
HYDROSTAT
1500 LOW IDLE
3025 HIGH IDLE
(DIESEL)
2300 RPM MOW OR TRANSPORT
2800 RPM MOW OR TRANSPORT
(GASOLINE)
OIL
COOLER
(OPTIONAL KIT)
Greensmaster 3200/3200–D
Right Turn
High Pressure
Low Pressure (Charge)
Return or Suction
Flow

Special Tools

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

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, 5000 and 10000 PSI gauges. Use gauges as recommended in Testing section of this chapter.

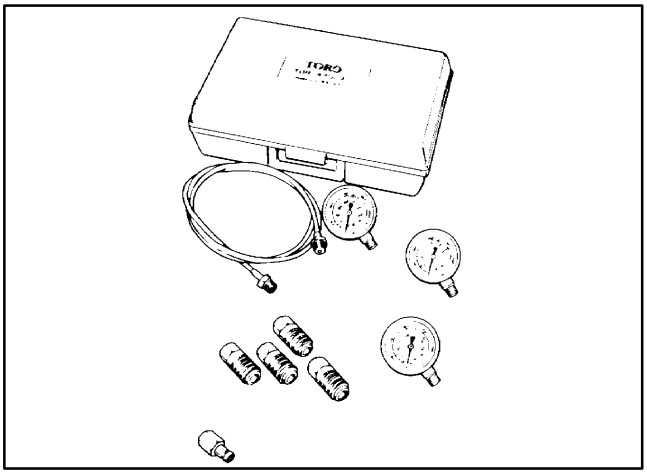


Figure 8

Hydraulic Tester – Pressure and Flow

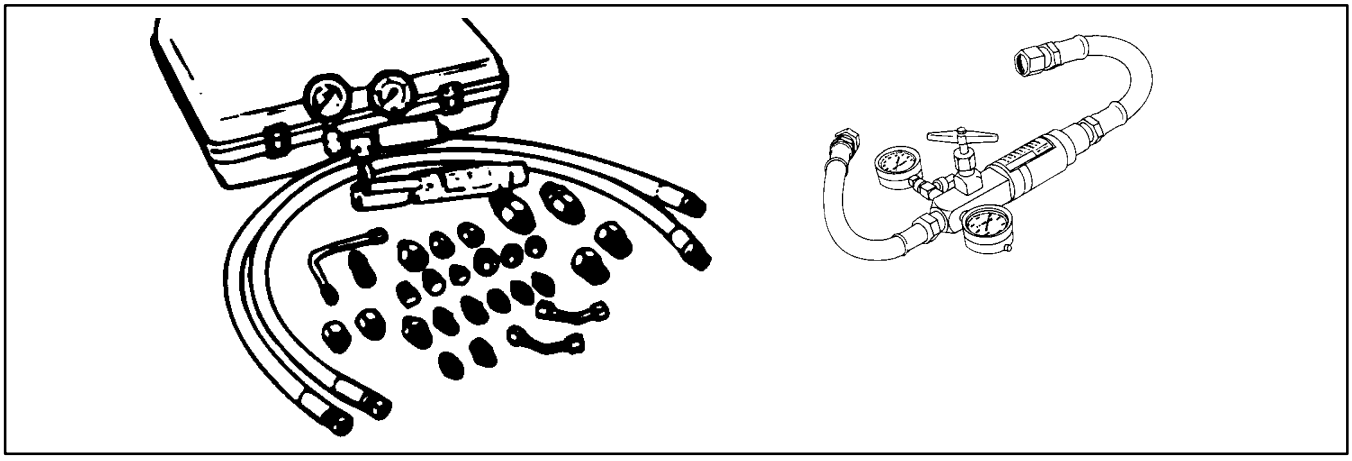


Figure 9

This tester requires O–ring face seal (ORFS) adapter fittings for use on this machine.

1. INLET HOSE: Hose connected from the system circuit to the inlet side of the hydraulic tester.

2. LOAD VALVE: A simulated working load is created in the circuit by turning the valve to restrict flow.

3. LOW PRESSURE GAUGE: Low range gauge to provide accurate reading at low pressure, 0 to 1000 PSI. A protector valve cuts out when pressure is about to exceed the normal range for the gauge. The cutout pressure is adjustable.

4. HIGH PRESSURE GAUGE: High range gauge which accommodates pressures beyond the capacity of the low pressure gauge, 0 to 5,000 PSI.

5. FLOW METER: This meter measures actual oil flow in the operating circuit with a gauge rated at 15 GPM.

6. OUTLET HOSE: A hose from the outlet side of the hydraulic tester connects to the hydraulic system circuit.

Troubleshooting

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

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

Problem	Possible Cause
Hydraulic oil leaks from system.	Fitting(s), hose(s), or tube(s) are loose or damaged. O–ring(s) or seal(s) are missing or damaged.
Hydraulic fluid foams.	Oil level in reservoir is low. Hydraulic system has wrong type of oil. One of the pump suction lines has an air leak.
Hydraulic system operates hot.	Transmission pressure is high due to load or brakes applied. Oil level in reservoir is low, or inlet filter is loose or clogged. Oil is contaminated or too light. Heat exchanger (when installed) is damaged or plugged. By–pass relief is stuck open or air flow is obstructed. Charge pressure is low. Towing by–pass valve is open or defective. Wheel motor(s) or reel motor(s) are worn or damaged. Traction pump is worn or damaged.
Neutral is difficult to find, or unit operates in one direction only.	External control linkage is misadjusted, disconnected, binding, or damaged. Traction pump is worn or damaged.
Traction response is sluggish.	Charge pressure is low. Hydraulic oil is very cold. Towing by–pass valve is open or worn. Brake is not released. Traction pump or wheel motor(s) are worn or damaged.
No traction exists in either direction.	Brake is not released. Oil level in reservoir is low. Towing by–pass valve is open. Charge pressure is low. Traction pump or wheel motor(s) are worn or damaged.
Wheel motor will not turn.	Internal parts in wheel motor are damaged. Brakes are binding. Key on wheel motor shaft is sheared or missing.

Problem	Possible Cause
Wheel motor will not hold load in neutral.	Make up fluid from charge pump is not available. Hydrostat ball check valves are damaged.
Reel motor drive pump is noisy (cavitation).	Reservoir oil level is low. Suction line is restricted. Suction line has an air leak.
Reels will not turn.	Solenoid valve S1 is stuck open. An electrical problem exists. (See Chapter 5–Electrical System) Relief valve R1 is stuck open. LC1 logic valve (when Backlap Kit is installed) is stuck open. Gear pump P1 is damaged.
Reel speed is erratic.	Reel to bedknife adjustment is too tight. Reel bearing(s) are damaged.
Reel motor case drain flow is excessive. Flow is greater than 0.5 GPM (1.9 LPM) at 1000 PSI.	Excessive internal wear in wheel motor exists. Reel bearing(s) are damaged.
Cutting units will not lift or lift slowly.	Engine speed is too low. Charge pump is damaged. Lift cylinder linkage is binding or broken. Lift cylinder bushings bind. Reservoir oil level is low. Charge pump pressure or flow is insufficient. Implement relief valve (R5) is stuck open. Solenoid valve (S2) is damaged. Lift cylinders leak internally. Relief valve (R2) is stuck open. Spool in steering control valve is hung up.
Cutting units raise, but will not stay up.	Lift cylinders leak internally. Solenoid valve (S4) leaks.

Problem	Possible Cause
Steering wheel is hard to turn.	Steering control valve has insufficient oil pressure. Emergency steering ball in steering control valve is missing or damaged.
Regular adjustments to steering wheel are necessary because of difficulty of driving in a straight line.	Leaf springs in steering control valve are worn or broken. Gear wheel set is worn. Steering cylinder is seized or its piston seals are worn.
Steering wheel will not return to the neutral position.	Spool and sleeve are sticking to housing assembly.
Steering wheel can turn on its own.	Leaf springs are broken or stuck. Spool and sleeve are sticking to housing assembly.
Backlash results when turning steering wheel.	Cardan shaft fork is worn or broken. Leaf springs are worn or broken. Splines on the steering column are worn.
Rear wheel shimmies when the steering wheel is turned.	Air is in the steering cylinder. Mechanical connections to the wheel or wheel bearing are worn.
The steering wheel can be turned without the rear wheel turning.	Oil is needed in the hydraulic reservoir. The steering cylinder is worn. The gear set in the steering control valve is worn.
Steering response is too slow and heavy when trying to turn quickly.	Oil supply to the steering control valve is insufficient.
Turning steering wheel turns machine in the opposite direction.	Hoses to the steering cylinder are reversed.
Steering force (possibly to one side only) is insufficient.	Pressure to steering control valve is low.

Testing

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

Before Performing Hydraulic Tests

IMPORTANT: All obvious areas such as oil supply, filter, binding 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

CAUTION

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

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

CAUTION

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

WARNING

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

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

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 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 can affect the accuracy of the tester readings.

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

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

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

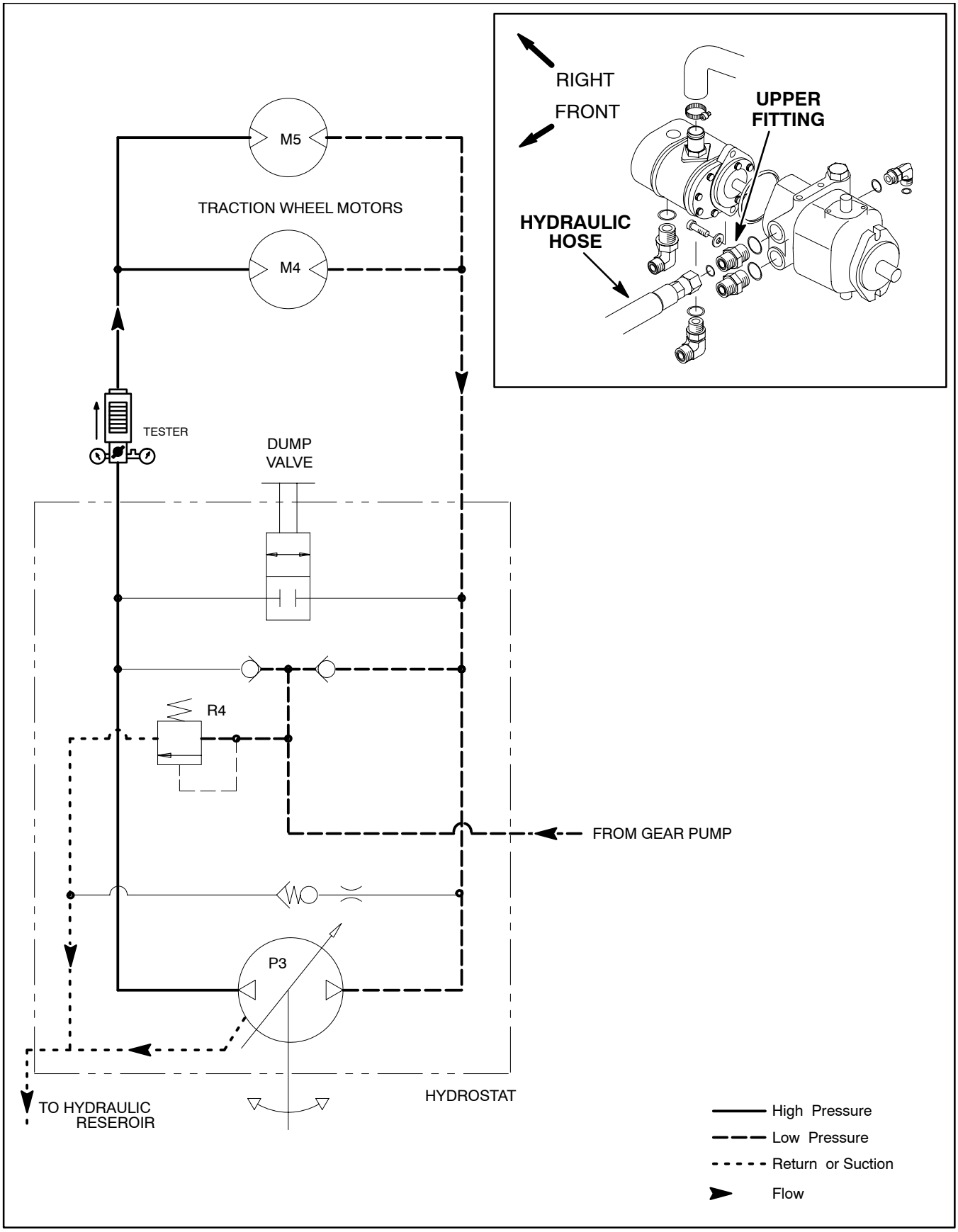
7. Position tester hoses so that **rotating** machine parts will not contact them and result in damage to the hoses or tester.

8. Check oil level in the reservoir. Make sure reservoir if full.

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

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

TEST NO. 1: Hydrostat Flow (P3)



Procedure for Hydrostat Flow (P3) Check:

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

2. Make sure machine is parked on a level surface with the cutting units lowered and off. Make sure engine is off.

3. Read Precautions for Hydraulic Testing.

4. Make sure that traction pedal is adjusted to the neutral position (see Traction Pedal in the Adjustments Section).

5. Block up one front traction wheel off the floor to allow flow through the traction circuit; disconnect brake linkage to this wheel (see Wheels and Brakes – Chapter 7).

6. If the unit is equipped with **3WD**, make sure rear wheel is blocked up to prevent the machine from moving.

7. Chock remaining wheels to prevent movement of the machine.

8. Attach a heavy chain to the rear of the machine frame and something solid in the shop.

9. Make sure parking brake is on.

10. Disconnect hose from the upper hydraulic fitting on the front side of the hydrostat.

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

12. Make sure mode selector is in the transport position.

13. Start engine and move the throttle to full speed.

    A. Units with diesel engine (3025 ± 50 RPM)

    B. Units with gasoline engine (2800 ± 28 RPM)

CAUTION

Use extreme caution when taking gauge readings. The front tire on the ground will be trying to move the machine forward.

14. Slowly push traction pedal into fully forward position.

15. Close flow control valve until pressure gauges read **1000 PSI**. Verify pump speed with a phototac.

    A. Units with diesel engine (3025 ± 50 RPM)

    B. Units with gasoline engine (2800 ± 28 RPM)

16. Observe flow gauge. TESTER READING should be:

    A. Units with diesel engine: minimum flow **14.6 GPM**

    B. Units with a gasoline engine: minimum flow **13.5 GPM**

17. Release traction pedal and turn off machine.

18. Disconnect tester from pump connection and hose. Reconnect hose to pump connection.

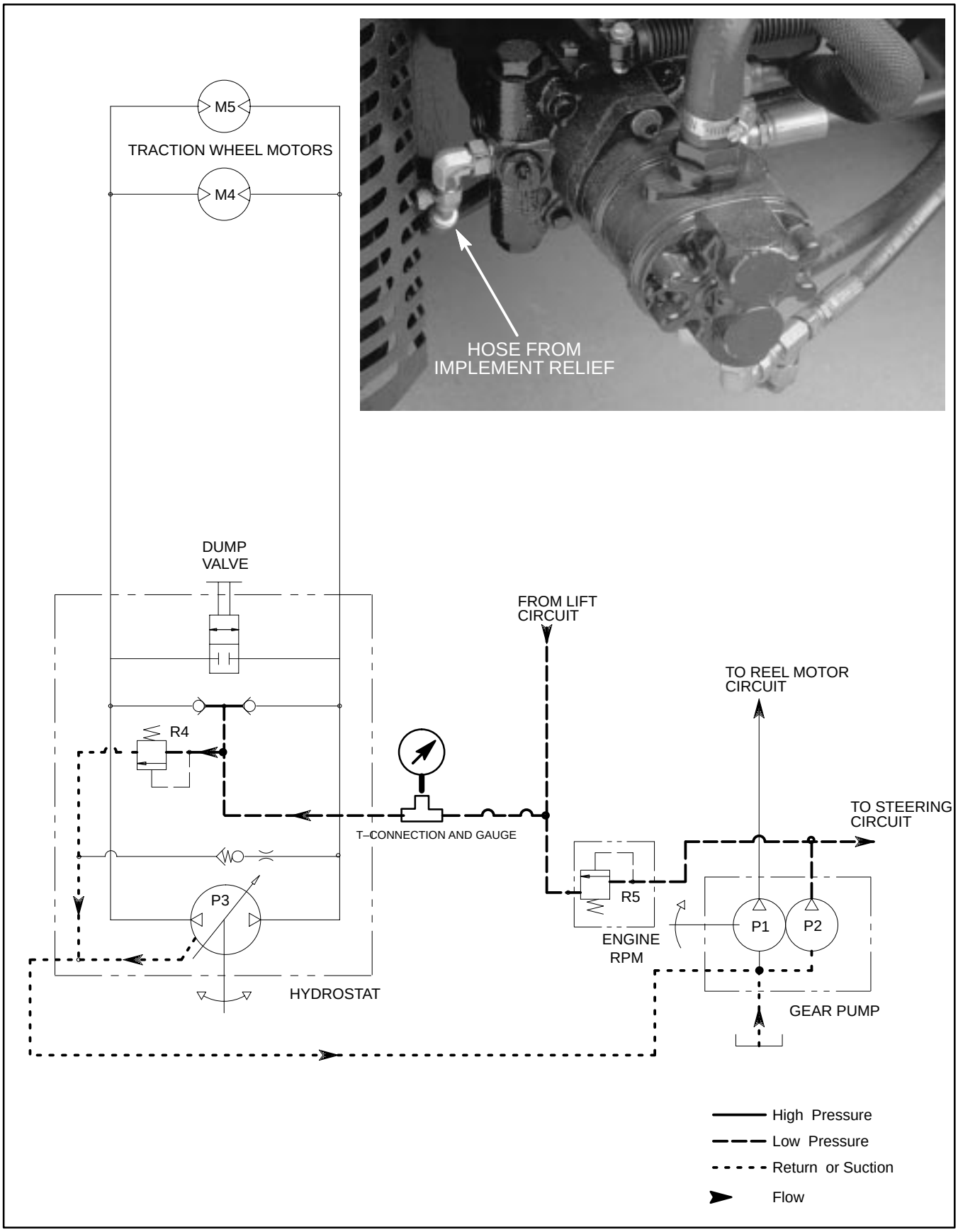
19. If specifications are not met consider the following:

    A. The hydrostat needs to be repaired or replaced as necessary.

    B. The traction pedal and traction speed may need adjustment (see Traction Pedal in the Adjustments Section).

20. Reconnect brake linkage to wheel (see Wheels and Brakes – Chapter 7).

TEST NO. 2: Charge Relief Valve (R4) Pressure



Procedure for Charge Relief Valve (R4) Pressure Check:

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

2. Make sure machine is parked on a level surface with the cutting units lowered. Make sure engine is off and the parking brake is engaged.

3. Read Precautions for Hydraulic Testing.

4. Disconnect hose to the rear 90° hydraulic fitting on the hydrostat coming from the implement relief valve (R5). Connect T–connector and gauge to the fitting and hose connection.

5. Operate engine at full speed.

   A. Units with a diesel engine **(3025 ± 50 RPM)**.

   B. Units with a gasoline engine **(2800 ± 28 RPM)**.

6. Make sure hydraulic oil is at operating temperature.

7. Make sure that traction pedal and lift control are in neutral and the parking brake is engaged.

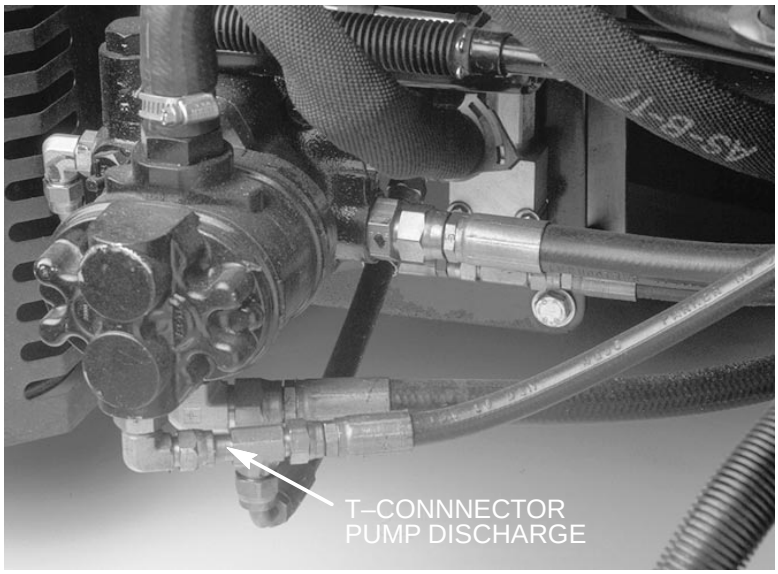
8. Pressure gauge should read from **100** to **150 PSI**.

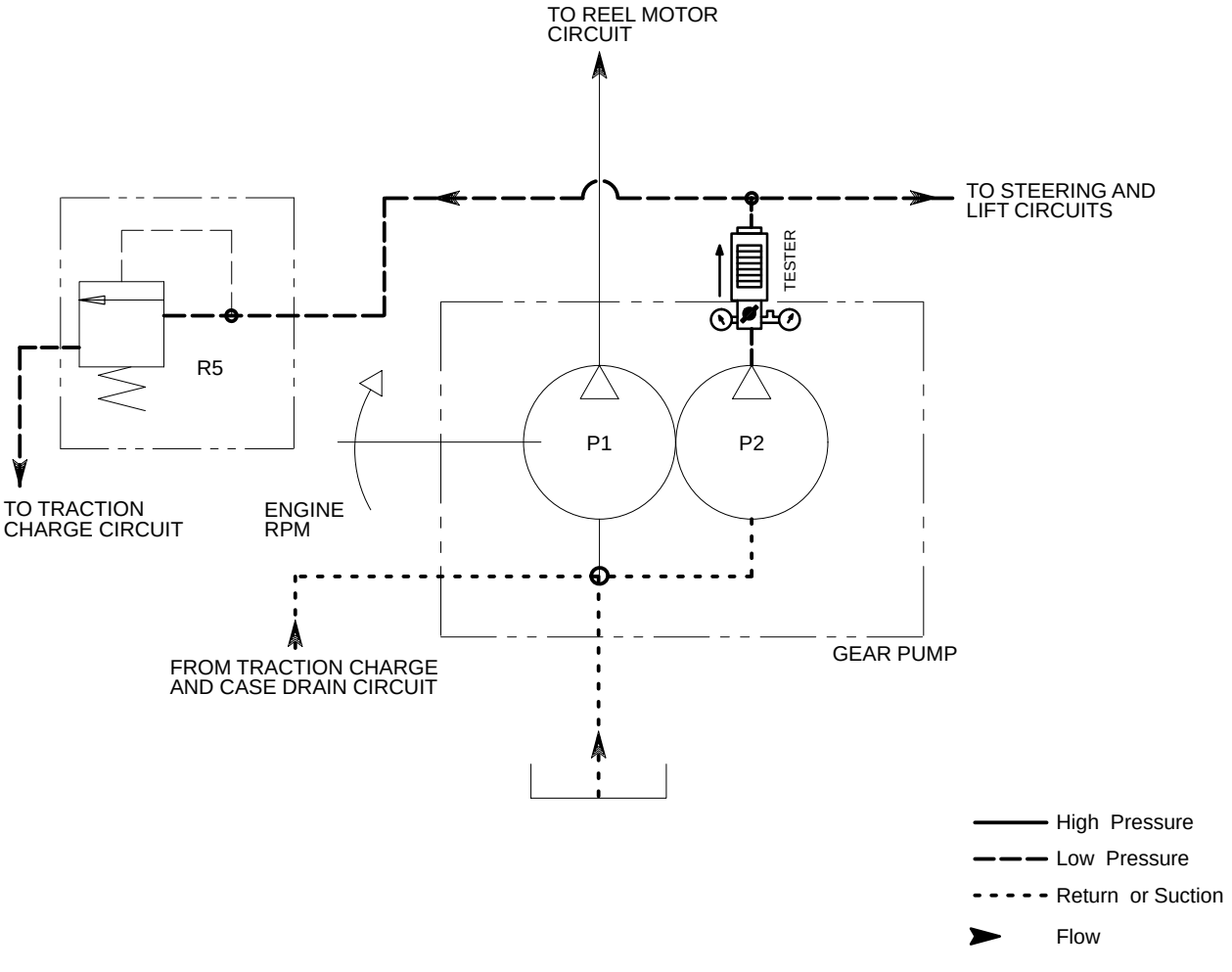
9. Shut off engine.

10. If specification is not met, replace back plate assembly containing the charge relief valve.

11. Disconnect gauge and T–connection from the 90° hydraulic fitting and hose connection. Reconnect hose to the hydrostat.

TEST NO. 3: Gear Pump (P2) Flow and Implement Relief Valve (R5) Pressure





Procedure for Gear Pump (P2) Flow Check:

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

2. Make sure machine is parked on a level surface with the cutting units lowered. Make sure engine is off and the parking brake is engaged.

3. Read Precautions for Hydraulic Testing.

4. Disconnect T–connector from the discharge fitting of the charge pump. Connect gage end of tester to the pump discharge fitting.

5. Connect the other end of the tester to the disconnected T–connector. Make sure flow control valve on tester is fully open.

6. Operate engine at full speed.

   A. Units with a diesel engine **(3025 ± 50 RPM)**.

   B. Units with a gasoline engine **(2800 ± 28 RPM)**.

7. Make sure that traction pedal and lift control are in neutral and the parking brake is engaged.

8. Watch flow and pressure gauges carefully while slowly closing the flow control valve until the pressure gauge reads **800 PSI**.

9. **Minimum** flow gauge reading should be **3.4 GPM**. If specification is not met, repair or replace pump.

Procedure for Implement Relief Valve (R5) Pressure Check:

CAUTION

Do not allow pressure to exceed 1200 PSI.

1. Fully open control valve on the tester.

2. Operate engine at full speed.

   A. Units with a diesel engine **(3025 ± 50 RPM)**.

   B. Units with a gasoline engine **(2800 ± 28 RPM)**.

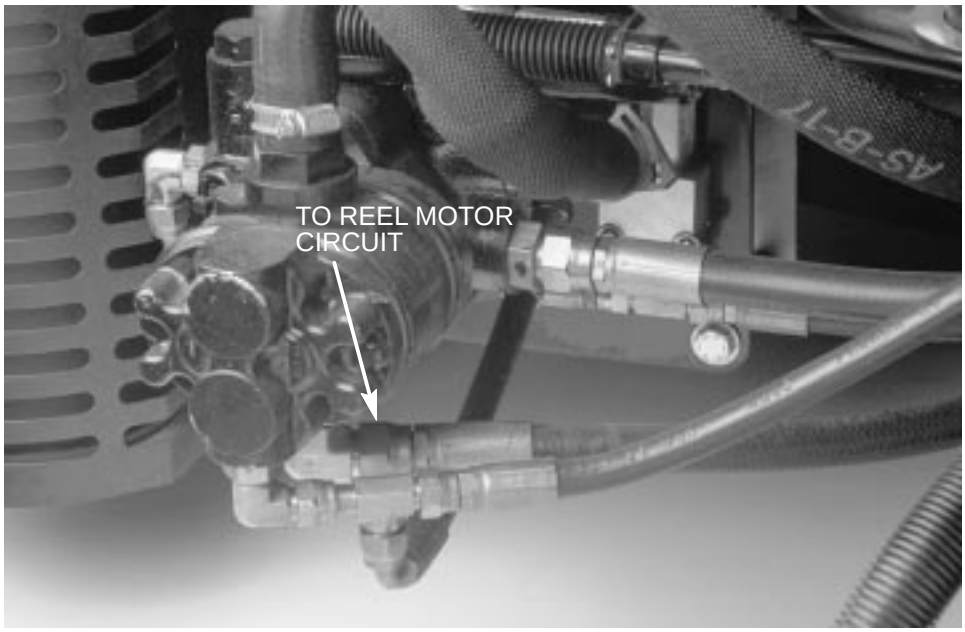
3. While holding the lift lever in the raised position, watch the pressure gauge. **Record pressure the relief valve opens at.**

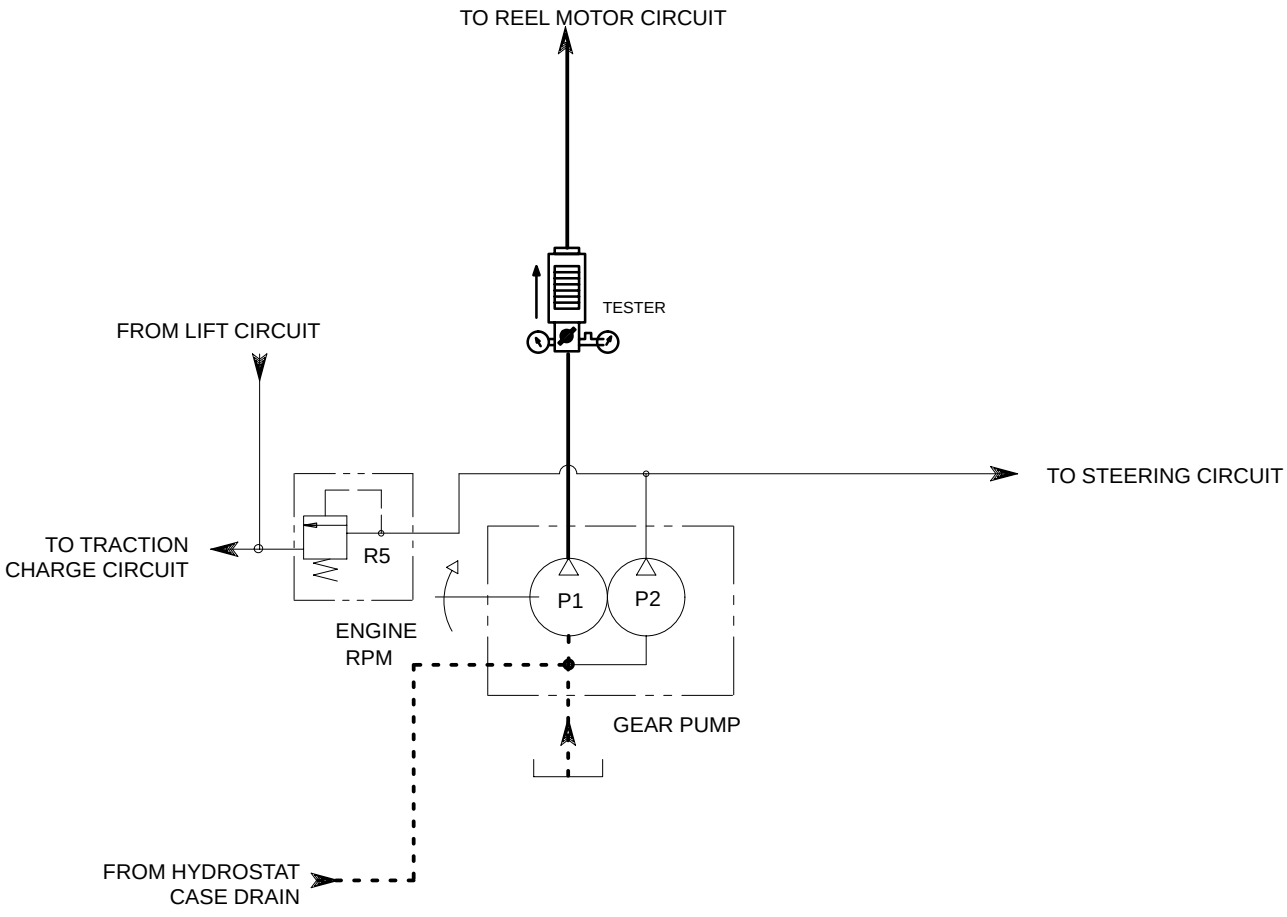
4. Pressure should be from **900 to 1100 PSI**.

5. Return lift lever to neutral position. Shut off engine.

6. Disconnect tester from the pump and hose. Reconnect hose to the pump.

TEST NO. 4: Gear Pump (P1) Flow





Procedure for Gear Pump (P1) Check:

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

2. Make sure machine is parked on a level surface with the cutting units lowered. Make sure engine is off and the parking brake is engaged.

3. Read Precautions for Hydraulic Testing.

4. Disconnect hose connection on the reel drive pump leading to port P1 on the hydraulic manifold.

5. Install tester in series with reel drive pump and the disconnected hose leading to port P1 of the hydraulic manifold. Make sure the flow control valve is fully open.

6. If a backlap kit is installed, make sure backlap knob on the valve block is in the **mow** position and reel speed is set to maximum.

7. Make sure tester load valve is fully open before starting the engine.

8. Start engine and move throttle to full speed. **Do not engage the cutting units**.

   A. Units with a diesel engine **(3025 ± 50 RPM)**.

   B. Units with a gasoline engine **(2800 ± 28 RPM)**.

9. Watch pressure gauge carefully while slowly closing the flow control valve until **2000 PSI** is obtained. Verify with a phototac that the pump speed is as specified in step 8.

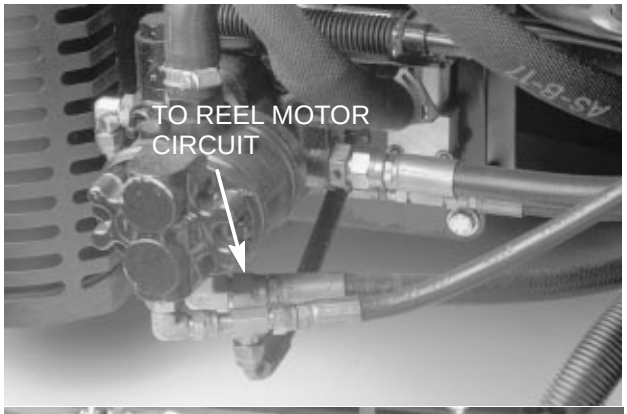
10. Flow indication should be **5.5 GPM** minimum.

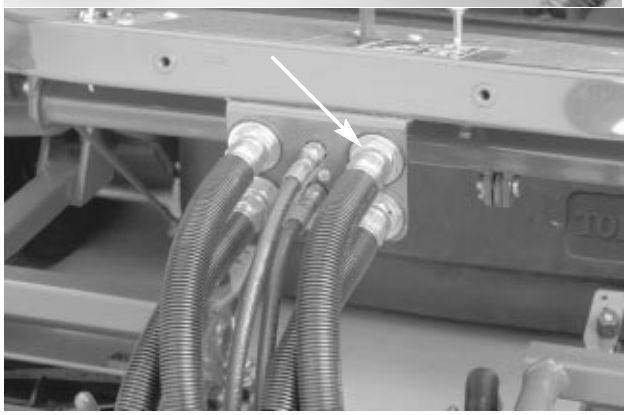
11. Shut off engine.

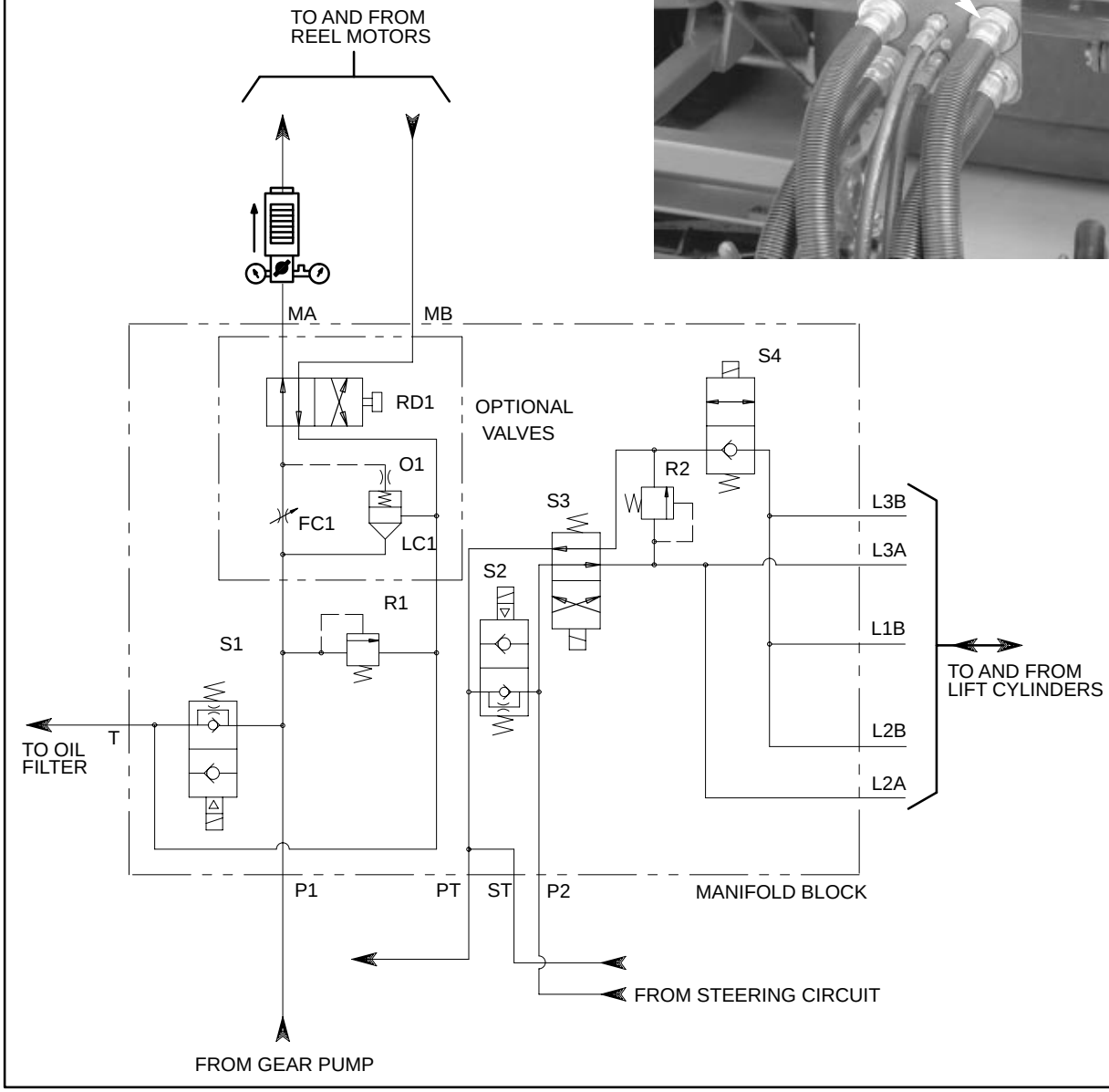
12. Disconnect tester from manifold and hose. Reconnect hose to the pump.

13. If flow was less than **5.5 GPM** or a pressure of **2000 PSI** cannot be obtained, check for restriction in the pump intake line. If line is not restricted, remove pump and repair or replace as necessary.

TEST NO. 5: Manifold Relief Valve (R1) Pressure







Procedure for <u>Manifold Relief Valve (R1) Pressure</u> Check:

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

2. Make sure machine is parked on a level surface with the cutting units lowered. Make sure engine is off and the parking brake is engaged.

3. Read Precautions for Hydraulic Testing.

4. Make sure reel speed adjuster knob (FC1) is set to the highest speed setting (fully open).

5. Disconnect hose connection on the bulkhead that leads to the left reel motor.

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

7. If a backlap kit is installed, make sure backlap knob on the valve block is in the mow position. Make sure reel speed knob is set to maximum.

CAUTION

Keep away from reels during test to prevent personal injury from the rotating reel blades.

8. Start engine and move throttle to full speed. Engage the cutting units.

   A. Units with a diesel engine **(3025 ± 50 RPM)**.

   B. Units with a gasoline engine **(2800 ± 28 RPM)**.

9. Watch pressure gauge carefully while slowly closing the flow control valve to fully closed.

10. System pressure should be from **2160** to **2640 PSI**.

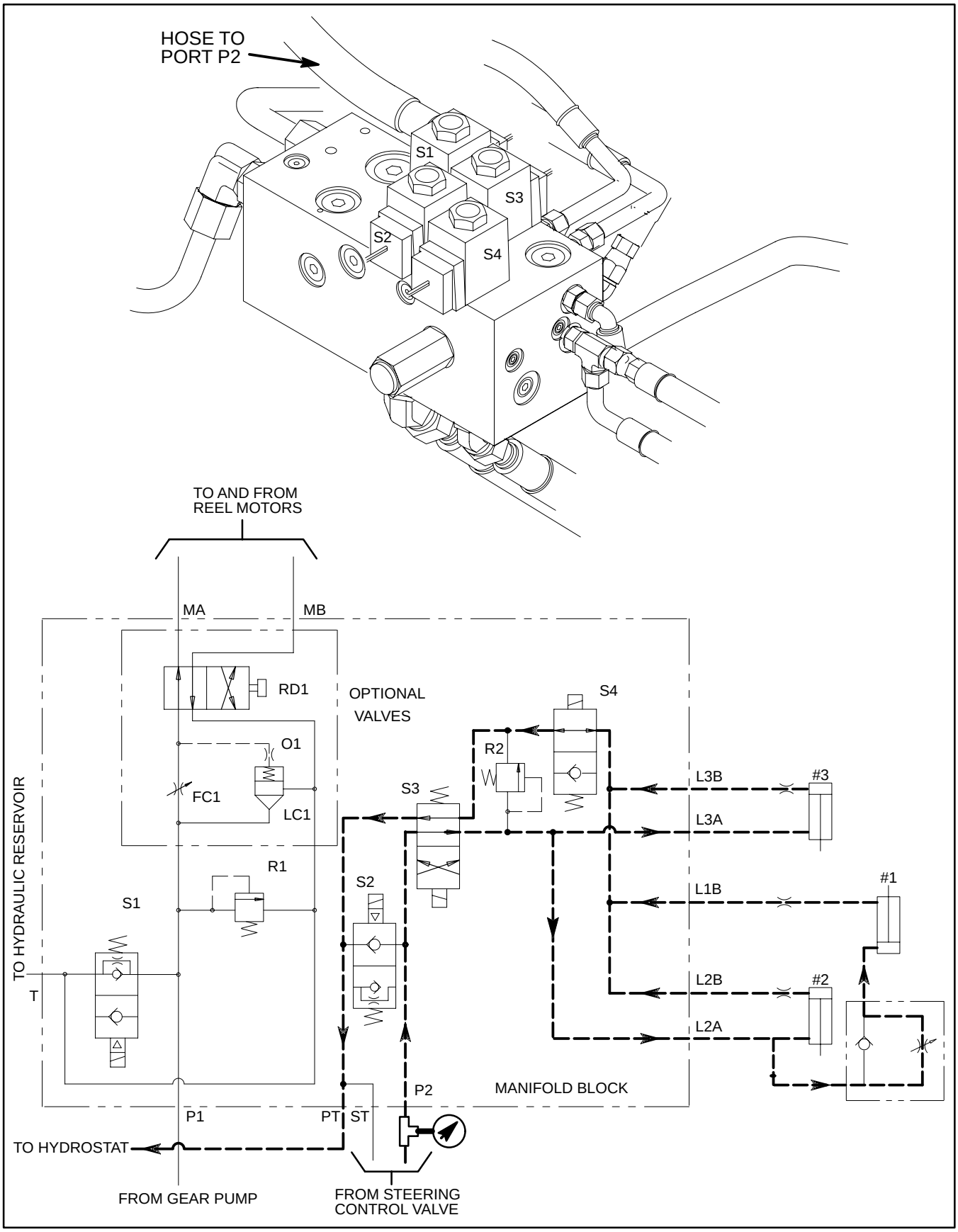
    A. If specification is **not** met, shut off engine and adjust relief valve (see Adjusting Manifold Relief Valves). Go to step 6.

    B. If this specification is met, go to step 11.

11. Disengage cutting units. Shut off engine.

12. Disconnect tester from manifold and hose. Reconnect hose to the pump.

TEST NO. 6: Manifold Relief Valve (R2) Pressure



Procedure for <u>Manifold Relief Valve (R2) Pressure</u> Check:

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

2. Make sure machine is parked on a level surface with the cutting units lowered. Make sure engine is off and the parking brake is engaged.

3. Read Precautions for Hydraulic Testing.

4. Disconnect hose connection attached to the hydraulic fitting at port P2. Connect T–connector and gauge to the fitting and hose connection.

5. For gasoline engines, change the following electrical connections:

   A. Disconnect the connectors for solenoids S3 and S4 at the manifold block.

   B. Connect male connector from solenoid S3 to the female connector (yellow/black and black), located on the wiring harness, for solenoid S4.

   C. Connect male connector from solenoid S4 to the female connector (orange/blue and black), located on the wiring harness, for solenoid S3.

6. For diesel engines, change the following electrical connections:

   A. Disconnect the connectors for solenoids S3 and S4 at the manifold block.

   B. Connect male connector from solenoid S3 to the female connector (gray and black), located on the wiring harness, for solenoid S4.

   C. Connect male connector from solenoid S4 to the female connector (violet and black), located on the wiring harness, for solenoid S3.

7. Start engine and move throttle to full speed. Engage the cutting units.

   A. Units with a diesel engine **(3025 ± 50 RPM)**.

   B. Units with a gasoline engine **(2800 ± 28 RPM)**.

8. Watch pressure gauge carefully while holding the Raise/Lower – Mow Control lever at **RAISE** until the manifold relief opens. Relief pressure should be **300 PSI**. Release lever and shut off engine.

9. For gasoline engines, change the following electrical connections:

   A. Disconnect the connectors for solenoids S3 and S4 at the manifold block.

   B. Connect male connector from solenoid S4 to the female connector (yellow/black and black), located on the wiring harness, for solenoid S4.

   C. Connect male connector from solenoid S3 to the female connector (orange/blue and black), located on the wiring harness, for solenoid S3.

10. For diesel engines, change the following electrical connections:

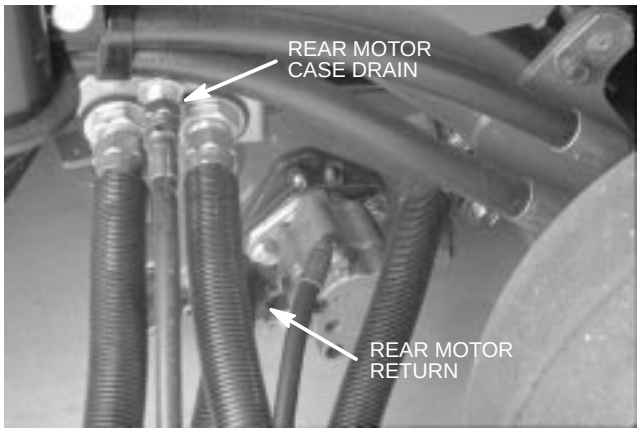
   A. Disconnect the connectors for solenoids S3 and S4 at the manifold block.

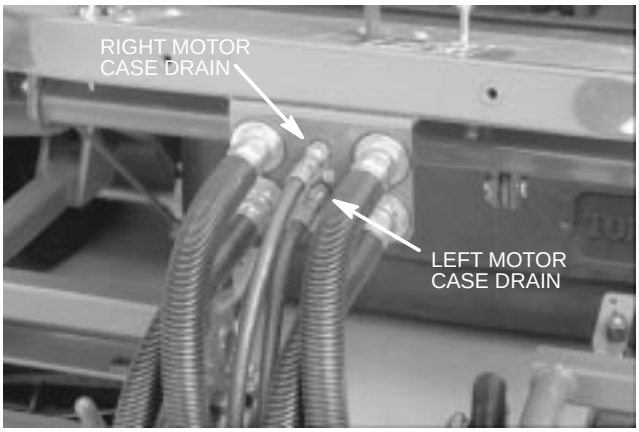
   B. Connect male connector from solenoid S4 to the female connector (gray and black), located on the wiring harness, for solenoid S4.

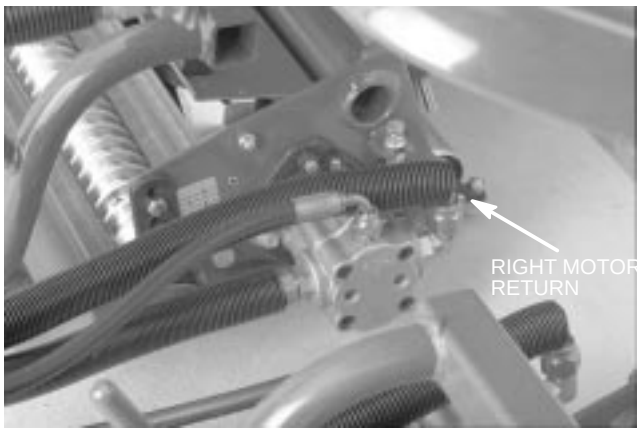
   C. Connect male connector from solenoid S3 to the female connector (violet and black), located on the wiring harness, for solenoid S3.

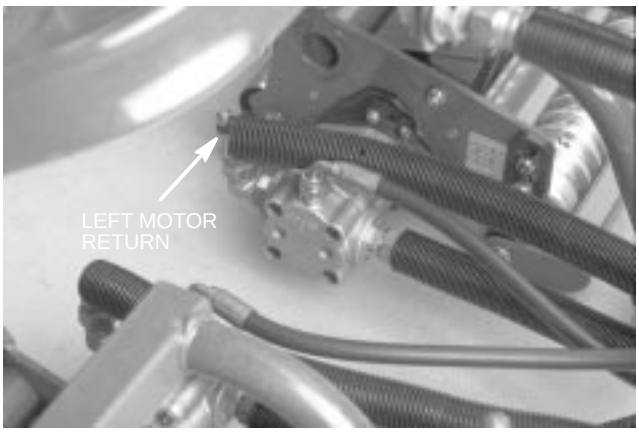
11. Disconnect test gauges from manifold and hoses. Reconnect hoses to hydraulic fittings on manifold.

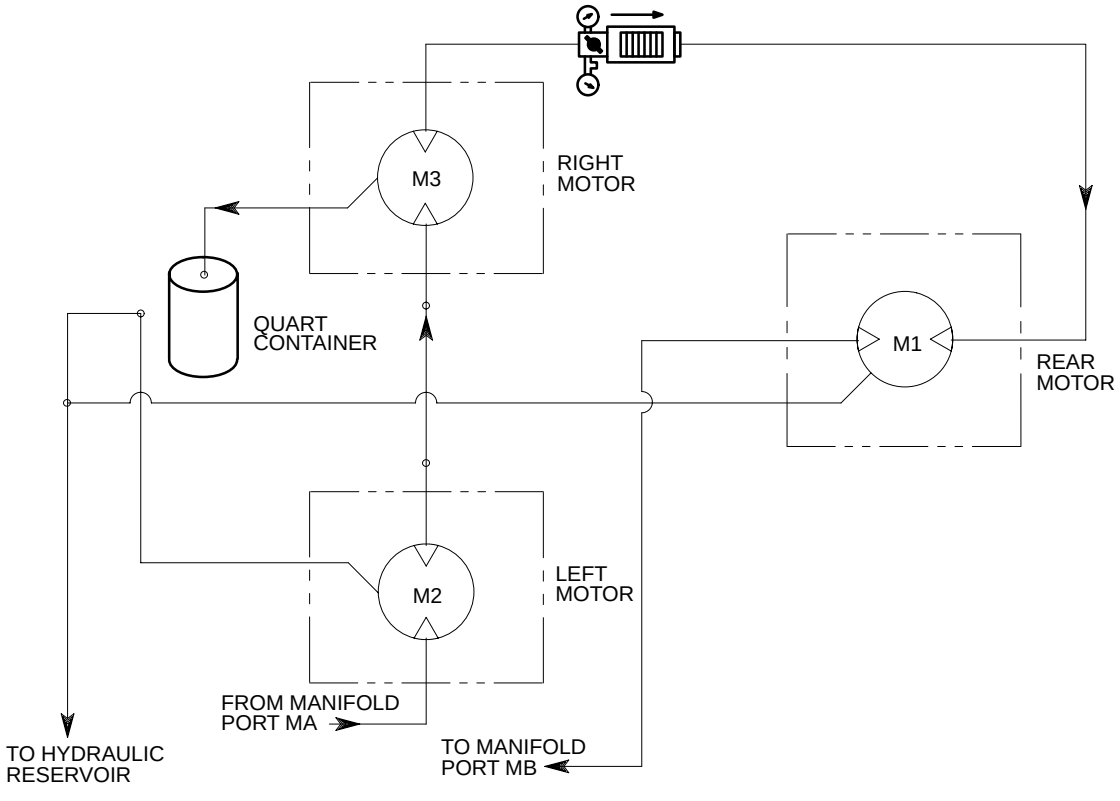
TEST NO. 7: Reel Motor Case Drain











Procedure for Reel Motor Case Drain Check:

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

2. Make sure machine is parked on a level surface with the cutting units lowered. Make sure engine is off and the parking brake is engaged.

3. Read Precautions for Hydraulic Testing.

4. For the suspected bad motor, disconnect return hose from motor that is used for mowing operation.

5. Install tester in series with the motor, and disconnected return hose. Make sure the flow control valve is fully open.

6. If a back lap kit is installed, make sure backlap knob on the valve block is in the **mow** position and reel speed is set to maximum.

7. Disconnect hose from case drain at the bulkhead fitting.

   A. Plug the bulkhead port.

   B. Put case drain hose into suitable container for collecting case drain leakage.

8. One person should sit on the seat and operate the machine while another person reads the tester and measures case drain leakage. Make sure functional control lever is in **NEUTRAL**. Start engine and move the throttle to full speed.

   A. Units with a diesel engine **(3025 ± 50 RPM)**.

   B. Units with a gasoline engine **(2800 ± 28 RPM)**.

CAUTION

Keep away from reels during test to prevent personal injury from the rotating reel blades.

9. Engage reels by positioning the functional control lever to **MOW** position. While watching pressure gauges, slowly close flow control valve until a pressure of **1000 PSI** is obtained.

10. Collect hydraulic fluid for **15** seconds by putting the case drain hose into a 1 quart container graduated in ounces (1 liter container graduated in milliliters).

11. Disengage cutting units by positioning functional control lever to **NEUTRAL** position. Stop the engine.

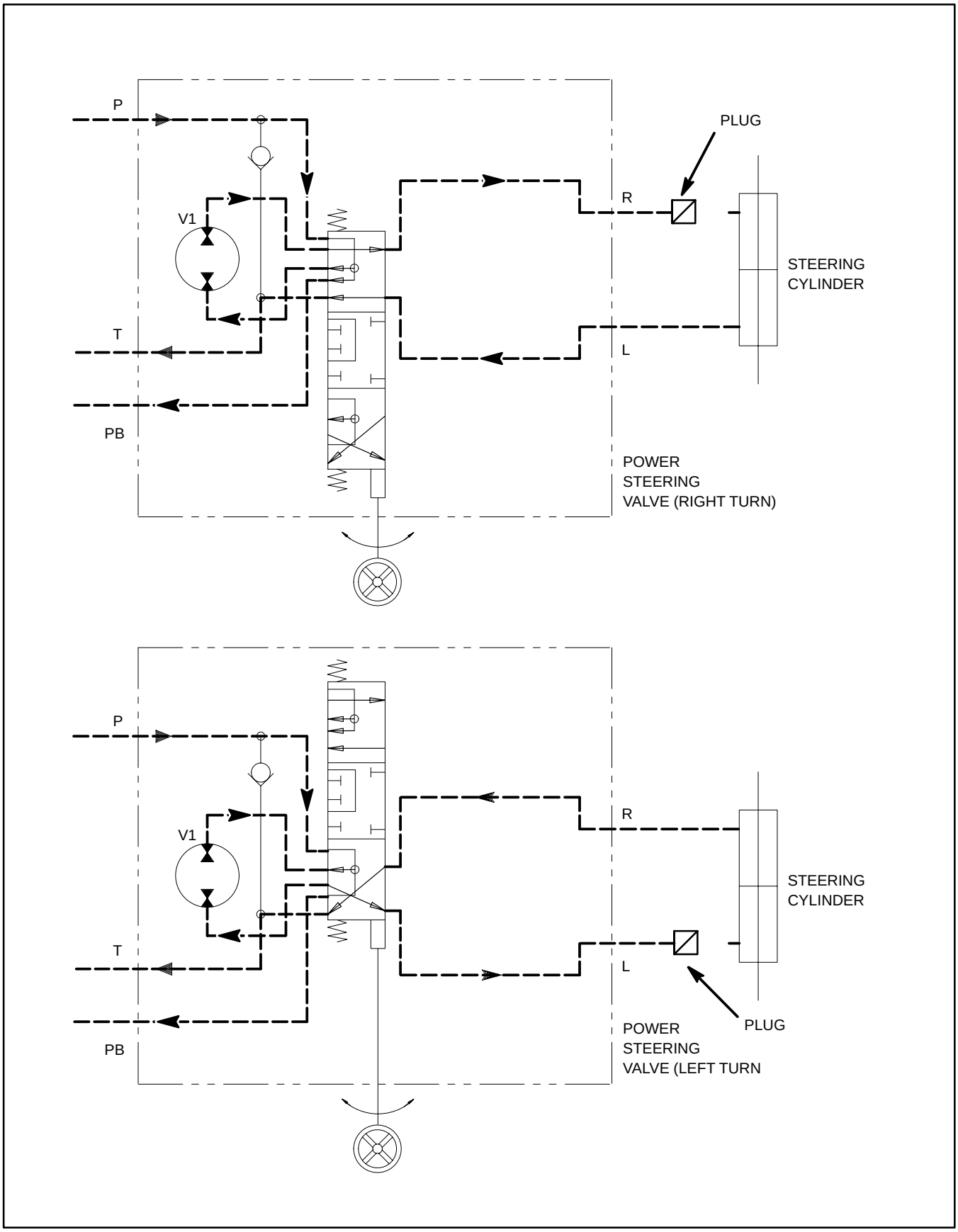
12. Measure the amount of oil collected in the container. Divide the number of ounces collected by **32** to get gallons per minute. (Divide the number of milliliters collected by **250** to get liters per minute).

13. Disconnect tester from motor and hose. Reconnect hose to the pump.

14. Remove plug from manifold fitting. Reconnect case drain hose to the bulkhead fitting.

15. If flow was greater than **0.5 GPM (1.9 LPM)**, repair or replace the reel motor as necessary.

TEST NO. 8: Steering Control Valve



Procedure for Steering Control Valve Check:

1. Make sure the hydraulic tank is full.

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

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 rear wheel.

   B. Steering wheel movements should be followed **immediately** by a corresponding rear wheel movement **without** the steering wheel continuing to turn.

4. Stop the unit with the engine running. Turn steering wheel with small quick movements in both directions. Let go of the steering wheel after each movement.

   A. The steering wheel must go back immediately to the neutral position.

   B. The steering wheel should **not** continuing to turn.

Note: The steering wheel must be able to turn with no more than 45 in–lb (52 kg–cm) of torque.

5. While the machine is stopped and the engine still running,

   A. Turn the steering wheel from stop to stop in each direction.

   B. Count and record the number of times the steering wheel turns in each direction.

6. Stop the engine.

   A. Again, turn the steering wheel from stop to stop in each direction.

   B. Again, count and record the number of times the steering wheel turns in each direction.

7. Compare the difference in the number of turns in each direction with the engine running and off. If the difference is 1 turn or greater in any direction, leakage in the cylinder, gear wheel set, or suction valve is to large.

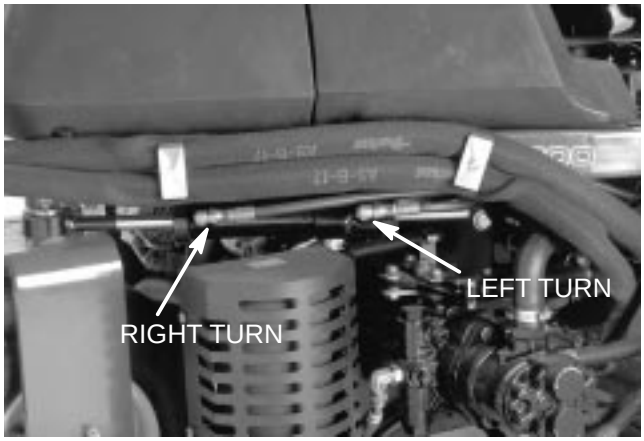


Figure 10

8. If leakage is detected in the step above,

   A. Make sure machine is parked on a level surface with the cutting units lowered. Make sure engine is off and the parking brake is engaged.

   B. Read Precautions for Hydraulic Testing.

   C. Remove a hose from one of the steering cylinder fittings. Plug the end of the hose (Fig. 10).

   D. Turn steering wheel in the direction of the removed hose.

   E. Remove the plug from the hose. Reconnect hose to the steering cylinder fitting.

   F. Remove a hose from the other steering cylinder fitting. Plug the end of the hose.

   G. Turn steering wheel in the other direction.

   H. If the steering wheel does not turn in both directions, the steering cylinder is defective. Other wise the steering control valve is defective.

   I. Remove the plug from the hose. Reconnect hose to the steering cylinder fitting.

Adjustments

Adjusting Transmission for Neutral

If the machine “creeps” when the traction control pedal is in the neutral position, the neutral return mechanism must be adjusted.

1. Block up under the frame so one of the front wheels is off the floor.

2. Start engine, move throttle to SLOW and check front wheel that is off shop floor; it must not be rotating.

3. If wheel is rotating, stop engine and proceed as follows:

   A. Loosen both jam nuts securing traction control cable to bulkhead on hydrostat. Make sure jam nuts are loosened equally and sufficiently to allow adjustment.

   B. Loosen nut securing eccentric to top of hydrostat.

   C. Move functional control lever to neutral, throttle to slow and start engine.

   D. Rotate eccentric until creep does not occur in either direction. When wheel stops rotating, tighten nut locking eccentric and adjustment. Verify the adjustment with throttle in SLOW and FAST position.

   E. From each side of bulkhead, tighten locknuts **evenly,** securing traction cable to bulkhead. Do not twist cable.

Note: If cable tension exists when in neutral, machine may creep when the functional control lever is moved to the Mow or Transport position.

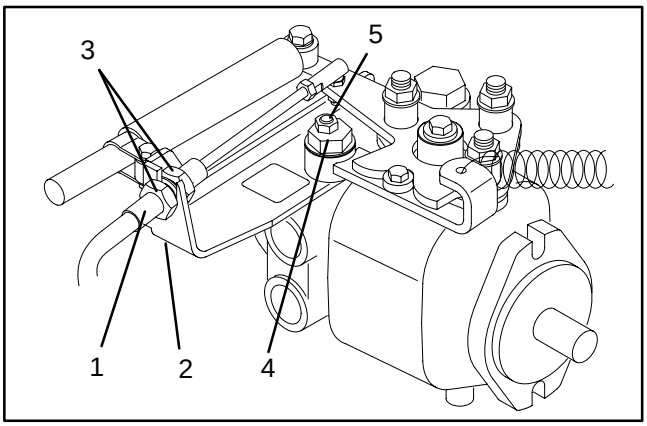


Figure 11

1. **Traction control cable**
2. **Bulkhead**
3. **Jam nuts**
4. **Eccentric**
5. **Lock nut**

Adjusting Transport Speed

The traction pedal is adjusted for maximum transport speed at the factory, but an adjustment may be required if pedal reaches full stroke before it contacts pedal stop, or if a decrease in transport speed is desired.

1. Press down on traction pedal and see if pedal contacts stop before tension is felt on cable. If an adjustment is required:

   A. Loosen flange head locknuts securing pedal stop to floor plate.

   B. Adjust pedal stop so it contacts pedal rod before minimum tension is felt on the cable. Tighten nuts.

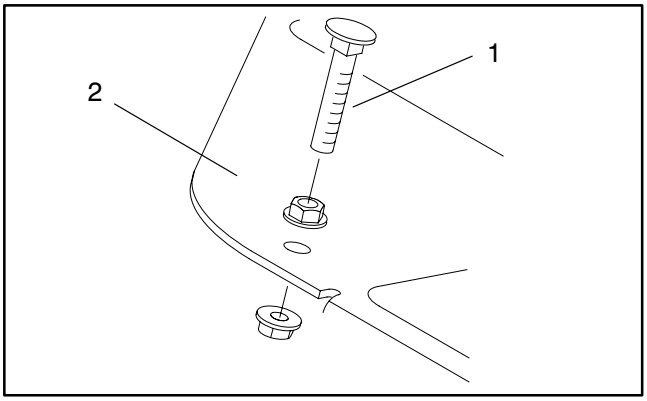


Figure 12

1. **Pedal stop**
2. **Floor plate**

Adjusting Cutting Unit Lift and Drop

The machine's cutting unit lift/drop circuit has a flow control valve which is preset at the factory to about 3 turns open. An adjustment may be required to compensate for differences in hydraulic oil temperatures, mowing speeds, etc. If an adjustment is required proceed as follows:

Note: Allow hydraulic oil to reach full operating temperature before adjusting flow control valve.

1. Raise seat and locate flow control valve mounted to the hydraulic cylinder for the center pull frame.

2. Loosen set screw on the adjusting knob of the flow control valve.

3. If center cutting unit is dropping too late, rotate knob 1/4 turn counterclockwise.

4. If the center cutting unit is dropping to early, rotate knob 1/4 turn clockwise.

5. After desired setting has be achieved, tighten set screw.

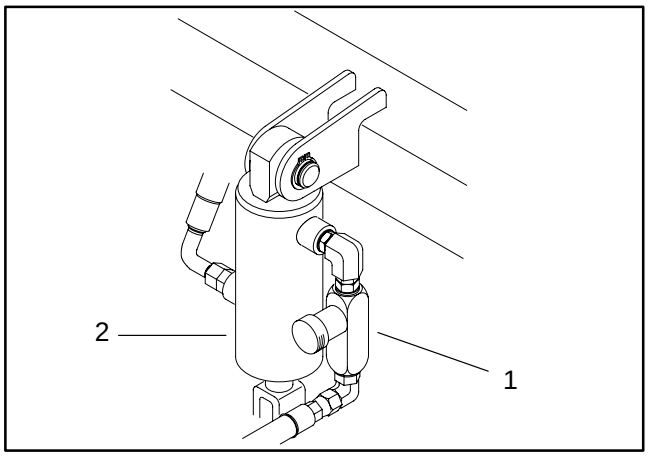


Figure 13

1. **Flow control valve** 2. **Rear hydraulic cylinder**

Adjusting Implement Relief Valve (R5)

The hydraulic lift and steering circuits are equipped with a relief valve. This valve is preset at the factory to 1000 PSI. An adjustment may be required if the setting proves to be off after testing (see TESTING). If an adjustment is required proceed as follows:

WARNING

Never adjust the relief valve with the hydraulic system pressurized. Hydraulic oil will spray out of the valve with the cap off. Personal injury may result. Always install the cap and tighten before pressurizing the system.

1. Remove cap from the relief valve with an allen wrench.

2. To **increase** pressure setting, turn the adjustment socket inside the valve 1/8 of a turn clockwise.

3. To **decrease** pressure setting, turn the adjustment socket inside the valve 1/8 of a turn counterclockwise.

4. Install and tighten cap to valve. Retest pressure setting (see TESTING).

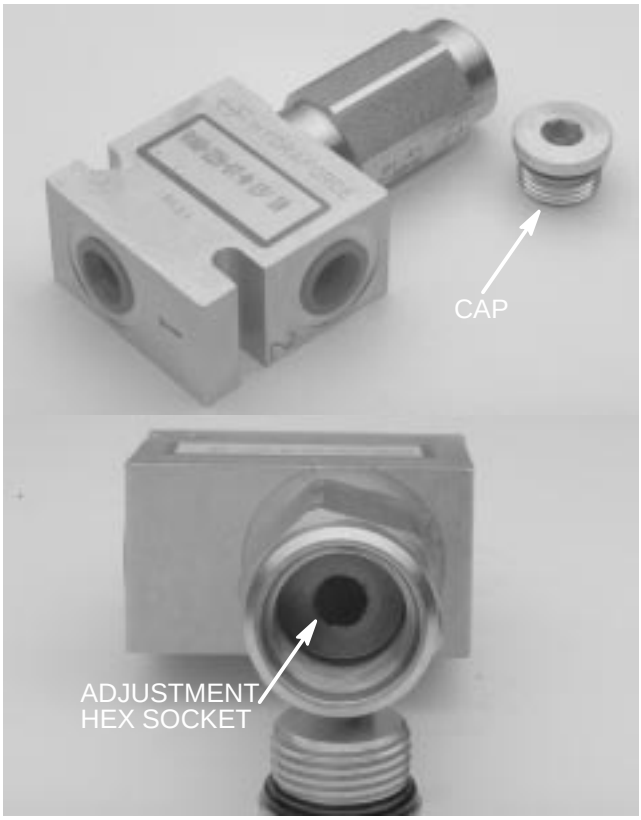


Figure 14

Adjusting Manifold Relief Valves (R1 and R2)

The hydraulic reel and lift circuits are equipped with relief valves. These valves are preset at the factory to 2400 PSI (R1) and 150 PSI (R2), but an adjustment may be required if the setting proves to be off after testing (see TESTING). If an adjustment is required proceed as follows:

WARNING

Never adjust the relief valve with the hydraulic system pressurized. Hydraulic oil may spray out of the valve with the cap off. Personal injury may result. Always install the cap and tighten before pressurizing the system.

1. Remove cap from the relief valve with an allen wrench.

Note: An 1/8–turn of the adjustment socket is about 50 psi (3.5 bar), or 1 turn is about 400 psi (27.6 bar).

2. To **increase** pressure setting, turn the adjustment socket inside the valve 1/8 of a turn clockwise.

3. To **decrease** pressure setting, turn the adjustment socket inside the valve 1/8 of a turn counterclockwise.

4. Install and tighten cap to valve. Retest pressure setting (see Testing).

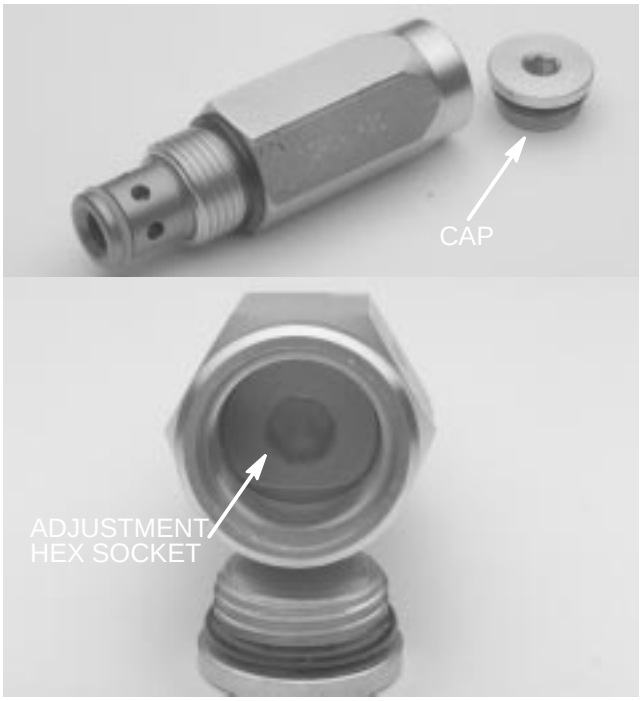


Figure 15

Hydrostatic Transmission

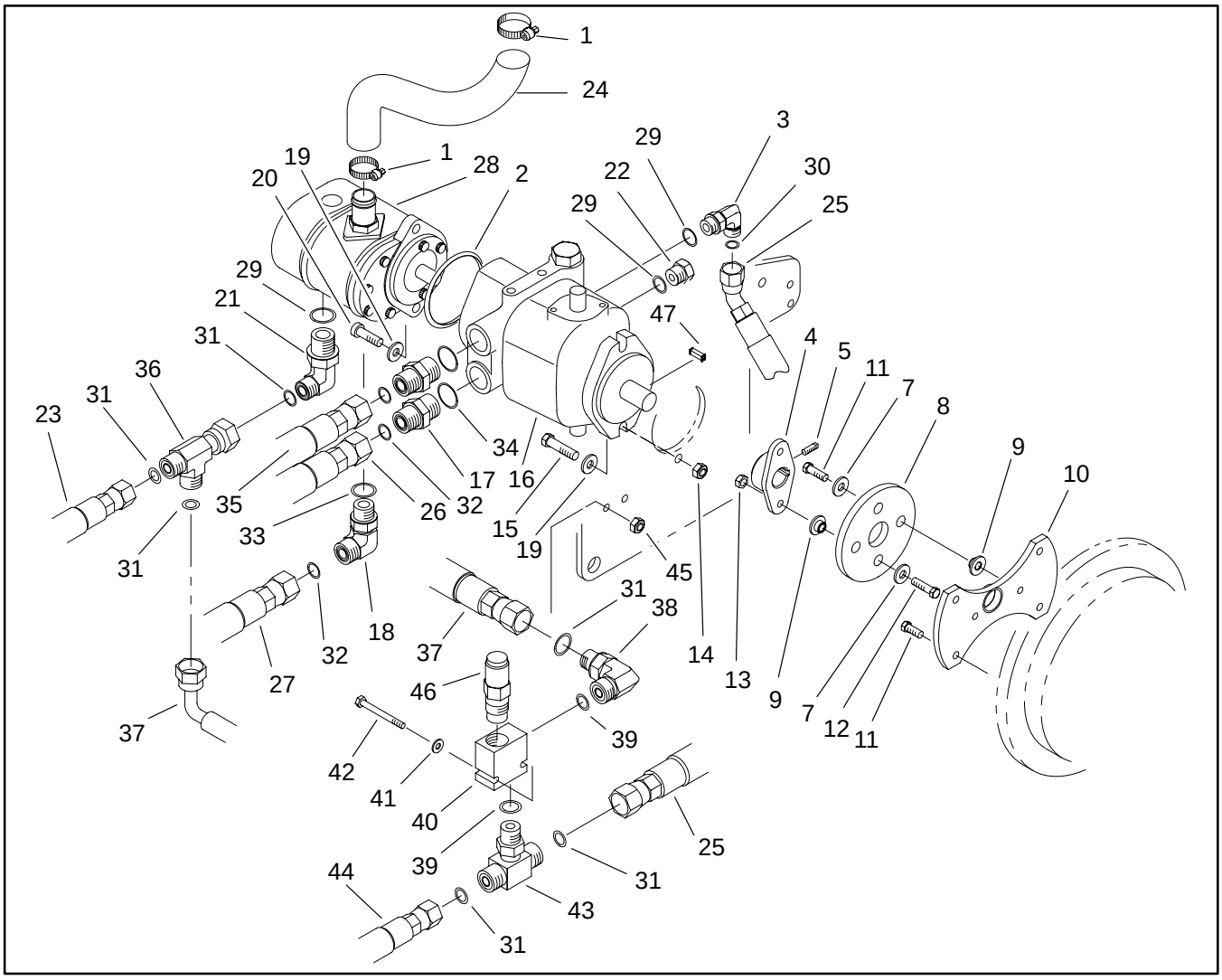


Figure 16

1. **Hose clamp**
2. **O–ring**
3. **90° hydraulic fitting**
4. **Pump hub**
5. **Square head screw**
6. **Not used**
7. **Flat washer**
8. **Rubber coupling**
9. **Coupling spacer**
10. **Pump Adapter**
11. **Cap screw**
12. **Cap screw**
13. **Lock nut**
14. **Lock nut**
15. **Cap screw**
16. **Hydrostat**
17. **Hydraulic fitting**
18. **90° hydraulic fitting**
19. **Flat washer**
20. **Socket head screw**
21. **90° hydraulic fitting**
22. **Plug**
23. **Hose assembly**
24. **Pump inlet hose**
25. **Hose assembly**
26. **Hose assembly**
27. **Hose assembly**
28. **Gear pump**
29. **O–ring**
30. **Not used**
31. **O–ring**
32. **O–ring**
33. **O–ring**
34. **O–ring**
35. **Hose assembly**
36. **T–fitting**
37. **Hose assembly**
38. **90° hydraulic fitting**
39. **O–ring**
40. **Relief valve**
41. **Flat washer**
42. **Cap screw**
43. **T–fitting**
44. **Hose assembly**
45. **Lock nut**
46. **Relief valve cartridge**
47. **Key**
48. **Pump plate**

Removal (Fig. 16)

1. Before removing any parts from the hydraulic system, park machine on a level surface, engage parking brake, lower cutting units, and stop engine.

