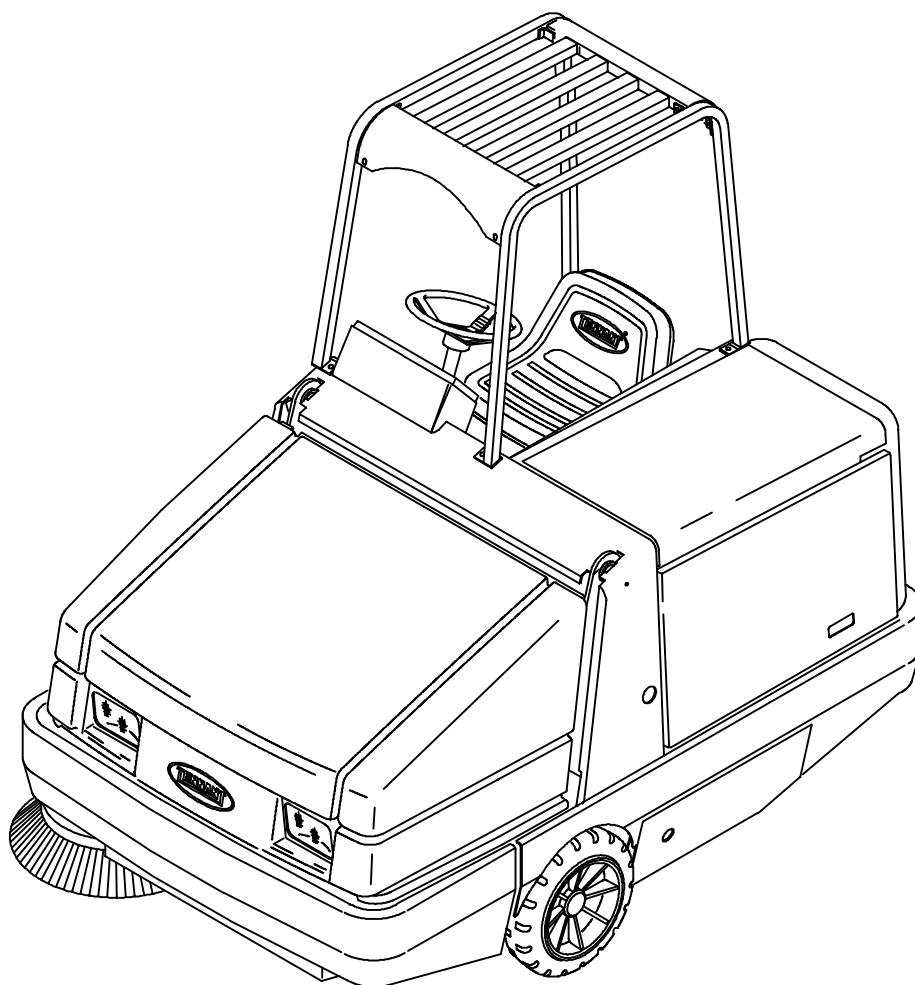




355/385

Gas/LP/Diesel

Service Manual



MM302
Rev. 05 (12-01)



This service manual is intended to be an aid for the disassembly and reassembly of your TENNANT Model 355/385.

The set is organized into seven major groups: General Information, Chassis, Sweeping, Electrical, Hydraulics, Engine-G/LPG, 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, and electrical troubleshooting.

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

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

Manual Number - MM302

Revision: 05

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 which could result in severe personal injury or death.

FOR SAFETY: To identify actions which 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 operator manual is read and understood.
 - If it is not in proper operating condition.
 - 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, oil, and liquid 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.
 - Make sure back-up alarm sounds and lights when reversing machine.
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.
5. **Before leaving or servicing machine:**
 - Do not carry passengers on machine.
 - Always follow safety and traffic rules.
 - Report machine damage or faulty operation immediately.
 - 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 of adequate capacity to lift 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.



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: Raised hopper may fall. Engage hopper support bar.



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



WARNING: Moving belt and fan. Keep away.

SAFETY PRECAUTIONS

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

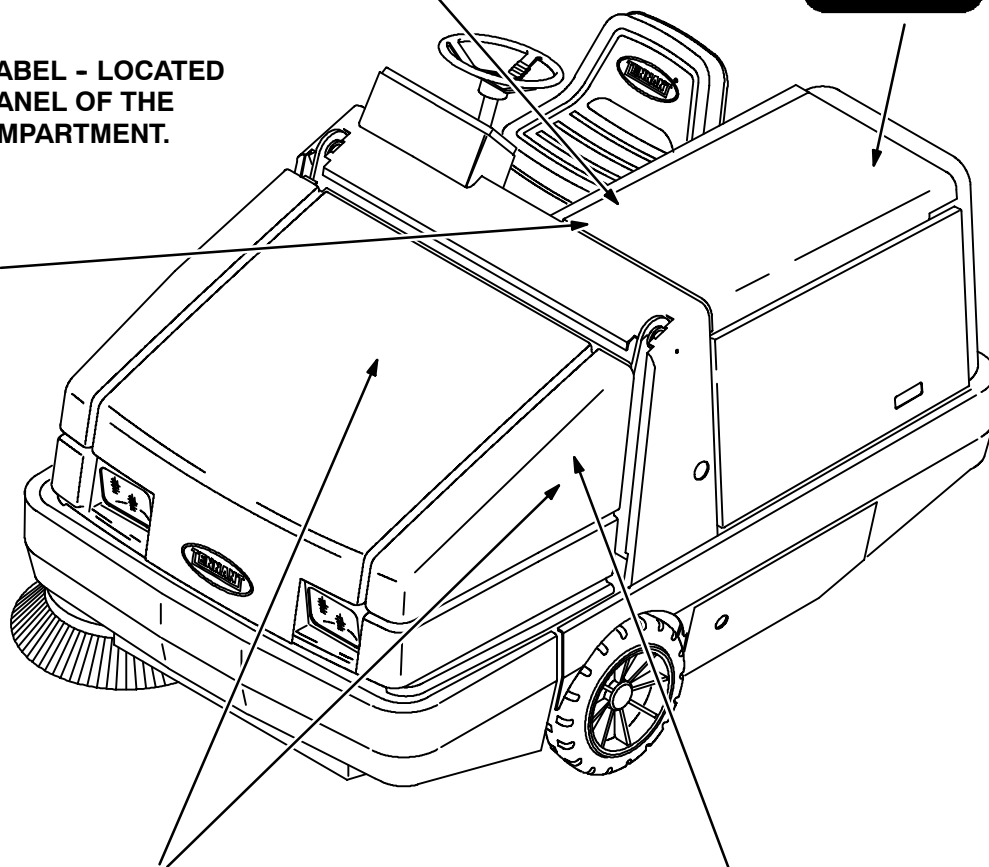
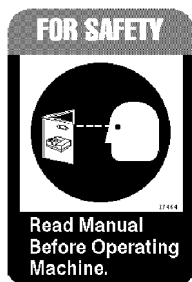
EMISSIONS LABEL - LOCATED ON THE SIDE PANEL OF THE OPERATOR COMPARTMENT.



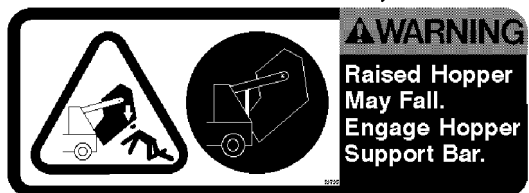
ENGINE FAN AND BELT LABEL - LOCATED ON THE RADIATOR SHROUD.



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



07748



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



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

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

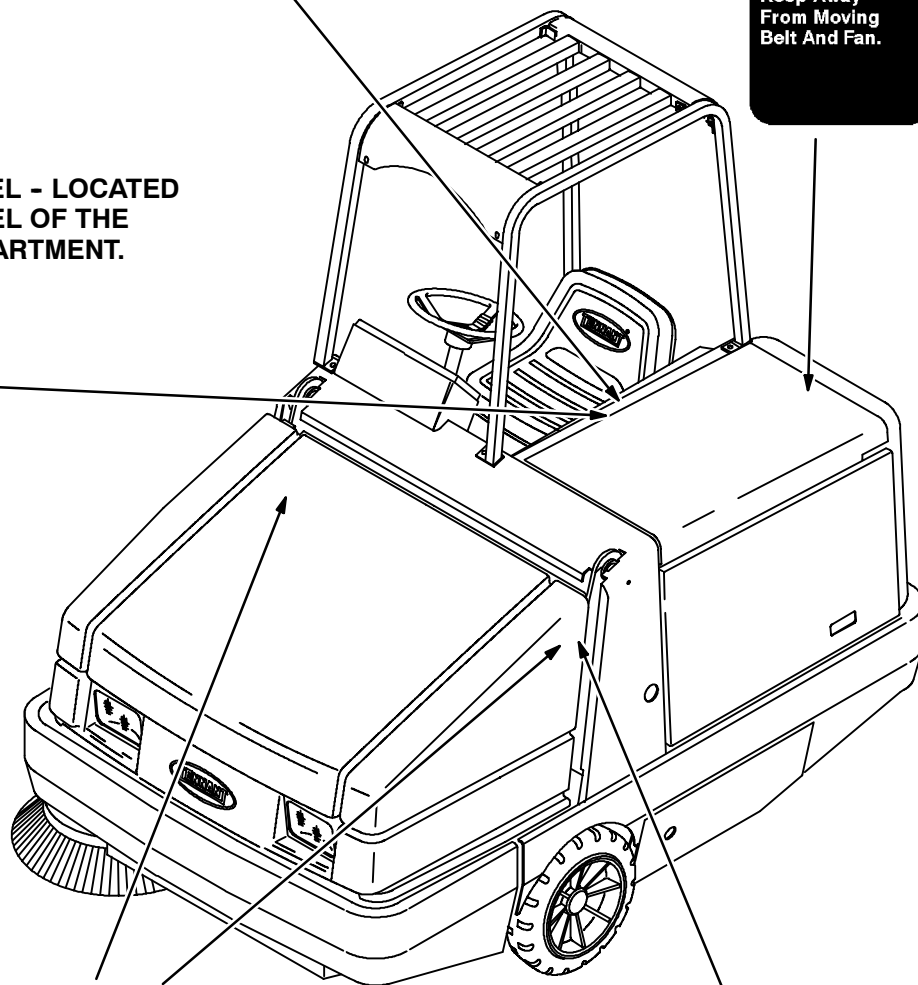
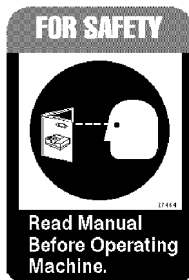
EMISSIONS LABEL - LOCATED ON THE SIDE PANEL OF THE OPERATOR COMPARTMENT.



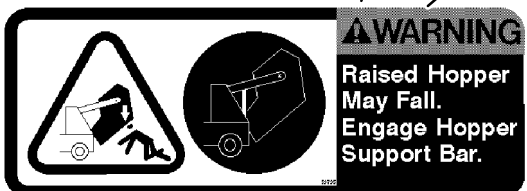
ENGINE FAN AND BELT LABEL - LOCATED ON THE RADIATOR SHROUD.



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



07522



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



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

SPECIFICATIONS

GENERAL MACHINE DIMENSIONS/CAPACITIES

Item	Dimension/capacity
Length	2360 mm (93 in)
Width	1590 mm (62.5 in)
Height	1475 mm (58 in)
Height with overhead guard	2080 mm (82 in)
Height with overhead guard and hazard light	2270 mm (89.5 in)
Height with cab	2100 mm (82.62 in)
Height with cab and hazard light	2285 mm (90 in)
Track	1345 mm (53 in)
Wheelbase	1135 mm (44.75 in)
Main brush diameter	355 mm (14 in)
Main brush length	1145 mm (45 in)
Side brush diameter	585 mm (23 in)
Sweeping path width	1145 mm (45 in)
Sweeping path width with side brush	1525 mm (60 in)
Main brush pattern width	50 to 65 mm (2.0 to 2.5 in)
Hopper weight capacity	545 kg (1200 lb)
Hopper volume capacity	396 L (14 cu ft)
Dust filter area	6.9 m ² (74 sq ft)
GVWR	1927 kg (4250 lb)
GVWR	2064 kg (4550 lb)
Sound level	80 dBa
Ceiling height minimum dumping clearance	2745 mm (9 ft)

GENERAL MACHINE PERFORMANCE

Item	Measure
Maximum forward speed	13.7 kmh (8.5 mph)
Maximum forward speed	16.1 kmh (10 mph)
Maximum reverse speed	4.0 kmh (2.5 mph)
Minimum aisle turn width, left	2870 mm (113 in)
Minimum aisle turn width, right	4725 mm (186 in)
Maximum rated climb and descent angle	6°
Maximum rated climb and descent angle	10°

GENERAL INFORMATION

POWER TYPE

Engine, gas, 1.1L and 1.3L	Type	Ignition	Cycle	Aspiration	Cylinders	Bore	Stroke
Ford VSG 1.11.3	Piston	Distributor-less-type spark	4	Natural	4	69 mm (2.70 in) 74 mm (2.91 in)	76 mm (2.97 in) 75 mm (2.97 in)
	Displacement		Net power, governed			Net power, maximum	
	1100 cc (67 cu in)1300 cc (79 cu in)		20.3 kw (28 hp) @ 2400 rpm 23.2 kw (32 hp) @ 2400 rpm			32.8 kw (44 hp) @ 3600 rpm 39.5 kw (53 hp) @ 4000 rpm	
	Fuel		Cooling system			Electrical system	
	Gasoline, 87 octane minimum, unleaded. Fuel tank: 36 L (9.6 gal)		Water/ethylene glycol antifreeze			12 V nominal	
	LPG, Fuel tank: 15 kg (33 lb)		Total: 4.5 L (1.2 gal) Radiator: 3.8 L (1 gal)			37 A alternator	
	Idle speed, no load		(Fast 1) governed speed, under load			(Fast 2) governed speed, under load	
	1350 ± 250 rpm		2000 ± 50 rpm			2400 ± 50 rpm	
	Spark plug gap		Firing order			Valve clearance, cold	
	1 mm (0.039 in)		1-2-4-3, counterclockwise rotation			0.22 mm (0.009 in) intake 0.32 mm (0.013 in) exhaust	
	Engine lubricating oil with filter						
	3.3 L (3.5 qt) 10W-30 SAE-SG/SH						

Engine, D	Type	Ignition	Cycle	Aspiration	Cylinders	Bore	Stroke
Kubota V1505-B	Piston	Diesel	4	Natural	4	78 mm (3.07 in)	78.4 mm (3.08 in)
	Displacement		Net power, governed			Net power, maximum	
	1500 cc (91.4 cu in)		24.6 kw (34 hp) @ 2400 rpm			27.2 kw (37.5 hp) @ 3000 rpm	
	Fuel		Cooling system			Electrical system	
	Diesel Fuel tank: 36 L (9.6 gal)		Water/ethylene glycol antifreeze			12 V nominal	
			Total: 4.5 L (1.2 gal)			37 A alternator	
			Radiator: 3.8 L (1 gal)				
	Idle speed, no load		(Fast 1) governed speed, under load			(Fast 2) governed speed, under load	
	950 ± 50 rpm		2000 ± 50 rpm			2400 ± 50 rpm	
	Engine lubricating oil without filter						
6 L (6.35 qt) SAE-CC/CD rated engine oil							

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	24.6 L (6.5 gal)	TENNANT part no. 65869 - above 7° C (45° F)
Hydraulic total	N/A L (N/A gal)	TENNANT part no. 65870 - below 7° C (45° F)

BRAKING SYSTEM

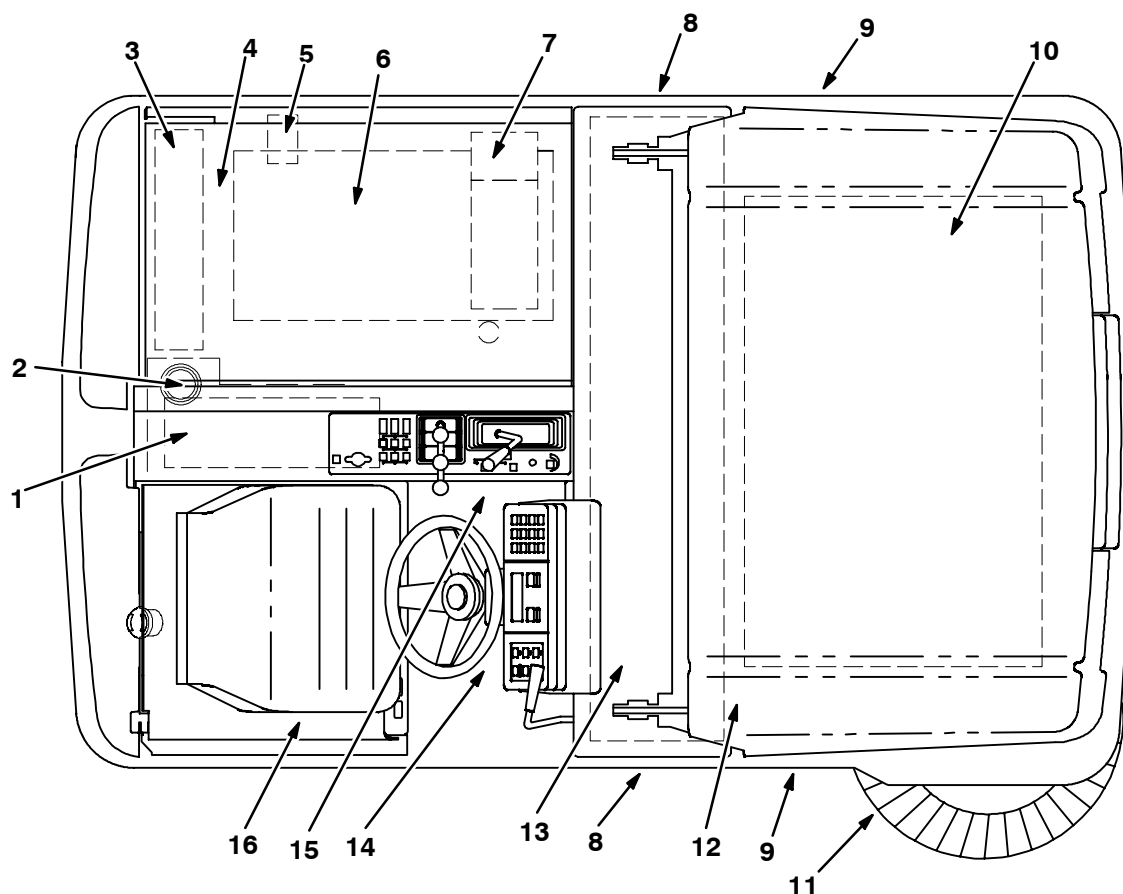
Type	Operation
Service brakes	Mechanical drum brakes (2), one per front wheel, cable actuated
Parking brake	Utilize service brakes, cable actuated

TIRES

Location	Type	Size	Pressure
Front (2)	Solid	5 x 18 in	-
Rear (1)	Pneumatic	6 x 19 in	790 \pm 35 kPa (115 \pm 5 psi)

GENERAL INFORMATION

MAINTENANCE - G/LPG



07747

MAINTENANCE CHART

Interval	Key	Description	Procedure	Lubricant/ Fluid	No. of Service Points
Daily	7	Engine air filter	Check indicator	-	1
			Empty dust cap	-	1
	6	Engine crankcase	Check oil level	EO	1
	8	Brush compartment skirts	Check for damage, wear and adjustment	-	5
	12	Hopper lip skirts	Check for damage, wear and adjustment	-	3
	12	Hopper side skirt	Check for damage and wear	-	1
	13	Main brush	Check for damage, wear, and adjustment	-	1
			Check brush pattern	-	1
	11	Side brush	Check for damage, wear, and adjustment	-	1
			Check brush pattern	-	1
50 Hours	13	Main brush	Rotate end-for-end	-	1

GENERAL INFORMATION

Interval	Key	Description	Procedure	Lubricant/ Fluid	No. of Service Points
100 Hours	10	Hopper dust filter	Check for damage, clean or replace	-	1
	3	Radiator	Clean core exterior	-	1
			Check coolant level	WG	1
	2	Hydraulic fluid reservoir	Check fluid level	HYDO	1
	1	Rear tire	Check pressure	-	1
	8	Main brush and hopper seals	Check for damage or wear	-	8
	6	Engine crankcase	Change oil and filter element	EO	1
200 Hours	4	Engine fan belt	■ Check tension	-	1
	3	Radiator hoses and clamps	Check for tightness and wear	-	2
	15	Parking brake	Check adjustment	-	1
	14	Brake pedal	Check and adjust travel	-	1
	1	Rear wheel support bearings	Lubricate	SPL	1
	11	Side brush guard	Rotate 90°	-	1
400 Hours	6	Engine	■ Check and adjust valve clearance	-	8
			Check and adjust idle speed	-	1
			Check and adjust carburetor idle mixture	-	1
			Clean or replace and adjust spark plugs	-	4
			Replace PCV valve. Clean PCV hoses, tubes, and fittings	-	-
			Fuel filters	-	2
	9	Front wheel bearings	Check, lubricate, and adjust	SPL	2
	3	Cooling system	Flush	WG	1
			Replace hydraulic breather	-	1
			Replace suction strainer	-	1
			Change hydraulic fluid	HYDO	1
800 Hours	5	Hydraulic fluid filter	Change filter element	-	1
	2	Hydraulic hoses	Check for wear and damage	-	31
	1	Propelling motor	■ Torque shaft nut	-	1
	1	Rear wheel	■ Torque wheel nuts	-	1
	16	Battery	■ Clean and tighten battery cable connections	-	1

LUBRICANT/FLUID

EO Engine oil, 10W30 SAE-SG/SH rated

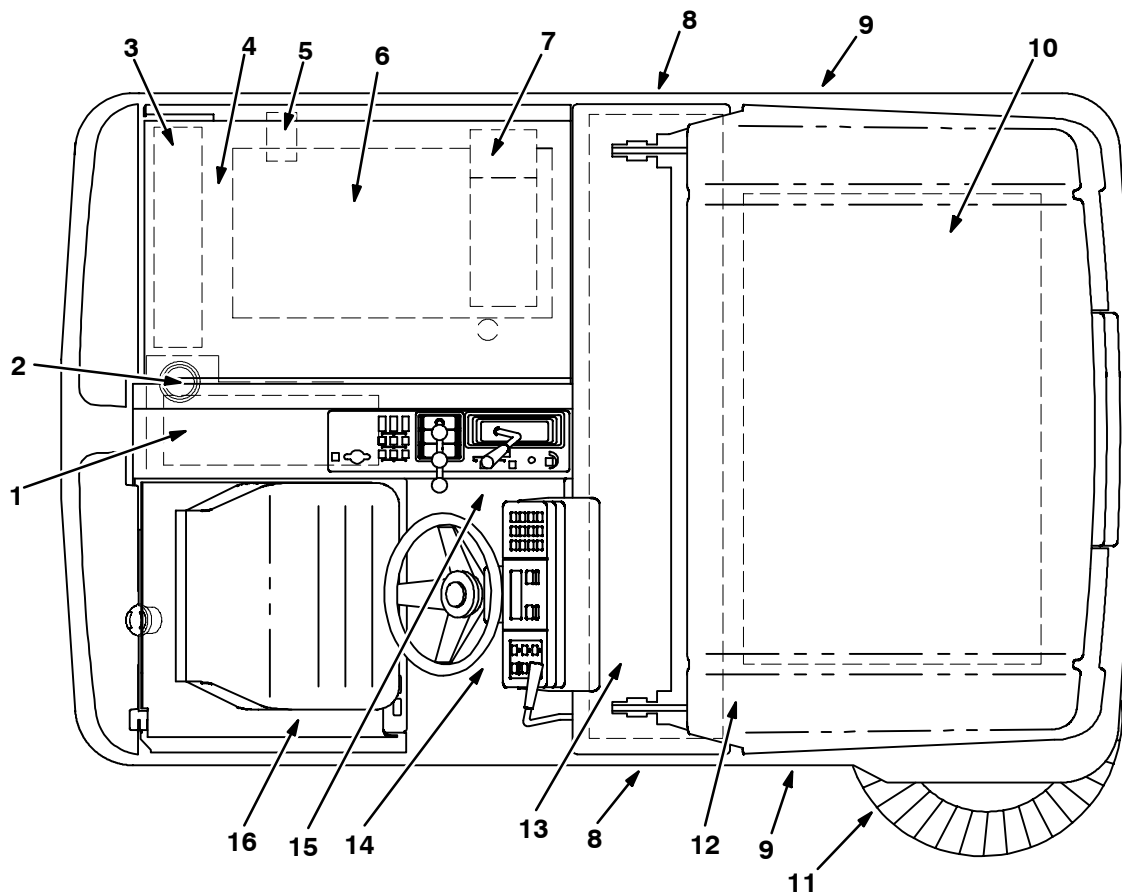
HYDO . . . Tennant Company or approved hydraulic fluid

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

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

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

MAINTENANCE



07747

MAINTENANCE CHART

Interval	Key	Description	Procedure	Lubricant/ Fluid	No. of Service Points
Daily	7	Engine air filter	Check indicator	-	1
			Empty dust cap	-	1
	6	Engine crankcase	Check oil level	EO	1
	8	Brush compartment skirts	Check for damage, wear and adjustment	-	5
	12	Hopper lip skirts	Check for damage, wear and adjustment	-	3
	12	Hopper side skirt	Check for damage and wear	-	1
	13	Main brush	Check for damage, wear, and adjustment	-	1
			Check brush pattern	-	1
	11	Side brush	Check for damage, wear, and adjustment	-	1
			Check brush pattern	-	1

GENERAL INFORMATION

Interval	Key	Description	Procedure	Lubricant/ Fluid	No. of Service Points
50 Hours	13	Main brush	Rotate end-for-end	-	1
	6	Fuel pipes and clamps	Check for tightness and wear	-	1
100 Hours	6	Engine crankcase	Change oil and filter	EO	1
	4	Engine fan belt	Check tension	-	1
	10	Hopper dust filter	Check for damage, clean or re- place	-	1
	3	Radiator	Clean core exterior	-	1
			Check coolant level	WG	1
	2	Hydraulic fluid reservoir	Check fluid level	HYDO	1
	1	Rear tire	Check pressure	-	1
	8	Main brush and hopper seals	Check for damage or wear	-	8
200 Hours	3	Radiator hoses and clamps	Check for tightness and wear	-	2
	15	Parking brake	Check adjustment	-	1
	14	Brake pedal	Check and adjust travel	-	1
	1	Rear wheel support bear- ings	Lubricate	SPL	1
	11	Side brush guard	Rotate 90°	-	1
400 Hours	9	Front wheel bearings	Check, lubricate, and adjust	SPL	2
	6	Fuel filter	Replace cartridge	-	1
	17	Fuel tank	Remove sediment	-	1
	3	Cooling system	Flush	WG	1
800 Hours	2	Hydraulic reservoir	Replace hydraulic breather	-	1
			Replace suction strainer	-	1
			Change hydraulic fluid	HYDO	1
	5	Hydraulic fluid filter	Change filter element	-	1
	2	Hydraulic hoses	Check for wear and damage	-	31
	1	Propelling motor	*Torque shaft nut	-	1
	1	Rear wheel	*Torque wheel nuts	-	1
	16	Battery	*Clean and tighten battery cable connections	-	1

LUBRICANT/FLUID

EO Engine oil, SAE-CC/CD rated

HYDO . Tennant Company or approved hydraulic fluid

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

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

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

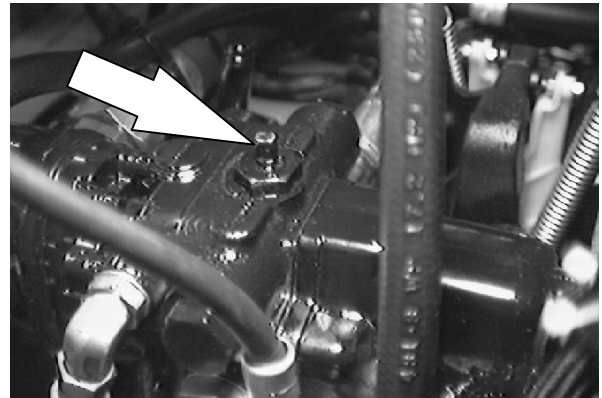
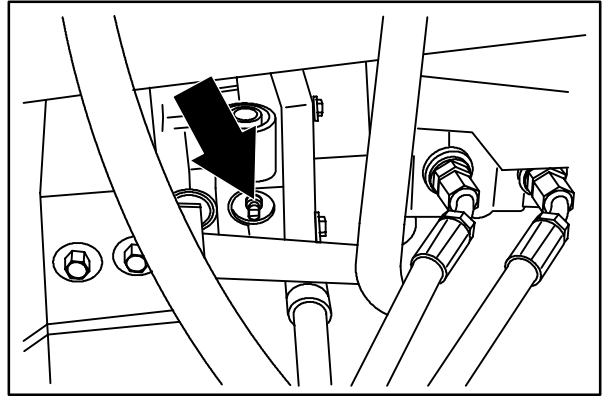
GENERAL INFORMATION

PUSHING OR TOWING MACHINE

The propelling pump has a towing valve to prevent damage to the hydraulic system when the machine is being towed. Turn the valve 90° clockwise before towing the machine.

You can push the machine from the front or rear, and tow it only from the rear.

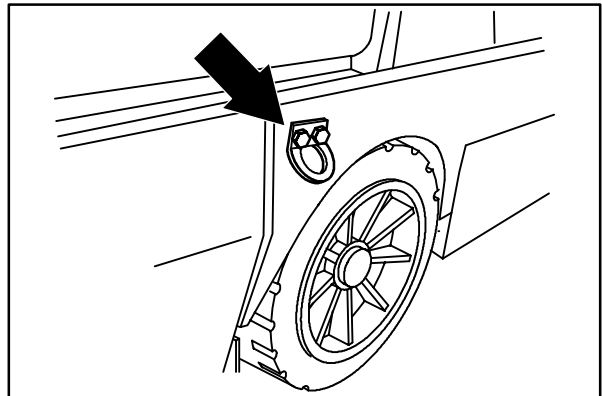
ATTENTION! Do not push or tow the machine without placing the rear wheel on a dolly or the towing valve activated. The hydraulic system may be damaged if machine is pushed or towed without these steps being taken.



TIEING DOWN MACHINE

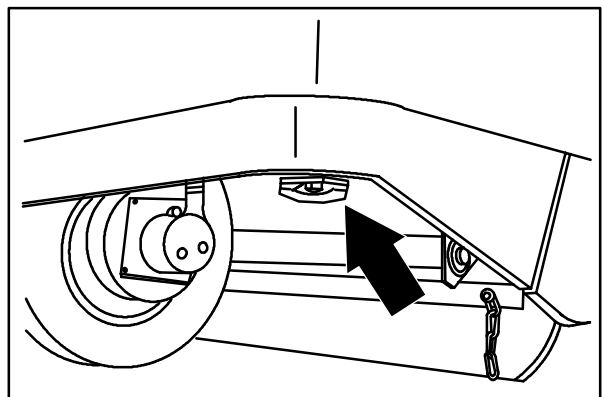
The machine can be tied down for transport using the tie-down brackets at the front and rear of the machine.

The front tie-down bracket is above the front tires.



The rear tie down is located on both sides of the tail light bracket under the rear bumper.

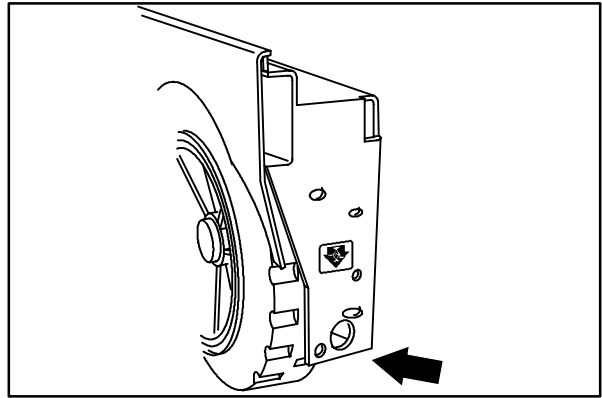
When transporting the machine on a trailer or in a truck, be sure to set the parking brake and block the tires to prevent the machine from rolling.



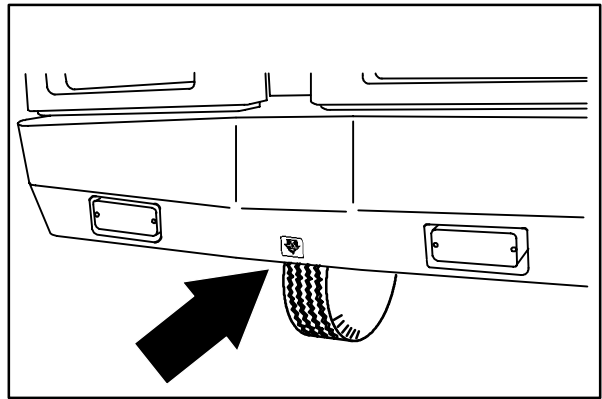
MACHINE JACKING

You can jack up the machine for service at the designated locations. Use a jack of adequate capacity and good working condition. Always stop the machine on a flat, level surface and block the tires before jacking the machine up.

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 middle flat bottom edge of the rear bumper between the taillights.



TO JACK UP THE MACHINE

1. Dump the debris hopper.
2. Park the machine on a level surface.
3. 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.

4. Block the machine tires that are not being jacked up, to secure the machine position.

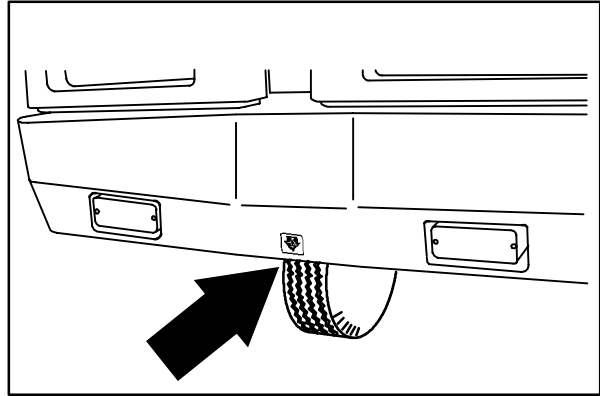
FOR SAFETY: When Servicing Machine, Block Machine Tires Before Jacking Machine Up.

5. Use a jack of adequate capacity to raise the machine. Jack up the machine only at the designated locations.

FOR SAFETY: When Servicing Machine, Jack Machine Up At Designated Locations Only. Block Machine Up With Jack Stands.

GENERAL INFORMATION

6. Block machine up with jack stands or similar devices near the designated jacking locations to secure the machine.
7. Lower the machine onto the jack stands.
8. Check to make sure the machine is secure.
9. When finished servicing the machine, raise the machine off the jack stands.
10. Remove the jack stands from under the machine.
11. Lower the machine.
12. Remove the blocks from the tires.



STORING MACHINE

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





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.

BOLT IDENTIFICATION

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

01395

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.

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CHASSIS

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

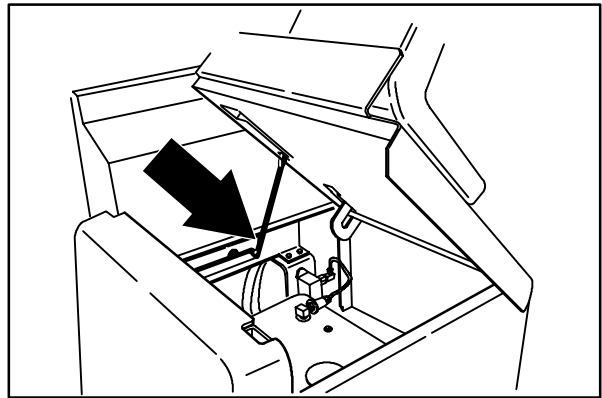
SEAT

The seat assembly is removable on both the 355 and 385. The seat can also be adjusted on both models, however you need tools to adjust it on the 355.

TO REMOVE SEAT ASSEMBLY

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

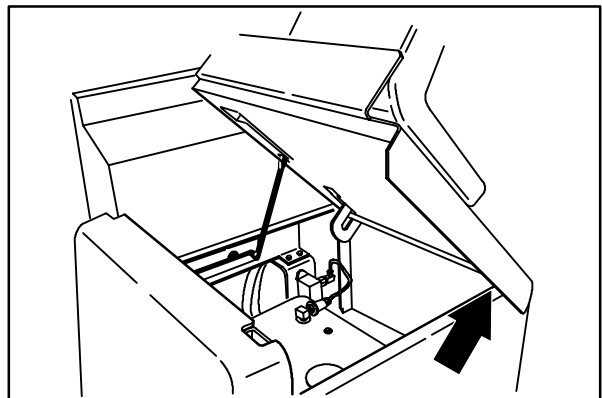
1. Tilt the seat assembly forward.
2. Slide the seat prop rod up and out of the rod slot.
3. Pull the hair cotter pin out of the pivot shaft.
4. Lift and slide the seat sideways off the machine.



TO REPLACE SEAT ASSEMBLY

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

1. Slide the seat assembly pins in the pivot holes on the seat support.
2. Slide the hair cotter pin in the hole on the pivot shaft to secure the seat.
3. Slide the seat rod through large hole in slot.
4. Lower the seat.

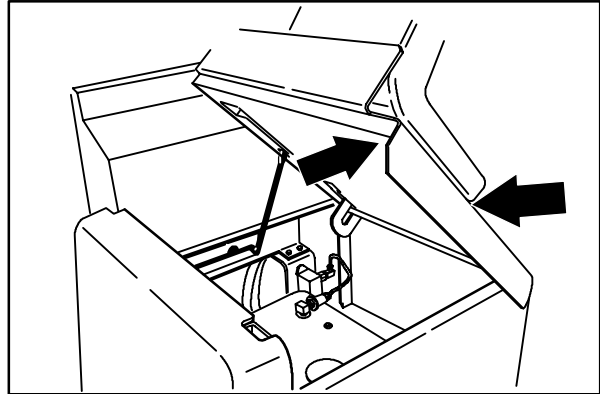


CHASSIS

TO ADJUST SEAT POSITION (355 ONLY)

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

1. Remove the seat assembly from the machine.
2. Remove the four hex screws holding the seat to the seat base.
3. Move the seat to the desired position.
4. Reinstall the four hex screws. Tighten to 35 – 46 Nm (26 – 34 ft lb).
5. Reinstall the seat assembly on the seat support. Reinstall the hair pin clip in the tapered pin and the prop rod back in the slot.

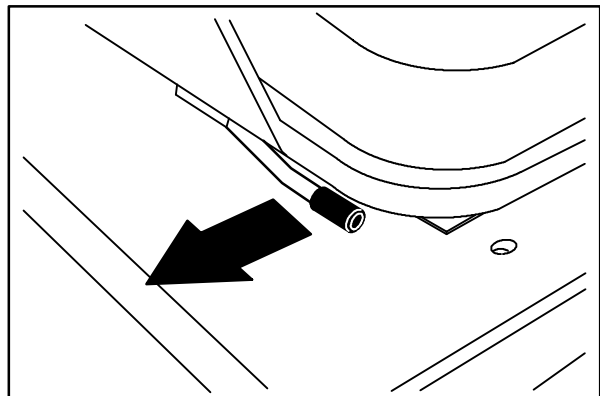


TO ADJUST SEAT POSITION (385 ONLY)

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

The operator seat is a fixed back style with a forward-backward adjustment.

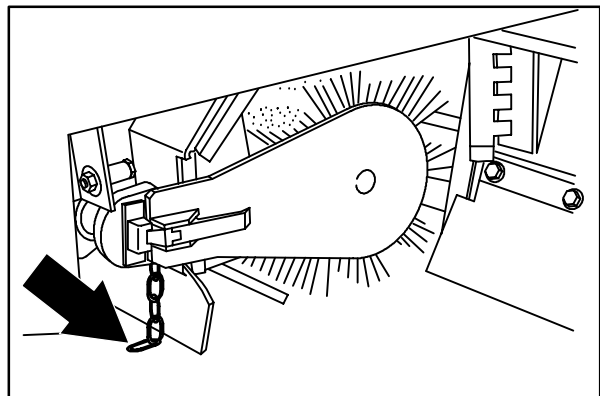
Adjust: Pull the lever out, slide the seat backward or forward to the desired position and release the lever.



STATIC DRAG CHAIN

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

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



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 cables.

Check the brake adjustment every 200 hours of operation. The brake pedal should not travel more than 25 mm (1 in) to fully engage the brakes.

TO REPLACE BRAKE SHOES

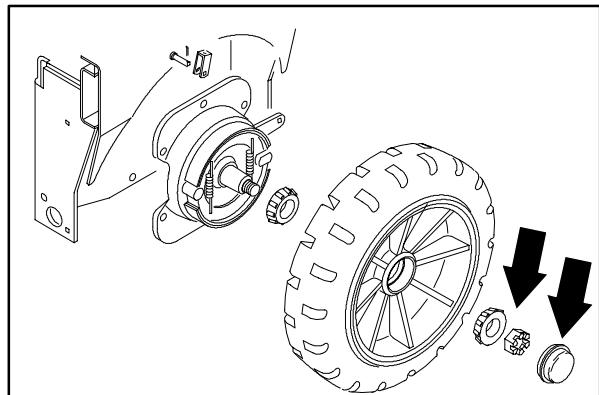
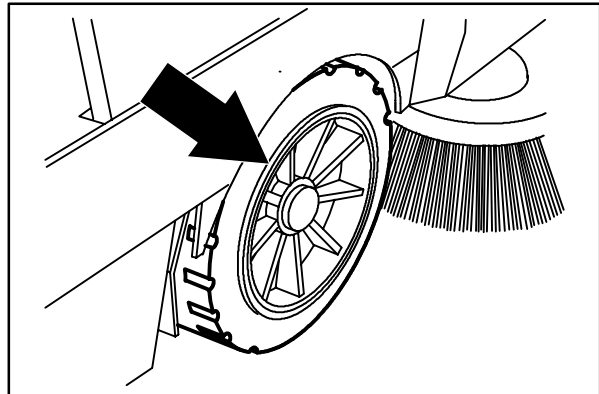
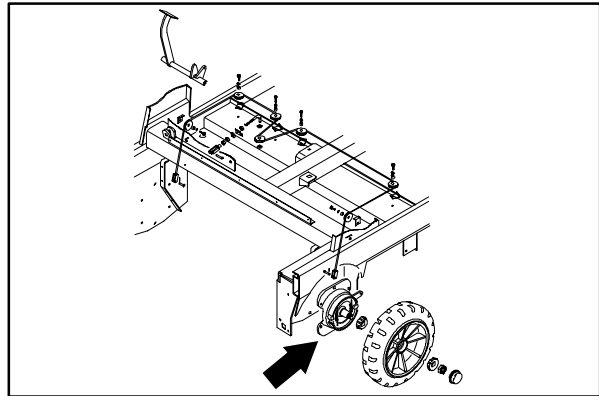
1. Empty the machine debris hopper.

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

2. Remove the seat assembly.
3. Turn the parking brake knurled knob counterclockwise until it stops.
4. Remove the battery to gain access to the floor plate bolts.
5. Remove the floor plate from the operators compartment.
6. Remove the cotter pin and clevis pin from the end of the brake rod yoke.
7. Thread the brake rod yoke away from the threaded rod to reduce the tension on the brake cable.
8. Jack up one front corner of the machine. Place jack stands under machine.

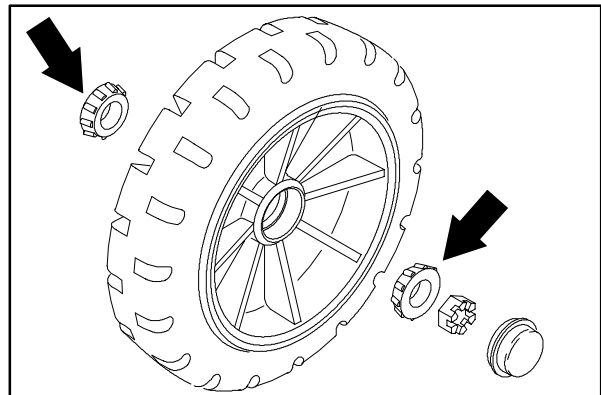
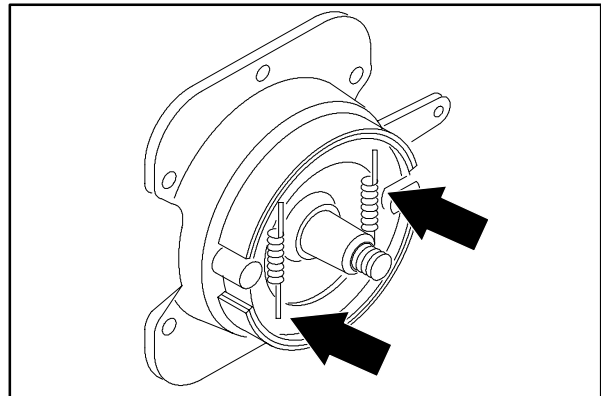
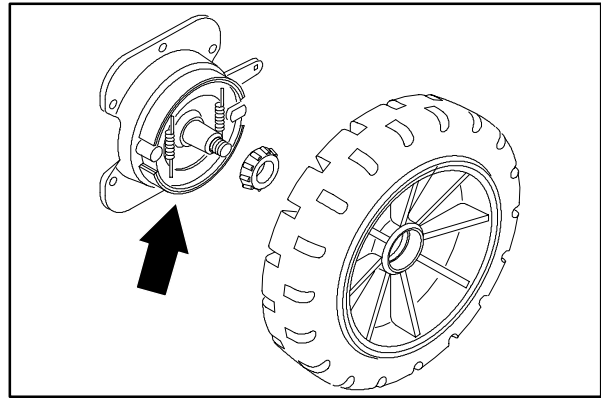
FOR SAFETY: Block machine tires before jacking machine up. Jack machine up at designated locations only. Block machine up with jack stands.

9. Remove the hub cap in the center of front wheel.
10. Remove the cotter pin, slotted nut, flat washer, and bearing cone.
11. Slide the wheel off the axle.



CHASSIS

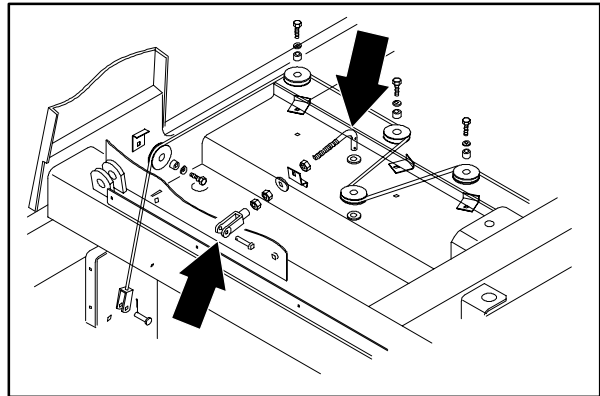
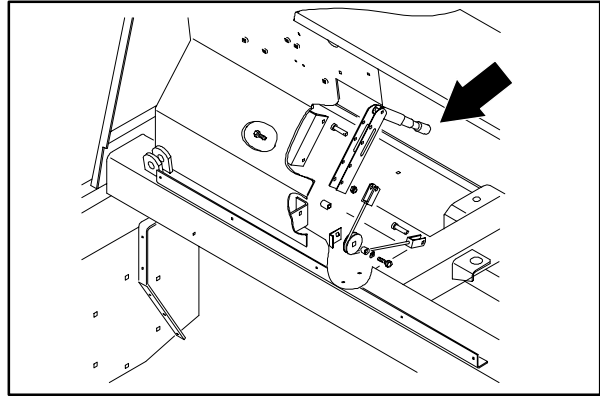
12. Remove the two tension springs holding the brake shoes together. Remove the old brake shoes.
13. Replace the brake shoes with new ones.
14. Reconnect the two brake tension springs to the new brake shoes.
15. Pack the wheel bearings with Lubriplate EMB grease.
16. Slide the wheel on the axle.
17. Slide the outer bearing, flat washer and nut on the shaft.
18. Tighten the nut with a hand wrench until the wheel binds, then back the nut off to nearest cotter pin hole.
19. Insert a new cotter pin through nut and hole.
20. After making sure the wheel spins freely, carefully reinstall the hub cap.
21. Remove the jackstands and lower the machine.
22. Repeat the procedure on the other wheel.
23. Go in the operators compartment and thread the brake cable clevis yoke away from the threaded rod until the brake pedal travels 25-50 mm (1-2 in) before engaging brakes.
24. Reinstall the clevis and cotter pin in the end of the brake rod yoke.
25. Tighten the brake clevis jam nuts.
26. Reinstall the operators compartment floor plate.
27. Reinstall the battery and cables.
28. Reinstall the seat assembly.
29. Adjust the parking brake.



TO ADJUST BRAKES

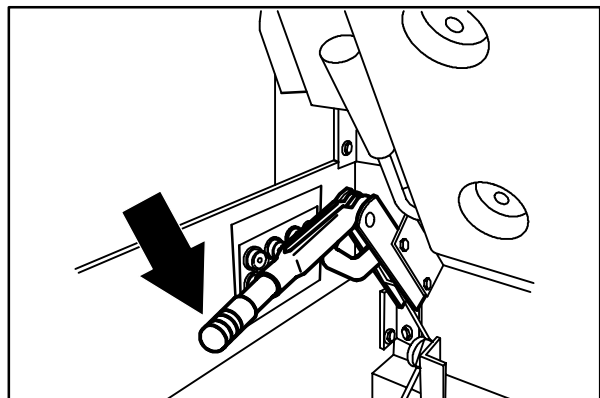
FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.

1. Turn the parking brake knurled knob counterclockwise until it stops.
2. Remove the seat assembly.
3. Remove the battery to gain access to the floor plate bolts in the operators compartment.
4. Remove the floor plate.
5. Remove the cotter pin and clevis pin from the end of the brake rod yoke.
6. Thread the yoke out on the brake rod to reduce the brake pedal travel required to engage brakes. The pedal should travel no more than 25-50 mm (1-2 in) before brakes engage.
7. Reinstall the clevis and cotter pin in the end of the brake rod yoke.
8. Reinstall the floor plate.
9. Reinstall the battery and battery cables.
10. Reinstall the seat assembly.
11. Adjust the parking brake.

**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 turning the knurled knob on the end of the parking brake clockwise. If the knob adjustment is inadequate, fully loosen the knob and adjust the brake linkage as described in TO ADJUST BRAKES. Adjust the parking brake so it will hold the Machine on a smooth 8 degree incline. The brake pedal should not travel more than 25 mm (1 in) to fully engage the brakes.



FRONT TIRES AND WHEELS

The machine front tires are solid.

Inspect the front wheel bearings for seal damage. Repack and adjust the front wheel bearings after every 400 hours of operation. Use Lubriplate EMB grease (TENNANT part no. 01433-1).

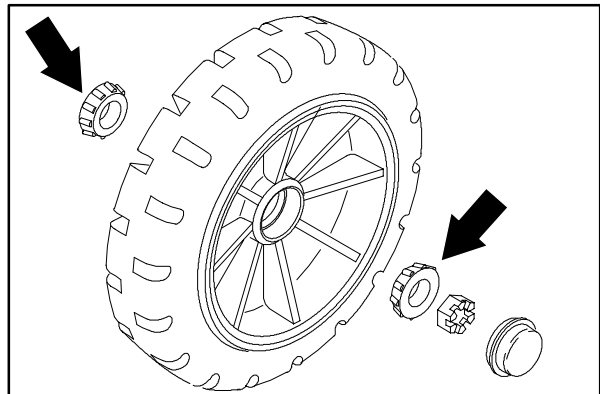
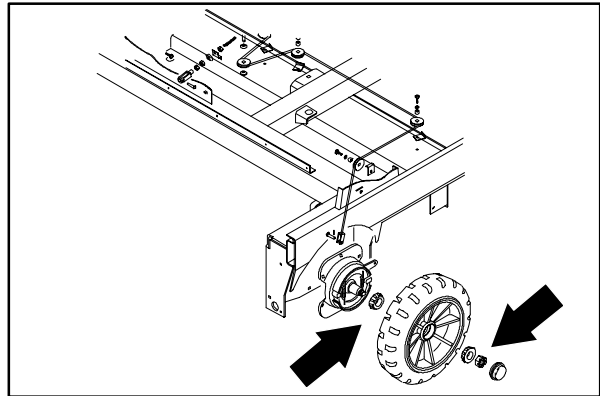
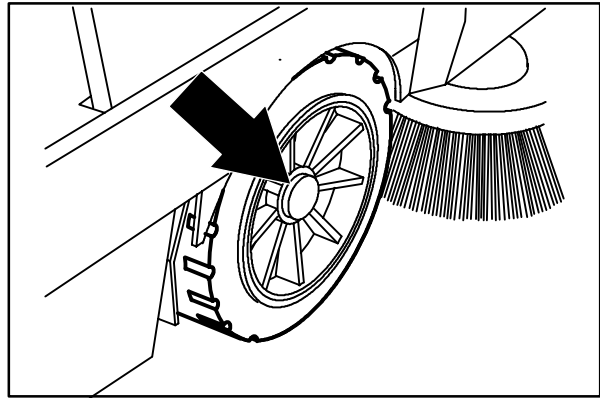
TO REPACK FRONT WHEEL BEARINGS

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

1. Empty the machine debris hopper.
2. Jack up one front corner of the machine. Place jack stands under 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 hub cap in the center of front wheel.
4. Remove the cotter pin, slotted nut, flat washer, and bearing cone.
5. Slide the wheel assembly off the axle.
6. Pack the wheel bearings with Lubriplate EMB grease.
7. Slide the wheel assembly back on the axle.
8. Slide the outer bearing, flat washer and nut on the axle shaft.
9. Tighten the nut with hand wrench until wheel binds, then back nut off to nearest hole.
10. Insert a new cotter pin through nut and hole.
11. After making sure the wheel spins freely, install the hub cap.
12. Lower the machine.
13. Repeat the procedure for the other front wheel.
14. Adjust the parking brake after the front wheel bearings have been greased.

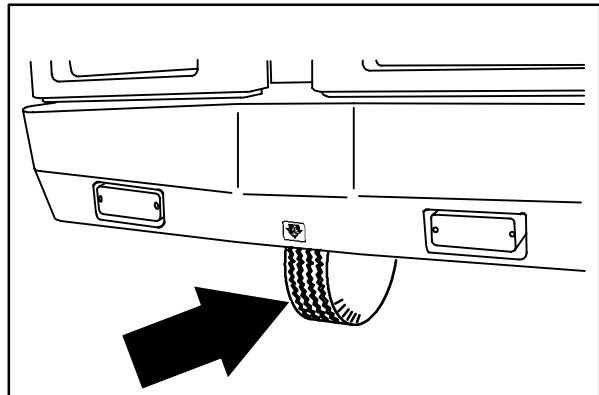
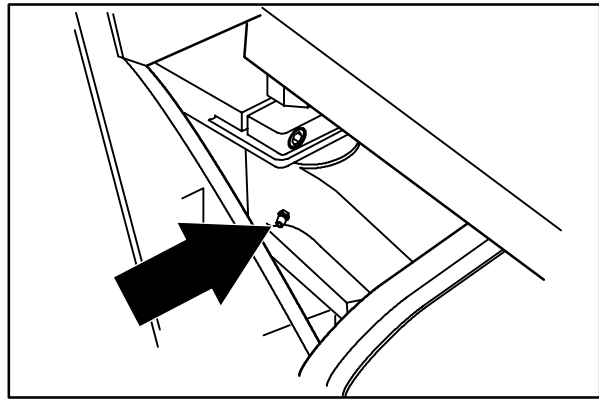


REAR TIRE AND WHEEL, AND WHEEL SUPPORT

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 ± 35 kPa (115 ± 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.



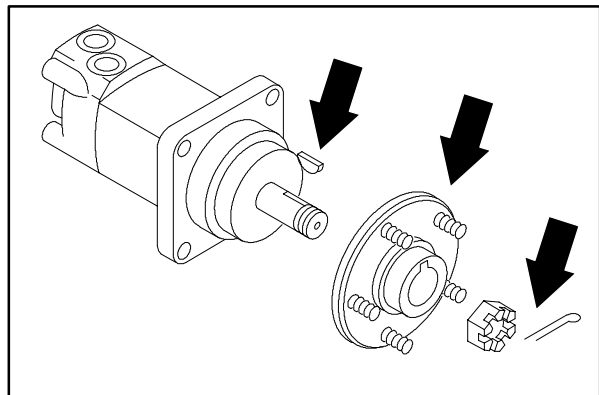
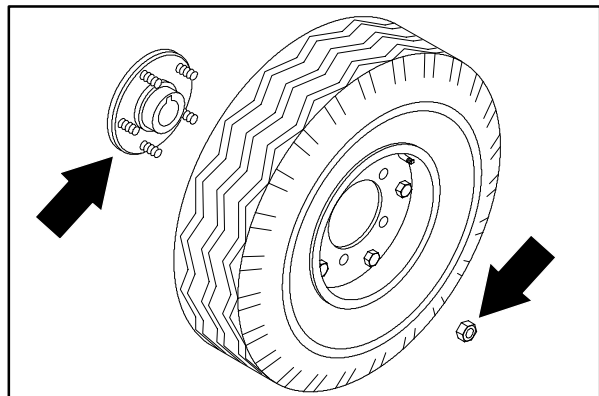
TO REPLACE REAR WHEEL HOUSING PIVOT BEARINGS

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.

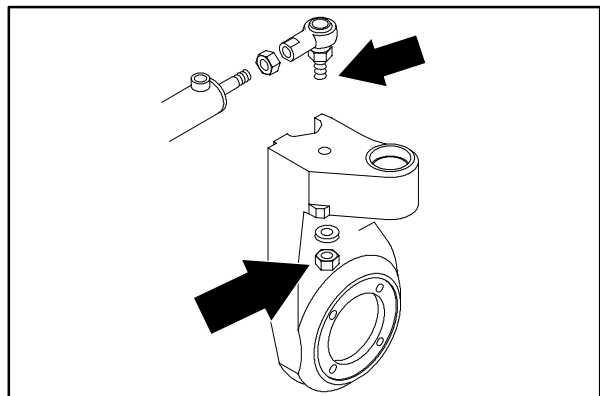
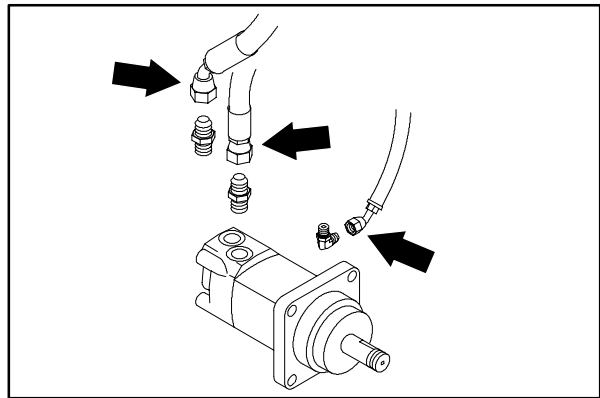
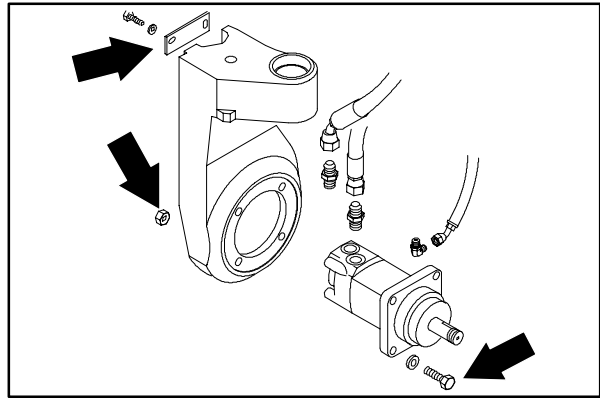


CHASSIS

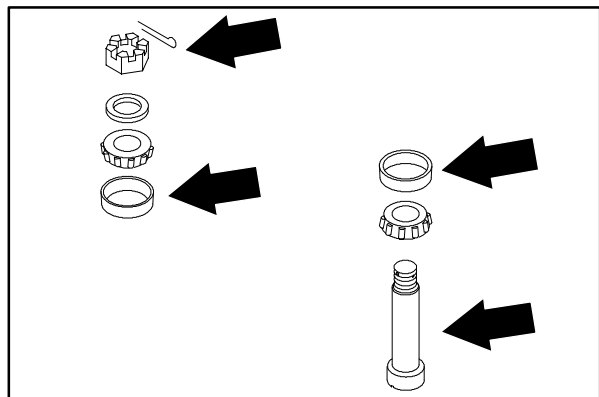
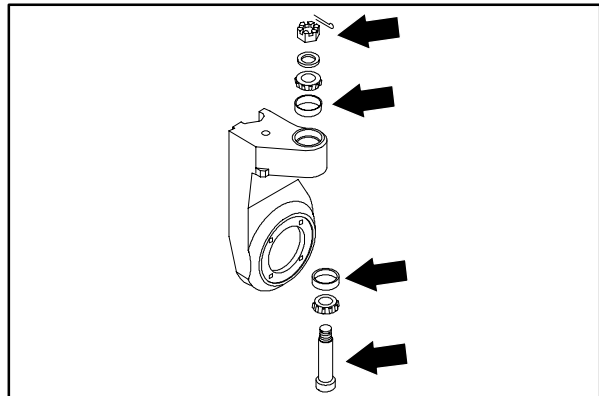
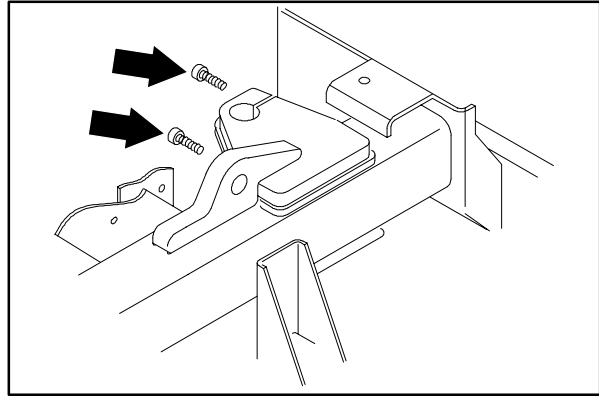
5. Drive the hub off the tapered motor shaft. A puller must be used.
6. Disconnect the hydraulic hoses from the motor.

NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.

7. Remove the four rear drive motor mounting bolts.
8. Slide the rear drive motor out of the wheel housing.
9. Remove the hydraulic hose clamp from the wheel housing.
10. Remove the 0.750 in. hex screw and nyloc nut attaching the rod end of steering cylinder to rear wheel housing.
11. Loosen the two M10 socket head bolts.
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.
15. Replace the pressed in bearing cups.
16. Pack the bearing cones with Lubriplate EMB grease. Coat 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 large pin up through the frame hole. 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.



21. Torque the top socket screw with hand torque wrench to 100 – 115 Nm (73–85 ft lb).
22. Tighten the castle nut to next slot and insert the cotter pin. Torque not to exceed 100 Nm (75 ft lb).
23. 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).
24. Tighten the lower socket screw to 100 – 115 Nm (73–85 ft lb).
25. Re-connect the rod end of the steering cylinder to the wheel housing using the .750x3.25 hex screw, nyloc nut, and four washers. Tighten to 270 – 300 Nm (200 – 220 ft lb).
26. Slide the new motor in the wheel housing. Note the motor orientation.
27. Thread the four socket cap screws through the wheel housing and into the motor. Tighten to 88–115 Nm (65–85 ft lb).
28. Reconnect the hydraulic hoses. See schematic in the HYDRAULICS section.
29. Reinstall the hose clamp to the wheel housing. Tighten the M8 hex screws to 18.5 – 24Nm (15 – 20 ft lb).
30. Mount the hub to the tapered motor shaft. Tighten the slotted nut to 500 Nm (375 ft lb). Install the cotter pin.
31. Install the rear tire and wheel assembly. Torque the rear wheel nuts to 142 – 156 Nm (105 – 115 ft lb).
32. Re-connect the battery cables and start the engine. Run the propelling in both directions. Check for any leaks.
33. Remove the jack stands and lower the machine to the ground.



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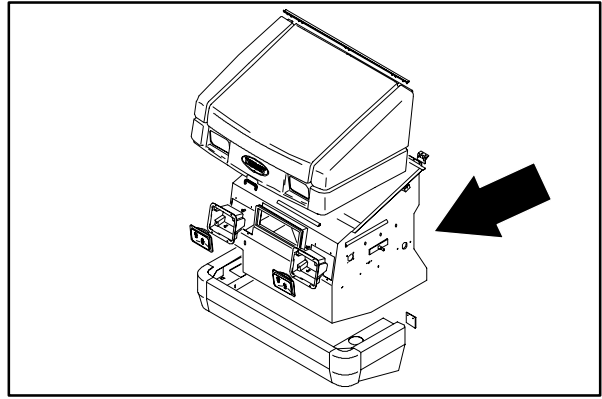
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INTRODUCTION

The side brush sweeps debris into the path of the main brush. The main brush sweeps debris from the floor into the hopper. The vacuum system pulls dust and air through the hopper and the hopper dust filter.

DEBRIS HOPPER

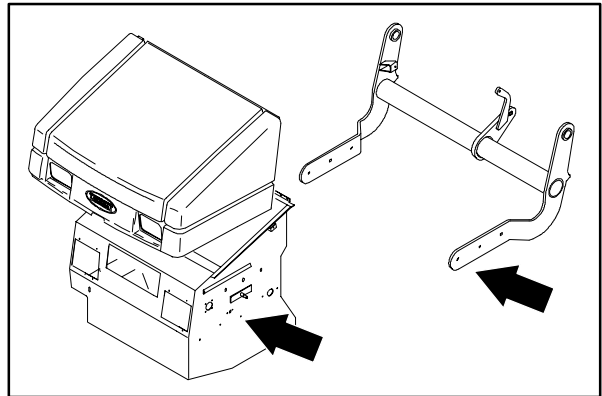
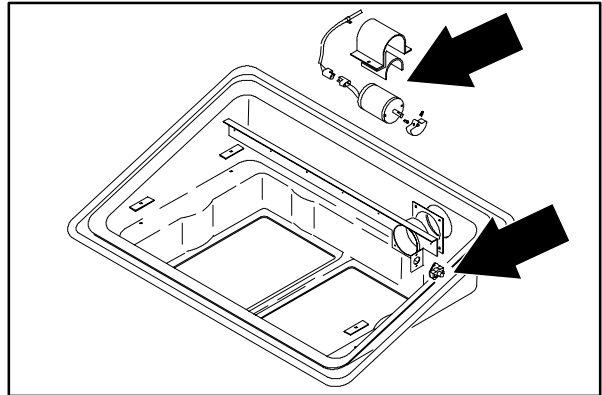
The debris hopper collects the debris swept up by the machine. The hopper includes the following main components: hopper dust filter, Thermo Sentry™, hopper dump door, and dust skirts. All adjustments have been made at the factory and require no regular maintenance. If hopper components are repaired 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 FROM MACHINE

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

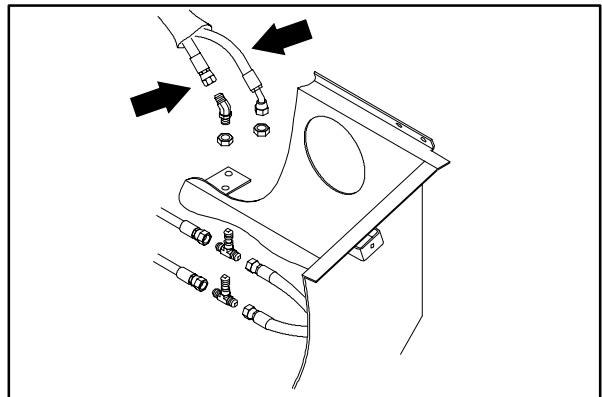
1. Engage the machine parking brake.
2. Start the engine and raise the hopper high enough to position two 4" tall blocks on the floor under the hopper. Lower the hopper down onto these blocks. Shut off the engine.
3. Raise hopper cover and disconnect the wires from filter shaker and Thermo Sentry™. Pull the filter carrier out far enough to disconnect the worm drive clamp holding the vacuum fan rubber duct to the back of the tray. Remove the filter carrier from the machine.
4. Remove the six M12 hex screws and nyloc nuts holding lift arms to hopper sides.
5. Start the machine and carefully back the tractor away from the hopper a few feet.



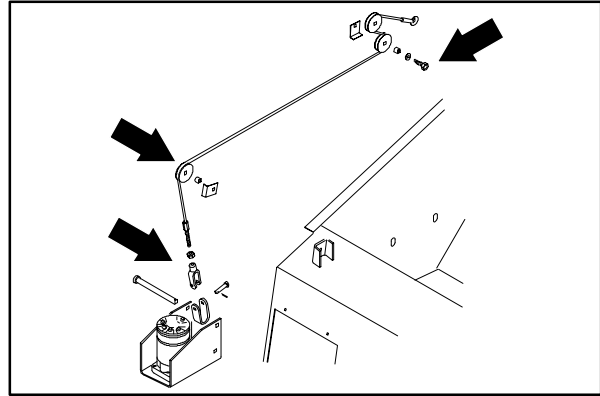
NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.

6. After the machine is clear from the hopper, shut off engine. Disconnect and plug the hydraulic hoses leading from main frame to the side brush motor and the two hydraulic tees on the back of the hopper.

NOTE: Do not start engine with any hydraulic hoses disconnected.



7. Disconnect the hopper wire harness from main harness.
8. Remove the cotter pin and clevis pin from the side brush lift cable at the side brush motor bracket.
9. Loosen the M8 hex screws holding the side brush lift cable to the hopper. Remove the cable from the pulleys.
10. 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.

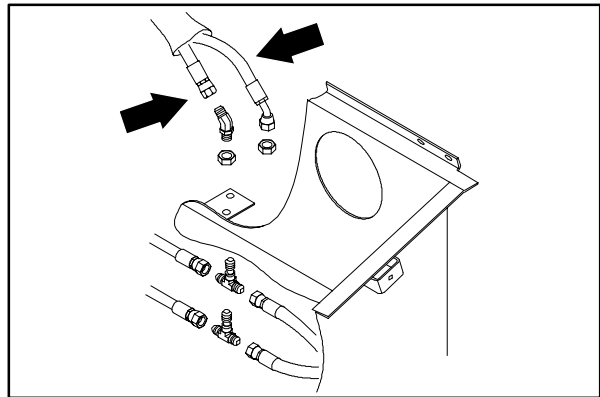
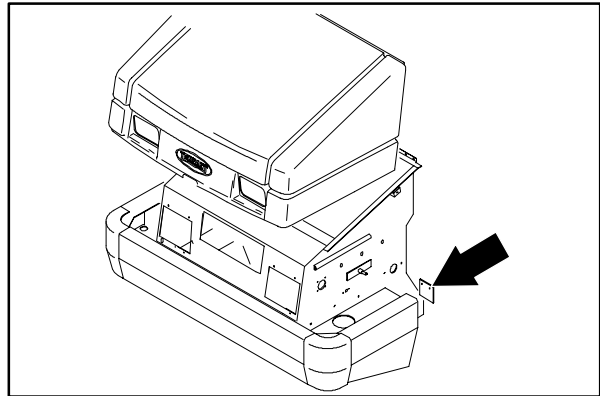
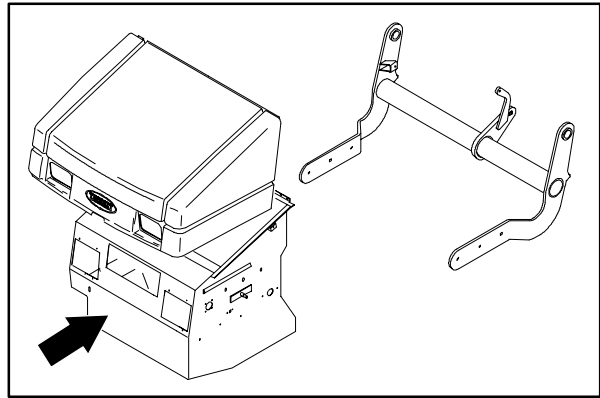
1. Position the hopper in front of machine. Move the hopper in close enough to reconnect the hydraulic hoses and wire harness. Make sure hopper cover is in the raised position.
2. See the schematic in the HYDRAULICS section of this manual for proper hose connections.
3. See the schematic in the ELECTRICAL section of this manual for proper harness connections.
4. The machine can now be started and carefully inched forward.
5. The hopper must go in until the rubber pads on the bumper hit the machine frame.

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

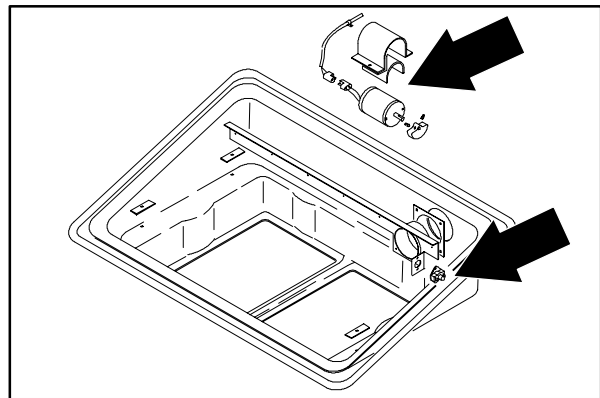
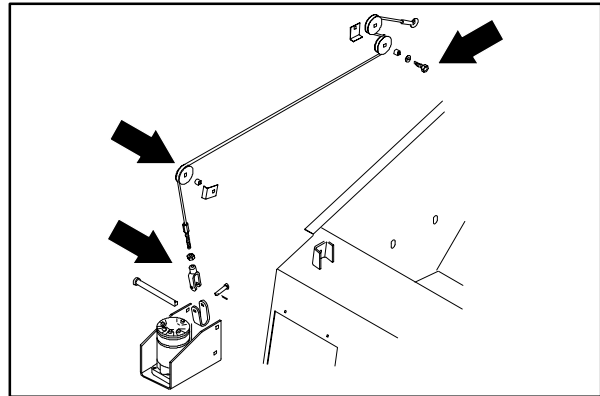
6. Remove the filter tray from hopper.
7. Align the holes in lift arms with holes in hopper sides. It may be necessary to use a pry bar for the final alignment.

NOTE: Hopper must be on 4" tall blocks for proper adjustment before installing hardware.

8. Install six M12 hex screws, nyloc nuts and Belleville washers along with the hopper plates. Tighten to 90 - 117 Nm (65 - 85 ft lb).
9. Install the hydraulic hose clamps to the hopper arm.



10. Place the side brush lift cable back in the pulleys on the hopper and tighten the M8 hex screws and nyloc nuts to 18 - 24 Nm (15 - 20 ft lb).
11. Reconnect the clevis end of the side brush lift cable with the side brush assembly using the clevis pin and cotter pin.
12. Reinstall the filter tray back in the hopper.
13. Reconnect the vacuum fan hose to the back of the filter tray using the worm drive clamp.
14. Reconnect wires to the filter shaker and Thermo Sentry™.
15. Start engine and check for proper operation of hopper vacuum fan, dump door, side brush rotation and side brush up and down.

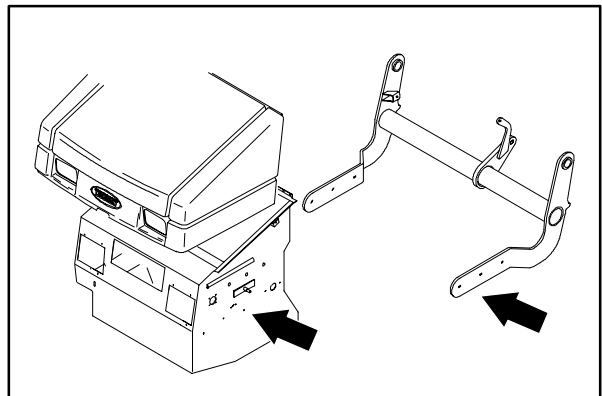
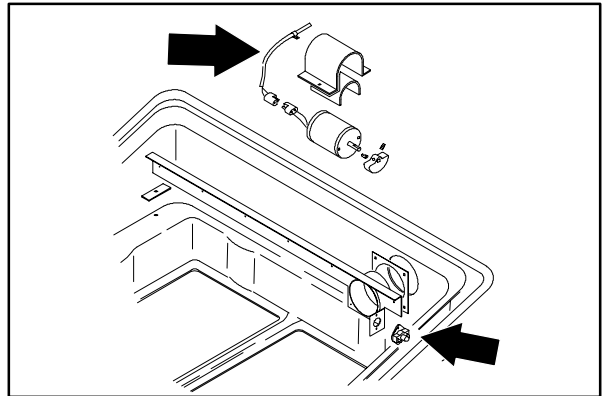
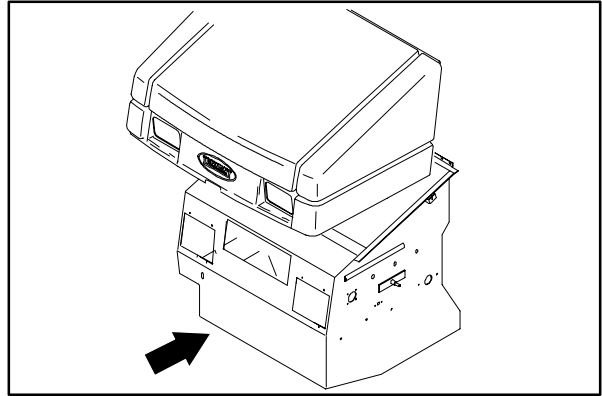


SWEEPING

TO ADJUST AND LEVEL HOPPER HEIGHT

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

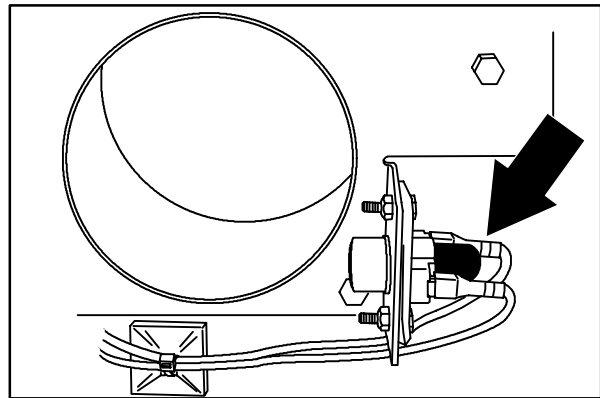
1. Engage the machine parking brake.
2. Start the engine and raise the hopper high enough to position two 4" tall blocks on the floor under the hopper. Lower the hopper down onto these blocks. Shut off the engine.
3. Raise hopper cover and disconnect the wires from filter shaker and Thermo Sentry™. Pull the filter carrier out far enough to disconnect the worm drive clamp holding the vacuum fan rubber duct to the back of the tray. Remove the filter carrier from the machine.
4. Loosen the six M12 hex screws and nyloc nuts holding lift arms to hopper. Make sure hopper arms drop down to their lowest level. The hopper must be all the way back against the main frame.
5. Re-tighten the six M12 hex screws and nyloc nuts to Tighten to 90 - 117 Nm (65 - 85 ft lb).
6. Reinstall the filter tray back in the hopper. Reconnect the wires to filter shaker and Thermo Sentry™.
7. Start the engine and raise the hopper high enough to remove two 4" tall blocks. Lower hopper and check hopper to floor clearance.



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.

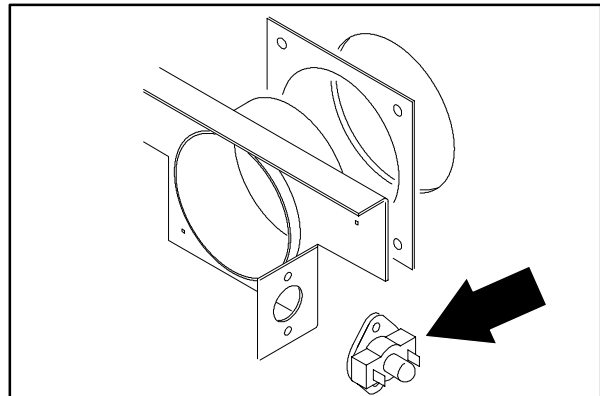
Reset the Thermo Sentry™ by pushing in its reset button.



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.
2. Disconnect the Thermo Sentry™ wire harness from hopper harness.
3. Remove the two bolts holding Thermo Sentry™ to the bracket.
4. Mount the new Thermo Sentry™ to bracket with existing hardware.
5. Reconnect the wires to the Thermo Sentry™.
6. Close the hopper cover.



HOPPER DUST FILTER

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 filter shaker switch.

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

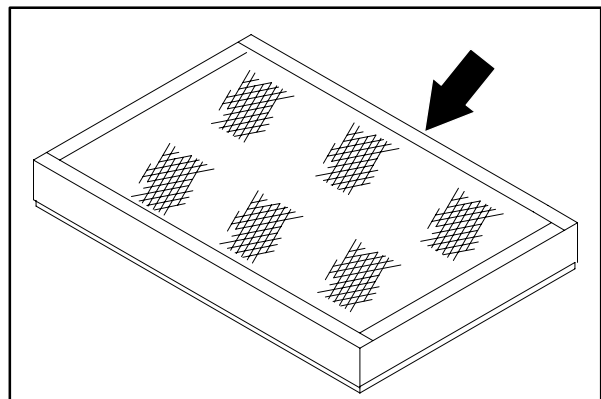
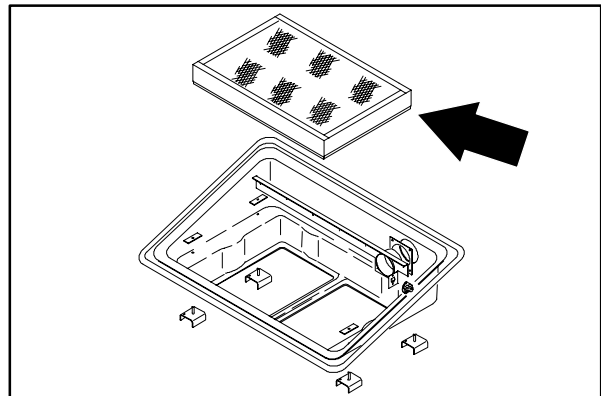
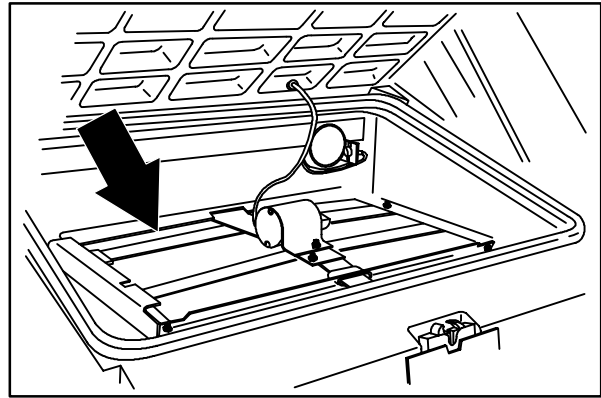
To clean the dust filter, use one of the following methods:

- **SHAKING** - Press the filter shaker switch.
- **TAPPING** - Tap the filter gently on a flat surface with the dirty side down. Do not damage the edges of the filter element or the filter will not seat properly in the filter frame.
- **AIR** - Blow compressed 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 When 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 dry before reinstalling it in the machine.

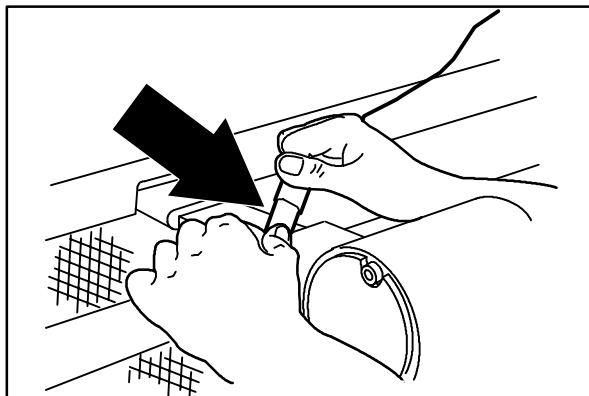


TO REPLACE HOPPER DUST FILTER

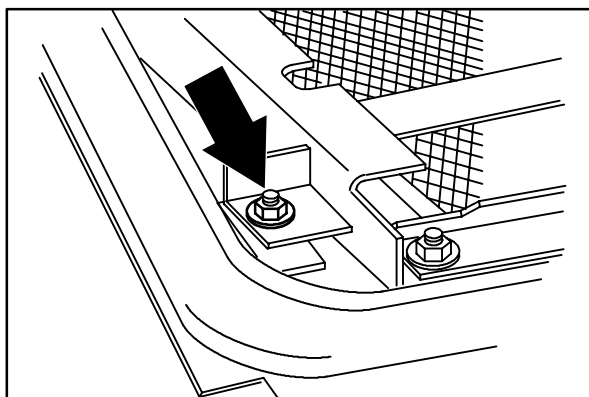
1. Stop the engine and set the machine parking brake.

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

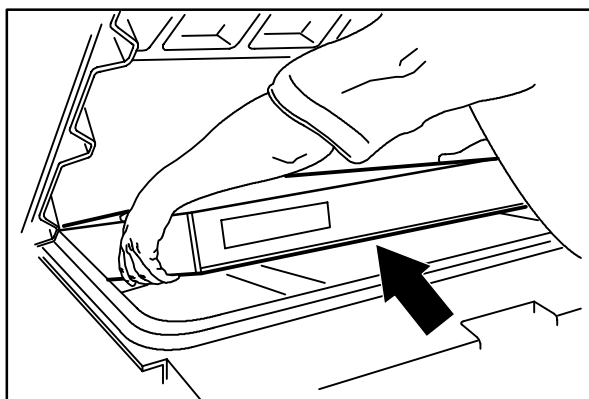
2. Open the hopper cover.
3. Disconnect the shaker motor wire connectors.



4. Remove the four retaining nuts from the filter shaker frame.
5. Pull the filter shaker frame out of the hopper.

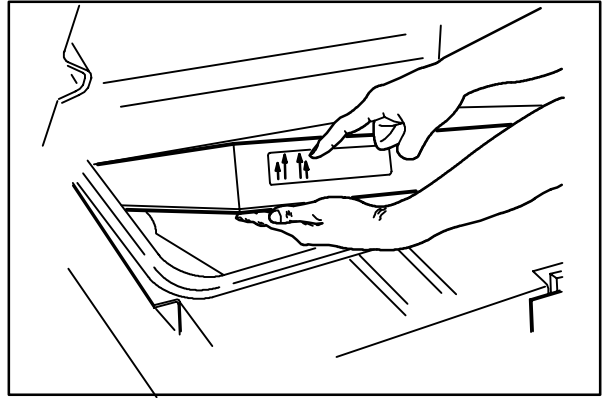


6. Lift the dust filter element out of the hopper insert.
7. Clean or discard the dust filter as required.



SWEEPING

8. Put the cleaned or new dust filter in the hopper insert with the arrows pointing up.
9. Put the shaker frame on top of the panel filter.
10. Install the four retaining nuts and tighten.
11. Connect the shaker motor wire connectors.
12. Close the hopper cover.



HOPPER DUMP DOOR

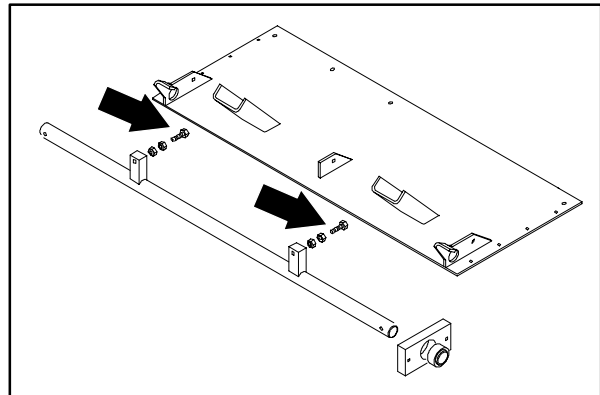
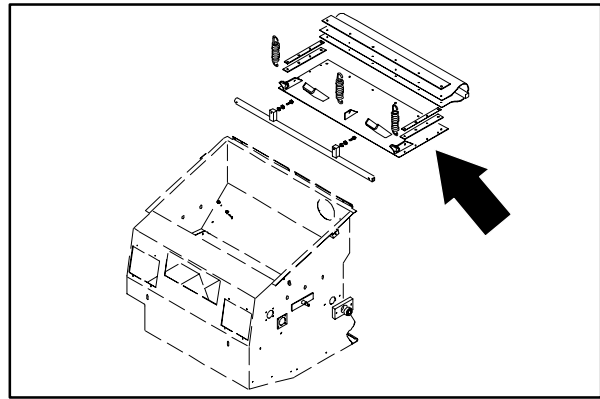
The hopper dump door is used to control debris when dumping. It also seals the hopper to the main brush compartment.

TO ADJUST HOPPER DUST DUMP DOOR

1. Make sure the hopper is emptied of all debris. Engage the parking brake.
2. Raise the hopper and engage the safety arm.
3. Open the dump door and 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. Measure the opening between the inside of the dump door to the inside lower corner of the hopper. This dimension should be 10.5"
5. Use the two adjustment screws on the dump door to achieve this dimension.

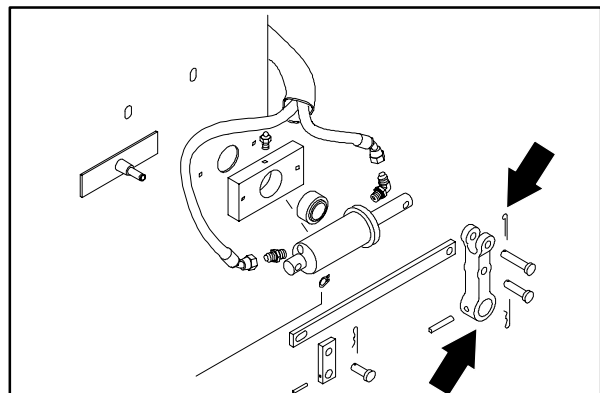
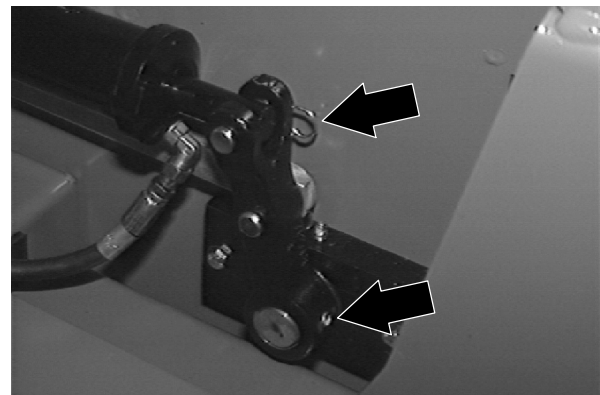


TO REMOVE HOPPER DUMP DOOR

1. Make sure the hopper is emptied of all debris. Engage the parking brake.
2. Open the dump door and hopper cover.

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

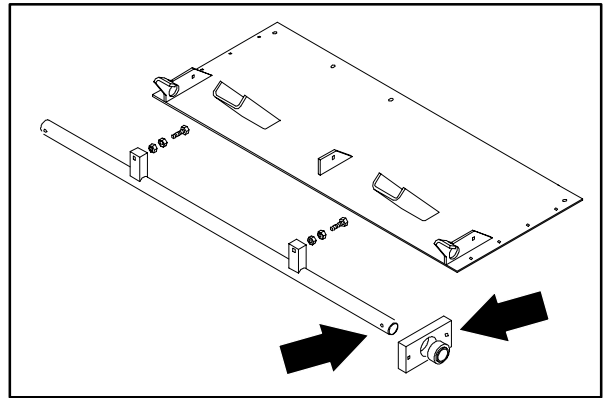
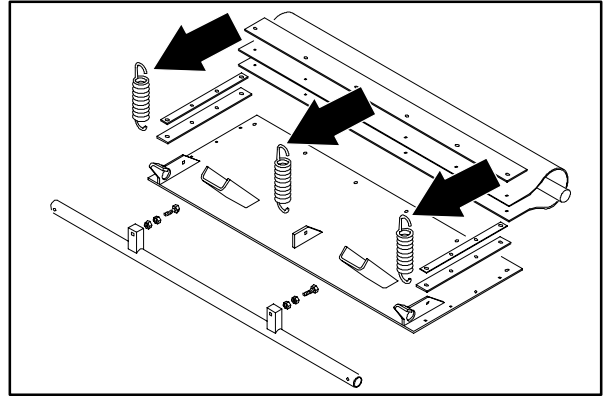
3. Disconnect the rod end of dump door cylinder and dust door pivot link from the dump door pivot yoke.
4. Drive the roll pins out of the pivot yokes. Remove the pivot yokes from machine.
5. Close the hopper cover.
6. Start the machine and raise the hopper. Engage the hopper safety arm.



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

SWEEPING

7. Loosen the two adjustment bolts on the dump door pivot rod.
8. Using a vice grip and a pry bar, remove the three springs from the dump door.
9. Open the hopper cover and remove the four M8 hex screws and flange nuts holding the bearing pivot hubs to the side of the hopper. Remove both hubs.
10. Slide the dump door all the way in either direction. Drop one side down and remove the dump door from the machine.

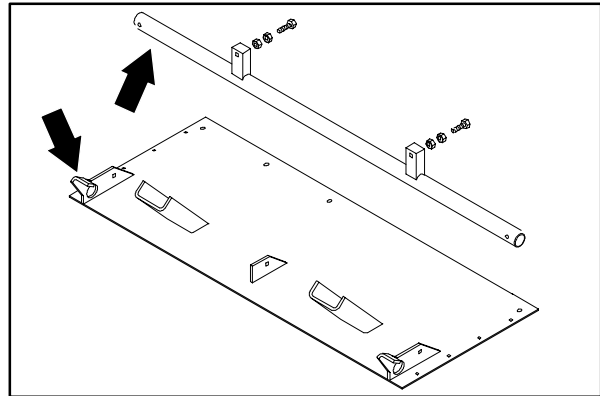


TO INSTALL HOPPER DUMP DOOR

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

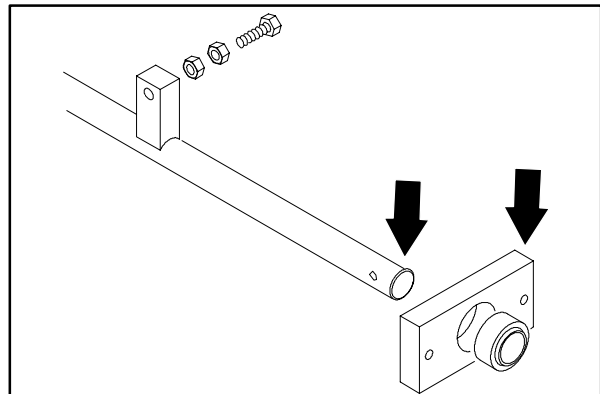
FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.

3. Slide the pivot rod weldment into the holes on hopper dump door assembly.

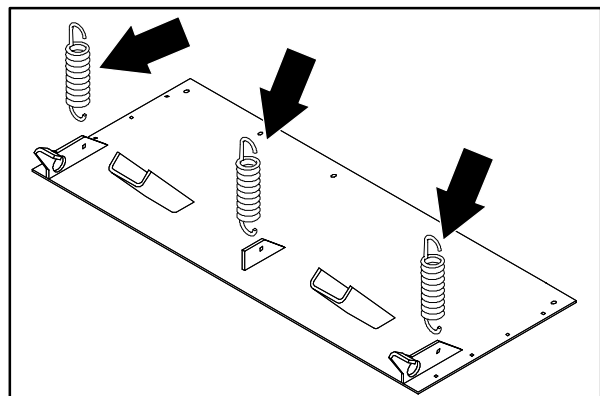


NOTE: Both of the bearing pivot blocks must be removed before the next step can be completed.

4. Place one end of the dump door assembly into one of the holes in rear of hopper. Slide the assembly all the way to one side, bring up the other end and place it in the other hole. Center the door in the hopper.
5. Reinstall both bearing pivot blocks using four M8 hex head screws and flange nuts. Tighten to 18 – 24 Nm (13 – 18 ft lb).



6. Reconnect the three tension springs from eye bolts in hopper to the holes in brackets on dump door. Use a vice grips and a pry bar to hook the springs in the holes.

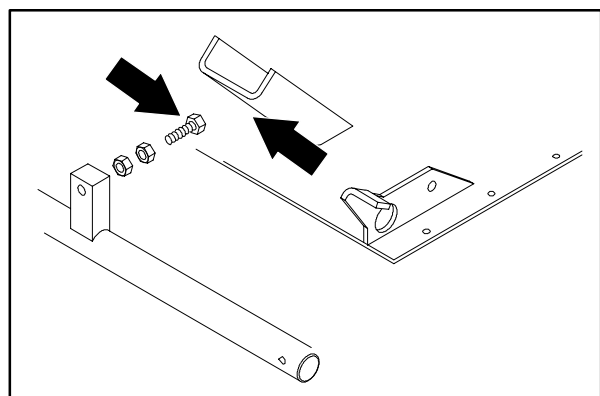


7. Set the adjustment bolts on dump door to .750" from the head of bolt to edge of the bracket.
8. Disengage the hopper safety arm and lower the hopper. Open the hopper cover.
9. Install the pivot yokes on the dump door rod with the smooth side pointed toward the hopper.

10. Align the holes in the dump door rod with the holes in the pivot yoke. Drive roll pins in with a hammer.

11. Reconnect the rod end of dump door cylinder and the dust door pivot link to the dump door pivot yoke.

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



MAIN BRUSH

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 65 to 75 mm (2.5 to 3.5 in) wide with the main brush in the **Down** position. Adjust the main brush pattern by turning the main brush pressure knob located next to the brush position lever.

Rotate the main brush end-for-end every 50 hours of operation for maximum brush life and best sweeping performance.

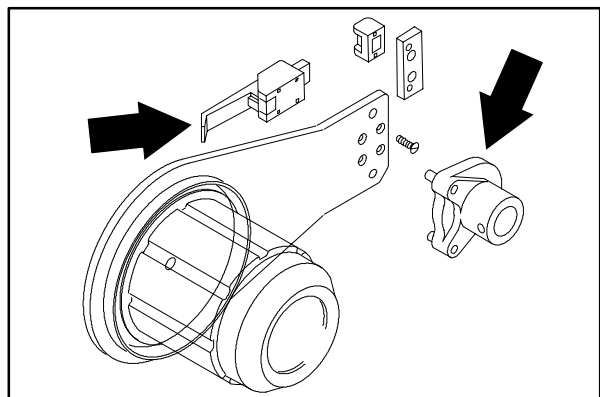
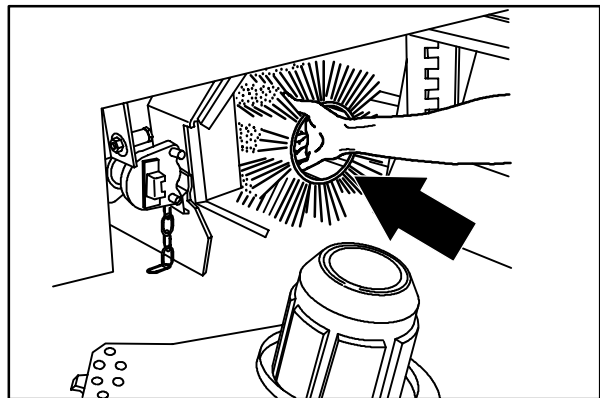
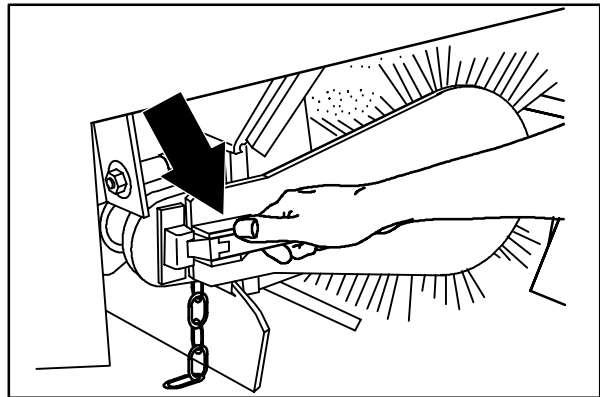
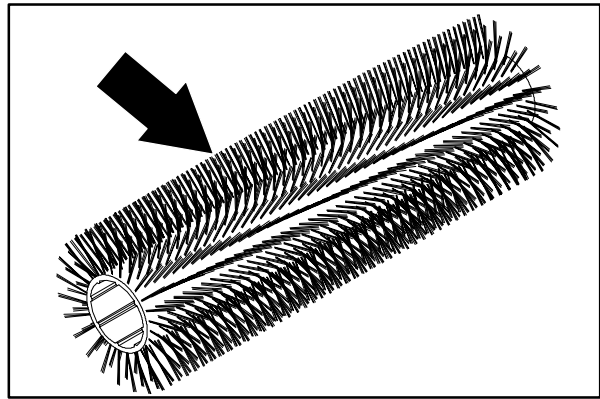
Replace the main brush when the remaining bristles measure 30 mm (1-1/4 in) in length.

