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Cooling System Troubleshooting

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General Information

General Information

The main function of a cooling system is to keep the engine at its optimum operating temperature. This results in the most efficient use of fuel and allows the engine oil to provide a good lubricating film. For the typical coolant plumbing, see **Fig. 1**.

The cooling system is a high-flow design, where most of the coolant in a warm engine moves relatively quickly across the radiator in a single pass.

Coolant flows from the radiator to the water pump, which forces the coolant into the engine block. Inside the block, the coolant flows around and between the cylinders, and then up into the cylinder head. From the head, it flows to the temperature regulator (thermostat) housing. If the engine is cool, the thermostat directs the coolant back to the water pump, and the water pump forces the coolant back into the engine. As the engine warms, the thermostat directs the coolant to the radiator. The thermostat keeps the engine temperature in the optimum range by controlling the two flows.

Coolant levels are monitored by a coolant level sensor. A float with an embedded magnet operates a switch in the sensor body to signal low or normal levels of coolant. Refer to **Subject 050** for more information and **Subject 140** for removal and installation procedures.

To prevent air and vapor from being trapped in the radiator or engine, vent lines rise from the high points where air and vapor would collect in those components. The vent lines carry any collected air to the surge tank.

General Information

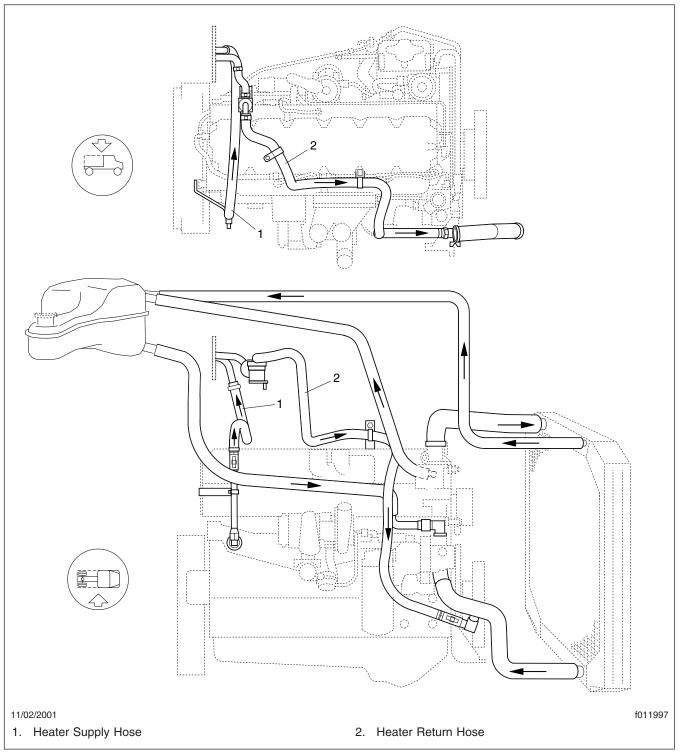


Fig. 1, Coolant Plumbing (typical)

Troubleshooting

Troubleshooting

sections of this manual or the engine and component manufacturer's service publications.

Possible causes of abnormally high or low coolant temperatures are listed below. For repairs, see other

Problem—Coolant Temperature Above Normal

Proble	m—Coolant Temperature Above Normal
Possible Cause	Remedy
Coolant leakage (see possible sources below) is causing a low coolant level. External Leakage: hoses and hose connections radiator seams, core, petcock and cap block core and drain plugs water pump thermostat housing surge tank heater hoses and core temperature sending unit(s) cylinder head(s) mating (gasket) surfaces coolant filter oil cooler Internal Leakage: cylinder head gasket warped head or block surfaces cracked cylinder head or block cylinder head capscrews loose, missing, or tightened unevenly oil cooler aftercooler.	Do the repairs necessary to stop the leaks. Fill to the surge tank sight glass with the correct mixture of antifreeze and water. See Group 20 of the Business Class M2 Maintenance Manual for coolant specifications.
Inoperative temperature gauge	Check the gauge wiring, circuit breaker, and sending unit. If the gauge circuit is okay, replace the temperature gauge. If the gauge circuit is broken, repair it and then check the temperature gauge operation.
Clogged radiator, aftercooler, or condenser fins	Clean the outside of the core and the condenser with compressed air directed from the fan side, or with water and a mild laundry soap. Straighten bent fins.
Collapsed or plugged radiator hose	Replace the hose(s).
Loose fan belt or water pump belt	Adjust belt tension.
Damaged cooling fan shroud	Repair or replace the shroud.
Incorrect or malfunctioning radiator cap	Make sure the correct radiator cap is installed. If the cap does not hold the correct pressure, replace it.
Viscous fan drive not operating to specifications	Check for unobstructed airflow through the radiator core, aftercooler, and condenser to the fan clutch sensor. Check that the radiator core is getting hot in front of the fan clutch (core is not internally clogged in that area) so that the sensor is getting a correct reading. If no radiator problems exist, refer to the viscous fan clutch section in this group for fan clutch inspection procedures and operation tests.
Incorrect engine oil level	Fill to the high (H) mark on the dipstick.
Too much antifreeze in system	Clean and flush the cooling system. Refill the system with the correct mixture of antifreeze and water.
Incorrect or inoperative thermostat	Make sure the correct thermostat is installed in the temperature regulator housing. Test the thermostat according to the engine manufacturer's instructions. Replace it if it does not operate correctly.
Malfunctioning water pump	Repair or replace the water pump.