CAUTION

Use caution when removing the lock nut from the pin. The extension spring is under tension and may cause personal injury during removal.

Note: The neutral system assembly can be remove from the hydrostat without complete disassembly.

2. Remove lock nut securing the pin and extension spring to the spring bracket. Do not unscrew jam nut from the pin. Release pin from the bracket (Fig. 17).

3. Disconnect extension spring from the neutral arm. Remove cap screw and pivot washer from camplate shaft of hydrostat (Fig. 18).

4. Remove both cap screws securing the cable support of the neutral system assembly to the hydrostat. Lift and secure neutral system assembly away from the hydrostat (Fig. 19).

5. Clean gear pump, hydrostat, hydraulic fittings, and hose assembly connection. Label all hose connections for reassembly purposes.

CAUTION

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

6. Clamp pump inlet hose (24) to prevent draining the hydraulic reservoir.

7. Remove both socket head screws (20) and flat washers (19) from the gear pump (28) flange and hydrostat (16).

8. Separate gear pump (28) from the hydrostat (16).

9. Plug suction port at the end of the gear pump to prevent possible leakage of hydraulic fluid (Fig. 20).

10. Remove O–ring (2) from either the gear pump (28) or hydrostat (16).

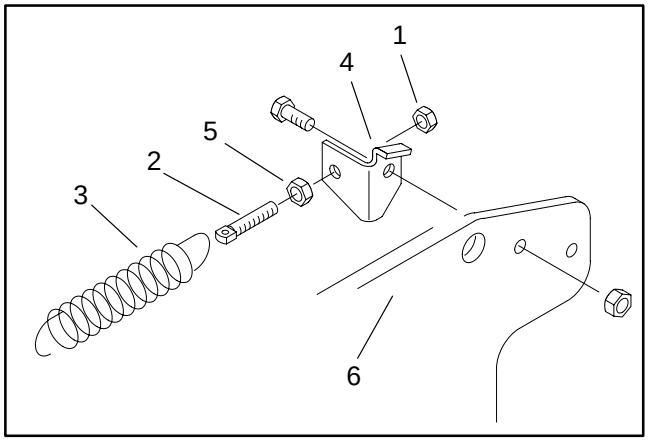


Figure 17

1. **Lock nut**
2. **Pin**
3. **Extension spring**
4. **Spring bracket**
5. **Jam nut**
6. **Pump plate**

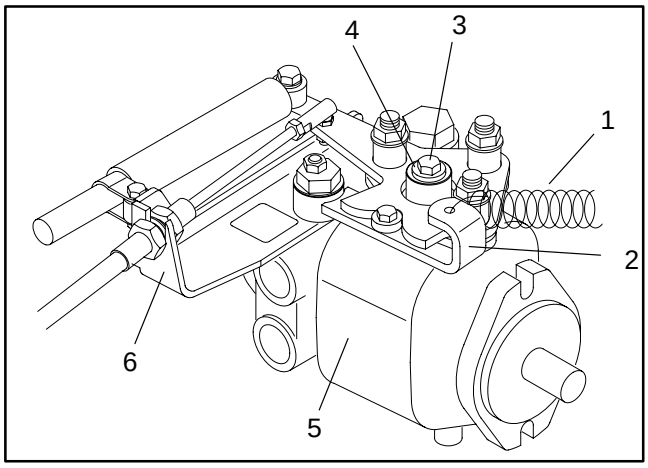


Figure 18

1. **Extension spring**
2. **Neutral arm**
3. **Cap screw**
4. **Pivot washer**
5. **Hydrostat**
6. **Cable support**

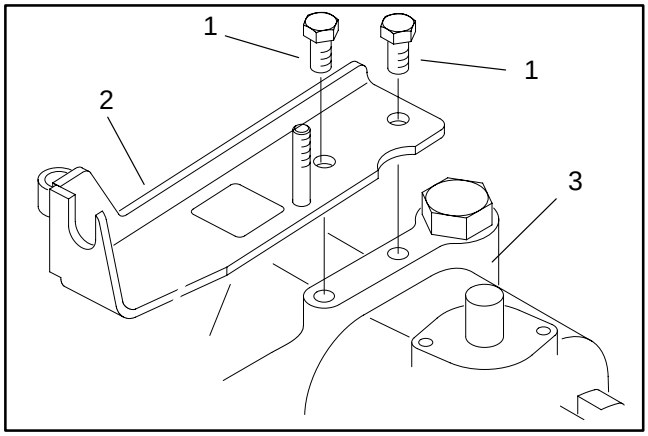


Figure 19

1. **Cap screw**
2. **Cable support**
3. **Hydrostat**

11. Pull gear pump (28) and connected hoses assemblies (23 and 27) away from the hydrostat (16) and secure.

12. Remove hose assemblies (25, 26, and 35) and O–rings (30 and 32) from the hydrostat (16). Allow hoses to drain into a suitable container. Plug open hose connections to prevent contamination.

13. Remove hydraulic fittings (3 and 17) and O–rings (29 and 34) from the hydrostat (16). Plug open ports on the hydrostat to prevent contamination.

14. Loosen both set screws (5) on the pump hub (4) enough to allow the hydrostat (16) shaft to be removed.

CAUTION

Support the hydrostat when removing its supporting fasteners to prevent it from falling and causing personal injury.

15. Remove both lock nuts (14), cap screws (15), and flat washers (19) from the hydrostat (16) flange and pump plate (48).

16. Separate hydrostat (16) from the pump plate (48) and pump hub (4). Remove key (47) from the hydrostat shaft.

Installation (Fig. 16)

1. Make sure the inside of the pump hub (4) is clean. Apply antiseize lubricant to both the hydrostat (16) shaft and the inside of the pump hub.

2. Coat key (47) with petroleum jelly and insert it into the hydrostat (16) shaft. Position the hydrostat to the pump plate (48) and pump hub (4). Slide the shaft into the hub with the key.

3. Secure the hydrostat (16) to the pump plate (48) with both cap screws (15), flat washers (19), and lock nuts (14).

4. Tighten both set screws (5) on the pump hub (4).

5. Lubricate all new O–rings with clean hydraulic fluid.

6. Remove plugs from the hydrostat (16). Install new O–rings (29 and 34) and hydraulic fittings (3 and 17) to the hydrostat.

7. Unplug hose connections. Inspect threads and sealing surfaces of hydraulic fittings and hydraulic hose connectors. Replace any damaged or worn fittings or connectors.

8. Install O–rings (30 and 32) and hose assemblies (25, 26, and 35) to the hydrostat (16).

IMPORTANT: Failure to remove the plug will cause excessive pressure in the hydrostat and damage seals.

9. Remove plug from the suction port on the gear pump (Fig. 20). Install O–ring (2) to the pump.

10. Position gear motor (28) to the hydrostat (16) so that the pump inlet is facing up. Secure gear pump to the hydrostat with both hex socket head screws (20) and flat washers (19). Torque screws from 27 to 31 ft–lb (3.7 to 4.3 kg–m).

11. Remove clamp from pump inlet hose (24).

12. Position neutral system assembly to the hydrostat (16). Secure assembly to the hydrostat by securing the cable support to the hydrostat with both cap screws (Fig. 19).

13. Fasten and tighten cap screw and pivot washer to the cam plate shaft of the hydrostat. Connect extension spring to the neutral arm (Fig. 18).

14. Insert pin into the spring bracket with the extension spring attached to the pin. Secure pin to the bracket with the lock nut (Fig. 17).

15. Check neutral position of the traction pedal. If adjustment is required, see Transmission Neutral Position Adjustment.

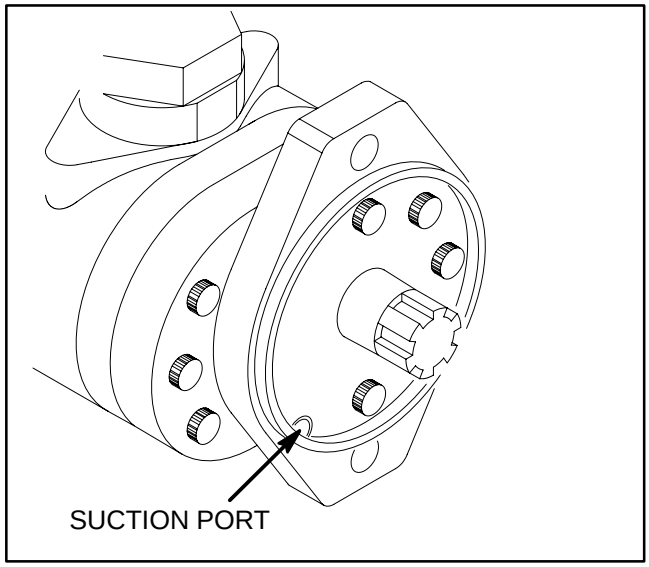


Figure 20

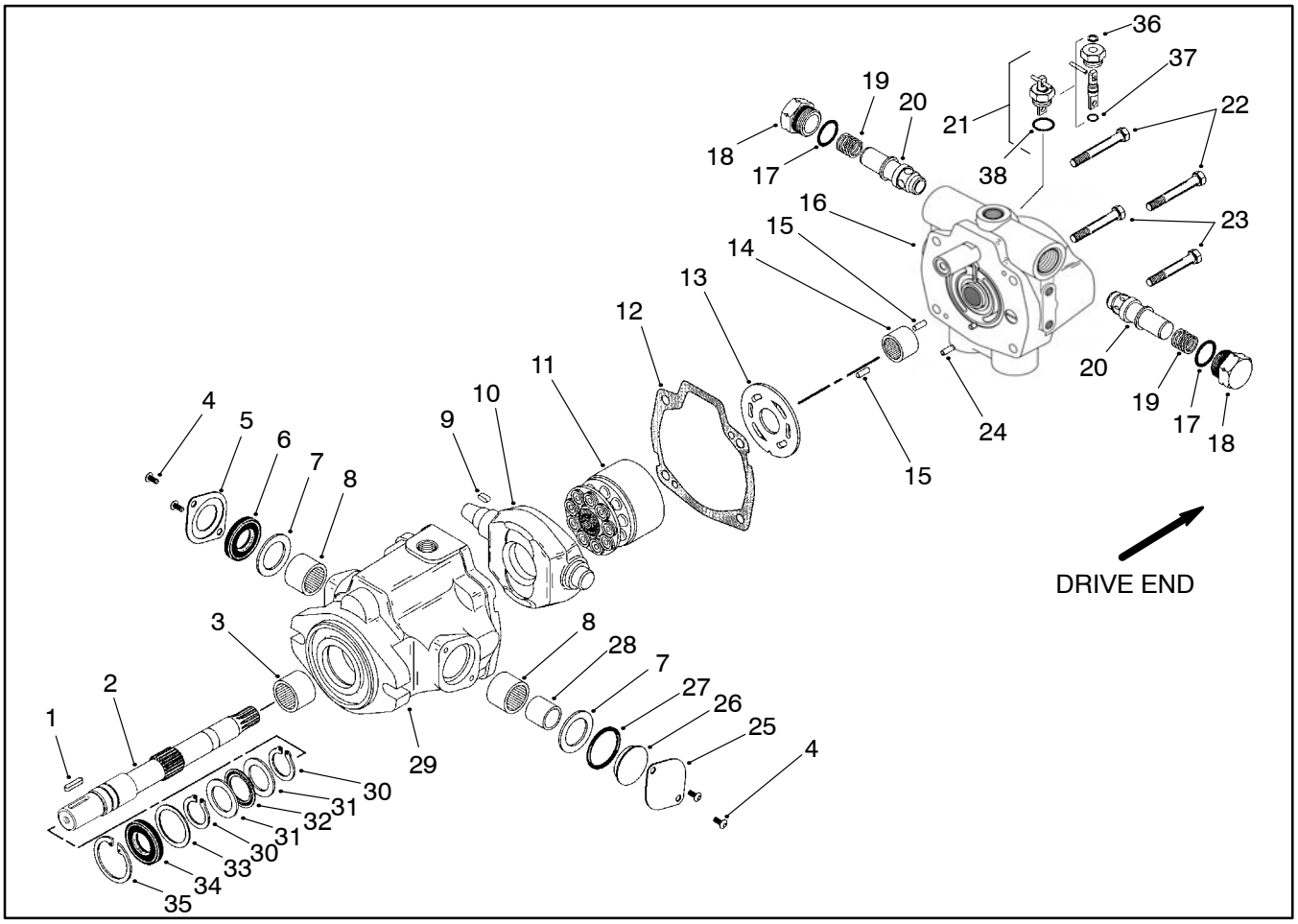


Figure 21

1. **Key**
2. **Drive shaft**
3. **Bearing**
4. **Screw**
5. **Cover seal**
6. **Shaft seal**
7. **Washer**
8. **Thrust bearing**
9. **Key**
10. **Cam plate**
11. **Rotating kit assembly**
12. **Gasket**
13. **Valve plate**
14. **Bearing**
15. **Dowel pin**
16. **Back plate assembly**
17. **O–ring**
18. **Plug**
19. **Spring**
20. **Seat**
21. **Dump valve assembly**
22. **Cap screw**
23. **Cap screw**
24. **Roll pin**
25. **Trunnion cover**
26. **Trunnion O–ring cover**
27. **O–ring**
28. **Inner race**
29. **Housing assembly**
30. **Retaining ring**
31. **Bearing race**
32. **Thrust bearing**
33. **Washer**
34. **Shaft seal**
35. **Retaining ring**
36. **Retaining ring**
37. **O–ring**
38. **O–ring**

Disassembly

1. Position pump into a vise with protected jaws so the drive end is pointed up. Clamp onto the mounting flange of the hydrostat.

2. Remove cap screws (22 and 23) from the backplate assembly (16).

3. Lift backplate assembly (16) up and off from the drive shaft (2) and housing assembly (29). Remove valve plate (13) from the backplate assembly or rotating kit assembly (11). Remove charge relieve valve and bleed–off valve from back plate assembly (see Fig. 23).

4. Remove dump valve assembly (21) and O–ring (38) from the backplate assembly (16). Remove O–rings (36 and 37) from the valve assembly.

5. Remove both plugs (18), O–rings (17), spring (19), and seats (20) from the backplate assembly (16).

6. Remove gasket (12) from the housing (29) or backplate assembly (16).

Note: To remove the rotating parts kit (11) from the shaft (2), a table or workbench with a hole in the working surface is required for the protruding shaft.

7. The rotating parts kit (11) can be removed from the shaft (2) as follows:

   A. Hold rotating parts kit (11) in place and remove the pump from the vise.

B. Position the housing assembly (29) end of the pump up and lower the shaft (2) through the hole in the table or workbench. Allow rotating parts kit (11) to rest on the table.

C. Remove rotating parts kit (11) by lifting away the housing assembly (29) and shaft (2).

8. The rotating parts kit (11) can be disassembled as follows (see Fig. 22):

A. Remove nine piston assemblies, spider, and spider pivot from the piston block.

CAUTION

Be careful when removing the spring from the piston block; the spring is highly compressed. Safely compress the spring before removing the retaining ring.

B. Use following parts to disassemble piston block:

2 5/16 in. I.D. ~~15/16~~ in. O.D. flat washers

1 5/16 in. ~~2 7/8~~ in. N.C. cap screw

1 5/16 in. N.C. nut

C. Place cap screw through one of the flat washers. Insert cap screw through the center of the piston block. Install second flat washer onto the capscrew so the washer rests on the three pins. Screw nut onto the cap screw.

D. Compress spring by tightening the nut onto cap screw. Remove retaining ring from the piston block.

E. Slide washer, spring, second washer, three pins, and retainer from inside the piston block.

9. Remove retaining ring (35) from the bore on the flange end of the housing assembly (29). Press the shaft (2), shaft seal (34), and washer (33) from the housing assembly.

10. Remove retaining ring (30), bearing race (31), thrust bearing (32), second bearing race (31), and second retaining ring (30) from the shaft (2).

11. Remove screws (4), trunnion cover (25), trunnion O–ring cover (26), O–ring (27), washer (7), inner race (28), and thrust bearing (8) from the housing assembly. Remove screws (4), seal cover (5), shaft seal (6), washer (7), and bearing (8) from the other side of the housing.

12. Position camplate (10) to one side and remove from the housing assembly (29).

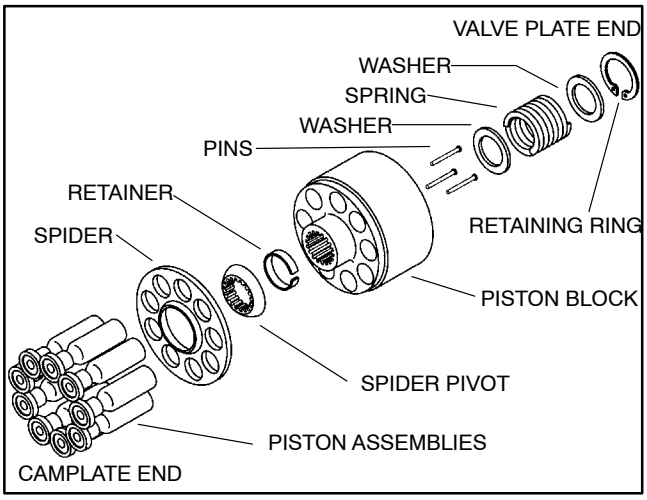


Figure 22

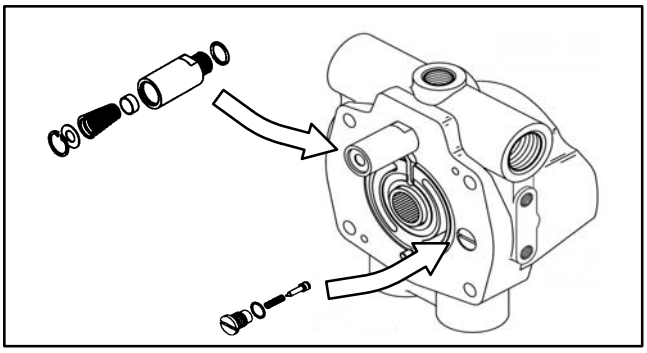


Figure 23

1. **Charge relief valve** 2. **Bleed–off valve**

Inspection

CAUTION

Use eye protection such as goggles when using compressed air

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

2. Inspect rotating parts kit (Fig. 22).

A. Verify that piston O.D. finish shows no wear or deep scratches. Piston shoes should fit snuggly onto the ball end of the pistons. The shoe surface that contacts the camplate should be smooth and flat. **Do not lap piston shoes.**

B. The piston block surface that makes contact with the valve plate should be smooth and free of deep scratches. **Do not lap piston shoes.**

C. The bore areas of the piston block should be free of scoring and contamination. Pistons should move freely in the bore areas.

3. Inspect backplate assembly (16) (Fig. 21).

A. Bearing needles must remain in bearing cage and move freely. Verify that bearing height on the numbered end meets the proper dimension (Fig. 23).

B. Check that the roll pin is tight and meets the proper height in (Fig. 23).

C. Replace entire assembly as a unit.

4. Inspect camplate assembly (10) (Fig. 21). There should be no signs of scoring on the piston shoe surfaces.

5. Inspect housing assembly (29) (Fig. 21).

A. Verify that bearing depth on the numbered end meets the proper dimension (Fig. 24).

B. Bearing needles must move freely and remain in their cage.

C. Examine the mutual contact surfaces on the spider and spider pivot; both contact areas should be smooth and free of wear.

Reassembly

1. Make sure all parts are clean. Lubricate all critical moving parts and O–rings with clean hydraulic oil.

2. If necessary, press new bearing (3) into housing assembly (29) to the proper dimension shown (Fig. 24).

3. Insert camplate (10) into the housing assembly (29).

4. On the short trunnion side of the camplate (10), install bearing (8) with numbered side to the inside of the pump. Install inner race (28) with the chamfer towards the inside of the pump. Install washer (7), O–ring (27), trunnion O–ring cover (26), and trunnion cover (25). Secure trunnion cover with two screws (4), and torque them from 36 to 48 in–lb (42 to 55 kg–cm).

5. On the long trunnion side of the camplate (10), install bearing (8) with numbered side to the inside of the pump. Install washer (7) and press shaft seal (6) into place. Secure seal cover (5) with two screws (4), and torque them from 36 to 48 in–lb (42 to 55 kg–cm).

6. Install retaining ring (30) towards the keyed end of the shaft (2). Slide bearing race (31), thrust bearing (32), second bearing race (31), and second retaining ring (30) into place over the splined end of the shaft.

7. Position washer (33) and shaft seal (34) onto the shaft (2) from the keyed end.

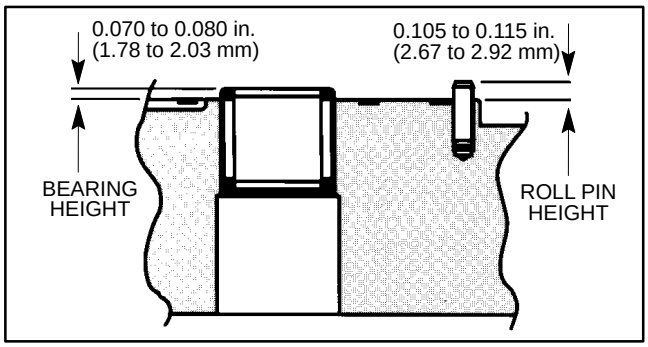


Figure 23

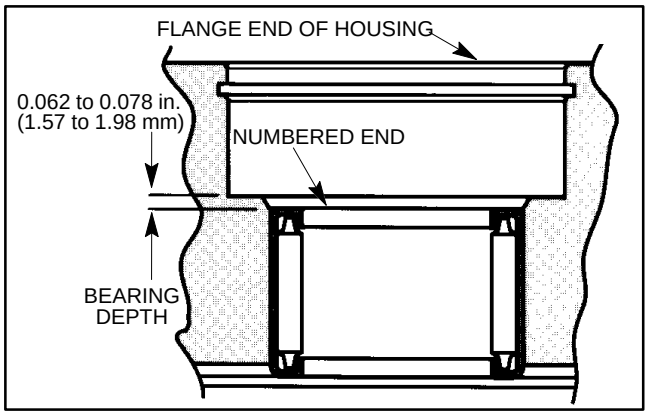


Figure 24

8. Install shaft (2) into the housing assembly (29) from the flanged end. Press shaft seal (34) into position with a seal driver. Install retaining ring (35) into the flanged end of the housing assembly (29).

9. Reassemble rotating kit assembly (11) as follows (Fig. 22):

A. Use following parts to reassemble piston block:

2	5/16 in. I.D. × 15/16 in. O.D. flat washers
1	5/16 in. × 2–7/8 in. N.C. cap screw
1	5/16 in. N.C. nut

B. Compress retainer and install into the spline of the piston block.

C. Position the head end of pins towards the inside of the block. Install the three pins into the special grooves in the piston block.

D. Install a washer, spring, and second washer into the piston block.

E. Place cap screw through one of the flat washers. Insert cap screw through the center of the piston block. Install second flat washer onto the capscrew so the washer rests on the three pins. Screw nut onto the cap screw.

F. Compress spring by tightening the nut onto the cap screw. Install the retaining ring into the piston block.

G. Unscrew the nut and remove washer and cap screw from the piston block.

H. Install spider pivot onto the three pins, and place the spider on the spider pivot.

I. Insert piston assemblies through the spider and into the piston block with the piston shoes resting on the spider.

10. Set rotating kit assembly (11) on a working surface with the piston shoes facing up. Insert shaft (2) through the rotating kit assembly with the flanged end of the housing assembly (29) up. Position rotating kit assembly into the housing assembly.

11. Make sure piston block and shaft (2) splines are aligned. Make sure piston block is engaged fully so the piston shoes are in contact with the camplate (10). **Make sure all parts are in their proper position before proceeding to the next step.**

12. Hold rotating kit assembly (11) in place, and clamp housing assembly (29) with the flange end down into a vise with protected jaws. Install gasket (12) and two dowel pins (15) into the housing assembly (29).

13. If necessary, press new bearing (14) or roll pin (24) into backplate assembly (16) to the proper dimension shown (Fig. 24). Bearing should be installed with numbered end outward. Roll pin should be installed with split oriented away from the bearing.

14. Install seat (20) and spring (19) into backplate assembly (16). Install new O–ring (17) and plug (18) into the backplate assembly. Torque plug from 95 to 105 ft–lb (13.1 to 14.5 kg–m).

15. Install new O–rings (36 and 37) onto dump valve assembly (21). Install dump valve assembly into the backplate assembly (16). Torque valve assembly from 27 to 30 ft–lb (3.7 to 4.1 kg–m).

16. Install charge relieve valve and bleed–off valve into back plate assembly (see Fig. 23).

17. Coat valve plate (13) with light coat of petroleum jelly on the steel side. Align the valve plate to the roll pin (24) on the backplate assembly (16). Install steel side of the valve plate to the backplate.

18. Install backplate assembly (16) to the housing assembly (29). Make sure gasket (12), valve plate (13), and dowel pins (115) stay in place.

19. Secure backplate assembly (16) to the housing assembly (29) with cap screws (22 and 23). Torque cap screws from 17 to 20 ft–lb (2.3 to 22.8 kg–m).

Hydraulic System Start–up

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

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

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

3. Make sure hydraulic reservoir is full. Add correct oil if necessary (see Checking the Hydraulic System Fluid). Drain, flush, and refill hydraulic system reservoir and change oil filter if component failure was severe or system is contaminated.

4. On GR3200, disconnect spark plug leads to prevent the engine from starting.

5. On GR3200–D, disconnect electrical connector to the fuel stop solenoid to prevent the engine from starting.

6. After repairs, check control linkage for proper adjustment, binding, or broken parts.

7. Make sure traction pedal is in **neutral** and the cutting unit switch is **off**. Turn ignition key switch; engage starter for fifteen (15) seconds to the prime pump.

8. On GR3200, reconnect spark plug leads.

9. On GR3200–D, reconnect electrical connector to the fuel stop solenoid.

10. Make sure traction pedal is in **neutral** and the cutting unit switch is **off**. Start engine and run it at low idle. The charge pump should pick up oil and fill the hydraulic system. If there is no indication of fill in 30 seconds, stop the engine and determine the cause.

CAUTION

Be careful when operating the cutting unit reels. Contact with the reel or other moving parts can result in personal injury.

11. After the hydraulic system starts to show signs of fill, accomplish the following:

A. If a reel motor was replaced or rebuilt, run the cutting units at the minimum speed setting (under no load) for 10 minutes in **both** directions.

B. If a reel motor drive pump was replaced or rebuilt, run the cutting units at the minimum speed setting (under no load) for 10 minutes.

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

12. Operate the traction unit and cutting unit by gradually increasing their work load to full over a 10 minute period.

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

Wheel Motors

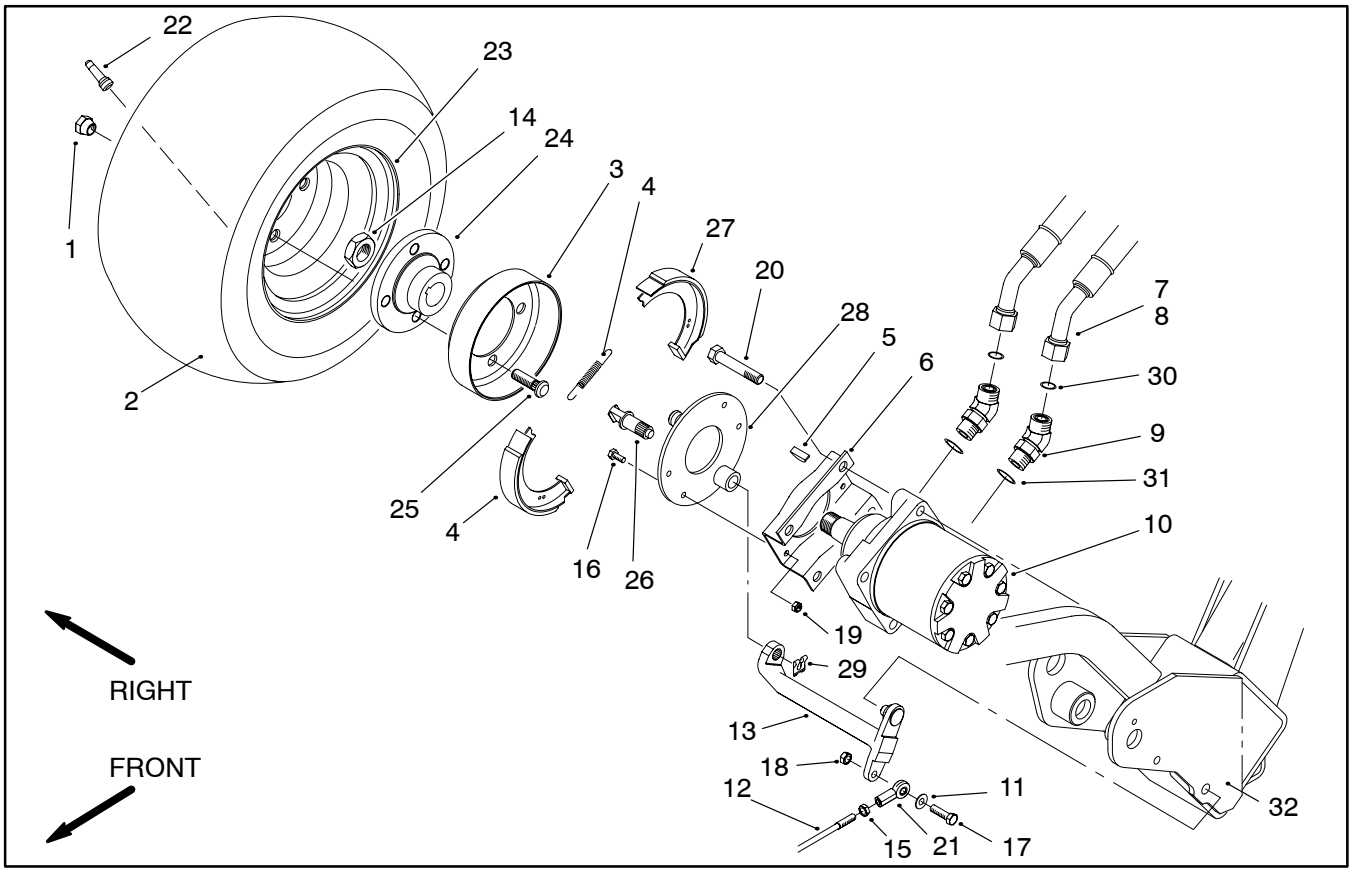


Figure 26

1. Lug nut
2. Tire
3. Brake drum
4. Return spring
5. Woodruff key
6. Brake bracket
7. Hose assembly (RH)
8. Hose assembly (LH)
9. 45° Fitting
10. Hydraulic wheel motor
11. Flat washer
12. Brake rod
13. Brake lever
14. Lock nut
15. Jam nut
16. Cap screw
17. Cap screw
18. Lock nut
19. Lock nut
20. Cap screw
21. Swivel clevis
22. Valve stem
23. Rim
24. Wheel hub
25. Drive stud
26. Brake cam
27. Brake shoe
28. Backing plate
29. Retaining clip
30. O–ring
31. O–ring
32. Frame

Front Wheel Motor Removal (Fig. 26)

1. Before removing any parts from the hydraulic system, park the machine on a level surface, engage the parking brake, lower the cutting units, and stop the engine.

CAUTION

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

2. Block front and rear of wheels not being lifted. Lift front wheel off the ground using a jack, and place blocks beneath the frame.

3. Remove lug nuts (1) and tire (2) and rim (23). Remove lock nut (14) from hydraulic wheel motor (10) shaft.

IMPORTANT: DO NOT hit wheel hub (24) with a hammer during removal or installation. Hammering may cause damage to the hydraulic wheel motor (10).

Note: The brake drum assembly consists of the wheel hub (24), brake drum (3), and drive stud (25).

4. Use a puller to remove brake drum assembly. Do not disassemble. Remove key (5) from the hydraulic wheel motor (10) shaft.

5. Remove retaining clip (29) from the brake cam (26) and brake lever (13). Separate lever from cam.

Note: The brake assembly consists of return spring (4), brake cam (26), brake shoes (27), backing plate (28), and retaining clip (29).

6. Remove brake assembly from the brake bracket (6) by removing four cap screws (16) and lock nuts (19) from the backing plate (28) and brake bracket. Do not disassemble.

7. Clean hydraulic wheel motor (10) and hydraulic connections. Label all connections for reassembly.

8. Disconnect both hose assemblies (7 or 8) and O–rings (30) from the both hydraulic fittings (9). Allow hoses to drain into a suitable container.

9. Remove hydraulic fittings (9) and O–rings (31) from the hydraulic wheel motor (10).

10. Put caps or plugs on disconnected hoses and motor ports to prevent contamination.

11. Remove four cap screws (20) from brake bracket (6) and hydraulic wheel motor (10). Remove motor from the frame.

Front Wheel Motor Installation (Fig. 26)

1. Position hydraulic wheel motor (10) to the frame (32). Make sure ports of motor face the rear of the machine. Secure motor and brake bracket (6) to the frame with four cap screws (20).

2. Remove caps or plugs from the hydraulic wheel motor (10). Lubricate new O–rings (31) with clean hydraulic fluid. Install O–rings and hydraulic fittings (9) to the motor and tighten.

3. Lubricate new O–rings (30) with clean hydraulic fluid. Install O–rings and hose assemblies (7 or 8) to the hydraulic fittings (9). Tighten hose connections.

Note: The brake assembly consists of return spring (4), brake cam (26), brake shoes (27), backing plate (28), and retaining clip (29).

4. Install brake assembly to the brake bracket (6) by securing the backing plate (28) to the brake bracket with four cap screws (16) and lock nuts (19).

5. Secure brake lever (13) to the brake cam (26) with the retaining clip (29).

IMPORTANT: DO NOT hit wheel hub (24) with a hammer during removal or installation. Hammering may cause damage to the hydraulic wheel motor (10).

Note: The brake drum assembly consists of the wheel hub (24), brake drum (3), and drive stud (25).

6. Install key (5) to the hydraulic wheel motor (10) shaft. Slide brake drum assembly onto the motor shaft.

7. Secure lock nut (14) to the hydraulic wheel motor (10) shaft. Torque nut from 250 to 400 ft–lb (34.6 to 55.3 kg–m).

8. Install tire (2) and rim (23) to the brake drum assembly. Secure rim with lug nuts (1). Torque nuts from 40 to 50 ft–lb, (5.5 to 6.9 kg–m).

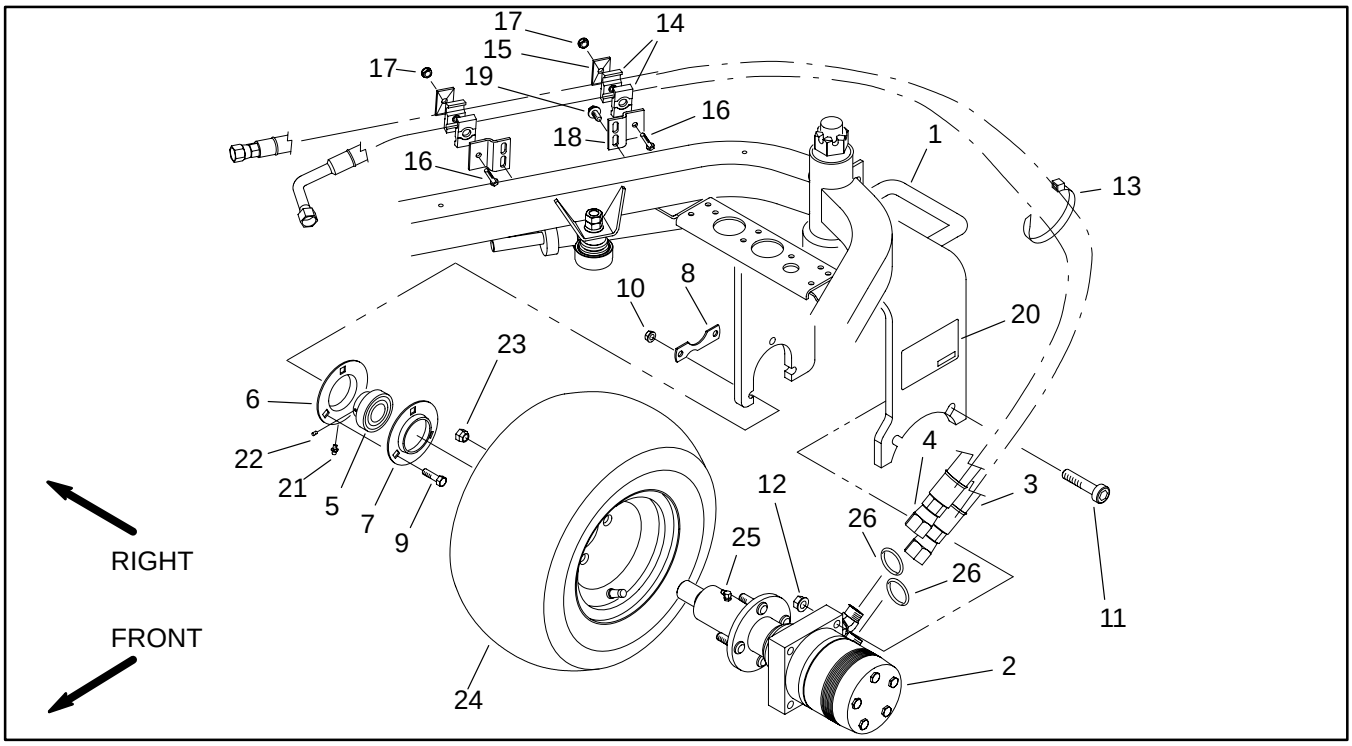


Figure 26

1. **Castor fork**
2. **Hydraulic motor & hub assembly**
3. **Hydraulic hose**
4. **Hydraulic hose**
5. **Bearing**
6. **Relube flangette**
7. **Standard flangette**
8. **Bearing tab**
9. **Cap screw**
10. **Lock nut**
11. **Socket head screw**
12. **Lock nut**
13. **Cable tie**
14. **Tube clamp**
15. **Cover plate**
16. **Cap screw**
17. **Lock nut**
18. **Clamp bracket**
19. **Wide head taper screw**
20. **3WD decal**
21. **Grease fitting**
22. **Set screw**
23. **Lug nut**
24. **Wheel**
25. **Grease fitting**
26. **O–ring**

Rear Wheel (3WD) Removal (Fig. 26)

1. Before removing any parts from the hydraulic system, park the machine on a level surface, engage the parking brake, lower the cutting units, and stop the engine.

CAUTION

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

2. Block front wheels. Lift rear wheel off the ground using a jack, and place blocks beneath the frame. Secure the rear wheel off the ground.

3. Clean motor and hose connections. Remove hose assemblies (3 and 4) and O–rings (26) from the hydraulic fittings on the hydraulic motor and hub assembly (2). Allow hoses to drain into a suitable container.

CAUTION

Support wheel and motor and hub assembly during removal to prevent dropping and causing personal injury.

4. Remove wheel (24) and hydraulic motor and hub assembly (2) from the castor fork (1) as follows:

A. Remove cap screws (9) and lock nuts (10) securing flangettes (6 and 7) and bearing tab (8).

B. Remove both socket head screws (11) and lock nuts (12) from castor fork and motor.

C. Lower wheel and hydraulic motor and hub assembly from the castor fork.

5. Loosen both set screws (22) on bearing (5). Slide flangettes (6 and 7) and bearing (5) off the motor shaft.

6. Remove grease fitting (25) from the hydraulic motor and hub assembly (2). Remove four lug nuts (23) and wheel (24) from the hub drive studs.

Rear Wheel (3WD) Installation (Fig. 26)

1. Make sure grease fitting (25) is removed from the hydraulic motor and hub assembly (2).

2. Secure wheel (24) to the four drive studs of the hydraulic motor and hub assembly (2) with four lug nuts (23). Torque nuts from 45 to 55 ft–lb, (6.2 to 7.6 kg–m).

3. Reinstall grease fitting into hydraulic motor and hub assembly (2) so it points away from the wheel (24).

4. Install flangette (7), bearing (5), and relube flangette (6) onto the motor shaft.

5. Position hydraulic motor and hub assembly (2), flangettes (6 and 7) with bearing (5), and wheel (24) into the castor fork (1). Make sure hose fittings on the motor face the rear.

6. Secure hydraulic motor and hub assembly (2) loosely to the left inside of the castor fork (1) with both socket head screws (11) lock nuts (12).

7. Secure flangettes (6 and 7) with bearing (5) loosely to the right inside of the castor fork (1).

   A. Position grease fitting (21) facing downward.

   B. Torque socket head screws (11) to 85 ft–lb (11.8 kg–m).

   C. Install capscrews (9) and lock nuts (10) to flangettes. Torque cap screws (9) to 30 ft–lb (4.2 kg–m).

8. Apply loctite to both set screws (22). torque both screws from 80 to 100 in–lb (92 to 115 kg–cm).

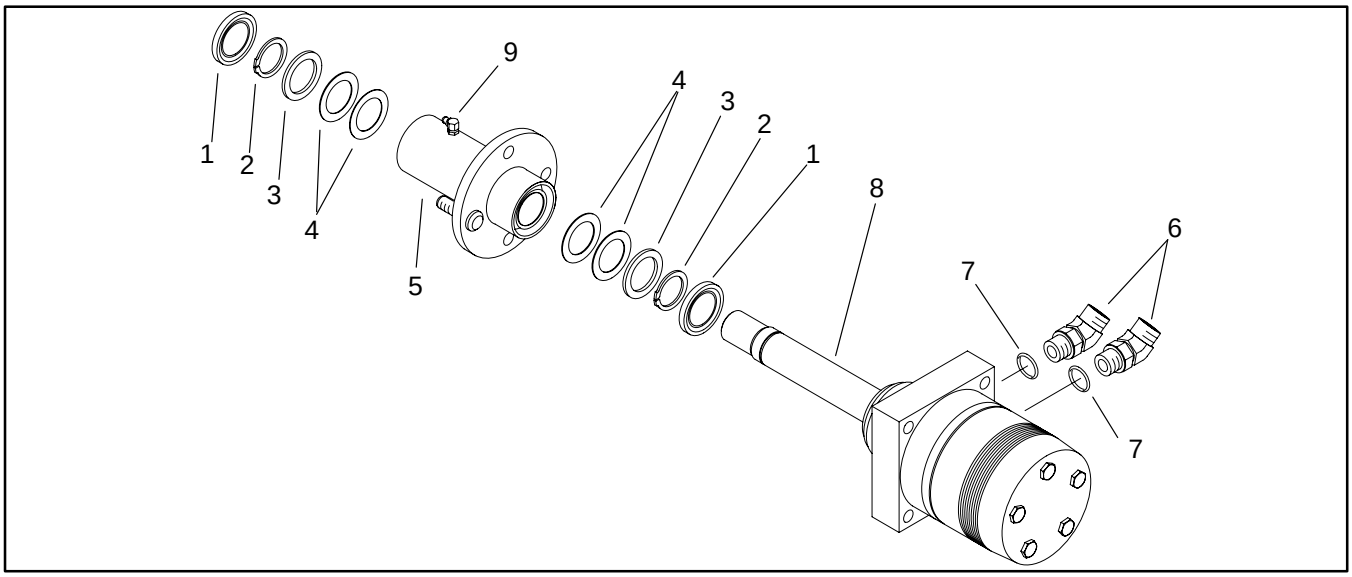


Figure 27

1. **Grease seal**
2. **Retaining ring**
3. **Washer**
4. **Thrust washer**
5. **Hub assembly**
6. **Hydraulic fitting**
7. **O–ring**
8. **Hydraulic motor**
9. **Grease fitting**

Motor and Hub Assembly Disassembly (Fig. 27)

1. Remove hydraulic fittings and O–rings from the hydraulic motor. Plug motor ports to prevent contamination.

2. Remove grease seal and retaining ring from the end of the motor shaft.

3. Slide hub assembly off the motor shaft with washers and thrust washers. Remove remaining retaining ring and grease seal from the shaft.

Motor and Hub Assembly Reassembly (Fig. 27)

1. Grease inner edge of new grease seal with No. 2 multipurpose lithium base grease. Slide seal onto motor shaft past groove closest to the motor. Install retaining ring into groove.

2. Slide flat washer and two thrust washers onto the motor shaft. Slide hub on the shaft with short side first.

3. Slide remaining thrust washers and flat washer onto the motor shaft. Install remaining retaining ring into the shaft groove.

4. Slide new grease seal onto shaft. Press grease seals into the hub so they are flush with both ends.

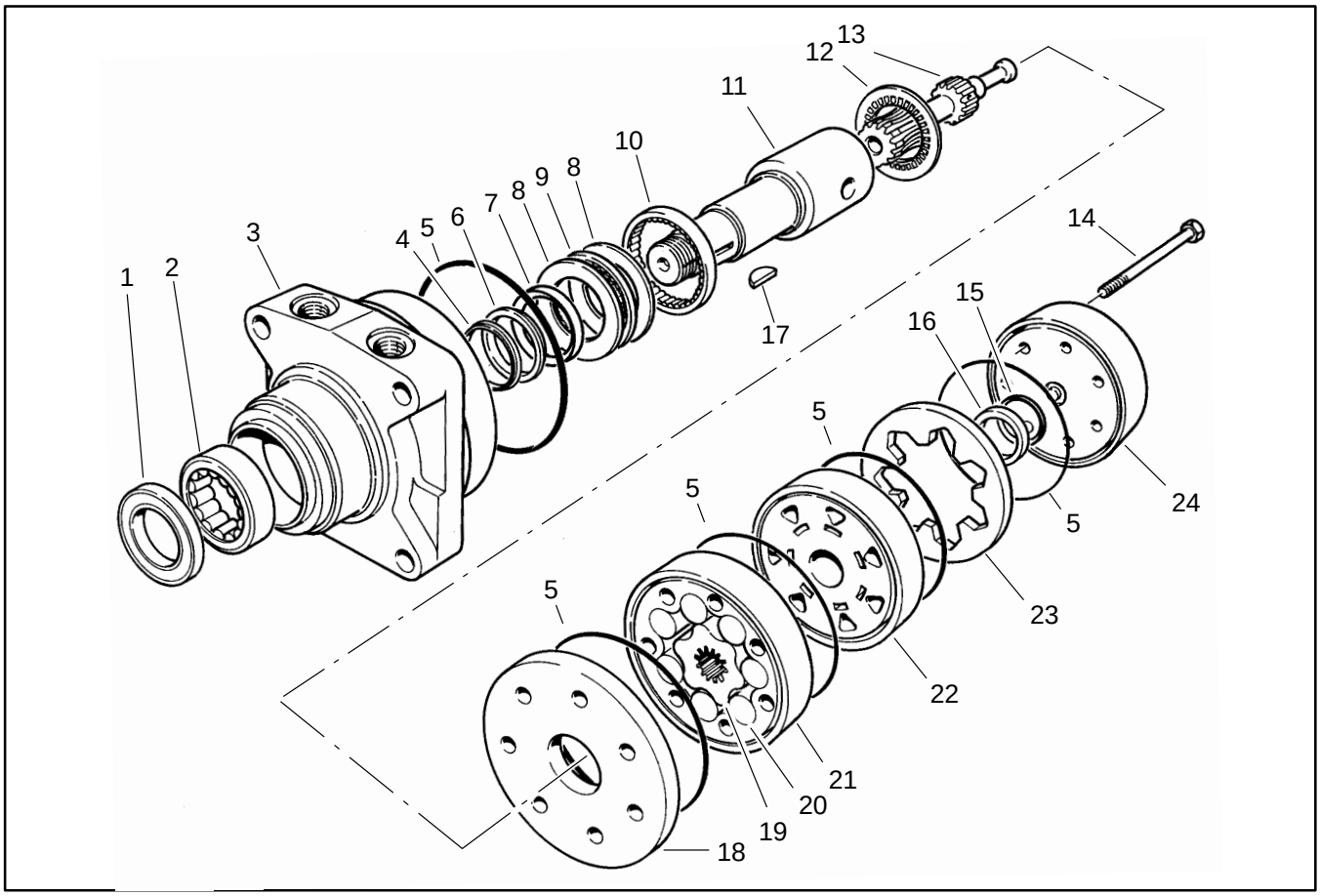


Figure 28

1. **Dirt & water seal**
2. **Bearing**
3. **Housing**
4. **Back–up washer**
5. **Seal ring**
6. **Back–up washer**
7. **Inner seal**
8. **Thrust washer**
9. **Thrust bearing**
10. **Bearing**
11. **Coupling shaft**
12. **Thrust bearing**
13. **Drive link**
14. **Cap screw**
15. **Commutator seal**
16. **Commutator**
17. **Woodruff key**
18. **Wear plate**
19. **Rotor**
20. **Vane**
21. **Stator**
22. **Manifold**
23. **Commutator ring**
24. **End cover assembly**

Wheel Motor Disassembly (Fig. 28)

WARNING

If the wheel motor is not held firmly in the vise, it could dislodge during service and cause injury.

1. Place wheel motor in a soft jawed vice with the coupling shaft (11) pointed down and the vise jaws clamping firmly on the sides of the housing (3).

2. Scribe an alignment mark down and across the wheel motor components from the end cover (24) to the housing (3) for facilitating reassembly (Fig. 29).

3. Remove seven cap screws (14). Remove end cover assembly (24) and seal ring (5).

4. Remove commutator ring (23).

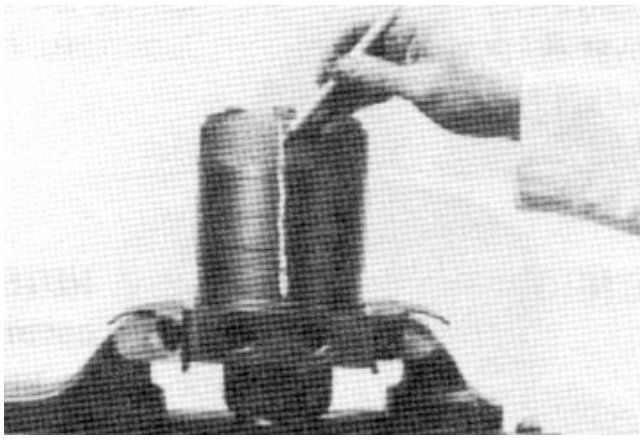


Figure 29

CAUTION

Use eye protection such as goggles when using compressed air

5. Remove commutator (16) and commutator seal (15). Remove commutator seal from the commutator using an air hose to blow air into the ring groove until the commutator seal is lifted out (Fig. 30).

Note: The manifold (22) is constructed of plates bonded together to form an integral component not subject to further disassembly for service. Compare configuration of both sides of the manifold to make sure that the same surface is reassembled against the rotor set.

6. Remove manifold (22). Remove seal rings (5) that are on both sides of the manifold.

Note: The rotor set consists of the rotor (19), vanes (20), and stator (21). Rotor set components may become disassembled during service procedures. Do not serviced separately.

Note: Marking all rotor set components and mating spline components for exact repositioning at assembly will make sure maximum wear life and performance of rotor set and wheel motor.

7. Mark surface of rotor (19) and stator (21) that is facing up with etching ink or a grease pencil before removing from the wheel motor. This will make sure correct reassembly of the rotor into the stator and the rotor set into wheel motor.

8. Remove rotor set and wearplate (18) together, and retain the rotor set in its assembled form with the same vane (20) to stator (21) contact surfaces. The drive link (13) may come away from the coupling shaft (11) with the rotor set and wearplate. You may have to shift the rotor set on the wearplate to work the drive link out of the rotor (19) and wearplate (Fig. 31).

9. Remove seal ring (5) that is between the rotor set and wearplate.

10. Remove drive link (13) from the coupling shaft (11) if it was not removed with rotor set and wear plate (18). Remove seal ring (5) from housing (3).

11. Remove thrust bearing (12) from the top of the coupling shaft (11).

12. Check exposed portion of coupling shaft (11) to be sure you have removed all signs of rust and corrosion which might prevent its withdrawal through the dirt and water seal (1) and outer bearing (2). Crocus cloth or fine emery paper may be used.

13. Remove coupling shaft (11); push on the output end of the shaft.

14. Remove inner seal (7) and back–up washers (4 and 6) from the housing by working them around the unseated thrust washers (8) and thrust bearing (9) (Fig. 32). **Do not remove the thrust washer.**

15. Remove housing (3) from the vise and invert it. Remove dirt and water seal (1). A blind hole bearing or seal puller is required.

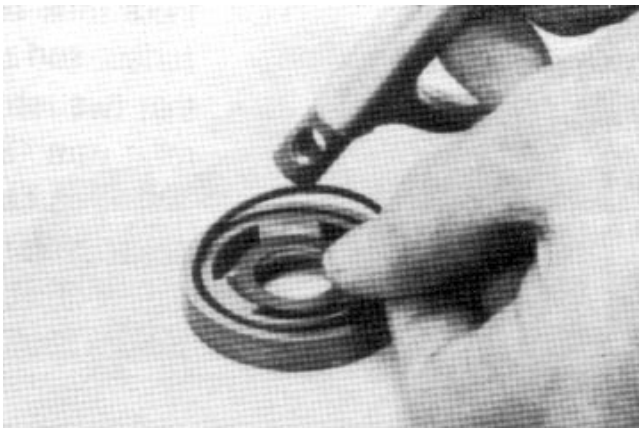


Figure 30

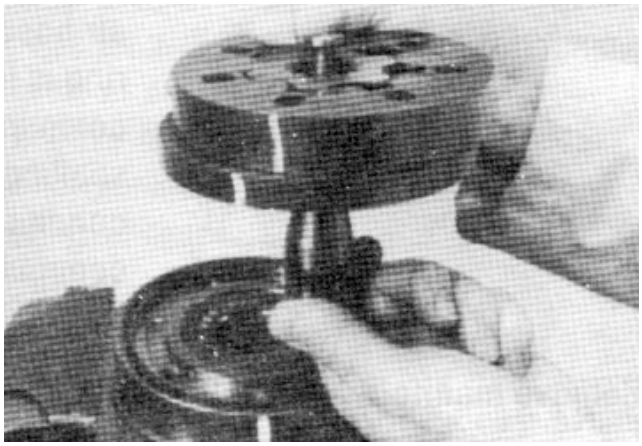


Figure 31

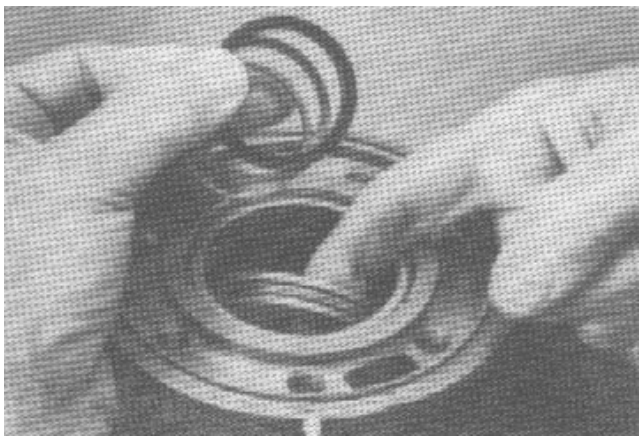


Figure 32

Wheel Motor Inspection (Fig. 28)

1. Inspect bolts (14) for damaged threads and sealing rings under the bolt head. Replace if damaged (Fig. 33).

Note: A polished pattern (not scratches) on the cover from rotation of the commutator (16) is normal. Discoloration would indicate excess fluid temperature, thermal shock, or excess speed and require system investigation for cause and close inspection of end cover, commutator, manifold, and rotor set.

CAUTION

Use eye protection such as goggles when using compressed air

2. Thoroughly wash end cover (24) in proper solvent and blow dry. Make sure the end cover valve apertures are free of contamination. Inspect end cover for cracks and the bolt head recesses for good bolt head sealing surfaces. Replace end cover as necessary (Fig. 34).

3. Inspect commutator ring (23) for cracks and burrs. Replace commutator ring as necessary.

4. Inspect commutator (16) for cracks, burrs, wear, scoring, chipping, and peening. **If any of these conditions exist, replace commutator and commutator ring (23) as a matched set.**

5. Inspect manifold (22) for cracks, surface scoring, peening, chipping. Replace manifold if any of these conditions exist. A polished pattern on the ground surface from commutator or rotor rotation is normal.

Note: The rotor set consists of the rotor (19), vanes (20), and stator (21). Rotor set components may become disassembled during service procedures.

6. Inspect the rotor set in its assembled form for nicks, scoring, and chipping on any surface. Inspect for broken and worn splines. **If the rotor set component requires replacement, the complete rotor set must be replaced as it is a matched set.**

7. Place rotor set and wear plate (18) on a flat surface and center the rotor (19) in the stator (21) such that two rotor lobes (180 degrees apart) and a roller vane (20) center line are on the same stator center line. Check the rotor lobe to roller vane clearance with a feeler gage at this common center line. If there is more than 0.005 inch (0.13 mm) of clearance, replace the entire rotor set (Fig. 35).

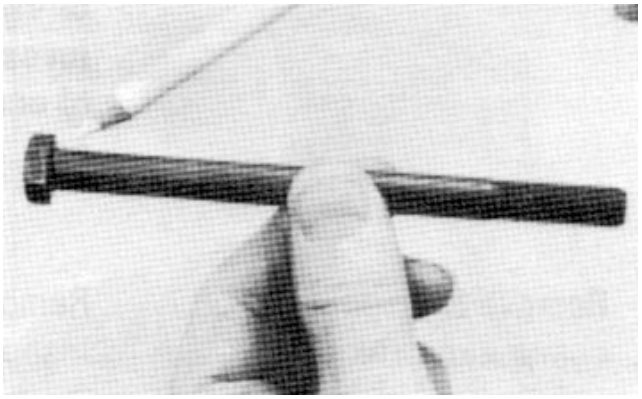


Figure 33

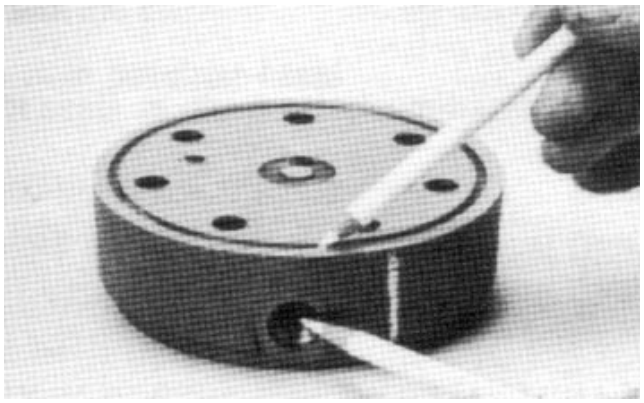


Figure 34

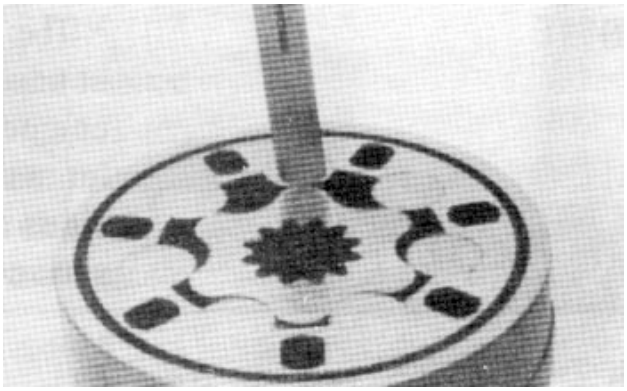


Figure 35

Figure 36

8. Inspect the wearplate (18) for cracks, peening, and scoring. A polished pattern on the wear plate from rotor rotation is normal. Replace as necessary.

9. Inspect drive link (13) for cracks and worn or damaged splines. No perceptible lash (play) should be noted between mating spline parts of the rotor (19) or coupling shaft (11). Replace as necessary (Fig. 36).

10. Inspect thrust bearing (12) for wear, peening, corrosion and a full complement of retained rollers. Replace as necessary.

11. Inspect coupling shaft (11) internal and external splines and keyway for damage and wear. Inspect bearing and sealing surfaces of the coupling shaft for chipping, nicks, grooves, severe wear, corrosion, and discoloration. Replace coupling shaft if any of these conditions exist. Minor shaft wear in seal area is permissible. If wear exceeds 0.020 inch (0.51 mm) diametrically, replace coupling shaft. A slight "polish" is permissible on the shaft bearing areas (Fig. 37).

Note: Do not remove inner bearing (10), thrust washers (8), thrust bearing (9), and outer bearing (2) from the housing (3). These parts should be inspected in place.

12. Inspect housing (3) for cracks. Inspect machined surfaces for nicks, burrs, peening, and corrosion. Remove burrs that can be removed without changing dimensional characteristics. Inspect tapped holes for thread damage. If the housing is defective in these areas, discard the housing assembly (Fig. 38).

13. If the housing (3) has passed inspection to this point, inspect outer bearing (2), inner bearing (10), thrust washers (8), and thrust bearing (9). Bearing rollers must be firmly retained in the bearing cages but must rotate and orbit freely. All rollers and thrust washers must be free of peening and corrosion. **If any bearing or thrust washer does not pass inspection, replace the housing (3) as a complete assembly (Fig. 39).**

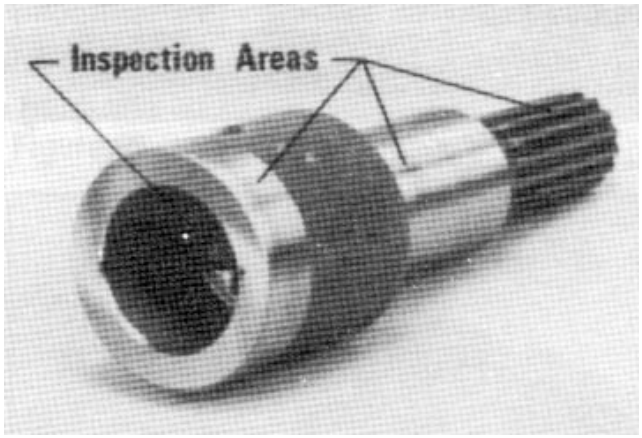


Figure 37

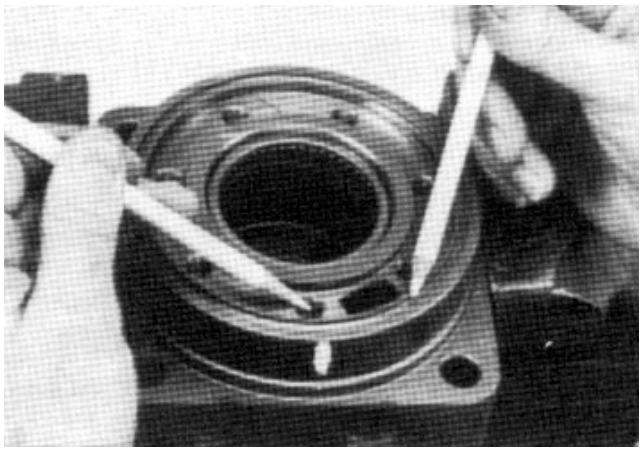


Figure 38

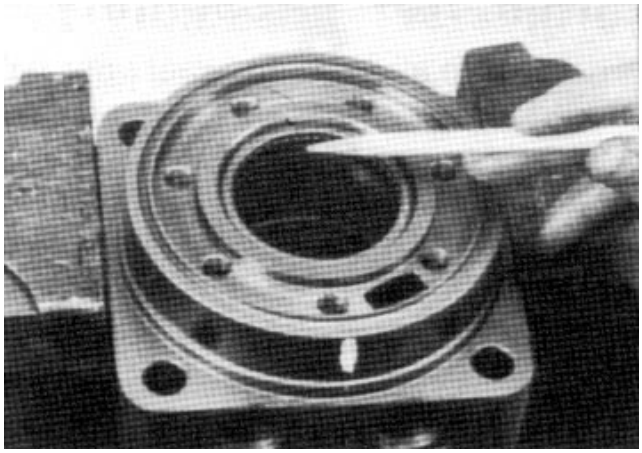


Figure 39

Wheel Motor Reassembly (Fig. 28)

1. Lubricate all seals and seal rings with clean hydraulic oil before assembly.

WARNING

Since they are flammable, be extremely careful when using any solvent. Even a small explosion or fire could cause injury or death.

CAUTION

Use eye protection such as goggles when using compressed air

2. Wash all parts in a clean petroleum–based solvent before assembly. Blow parts dry with compressed air.

3. Press a new dirt and water seal (1) into the housing (3) outer bearing counterbore. Press seal in with the lip facing out and until the seal is 0.020 inch (0.51 mm) below the end of housing.

4. Place housing (3) into a soft jawed vise with the coupling shaft bore down; clamp against the mounting flange.

IMPORTANT: Early model wheel motors that do not have back–up washer (6). Assemble with a new back–up washer (4), new back–up washer (6), and new seal (7).

5. A housing (3) that does not require replacement will require that the two thrust washers (8) and thrust bearing (9) be unseated and vertical to the counterbore and the new back–up washer (4), new back–up washer (6), and new seal (7) be worked around the thrust bearing package and placed into their respective counterbores (Fig. 41 and 40). The seal lip must face out of the seal counterbore and toward the inside of wheel motor (Fig. 42). Be sure the thrust bearing package is reseated correctly after assembly of the new seal and back–up washers.

6. Apply masking tape around splines or keyway on coupling shaft (11) to prevent damage to seal.

IMPORTANT: The outer bearing (2) is not lubricated by the system's hydraulic fluid. Make sure it is thoroughly packed with the recommended grease.

Figure 40

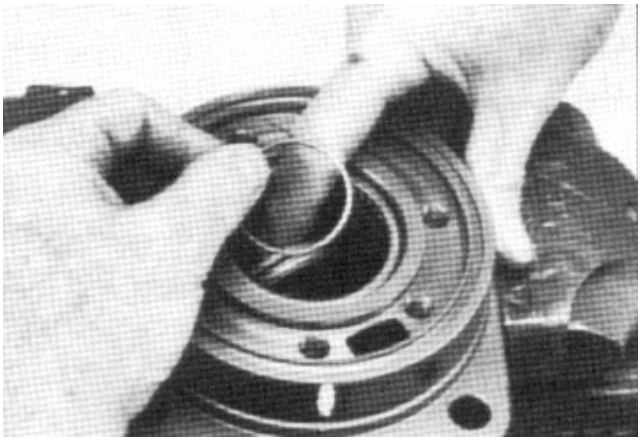


Figure 41

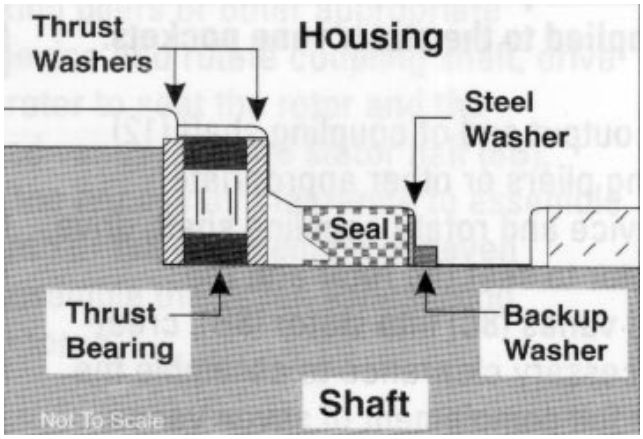


Figure 42

Note: Coupling shaft (11) should be approximately 0.10 inch (2.54 mm) below the housing wear plate surface to allow the assembly of thrust bearing (12). The coupling shaft must rotate smoothly on the thrust bearing (9) and thrust washer (8) (Fig. 43).

7. Make sure that a generous amount of clean corrosion resistant grease has been applied to the outer bearing (2). Install the coupling shaft (11) into housing (3), and seat shaft against the second thrust washer (8).

8. Install thrust bearing (12) onto the end of coupling shaft (11).

9. Apply a small amount of clean petroleum jelly to a new seal ring (5) and insert it into the housing (3) seal ring groove.

Note: One or two alignment studs screwed finger tight into housing (18) bolt holes, approximately 180 degrees apart, will facilitate the assembly and alignment of components as required in the following procedures. The studs can be made by cutting off the heads of 3/8–24 UNF 2A bolts so they are 0.5 inch (12.7 mm) or longer than cap screw (14).

Note: Use any alignment marks put on the coupling shaft (11) and drive link (13) before disassembly to assemble the drive link splines in their original position in the mating coupling shaft splines.

10. Install drive link (13) with the long splined end down into the coupling shaft (11). Engage the drive link splines so they mesh with the coupling shaft splines (Fig. 44).

11. Assemble wear plate (18) over the drive link (13) and alignment studs onto the housing (3).

12. Apply a small amount of clean petroleum jelly to a new seal ring (5) and assemble it into the seal ring groove on the wear plate side of the stator (21).

Note: The rotor set consists of the rotor (19), vanes (20), and stator (21). Rotor set components may become disassembled during service procedures. Do not service separately.

Note: It may be necessary to turn one alignment stud out of the housing (3) temporarily to assemble rotor set over the drive link (13).

Note: The rotor set rotor counterbore side must be down against wear plate for drive link clearance and to maintain the original rotor–drive link spline contact. A rotor set without a counterbore and that was not etched before disassembly can be reinstalled using the drive link spline pattern on the rotor splines if apparent, to determine which side was down. The rotor set seal ring groove faces toward the wear plate (18).

13. Install assembled rotor set onto wear plate (18) with rotor (19) counterbore and seal ring side down. The splines should mesh with the drive link (13) splines.

14. If disassembled rotor (19), stator (21), and vanes (20) cannot be readily assembled by hand, assemble with the following procedures:

A. Place stator (21) onto wear plate (18) with seal ring (5) side down. Be sure the seal ring is in place.

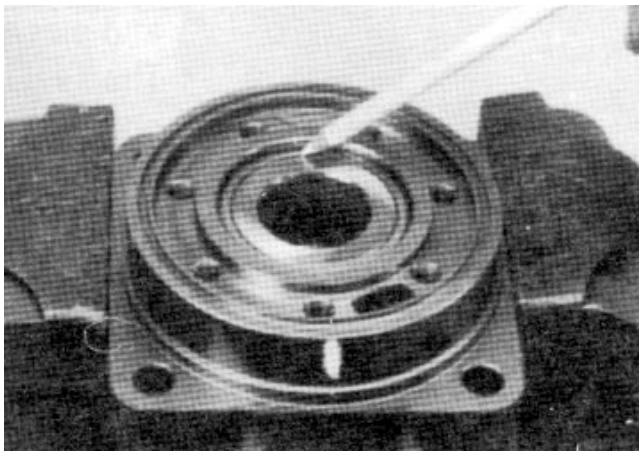


Figure 43

Figure 44

B. If assembly alignment studs are not being utilized, align stator (21) bolt holes with wear plate (18) and housing (3) bolt holes. Screw two cap screws (14) finger tight into bolt holes approximately 180 degrees apart to retain stator and wear plate stationary.

Note: If the manifold (22) side of the rotor (19) was etched during wheel motor disassembly, this side should be up. If the rotor is not etched and does not have a counterbore, use the drive link spline contact pattern apparent on the rotor splines to determine the rotor side that must be against the wear plate.

C. Place rotor (19) with counterbore down, if applicable, into stator (21), and then onto wearplate (18) so rotor splines mesh with drive link (13) splines.

IMPORTANT: Do not force rotor vanes into place, the coating applied to stator vane pockets could shear off.

D. Assemble six vanes (20), or as many vanes that will readily assemble into the stator vane pockets.

E. Grasp the output end of coupling shaft (11) with locking pliers or other appropriate turning device. Rotate coupling shaft, drive link (13), and rotor (19) to seat the rotor and the assembled vanes (20) into the stator (21). This rotation should create the necessary clearance to assemble the seventh or remaining vanes. Use minimum force when assembling the remaining vane (s).

F. Remove the two assembled bolts (14) if used to retain stator and wear plate.

Note: The manifold (22) is made up of several plates bonded together permanently to form an integral component. The manifold surface that must contact the rotor set has it's series of irregular shaped cavities on the largest circumference or circle around the inside diameter. The polished impression left on the manifold by the rotor set is another indication of which surface must contact the rotor set.

15. Apply clean petroleum jelly to a new seal ring (5) and assemble it in the seal ring groove in the rotor set contact side of manifold (22).

16. Assemble the manifold (22) over the alignment studs and drive link (13) and onto the rotor set. Be sure the correct manifold surface is against the rotor set.

17. Apply clean petroleum jelly to a new seal ring (5) and insert it in the seal ring groove exposed on the manifold (22).

