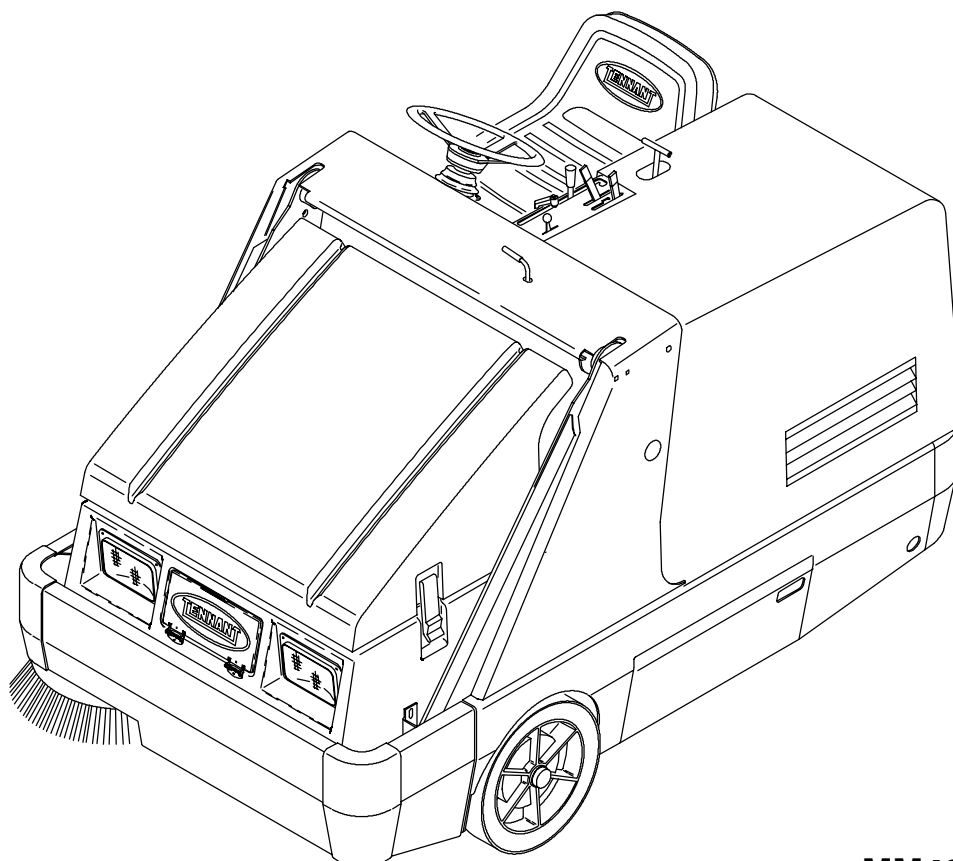




# 6400IC

Service Manual



MM433

Rev. 02





This service manual is intended to be used as an aid in the detailed service, repair, and troubleshooting of your TENNANT Model 6400IC.

The set is organized into eight major groups: General Information, Chassis, Sweeping, Electrical, Hydraulics, Engine-G/LPG air cooled, Engine-G/LP liquid cooled, and Engine-D.

**General Information:** Machine transport, machine jacking, machine storage, machine specifications, and machine maintenance chart.

**Chassis:** Tire/wheel replacement, brake adjustment and replacement, seat removal and installation, chassis lubrication, and steering adjustment and replacement.

**Sweeping:** Hopper repair/replacement, brush repair/replacement, skirt/seal repair/replacement, and sweeping troubleshooting.

**Electrical:** Battery maintenance and replacement, instrument panel replacement, schematics, and electrical troubleshooting.

**Hydraulics:** Valve replacement/repair, motor replacement/repair, cylinder replacement/repair, pump replacement/repair, filter replacement, schematics, and hydraulics troubleshooting.

**Engine - G/LPG air cooled:** Air filter replacement, oil changing, cooling system maintenance/repair, fuel system maintenance/repair, governor adjustment/repair, engine troubleshooting, and engine repairs.

**Engine - G/LPG liquid cooled:** Air filter replacement, oil changing, cooling system maintenance/repair, fuel system maintenance/repair, governor adjustment/repair, engine troubleshooting, and engine repairs.

**Engine - D:** Air filter replacement, oil changing, cooling system maintenance/repair, fuel system maintenance/repair, governor adjustment/repair, engine troubleshooting, and engine repairs.

Manual Number - MM433

Revision: 02

Published: 12-01



**CALIFORNIA PROPOSITION 65 WARNING:**

**Engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.**

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## SAFETY PRECAUTIONS

The following precautions are used throughout this manual as indicated in their description:



**WARNING:** To warn of hazards or unsafe practices that could result in severe personal injury or death.

**FOR SAFETY:** To identify actions that must be followed for safe operation of equipment.

The machine is suited to sweep disposable debris. Do not use the machine other than described in this Operator Manual. The machine is not designed for use on public roads.

The following information signals potentially dangerous conditions to the operator or equipment:

**FOR SAFETY:**

1. **Do not operate machine:**
  - Unless trained and authorized.
  - Unless operation manual is read and understood.
  - In flammable or explosive areas unless designed for use in those areas.
  - In areas with possible falling objects unless equipped with overhead guard.
2. **Before starting machine:**
  - Check for fuel leaks.
  - Keep sparks and open flame away from refueling area.
  - Make sure all safety devices are in place and operate properly.
  - Check brakes and steering for proper operation.
3. **When starting machine:**
  - Keep foot on brake and directional pedal in neutral.
4. **When using machine:**
  - Use brakes to stop machine.
  - Go slow on inclines and slippery surfaces.
  - Use care when reversing machine.
  - Move machine with care when hopper is raised.
  - Make sure adequate clearance is available before raising hopper.
  - Do not carry riders on machine.
  - Always follow safety and traffic rules.
  - Report machine damage or faulty operation immediately.
5. **Before leaving or servicing machine:**
  - Stop on level surface.
  - Set parking brake.
  - Turn off machine and remove key.
6. **When servicing machine:**
  - Avoid moving parts. do not wear loose jackets, shirts, or sleeves.
  - Block machine tires before jacking machine up.
  - Jack machine up at designated locations only. block machine up with jack stands.
  - Use hoist or jack that will support the weight of the machine.
  - Wear eye and ear protection when using pressurized air or water.
  - Disconnect battery connections before working on machine.
  - Avoid contact with battery acid.
  - Avoid contact with hot engine coolant.
  - Allow engine to cool.
  - Keep flames and sparks away from fuel system service area. Keep area well ventilated.
  - Use cardboard to locate leaking hydraulic fluid under pressure.
  - Use Tennant supplied or approved replacement parts.
7. **When loading/unloading machine onto/off truck or trailer:**
  - Turn off machine.
  - Use truck or trailer that will support the weight of the machine.
  - Use winch. Do not drive the machine onto/off the truck or trailer unless the load height is 380 mm (15 in) or less from the ground.
  - Set parking brake after machine is loaded.
  - Block machine tires.
  - Tie machine down to truck or trailer.

## GENERAL INFORMATION

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**WARNING:** Engine emits toxic gases. Severe respiratory damage or asphyxiation can result. Provide adequate ventilation. Consult with your regulatory authorities for exposure limits. Keep engine properly tuned.



**WARNING:** Lift arm pinch point. Stay clear of hopper lift arms.



**WARNING:** Raised hopper may fall. Engage hopper support bar.

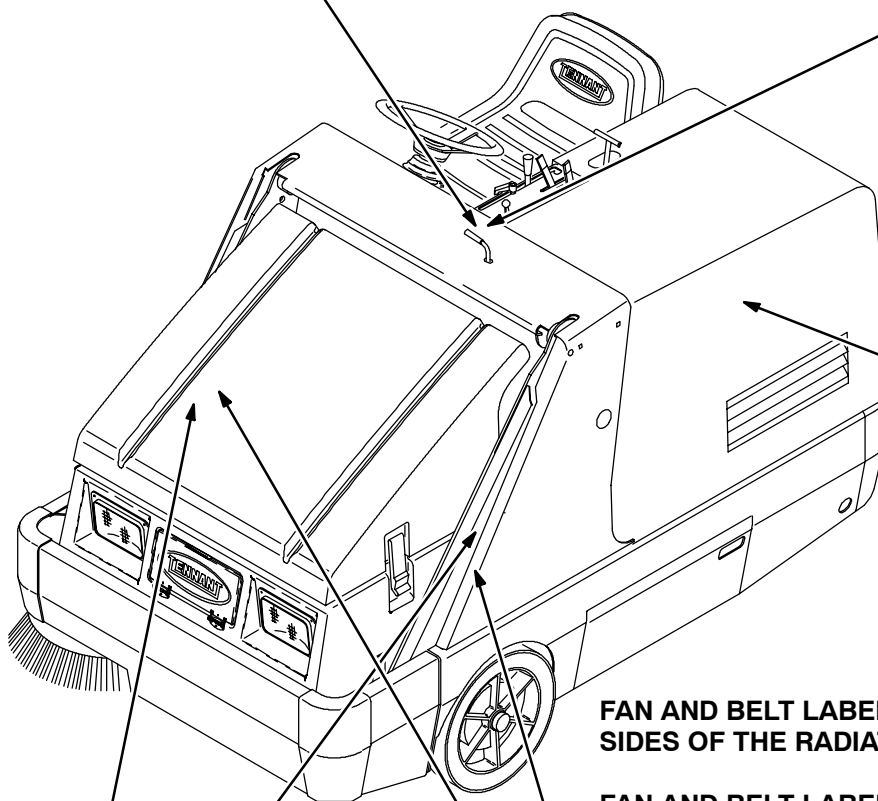
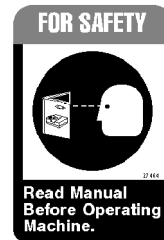
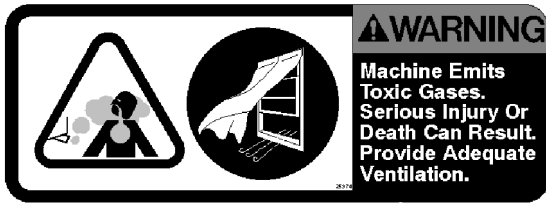


**WARNING:** Moving belt and fan. Keep away.

The following safety labels are mounted on the machine in the locations indicated. If these or any labels become damaged or illegible, install a new label in its place.

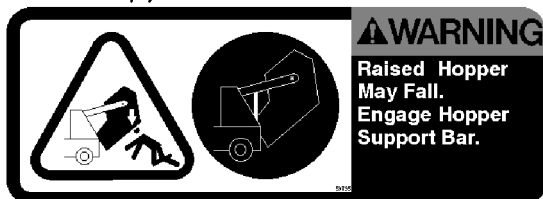
**EMISSIONS LABEL - LOCATED ON THE SIDE OF THE OPERATOR COMPARTMENT.**

**FOR SAFETY LABEL - LOCATED ON THE SIDE OF THE OPERATOR COMPARTMENT.**



**FAN AND BELT LABEL - LOCATED ON THE SIDES OF THE RADIATOR SHROUD.**

**FAN AND BELT LABEL - LOCATED ON THE VACUUM FAN HOUSING AND BELT SHROUD.**



**HOPPER SUPPORT LABEL - LOCATED ON BOTH LIFT ARMS AND THE HOPPER SUPPORT BAR.**



**HOPPER LIFT ARMS LABEL - LOCATED ON BOTH LIFT ARMS.**

**SPECIFICATIONS****GENERAL MACHINE DIMENSIONS/CAPACITIES**

Item	Dimension/capacity	
Length	2085 mm	(82 in)
Length with side brush	2260 mm	(89 in)
Width	1230 mm	(48.4 in)
Width with side brush	1395 mm	(55 in)
Height	1435 mm	(56.5 in)
Height with overhead guard	2085 mm	(82 in)
Track	1135 mm	(44.7 in)
Wheelbase	1135 mm	(44.7 in)
Main sweeping brush diameter	355 mm	(14 in)
Main sweeping brush length	915 mm	(36 in)
Side brush diameter	585 mm	(23 in)
Sweeping path width	915 mm	(36 in)
Sweeping path width with side brush	1270 mm	(50 in)
Main sweeping brush pattern width	50 to 75 mm	(2 to 3 in)
Hopper weight capacity	315 kg	(700 lb)
Hopper volume capacity	315 L	(11.25 ft <sup>3</sup> )
Dust filter area	6.9 m <sup>2</sup>	(74 ft <sup>2</sup> )
GVWR	1542 kg	(3400 lb)
Ceiling height minimum dumping clearance	2340 mm	(92 in)

**GENERAL MACHINE PERFORMANCE**

Item	Measure	
Maximum forward speed	9.6 km/h	(6 mph)
Maximum reverse speed	4.8 km/h	(3 mph)
Minimum aisle turn width, left	2360 mm	(93 in)
Minimum turning radius, right	1490 mm	(58.7 in)
Minimum turning radius, left	1135 mm	(44.7 in)
Maximum rated incline with empty hopper	10° / 17.6%	
Maximum rated incline with full hopper	8° / 14.1%	

**POWER TYPE: GAS AIR COOLED**

Engine	Type	Ignition	Cycle	Aspiration	Cylinders	Bore	Stroke
Kohler CH20	Piston	Capacitive discharge	4	Natural	2	77 mm (3.03 in)	67 mm (2.64 in)
	Displacement		Net power, governed			Net power, maximum	
	624 cc (38.1 cu in)		11.9 kw (16 hp) @ 2800 rpm			14.9 kw (20 hp) @ 3600 rpm	
	Fuel		Cooling system			Electrical system	
	Gasoline, 87 octane minimum, unleaded. Fuel tank: 27.6 L ( 7.3 gal)		Air			12 V nominal	
	LPG, Fuel tank: 15 kg (33 lb)					25 A alternator	
	Idle speed, no load		(Fast) governed speed, under load			Firing order	
	1200 rpm $\pm$ 100rpm		2750 rpm $\pm$ 25 rpm			1 - 2	
	Spark plug gap		Valve clearance, cold			Engine lubricating oil with filter	
	1 mm (0.040 in)		0.038 to 0.076 mm (0.0015 to 0.0030 in) intake 0.050 to 0.088 mm (0.0020 to 0.0035 in) exhaust			1.9 L (2 qt) 10W30 SAE-SG/SH	

**POWER TYPE: GAS LIQUID COOLED**

Engine	Type	Ignition	Cycle	Aspiration	Cylinders	Bore	Stroke
Kubota DG750	Piston	Breakerless-type spark	4	Natural	3	68 mm (2.68 in)	68 mm (2.68 in)
	Displacement		Net power, governed			Net power, maximum	
	740 cc (45.21 cu in)		12.3 kw (16.5 hp) @ 2500 rpm			18.3 kw (24.5 hp) @ 3600 rpm	
	Fuel		Cooling system			Electrical system	
	Gasoline, 87 octane minimum, unleaded. Fuel tank: 27.6 L ( 7.3 gal)		Water/ethylene glycol antifreeze			12 V nominal	
	LPG, Fuel tank: 15 kg ( 33lb)		Total: 8 L ( 2gal)			40 A alternator	
			Radiator: 4 L ( 1gal)				
	Idle speed, no load		(Fast) governed speed, under load			Firing order	
	1400 rpm $\pm$ 50 rpm		2450 rpm $\pm$ 25 rpm			1-2-3	
	Spark plug gap		Valve clearance, cold			Engine lubricating oil with filter	
	1 mm (0.043 in)		0.145 to 0.185 mm (0.0057 to 0.0072 in) intake and exhaust			3.25 L (3.4 qt) 10W30 SAE-SG/SH	

## GENERAL INFORMATION

### POWER TYPE: DIESEL LIQUID COOLED

Engine	Type	Ignition	Cycle	Aspiration	Cylinders	Bore	Stroke
Kubota D905	Piston	Diesel	4	Natural	3	72 mm (2.83 in)	73.6 mm (2.90 in)
	Displacement		Net power, governed			Net power, maximum	
	898 cc (54.86 cu in)		13 kw (17.5 hp) @ 2500 rpm			19.4 kw (26 hp) @ 3600 rpm	
	Fuel		Cooling system			Electrical system	
	Diesel Fuel tank: 27.6 L ( 7.3 gal)		Water/ethylene glycol antifreeze			12 V nominal	
			Total: 8 L ( 2 gal)			30 A alternator	
			Radiator: 4 L ( 1 gal)				
	Idle speed, no load		(Fast) governed speed, under load			Engine lubricating oil with filter	
	1400 rpm ± 50 rpm		2450 rpm ± 25 rpm			5.1 L (5.4 qt) SAE-CD/CE	

### STEERING

Type	Power source	Emergency steering
Rear wheel, hydraulic cylinder and rotary valve controlled	Hydraulic accessory pump	Manual

### HYDRAULIC SYSTEM

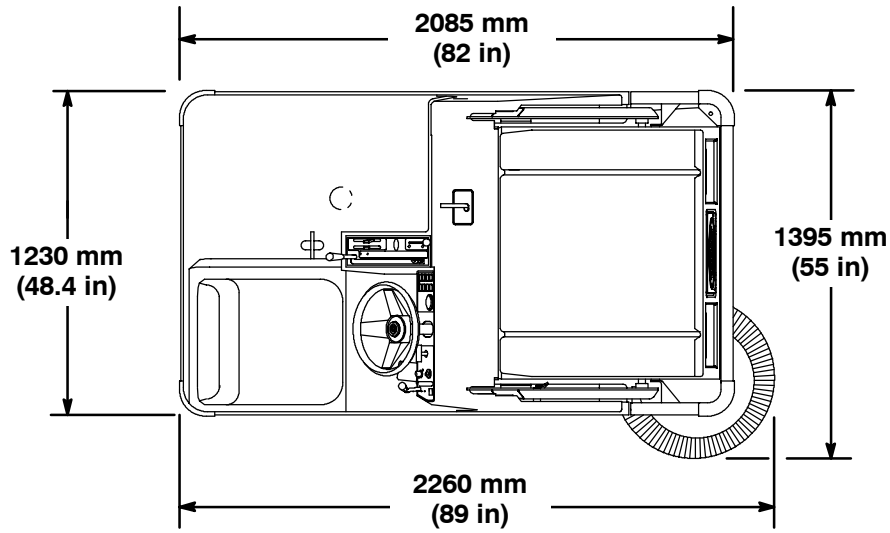
System	Capacity	Fluid Type
Hydraulic reservoir	19.3 L ( 5.12 gal)	TENNANT part no. 65869 - above 7° C (45° F) TENNANT part no. 65870 - below 7° C (45° F)
Hydraulic total	20.8 L ( 5.5 gal)	

### BRAKING SYSTEM

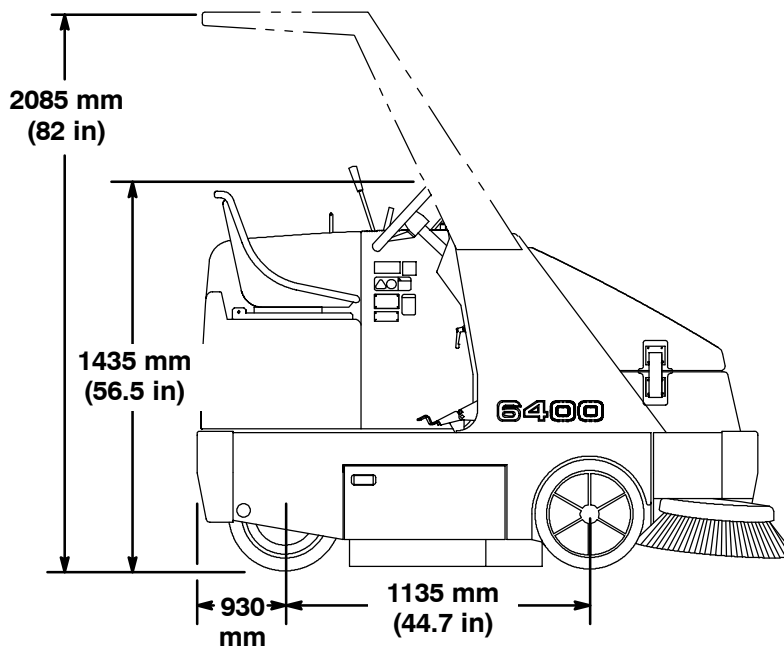
Type	Operation
Service brakes	Mechanical drum brakes (2), one per front wheel, cable actuated
Parking brake	Utilize service brakes, rod actuated

### TIRES

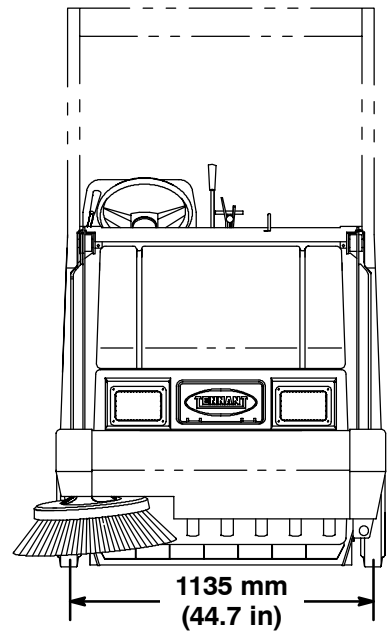
Location	Type	Size	Pressure
Front (2)	Solid	406 x 89 x 308 (16 x 3 1/2 x 12 1/8)	N/A
Rear (1)	Pneumatic	150/75 R8 10P (16 x 68)	795kPa (115 psi)



TOP VIEW



SIDE VIEW

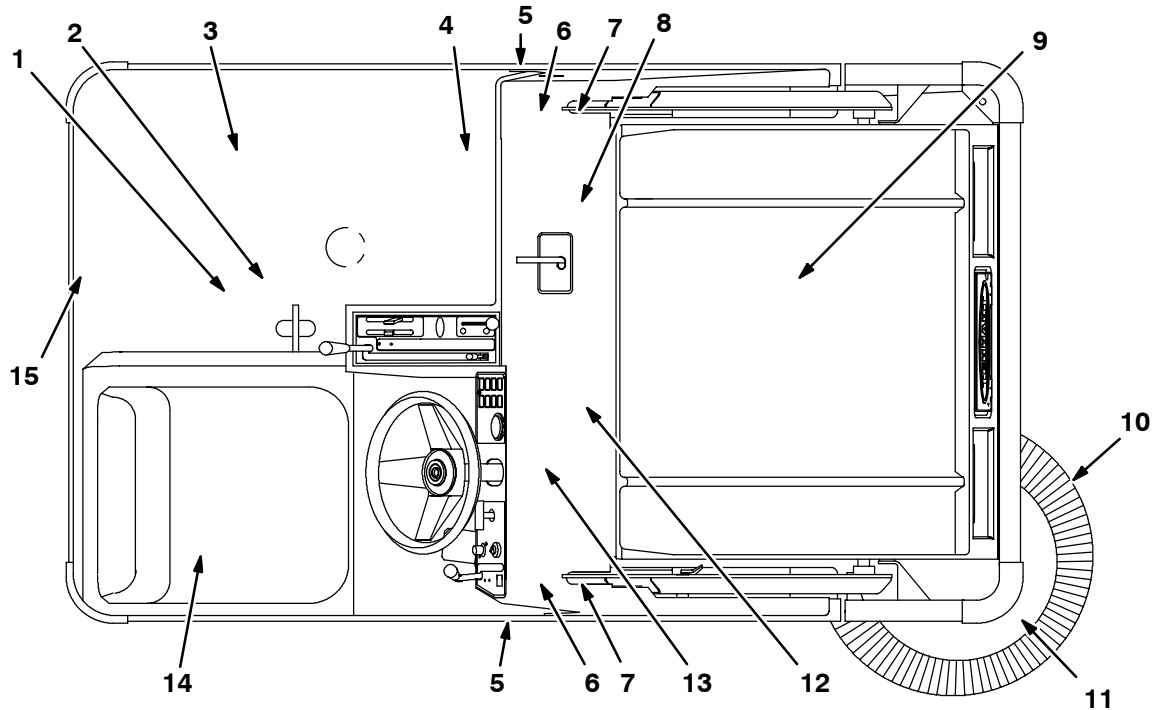


FRONT VIEW

MACHINE DIMENSIONS

350158-350165

## MAINTENANCE



350158

### MAINTENANCE CHART, GAS/LP AIR COOLED-

Interval	Key	Description	Procedure	Lubricant/ Fluid	No. of Service Points
Daily	3	Engine	Check oil level	EO	1
			Check air intake and cooling areas for debris	-	1
	5	Brush compartment skirts	Check for damage, wear and adjustment	-	5
	11	Hopper lip skirts	Check for damage, wear and adjustment	-	3
	8	Main brush	Check for damage or wear	-	1
			Check brush pattern	-	1
	10	Side brush	Check for damage or wear	-	1
			Check brush pattern	-	1
	9	Hopper dust filter	Shake	-	1
25 Hours	3	Engine	Clean air filter pre-cleaner element	-	1
50 Hours	8	Main brush	Rotate end-for-end	-	1



Interval	Key	Description	Procedure	Lubricant/ Fluid	No. of Service Points
100 Hours	9	Hopper dust filter	Check for damage, clean or replace	-	1
	14	Hydraulic fluid reservoir	Check fluid level	HYDO	1
	6	Tires	Check for damage	-	3
			Check pressure	-	1
	12	Main brush and hopper seals	Check for damage or wear	-	8
	3	Engine	Change oil and filter element	EO	1
			Clean or replace spark plugs	-	2
			Clean or replace air filter element	-	1
			Clean cooling fins	-	1
	4	Battery	■ Check electrolyte	DW	1
200 Hours	1	Rear wheel support bearings	Lubricate	SPL	2
	13	Brakes	Check and adjust travel	-	1
	2	Steering cylinder	Lubricate	SPL	1
	3	Vacuum fan belt	Check tension and wear	-	1
	11	Side brush guard	Rotate 90°	-	1
	7	Hopper lift arm pivots	Lubricate	SPL	2
	11	Side brush pivot	Check adjustment	-	1
400 Hours	6	Front wheel bearings	Check for seal damage	-	2
800 Hours	14	Hydraulic fluid reservoir	Replace filler cap	-	1
			Replace suction strainer	-	1
			Change hydraulic fluid	HYDO	1
	15	Hydraulic fluid filter	■ Change filter element	-	1
	-	Hydraulic hoses	Check for wear and damage	-	All
	2	Propelling motor	■ Torque shaft nut	-	1
	2	Rear wheel	■ Torque wheel nuts	-	1
	3	Engine	Replace fuel filter	-	1
	4	Battery	■ Clean and tighten battery cable connections	-	1

## LUBRICANT/FLUID

DW . . . Distilled water

EO . . . Engine oil, SAE-SG/SH rated

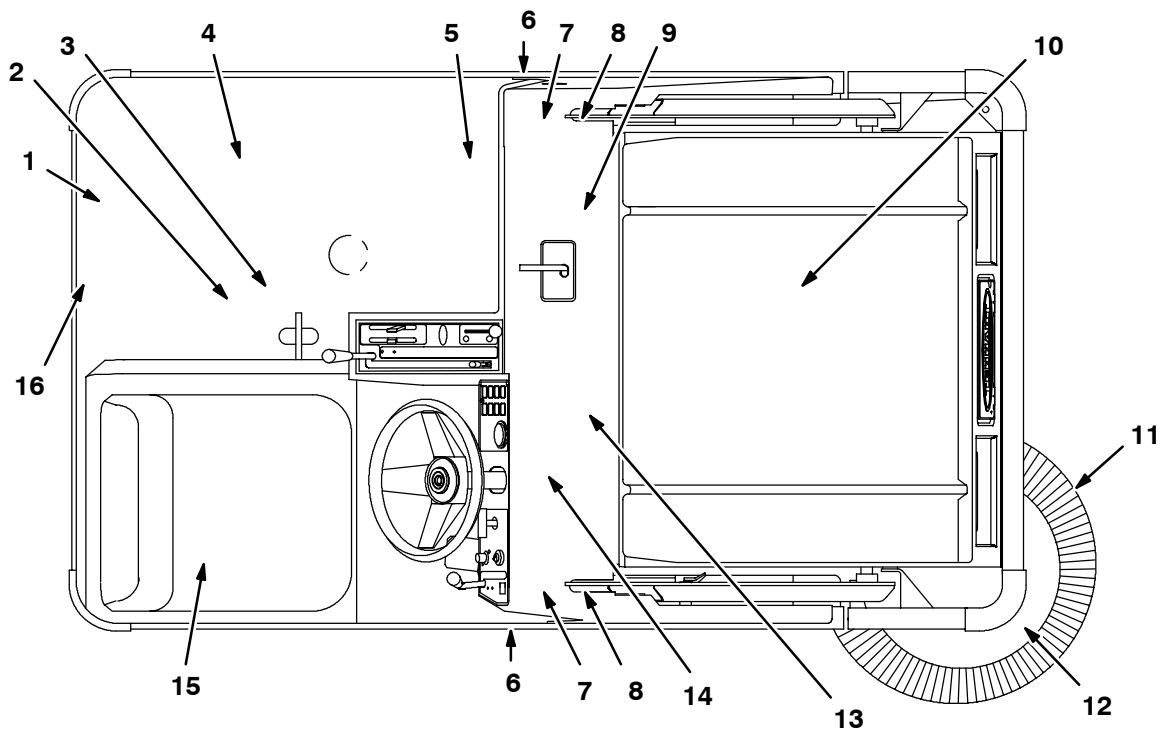
HYDO . Tennant or approved hydraulic fluid

SPL . . . Special lubricant, Lubriplate EMB grease (TENNANT part no. 01433-1)

NOTE: Also check procedures indicated (■) after the first 50 hours of operation.

NOTE: More frequent intervals may be required in extremely dusty conditions.

## GENERAL INFORMATION



350158

### MAINTENANCE CHART, GAS/LP LIQUID COOLED

Interval	Key	Description	Procedure	Lubricant/ Fluid	No. of Service Points
Daily	4	Engine	Check oil level	EO	1
			Empty air filter dust cap	-	1
			Check optional air filter indicator	-	1
	6	Brush compartment skirts	Check for damage, wear and adjustment	-	5
	12	Hopper lip skirts	Check for damage, wear and adjustment	-	3
	9	Main brush	Check for damage or wear	-	1
			Check brush pattern	-	1
	11	Side brush	Check for damage or wear	-	1
			Check brush pattern	-	1
	10	Hopper dust filter	Shake	-	1
50 Hours	9	Main brush	Rotate end-for-end	-	1

Interval	Key	Description	Procedure	Lubricant/ Fluid	No. of Service Points
100 Hours	10	Hopper dust filter	Check for damage, clean or replace	-	1
	15	Hydraulic fluid reservoir	Check fluid level	HYDO	1
	7	Tires	Check for damage	-	3
			Check pressure	-	1
	13	Main brush and hopper seals	Check for damage or wear	-	8
	1	Radiator	Clean core exterior	-	1
			Check coolant level	WG	1
	4	Engine	Change oil and filter element	EO	1
			Check belt tension	-	1
			Clean or replace air filter element	-	1
	5	Battery	■ Check electrolyte	DW	1
200 Hours	2	Rear wheel support bearings	Lubricate	SPL	2
	1	Radiator hoses and clamps	Check for tightness and wear	-	2
	14	Brakes	Check and adjust travel	-	1
	3	Steering cylinder	Lubricate	SPL	1
	4	Vacuum fan belt	Check tension and wear	-	1
	12	Side brush guard	Rotate 90°	-	1
	8	Hopper lift arm pivots	Lubricate	SPL	2
	12	Side brush pivot	Check adjustment	-	1
400 Hours	4	Engine	Clean or replace and adjust spark plugs	-	3
	7	Front wheel bearings	Check for seal damage	-	2
800 Hours	15	Hydraulic fluid reservoir	Replace filler cap	-	1
			Replace suction strainer	-	1
			Change hydraulic fluid	HYDO	1
	16	Hydraulic fluid filter	Change filter element	-	1
	-	Hydraulic hoses	Check for wear and damage	-	All
	3	Propelling motor	■ Torque shaft nut	-	1
	3	Rear wheel	■ Torque wheel nuts	-	1
	5	Battery	■ Clean and tighten battery cable connections	-	1
	4	Engine	Replace fuel filter	-	1
			Check valve clearance	-	1
	1	Cooling system	Flush	WG	1

**LUBRICANT/FLUID**

DW . . . Distilled water

EO . . . Engine oil, SAE-SG/SH rated

HYDO . Tennant or approved hydraulic fluid

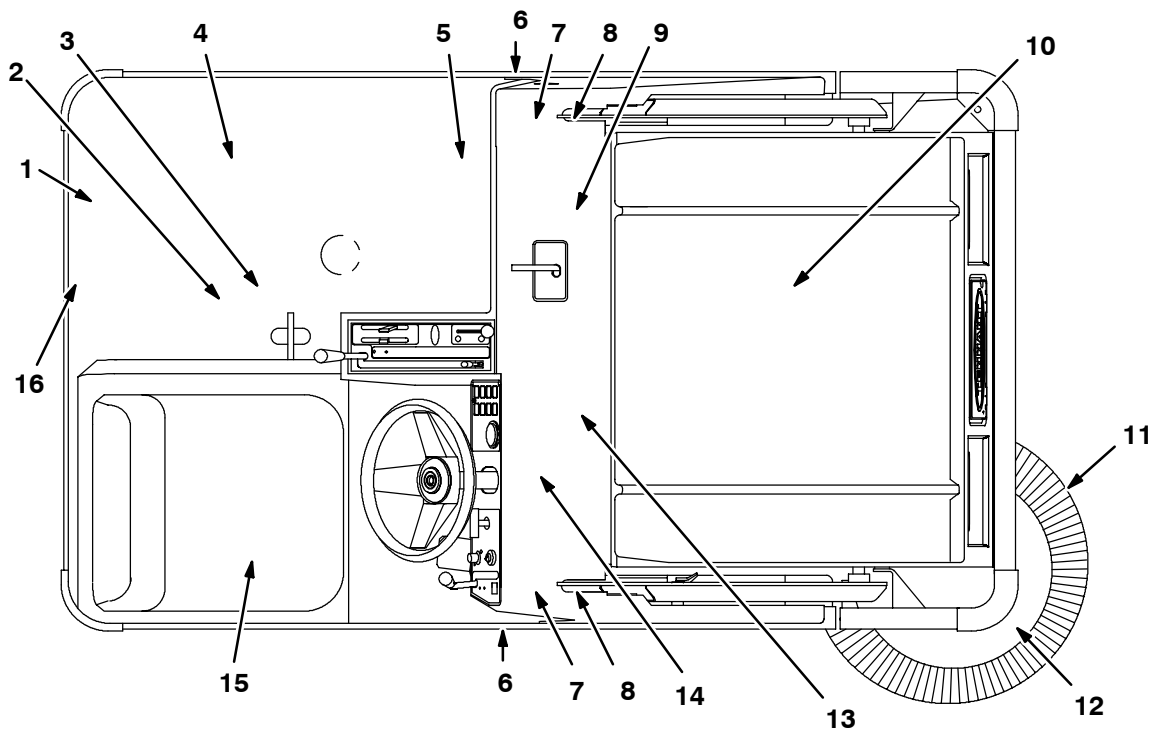
SPL . . . Special lubricant, Lubriplate EMB grease (TENNANT part no. 01433-1)

WG . . . Water and permanent-type ethylene glycol anti-freeze, -34° C (-30° F)

NOTE: Also check procedures indicated (■) after the first 50 hours of operation.

NOTE: More frequent intervals may be required in extremely dusty conditions.

## GENERAL INFORMATION



350158

### MAINTENANCE CHART, DIESEL

Interval	Key	Description	Procedure	Lubricant/ Fluid	No. of Service Points
Daily	4	Engine	Check oil level	EO	1
			Empty air filter dust cap	-	1
			Check optional air filter indicator	-	1
	6	Brush compartment skirts	Check for damage, wear and adjustment	-	5
	12	Hopper lip skirts	Check for damage, wear and adjustment	-	3
	9	Main brush	Check for damage or wear	-	1
			Check brush pattern	-	1
	11	Side brush	Check for damage or wear	-	1
			Check brush pattern	-	1
	10	Hopper dust filter	Shake	-	1
50 Hours	9	Main brush	Rotate end-for-end	-	1
	4	Fuel pipes and clamps	Check for tightness and wear	-	All

Interval	Key	Description	Procedure	Lubricant/ Fluid	No. of Service Points
100 Hours	10	Hopper dust filter	Check for damage, clean or replace	-	1
	15	Hydraulic fluid reservoir	Check fluid level	HYDO	1
	7	Tires	Check for damage	-	3
			Check pressure	-	1
	13	Main brush and hopper seals	Check for damage or wear	-	8
	1	Radiator	Clean core exterior	-	1
			Check coolant level	WG	1
	4	Engine	■Change oil and filter element	EO	1
			Check belt tension	-	1
			Clean or replace filter element	-	1
	5	Battery	■Check electrolyte	DW	1
200 Hours	2	Rear wheel support bearings	Lubricate	SPL	2
	1	Radiator hoses and clamps	Check for tightness and wear	-	2
	14	Brakes	Check and adjust travel	-	1
	3	Steering cylinder	Lubricate	SPL	1
	4	Vacuum fan belt	Check tension and wear	-	1
	12	Side brush guard	Rotate 90°	-	1
	8	Hopper lift arm pivots	Lubricate	SPL	2
	12	Side brush pivot	Check adjustment	-	1
400 Hours	4	Fuel filter cartridge	Replace element	-	1
	7	Front wheel bearings	Check for seal damage	-	2
800 Hours	15	Hydraulic fluid reservoir	Replace filler cap	-	1
			Replace suction strainer	-	1
			Change hydraulic fluid	HYDO	1
	16	Hydraulic fluid filter	Change filter element	-	1
	-	Hydraulic hoses	Check for wear and damage	-	All
	3	Propelling motor	■Torque shaft nut	-	1
	3	Rear wheel	■Torque wheel nuts	-	1
	5	Battery	■Clean and tighten battery cable connections	-	1
	4	Engine	Check valve clearance	-	1
	1	Cooling system	Flush	WG	1

# LUBRICANT/FLUID

DW . . . Distilled water

EO . . . Engine oil, SAE-CD/CE rated

HYDO . Tennant or approved hydraulic fluid

SPL . . . Special lubricant, Lubriplate EMB grease (TENNANT part no. 01433-1)

WG . . . Water and permanent-type ethylene glycol anti-freeze, -34° C (-30° F)

*NOTE: Also check procedures indicated (■) after the first 50 hours of operation.*

*NOTE: More frequent intervals may be required in extremely dusty conditions.*

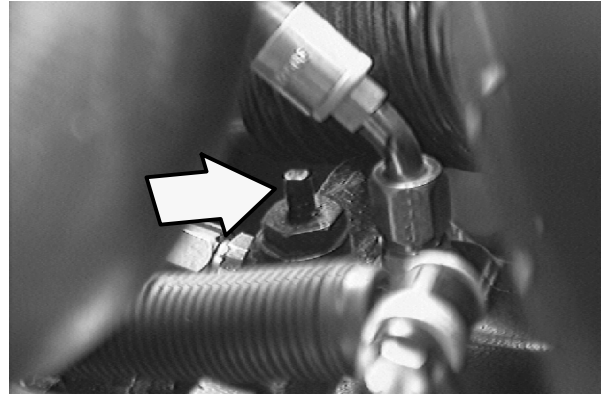
### PUSHING, TOWING, AND TRANSPORTING THE MACHINE

#### PUSHING OR TOWING THE MACHINE

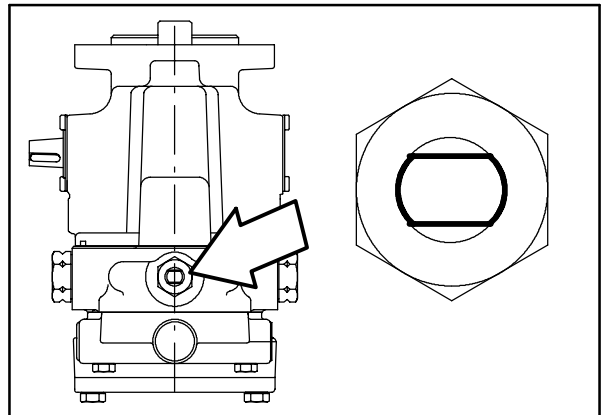
If the machine becomes disabled, it can be pushed from the front or rear, but towed only from the rear.

The propelling pump has a bypass valve to prevent damage to the hydraulic system when the machine is being pushed or towed. This valve allows a disabled machine to be moved for a *very short distance* and at a speed to not exceed 1.6 kp/h (1 mph). The machine is NOT intended to be pushed or towed a long distance or at a high speed.

**ATTENTION! Do not push or tow machine for a long distance and without using the bypass valve, or the machine hydraulic system may be damaged.**



Turn the bypass valve 90° from the normal position before pushing or towing the machine. **The illustration shows the bypass valve in the pushing or towing position.**



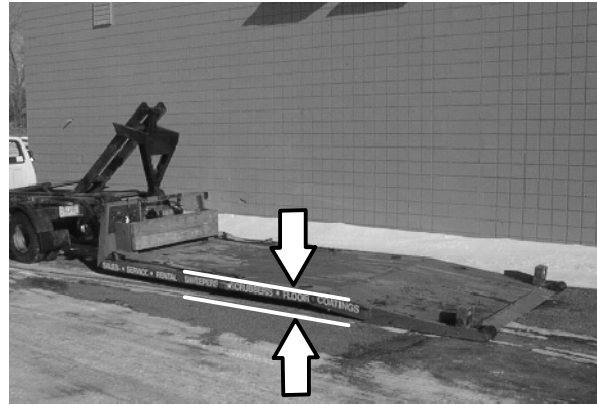
## TRANSPORTING THE MACHINE

1. Position the rear of the machine at the loading edge of the truck or trailer.  
**FOR SAFETY: Use truck or trailer that will support the weight of the machine.**

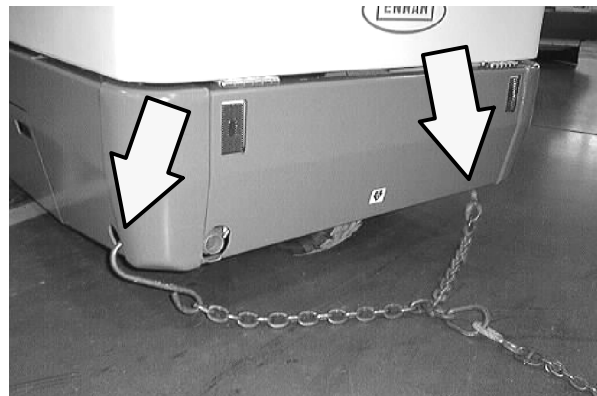
*NOTE: Empty the hopper before transporting the machine.*

2. If the loading surface is not horizontal or is higher than 380 mm (15 in) from the ground, use a winch to load machine.

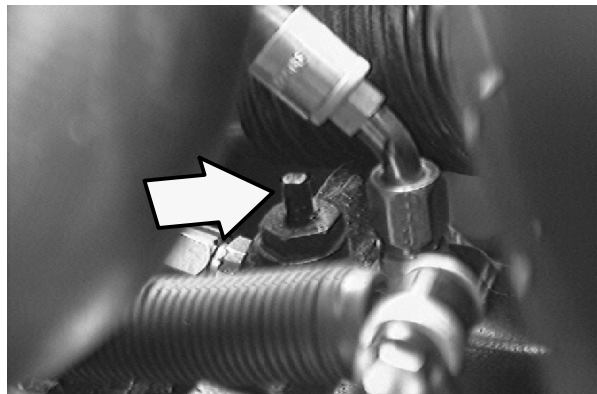
If the loading surface is horizontal AND is 380 mm (15 in) or less from the ground, the machine may be driven onto the truck or trailer.



3. To winch the machine onto the truck or trailer, attach the winching chains to the rear tie down locations. The rear tie-down locations are the holes in the sides of the machine frame near the rear bumper.



4. Turn the bypass valve 90° from the normal position before winching the machine onto the truck or trailer. See *PUSHING OR TOWING THE MACHINE* section of this manual. Make sure the machine is centered.  
**FOR SAFETY: When loading machine onto truck or trailer, use winch. Do not drive the machine onto the truck or trailer unless the loading surface is horizontal AND is 380 mm (15 in) or less from the ground.**



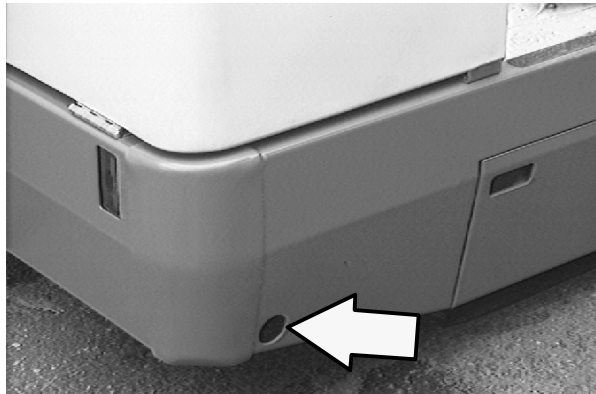
## GENERAL INFORMATION

5. Position the machine onto the truck or trailer as far as possible. If the machine starts to veer off the centerline of the truck or trailer, stop and turn the steering wheel to center the machine.
6. Set the parking brake and block the machine tires. Tie down the machine to the truck or trailer before transporting.

The front tie-down locations are the holes in the wheel pockets at the front of the machine frame.



The rear tie-down locations are the holes in the sides of the machine frame near the rear bumper.



7. If the loading surface is not horizontal or is higher than 380 mm (15 in) from the ground, use a winch to unload machine.

If the loading surface is horizontal AND is 380 mm (15 in) or less from the ground, the machine may be driven off the truck or trailer.

**FOR SAFETY: When unloading machine off truck or trailer, use winch. Do not drive the machine off the truck or trailer unless the loading surface is horizontal AND 380 mm (15 in) or less from the ground.**



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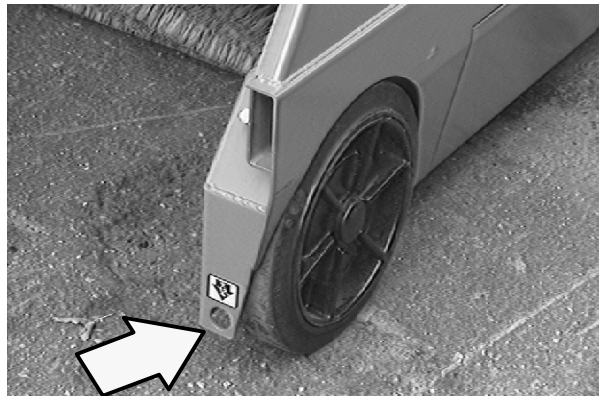
## MACHINE JACKING

---

Empty the hopper before jacking the machine. The machine can be raised for service at the designated locations. Use a hoist or jack that will support the weight of the machine. Always stop the machine on a flat, level surface and block the tires before jacking up the machine.

**FOR SAFETY: Before leaving or servicing machine, stop on level surface, set parking brake, turn off machine, and remove key.**

The front jacking locations are on the flat bottom edge of the front of the machine frame next to the front tires.



The rear jacking location is the center of the rear bumper.

**FOR SAFETY: When servicing machine, block machine tires before jacking up machine.**

**FOR SAFETY: When servicing machine, jack up machine at designated locations only. Block machine up with jack stands.**



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### STORING MACHINE

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Before storing the machine for an extended period of time, the machine needs to be prepped to lessen the chance of rust, sludge, and other undesirable deposits from forming. Contact TENNANT service personnel.

#### TO STORE MACHINE UP TO 30 DAYS

1. Dump the debris hopper.
2. Change engine oil.
3. Raise the main brush and side brush.
4. Park the machine on a level surface in a cool, dry area.
5. Stop the engine and set the machine parking brake.
6. Check the hydraulic fluid level. It should be up to the FULL mark on the dipstick to prevent excessive condensation from forming in the reservoir.

**TO STORE MACHINE 30 TO 90 DAYS**

1. All of the above plus the following:
2. **GAS/LP MACHINES:**  
Remove the spark plugs.
3. Pour 90 cc (3 oz) of clean engine oil into each spark plug hole.
4. Remove the ignition coil high tension wire.  
Operate the engine starter motor for at least a dozen revolutions. This distributes the oil over the cylinder walls.

*NOTE: Before preparing the engine for storage, allow it to cool down to the surrounding temperature. Oil adheres to cold metal surfaces much better than hot surfaces.*

5. Replace the high tension coil wire and spark plugs.
6. Drain the gasoline from the carburetor.

**TO STORE MACHINE FOR MORE THAN 90 DAYS**

1. All of the above plus the following:
2. Drain the engine oil from the engine oil pan.
3. Drain the coolant from the radiator and engine block.
4. Close the engine cooling system drain cocks.
5. Drain gasoline from the carburetor, fuel tank, and the fuel lines.
6. Seal the air cleaner inlet and the exhaust outlet with weatherproof masking tape.
7. Tighten the engine oil filler cap, the fuel tank cap, and the radiator cap to make certain they are securely in place.

## HARDWARE INFORMATION

The following charts state standard plated hardware tightening ranges for normal assembly applications. Decrease the specified torque by 20% when using a thread lubricant. Do not substitute lower grade hardware for higher grade hardware. If higher grade hardware than specified is substituted, tighten only to the specified hardware torque value to avoid damaging the threads of the part being threaded into, as when threading into speed nuts or weldments.

### STANDARD BOLT TORQUE CHART

Thread Size	SAE Grade 5 Torque ft lb (Nm)	SAE Grade 8 Torque ft lb (Nm)
0.25 in	7-10 (9-14)	10-13 (14-38)
0.31 in	15-20 (20-27)	20-26 (27-35)
0.38 in	27-35 (37-47)	36-47 (49-64)
0.44 in	43-56 (58-76)	53-76 (72-103)
0.50 in	65-85 (88-115)	89-116 (121-157)
0.62 in	130-170 (176-231)	117-265 (159-359)
0.75 in	215-280 (291-380)	313-407 (424-552)
1.00 in	500-650 (678-881)	757-984 (1026-1334)

*NOTE: Decrease torque by 20% when using a thread lubricant.*

### METRIC BOLT TORQUE CHART





Thread Size	Class 8.8 Torque ft lb (Nm)	Class 10.9 Torque ft lb (Nm)
M4	2 (3)	3 (4)
M5	4 (5)	6 (8)
M6	7 (9)	10 (14)
M8	18 (24)	25 (34)
M10	32 (43)	47 (64)
M12	58 (79)	83 (112)
M14	94 (127)	133 (180)
M16	144 (195)	196 (265)
M20	260 (352)	336 (455)
M24	470 (637)	664 (900)

*NOTE: Decrease torque by 20% when using a thread lubricant.*

Exceptions to the above chart:

Check the machine for exceptions!

### BOLT IDENTIFICATION

Identification Grade Marking	Specification and Grade
	SAE-Grade 5
	SAE-Grade 8
	ISO-Grade 8.8
	ISO-Grade 10.9

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### THREAD SEALANT AND LOCKING COMPOUNDS

Thread sealants and locking compounds may be used on this machine. They include the following:

Loctite 515 sealant - gasket forming material. TENNANT Part No. 75567, 15 oz (440 ml) cartridge.

Loctite 242 blue - medium strength thread locking compound. TENNANT Part No. 32676, 0.5 ml tube.

Loctite 271 red - high strength thread locking compound. TENNANT Part No. 19857, 0.5 ml tube.

## HYDRAULIC FITTING INFORMATION

HYDRAULIC TAPERED PIPE FITTING (NPT)  
TORQUE CHART

*NOTE: Ratings listed are when using teflon thread seal.*

Size	Minimum Torque	Maximum Torque
1/4 NPT	10 ft lb (14 Nm)	30 ft lb (41 Nm)
1/2 NPT	25 ft lb (34 Nm)	50 ft lb (68 Nm)
3/4 NPT	50 ft lb (68 Nm)	100 ft lb (136 Nm)

HYDRAULIC TAPERED SEAT FITTING (JIC)  
TORQUE CHART

Tube O.D. (in)	Thread Size	Maximum Torque
0.25	0.44-20	9 ft lb (12 Nm)
0.38	0.56-18	20 ft lb (27 Nm)
0.50	0.75-16	30 ft lb (41 Nm)
0.62	0.88-14	40 ft lb (54 Nm)
0.75	1.12-12	70 ft lb (95 Nm)
1.0	1.31-12	90 ft lb (122 Nm)

HYDRAULIC O-RING FITTING TORQUE  
CHART

Tube O.D. (in)	Thread Size	Minimum Torque	Maximum Torque
0.25	0.44-20	6 ft lb (8 Nm)	9 ft lb (12 Nm)
0.38	0.56-18	13 ft lb (18 Nm)	20 ft lb (27 Nm)
		*10 ft lb (14 Nm)	12 ft lb (16 Nm)
0.50	0.75-16	20 ft lb (27 Nm)	30 ft lb (41 Nm)
		*21 ft lb (28 Nm)	24 ft lb (33 Nm)
0.62	0.88-14	25 ft lb (34 Nm)	40 ft lb (54 Nm)
0.75	1.12-12	45 ft lb (61 Nm)	70 ft lb (95 Nm)
1.0	1.31-12	60 ft lb (81 Nm)	90 ft lb (122 Nm)

*NOTE: Do not use sealant on o-ring threads.*

\*Aluminum bodied components

## MACHINE TROUBLESHOOTING

Problem	Cause	Remedy
Excessive dusting	Vacuum fan off	Move vacuum and filter shaker lever to <b>Vacuum fan on</b> position
	Brush skirts and dust seals worn, damaged, out of adjustment	Replace or adjust brush skirts or dust seals
	Hopper dust filter clogged	Shake and/or clean or replace dust filter
	Vacuum hose damaged	Replace vacuum hose
	Vacuum fan failure	Contact TENNANT service personnel
	Thermo Sentry™ tripped	Reset Thermo Sentry™
	Hopper door partially or completely closed	Open hopper door
Poor sweeping performance	Brush bristles worn	Replace brushes
	Main and side brushes not adjusted properly	Adjust main and side brushes
	Debris caught in main brush drive mechanism	Remove debris from the drive mechanism.
	Main brush drive failure	Contact TENNANT service personnel
	Side brush drive failure	Contact TENNANT service personnel
	Hopper full	Empty hopper
	Hopper lip skirts worn or damaged	Replace lip skirts
	Hopper door partially or completely closed	Open hopper door
	Wrong sweeping brush	Contact TENNANT representative for recommendations
	Recirculation flap damaged	Replace flap

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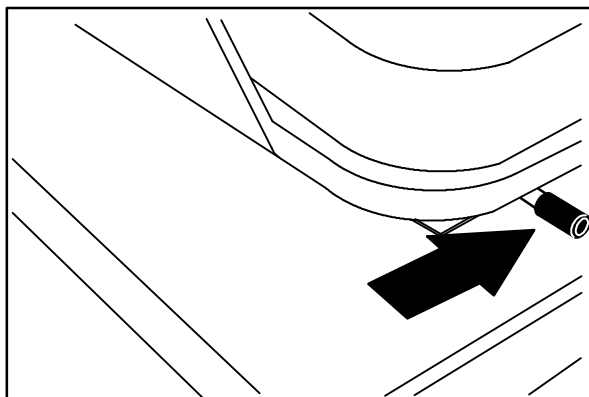


**INTRODUCTION**

This section includes information on the main chassis related components for example the seat, steering, brakes and tires.

### SEAT

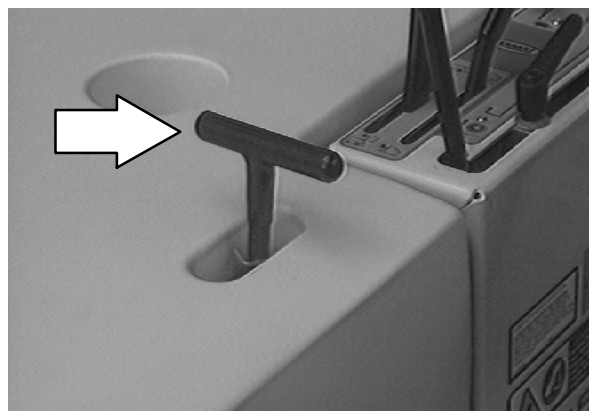
The seat assembly is removable on the model 6400. The seat can also be adjusted forward and backward using the handle on the front of the right hand seat bracket.



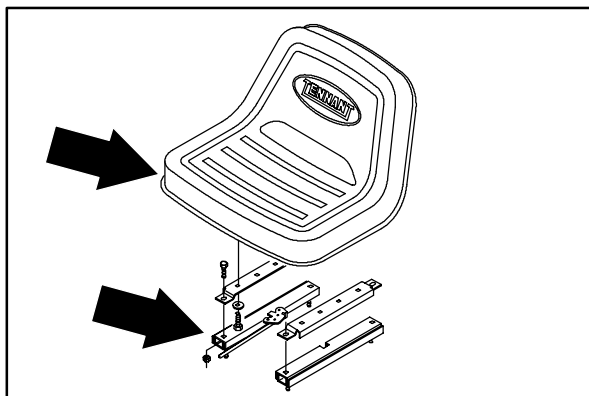
### TO REPLACE OPERATOR SEAT

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

1. Tilt the seat shroud back against the support cable.

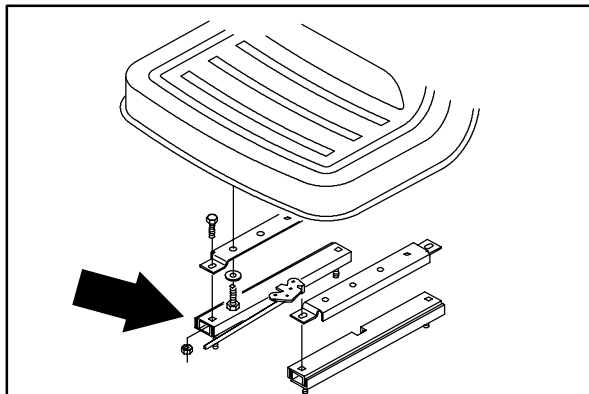


2. Remove the four hex nuts holding the seat brackets to the seat shroud.

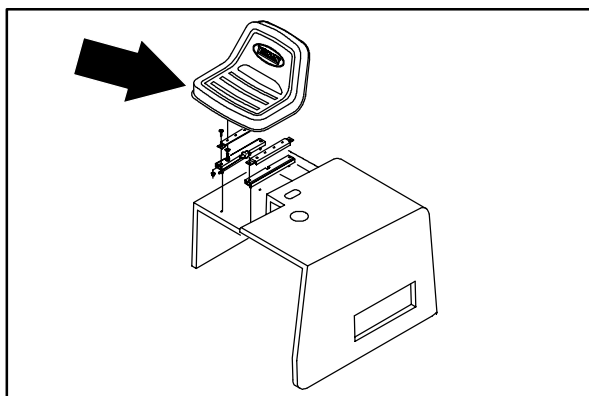


3. Remove the seat assembly from the seat shroud.

4. Remove the two seat brackets from the bottom of the old seat. Note the orientation of the brackets.
5. Install the two seat brackets on the bottom of the new seat.



6. Position the new seat and brackets on the seat shroud. Line up the holes and install the hardware. Tighten the hex screws to 18.5 - 24Nm (15 - 20 ft lb).

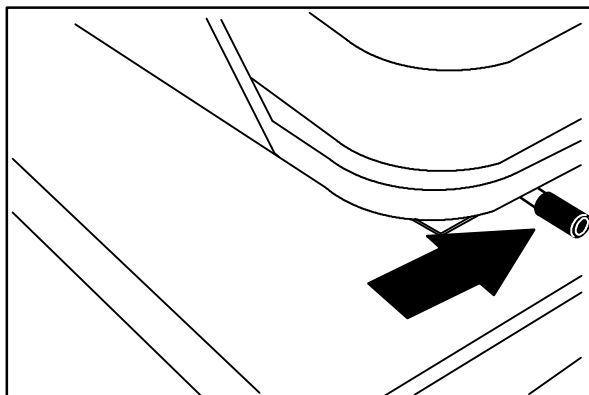


7. Close the seat shroud and adjust the seat to a comfortable position.

### TO ADJUST SEAT POSITION

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

1. While sitting on the seat, reach under the front right corner and grasp the lock lever.
2. Move the lock lever to the left until the seat moves freely.
3. Slide the seat forward or backward to a comfortable position. Release the lock lever.
4. The seat is now locked in the chosen position.



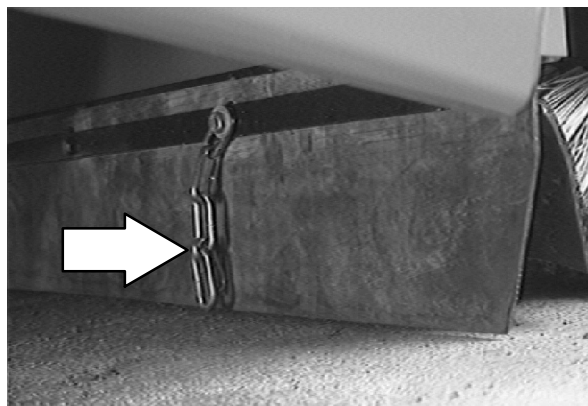
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### STATIC DRAG CHAIN

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The static drag chain prevents build up of static electricity in the machine. The chain is attached near the rear of the brush compartment skirts.

The chain should be in contact with the floor at all times.

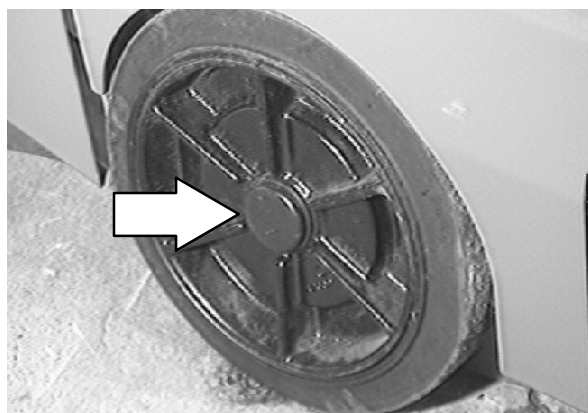


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## FRONT TIRES AND WHEELS

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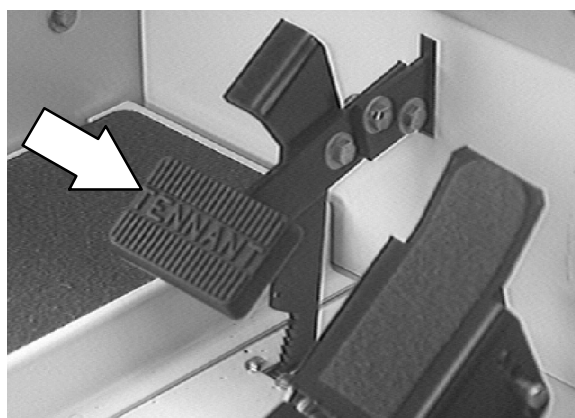
The machine front tires are solid. Inspect the front wheel bearings for seal damage.



### TO REPLACE FRONT WHEEL BEARINGS

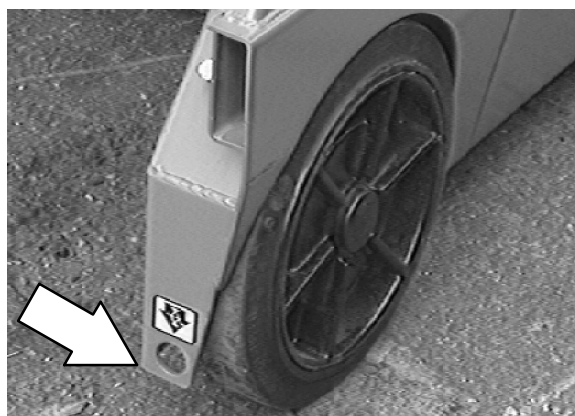
**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

1. Disengage the parking brake if activated.

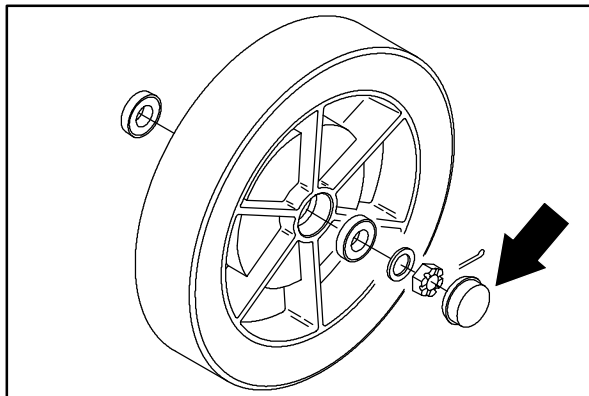


2. Jack up one front corner of the machine.  
Place jack stands under machine frame.

**FOR SAFETY: Block machine tires before jacking machine up. Jack machine up at designated locations only. Block machine up with jack stands.**

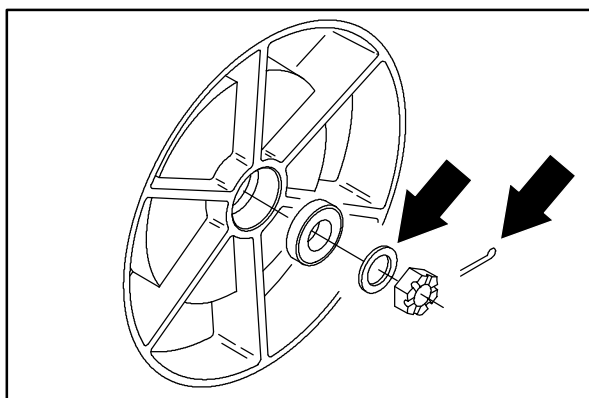


3. Remove the hub cap in the center of front wheel.



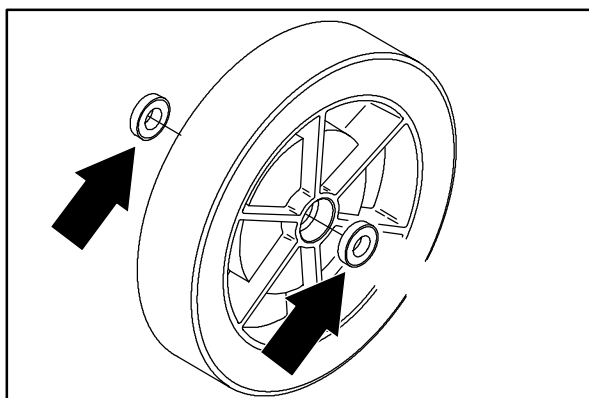
4. Remove the cotter pin, slotted nut, and flat washer.

5. Slide the wheel off the axle.



6. Press the old bearings out. Press the new bearings in the wheel in the same orientation.

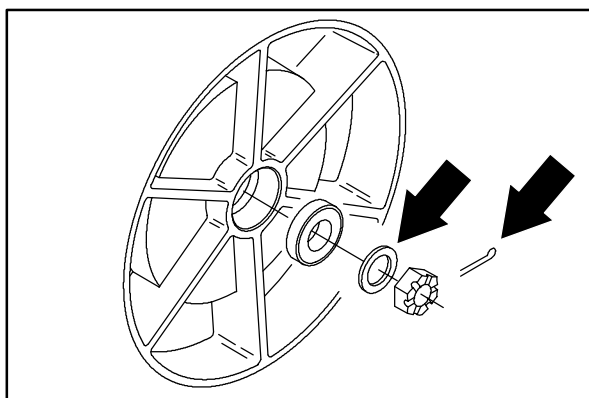
7. Slide the wheel back on the axle.



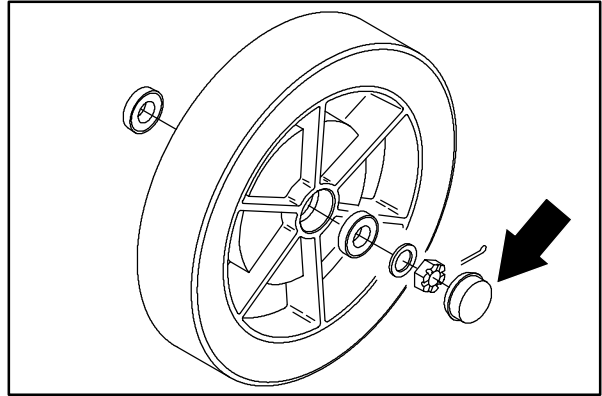
8. Slide the flat washer and nut on the shaft.

9. Tighten the nut with a hand wrench until the wheel binds, then back the nut off to nearest cotter pin hole.

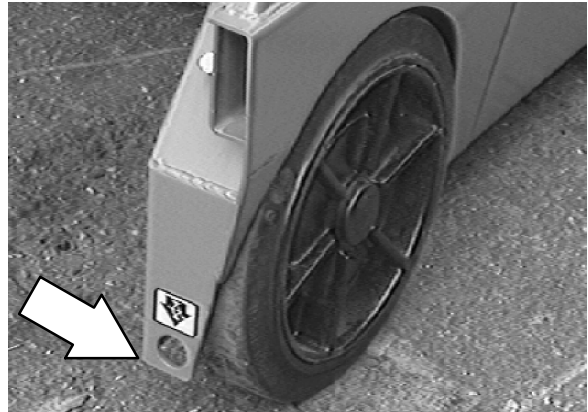
10. Insert a new cotter pin through nut and hole.



11. After making sure the wheel spins freely, carefully reinstall the hub cap.



12. Remove the jackstands and lower the machine.



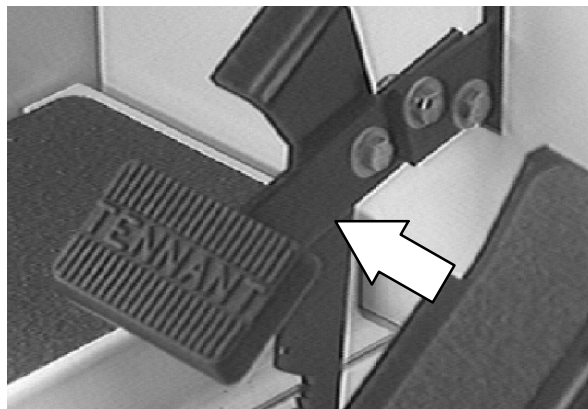
13. Repeat the procedure on the other wheel.

### BRAKES AND TIRES

#### SERVICE BRAKES

The mechanical service brakes are located on the front wheels. The brakes are operated by the foot brake pedal and connecting rods.

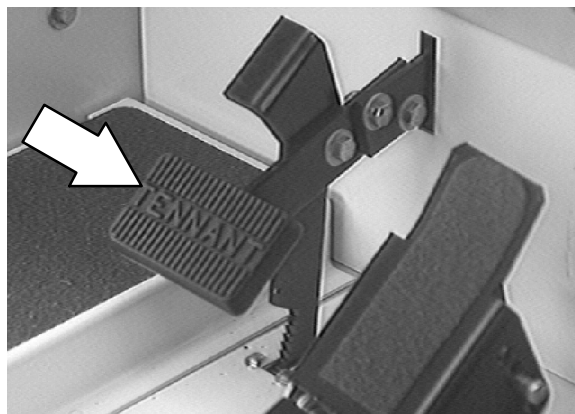
Check the brake adjustment every 200 hours of operation. The brake pedal should not travel more than 2 inches to fully engage the brakes.



#### TO REPLACE BRAKE SHOES

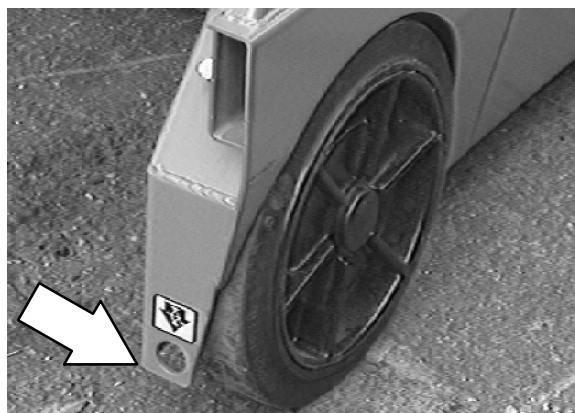
**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

1. Disengage the parking brake if activated.



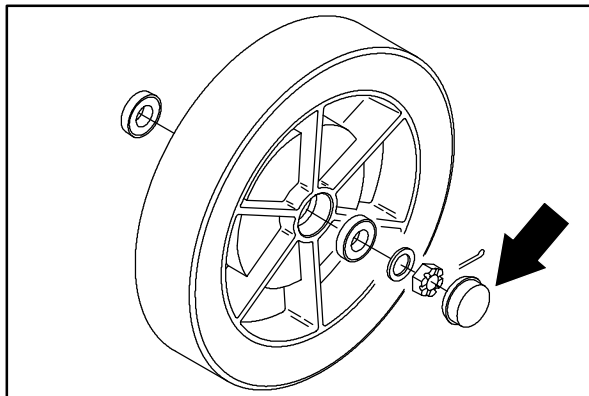
2. Jack up one front corner of the machine.  
Place jack stands under machine frame.

**FOR SAFETY: Block machine tires before jacking machine up. Jack machine up at designated locations only. Block machine up with jack stands.**



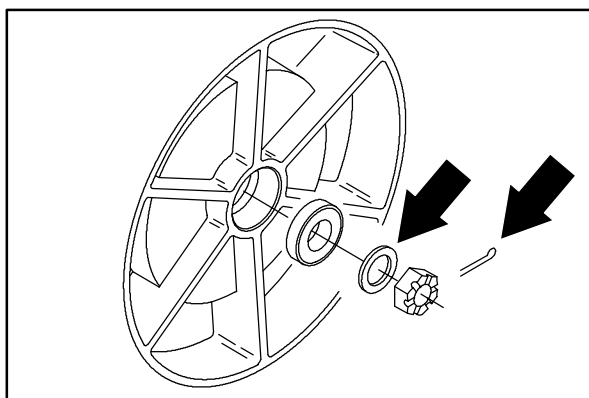


3. Remove the hub cap in the center of front wheel.



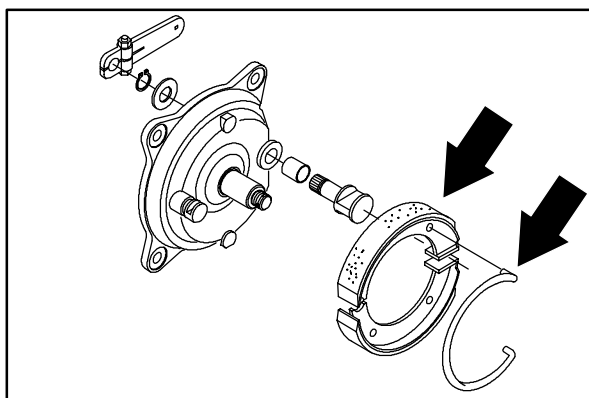
4. Remove the cotter pin, slotted nut, and flat washer.

5. Slide the wheel off the axle.



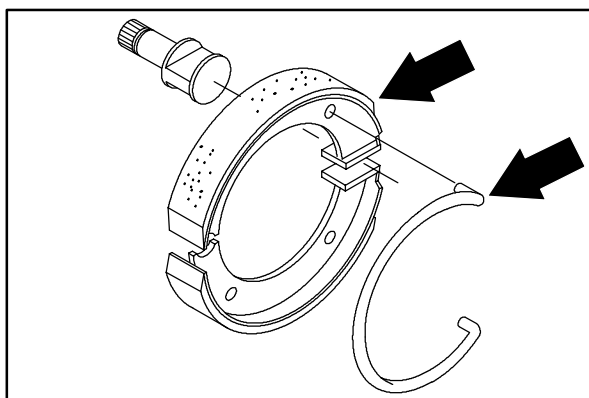
6. Remove the one large "C" shaped tension spring holding the old brake shoes together. Remove the old brake shoes.

7. Replace the old brake shoes with new brake shoes.



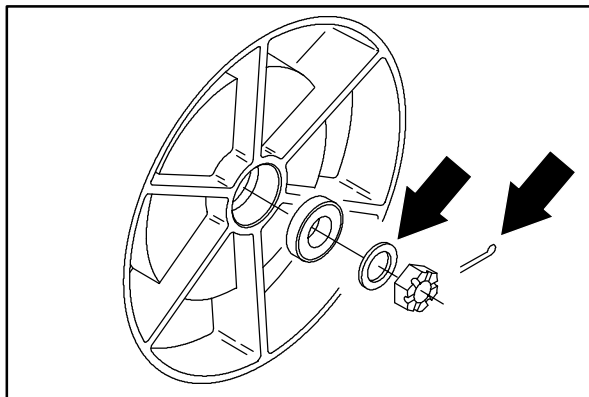
8. Reinstall the one large "C" shaped brake tension spring on the new brake shoes.

9. Slide the wheel back on the axle.

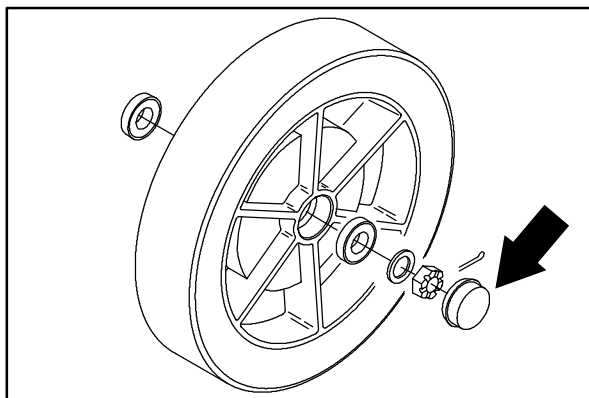


## CHASSIS

10. Reinstall the flat washer and nut on the axle shaft.
11. Tighten the nut with a hand wrench until the wheel binds, then back the nut off to nearest cotter pin hole.
12. Insert a new cotter pin through nut and hole.



13. After making sure the wheel spins freely, carefully reinstall the hub cap.



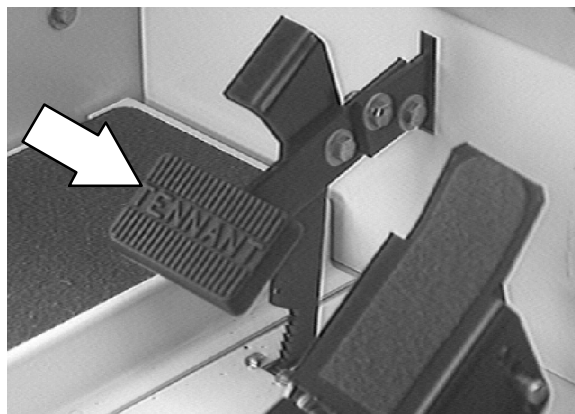
14. Remove the jackstands and lower the machine.



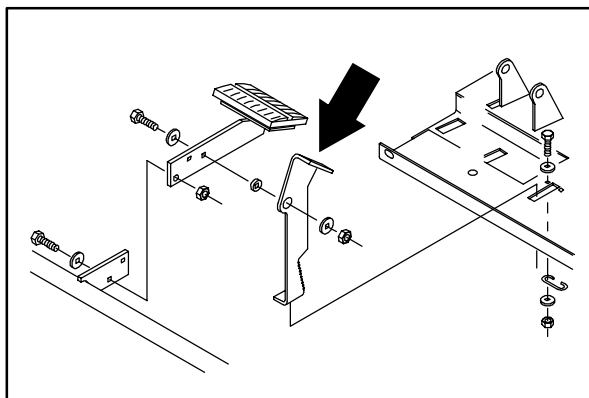
15. Repeat the procedure on the other wheel.

## PARKING BRAKE

The parking brake is set with the parking brake lever that activates the service brakes.



Adjust the parking brake whenever it becomes very easy to set, when the machine rolls after setting the parking brake, and after every 200 hours of operation. The parking brake may be tightened by adjusting the brake rod clevis on the ends of the brake cross shaft. See TO ADJUST BRAKES instructions. Adjust the parking brake so it will hold the Machine on a smooth 8 degree incline. The brake pedal should not travel more than 2 inches to fully engage the brakes.



### TO ADJUST BRAKES

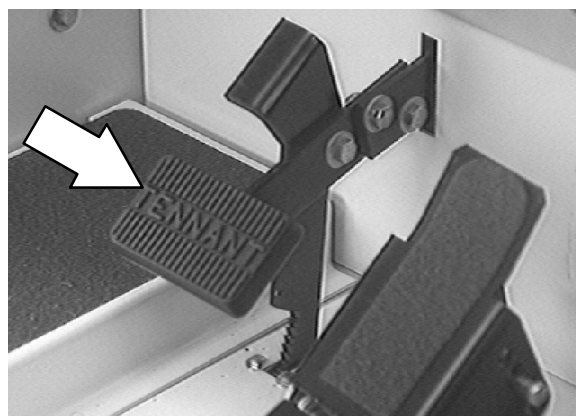
**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

1. Raise the hopper and engage the support bar.

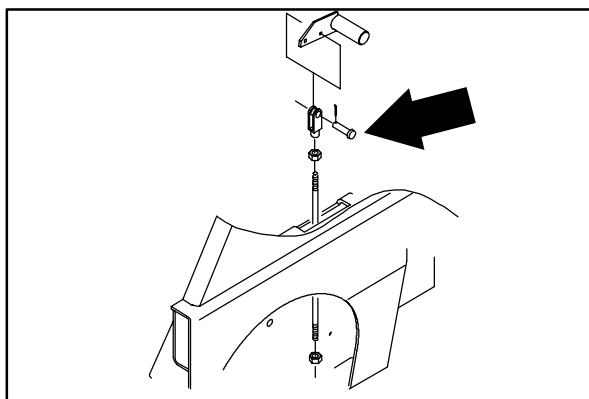


2. Disengage the parking brake if activated.

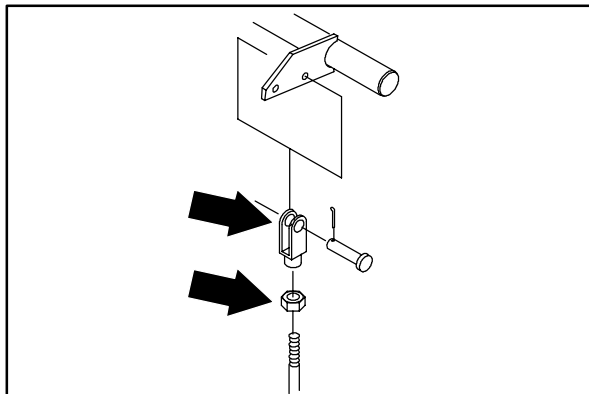
**FOR SAFETY: Block machine tires before jacking machine up. Jack machine up at designated locations only. Block machine up with jack stands.**



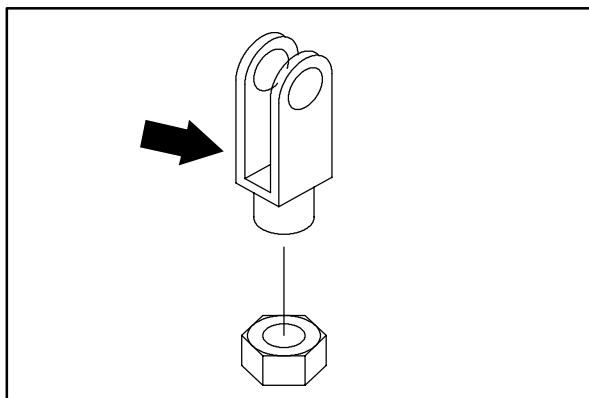
3. Remove the cotter pin and the clevis pin holding the brake rod clevis to the brake assembly lever.



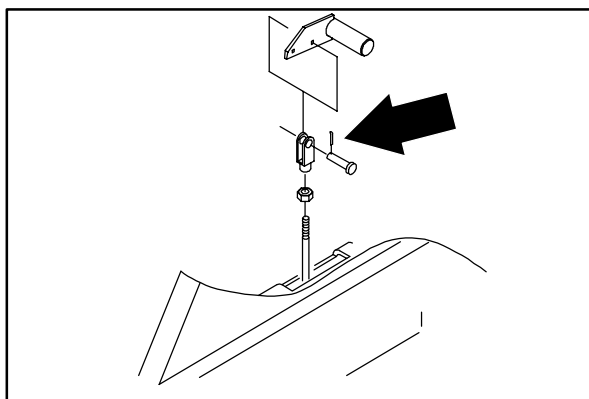
4. Loosen the jam nut on the brake rod.



5. Turn the clevis in or out to achieve proper adjustment and pedal travel. The pedal should move no more than 1" before engaging the brakes.

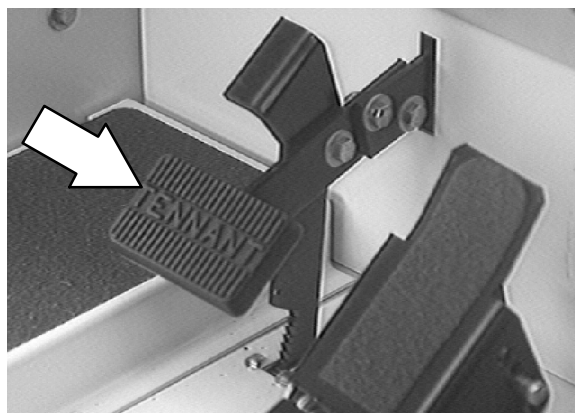


6. Reinstall the cotter pin and the clevis pin in the brake rod clevis and the brake assembly lever.



7. Repeat the procedure on both sides.

8. Drive the machine and operate the brakes. Check for equal engagement of the brakes on both wheels.



### REAR TIRE AND WHEEL, AND WHEEL SUPPORT

The standard rear machine tire is pneumatic. The rear wheel support pivots the rear wheel. It consists of the rear tire and drive motor. The support has one grease fitting for the bearings. The rear wheel support bearings must be lubricated every 200 hours of operation. Use Lubriplate EMB grease (TENNANT part no. 01433-1).

Check the rear tire pressure every 100 hours of operation. The proper tire air pressure is  $790 \pm 35$  kPa ( $115 \pm 5$  psi).

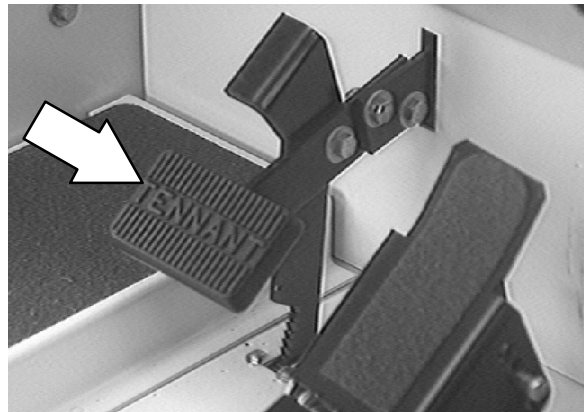
Torque the rear wheel nuts in a star pattern to 122 to 150 Nm (90 to 110 ft lb) after the first 50-hours of operation, and every 800 hours thereafter.



### TO REPLACE REAR WHEEL HOUSING PIVOT BEARINGS

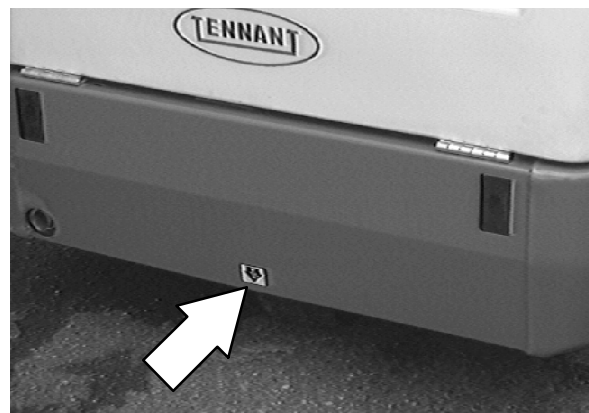
**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

1. Engage parking brake, block front tires.



2. Jack up rear of machine. Use jack stands to support machine.

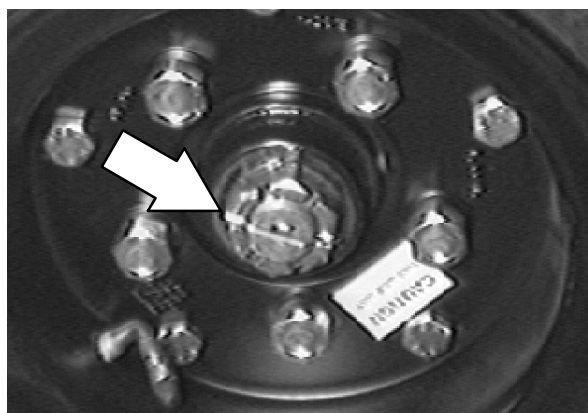
**FOR SAFETY: Block machine tires before jacking machine up. Jack machine up at designated locations only. Block machine up with jack stands.**



3. Remove the rear tire and wheel assembly from the drive motor hub.

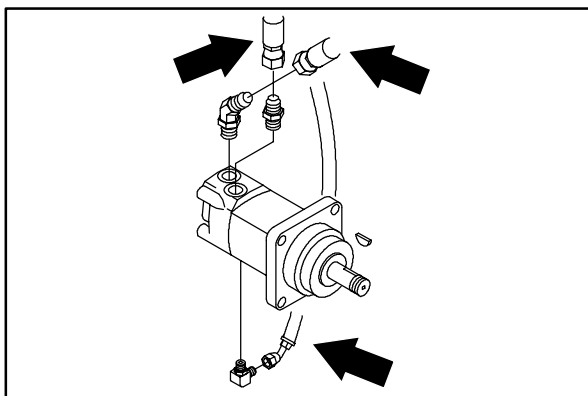


4. Remove the cotter pin and slotted nut from drive wheel shaft.
5. Use a puller to remove the drive hub from the tapered motor shaft.

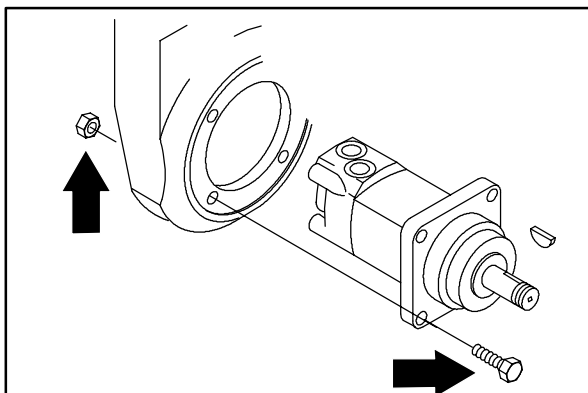


6. Disconnect the hydraulic hoses from the drive motor.

*NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.*

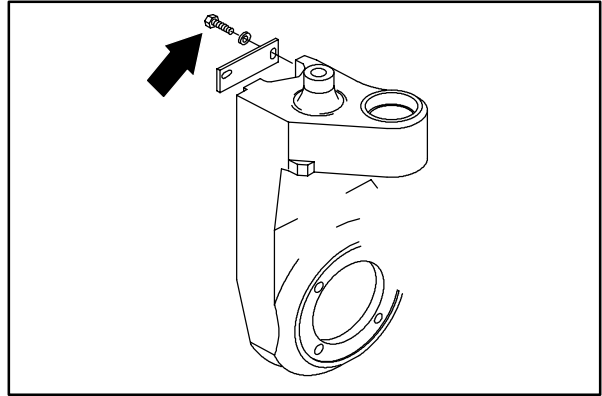


7. Remove the rear drive motor mounting bolts.
8. Slide the rear drive motor out of the wheel housing.

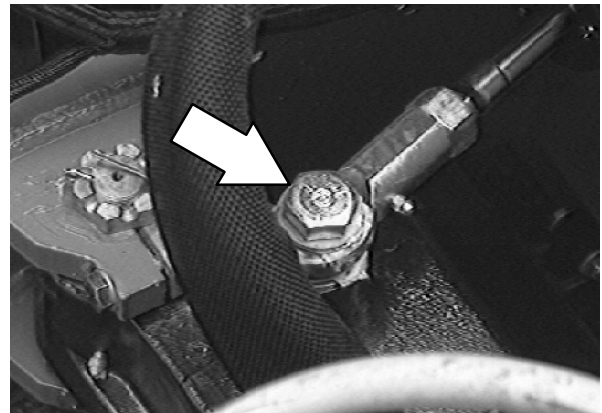


## CHASSIS

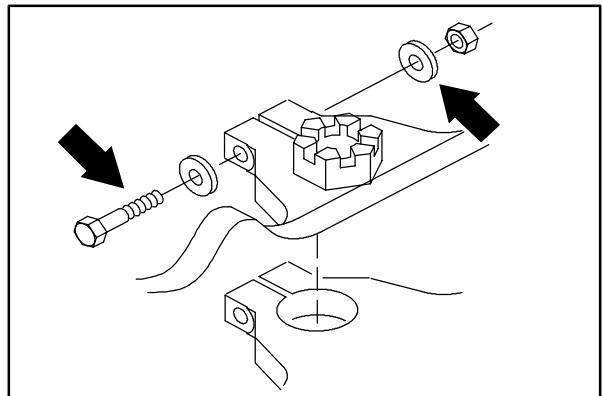
9. Remove the hydraulic hose clamp from the wheel housing.



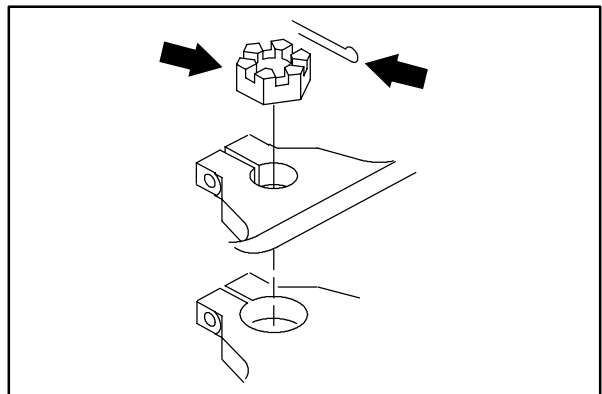
10. Remove the hex screw and nyloc nut attaching the rod end of steering cylinder to rear wheel housing.



11. Loosen the two socket head bolts holding the drive housing pivot pin in the frame.

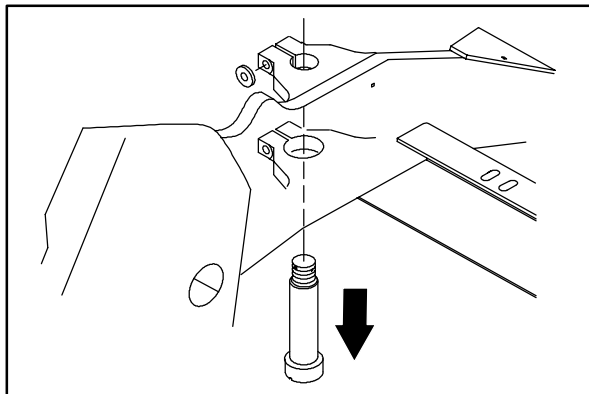


12. Remove the cotter pin from the large slotted nut on top of the rear housing pivot pin. Remove the slotted nut.



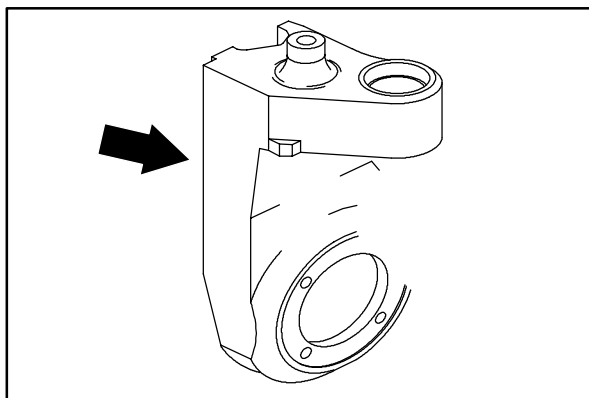


13. Drop the pivot pin down and out of the machine.

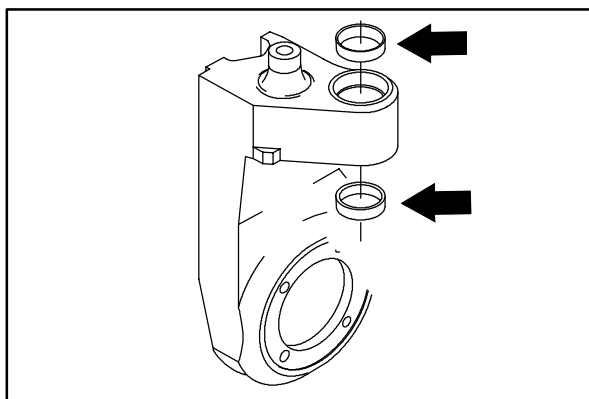


14. Slide the wheel housing out of the main frame.

*NOTE: Make sure to retain the thrust washer from on top of the upper bearing cone.*

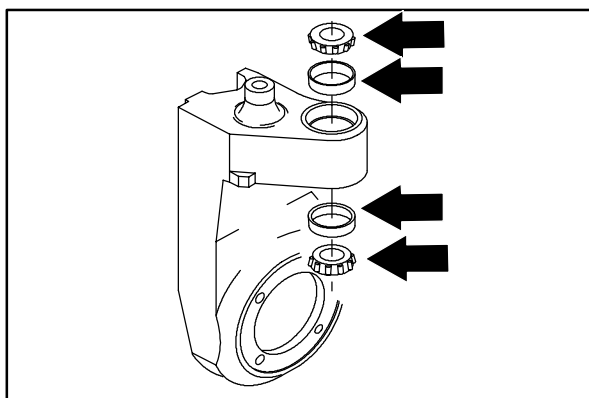


15. Replace the pressed in bearing cups.

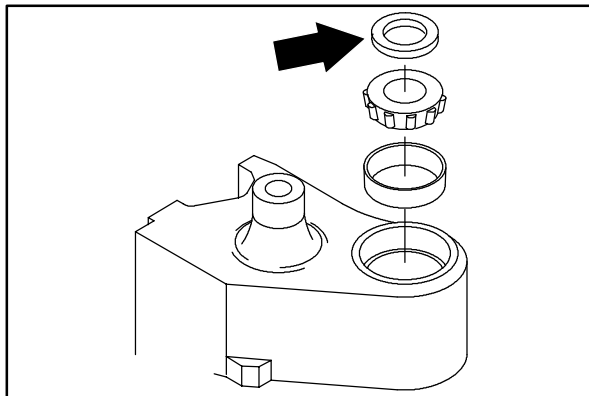


16. Pack the new bearing cones with Lubriplate EMB grease. Coat the bearing cups with grease.

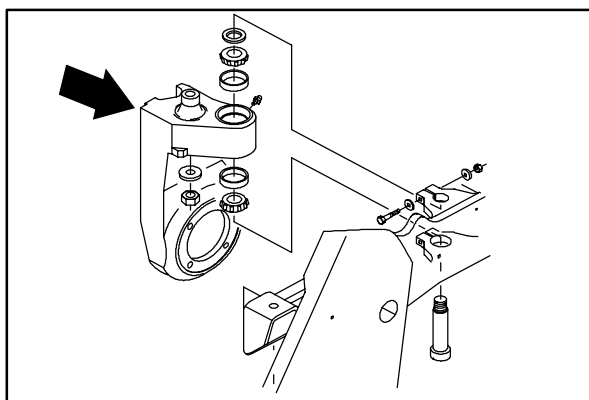
17. Position the bearings in the housing.



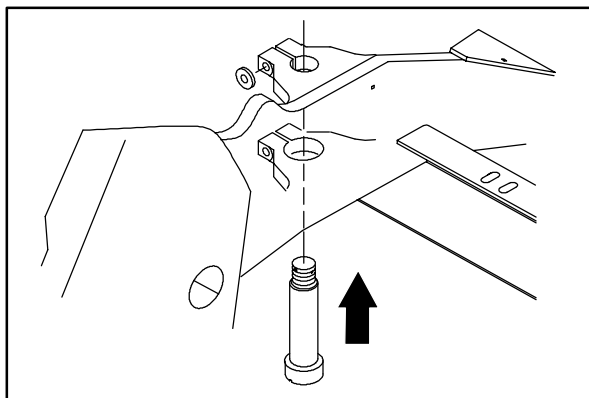
18. Position the thrust washer on top of the upper bearing cone.



19. Slide the wheel housing in position in main frame.



20. Slide the pivot pin up through the frame hole.



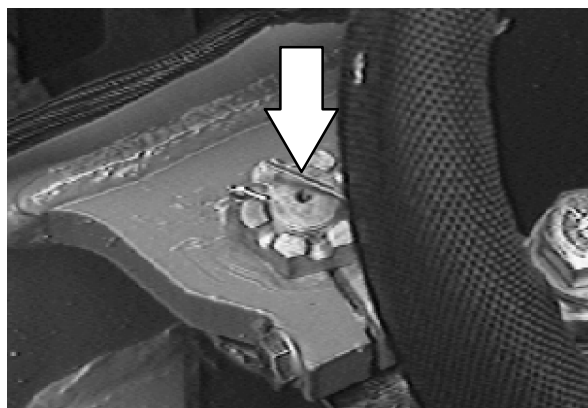
21. Thread castle nut on the pin. Tighten to 34 - 40 Nm (25 - 30 ft lb). Check for any play. If the pin is not seated, tap with rubber mallet and re-torque castle nut.



22. Torque the top socket screw with hand torque wrench to 100 – 115 Nm (73–85 ft lb).

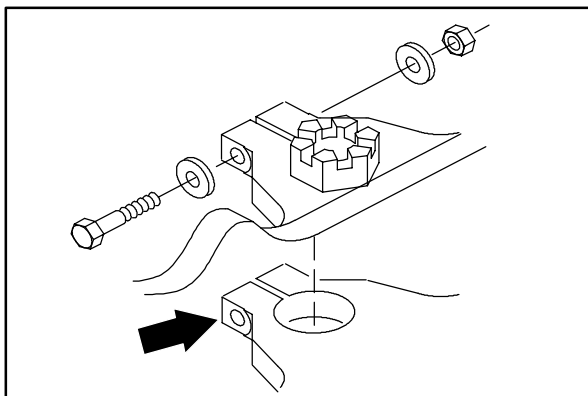


23. Tighten the castle nut to next slot and insert the cotter pin. Torque not to exceed 100 Nm (75 ft lb).

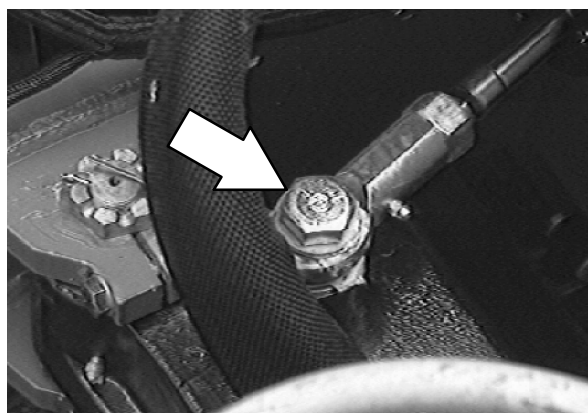


24. Check the wheel housing to see if it rocks or binds. If it does, loosen the top socket screw, move the casting to seat bearing, and re-tighten socket screw to 100 – 115 Nm (73–85 ft lb).

25. Tighten the lower socket screw to 100 – 115 Nm (73–85 ft lb).

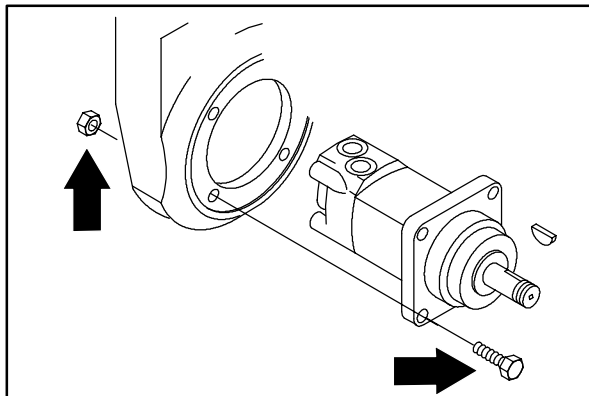


26. Re-connect the rod end of the steering cylinder to the wheel housing using the .750x3.25 hex screw, nyloc nut, and flat washers. Tighten to 270 – 300 Nm (200 – 220 ft lb).

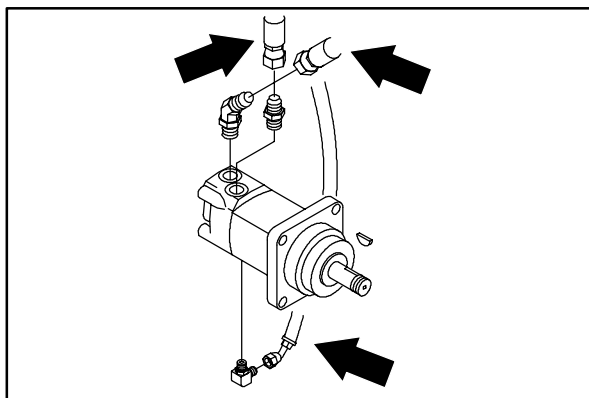


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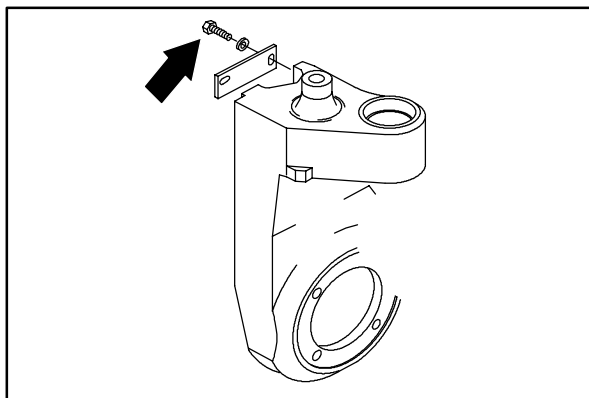
27. Slide the drive motor in the wheel housing.  
Note the motor orientation.
28. Thread the four hex screws through the wheel housing and into the motor. Tighten to 88–115 Nm (65–85 ft lb).



29. Reconnect the hydraulic hoses. See schematic in the HYDRAULICS section.

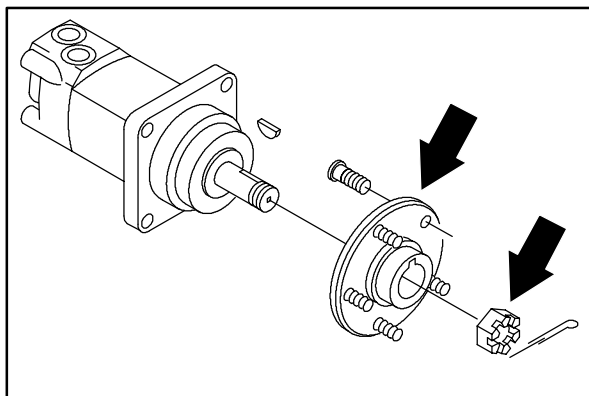


30. Reinstall the hose clamp to the wheel housing. Tighten the hex screws to 18.5 – 24Nm (15 – 20 ft lb).



31. Mount the hub to the tapered motor shaft.  
Tighten the slotted nut to (250 ft lb).  
Install the cotter pin.

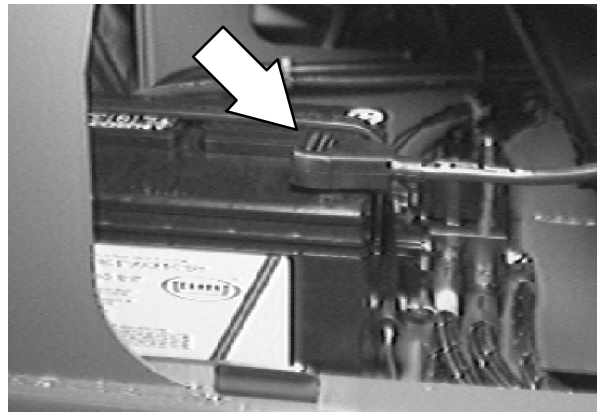
**NOTE:** Make sure the key is installed on the tapered shaft of the drive motor.



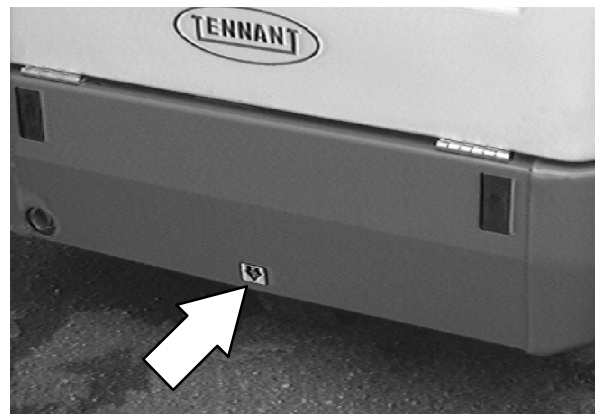
32. Install the rear tire and wheel assembly.  
Torque the rear wheel nuts to 122 – 150 Nm  
(90 – 110 ft lb).



33. Re-connect the battery cables and start the engine. Run the propelling in both directions. Check for any leaks.



34. Remove the jack stands and lower the machine to the ground.



35. Operate the machine. Check the rear drive for proper operation.



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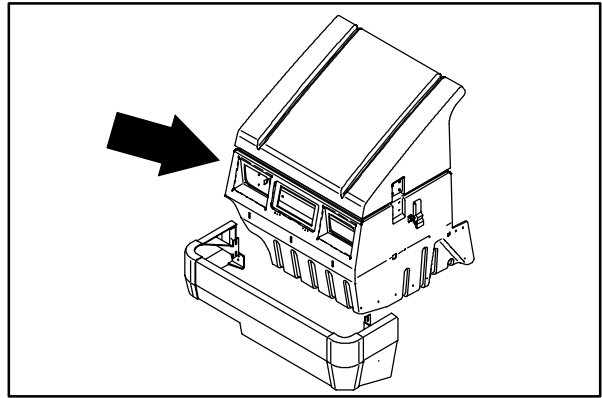


**INTRODUCTION**

This section includes information on the sweeping operation. The side brush sweeps debris in front of the machine and the main brush sweeps the debris into the hopper. The vacuum fan pulls air from the hopper and through the dust filter.

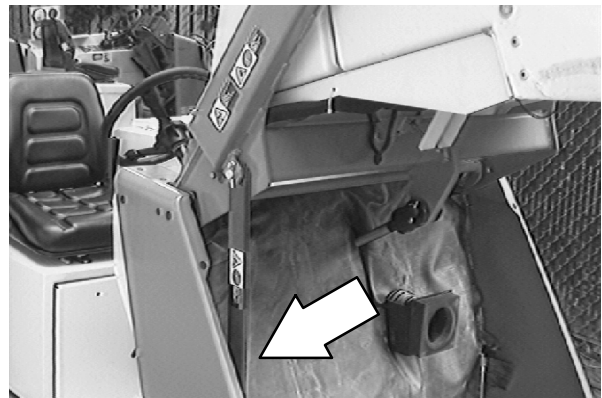
## **DEBRIS HOPPER**

The debris hopper collects the debris swept up by the machine. The hopper includes the following main components: hopper dust filter, Thermo Sentry, hopper dump door, and dust skirts. All adjustments have been made at the factory and require no regular maintenance. If hopper components are repaired or replaced, some components may need to be readjusted for best performance. The hopper may need to be removed from the machine for some repair or service work.

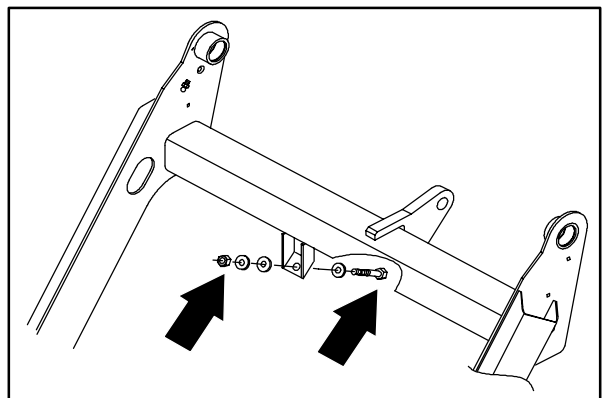


### **TO REMOVE HOPPER**

1. Start the machine and raise the hopper. Engage the support bar.

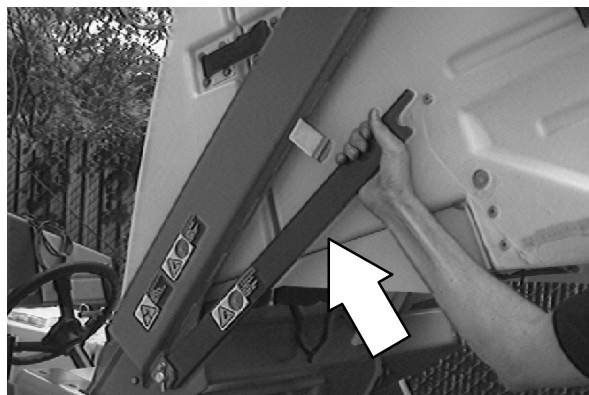


2. Remove the hopper level adjustment bolt, nut, and washers.
3. Cut the plastic ties holding the hopper harness to the main harness.
4. Disconnect the battery cables.



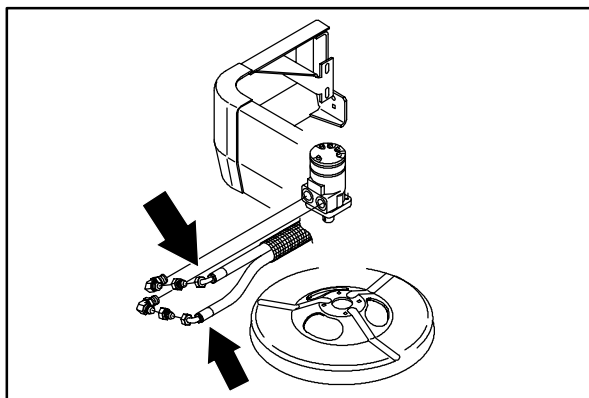
5. Disengage the hopper support bar and lower the hopper. Place (two) 2-3/4 " blocks under the hopper.

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

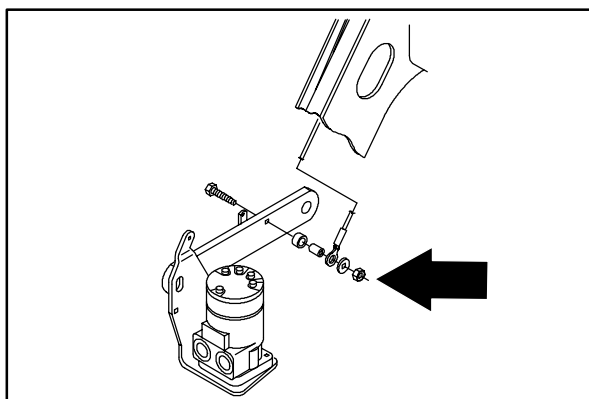


6. Disconnect the hydraulic hoses leading to the side brush motor.

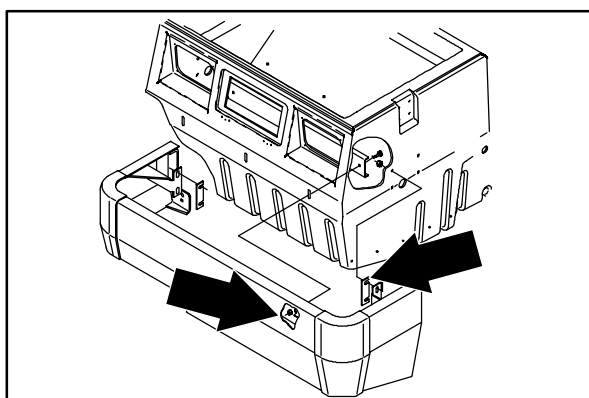
*NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.*



7. Disconnect the side brush lift cable at the hydraulic motor.

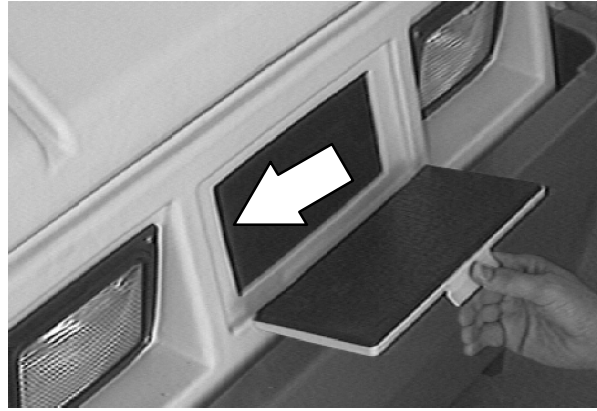


8. Remove the four hex screws holding the hopper bumper to the sides of the hopper.

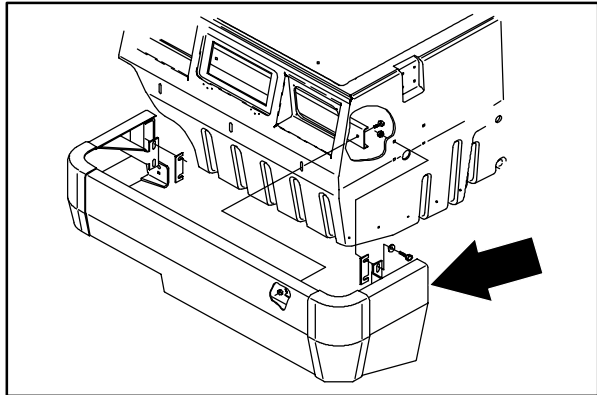


## SWEEPING

9. Reach in through the access door in the front of the hopper and remove the three hex screws holding the bumper to the front of the hopper.

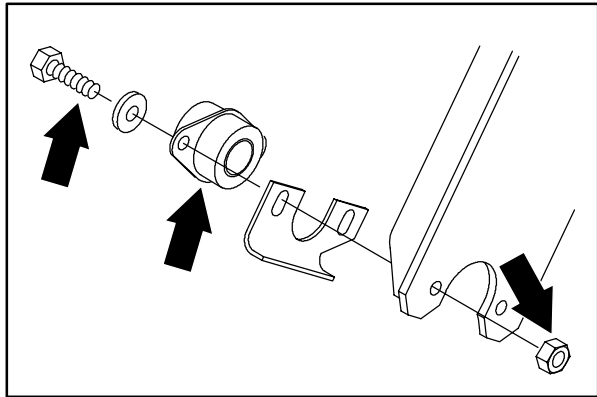


10. Remove the bumper and side brush assembly from the machine.



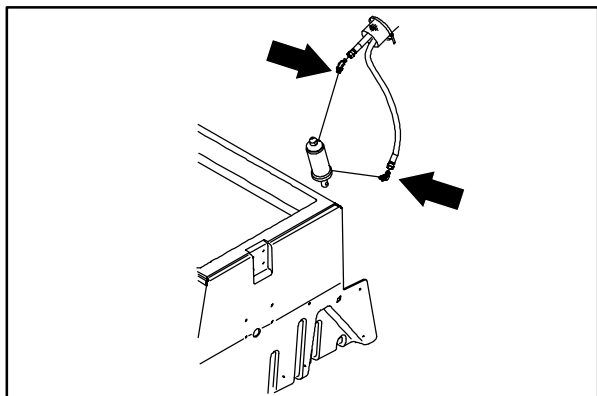
11. Remove the two hex screws and nyloc nuts holding the pivot bearings to each side of the hopper lift arm.

12. The hopper can now be pulled away from the machine.



13. Disconnect and plug the hydraulic hoses leading to the hopper dump door cylinder.

14. The hopper can now be removed from the machine.

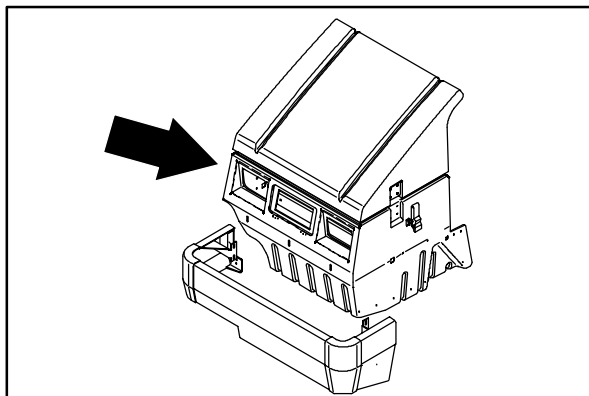


**TO INSTALL HOPPER**

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

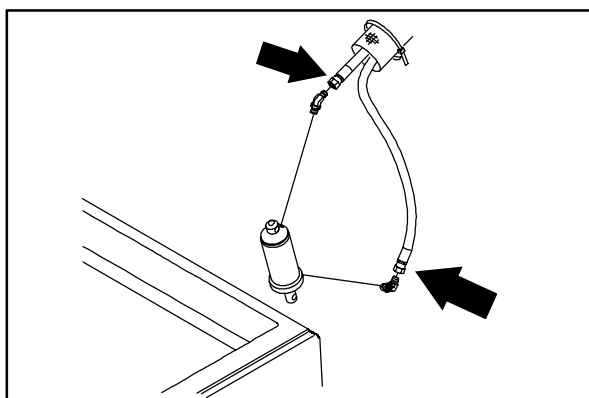
1. Position the hopper in front of machine.  
Make sure the hopper is sitting on (two) 2-3/4 " blocks.

*NOTE: Be careful not to pinch hydraulic hoses or electrical wires during this procedure.*

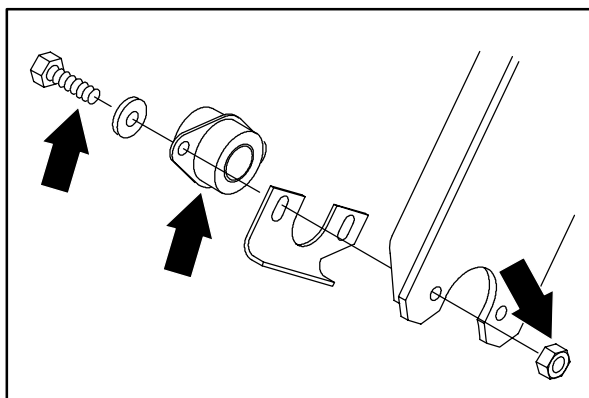


2. Reconnect the hydraulic hoses to the dump door cylinder. See the schematic in the HYDRAULICS section of this manual for proper hose connections.

*NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.*

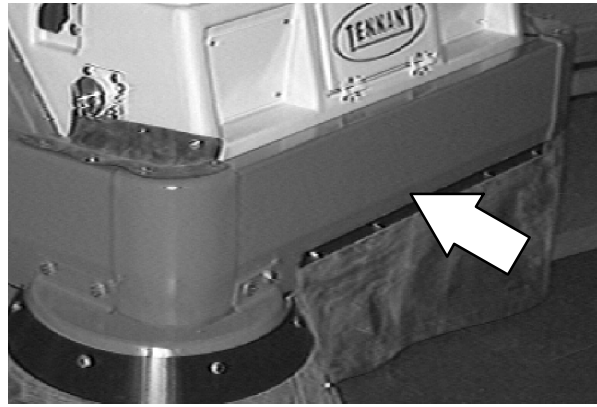


3. Line up the holes in the hopper pivot bearing flanges with the holes in the hopper lift arms. Install the four hex screws and nyloc nuts. Tighten to 18 - 24 Nm (15 - 20 ft lb).

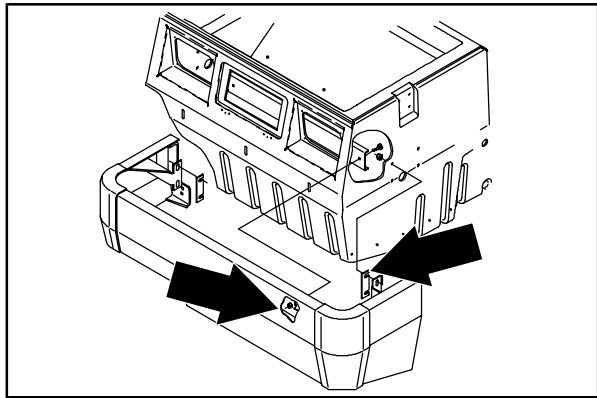


## SWEEPING

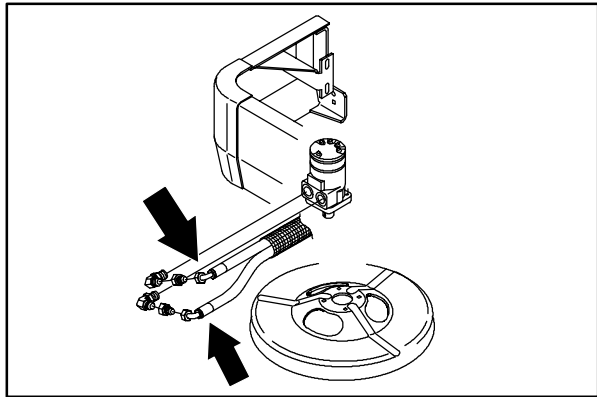
4. Position the side brush and front bumper assembly on the front of the hopper.



5. Line up the holes in the front and on the side of the hopper with the holes in the bumper assembly. Install the seven hex screws and tighten to 18 - 24 Nm (15 - 20 ft lb).



6. Reconnect the hydraulic hoses to the side brush motor. See the schematic in the HYDRAULICS section of this manual for proper hose connections.

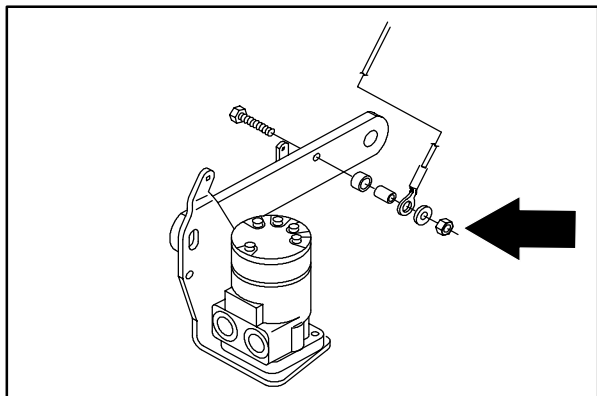


7. Reconnect the side brush lift cable at the side brush assembly.

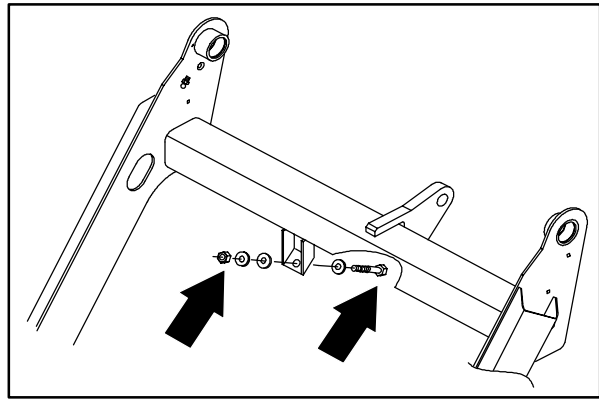
8. Reconnect the hopper harness to the main harness.

9. See the schematic in the ELECTRICAL section of this manual for proper harness connections.

10. Reconnect the battery cables.



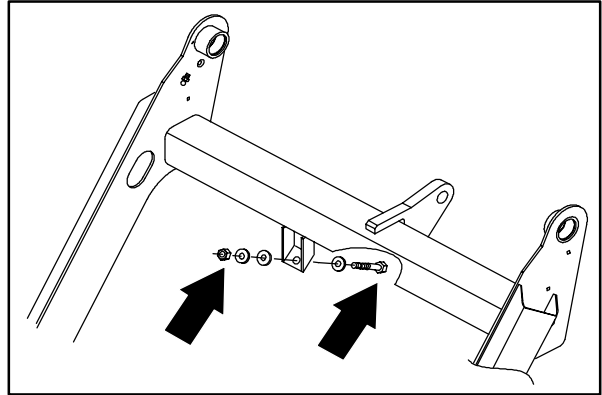
11. Reinstall the lip height adjustment bolt on the back of the hopper.
12. Start the machine and check for proper operation of hopper vacuum fan, dump door, side brush rotation and side brush up and down.



### TO ADJUST HOPPER LIP HEIGHT

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

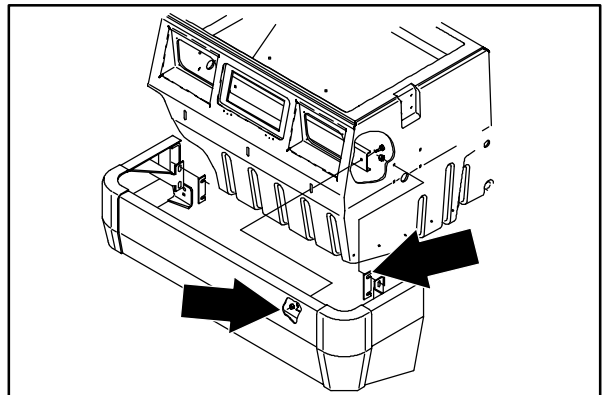
1. The hopper lip height adjustment should be 2-3/4" from the floor to the hopper bottom.
2. To achieve this measurement, adjust the length of the adjustment bolt on the back of the hopper.



### TO ADJUST HOPPER BUMPER

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

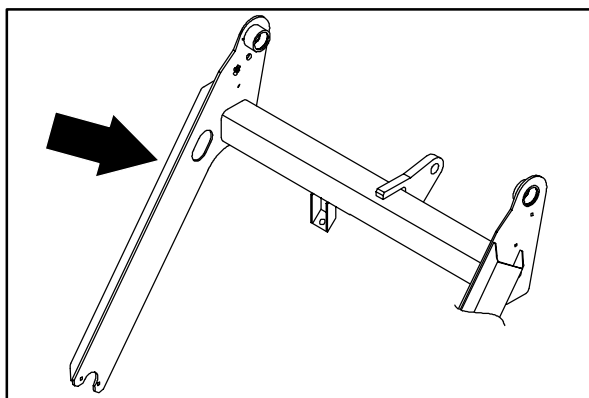
1. Loosen the four hex screws and nyloc nuts holding the hopper bumper to the sides of the hopper.
2. Loosen the three hex screws holding the hopper bumper to the front of the hopper.
3. Adjust the hopper bumper so it is level with the machine frame.
4. Firmly tighten all of the hardware.





## HOPPER LIFT ARM

The hopper lift arm assembly and hopper lift cylinder raises and lowers the debris hopper. The lift arm is held in place by two pivot pins.

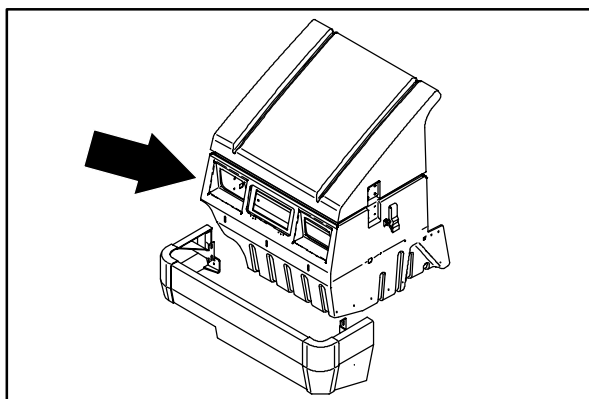


### TO REMOVE HOPPER LIFT ARM

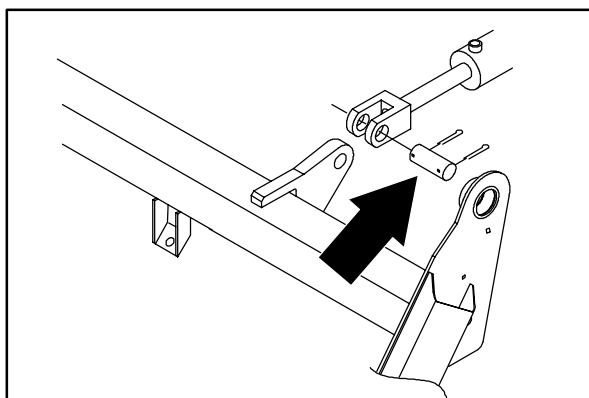
1. Park the machine on a smooth, level surface.
2. Stop the machine and set the machine parking brake.

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

3. Remove the debris hopper. See TO REMOVE HOPPER FROM MACHINE instructions.

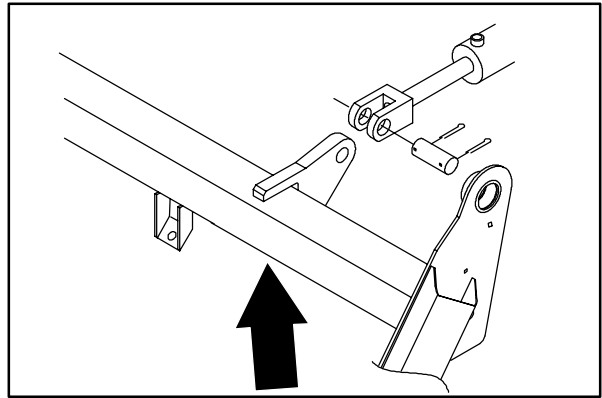


4. Remove the cotter pins from the upper, hopper lift cylinder pin.

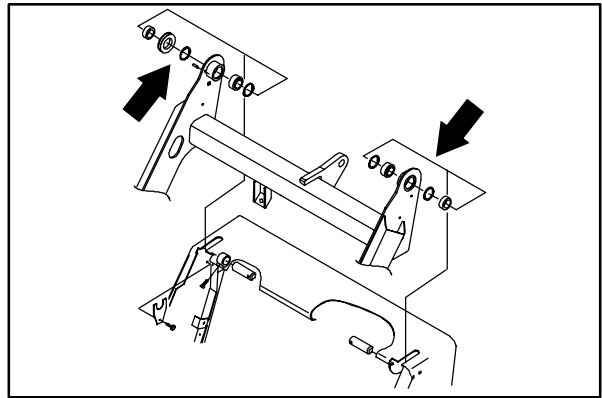


## SWEEPING

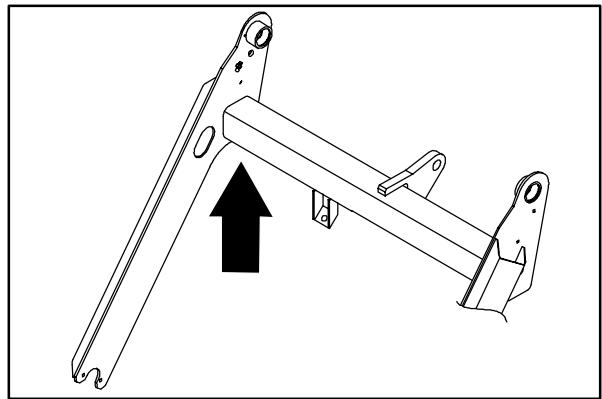
5. Raise up slightly on the lift arm to take pressure off the cylinder pin. Remove the pin.



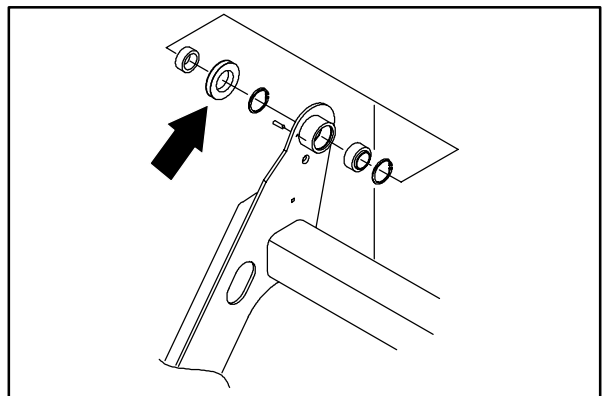
6. Remove the hex hardware holding the hopper pivot pins to the frame towers.



7. Raise up slightly on the lift arm to take pressure off the pins. Remove the pins and washers and remove the lift arm from the machine.



8. If the large self aligning bearing needs to be changed, remove retaining rings and press the old bearing out of the lift arm.



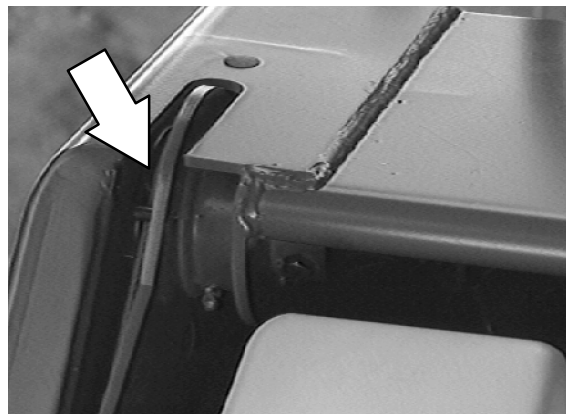
**TO INSTALL HOPPER LIFT ARM**

1. Park the machine on a smooth, level surface.
2. Stop the machine and set the machine parking brake.

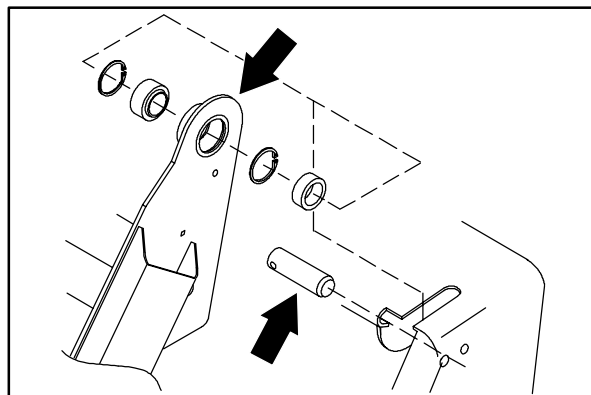
**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

3. Position lift arm in the machine, aligning the upper bearings in the lift arm with the holes in the towers of the machine.

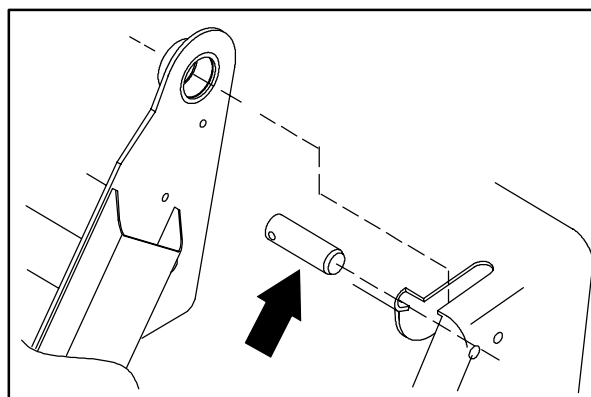
*NOTE: Make sure the side brush lift cable is looped over the plastic pulley on the right hand lift arm pin.*



4. Install the lift arm pins in the bearings from the inside of the machine. Make sure to reinstall the spacer washers that were removed when the pins were removed.

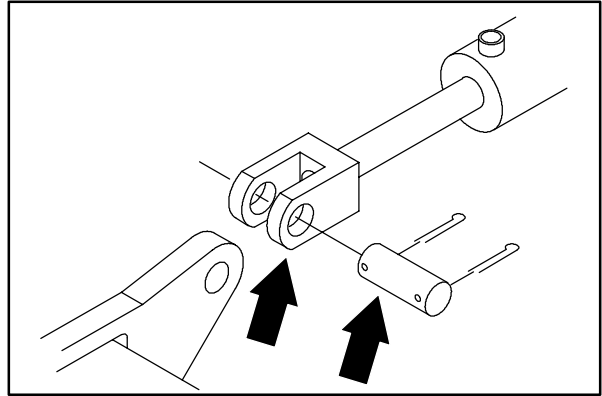


5. Align the hole in lift arm pin with the hole in the pin boss on the tower. Install the hex screws and tighten to 18 - 24 Nm (13 - 18 ft lb).



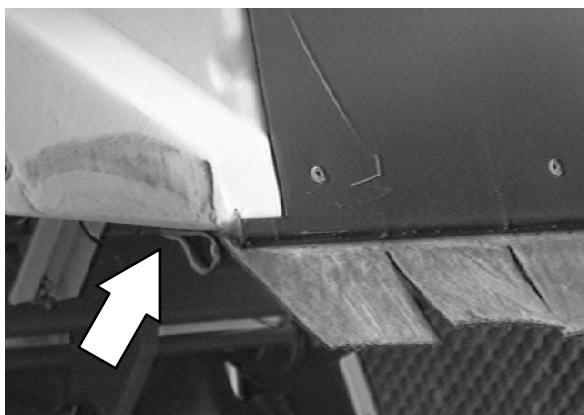
## SWEEPING

6. Align the small fiberglide bearing in the lift arm cylinder lug with the hole in the clevis on the hopper lift cylinder. Reinstall the cylinder pin and cotter pins.
7. Reinstall the hopper assembly. See TO INSTALL HOPPER instructions.