Troubleshooting

Problem—Coolant Temperature Above Normal			
Possible Cause Remedy			
Internally plugged or damaged radiator core	To check for blockages, warm the engine to normal operating temperature. Turn off the engine, and run your hand over the finned surface of the radiator. If there is a blockage in the radiator, it should cause an obvious temperature difference from one area of the core to another. An obvious difference between inlet and outlet temperatures is normal. If blockage is suspected, clean and flush the cooling system. Repair or replace a damaged core.		
Air or combustion gases entering cooling system	Check the cylinder heads, head gaskets, cylinder liners, and aftercooler for leaks. Repair or replace parts, as necessary.		
Internally plugged or damaged aftercooler	Repair or replace the aftercooler.		
Internally plugged or damaged oil cooler	Repair or replace the oil cooler.		
Engine receiving too much fuel	Refer to the engine manufacturer's fuel delivery system adjustment procedures.		
Wrong replacement fan installed	Install the correct fan.		
Exhaust blockage	Remove the blockage.		
Frozen coolant in radiator due to subfreezing temperatures	Use the proper antifreeze-to-water ratio needed for winter temperatures.		

Problem—Coolant Temperature Below Normal

Problem—Coolant Temperature Below Normal			
Possible Cause Remedy			
Inoperative temperature gauge	Check the gauge circuit wires, circuit breaker, and sending unit. If the gauge circuit is okay, replace the temperature gauge. If the gauge circuit is broken, repair it and then check the temperature gauge operation.		
Viscous fan drive operates continuously	See Section 20.02 of this manual for fan clutch inspection procedures and operation tests. Replace the fan drive if necessary.		
Incorrect or inoperative thermostat	Make sure the correct thermostat is installed. Test the thermostat according to the engine manufacturer's instructions. Replace it if it does not operate correctly.		

Problem—Coolant Level Sensor Failures

Problem—Coolant Level Sensor Failures		
Possible Cause Remedy		
Float is sticky	Make sure the coolant is free from corrosion and debris.	
Broken locking tab	Replace the sensor. Refer to Subject 140 for removal and installation procedures.	
Worn float axle The magnet has moved away from the sensor. Refer to Subject 140 for removal and installation procedures and replace the sensor.		

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General Information

General Information

The main function of a cooling system is to keep the engine at its optimum operating temperature. This results in the most efficient use of fuel and allows the engine oil to provide a good lubricating film.

The central component of the cooling system, the radiator assembly, includes the surge tank (remote mounted on the firewall), the radiator, and the surge tank pressure relief cap.

The surge tank provides storage space for reserve coolant, expansion space for heated coolant, and deaeration space. When coolant in the radiator runs low, reserve coolant stored in the surge tank flows from the tank through the fill hose to the water pump. As the coolant heats and expands beyond radiator capacity, excess coolant travels back through the fill hose from the water pump to the surge tank. Any air trapped in the engine block or radiator rises to the top of the engine or radiator and escapes through the vent hoses to the surge tank.

The low coolant level sensor in the surge tank sends a signal to the driver display screen to warn the driver of a low coolant condition. The Gentech low coolant level sensor is located in the coolant surge tank on EPA07 and later vehicles. A float with an embedded magnet operates a switch in the sensor body to signal low or normal levels of coolant. The surge tank is translucent polypropylene so you can see the coolant level and compare it to the maximum and minimum levels marked on the tank.

When the engine is running, some of the reserve coolant in the surge tank is drawn into the engine. A coolant level that appears acceptable when the engine is off may fall below the acceptable level when the engine is running at high speed. Many engine systems need the coolant level in the surge tank to be filled to the upper fill mark.

These vehicles use full-flow (or high-flow) radiators. With full-flow radiators, the coolant flows into the radiator at the top of the left side tank and flows out of the radiator at the bottom of the right side tank. Most of the engine coolant is routed through the radiator, and it moves relatively quickly in a single pass.

There are three sizes of two-row radiators in use:

- 805-square-inch area
- 870-square-inch area
- 1000-square-inch area

The radiators use glass-filled nylon side tanks. The edges of the radiator core header are compressed in a "dimple wave lock" crimp (see Fig. 1) that holds the tanks on the radiator core, and the tanks and core are held in steel channels that mount on the front closing crossmember. The radiator is also secured by struts that run between the top of the radiator and the firewall. The fins of the radiator core are reinforced along their forward edge to resist damage from road debris and pressure washing.

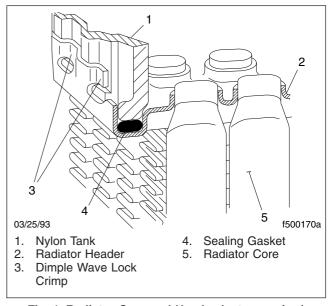


Fig. 1, Radiator Core and Header (cutaway view)

Because crimping holds the nylon side tanks tanks in place, the radiators can be disassembled and assembled.

The surge tank cap limits system pressure to about 11 to 12 psi (76 to 83 kPa), which raises the boiling point of the coolant. If the cooling system overheats, excess coolant is released through the overflow tube.