TO REPLACE MAIN BRUSH

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

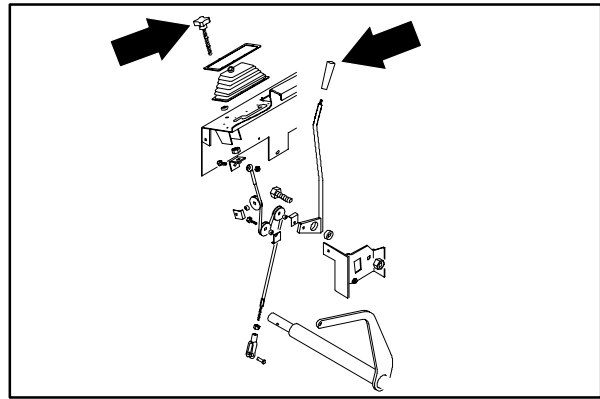
FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.

2. Raise the main brush.
3. Open the right side main brush access door.
4. Unlatch 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, push it all the way onto the plug.
8. Slide the main brush idler plate plug onto the main brush.
9. Latch the idler plate onto the machine frame.
10. Close the right side main brush access door.



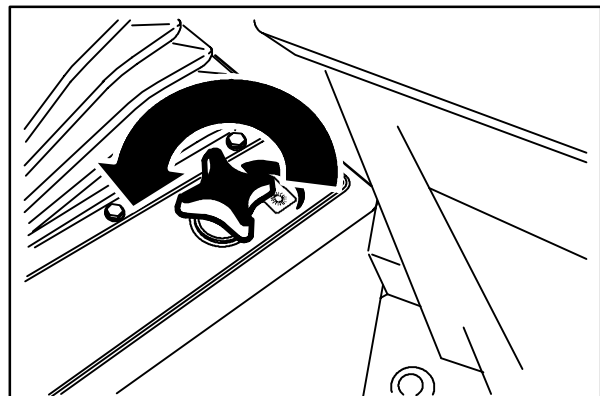
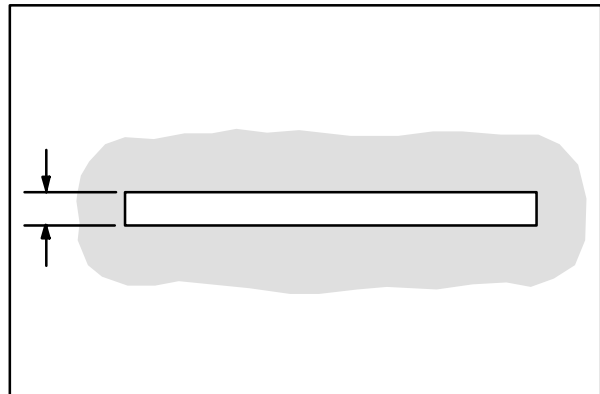
TO CHECK AND ADJUST MAIN BRUSH PATTERN

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. Start the main brush.
4. Lower 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.



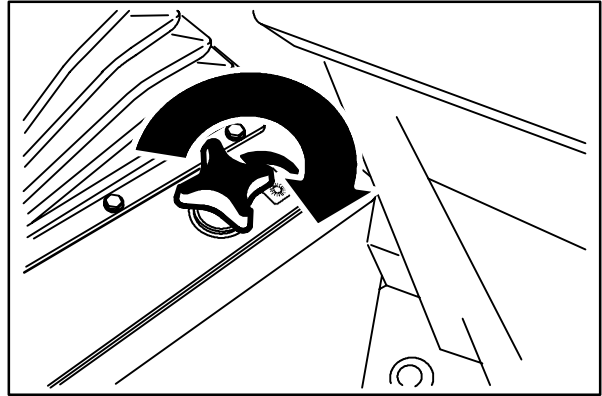
NOTE: If chalk or other material is not available, allow the brushes to spin on the floor for two minutes. A polish mark will remain on the floor.

5. Raise the main brush.
6. Stop the main brush.
7. Drive the machine off the test area.
8. Observe the width of the brush pattern. The proper brush pattern width is 50 to 65 mm (2.0 to 2.5 in).
9. To increase the width of the main brush pattern, turn the main brush down pressure knob counter-clockwise.



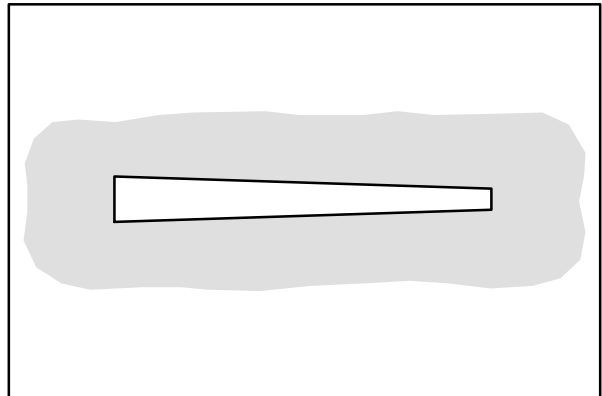
SWEEPING

To decrease the width of the main brush pattern, turn the main brush down pressure knob clockwise.

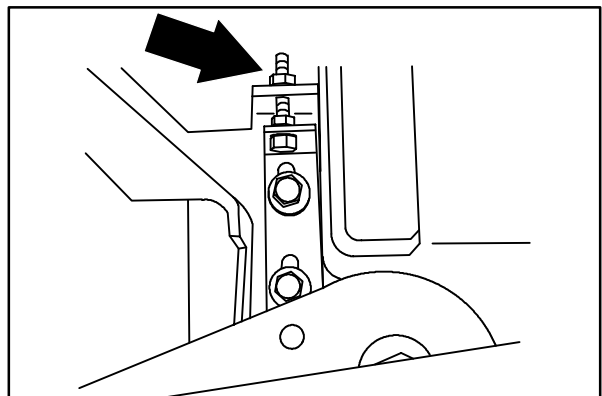
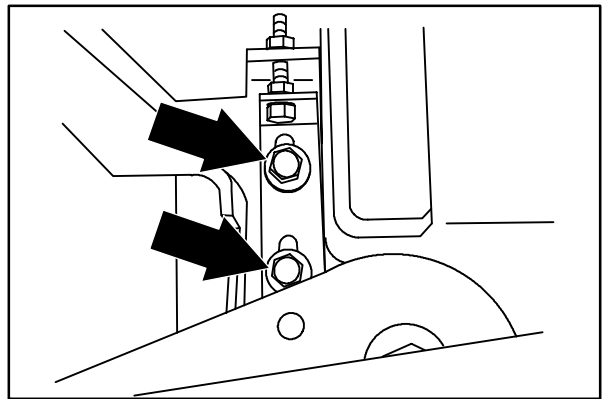


If the main brush pattern is tapered, more than 15 mm (0.5 in) on one end than the other, adjust taper.

A. Loosen the bracket mounting bolts.



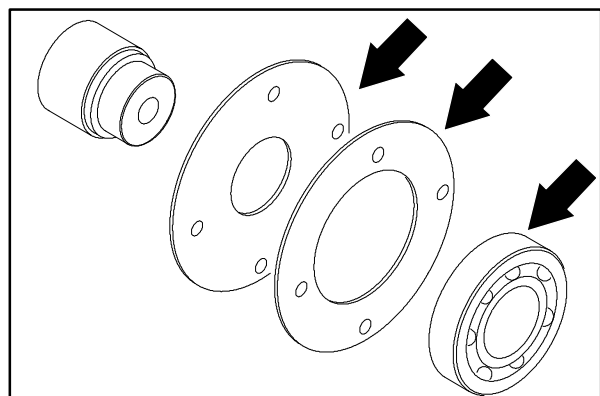
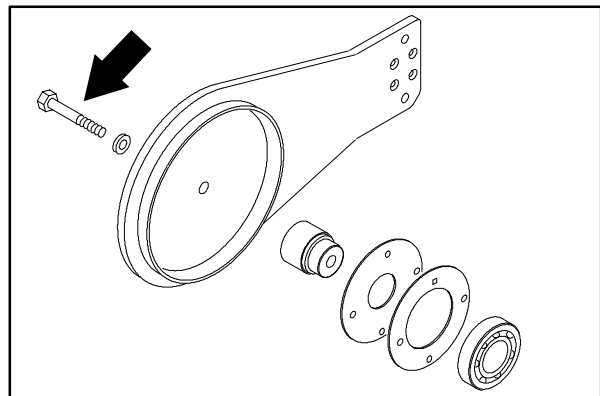
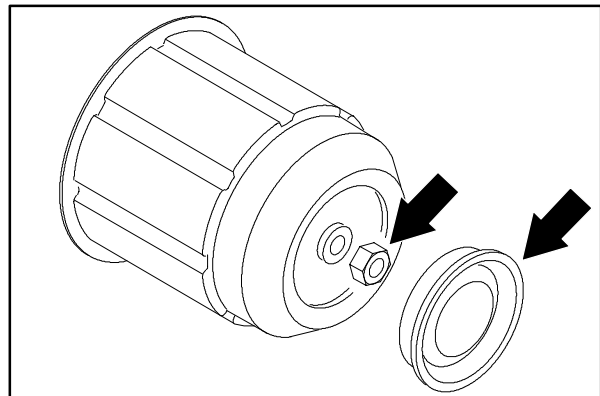
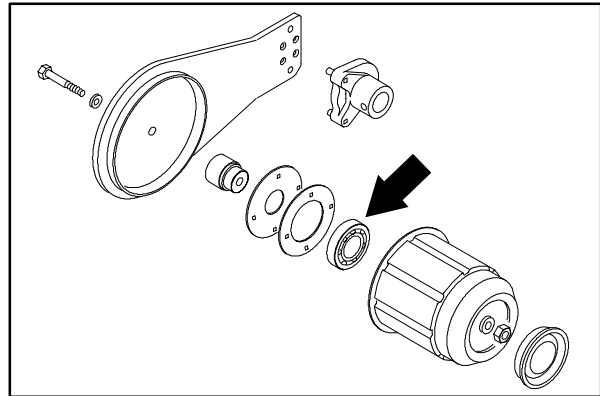
- B. Turn the taper adjustment nut counter-clockwise to increase the pattern width at the brush drive end, and clockwise to decrease the pattern width at the brush drive end. Tighten the mounting bolts.
- C. Check the main brush pattern and readjust as necessary. Then adjust the width of the main brush pattern.



TO REPLACE MAIN BRUSH IDLER PLUG 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 from the machine.
 2. Remove the plastic cap from the idler plug.
 3. Clean the area around where the cap was mounted to the idler plug.
 4. Remove the M12 hex screw, nyloc hex nut, and washer holding the idler plug to the idler arm. Save the hardware.
 5. Remove the four M6 hex screws holding the idler shaft in the idler plug. Remove the shaft and cover. Save the hardware.
 6. Remove the bearing seal plate, retainer and bearing.
 7. Clean the inside of the idler plug.
 8. Place a new bearing, the seal plate and the retainer in the idler.
 9. Thread the four screws and flat washers into place.
 10. Install the idler shaft and tighten the four bolts to 8–10 Nm (6–8 ft lb).
 11. Slide the idler plug on the idler arm shaft. Secure it with the hardware removed earlier. Tighten hardware to 68–81 Nm (50–60 ft lb).
 12. Apply RTV to contact area where plastic cap will fit one end of idler plug. Snap plastic cap into place.
- NOTE: If you replace idler arm latch, use blue locktite on hardware to hold in place.*
13. Reinstall the idler arm on the machine.
 14. Operate the machine and check for proper operation.



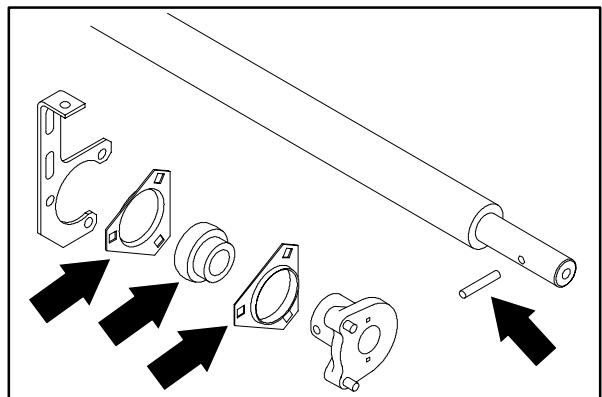
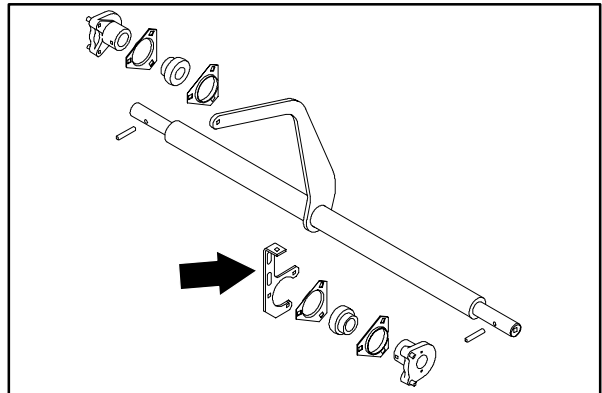
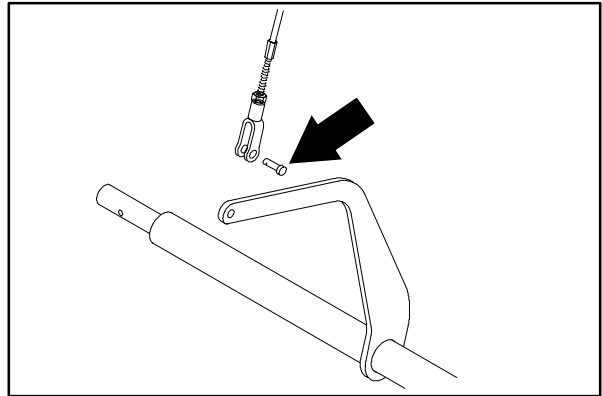
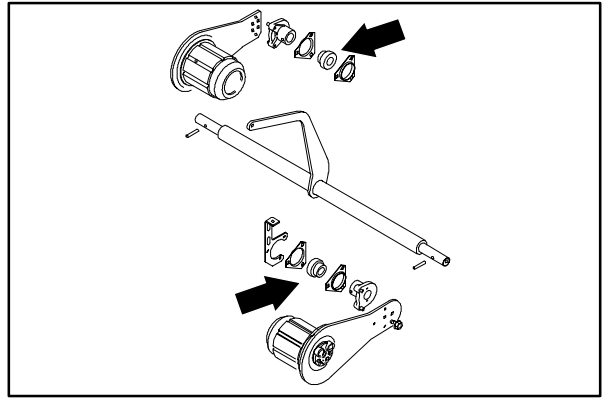
SWEEPING

TO REPLACE BRUSH SHAFT BEARINGS

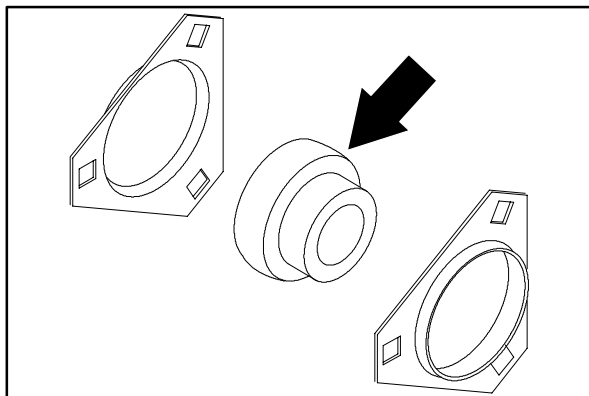
FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.

1. Remove the main brush and idler arm from the machine.
2. Remove the brush motor arm assembly from the machine.
3. Remove the brush lift cable clevis from brush shaft arm.
4. Loosen the main brush taper adjustment screw.
5. Remove the two bolts holding each of the two brush shaft bearings and retainers to the machine frame.
6. Pull the brush shaft out of the machine.
7. Hammer the brush hub roll pins out of the brush hubs.
8. Slide the brush hubs off the ends of the shaft.
9. Remove the hardware holding the bearing collars in place.
10. Loosen the set screws in the locking collars and slide the bearings off the shaft.
11. Slide the new bearings on the shaft with the locking collars facing out. Be sure to have a bearing retainer on both sides of each bearing.
12. Slide the brush hubs on the shaft ends.
13. Align the hole in the hub with the hole in the brush shaft.
14. Hammer a roll pin back in each hole.
15. Mount the shaft hangers to the bearing retainers. Tighten hardware to 22-27 Nm (16-20 ft lb).

NOTE: If you are replacing the idler arm latch bracket, use blue locktite to hold the bolts in place. Tighten the bolts to 8-10 Nm (6-8 ft lb).



16. Mount the brush shaft in the machine.
Tighten hardware to 22-27 Nm (16-20 ft lb).
17. Center the brush shaft in the machine.
Tighten the bearing locking collar set screws.
18. Reconnect the main brush lift cable to the brush shaft arm with the clevis and cotter pin.
19. 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. One-half of the side brush bristles should contact the floor when the brush is in motion. Adjust the side brush pattern by the side brush down pressure knob. Turn the knob 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

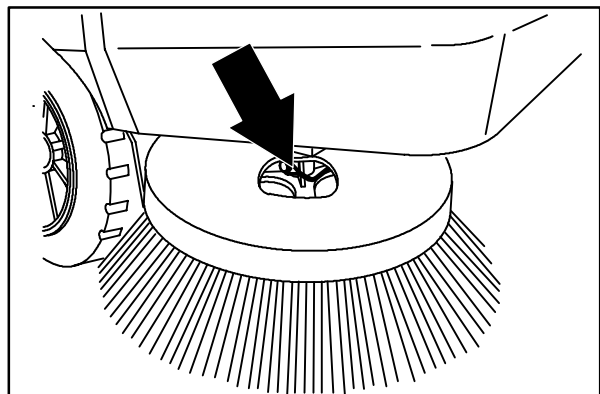
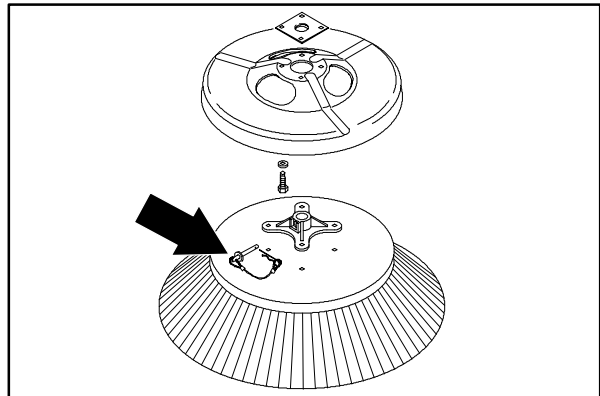
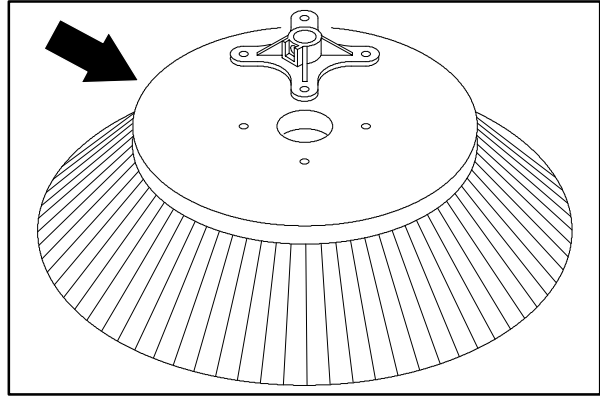
1. Empty the debris hopper.
2. Set the machine parking brake.

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

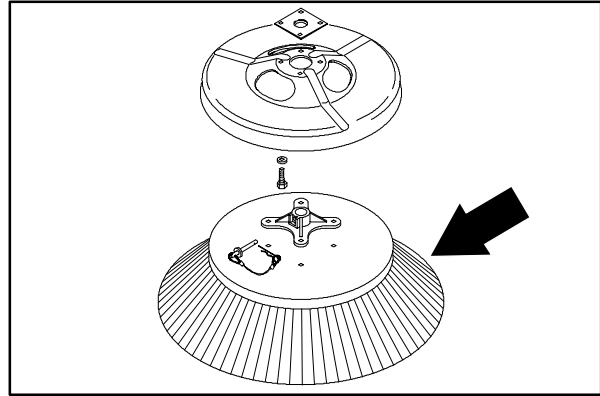
3. Raise the side brush.
4. Remove the side brush retaining pin from the side brush drive shaft by pulling the pin keeper off and over the end of the pin. Remove the pin.
5. Slide the side brush off the side brush motor shaft.

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.



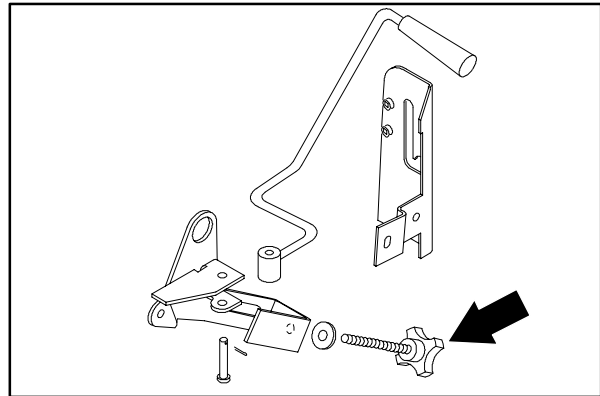
8. Secure the pin by clipping the pin keeper over the end of the pin.
9. Disengage the hopper support bar and lower the hopper.
10. Adjust the side brush pattern with the side brush down pressure knob.



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.

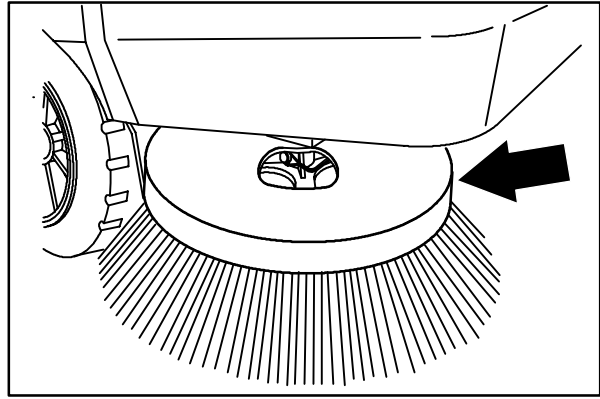
1. Lower the side brush.
2. Thread the side brush knob into the bracket to increase side brush pattern. Thread the side brush knob out of the bracket to decrease side brush pattern. One-half of the bristles should normally contact the floor.
3. Raise the side brush.



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.

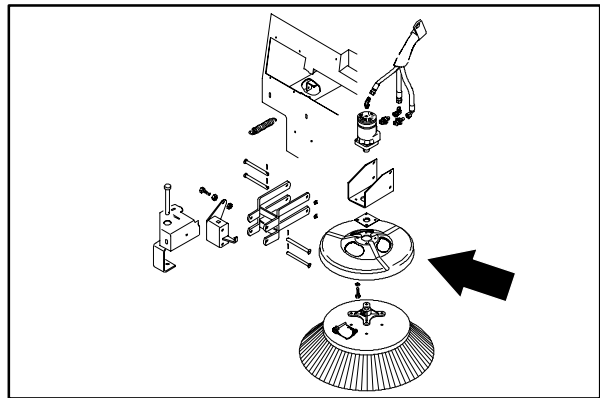
Rotate the side brush guard 90degrees every 200 hours of operation. Replace the brush guard after all four sides have been used.



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).



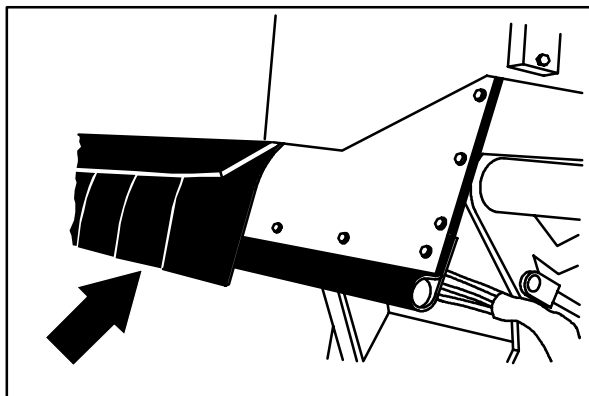
SKIRTS AND SEALS

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

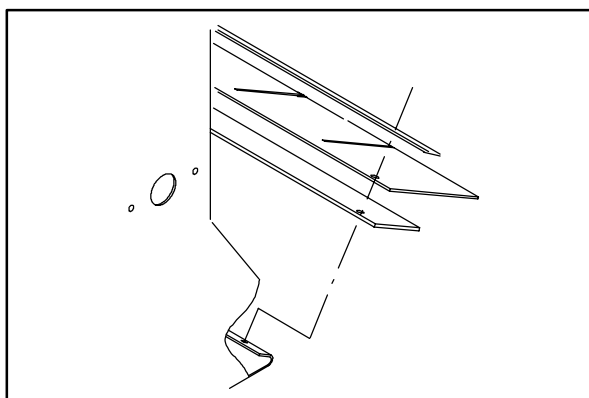
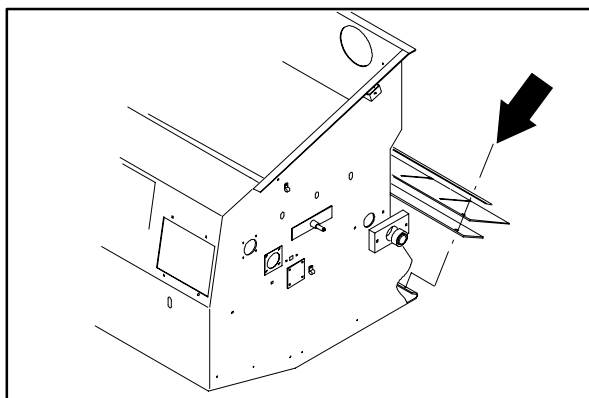
1. Dump the machine debris hopper.
2. Set the machine parking brake.
3. Raise the hopper, engage the hopper support bar, and lower the hopper onto the support bar. Shut off the engine.



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 engine and lower the hopper.



SWEEPING

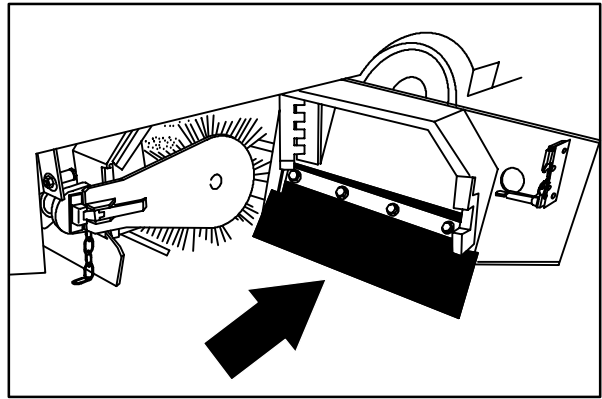
BRUSH DOOR SKIRTS

The brush door skirts are located on the bottom of each of the two main brush doors. They 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.

NOTE: Rear tire pressure will affect skirt clearances.

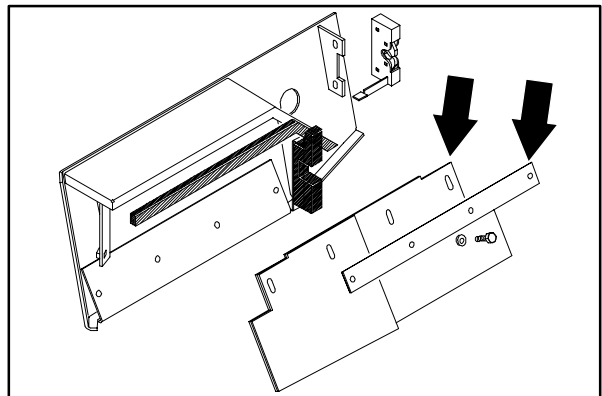
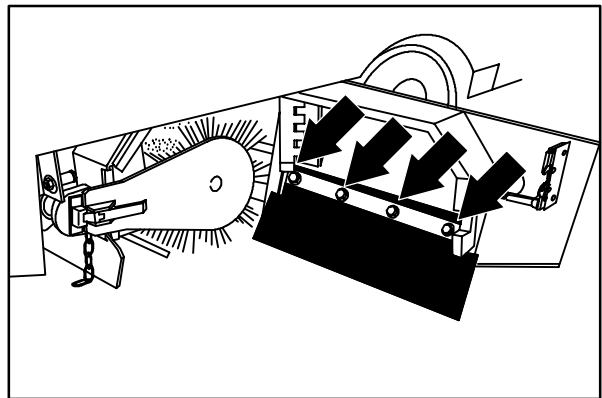


TO REPLACE AND ADJUST BRUSH DOOR SKIRTS

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

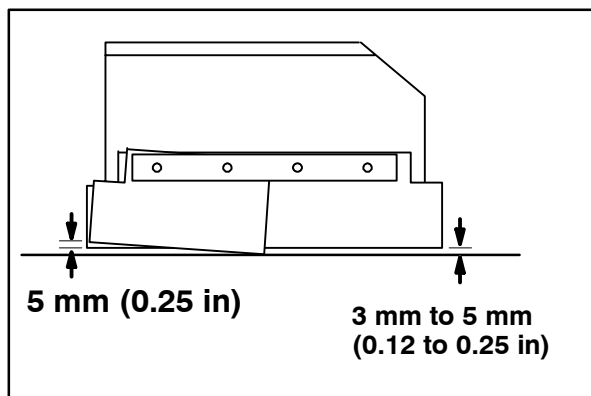
FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.

3. Open the main brush doors.
4. Remove the brush door skirt retaining bolts.
5. Remove the skirt retaining strip and door skirts.
6. Position the new long door skirt on the brush door.
7. Place the new half-length skirt over the front half of the long skirt. Place the retainer over the skirts.
8. Thread the skirt retaining bolts through the brush door, the door skirts, 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 long brush door skirt up or down so it will clear the floor by 3–5 mm (0.12 to 0.25 in). Secure the two bolts holding only one skirt.
10. Adjust the inner half-length skirt so the front edge of it is 5 mm (0.25 in) above the long skirt and the back half just touches the floor. tighten all four bolts to 6–8 ft lb (8–10 Nm).
11. Repeat for the other brush door.



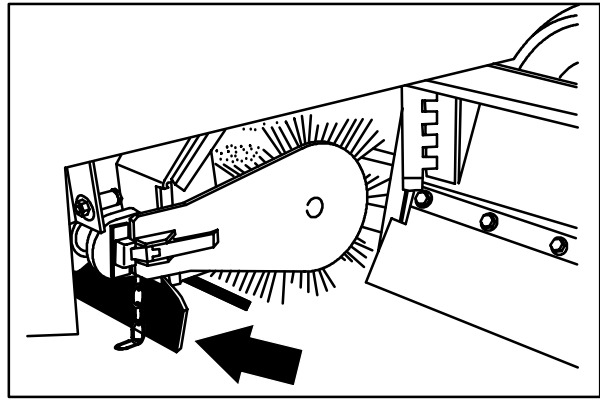
SWEEPING

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.

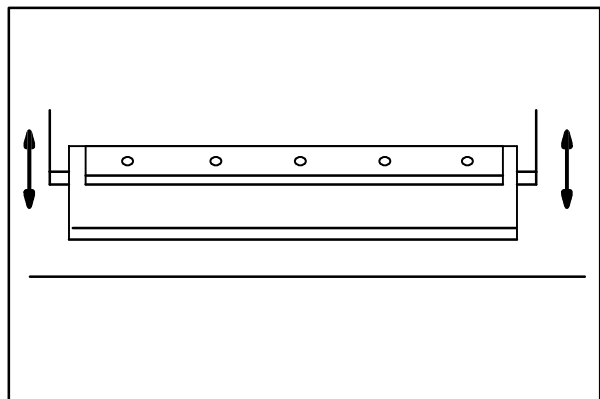
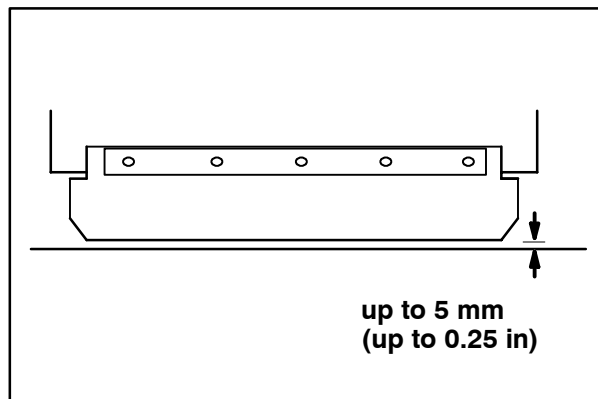


TO REPLACE AND ADJUST THE REAR SKIRT AND DEFLECTOR BLADE

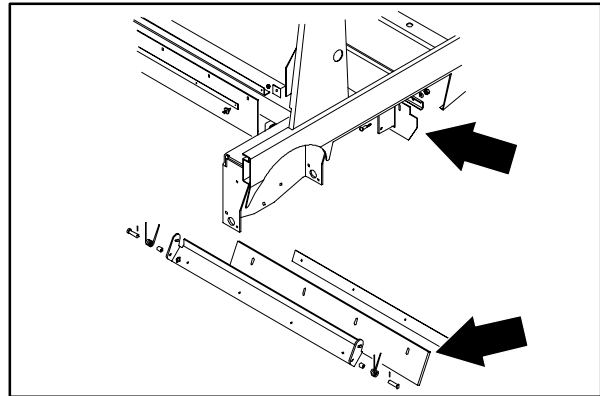
1. Park the machine on a smooth, level surface.
2. Stop the engine and set the machine parking brake.

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

3. Open the main brush doors.
4. Remove the main brush.
5. Remove the retaining strip and floor skirt. Discard the old skirt.
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.



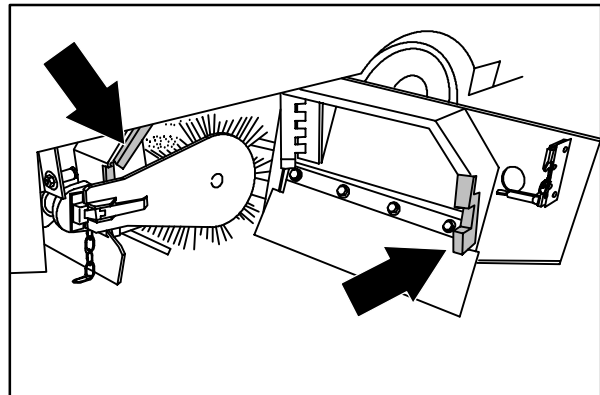
11. Position the new blade on the machine.
12. Thread the mounting bolts through the mounting bracket, the brush contact blade, and the retaining strip.
13. Tighten the brush contact blade mounting bolts to 8–14 Nm (6–10 ft lb).
14. Make sure the deflector spring moves the blade into position freely.
15. Reinstall the main brush.
16. Close the main brush doors.
17. Operate the machine and check for proper operation.



BRUSH DOOR SEALS

The brush door seals are located on both main brush doors and on corresponding portions of the main frame. They seal the main brush compartment.

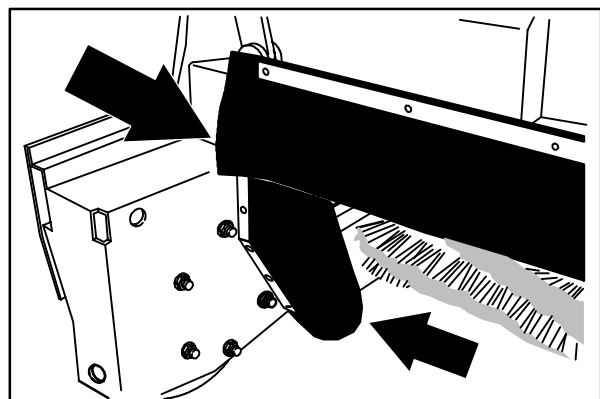
Inspect the seals for wear or damage every 100 hours of operation.



HOPPER SEALS

The hopper seals are located on the top and 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.



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TO REPLACE HOPPER SEALS

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

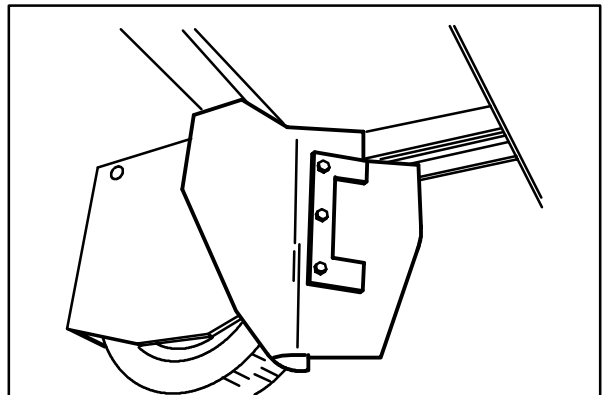
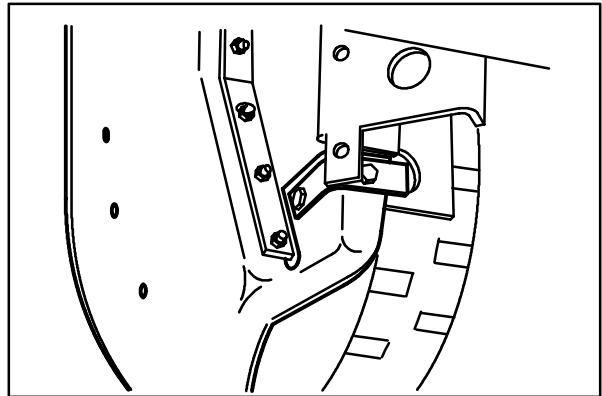
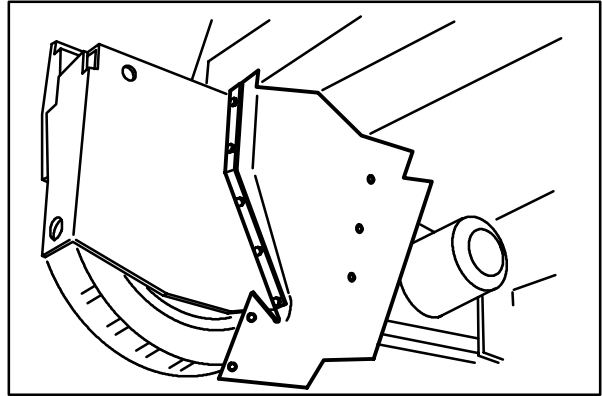


WARNING: Raised Hopper May Fall. Engage Hopper Support Bar.

3. Raise hopper and engage hopper support bar.

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

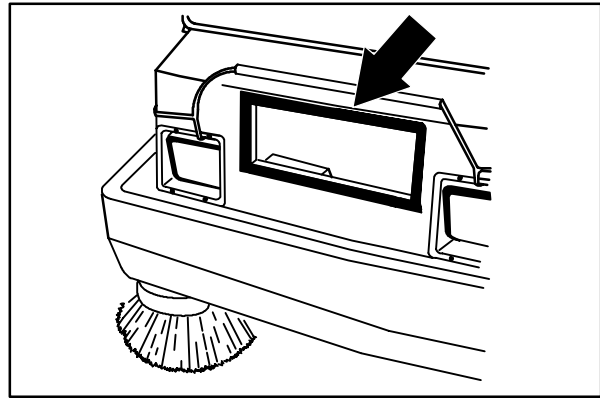
4. Open the main brush doors.
5. Remove the main brush.
6. Remove the skirt retainer and skirt from each side of the machine. Remove the plastic hardware by prying under the head.
7. Position the new skirt and existing retainer on the front of the machine frame. Secure with plastic push-in hardware.
8. Pull the new skirt around inside of frame. Push the skirt all of the way in its slots. Secure with existing angle retainer and two M6 bolts, flat washers, and nyloc nuts. Tighten to 4–5 Nm (3–4 ft lb).
9. Pull the skirt toward the brush door. Secure in place with the C-shaped retainer and bolts. Tighten to 8–10 Nm (6–8 ft lb).
10. Repeat on the other side of the main frame.



HOPPER INSPECTION DOOR SEAL

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

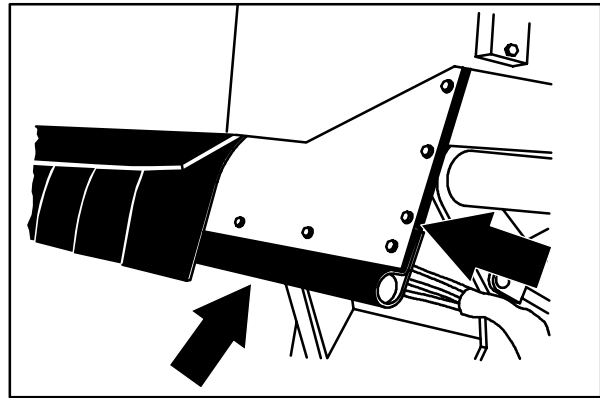
Check the seal for wear or damage every 100 hours of operation.



HOPPER DOOR SEALS

The hopper door seals are located on the hopper door. They seal the hopper when the hopper door is closed. Use RTV between the sponge cord and door seal. Make sure the seals are straight. Tighten hardware to 3–4 Nm (2.5–3.5 ft lb). Hardware should be oriented with the nyloc nuts on the top side of the door.

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

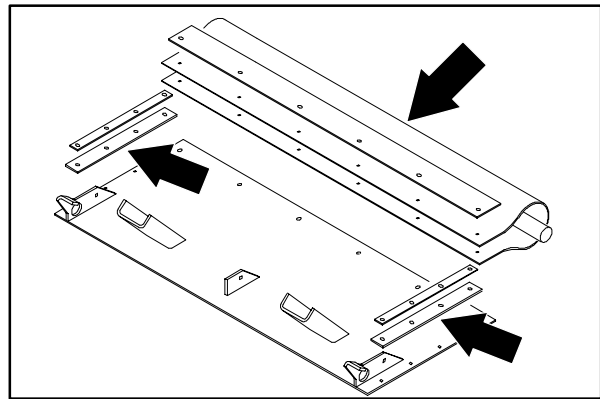


TO REPLACE HOPPER DOOR SEALS

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

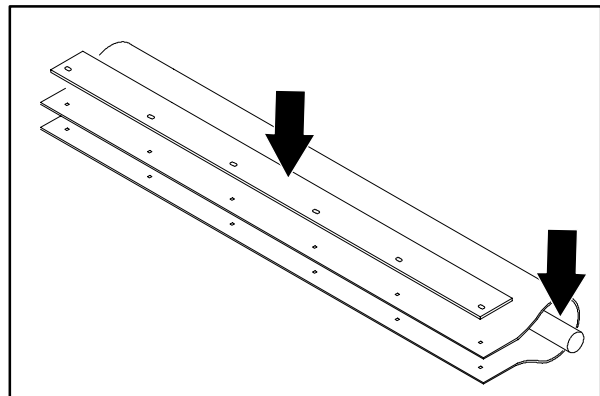
⚠ WARNING: Raised Hopper May Fall. Engage Hopper Support Bar.

3. Raise hopper and engage hopper support bar.



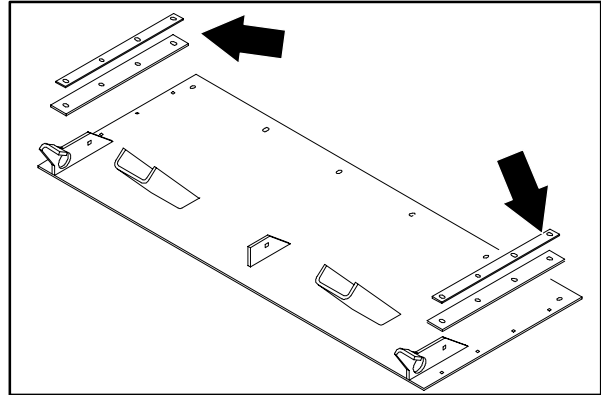
FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.

4. Remove the six M6 hex screws and nyloc nuts holding dump door seal, retainer, and sponge cord to dump door. Discard seal.
5. Use black RTV to hold sponge cord to new dump door seal.



SWEEPING

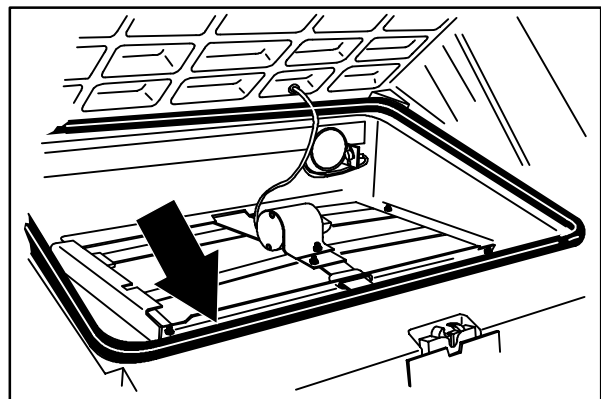
6. Align the holes in seal with holes on dump door and retainer. Reinstall M6 hex screws and nyloc nuts. Tighten to 3.3 – 4.4 Nm (30 – 39 In lb).
7. Remove four M6 hex screws and nyloc nuts holding dump door side seals and retainers to each side. Note the direction of the hardware. Discard the old seals.
8. Align the holes in seal with holes on dump door and retainer. Reinstall M6 hex screws and nyloc nuts. Tighten to 3.3 – 4.4 Nm (30 – 39 In lb). Make sure seals are lined up with edge of hopper when tightening.
9. Start machine and lower hopper.
10. Operate the machine and check the dump door for proper operation.



HOPPER COVER SEAL

The hopper cover seal is located on the top edges of the hopper insert. It seals the hopper filter compartment.

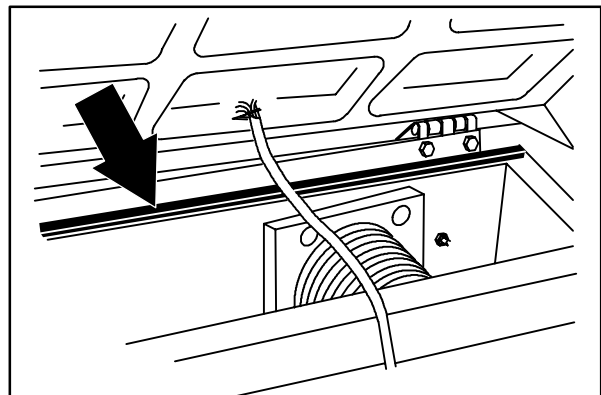
Check the seal for wear or damage every 100 hours of operation.



HOPPER DUST SEAL

The hopper dust seal is located under the hopper insert along the top of the hopper.

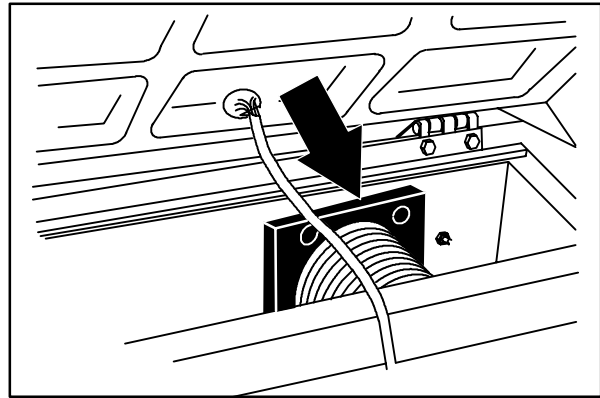
Check the seal for wear or damage every 100 hours of operation. You can reach the seal by removing the hopper insert.



HOPPER VACUUM FAN SEAL

The hopper vacuum fan seal is mounted on the inside of the hopper around the vacuum fan inlet.

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

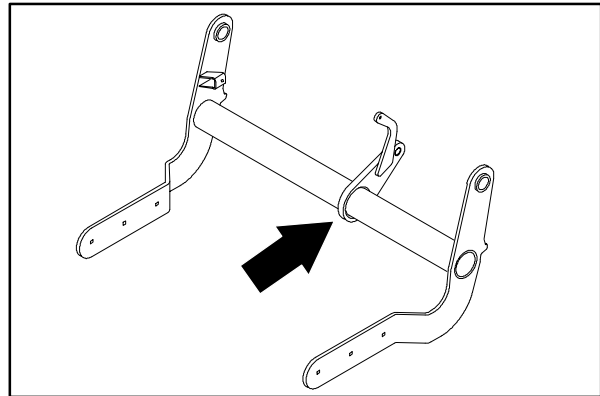


HOPPER LIFT ARM

The hopper lift arm raise and lower the debris hopper. The lift arm is held in place by two self-aligning bearings, two pivot pins, and two retaining rings.

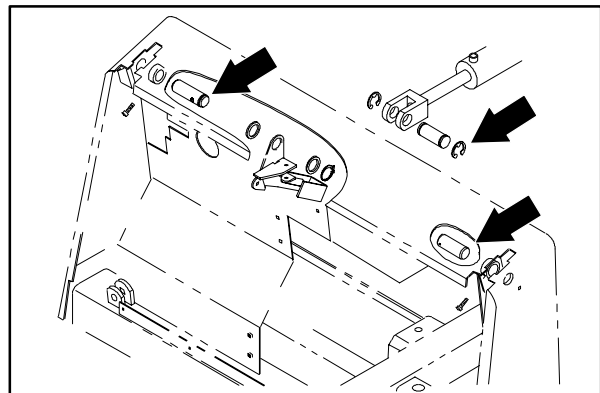
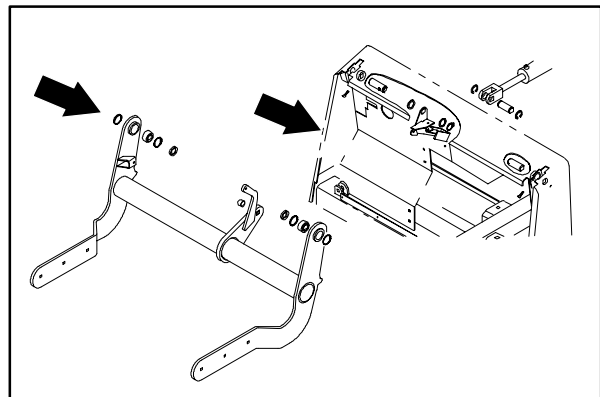
TO REMOVE HOPPER LIFT ARM

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. Remove the debris hopper. See TO REMOVE HOPPER FROM MACHINE instructions.
4. Remove the M10 nyloc nut holding the hopper up speed limiter rod to the lift arm. Disconnect the rod from the lift arm.
5. Remove the retaining rings on the upper, hopper lift cylinder pin.
6. Raise up slightly on the lift arm to take pressure off the cylinder pin. Remove the pin.
7. Remove the socket screws holding the hopper pivot pins to the frame towers.
8. 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.
9. If the large self aligning bearing needs to be changed, remove retaining rings and press out.

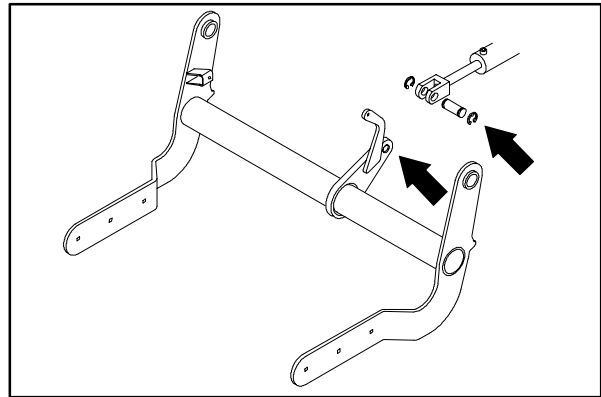
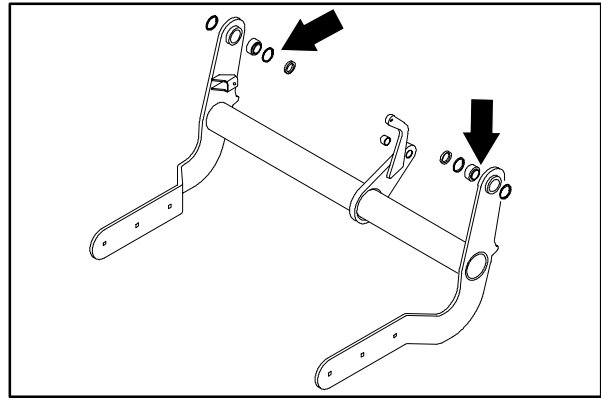


TO INSTALL HOPPER LIFT ARM

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

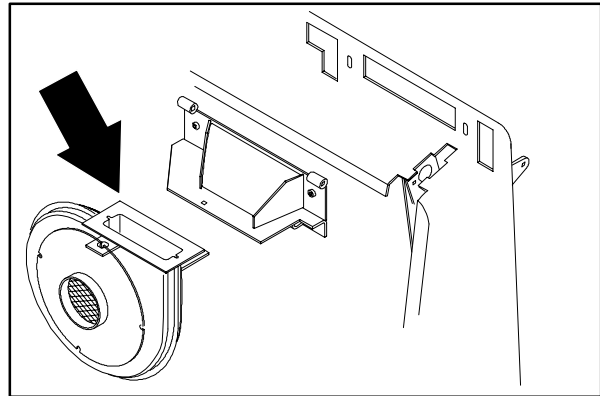
FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.

3. Position lift arm in the machine, aligning the large upper bearings with the holes in the towers of the machine.
4. Install the lift arm pins into 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 socket head screws and tighten to 18 - 24 Nm (13 - 18 ft lb).
6. Align the small fiberglide bearing with the hole in the clevis on the hopper lift cylinder. Reinstall the cylinder pin and retainer rings.
7. Reconnect the speed limiter rod to the lift arm. Tighten the M10 nyloc to 37 - 48 Nm (26 - 34 ft lb).
8. Reinstall the hopper assembly. See TO INSTALL HOPPER instructions.



VACUUM FAN

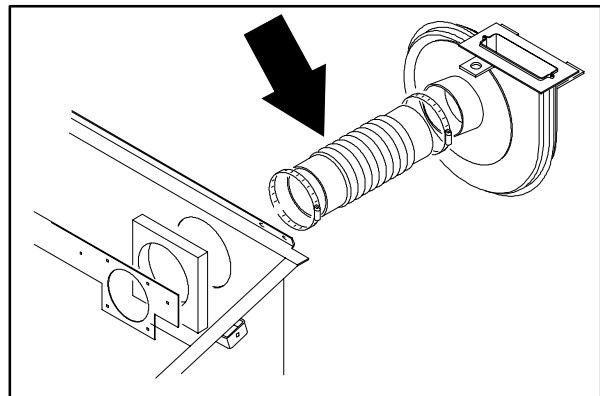
The vacuum fan is located on the machine lintel, above the propel pump, on the back of the engine. It is used during sweeping to control dusting by pulling air from the main brush area through the hopper to the dust filters.



TO REMOVE VACUUM FAN ASSEMBLY

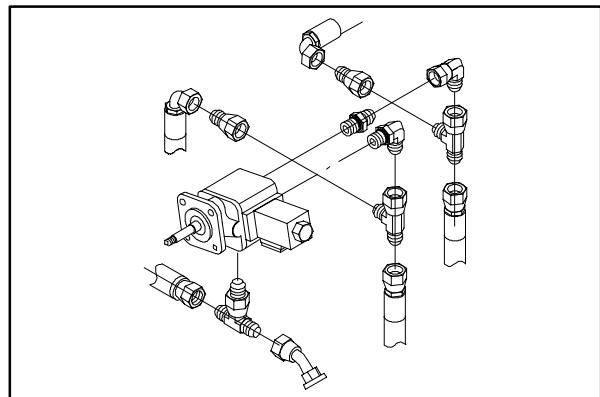
1. Park the machine on a smooth, level surface.
2. Stop the engine and set the machine parking brake. Raise the hopper and engage hopper up safety arm.

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

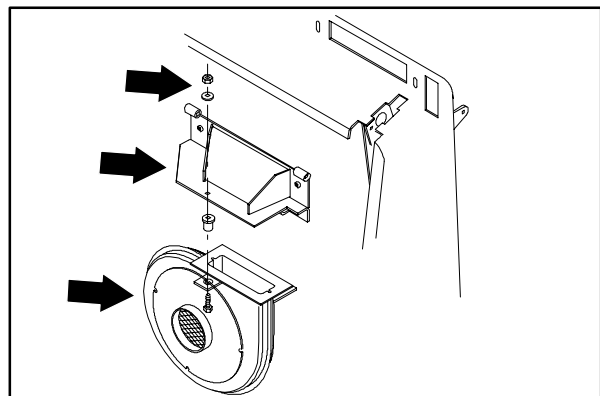


3. Remove the large hose connected to the vacuum fan inlet.
4. Remove the four M8 hex screws holding the front panel to the front of the machine. Remove the panel.
5. Disconnect and plug the three hydraulic hoses leading to the vacuum fan motor.

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



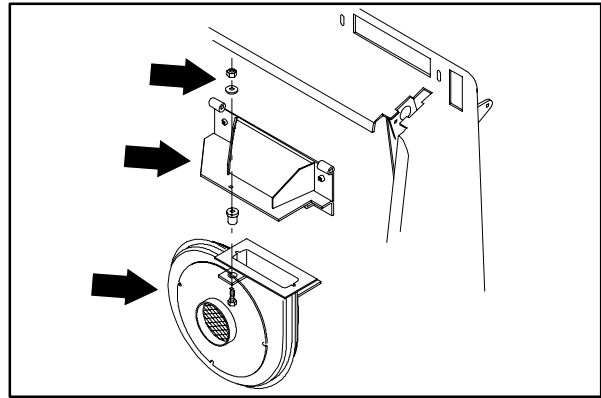
6. Disconnect the wire harness from the vacuum fan motor solenoid.
7. Remove the three M10 hex screws and nyloc nuts holding the vacuum fan assembly to the fan transition mount bracket. Remove the fan assembly out the front of the machine.



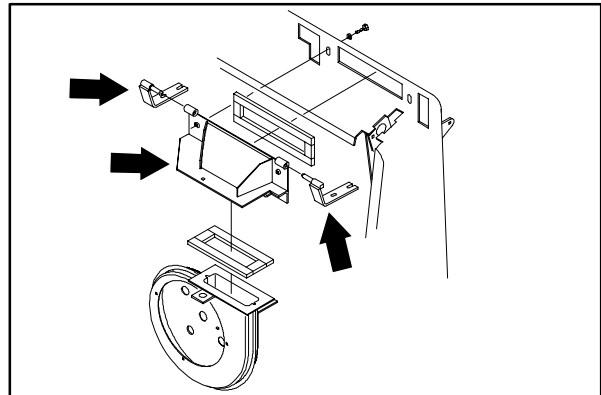
TO INSTALL VACUUM FAN ASSEMBLY

1. Park the machine on a smooth, level surface.
2. Stop the engine and set the machine parking brake. Raise the hopper and engage hopper up safety arm.

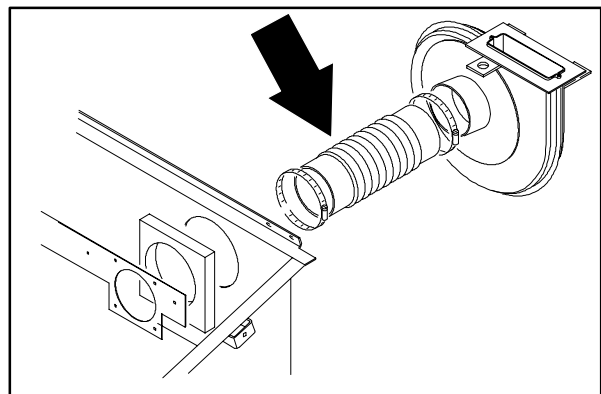
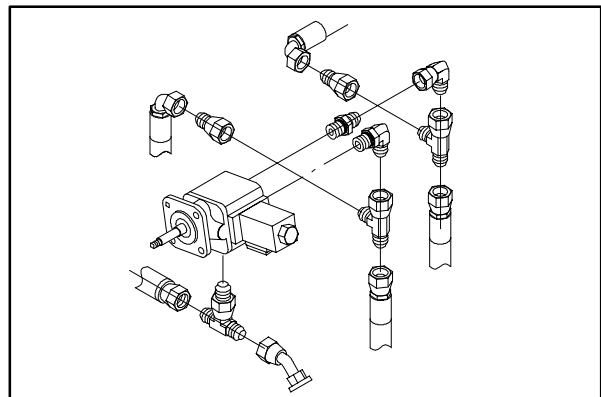
FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.



3. Bring the fan assembly in from the front of the machine, under the lift arms.
4. Align the holes in fan isolators with the holes in the fan transition mount bracket.
5. Install the three M10 hex screws, washers and nyloc nuts with holes on the underside of the fan transition mount bracket. Tighten to 18 - 24 Nm (13 - 18 ft lb).
6. Reconnect the hydraulic hoses. See the schematic in the HYDRAULIC section.
7. Reconnect the wire harness to the vacuum fan solenoid. See the schematic in the ELECTRICAL section.



8. Make sure the wires and hoses are tied and clamped properly.
9. Reinstall the front dust panel using the four M8 hex screws and washers. Tighten to 18 - 24 Nm (15 - 20 ft lb).
10. Reconnect the vacuum fan to the hopper flex hose.
11. Start the machine and operate the vacuum fan. Check for leaks and proper operation.



TO REPLACE VACUUM FAN IMPELLER

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. Remove vacuum fan from machine. See TO REMOVE VACUUM FAN instructions in this section.

4. Place the vacuum fan assembly in a vice.

5. Remove the four 0.25 in. hex screws and fender washers holding inlet plate to the fan housing. Remove the inlet plate.

6. Hold the impeller from turning and remove the 0.31 in. hex nut from the center of the fan motor shaft.

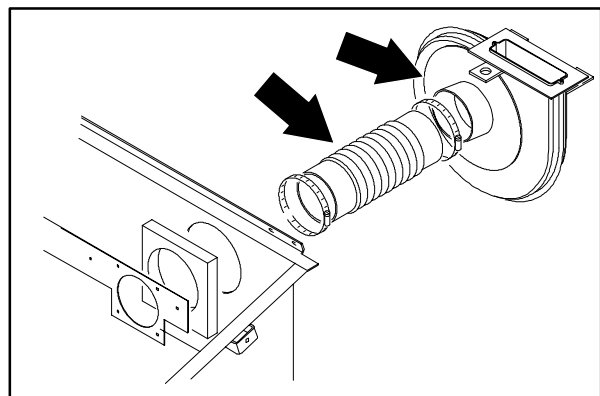
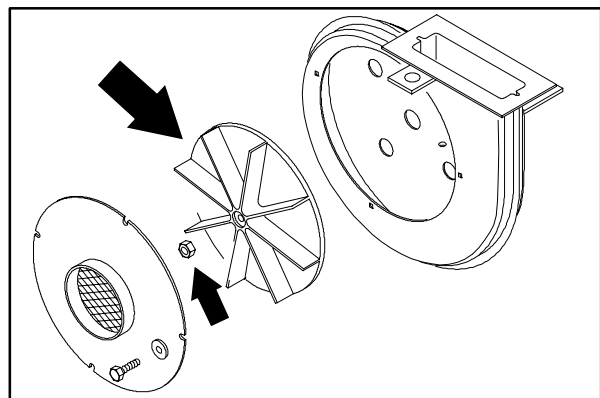
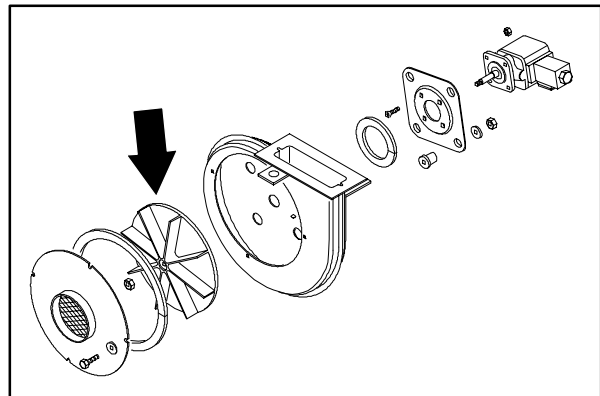
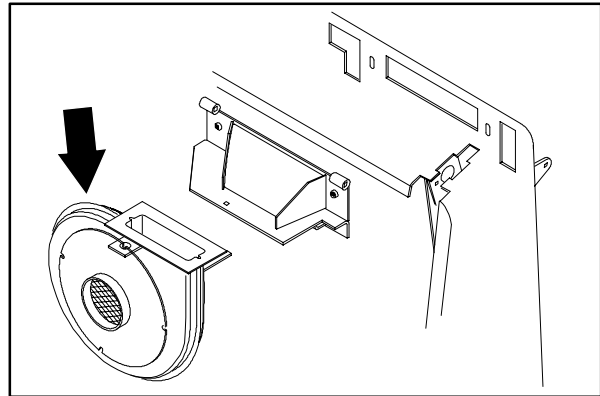
7. Pull the impeller off the fan motor shaft. The impeller may have to be lightly pried off. Be careful not to loose the square key.

8. Put a small amount of grease on the motor shaft before installing the new impeller. Make sure the square key is in place on the motor shaft. Slide the impeller all the way on and spin it slowly. If the impeller rubs on the housing, remove it and place a 0.38 in. flat washer on the motor shaft under the impeller and re-assemble the impeller.

9. Hold the new impeller from turning and firmly tighten the 0.31 in. flex lock nut.

10. Reinstall the inlet plate with the four 0.25 in. hex screws and fender washers. Tighten to 11 - 14 Nm (7 - 10 ft lb).

11. Reinstall the vacuum fan assembly back in the machine. See TO INSTALL VACUUM FAN instructions.



MACHINE TROUBLESHOOTING

Problem	Cause	Remedy
Excessive dusting	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
	Engine operating at (Fast 2) speed	Operate engine at (Fast 1) speed
	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™
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	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
	Main brush in Down position	Put main brush in Float position

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LOW L.P. FUEL CIRCUIT	4-64

ELECTRICAL SYSTEM

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

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.

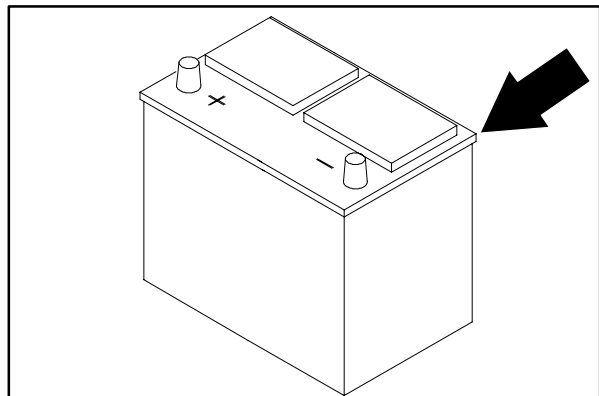
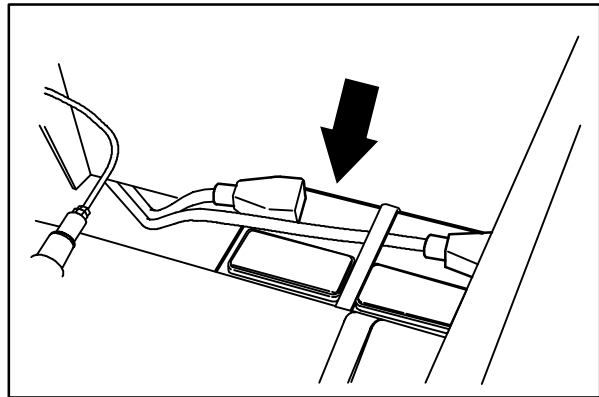
After the first 50 hours of operation, and every 800 hours after that, clean and tighten the battery connections.

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.**



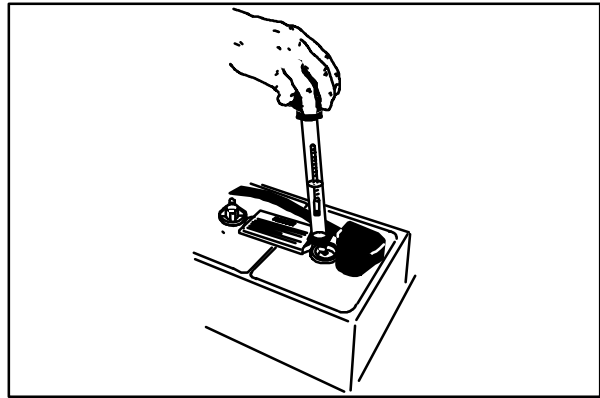
ELECTRICAL

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

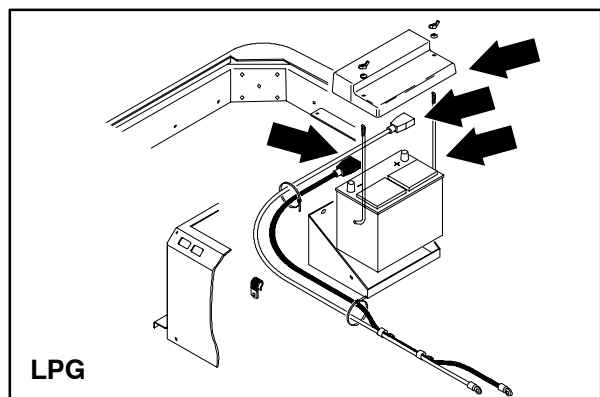
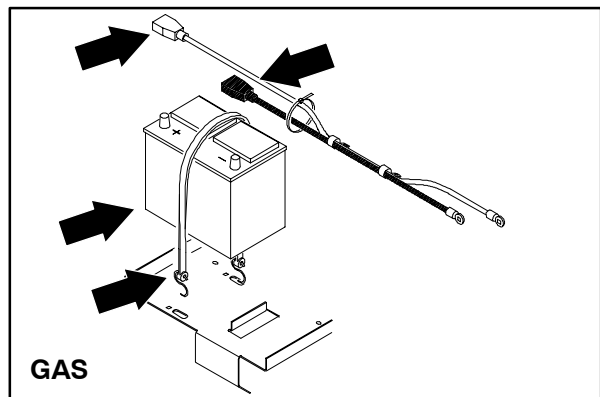
NOTE: If the readings are taken when the battery electrolyte is any temperature other than 27° C (80° F), the reading must be temperature corrected. Add or subtract to the specific gravity reading 0.004, 4 points, for each 6° C (10° F) above or below 27° C (80° F).



TO REPLACE BATTERY

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

1. Lift the seat assembly and engage the prop rod.
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 assembly and start the machine to test the new battery.



INSTRUMENT PANEL

The instrument panel consists of a circuit board, a touch panel, and a water/dust resistant plastic enclosure. Its touch panel controls various machine functions, while its indicator lights keep the operator informed on machine performance.

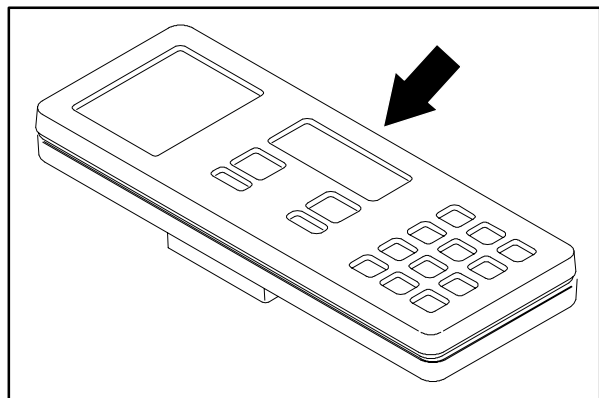
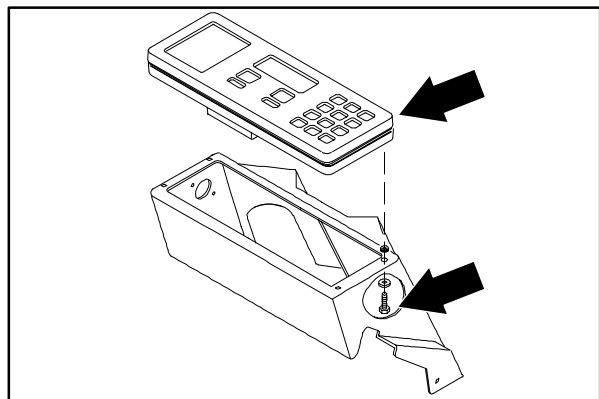
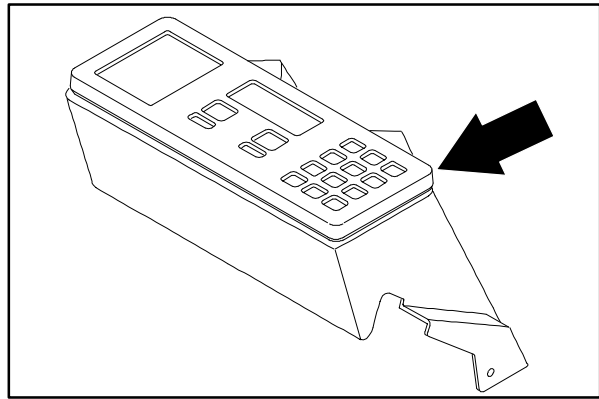
TO REPLACE INSTRUMENT PANEL

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

1. Remove battery cables from battery.
2. Put the steering wheel in lowest position.
3. Remove the two M8 hex screws and two M6 hex screws holding the dash panel to the machine frame.
4. Pull the dash panel back away from machine.
5. Remove the four M5 pan head screws holding the instrument panel to the dash panel.
6. Loosen the allen head screw in center of wire harness plug. Unplug the harness.
7. Remove the instrument panel from the dash panel.
8. Install the new instrument panel back on the dash panel with the four M5 pan head screws and washers.
9. Push the harness plug back in the instrument panel plug.

NOTE: Slot in panel must line up with notch on plug. Hand tighten allen head screw.

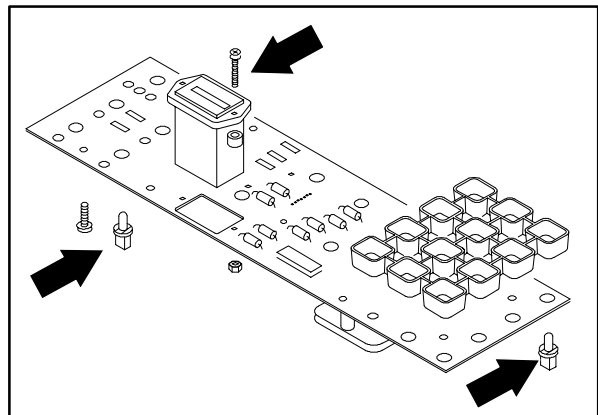
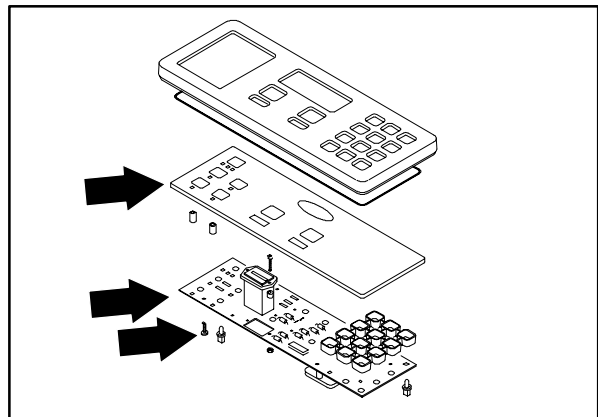
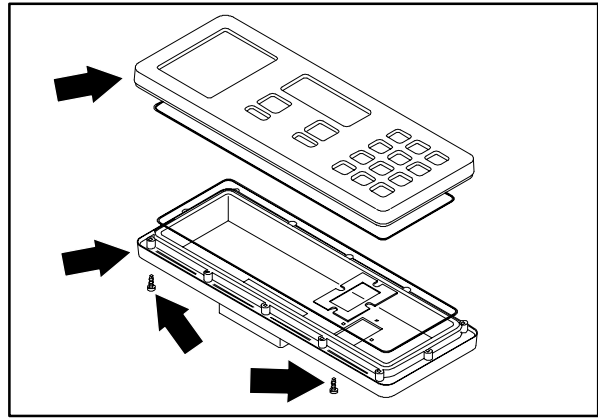
10. Position the dash panel back on the machine frame and reinstall the two M6 hex screws and two M8 hex screws. Hand tighten.
11. Reconnect the battery cables.
12. Start the machine and check for proper operation.



TO DISASSEMBLE INSTRUMENT PANEL

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

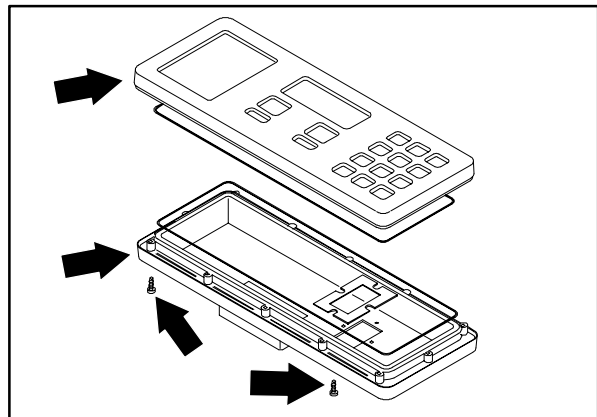
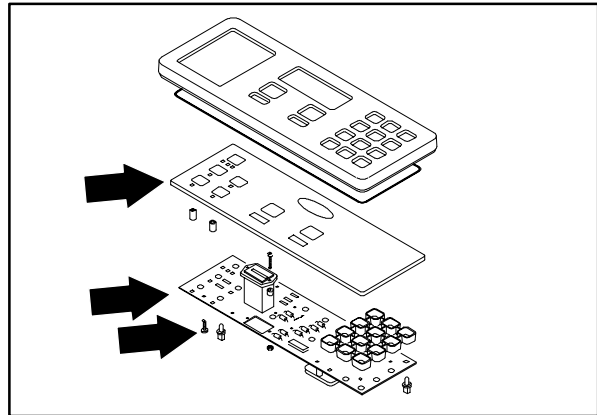
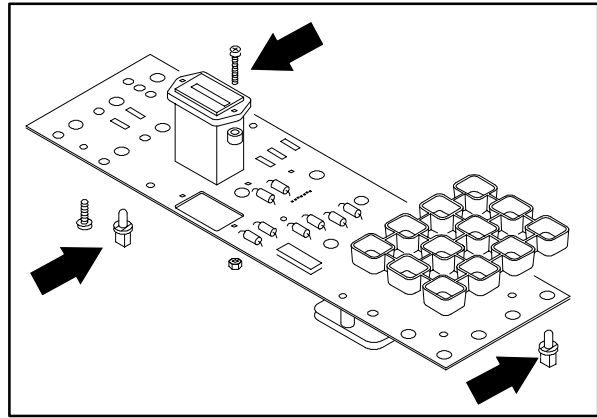
1. Remove the instrument panel from the machine. See TO REPLACE INSTRUMENT PANEL instructions.
2. Place the instrument panel face down and remove the twelve larger pan head screws.
3. The touch panel case can now be separated from the outer case. A new O-ring gasket can be installed if necessary.
4. To disassemble the touch panel case further, remove the four smaller pan head screws from the center of the case box.
5. Remove the case box from the circuit board / touch panel assembly.
6. The O-ring and connector gaskets can now be replaced in the case box if necessary.
7. Remove the eight pan head screws. Unplug the flat connector and ground strap. Remove the touch panel from the circuit board.
8. Any burned-out lamps can now be changed by turning them 1/4 turn counterclockwise and lifting out.
9. To replace the hour meter, unplug the two wires from the hour meter and remove the two pan head screws.



TO REASSEMBLE INSTRUMENT PANEL

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

1. Position the circuit board over the touch panel. Feed the flat connector from the panel through the slot in the board. Plug in and reconnect the ground strap.
2. Reinstall the eight pan head screws and hand tighten lightly.
3. Turn the circuit board assembly over and place it back in the case box.
4. Reinstall the four smaller pan head screws in center of case box.
5. Reinstall the touch panel case on the outer case.
6. Reinstall the twelve pan head screws and hand tighten lightly.
7. The instrument panel is now ready to be reinstalled on the machine. See TO REPLACE INSTRUMENT PANEL instructions.



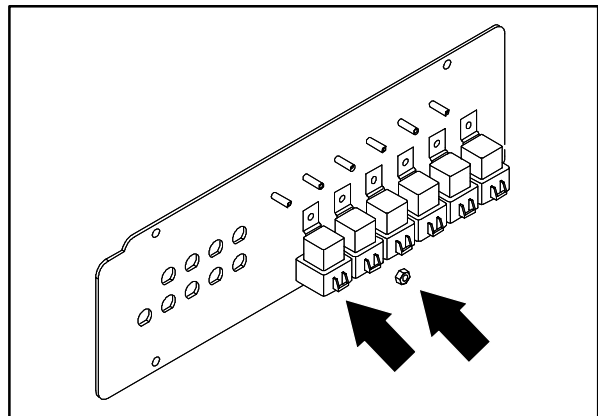
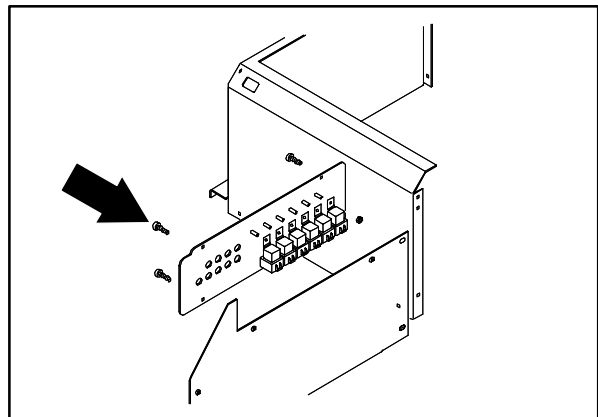
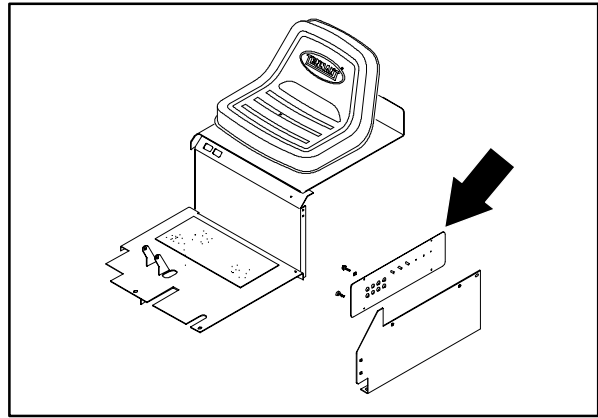
TO REPLACE ELECTRICAL RELAY

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

1. Disconnect the battery cables from the battery.
2. Remove the four pan head screws holding the circuit breaker plate to the side of the operators compartment. Pull the panel out far enough to access the relays.
3. Use the electrical schematic to locate the relay that needs to be replaced.
4. Push the two tabs on the electrical plug of the main harness and remove it from the bad relay.
5. Remove the hex nut holding the relay to the panel. Remove and discard the relay.
6. Position the new relay on the panel stud. Reinstall the hex nut and hand tighten.
7. Plug the main harness in the new relay. See TO REPLACE INSTRUMENT PANEL instructions.

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

8. Reinstall the circuit breaker panel on the machine. Hand tighten the hardware.
9. Start the machine and check the new relay for proper operation.



CIRCUIT BREAKERS

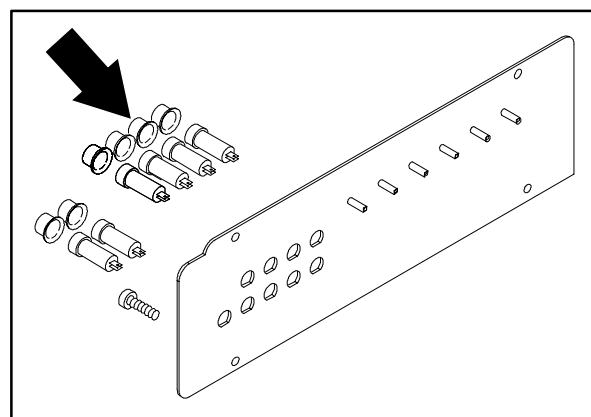
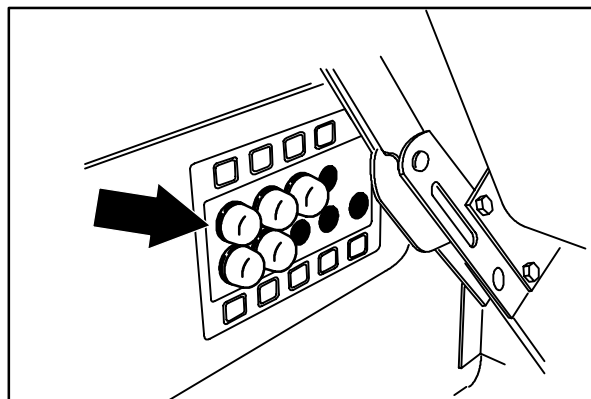
The circuit breakers are resettable electrical circuit protection devices. Their design stops the flow of current in the event of a circuit overload. Once a circuit breaker is tripped, it must be reset manually. Press the reset button after the breaker has cooled down.

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	AMP RATING	CIRCUIT PROTECTED
CB-1	15 AMP	ENGINE AND THROTTLE
CB-2	15 AMP	VACUUM FAN AND FILTER SHAKER
CB-3	15 AMP	OPERATING LIGHTS
CB-4	15 AMP	HAZARD LIGHT AND BACKUP ALARM
CB-5	15 AMP	HORN
CB-6	2.5 AMP	INSTRUMENT PANEL
CB-7	15 AMP	HEATER/ DEFROST AND WINDSHIELD WIPER
CB-8	15 AMP	TURN SIGNALS
CB-9	15 AMP	AUXILIARY SIDE BRUSH
CB-10	15 AMP	CAB PRESSURIZER



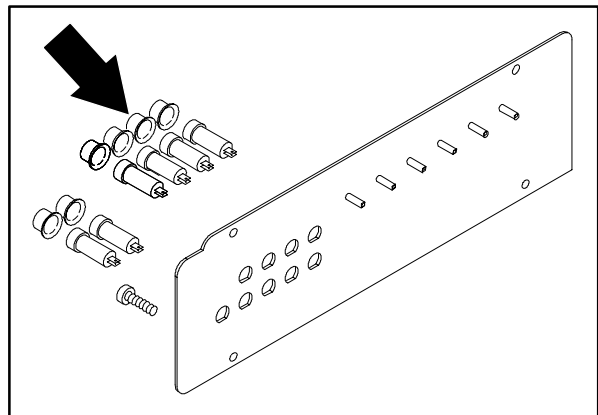
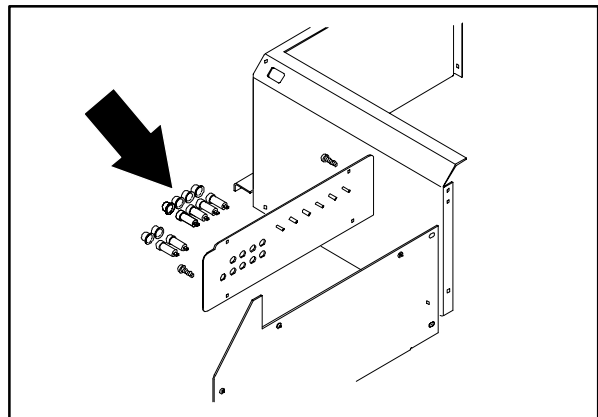
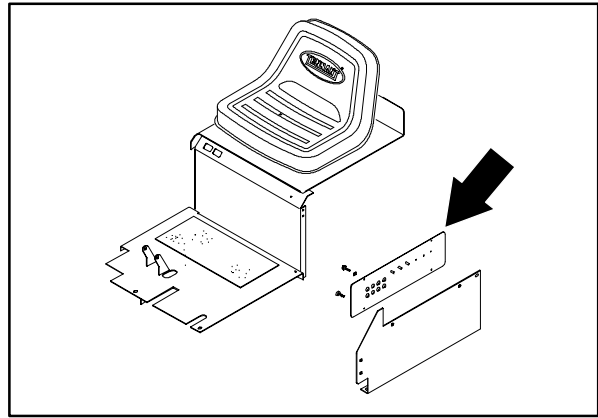
TO REPLACE CIRCUIT BREAKER

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

1. Disconnect the battery cables from the battery.
2. Remove the four pan head screws holding the circuit breaker plate to the side of the operators compartment. Pull the panel out far enough to access the relays.
3. Use the electrical schematic to locate the circuit breaker that needs to be replaced. Disconnect the wires leading to the bad circuit breaker.
4. The metal ring must be removed in order to remove the old circuit breaker. It may need to be cut off to remove.
5. Remove the old circuit breaker and discard.
6. Position the new circuit breaker in the hole in the panel.

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

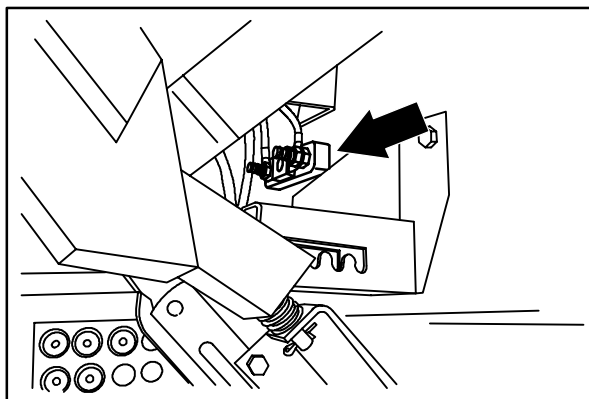
7. Plug the main harness wires into the new circuit breaker. See TO REPLACE INSTRUMENT PANEL instructions.
8. Reinstall the circuit breaker panel on the machine. Hand tighten the hardware.
9. Start the machine and check the new circuit breaker for proper operation.



FUSE (Diesel only)

Fuses are a one-time protection device designed to stop the flow of current in the event of a circuit overload. Never substitute higher value fuses than specified.

The fuse is located in the operator compartment under the steering column.



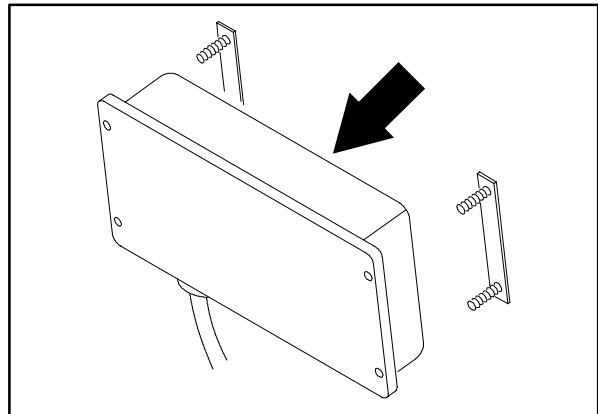
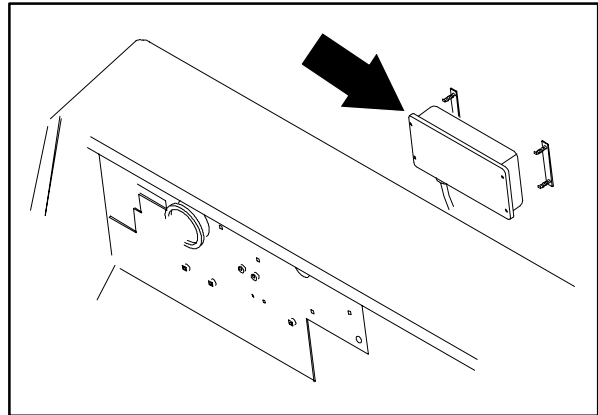
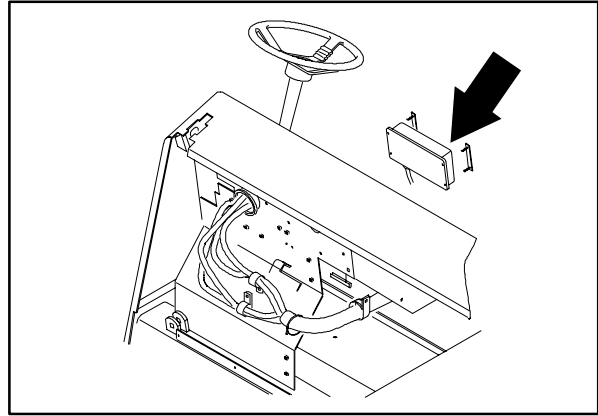
FUSE	RATING	CIRCUIT PROTECTED
FU-1	40 AMP	GLOW PLUGS

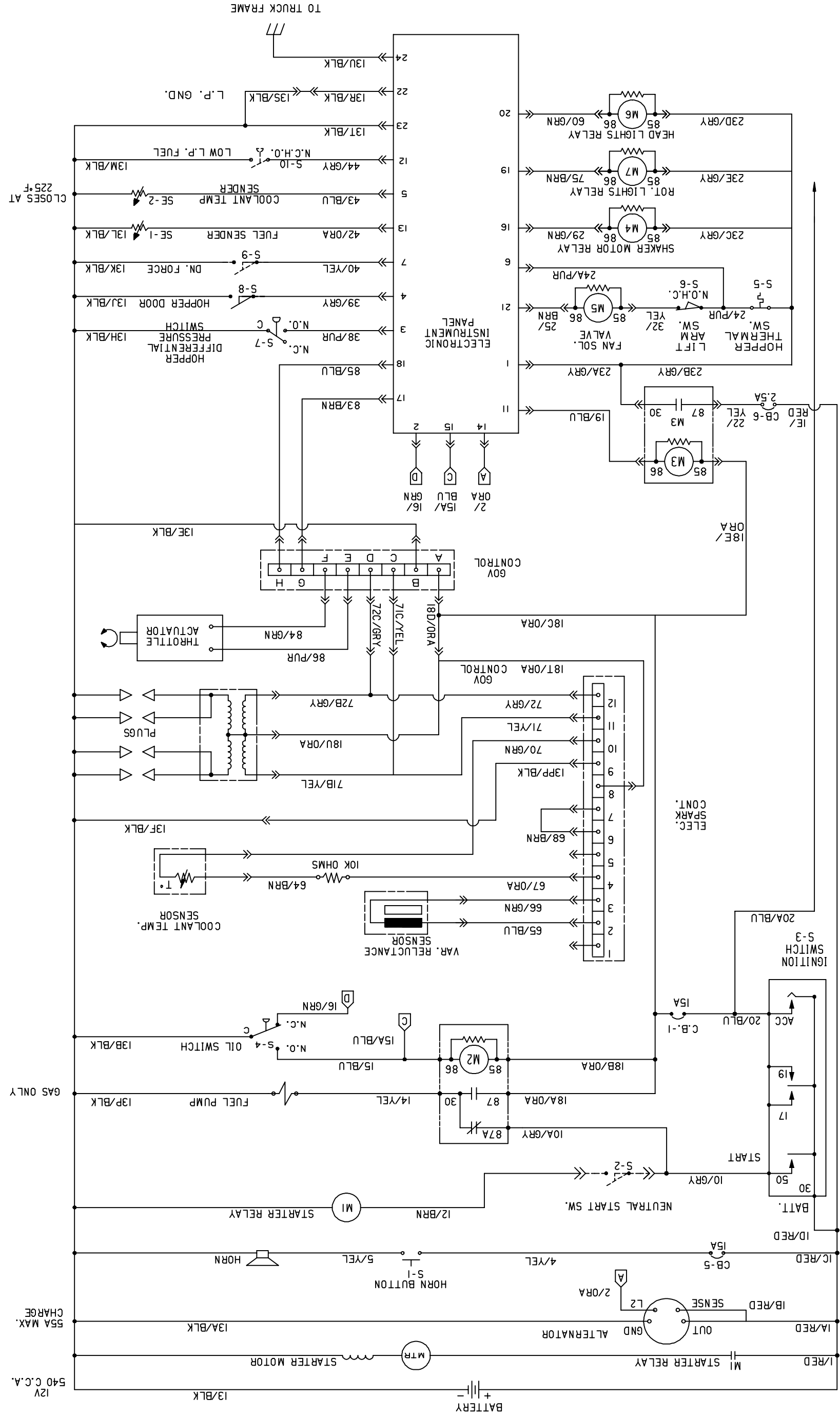
TO REPLACE GOVERNOR CONTROL BOX

1. Start the machine and raise the hopper. Engage the safety arm and shut off the machine.

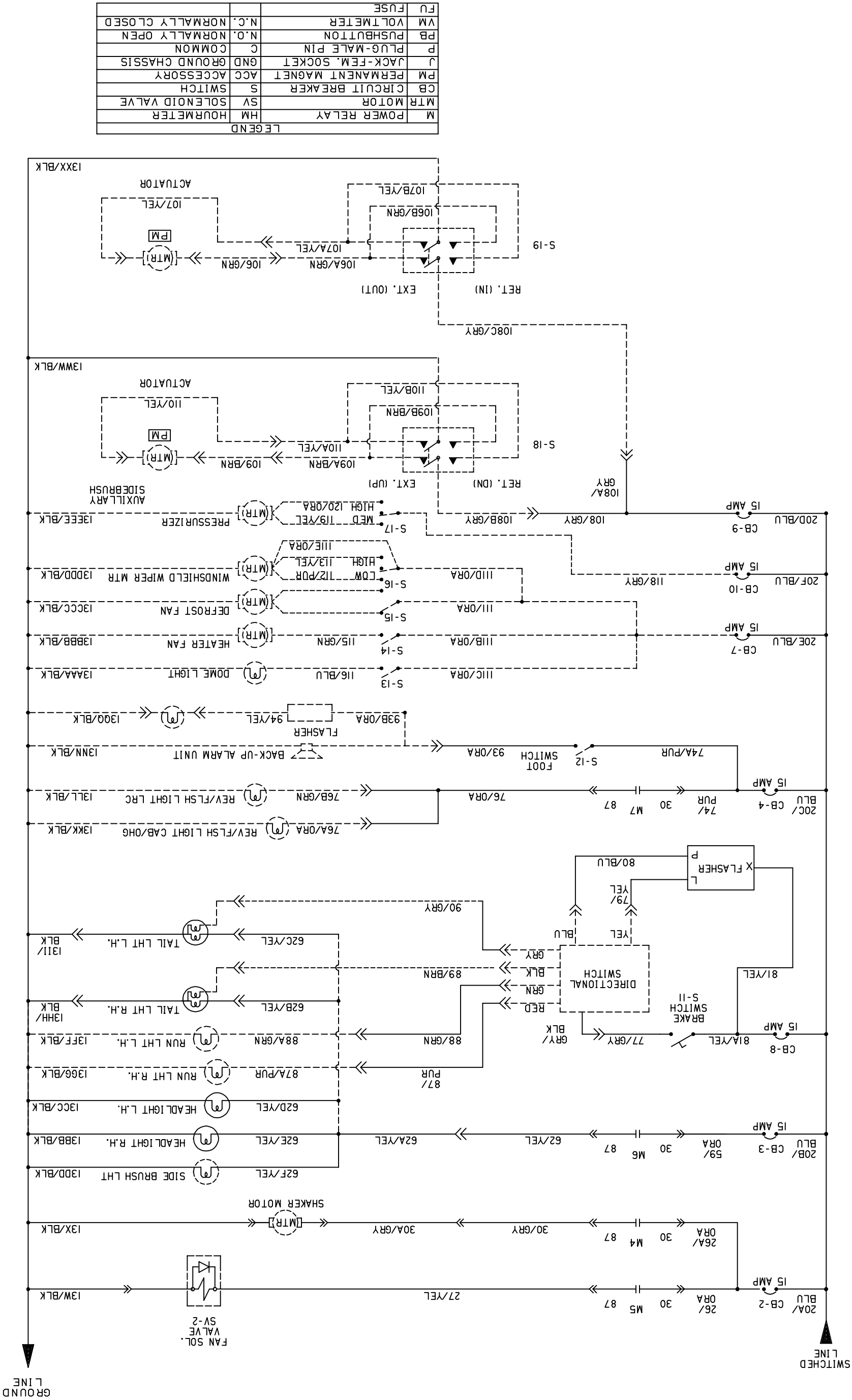
FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.