## HOPPER DUMP DOOR

The hopper dump door is used to control debris when dumping. It also seals the hopper to the main brush compartment. The dump door is open and closed with a hydraulic cylinder.



### TO REMOVE HOPPER DUMP DOOR

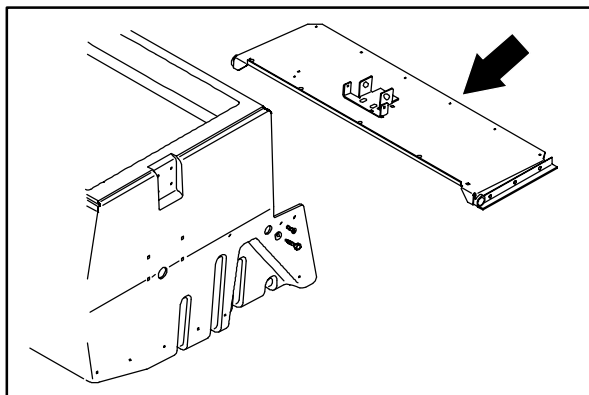
1. Make sure the hopper is emptied of all debris. Engage the parking brake.
2. Raise the hopper and engage the prop rod.



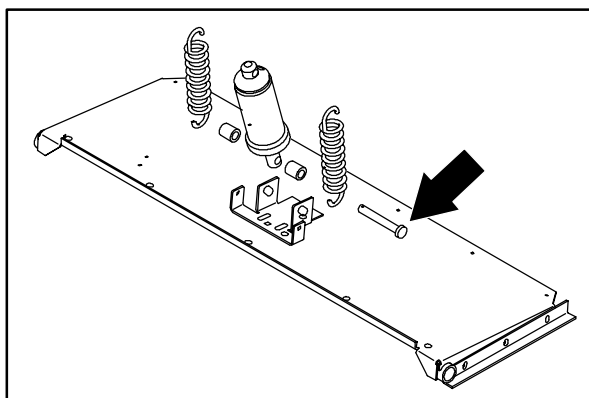
**WARNING: Raised Hopper May Fall.  
Engage Hopper Support Bar.**

3. Open the dump door. Shut off the machine.

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

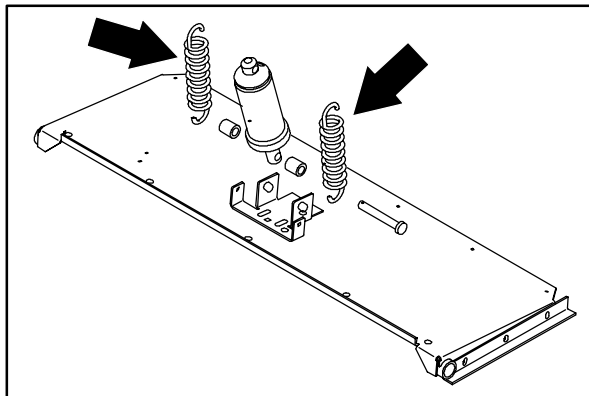


4. Disconnect the rod end of dump door cylinder from the bracket on the center of the dump door.

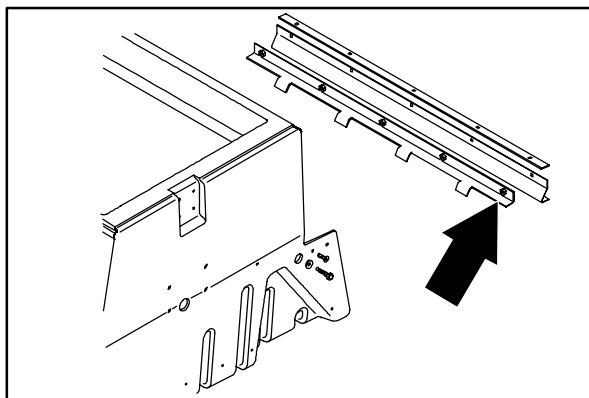


## SWEEPING

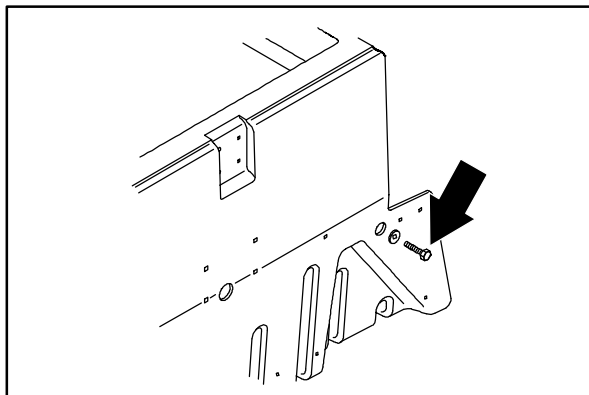
5. Remove the two tension springs from the dump door and the back off the hopper.



6. Remove the five hex screws holding the seal on the front of the dump door to the back of the hopper.



7. Use a razer knife to remove the RTV from the two dump door pivot bolts on each side of the hopper. Remove the two hex screws.



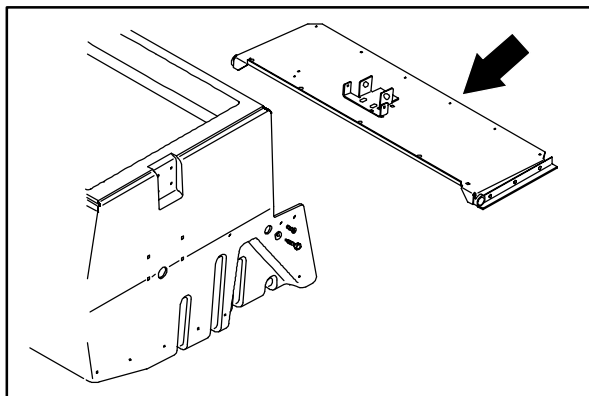
8. Drop the dump door down and out of the hopper.

**TO INSTALL HOPPER DUMP DOOR**

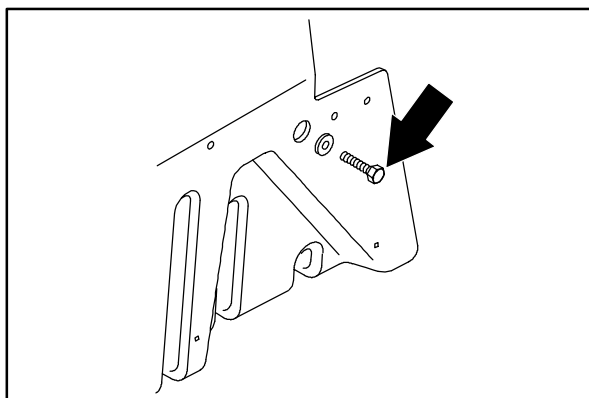
1. Make sure the hopper is emptied of all debris. Engage the parking brake.
2. Raise the hopper and engage the prop rod. Shut off the machine.

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

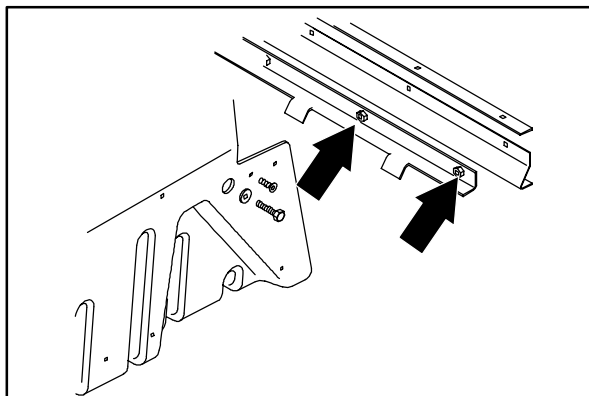
3. Position the dump door in the hopper. Line up the pivot holes in the dump door with the mount holes in each side of the hopper.



4. Install the two hex screws and nuts. Hand tighten tight.
5. Put a small amount of RTV around the two hex screws.

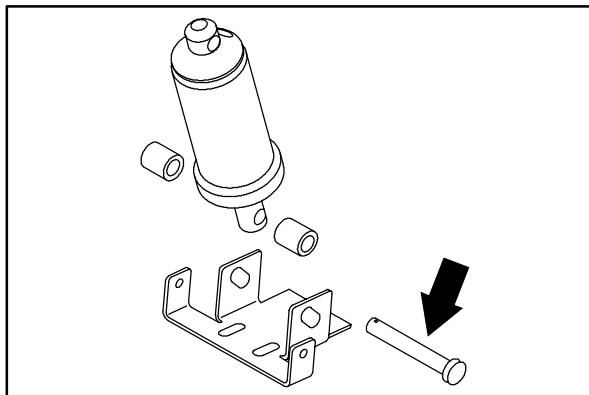


6. Reinstall the seal on the front of the dump door. Hand tighten the five hex screws tight.

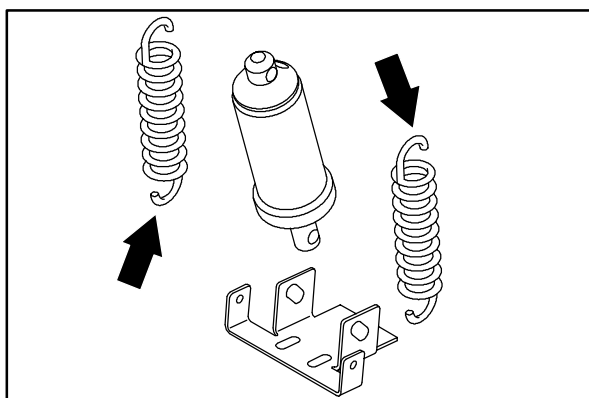


## SWEEPING

7. Reconnect the rod end of dump door cylinder to the mount bracket on the center of the dump door.

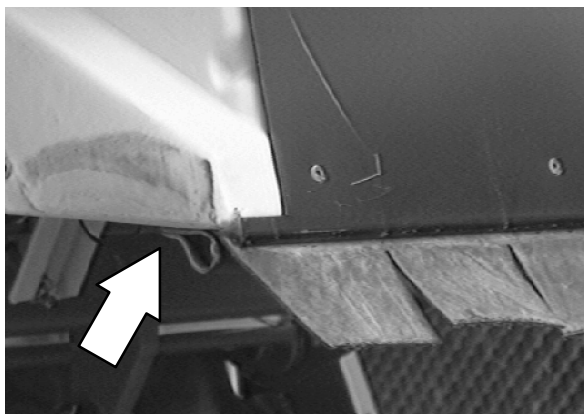


8. Reconnect the two tension springs to the mount bracket.



9. Start the machine and open and close hopper door a few times. Check for proper operation.

*NOTE: Make sure the seals on the dump door are adjusted so they contact the inside wall of the hopper.*





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## HOPPER DUST FILTER

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The dust filter filters the air pulled up from the hopper. The dust filter is equipped with a shaker to remove the accumulated dust particles. The dust filter shaker is operated by the vacuum and filter shaker lever.

Shake the dust filter before emptying the hopper and at the end of every work shift. Check and clean or replace the dust filter after every 100 hours of operation.

To clean the dust filter, use one of the following methods:

- **SHAKING** – Move the vacuum and filter shaker lever to the **Filter shaker** position.
- **TAPPING** – Tap the filter gently on a flat surface with the dirty side down. Do not damage the edges of the filter element and seals, or the filter will not seat properly in the filter frame.
- **AIR** – Blow air through the dust filter, opposite the direction of the arrows. This may be done with the dust filter in the machine. Always wear eye protection when using compressed air.

**FOR SAFETY: When servicing machine, wear eye and ear protection if using pressurized air or water.**

- **WATER** – Soak the dust filter in a water and mild detergent solution. Rinse the dust filter until it is clean. Air dry the wet dust filter; do not use compressed air.

*NOTE: Be sure the dust filter is completely dry before reinstalling it in the machine.*

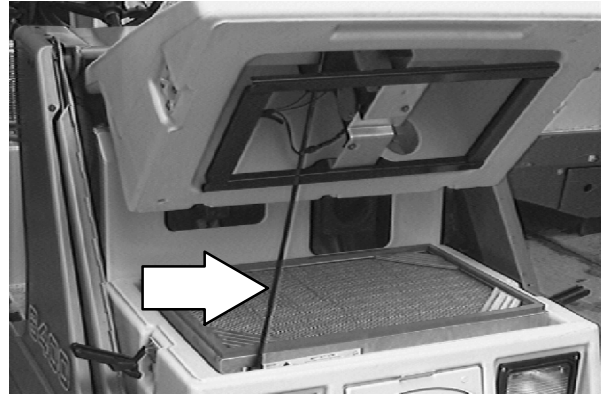


### TO REPLACE HOPPER DUST FILTER

1. Stop the machine, set the parking brake and turn the machine power off.

**FOR SAFETY: Before leaving or servicing machine, stop on level surface, set parking brake, turn off machine, and remove key.**

2. Unlatch and open the hopper cover. Support the hopper with the hopper cover prop rod.



3. Lift the dust filter element out of the hopper insert.



4. Clean or discard the dust filter as required.
5. Clean and inspect the filter sealing surfaces. Make sure the foam element centering strips attached to the hopper and intact. Put the cleaned or new dust filter in the hopper insert with the arrows pointing up.
6. Lower the hopper cover support and close the hopper cover. Latch the hopper cover.

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## MAIN BRUSH

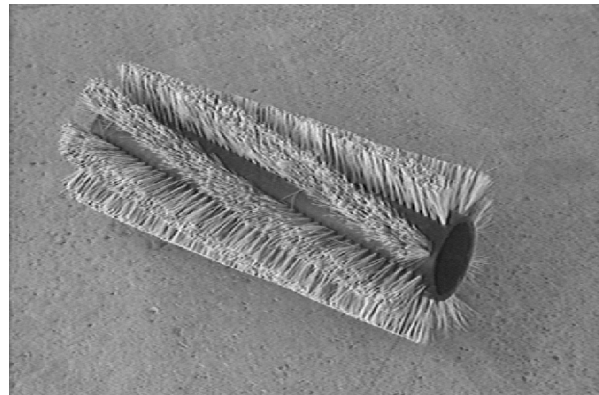
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The main brush is cylindrical and spans the width of the machine, sweeping debris into the hopper.

Check the brush daily for wear or damage. Remove any string or wire tangled on the main brush, main brush drive hub, or main brush idler hub.

Check the main brush pattern daily. The pattern should be 50 to 75 mm (2 to 3 in) wide with the main brush in the lowered position. Adjust the main brush pattern by turning the main brush down pressure knob and moving the brush stop.

Rotate the main brush end-for-end after every 50 hours of operation for maximum brush life and best sweeping performance. Replace the main brush when the remaining bristles measure 25 mm (1 in) in length.

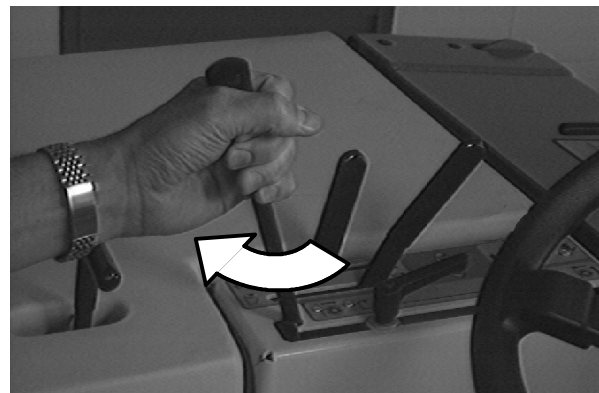


## TO REPLACE MAIN BRUSH

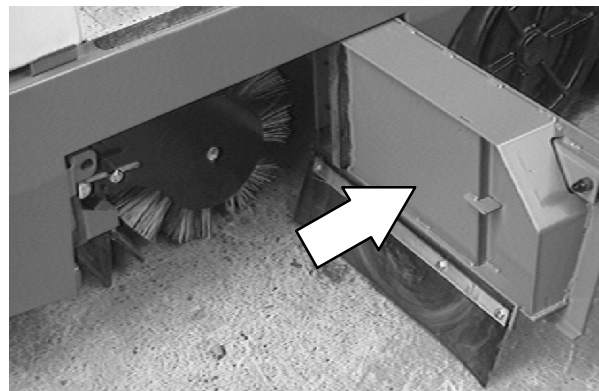
1. Stop the machine and set the parking brake.

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

2. Raise the main brush.

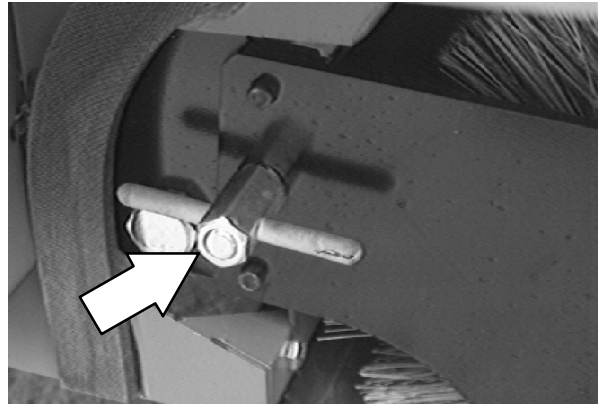


3. Open the right side main brush access door.

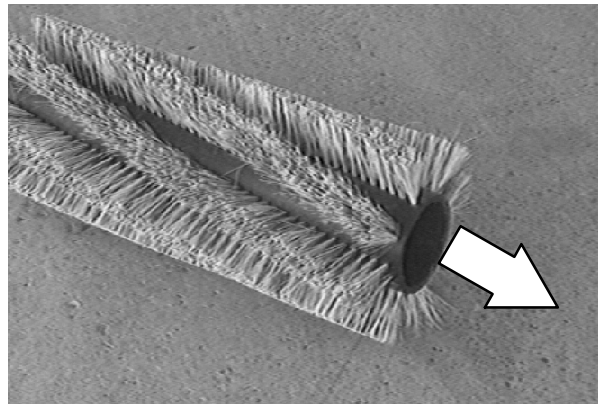


## SWEEPING

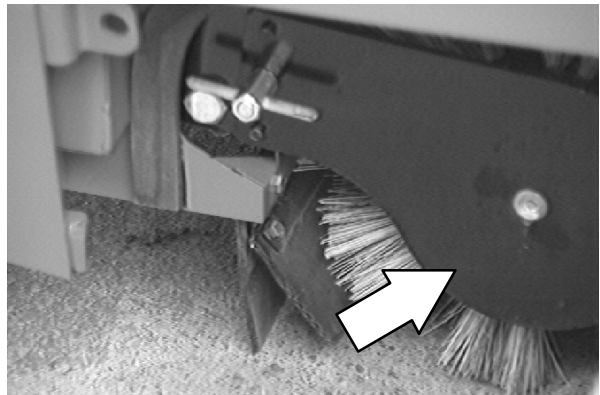
4. Unscrew the attachment bolt and remove the brush idler plate.



5. Grasp the main brush; pull it off the brush drive plug and out of the main brush compartment.
6. Put the new or rotated end-for-end main brush on the floor next to the access door.
7. Slide the main brush onto the drive plug. Rotate the brush until it engages the drive plug, and push it all the way onto the plug.

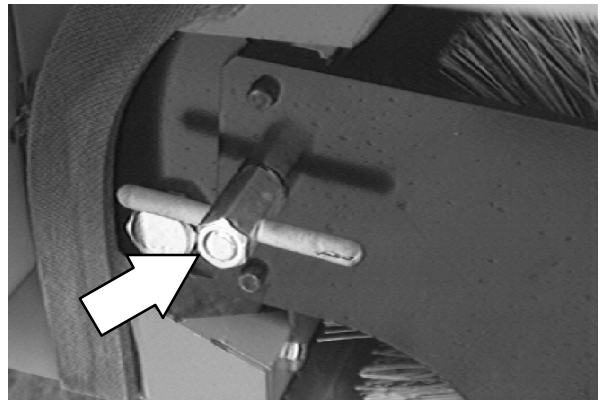


8. Slide the main brush idler plate plug in the main brush.



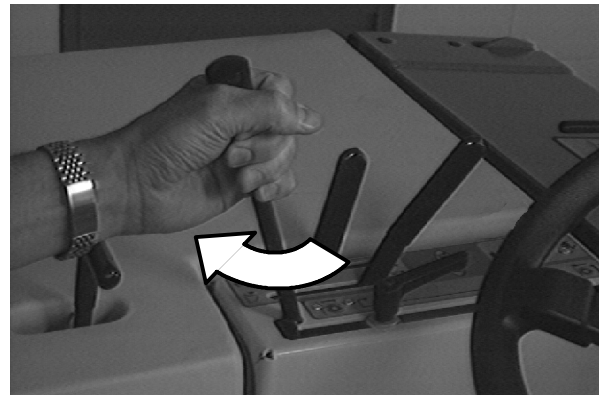
9. Reinstall the attachment bolt.

10. Close the right side main brush access door. Check the main brush pattern.



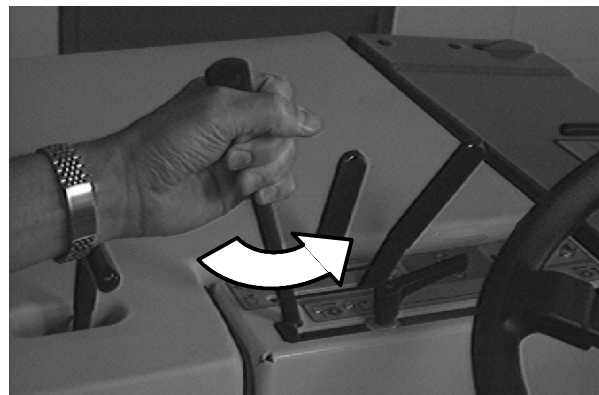
**TO CHECK AND ADJUST MAIN BRUSH PATTERN**

1. Apply chalk, or some other material that will not blow away easily, to a smooth, level floor.
2. Raise the side brush and main brush and position the main brush over the chalked area.

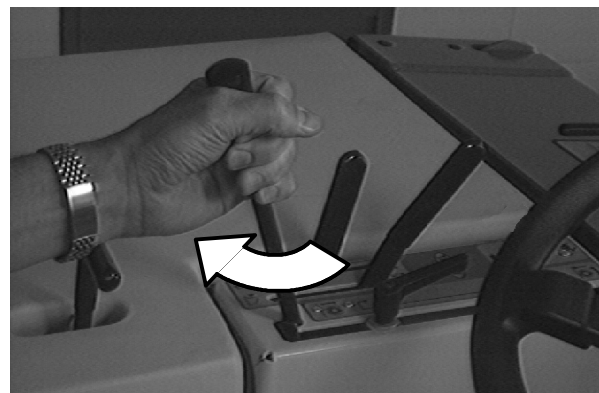


3. Lower and start the main brush for 15 to 20 seconds while keeping a foot on the brakes to keep the machine from moving. This will lower the rotating main brush.

*NOTE: If chalk or other material is not available, allow the brushes to spin on the floor for two minutes. A polish mark will remain on the floor.*



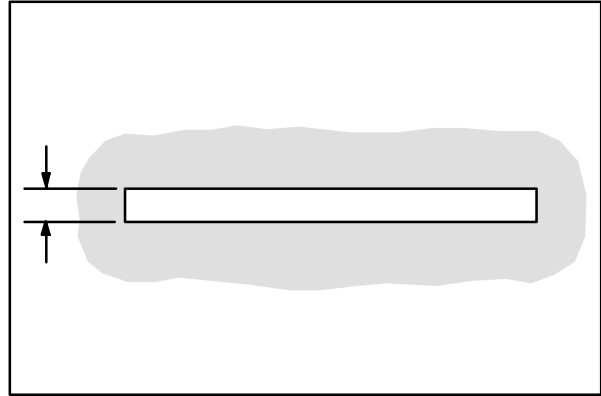
4. Raise and stop the main brush.



5. Drive the machine off the test area.

## SWEEPING

6. Observe the width of the brush pattern. The proper brush pattern width is 50 to 75 mm (2 to 3 in).



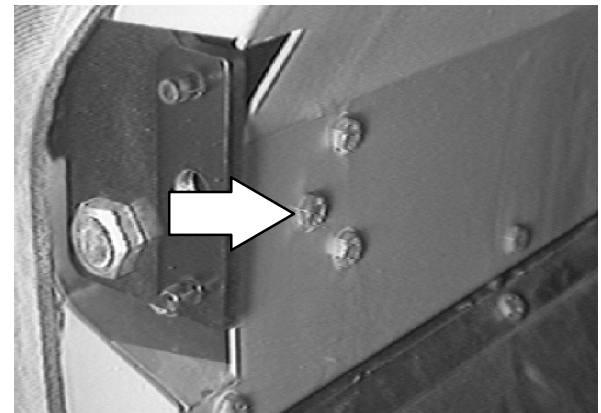
7. To increase the width of the main brush pattern, loosen the main brush pattern adjustment handle and slide forward in the slot.

*To decrease the width of the main brush pattern, loosen the main brush pattern adjustment handle and slide backward in the slot.*

*If the main brush pattern is tapered, more than 15 mm (0.5 in) on one end than the other, adjust taper.*

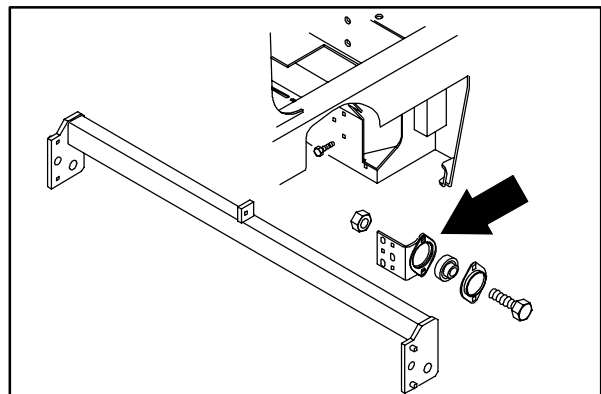


1. Loosen the brush shaft bearing bracket mounting bolts.



- A. Move the brush shaft bearing bracket up or down in the slots.

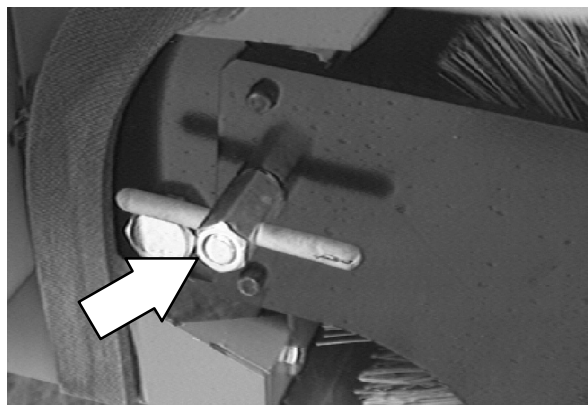
- B. Re-check the main brush pattern and readjust as necessary. Then adjust the width of the main brush pattern.



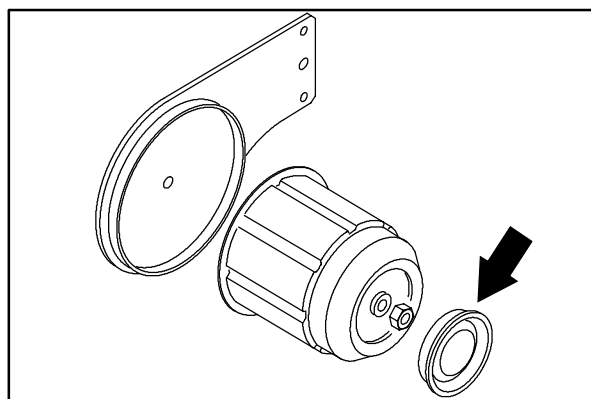
**TO REPLACE MAIN BRUSH IDLER PLUG BEARING**

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

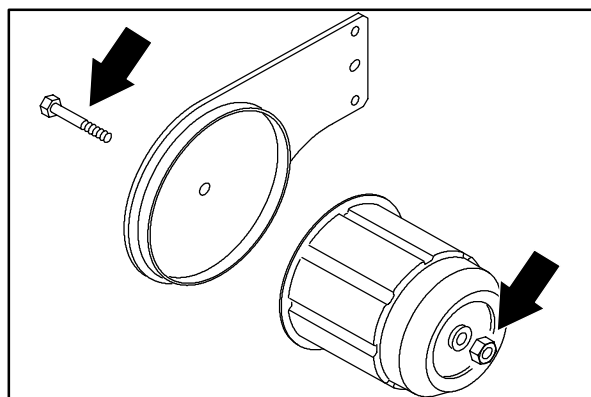
1. Remove the main brush idler arm from the machine.



2. Remove the plastic cap from the idler plug.
3. Clean the area around where the cap was mounted in the idler plug.

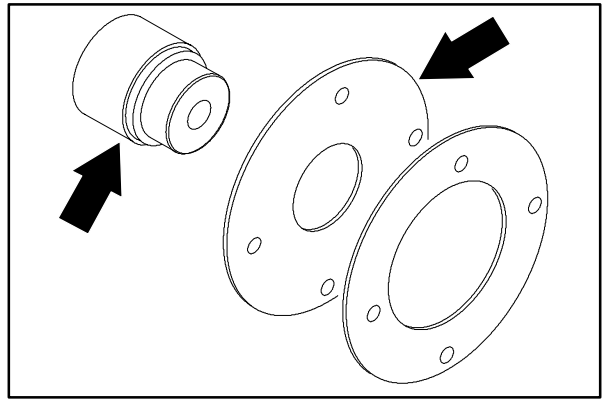


4. Remove the M12 flat screw, nyloc hex nut, and washer holding the idler plug to the idler arm.

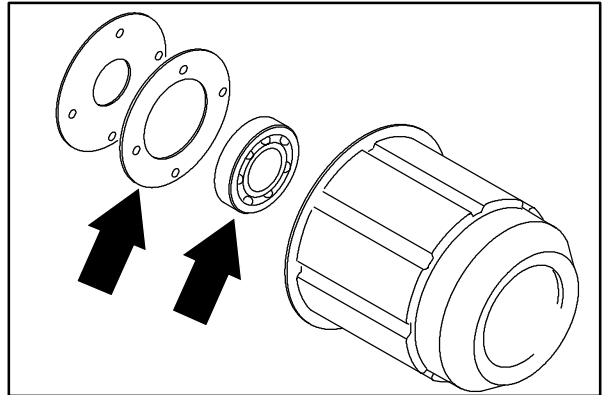


## SWEEPING

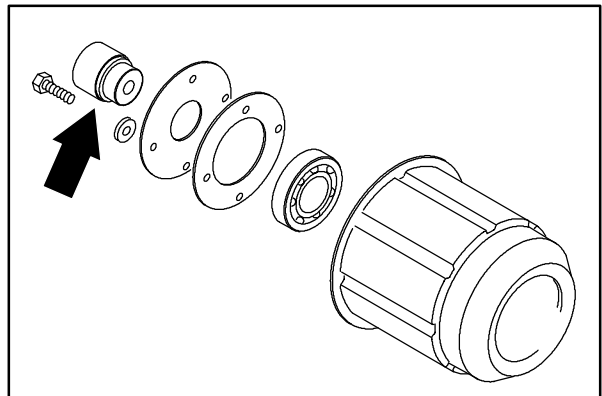
5. Remove the four M6 hex screws holding the idler shaft in the idler plug. Remove the shaft and cover.



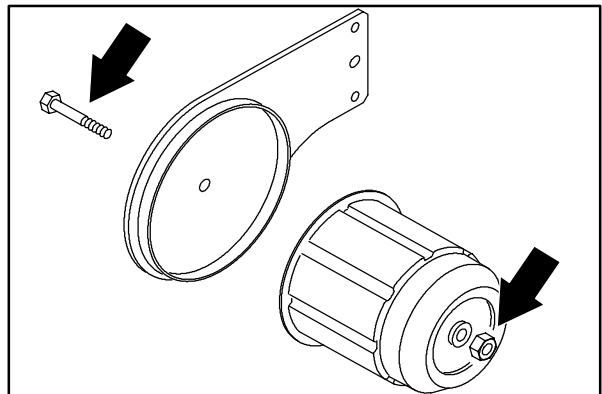
6. Remove the bearing seal plate, retainer and bearing.
7. Place a new bearing, the old seal plate, and the retainer on the idler.
8. Reinstall the four hex screws that hold the bearing seal plate and retainer in place. Leave screws loose for now.



9. Install the idler shaft in the new bearing. Tighten the four hex screws to 8–10 Nm (6–8 ft lb).

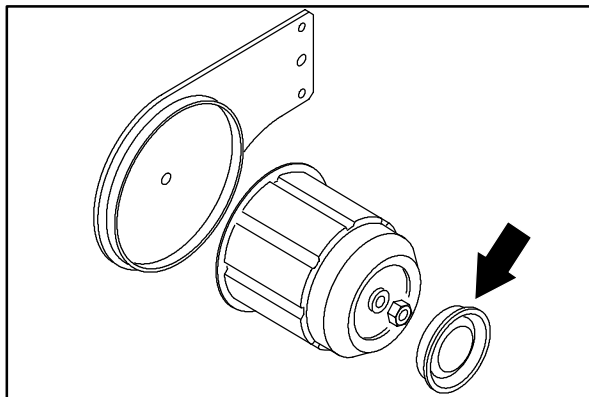


10. Position the idler plug on the idler arm shaft. Reinstall the long flat screw. Tighten to 68–81 Nm (50–60 ft lb).

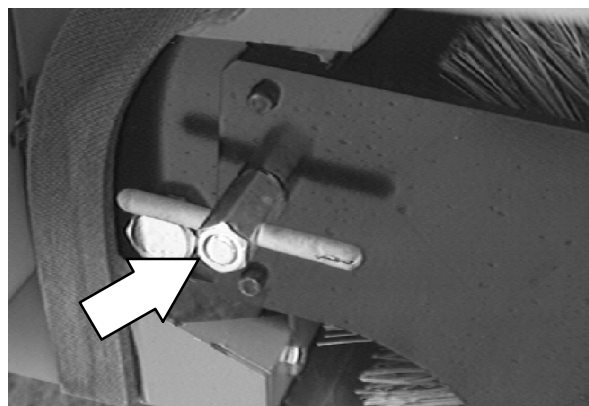




11. Put a small amount of RTV on the lip of the plastic cap and install in the end of the idler plug.



12. Reinstall the idler arm on the machine.



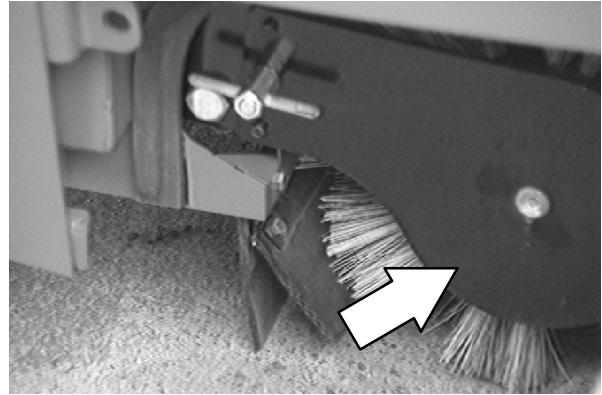
13. Operate the machine and check for proper operation.

## SWEEPING

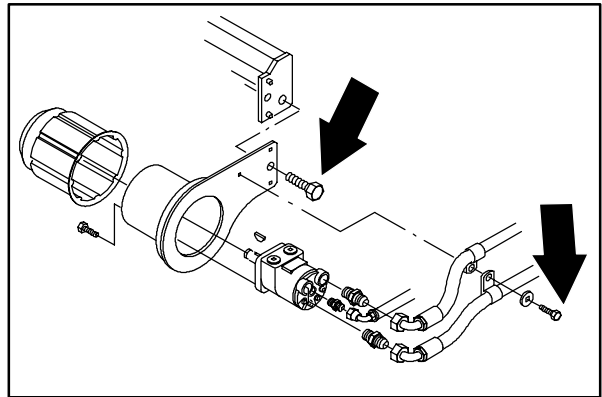
### TO REPLACE MAIN BRUSH SHAFT BEARINGS

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

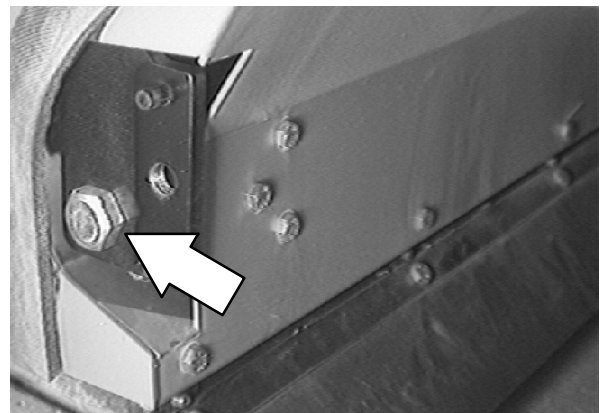
1. Remove the main brush idler arm and brush from the right side of the machine.



2. Remove the main brush motor arm assembly from the left side of the machine.

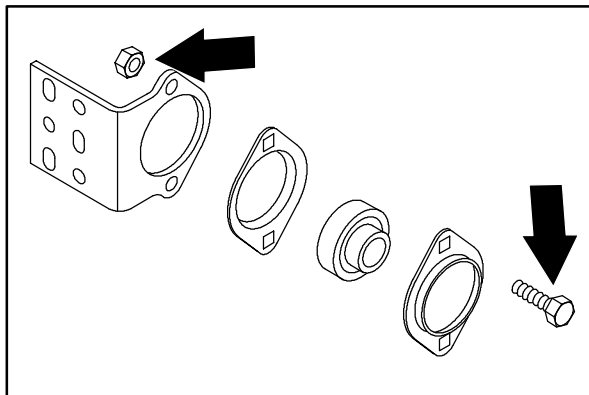


3. Remove the large hex screw and nyloc nut holding the brush arm to the pivot bearings.



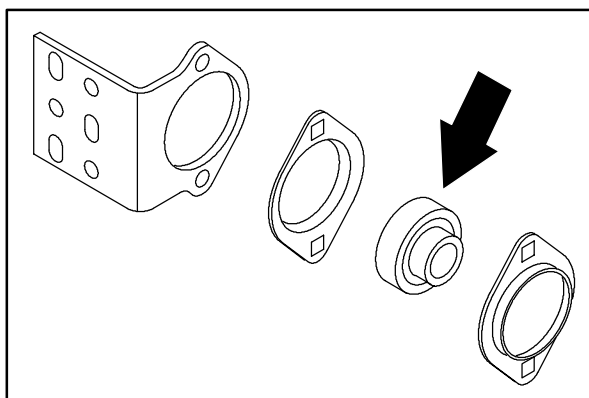
4. Let the brush arm drop down and out of the way.

5. Remove the two bolts holding each of the two brush shaft bearings and retainers to the bearing brackets.

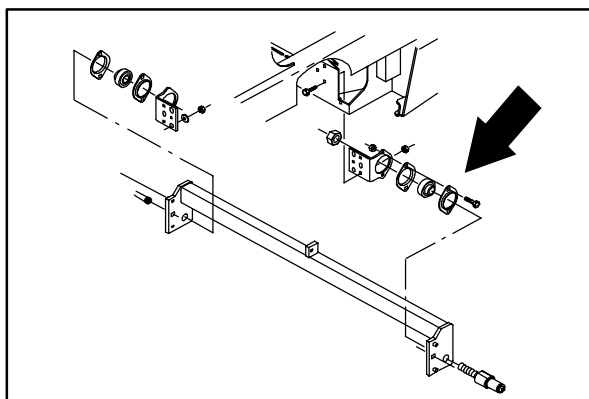


6. Remove the old brush shaft bearings.

7. Position the new brush shaft bearings on the mount brackets. Make sure to have the lock collars pointing to the outside of the machine.

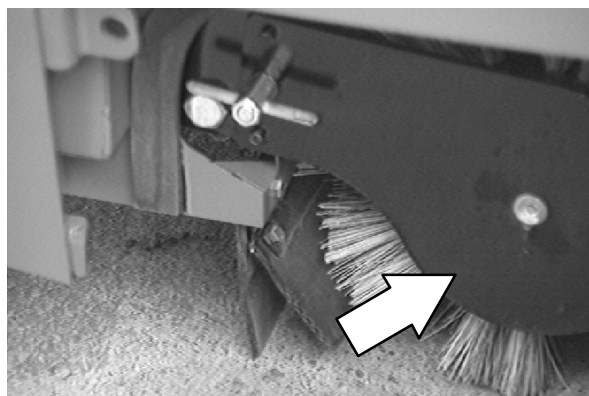


8. Reinstall the two bolts holding each of the two brush shaft bearings and retainers to the bearing brackets. Tighten to 18 – 24 Nm (15 – 20 ft lb).



9. Reinstall the main brush motor plate and idler plate.

10. Check main brush pattern for taper and width. Adjust as necessary. See TO CHECK AND ADJUST MAIN BRUSH PATTERN.



## SIDE BRUSH

The side brush sweeps debris along edges into the path of the main brush.

Check the brush daily for wear or damage. Remove any string or wire found tangled on the side brush or side brush drive hub.

Check the side brush pattern daily. The side brush bristles should contact the floor in a 10 o'clock to 3 o'clock pattern when the brush is in motion. Adjust the side brush pattern with the side brush down pressure lever. Turn the lever counter-clockwise to increase the brush contact with the sweeping surface, and clockwise to decrease the brush contact with the sweeping surface.

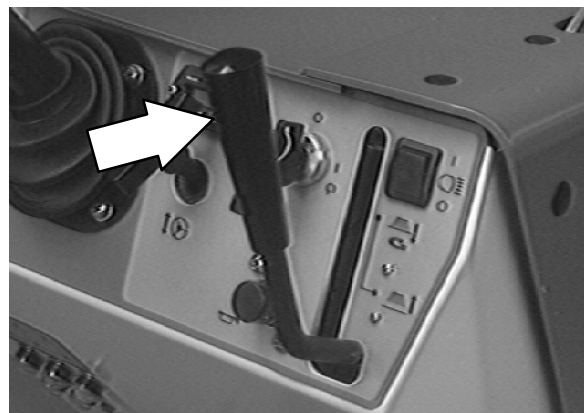
The side brush should be replaced when it no longer sweeps effectively for your application. A guideline length is when the remaining bristles measure 50 mm (2 in) in length. You may change the side brush sooner if you are sweeping light litter, or wear the bristles shorter if you are sweeping heavy debris.

### TO REPLACE SIDE BRUSH

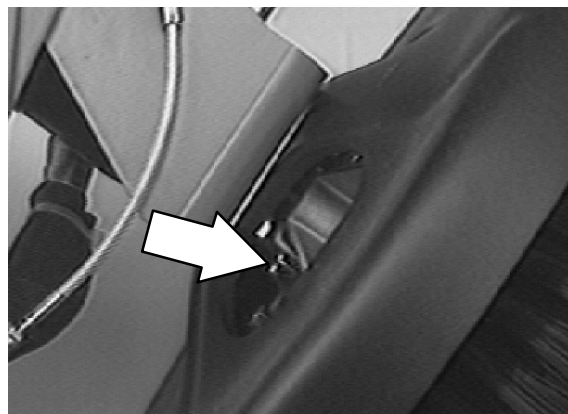
1. Empty the debris hopper.
2. Set the machine parking brake.

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

3. Raise the side brush.



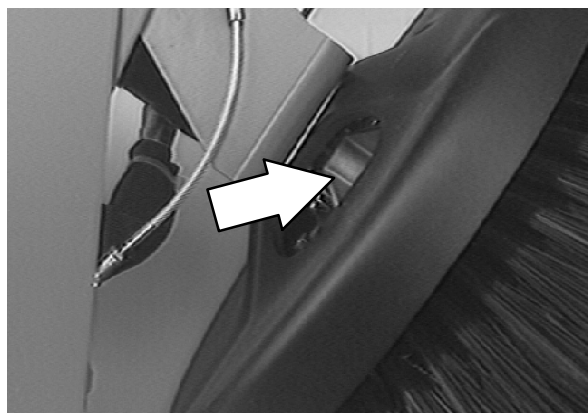
4. Remove the side brush retaining pin from the side brush drive shaft by pulling the pin keeper off and over the end of the pin. Remove the pin.
5. Slide the side brush off the side brush motor shaft.



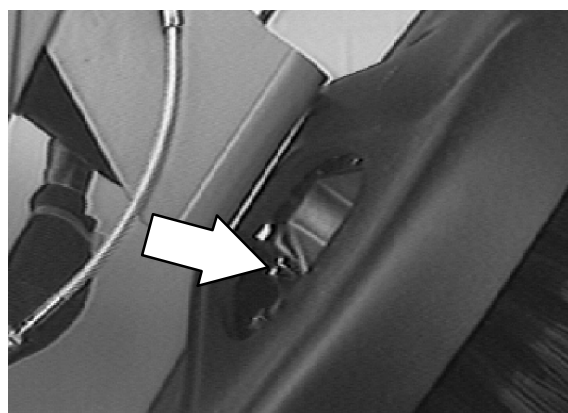
*NOTE: Remove the drive hub and put it on the new brush if one is not installed.*



6. Slide the new side brush on the side brush motor shaft.

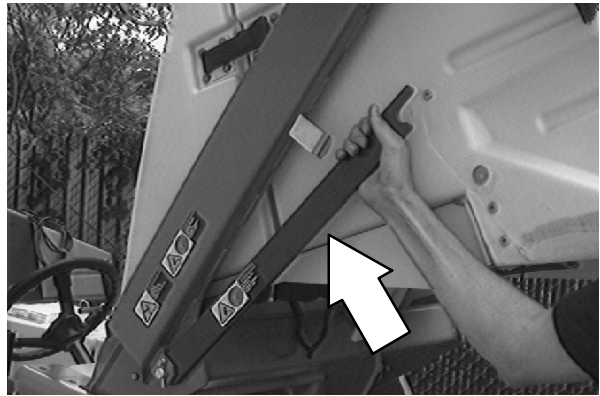


7. Reinstall the side brush retaining pin through the side brush hub and shaft.
8. Secure the pin by clipping the pin keeper over the end of the pin.

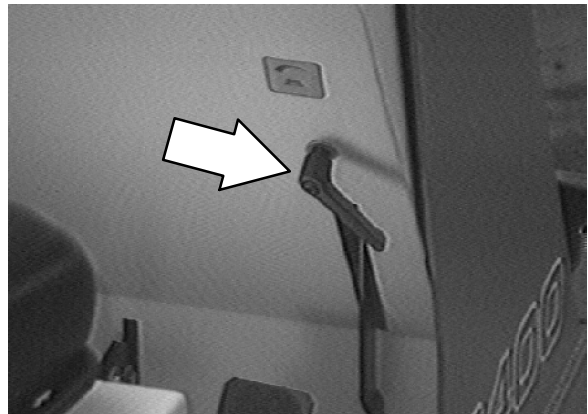


## SWEEPING

9. Disengage the hopper support bar and lower the hopper.



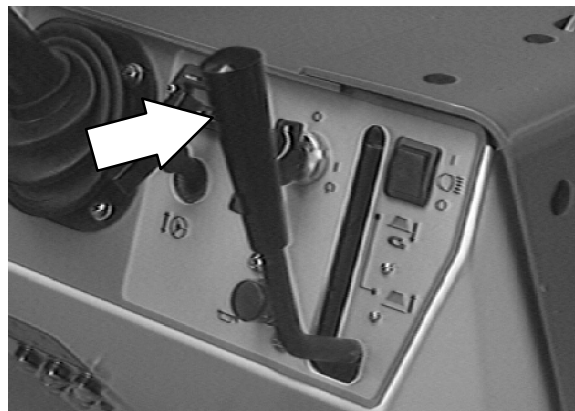
10. Adjust the side brush pattern with the side brush down pressure lever.



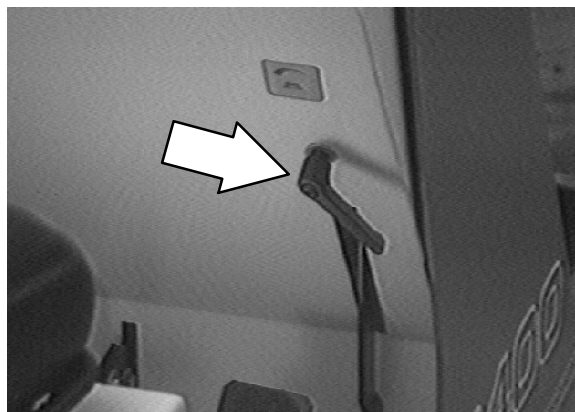
**TO ADJUST SIDE BRUSH PATTERN**

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

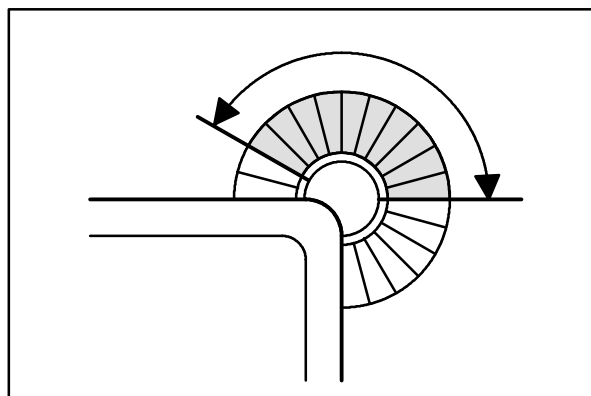
1. Lower the side brush.



2. Turn the side brush lever clockwise to decrease side brush pattern. Turn the side brush lever counter-clockwise to increase side brush pattern.



*One-half of the bristles should normally contact the floor.*



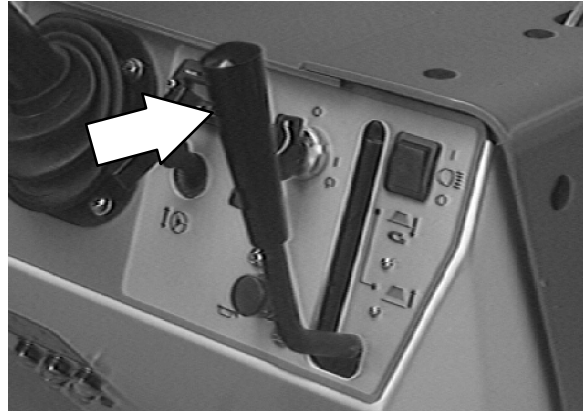
3. Raise the side brush.

## SWEEPING

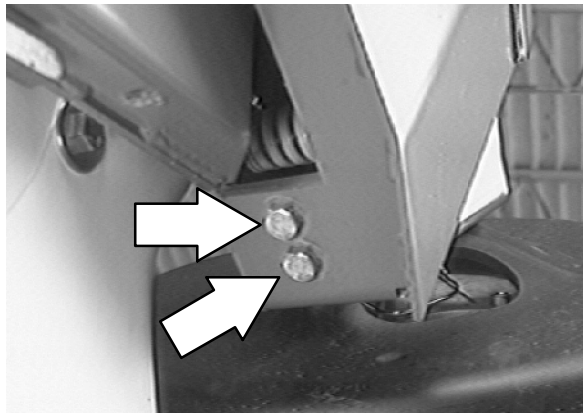
### TO ADJUST SIDE BRUSH TILT PATTERN

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

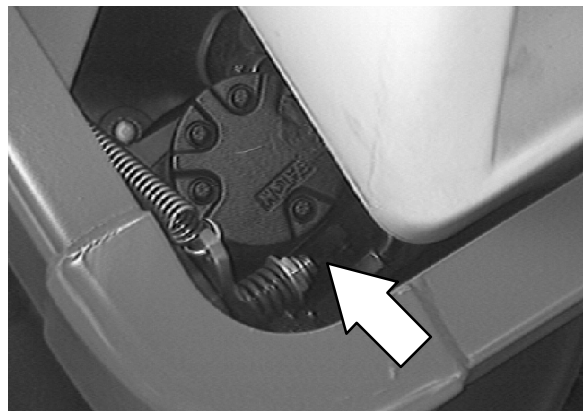
1. Lower the side brush.
2. Raise the hopper slightly and shut off the machine.



3. Loosen the two hex screws on the back of the hopper bumper near the side brush assembly.

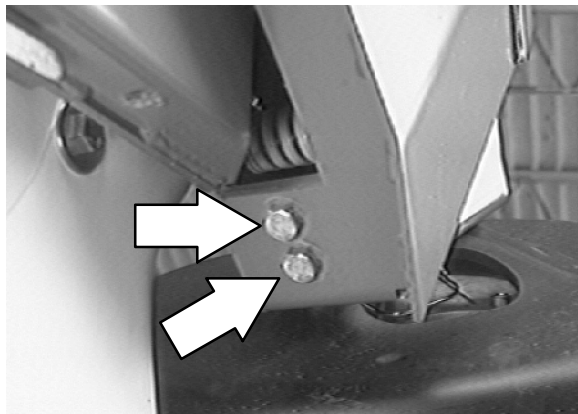


4. Tilt the side brush in either direction.





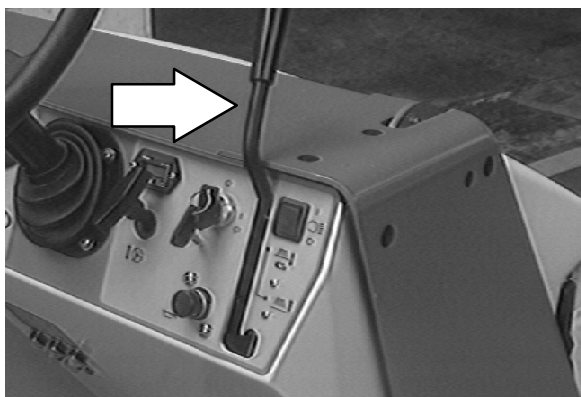
5. Tighten the hardware firmly.



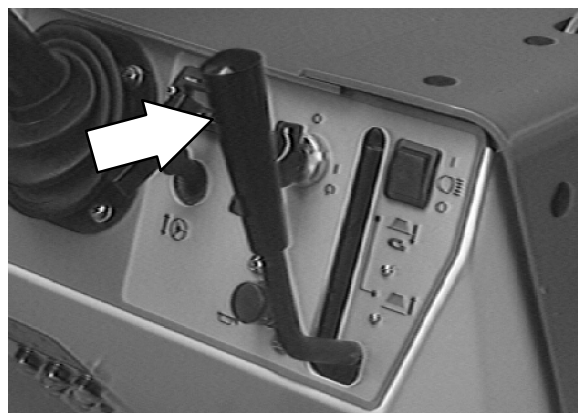
6. Lower the hopper.



7. Start the machine and turn on the side brush. Check the side brush pattern.



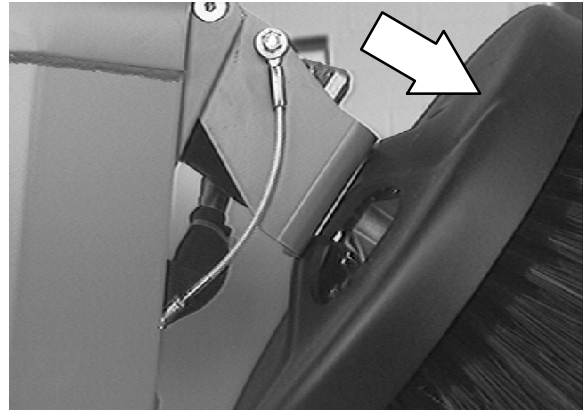
8. Raise the side brush.



### SIDE BRUSH GUARD

The side brush guard protects the side brush from objects along path of the machine. It deflects the side brush out of harms way.

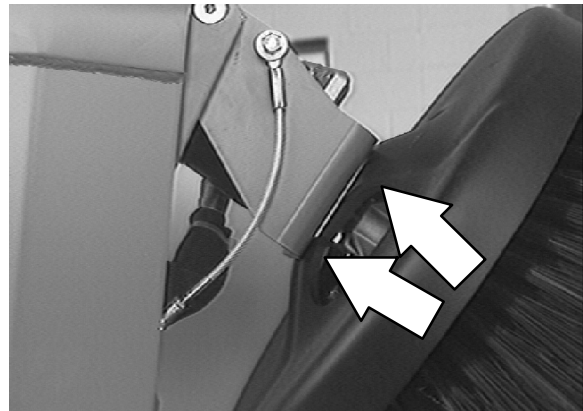
Rotate the side brush guard 90° every 200 hours of operation. Replace the brush guard after all four sides have been used.



### TO ROTATE OR REPLACE SIDE BRUSH GUARD

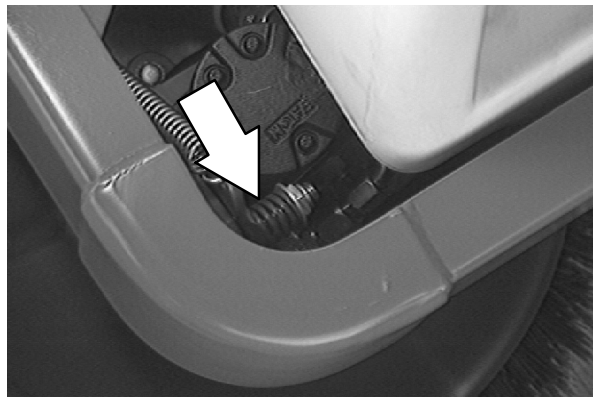
**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

1. Remove the side brush.
2. Remove the four bolts holding the side brush guard to the side brush motor.
3. Rotate or replace the side brush guard.
4. Reinstall the four bolts in the side brush motor and tighten to 22-27 Nm (16-20 ft lb).

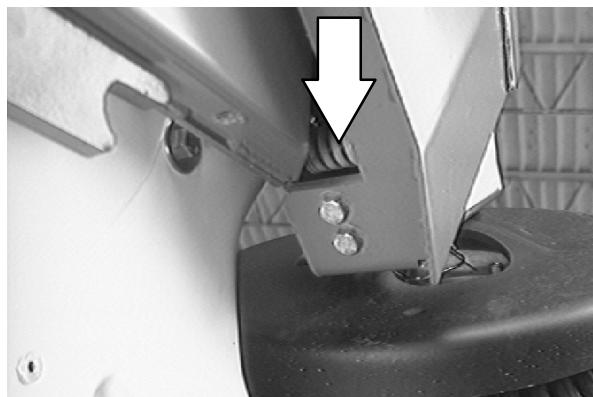


**SIDE BRUSH PIVOT**

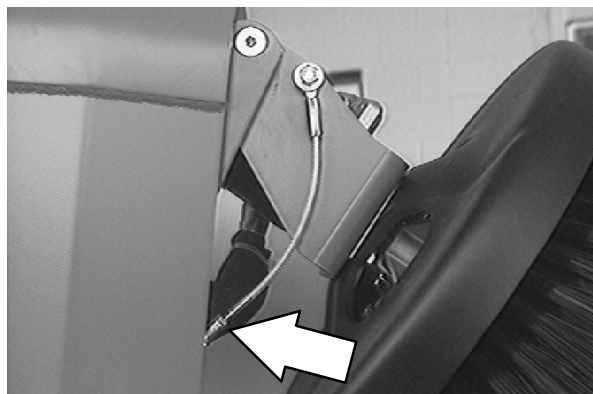
The side brush pivot should be checked for excessive movement after every 200 hours of operation.



Torque the front and rear compression springs to reduce excessive movement.



The side brush tilt is adjusted with the side brush cable. Turn the clevis on the cable to get the desired side brush pattern.



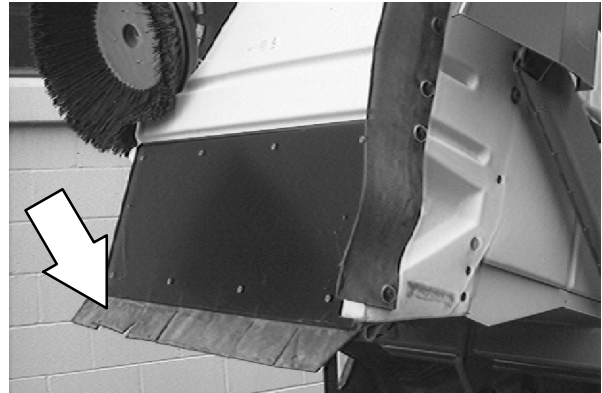
## SKIRTS AND SEALS

### HOPPER LIP SKIRTS

The hopper lip skirts are located on the bottom rear of the hopper. The skirts float over debris and help deflect that debris into the hopper. The hopper lip skirts consist of five bottom lip segments and two additional side lip segments.

Check the hopper lip skirts for wear or damage daily.

Replace the hopper lip skirts when they no longer touch the floor.



### TO REPLACE HOPPER LIP SKIRTS

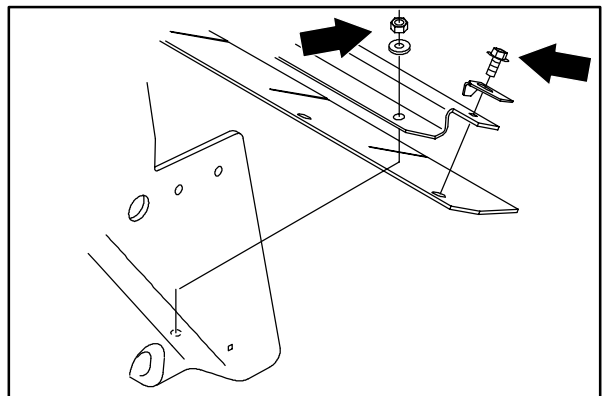
1. Dump the machine debris hopper.
2. Set the machine parking brake.
3. Raise the hopper, engage the hopper support bar. Shut off the machine.

**! WARNING: Raised Hopper May Fall. Engage Hopper Support Bar.**

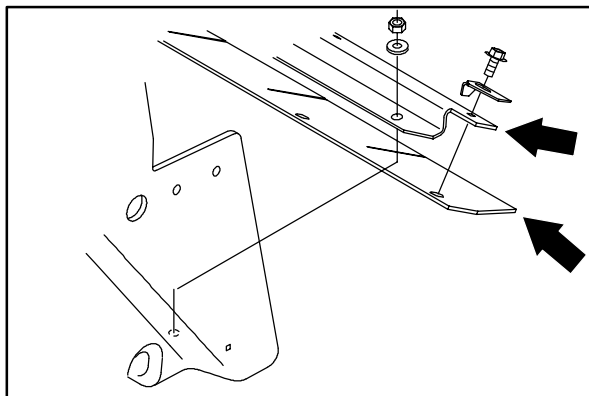
**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**



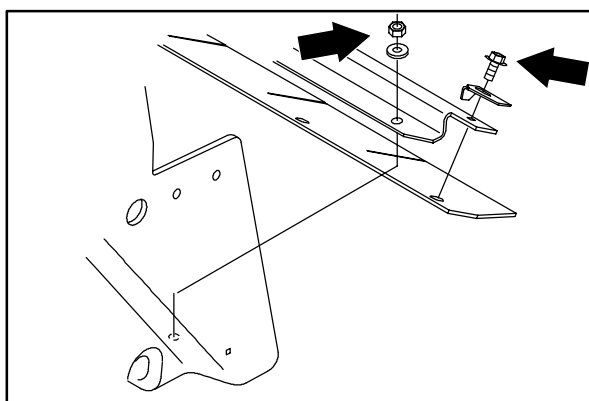
4. Remove the hopper lip retaining strip mounting hardware.



5. Remove the hopper lip retaining strip, hopper lip, and the back-up strip. Discard the hopper lip.



6. Thread the retaining strip mounting bolts through the retaining strip, the new hopper lip, and the back-up strip.
7. Tighten the mounting hardware to 8-14 Nm (6-10 ft lb).



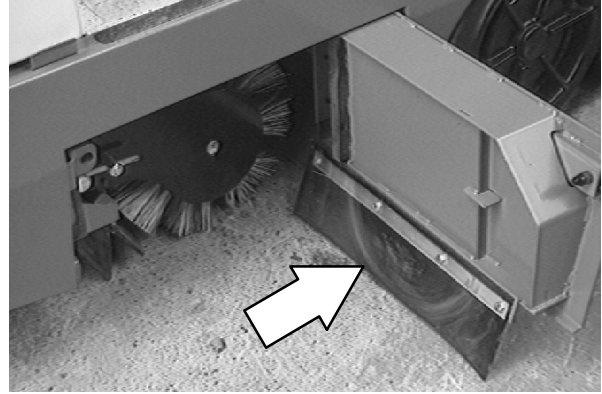
8. Start the machine and lower the hopper.



## SWEEPING

### BRUSH DOOR SKIRTS

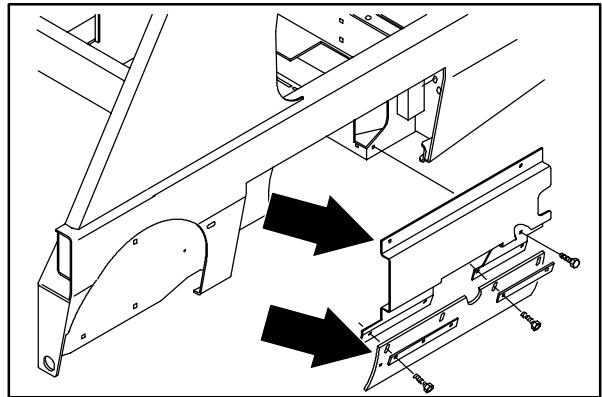
The right hand brush door skirt is located on the bottom of the main brush door.



The left hand skirt is located on a skirt mount plate behind the left brush door. Both skirts should clear the floor up to 5 mm (0.25 in) in dusty conditions, and touch the floor otherwise.

Check the skirts for wear or damage and adjustment daily.

*NOTE: The brush door skirts have slotted holes to allow for a ground clearance adjustment. The door must be closed for proper adjustment.*



### TO REPLACE AND ADJUST RIGHT HAND BRUSH DOOR SKIRT

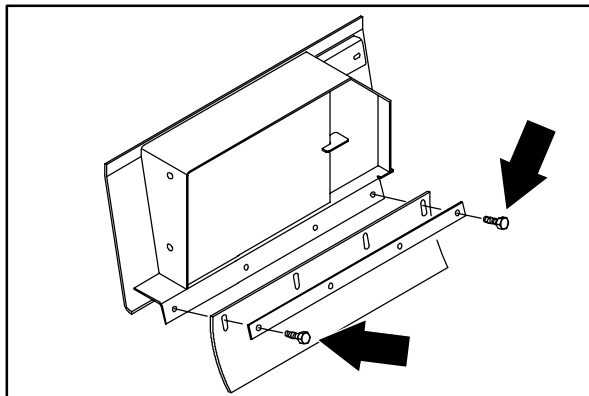
1. Park the machine on a smooth, level surface.
2. Stop the machine and set the machine parking brake.

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

3. Open the right hand brush door.



4. Remove the brush door skirt retaining bolts.

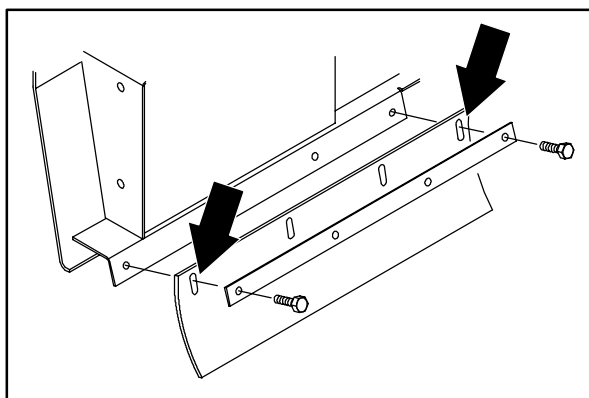


5. Remove the skirt retaining strip and door skirt.
6. Position the new brush door skirt on the brush door.
7. Position the retainer over the new skirt.



8. Thread the skirt retaining bolts through the brush door, the door skirt, and in the skirt retaining strip.

*NOTE: The brush door skirts have slotted holes to allow for a ground clearance adjustment. The door must be closed for proper adjustment.*



9. Slide the brush door skirt up or down so it will clear the floor by 3-5 mm (0.12 to 0.25 in). Hand tighten the hex screws firmly.



10. Operate the machine and check the new skirt for proper operation.

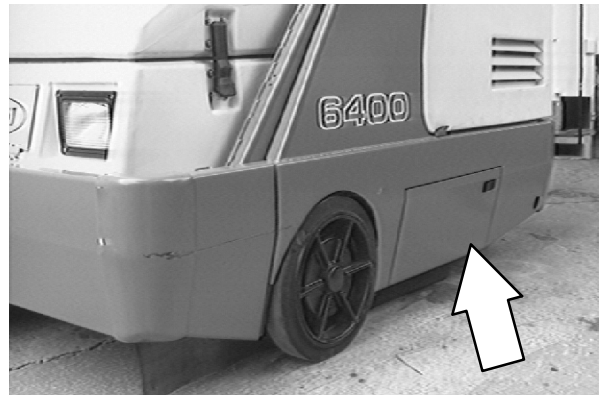
## SWEEPING

### TO REPLACE AND ADJUST LEFT HAND BRUSH DOOR SKIRT

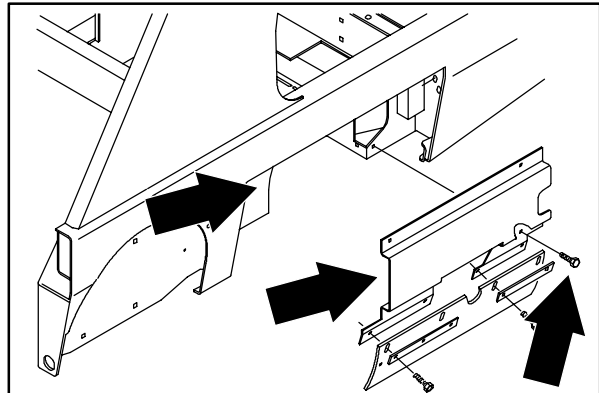
1. Park the machine on a smooth, level surface.
2. Stop the machine and set the machine parking brake.

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

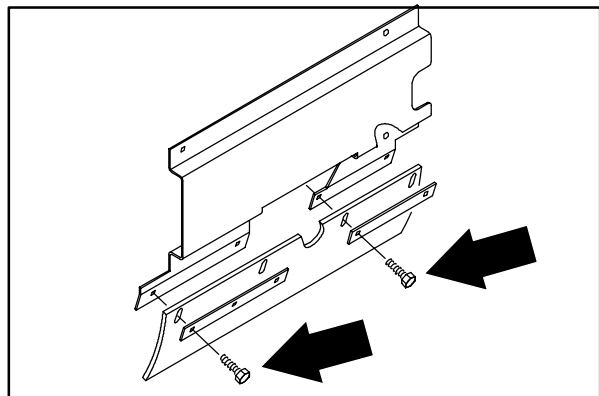
3. Open the left hand brush door.



4. Remove the four hex screws holding the skirt mount plate to the machine.

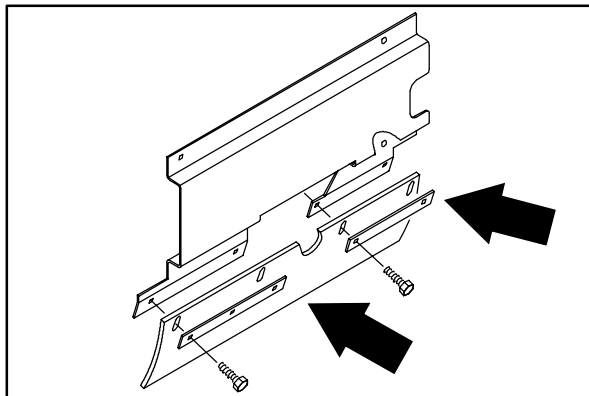


5. Remove the brush skirt retaining bolts.



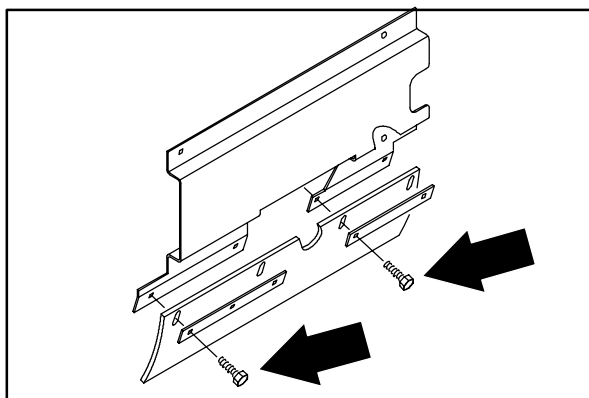


6. Remove the skirt retaining strips and brush skirt.
7. Position the new brush skirt on the mount plate.
8. Position the retainer over the new skirt.

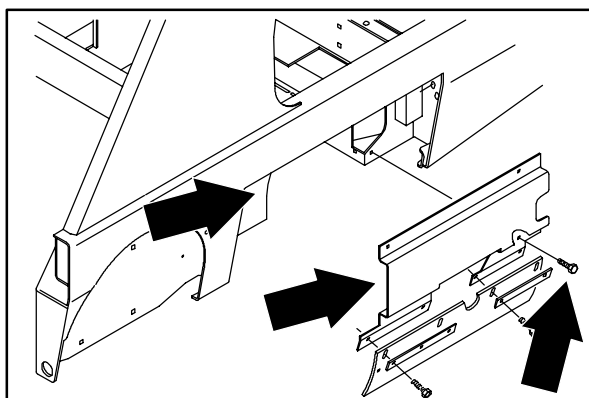


9. Thread the skirt retaining bolts through the mount plate, the door skirt, and in the skirt retaining strip.

*NOTE: The brush skirts have slotted holes to allow for a ground clearance adjustment. The skirt plate must be mounted on the machine for proper adjustment.*

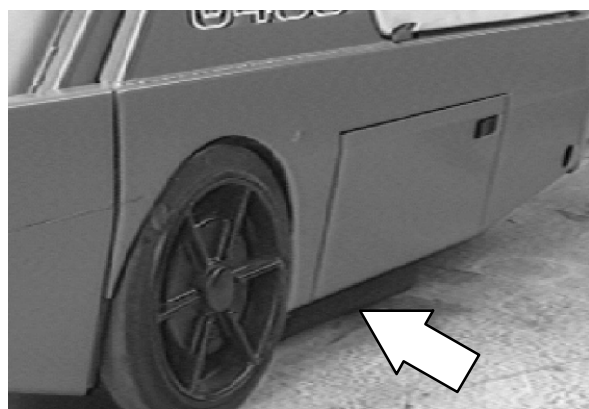


10. Reinstall the skirt mount plate on the machine. Tighten the hex screws to 18 - 24 Nm (15 - 20 ft lb).



11. Slide the brush door skirt up or down so it will clear the floor by 3-5 mm (0.12 to 0.25 in). Hand tighten the hex screws firmly.

12. Operate the machine and check the new skirts for proper operation.

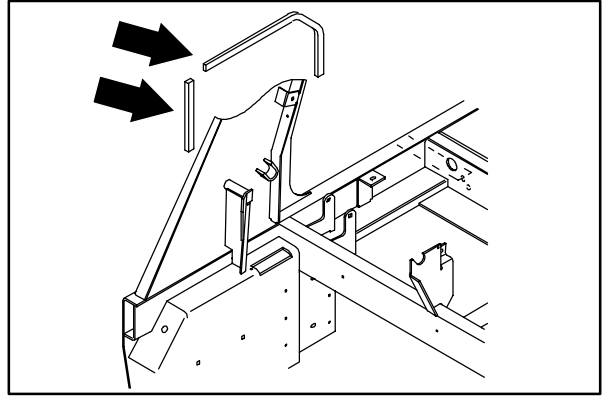


## SWEEPING

### RIGHT BRUSH DOOR SEAL

The brush door seal is located on the right brush door and on corresponding portions of the main frame. They seal the right side of the main brush compartment.

Inspect the seal for wear or damage every 100 hours of operation.

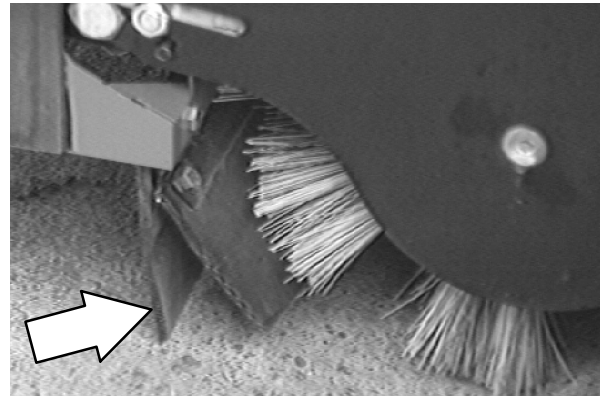


### REAR SKIRT AND DEFLECTOR BLADE

The rear skirt and the deflector blade are located on the bottom rear of the main brush compartment. The rear skirt should clear the floor up to 5 mm (0.25 in) in dusty conditions, and touch the floor otherwise. The deflector blade is spring loaded.

Check the skirt and blade for wear or damage and adjustment daily.

*NOTE: Rear tire pressure will affect skirt clearances.*

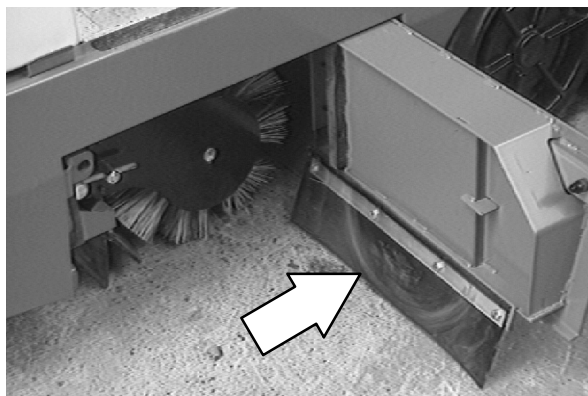


**TO REPLACE AND ADJUST THE REAR SKIRT AND DEFLECTOR BLADE**

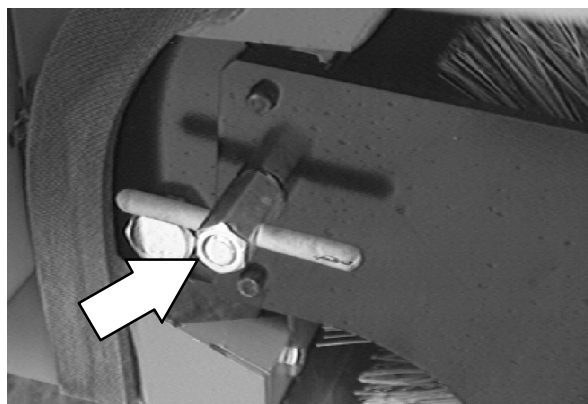
1. Park the machine on a smooth, level surface.
2. Stop the machine and set the parking brake.

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

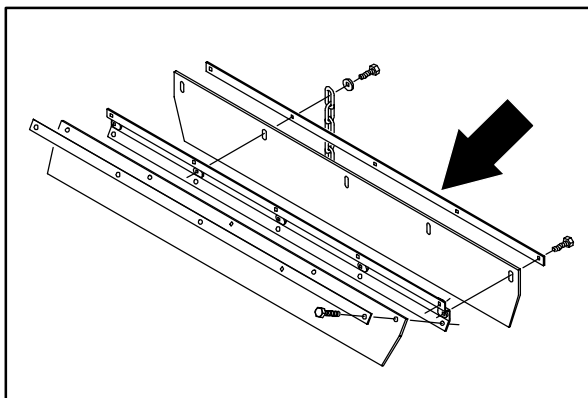
3. Open the main brush doors.



4. Remove the main brush.

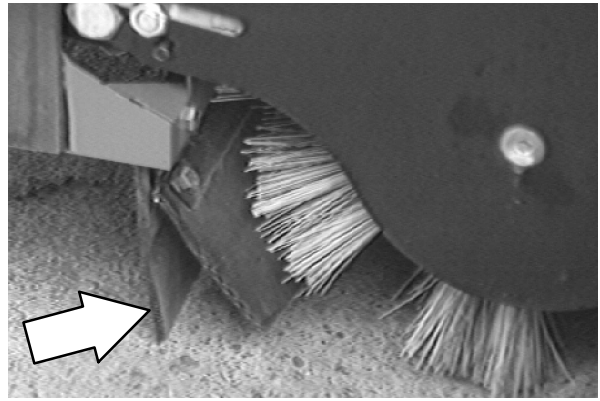


5. Remove the retaining strip and floor skirt. Discard the old skirt.

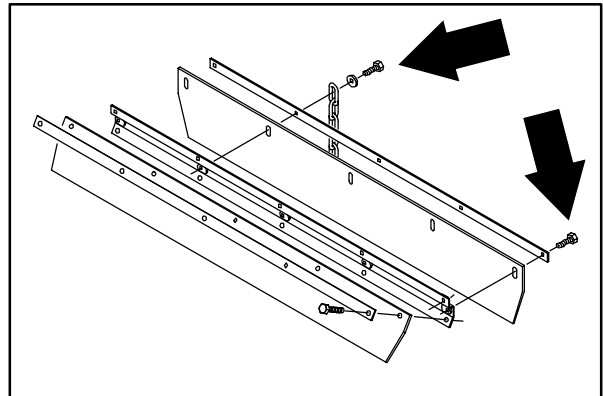


## SWEEPING

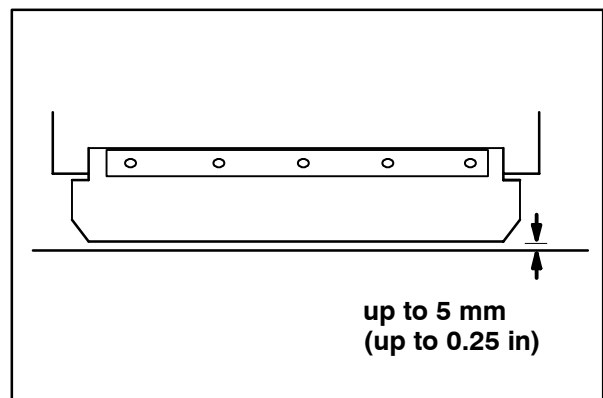
6. Position the new skirt on the machine.



7. Thread the mounting bolts through the machine frame, the rear floor skirt, and the retaining strip toward the rear wheel.

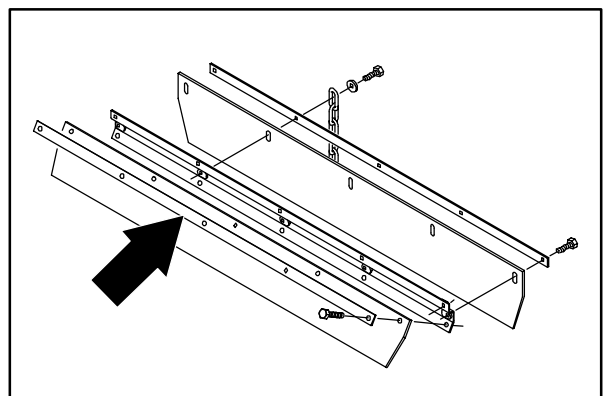


8. Slide the rear floor skirt up or down so that the skirt clears the floor up to a maximum of 5 mm (0.25 in).

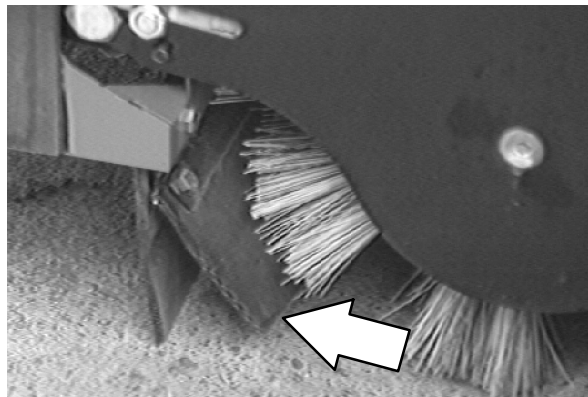


9. Tighten the rear floor skirt mounting bolts to 8-14 Nm (6-10 ft lb).

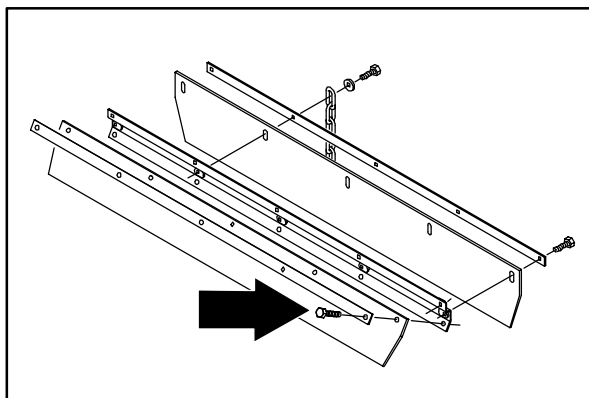
10. Remove the brush contact blade retaining strip and the brush contact blade. Discard the old blade.



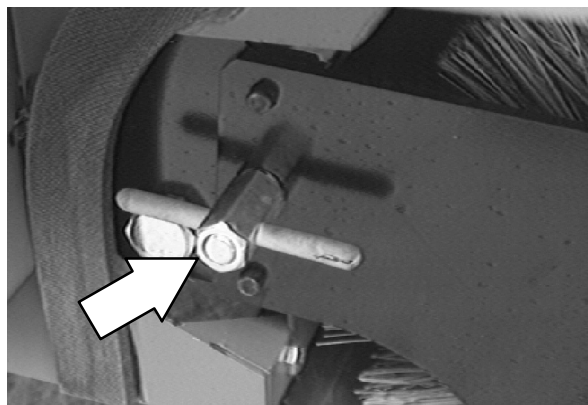
11. Position the new blade on the machine.



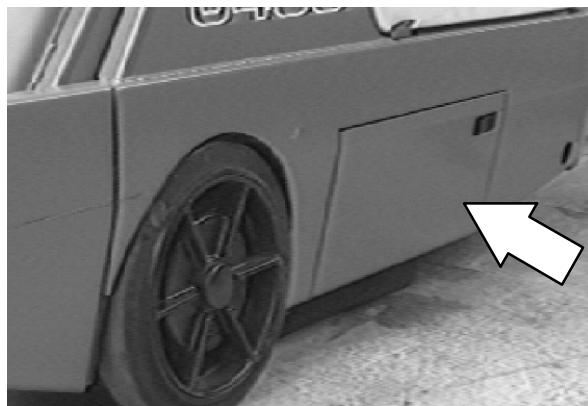
12. Thread the mounting bolts through the mounting bracket, the brush contact blade, and the retaining strip.
13. Tighten the brush contact blade mounting bolts to 8-14 Nm (6-10 ft lb).



14. Reinstall the main brush.



15. Close the main brush doors.



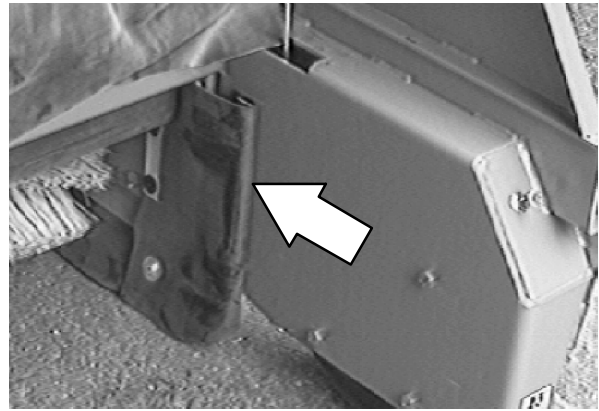
16. Operate the machine and check for proper operation.

## SWEEPING

### HOPPER SIDE SEALS

The hopper seals are located on the side portions of the machine frame that contact the hopper. They seal the main brush compartment. Tighten the seal hardware to 4–5 Nm (3–4 ft lb).

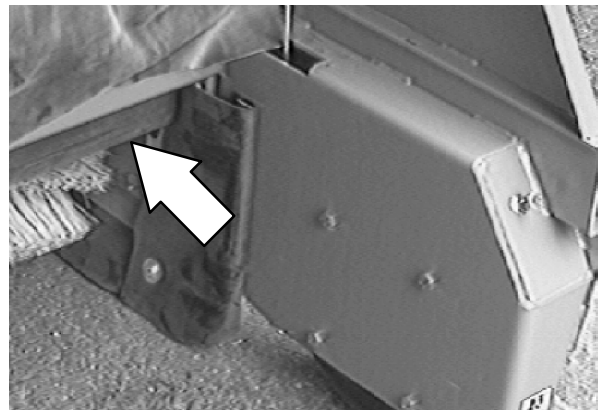
Inspect the seals for wear or damage every 100 hours of operation.



### HOPPER TOP SEAL

The hopper dust seal is located under the front of the machine frame in the area of the machine that is contacted when the hopper is in the down position.

Check the seal for wear or damage every 100 hours of operation. You can reach the seal by lifting the hopper and engaging the prop arm.



**TO REPLACE HOPPER SIDE SEALS**

1. Park the machine on a smooth, level surface.
2. Stop the machine and set the parking brake.
3. Raise hopper and engage hopper support bar.

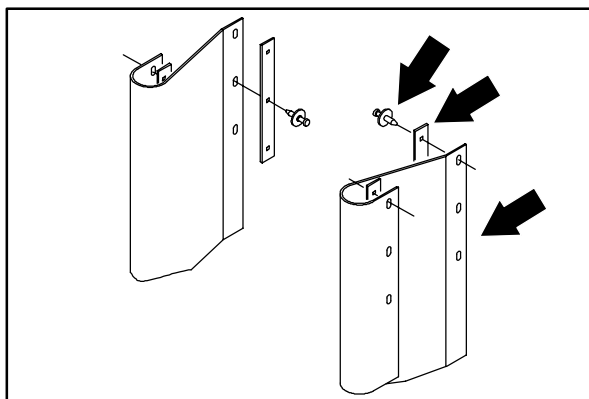


**WARNING: Raised Hopper May Fall.  
Engage Hopper Support Bar.**

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**



4. Remove the skirt retainer and skirt from each side of the machine. Remove the plastic hardware by prying under the head.



5. Position the new skirt and existing retainer on the front of the machine frame. Secure with plastic push-in hardware.



6. Repeat on the other side of the main frame.

## **SWEEPING**

### **HOPPER INSPECTION DOOR SEAL**

The hopper inspection door seal is located on the hopper and seals the front of the debris hopper.

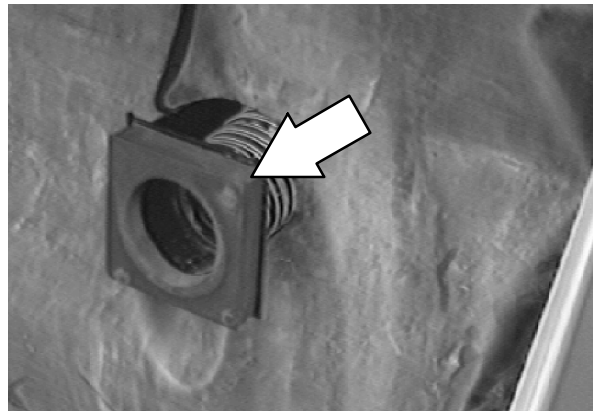
Check the seal for wear or damage every 100 hours of operation.



### **HOPPER VACUUM FAN SEAL**

The hopper vacuum fan seal is mounted on the front the vacuum fan inlet assembly.

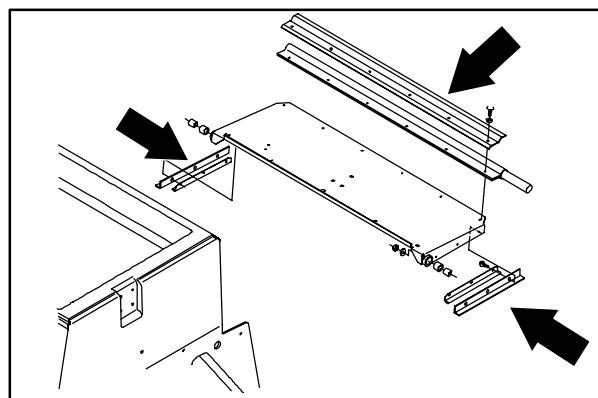
Check the seal for wear or damage every 100 hours of operation. You can reach the seal by removing the hopper insert.



### **HOPPER DUMP DOOR SEALS**

The hopper door seals are located on the hopper door. They seal the hopper when the hopper door is closed. Tighten hardware to 3–4 Nm (2.5–3.5 ft lb).

Check the seals for wear or damage every 100 hours of operation.





**TO REPLACE HOPPER DUMP DOOR SEALS**

1. Park the machine on a smooth, level surface and open the hopper dump door.
2. Stop the machine and set the parking brake.
3. Raise hopper and engage hopper support bar.

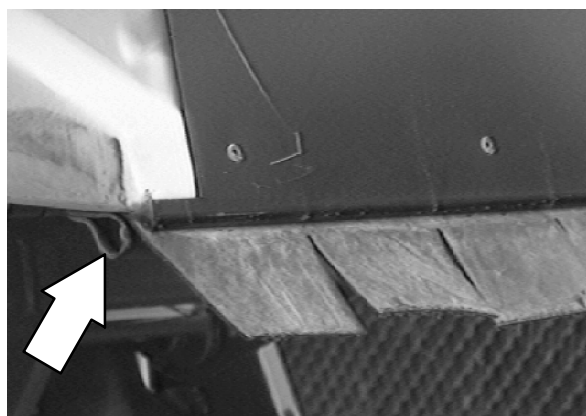


**WARNING: Raised Hopper May Fall.  
Engage Hopper Support Bar.**

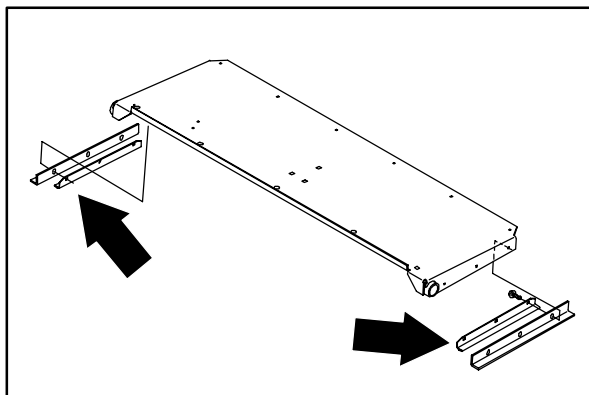
**FOR SAFETY: Before Leaving Or Servicing  
Machine; Stop On Level Surface, Set Parking  
Brake, Turn Off Machine And Remove Key.**



4. Remove the six hex screws holding the dump door seal, retainer, and sponge cord to dump door. Discard the old seal.

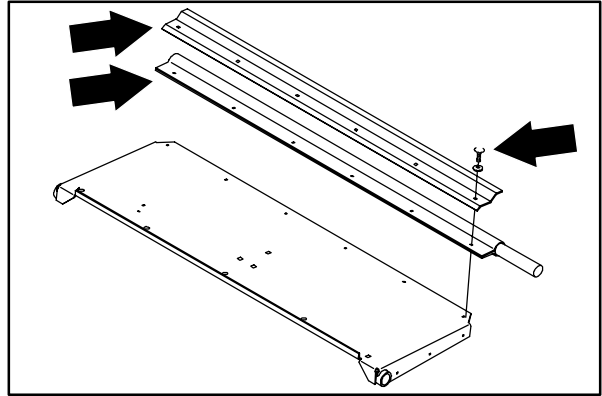


5. Remove the three hex screws holding each side seal to the dump door. Discard the old seals.

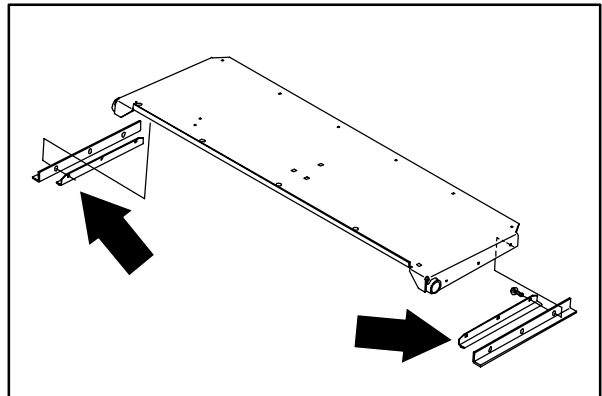


## SWEEPING

6. Align the holes in the new seal with holes on the rear of the dump door and retainer. Reinstall the six hex screws. Tighten to 3.3 – 4.4 Nm (30 – 39 In lb).



7. Align the holes in the new side seal with holes on the edge of the dump door and retainer. Reinstall the three hex screws. Tighten to 3.3 – 4.4 Nm (30 – 39 In lb). *Make sure the seals are lined up with edge of hopper when tightening.*



8. Start machine and lower hopper.

9. Operate the machine and check the dump door for proper operation.



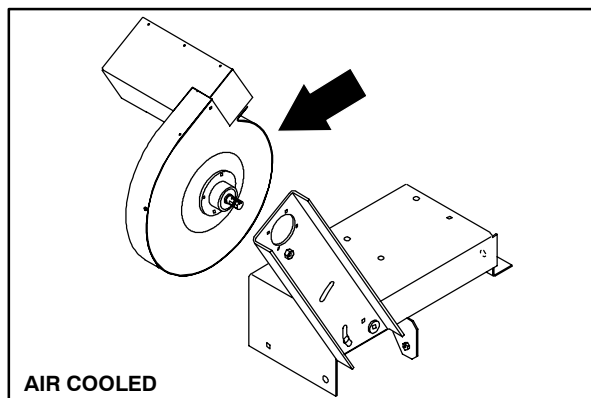
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**VACUUM FAN**

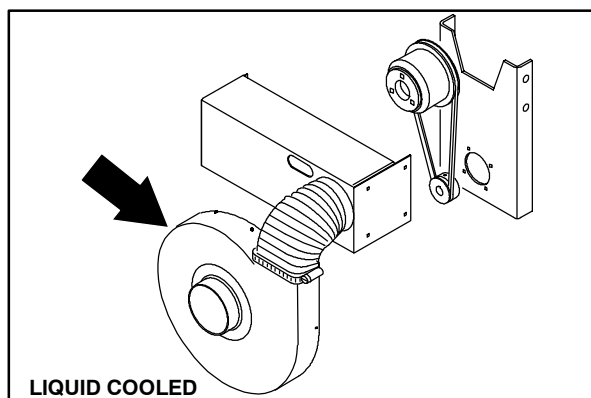
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The vacuum fan is located in the engine compartment. The vacuum fan is used during sweeping to control dusting by pulling air from the main brush area through the hopper to the dust filters.

On the air cooled machine the vacuum fan is located in front of the engine.



On the water cooled machine the vacuum fan is located under the radiator.



## SWEEPING

### TO REMOVE VACUUM FAN ASSEMBLY (Liquid cooled)

1. Park the machine on a smooth, level surface.
2. Stop the engine and set the machine parking brake.

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

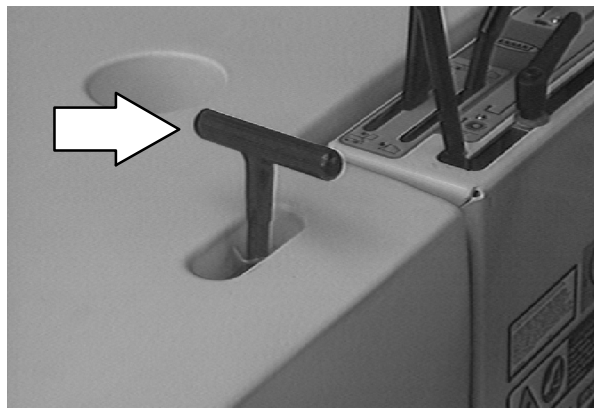
3. Jack up the rear of the machine and install jack stands under the machine frame.



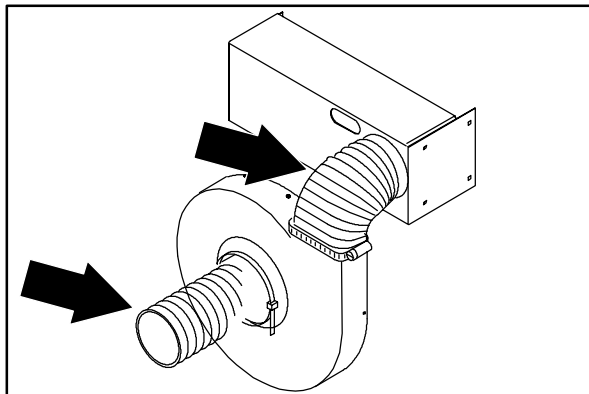
4. Remove the rear tire and wheel assembly.



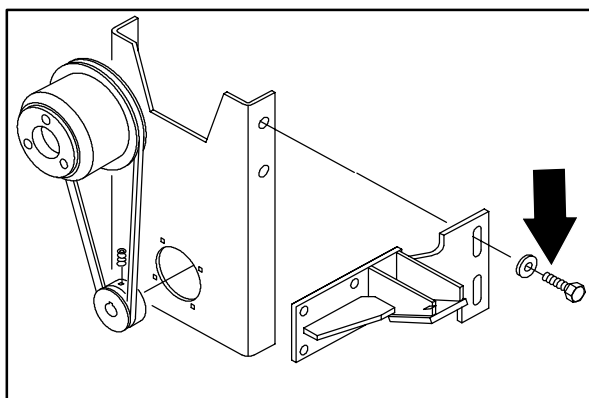
5. Open the seat shroud.



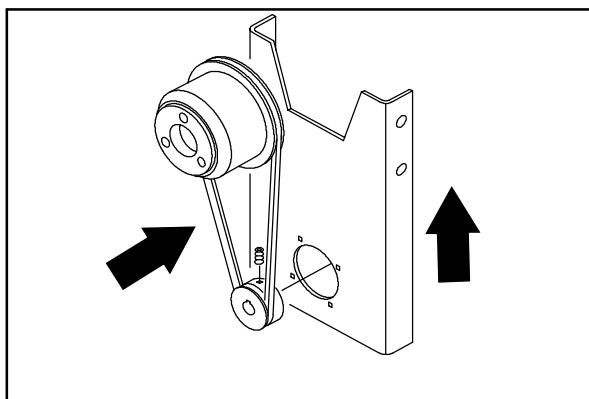
6. Remove the two vacuum hoses connected to the vacuum fan assembly.



7. Loosen the four hex screws holding the vacuum fan assembly to the bottom mount bracket.



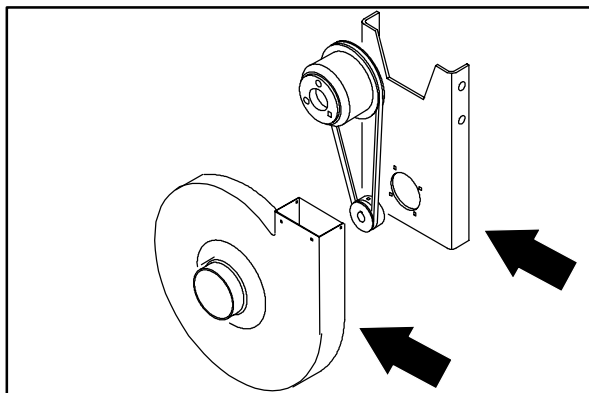
8. Move the vacuum fan assembly up far enough to remove the V-belt from the sheave. Remove the V-belt.



9. Remove the four hex screws holding the vacuum fan assembly to the bottom mount bracket.

10. Remove the vacuum fan assembly from the bottom of the machine.

*NOTE: The vacuum fan assembly must be removed out the bottom of the machine.*



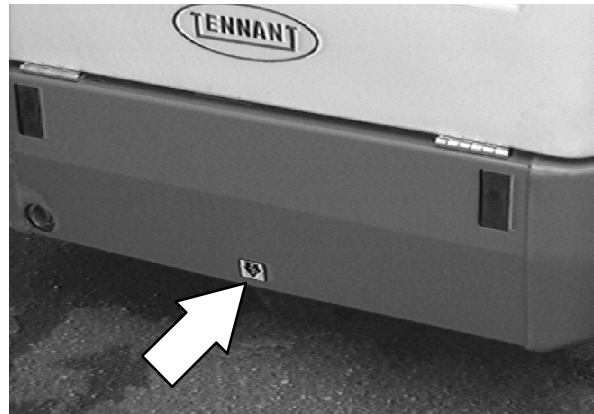
## SWEEPING

### TO INSTALL VACUUM FAN ASSEMBLY (Liquid cooled)

1. Park the machine on a smooth, level surface.
2. Stop the engine and set the machine parking brake.

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

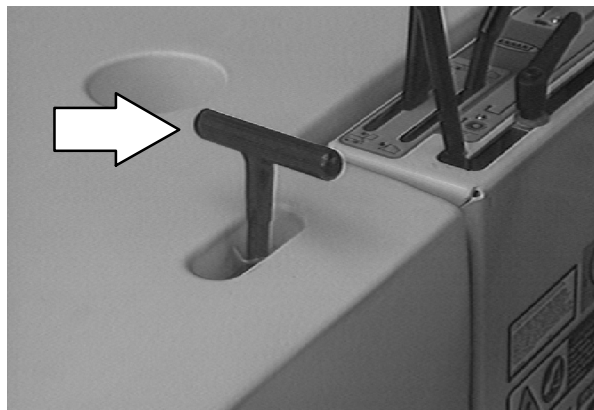
3. Jack up the rear of the machine and install jack stands under the machine frame.



4. Remove the rear tire and wheel assembly.

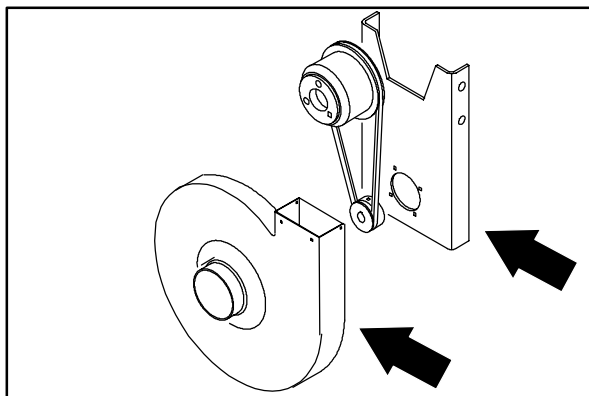


5. Open the seat shroud.

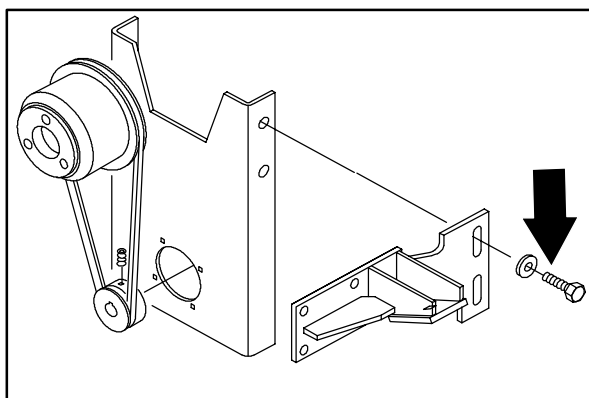


6. Position the vacuum fan assembly in the machine.

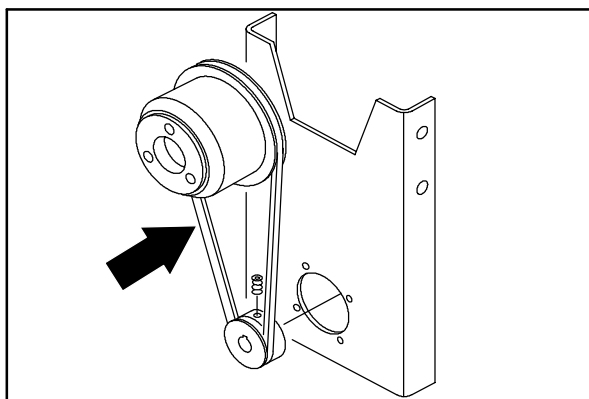
*NOTE: Bring the vacuum fan assembly in under the rear of the machine.*



7. Align the holes in vacuum fan mount bracket with the bracket on the machine. Reinstall the four hex screws and nuts. Leave loose for now.

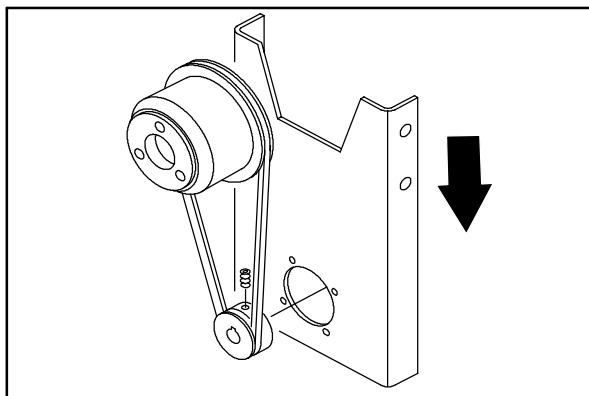


8. Reinstall the V-belt on the vacuum fan sheave and engine sheave.



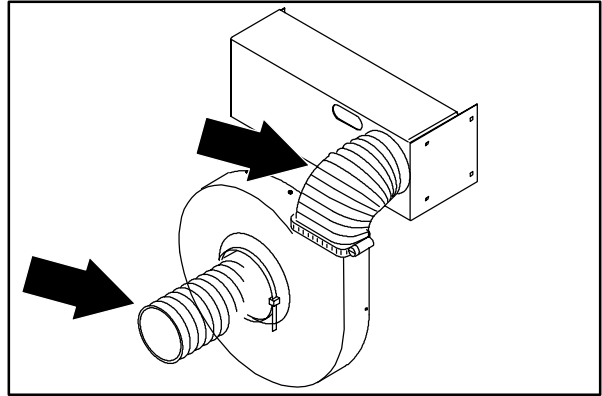
9. Pull down lightly on the vacuum fan assembly to tighten the V-belt. The belt spec. is  $20 \pm 3$  lb tension. Apply 1.5 lb at the middle of the belt span to obtain .17 inch of deflection.

10. Firmly tighten the four hex screws.



## SWEEPING

11. Reconnect the two vacuum hoses to the vacuum fan housing.



12. Reinstall the rear tire and wheel assembly. Tighten the wheel nuts to 122 - 150 Nm (90 - 110 ft lb).



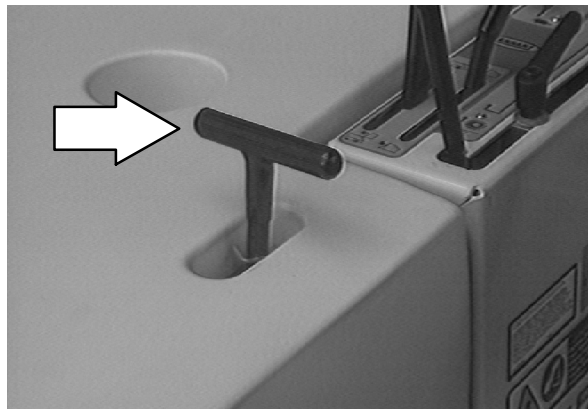
13. Remove the jack stands and lower the machine.
14. Start the machine and operate the vacuum fan. Check for proper operation.



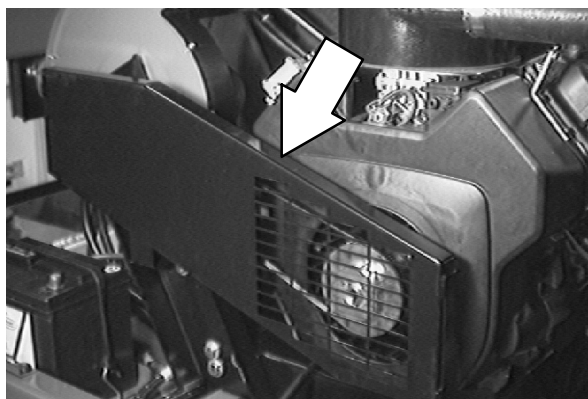
**TO REMOVE VACUUM FAN ASSEMBLY  
(Air cooled)**

1. Park the machine on a smooth, level surface.
2. Stop the engine and set the machine parking brake. Open the engine shroud.

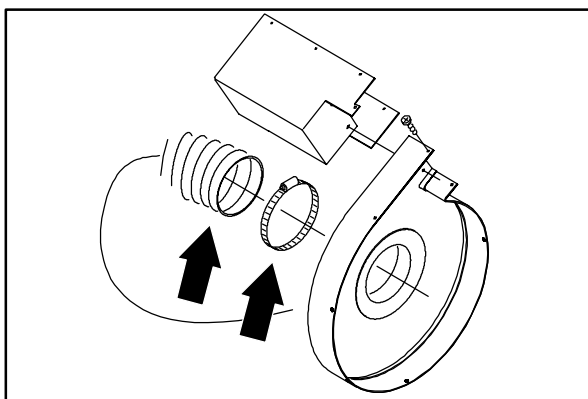
**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**



3. Remove the vacuum fan belt guard.

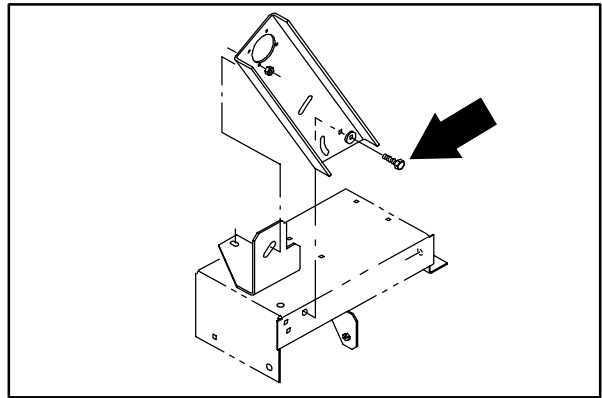


4. Remove the vacuum hose connected to the vacuum fan assembly.

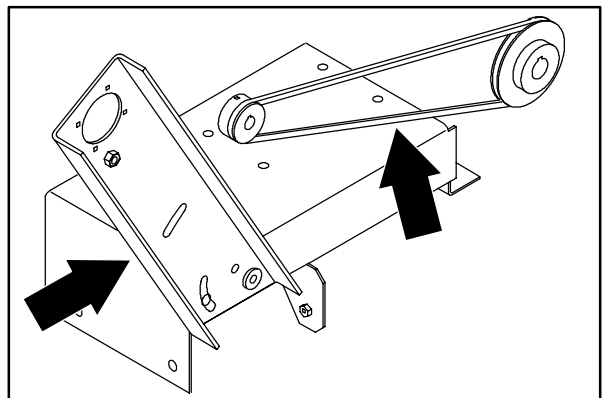


## SWEEPING

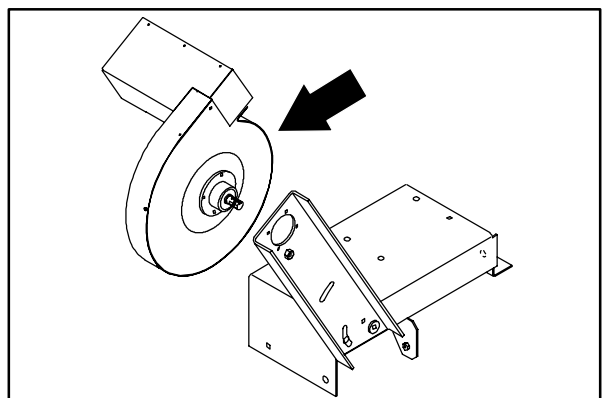
5. Loosen the three hex screws holding the vacuum fan assembly mount bracket to the machine frame.



6. Move the vacuum fan assembly toward the engine and remove the V-belt from the sheave. Remove the V-belt.



7. Remove the three hex screws holding the vacuum fan assembly to the machine frame.

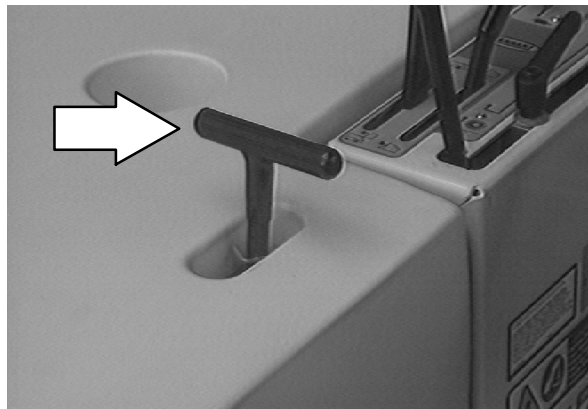


8. Remove the vacuum fan assembly from the machine.

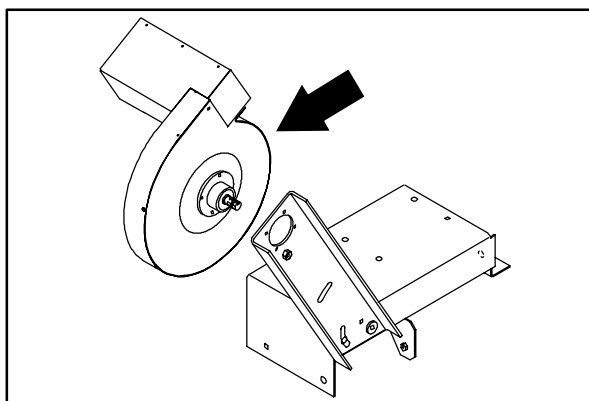
**TO INSTALL VACUUM FAN ASSEMBLY  
(Air cooled)**

1. Park the machine on a smooth, level surface.
2. Stop the engine and set the machine parking brake. Open the engine shroud.

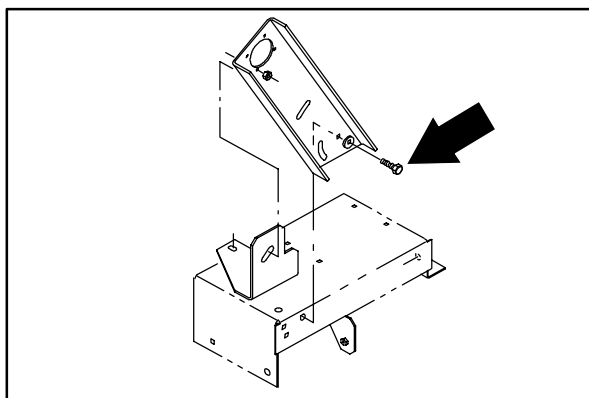
**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**



3. Position the vacuum fan assembly in the machine.

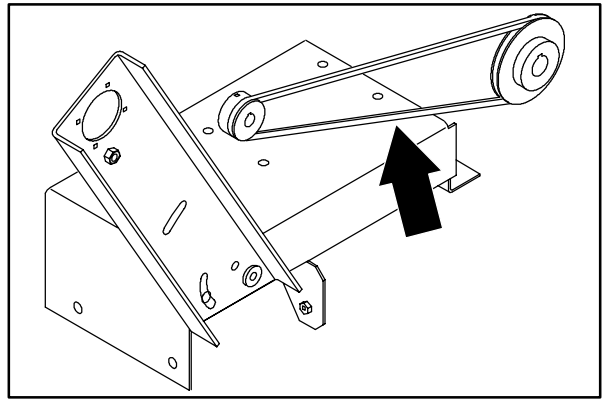


4. Align the holes in vacuum fan mount bracket with the holes in the machine frame. Reinstall the three hex screws. Leave loose for now.



## SWEEPING

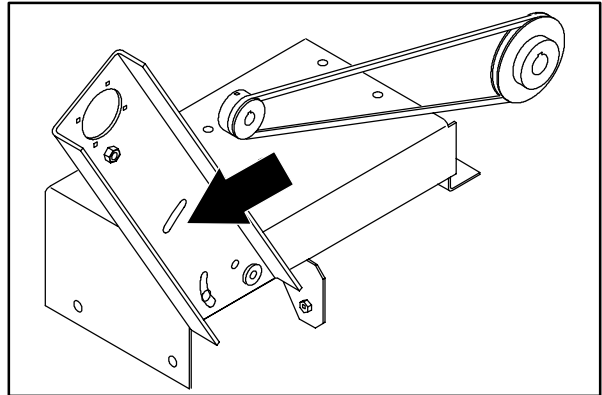
5. Reinstall the V-belt on the vacuum fan sheave and engine sheave.



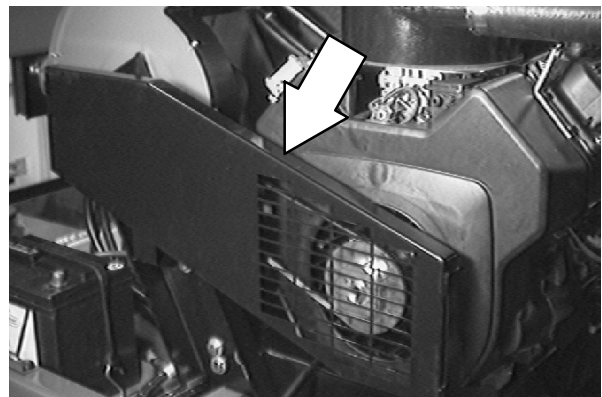
6. Pull the vacuum fan assembly toward the front of the machine to tighten the V-belt. The belt spec. is  $20 \pm 3$  lb tension. Apply 1.5 lb at the middle of the belt span to obtain .28 inch of deflection.

*NOTE: Use a straight edge to make sure the sheave on the engine is in line with the sheave on the vacuum fan assembly.*

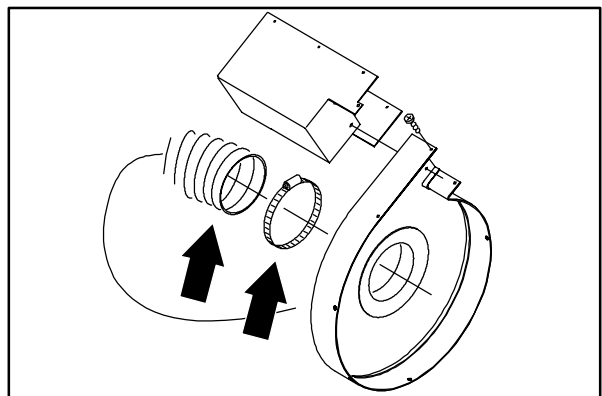
7. Firmly tighten the hex screws.



8. Reinstall the fan belt guard.



9. Reconnect the vacuum hose to the vacuum fan housing.



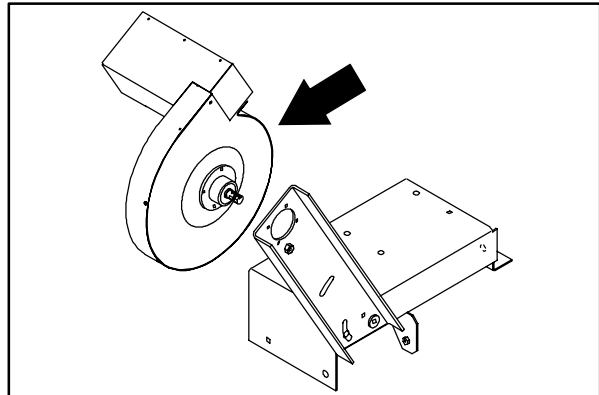
10. Start the machine and operate the vacuum fan. Check for proper operation.

**TO REPLACE VACUUM FAN IMPELLER**

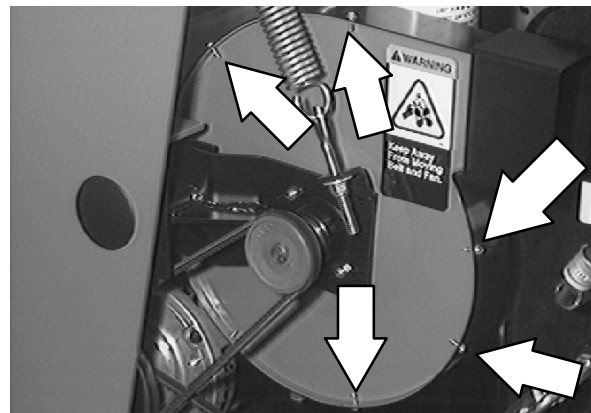
1. Park the machine on a smooth, level surface.
2. Stop the machine and set the parking brake.

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

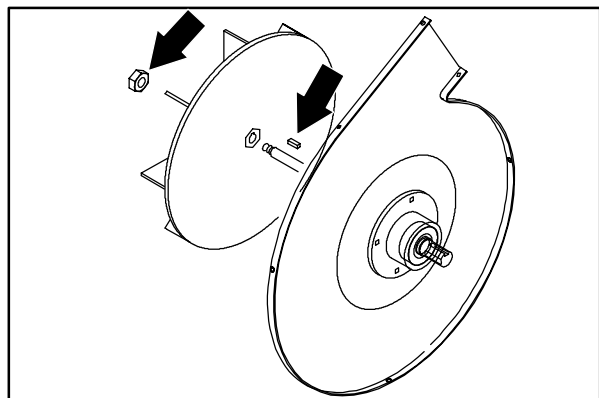
3. Remove the vacuum fan assembly from the machine. See TO REMOVE VACUUM FAN ASSEMBLY instructions in this section.



4. Remove the nine thread cutting screws holding the fan housing to the fan assembly. Remove the housing.



5. Hold the impeller from turning and remove the hex nut from the end of the fan impeller shaft. Pull the impeller straight off the shaft.

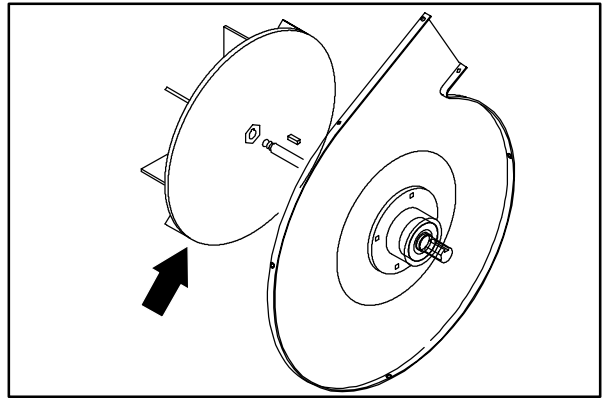


**NOTE:** Make sure to retain the shaft key and spacer.

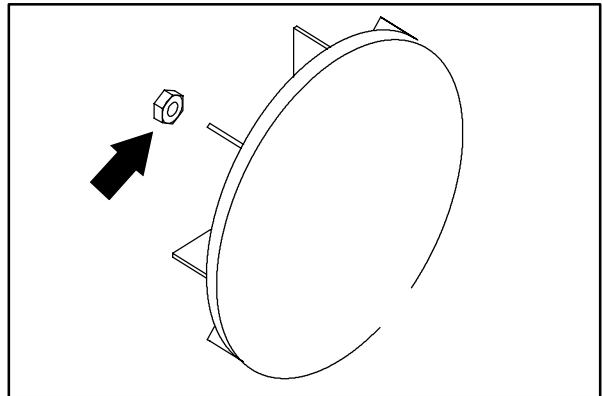
## SWEEPING

- Put a small amount of grease on the impeller shaft before installing the new impeller. Slide the new impeller on the shaft.

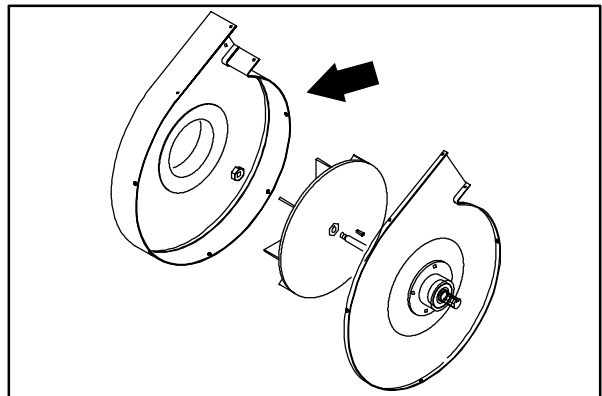
*NOTE: Make sure the impeller spacer and square key are in place on the impeller shaft.*



- Reinstall the hex nut on the end of the impeller shaft.
- Hold the new impeller from turning and firmly tighten the flex lock nut.

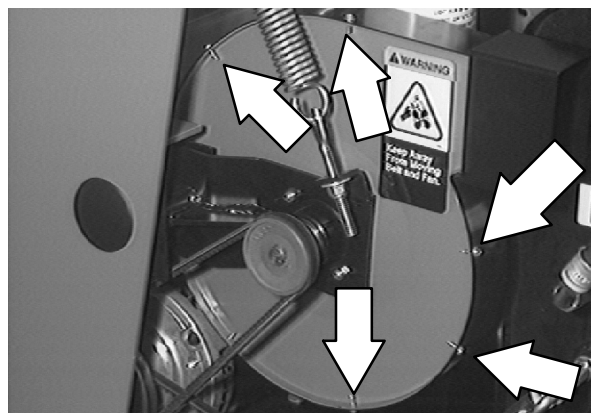


- Reinstall the fan housing on the fan assembly.



- Reinstall the nine thread cutting screws in the fan housing. Hand tighten.

- Reinstall the vacuum fan assembly in the machine. See TO INSTALL VACUUM FAN ASSEMBLY instructions in this section.

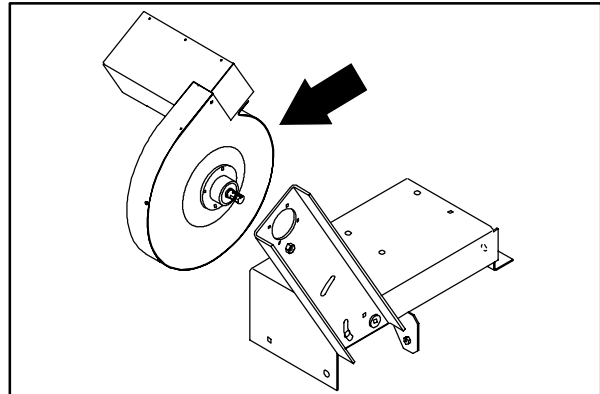


## TO REPLACE VACUUM FAN IMPELLER BEARINGS

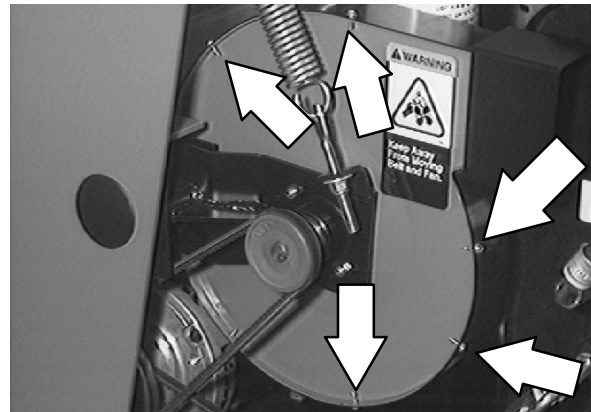
1. Park the machine on a smooth, level surface.
2. Stop the machine and set the parking brake.

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

3. Remove the vacuum fan assembly from the machine. See TO REMOVE VACUUM FAN ASSEMBLY instructions in this section.

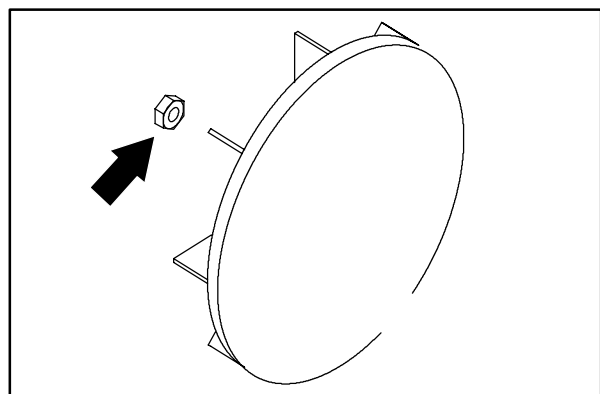


4. Remove the nine thread cutting screws holding the fan housing to the fan assembly. Remove the housing.



5. Hold the impeller from turning and remove the hex nut from the end of the fan impeller shaft. Pull the impeller straight off the shaft.

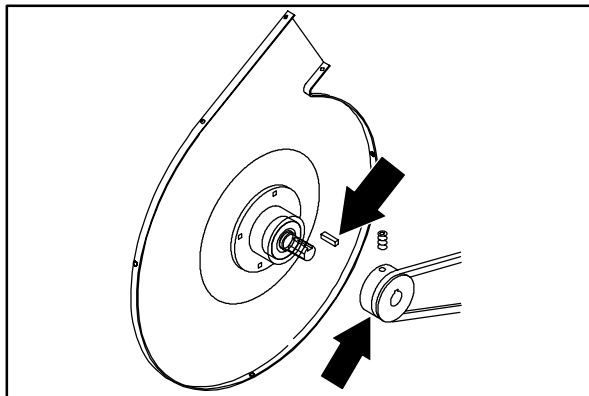
**NOTE:** Make sure to retain the shaft key and spacer.



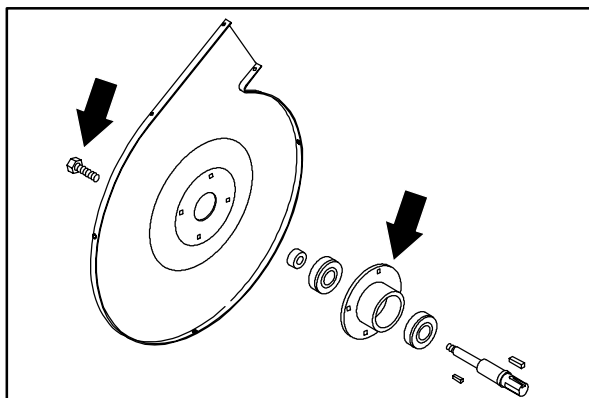
## SWEEPING

6. Loosen the two set screws holding the belt sheave to the impeller shaft. Remove the sheave.

*NOTE: Make sure to retain the shaft key.*

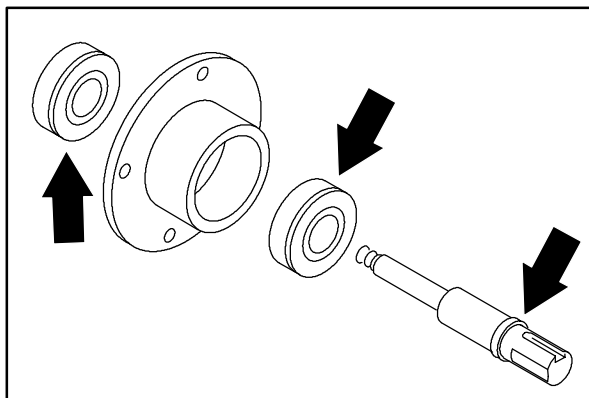


7. Remove the four hex screws holding the bearing assembly to the fan mount bracket and fan assembly back plate. Remove the bearing assembly.

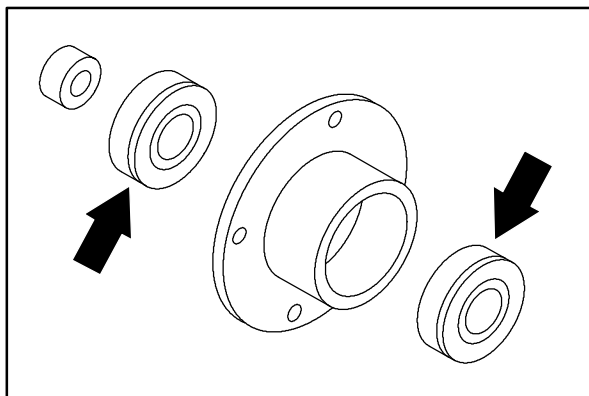


8. Use a small press to remove the impeller shaft and two bearings from the bearing housing.

*NOTE: Make sure to note the orientation of the bearings and impeller shaft in relation to the bearing housing.*

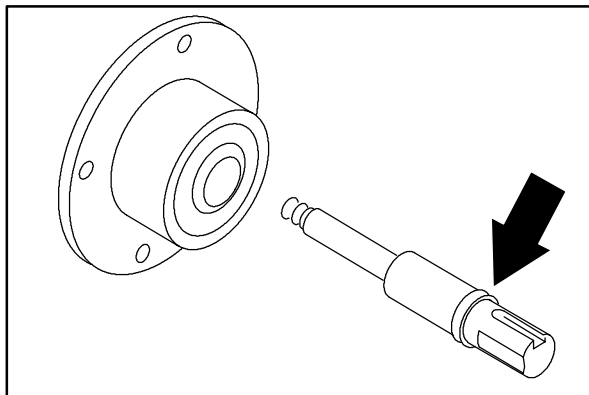


9. Press two new bearings in the bearing housing.

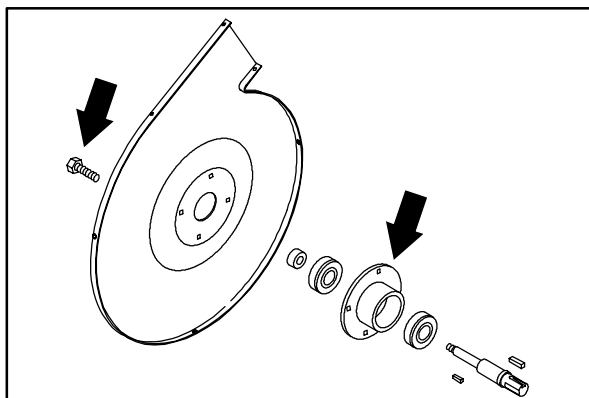




10. Press the impeller shaft in the new bearings.

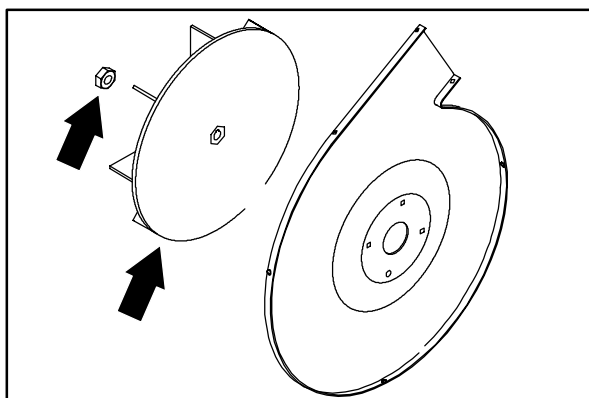


11. Reinstall the bearing housing and fan assembly back plate on the fan mount plate. Tighten the four M6 hex screws and nyloc nuts to 7.6 – 9.9 Nm (5 – 6 ft lb).

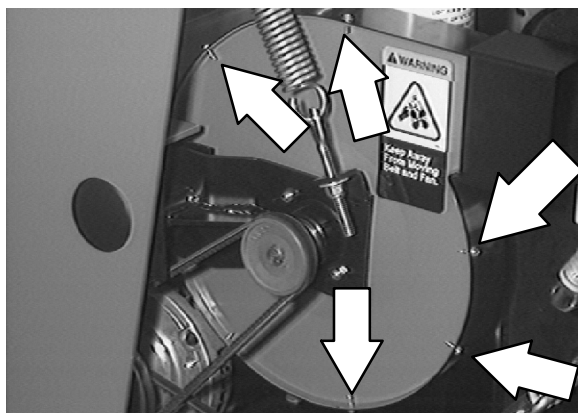


12. Reinstall the spacer, key, and impeller on the shaft.

*NOTE: Place a small amount of grease on the impeller shaft to ease installation.*

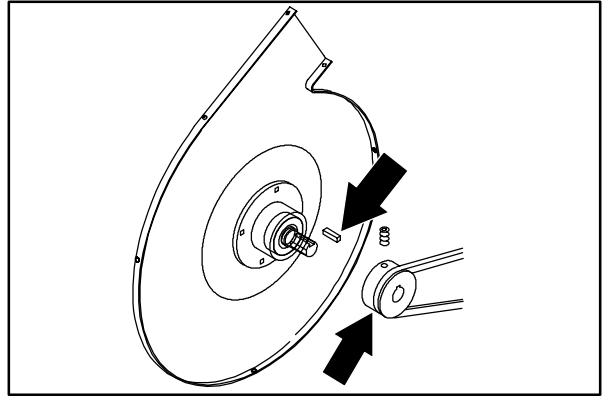


13. Reinstall the fan impeller housing using the nine thread cutting screws. Tighten to 223 – 290 Ncm (20 – 25 in lb).

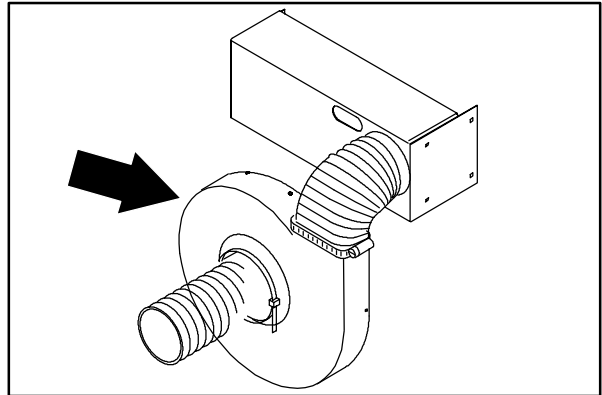


## SWEEPING

14. Go to the other side and reinstall the square key and sheave. Push the sheave all the way on and hand tighten the two set screws tight.