For more general information about the radiator and surge tank, and for cooling system troubleshooting procedures, refer to **Section 20.00**.

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Radiator Removal and Installation

NOTICE: If the radiator is being replaced due to a failure of the transmission cooler, cleaning contamination from the transmission is necessary. Failure to do so can lead to a transmission failure.

Allison automatic transmissions: It is required to test the transmission fluid for contamination. The presence of water and/or any trace of ethylene glycol coolant mixtures in the transmission oil in an Allison transmission is detrimental to the internal components. Refer to the Allison service literature for more information and proper procedures, or contact an authorized Allison service facility.

Standard transmissions: The presence of water and/or ethylene glycol coolant mixtures in the lubricant in standard transmissions decreases the effectiveness of the lubricant and causes rust and wear to internal parts. If contamination is detected, refer to the transmission manufacturer's service literature for proper procedures.

Removal

The 870-square-inch radiator is held in place by a support bracket that is attached to the front of the radiator, and to the closing crossmember. An isolator assembly is installed between the L-shaped radiator support bracket and the front closing crossmember. Four strut rods, attached to the sides of the radiator and the frontwall, stabilize the radiator. See **Fig. 1** for the installation drawing.

The 805-square-inch radiator mounts with brackets attached to the sides of the radiator that attach to isolators mounted on the frame rails. Two strut rods attach to the sides of the radiator and to brackets on the frame rail. See **Fig. 2** for the installation drawing.

The 1000-square-inch radiator is a cross flow configuration. It is attached to a mounting bracket on the closing crossmember by two studs with isolators. Three strut rods, attached to the top of the radiator and to brackets on the frontwall, stabilize the radiator. See Fig. 3 for the installation drawing.

NOTE: The M2 112 may be equipped with a 1350-square-inch radiator, which mounts on a module support bracket under the charge air cooler.

 Park the vehicle on a level surface, shut down the engine, set the parking brake. Chock the tires.

- 2. Open the hood.
- 3. Disconnect the hood damper from the bracket on the bumper by pulling the end of the cylinder out of the nylon clip.

WARNING

Drain the coolant only when the coolant and engine are cool. Draining it when these are hot could cause severe personal injury due to scalding.

- 4. Drain the coolant.
 - 4.1 Remove the cap from the surge tank.
 - 4.2 Place a clean container under the radiator.
 - 4.3 Open the draincock at the bottom of the radiator.
- If equipped, disconnect the transmission oil cooler hoses.
 - 5.1 Place a clean container under the hose connections.
 - 5.2 Disconnect the transmission oil cooler hoses from the radiator, or the transmission oil cooler, mounted below the radiator.

After the hoses have drained, cover them to keep out dirt. Secure the hoses to the side, above the level of the automatic transmission.

- 6. Disconnect the upper and lower radiator hoses.
- 7. Disconnect the upper left surge tank hose from the radiator.
- 8. Disconnect the charge air cooler hoses from the charge air cooler.
- 9. With an assistant supporting the hood, disconnect the hood-stop cables from the top of the radiator and support the hood on a padded table.
- 10. Disconnect the radiator struts from the radiator. Swing them out of the way.
- 11. If equipped with a viscous fan clutch, remove the fan and clutch from the fan hub. See **Section 20.04**, Subject 110 for the procedure.
- 12. Remove the fasteners holding the fan shroud to the radiator, then remove the fan shroud.

NOTE: Do not disconnect the refrigerant lines.