2. Disconnect the battery cables from the battery.
3. Locate the control box under the dash panel and to the left of the steering control motor.
4. Unplug the control box from the main harness.
5. Go around the front of the machine and remove the four hex nuts holding the control box to the machine frame. Remove the control box. Retain the two plate weldments.
6. Position the new control box in the machine. Reinstall the two plate weldments and hex screws. Hand tighten.
7. Connect the new control box to the main harness. See electrical schematic.
8. Start the machine and check the new control box for proper operation.
9. Disengage the safety arm and lower the hopper.



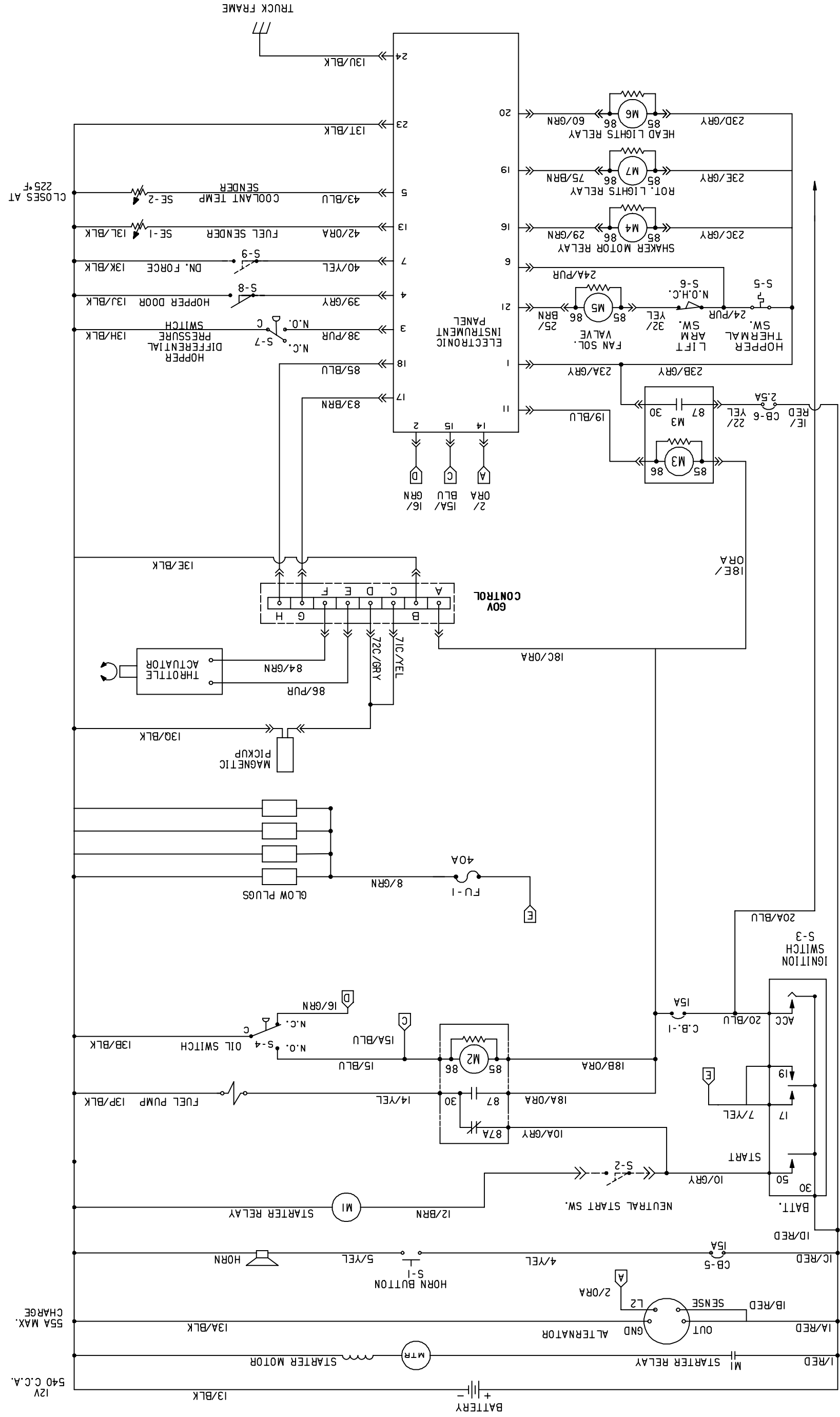


ELECTRICAL SCHEMATIC (Gas and LP)



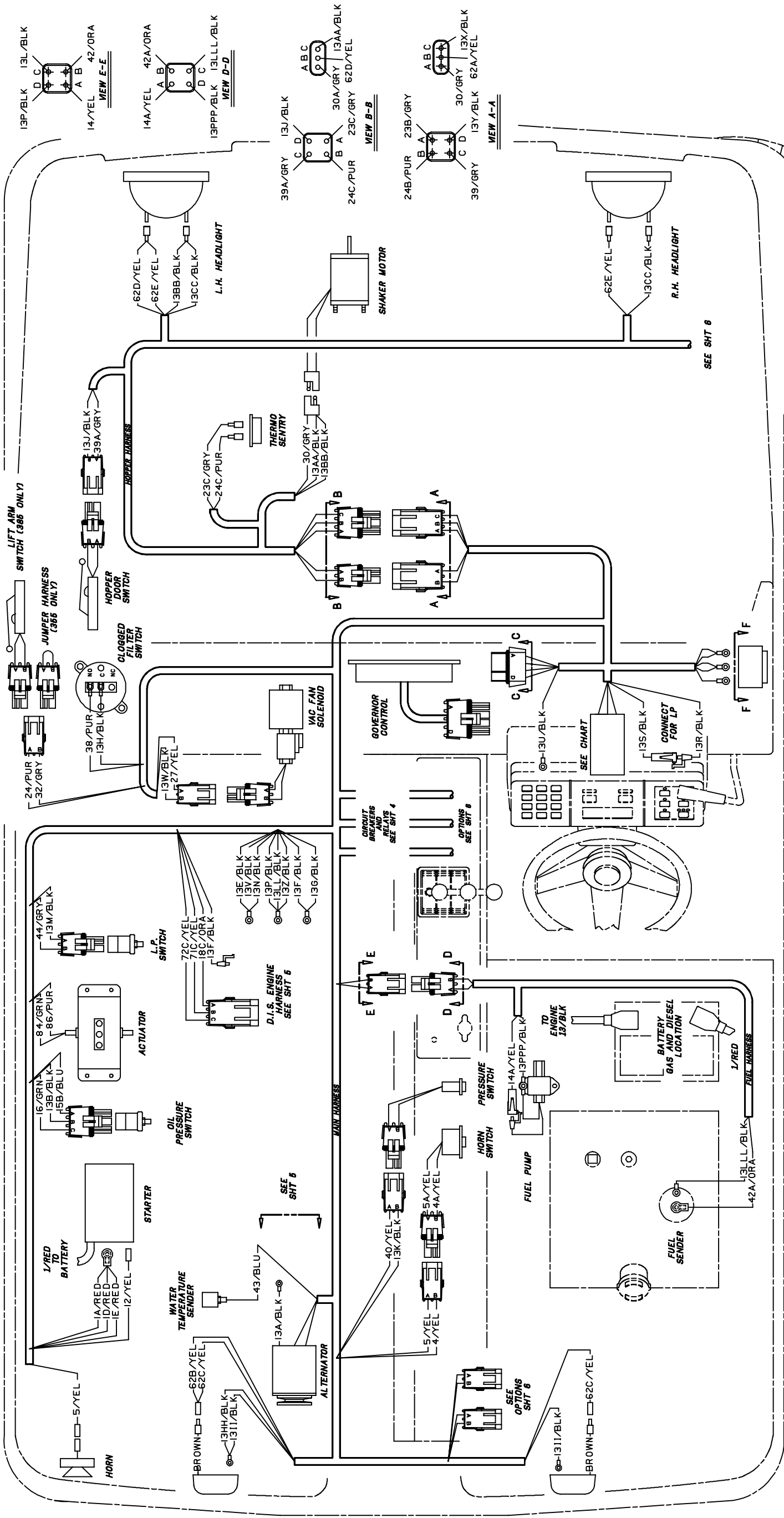
LEGEND			
M	POWER RELAY	HM	HOURMETER
MTR	MOTOR	SV	SOLENOID VALVE
CB	CIRCUIT BREAKER	S	SWITCH
PM	PERMANENT MAGNET	ACC	ACCESSORY
J	JACK-FEM. SOCKET	GND	GROUND CHASSIS
P	PLUG-MALE PIN	C	COMMON
PB	PUSHBUTTON	N.O.	NORMALLY OPEN
VM	VOLTMETER	N.C.	NORMALLY CLOSED
FU	FUSE		

ELECTRICAL SCHEMATIC (Gas and LP)

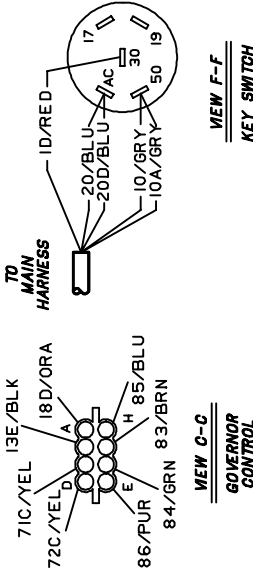


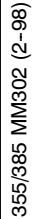
ELECTRICAL SCHEMATIC (Diesel)

WIRE HARNESS GROUP

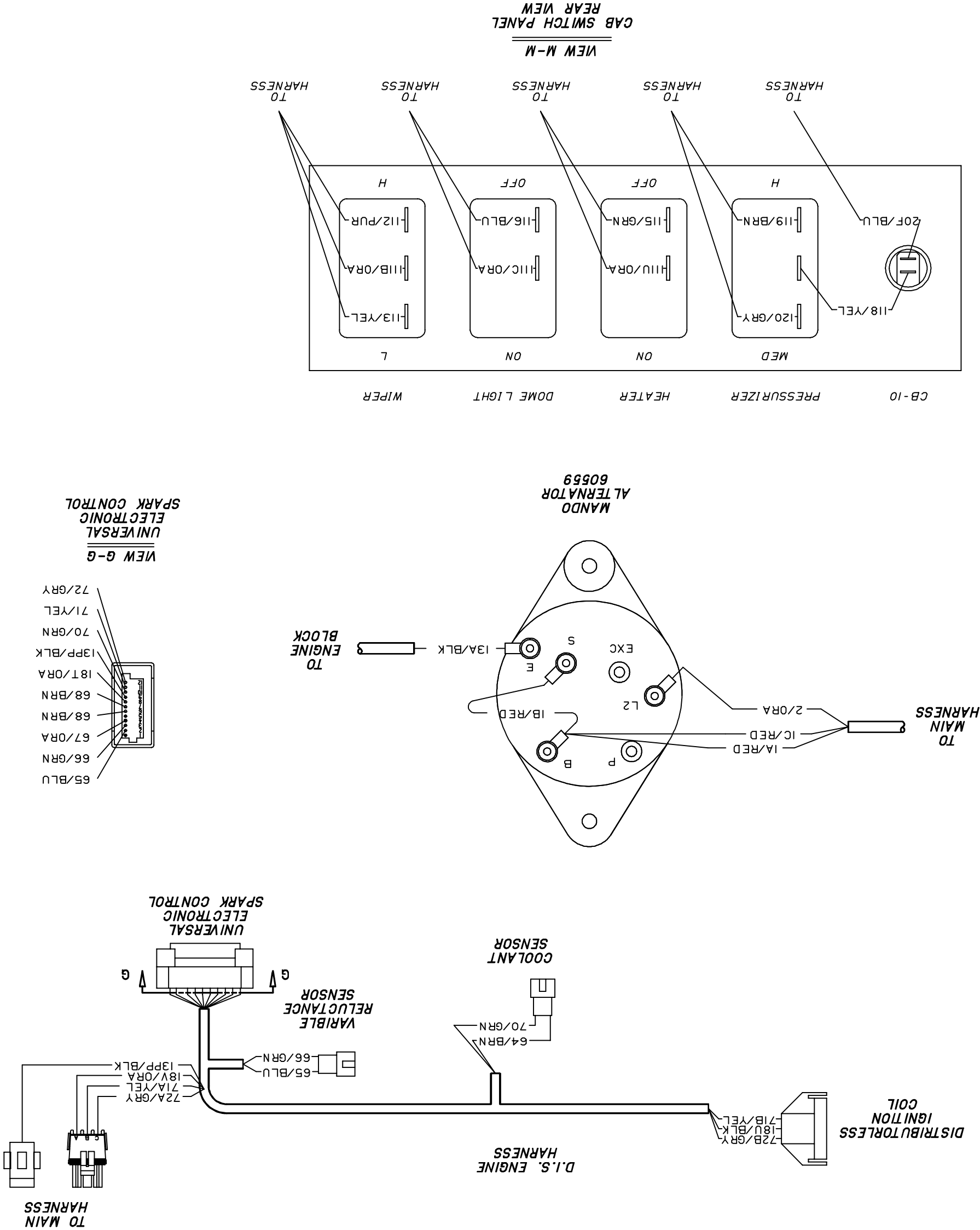


SOCKET NO.	WIRE NO.	COLOR	SOCKET NO.	WIRE NO.	COLOR	SOCKET NO.	WIRE NO.	COLOR
1	23A	GRY	7	40	YEL	13	42	ORA
2	16	GRN	8	PLUG		14	2	ORA
3	38	PUR	9	PLUG		15	15A	BLU
4	39	GRY	10	PLUG		16	29	GRN
5	43	BLU	11	19	BLU	17	83	BRN
6	24A	PUR	12	44	GRY	18	85	BLU





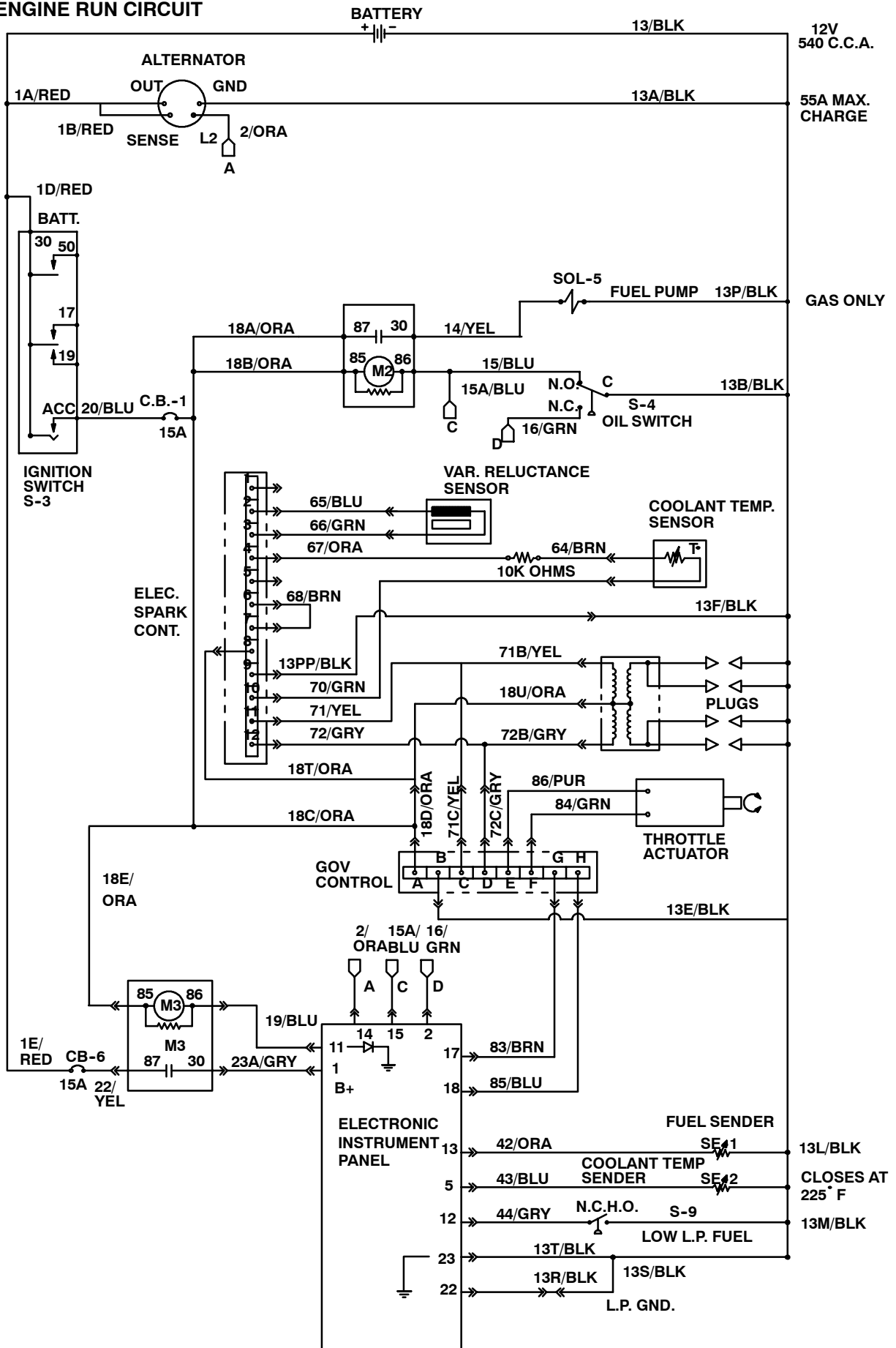
WIRE HARNESS GROUP



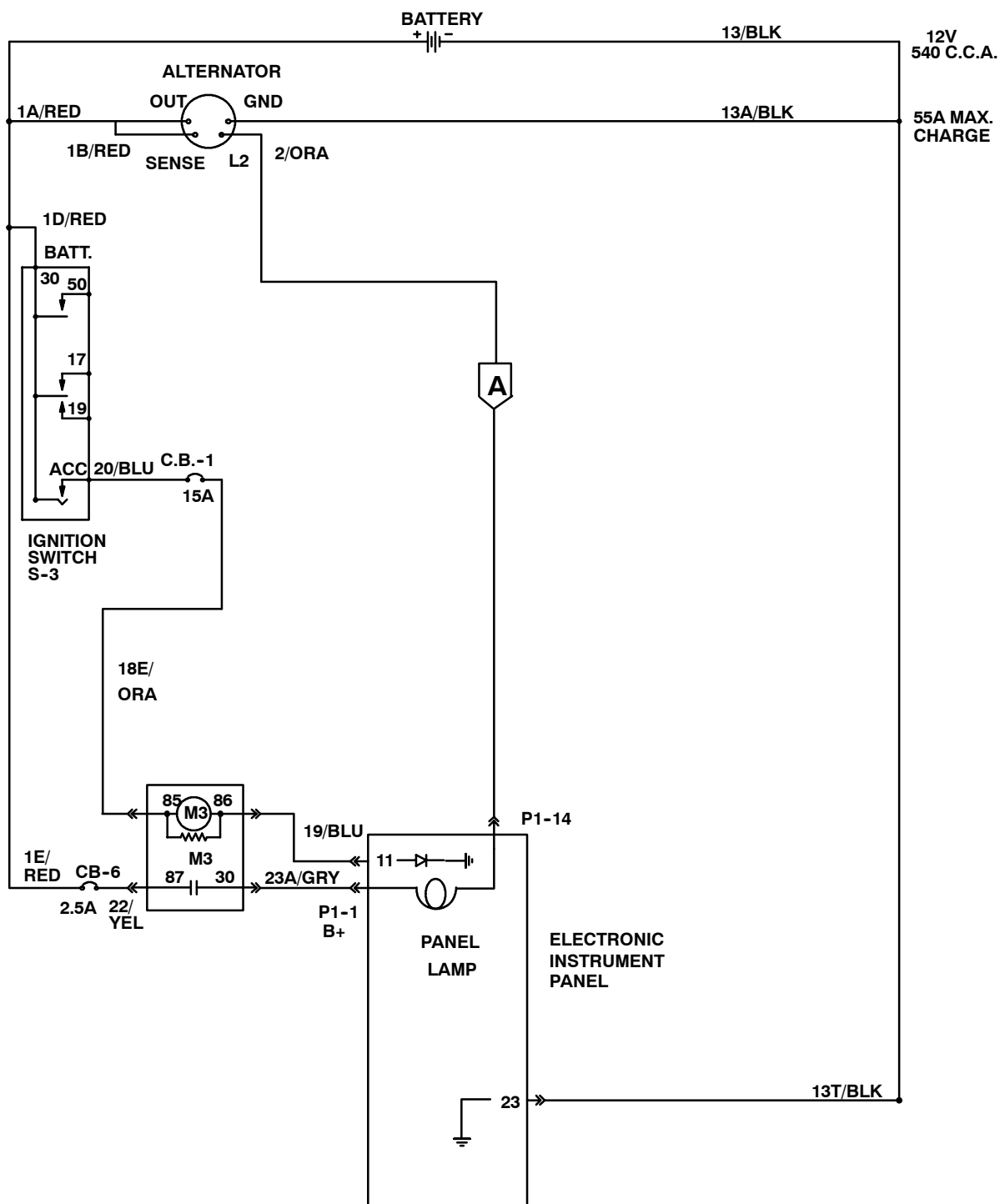
TROUBLESHOOTING

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.

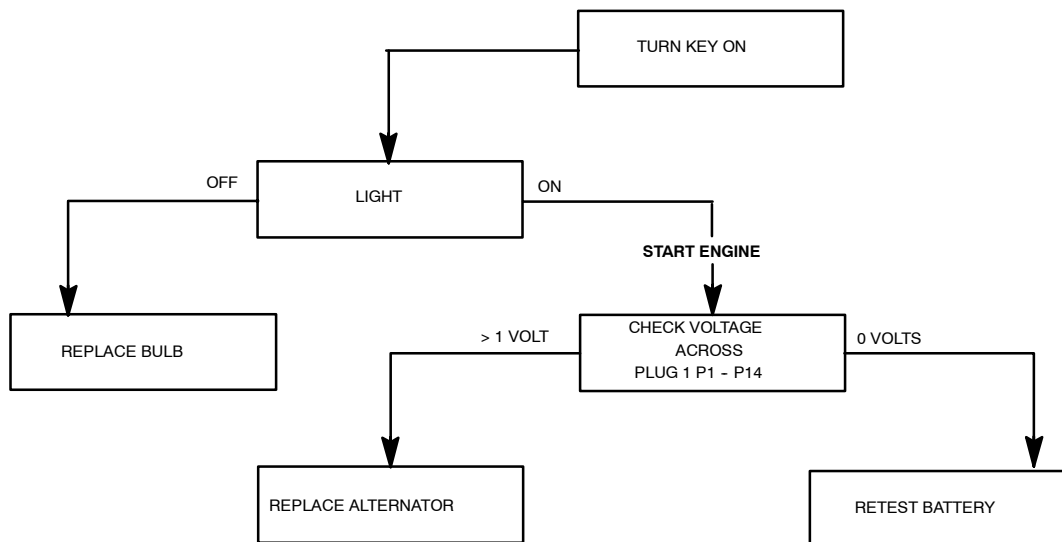
ENGINE RUN CIRCUIT



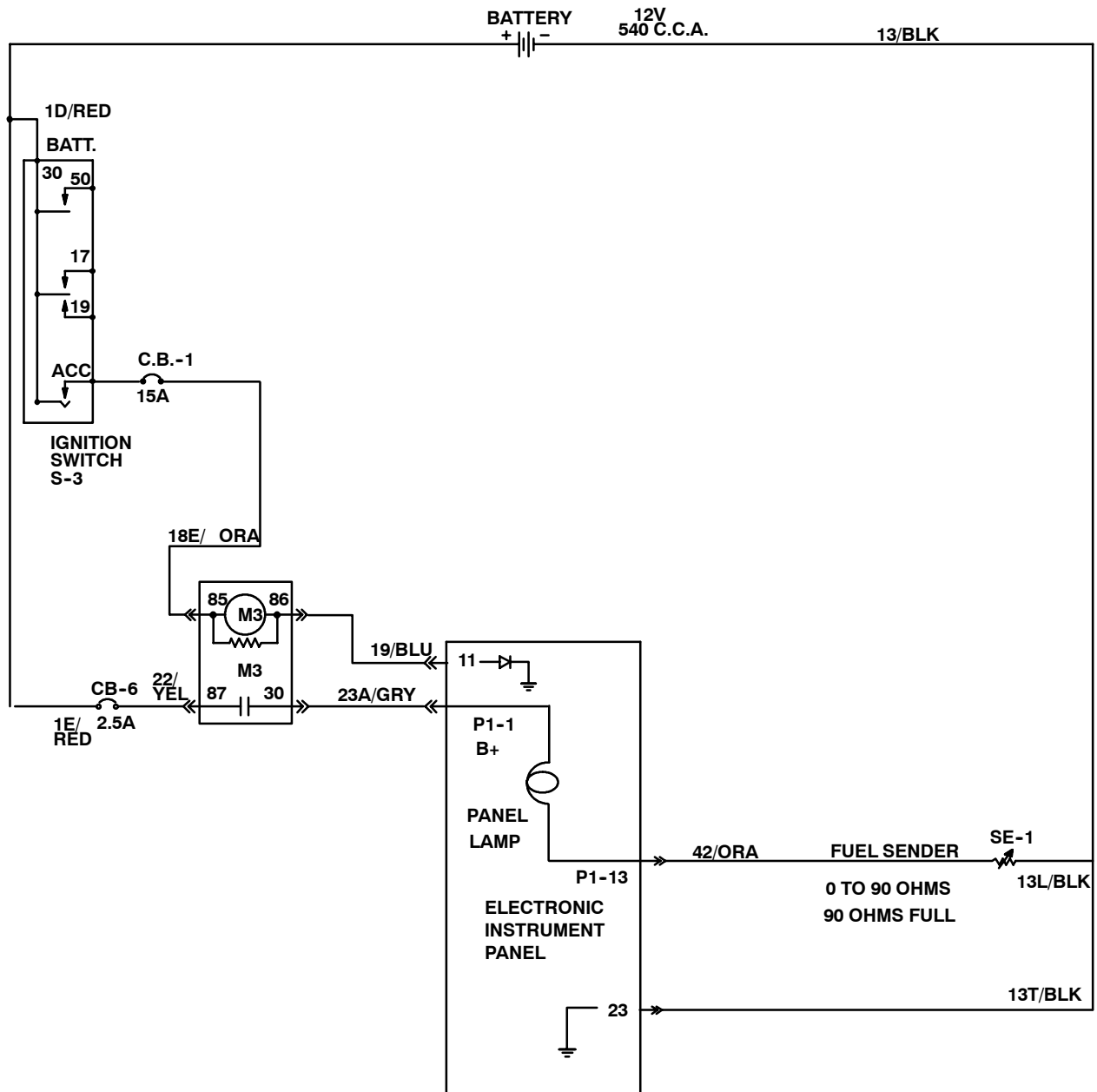
ALTERNATOR FAULT



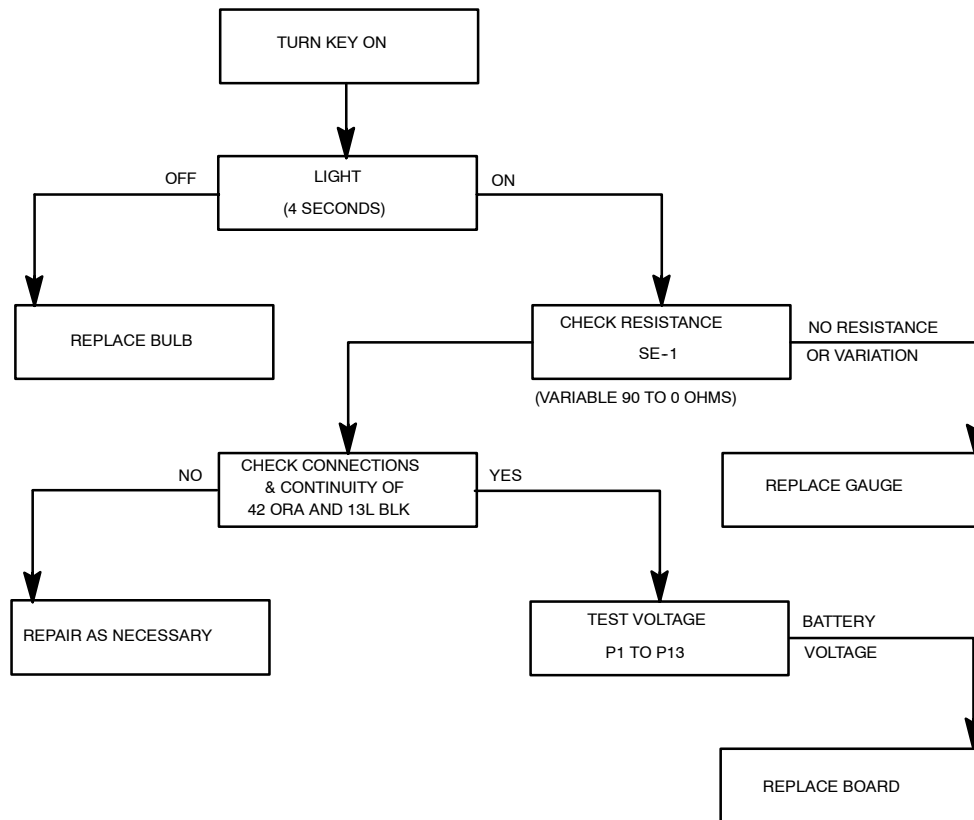
ALTERNATOR AFTER CHECKING THE BATTERY AND ITS CONNECTIONS



FUEL SENDER CIRCUIT

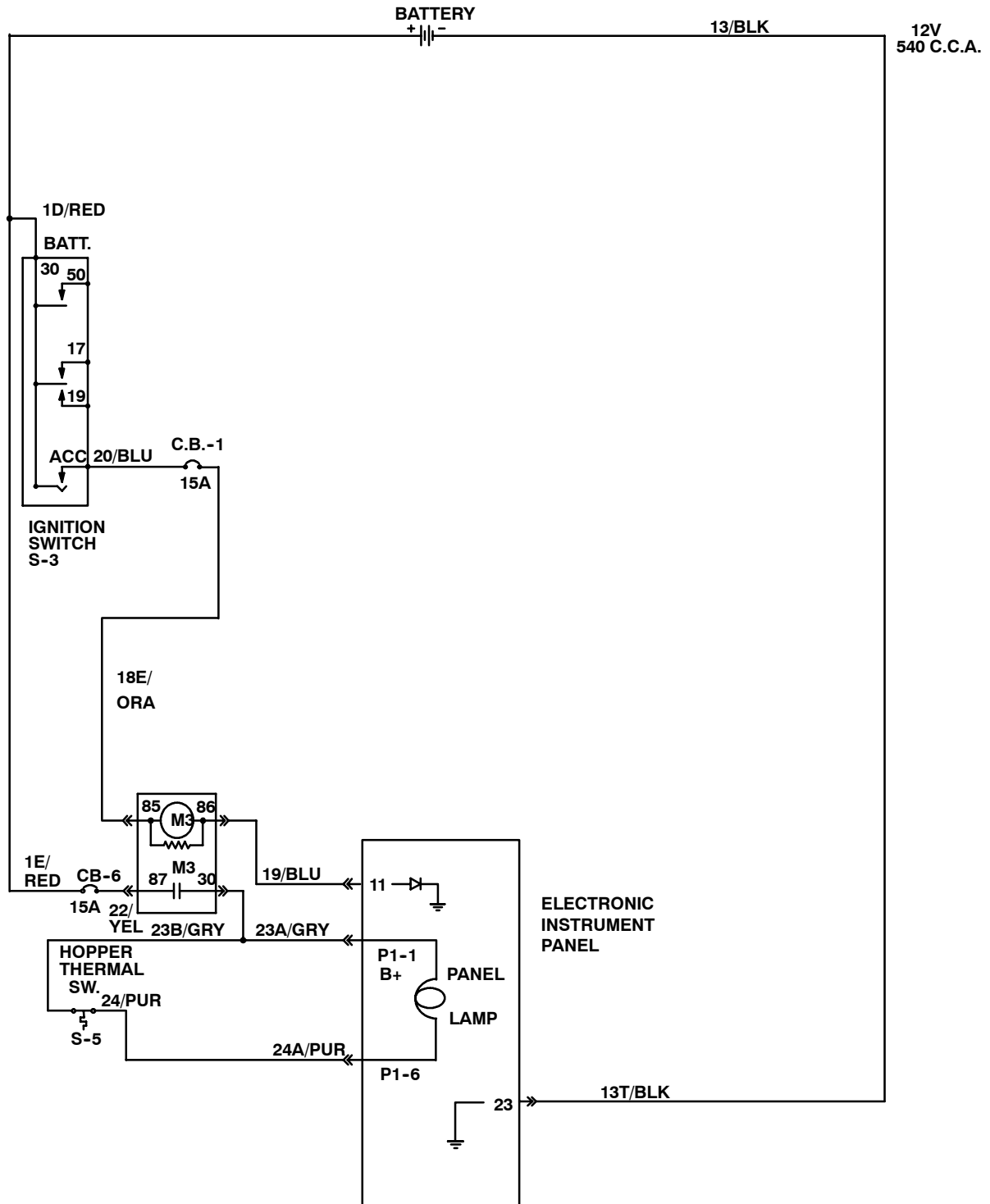


FUEL LIGHT



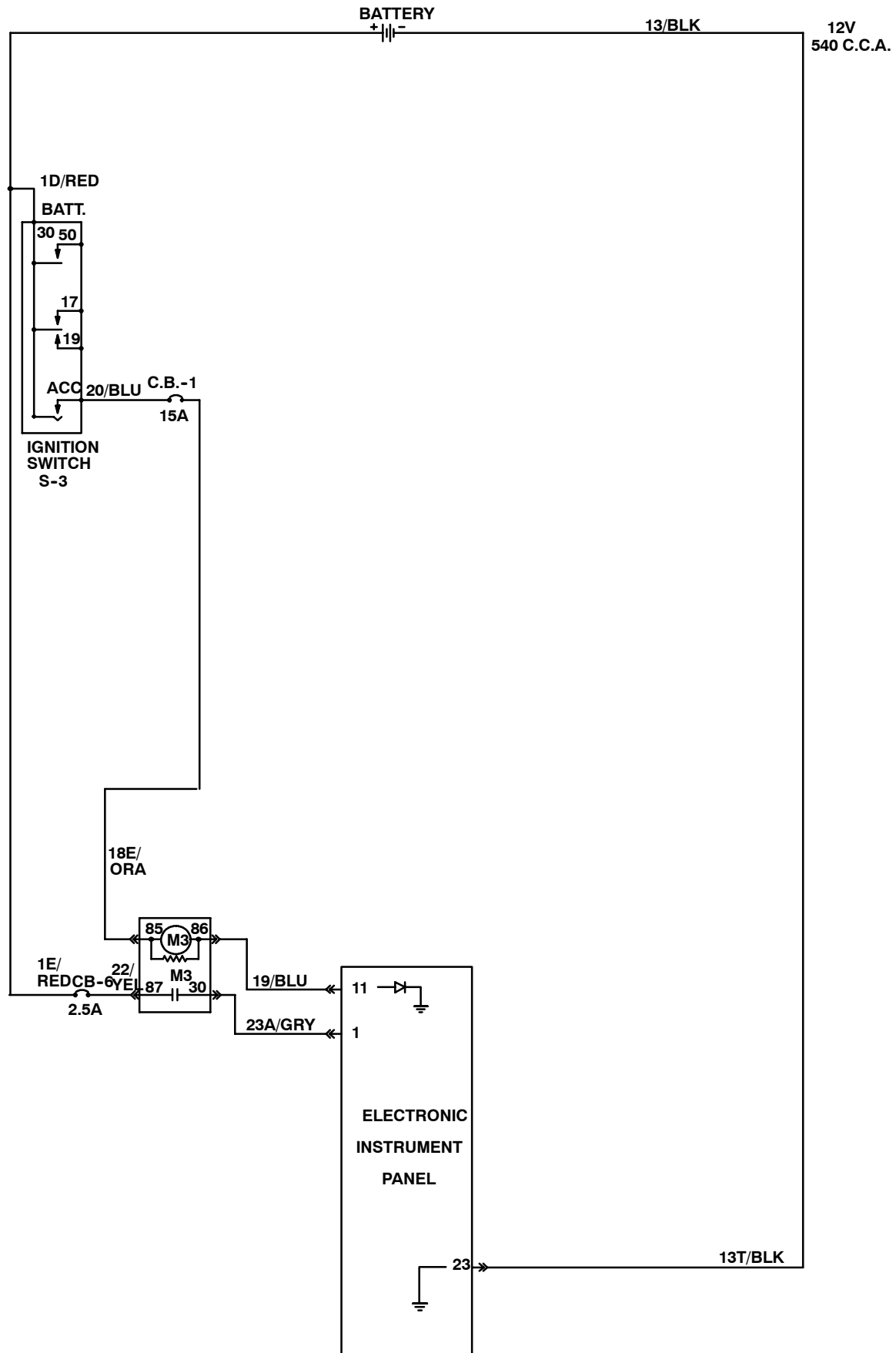


THERMAL SENTRY

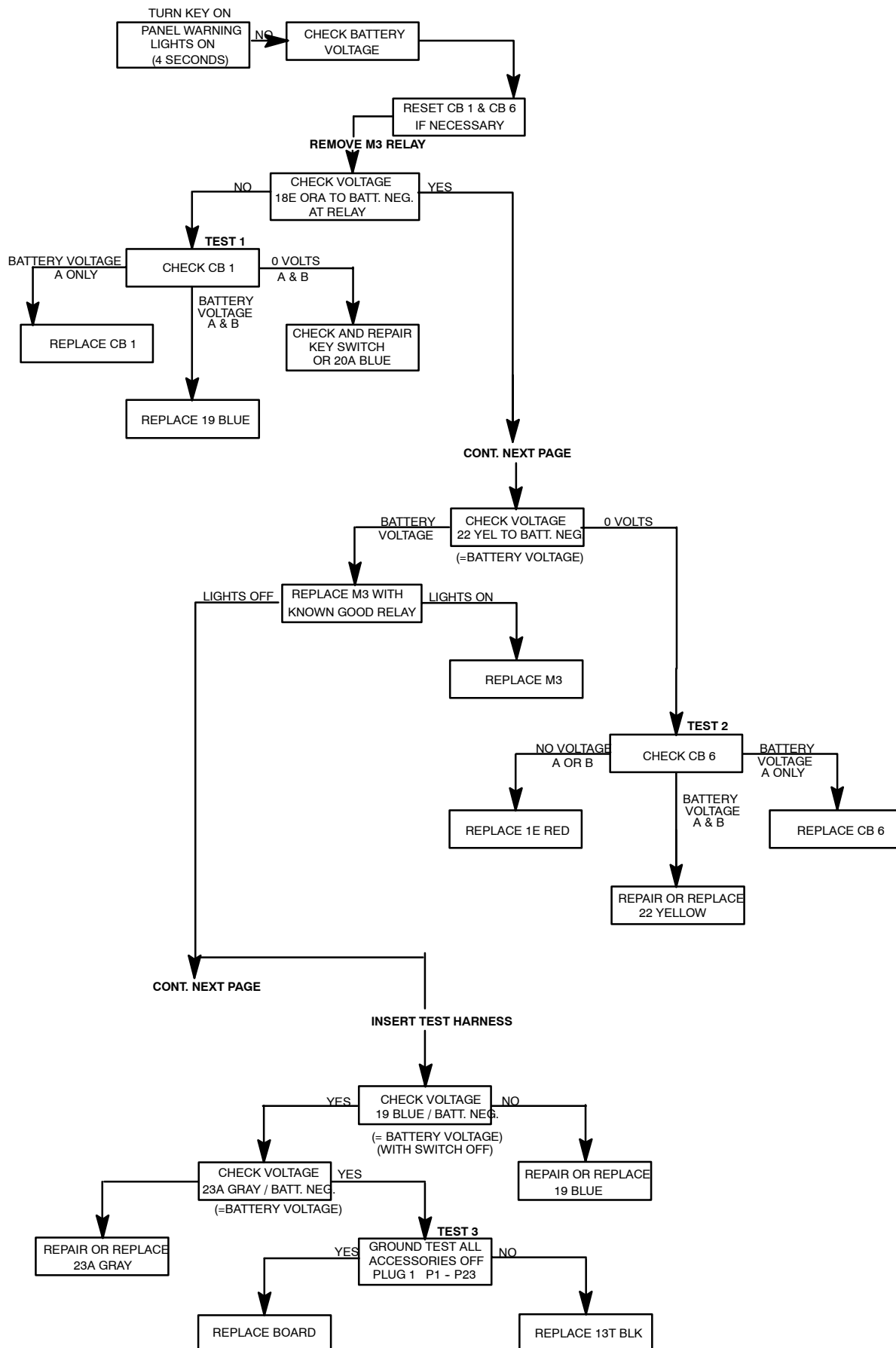


THERMAL OPEN - 0 VOLTS, LIGHT ON

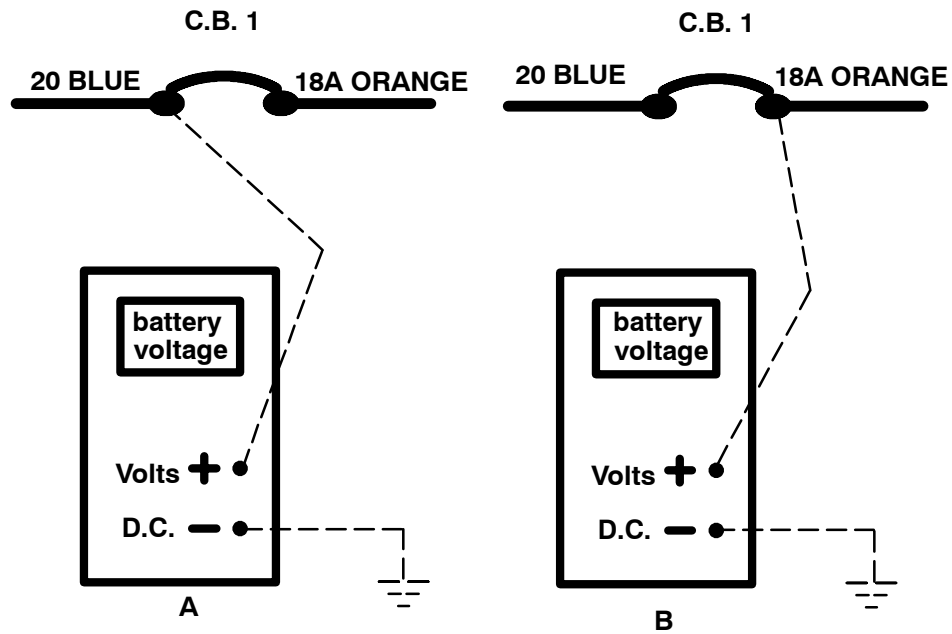
POWER UP CIRCUIT



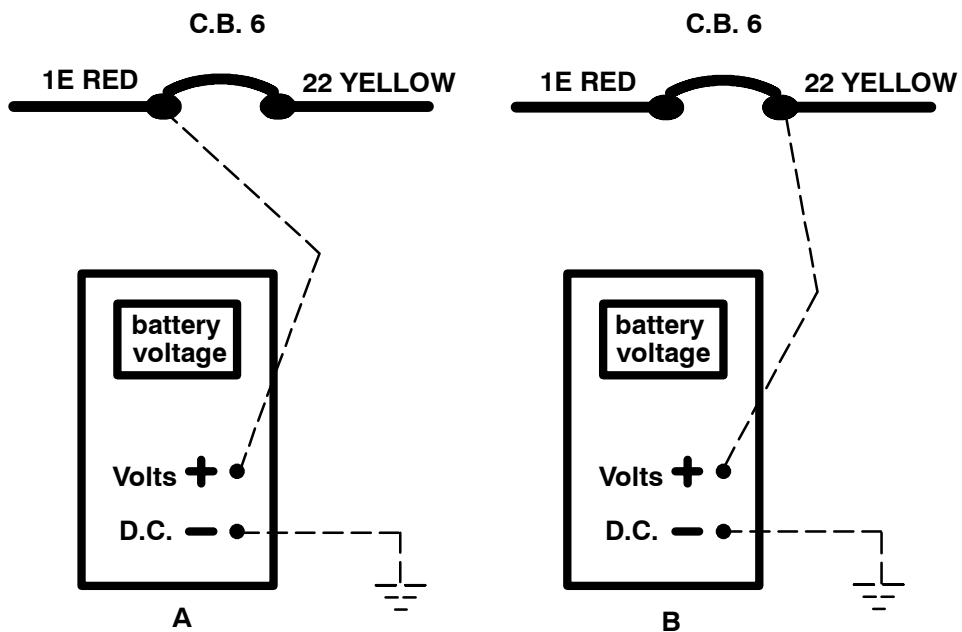
POWER UP TESTING



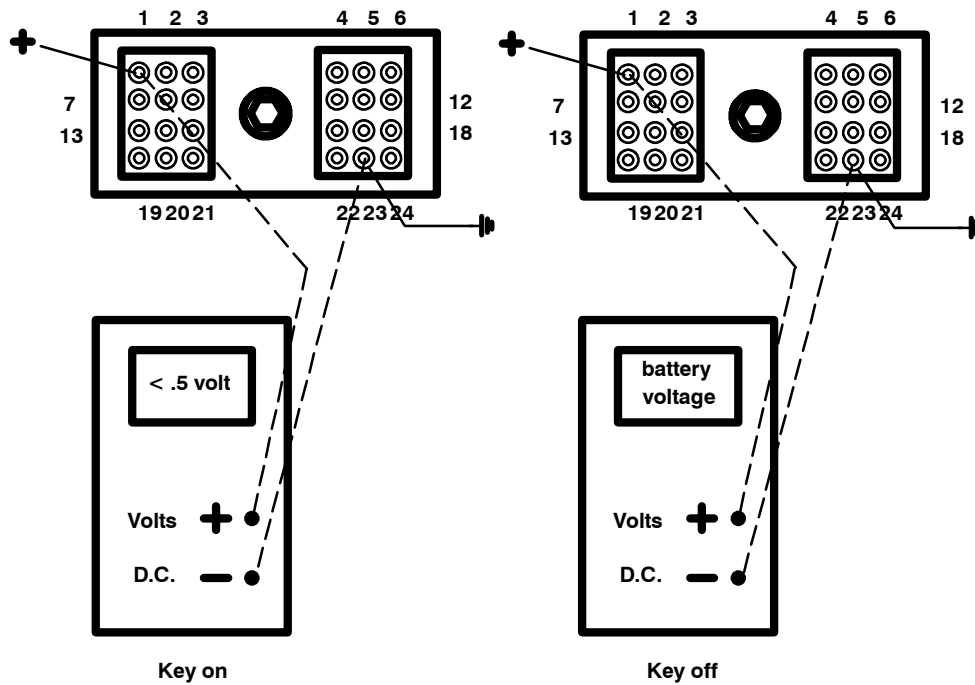
Power Up - Test 1



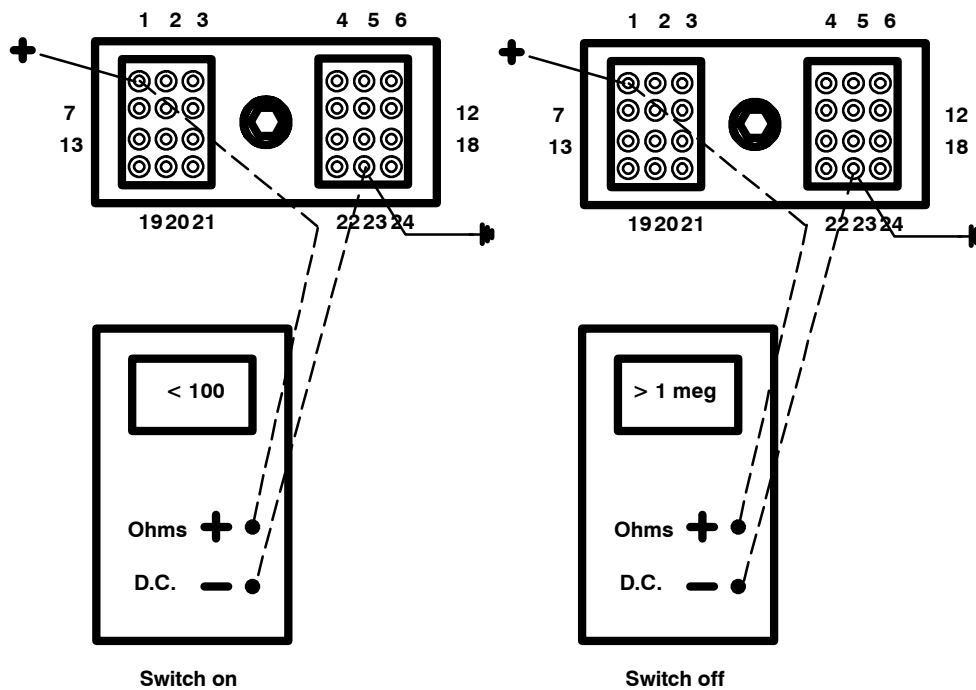
Power Up - Test 2

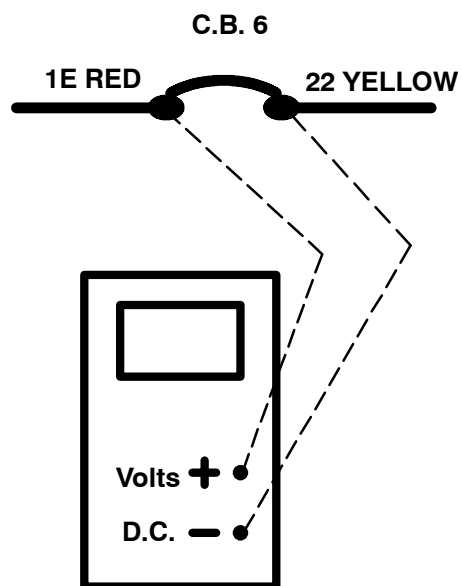


Instrument Panel Test Plug in Power Up - Test 3

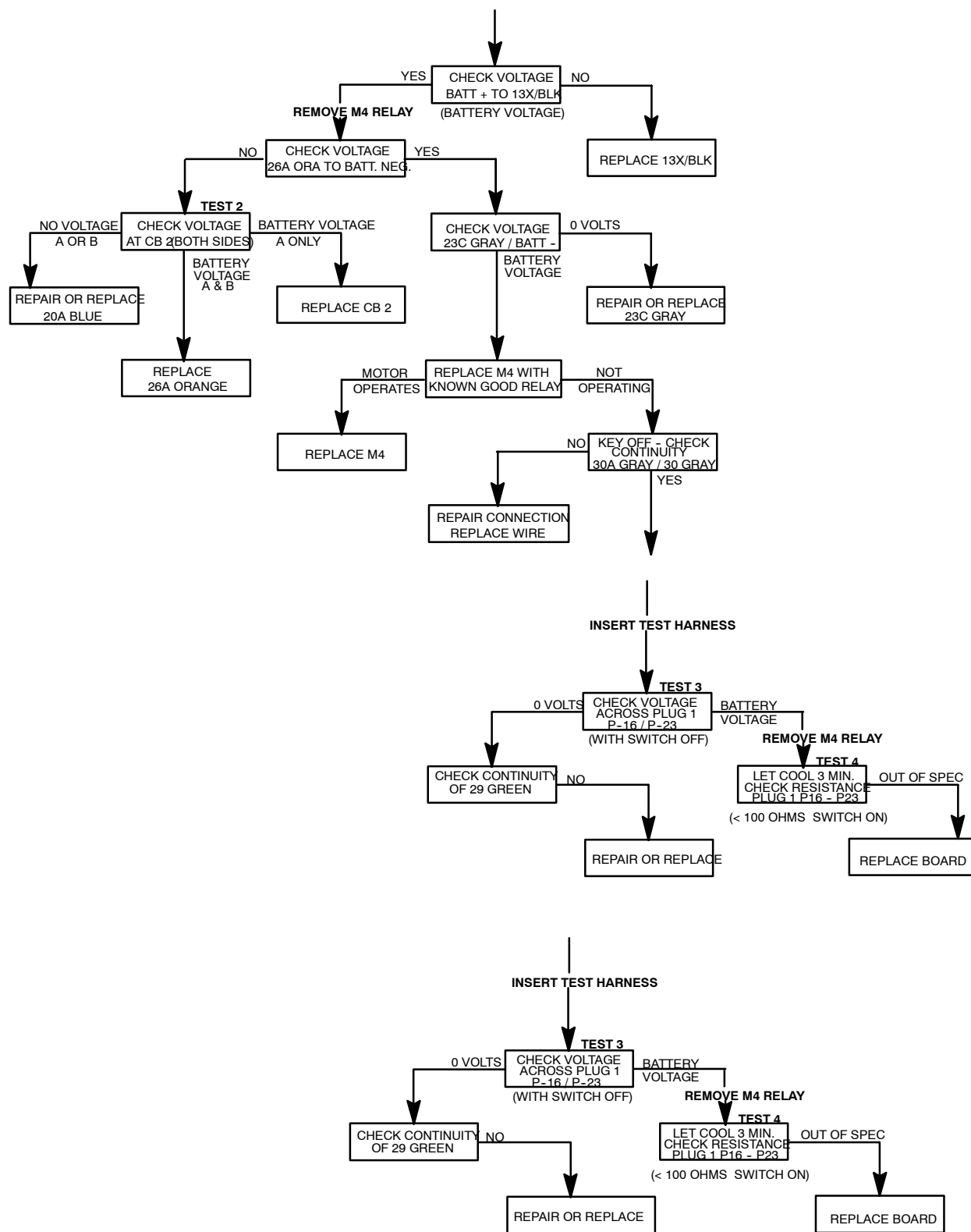


Instrument Panel Test Plug in Power Up - Test 4

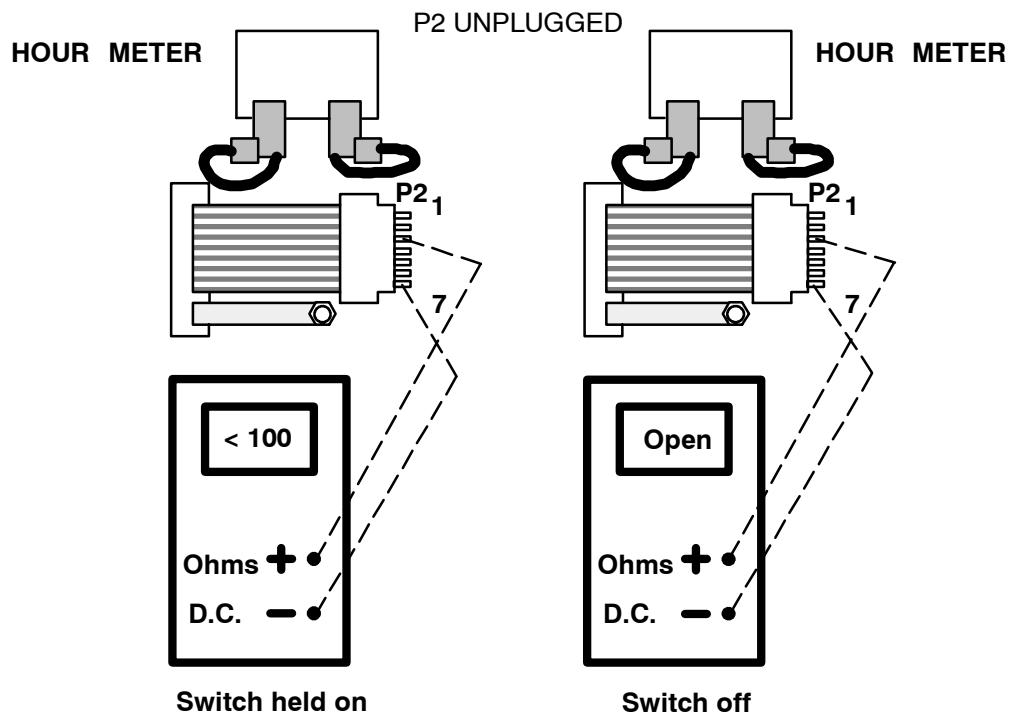




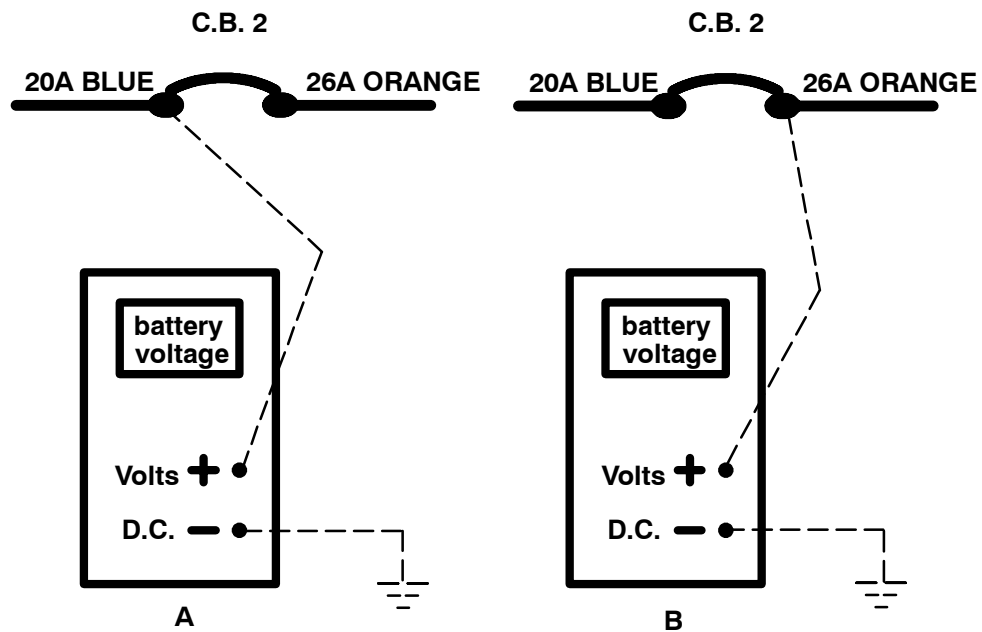




Shaker - Test 1

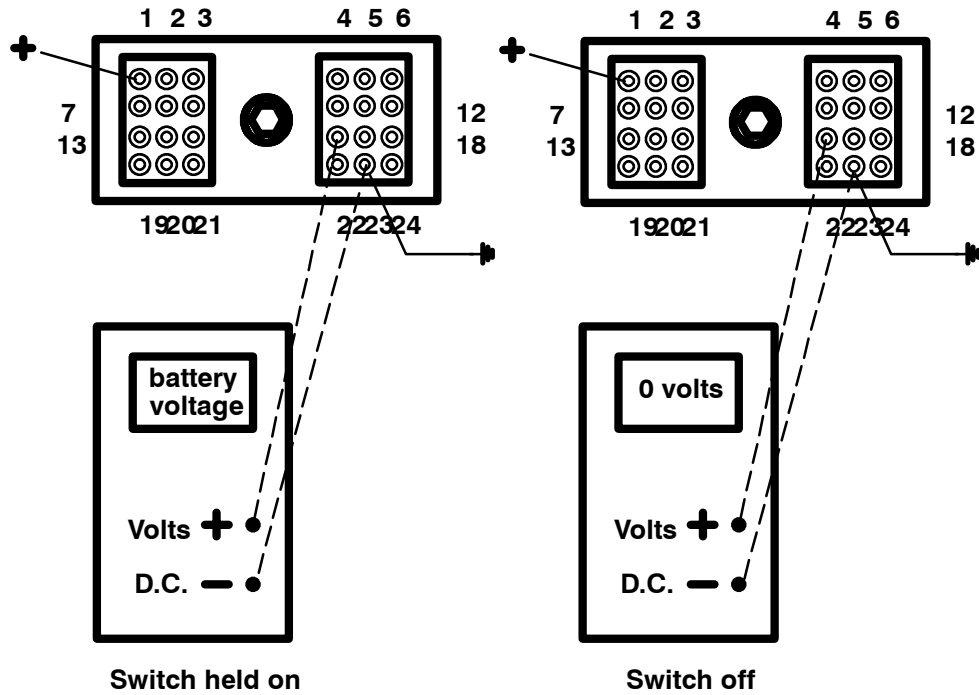


Shaker - Test 2

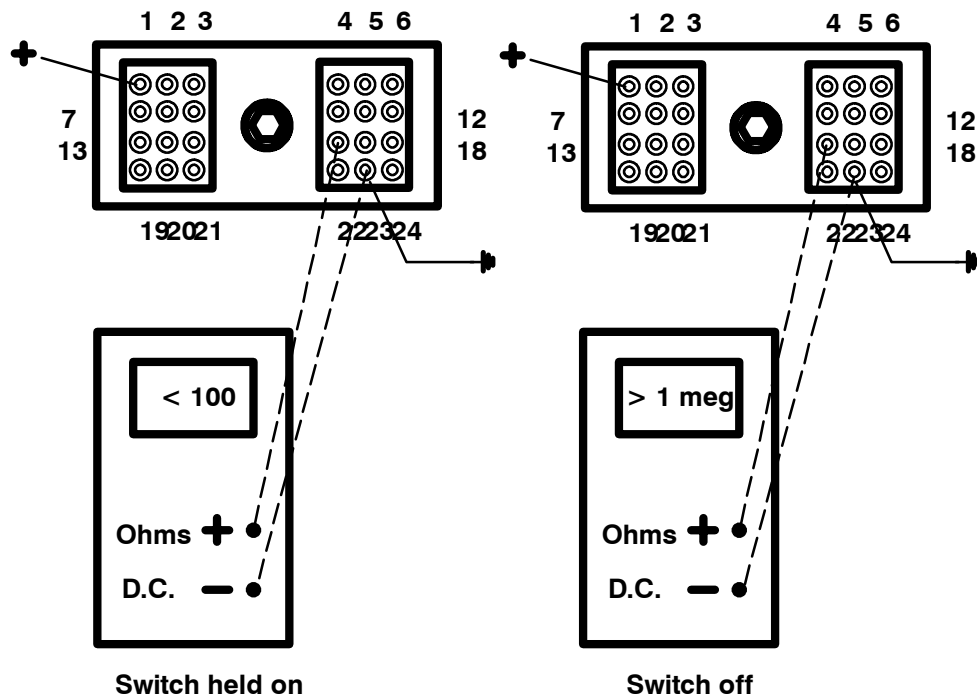


Instrument Panel Test Plug in

Shaker - Test 3

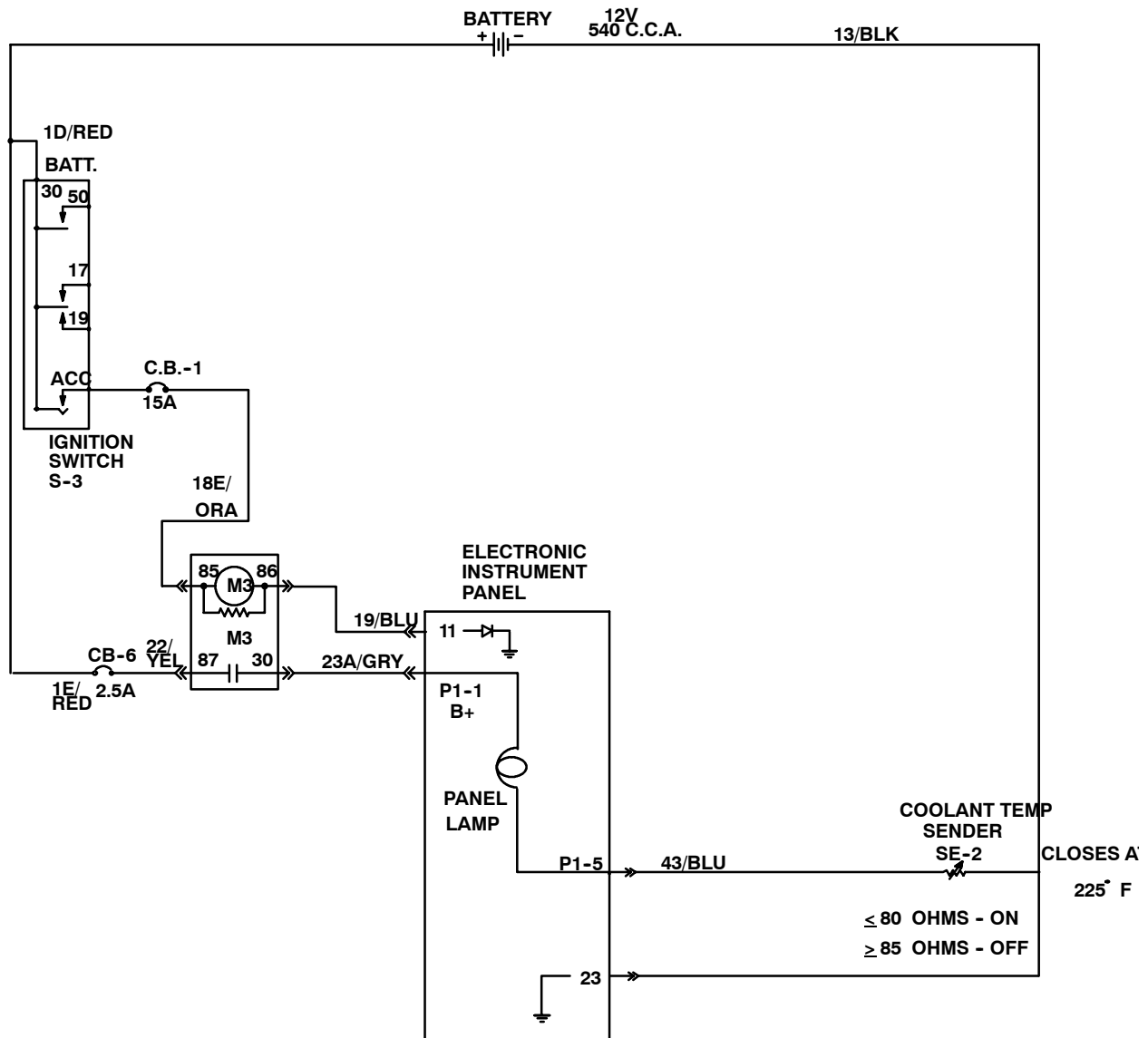


Instrument Panel Test Plug in Shaker - Test 4

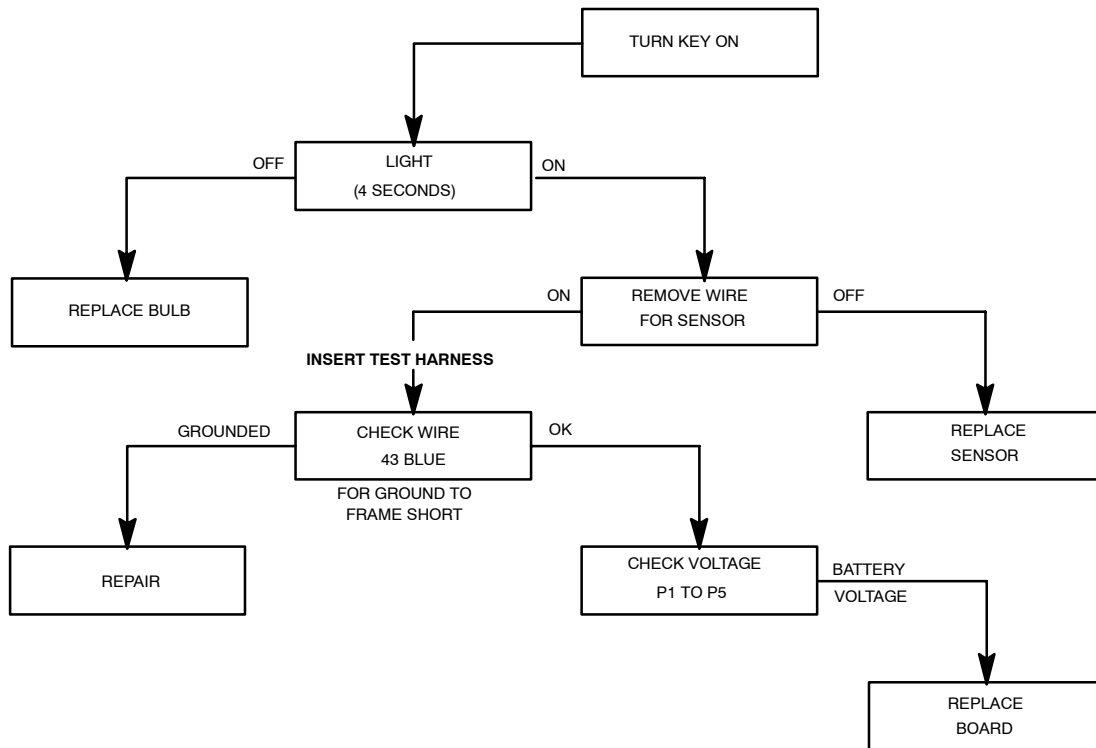


ELECTRICAL

COOLANT SENDER CIRCUIT



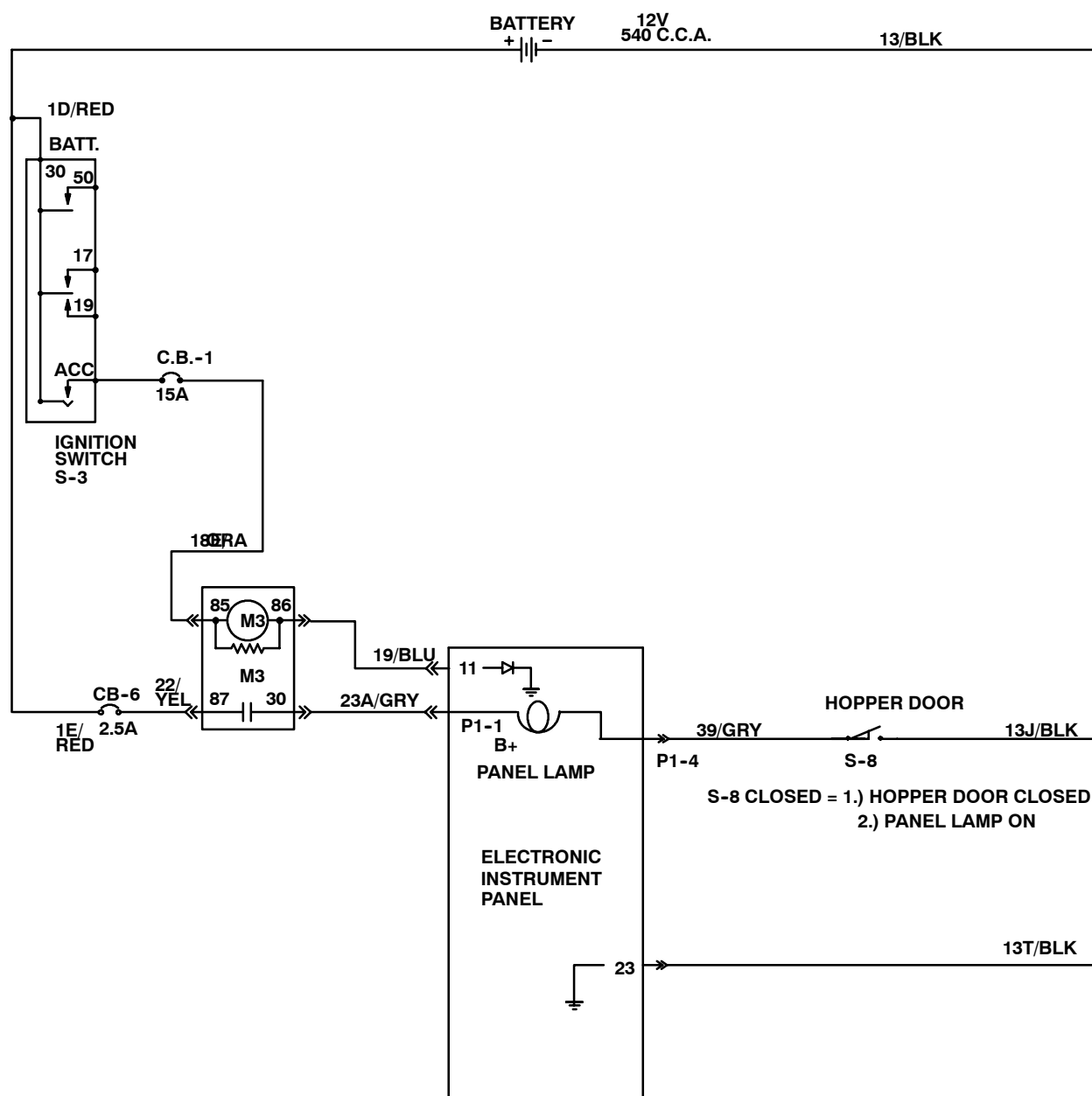
COOLANT TEMPERATURE



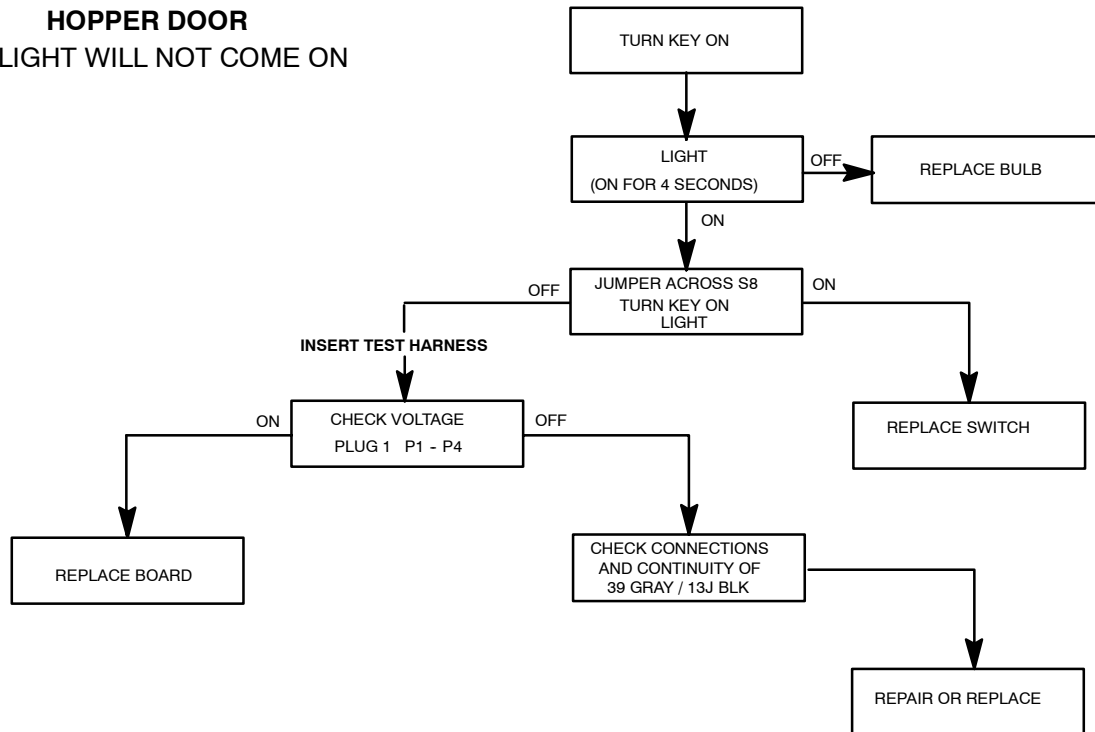
VACUUM FAN CIRCUIT



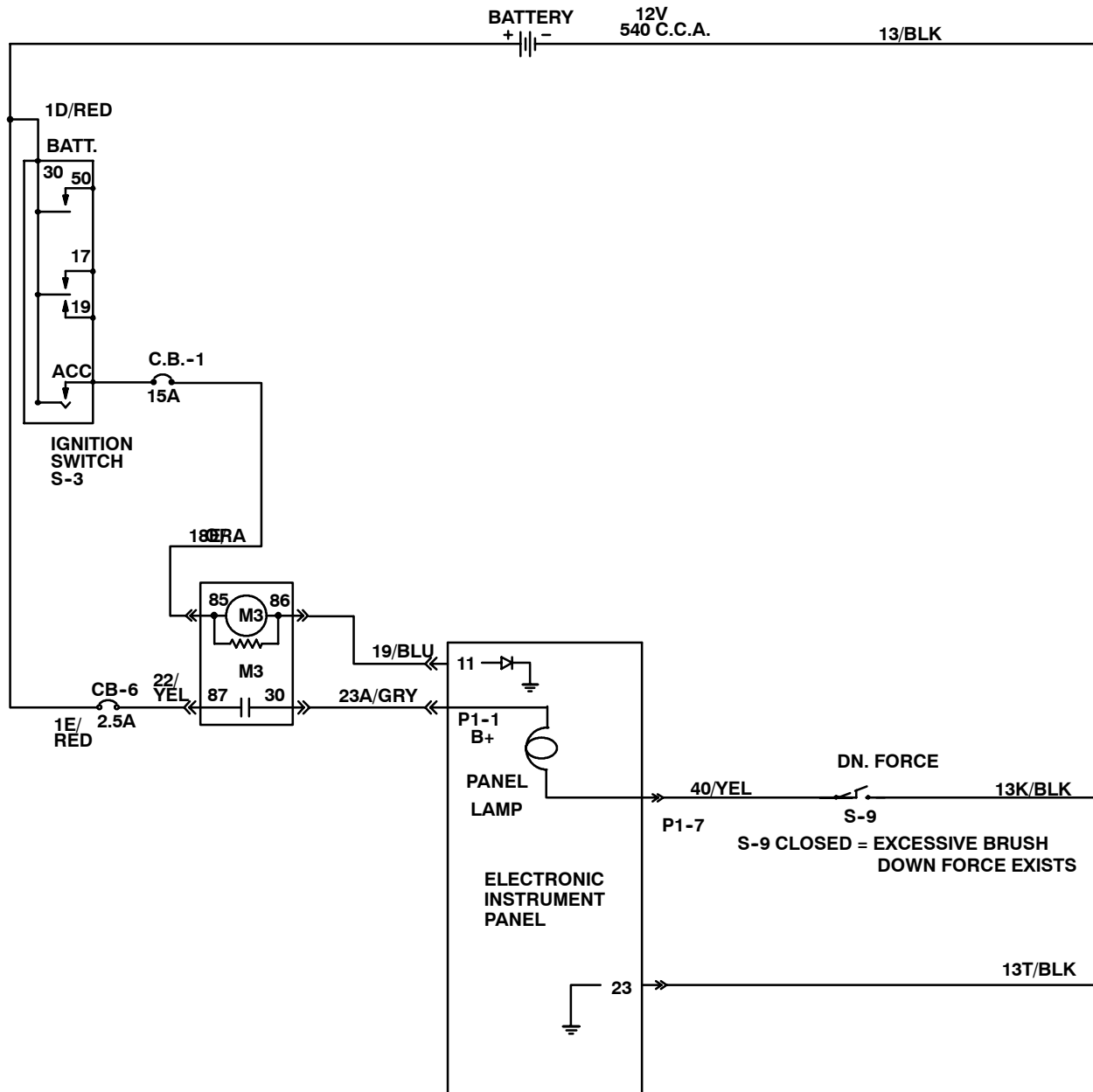
HOPPER DOOR CIRCUIT



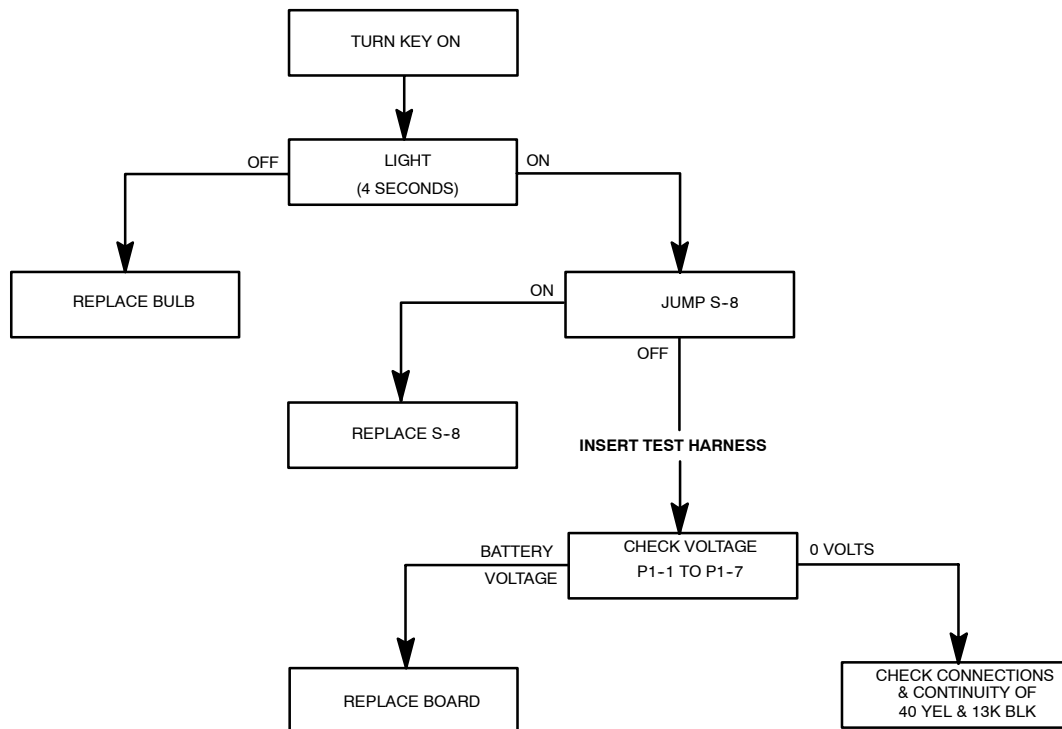
HOPPER DOOR LIGHT WILL NOT COME ON



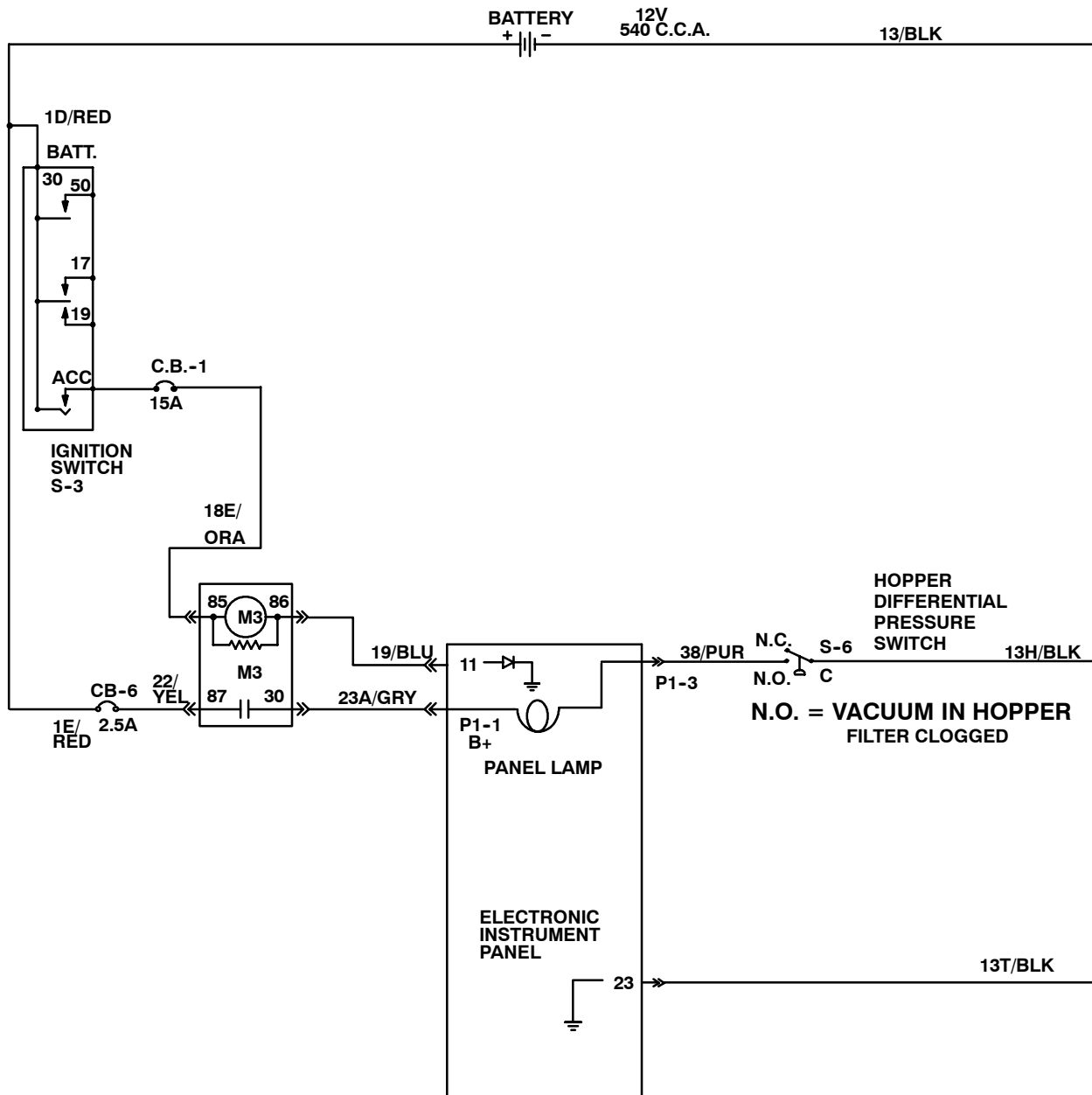
DOWN FORCE CIRCUIT



DOWN FORCE CIRCUIT



CLOGGED FILTER SWITCH CIRCUIT

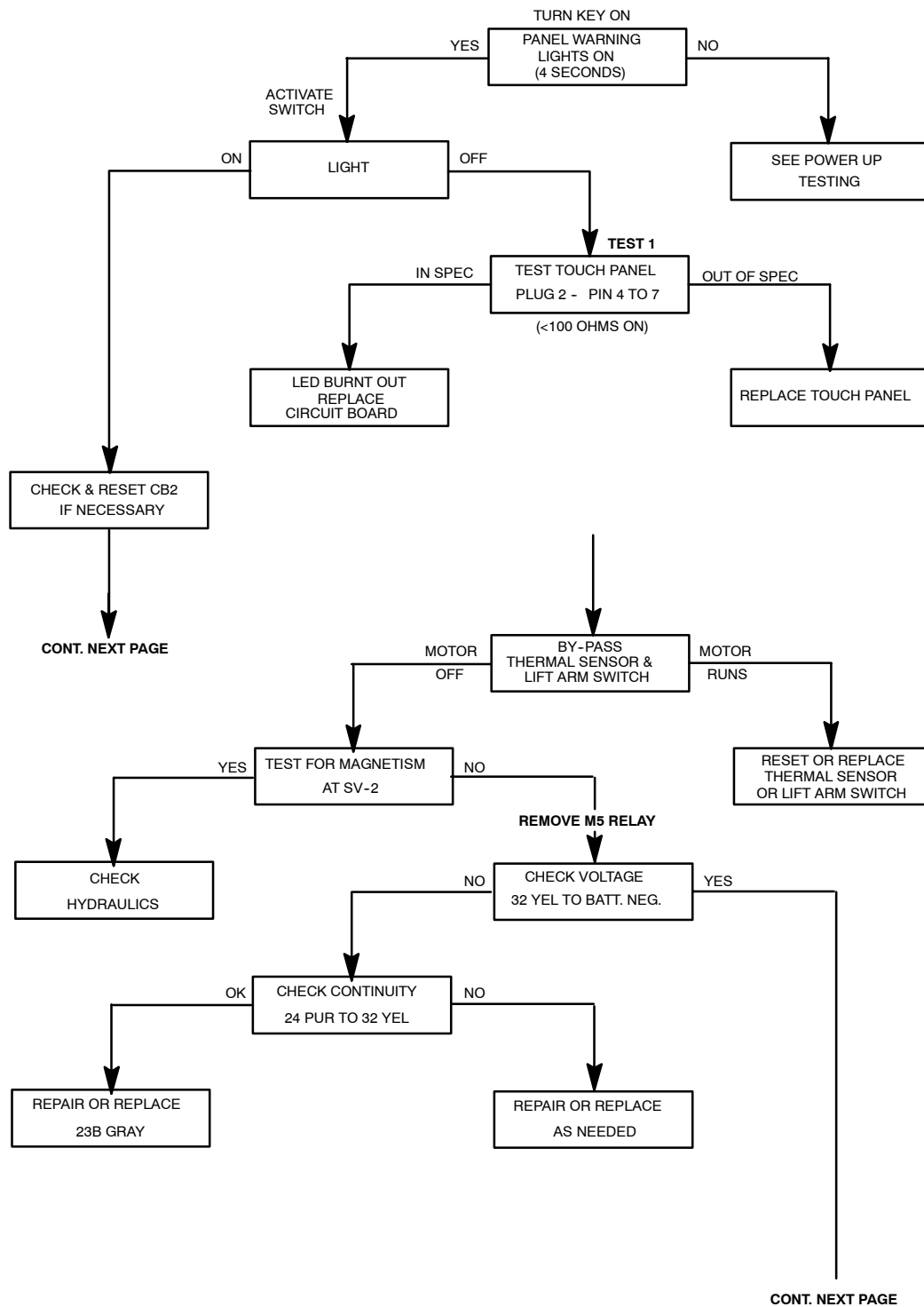


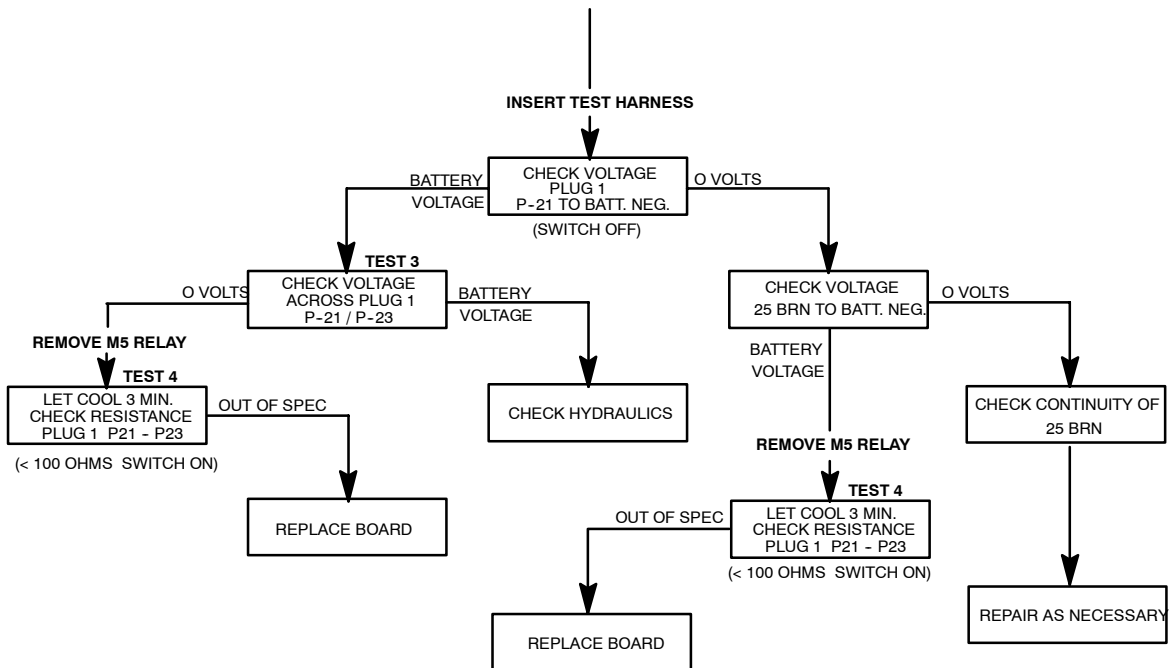
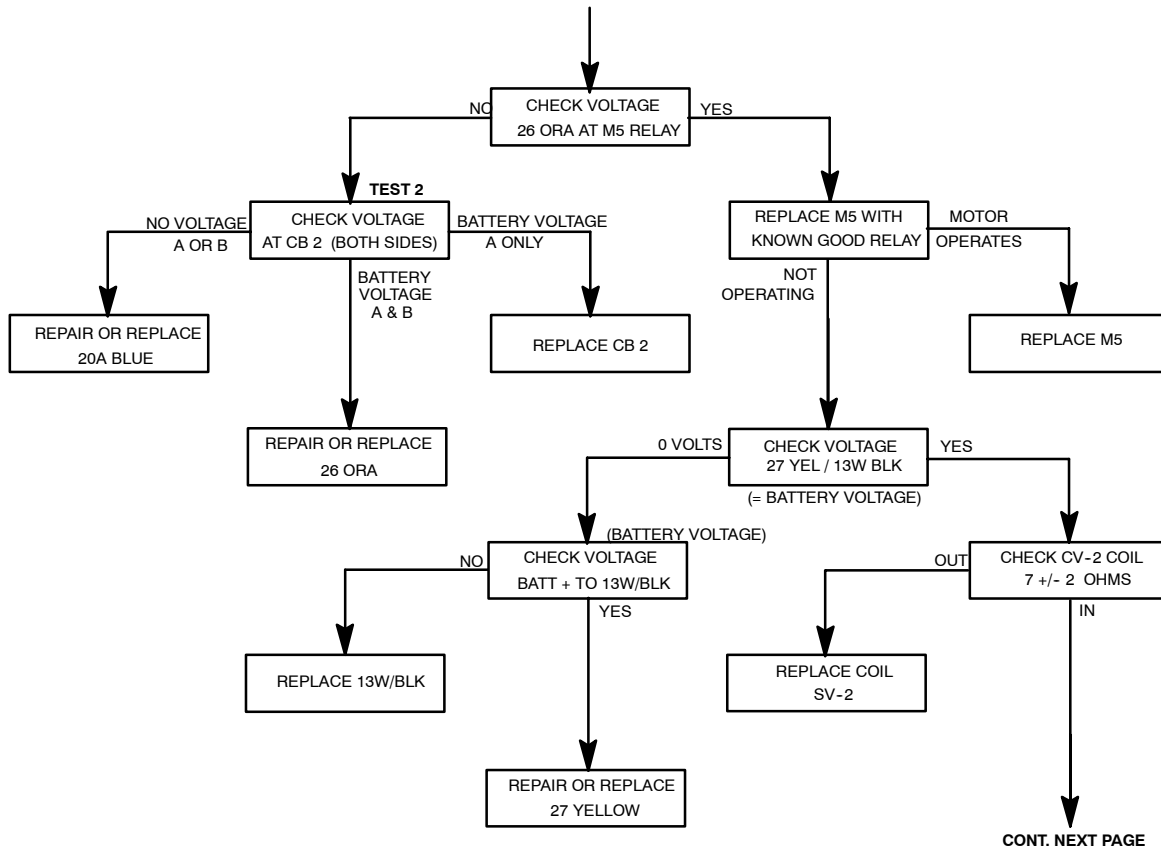
REMOVE WIRE 38 PURPLE, PLACE JUMPER TO GROUND,
LIGHT WILL COME ON.