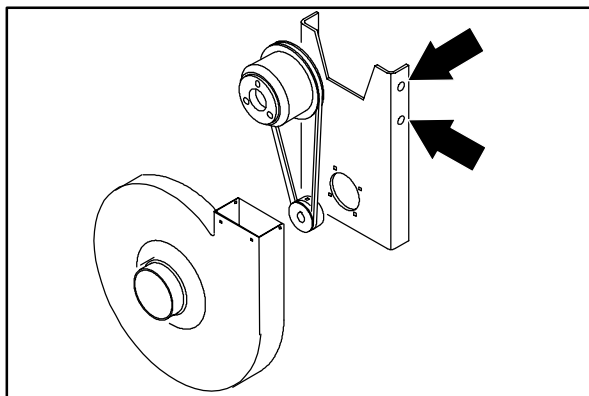
15. Reinstall the vacuum fan assembly in the machine. See TO INSTALL VACUUM FAN ASSEMBLY instructions in this section.



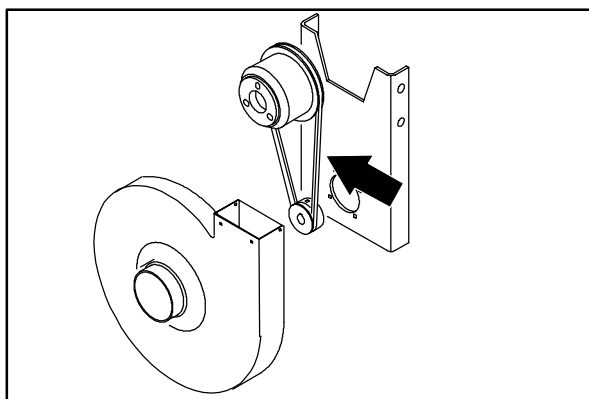
## TO TENSION VACUUM FAN BELT (liquid cooled)

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

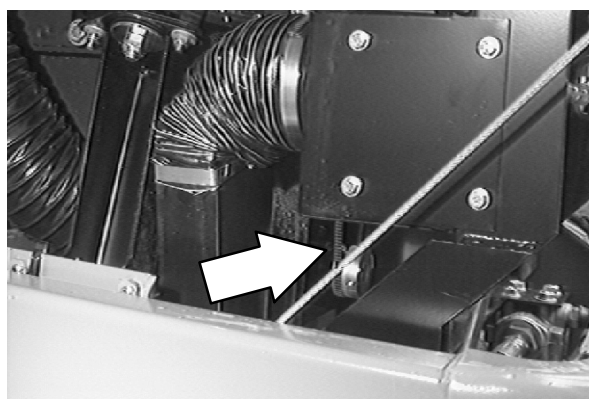
1. Loosen the four hex screws holding the vacuum fan assembly to the mount bracket under the radiator.



2. Use a static 20lbs (+ or - 3lbs) to tension the V-belt.
3. Tighten the four hex screws.
4. Apply 1-1/2 lbs of force to the middle of the V-belt (1/2 way between the two sheaves). There should be approximately 5/32" of deflection.



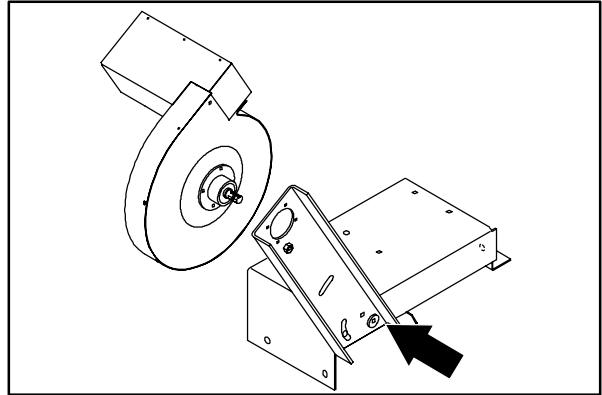
5. Re-check belt tension.



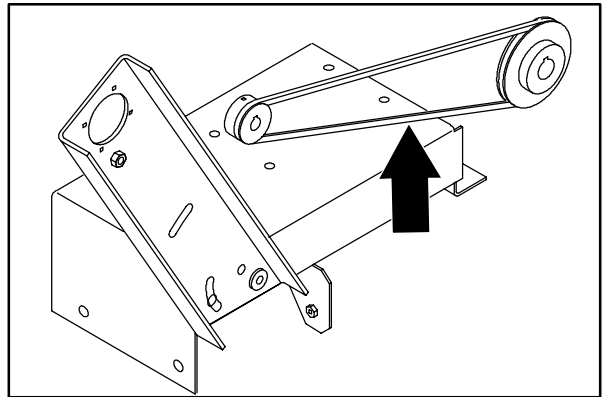
### TO TENSION VACUUM FAN BELT (Air cooled)

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

1. Loosen the hex screws holding the vacuum fan assembly mount plate to the engine mount bracket.



2. Use a static 20lbs (+ or - 3lbs) to tension the V-belt.
3. Tighten the hex screws.
4. Apply 1-1/2 lbs of force to the middle of the V-belt (1/2 way between the two sheaves). There should be approximately 1/4" of deflection.



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**MACHINE TROUBLESHOOTING**


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<b>Problem</b>	<b>Cause</b>	<b>Remedy</b>
<i>Excessive dusting</i>	Brush skirts and dust seals worn, damaged, out of adjustment	Replace or adjust brush skirts or dust seals
	Hopper dust filter clogged	Shake and/or clean or replace dust filter
	Vacuum hose damaged	Replace vacuum hose
	Vacuum fan failure	Contact TENNANT service personnel
	Hopper door partially or completely closed	Open the hopper door
	Thermo Sentry™ tripped	Reset Thermo Sentry™
<i>Poor sweeping performance</i>	Brush bristles worn	Replace brushes
	Main and side brushes not adjusted properly	Adjust main and side brushes
	Debris caught in main brush drive mechanism	Free drive mechanism of debris
	Main brush drive failure	Contact TENNANT service personnel
	Side brush drive failure	Contact TENNANT service personnel
	Hopper full	Empty hopper
	Hopper lip skirts worn or damaged	Replace lip skirts
	Hopper door partially or completely closed	Open the hopper door
	Wrong sweeping brush	Contact TENNANT representative for recommendations



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**INTRODUCTION**

The machines electrical system consists of the battery, instrument panel, switches, relays, and circuit breakers.

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## ELECTRICAL SYSTEM

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The machine electrical system consists of the battery, alternator, and related components. This section includes information on these components and their troubleshooting.

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### BATTERY

---

The battery used in the machine is a low maintenance battery. It has been constructed with special materials and has extra electrolyte to reduce or eliminate maintenance. Its design reduces electrolyte loss and contamination. Do not add water, remove the battery vent plugs, or check the battery specific gravity. For specific instructions, see the battery label.

Do not allow the battery to remain in discharged condition for any time. Do not operate the machine if the battery is in poor condition or discharged beyond 80%, specific gravity below 1.120.

After the first 50 hours of operation, and every 800 hours after that, clean and tighten the battery connections.

Periodically clean the top surface of the batteries and the terminals, and check for loose connections. Use a strong solution of baking soda and water. Brush the solution sparingly over the battery tops, terminals, and cable clamps. Do not allow any baking soda solution to enter the batteries. Use a wire brush to clean the terminal posts and the cable connectors. After cleaning, apply a coating of clear battery post protectant to the terminals and the cable connectors. Keep the tops of the batteries clean and dry.

Keep all metallic objects off the top of the batteries, which may cause a short circuit. Replace any worn or damaged wires.

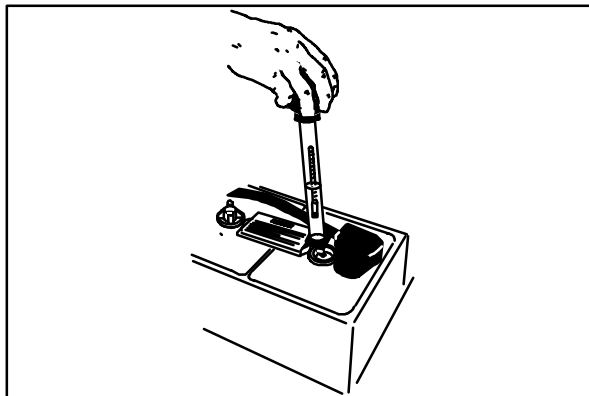
The electrolyte level in regular non-sealed batteries can be checked. The level must always be above the battery plates. Never add acid to the batteries, only distilled water. Keep the battery caps on the batteries always except when adding water or taking hydrometer readings.

**FOR SAFETY: When Servicing Machine, Avoid Contact With Battery Acid.**



Using a hydrometer to measure the specific gravity is a way to determine the charge level and condition of the batteries. If one or more of the battery cells test lower than the other battery cells (0.050 or more), the cell is damaged, shorted, or is about to fail.

*NOTE: Do not take readings immediately after adding distilled water. If the water and acid are not thoroughly mixed, the readings may not be accurate. Check the hydrometer readings against the following chart to determine the remaining battery charge level:*



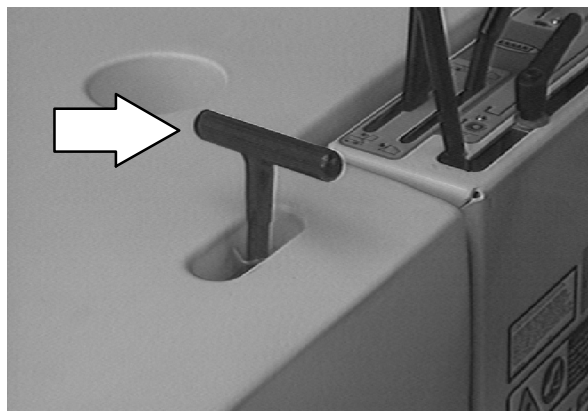
SPECIFIC GRAVITY at 27° C (80° F)	BATTERY CHARGE
1.260 - 1.280	100% Charged
1.230 - 1.250	75% Charged
1.200 - 1.220	50% Charged
1.170 - 1.190	25% Charged
1.110 - 1.160	Discharged

*NOTE: If the readings are taken when the battery electrolyte is any temperature other than 27° C (80° F), the reading must be temperature corrected. Add or subtract to the specific gravity reading 0.004, 4 points, for each 6° C (10° F) above or below 27° C (80° F).*

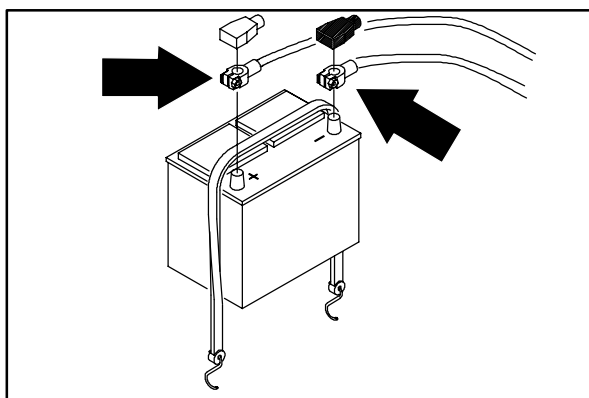
### TO REPLACE BATTERY

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

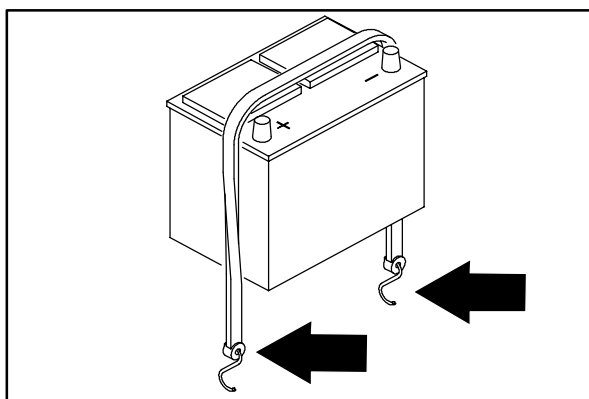
1. Tilt the seat support. Locate the battery on the left side of the machine in front of the engine.



2. Disconnect the battery cables.



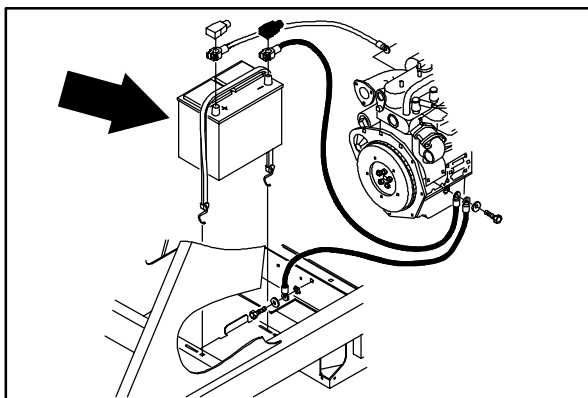
3. Remove the battery hold down strap.



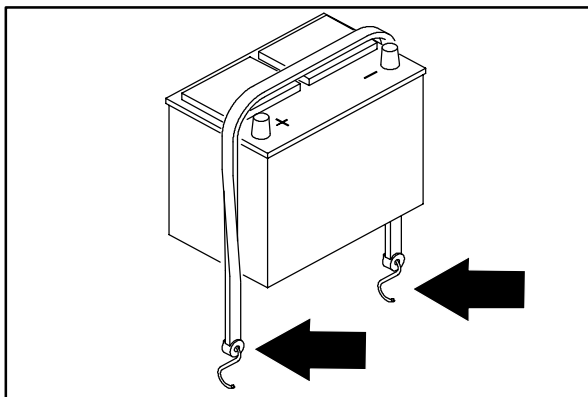
4. Lift the battery out of the machine using a battery lifting device.



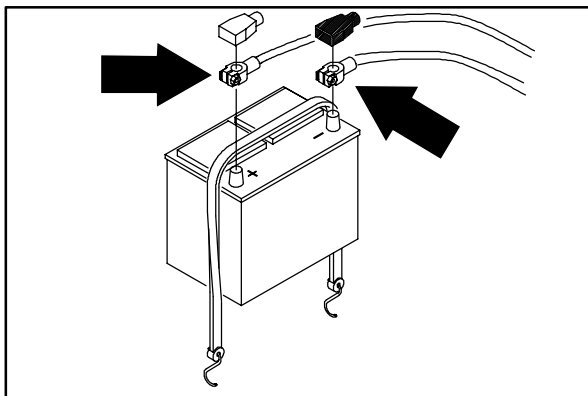
5. Make sure that both posts are clean on the new battery. Position the new battery in the machine.



6. Reinstall the battery hold down strap.



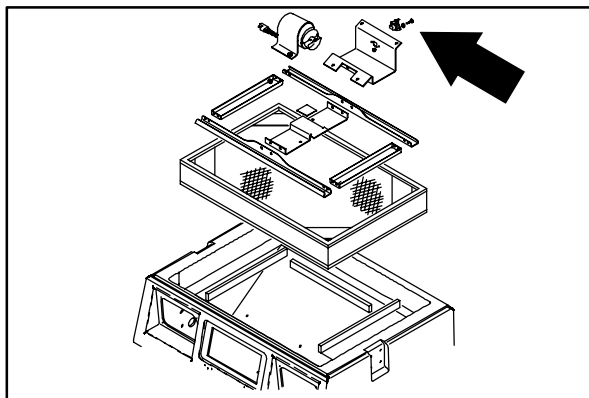
7. Reconnect the positive, then the negative battery cables.



8. Lower the seat support and start the machine to test the new battery.

## THERMO SENTRY™

The Thermo Sentry™ senses the temperature of the air pulled up from the hopper. If there is a fire in the hopper, the Thermo Sentry™ stops the vacuum fan and cuts off the air flow.



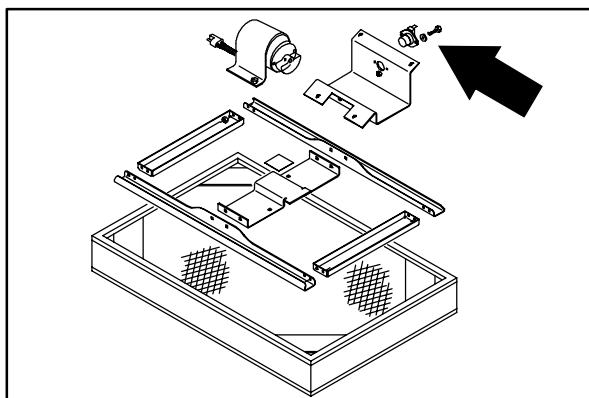
### TO REPLACE THERMO SENTRY™

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

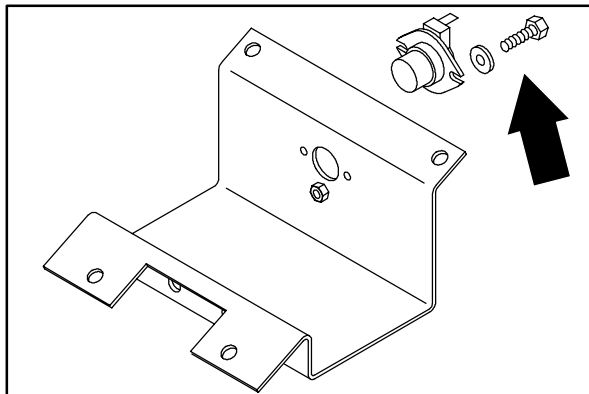
1. Open the hopper cover and engage prop rod.



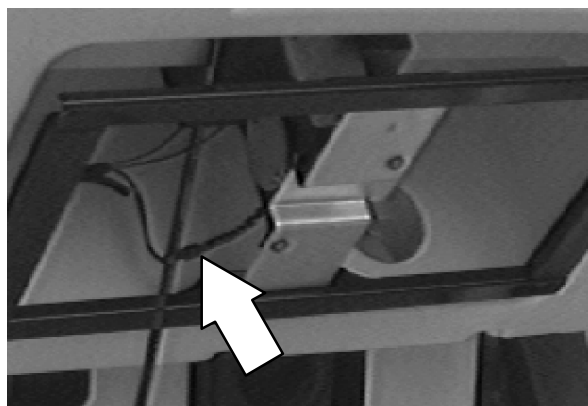
2. Locate the Thermo Sentry™ on the back of the filter shaker motor bracket. Unplug the two wires leading to the Thermo Sentry™.



3. Remove the hex screws holding the Thermo Sentry™ to the bracket. Remove from the hopper.
4. Install the new Thermo Sentry™ on the bracket. Reinstall the hardware and tighten,



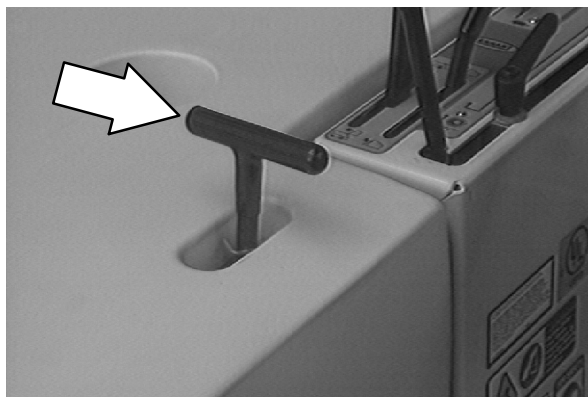
5. Reconnect the wires and close the hopper cover.



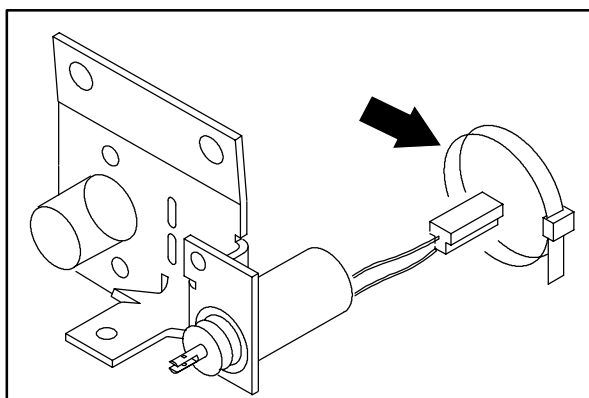
### TO REPLACE THERMO SENTRY™ SHUT OFF SOLENOID

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

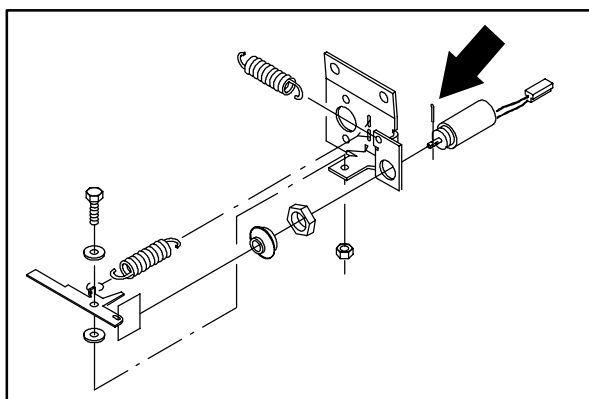
1. Open the seat support.



2. Cut the plastic wire tie holding the Thermo Sentry™ solenoid wire to the machine. Disconnect the Thermo Sentry™ solenoid wire harness from hopper harness.

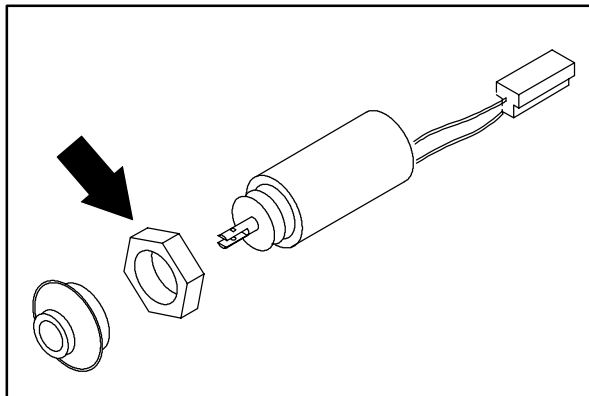


3. Remove the pin connecting the rod of the Thermo Sentry™ solenoid to the lever.

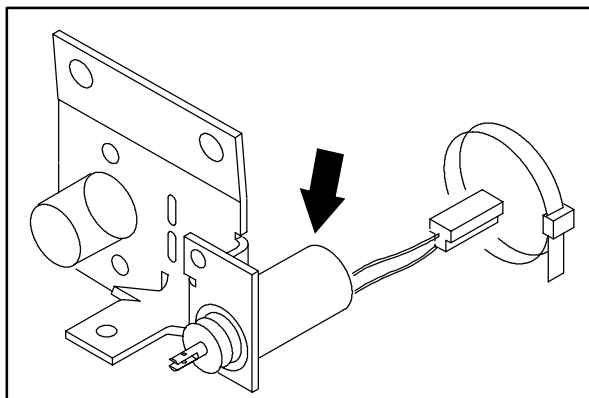




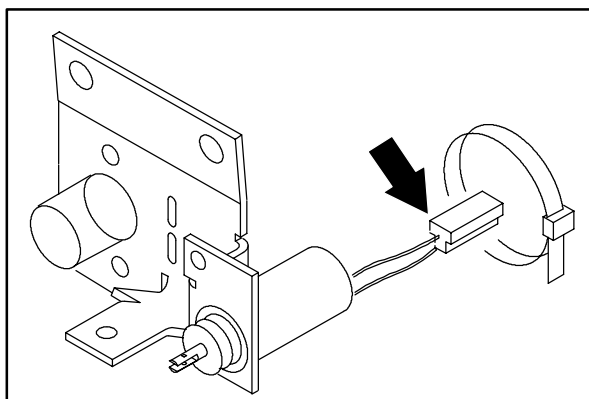
4. Remove the large nut holding Thermo Sentry™ solenoid to the bracket. Remove the Thermo Sentry™ solenoid from the machine.



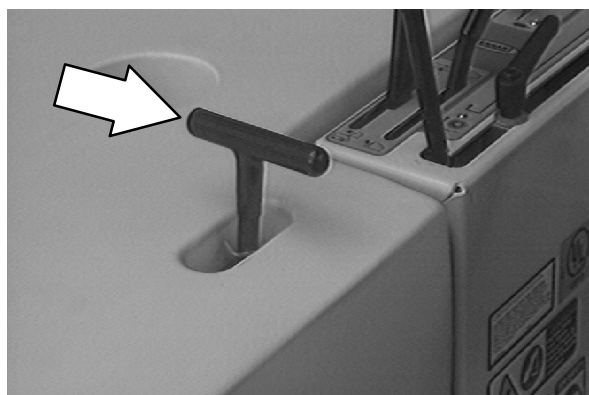
5. Mount the new Thermo Sentry™ solenoid on the bracket with existing hardware.



6. Reconnect the wires to the Thermo Sentry™ solenoid.

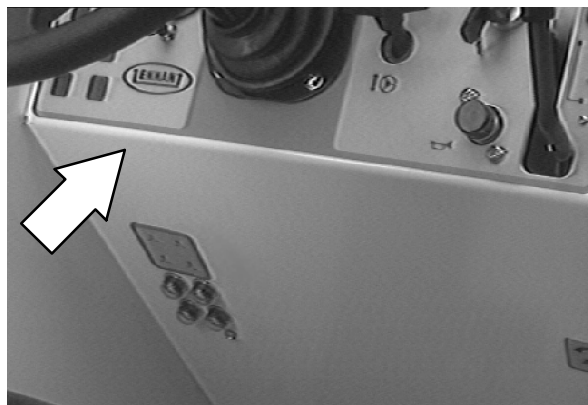


7. Close the seat support.



## INSTRUMENT PANEL

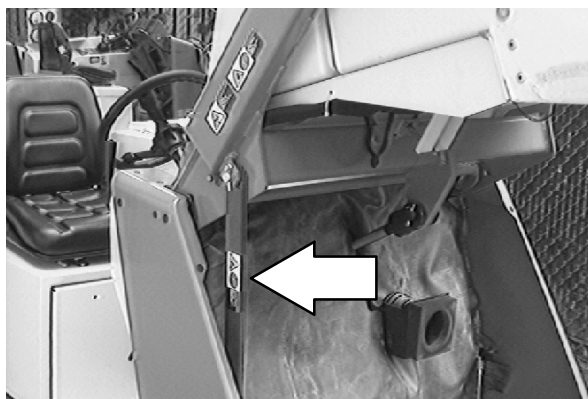
The instrument panel consists of a key switch, light switch, hour meter, fuel gauge, horn button, circuit breakers, and indicator light panel.



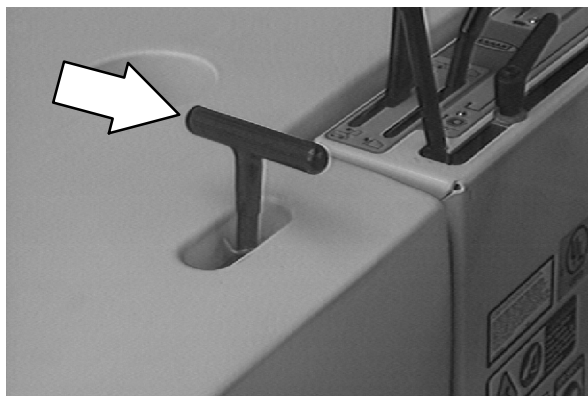
### TO REPLACE INDICATOR LIGHT

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

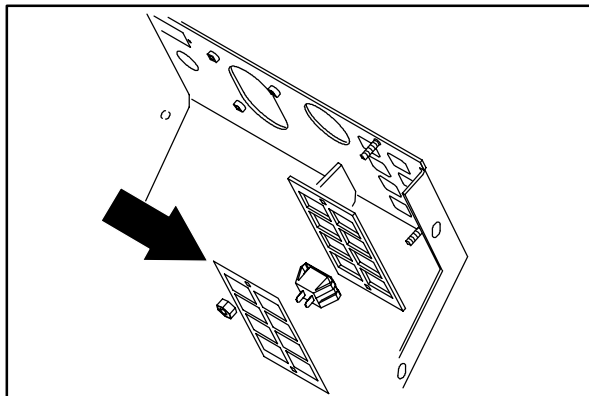
1. Raise the hopper and engage the support bar.



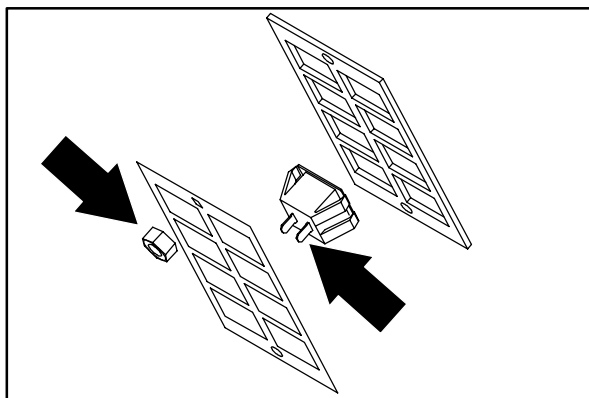
2. Open the seat support and disconnect the battery.



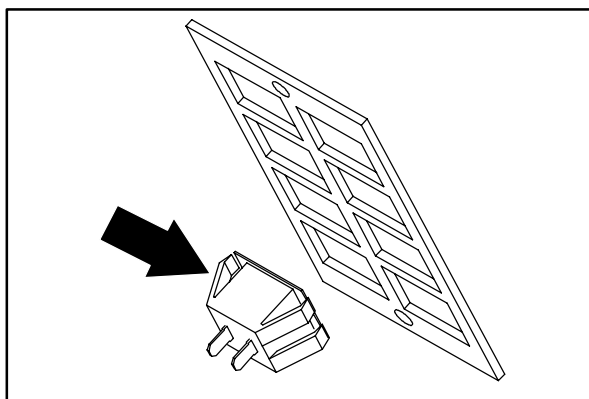
3. Locate the indicator light panel mount plate next to the power steering orbital control.



4. Remove the two nyloc nuts holding the mount plate to the instrument panel. Pull the mount plate back away from the instrument panel.



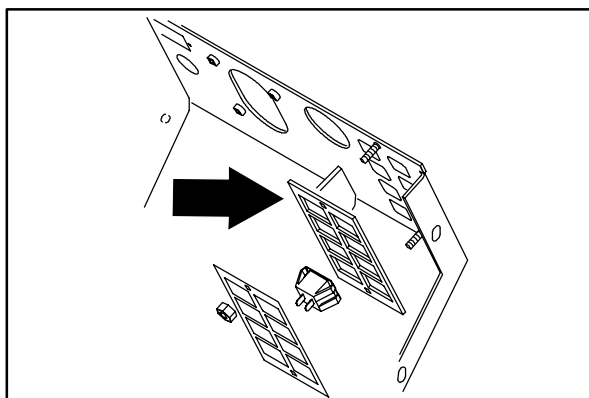
5. Unplug the two wires leading to the light that needs to be changed.



6. Squeeze the sides of the light and push the light out of the mount plate.

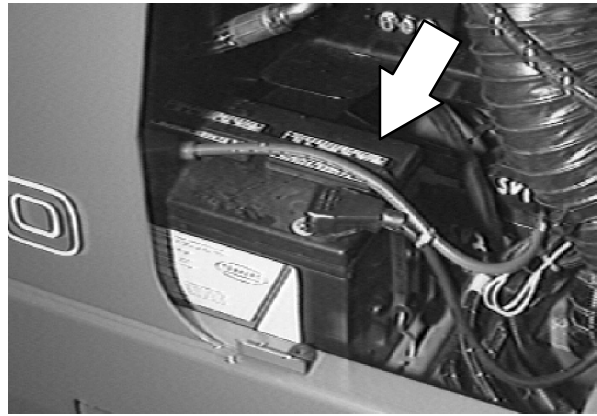
7. Install the new light in the mount plate. Snap in place.

8. Reconnect the wires to the new light. See schematic in this section.

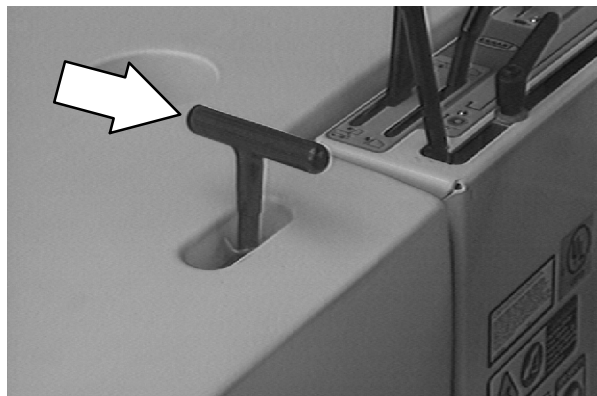


9. Position the mount plate back on the instrument panel. Reinstall the two nyloc nuts and tighten.

10. Reconnect the battery cable.



11. Close the seat support.



12. Start the machine and lower the hopper. Check the indicator lights for proper operation.

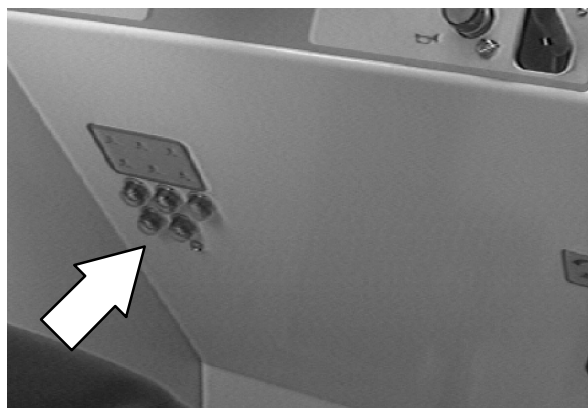
## CIRCUIT BREAKERS

The circuit breakers are resettable electrical circuit protection devices. Their design stops the flow of current in the event of a circuit overload. Once a circuit breaker is tripped, it must be reset manually. Press the reset button after the breaker has cooled down.

If the overload that caused the circuit breaker to trip is still there, the circuit breaker will continue to stop current flow until the problem is corrected.

The circuit breakers are located in the operator compartment.

The chart lists the circuit breakers and the electrical components they protect.



Circuit Breaker	Rating	Circuit Protected
CB-1	15 A	Thermo Sentry™
CB-2	15 A	Hourmeter, engine, fuel level
CB-3	15 A	Hopper, brushes
CB-4	15 A	Operating lights
CB-5	15 A	Horn

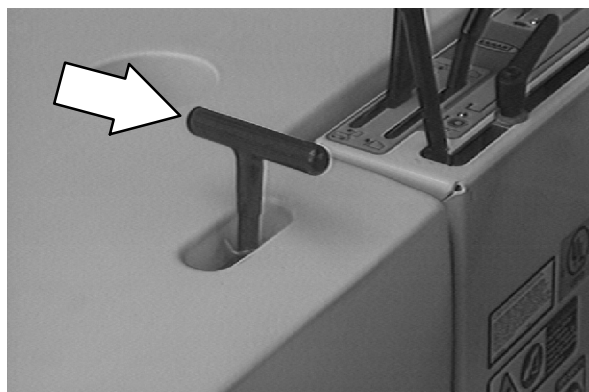
### TO REPLACE CIRCUIT BREAKER

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

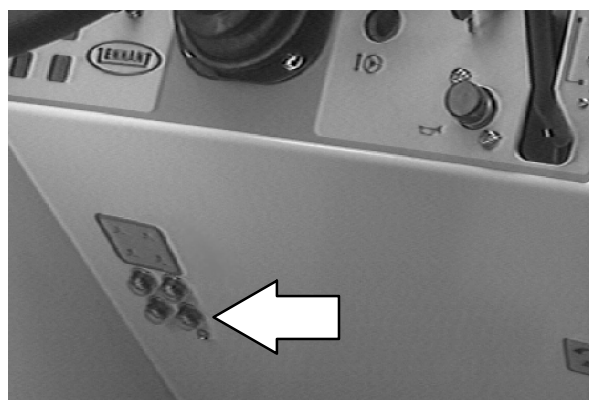
1. Raise the hopper and engage the support bar.



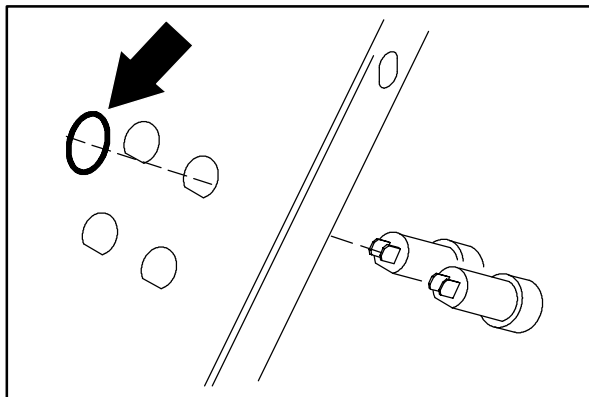
2. Open the seat support and disconnect the battery.



3. Locate the circuit breakers below the indicator light panel.
4. Use the electrical schematic in this section to locate the circuit breaker that needs to be replaced.
5. Disconnect the wires leading to the faulty circuit breaker.



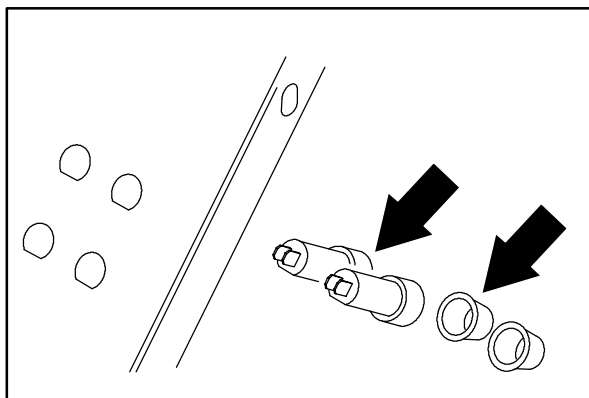
6. The metal ring must be removed in order to remove the old circuit breaker. *It may need to be cut off.*



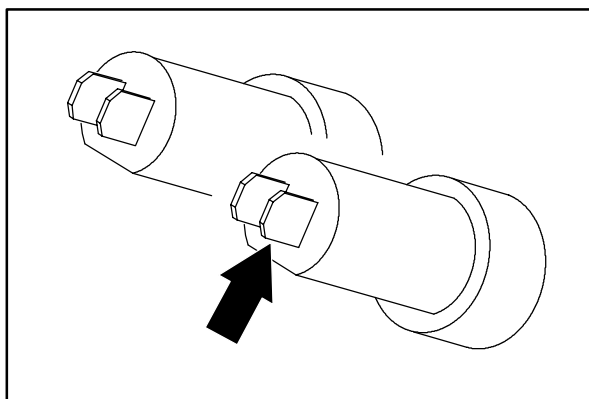
7. Remove the old circuit breaker and discard.

8. Position the new circuit breaker in the hole in the panel. Install the metal lock ring.

**NOTE:** *The circuit breaker will only fit in the hole in one direction.*



9. Plug the main harness wires into the new circuit breaker. *See the schematic in this section.*

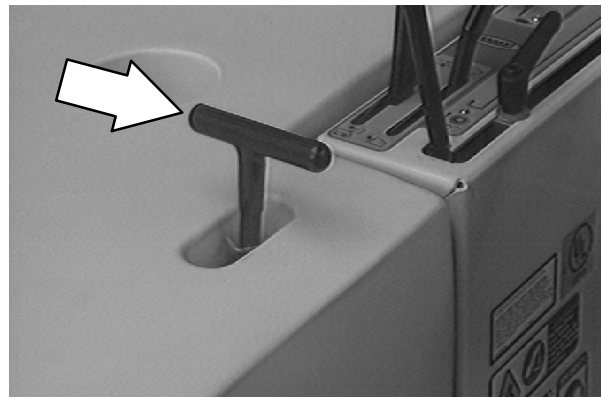


10. Reconnect the battery cables.



11. Close the seat support.

12. Start the machine and lower the hopper.  
Check the new circuit breaker for proper  
operation.





**TO REPLACE FILTER SHAKER MOTOR**

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

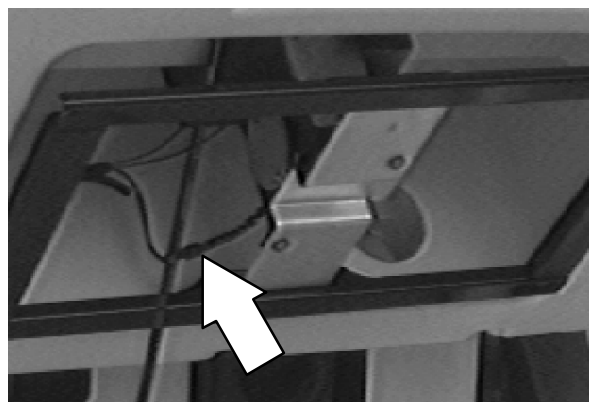
1. Open the hopper cover and engage the prop rod.



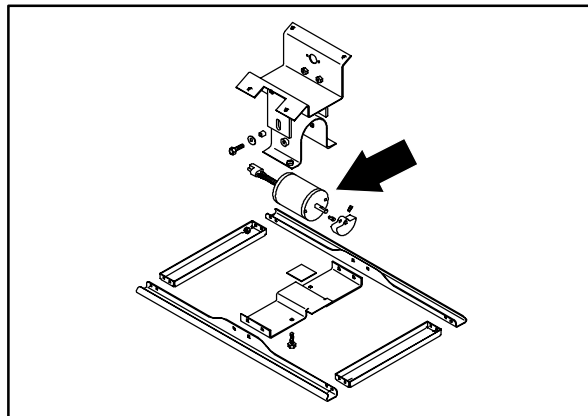
2. Locate the filter shaker motor on the top side of the filter shaker assembly.



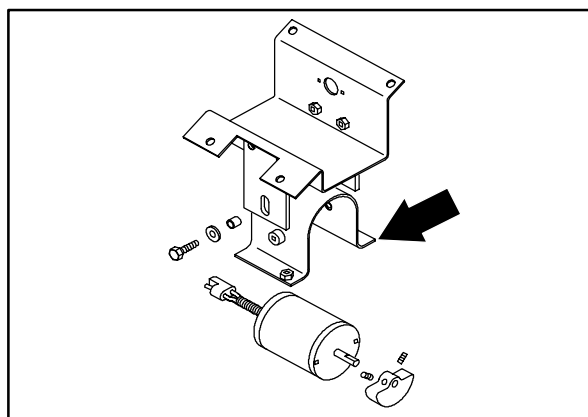
3. Unplug the filter shaker motor from the hopper harness.



4. Remove the two hex screws and sleeves holding the shaker motor assembly to the shaker support bracket. Remove the shaker motor assembly from the hopper.

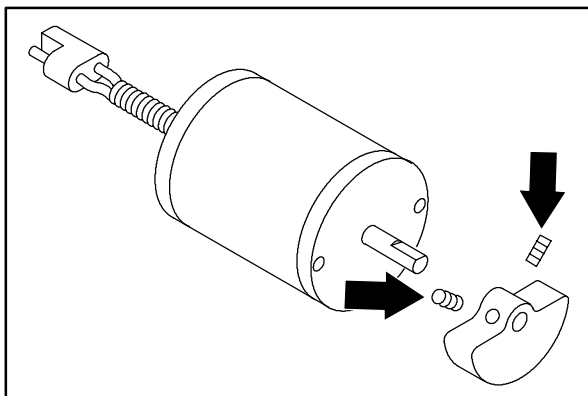


5. Remove the two hex screws holding the shaker motor bracket to the motor assembly. Remove the motor from the assembly.

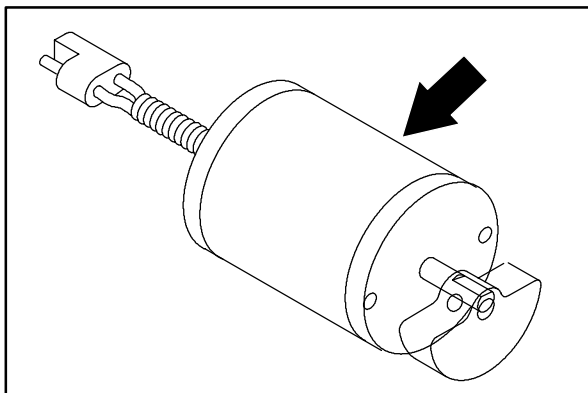


6. Loosen the two set screws on the eccentric weight. Pull the weight off the motor shaft.

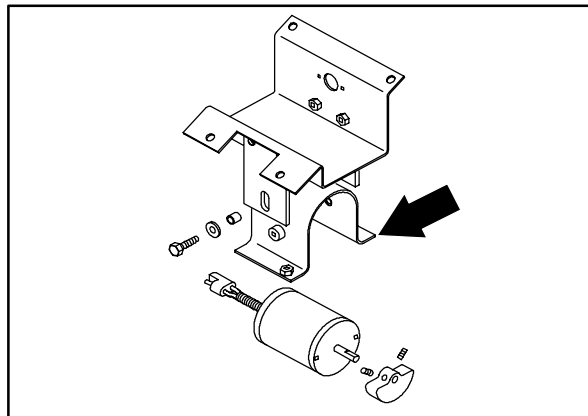
7. Install the eccentric weight on the new shaker motor. Position the weight flush with the guard plate.



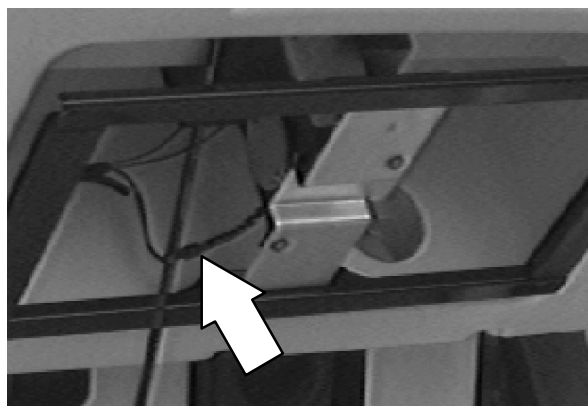
8. Install the new shaker motor on the assembly mount plate. Tighten the two hex screws to 18 - 24 Nm (15 - 20 ft lb).



9. Reinstall the motor assembly on the shaker motor support bracket. Make sure the sleeves are in place on the two hex screws. tighten to 18 - 24 Nm (15 - 20 ft lb).



10. Plug the shaker motor into the hopper harness.
11. Test the shaker motor for proper operation.



12. Disengage the hopper cover prop rod and lower the cover.



## ELECTRICAL

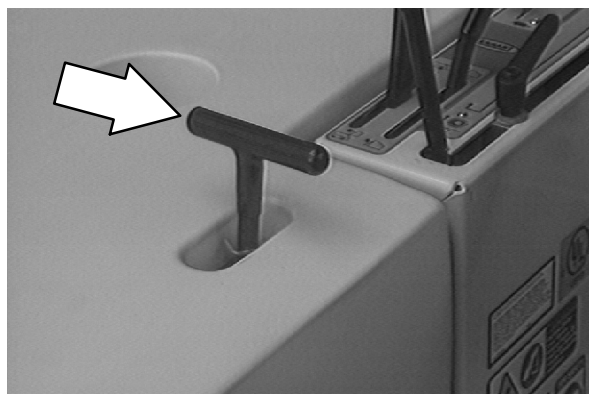
### TO REPLACE MACHINE ELECTRICAL RELAY

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

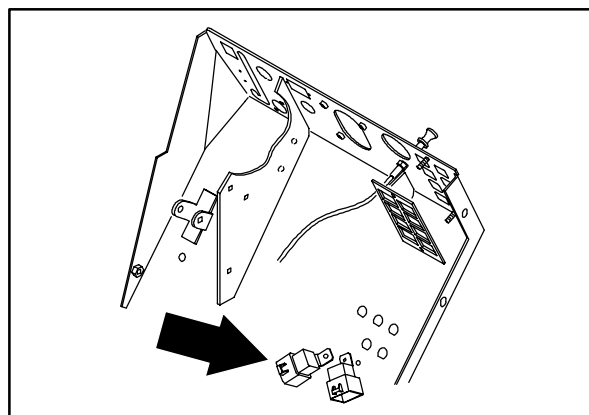
1. Raise the hopper and engage the support bar.



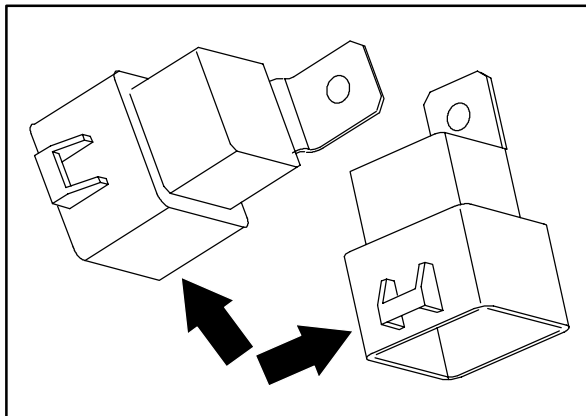
2. Open the seat support and remove the battery cables from battery.



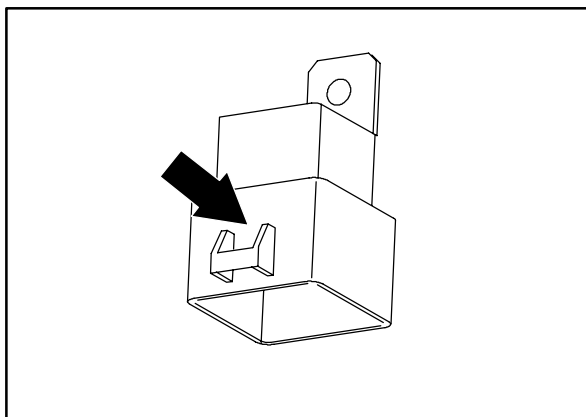
3. Locate the relays under the circuit breakers.



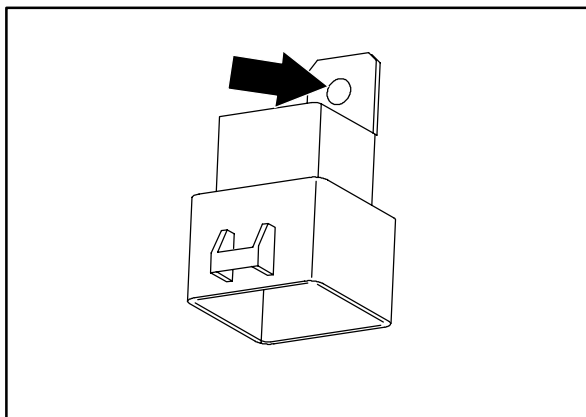
4. Use the electrical schematic to locate the relay that needs to be replaced.



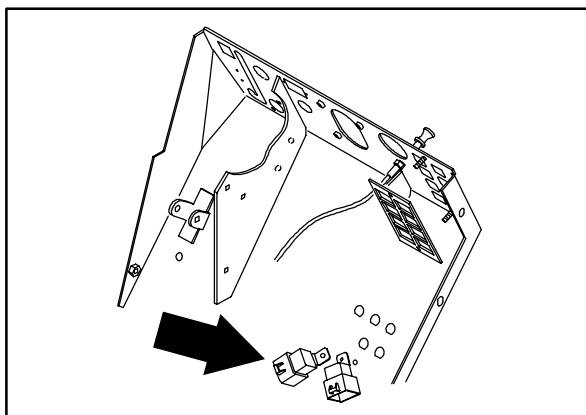
5. Push the two tabs on the electrical plug of the main harness and remove it from the faulty relay.



6. Remove the hex nut holding the relay to the panel. Remove and discard the relay.

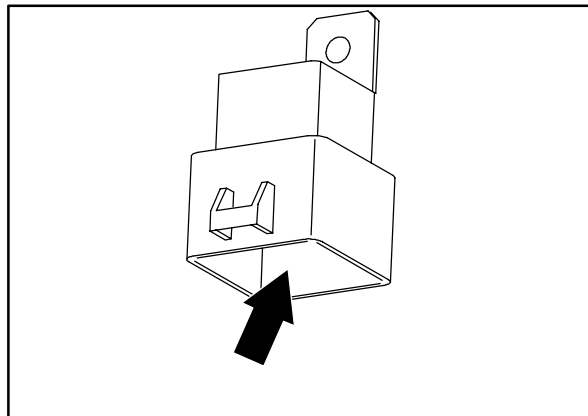


7. Position the new relay on the instrument panel. Reinstall the hex screw and nyloc nut. Hand tighten.



8. Plug the main harness in the new relay. See the schematic in this section.

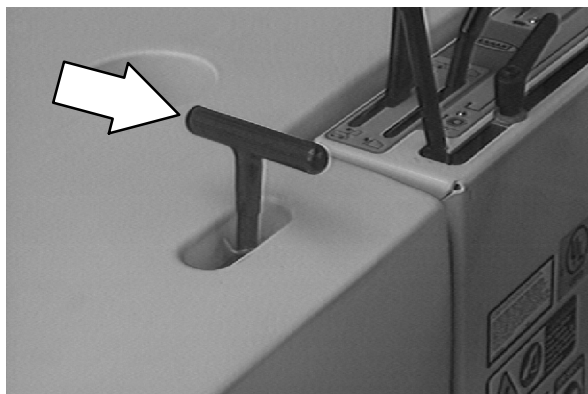
*NOTE: The harness plug will only fit in the new relay in one direction.*



9. Reconnect the battery cables.



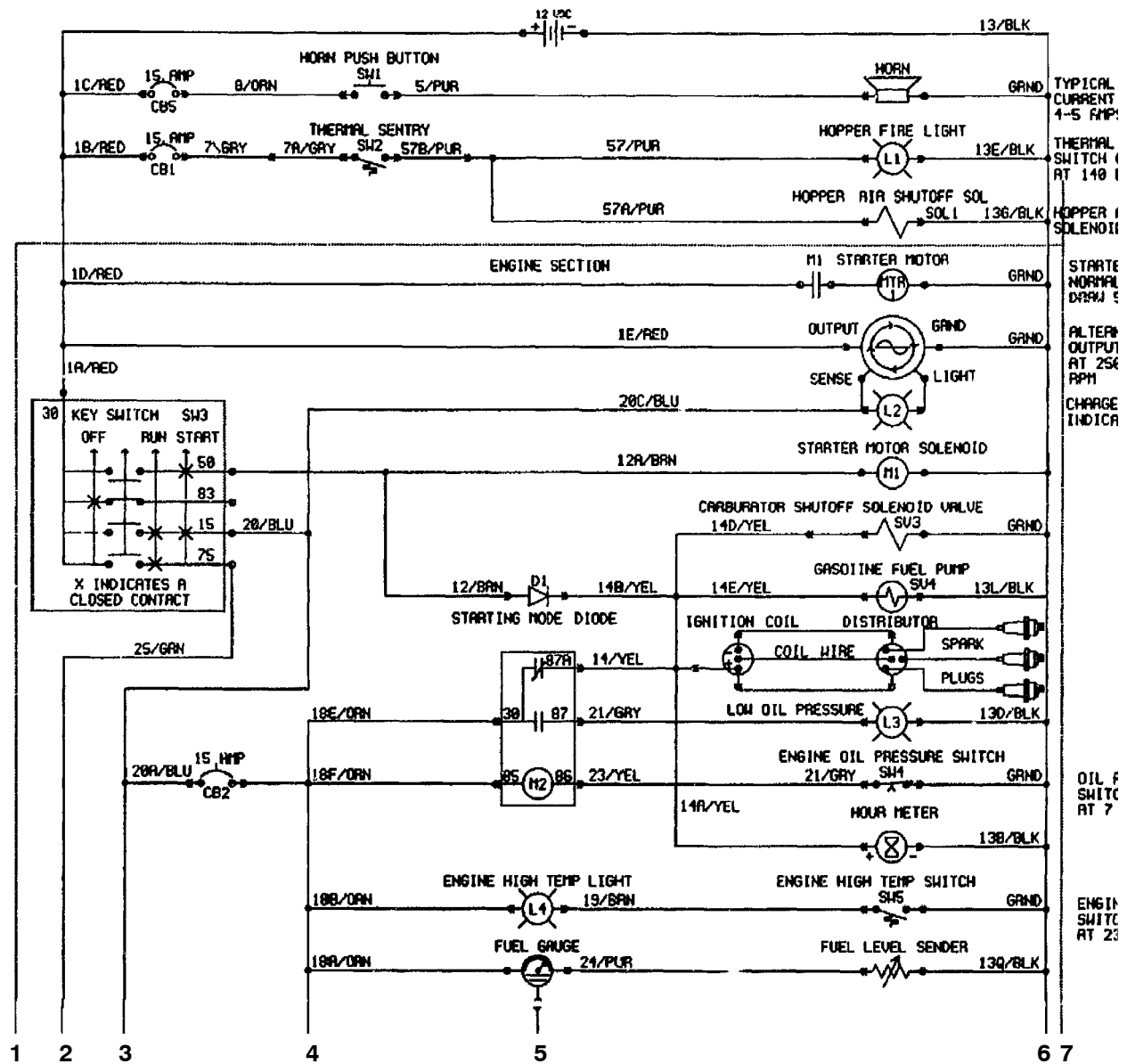
10. Close the seat support.



11. Start the engine and lower the hopper.  
Check the new relay for proper operation.

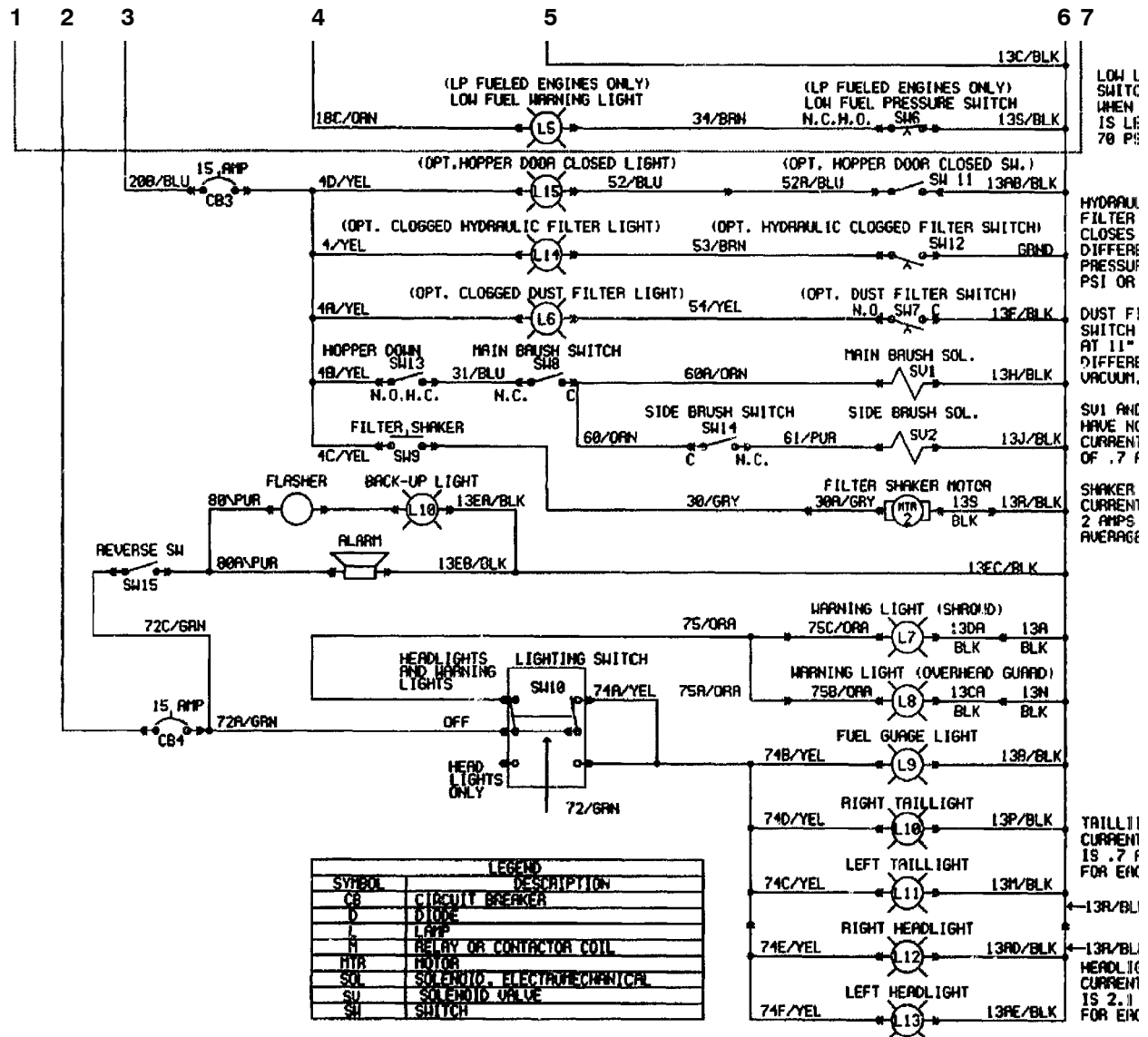


## ELECTRICAL SCHEMATIC GAS/LP LIQUID COOLED



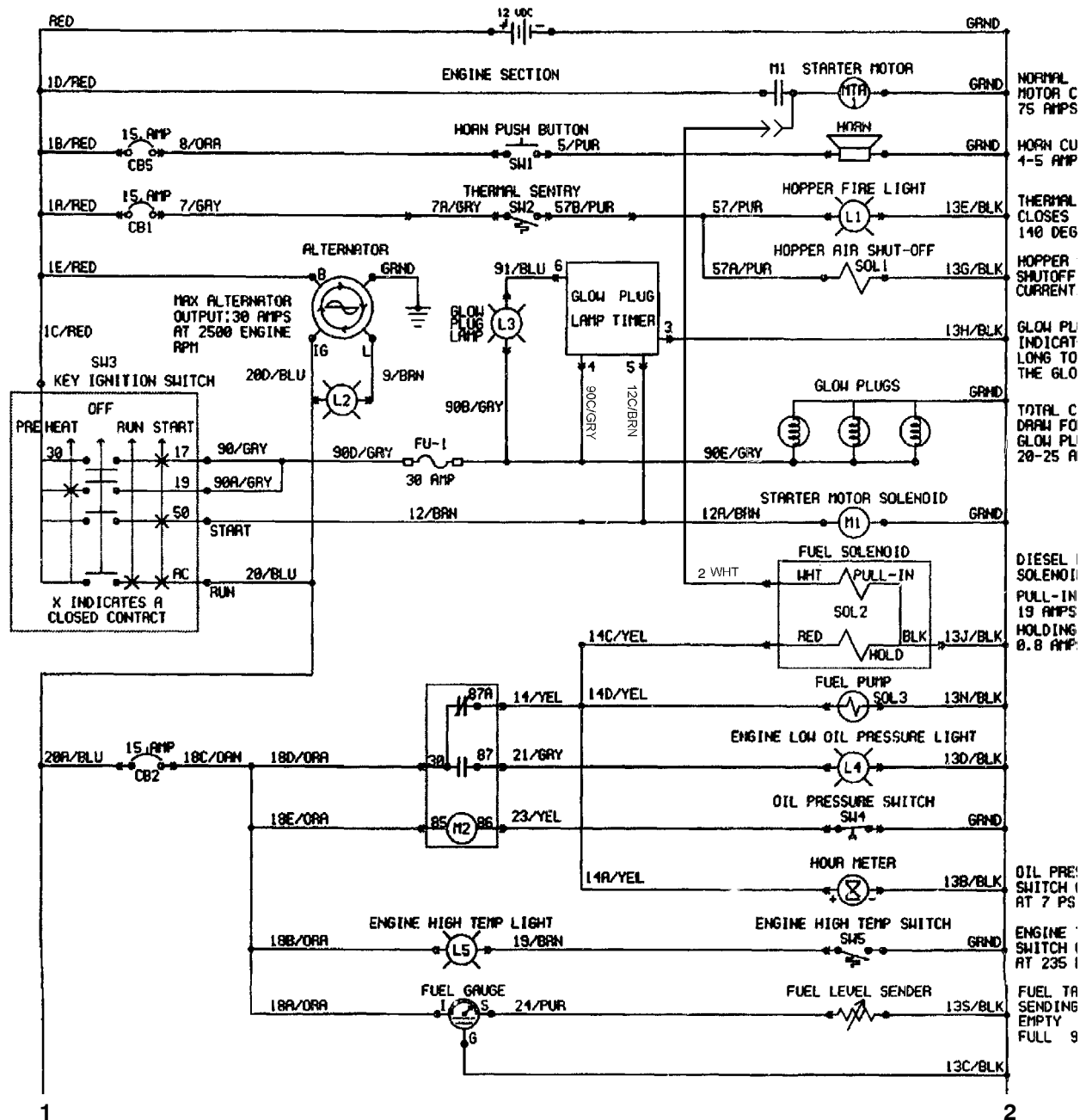


## ELECTRICAL SCHEMATIC GAS/LP LIQUID COOLED

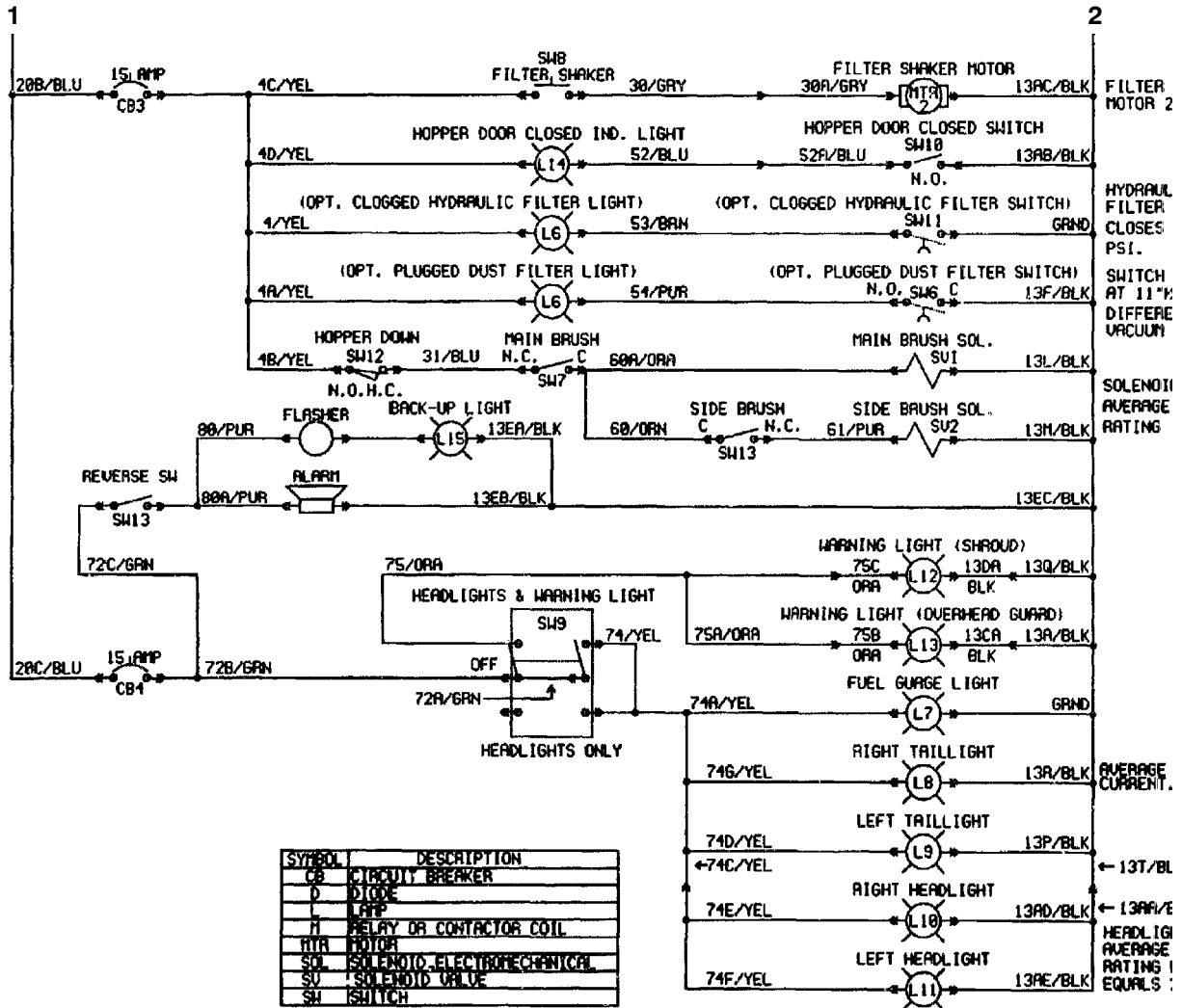


350167 - G, LP, LIQ

## ELECTRICAL SCHEMATIC DIESEL

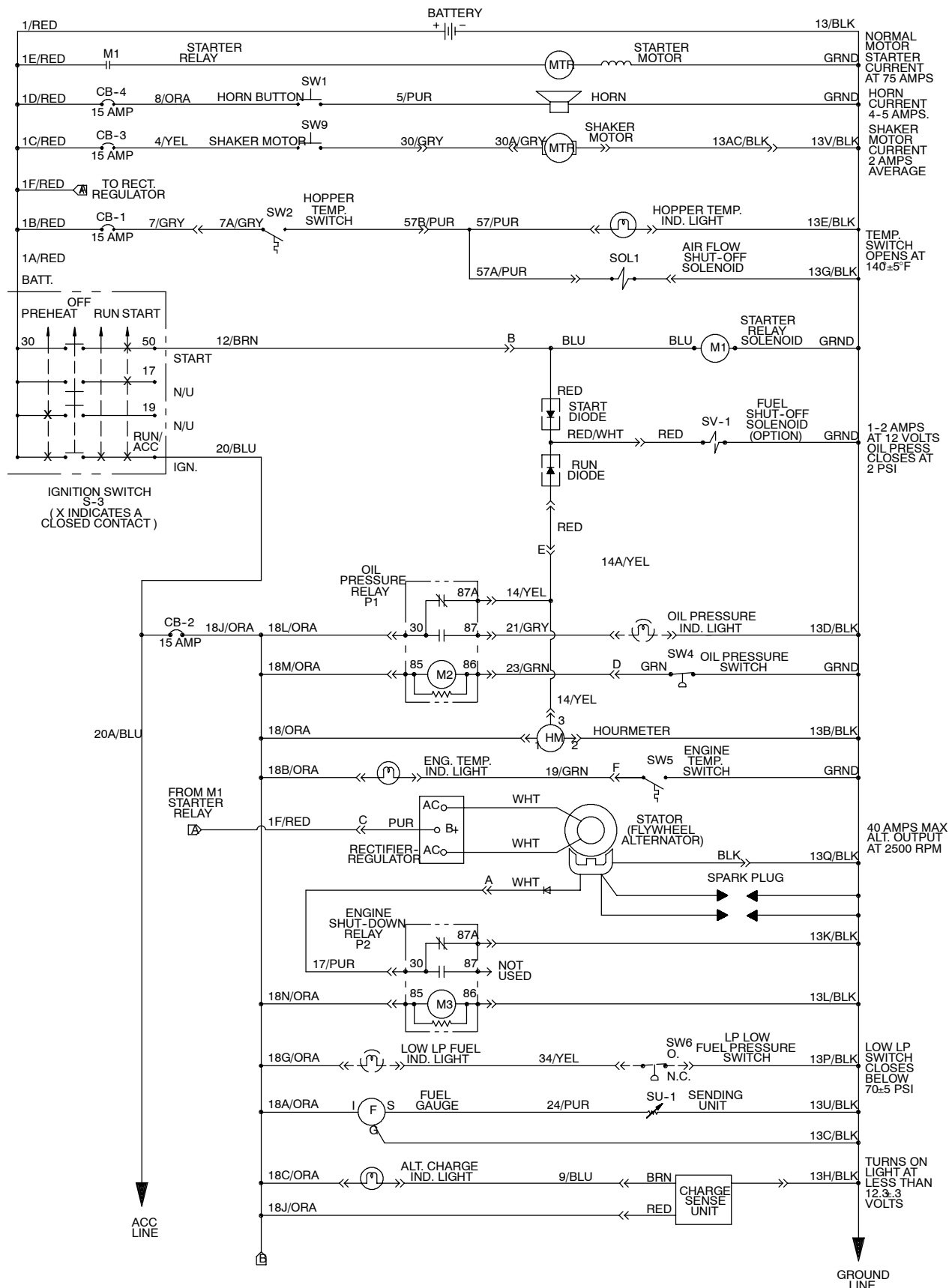


## ELECTRICAL SCHEMATIC DIESEL

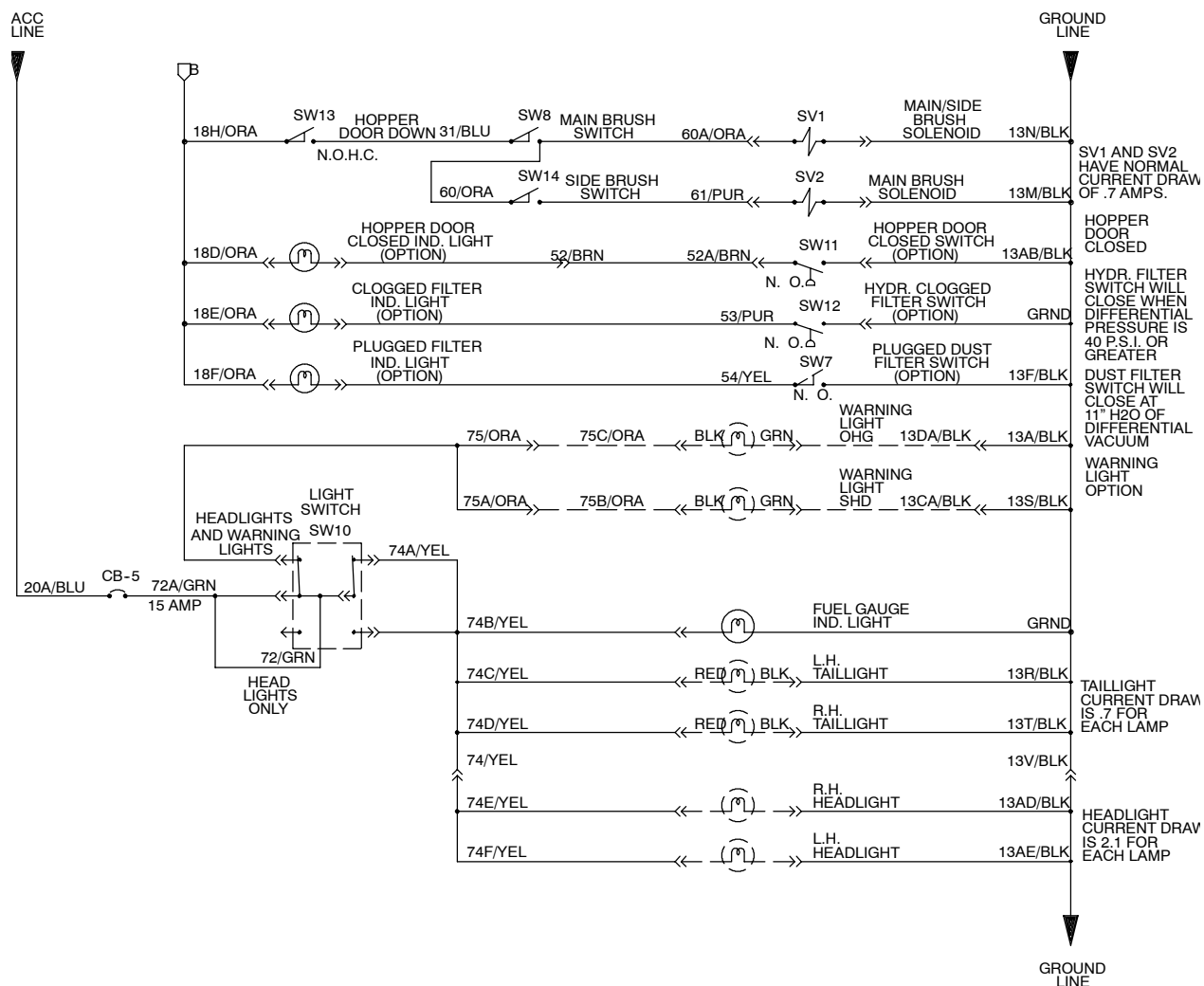


350169 - D

## ELECTRICAL SCHEMATIC GAS/LP AIR COOLED



## ELECTRICAL SCHEMATIC GAS/LP AIR COOLED

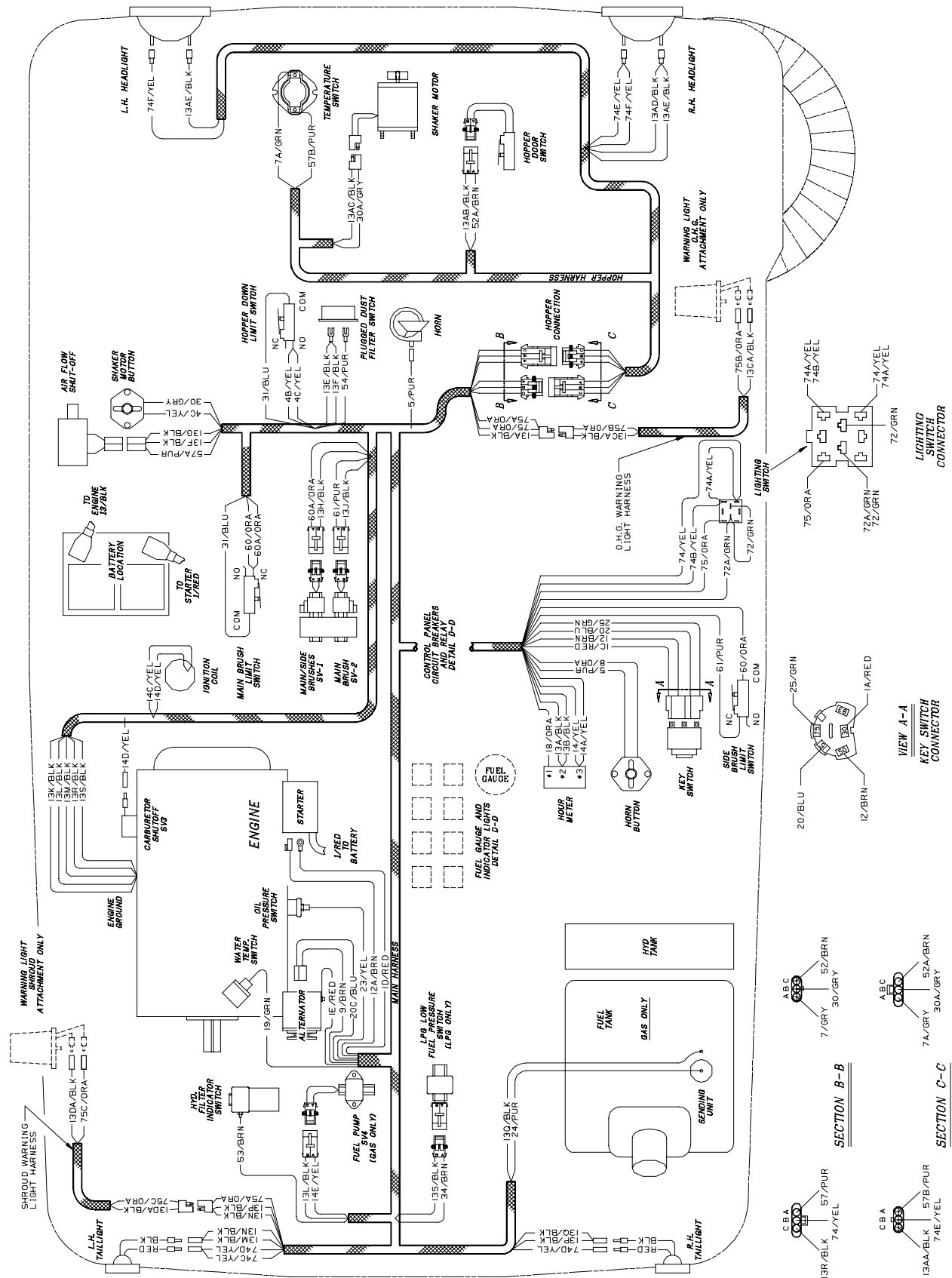


## LEGEND

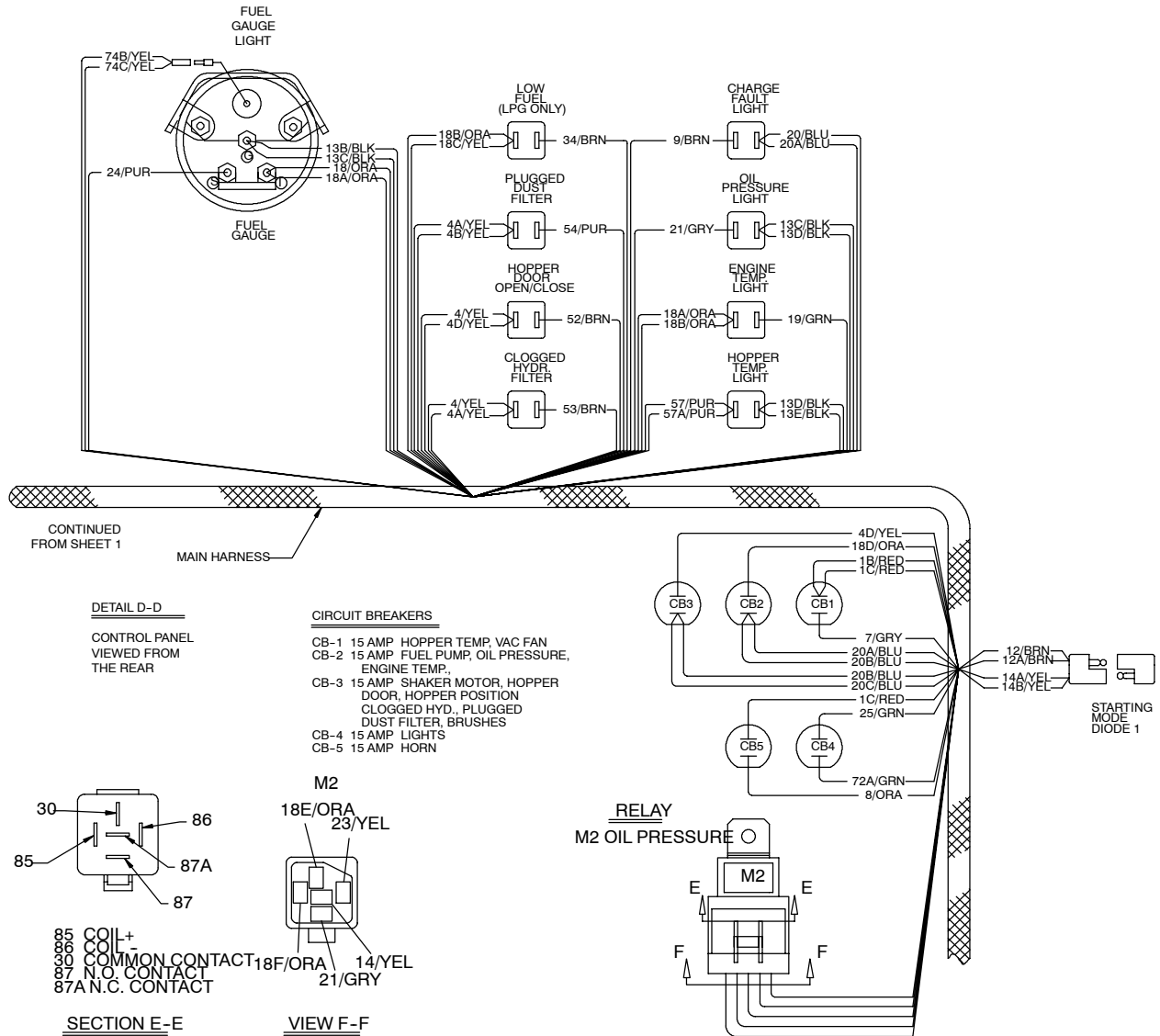
CB	CIRCUIT BREAKER	M	RELAY CONTACTR
MTR	MOTOR	F	FUEL GAUGE
PM	PERMANENT MAGNET	J	JACK
S	SWITCH	P	PLUG
SU	SENDING UNIT	SV	SOLENOID VALVE
HM	HOUR METER		

350168

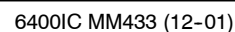
## WIRE HARNESS GROUP GAS/LP LIQUID COOLED



## WIRE HARNESS GROUP GAS/LP LIQUID COOLED

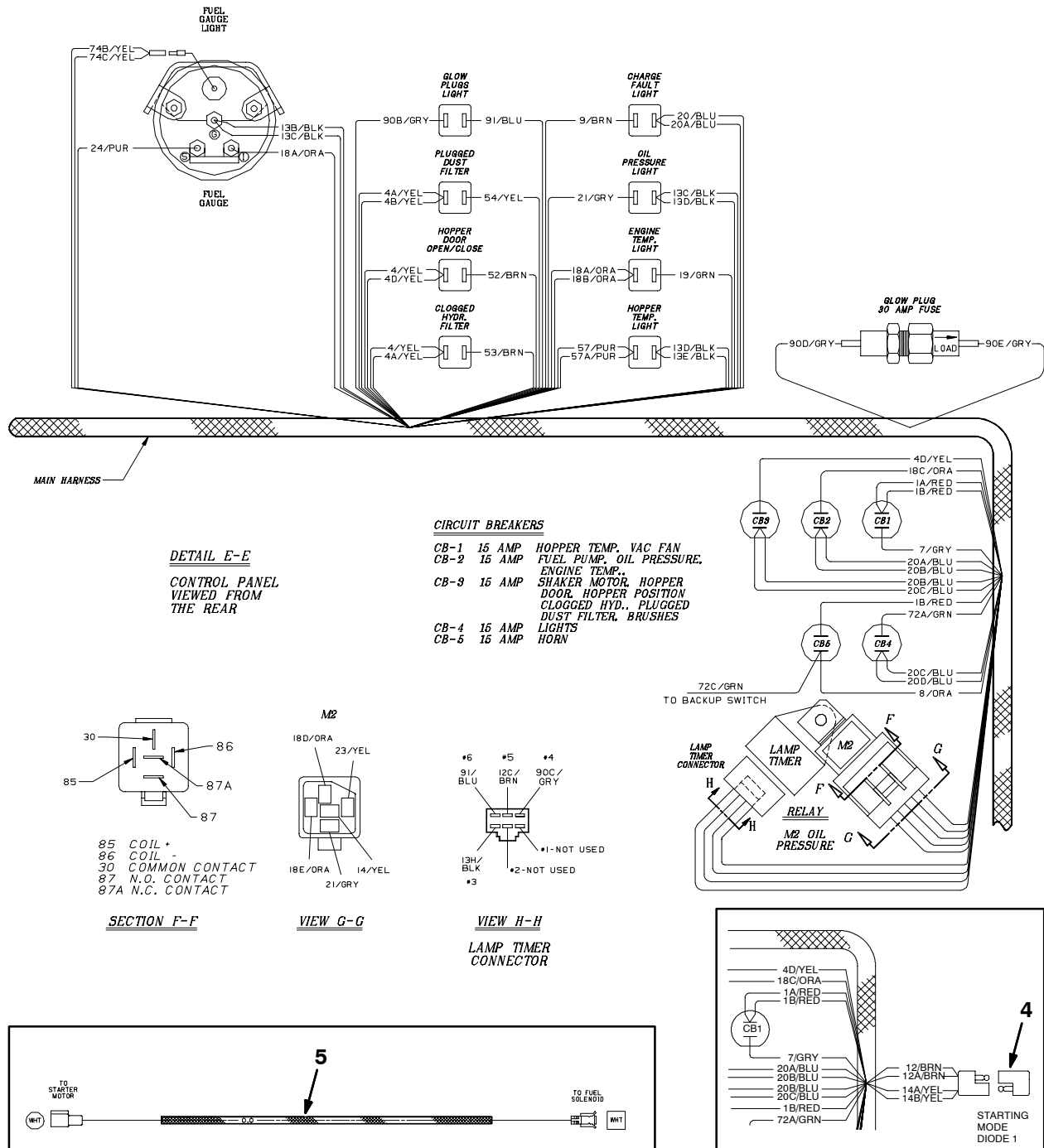


350139 - G, LP, LIQ



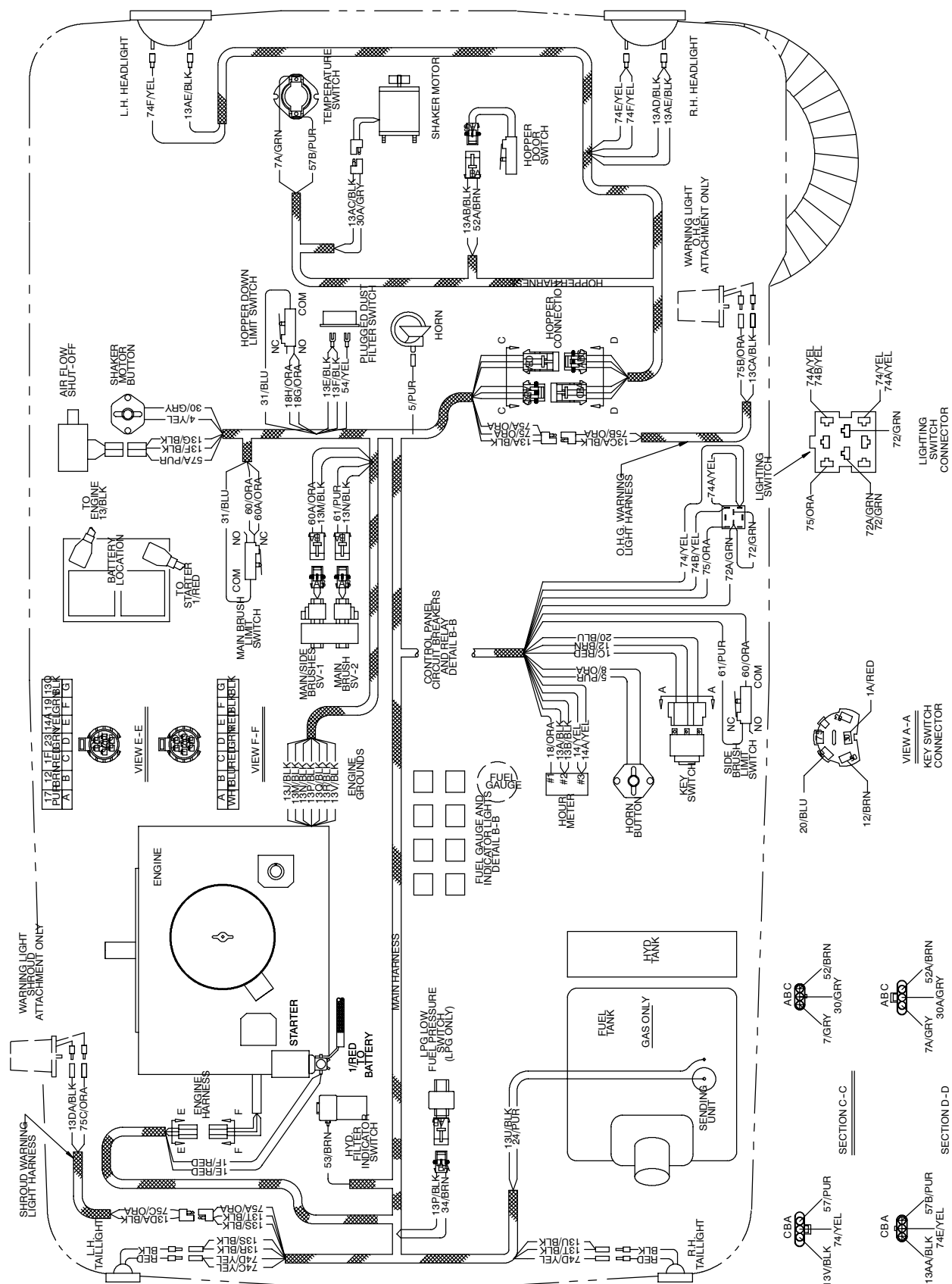


## WIRE HARNESS GROUP DIESEL

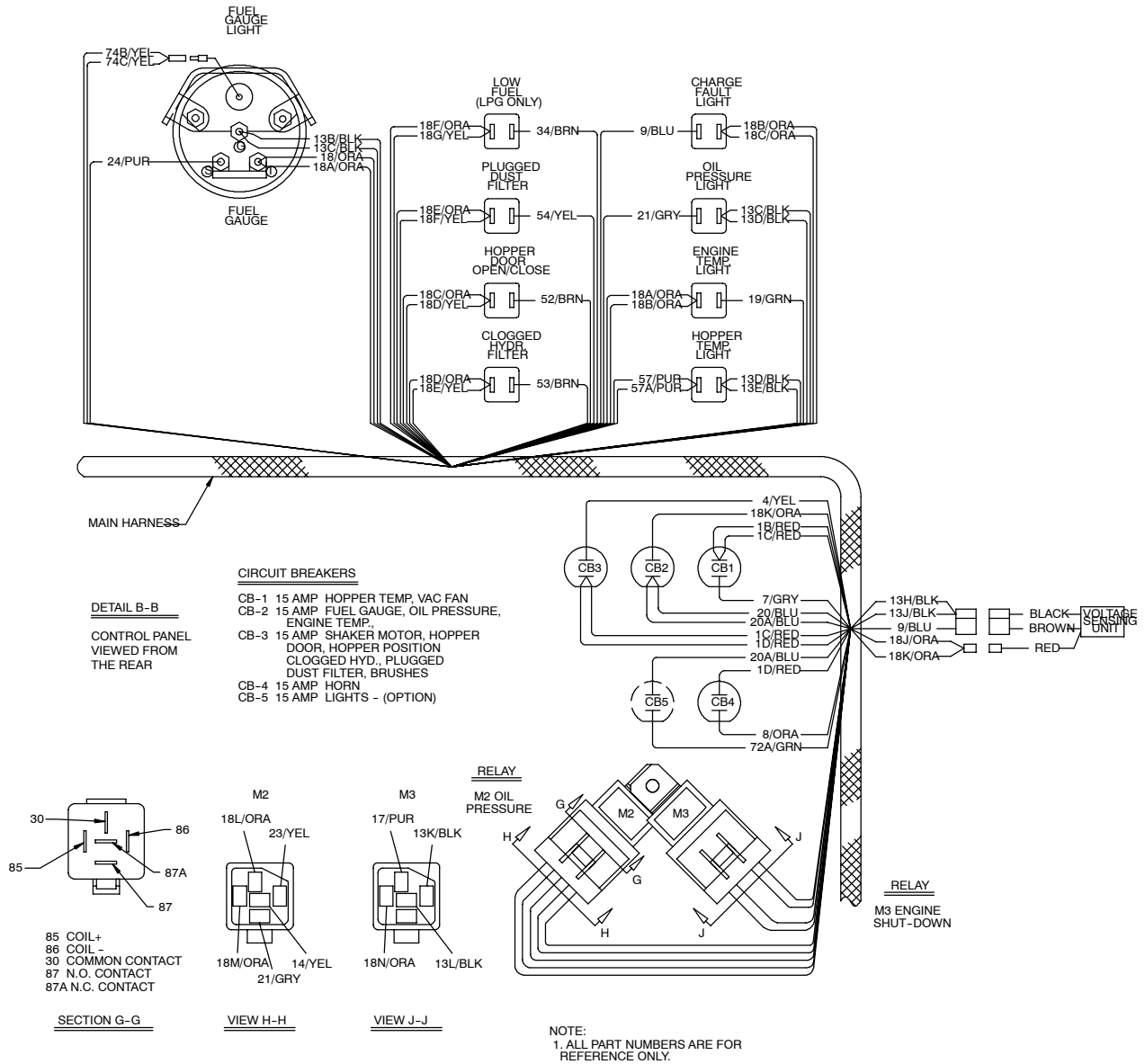


350137 - D

## WIRE HARNESS GROUP GAS/LP AIR COOLED



## WIRE HARNESS GROUP GAS/LP AIR COOLED





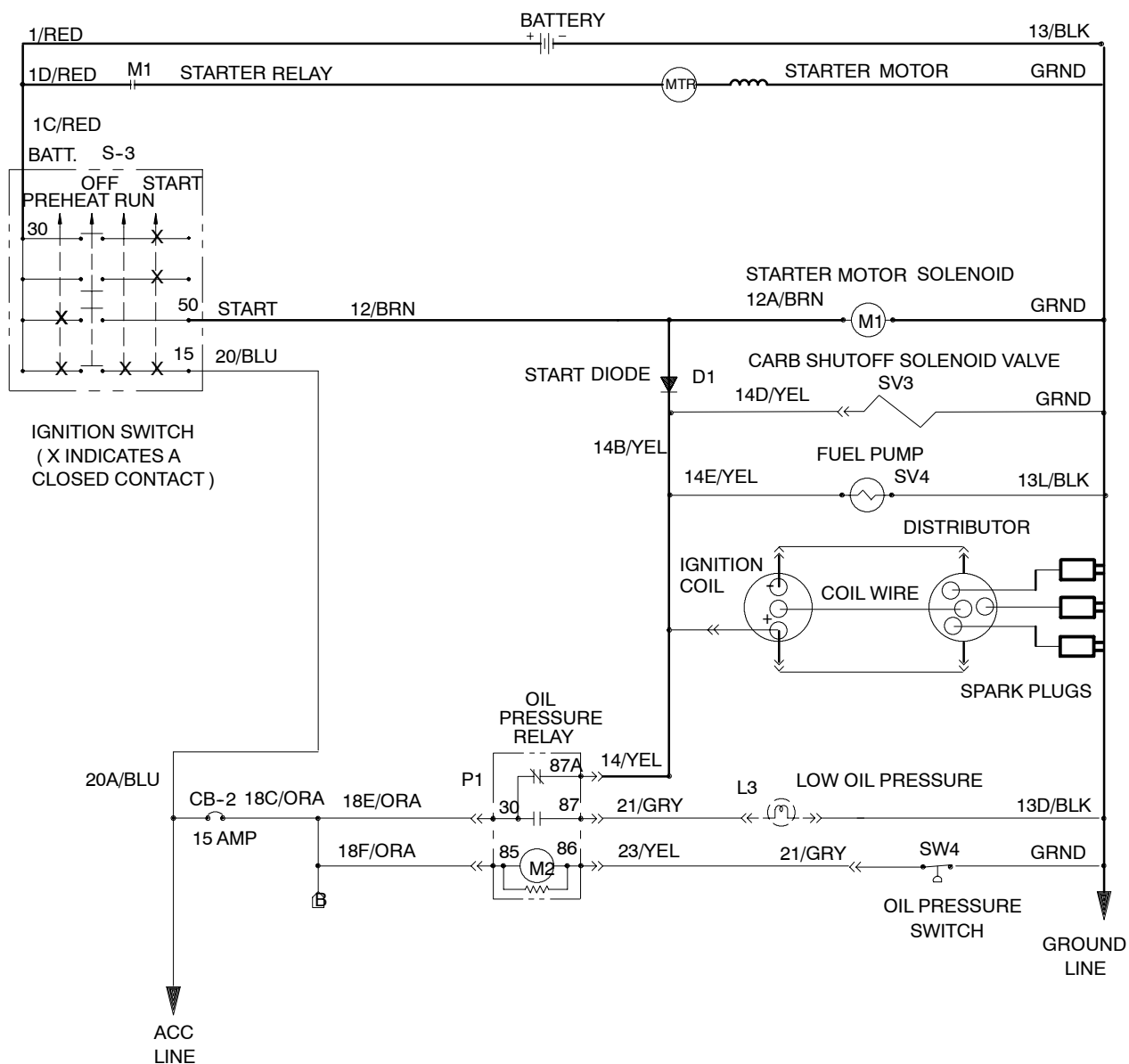
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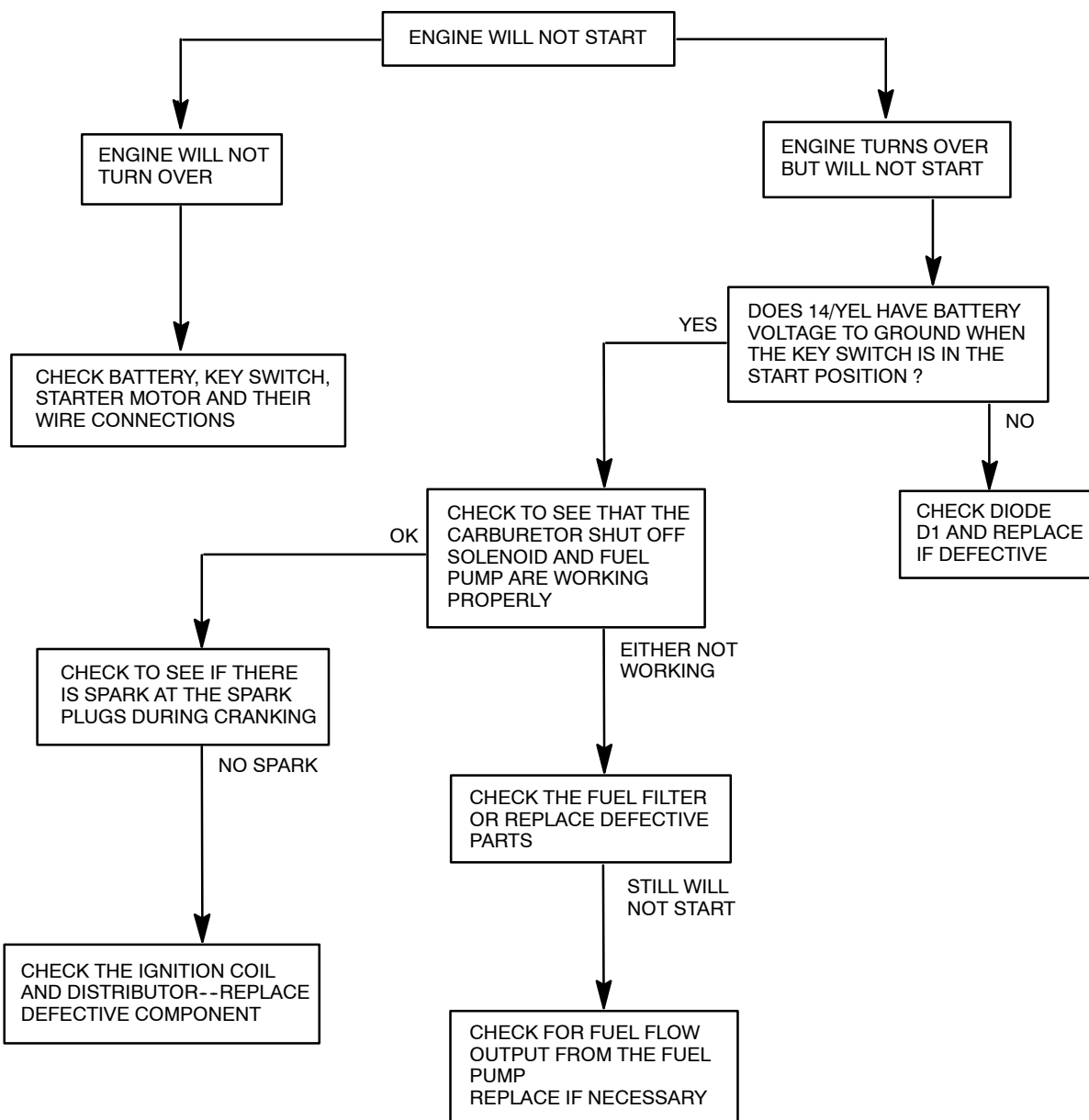
**TROUBLESHOOTING**

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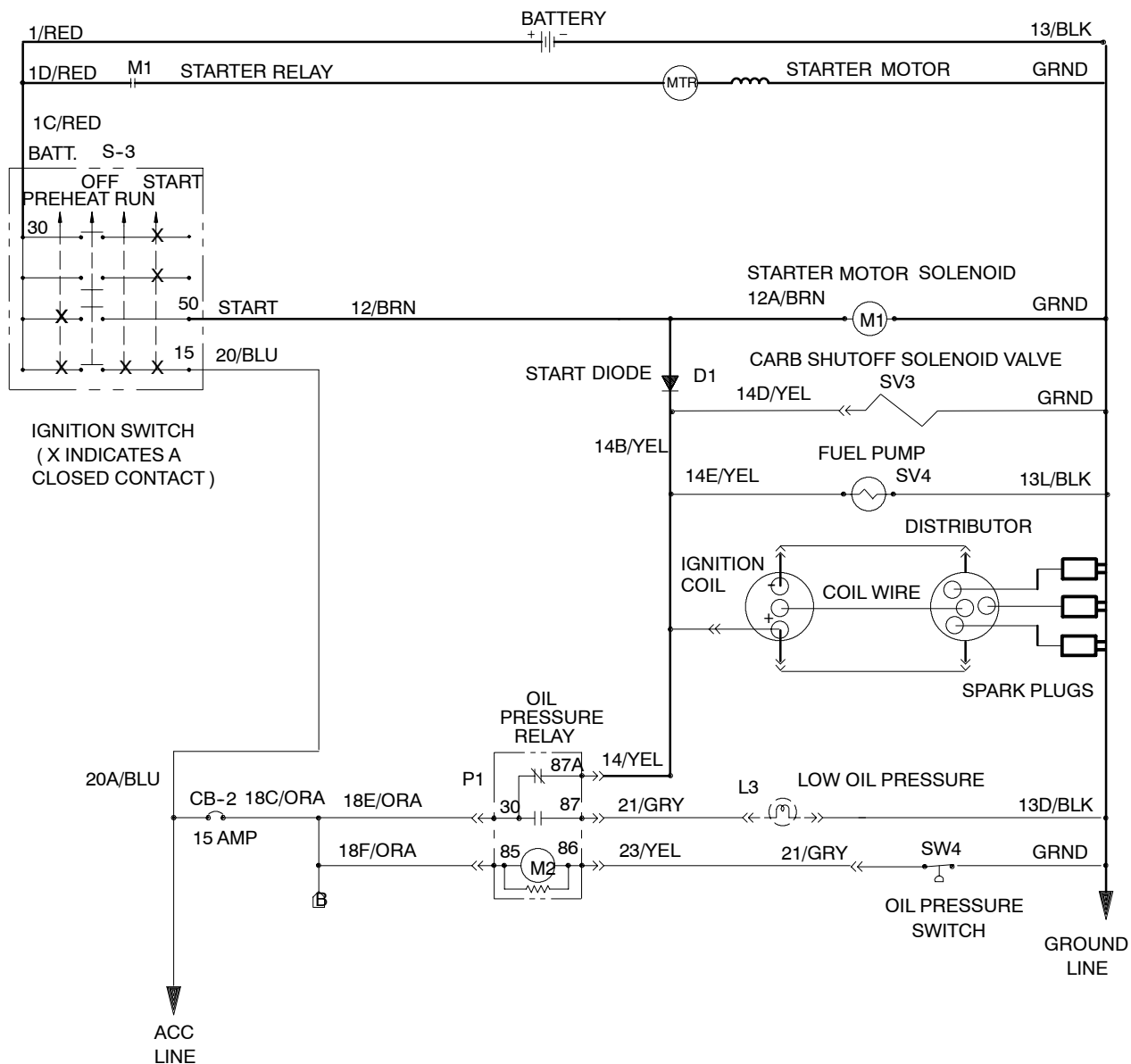
The troubleshooting charts that follow are organized so they lead you through the circuits. They include flow charts and instructions for you as to where to insert your test instruments.

# LIQUID COOLED GAS/LP ENGINE WILL NOT START

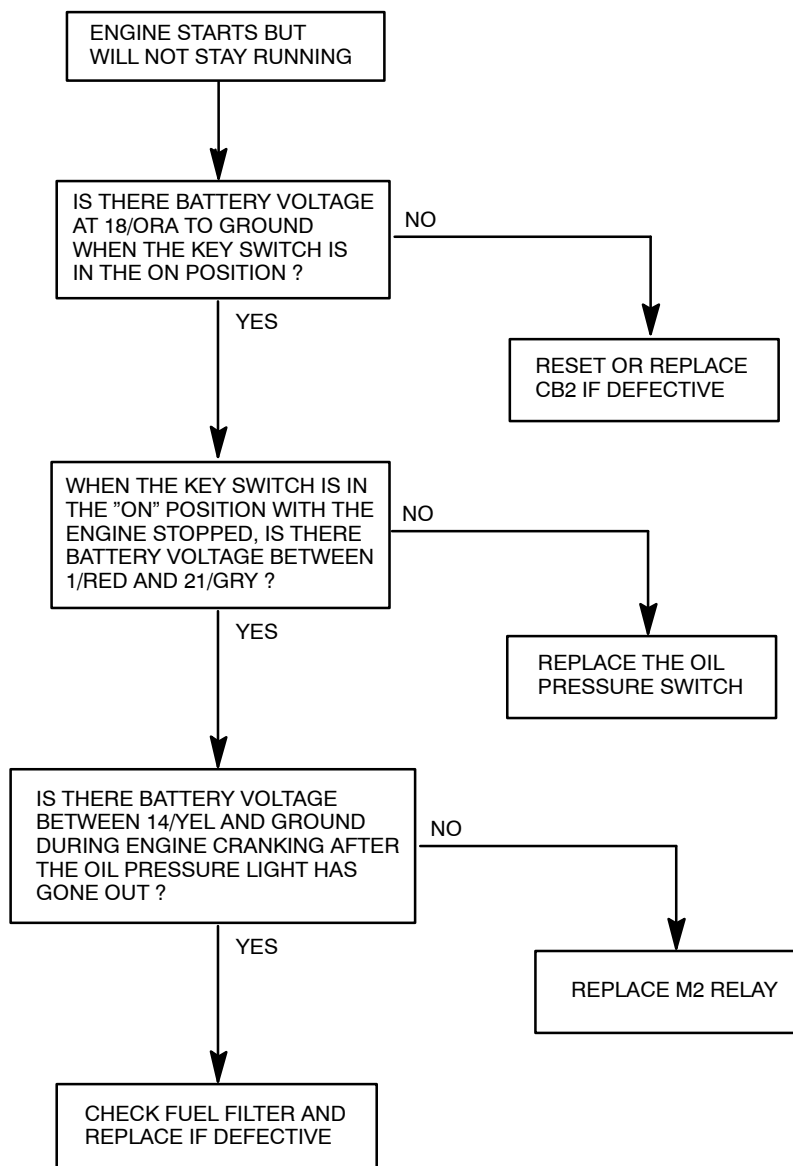


**LIQUID COOLED GAS/LP  
ENGINE WILL NOT START**

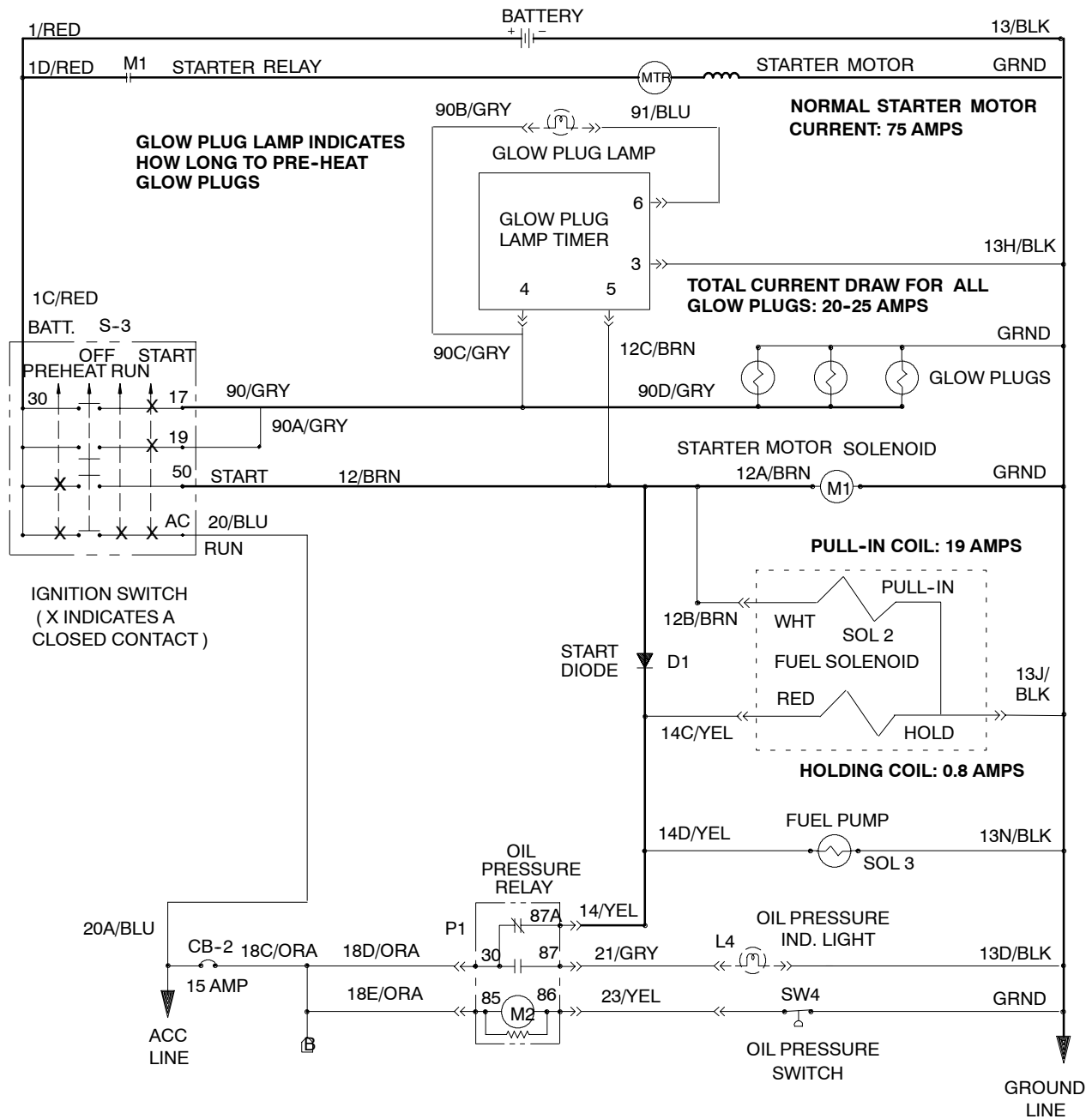
# LIQUID COOLED GAS/LP ENGINE STARTS BUT WILL NOT STAY RUNNING





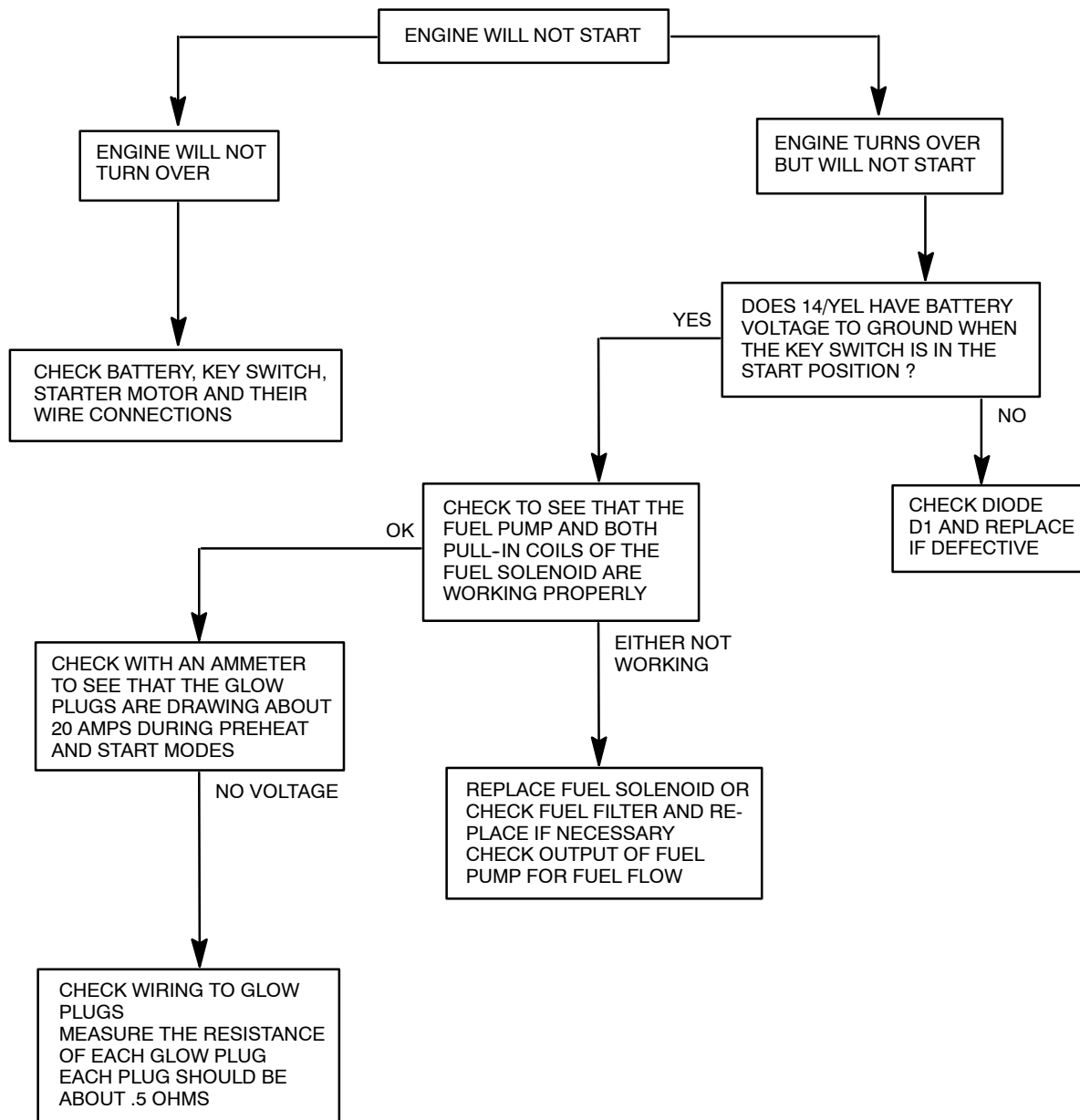
**LIQUID COOLED GAS/LP  
ENGINE STARTS BUT WILL  
NOT STAY RUNNING**

# **DIESEL ENGINE WILL NOT START**

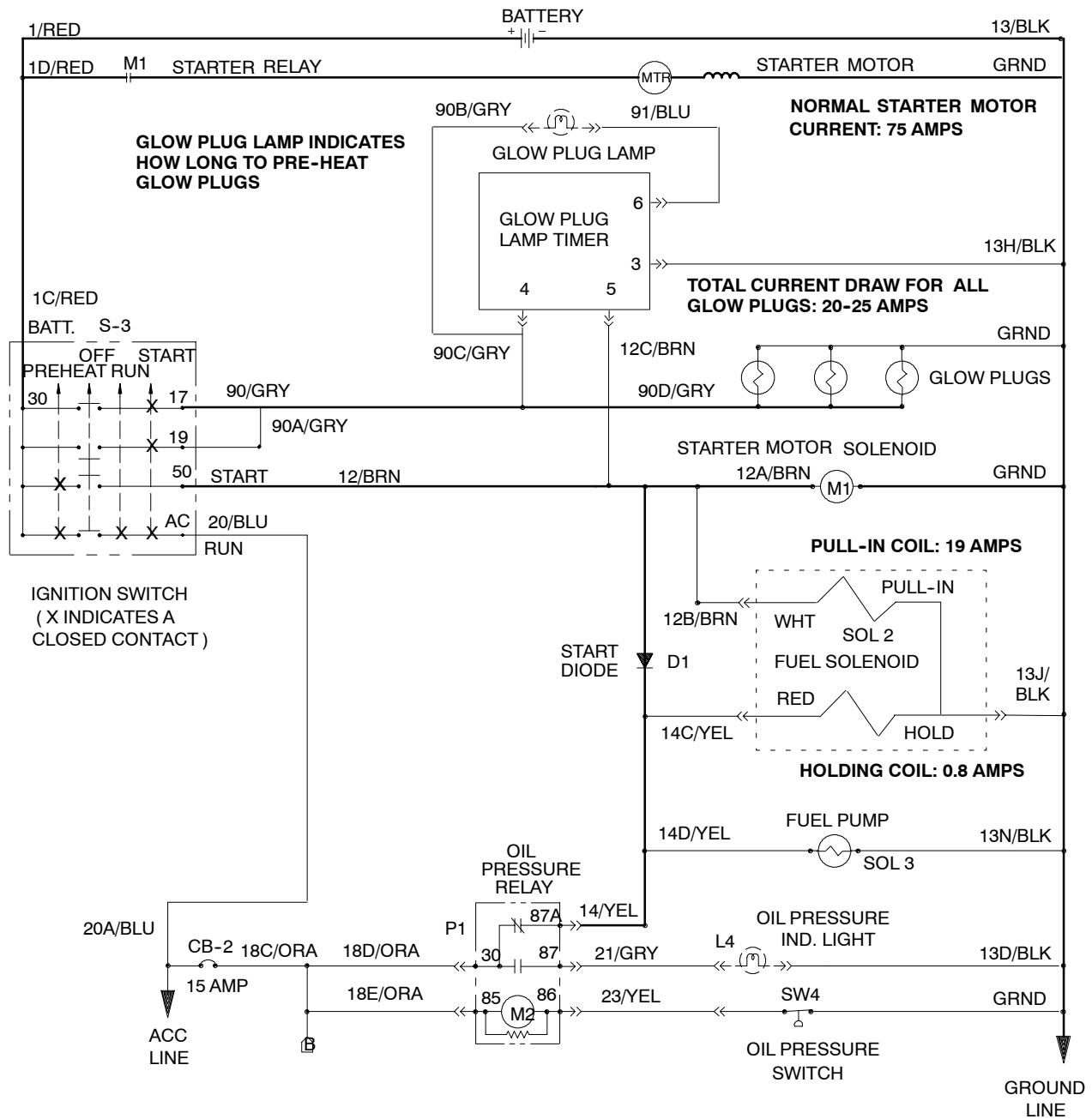


## **LEGEND**

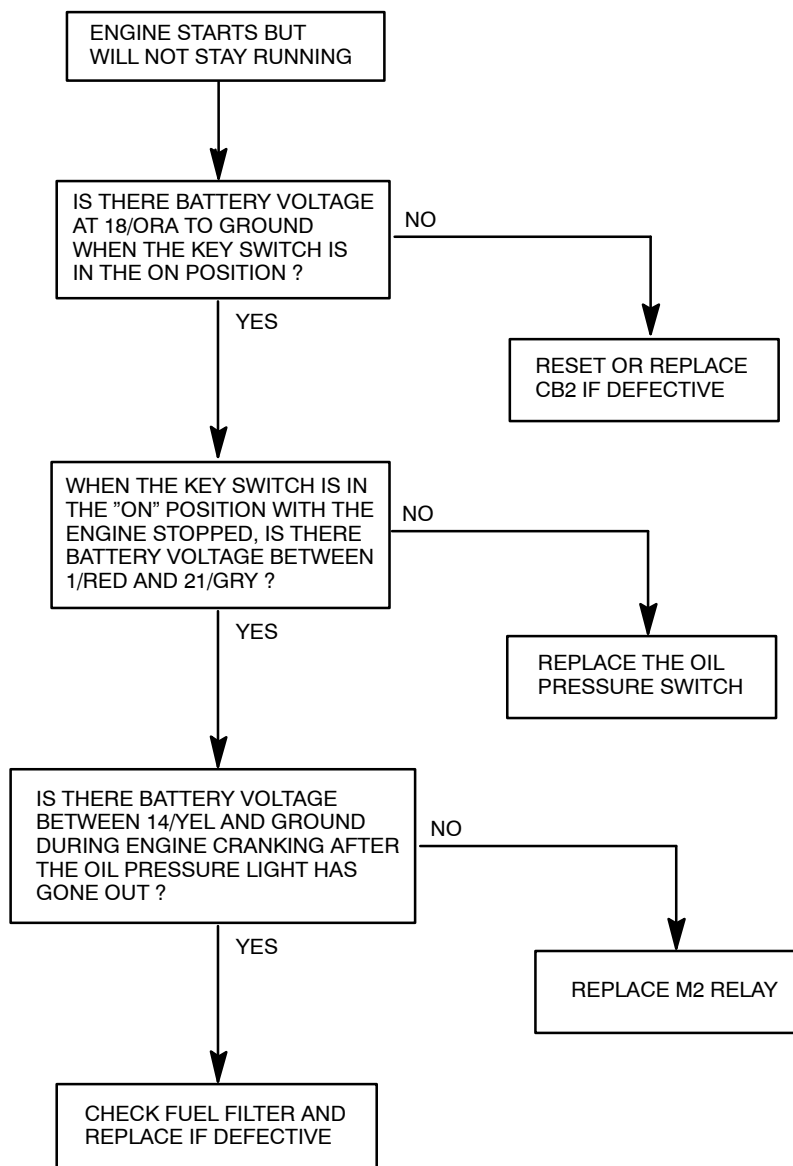
SYMBOL	DESCRIPTION
CB	CIRCUIT BREAKER
D	DIODE
L	LAMP
M	RELAY OR CONTACTOR COIL
MTR	MOTOR
SOL	SOLENOID, ELECTROMECHANICAL
SV	SOLENOID VALVE
SW	SWITCH

**DIESEL ENGINE WILL NOT START**

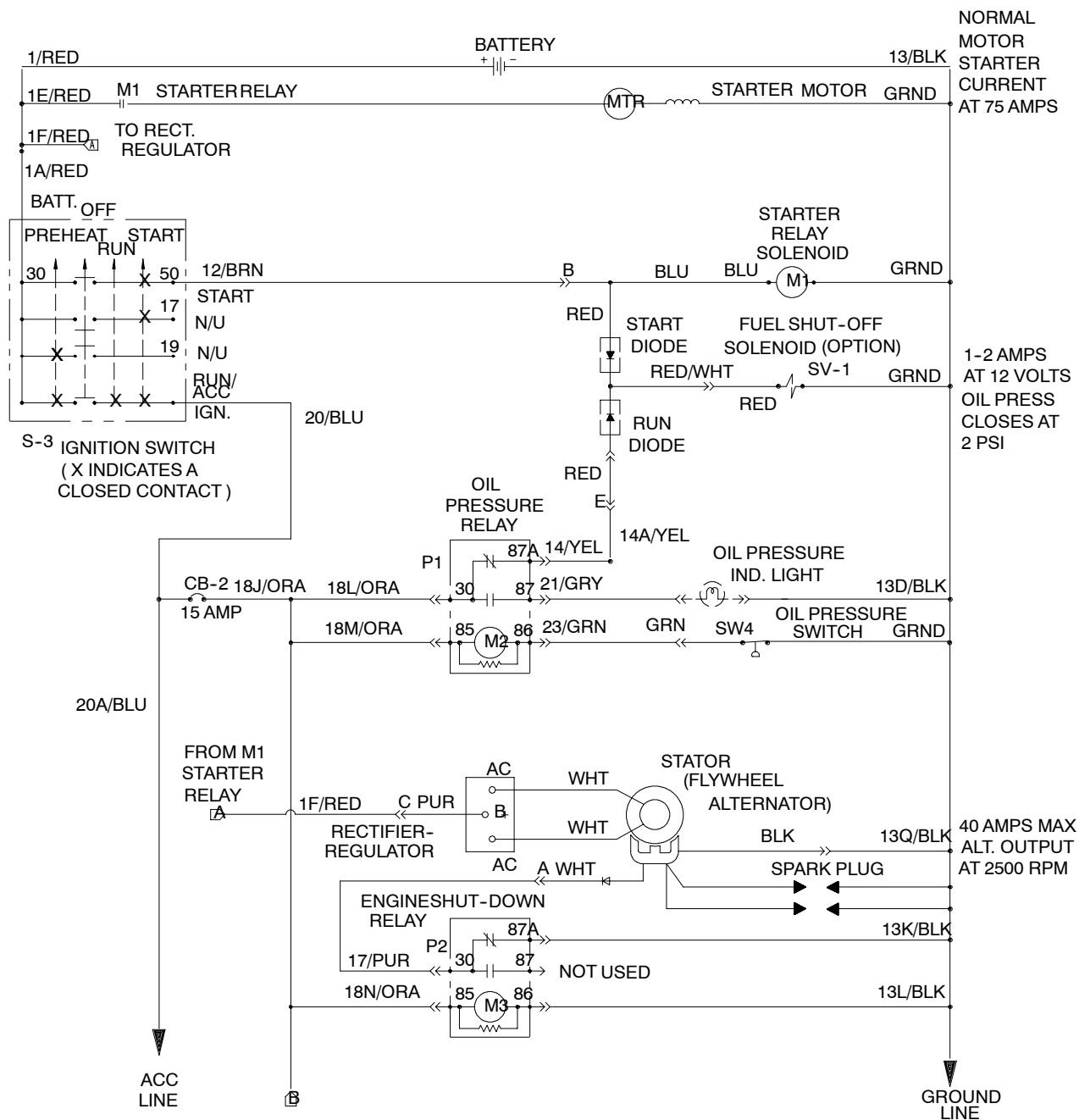
## DIESEL ENGINE STARTS BUT WILL NOT STAY RUNNING

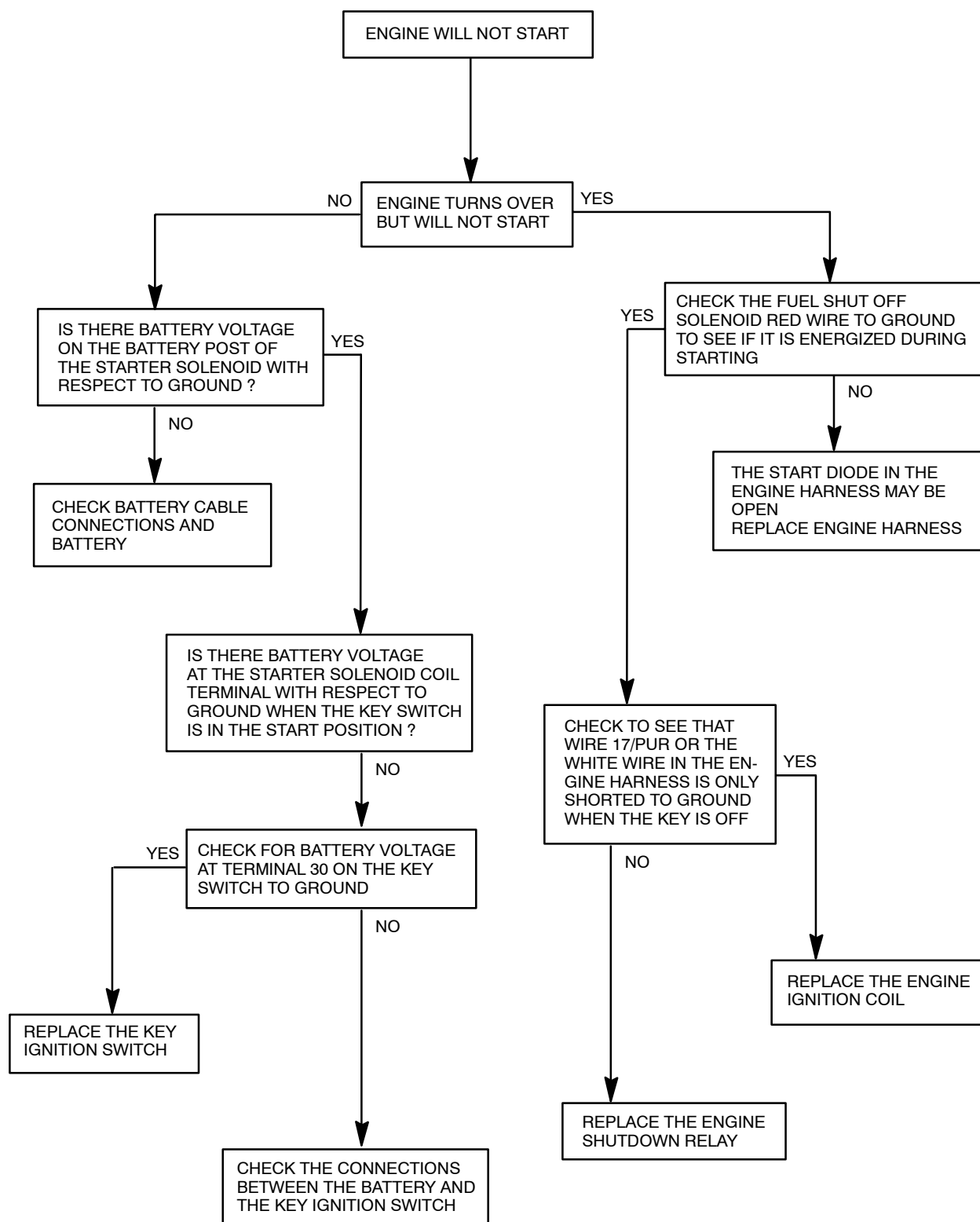


LEGEND	
SYMBOL	DESCRIPTION
CB	CIRCUIT BREAKER
D	DIODE
L	LAMP
M	RELAY OR CONTACTOR COIL
MTR	MOTOR
SOL	SOLENOID, ELECTROMECHANICAL
SV	SOLENOID VALVE
SW	SWITCH

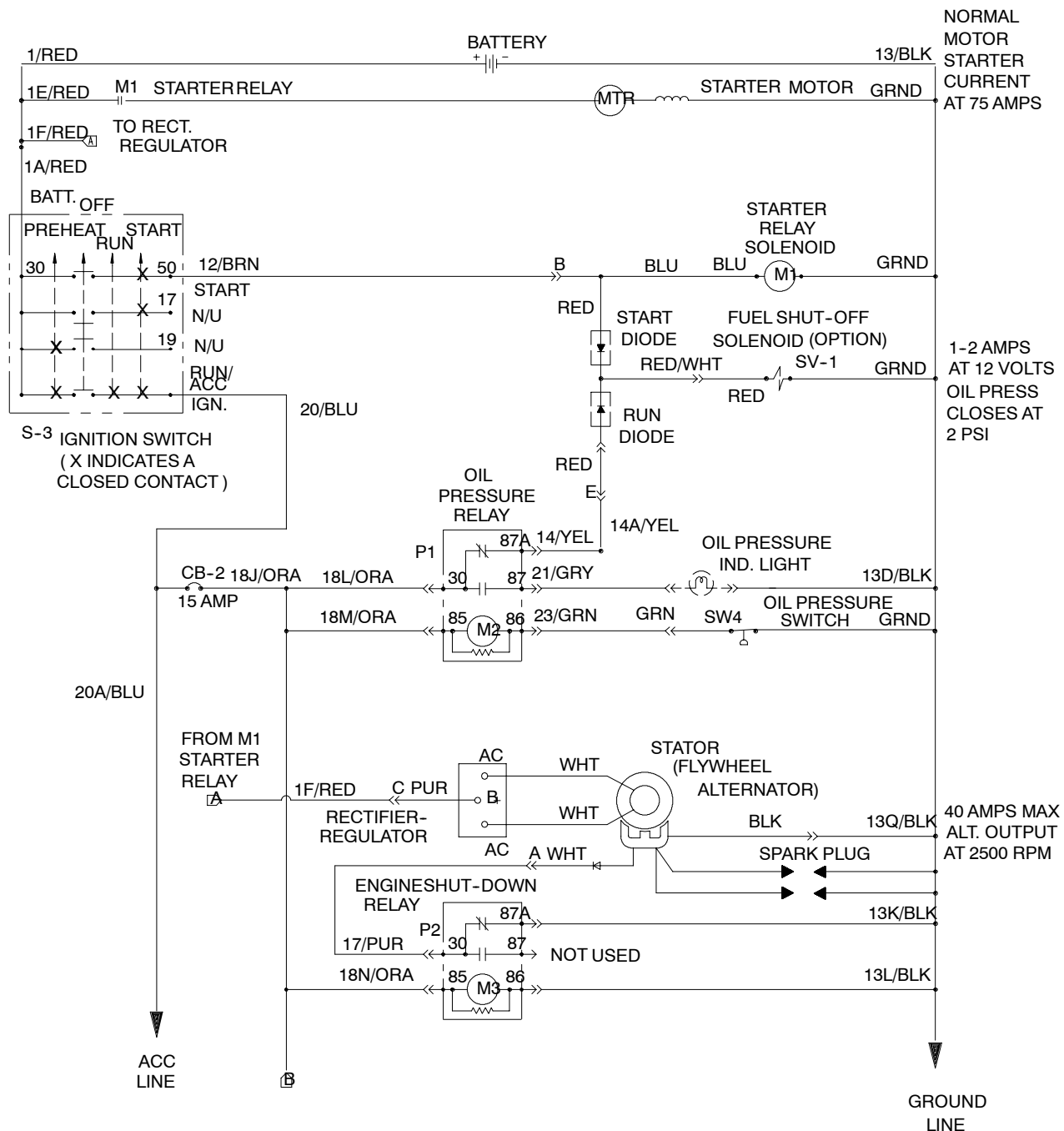
**DIESEL ENGINE STARTS BUT  
WILL NOT STAY RUNNING**

# AIR COOLED GAS/LP ENGINE WILL NOT START

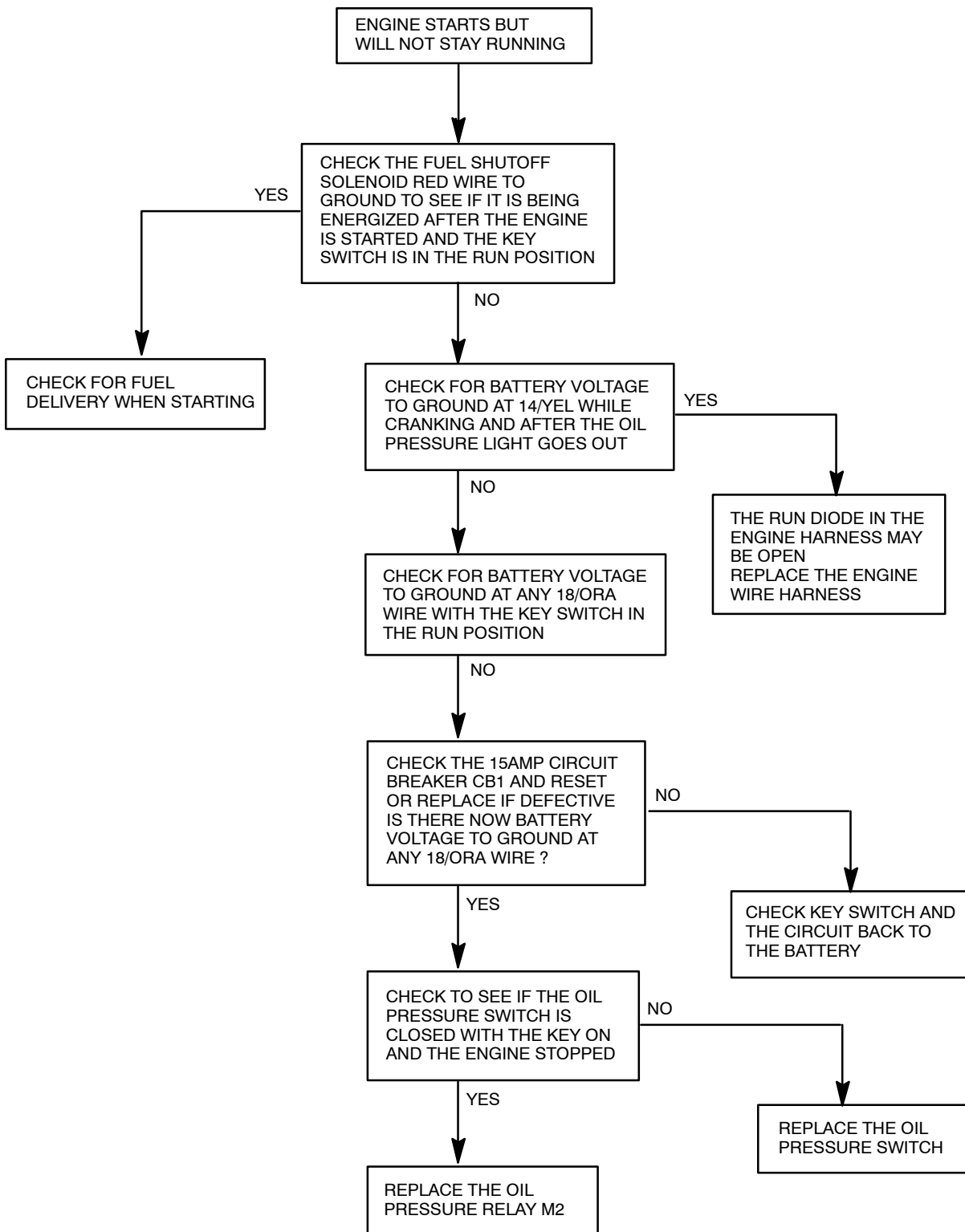


AIR COOLED GAS/LP  
ENGINE WILL NOT START

# AIR COOLED GAS/LP ENGINE STARTS BUT WILL NOT STAY RUNNING





**AIR COOLED GAS/LP ENGINE  
STARTS BUT WILL NOT STAY  
RUNNING**



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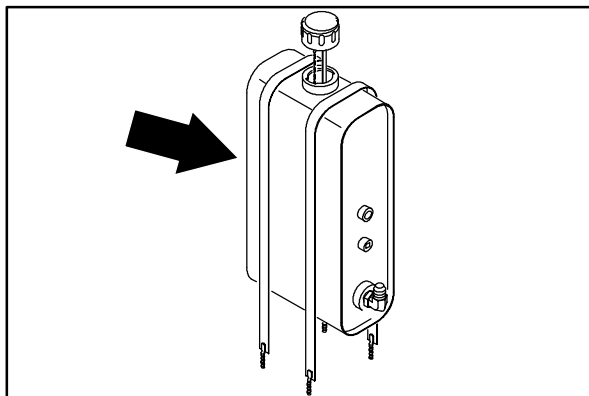
**INTRODUCTION**

The hydraulic system consists of the propel pump, accessory pump, control valve, and drive motors.