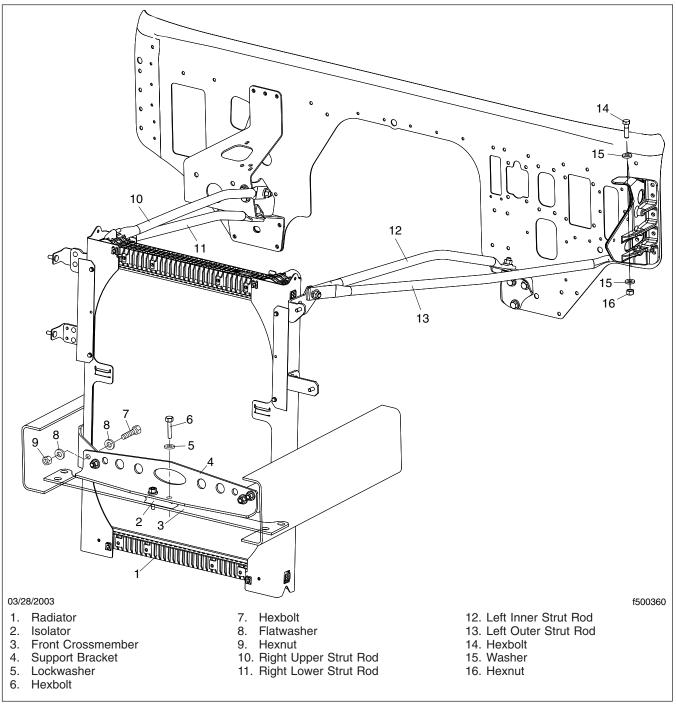


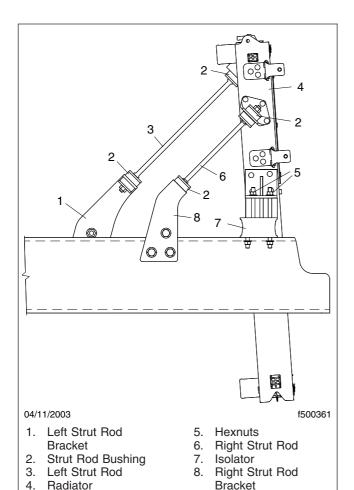
Fig. 1, 870-Square-Inch Radiator

13. Move the A/C condenser aside.

13.1 Free up the refrigerant lines from any stand-off brackets near the radiator.

20.01

Radiator Removal and Installation



- Fig. 2, 805-Square-Inch Radiator
- 13.2 Swing the condenser out of the way and wrap it with cardboard. Secure it with tiestraps.
- 14. Position a hoist over the radiator.
- 15. Connect straps or chains to the radiator.
- Remove the nuts from the studs holding the radiator to the radiator support bracket.
 - On the M2 112 with the 1350-square-inch radiator, remove the radiator mounting nuts from the module support bracket, underneath the charge air cooler.
- Carefully move the radiator back toward the frontwall. If necessary, pry the lower bracket studs from the holes in the radiator support bracket.

- 18. Lift the radiator assembly from the vehicle.
- 19. If necessary, remove the charge air cooler from the radiator. For instructions, see **Group 09**.
- 20. If the vehicle has a transmission oil cooler, remove it from the radiator. For instructions, see **Group 26**.

Installation

- If there is a transmission oil cooler, install it on the radiator.
- 2. If it was removed, install the charge air cooler on the radiator. For instructions, see **Group 09**.
- Using a suitable hoist, align the studs of the radiator lower brackets with the holes in the radiator support bracket, and lower the radiator into place.
- 4. For 870- and 1000-square-inch radiators, install the 1/2–13 hexnuts and washers onto the studs on the radiator lower brackets. Tighten 68 lbf-ft (92 N·m).
 - For 805-square-inch radiators, install the nuts and washers on the studs on the isolators at the sides of the radiator.
- 5. Remove the chains or straps from the radiator.
- 6. Attach the radiator strut rods to the radiator. Tighten the 1/2–13 hexnuts 68 lbf·ft (92 N·m).
- 7. Install the air conditioner condenser on the front of the radiator. Tighten the fasteners firmly.
- 8. Install any standoff brackets that were removed from the refrigerant lines.
- 9. Install the fan shroud onto the radiator.
- Install the fan and the viscous fan clutch on the fan hub. See Section 20.04, Subject 110, for the procedure.
- Connect the upper surge tank hose to the radiator.
- 12. Connect the upper and lower radiator hoses.

Remove the seals from the coolant hose ends, connect the hoses to the radiator, and tighten the hose clamps. See **Table 1** for proper torque values.

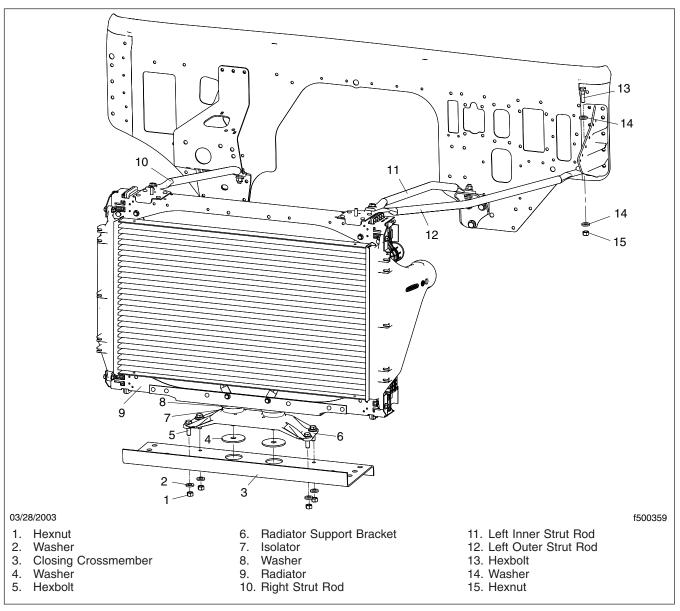


Fig. 3, 1000-Square-Inch Radiator

NOTE: Your hose clamps can be either T-bolt clamps (see Fig. 4), Breeze Constant-Torque clamps (see Fig. 5), or ABA clamps (see Fig. 6).

NOTE: All hose clamp adjusters lose torque after installation, due to cold-flow of the hose material from under the clamp. Breeze Constant Torque clamps typically show a 30 percent loss

of torque shortly after installation; a 50 percent loss after heat-cycling, and up to 80 percent loss after time and repeated heat cycles. However, when correctly installed, Breeze Constant-Torque clamps adjust automatically, holding enough torque to keep consistent sealing pressure. During vehicle operation and shutdown, the screw tip may adjust in and out, according to temperature and pressure changes. The

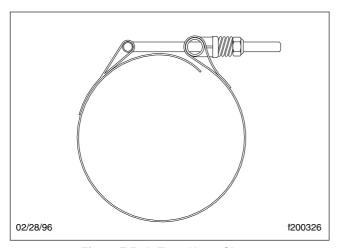


Fig. 4, T-Bolt Type Hose Clamp

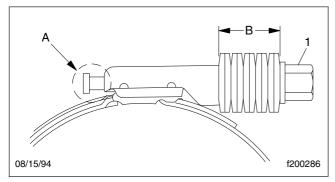


Fig. 5, Breeze Constant-Torque Hose Clamp Installation

torque may need to be adjusted for individual applications.