VACUUM FAN CIRCUIT

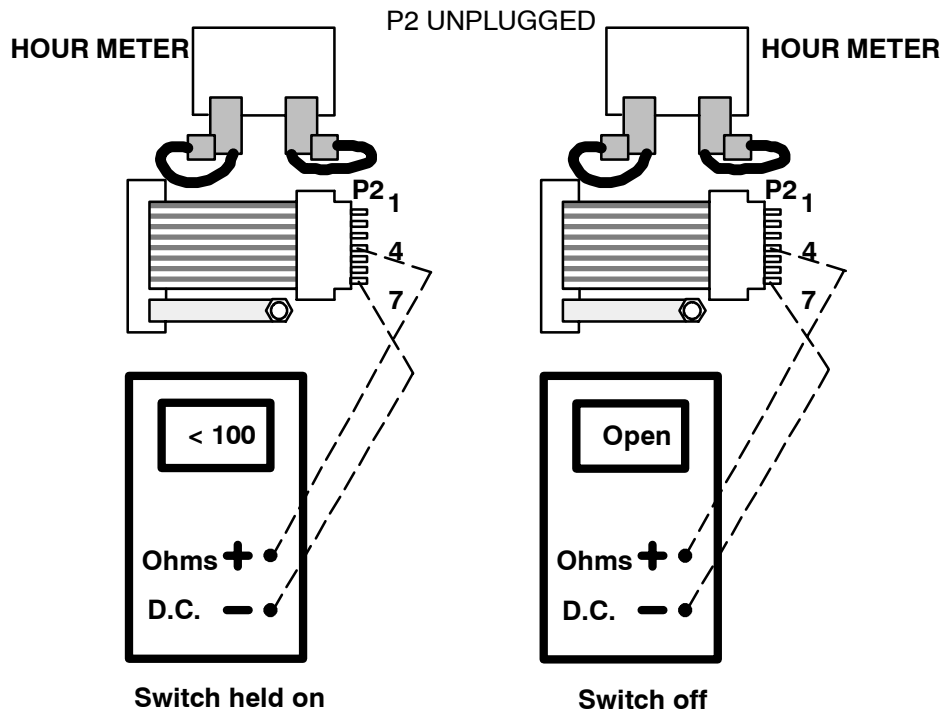


VACUUM FAN FAILURE

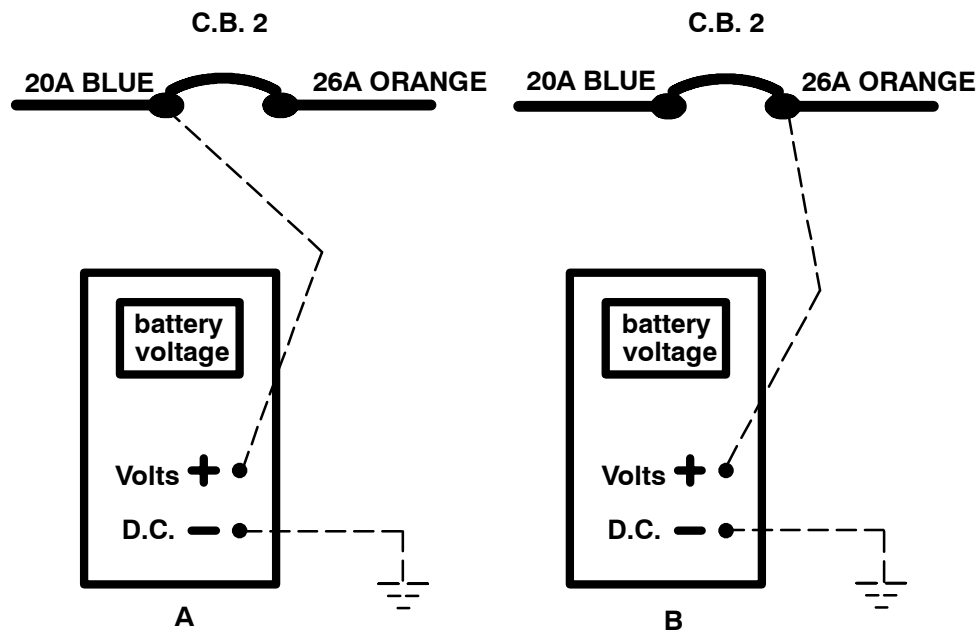




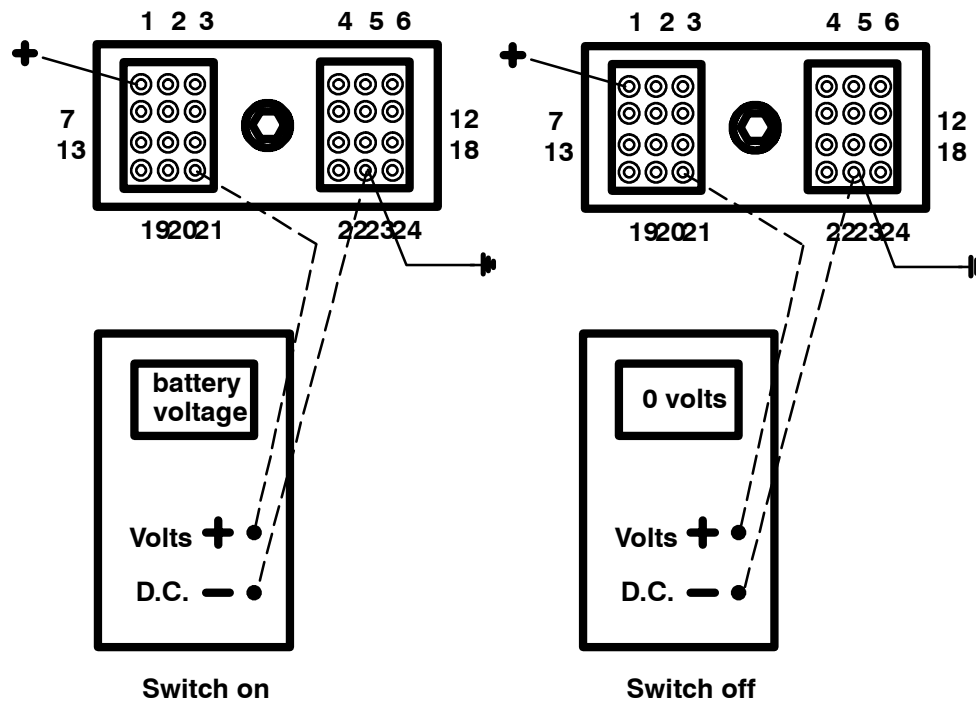
Vac Fan - Test 1



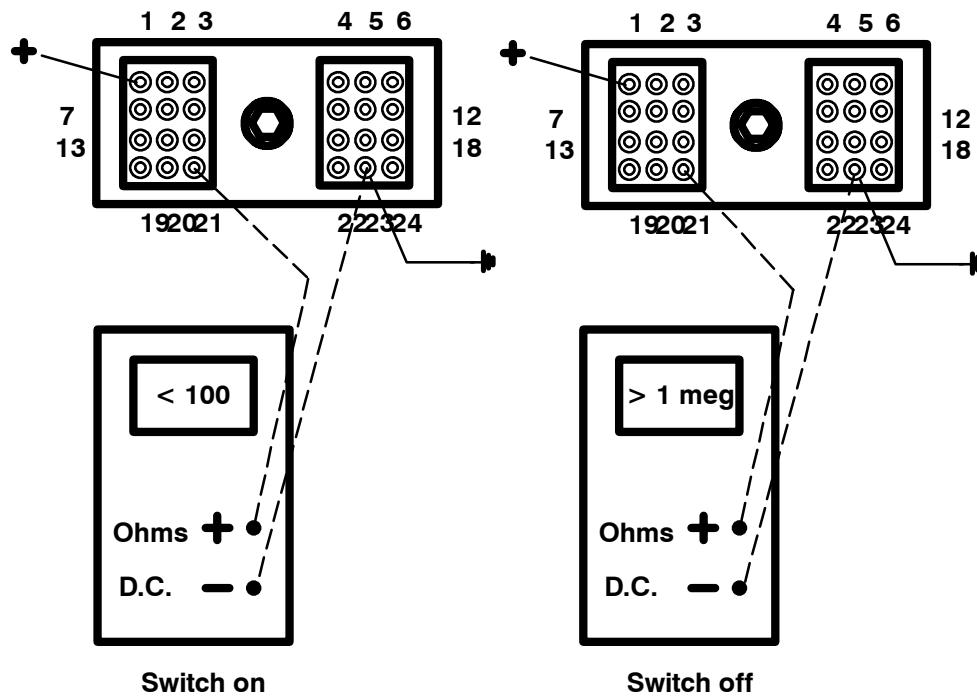
Vac Fan - Test 2



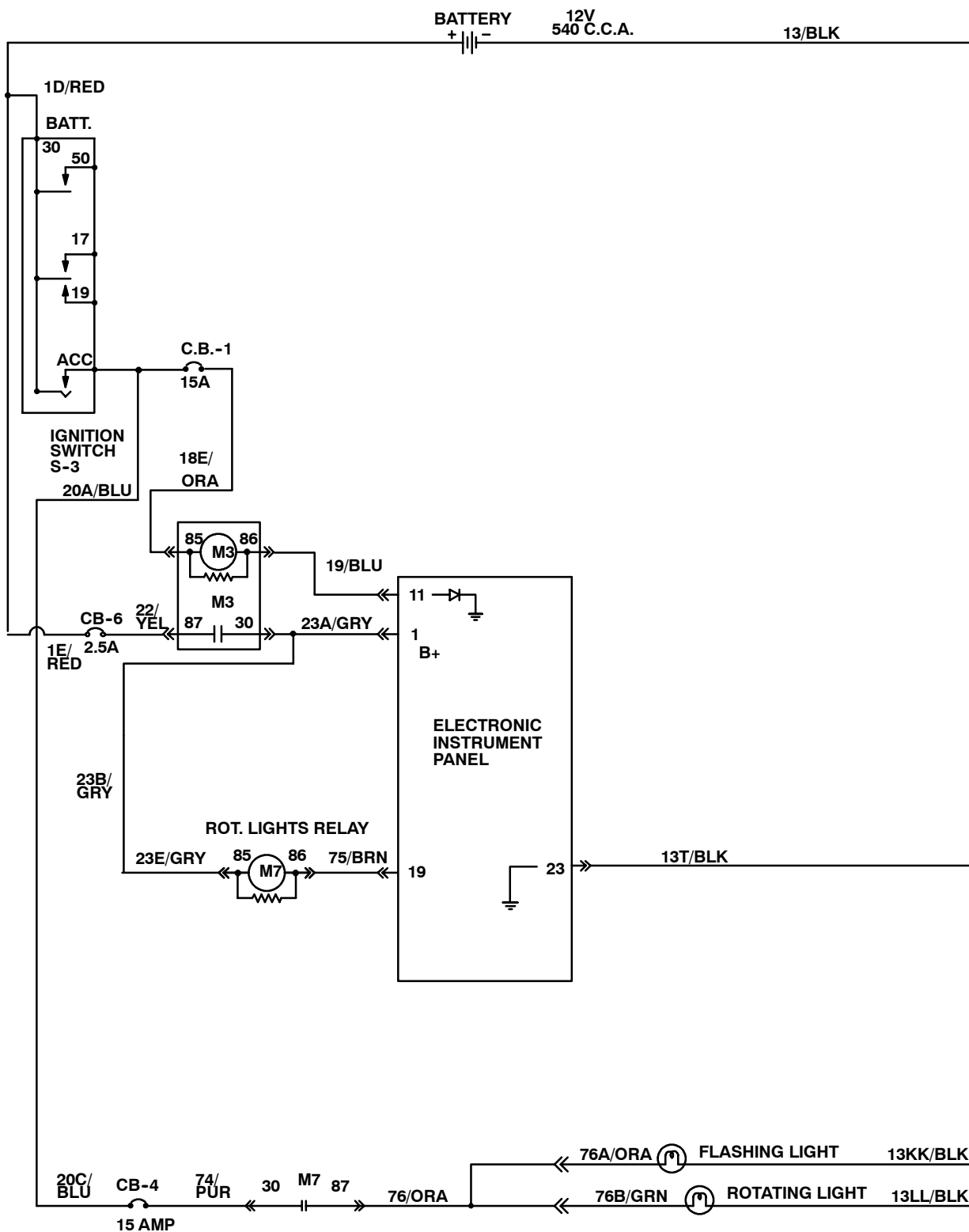
Instrument Panel Test Plug in Vac Fan - Test 3



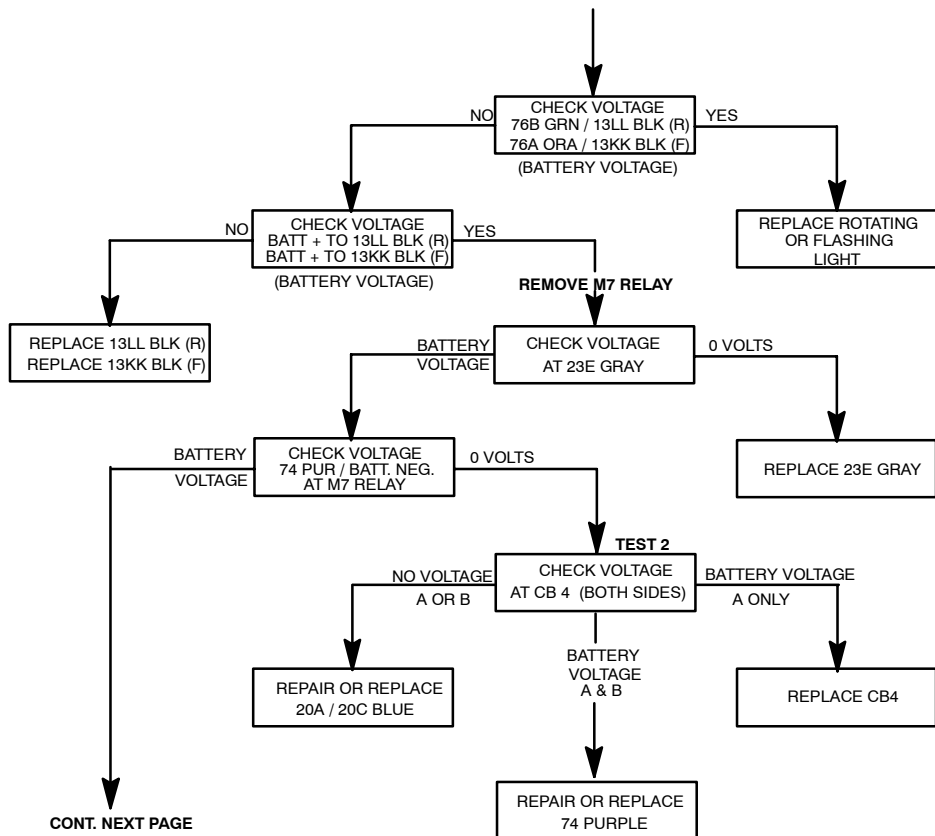
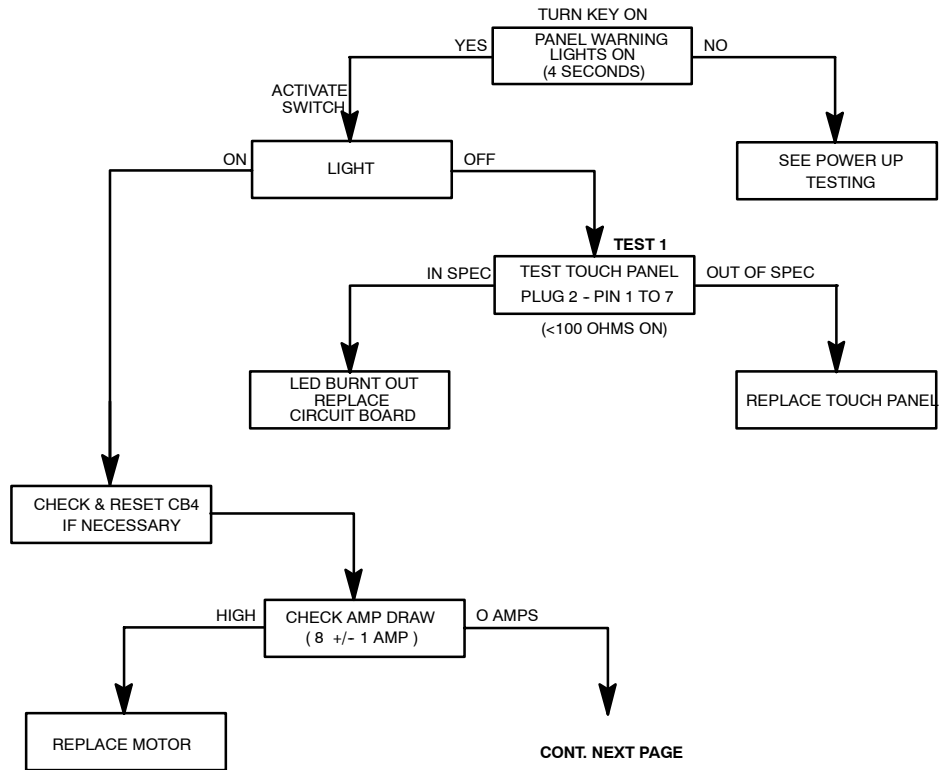
Instrument Panel Test Plug in Vac Fan - Test 4

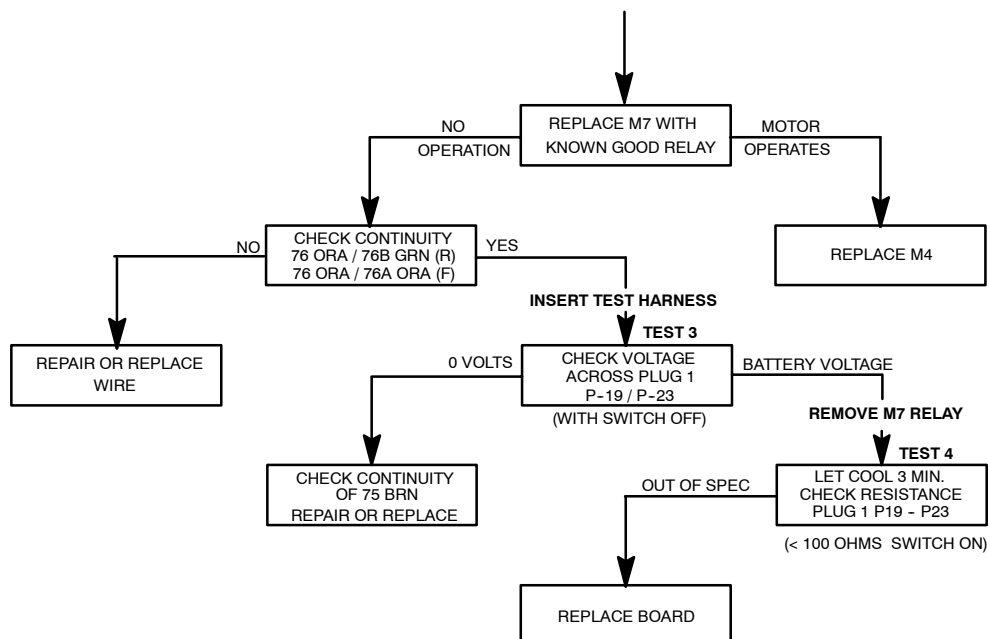


ROTATING LIGHT CIRCUIT

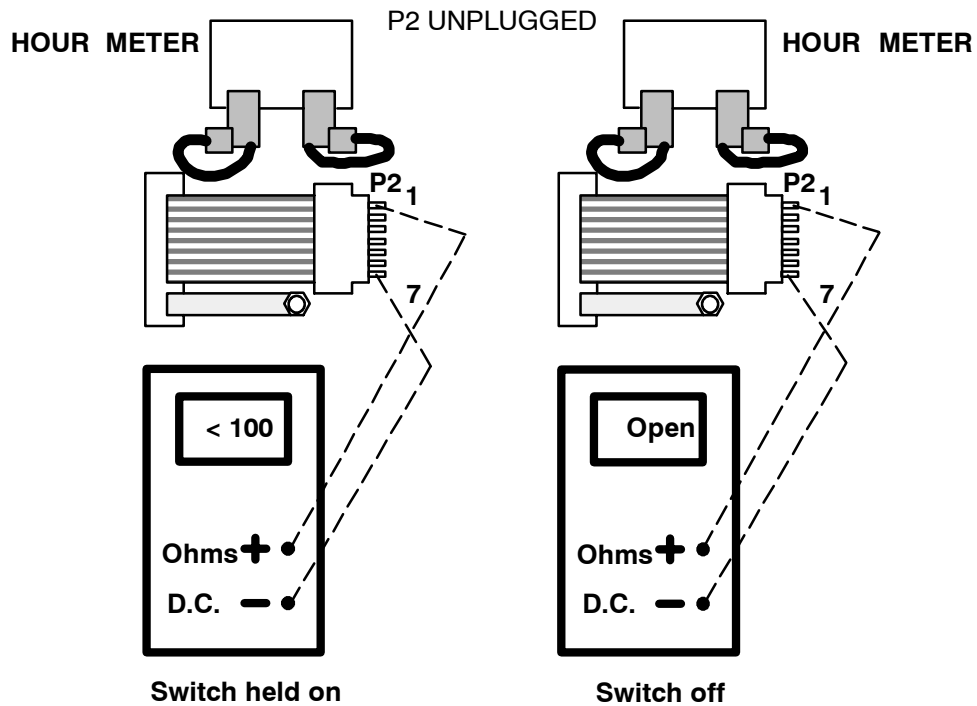


FLASHING & ROTATING LIGHT FAILURE

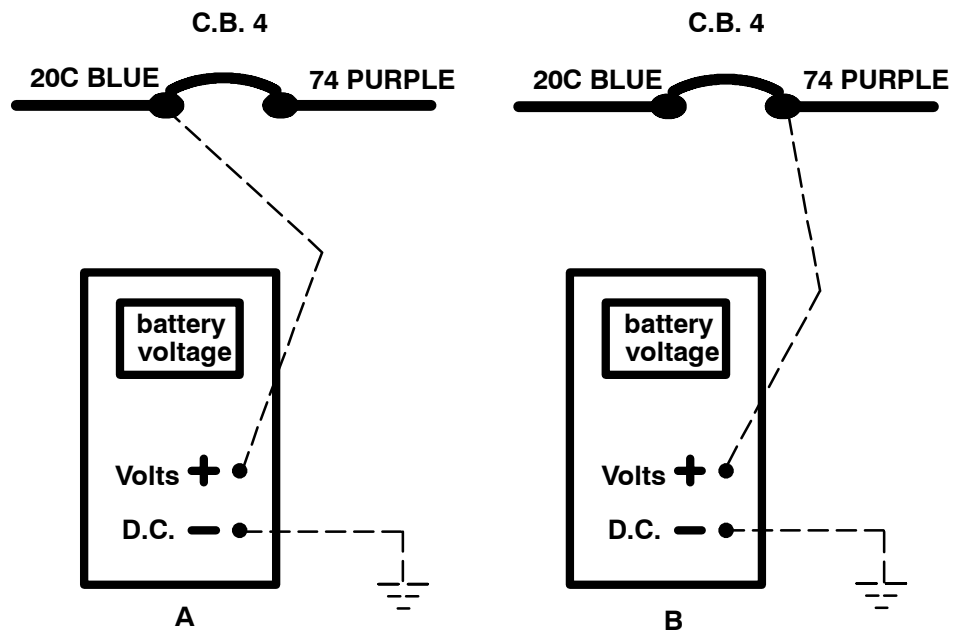




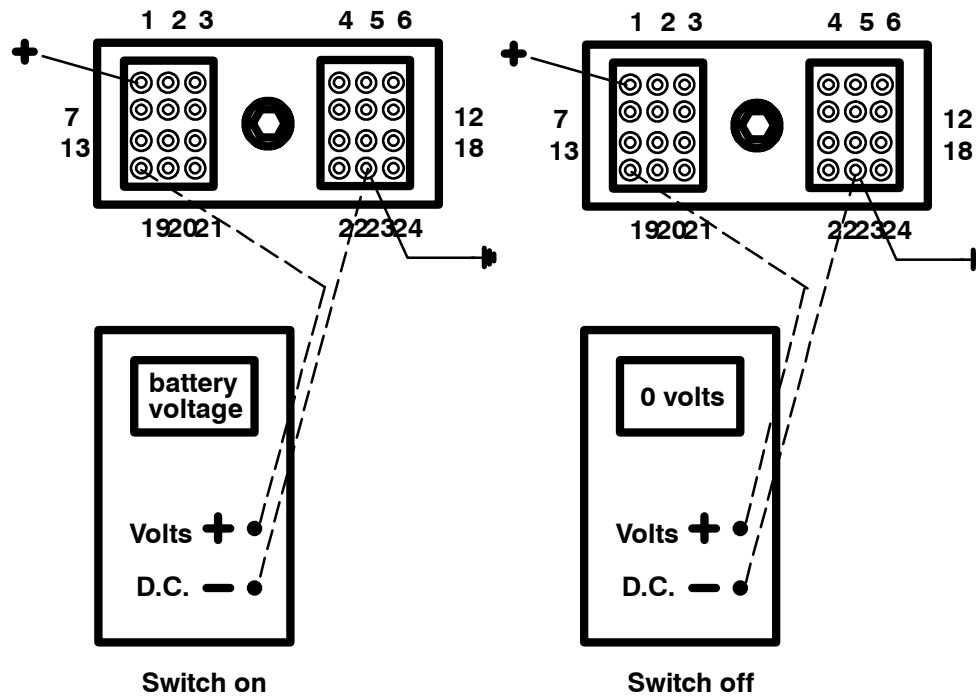
Rotating Light - Test 1



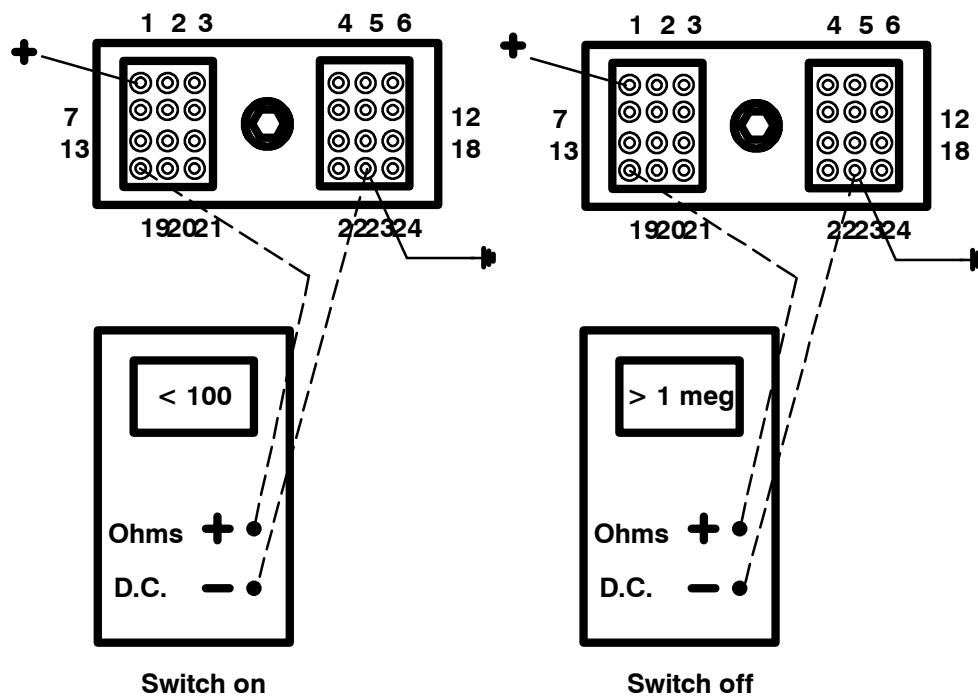
Rotating Light - Test 2



Instrument Panel Test Plug in Rotating light – Test 3



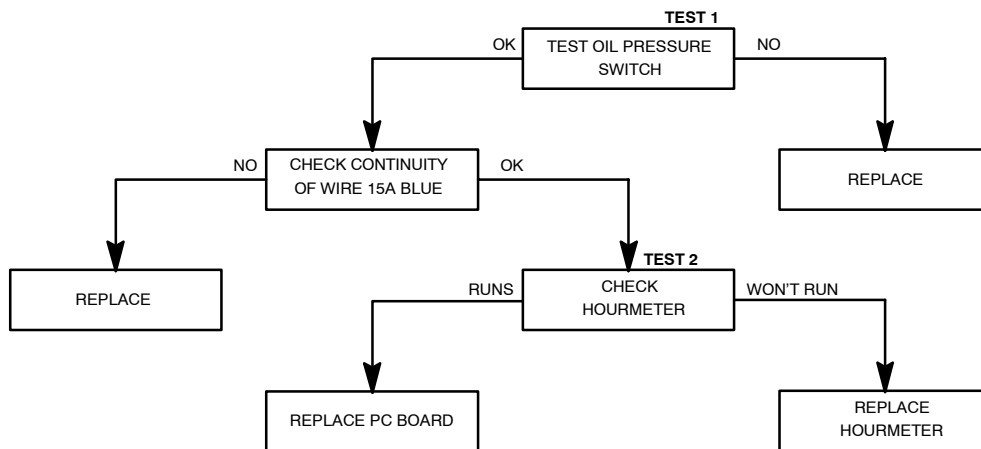
Instrument Panel Test Plug in Rotating light – Test 4



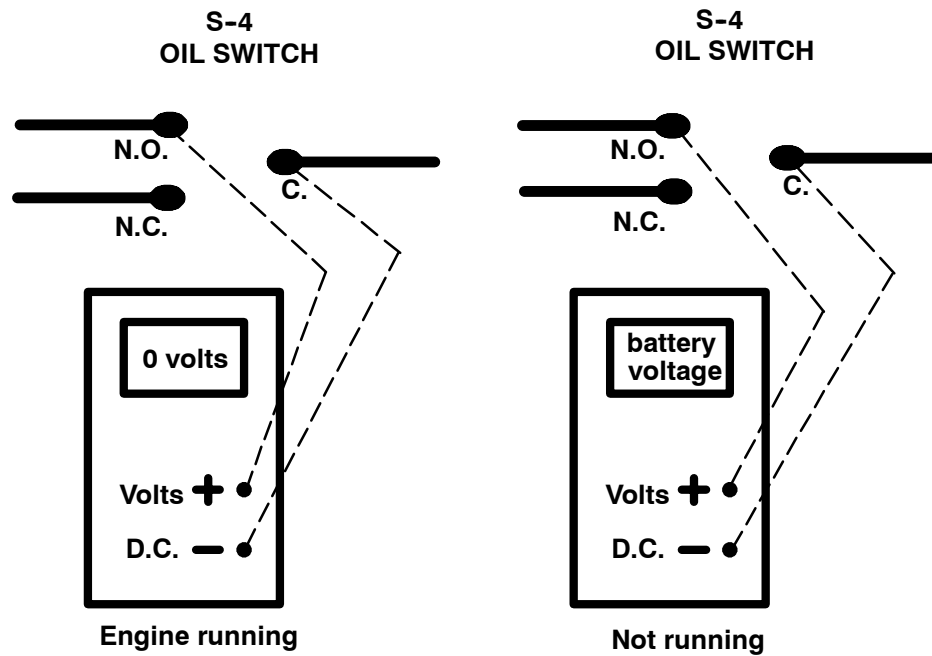


HOURLMETER WON'T WORK

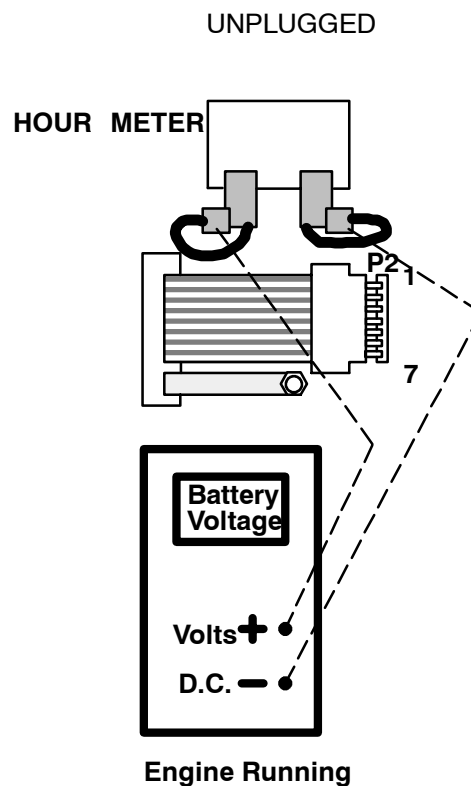
THE HOURLMETER RUNS WHEN THE ENGINE IS RUNNING ONLY, NOT WITH THE KEY ON.



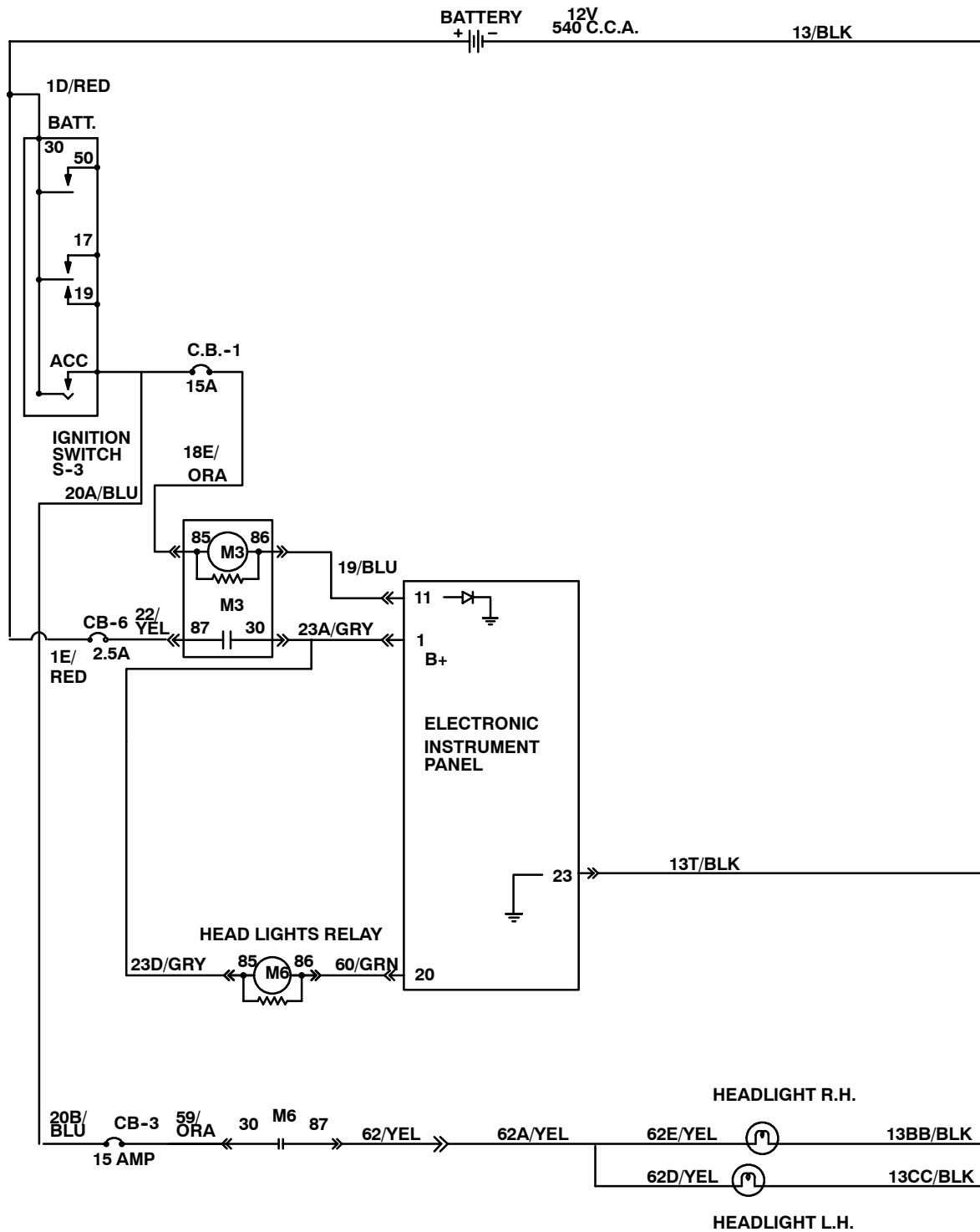
Hourmeter - Test 1



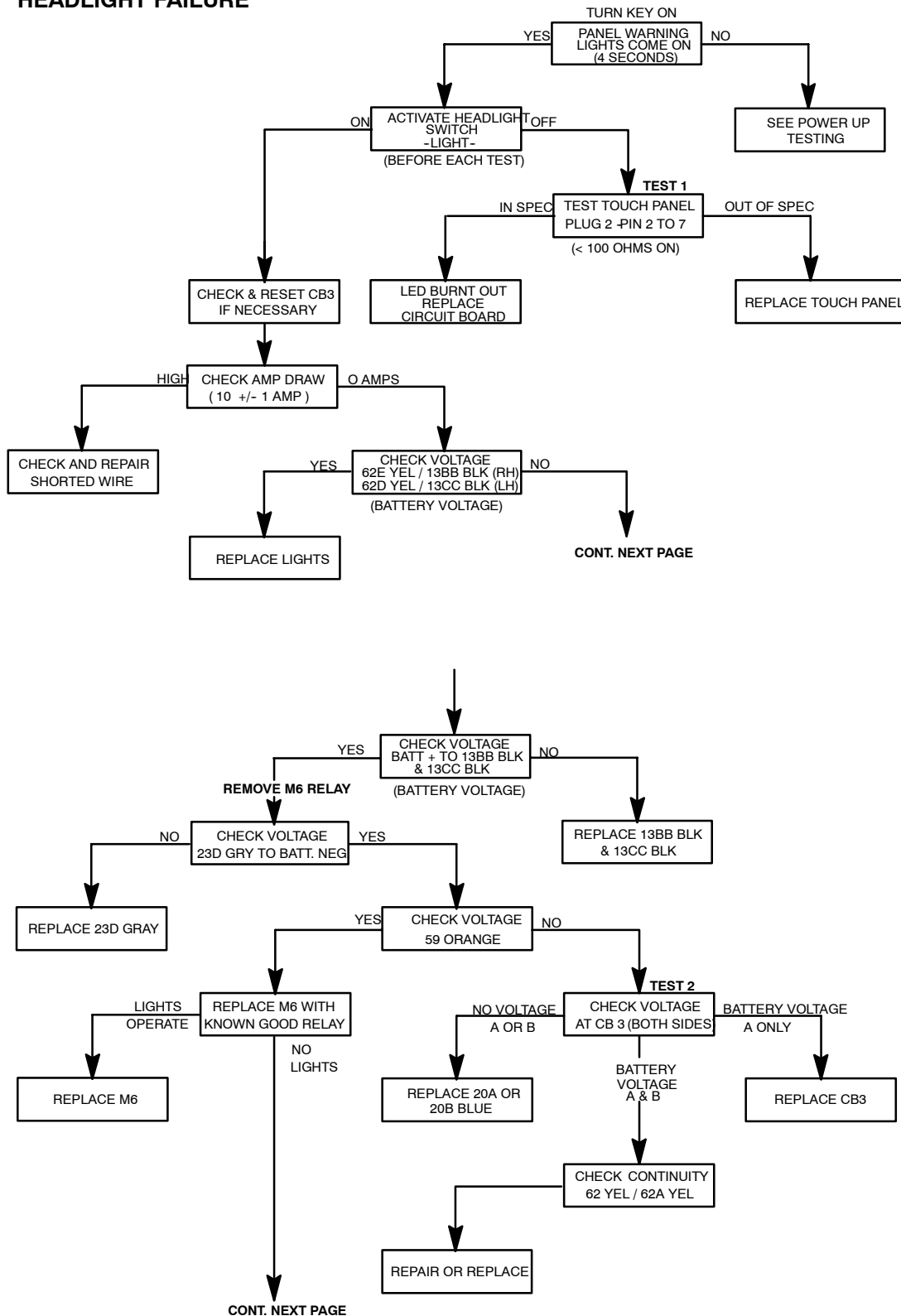
Hourmeter - Test 2

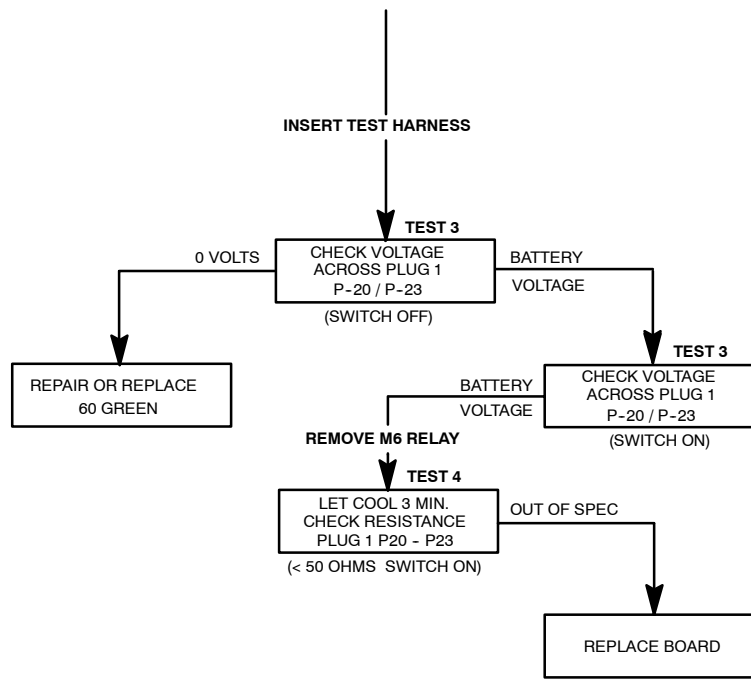


HEADLIGHT CIRCUIT

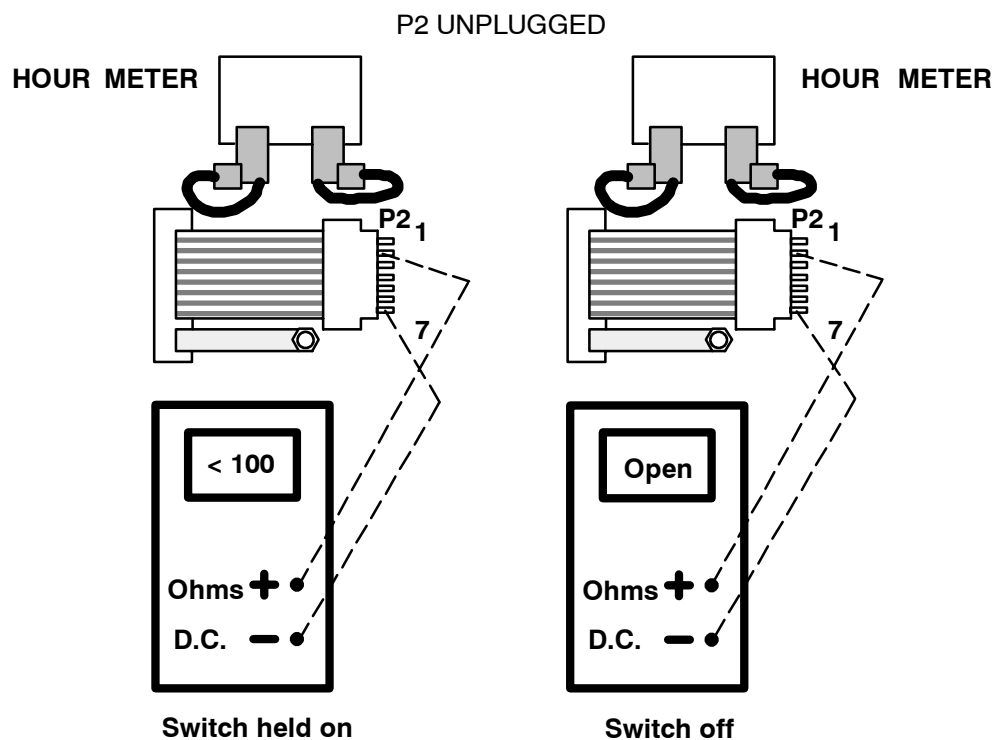


HEADLIGHT FAILURE

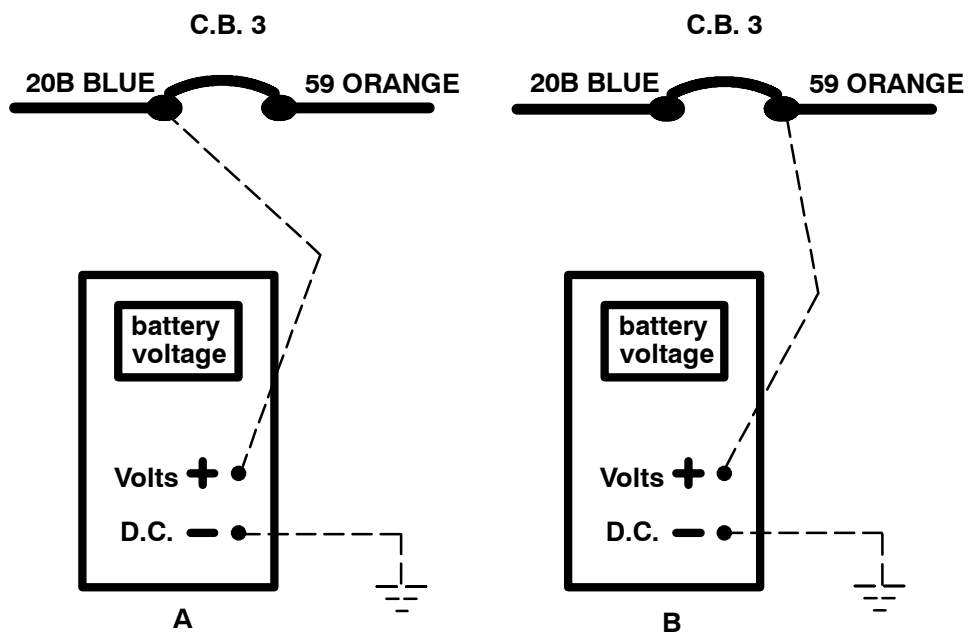




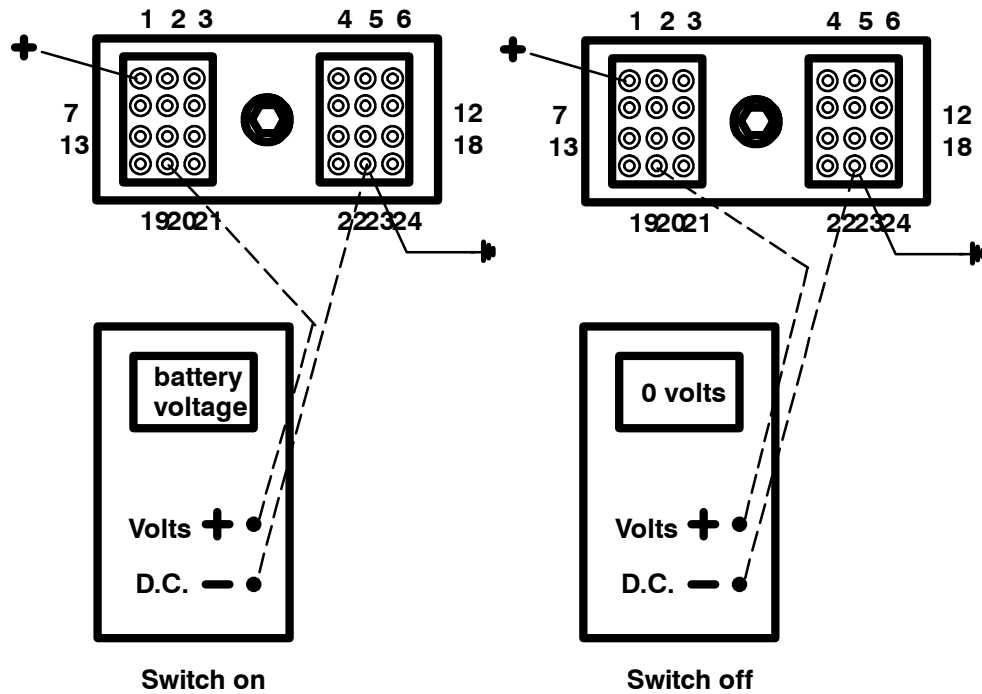
Headlight - Test 1



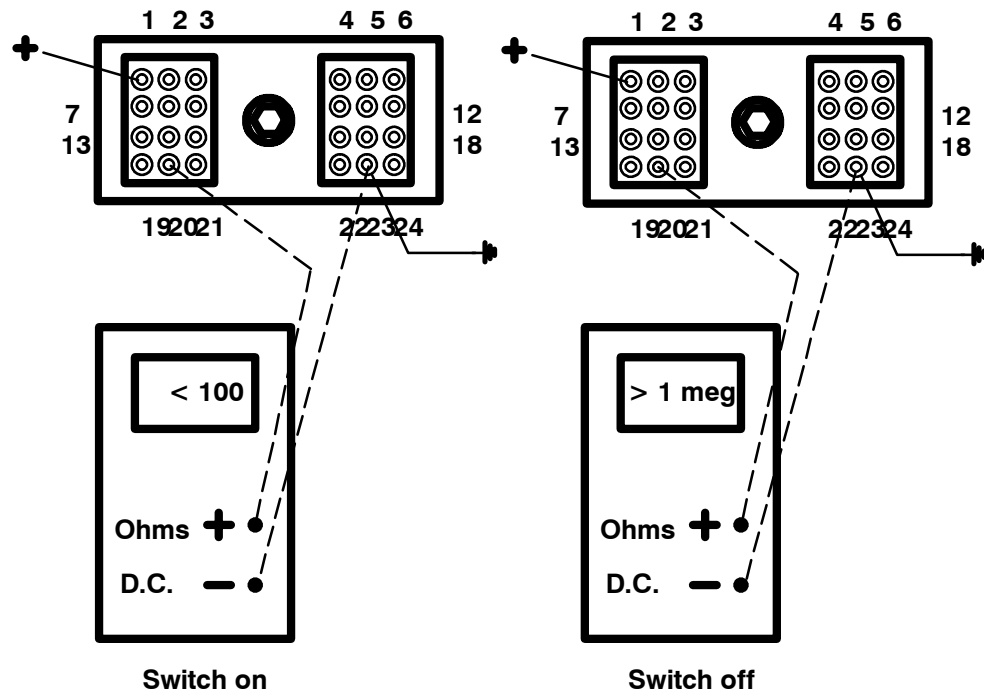
Headlights - Test 2



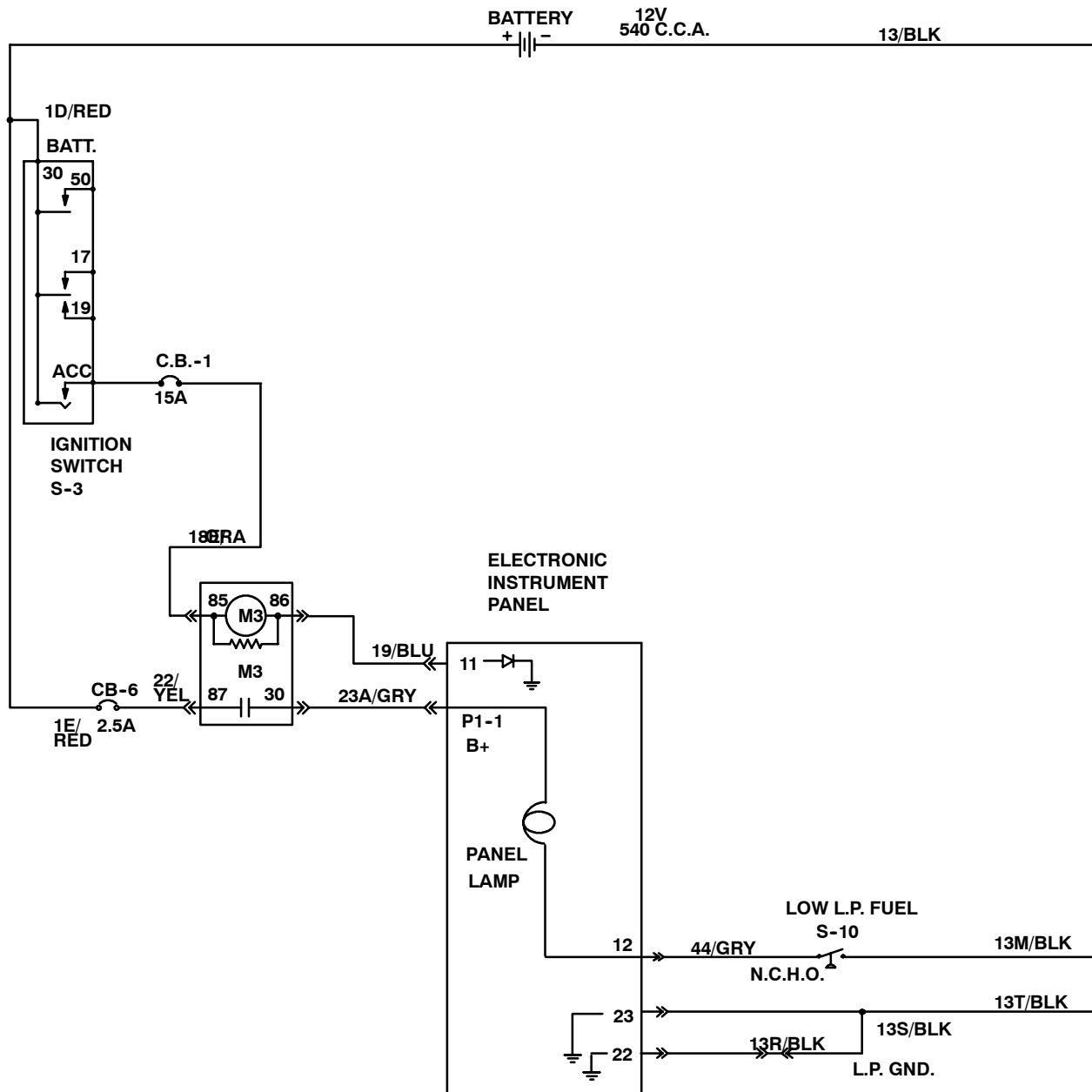
Instrument Panel Test Plug in Head lights – Test 3



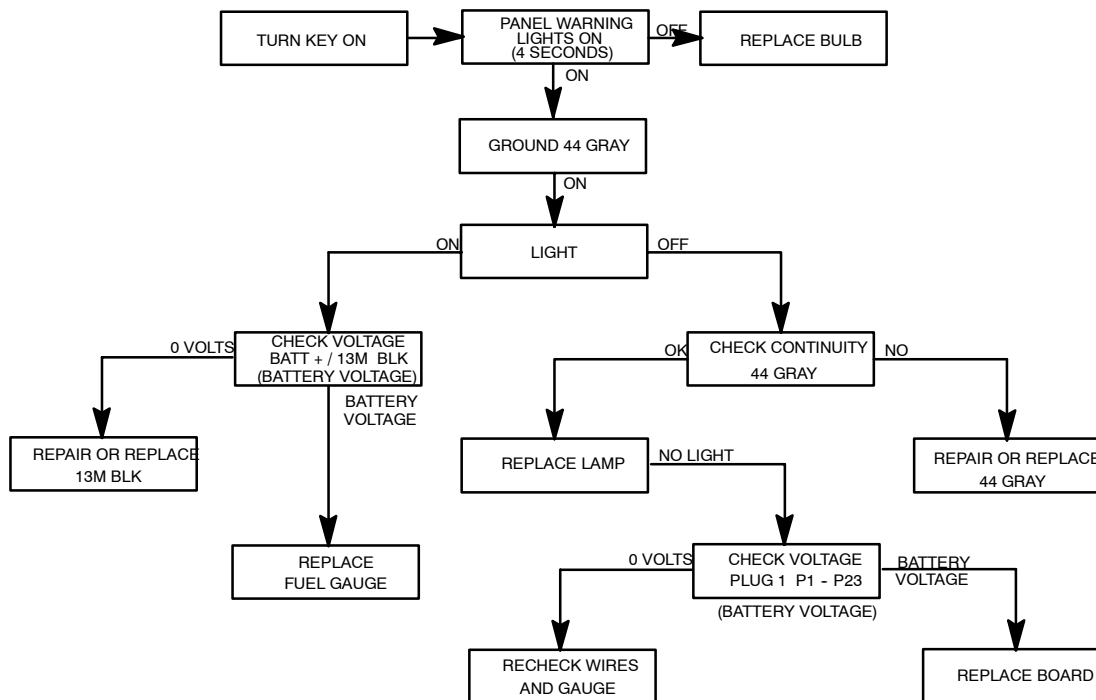
Instrument Panel Test Plug in Head lights – Test 4



LOW L.P. FUEL CIRCUIT



LOW LP FUEL LIGHT
TO TEST LAMP: REMOVE WIRE 44 GRAY, PLACE A JUMPER
WIRE FROM IT TO GROUND.



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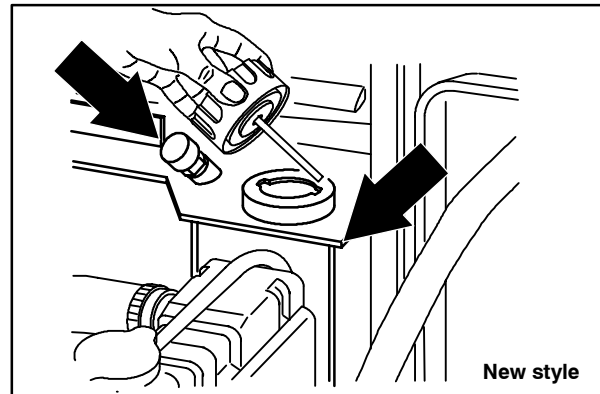
HYDRAULICS

HYDRAULIC FLUID RESERVOIR

The reservoir is located in the engine compartment next to the radiator.

355

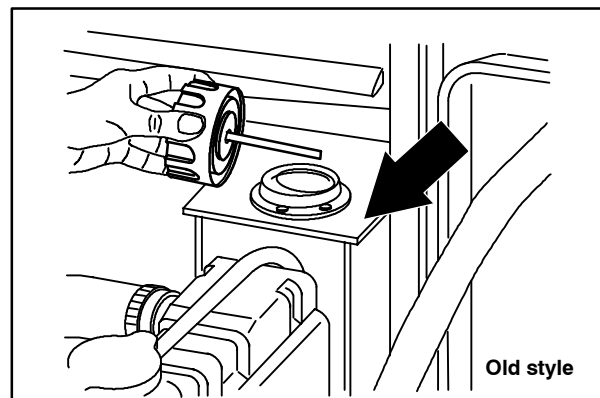
Mounted on top of the reservoir is a filler cap with a fluid level dipstick. The reservoir also has a hydraulic breather. On machines below serial number 003219, the breather is built into the filler cap. On machines serial number 003219 and above, the breather is located next to the filler cap. Replace the hydraulic breather after every 800 hours of operation.



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Mounted on top of the reservoir is a filler cap with a fluid level dipstick. The reservoir also has a hydraulic breather. On machines below serial number 006677, the breather is built into the filler cap. On machines serial number 006677 and above, the breather is located next to the filler cap. Replace the hydraulic breather after every 800 hours of operation.

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.



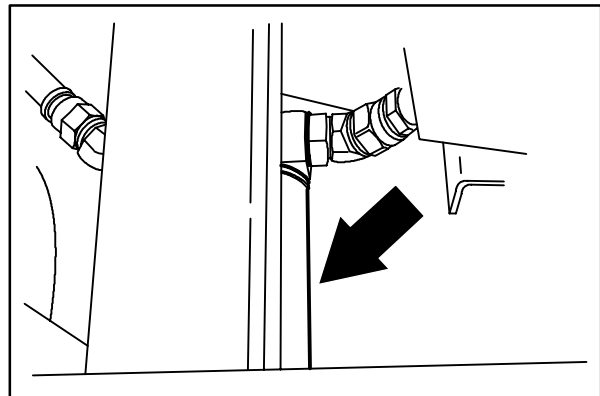
Lubricate the filler cap gasket with a film of hydraulic fluid before putting the cap back on the reservoir.

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 part no.	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.

European manufactured machines are filled with locally available hydraulic fluids. Check the label on the hydraulic fluid reservoir.

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.

TO DRAIN HYDRAULIC FLUID RESERVOIR AND REPLACE FILTER ELEMENT

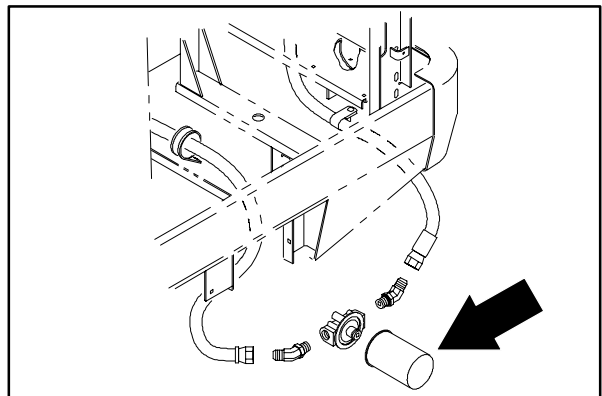
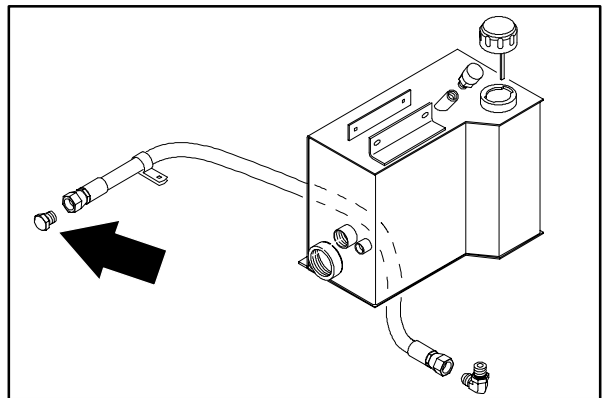
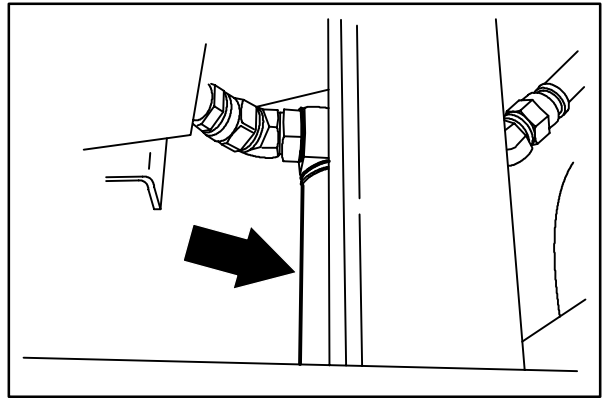
1. Stop the engine and set the machine parking brake.

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 machine. Drain the fluid into a pan. Properly discard the old fluid.
4. 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.

5. Apply a thin coat of hydraulic fluid to the seal of the new hydraulic fluid filter element.
6. Thread and hand tighten the new hydraulic fluid filter element on the filter head.



HYDRAULICS

TO FILL HYDRAULIC FLUID RESERVOIR

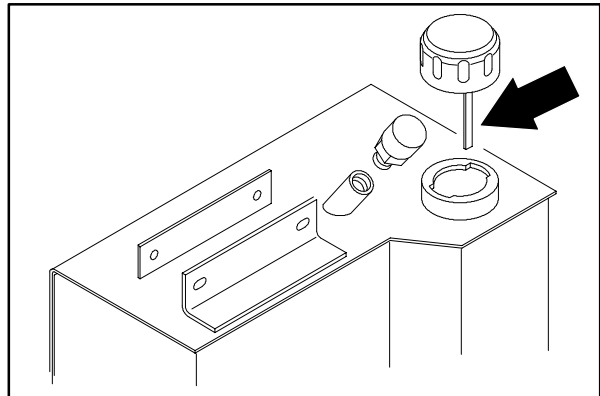
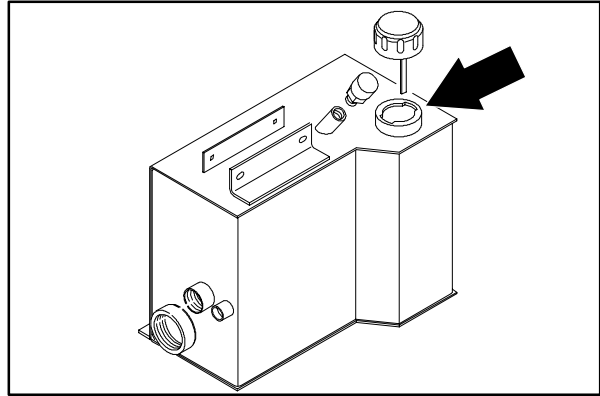
1. Remove the reservoir breather-filler cap.
2. Pour new, approved hydraulic fluid through a 200 mesh screened funnel and into the reservoir.

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

3. Check the hydraulic fluid level in the reservoir with the fluid level dipstick.
4. 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.

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



HYDRAULIC HOSES

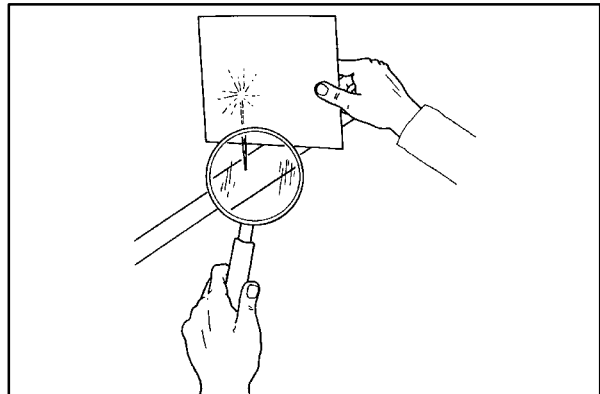
Check the hydraulic hoses every 800 hours of operation for wear or damage.

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.

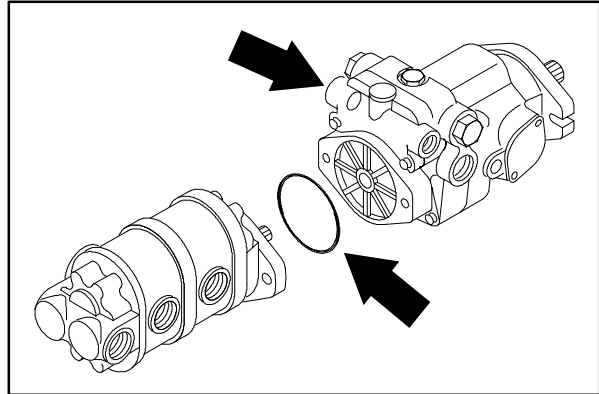
If you discover a fluid leak, contact your mechanic/supervisor.



HYDRAULIC PUMPS

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.

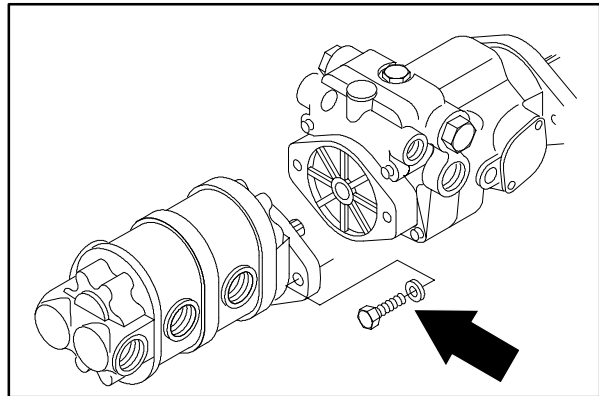


TO REPLACE PROPEL PUMP

1. Raise the hopper and engage the safety arm.

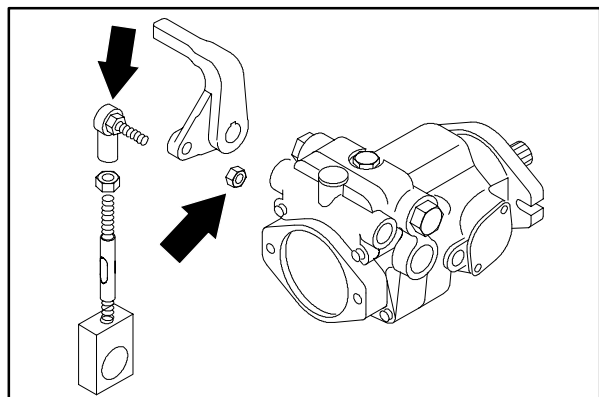
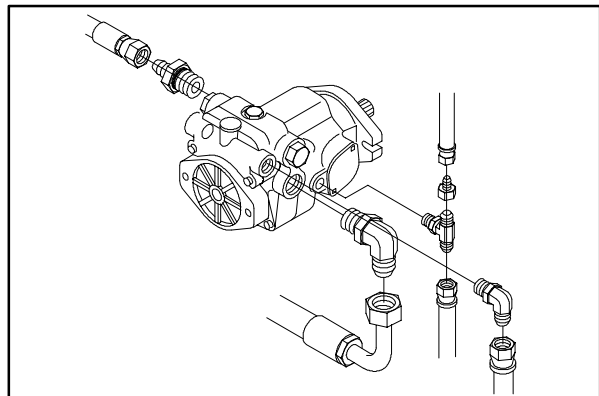
FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake, Turn Off Machine And Remove Key.

2. Remove the front dust panel from the machine.
3. Remove the two 0.375 in. hex screws holding the accessory pump to the propel pump.
4. Pull the accessory pump straight out of the propel pump without disconnecting the hydraulic hoses. Make sure not to lose the rubber O-ring on the accessory pump.
5. Disconnect and plug the hoses going to the propel pump.



NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.

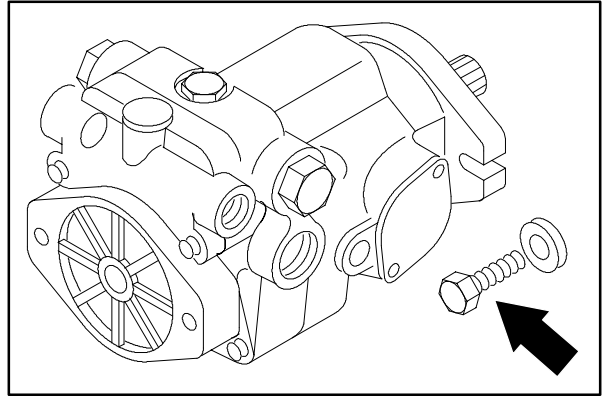
6. Remove the M8 nyloc nut holding the control rod balljoint to directional control arm. Pull the rod out of the arm.
7. Remove the two M10 hex screws holding the propel pump to the bellhousing.
8. Pivot the propel pump clockwise until the directional control arm is clear of the centering spring arms.
9. The propel pump can now be pulled straight back and out of the pump coupling.



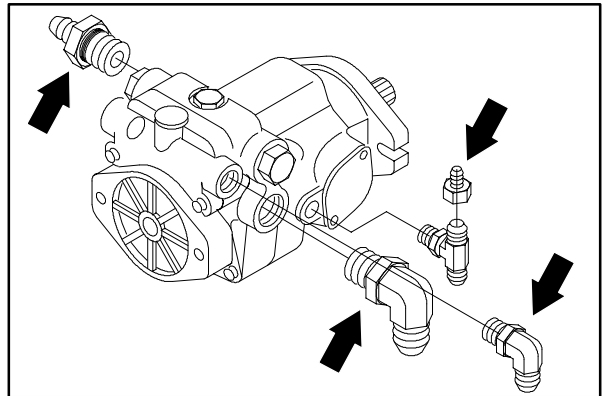
HYDRAULICS

10. Place the propel pump in a vice and remove the hydraulic fittings. Remove the fittings and install in the new pump in the same orientation.
11. Remove the 0.31 in. hex screw holding the directional control arm to the pump shaft. Remove the arm.

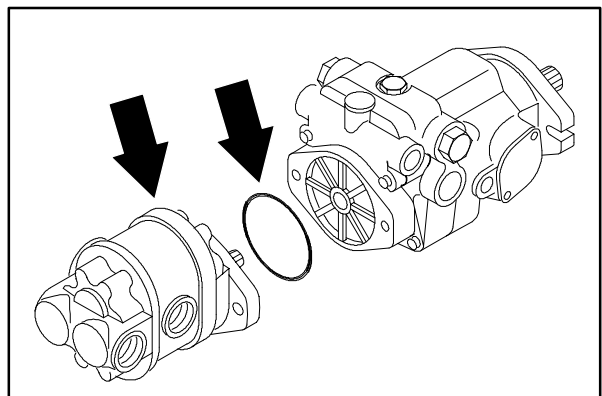
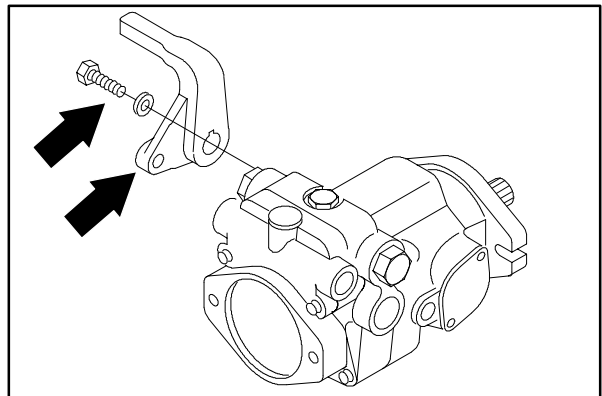
NOTE: The pump control arm is on a tapered shaft and will need to be pried off or removed with a puller.



12. Make sure the key is in place on the directional control shaft when installing the directional control arm on the new propel pump. Use the 0.31 in. fine thread hex screw with blue loctite 242 and tighten to 22-27 Nm (16-20 ft lb).
13. Place some grease on the splines of the input shaft on the propel pump.
14. The new propel pump can now be positioned back in the bellhousing/flywheel area. Make sure the splines of the pump line up with the splines of the flywheel coupling.
15. Once the pump is all the way in the coupling, rotate it counter-clockwise until the directional control arm is down between the centering spring arms.
16. Reinstall the two M10 hex screws and hand tighten tight.
17. Reinstall the control rod balljoint and rod to the directional control arm. Reinstall the M8 nyloc nut and tighten to 18 - 24 Nm (15 - 20 ft lb).
18. Reconnect the hydraulic hoses to the propel pump. Use the schematic in this section.



19. Position the accessory pump back in the end of the propel pump. Make sure the rubber O-ring is in place on the accessory pump. Reinstall the two 0.375 in. hex screws and tighten to 36 - 40 Nm (27 - 30 ft lb). Use loctite 242 blue on the threads.
20. Start the machine and check the propel circuit for proper operation.
21. Reinstall the front dust panel. Tighten the four M8 hex screws to 18 - 24 Nm (15 - 20 ft lb). Lower the hopper.



TO REPLACE ACCESSORY PUMP

1. Raise the hopper and engage the safety arm.

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

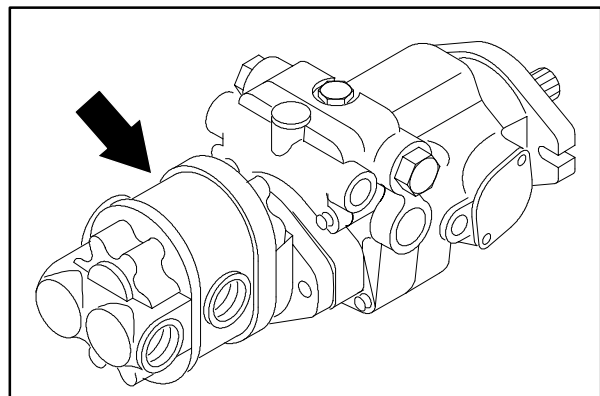
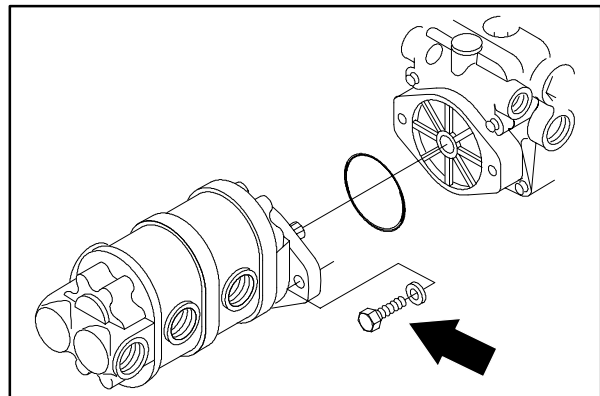
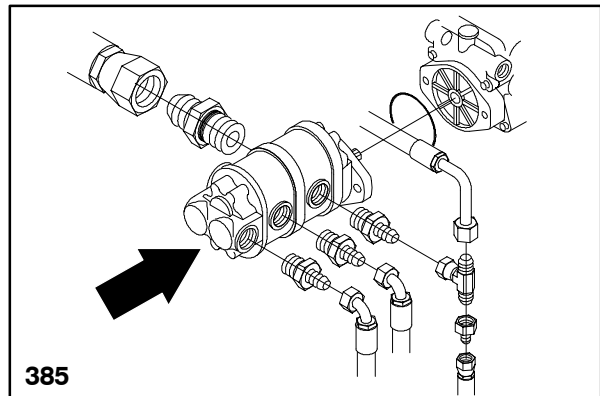
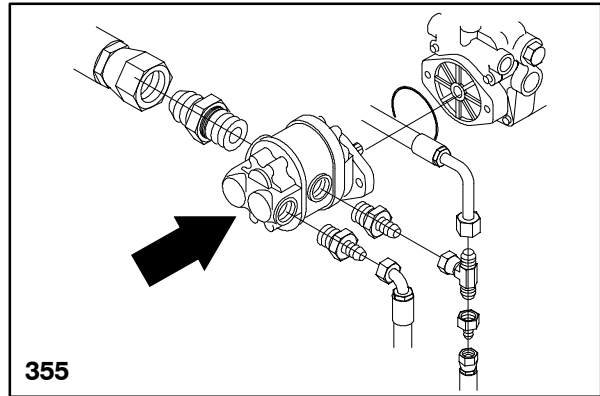
2. Remove the front dust panel from the machine.

NOTE: The hydraulic tank should be drained when removing the accessory pump. A small vacuum pump can also be used to reduce the amount of oil that leaks from the hydraulic tank when the main suction line is removed.

3. Disconnect and plug the hoses going to the accessory pump.

NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.

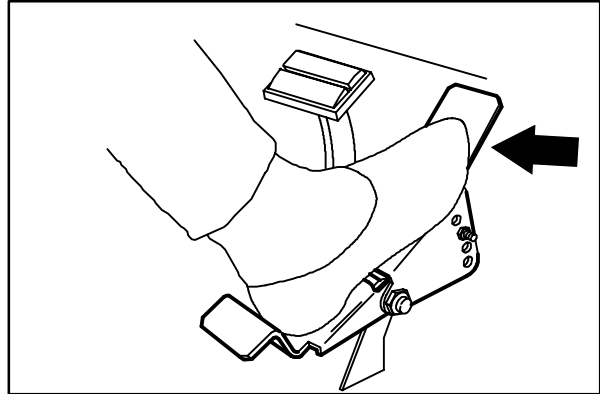
4. Remove the two 0.375 in. hex screws holding the accessory pump to the propel pump.
5. The accessory pump can now be removed from the machine.
6. Place the accessory pump in a vice and remove the hydraulic fittings. Install the fittings in the new pump in the same orientation.
7. Position the accessory pump back in the end of the propel pump. Make sure the rubber O-ring is in place on the accessory pump. Reinstall the two 0.375 in. hex screws and tighten to 36 – 40 Nm (27 – 30 ft lb). Use loctite 242 blue on the threads.
8. Reconnect the hydraulic hoses to the accessory pump. Use the schematic in this section. Refill the hydraulic tank if it was drained earlier.
9. Start the machine and check the accessory circuit for proper operation.
10. Reinstall the front dust panel and tighten the four M8 hex screws to 18 – 24 Nm (15 – 20 ft lb). Lower the hopper.



DIRECTIONAL PEDAL

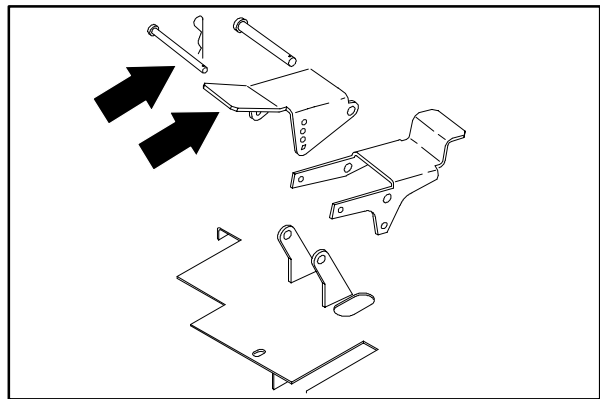
The directional pedal controls the flow of hydraulic fluid to the hydraulic propelling motor.

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.



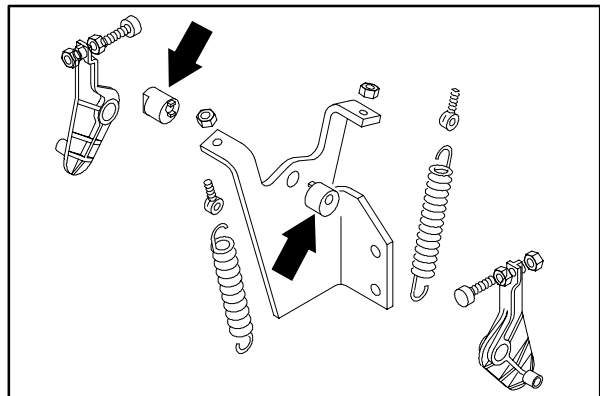
TO ADJUST DIRECTIONAL CONTROL FOOT PEDAL - 385 ONLY

1. Remove the hair cotter pin holding the clevis pin in place.
2. Remove the clevis pin.
3. Position the top portion of the directional pedal at the desired angle.
4. Align the holes and slide the clevis pin through.
5. Secure the pin with a hair cotter pin.

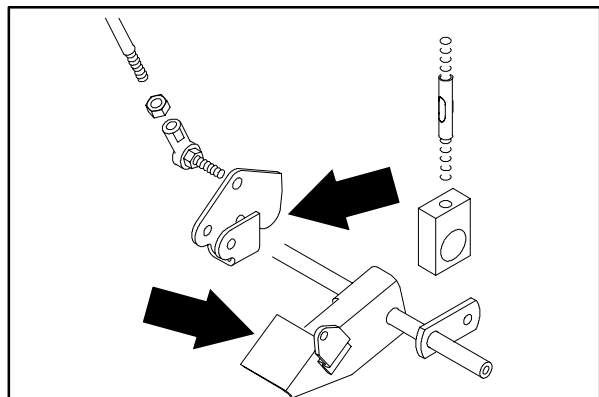
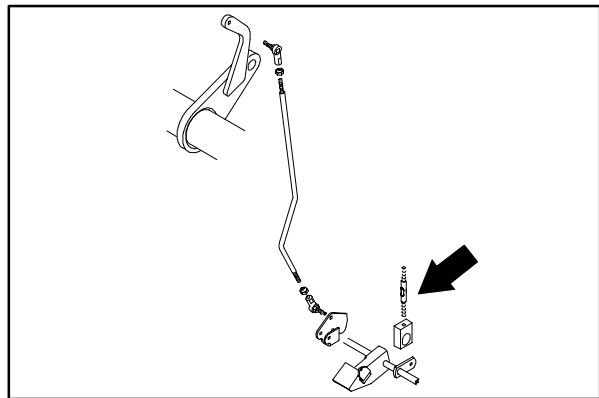
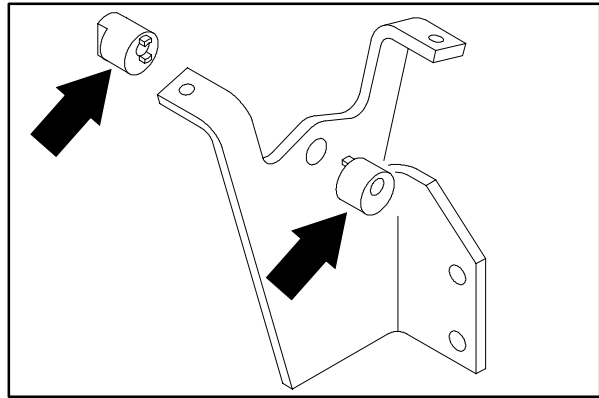


TO ADJUST DIRECTIONAL CONTROL LINKAGE

1. Engage the parking brake.
2. Jack up the rear of the machine. Place jack stands under the frame and lower the machine down.
3. Open engine hood and side door.
4. Locate the centering spring cam arms and cam on the propel pump, near the center frame tube. Loosen the M8 cam bolt.
5. Start the engine.
6. Adjust the cams so the rear wheel does not turn. Turning the cams toward the front of the machine will make the wheel go forward. Turning the cams toward the rear of the machine will make the wheel go backward.



7. Stop the engine.
8. Hold the cams in position and tighten the cam bolts.
9. Start the engine and test to verify adjustment. Repeat if necessary.
10. Lower the machine.
11. Start the engine. Move the directional control pedal forward and backward to make sure machine will not move when the directional control pedal is in neutral. Readjust as necessary.
12. Raise the hopper and engage hopper support bar.
13. The machine should travel 1.6 kmh (1 mph) maximum forward speed. To adjust, turn the speed control rod (directional control rod with a balljoint and a vibration isolator.) Turning the rod clockwise, as viewed from above, will slow machine. Turning it counterclockwise will speed machine.
14. Lower the hopper and stop the engine.
15. Check the gap between the speed limiter bracket and the contact surface as the drive linkage rod assembly is 1.5–3 mm (0.06 – 0.12 in).
16. Adjust the balljoint on the end of the speed control rod to get the correct gap. Tighten all jam nuts.



HYDRAULICS

TO REPLACE HOPPER LIFT CYLINDER

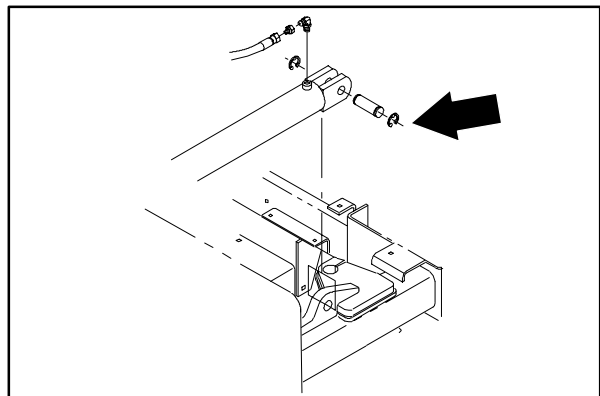
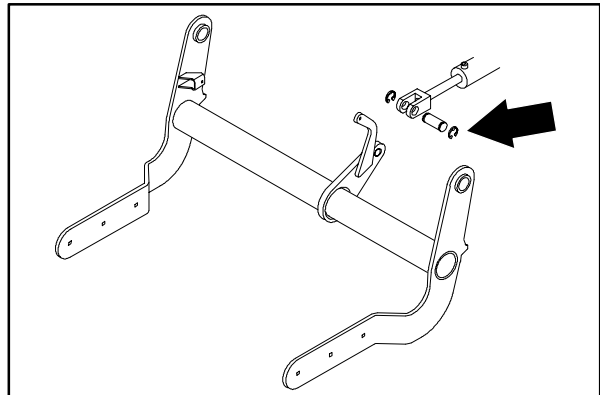
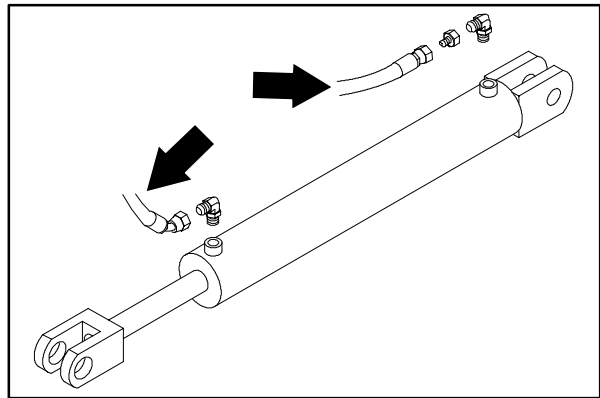
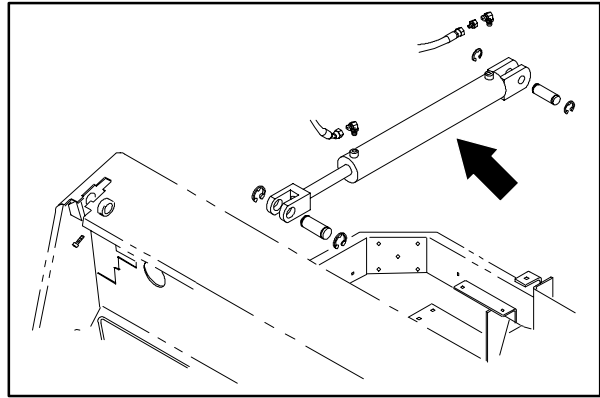
1. Empty the debris hopper.
2. Set the machine parking brake.
3. Raise the hopper and engage the safety arm. Shut off the engine. Move the hopper lift handle back and forth a few times.

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 and retain one of the "C" clips from the grooved pin in the upper clevis of the lift cylinder. Remove the grooved pin.
6. Remove and retain one of the "C" clips from the grooved pin in the lower clevis of the lift cylinder. Remove the grooved pin. Remove the old lift cylinder from the machine.
7. Remove the fittings from the old cylinder and install in the new cylinder in the same orientation.
8. Position the new cylinder in the machine with the rod end pointing to the front of the machine.
9. Align the bottom of the lift cylinder with the hole in the frame mount lug. Reinstall the grooved pin and "C" clip.
10. Align the top of the lift cylinder with the hole in the lift arm cylinder mount lug. Reinstall the grooved pin and "C" clip.
11. Reconnect the hydraulic hoses to the new cylinder. See schematic in this section.
12. Start the machine and raise the hopper. Check for any leaks and proper operation.

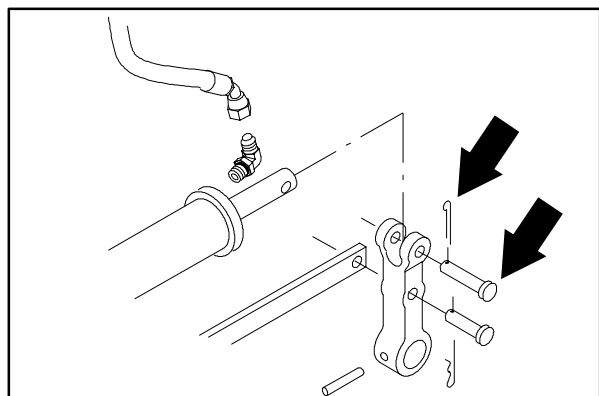
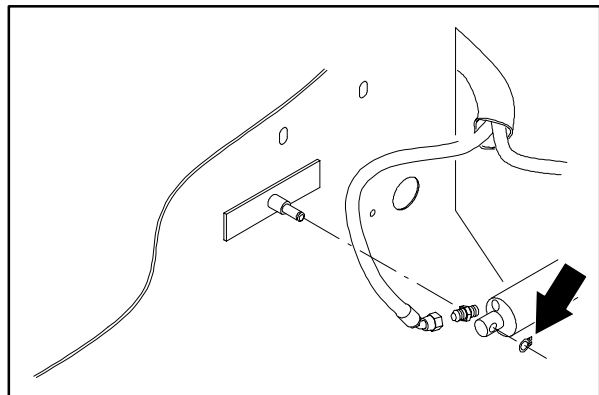
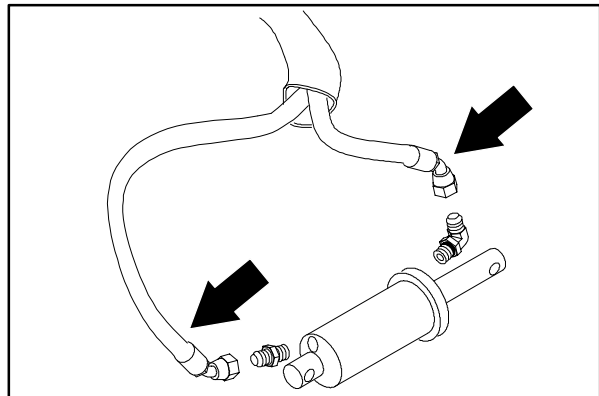
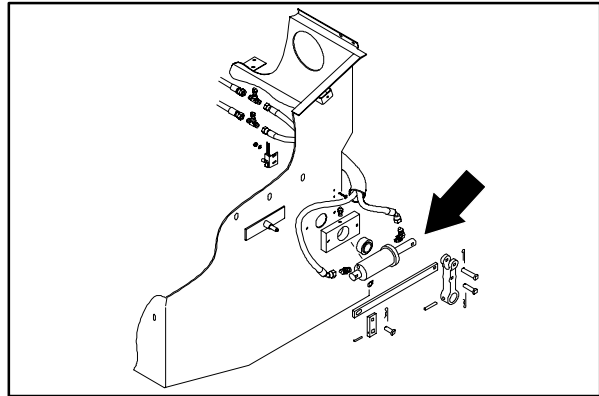


TO REPLACE HOPPER DUMP DOOR CYLINDER

1. 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.

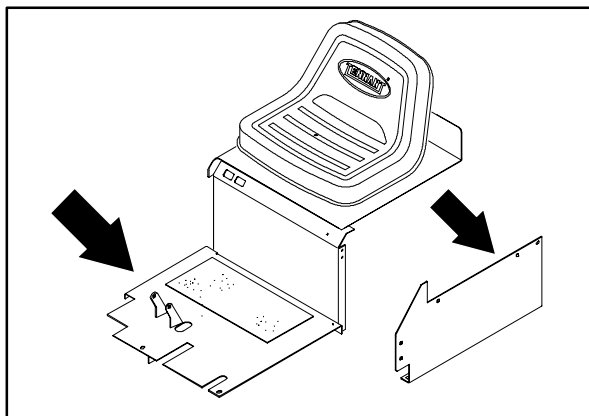
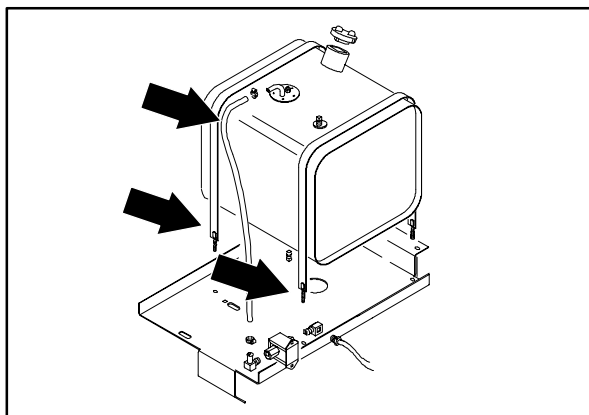
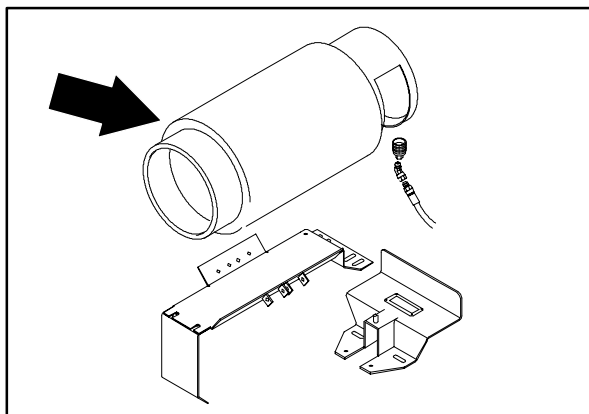
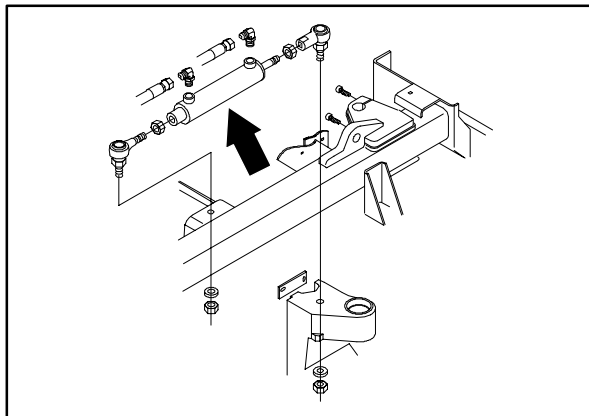
2. Open the hopper cover.
3. Disconnect and plug the two hoses leading to the hopper dump door cylinder.
4. Remove the retaining ring from the front cylinder mount pin.
5. Remove the cotter pin and clevis pin from the rear of the dump door cylinder where it attaches to the pivot yoke.
6. Remove the old cylinder from the hopper.
7. Remove the fittings from the old cylinder and install in the new cylinder in the same orientation.
8. Position the new cylinder in the machine with the rod end pointing to the rear of the machine hopper.
9. Slip the piston end of the new cylinder over the pin on the hopper. Reinstall the retaining ring.
10. Reinstall the clevis pin and cotter pin in the rod end of the dump door cylinder and the door pivot yoke.
11. Reconnect the hydraulic hoses to the dump door cylinder. See the schematic in this section.
12. Start the machine and open and close the hopper dump door. Check for any leaks and proper operation.



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 rear frame for safety.
2. Open the engine cover and side door.
3. Disconnect the battery cables and remove the battery from the machine.
4. Open the right rear machine casting.
5. **LPG machines:** Disconnect the LP tank and remove it.
6. **Gas and Diesel machines:** Disconnect the fuel lines at the tank. Remove the two tank straps. Remove the fuel tank from the machine.
7. Turn the steering wheel to the left so the rear drive casting can be accessed from the fuel tank area of the machine.
8. Disconnect the directional control pedal from the control rod balljoint.
9. Remove the four M8 hex screws holding the floor plate to the machine. Remove the floor plate from the machine.
10. Remove the two M6 pan head screws and four M8 hex screws holding the lower inside panel to the machine. Remove the panel from the machine.
11. Remove the 0.750 in. nyloc nut holding the piston end of the steering cylinder rod end to the machine frame.
12. Remove the clamp holding the drive motor hydraulic hoses to rear casting. Move the hoses to gain access to the steering cylinder.
13. Remove the 0.750 in. nyloc nut holding the steering cylinder rod end balljoint to the rear drive casting.



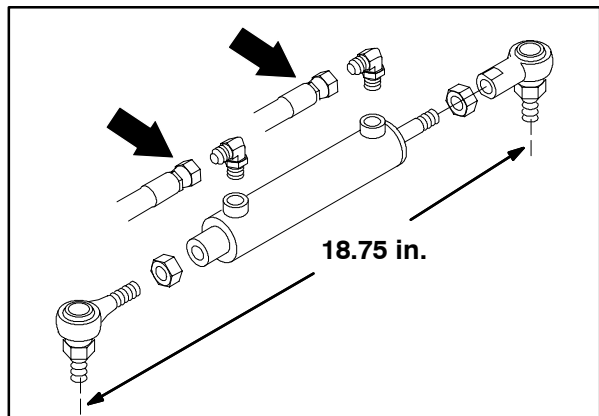
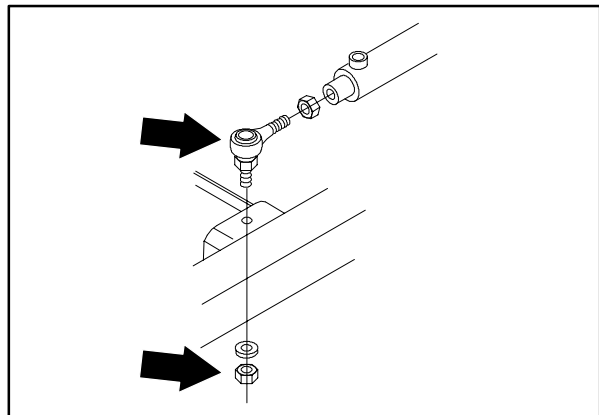
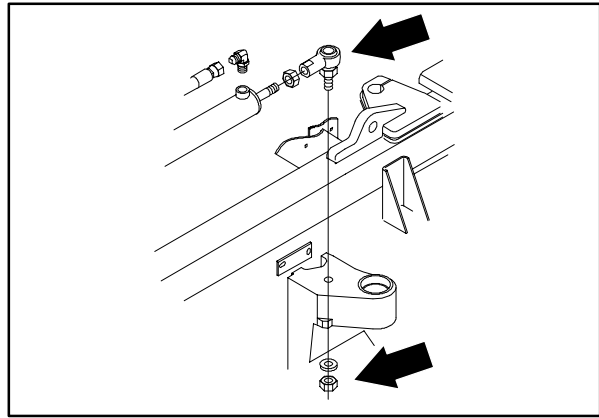
14. Disconnect and cap the two hydraulic hoses leading to the steering cylinder.

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

15. Remove the steering cylinder from the machine.
16. Remove the fittings from old cylinder. Install the fittings in the new cylinder in the same orientation.
17. 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.
18. Position the new steering cylinder and balljoint assembly in the machine with the rod part of the cylinder toward the rear of the machine.
19. Reinstall the 0.750 in. nyloc nuts on the steering cylinder balljoints and hand tighten as tight as possible.
20. Reconnect the hydraulic hoses to the steering cylinder. See schematic in this section.

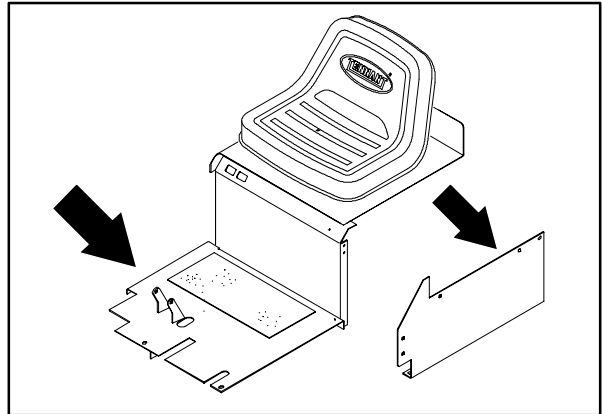
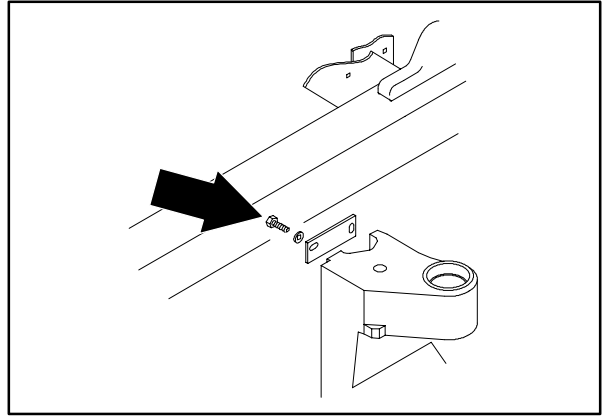
NOTE: Always observe hydraulic cleanliness requirements when opening hydraulic lines.

21. Reinstall the lower inside panel on the machine. Tighten the two M6 pan head screws to 11 - 14 Nm (7 - 10 ft lb) and the four M8 hex screws to 18 - 24 Nm (15 - 20 ft lb).



HYDRAULICS

22. Reinstall the floor plate in the machine.
Tighten the four M8 hex screws to 18 – 24 Nm (15 – 20 ft lb).
23. Reconnect the directional control pedal to the control rod balljoint. Hand tighten tight.
24. Reinstall the clamp holding the drive motor hydraulic hoses to rear casting.
25. **LPG machines:** Reinstall the LP tank.
26. **Gas and Diesel machines:** Reinstall the fuel tank and straps. Reconnect the fuel lines to the tank.
27. Reinstall the battery and reconnect battery cables.
28. Close the right rear casting.
29. Remove jack stands from machine and lower.
30. With the seat in the up position, start machine and turn steering wheel in both directions. Observe the steering cylinder for any leaks.