## HYDRAULICS

### HYDRAULIC FLUID RESERVOIR

Check the hydraulic fluid level at operating temperature every 100 hours of operation. Make sure the hopper is down when checking hydraulic fluid level. The end of the dipstick is marked with FULL and ADD levels to indicate the level of hydraulic fluid in the reservoir.



Lubricate the filler cap gasket with a film of hydraulic fluid before putting the cap back on the reservoir.

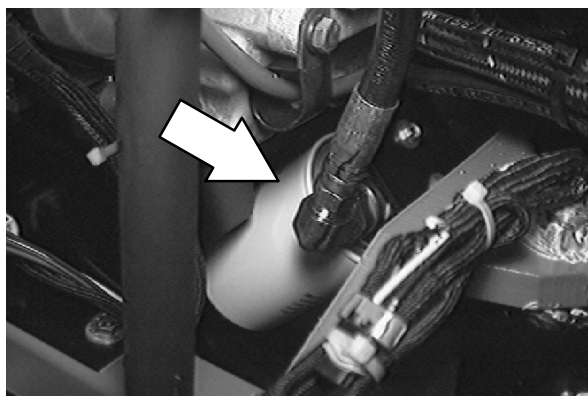
**ATTENTION! Do not overfill the hydraulic fluid reservoir or operate the machine with a low level of hydraulic fluid in the reservoir. Damage to the machine hydraulic system may result.**

Drain and refill the hydraulic fluid reservoir with new hydraulic fluid every 800 hours of operation.



The hydraulic fluid filter is located at the bottom of the engine compartment. Replace the filter element every 800 hours of operation.

The reservoir has a built-in strainer outlet that filters hydraulic fluid before it enters the system. Replace the strainer every 800 hours of operation.



## HYDRAULIC FLUID

The quality and condition of the hydraulic fluid play a very important role in how well the machine operates. Tennant's hydraulic fluid is specially selected to meet the needs of Tennant machines.

Tennant's hydraulic fluids provide a longer life for the hydraulic components. There are two fluids available for different temperature ranges:

Tennant hydraulic fluid	
Part number	Ambient temperature
65869	above 7° C (45° F)
65870	below 7° C (45° F)

The higher temperature fluid has a higher viscosity and should not be used at the lower temperatures. Damage to the hydraulic pumps may occur because of improper lubrication.

The lower temperature fluid is a thinner fluid for colder temperatures.

If a locally available hydraulic fluid is used, make sure the specifications match Tennant hydraulic fluid specifications. Using substitute fluids can cause premature failure of hydraulic components.

**ATTENTION! Hydraulic components depend on system hydraulic fluid for internal lubrication. Malfunctions, accelerated wear, and damage will result if dirt or other contaminants enter the hydraulic system.**

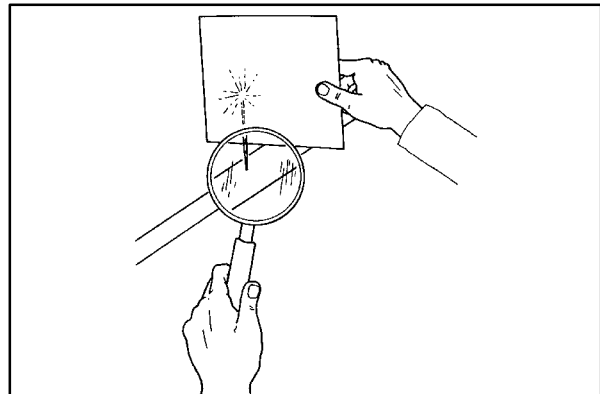
## HYDRAULIC HOSES

Check the hydraulic hoses after every 800 hours of operation for wear or damage.

Fluid escaping at high pressure from a very small hole can be almost invisible, and can cause serious injuries.

See a doctor at once if injury results from escaping hydraulic fluid. Serious infection or reaction can develop if proper medical treatment is not given immediately.

**FOR SAFETY: When servicing machine, use cardboard to locate leaking hydraulic fluid under pressure.**



00002

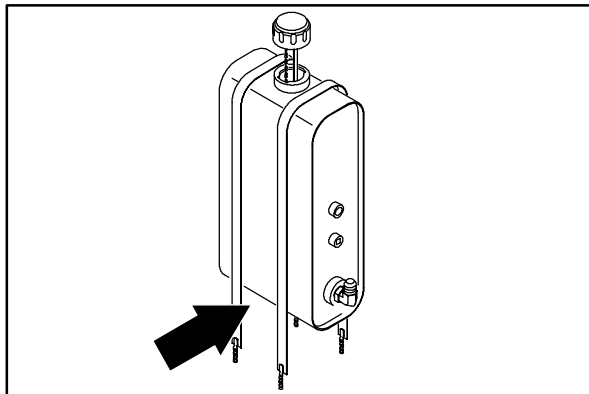
## HYDRAULICS

### TO DRAIN HYDRAULIC FLUID RESERVOIR AND REPLACE FILTER ELEMENT

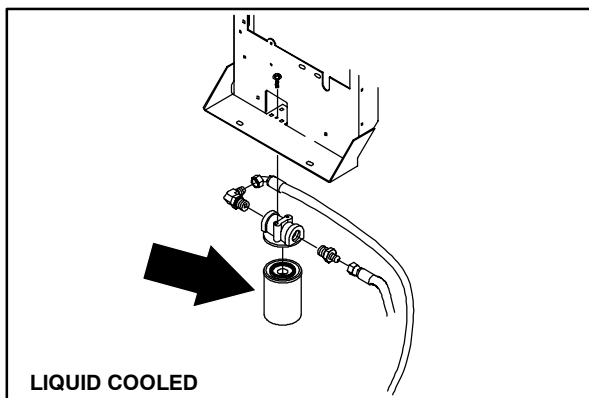
1. Stop the engine and set the machine parking brake.

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

2. Wait for the hydraulic fluid to cool down.
3. Remove the drain plug from the bottom of the hydraulic tank on the right hand side of the machine. Drain the fluid into a pan. Properly discard the old fluid.

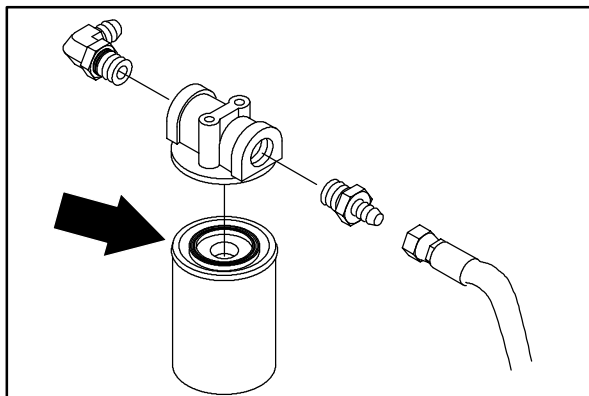


4. Open the seat support and locate the hydraulic oil filter at the back, left hand side of the machine, under the radiator.



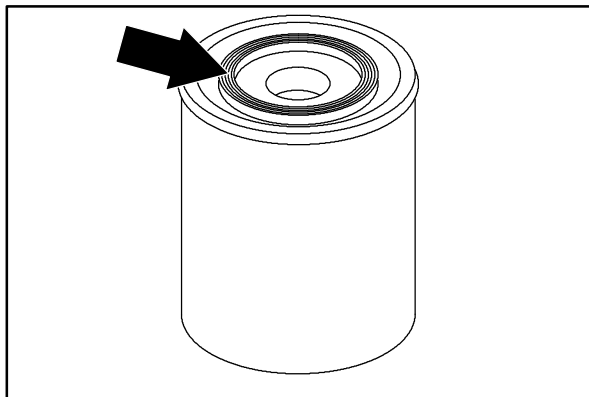
5. Unthread and discard the hydraulic fluid filter element. Hydraulic fluid will drain through the filter head. Discard the used hydraulic fluid. Loosen the breather-filler cap.

*NOTE: Be aware the hydraulic filter is lower than the reservoir. All fluid will drain from the reservoir. Discard all hydraulic fluid drained from the system. The fluid may contain foreign material harmful to the hydraulic system.*

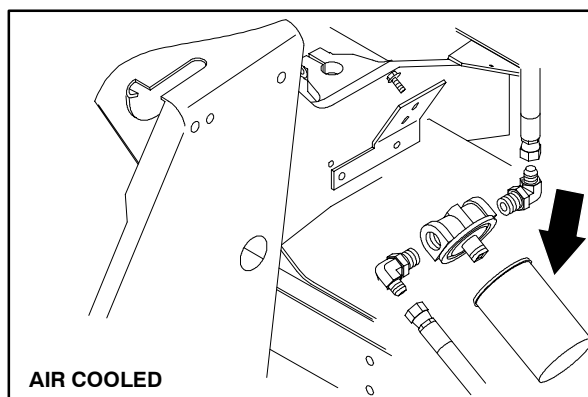




6. Apply a thin coat of hydraulic fluid to the seal of the new hydraulic fluid filter element.



7. Thread and hand tighten the new hydraulic fluid filter element on the filter head.

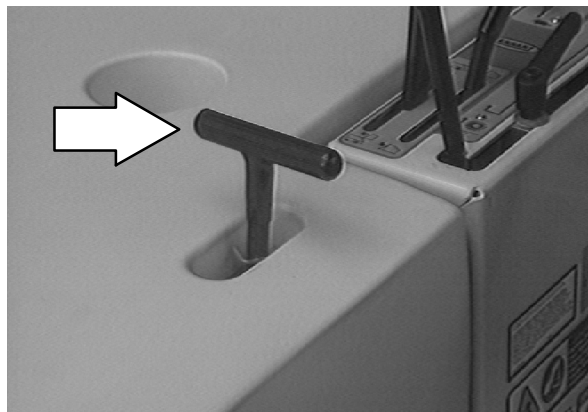


8. Refill the hydraulic reservoir.



### TO FILL HYDRAULIC FLUID RESERVOIR

1. Open the seat support.

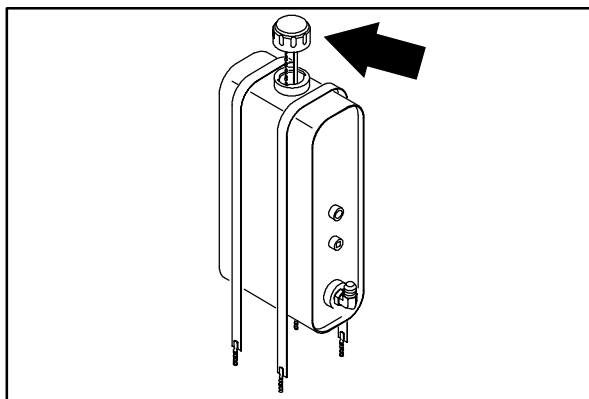


2. Remove the reservoir breather-filler cap.

*NOTE: Make sure the hydraulic reservoir drain plug is installed in the bottom of the tank before refilling.*

3. Pour new, approved hydraulic fluid through a 200 mesh screened funnel and into the reservoir.

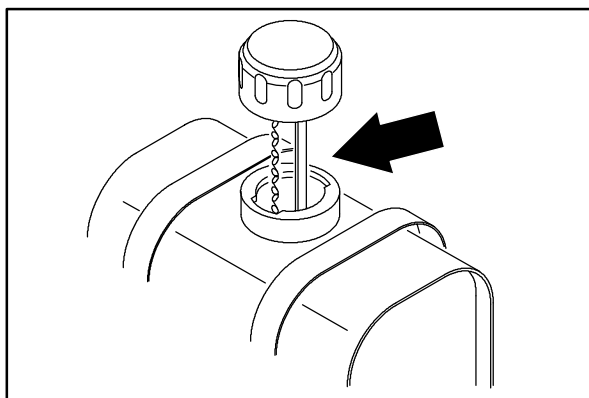
**ATTENTION! Use only new, approved hydraulic fluid to fill the hydraulic fluid reservoir. Do not overfill.**



4. Check the hydraulic fluid level in the reservoir with the fluid level dipstick.
5. Add hydraulic fluid until the level in the reservoir is between the ADD and the FULL range. Do not overfill.

*NOTE: Do not overfill the hydraulic fluid reservoir. Hydraulic fluid expands as it reaches its normal operating temperature. Always allow for expansion when filling the reservoir.*

6. Put the reservoir breather-filler cap on the reservoir.
7. Start engine and operate all the hydraulic components.
8. Recheck the hydraulic fluid level.
9. Check for any leaks.

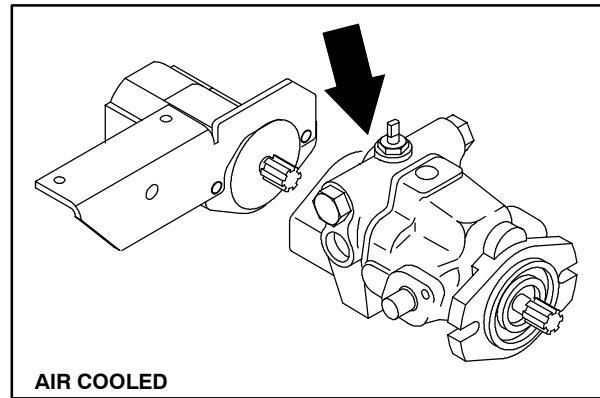


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**HYDRAULIC PUMPS**

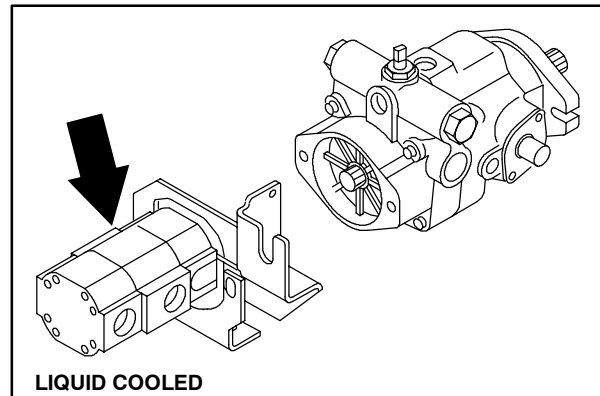
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The machine propelling pump is a variable displacement hydraulic piston pump.



The machine accessory pump is a hydraulic gear pump.

After repairing or replacing a hydraulic pump, or when system contamination is likely, change the hydraulic fluid in the reservoir and the hydraulic fluid filter.



## HYDRAULICS

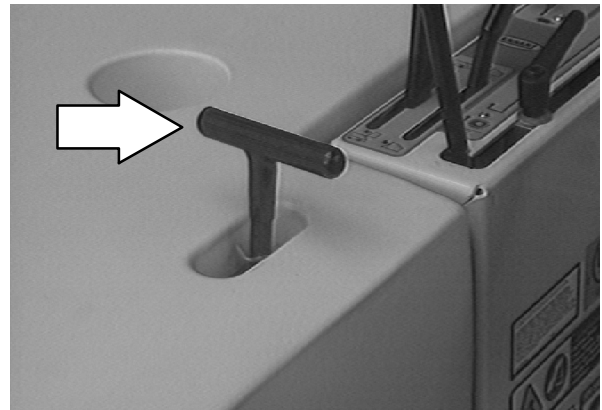
### TO REPLACE PROPEL PUMP (Liquid cooled)

1. Raise the hopper and engage the support bar. Remove the front rubber firewall.

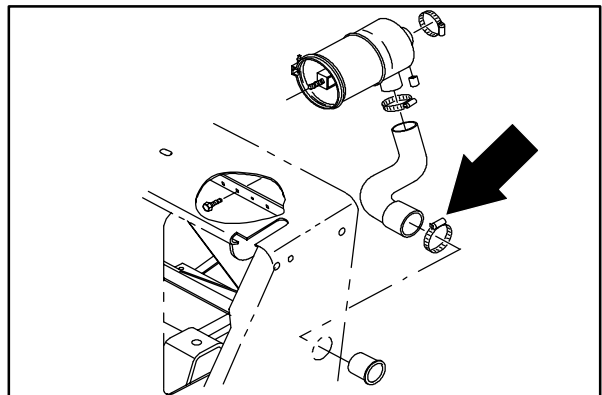
**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**



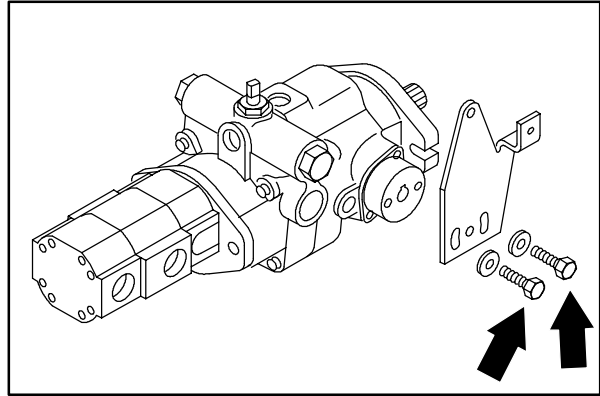
2. Open the seat support and disconnect the battery cables.



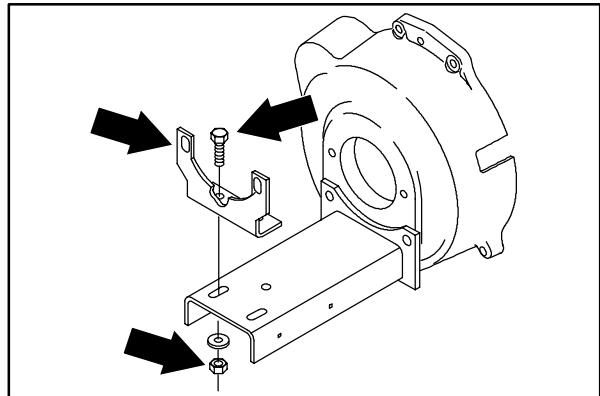
3. Remove the hose leading from the air cleaner to the machine lintel.



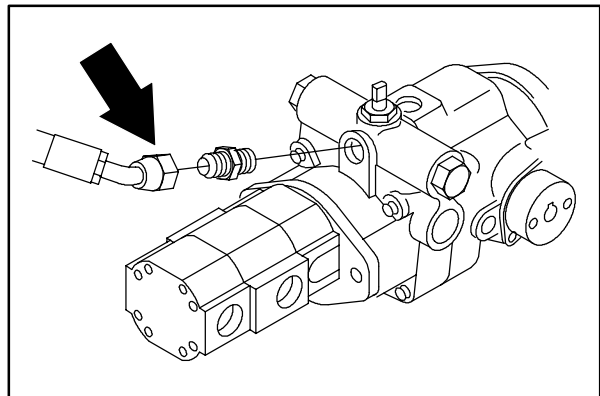
4. Remove the three hex screws holding the directional arm to the propel pump.



5. Remove the two hex screws and nyloc nuts holding the propel pump bracket to the engine bellhousing bracket.

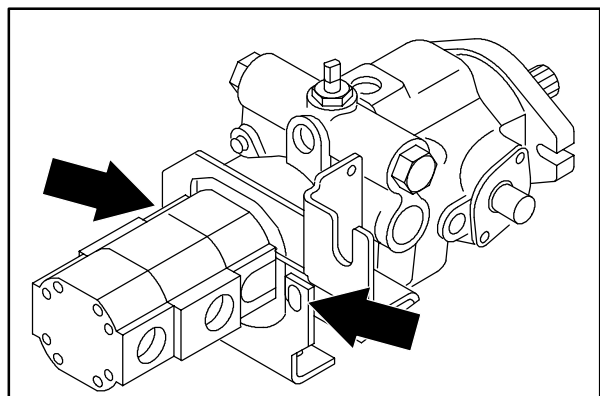


6. Disconnect and plug the hydraulic charge line leading to the back of the propel pump.



7. Remove the two hex screws holding the accessory pump and directional bracket to the propel pump. Move the directional spring assembly out of the way.

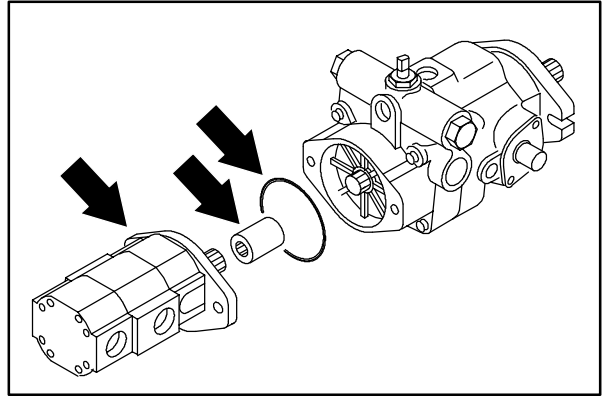
**NOTE:** Do not disconnect the hydraulic hoses leading to the accessory pump.



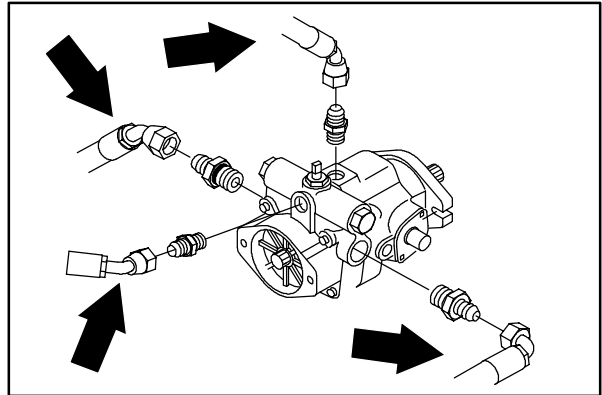
## HYDRAULICS

8. Pull the accessory pump out of the back of the propel pump. Do not loose the rubber O-ring from between the accessory pump and propel pump.

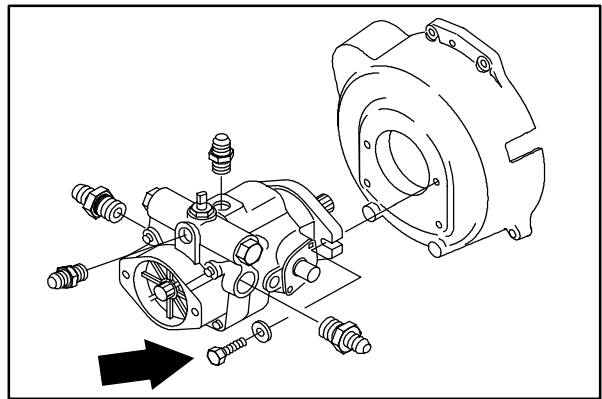
*NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.*



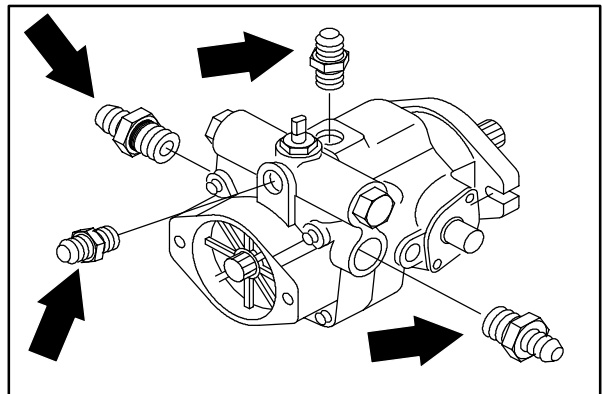
9. Mark, disconnect, and plug the hydraulic hoses leading to the propel pump.



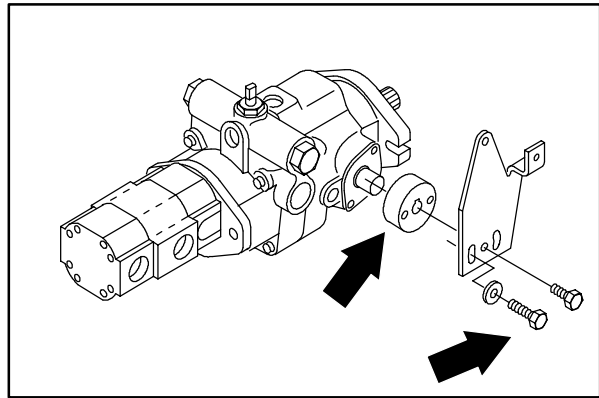
10. Remove the two hex screws holding the propel pump to the bellhousing. Pull the propel pump out of the bellhousing and remove it from the machine.



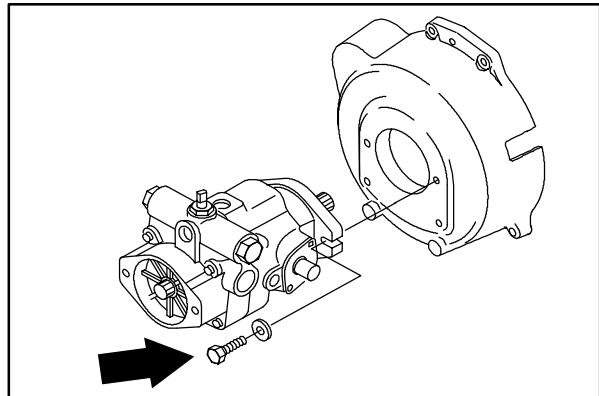
11. Remove the hydraulic fittings from the old pump and install in the new pump in the same orientation.



12. Remove the directional arm hub from the old pump and install on the new pump in the same orientation.

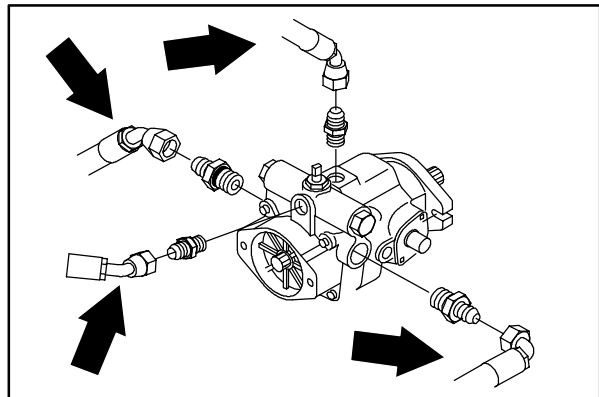


13. Position the new propel pump in the bellhousing. Reinstall the two hex screws and tighten to 36 - 40 Nm (27 - 30 ft lb). Use loctite 242 blue on the threads.

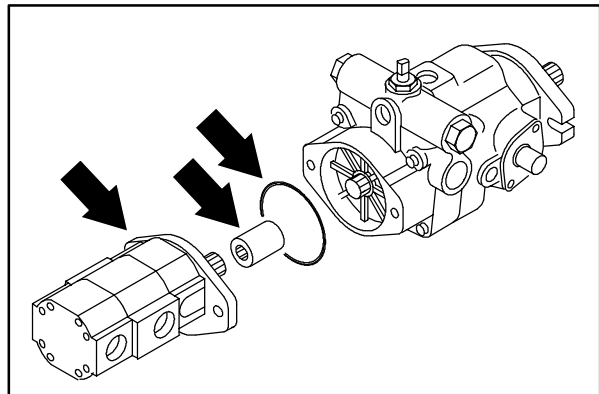


14. Reconnect the hydraulic hoses to the new propel pump. See the hose pictorial in this section.

*NOTE: Do not reconnect the charge line to the propel pump until after the accessory pump and directional spring mount bracket are installed.*

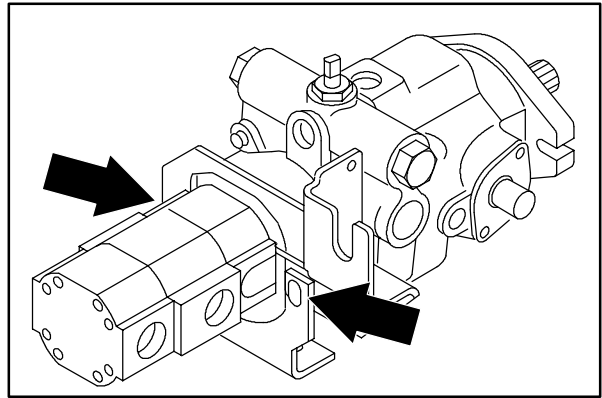


15. Position the accessory pump in the back of the new propel pump. Make sure the O-ring is in place on the accessory pump.

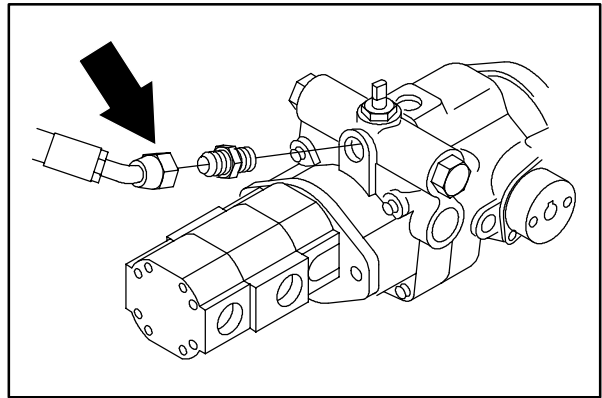


## HYDRAULICS

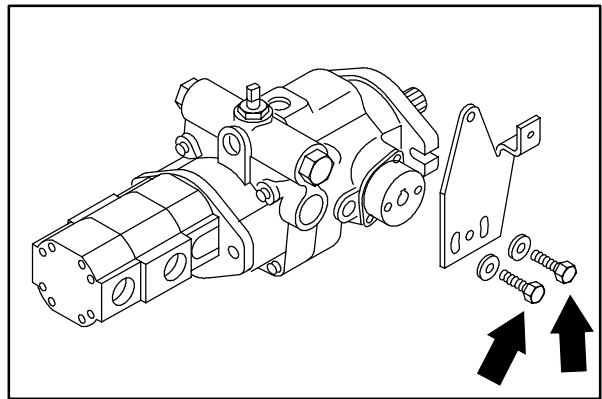
16. Position the directional spring mount bracket over the mounting flange on the accessory pump.
17. Line up the holes in the pump mount bracket with the mount holes in the accessory pump. Reinstall the two hex screws and tighten to 36 - 40 Nm (27 - 30 ft lb). Use loctite 242 blue on the threads.



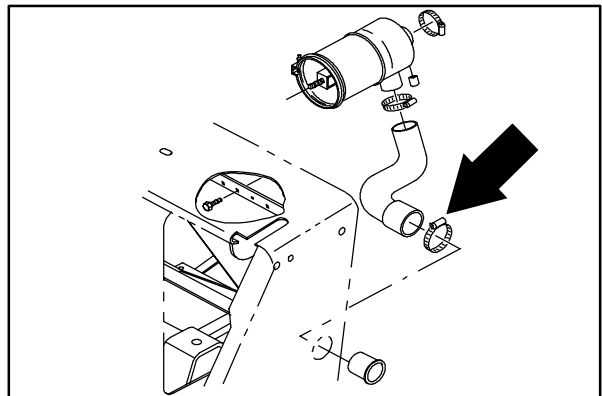
18. Reconnect the charge line to the propel pump.



19. Reinstall the directional arm to the propel pump. Leave the three hex screws loose for now.



20. Reinstall the hose to the air cleaner and machine lintel.

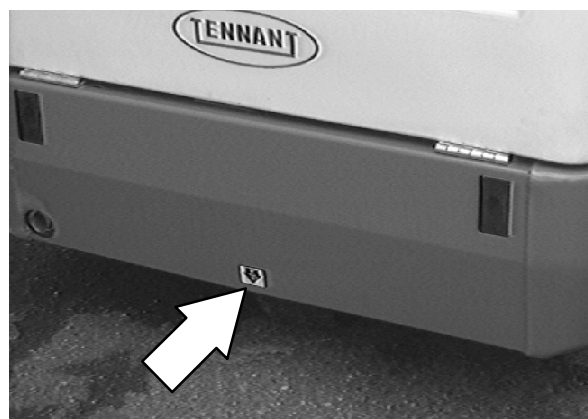




21. Reconnect the battery cables. Reinstall the front rubber firewall.



22. Raise the rear drive tire off the floor. Place jack stands under the frame.



23. Adjust the neutral centering of the new propel pump. See TO ADJUST DIRECTIONAL SPRING instructions.

## HYDRAULICS

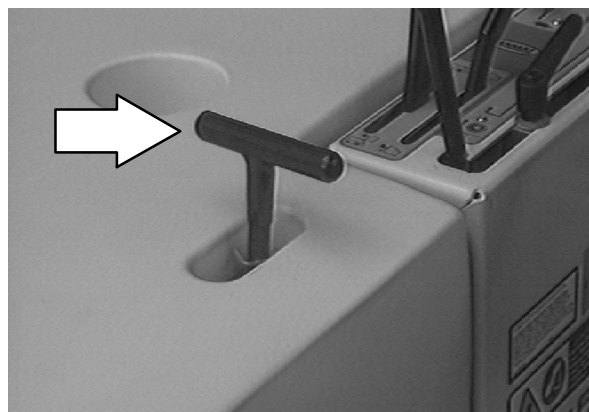
### TO REPLACE ACCESSARY PUMP (Liquid cooled)

1. Raise the hopper and engage the support bar. Remove the front rubber firewall.

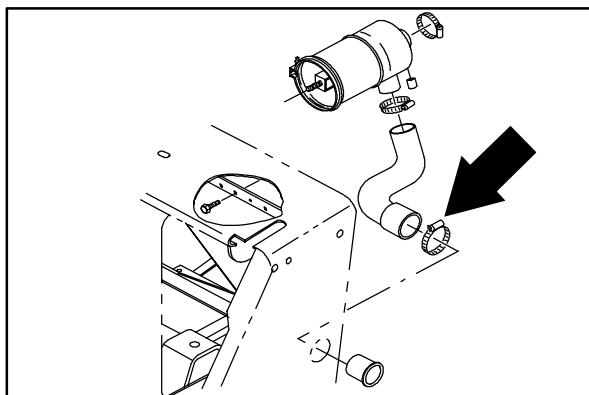
**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**



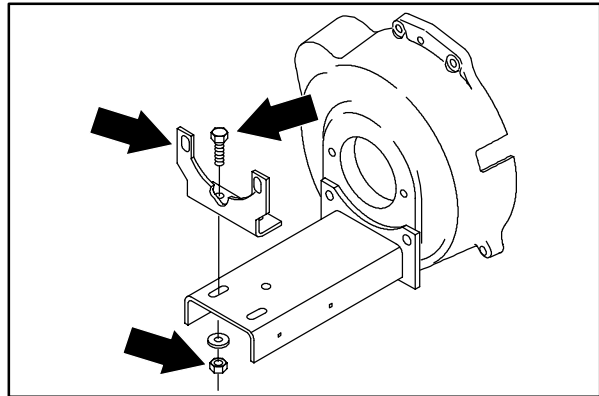
2. Open the seat support and disconnect the battery cables.



3. Remove the hose leading from the air cleaner to the machine lintel.

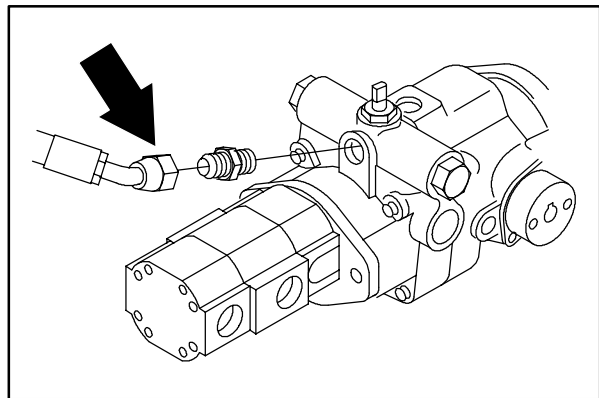


4. Remove the two hex screws and nyloc nuts holding the propel pump bracket to the engine bellhousing bracket.

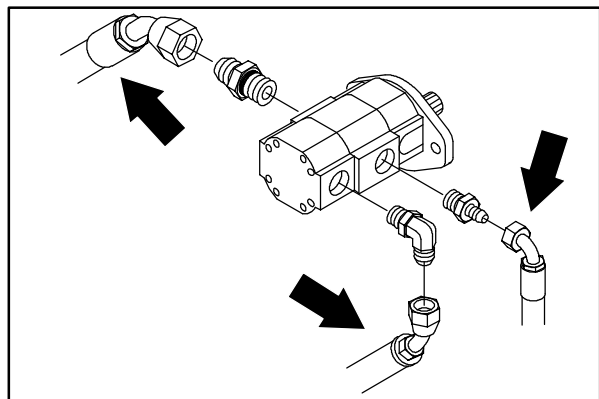


5. Disconnect and plug the hydraulic charge line leading to the back of the propel pump.

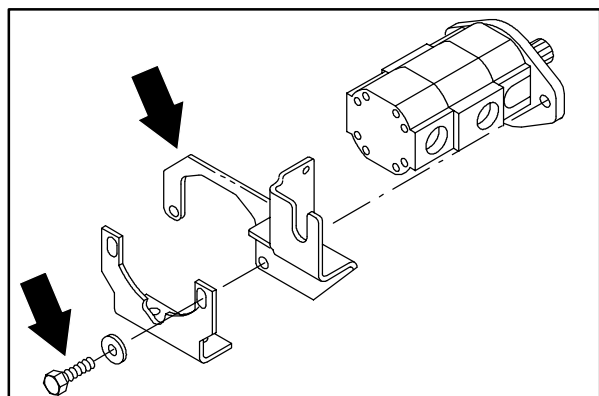
*NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.*



6. Disconnect and plug the hydraulic hoses leading to the accessory pump.

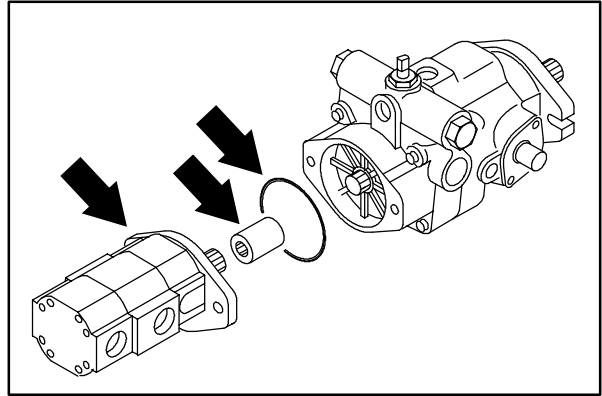


7. Remove the two hex screws holding the accessory pump and directional bracket to the propel pump. Move the directional spring assembly out of the way.

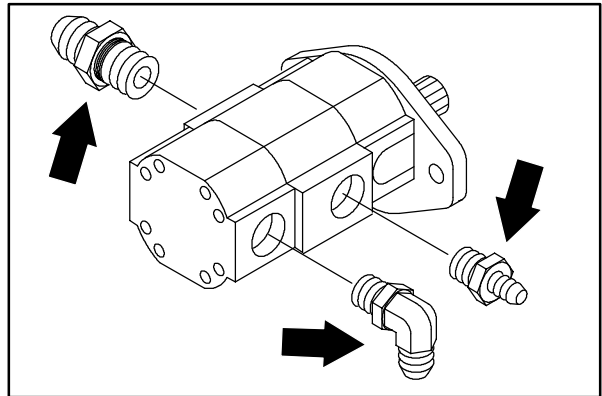


## HYDRAULICS

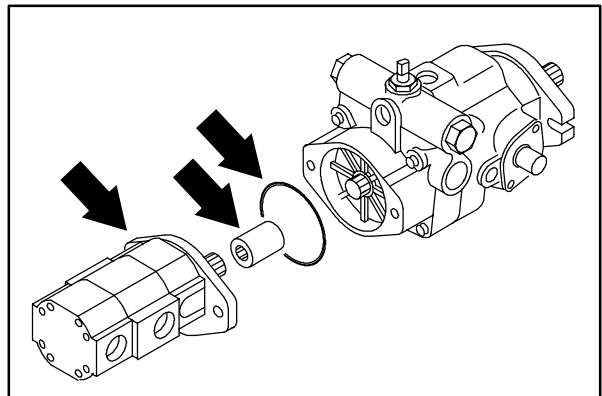
8. Pull the accessory pump out of the back of the propel pump. Do not loose the rubber O-ring from between the accessory pump and propel pump.



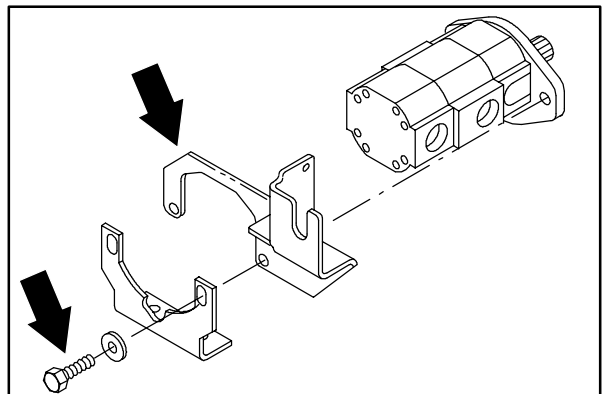
9. Remove the fittings from the old accessory and install in the new accessory pump in the same orientation.



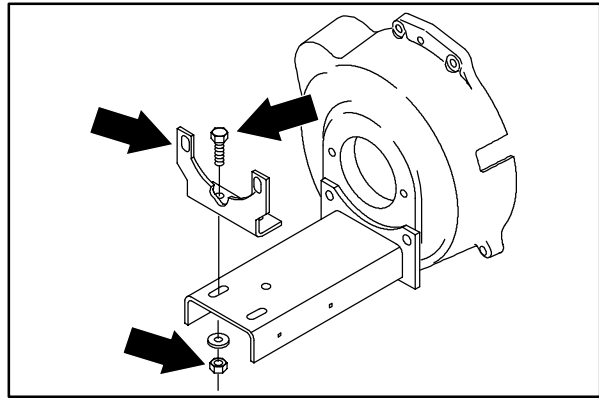
10. Position the new accessory pump in the back of the propel pump. Make sure the O-ring is in place on the accessory pump.



11. Position the directional spring mount bracket over the mounting flange on the new accessory pump.

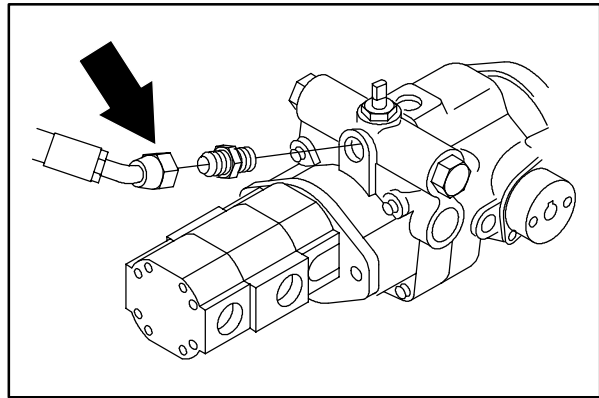


12. Line up the holes in the pump mount bracket with the mount holes in the new accessory pump. Reinstall the two hex screws and tighten to 36 - 40 Nm (27 - 30 ft lb). Use loctite 242 blue on the threads.

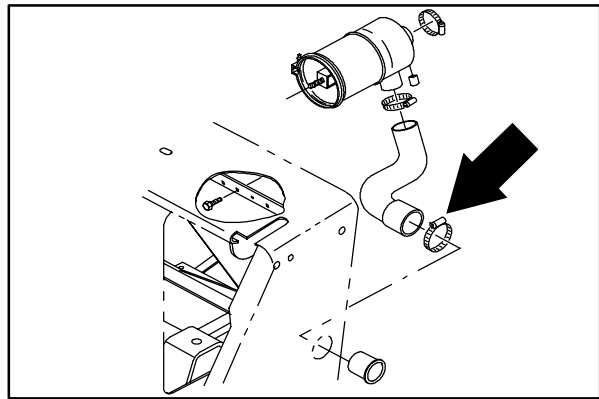


13. Reconnect the charge line to the propel pump.

*NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.*



14. Reinstall the hose to the air cleaner and machine lintel.



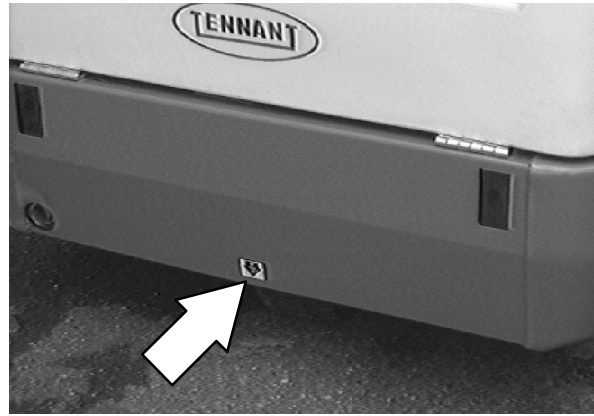
15. Reconnect the battery cables. Reinstall the front rubber firewall.



## HYDRAULICS

16. Raise the rear drive tire off the floor. Place jack stands under the frame.

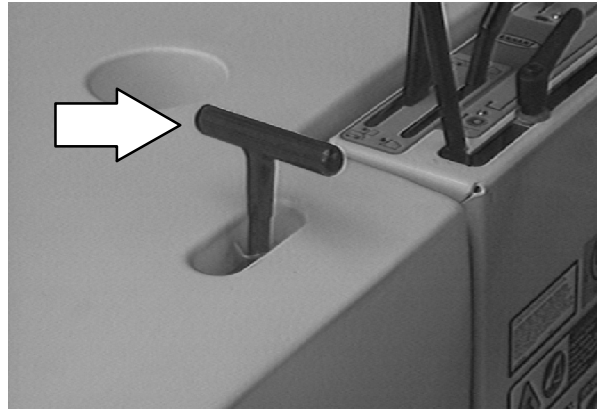
17. Adjust the neutral centering of the new propel pump. See TO ADJUST DIRECTIONAL SPRING instructions.



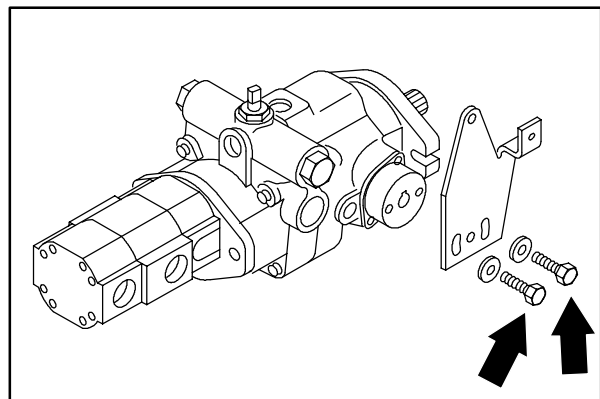
## TO REPLACE PROPEL PUMP (Air cooled)

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

1. Open the seat support and disconnect the battery cables.

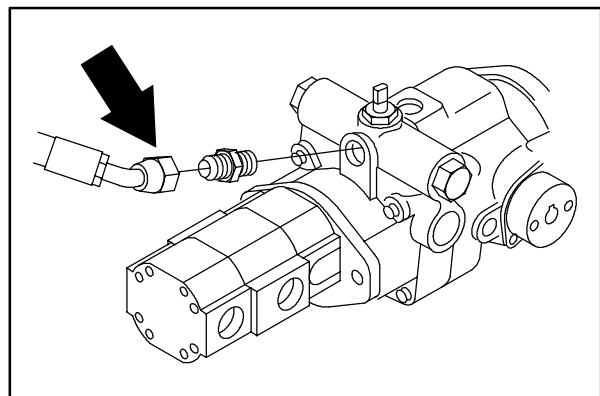


2. Remove the three hex screws holding the directional arm to the propel pump.



3. Disconnect and plug the hydraulic charge line leading to the back of the propel pump.

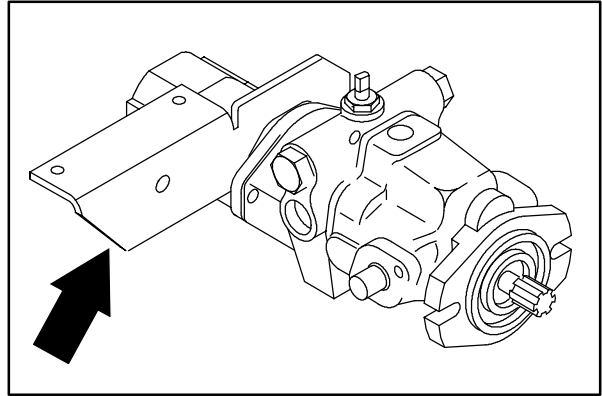
*NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.*



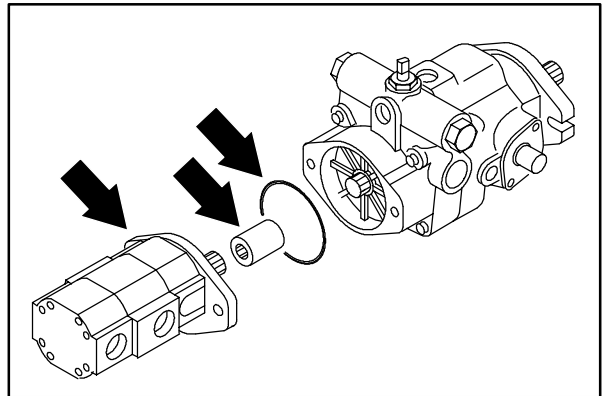
## HYDRAULICS

4. Remove the two hex screws holding the accessory pump and directional bracket to the propel pump. Move the directional spring assembly out of the way.

*NOTE: Do not disconnect the hydraulic hoses leading to the accessory pump.*

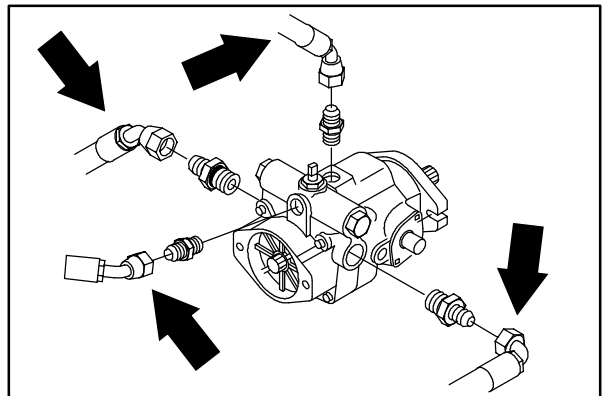


5. Pull the accessory pump out of the back of the propel pump. Do not lose the rubber O-ring from between the accessory pump and propel pump.

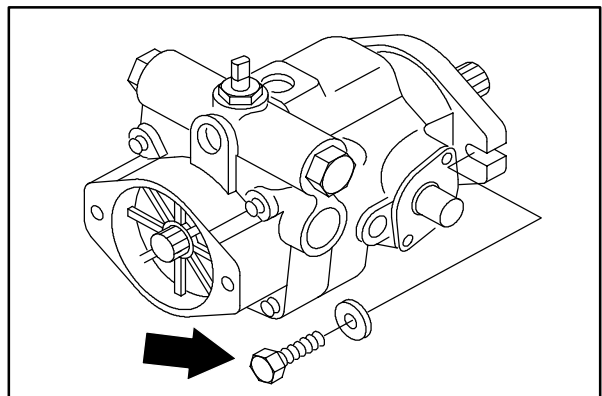


6. Disconnect and plug the hydraulic hoses leading to the propel pump.

*NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.*

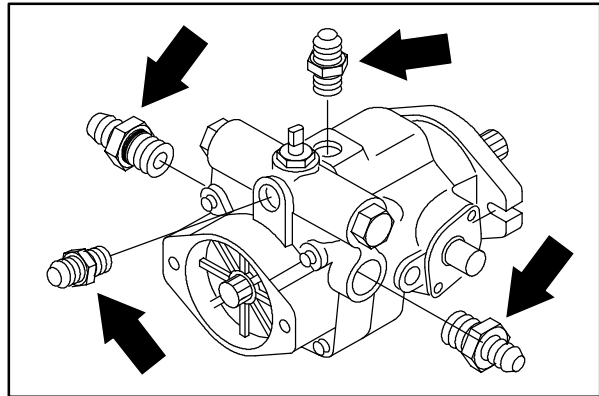


7. Remove the two hex screws holding the propel pump to the bellhousing. Pull the propel pump out of the bellhousing and remove it from the machine.

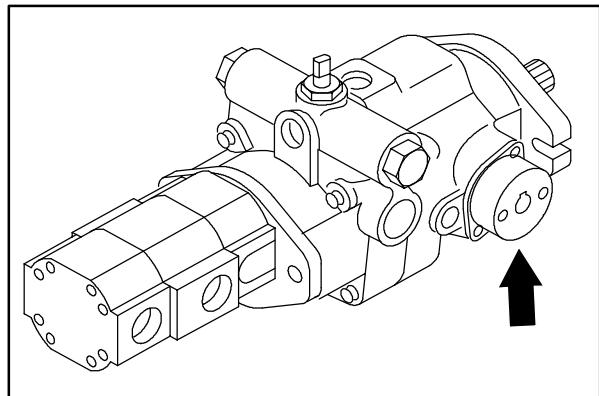




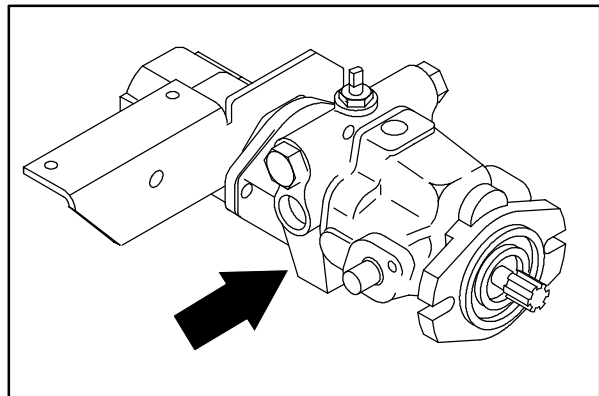
8. Remove the hydraulic fittings from the old pump and install in the new pump in the same orientation.



9. Remove the directional arm hub from the old pump and install on the new pump in the same orientation.

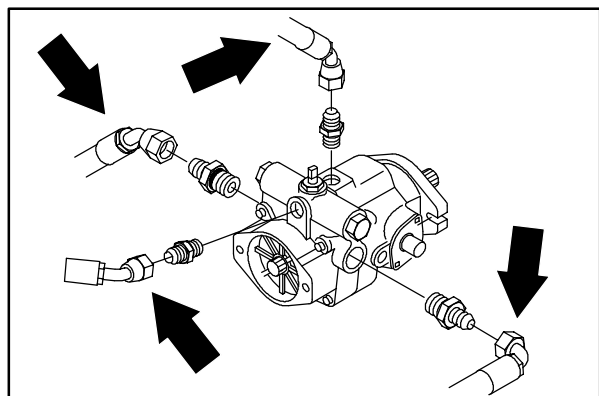


10. Position the new propel pump in the bellhousing. Reinstall the two hex screws and tighten to 36 – 40 Nm (27 – 30 ft lb). Use loctite 242 blue on the threads.



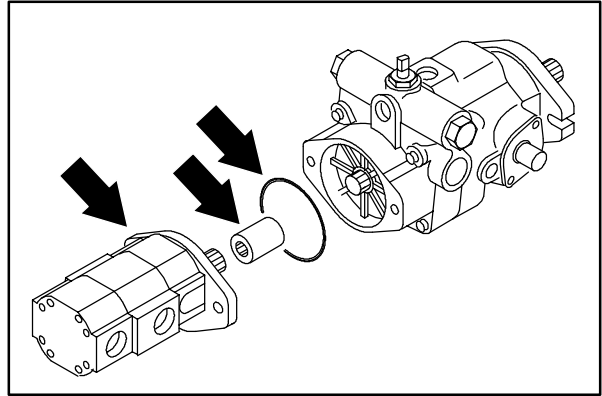
11. Reconnect the hydraulic hoses to the new propel pump. See the hose pictorial in this section.

**NOTE:** Do not reconnect the charge line to the propel pump until after the accessory pump and directional spring mount bracket are installed.

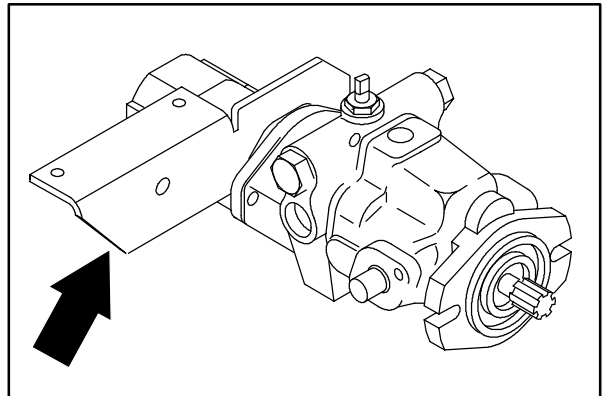


## HYDRAULICS

12. Position the accessory pump in the back of the new propel pump. Make sure the O-ring is in place on the accessory pump.

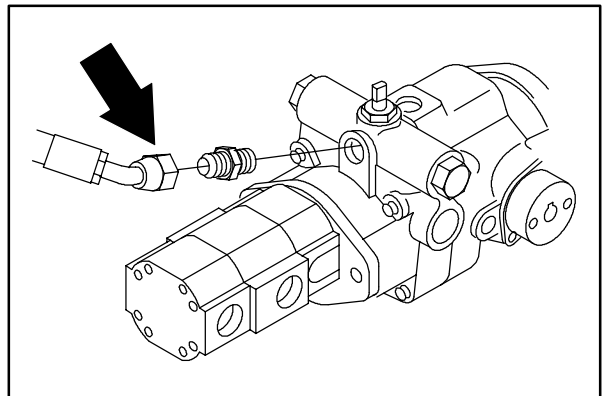


13. Position the directional spring mount bracket over the mounting flange on the accessory pump.
14. Line up the holes in the pump mount bracket with the mount holes in the accessory pump. Reinstall the two hex screws and tighten to 36 - 40 Nm (27 - 30 ft lb). Use loctite 242 blue on the threads.

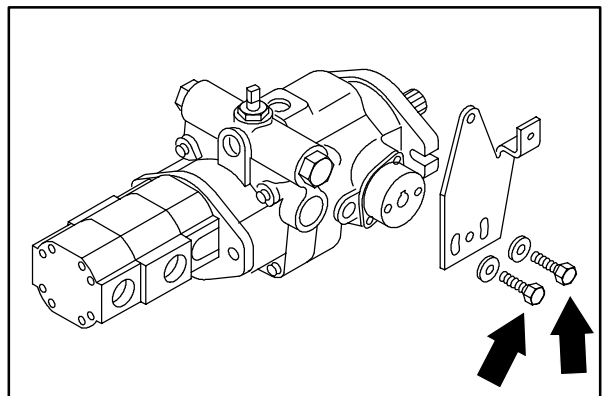


15. Reconnect the charge line to the propel pump.

*NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.*



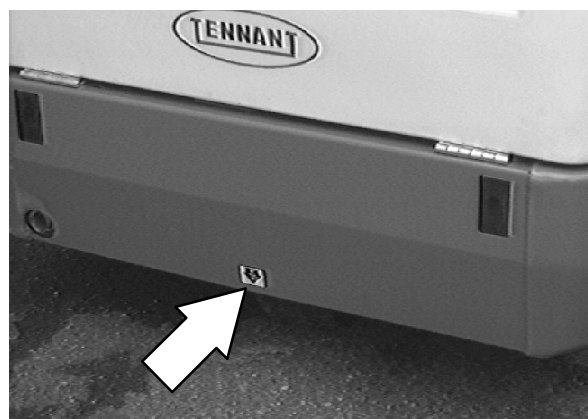
16. Reinstall the directional arm to the propel pump. Leave the three hex screws loose for now.



17. Reconnect the battery cables.



18. Raise the rear drive tire off the floor. Place jack stands under the frame.



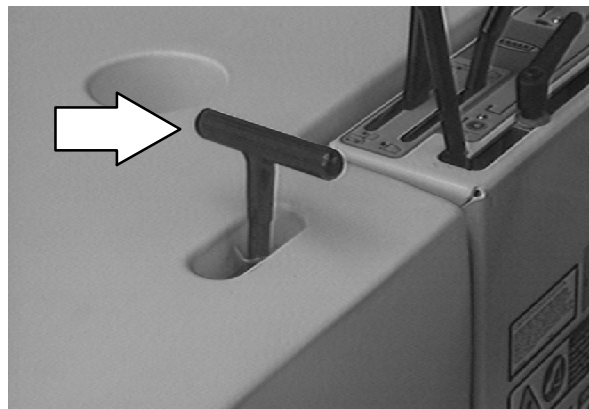
19. Adjust the neutral centering of the new propel pump. See TO ADJUST DIRECTIONAL SPRING instructions.

## HYDRAULICS

### TO REPLACE ACCESSORY PUMP (Air cooled)

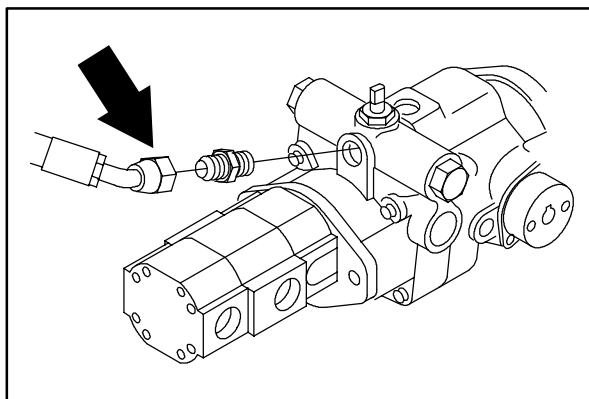
**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

1. Open the seat support and disconnect the battery cables.

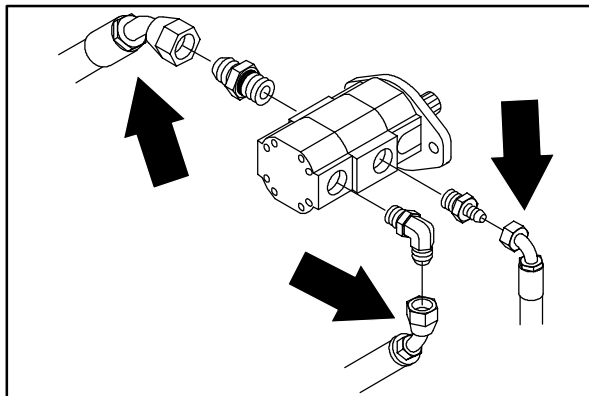


2. Disconnect and plug the hydraulic charge line leading to the back of the propel pump.

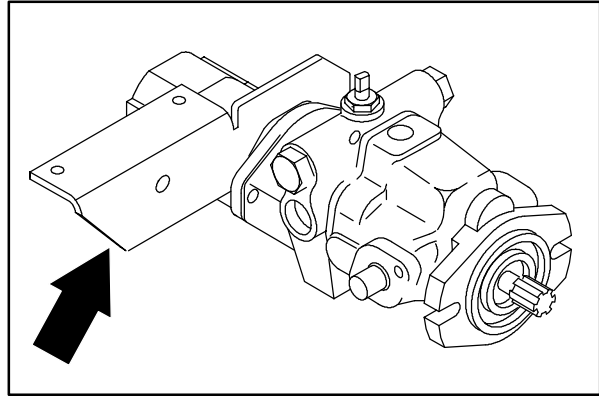
*NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.*



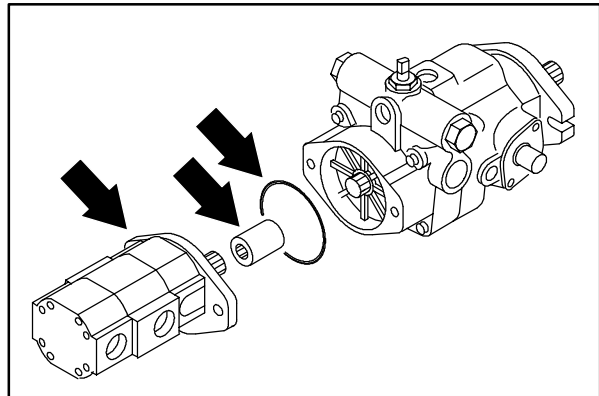
3. Disconnect and plug the hydraulic hoses leading to the accessory pump.



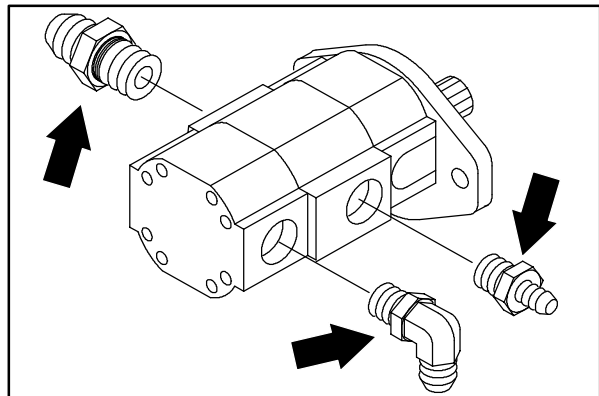
4. Remove the two hex screws holding the accessory pump and directional bracket to the propel pump. Move the directional spring assembly out of the way.



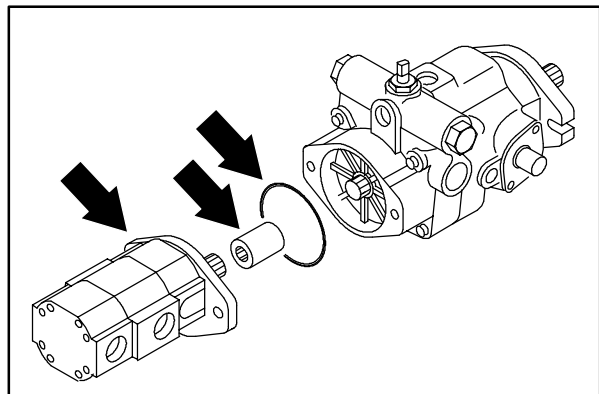
5. Pull the accessory pump out of the back of the propel pump. Do not loose the rubber O-ring from between the accessory pump and propel pump.



6. Remove the fittings from the old accessory pump and install in the new accessory pump in the same orientation.

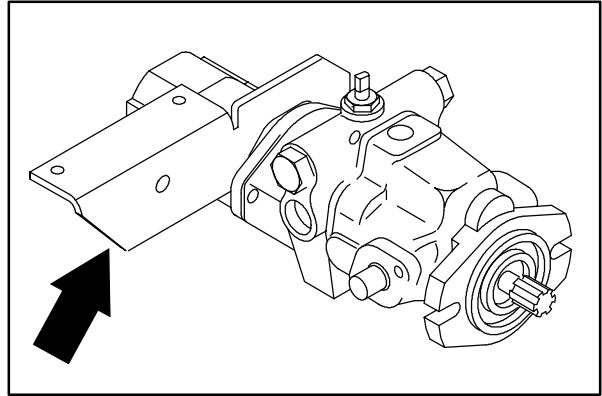


7. Position the new accessory pump in the back of the propel pump. Make sure the O-ring is in place on the accessory pump.

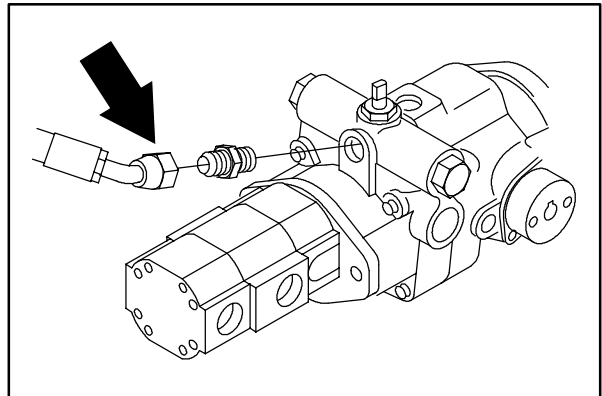


## HYDRAULICS

8. Position the directional spring mount bracket over the mounting flange on the new accessory pump.
9. Line up the holes in the pump mount bracket with the mount holes in the new accessory pump. Reinstall the two hex screws and tighten to 36 - 40 Nm (27 - 30 ft lb). Use loctite 242 blue on the threads.



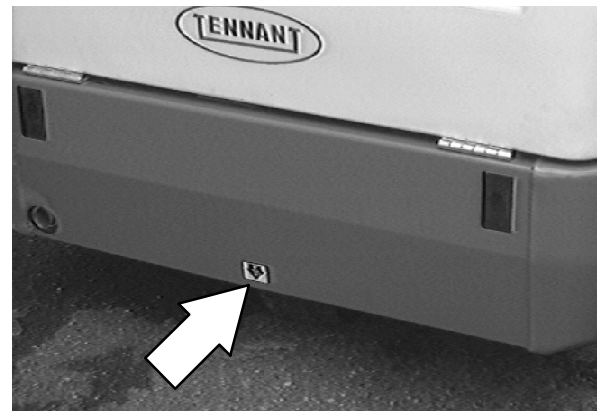
10. Reconnect the charge line to the propel pump.



11. Reconnect the battery cables. Reinstall the front rubber firewall.



12. Raise the rear drive tire off the floor. Place jack stands under the frame.

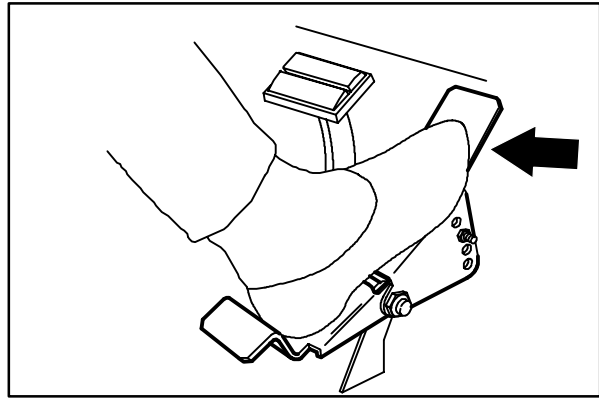


13. Adjust the neutral centering of the new propel pump. See TO ADJUST DIRECTIONAL SPRING instructions.

## DIRECTIONAL PEDAL

The directional pedal controls the flow of hydraulic fluid to the hydraulic propelling motor.

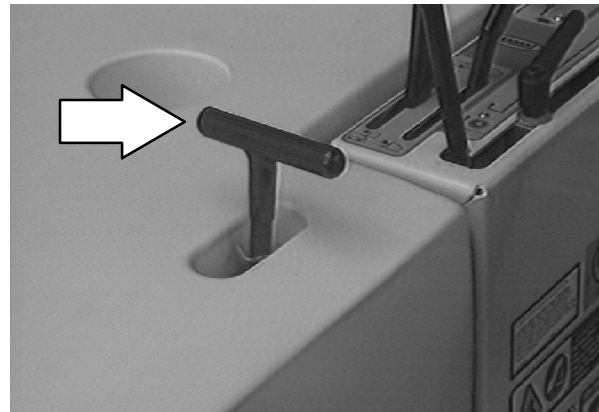
The pedal neutral position is the position in which the propelling pump sends no hydraulic fluid to the propelling motor. The machine should not move when the pedal neutral position is adjusted correctly. The pedal linkages should also be adjusted whenever the reverse is faster or slower than machine specification.



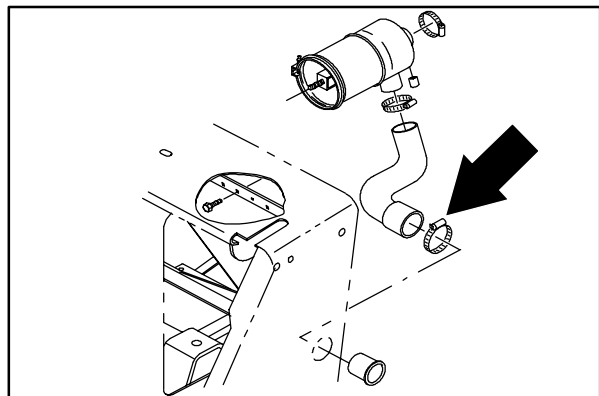
## TO REPLACE DIRECTIONAL SPRING (Liquid cooled)

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

1. Open the seat support and disconnect the battery cables.

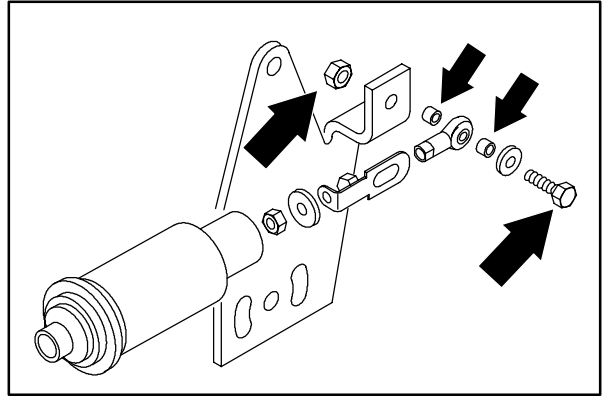


2. Remove the lower hose from the air cleaner assembly for better access to the directional spring.

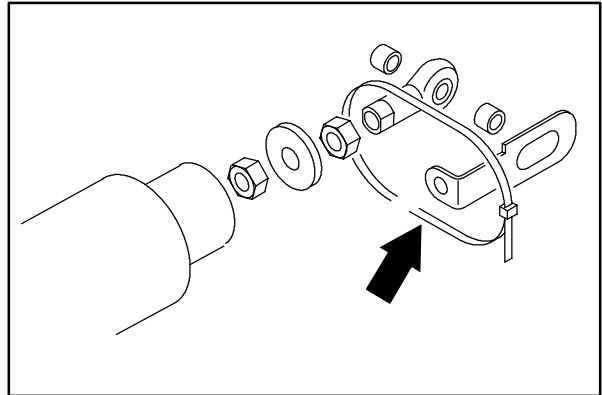


## HYDRAULICS

3. Remove the hex screw and nyloc nut holding the directional spring ball end to the propel pump arm. Retain the two spacers.

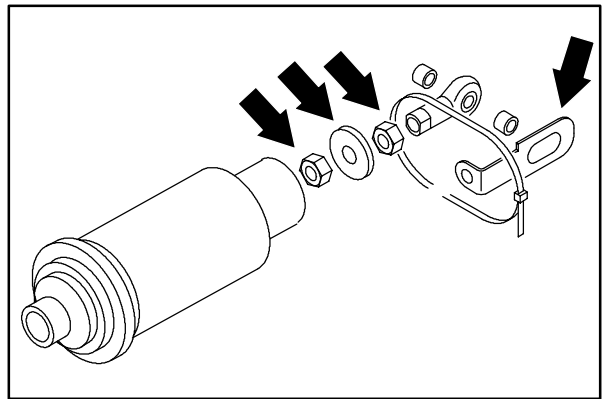


4. Cut the plastic tie from around the propel cable bracket.



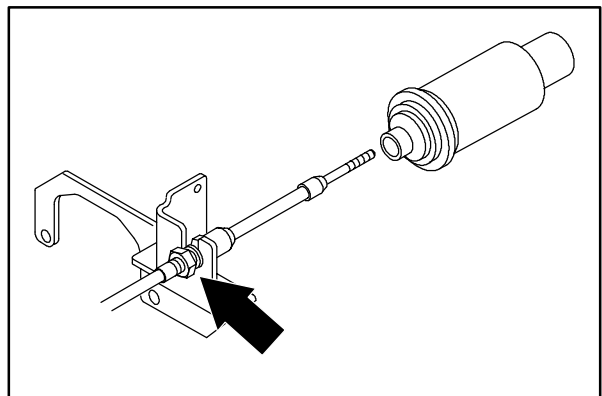
5. Remove the ball end, 1st jam nut, washer, propel cable bracket, and 2nd jam nut from the end of the directional cable.

*NOTE: Make note of the location of the 2nd jam nut for proper re-assembly.*



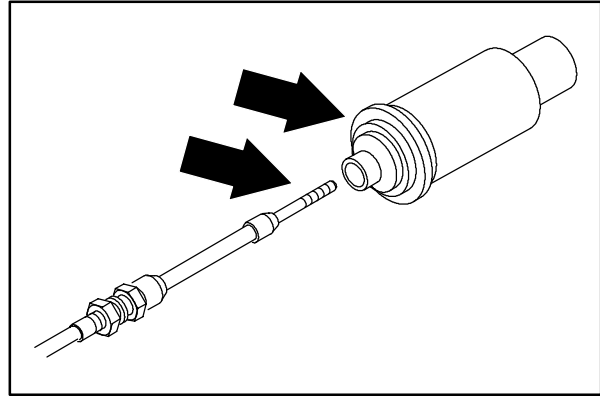
6. Loosen the large jam nut holding the directional spring to the directional spring mount bracket. Pull the directional spring up out of the slot.

*NOTE: Mark the directional cable before removing the directional spring to make sure the new spring is install in the same location.*

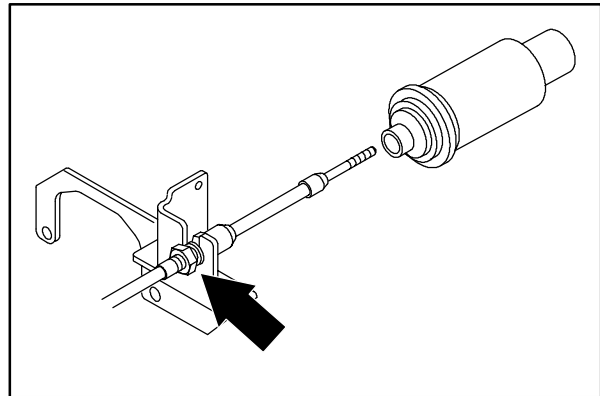




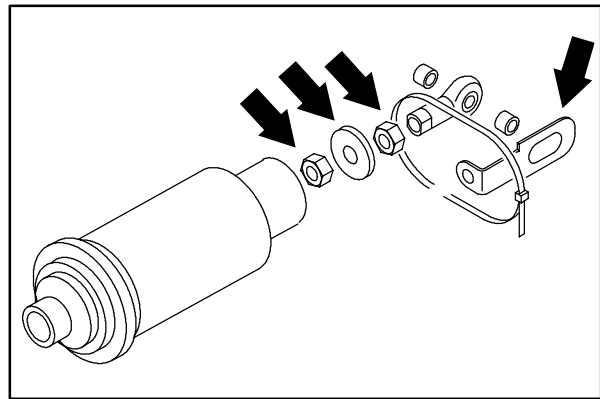
7. Un-screw the directional spring from the directional cable.
8. Install the new directional spring on the old directional cable. Position the new spring in the same location on the cable as the old one.



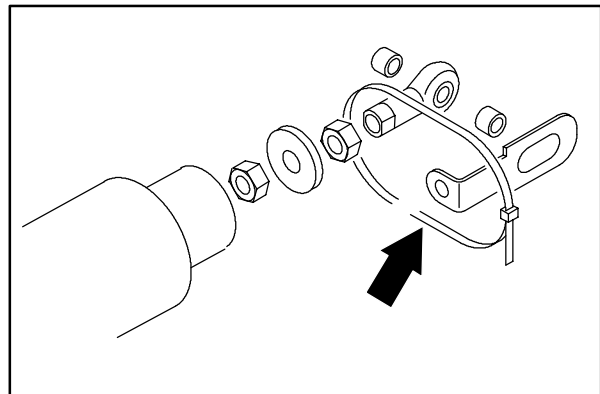
9. Place the new directional spring in the mount slot. Tighten the large jam nut firmly.



10. Reinstall the 1st jam nut, cable bracket, rubber washer, 2nd jam nut, and ball end. Tighten the jam nuts in the same location as they were removed.

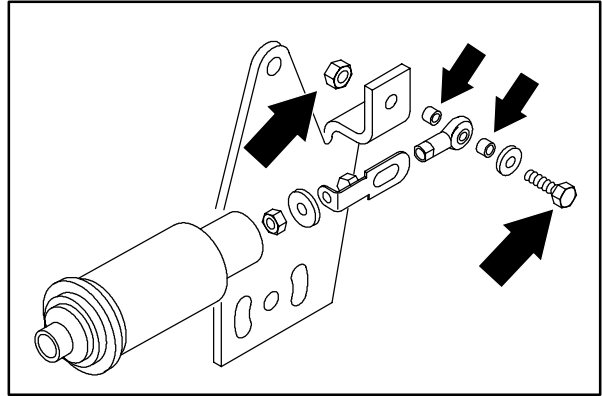


11. Install a new plastic wire tie around the cable bracket.

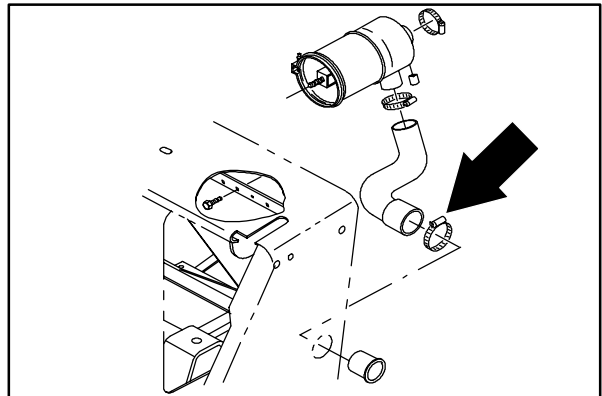


## HYDRAULICS

12. Reconnect the cable ball end to the propel pump arm. Tighten the hex screw to 11 – 14 Nm (7 – 10 ft lb).



13. Reinstall the lower hose on the air cleaner assembly.

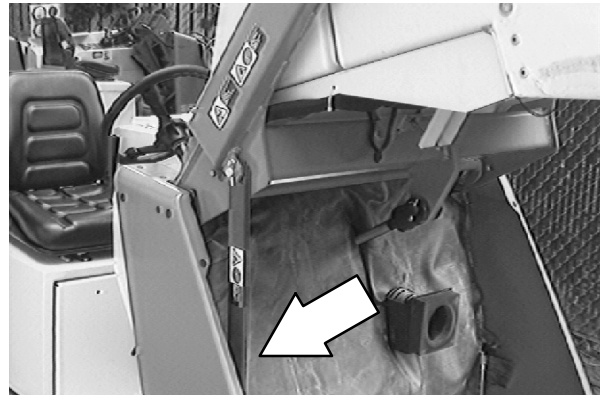


14. See TO ADJUST DIRECTIONAL SPRING instructions.

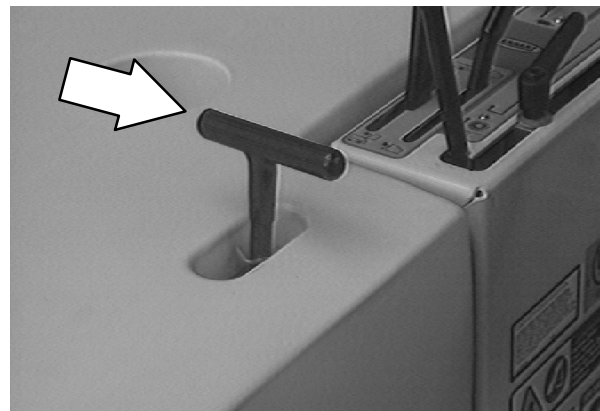
**TO REPLACE DIRECTIONAL CABLE  
(Liquid cooled)**

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

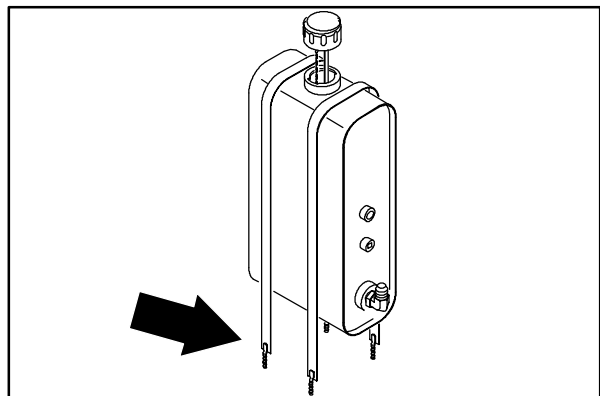
1. Raise the hopper and engage the support bar. Remove the front rubber firewall.



2. Open the seat support and disconnect the battery cables.

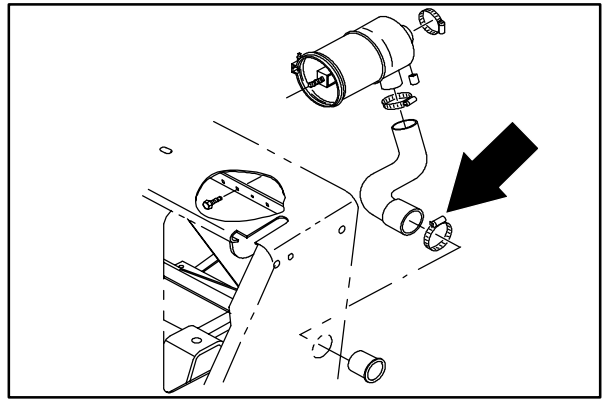


3. Remove the two hydraulic tank straps. Lift the tank up far enough to access the cable. Do not disconnect the hydraulic hoses.

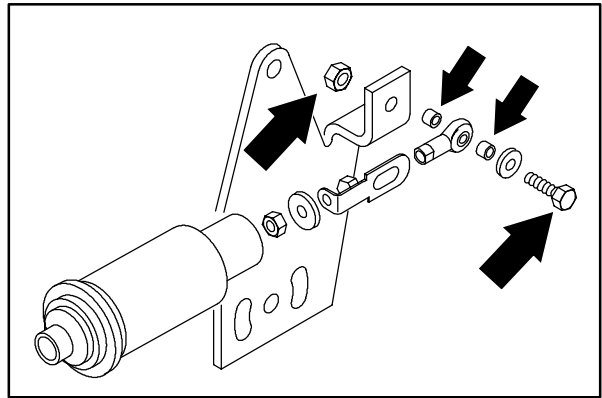


## HYDRAULICS

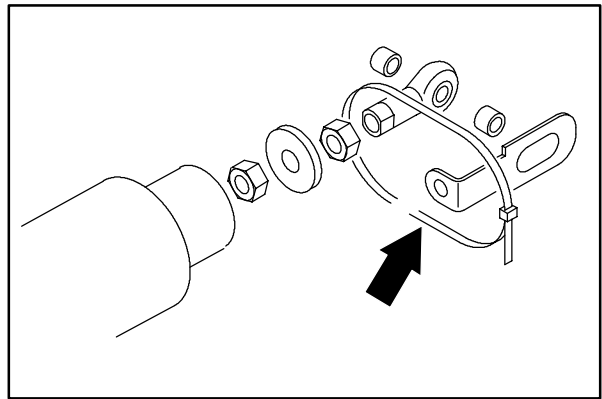
4. Remove the lower hose from the air cleaner assembly for better access to the directional spring.



5. Remove the hex screw, spacer, and nyloc nut holding the directional spring ball end to the propel pump arm.

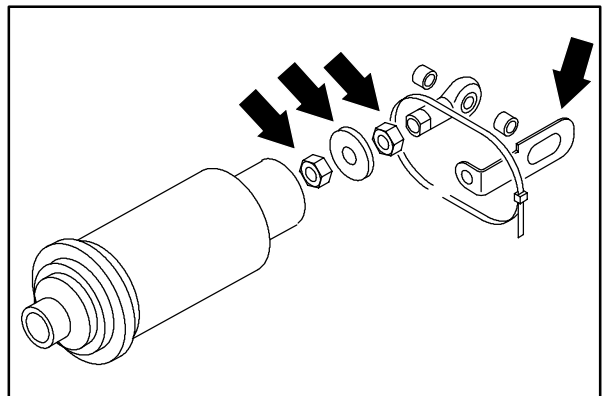


6. Cut the plastic tie from around the propel cable bracket.



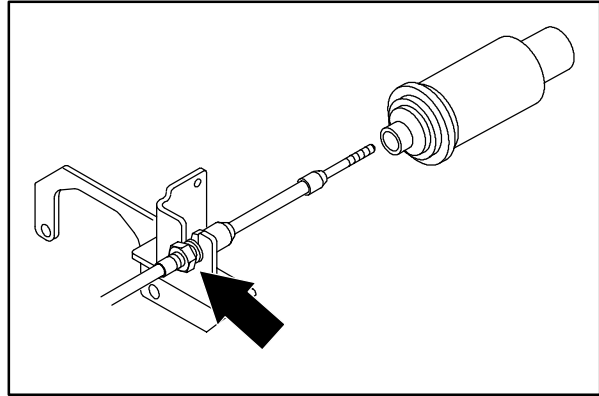
7. Remove the ball end, 1st jam nut, washer, propel cable bracket, and 2nd jam nut from the end of the directional cable.

*NOTE: Make note of the location of the 2nd jam nut for proper re-assembly.*

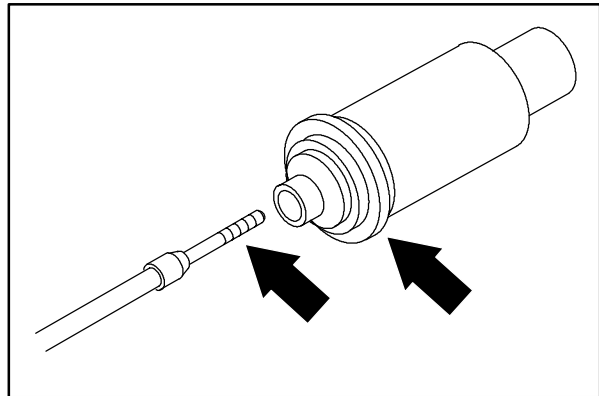


8. Loosen the large jam nut holding the directional spring to the directional spring mount bracket. Pull the directional spring up out of the slot.

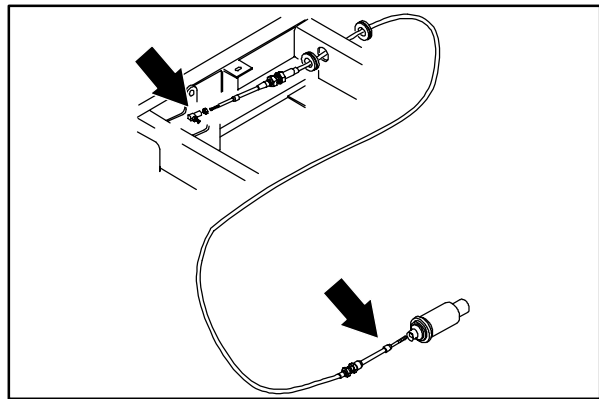
*NOTE: Mark the directional cable before removing the directional spring to make sure the new spring is install in the same location.*



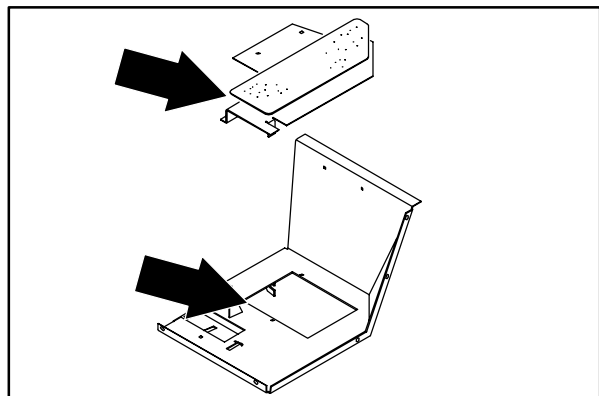
9. Un-screw the directional spring from the directional cable.



10. Push the directional cable through the large cable clamp under the hydraulic accessory pump.



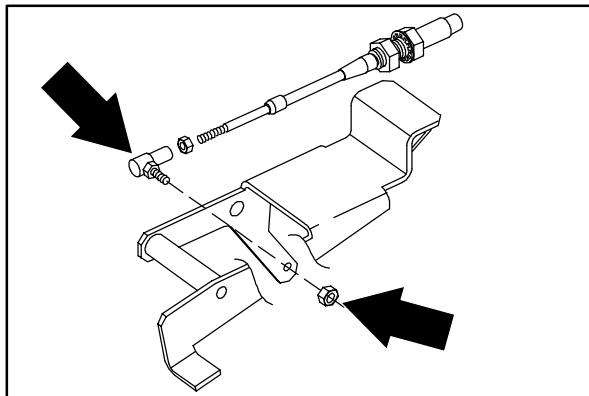
11. Go to the operators compartment and remove the floor plate access panel.



## HYDRAULICS

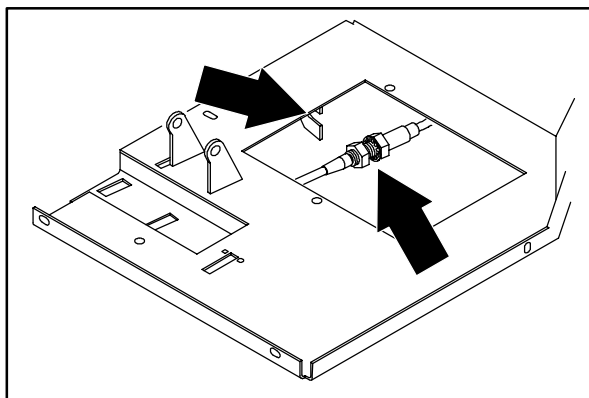
12. Reach in through the access hole and remove the hex screw and nyloc nut holding the rod end stud on the end of the directional cable to the directional pedal assembly.

*NOTE: Make sure to mark the location of the jam nuts on the cable. This adjustment controls forward and reverse speed.*



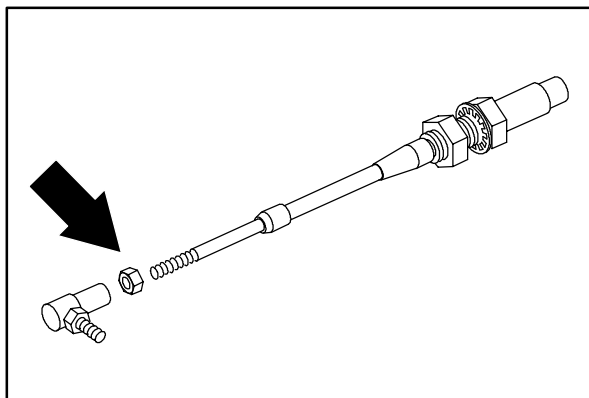
13. Loosen the large jam nut holding the directional cable to the floor plate. Drop the directional cable out of the slot.

14. Remove the clamp holding the directional cable to the side panel of the operators compartment.



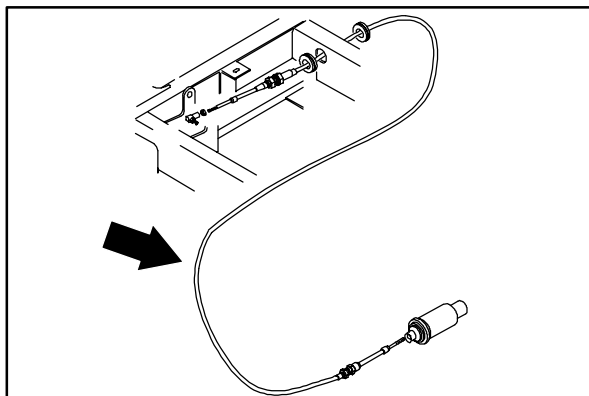
15. Remove the old directional cable from the machine. Remove the rod end from the old cable and install on the new cable in the same location.

*NOTE: One end of the new cable has 1 inch of thread and the other end has 1-1/2 inch of thread. The end with 1 inch of thread goes toward the directional pedal and the end with 1-1/2 inch of thread goes toward the propel pump.*

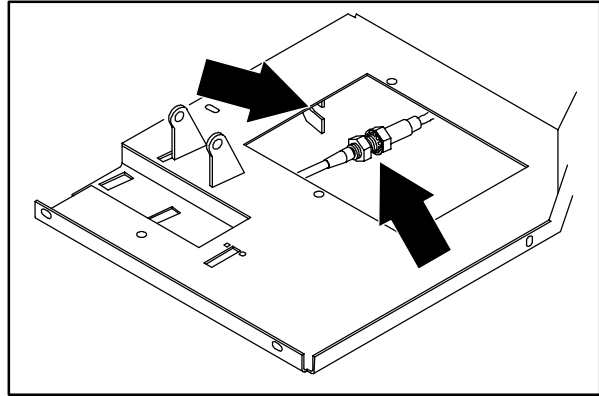


16. Carefully route the new directional cable in the machine. Follow the same path as the old cable.

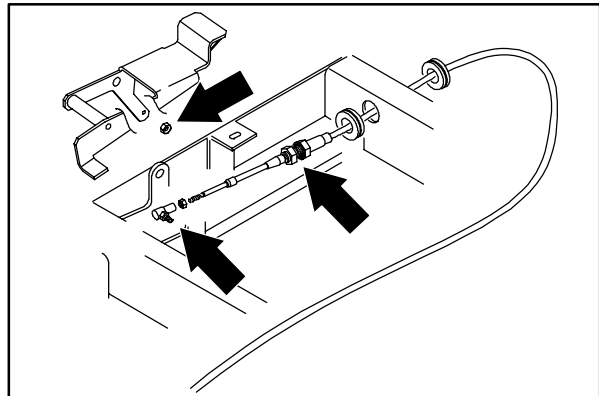
17. Reinstall the clamp on the new directional cable at the operator compartment side panel.



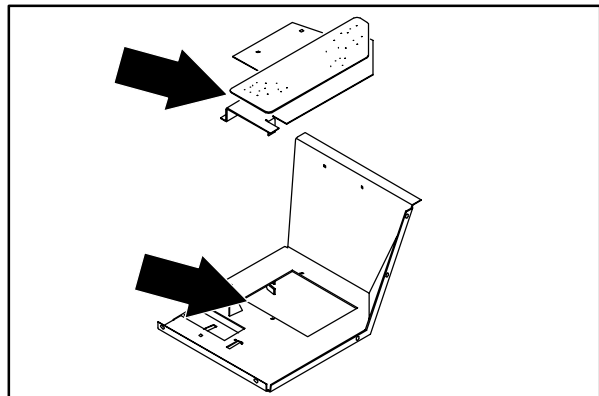
18. Position the new cable in the slot on the bottom of the operators compartment. Tighten the large jam nut tight.



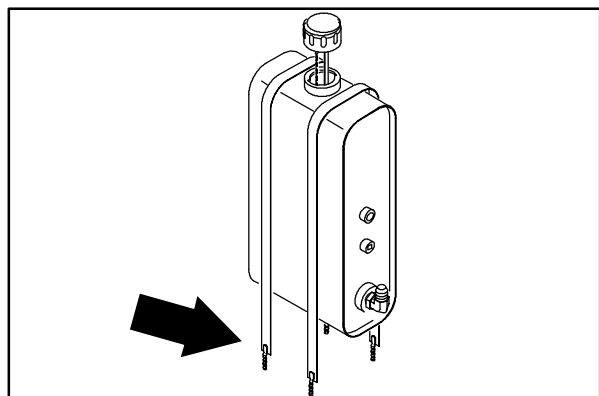
19. Reconnect the cable clevis to the directional pedal. Tighten the hex screw and nyloc to 11 - 14 Nm (7 - 10 ft lb).



20. Reinstall the floor access plate.

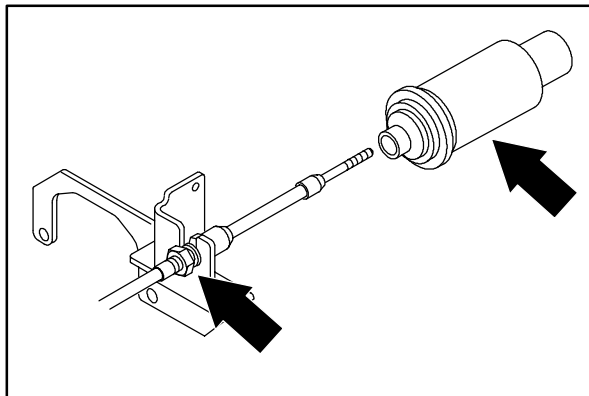


21. Position the hydraulic tank back down on the frame. Reinstall the two tank straps.



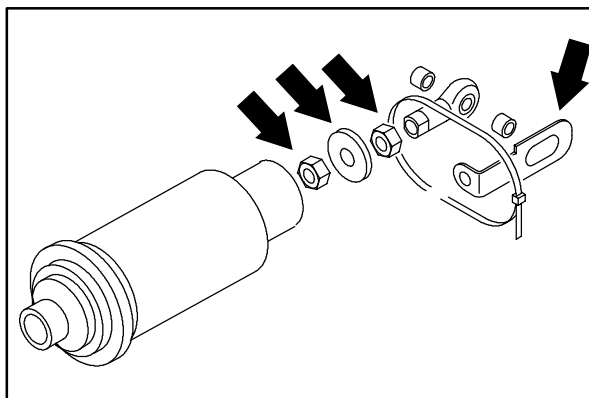
## HYDRAULICS

22. Go to the engine side and install the old directional spring on the new directional cable. Position it in the new cable in the same location as it was removed from the old cable.
23. Place the old directional spring and new cable in the mount slot. Tighten the large jam nut firmly.

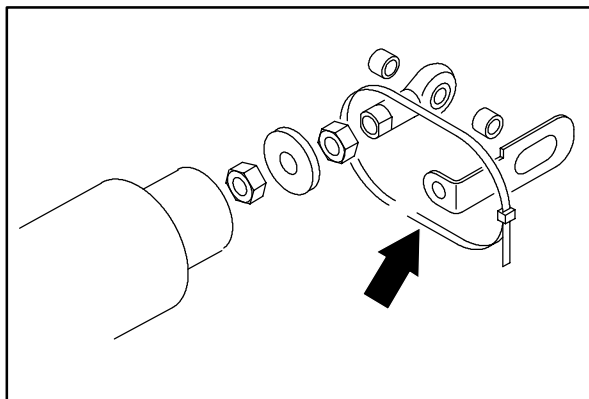


24. Reinstall the 1st jam nut, cable bracket, rubber washer, 2nd jam nut, and ball end. Tighten the jam nuts in the same location as they were removed.

*NOTE: Make note of the location of the 2nd jam nut for proper re-assembly.*



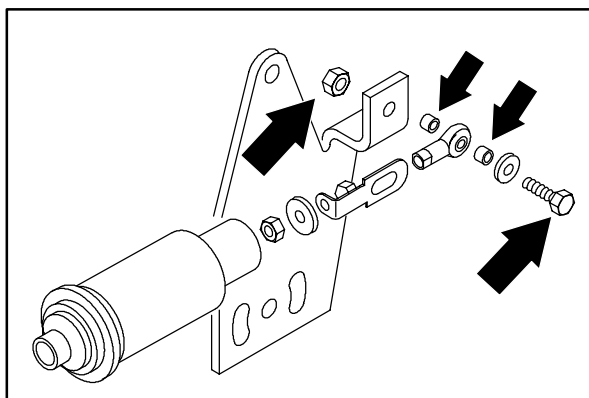
25. Install a new plastic wire tie around the cable bracket. Reinstall the front rubber firewall.



26. Reconnect the cable ball end to the propel pump arm. Tighten the hex screw to 11 - 14 Nm (7 - 10 ft lb).

*NOTE: Make sure the spacers are in place under the ball end.*

27. See TO ADJUST DIRECTIONAL SPRING instructions.

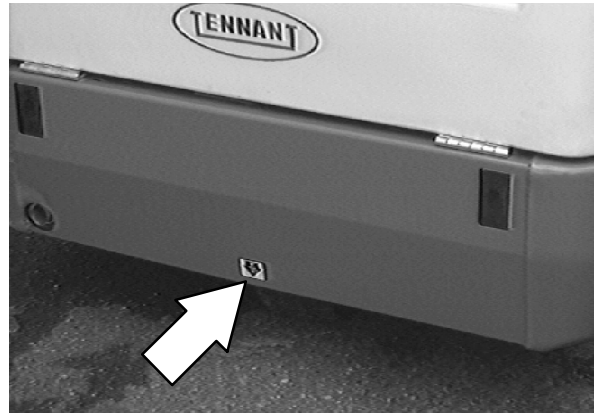




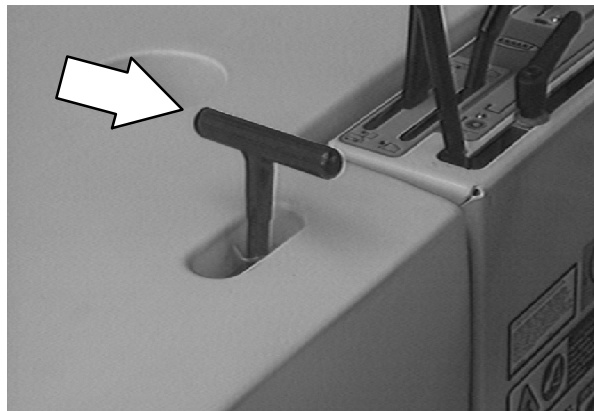
## TO ADJUST DIRECTIONAL SPRING (Liquid cooled)

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

1. Raise the rear of the machine and install jack stands under the machine frame.



2. Open the seat support.

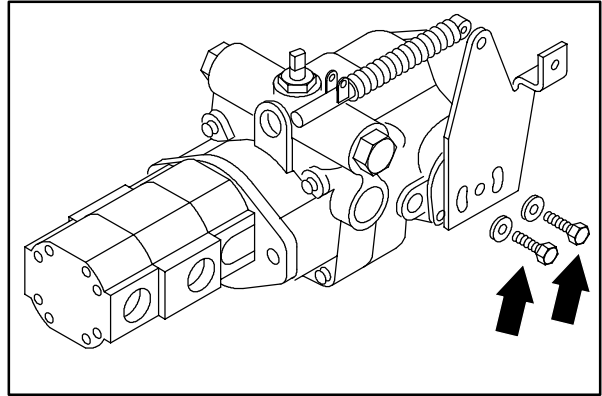


3. Start the machine and check the rear tire for any rotation. If the tire is rotating in either direction the centering spring needs to be adjusted.

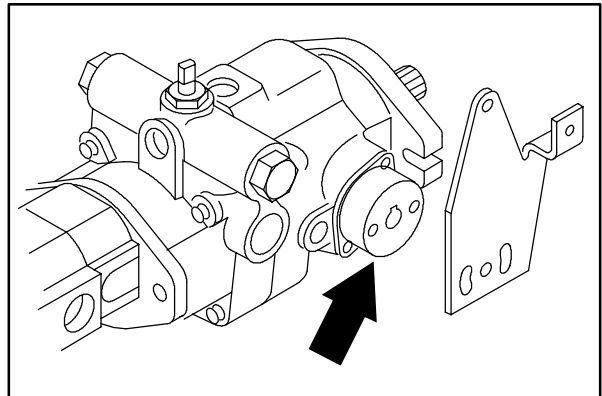


## HYDRAULICS

4. Loosen the three hex screws holding the directional arm to the propel pump shaft.



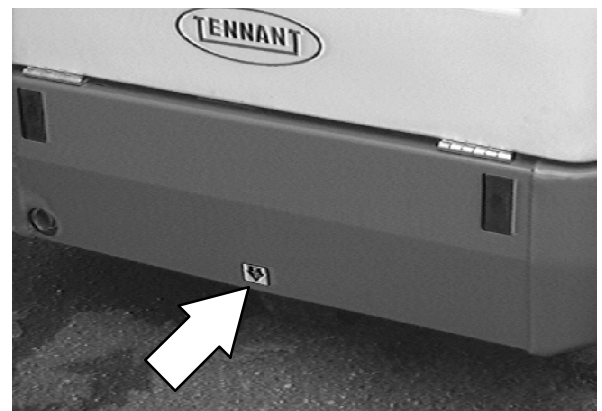
5. Rotate the pump shaft hub, on the inside of the directional arm, either clockwise or counter clockwise to achieve neutral centering.



6. Check to make sure the rear tire is not turning with the engine running. If the tire is not turning--tighten the three hex screws on the directional arm. Tighten to 18 - 24 Nm (15 - 20 ft lb).



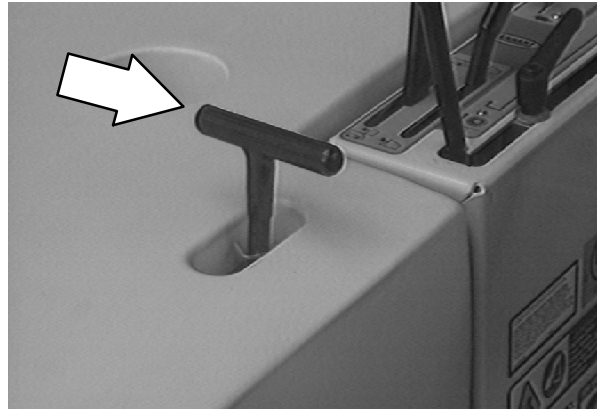
7. Remove the jack stands and lower the machine. Check to make sure the machine does not creep.



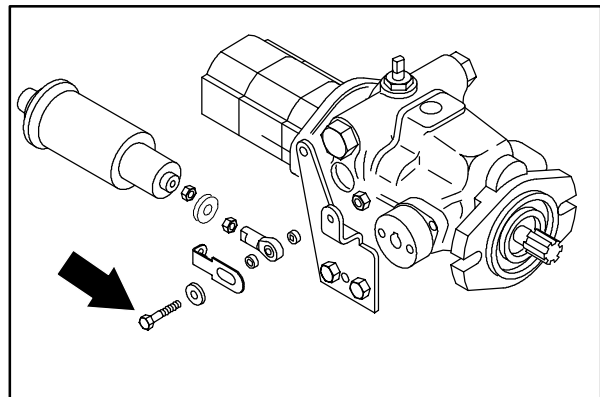
**TO REPLACE DIRECTIONAL SPRING  
(Air cooled)**

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

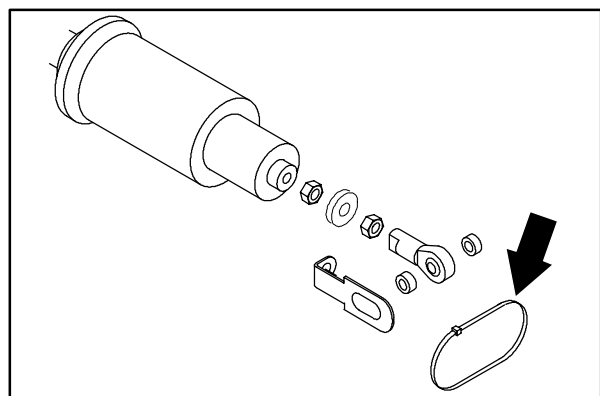
1. Open the seat support and disconnect the battery cables.



2. Remove the hex screw and nyloc nut holding the directional spring ball end to the propel pump arm. Retain the two spacers.



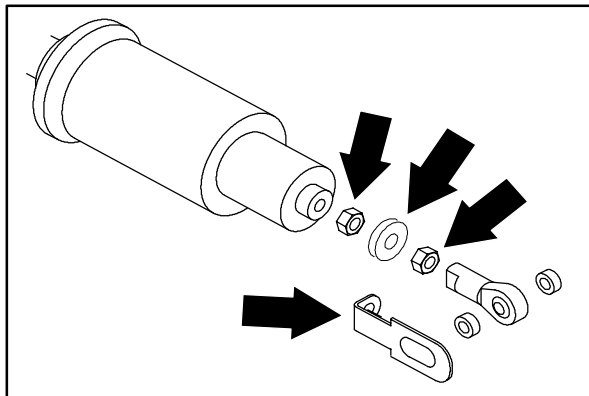
3. Cut the plastic tie from around the propel cable bracket.



## HYDRAULICS

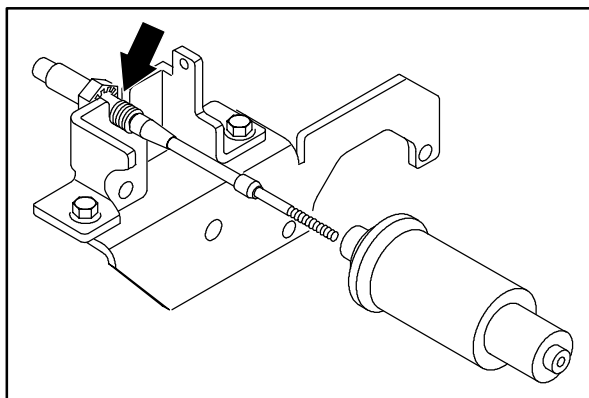
4. Remove the ball end, 1st jam nut, propel cable bracket, and 2nd jam nut from the end of the directional cable.

*NOTE: Make note of the location of the 2nd jam nut for proper re-assembly.*

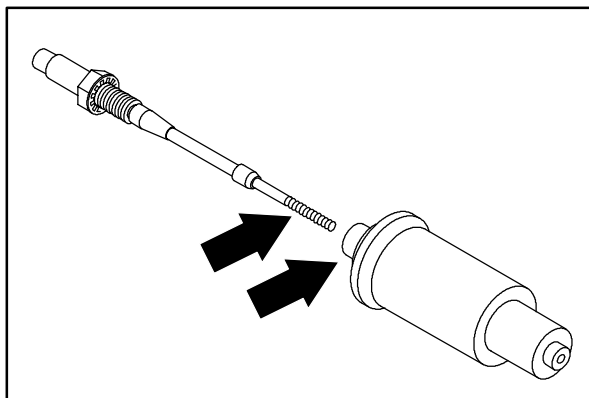


5. Loosen the large jam nut holding the directional spring to the directional spring mount bracket. Pull the directional spring up out of the slot.

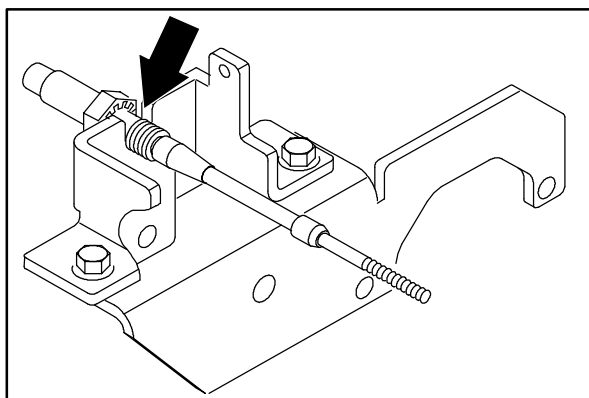
*NOTE: Mark the directional cable before removing the directional spring to make sure the new spring is install in the same location.*



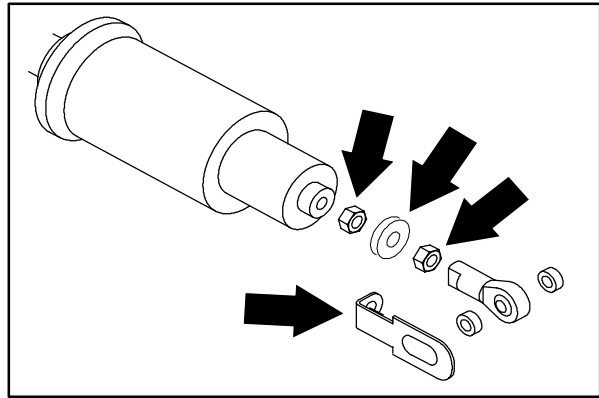
6. Un-screw the directional spring from the directional cable.
7. Install the new directional spring on the old directional cable, thread it on completely. Position the new spring in the same location on the cable as the old one.



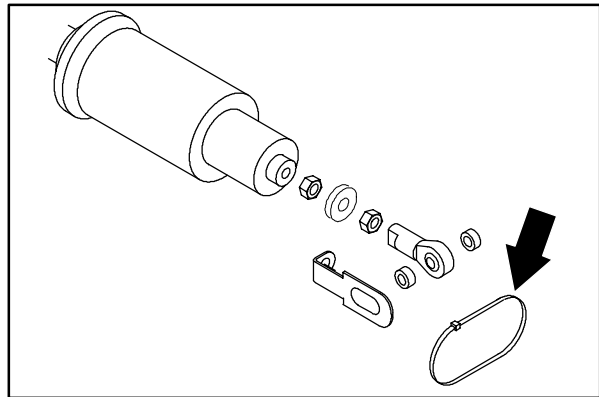
8. Place the new directional spring in the mount slot. Tighten the large jam nut firmly.



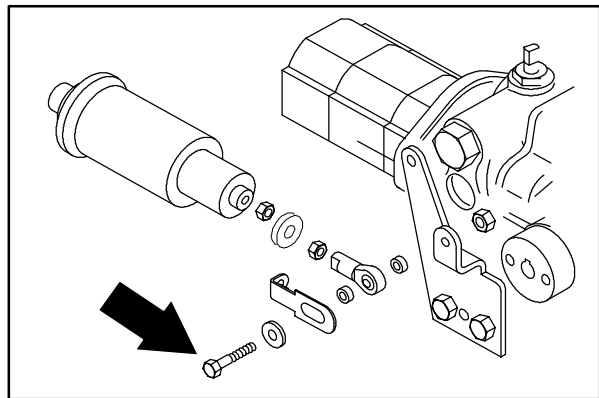
9. Reinstall the 1st jam nut, cable bracket, 2nd jam nut, and ball end. Tighten the jam nuts in the same location as they were removed.



10. Install a new plastic wire tie around the cable bracket.



11. Reconnect the cable ball end to the propel pump arm. Tighten the hex screw to 11 - 14 Nm (7 - 10 ft lb).



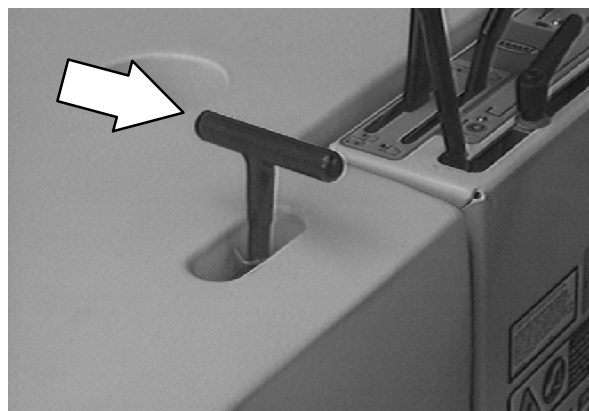
12. See TO ADJUST DIRECTIONAL SPRING instructions.

## HYDRAULICS

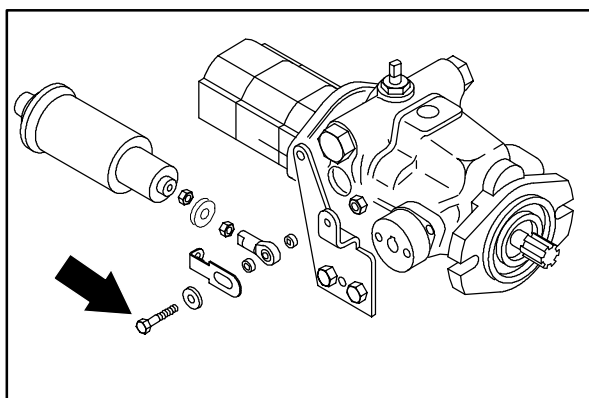
### TO REPLACE DIRECTIONAL CABLE (Air cooled)

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

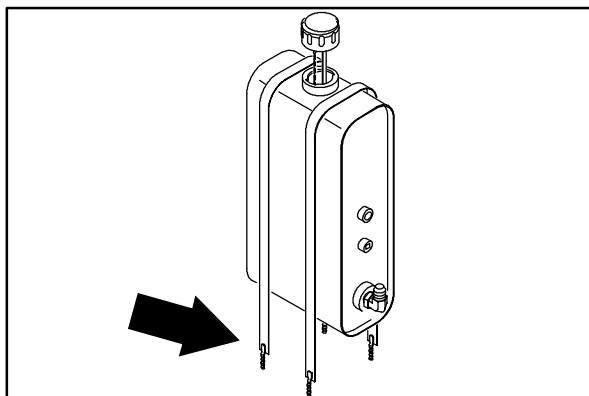
1. Open the seat support and disconnect the battery cables.



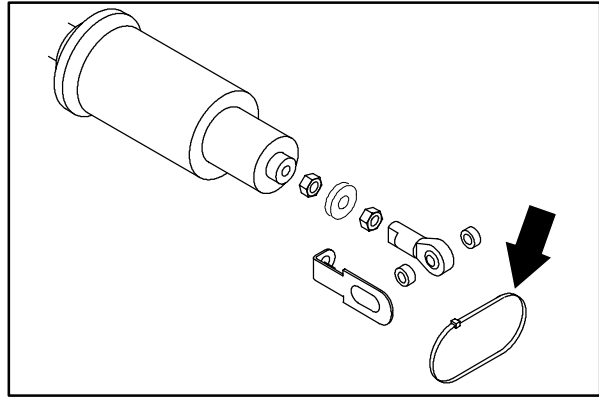
2. Remove the hex screw and nyloc nut holding the directional spring ball end to the propel pump arm. Retain the two spacers.



3. Remove the two hydraulic tank straps. Lift the tank up far enough to access the cable. Do not disconnect the hydraulic hoses.

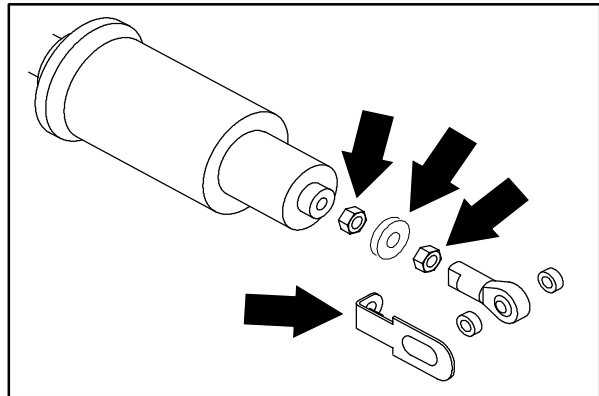


4. Cut the plastic tie from around the propel cable bracket.



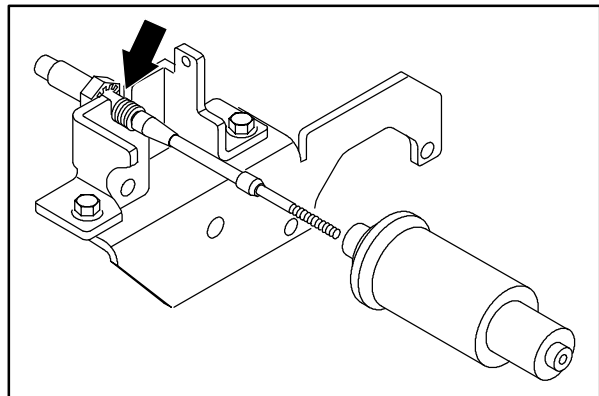
5. Remove the ball end, 1st jam nut, propel cable bracket, and 2nd jam nut from the end of the directional cable.

*NOTE: Make note of the location of the 2nd jam nut for proper re-assembly.*

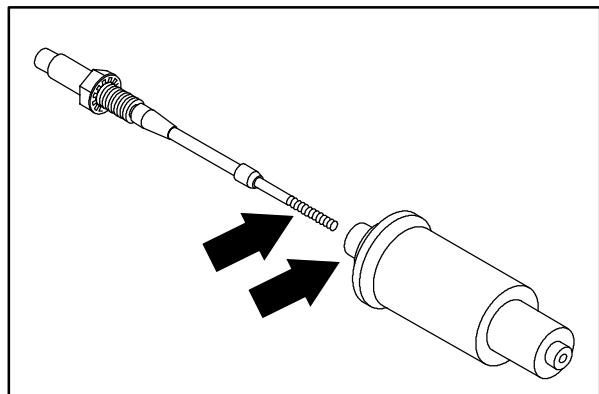


6. Loosen the large jam nut holding the directional spring to the directional spring mount bracket. Pull the directional spring up out of the slot.

*NOTE: Mark the directional cable before removing the directional spring to make sure the new spring is install in the same location.*



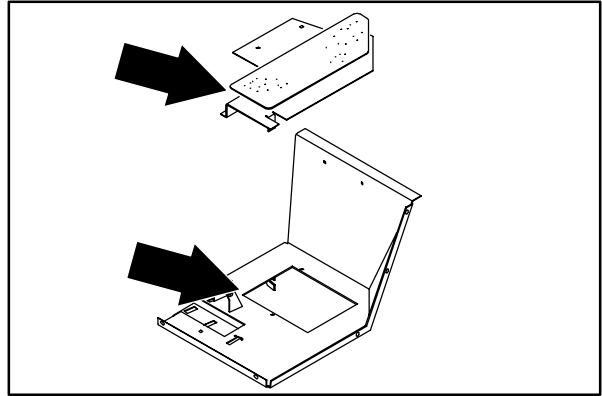
7. Un-screw the directional spring from the directional cable.



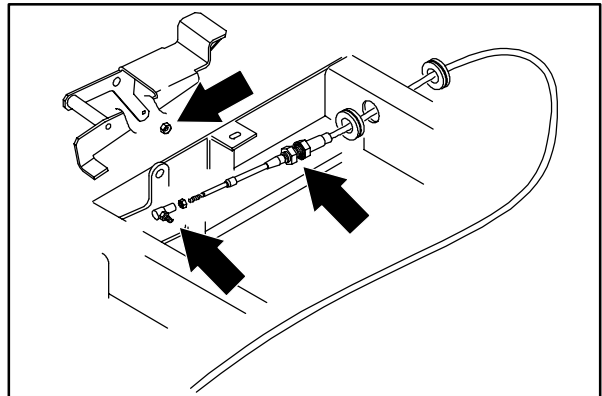
## HYDRAULICS

8. Go to the operators compartment and remove the floor plate access panel.

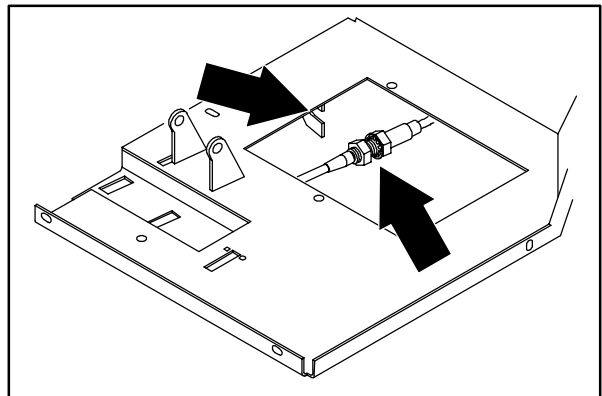
*NOTE: Make sure to mark the location of the jam nuts on the cable. This adjustment controls forward and reverse speed.*



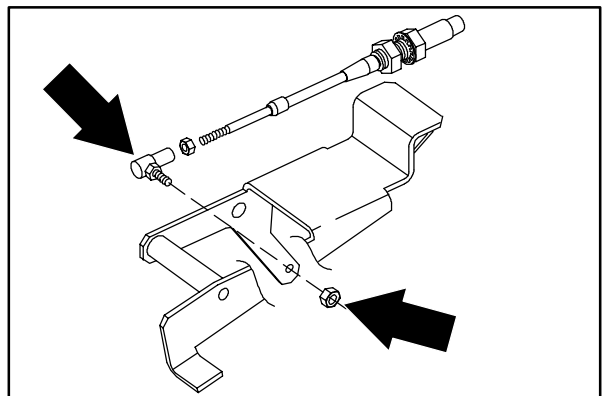
9. Reach in through the access hole and remove the hex screw and nyloc nut holding the clevis on the end of the directional cable to the directional pedal assembly.



10. Loosen the large jam nut holding the directional cable to the floor plate. Drop the directional cable out of the slot.



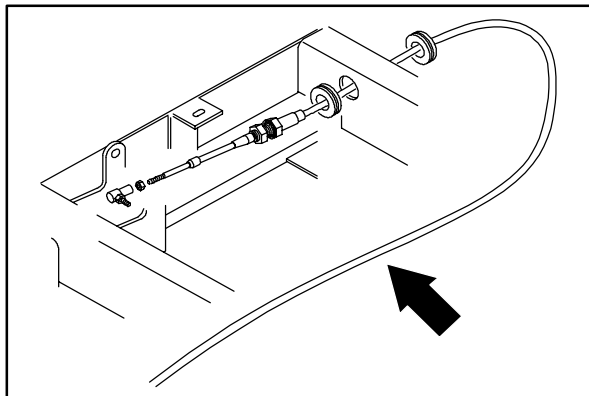
11. Remove the old directional cable from the machine. Remove the clevis from the old cable and install on the new cable in the same location.



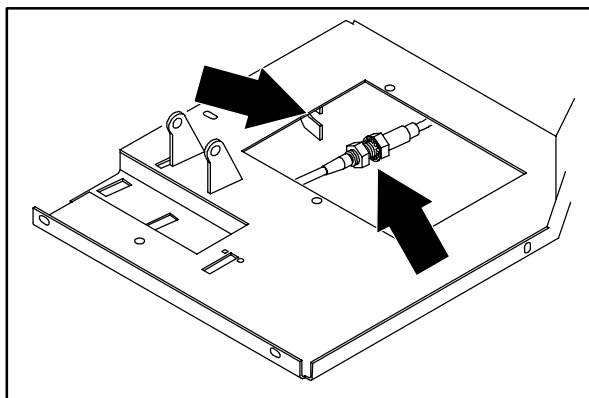


12. Carefully route the new directional cable in the machine.

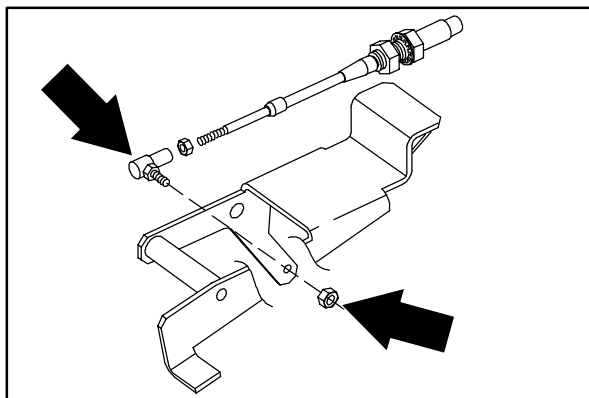
*NOTE: One end of the new cable has 1 inch of thread and the other end has 1-1/2 inch of thread. The end with 1 inch of thread goes toward the directional pedal and the end with 1-1/2 inch of thread goes toward the propel pump.*



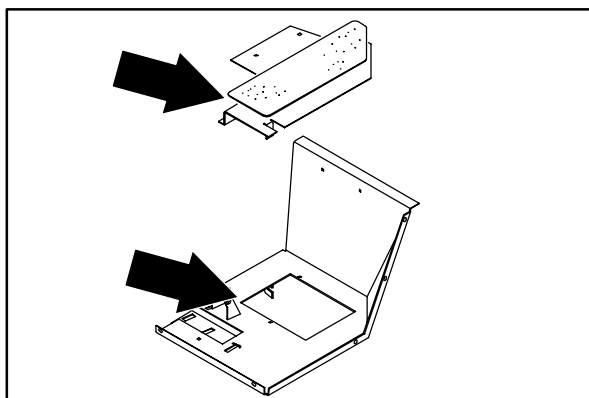
13. Position the new cable in the slot on the bottom of the operators compartment. Tighten the large jam nut tight.



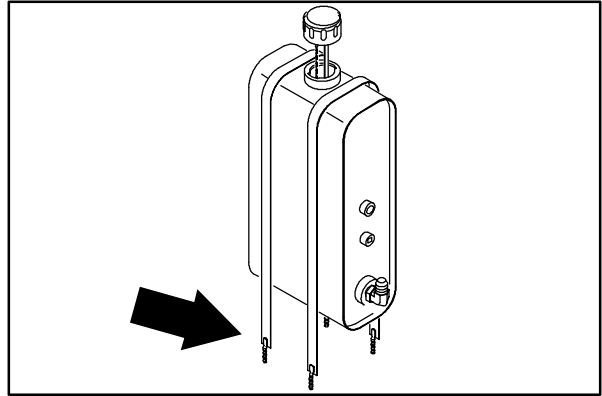
14. Reconnect the cable clevis to the directional pedal. Tighten the hex screw and nyloc to 11 - 14 Nm (7 - 10 ft lb).



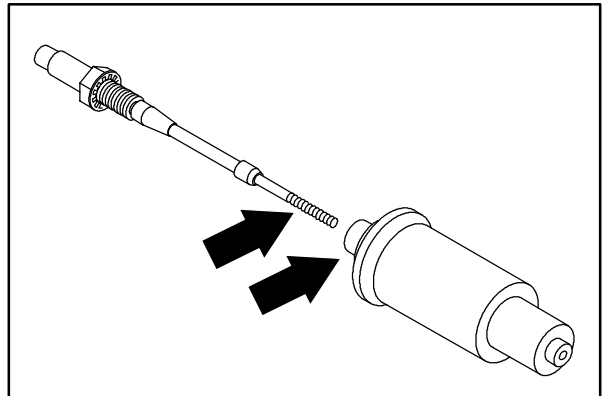
15. Reinstall the floor access plate.



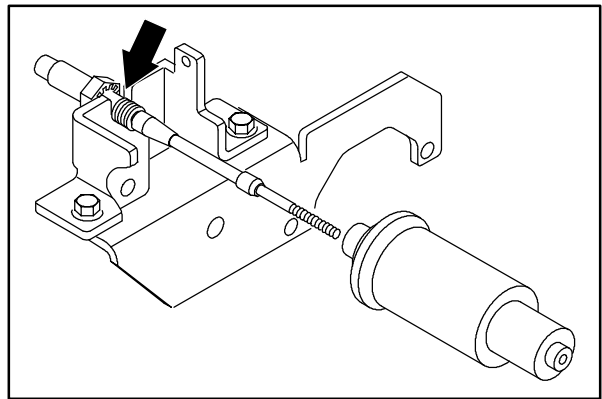
16. Position the hydraulic tank back down on the frame. Reinstall the two tank straps.



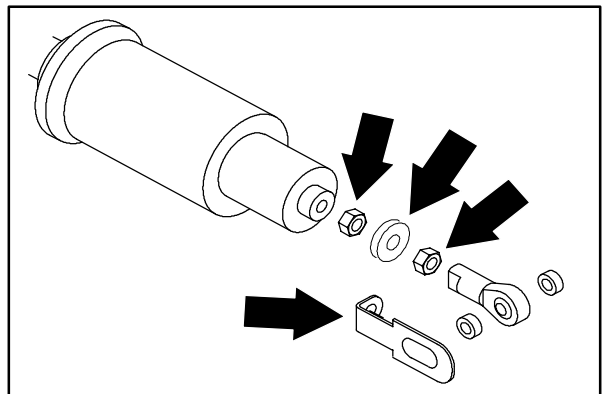
17. Go to the engine area and install the old directional spring on the new directional cable. Position it in the new cable in the same location as it was removed from the old cable.



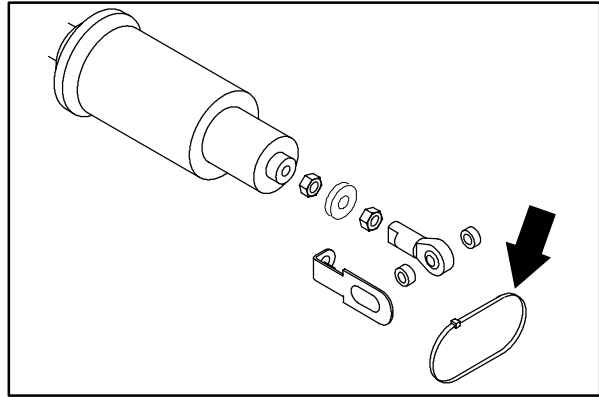
18. Place the old directional spring and new cable in the mount slot. Tighten the large jam nut firmly.



19. Reinstall the 1st jam nut, cable bracket, 2nd jam nut, and ball end. Tighten the jam nuts in the same location as they were removed.



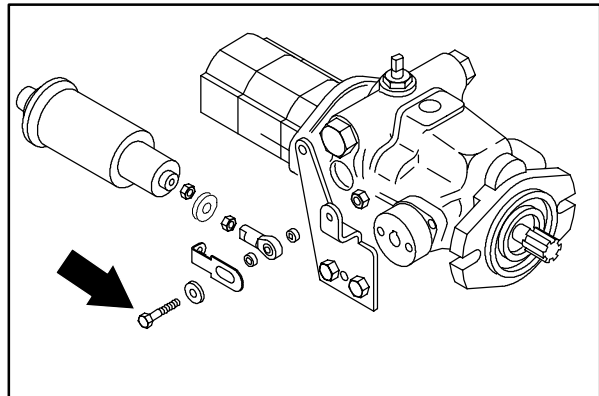
20. Install a new plastic wire tie around the cable bracket.



21. Reconnect the cable ball end to the propel pump arm. Tighten the hex screw to 11 - 14 Nm (7 - 10 ft lb).

*NOTE: Make sure the spacer is in place under the ball end.*

22. See TO ADJUST DIRECTIONAL SPRING instructions.

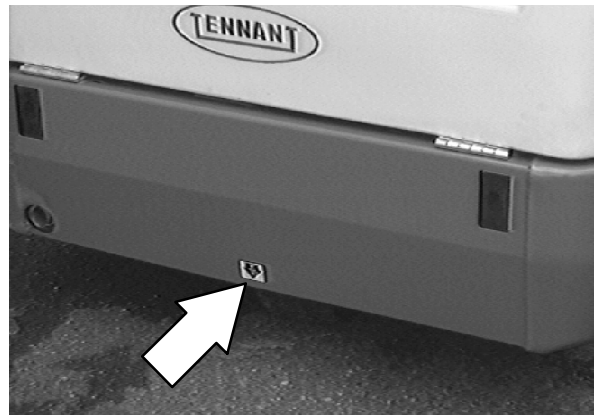


## HYDRAULICS

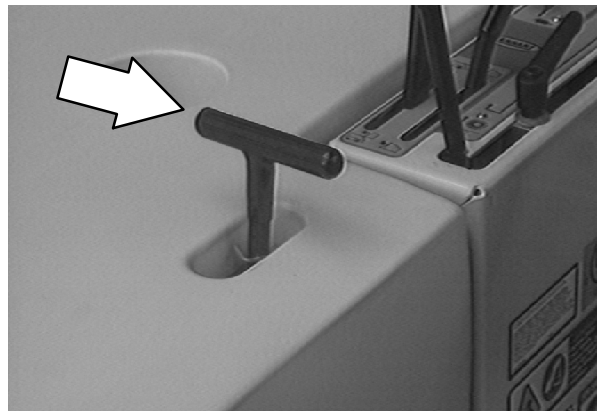
### TO ADJUST DIRECTIONAL SPRING (Air cooled)

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

1. Raise the rear of the machine and install jack stands under the machine frame.



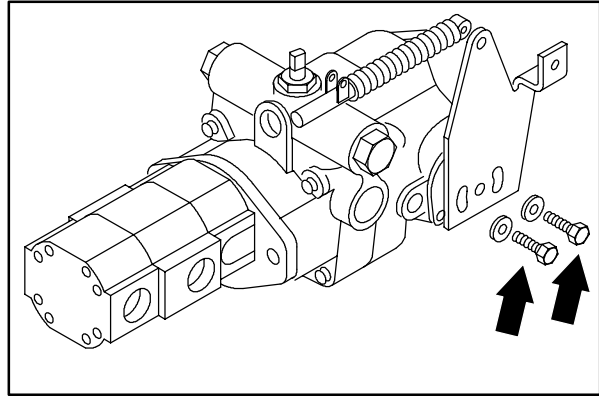
2. Open the seat support.