ABA Radial worm-drive hose clamps may lose 30 percent of their torque at the screw adjuster, shortly after being correctly tightened. This is due to cold-flow of the hose material, not an actual loosening of the clamp. This is the way they are designed to work, they should not be tightened further. To check the torque of an ABA clamp, it must be loosened completely, then torqued to the proper value listed in **Table 1**.

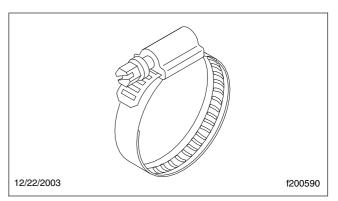


Fig. 6, ABA Radial Worm-Drive Hose Clamp (typical)

Over-tightening an ABA Radial worm-drive hose clamp can result in coolant leaks.

- 13. Connect the charge air cooler hoses. Tighten the constant torque hose clamps 60 lbf·in (680 N·cm).
- 14. If applicable, connect the transmission oil cooler hoses.
- Attach the hood-stop cables to the top of the radiator.
- 16. Connect the hood damper to the bracket on the bumper.
- 17. Fill the radiator with coolant. Refer to Group 20 of the *Business Class M2® Maintenance Manual* for approved coolants and system capacities.
 - 17.1 Add approved coolant to the radiator.
 - 17.2 Idle the engine with the heater circulation valve open for 15 to 20 minutes.
 - 17.3 Add coolant as necessary to fill the system to capacity.
- 18. While the engine is idling, check for leaks. Tighten fittings and connections to specified torque.
- 19. Remove the chocks from the tires.

Hose Clamp Torque Values				
Clamp Type Size Torque: lbf-in (N-cm)				
T-Bolt	All	55 (620)		
Breeze Constant-Torque	e Constant-Torque 5/16-inch tightening screw hex			
	3/8-inch tightening screw hex	90 (1020)		

Hose Clamp Torque Values					
Clamp Type	Size	Torque: Ibf·in (N·cm)			
ABA	1.26-inch Diameter	31 (360)			
	1.50-inch Diameter	35 (400)			
	1.73-inch Diameter	35 (400)			
	1.97-inch Diameter	35 (400)			
	2.28-inch Diameter	35 (400)			
	2.68-inch Diameter	40 (460)			
	3.03-inch Diameter	40 (460)			

Table 1, Hose Clamp Torque Values

Radiator Pressure Testing

Pressure Testing

- 1. Remove the radiator from the vehicle. For instructions, refer to **Subject 100**.
- 2. Pressure-test the radiator.
 - 2.1 Plug the inlet, outlet, and all other ports on the radiator assembly.

NOTICE —

Don't apply a higher amount of air pressure than specified below; too much pressure will damage the radiator core.

- 2.2 Remove the radiator cap, and install a pressure regulator and gauge. Using a hand pump, apply 20 psi (140 kPa) air pressure through the filler neck.
- 2.3 Submerge the radiator in a tank of water and check it for leaks. Remove the radiator from the water.
- 2.4 Remove the plugs and the testing gauge, and install the radiator cap. Repair the radiator, if necessary.
- 3. Install the radiator in the vehicle. For instructions, refer to **Subject 100**.

Radiator Disassembly and Assembly

IMPORTANT: Disassembling and assembling radiators with nylon tanks requires the special tools listed in **Table 1**.

Dissassembly Tools				
Description	Quantity			
Plastech II® Tanking Machine With Five 2-Inch Cylinders	1			
T-Bar	1			
Hooked-End Bar	1			
Wave Form Bar	1			

Table 1, Disassembly Tools

Order these tools from:

RAD PAL 2364 17 St. Detroit, MI 48216 313-963-3194

Disassembly

Before disassembling the radiator, pressure flush it and check the surge tank, following the instructions in Group 20 of the *Business Class M2 Maintenance Manual*. Clean and check the exterior of the radiator, following the instructions in the *Business Class M2 Driver's Manual*.

1. Remove the radiator from the vehicle; for instructions, refer to **Subject 100**. See **Fig. 1**.

- NOTICE ----

Use care when handling or supporting the nylon tanks. Failure to do so could damage the tanks.

- 2. Remove the side channels from the radiator assembly.
 - 2.1 Remove the four spring clips that hold the side channel mounting pins in position. See Fig. 2. Insert a screwdriver blade in the open end of each clip, and pry the clip open until it clears the edge of the mounting pin. Then, slip the clip off the pin.
 - 2.2 Use a rubber mallet and a punch to tap out the four mounting pins. See **Fig. 3**.
 - 2.3 Slip the side channels off the radiator core and tank assembly. See **Fig. 4**.

- 3. Leak test the radiator core and tank assembly.
 - 3.1 Securely plug all tank ports.

- NOTICE ----

Don't apply a higher amount of pressure than specified below; too much pressure will damage the radiator core.