18. Assemble the commutator ring (6) over alignment studs onto the manifold (22) (Fig. 45).

19. Assemble a new commutator seal (15) flat side up, into commutator (16) and assemble commutator over the end of drive link (13) onto manifold (22) with seal ring side up.

20. Assemble new seal ring (5) into end cover (24) and assemble end cover over the alignment studs and onto the commutator set (Fig. 46).

21. Assemble seven cap screws (14) and screw them in finger tight. Remove and replace the two alignment studs with bolts after the other bolts are in place. Alternately and progressively tighten the bolts to pull the end cover and other components into place with a final torque of 45 to 55 ft–lb (6.2 to 7.6 kg–m).

22. Check motor shaft for rotation. Torque require to rotate shaft should not exceed 50 ft–lb (6.9 kg–m).

Figure 45

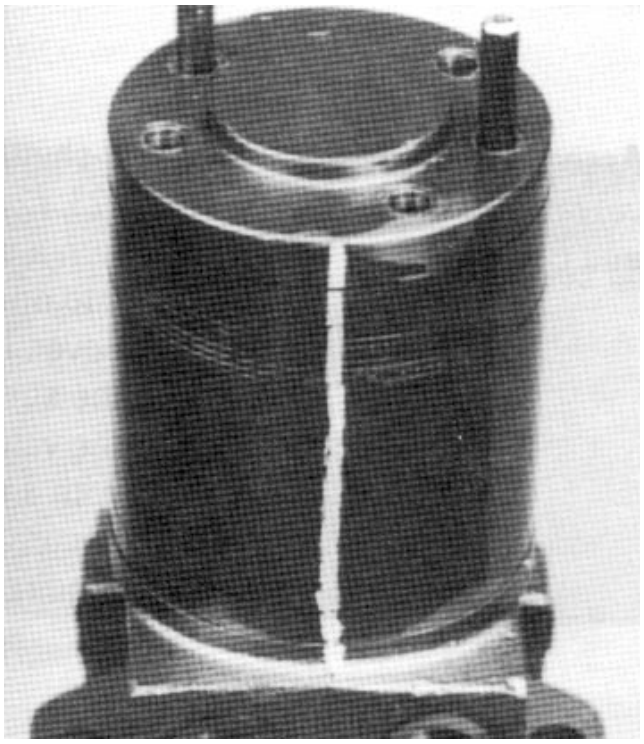


Figure 46

Changing Hydraulic Oil and Filter

Change hydraulic filter initially after the first 50 operating hours, thereafter change hydraulic oil and filter after every 800 hours. If oil becomes contaminated, contact your local TORO distributor because the system must be flushed. Contaminated oil looks milky or black when compared to clean oil.

Note: If oil is not going to be drained, disconnect and plug hydraulic line going to filter.

1. Clean area around filter mounting area. Place drain pan under filter and remove filter.

2. Fill the replacement filter with hydraulic fluid (see Check Hydraulic System Fluid), lubricate the sealing gasket and hand turn until gasket contacts filter head. Then tighten 3/4 turn further. Filter should now be sealed.

3. Fill hydraulic reservoir with approximately 5.5 gallons of hydraulic oil (see Check Hydraulic System Fluid).

4. Start the machine and run it at idle for 3 to 5 minutes to circulate the fluid and remove any air trapped in the system. Stop the machine and recheck the fluid level.

5. Dispose of hydraulic fluid properly.

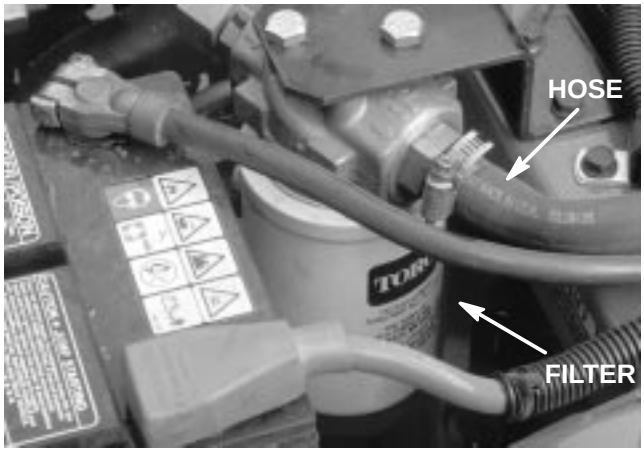


Figure 47

Lubrication

CAUTION

Before servicing or making adjustments to the machine, stop engine and remove key from the switch.

The traction unit has grease fittings that must be lubricated regularly with No. 2 General Purpose Lithium Base Grease. If machine is operated under normal conditions, lubricate all bearings and bushings after every 50 hours of operation. **Lubricate fittings immediately after every washing, regardless of the interval listed.**

The traction unit pedal pivot bushing must be lubricated). The grease fitting is located under the foot plate and is connected to the pedal.

1. Wipe grease fitting clean so foreign matter cannot be forced into the bearing or bushing.

2. Pump grease into the bearing or bushing.

3. Wipe up excess grease.

4. Apply grease to reel motor spline shaft and onto lift arm when cutting unit is removed for service.

5. Apply a few drops of SAE 30 engine oil or spray lubricant (WD 40) to all pivot points daily after cleaning.

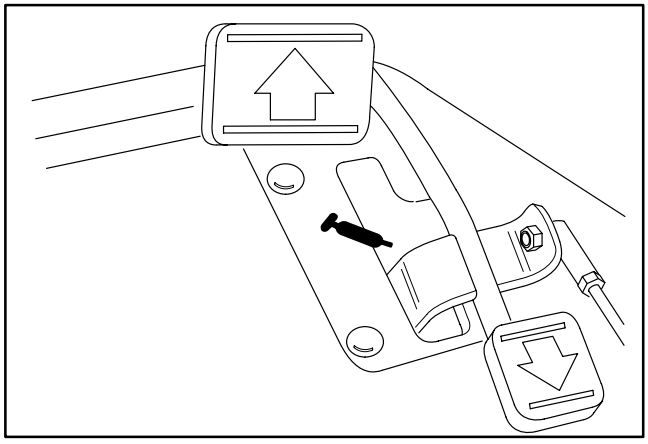


Figure 48

Hydraulic Gear Pump

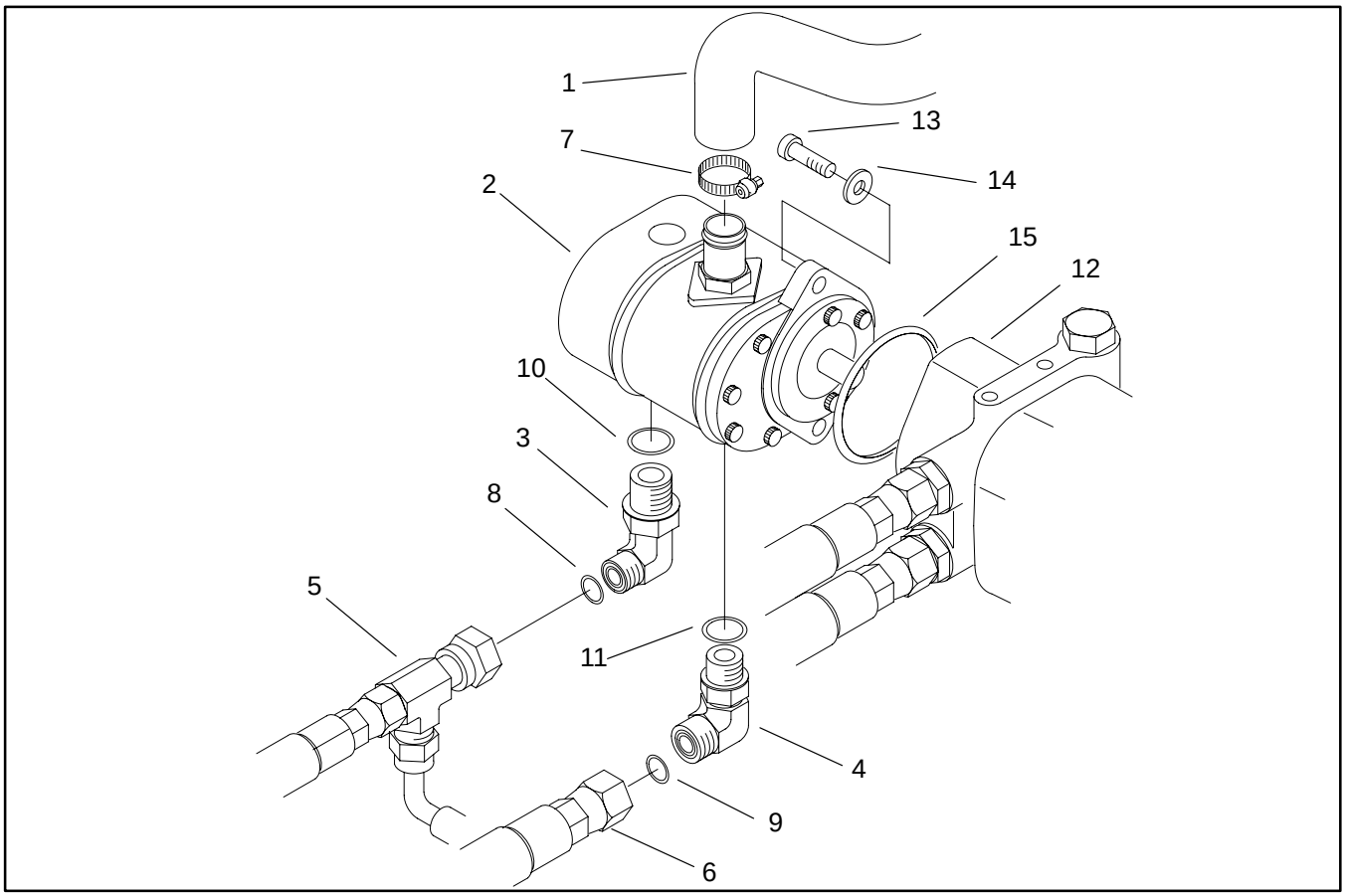


Figure 49

1. **Pump inlet hose**
2. **Gear pump**
3. **Hydraulic fitting**
4. **Hydraulic fitting**
5. **Hydraulic T–fitting**
6. **Hose assembly**
7. **Hose clamp**
8. **O–ring**
9. **O–ring**
10. **O–ring**
11. **O–ring**
12. **Hydrostat**
13. **Hex socket screw**
14. **Flat washer**
15. **O–ring**

Removal (Fig. 49)

1. Before removing any parts from the hydraulic system, park machine on a level surface, engage parking brake, lower cutting units, and stop engine.

CAUTION

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

2. Clamp pump inlet hose to prevent draining the hydraulic tank.

3. Clean gear pump, hydraulic fittings, and hose assembly connection. Label all hose connections for reassembly purposes. Put caps or plugs on any hose connections left open or exposed.

4. Loosen hose clamp, and remove pump inlet hose from the gear pump. Allow hydraulic oil to drain from hose into a suitable container.

5. Remove hose assembly, hydraulic T–fitting, and O–rings from hydraulic fittings. Allow hydraulic oil to drain from hoses into a suitable container.

6. Note position hydraulic fittings for reassembly purposes. Remove hydraulic fittings and O–rings from the gear pump.

7. Support gear pump. Separate gear pump from the hydrostat by removing both hex socket head screws and flat washers. Remove O–ring from between the gear pump and hydrostat.

Installation (Fig. 49)

1. Make sure mounting and O–ring sealing surfaces on the gear pump and hydrostat are clean.

2. Replace all O–rings with new ones. Apply clean hydraulic oil to all O–rings.

3. Place O–ring on the gear pump.

4. Position gear motor to the hydrostat so that the pump inlet is facing up.

5. Secure gear pump to the hydrostat with both hex socket head screws and flat washers. Torque screws from 27 to 31 ft–lb (3.7 to 4.3 kg–m).

6. Inspect threads and sealing surfaces of hydraulic fittings and hydraulic hose connector. Replace any damaged or worn fittings or connector.

7. Install O–rings into gear pump. Install fittings and tighten to positions noted during removal.

8. Secure pump inlet hose and hose clamp to the gear pump. Tighten hose clamp.

9. Remove clamp from pump inlet hose to allow hydraulic oil flow to the gear pump.

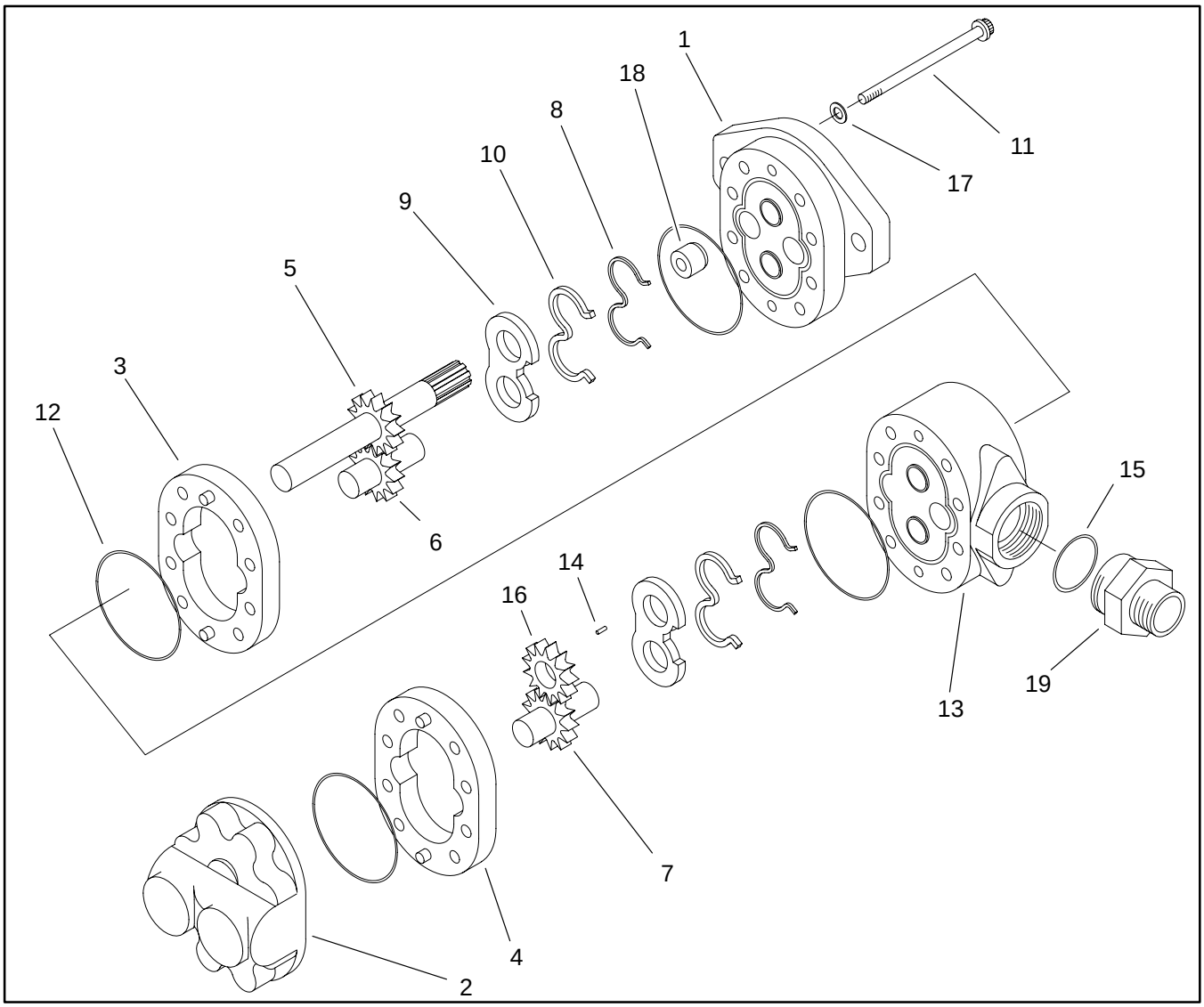


Figure 50

1. **Front plate**
2. **Back plate**
3. **Front body**
4. **Back body**
5. **Drive gear**
6. **Front idler gear**
7. **Back idler gear**
8. **Back–up gasket**
9. **Wear plate**
10. **Pressure seal**
11. **Cap screw**
12. **O–ring**
13. **Adapter plate**
14. **Key**
15. **O–ring**
16. **Back gear**
17. **Washer**
18. **Plug**
19. **Suction fitting**

Disassembly (Fig. 50)

1. Make sure caps or plugs are in motor openings to prevent contamination. Clean motor with solvent.

2. Make a scribe mark **diagonally** across the front plate, body, adapter plate, body, and back–up plate for reassembly purposes (Fig. 51).

IMPORTANT: Use extreme caution when using a vise to hold the gear pump. Do not over tighten. Parts may be distorted.

3. Secure gear pump in a vise with the shaft end up. Remove eight cap screws and four washers from the pump.

4. Remove gear pump from the vise. Position pump with the shaft end facing down.

5. Remove back plate from front body by tapping back plate with a soft face hammer. Remove O–ring from the back plate with a O–ring pick.

6. Remove back body from adapter plate by tapping body with a soft face hammer.

7. Remove back idler gear from the wear plate and adapter plate. Remove back gear from the drive gear shaft.

8. Remove wear plate with pressure seal and back–up gasket from the adapter plate. Note position of the open side of the wear plate.

9. Remove key from the drive gear shaft with a pencil magnet.

10. Remove O–ring from the adapter plate with a O–ring pick.

11. Remove adapter plate from body by tapping adapter plate with a soft face hammer. Remove O–ring from the other side of the adapter plate with an O–ring pick.

12. Remove second front body from the front plate.

13. Remove remaining front idler gear and drive gear from the wear plate and front plate. Remove O–ring from front plate.

14. Remove wear plate with pressure seal and back–up gasket from the front plate. Note position of the open side of wear plate. Do not remove plug from front plate.

15. Remove back–up gaskets and pressure seals from both wear plates with an O–ring pick.

Inspection (Fig. 50)

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

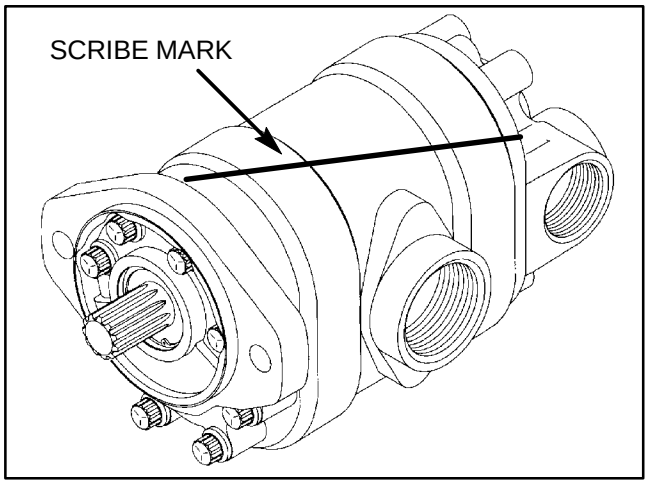


Figure 51

CAUTION

Use eye protection such as goggles when using compressed air.

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

3. Inspect gear, drive gear, and idler gears for the following:

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

   B. Gear shafts should be free of rough surfaces and excessive wear at bushing points and sealing areas.

   C. Gear shaft diameter in the bushing area should not be less than 0.748 inch (19.0 mm).

   D. Gears should be free of excessive scoring and wear.

   E. Make sure drive and idler gears have their snap rings in the grooves on each side.

   F. Break sharp edges of gear teeth with emery cloth.

   G. Gear width on the drive gear and front idler gear should not be less than 0.384 inch (9.75 mm). Gear width on the back gear and back idler gear should not be less than 0.244 inch (6.20 mm).

4. Inspect body for the following:

   A. Gear pockets should be free of excessive scoring and wear.

   B. Inside diameter of gear pockets should not exceed 1.719 inches (43.7mm).

5. Inspect front plate, back plate, and adapter plate as follows:

A. Inside diameter of all bushings should not exceed 0.755 inch (19.2 mm).

B. Bushings in the front plate should extend 0.126 inch (3.20 mm) from the plate surface.

C. Bushings on the wear plate side of the adapter plate should extend 0.126 inch (3.20 mm) from the plate surface.

D. Scoring on the face of the back plate or the back plate side of the adapter plate should not exceed 0.0015 inch (0.038 mm)

E. The oil groove in the bushings of the front plate should be opposite each other and in line with with the dowel pin holes. The oil groove in the bushings of the back plate should be about 37° to the pressure port (Fig. 52 and 53).

Reassembly (Fig. 50)

Note: When reassembling the pump, check the scribe marks on each part to make sure the parts are properly aligned during reassembly.

1. Lubricate new wear O–rings, pressure seals, back–up gaskets, and wear plates with a thin coat of petroleum jelly. Lubricate all other internal parts freely with clean hydraulic oil.

2. Install O–ring into the groove of the front plate.

3. Lubricate gear pockets of front body with a thin coat of petroleum jelly. Place front body onto front plate so the half moon port cavities face away from the front plate.

4. Install new pressure seal and back–up gasket into both new wear plates. The flat section in the middle of the back–up gasket must face away from the wear plate inside the seal.

5. Install wear plate into the gear pocket with the pressure seal and back–up gasket against the front plate. Make sure mid section cut–away of the wear plate is on the suction side of the pump.

6. Dip drive gear and front idler gear into clean hydraulic oil. Install gear shafts into the front plate bushings so that the gears set inside the gear pockets.

7. Install new O–ring into the groove of the adapter plate on the side with the bushings below the surface.

8. Align scribe marks on the body and adapter plate. Install adapter plate onto the body and gear shafts.

9. Install second new O–ring to the other side of the adapter plate.

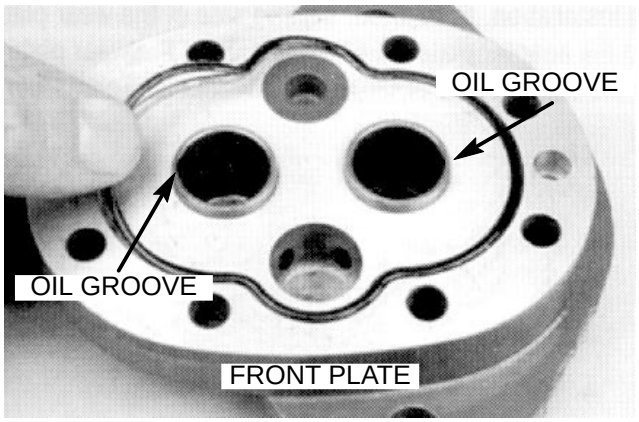


Figure 52

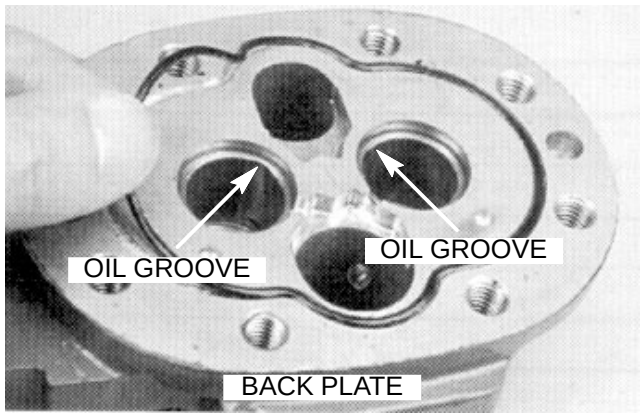


Figure 53

10. Coat key lightly with petroleum jelly to hold it in place. Install key into the slot in the drive gear shaft.

11. Align scribe marks on back body and adapter plate. Install body onto adapter plate and drive gear shaft.

IMPORTANT: Do not dislodge seals during installation.

12. Install wear plate into the gear pocket of back body with the pressure seal and back–up gasket against the adapter plate. Make sure mid section cut–away of the wear plate is on the suction side of the pump.

13. Lubricate back gear with clean hydraulic oil. Install gear onto the drive gear shaft and key.

14. Lubricate back idler gear with clean hydraulic oil. Install idler gear into the gear pocket of back body and the adapter plate.

15. Install new O–ring into the groove of the back plate.

16. Align scribe marks on the back plate and body. Install back plate onto the body and gear shafts.

17. Secure pump together with cap screws and new washers on cap screws external of the flange cavity. Torque cap screws in a criss–cross pattern from 25 to 28 ft–lb (3.5 to 3.9 kg–m).

Implement Relief Valve

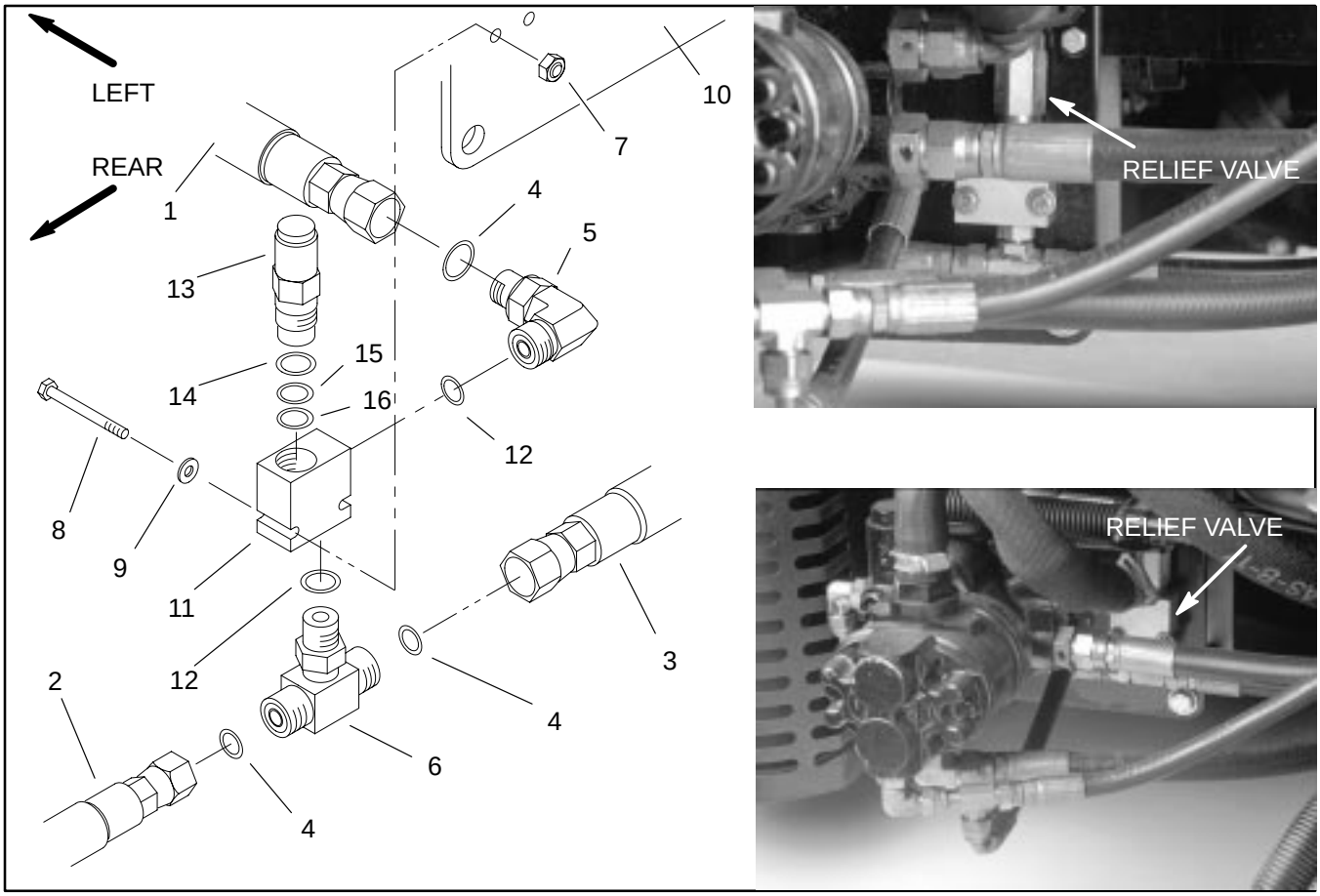


Figure 54

1. **Hose assembly**
2. **Hose assembly**
3. **Hose assembly**
4. **O–ring**
5. **90° hydraulic fitting**
6. **Tee hydraulic fitting**
7. **Lock nut**
8. **Cap screw**
9. **Flat washer**
10. **Mounting plate**
11. **Relief valve body**
12. **O–ring**
13. **Relief valve cartridge**
14. **O–ring**
15. **O–ring**
16. **Back–up ring**

Removal

1. Before removing any parts from the hydraulic system, park the machine on a level surface, engage the parking brake, lower the cutting units, and stop the engine.

CAUTION

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

2. Clean relief valve and hydraulic connections.

3. Label all hydraulic connections for reassembly.

4. Disconnect hose assemblies and O–rings from the both hydraulic fittings. Allow hoses to drain into a suitable container.

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

6. Unscrew lock nuts from cap screws. Remove screws and flat washers from the relief valve body and mounting plate.

7. Remove tee fitting, 90° fitting, and O–rings from the valve body.

Installation

1. Remove caps or plugs from disconnected hoses.

2. Lubricate new O–rings with clean hydraulic fluid. Install O–rings and hydraulic fittings to the valve body.

3. Secure valve body to the mounting plate with cap screws, flat washers, and lock nuts.

4. Install O–rings and hose assemblies to hydraulic fittings. Tighten hose connections.

Disassembly

1. Unscrew relief valve cartridge from the relief valve body. Remove O–rings and back–up ring.

2. Inspect ports of the relief valve body for damaged sealing surfaces and threads and contamination.

3. Inspect relief valve cartridge for damaged sealing surfaces and contamination.

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

   B. If sealing surfaces appear pitted or damaged, the hydraulic system may be over heating or there may be water in the system.

CAUTION

Use eye protection such as goggles when using compressed air

4. Clean relief valve cartridge using clean mineral spirits to flush out any contamination. Submerge cartridge in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. Use compressed air for cleaning.

Reassembly

1. Lubricate new O–rings and back–up ring with clean hydraulic fluid. Install O–rings and back–up ring to the relief valve cartridge.

2. Screw relief valve cartridge into the relief valve body. Torque cartridge to 20 ft–lb (2.8 kg–m).

3. Lubricate new O–rings with clean hydraulic fluid. Connect hydraulic fittings and O–rings to the relief valve body.

Reel Motors

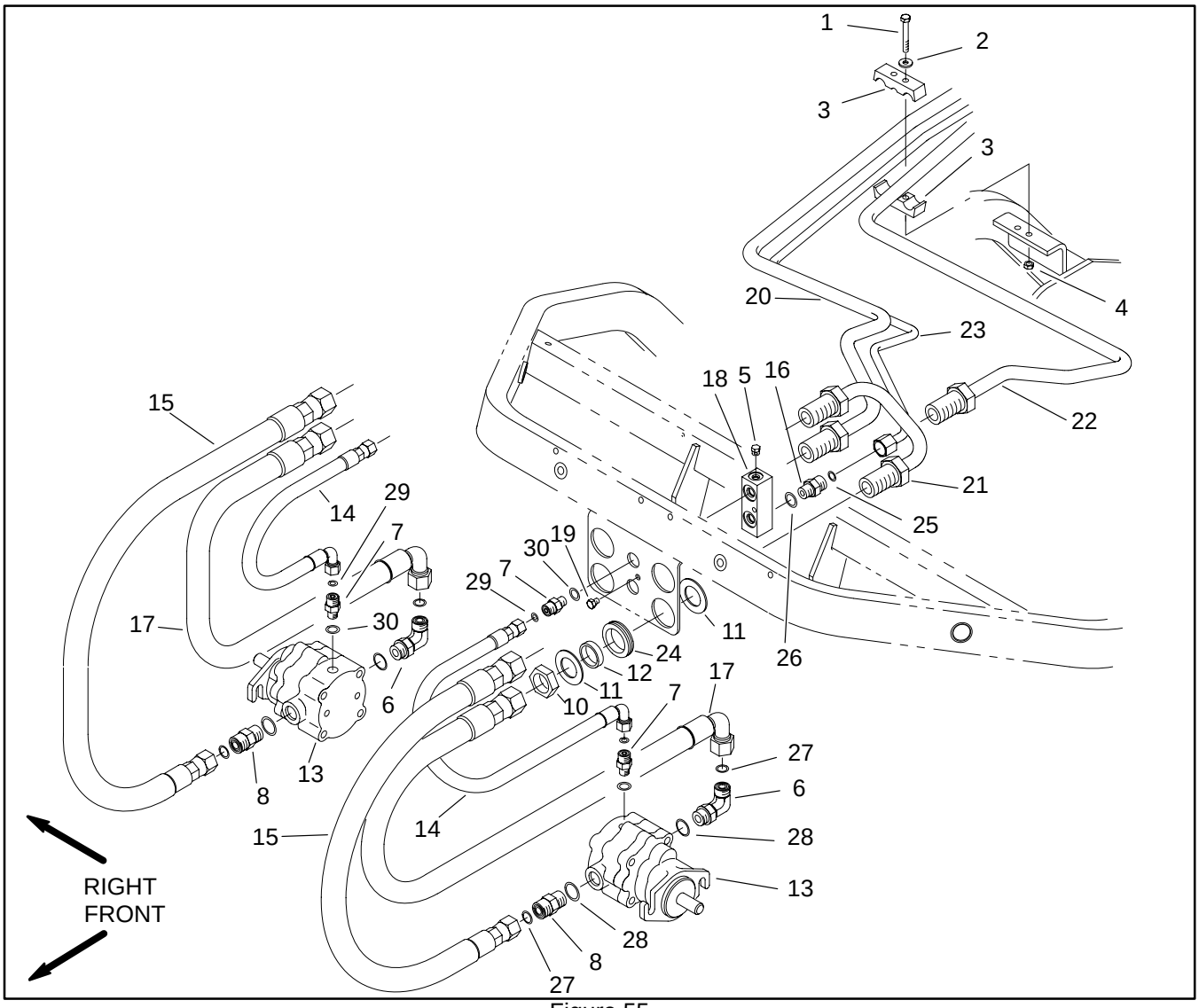


Figure 55

1. **Cap screw**
2. **Flat washer**
3. **Tube clamp**
4. **Lock nut**
5. **Plug**
6. **90° Hydraulic fitting**
7. **Hydraulic fitting**
8. **Hydraulic fitting**
9. **Not used**
10. **Bulkhead nut**
11. **Washer**
12. **Spacer**
13. **Reel motor**
14. **Hose assembly**
15. **Hose assembly**
16. **Hydraulic fitting**
17. **Hose assembly**
18. **T–block**
19. **Cap screw**
20. **Hydraulic tube**
21. **Hydraulic tube**
22. **Hydraulic tube**
23. **hydraulic tube**
24. **Rubber grommet**
25. **O–ring**
26. **O–ring**
27. **O–ring**
28. **O–ring**
29. **O–ring**
30. **O–ring**

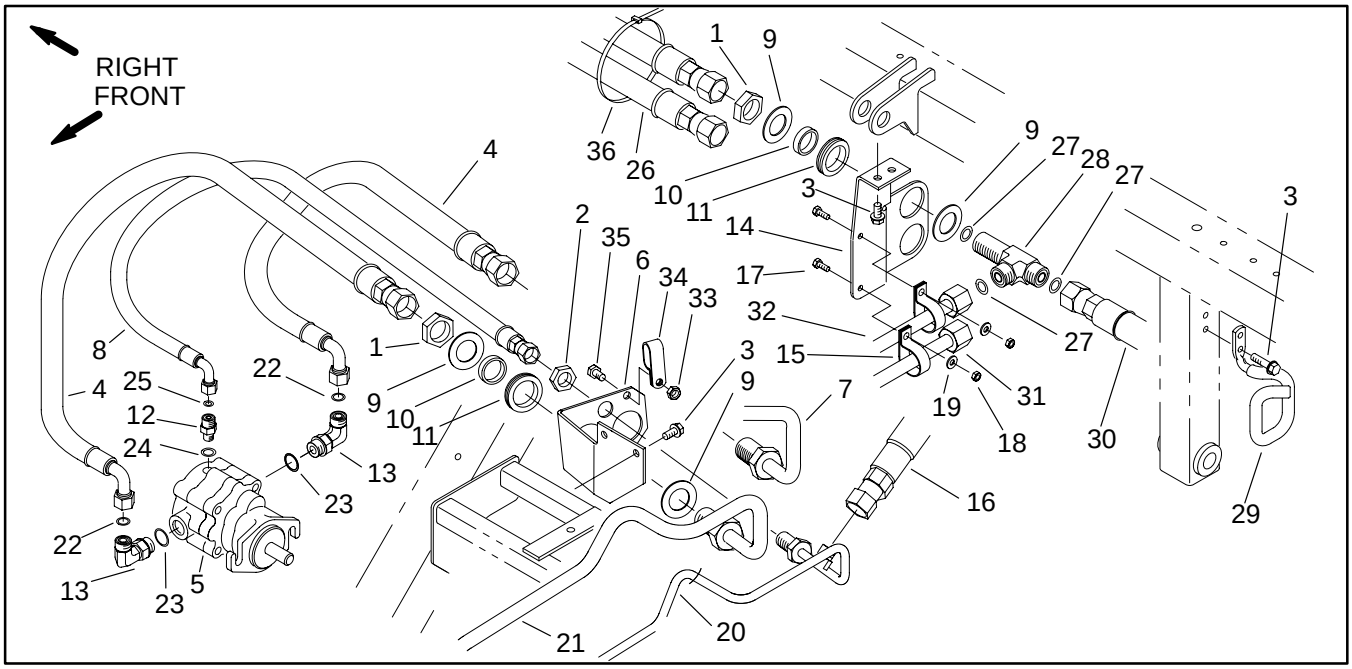


Figure 56

1. **Bulkhead nut**
2. **Bulkhead nut**
3. **Cap screw**
4. **Hose assembly**
5. **Reel motor**
6. **Bulkhead bracket**
7. **Hydraulic tube**
8. **Hose assembly**
9. **Washer**
10. **Spacer**
11. **Rubber grommet**
12. **Hydraulic fitting**
13. **90° Hydraulic fitting**
14. **Bulkhead bracket**
15. **R–clamp**
16. **Hose assembly**
17. **Cap screw**
18. **Lock nut**
19. **Flat washer**
20. **Hydraulic tube**
21. **Hydraulic tube**
22. **O–ring**
23. **O–ring**
24. **O–ring**
25. **O–ring**
26. **Hose assembly**
27. **O–ring**
28. **Bulkhead T–fitting**
29. **Hose retainer**
30. **Hose assembly**
31. **Hydraulic tube**
32. **Hydraulic tube**
33. **Lock nut**
34. **Double tube clamp**
35. **Cap screw**
36. **Cable tie**

Removal (Fig. 55 and 56)

1. Before removing any parts from the hydraulic system, park machine on a level surface, engage parking brake, lower cutting units, and stop engine.

CAUTION

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

2. Remove reel motor from the cutting unit (see Cutting Unit Removal and Installation in Chapter 7– Cutting Units).

3. Clean reel motor, hydraulic fittings, and hose connections.

Note: The position of hydraulic fittings on the reel motor is critical to properly reconnecting hydraulic hoses.

4. Label all hose connections for reassembly purposes. Matchmark reel motor and all hydraulic fittings for reassembly purposes.

5. Remove hose connections from the hydraulic fittings on the reel motor. Allow hydraulic oil to drain from hoses into a suitable container. Put caps or plugs on ends of hoses to prevent contamination.

6. Remove hydraulic fittings and O–rings from the reel motor. Put caps or plugs in motor openings to prevent contamination.

Installation (Fig. 55 and 56)

1. Make sure hydraulic fitting ports and O–ring sealing surfaces on the reel motor are clean.

2. Make sure hydraulic fittings are clean. Inspect threads and sealing surfaces of fittings. Replace any worn or damaged fittings.

3. Remove caps or plugs in motor openings and hose assemblies.

4. Apply clean hydraulic oil to all O–rings.

5. Place O–ring on the face seal of a hydraulic fitting. Secure fitting to the reel motor. Make sure that the match marks are aligned. Repeat this step for the remaining fittings.

6. Make sure hose connections are clean. Inspect threads and sealing surfaces of connections. Replace any worn or damaged connections.

7. Install reel motor to the cutting unit (see Cutting Unit Removal and Installation in Chapter 7– Cutting Units).

8. Secure hose connection to the proper hydraulic fitting on the reel motor. Repeat this step for the remaining hose connections.

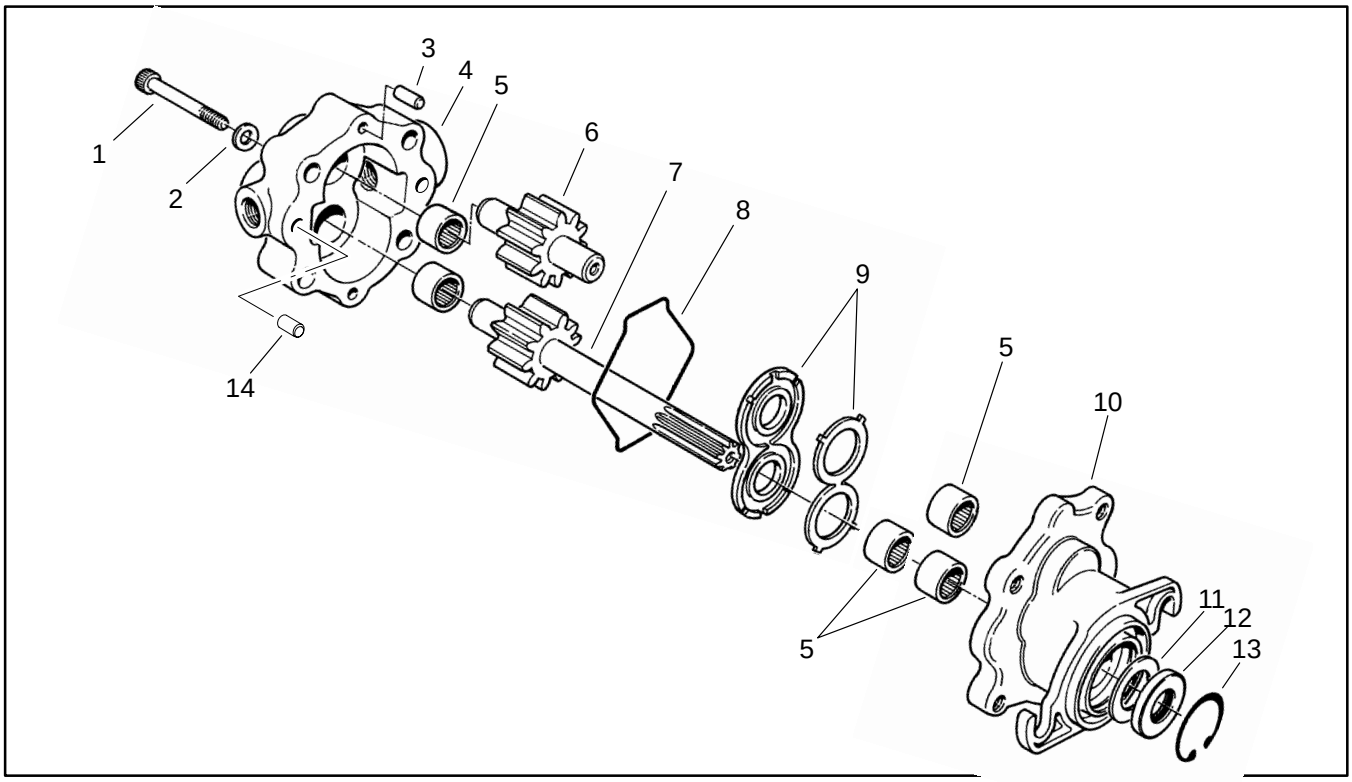


Figure 57

1. **Hex socket head screw**
2. **Washer**
3. **Dowel pin**
4. **Cover assembly**
5. **Needle bearing**
6. **Idler gear assembly**
7. **Drive shaft assembly**
8. **Seal ring**
9. **Load plate assembly**
10. **Body assembly**
11. **Spacer**
12. **Shaft seal**
13. **Retaining ring**
14. **Dowel pin**

Disassembly (Fig. 57)

1. Make sure caps or plugs are in motor openings to prevent contamination. Clean motor with solvent.

IMPORTANT: Use extreme caution when using a vise to hold the motor. Do not over tighten. Parts may be distorted.

2. Remove shaft seal as follows:

   A. Remove retaining ring with retaining ring pliers.

   B. Plug both motor ports (3/4–16 UNF–2B) with threaded plugs. Attach hydraulic hand pump to the external drain port (7/16–20 UNF–2B).

CAUTION

Point shaft seal away from face and body to prevent possible injury.

IMPORTANT: Do not chisel or pry the shaft seal out of its cavity. This could cause damage to the seal bore or shaft and/or mounting hub area.

   C. Apply pressure gradually into the motor. The seal should ”pop” easily out of the cavity.

   D. Remove shaft seal and spacer from body assembly.

3. Remove hex socket head screws and washers from the cover assembly and body assembly.

4. Separate cover assembly from body assembly by tapping lightly on the drive shaft with a plastic hammer; do not pry apart.

5. Remove load plate assembly from the drive shaft and idler gear assemblies. Discard load plate assembly.

6. Remove seal ring from the body assembly. Discard seal ring.

Inspection (Fig. 57)

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

CAUTION

Use eye protection such as goggles when using compressed air.

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

3. Inspect drive shaft and idler gear assemblies.

   A. Bushing points and seal areas should be free of excessive excessive wear and rough surfaces.

   B. Gear faces should be free of excessive scoring and wear.

   C. Gears should be free of excessive wear, nicks, and, missing or broken teeth. Break sharp edges with emery cloth.

   D. Replace if either shaft is visibly bent.

4. Inspect cover and body assemblies.

   A. Bearing needles should remain in cage and move freely. If needle bearing (s) need replacement, the entire assembly must be replaced.

   B. Sealing faces and gear pockets should be free of excessive scoring.

Assembly (Fig. 57)

1. Coat new seal ring lightly with petroleum jelly. Install seal ring into matching groove on the body assembly.

2. Apply a thin coat of petroleum jelly to both gear pockets of the cover assembly. Install dowel pins into body assembly.

Note: Make sure idler gear is installed into the gear pocket opposite the external drain port.

3. Dip idler gear and drive shaft assemblies into clean hydraulic oil. Install both assemblies into the cover assembly gear pockets. Make sure that both gears mesh.

4. Coat new load plate assembly lightly with petroleum jelly. Install load plate assembly onto idler gear and drive shaft assemblies. Make sure seal of assembly faces away from the gear face.

5. Slide body assembly over the idler gear and drive shaft assemblies onto the cover assembly. Make sure that none of the parts become displaced. Install hex socket head screws and washers. Hand tighten screws.

6. Rotate drive shaft to make sure gears mesh properly. Torque hex socket head screws from 190 to 210 in–lb (219 to 242 kg–cm).

7. Install new spacer onto the drive shaft and into the body assembly.

IMPORTANT: Use extreme care when installing the shaft seal to prevent damage to the seal.

8. Install new shaft seal as follows:

   A. Make sure that the bore of the body assembly is clean and free of burrs and nicks which could damage the seal.

   B. Lubricate lips of the seal generously with clean No. 2 multipurpose lithium base grease. Apply Loctite gasket eliminator 515 or equivalent to the outer edge of the metal case of the seal.

   C. Make sure metal case of shaft seal faces away from the motor. Use seal installer to press shaft seal squarely into the bore.

9. Install retaining ring into bore of the body assembly.

10. Lubricate motor generously with clean hydraulic oil.

Oil Cooler

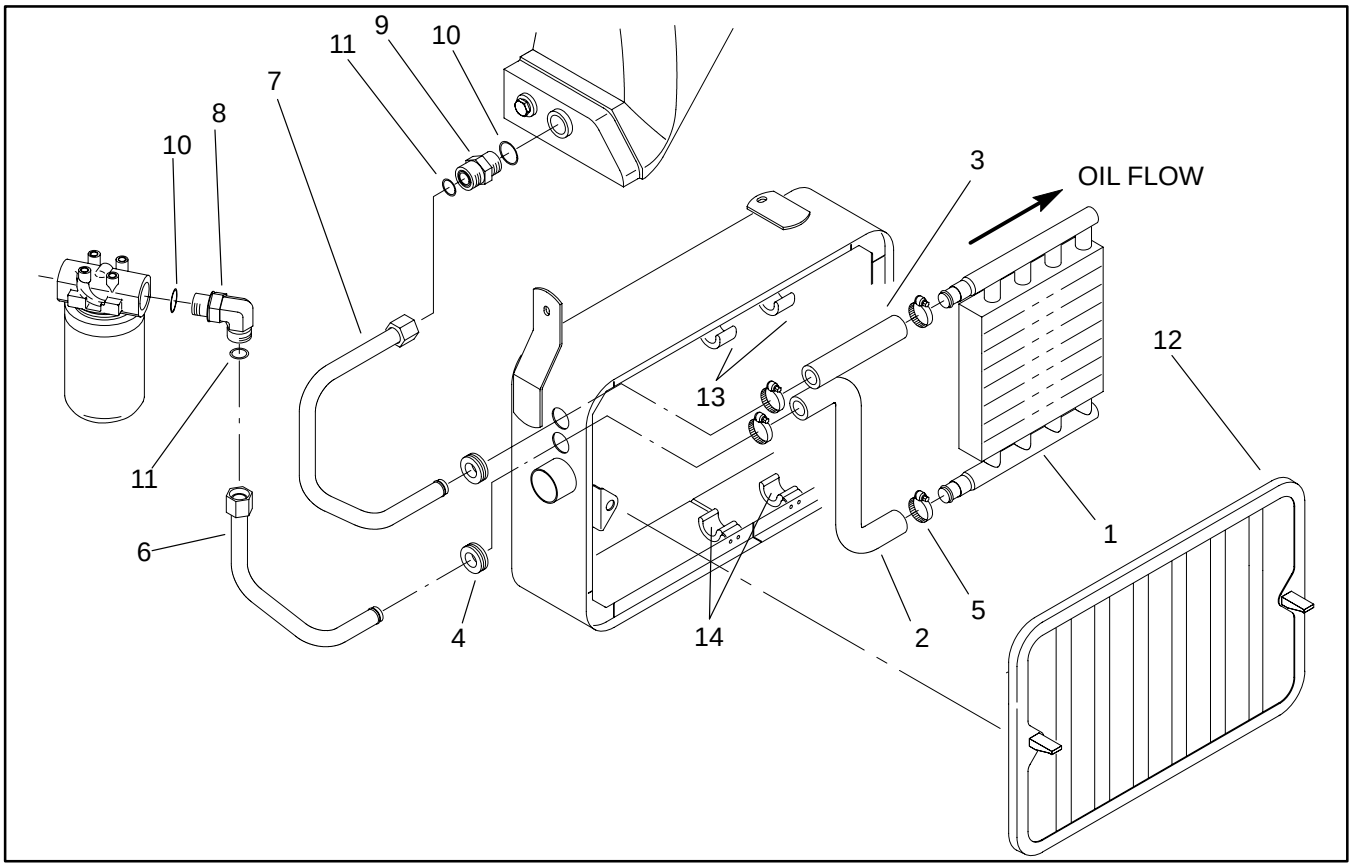


Figure 58

1. **Oil cooler**
2. **Lower formed hose**
3. **Upper formed hose**
4. **Grommet**
5. **Hose clamp**
6. **Tube assembly**
7. **Tube assembly**
8. **Hydraulic fitting**
9. **Hydraulic fitting**
10. **O–ring**
11. **O–ring**
12. **Radiator screen**
13. **Upper cooler bracket**
14. **Lower cooler bracket**

Removal (Fig. 58)

1. Before removing any parts from the hydraulic system, park machine on a level surface, engage parking brake, lower cutting units, and stop engine.

CAUTION

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

2. Clamp upper and lower formed hoses to prevent draining of the hydraulic system and tank.

3. Remove loosen hose clamps securing the formed hoses to the oil cooler.

4. Lift oil cooler up from the cooler brackets. Remove oil cooler from the formed hoses. Allow hoses and cooler to drain into a suitable container.

5. To clean the oil cooler, back flush with cleaning solvent. After the cooler is clean, make sure all solvent is drained from the cooler.

CAUTION

Use eye protection such as goggles when using compressed air.

6. Use compressed air in a direction opposite the oil flow to dry the cooler.

7. Plug ends of the oil cooler. Clean exterior of the cooler.

8. The oil cooler should be free of corrosion and excessive pitting of tubes.

Installation (Fig. 58)

1. Make sure formed hoses and openings of the oil cooler are clean.

2. Remove plugs from oil cooler openings.

3. Hang oil cooler onto cooler brackets while attaching the formed hoses to the cooler. Secure hoses by tightening the hose clamps.

4. Clean radiator screen and reinstall.

5. Remove clamps that where used to prevent drainage from the formed hoses.

6. Fill hydraulic tank (see Check Hydraulic System Fluid).

7. Start machine. Run machine at idle for 3 to 5 minutes to circulate hydraulic fluid and remove any air trapped in the system. Stop machine and recheck hydraulic tank level.

Lift Cylinders

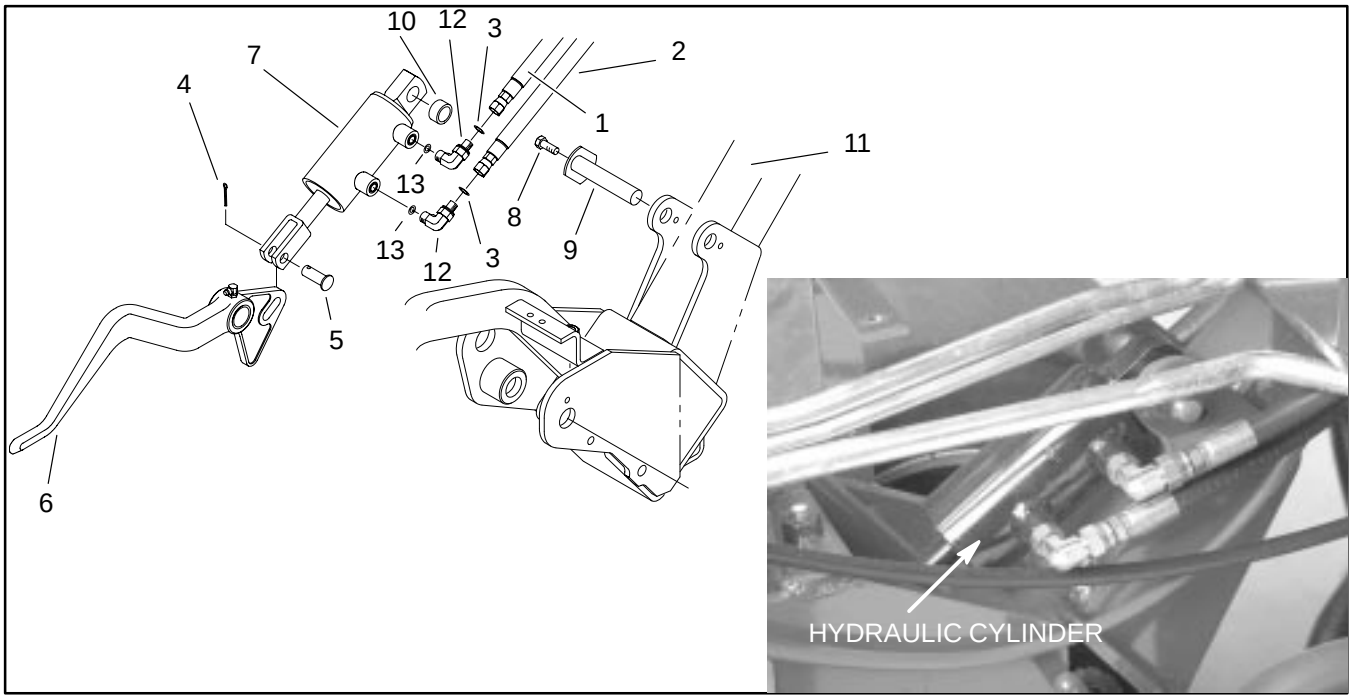


Figure 59

1. **Hose assembly**
2. **Hose assembly**
3. **O–ring**
4. **Cotter pin**
5. **Clevis pin**
6. **Lift arm**
7. **Hydraulic cylinder**
8. **Cap screw**
9. **Ram pivot pin**
10. **Spacer**
11. **Frame**
12. **90° Hydraulic fitting**
13. **O–ring**

Front Cylinder Removal (Fig. 59)

1. Before removing any parts from the hydraulic system, park the machine on a level surface, engage the parking brake, lower the cutting units, and stop the engine.

CAUTION

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

2. Label all hydraulic connections for reassembly.

3. Disconnect hose assemblies and O–rings from the hydraulic fittings. Allow hoses to drain into a suitable container.

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

5. Remove cotter pin from the clevis pin. Pull clevis pin from the hydraulic cylinder and lift arm.

6. Support hydraulic cylinder to prevent it from dropping.

   A. Remove cap screw from the ram pivot pin.

   B. Pull ram pivot pin from the frame, spacer, and hydraulic cylinder.

   C. Remove hydraulic cylinder from the frame.

Front Cylinder Installation

1. Position hydraulic cylinder to the frame. Insert ram pivot pin with through the frame bracket, spacer, and cylinder. Secure pin with cap screw.

2. Position clevis of the hydraulic cylinder to the lift arm. Insert clevis pin through the cylinder clevis and secure with cotter pin.

3. Remove caps or plugs from the disconnected hoses and fittings. Connect hose assemblies and O–rings to the hydraulic fittings. Tighten hose connections.

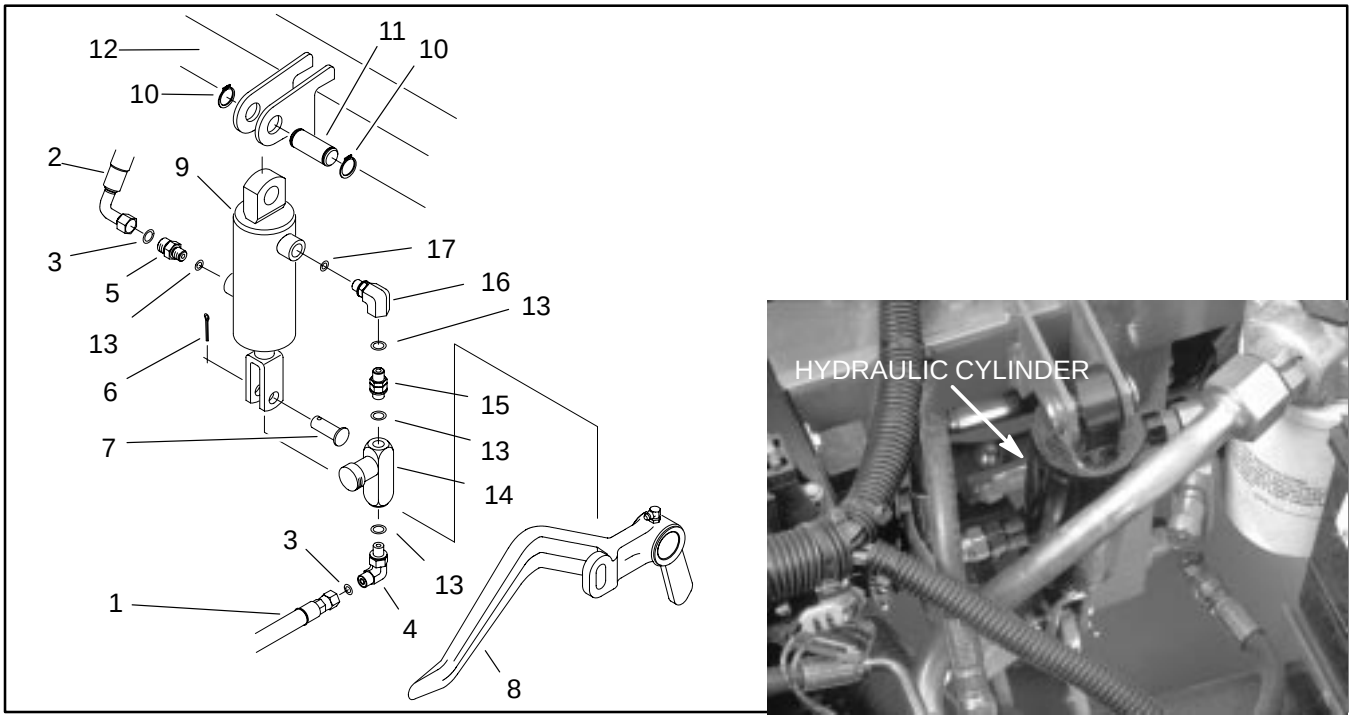


Figure 60

1. **Hose assembly**
2. **Hose assembly**
3. **O–ring**
4. **90° hydraulic fitting**
5. **Hydraulic fitting**
6. **Cotter pin**
7. **Clevis pin**
8. **Lift arm**
9. **Hydraulic cylinder**
10. **Retaining ring**
11. **Cylinder pin**
12. **Frame**
13. **O–ring**
14. **Flow control valve**
15. **Hydraulic union fitting**
16. **90° hydraulic fitting**
17. **O–ring**

Rear Cylinder Removal (Fig. 60)

1. Before removing any parts from the hydraulic system, park the machine on a level surface, engage the parking brake, lower the cutting units, and stop the engine.

CAUTION

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

2. Label all hydraulic connections for reassembly.

3. Disconnect hose assemblies and O–ring from the hydraulic fittings. Allow hoses to drain into a suitable container.

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

5. Remove cotter pin from the clevis pin. Pull clevis pin from the hydraulic cylinder and lift arm.

6. Support hydraulic cylinder to prevent it from dropping.

   A. Remove a retaining ring from the cylinder pin.

   B. Pull cylinder pin from the hydraulic cylinder and frame.

   C. Remove hydraulic cylinder from the frame.

Rear Cylinder Installation

1. Position hydraulic cylinder tho the frame. Insert cylinder pin with retaining ring through the frame bracket and cylinder. Secure pin with retaining ring.

2. Position clevis of the hydraulic cylinder to the lift arm. Insert clevis pin through the cylinder clevis and secure with cotter pin.

3. Remove caps or plugs from the disconnected hose and fittings. Connect hose assemblies and O–rings to the hydraulic fittings. Tighten hose connections.

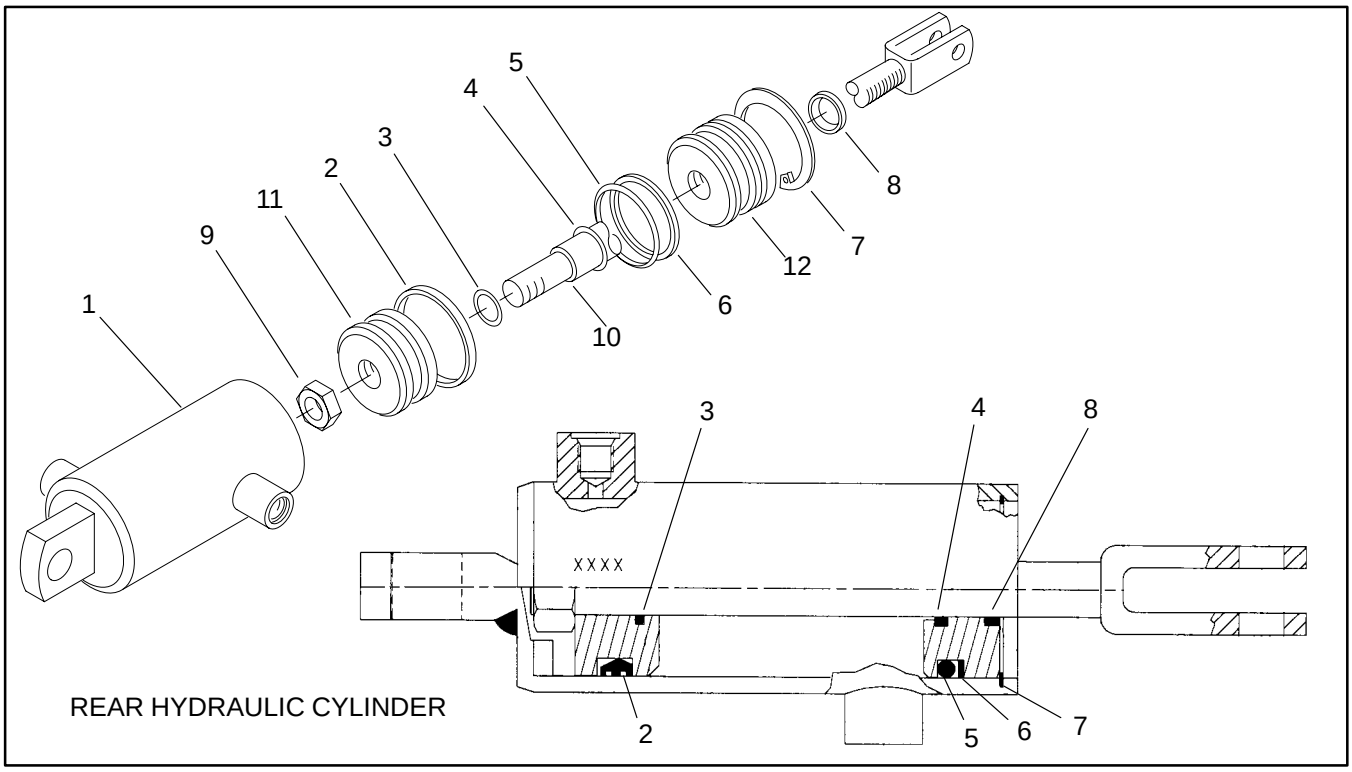


Figure 61

1. **Barrel**
2. **Uni–ring**
3. **O–ring**
4. **PDF seal**
5. **O–ring**
6. **Back–up washer**
7. **Retaining ring**
8. **Dust seal**
9. **Lock nut**
10. **Shaft**
11. **Piston**
12. **Head**

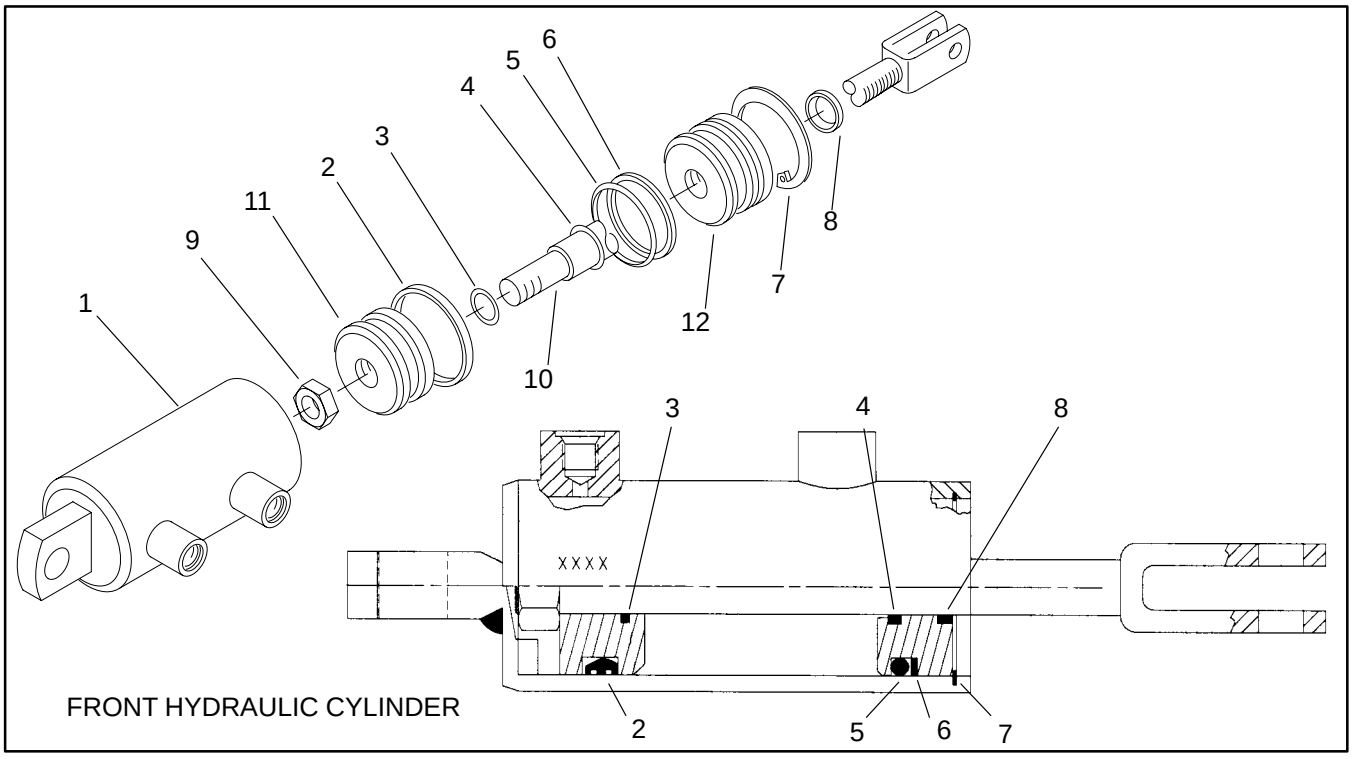


Figure 62

1. **Barrel**
2. **Uni–ring**
3. **O–ring**
4. **PDF seal**
5. **O–ring**
6. **Back–up washer**
7. **Retaining ring**
8. **Dust seal**
9. **Lock nut**
10. **Shaft**
11. **Piston**
12. **Head**

Front and Rear Cylinder Disassembly

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

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

2. Mount hydraulic cylinder in a vice. Remove dust seal and retaining ring. **NOTE:** Later production lift cylinders are equipped with a threaded collar. If so equipped, remove internal collar with a spanner wrench.

3. 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 vice.

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

5. Remove Uni–ring and O–ring from the piston. Remove PDF seal, O–ring, and back–up washer from the head.

Front and Rear Cylinder Reassembly

1. Coat new O–rings, Uni–rings, PDF seal, back–up washer, and dust seal with with clean hydraulic oil. Install Uni–ring and O–ring to the piston. Install PDF seal, O–ring, and back–up washer to the head.

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

2. Mount shaft securely in a vise by clamping on the clevis of the shaft. Slide head onto the onto the shaft. Install piston and lock nut onto the shaft. Tighten lock nut.

3. Remove shaft from the vise.

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

4. Mount barrel in a vice.

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

6. Secure head in the barrel with the retaining ring. **NOTE:** Later production lift cylinders are equipped with a threaded collar. To install collar, clean threads of collar and threads in cylinder barrel. Apply medium strength thread locking compound (e.g. Loctite #242) to threads of collar. Install collar into barrel using a spanner wrench. Tighten collar until snug and the outer end of the collar is flush with end of the barrel.

Rear Lift Cylinder Flow Control Valve

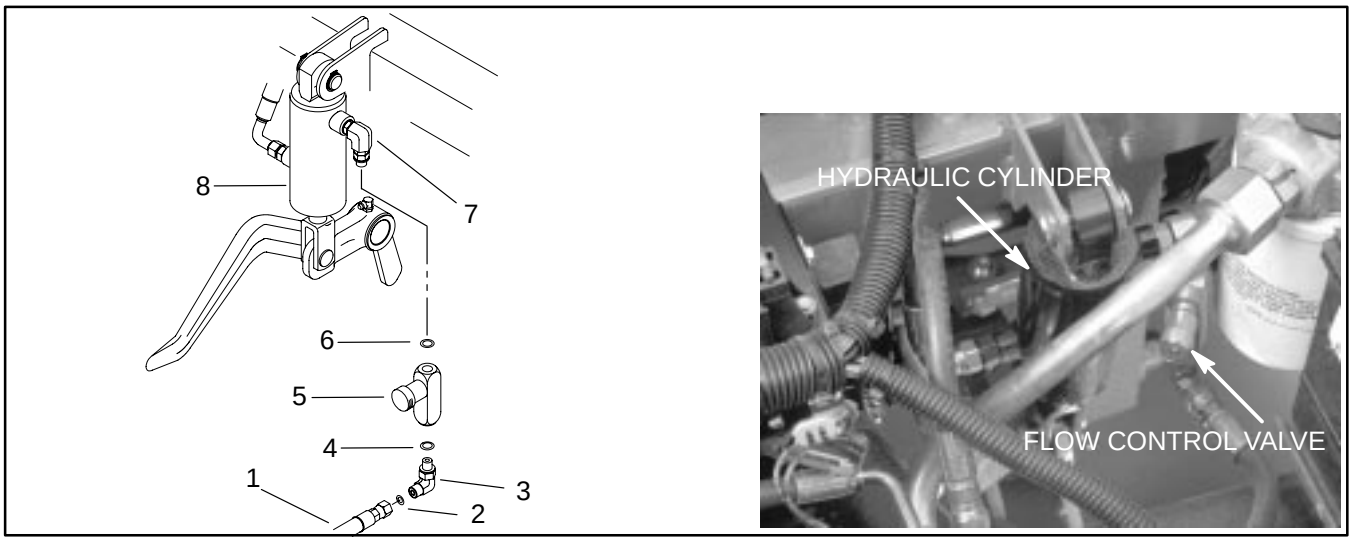


Figure 63

1. **Hose assembly**
2. **O–ring**
3. **90° hydraulic fitting**
4. **O–ring**
5. **Flow control valve**
6. **O–ring**
7. **90° hydraulic fitting**
8. **Hydraulic cylinder**

Removal

1. Before removing any parts from the hydraulic system, park machine on a level surface, engage parking brake, lower cutting units, and stop the engine.

CAUTION

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

2. Clean control valve, hydraulic fittings, and hose connection.

3. Label all hydraulic connections for reassembly. Disconnect hose assembly and O–ring from the hydraulic fitting. Allow hose to drain into a suitable container. Plug disconnected hose to prevent contamination.

4. Remove hydraulic fitting and O–ring from flow control valve. Remove valve and O–ring from hydraulic fitting. Put caps or plug on hydraulic cylinder fitting to prevent contamination.

Installation

1. Remove plugs from hose assembly and hydraulic fitting. Lubricate all new O–rings with clean hydraulic oil.

2. Install flow control valve and O–ring to the hydraulic fitting on the hydraulic cylinder. Make sure adjustment knob faces forward.

3. Install O–ring and hydraulic fitting to the flow control valve. Install O–ring and hose assembly to the hydraulic fitting.