TO REPLACE STEERING VALVE

1. Raise the hopper and engage the safety arm.

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

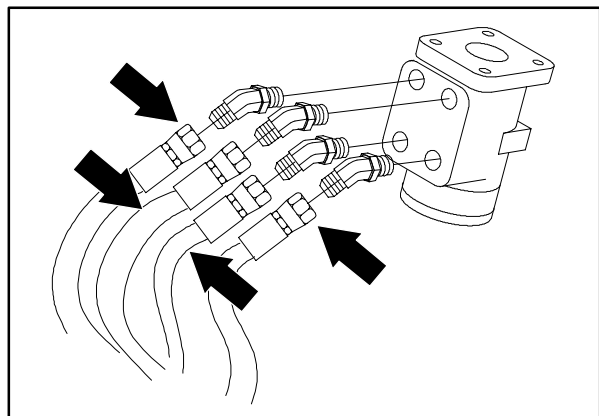
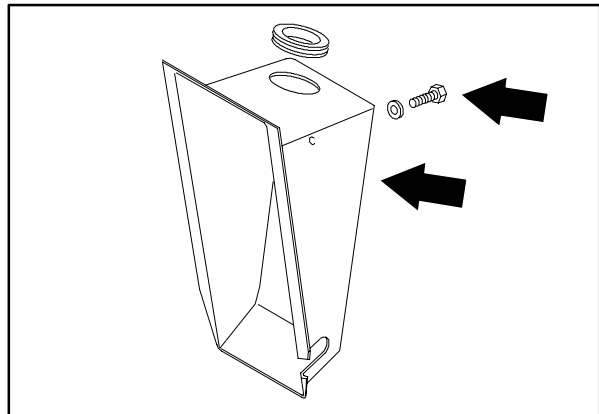
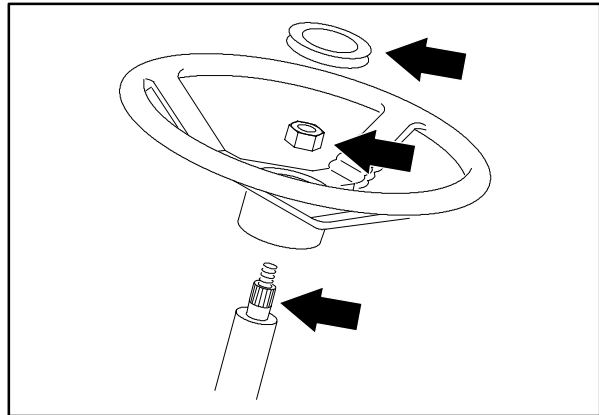
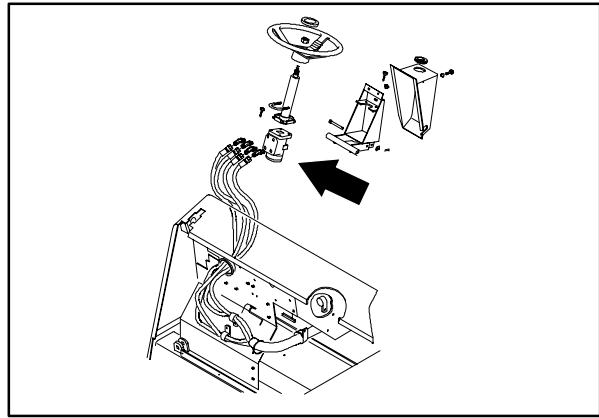
2. Turn off the engine and engage the parking brake.
3. Remove battery cables from battery.
4. Remove the rubber cap in the center of the steering wheel. Remove the large nut.
5. Remove the steering wheel.

NOTE: A puller may have to be used to remove the steering wheel from the steering valve shaft.

6. Remove the two M6 pan head screws holding the plastic steering valve cover to the tilt bracket. Remove the steering valve cover from the machine.
7. Tilt the steering wheel to the lowest position.
8. Remove and plug the four hydraulic hoses on the steering control motor.

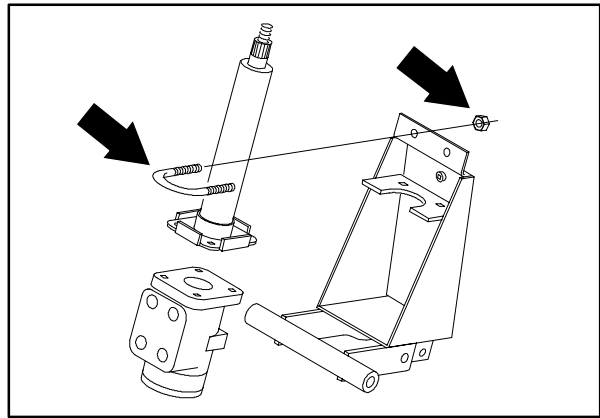
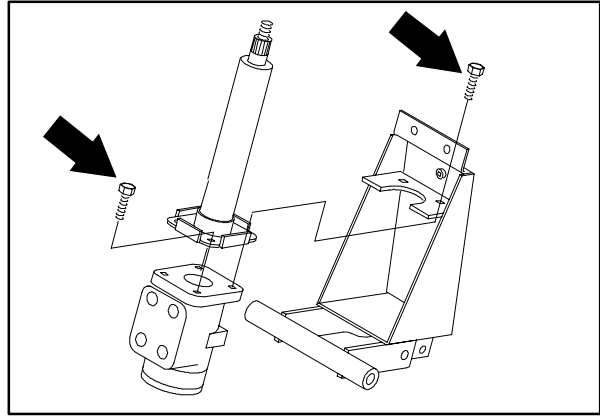
NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.

9. Remove the four 0.375 in. hex screws holding the hydraulic steering valve to the steering column.
10. Remove the two 0.31 in. hex nuts holding the U-bolt to the steering bracket. Remove the U-bolt from the bracket.
11. The hydraulic steering valve can now be removed from machine.
12. Remove hydraulic fittings from old control motor. Install the fittings in the new valve in the same orientation.



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13. Install the new hydraulic steering valve in the machine. Position the ports at the same angle as the old valve. Reinstall the four 0.375 in. hex screws and tighten to 31 – 40 Nm (27 – 35 ft lb).
14. Reinstall the U-bolt and two 0.31 in. hex nuts. Hand tighten lightly.
15. Reconnect the hydraulic hoses to hydraulic steering valve. See the schematic in this section.
16. Reinstall the plastic steering cover and two M6 pan head screws. Tighten to 11 – 14 Nm (7 – 10 ft lb).
17. Reinstall the steering wheel on the steering column. Tighten the wheel nut to 18 – 24 Nm (15 – 20 ft lb).
18. Reinstall the rubber steering wheel cover.
19. Reconnect the battery cables and start engine. Move the steering wheel checking for any leaks and proper operation.



HYDRAULIC CONTROL VALVE

The hydraulic control valve serves three functions; **1.** The hopper up and down. **2.** The brushes on and off. **3.** The hopper dump door open and close.

TO REPLACE CONTROL VALVE

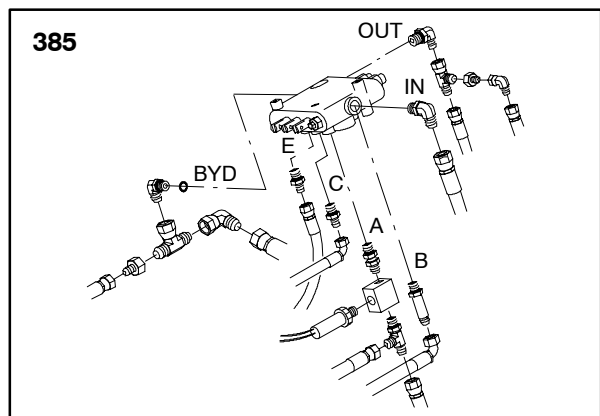
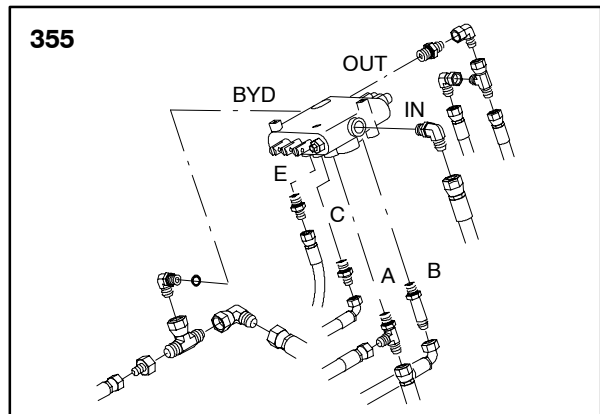
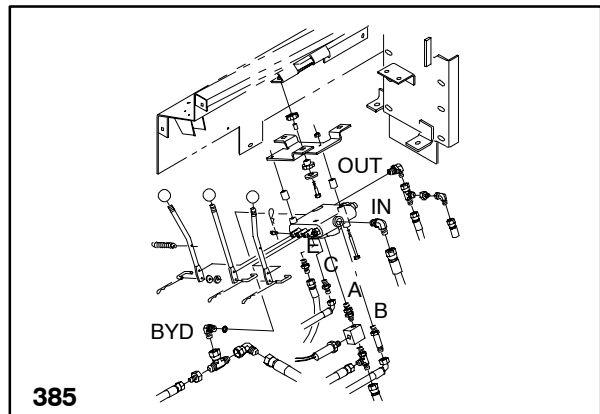
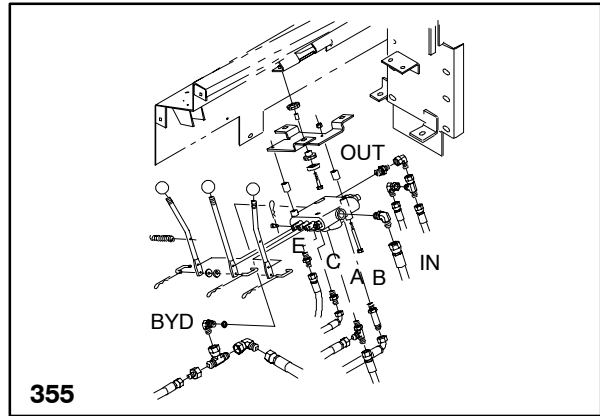
1. Raise the hopper and engage the safety arm.

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

2. Remove the three valve handle knobs.
3. Open the engine cover and side door.
4. Mark and disconnect the hydraulic hoses from the control valve. Start with the hose nearest the outside of the machine and work toward the operators compartment.

NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.

5. Remove the two M6 hex screws and nyloc nuts holding the control valve to the valve mount bracket. Remove the valve from the machine.
6. Remove the fittings from the old valve and install in the new valve in the same orientation.
7. Install the new valve back on the valve mount bracket. Make sure the handles go through the handle bellows in the machine center panel. Reinstall the two M6 hex screws and nyloc nuts. Tighten to 11 - 14 Nm (7 - 10 ft lb).
8. Reconnect the hydraulic hoses. See schematic in this section.
9. Thread the three valve knobs on the valve handles. Use a small amount of blue lockite.
10. Check the hydraulic fluid level.
11. Start the machine and check the control valve for proper operation.



HYDRAULICS

TO REPLACE MAIN BRUSH MOTOR

1. Raise the hopper and engage the safety arm.

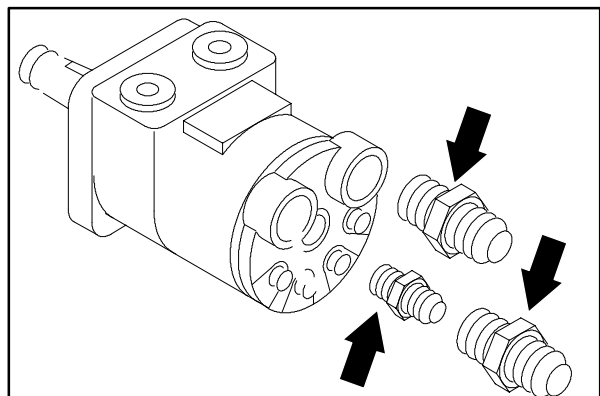
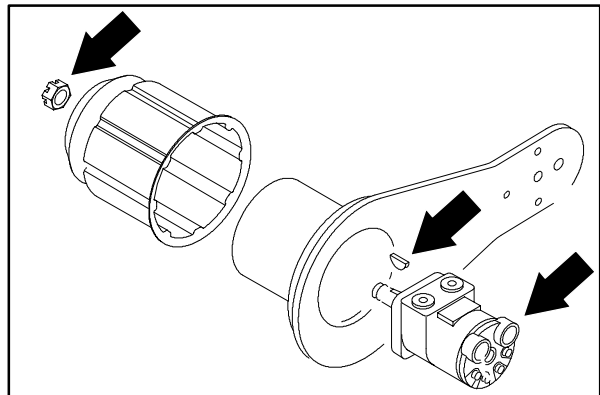
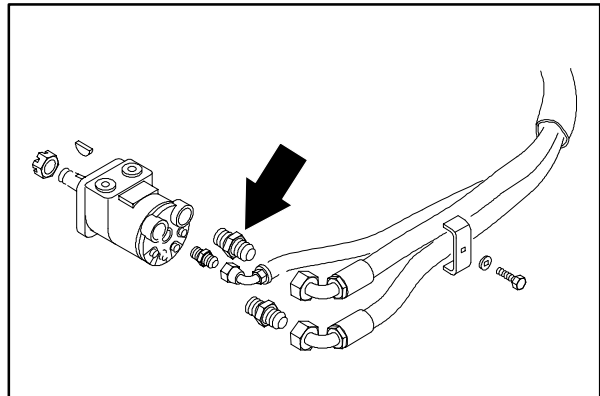
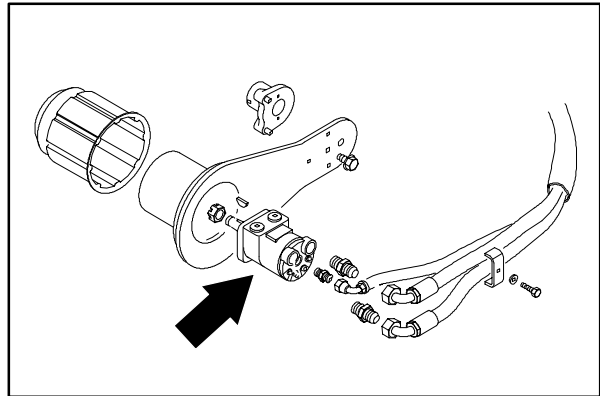
⚠ WARNING: Raised Hopper May Fall. Engage Hopper Support Bar.

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 and plug the hydraulic hoses from the main brush motor.

NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.

4. Remove the cotter pin from castle nut at the end of main brush drive motor plug.
5. Hold the brush drive plug and remove castle nut.
6. A puller must be used to remove the brush drive plug from tapered shaft on the main brush motor.
7. Remove the four .375 hex screws holding the main brush motor to the brush arm.
8. Remove the hydraulic fittings from old motor and install in the new motor in the same orientation.
9. Install the new main brush motor in the brush arm. Tighten the .375 hex screws to (27 – 53 ft lb). Make sure the corners of brush motor line up with the slots in brush arm.
10. Reconnect the hydraulic hoses to the new motor. See schematic in the HYDRAULIC section.
11. Reinstall the brush drive plug back on the tapered shaft of the new motor. Make sure the key is in place.
12. 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.
13. Reinstall the main brush. Operate the machine and check for proper operation.



TO REPLACE SIDE BRUSH MOTOR

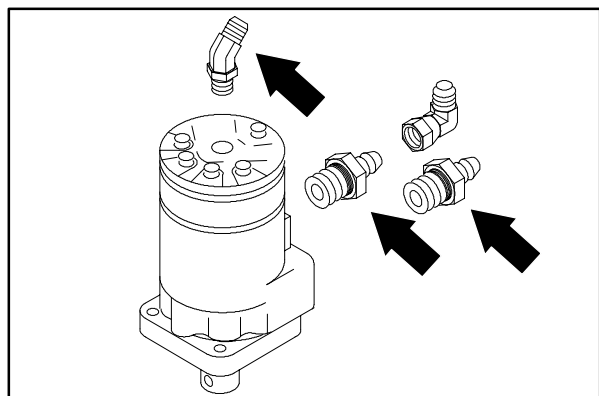
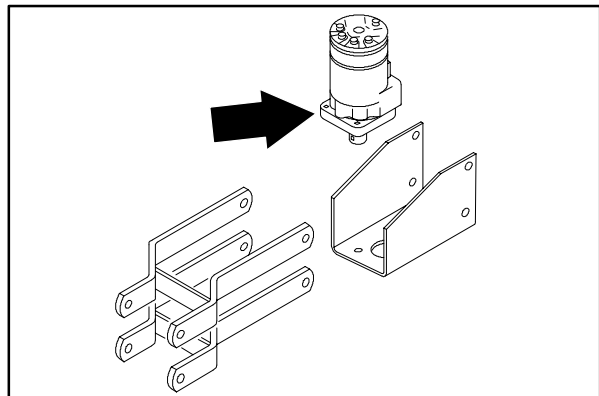
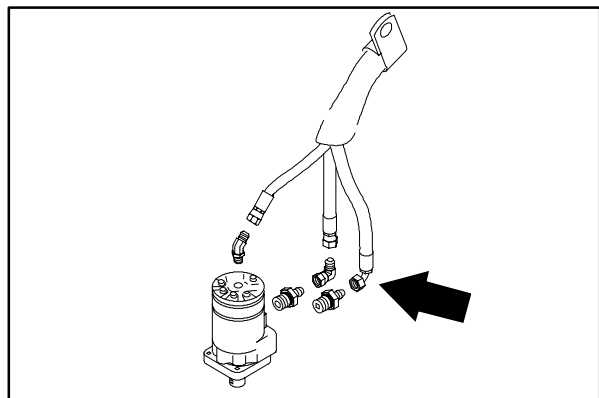
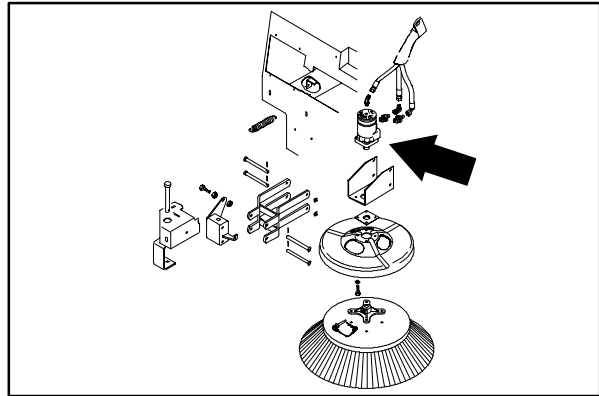
1. Empty the debris hopper.
2. Set the machine parking brake.
3. Raise the hopper and engage the safety arm. Shut off the engine.

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 from the side brush motor.

NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.

7. Remove the four .375 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 the HYDRAULICS 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 knob.

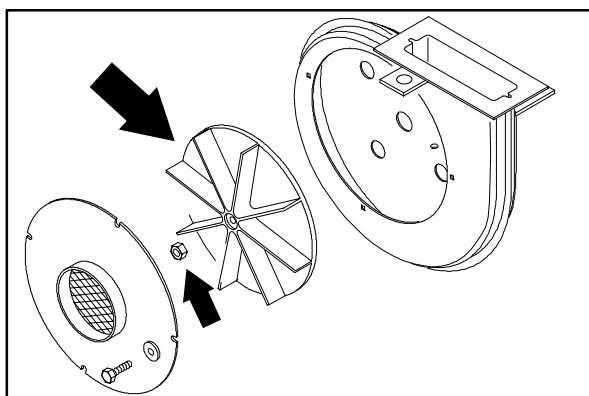
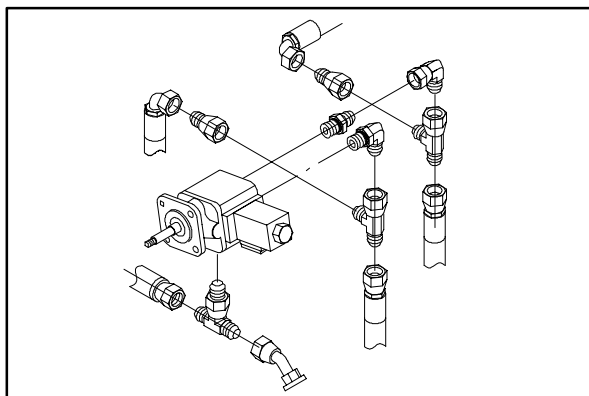
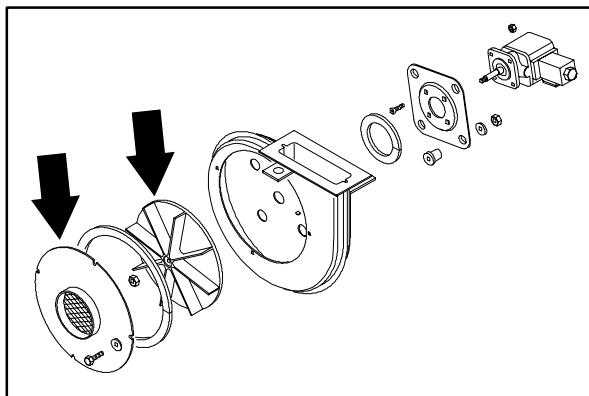
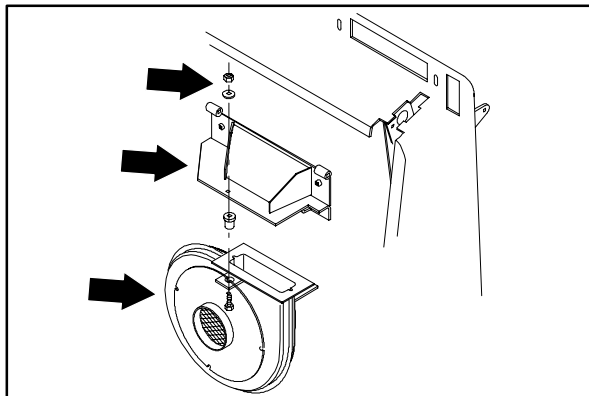


TO REPLACE VACUUM FAN MOTOR

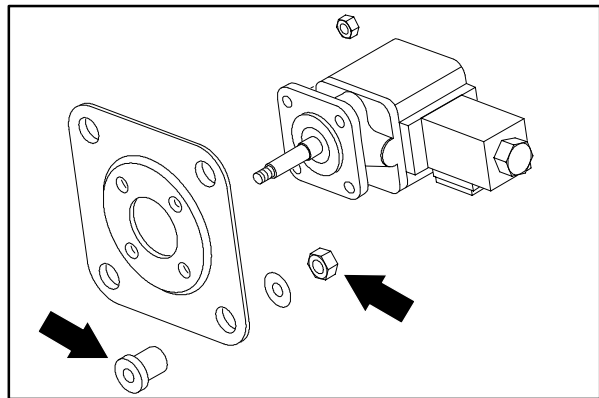
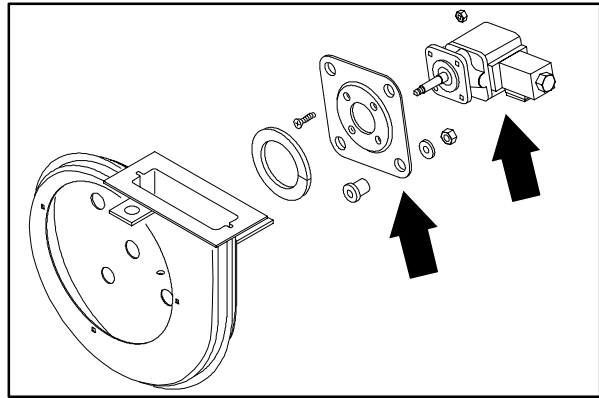
1. Park the machine on a smooth, level surface.
2. Stop the engine and set the machine parking brake.

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

3. Remove vacuum fan from machine. See TO REMOVE SWEEPING VACUUM FAN instructions.
4. Place the vacuum fan assembly in a vice.
5. Remove the four 0.25 in. hex screws and fender washers holding the inlet plate to the vacuum fan housing. Remove the inlet plate.
6. Hold the old impeller from turning and remove the 0.31 in. hex nut from the center of the fan motor shaft.
7. Pull the impeller off the fan motor shaft. The impeller may have to be lightly pried off. Be careful not to loose the square key.
8. Remove the four M10 nyloc nuts holding the hydraulic motor plate to the vacuum fan housing.
9. Remove the motor and plate assembly and clamp it in a vice.
10. Remove the four M8 flat head screws and nyloc nuts holding the fan motor to the motor mount plate.
11. Remove the hydraulic fittings and install in the new fan motor in the same orientation.
12. Install the new fan motor on the motor mount plate using the four M8 flat head screws and nyloc nuts. Tighten to 18 - 24 Nm (13 - 18 ft lb).



13. Reinstall the motor and mount plate back on the fan housing using the four M10 nyloc nuts and flat washers. Tighten to 18 – 24 Nm (13 – 18 ft lb). The motor should be oriented with solenoid valve pointed toward the outside of the machine.
14. Put a small amount of grease on the motor shaft before installing the new impeller. Make sure the square key is in place on the motor shaft. Slide the impeller all the way on and spin it slowly. If the impeller rubs on the housing, remove it and place a 0.38 in. flat washer on the motor shaft under the impeller and re-assemble the impeller.
15. Hold the new impeller from turning and firmly tighten the 0.31 in. flex lock nut.
16. Reinstall the inlet plate with the four 0.25 in. hex screws and fender washers. Tighten to 11 – 14 Nm (7 – 10 ft lb).
17. Reinstall the vacuum fan assembly back in the machine. See TO INSTALL VACUUM FAN instructions.

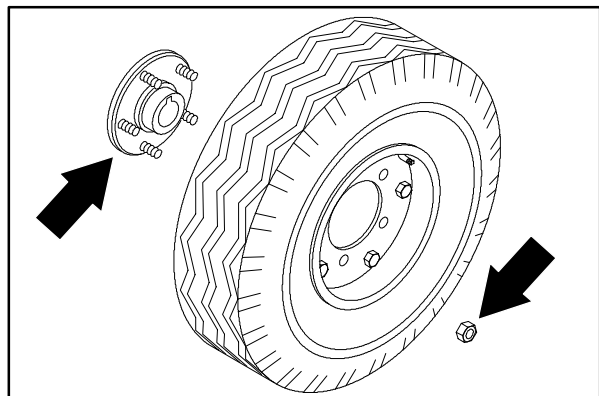


TO REPLACE REAR DRIVE MOTOR

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

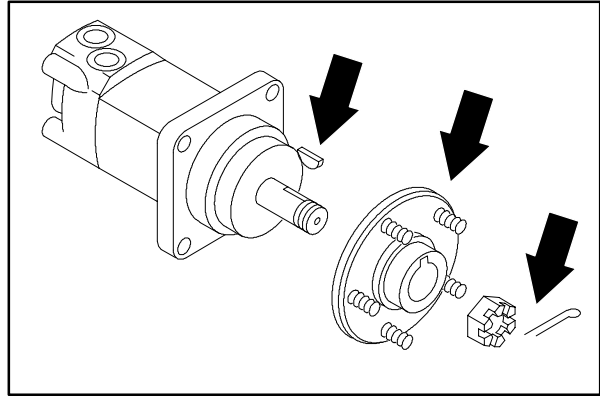
1. Engage the parking brake and block the front tires.
2. Jack up the rear of the machine. Use jack stands to support machine.

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



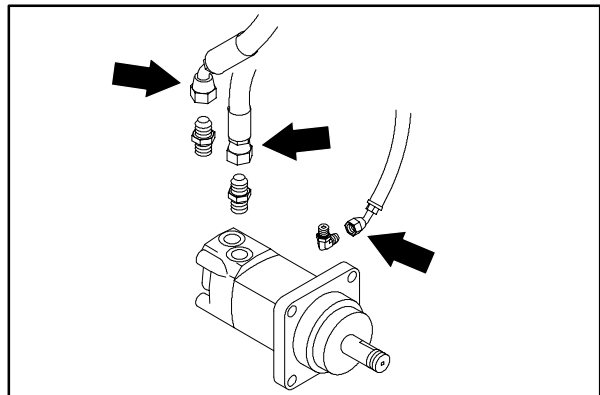
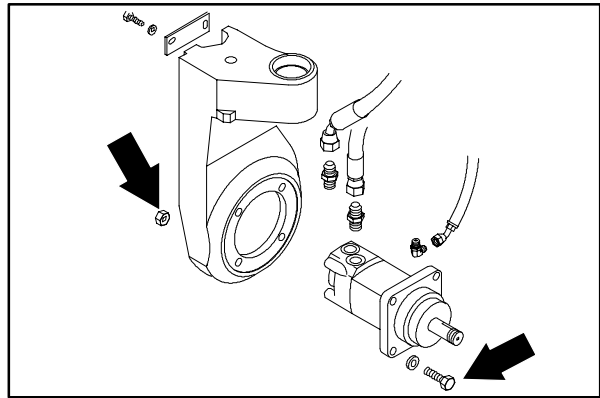
HYDRAULICS

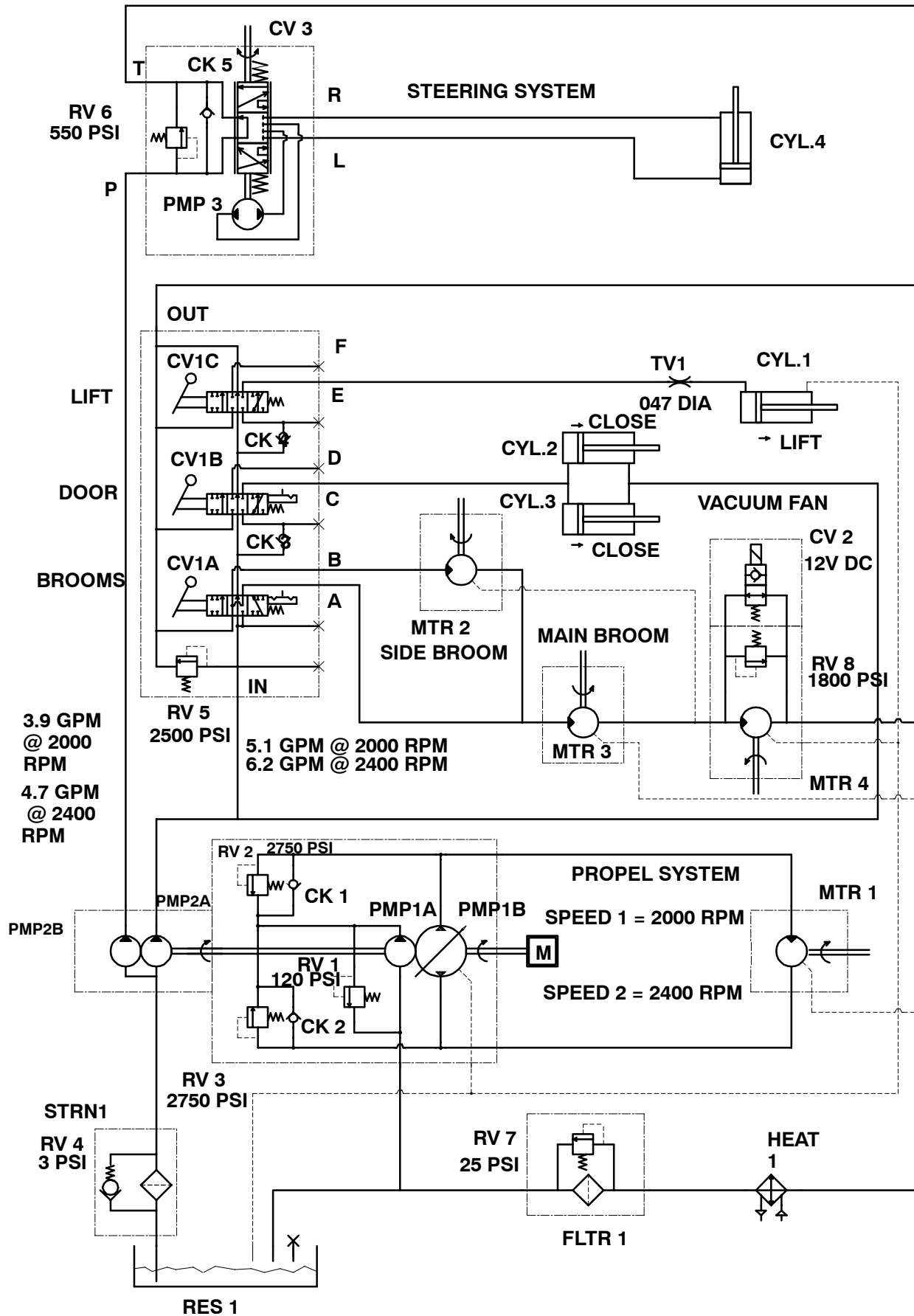
3. Remove the rear tire and wheel assembly from the drive motor hub.
4. Remove the cotter pin and slotted nut from drive wheel shaft.
5. Drive the hub off the tapered motor shaft. A puller must be used.
6. Disconnect the hydraulic hoses from the drive motor.



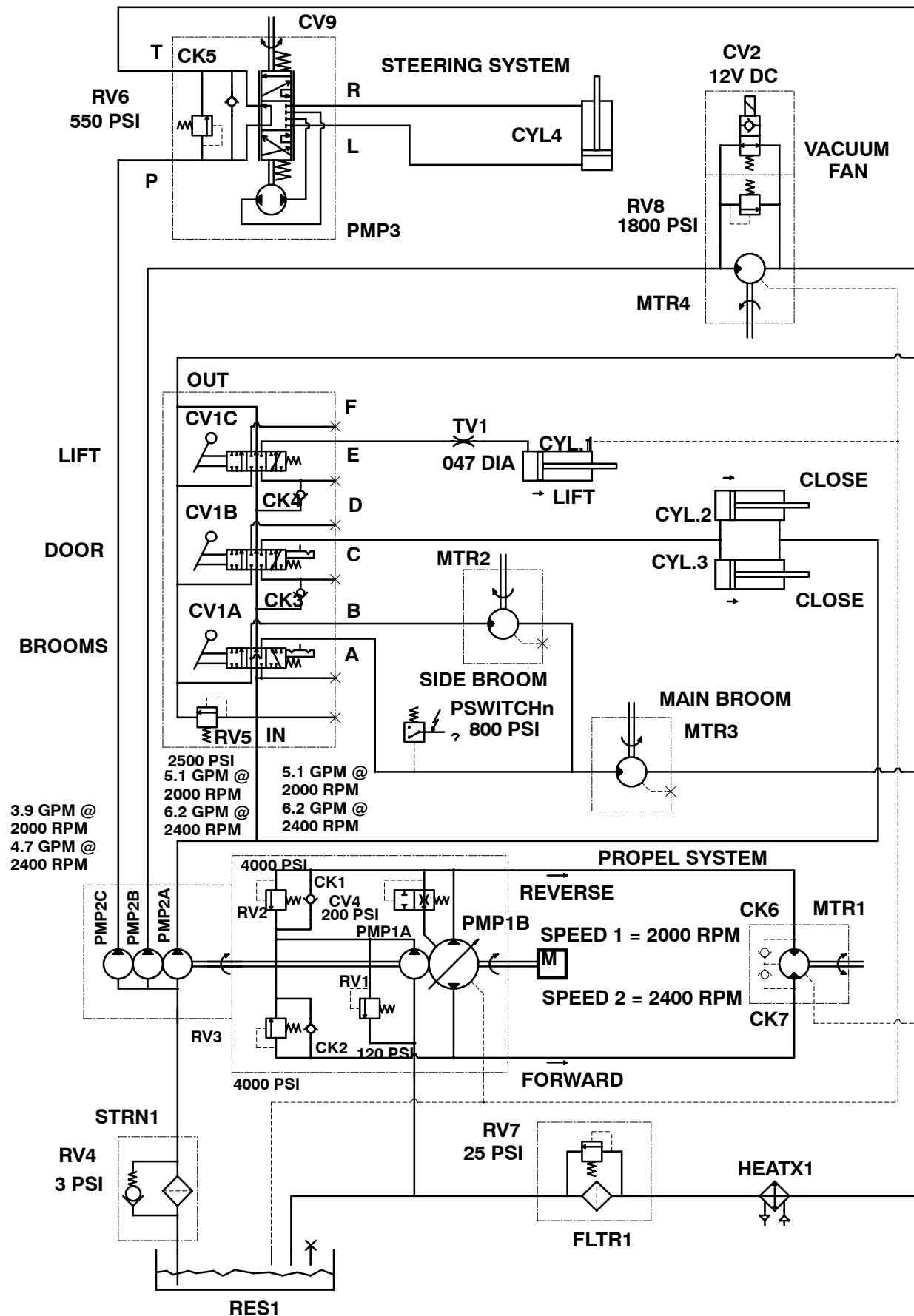
NOTE: Observe hydraulic cleanliness requirements when opening hydraulic lines.

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.
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. Lower the machine to the ground.

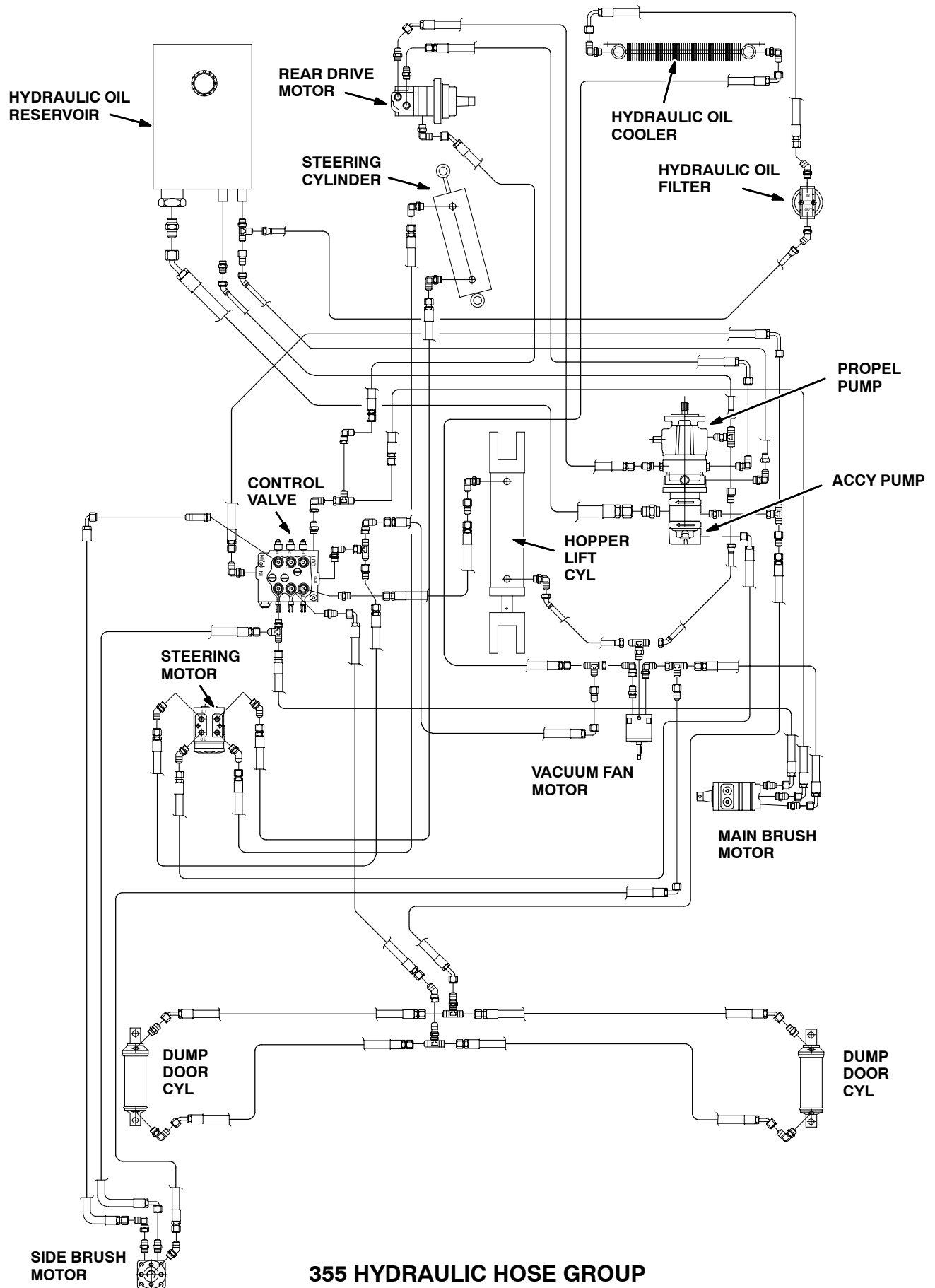


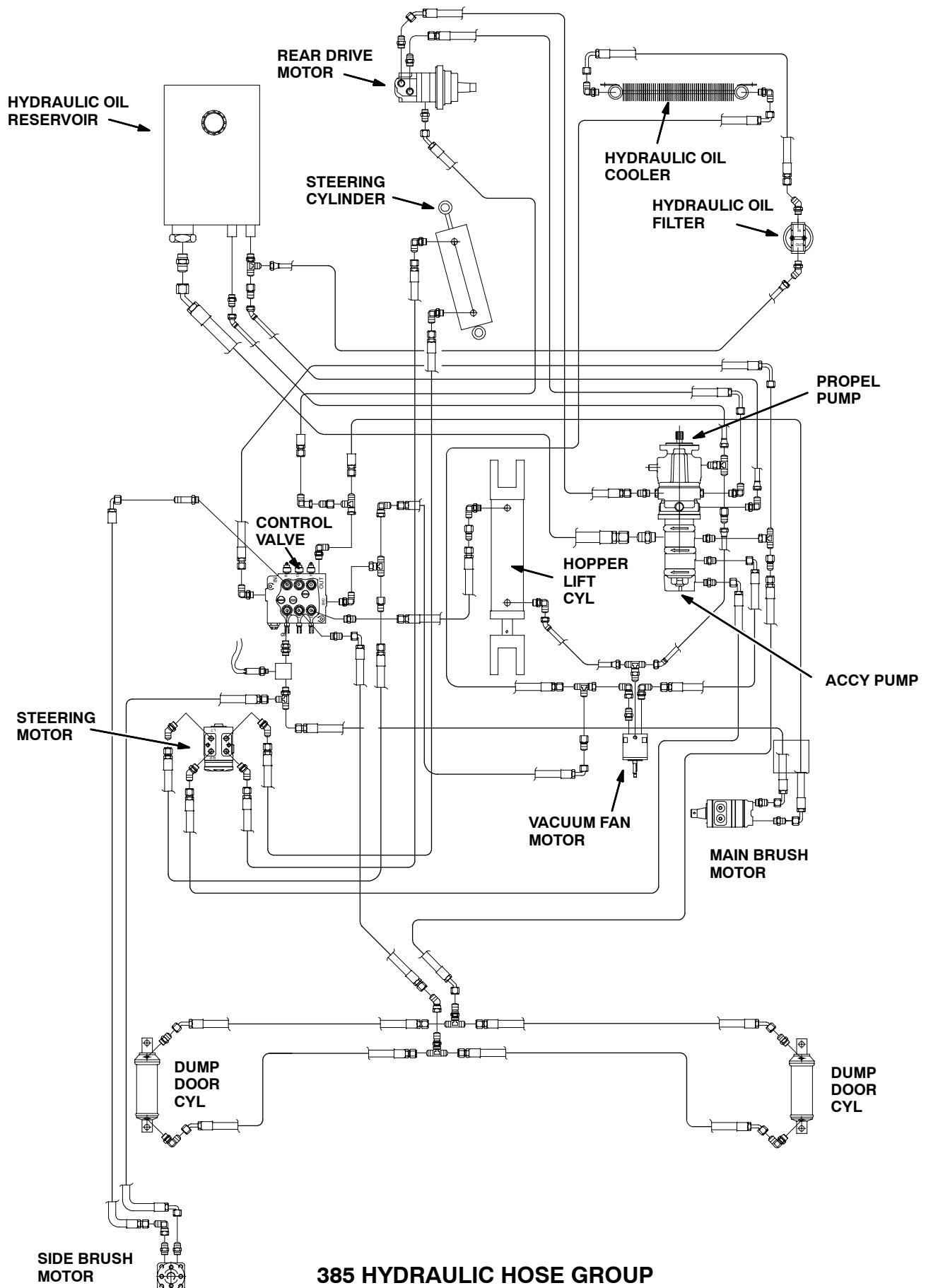


355 HYDRAULIC SCHEMATIC



385 HYDRAULIC SCHEMATIC

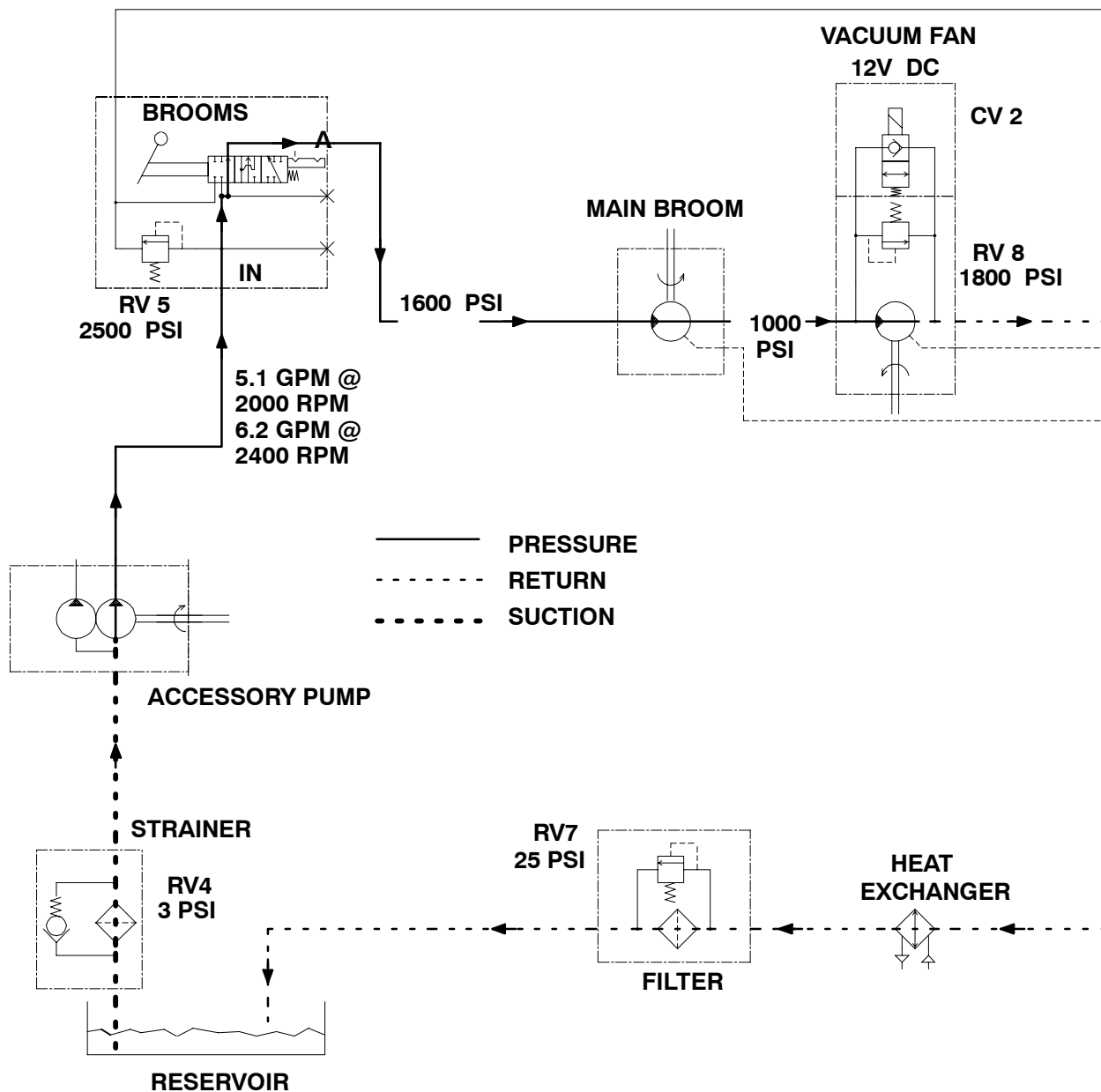




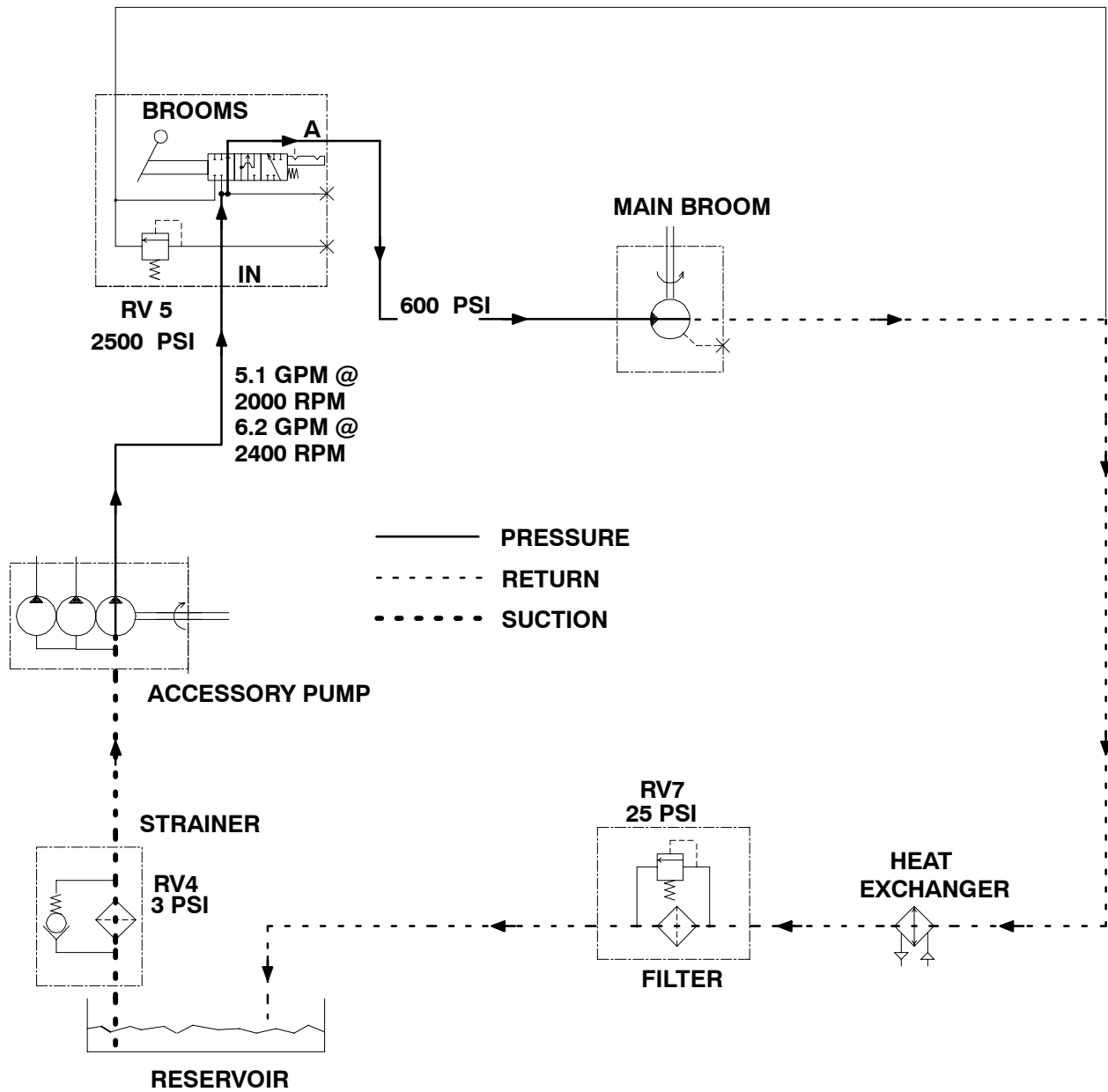
TROUBLESHOOTING

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

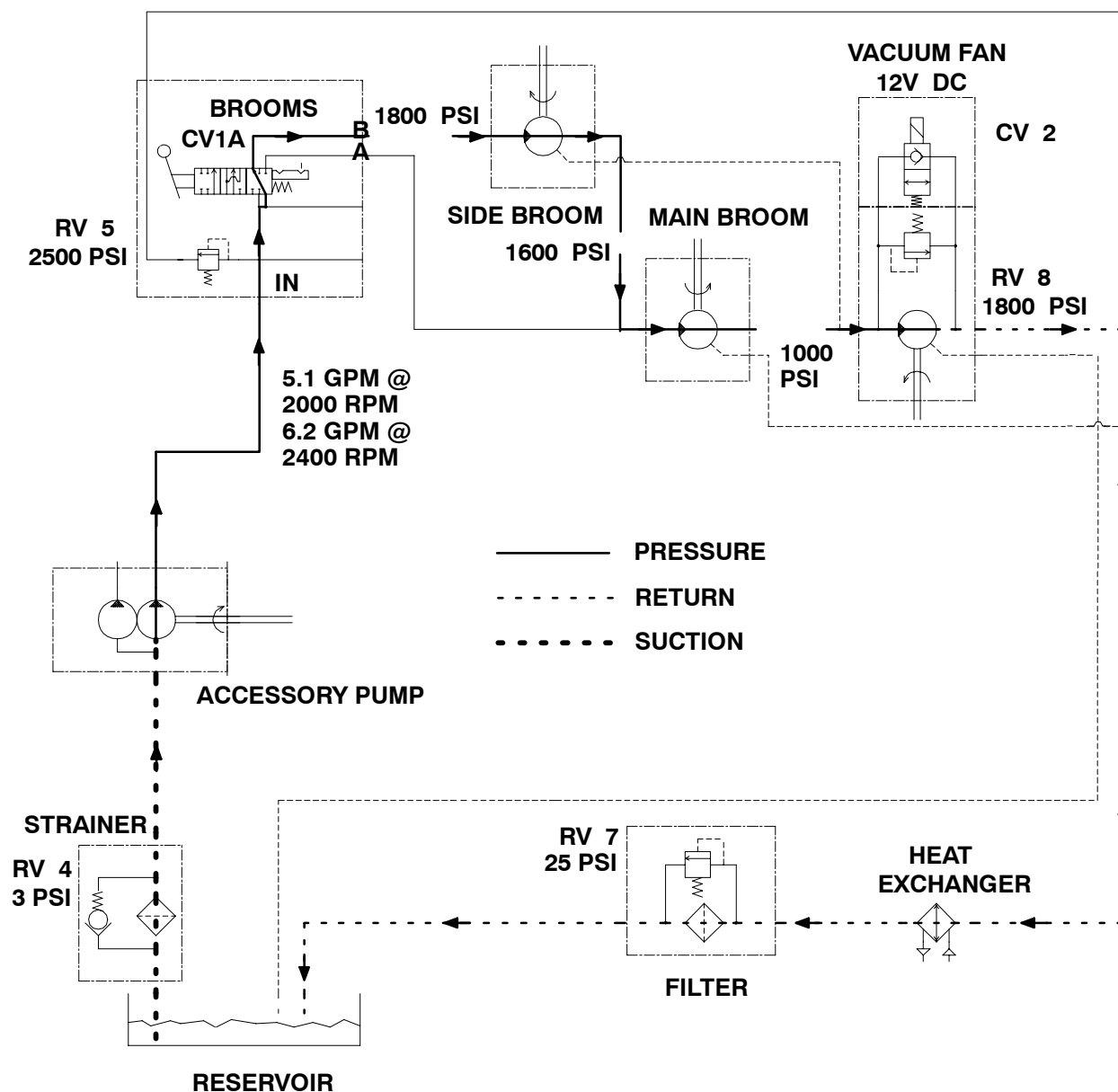
355 MAIN BRUSH / VAC FAN

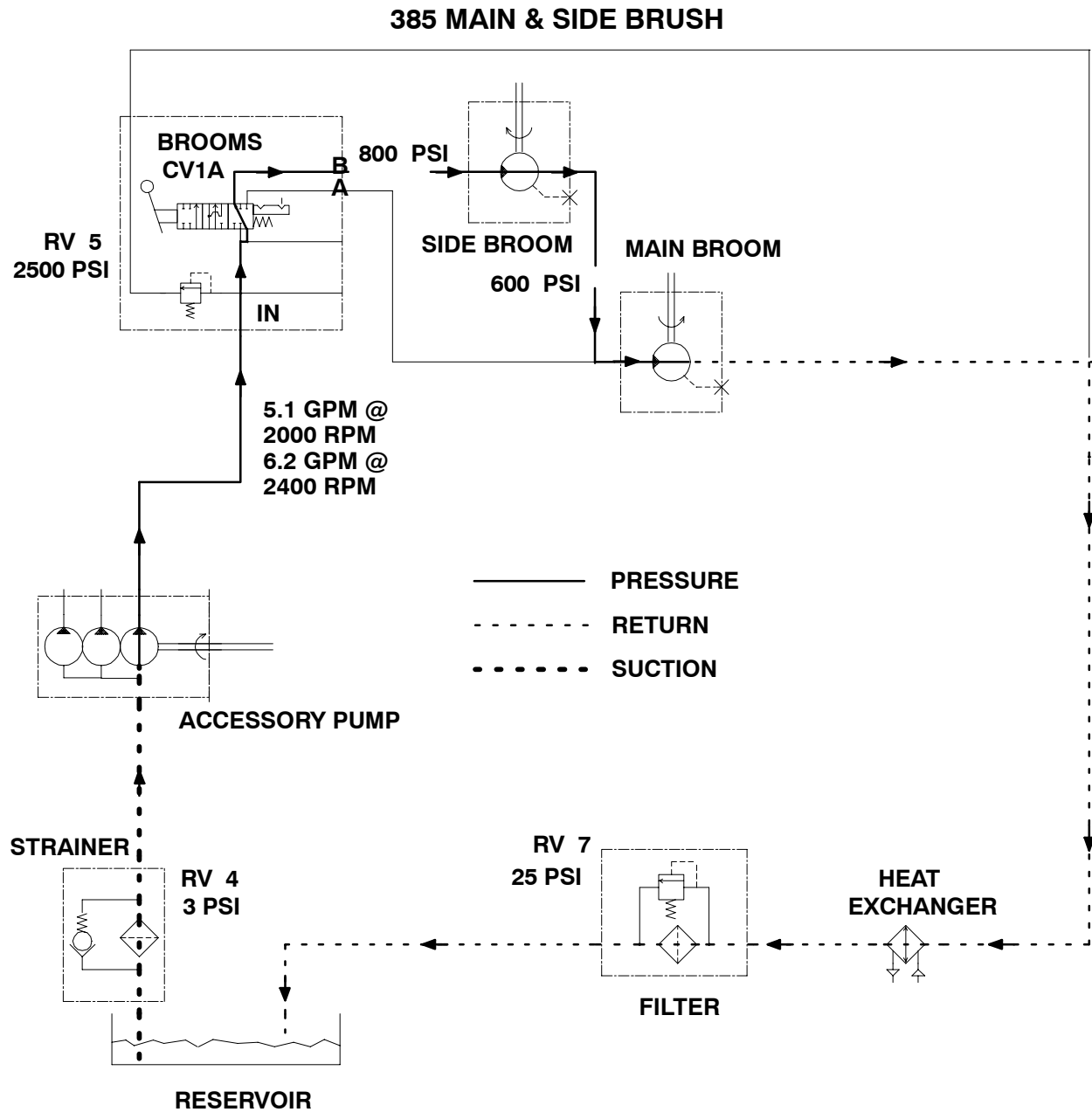


385 MAIN BRUSH

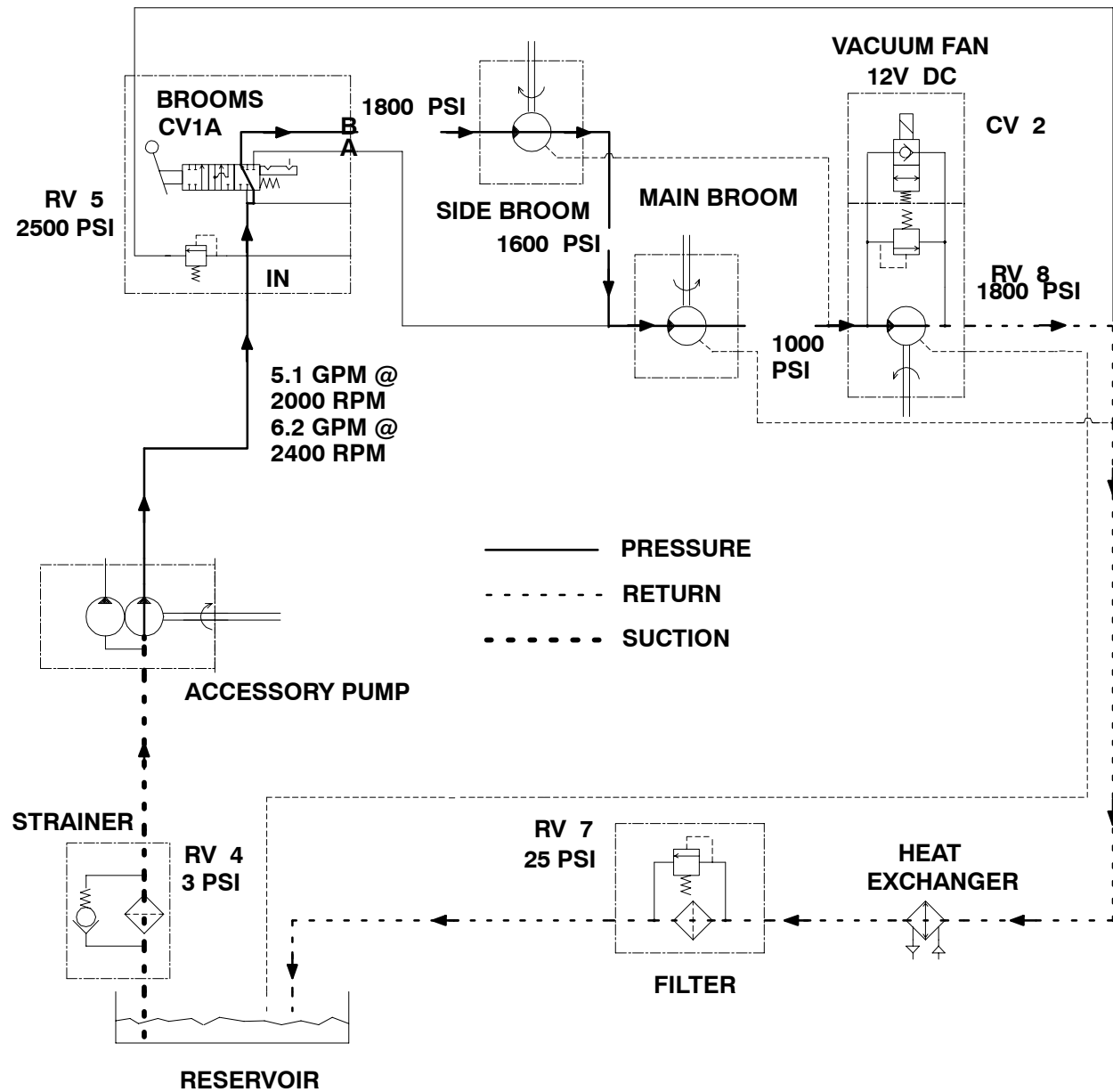


355 SIDE BRUSH/MAIN & VAC FAN

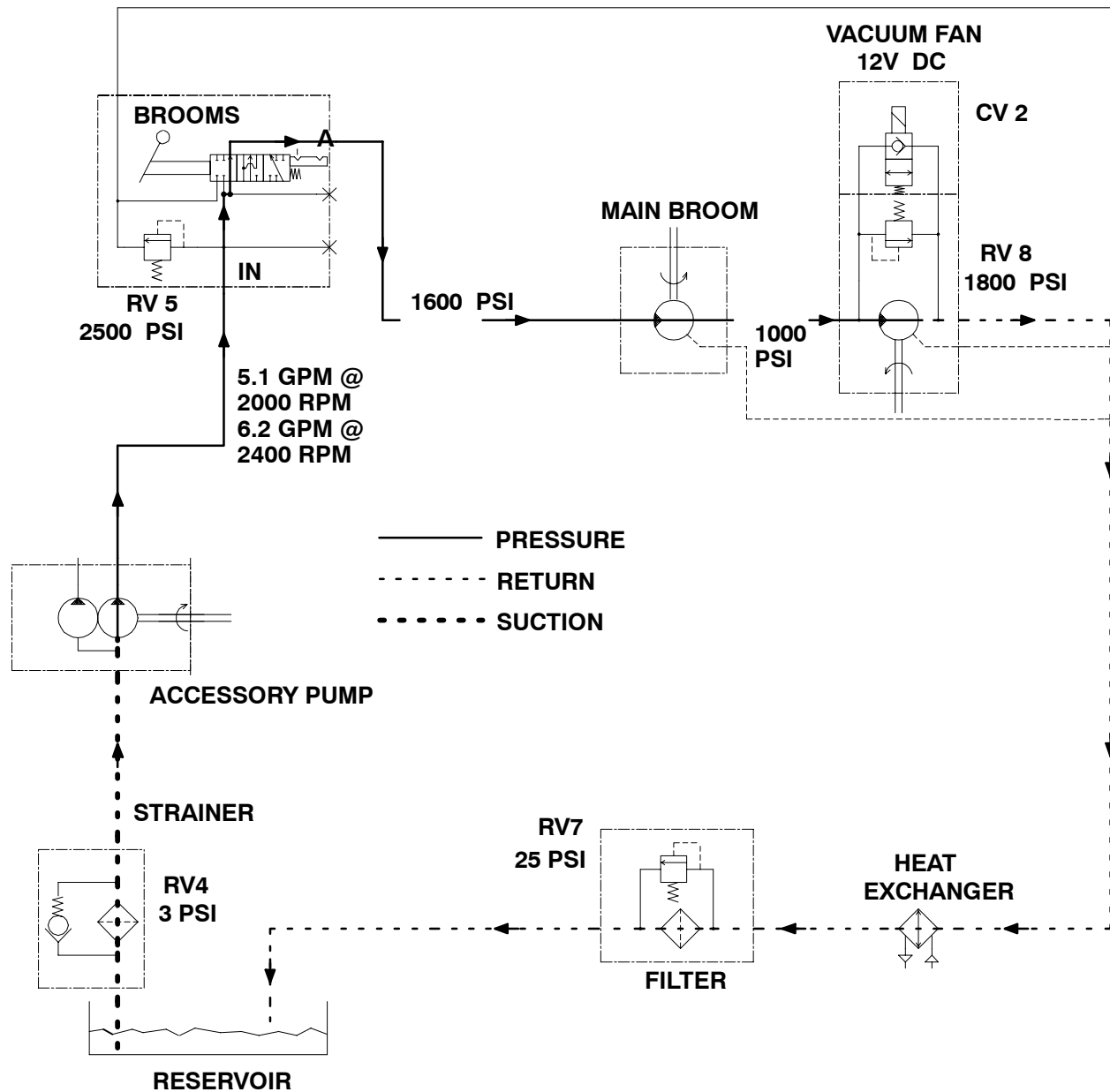


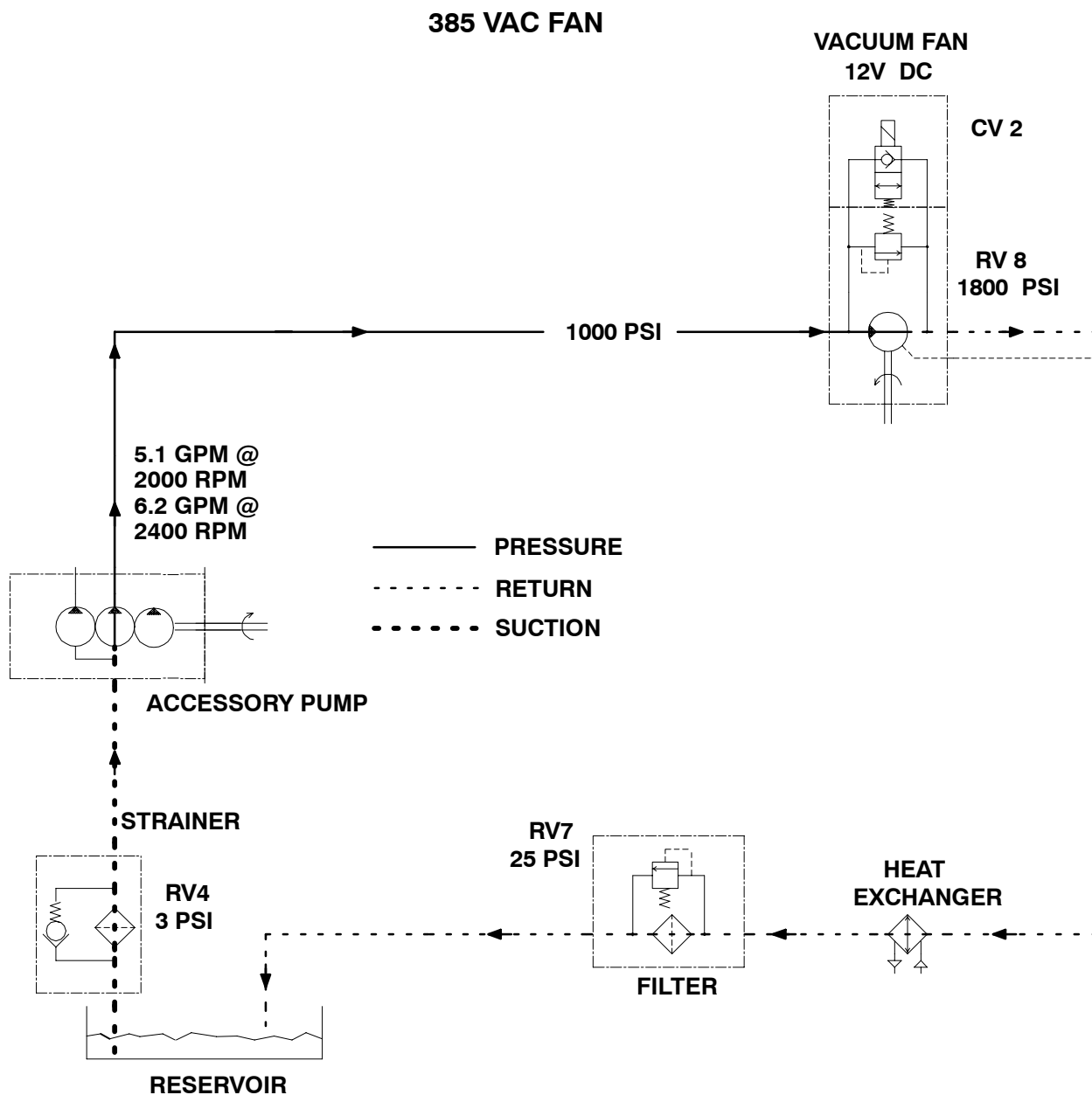


355 SIDE BRUSH/MAIN & VAC FAN

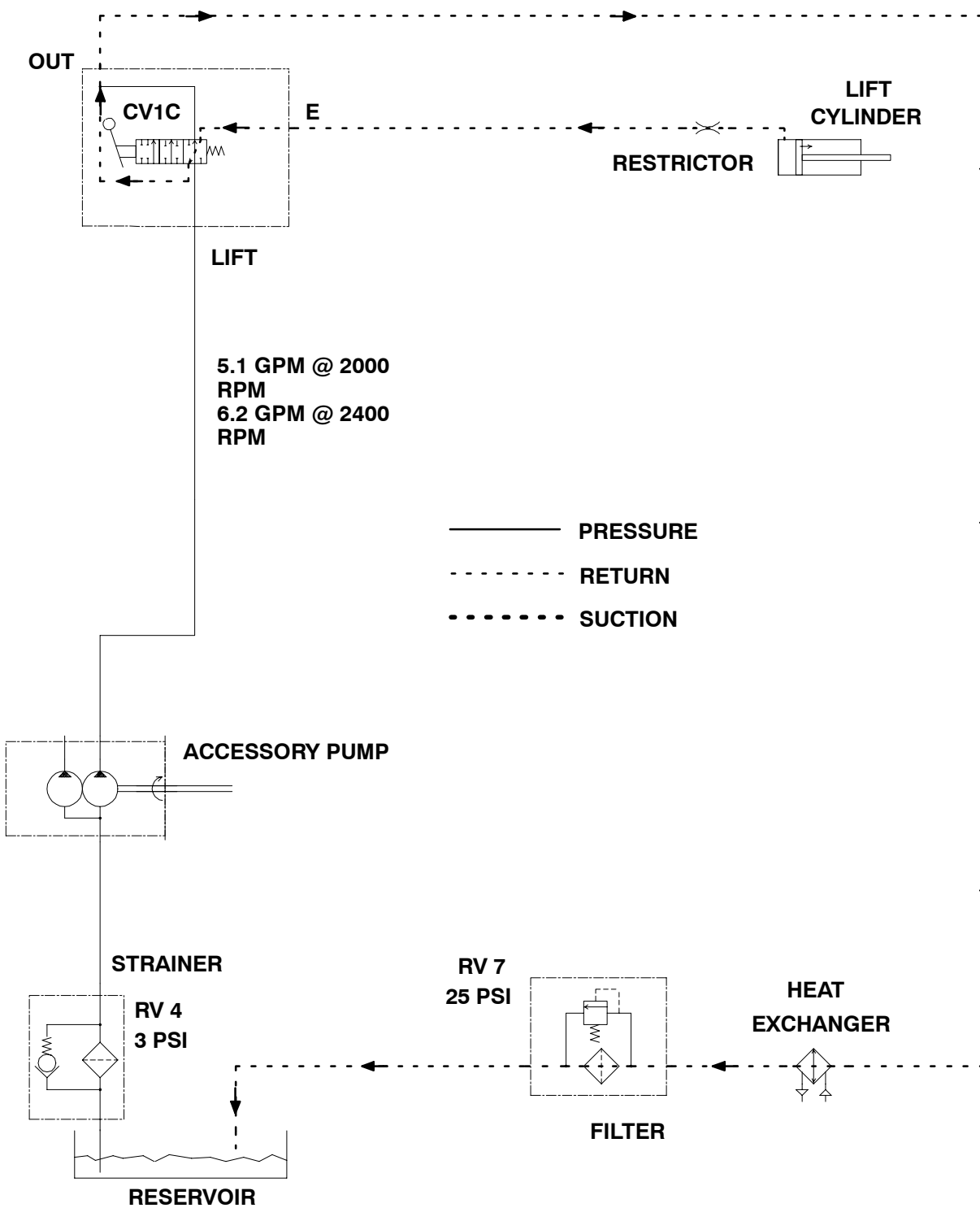


355 MAIN BRUSH / VAC FAN

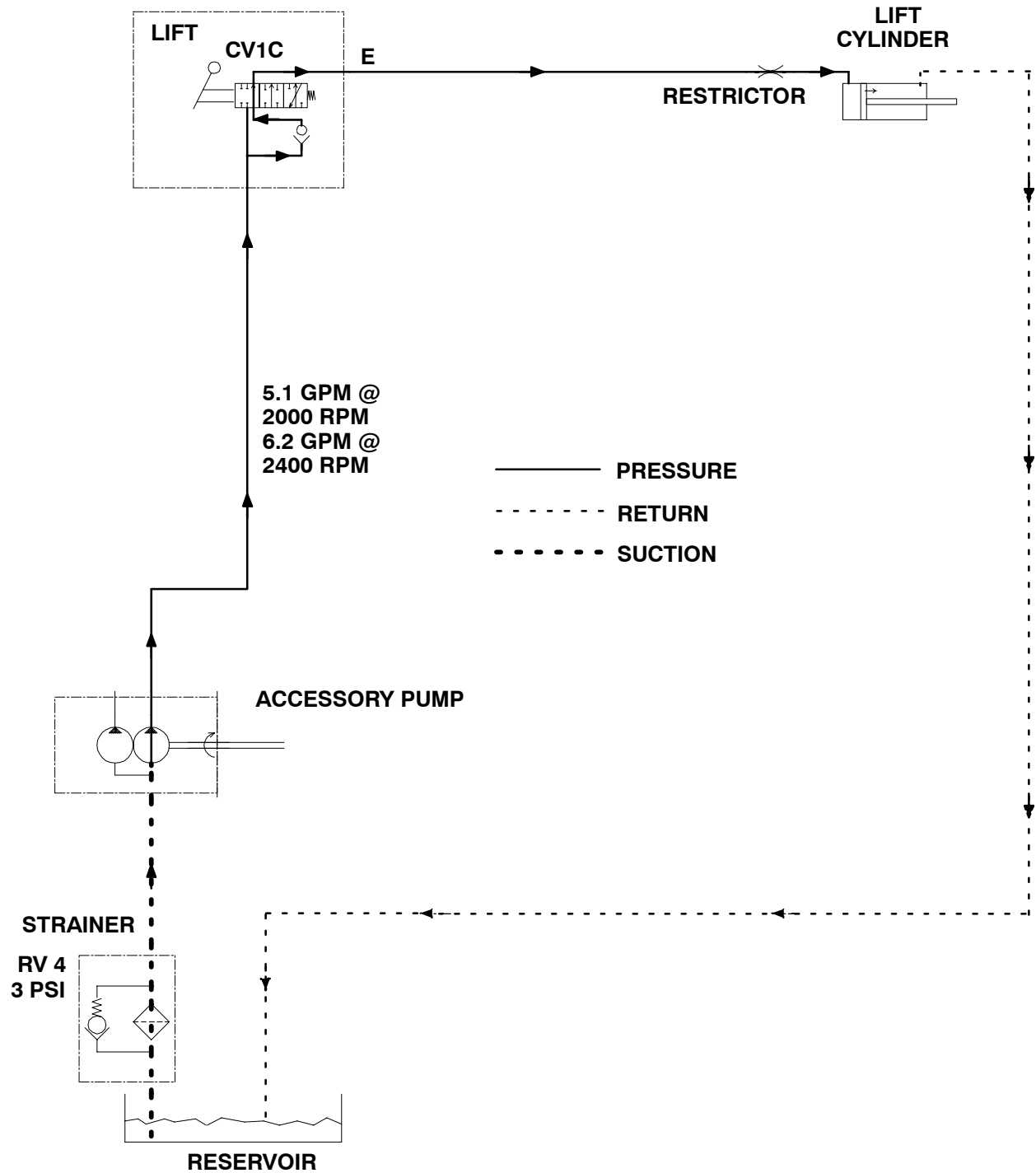


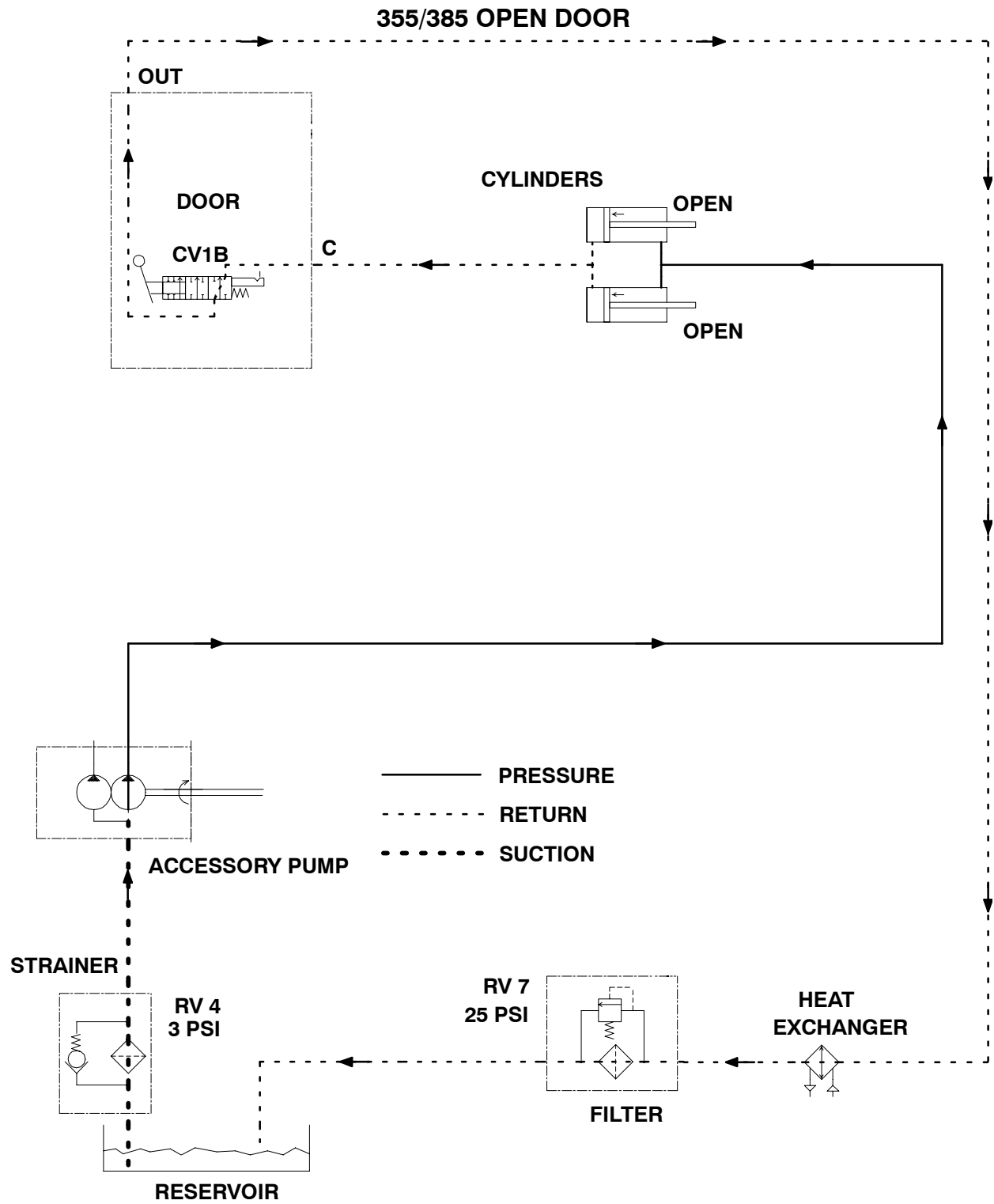


355/385 LOWER HOPPER

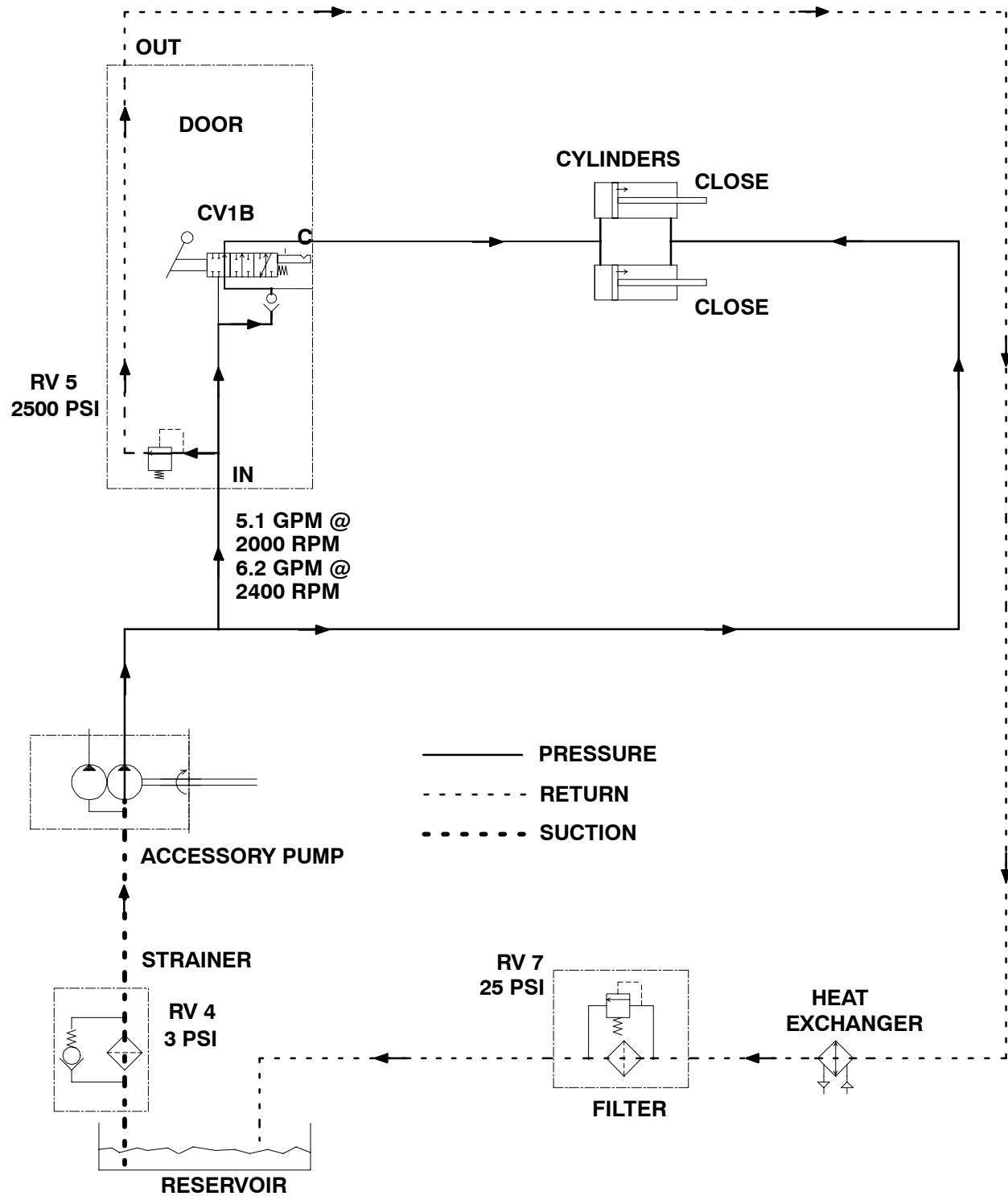


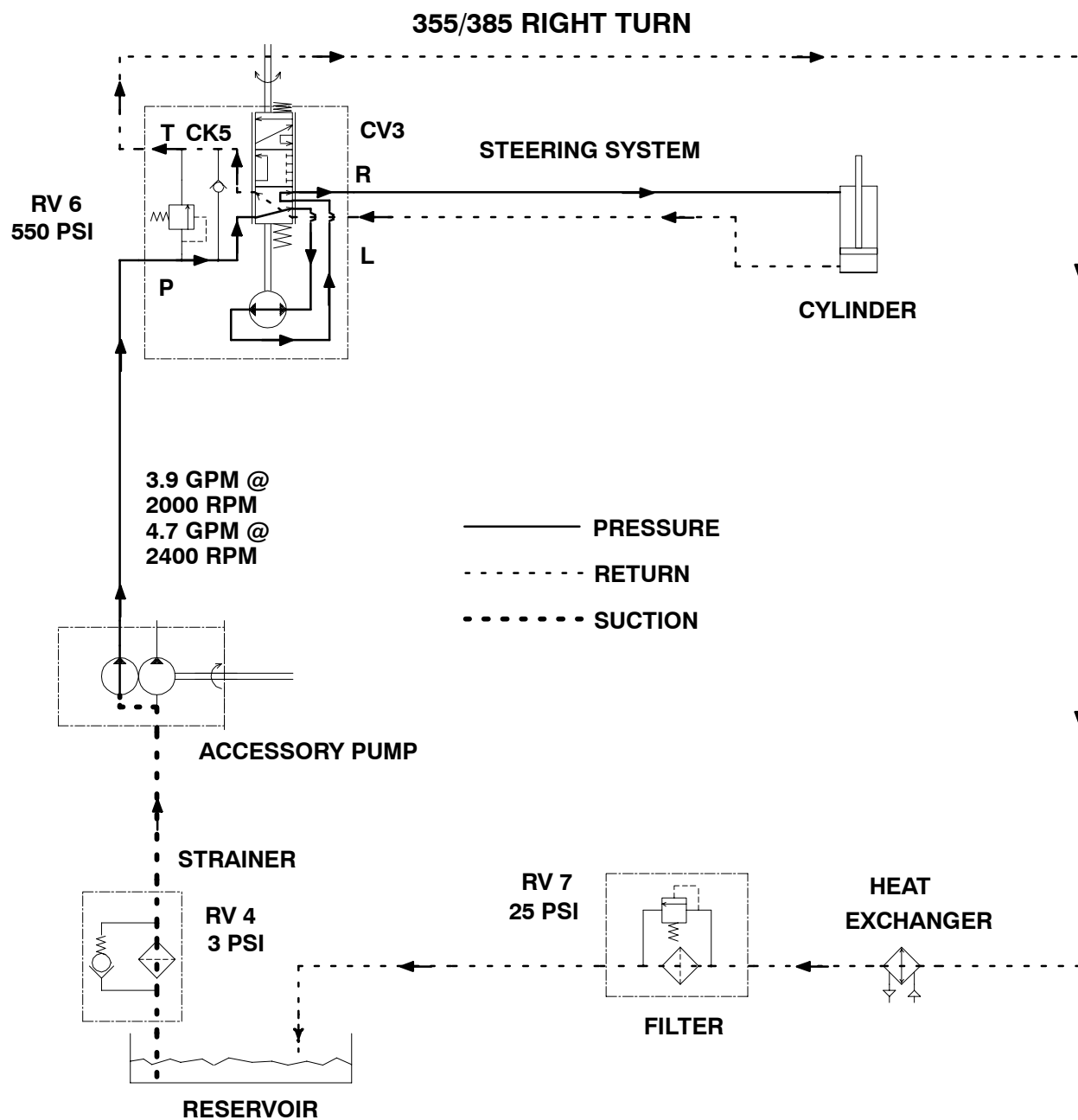
355/385 RAISE HOPPER

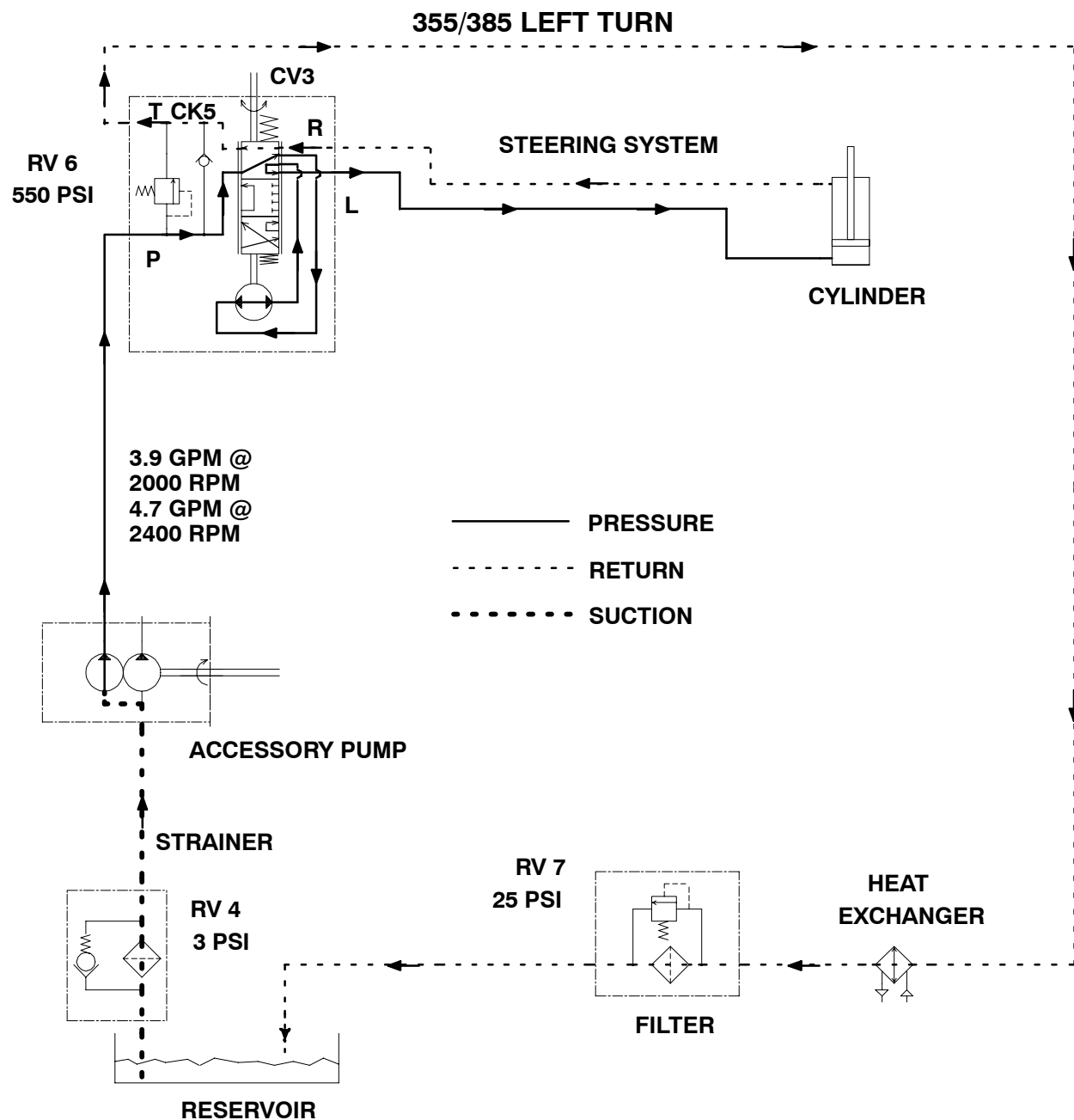




355/385 CLOSE DOOR







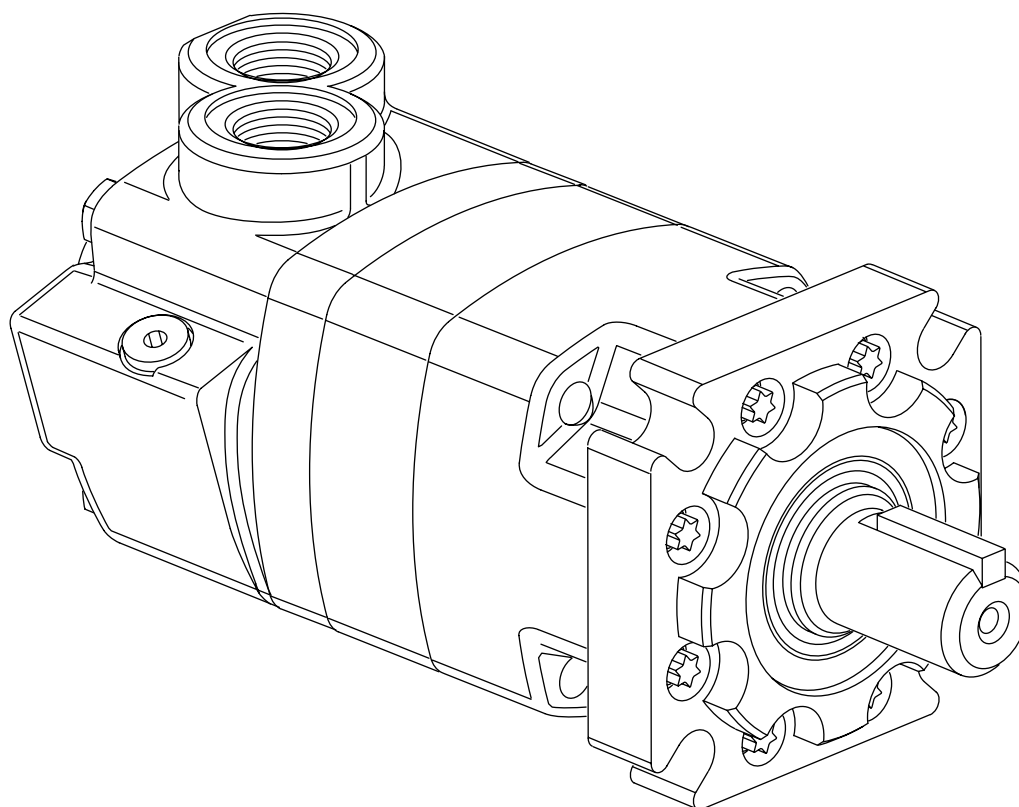
Char-Lynn®

Disc Valve Motor

No. 7-118
May, 1999

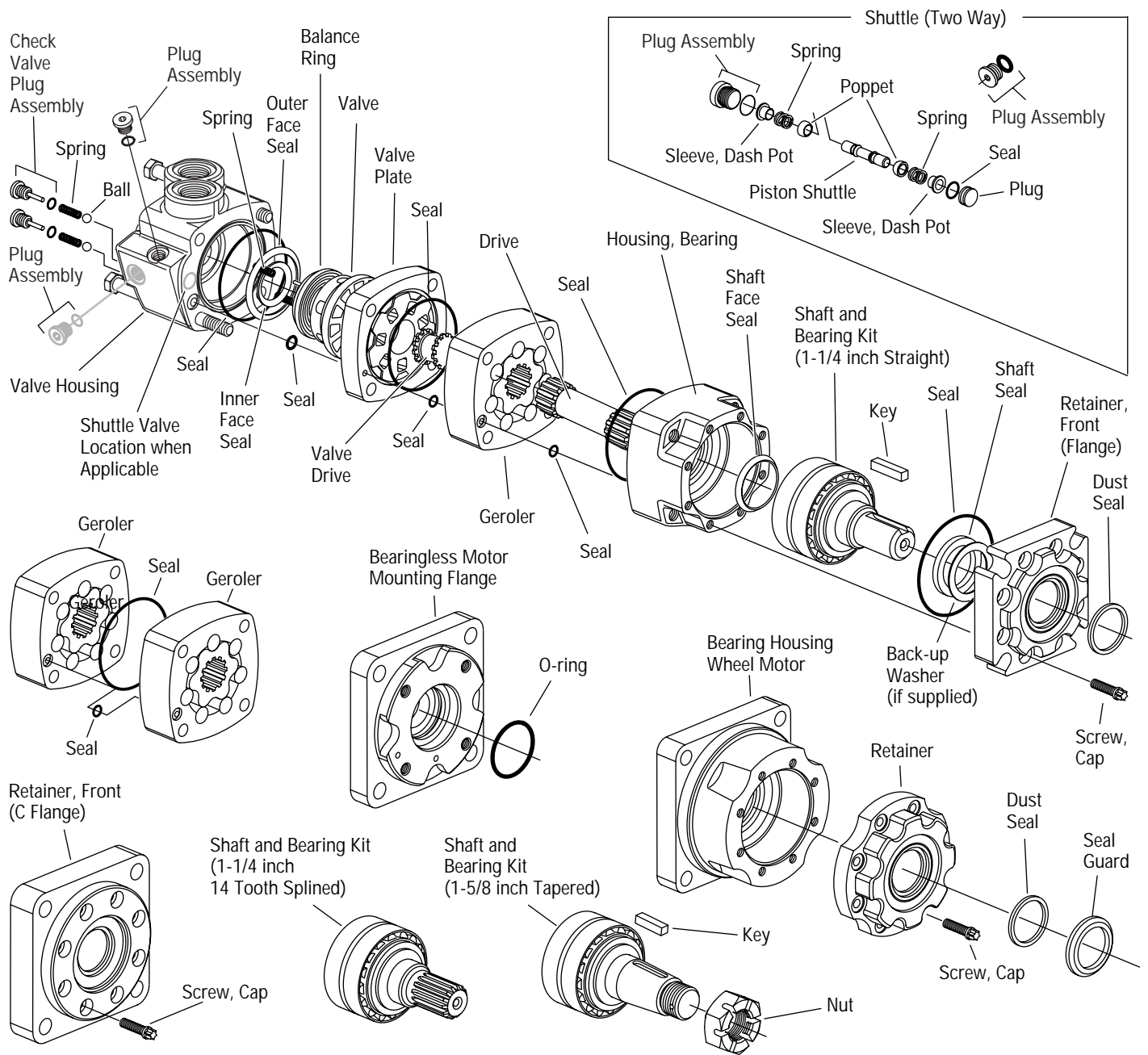


Repair Information



4000 Series
Geroler® Motors

Std., Whl. and Brgl. **-004** Std. and Whl. **-006**



Tools

Wheel motor and bearingless motor repair information on page 9 and 10.
 Shuttle valve and seal guard repair information on page 10.
 Seal guard reference on page 10.