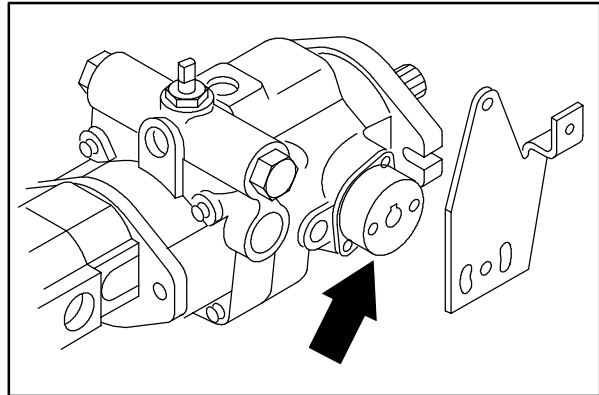
3. Start the machine and check the rear tire for any rotation. If the tire is rotating in either direction the centering spring needs to be adjusted.



4. Loosen the three hex screws holding the directional arm to the propel pump shaft.



5. Rotate the pump shaft hub, on the inside of the directional arm, either clockwise or counter clockwise to achieve neutral centering.



6. Check to make sure the rear tire is not turning with the engine running. If the tire is not turning--tighten the three hex screws on the directional arm. Tighten to 18 - 24 Nm (15 - 20 ft lb).



7. Remove the jack stands and lower the machine. Check to make sure the machine does not creep.

### TO REPLACE HOPPER LIFT CYLINDER

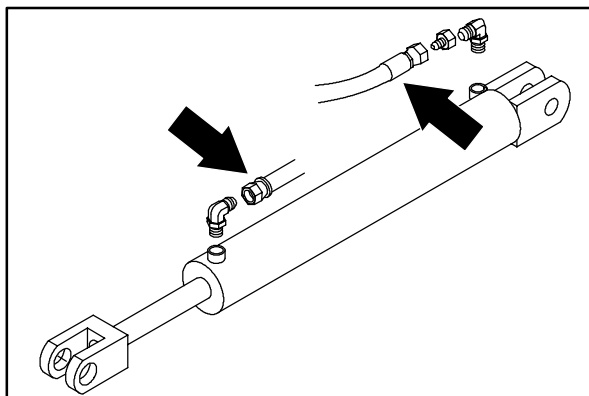
1. Empty the debris hopper.
2. Set the machine parking brake.
3. Raise the hopper and engage the prop arm. Shut off the engine. Move the hopper lift handle back and forth a few times. Remove the front rubber firewall.

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

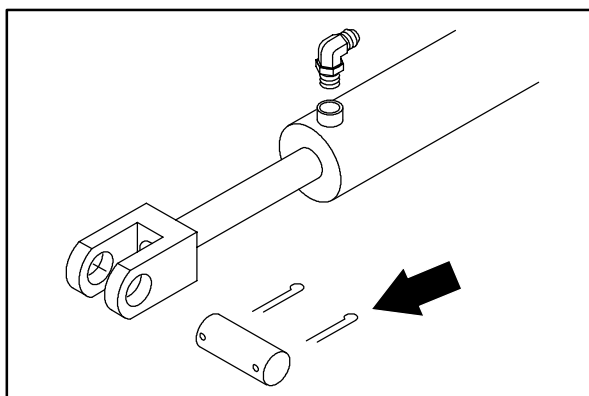


4. Disconnect and cap the two hydraulic hoses leading to the hopper lift cylinder.

*NOTE: Always observe hydraulic cleanliness requirements when opening hydraulic lines.*

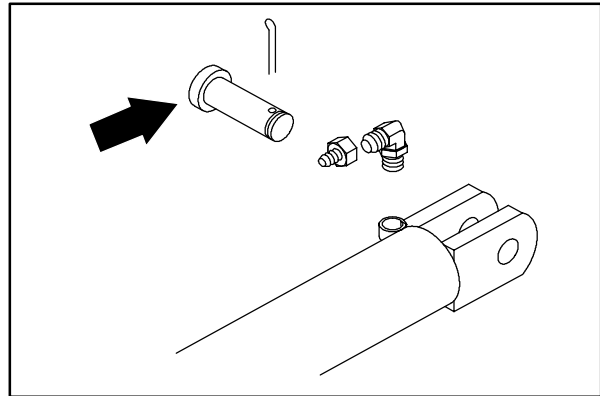


5. Remove the inside cotter pin from the upper clevis pin on the upper end of the hopper lift cylinder. Remove the clevis pin.

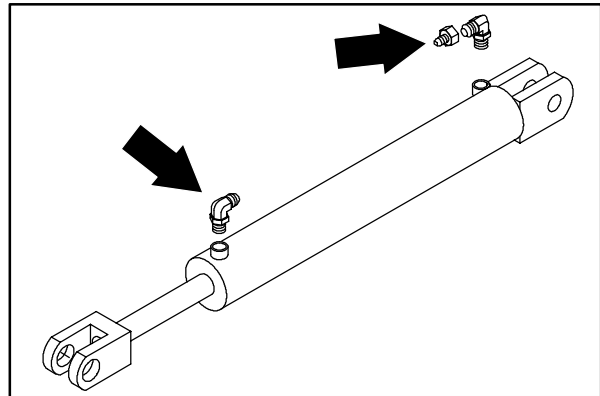


6. Remove the inside cotter pin from the lower clevis pin on the lower end of the hopper lift cylinder. Remove the clevis pin.

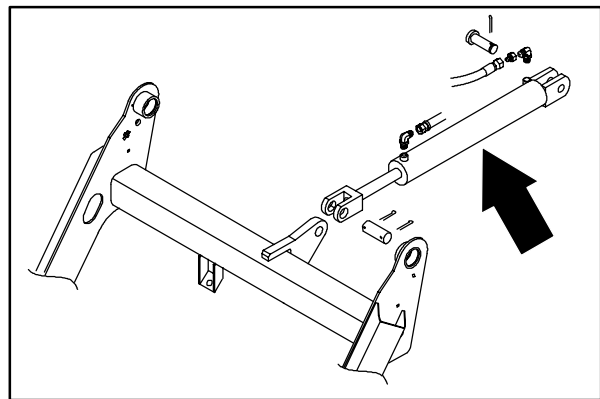
7. Remove the hopper lift cylinder from the machine.



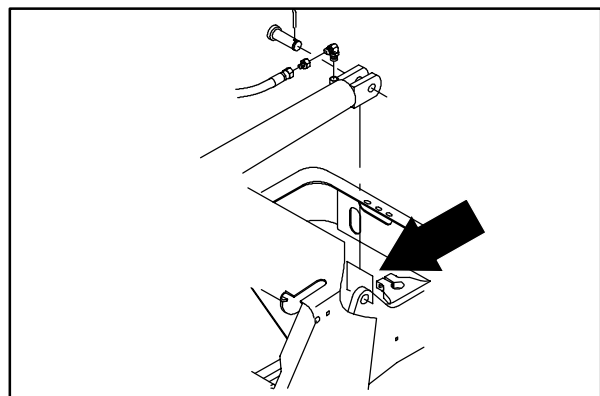
8. Remove the fittings from the old cylinder and install in the new cylinder in the same orientation.



9. Position the new cylinder in the machine with the rod end pointing to the front of the machine.

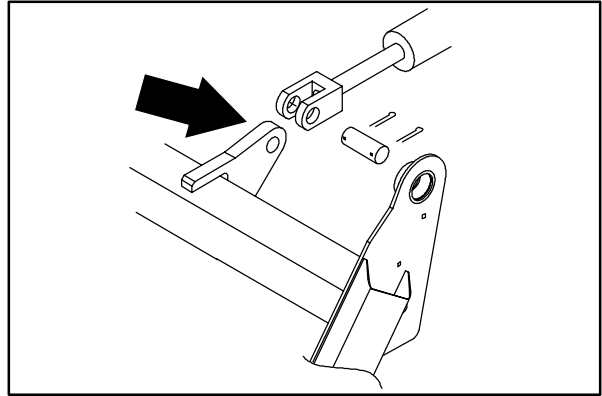


10. Align the bottom of the lift cylinder with the hole in the frame mount lug. Reinstall the clevis pin and cotter pin.

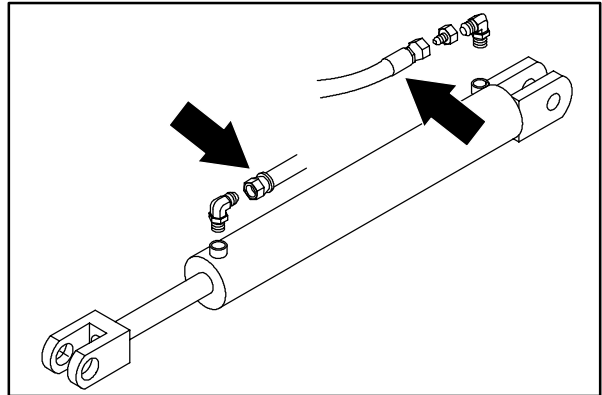


## HYDRAULICS

11. Align the top of the lift cylinder with the hole in the lift arm cylinder mount lug. Reinstall the clevis pin and cotter pin.



12. Reconnect the hydraulic hoses to the new cylinder. See schematic in this section.



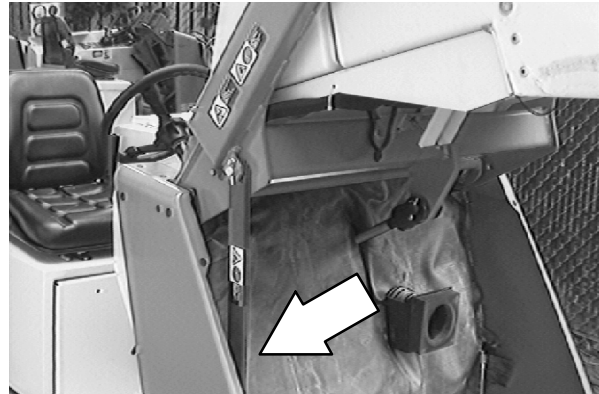
13. Start the machine and operate the hopper. Check for any leaks and proper operation. Reinstall the front rubber firewall.



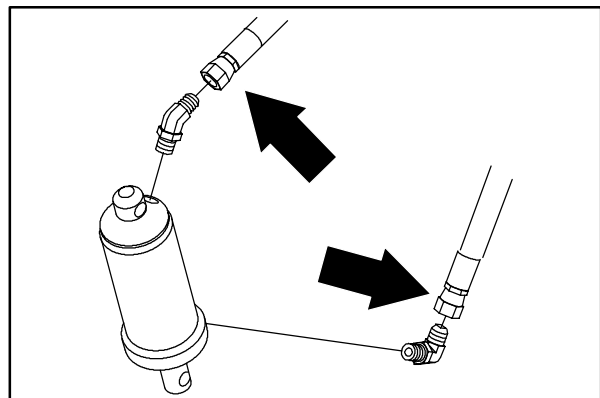
**TO REPLACE HOPPER DUMP DOOR CYLINDER**

1. Dump the debris hopper.
2. Raise the hopper and open the dump door. Engage the support bar.
3. Set the machine parking brake.

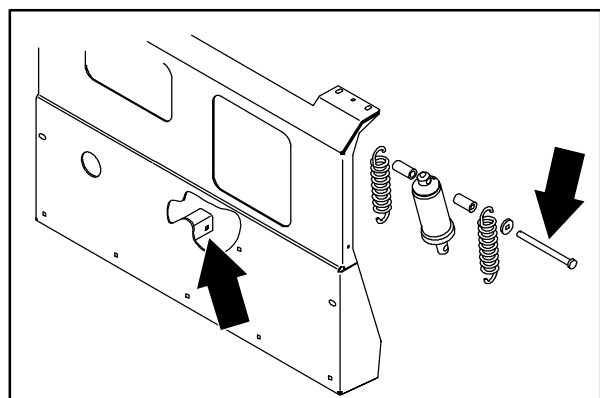
**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**



4. Disconnect and plug the two hoses leading to the hopper dump door cylinder.

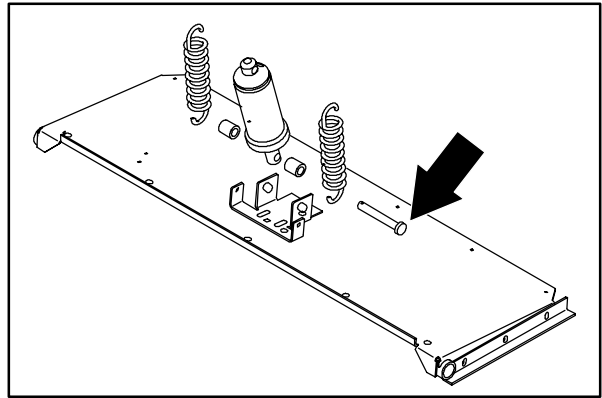


5. Remove the cotter pin and clevis pin from the top of the dump door cylinder where it attaches to the center/rear of the debris hopper.

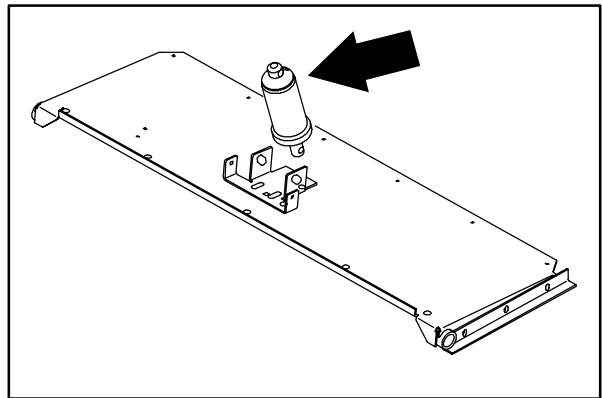


## HYDRAULICS

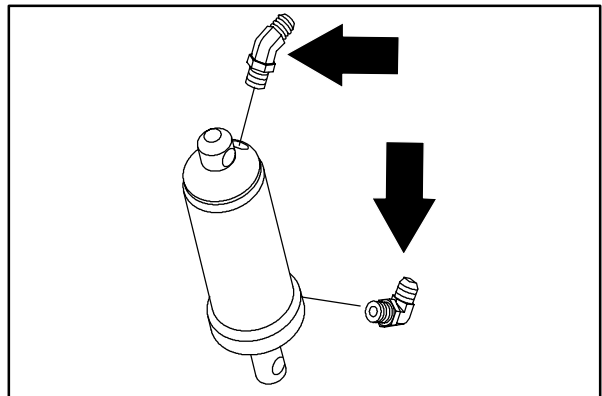
6. Remove the cotter pin and clevis pin from the bottom of the dump door cylinder where it attaches to the center of the dump door.



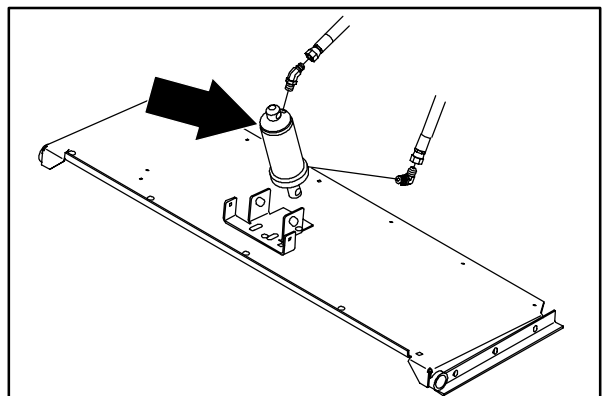
7. Remove the old cylinder from the hopper.



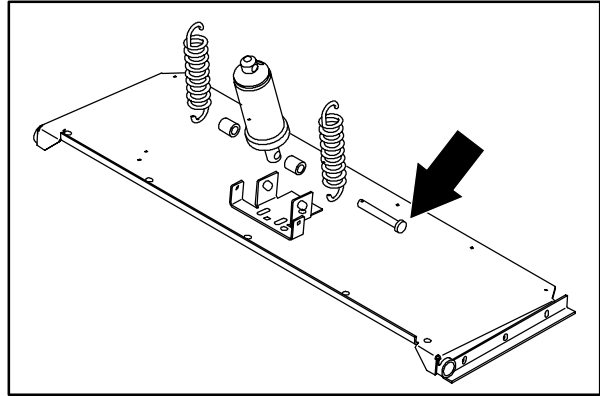
8. Remove the fittings from the old cylinder and install in the new cylinder in the same orientation.



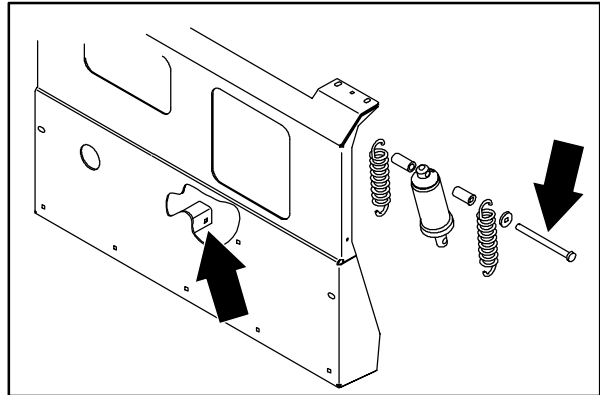
9. Position the new cylinder in the machine with the rod end pointing to the center of the dump door.



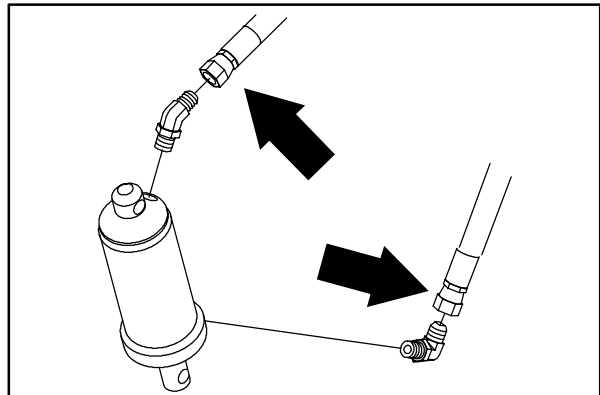
10. Reinstall the clevis pin and cotter pin in the lower end of the dump door cylinder.



11. Reinstall the clevis pin and cotter pin in the upper end of the dump door cylinder.



12. Reconnect the hydraulic hoses to the dump door cylinder. See the schematic in this section.



13. Start the machine and open and close the hopper dump door. Check for any leaks and proper operation. Reinstall the front rubber firewall.

## HYDRAULICS

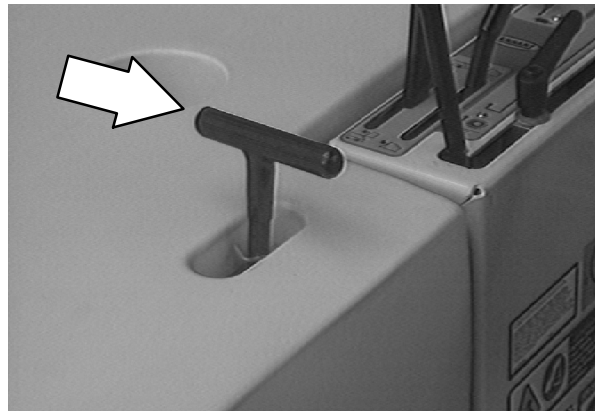
### TO REPLACE STEERING CYLINDER

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake., Turn Off Machine And Remove Key.**

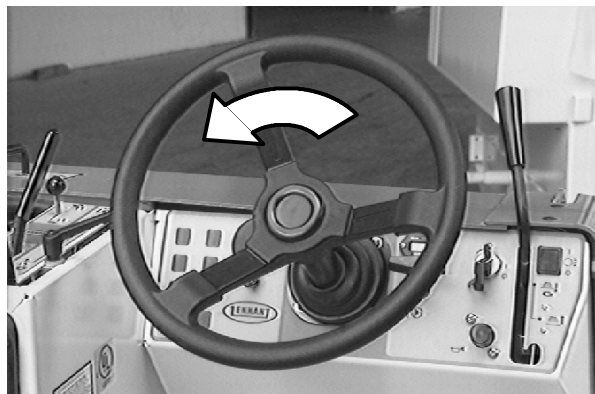
1. Raise the rear of the machine with a hoist or floor jack. Put jack stands under the rear frame.



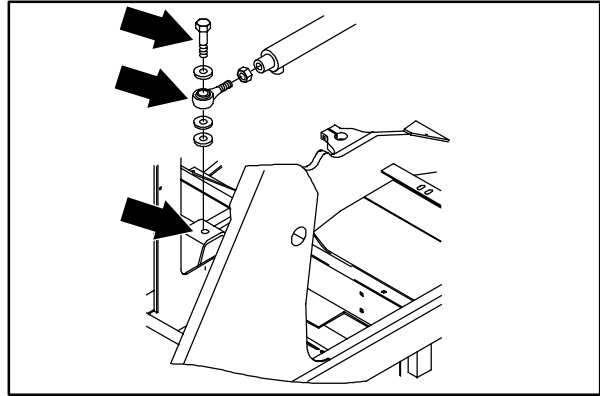
2. Open the seat support.



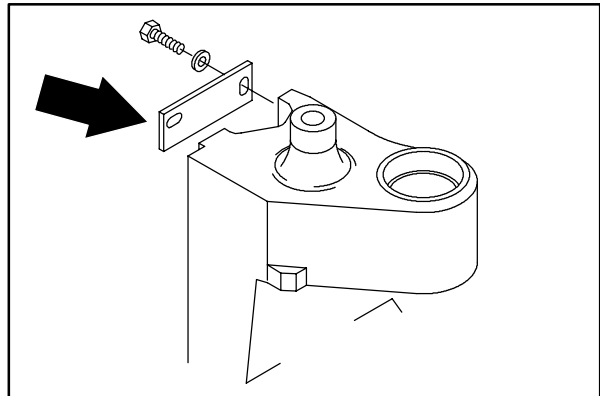
3. Turn the steering wheel to the left so the rear drive casting can be accessed from the fuel tank area of the machine.



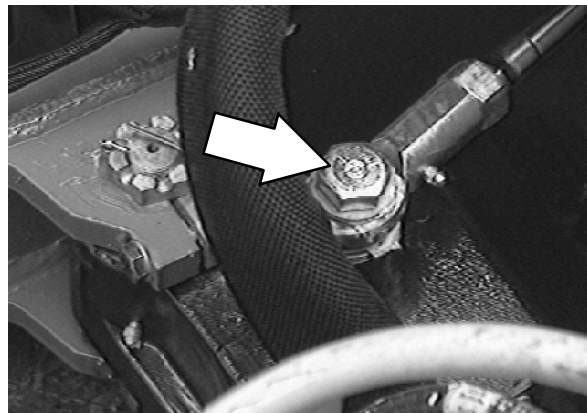
4. Remove the nyloc nut holding the piston end of the steering cylinder rod end to the machine frame.



5. Remove the clamp holding the drive motor hydraulic hoses to rear casting. Move the hoses to gain access to the steering cylinder.

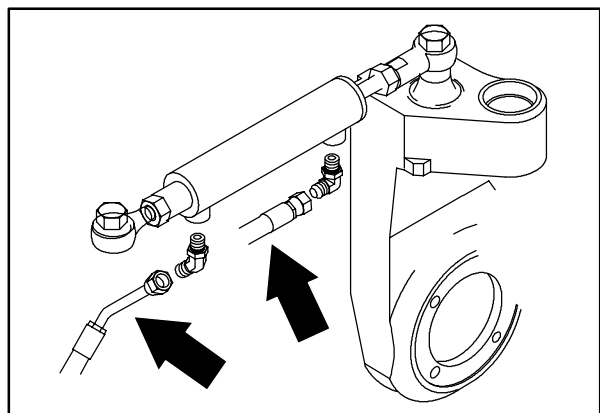


6. Remove the hex screw and nut holding the steering cylinder rod end balljoint to the rear drive casting.

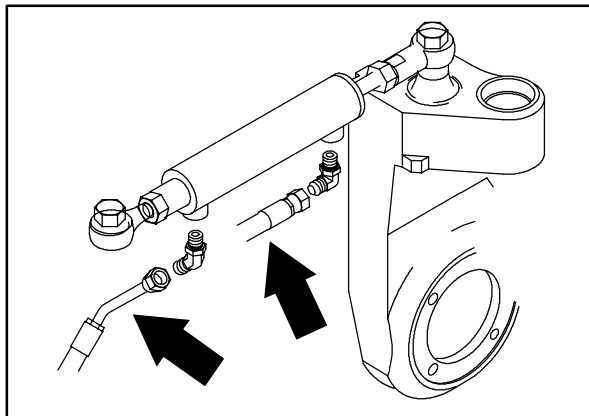


7. Disconnect and cap the two hydraulic hoses leading to the steering cylinder.

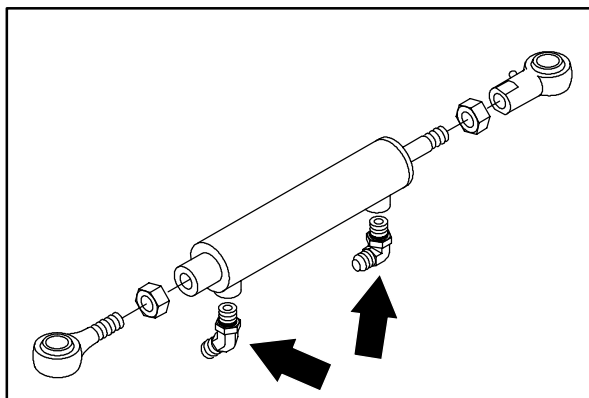
*NOTE: Always observe hydraulic cleanliness requirements when opening hydraulic lines.*



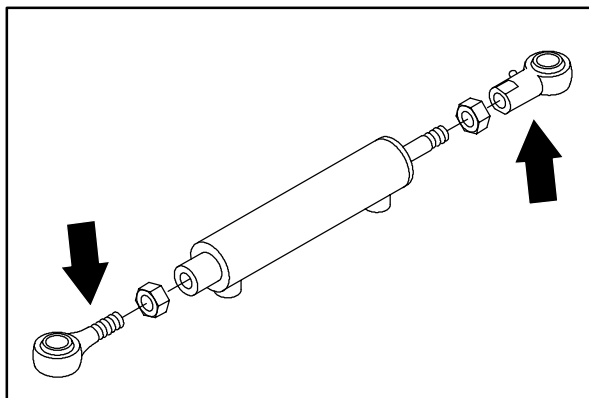
8. Remove the steering cylinder from the machine.



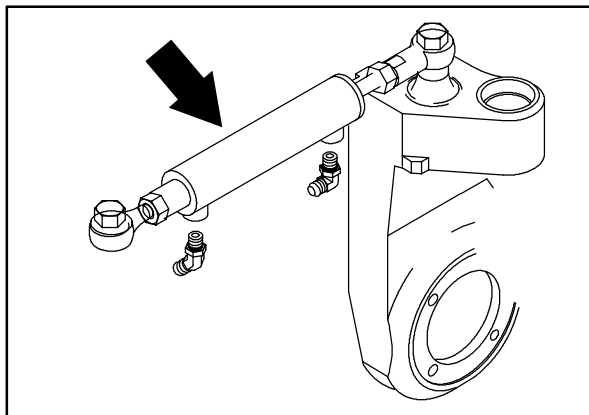
9. Remove the fittings from old cylinder. Install the fittings in the new cylinder in the same orientation.



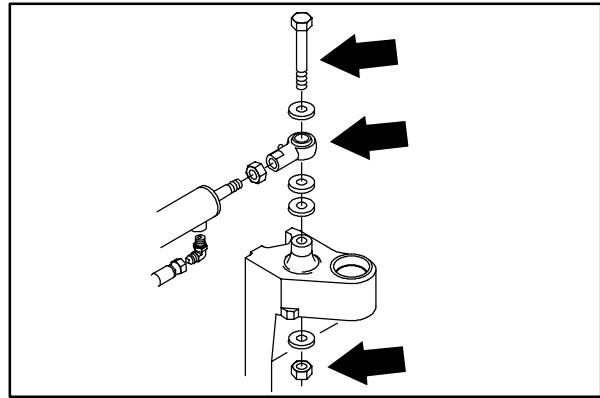
10. Remove the ball joint ends from the old cylinder and install on the new cylinder. Make sure that the balljoints are pointed down and the center line distance between them is 18.75 in.



11. Position the new steering cylinder and balljoint assembly in the machine with the rod part of the cylinder toward the rear of the machine.

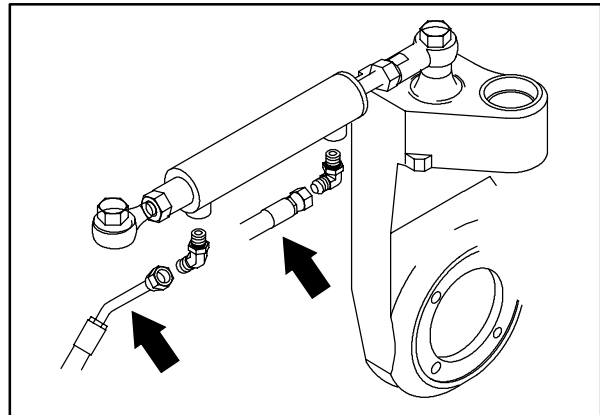


12. Reinstall the hex screws and nuts on the steering cylinder rod ends and tighten to 250 ft lb.

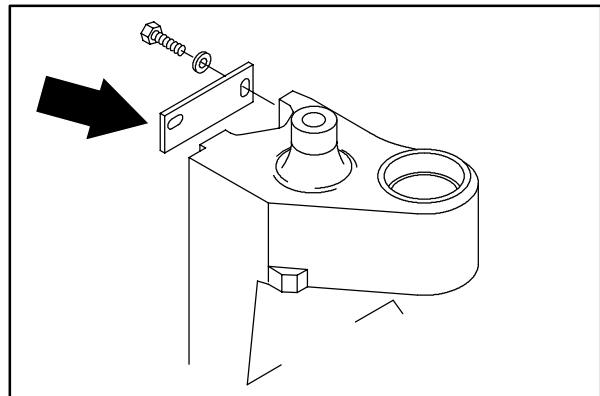


13. Reconnect the hydraulic hoses to the steering cylinder. See schematic in this section.

*NOTE: Always observe hydraulic cleanliness requirements when opening hydraulic lines.*

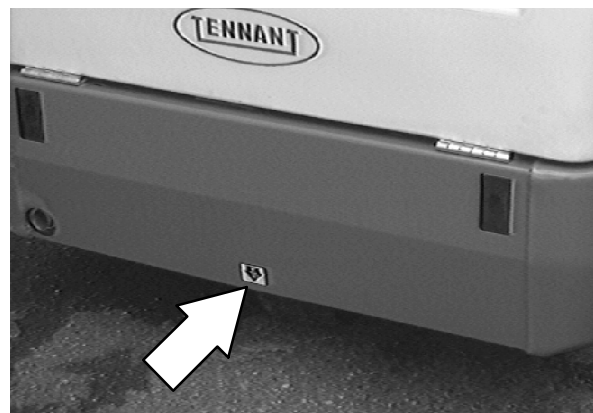


14. Reinstall the clamp holding the drive motor hydraulic hoses to rear casting.



15. Remove the jack stands from machine and lower.

16. Start machine and turn steering wheel in both directions. Observe the steering cylinder for any leaks.

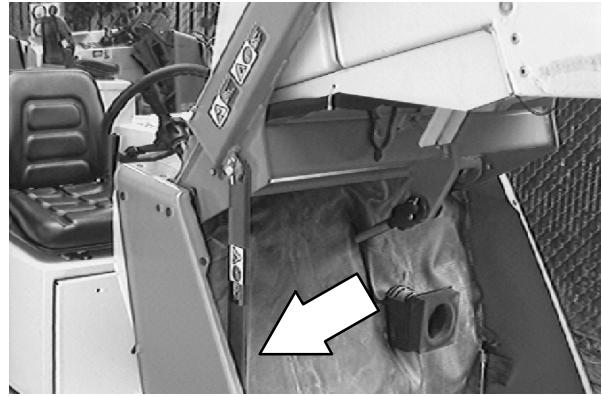


## HYDRAULICS

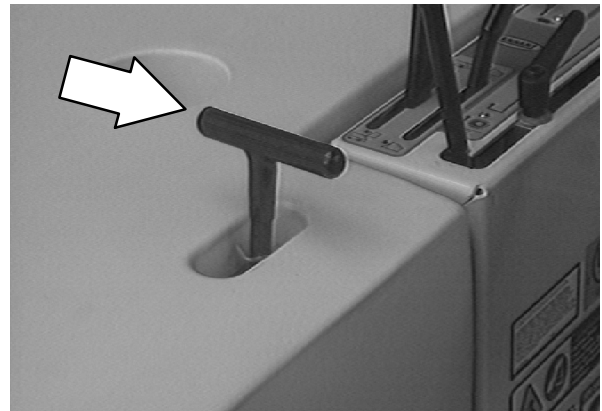
### TO REPLACE STEERING VALVE

1. Raise the hopper and engage the support bar. Remove the front rubber firewall.

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**



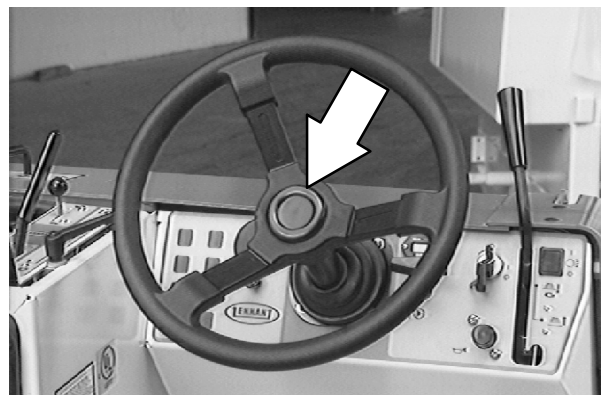
2. Turn off the engine and engage the parking brake. Open the seat support.



3. Remove battery cables from battery.



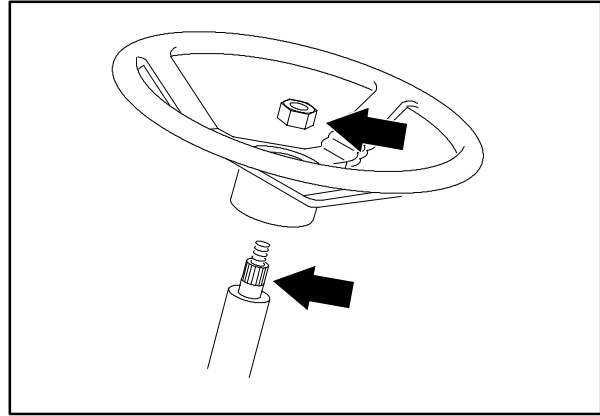
4. Remove the rubber cap in the center of the steering wheel.



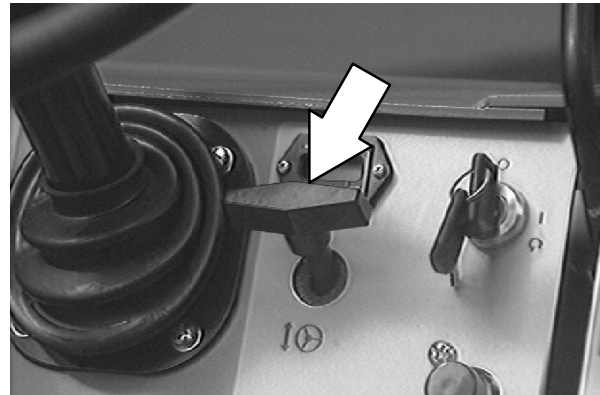


5. Remove the large nut. Remove the steering wheel.

*NOTE: A puller may have to be used to remove the steering wheel from the steering valve shaft.*

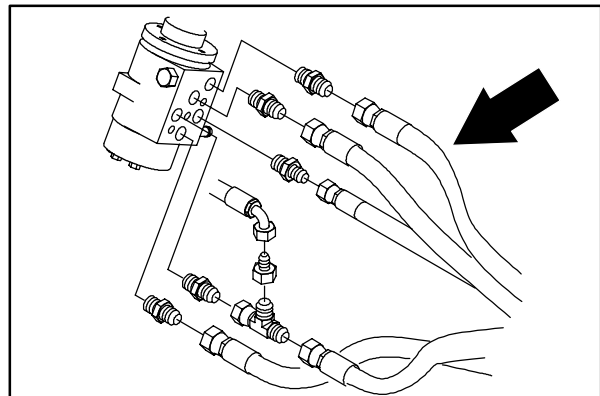


6. Tilt the steering wheel to the lowest position.

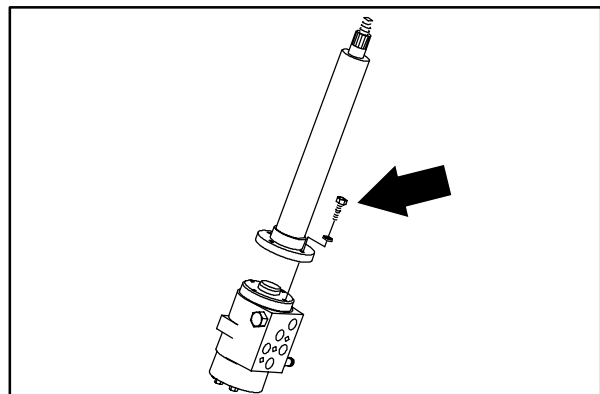


7. Remove and plug the five hydraulic hoses on the steering control motor.

*NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.*

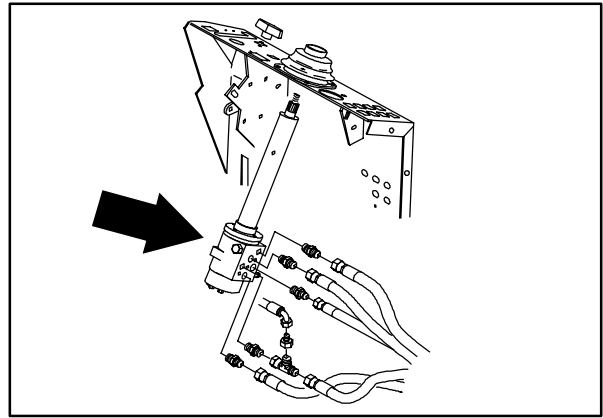


8. Remove the hex screws holding the hydraulic steering valve to the steering column.

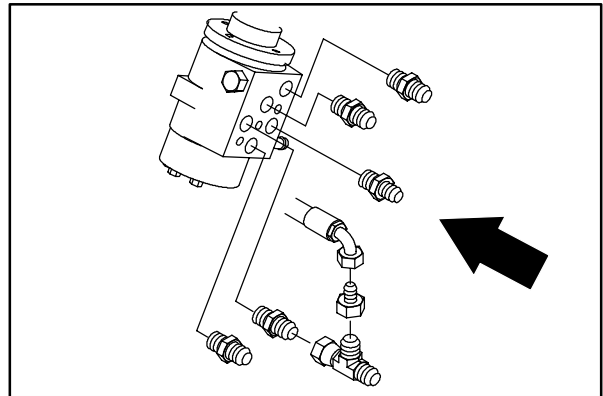


## HYDRAULICS

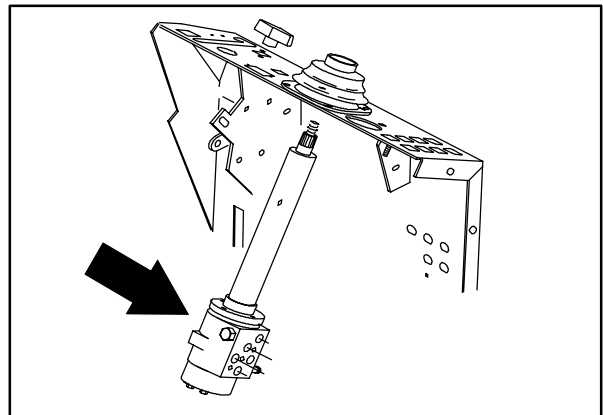
9. The hydraulic steering valve can now be removed from machine.



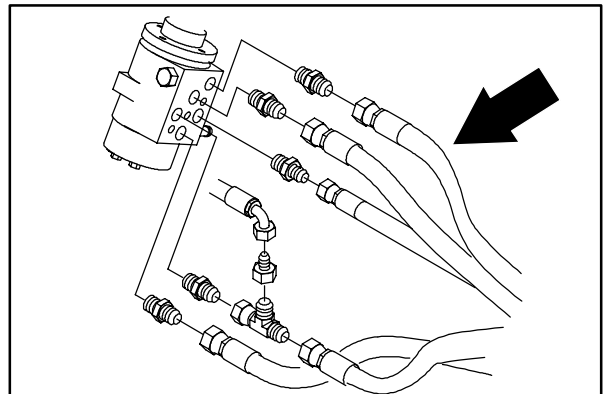
10. Remove hydraulic fittings from old control motor. Install the fittings in the new valve in the same orientation.



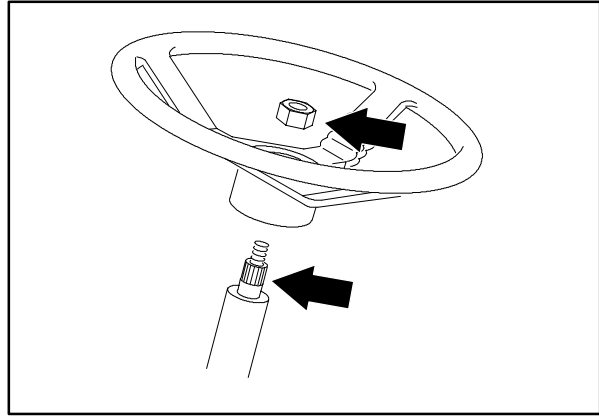
11. Install the new hydraulic steering valve in the machine. Position the ports in the same orientation as the old valve. Reinstall the hex screws and tighten to 31 - 40 Nm (27 - 35 ft lb).



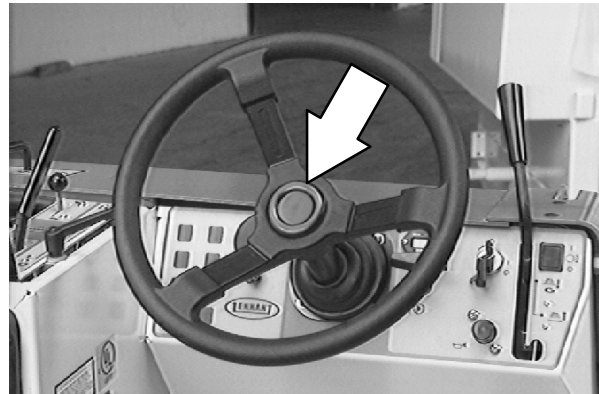
12. Reconnect the hydraulic hoses to hydraulic steering valve. *See the schematic in this section.*



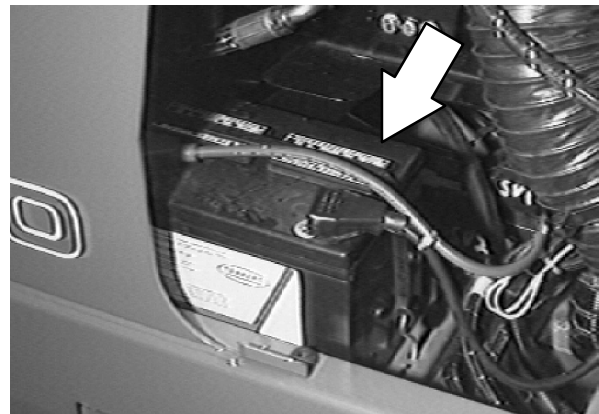
13. Reinstall the steering wheel on the steering column. Tighten the wheel nut to 18 - 24 Nm (15 - 20 ft lb).



14. Reinstall the rubber steering wheel cover.

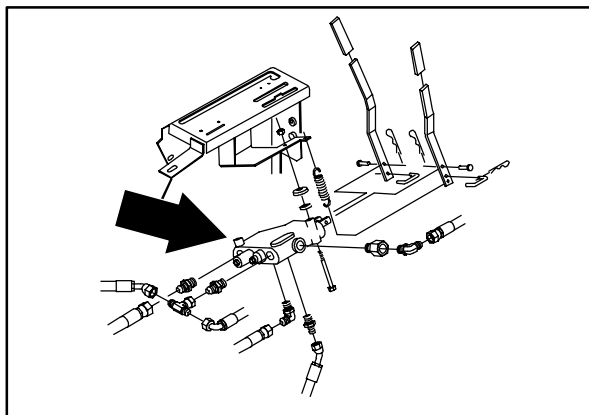


15. Reconnect the battery cables and start engine. Turn the steering wheel and check for any leaks and proper operation. Reinstall the front rubber firewall.



## HYDRAULIC CONTROL VALVE

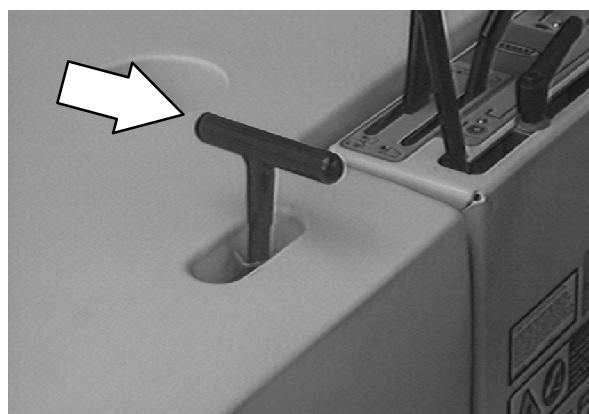
The main control valve is used to raise and lower the hopper, open and close the dump door, and provide hydraulic flow to the main and side brushes. The main and side brushes will only turn on when the hopper is in the down position.



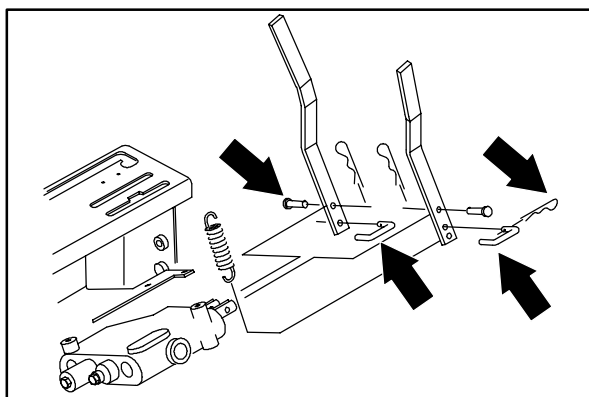
### TO REPLACE CONTROL VALVE

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

1. Open the seat support.

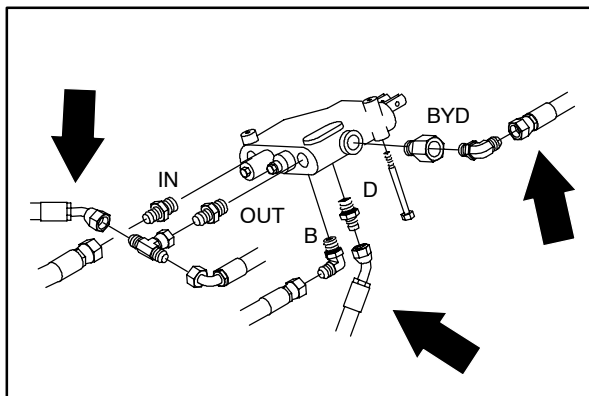


2. Remove the hair pins, C pins, and tension spring holding the valve handles to the valve.

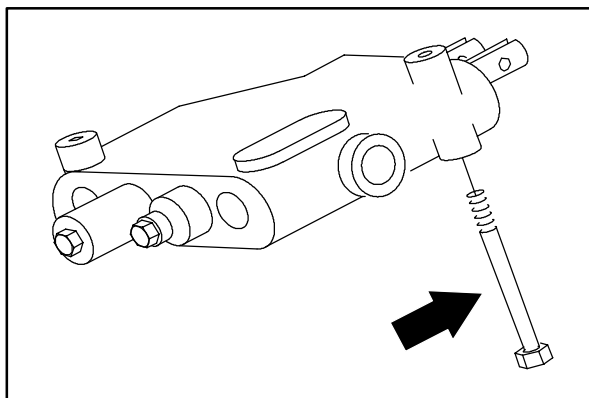


3. Mark, disconnect, and plug the hydraulic hoses leading to the control valve.

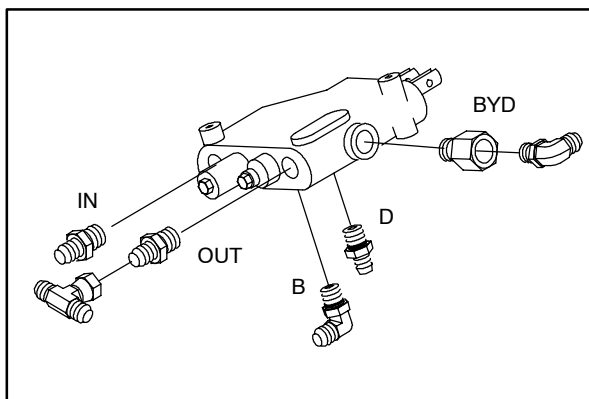
*NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.*



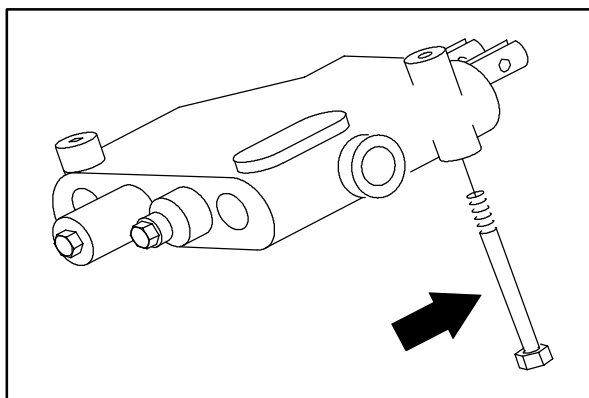
4. Remove the two M6 hex screws and nyloc nuts holding the control valve to the valve mount bracket. Remove the valve from the machine.



5. Remove the fittings from the old valve and install in the new valve in the same orientation.

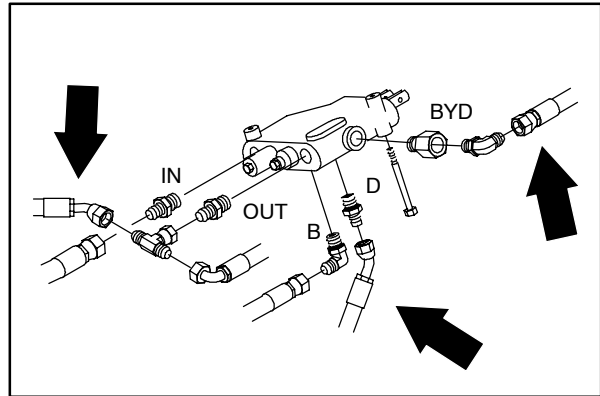


6. Install the new valve back on the valve mount bracket. Reinstall the two M6 hex screws and nyloc nuts. Tighten to 115 - 225 Ncm (10 - 20 in lb).

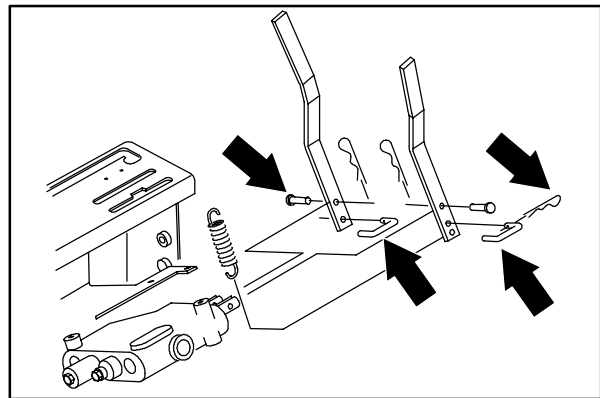


## HYDRAULICS

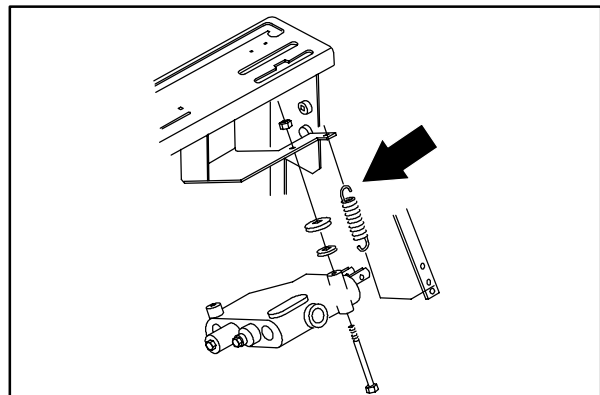
7. Reconnect the hydraulic hoses. See schematic in this section.



8. Reinstall the two valve handles, C pins, and hair pins on the new valves.



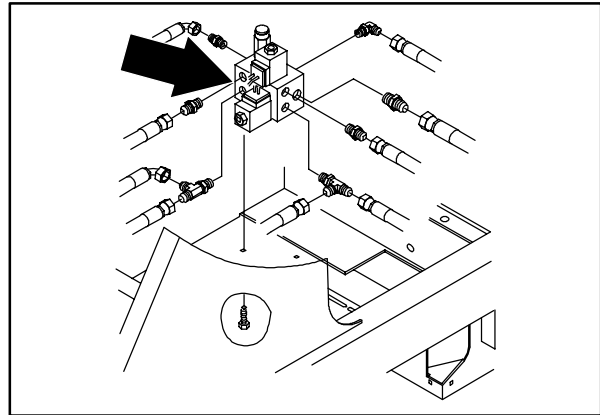
9. Reconnect the tension spring to the left handle.



10. Start the machine and check the control valve for proper operation.

## HYDRAULIC SOLENOID VALVE

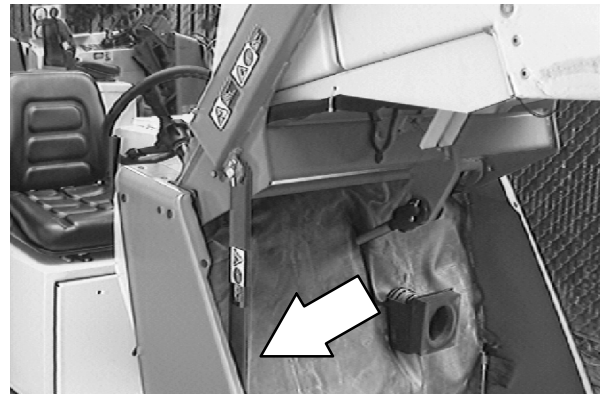
The hydraulic solenoid valve controls the operation of the main and side brush. The solenoid valve coil is electrically activated when the side brush or main brush handles are placed in the down position. The solenoid valve also contains a relief valve to protect the hydraulic system from damage.



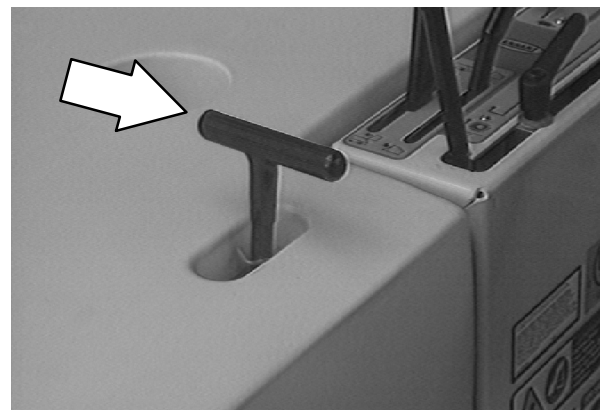
### TO REPLACE SOLENOID VALVE

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

1. Raise the hopper and engage the support bar. Remove the front rubber firewall.

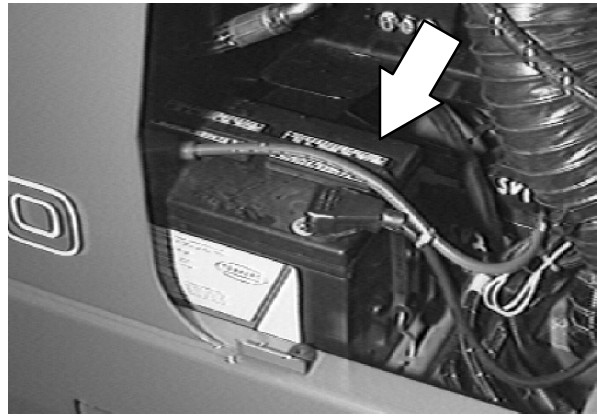


2. Open the seat support.

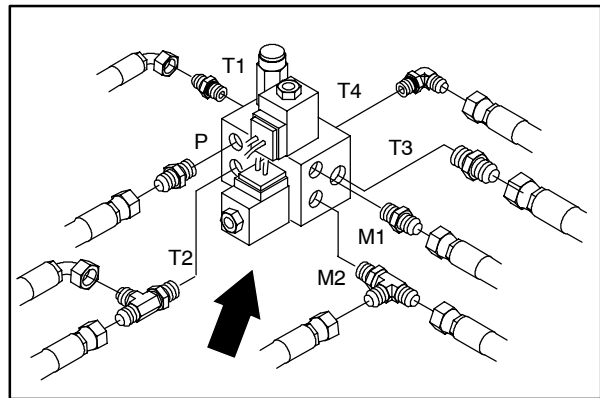


## HYDRAULICS

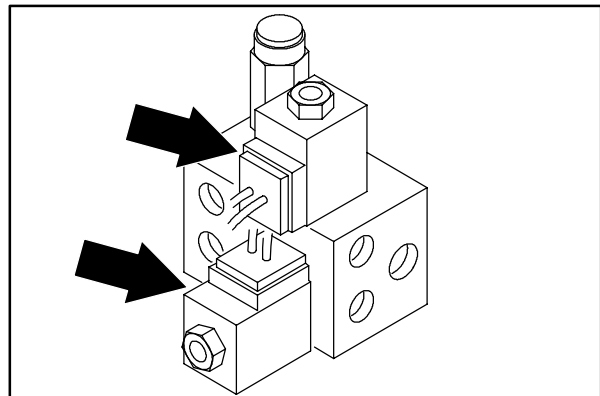
3. Disconnect the battery cables and remove the battery from the machine.



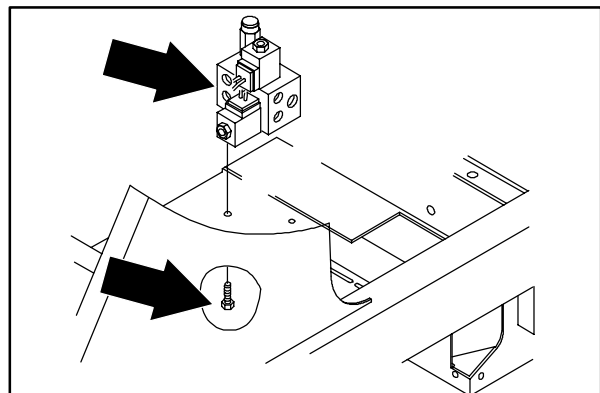
4. Mark, disconnect, and plug the hydraulic hoses leading to the solenoid valve.



5. Un-plug the two electrical coils from the main harness.

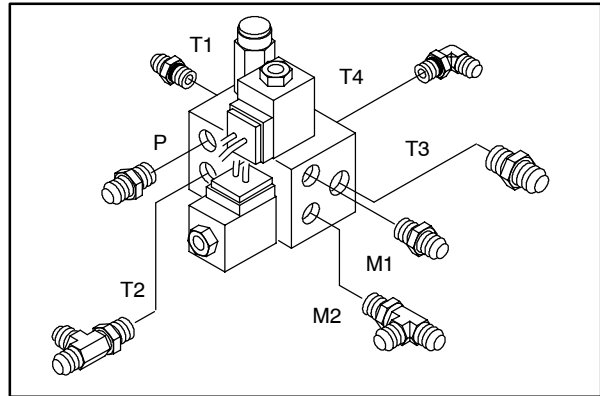


6. Go in front of the machine and down under the brush wrap. Locate the two hex screws holding the solenoid valve to the machine frame. Remove the valve from the machine.

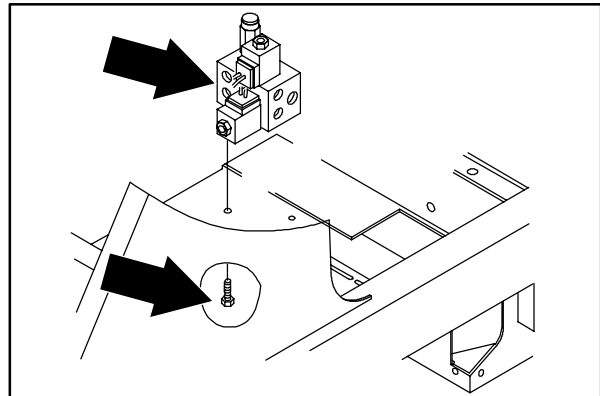




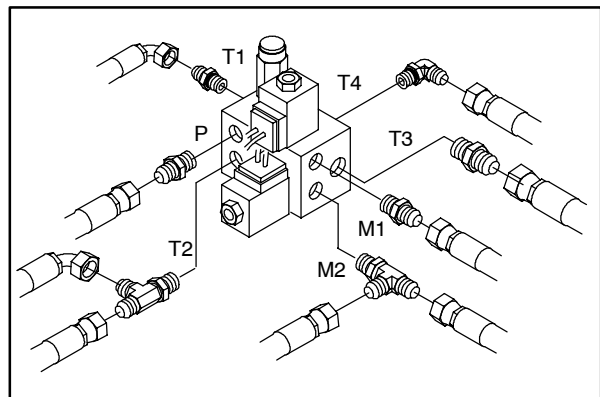
7. Remove the fittings from the old solenoid valve and install in the new valve in the same orientation.



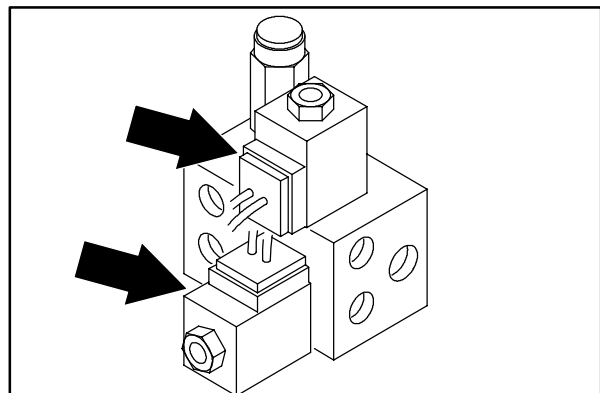
8. Position the new valve in the machine. Line up the holes in the frame with the two holes in the valve. Reinstall the two hex screws and tighten to 18 - 24 Nm (15 - 20 ft lb).



9. Reconnect the hydraulic hoses. See schematic in this section.

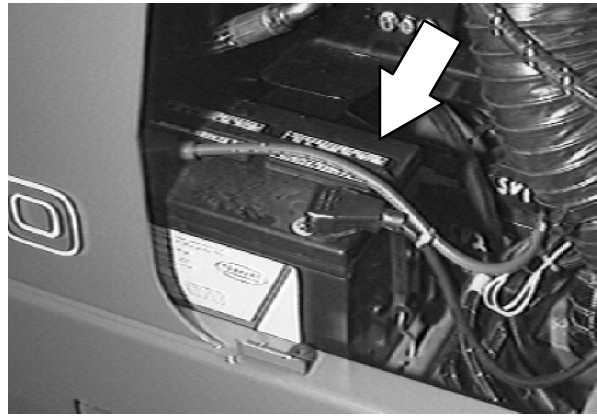


10. Reconnect the two electrical coils to the main harness.



## HYDRAULICS

11. Reinstall the battery and connect the battery cables.
12. Start the machine and check the new valve for any leak and proper operation. Reinstall the front rubber firewall.



**TO REPLACE MAIN BRUSH MOTOR**

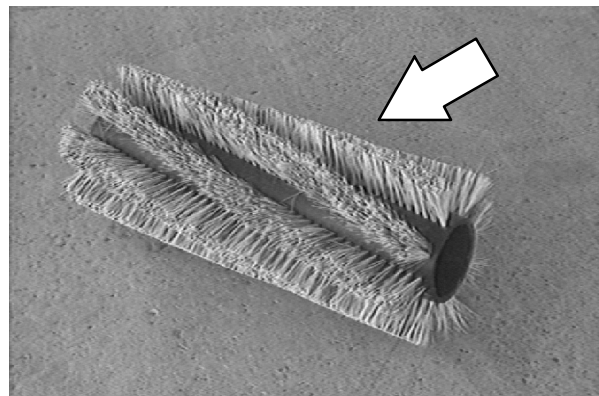
1. Raise the hopper and engage the support bar.

**⚠ WARNING: Raised Hopper May Fall. Engage Hopper Support Bar.**

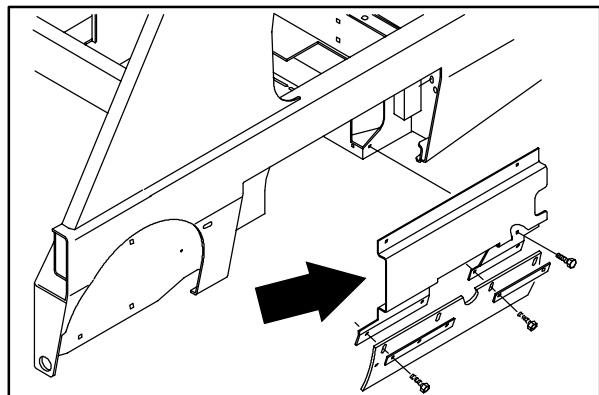
**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**



2. Remove the main brush from the machine.

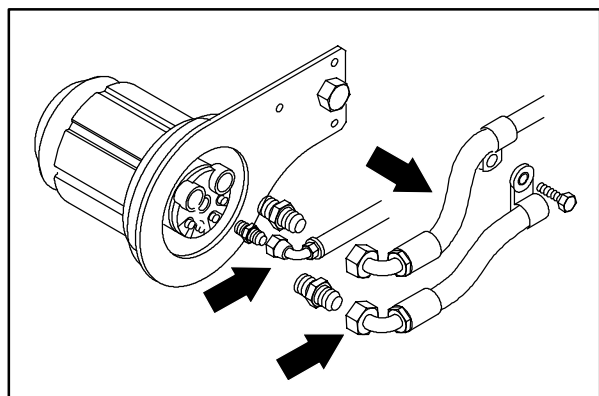


3. Remove the four hex screws holding the dust skirt assembly plate to the machine. Remove the skirt assembly from the machine.

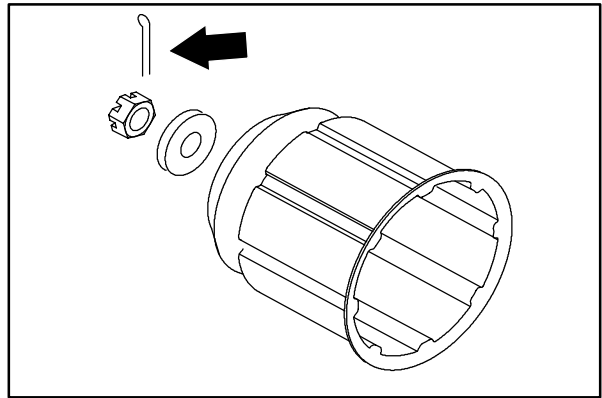


4. Remove and plug the hydraulic hoses leading to the main brush motor.

*NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.*

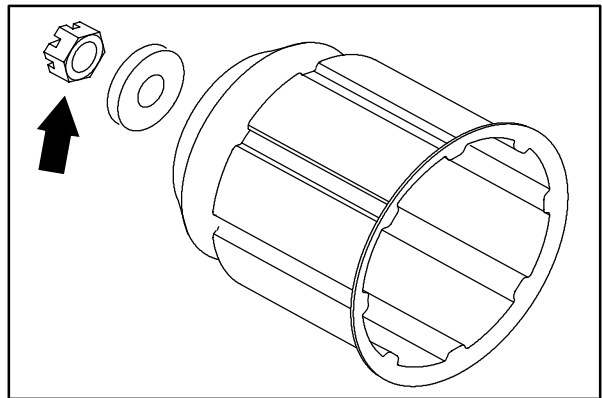


5. Remove the cotter pin from castle nut at the end of main brush drive motor plug.

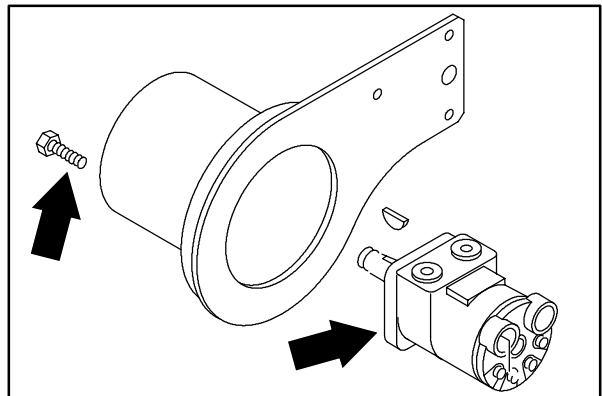


6. Hold the brush drive plug from turning and remove the castle nut.

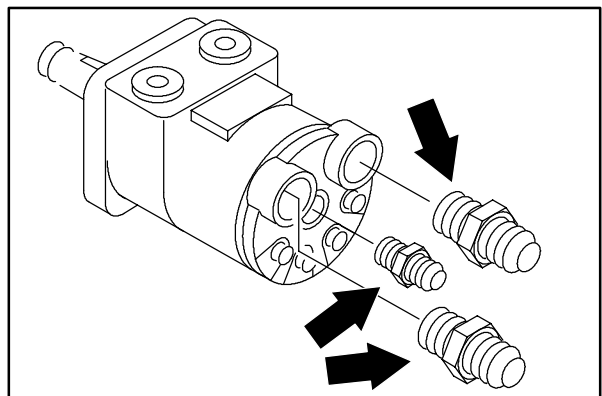
7. A puller must be used to remove the brush drive plug from tapered shaft on the main brush motor.



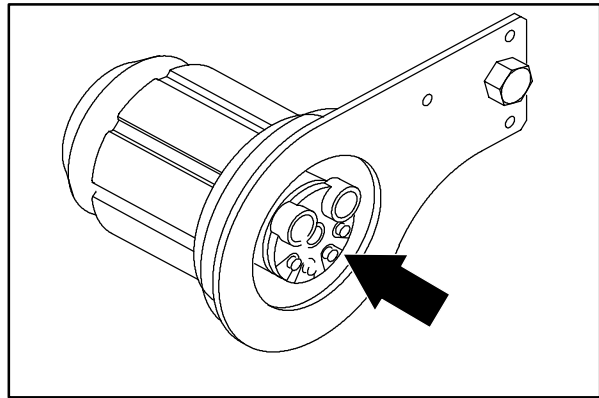
8. Remove the four hex screws holding the main brush motor to the brush arm. Remove the motor from the machine.



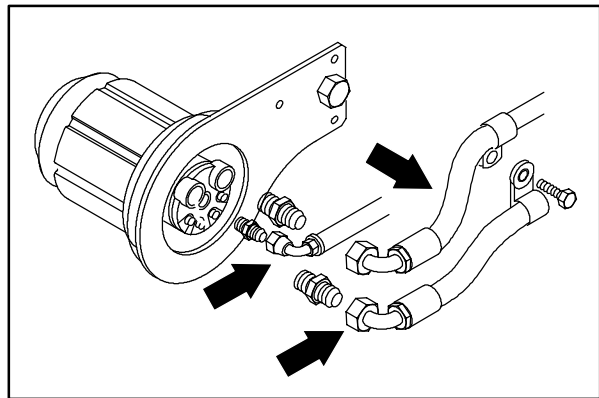
9. Remove the hydraulic fittings from old motor and install in the new motor in the same orientation.



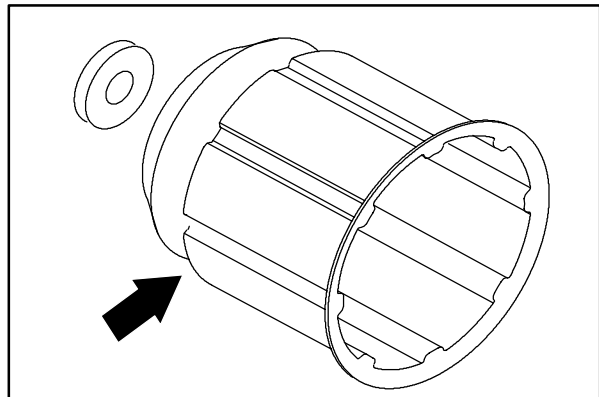
10. Install the new main brush motor in the brush arm. Tighten the hex screws to (27 – 53 ft lb).



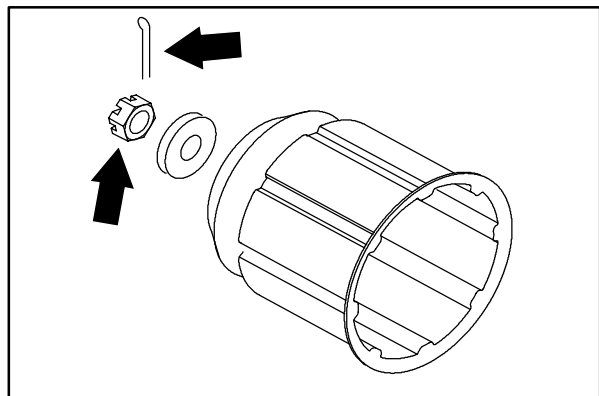
11. Reconnect the hydraulic hoses to the new motor. See schematic in this section.



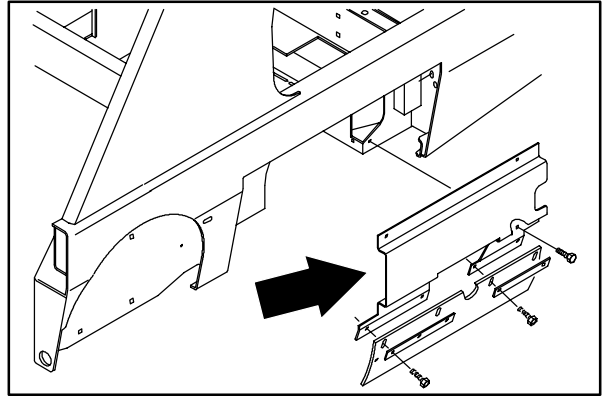
12. Reinstall the brush drive plug onto the tapered shaft of the new motor. Make sure the key is in place.



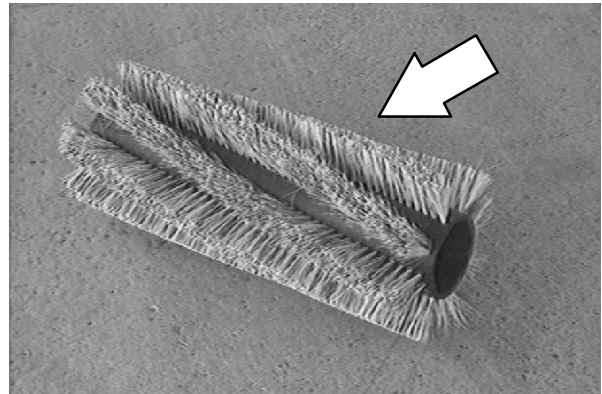
13. Reinstall the castle nut and tighten to 40 – 54 Nm (30 – 40 ft lb). Continue to tighten castle nut until it lines up with hole in brush motor shaft. Install a new cotter pin.



14. Reinstall the dust skirt assembly on the machine. Tighten the hex screws to 18 - 24 Nm (15 - 20 ft lb).



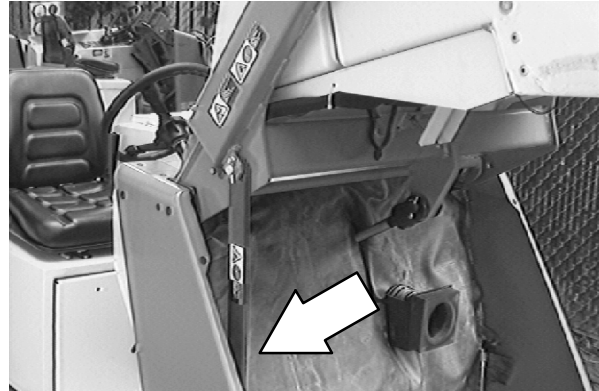
15. Reinstall the main brush. Operate the machine and check for proper operation.



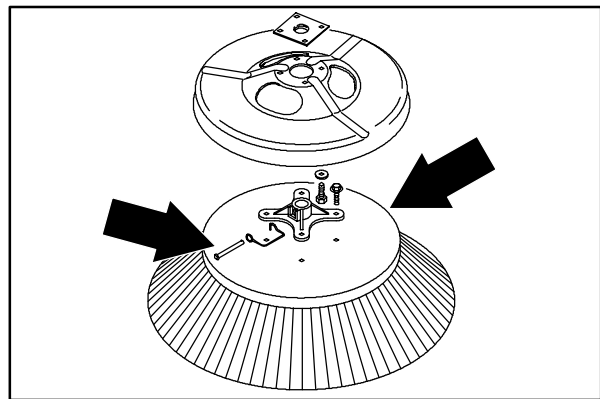
**TO REPLACE SIDE BRUSH MOTOR**

1. Empty the debris hopper.
2. Set the machine parking brake.
3. Raise the hopper and engage the support bar.

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

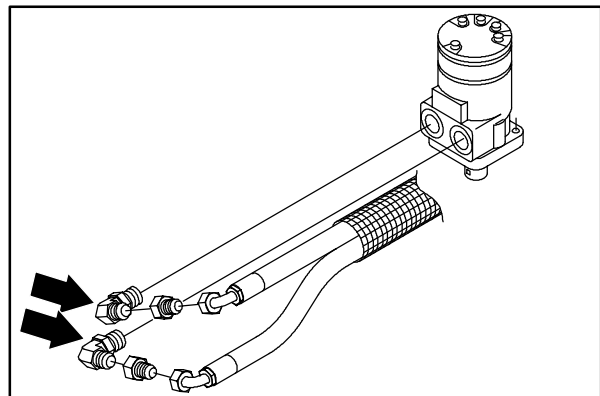


4. Remove the side brush retaining pin from the side brush drive shaft by pulling the pin keeper over the end of the pin.
5. Remove the side brush from the side brush motor.



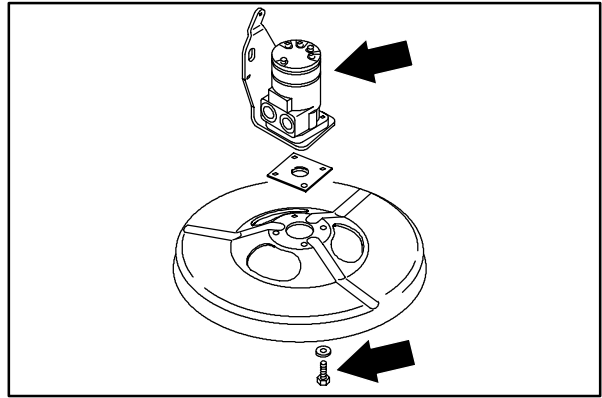
6. Remove and plug the hydraulic hoses leading to the side brush motor.

*Note: Observe hydraulic cleanliness requirements when opening hydraulic lines.*

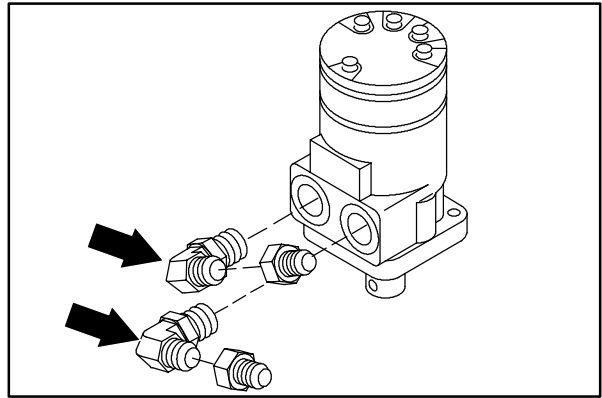


## HYDRAULICS

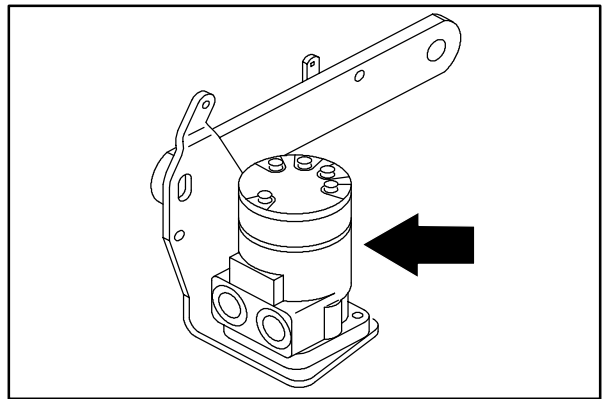
7. Remove the four hex screws holding the side brush motor to the mount bracket. Remove the side brush guard and side brush motor from machine.



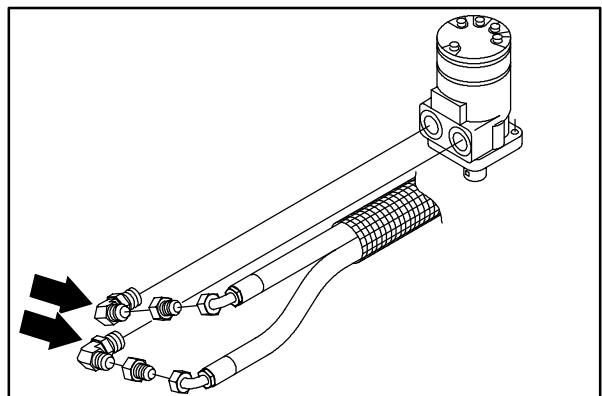
8. Remove the hydraulic fittings from the old motor and install in the new motor in the same orientation.



9. Install the new side brush motor and the side brush guard on the mount bracket. Tighten the four hex screws to (27 - 35 ft lb).

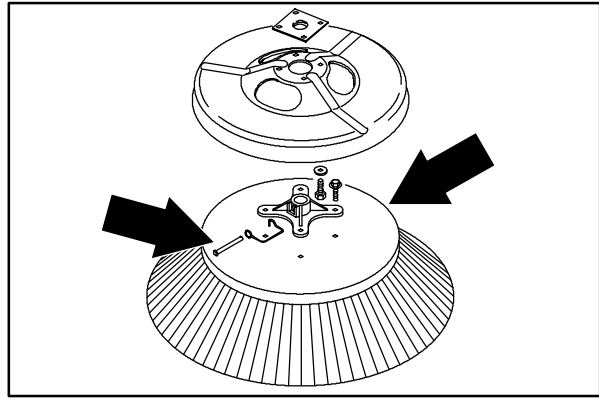


10. Reconnect the hydraulic hoses to the side brush motor. See schematic in this section.

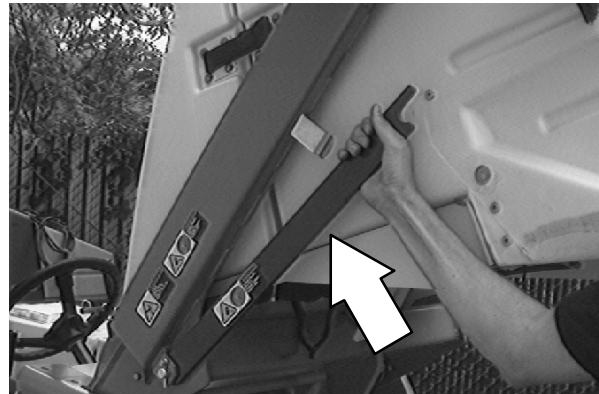




11. Reinstall the side brush on the side brush motor.
12. Reinstall the side brush retaining pin through the side brush hub and shaft.
13. Secure the pin by clipping the pin keeper over the end of the pin.



14. Disengage the hopper support bar and lower the hopper.



15. Adjust the side brush pattern with the side brush down pressure lever.



### TO REPLACE REAR DRIVE MOTOR

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

1. Engage the parking brake and block the front tires.
2. Jack up the rear of the machine. Use jack stands to support machine.

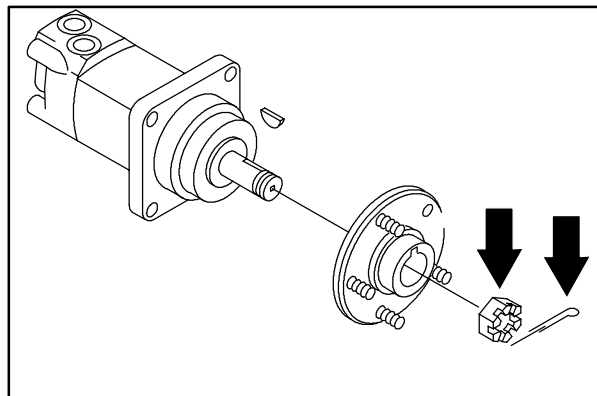
**FOR SAFETY: Block machine tires before jacking machine up. Jack machine up at designated locations only. Block machine up with jack stands.**



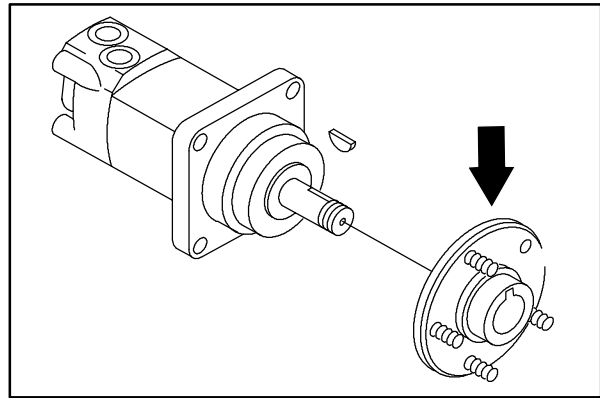
3. Remove the rear tire and wheel assembly from the drive motor hub.



4. Remove the cotter pin and slotted nut from drive wheel shaft.

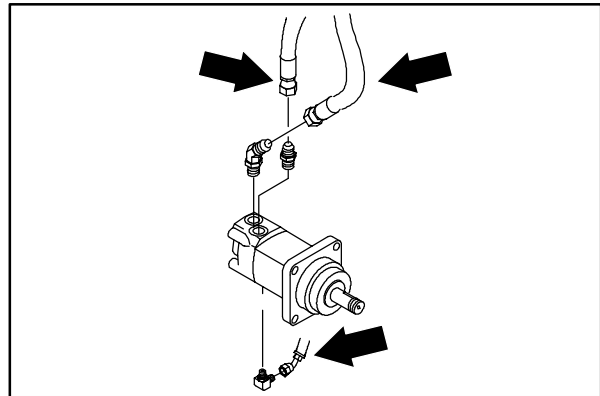


5. Remove the hub from the tapered motor shaft. *A puller may need to be used.*



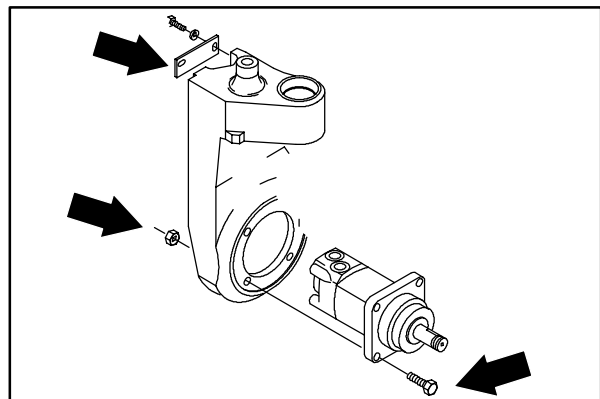
6. Disconnect the hydraulic hoses from the drive motor.

*NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.*

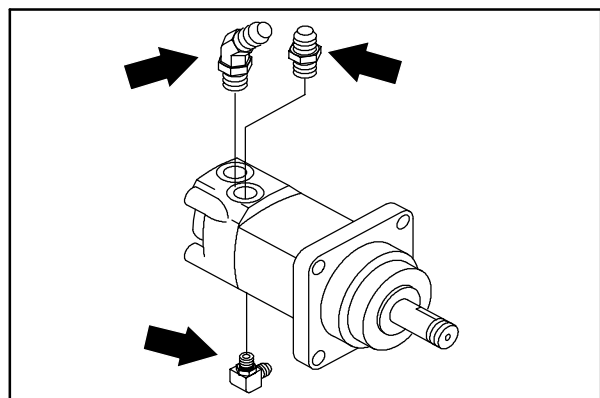


7. Remove the four motor mounting bolts.

8. Slide the motor out of the rear wheel housing.

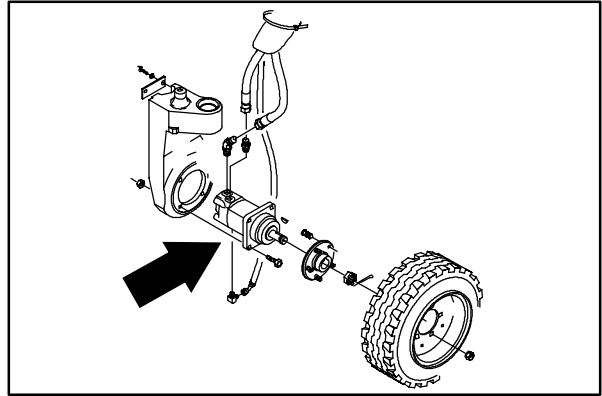


9. Remove the hydraulic fittings from the old motor and install in the new motor in the same orientation.

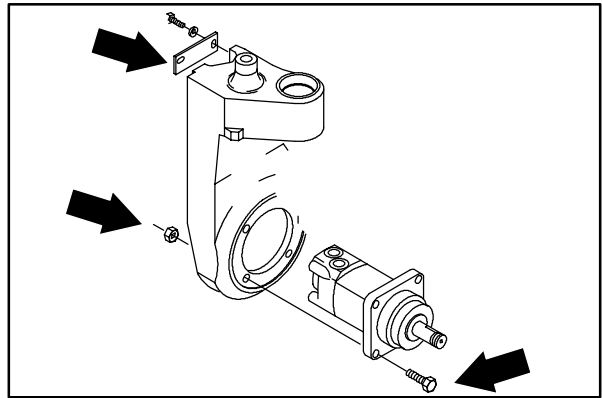


## HYDRAULICS

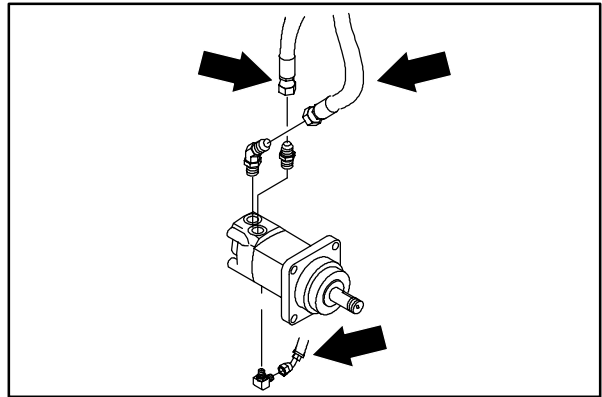
10. Slide the new motor back in the wheel housing. Note the hydraulic fitting orientation.



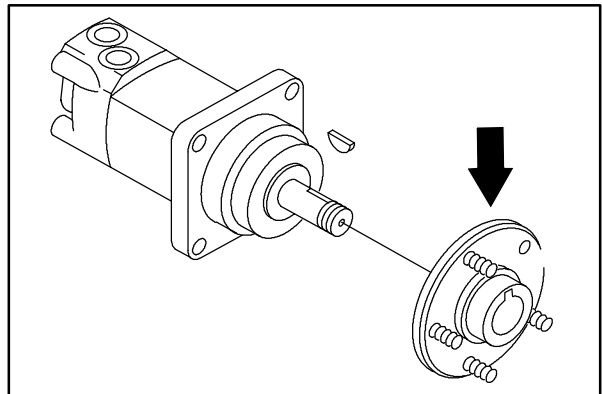
11. Reinstall the four hex head screws and tighten to 88–115 Nm (65–85 ft lb).



12. Reconnect the hydraulic hoses. See schematic in the HYDRAULICS section.



13. Mount the drive hub to the tapered motor shaft. Tighten the castle nut to 270 Nm (200 ft lb) and put new 0.125 x 2.50 cotter pin through slotted nut.



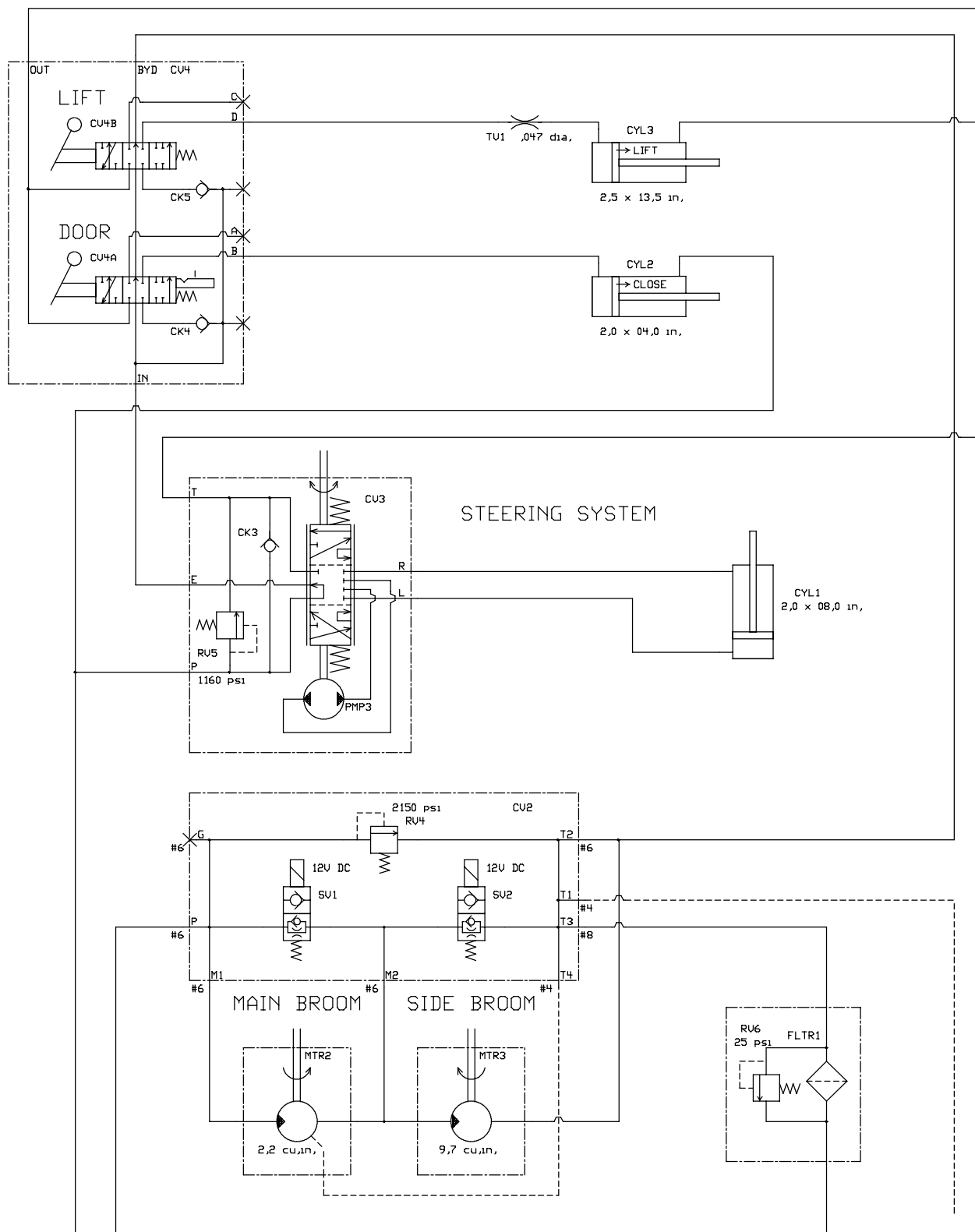
14. Install the rear tire. Tighten the nuts to 122-150 Nm (90-110 ft lb).



15. Remove the jack stands and lower the machine.

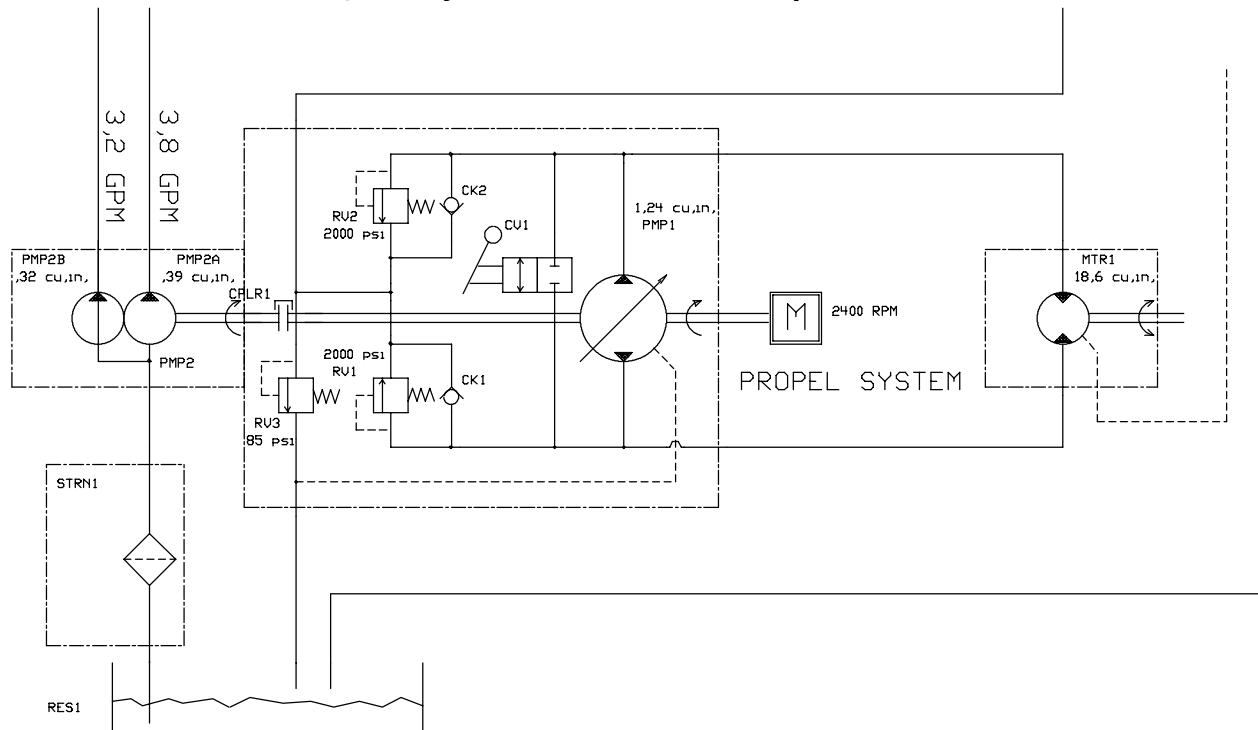


**Fig. 1 - Hydraulic Schematic, Liquid cooled**



350156 - LIQ

**Fig. 1 - Hydraulic Schematic, Liquid cooled**



350156 - LIQ

**Fig. 2 - Hydraulic Schematic, Air Cooled**

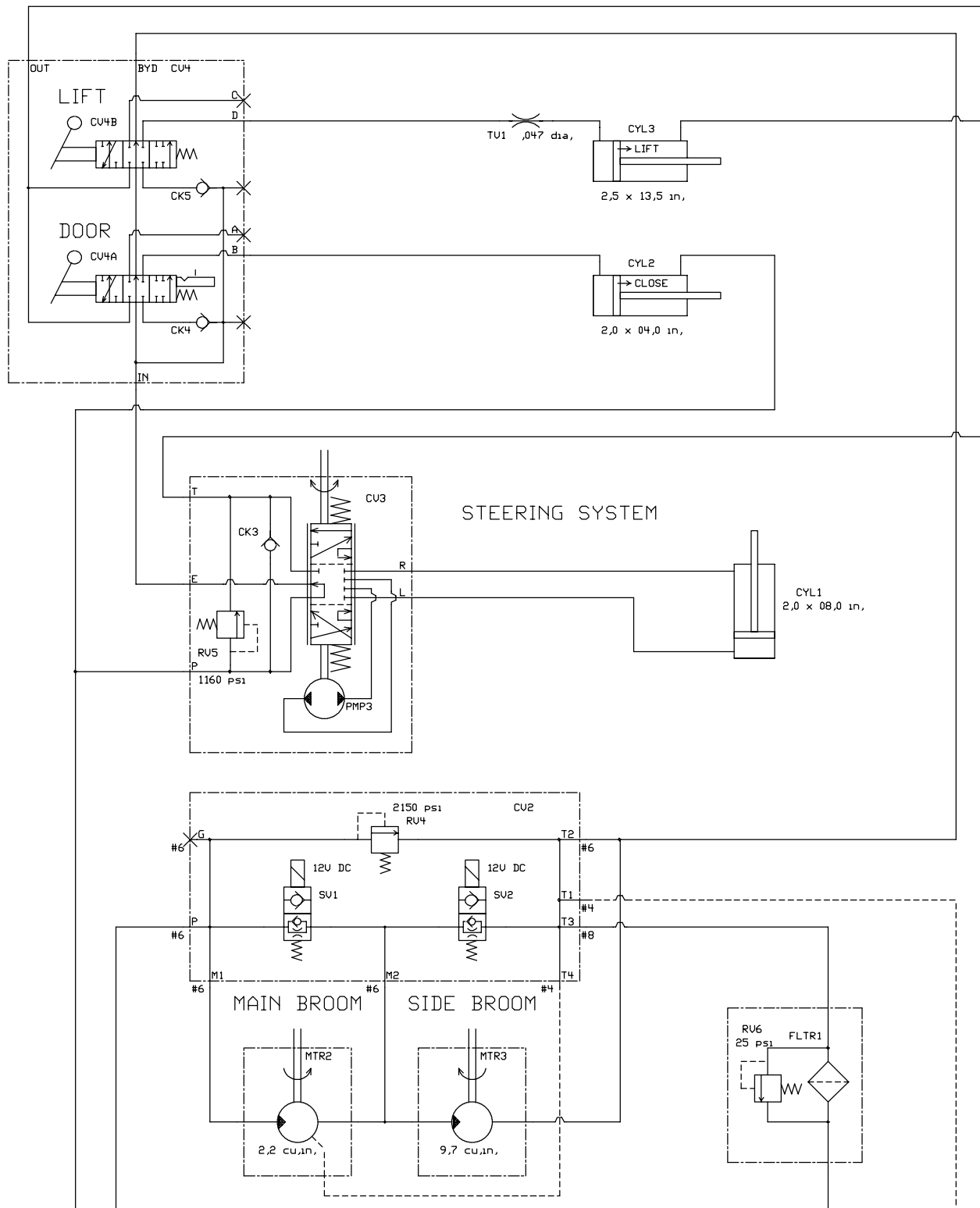
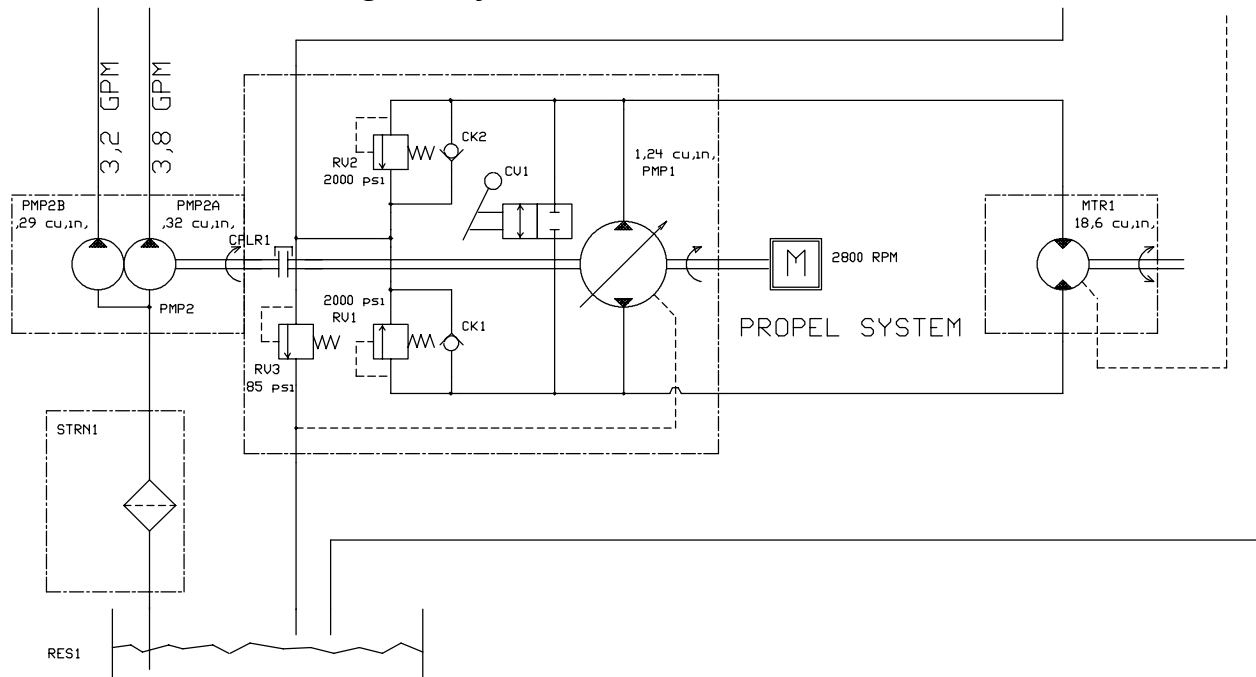




Fig. 2 - Hydraulic Schematic, Air Cooled



350157 - AIR

**Fig. 3 - Hydraulic Hose Group, Liquid Cooled**

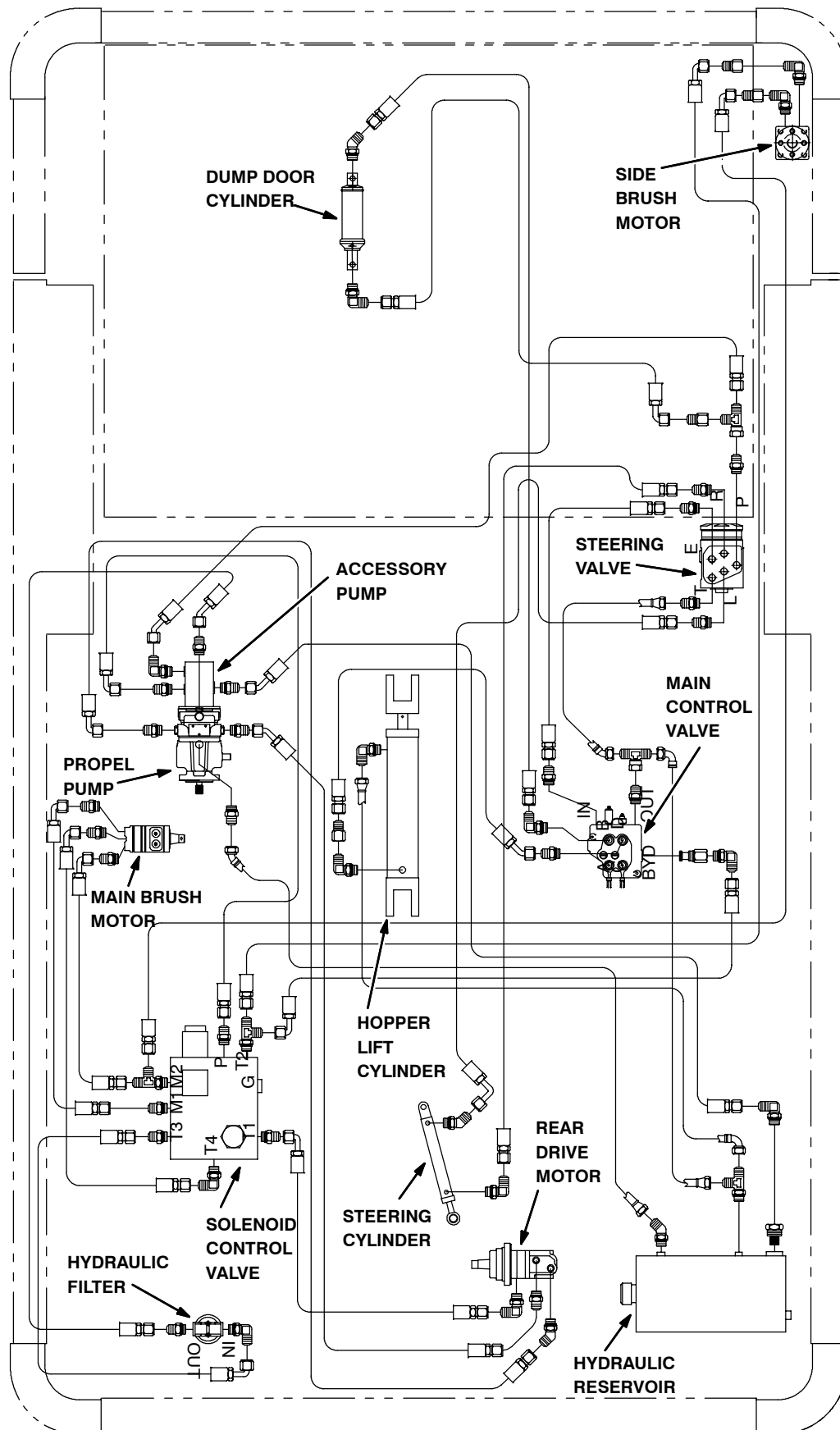
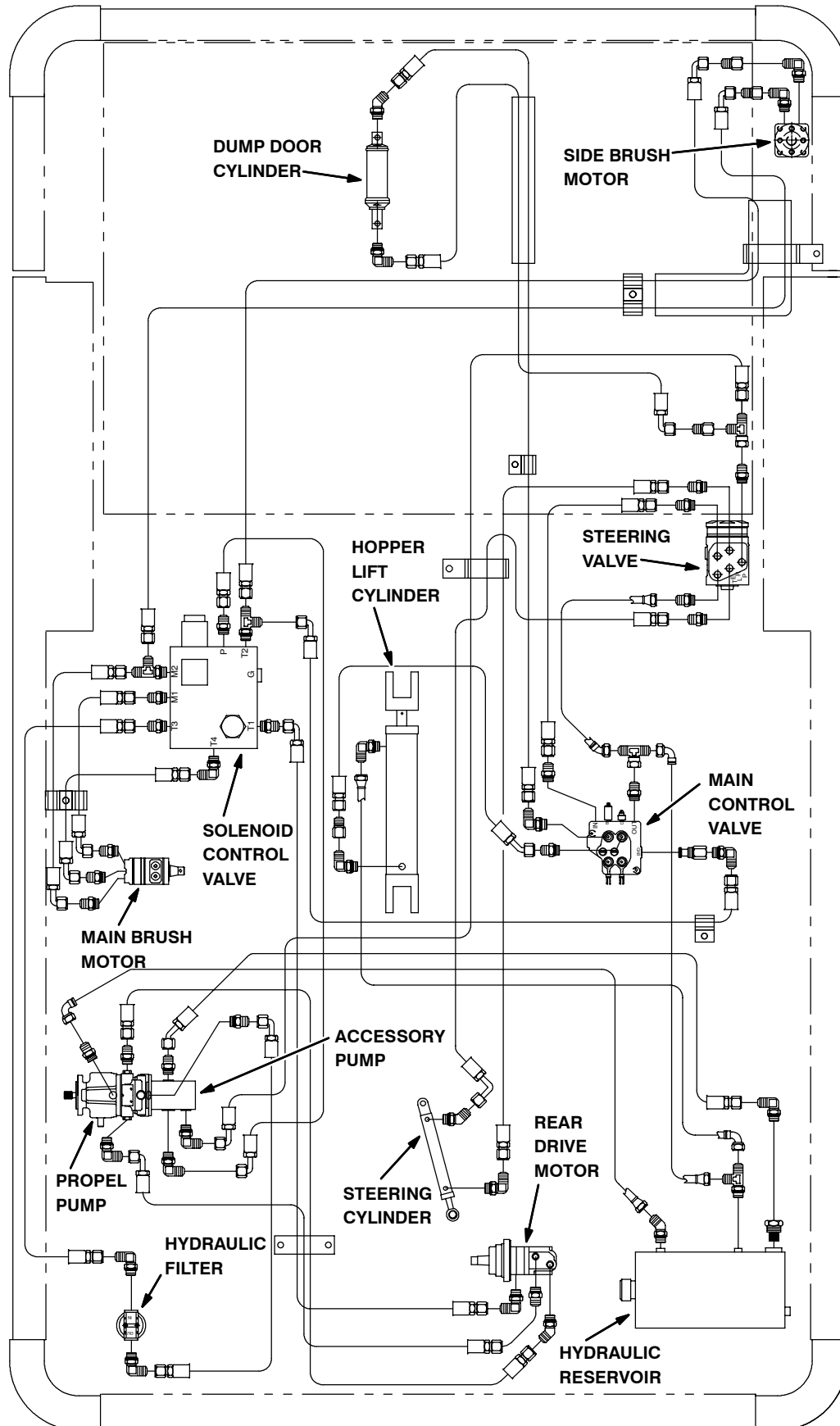


Fig. 4 - Hydraulic Hose Group, Air Cooled



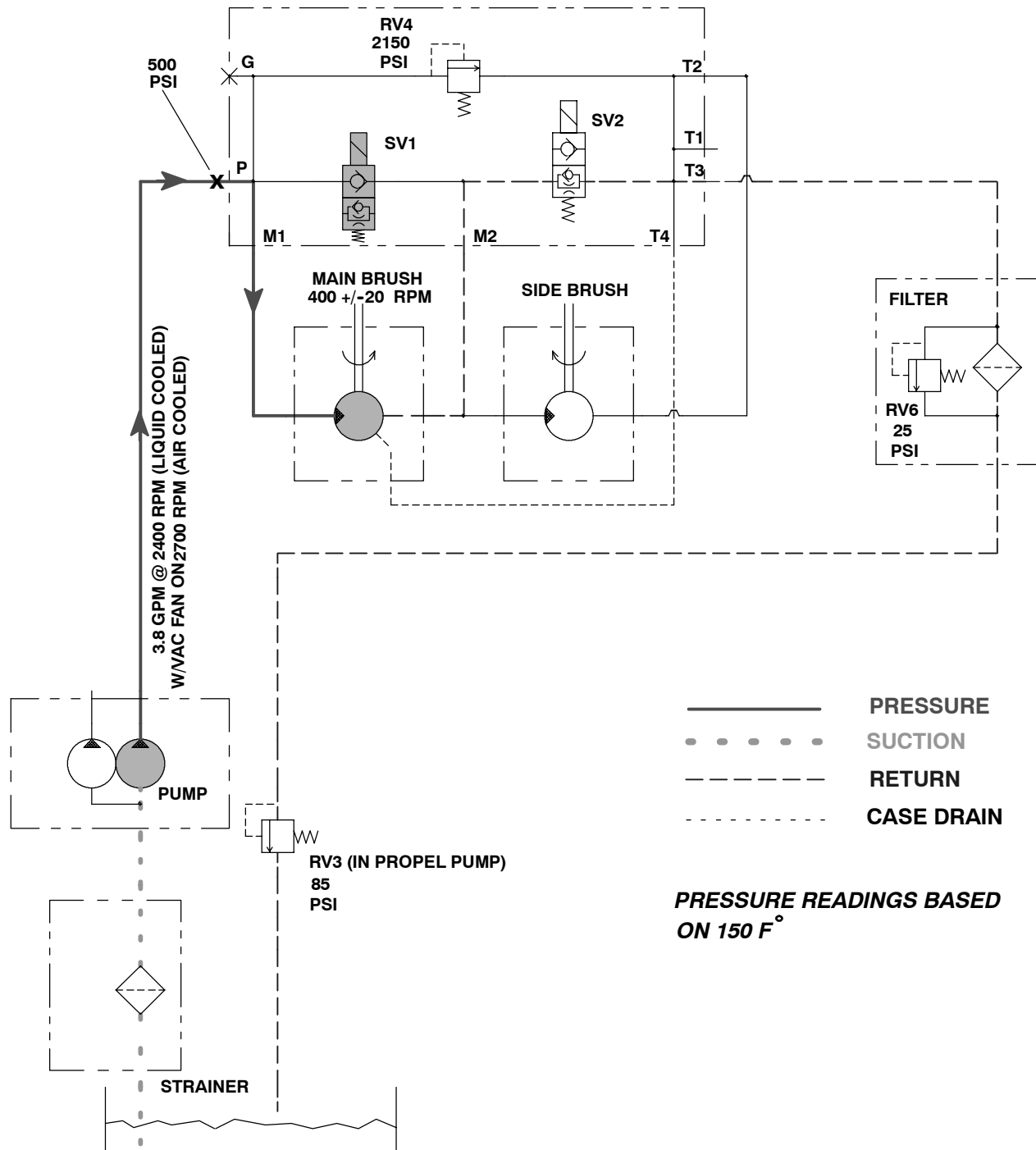
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### TROUBLESHOOTING

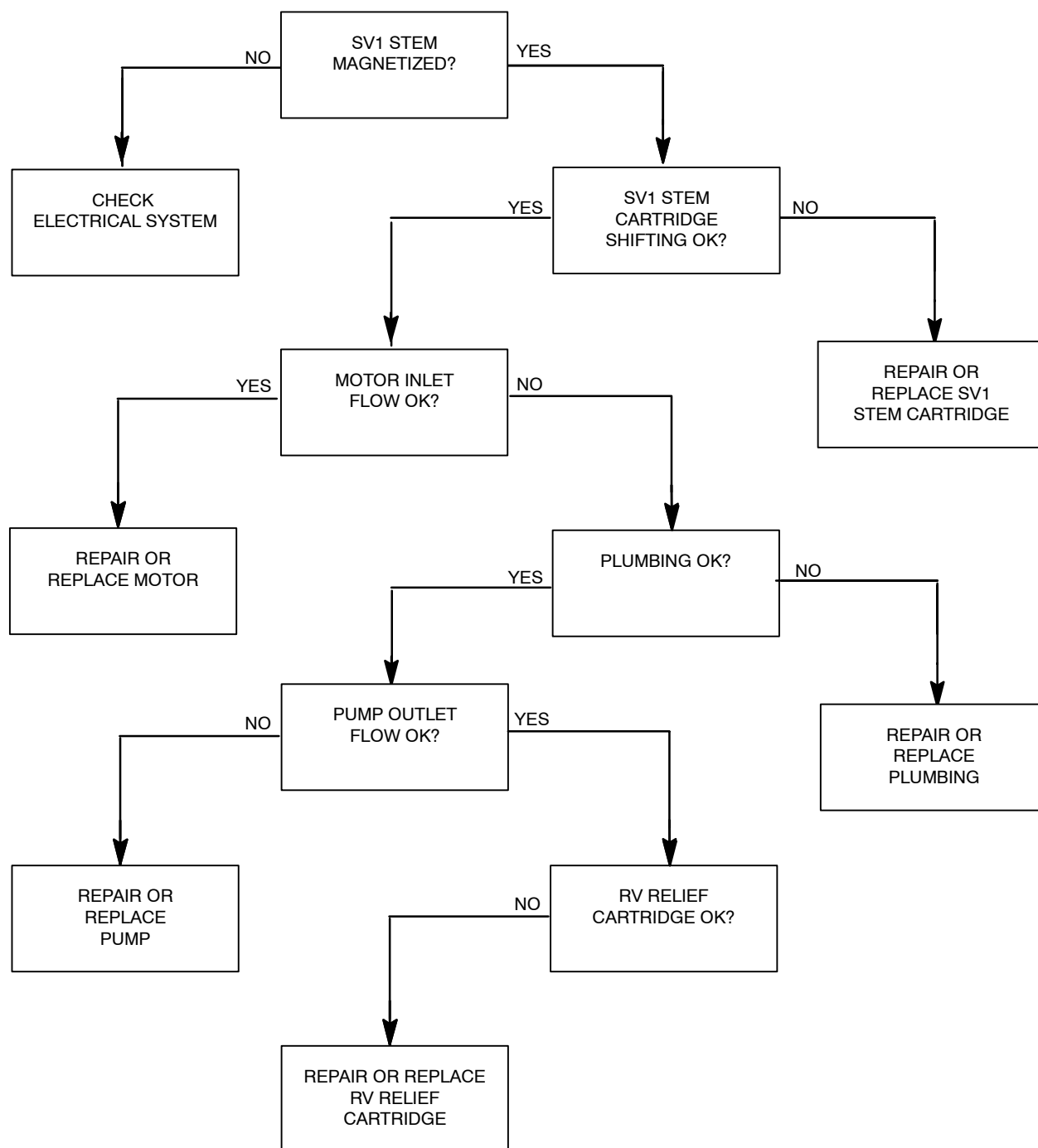
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The troubleshooting charts that follow are organized so they lead you through the circuits. They include flow charts and instructions for you as to where to insert your test instruments.