4. Adjust flow control valve as follows:

   A. Turn adjustment knob in fully clockwise, and then turn out counterclockwise 3 turns.

   B. Adjust knob no more than 1/2 turn in either direction until the number 8 is aligned with the dimple on the valve body. Lock adjustment knob by tightening set screw.

Figure 64

Flushing Hydraulic System

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

IMPORTANT: Flush hydraulic system when changIng from petroleum base hydraulic fluid. Operate machine under normal operating conditions for at least four (4) hours before draining.

1. Park machine on a level surface. Lower cutting units, stop engine, and engage parking.

CAUTION

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

2. Clean area around hydrostat and pump inlet hose. Clamp pump inlet hose. Remove hose from hydrostat, release clamp, and drain reservoir into a suitable container. Drain hydraulic system. Make sure lift cylinders, hoses, and tube lines are drained while the system is warm. Discard filter (Fig. 65).

3. Clean oil filter mounting area. Remove filter and drain into a suitable container. Discard filter (Fig. 66).

4. Inspect and clean reservoir (see Inspecting Reservoir Parts).

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

Note: Use only hydraulic fluids (including biodegradable) specified in Checking Hydraulic System Fluid in General section. Other fluids could cause system damage.

6. Reconnect all hydraulic hoses and lines that were disconnected prior to draining. Fill hydraulic reservoir.

7. Disconnect electrical connector to the fuel stop solenoid to prevent engine from starting on diesel engine. Lift all spark plug leads on gas engine.

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

9. Connect electrical connector to the fuel stop solenoid on diesel engine. Connect all spark plug leads on gas engine.

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

11. Raise and lower cutting units several times.

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

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

14. Check condition of hydraulic oil. If the flushing fluid shows any signs of contamination, or if you are changing to biodegradable fluid, repeat steps 1 through 14 again.

15. Assume normal operation and follow recommended maintenance intervals.

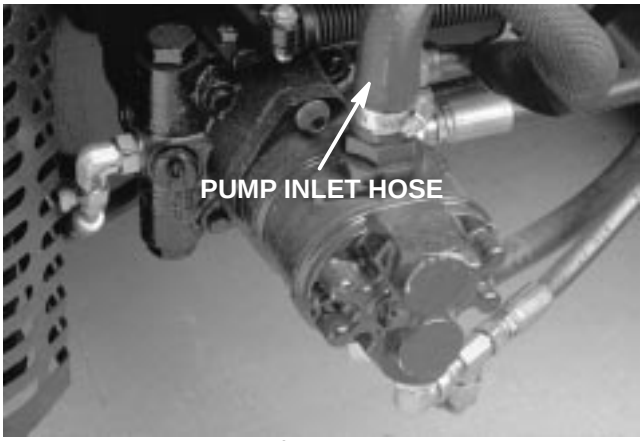


Figure 65

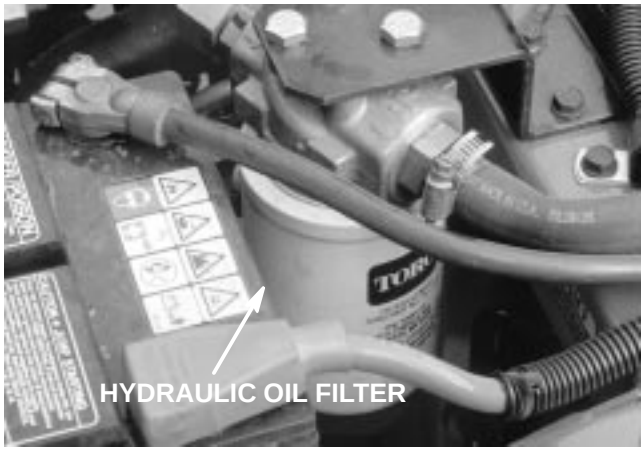


Figure 66

Hydraulic Manifold

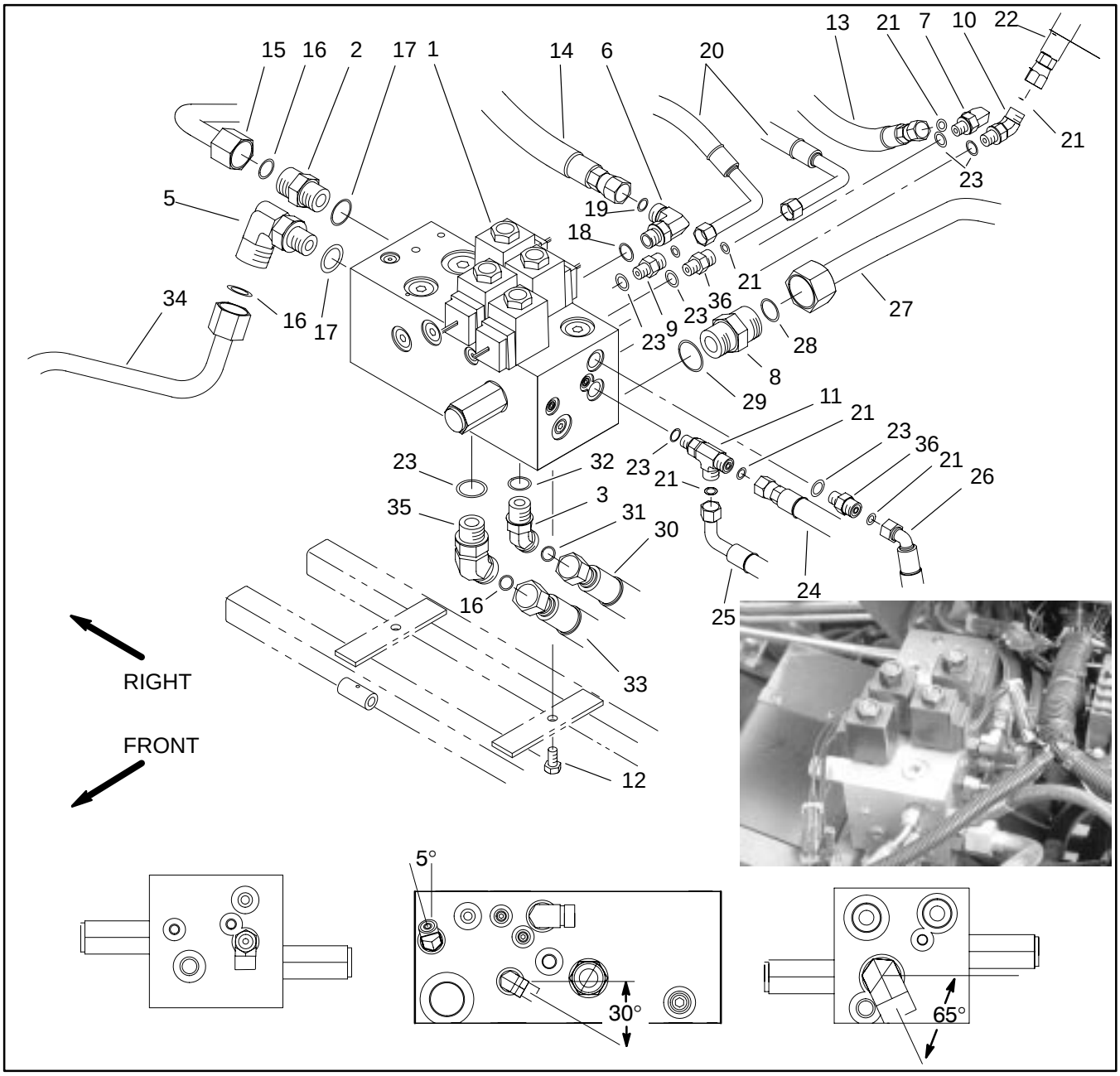


Figure 67

1. **Hydraulic manifold assembly**
2. **Hydraulic fitting (Port MB)**
3. **45° hydraulic fitting (Port PT)**
4. **Not used**
5. **90° hydraulic fitting (Port MA)**
6. **90° hydraulic fitting (Port P2)**
7. **90° hydraulic fitting (Port ST)**
8. **Hydraulic fitting (Port T)**
9. **Hydraulic fitting (Port L3A)**
10. **45° hydraulic fitting (Port L1B)**
11. **Hydraulic T–fitting (Port L2A)**
12. **Cap screw**
13. **Hose assembly**
14. **Hose assembly**
15. **Hydraulic tube**
16. **O–ring**
17. **O–ring**
18. **O–ring**
19. **O–ring**
20. **Hose assembly**
21. **O–ring**
22. **Hose assembly**
23. **O–ring**
24. **Hose assembly**
25. **Hose assembly**
26. **Hose assembly**
27. **Hydraulic tube**
28. **O–ring**
29. **O–ring**
30. **Hose assembly**
31. **O–ring**
32. **O–ring**
33. **Hose assembly**
34. **Hydraulic tube**
35. **Hydraulic fitting (Port P1)**
36. **Orifice fitting (Ports L2B & L3B)**

Note: The ports on the manifold are marked for easy identification of components. Example: R1 is the reel circuit relief valve and P1 is the gear pump connection port. (See Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port location).

Removal (Fig. 67)

1. Before removing any parts from the hydraulic system, park machine on a level surface, engage parking brake, lower cutting units, and stop the engine.

CAUTION

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

2. Disconnect solenoid valve electrical connectors. If a backlap kit is installed, disconnect electrical connector to the ball switch.

3. Clean manifold and hydraulic connections. Label all hydraulic connections and electrical connections for reassembly.

4. Disconnect hose assemblies and their respective O–rings from hydraulic fittings. Allow hoses to drain into a suitable container.

5. Put caps or plugs in disconnected hoses and manifold ports to prevent contamination.

6. Remove both cap screws (12) from the hydraulic manifold. Remove manifold assembly from the machine.

7. Disconnect hydraulic fittings and O–rings from the manifold.

Installation (Fig. 67)

1. Remove caps or plugs from manifold assembly.

Note: Fitting orientation is determined by viewing the manifold assembly from the side with its solenoids facing up.

2. Install hydraulic fittings and their respective O–rings to the manifold assembly, and orient them as follows:

Fitting Type	Part #	Port Marking	Orientation
45°	3	PT	1 O'clock
Straight	2	MB	–
45°	10	L1B	10 O'clock
Straight	9	L3A	–
90°	6	P2	3 O'clock
90°	7	ST	4 O'clock
90°	5	MA	7 O'clock
Tee	11	L2A	11 O'clock
Straight	8	T	–
45°	35	P1	1 O'clock
Orifice	36	L2B,L3B	–

3. Position manifold assembly to the support frame. Secure assembly to the frame with both cap screws.

4. Remove caps or plugs from disconnected hoses and manifold.

5. Connect hose assemblies and their respective O–rings to hydraulic fittings.

6. Connect solenoid valve electrical connectors. If a backlap kit is installed, connect electrical connector for the ball switch.

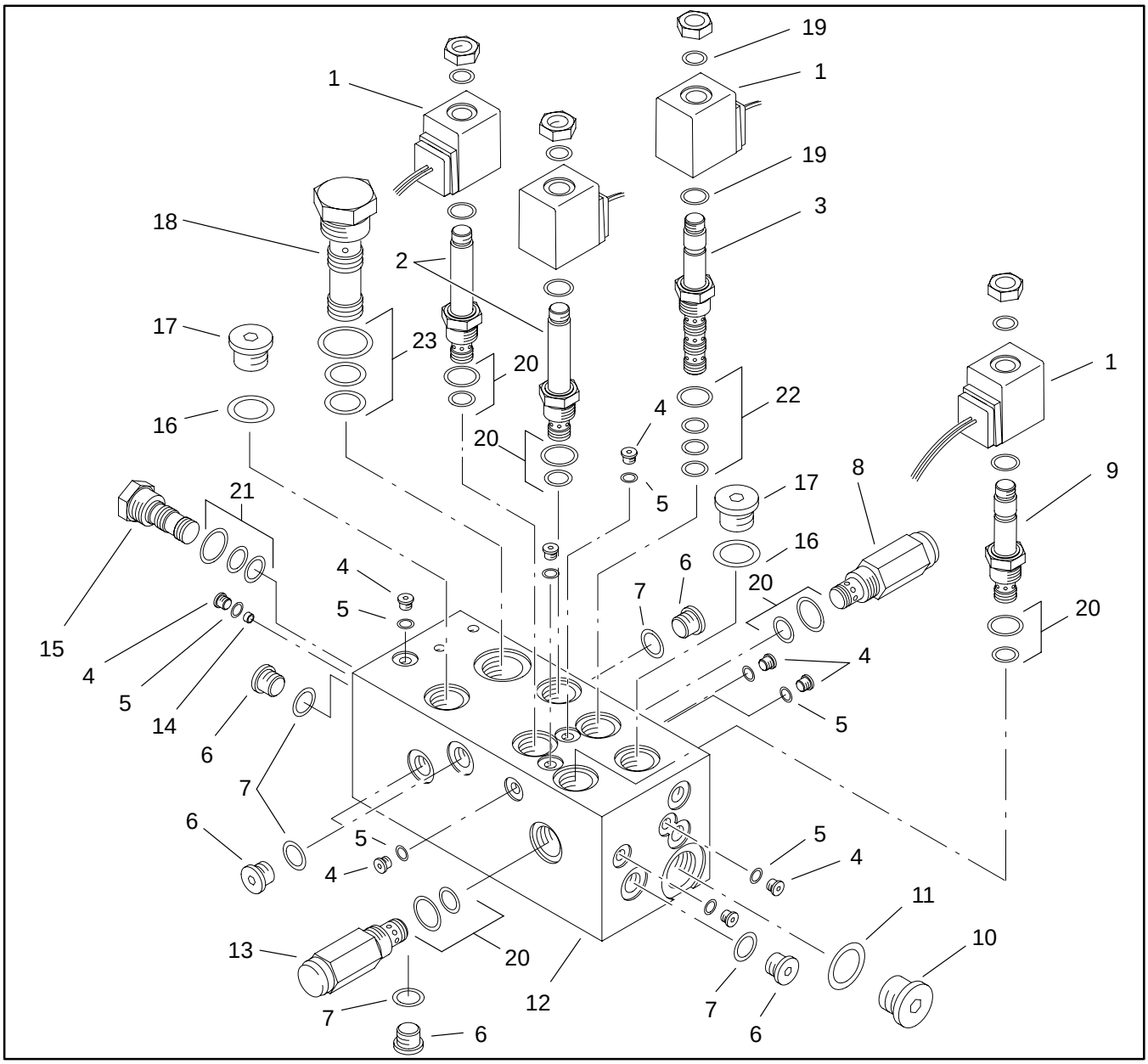


Figure 68

1. **20 watt solenoid**
2. **N.O. cartridge (Ports S1 & S2)**
3. **4Way/2Position cartridge (Port S3)**
4. **Plug**
5. **O–ring**
6. **Plug**
7. **O–ring**
8. **2000 PSI relief cartridge (Port R1)**
9. **N.C. cartridge (Port S4)**
10. **Plug**
11. **O–ring**
12. **Manifold body**
13. **150 PSI relief cartridge (Port R2)**
14. **Orifice plug**
15. **Cavity plug**
16. **O–ring**
17. **Plug**
18. **Plug**
19. **Solenoid seal**
20. **Seal kit**
21. **Seal kit**
22. **Seal kit**
23. **Seal kit**

Note: The ports on the manifold are marked for easy identification of components. Example: R1 is the reel circuit relief valve and P1 is the gear pump connection port. (See Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port location).

Solenoid Operated Cartridge Valves (Fig. 68)

1. Make sure the manifold is clean before removing the valve (s).

2. Remove nut securing solenoid to the cartridge valve. Slide solenoid and both O–rings off the valve.

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

3. Remove cartridge valve with a deep socket wrench. Remove seal kit.

4. Visually inspect the port in the manifold for damage to the sealing surfaces, damaged threads, and contamination.

5. Visually inspect cartridge valve for damaged sealing surfaces and contamination.

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

   B. If spool valve (8) sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.

CAUTION

Use eye protection such as goggles when using compressed air

6. Clean cartridge valve using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Use a probe to push the internal spool in and out 20 to 30 times to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. Use compressed air for cleaning.

7. Reinstall the cartridge valve:

   A. Lubricate new O–rings and backup rings of seal kit with clean hydraulic oil and install. The O–ring and backup ring must be arranged properly on the cartridge valve for proper operation and sealing.

   B. Thread spool valve carefully into port. The valve should go in easily without binding.

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

   C. Torque cartridge valve using a deep socket to 35 ft–lb (4.8 kg–m).

   D. Make sure a new O–ring is at each end of the solenoid coil. Install solenoid coil to the cartridge valve. Apply ”Loctite 242” or equivalent to the threads of the valve. Torque nut to 15 in–lb (17 kg–cm).

   E. If problems still exit, remove valve and clean again or replace valve.

Cartridge Relief Valves (Fig. 68)

1. Make sure the manifold is clean before removing the cartridge valve and seal kit.

2. Remove cartridge relief valve.

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

4. Visually inspect cartridge relief valve for damaged sealing surfaces and contamination.

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

   B. If sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.

CAUTION

Use eye protection such as goggles when using compressed air

5. Clean cartridge relief valve using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. Use compressed air for cleaning.

6. Reinstall the cartridge relief valve:

   A. Lubricate new O–ring and backup ring of seal kit with clean hydraulic oil and install. The O–ring and backup ring must be arranged properly on the cartridge valve for proper operation and sealing.

   B. Thread cartridge relief valve carefully into the applicable port. The valve should go in easily without binding. Torque valve to 35 ft–lb (4.8 kg–m).

Backlap Kit

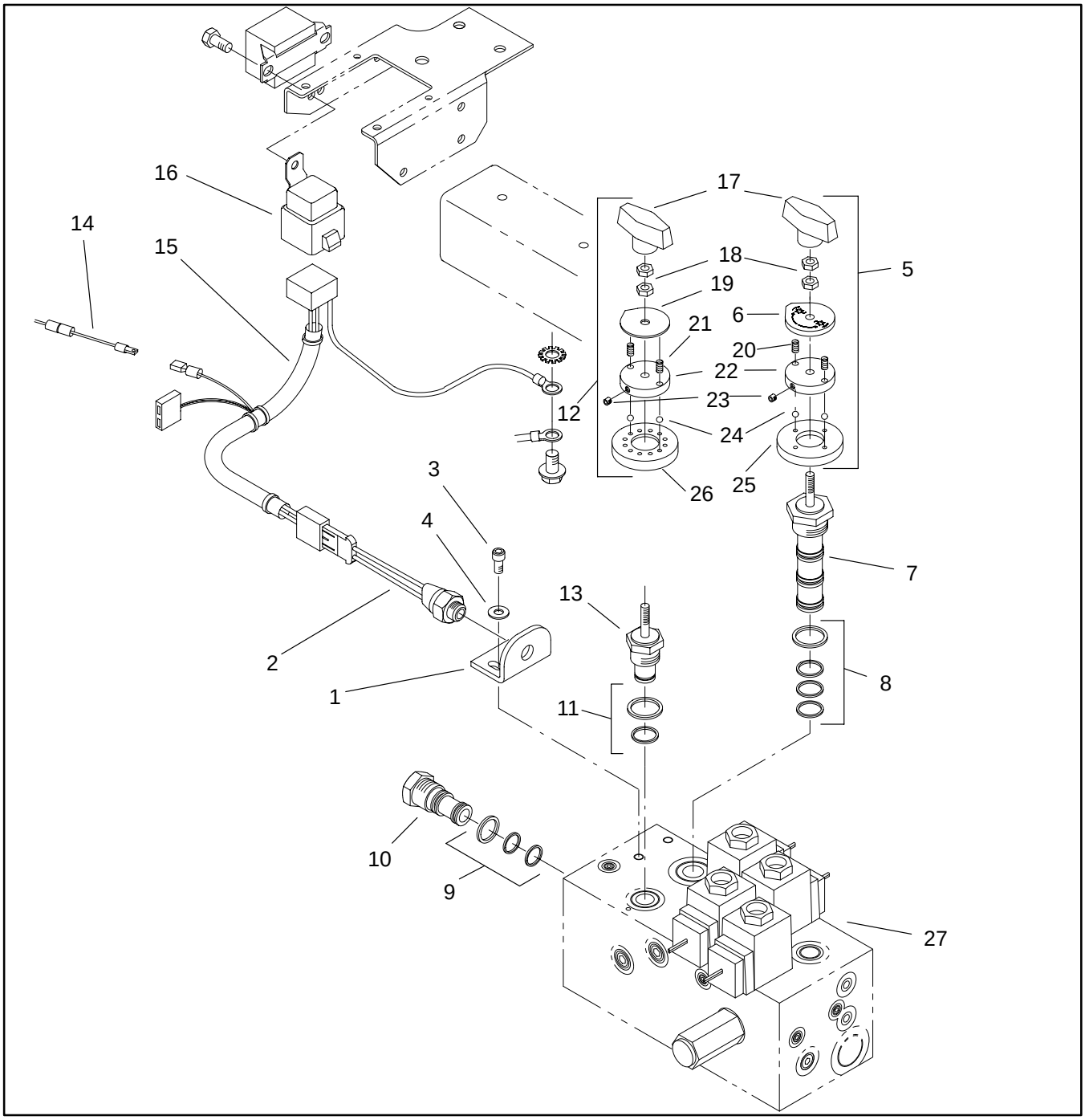


Figure 69

1. **Backlap bracket**
2. **N.O. ball switch**
3. **Socket head screw**
4. **Flat washer**
5. **Detent kit**
6. **Indicator kit**
7. **Directional cartridge valve (Port RD1)**
8. **Seal kit**
9. **Seal kit**
10. **Logic cartridge (Port LC1)**
11. **Seal kit**
12. **Detent kit**
13. **Flow control cartridge (Port FC1)**
14. **Jumper wire**
15. **Harness**
16. **Relay**
17. **Knob**
18. **Jam nut**
19. **Indicator plate**
20. **Spring**
21. **Spring**
22. **Detent plate**
23. **Set screw**
24. **Ball**
25. **Locating plate**
26. **Locating plate**
27. **Manifold**

Note: The ports on the manifold are marked for easy identification of components. Example: LC1 is for the reel logic cartridge and RD1 is for the directional valve port. (See Hydraulic Schematics to identify the function of the hydraulic lines and cartridge valves at each port location).

Flow Control and Two Position Directional Valves (Fig. 69)

1. Remove knob assembly:

   A. Unscrew and remove knob (17). Remove both jam nuts (18).

   B. Slide off applicable indicator plate (6 or 19) being careful not to lose springs (20 or 21). Remove spring.

   C. Loosen set screw (23) and slide detent plate (22) off the applicable cartridge valve (7 or 13) stem.

   D. Remove the applicable locating plate with pin (25 or 26) from the cartridge valve stem and manifold (27).

2. Make sure the manifold is clean before removing the cartridge valve (7 or 13). Remove the valve and seal kit (8 or 11).

3. Visually inspect the port in the manifold (27) for damage to the sealing surfaces, damaged threads, and contamination.

4. Visually inspect cartridge valve (7 or 13) for damaged sealing surfaces and contamination.

   A. Contamination may cause valves to stick or hang up, it can become lodged in small valve orifices or seal areas causing malfunction.

   B. If sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.

CAUTION

Use eye protection such as goggles when using compressed air

5. If necessary, clean cartridge valve (7 or 13) using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. Use compressed air for cleaning.

6. Reinstall the cartridge valve (7 or 13):

   A. Lubricate new O–ring and backup ring of seal kit (8 or 11) with clean hydraulic oil and install. The O–ring and backup ring of seal kit must be arranged properly on the cartridge valve (7 or 13) for proper operation and sealing.

   B. Thread valve carefully into the applicable port (RD1 or FC1). The valve should go in easily without binding. Torque valve to 35 ft–lb (4.8 kg–m).

7. Reinstall knob assembly:

   A. Install applicable locating plate (25 or 26) so that the pin seats into the locating hole.

   B. Turn the threaded cartridge valve (7 or 13) stem carefully clockwise until it stops.

   C. Face detent plate (22) counterbore down. Thread detent plate down onto the valve stem until it is stopped by the locating plate. Turn detent plate back counterclockwise 1/4 turn.

   D. Center one detent plate hole over a locating plate indentation. Drop a ball (24) into each hole, then drop a spring (20 or 21) into each hole.

   E. On directional cartridge valve (7), place indicator plate (6) over the detent plate. Make sure the arrow points directly at the number 1 on the locating plate.

   F. On flow control cartridge valve (13), place indicator plate (19) over the detent plate. Make sure the arrow points to the right at 45°.

   G. While pushing down on the indicator plate (6 or 19) and compressing the springs, thread down a jam nut (18). While tightening the set screw (23), tighten jam nut at the same time using a 7/16 – inch wrench

   H. Thread second jam nut all the way down the valve stem. Apply ”Loctite 242” or equivalent the valve stem threads. Screw knob (17) all the way down until it hits the upper jam nut.

   I. On directional cartridge valve (7), turn knob (17) counterclockwise so the arrow is 90° with the back of the manifold (27). Simultaneously tighten upper jam nut (18) and turn knob so it is tight and the arrow is pointing 45° to the right in line with the indicator plate (6).

   J. On flow control cartridge valve (13), turn knob (17) counterclockwise until the arrow points at the number ”5”. Simultaneously tighten upper jam nut (18) and turn knob so it is tight and the arrow is pointing at the number ”1” on the locating plate (19).

Logic Cartridge Valves (Fig. 69)

1. Make sure the manifold (27) is clean before removing logic cartridge valve (10) and seal kit (9). Remove cartridge valve.

2. Visually inspect the port in the manifold (27) for damage to the sealing surfaces, damaged threads, and contamination.

3. Visually inspect logic cartridge valve (10) for damaged sealing surfaces and contamination.

   A. Contamination may cause valves to stick or hang up, it can become lodged in small valve orifices or seal areas causing malfunction.

   B. If sealing surfaces appear pitted or damaged, the hydraulic system may be overheating or there may be water in the system.

CAUTION

Use eye protection such as goggles when using compressed air

4. Clean logic cartridge valve (10) using clean mineral spirits. Submerge valve in clean mineral spirits to flush out contamination. Particles as fine as talcum powder can affect the operation of high pressure hydraulic valves. Use compressed air for cleaning.

5. Reinstall logic cartridge valve (10):

   A. Lubricate new O–ring and backup ring of seal kit (9) with clean hydraulic oil and install. The O–ring and backup ring must be arranged properly on the cartridge valve for proper operation and sealing.

   B. Thread cartridge valve carefully into the port (LC1). The valve should go in easily without binding. Torque the valve to 35 ft–lb (4.8 kg–m).

Steering Control Valve

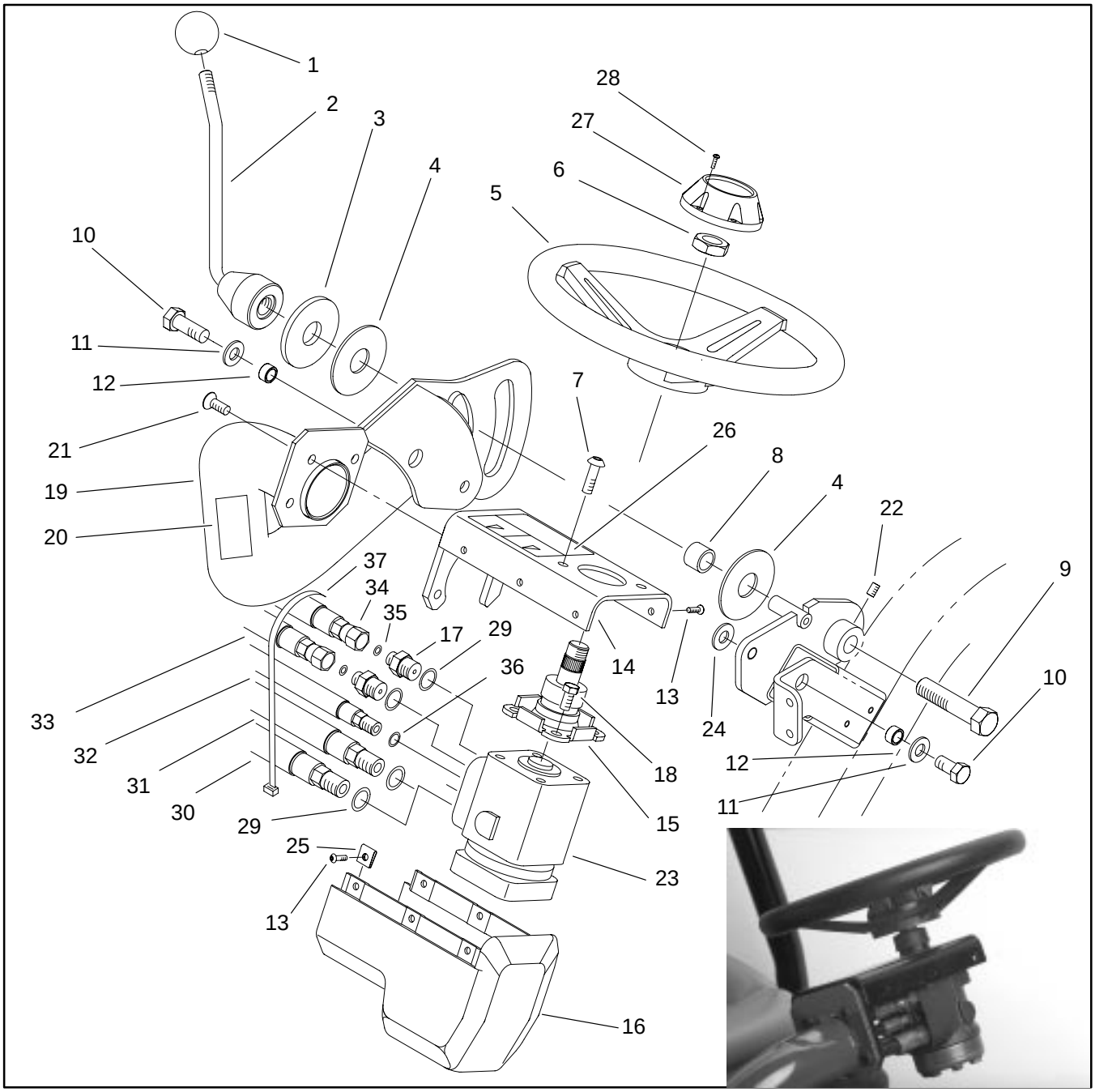


Figure 70

1. **Knob**
2. **Lockup handle**
3. **Lockup spacer**
4. **Friction disc**
5. **Steering wheel**
6. **Steering wheel nut**
7. **Socket head screw**
8. **Lockup spacer**
9. **Socket head screw**
10. **Cap screw**
11. **Flat washer**
12. **Bushing**
13. **Socket head screw**
14. **Steering arm cover**
15. **Steering column assembly**
16. **Steering valve cover**
17. **Hydraulic fitting**
18. **Cap screw**
19. **Steering arm**
20. **Decal**
21. **Socket head screw**
22. **Set screw**
23. **Steering control valve**
24. **Thrust washer**
25. **Speed nut**
26. **Warning decal**
27. **Steering wheel cap**
28. **Screw**
29. **O–ring**
30. **Hose assembly**
31. **Hose assembly**
32. **Hose assembly**
33. **Hose assembly**
34. **Hose assembly**
35. **O–ring**
36. **O–ring**
37. **Cable tie**

Removal (Fig. 70)

1. Before removing any parts from the hydraulic system, park the machine on a level surface, engage the parking brake, lower the cutting units, and stop the engine.

CAUTION

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

2. Remove screws (28) and steering wheel cap (27) from the steering wheel (5).

3. Remove steering wheel nut (6) from the steering column assembly (15).

4. Remove screws (13) from the speed nuts (25) and steering valve cover (16). Remove cover from the steering cover assembly (14).

5. Clean steering control valve, hydraulic fittings, hose connections, and hydraulic manifold block.

6. Cut and remove cable tie (37) from the hose assemblies. Label all hydraulic connections for reassembly.

7. Disconnect hose assemblies (33 and 34) and remove O–rings (35) from hydraulic fittings (17). Allow hoses to drain into a suitable container.

8. Disconnect hose assembly (30) and remove O–ring from 45° hydraulic fitting on hydraulic manifold port P2 (Fig. 71). Allow hose to drain into a suitable container.

9. Disconnect hose assembly (31) and remove O–ring from T–fitting on the end of the gear pump P2 (Fig. 72). Allow hose to drain into a suitable container.

10. Disconnect hose assembly (32) and remove O–ring from the rear hydraulic fitting on the steering cylinder (Fig. 73). Allow hose to drain into a suitable container.

11. Put caps or plugs on disconnected hoses, fittings, and open ports to prevent contamination.

12. Remove screws (7) from the steering cover assembly (14) and steering control valve (23). Pull control valve and attached hose assemblies free of the machine.

13. Remove hose assemblies (30, 31, and 32) and O–rings (29 and36) from the steering control valve (23). Remove hydraulic fittings (17) and O–rings (29) from the control valve. Plug ports to prevent contamination.

14. Remove both cap screws (18) and steering column assembly (15) from the steering control valve (23).

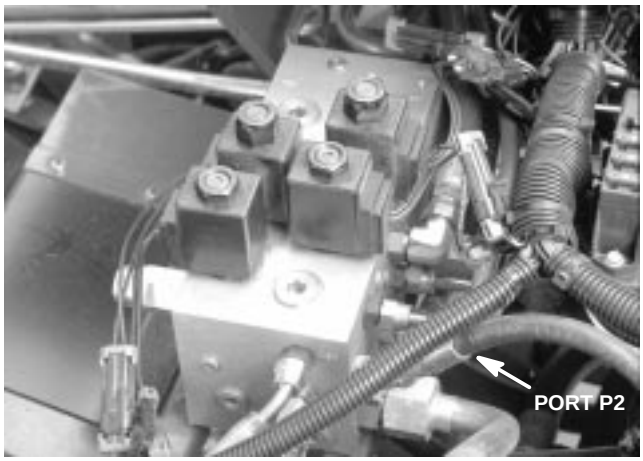


Figure 71

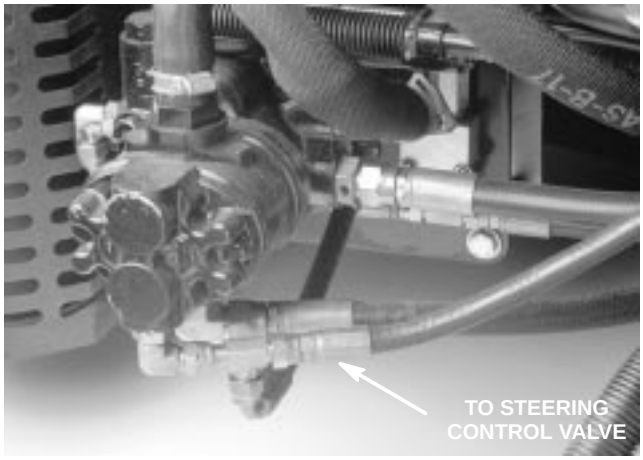


Figure 72

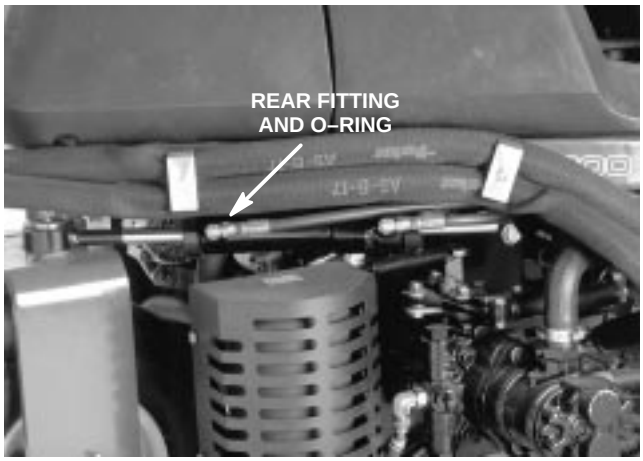


Figure 73

Installation (Fig. 70)

1. Remove caps or plugs from the disconnected, fittings, and ports.

2. Install steering column assembly (15) and both cap screws (18) to the steering control valve (23).

3. Install hydraulic fittings (17) and O–rings (29) to the steering control valve (23). Install hose assemblies (30, 31, and 32) and O–rings (29 and 36) to the control valve.

4. Position steering control valve (23) into the steering cover assembly (14) and secure with both screws (7).

5. Connect hose assembly (30) with O–ring to 45° hydraulic fitting on hydraulic manifold port P2 (Fig. 71).

6. Connect hose assembly (31) with O–ring to T–fitting on the end of the gear pump (Fig. 72).

7. Connect hose assembly (32) with O–ring to the rear hydraulic fitting on the steering cylinder (Fig. 73).

8. Connect hose assemblies (33 and 34) with O–rings (35) to hydraulic fittings (17).

9. Install cable tie (37) to the hose assemblies.

10. Position steering valve cover (16) to the steering cover assembly (14). Secure cover to assembly with screws (13) and speed nuts (25).

11. Install steering wheel nut (6) to the steering column assembly (15). Torque nut to 35 ft–lb (4.8 kg–m).

12. Secure steering wheel cap (27) with screws (28) to the steering wheel (5).

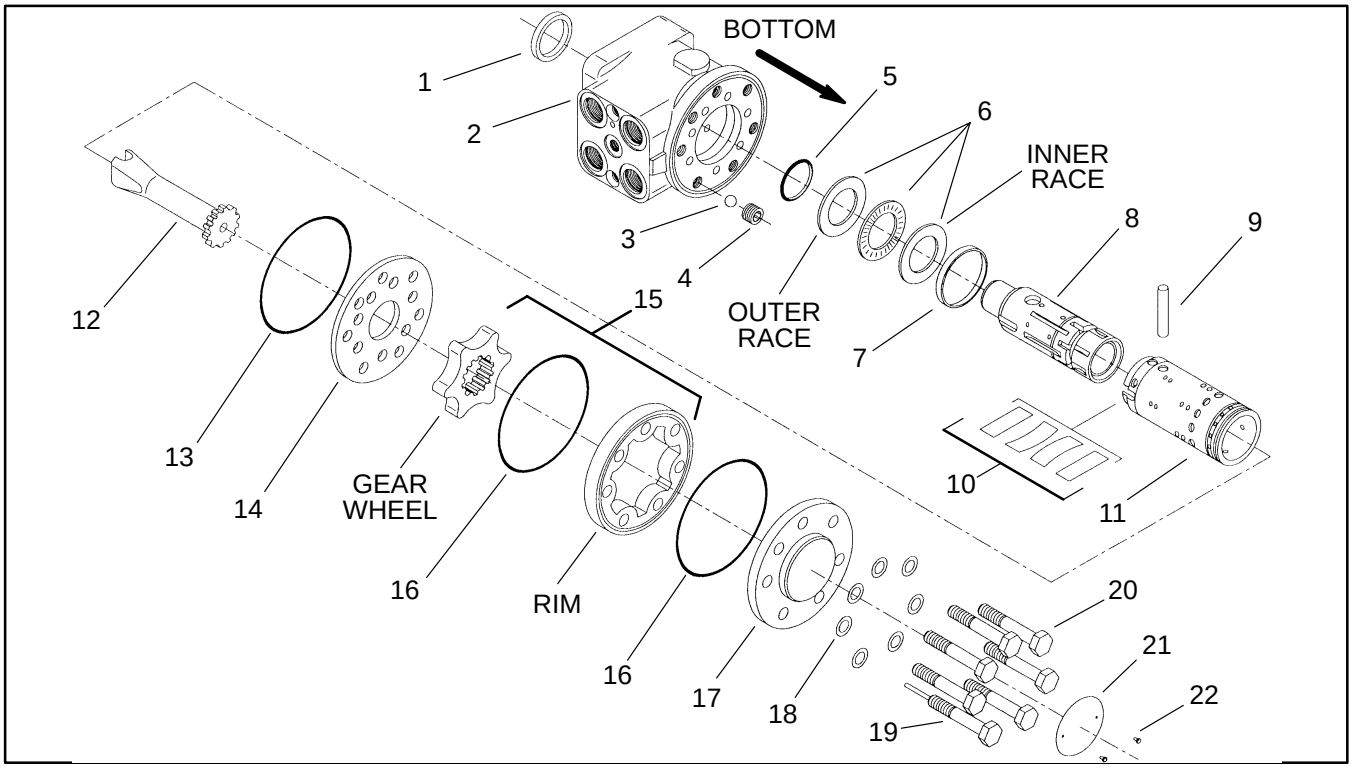


Figure 74

1. **Dust seal**
2. **Housing**
3. **Ball**
4. **Threaded bushing**
5. **O–ring/kin–ring**
6. **Bearing assembly**
7. **Ring**
8. **Spool**
9. **Cross pin**
10. **Spring set**
11. **Sleeve**
12. **Cardan shaft**
13. **O–ring**
14. **Distributor plate**
15. **Gear wheel set**
16. **O–ring**
17. **End cover**
18. **Washer**
19. **Special screw**
20. **Screw**
21. **Name plate**
22. **Drive screw**

Disassembly (Fig. 74)

1. Make sure caps or plugs are in motor openings to prevent contamination. Clean motor with solvent.

IMPORTANT: Use caution when using a vise to hold the control valve. Do not over tighten. Parts may become distorted.

2. Secure control valve in a vise with the screw heads up. Remove six screws, one special screw, and seven washers from the valve.

3. Slide end cover off the gear wheel set. Remove gear wheel set. Remove both O–rings from the rim.

4. Lift and remove cardan shaft from the control valve.

5. Remove distributor plate from the control valve and O–ring from housing.

6. Screw out threaded bushing from the control valve. Remove remove valve from the vise and shake out the ball.

Note: The cross pin can be seen through the open end of the spool.

7. Make sure cross pin is kept horizontal in the spool and sleeve. Remove sleeve, ring, and bearing from the housing by pressing the spool out the housing bottom (Fig. 75).

Note: The outer race of the bearing assembly may stick in the housing. Make sure race is removed from the housing.

8. Remove ring and bearing assembly from the spool.

Note: There is a small match mark on both the spool and sleeve near one of the slots for the spring. If the mark is not visible, match mark both the sleeve and spool before removing the springs (Fig. 76).

9. Use special screw to press out cross pin from the sleeve and spool (Fig. 75). Press spool carefully out of the sleeve.

10. Press springs out of their slots in the spool.

11. Remove dust seal and O–ring/kin–ring from the housing. Discard all seals, O–rings, and washers.

12. Remove all nicks and burrs from all parts with an emery cloth.

CAUTION

Use eye protection such as goggles when using compressed air

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

Reassembly (Fig. 74)

1. Lubricate all parts, O–ring/kin–ring, dust seal, washers, and O–rings with clean hydraulic fluid.

2. Insert two flat springs into the slot of the spool. Insert two curved springs between the flat springs and press them into place (Fig. 77).

3. Install spool into the sleeve. Make sure match marks on each part are aligned. Press springs together and push them into slot in the sleeve. Line up springs and center them (Fig. 76 and 77).

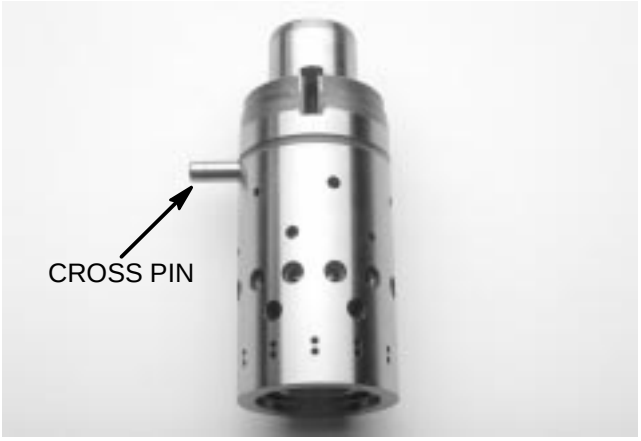


Figure 75

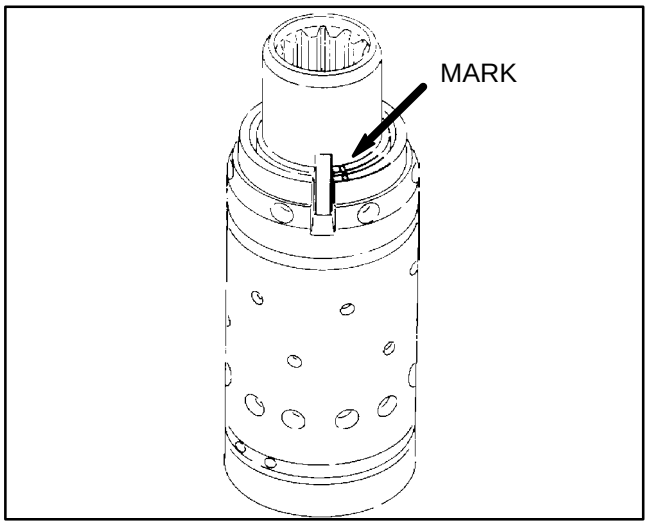


Figure 76

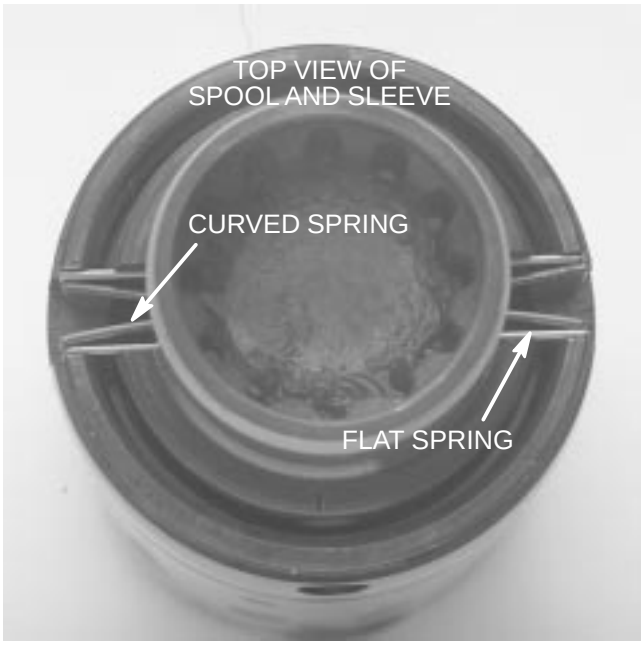


Figure 77

4. Install ring over the sleeve. Make sure ring is able to rotate free of the springs.

5. Insert cross pin into the spool and sleeve (Fig. 75).

6. Install bearing assembly onto the spool and sleeve (Fig. 78).

7. Coat new O–ring/kin–ring lightly with petroleum jelly. Install ring carefully into the inner bore of the housing so that they fit snuggly in place (Fig. 79 and 80).

Note: The cross pin should be held horizontal when inserting the spool and sleeve into the housing.

Note: The clearance between the sleeve and the housing bore is very tight. The heat from one's hand can cause the sleeve to expand enough so that it will not fit into the housing. Refrigerate the spool/sleeve assembly prior to installation. Insulate assembly from one's hand when installing.

8. Guide spool and sleeve into the housing carefully by using a light turning motion. Be careful no to damage the O–ring/kin–ring.

9. Place ball into the largest threaded hole. Secure ball into hole by threading in the bushing. Make sure the top of the bushing lies just bellow the surface of the housing (Fig. 80).

10. Coat new O–ring lightly with petroleum jelly. Install O–ring into groove on housing surface.

11. Mount distributor plate onto housing. Make sure channel holes in plate match the hole of the housing.

12. Insert cardan shaft carefully into the bore of the housing. Make sure shaft slot is parallel with the surface of the connection flange.

13. Coat both new O–rings lightly with petroleum jelly. Install O–rings into grooves on rim of gear wheel set. Place rim onto distributor plate.

IMPORTANT: The gear wheel fits into the cardan shaft from one direction only. The tooth base on the wheel should be positioned in relation to the shaft slot (Fig. 81).

14. Fit gear wheel onto cardan shaft and into the rim. Make sure holes in rim are aligned with holes in the housing.

15. Install end cover onto rim of gear wheel.

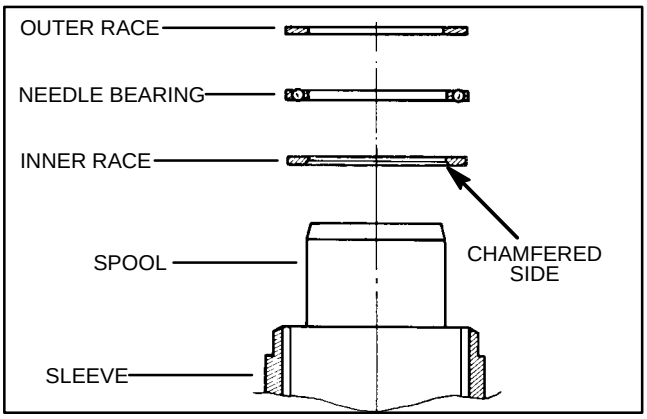


Figure 78

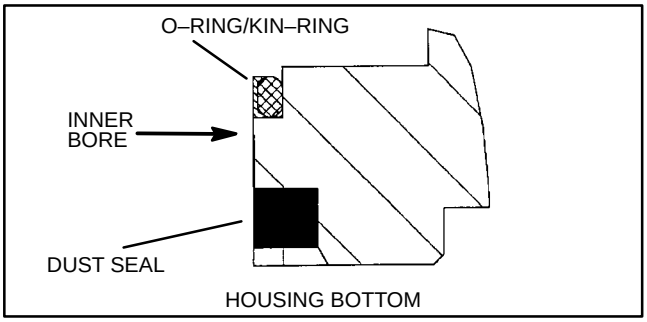


Figure 79

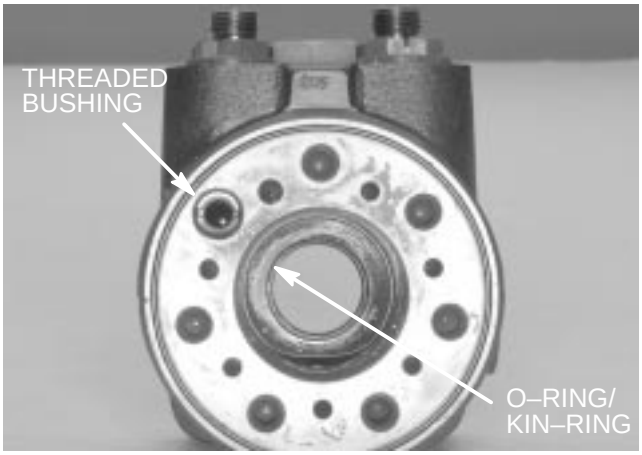


Figure 80

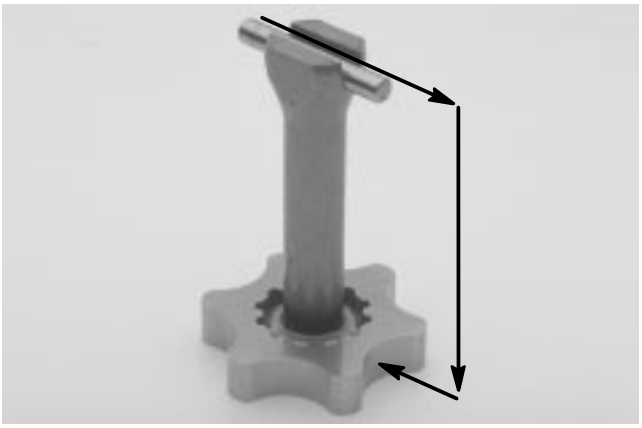


Figure 81

16. Secure special screw with new washer into the hole shown (Fig. 82 and 83).

17. Secure remaining screws with washers into control valve. Torque all screws in a criss–cross pattern from 18 to 27 ft–lb (2.4 to 3.7 kg–m).

18. Install dust seal carefully into the housing.

Figure 82

Figure 83

Steering Cylinder

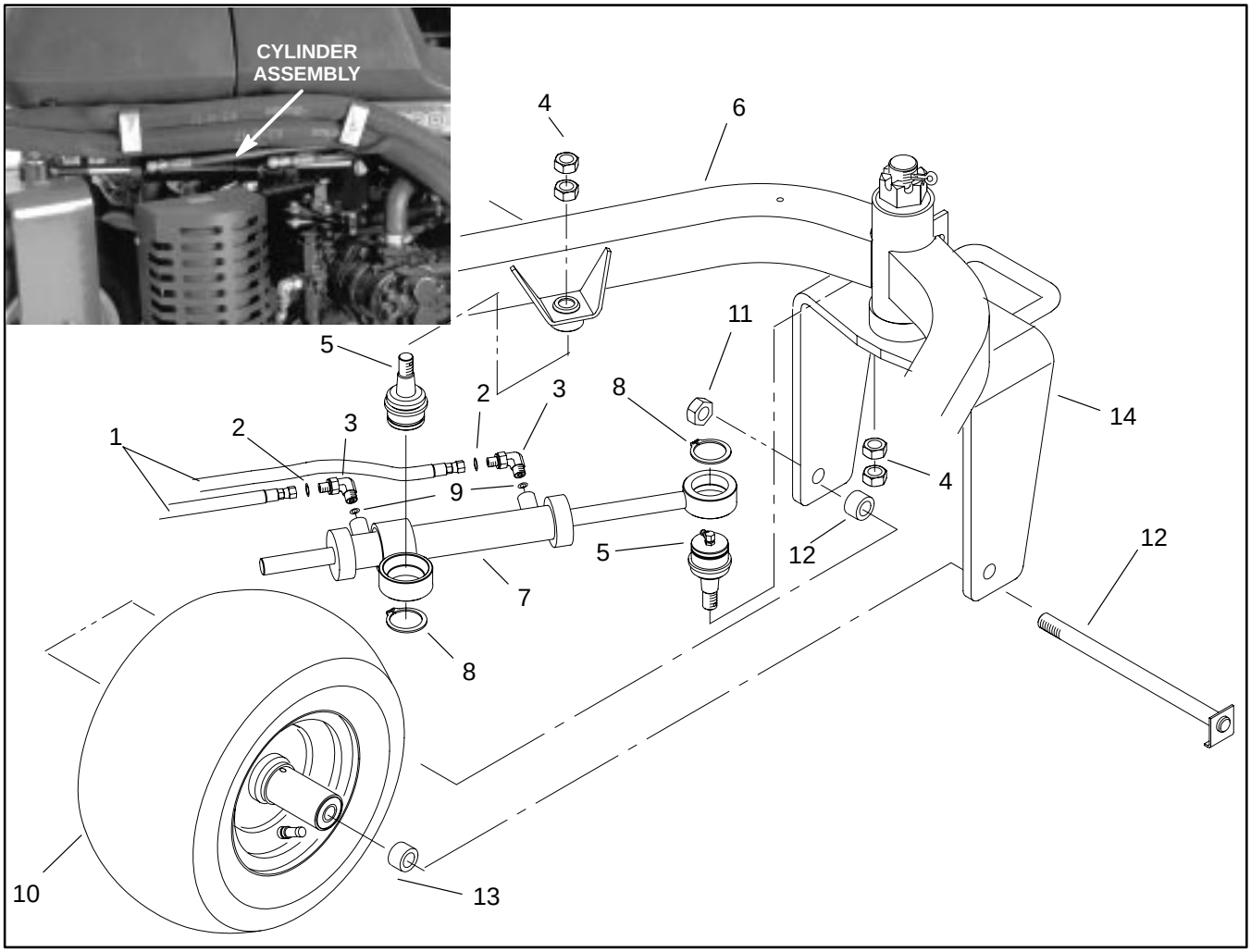


Figure 84

1. **Hose assembly**
2. **O–ring**
3. **Hydraulic fitting**
4. **Jam nut**
5. **Ball joint**
6. **Frame**
7. **Steering cylinder**
8. **Retaining ring**
9. **O–ring**
10. **Wheel**
11. **Lock nut**
12. **Bolt**
13. **Spacer**
14. **Castor fork**

Removal (Fig. 84)

1. Before removing any parts from the hydraulic system, park machine on a level surface, set brake, lower cutting units, and stop engine.

CAUTION

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

2. Clean steering cylinder assembly, hydraulic fittings, and hose assembly connections. Label all hose connections for reassembly purposes

3. Remove hose assemblies and O–rings from hydraulic fittings. Allow hoses to drain into a suitable container. Put caps or plugs on any hose connections left open or exposed.

4. Gain access to front ball joint.

   A. Remove three cap screws and flat washers securing the fuel tank base plate to frame. Two screws are on the top of the plate at the front corners of the tank. The third screw is in front of the castor fork and below the plate.

   B. Tilt fuel tank base up by lifting at the right of the machine to gain access to the top of the jam nuts and ball joint. Prop up tank securely.

5. Remove both jam nuts from the ball joint. Rotate steering cylinder and detach ball joint from frame bracket.

6. Pivot steering cylinder out from the frame. Remove retaining ring from the rear of the cylinder. Remove cylinder from rear ball joint.

7. Remove front retaining ring and ball joint from the steering cylinder. Remove hydraulic fittings and O–rings from the cylinder.

CAUTION

Support rear wheel to prevent dropping them and causing personal injury while removing hex nut. Use two people to remove steering cylinder.

8. If the rear ball joint needs to be removed, accomplish the following:

   A. Block front wheels. Jack up rear wheel off the ground by the frame. Secure the frame with the wheel off the ground.

   B. Remove lock nut, bolt, spacers, and wheel from the castor fork.

   C. Remove jam nuts and ball joint from the castor fork.

Installation (Fig. 84)

1. f the rear ball joint was removed, accomplish the following:

   A. Secure ball joint to the castor fork with jam nuts. Torque nuts from 65 to 85 ft–lb (9.0 to 11.8 kg–m).

   B. Install wheel to the castor fork by inserting the bolt through the fork, spacer, wheel, spacer, and fork. Secure bolt with lock nut.

   C. Lower wheel to ground

2. Install hydraulic fittings and O–rings to the steering cylinder. Install front ball joint to the cylinder and secure with retaining ring.

3. Install steering cylinder to the rear ball joint. and secure with retaining ring.

4. Pivot steering cylinder into the frame. Rotate steering cylinder and install ball joint to the frame bracket. Secure ball joint to the bracket with jam nuts. Torque nuts from 65 to 85 ft–lb (9.0 to 11.8 kg–m).

5. Lower fuel tank base to the frame. Secure base to the frame with the three cap screws and flat washers.

6. Remove caps or plugs from the disconnected hose and fittings. Connect hose assemblies and O–rings to the hydraulic fittings. Tighten hose connections.

Hydraulic Reservoir

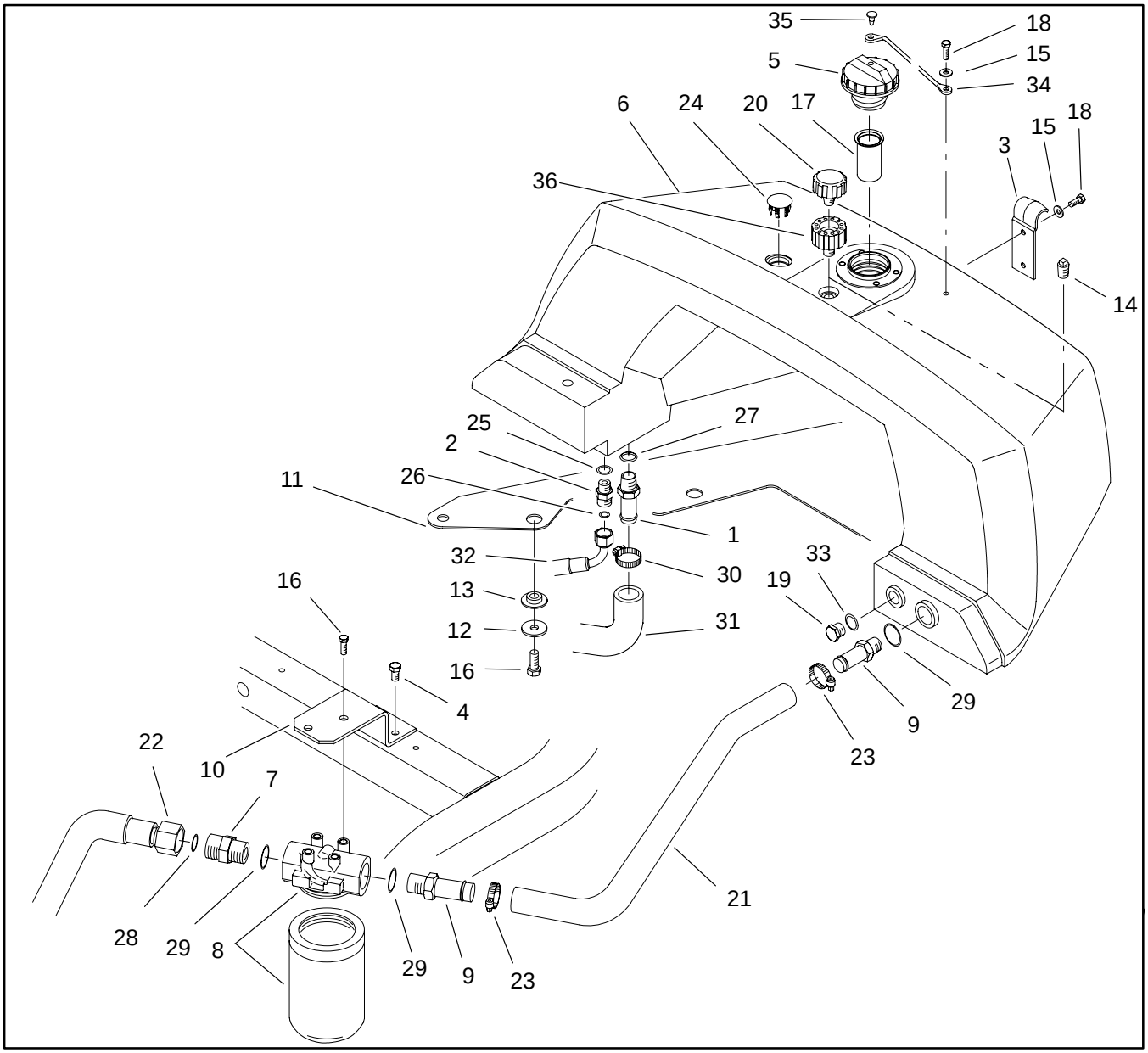


Figure 85

1. **Hydraulic barb fitting**
2. **Hydraulic fitting**
3. **Fuel tank clamp**
4. **Cap screw**
5. **Hydraulic oil clamp**
6. **Hydraulic tank**
7. **Hydraulic fitting**
8. **Oil filter assembly**
9. **Hydraulic barb fitting**
10. **Oil filter mount**
11. **Mounting plate**
12. **Flat washer**
13. **Grommet**
14. **Pipe plug**
15. **Flat washer**
16. **Cap screw**
17. **Filler screen**
18. **Cap screw**
19. **Plug**
20. **Air breather**
21. **Formed hose**
22. **Hose assembly**
23. **Hose clamp**
24. **Serrated plug**
25. **O–ring**
26. **O–ring**
27. **O–ring**
28. **O–ring**
29. **O–ring**
30. **Hose clamp**
31. **Pump inlet hose**
32. **Hose assembly**
33. **O–ring**
34. **Tether**
35. **plug**
36. **Breather adapter**

Note: The hydraulic reservoirs on the GR3200 and GR3200–D are identical on both models except for a few exceptions. The gasoline model has Leak Detection installed on top of the reservoir. The serrated plug (24) and breather adapter (36) are not installed on the GR3200; pipe plug (14) replaces the breather adapter. On the GR3200, the hydraulic oil cap (5), one flat washers (15), filler screen (17), one cap screw (18), air breather (20), tether (34), and plug (35) are installed on the leak detection tank.

Removing Hydraulic Reservoir (Fig. 85)

1. Before removing any parts from the hydraulic system, park machine on a level surface, set brake, lower cutting units, and stop engine.

CAUTION

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

2. Clean oil filter assembly (8) and hose connection, hydraulic tank (6) and hose connections, and pump inlet hose connections at the hydrostat.

3. Place a suitable container under the hydrostat to collect hydraulic oil. Clamp pump inlet hose to prevent drainage. Remove pump inlet hose from hydrostat and direct to container. Release clamp from hose (Fig. 86).

4. Disconnect hose assembly from the hydraulic fitting welded to the reel motor case drain tube located below the right side of the frame. Allow hose to drain to a suitable container (Fig. 87).

5. Disconnect formed hose (21) from hydraulic barb fitting (9). Allow hose to drain to a suitable container.

6. Remove cap screw and flat washer securing the console shroud to the hydraulic tank. Remove both cap screws and flat washers securing the console shroud to the lower panel (Fig. 88).

7. Remove three hex head screws and flat washers securing the mounting plate (11) to the frame. Two screws are located on the top of the plate at the front corners of the fuel tank. The third screw is in front of the castor fork and below the plate.

8. Tilt mounting plate (11) up by lifting at the rear of the machine. Prop up plate securely. Remove four cap screws (16) and flat washers (12) securing the hydraulic tank (6) to the mounting plate.

9. Remove hydraulic tank (6) from the mounting plate (11).

10. Hoses (31 and 32), hydraulic fittings (9,1, and 2), and O–rings (29, 27, and 25) may be removed from the hydraulic tank (6).

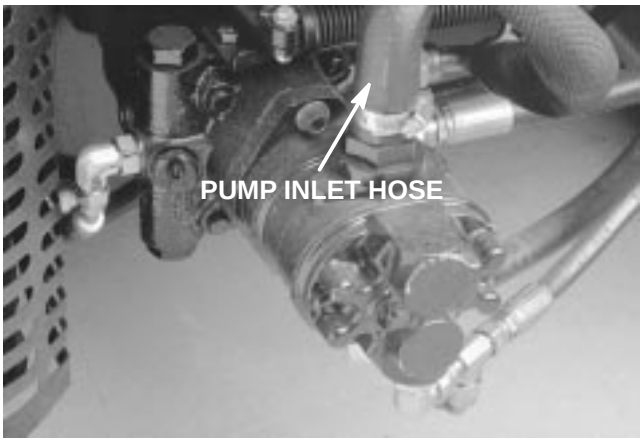


Figure 86

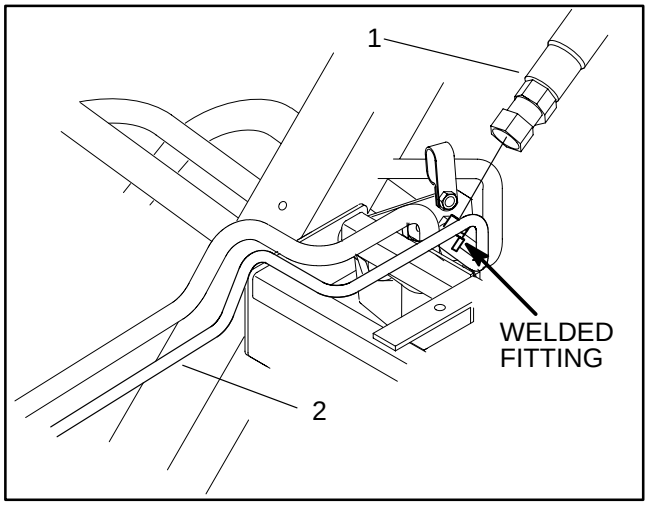


Figure 87

1. Hose assembly **2. Case drain tube**

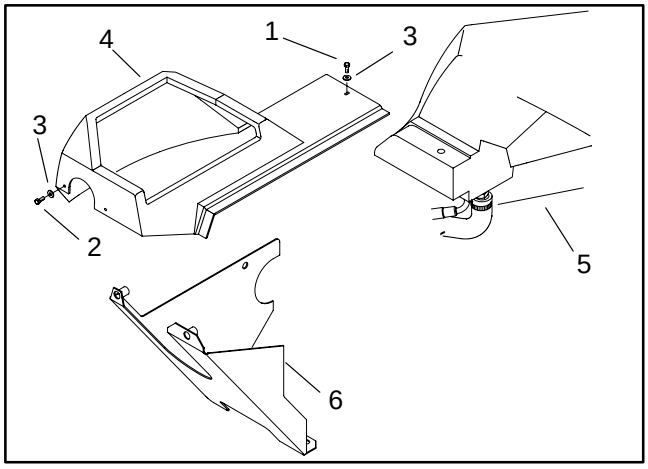


Figure 88

1. Cap screw
2. Cap screw
3. Flat washer
4. Console shroud
5. Hydraulic tank
6. Lower panel

Inspecting Reservoir Parts (Fig. 85)

1. Clean tank and filler screen with solvent.

2. Inspect tank for leaks, cracks, or other damage.

3. Replace hydraulic hoses if worn or leaking.

4. Make sure cap screws are secure. If loose, remove and reinstall cap screws with "Loctite 242" or equivalent.

5. Make sure all bracket fasteners are tight.

Installing Hydraulic Reservoir (Fig. 85)

1. If removed from the hydraulic tank (6), install the following:

   A. O–ring (27), hydraulic barb fitting (1), and pump inlet hose (31).

   B. O–ring (25), hydraulic fitting (2), and hose assembly (32).

   C. O–ring (29) and hydraulic barb fitting (9).

2. Place antiseize lubricant into all four inserts at the bottom of the hydraulic tank (6). Position tank onto the mounting plate (11).

3. Secure hydraulic tank to the mounting plate with four cap screws (16) and flat washers (12). Torque cap screws from 30 to 60 in–lb (35 to 69 kg–cm).

4. Secure mounting plate (11) to the frame with three hex head screws and flat washers Two screws go on the top of the plate at the front corners of the fuel tank. The third screw goes in front of the castor fork and below the plate.

5. Secure console shroud to the hydraulic tank with cap screw and flat washer, and to the lower panel with both cap screws and flat washers (Fig. 88).

6. Secure formed hose (21) to hydraulic barb fitting (9) with hose clamp (23).

7. Connect hose assembly to the hydraulic fitting welded to the reel motor case drain tube located below the right side of the frame (Fig. 87).

8. Secure pump inlet hose to hydrostat with hose clamp (Fig. 86).

Leak Detector

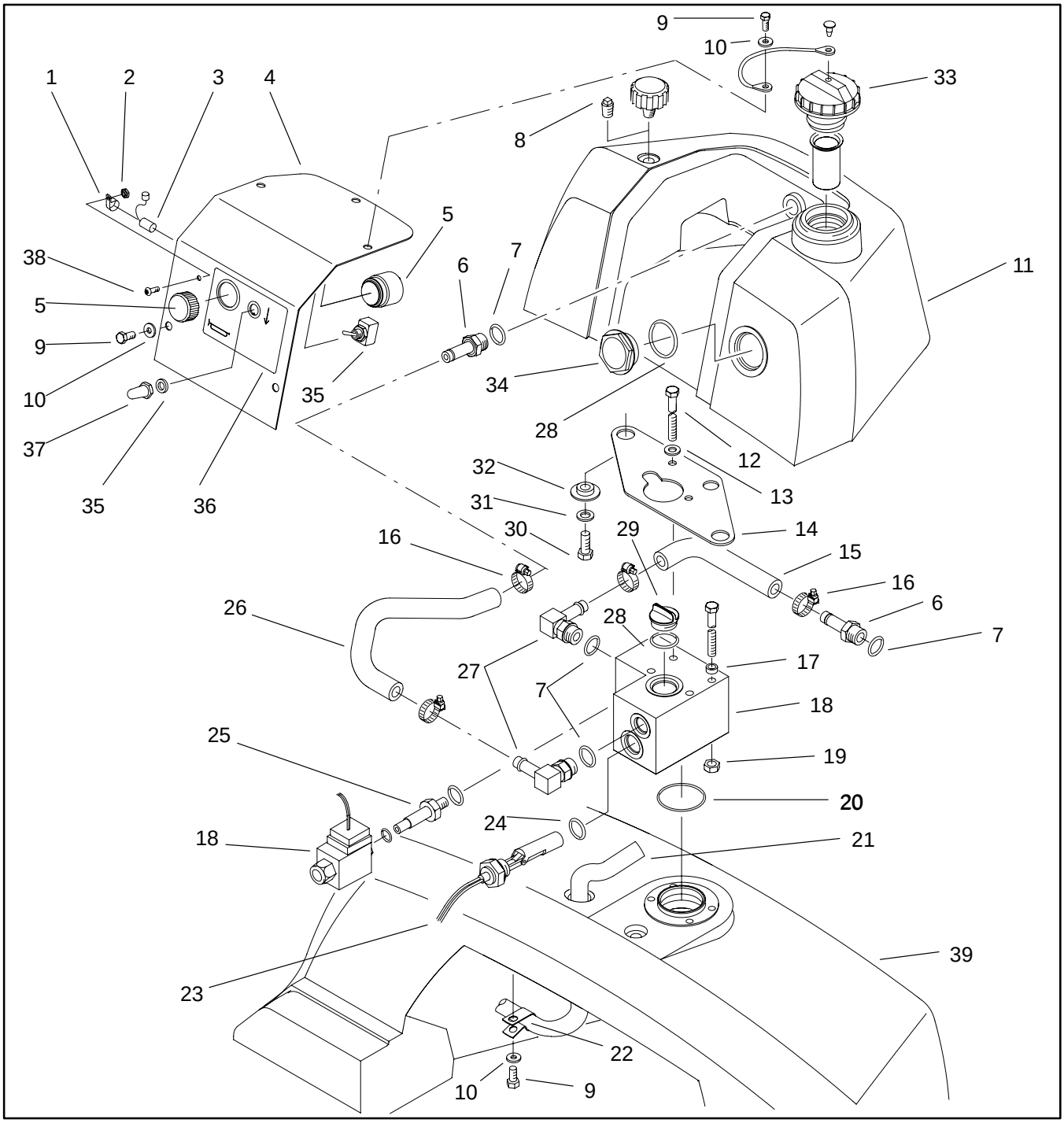


Figure 89

1. Clamp
2. Lock nut
3. Delay timer
4. Cover plate
5. Audio alarm assembly
6. Hydraulic barb fitting
7. O–ring
8. Pipe plug
9. Cap screw
10. Flat washer
11. Leak detection tank
12. Cap screw
13. Flat washer
14. Mounting plate
15. Formed outlet hose
16. Hose clamp
17. Idler washer
18. Valve assembly
19. Lock nut
20. O–ring
21. Leak detector harness
22. R–clamp
23. Oil level sensor
24. O–ring
25. Cartridge valve with O–ring
26. Formed inlet hose
27. Hydraulic barb fitting
28. O–ring
29. Plug
30. Cap screw
31. Flat washer
32. Grommet
33. Hydraulic oil cap
34. Sight gauge
35. Toggle switch
36. Leak detector decal
37. Toggle switch boot
38. Socket head screw
39. Hydraulic tank

Removal (Fig. 89)

1. Before removing any parts from the hydraulic system, park machine on a level surface, set brake, lower cutting units, and stop engine.