- 3.2 At one tank port, install a pressure regulator and gauge. Using a hand pump, apply 20 psi (138 kPa) air pressure through the port.
- 3.3 Submerge the radiator in a tank of water and check it for leaks. Mark any leaks for repair. If a leak is between the radiator core header and a tank, remove the tank and inspect the tank flange, the header sealing surface, and the sealing gasket. If the leak is in the core, but within 3 inches (7.5 cm) of the tank, remove the tank before repairing the leak. If the leak is in the tank, replace the tank.
- 4. Remove the tanks.
 - 4.1 Place the radiator core and tank assembly in the disassembly/assembly fixture, and clamp the assembly securely in place. See **Fig. 5**.
 - 4.2 Position the tank clamping cylinders evenly across the top of the tank. Make sure the cylinders' rubber plungers will not press against breakable fittings, such as vent tube ports.

— NOTICE ——

Apply only enough pressure to compress the sealing gasket. Too much pressure will crack the nylon tank.

4.3 Apply pressure evenly across the top of the tank until the tank-to-core sealing gasket is compressed enough to show a small gap between the bottom of the dimple wave lock crimp and the tank sealing flange.

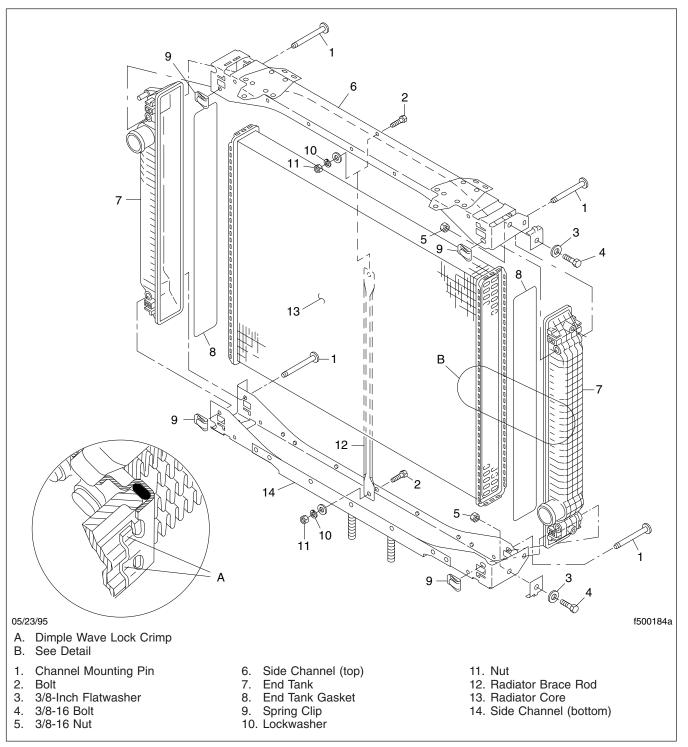


Fig. 1, Radiator With Plastic End Tanks

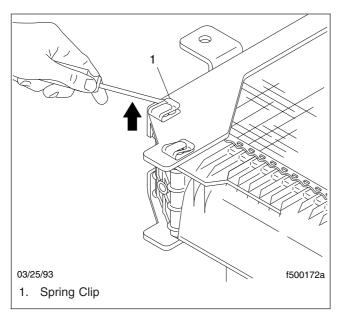


Fig. 2, Remove the Spring Clip

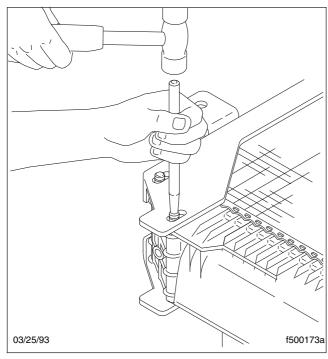


Fig. 3, Tap Out the Mounting Pins

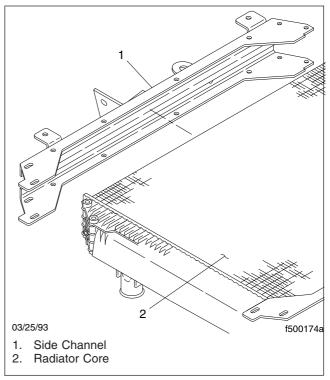


Fig. 4, Remove the Side Channels

NOTICE

In some places, especially around the tank ports, the wave lock crimps may have to be unlocked with a screwdriver. When using a screwdriver, use care not to crack or gouge the nylon tank.

- 4.4 Place the T-bar into the T-bar groove in the disassembly/assembly fixture. See **Fig. 6**.
- 4.5 Slide the hooked-end bar over the T-bar. Place the hook over the top of the wave crimp and pull the T-bar back to unlock the crimp. See **Fig. 6**.
- 4.6 Slide the hooked-end bar and the T-bar down the T-bar groove to the next wave crimp, and repeat the previous step until all the wave crimps are unlocked.
- Once the wave crimps are unlocked, remove the tank.
 - 5.1 Release the pressure from the tank, and move the clamping cylinders off the radiator core and tank assembly.