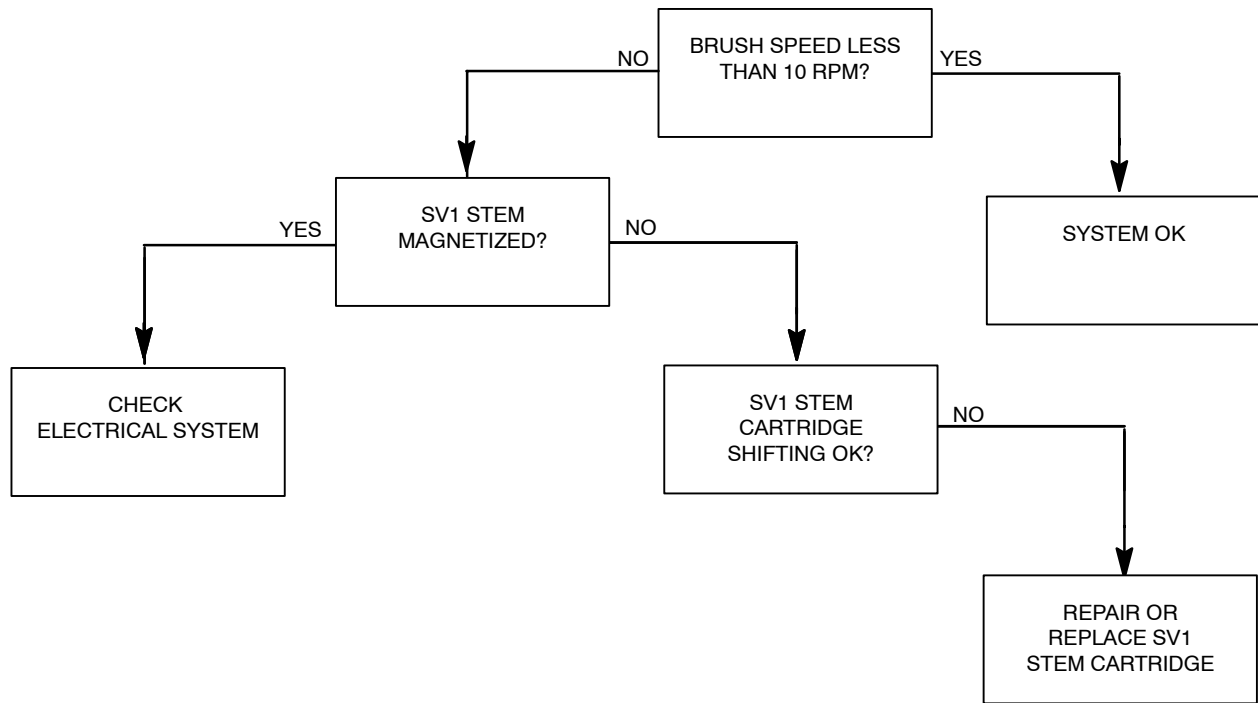
# MAIN BRUSH ON CIRCUIT



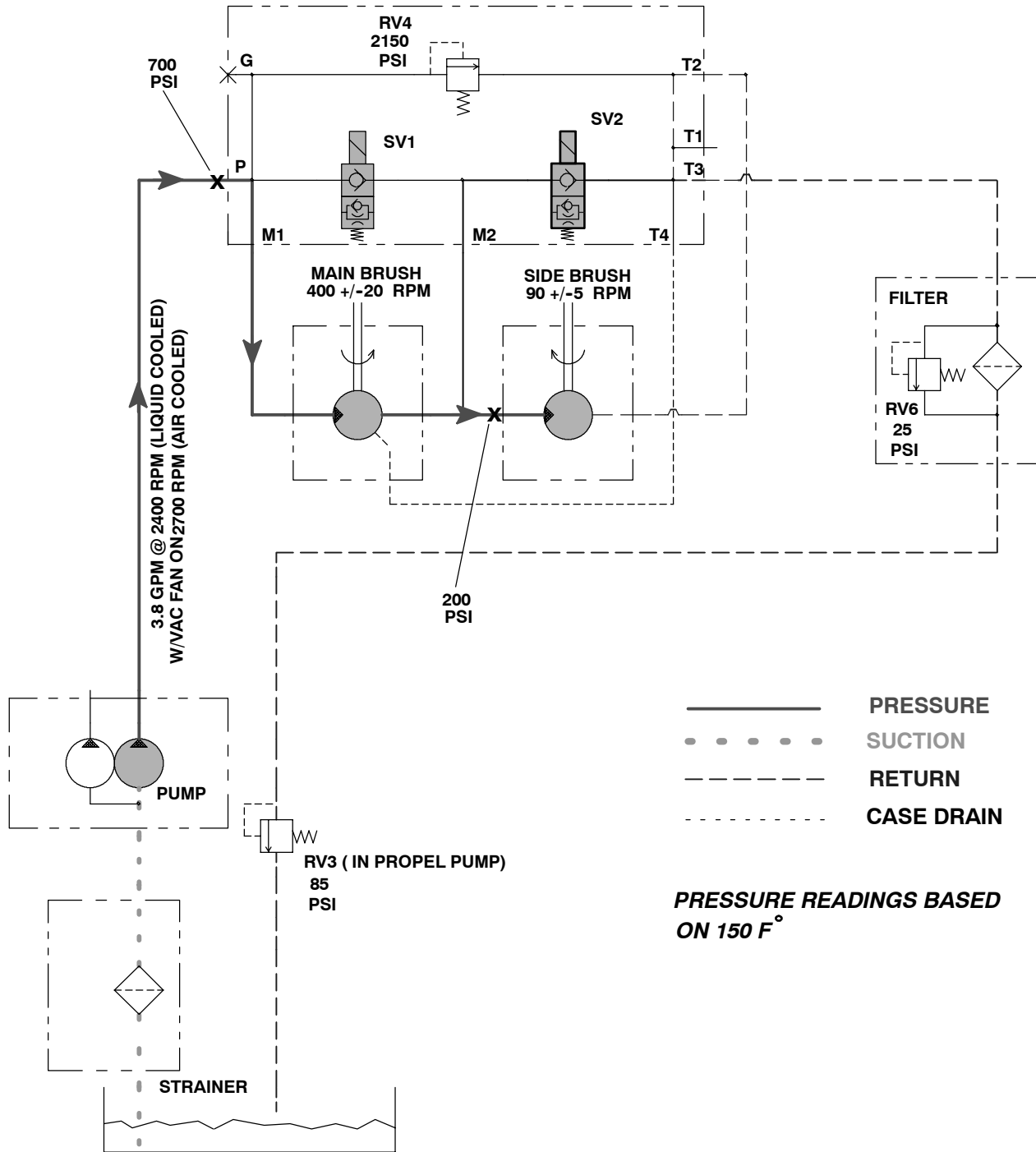
# MAIN BRUSH DOES NOT TURN ON



# MAIN BRUSH DOES NOT TURN OFF

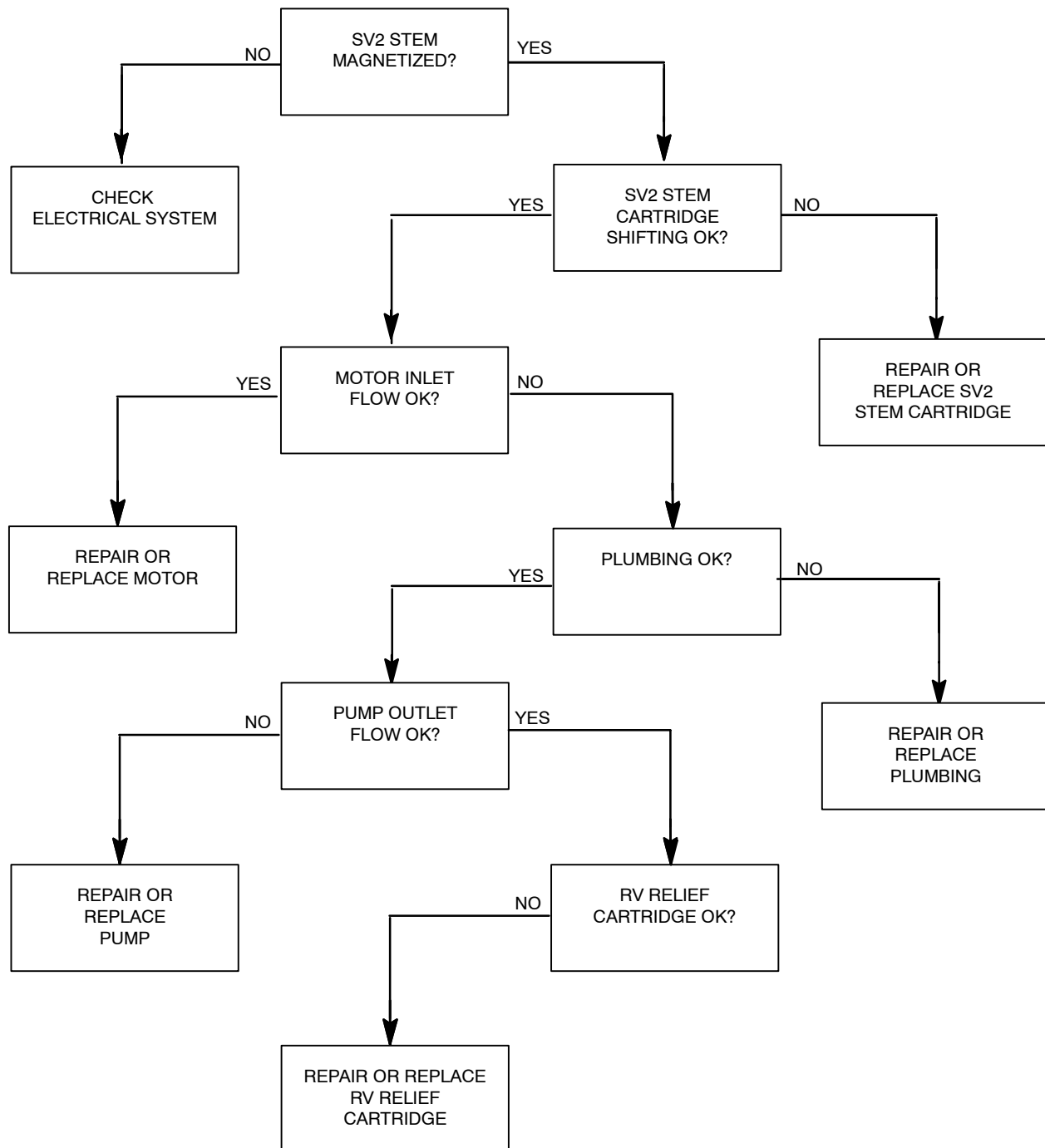


# MAIN BRUSH & SIDE BRUSH ON CIRCUIT

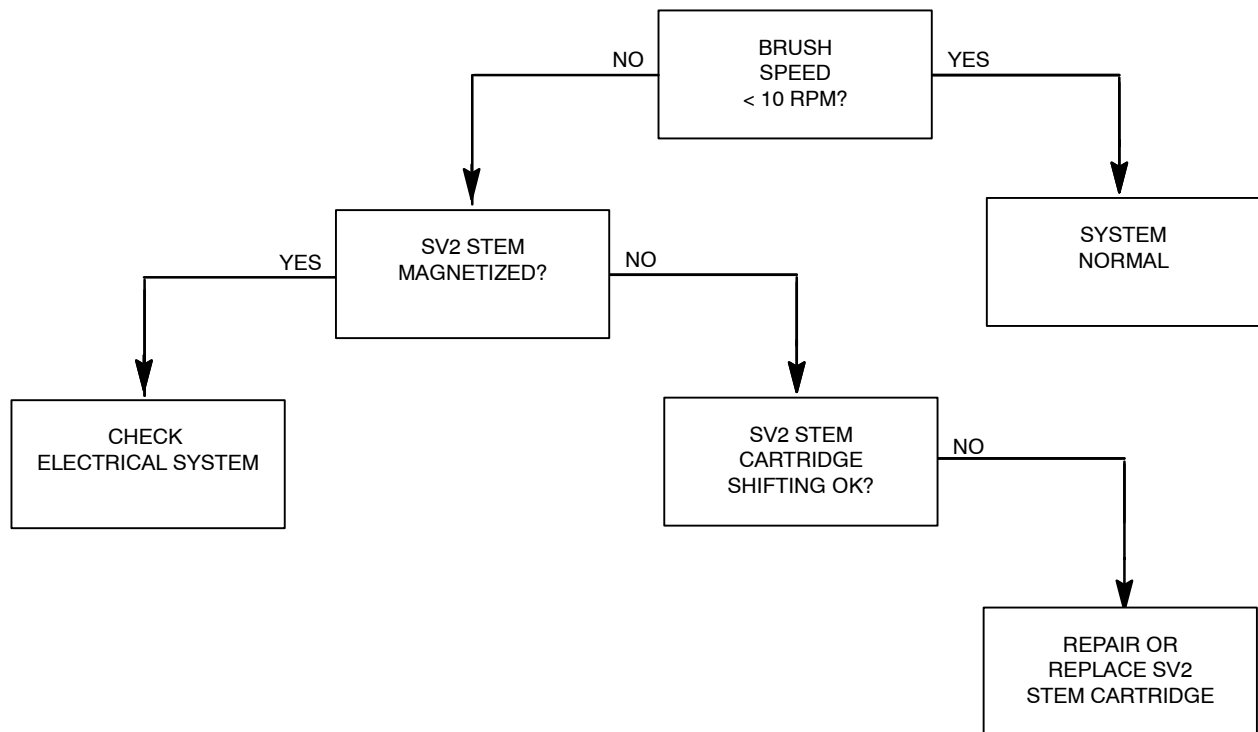




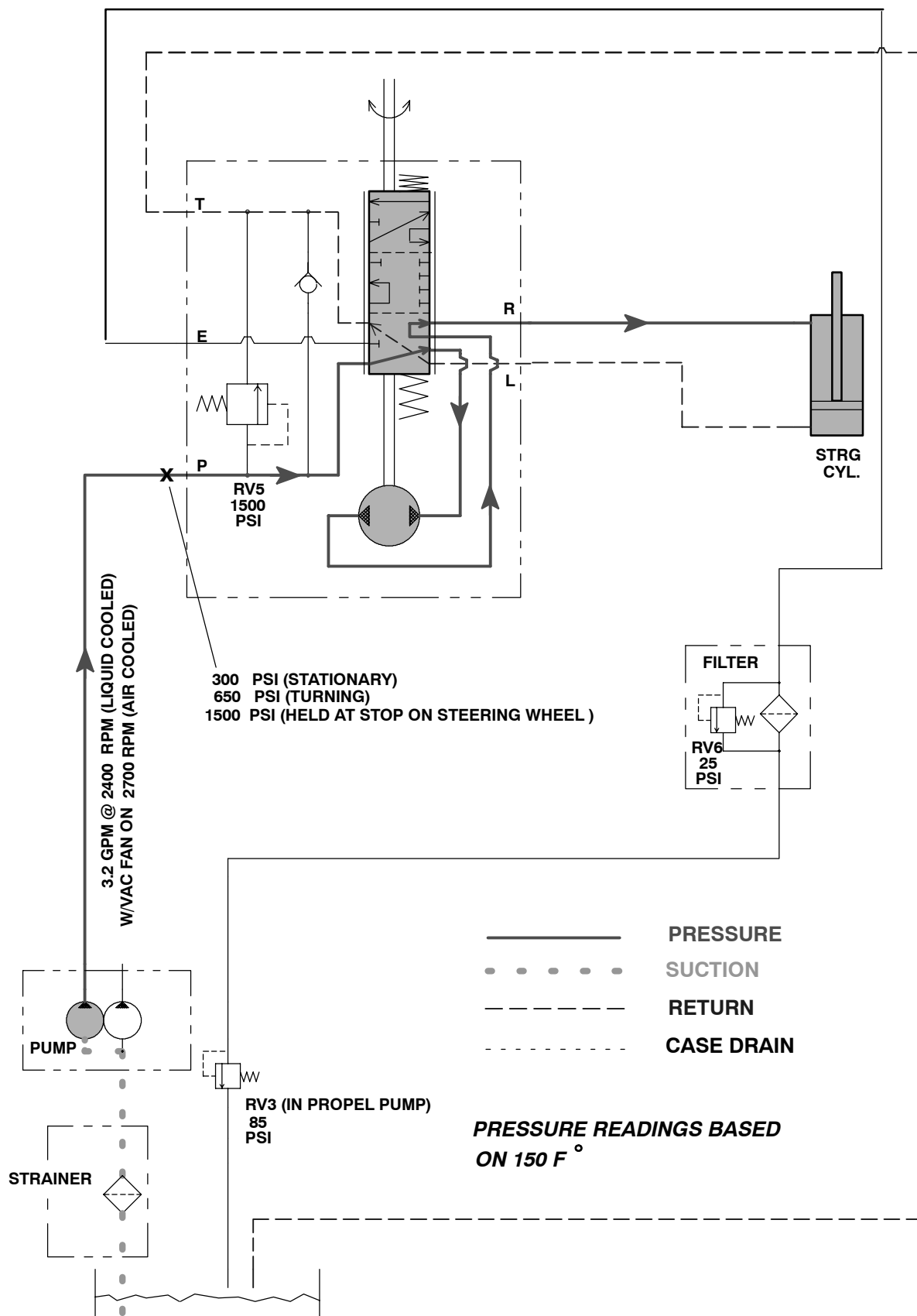
# SIDE BRUSH DOES NOT TURN ON



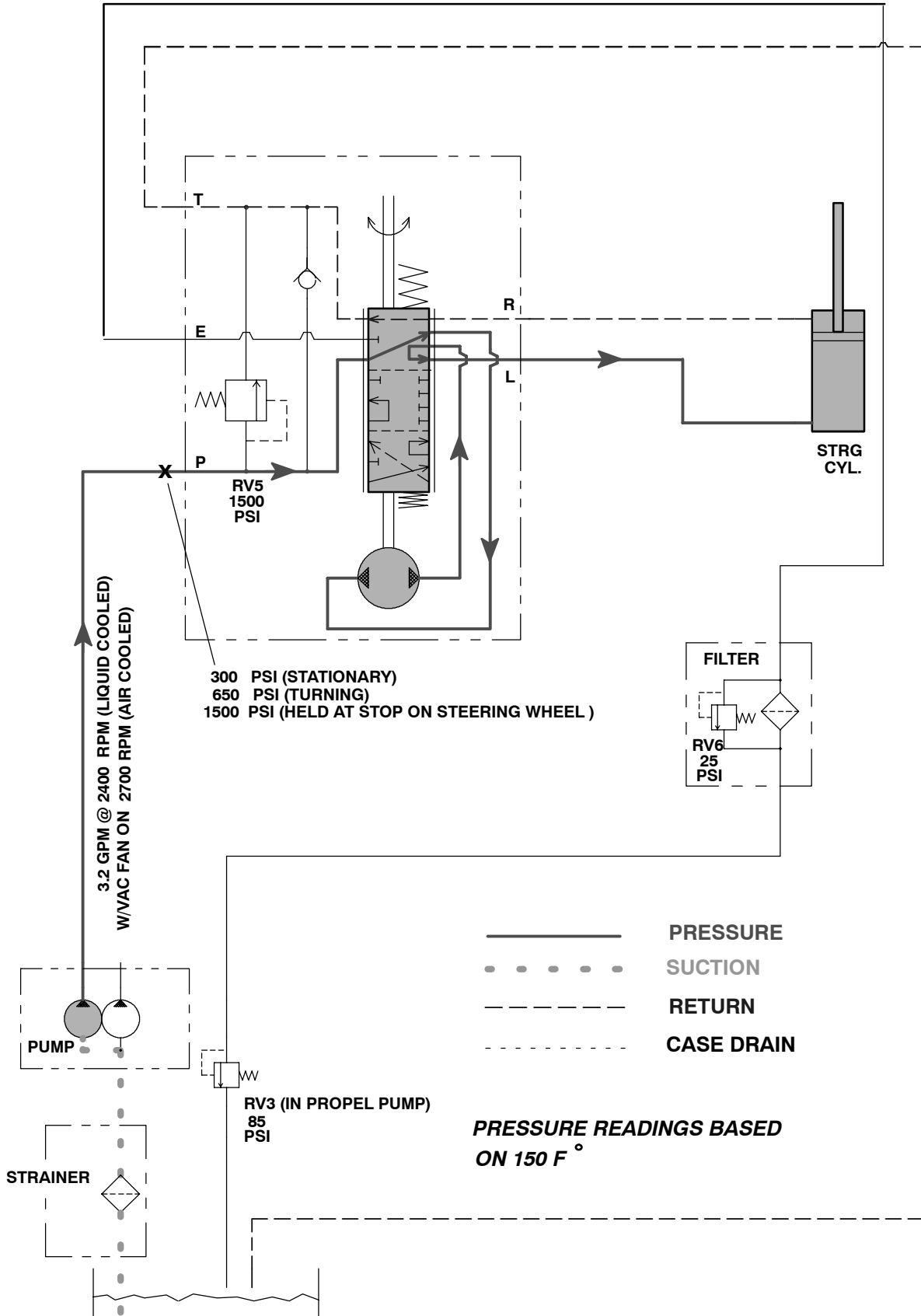
# SIDE BRUSH DOES NOT TURN OFF



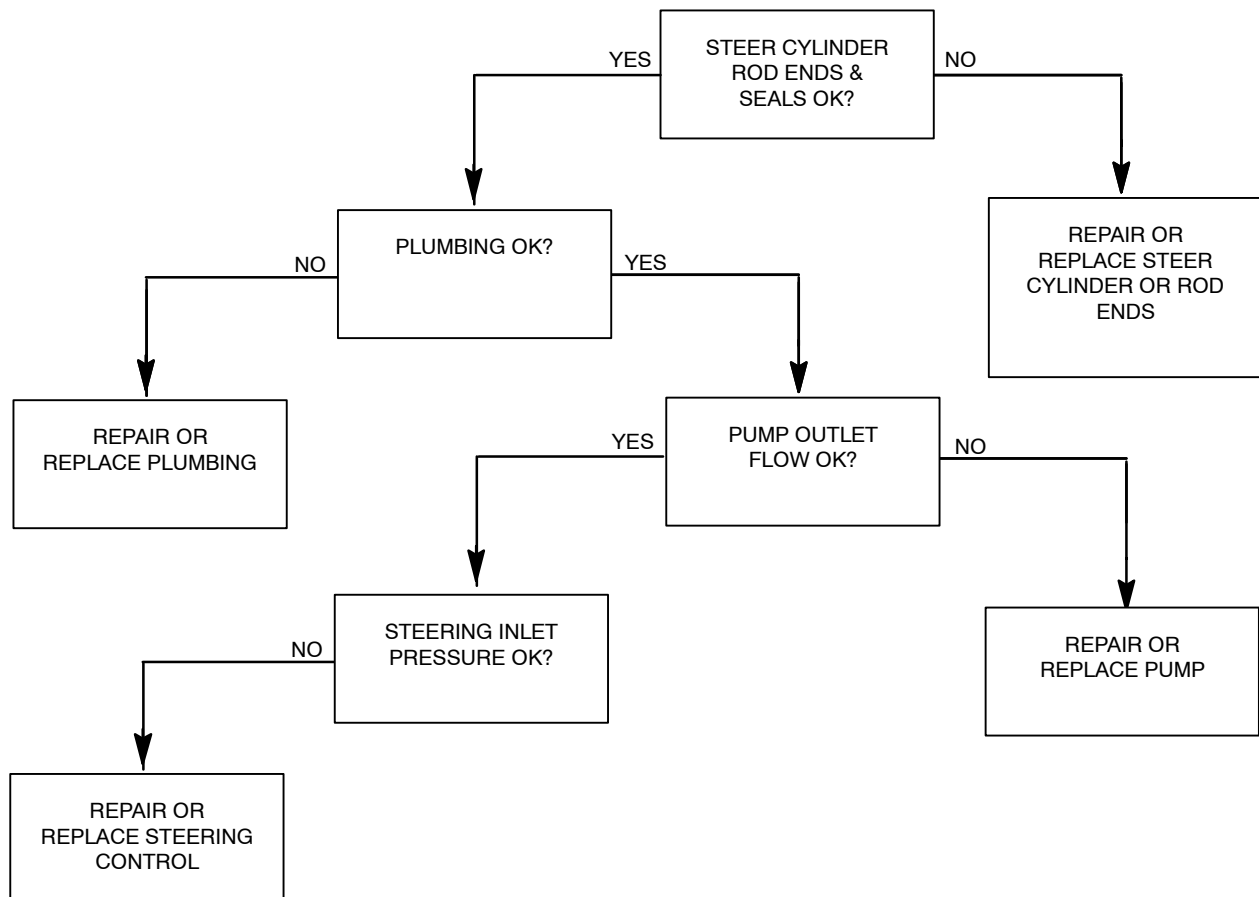
# STEERING CIRCUIT RIGHT TURN



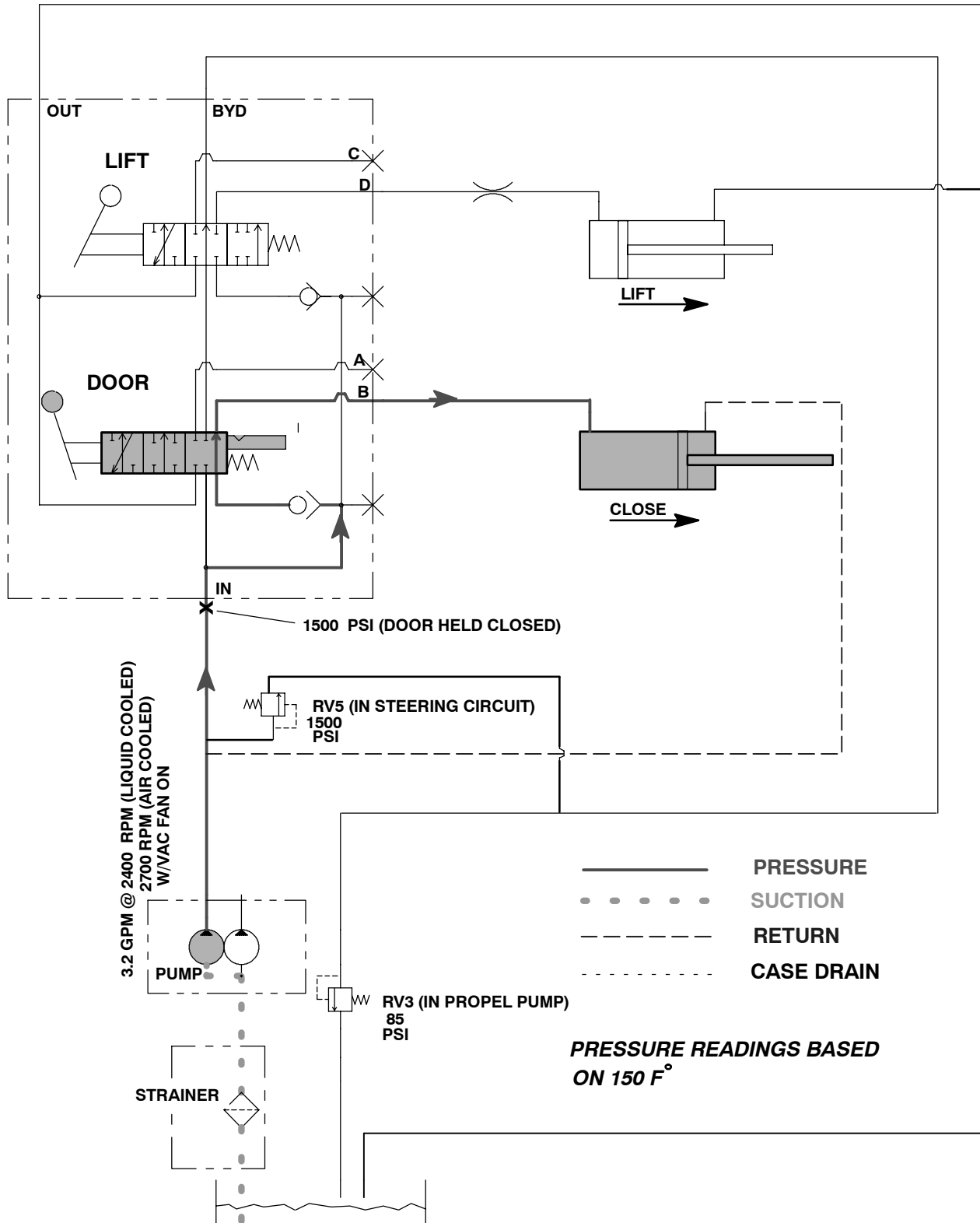
# STEERING CIRCUIT LEFT TURN



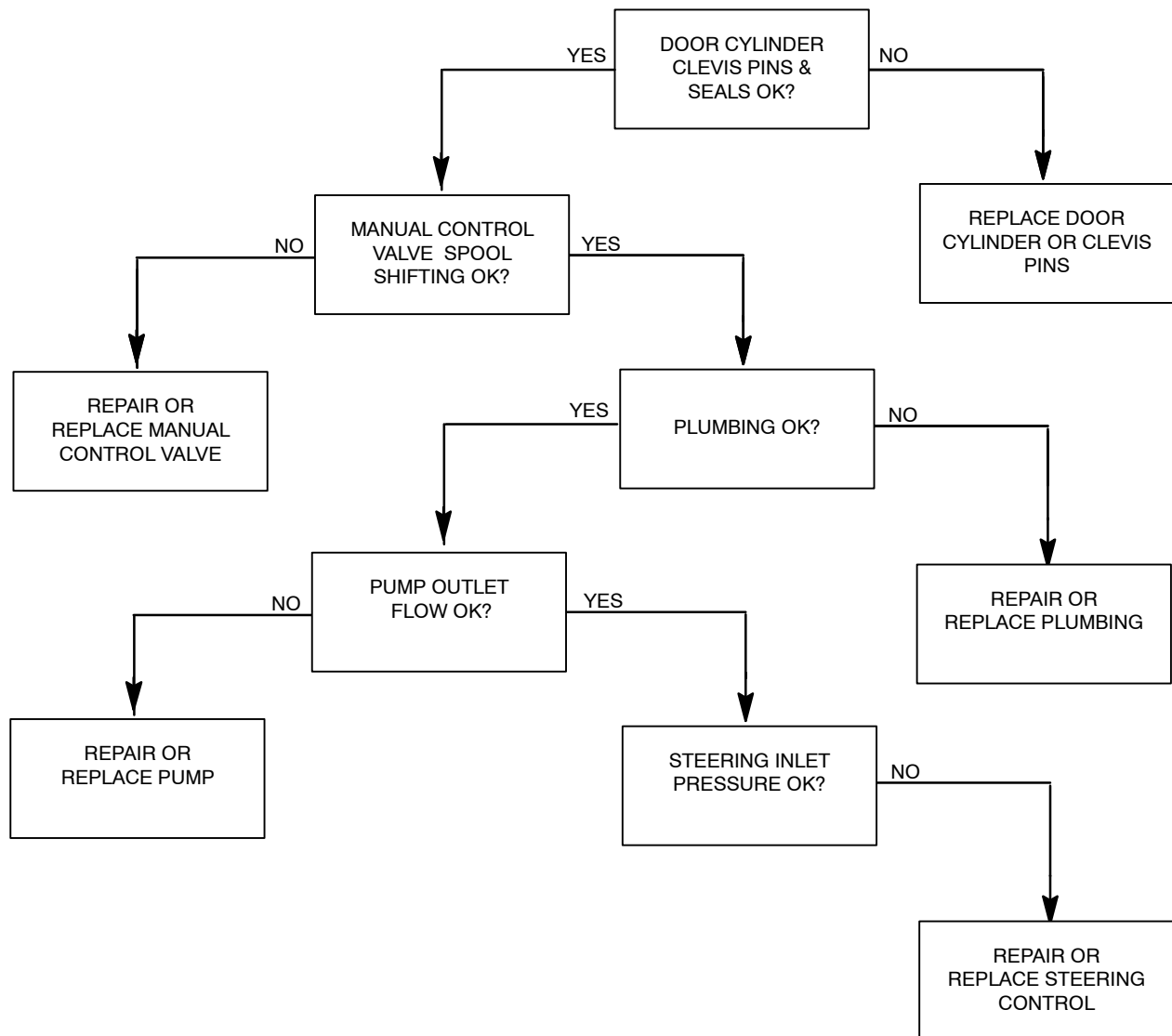
# POWER STEERING IS NOT NORMAL



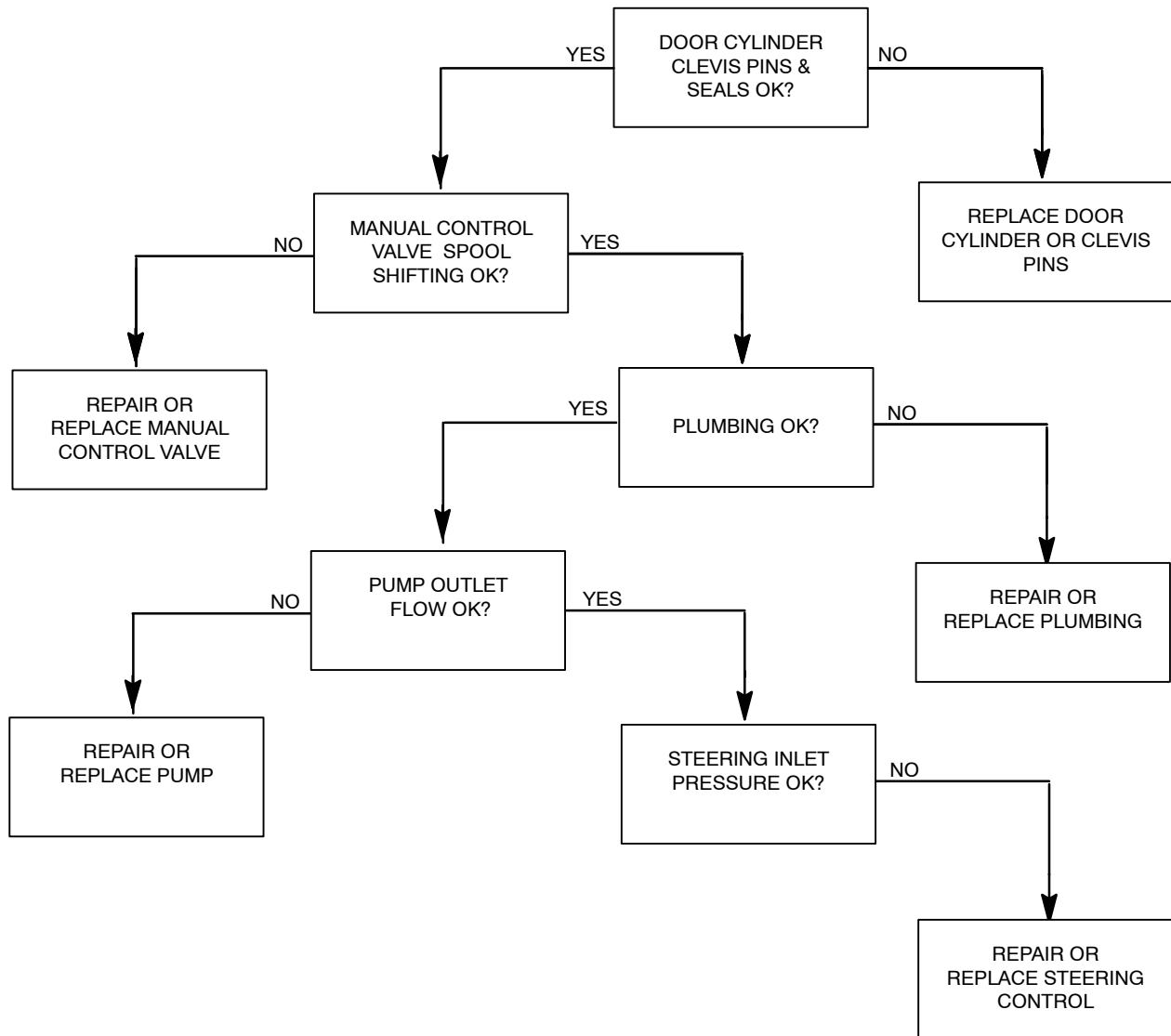
# HOPPER DOOR CIRCUIT CLOSED



# HOPPER DOOR DOES NOT OPEN

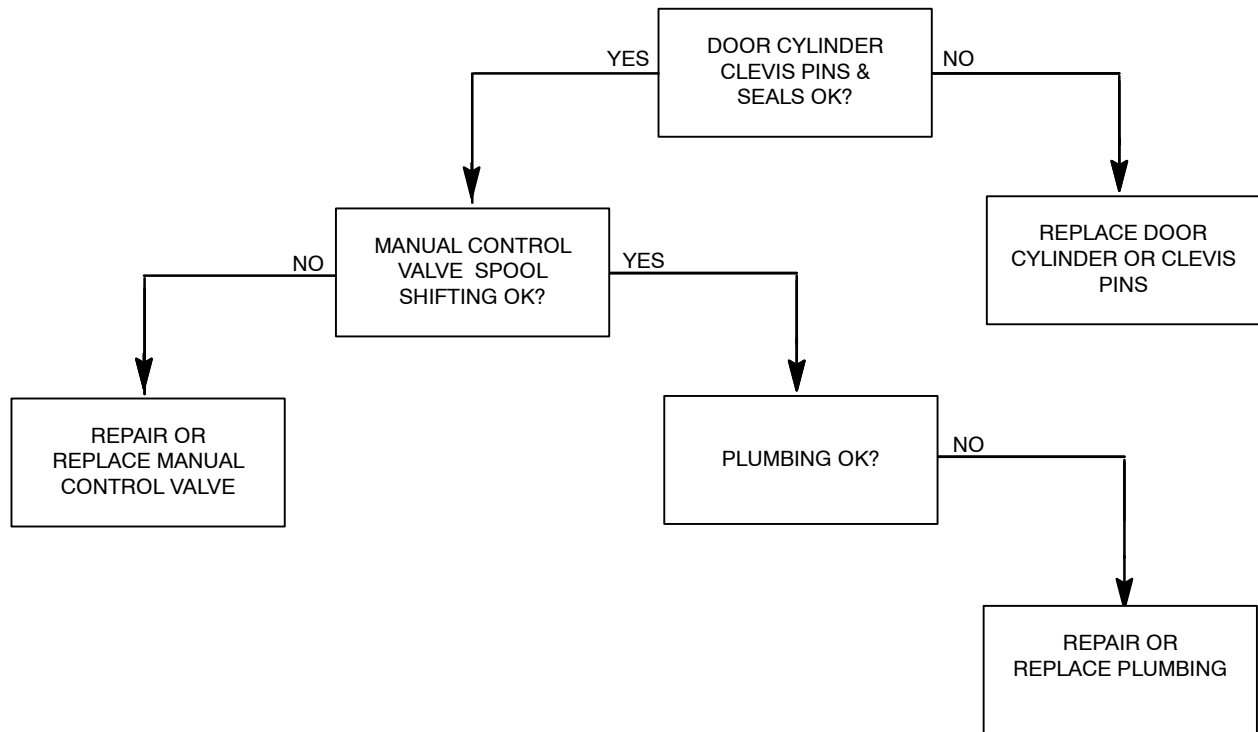


# HOPPER DOOR DOES NOT CLOSE

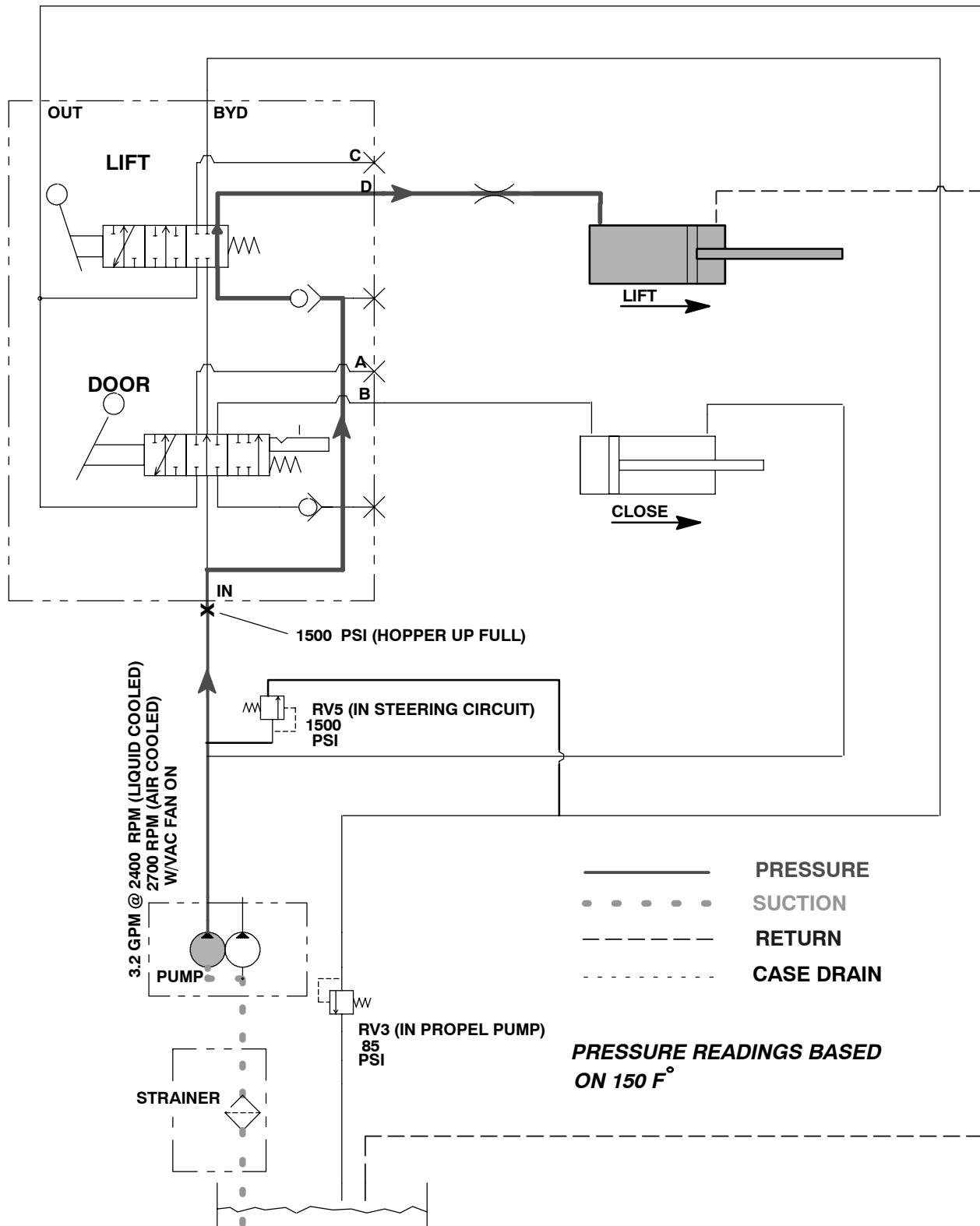




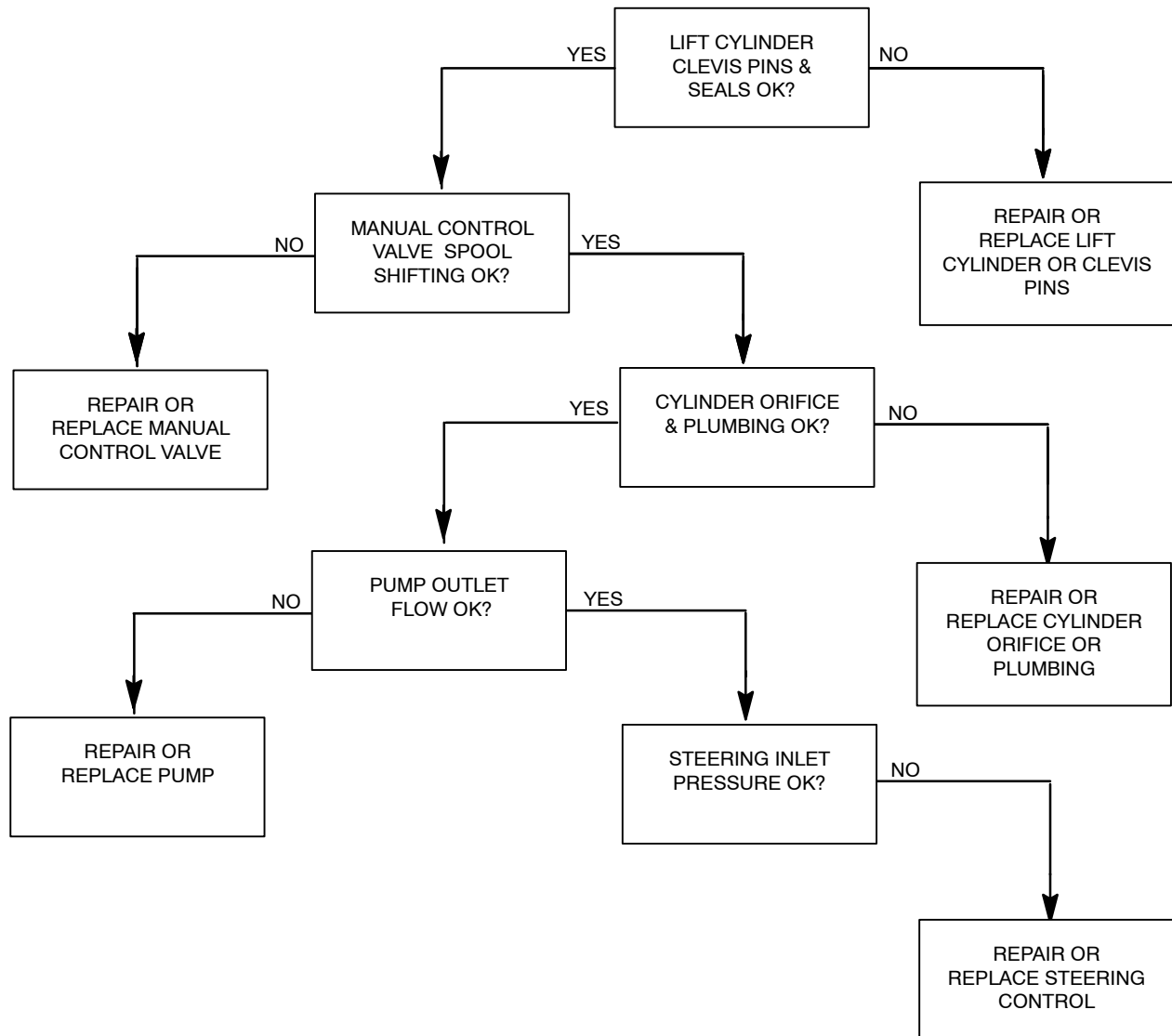
# HOPPER DOOR DOES NOT STAY CLOSED



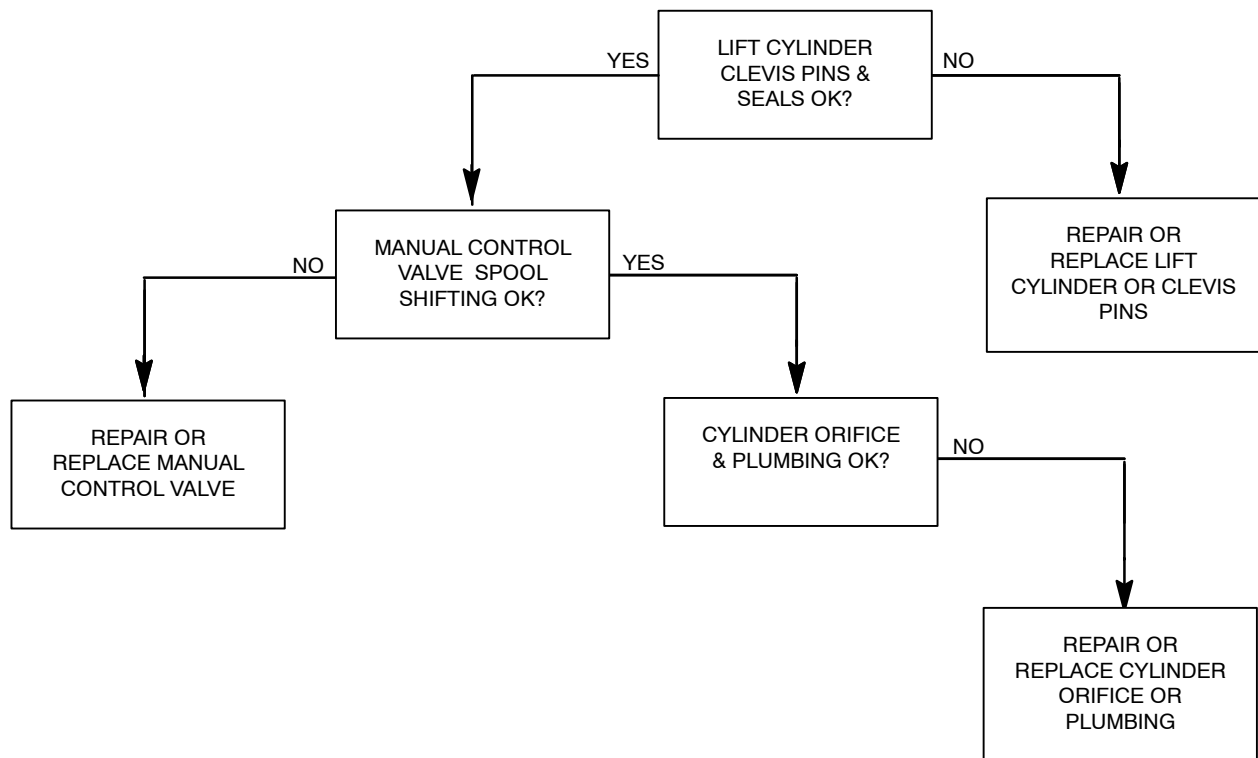
# HOPPER LIFT CIRCUIT



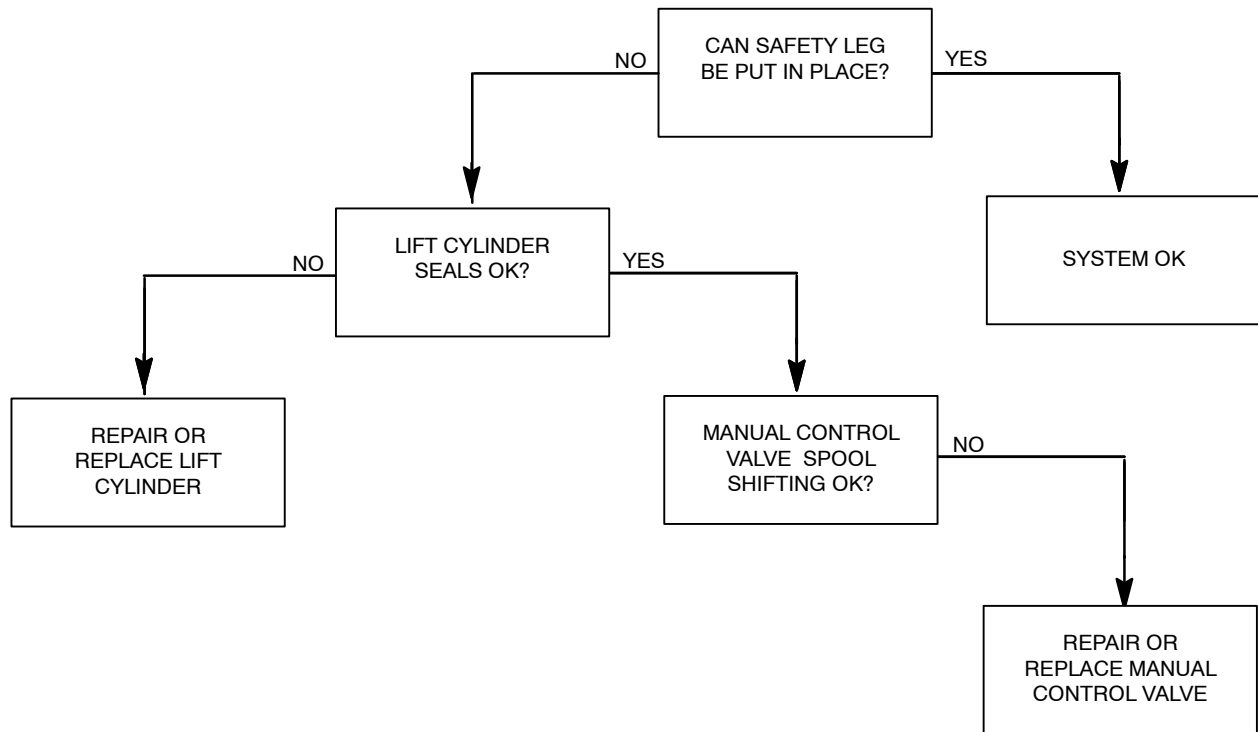
# HOPPER DOES NOT RAISE



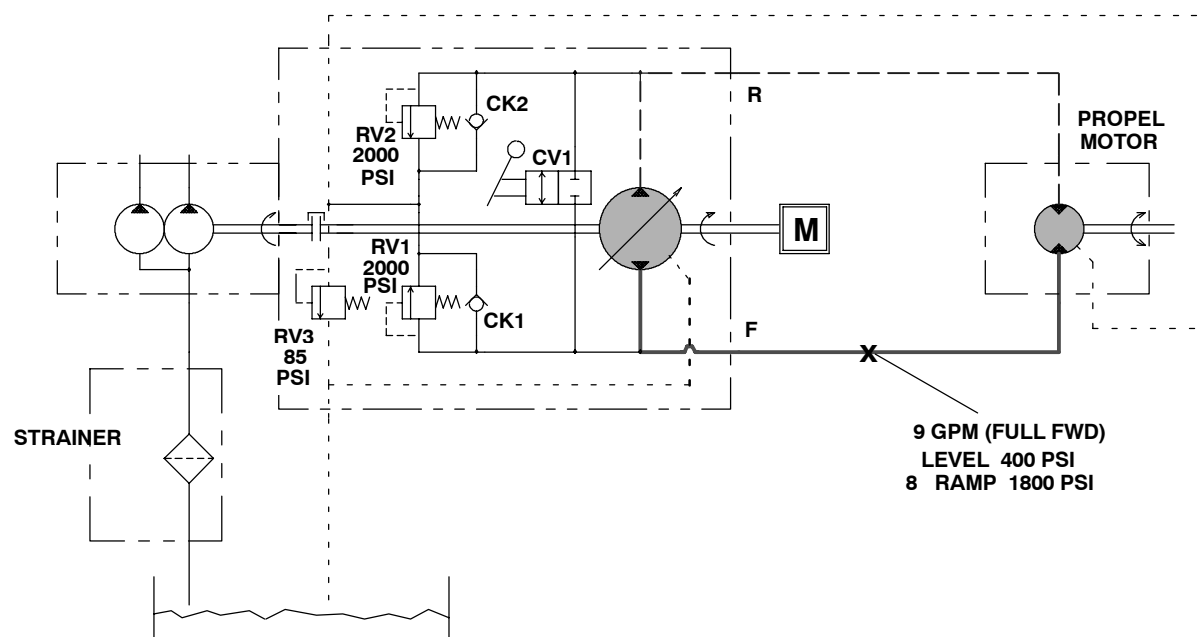
# HOPPER DOES NOT LOWER



# HOPPER DOES NOT HOLD UP POSITION



# PROPEL CIRCUIT



—————	PRESSURE
• • • • •	SUCTION
-----	RETURN
.....	CASE DRAIN

**PRESSURE READINGS BASED  
ON 150 F °**

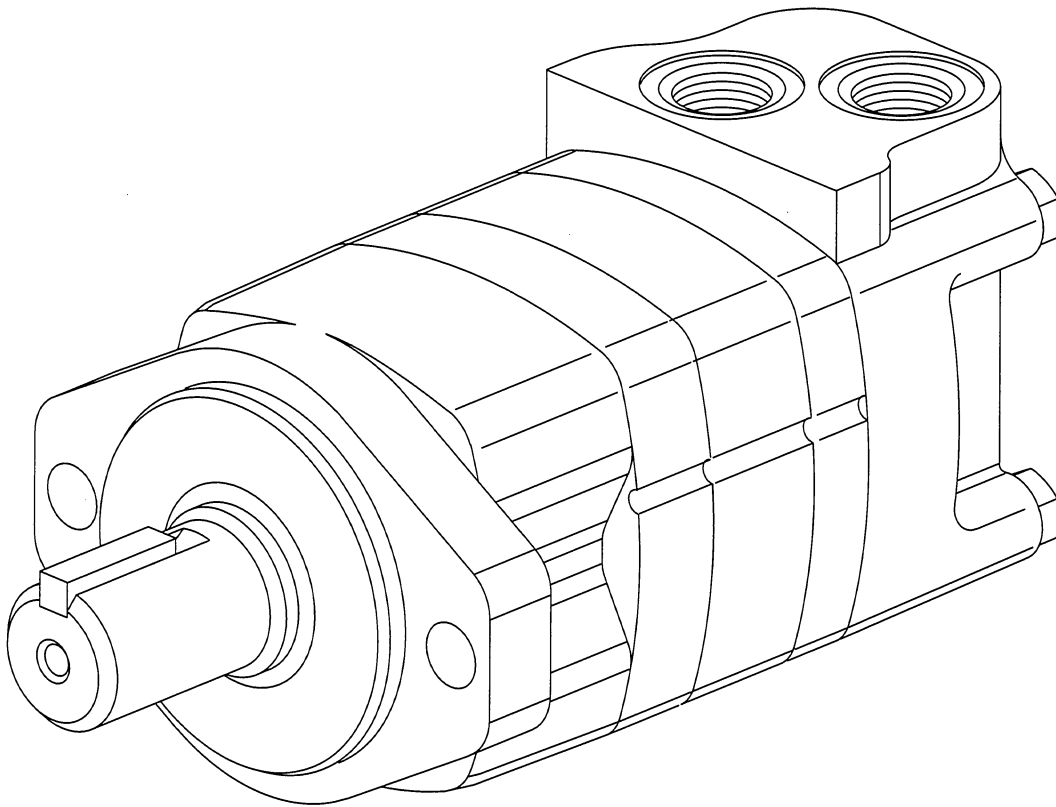
# Char-Lynn®

Hydraulic Motor

No. 7-124  
Revised December, 1994

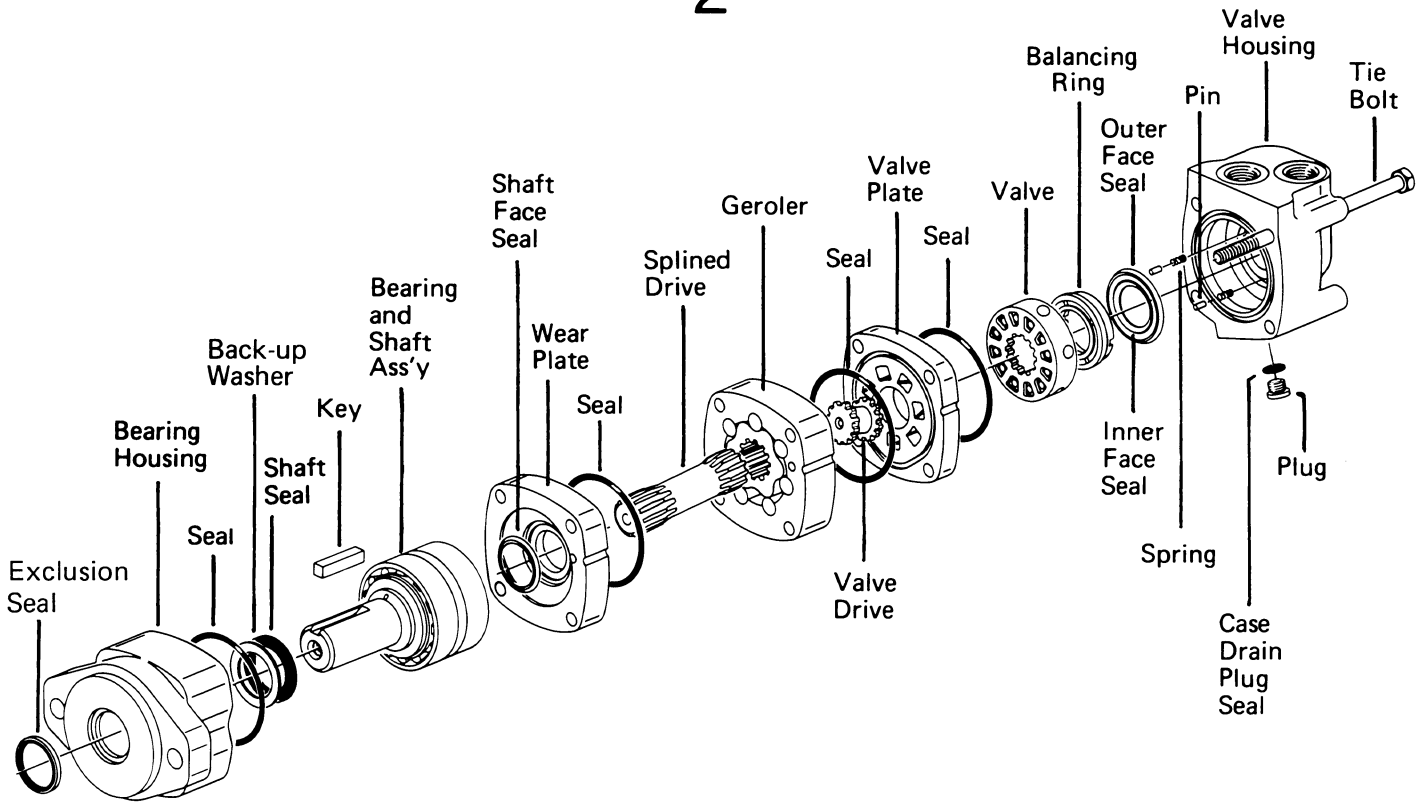


## Repair Information



**2000 Series**  
**Disc Valve Geroler Motor**

**006**



#### Tools required for disassembly and reassembly.

Torque wrench 500 lb-in[57Nm] capacity

12-16[300-450]\* breaker bar

9/16 socket

Small screwdriver 6-8x1/4[150-200x6,5] blade

3/16 allen wrench

Press

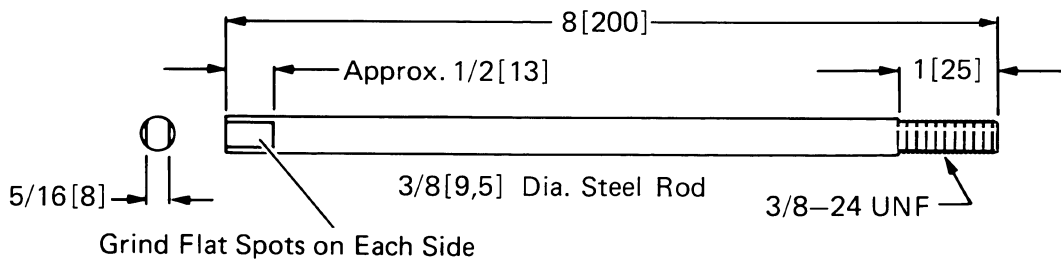
\*Unless indicated otherwise, measurements are given in inches[mm].

\*\*Shaft seal installation tool (600496)

\*\*Bullet (600465) for 1 diameter shafts

**The following tools are not necessary for disassembly and reassembly, but are extremely helpful.**

Alignment studs (2)



\*\*Available-by special order



Cleanliness is extremely important when repairing a hydraulic motor. Work in a clean area. Before disconnecting the lines, clean the port area of the motor thoroughly. Use a wire brush to remove foreign material and debris from around the exterior joints of the motor. Check the shaft and keyslot, remove all nicks, burrs or sharp edges that might damage the bearing housing seals when installing the shaft and bearing assembly. Before starting the disassembly procedures, drain the oil from inside the motor.

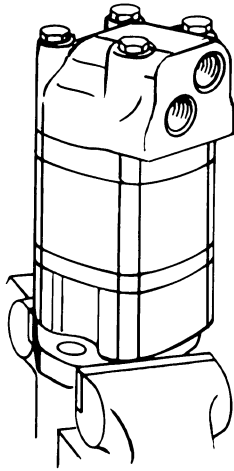


Figure 1

1 Place the motor in a vise with the output shaft down. Clamp across the mounting flange of the motor not the housing. Excessive clamping pressure will cause distortion. When clamping, use some protective device on the vise, such as special soft jaws, pieces of hard rubber or board.

Although not all drawings show the motor in a vise, we recommend that you keep the motor in the vise during disassembly and reassembly. Follow the clamping procedures explained throughout the manual.

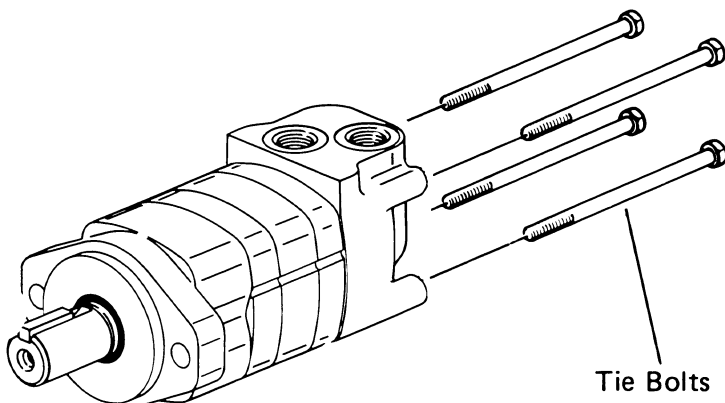


Figure 2

2 Remove 4 bolts from motor.

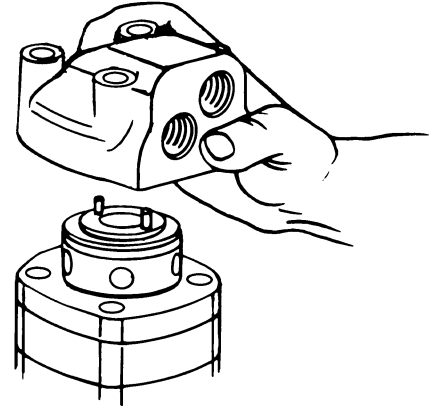


Figure 3

3 Lift valve housing straight up. If done carefully the pins, springs, balance ring assembly, and valve will remain on the valve plate.

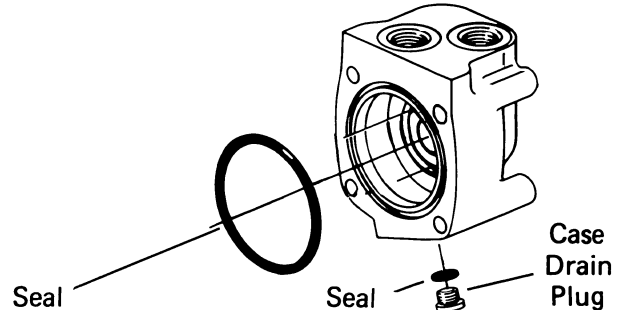


Figure 4

4 Carefully remove 3[76] diameter seal from valve housing.

5 Remove case drain plug—with seal, from valve housing.

6 Remove 2 pins and 2 springs from balance ring assembly, see Fig. 5.

# Disassembly

4

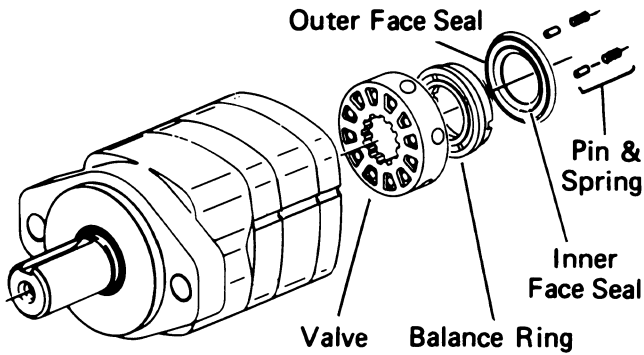


Figure 5

7 Remove balance ring assembly.

8 Remove inner and outer face seals from balance ring.

9 Remove the valve.

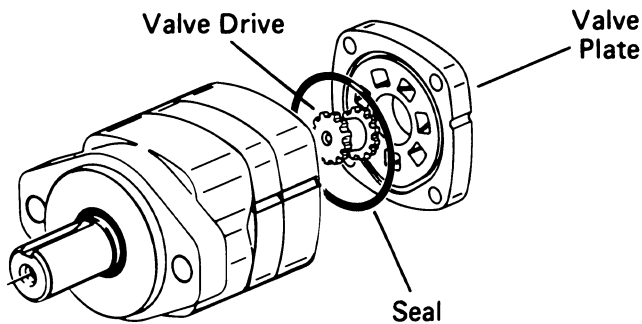


Figure 6

10 Remove the valve plate.

11 Remove the 3[76] diameter seal from valve plate.

12 Remove the valve drive.

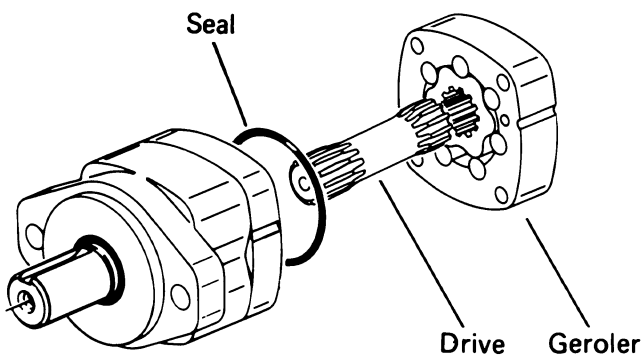


Figure 7

13 Remove the Geroler. Be sure to retain the rollers in the outer ring if they are loose.

14 Remove the drive.

15 Remove the 3[76] diameter seal from wear plate, see Fig. 7.

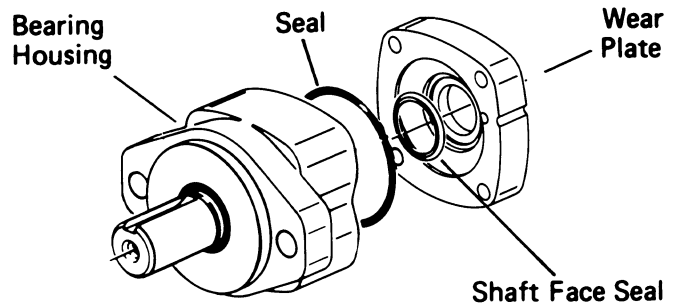


Figure 8

16 Remove the wear plate.

17 Remove the shaft face seal from the wear plate.

18 Remove the 3[76] diameter seal from bearing housing.

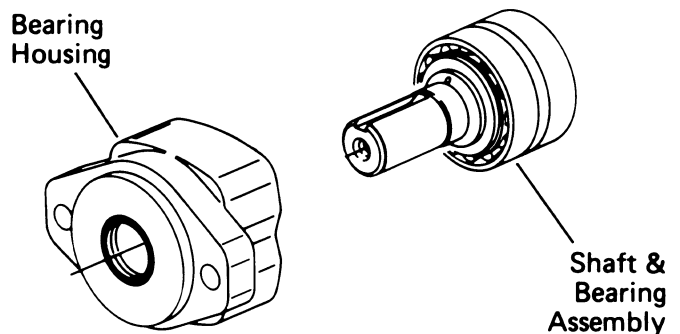


Figure 9

19 You may need a press to remove shaft and bearing assembly from bearing housing. (Key must be removed before removing shaft.)

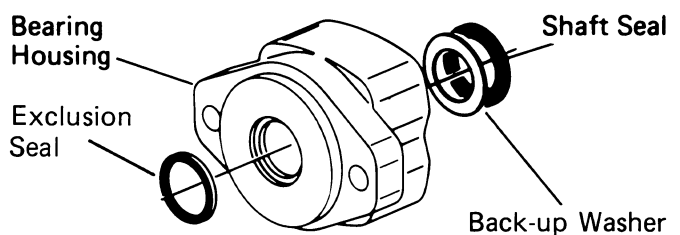


Figure 10

20 Use a small screwdriver to remove shaft seal, back-up washer and exclusion seal from bearing housing, see Fig. 10. Do not damage bore of housing.

**Note:** Individual parts of shaft and bearing assembly are not sold separately. Replace as a unit.

Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage. Clean all metal parts in clean solvent. Blow dry with air. Do not wipe dry with cloth or paper towel because lint or other matter can get in the hydraulic system and cause damage. Do not use a coarse grit or try to file or grind these parts. Check around the keyway and chamfered area of the shaft for burrs, nicks or sharp edges that can damage the seals when reassembling the bearing housing.

**Note:** Lubricate all seals (prior to installation) with petroleum jelly such as Vaseline. Use new seals when reassembling this motor. Refer to parts list (6-129) for proper seal kit number.

**21** Use a press to install exclusion seal in outer bore of bearing housing. Lip of seal must face outward. See Fig. 11. If a press is **not** available use a plastic or rubber hammer, being careful not to damage or cock seal in the bore.

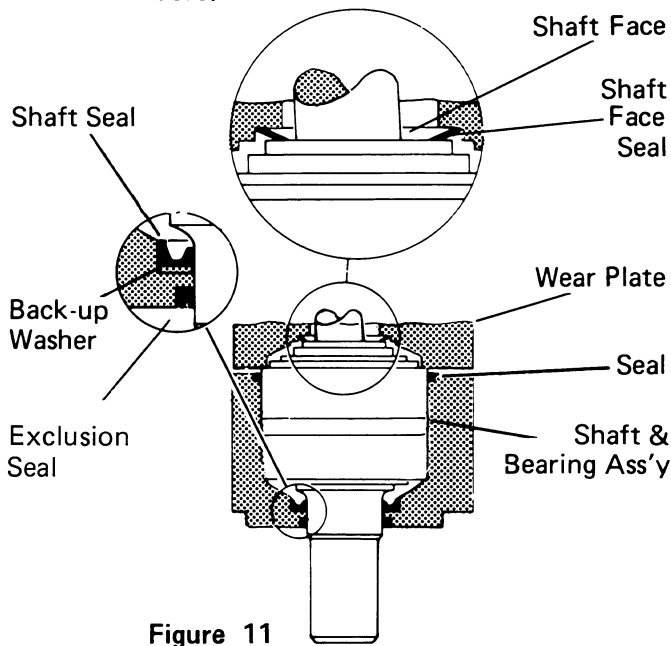


Figure 11

**22** Place back-up washer into seal bore. Place shaft seal onto installation tool (600496) and press seal into seal bore of the housing.

**23** Clamp housing in vise, see Fig. 1.

**24** Place protective bullet (see note below) over shaft. Apply petroleum jelly to inside diameter of dust and shaft seal. You may need a press to install shaft and bearing assembly. Do not distort shaft seal. Damage to this seal will cause leakage.

**Note:** Bullet (600465), for 1" shafts, available--by special order. Use tape over other shafts to prevent cutting the seals.

**25** Apply petroleum jelly to the 3[76] diameter seal. Install seal into the bearing housing.

**26** Alignment studs can be very helpful in reassembly of the motor. See special tool listing page 2. If you use studs, install 2 studs diagonally opposed in the bearing housing.

**27** Install the shaft face seal in the wear plate as shown in Fig. 11. Do not distort seal.

**28** Install the wear plate, see Fig. 11.

**29** Apply a light film of petroleum jelly to the 3[76] diameter seal and install seal in the wear plate.

**30** Install the drive into the output shaft.

**31** Align the notch on the outside of the Geroler with the notch on the wear plate. Install the Geroler against the wear plate. Be sure to retain the rollers in the outer ring if they are loose.

**32** Install the valve drive in the Geroler.

**Note:** Installation at this time involves 3 steps in the timing of the motor. Timing determines the direction of rotation of the output shaft. Timing parts include:

1. Geroler
2. Valve Drive
3. Valve Plate
4. Valve

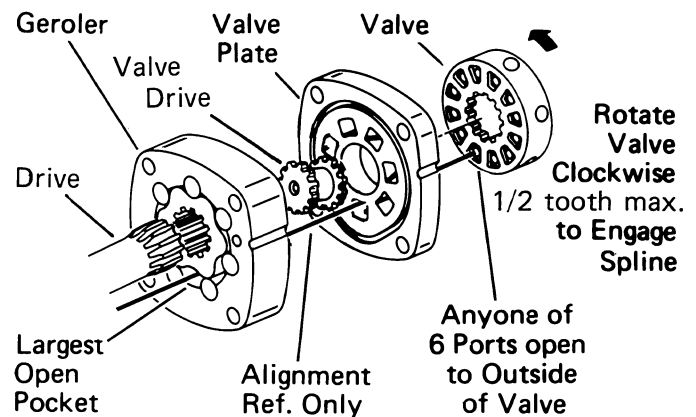


Figure 12 Timing Alignment

**Timing Step # 1**—Locate the largest open pocket in the Geroler and mark it on the outside edge of the Geroler.

**33** Apply a light film of petroleum jelly to the 3[76] diameter seal. Install seal in groove of valve plate.

# Reassembly

## 6

**34** Align the notch on the outside of the valve plate with the notch on the Geroler as shown in Fig. 12.

**Timing Step # 2—** Locate the slot opening in the valve plate which is in line with the largest open pocket of the Geroler.

**Timing Step # 3—** Locate any one of the side openings of the valve and align this opening with the open slot of the valve plate that is in line with the largest open pocket of the Geroler. Install the valve by rotating it clockwise until the spline teeth engage (1/2 spline tooth max. ). This will provide the proper rotation when pressurized as shown in Fig. 13.

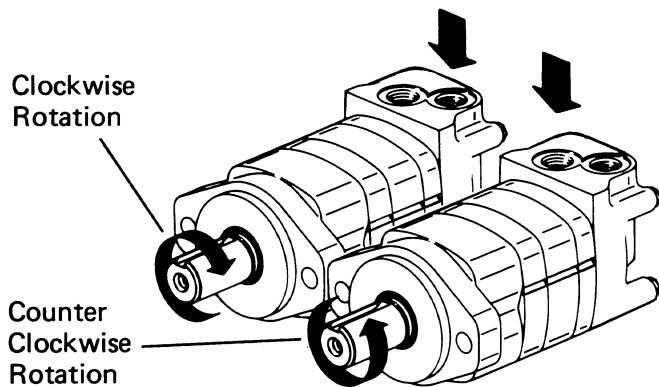


Figure 13

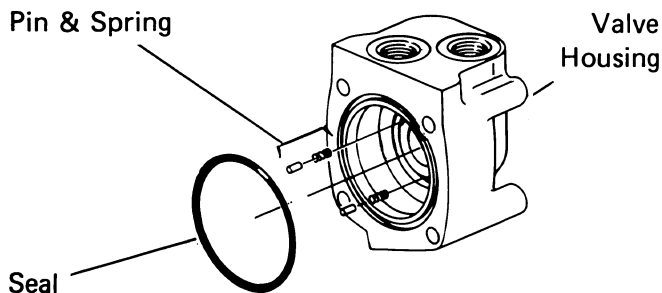


Figure 14

**35** Install 2 springs and 2 pins in the holes located in the bore of the valve housing, as shown in Fig. 14.

**36** Apply a light film of petroleum jelly to the 3[76] diameter seal. Install seal in the valve housing.

**37** Apply petroleum jelly to inner and outer face seals. Install seals on balance ring as shown in Fig. 15.

**Important:** Install face seals in the positions shown in Fig. 15. or the motor will not operate properly. Do not force or bend the face seals. Any damage to these seals will affect the operation of the motor.

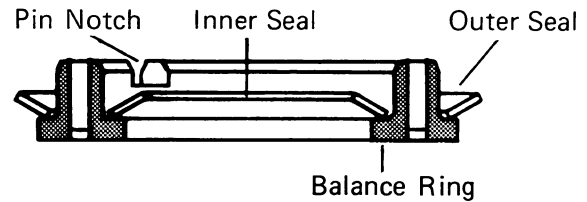


Figure 15

**38** Align pin notches in balance ring with pins in bore of valve housing. Install balance ring assembly in valve housing.

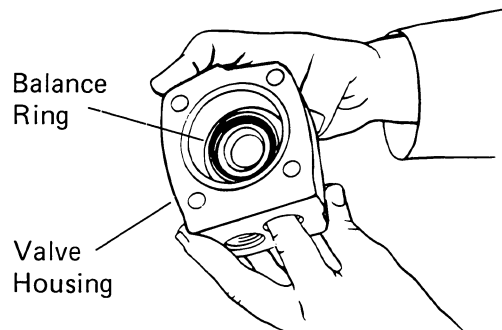


Figure 16

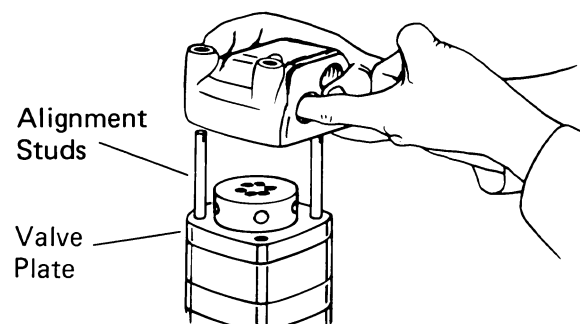


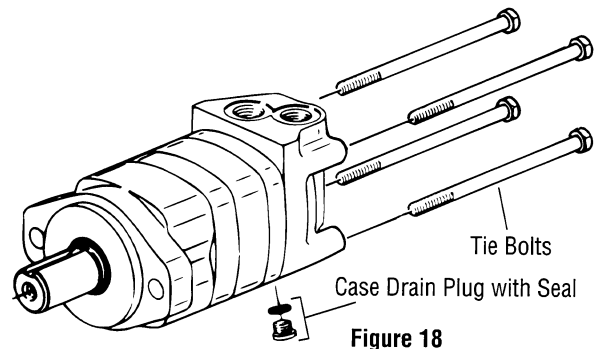
Figure 17

**39** Insert your finger through port of valve housing. Apply pressure to side of balance ring as shown in Fig. 16. Hold ring in position until valve housing is in place against valve plate. See Fig. 17.

**Note:** After installing the valve housing on the valve plate check for proper placement. Push down on the valve housing. You should get a slight spring action.

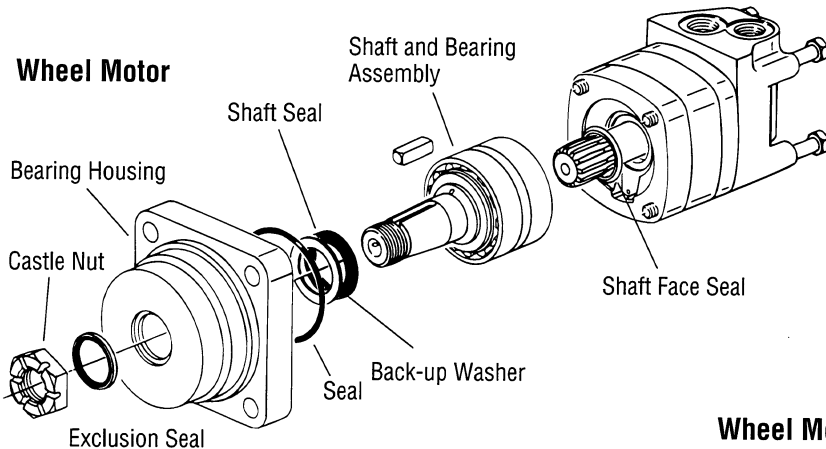
**40** Install tie bolts. If you use alignment Studs, install 2 bolts opposite the studs. Finger tighten the bolts. Remove the alignment studs and replace with the two remaining bolts. Torque all four bolts alternately to 50 Nm [450 lb-in].

**41** Install seal on case drain plug then install in valve housing. torque to 6 Nm [50 lb-in].



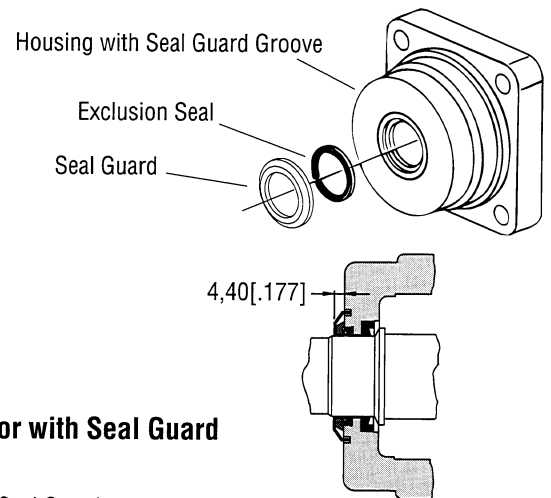
**Figure 18**

### Wheel Motor



**Figure 19**

On wheel motors, a different bearing housing is used, see Fig. 19. Other than this the same parts are the same as the standard motor and the same disassembly and reassembly procedures apply.



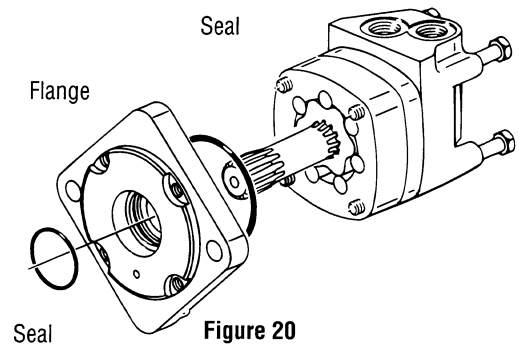
### Wheel Motor with Seal Guard

Installation of Seal Guard:

After completing assembly of the shaft and bearing assembly into the bearing housing, press the seal guard onto the shaft with a tool that will provide an even push over the seal. This tool must bottom out against the bearing housing and provide a 4,5 mm [.177 inch] stop for the seal guard.

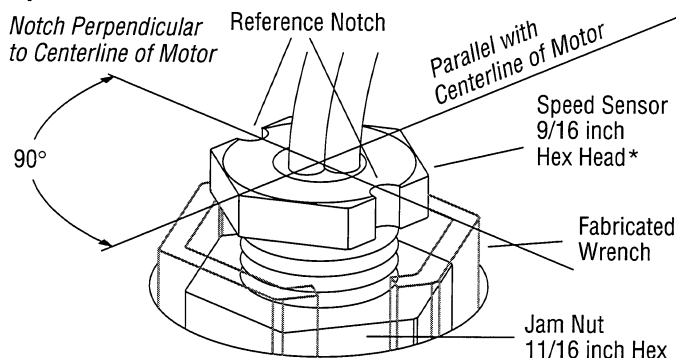
### Bearingless Motor

This motor is the same as the standard motor without the shaft/bearing assembly, and bearing housing. The mounting flange replaces the bearing housing, see Fig. 20 Follow same disassembly and reassembly procedures as rear section of standard motor.



**Figure 20**

### Speed Sensor Installation



\*Turn Speed Sensor in to bottom (making sure jam nut is backed off sufficiently), back off 1/4 turn (CCW) and if reference notch(s) is not positioned as shown above continue turning (CCW) to align reference notch 90° off of centerline of motor or perpendicular to motor shaft. Hold speed sensor in this position and tighten jam nut to 8,5 — 14 Nm [75 — 125 lb-in].

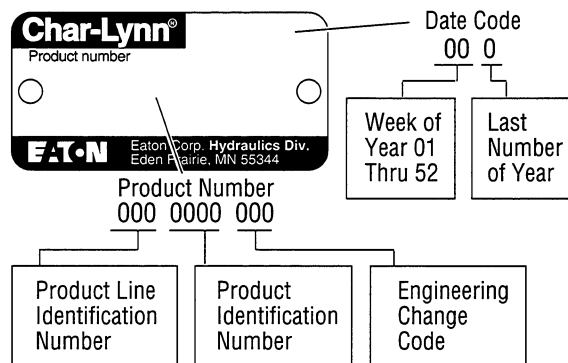
For Additional Literature Contact Eaton Corp. Hydraulics Division 15151 Highway 5 Eden Prairie, MN 55344.

- Specifications and performance Data, Catalog No. 11-878
- Replacement Part Numbers and Kit Information — Parts Information No. 6-129

## How to Order Replacement Parts

### Each Order Must Include the Following:

1. Product Number
2. Date Code
3. Part Name
4. Part Number
5. Quantity of Parts



## Product Numbers—2000 Series

Use digit prefix —**104-**, **105-**, or **106-** plus four digit number from charts for complete product number—Example **106-1043**.

			Displacement cm <sup>3</sup> /r [ in <sup>3</sup> /r ] and Product Number								
Mounting	Shaft	Ports	80 [ 4.9]	100 [ 6.2]	130 [ 8.0]	160 [ 9.6]	195 [11.9]	245 [14.9]	305 [18.7]	395 [24.0]	490 [29.8]
2 Bolt SAE A Flange	1 inch Straight	7/8-14 O-ring Staggered	<b>104</b> -1001	-1002	-1003	-1004	-1005	-1006	-1007	-1143	—
		1-1/16—12 O-ring 180° Apart	<b>104</b> -1037	-1038	-1039	-1040	-1041	-1042	-1043	-1044	—
	1-1/4 Inch Straight	7/8-14 O-ring Staggered	<b>104</b> -1022	-1023	-1024	-1025	-1026	-1027	-1028	-1228	-1420
		1-1/16—12 O-ring 180° Apart	<b>104</b> -1061	-1062	-1063	-1064	-1065	-1066	-1067	-1068	-1421
	1-1/4 Inch 14 T Splined	7/8-14 O-ring Staggered	<b>104</b> -1029	-1030	-1031	-1032	-1033	-1034	-1035	-1229	-1422
		1-1/16—12 O-ring 180° Apart	<b>104</b> -1087	-1088	-1089	-1090	-1091	-1092	-1093	-1094	-1423
2 Bolt SAE B Flange	1-1/4 Inch Straight	7/8-14 O-ring Staggered	<b>104</b> -1200	-1201	-1202	-1203	-1204	-1205	-1206	-1207	—
	1-1/4 In. Involute SAE C Splined	7/8-14 O-ring Staggered	<b>104</b> -1208	-1209	-1210	-1211	-1212	-1213	-1214	-1215	—
	1 Inch SAE 6B Splined	7/8-14 O-ring Staggered	<b>104</b> -1193	-1194	-1195	-1196	-1197	-1198	-1199	—	—
	7/8 Inch SAE B Splined	7/8-14 O-ring Staggered	<b>104</b> -1216	-1217	-1218	-1219	-1220	—	—	—	—
Standard with 4 Bolt Square Flange	32 mm Straight	G 1/2 (BSP)	<b>104</b> -1384	-1385	-1386	-1387	-1388	-1389	-1390	-1391	—
	1-1/4 Inch 14 T Splined	G 1/2 (BSP)	<b>104</b> -1376	-1377	-1378	-1379	-1380	-1381	-1382	-1383	—
Wheel Motor	1-1/4 Inch Straight	7/8-14 O-ring Staggered	<b>105</b> - —	—	—	—	—	—	—	—	-1148
		1-1/16—12 O-ring 180° Apart	<b>105</b> - —	—	—	—	—	—	—	—	-1149
	32 mm Straight	G 1/2 (BSP)	<b>105</b> -1134	-1135	-1136	-1137	-1138	-1139	-1140	-1141	—
	1-1/4 Inch Tapered	7/8-14 O-ring Staggered	<b>105</b> -1001	-1002	-1003	-1004	-1005	-1006	-1007	-1060	-1152
		1-1/16—12 O-ring 180° Apart	<b>105</b> -1071	-1072	-1073	-1074	-1075	-1076	-1077	-1078	—
	1-1/4 Inch 14 T Splined	7/8-14 O-ring Staggered	<b>105</b> -1029	-1030	-1031	-1032	-1033	-1034	-1035	-1096	—
		1-1/16—12 O-ring 180° Apart	<b>105</b> -1079	-1080	-1081	-1082	-1083	-1084	-1085	-1086	—
Bearingless		7/8-14 O-ring Staggered	<b>106</b> -1008	-1009	-1010	-1011	-1012	-1013	-1014	-1015	-1047
		G 1/2 (BSP)	<b>106</b> -1038	-1039	-1040	-1041	-1042	-1043	-1044	-1045	—

106-1043

Eaton Corporation  
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 Scotland, KY7 4NW  
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 Fax 44/1-592-773-184

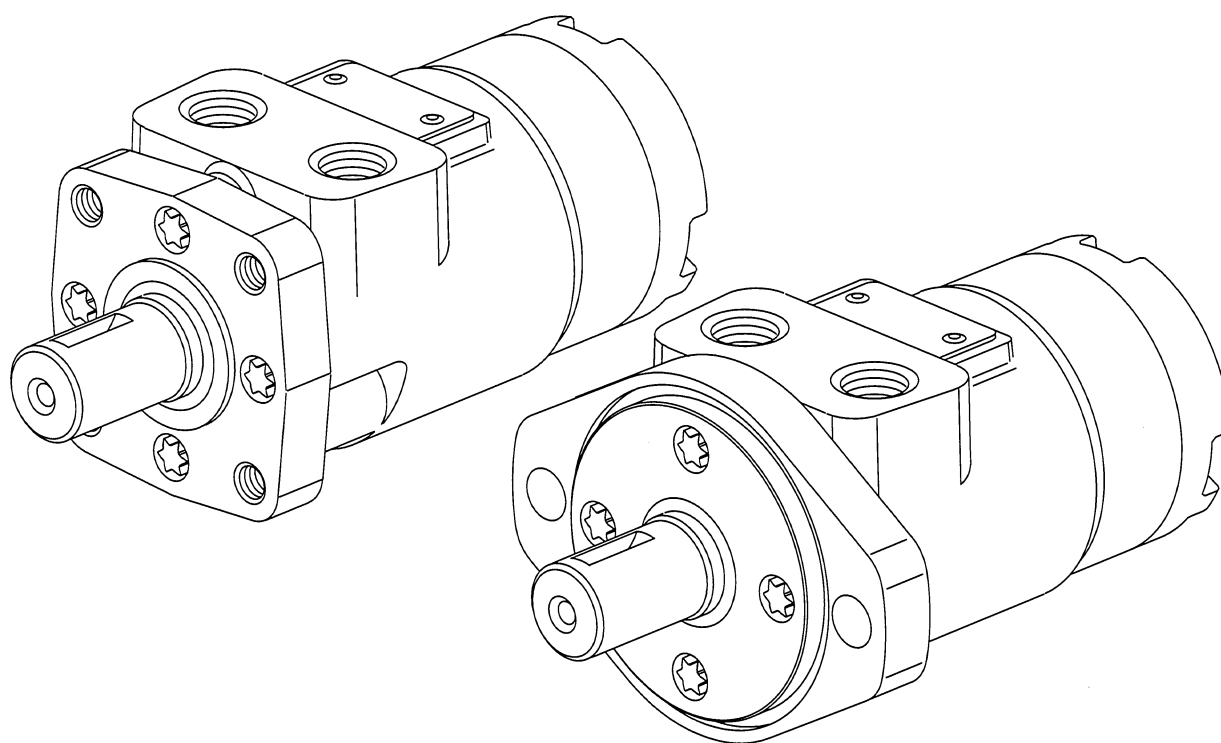
# Char-Lynn®

Hydraulic Motor

No. 7-125  
January, 1995

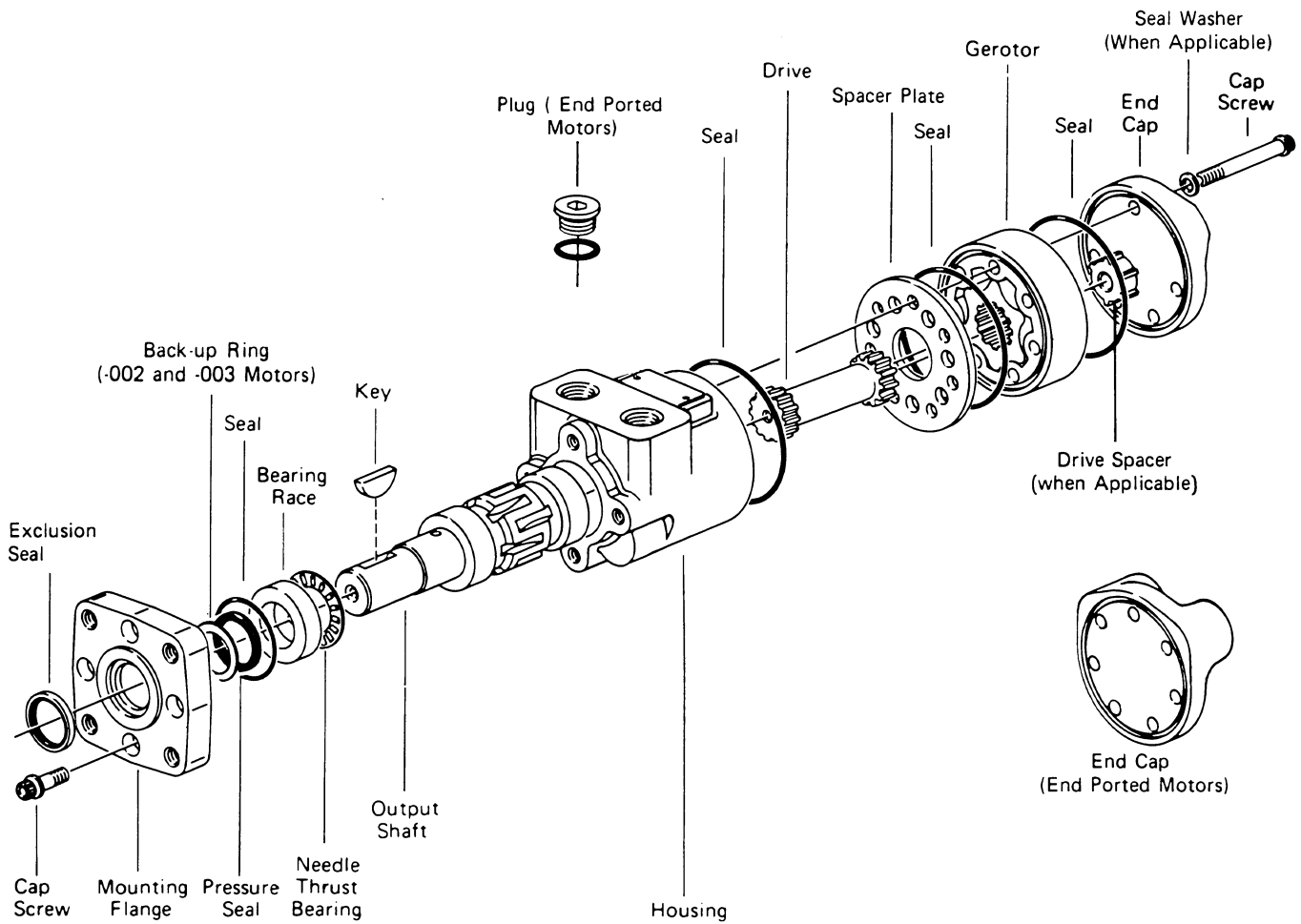


## Repair Information



**A Series**  
**General Purpose Geroler® Motor**

**001 002 003**



#### Tools required for disassembly and reassembly.

- Torque wrench (300 lb-in [34Nm] capacity)
- 12-16 in. [300-400mm] breaker bar
- \* 5/16 –12 point socket no. 5422 (Heavy Duty 500 lb-in [56Nm] Capacity)
- Small screwdriver (6-8x1/4 in. [150-200x6mm] flat blade), see page 5 for tooling information.
- \* Shaft pressure seal installation tool for 001 motor P/N 600470, for 002 and 003 motors P/N 600523
- \* Seal sleeve or bullet P/N 600304 (1 in. dia. shaft), P/N 600466 (7/8 in. dia. shaft)

\*Tools available—by special order—through our service department.



## Repair Information

### A Series Char-Lynn Motors Disassembly

Instructions in this manual are for standard A Series Motors (130-XXXX-001, 002 and 003).

Cleanliness is extremely important when repairing these motors. Work in a clean area. Before disconnecting lines, clean port area of motor. Remove key when used. Check shaft and key slot. Remove burrs, nicks and sharp edges. Before disassembly, drain oil from motor. Then plug ports and thoroughly clean exterior of motor.

Although not all drawings show the motor in a vise, we recommend that you keep the motor in a vise during disassembly. Follow the clamping procedures explained throughout the manual.

#### Gerotor End

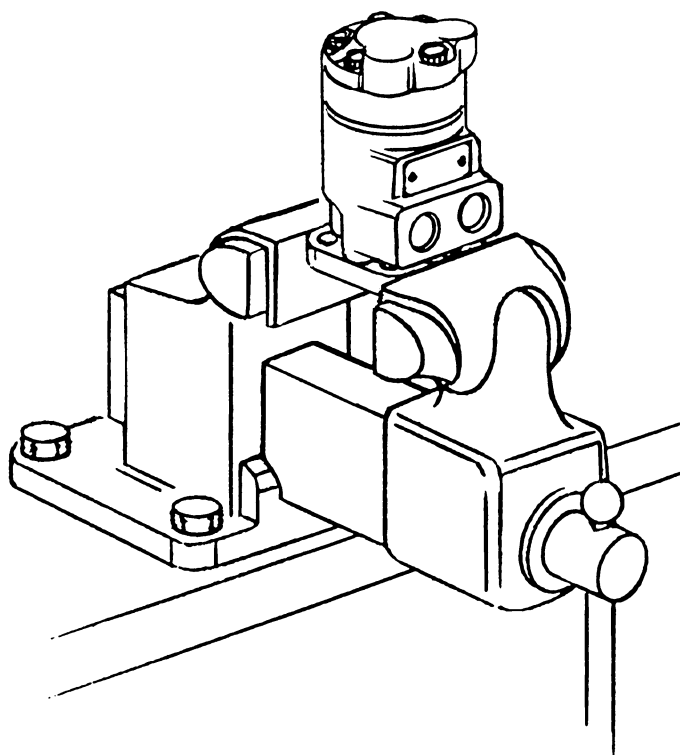


Figure 1

1 Place motor in vise and clamp across edge of flange with output shaft down. When clamping, use protective device on vise such as special soft jaws, pieces of hard rubber or board. See Figure 1.

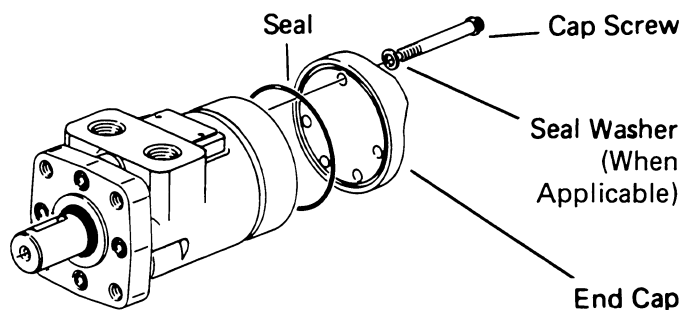


Figure 2

2 Remove cap screws and seal washers (when applicable). See Figure 2.

3 Remove end cap.

4 Remove seal from end cap.

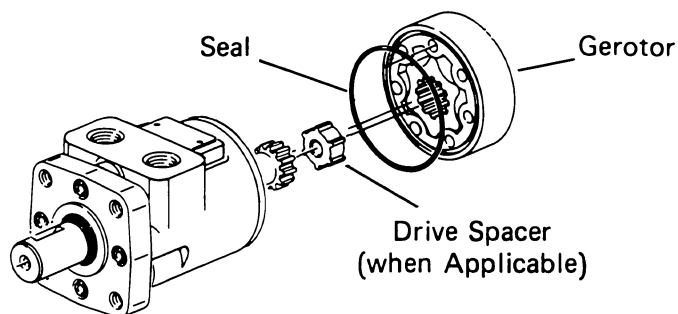


Figure 3

5 Remove gerotor.

6 Remove seal from gerotor (Figure 3).

7 Remove drive spacer if applicable.

3

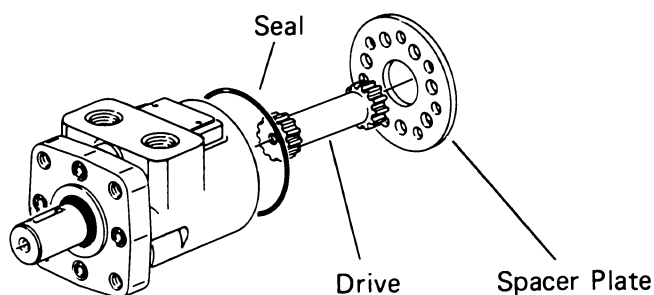


Figure 4

- 8 Remove drive. See Figure 4.
- 9 Remove spacer plate.
- 10 Remove seal from housing.
- 11 Remove output shaft from housing.
- 12 Remove needle thrust bearing from shaft or housing.

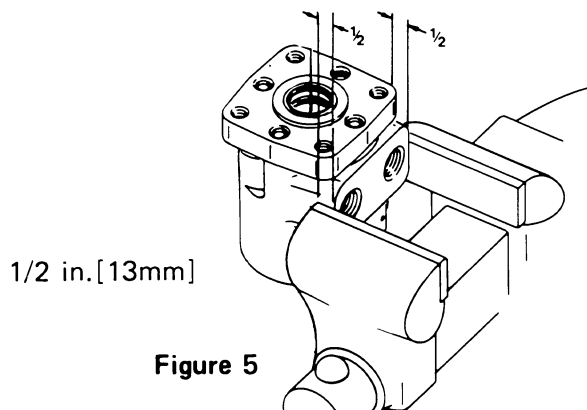


Figure 5

13 Reposition motor in vise. Clamp across ports as shown in Figure 5. Do not clamp on side of housing. Excessive clamping pressure on side of housing causes distortion.

14 Remove cap screws from mounting flange. These screws are assembled with Loctite to hold them in place.

The screws will require 300-400 lb-in [35-45 Nm] of torque to break loose and 100 lb-in [11 Nm] torque to remove. Do not use impact wrench on Loctited screws. This could result in rounded heads or broken sockets.

**Note:** If torque higher than given above is required to break screws loose, apply heat according to following instructions:

4

When heated, Loctite partially melts. This reduces torque required to remove screw. Use small flame propane torch to heat small area of housing where screw enters. See Figure 6. **Be careful not to overheat housing** and damage motor. Gradually apply torque to screw with **socket** wrench as heat is applied for 8 to 10 seconds. As soon as screw breaks loose, remove heat from housing. Continue turning screw until it is completely removed.

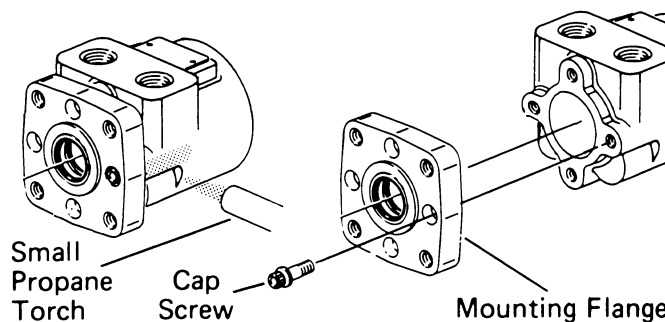


Figure 6

15 Remove motor from vise. Place motor on clean flat surface. Carefully remove flange from housing.

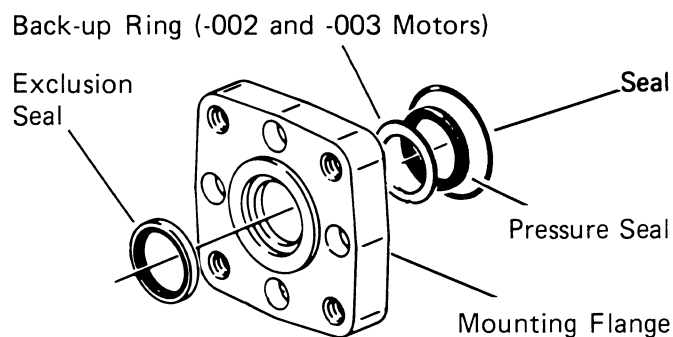


Figure 7

16 Exclusion seal, back-up ring, pressure seal and seal will come off with flange (Figure 7). Use seal removal tool, shown in Figures 8 and 9, to remove exclusion and pressure seals.

**Important:** Be careful not to scratch seal cavity O.D. This could create a leak path.

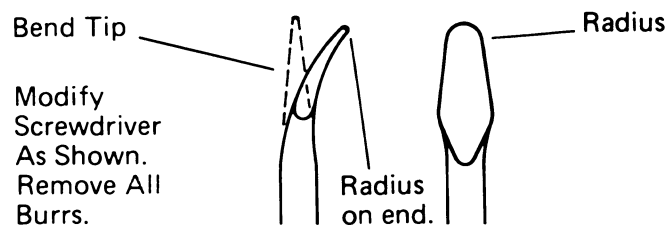
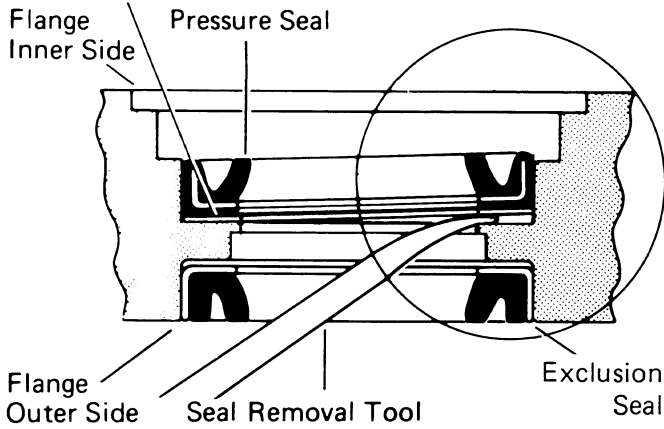


Figure 8

Back-up Ring (-002 and -003 Motors)



Work from outer side for both (either) seals.

Figure 9

## Reassembly

### Shaft End

Check all mating surfaces. Replace any parts with scratches or burrs that could cause leakage or damage. Clean all metal parts in clean solvent. Blow dry with air. Do not wipe parts with cloth or paper towel because lint or other matter could get into the hydraulic system and cause damage.

Check around key slot and chamfered area of shaft for burrs, nicks or sharp edges that could damage seals during reassembly. Remove nicks or burrs with a hard smooth stone (such as an Arkansas stone). Do not file or grind motor parts.

**Note:** Lubricate all seals with petroleum jelly. Use new seals when reassembling motor. Refer to parts list 6-130 for proper seal kit numbers.

**Important:** Do not stretch seals before installing them.

Cleanliness is extremely important in the successful application of Loctite. Before Loctite can be applied, the parts should be cleaned as follows:

**Note:** Fully cured Loctite resists most solvents, oils, gasoline and kerosene and is not affected by cleaning operations. It is not necessary to remove cured Loctite that is securely bonded in tapped holes; however, any loose particles of cured Loctite should be removed.

**a.** Wash the housing with solvent to remove oil, grease and debris. Pay particular attention to four tapped holes on flange end.

**b.** Blow dry with compressed air. Clean and dry tapped holes.

**c.** Wire brush screw threads to remove cured Loctite and other debris. Discard any screws that have damaged threads or rounded heads.

**d.** Wash screws with non-petroleum base solvent. Blow dry with compressed air.

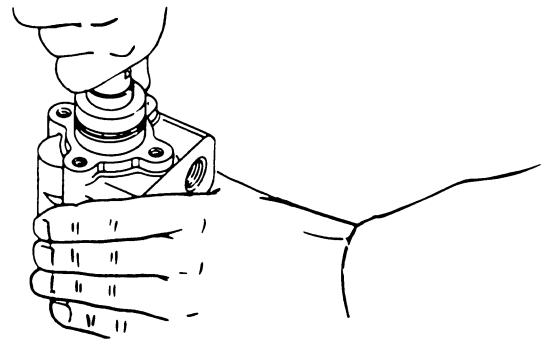
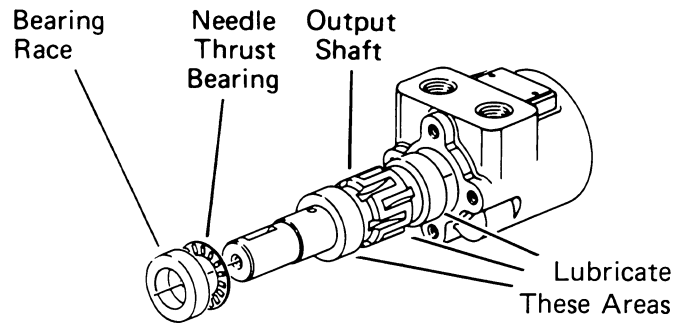
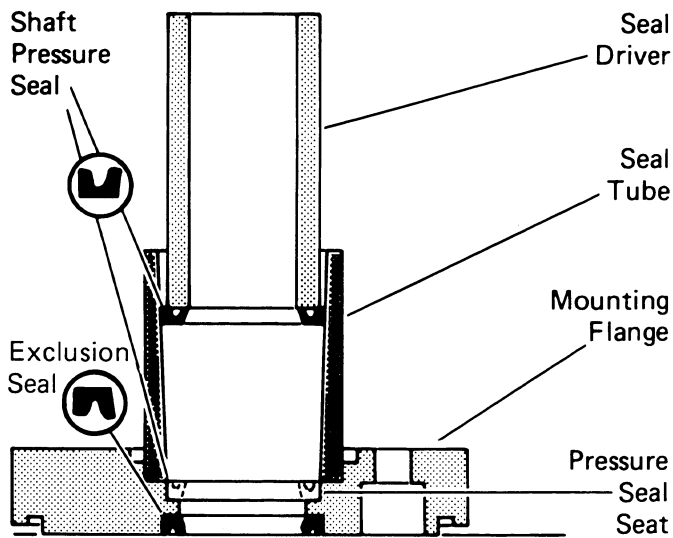


Figure 10

**17** Lubricate output shaft with hydraulic oil, then install shaft in housing. See Figure 10.

**Important:** Do not permit oil to get into the four tapped holes.

**18** Install needle thrust bearing, then bearing race on shaft. Pull shaft partially out of housing. Push all three parts in housing together. See Figure 10. The bearing race must rotate freely when in position.



Seal Installation Tool  
No. 600470 –001 Motors  
No. 600523 –002 and –003 Motors

Figure 11

**19** Install exclusion seal in flange. See Figure 11. Carefully press exclusion seal into place.

**20** Visually check seal seat in mounting flange for scratches or other marks that might damage the pressure seal. Check for cracks in flange that could cause leakage.

**21** Lubricate I.D. of seal tube and O.D. of shaft pressure seal with light film of clean petroleum jelly. Align small I.D. end of seal tube with seal seat in mounting flange. Install back-up ring and pressure seal in tube with lips of seal face up. See Figure 11. Insert seal driver in tube and firmly push seal seat with a rotating action.

**Important:** After installing seal in flange, examine seal condition. If damaged or improperly installed, you must replace it before continuing with reassembly.

**22** Install 1<sup>5</sup>/<sub>16</sub> in. [49 mm] I.D. seal in flange.

**23** It is recommended to apply a light coat of Loctite Primer NF in tapped holes of housing. Allow primer to air dry for at least 1 minute. Do not force dry with air jet; the primer will blow away.

Use of primer is optional. With primer, Loctite curing time is approximately 15 minutes. Without primer, curing time is approximately 6 hours.

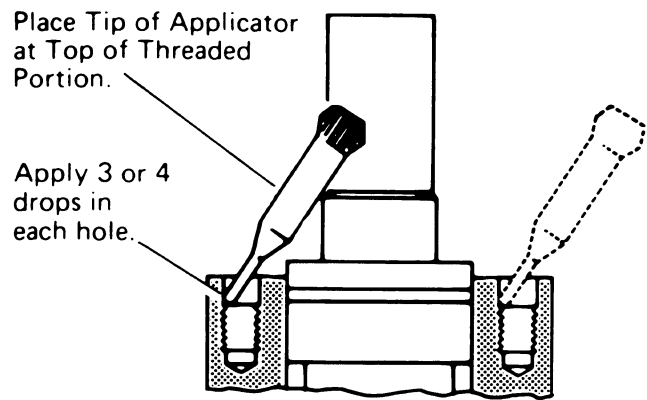


Figure 12

**24** Apply 3 or 4 drops of Loctite sealant at top of thread for each of four holes in housing. See Figure 12. Do not allow parts with Loctite applied to come in contact with any metal parts other than those for assembly. Wipe off excess Loctite from housing face, using a non-petroleum base solvent.

Do not apply Loctite to threads more than 15 minutes before installing screws. If housing stands for more than 15 minutes, repeat application. No additional cleaning or removal of previously applied Loctite is necessary.

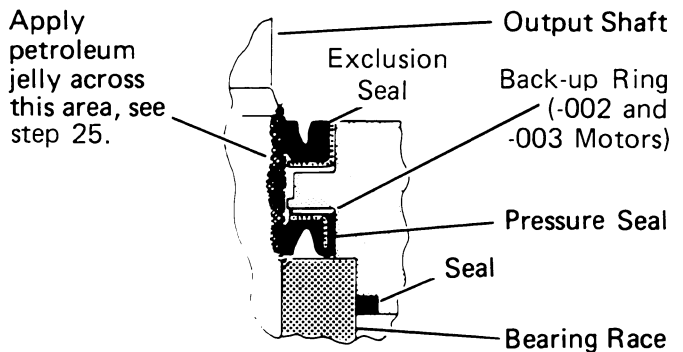


Figure 13

**25** Before installing flange and seal assembly over shaft, place protective sleeve or bullet over shaft. Then lubricate space between exclusion seal and pressure seal, as well as lips of both seals. See Figure 13.

Install flange. Rotate flange slowly while pushing down over shaft. Be careful not to invert or damage seals.

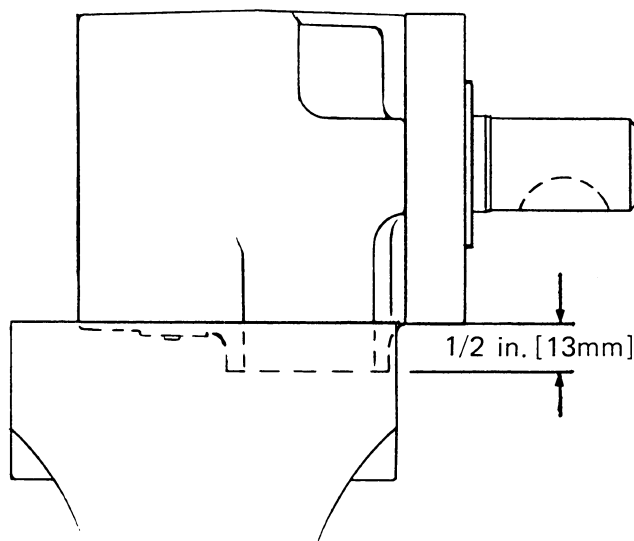


Figure 14

**26** After removing bullet, clamp motor in vise as shown in Figure 14. Make sure shaft cannot fall out. Install **dry** screws and alternately torque them immediately to 250 lb-in [28 Nm]. If you use primer, allow to cure for **10 to 15 minutes**. Without primer, allow 6 hours curing time before subjecting motor to high torque reversals. On all other applications, you can run motor immediately.

If you use new screws, make sure they are the correct length:  $\frac{7}{8}$  in. [22 mm] under head length. See parts list for correct part number.

### Gerotor End

**27** Reposition motor with gerotor end up, then clamp across ports. Do not clamp on side of housing.

**Important:** To aid installation of seals, apply light coat of clean petroleum jelly to seals. Do not stretch seals before installing them in groove.

**28** Pour approximately 35 cc of clean hydraulic oil in output shaft cavity.

**29** Install  $2\frac{7}{8}$  in. [73 mm] I.D. seal in housing seal groove. Avoid twisting seal.

### Timing Procedure

**a.** Install drive. Use felt tip marker to mark one drive tooth. Align this tooth with timing dot on shaft.

**Note:** If drive is not symmetrical, install larger splined end into shaft.

**b.** Install spacer plate.

**c.** Install  $2\frac{7}{8}$  in. [73 mm] I.D. seal in gerotor seal groove. Carefully place gerotor on spacer plate, seal side toward spacer plate.

**Standard Rotation** Align any star point with tooth marked on drive. See Figure 15.

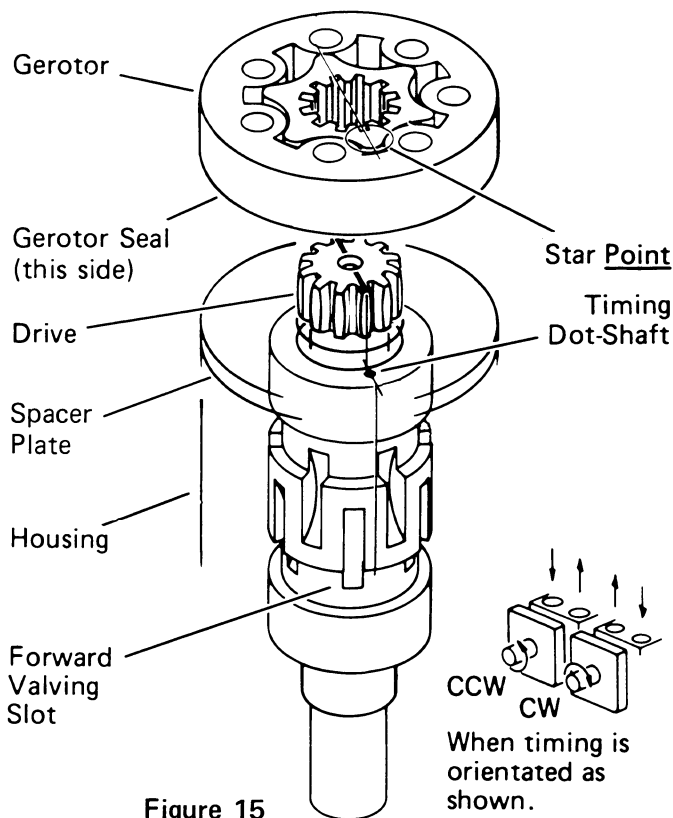


Figure 15

**Reverse Rotation** Align any star valley with marked tooth. See Figure 16.

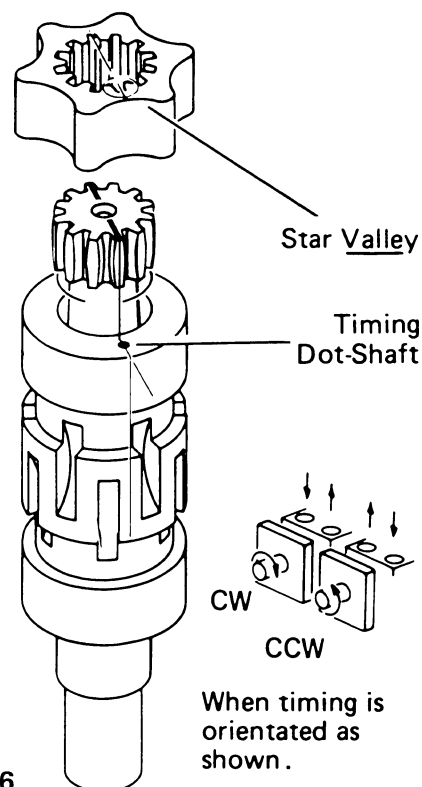


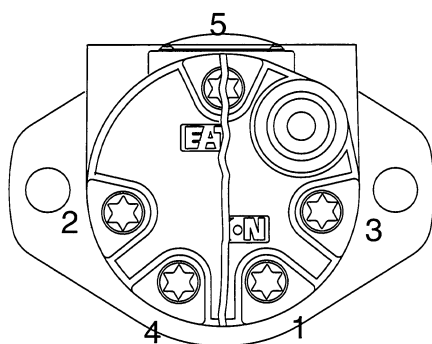
Figure 16

Reassembly Continued from Page 7

**30** Rotate gerotor to line up with bolt holes. Be careful not to disengage star from drive or disturb gerotor seal.

**31** Install drive spacer if applicable.

**32** Install 2 7/8 in. [73 mm] seal in end cap. Carefully place end cap on gerotor.



Bolt Torquing Sequence

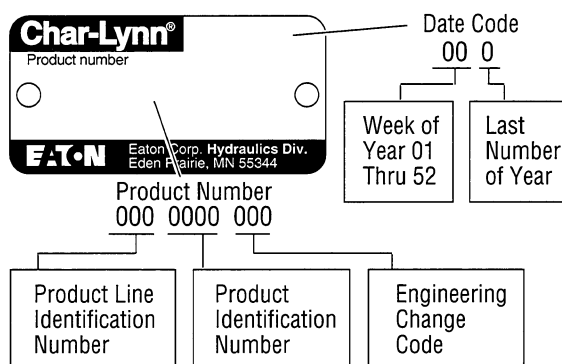
**Figure 17**

**33** Install cap screws and seal washers (if applicable) in end cap. Pretighten screws to 40 lb-in [7,4 Nm]. Make sure seal are properly seated. Then torque screws 275-300 lb-in [30-40 Nm] in sequence, as shown in figure 17.

## How to Order Replacement Parts

### Each Order Must Include the Following:

- |                   |                      |
|-------------------|----------------------|
| 1. Product Number | 4. Part Number       |
| 2. Date Code      | 5. Quantity of Parts |
| 3. Part Name      |                      |

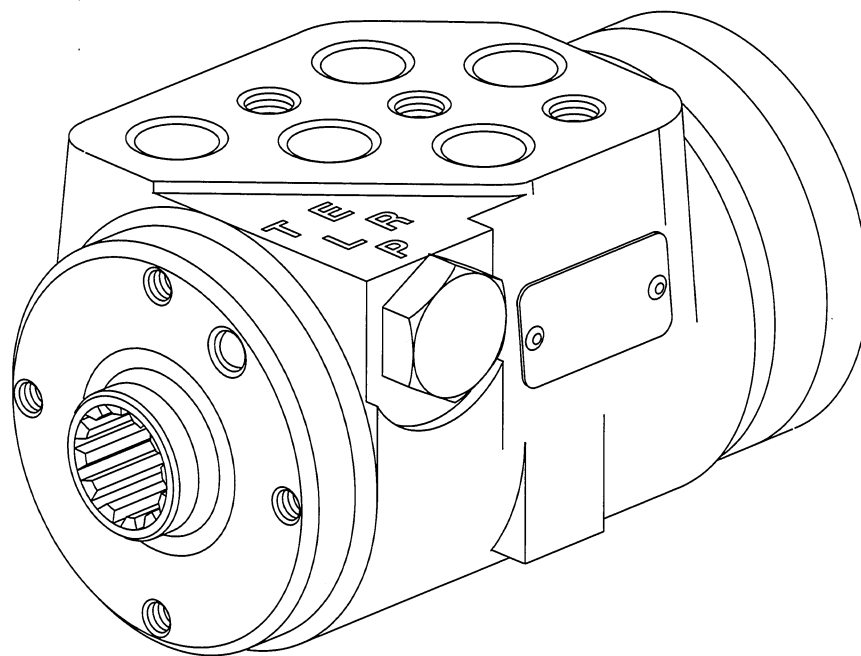


Eaton Corporation  
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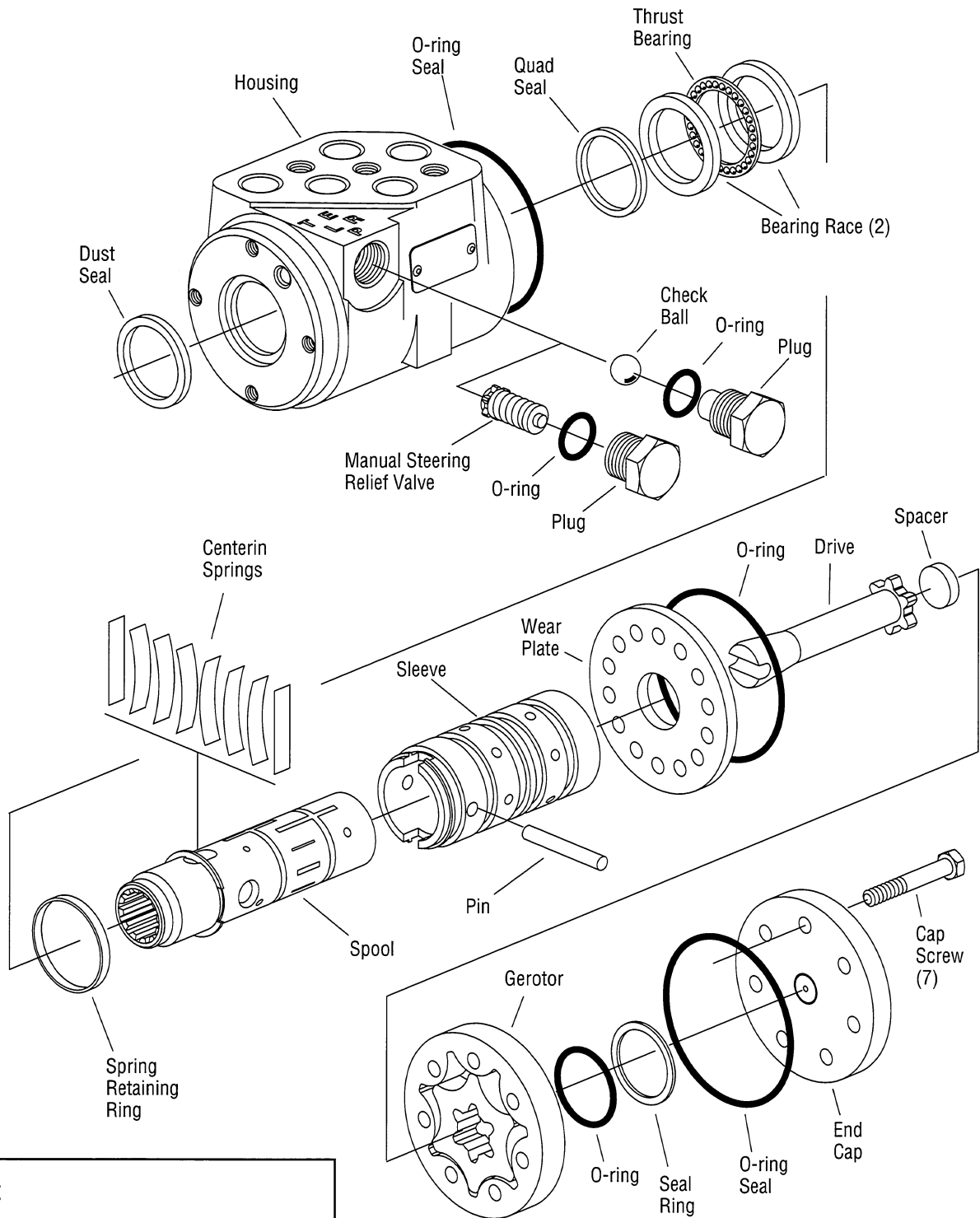
## Repair Information



**2 Series**  
**Steering Control Unit**

**001**

## 2 Series Steering Control Units



### Tool List

- 10 mm Socket
- 7/8 in. Socket
- Torque Wrench (18 Nm [160 lb-in] Capacity)
- Small Blade Screwdriver



## 2 Series Steering Control Units

### Disassembly

Cleanliness is extremely important when repairing hydraulic Steering Control Units (SCU). Work in a clean area. Before disconnecting the hydraulic lines, clean the port area of the SCU. Before disassembly, drain the oil, then plug the ports and thoroughly clean the exterior of the SCU. During repairs, always protect machined surfaces.

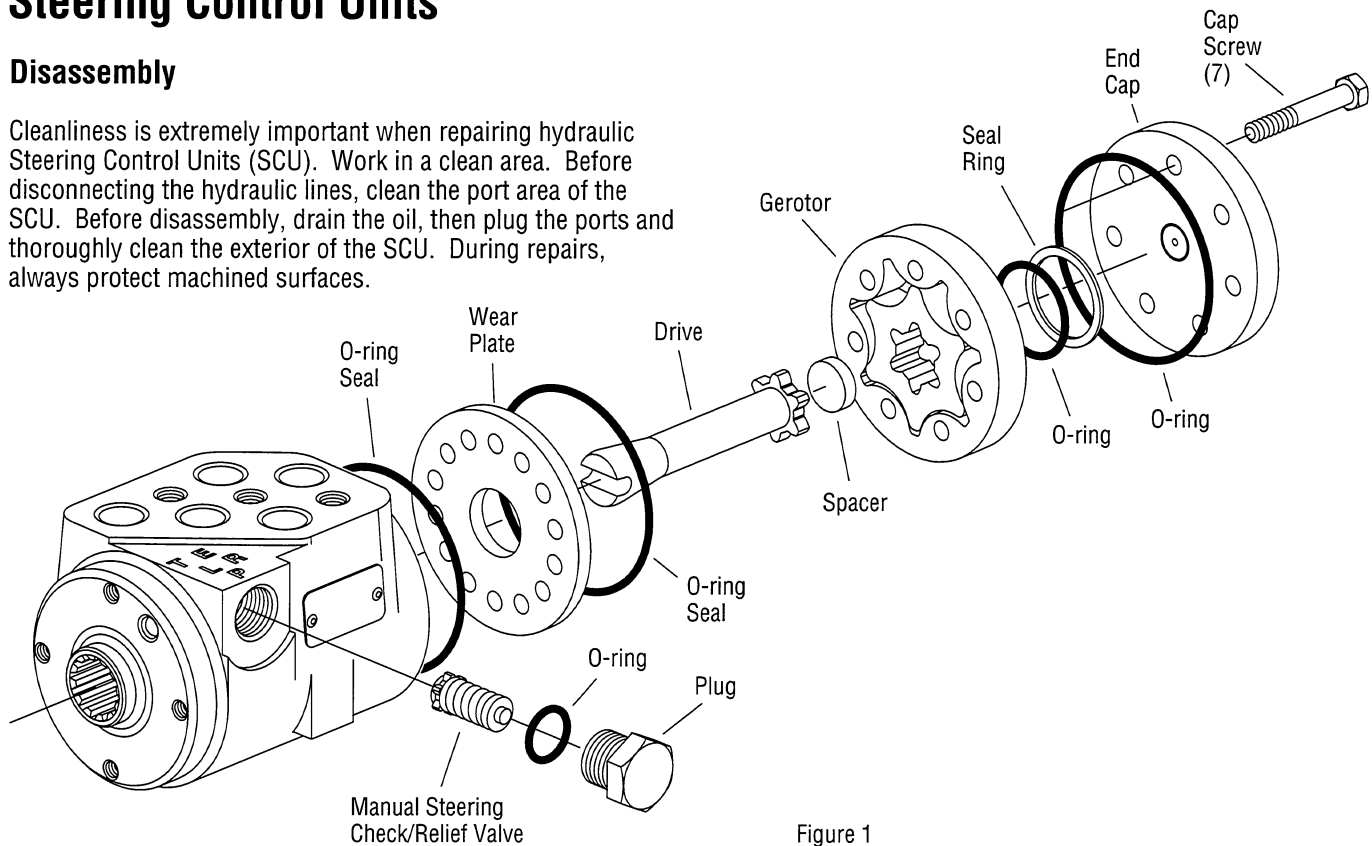


Figure 1

**1** Remove the 7 cap screws and disassemble the SCU as shown in figure 1.

**2** Remove the plug and manual steering check as shown in figure 1.

**Note:** The manual steering check may be a check ball or a check/relief valve.

**3** Slide the spool and sleeve from the housing, see figure 2.

**4** Remove the thrust bearing and bearing races.

**5** Remove the quad seal.

**6** Using a small blade screwdriver, carefully pry the dust seal from the housing.

**Important:** Do not damage the dust seal seat.

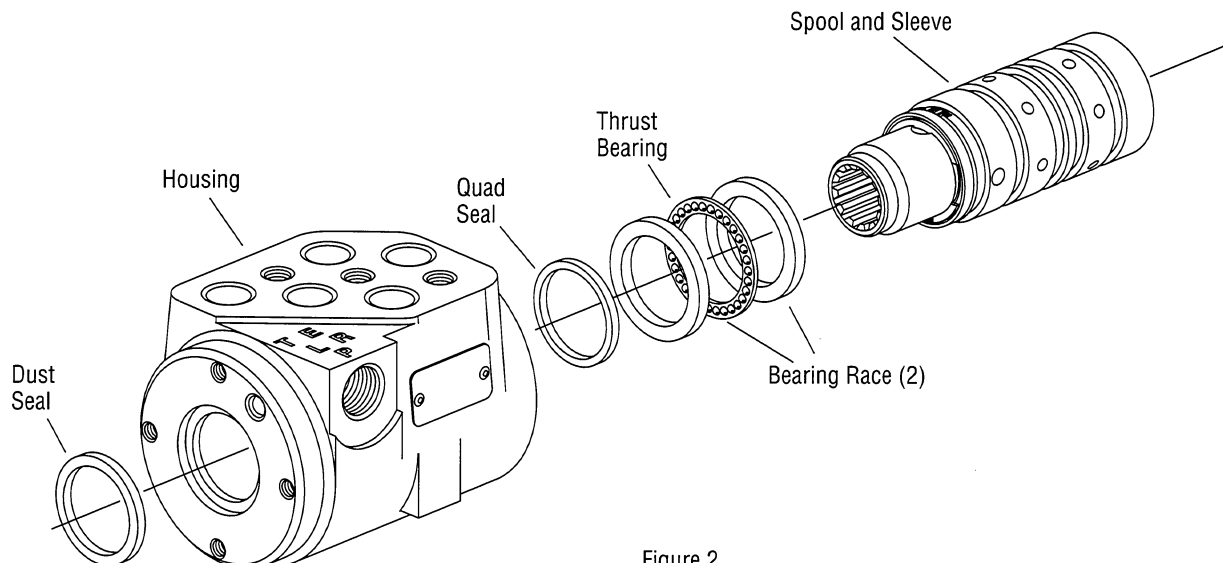


Figure 2

## 2 Series Steering Control Units

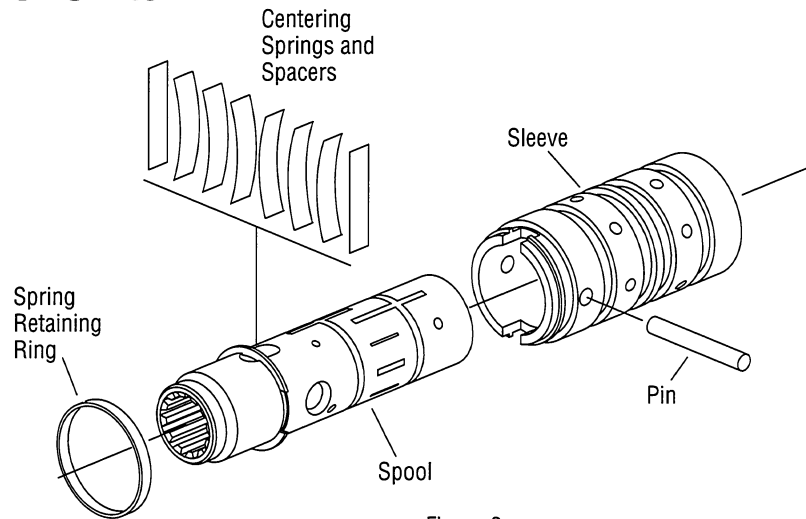


Figure 3

**7** Remove the pin that holds the spool and sleeve together, see figure 3.

**8** Carefully slide the spool out of the sleeve. The springs and retaining ring will stay with the spool as it's removed.

**9** Remove the retaining ring and springs.

**Caution:** The centering springs are under tension; remove the retaining ring carefully.

### Reassembly

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

**Note:** Always use new seals when reassembling hydraulic steering control units. Refer to parts list 6-323 for seal kit part numbers, replacement parts, and ordering information.

**Important:** During reassembly lubricate the new seals with a petroleum jelly like Vaseline. Also lubricate machined surfaces and bearings with clean hydraulic fluid.

**10** Install the quad seal:

- Put one of the bearing races and sleeve into the housing.
- Together, the housing and bearing race create a groove into which the quad seal will be installed.
- Hold the bearing race tightly against the input end of the housing by pushing on the gerotor end of the sleeve.
- Fit the quad seal into its seat through the input end of the housing. Be sure the seal is not twisted.
- Remove the sleeve and bearing race.

## 2 Series Steering Control Units

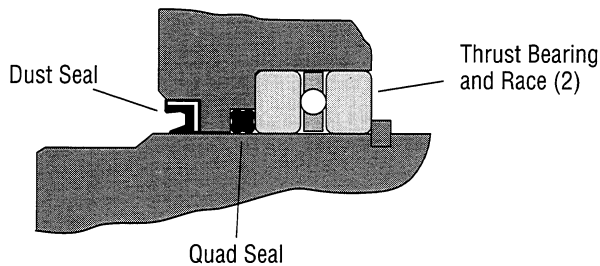


Figure 4

- 11 Lubricate and install the dust seal, see figure 4 for correct seal orientation.
- 12 Install the centering springs in the spool. It is best to install the two flat pieces first. Next, install the curved pieces, three at a time.
- 13 Fit the retaining ring over the centering springs.
- 14 Apply a light coating of clean hydraulic fluid to the spool and slide it into the sleeve. Be sure the centering springs fit into the notches in the sleeve.
- 15 Install the pin, see figure 3.
- 16 Apply a light coating of petroleum jelly to the inner edge of the dust and quad seals.
- 17 Put the thrust bearing and races into the housing. The thrust bearing goes between the two races, see figure 2.
- 18 Apply a light coating of clean hydraulic fluid to the spool and sleeve assembly and slide it into the housing.

**Important:** Do not damage the dust or quad seals.

- 19 Clamp the housing in a vise as shown in figure 5. Use just enough clamping force to hold the housing securely.

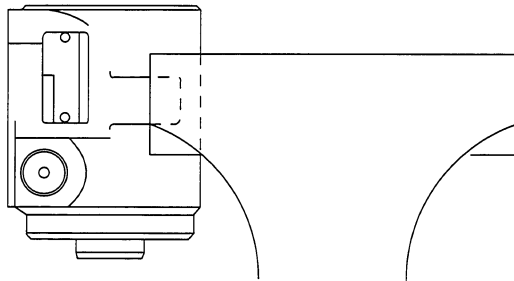


Figure 5

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

- 21 Install the wear plate and align the holes in the wear plate with threaded holes in the housing.

**Note:** The holes in the wear plate are symmetrical.

- 22 Install the drive, be sure the slot in the drive engages the pin.

- 23 Lubricate and install a new o-ring seal in the groove in the wear plate.

- 24 Install the gerotor and align the screw holes.

- 25 Lubricate and install a new o-ring seal in the groove in the gerotor ring.

- 26 Lubricate and install a new o-ring and seal ring in the groove in the gerotor star.

- 27 Install the spacer.

- 28 Install the end cap and 7 cap screws. Tighten the cap screws, in a criss-cross pattern, to 16 -18 Nm [140 -160 lb-in].

- 29 Remove the SCU from the vise.

- 30 Install the relief valve/check or check ball and plug. Use a new o-ring and tighten the plug to 17 Nm [150 lb-in].

System	Ports	Relief Valve Setting Bar [PSI]	Displacement cm³/r [in³/r] and Product Number					
			31 [1.9]	39 [2.4]	51 [3.1]	63 [3.8]	74 [4.5]	100 [6.1]
Open Center Non-Load Reaction	9/16 Inch Plug-O (4)	None	291-1001-001	291-1002-001	291-1003-001	291-1004-001	291-1005-001	291-1006-001
		40 [ 580]	291-1001-041	291-1002-041	291-1003-041	291-1004-041	291-1005-041	291-1006-041
		50 [ 725]	291-1001-051	291-1002-051	291-1003-051	291-1004-051	291-1005-051	291-1006-051
		63 [ 914]	291-1001-061	291-1002-061	291-1003-061	291-1004-061	291-1005-061	291-1006-061
		70 [1015]	291-1001-071	291-1002-071	291-1003-071	291-1004-071	291-1005-071	291-1006-071
	9/16 -18 Inch SAE (4)	None	291-1007-001	291-1008-001	291-1009-001	291-1010-001	291-1011-001	291-1012-001
		40 [ 580]	291-1007-041	291-1008-041	291-1009-041	291-1010-041	291-1011-041	291-1012-041
		50 [ 725]	291-1007-051	291-1008-051	291-1009-051	291-1010-051	291-1011-051	291-1012-051
		63 [ 914]	291-1007-061	291-1008-061	291-1009-061	291-1010-061	291-1011-061	291-1012-061
		70 [1015]	291-1007-071	291-1008-071	291-1009-071	291-1010-071	291-1011-071	291-1012-071
Power Beyond Non-Load Reaction	9/16 Inch Plug-O (5)	None	291-5001-001	291-5002-001	291-5003-001	291-5004-001	291-5005-001	291-5006-001
		40 [ 580]	291-5001-041	291-5002-041	291-5003-041	291-5004-041	291-5005-041	291-5006-041
		50 [ 725]	291-5001-051	291-5002-051	291-5003-051	291-5004-051	291-5005-051	291-5006-051
		63 [ 914]	291-5001-061	291-5002-061	291-5003-061	291-5004-061	291-5005-061	291-5006-061
		70 [1015]	291-5001-071	291-5002-071	291-5003-071	291-5004-071	291-5005-071	291-5006-071
	9/16 -18 Inch SAE (5)	None	291-5007-001	291-5008-001	291-5009-001	291-5010-001	291-5011-001	291-5012-001
		40 [ 580]	291-5007-041	291-5008-041	291-5009-041	291-5010-041	291-5011-041	291-5012-041
		50 [ 725]	291-5007-051	291-5008-051	291-5009-051	291-5010-051	291-5011-051	291-5012-051
		63 [ 914]	291-5007-061	291-5008-061	291-5009-061	291-5010-061	291-5011-061	291-5012-061
		70 [1015]	291-5007-071	291-5008-071	291-5009-071	291-5010-071	291-5011-071	291-5012-071
Dynamic Signal Load Sensing	9/16 Inch Plug-O (5)	None	293-4001-001	293-4002-001	293-4003-001	293-4004-001	293-4005-001	293-4006-001
	9/16 -18 Inch SAE (5)	None	293-4007-001	293-4008-001	293-4009-001	293-4010-001	293-4011-001	293-4012-001

Open Center Non-Load Reaction	9/16 Inch Plug-O (4)	None	291-1001-121	291-1002-121	291-1003-121	291-1004-121	291-1005-121	291-1006-121
		80 [1160]	291-1001-081	291-1002-081	291-1003-081	291-1004-081	291-1005-081	291-1006-081
		90 [1305]	291-1001-091	291-1002-091	291-1003-091	291-1004-091	291-1005-091	291-1006-091
		100 [1450]	291-1001-101	291-1002-101	291-1003-101	291-1004-101	291-1005-101	291-1006-101
	9/16 -18 Inch SAE (4)	None	291-1007-121	291-1008-121	291-1009-121	291-1010-121	291-1011-121	291-1012-121
		80 [1160]	291-1007-081	291-1008-081	291-1009-081	291-1010-081	291-1011-081	291-1012-081
		90 [1305]	291-1007-091	291-1008-091	291-1009-091	291-1010-091	291-1011-091	291-1012-091
		100 [1450]	291-1007-101	291-1008-101	291-1009-101	291-1010-101	291-1011-101	291-1012-101
Power Beyond Non-Load Reaction	9/16 Inch Plug-O (5)	None	291-5001-121	291-5002-121	291-5003-121	291-5004-121	291-5005-121	291-5006-121
		80 [1160]	291-5001-081	291-5002-081	291-5003-081	291-5004-081	291-5005-081	291-5006-081
		90 [1305]	291-5001-091	291-5002-091	291-5003-091	291-5004-091	291-5005-091	291-5006-091
		100 [1450]	291-5001-101	291-5002-101	291-5003-101	291-5004-101	291-5005-101	291-5006-101
	9/16 -18 Inch SAE (5)	None	291-5007-121	291-5008-121	291-5009-121	291-5010-121	291-5011-121	291-5012-121
		80 [1160]	291-5007-081	291-5008-081	291-5009-081	291-5010-081	291-5011-081	291-5012-081
		90 [1305]	291-5007-091	291-5008-091	291-5009-091	291-5010-091	291-5011-091	291-5012-091
		100 [1450]	291-5007-101	291-5008-101	291-5009-101	291-5010-101	291-5011-101	291-5012-101
Dynamic Signal Load Sensing	9/16 Inch Plug-O (5)	None	293-4001-121	293-4002-121	293-4003-121	293-4004-121	293-4005-121	293-4006-121
	9/16 -18 Inch SAE (5)	None	293-4007-121	293-4008-121	293-4009-121	293-4010-121	293-4011-121	293-4012-121



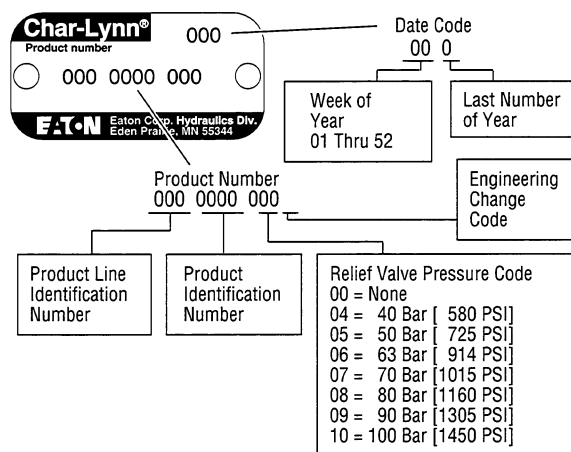
## How to Order Replacement Parts

### Each Order Must Include the Following:

1. Product Number
2. Date Code
3. Part Name
4. Part Number
5. Quantity of Parts

For More Detailed Information Contact Eaton Corp. Hydraulics Division 15151 Highway 5 Eden Prairie, MN 55344.

- Specifications and performance Data, Catalog No. 11-872
- Replacement Part Numbers and Kit Information — Parts Information No. 7-310.



Eaton Corporation  
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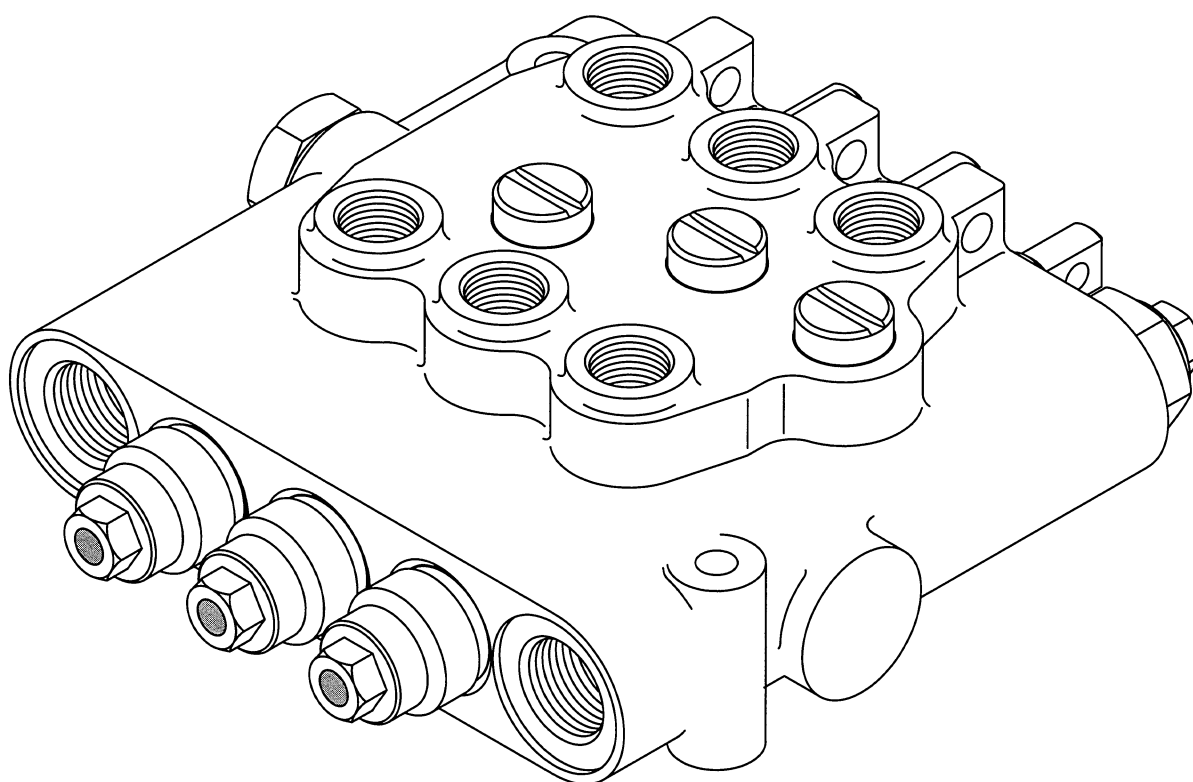
**Eaton  
Hydraulics  
Division**

# Repair Information

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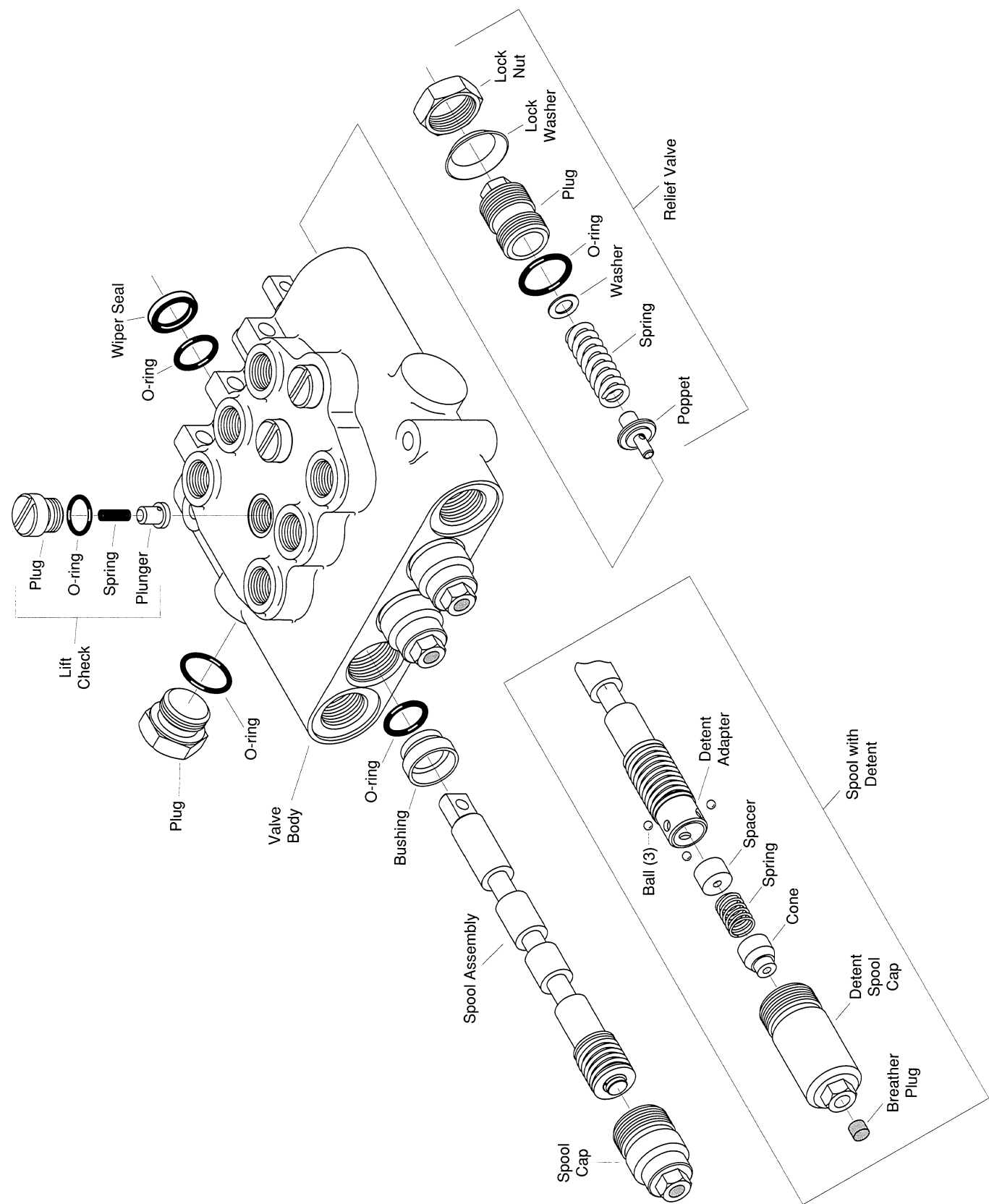
## **Model 30920 - 30930 Directional Control Valve**

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**EAT•N**

Parts Drawing





## Disassembly

Refer to the Parts Drawing as you perform the repairs.

1. Plug all ports and clean the outside of the valve thoroughly.
2. Mark the spools and their specific bores. The spools are matched to the bores and must not be switched.

3. Remove the spool caps and slide the spool assemblies from their bores.

If spools are detented, take care not to lose the balls, spacer, detent spring, or cone.

4. Remove the o-rings and bushings from the spools.
5. Remove the wiper seals and o-rings from the valve body.
6. Disassemble the spool assemblies only if the retaining ring, spacer, spool spring, or washer need to be replaced see figure 1.

**Note:** Do not disassemble spool assemblies with detents.

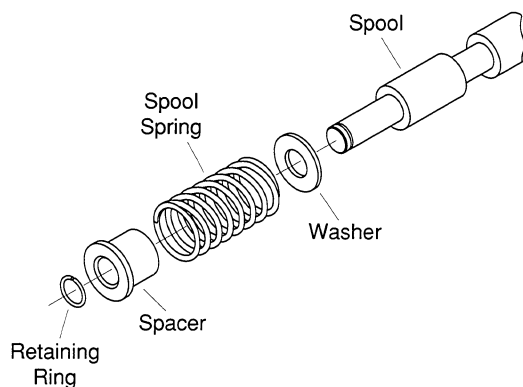


figure 1

7. Remove the lift check plugs, springs, and lift check plungers.
8. Remove the plug from the BYD port. This may be a solid plug, pressure beyond plug, or closed center plug.
9. Remove the relief valve lock nut, lock washer, plug, and o-ring .
10. Remove the washer, relief valve spring, and poppet.
11. Remove all o-rings and back-up rings from the plugs.

## Inspection

1. Inspect the spools for wear. If wear is excessive, the valve becomes non-serviceable.
2. Inspect all of the springs and replace as necessary. Replace spool springs as shown in figure 1.

**Note:** The spool springs on detented spools are not serviceable.

3. Inspect the relief valve parts for wear and replace as necessary.
4. Inspect the lift check plungers and their seats in the valve body.