Tools required for disassembly and reassembly

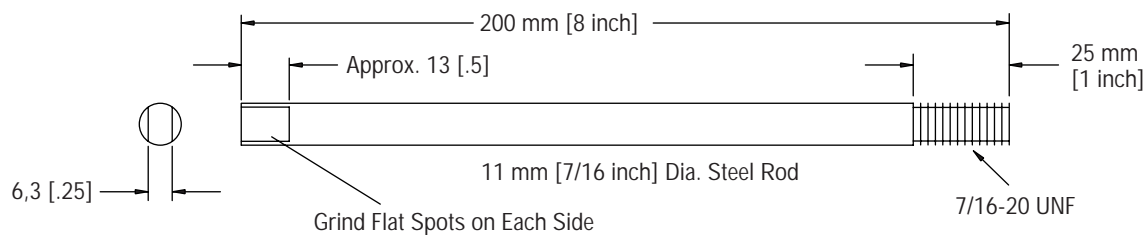
- Torque wrench (68 Nm [600 lb-in] capacity)
- 300 to 400 mm [12 to 16 inch] breaker bar
- 3/4 inch and 1/2 inch sockets
- Small screwdriver (150 to 200 mm [6 to 8 inch] long, 6 mm [.25 inch] blade)
- 3/16 inch Hex Key
- Hydraulic press — 1335 N [300 lbf]
- Shaft face seal (-004) installation tool 600468
- Shaft face seal (-006) installation tool 600421-2
- * — Bullet (600463) for 1-1/4 inch diameter shafts
- Shaft seal installation tool (2 -1/4 inch socket)
- Torq wrench required for eight mounting flange screws (replacement screws or -006 design)

No. E10

The following tools are not necessary for disassembly and reassembly but are extremely helpful

- Alignment studs (2), see dimensions below

* Available by special order, contact Eaton Corp.,
 Hydraulics Division Service Dept.



Disassembly

Cleanliness is extremely important when repairing a hydraulic motor. Work in a clean area. Before disconnecting the lines, clean port area of motor thoroughly. Use a wire brush to remove foreign material and debris from exterior joints of motor. Check shaft and keyway. Use 600 grit paper/cloth to remove all nicks, burrs, and sharp edges that might damage the shaft seals when installing retainer on shaft and bearing assembly. Before starting disassembly procedures, drain oil from inside of motor.

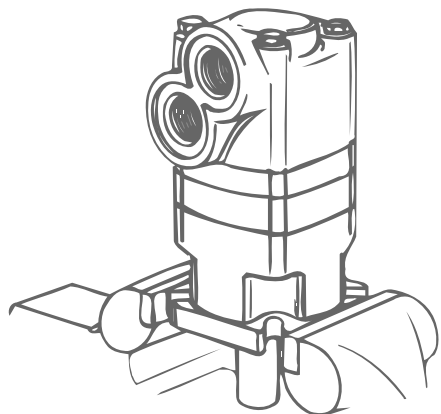


Figure 1

1 Place motor in a vise with output shaft down. Clamp across edge of mounting flange, not on housing (see Figure 1). Excessive clamping pressure will cause distortion. When clamping, use some protective device on vise, such as special soft jaws, pieces of hard rubber or board.

Although not all drawings show the motor in a vise, it is recommended that you keep the motor in the vise during disassembly. Follow the clamping procedures explained throughout the manual.

2 Remove 4 bolts from the valve housing.

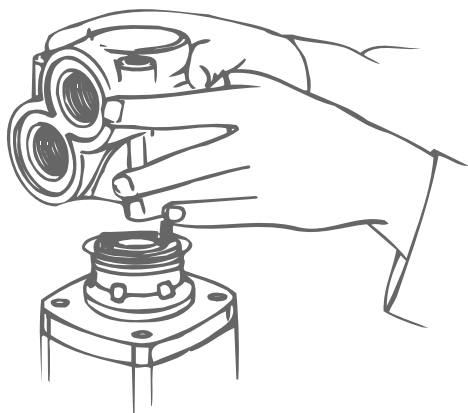


Figure 2

3 Lift valve housing straight up. If done carefully, the springs and balance ring subassembly will remain on valve for easy removal.

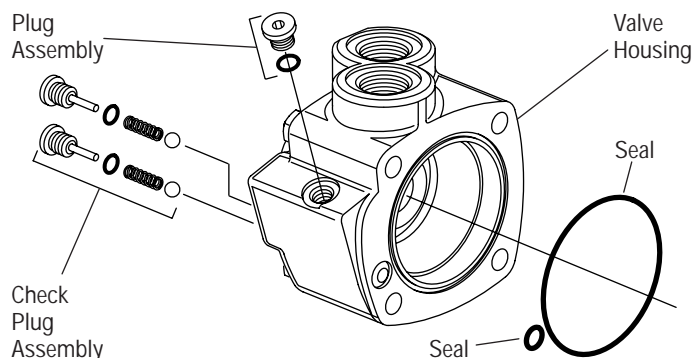


Figure 3

4 Carefully remove the following from the valve housing:

- 1 seal, 82,3 mm [3.24 inch] I.D.
- 1 seal, 8,9 mm [.35 inch] I.D.
- 2 check valve plug assemblies (plug, seal, spring, ball) 1 plug (case drain) with seal.

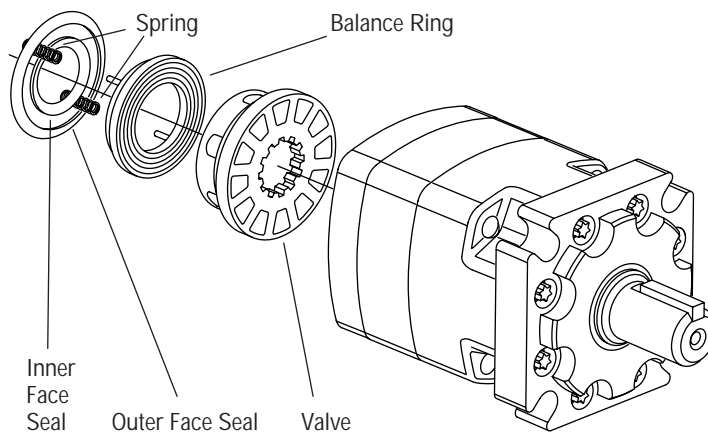


Figure 4

5 Remove 2 balance ring springs.

6 Remove balance ring subassembly.

7 Remove inner and outer face seals from the balance ring.

8 Lift off valve.

Disassembly

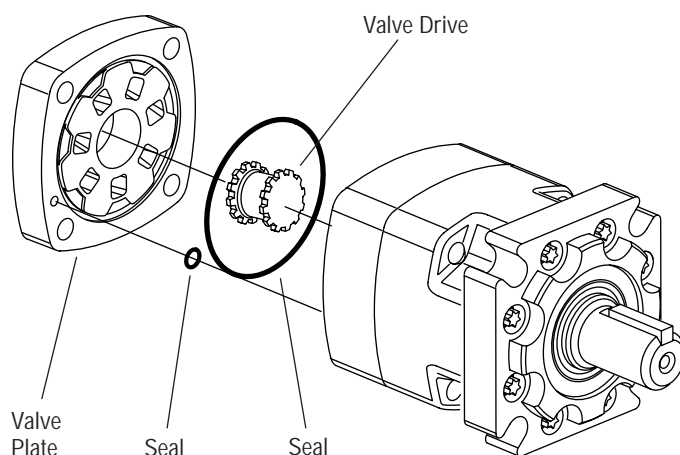


Figure 5

9 Remove valve plate.

10 Remove 88,6 mm [3.49 inch] I.D. seal from valve plate (see Figure 5).

11 Remove valve drive (see Figure 5).

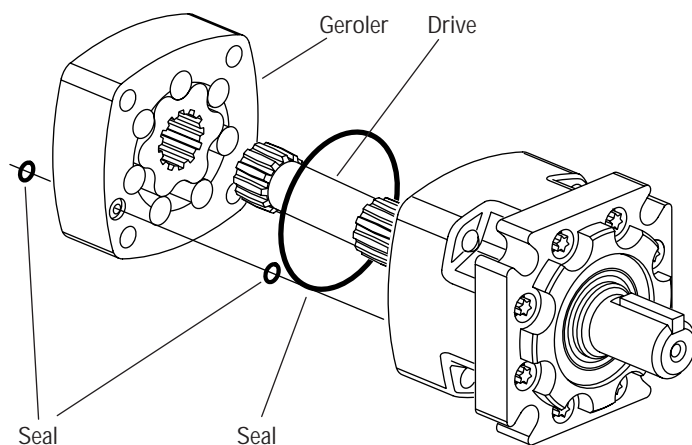


Figure 6

12 Remove Geroler. Retain rollers in outer Geroler ring if they are loose.

13 Remove 2 seals from Geroler, 1 seal on each side of Geroler.

14 Remove drive.

15 Remove 88,6 mm [3.49 inch] I.D. seal from bearing housing.

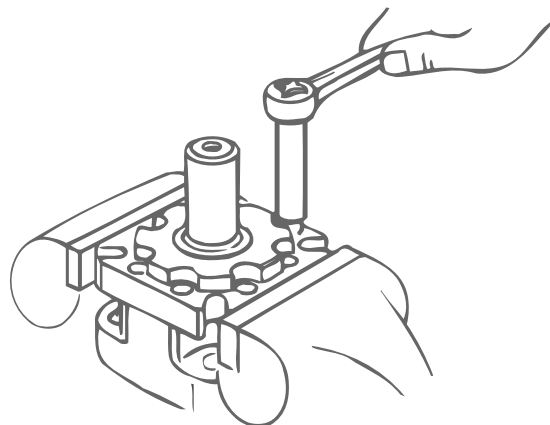


Figure 7

16 Use a stud remover or vise grips to remove studs (earlier models only). Clamp bearing housing in vise as shown in Figure 7. Loosen 8 screws. Remove screws, washers (discard washers, as they are not required for reassembly), and mounting flange (see Figure 8).

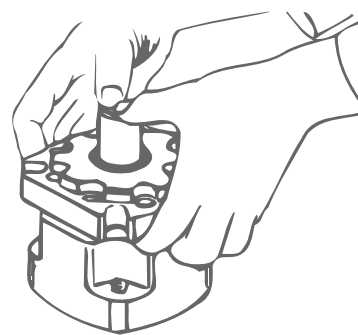


Figure 8

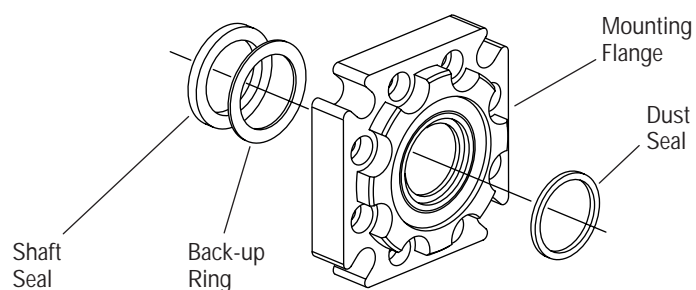


Figure 9

17 Remove shaft seal, back-up ring (if used) and dust seal from flange. Use a small screwdriver to remove dust seal. Do not damage bore of flange.

Disassembly

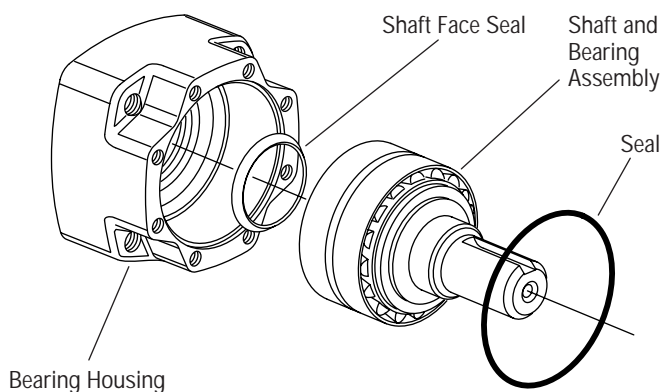


Figure 10

18 Remove shaft and bearing assembly. You may need a press to remove shaft and bearing assembly (see Figure 10).

19 Remove shaft face seal from bore of bearing housing (see Figure 10). Do not damage bore of bearing housing.

Note: Individual parts of the shaft and bearing assembly are not sold separately and must be replaced as a unit.

Reassembly

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 with cloth or paper towel because lint or other matter could get into the hydraulic system and cause damage. Do not use a coarse grit papers/cloth or try to file or grind motor 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 retainer.

Note: Lubricate all seals (prior to installation) with petroleum jelly such as Vaseline®. Use new seals when reassembling the motor.

Note: Shaft face seal installation tool is available by special order. Contact Eaton Corporation, Hydraulics Division (Service Department). 600468 (-004) 600421-2 (-006).

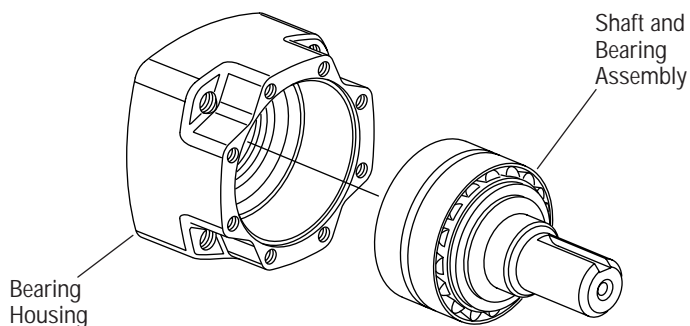


Figure 12

22 Install shaft and bearing assembly in bearing housing (see Figure 12). Do not damage seal in bore of housing. You may need a press to install shaft and bearing assembly.

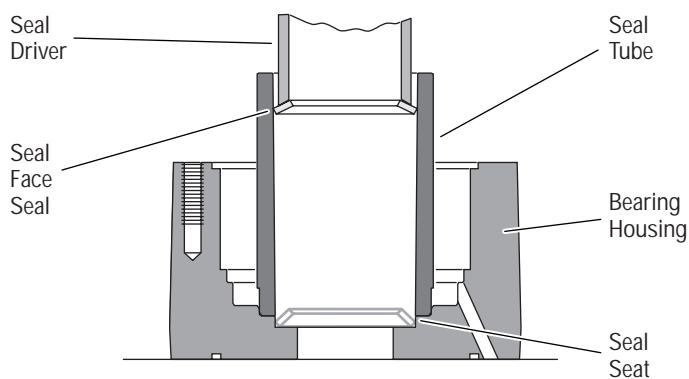


Figure 11

21 Place bearing housing on smooth flat surface with largest open end of housing up. Apply petroleum jelly to shaft face seal. Install seal in seal seat. Seat seal properly in groove (see Figure 11). A damaged or improperly installed shaft face seal could cause internal lubrication loss and subsequent parts wear.

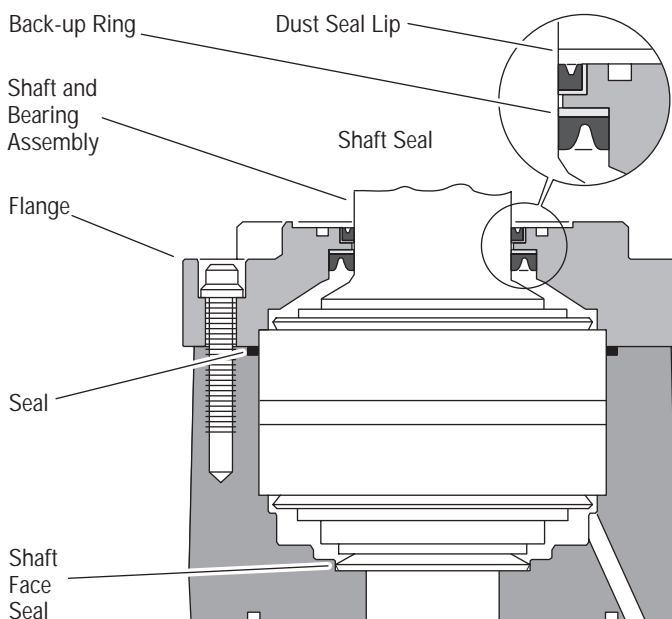


Figure 13

Reassembly

23 Apply petroleum jelly to 88,6 [3.49] ID seal. Install seal in seal groove of bearing housing (see Figure 13).

24 Use a small press, if available, to install dust seal in retainer. Metal side of dust seal must face toward flange, as shown in Figure 13. If a press is not available, use a plastic or rubber hammer to tap dust seal in place.

25 Install 92,1 [3.62] ID seal, back-up ring and shaft seal in retainer. Flat or smooth side of shaft seal must face toward retainer as shown in Figure 13. Apply petroleum jelly to inside diameter of shaft seal (after installing seal).

26 Before installing retainer, place a protective sleeve of bullet (see note below) over shaft. Grease inside diameter of dust and shaft seals. To prevent damage to seals, install retainer over shaft with a twisting motion. Do not cut or distort shaft seal. Damage to shaft seal will cause external leakage.

Note: Bullet 600463 for 1-1/4 inch diameter shafts available by special order through Eaton Hydraulics Division service department.

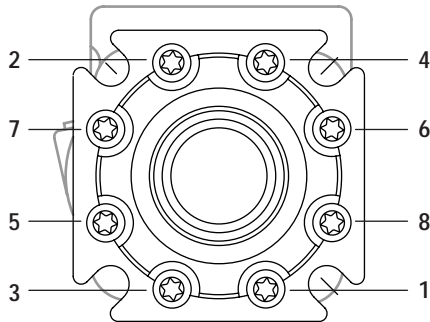


Figure 14

27 Lubricate threads of 8 screws with a film of light oil. Install and finger tighten screws. Clamp bearing housing in vise. Torque screws to 6 Nm [50 lb-in] in sequence (see Figure 14). Then final torque to 34 Nm [300 lb-in], in sequence. Install key (when used) in keyway of shaft.

Note: Full torque 34 Nm [300 lb-in] on one bolt at a time can damage bolt or retainer.

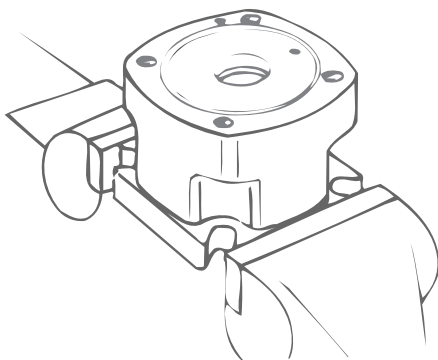


Figure 15

28 Reposition motor in vise with output shaft down. Clamp across edges of retainer as shown in Fig. 15.

29 Pour a small amount of light oil inside the output shaft.

30 Apply a light film of petroleum jelly on 88,6 mm [3.49 inch] I.D. seal. Install seal in bearing housing.

31 Install drive in output shaft (insert longer splined end of drive first), (see parts drawing on page 2).

32 To help in the reassembly procedure, it is recommended using two alignment studs (see special tools page 3) diagonally opposed in the four bolt holes of the bearing housing.

33 Apply petroleum jelly on 2 seals, 9,3 mm [.25 inch] I.D. Install seals (1 on each side of Geroler) in case drain grooves of Geroler.

Note: Installation at this point involves 3 steps in timing 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

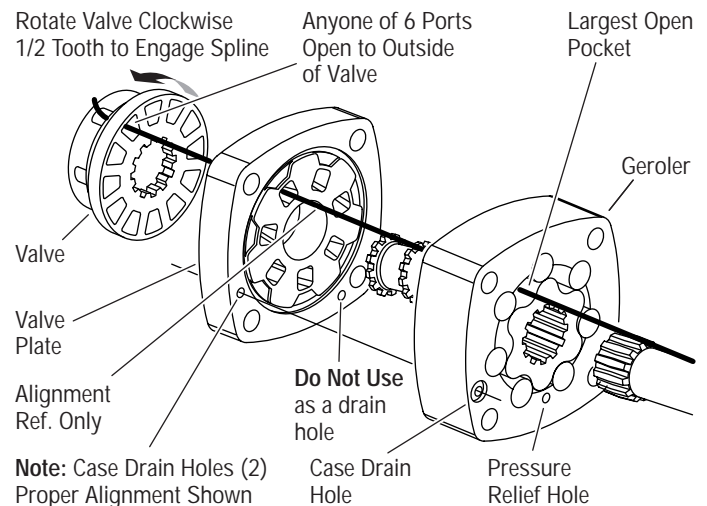


Figure 16 Timing Alignment

Timing Step No. 1 — Locate largest open pocket in Geroler. Then mark location of pocket on outside edge of Geroler (see Figure 16).

34 Align case drain hole and pressure relief hole in Geroler with case drain hole and pressure relief hole in bearing housing. Install Geroler on bearing housing (see Figure 16). Retain rollers in outer Geroler ring if they are loose.

35 Install valve drive in Geroler.

Reassembly

36 Apply a light film of petroleum jelly on 88,6 mm [3.49 inch] I.D. seal. Install seal in valve plate.

37 Align case drain hole in valve plate with case drain hole in Geroler. Install valve plate (seal side toward Geroler) on Geroler as shown in Figure 16.

Timing Step No. 2 — Locate slot opening in valve plate which is in line with largest open pocket of Geroler (see Figure 16).

38 Use the following procedure for installing the valve on the valve plate.

Timing Step No. 3 — Locate any one of the side openings of the valve that goes through to the face of the valve. **Line up this side opening in the valve with open slot of valve plate that is in line with largest open pocket of Geroler.** Rotate valve clockwise (1/2 spline tooth) to engage valve with the valve drive spline, alignment reference shown in Figure 17 (above). This procedure provides standard timing when pressurized as shown in Figure 17.

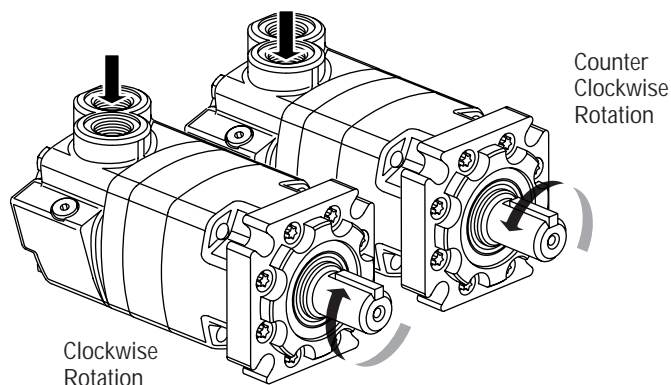


Figure 17

39 Apply clean grease on balance ring assembly springs. Install springs in 2 holes located inside bore face of valve housing (see Figure 18).

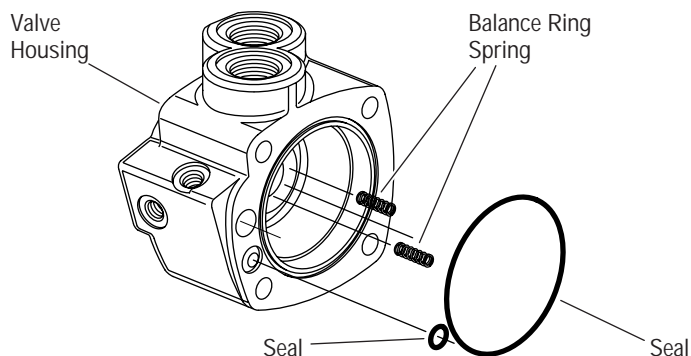


Figure 18

40 Apply a light film of petroleum jelly on 8,9 mm [.35 inch] I.D. seal. Install seal in case drain groove of valve housing.

41 Apply a light film of petroleum jelly on 82,3 mm [3.24 inch] I.D. seal. Install seal in outside seal groove of valve housing.

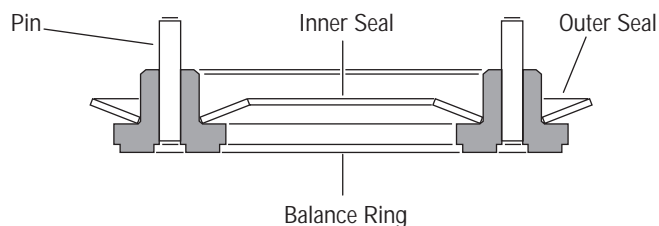


Figure 19

42 Apply petroleum jelly on inner and outer face seals. Install seals on balance ring as shown in Figure 19.

Important: Install face seals in the positions shown in Figure 19 or the motor will not operate properly. Do not force or bend these face seals. Any damage to these seals will affect the operation of the motor.

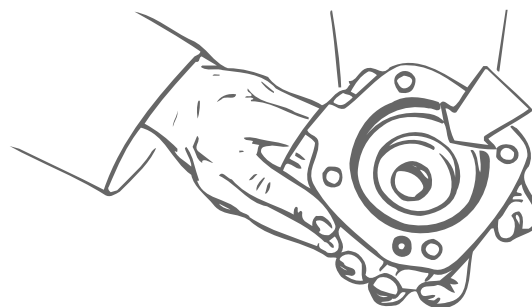


Figure 20

43 Align 2 pins of balance ring with 2 spring holes in valve housing as shown in Figure 20. Install balance ring in valve housing.

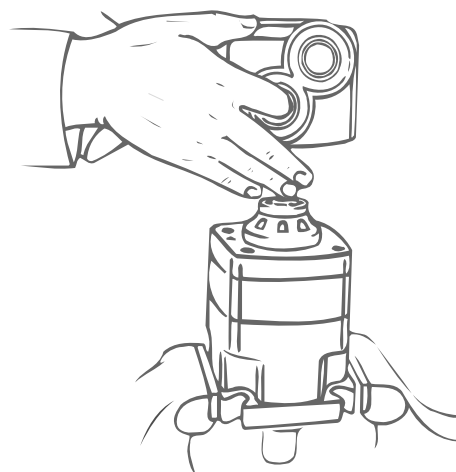


Figure 21

Reassembly

44 Insert your finger through port of housing. Apply pressure to side of balance ring assembly. Hold ring in position until valve housing is in place (see Figure 21). Align case drain hole in housing with case drain hole in valve plate. Install valve housing against valve plate (see Figure 22).

Note: After installing valve housing on valve plate, check between body parts of motor for unseated seals.

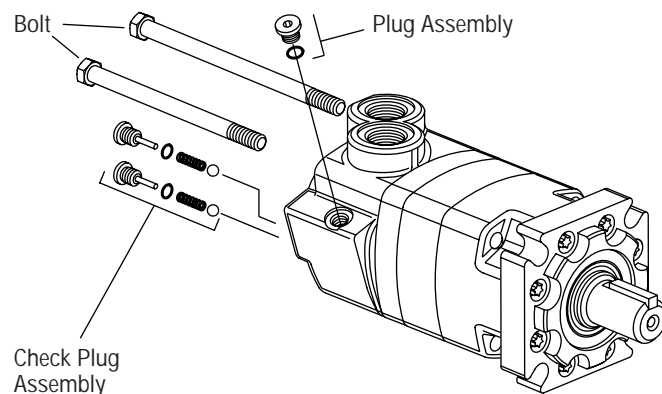


Figure 22

45 Install and finger tighten 2 bolts (or studs for earlier models) opposite alignment studs. Remove alignment studs and install remaining bolts (or studs and 4 nuts for earlier models). Torque bolts (or nuts) to 85 Nm [750 lb-in], in sequence (see Figure 23).

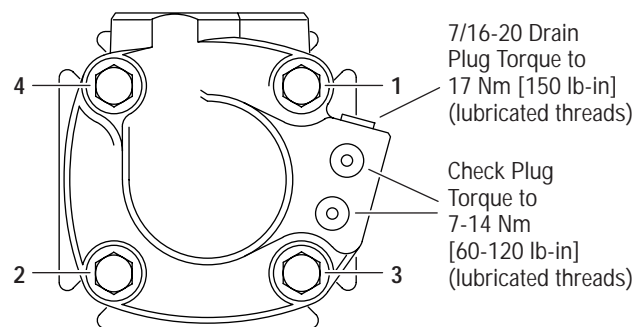


Figure 23

46 Install 2 check plug assemblies (ball, spring, plug with seal). Also install case drain plug with seal, parts shown in Figure 22 (plug torque shown in Figure 24).

Wheel Motors

A different bearing housing is used on wheel motors (see Figure 24). Other than this, the parts are the same as the standard motor and the same disassembly and reassembly procedures apply.

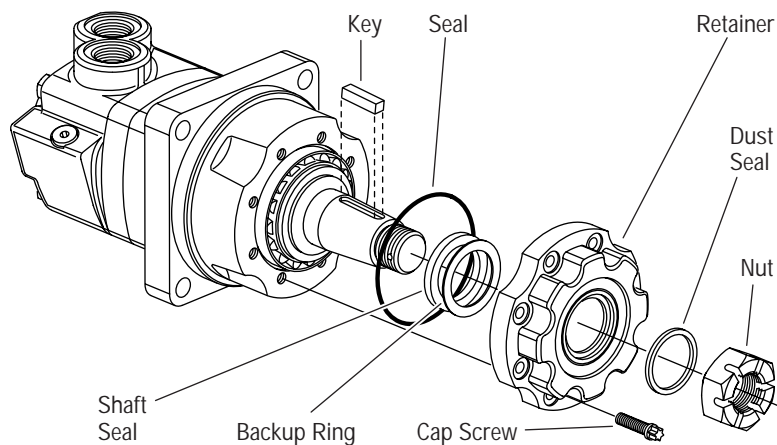


Figure 24

Bearingless Motors

This motor is the same as the standard without the shaft/bearing assembly, bearing housing and retainer. The mounting flange replaces the bearing housing (see Figure 25). Follow same disassembly and reassembly procedures as rear section of standard motor.

Important: Loctite® information for bearingless motor on page 10.

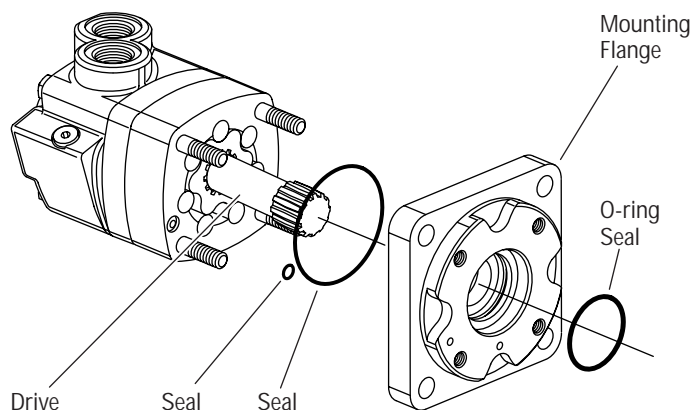


Figure 25

Reassembly

Important: This motor requires Loctite in threaded holes of mounting flange.

Follow these procedures:

Adequate Loctite penetration and sealing depend highly on cleanliness and dryness of threads. Use a non-petroleum base solvent to clean excess oil from threads of flange after disassembly. You may need to use a tap to clean threads of excess old Loctite. After you have fully reassembled the motor, apply 2 to 3 drops of Loctite no. 290 at top of threaded holes (see Figure 26).

Note: Allow Loctite 5 minutes for thread penetration before installing motor on gear case.

Attention:
Do not use
more than
3 drops of
Loctite on
threaded
portion.

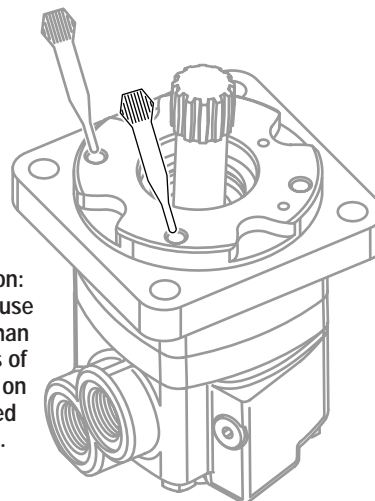
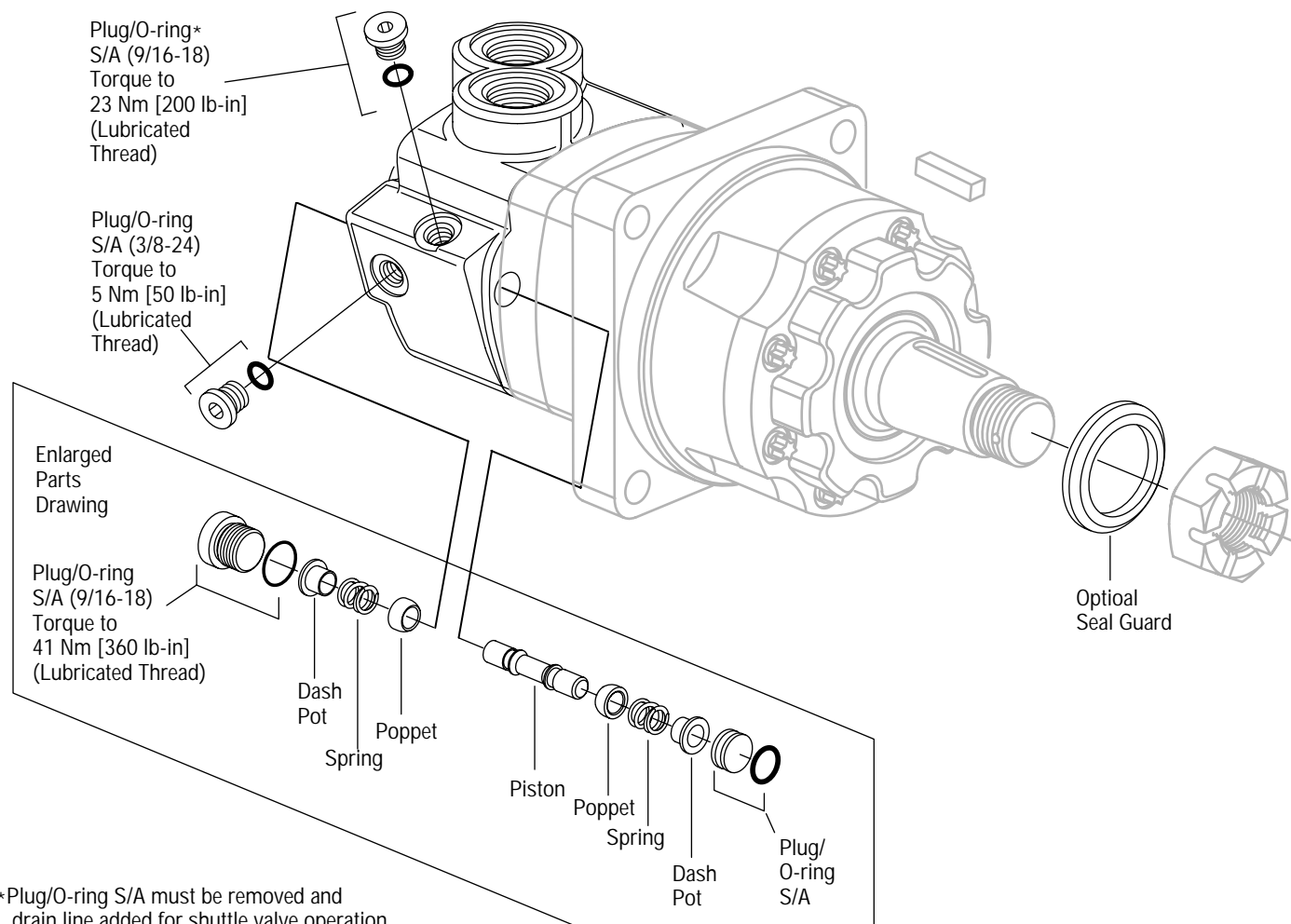


Figure 26

Motors with Shuttle and, or Seal Guard



*Plug/O-ring S/A must be removed and drain line added for shuttle valve operation.

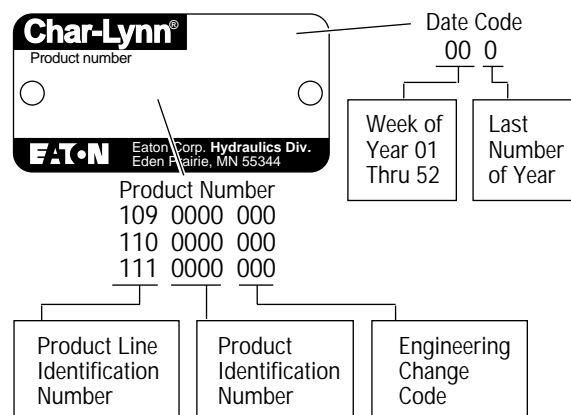
How to Order Replacement Parts

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. 11-878.
- Replacement part numbers and kit information — Parts Information No. 6-126.



Product Numbers—4000 Series Motors

Use digit prefix —109-, 110-, or 111- plus four digit number from charts for complete product number—Example 111-1057.

Orders will not be accepted without three digit prefix.

			Displ. cm³/r [in³/r] Product Number								
Mounting	Shaft	Ports	110 [6.7]	130 [7.9]	160 [9.9]	205 [12.5]	245 [15.0]	310 [19.0]	395 [24.0]	495 [30.0]	625 [38.0]
Standard SAE B-Mount	1-1/4 inch Straight	1-1/16 O-ring	109-1100	-1101	-1102	-1103	-1104	-1105	-1106	-1212	-1215
		3/4 inch Split Flange	109-1001	-1054	-1002	-1003	-1055	-1056	-1057	—	—
	1-5/8 Inch Tapered	1-1/16 O-ring	109-1107	-1108	-1109	-1110	-1111	-1112	-1113	—	—
		3/4 inch Split Flange	109-1006	-1058	-1007	-1008	-1059	-1060	-1061	—	—
	1-1/4 Inch 14 T Splined	1-1/16 O-ring	109-1114	-1115	-1116	-1117	-1118	-1119	-1120	—	—
		3/4 inch Split Flange	109-1011	-1062	-1012	-1013	-1063	-1064	-1065	—	—
Standard SAE C-Mount	40 mm Straight	G 3/4 (BSP)	109-1184	-1185	-1227	-1224	-1225	-1189	-1190	—	—
	1-1/2 Inch 17 T Splined	G 3/4 (BSP)	109-1191	-1192	-1193	-1194	-1195	-1196	-1197	—	—
Wheel Motor	1-1/4 inch Straight	1-1/16 O-ring	110-1074	-1075	-1076	-1077	-1078	-1079	-1080	—	-1122
		3/4 inch Split Flange	110-1001	-1040	-1002	-1003	-1041	-1042	-1043	—	—
	40 mm Straight	G 3/4 (BSP)	110-1108	-1109	-1110	-1111	-1112	-1113	-1125	—	—
	1-5/8 Inch Tapered	1-1/16 O-ring	110-1081	-1082	-1083	-1084	-1085	-1086	-1087	1116	-1117
		3/4 inch Split Flange	110-1006	-1044	-1007	-1008	-1045	-1046	-1047	—	—
	1-1/4 Inch 14 T Splined	1-1/16 O-ring	110-1088	-1089	-1090	-1091	-1092	-1093	-1094	—	—
3/4 inch Split Flange		110-1011	-1048	-1012	-1013	-1049	-1050	-1051	—	—	
Bearingless		1-1/16 O-ring	111-1033	-1034	-1035	-1036	-1037	-1038	-1039	-1062	-1063
		3/4 inch Split Flange	111-1044	-1015	-1045	-1046	-1016	-1017	-1018	—	—
		G 3/4 (BSP)	111-1052	-1053	-1054	-1055	-1056	-1057	-1058	—	—

111-1057

4000 Series Motors

Eaton Corporation
Hydraulics Division
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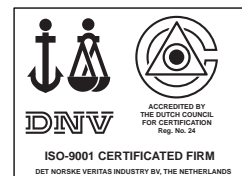
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Products in this catalog are manufactured
in an ISO-9001-certified site.

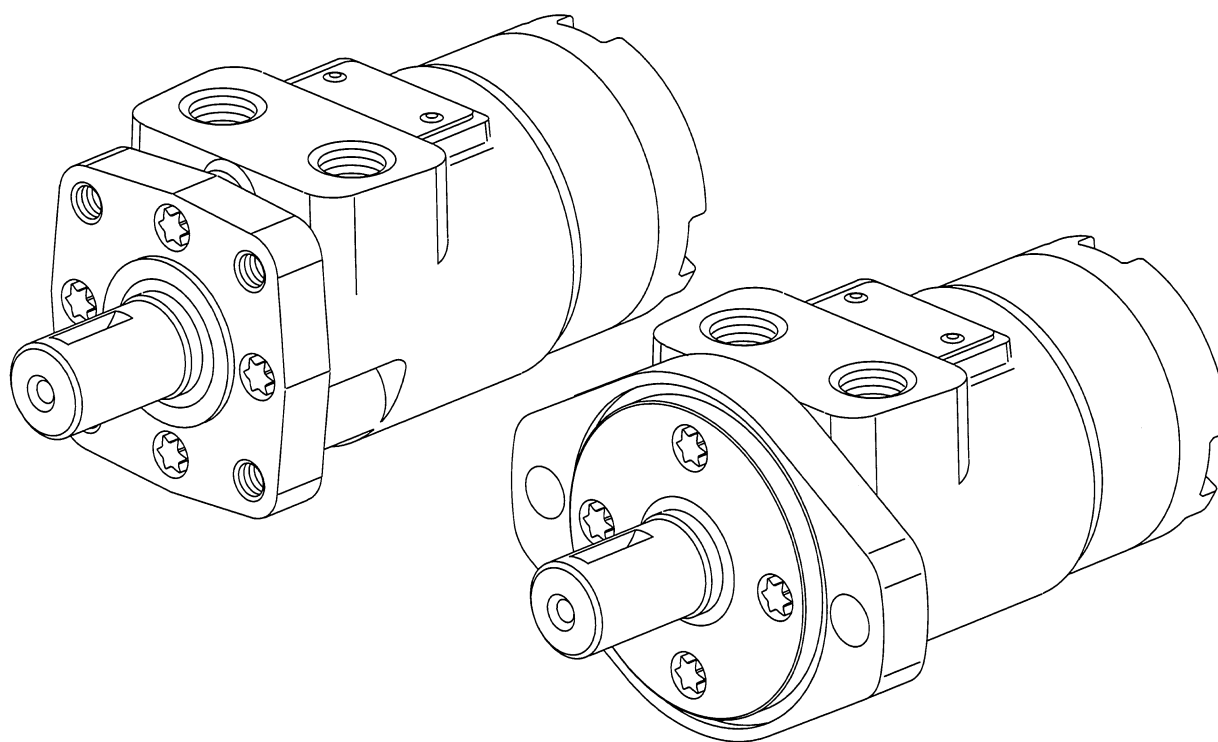
Char-Lynn®

Hydraulic Motor

No. 7-125
January, 1995

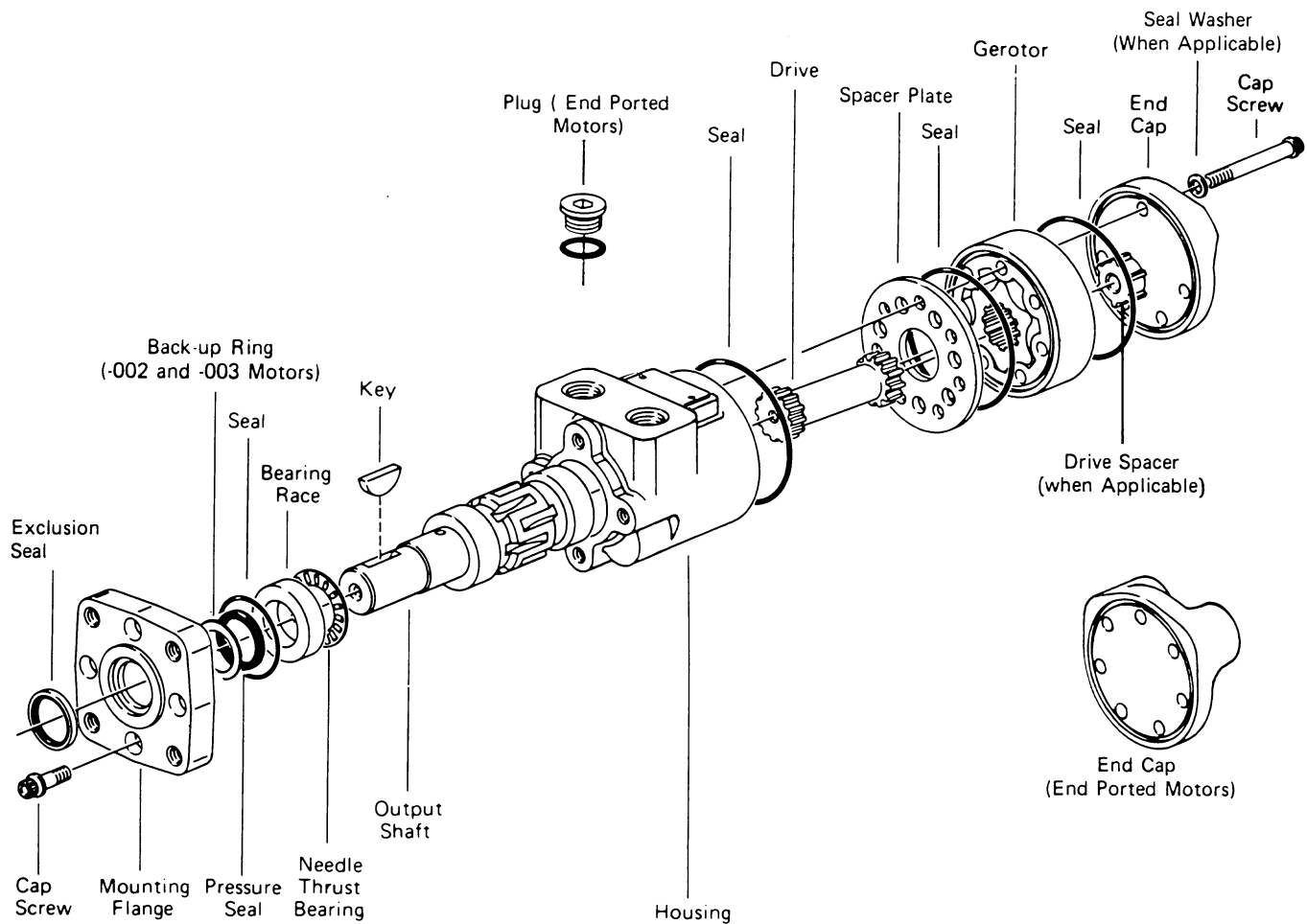
EAT•N

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

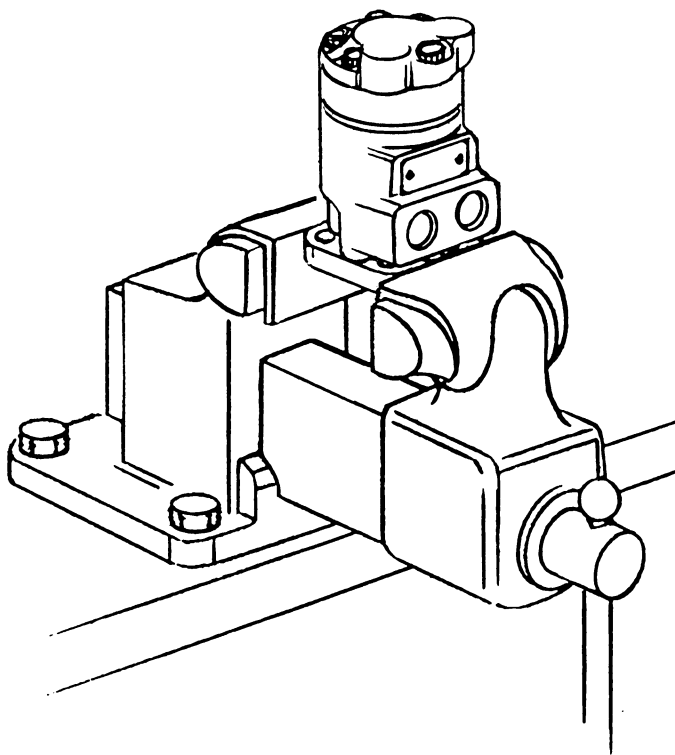


Figure 1

- 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.

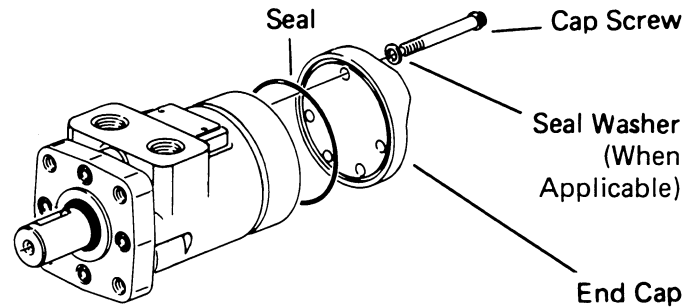


Figure 2

- 2 Remove cap screws and seal washers (when applicable). See Figure 2.
- 3 Remove end cap.
- 4 Remove seal from end cap.

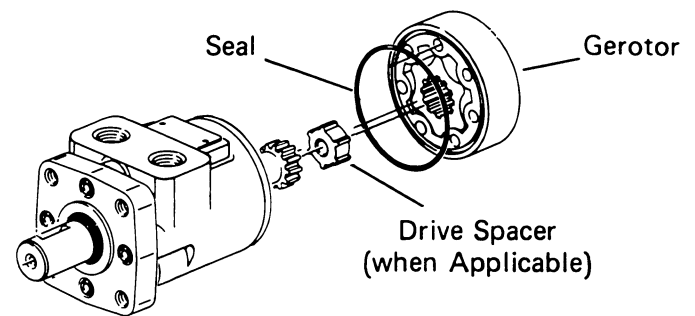


Figure 3

- 5 Remove gerotor.
- 6 Remove seal from gerotor (Figure 3).
- 7 Remove drive spacer if applicable.

3

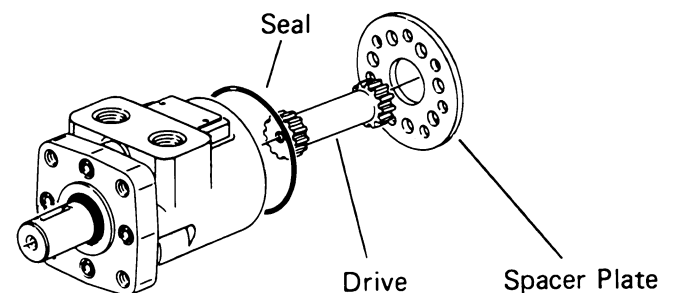


Figure 4

- 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.

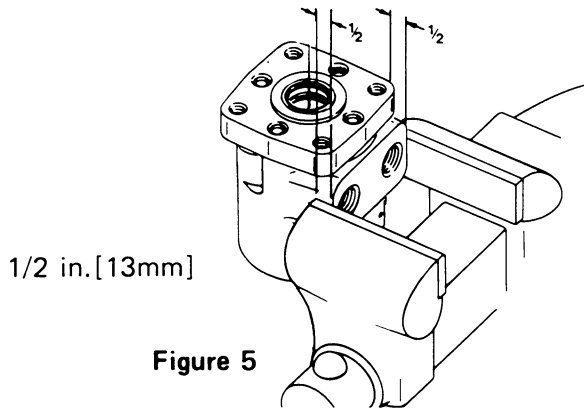


Figure 5

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.

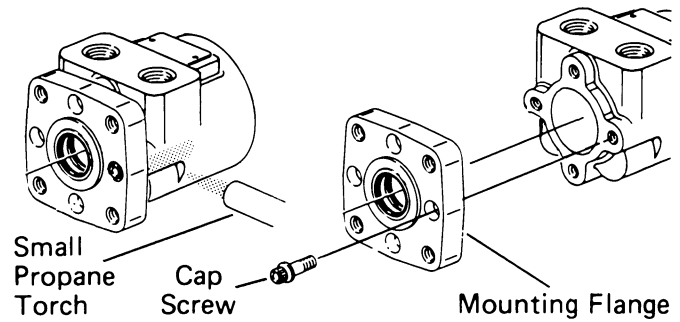


Figure 6

15 Remove motor from vise. Place motor on clean flat surface. Carefully remove flange from housing.

Back-up Ring (-002 and -003 Motors)

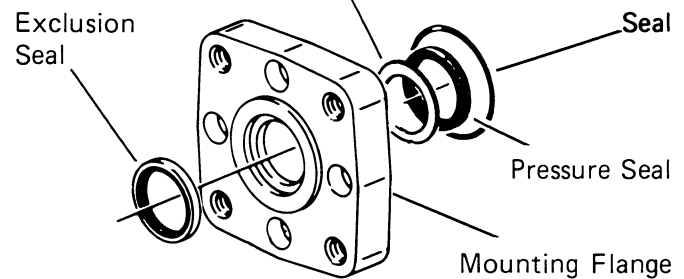


Figure 7

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.

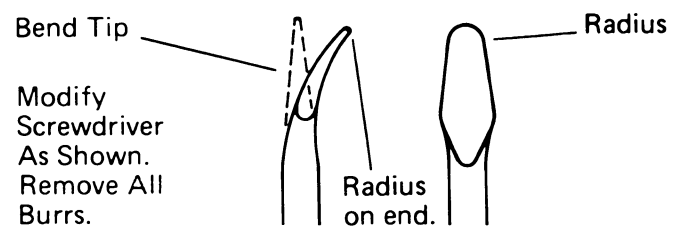
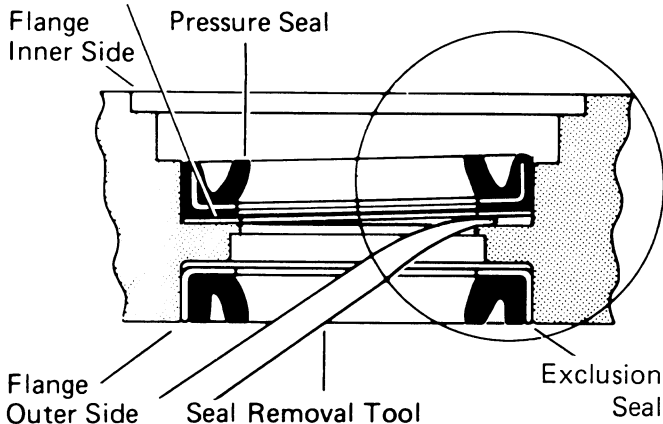


Figure 8

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.

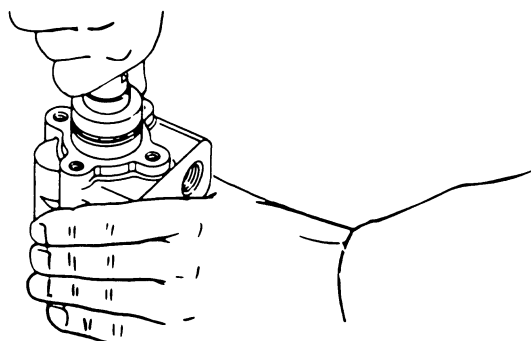
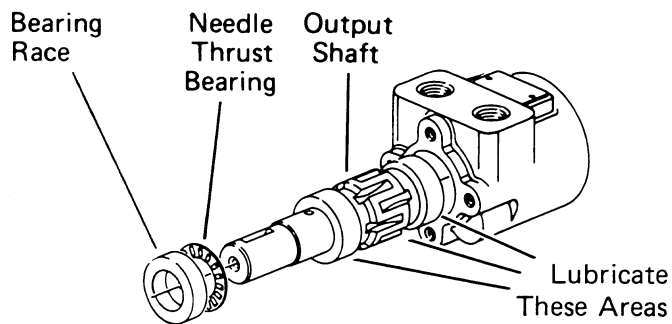
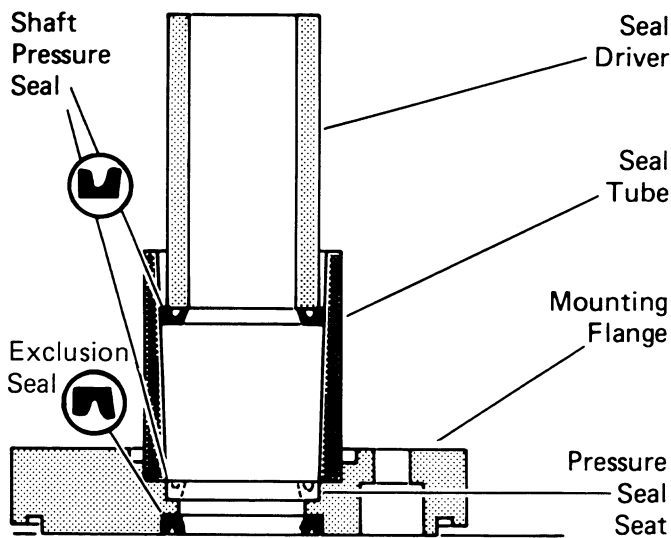


Figure 10

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 1¹⁵/₁₆ 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.

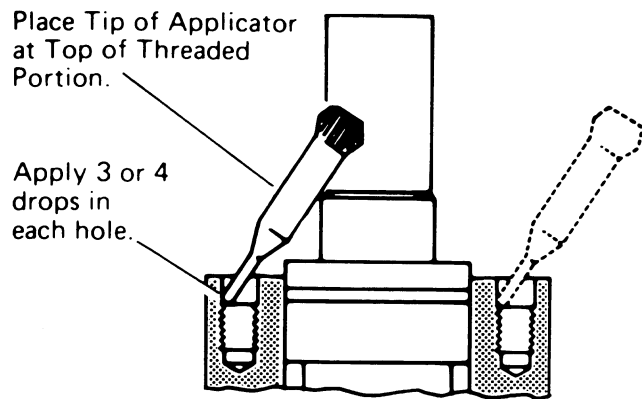


Figure 12

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.

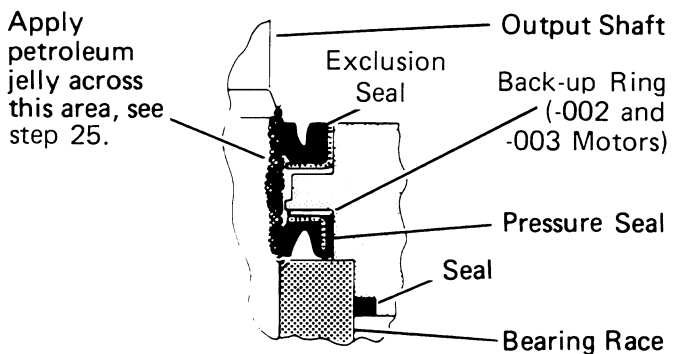


Figure 13

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.

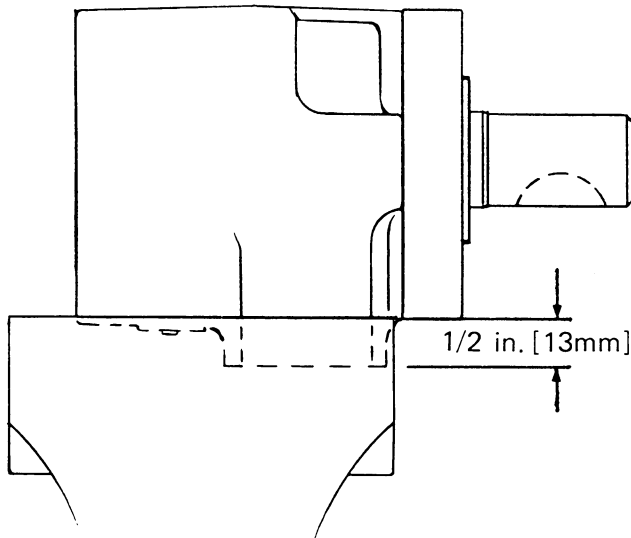


Figure 14

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.

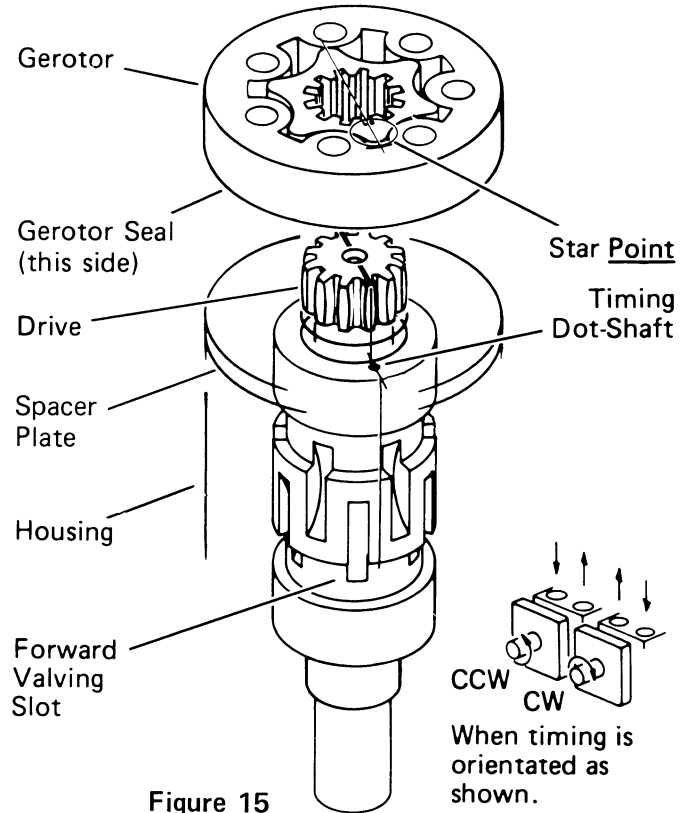


Figure 15

Reverse Rotation Align any star valley with marked tooth. See Figure 16.

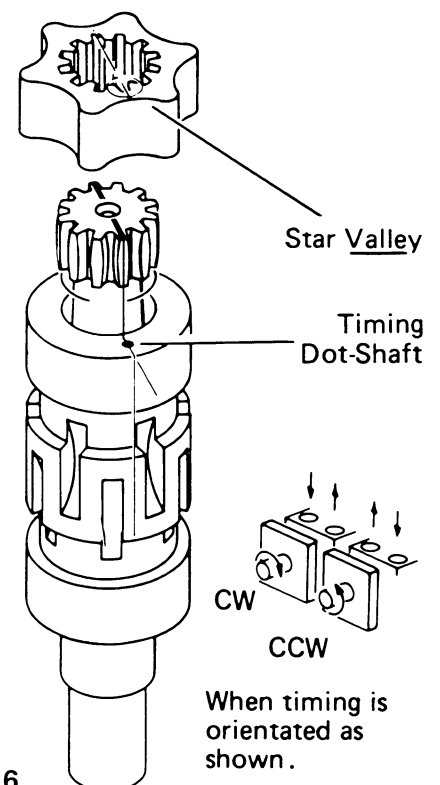


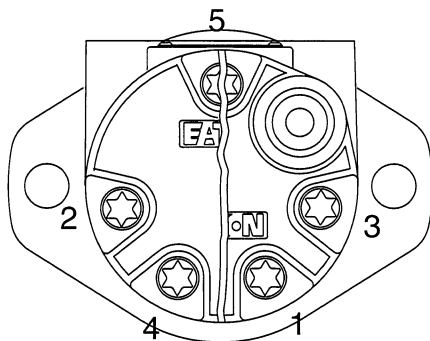
Figure 16

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

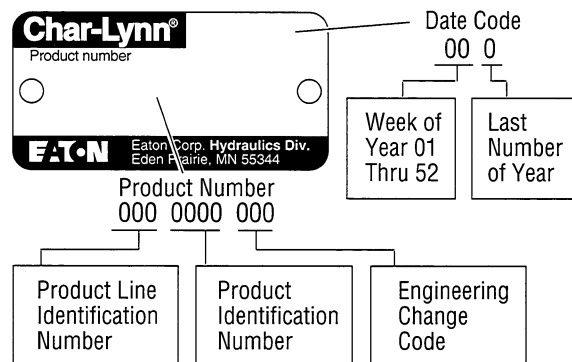
Figure 17

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
2. Date Code
3. Part Name
4. Part Number
5. Quantity of Parts



Eaton Corporation
Hydraulics Division
15151 Hwy. 5
Eden Prairie, MN 55344
Telephone 612/937-9800
Fax 612/937-7130

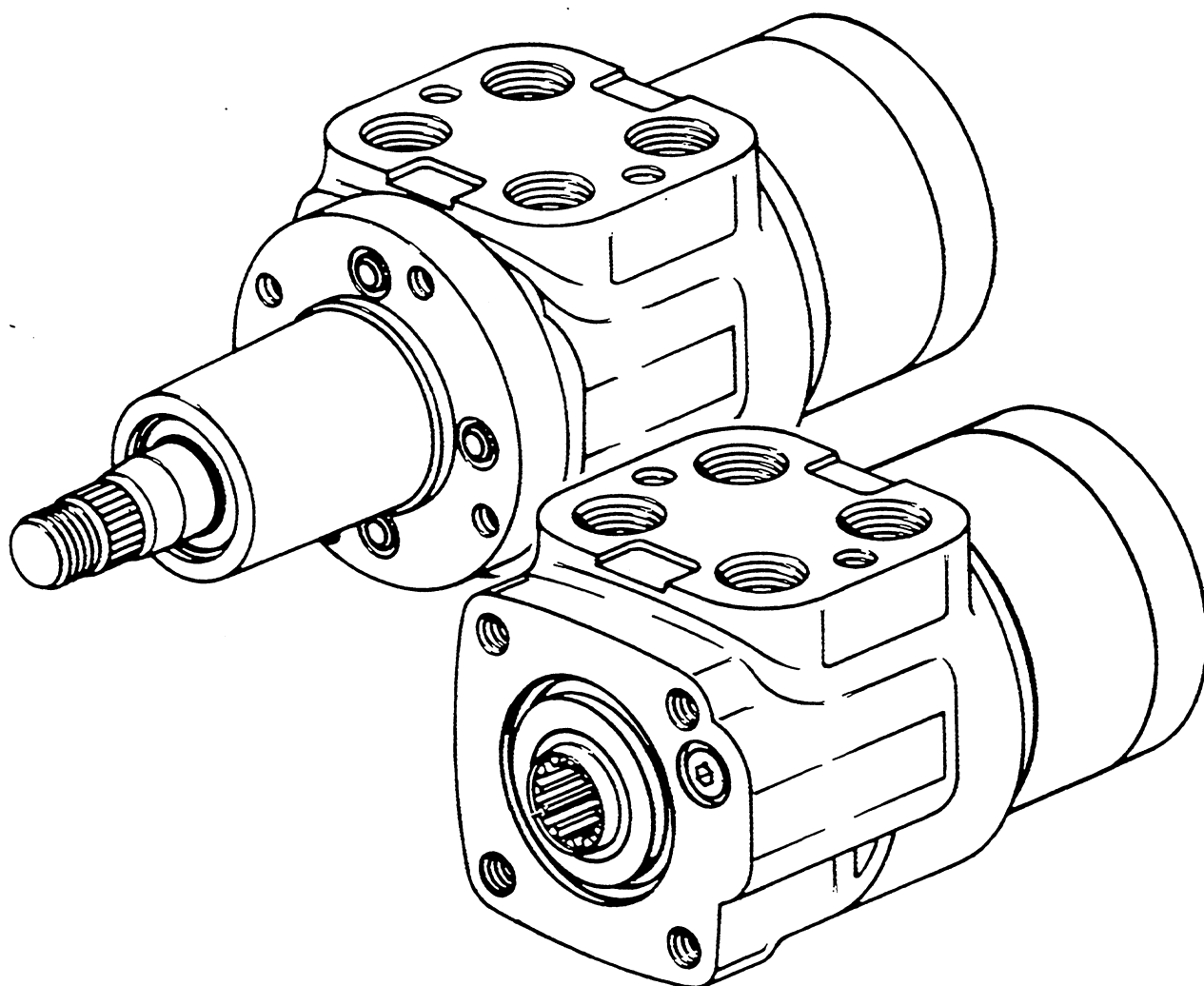
Eaton Ltd.
Hydraulics Division
Glenrothes, Fife
Scotland, KY7 4NW
Telephone 44/592-771-771
Fax 44/592-773-184

**Eaton
Hydraulics
Division**

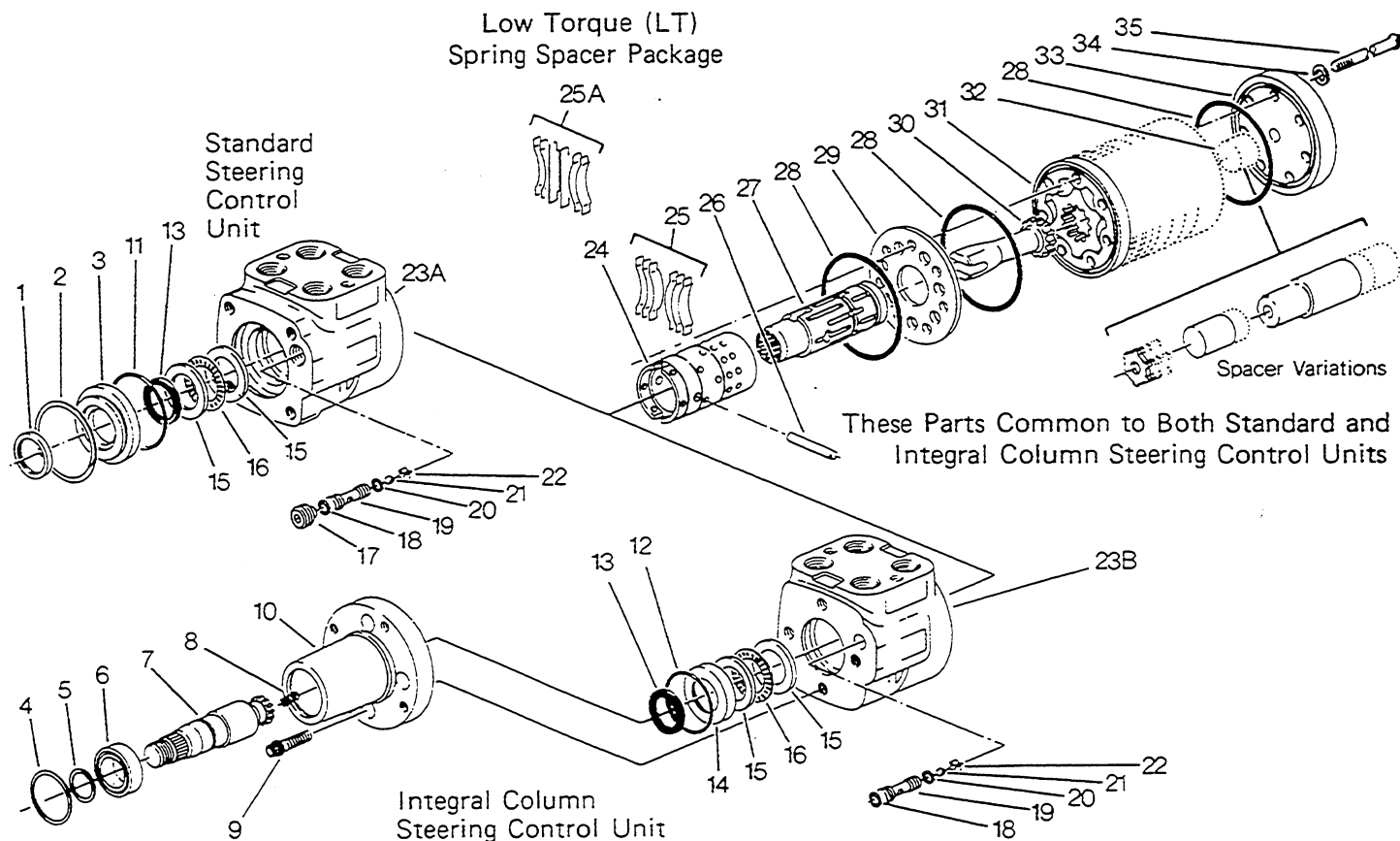
Repair Information

Steering Control Units, Char-Lynn®

001



EAT•N



1. Dust Seal
2. Retaining Ring
3. Seal Gland Bushing
4. Retaining Ring
5. Retaining Ring
6. Control Column Bearing Ass'y
7. Control Shaft
8. Spring
9. Cap Screw
10. Steering Control Column
11. Seal, 2-1/8" OD
12. Seal, 1-15/16" OD

13. Quad Ring Seal
14. Bearing Locator
15. Bearing Race
16. Needle Thrust Bearing
17. Set Screw
18. Seal, 5/8" OD
19. Check Ball Seat
20. Seal, 7/16" OD
21. Check Ball
22. Check Ball Retainer
- 23A. Standard Housing
- 23B. Housing w/integral control column

24. Control Sleeve
25. Centering Springs
- 25A. Centering Springs and Spacers (LT)
26. Pin
27. Control Spool
28. Seal, 3" OD
29. Spacer Plate
30. Drive
31. Meter (Gerotor)
32. Spacer(s)
33. End Cap
34. Seal Washer
35. Cap Screw

See pages 10 thru 12 for disassembly and reassembly instructions covering the power steering integral control column.

Tools required for disassembly and reassembly.

- Screwdriver (4"-6" long, 1/8" flat blade)
- * 5/16" - 12 pt. socket 5422
- Breaker bar wrench
- Torque wrench (275 inch pound capacity)
- Plastic hammer or rubber hammer
- 1/4" Allen wrench
- #10-24 machine screw, 1-1/2" long.
- Needle nose pliers

* Tools available--by special order--through our service department.

The following tool isn't necessary for disassembly and reassembly, but is extremely helpful.

*Spring installation tool 600057

Disassembly

Cleanliness is extremely important when repairing a steering control unit. Work in a clean area. Before disconnecting lines, clean port area of unit thoroughly. Use a wire brush to remove foreign material and debris from around exterior joints of the unit.

Note: Trouble shooting information on pages 13, 14, and 15 defines terms and problems, possible causes for problems, and recommends procedures for correcting problems.

Although not all drawings show the unit in a vise, we recommend that you keep the unit in the vise during disassembly. Follow the clamping procedures explained throughout the manual.

Meter (Gerotor) End

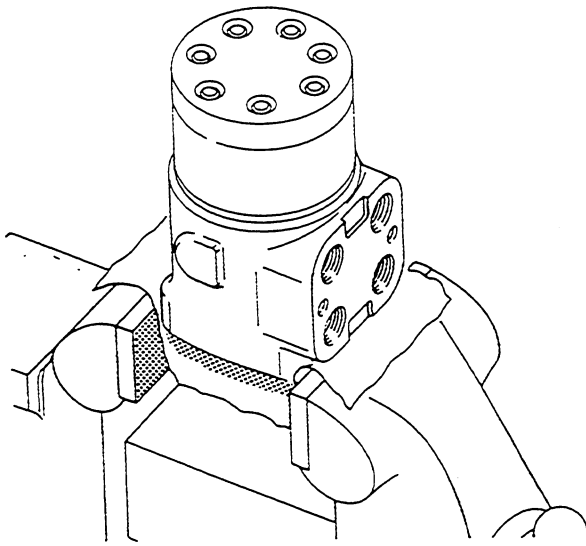


Figure 1

1 Clamp unit in vise, meter end up. Clamp lightly on edges of mounting area, see Fig. 1. Use protective material on vise jaws. Housing distortion could result if jaws are overtightened.

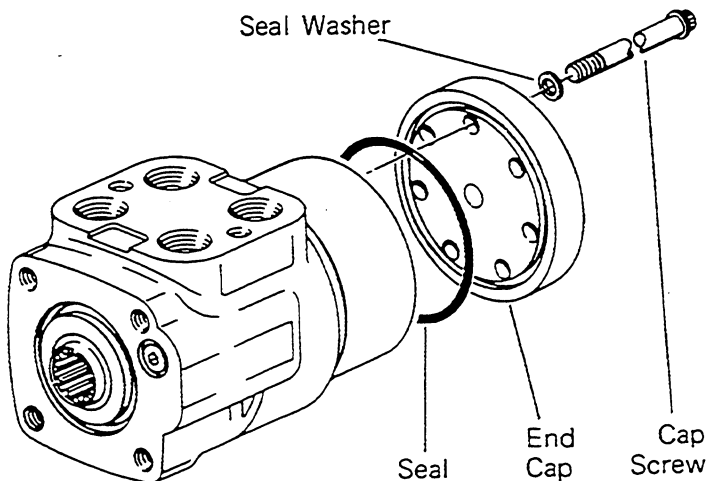


Figure 2

4

- 2 Remove 5/16" cap screws.
- 3 Remove end cap.
- 4 Remove seal from end cap.

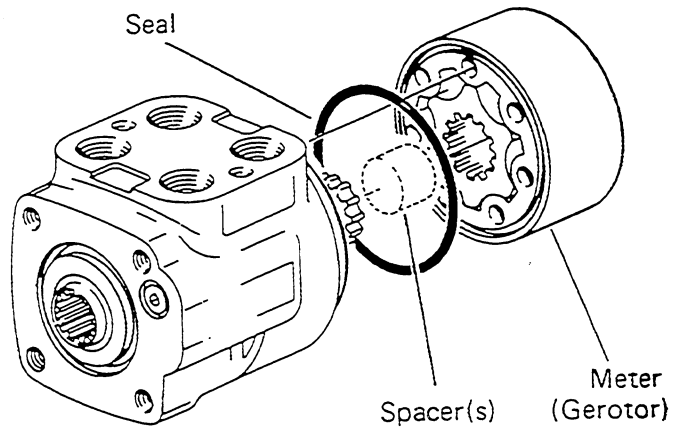


Figure 3

- 5 Remove meter. Be careful not to drop star.
- 6 Remove seal from meter.
- 7 Remove drive spacer(s) (not used on 4.5 cu. in displacement units).

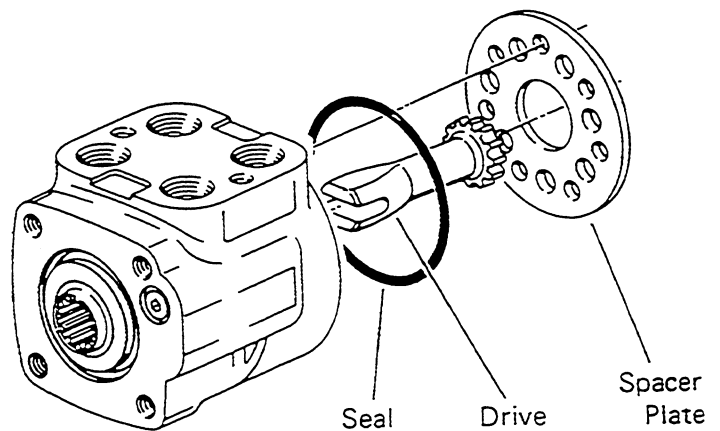


Figure 4

- 8 Remove drive.
- 9 Remove spacer plate.
- 10 Remove seal from housing.

Control End

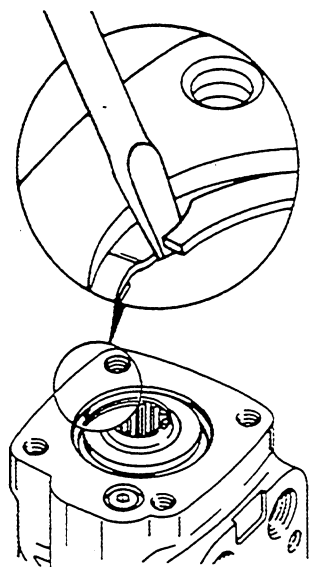


Figure 5

11 Remove housing from vise. Place housing on a clean soft cloth to protect surface finish. Use a thin bladed screwdriver to pry retaining ring from housing, as shown in Fig. 5.

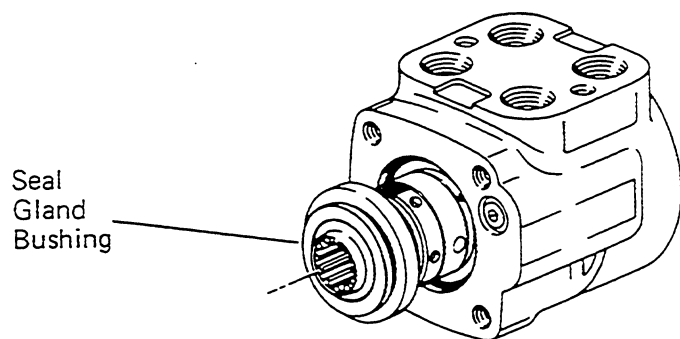


Figure 6

12 Rotate spool and sleeve until pin is horizontal. Push spool and sleeve assembly forward with your thumbs just far enough to free gland bushing from housing, see Fig. 6. Remove bushing

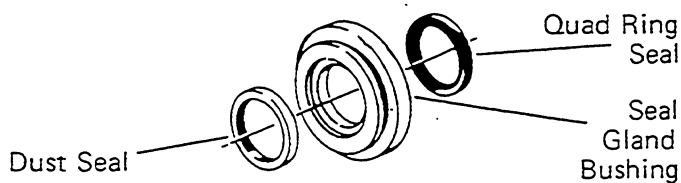


Figure 7

13 Remove quad ring seal from seal gland bushing.

14 Use a thin bladed screwdriver to pry dust seal from seal gland bushing. Do not damage bushing.

Note: If the unit you are repairing is a low input torque steering control unit, see page 12 for disassembly and reassembly procedures.

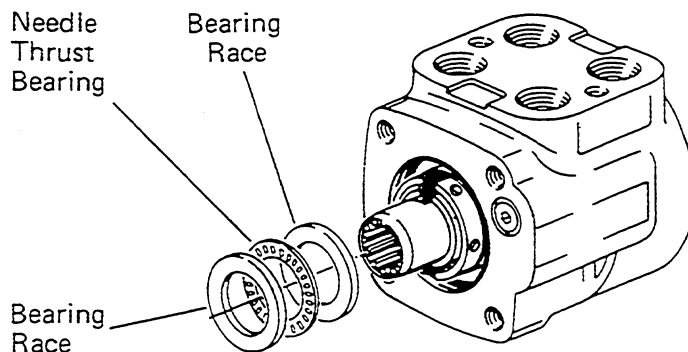


Figure 8

15 Remove 2 bearing races and the needle thrust bearing from spool and sleeve assembly.

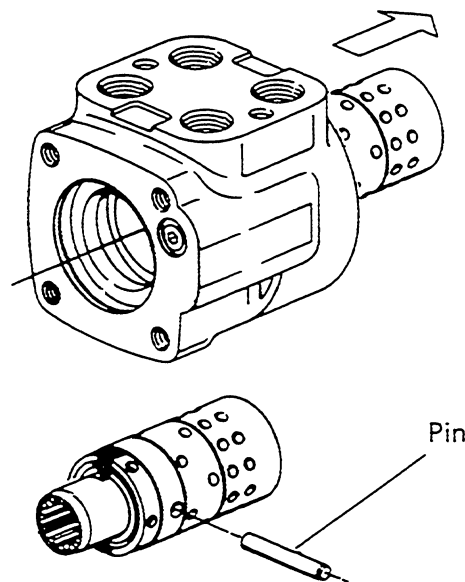


Figure 9

16 Remove spool and sleeve assembly from 14 hole end of housing, see Fig. 9.

Attention: Do not bind spool and sleeve in housing. Rotate spool and sleeve assembly slowly when removing from housing.

17 Push pin from spool and sleeve assembly.

Disassembly

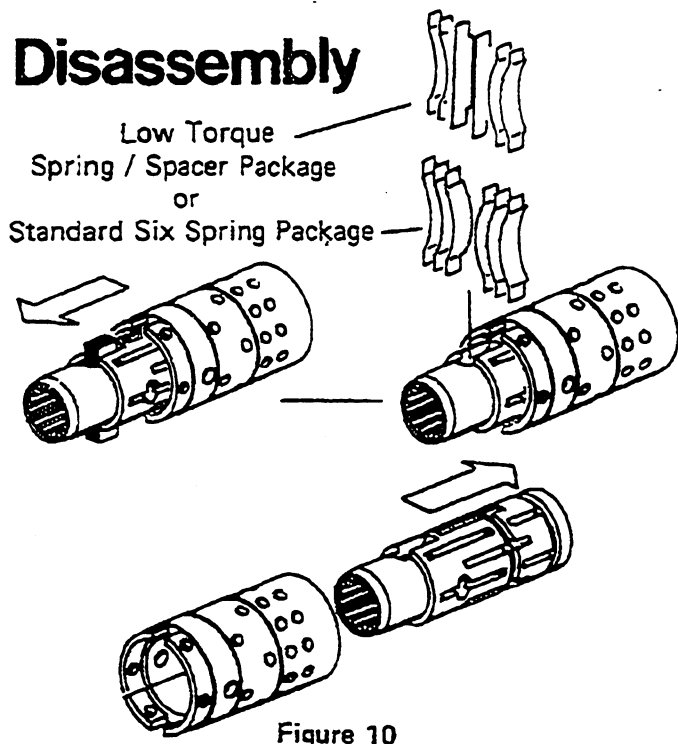


Figure 10

18 Push spool partially from control end of sleeve, then remove 6 centering springs from spool carefully by hand, see Fig. 10.

19 Push spool back through and out of sleeve, see Fig. 10. Rotate spool slowly when removing from sleeve.

20 Remove seal from housing, see Fig. 11.

6

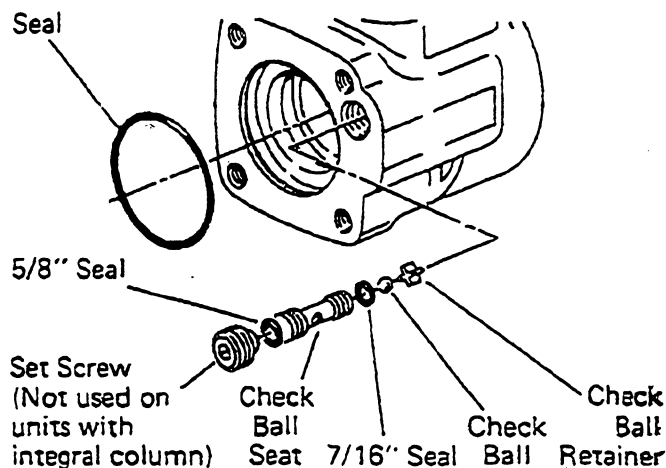


Figure 11

21 Remove set screw (not used on units with integral column) from housing, see Fig. 11.

22 Screw a #10-24 machine screw into end of check ball seat. Then by pulling on screw, with a pliers, lift seat out of housing.

23 Remove 2 seals from check valve seat.

24 Tip housing to remove check ball and check ball retainer.

Reassembly

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 into the hydraulic system and cause damage. Do not use a coarse grit or try to file or grind these parts.

Note: Lubricate all seals with clean petroleum jelly such as Vaseline.

Do not use excessive lubricant on seals for meter section.

Refer to parts listings covering your steering control unit when ordering replacement parts. A good service policy is to replace all old seals with new seals.

Control End

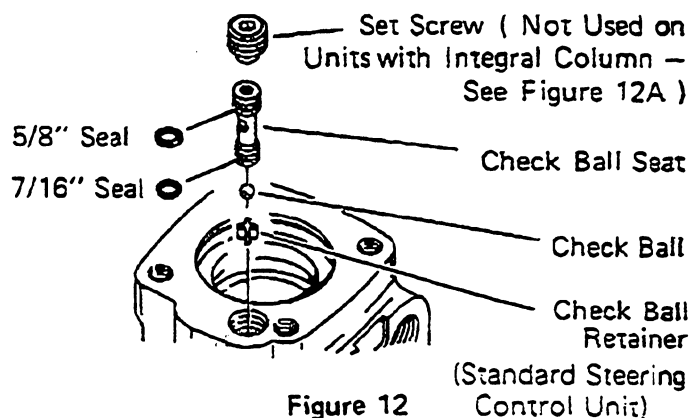


Figure 12

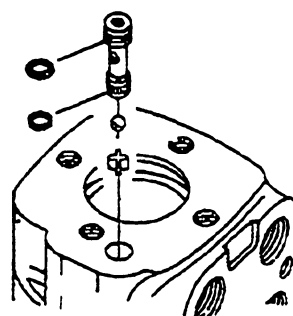
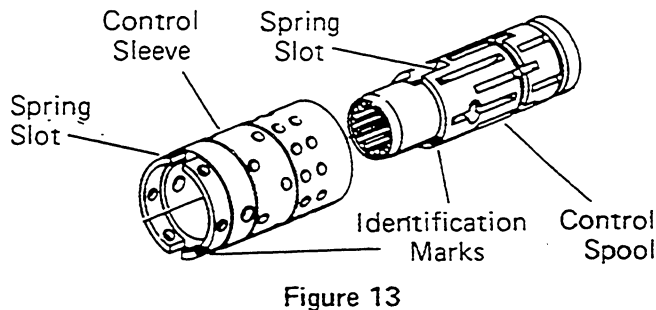


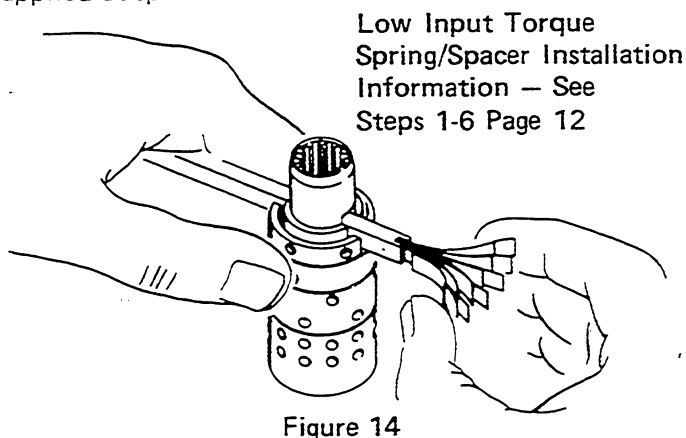
Figure 12A

(Integral Column Steering Control Unit)

- 1 Use a needle nose pliers to lower check ball retainer into check valve hole of housing. Make sure retainer is straight (not tilted on edge) in housing, see Fig. 12.
- 2 Install check ball in housing.
- 3 Lubricate 5/8" diameter seal and 7/16" diameter seal. Install seals on check ball seat as shown in Fig. 12.
- 4 Lubricate check ball seat and seals thoroughly before installing seat in housing. When installing seat do not twist or damage seals. Install check ball seat in housing, insert open end of seat first, see Fig. 12. Push check ball seat to shoulder of hole.
- 5 Install set screw (not used on units with integral column, see Fig. 12A). Use a 1/4" allen wrench to torque set screw to 100 inch pounds. To prevent interference, make sure top of set screw is slightly below housing mounting surface.



- 6 Assemble spool and sleeve carefully so that the spring slots line up at the same end. Rotate spool while sliding parts together. Some spool and sleeve sets have identification marks, align these marks as shown in Fig. 13. Test for free rotation. Spool should rotate smoothly in sleeve with finger tip force applied at splined end.



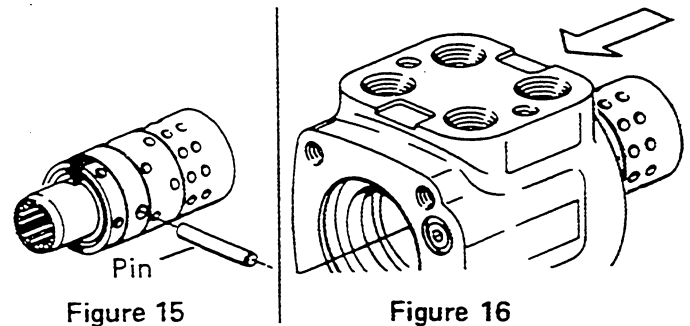
- 7 Bring spring slots of both parts in line and stand parts on end of bench. Insert spring installa-

tion tool through spring slots of both parts. Tool is available as part no. 600057. Position 3 pairs of centering springs (or 2 sets of 3 each) on bench so that extended edge is down and arched center section is together. In this position, insert one end of entire spring set into spring installation tool, as shown in Fig. 14, with spring notches facing sleeve.

- 8 Compress extended end of centering spring set and push into spool sleeve assembly withdrawing installation tool at the same time.

- 9 Center the spring set in the parts so that they push down evenly and flush with the upper surface of the spool and sleeve.

- 10 Install pin through spool and sleeve assembly until pin becomes flush at both sides of sleeve.



- 11 Position the spool and sleeve assembly so that the splined end of the spool enters the 14 hole end of housing first, see Fig. 16.

Attention: Be extremely careful that the parts do not tilt out of position while inserting. Push parts gently into place with slight rotating action, keep pin nearly horizontal. Bring the spool assembly entirely within the housing bore until the parts are flush at the meter end or 14 hole end of housing. Do not pull the spool assembly beyond this point to prevent the cross pin from dropping into the discharge groove of the housing. With the spool assembly in this flush position, check for free rotation within the housing by turning with light finger tip force at the splined end.

Reassembly

8

12 Place housing on clean, lint free cloth. Install 2-1/8" diameter seal in housing, see Fig. 17.

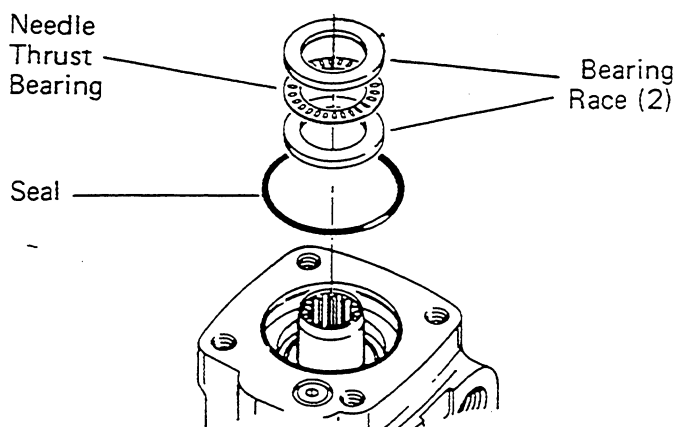


Figure 17

13 Install 2 bearing races and the needle thrust bearing in the order shown in Fig. 17.

14 Install 1-1/4" diameter dust seal in seal gland bushing, flat or smooth side of dust seal must face down towards bushing, see Fig. 19.

15 Install the quad ring seal in seal gland bushing. Smooth seal in place with your finger. Do not use any seal that falls freely into pocket of bushing, see Fig. 19.

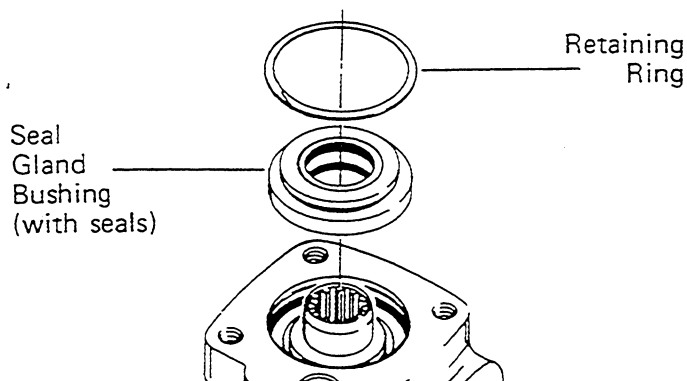


Figure 18

16 Install seal gland bushing over the spool end with a twisting motion. Tap the bushing in place with a rubber hammer. Make sure the bushing is flush against the bearing race.

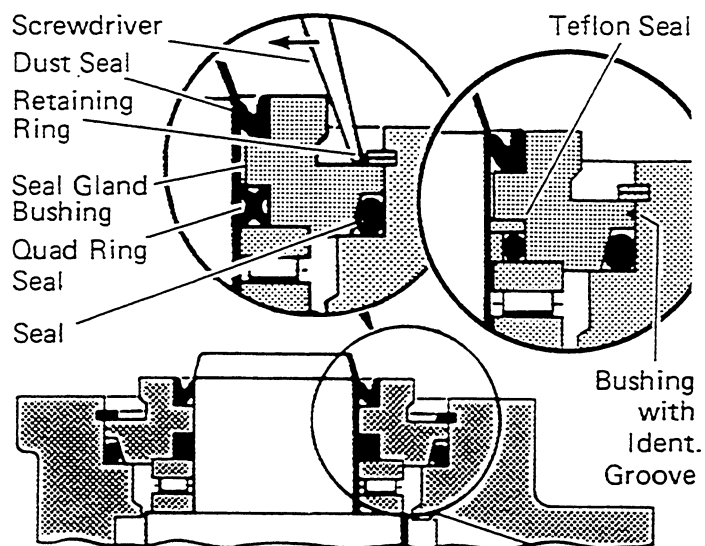


Figure 19

17 Install retaining ring (see Fig. 18-19) in housing. After installing ring, tap on ring end or pry with screwdriver around entire circumference of ring to properly seat ring in groove.

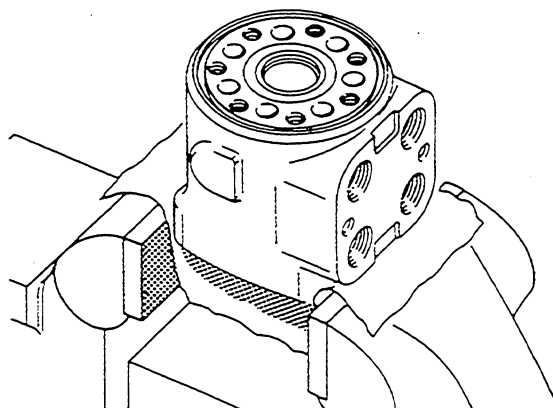


Figure 20

18 Clamp housing in vise, as shown in Fig. 20. Clamp lightly on edges of mounting area. Do not over tighten jaws.

Note: Check to insure that the spool and sleeve are flush or slightly below the 14 hole surface of the housing.

Attention: Clean the upper surface of the housing by wiping with the palm of clean hand. Clean each of the flat surfaces of the meter section parts in a similar way when ready for reassembly. Do not use cloth or paper to clean surfaces.

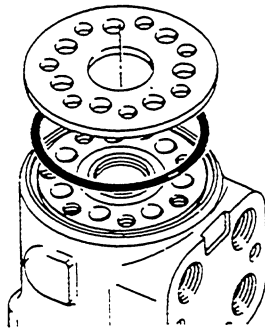


Figure 21

19 Install 3" diameter seal in housing, see Fig. 21.

20 Install spacer plate. Align bolt holes in spacer plate with tapped holes in housing.

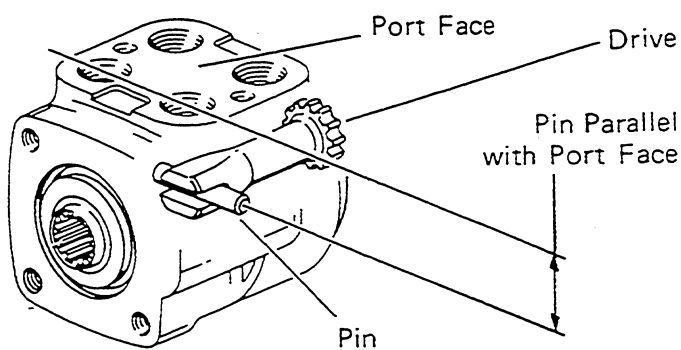


Figure 22

21 Rotate spool and sleeve assembly until pin is parallel with port face, see Fig. 22. Install drive, make sure you engage drive with pin, To assure proper alignment, mark drive as shown in Fig. 24 (ref. B). Note relationship between slotted end of drive to splined end of drive when marking.