CAUTION

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

2. Clean oil filter assembly. Place clean container, large enough to collect 2 gallons (7.6 liters), under the oil filter assembly to collect hydraulic oil.

3. Crack open oil filter and allow at least 2 gallons (7.6 liters) of hydraulic oil to drain into the container, then tighten oil filter to stop drainage. Uncap hydraulic oil tank and allow enough time for the hydraulic oil to drain out of the leak detection tank into the hydraulic oil tank.

4. Remove five cap screws and flat washers securing the cover plate and cap tether to the leak detection tank. Remove cover plate from tank (Fig. 90).

5. Remove cap screw and flat washer securing R–clamp and leak detector harness to the underside of the hydraulic tank. Pull clamp free of harness (Fig. 91).

6. Unplug leak detector harness from 2–pin plug, with yellow/orange and black wires, on the main tractor harness. Pull leak detector harness out of the access hole on the hydraulic tank.

7. Loosen four cap screws securing the valve assembly to the fill neck on the hydraulic tank. Lift leak detection tank from the hydraulic tank. Remove O–ring from fill neck boss (Fig. 91).

Installation (Fig. 89)

1. Top off main hydraulic tank until fluid is visible at base of breather port. This will ensure that the maximum amount of air is purged from the main tank before installing the leak detector.

2. Make sure filler screen is placed in neck of auxiliary tank.

3. Make sure five capscrews and washers securing the cover plate to auxiliary hydraulic tank are removed with the cover plate (Fig. 90).

4. Clean mating surfaces of block and fill neck with a clean, dry rag. Carefully place new O–ring over fill neck boss (Fig. 91).

5. Route wire harness through access hole in hydraulic tank. Align valve assembly with fill neck. Secure valve to hydraulic tank fill neck with four capscrews (Fig. 91).

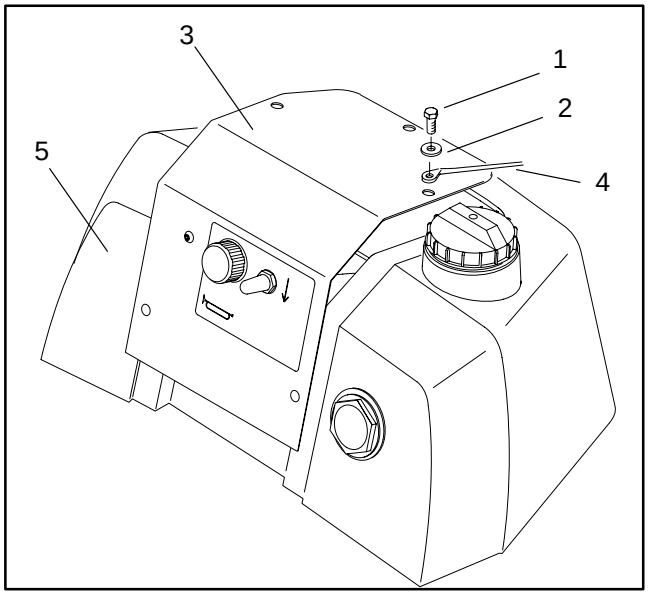


Figure 90

1. **Cap screw**
2. **Flat washer**
3. **Cover plate**
4. **Cap tether**
5. **Leak detection tank**

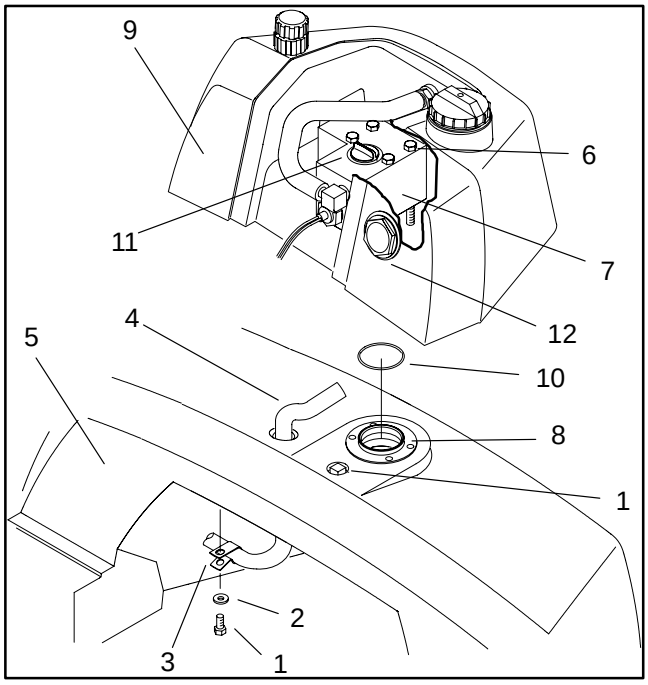


Figure 91

1. **Cap screw**
2. **Flat washer**
3. **R–ring**
4. **Leak detector harness**
5. **Hydraulic tank**
6. **Cap screw**
7. **Valve assembly**
8. **Fill neck**
9. **Leak detection tank**
10. **O–ring**
11. **Plug**
12. **Sight gauge**

IMPORTANT: Do not over tighten cap screw. Threads in tank may become damaged.

6. Locate plugged 2–pin connector with yellow/orange and black wires in main tractor harness. Attach leak detector harness. Secure leak detector harness to underside of leak detection tank with R–clamp and capscrew.

7. Remove plug from top of the valve assembly. Carefully fill float cavity to the top of the threads. Replace and tighten fill plug. Clean up any spilled oil (Fig. 91).

8. Before reattaching cover plate, test leak detector switch with ignition key switch in **ON/RUN** position. The buzzer should sound with toggle switch held down for 1 second.

9. If the buzzer fails to sound, check to see if the ignition key switch is in **ON/RUN** position, all connections are secure, and the test switch is held for 1 full second.

IMPORTANT: Do not over tighten cap screws. Threads in tank may become damaged.

10. Secure cover plate and cap tether to the leak detection tank with five cap screws and flat washers (Fig. 91).

Note: Monitor hydraulic fluid level in sight glass and as air is removed from the hydraulic circuit, auxiliary tank may need to be topped off after initial fill.

11. Fill leak detection tank to the top of sight gauge (Fig. 91).

IMPORTANT: If a leak occurs or oil is removed from the hydraulic system for service, the lost oil must be replaced. If a large amount of oil is lost, remove leak detection tank cover plate and follow steps 7 through11 for refilling instructions. For small amounts of oil, simply add oil to auxiliary tank.

Disassembly and Inspection (Fig. 89)

1. The leak detector can be disassembled using the Leak detector assembly drawing as a guide.

2. Clean tank and filler screen with solvent. Inspect parts for the following:

   A. Leaking, cracked, or damaged leak detection tank.

   B. Worn or leaking hydraulic hoses. Replace if necessary.

   C. Visibly worn or damaged parts.

Assembly (Fig. 89)

1. Coat all O–rings with clean hydraulic oil.

2. Secure sight gauge (34) and new O–ring (28) to the leak detection tank (11). Torque gauge from 100 to 125 in–lb (115 to 144 kg–cm).

3. Secure both hydraulic barb fittings (6) and new O–rings (7) to the leak detection tank. Torque both fittings from 17 to 21 ft–lb (2.4 to 2.9 kg–m).

4. Apply antiseize lubricant to threaded holes on bottom of leak detection tank. Secure mounting plate (14) to tank with two grommets (32), flat washers (31), and cap screws (30). Torque both screws from 30 to 60 in–lb (35 to 69 kg–cm).

5. Secure formed inlet hose (26) to the hydraulic barb fitting (6) attached to the end of the tank with hose clamp (16). Secure formed outlet hose (15) to the hydraulic barb fitting (6) attached to the inner side of the tank with hose clamp (16).

6. Secure both hydraulic barb fittings (27) and O–rings (28) to the valve assembly (18). Secure oil level sensor (23) and O–ring (24) to the assembly. Secure cartridge valve with O–ring (25) to assembly. Hand tighten plug (29) and O–ring (28) to the assembly.

7. Position valve assembly (18) under the mounting bracket (14). Insert four cap screws (12) with two flat washers (13) and two idler washers (17) through the bracket and assembly. Hand tighten four M8–1.25 lock nuts to the cap screws.

8. Secure toggle switch (35) to cover plate (4) with nut, then secure toggle switch boot (37) to switch. Secure audio alarm (5) to plate with cap. Secure delay timer (3) to the plate with clamp (1), socket head screw (38), and lock nut (2).

9. Connect leak detector harness to the following:

   A. The connector with red and black wires to the delay timer (3).

   B. The black/white and black wires to the negative terminal of the audio alarm (5). Connect red and yellow wires to the positive terminal.

   C. The black and gray wires to the negative terminal of the toggle switch (35). Connect red and yellow wires to the positive terminal.

   D. The red/white and red wires to the positive terminal of the valve solenoid (18). Connect black wires to the negative terminal.

   E. The connector with yellow and gray wires to the oil level sensor (23).

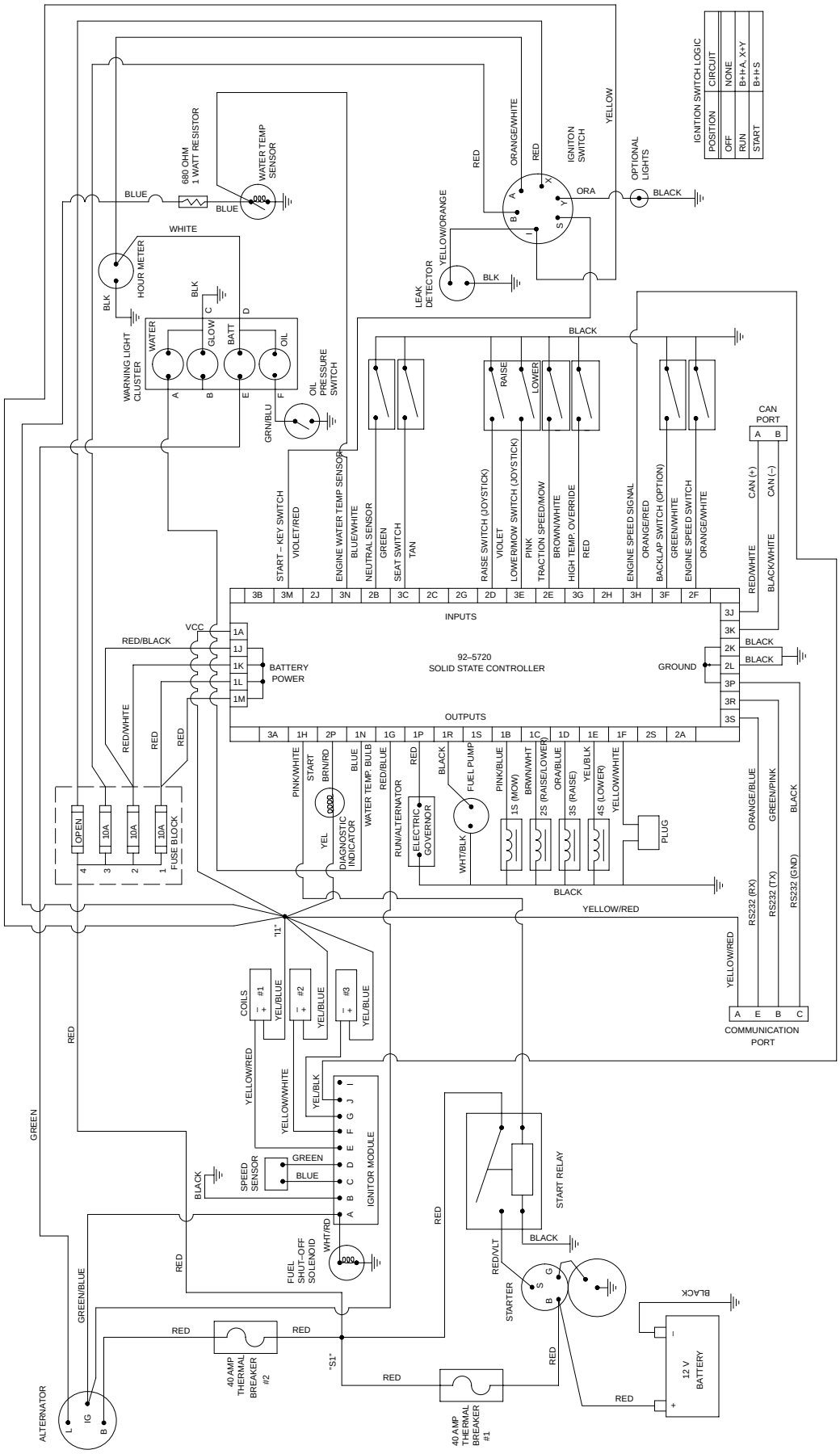
10. Verify leak detector operation (see Leak Detector in Chapter 7 – Electrical System).

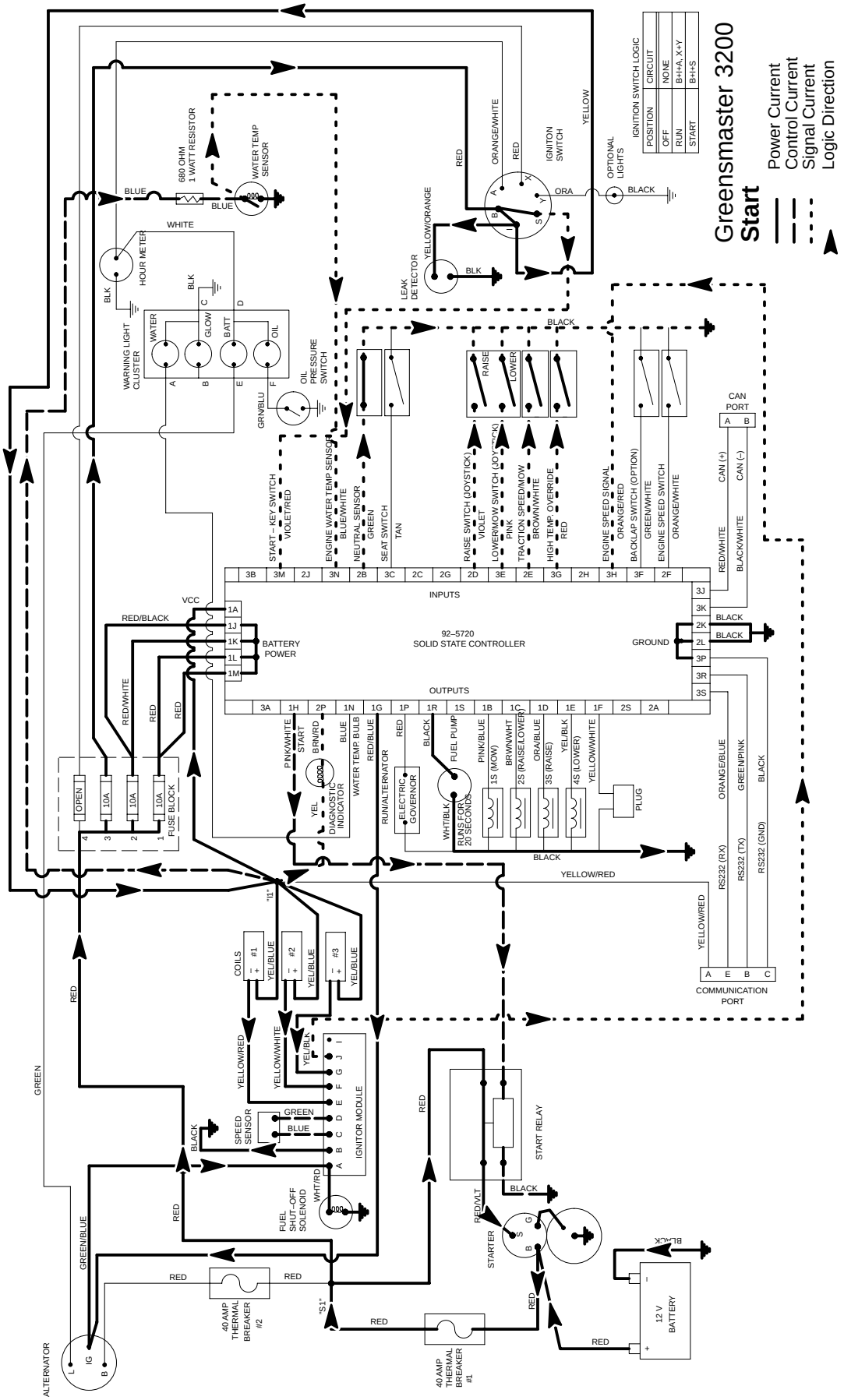
Chapter 6

Electrical System

Table of Contents

Wiring Schematics

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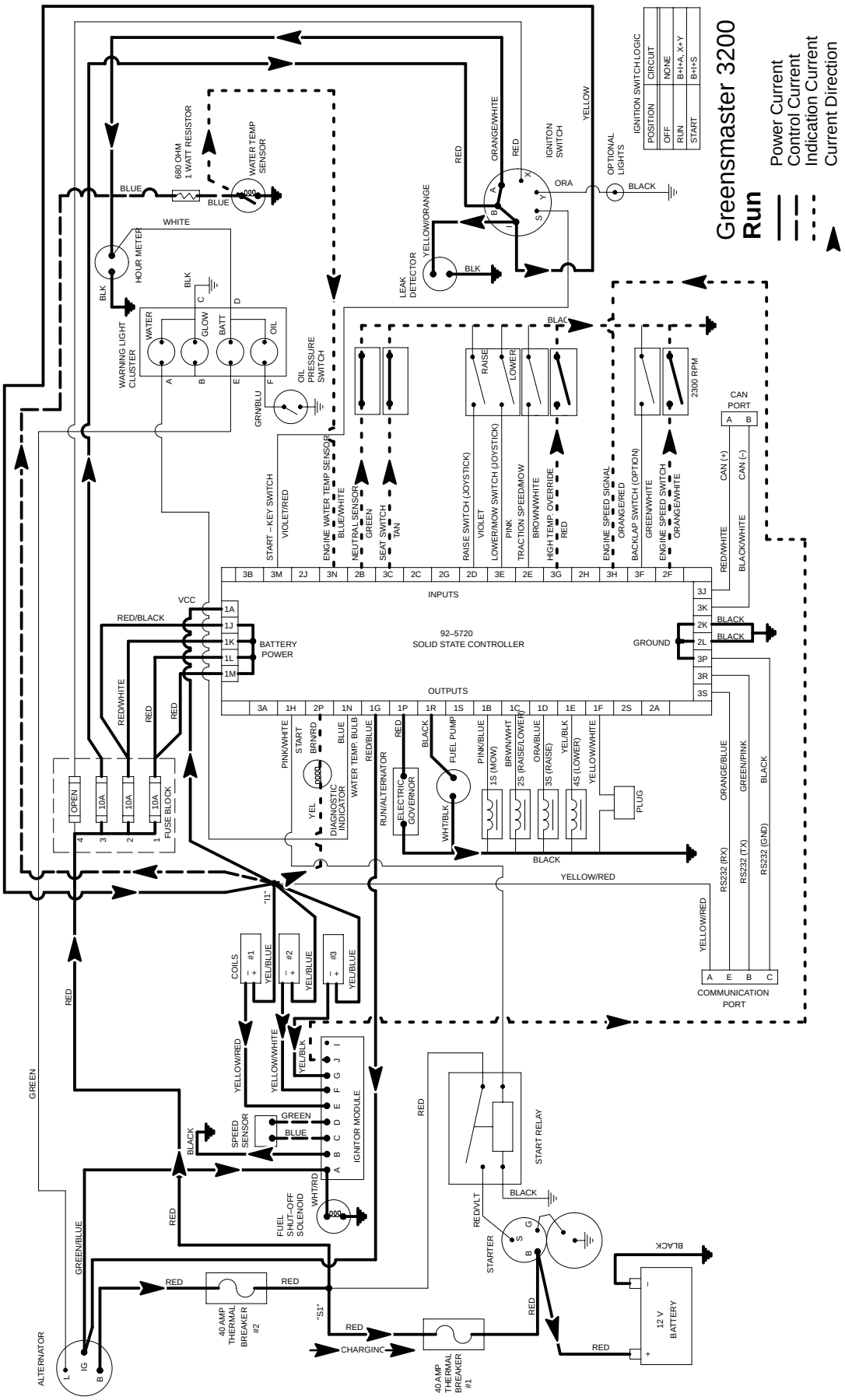
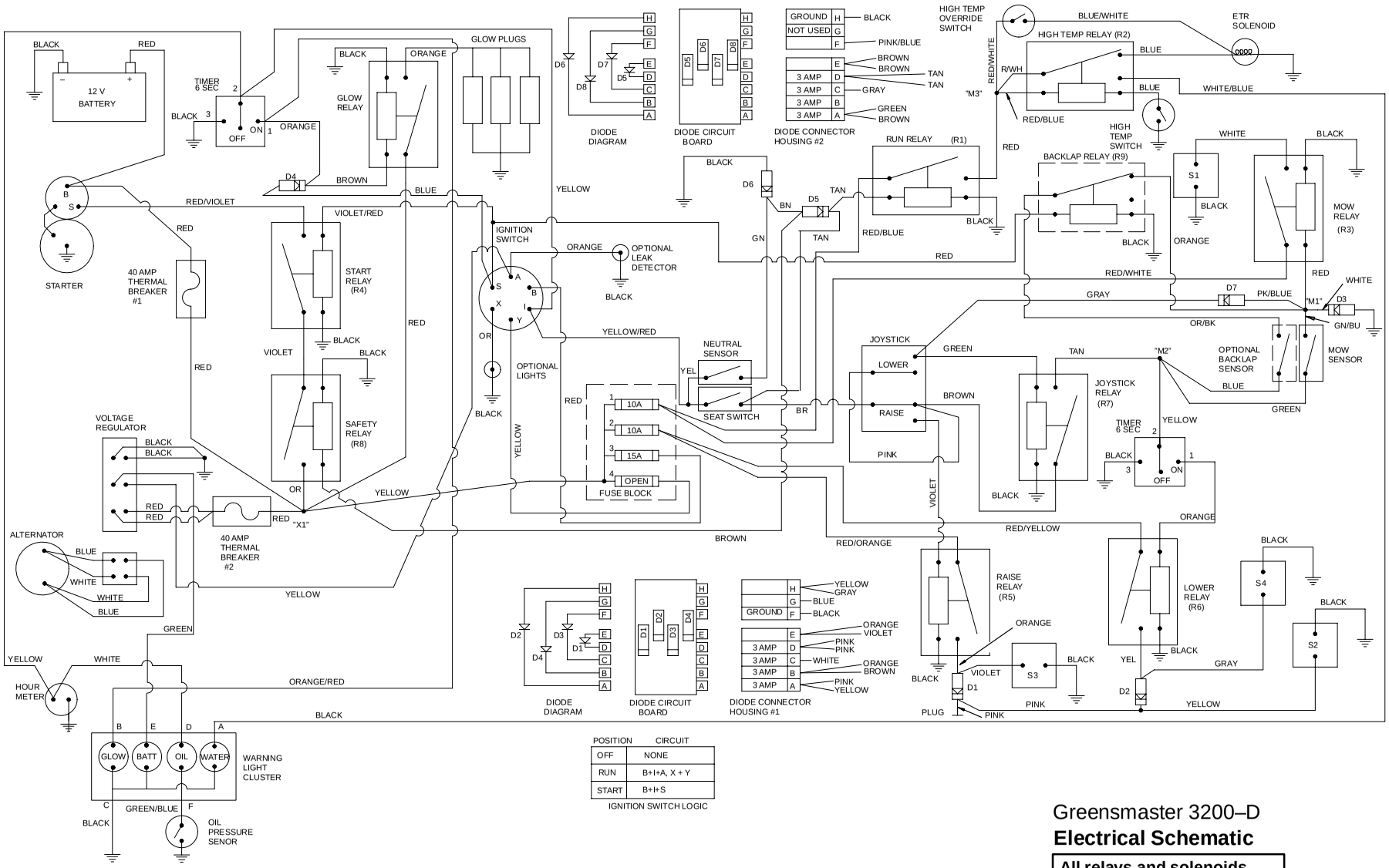
Power Current
Control Current
Signal Current
Logic Direction
IGNITION SWITCH LOGIC
POSITION | CIRCUIT
OFF | NONE
RUN | B+I+A, X+Y
START | B+I+S
92–5720
SOLID STATE CONTROLLER
INPUTS
OUTPUTS
BATTERY POWER
GROUND
VCC
FUSE BLOCK
OPEN
10A
10A
10A
IGNITION SWITCH
OPTIONAL LIGHTS
680 OHM 1 WATT RESISTOR
WATER TEMP SENSOR
HOUR METER
WARNING LIGHT CLUSTER
WATER
GLOW
BATT
OIL
OIL PRESSURE SWITCH
LEAK DETECTOR
RAISE
LOWER
CAN PORT
CAN (+)
CAN (–)
START – KEY SWITCH
ENGINE WATER TEMP SENSOR
NEUTRAL SENSOR
SEAT SWITCH
RAISE SWITCH (JOYSTICK)
LOWER/MOW SWITCH (JOYSTICK)
TRACTION SPEED/MOW
HIGH TEMP. OVERRIDE
ENGINE SPEED SIGNAL
BACKLAP SWITCH (OPTION)
ENGINE SPEED SWITCH
DIAGNOSTIC INDICATOR
WATER TEMP. BULB
RUN/ALTERNATOR
ELECTRIC GOVERNOR
FUEL PUMP
RUNS FOR 20 SECONDS
1S (MOW)
2S (RAISE/LOWER)
3S (RAISE)
4S (LOWER)
PLUG
RS232 (RX)
RS232 (TX)
RS232 (GND)
COMMUNICATION PORT
COILS
SPEED SENSOR
IGNITOR MODULE
START RELAY
FUEL SHUT–OFF SOLENOID
STARTER
ALTERNATOR
40 AMP THERMAL BREAKER #2
40 AMP THERMAL BREAKER #1
12 V BATTERY


Greensmaster 3200
Run
Power Current
Control Current
Indication Current
Current Direction
IGNITION SWITCH LOGIC
POSITION
CIRCUIT
OFF
NONE
RUN
B+I+A, X+Y
START
B+I+S
IGNITON SWITCH
OPTIONAL LIGHTS
680 OHM 1 WATT RESISTOR
WATER TEMP SENSOR
HOUR METER
WARNING LIGHT CLUSTER
WATER
GLOW
BATT
OIL
OIL PRESSURE SWITCH
LEAK DETECTOR
START – KEY SWITCH
ENGINE WATER TEMP SENSOR
NEUTRAL SENSOR
SEAT SWITCH
RAISE SWITCH (JOYSTICK)
LOWER/MOW SWITCH (JOYSTICK)
TRACTION SPEED/MOW
HIGH TEMP. OVERRIDE
ENGINE SPEED SIGNAL
BACKLAP SWITCH (OPTION)
ENGINE SPEED SWITCH
2300 RPM
CAN PORT
CAN (+)
CAN (-)
INPUTS
OUTPUTS
92–5720
SOLID STATE CONTROLLER
VCC
BATTERY POWER
GROUND
FUSE BLOCK
OPEN
10A
DIAGNOSTIC INDICATOR
WATER TEMP. BULB
RUN/ALTERNATOR
ELECTRIC GOVERNOR
FUEL PUMP
1S (MOW)
2S (RAISE/LOWER)
3S (RAISE)
4S (LOWER)
PLUG
RS232 (RX)
RS232 (TX)
RS232 (GND)
COMMUNICATION PORT
COILS
SPEED SENSOR
IGNITOR MODULE
FUEL SHUT–OFF SOLENOID
START RELAY
STARTER
ALTERNATOR
40 AMP THERMAL BREAKER #2
40 AMP THERMAL BREAKER #1
CHARGING
12 V BATTERY



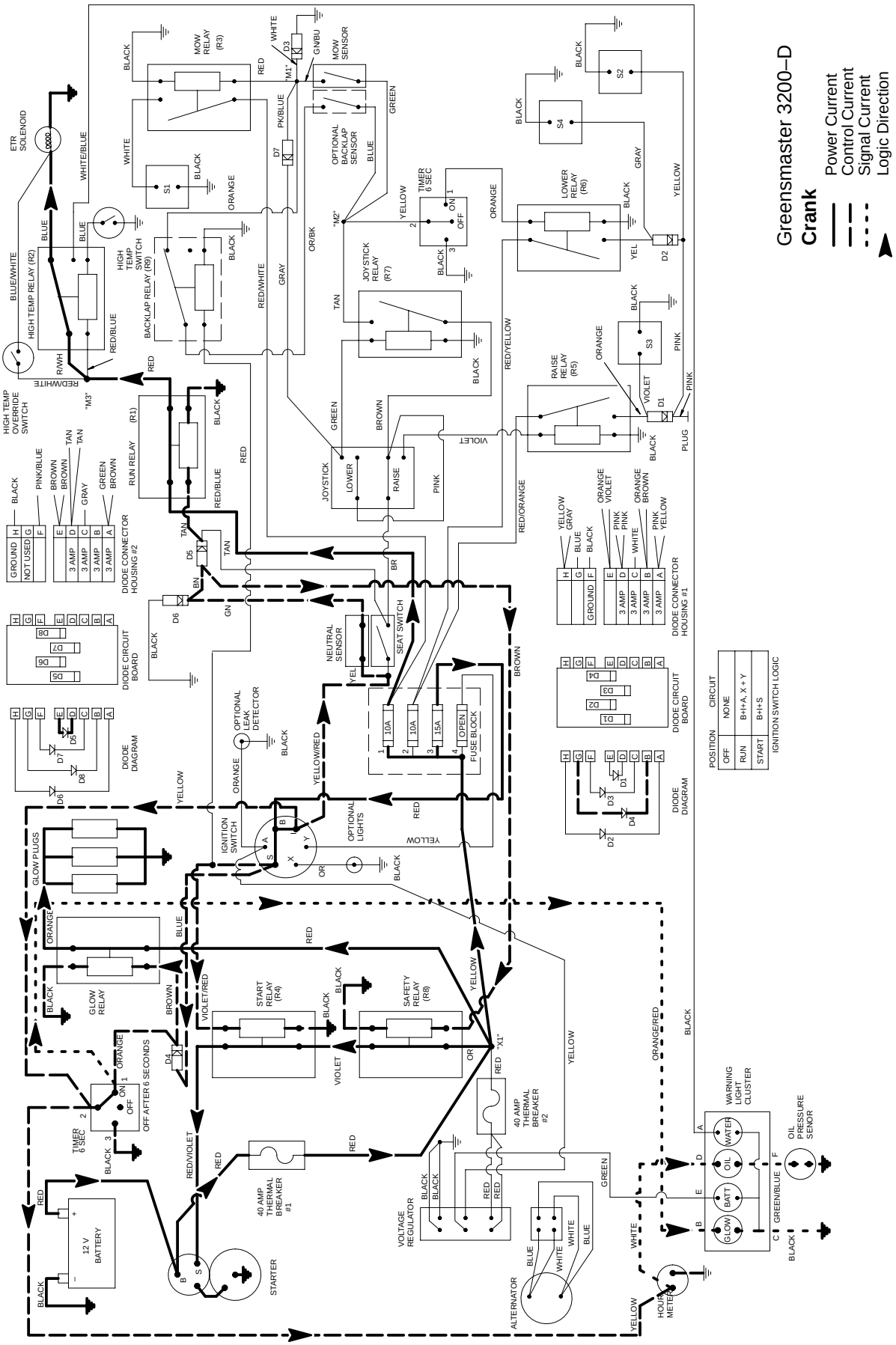
POSITION	CIRCUIT
OFF	NONE
RUN	B+I+A, X + Y
START	B+I+S

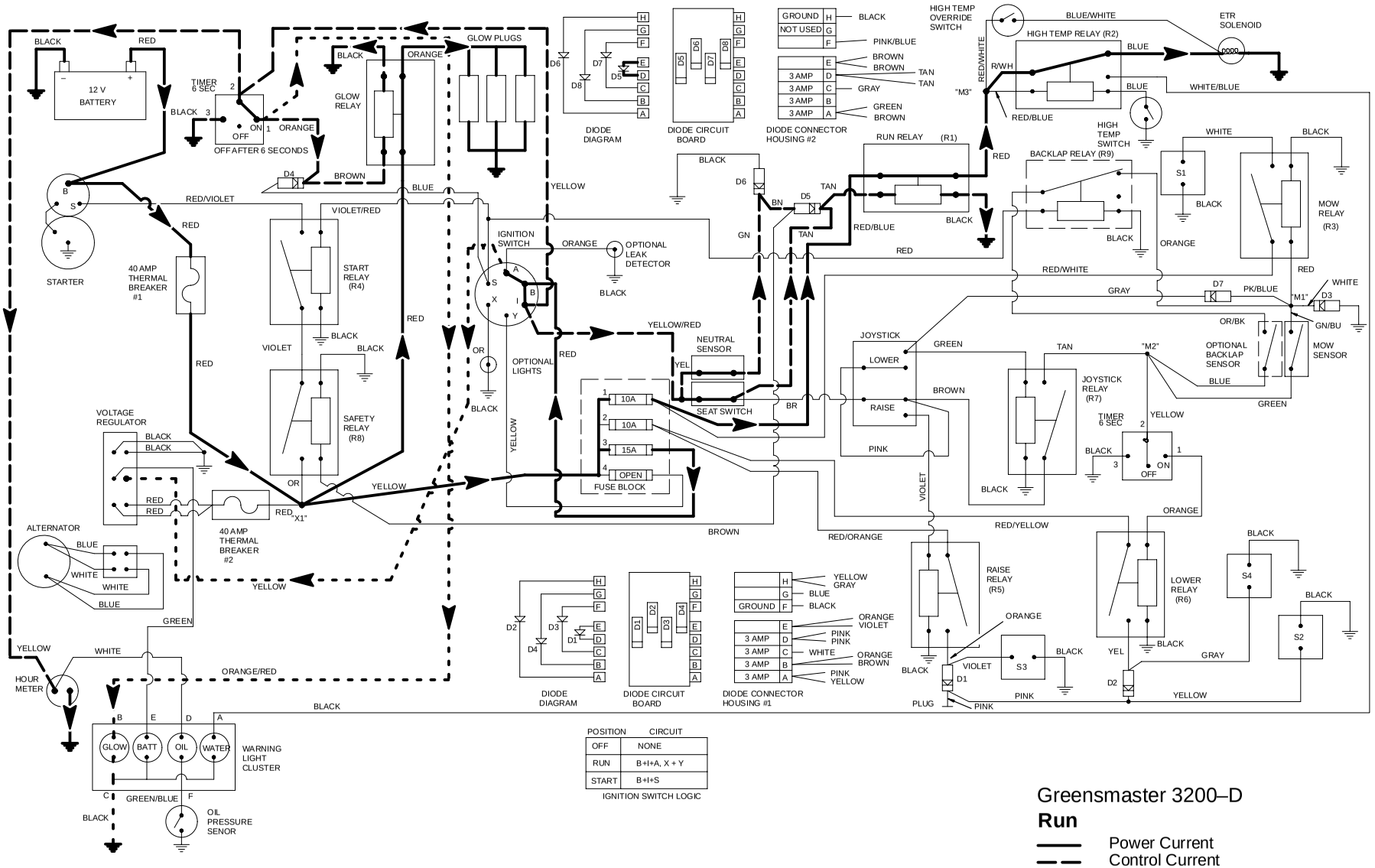
IGNITION SWITCH LOGIC

Greensmaster 3200–D

Electrical Schematic

All relays and solenoids are shown as de–energized.


Greensmaster 3200–D
Crank
Power Current
Control Current
Signal Current
Logic Direction
12 V BATTERY
STARTER
ALTERNATOR
VOLTAGE REGULATOR
IGNITION SWITCH
FUSE BLOCK
10A
10A
15A
OPEN
SEAT SWITCH
NEUTRAL SENSOR
GLOW PLUGS
GLOW RELAY
START RELAY (R4)
SAFETY RELAY (R8)
RUN RELAY (R1)
HIGH TEMP RELAY (R2)
HIGH TEMP OVERRIDE SWITCH
HIGH TEMP SWITCH
ETR SOLENOID
MOW RELAY (R3)
MOW SENSOR
BACKLAP RELAY (R9)
OPTIONAL BACKLAP SENSOR
JOYSTICK RELAY (R7)
JOYSTICK
RAISE RELAY (R5)
LOWER RELAY (R6)
TIMER 6 SEC
OFF AFTER 6 SECONDS
OPTIONAL LEAK DETECTOR
OPTIONAL LIGHTS
40 AMP THERMAL BREAKER #1
40 AMP THERMAL BREAKER #2
WARNING LIGHT CLUSTER
OIL PRESSURE SENOR
HOUR METER
DIODE CONNECTOR HOUSING #2
DIODE CONNECTOR HOUSING #1
DIODE CIRCUIT BOARD
DIODE DIAGRAM
GROUND
NOT USED
3 AMP
POSITION
CIRCUIT
OFF
NONE
RUN
B+I+A, X + Y
START
B+I+S
IGNITION SWITCH LOGIC



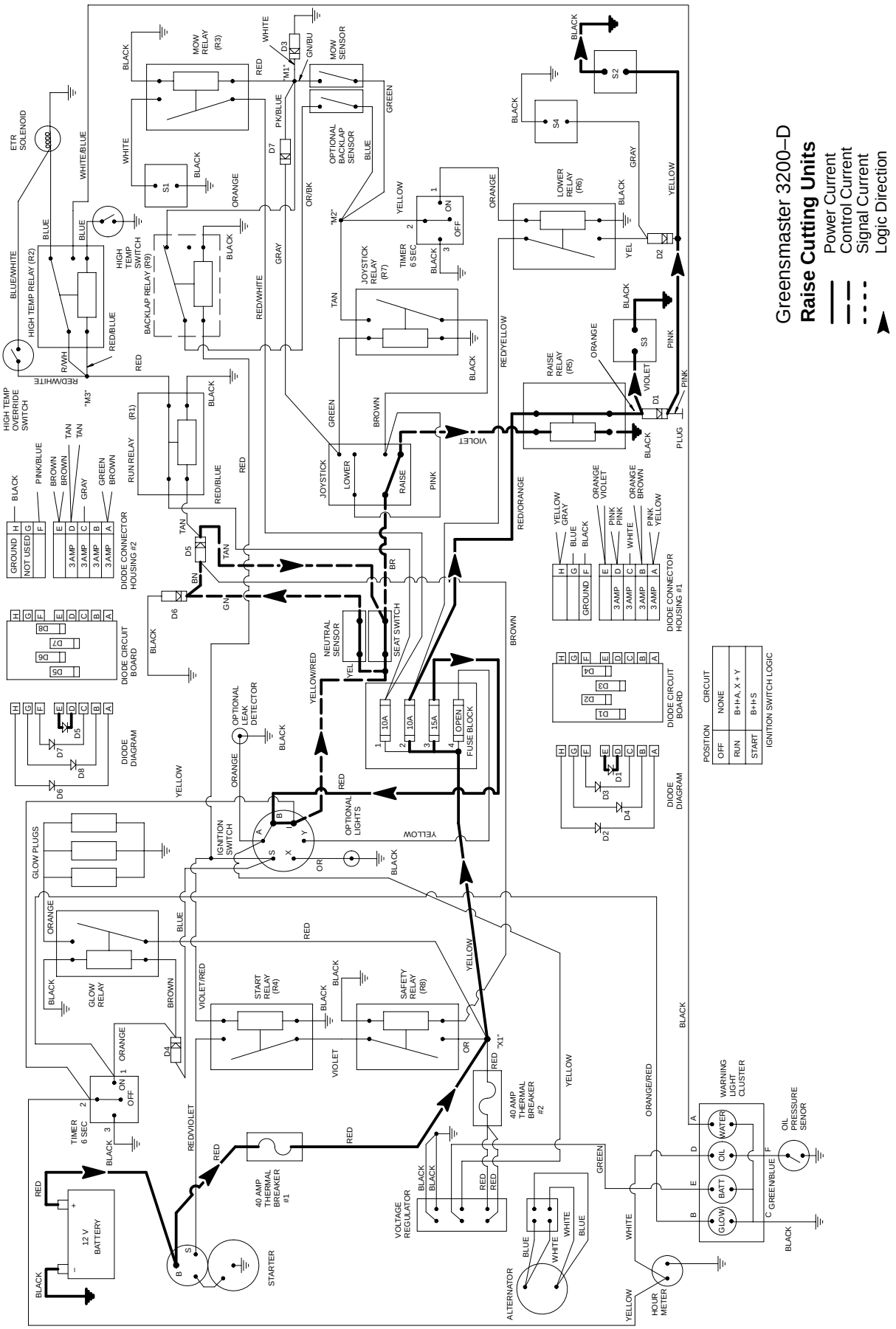
POSITION	CIRCUIT
OFF	NONE
RUN	B+/I+A, X + Y
START	B+/I+S

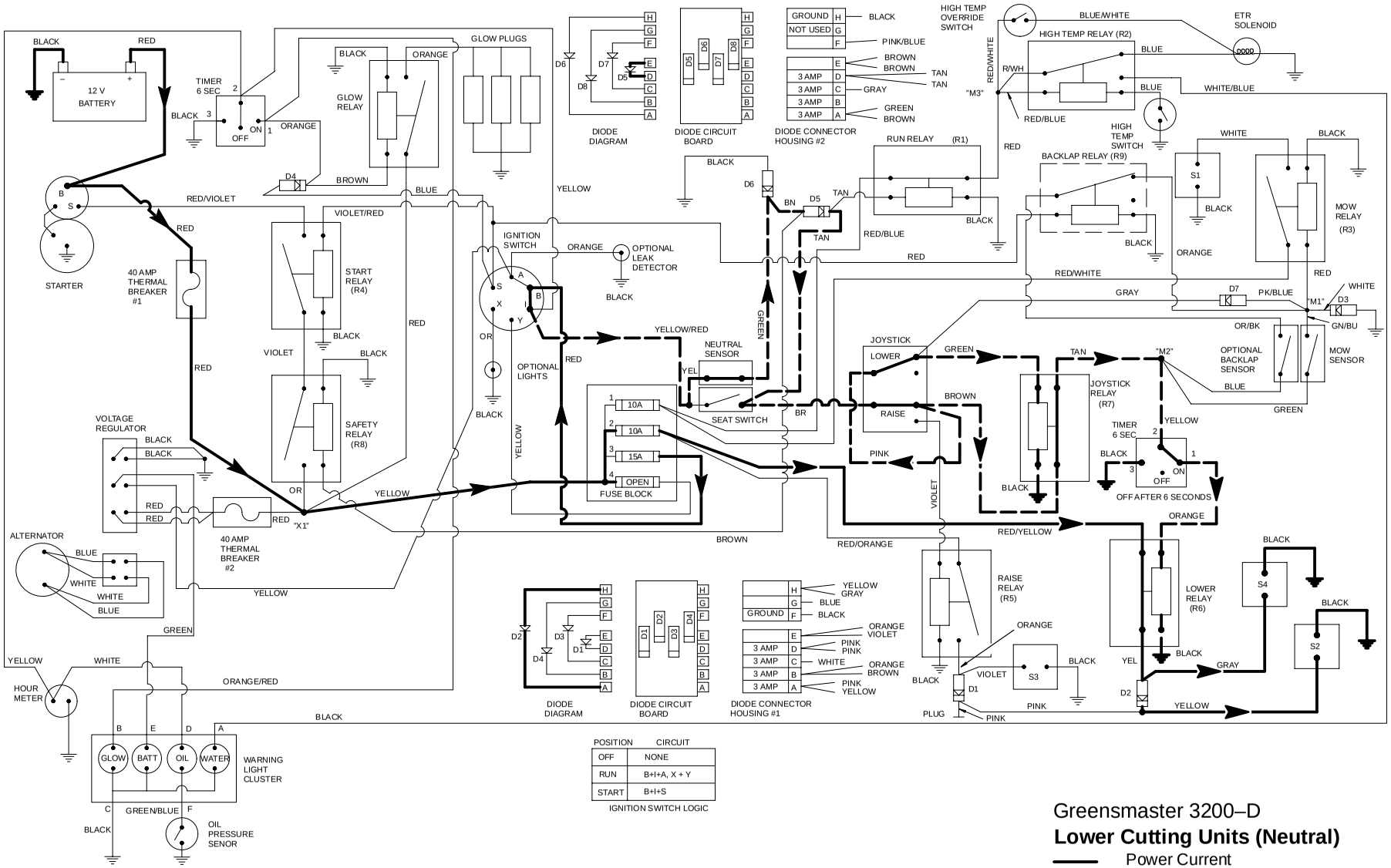
IGNITION SWITCH LOGIC

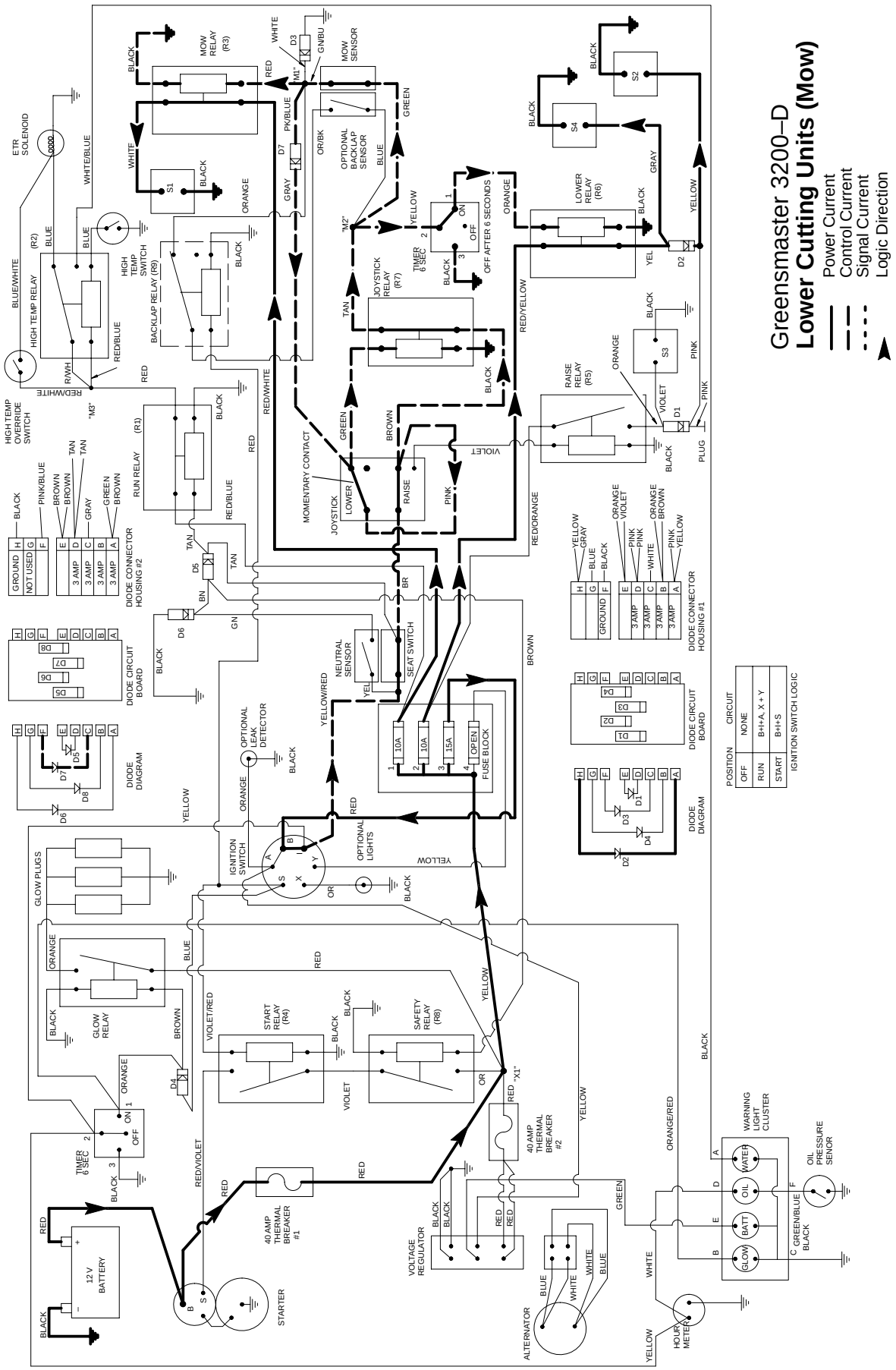
Greensmaster 3200–D

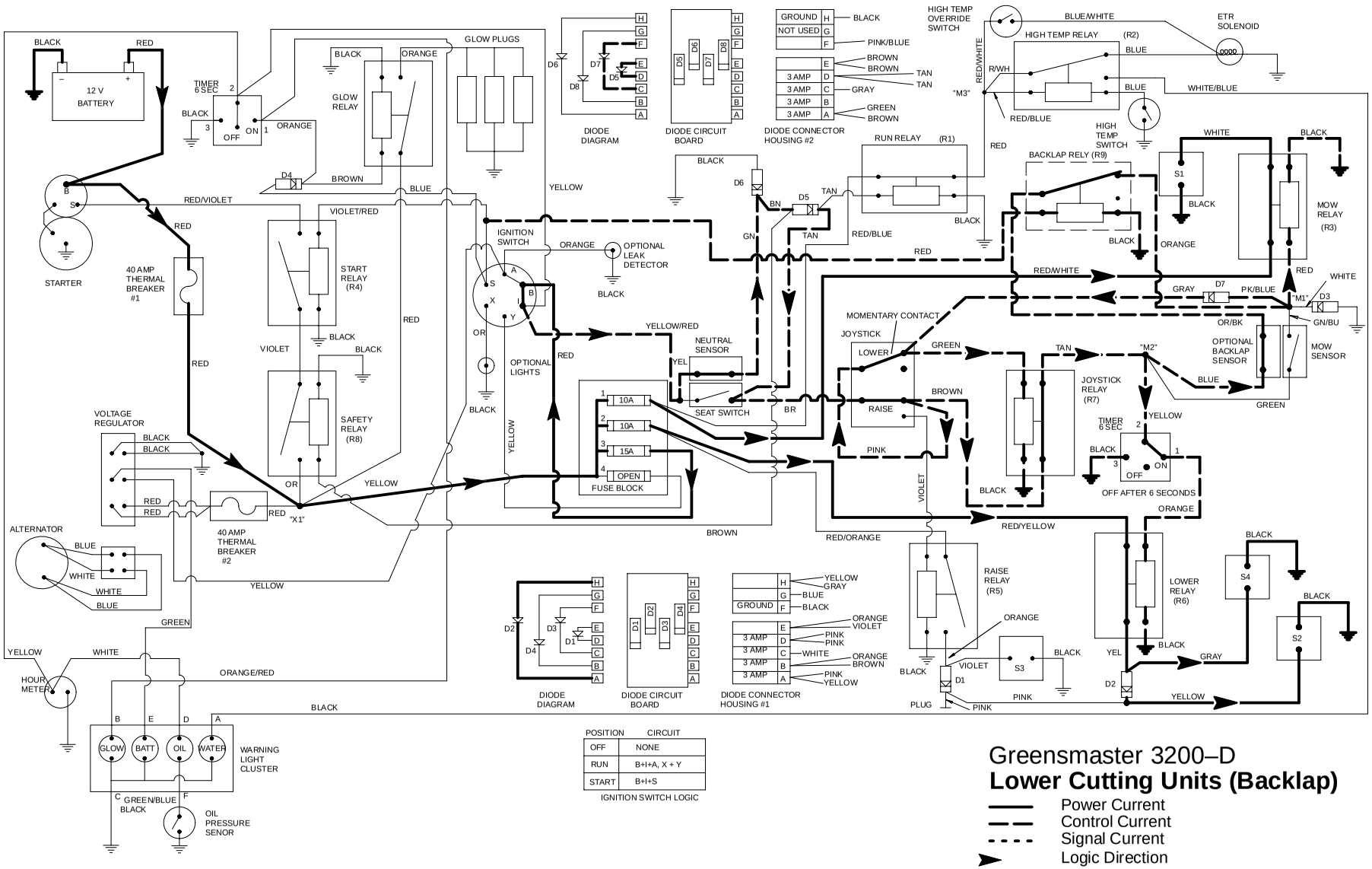
Run

- Power Current
- Control Current
- Signal Current
- Logic Direction


Greensmaster 3200–D
Raise Cutting Units
Power Current
Control Current
Signal Current
Logic Direction
12 V BATTERY
STARTER
ALTERNATOR
VOLTAGE REGULATOR
IGNITION SWITCH
GLOW PLUGS
GLOW RELAY
START RELAY (R4)
SAFETY RELAY (R8)
RUN RELAY (R1)
BACKLAP RELAY (R9)
HIGH TEMP RELAY (R2)
MOW RELAY (R3)
JOYSTICK RELAY (R7)
LOWER RELAY (R6)
RAISE RELAY (R5)
TIMER 6 SEC
ETR SOLENOID
HIGH TEMP OVERRIDE SWITCH
HIGH TEMP SWITCH
MOW SENSOR
OPTIONAL BACKLAP SENSOR
NEUTRAL SENSOR
SEAT SWITCH
OPTIONAL LEAK DETECTOR
OPTIONAL LIGHTS
FUSE BLOCK
10A
10A
15A
OPEN
40 AMP THERMAL BREAKER #1
40 AMP THERMAL BREAKER #2
WARNING LIGHT CLUSTER
WATER
OIL
BATT
GLOW
OIL PRESSURE SENOR
HOUR METER
JOYSTICK
LOWER
RAISE
DIODE CONNECTOR HOUSING #2
DIODE CONNECTOR HOUSING #1
DIODE CIRCUIT BOARD
DIODE DIAGRAM
GROUND
NOT USED
3 AMP
PLUG
POSITION
CIRCUIT
OFF
NONE
RUN
B+I+A, X + Y
START
B+I+S
IGNITION SWITCH LOGIC


12 V BATTERY
STARTER
40 AMP THERMAL BREAKER #1
40 AMP THERMAL BREAKER #2
TIMER 6 SEC
GLOW RELAY
GLOW PLUGS
START RELAY (R4)
SAFETY RELAY (R8)
IGNITION SWITCH
OPTIONAL LEAK DETECTOR
OPTIONAL LIGHTS
VOLTAGE REGULATOR
ALTERNATOR
HOUR METER
WARNING LIGHT CLUSTER
GLOW
BATT
OIL
WATER
OIL PRESSURE SENOR
DIODE DIAGRAM
DIODE CIRCUIT BOARD
DIODE CONNECTOR HOUSING #2
DIODE CONNECTOR HOUSING #1
NEUTRAL SENSOR
SEAT SWITCH
FUSE BLOCK
10A
10A
15A
OPEN
HIGH TEMP OVERRIDE SWITCH
HIGH TEMP RELAY (R2)
ETR SOLENOID
HIGH TEMP SWITCH
RUN RELAY (R1)
BACKLAP RELAY (R9)
MOW RELAY (R3)
JOYSTICK
LOWER
RAISE
JOYSTICK RELAY (R7)
OPTIONAL BACKLAP SENSOR
MOW SENSOR
TIMER 6 SEC
OFF AFTER 6 SECONDS
RAISE RELAY (R5)
LOWER RELAY (R6)
S1
S2
S3
S4
PLUG
"M1"
"M2"
"M3"
"X1"
GROUND
NOT USED
3 AMP
OFF
ON
POSITION
CIRCUIT
OFF
NONE
RUN
B+I+A, X + Y
START
B+I+S
IGNITION SWITCH LOGIC
Greensmaster 3200–D
Lower Cutting Units (Neutral)
Power Current
Control Current
Signal Current
Logic Direction


Greensmaster 3200–D
Lower Cutting Units (Mow)
Power Current
Control Current
Signal Current
Logic Direction
12 V BATTERY
STARTER
ALTERNATOR
VOLTAGE REGULATOR
IGNITION SWITCH
GLOW PLUGS
GLOW RELAY
START RELAY (R4)
SAFETY RELAY (R8)
RUN RELAY (R1)
MOW RELAY (R3)
LOWER RELAY (R6)
RAISE RELAY (R5)
JOYSTICK RELAY (R7)
BACKLAP RELAY (R9)
HIGH TEMP RELAY (R2)
HIGH TEMP OVERRIDE SWITCH
HIGH TEMP SWITCH
ETR SOLENOID
MOW SENSOR
OPTIONAL BACKLAP SENSOR
NEUTRAL SENSOR
SEAT SWITCH
JOYSTICK
MOMENTARY CONTACT
TIMER 6 SEC
OFF AFTER 6 SECONDS
OPTIONAL LEAK DETECTOR
OPTIONAL LIGHTS
FUSE BLOCK
10A
10A
15A
OPEN
40 AMP THERMAL BREAKER #1
40 AMP THERMAL BREAKER #2
DIODE CIRCUIT BOARD
DIODE DIAGRAM
DIODE CONNECTOR HOUSING #1
DIODE CONNECTOR HOUSING #2
WARNING LIGHT CLUSTER
OIL PRESSURE SENOR
HOUR METER
POSITION
CIRCUIT
OFF
NONE
RUN
B+I+A, X + Y
START
B+I+S
IGNITION SWITCH LOGIC



POSITION	CIRCUIT
OFF	NONE
RUN	B+I+A, X + Y
START	B+I+S

IGNITION SWITCH LOGIC

Greensmaster 3200–D
Lower Cutting Units (Backlap)

Power Current
Control Current
Signal Current
Logic Direction

Special Tools

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

Multimeter

The meter 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.

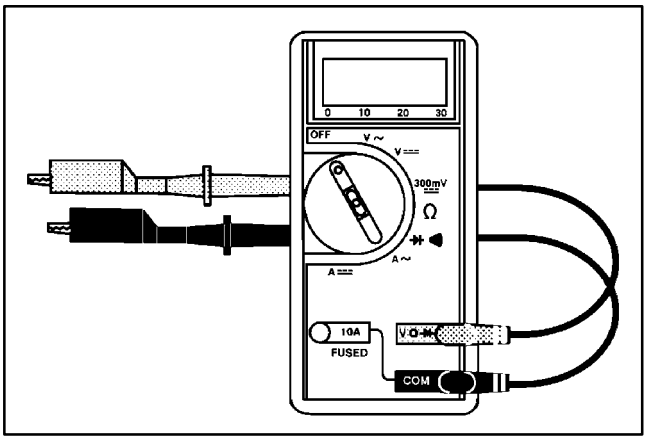


Figure 1

Skin–Over Grease

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

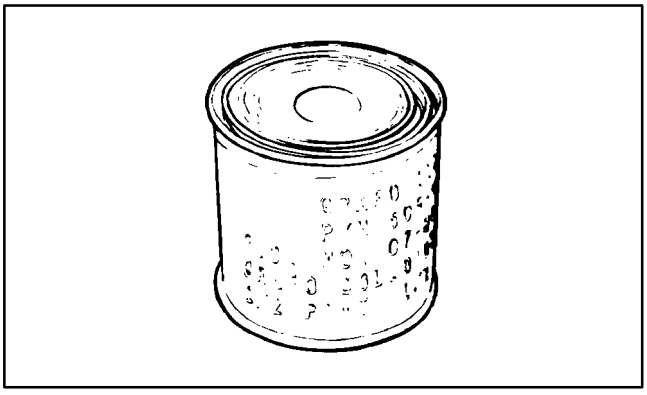


Figure 2

Toro Automated Control Electronics© Diagnostic Tool (GR3200)

Diagnostic ACE© Display

The diagnostic display is connected to the wiring harness connector located under the seat to help the user verfiy correct electrical functions of the machine (Fig. 3 and 4).

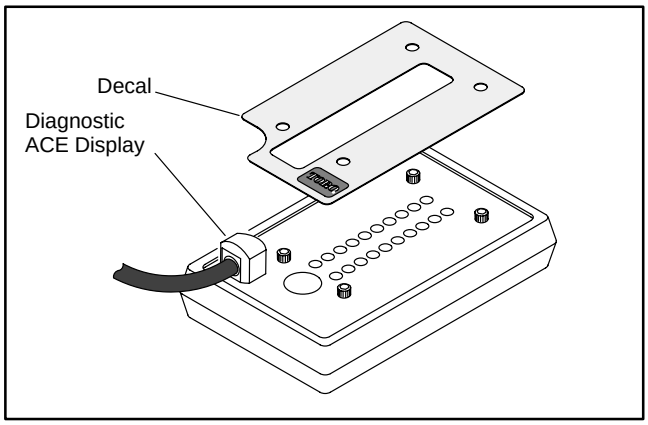


Figure 3

Figure 4

Troubleshooting (GR3200)

For all electrical problems, use ACE Troubleshooting Guide. The handheld Diagnostic ACE display allows electrical problems to be found quickly.

If any interlock switches are by–passed, they must be reconnected for proper troubleshooting and safety.

ACE Troubleshooting Guide (GR3200)

Diagnostic Light

The GR 3200 is equipped with a diagnostic light that indicates if the Electronic Controller Unit (ECU) is functioning correctly. This light is green, and it is located under the seat and on the bracket supporting the fuse block. The diagnostic light will be **on** when the ECU is functioning correctly and the ignition switch is to the ON position. The light will flash if the ECU detects any of the following malfunctions in the electrical system (Fig. 5):

1. An electrically ”open” condition.
2. An electrically ”shorted” condition.
3. There is an over temperature condition in the ECU circuitry.

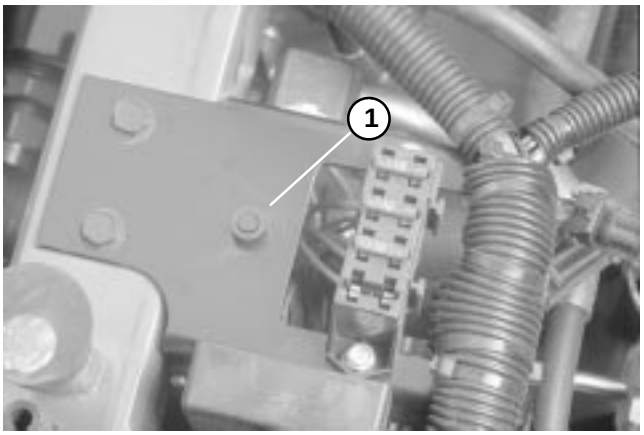


Figure 5

1. Diagnostic light

Diagnostic ACE Display

The GR 3200 is equipped with an ECU that controls most of the machine functions. The controller determines which function is required for various input switch conditions (i.e. seat switch, ignition switch, etc.) by producing various outputs to actuate solenoids or relays.

Each of the input switches, output solenoids, and relays must be connected and functioning properly for the ECU to properly control the machine.

The Diagnostic ACE display will help the user verify correct electrical functions of the machine.

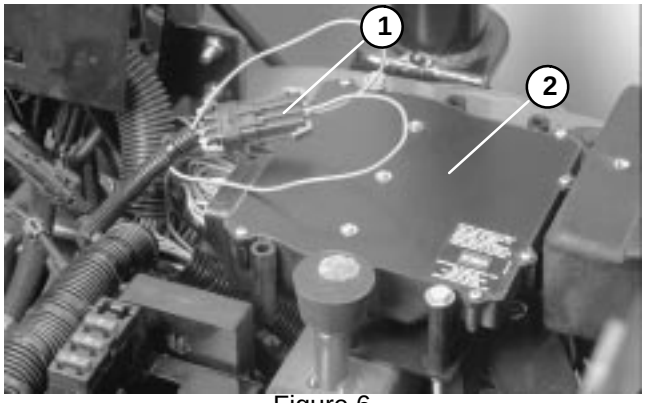


Figure 6

1. Loopback connector **2. ECU**

Verify Input Function (Fig. 6)

1. Park machine on a level surface, lower the cutting units, stop the engine and engage the parking brake.

2. Lift up the seat. Locate wire harness and loopback connector. Carefully unplug loopback connector from harness connector.

3. Connect Diagnostic ACE display connector to the harness connector. Make sure correct overlay decal is positioned on Diagnostic ACE display.

4. Turn Ignition switch to ON; **do not start machine**.

Note: The **red** text on the overlay decal refers to **input** switches and the **green** text refers to **output** switches.

5. The Inputs Displayed LED on lower right column of the Diagnostic ACE should be lighted. If the Outputs Displayed LED is lighted, press and release Toggle Input/ Output button on Diagnostic ACE to change to the Inputs Displayed LED. **Do not hold button down.**

Note: The Diagnostic ACE will illuminate a LED associated with each input when its associated input switch is closed.

6. Change each switch individually from open to closed (i.e., sit on seat, engage traction pedal, etc.).

   A. Observe that the appropriate LED on Diagnostic ACE blinks **on** and **off** when its corresponding switch is opened and closed.

   B. Check each switch that can be actuated by hand.

7. If switch is closed and appropriate LED does not

turn on, check all wiring and connections to switch and/or check switch with an ohm meter. Replace any defective switches and repair any defective wiring.

Verify Output Function (Fig. 6)

The Diagnostic ACE also has the ability to detect which output solenoids or relays are turned on. This is a quick way to determine if a machine malfunction is electrical or hydraulic.

1. Park machine on a level surface, lower the cutting units, stop the engine and engage the parking brake.

2. Lift up the seat. Locate wire harness and connectors near controller. Carefully unplug loopback connector from harness connector.

3. Connect the Diagnostic ACE connector to the harness connector. Make sure correct overlay decal is positioned on Diagnostic ACE.

4. Turn Ignition switch to ON; **do not start machine.**

Note: The **red** text on the overlay decal refers to **input** switches and the **green** text refers to **output** switches.

5. The Outputs Displayed LED on the lower right column of the Diagnostic ACE should be lighted. If the Inputs Displayed LED is lighted, press Toggle Input/Output button on the Diagnostic ACE to change the LED to Outputs Displayed.

Note: It may be necessary to toggle between Inputs Displayed and Outputs Displayed several times to do the following step. To toggle back and forth, press Toggle Input/Output button once. This may be done as often as required. **Do not hold button**.

6. Operate desired function switch on the machine. The appropriate output LED's should illuminate to indicate that the ECU is turning on that function.

Note: If any output LED is blinking, this indicates an electrical problem with that OUTPUT. Repair or replace defective electrical parts immediately. To reset a blinking LED, turn Ignition switch to OFF and then back to ON.

If output LED's are not blinking and not lighted, verify that the required input switches are in their necessary positions to allow that function to occur. Verify correct switch position or output.

If the output LED's are **on** as specified with the machine not functioning properly, a non–electrical problem exits. Repair as necessary.

If each input switch is in the correct position and functioning correctly with the output LED's not correctly lighted, an ECU problem exits. If this condition occurs, contact your Toro Distributor for assistance.

Retrieving Stored Faults (Fig. 6)

1. Turn ignition switch to OFF. Connect Diagnostic ACE to the harness connector of the ECU.

2. Move Raise/Lower/Mow control lever to RAISE and hold.

3. Turn Ignition switch to ON while continuing to hold the Raise/Lower/Mow control lever to RAISE until the top left light on the Diagnostic ACE comes on (approximately 2 seconds).

4. Make sure Diagnostic ACE is set to OUTPUTS.

5. Release Raise/Lower/Mow control lever to the center position.

IMPORTANT: There will be 8 records displayed. The fault is displayed on the 8th record. Each record will be displayed for 10 seconds. Records will repeat until the Ignition switch is turned to OFF. The unit will not start in this mode.

6. Observe Diagnostic ACE for the playback of the retained fault in the ECU memory. The problem circuit will be flashing.

Clearing Fault Memory (Fig. 6)

Note: Once a fault is repaired, it must be must be cleared from the ECU's memory.

1. Turn Ignition switch to OFF.

2. Position Raise/Lower/Mow control lever to RAISE.

3. Depress and hold High Temperature Override button.

4. Turn Ignition switch ON while holding the Raise/Lower/Mow control lever to RAISE, and keeping the High Temperature Override button depressed. Maintain this condition until the green lamp on the ECU starts to flash (approximately 2 seconds).

5. Release Raise/Lower/Mow control lever and High Temperature Override button. Turn Ignition switch to OFF. **Fault memory is now cleared.**

IMPORTANT: The Diagnostic ACE display must not be left connected to the machine. After using the Diagnostic ACE, disconnect it from the machine and reconnect loopback connector to the harness connector. The machine will not operate without the loopback connector installed to the harness. Store Diagnostic ACE in a dry, secure location.

For effective troubleshooting and repairs, you must have a good understanding of the electrical circuits and components used on this machine (see Wiring Schematics section of this chapter).

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

Starting Problems (GR3200)

Problem	Possible Causes
Starter solenoid clicks, but starter will not crank (if solenoid clicks, the problem is not with the ECU or its inputs).	Battery charge is low. Battery cables are loose or corroded. Battery ground to frame is loose or corroded. Wiring at starter is faulty. Starter solenoid is faulty. Starter mounting bolts are loose or not supplying a sufficient ground for solenoid. Starter is faulty causing incomplete circuit for solenoid.
Nothing happens when a start attempt is made.	Functional control lever is not in NEUTRAL. Neutral or traction speed/mow sensor is out of adjustment or faulty. Battery is dead. Battery cables are loose or corroded. Battery ground to frame is loose or corroded. 40 ampere thermal breaker is open. Fuses to ECU and/or ignition switch are blown. Fuse block is faulty. Wiring to the start circuit (see Wiring Schematics) components is loose, corroded, or damaged. Ignition switch is faulty. Starter relay is faulty. Temperature sender is faulty. The ECU is faulty.

Starting Problems (GR3200) (continued)

Problem	Possible Causes
Engine cranks, but does not fire.	Wiring to start circuits (see Wiring Schematics) is loose, corroded, or damaged. The ECU is faulty. The ignition components (ignitor module, speed sensor, ignition coils, and spark plugs) are faulty. Fuel valve solenoid, fuel pump, or electric governor is faulty. Engine or fuel system is malfunctioning (see Chapter 3 – Daihatsu Engine).
Engine cranks (but should not) with the Functional Control Lever out of the NEUTRAL position.	Neutral) sensor is out of adjustment, faulty, or short circuited. The ECU is faulty.

General Run and Transport Problems (GR3200)

Problem	Possible Causes
Engine kills when the functional control lever is in the MOW or TRANSPORT position with the operator in the seat.	Operator is sitting too far forward on the seat (seat switch not depressed). Seat switch, mow senor, or neutral sensor is faulty or out of adjustment. Seat switch wiring is loose, corroded, or damaged. The ECU is faulty Engine overheated.
Battery does not charge.	Wiring to the charging circuits (see Wiring Schematics) components is loose, corroded, or damaged. Voltage regulator/alternator is faulty. 40 ampere thermal breaker is open. The ECU is faulty Battery is dead.

Cutting Unit Operating Problems (GR3200)

Problem	Possible Causes
Cutting units run (but should not) when raised. However, they shut off with the cutting unit switch	The mow sensor is faulty.
Cutting units do not engage.	Wiring to run/mow/backlap circuits (see Wiring Schematics) components is loose, corroded, or damaged. Cutting units are not lowered. Cutting unit lower/mow or traction speed/mow switch is faulty. The ECU is faulty. Cutting solenoid valve S1 is faulty.

Troubleshooting (GR3200–D)

CAUTION

Remove all jewelry, especially rings and watches, before doing any electrical troubleshooting or testing. Disconnect the battery cables unless the test requires battery voltage.

For effective troubleshooting and repairs, you must have a good understanding of the electrical circuits and components used on this machine (see Wiring Schematics section of this chapter).

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

Starting Problems (GR3200–D)

Problem	Possible Causes
Starter solenoid clicks, but starter will not crank (if solenoid clicks, problem is not in safety interlock system).	Battery charge is low. Battery cables are loose or corroded. Battery ground to frame is loose or corroded. Wiring at starter is faulty. Starter solenoid is faulty. Starter mounting bolts are loose or not supplying a sufficient ground for solenoid. Starter is faulty and causing an incomplete circuit for the solenoid. Relay R4 or R8 has intermittent ground.
Nothing happens when start attempt is made.	Battery is dead. Wiring to the start circuit (see Wiring Schematics) components is loose, corroded, or damaged. Battery cables are loose or corroded. Battery ground to frame is loose or corroded. 40 ampere thermal breaker is open. Fuse block is faulty. 10 ampere fuse to the run relay is loose or blown. Diode D6, safety relay, or start relay is faulty. 15 ampere fuse to the ignition switch is loose or blown. The ignition switch is faulty. Starter solenoid is faulty. High temperature relay, run relay, and/or high temperature switch are faulty. Neutral sensor is out of adjustment or faulty. The ETR solenoid is faulty.

Starting Problems (GR3200–D) (continued)

Problem	Possible Causes
Engine cranks, but does not start.	Wiring to start circuits (see Wiring Schematics) is loose, corroded, or damaged. Diode D5 circuit is open. Run relay or high temperature relay is faulty. High temperature switch is shorted. ETR solenoid is faulty. Glow plugs are faulty. Engine or fuel system is malfunctioning (see Chapter 4 – Perkins Engine). Engine and fuel may be to cold.
Engine cranks (but should not) with the Functional Control Lever in the MOW or TRANSPORT position.	Neutral sensor is out of adjustment, faulty, or short circuited.

General Run and Transport Problems (GR3200–D)

Problem	Possible Causes
Engine kills when the Functional Control Lever is in the MOW or TRANSPORT position with the operator in the seat.	Operator is sitting too far forward on the seat (seat switch not depressed). Seat hinge, support pin, or spring binding is preventing the seat switch from closing. Seat switch is faulty or out of adjustment. Seat switch wiring is loose, corroded, or damaged.
Battery does not charge.	Wiring to the charging circuit (see Wiring Schematics) components is loose, corroded, or damaged. Voltage regulator/alternator is faulty. 40 ampere thermal breaker is open. Ignition switch is faulty. Battery is dead.
Engine kills during operation (operator sitting on seat).	Operator moved too far forward on the seat (seat switch not depressed). Engine overheated. Wiring to the run circuits (see Wiring Schematics) components became broken or disconnected.