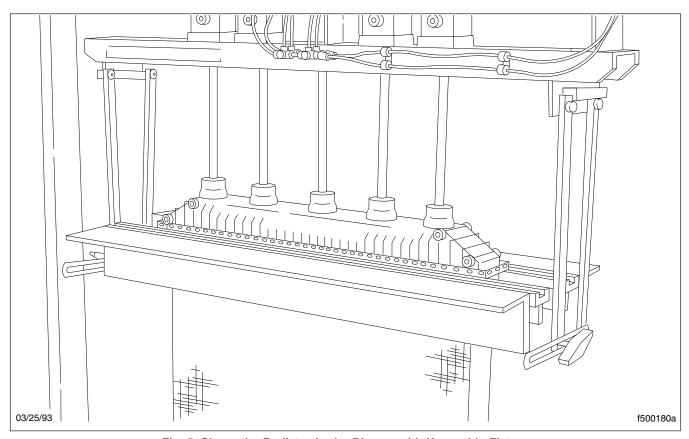


Fig. 5, Clamp the Radiator in the Disassembly/Assembly Fixture

NOTICE -

If needed, use a rubber mallet or the heel of your hand and tap the side of the tank to loosen it. Do not use a screwdriver against the tank sealing flange. A screwdriver blade may damage the flange and prevent a good seal after the tank is installed.

- 5.2 Lift the tank from the forward side, the side opposite the tank ports. Remove the nylon tank from the radiator core. See Fig. 7.
- 5.3 Remove the sealing gasket from the sealing surface of the radiator core header. See **Fig. 8**.
- 5.4 Clean the sealing surface of the radiator core header.
- 5.5 Repair any leaks marked during leak testing.

5.6 Repeat the preceding steps to remove the opposite tank.

IMPORTANT: Check the tubes of the radiator core for scale deposits. If the radiator has been pressure-flushed, and the tubes are still clogged, the radiator should be rodded or boiled out with acid by an experienced radiator shop. Otherwise, replace the core.

Assembly

- 1. Install the nylon tanks on the radiator core.
 - 1.1 With the radiator securely clamped in the disassembly/assembly fixture, header sealing surface up, make sure the bottom of the radiator core and tank assembly is completely supported, and that the header

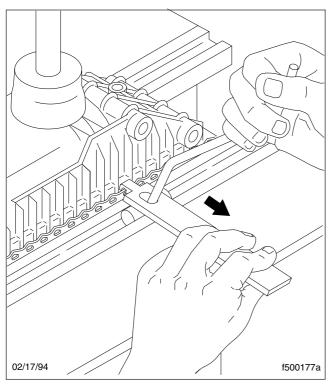


Fig. 6, Place the T-Bar

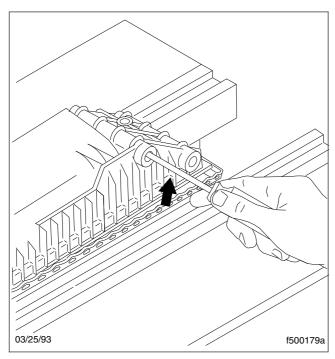


Fig. 7, Lift the Tank

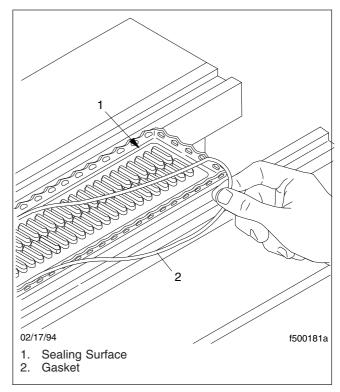


Fig. 8, Remove the Gasket

sealing surface is free of any dents, tool marks, or foreign particles.

- 1.2 Lubricate a new sealing gasket with a soap and water solution, and position the gasket on the header sealing surface. See Fig. 8. To make sure the gasket is not twisted, run a finger along the gasket as it lies on the sealing surface. The mold lines of the gasket should be on the outside and inside diameters of the gasket; if you can feel a mold line cross over the top of the gasket, the gasket is twisted.
- 1.3 Inspect the tank sealing flange. The flange must be clean and free of defects. If the sealing flange is damaged, replace the tank.
- 1.4 Place the tank on the gasket, and tap the tank with a rubber mallet or the heel of your hand to seat the tank. Make sure the tank ports are facing the correct direction.
- 1.5 Position the tank clamping cylinders evenly across the top of the tank. Make

sure the cylinders' rubber plungers will not press against breakable fittings, such as vent tube ports. See **Fig. 5**.

- NOTICE -

Apply only enough pressure to compress the sealing gasket. Too much pressure will crack the nylon tank.

- 1.6 Apply pressure evenly across the top of the tank until the tank-to-core sealing gasket is compressed enough to show a small gap between the bottom of the dimple wave lock crimp and the tank sealing flange.
- 1.7 Place the T-bar into the T-bar groove in the disassembly/assembly fixture.
- 1.8 Slide the wave form bar over the T-bar, and center the bar in front of the wave crimp slot.

- NOTICE -

Do not push the wave crimp until it touches the side of the nylon tank, or the tank may crack.

- 1.9 Push the T-bar forward to crimp the header's edge until it almost touches the tank's side. See Fig. 9.
- 1.10 Slide the tools down the T-bar groove to the next wave crimp slot, and repeat the previous steps until all the wave crimps are crimped.

- NOTICE —

In some places, especially around the tank ports, the wave crimps may have to be crimped with a screwdriver. When using a screwdriver, use care not to crack or gouge the nylon tank.