## Reassembly

1. Wash all metal parts in clean solvent and blow them dry with compressed air. Do not wipe parts dry with paper towels or cloth. Lint in a hydraulic system will cause damage.

**Note:** Replace all o-rings, back-up rings and wiper seals as new.

2. Install new o-rings and wiper seals in the valve body.
3. Slide the bushings and new o-rings over the spools.
4. Liberally lubricate the spools with clean hydraulic fluid and install them in their proper bores.
5. Install the spool caps and tighten them to 20 - 25 lb-ft [27 - 34 Nm].
6. If spools are detented, install the spool caps as follows:

Remove the brass breather plug from the spool cap using a 3/16 inch drift punch.

Insert the punch through the hole in the spool cap.

Put the spacer, detent spring, cone, and balls into the detent adapter.

Hold the parts in place with the drift punch, while threading the spool cap into the valve body.

Tighten the cap to 20 - 25 lb-ft [27 - 34 Nm].

Install the breather plug.

7. Install the lift check plungers, springs, and lift check plugs. Use new o-rings and tighten the plugs to 20 - 25 lb-ft [27 - 34 Nm].
8. Install a new o-ring on the relief valve plug .
9. Insert the washer and relief valve spring into the plug .
10. Place the poppet on the spring and carefully install the relief valve into the valve body.
11. Install the lock washer and nut .
12. Adjust the relief valve setting and tighten the lock nut to 21 - 24 lb-ft [28 - 33 Nm].

---

Eaton Corporation **Hydraulics Division**, 15151 Highway 5, Eden Prairie, MN 55344 Telephone (612) 937-9800

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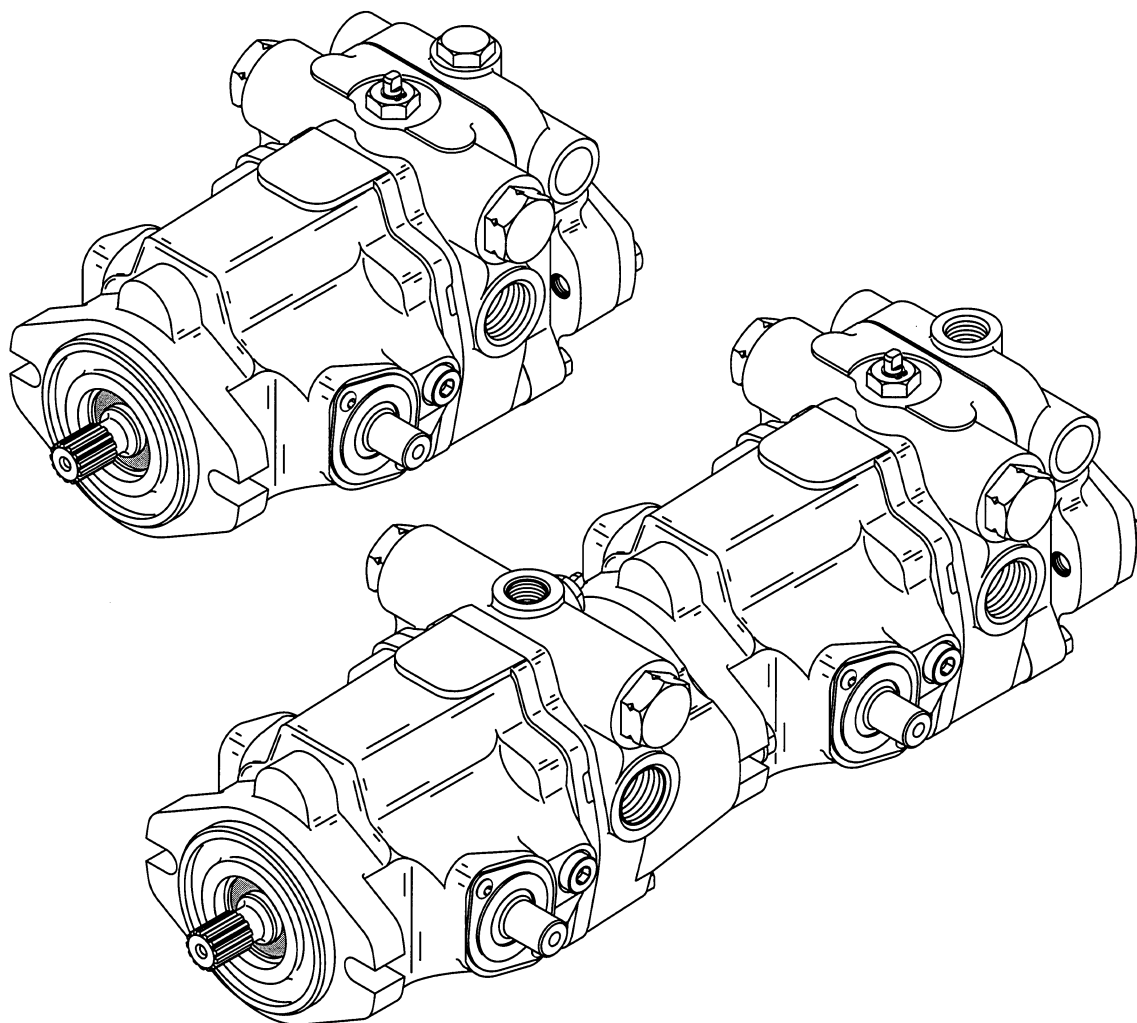


Printed in U.S.A.

FORM NO. 7- 503  
Issued June 1989



## Repair Information



**Model 70142 / 70144**, 20.3 cm<sup>3</sup>/r [1.24 in<sup>3</sup>/r] Displacement  
**and 70145**, 23.6 cm<sup>3</sup>/r [1.44 in<sup>3</sup>/r] Displacement  
**Variable Displacement Piston Pump**

**-01**

with **Valve Plate**

# Introduction

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## Introduction

This manual provides service information for the Eaton Models 70142 / 70144 and 70145 Variable Displacement Piston Pumps. Step by step instructions for the complete disassembly, inspection, and reassembly of the pump are given. The following recommendations should be followed to insure successful repairs.

- Remove the pump from the application.
- Cleanliness is extremely important.
- Clean the port areas thoroughly before disconnecting the hydraulic lines.
- Plug the pump ports and cover the open hydraulic lines immediately after they're disconnected.
- Drain the oil and clean the exterior of the pump before making repairs.
- Wash all metal parts in clean solvent.
- Use compressed air to dry the parts. Do not wipe them dry with paper towels or cloth.
- The compressed air should be filtered and moisture free.
- Always use new seals when reassembling hydraulic pumps.
- For replacement parts and ordering information refer to parts list 6-632.
- Lubricate the new rubber seals with a petroleum jelly (vaseline) before installation.
- Torque all bolts over gasketed joints, then repeat the torquing sequence to make-up for gasket compression.
- Verifying the accuracy of pump repairs on an authorized test stand is essential.

# Identification and Tools Required

## Identification Numbers

Stamped on each unit.

### A - Product Number Description

70142 = Piston Pump (20.3 cm<sup>3</sup>/r [1.24 in<sup>3</sup>/r]) with Gerotor  
 70144 = Piston Pump (20.3 cm<sup>3</sup>/r [1.24 in<sup>3</sup>/r]) without Gerotor  
 70145 = Piston Pump (23.6 cm<sup>3</sup>/r [1.44 in<sup>3</sup>/r]) with or without Gerotor  
 78113 = Tandem Piston Pumps (20.3 cm<sup>3</sup>/r [1.24 in<sup>3</sup>/r]) no Gear Pump  
 78114 = Tandem Piston Pumps (20.3 cm<sup>3</sup>/r [1.24 in<sup>3</sup>/r]) with Gear Pump  
 78115 = Tandem Piston Pumps (23.6 cm<sup>3</sup>/r [1.44 in<sup>3</sup>/r]) no Gear Pump  
 78116 = Tandem Piston Pumps (23.6 cm<sup>3</sup>/r [1.44 in<sup>3</sup>/r]) with Gear Pump

### B - Rotation,

R = Righthand,

L = Lefthand

### C - Sequential Letters

### D - Design Code Number

### Single Pump - Product Number

**7 0 1 4 2 - R A A - 0 1**

A
B
C
D

### Tandem Pumps - Product Number

**7 8 1 1 3 - R A B - 0 1**

A
B
C
D

### Serial Number Code:

**B 93 01 31 JB**

Revision level  
of parts list. ———

Last two digits  
of year built. ———  
( 93 for 1993 etc.)

Testers Initials ———

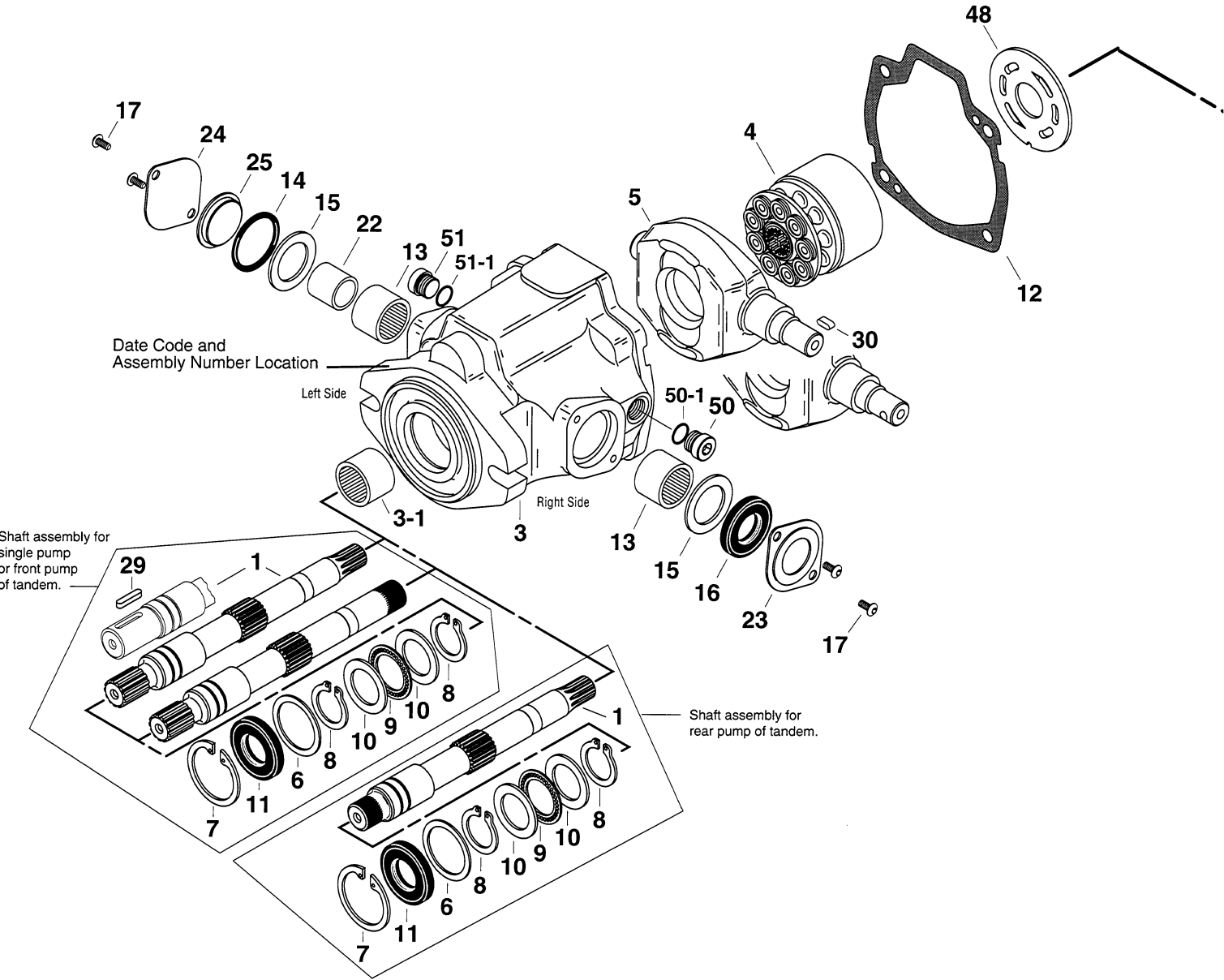
Day of Month  
(two digits) ———

Month (two digits) ———

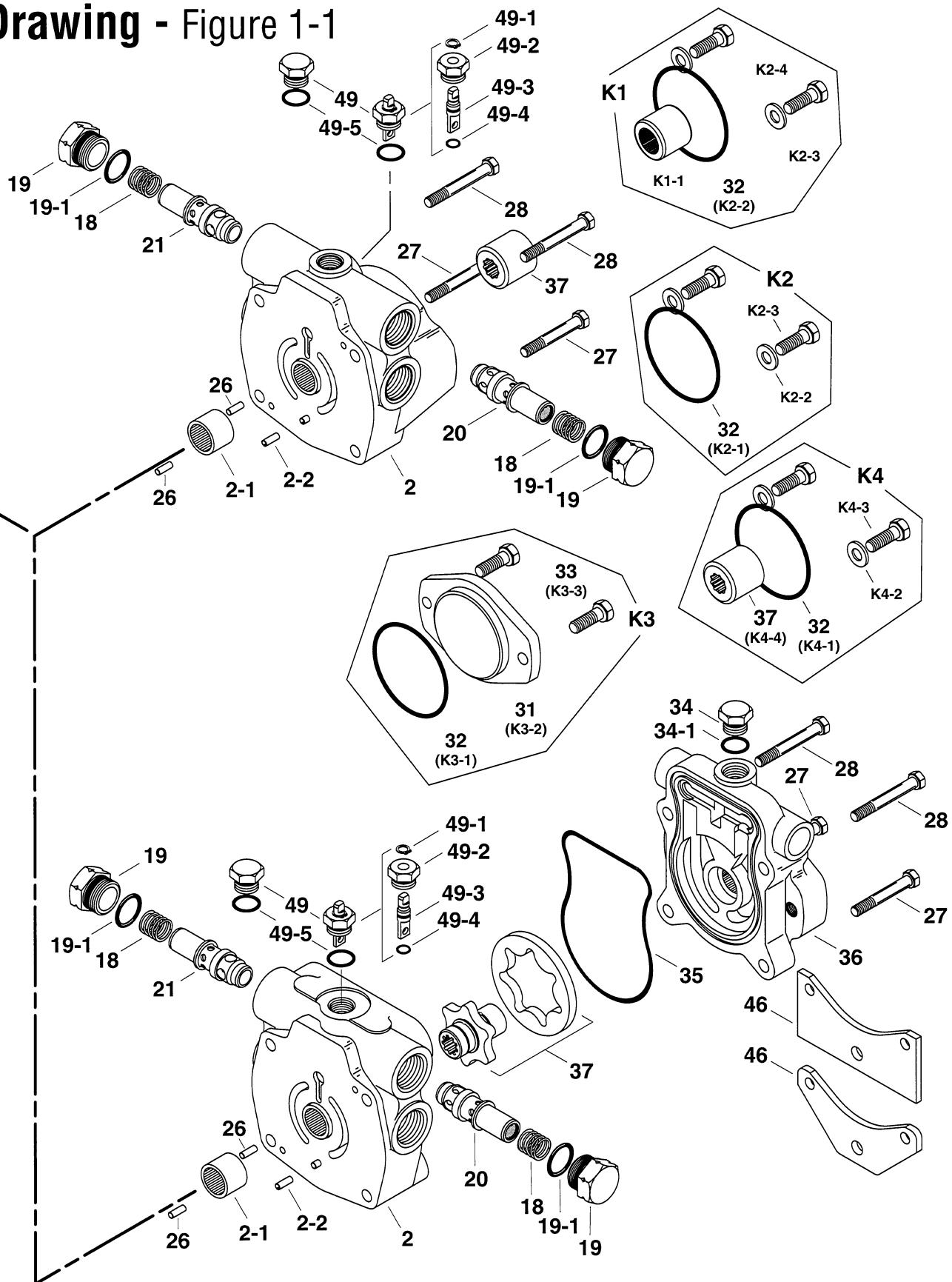
## Required Tools

- 7/16 in. Hex Key (Allen)
- O-ring Pick
- 9/16 in. End Wrench
- Torque Wrench (135.6 N·m [100 lbf·ft] capacity)
- 1 in. End Wrench
- Hammer (soft face)
- 9/16 in. Socket
- Light Petroleum Jelly
- 1/2 in. Socket
- Seal Driver
- Internal Retaining Ring Pliers (straight .090 tip)
- Arbor Press
- External Retaining Ring Pliers (straight .070 tip)

# Parts Drawing - Figure 1-1



# Parts Drawing - Figure 1-1



# Parts List

Item	Qty.	Description
1	1	Drive Shaft
2	1	Backplate Assembly
3	1	Housing Assembly
4	1	Rotating Kit Assembly
5	1	Camplate
6	1	Washer
+ 7	1	Retaining Ring
+ 8	2	Retaining Ring
9	1	Thrust Bearing
10	2	Bearing Race
+ 11	1	Shaft Seal, Drive
+ 12	1	Housing Gasket
13	2	Needle Bearing
+ 14	1	O-ring, 3.175 mm Dia. x 31.75 mm ID. [.125 in. Dia. x 1.25 in. ID.]
15	2	Washer
+ 16	1	Shaft Seal, Trunnion
17	4	Screw, Pan Head
18	2	Spring
19	2	Plug Assembly
+ 19-1	2	O-ring, 2.38 mm Dia. x 22.23 mm ID. [.0937 in. Dia. x .875 in. ID.]
20	1	Relief Valve for Port "C"
21	1	Relief Valve for Port "D"
22	1	Inner Race
23	1	Seal Cover
24	1	Trunnion Cover
25	1	Cover, O-ring
26	2	Dowel Pin
27	2	Cap Screws, 5/16-18, 50.8 mm [2 in.] Long
28	2	Cap Screws, 5/16-18, 63.5 mm [2.5 in.] Long
29	1	Key, Drive Shaft
30	1	Key, Camplate Trunnion
31	1	Cover Plate (In K3 kit)
+ 32	1	O-ring (In K1, K2, K3 & K4 kit)
33	2	Cap Screws, Cover Plate (In K3 kit)
34	1	Plug Assembly
+ 34-1	1	O-ring, 2.21 mm Dia. x 16.36 mm ID. [.087 in. Dia. x .644 in. ID.]
+ 35	1	Molded O-ring
36	1	Charge Pump Adaptor
37	1	Gerotor set and coupler sub-assembly 6.9 cm <sup>3</sup> /r [.42 in <sup>3</sup> /r] displacement, 6.35 mm [.25 in.] width 13.8 cm <sup>3</sup> /r [.84 in <sup>3</sup> /r] displacement, 12.7 mm [.5 in.] width
37	1	9 tooth coupler (In K4 kit)
46	1	Mounting Bracket, Square shaped
46	1	Mounting Bracket, "V" shaped
48	1	Valve Plate



# Parts List

Item	Qty.	Description
49	1	Dump Valve sub-assembly
+ 49-1	1	Retaining Ring
49-2	1	Separator Plug
49-3	1	Separator
+ 49-4	1	O-ring, 1.59 mm Dia. x 9.53 mm I.D. [.0625 in. Dia. x .375 in. I.D.]
+ 49-5	1	O-ring, 2.46 mm Dia. x 19.18 mm I.D. [.097 in. Dia. x .755 in. I.D.]
49	1	Plug Assembly
49-5	1	O-ring, 2.46 mm Dia. x 19.18 mm I.D. [.097 in. Dia. x .755 in. I.D.]
50	1	Plug Assembly
+ 50-1	1	O-ring, 1.98 mm Dia. x 11.89 mm ID. [.078 in. Dia. x .468 in. ID.]
51	1	Plug Assembly
+ 51-1	1	O-ring, 1.98 mm Dia. x 11.89 mm ID. [.078 in. Dia. x .468 in. ID.]

## Mounting Kits

K1	1	Tandem Piston Pump Mounting Kit
K1-1	1	35T Coupler, 36.8 mm [1.45 in.] long
K1-2	1	O-ring, 1.59 mm Dia. x 101.6 mm ID. [.0625 in. Dia. x 4 in. ID.]
K1-3	2	Cap Screws
K1-4	2	Washer
K2	1	Gear Pump Mounting Kit
K2-1	1	O-ring, 1.59 mm Dia. x 82.55 mm ID. [.0625 in. Dia. x 3.25 in. ID.]
K2-2	2	Washer
K2-3	2	Cap Screws
K3	1	Cover Plate Kit
K3-1	1	O-ring, 1.59 mm Dia. x 82.55 mm ID. [.0625 in. Dia. x 3.25 in. ID.]
K3-2	1	Cover Plate
K3-3	2	Cap Screws
K4	1	Gear Pump Mounting Kit with Coupler
K4-1	1	9T Coupler
K4-2	1	O-ring, 1.59 mm Dia. x 101.6 mm ID. [.0625 in. Dia. x 4 in. ID.]
K4-3	2	Cap Screws
K4-4	2	Washer

## Seal Repair Kit

70142-938	Seal Repair Kit for 70142, 70144 and 70145 piston pump.
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**Legend**                      +      Included in seal repair kit.

# Disassembly

## Disassembly

The following instructions apply to a variable displacement piston pump with or without a gerotor charge pump. A tandem pump assembly should be separated into individual pumps before disassembly.

**1** Position the pump into a protected jaw vise, clamping onto the outer portion of the flange, with the input drive shaft down. Remove the four cap screws retaining charge pump adapter or backplate.

No gerotor charge pump skip to step 6.

**2** Lift the charge pump adapter assembly straight up off backplate, shaft, and gerotor. Gerotor may stay in adapter or on backplate.

**3** Remove o-ring from charge pump adapter.

**4** Remove outer gerotor ring from either the charge pump adapter or the inner gerotor ring.

Refer to Appendix A for disassembly and inspection of charge pump adapter assembly.

**5** Remove the inner gerotor ring and coupler assembly from shaft.

**6** Lift backplate straight up off of shaft and housing. Remove valve plate from backplate or from rotating kit assembly, still in housing.

**7** From backplate remove dump valve assembly or plug assembly, and relief valve assemblies. Note: Mark the relief valve in relationship to the cavity it was removed, for reassembly purposes.

### Backplate Inspection:

- Check the bearing (press fit) in backplate. If needles remain in cage, move freely, and setting is at the dimension shown in figure 1-3, removal not required.

- Check roll pin in backplate. If tight and set to the dimension shown in figure 1-3, removal not required.

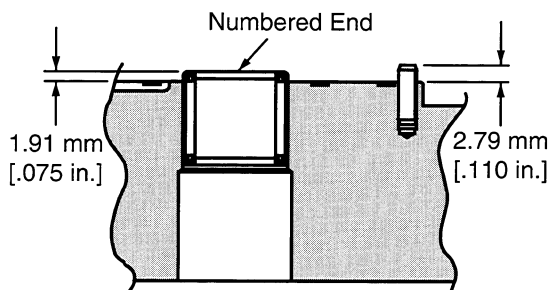


Figure 1-3

**8** Remove housing gasket from housing or backplate.

**9** To remove rotating kit assembly from housing, first remove pump from vise holding the rotating kit assembly in position. Lower pump so that the shaft end (flange end) is up. Set the rear of housing onto table with housing flat and rotating kit assembly at rest on table. Hole in table for protruding shaft is required. Remove by lifting the housing and shaft from rotating kit assembly.

Refer to Appendix B for disassembly and inspection of rotating kit.

**10** Remove retaining ring from the front of housing. Press the shaft, shaft seal or spacer, and washer from housing. Remove retaining ring, thrust washer, thrust bearing, second thrust washer, and second retaining ring from shaft.

**11** To remove camplate from housing, remove the two screws from both sides of housing (four total) retaining seal cover and trunnion cover. Remove seal cover, shaft seal, washer, and bearing from housing. Remove trunnion cover, o-ring cover, o-ring, washer, inner race, and bearing from housing. Slide the camplate over to one side and remove thru the back side of housing.

### Camplate Inspection:

- The finish on the piston shoe surfaces of the camplate should show no signs of scoring.

### Housing Inspection:

- Check the bearing (press fit) in front of housing. If needles remain in cage, move freely, and setting at the dimension shown in figure 1-4, removal not required.

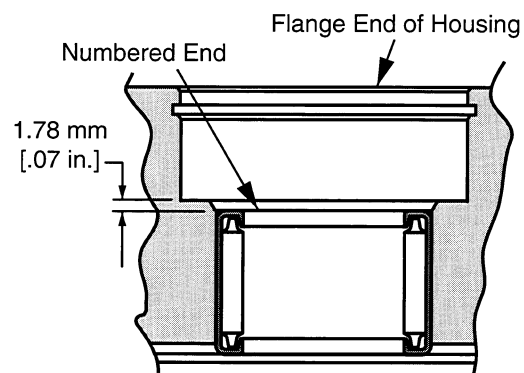


Figure 1-4

**12** Discard the shaft seal, gaskets, and o-rings from all assemblies. Replace with new seals upon reassembly.

# Reassembly

## Reassembly

**1** All parts should be cleaned and critical moving parts lubricated before reassembly.

**2** If necessary, press new bearing in housing to dimension shown in figure 1-4 with the numbered end of bearing outward.

**3** Starting with the camplate, insert camplate into the housing with the long trunnion side down and to the appropriate side of linkage on the machine.

**4** On the short trunnion side of camplate install bearing (bearing with numbered side to the inside of pump), bearing race (race with chamfer toward inside of pump), washer, o-ring, o-ring cover, trunnion cover, and retain with two screws. Torque screws 4.1 to 5.4 N·m [36 to 48 lbf·ft].

**5** On the long trunnion side of camplate install bearing (bearing with numbered side to the inside of pump), washer, trunnion shaft seal, seal cover, and retain with two screws. Torque screws 4.1 to 5.4 N·m [36 to 48 lbf·ft].

**6** To install shaft, place exterior retaining ring, thrust race, thrust bearing, second thrust race, and second retaining ring onto shaft. Position washer and shaft seal or spacer onto shaft.

**7** Install shaft assembly into front of housing: For units with spacer, retain with interior retaining ring and go on to step 8. For units with shaft seal, seat seal into position with seal driver and retain with interior retaining ring.

Refer to Appendix B for reassembly of rotating kit assembly.

**8** With flange end of housing up, position rotating kit assembly onto shaft and into housing. Align the spline within the piston block with shaft internal spline. Make sure piston block is engaged fully to put piston shoes in contact with camplate. Check all parts for proper position before proceeding.

**9** Clamp pump assembly in a protected jaw vise with the open end of the housing up. Install gasket and two dowel pins onto housing.

**10** If necessary, press new bearing and roll pin in backplate to dimension shown in figure 1-3. Bearing installed with the numbered end outward. Roll pin installed with split oriented away from bearing.

**11** Install new o-ring on relief valves. Install relief valve in its original cavity in backplate that it was removed. Torque 128 to 142 N·m [95 to 105 lbf·ft].

**12** Install new o-ring on dump valve or plug. Install dump valve or plug into backplate. Torque dump valve or plug to 36.6 to 40.7 N·m [27 to 30 lbf·ft]

**13** Apply a small amount of petroleum jelly to the steel side of valve plate to hold in place for installation. Aligning the index pin, place the valve plate in position onto the backplate, with steel side against backplate.

**14** Install backplate assembly onto housing assembly. Making sure valve plate and gasket stay in place.

No gerotor charge pump, skip to step 17.

**15** Install inner gerotor and coupler assembly. The coupler has a "V" groove on one end and this end of coupler should enter backplate first. Lubricate inner gerotor.

Refer to Appendix A for reassembly of Charge relief valve in adapter plate.

**16** Install o-ring and outer gerotor ring onto adapter plate. Lubricate both o-ring and outer gerotor ring to hold in position during assembly of adapter plate. Install adapter plate onto backplate. Make sure o-ring and gerotor ring stay in place.

**17** Retain backplate and adapter plate (when used) with four cap screws, Torque 23 to 27 N·m [17 to 20 lbf·ft].

**18** Install new o-rings on all plugs. Install plugs into housing. Torque 9/16 in. - 18 plug 28 to 32 N·m [21 to 24 lbf·ft].

**19** Refer to start-up procedures on page 17.

# Appendix A - Charge Pump Adapter Assembly

Configuration for  
13.8 to 17.2 bar [200 to 250 lbf/in<sup>2</sup>] or  
17.2 to 20.7 bar [250 to 300 lbf/in<sup>2</sup>]  
Charge Relief Valve

Configuration for  
6.9 to 1.3 bar  
[100 to 150 lbf/in<sup>2</sup>]  
Charge Relief Valve

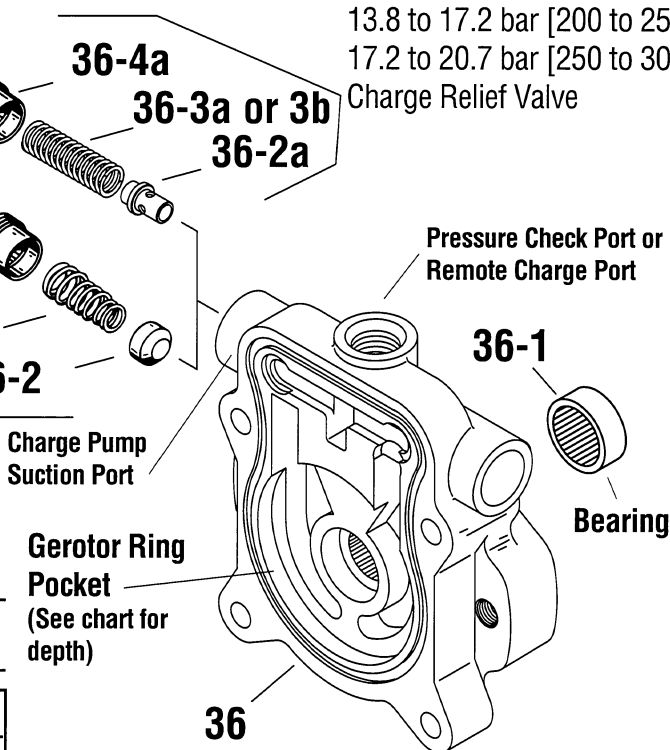
## Gerotor Pocket Depth

Displacement cm <sup>3</sup> /r [in <sup>3</sup> /r]	Depth of Pocket mm [in.]
6.9 [.42]	6.35 [.25]
13.8 [.84]	12.7 [.50]

Item	Qty.	Description
36	1	Charge Pump Adapter Assy.
36-1	1	Bearing (press fit)
36-2	1	Poppet, Cup
36-2a	1	Poppet, Pin
36-3	1	Spring, Tapered
36-3a	1	Spring, "Light Green" *
36-3b	1	Spring, "Pink" **
36-4	1	Spring Retainer
36-4a	1	Spring Retainer

\*200 to 250 lbf/in<sup>2</sup>

\*\*250 to 300 lbf/in<sup>2</sup>



## Reassembly - Charge Pump Adapter Assembly

- 1 If necessary, press new bearing in adapter assembly. The bearing to dimension shown in figure 1-2 with the numbered end of bearing outward and closest to mounting flange.
- 2 Install cup poppet or pin poppet, spring, and spring retainer into charge pump adapter. Torque retainer 6.8 to 9.5 N·m [5 to 7 lbf·ft.]

## Disassembly - Charge Pump Adapter Assembly

- 1 Remove spring retainer, spring, and poppet from adapter assembly.

### Inspection:

- Inspect the charge pump relief valve seat inside the charge pump adapter. Check to insure that seat is smooth and free of burrs or other defects.
- Inspect the charge pump relief valve spring.
- Inspect the bearing inside the charge pump adapter. The bearing needles must remain in the bearing cage and bearing at dimension shown in figure 1-2.
- Inspect the gerotor pocket inside the charge pump adapter assembly. It should not be scored excessively.

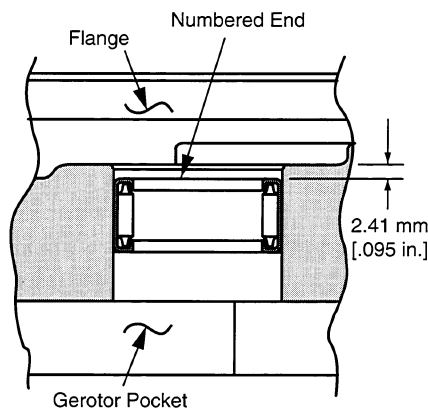
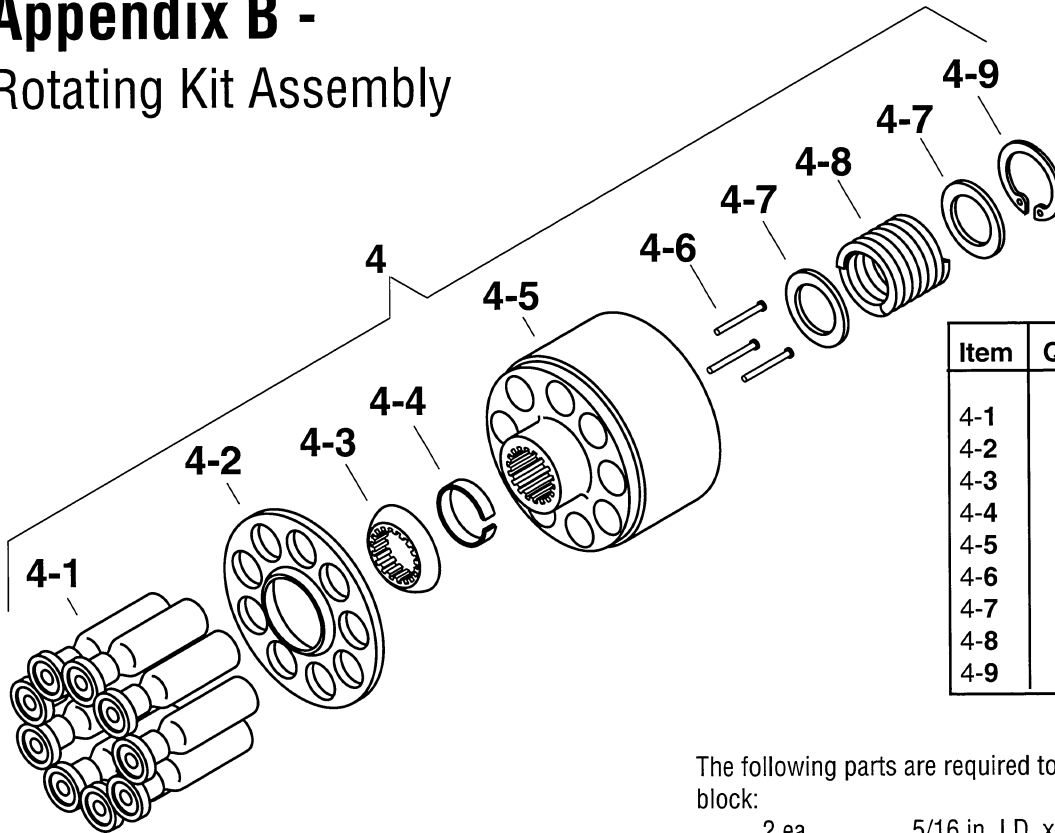


Figure 1-2

# Appendix B - Rotating Kit Assembly



Item	Qty.	Description
4-1	9	Piston assemblies
4-2	1	Spider
4-3	1	Spider Pivot
4-4	1	Retainer
4-5	1	Piston Block
4-6	3	Pins
4-7	2	Washer
4-8	1	Spring
4-9	1	Retaining Ring

## Disassembly - Rotating Kit Assembly

Disassembly of rotating assembly is required for inspection only.

- 1 Remove the nine piston assemblies, spider, and spider pivot from piston block.

### Inspection:

- Examine the O.D. of the pistons for finish condition. They should not show wear or deep scratches. Inspect the shoes for a snug fit on the ball end of the pistons and a flat smooth surface that comes in contact with the camplate. **Do not lap piston shoes.**

- Examine the spider for wear in the pivot area.
- Examine the pivot to insure smoothness and no signs of wear.

- Inspect the piston block surface that makes contact with valve plate. This surface should be smooth and free of deep scratches. **Do not lap piston block.**

- The pistons should move freely in the piston block bore. If not free moving, examine the bore for scoring or contamination.

- 2 To inspect pins and spring **Caution** should be taken in removing spring. The **spring is highly compressed** and the retaining ring should not be removed without compressing the spring safely.

The following parts are required to disassemble the piston block:

- 2 ea. 5/16 in. I.D. x 15/16 in. O.D. flat washers
- 1 ea. 5/16 in. x 2-7/8 in. N.C. cap screw, and
- 1 ea. 5/16 in. N.C. nut

To remove spring, place one of the flat washers over the 5/16 in. x 2-7/8 in. cap screw. Put cap screw through the center of the piston block and apply the second washer. Let washer rest on the three pins and retain with nut. Turning nut and compressing spring inside the block. Use a pair of retaining ring pliers and remove the internal retaining ring. Remove nut, bolt, and the two washers from block. Removing the washer, spring, second washer, three pins, and pin keeper at the same time.

## Reassembly - Rotating Kit Assembly

- 1 To reassemble the rotating kit assembly complete the following: Compress the pin keeper and install in the spline of the piston block. Install the three pins with head end to the inside of the block and position in the special grooves of the piston block spline.

- 2 Install the washer, spring, and second washer into the piston block. Use the two 5/16 in. I.D. washers, nut, and 5/16 in. x 2-7/8 in. cap screw to compress the spring and retain with retaining ring. Remove the nut, cap screw, and the two washers.

- 3 Install the pivot onto the three pins, spider on the pivot, and piston assemblies thru the spider and into piston block, resting on spider.

# Fault - Logic Trouble Shooting

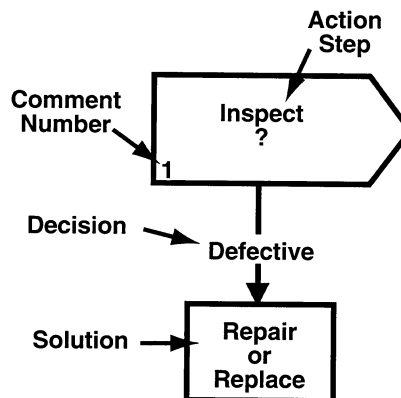
This fault - logic trouble shooting guide is a diagnostic aid in locating transmission problems.

Match the transmission symptoms with the problem statements and follow the action steps shown in the box diagrams. This will give expedient aid in correcting minor problems eliminating unnecessary machine down time.

Following the fault - logic diagrams are diagram action comments of the action steps shown in the diagrams. Where applicable, the comment number of the statement appears in the action block of the diagrams.

## Explanatory Diagram

Symptom:



## Recommended Gauge Locations

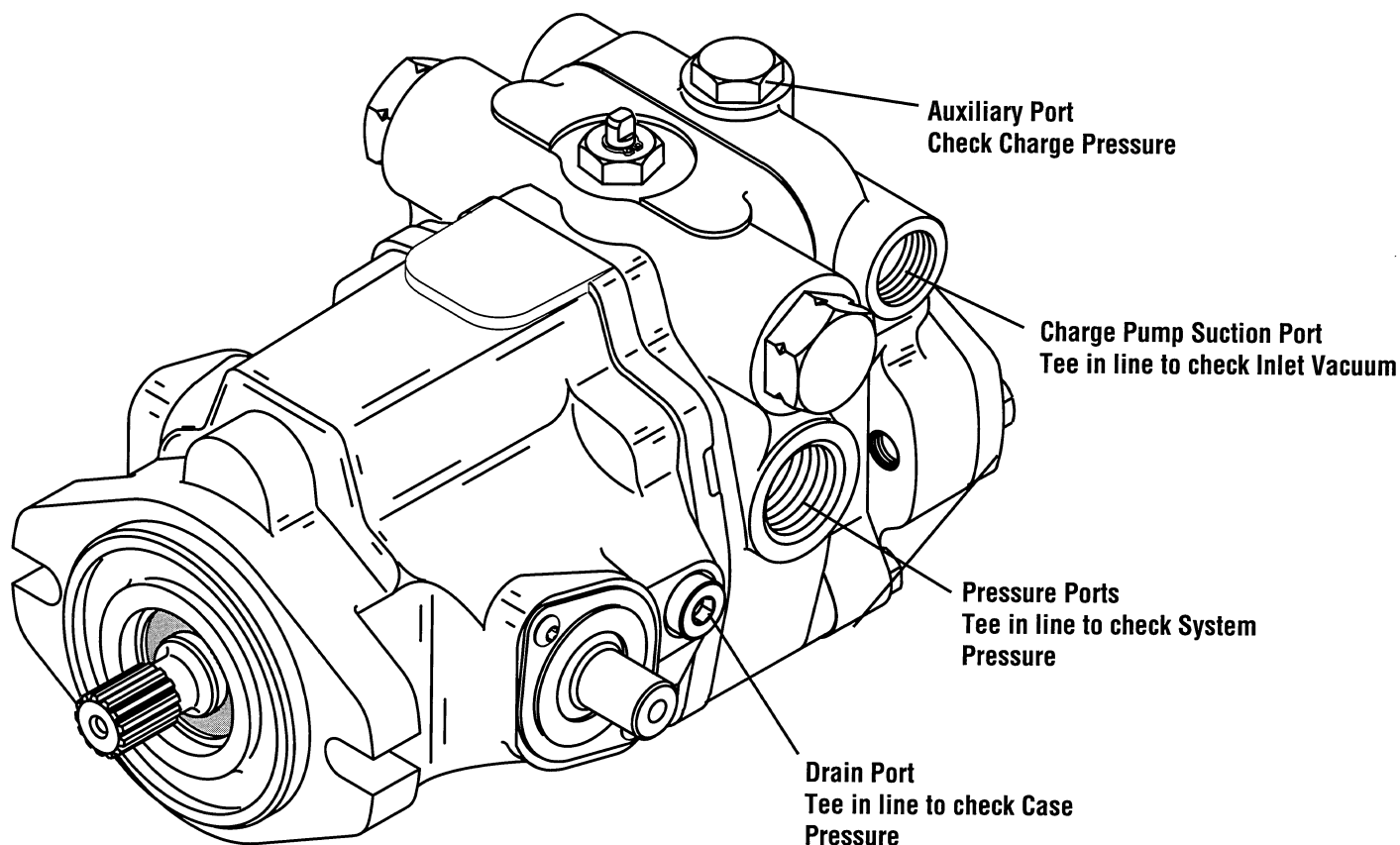


Figure 3-1

## Gauges Recommended

Inlet vacuum gauge: 207 bar to 0 bar [30 lbf/in<sup>2</sup> to 30 inHg]

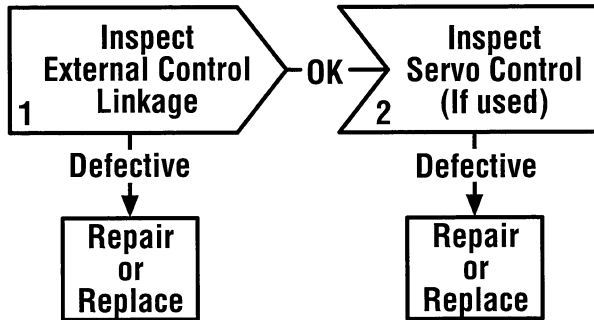
System pressure gauge: 700 bar [10,000 lbf/in<sup>2</sup>]

Charge pressure gauge: 0 to 50 bar [0 to 600 lbf/in<sup>2</sup>]

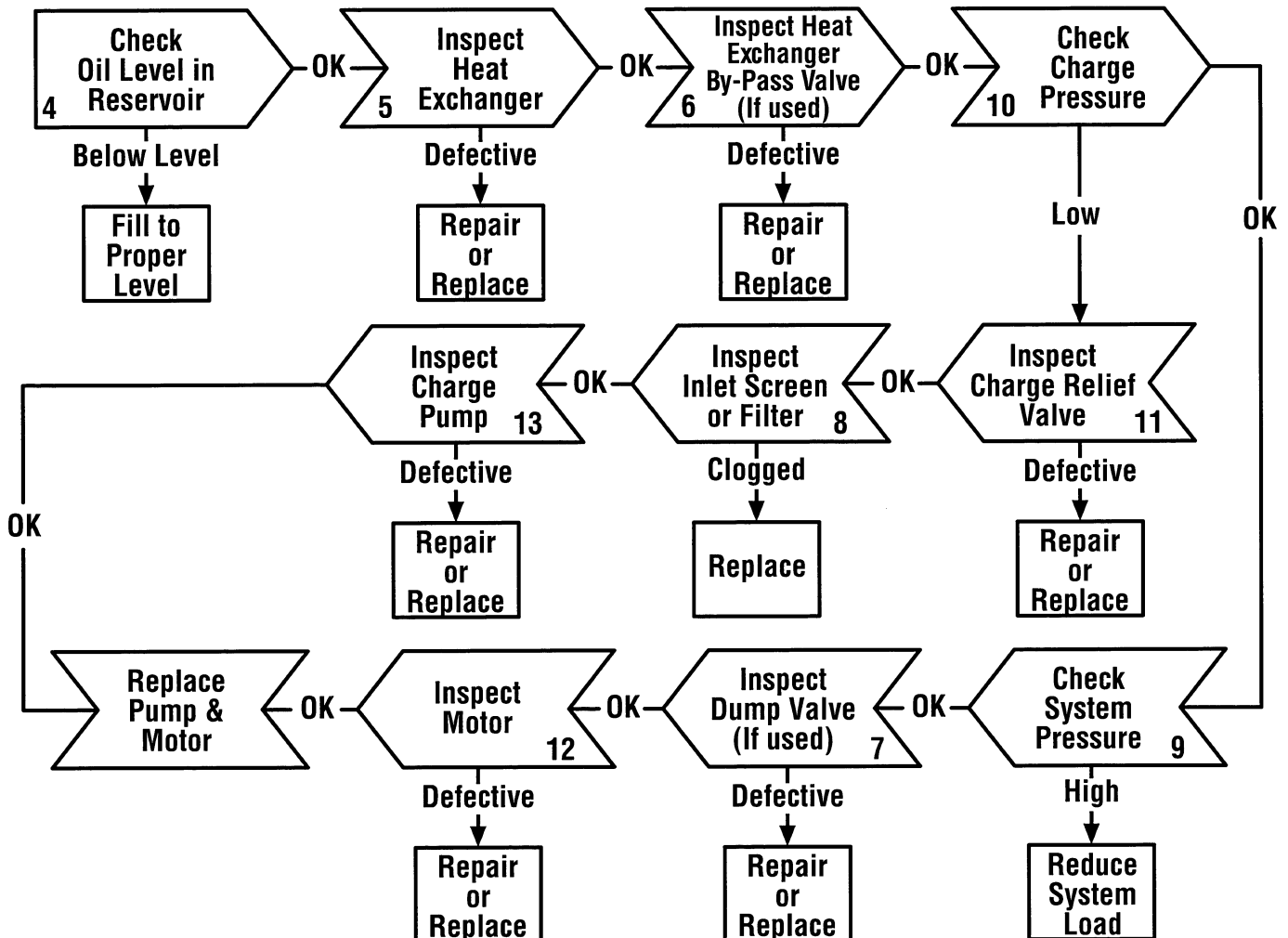
Case pressure gauge: 0 to 25 bar [0 to 300 lbf/in<sup>2</sup>]

# Fault - Logic Trouble Shooting

## Symptom: Neutral Difficult or Impossible to Find



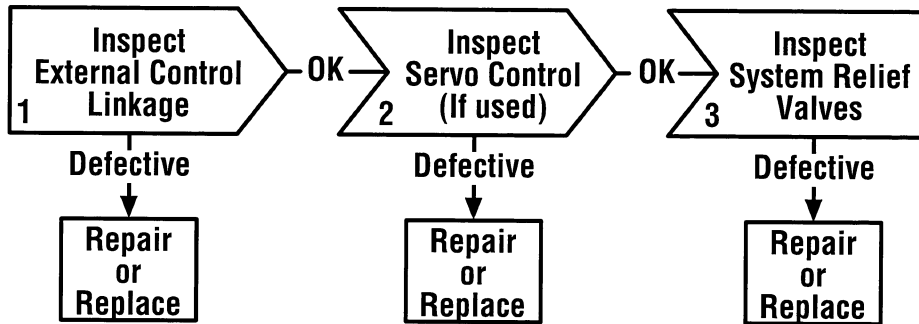
## Symptom: System Operating Hot



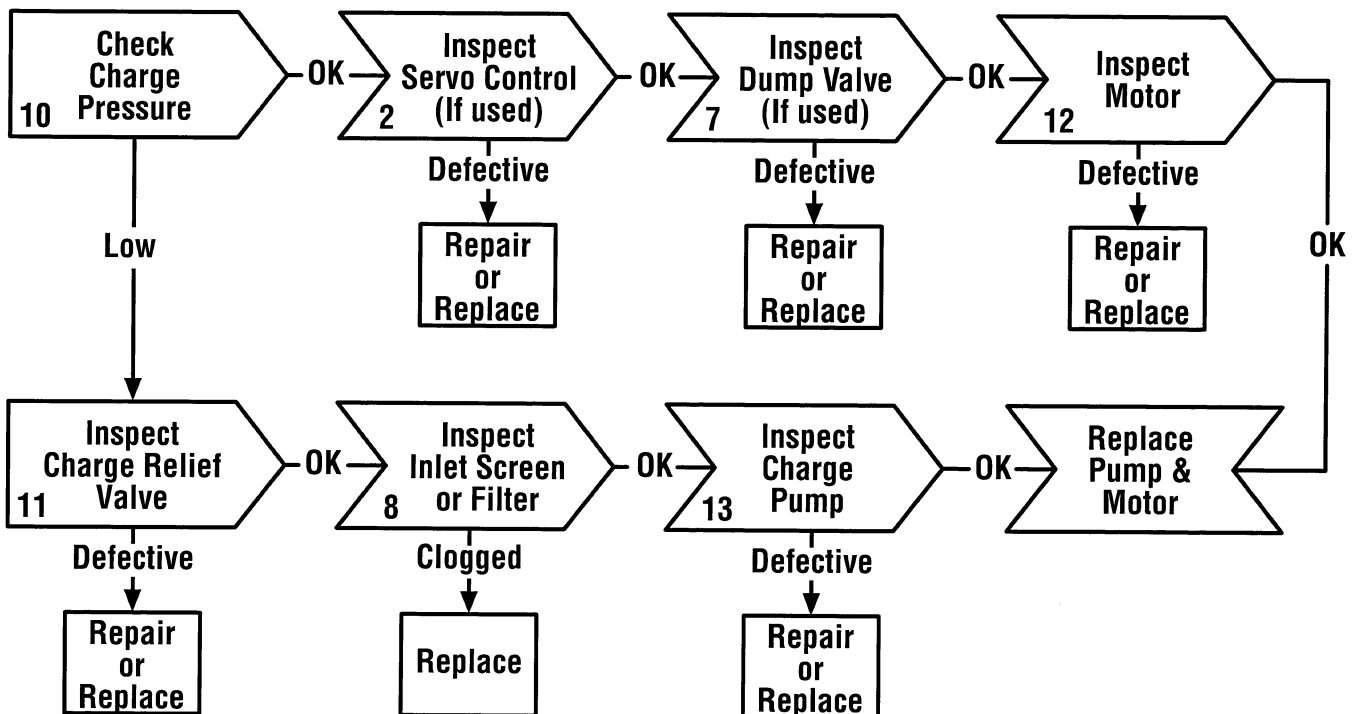
# Fault - Logic

## Trouble Shooting

### Symptom: Operates in One Diection Only



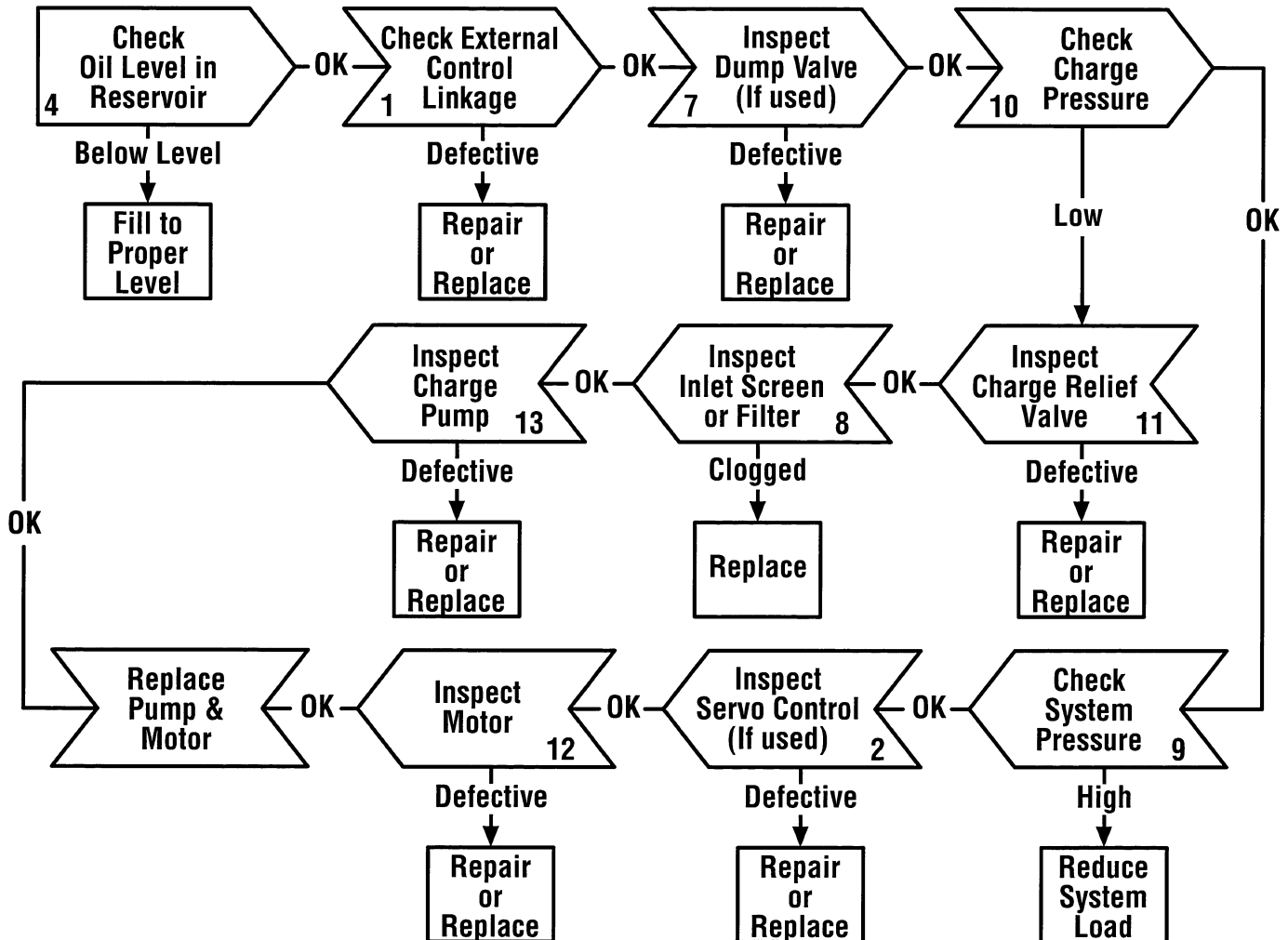
### Symptom: System Response Sluggish





# Fault - Logic Trouble Shooting

## Symptom: System Will Not Operate In Either Direction



# Fault - Logic Trouble Shooting

## Diagram Action Step Comments

- 1 **Inspect External Control Linkage for:**
  - a. misadjusted or disconnected
  - b. binding, bent, or broken
  - c. misadjusted, damaged or broken neutral return spring
- 2 **Inspect Servo Control Valve for: (if used)**
  - a. proper inlet pressure
  - b. misadjusted, damaged or broken neutral return spring
  - c. galled or stuck control spool
  - d. galled or stuck servo piston
- 3 **Inspect System Relief Valves \* for:**
  - a. improper pressure relief setting
  - b. damaged or broken spring
  - c. valve held off seat
  - d. damaged valve seat
- 4 **Check Oil Level in Reservoir:**
  - a. consult owner/operators manual for the proper type fluid and level
- 5 **Inspect Heat Exchanger for:**
  - a. obstructed air flow (air cooled)
  - b. obstructed water flow (water cooled)
  - c. improper plumbing (inlet to outlet)
  - d. obstructed fluid flow
- 6 **Inspect Heat Exchanger By-Pass Valve for: (if used)**
  - a. improper pressure adjustment
  - b. stuck or broken valve
- 7 **Inspect Dump Valve for: (if used)**
  - a. held in a partial or full open position
- 8 **Inspect Inlet Screen or Filter for:**
  - a. plugged or clogged screen or filter element
  - b. obstructed inlet or outlet
  - c. open inlet to charge pump
- 9 **Check System Pressure:**
  - a. See figure 3-1 for location of pressure gauge installation.
  - b. consult owner/operators manual for maximum system relief valve settings
- 10 **Check Charge Pressure:**
  - a. See figure 3-1 for location of pressure gauge installation.
  - b. consult owner/operators manual for maximum charge relief valve settings

- 11 **Inspect Charge Relief Valve for:**
  - a. improper charge relief pressure setting \*
  - b. damaged or broken spring
  - c. poppet valve held off seat
- 12 **Inspect Motor for:**
  - a. disconnected coupling
- 13 **Inspect Charge Pump for:**
  - a. broken or missing drive key
  - b. damaged or missing o-ring
  - c. excessive gerotor clearance
  - d. galled or broken gerotor set

**\* System/Charge Relief Valve  
Pressure Settings for  
Eaton's Variable Displacement  
Controlled Piston Pumps**

Inlet Vacuum	6 inHg max.
Case Pressure	25 lbf/in <sup>2</sup> maximum
Charge Pressure	100 to 150 lbf/in <sup>2</sup> Standard 200 to 250 lbf/in <sup>2</sup> Optional 250 to 300 lbf/in <sup>2</sup> Optional
System Pressure	5000 lbf/in <sup>2</sup> maximum 3000 lbf/in <sup>2</sup> continuous

The high pressure relief valves are all factory preset and cannot be readjusted.

The pressure setting and assembly number is stamped on each high pressure relief valve cartridge.

Valve Identification Example:

32060-IA                      5000

└──────────────────────────┘ Relief Valve Setting

└──────────────────────────┘ Relief Valve Assembly Number

# Start-up Procedure

When initially starting a new or a rebuilt transmission system, it is extremely important that the start-up procedure be followed. It prevents the chance of damaging the unit which might occur if the system was not properly purged of air before start-up.

**1** After the transmission components have been properly installed, fill the pump housing at least half full with filtered system oil. Connect all hydraulic lines and check to be sure they are tight.

**2** Install and adjust all control linkage.

**3** Fill the reservoir with an approved oil that has been filtered through a 10 micron filter. Refer to Eaton Hydraulics Technical Data sheet number 3-401 titled Hydraulic Fluid Recommendations.

**4** Gasoline or L.P. engines: remove the coil wire and turn the engine over for 15 seconds. Diesel engines: shut off the fuel flow to the injectors and turn the engine over for 15 seconds.

**5** Replace the coil wire or return the fuel flow to the injectors. Place the transmission unit in the neutral position, start the engine and run it at a low idle. The charge pump should immediately pick up oil and fill the system. If there is no indication of fill in 30 seconds, stop engine and determine the cause.

**6** After the system starts to show signs of fill, slowly move pump camplate to a slight cam angle. Continue to operate system slowly with no load on motors until system responds fully.

**7** Check fluid level in the reservoir and refill if necessary to the proper level with an approved filtered oil.

**8** Check all line connections for leaks and tighten if necessary.

**9** The machine is now ready to be put into operation.

**10** Frequent filter changes are recommended for the first two changes after placing the machine back into operation. Change the first filter in 3-5 hours and the second at approximately 50 hours approx. hours. Routinely scheduled filter changes are recommended for maximum life of the hydraulic system.

# Notes

# Notes

**Order parts from number 6-632 Parts Information booklet.  
Each order must include the following information.**

1. Product and/or Part Number
2. Serial Code Number
3. Part Name
4. Quantity

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## AIR COOLED GAS ENGINE SERVICE MANUAL

KOHLER CH25

TENNANT Part Number 371687





## **INTRODUCTION**

This section includes repair information on the engine and related systems, such as fuel, electrical, and engine removal.

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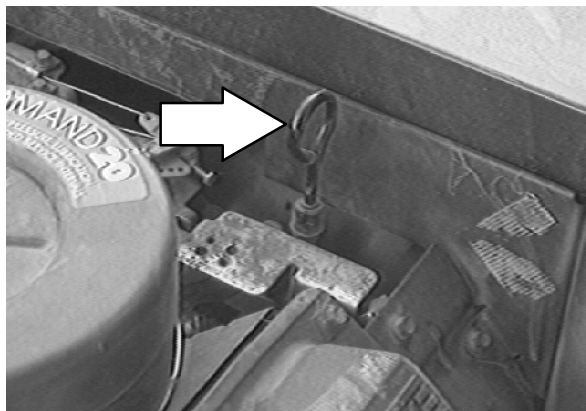
### LUBRICATION

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#### ENGINE OIL

Check the engine oil level daily. Change the engine oil and oil filter every 100 hours of machine operation. Use 10W30 SAE-SG/SH rated engine oil.

Fill the engine with oil to the level indicated on the oil dipstick. The engine oil capacity is 1.9 L (2 qt) including the oil filter.



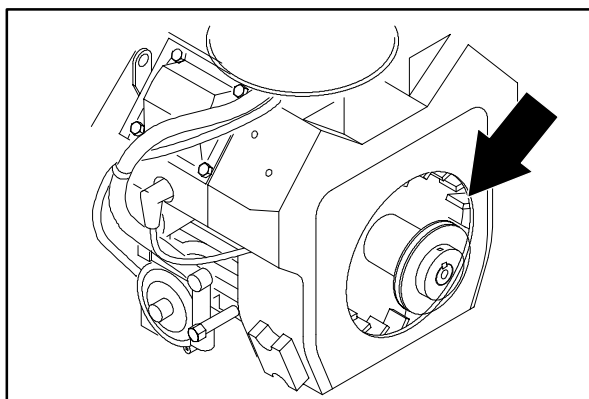
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### COOLING SYSTEM

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This engine is air cooled and does not have any anti-freeze coolant or a radiator. The flywheel mounted fan blows air over the engine cylinders and head to remove engine heat.

The cooling fins should be cleaned every 100 hours by blowing compressed air across them.



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## AIR INTAKE SYSTEM

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### AIR FILTER

The engine air filter is made up of two parts, a precleaner element and the air filter element. The precleaner element must be cleaned and re-oiled after every 25 hours of operation. The air filter element should be cleaned or replaced after every 100 hours of operation. The filter element must be replaced if it is damaged or has been cleaned three times.

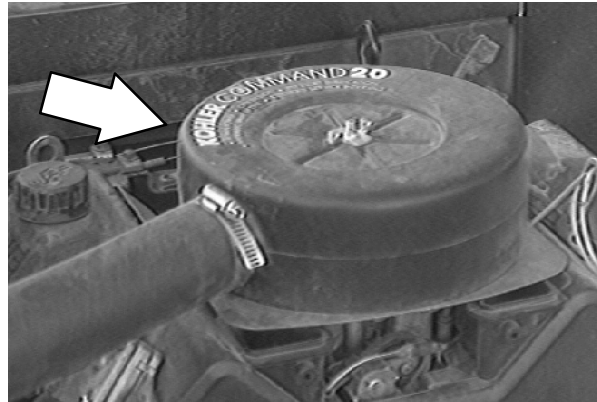
To clean the filter elements, remove the air filter cover. Remove the precleaner element, wash in liquid detergent and water, and squeeze it dry in a cloth. Remove the air filter element nut and inner cover, then remove the air filter element. Carefully clean the covers and the interior of the housing with a damp cloth. Clean the housing sealing surfaces.

Using an air hose, direct clean, dry air, maximum 205 kPa (30 psi), up and down the pleats on the inside of the element. Do not rap, tap or pound dust out of the element.

**FOR SAFETY: When servicing machine, wear eye and ear protection if using pressurized air or water.**

After cleaning the air filter element, inspect it for damage by placing a bright light inside. The slightest rupture requires replacement of the element. Inspect the seals on the ends of the element. They should be flexible and undamaged.

Oil the precleaner element with 30 cc (1 oz) of clean engine oil. Squeeze precleaner element to distribute the oil evenly throughout the foam.

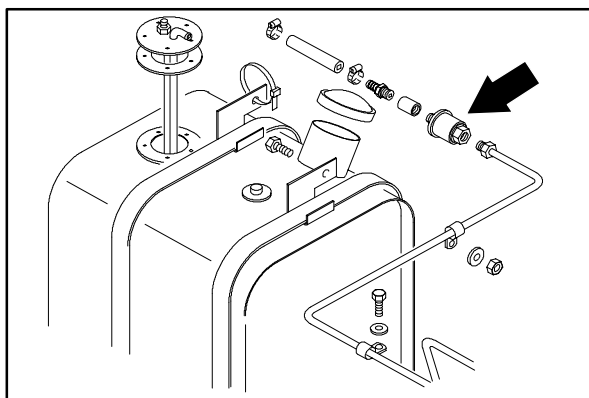
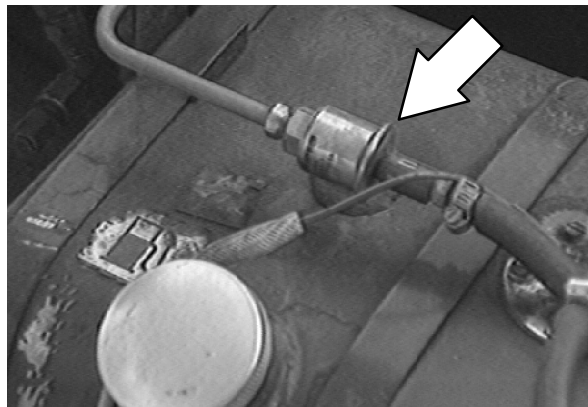


### FUEL SYSTEM - GASOLINE

#### FUEL FILTERS

The fuel filter trap fuel contaminants. The filter is located on the fuel line going into the carburetor.

Replace the filter elements every 400 hours of operation.

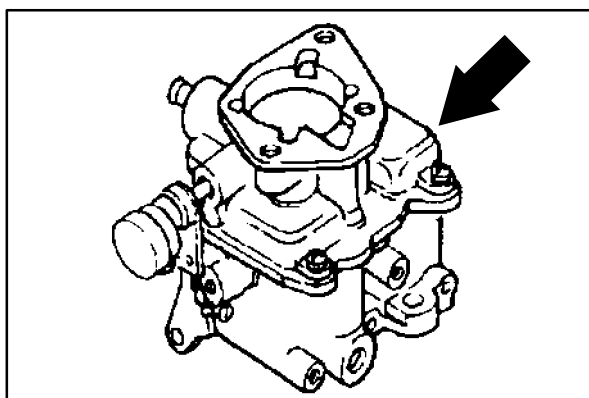


#### CARBURETOR

The carburetor has two basic adjustments. Those adjustments are idle fuel mixture and idle speed. Check and adjust idle fuel mixture and idle speed every 100 hours of operation.

**FOR SAFETY: When Servicing Machine, Keep Flames And Sparks Away From Fuel System Service Area. Keep Area Well Ventilated.**

The idle speed is controlled by a screw located on the side of the carburetor next to the throttle linkage. Increase the engine speed by turning the screw clockwise. Decrease the engine speed by turning the screw counter-clockwise. Idle speed is 1200 RPM + or - 50 RPM.



## FUEL SYSTEM - LPG

The liquid withdrawal LPG fuel system has up of five components: the LPG fuel tank, pressure relief valve, fuel filter lock, vaporizer-regulator, and the carburetor.

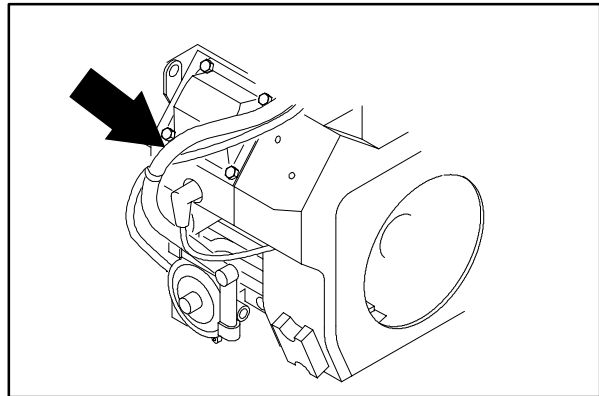
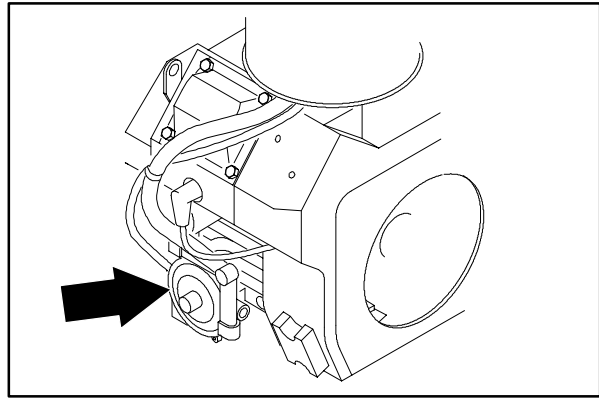
Liquid LPG fuel flows from the LPG tank under its own pressure, to the pressure relief valve. Usually this valve is closed, preventing LPG fuel from escaping into the atmosphere. The valve opens to relieve pressure if the fuel pressure exceeds system limits. From the pressure relief valve, the liquid LPG fuel flows to the fuel filter lock.

The fuel filter lock filters unwanted tank scale and deposits out of the LPG fuel. The fuel filter lock also stops the flow of LPG fuel when the engine is not operating. The LPG is operated with engine vacuum.

The vaporizer section of the vaporizer-regulator converts the liquid LPG fuel into a gaseous LPG fuel. From the vaporizer section, the gaseous LPG fuel is sent to the primary regulator section of the vaporizer-regulator. The primary regulator section reduces the pressure of the LPG fuel. The secondary regulator section reduces the LPG fuel pressure to the level required by the carburetor. From the vaporizer-regulator, the LPG fuel is sent to the carburetor where it is finally metered into the air flow sent to the engine combustion chamber.

Never operate an LPG powered machine if the LPG fuel system is leaking, or if any component in the fuel system is malfunctioning. Operating the machine under either of these conditions may cause a fire or explosion.

Check for frosting. If frosting occurs on or near any LPG component, there is a possible LPG fuel leak or malfunctioning component.

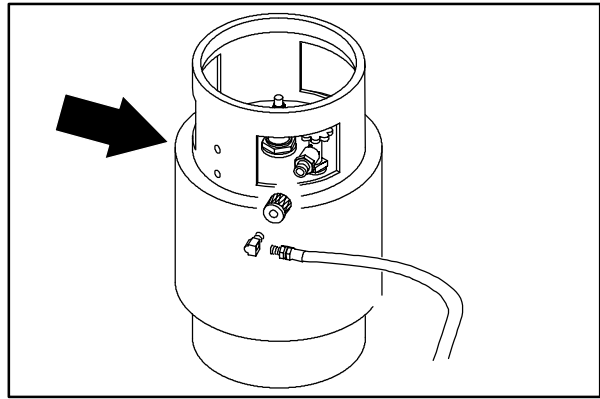


To locate the leak, apply a soapy water solution to the suspected area. Watch for bubbles forming in this suspected area. This area may have an LPG fuel leak. Repair or replace the part. Use Loctite brand Stainless Steel PST thread sealant when reassembling. Aging or high humidity does not affect this epoxy-type sealant. Be sure to follow application directions and apply proper torque when reconnecting fittings. Never bypass safety components except to test. If they are defective, replace them before operating the machine. Frosting does not occur before the engine reaches operating temperature. Check after engine reaches operating temperature.

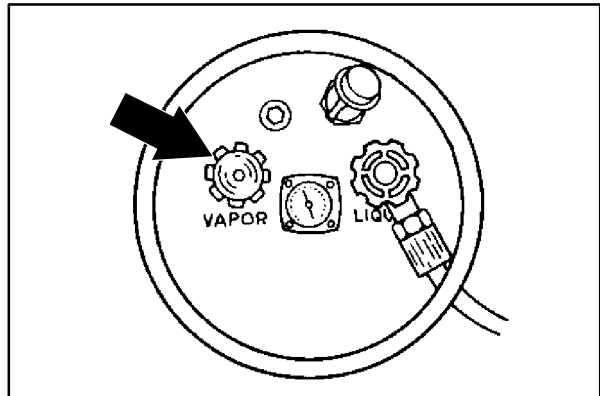
Check routings of all LPG hoses. Keep them away from sharp edges, exhaust manifolds, or other hot surfaces. Check for signs of abrasion or deterioration. Replace worn or damaged hoses.

## LP FUEL TANK

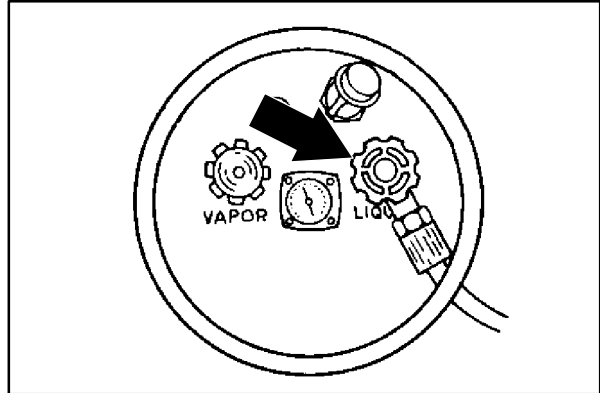
The LPG fuel tank should be inspected for sharp dents, gouges, leaks, and broken protecting rings whenever the tank is refilled. All tank valves must be inspected for leaks using a soap solution. Valves must also be checked for dirt, paint, or other debris in the valve openings. The following specific checks must also be made:



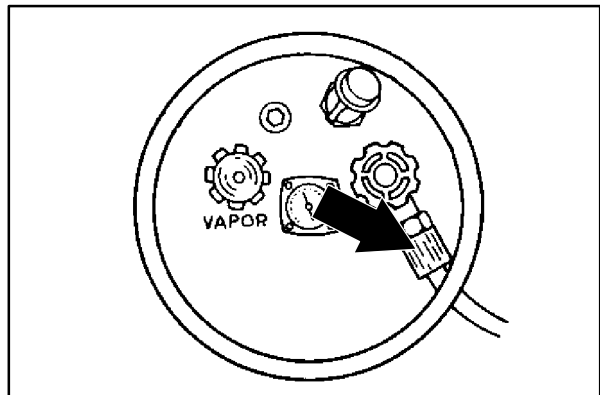
**Filler Valve** – Check the valve for proper functioning and the presence of the handwheel. Valve must be closed except during filling.



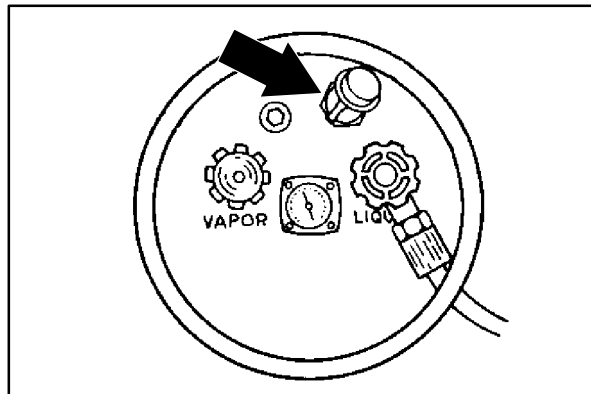
**Liquid Service Valves** – Check the valve for proper functioning and presence of the handwheel. The valve must be closed except when in service.



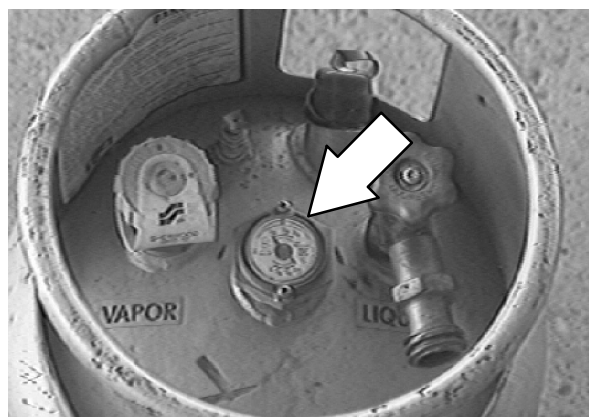
**Tank Service Valve Coupling** – Check for proper functioning, thread condition, and damaged or missing washers or o-rings.



**Safety Relief Valve** – Check for damage. Check for the presence of the relief valve elbow and the proper direction of the elbow. If the rain cap is missing, check for foreign matter and replace the rain cap. Do not tamper with the relief valve setting.



**Magnetic Liquid Level Gauge** – Check the operation against the maximum filling point as determined by weight.





An LPG fuel tank with any of the stated defects must be removed from service and be repaired or destroyed accordingly.

If an LPG fuel tank is damaged or leaking, it should be removed to a designated safe area. Do not attempt to make repairs to the tank, regardless of condition. Qualified personnel must make repairs or disposal.

The care an LPG fuel tank receives has a direct bearing on how long that tank can be used safely. LPG fuel tanks must not be dropped or dragged across any surface. To move LPG fuel tanks, use a hand truck or roll the tank on its foot ring while it is being held in a position slightly off the vertical.

Whether the storage is inside or outside, fuel tanks should not be stored near combustible materials or high temperature sources such as ovens and furnaces, since the heat may raise the pressure of the fuel to a point where the safety relief valves would function. Store the tanks in a way that if the safety relief valves do function, they will relieve vapor and not liquid.

Valves on empty tanks must be closed during storage and transportation.

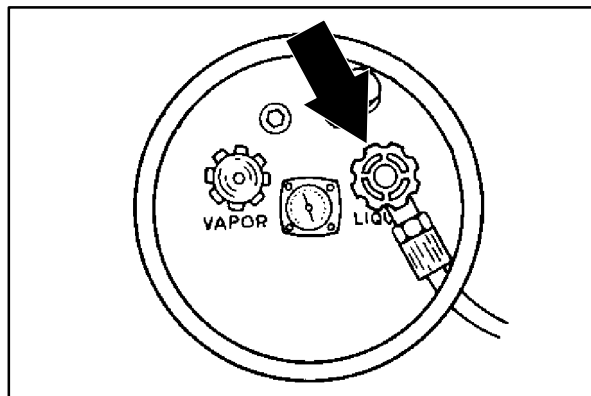
Similar precautions should be taken in storing machines fitted with LPG fuel tanks. The machines may be stored or serviced inside buildings, provided there are no leaks in the fuel system and the tanks are not overfilled. While machines are being repaired inside a building, the shut-off valve on the tank must be closed, except when the engine has to be operated.

Changing the tank is a chance for the machine operator to carefully check over the tank, fittings, and the fuel lines and fittings. If abnormal wear is detected, report the findings to the appropriate personnel.

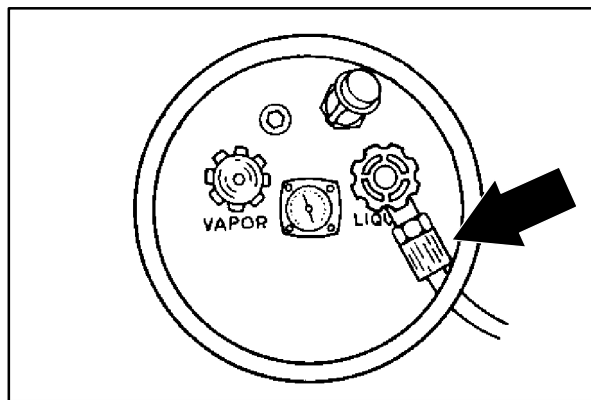
### TO CHANGE AN LPG FUEL TANK

1. Park the machine in a designated safe area.
2. Close the tank service valve.
3. Operate the engine until it stops from lack of fuel, then set the machine parking brake.

**FOR SAFETY: Before Leaving Or Servicing Machine: Stop On Level Surface, Set The Parking Brake, Turn Off Machine And Remove Key.**



4. Put on gloves and remove the quick-disconnect tank coupling.
5. Inspect the LPG fuel lines for wear or damage.
6. Remove the empty LPG fuel tank from the machine.
7. Check the tank for damage or wear.
8. Store the tank in a designated, safe area.
9. Select a filled LPG fuel tank and inspect it for damage or leaks.

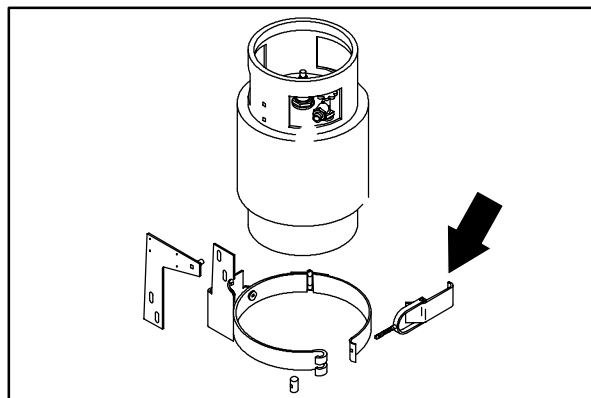


**NOTE: Make sure the LPG fuel tank matches the fuel system (liquid tank with liquid system).**

10. Carefully put the LPG tank in the machine so that the tank centering pin enters the aligning hole in the tank collar.

**NOTE: If you cannot line up the centering pin, make sure you have the correct LPG fuel tank and then adjust the pin locator in or out.**

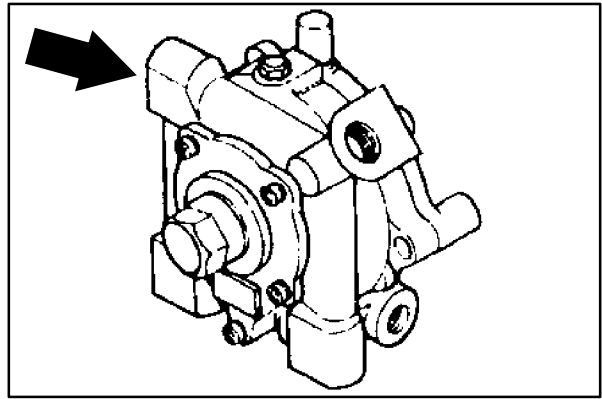
11. Fasten the tank hold-down clamp to lock the tank in position.
12. Connect the LPG fuel line to the tank service coupling. Make sure the service coupling is clean and free of damage. Also make sure it matches the machine service coupling.
13. Open the tank service valve slowly and check for leaks. Close the service valve immediately if an LPG leak is found, and tell the appropriate personnel.
14. If no leaks are found, the engine is ready to start.



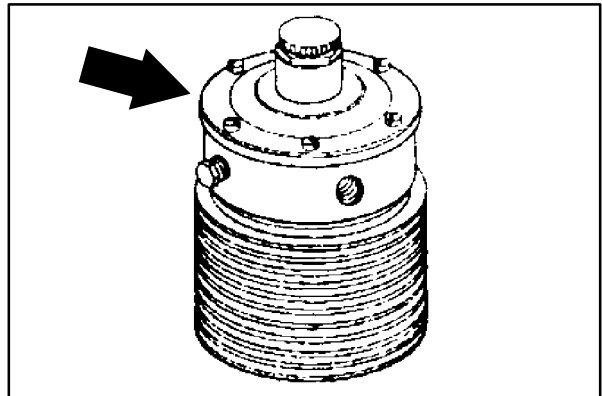
**REGULATOR**

If any malfunction is found, completely disassemble the regulator. Clean all the parts in alcohol.

Inspect all the parts and replace where needed. Carefully reassemble the regulator with the seal repair kit. Check for proper operation.

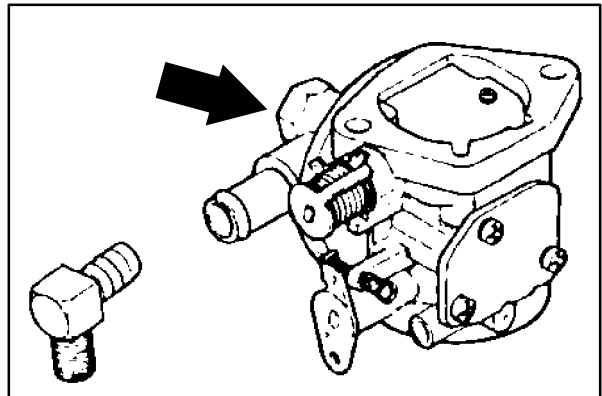
**VAPORIZER**

The vaporizer is mounted on the engine shroud. The hot air from the engine flows over the vaporizer.

**CARBURETOR**

If any malfunction is found, completely disassemble the carburetor. Clean all the parts in alcohol.

Inspect all the parts and replace where needed. Carefully reassemble the carburetor with the seal repair kit.



**LPG FUEL TROUBLESHOOTING**

<b>Problem</b>	<b>Cause</b>	<b>Remedy</b>
<i>Engine will not start</i>	Out of fuel	Replace fuel tank with full one
	Service valve opened too quickly - check valve stopped fuel flow	Close service valve and reopen slowly
	Plugged fuel filter	Replace filter
	Kinked or restricted fuel line	Straighten or replace fuel line
	Engine out of tune	Tune-up engine
	Oil pressure switch failure	Replace oil pressure switch
	Fuel lock valve failure	Repair or replace fuel filter lock
	Vaporizer-regulator failure	Repair or replace vaporizer-regulator
<i>Engine runs unevenly or lacks power</i>	Wrong type of fuel tank - vapor withdrawal tank	Replace vapor withdrawal tank with liquid withdrawal tank
	Plugged fuel filter	Replace filter
	Kinked or restricted fuel line	Straighten or replace fuel line
	Engine out of tune	Tune-up engine
	Restricted air filter	Clean or replace air filter element
	Vaporizer-regulator out of adjustment	Adjust vaporizer-regulator

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**CYLINDER HEAD**

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See Kohler engine service manual at the end of this section.

**VALVE TAPPET CLEARANCE**

See Kohler engine service manual at the end of this section.

**CRANKCASE VENTILATION SYSTEM**

Clean the crankcase ventilation hoses, tubes, and fittings and replace the PCV valve every 400 hours of operation.

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**GOVERNOR**

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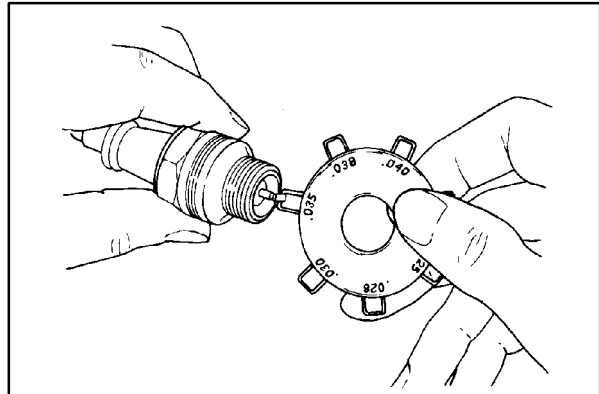
The mechanical governor controls engine speed.  
The governor should never need to be adjusted.

## IGNITION SYSTEM

### SPARK PLUGS

Clean or replace, and set the gap of the spark plugs every 400 hours of operation. A wire gauge is best for checking the spark plug gap. A flat gauge should not be used unless the electrode surfaces have been dressed with a small file to get parallel surfaces between the center and side electrode. Set the spark plug gap by bending the side electrode. All spark plugs, new or used, should have the gaps checked and reset if necessary.

The proper spark plug gap is 1 mm (0.040 in).



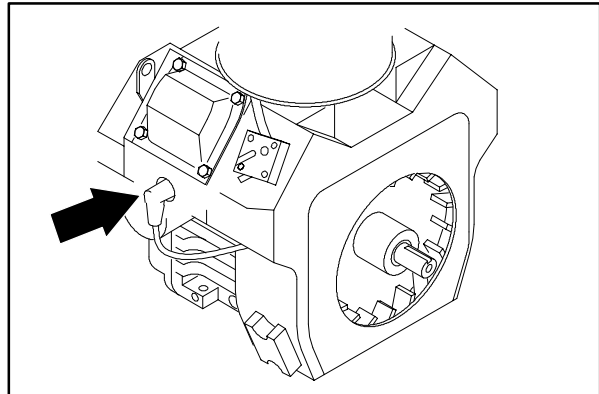
### TO REPLACE SPARK PLUGS

**FOR SAFETY: Before Leaving Or Servicing Machine: Stop On Level Surface, Set The Parking Brake, Turn Off Machine And Remove Key.**

1. Open the seat support.
2. Remove the spark plug wires from the two spark plugs.

*NOTE: Clean any dirt from the spark plug seat area before removing the spark plugs.*

3. Remove the spark plugs from the engine
4. Clean the spark plug seat in the cylinder head.
5. Use a new seat gasket and screw the plug in by hand.
6. Tighten the spark plugs with a socket wrench of the correct size.



### TO REPLACE ALTERNATOR

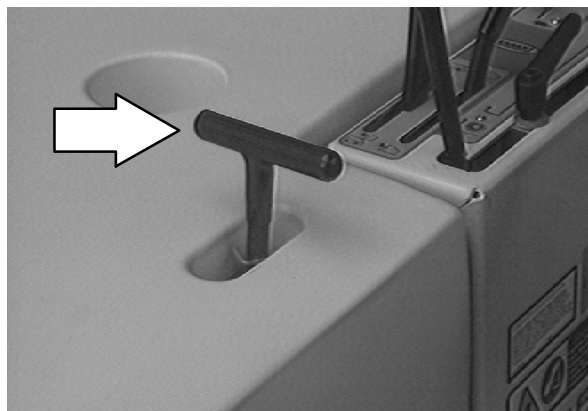
**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

The alternator on this engine is located internally. The engine flywheel must be removed for access to the alternator.

### TO REPLACE STARTER

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

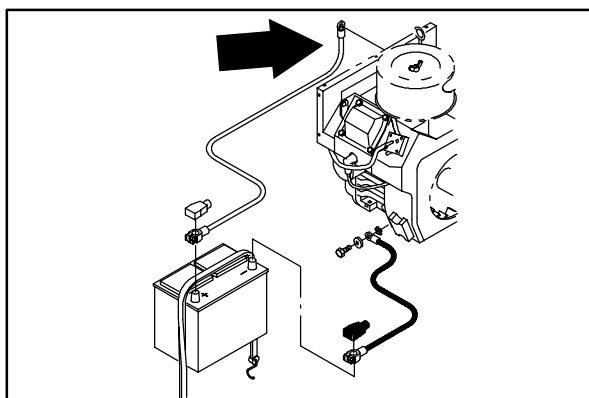
1. Open the seat support.



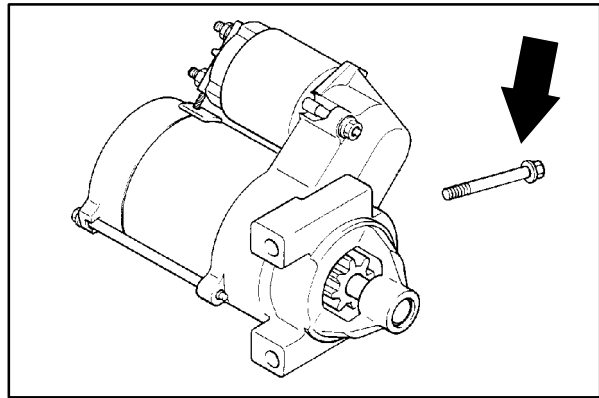
2. Disconnect the battery cables.



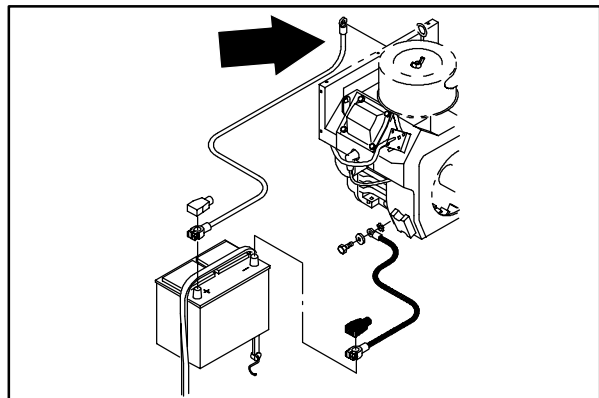
3. Disconnect the wires leading to the back of the starter.



4. Remove the two hex screws holding the starter to the engine block.
5. Pull the starter straight out of the engine shrouding and remove it from the machine.
6. Install the new starter in the machine. Align the two holes in the starter with the holes in the block. Reinstall the two hex screws and tighten to



7. Reconnect the wires to the back of the starter. See the schematic in the ELECTRICAL section.



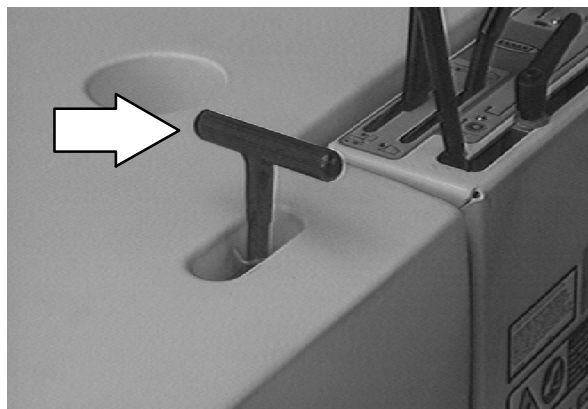
8. Reconnect the battery cables and start the engine. Check the starter for proper operation.



### TO REMOVE ENGINE

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake., Turn Off Machine And Remove Key.**

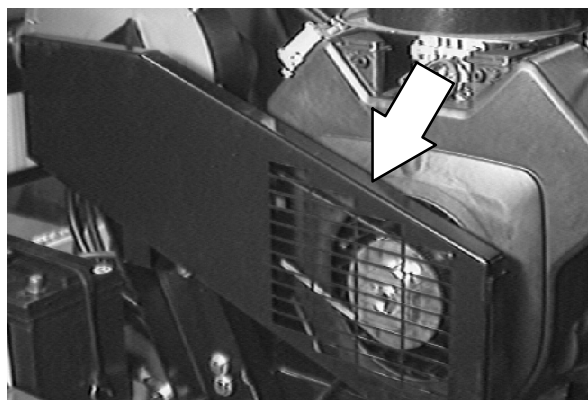
1. Open the seat support.



2. Disconnect the battery cables.

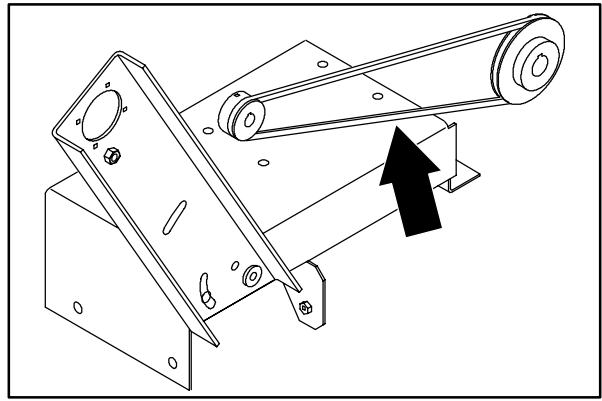


3. Remove the belt guard on the out side of the engine.

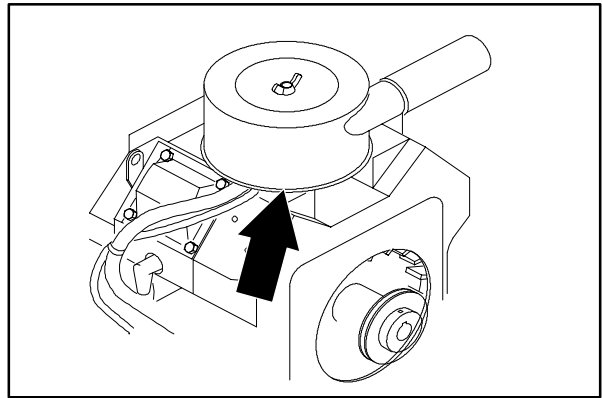




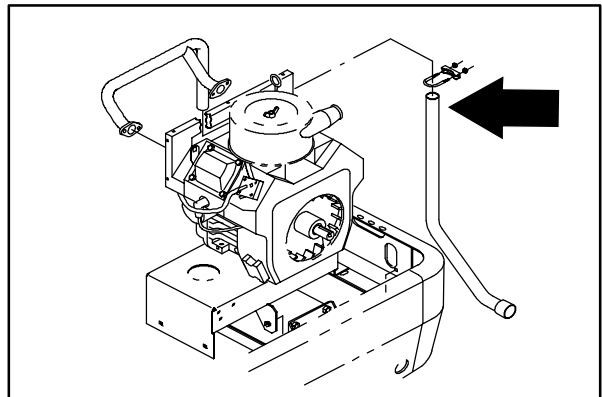
4. Loosen the vacuum fan assembly and remove the V-belt from the engine and fan assembly.



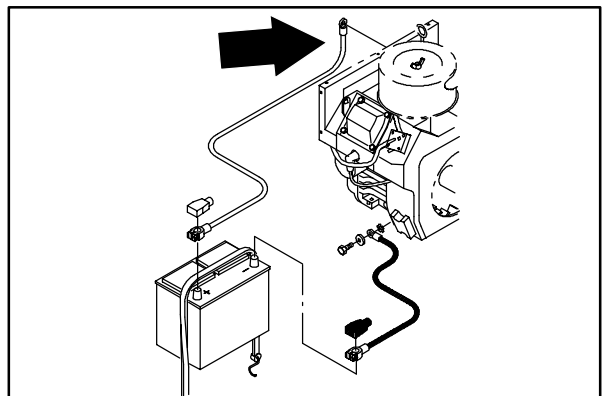
5. Disconnect the throttle cable and choke cable from the engine.



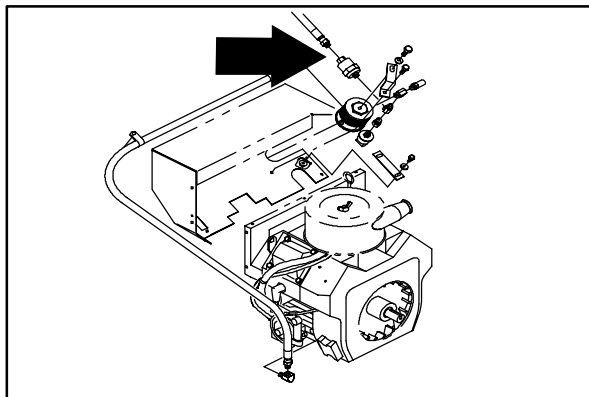
6. Remove the muffler clamp holding the exhaust pipe to the engine manifold. Slip the pipe down off the manifold.



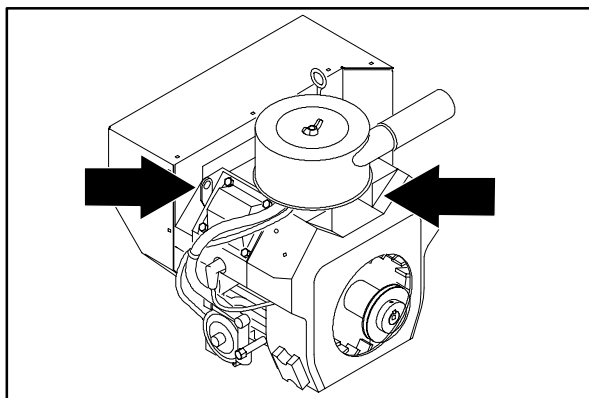
7. Disconnect the wire harness from the starter and engine. Move the wires out of the way for engine removal.



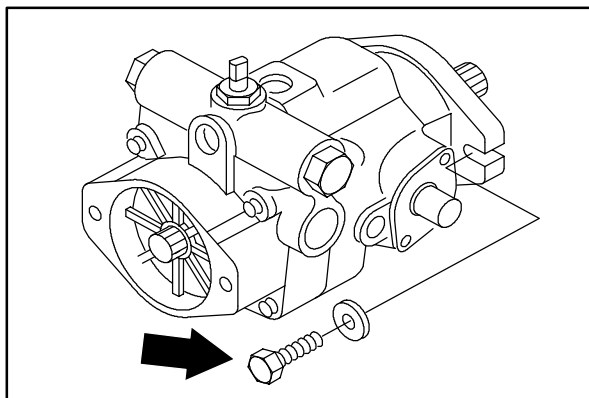
8. Disconnect the fuel line at the engine mounted fuel pump on the **gas machine**. On an **LPG machine**, disconnect the line from tank at fuel lockoff / vaporizer.



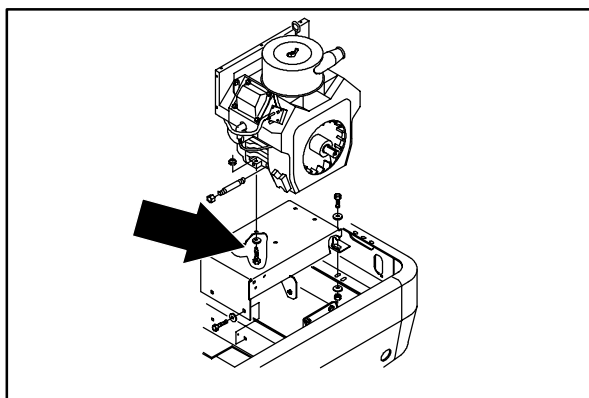
9. Using an overhead hoist, hook a chain through the two pick-up points on the top of the engine. Put a slight amount of tension on the chain.



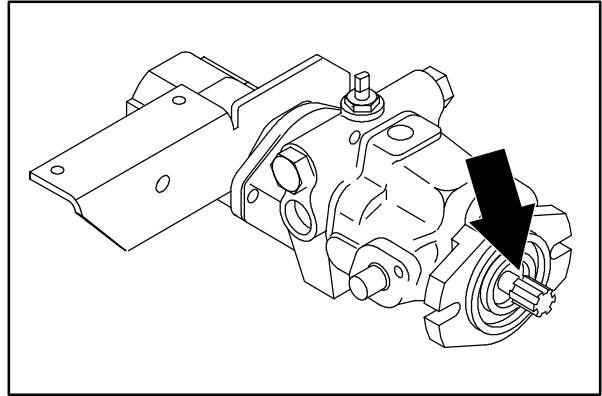
10. Remove the two hex screws holding the propel pump/Accessory pump assembly to the back of the engine.
11. Remove the clamp holding the propel hoses to the back of the engine.



12. Remove the four hex screws holding the engine to the engine mount plate.

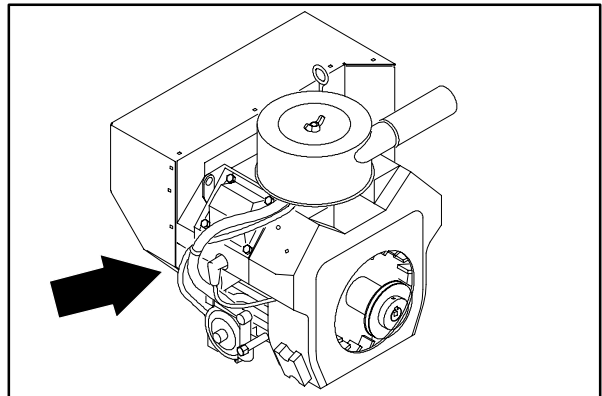


13. Pull the engine out of the propel pump/accessory pump assembly.



14. The engine can now be carefully removed from the machine.

*NOTE: Make sure the engine is clear of any wires or hoses before you lift it out of the machine.*

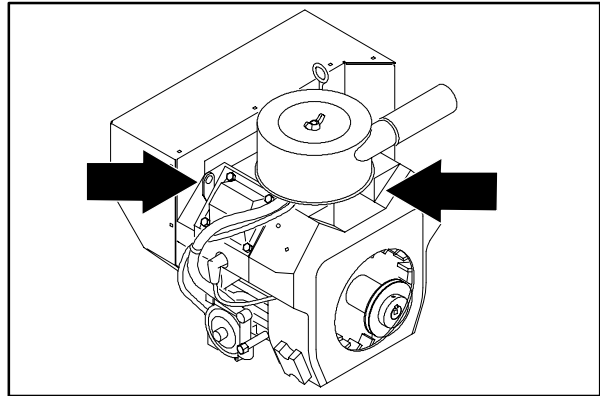


### TO INSTALL ENGINE

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake., Turn Off Machine And Remove Key.**

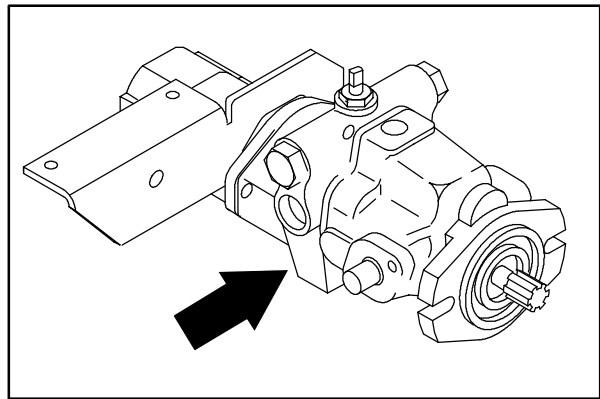
1. Using an overhead hoist, hook a chain through the two pick-up points on top of the engine. Carefully position the engine back in the engine compartment.

*NOTE: Make sure the hoses, wire harness, exhaust pipe and propel pump are pulled back out of the way when lowering engine assembly into place.*

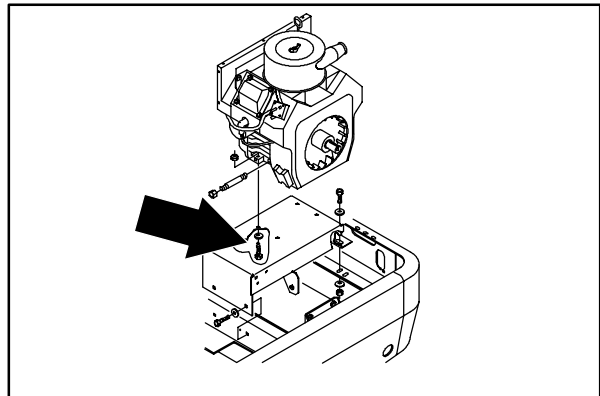


2. Position the engine in the area of the propel pump/accessory pump assembly. Slip the pump assembly in the engine coupling. Reinstall the two hex screws and tighten to 37 - 48 Nm (26 - 34 ft lb).

*NOTE: Make sure the splines on pump line up with splines in coupler when installing pump.*



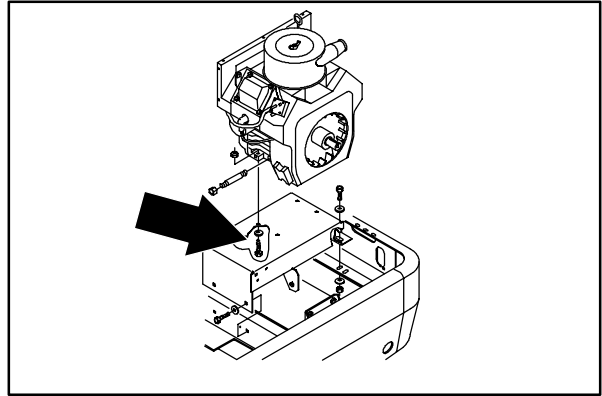
3. Carefully align the mount holes in the engine block with the mount holes in the engine mount plate.



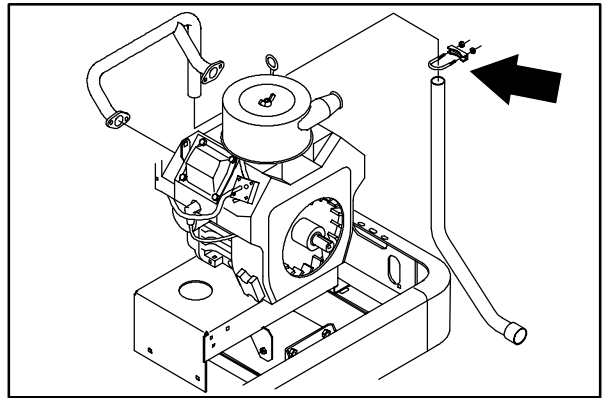
4. Reinstall the four hex screws in the engine mount holes and through the mount plate. Tighten to 37 - 48 Nm (26 - 34 ft lb).

*NOTE: Make sure the ground cable is reinstalled under the front right engine mount screw.*

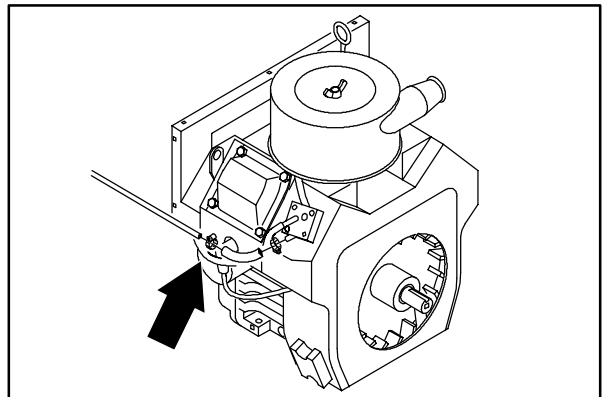
5. Remove the hoist from the engine.



6. Reinstall exhaust pipe back on the engine manifold. Reinstall the muffler clamp and hand tighten tight.



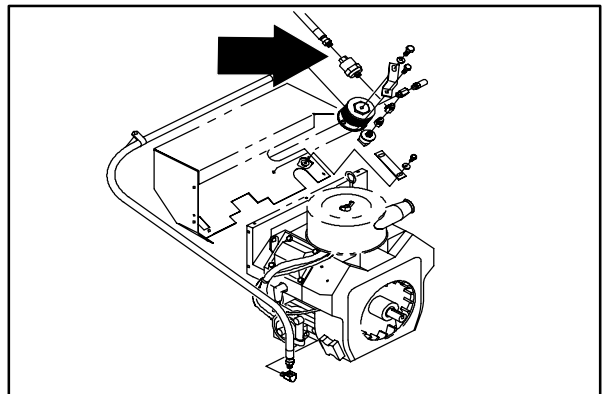
7. Reconnect the gas line to the engine mounted fuel pump.



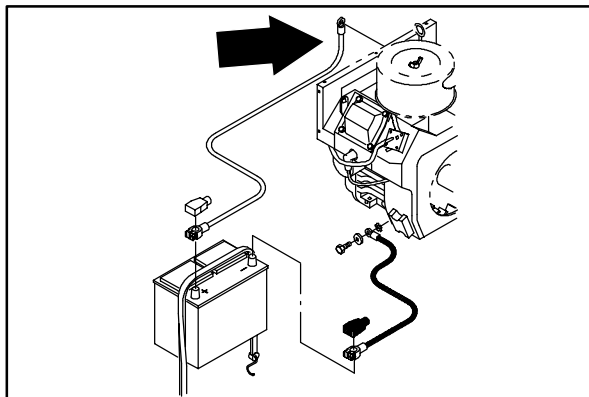
8. Reconnect the LPG line to the fuel lock-off.

9. Reconnect the throttle cable and choke cable.

10. Reinstall the clamp with the propel hoses on the back of the engine.

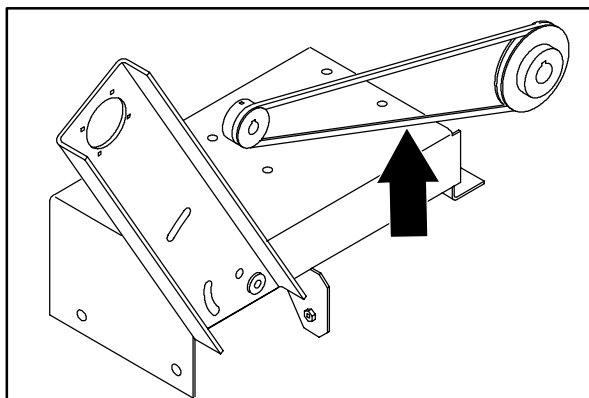


11. Reconnect the wire harness to the engine and starter. Use the schematic in the ELECTRICAL section of this manual if needed.

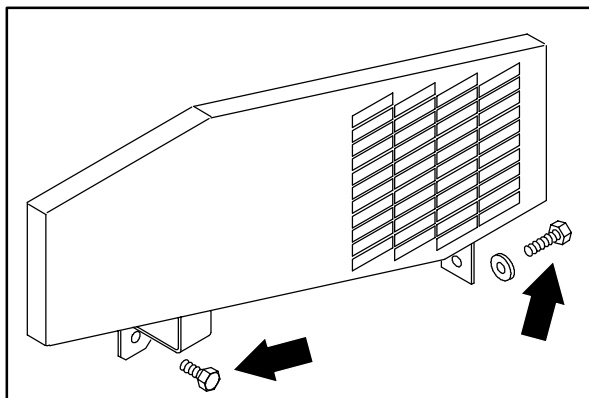


12. Reinstall the V-belt on the engine pulley leading to the vacuum fan assembly. Align and tension the V-belt. See TO TENSION VACUUM FAN BELT (air cooled) instructions in the SWEEPING section.

*NOTE: Use a straight edge to make sure the sheave on the engine is in line with the sheave on the vacuum fan assembly.*



13. Reinstall the belt guard on the out side of the engine.



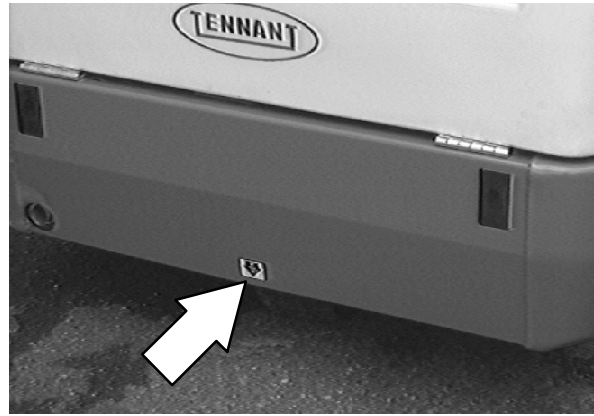
14. Reconnect the battery cables to the battery.



15. Raise the rear of the machine and place jack stands under the machine frame.

**FOR SAFETY: Block machine tires before jacking machine up. Jack machine up at designated locations only. Block machine up with jack stands.**

16. Start the engine and check for any leaks and proper operation.







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**LIQUID COOLED GAS ENGINE SERVICE  
MANUAL****KUBOTA GW750B  
TENNANT Part Number 385999**



**INTRODUCTION**

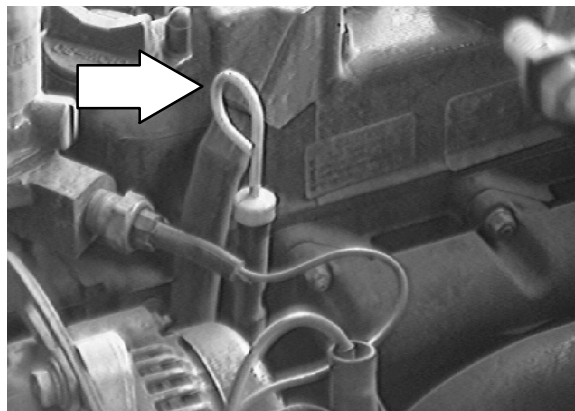
This section includes repair information on the engine and related systems, such as fuel, electrical, and engine removal.

### LUBRICATION

#### ENGINE OIL

Check the engine oil level daily. Change the engine oil and oil filter every 100 hours of machine operation. Use 10W30 SAE-SG/SH rated engine oil.

Fill the engine with oil to the level indicated on the oil dipstick. The engine oil capacity is 3.3 L (3.5 qt) including the oil filter.

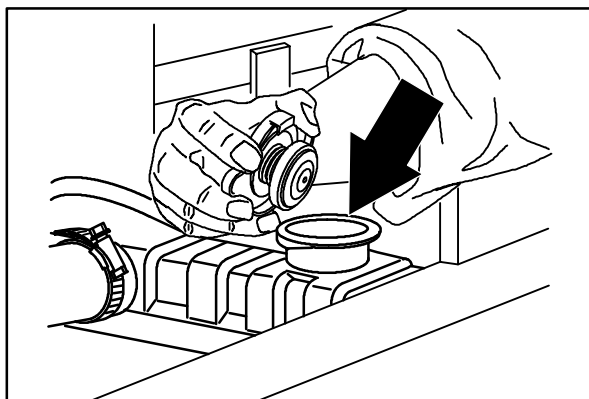


### COOLING SYSTEM

Check the radiator coolant level every 100 hours of operation. Use clean water mixed with a permanent-type, ethylene glycol antifreeze to a  $-34^{\circ}\text{C}$  ( $-30^{\circ}\text{F}$ ) rating.

**FOR SAFETY: When Servicing Machine, Avoid Contact With Hot Engine Coolant.**

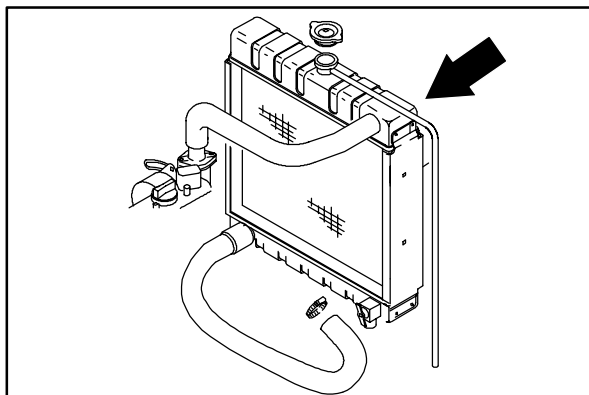
Check the radiator hoses and clamps every 200 hours of operation. Tighten the clamps if they are loose. Replace the hoses and clamps if the hoses are cracked, harden, or swollen.



Check the radiator core exterior and hydraulic cooler fins for debris every 100 hours of operation. Blow or rinse all dust, which may have collected on the radiator, in through the grille and radiator fins, opposite the direction of normal air flow. The grille and hydraulic cooler open for easier cleaning. Be careful not to bend the cooling fins when cleaning. Clean thoroughly to prevent the fins becoming encrusted with dust. Clean the radiator and cooler only after the radiator has cooled to avoid cracking.

**FOR SAFETY: When Servicing Machine, Wear Eye And Ear Protection When Using Pressurized Air Or Water.**

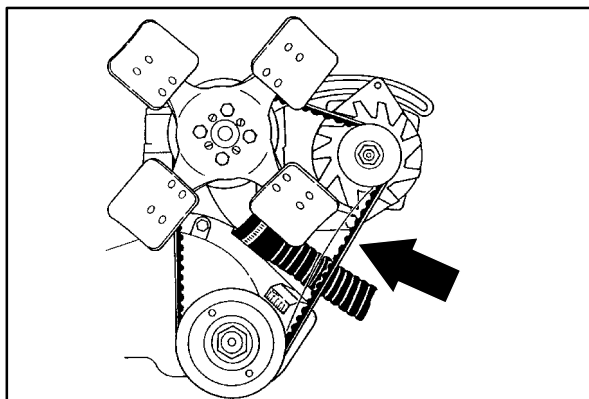
Flush the radiator and the cooling system every 400 hours of operation, using a dependable cleaning compound.



## ENGINE FAN BELT

The engine fan belt is driven by the engine crankshaft pulley and drives the alternator pulley. Proper belt tension is 9 to 10 mm (0.35 to 0.39 in) for a new belt and 10 to 11 mm (0.39 to 0.43 in) for a used belt with a force of 10 kg (22 lb).

Check and adjust the belt tension every 100 hours of operation.

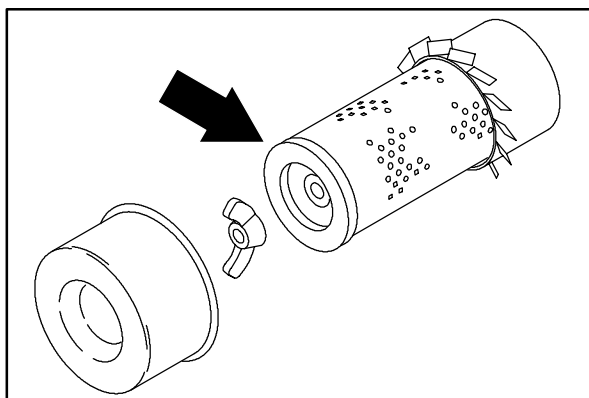


## AIR INTAKE SYSTEM

### AIR FILTER

The engine air filter housing has a dust cap and a dry cartridge-type air filter element. Empty the dust cap daily. The air filter must be replaced whenever the filter element is damaged or has been cleaned three times.

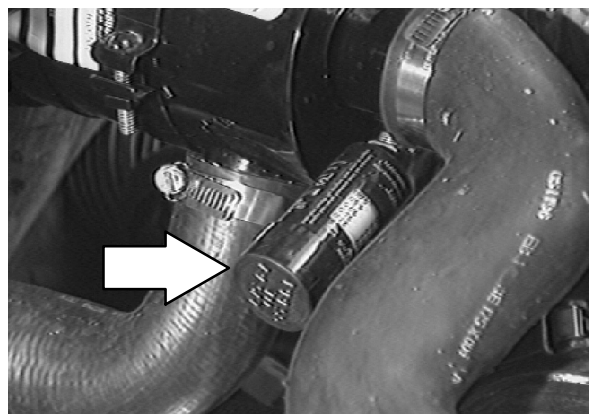
Service the air filter element only when the air filter indicator shows restriction in the air intake system. Do not remove the air filter element from the housing unless it is restricting air flow.



### AIR FILTER INDICATOR (OPTIONAL)

The air filter indicator shows when to clean or replace the air filter element. Check the indicator daily. The indicator's red line will move as the air filter element fills with dirt. Do not clean or replace the air filter element until the red line reaches 5 kPa (20 in H<sub>2</sub>O) and the "SERVICE WHEN RED" window is filled with red. The indicator's red line may return to a lower reading on the scale when the engine shuts off. The red line will return to a correct reading after the engine runs for a while.

Reset the air filter indicator by pushing the reset button on the end of the indicator after cleaning or replacing the air filter element.



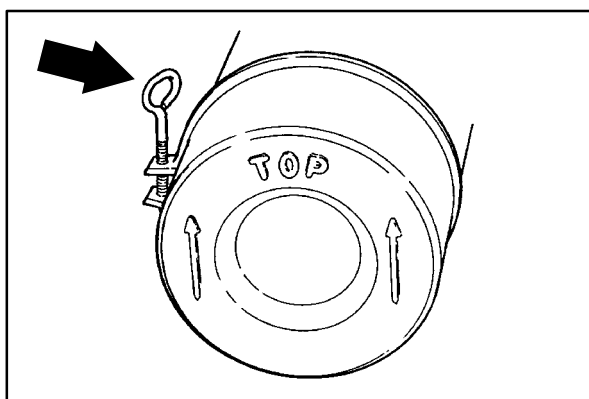
### TO REPLACE AIR FILTER ELEMENT

**FOR SAFETY: Before Leaving Or Servicing Machine: Stop On Level Surface, Set The Parking Brake, Turn Off Machine And Remove Key.**

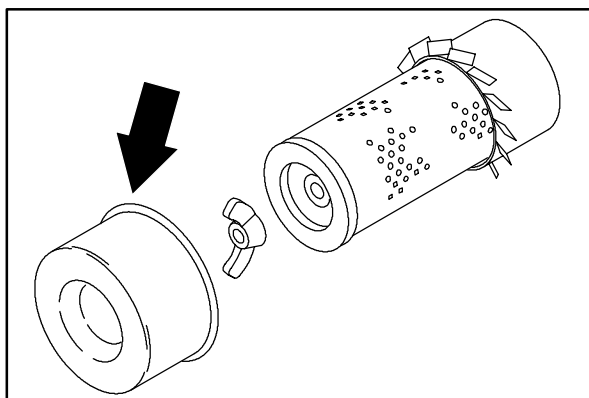
1. Start the engine and raise the debris hopper. Engage the support bar.



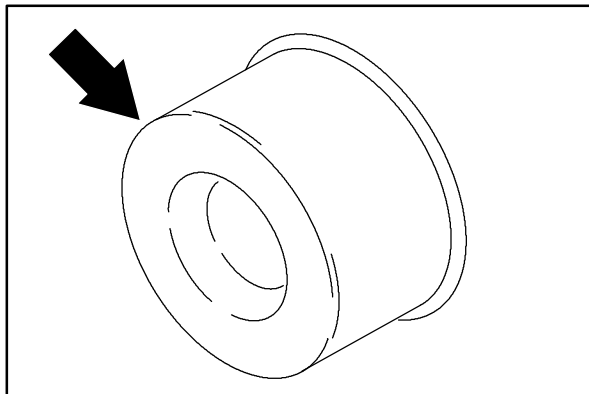
2. Unscrew the clamp ring on the filter.



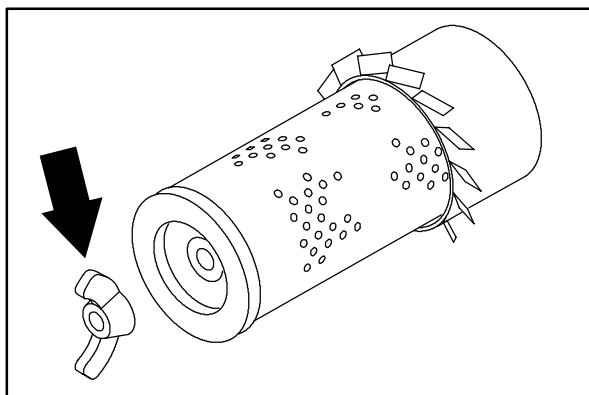
3. Remove the dust cap.



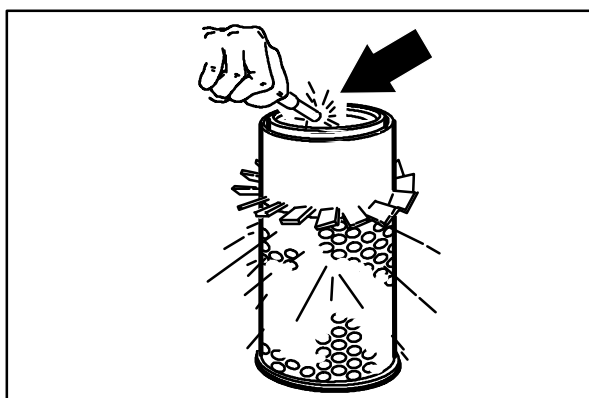
4. Empty the dust cap.



5. Remove the filter wing nut.

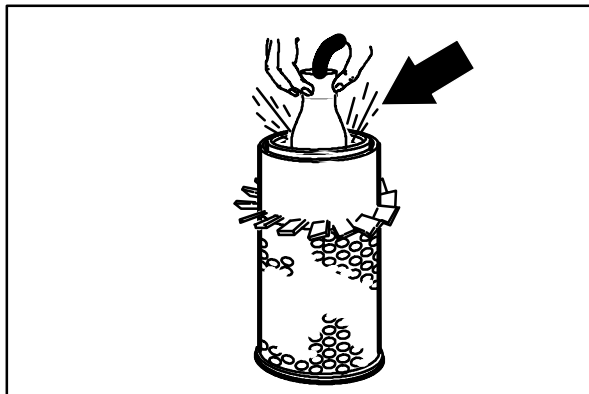


6. Pull the filter element out of the filter housing.
7. Clean the interior of the air cleaner housing with a camp cloth. Clean the element housing sealing surfaces.
8. Using an air hose, direct dry, clean air maximum 205 kPa (30 psi) up and down pleats on the inside of the filter. Do not rap, tap, or pound dust out of the element.

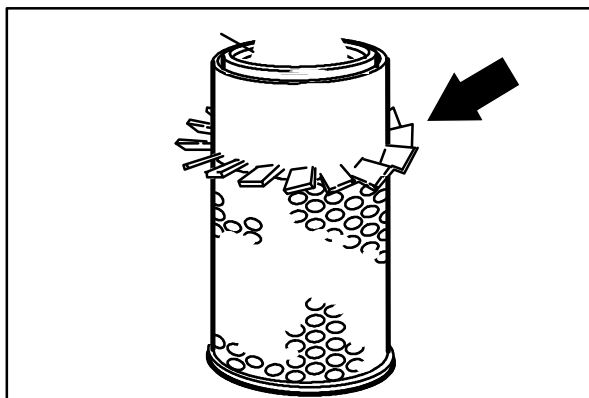


**FOR SAFETY: When Servicing Machine, Wear Eye And Ear Protection When Using Pressurized Air Or Water.**

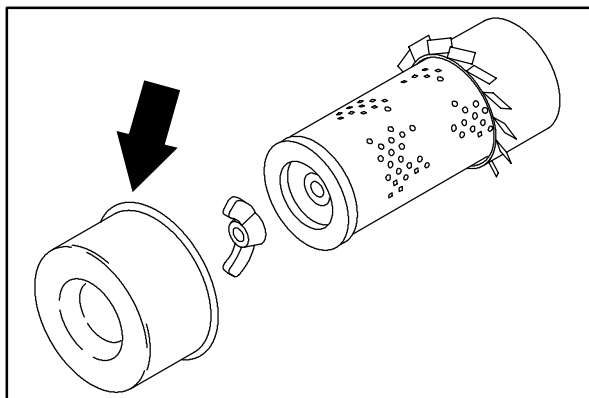
9. After cleaning the air filter element, inspect it for damage by placing a bright light inside. The slightest rupture requires replacement of the filter. Clean and inspect the seals on the ends of the element. They should be unbroken and flexible. Remember to replace the element after cleaning it three times.



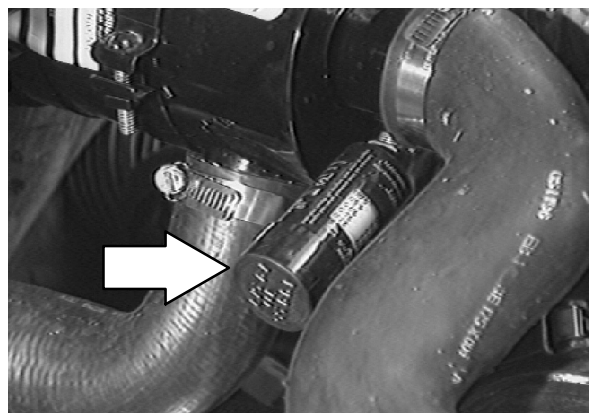
10. Install the new or cleaned filter element so the fins on the element are at the intake end of the air cleaner. Be careful not to damage the fins. Make sure the element is seating evenly. Tighten the element wing nut.



11. Install the dust cap with the arrows pointing up. Tighten the clamp ring to hold it in place. Check all intake hose connections for leaks or abrasions.



12. Reset the air filter restriction indicator.



13. Lower the debris hopper.



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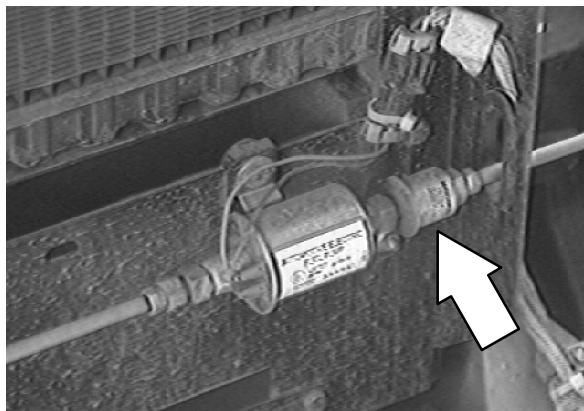
## FUEL SYSTEM - GASOLINE

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### FUEL FILTERS

The fuel filter trap fuel contaminants. The filter is located on the fuel line going into the fuel pump.

Replace the filter elements every 400 hours of operation.



### CARBURETOR

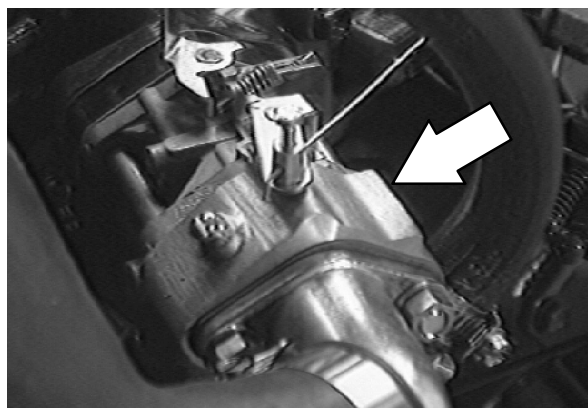
The carburetor has two basic adjustments. Those adjustments are idle fuel mixture and idle speed. Check and adjust idle fuel mixture and idle speed periodically.

**FOR SAFETY: When servicing machine, allow engine to cool. Keep flames and sparks away from fuel system service area. Keep area well ventilated.**

The carburetor is designed to deliver the correct fuel-to-air mixture to the engine under all operating conditions. The high idle is set at the factory and cannot be adjusted. The low idle fuel adjusting needle is also set at the factory and normally does not need adjustment.

**FOR SAFETY: When servicing machine, allow engine to cool. Keep flames and sparks away from fuel system service area. Keep area well ventilated.**

If the engine is hard-starting or runs roughly or stalls at low idle speed, it may be necessary to adjust or service the carburetor.



### FUEL SYSTEM - LPG

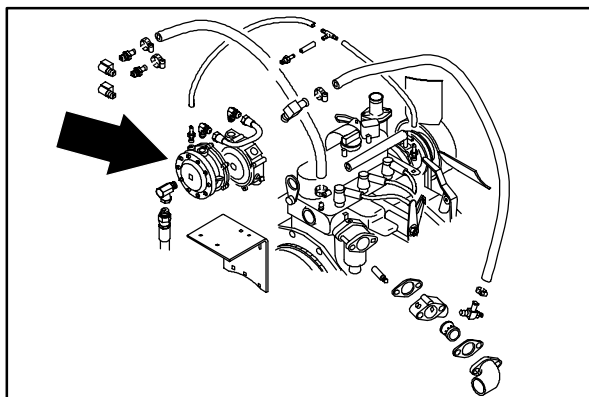
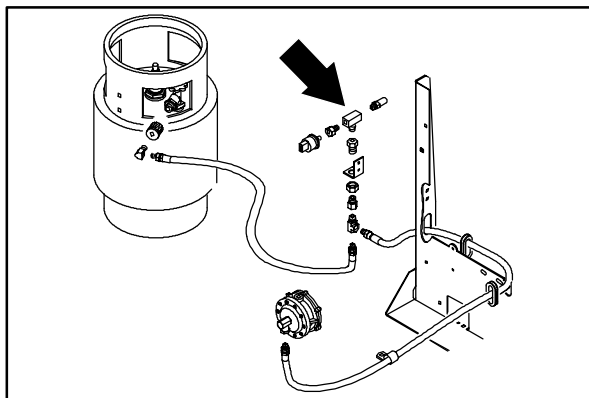
The liquid withdrawal LPG fuel system has up of five components: the LPG fuel tank, pressure relief valve, fuel filter lock, vaporizer-regulator, and the carburetor.

Liquid LPG fuel flows from the LPG tank under its own pressure, to the pressure relief valve. Usually this valve is closed, preventing LPG fuel from escaping into the atmosphere. The valve opens to relieve pressure if the fuel pressure exceeds system limits. From the pressure relief valve, the liquid LPG fuel flows to the fuel filter lock.

The fuel filter lock filters unwanted tank scale and deposits out of the LPG fuel. The fuel filter lock also stops the flow of LPG fuel when the engine is not operating. The LPG is operated with engine vacuum.

The vaporizer section of the vaporizer-regulator converts the liquid LPG fuel into a gaseous LPG fuel. From the vaporizer section, the gaseous LPG fuel is sent to the primary regulator section of the vaporizer-regulator. The primary regulator section reduces the pressure of the LPG fuel. The secondary regulator section reduces the LPG fuel pressure to the level required by the carburetor. From the vaporizer-regulator, the LPG fuel is sent to the carburetor where it is finally metered into the air flow sent to the engine combustion chamber.

Never operate an LPG powered machine if the LPG fuel system is leaking, or if any component in the fuel system is malfunctioning. Operating the machine under either of these conditions may cause a fire or explosion.



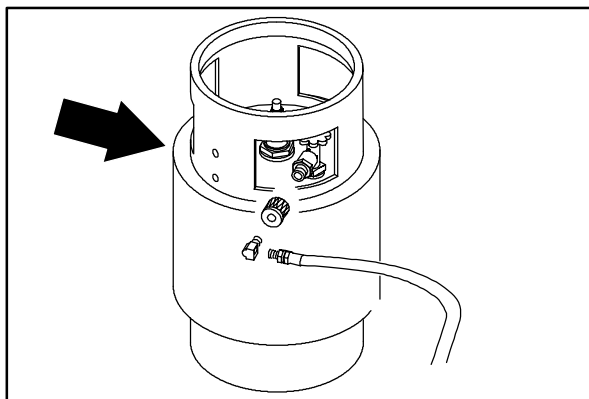
Check for frosting. If frosting occurs on or near any LPG component, there is a possible LPG fuel leak or malfunctioning component.

To locate the leak, apply a soapy water solution to the suspected area. Watch for bubbles forming in this suspected area. This area may have an LPG fuel leak. Repair or replace the part. Use Loctite brand Stainless Steel PST thread sealant when reassembling. Aging or high humidity does not affect this epoxy-type sealant. Be sure to follow application directions and apply proper torque when reconnecting fittings. Never bypass safety components except to test. If they are defective, replace them before operating the machine. Frosting does not occur before the engine reaches operating temperature. Check after engine reaches operating temperature.

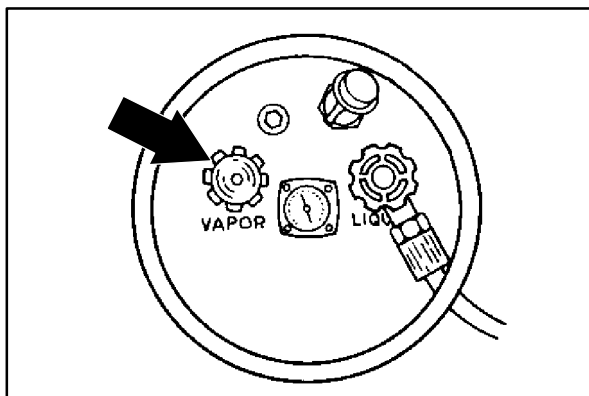
Check routings of all LPG hoses. Keep them away from sharp edges, exhaust manifolds, or other hot surfaces. Check for signs of abrasion or deterioration. Replace worn or damaged hoses.

### LP FUEL TANKS

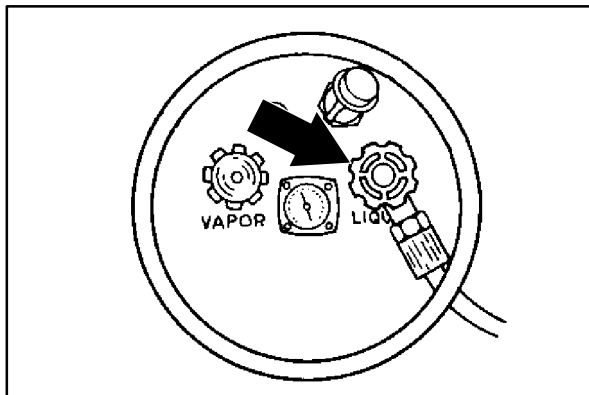
The LPG fuel tanks should be inspected for sharp dents, gouges, leaks, and broken protecting rings whenever the tanks are refilled. All tank valves must be inspected for leaks using a soap solution. Valves must also be checked for dirt, paint, or other debris in the valve openings. The following specific checks must also be made:



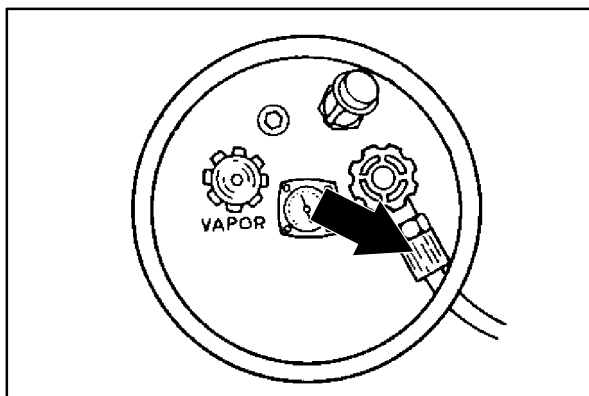
**Filler Valve** – Check the valve for proper functioning and the presence of the handwheel. Valve must be closed except during filling.