Cutting Unit Operating Problems (GR3200–D)

Problem	Possible Causes
Cutting units run (but should not) when raised.	Joy stick relay R7 is faulty or shorted. Solenoid valve S1 is faulty. Mow relay is faulty or shorted. Mow sensor is shorted.
Cutting units do not run when lowered with the Functional Control Lever in the MOW or NEU position.	Wiring to run/mow/backlap circuits (see Wiring Schematics) components is loose, corroded, or damaged. Fuse block or fuse is faulty. Solenoid valve S1 is faulty. Mow sensor and/or mow relay is faulty or grounded. Raise switch and/or joystick relay R7 is faulty or grounded.
Cutting units will not raise.	Wiring to run/mow/backlap circuits (see Wiring Schematics) components is loose, corroded, or damaged. Fuse block or fuse is faulty. Solenoid valve S3 and/or S2 is faulty. Diode D1 is open. Raise switch and/or raise relay is faulty or grounded.
Cutting units will not lower.	Wiring to run/mow/backlap circuits (see Wiring Schematics) components is loose, corroded, or damaged. Fuse block or fuse is faulty. Diode D2 is open. Raise switch is faulty. Lower switch is faulty. Joystick relay is faulty. 6 second timer is faulty. Solenoid valve S2 or S4 is faulty. Lower relay is faulty.

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 to 100 F. The ignition key should be off and all accessories turned off. Connect the positive (+) meter lead to the positive battery post and the negative (–) meter lead the 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

Glow Plug System Test (GR3200–D)

This is a fast, simple test that can help you determine a glow plug system's integrity and operation. The test should be run anytime hard starting (cold) is encountered on a diesel engine equipped with a glow plug system.

Tool(s) required: Digital multimeter and/or AC/DC current transducer (Hall Effect).

Test instructions: Properly connect the current transducer to the digital multimeter (refer to manufacturer's instructions). Set the multimeter on the volts scale. With the key off, place the current transducer around the main glow plug power supply wire(s) and read the meter prior to activating glow plug system. Adjust the transducer to read zero (if applicable). Cycle the glow plug system at least two times (per instructions in Operator's Manual) and record the final results.

The Reelmaster 3200–D glow plug system should have a reading of about **21 Amps**.

Starting System Test

This is an excellent test to use when a "slow crank/no start" problem is encountered. It will tell you if the problem is due to an electrical open, short or high resistance in the starter circuit.

Note: The Battery condition and state of charge must checked before testing the starter system.

Tool(s) required: Digital multimeter and/or AC/DC current transducer (Hall Effect).

Test instructions: Properly connect current transducer to the digital multimeter (refer to manufacturers instructions). Set the multimeter on volts scale. With the key off, place the current transducer around the main negative (–) battery cable and read the meter prior to activating the starter system. Adjust the transducer to read zero (if applicable). Crank the engine for at least 3 seconds and record the results. Typical starter system draw is as follow:

170 to 220 Amps at 65 F for the GR3200–D.

95 to 150 Amps at 65 F for the GR3200.

If current draw is **significantly higher** than listed, check for a shorted condition. If current draw is **significantly lower** than listed, check for high resistance.

Component Testing

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

Note: See the **Perkins 100 Series Workshop Manual** for more component testing information.

CAUTION

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

Ignition Switch

The ignition (key) switch has three positions (OFF, RUN, and START). The terminals are marked as shown. The circuitry of the ignition switch is shown in the chart. With the use of a multimeter (ohms setting), the switch functions may be tested to determine whether continuity exists between the various terminals for each position. Verify continuity between switch terminals.

POSITION	CIRCUIT
OFF	NONE
RUN	B + I + A, X + Y
START	B + I + S

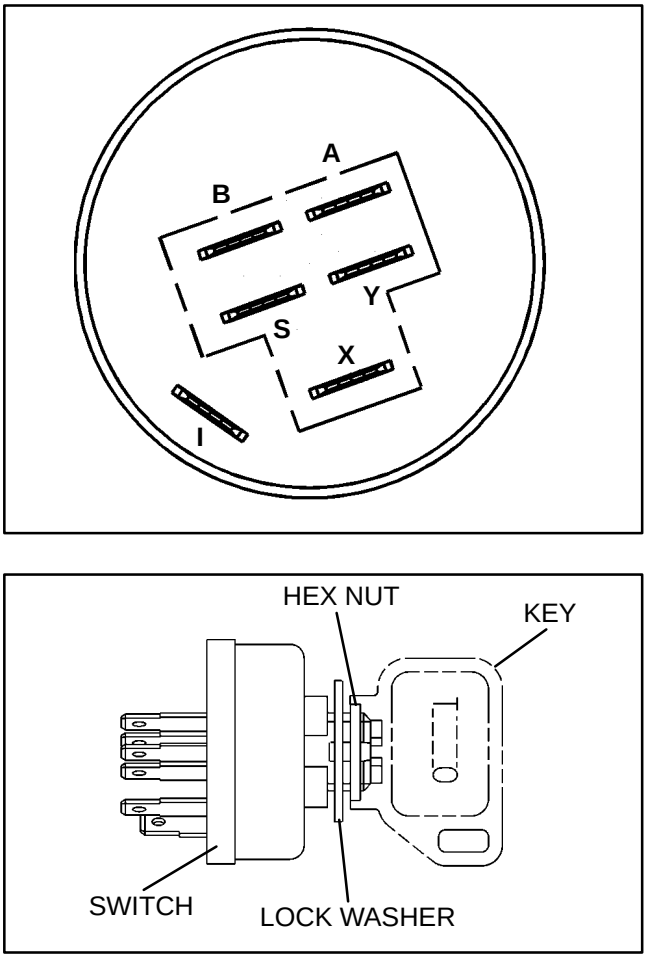


Figure 7

Electrical Relays

1. Verify coil resistance between terminals 86 and 85 with a multimeter (ohms setting). Resistance should be from 80 to 90 ohms. There should be continuity between terminals 87A and 30.

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

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

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

5. Disconnect voltage from and multimeter leads from relay terminals.

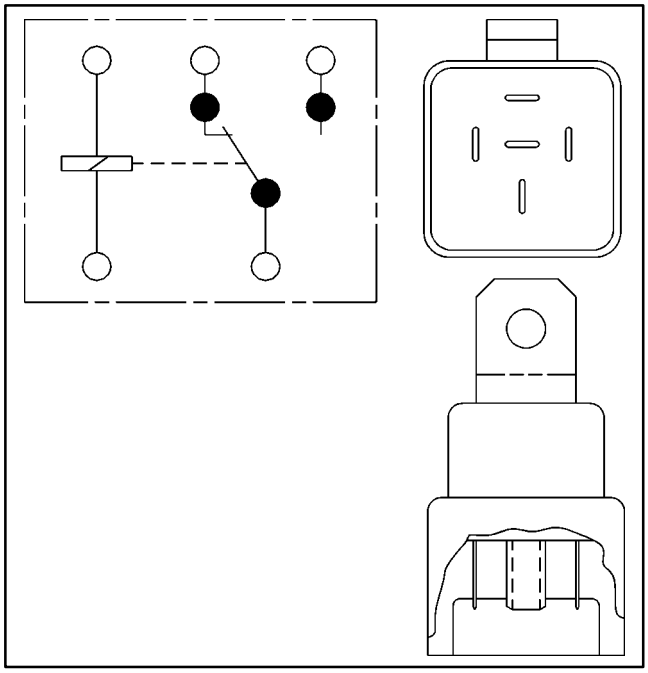


Figure 8

Solenoid Valve Coils

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

1. Make sure engine is off. Disconnect solenoid valve electrical connector.

2. Apply 12VDC source directly to the solenoid. Listen for solenoid to switch on.

3. Measure resistance between the two connector terminals. The resistance should be about 7.2 ohms.

4. Replace solenoid if necessary. Reconnect solenoid valve electrical connector.

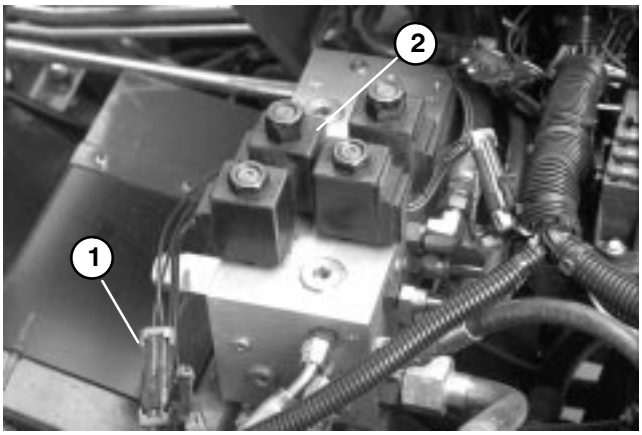


Figure 9

1. Electrical connector **2. Solenoid**

Seat Switch

This switch is normally open and closes when the operator is on the seat. If the neutral switch or traction interlock switch is open when the operator raises out of the seat, the engine will stop. The switch and its electrical connector are located directly under the seat.

1. Make sure the engine is off. Remove seat from the support assembly by removing four lock nuts from the seat bolts.

2. Disconnect electrical connector from the switch.

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

4. With no operator in the seat, there should be no continuity between the terminals.

5. Press directly onto the seat switch through the seat cushion. There should be continuity as the seat cushion approaches the bottom of its travel.

6. Connect switch electrical connector. Reinstall seat.

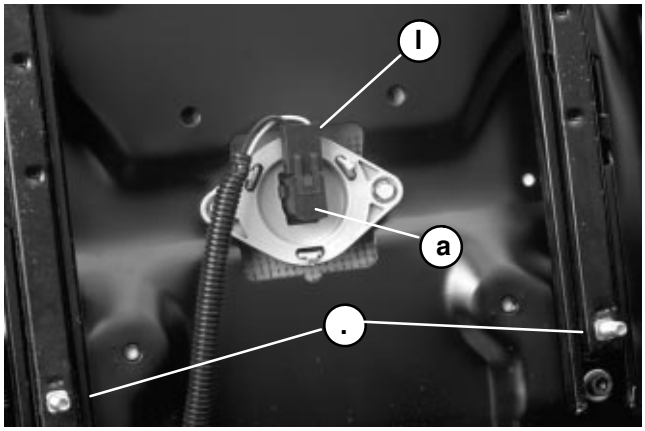


Figure 10

. , deat bprts a, deat sv rtgl
l , bregtrrgangpooegtpr

Reed Switch and Actuator

Both switches are normally open. They close when the actuator comes in close proximity to the switch. These switches are used in conjunction with the Functional Control Lever to sense the lever in either the NEUTRAL or MOW position.

1. Make sure the engine is off. Disconnect electrical connectors to both switches. Place the Functional Control Lever in the NEUTRAL position.

2. Check the continuity of both switches by connecting a multimeter (ohms setting) across the connector terminals. The NEUTRAL switch should have continuity and the MOW switch should read open.

3. Place the Functional Control Lever in the MOW position.

4. Check the continuity of both switches by connecting a multimeter (ohms setting) across the connector terminals. The NEUTRAL switch should read open and the MOW switch should have continuity.

5. Make sure distance between sensing ends of actuator and switches is 0.050 to 0.100 inch (1.27 to 2.54 mm) when Functional Control Lever is in the NEUTRAL and MOW positions. Adjust switches and actuator as necessary. Finger tighten jam nuts, then further tighten jam nuts 30 degrees past finger tight.

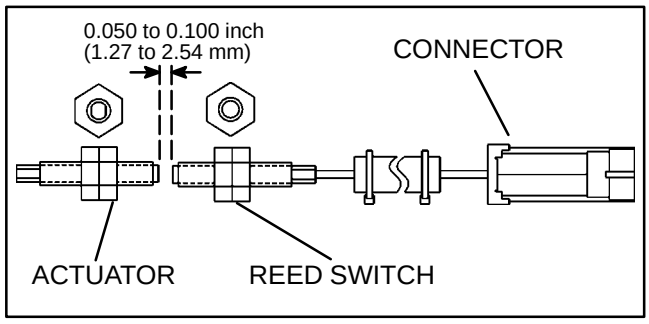


Figure 11

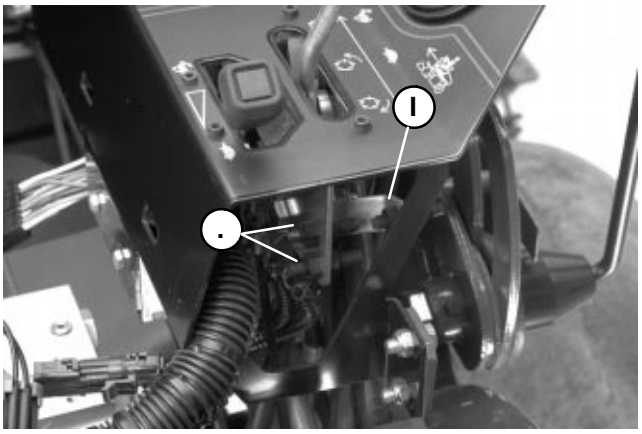


Figure 12

. , ceeh sv rtgl l , ceeh sv rtgl agtuatpr

Backlap Switch

The backlap switch is located on the hydraulic manifold (when the Backlap Kit is installed). It is normally open and closes when the backlap knob is turn clockwise to the backlap position.

1. With the engine off, disconnect electrical connector.

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

3. Turn the backlap knob clockwise to the backlap position while watching the multimeter. Continuity should be made as the switch closes.

4. Turn the backlap knob counterclockwise to the mow position while watching the multimeter. Continuity should be broken as the switch opens.

5. Reconnect the electrical connector.

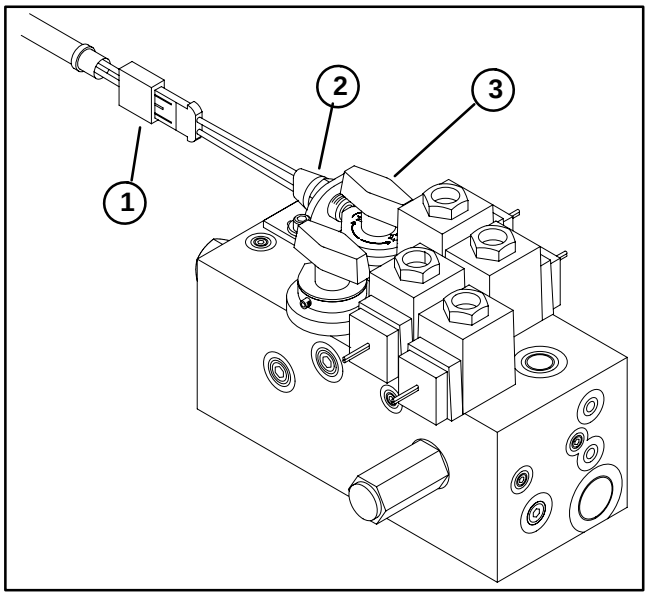


Figure 13

1. **Connector**
2. **Switch**
3. **Backlap knob**

Hour Meter

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

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

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

4. Disconnect the voltage source from the hour meter.

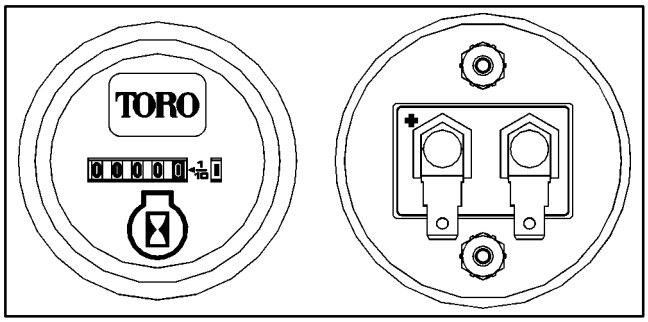


Figure 14

40 Ampere Thermal Breaker

This device operates as a thermal overload. After the device trips, time should be allowed for it to cool and reset.

1. Verify continuity between the two terminals.

2. Replace if necessary.

Figure 15

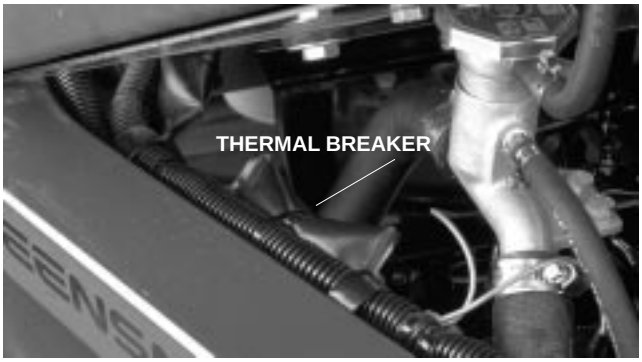


Figure 16

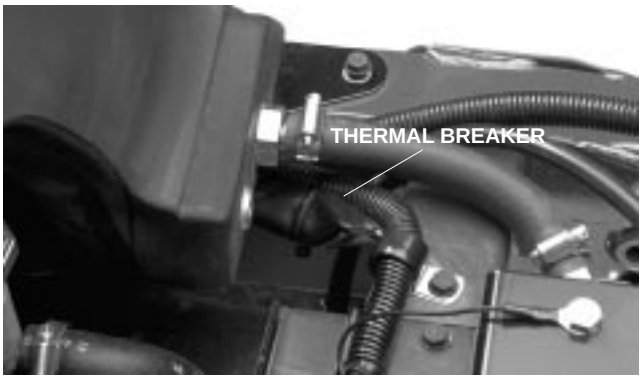


Figure 17

Fuse Block

Fuses can be removed to check continuity, The test meter should read **less than 1 ohm**.

For the GR3200, fuses supply power tho the following (Fig. 18):

1. The top 10 ampere fuse supplies power to terminals 1L and 1M of the solid state controller.

2. The middle 10 ampere fuse supplies power to terminals 1J and 1K of the solid state controller.

3. The bottom 10 ampere fuse supplies power to terminal B of the ignition switch.

For the GR3200–D, fuses supply power tho the following (Fig. 19):

1. The top 10 ampere fuse supplies power to the run and mow relays.

2. The middle 10 ampere fuse supplies power to the raise and lower relays.

3. The bottom 15 ampere fuse supplies power to terminal B of the ignition switch.

Figure 18

Figure 19

Leak Detector

Operation

The leak detector system is designed to assist in the early detection of hydraulic oil system leaks. If the oil level in the main tank is lowered by 4 to 5 ounces, the level switch in the leak detection tank will close. After a 1 second delay, the alarm will sound alerting the operator. Expansion of oil from the normal heating of the hydraulic oil during machine operation will cause oil to transfer into the leak detection tank. The oil is allowed to return to the main tank when the ignition switch is turned off (see Fig. 20, 21, and 22).

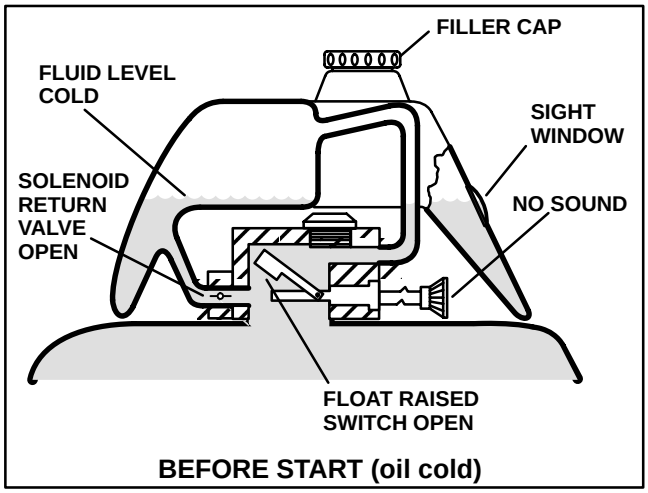


Figure 20

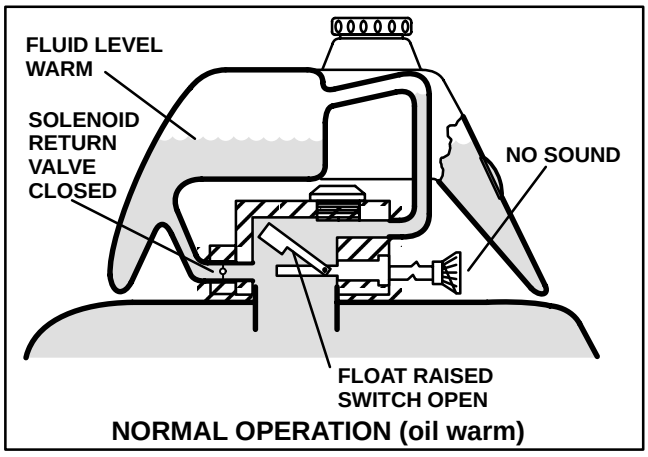


Figure 21

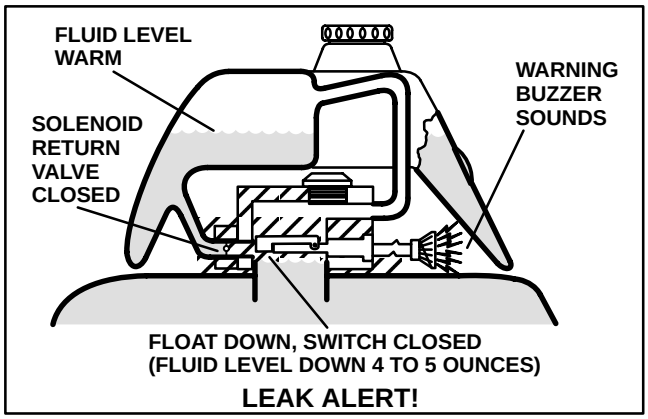


Figure 22

Test Operation

1. Place ignition switch in the ON position. DO NOT START ENGINE. Move leak detector switch downward and hold. After the one second time delay elapses, the alarm should sound.

2. Release leak detector switch.

3. Remove cover plate from leak detector. Remove plug from valve assembly.

4. Insert clean rod or screw driver into valve assembly and gently push down on switch float (Fig. 23). Alarm should sound after one second delay.

5. Release float; alarm should stop sounding.

6. If alarm fails to stop sounding, turn ignition switch to OFF position. Locate solenoid on leak detector. Swap solenoid wires and repeat steps 4 and 5.

7. Install plug to valve assembly and cover plate to tank. Move ignition switch to OFF position.

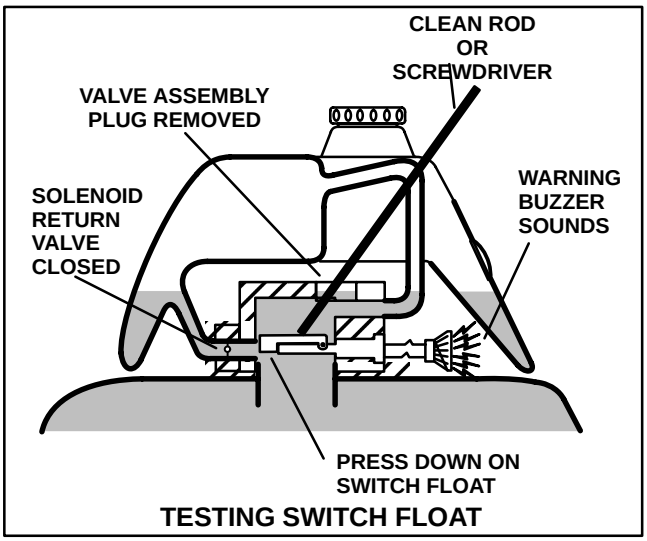


Figure 23

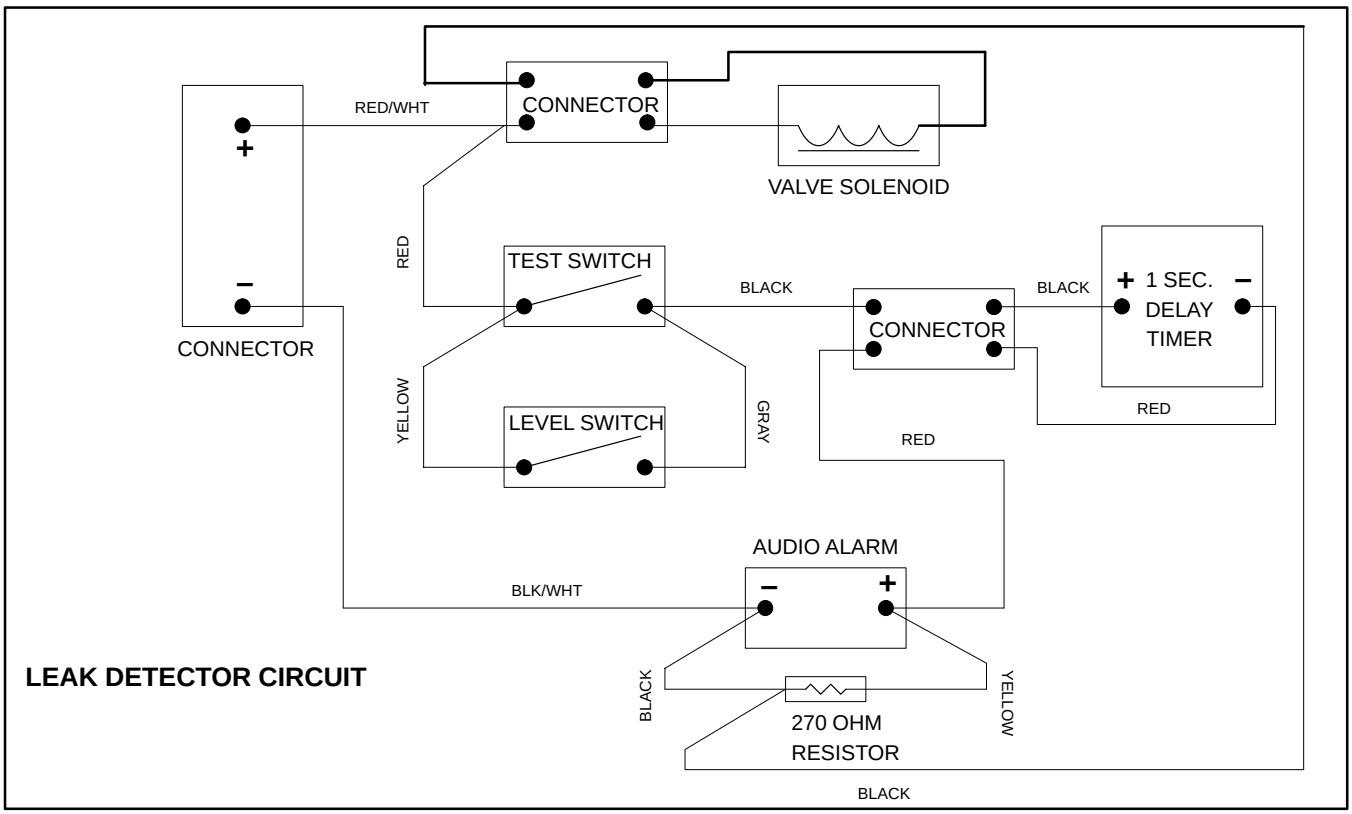


Figure 24

Components can be tested by isolating them from the rest of the circuit and individually testing the suspected component.

Delay Timer

This is a solid state device with no moving parts. Upon the application of power, the time delay is initiated. At the completion of the 1 second delay, the audio alarm becomes energized. When power is removed the timer is reset.

1. Isolate timer from the circuit. Connect 12VDC source in series with voltmeter to connector of timer. Make sure to observe polarity.

2. The voltmeter should jump from 0 to 12VDC after the 1 second delay. Remove voltage source from the timer. Reconnect timer to the circuit.

Audio Alarm

1. Isolate alarm from the circuit. Connect 12VDC source to terminals. Make sure to observe polarity.

2. Alarm should sound. Remove voltage source from the alarm. Reconnect alarm to the circuit.

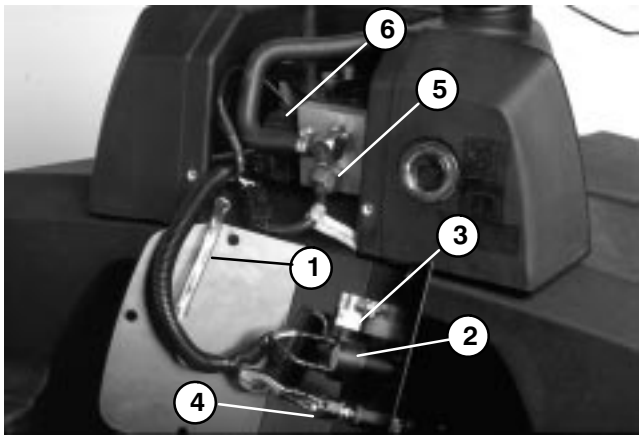


Figure 25

1. **270 ohm resistor**
2. **Audio alarm**
3. **Delay timer**
4. **Toggle switch**
5. **Level detector**
6. **Valve solenoid**

Valve Solenoid

1. Isolate solenoid from the circuit. Connect multimeter (Ohms setting) to connector. Make sure to observe polarity.

2. Resistance should about 7.2 ohms.

Warning Light Cluster (GR 3200)

Note: Individual light bulbs can be tested by removing them from the lighting cluster and applying 12 VDC to their wiring terminals.

Oil Pressure Light

The oil pressure light should come on when the ignition switch is in the ON position with the engine not running. Also, it should light with the engine running when the oil pressure drops below 4 PSI (0.3 kg/cm^2).

1. Disconnect green/blue wire from the oil pressure switch.

2. Ground green/blue wire to the engine block.

3. Turn the ignition switch to ON; the light should come on.

4. Turn the ignition switch to OFF. Connect green/blue wire to the oil pressure switch.

High Temperature (Water) Shutdown Light

When the coolant temperature is above 218 F (103 C), the temperature light comes on as the high temperature shutdown switch and relay stopped the engine. The ignition switch must be in either the ON or START position for the light to come on. Test this circuit using the diagnostic ACE (see ACE Troubleshooting guide).

Glow Light

The glow light is not connected to any circuit.

Battery Light

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

1. Turn ignition switch to ON; the light should come on.

2. Turn ignition switch to OFF.

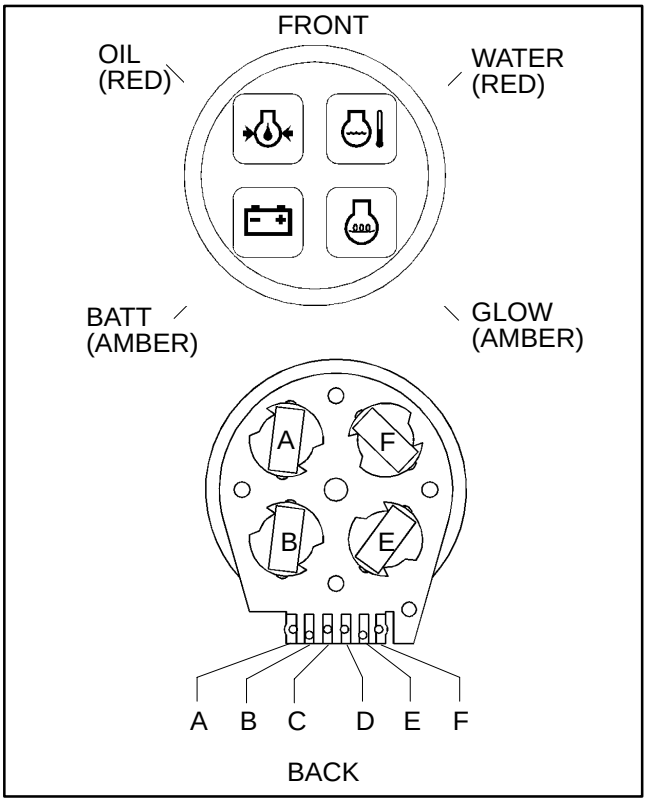


Figure 26

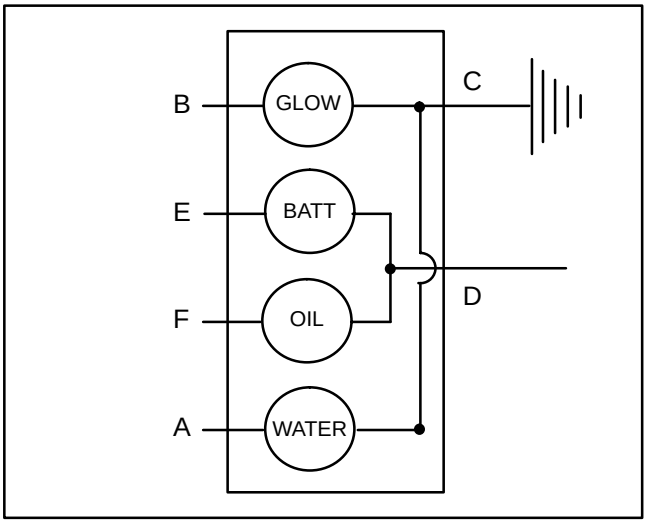


Figure 27

40 Ampere Charging System (GR 3200)

The alternator is belt driven and internally regulated (Fig. 28).

Note: Prior to testing the charging system, make sure the V–belt to the alternator is in good operation condition and adjusted properly (see Belt Adjustment in Chapter 3 – Daihatsu Engine).

Test Equipment

Briggs and Stratton recommends using their digital multimeter and shunt. The part numbers for these two pieces of test equipment are supplied in the Briggs and Stratton/Daihatsu Repair Manual that is located at the end of Chapter 3 – Daihatsu Engine (Fig. 29).

If the above test equipment is not available, a shunt capable of handling at least 40 ampere can be used. Also, a digital multimeter with a high impedance millivolt scale (with at least 300mv range) can be used in conjunction with the shunt.

Testing for DC Current Output (Fig. 30)

1. Install the DC shunt on the negative terminal of the battery. Make sure all connections are clean and tight for reliable amperage readings.

2. Attach RED meter test lead to the POSITIVE post of the shunt.

3. Attach BLACK meter test lead to the NEGATIVE post of the shunt.

4. Place multimeter to the millivolts scale.

5. Start the engine and run at **2000 rpm**. Determine current output. Current output should be from **4 to 20 ampere** depending upon battery voltage and/or current draw on the system.

6. If no or low current output is found, make sure all connections are clean and secure. If there is still no or low current output, replace the alternator.

Figure 28

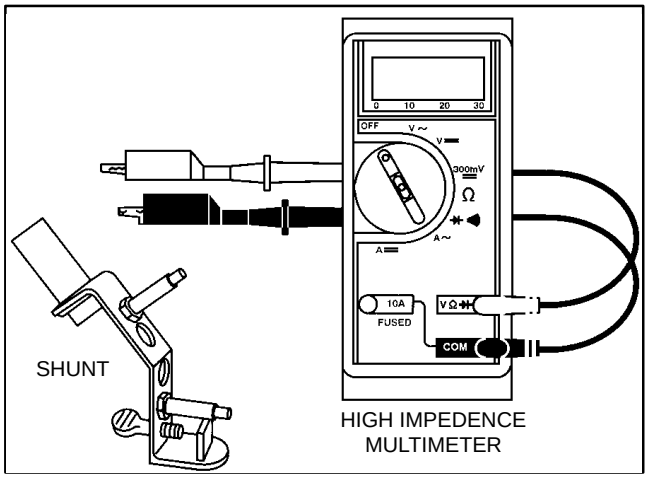


Figure 29

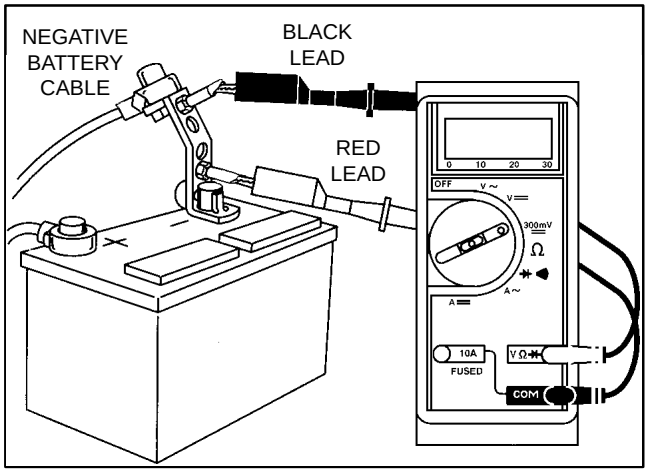


Figure 30

Temperature Sender (GR 3200)

The switch is located on the side of the water pump. There is a blue wire attached to the switch.

CAUTION

Allow the engine to cool to a safe temperature before removing the temperature sender from the engine.

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

2. Allow enough time so the temperature switch can cool to room temperature of 70 F (21 C).

Note: When operating at normal engine temperatures, the temperature sender is extremely accurate. To accurately test the sender requires an elaborate test setup and special calculations. It might be more cost effective to replace the unit. The following step is a quick check of the sender.

3. Check the continuity of the sender with a multimeter (ohms setting). The sender should be between 2.5 to 3.0 Kohms.

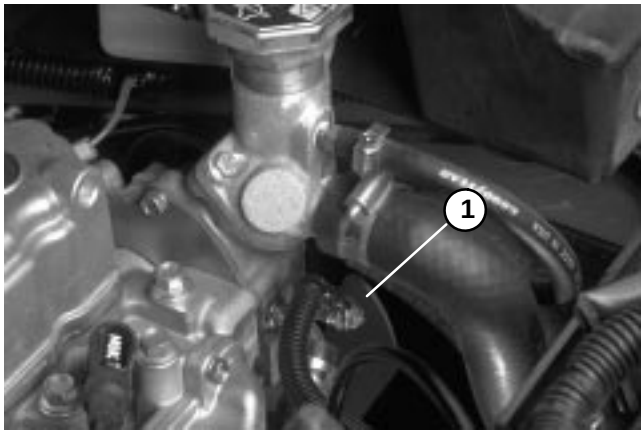


Figure 31

1. **Temperature sender**

High Temperature Switch (GR 3200–D)

The switch is located on top of the water pump. The pump is between the fan pulley assembly and the cylinder head. There is a blue wire attached to the switch (Fig. 32).

1. Lower the coolant level in the engine and remove the high temperature shutdown switch.

2. Put the switch in a container of oil with a thermometer and slowly heat the oil (Fig. 33).

CAUTION

Handle the hot oil with extreme care to prevent personal injury or fire.

3. Check the continuity of the switch with a multimeter (ohms setting). The switch is normally open and should close at 206 to 218 F (97 to 103 C)

4. Allow the oil to cool. The switch should open at 194 F (90 C).. Replace switch as necessary.

5. Install switch and restore coolant level to the engine.

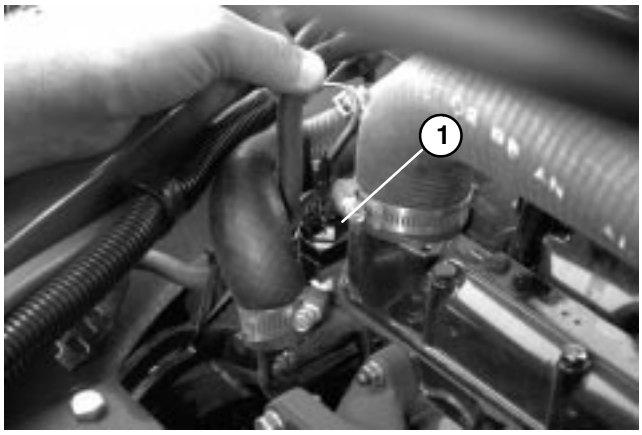


Figure 32

1. High temperature shutdown switch

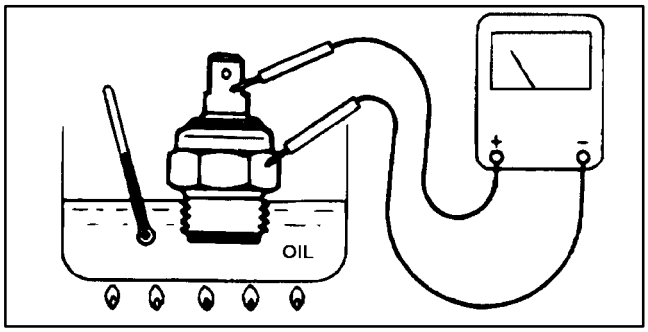


Figure 33

Warning Light Cluster (GR 3200–D)

Note: Individual light bulbs can be tested by removing them from the lighting cluster and applying 12 VDC to their wiring terminals.

Oil Pressure Light

The oil pressure light should come on when the ignition switch is in the ON position with the engine not running. Also, it should light with the engine running when the oil pressure drops below 4 PSI (0.3 kg/cm^2).

1. Disconnect green/blue wire from the oil pressure switch.

2. Ground green/blue wire to the engine block.

3. Turn the ignition switch to ON; the light should come on.

4. Turn the ignition switch to OFF. Connect green/blue wire to the oil pressure switch.

High Temperature (Water) Shutdown Light

The temperature light should come on only if the high temperature shutdown switch and relay have stopped the engine when the coolant temperature is above 206 F (97 C). The ignition switch must be in either the ON or START position for the light to come on.

1. Disconnect the blue wire from the high temperature shutdown switch.

2. Ground the blue wire to the engine block.

3. Turn the ignition switch to ON; the light should come on and the high temperature shutdown relay should click.

4. Turn the ignition switch to OFF and connect the blue wire to the high temperature shutdown switch.

Glow Light

The glow light should come on with the ignition in the START position.

1. Turn the ignition switch to START; the light should come on.

2. Turn the ignition switch to OFF.

Battery Light

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

1. Turn ignition switch to ON; the light should come on.

2. Turn ignition switch to OFF.

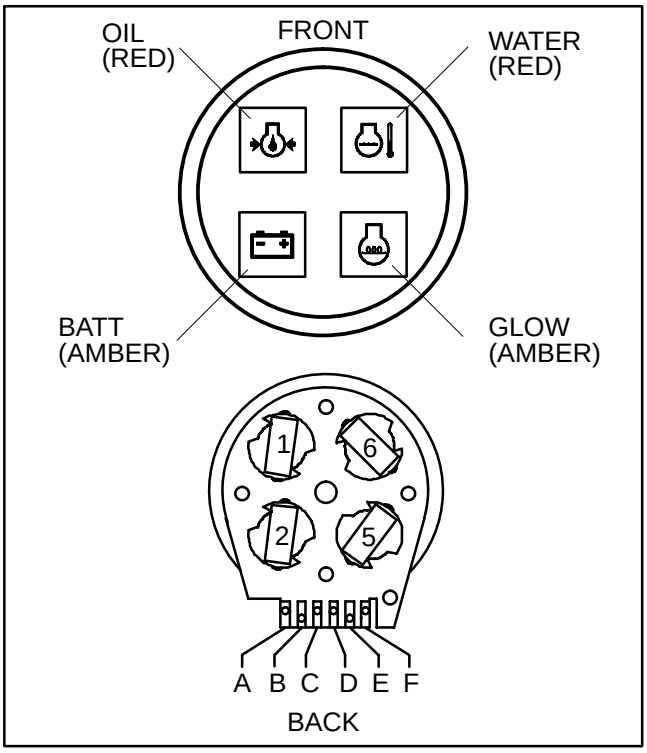


Figure 34

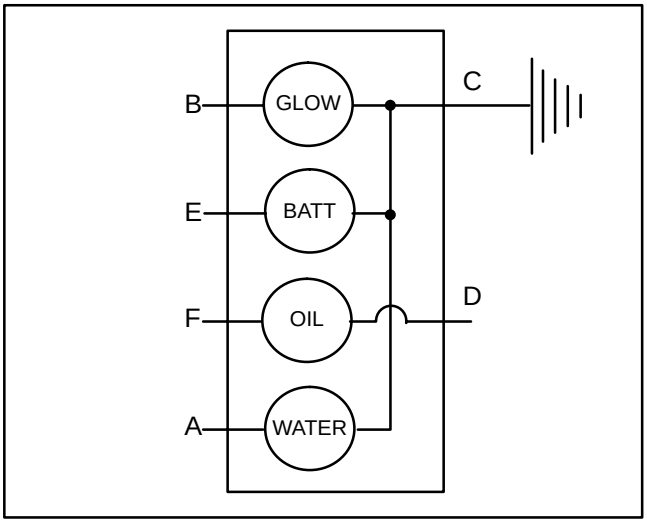


Figure 35

Oil Pressure Switch (GR 3200–D)

The switch is located on the front cylinder head above the injection pump and governor assembly. It is a normally closed switch and opens with pressure. The operating range for the switch is 2.8 to 5.7 PSI (0.2 to 04 kg/cm^2).

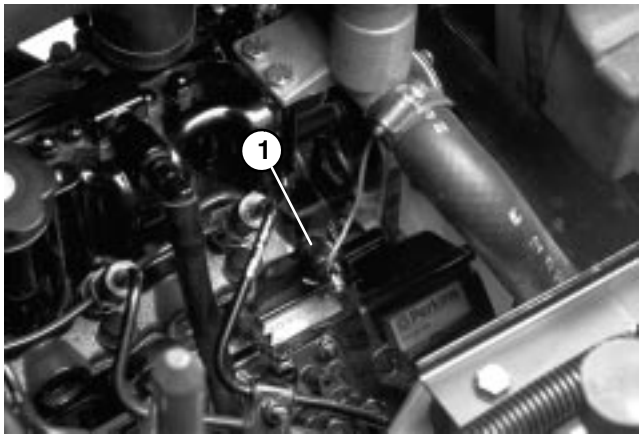


Figure 36

1. Oil pressure switch

Testing with the engine off

1. Turn the ignition switch to ON. The oil pressure lamp should be on.

2. If the lamp is not on, disconnect the brown wire from the switch and ground it to the engine block.

3. If the lamp comes on the switch is bad.

4. If the lamp does not come on after step 2, check the indicating circuit (see Electrical Schematic (3200–D).

Testing with the engine on

1. If the lamp is on with the engine running, shut off the engine **immediately**.

2. Disconnect the brown wire from the switch.

3. Turn the ignition switch to ON. The oil pressure lamp should go out.

4. If the light is still on, check for short circuiting in the indication circuit (see Indicating and Safety Circuits).

5. Return ignition switch to OFF and connect the brown wire to the switch.

6. Remove switch and install test gauge in the oil pressure switch port.

7. Start the engine and check for a **minimum** of 30 psi at 1400 RPM. If the engine oil pressure is low, shut off the engine **immediately**.

8. Shut off the engine and remove the test gauge.

9. If the engine oil pressure is good, replace the switch.

Glow Plug and Lower Reels Timer (GR 3200–D)

This is a solid state timer. Upon the application of power, the load is energized and the time delay is started. After 6 seconds the load is de–energized.

1. Connect voltmeter across test load and test load to timer. Connect 12VDC source to timer and load. Make sure to observe polarity. After 6 seconds, there should be no voltage across the load.

2. Disconnect timer from 12VDC source and test load.

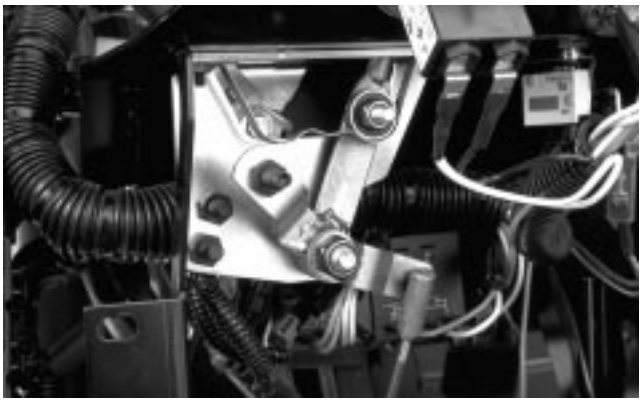


Figure 37

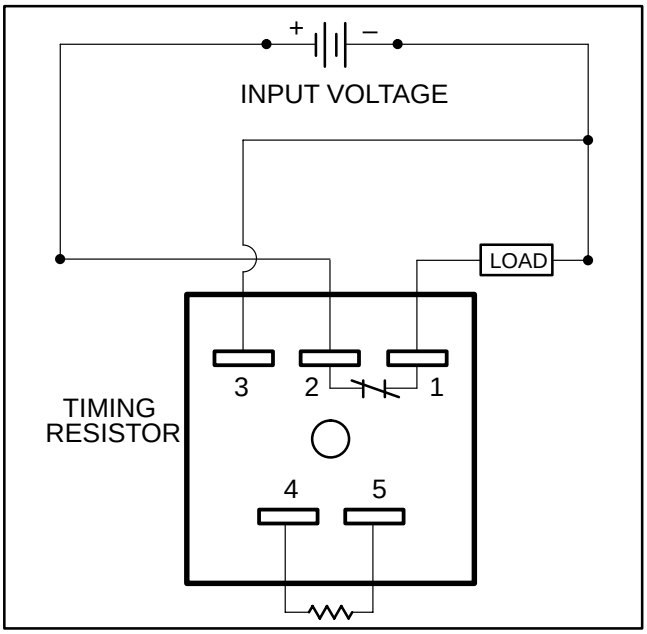


Figure 38

Glow Relay (GR 3200–D)

1. Verify coil resistance between terminals 86 and 85 with a multimeter (ohms setting). Resistance should be from 41 to 51 ohms.

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

3. Disconnect voltage from and multimeter leads from relay terminals.

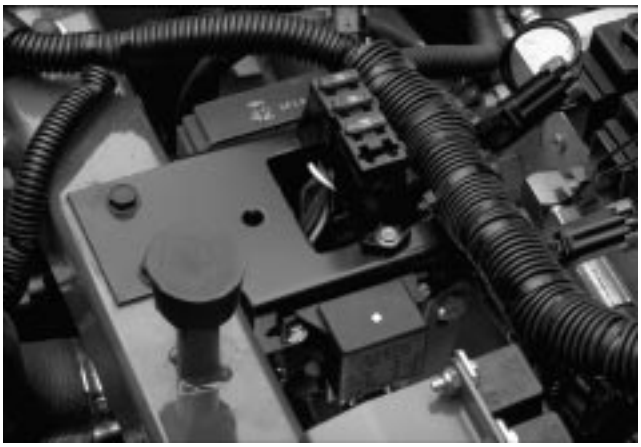


Figure 39

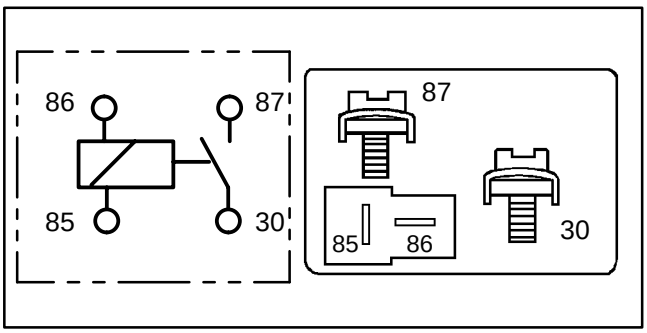


Figure 40

Diode Circuit Board (GR 3200–D)

Each circuit board contains four diodes. The diodes are used for circuit protection from inductive voltage spikes and for safety circuit logic. Diode D8 is not used.

Diode D1

This diode prevents current flow to solenoid S3 when solenoids S2 and S4 are energized through lower relay R6.

Diode D2

This diode prevents current flow to solenoid S4 when solenoids S2 and S3 are energized through Raise relay R5.

Diode D3

Prevents a negative spike from damaging the Mow and Backlap Sensor switches by allowing a ground path for the mow relay when it de–energizes.

Diode D4

Prevents a negative spike from damaging the Ignition switch when the Glow relay is de–energized.

Diode D5

Allows the engine to start only with the Functional Control Lever in NEUTRAL (neutral sensor closed). Also, it allows the engine to continue to run with either the Functional Control Lever in NEUTRAL (Neutral Sensor closed) or the operator sitting in the seat (Seat switch closed).

Diode D6

Prevents a negative spike from damaging the Neutral Sensor and Seat switch by allowing a ground path for the Run relay when it de–energizes.

Diode D7

Maintains current flow to the Joystick relay after the momentary Lower switch of the Joy Stick opens.

Diode D8

This component is not used.

Testing

The diodes can be individually tested using a digital multimeter (ohms setting) and the table to the right.

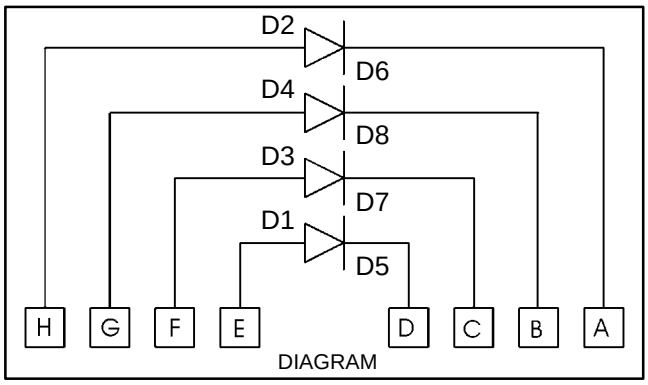


Figure 41

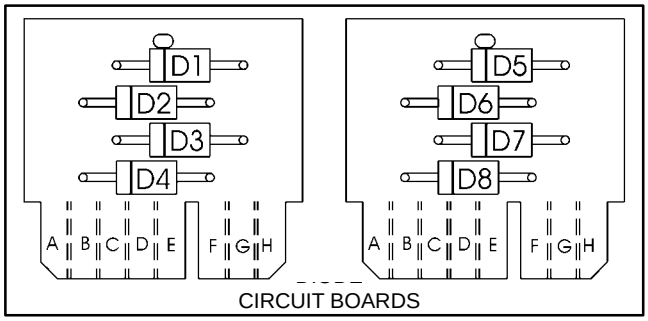


Figure 42

Red Lead (+) on Terminal	Black Lead (–) on Terminal	Continuity
H	A	YES
A	H	NO
G	B	YES
B	G	NO
F	C	YES
C	F	NO
E	D	YES
D	E	NO

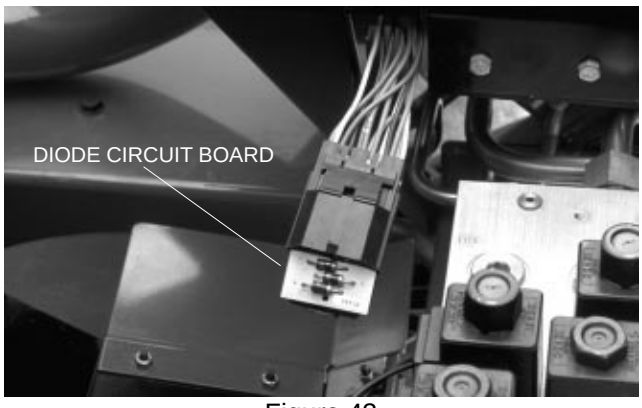


Figure 43

ETR Solenoid (GR 3200–D)

The ETR solenoid must be energized for the engine to run. It is mounted on the engine block next to the injection pump and has a blue and a blue/white wire attached to it.

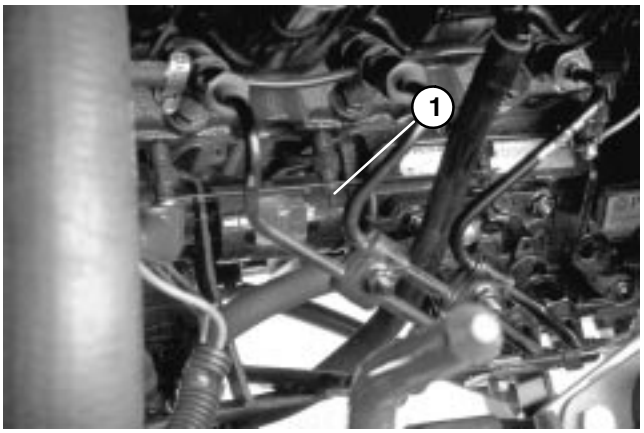


Figure 44

1. ETR solenoid

In Place Testing

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

1. Disconnect the wires from the solenoid.

2. Using a digital multimeter, ground one lead to the engine block and connect the other to the solenoid terminal.

3. The resistance should be about 11.5 ohms.

4. Connect the wire to the solenoid.

Live testing

1. Disconnect the wire from the solenoid.

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

2. Connect a positive (+) test lead from a 12 VDC source to the solenoid terminal.

3. Touch a negative (–) test lead from the 12 VDC source to the solenoid body. The plunger should retract making an audible ”click”.

4. Disconnect the test leads from the solenoid.

5. Reconnect the wires to the solenoid.

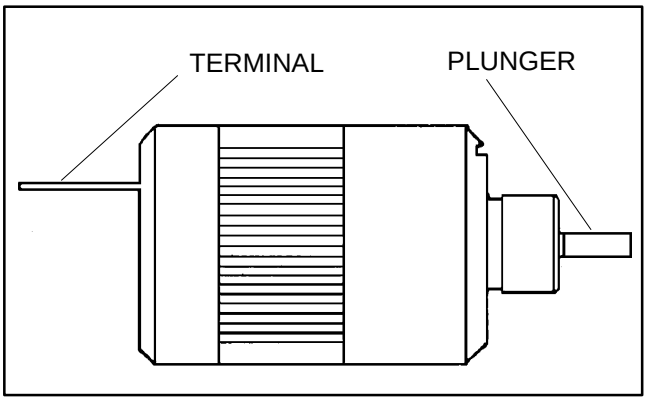


Figure 45

27 Ampere Charging System (GR 3200–D)

The alternator is belt driven and externally regulated. There are four terminals on the alternator electrical connector (Fig. 46 and 47).

Note: Prior to testing the charging system, make sure the V–belt to the alternator is in good operation condition and adjusted properly (see Belt Adjustment in Chapter 4 – Perkins Engine).

Test Equipment

A digital multimeter and shunt are recommended for testing the charging system. A shunt capable of handling at least 40 ampere should be used. Also, a digital multimeter with a high impedance millivolt scale (with at least 300mv range) should be used in conjunction with the shunt (Fig. 48).

DC Current and Voltage Regulator Output (Fig. 49)

1. Install the DC shunt on the negative terminal of the battery. Make sure all connections are clean and tight for reliable amperage readings.

2. Attach RED meter test lead to the POSITIVE post of the shunt.

3. Attach BLACK meter test lead to the NEGATIVE post of the shunt.

4. Place multimeter to the millivolts scale.

5. Start the engine and run so the alternator is running at **5000 rpm**. Determine current output. Current output should be from **1 to 27 ampere** depending upon battery voltage and/or current draw on the system. Voltage across the battery terminals should be from **13.7 to 14.7 VDC**.

6. If no or low current output is found, make sure all connections are clean and secure. If there is still no or low current output, remove shunt and test leads, reconnect battery, and test alternator output below.

AC Voltage Alternator Output (Fig. 50)

1. Make sure the engine is OFF. Disconnect connector with sky blue and white wires leading from the alternator to the voltage regulator.

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

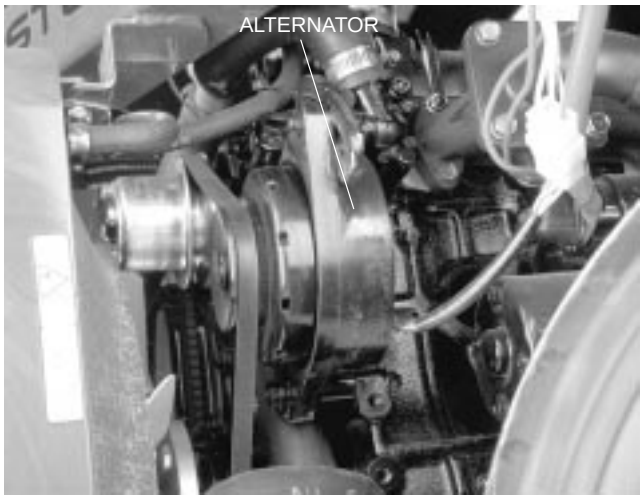


Figure 46

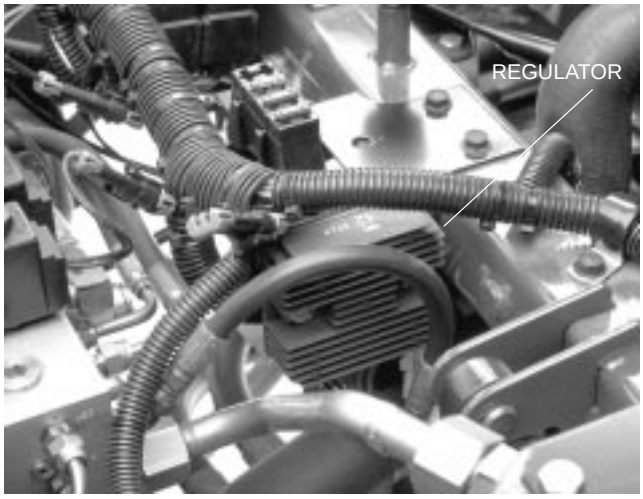


Figure 47

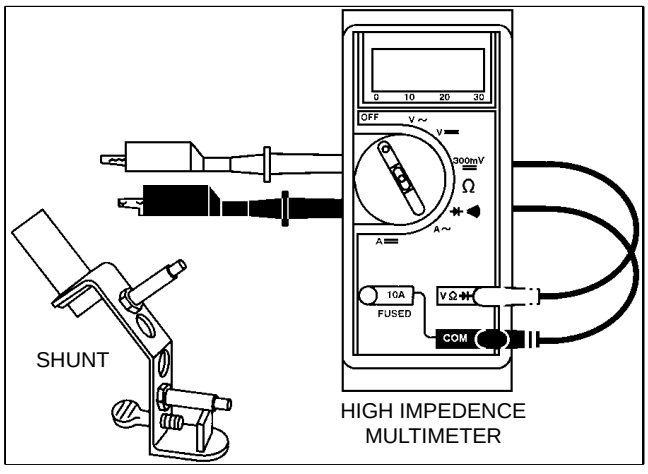


Figure 48

2. Test continuity of the alternator windings by setting the multimeter to the ohms scale. Read all combinations between the sky blue and white wires (criss–cross) on the connector from the alternator.

A. Two measurements should be **0.1 ohms**.

B. Two measurements should be **O/L**.

3. Check insulation resistance between lead wires and alternator casing.

A. Make sure test lead makes good contact with the alternator casing.

B. Resistance for each coil should be greater or equal to **3 Megohms**.

4. Place Functional Control Lever in NEUTRAL and start engine.

5. Run engine so the alternator is running at **2365 rpm**. Read combinations between the sky blue and white wires (criss–cross) on the connector from which continuity was found in step 2. Voltage across the connector terminals should be about **39.4 VAC**.

6. If the AC voltage output of the alternator is correct and the DC current and voltage outputs are bad, replace the voltage regulator. If the AC voltage output of the alternator is bad, replace the alternator and retest the voltage regulator.

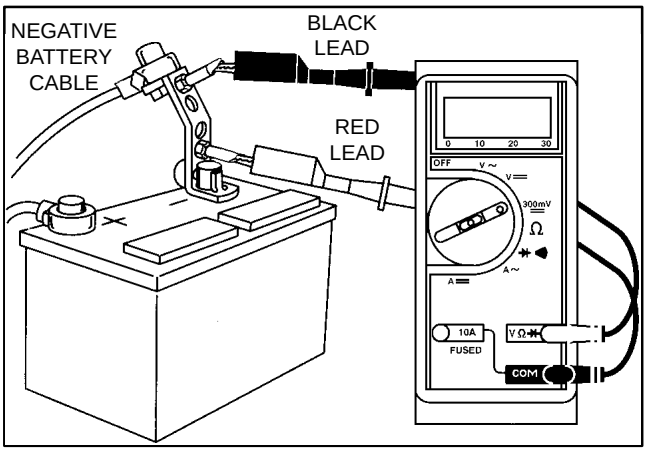


Figure 49

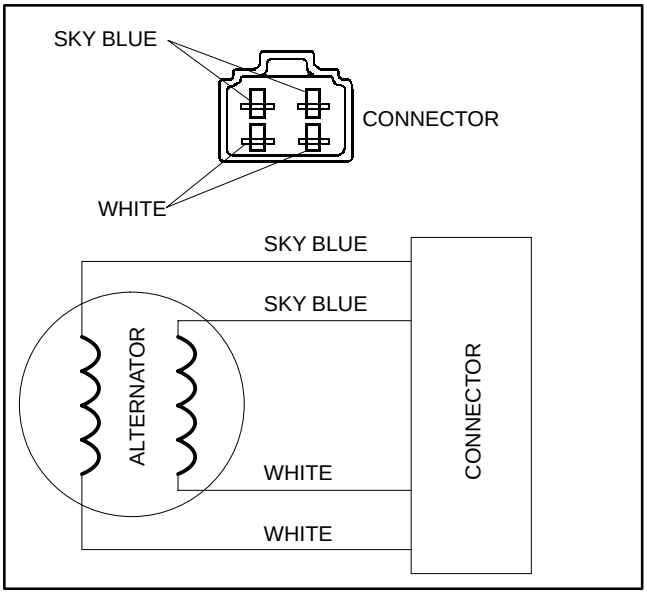


Figure 50

NOTE: See the Perkins 100 Series Workshop Manual or Briggs and Stratton Vanguard 3/LC Repair Manual for more component repair information.

Verify Interlock System Operation

CAUTION

The interlock switches are for the operator's protection; do not disconnect them. Check the operation of the interlock switches daily for proper operation. Replace any malfunctioning switches before operating the machine.

The purposes of the interlock switches are as follows: to prevent the engine from cranking or starting unless the Functional Control Lever is in NEUTRAL, to prevent operating the traction pedal with Functional Control Lever is in NEUTRAL, and Also, shut off the engine if the operator leaves the seat without the Functional Control Lever in NEUTRAL. Also, the reels will shut off if the Functional Control Lever is moved to NEUTRAL or TRANSPORT.

1. Sit on the seat, engage parking brake, and move Functional Control Lever to NEUTRAL. Try to depress traction pedal. If the pedal does not depress, the interlock system is operating correctly. Correct problem if not operating properly.

2. Sit on the seat, engage parking brake, keep traction pedal in neutral, and place Functional Control Lever in MOW or TRANSPORT. Try to start the engine. If the engine does not crank, the interlock system is operating correctly. Correct problem if not operating properly.

3. Sit on the seat and start engine. Move Functional Control Lever to Mow. Raise off the seat. If the engine stops, the interlock system is operating correctly. Correct problem if not operating properly.

4. Sit on the seat, engage parking brake, keep traction pedal in neutral, and place Functional Control Lever in NEUTRAL. Start the engine. Move Raise / Lower – Mow Control Lever forward to lower the cutting units. If the units do not start rotating, the interlock system is operating correctly. Correct problem if not operating properly.

Battery Service

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

CAUTION

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

Electrolyte Specific Gravity
Fully charged: 1.265 corrected to 80 F (26.7 C)
Discharged: less than 1.240

Battery Specifications
BCI Group Size 26:
Type 26 SMF–5
530 Amp Cranking Performance at 0 F (–17.8 C)
85 Minute Reserve Capacity at 80 F (26.7 C)

Removal (Fig. 51 and 52)

IMPORTANT: Be careful not to damage terminal posts or cable connectors when removing the battery cables.

1. Remove cap screw, washer, and battery retainer.

2. Disconnect the ground cable (–) first to prevent short circuiting the battery, other components, or the operators hands. Disconnect the positive (+) cable.

3. Make sure that the filler caps are on tightly.

4. Remove battery from the battery compartment to a service area. This will minimize possible battery damage and allow better access for inspection and service.

Inspection, Maintenance, and Testing

1. Perform following inspections and maintenance:

   A. Check for cracks caused by overly tight or loose hold–down clamp. Replace battery if cracked and leaking.

   B. Check battery terminal posts for corrosion. Use a terminal brush or steel wool to clean corrosion from the battery terminal posts.

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

Figure 51

1. Cap screw & washer **2. Battery retainer**

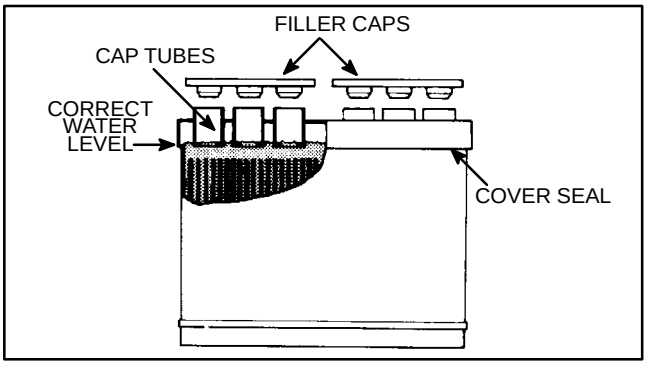


Figure 52

   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 the 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 to the bottom of the cap tubes. Charge at 15 to 25 amps for 15 minutes to allow sufficient mixing of the electrolyte.

2. Conduct a hydrometer test of the battery electrolyte.

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

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

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

Example:	Cell Temperature 100 F	
	Cell Gravity	1.245
	ADD (20 above 80 F)	0.008
	Correction to 80 F	1.253

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

3. Perform a high–discharge test with an adjustable load tester.

This is one of the most reliable means of testing a battery as it simulates the cold–cranking test. A commercial battery load tester is **required** to perform this test.

CAUTION

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

A. Check the voltage across the battery terminals prior to testing the battery. If the voltage is less than 12.0 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 the 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 instruction**s. Connect a digital multimeter to the battery terminals.

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

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

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

Minimum Voltage	Battery Electrolyte Temperature	
9.6	70 F (and up)	21.1 C (and up)
9.5	60 F	15.6 C
9.4	50 F	10.0 C
9.3	40 F	4.4 C
9.1	30 F	–1.1 C
8.9	20 F	–6.7 C
8.7	10 F	–12.2 C
8.5	0 F	–17.8 C

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

Installation

IMPORTANT: To prevent possible electrical problems, install only a fully charged battery.

1. Make sure the ignition switch and all accessories are off.

2. Make sure the battery compartment is clean and repainted if necessary.

3. Make sure all battery cables and connection are in good condition and that the battery hold down clamp has been repaired or replaced.

4. Lift seat and place the battery in its compartment. Make sure battery is level and flat. Push the positive cable connector onto positive battery post. Do not hammer; this will damage the battery. Tighten bolts with two wrenches.

5. Secure battery retainer to the battery with the washer and cap screw. Do not overtighten to prevent cracking or distorting the battery case (Fig. 51).

6. Apply a light coat of grease on all battery posts and cable connectors to reduce corrosion after connections are made.

7. Connect a digital multimeter (set to amps) between the negative battery post and the negative (ground) cable connector. The reading should be less than 0.1 amp. If the reading is 0.1 amp or more, the unit's electrical system should be tested and repaired.

8. Connect the negative (ground) cable connector to the negative battery post.

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 open specific gravity or 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 (15.5 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 (51.6 C) or the electrolyte is violently gassing or spewing, the charging rate must be lowered or temporarily stopped.

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

Chapter 7

Wheels and Brakes

Table of Contents

Specifications

Item	Description
Front tire pressure	8 to 12 PSI, (0.55 to 0.83 bar)
Rear tire pressure	8 to 15 PSI, (0.55 to 1.04 bar)
Wheel lug nut torque	40 to 50 ft–lb, (5.5 to 6.9 kg–m)

Brake Adjustment

CAUTION

Before and after adjusting the brakes, always check the brakes in a wide open area that is flat and free of other persons and obstructions.

1. While driving the machine, depress the brake pedal. Both wheels should lock equally.

2. Park machine on a level surface. Make sure engine is off.

3. Remove cotter pin and clevis pin from the clevis and brake pedal tab.

4. Loosen jam nut on the brake rod.

5. Adjust clevis for proper amount of free travel.

   A. Loosen clevis by exposing more threads on the brake rod to decrease free travel of the brake pedal.

   B. Tighten clevis by exposing fewer threads on the brake rod to increase free travel of the brake pedal.

6. Assemble clevis to the brake pedal by installing clevis pin and cotter pin.

7. Check the amount of free travel of the brake pedal when the adjustment is complete. There should be from1/2 to 1 inch (1.3 to 2.5 cm) of travel before the brake shoes make contact with the brake drums. Readjust brake if necessary to achieve this setting.