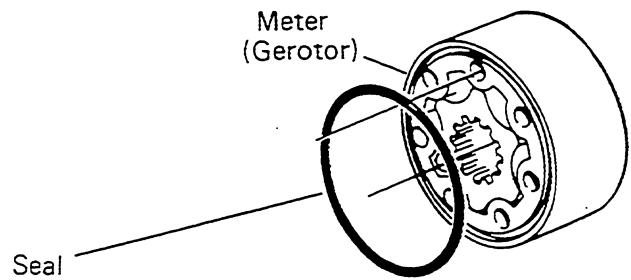


Figure 23

22 Install 3" diameter seal in meter.

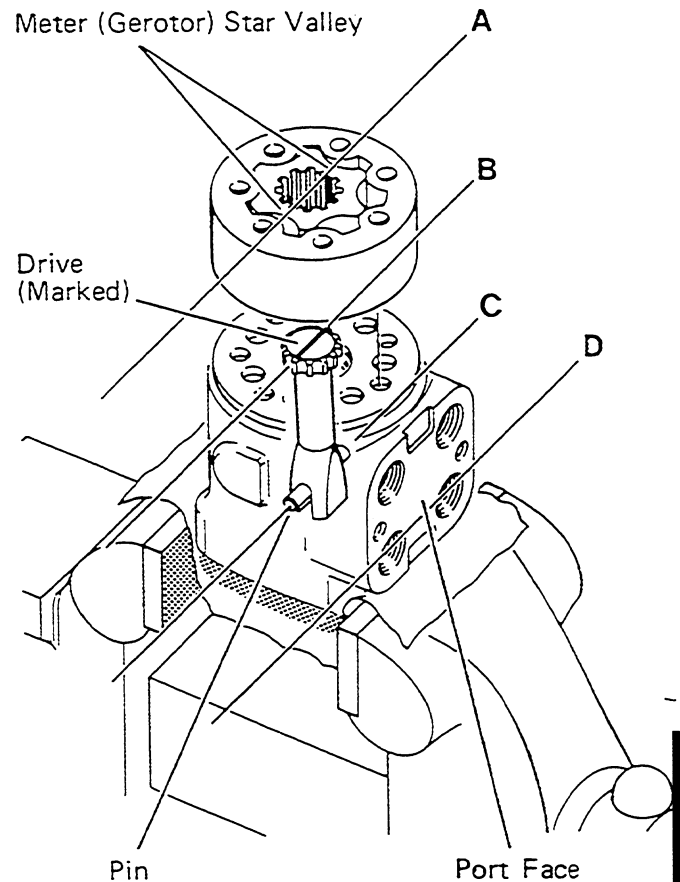


Figure 24

23 With seal side of meter toward spacer plate, align star valleys (ref. A) on drive (ref. B). Note the parallel relationship of reference lines A, B, C, and D— Fig. 24. Align bolt holes without disengaging meter from drive.

Reassembly

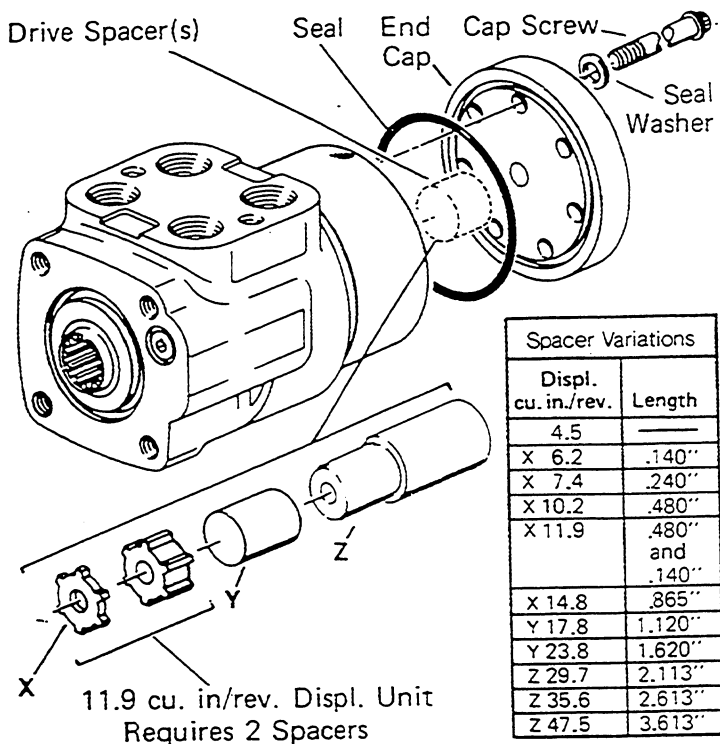


Figure 25

10

24 Install drive spacer(s) when used, in meter, see Fig. 25.

25 Install 3" diameter seal in end cap.

26 Install end cap on gerotor, align holes.

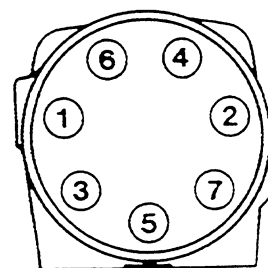


Figure 26

27 Install 7 dry cap screws with new seal washers in end cap. Pretighten screws to 150 inch pounds, then torque screws to 275 inch pounds in sequence shown in Fig. 26.

Disassembly

Disassembly of Integral Column Sub Assembly

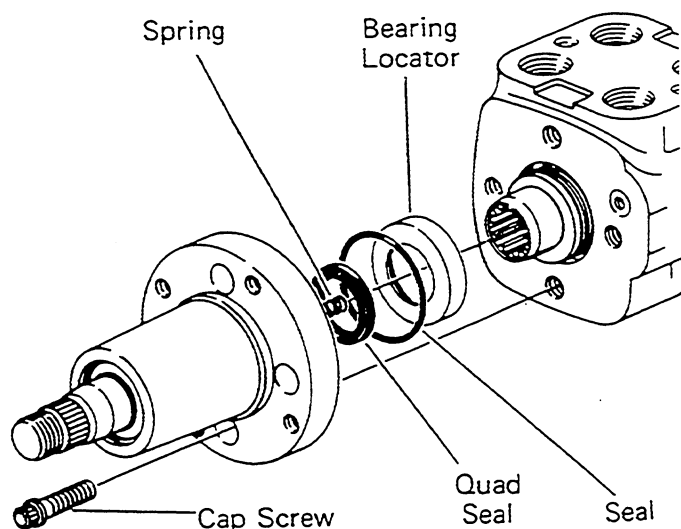


Figure 27

- 1 Remove 4 cap screws from column.
- 2 Remove column and spring, see Fig. 27.
- 3 Remove bearing locator.
- 4 Remove quad ring seal, and 1-15/16" diameter seal from column.

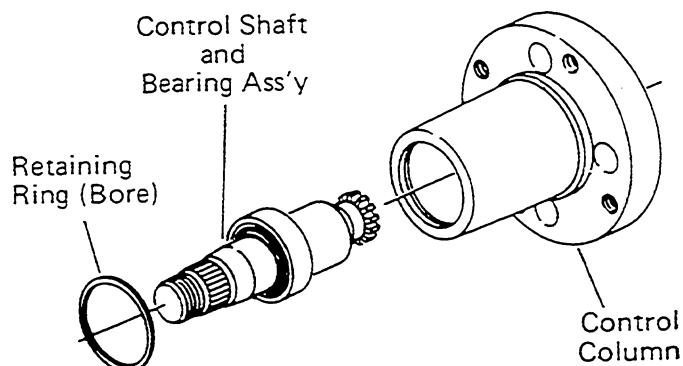


Figure 28

5 Use a thin bladed screwdriver to pry retaining ring from bore of control column.

6 Remove control shaft and bearing assembly from column, see Fig. 28. If tight, tap lightly with a plastic hammer or rubber hammer) on splined end of control shaft until the shaft breaks loose from the column.

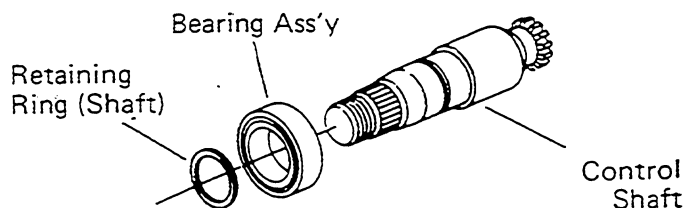


Figure 29

7 Use a thin bladed screwdriver to pry retaining ring from shaft. The retaining ring fits very tight, be careful not to distort it. Remove this ring only if it's necessary to remove bearing assembly from shaft, see Fig. 29.

8 Press bearing assembly from control shaft. Remove bearing assembly from threaded end of shaft, see Fig. 29. Remove this bearing assembly only if necessary.

Reassembly

Reassembly of Integral Column Sub Assembly

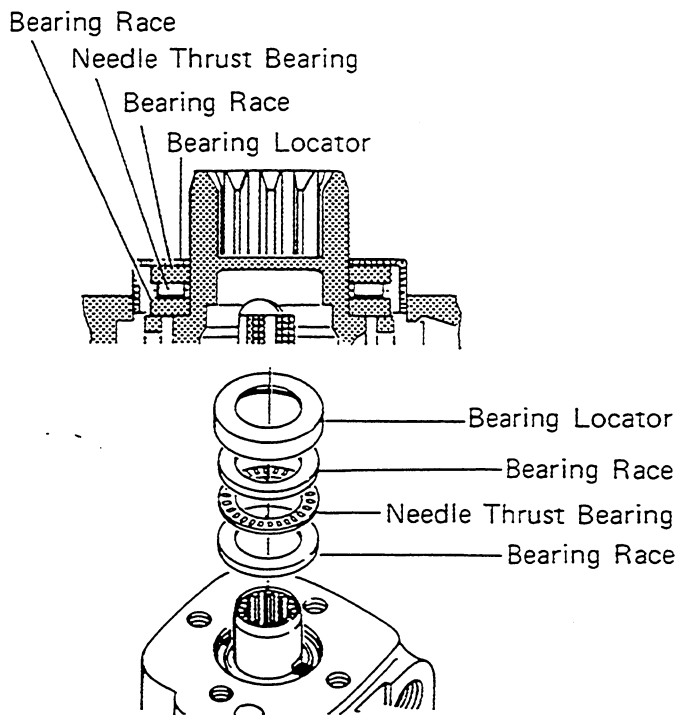


Figure 30

1 Install bearing locator over 2 bearing races and the needle thrust bearing, see Fig. 30. Use a soft plastic hammer or rubber hammer to lightly tap bearing locator in housing.

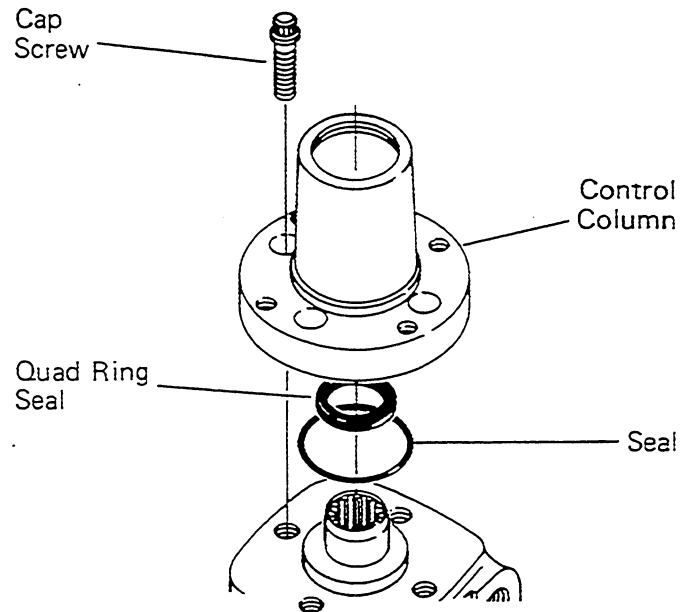


Figure 31

2 Install dry quad ring seal, and lubricated 1-15/16" diameter seal in column, see Fig. 31.

3 Install column on housing. Align bolt holes.

4 Install 4 dry cap screws. Torque screws in a criss-cross pattern to 200 inch pounds.

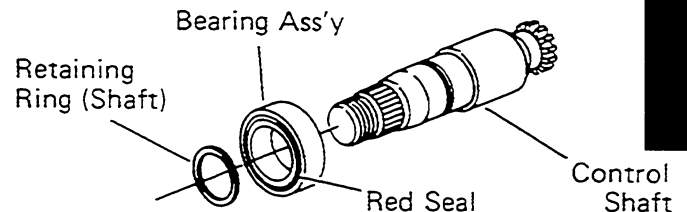


Figure 32

5 Press bearing assembly on control shaft with seal (red) side of bearing assembly facing toward threaded end of shaft. Make sure the bearing assembly seats against shoulder of shaft.

6 Install retaining ring on control shaft, see Fig. 32. Make sure ring seats properly in ring slot above bearing assembly.

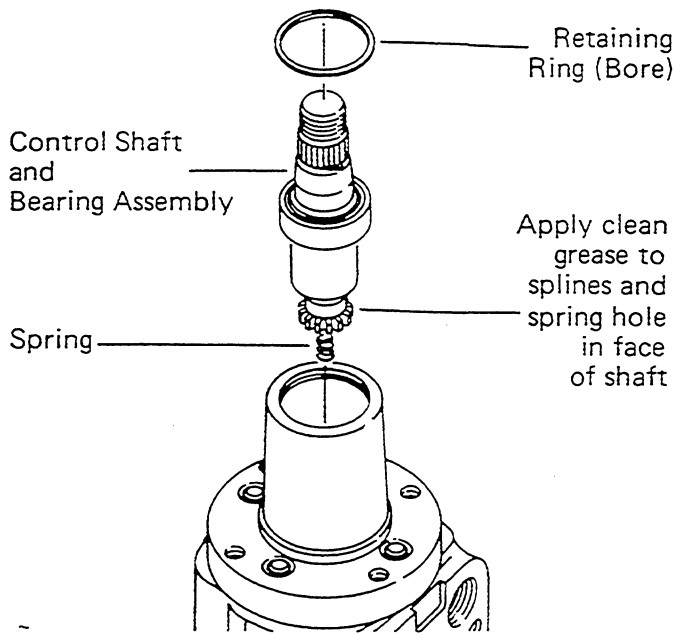


Figure 33

7 Apply clean grease to splines and spring hole located in face of control shaft, see Fig. 33. Install spring in hole. The grease should hold the spring in place until you install control shaft in column.

8 Install control shaft and bearing assembly in column (insert splined end of control shaft in column first), see Fig 33. Turn shaft to engage with spool. Push bearing assembly in far enough so you can install retaining ring in bore of column.

9 Install retaining ring in bore of column. Make sure you fully seat this retaining ring in ring groove.

How to order replacement parts.

Each order must include the following information:

1. Product Number
2. Date Code
3. Part Name
4. Part Number
5. Quantity of Parts

Char-Lynn Product number 000

E-T-N Eaton Corp. Hydraulics Div. Eden Prairie, MN 55344

Date Code: 00 0

Week of Year 01 Thru 52

Last Number of Year 198__

Product Number: 000 - 0000 - 000

Product Line Identification Number: 000

Product Identification Number: 0000

Engineering Change Code: 000

Low Input Torque Steering Control Unit

1 After disassembling steering control unit, discard quad-ring seal, seal gland bushing and two centering springs. Seal gland bushings for Teflon seal and quad-ring seal are not interchangeable.

2 Low torque steering control unit has one pair of spring spacers and two pairs of centering springs. Install spring spacers between two sets of centering springs. The installation procedure is the same as that used on the standard units.

3 Install Teflon seal, o-ring and back-up ring on the spool, see Figure X.

Note: Apply a light coat of hydraulic oil to all seals before installation.

4 Install dust seal in seal gland bushing, flat or smooth side down. This bushing has identification groove in outer diameter. Non-grooved bushing cannot be used with Teflon seal.

5 Install seal gland bushing over spool end with a twisting motion. Tap bushing in place with a rubber hammer. Make sure bushing is flush against bearing race.

6 Install retaining ring (see Figure X) in housing. After installing ring , tap on ring end or pry with screwdriver around entire circumference of ring to properly seat ring in groove.

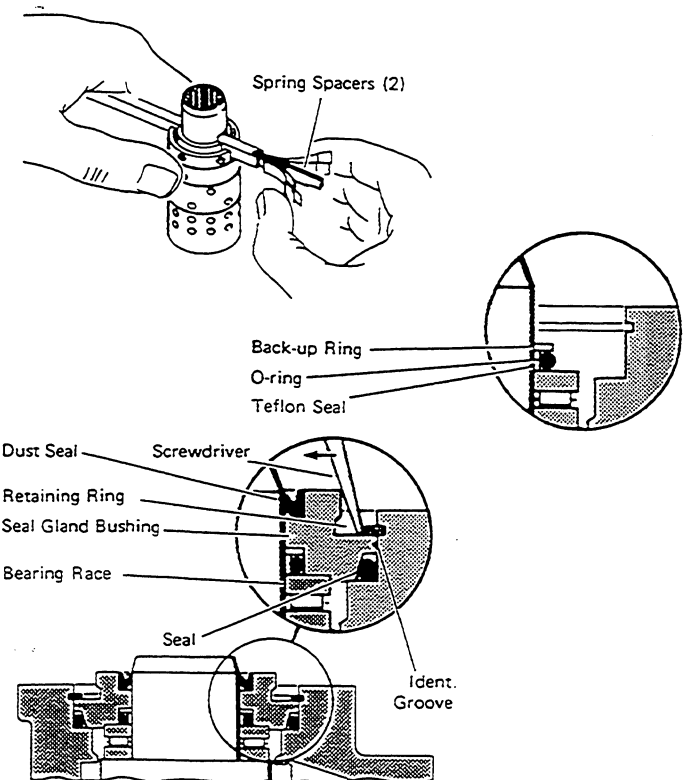


Figure X

Most steering problems can be corrected if the problem is properly defined. The entire steering system should be evaluated before removing any components. The steering control unit is generally not the cause of most steering problems. The following is a list of steering problems along with possible causes and suggested corrections.

<u>Problem</u>	<u>Possible Cause</u>	<u>Correction</u>
1. Slow steering, hard steering, or loss of power assist.	Worn or malfunctioning pump.	Replace pump.
	Stuck flow divider piston.	Replace flow divider.
	Worn pump compensator allowing the system pressure to be less than specified.	Replace pump and compensator.
	Malfunctioning relief valve allowing the system pressure to be less than specified.	Replace the relief valve.
	Overloaded steer axle.	Reduce load.
2. Wander—Tendency of vehicle path to deviate from course defined by operator input.	If load sensing system	Correct
	1. Leaking or kinked load sensing signal line.	Check spring and sticking spool. Check damping orifices in both ends of main bore for debris. Check system pressure at SCU inlet for proper system pressure. If not correct replace priority valve relief cartridge.
	2. Malfunctioning priority valve.	
	Air in the system due to low level of oil, cavitating pump, leaky fitting, pinched hose, etc.	
	Worn mechanical linkage.	
	Bending of linkage or cylinder rod.	
	Loose cylinder piston.	Correct condition and add fluid.
	Leaky crossover relief or anti-cavitation valve in cylinder lines.	Repair or replace.
	Severe wear in steering control unit.	Repair or replace.
	Single rod end cylinder slowly extends without turning the steering wheel.	Repair or replace.
	Worn or damaged steering linkage.	Repair or replace the accessory valve.
3. Drift—Diviation of vehicle path, without operator input, from normally expected continuing course.		Replace the steering control unit.
		A small rate of extension may be normal on a closed center system.
4. Slip—A slow movement of steering wheel fails to cause any movement of steered wheels.	Worn or damaged steering linkage.	Replace linkage and align front end.
	Leakage of cylinder piston seals or accessory valve between cylinder lines or ports.	Replace seals or accessory valve.
	Worn steering control unit meter.	Replace steering control unit.
5. Temporary hard steering or hang-up—A momentary increase in steering wheel torque during steering reversal or initial input.	Thermal Shock*	Check unit for proper operation and cause of thermal shock.

*Thermal shock definition bottom of page 14.

<u>Problem</u>	<u>Possible Cause</u>	<u>Correction</u>
6. Erratic steering.	Air in system due to low level of oil, cavitating pump, leaky fitting, pinched hose, etc.	Correct condition and add fluid.
	Loose cylinder piston.	Replace cylinder.
	*Thermal shock damage.	Replace steering control unit.
	Sticking flow control spool.	Replace flow control valve.
7. "Spongy" or soft steering.	Air in hydraulic system. Most likely air trapped in cylinders or lines.	Bleed air out of system. Placing ports on top of the cylinder will help prevent air trapping.
	Low fluid level.	Add fluid and check for leaks.
8. Free Wheeling—Steering wheel turns freely with no feeling of pressure and no action on steered wheels.	Steering column upper shaft is loose or damaged.	Tighten steering wheel nut.
	Lower splines of column may be disengaged or broken.	Repair or replace column.
	Steering control unit meter has a lack of oil. This can happen on start-up, after repair, or long periods of non use.	Usually starting engine will cure problem.
	No flow to steering unit can be caused by:	
	1. Low fluid level. 2. Ruptured hose. 3. Internal steering control unit damage due to thermal shock*.	Add fluid and check for leaks. Replace hose. Replace the unit.
9. Free Wheeling—Steering wheel turns with slight resistance but results in little or no steered wheel action.	Leaking crossover relief or anti-cavitation valve in cylinder lines.	Repair or replace the accessory valve.
	Piston seal blown out.	Determine cause. Correct and replace seal.
10. Excessive free play at steering wheel.	Loose steering wheel nut. Steering column shaft worn or damaged. There should be very little free play in the unit itself.	Repair or replace steering wheel connection or column.
11. Excessive free play at steered wheels.	Broken or worn linkage between cylinder and steered wheels.	Check for loose fitting bearings and anchor points in steering linkage between cylinder and steered wheels.
	Leaky cylinder seals.	Replace cylinder seals.

*Thermal shock—A condition caused when the hydraulic system is operated for some time without turning the steering wheel so that fluid in the reservoir and system is hot and the steering control unit is relatively cool (more than 50° F temperature differential). When the steering wheel is turned quickly the result is temporary seizure and possible damage to internal parts of the steering control unit. The temporary seizure may be followed by total free wheeling. This applies to closed center and load sensing units only.

<u>Problem</u>	<u>Possible Cause</u>	<u>Correction</u>
12. Binding or poor centering of steering wheel.	Binding or misalignment in steering column or splined input connection.	Align column pilot and spline to steering control unit.
	High back pressure in tank line can cause slow return to center. Should not exceed 300 psi.	Revise circuit return line.
	Large particles can cause binding between the spool and sleeve.	Clean the unit and filter the oil. If another component has failed generating contaminants, flush the system while bypassing the steering control unit.
13. Steering unit locks up.	Large particles in meter section.	Clean the unit.
	Insufficient hydraulic power (units over 15 cu. in./rev.)	Check hydraulic power supply.
	Severe wear and/or broken pin.	Replace the unit.
	*Thermal shock.	Replace the unit.
14. Steering wheel oscillates or turns by itself, either side of neutral, after operator has removed input.	Parts assembled wrong. Steering unit improperly timed.	Correct timing.
	Lines connected to wrong ports.	Reconnect lines correctly.
15. Steered wheels turn in wrong direction when operator activates steering wheel	Lines connected to wrong cylinder ports.	Reconnect lines correctly.
16. Kick—Momentary kick back of steering wheel at start of steering.	No inlet check valve on steering control unit.	Install a check valve.
17. Instability—Fluid-born oscillation.	Air in lines	Check pump inlet. Bleed sensing lines.
	Harmonic system	Add hose or an accumulator.
	Plumbing	Bleed all lines. Pilot lines should be tubing. lines to cylinder should be tubing. If 2 pilot lines are used go to 1.
	Relief Setting	Pump relief should be 300 PSI above priority relief.
	Priority Valve	Bleed by holding against stop for 30 seconds on models w/built in relief only.
		Decrease damping orifice by adding small wire.
		Increase spring rate (this will raise the standby pressure).
	Load Sensing Pump	Compensator sticky. Increase standby pressure.

*Thermal shock definition bottom of page 14.

Selection Data

3 Series

System	Load Circuit	Rated Flow GPM ★ [LPM]	Port Size	External Configuration	Product Number						
					Displacement-cu. in. rev. [cu. cm. rev.]						
					4.5 [75]	6.2 [100]	7.4 [120]	10.2 [165]	11.9 [195]	14.8 [240]	17.8 [290]
Open Center	Non-Load Reaction	2-4 [7.5-15]	9/16-18	Standard	211-1001	211-1002	211-1003	-	-	-	-
				Integral Column	211-1004	211-1005	211-1006	-	-	-	-
Closed Center	Non-Load Reaction	2-4 [7.5-15]	9/16-18	Standard	212-1009	212-1010	212-1011	212-1012	-	-	-
	Load Reaction	2-4 [7.5-15]	9/16-18	Standard	212-1021	212-1022	212-1023	212-1024	-	-	-
				Integral Column	212-1025	212-1026	212-1027	212-1028	-	-	-

6 Series

					Displacement-cu. in. rev. [cu. cm. rev.]						
					4.5 [75]	6.2 [100]	7.4 [120]	10.2 [165]	11.9 [195]	14.8 [240]	17.8 [290]
Open Center	Non-Load Reaction	4-8 [15-30]	3/4-16	Standard	211-1007	211-1008	211-1009	211-1010	211-1011	211-1012	211-1013
				Integral Column	211-1014	211-1015	211-1016	211-1017	211-1018	211-1019	211-1020
	Load Reaction	4-8 [15-30]	3/4-16	Standard	211-1047	211-1048	211-1049	211-1050	211-1051	211-1052	211-1053
Closed Center	Non-Load Reaction	12 [45]	3/4-16	Standard	212-1001	212-1002	212-1003	212-1004	212-1005	212-1006	212-1007
	Load Reaction	8 [30]	3/4-16	Standard	-	-	-	212-1018	212-1019	212-1020	-
Load Sensing	Non-Load Reaction	6 [23]	3/4-16	Standard	213-1001	213-1002	213-1003	213-1004	213-1005	213-1006	213-1007

12 Series

					Displacement-cu. in. rev. [cu. cm. rev.]						
					17.8 [290]	23.8 [390]	29.7 [490]	35.6 [585]	47.5 [780]		
Open Center	Non-Load Reaction	8-16 [30-60]	3/4-16	Standard	211-1037	211-1038	211-1039	211-1040	211-1041	-	-
				Integral Column	211-1042	211-1043	211-1044	211-1045	211-1046	-	-
Closed Center	Non-Load Reaction	16 [60]	3/4-16	Standard	-	212-1014	212-1015	212-1016	212-1017	-	-
Load Sensing	Non-Load Reaction	12 [45]	3/4-16	Standard	213-1012	213-1013	213-1014	213-1015	213-1016	-	-

Other combinations of the above standard features available on special order—consult factory

★For closed center unit, rated flow is measured at 1000 PSI pressure drop at full valve deflection.
For load sensing unit, rated flow is designed for 65 PSI pressure drop between inlet (P) and load sensing (LS) port at full valve deflection.

Eaton Corporation Hydraulics Division 15151 Highway 5 Eden Prairie, MN 55344 Telephone (612) 937-9800

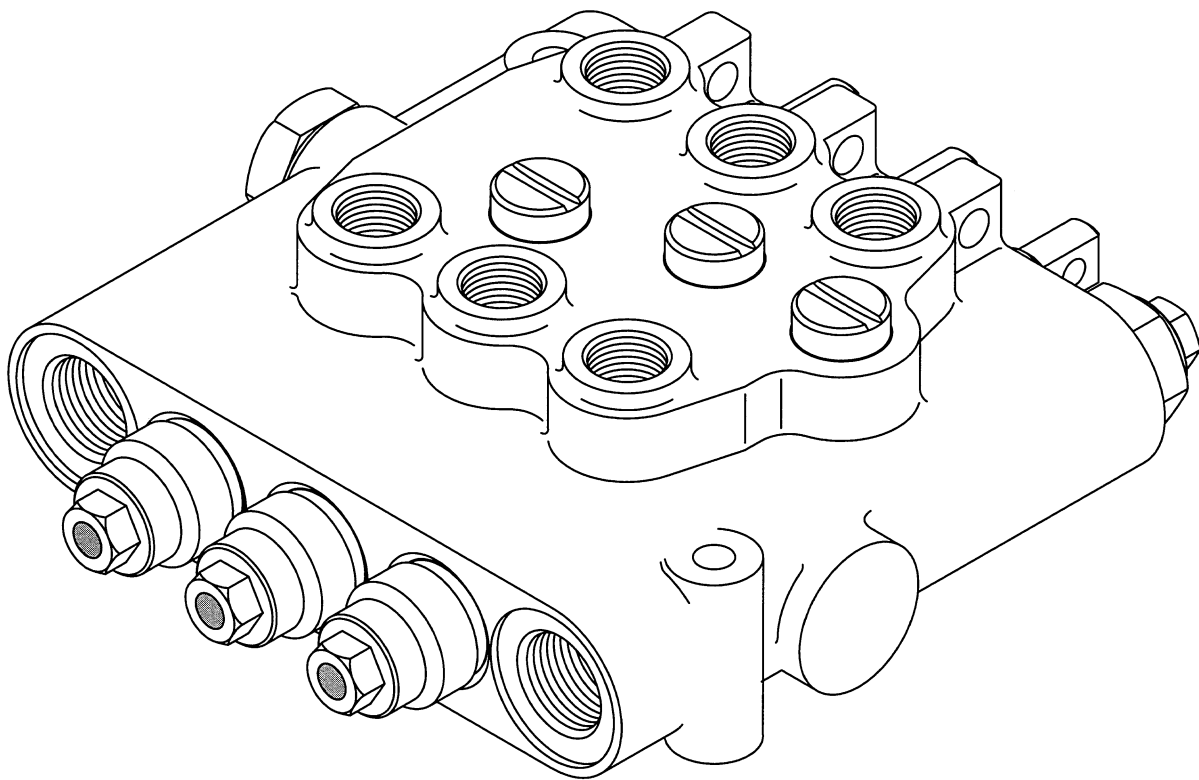
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Hydraulics
Division**

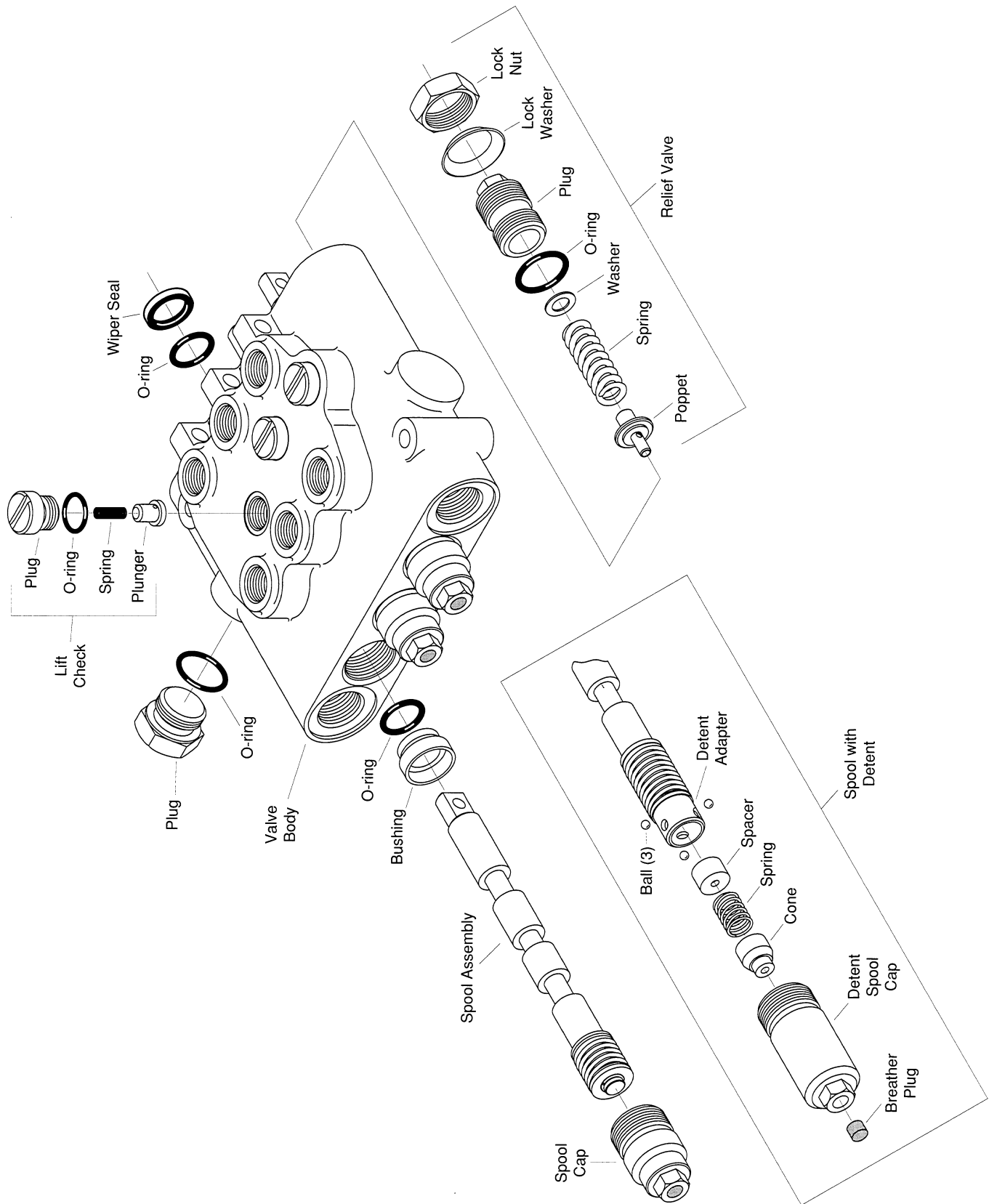
Repair Information

Model 30920 - 30930 Directional Control Valve



EAT•N

Parts Drawing



Disassembly

Refer to the Parts Drawing as you perform the repairs.

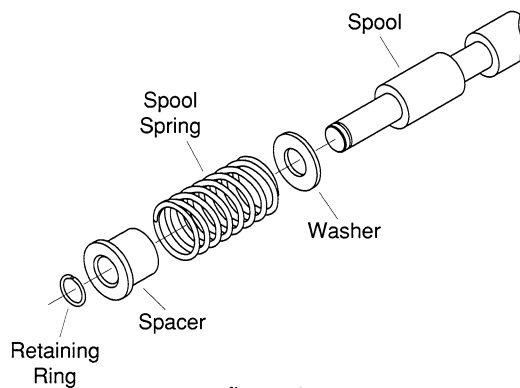
1. Plug all ports and clean the outside of the valve thoroughly.
2. Mark the spools and their specific bores. The spools are matched to the bores and must not be switched.

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.



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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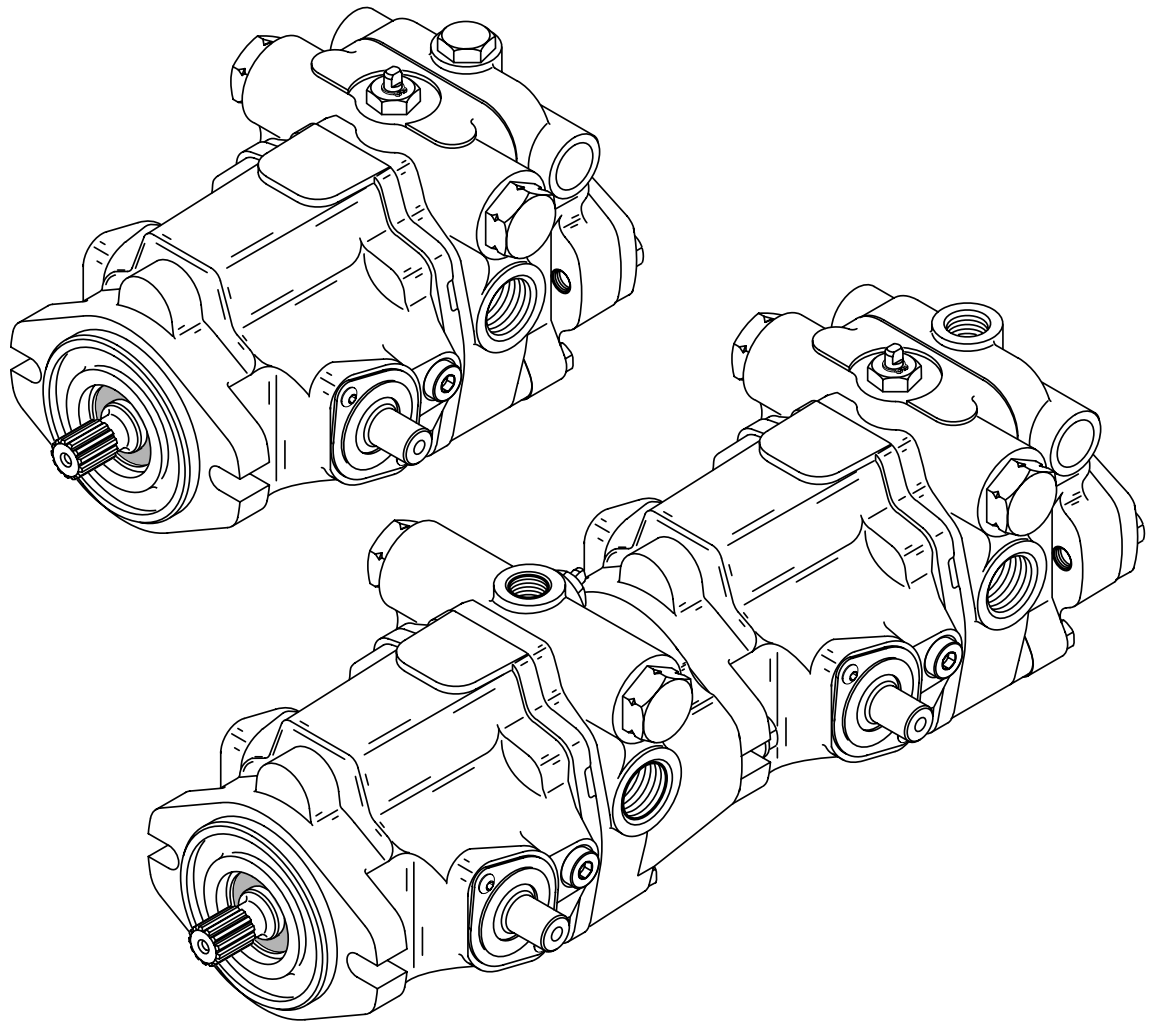


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Repair Information



**Model 70142 / 70144, 20.3 cm³/r [1.24 in³/r] Displacement
and 70145, 23.6 cm³/r [1.44 in³/r] Displacement**

Variable Displacement Piston Pump

design code **01 02**

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 cm³/r [1.24 in³/r]) with Gerotor

70144 = Piston Pump (20.3 cm³/r [1.24 in³/r]) without Gerotor

70145 = Piston Pump (23.6 cm³/r [1.44 in³/r]) with or without Gerotor

78113 = Tandem Piston Pumps (20.3 cm³/r [1.24 in³/r]) **no Gear Pump**

78114 = Tandem Piston Pumps (20.3 cm³/r [1.24 in³/r]) with Gear Pump

78115 = Tandem Piston Pumps (23.6 cm³/r [1.44 in³/r]) **no Gear Pump**

78116 = Tandem Piston Pumps (23.6 cm³/r [1.44 in³/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 ————

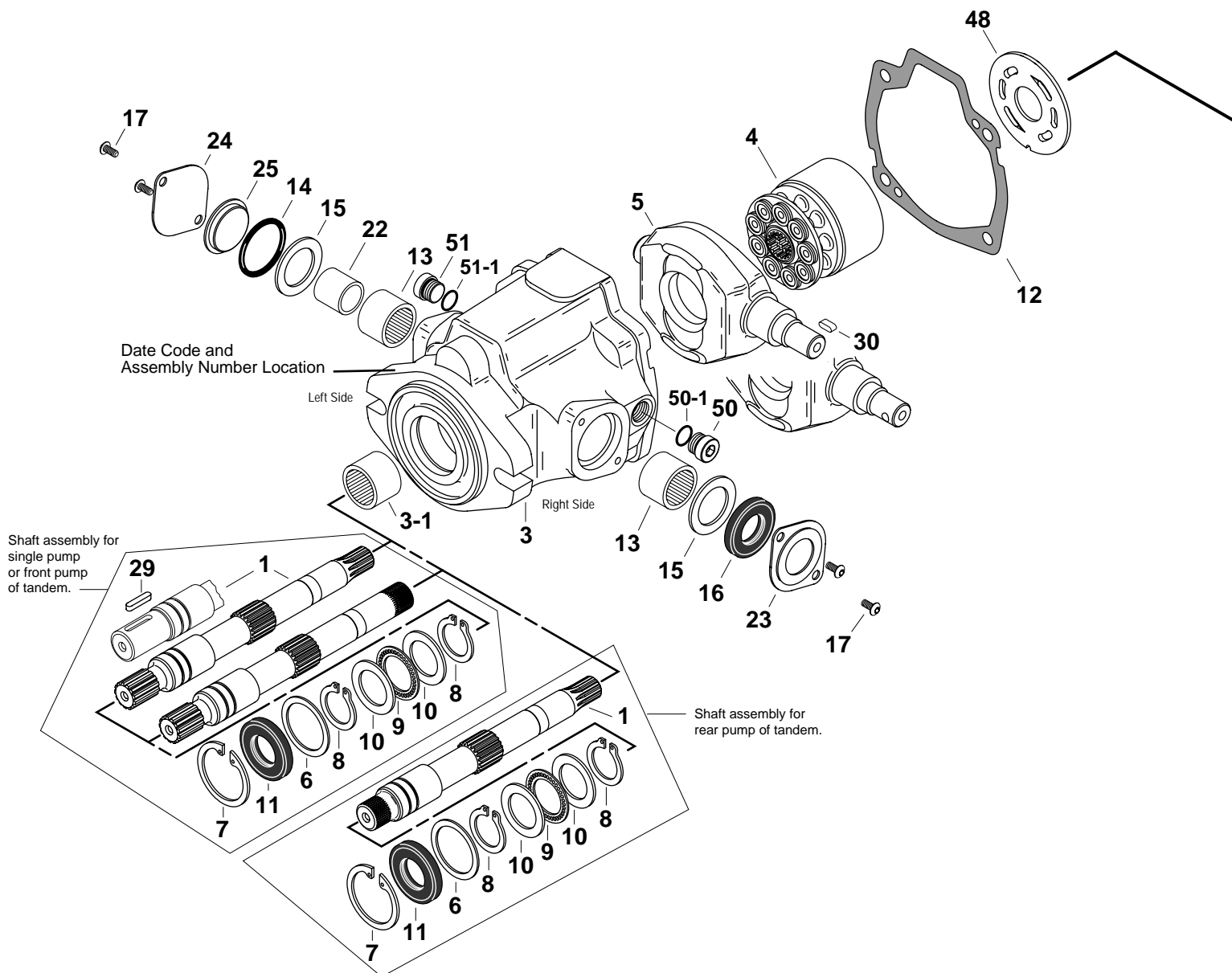
Day of Month (two digits) ————

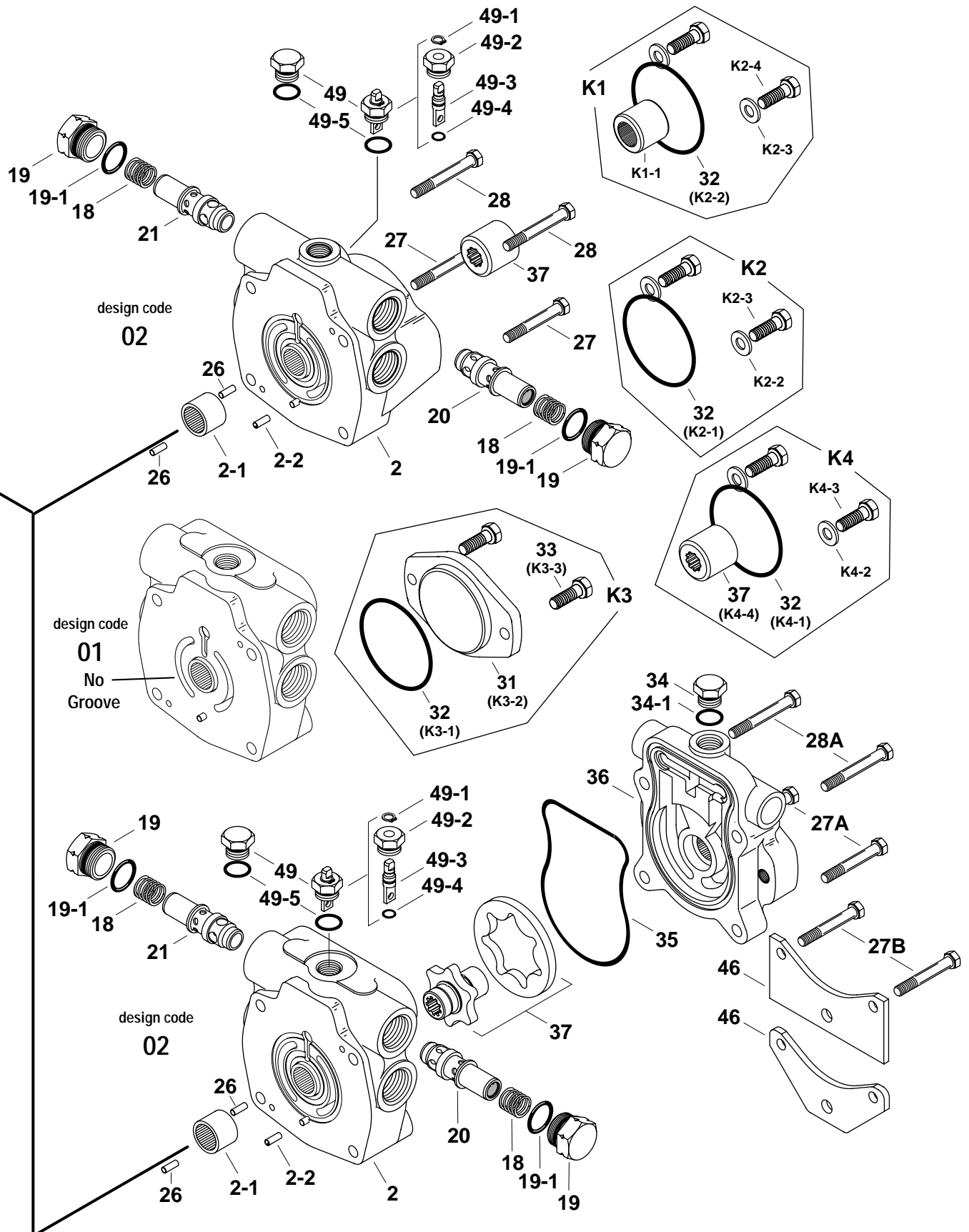
Month (two digits) ————

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 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 ³ /r [.42 in ³ /r] displacement, 6.35 mm [.25 in.] width 13.8 cm ³ /r [.84 in ³ /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.

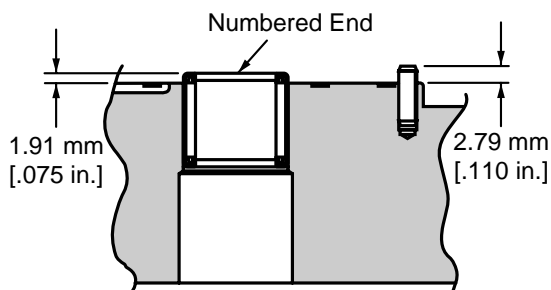


Figure 1-3

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.

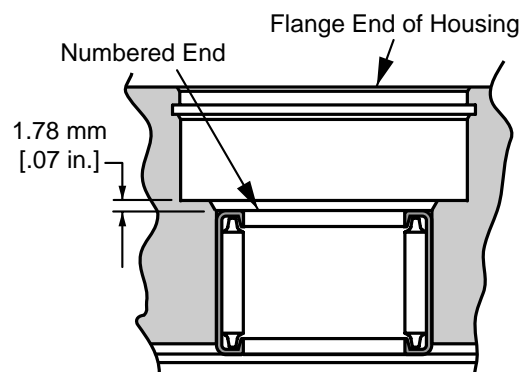


Figure 1-4

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·in].
- 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·in].
- 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.

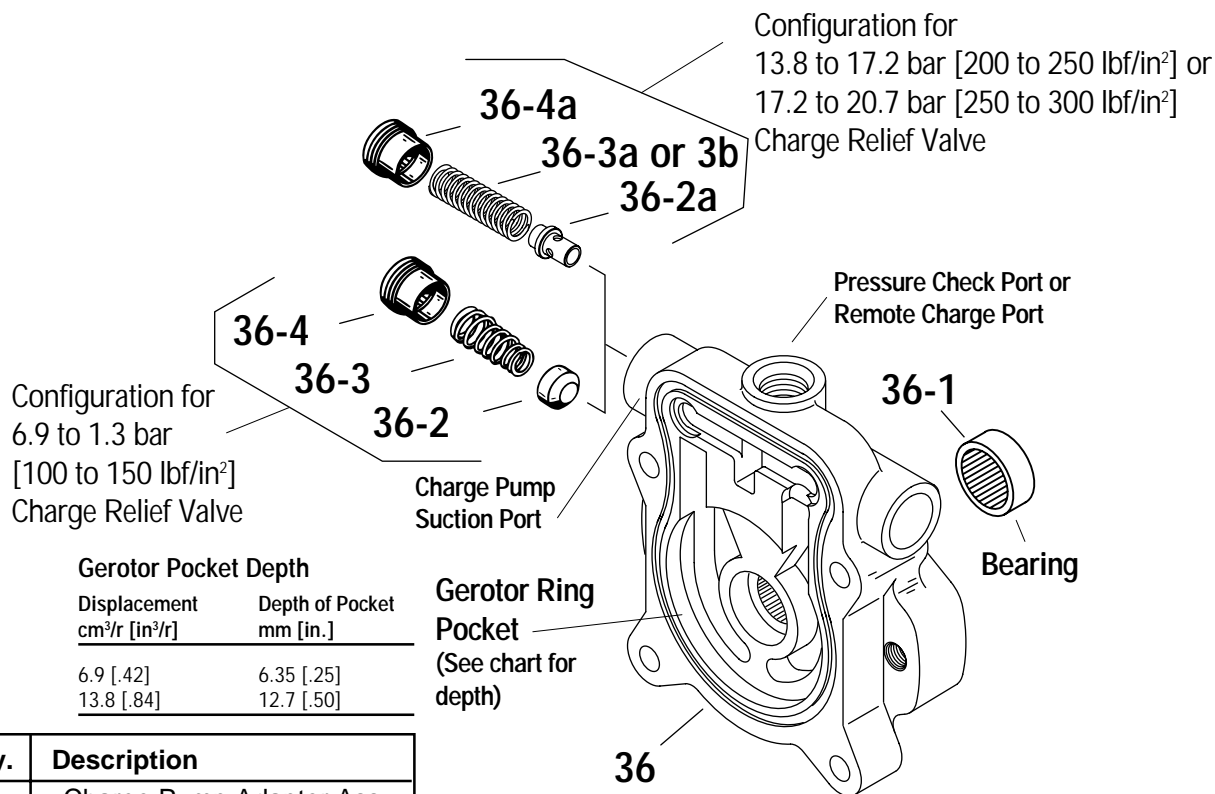
- 16 Install o-ring and outer gerotor ring onto adapter plate. Lubricate both o-ring and outer gerotor ring to hold in position during assembly of adapter plate. Install adapter plate onto backplate. Make sure o-ring and gerotor ring stay in place.

- 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



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/in²

**250 to 300 lbf/in²

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 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.

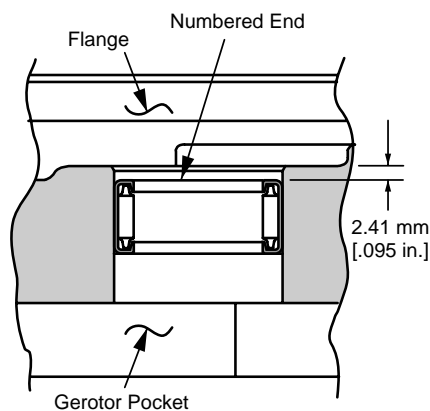
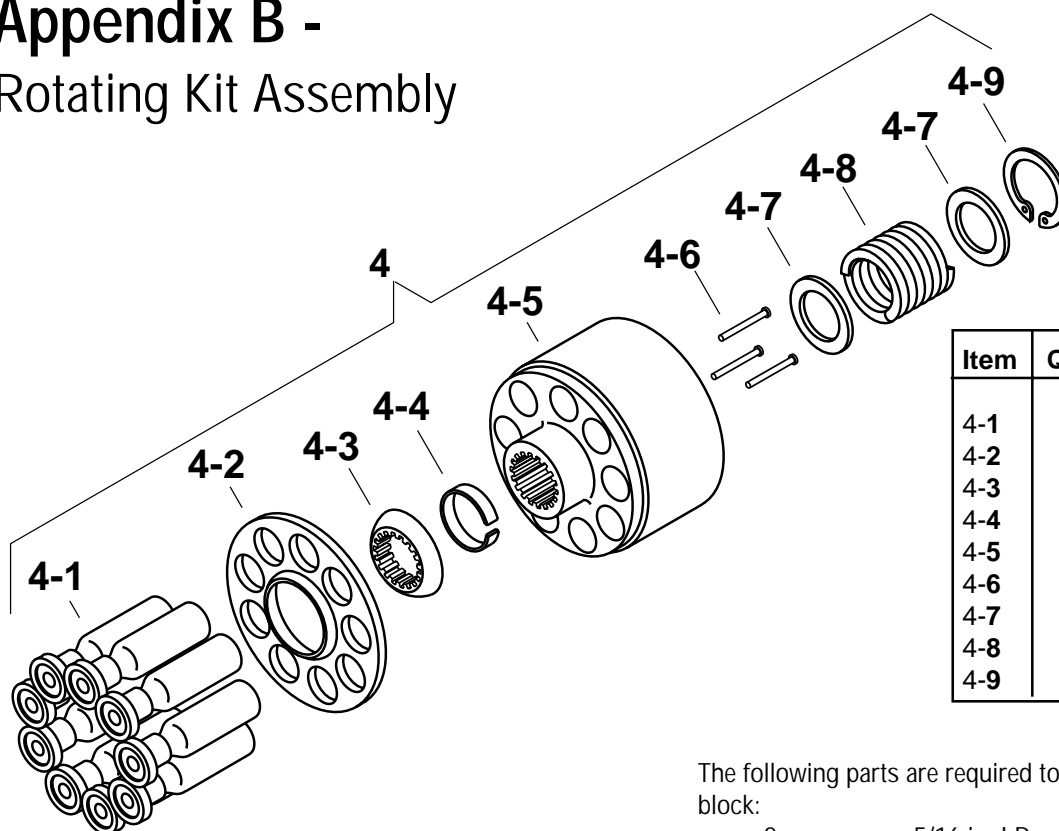


Figure 1-2

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.

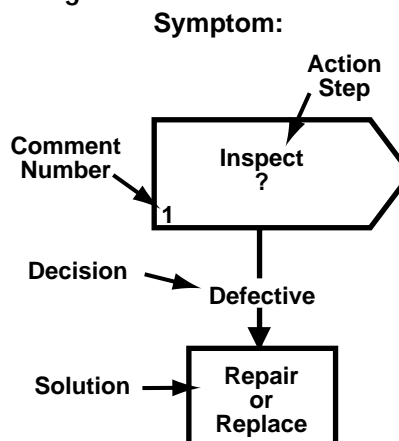
Fault - Logic Trouble Shooting

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



Recommended Gauge Locations

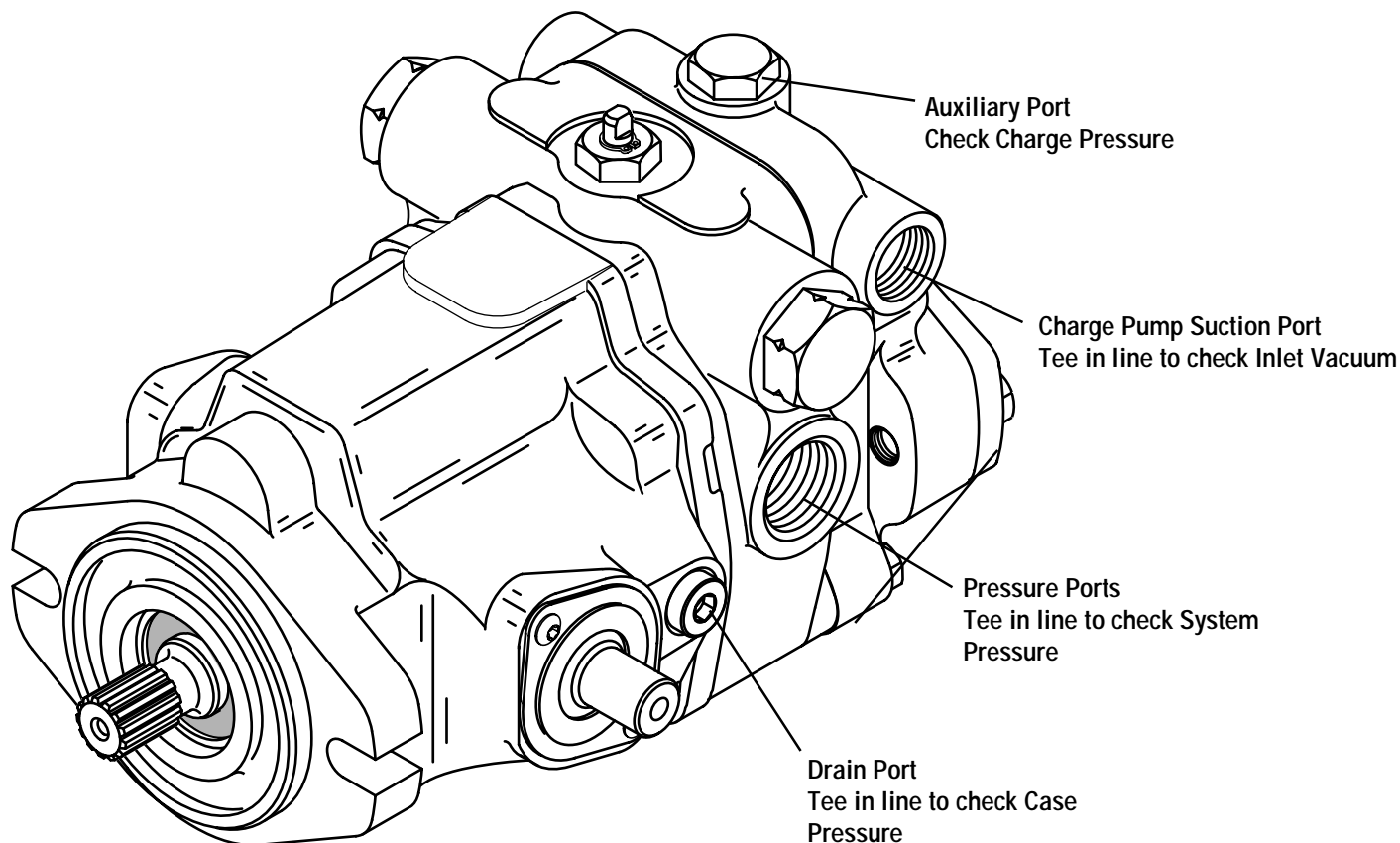


Figure 3-1

Gauges Recommended

Inlet vacuum gauge: 207 bar to 0 bar [30 lbf/in² to 30 inHg]

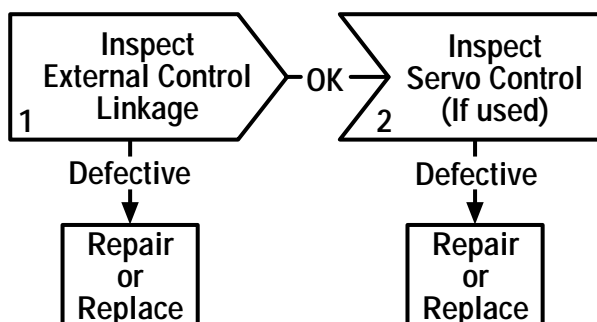
System pressure gauge: 700 bar [10,000 lbf/in²]

Charge pressure gauge: 0 to 50 bar [0 to 600 lbf/in²]

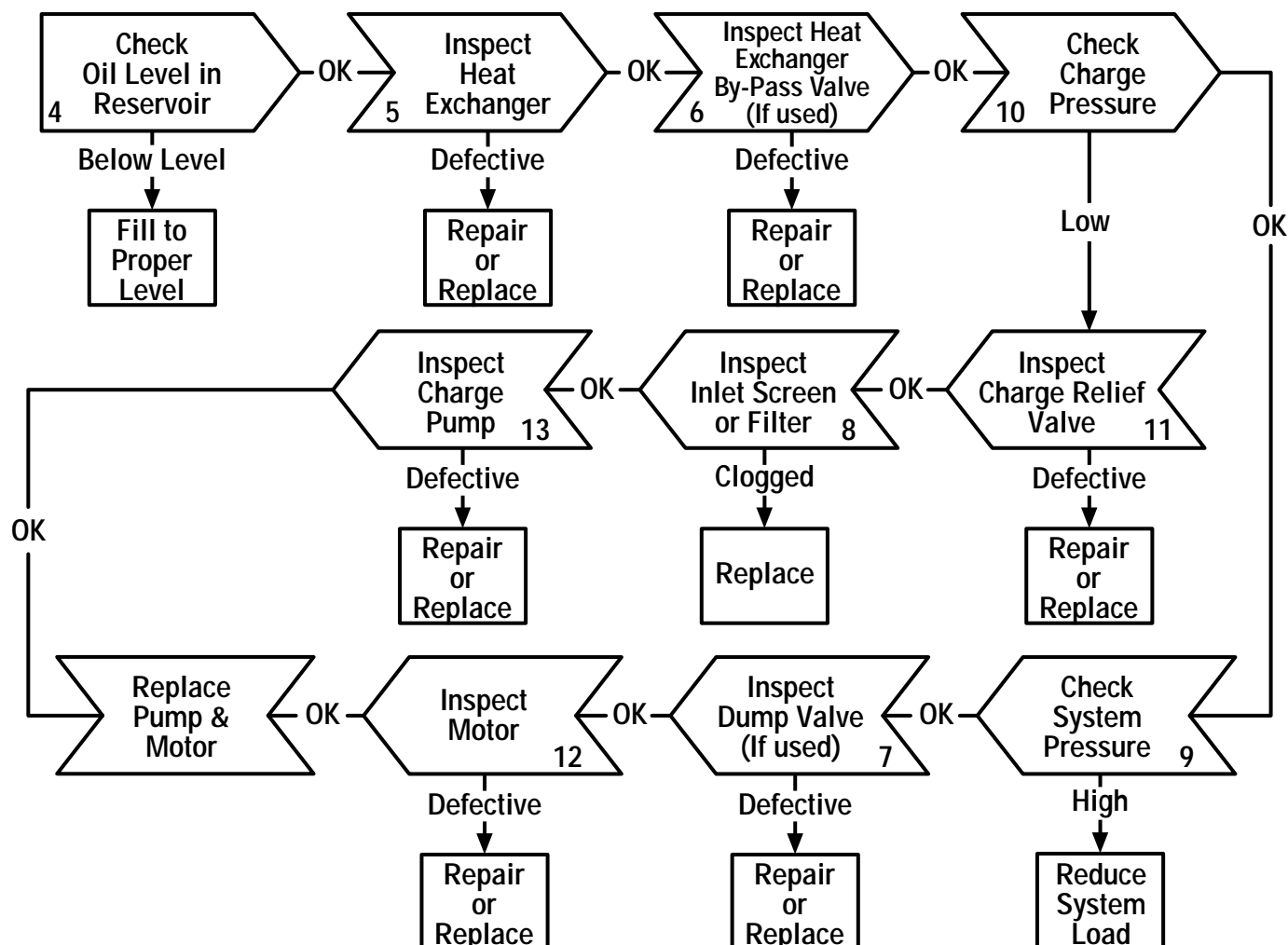
Case pressure gauge: 0 to 25 bar [0 to 300 lbf/in²]

Fault - Logic Trouble Shooting

Symptom: Neutral Difficult or Impossible to Find



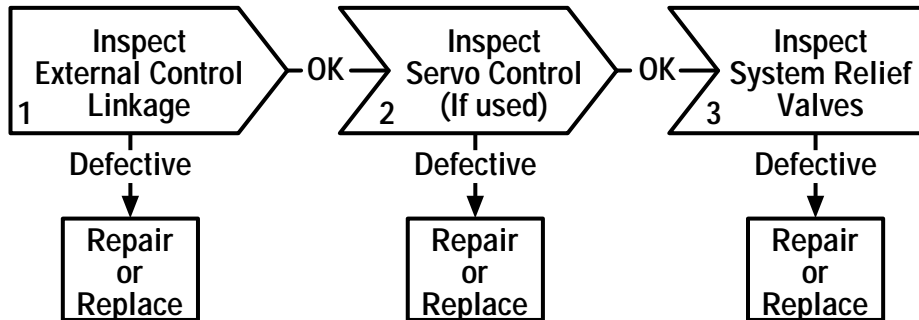
Symptom: System Operating Hot



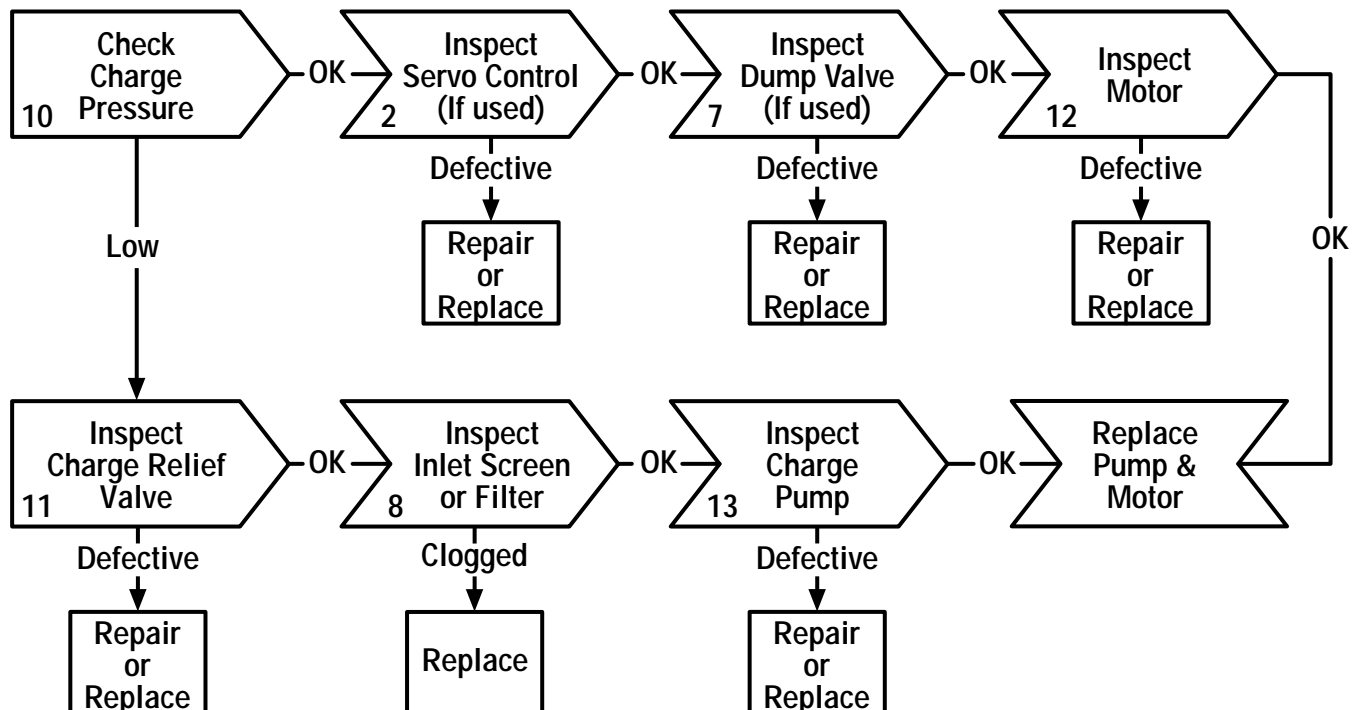
Fault - Logic

Trouble Shooting

Symptom: Operates in One Diection Only



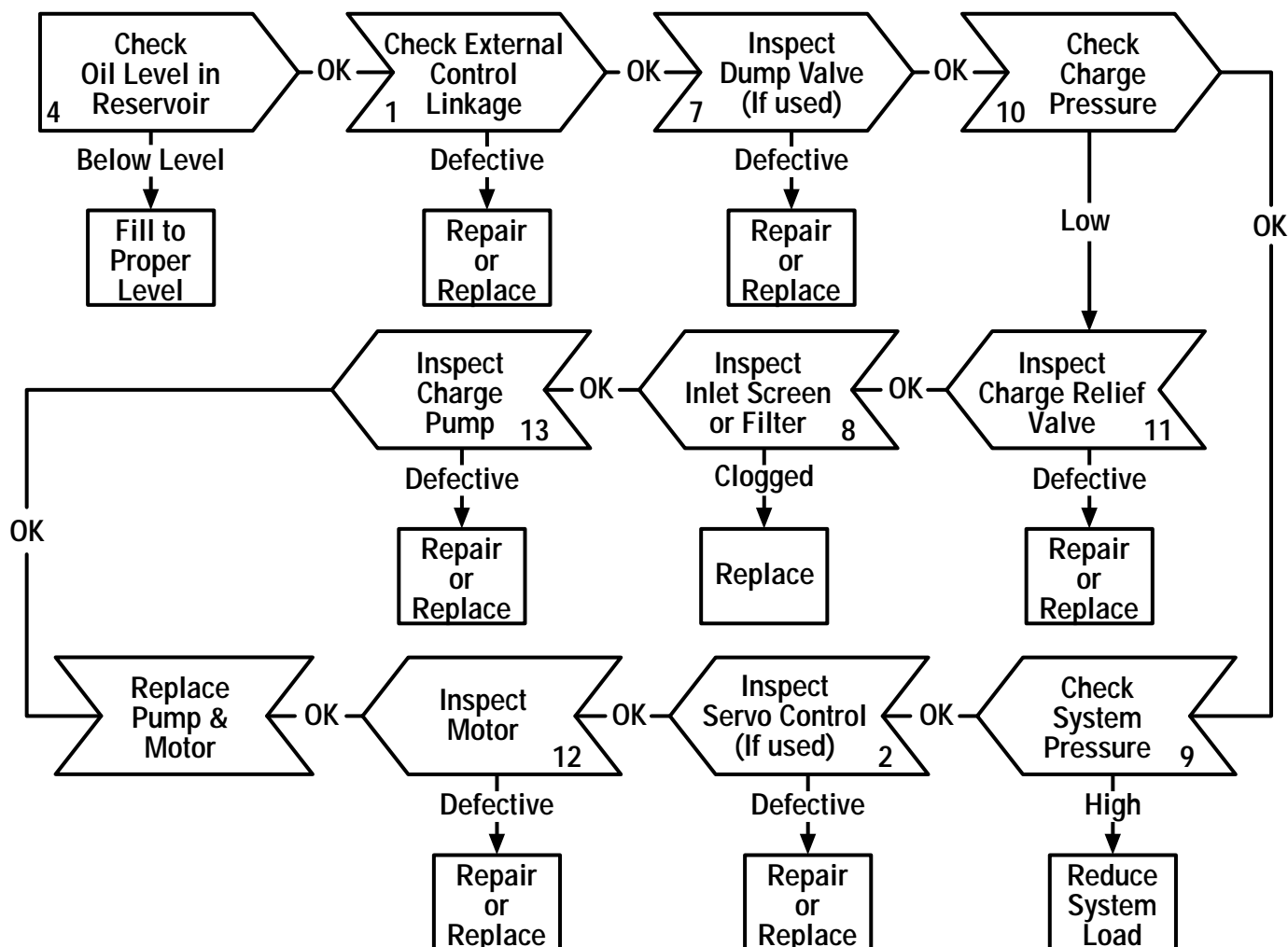
Symptom: System Response Sluggish



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 ² maximum
Charge Pressure	100 to 150 lbf/in ² Standard 200 to 250 lbf/in ² Optional 250 to 300 lbf/in ² Optional
System Pressure	5000 lbf/in ² maximum 3000 lbf/in ² 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:

32060-1A 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

Eaton Corporation
Hydraulics Division
15151 Hwy. 5
Eden Prairie, MN 55344
Telephone 612/937-9800
Fax 612/937-7130

Eaton Ltd.
Hydraulics Division
Glenrothes, Fife
Scotland, KY7 4NW
Telephone 44/592-771-771
Fax 44/592-773-184

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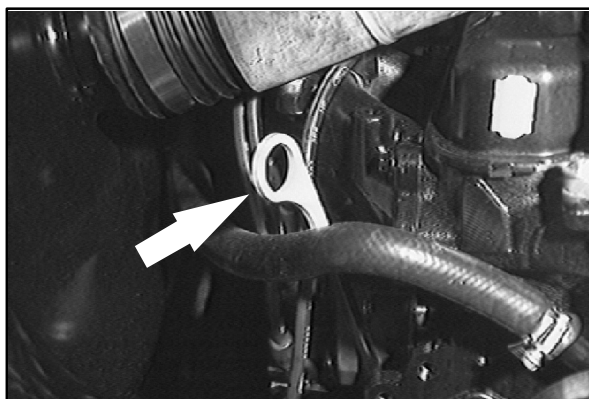
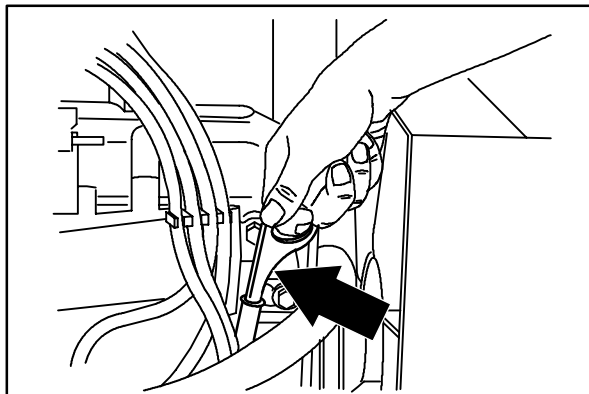
GAS/LPG ENGINE SERVICE MANUAL:**FORD VSG 411/413****TENNANT Part Number 38978**

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°C (-30°F) rating.

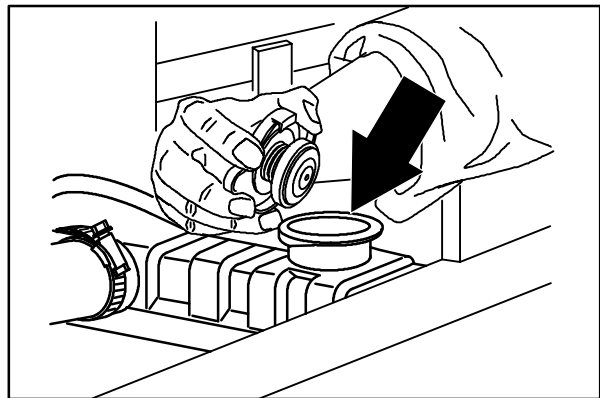
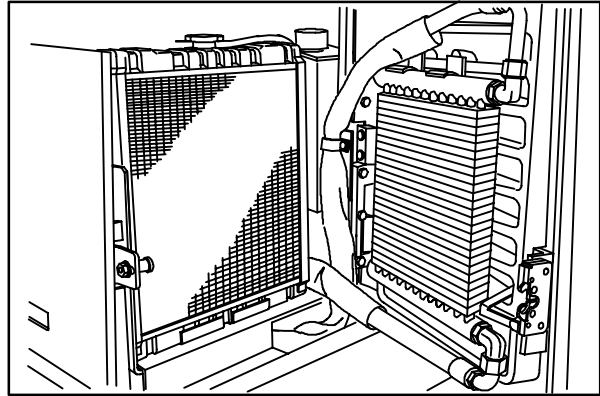
FOR SAFETY: When Servicing Machine, Avoid Contact With Hot Engine Coolant.

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.

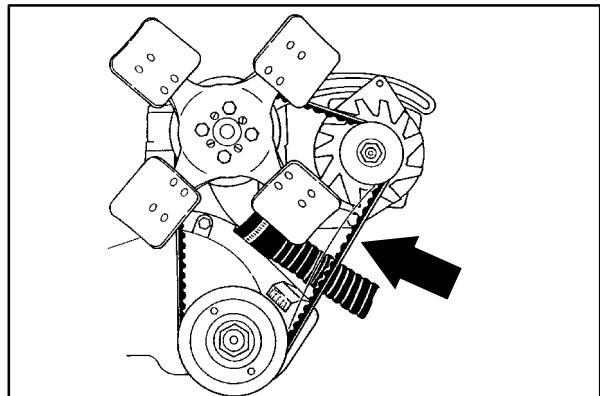
Flush the radiator and the cooling system every 400 hours of operation, using a dependable cleaning compound.



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.

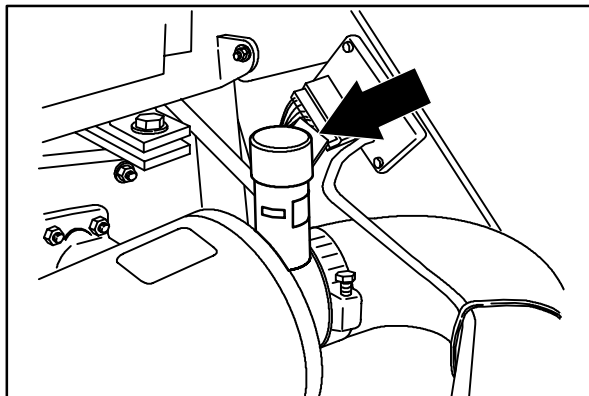
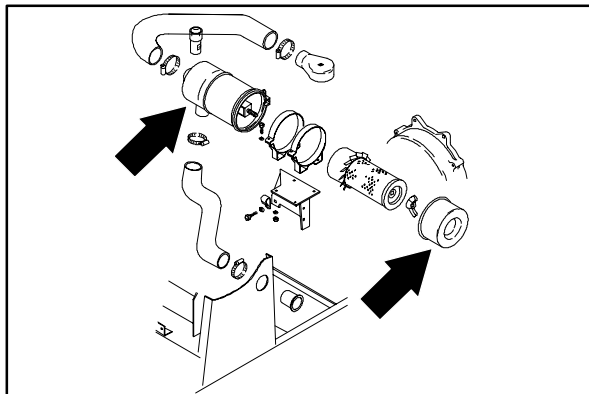


AIR INTAKE SYSTEM

AIR FILTER INDICATOR

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 H₂O) 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.

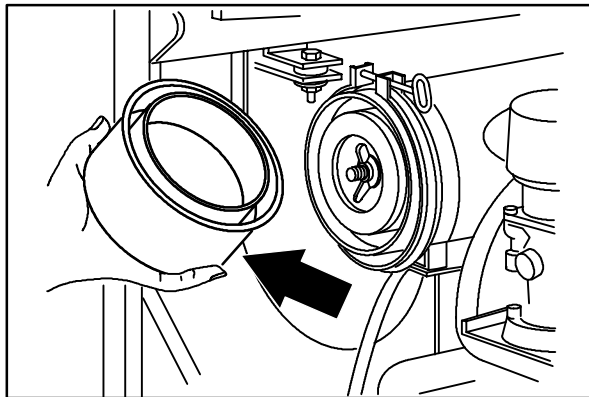
Reset the air filter indicator by pushing the reset button on the end of the indicator after cleaning or replacing the air filter element.



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.



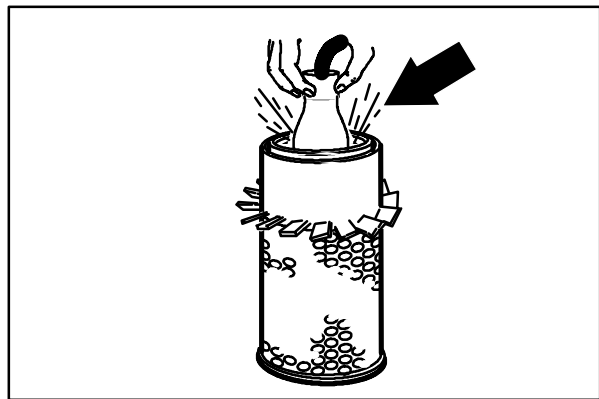
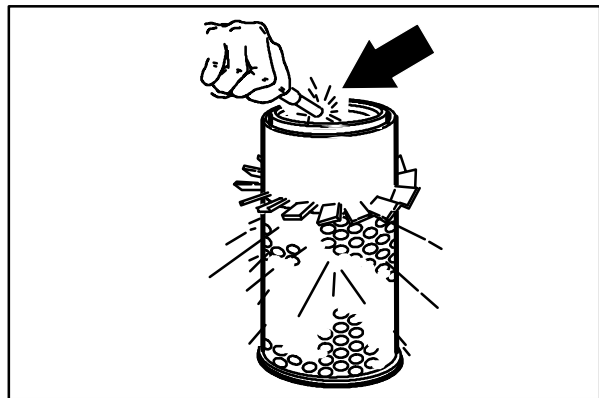
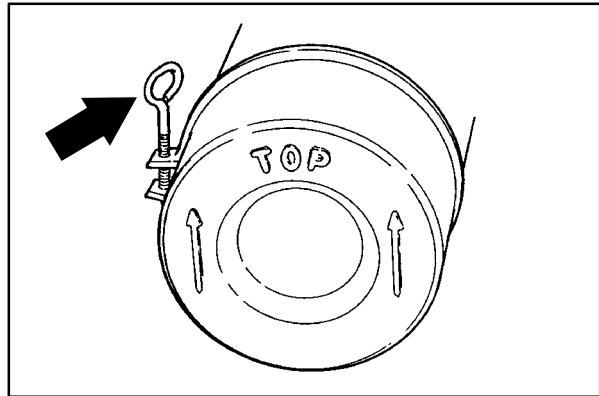
TO REPLACE AIR FILTER ELEMENT

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

1. Open the engine cover and side door.
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. Close the access doors.

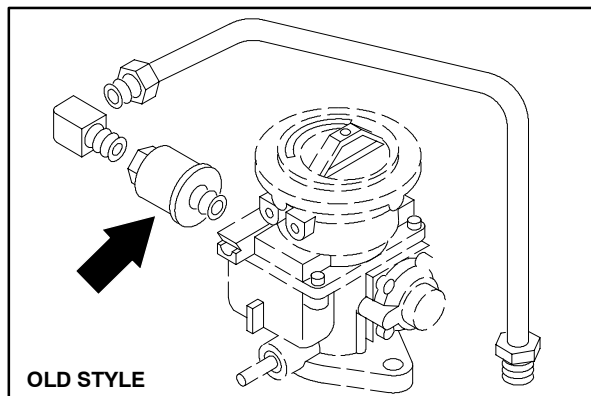
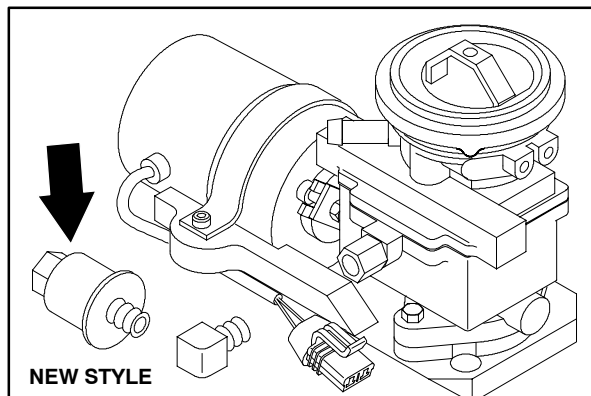


FUEL SYSTEM - GASOLINE

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.

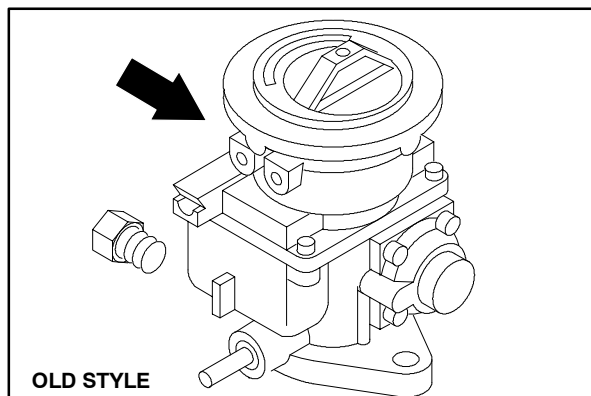
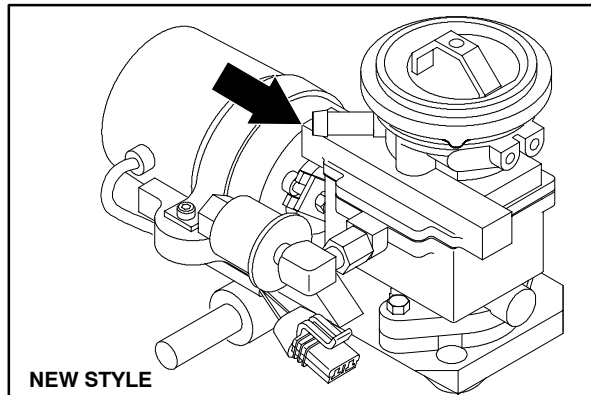


CARBURETOR

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 800 to 900 rpm for gasoline, and 900 to 1000 for LPG, with no power to the electronic governor.



FUEL SYSTEM - LPG

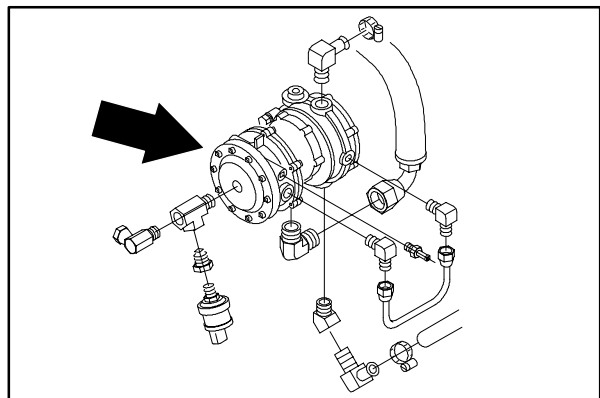
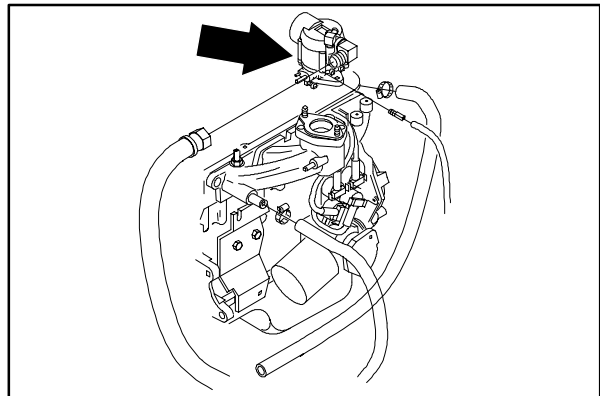
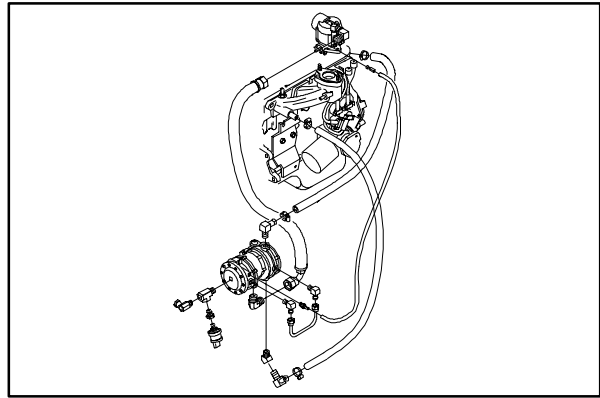
The liquid withdrawal LPG fuel system has up of five components: the LPG fuel tank, pressure relief valve, fuel filter lock, vaporizer-regulator, and the carburetor.

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 oil pressure switch controls the fuel filter lock. When the engine oil pressure is 35 kPa (5 psi) or greater, the oil pressure switch permits an electrical current to open the fuel filter lock which allows LPG fuel to flow on to the vaporizer-regulator. The oil pressure switch is bypassed when the engine is being started, allowing LPG fuel to flow.

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.

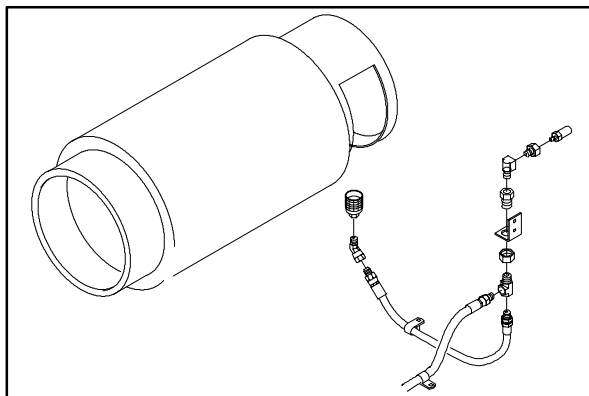
Never operate an LPG powered machine if the LPG fuel system is leaking, or if any component in the fuel system is malfunctioning. Operating the machine under either of these conditions may cause a fire or explosion.



Check for frosting. If frosting occurs on or near any LPG component, there is a possible LPG fuel leak or malfunctioning component.

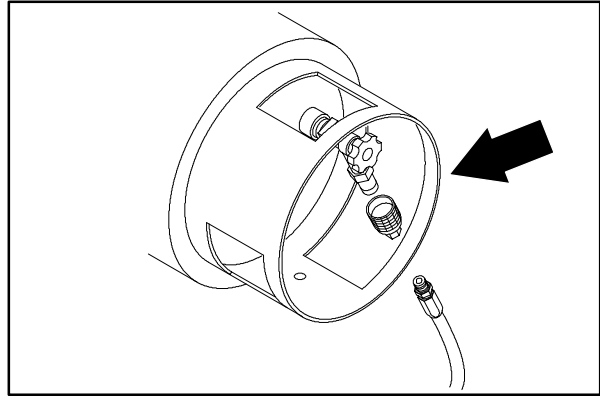
To locate the leak, apply a soapy water solution to the suspected area. Watch for bubbles forming in this suspected area. This area may have an LPG fuel leak. Repair or replace the part. Use Loctite brand Stainless Steel PST thread sealant when reassembling. Aging or high humidity does not affect this 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.

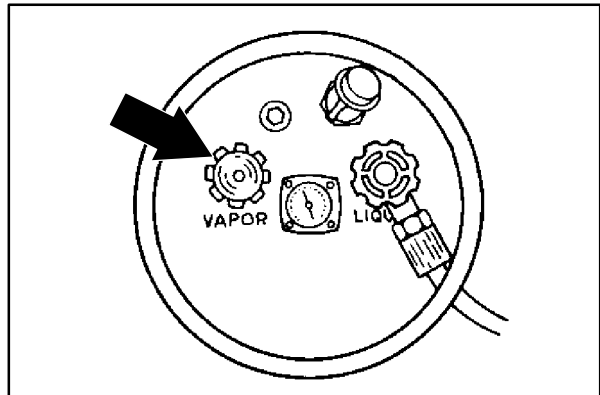


LP FUEL TANKS

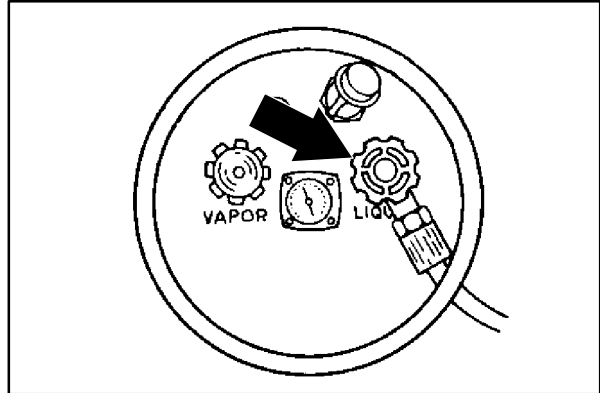
The LPG fuel tanks should be inspected for sharp dents, gouges, leaks, and broken protecting rings whenever the tanks are refilled. All tank valves must be inspected for leaks using a soap solution. Valves must also be checked for dirt, paint, or other debris in the valve openings. The following specific checks must also be made:



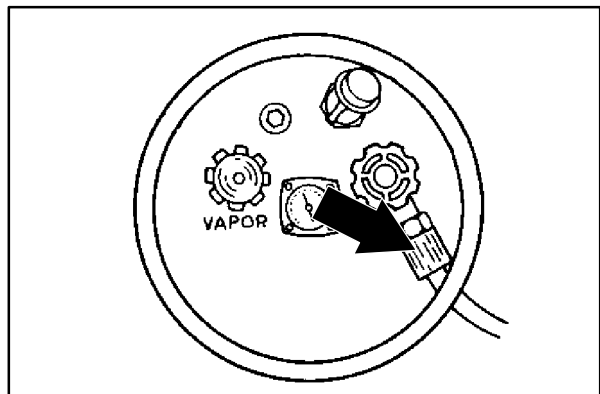
Filler Valve – Check the valve for proper functioning and the presence of the handwheel. Valve must be closed except during filling.



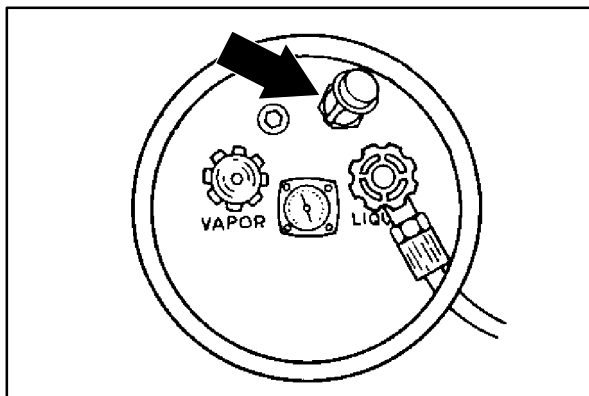
Liquid Service Valves – Check the valve for proper functioning and presence of the handwheel. The valve must be closed except when in service.



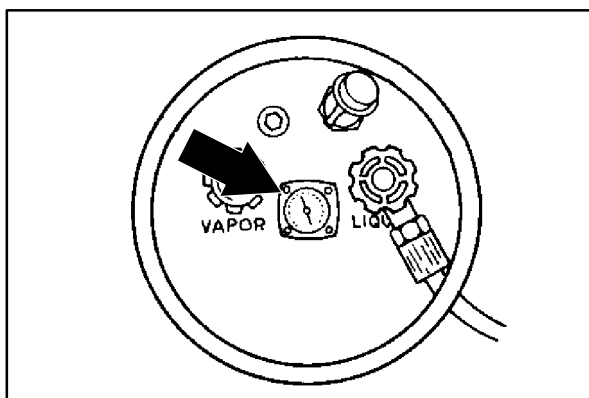
Tank Service Valve Coupling – Check for proper functioning, thread condition, and damaged or missing washers or o-rings.



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.

ENGINE - G/LPG

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.

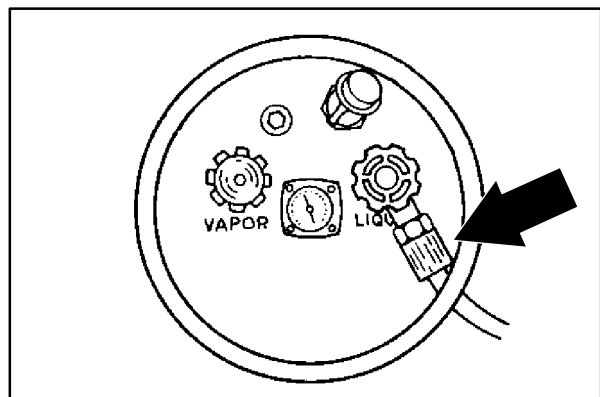
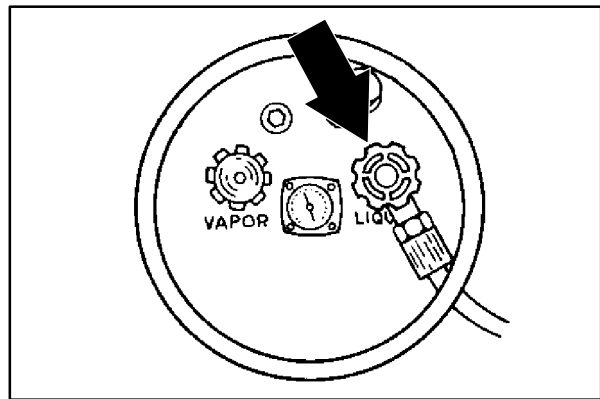
CHANGING THE LPG FUEL TANK

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.

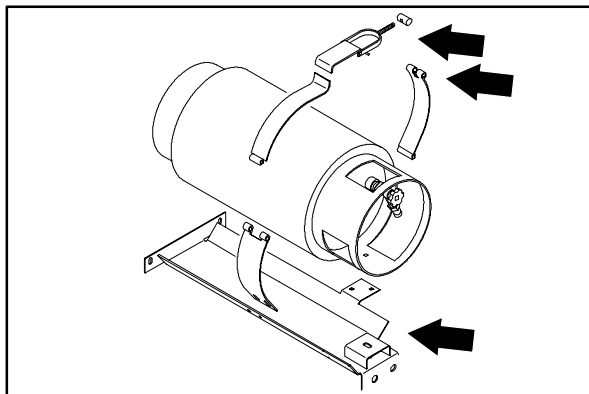
NOTE: Make sure the LPG fuel tank matches the fuel system (liquid tank with liquid system).



10. Carefully put the LPG tank in the machine so that the tank centering pin enters the aligning hole in the tank collar.

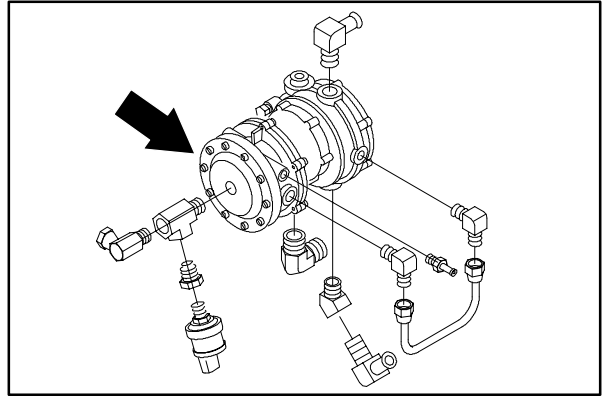
NOTE: If you cannot line up the centering pin, make sure you have the correct LPG fuel tank and then adjust the pin locator in or out.

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

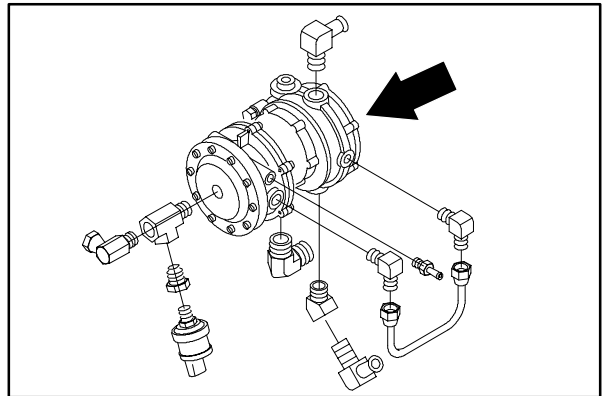
The fuel filter lock filters the LPG fuel. It also stops the flow of LPG fuel to the engine when the engine is not operating or when the engine oil pressure is less than 35 kPa (5 psi).



VAPORIZER-REGULATOR

If any malfunction is found, completely disassemble the vaporizer-regulator. Clean all the parts in alcohol.