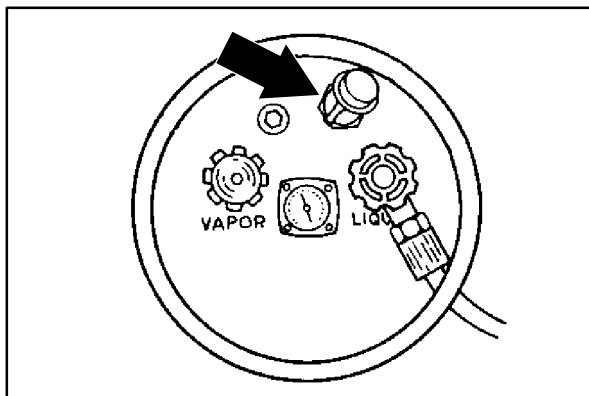
**Liquid Service Valves** – Check the valve for proper functioning and presence of the handwheel. The valve must be closed except when in service.



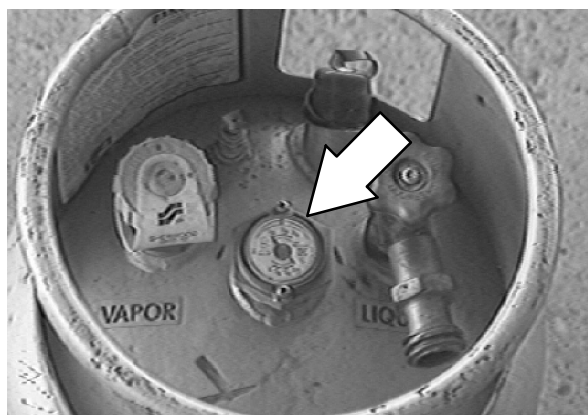
**Tank Service Valve Coupling** – Check for proper functioning, thread condition, and damaged or missing washers or o-rings.



**Safety Relief Valve** – Check for damage. Check for the presence of the relief valve elbow and the proper direction of the elbow. If the rain cap is missing, check for foreign matter and replace the rain cap. Do not tamper with the relief valve setting.



**Magnetic Liquid Level Gauge** – Check the operation against the maximum filling point as determined by weight.



An LPG fuel tank with any of the stated defects must be removed from service and be repaired or destroyed accordingly.

If an LPG fuel tank is damaged or leaking, it should be removed to a designated safe area. Do not attempt to make repairs to the tank, regardless of condition. Qualified personnel must make repairs or disposal.

The care an LPG fuel tank receives has a direct bearing on how long that tank can be used safely. LPG fuel tanks must not be dropped or dragged across any surface. To move LPG fuel tanks, use a hand truck or roll the tank on its foot ring while it is being held in a position slightly off the vertical.

Whether the storage is inside or outside, fuel tanks should not be stored near combustible materials or high temperature sources such as ovens and furnaces, since the heat may raise the pressure of the fuel to a point where the safety relief valves would function. Store the tanks in a way that if the safety relief valves do function, they will relieve vapor and not liquid.

Valves on empty tanks must be closed during storage and transportation.

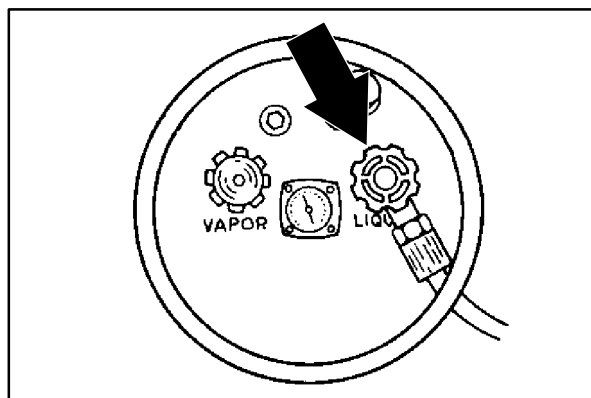
Similar precautions should be taken in storing machines fitted with LPG fuel tanks. The machines may be stored or serviced inside buildings, provided there are no leaks in the fuel system and the tanks are not overfilled. While machines are being repaired inside a building, the shut-off valve on the tank must be closed, except when the engine has to be operated.

Changing the tank is a chance for the machine operator to carefully check over the tank, fittings, and the fuel lines and fittings. If abnormal wear is detected, report the findings to the appropriate personnel.

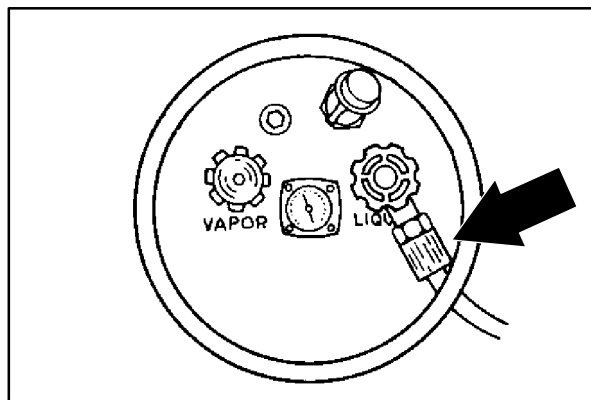
**TO CHANGE AN LPG FUEL TANK**

1. Park the machine in a designated safe area.
2. Close the tank service valve.
3. Operate the engine until it stops from lack of fuel, then set the machine parking brake.

**FOR SAFETY: Before Leaving Or Servicing Machine: Stop On Level Surface, Set The Parking Brake, Turn Off Machine And Remove Key.**



4. Put on gloves and remove the quick-disconnect tank coupling.
5. Inspect the LPG fuel lines for wear or damage.
6. Remove the empty LPG fuel tank from the machine.
7. Check the tank for damage or wear.
8. Store the tank in a designated, safe area.
9. Select a filled LPG fuel tank and inspect it for damage or leaks.

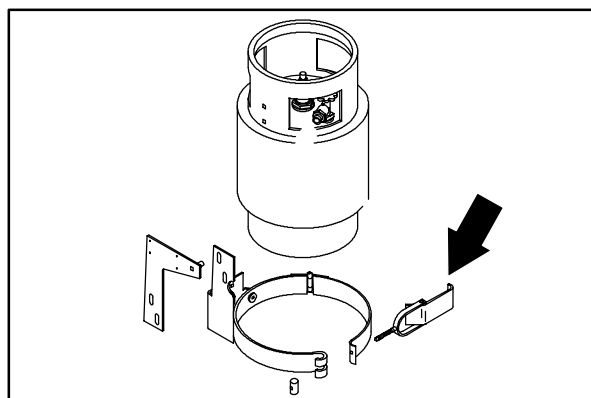


**NOTE:** Make sure the LPG fuel tank matches the fuel system (liquid tank with liquid system).

10. Carefully put the LPG tank in the machine so that the tank centering pin enters the aligning hole in the tank collar.

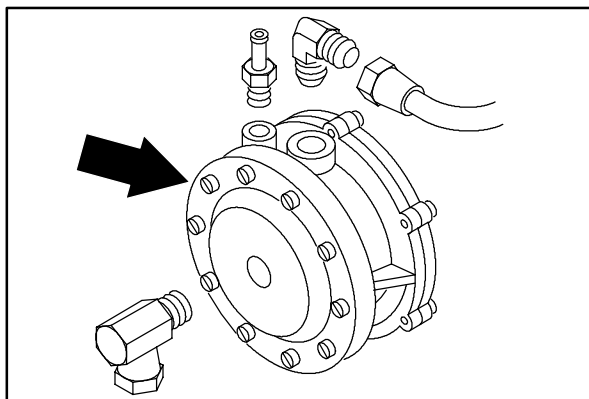
**NOTE:** If you cannot line up the centering pin, make sure you have the correct LPG fuel tank and then adjust the pin locator in or out.

11. Fasten the tank hold-down clamp to lock the tank in position.
12. Connect the LPG fuel line to the tank service coupling. Make sure the service coupling is clean and free of damage. Also make sure it matches the machine service coupling.
13. Open the tank service valve slowly and check for leaks. Close the service valve immediately if an LPG leak is found, and tell the appropriate personnel.
14. If no leaks are found, the engine is ready to start.



### FUEL FILTER LOCK

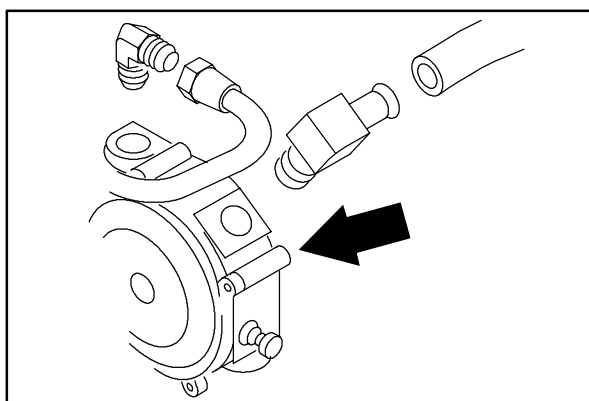
The fuel filter lock filters the LPG fuel. It also stops the flow of LPG fuel to the engine when the engine is not operating.



### VAPORIZER-REGULATOR

If any malfunction is found, completely disassemble the vaporizer-regulator. Clean all the parts in alcohol.

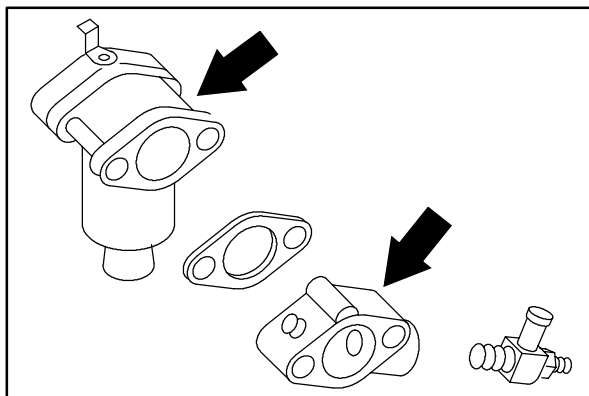
Inspect all the parts and replace where needed. Carefully reassemble the vaporizer-regulator with the seal repair kit. Check for proper operation.



### CARBURETOR

If any malfunction is found, completely disassemble the carburetor. Clean all the parts in alcohol.

Inspect all the parts and replace where needed. Carefully reassemble the carburetor with the seal repair kit.



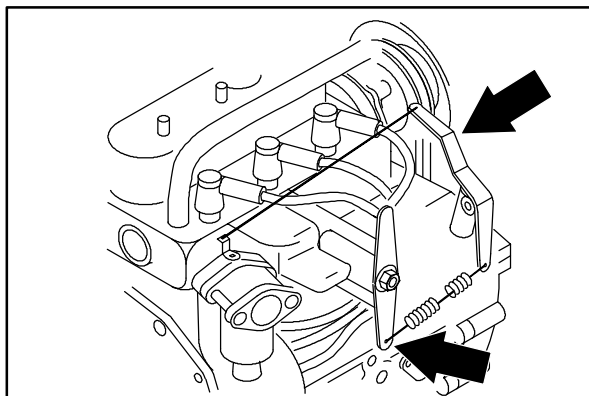


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**GOVERNOR**

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The mechanical governor controls engine speed. The governor is factory set and is not user serviceable.



**LPG FUEL TROUBLESHOOTING**

<b>Problem</b>	<b>Cause</b>	<b>Remedy</b>
<i>Engine will not start</i>	Out of fuel	Replace fuel tank with full one
	Service valve opened too quickly - check valve stopped fuel flow	Close service valve and reopen slowly
	Plugged fuel filter	Replace filter
	Kinked or restricted fuel line	Straighten or replace fuel line
	Engine out of tune	Tune-up engine
	Oil pressure switch failure	Replace oil pressure switch
	Fuel lock valve failure	Repair or replace fuel filter lock
	Vaporizer-regulator failure	Repair or replace vaporizer-regulator
<i>Engine runs unevenly or lacks power</i>	Wrong type of fuel tank - vapor withdrawal tank	Replace vapor withdrawal tank with liquid withdrawal tank
	Plugged fuel filter	Replace filter
	Kinked or restricted fuel line	Straighten or replace fuel line
	Engine out of tune	Tune-up engine
	Restricted air filter	Clean or replace air filter element
	Vaporizer-regulator out of adjustment	Adjust vaporizer-regulator

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**CYLINDER HEAD**

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See Kubota engine service manual at the end of this section.

**VALVE CLEARANCE**

Check and adjust the intake and exhaust valve clearance to 0.145 to 0.185 mm (0.0057 to 0.0072 in) while the engine is cold after every 800 hours of operation. See Kubota engine service manual at the end of this section.

**CRANKCASE VENTILATION SYSTEM**

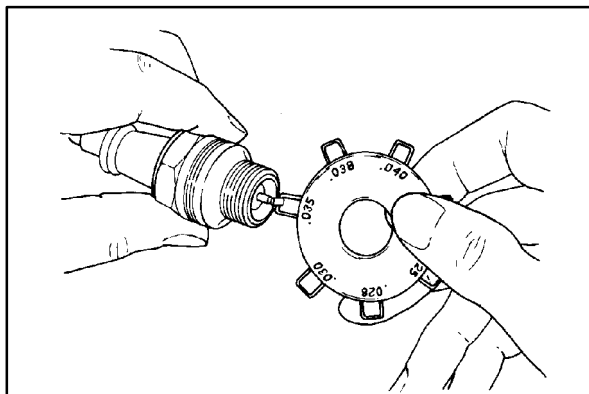
Clean the crankcase ventilation hoses, tubes, and fittings and replace the PCV valve every 400 hours of operation.

## IGNITION SYSTEM

### SPARK PLUGS

Clean or replace, and set the gap of the spark plugs every 400 hours of operation. A wire gauge is best for checking the spark plug gap. A flat gauge should not be used unless the electrode surfaces have been dressed with a small file to get parallel surfaces between the center and side electrode. Set the spark plug gap by bending the side electrode. All spark plugs, new or used, should have the gaps checked and reset if necessary.

The proper spark plug gap is 1 mm (0.040 in).



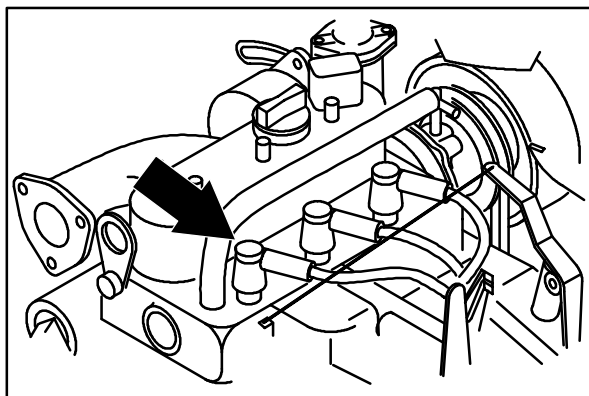
### TO REPLACE SPARK PLUGS

**FOR SAFETY: Before Leaving Or Servicing Machine: Stop On Level Surface, Set The Parking Brake, Turn Off Machine And Remove Key.**

1. Open the seat support.
2. Remove the spark plug wires from the three spark plugs.

*NOTE: Clean any dirt from the spark plug seat area before removing the spark plugs.*

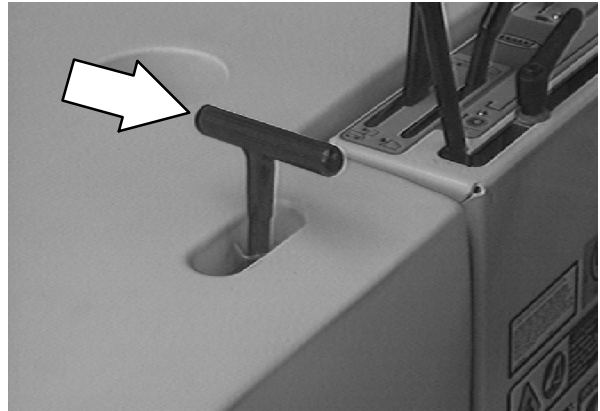
3. Remove the spark plugs from the engine
4. Clean the spark plug seat in the cylinder head.
5. Use a new seat gasket and screw the plug in by hand.
6. Tighten the spark plugs with a socket wrench of the correct size.



### TO REPLACE ALTERNATOR

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

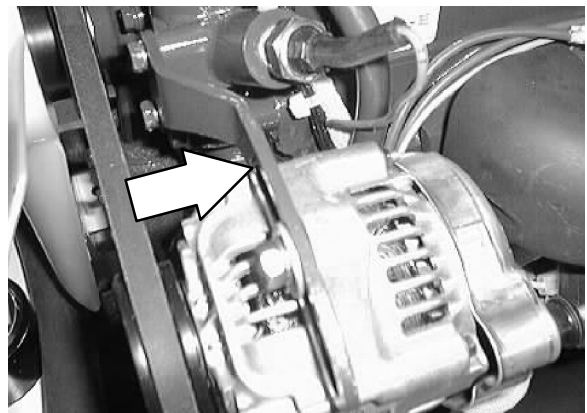
1. Open the seat support.



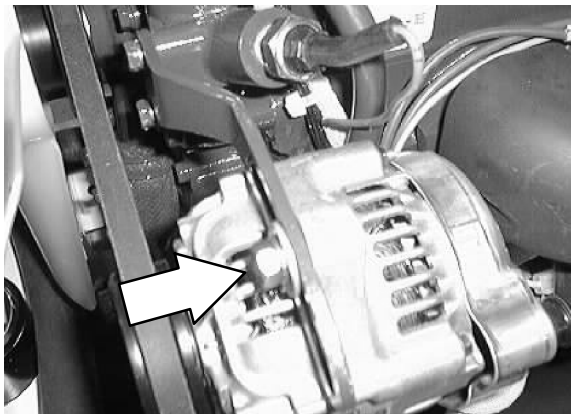
2. Disconnect the battery cables from the battery.



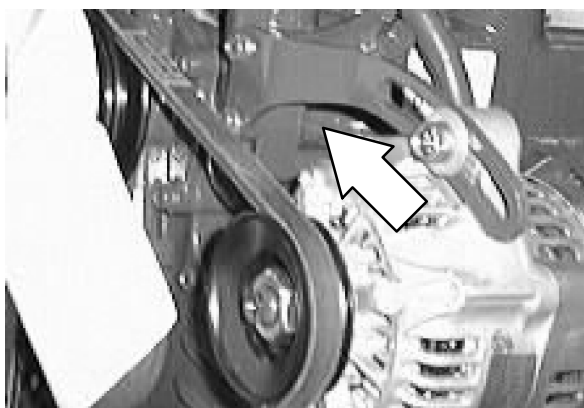
3. Cut any plastic wire ties holding the wire harness to the alternator bracket.



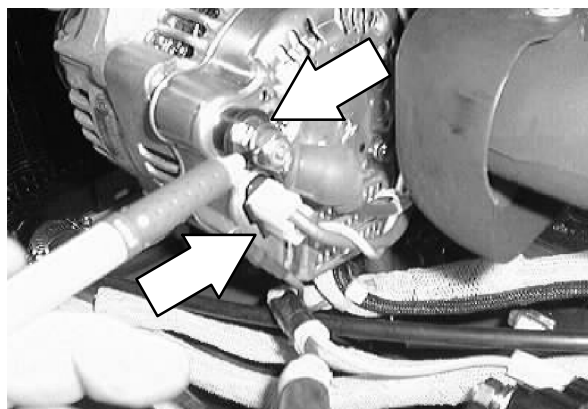
4. Remove the hex screw holding the top of the alternator to the mount bracket. Remove and retain the heat shield.



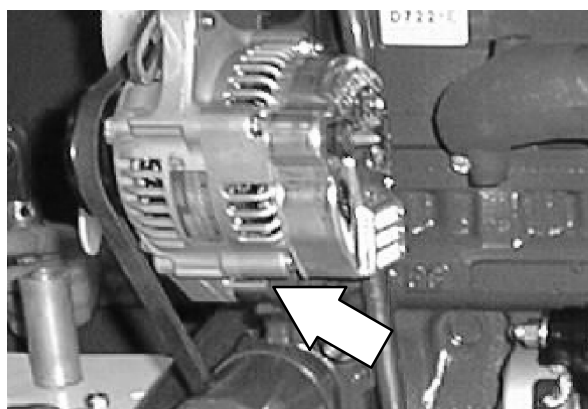
5. Push the alternator in toward the engine and remove the V-belt.



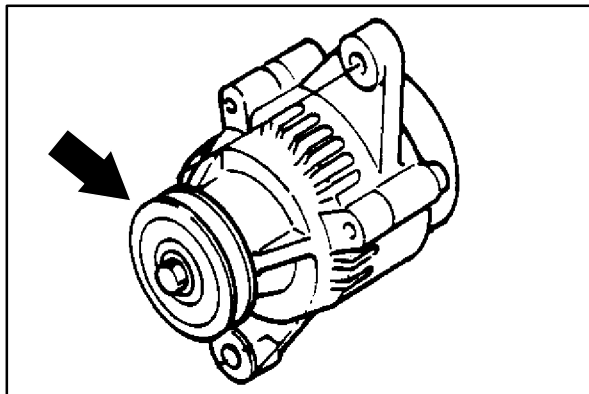
6. Disconnect the wires leading to the back of the alternator.



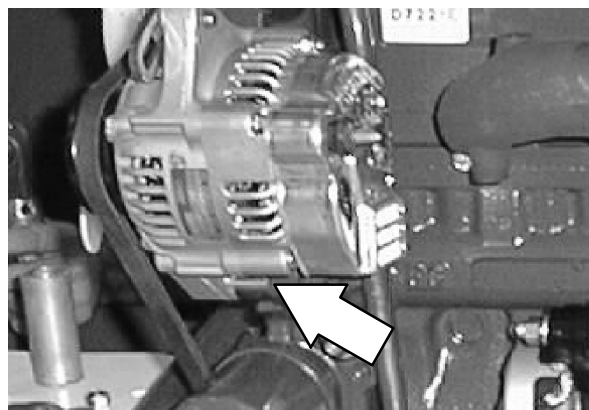
7. Remove the hex screw and nyloc nut holding the bottom of the alternator to the lower mount bracket.
8. The alternator can now be removed from the machine.



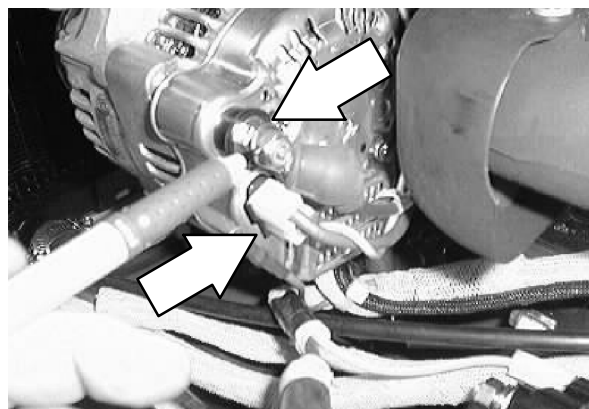
9. If the new or rebuilt alternator needs a drive pulley, remove the pulley from the old alternator. Hold the pulley from turning and use an impact wrench to remove the hex nut.
10. Install the pulley, washer, and hex nut on the new alternator. Firmly tighten the nut with the impact.



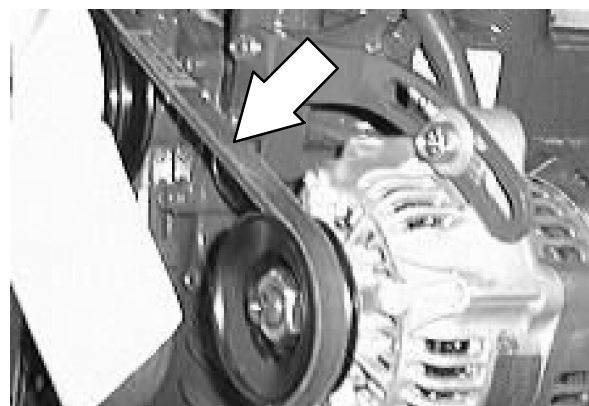
11. Install the new alternator back in the machine. Align the bottom hole in the alternator with hole in lower mount bracket. Reinstall the hex bolt, ground cable, and nyloc nut. Leave it loose for now.



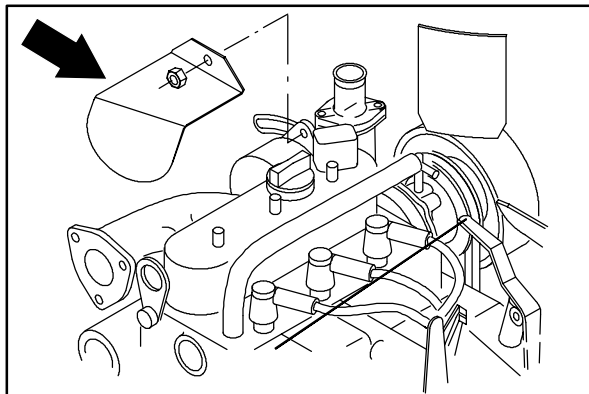
12. Reconnect the wires to the back of alternator. See the schematic in the ELECTRICAL section.



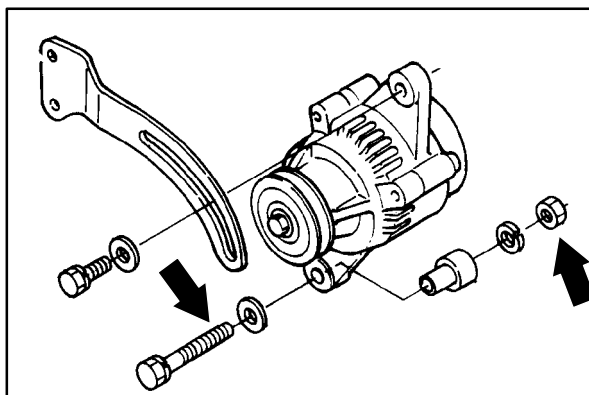
13. Place the V-belt back on the alternator pulley.



14. Reinstall the hex screw and heat shield in the top hole of the alternator through upper slotted mounting bracket. Pull the alternator toward the operator compartment to tighten the belt. See adjustment in ENGINE FAN BELT description. Tighten the hex screw to 18 - 24 Nm (13 - 18 ft lb).



15. Tighten the bottom hex screw to 18 - 24 Nm (15 - 20 ft lb).



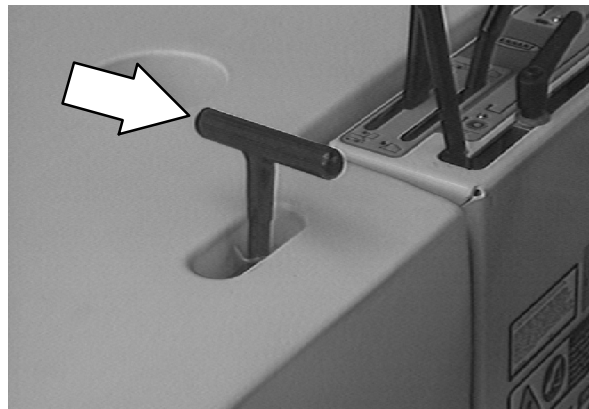
16. Reconnect the battery cables and start the engine. Check the new alternator for proper operation.



### TO REPLACE STARTER

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

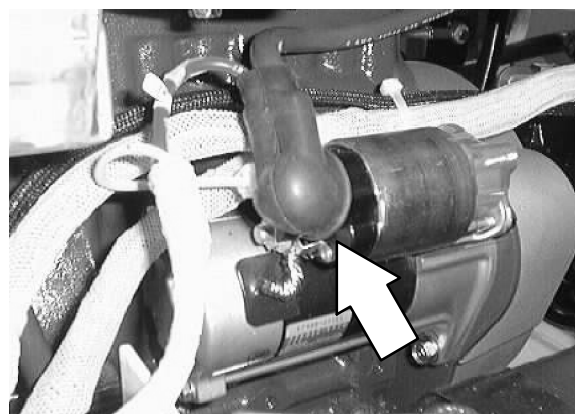
1. Open the seat support.



2. Disconnect the battery cables from the battery.

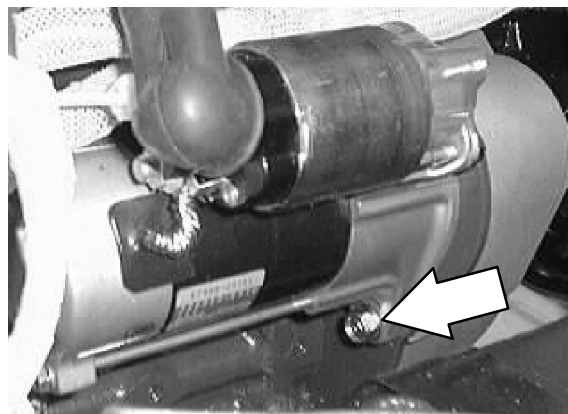


3. Disconnect the wires leading to the back of the starter.

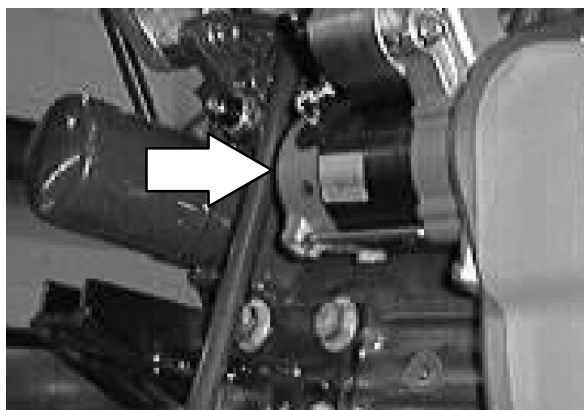




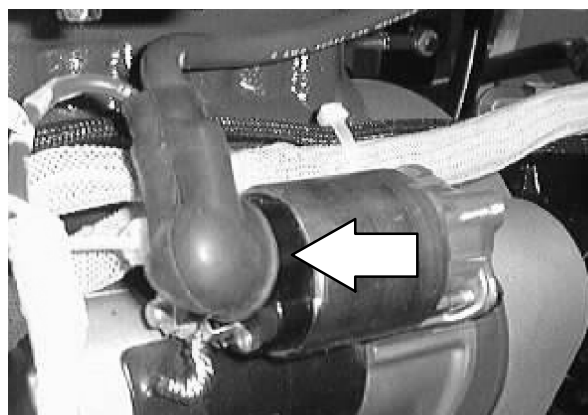
4. Remove the two hex screws holding the starter to the engine bellhousing.
5. Pull the starter straight out of the bellhousing and remove it from the machine.



6. Install the new starter in the machine. Align the two holes in the starter with the holes in the bellhousing. Reinstall the two hex screws. Tighten to 18 - 24 Nm (15 - 20 ft lb).



7. Reconnect the wires to the back of the starter. See the schematic in the ELECTRICAL section.



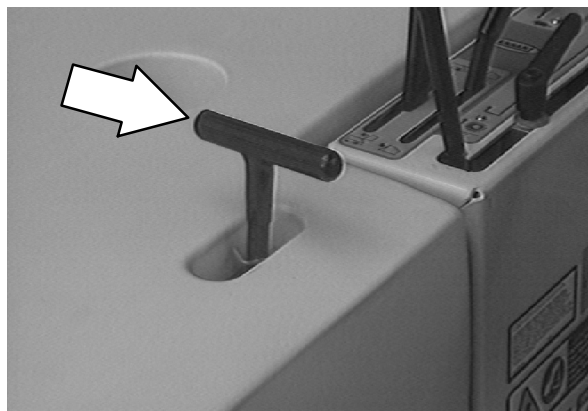
8. Reconnect the battery cables and check the starter for proper operation.



### TO REMOVE ENGINE

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake., Turn Off Machine And Remove Key.**

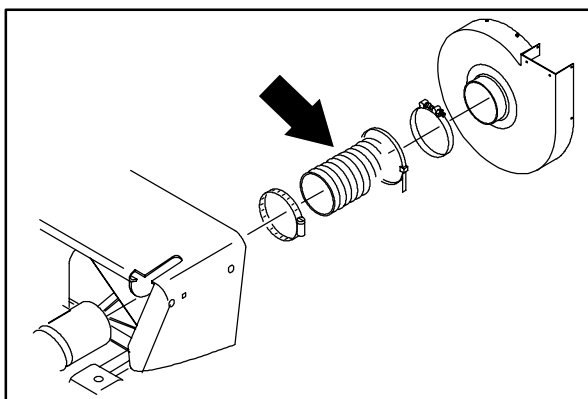
1. Open the seat support.



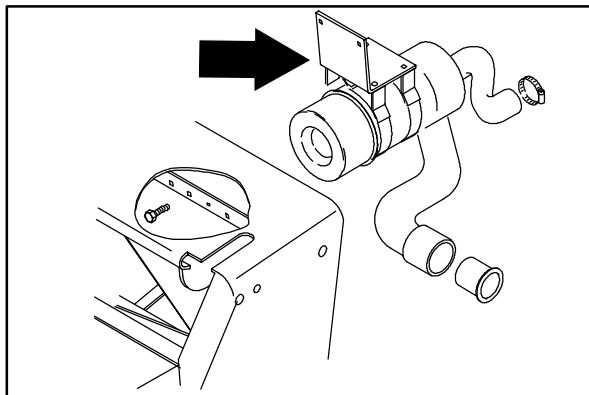
2. Disconnect the battery cables from the battery.



3. Remove the large hose leading from the vacuum fan to the shut-off assembly.

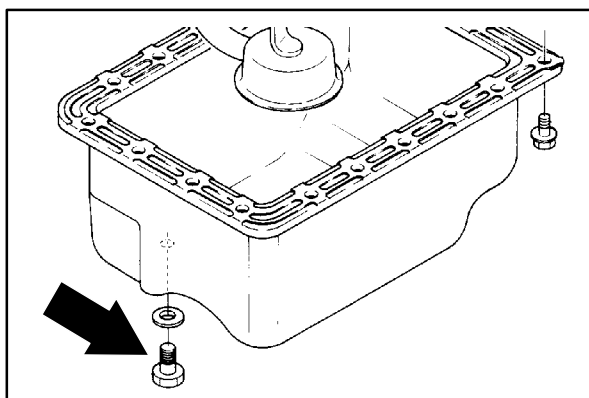


4. Remove the two hex screws holding the air cleaner assembly and mounting bracket to the bottom of the machine lintel. Remove the air cleaner assembly from the machine.

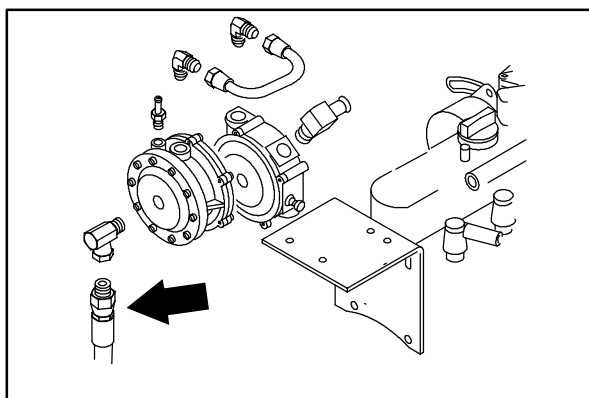


5. Drain the engine oil and remove the engine oil filter.

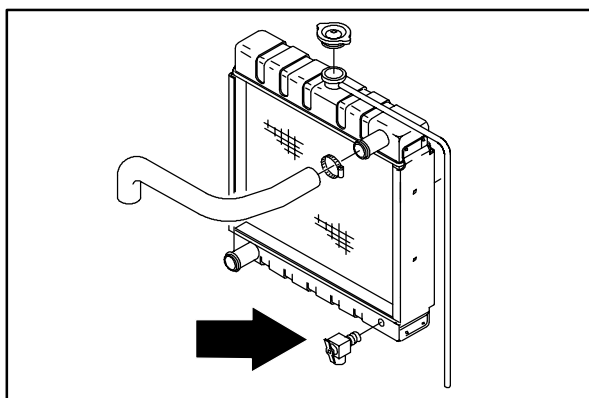
*NOTE: Oil filter must be removed in order to access the right rear motor mount bolt.*



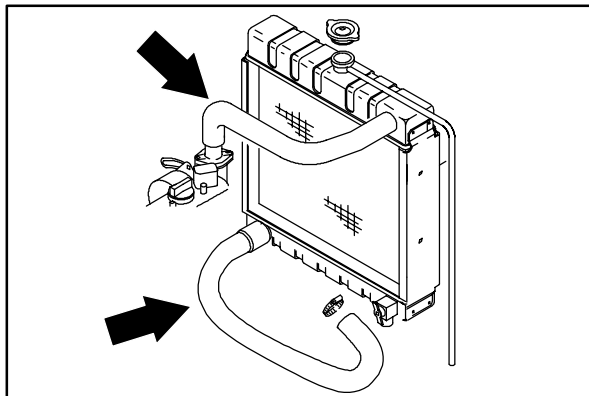
6. Disconnect the fuel line at the connection between the hose and steel line on a gas machine. On an LPG machine, disconnect the line leading from the tank to the fuel lockoff / vaporizer.



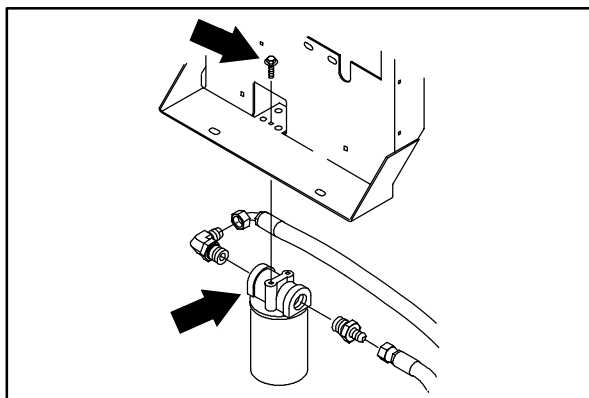
7. Drain the coolant from the radiator.



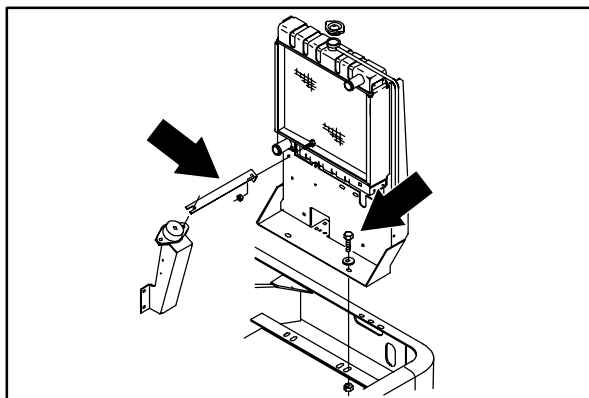
8. Remove the two radiator hoses from the engine.



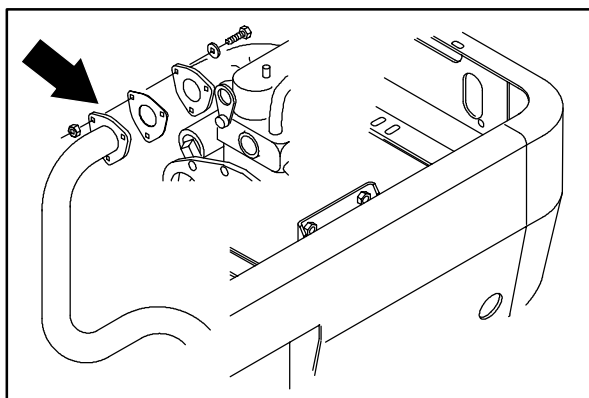
9. Remove the hex screws holding the hydraulic oil filter to the bottom of the radiator mount assembly. Let the filter drop down. *Do not disconnect the hydraulic hoses.*



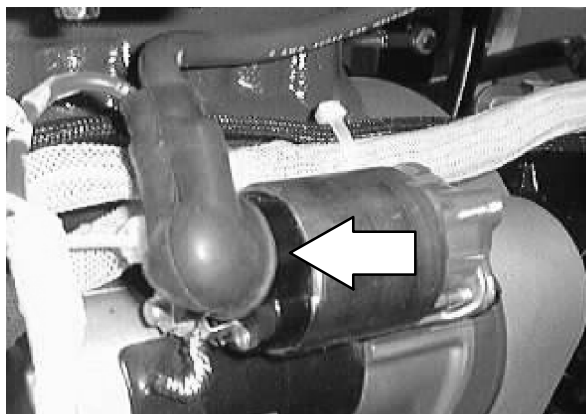
10. Remove the hex screw holding the radiator mount strap to the lower right corner of the radiator assembly.
11. Remove the two hex screws holding the radiator assembly to the machine frame.
12. Remove the radiator assembly from the machine.



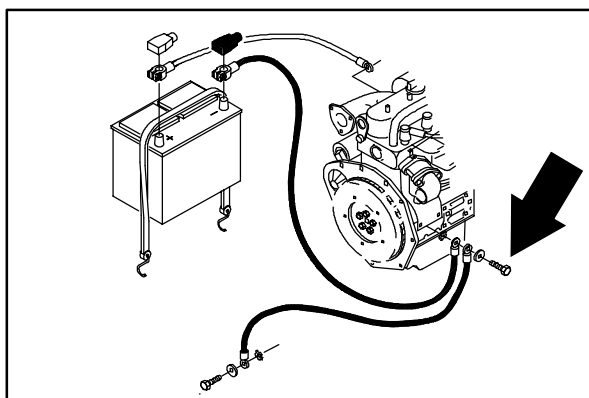
13. Remove the hex screws holding the exhaust pipe to the engine manifold.



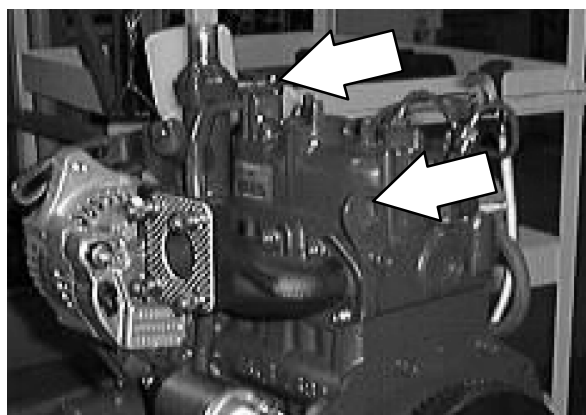
14. Disconnect the wire harness from the alternator, starter, oil sender, temp. sender, ect. Move the wires out of the way for engine removal.



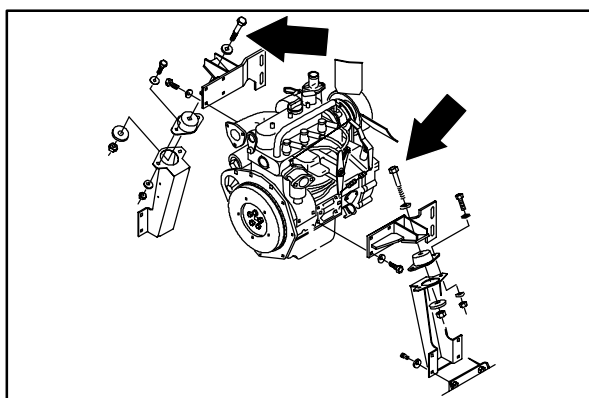
15. Disconnect the engine ground strap from the machine frame.



16. Using an overhead hoist, hook a chain through the two pick-up points on the top of the engine. Put a slight amount of tension on the chain.

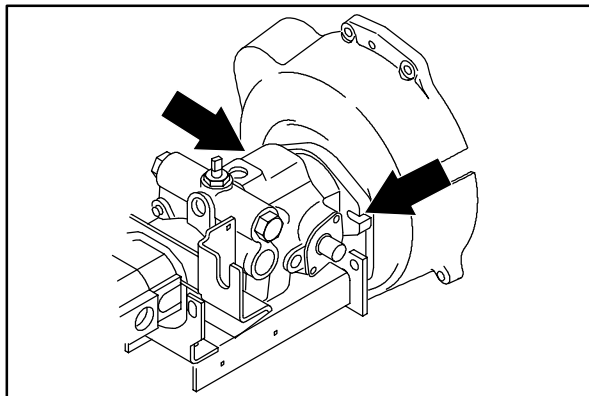


17. Remove the two hex screws and nyloc nuts holding the rear motor mounts to the rubber isolators on the frame brackets.



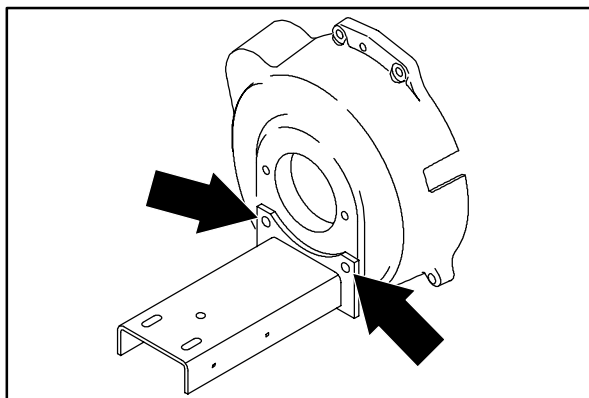
18. Remove the two hex screws holding the propel pump to the flywheel housing.

*NOTE: Place a block of wood under the hydraulic pump assembly for support when removing the engine.*



19. Remove the two hex screws holding the front motor mount plate to the bottom of the bellhousing.

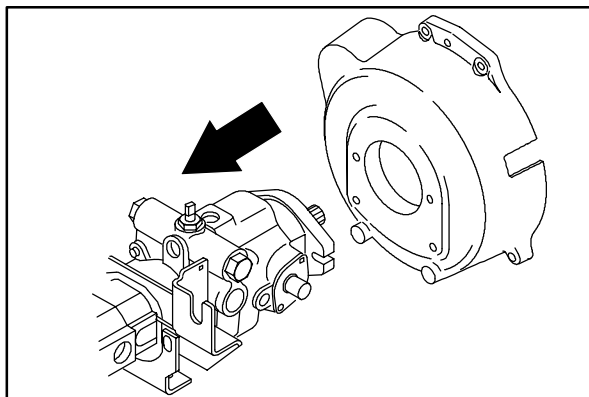
20. Disconnect the throttle cable and choke cable from the engine.



21. Pull the engine back until the hydraulic pump assembly is free of the bellhousing.

22. The engine can now be carefully lifted out.

*NOTE: Make sure the engine is clear of any wires or hoses before you lift it out of the frame.*

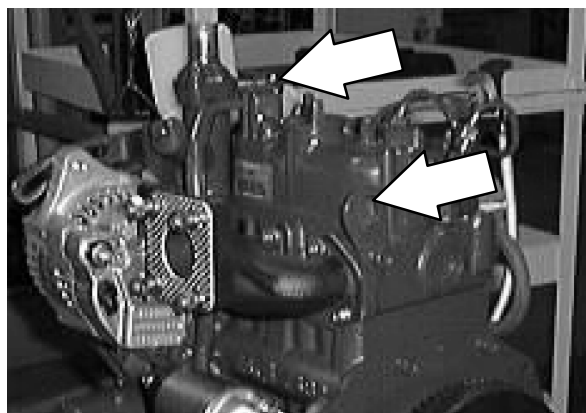


**TO INSTALL ENGINE**

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake., Turn Off Machine And Remove Key.**

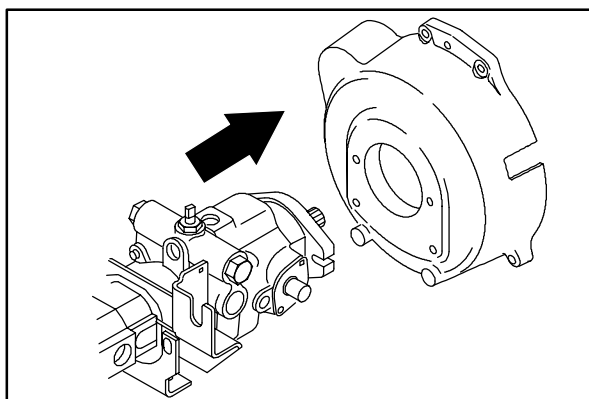
1. Using an overhead hoist, hook a chain through the two pick-up points on top of the engine. Carefully position the engine back in the engine compartment.

*NOTE: Make sure the hoses, wire harness, exhaust pipe and propel pump are pulled back out of the way when lowering engine assembly into place.*

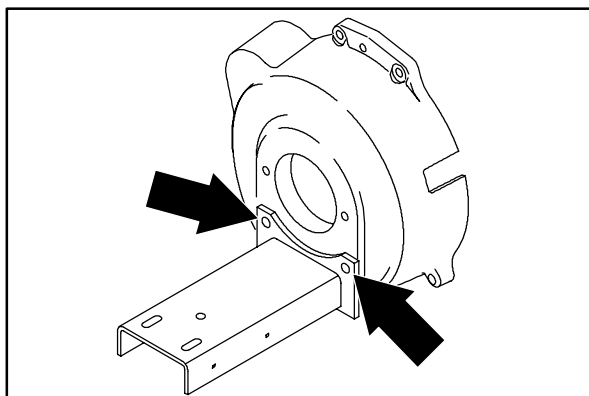


2. Slide the engine toward the front of the machine until the propel pump is positioned back in the bellhousing. Start the two hex screws only. Use a small amount of blue loctite 242 on the threads.

*NOTE: Make sure the splines on pump line up with splines in coupler when installing pump.*

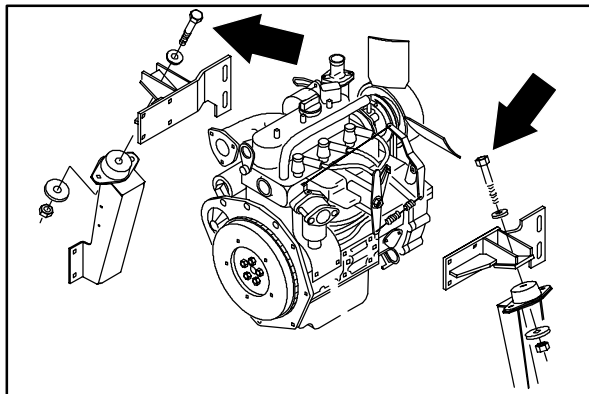


3. Reinstall the hex screws in the front motor mount plate and bellhousing. Use a small amount of blue loctite 242 on the threads. *Leave loose for now.*

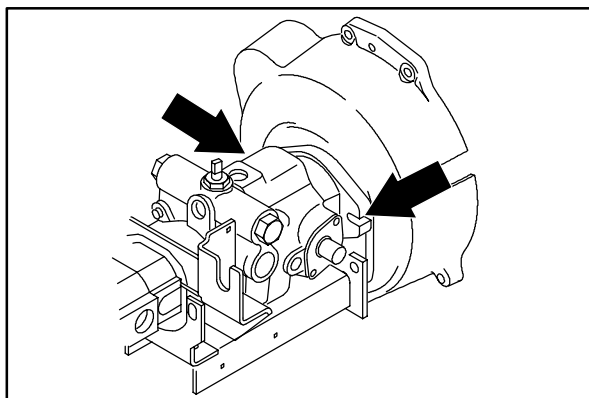


4. Carefully align the mount holes in the rubber isolators on the rear engine mounts with the holes in the frame brackets. Install the two hex screws and nyloc nuts.

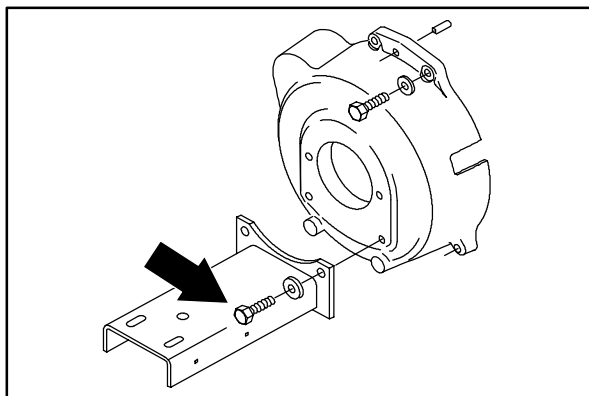
*NOTE: The left rear frame bracket may need to be loosened up in order to install both motor mount hex screws.*



5. Go back and tighten the propel pump hardware to 37 - 48 Nm (26 - 34 ft lb).

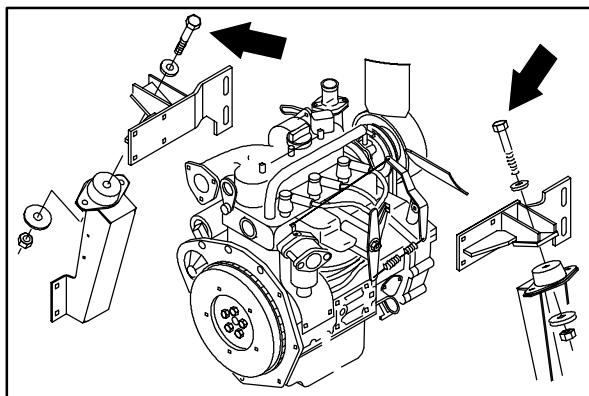


6. Tighten the hex screws holding the front motor mount plate to the bellhousing. Tighten to 13 - 18 Nm (10 - 13 ft lb).



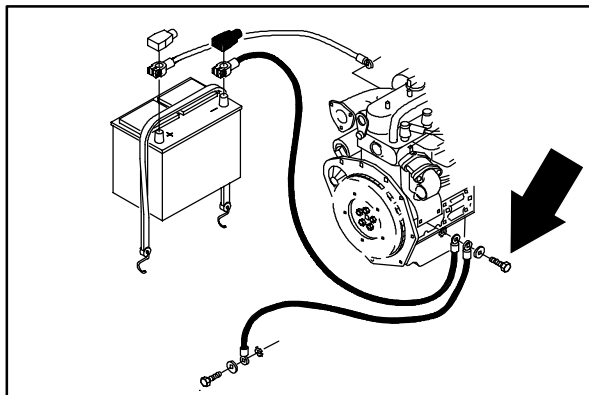
7. Tighten the hex screws holding the rear rubber isolators to the frame mount brackets. *Hand tighten tight.*

8. Remove the hoist from the engine.

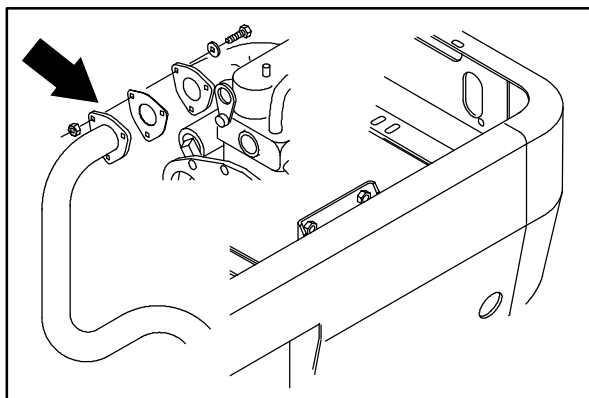




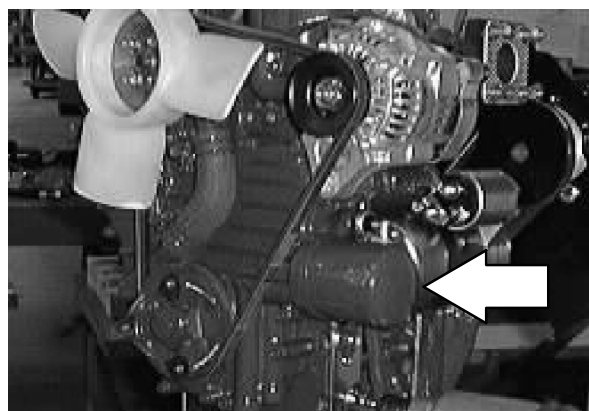
9. Reconnect the ground cable from the bellhousing to the machine frame.



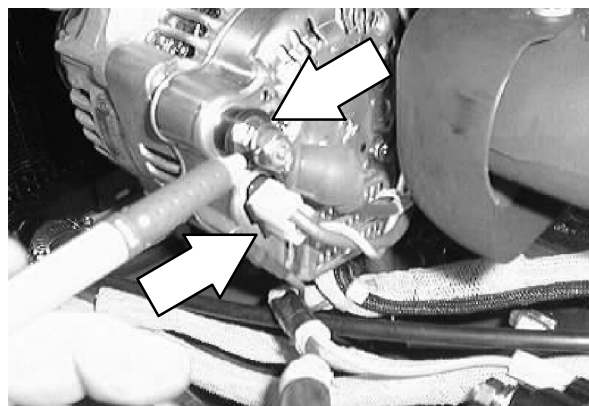
10. Reinstall the exhaust pipe onto the engine manifold. Reinstall the hex screws and hand tighten.



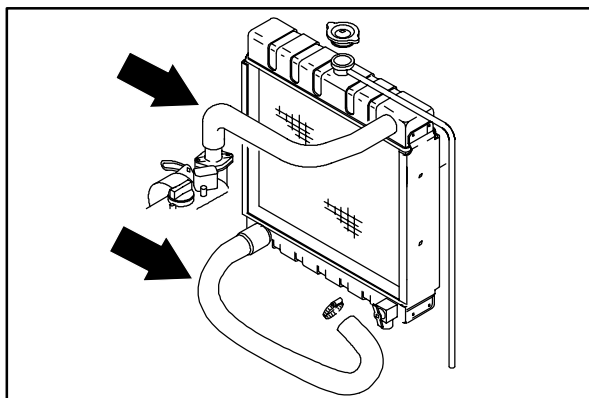
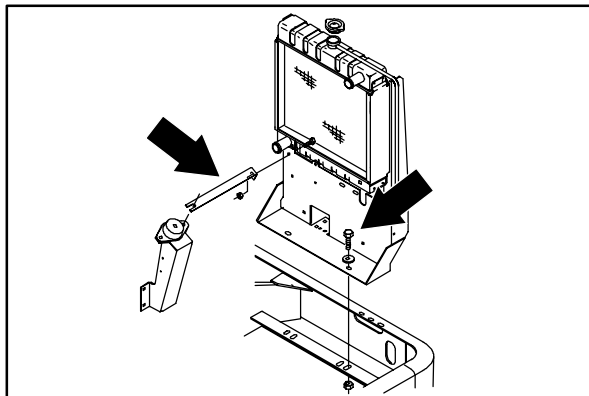
11. Install a new engine oil filter and fill the engine with the proper grade of oil. On the Gas/LPG engine, use 3.3 L (3.5 qt) 10W-30 SAE-SG/SH with a new filter.



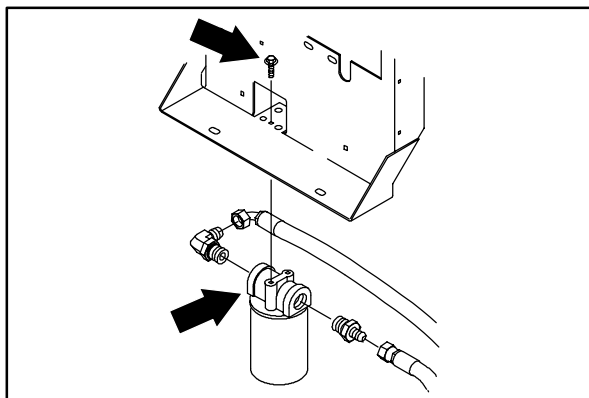
12. Reconnect the wire harness to the engine components; alternator, starter, oil switch, temperature sender, ect. See schematic in the ELECTRICAL section of this manual.



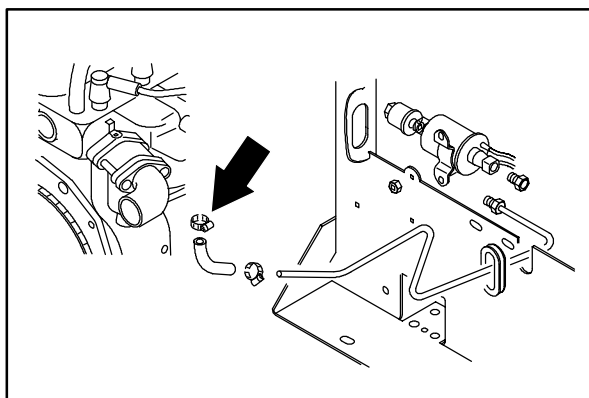
13. Position the radiator back in the machine. Align the two holes in the bottom of the radiator mount bracket holes in the frame. Reinstall the two nyloc nuts and washers. Leave loose for now.
14. Reinstall the hex screw holding the radiator brace to the bottom right corner of the radiator assembly. Tighten to 18 – 24 Nm (15 – 20 ft lb). Go back and tighten the two hex screws on the bottom of the mount bracket. Tighten to 37 – 48 Nm (26 – 34 ft lb).
15. Reinstall the radiator hoses to engine and fill the radiator with coolant.



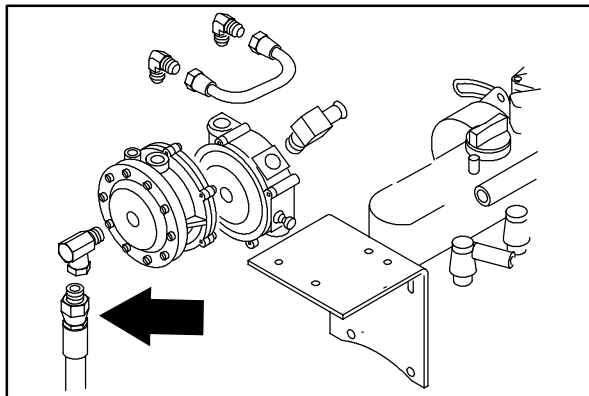
16. Position the hydraulic oil filter on the bottom of the radiator mount bracket and reinstall the four hex screws. On the standard filter tighten to 11 – 13 Nm (7 – 10 ft lb). On filter with indicator tighten to 31 – 40 Nm (37 – 35 ft lb).



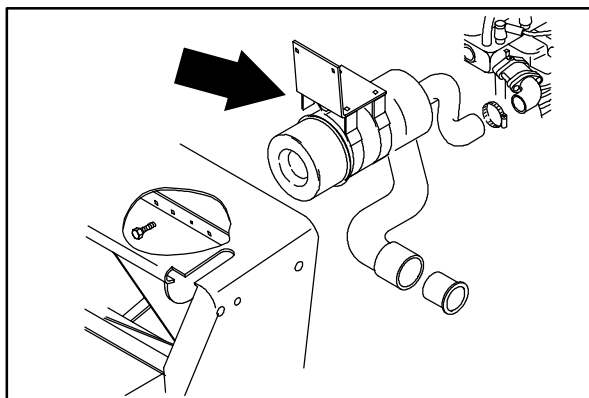
17. Reconnect fuel line on the Gas machine.



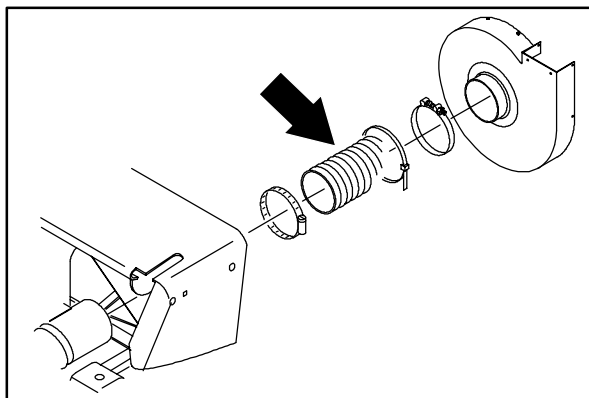
18. On the LPG machine, reinstall the LPG hose to the lockoff/vaporizer.
19. Reconnect the throttle cable and choke cable.



20. Reinstall the air cleaner mount bracket and air cleaner assembly to the bottom of the frame lintel. Tighten to 18 - 24 Nm (15 - 20 ft lb).



21. Reinstall the large hose to the vacuum fan and shut-off assembly.

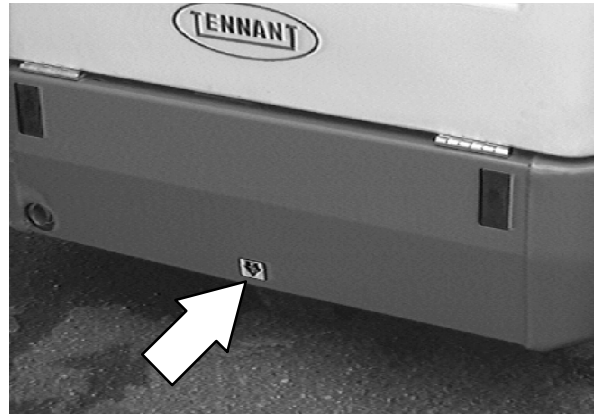


22. Reconnect the battery cables to the battery.



23. Jack up the rear of the machine.

**FOR SAFETY: Block machine tires before jacking machine up. Jack machine up at designated locations only. Block machine up with jack stands.**



24. Start the engine and check for any leaks and proper operation. Reinstall the front rubber firewall.



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## DIESEL ENGINE SERVICE MANUAL

KUBOTA D905B (E)

TENNANT Part Number 371686



**INTRODUCTION**

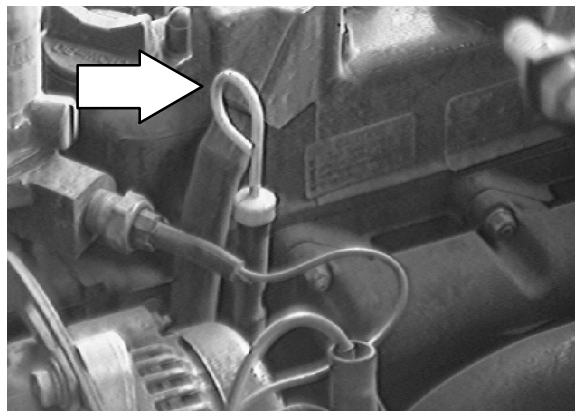
This section includes repair information on the engine and related systems, such as fuel, electrical, and engine removal.

## LUBRICATION

### ENGINE OIL

Check the engine oil level daily. Change the engine oil and oil filter every 100 hours of machine operation. Use 10W30 SAE-CD/CE rated engine oil.

Fill the engine with oil to the level indicated on the oil dipstick. The engine oil capacity is 5.1 L (5.4 qt) with out the oil filter.

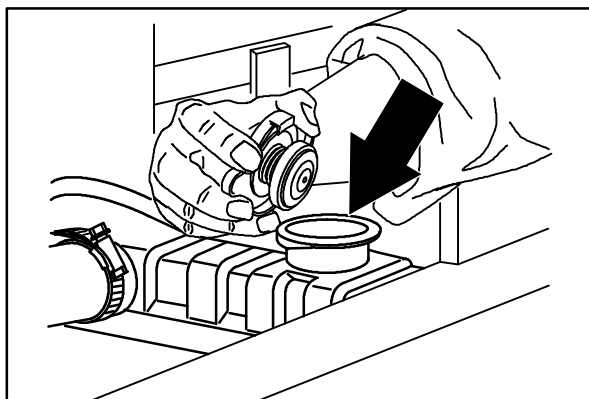


## COOLING SYSTEM

Check the radiator coolant level every 100 hours of operation. Use clean water mixed with a permanent-type, ethylene glycol antifreeze to a  $-34^{\circ}\text{C}$  ( $-30^{\circ}\text{F}$ ) rating.

**FOR SAFETY: When Servicing Machine, Avoid Contact With Hot Engine Coolant.**

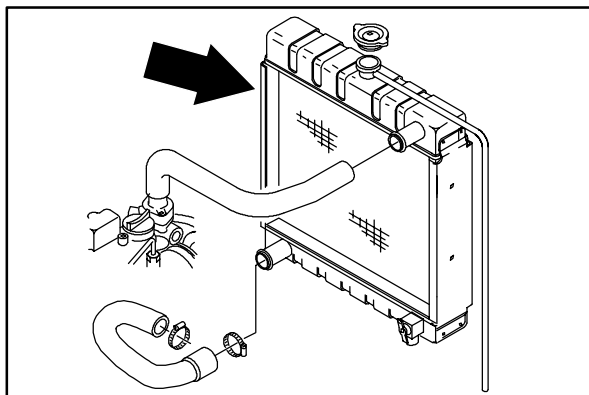
Check the radiator hoses and clamps every 200 hours of operation. Tighten the clamps if they are loose. Replace the hoses and clamps if the hoses are cracked, harden, or swollen.



Check the radiator core exterior and hydraulic cooler fins for debris every 100 hours of operation. Blow or rinse all dust, which may have collected on the radiator, in through the grille and radiator fins, opposite the direction of normal air flow. The grille and hydraulic cooler open for easier cleaning. Be careful not to bend the cooling fins when cleaning. Clean thoroughly to prevent the fins becoming encrusted with dust. Clean the radiator and cooler only after the radiator has cooled to avoid cracking.

**FOR SAFETY: When Servicing Machine, Wear Eye And Ear Protection When Using Pressurized Air Or Water.**

Flush the radiator and the cooling system every 400 hours of operation, using a dependable cleaning compound.

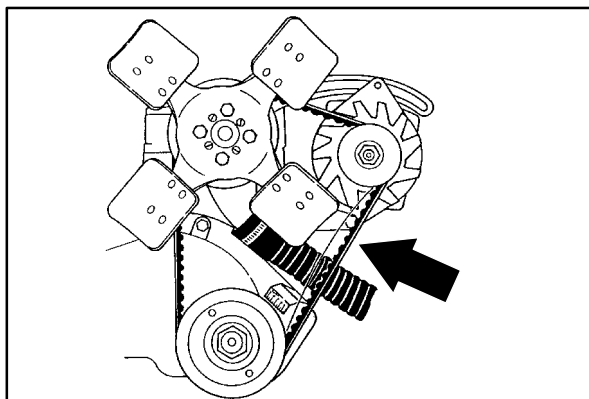




## ENGINE FAN BELT

The engine fan belt is driven by the engine crankshaft pulley and drives the alternator pulley. Proper belt tension is 9 to 10 mm (0.35 to 0.39 in) for a new belt and 10 to 11 mm (0.39 to 0.43 in) for a used belt with a force of 10 kg (22 lb).

Check and adjust the belt tension every 100 hours of operation.

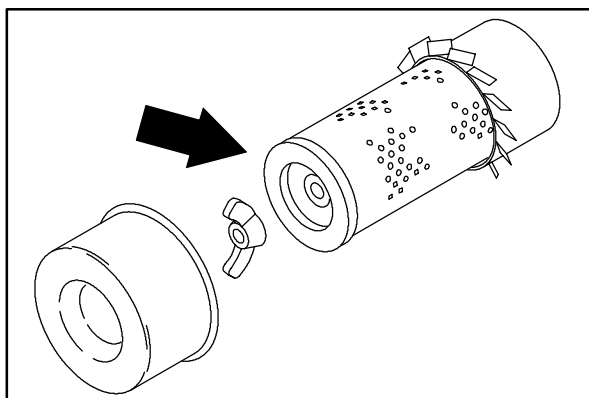


## AIR INTAKE SYSTEM

### AIR FILTER

The engine air filter housing has a dust cap and a dry cartridge-type air filter element. Empty the dust cap daily. The air filter must be replaced whenever the filter element is damaged or has been cleaned three times.

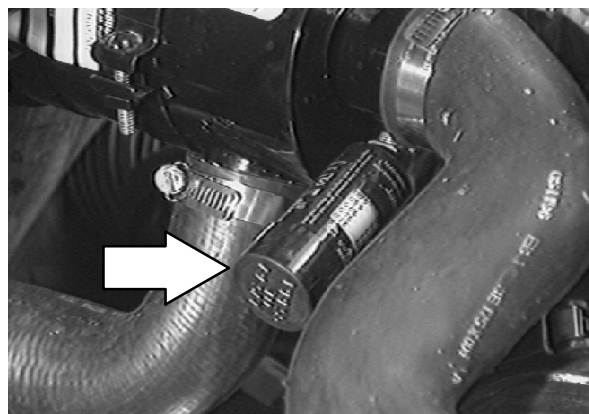
Service the air filter element only when the air filter indicator shows restriction in the air intake system. Do not remove the air filter element from the housing unless it is restricting air flow.



### AIR FILTER INDICATOR (OPTIONAL)

The air filter indicator shows when to clean or replace the air filter element. Check the indicator daily. The indicator's red line will move as the air filter element fills with dirt. Do not clean or replace the air filter element until the red line reaches 5 kPa (20 in H<sub>2</sub>O) and the "SERVICE WHEN RED" window is filled with red. The indicator's red line may return to a lower reading on the scale when the engine shuts off. The red line will return to a correct reading after the engine runs for a while.

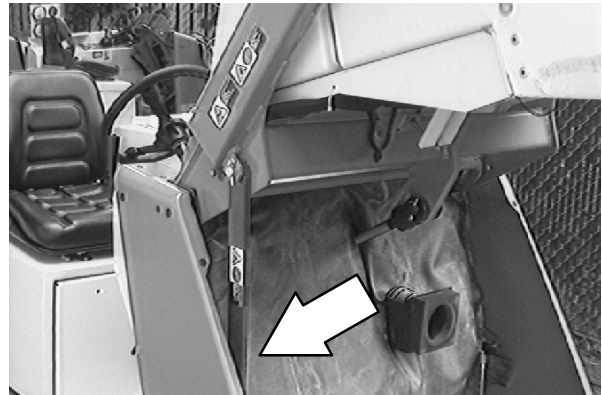
Reset the air filter indicator by pushing the reset button on the end of the indicator after cleaning or replacing the air filter element.



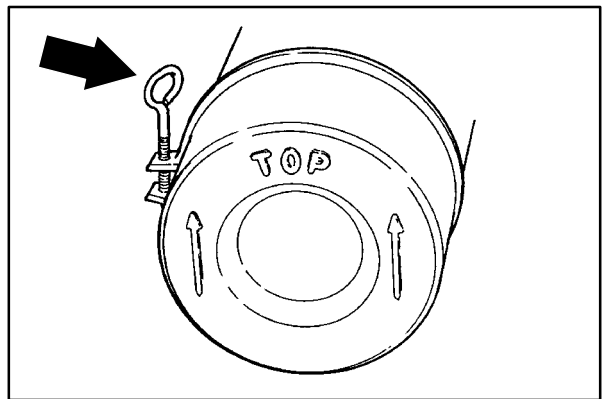
### TO REPLACE AIR FILTER ELEMENT

**FOR SAFETY: Before Leaving Or Servicing Machine: Stop On Level Surface, Set The Parking Brake, Turn Off Machine And Remove Key.**

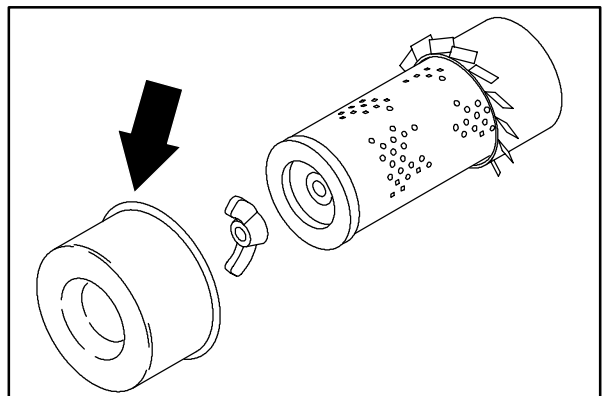
1. Start the engine and raise the debris hopper. Engage the support bar.



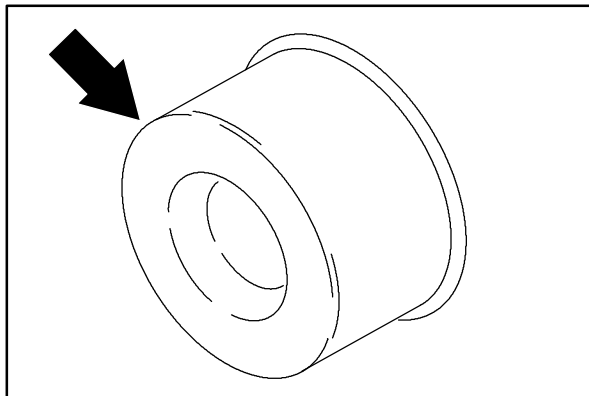
2. Unscrew the clamp ring on the filter.



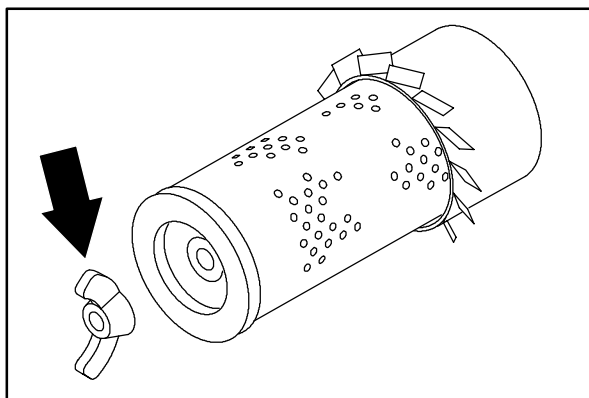
3. Remove the dust cap.



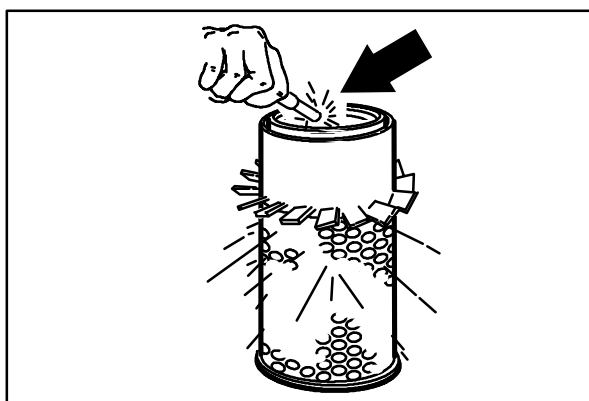
4. Empty the dust cap.



5. Remove the filter wing nut.

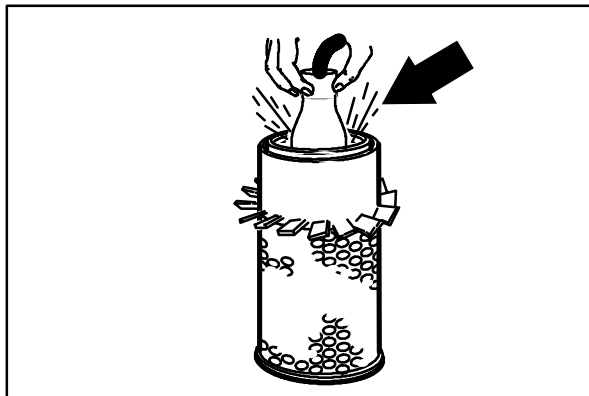


6. Pull the filter element out of the filter housing.
7. Clean the interior of the air cleaner housing with a camp cloth. Clean the element housing sealing surfaces.
8. Using an air hose, direct dry, clean air maximum 205 kPa (30 psi) up and down pleats on the inside of the filter. Do not rap, tap, or pound dust out of the element.

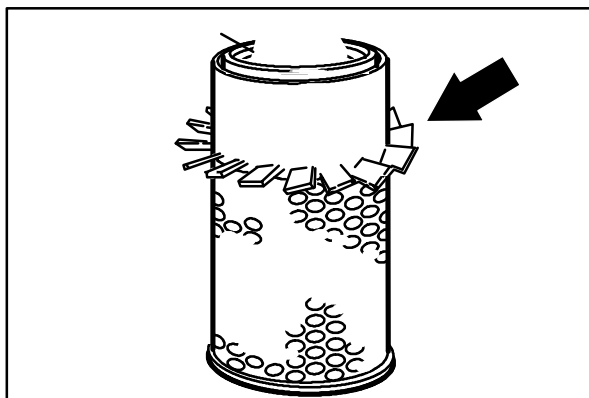


**FOR SAFETY: When Servicing Machine, Wear Eye And Ear Protection When Using Pressurized Air Or Water.**

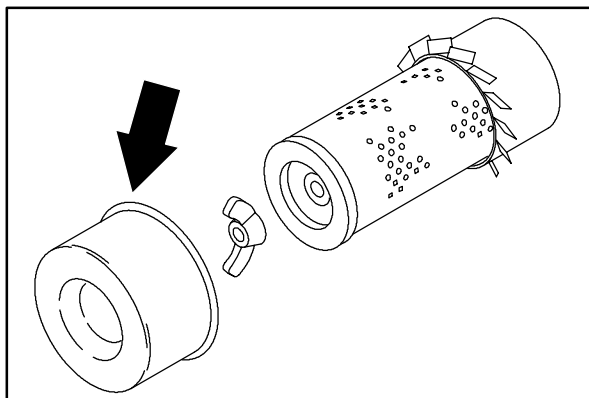
9. After cleaning the air filter element, inspect it for damage by placing a bright light inside. The slightest rupture requires replacement of the filter. Clean and inspect the seals on the ends of the element. They should be unbroken and flexible. Remember to replace the element after cleaning it three times.



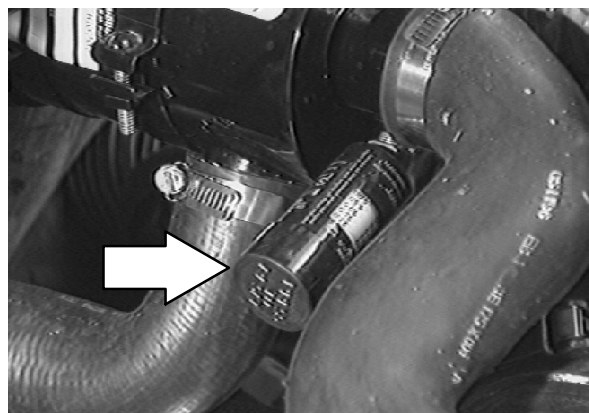
10. Install the new or cleaned filter element so the fins on the element are at the intake end of the air cleaner. Be careful not to damage the fins. Make sure the element is seating evenly. Tighten the element wing nut.



11. Install the dust cap with the arrows pointing up. Tighten the clamp ring to hold it in place. Check all intake hose connections for leaks or abrasions.



12. Reset the air filter restriction indicator.

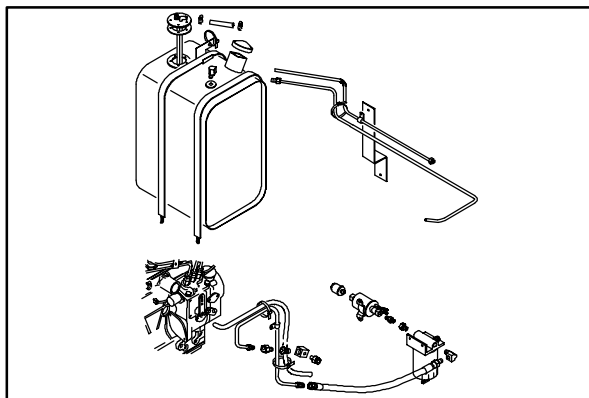


13. Lower the debris hopper.

## FUEL SYSTEM - DIESEL

The diesel fuel system is made up of five basic components which are: fuel tank, fuel filter/water trap, fuel pump, injection pump, and injectors.

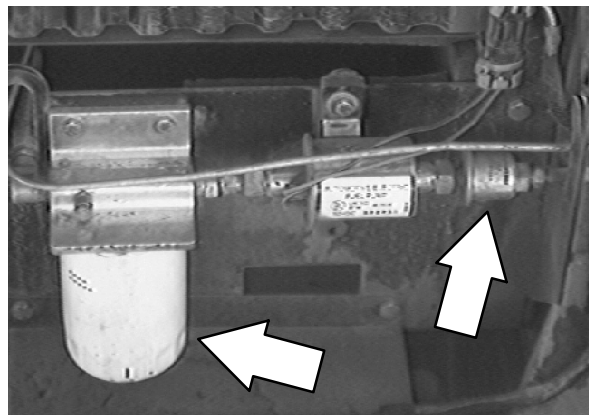
Fuel flows from the fuel tank through the fuel filter/water trap. The water trap-filter separates water and impurities from the fuel. From the fuel water trap-filter, fuel is drawn through the electric fuel pump and pumped to the injection pump. The injection pump pressurizes and sends fuel to the injectors. The injectors atomize and inject proper amounts of fuel into the combustion chamber at the proper times. Excess fuel is returned to the fuel tank through an overflow pipe.



## FUEL FILTERS

The large fuel filter cartridge filters impurities from the fuel. It is located low on the left side of the machine below the radiator mount.

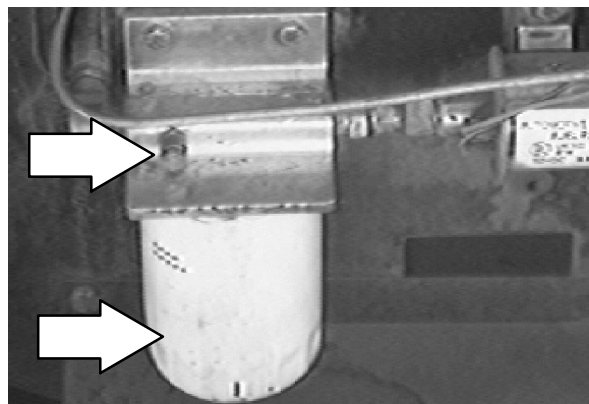
The smaller in-line fuel filter is located ahead of the fuel pump. It filters out impurities that could damage the fuel pump.



## TO REPLACE THE FUEL FILTER CARTRIDGE

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, And Turn Off Machine.**

1. Loosen the unit vent plug and open the water trap drain to drain diesel fuel.
2. Remove the filter cartridge from the filter head.
3. Lubricate the o-ring of the new filter cartridge and spin it onto the filter head.
4. Bleed the fuel lines of air as described in TO PRIME FUEL SYSTEM instructions.

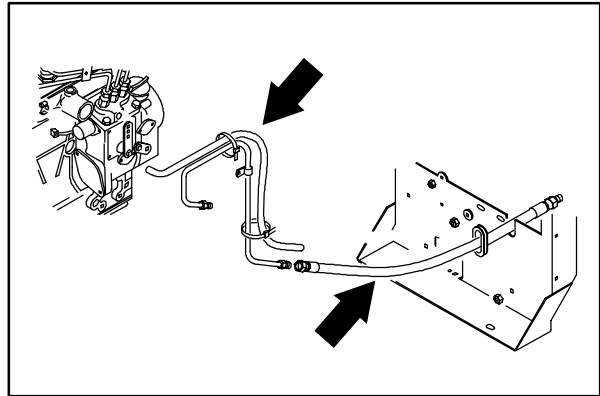


### FUEL LINES

Check the fuel lines every 50 hours of operation. If the clamp band is loose, apply oil to the screw of the band, and securely tighten the band.

Made of rubber, the fuel lines become worn out whether the engine has been used much or not. Replace the fuel lines and clamp bands every two years.

If the fuel lines and clamp bands are found worn or damaged before two years' time, replace or repair them at once. Bleed the fuel system after replacement of any of the fuel lines, see TO PRIME THE FUEL SYSTEM. When the fuel lines are not installed, plug both ends with clean cloth or paper to prevent dirt from entering the lines. Dirt in the lines can cause fuel injection pump malfunction.



### PRIMING FUEL SYSTEM

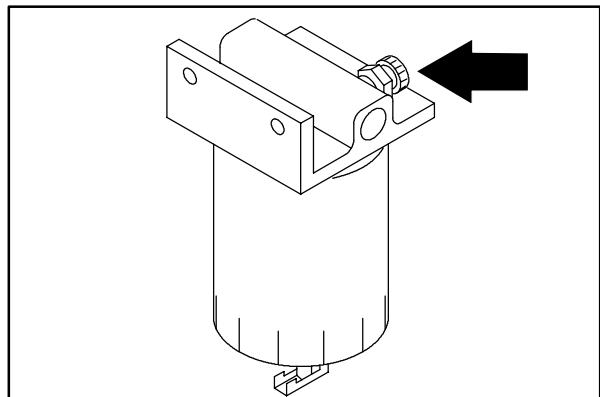
Priming the fuel system removes pockets of air in the fuel lines and fuel components. Air in the fuel system will prevent smooth engine operation.

Prime the fuel system after running out of fuel, changing fuel filter element or repairing a fuel system component.

### TO PRIME FUEL SYSTEM

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, And Turn Off Machine.**

1. Make sure the fuel tank is full.
2. Open the air vent on top of the fuel filter.
3. Start the engine, operate it for one minute, then stop it; or operate the starter motor in ten-second intervals until a steady stream of fuel flows from the vent.
4. Close the air vent and shut off the engine.
5. Clean up any fuel that was spilled during the bleeding process.

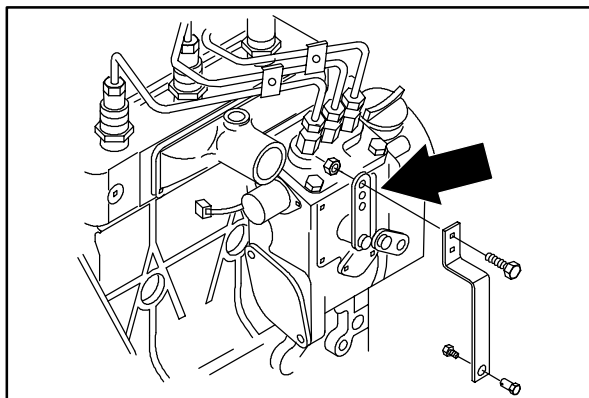


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**GOVERNOR**

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The mechanical governor controls engine speed. The governor is factory set and is not user serviceable.



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**CYLINDER HEAD**

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**VALVE TAPPET CLEARANCE**

The valve tappet clearance must be checked and adjusted if necessary every 400 hours of operation. See Kubota Diesel Engine Workshop Manual for 78.4 mm Stroke Series.

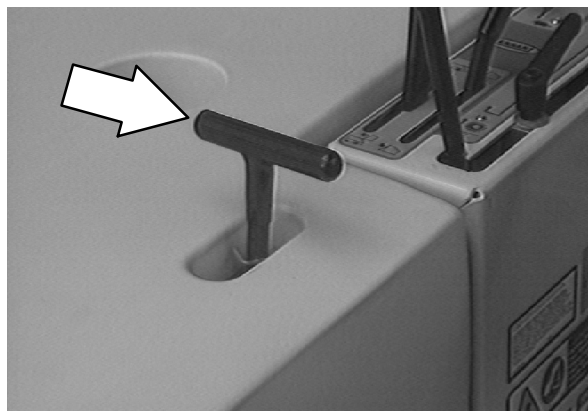
**CRANKCASE VENTILATION SYSTEM**

See Kubota Diesel Engine Workshop Manual for 78.4 mm Stroke Series.

### TO REPLACE ALTERNATOR

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

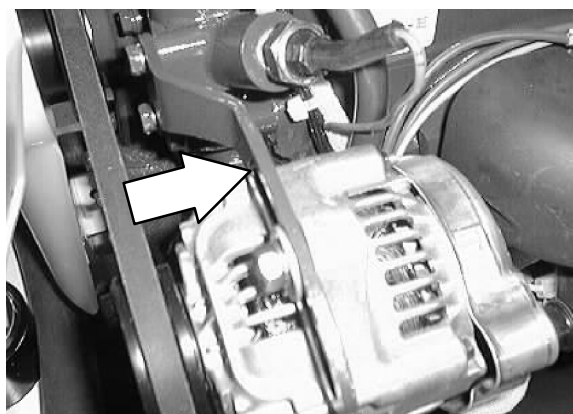
1. Open the seat support.



2. Disconnect the battery cables from the battery.

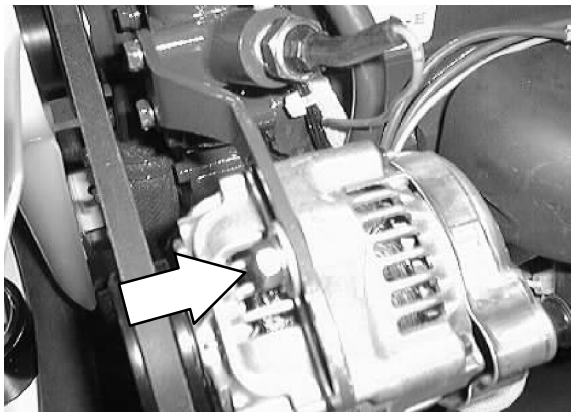


3. Cut any plastic wire ties holding the wire harness to the alternator bracket.

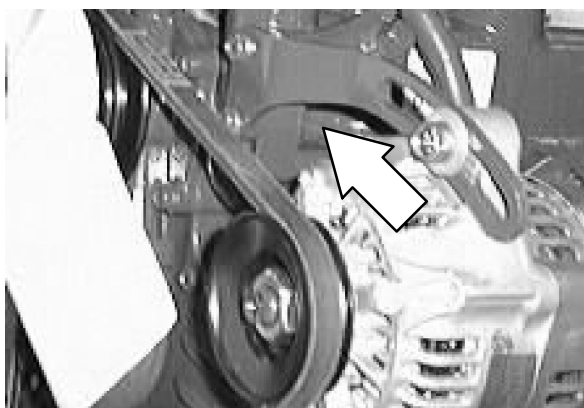




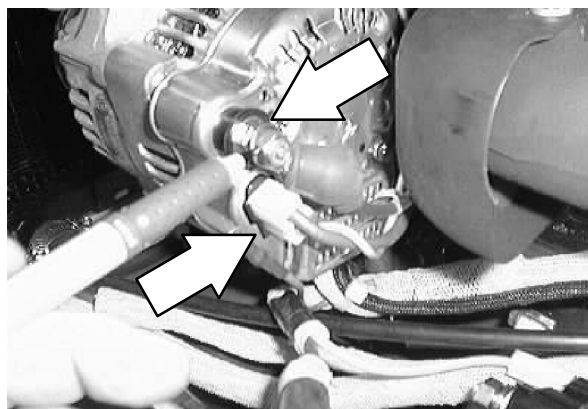
4. Remove the hex screw holding the top of the alternator to the mount bracket. Remove and retain the heat shield.



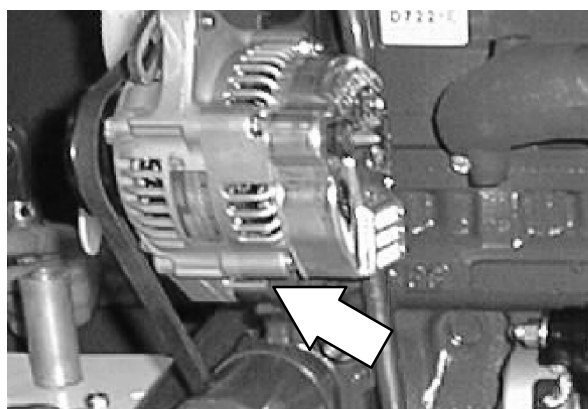
5. Push the alternator in toward the engine and remove the V-belt.



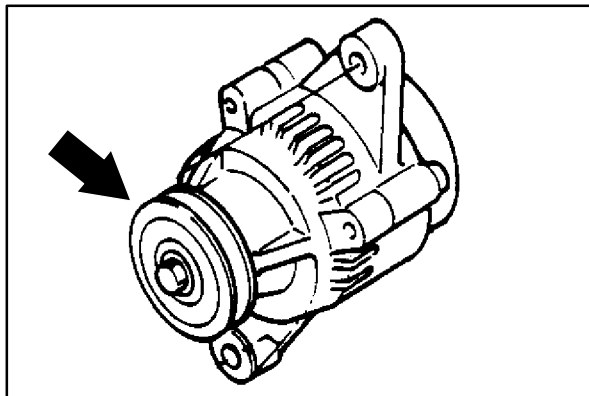
6. Disconnect the wires leading to the back of the alternator.



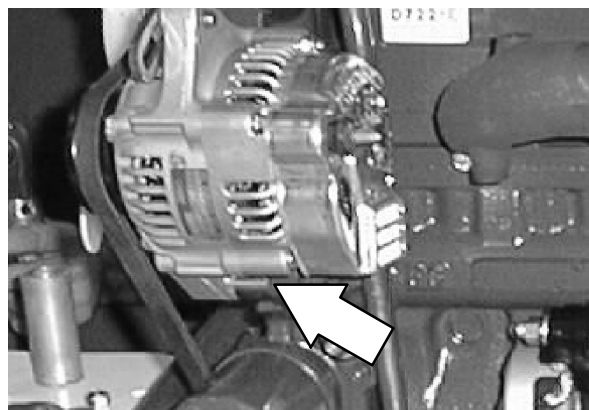
7. Remove the hex screw and nyloc nut holding the bottom of the alternator to the lower mount bracket.
8. The alternator can now be removed from the machine.



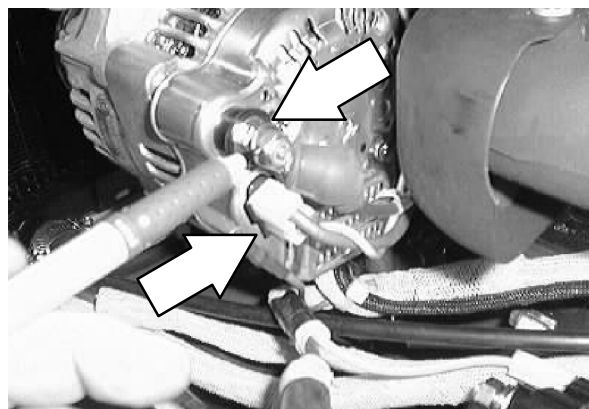
9. If the new or rebuilt alternator needs a drive pulley, remove the pulley from the old alternator. Hold the pulley from turning and use an impact wrench to remove the hex nut.
10. Install the pulley, washer, and hex nut on the new alternator. Firmly tighten the nut with the impact.



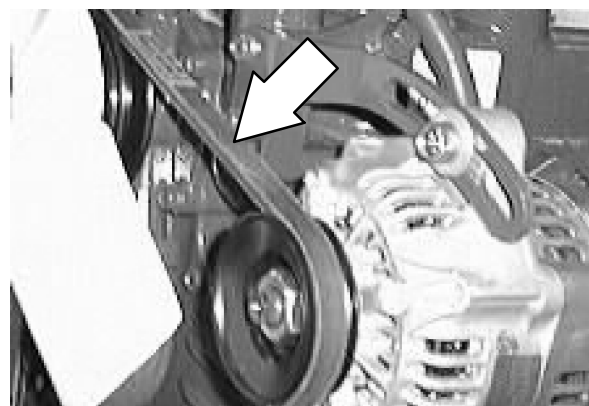
11. Install the new alternator back in the machine. Align the bottom hole in the alternator with hole in lower mount bracket. Reinstall the hex bolt, ground cable, and nyloc nut. Leave it loose for now.



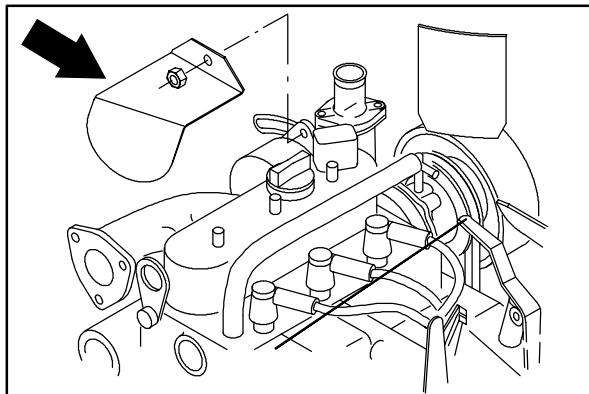
12. Reconnect the wires to the back of alternator. See the schematic in the ELECTRICAL section.



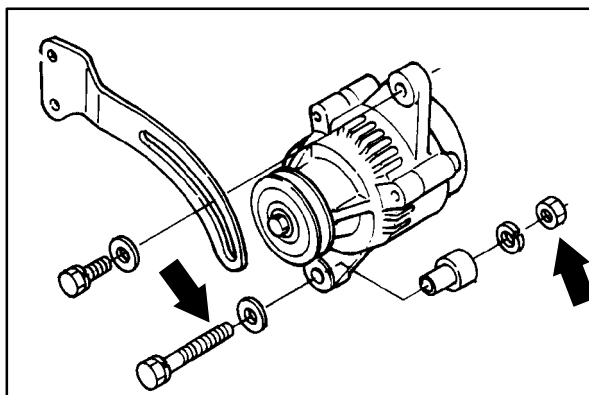
13. Place the V-belt back on the alternator pulley.



14. Reinstall the hex screw and heat shield in the top hole of the alternator through upper slotted mounting bracket. Pull the alternator toward the operator compartment to tighten the belt. See adjustment in ENGINE FAN BELT description. Tighten the hex screw to 18 - 24 Nm (13 - 18 ft lb).



15. Tighten the bottom hex screw to 18 - 24 Nm (15 - 20 ft lb).



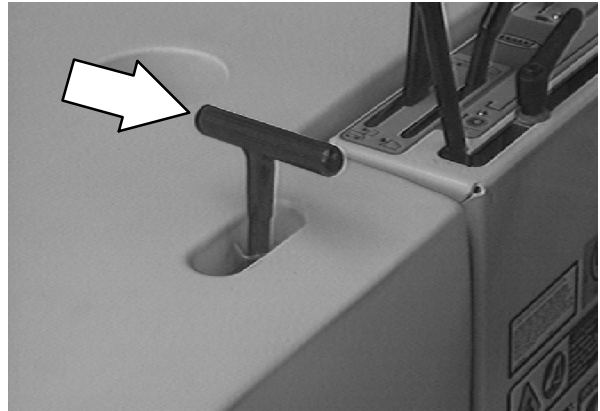
16. Reconnect the battery cables and start the engine. Check the new alternator for proper operation.



### TO REPLACE STARTER

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.**

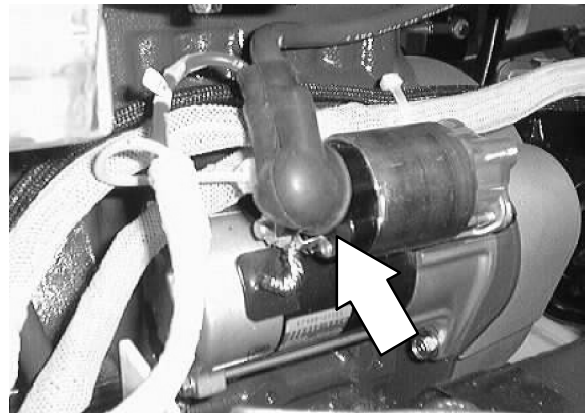
1. Open the seat support.



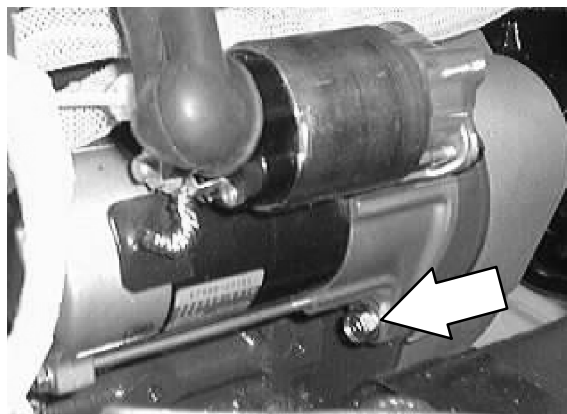
2. Disconnect the battery cables from the battery.



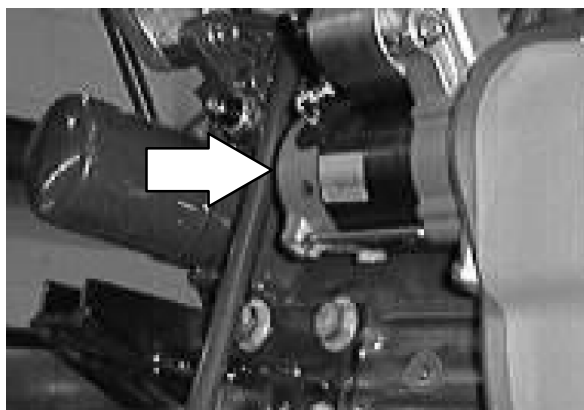
3. Disconnect the wires leading to the back of the starter.



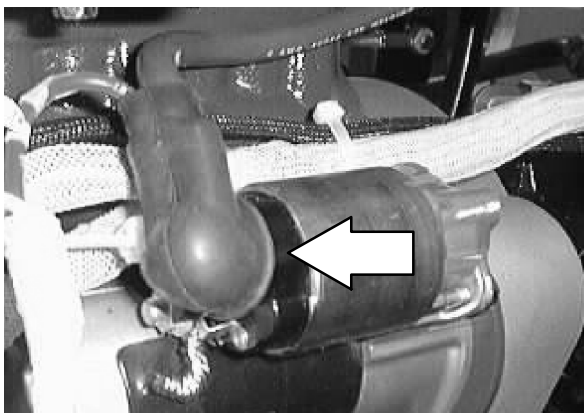
4. Remove the two hex screws holding the starter to the engine bellhousing.
5. Pull the starter straight out of the bellhousing and remove it from the machine.



6. Install the new starter in the machine. Align the two holes in the starter with the holes in the bellhousing. Reinstall the two hex screws. Tighten to 18 - 24 Nm (15 - 20 ft lb).



7. Reconnect the wires to the back of the starter. See the schematic in the ELECTRICAL section.



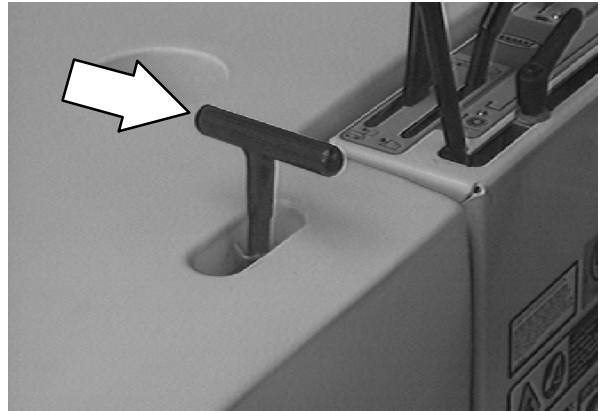
8. Reconnect the battery cables and check the starter for proper operation.



### TO REMOVE ENGINE

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake., Turn Off Machine And Remove Key.**

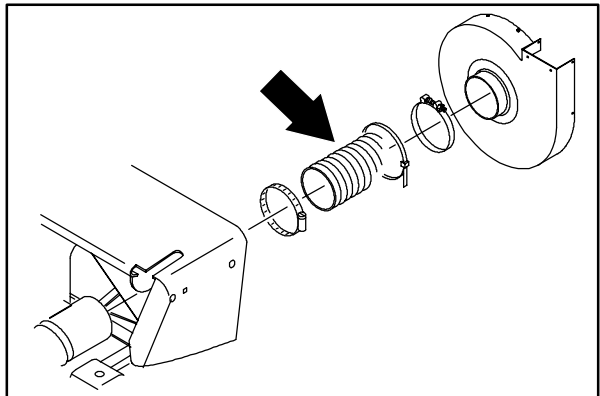
1. Open the seat support.



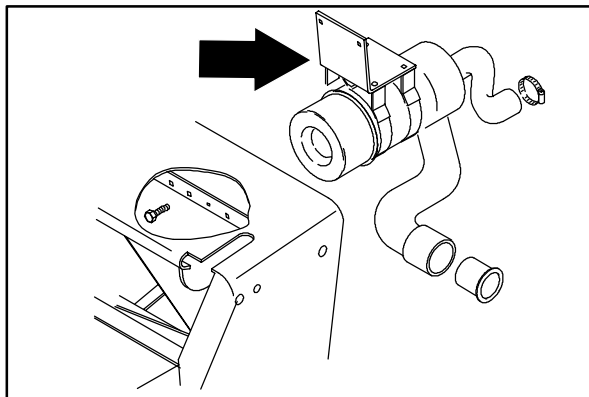
2. Disconnect the battery cables from the battery.



3. Remove the large hose leading from the vacuum fan to the shut-off assembly.

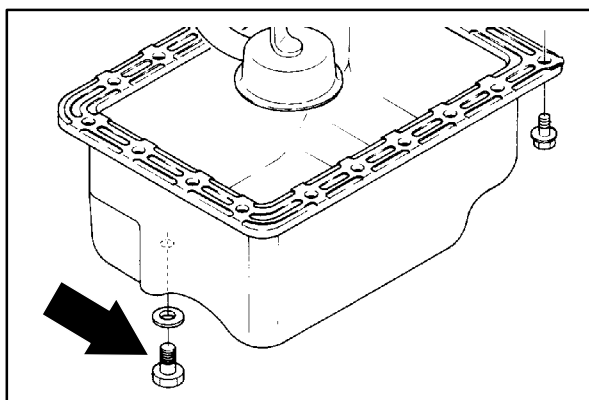


4. Remove the two hex screws holding the air cleaner assembly and mounting bracket to the bottom of the machine lintel. Remove the air cleaner assembly from the machine.

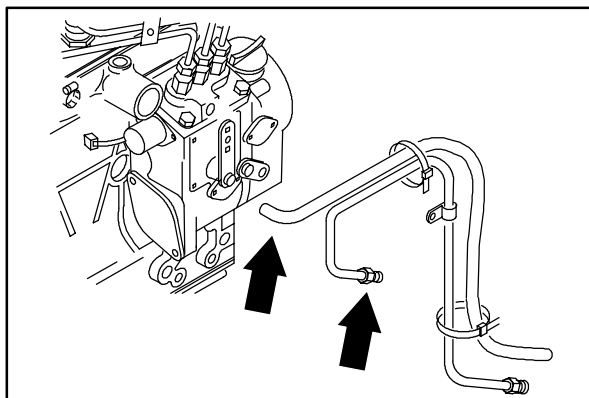


5. Drain the engine oil and remove the engine oil filter.

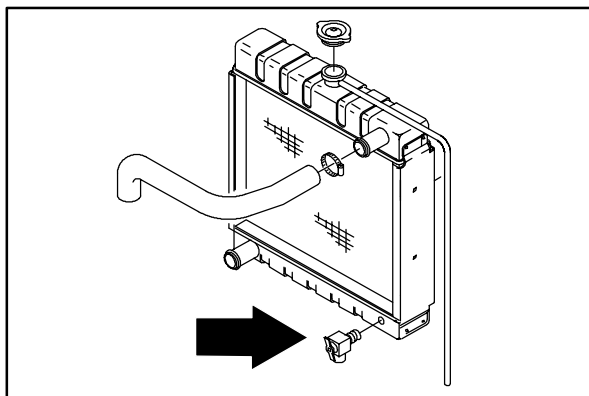
*NOTE: Oil filter must be removed in order to access the right rear motor mount bolt.*



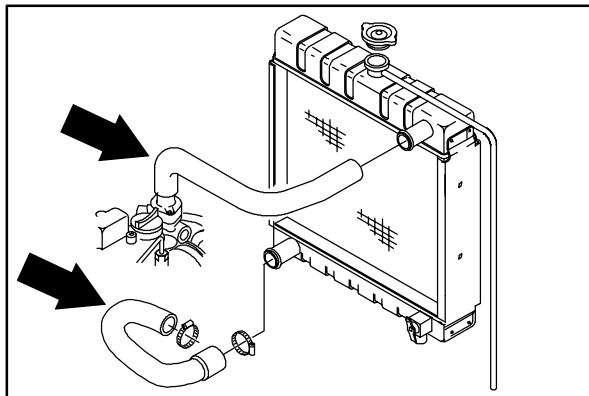
6. Disconnect the fuel line at the injector pump. Remove the fuel line where it goes through the radiator mount.



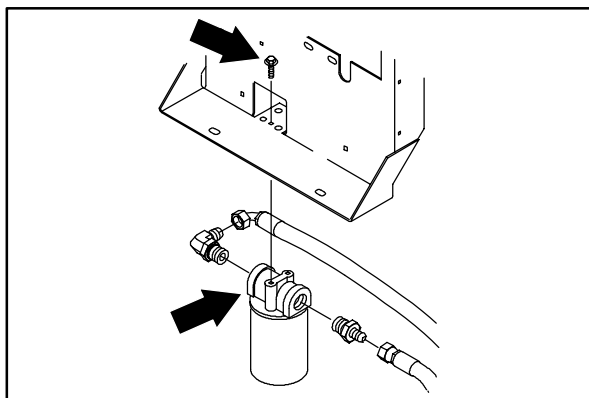
7. Drain the coolant from the radiator.



8. Remove the two radiator hoses from the engine.



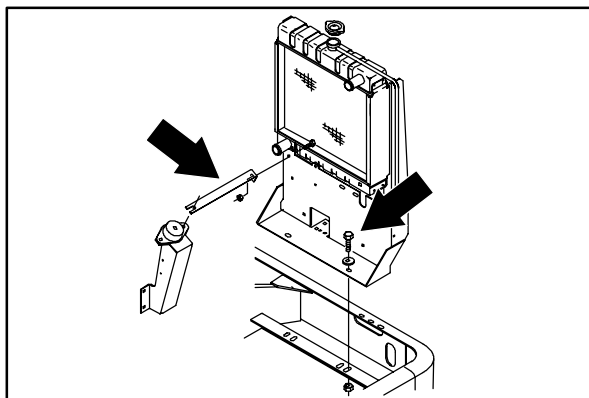
9. Remove the hex screws holding the hydraulic oil filter to the bottom of the radiator mount assembly. Let the filter drop down. Do not disconnect the hydraulic hoses.



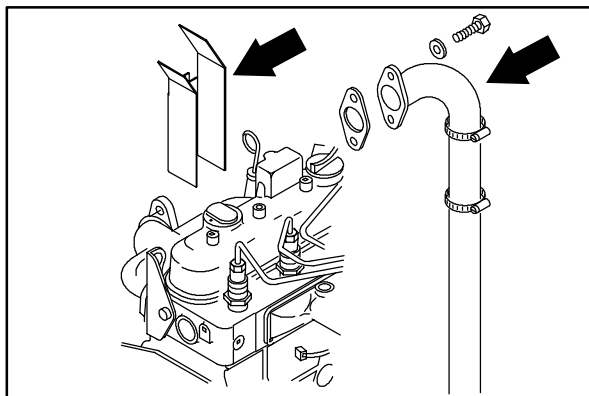
10. Remove the hex screw holding the radiator mount strap to the lower right corner of the radiator assembly.

11. Remove the two hex screws holding the radiator assembly to the machine frame.

12. Remove the radiator assembly from the machine.

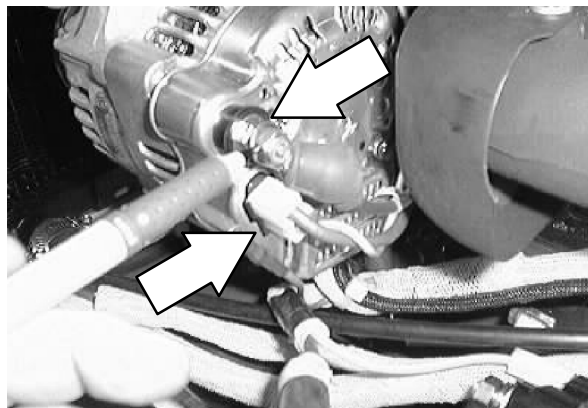


13. Remove the hex screws holding the exhaust pipe to the engine manifold.

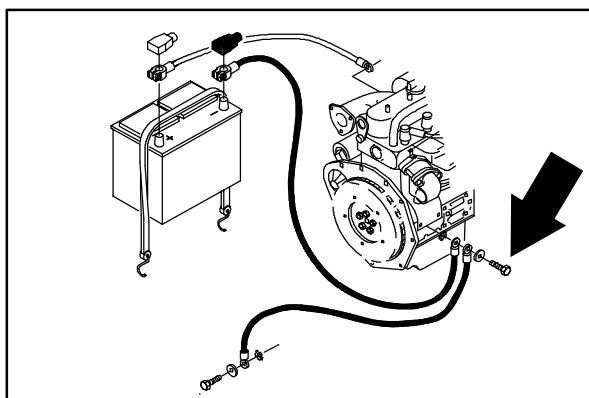




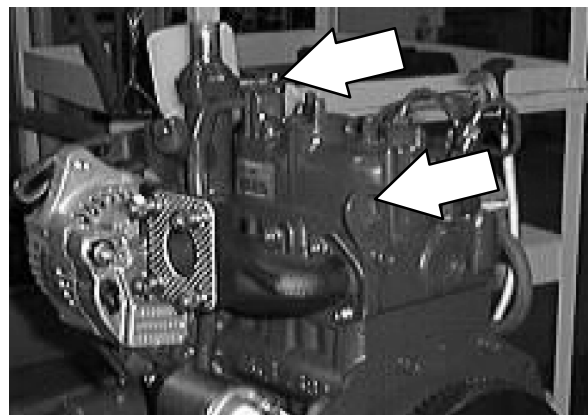
14. Disconnect the wire harness from the alternator, starter, oil sender, temp. sender, glow plugs, ect. Move the wires out of the way for engine removal.



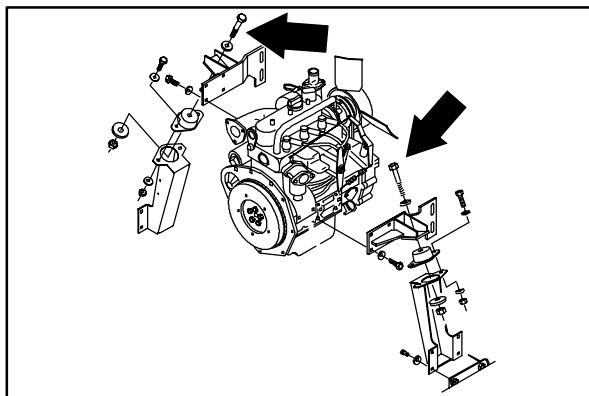
15. Disconnect the engine ground strap from the machine frame.



16. Using an overhead hoist, hook a chain through the two pick-up points on the top of the engine. Put a slight amount of tension on the chain.



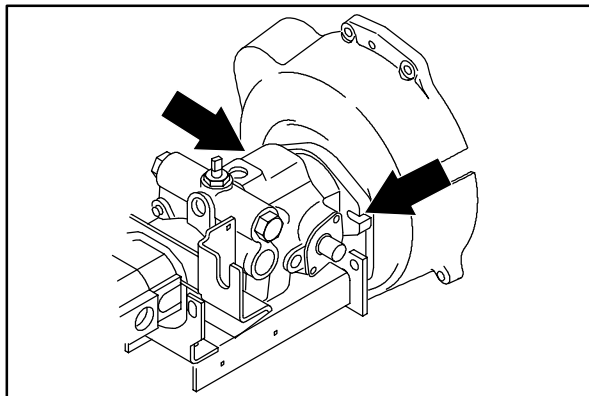
17. Remove the two hex screws and nyloc nuts holding the rear motor mounts to the rubber isolators on the frame brackets.



## ENGINE-DIESEL

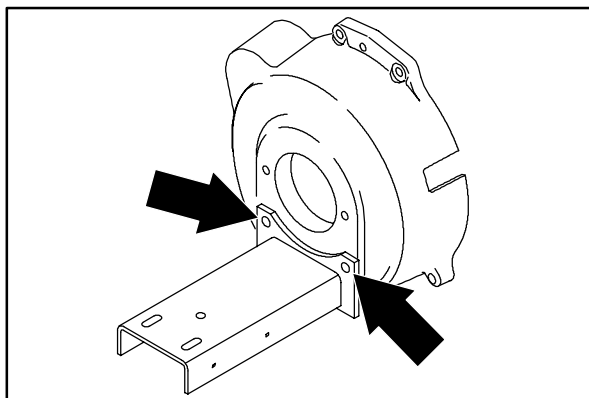
18. Remove the two hex screws holding the propel pump to the flywheel housing.

*NOTE: Place a block of wood under the hydraulic pump assembly for support when removing the engine.*



19. Remove the two hex screws holding the front motor mount plate to the bottom of the bellhousing.

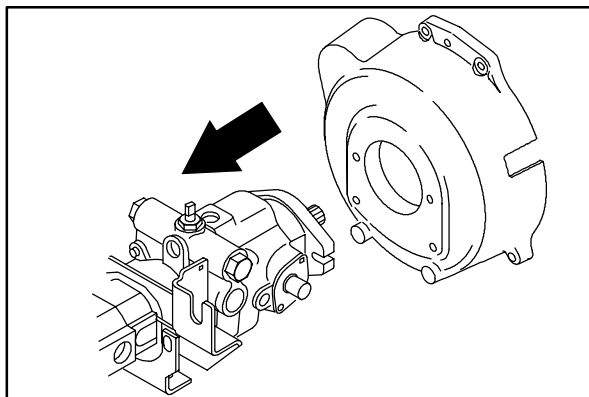
20. Disconnect the throttle cable from the engine.



21. Pull the engine back until the hydraulic pump assembly is free of the bellhousing.

22. The engine can now be carefully lifted out.

*NOTE: Make sure the engine is clear of any wires or hoses before you lift it out of the frame.*

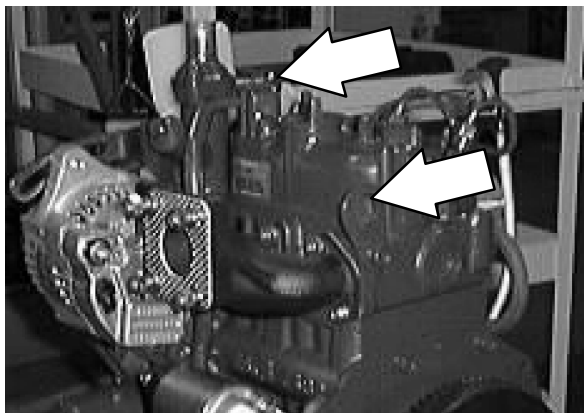


**TO INSTALL ENGINE**

**FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake., Turn Off Machine And Remove Key.**

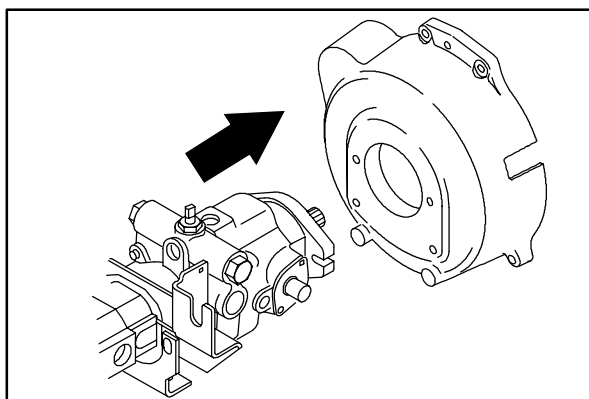
1. Using an overhead hoist, hook a chain through the two pick-up points on top of the engine. Carefully position the engine back in the engine compartment.

*NOTE: Make sure the hoses, wire harness, exhaust pipe and propel pump are pulled back out of the way when lowering engine assembly into place.*

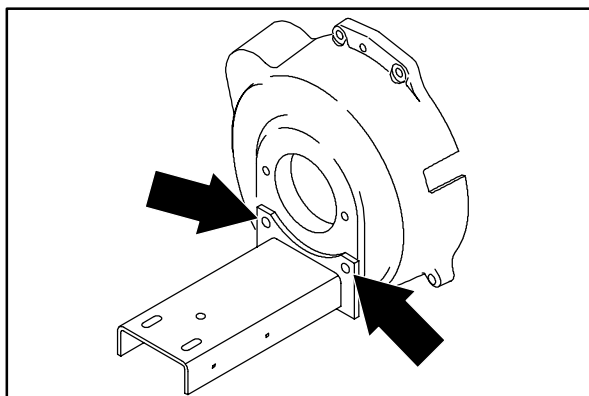


2. Slide the engine toward the front of the machine until the propel pump is positioned back in the bellhousing. Start the two hex screws only. Use a small amount of blue loctite 242 on the threads.

*NOTE: Make sure the splines on pump line up with splines in coupler when installing pump.*

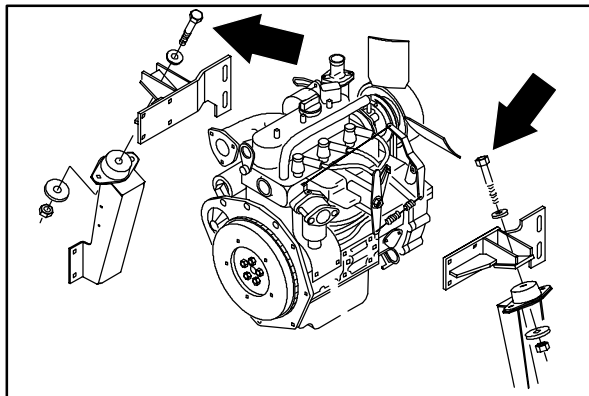


3. Reinstall the hex screws in the front motor mount plate and bellhousing. Use a small amount of blue loctite 242 on the threads. *Leave loose for now.*

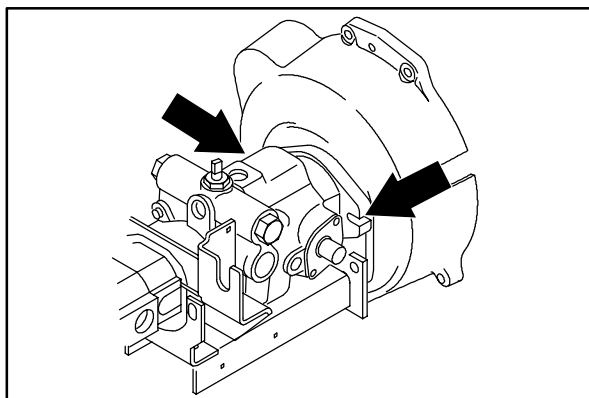


4. Carefully align the mount holes in the rubber isolators on the rear engine mounts with the holes in the frame brackets. Install the two hex screws and nyloc nuts.

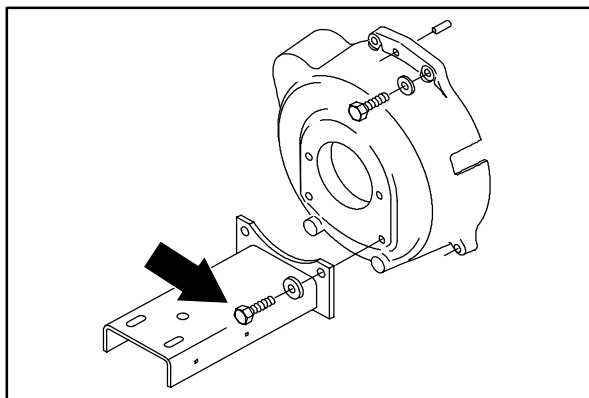
*NOTE: The left rear frame bracket may need to be loosened up in order to install both motor mount hex screws.*



5. Go back and tighten the propel pump hardware to 37 - 48 Nm (26 - 34 ft lb).

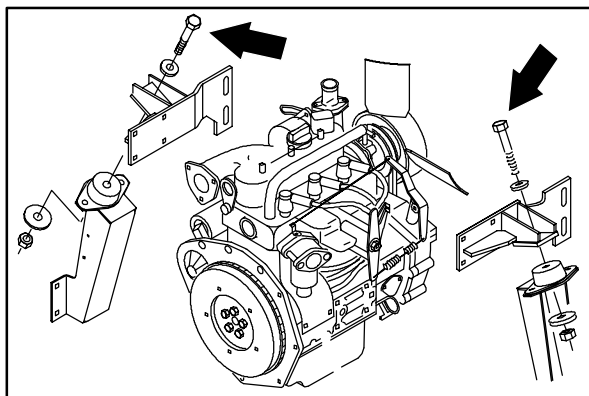


6. Tighten the hex screws holding the front motor mount plate to the bellhousing. Tighten to 13 - 18 Nm (10 - 13 ft lb).

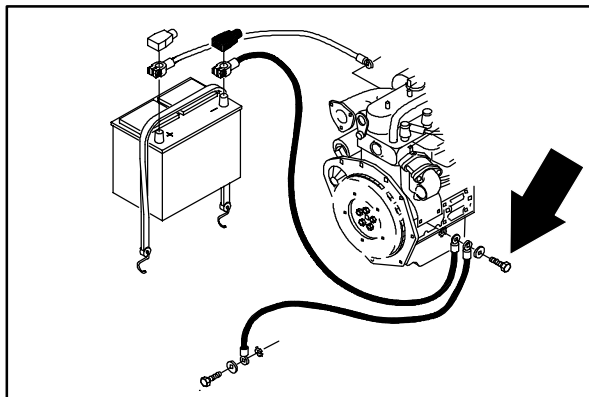


7. Tighten the hex screws holding the rear rubber isolators to the frame mount brackets. *Hand tighten tight.*

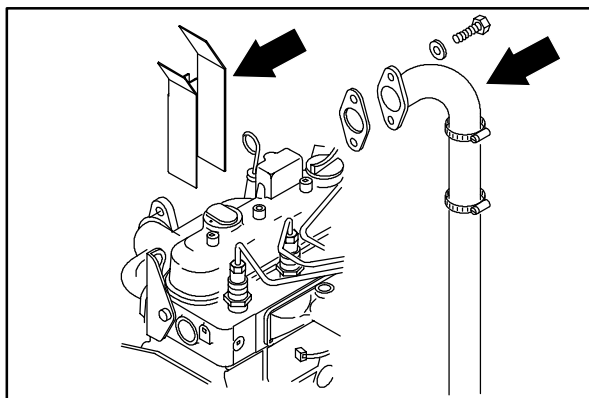
8. Remove the hoist from the engine.



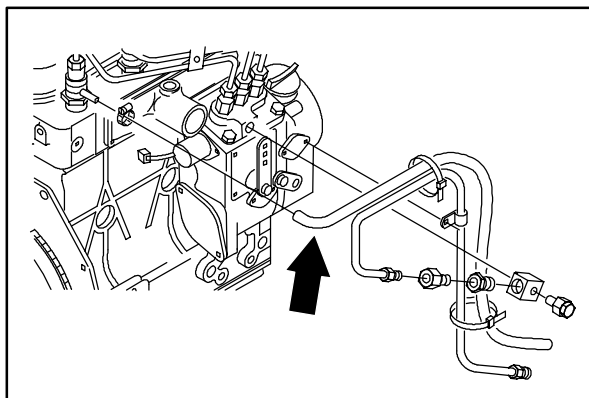
9. Reconnect the ground cable from the bellhousing to the machine frame.



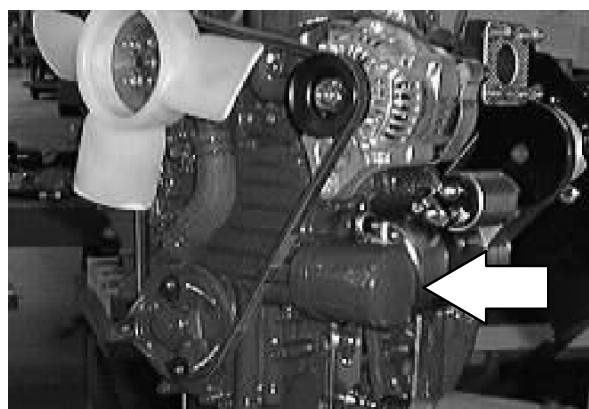
10. Reinstall the exhaust pipe onto the engine manifold. Reinstall the hex screws and hand tighten.



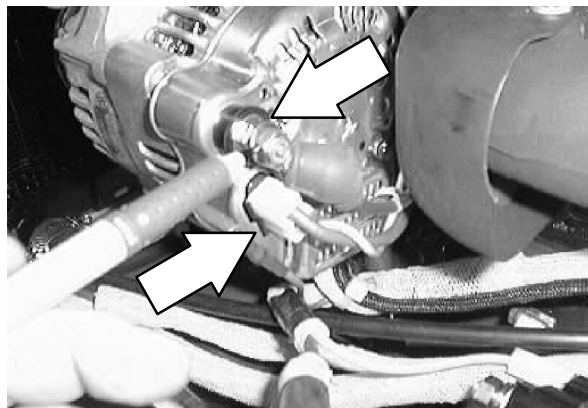
11. Reconnect the fuel line to the injector pump.



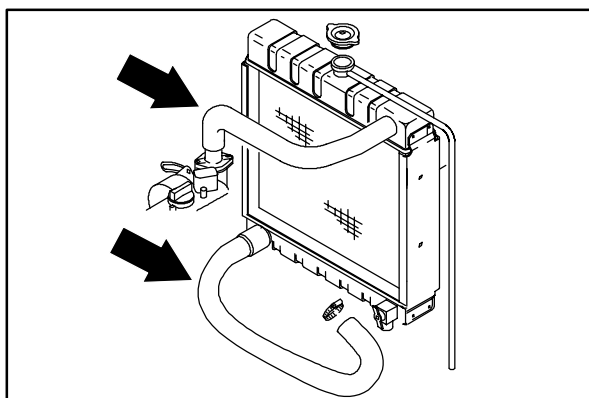
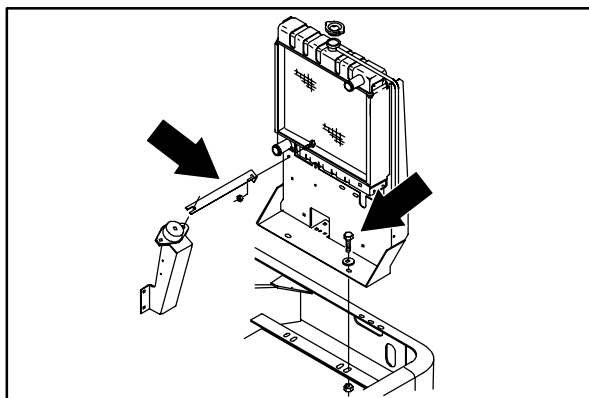
12. Install a new engine oil filter and fill the engine with the proper grade of oil. On the Diesel engine, use 5.1 L (5.4 qt) 10W-30 SAE-CC/CD with a new filter.



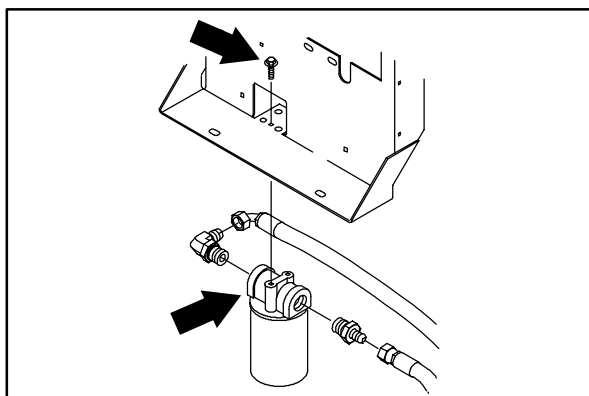
13. Reconnect the wire harness to the engine components; alternator, starter, oil switch, temperature sender, ect. See schematic in the ELECTRICAL section of this manual.



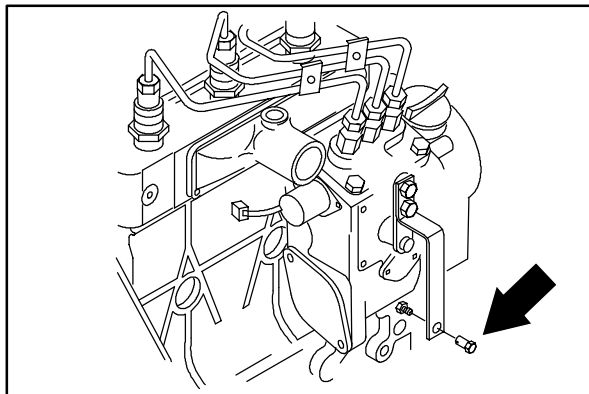
14. Position the radiator back in the machine. Align the two holes in the bottom of the radiator mount bracket holes in the frame. Reinstall the two nyloc nuts and washers. Leave loose for now.
15. Reinstall the hex screw holding the radiator brace to the bottom right corner of the radiator assembly. Tighten to 18 - 24 Nm (15 - 20 ft lb). Go back and tighten the two hex screws on the bottom of the mount bracket. Tighten to 37 - 48 Nm (26 - 34 ft lb).
16. Reinstall the radiator hoses to engine and fill the radiator with coolant.



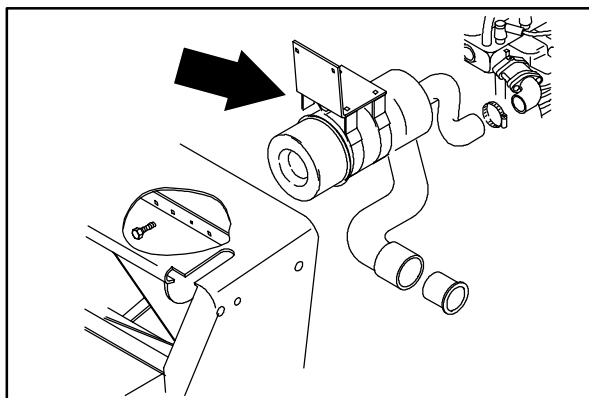
17. Position the hydraulic oil filter on the bottom of the radiator mount bracket and reinstall the four hex screws. On the standard filter tighten to 11 - 13 Nm (7 - 10 ft lb). On filter with indicator tighten to 31 - 40 Nm (37 - 35 ft lb).



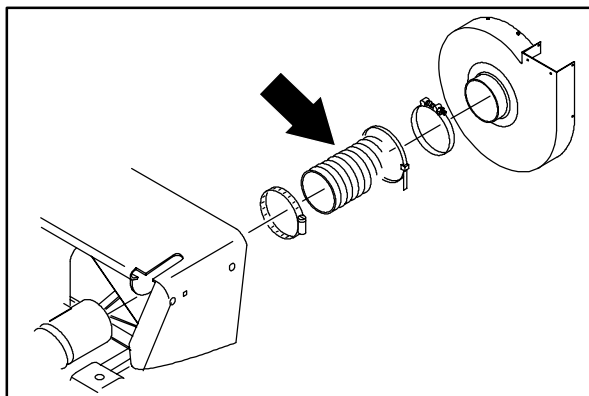
18. Reconnect the throttle cable.



19. Reinstall the air cleaner mount bracket and air cleaner assembly to the bottom of the frame lintel. Tighten to 18 - 24 Nm (15 - 20 ft lb).



20. Reinstall the large hose to the vacuum fan and shut-off assembly.



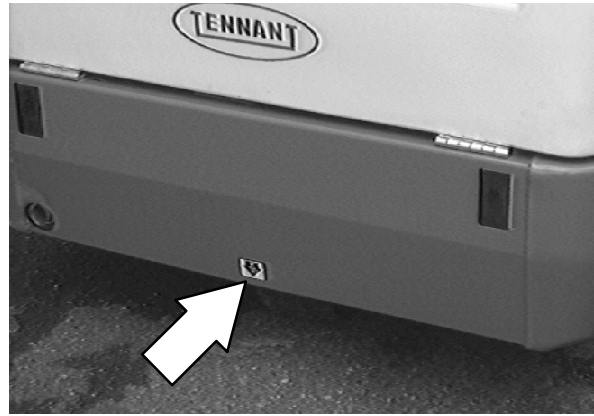
21. Reconnect the battery cables to the battery.



22. Jack up the rear of the machine.

**FOR SAFETY: Block machine tires before jacking machine up. Jack machine up at designated locations only. Block machine up with jack stands.**

23. Start the engine and check for any leaks and proper operation. See TO BLEED FUEL SYSTEM instructions if needed.



24. Start the engine and check for any leaks and proper operation. Reinstall the front rubber firewall.







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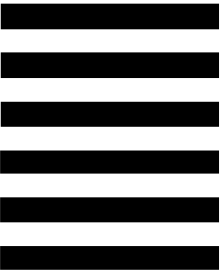
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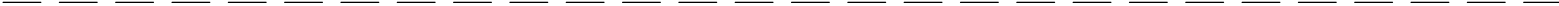
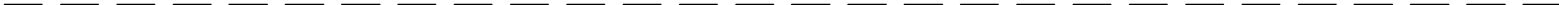
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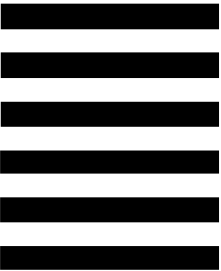
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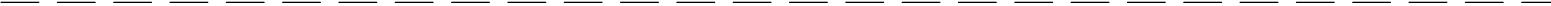
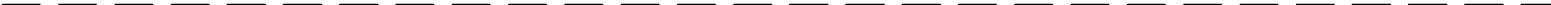
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