8. Drive the machine and depress the brake pedal. Both wheels should lock equally. Readjust brake if necessary.

9. It is recommended that the brakes be burnished annually. Burnish the brakes as follows:

   A. Firmly apply brakes and drive machine at mowing speed until the brakes are hot and begin to smell.

   B. The brakes may require adjustment after burnishing.

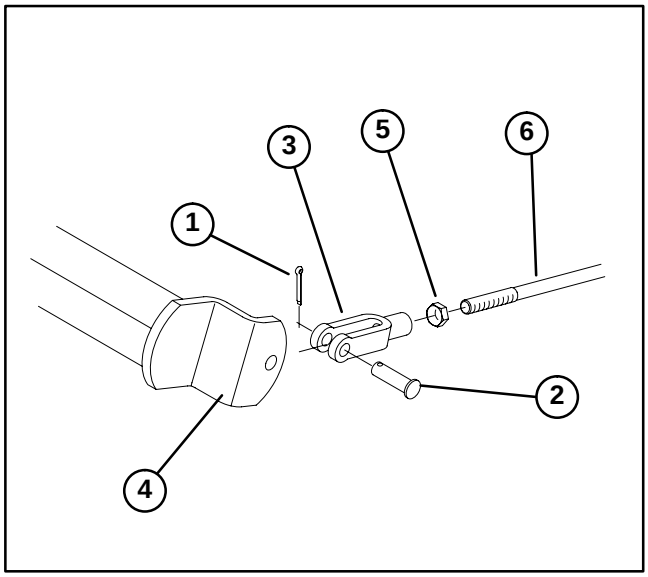


Figure 1

1. **Cotter pin**
2. **Clevis pin**
3. **Clevis**
4. **Brake pedal tab**
5. **Jam nut**
6. **Brake rod**

Rear Wheel (2WD)

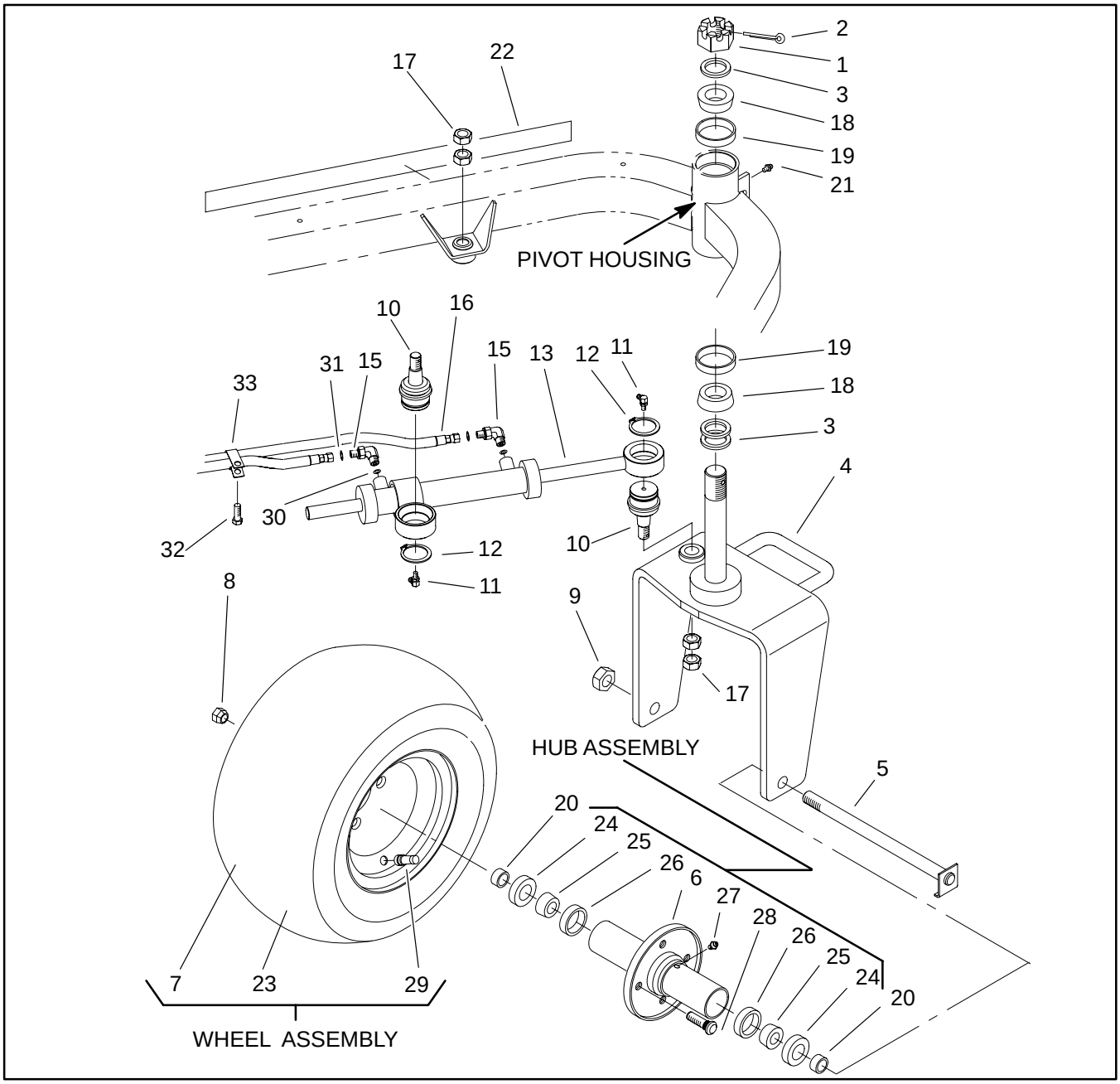


Figure 2

1. Hex nut
2. Cotter pin
3. Steering washer
4. Castor fork
5. Bolt
6. Wheel hub
7. Tire
8. Lug nut
9. Lock nut
10. Ball joint
11. 90° grease fitting
12. Retaining ring
13. Steering cylinder
14. Hose assembly
15. Hydraulic fitting
16. Hose assembly
17. Jam nut
18. Bearing cone
19. Bearing cup
20. Cylinder spacer
21. Straight grease fitting
22. Decal
23. Rim
24. Shaft seal
25. Bearing cone
26. Bearing cup
27. Grease fitting
28. Drive stud
29. Valve stem with cap
30. O–ring
31. O–ring
32. Hex head screw
33. Hose clamp

Removal (Fig. 2)

1. Park machine on a level surface. Make sure engine is off. Set brake and block front wheels.

2. Jack up and secure the rear wheel off the ground.

Note: The wheel assembly consists of the tire (7), rim (23), and valve stem (29) with cap. The hub assembly consists of the wheel hub (6), shaft seal (24), bearing cone (25), bearing cup (26), grease fitting (27), and drive stud (28).

3. Remove lock nut (9) from bolt (5). Pull bolt from the castor fork (4), cylinder spacers (20), and the wheel and hub assemblies.

4. Remove wheel and hub assemblies from the castor fork (4).

5. If damage to the bearings in the castor fork pivot housing is suspected, remove castor fork (4) from the frame as follows:

A. Remove three hex head screws and flat washers securing the fuel tank base plate to the frame. The two screws are located on the top of the plate at the front corners of the tank. The third screw is in front of the castor fork and below the plate.

B. Tilt fuel tank base up by lifting at the rear of the machine to gain access to the top of the castor fork. Prop up tank securely.

C. Remove both jam nuts (17) securing the ball joint (10) to the castor fork (4).

CAUTION

Support the castor fork (4) while removing the hex nut (1) to prevent the fork from dropping and causing personal injury.

D. Remove cotter pin (2) and hex nut (1) from the castor fork (4) shaft. Lower castor fork from the frame and make sure ball joint (10) releases from the shaft ring of the steering cylinder (13).

E. Inspect bearing cones (18) and bearing cups (19) for damage, and replace if necessary.

F. Remove bearing cones (18) and bearing cups (19) from the castor fork pivot housing on the frame.

6. Remove lug nuts (8) from the drive studs (28) of the wheel hub (6). Separate wheel and hub assemblies.

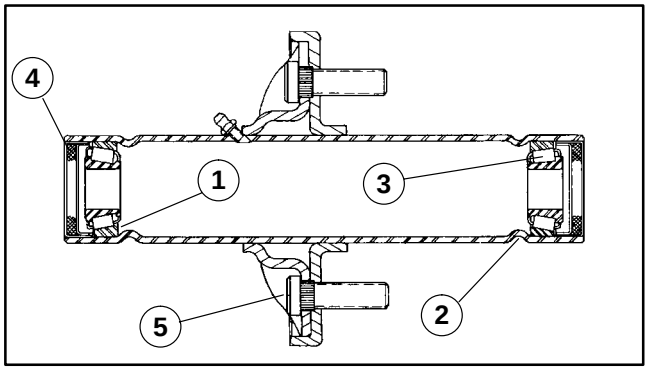


Figure 3

1. **Bearing cup**
2. **Wheel hub**
3. **Bearing cone**
4. **Shaft seal**
5. **Drive stud**

Disassembly (Fig. 2)

1. If drive studs (28) are bent or damaged, press studs from the wheel hub (6).

2. Pull shaft seals (24), bearing cones (25), and bearing cups (26) from the wheel hub (6).

Assembly (Fig. 3)

1. Press new bearing cups into the wheel hub with the thick edges towards the inside.

2. Install new bearing cones into the wheel hub. Press new shaft seals into the hub with the lip of the seals facing towards the inside.

3. If removed. press new drive stud (28) into the wheel hub (6).

Installation (Fig. 2)

1. Slide wheel assembly onto the drive studs (28). Tighten lug nuts (8) to the drive studs (28) evenly in a crossing pattern to a torque of 45 to 55 ft–lb (6.2 to 7.6 kg–m).

2. If the bearings in the castor fork pivot housing were removed, install castor fork (4) to the frame as follows:

A. Press new bearing cups (19) into the castor fork pivot housing with the thick side of the cups facing each other.

B. Pack both bearing cones (18) with No. 2 multipurpose lithium base grease. Place two steering washers (3) onto the castor fork (4) shaft. Place bearing cone on top of washers with the thick edge touching the washers.

C. Insert castor fork shaft up through the pivot housing and bearing cups.

D. Place second bearing cone on the castor fork shaft with the wide edge up. Place remaining steering washer on top of the bearing cone.

E. Run hex nut (1) onto castor fork shaft until drag is felt while rotating the castor fork. Back–off hex nut to align the hole to the slot. Install and secure cotter pin (2) into the shaft.

F. Secure ball joint (10) to the castor fork (4) with both jam nuts (17).

G. Secure fuel tank base plate to the frame with three hex head screws and flat washers. The two screws and flat washers go on the top of the plate at the front corners of the tank. The third screw goes through support from under the plate.

3. Install wheel and hub assemblies into the castor fork (4). Insert bolt (5) into one of the castor fork mounting holes. Install a spacer (20), and slide bolt through the wheel and hub assemblies.

4. Install another spacer (20) onto the bolt (5). Route the bolt through the remaining castor fork (4) mounting hole.

5. Position bend of the bolt (5) head under the bottom edge of the castor fork (4). Install and tighten locknut (9) to secure wheel to the castor fork. Do not overtighten locknut, the wheel must rotate freely.

6. Wipe grease fitting clean on hub (6) and pivot housing. Pump grease into hub until grease is seen exiting at both shaft seals (24). Pump grease into pivot housing until grease is seen exiting at both ends of the housing. Wipe up excess grease.

Rear Wheel (3WD)

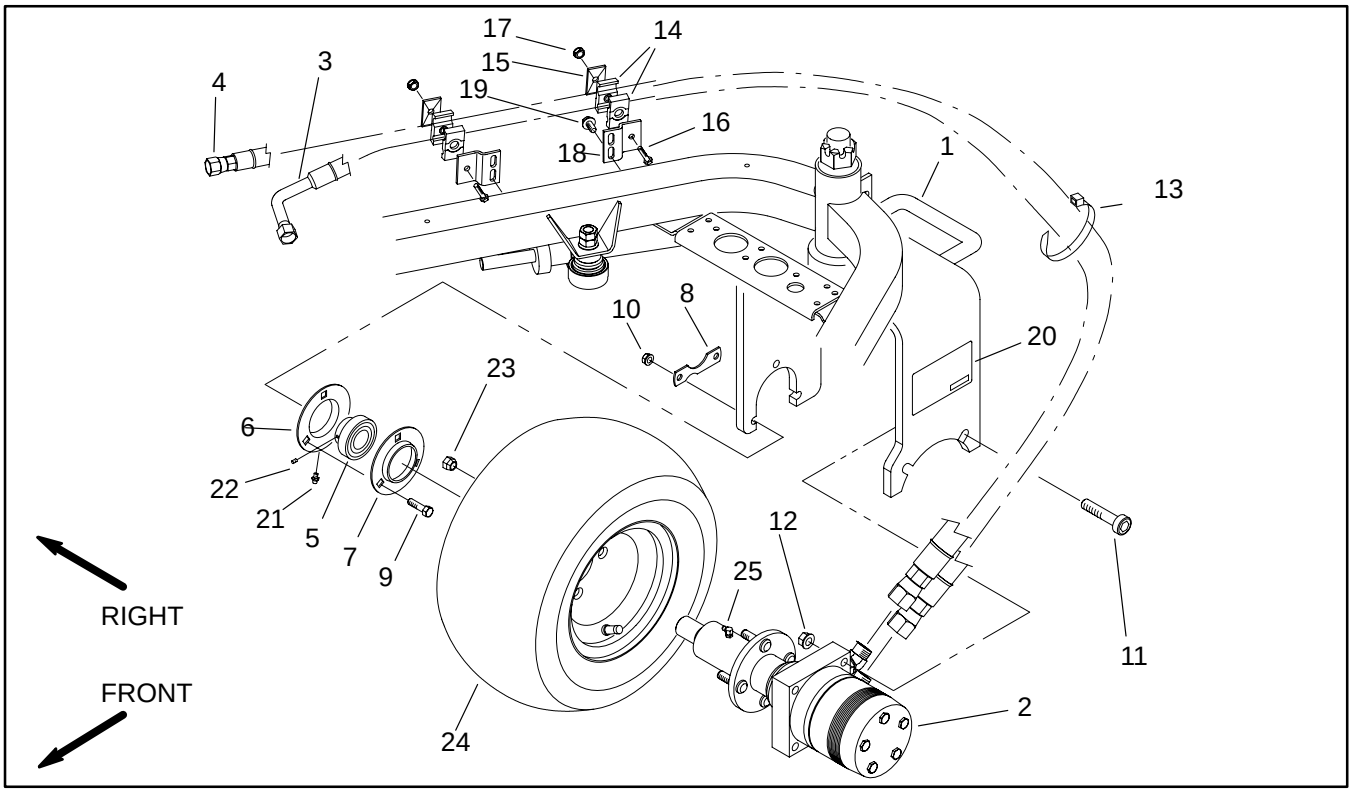


Figure 4

1. **Castor fork**
2. **Hydraulic motor & hub assembly**
3. **Hydraulic hose**
4. **Hydraulic hose**
5. **Bearing**
6. **Relube flangette**
7. **Standard flangette**
8. **Bearing tab**
9. **Hex head screw**
10. **Lock nut**
11. **Socket head screw**
12. **Lock nut**
13. **Cable tie**
14. **Tube clamp**
15. **Cover plate**
16. **Hex head screw**
17. **Lock nut**
18. **Clamp bracket**
19. **Wide head taper screw**
20. **3WD decal**
21. **Grease fitting**
22. **Set screw**
23. **Lug nut**
24. **Wheel**
25. **Grease fitting**

Removal (Fig. 4)

1. Park machine on a level surface. Make sure engine is off. Set brake and block front wheels.

2. Jack up and secure the rear wheel off the ground.

CAUTION

Support wheel (24) and motor and hub assembly (12) to prevent dropping them and causing personal injury while removing hex head screws (9) and socket head screws (11).

3. Remove wheel (24) and hydraulic motor and hub assembly (2) from the castor fork (1) as follows:

   A. Remove hex head screws (9) and lock nuts (10) securing flangettes (6 and 7) and bearing tab (8).

   B. Remove both socket head screws (11) and lock nuts (12) securing the hydraulic motor and hub assembly to the castor fork (1).

   C. Lower wheel and hydraulic motor and hub assembly from the castor fork.

4. Loosen set screws (22) on bearing (5). Pull flangettes (6 and 7) and bearing from the hydraulic motor shaft.

5. Remove grease fitting (25) from the hydraulic motor and hub assembly (2). Remove four lug nuts (23) and wheel (24) from the hub drive studs.

6. If the castor fork (1) requires removal, see Rear Wheel (2WD) Removal.

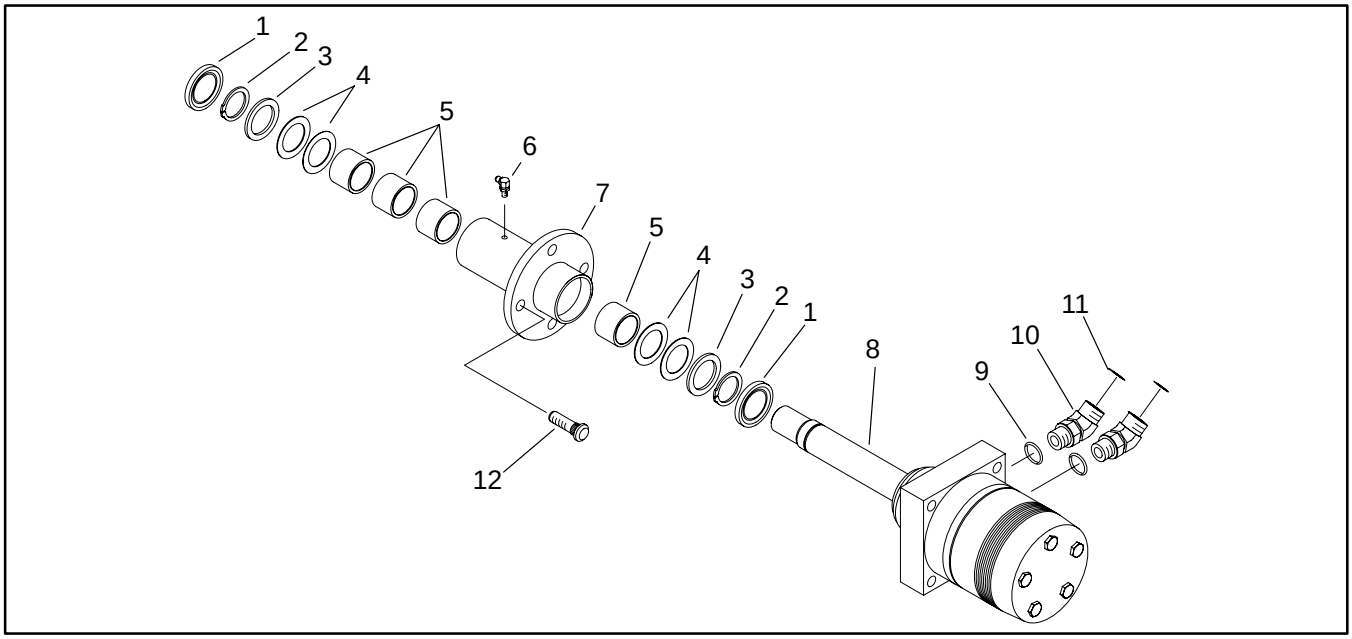


Figure 5

1. **Grease seal**
2. **Retaining ring**
3. **Washer**
4. **Thrust washer**
5. **Clutch roller bearing**
6. **Grease fitting**
7. **Hub**
8. **Hydraulic motor**
9. **O–ring**
10. **45° hydraulic fitting**
11. **O–ring**
12. **Drive stud**

Disassembly (Fig. 5)

1. Remove grease seal (1) and retaining ring (2) from the long end of hub (7).

2. Remove washer (3), two thrust washers (4), and hub (7) from the hydraulic motor (8) shaft. Remove remaining two thrust washers (4), washer (3), retaining ring (2), and grease seal (1) from the shaft.

3. If drive studs (12) are bent or damaged, press studs from the wheel hub (7).

4. Press roller clutch bearings (5) from the hub (7).

Assembly (Fig. 5)

1. If drive studs (12) were removed, press new studs into the wheel hub (7).

2. Press roller clutch bearings (5) into the hub (7) as follows (Fig. 6):

Note: The arrow on the side of the clutch roller bearings (5) should point to the long side of end of the hub (7).

A. Press two bearings into each end of the hub.

B. The outer edge of the outer bearings must be flush with the recessed edge within the hub.

3. Grease inner edge of the new grease seal (1) with No. 2 multipurpose lithium base grease. Slide seal onto motor shaft past groove closest to the motor. Install retaining ring (2) into groove.

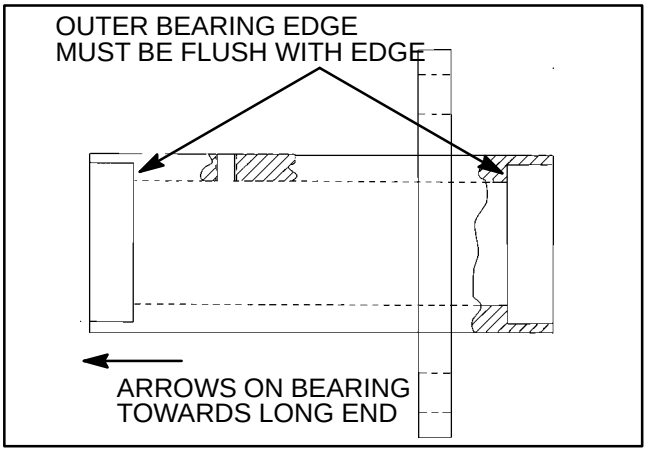


Figure 6

4. Slide flat washer (3) and two thrust washers (4) onto the motor shaft. Slide hub (7) onto the shaft with the short side first.

5. Slide remaining thrust washers (4) and flat washer (3) onto the motor shaft. Install remaining retaining ring (2) into the shaft groove. Slide new grease seal (1) onto motor shaft.

IMPORTANT:The hub (7) should spin freely in the forward direction, but lock on the hydraulic motor (8) shaft when it is spun in the reverse direction.

6. Press grease seals (1) into the hub (7) so they are flush with the end of the hub.

Installation (Fig. 4)

1. Secure wheel (24) to the four drive studs of the hydraulic motor and hub assembly (2) with four lug nuts (23). Torque nuts from 45 to 55 ft–lb, (6.2 to 7.6 kg–m).

2. Reinstall grease fitting into hydraulic motor and hub assembly (2) so it points away from the wheel (24).

3. Install flangette (7), bearing (5), and relube flangette (6) onto the motor shaft.

4. Position hydraulic motor and hub assembly (2), flangettes (6 and 7) with bearing (5), and wheel (24) into the castor fork (1). Make sure hose fittings on the motor face the rear.

5. Secure hydraulic motor and hub assembly (2) loosely to the left inside of the castor fork (1) with both socket head screws (11) lock nuts (12).

6. Secure flangettes (6 and 7) with bearing (5) loosely to the right inside of the castor fork (1).

   A. Position grease fitting (21) facing downward.

   B. Torque both socket head screws (11) to 85 ft–lb (11.8 kg–m).

   C. Torque both hex head screws (9) to 30 ft–lb (4.2 kg–m).

7. Apply loctite to both set screws (22). torque both screws from 80 to 100 in–lb (92 to 115 kg–cm).

Front Wheel and Brake

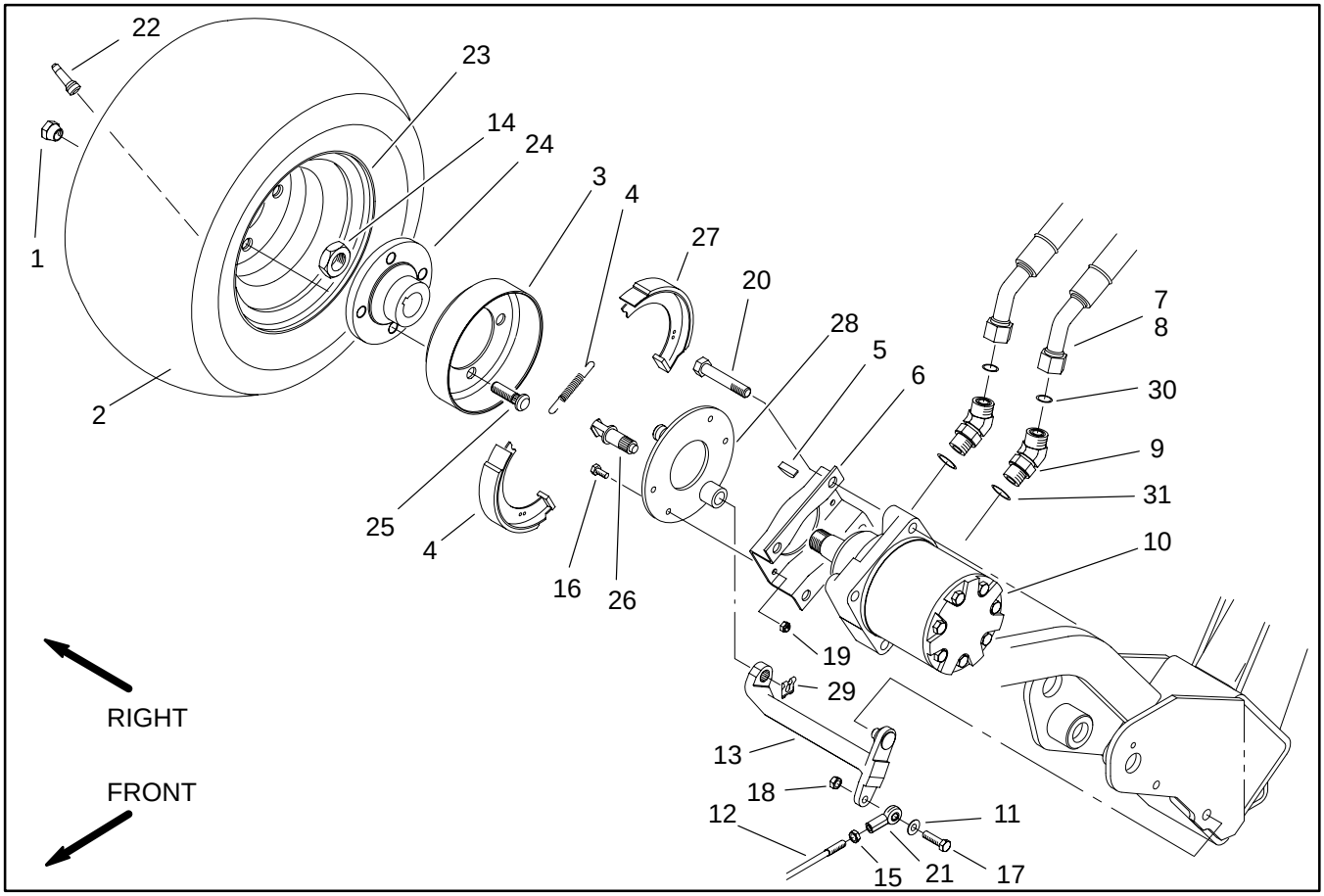


Figure 7

1. **Lug nut**
2. **Tire**
3. **Brake drum**
4. **Return spring**
5. **Woodruff key**
6. **Brake bracket**
7. **Hose assembly (RH)**
8. **Hose assembly (LH)**
9. **45° Fitting**
10. **Hydraulic wheel motor**
11. **Flat washer**
12. **Brake rod**
13. **Brake lever**
14. **Lock nut**
15. **Jam nut**
16. **Hex head screw**
17. **Hex head screw**
18. **Lock nut**
19. **Lock nut**
20. **Hex head screw**
21. **Swivel clevis**
22. **Valve stem**
23. **Rim**
24. **Wheel hub**
25. **Drive stud**
26. **Brake cam**
27. **Brake shoe**
28. **Backing plate**
29. **Retaining clip**
30. **O−ring**
31. **O−ring**

Removal (Fig. 7)

1. Park machine on a level surface. Make sure engine is off. Make sure brake is in the OFF position.

2. Lift front wheel off the ground using a jack, and place blocks beneath the frame under the hydraulic wheel motor (10). Block front and rear of other wheels.

3. Remove lug nuts (1) and tire (2) and rim (23). Remove lock nut (14) from hydraulic wheel motor (10) shaft.

IMPORTANT: DO NOT hit wheel hub (24) with a hammer during removal or installation. Hammering may cause damage to the hydraulic wheel motor (10).

4. Use a puller to remove the wheel hub (24) and brake drum (3). Remove the key (5) from the hydraulic wheel motor (10) shaft.

5. Remove return springs (4) from brake shoes (27). Remove brake shoes from backing plate (28).

6. Remove retaining clip (29) and brake cam (26) from the brake lever (13) and backing plate (28).

7. Remove four hex head screws (16), lock nuts (19), and backing plate (28) from the brake bracket (6).

8. Parts should be clean and free of rust. Inspect brake shoe (27) and brake drum (3) contact surfaces for excessive wear. Replace any worn or damaged parts.

Installation (Fig. 7 and 8)

1. Secure backing plate (28) to the brake bracket (6) with the four hex head screws (16) and lock nuts (19).

2. Position both brake shoes (27) on the backing plate (28). Insert return springs (4) into the holes of both brake shoes (27).

3. Install brake cam (26) into the backing plate (28) and brake lever (13). Secure cam to the lever with the retaining clip (29).

4. Make sure that wheel hub bore and wheel motor shaft are thoroughly cleaned. Install key (5) to the hydraulic wheel motor (10) shaft. Slide hub over shaft and key.

5. Secure wheel hub (24) to motor shaft with lock nut (14). Torque nut from 250 to 400 ft–lb (34.6 to 55.3 kg–m).

6. Install rim (23) on the wheel hub (24). Secure rim with lug nuts (1) to the wheel hub (23) drive studs. Tighten lug nuts evenly in a crossing pattern to a torque from 40 to 50 ft–lb (5.5 to 6.9 kg–m).

7. Check and adjust brakes (see Brake Adjustment).

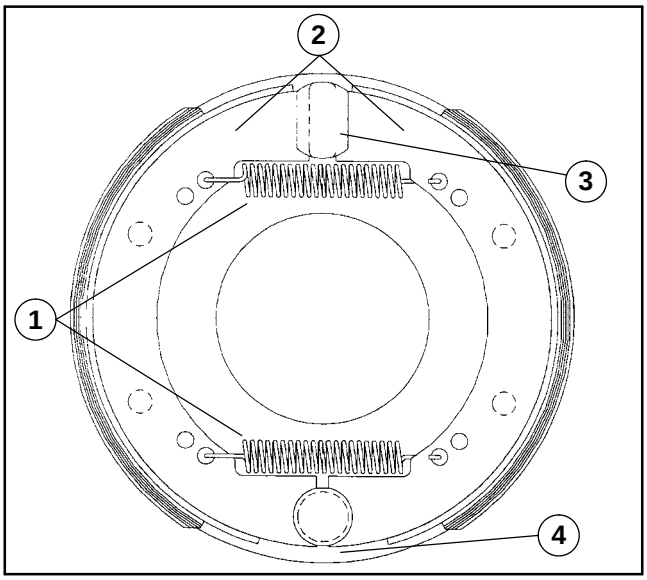


Figure 8

1. Return spring
2. Brake shoe
3. Brake cam
4. Backing plate

Lubrication

CAUTION

Before servicing or making adjustments to the machine, stop engine and remove the key from the ignition switch.

The rear wheel has grease fittings that must be lubricated regularly with No. 2 general purpose lithium base grease. If the machine is operated under normal conditions, lubricate all bearings and bushings after every 50 hours of operation. Lubricate fittings immediately **after every** washing, regardless of the interval listed.

The rear wheel bearings and bushings that must be lubricated are: rear wheel hub, castor fork bearing, and ball joints.

1. Wipe grease fittings clean so foreign matter cannot be forced into the bearing or bushing.

2. Pump grease into the bearing or bushing.

3. Wipe up excess grease.

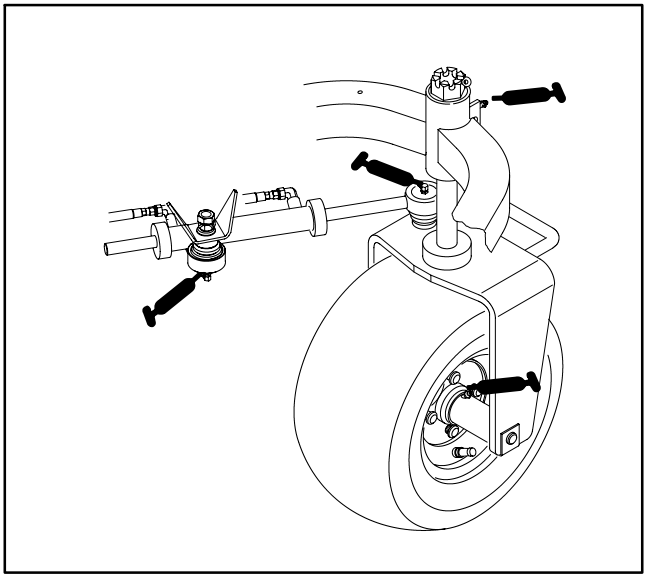


Figure 9

Chapter 8

Cutting Units

Table of Contents

Introduction

There are two different types of cutting units covered in this chapter: the Single Point Adjust and 4–Bolt Adjust. Both units are similar in design and construction. However, each unit has different bedbars with different methods of bedknife adjustment (see Specifications).

Maintenance procedures for both cutting units are the same, except where noted. If a chapter subheading does not specify a particular type of cutting unit, the procedure can be used for both types of units. A particular unit may be illustrated, but the component parts and maintenance procedures are the same for each type of unit.

Specifications

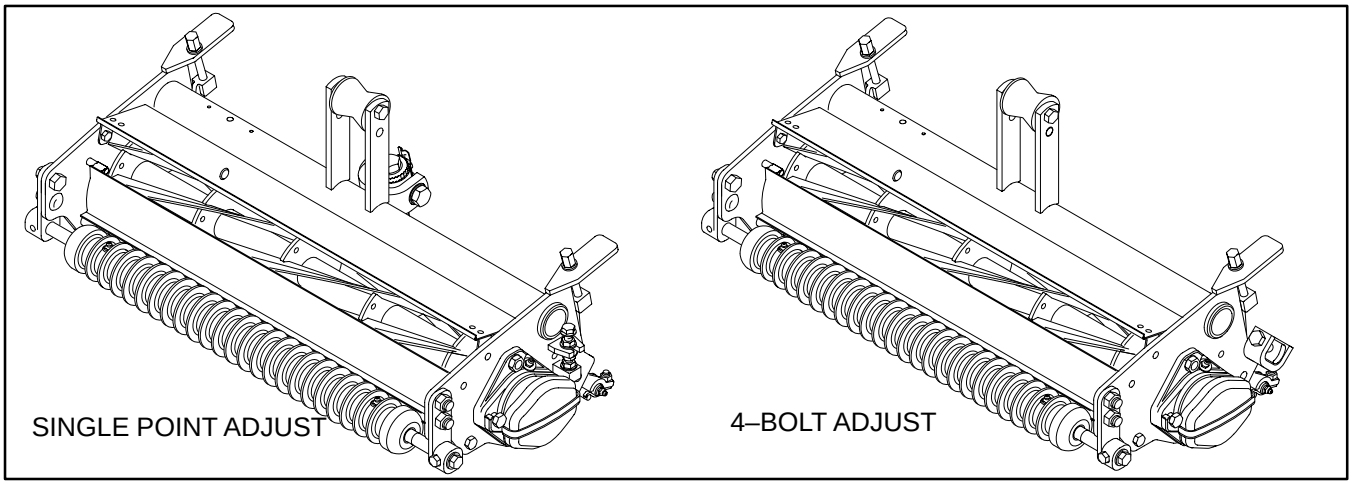


Figure 1

Height–of–Cut (HOC): The cutting height is adjusted on the rear roller by two vertical screws which are held by two locking capscrews. The bench HOC range is 3/32 inch to 1–1/32 inches (2.4 mm to 26.2 mm). The effective HOC may vary depending on turf conditions and the bedknife installed.

Reel Construction: The reels are 5 inches (13 cm) in diameter and 21 inches (53.3 cm) in length. High carbon steel blades are welded to 5 stamped steel spiders and heat treated to RC 48–54 hardness. The reel is ground for diameter, concentricity, and back grind.

Reel Bearings: An inverted seal is pressed onto the reel shaft. Two double row ball bearings (30 mm I.D.) are press fit onto the reel shaft. Bearing side load is maintained by a 3–1/2 turn wave washer with no adjusting nut.

Reel Drive: The reel weldment shaft is a 1.375 inch (3.493 cm) diameter tube with drive inserts permanently pressed into both ends. A replaceable floating coupler with an internal eight tooth spline is factory installed on the right end. A snap ring holds the coupler in place. The floating coupler may be moved to the other end when the cutting unit is used in the tractor's front right position.

Frame Construction: A single top tube is welded between two sideplates. A bolt–in cross rod acts to set the front frame width and stiffen the assembly. The lift straps have a replaceable roller that may be moved to change transport height of the cutting unit.

Bedknife: This high carbon steel bedknife is replaceable, single edged, and austempered to RC 48–55. It is fastened to a machined cast iron bedbar with 13 screws. The tournament bedknife is supplied as the standard bedknife (Part No. 93–4263).

Options:

Micro Cut Bedknife	Part No. 93–4262
Low Cut Bedknife	Part No. 93–4264
High Cut Bedknife	Part No. 94–6392
Fairway Bedknife	Part No. 94–6393

Bedknife Adjustment (Single Point Adjust): A single control screw with detents moves the bedknife 0.0007 inch (0.018 mm) for each indexed position. A linear adjustment on the bedbar left end allows leveling of the bedknife to the reel blades. A centered lever arm regulates the bedknife to reel contact with two rubber bushings acting as pivots.

Bedknife Adjustment (4–Bolt Adjust): Two opposing screws on each end of the bedbar level and regulate the bedknife to reel contact.

Front Roller: The standard front roller is a 2.5 inch (6.4 cm) diameter Wiehle. The right bracket provides leveling with an eccentric shoulder bolt. A second eccentric may be added to the left bracket for increased leveling range. The roller has a through shaft with greaseable ball bearings.

Rear Roller: The standard rear roller is a smooth roller with a 2 inch *(5.2* cm) diameter. The roller has a through shaft with greaseable ball bearings.

Front Shield: A snap–in shield covers the lower front of the reel. The shield helps improve grass throwing into the basket, and it prevents the basket sealing flap from being damaged by the reel.

Counterbalance Weight: For easy installation, the weight has a spin flange like the reel motors. It is installed opposite the reel motor. It seals the bearing and balances the reel motor's weight during cutting.

Lift Roller Position

The cutting unit comes with its lift roller installed in the top position. The position of the roller may be changed as follows:

1. Remove hex head screw and lock nut from the lift roller and frame.

2. Position lift roller to the proper hole on the frame. Insert hex head screw through the frame and roller.

   Lower Hole – for increased transport height.

   Upper Hole – standard transport height so the cutting unit is level when it touches down upon lowering.

3. Secure hex head screw with the lock nut.

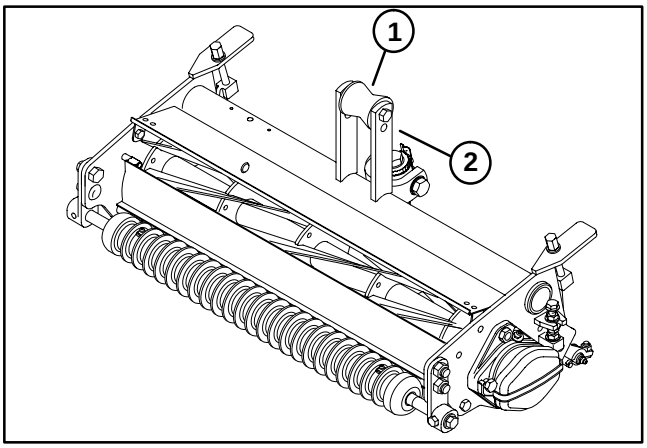


Figure 2

1. **Lift roller**
2. **Hex head screw**

Grass Basket Removal and Installation

1. Grasp basket by top rear lip and slide on or off the basket mounting rods.

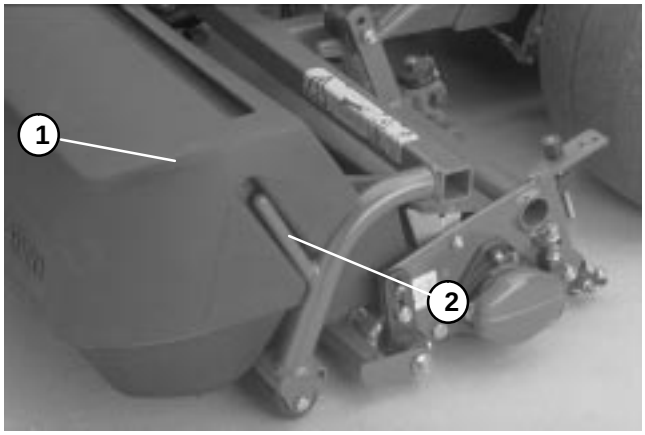


Figure 3

1. **Grass basket**
2. **Mounting rod**

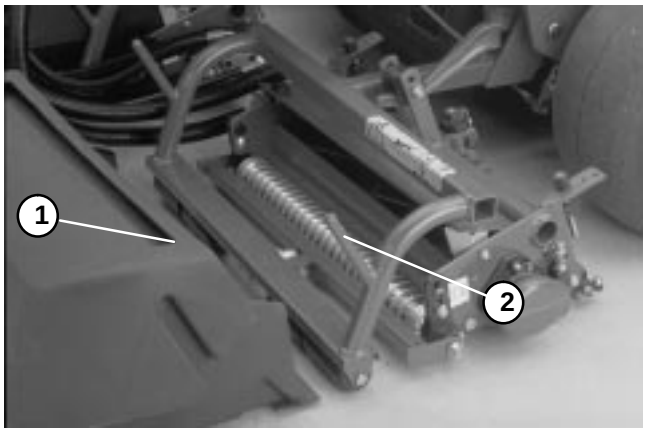


Figure 4

1. **Grass basket**
2. **Mounting rod**

Special Tools

OTC (Owatonna Tool Company) supplies special tools for servicing Toro Commercial Products. The *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE* shows service tool applications.

Some tools may have been supplied with your mower or available as TORO parts. Some tools may also be available from a local supplier.

Gauge Bar Assembly

Used to verify height–of–cut. Toro Part No. 13–8199.

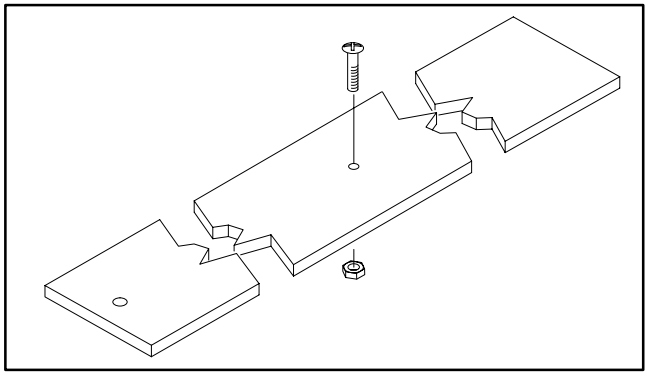


Figure 5

Backlapping Brush Assembly – TOR299100

Used to apply lapping compound to cutting units while keeping the operator's hands at a safe distance from the rotating reel.

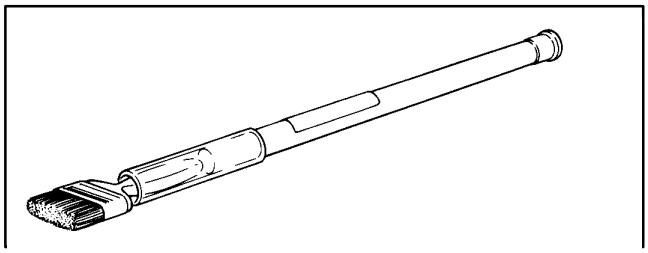


Figure 6

Bedknife Screw Tool – TOR510880

This screwdriver–type bit is made to fit Toro bedknife attaching screws. Use this bit with a torque wrench to secure the bedknife to the bedbar.

DO NOT use and air or manual impact wrench with this tool so damage to the bedbar will be prevented.

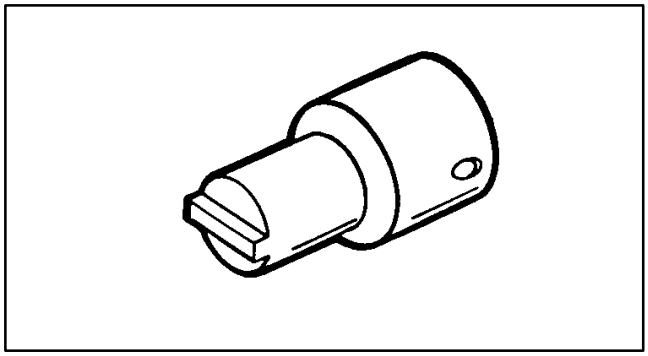


Figure 7

Bearing Replacement Tool Kit – TOR238900A

The puller is used to remove the bearings from the Wiehle Rear Roller kit (Model 04488) rollers **only**. A driving tube is used to install bearings into the roller. A drill bushing is used to drill into bearing shafts without a removal hole.

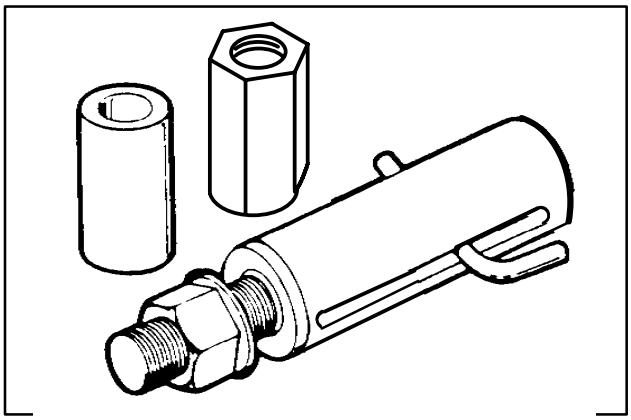


Figure 8

Plastic Plug

This cap is used for placement into the bearing housing when the reel motor is removed. It prevents dirt and debris from entering the housing. Toro Part No. 2410–30.

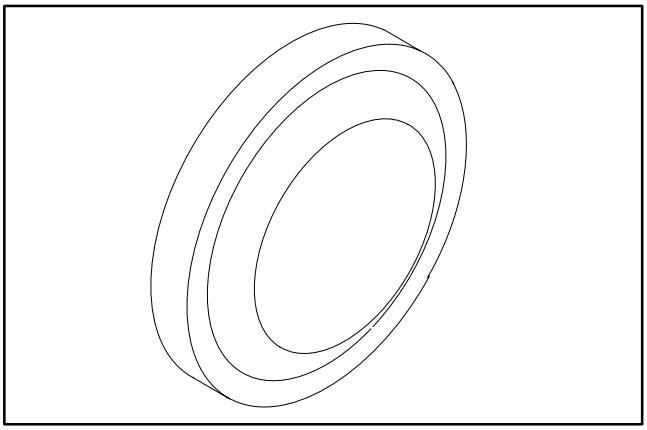


Figure 9

Troubleshooting

There are a number of factors that can contribute to unsatisfactory quality of cut, some of which may be turf conditions. Turf conditions such as excessive thatch, “sponginess” or attempting to cut off too much grass height may not always be overcome by adjusting the cutting unit. It is important to remember that the lower the height–of–cut, the more critical these factors are. See Adjustments and Service and Repairs sections for detailed adjustments and repair information.

Factors That Can Affect Quality of Cut

Factor	Possible Problem/Correction
Tire pressure	Check pressure of all tires. Pressure must be equal on both front tires. Adjust pressure as necessary. See General section in Chapter 6 – Wheels and Brakes.
Governed engine speed	Check maximum governed engine speed. Adjust engine to specifications if necessary. See Adjustments section in Chapter 3 or 4 – Vanguard or Perkins Engine.
Reel bearing condition	Check bearings for wear and replace if necessary. Make sure bearing housings are secured properly. Keep bearings well lubricated. See Reel and Bearing Removal and Installation.
Reel and bedknife sharpness	A reel and/or bedknife that has rounded cutting edges or ”rifling (grooved or wavy appearance) cannot be corrected by tightening the bedknife to reel contact. Grind reel to remove taper and/or rifling. Grind bedknife to sharpen and/or remove rifling. The most common cause of rifling is bedknife to reel contact that is too tight. **A new bedknife must be ground or backlapped after installation to the bedbar.**
Bedknife to reel adjustment	Check bedknife to reel contact daily. The bedknife must have light contact across the entire reel. No contact will dull the cutting edges. Excessive contact accelerates wear of both edges. Quality of cut is adversely affected by both conditions (see Bedknife to Reel Adjustment). Slightly dull cutting edges may be corrected by backlapping (see Backlapping). Excessively dull cutting edges must be corrected by grinding the reel and bedknife (see Preparing Reel for Grinding).

Factor	Possible Problem/Correction
Bedknife attitude	Set attitude (angle) as recommended. See Leveling Front Roller to Reel and Attitude Adjustments.
Rear roller adjustment	Check and adjust as necessary. The rear roller must be leveled so it is parallel with the reel for proper height–of–cut setting. See Height–of–Cut Adjustment.
Height–of–cut	“Effective” or actual height–of–cut depends on the cutting unit weight and turf conditions. Effective height–of–cut will be different from the bench set height–of–cut. See Height–of–Cut Adjustment.
Proper bedknife selection for height–of–cut desired	If the bedknife is too thick for effective height–of–cut, poor quality of cut will result.
Stability of bedbar	Make sure bedbar pivot bolts are seated securely. Check condition of the bushings in the side plates. See Bedbar Removal and Installation.
Number of reel blades	Use correct number of blades for clip frequency and optimum height–of–cut range.
Cutting unit alignment and pull frame ground following	Check pull frames and lift arms for damage, binding, or bushing wear. Repair if necessary.
Roller condition	Make sure rollers rotate freely. Grease roller as recommended and repair bearings as necessary. See Roller Bearing Replacement in Service and Repairs section.
Reel speed	All reels must rotate at the same speed (within 100 rpm). All cutting units must have equal bedknife to reel, front roller to reel, attitude, and height–of–cut adjustments. Check reel speed setting if a backlap/variable reel speed kit is installed. See Adjustments in this chapter and Troubleshooting in Chapter 5 – Hydraulic System.
Traction speed	Check maximum governed engine speed. Adjust engine to specifications if necessary. See Adjustments section in Chapter 3 or 4 – Vanguard or Perkins Engine. Check traction pedal adjustment. See Adjusting Transport and Mowing Speed, and Troubleshooting in Chapter 5 – Hydraulic System.
Cutting Unit drop speed and sequence	Center cutting unit must drop after front cutting units. See Troubleshooting in Chapter 5 – Hydraulic System.

Adjustments

CAUTION

Never work on a machine with the engine running. Always stop the engine and remove the key from the ignition switch first.

Daily Adjustments (Single Point Adjust Cutting Units)

Prior to each day's mowing, or as required, each cutting unit must be checked to verify proper bedknife–to–reel contact. **This must be performed even though quality of cut is acceptable.**

1. Lower cutting units onto a hard surface, shut off engine, and remove the key from the ignition switch.

2. Slowly rotate reel in the reverse direction listening for reel–to–bedknife contact. If no contact is evident, turn bedknife adjusting knob clockwise, one click at a time, until light contact is felt and heard.

3. If excessive contact is felt, turn bedknife adjusting knob counterclockwise, one click at a time, until no contact is evident. Then turn bedknife adjusting knob clockwise, one click at a time, until light contact is felt and heard.

IMPORTANT: Light bedknife to reel contact is preferred at all times. If light contact is not maintained, bedknife and reel edges will not sufficiently self–sharpen, and dull cutting edges will result after a period of operation. Excessive contact can cause accelerated and/or uneven bedknife and reel wear. Thus, quality of cut may be adversely affected.

Note: As the reel blades continue to run against the bedknife, a slight burr will appear on the front cutting edge surface for the full length of the bedknife. If a file is occasionally run across the front edge to remove this burr, quality of cut will improve. If this burr is not removed, the quality of cut will appear as if it was cut with a dull reel (grass will appear torn or ripped).

After extended running, a ridge will eventually develop at both ends of the bedknife. These ridges must be rounded off or filed flush with the cutting edge of the bedknife to assure smooth operation.

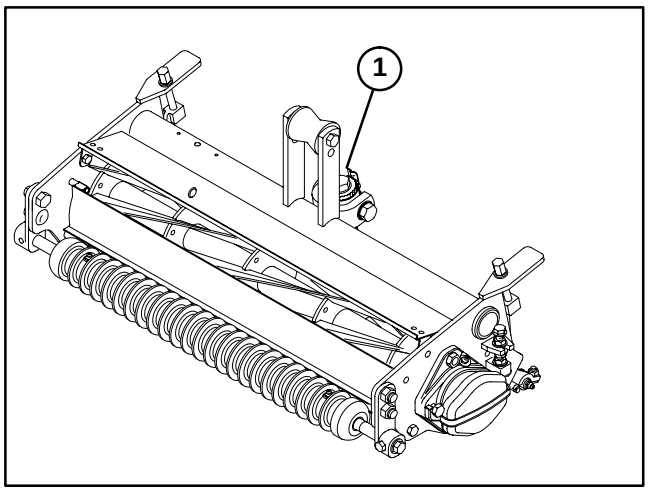


Figure 10

1. **Adjustor**

Daily Adjustments (4–Bolt Adjust Cutting Units)

Prior to each day's mowing, or as required, each cutting unit must be checked to verify proper bedknife–to–reel contact. **This must be performed even though quality of cut is acceptable.**

1. Lower cutting units onto a hard surface, shut off engine, and remove the key from the ignition switch.

2. Slowly rotate reel in the reverse direction listening for reel–to–bedknife contact. If no contact is evident, adjust bedknife to reel (see Bedknife to Reel Adjustment (4–bolt Adjust Cutting Units)).

3. If excessive contact is felt, adjust bedknife (see Bedknife to Reel Adjustment (4–bolt Adjust Cutting Units)).

IMPORTANT: Light bedknife to reel contact is preferred at all times. If light contact is not maintained, bedknife and reel edges will not sufficiently self–sharpen, and dull cutting edges will result after a period of operation. Excessive contact can cause accelerated and/or uneven bedknife and reel wear. Thus, quality of cut may be adversely affected.

Note: As the reel blades continue to run against the bedknife, a slight burr will appear on the front cutting edge surface the full length of the bedknife. If a file is occasionally run across the front edge to remove this burr, improved cutting can be obtained.

After extended running, a ridge will eventually develop at both ends of the bedknife. These notches must be rounded off or filed flush with the cutting edge of the bedknife to assure smooth operation.

Bedknife to Reel Parallel Adjustment (Single Point Adjust Cutting Units)

1. If the cutting unit is not removed from the machine,

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

   B. Remove reel motor from the cutting unit and cutting unit from lift arm (see Cutting Unit Removal and Installation).

2. Make sure reel contact is removed by turning the bedknife adjustor counterclockwise (Fig. 11).

3. Position cutting unit with the front roller up (Fig. 12).

   A. On either end of the front side of the reel, insert a long strip of newspaper between the reel and bedknife.

   B. While slowly rotating the reel forward, turn bedknife adjustor clockwise, one click at a time, until the paper is pinched lightly all the way across the reel. A slight drag should result when the paper is pulled. This drag should be the same for the entire length of the bedknife.

   C. If equal adjustment is not obtained for the entire length of bedknife, proceed to steps 4. through 7.

4. Loosen both flange lock nuts secured to the frame tab (Fig. 11). Also, loosen both flange lock nuts securing the pivot hub to the frame (Fig. 12).

5. Rotate flange lock nuts, on the top and bottom of the frame tab, clockwise or counterclockwise to raise or lower the end of the bedbar, as required. Do not loosen the bottom flange nut tightened against the pivot hub. Tighten both flange lock nuts against the frame tab to secure the adjustment adjustment (Fig. 11).

6. Check adjustments by repeating steps 2. and 3. After the adjustments are accomplished, make sure of the following (Fig. 12):

   A. The reel can pinch the paper when inserted from the front.

   B. The reel can cut the paper when inserted at a right angle. It should be possible to cut the paper with minimum contact between the bedknife and the reel blades.

   C. Should the reel be unable to cut the paper, it will be necessary to either backlap or regrind the cutting unit to achieve the sharp edges needed for precision cutting. Refer to Toro Reel Sharpening Manual, Form No. 80–300PT.

7. When light contact on the paper is evident at each end of the bedknife, tighten flange lock nuts to securely retain the pivot hub (Fig. 12).

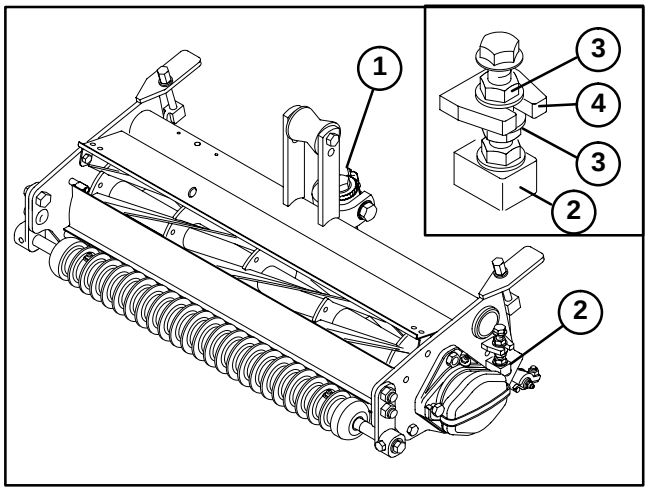


Figure 11

1. **Adjustor**
2. **Pivot hub (LH)**
3. **Flange lock nut**
4. **Frame tab**

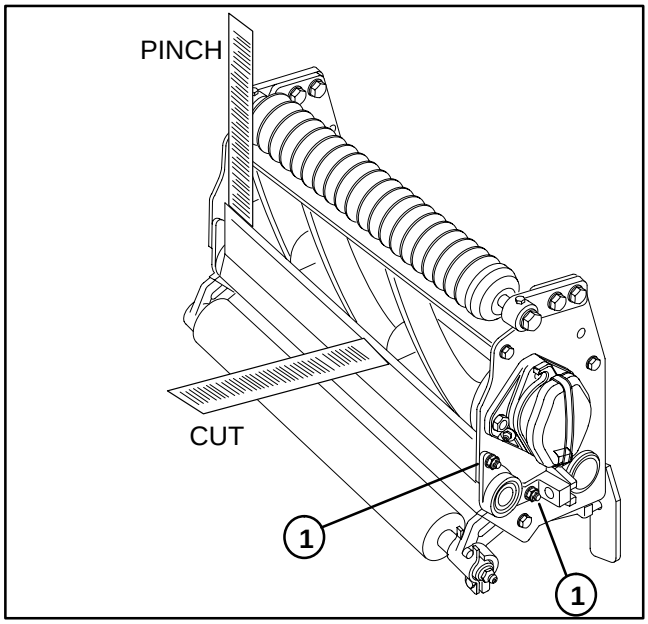


Figure 12

1. **Flange lock nut**

Bedknife to Reel Parallel Adjustment (4–Bolt Adjust Cutting Units)

1. If the cutting unit is not removed from the machine,

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

   B. Remove reel motor from the cutting unit and cutting unit from lift arm (see Cutting Unit Removal and Installation).

IMPORTANT: Use only a M13 wrench, 3 to 6 inches (7.5 to 15 cm) in length, when adjusting the hex head screws. A longer wrench will provide too much leverage and may cause distortion of the mounting plate (Fig. 13).

2. Make sure reel contact is removed by loosening the top hex head screw on each side of cutting.

3. Position cutting unit with the front roller up (Fig. 13).

   A. On either end of the front side of the reel, insert a long strip of newspaper between the reel and bedknife.

   B. While slowly rotating the reel forward, adjust top and bottom hex head screws until the paper is pinched lightly all the way across the reel. A slight drag should result when the paper is pulled. This drag should be the same for the entire length of the bedknife.

4. After adjusting bedknife to reel, make sure that both top and bottom adjusting screws are secured against the bedbar tabs on each end of the cutting unit (Fig. 13).

5. After the adjustment is accomplished, make sure of the following (Fig. 14):

   A. The reel can pinch the paper when inserted from the front.

   B. The reel can cut the paper when inserted at a right angle. It should be possible to cut the paper with minimum contact between the bedknife and the reel blades.

   C. Should the reel be unable to cut the paper, it will be necessary to either backlap or regrind the cutting unit to achieve the sharp edges needed for precision cutting. Refer to Toro Reel Sharpening Manual, Form No. 80–300PT.

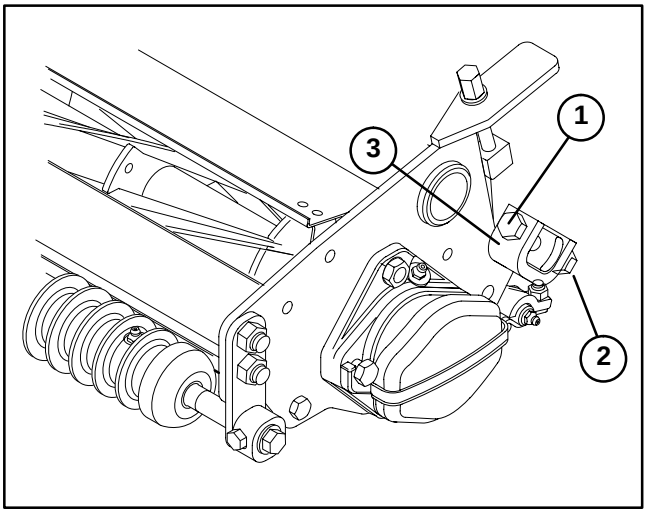


Figure 13

1. **Bottom hex head screw**
2. **Top hex head screw**
3. **Mounting plate**

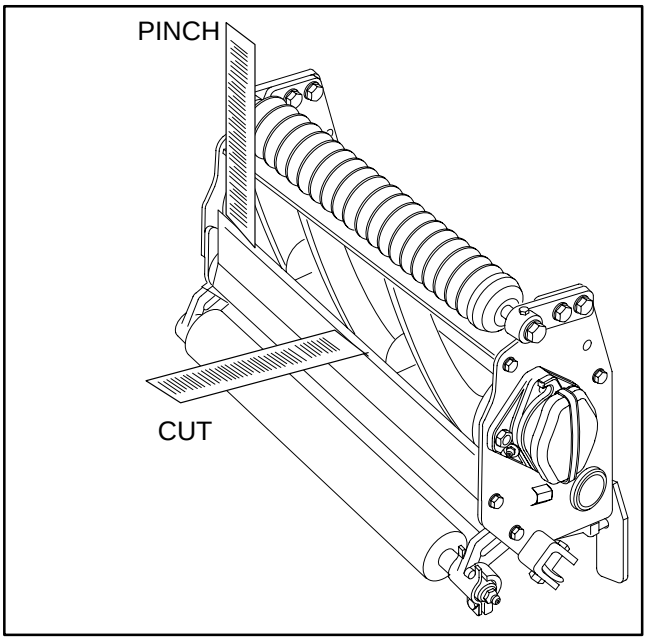


Figure 14

Leveling Front Roller to Reel Adjustment

1. If the cutting unit is not removed from the machine,

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

   B. Remove reel motor from the cutting unit and cutting unit from lift arm (see Cutting Unit Removal and Installation).

Note: Make sure leveling plate covers the full length of reel blades. Three blades must contact the plate.

2. Position cutting unit on a cutting leveling plate or a known flat and level surface.

3. Position a 1/4–inch or thicker bar stock under the reel blades and against the front face of the bedknife.

Note: Make sure both front brackets are in the same hole (see Attitude Adjustment).

4. Loosen both lock nuts securing the right front bracket.

Note: The right front bracket is secured to the frame with an eccentric bolt, while the left front bracket is secured with a shoulder bolt. The eccentric bolt has an offset, which when rotated, acts as an eccentric (cam) to raise or lower the roller. On the bolt head there is an identification dot which denotes the offset of the bolt. The dot indicates in which direction the right end of roller moves when bolt is turned.

5. While holding the reel securely on the plate and maintaining pressure on the front roller, rotate eccentric bolt until the roller is level.

Note: If additional adjustment is required, replace shoulder bolt on the left front bracket with another eccentric bolt, part no. 95–1617.

6. Verify roller is level. Insert a piece of paper or 0.003 inch (0.076 mm) feeler gauge under each end of the roller.

7. When the roller is level, tighten lock nuts securely.

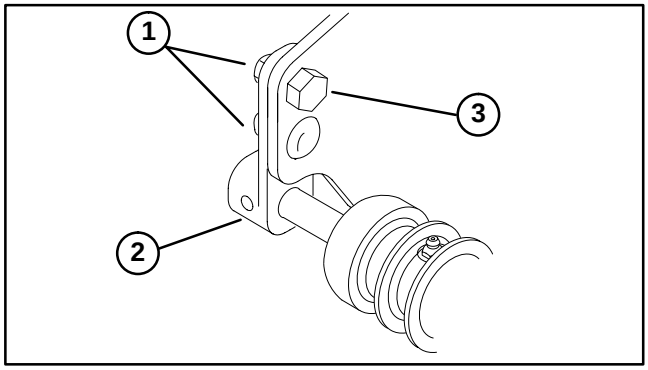


Figure 15

1. **Lock nuts**
2. **Right front roller bracket**
3. **Eccentric bolt**

Attitude Adjustment

Note: There are four positions for the front roller brackets. A more aggressive setting will increase grass removal and provide a cleaner cut, but may cause increased scalping and marking (Fig. 16).

Position 1: Least aggressive; used for very soft and tender turf or the highest height–of–cut.

Position 2: Standard position; used for most conditions.

Position 3: More aggressive; used on firm turf.

Position 4: Most aggressive; used only on very firm greens or at the lowest height–of–cut.

Note: The top of the right front bracket is secured to the frame with an eccentric bolt, while the left front bracket is secured with a shoulder bolt (Fig. 17).

1. If the cutting unit is not already removed from the machine,

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

   B. Remove reel motor from the cutting unit and cutting unit from lift arm (see Cutting Unit Removal and Installation).

2. Remove lock nuts from the eccentric (shoulder) bolt and carriage bolt securing both front brackets.

3. Remove eccentric (shoulder) bolt and carriage bolt from both front brackets and the side plates.

4. Position **both** front brackets as follows:

Note: The top side plate hole and top bracket hole should yield **Position 2** (standard setting).

   A. Insert eccentric bolt (shoulder bolt) through one of the two positions in the figure 8 hole in the frame and one of the top holes of the front bracket (Fig. 17) so the point on the bracket is at the desired position number on the decal (Fig. 16).

   B. Screw lock nut onto the eccentric bolt (shoulder bolt).

   C. Insert carriage screw through the bottom hole of the frame and front bracket. Secure carriage screw and eccentric bolt (shoulder bolt) with lock nuts.

5. Level front roller to the reel (see Leveling Front Roller to Reel).

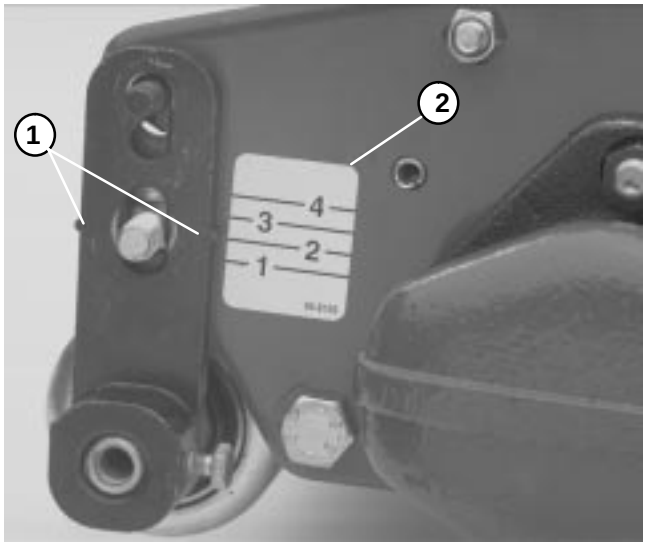


Figure 16

1. **Point**
2. **Decal**

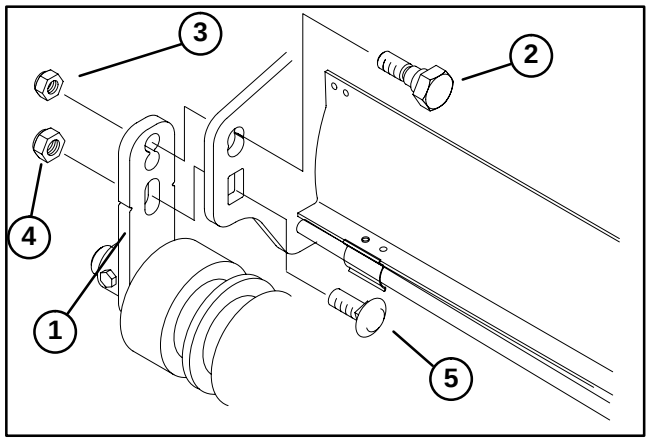


Figure 17

1. **Front bracket**
2. **Eccentric (shoulder) bolt**
3. **Lock nut**
4. **Lock nut**
5. **Carriage screw**

Height–of–Cut Adjustment

1. If the cutting unit is not already removed from the machine,

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

   B. Remove reel motor from the cutting unit and cutting unit from lift arm (see Cutting Unit Removal and Installation).

2. Verify that front roller is level and bedknife to reel contact is correct (see Bedknife to Reel Adjustment and Leveling Front Roller to Reel).

3. Turn cutting unit over (90°) and rest it on the rear roller and top rear tabs. Loosen locknuts on the capscrews retaining the rear roller brackets.

4. On gauge bar (Part no. 13–8199), set head of screw to desired height of cut. This measurement is from bar face to underside of screw head.

5. Place the bar across the front and rear rollers. Adjust rear roller with height–of–cut adjuster until the underside of screw head engages the bedknife cutting edge.

6. Repeat procedure on each end of bedknife. Tighten lock nuts to secure rear roller brackets on each end.

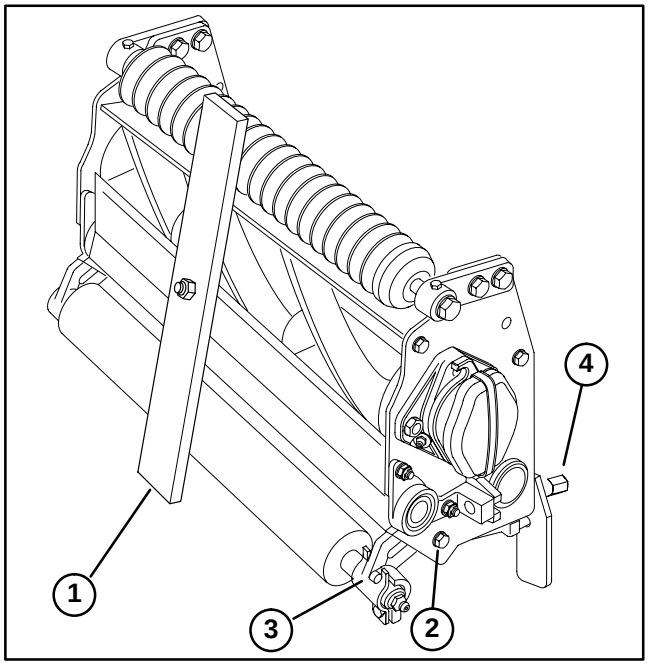


Figure 18

1. **Gauge bar**
2. **Cap screw**
3. **Rear roller bracket**
4. **Height–of–cut adjuster**

Rear Roller Scraper Adjustment

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

2. Loosen flange nuts securing both bracket assemblies to the hex head screws on each roller bracket.

3. Adjust flange nuts up or down until bottom edge of scraper is the same height as the top edge of the cutting unit bedknife at each end or the same as the height–of–cut setting.

Note: If scraper is not adjusted correctly it will not properly clean roller, will ruffle the grass or leave large clumps on the grass.

4. Move scraper in or out to ensure the edge is flush with the full length of the roller. Tighten top flange nuts to secure the adjustment.

IMPORTANT: Thoroughly wash cutting unit after each use. Pull scraper away from the roller when washing. Failure to follow this practice may result in pitting of the roller.

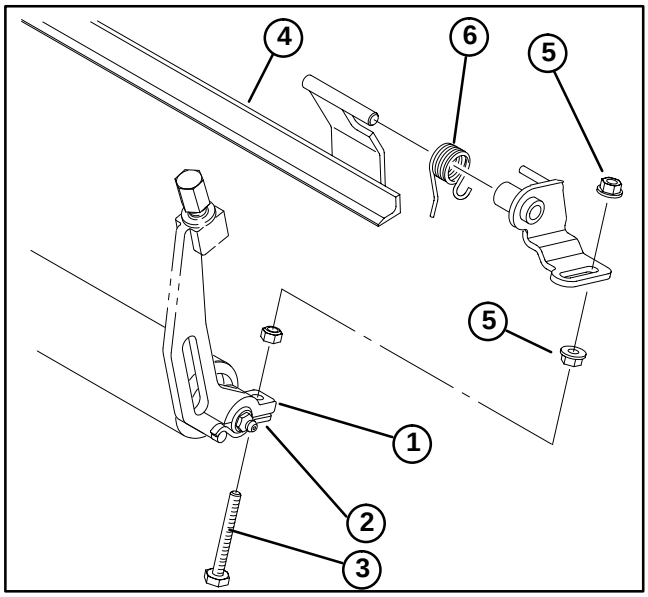


Figure 19

1. **Flange nuts**
2. **Bracket assembly**
3. **Hex head screw**
4. **Scraper**
5. **Lock nut**
6. **Spring**

Cutting Unit Removal and Installation

Removal

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

Note: When sharpening, setting height–of–cut, or performing other maintenance procedures on the cutting units, store cutting unit reel motors in the support tubes on the front of the frame to prevent damage to the hoses.

2. Loosen flange head screws on the bearing housing that secure the hydraulic motor to the cutting units. Rotate motor clockwise, and remove motor from the bearing housing (Fig. 20).

3. Place protective plastic cap (see Special Tools) into the hole in the bearing housing from which the hydraulic motor was removed.

4. Remove both shoulder bolts securing the front roller axle to the pull frame (Fig. 21).

5. Slide center ball joint loose and remove pull frame (Fig. 21).

6. Slide the cutting unit lift roller off the lift arm while sliding the cutting unit under the pull frame (Fig. 21).

Installation

Note: All cutting units are shipped with the counter weight mounted to left end and drive coupler mounted in the right end of cutting unit. To mount the cutting unit in the right front position, on a GR3200, proceed as follows:

1. To mount a cutting unit in the right front position proceed as follows(Fig. 22):

   A. Remove both flange head screws and lockwashers securing the counter weight to the left end of cutting unit. Remove counter weight.

   B. Remove snap ring securing the drive coupler in the right bearing housing. Remove drive coupler.

   C. Apply No. 2 multipurpose lithium base grease to the inside of the drive coupler. Install drive coupler into the left end of the reel shaft with the snap ring.

   D. Install counter weight to the right end of the cutting unit with the flange head screws and lockwashers. Move RH end screws to the left end.