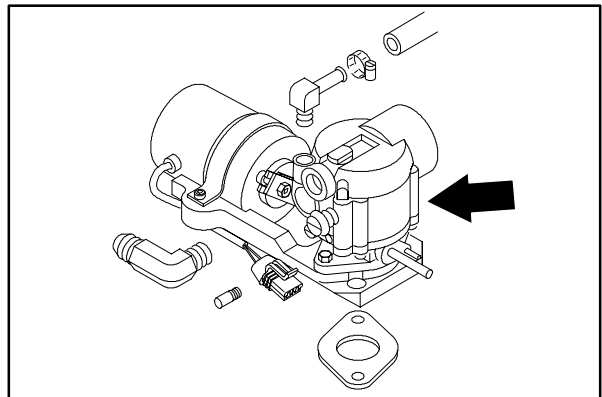
Inspect all the parts and replace where needed. Carefully reassemble the vaporizer-regulator with the seal repair kit. Check for proper operation.



CARBURETOR

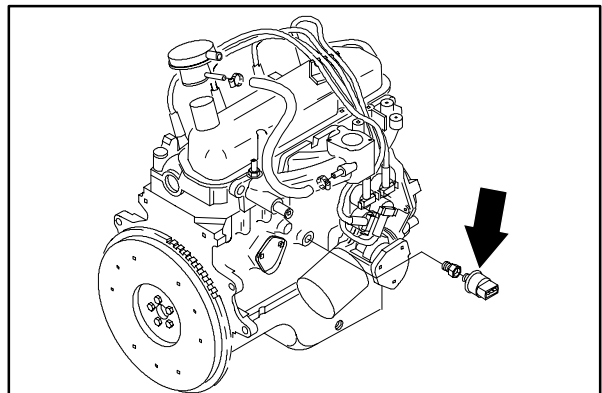
If any malfunction is found, completely disassemble the carburetor. Clean all the parts in alcohol.

Inspect all the parts and replace where needed. Carefully reassemble the carburetor with the seal repair kit.



OIL PRESSURE SWITCH

The engine oil pressure switch requires no regular maintenance. Never bypass the oil pressure switch. The switch is a safety feature that prevents LPG fuel from flowing when the engine is not operating properly.



LPG FUEL TROUBLESHOOTING

Problem	Cause	Remedy
Engine will not start	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
Engine runs unevenly or lacks power	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

CYLINDER HEAD

A three-stage torque procedure should be used when reassembling the cylinder head. Tighten the cylinder head bolts seasonally. See Ford VSG 411/413 Engine Service Manual.

VALVE TAPPET CLEARANCE

Check and adjust the intake valve clearance to 0.22 mm (0.009 in), and the exhaust valve clearance to 0.32 mm (0.013 in) while the engine is cold the first 50 hours of operation and every 400 hours thereafter. See Ford VSG 411/413 Engine Service Manual.

CRANKCASE VENTILATION SYSTEM

Clean the crankcase ventilation hoses, tubes, and fittings and replace the PCV valve every 400 hours of operation.

GOVERNOR TROUBLESHOOTING

1. The first step in this troubleshooting is to disconnect the throttle linkage at the carburetor and work the throttle at the carburetor by hand.

If you can run the engine by hand and it works with no problems, go to step four.

If the problem continues, it is not with the governor, it is with the ignition signal fuel systems or the engine itself.

2. IGNITION SIGNAL

The DIS engine has no distributor, but the timing signals that drive the governor originate from the Ignition Control input leads. They are the Yellow Wire #71 and the Yellow Wire #72. To test this, use the governor test harness (TENNANT Part No. 66137). Once the harness is in place, use a tach/dwell meter to test for the proper RPM's and a flat ignition signal. Test at the test plug at either Pin C, or Pin D.

NOTE: An inductive RPM pickup won't work for this test.

NOTE: When checking the RPM's at Pin C, and Pin D, the ignition signal will be half of the total RPM's the engine is running at because of the DIS system.

Your readings should be:

TOTAL READING-GAS

- A. Start/Idle - 800 RPM
- B. I - 1350 ± 50 RPM
- C. II - 2400 ± 50 RPM

TOTAL READING-LPG

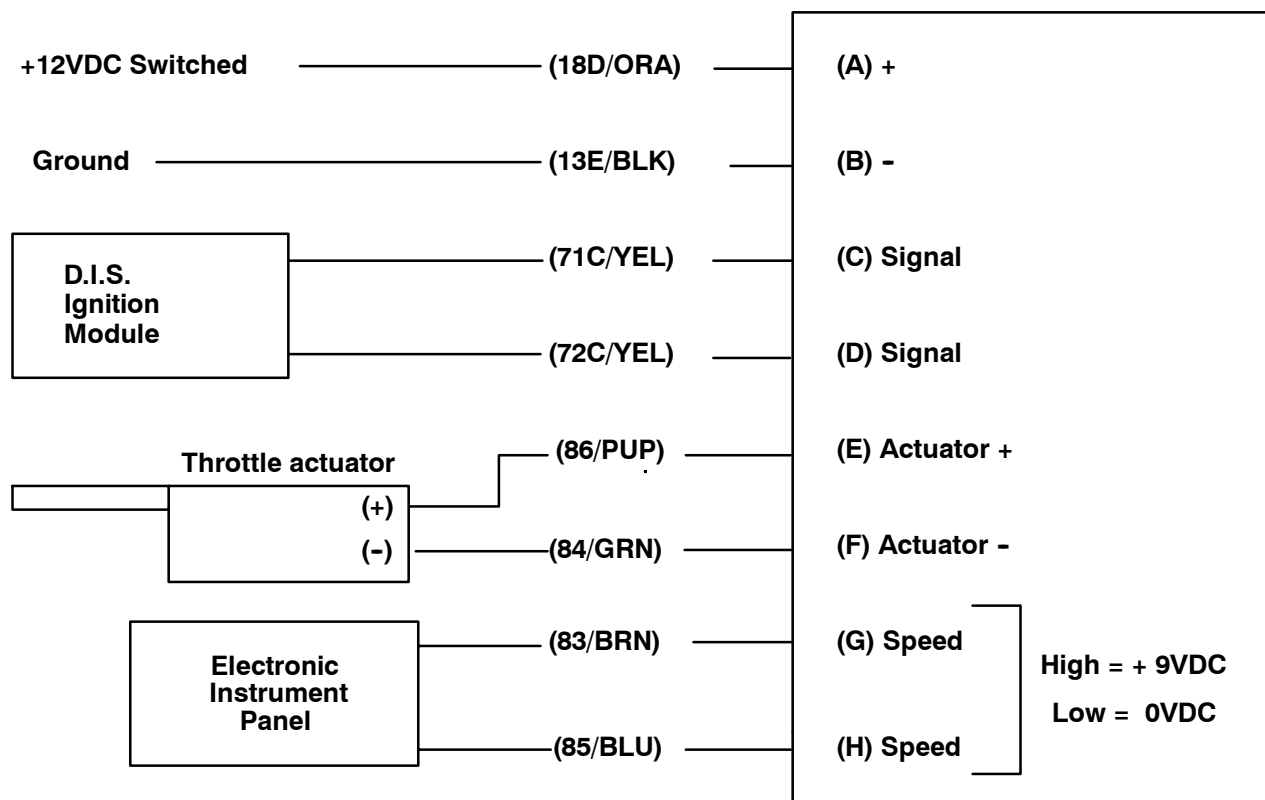
- A. Start/Idle - 900 RPM
- B. I - 1350 ± 50 RPM
- C. II - 2400 ± 50 RPM

3. FUEL SYSTEM

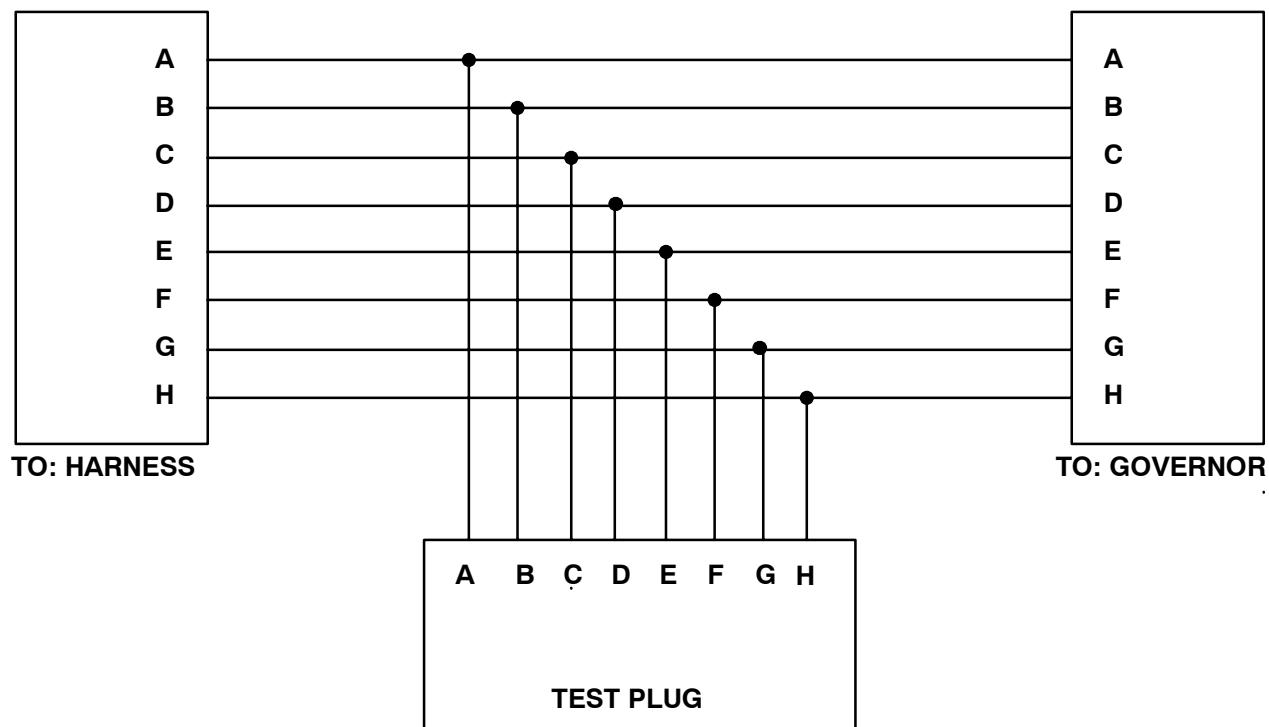
A common problem that has been encountered on LPG machines is a restricted fuel hose (a clogged fuel filter can have the same effect).

If the governor opens the carburetor wide open and the engine loses speed, the problem is not in the governor. The fuel system is at fault. The purpose of the governor is to open the carburetor and to bring the engine to set RPM's depending on where you have the speed control switch set at.

After you have verified that the ignition system and the fuel system are not at fault, go to the next step.



ELECTRONIC GOVERNOR WIRING PICTORIAL



NOTE: The wire colors of the test harness do not necessarily match the machine harness.

5. SYSTEM GROUNDS

The wire harness grounds on the machines with a DIS engine are routed to the stud on the alternator, and from there, a separate cable is routed to the bolt on the bell housing where the battery cable is attached.

If a bad ground is present, the engine will tend to run over speed.

The machine must have good grounds throughout from the battery cable to the control box.

The battery cable must be clean and tight.

There must not be a greater voltage drop than .2 volts between Pin B, on the test harness, the engine, the alternator, and the battery positive terminal and the battery negative terminal.

To do this, take your voltmeter and set it on the DC volts scale. Then with your positive probe, clamp it to battery positive. Then with the negative probe, move it to the above-stated places on the machine.

The actuator is internally isolated and does not require that the cable be grounded.

6. START-UP CHECK

With the throttle switch in the engine start position, turn the ignition switch to the on position. The actuator should cycle the carburetor lever once.

NOTE: A cycle is to move from the off or idle position to the open position and then return to the off or idle position.

If this does not happen, the power wiring to the control box is probably at fault or the control box is faulty. IT IS RARE TO HAVE A FAULTY CONTROL BOX, so proceed with the following voltage checks BEFORE REPLACING IT.

7. THROTTLE CONTROL SWITCH CHECK

If the engine doesn't respond to the throttle switch control:

- A. With the engine running, disconnect Wire 86, purple wire, at the actuator.

- B. Connect a jumper wire from the battery terminal on the starter to the terminal where you removed Wire 86, purple wire, from the actuator.

The engine should come up to operating speed. If the engine comes up to speed, replace the throttle control switch. If the engine doesn't respond, go to the next step.

8. OPERATING VOLTAGE

The following voltage checks are done with the machine not running and using a Fluke or Beckman digital multimeter and the governor test harness.

Throttle control switch in start/idle position:

Pin A - Battery Voltage $\pm .2$

Pin B - 0 - this is a ground

Pin C - Battery Voltage $\pm .2$

Pin D - Battery Voltage $\pm .2$

Pin E - Battery Voltage $\pm .2$

Pin F - Battery Voltage $\pm .2$

Pin G - Battery Voltage $\pm .2$

Pin H - 3 to 3.5 VDC

Throttle control switch in the normal sweep position:

Pin G - < 1 VDC

Pin H - 7 to 9 VDC

Throttle control switch in the Litter sweep position:

Pin G - < 1 VDC

Pin H - < 1 VDC

The following voltage and RPM readings are at the electric control box using the test harness with the machine running.

NOTE: When you are testing if you should be in the DC or AC scale on your multimeter. You will also need your tach/dwell for the RPM checks.

The readings are taken with either a Fluke or Beckman digital multimeter:

Throttle control switch in the start/idle position:

Pin C - 675 ± 100 RPM

Pin D - 675 ± 100 RPM

Pin E - Battery Voltage $\pm .2$

Pin F - 6 to 6.5 VAC

Throttle control switch in the normal sweep position:

Pin C - 1100 ± 25 RPM

Pin D - 1100 ± 25 RPM

Pin E - Battery Voltage $\pm .2$

Pin F - 6.5 to 7 VAC

Throttle control switch in the litter sweep position:

Pin C - 1200 ± 25 RPM

Pin D - 1200 ± 25 RPM

Pin E - Battery Voltage $\pm .2$

Pin F - 7 to 7.5 VAC

If you do not get these values:

Pin A - Check battery, wiring/connections, and also the charging system.

Pin B - Check all grounds.

Pin C - Check ignition system and fuel systems.

Pin D - Check ignition system and fuel systems.

Pin E - Possible control board.

Pin F - Possible control board.

Pin G - Possible switch.

Pin F - Possible switch.

The volt readings at the actuator with the machine running and using a Fluke or Beckman digital multimeter:

At the terminal where Wire 84, green wire, is hooked to:

Start/Idle - 6 to 6.5 VAC \pm .2

Normal - 6.5 to 7 VAC \pm .2

Litter - 7 to 7.5 VAC \pm .2

At the terminal where Wire 86, purple wire, is hooked to:

Start/Idle - 12 to 14.5 VDC \pm .2

Normal - 12 to 14.5 VDC \pm .2

Litter - 12 to 14.5 VDC \pm .2

9. CONTROL BOX ADJUSTMENT

If all the above aspects, in particular the linkage, have been verified and the warmed up engine either:

- A. Hunts at running speed with the accessories off.
- B. Responds very sluggishly to switch changes, an adjustment change in the control box may be necessary.

Cut and remove the RTV seal on the back of the box.

A slight adjustment of the sensitivity screw may be necessary to correct the conditions mentioned above. Turn the screw approximately 2° at a time and wait for 30 seconds to verify the change. Be careful. Only a slight change is necessary, and the "pot" can be broken if too much force is used.

After the control throttle response is achieved, verify that the operating speeds are correct and adjust, if necessary. After the speeds are reset, the sensitivity screw may have to be readjusted.

In general, if a new box is being installed, a gasoline-equipped machine may require that the sensitivity be reduced slightly.

When the sensitivity is adjusted, the run speed should not be affected. If the adjustment is too great, the start speed will be affected. Verify that the start speed is correct.

If too much sensitivity is adjusted in, the engine will either hunt in a no load condition or over speed severely when the speed switch is actuated.

If too little sensitivity is adjusted in, the engine will seem sluggish. The engine speed will drop off when the load is increased and not recover promptly.

The engine speed should not drop off, but you can have the three hunts of the engine.

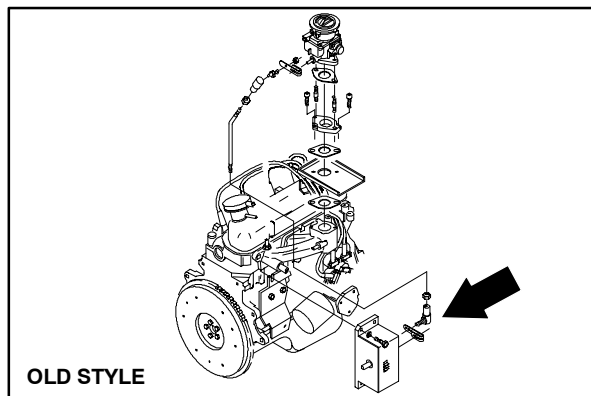
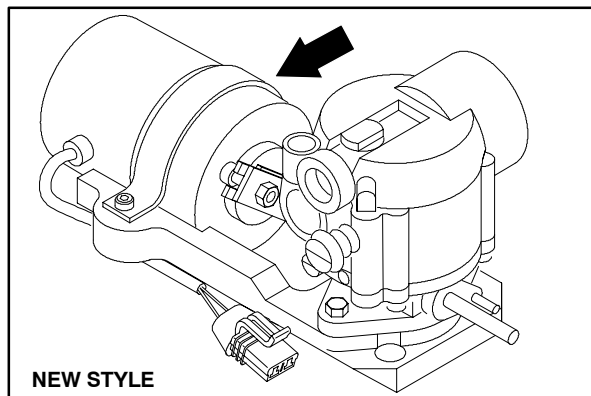
If, for some reason, the sensitivity adjustment became grossly maladjusted, a good starting point can be obtained by rotating the pot fully counterclockwise and then back clockwise 45°.

After the adjustments are made and verified, reassemble the back plate and reseal the plate with a bead of RTV to keep dust and moisture out of the box.

GOVERNOR

The electronic governor controls engine speed. The governor consists of an ignition control assembly, a control box, and an actuator mounted on the carburetor. The ignition control assembly and control box regulate the actuator, which in turn controls the throttle.

The electronic governor is factory set and is not user serviceable.

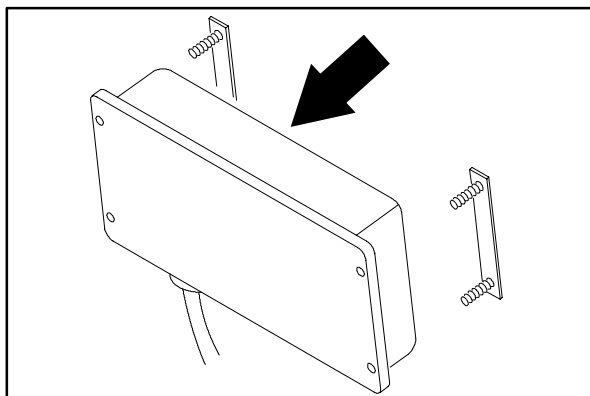
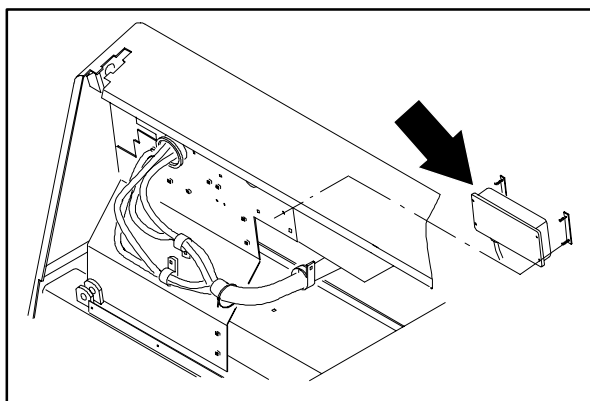


TO ADJUST GOVERNOR

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

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

2. Start the engine and warm to operating temperature.
3. Move the speed switch to idle, all accessories off.
4. Move the speed switch to the fast position.
5. If more than three engine speed surges occur, turn the surge adjustment screw (located on back of governor control box under hole plug) counterclockwise one-eighth of a turn.
6. Repeat until less than three surges occur.
7. Replace hole plug if removed for adjustment.
8. Remove the jack stands and lower the machine.

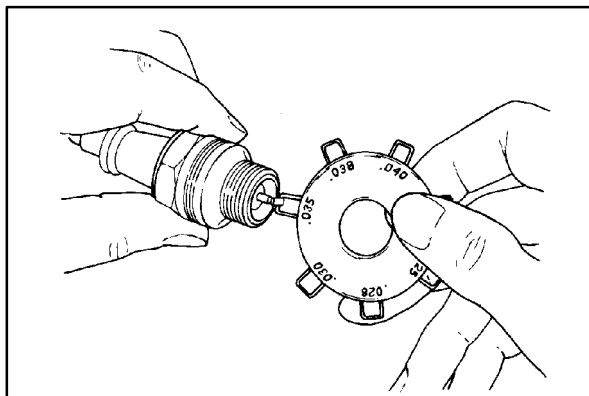


IGNITION SYSTEM

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).



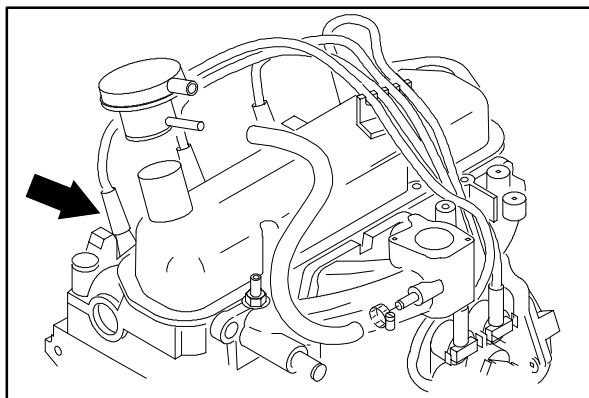
TO REPLACE SPARK PLUGS

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

1. Open the engine cover and side door.
2. Remove the spark plug wires from the four 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.



FORD DISTRIBUTORLESS IGNITION SYSTEM

SYNOPSIS:

This is a troubleshooting guide for the Ford Distributorless Ignition System.

Unlike a conventional system, the Ford Distributorless Ignition System (DIS) uses two coils that each fire one pair of spark plugs. The spark plugs are also fired on both the power and exhaust stroke.

The DIS system also uses a Universal Electronic Spark Control (UESC) module which adjusts the timing of the engine. The degree of timing change needed is determined by electrical and vacuum input to the UESC, these are:

ENGINE LOAD - FROM PRESSURE REDUCER

Located in the intake manifold

Minimum 21 KPA (6.22" Hg)

Maximum 101 KPA (29.91" Hg)

ENGINE TEMPERATURE

The Engine Coolant Temperature Sensor (ECTS) located in the intake manifold water jacket sends engine temperature information to UESC.

Minimum -39° C 38° F

Maximum 112° C 232° F

When the engine is starting, at 250 RPM or less, the timing is set at 10° before top dead center (BTDC).

RUN MODE

In this mode the RPM is above 250 and the spark advance is calculated in three sections which are added together to maintain optimum running condition.

The Base Spark Advance (BSA) is calculated by the UESC module looking at speed and load inputs.

The Spark Advance Offset Temperature (SAOT) will change ignition timing. This is determined by the Engine Coolant Temperature (ECT). This allows the spark advance to be altered during cold engine conditions.

SERVICING AND TESTING**SERVICING**

1. Every 400 hours, remove the spark plugs and clean and adjust the electrode.
2. Clean and visually check spark plug high tension leads and test for resistance. The Ohm meter should read between 9,000 and 16,000 Ohms.

TESTING**Secondary Coil Testing**

Remove the four (4) spark plug wires and measure the secondary coil resistance by placing the meter into plug wire terminal.

1 - 4 at the coil

2 - 3 at the coil

On each test you should read $14,000 \pm 50$ Ohms.

Universal Spark Control Module Diaphragm Testing

Using a vacuum pump, apply 15" Hg to the UESC and vacuum inlet. The diaphragm should hold the pressure. If it fails, replace UESC unit.

To test the sensors and wiring harness, follow the direction on the next three pages.

“FAILURE MODE OF DIS” IGNITION HARNESS

The Ford DIS Universal Spark Control was checked for “poor connection”.

The results of open leads were:

Term 11 or 12 Ignition Coil Signal Leads - The governor received 1/2 of its intended signal and caused the actuator to hold the carb arm wide open. At the same time, the engine missed due to incorrect firing of plugs, but the speed still climbed to about 3,000–4,000 rpm. When either of these leads were opened at the start speed, the engine missed slightly and rose to double the start speed or about 3,000 rpm.

Term 9 Ground - Any failure here killed the engine instantly or caused the engine to slow down if it were cycled.

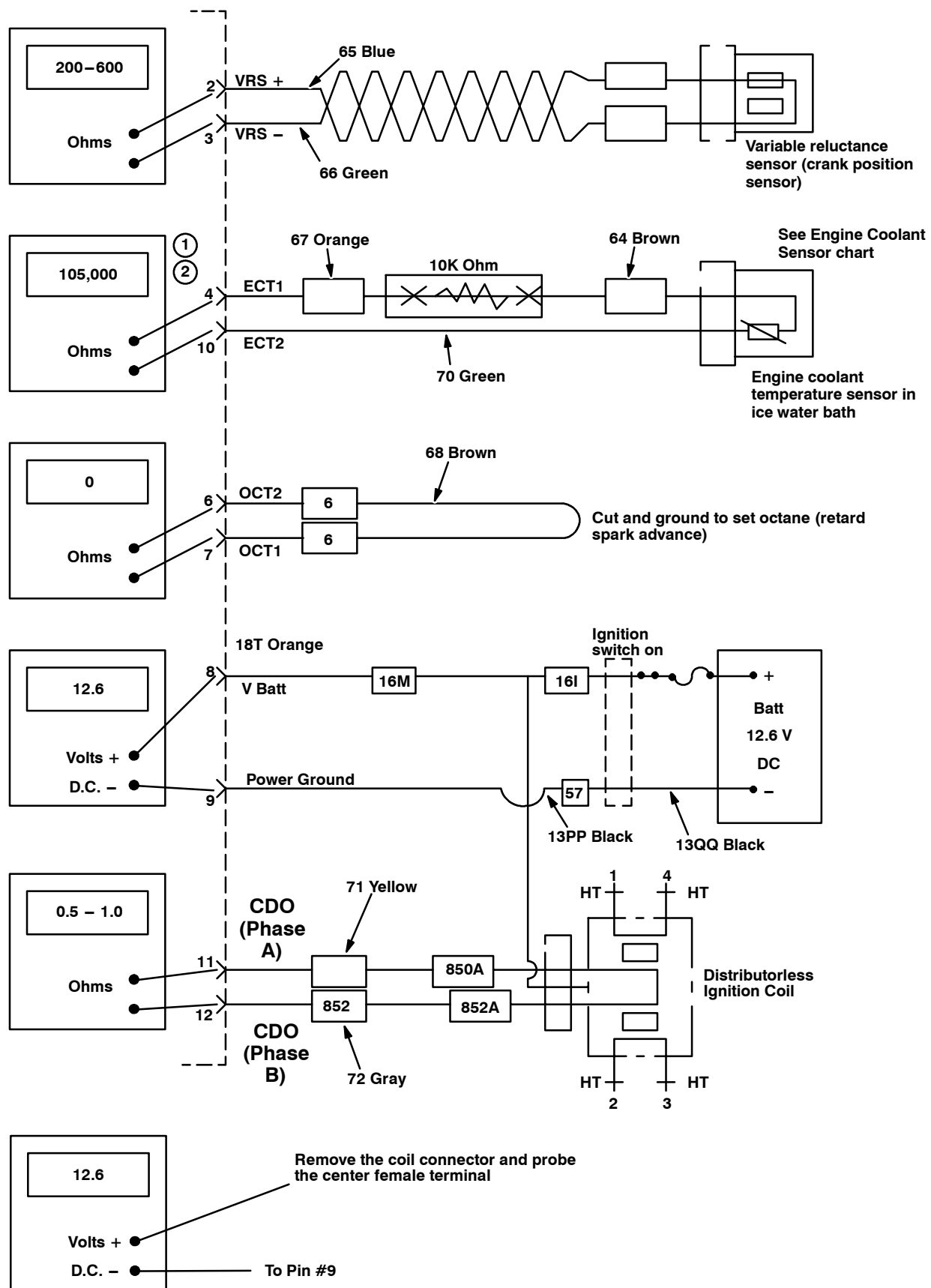
Term 6 & 7 Octane Selector - Opening these terminals retards the spark in varying degrees. Under light to moderate load conditions, no adverse effect will take place. However, run-on or pre-ignition may take place.

Term 4 & 10 Coolant Sensor - Contrary to previous thoughts, opening the lead doesn't noticeably affect the engine. The timing only changes a few degrees.

Term 2 & 3 Crank Position Sensor - Opening either of these leads kills the engine quickly and it will not start.

Term 8 Power Lead - Opening this lead kills the engine and it will not start.

In summary, no alarming effect happens except if the coil signal leads are interrupted. These are the end leads on the module and if the harness has too much tension on it, the signal will become intermittent and cause the engine to overspeed. The only obvious damage will probably occur to the propelling pump, as the fan is rated for operation to 10,000 rpm. If the acc. are on when the lead becomes intermittent, the engine will not develop enough power to overspeed excessively.



FORD DIS IGNITION

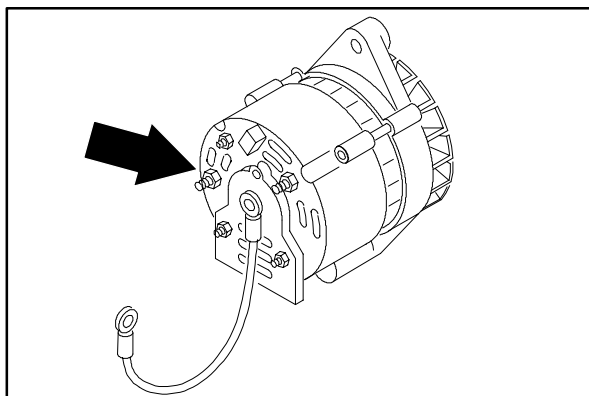
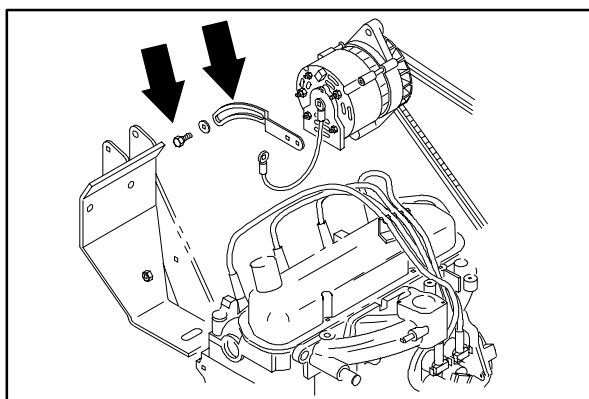
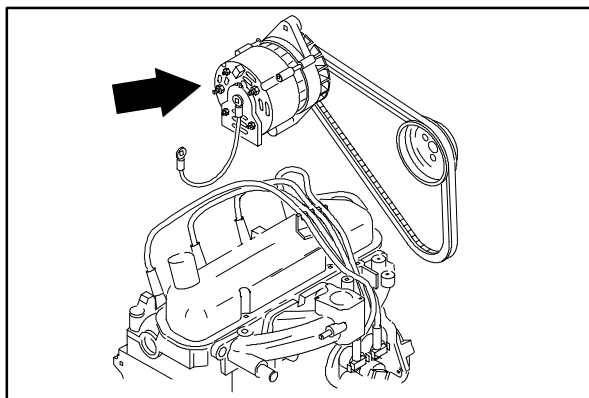
ENGINE COOLER SENSOR

Temperature ° C ° F		Sensor (Ohms) ± .02°	Sensor & Harness (Ohms) ± .03°
-30	-22	481,000	491,000
-20	4	271,000	281,000
-10	14	158,000	168,000
0	32	95,000	105,000
10	50	58,750	68,750
20	68	37,300	47,300
30	86	24,270	34,270
40	104	16,150	26,150
50	122	10,970	20,970
60	140	7,600	17,600
70	158	5,360	15,360
80	176	3,840	13,840
90	194	2,800	12,800
100	212	2,070	12,070
110	230	1,550	11,550
120	248	1,180	11,180
130	266	930	10,930
140	284	701	10,701
150	302	550	10,550

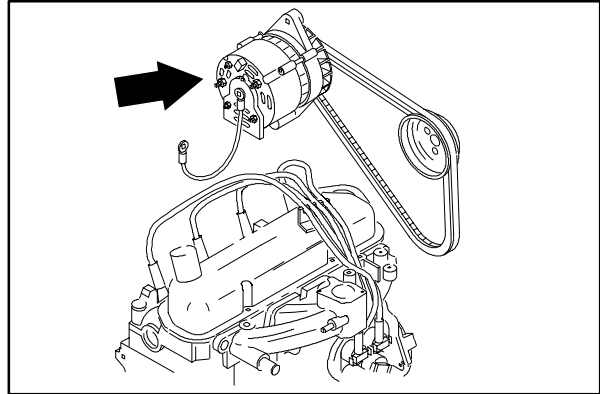
TO REPLACE ALTERNATOR

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

1. Disconnect the battery cables from the battery.
2. Open the engine side door and raise the engine hood.
3. Disconnect the wires leading to the back of the alternator.
4. Remove the 0.31 in. hex screw holding the top of the alternator to the mount bracket. Push the alternator in toward the engine and remove the V-belt.
5. Remove the M8 hex screw and nyloc nut holding the bottom of the alternator to the lower mount bracket.
6. The alternator can now be removed from the machine. Bring the alternator up and over the engine.
7. 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.
8. Install the pulley, washer, and hex nut on the new alternator. Firmly tighten the nut with the impact.
9. Install the new alternator back in the machine. Align the bottom hole in the alternator with hole in lower mount bracket. Reinstall the M8 hex bolt, ground cable, and nyloc nut. Leave it loose for now.
10. Place the V-belt back on the alternator pulley.



11. Reinstall the 0.31 in. hex screw in the top hole of the alternator through upper slotted mounting bracket. Push the alternator toward the hydraulic oil tank to tighten the belt. See adjustment in ENGINE FAN BELT description. Tighten the hex screw to 18 - 24 Nm (13 - 18 ft lb).
12. Tighten the bottom M8 hex screw to 18 - 24 Nm (15 - 20 ft lb).
13. Reconnect the wires to the back of alternator. See the schematic in the ELECTRICAL section.
14. Reconnect the battery cables and start the engine. Check the new alternator for proper operation.



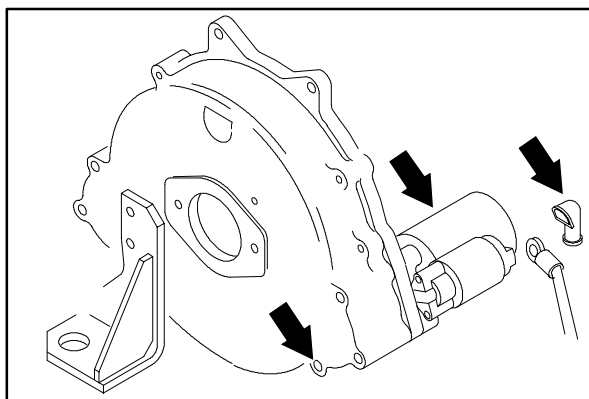
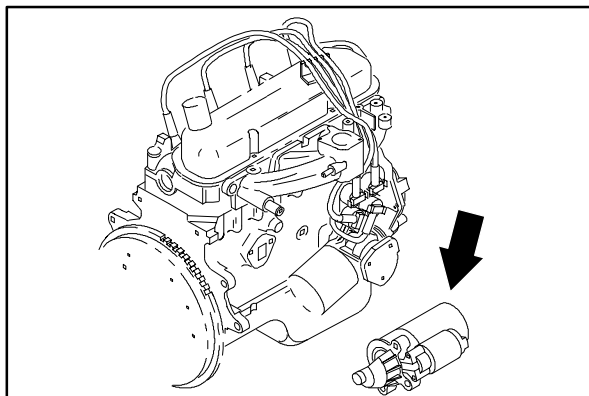
TO REPLACE STARTER

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

1. Disconnect the battery cables from the battery.
2. Open the engine side door and raise the engine hood.
3. Disconnect the wires leading to the back of the starter.
4. Remove the three M10 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 three holes in the starter with the holes in the bellhousing. Reinstall the three M10 hex screws and one M10 nyloc. Tighten to 52 - 67 Nm (39 - 51 ft lb).

NOTE: The bottom hex screw has a nyloc nut on the starter side.

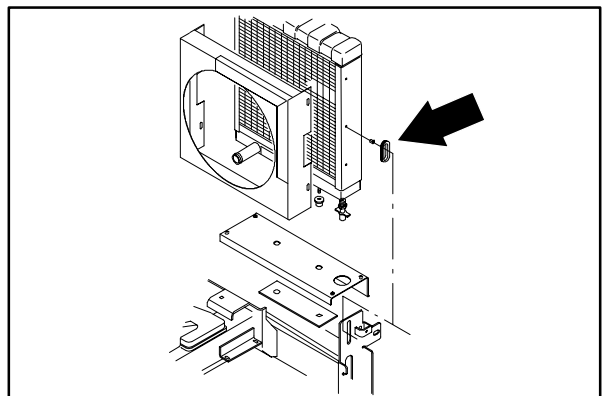
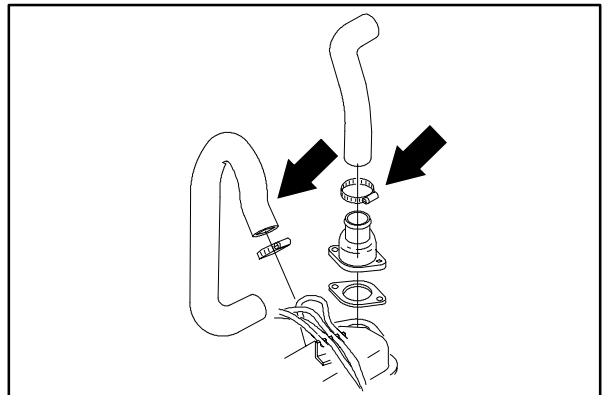
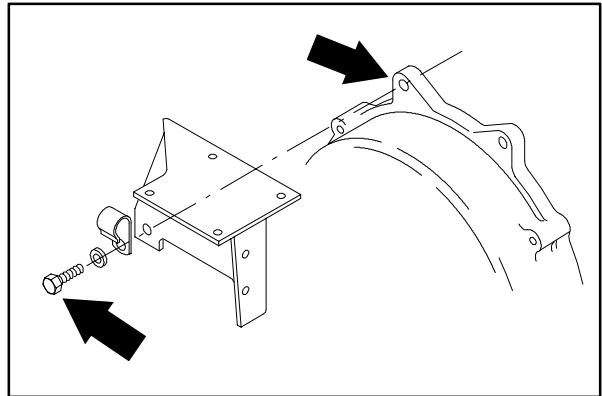
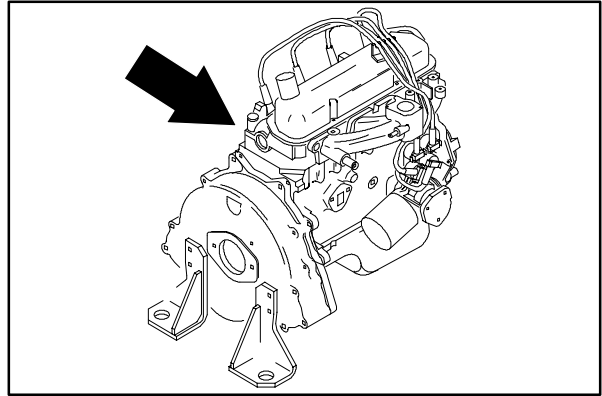
7. Reconnect the wires to the back of the starter. See the schematic in the ELECTRICAL section.
8. Reconnect the battery cables and start the engine. Check the starter for proper operation.



TO REMOVE ENGINE

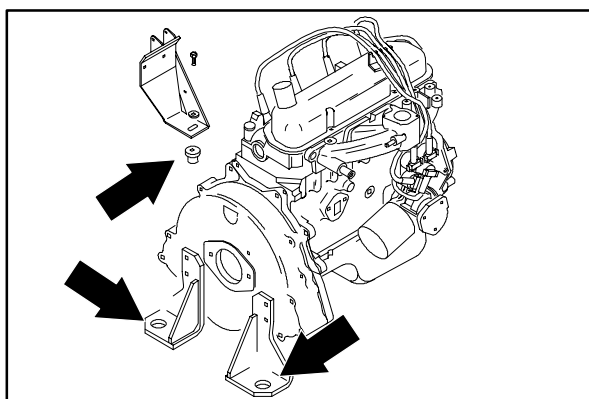
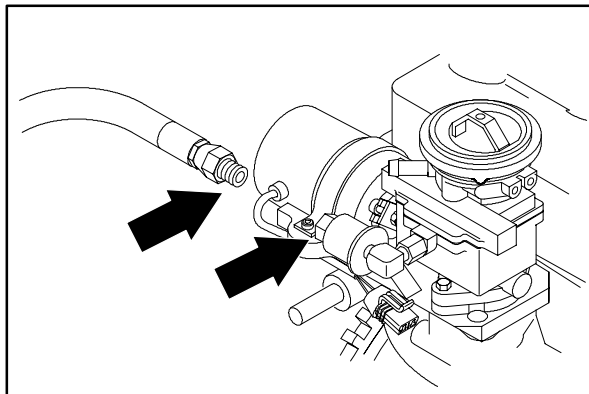
FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake. Turn Off Machine And Remove Key.

1. Disconnect the battery cables from the battery.
2. Remove the engine cover and side door.
3. Remove the two M10 hex screws holding the air cleaner assembly and mounting bracket to the back of the bellhousing. Remove the air cleaner assembly from the engine.
4. Drain the engine oil into a pan.
5. Drain the coolant from the radiator.
6. Remove the two radiator hoses from the engine.
7. Open the left rear machine casting.
8. Remove the one M6 hex screw, spacer, and fender washer holding the top left side of the radiator to the mount bracket.
9. Go under machine and remove the two 0.375 in. nyloc nuts holding the bottom of the radiator to the mount bracket.
10. Pull the radiator back so it clears the engine fan. Remove the radiator assembly from the machine.
11. Remove the muffler clamp holding the exhaust pipe to the engine manifold. Slip the pipe off the manifold.
12. Disconnect the wire harness from the alternator, starter, oil sender, temp. sender, governor, mag. pick-up, ect. Move the wires out of the way for engine removal.
13. Disconnect the engine ground strap from the machine frame.



14. Disconnect the fuel line at the carburetor on the gas machine. On an LPG machine, disconnect the line from tank at fuel lockoff / vaporizer.
15. 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.
16. Remove the two M10 hex screws holding the right rear motor mount to the bellhousing. Pull the centering spring assembly out of the way of the propel pump.
17. Remove the two M10 hex screws holding the propel pump to the flywheel housing.
18. Pull the propel pump back and out of the flywheel coupling.
19. Remove the two M12 hex screws holding the remaining motor mounts to the rubber isolators.
20. 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.

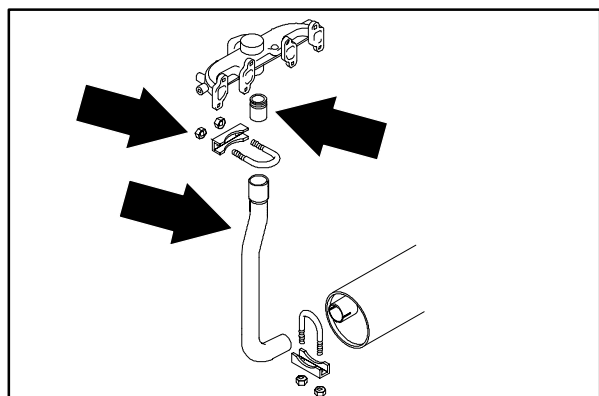
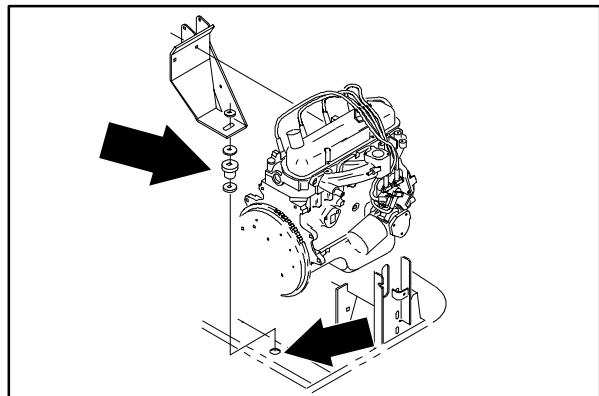
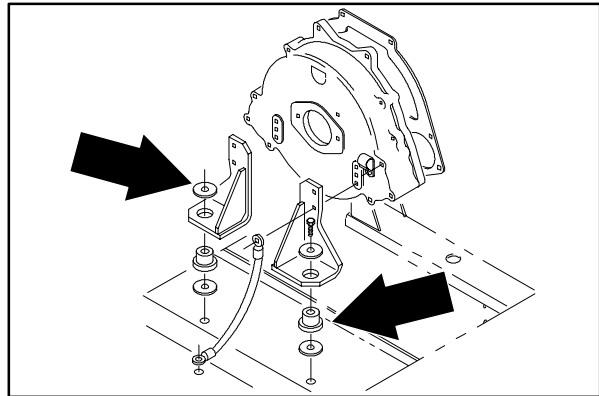
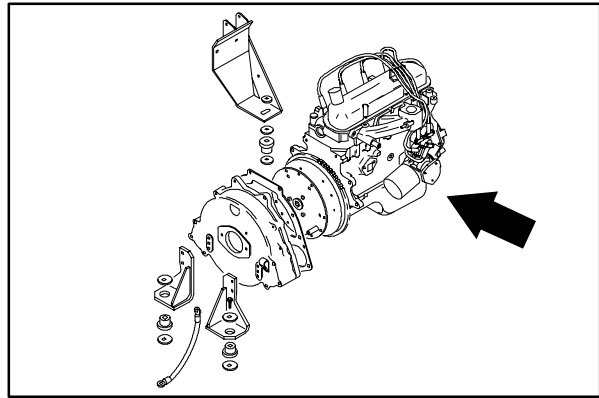
1. Using an overhead hoist, hook a chain through the two pick-up points on top of the engine. Carefully position the engine back in the engine compartment.

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. Carefully align the mount holes in the motor mounts with the mount holes in the machine frame.
3. Reinstall the M12 hex screws in the one front, and the one left rear motor mount. Leave the hoist hooked up and the hardware loose for now.
4. Position the propel pump back in the bellhousing and drive coupling. Reinstall the two M10 hex screws, using blue loctite 242, and hand tighten tight.

NOTE: Make sure the splines on pump line up with splines in coupler when installing pump.

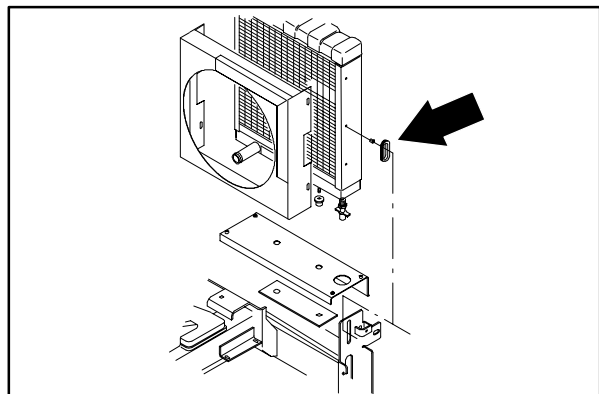
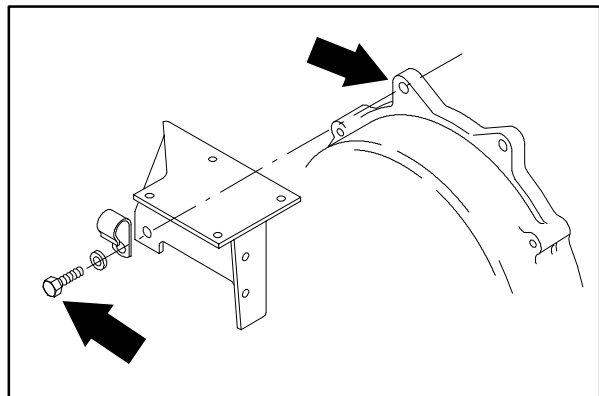
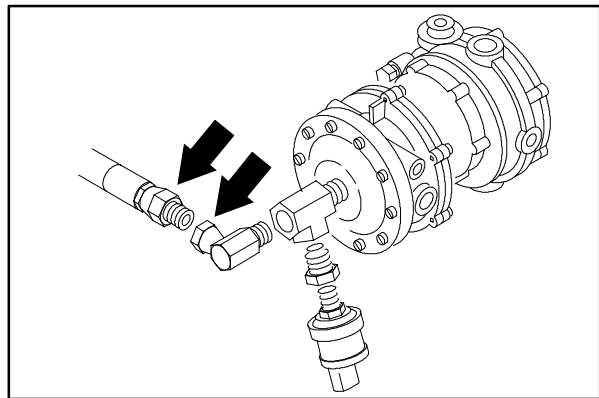
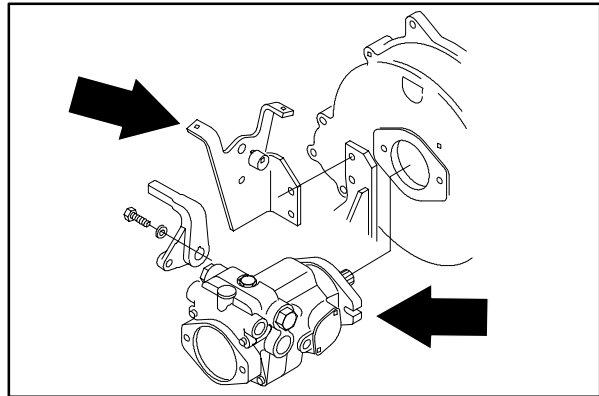
5. Position the centering spring assembly back on the pump directional arm.
6. Align the holes in the right rear motor mount with the holes in the bellhousing and centering spring mount bracket. Reinstall the two M10 hex screws, using blue loctite 242, and tighten to 52 – 67 Nm (39 – 51 ft lb).
7. Remove the hoist from the engine.
8. Go back and tighten the remaining two motor mount hex screws to 64 – 83 Nm (50 – 60 ft lb).
9. Reconnect the ground cable from the bellhousing to the machine frame.
10. Reinstall exhaust pipe back on the engine manifold. Reinstall the muffler clamp and hand tighten tight.



11. Reconnect fuel line on the Gas machine.
12. On the LPG machine, reinstall the LPG hose to the lockoff/vaporizer.
13. Fill the engine with the proper grade of oil. On the Gas/LPG engine, use 3.3 L (3.5 qt) 10W-30 SAE-SE/SF with a new filter.
14. Reconnect the wire harness to the engine components; alternator, starter, governor actuator, oil switch, temperature sender, and ignition module. Use the schematic in the ELECTRICAL section of this manual if needed.
15. Position the radiator back in the machine. Align the two bottom studs on the radiator assembly with the isolators in the mount bracket. Reinstall the two 0.375 nyloc nuts and washers. Lightly hand tighten.
16. Reinstall the M6 hex screw, washer, and spacer to the upper left side of the radiator. Hand tighten.
17. Reinstall the radiator hoses to engine and fill the radiator with coolant.
18. Reinstall the air cleaner mount bracket and air cleaner assembly on the rear of the bellhousing. Use the two M10 hex screws. Tighten to 37 - 48 Nm (26 - 34 ft lb).
19. Reinstall the engine cover and side door.
20. Reconnect the battery cables to the battery.
21. 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.

22. Start the engine and check for any leaks and proper operation.



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DIESEL ENGINE SERVICE MANUAL

KUBOTA V1505 B (E)

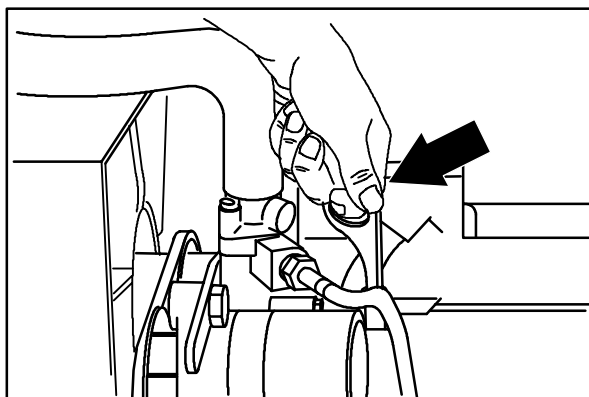
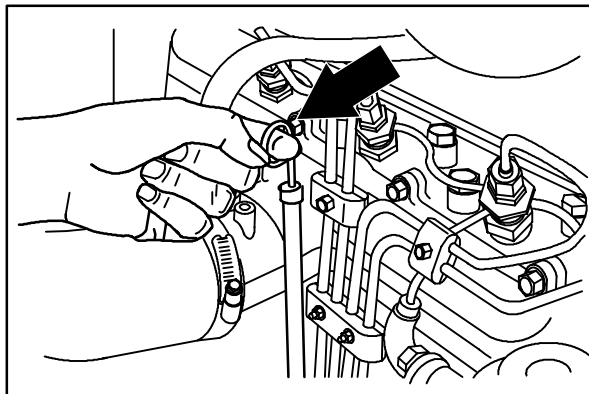
TENNANT Part Number 84660

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-CC/CD rated engine oil.

Fill the engine with oil to the level indicated on the oil dipstick. The engine oil capacity is 6 L (6.3 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°C (-30°F) rating.

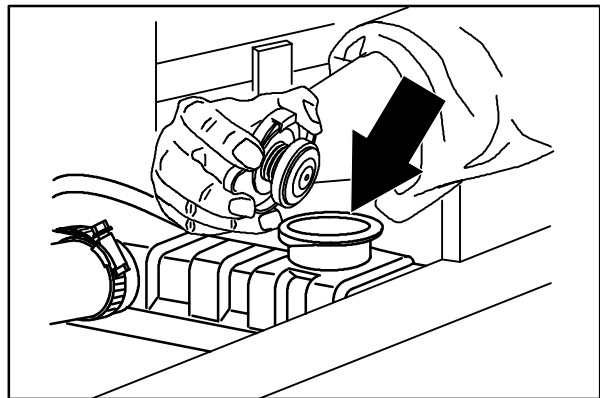
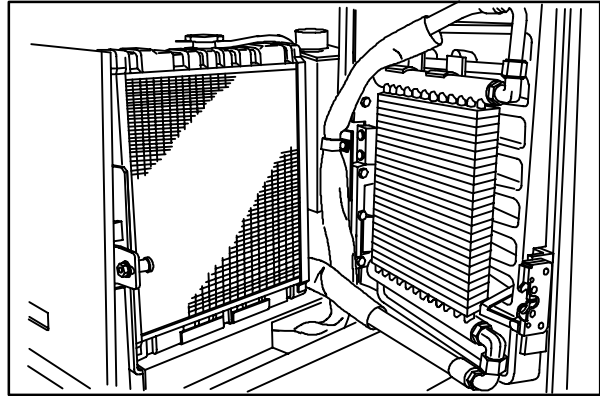
FOR SAFETY: When Servicing Machine, Avoid Contact With Hot Engine Coolant.

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.

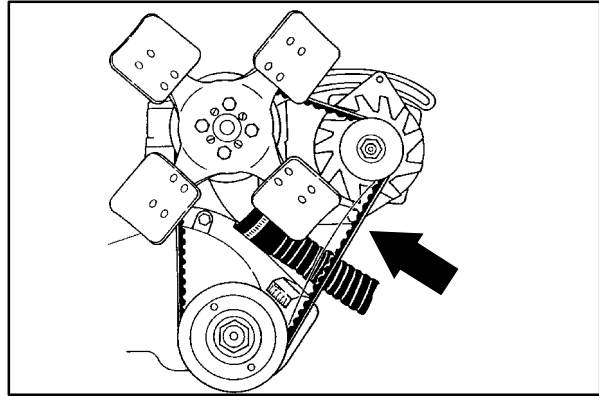
Flush the radiator and the cooling system every 400 hours of operation, using a dependable cleaning compound.



ENGINE FAN BELT

The engine fan belt is driven by the engine crankshaft pulley and drives the alternator pulley. Proper belt tension is 13 mm (0.50 in) from a force of 4 to 5 kg (8 to 10 lb) applied at the mid-point of the longest span.

Check and adjust the belt tension every 100 hours of operation.

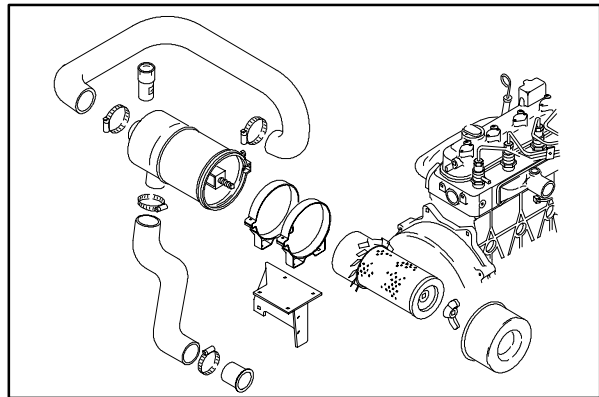


AIR INTAKE SYSTEM

AIR FILTER INDICATOR

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 H₂O) 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.

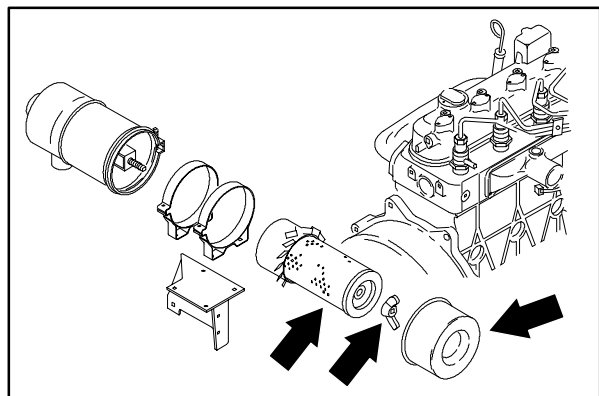
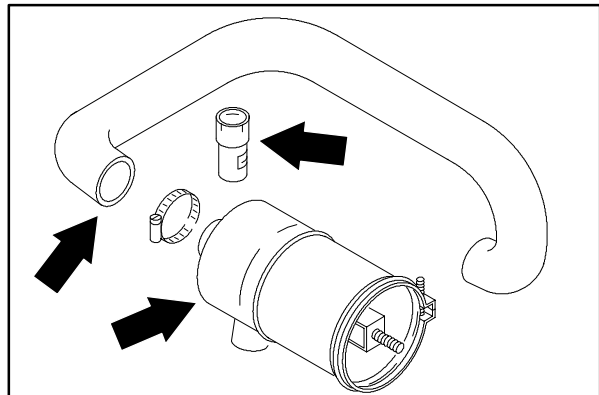


AIR FILTER

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.

Machines with the heavy duty air filter option have a safety element. It is inside the standard element. Replace, do not clean this element after the regular element has been damaged or 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 unless it is restricting air flow.



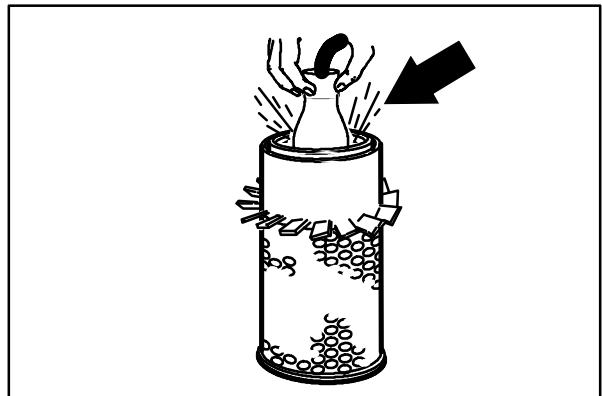
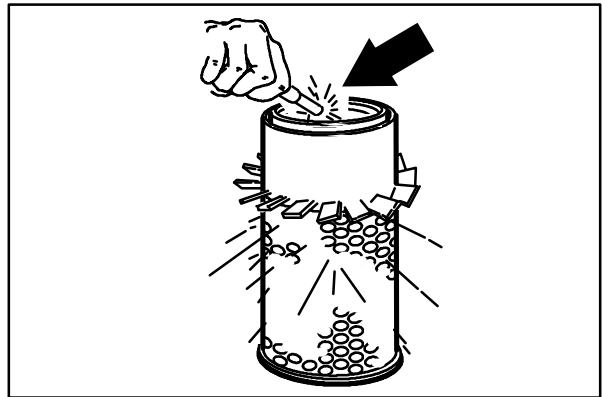
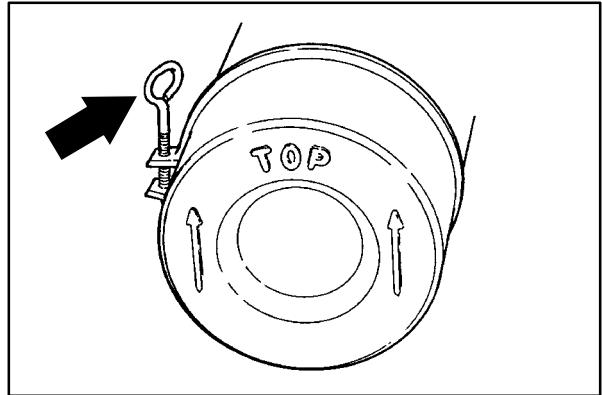
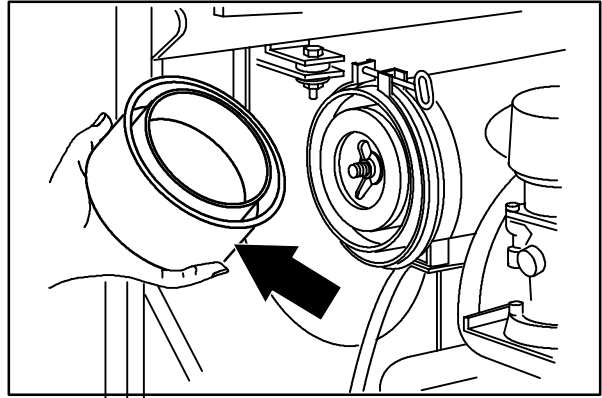
TO REPLACE AIR FILTER ELEMENT

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

1. Open the engine cover and side door.
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. Close the access doors.



CYLINDER HEAD

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.

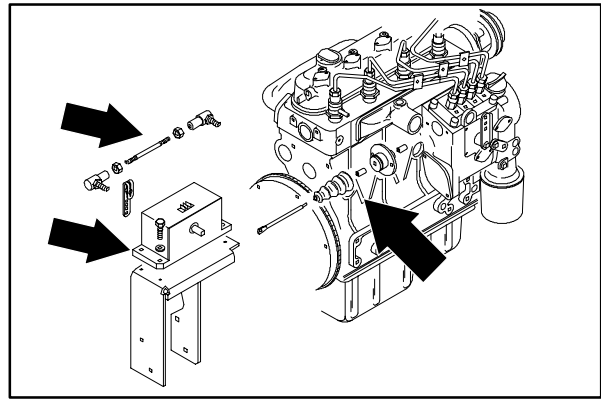
CRANKCASE VENTILATION SYSTEM

See Kubota Diesel Engine Workshop Manual for 78.4 mm Stroke Series.

GOVERNOR

The electronic governor controls engine speed. The governor consists of an ignition control assembly, a control box located, and an actuator mounted on the engine. The ignition control assembly and control box regulate the actuator, which in turn controls the throttle.

The electronic governor is factory set and is not user serviceable.

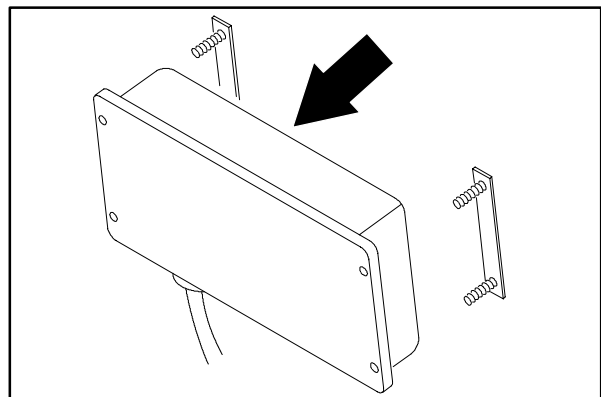
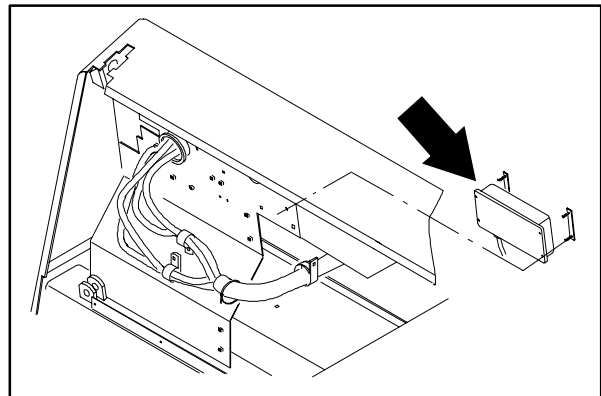


TO ADJUST GOVERNOR

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

FOR SAFETY: Before Leaving Or Servicing Machine: Stop On Level Surface, Set The Parking Brake.

2. Start the engine and warm to operating temperature.
3. Move the speed switch to idle, all accessories off.
4. Move the speed switch to fast position.
5. If more than three engine speed surges occur, turn the surge adjustment screw (located on back of governor control box under hole plug) counterclockwise one-eighth of a turn.
6. Repeat until less than three surges occur.
7. Replace hole plug if removed for adjustment.
8. Remove the jack stands and lower the machine.



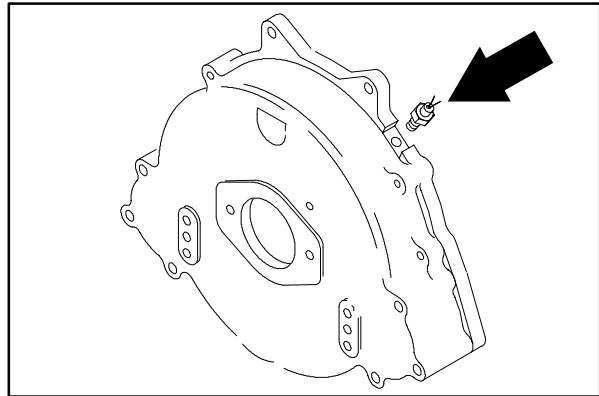
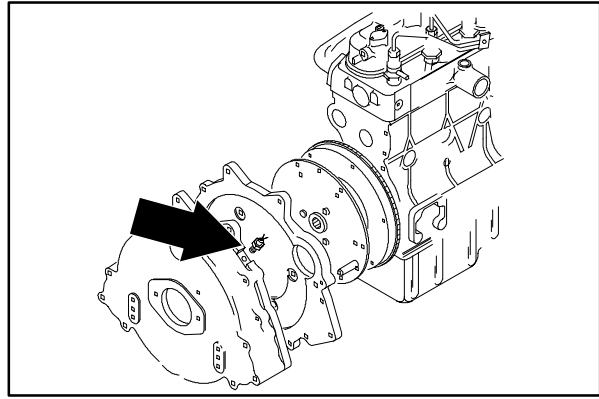
**TO ADJUST TRANSDUCER
(MAGNETIC PICKUP)**

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

1. Turn the flywheel until you see a starter ring gear tooth centered in the mag pickup hole.

NOTE: On existing engines in the field, there is one tooth marked white for ease of visibility. On new engines, you may want to mark a tooth white in the vicinity of the mag pickup and then turn the flywheel until it is centered.

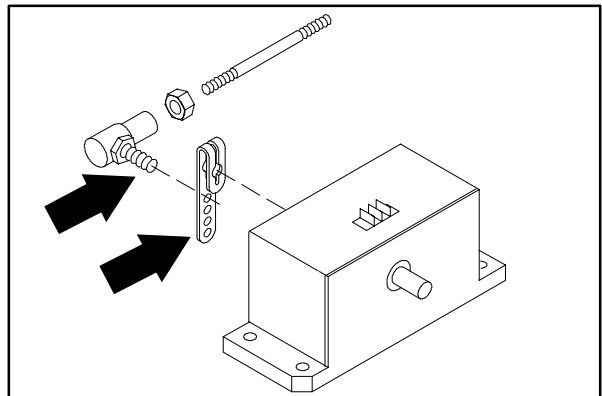
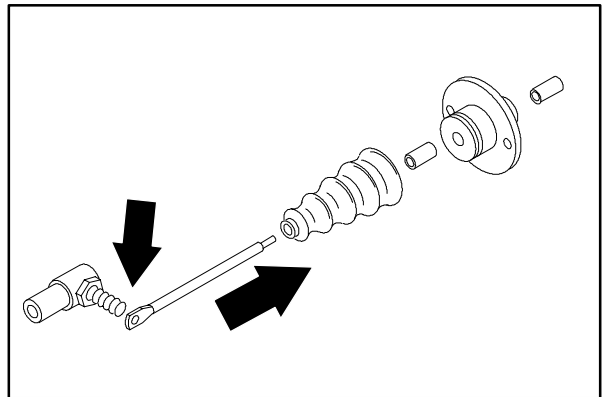
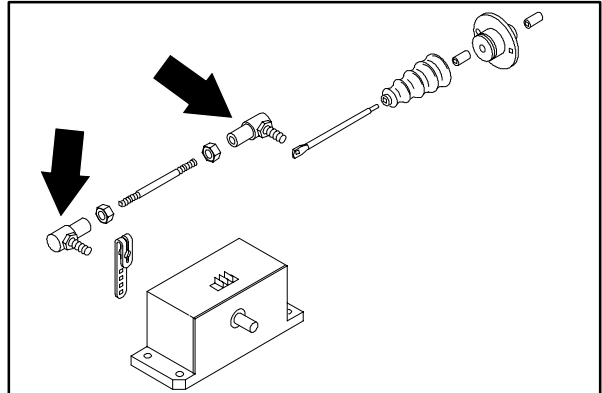
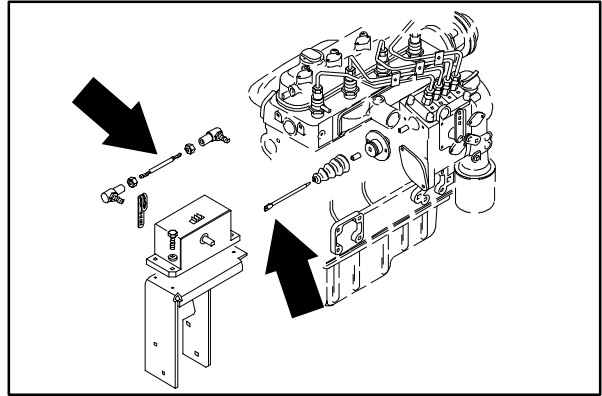
2. Screw the new transducer (mag pickup) in until it lightly hits the tooth.
3. Back the transducer (mag pickup) out 1/4 turn to 1/2 turn (.015 + or - .005 in. gap). Tighten the jam nut.
4. Slowly turn the engine over to make sure the flywheel does not hit the transducer (mag pickup).
5. If it hits, turn the transducer (mag pickup) out 1/4 more and repeat step 4.



TO ADJUST THROTTLE LINKAGE

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

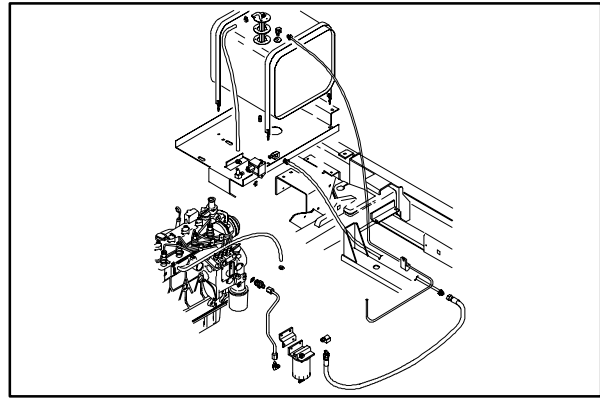
1. Assemble the throttle rod and two ball joints together. Screw both ball joints all the way in and then back out 1 turn.
2. Mount one ball joint to governor actuator lever hole nearest to the actuator shaft mounting hole in the lever.
3. Connect the lever to the actuator shaft loosely--**with the lever pointing down.**
4. Connect the other ball joint to the diesel throttle block rod and snug up the nut.
5. Push the lever and throttle rod assembly toward the diesel throttle block until it stops and hold it there.
6. Tighten the actuator lever to the actuator shaft.
7. Remove the ball joint from the diesel throttle block rod and turn the ball joint out 2 turns (.071 in.) to provide fuel shut-off pre-load.
8. Reconnect the ball joint to the diesel throttle block rod and tighten the nut.



FUEL SYSTEM - DIESEL

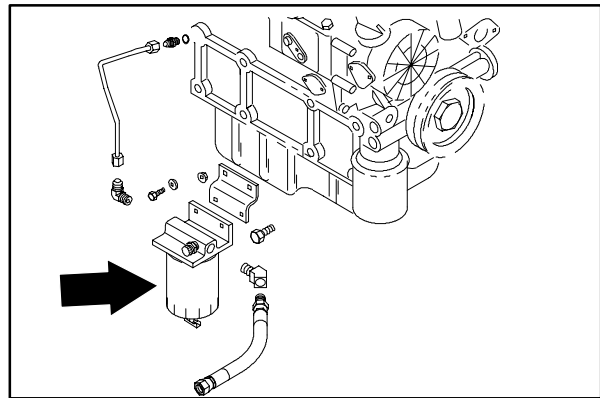
The diesel fuel system is made up of five basic components which are: fuel tank, fuel filter/water trap, fuel pump, injection pump, and injectors.

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 FILTER

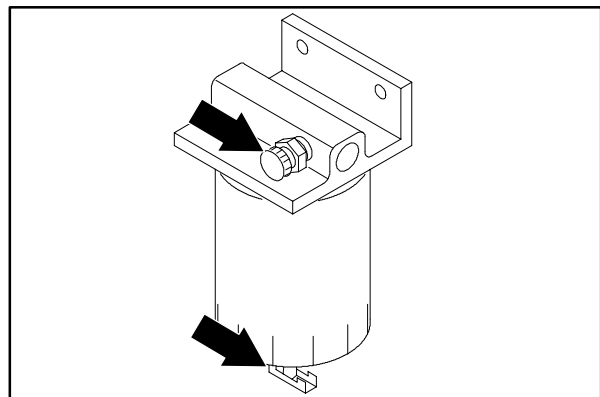
The fuel filter cartridge filters impurities from the fuel. It is located low on the left side of the engine block



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.

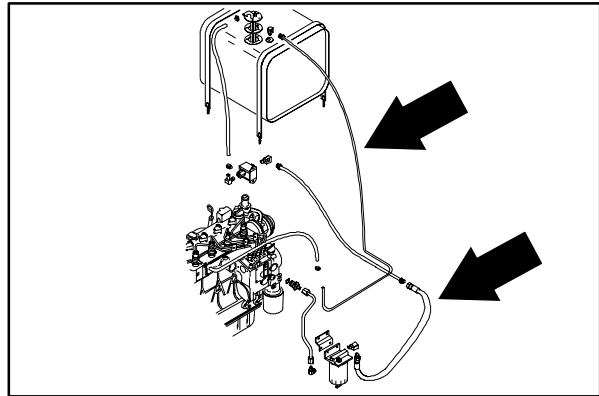


FUEL LINES

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

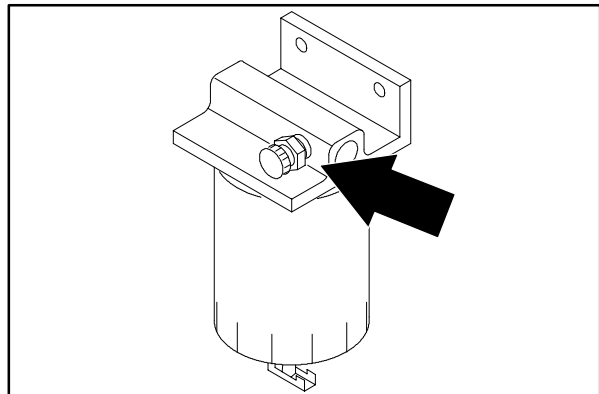
Priming the fuel system removes pockets of air in the fuel lines and fuel components. Air in the fuel system will prevent smooth engine operation.

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.

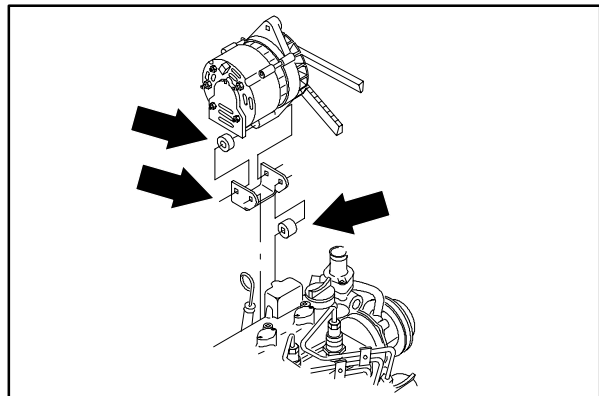
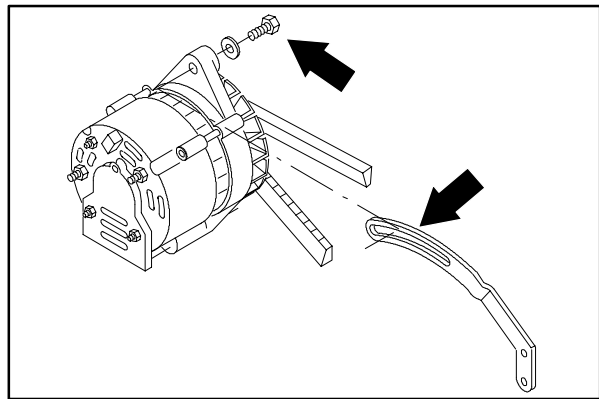
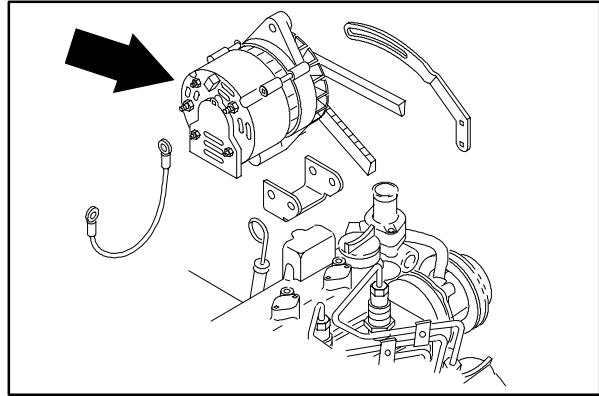
1. Make sure the fuel tank is full.
2. Open the air vent on top of the fuel filter.
3. Start the engine, operate it for one minute, then stop it; or operate the starter motor in ten-second intervals until a steady stream of fuel flows from the vent.
4. Close the air vent and shut off the engine.
5. Clean up any fuel that was spilled during the bleeding process.



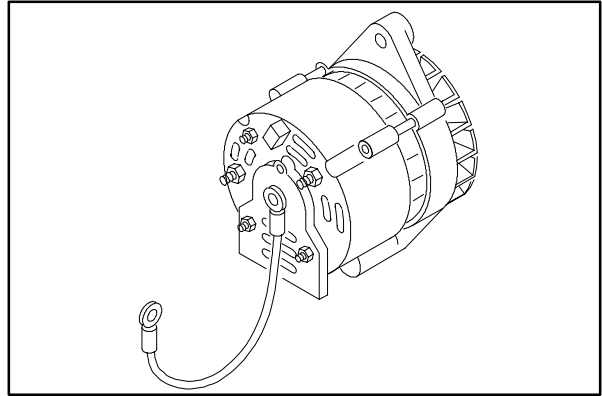
TO REPLACE ALTERNATOR

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

1. Disconnect the battery cables from the battery.
2. Open the engine side door and raise the engine hood.
3. Disconnect the wires leading to the back of the alternator.
4. Remove the 0.31 in. hex screw holding the top of the alternator to the mount bracket. Push the alternator in toward the engine and remove the V-belt.
5. Remove the M8 hex screw and nyloc nut holding the bottom of the alternator to the lower mount bracket.
6. The alternator can now be removed from the machine. Bring the alternator up and over the engine.
7. 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.
8. Install the pulley, washer, and hex nut on the new alternator. Firmly tighten the nut with the impact.
9. Install the new alternator back in the machine. Align the bottom hole in the alternator with hole in lower mount bracket. Reinstall the M8 hex bolt, ground cable, and nyloc nut. Leave it loose for now.
10. Place the V-belt back on the alternator pulley.



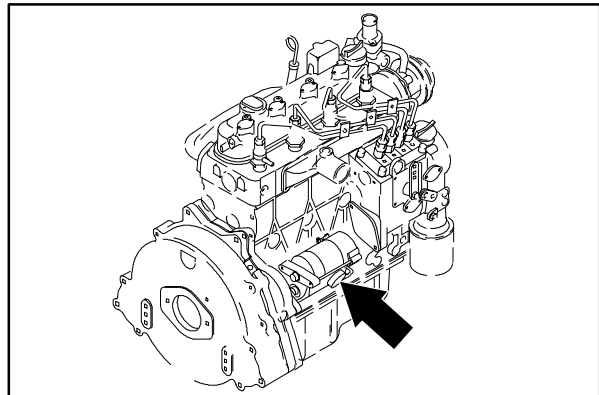
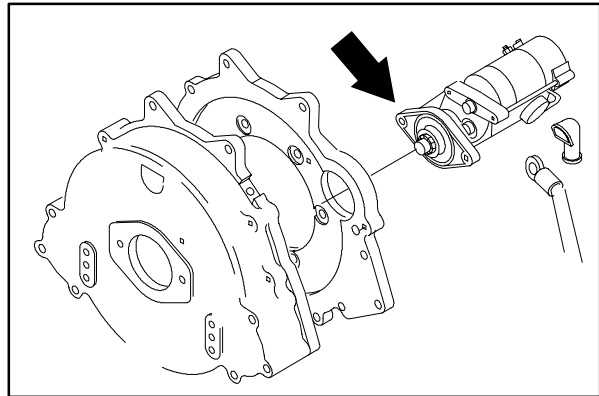
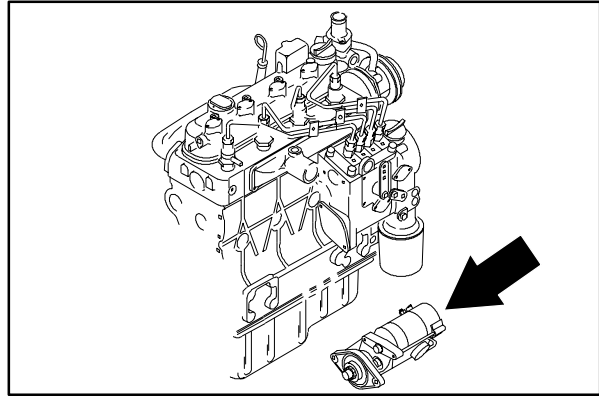
11. Reinstall the 0.31 in. hex screw in the top hole of the alternator through upper slotted mounting bracket. Push the alternator toward the hydraulic oil tank to tighten the belt. See adjustment in ENGINE FAN BELT description. Tighten the hex screw to 18 - 24 Nm (13 - 18 ft lb).
12. Tighten the bottom M8 hex screw to 18 - 24 Nm (15 - 20 ft lb).
13. Reconnect the wires to the back of alternator. See the schematic in the ELECTRICAL section.
14. 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.

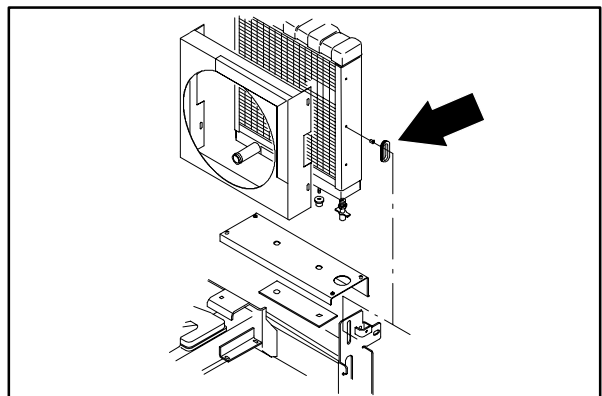
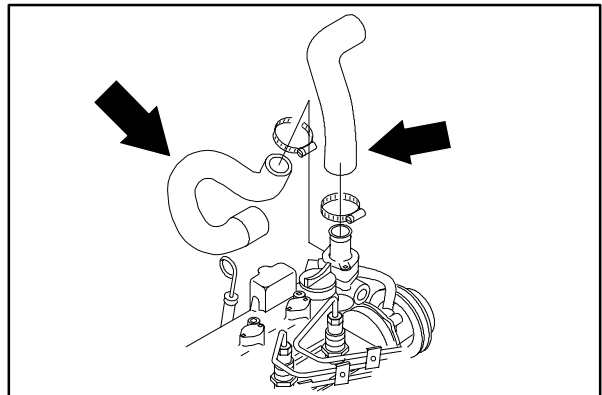
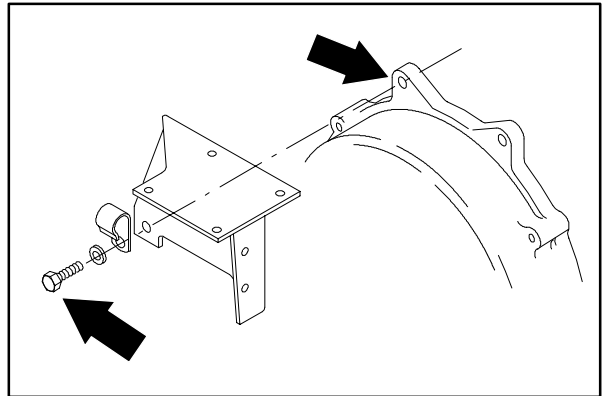
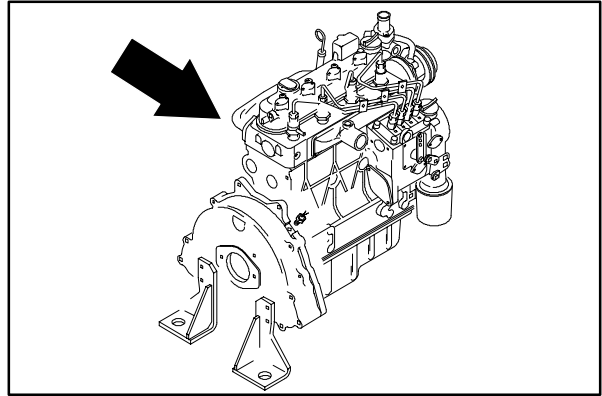
1. Disconnect the battery cables from the battery.
2. Open the engine side door and raise the engine hood.
3. Disconnect the wires leading to the engine starter.
4. Remove the two M8 hex screws holding the starter to the engine bellhousing.
5. Pull the starter straight out of the bellhousing and remove 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 M8 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 start the engine. Check the starter for proper operation.



TO REMOVE ENGINE

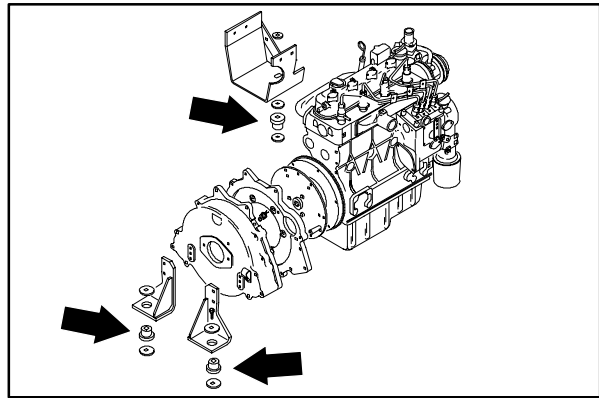
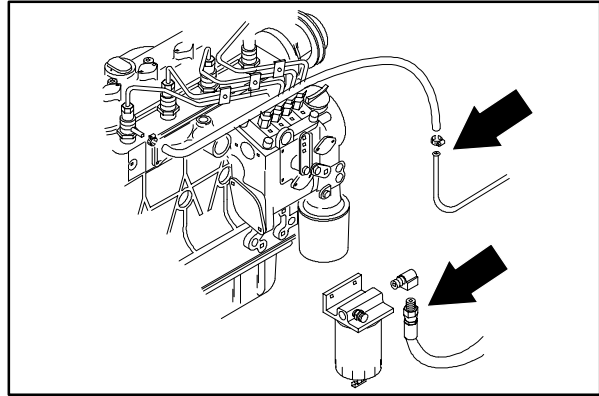
FOR SAFETY: Before Leaving Or Servicing Machine; Stop On Level Surface, Set Parking Brake. Turn Off Machine And Remove Key.

1. Disconnect the battery cables from the battery.
2. Remove the engine cover and side door.
3. Remove the two M10 hex screws holding the air cleaner assembly and mounting bracket to the back of the bellhousing. Remove the air cleaner assembly from the engine.
4. Drain the engine oil into a pan.
5. Drain the coolant from the radiator.
6. Remove the two radiator hoses from the engine.
7. Open the left rear machine casting.
8. Remove the one M6 hex screw, spacer, and fender washer holding the top left side of the radiator to the mount bracket.
9. Go under machine and remove the two 0.375 in. nyloc nuts holding the bottom of the radiator to the mount bracket.
10. Pull the radiator back so it clears the engine fan. Remove the radiator assembly from the machine.
11. Remove the muffler clamp holding the exhaust pipe to the engine manifold. Slip the pipe off the manifold.
12. Disconnect the wire harness from the alternator, starter, oil sender, temp. sender, governor, mag. pick-up, ect. Move the wires out of the way for engine removal.
13. Disconnect the engine ground strap from the machine frame.



14. Disconnect the fuel line at the filter/separator and the return line.
15. 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.
16. Remove the two M10 hex screws holding the right rear motor mount to the bellhousing. Pull the centering spring assembly out of the way of the propel pump.
17. Remove the two M10 hex screws holding the propel pump to the flywheel housing.
18. Pull the propel pump back and out of the flywheel coupling.
19. Remove the two M12 hex screws holding the remaining motor mounts to the rubber isolators.
20. 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.

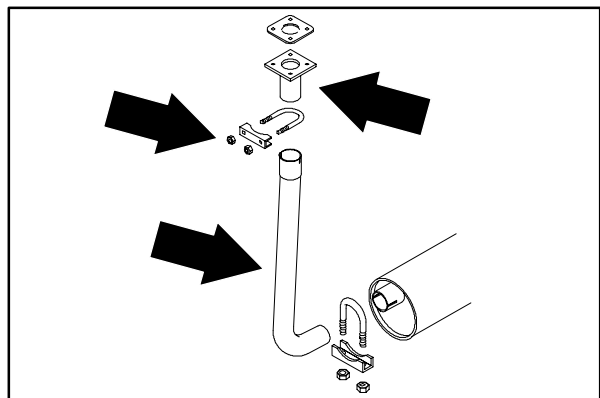
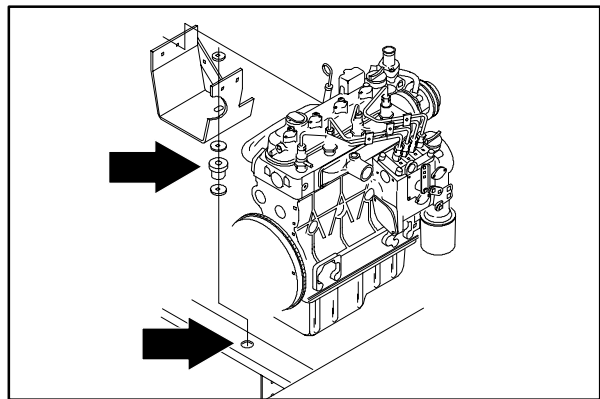
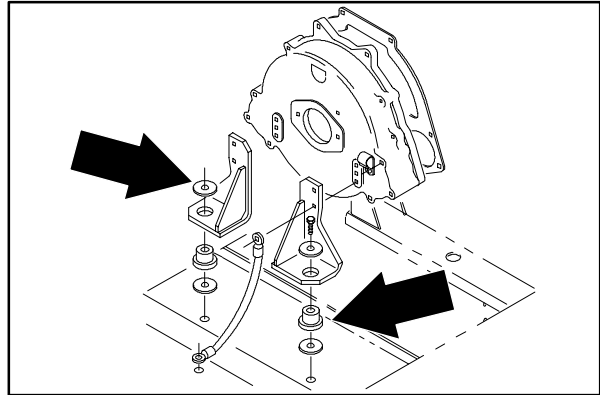
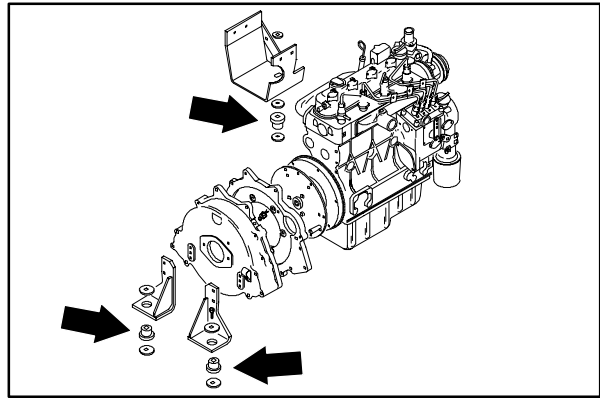
1. Using an overhead hoist, hook a chain through the two pick-up points on top of the engine. Carefully position the engine back in the engine compartment.

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. Carefully align the mount holes in the motor mounts with the mount holes in the machine frame.
3. Reinstall the M12 hex screws in the one front, and the one left rear motor mount. Leave the hoist hooked up and the hardware loose for now.
4. Position the propel pump back in the bellhousing and drive coupling. Reinstall the two M10 hex screws, using blue loctite 242, and hand tighten tight.

NOTE: Make sure the splines on pump line up with splines in coupler when installing pump.

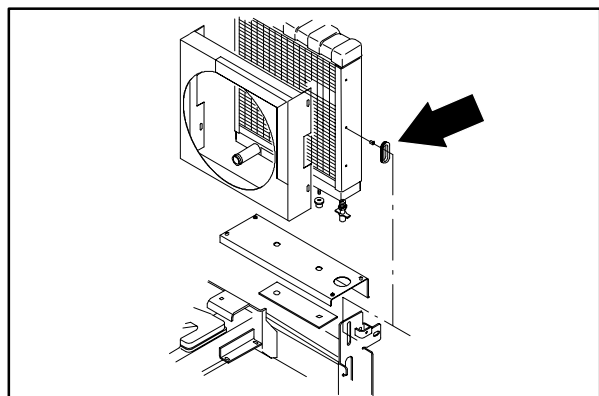
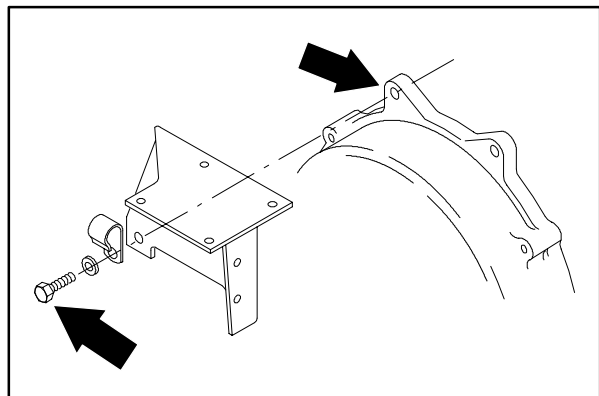
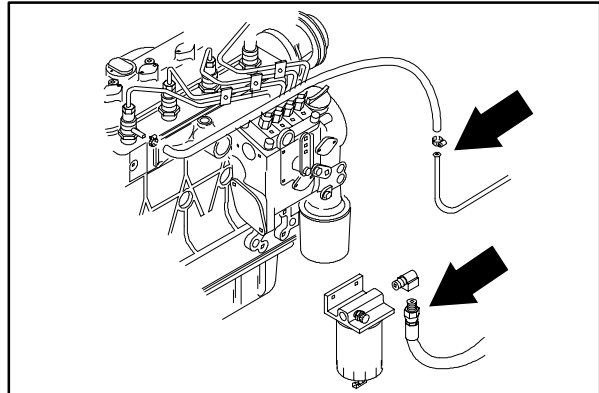
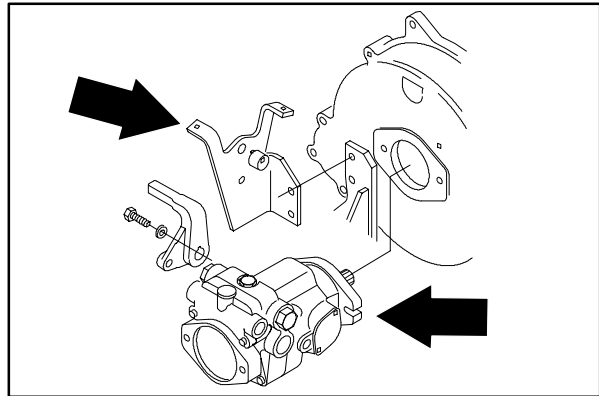
5. Position the centering spring assembly back on the pump directional arm.
6. Align the holes in the right rear motor mount with the holes in the bellhousing and centering spring mount bracket. Reinstall the two M10 hex screws, using blue loctite 242, and tighten to 52 – 67 Nm (39 – 51 ft lb).
7. Remove the hoist from the engine.
8. Go back and tighten the remaining two motor mount hex screws to 64 – 83 Nm (50 – 60 ft lb).
9. Reconnect the ground cable from the bellhousing to the machine frame.
10. Reinstall exhaust pipe back on the engine manifold. Reinstall the muffler clamp and hand tighten tight.



11. Reconnect fuel lines on the filter/separator and return line.
12. Fill the engine with the proper grade of oil. Use 6L (6.35 qt) of 10W30 SAE-CC/CD rated engine oil with a new filter.
13. Reconnect the wire harness to the engine components; alternator, starter, governor actuator, oil switch, temperature sender, and glow plugs. Use the schematic in the ELECTRICAL section of this manual if needed.
14. Position the radiator back in the machine. Align the two bottom studs on the radiator assembly with the isolators in the mount bracket. Reinstall the two 0.375 nyloc nuts and washers. Lightly hand tighten.
15. Reinstall the M6 hex screw, washer, and spacer to the upper left side of the radiator. Hand tighten.
16. Reinstall the radiator hoses to engine and fill the radiator with coolant.
17. Reinstall the air cleaner mount bracket and air cleaner assembly on the rear of the bellhousing. Use the two M10 hex screws. Tighten to 37 - 48 Nm (26 - 34 ft lb).
18. Reinstall the engine cover and side door.
19. Reconnect the battery cables to the battery.
20. 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.

21. Start the engine and check for any leaks and proper operation.

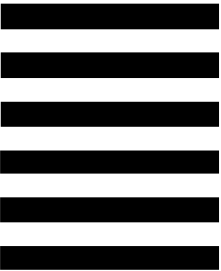




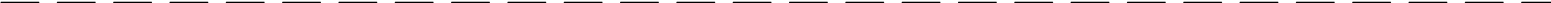
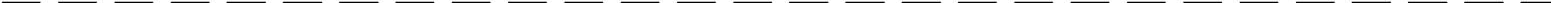
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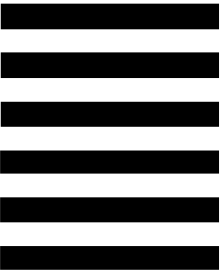
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