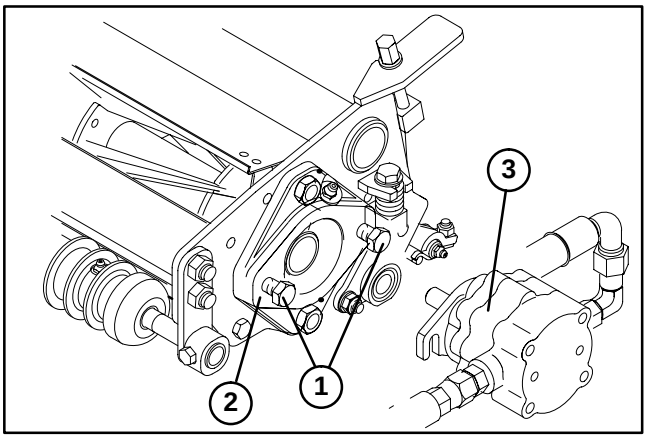


Figure 20

1. **Flange head screws**
2. **Bearing housing**
3. **Hydraulic motor**

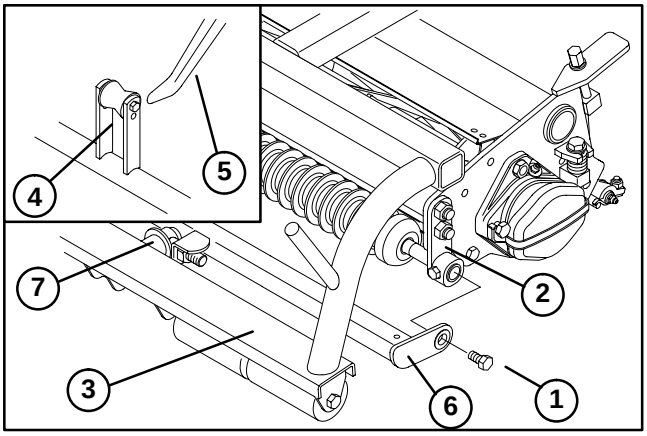


Figure 21

1. **Shoulder bolt**
2. **Front roller bracket**
3. **Carrier frame**
4. **Lift roller**
5. **Lift arm**
6. **Pull frame**
7. **Ball joint**

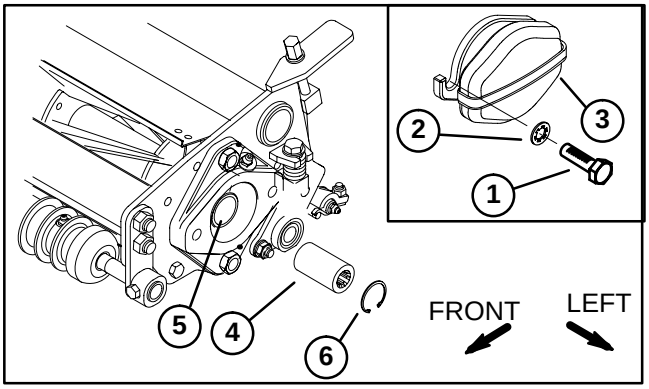


Figure 22

1. **Flange head screw**
2. **Lock washer**
3. **Counter weight**
4. **Drive coupler**
5. **Left end of reel shaft**
6. **Snap ring**

2. Mount cutting unit to the pull frame with both shoulder bolts.

3. Slide the cutting unit under the pull frame while hooking the lift roller onto lift arm (Fig. 21).

4. Connect center ball joint on pull frame to the carrier frame (Fig. 21).

5. Remove the plastic cap from the bearing housing.

6. Install hydraulic motor to bearing housing as follows (Fig. 2

A. Coat spline shaft of the motor with clean No. 2 multipurpose lithium base grease.

B. Install motor by rotating the motor clockwise so the motor flanges clear the flange head screws.

C. Rotate the motor counterclockwise until the motor flanges are encircling the flange head screws. Tighten flange head screws.

Backlapping (Units without Backlap/Variable Reel Speed Kit)

CAUTION

Be careful when backlapping the reel because contact with the reel or other moving parts can result in personal injury.

1. Remove reel motors from the cutting units and cutting units from the lift arms and pull frame (see Cutting Unit Removal and Installation).

2. Connect the backlapping machine to the cutting unit by inserting a piece of 3/8–inch socket extension drive into the splined coupling at right end of cutting unit. If coupling is in the left end of cutting unit, move coupling the right end for backlapping.

3. Attach backlap motor or drive to the socket extension.

4. Follow instructions and procedures on Backlapping are in the TORO Sharpening Reel & Rotary Mowers Manual Form No. 80–300PT.

5. If the splined coupling was moved from the left side of the cutting unit for backlapping, replace the coupling to the left side.

Note: For a better cutting edge, run a file across the front face of the bedknife when the lapping operation is completed. This will remove any burrs or rough edges that may have built up on the cutting edge.

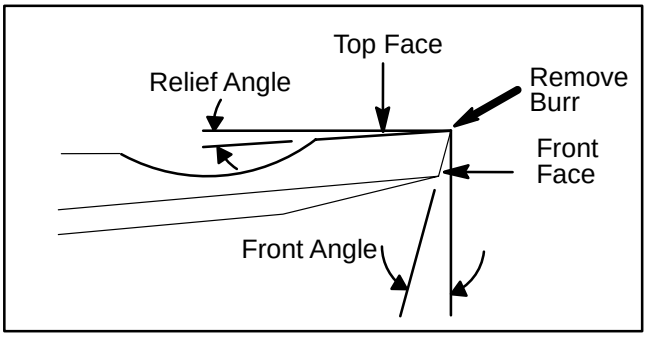


Figure 23

Backlapping (Units with Backlap/Variable Reel Speed Kit)

DANGER

TO AVOID PERSONAL INJURY OR DEATH:

- **Never place hands or feet in the reel area while the engine is running.**
- **While backlapping, the reels may stall and then restart.**
- **Do not attempt to restart reels by hand or foot.**
- **Do not adjust reels while the engine is running.**
- **If a reel stalls, stop engine before attempting to clear the reel.**
- **Reel motors are connected in series, moving one motor moves the other two.**

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

2. Move functional control lever to the Neutral/Backlap position.

IMPORTANT: Do not attempt to rotate the directional valve knob when the machine or reels are running.

3. Raise seat and rotate directional valve knob fully clockwise to the backlap position.

4. Rotate flow control valve knob to position 6.

5. On all cutting units, make initial reel to bedknife adjustments appropriate for backlapping (see Bedknife to Reel Parallel Adjustment).

6. Start engine and move Raise / Lower – Mow control forward to start the reels.

7. Rotate flow control valve knob to position 1.

8. Apply lapping compound with a long handled brush (see Special Tools).

CAUTION

Be careful when backlapping the reel because contact with the reel or other moving parts can result in personal injury.

9. To make an adjustment to the cutting units while backlapping, turn reels OFF by moving the RAISE/LOWER–MOW control to the RAISE position. Shut off engine. After the adjustments have been completed, repeat steps 4 through 6.

10. When the backlap operation is completed, shut off engine and rotate directional valve knob counter–clockwise fully (90° from the backlap position) to forward position. Also, rotate flow control valve knob to position 13 for height–of–cut settings of a 1/4 inch or below.

Note: For additional settings, refer to the instructions on the decal that is located on the underside of the seat support.

11. Wash all lapping compound off the cutting units.

12. For a better cutting edge, run a file across the front face of the bedknife when the lapping operation is completed. This will remove any burrs or rough edges that may have built up on the cutting edge.

Note: Additional instructions and procedures on Backlapping are available in the TORO Sharpening Reel & Rotary Mowers Manual Form No. 80–300SL.

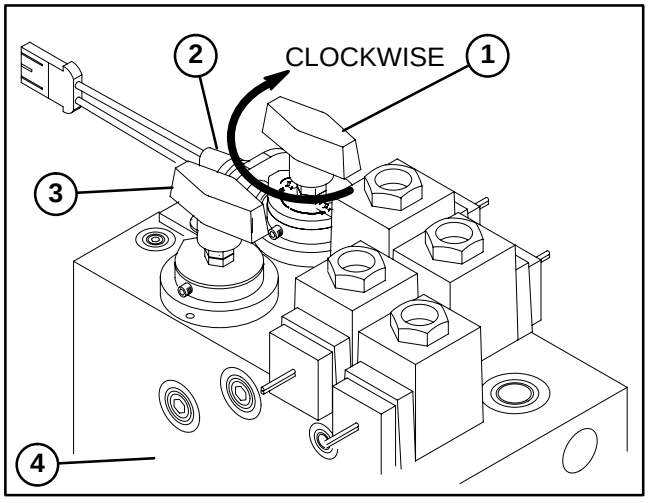


Figure 24

1. **Directional valve knob**
2. **Ball switch**
3. **Flow control valve knob**
4. **Hydraulic manifold**

Rollers and Bedbar Assembly (Single Point Adjust Cutting Units)

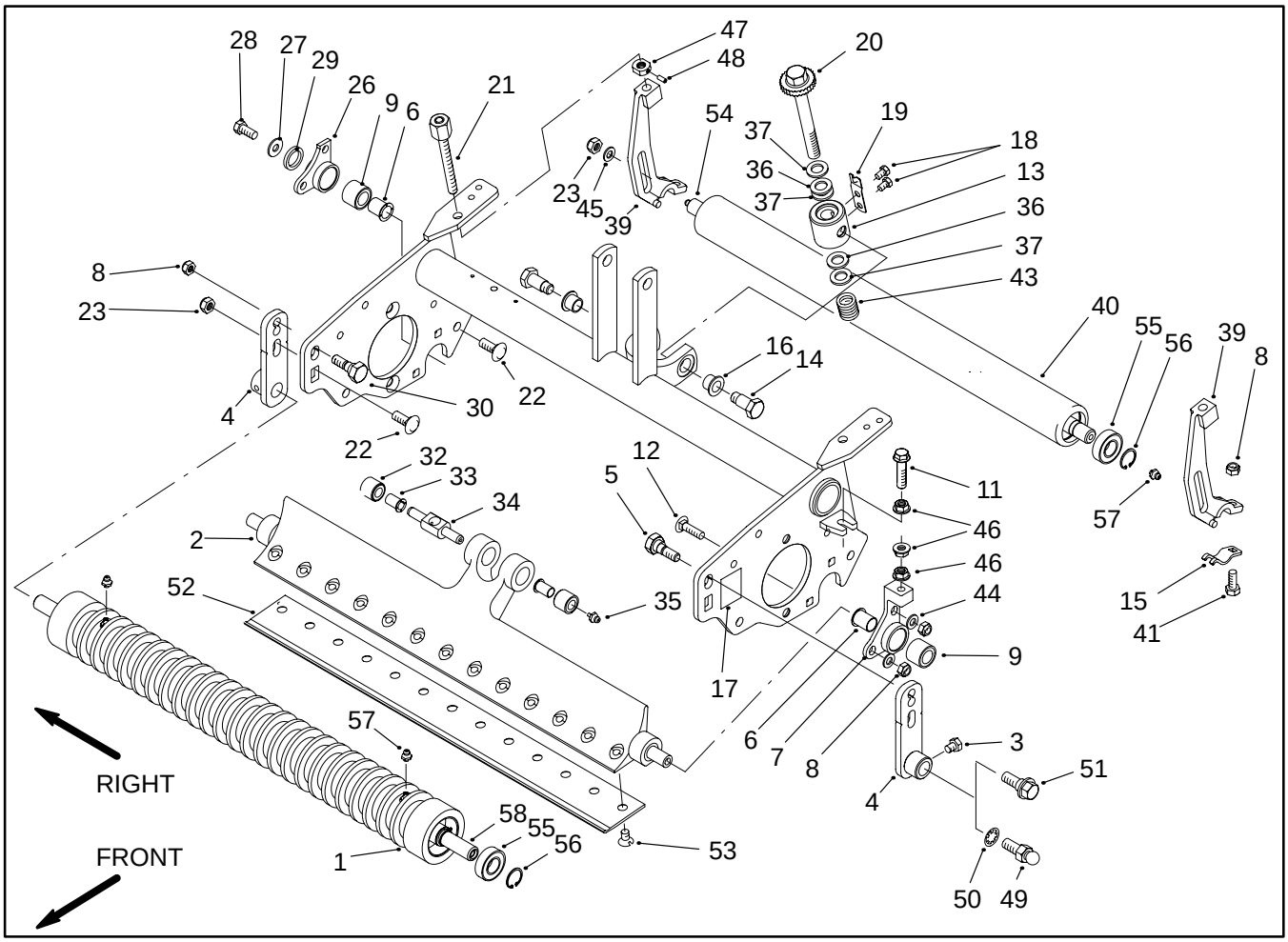


Figure 25

1. Wiehle roller
2. Bedbar
3. Hex head screw
4. Front bracket
5. Shoulder bolt
6. Flanged bushing
7. Pivot hub (LH)
8. Lock nut
9. Bushing
10. Not used
11. Hex head flange screw
12. Carriage screw
13. Pivot housing
14. Pivot screw
15. Height–of –cut tab
16. Plastic bushing
17. Bracket position decal
18. Hex head screw
19. Spring arm
20. Adjustor
21. Height–of–cut (H–O–C) adjustor
22. Carriage screw
23. Lock nut
24. Not used
25. Not used
26. Pivot hub (RH)
27. Flat washer
28. Hex head flange screw
29. Quad ring
30. Eccentric bolt
31. Not used
32. Rubber bushing
33. Steering links bushing
34. Bedbar pivot
35. Grease fitting
36. Nylon thrust washer
37. Thrust washer
38. Not used
39. Height–of–cut (H–O–C) adjustment bracket
40. Roller tube
41. Screw
42. Not used
43. Compression spring
44. Flat washer
45. Flat washer
46. Flange lock nut
47. Locking nut
48. Set screw
49. Ball stud (used on old suspensions)
50. Lock washer
51. Shoulder bolt
52. Bedknife
53. Special screw
54. Shaft
55. Bearing
56. Retaining ring
57. Grease fitting
58. Wiehle roller shaft

Front Roller Removal and Installation

Removal

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

Note: The front roller can be removed with the cutting unit either attached to the lift arm or removed from the lift arm. Determine your maintenance needs.

2. If removing the cutting unit, remove reel motor from the cutting unit and the cutting unit from lift arm (see Cutting Unit Removal and Installation). Place cutting unit on a level working surface.

3. If keeping the cutting unit on the lift arm, remove both shoulder bolts securing the front brackets to the pull frame (Fig. 26).

4. Remove cap screws securing the roller shafts to each front bracket (Fig. 27).

Note: The right front bracket is secured to the frame with an eccentric bolt and carriage screw, while the left front bracket is secured with a shoulder bolt and carriage screw (Fig. 27).

5. On either end of the roller, remove eccentric bolt (shoulder bolt), carriage screw, and lock nuts securing the front bracket to the frame (Fig. 27).

6. Remove the front brackets and roller from the cutting unit. Remove the front brackets from the roller shaft (Fig. 27).

7. If the front roller position is to be changed, the remaining front bracket may be removed from the frame using step 5.

Installation

1. Place cutting unit on a level working surface.

Note: The front roller brackets have four positions. A more aggressive setting will increase grass removal and provide a cleaner cut, but may cause increased scalping and marking (Fig. 28).

Position 1: Least aggressive; used for very soft and tender turf or the highest height–of–cut.

Position 2: Standard position; used for most conditions.

Position 3: More aggressive; used on firm turf.

Position 4: Most aggressive; used only on very firm greens or at the lowest height–of–Cut.

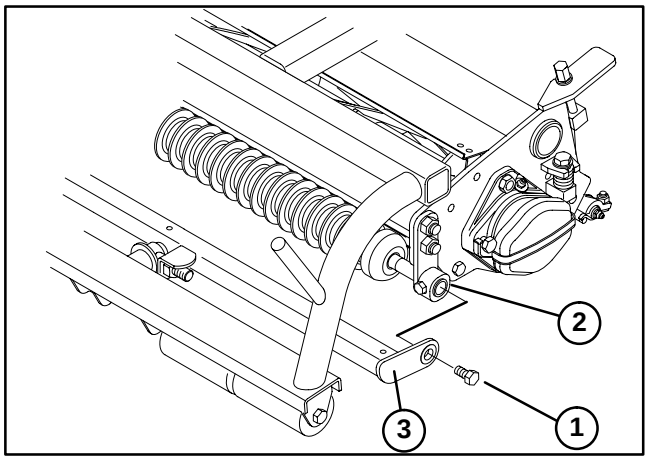


Figure 26

1. **Shoulder bolt**
2. **Front bracket**
3. **Pull frame**

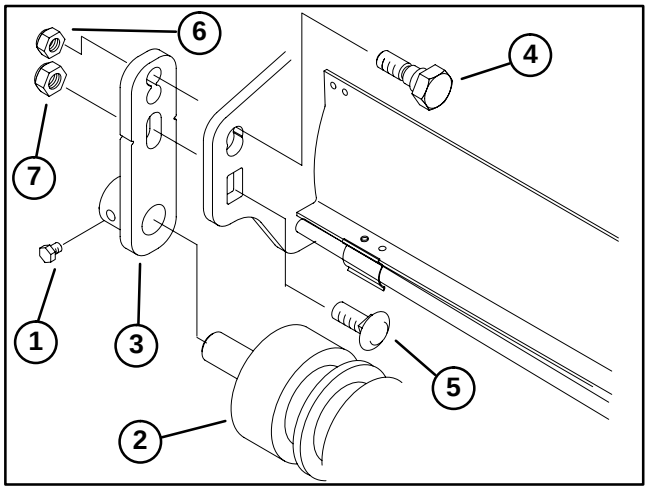


Figure 27

1. **Cap screw**
2. **Roller**
3. **Front bracket**
4. **Eccentric (shoulder) bolt**
5. **Carriage screw**
6. **Lock nut**
7. **Lock nut**

Figure 28

2. If both front brackets were removed, position bracket as follows (Fig. 27):

A. Insert eccentric bolt (shoulder bolt) through the top hole on the frame and one of the top holes of the front bracket so the point on the bracket is at the desired position number on the decal (Fig. 28).

B. Screw lock nut onto the eccentric bolt (shoulder bolt) to hold front bracket in place.

C. Insert carriage screw through the bottom hole of the frame and front bracket. Secure screw and eccentric bolt (shoulder bolt) with lock nuts.

3. Place roller shaft into the front bracket. Slide second front bracket on the other end of roller. Secure bracket as in step 2. (Fig. 27).

4. Apply Loctite 242 or equivalent to the cap screw threads. Center roller in the front brackets and secure into place with the cap screws (Fig. 27).

5. Level front roller to the reel (see Leveling Front Roller to Reel and Attitude Setting).

6. If the cutting unit was kept on the lift arm, attach the front brackets to the pull frame by securing with both shoulder bolts (Fig. 26).

Rear Roller and Height–of–Cut Adjuster Removal and Installation

Removal (Fig. 25)

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

Note: The rear roller can be removed with the cutting unit either attached to the lift arm or removed from the lift arm. Determine your maintenance needs.

2. If removing the cutting unit, remove reel motor from the cutting unit and the cutting unit from the lift arm (see Cutting Unit Removal and Installation). Place cutting unit on a level working surface.

3. If keeping the cutting unit on the lift arm, lower the cutting unit onto a wood board thick enough to allow the rear roller to be released down from the height–of–cut (H–O–C) adjustment brackets (39).

4. Remove rear roller as follows:

   A. Remove carriage screw (41) and lock nut (8) from both H–O–C adjustment brackets (39).

   B. Remove height–of–cut tab (15) from both H–O–C adjustment brackets.

   C. Tilt back of the cutting unit up, and remove rear roller from both H–O–C adjustment brackets.

5. If the height–of–cut (H–O–C) adjusters (21) or H–O–C adjustment brackets (39) need removing, remove them as follows (Fig. 25):

   A. Remove lock nut (23), flat washer (45), and carriage screw (22) from the H–O–C adjustment bracket and frame.

   B. Unscrew H–O–C adjuster from the top block of the H–O–C adjustment bracket.

   C. Remove set screw (48) from the locking nut (47) securing the H–O–C adjuster to the frame tab.

   D. Unscrew locking nut from the H–O–C adjuster. Slide adjuster from the frame tab.

Installation (Fig. 25)

1. Place cutting unit on a level working surface.

2. If the H–O–C adjusters (21) or H–O–C adjustment brackets (39) were removed, reinstall brackets as follows:

   A. Apply loctite 242 or equivalent to the threads of the H–O–C adjusters about 1/4 inch (6 mm) below the hex and to the threads of the set screw (48). Start set screw into locking nut (47).

   B. Place H–O–C adjuster through the holes of the frame tabs. Screw locking nut onto the adjuster, and run to the bottom of the frame tab. Make sure adjuster is free to rotate with no end play.

   C. Tighten set screw into the locking nut.

   D. Position H–O–C adjustment bracket on the inside of the frame. Screw H–O–C adjuster into the H–O–C adjustment bracket until the top of the bracket is 0.68 inch (18 mm) from the bottom of the frame tab.

   E. Insert carriage screws (22) through the H–O–C adjustment bracket and frame. Secure bracket and screw with flat washer (45) and locking nut.

3. Reinstall rear roller as follows (Fig. 25):

   A. Tilt back of the cutting unit up, and position rear roller shaft (54) under each H–O–C adjustment bracket (39). Lower unit and brackets onto the roller shafts.

   B. Attach height–of–cut tab (15) to both H–O–C adjustment brackets so the tab is below the roller shaft.

   C. Make sure roller is centered on the cutting unit. Secure height–of–cut tab to the H–O–C adjustment bracket with carriage screw (41) and lock nut (8).

4. If the H–O–C adjustment brackets (39) were removed, verify height–of–cut (see Height–of–Cut Adjustment).

5. If the cutting unit was removed from the lift arm, reinstall reel motor to the cutting unit and the cutting unit to lift arm (see Cutting Unit Removal and Installation).

Roller Bearing Replacement (All Rollers except Wiehle Rear Roller)

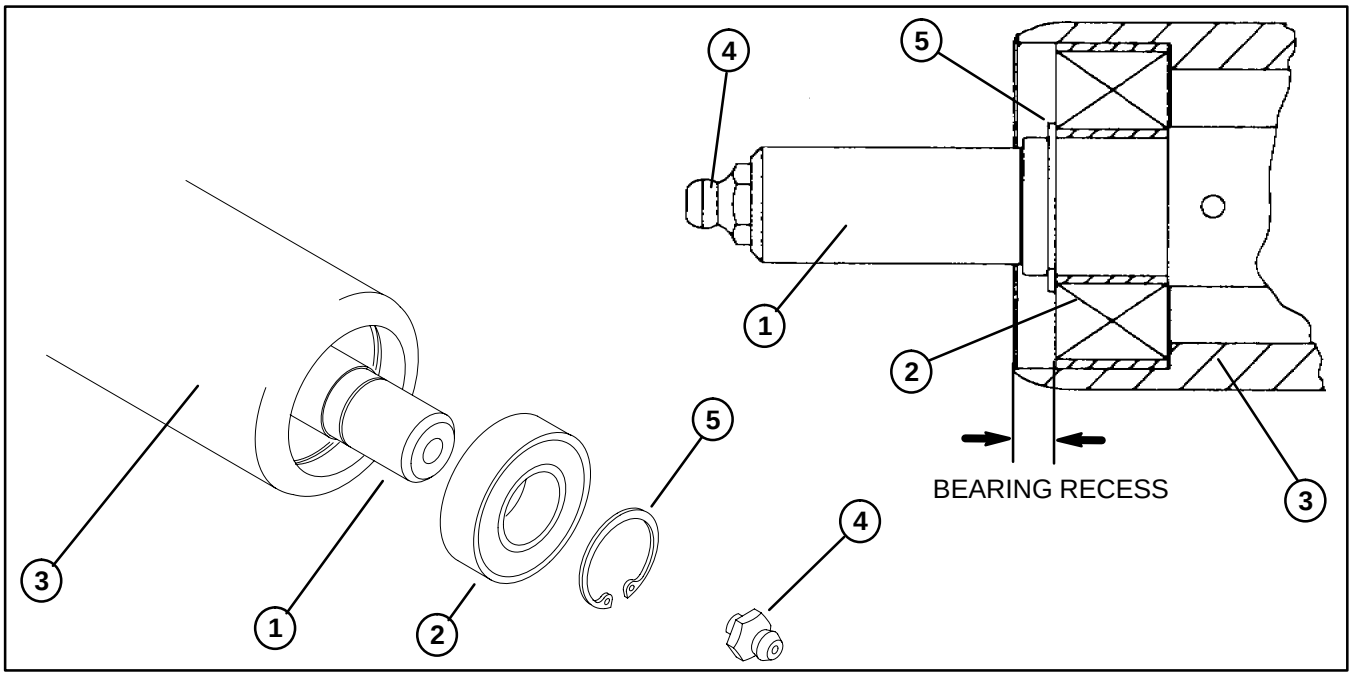


Figure 29

1. **Shaft**
2. **Bearing**
3. **Roller tube**
4. **Grease fitting**
5. **Retaining Ring**

Removal

1. Clean inside of roller around the shaft and bearing. Both ends of the roller should be free of dirt and debris.

2. Secure roller tube in a vise keeping it level.

IMPORTANT: On rollers with the grease fittings attached to to the end of the roller shaft, Remove both grease fittings before removing the bearings.

3. Remove retaining ring from the both ends of the roller.

4. Use a soft hammer to pound the shaft and bearing out of the roller. Remove bearing from the shaft.

5. Pull the remaining bearing from the roller.

Installation

IMPORTANT: Replace both bearings with new bearings since both bearings may be damaged during removal.

1. Clean inside of roller around bearing. Both ends inside the roller should be free of dirt and debris.

2. Press bearing into the roller with the seal side facing outward. **Make sure bearing is recessed from the end of the roller as described in the table above.**

ROLLER	TORO PART NO.	BEARING RECESS
Full Rear	93–2465	0.220 to 0.240 in (5.89 to 6.10 mm)
Narrow Wiehle	94–8171	0.020 to 0.040 in (0.508 to 1.02 mm)
Full Front	94–3478	0.210 to 0.250 in (5.33 to 6.35 mm)
Wide Wiehle	93–2468	0.020 to 0.040 in (0.508 to 1.02 mm)

3. Apply antiseize lubricant to the bearing ends of the shaft. Insert shaft through the roller and bearing inner race.

4. Press second bearing with the seal side facing out into the roller and onto the shaft. Make sure bearing is recessed from the end of the roller as described in the table above.

IMPORTANT: Install both retaining rings so the concave side faces the bearing.

5. Make sure the roller spins freely. The maximum rolling torque allowed is 5 in–lb (5.8 kg–cm) with no bearing end play.

6. Install grease fittings. Lubricate bearings (see Lubrication).

Wiehle Rear Roller Bearing Replacement

Note: This procedure is for the Wiehle Rear Roller Kit (Model 04488) only.

Remove Bearings

Note: Use the bearing replacement tool kit to remove the roller bearings (see Special Tools).

Note: It is recommended to replace bearings at both ends of the roller after bearing failure.

1. If a hole is not on the bearing shaft, use drill bushing (supplied with bearing replacement kit) to drill a hole in the bearing shaft.

2. Remove roller bearing with bearing puller.

3. Clean roller bearing cavity and remove any rust with a crocus cloth.

4. Repeat above steps for the other roller bearing.

Install New Bearings

1. Make sure roller bearing cavity is clean and free of dirt. Apply No. 2 multipurpose lithium based grease to the roller bearing.

2. Press roller bearing into roller so that the outside surface of the bearing is flush with the end of the roller.

3. Grease the bearing with No. 2 multipurpose lithium based grease until grease appears at the seal of the bearing.

4. Repeat above steps for the other roller bearing.

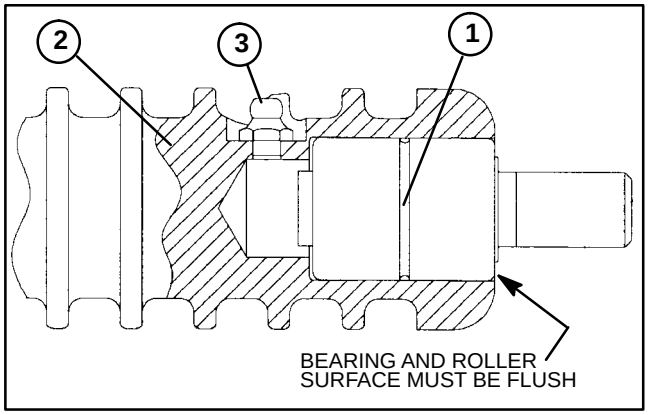


Figure 30

1. **Roller bearing**
2. **Roller (Wiehle)**
3. **Grease fitting**

Bedbar Removal and Installation (Single Point Adjust Cutting Units)

Removal

1. Remove rear roller (see Rear Roller Removal and Installation).

2. Loosen both flange lock nuts securing the hex head flange screw to the frame tab (Fig. 31).

3. Remove hex head flange screw (28), flat washer (27), and quad ring (29) from the bedbar (2) on the right side of the unit (Fig. 25).

4. Remove both pivot screws (14) from the pivot housing (13) and frame. Replace plastic bushings (16) if worn or damaged (Fig. 25).

5. Remove both lock nuts and flat washers from each carriage screw securing the pivot hubs to the frame (Fig. 31 and 32).

6. Remove carriage screws (12) from the pivot hubs (7 and 26) and frame. Remove bedbar (2) from the cutting unit (Fig. 25).

7. Remove both pivot hubs (7 and 26) from the bedbar (2). Replace bushings (6 and 9) if they are worn or damaged (Fig. 25).

Installation

1. Apply antiseize lubricant to both bedbar pins. Tap pivot hub (7) to the bedbar pin on the left side of the bedbar (2) with a soft hammer. Tap pivot hub (26) to the bedbar pin on the right side of the bedbar with a soft hammer (Fig. NO TAG).

2. Position bedbar (2) to the cutting unit. Insert carriage screws (12) through the frame and pivot hubs (7 and 26) on each side of the frame (Fig. 25).

3. Secure carriage screws with flat washers and lock nuts (Fig. 31 and 32).

4. Secure pivot housing (13) to the frame with both pivot screws (14) (Fig. 25).

5. Secure quad ring (29) and flat washer (27) to the right bedbar pin with the hex head flange screw (28) (Fig. 25).

6. Reinstall rear roller (see Rear Roller Removal and Installation).

7. Adjust bedbar to reel, and tighten both flange lock nuts securing the cap screw to the frame tab (see Bedknife to Reel Adjustment).

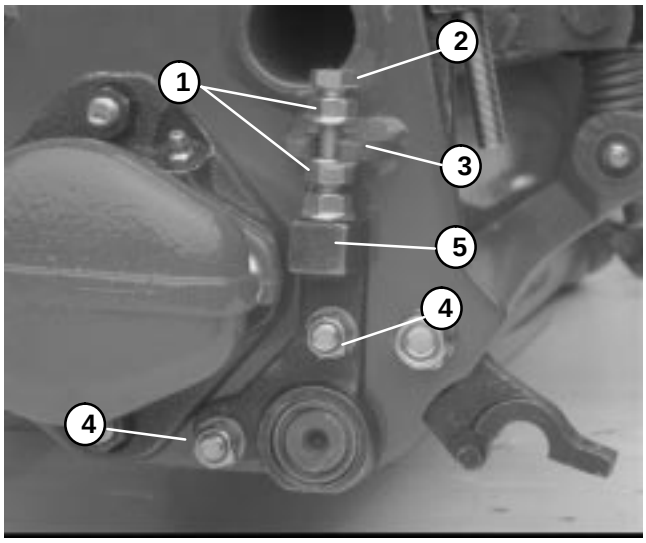


Figure 31

1. **Flange lock nut**
2. **Hex head flange screw**
3. **Frame tab**
4. **Lock nuts & flat washer**
5. **Pivot hub (LH)**

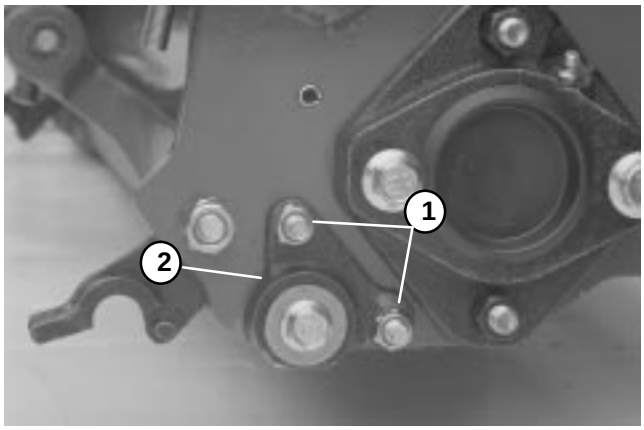


Figure 32

1. **Lock nut & flat washer**
2. **Pivot hub (RH)**

Rollers and Bedbar Assembly (4–Bolt Adjust Cutting Units)

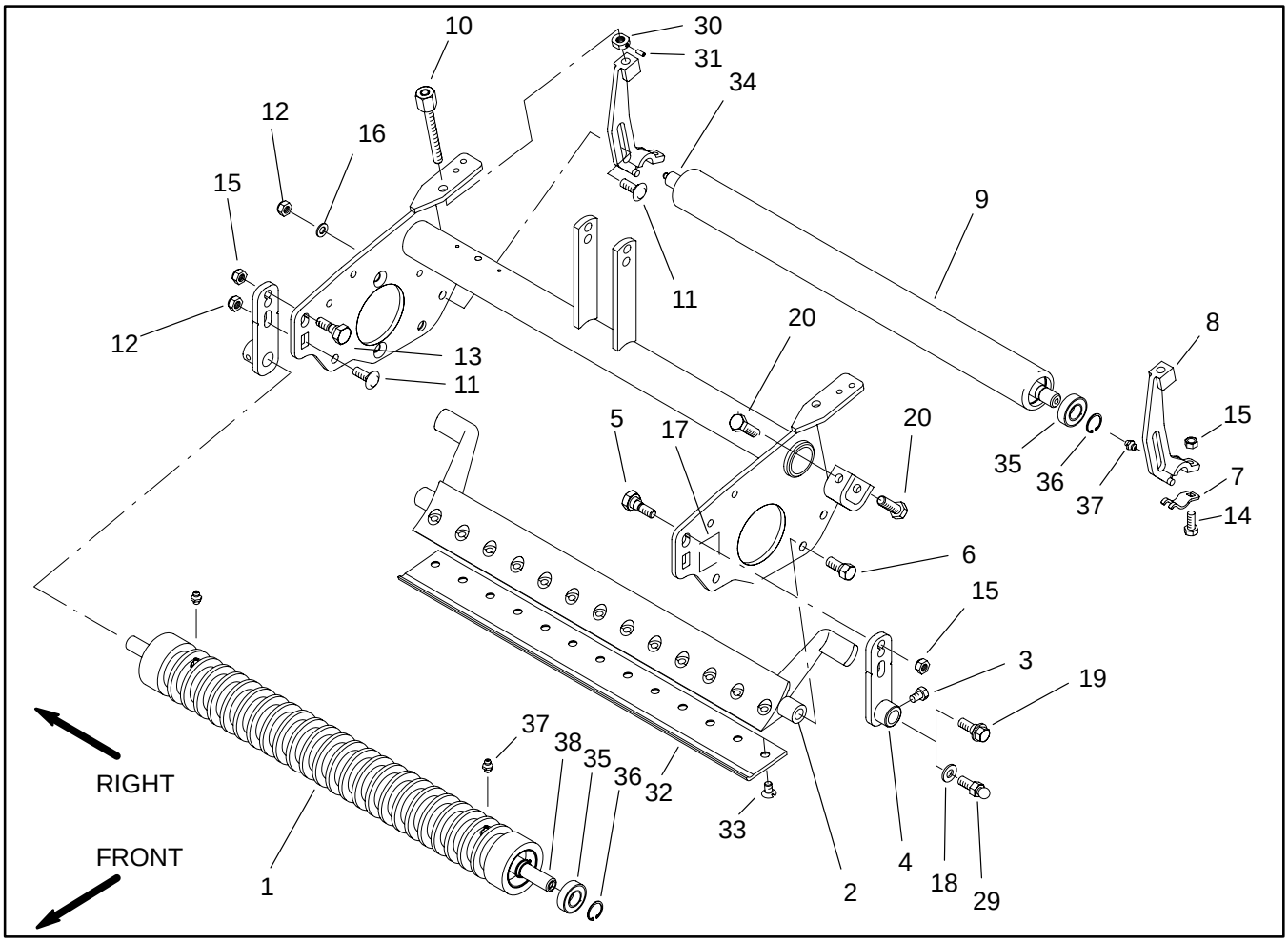


Figure 33

1. Wiehle roller
2. Bedbar
3. Hex head screw
4. Front bracket
5. Shoulder bolt
6. Wheel bolt
7. Height–of–cut (H–O–C) tab
8. Height–of–cut (H–O–C) adjustment bracket
9. Roller tube
10. Height–of–cut (H–O–C) adjuster
11. Carriage screw
12. Lock nut
13. Eccentric bolt
14. Screw
15. Lock nut
16. Flat washer
17. Bracket position decal
18. Lock washer
19. Shoulder bolt
20. Hex head screw
21. Not used
22. Not used
23. Not used
24. Not used
25. Not used
26. Not used
27. Not used
28. Not used
29. Ball stud (used on old suspensions)
30. Lock nut
31. Set screw
32. Bedknife
33. Special screw
34. Shaft
35. Bearing
36. Retaining ring
37. Grease fitting
38. Wiehle roller shaft

Bedbar Removal and Installation (4–Bolt Adjust Cutting Units)

Removal

1. Position cutting unit on a clean level surface to allow access to the bedbar and rear roller.

2. Remove rear roller (see Rear Roller Removal and Installation).

Note: The top hex head screws should remain in the adjustment brackets. This will allow for an easier adjustment of the bedbar when it is reinstalled (Fig. 34).

3. Remove bottom hex head screw from each bedbar adjustment bracket located on both sides of the frame (Fig. 34).

4. Remove both wheel bolts (6) from each end of the bedbar (2) and frame (Fig. 33).

5. Remove bedbar (2) from the cutting unit (Fig. NO TAG).

Installation

1. Apply antiseize lubricant to the threads of both wheel bolts (6) (Fig. 33).

2. Position bedbar (2) to the cutting unit. Insert wheel bolts (6) through the frame and screw into the bedbar (Fig. 33).

3. Torque both wheel bolts (6) from 20 to 40 ft–lbs (2.8 to 5.5 kg–cm).

4. Start bottom hex head screws into the bottom of the adjustment brackets. Keep bedknife away from the reel while running up both screws to contact the bedbar ears (Fig. 34).

5. Reinstall rear roller (see Rear Roller Removal and Installation).

6. Adjust bedbar to reel (see Bedknife to Reel Adjustment).

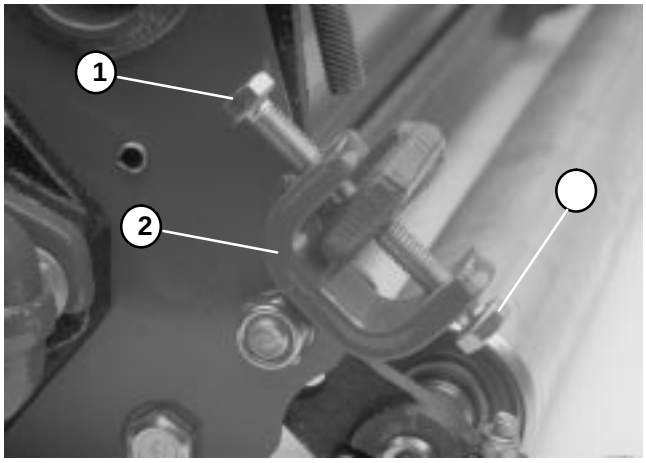


Figure 34

1. **Top hex head screw**
2. **Adjustment bracket**
3. **Bottom hex head screw**

Bedknife Replacement and Grinding

Removal

1. Remove bedbar from frame (see Bedbar Removal).

2. Remove screws from bedbar using a socket wrench and bedknife screw tool (see Special Tools). Discard screws. Remove bedknife from the bedbar (Fig. 35).

3. Use a scraper to remove all rust, scale and corrosion from bedbar surface before installing new bedknife (Fig. 36).

4. Install bedbar to frame (see Bedbar Installation).

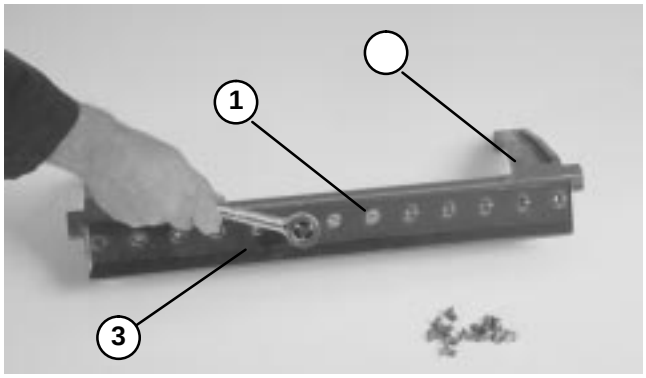


Figure 35

1. **Screw**
2. **Bedbar**
3. **Bedknife**

Replacement

1. Make sure bedbar threads are clean.

2. Use new screws. Apply anti–seize lubricant to the screw before installing.

IMPORTANT: Do not use an impact wrench to tighten screws into the bedbar.

3. Using a torque wrench and bedknife screw tool, tighten screws to a torque of 200 to 250 in–lb (230 to 288 kg–cm). Use a torquing pattern working from the center toward each end of the bedknife (Fig. 37).

Figure 36

Grinding

Since there can be variations in the mounting surface of the bedbar, a new bedknife will not be perfectly flat after it is installed. Because of this, it is necessary to backlap or grind a new bedknife after installing it to the bedbar. Follow the existing angle that was ground into the bedknife and grind only enough to make sure the top surface is true (Fig. 38).

1. Remove bedbar from the cutting unit (see Bedbar Removal).

Note: When grinding, be careful to not overheat the bedknife. Remove small amounts of material with each pass of the grinder.

2. Use TORO Sharpening Reel and Rotary Mowers Manual, Form No. 80-300 PT, for grinding the bedknife.

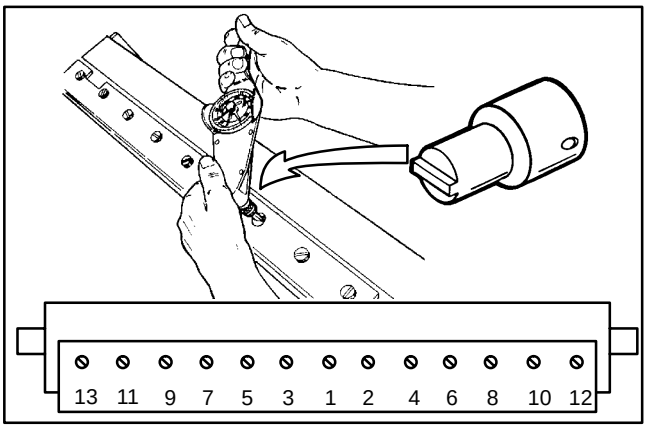


Figure 37

Bedknife Grinding Specifications	
Relief Angle	5°
Relief Angle Range	3° to 6°
Front Angle	15°
Front Angle Range	13° to 17°

3. Reinstall bedbar to the cutting (see Bedbar Installation).

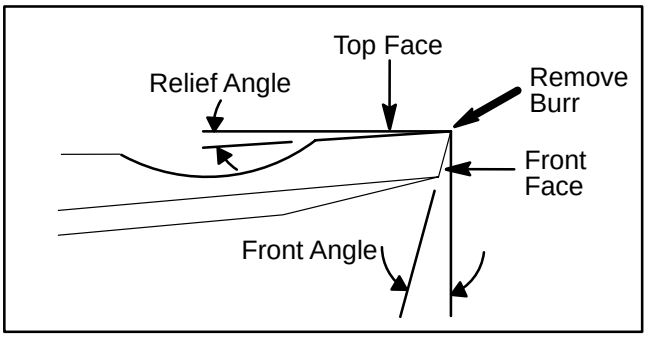


Figure 38

Bedknife Adjuster Service (Single Point Adjust Cutting Unit)

Removal

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

2. Remove both pivot screws (14) from the pivot housing (13). Replace plastic bushings (16) if worn or damaged (Fig. 25).

3. Unscrew adjustor (20) from the bedbar pivot (34) (Fig. 25).

Disassembly (Fig. 39)

1. Remove compression spring, adjustor, thrust washers, and nylon thrust washers from the pivot housing.

2. If the spring arm is damaged, remove it from the pivot housing by removing both hex head screws.

Assembly (Fig. 39)

1. If the spring arm was removed, apply loctite 242 or equivalent to the threads of both hex head screws. Secure spring arm to the pivot housing with both hex head screws.

2. Place thrust washer, new nylon thrust washer, and second thrust washer onto the adjustor. Insert adjustor through the pivot housing.

3. Slide nylon thrust washer onto adjustor. Slide thrust washer onto adjustor and over nylon washer. Slide compression onto adjustor.

Installation

1. Place antiseize lubricant onto the threads of the adjustor (Fig. 39).

2. Screw adjustor (20) into bedbar pivot (34) enough to align holes of the frame bracket and pivot housing (13) (Fig. 25).

3. Place pivot screws (14) through bushings (16) in the frame bracket and into the pivot housing (13). Tighten screws into the pivot housing (Fig. 25).

4. Adjust bedbar to reel (see Bedknife to Reel Adjustment).

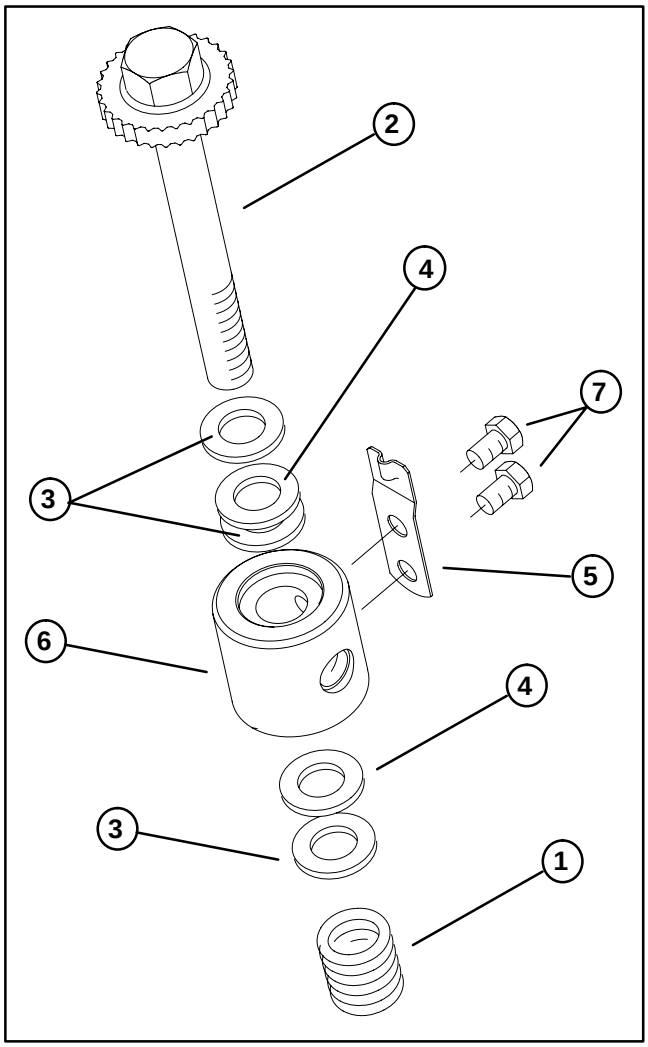


Figure 39

1. **Compression spring**
2. **Adjustor**
3. **Thrust washer**
4. **Nylon thrust washer**
5. **Spring arm**
6. **Pivot housing**
7. **Hex head screw**

Reel and Shields Assembly (Single Point Adjust Cutting Unit)

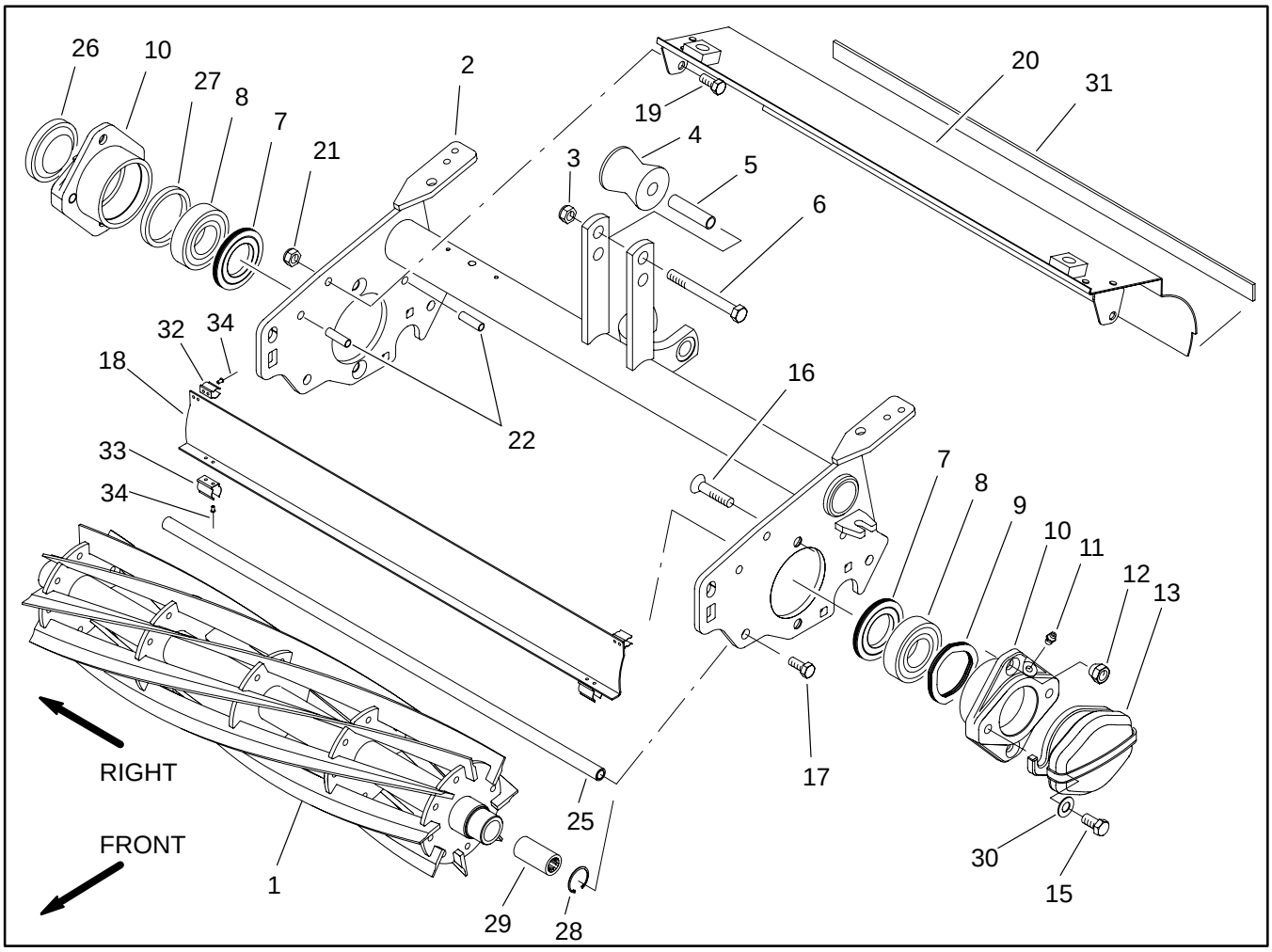


Figure 40

1. **Reel**
2. **Frame**
3. **Lock nut**
4. **Lift roller**
5. **Roller spacer**
6. **Hex head screw**
7. **Grease seal**
8. **Bearing**
9. **Flat wire spring**
10. **Bearing housing**
11. **Grease fitting**
12. **Taper nut**
13. **Counterweight**
14. **Not used**
15. **Hex head flange screw**
16. **Tapered screw**
17. **Hex head screw**
18. **Front shield assembly (includes #32 thru 34)**
19. **Hex head screw**
20. **Rear shield assembly**
21. **Lock nut**
22. **Spring pin**
23. **Not used**
24. **Not used**
25. **Shield rod**
26. **Plastic cap**
27. **Bearing spacer**
28. **Retaining ring**
29. **Drive coupler**
30. **Washer**
31. **Seal strip**
32. **Small spring clip**
33. **Large spring clip**
34. **Pop rivet**

Note: The counterweight (13) and drive coupler (29) are not installed on the same side of the cutting unit. The coupler would be installed on the side of the unit accepting the hydraulic motor. The counterweight would be on the side opposite the motor.

Reel and Bearing Removal and Installation

Removal (Fig. 40)

1. Remove reel motor from the cutting unit and the cutting unit from lift arm (see Cutting Unit Removal and Installation).

2. Place cutting unit on a level working surface.

3. Remove front grass shield (18) from spring pins (22) and shield rod (25).

4. Remove shield rod (25) from frame by removing both hex head screws (17).

5. Remove front roller from the cutting unit (see Front Roller Removal and Installation).

IMPORTANT: Place strips of wood below the reel to prevent the reel from dropping out of the cutting unit when the bearing housings are removed.

6. Remove both bearing housings (10) by removing the tapered nuts (12) and tapered screws (16) securing the housings to the frame. Pull both housings away from the frame and away from the reel ends.

7. Remove reel (1) with the bearings (8) and grease seals (7) from the cutting unit.

8. Remove bearing spacer (27) and flat wire spring (9) from their bearing housings (10). Clean inside of each housing. Both housings should be free of dirt and debris.

Note: If bearings (8) are removed, replace grease seals (7).

9. If necessary, remove bearings (8) and grease seals (7) as follows (see Inspection below):

   A. Prevent damage to bearings by pulling on the inner bearing race.

   B. Use bearing puller to remove bearings and seals.

Inspection

1. Inspect drive coupler (29) as follows (Fig. 40):

   A. Remove retaining ring (28) and drive coupler from the reel shaft (1).

   B. Clean drive coupler. Coupler should be free of dirt and debris.

   C. Drive coupler should be free of bending and distortion. Check splines for excessive cracks and distortion. Replace coupler if necessary.

2. Inspect reel (1) as follows:

   A. Check reel shaft for bending and distortion by placing the shaft ends in V–blocks. Replace reel if necessary.

   B. Check reel blades for bending or cracking. Replace reel if necessary.

   C. Check drive adapter inside of reel shaft. Adapter should be free of bending and distortion. Check splines for excessive cracks and distortion. Replace reel if necessary (Fig. 41).

   D. Check service limit of reel diameter (see Reel Grinding Specifications in Preparing Reel for Grinding).

3. Inspect bearings (8) and grease seals (7) as follows (Fig. 40):

   A. Seals must be free of cracks and tears. Replace seals as necessary.

   B. Bearing roller balls must be free of deformation and scoring. Replace bearing if necessary.

   C. Bearing must spin freely and have minimal axial play. Replace bearing if necessary.

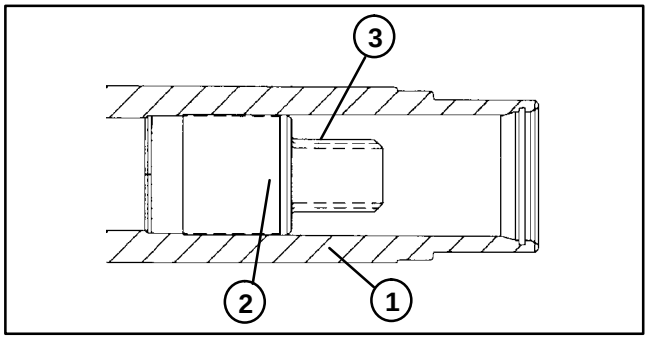


Figure 41

1. **Reel shaft**
2. **Drive adapter**
3. **Adapter spline**

Installation (Fig. 40)

Note: If bearings (8) where removed, grease seals (7) should be replaced. Both bearings should be replaced as a set.

1. If bearings (8) and grease seals (7) were removed from the reel shaft (1), install seals and bearings to the shaft as follows:

   A. Pack both bearings with No. 2 multipurpose lithium base grease.

   B. Clean bearing surfaces of reel shaft. Apply anti-seize lubricant to both bearing surfaces (Fig. 42).

IMPORTANT: Pressing the seal too far onto the reel shaft will cause the seal to spread, and not allow it to be tight on the shaft (Fig. 42).

   C. With the lip side of the seal facing the reel spider, press seal onto each end of the reel shaft (Fig. 42).

   D. Press bearing onto each end of the reel shaft (Fig. 42).

IMPORTANT: Do not install the flat wire spring (9) into the right bearing housing. Damage to the spring may result as well as increased noise and poor quality of cut.

2. Install right bearing housing (10) as follows:

   A. Insert bearing housing (10) into the right sideplate of the frame so that the grease fitting (11) is facing up.

   B. Apply Loctite 242 or equivalent to the threads of the two tapered screws (16).

   C. Insert both tapered screws (16) through the side plate and bearing housing (10). Start tapered nuts (12) onto screws.

   D. Place bearing spacer (27) into the bearing housing (10).

3. Position reel (1) into the cutting unit frame. Slide end of reel into bearing housing (10) while keeping the bearing (8) straight.

4. Install left bearing housing (10) as follows:

   A. Insert bearing housing (10) into the left sideplate of the frame over the bearing (8). Make sure the grease fitting (11) is facing up.

   B. Apply Loctite 242 or equivalent to the threads of the two tapered screws (16).

   C. Insert both tapered screws (16) through the side plate and bearing housing (10). Start tapered nuts (12) onto the screws.

   D. Place flat wire spring (9) into the bearing housing (10).

5. Reinstall shield rod (25) to the frame. Secure rod with both hex head screws (17).

6. Tap both bearing housings (10) with a soft hammer to seat bearings (8). Tighten tapered nuts (12) to secure housings.

7. Insert drive coupler (29) into end of reel shaft (1) to accept hydraulic reel motor. Make sure splines of coupler mess with those of the drive adapter. Secure coupler with retaining ring (28) (Fig. 40 and 41).

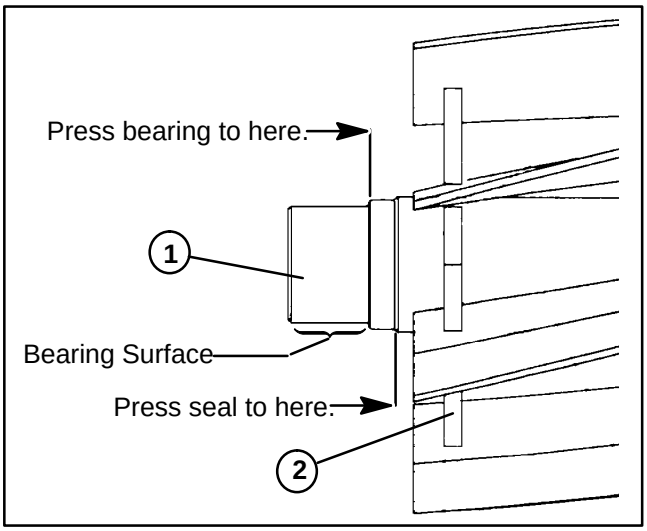


Figure 42

1. Reel shaft bearing **2. Reel spider**

Preparing a Reel for Grinding

Note: Check to make sure the reel bearings are in good condition before grinding a reel.

1. Remove bedbar assembly (see Bedbar Removal and Installation).

2. Remove parts as necessary to mount cutting unit into grinder (e.g., front roller, front roller brackets).

Note: The cutting unit must be aligned so the grinding wheel will travel parallel to the reel shaft. This will result in the the reel being ground to the desired cylinder shape.

Note: When grinding, be careful to not overheat the reel blades. Remove small amounts of material with each pass of the grinder.

3. After completing the grinding process:

   A. Install parts removed to mount cutting unit into grinder.

   B. Install bedbar assembly (see Bedbar Removal and Installation).

   C. Complete cutting unit set–up and adjustment sequence (see Adjustments section).

Reel Grinding Specifications	
Nominal Reel Diameter	5 in (126 mm)
Service Limit Reel Diameter	4.5 in (114 mm)
Blade Relief Angle	30°
Relief Angle Range	20° to 40°
Blade Land Width	0.040 in (1.0 mm)
Land Width Range	0.030 to 0.060 in (0.7 to 1.5 mm)
Max. Reel Taper	0.040 in (1.0 mm)

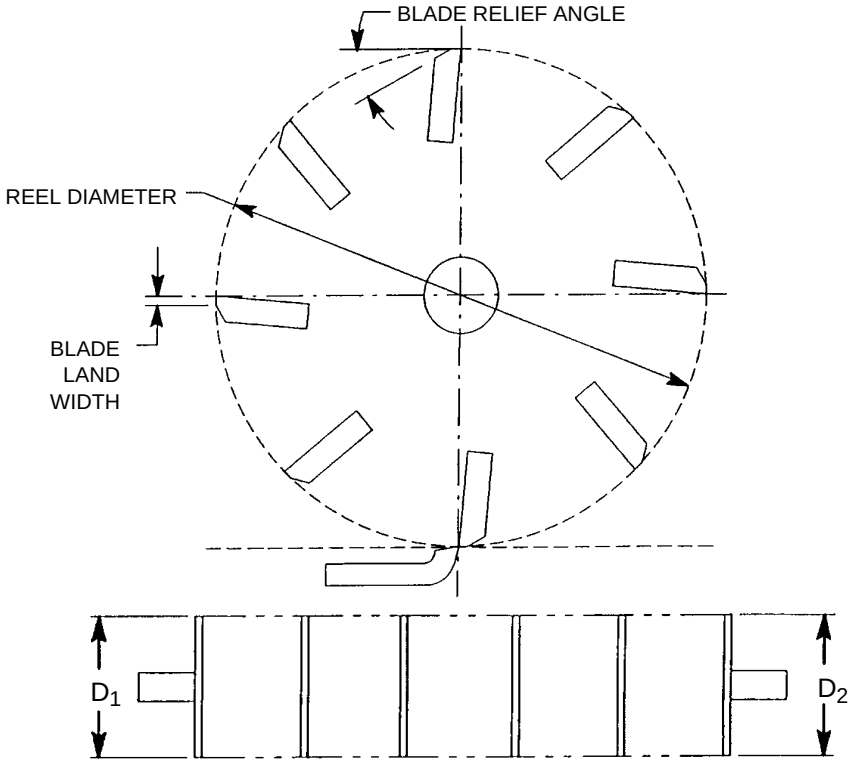


Figure 43

Rear Roller Scraper Removal and Installation

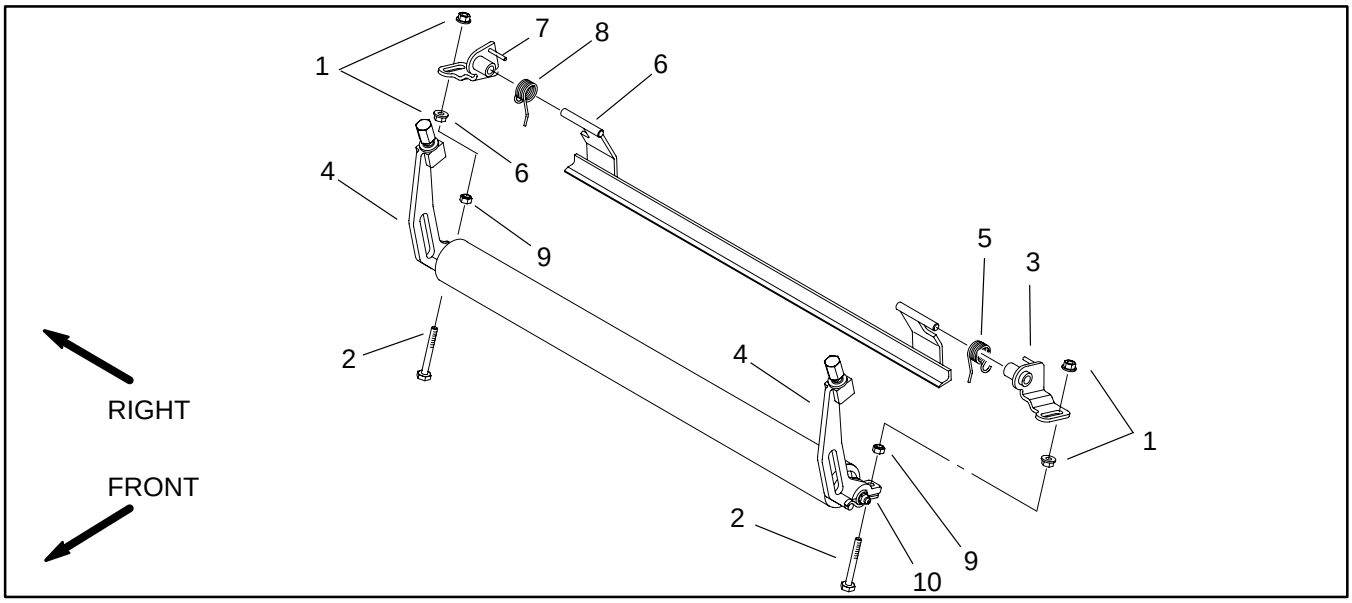


Figure 44

1. **Flange head nut**
2. **Hex head screw**
3. **Bracket (LH)**
4. **Height–of–cut adjustment bracket**
5. **Torsion spring (LH)**
6. **Scraper**
7. **Bracket (RH)**
8. **Torsion spring (RH)**
9. **Lock nut**
10. **Height–of–cut tab**

Removal

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

2. Remove flange head nut from the hex head screw securing the bracket (LH) to the height–of–cut (H–O–C) adjustment bracket.

3. Remove bracket (LH) and torsion spring (LH) from the scraper and hex head screw. Pull scraper from the bracket (RH).

4. Remove torsion spring (RH) from bracket (RH).

5. Remove flange head nut from the hex head screw securing the bracket (RH) to the (H–O–C) adjustment bracket. Remove bracket (RH) from the hex head screw.

6. If the rear roller scraper is to be permanently removed,

   A. Remove remaining flange head nut, lock nut, and hex head screw from the H–O–C adjustment bracket and collar.

   B. Insert carriage screws (M8–1.25 x 20) through both H–O–C adjustment brackets and collars to secure the rear roller to the brackets. Secure screws with lock nuts.

Installation

1. If the rear roller scraper was not previously installed, remove carriage bolt and nut securing the rear of each roller collar to roller bracket.

2. Insert a 8mm hex head screw through holes in height–of–cut tab and H–O–C adjustment bracket and secure with a locknut (Fig).

Note: If screw does not fit through holes in roller collar and roller bracket, enlarge holes with a 0.328 inch (8.33 mm) diameter drill.

3. Thread flange nut (flange up) onto each hex head screw.

4. Insert bracket (LH) onto the hex head screw on left H–O–C adjustment bracket; loosely secure with a flange head nut.

5. Slide torsion spring (LH) with hook outward onto bracket (LH) and position hook around bracket (LH).

6. Insert left end of scraper into the hole in the bracket (LH). Place end of torsion spring (LH) behind scraper.

7. Repeat procedure on right end of scraper while loosely securing bracket (RH) to hex head screw on the right H–O–C adjustment bracket.

8. Adjust roller scraper to the roller (see Rear Roller Scraper Adjustment).

Reel and Shields Assembly (4–Bolt Adjust Cutting Unit)

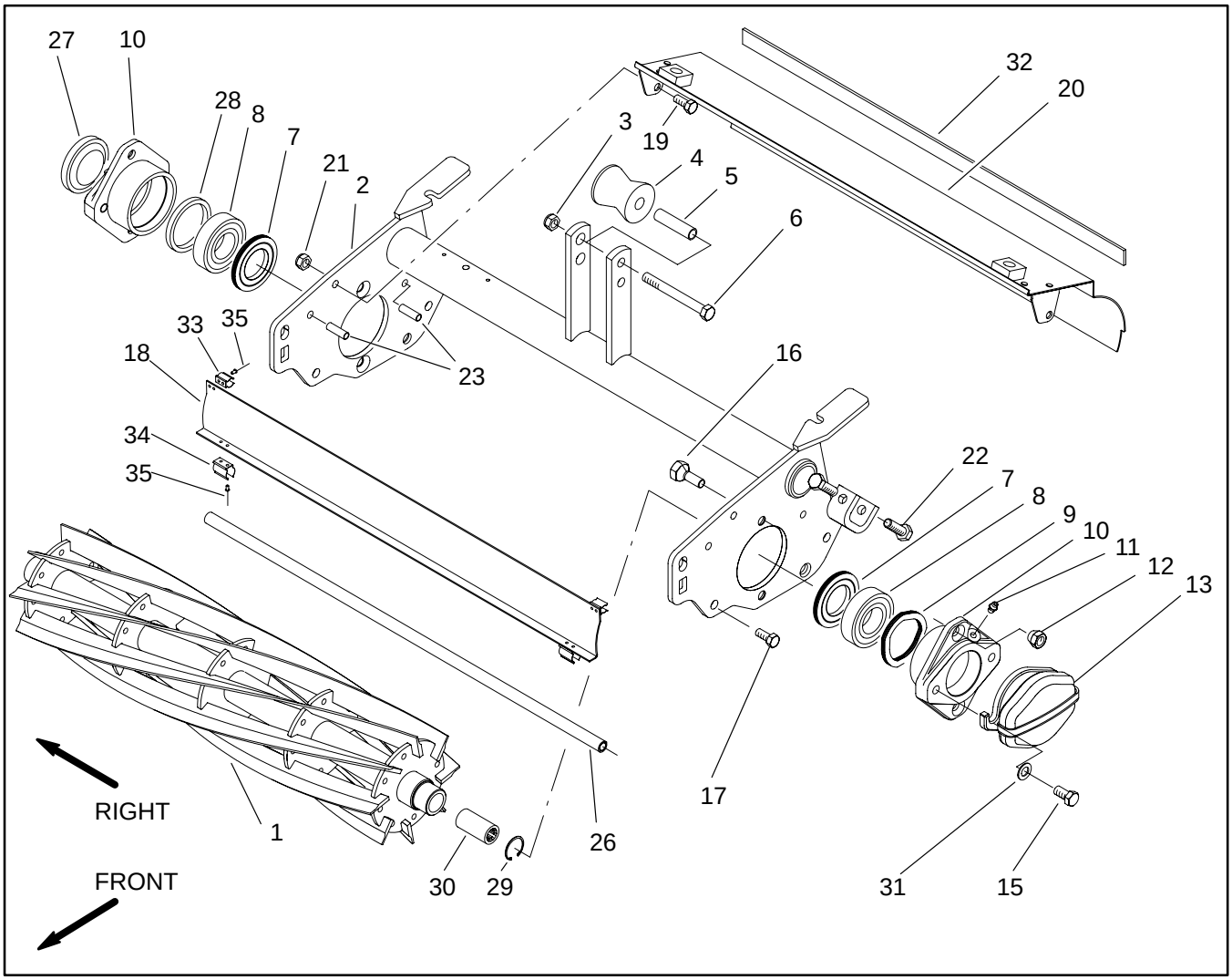


Figure 45

1. Reel
2. Frame
3. Lock nut
4. Lift Roller
5. Roller spacer
6. Hex head screw
7. Grease seal
8. Bearing
9. Flat wire spring
10. Bearing housing
11. Grease fitting
12. Taper Nut
13. Counter weight
14. Not used
15. Hex head flange screw
16. Tapered screw
17. Hex head screw
18. Front shield assembly
19. Hex head screw
20. Rear shield assembly
21. Lock nut
22. Hex head screw
23. Spring pin
24. Not used
25. Not used
26. Shield rod
27. Plastic cap
28. Bearing spacer
29. Retaining ring
30. Drive coupler
31. Washer
32. Seal strip
33. Small spring clip
34. Large spring clip
35. Pop rivet

Note: The counterweight (13) and drive coupler (29) are not installed on the same side of the cutting unit. The coupler would be installed on the side of the unit accepting the hydraulic motor. The counterweight would be on the side opposite the motor.

Lubrication

Single Point Adjust cutting units have seven grease fittings and 4–Bolt units have six fittings. Each grease fitting must be lubricated regularly with No. 2 multipurpose lithium base grease.

The grease fitting locations are: the bedknife pivot hub (Single Point Adjust only, (Fig. 46)), both reel bearings, and two on both the front and rear roller.

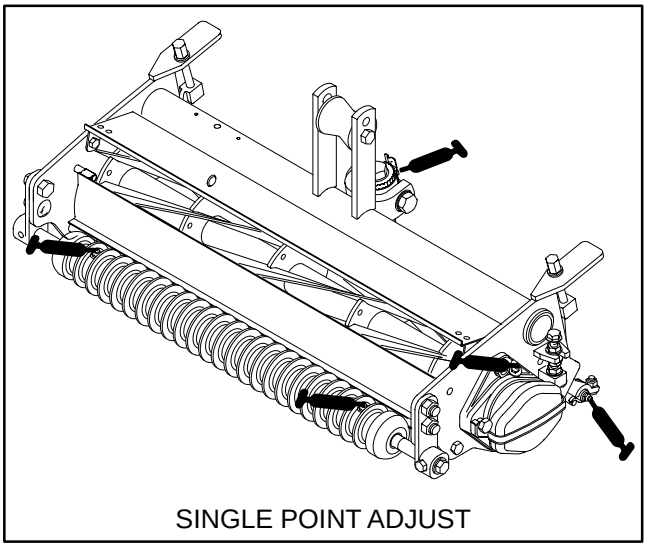
IMPORTANT: Lubricate cutting units immediately after washing helps purge water out of bearings and increases bearing life. Grease immediately after washing regardless of the service interval listed.

1. Wipe each grease fitting with a clean rag.

IMPORTANT: Do not apply too much pressure, or the grease seals will be permanently damaged. Use only a hand pumped grease gun.

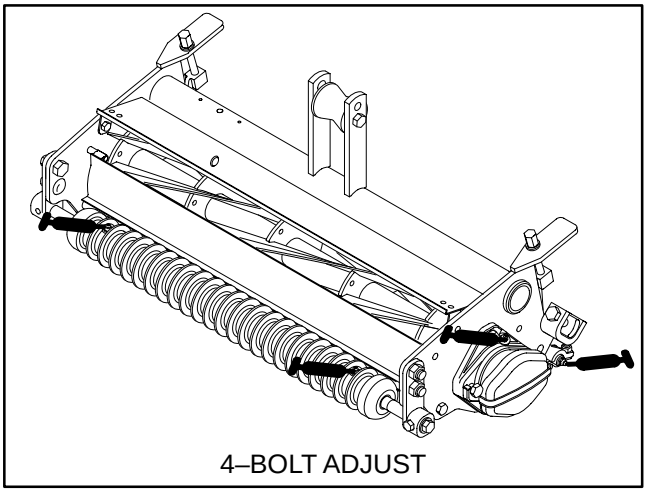
2. Apply grease until pressure is felt against handle.

3. Wipe excess grease from the fittings.



SINGLE POINT ADJUST

Figure 46



4–BOLT ADJUST

Figure 47

Commercial Products

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