- 1.11 Release the pressure from the tank, and move the clamping cylinders off the radiator core and tank assembly.
- 1.12 Repeat the first step in this procedure to install the opposite tank.
- 2. Leak test the radiator core and tank assembly. For instructions, refer to "Disassembly."
- 3. Install the radiator side channels.

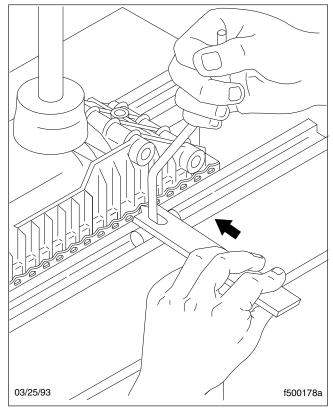


Fig. 9, Crimp the Header

- 3.1 Slide the side channels onto the radiator core and tank assembly.
- 3.2 Using a rubber mallet and a punch, install the four mounting pins through the side channel holes and tank bosses. See Fig. 10.
- 3.3 Install the four spring clips to secure the mounting pins in position. See Fig. 11. To install each clip, place the clip over the end of the mounting pin, and slide the clip until it engages the groove in the pin and the open end of the clips snaps over the edge of the pin. If necessary, use a clamp to compress the side channel while installing the clips.
- Install the radiator in the vehicle. For instructions, refer to Subject 100.

20.01

Radiator Disassembly and Assembly

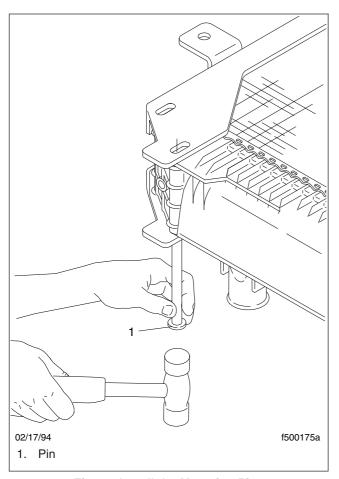


Fig. 10, Install the Mounting Pins

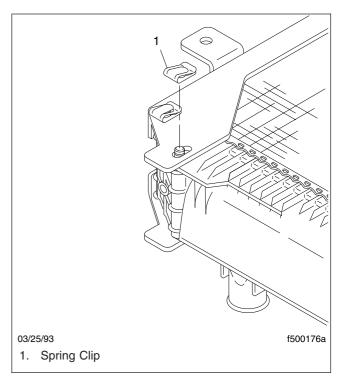


Fig. 11, Install the Spring Clips

20.01

Surge Tank Removal and Installation

Removal

- Park the vehicle on a level surface, shut down the engine, set the parking brake, and chock the tires.
- 2. Tilt the hood.



Drain the coolant only when the coolant and engine are cool. Draining it when these are hot could cause severe personal injury due to scalding.

- 3. Drain the radiator.
 - 3.1 Remove the surge tank cap.
 - 3.2 Open the draincock on the bottom of the radiator to drain the engine coolant. Drain only enough coolant to empty the surge tank.
- 4. Remove the surge tank.
 - 4.1 Mark and disconnect the engine and radiator vent hoses from the front of the surge tank. There are three hoses. See Fig. 1.

NOTE: Cap all the disconnected hoses to prevent the remaining coolant from spilling.

- 4.2 Remove the fasteners holding the right side of the surge tank to the air cleaner bracket. See Fig. 1.
- 4.3 Remove the fasteners holding the left side of the surge tank to the frontwall and the HVAC air plenum.
- 4.4 Remove the surge tank from the vehicle.
- 5. If replacing the surge tank, remove the overflow hose from the bottom.
- If removing the coolant level sensor, see Subject 140.

Installation

- If it was removed, install the overflow hose to the bottom of the surge tank.
- 2. Position the surge tank onto the air cleaner bracket, then install the M8 fasteners. See

Fig. 1. Tighten just enough to hold the surge tank in place.

- Using the fasteners previously removed, attach the surge tank to the HVAC air plenum and the frontwall.
- 4. Tighten all the fasteners 18 lbf-ft (24 N·m).
- 5. As previously marked, connect the engine and radiator hoses to the surge tank.
- 6. Fill the coolant system through the surge tank.
- 7. Install the surge tank cap.
- 8. Start the engine and check for coolant leaks. Repair any leaks.
- 9. Lower the hood and remove the chocks from the tires.

Surge Tank Removal and Installation

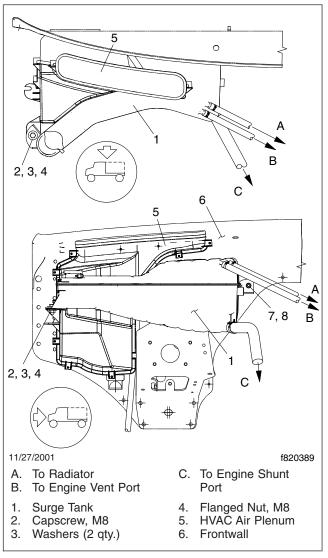


Fig. 1, Surge Tank Installation (top and front views)

Coolant Level Sensor Removal and Installation

Removal

Complete the following instructions to remove the coolant level sensor. Refer to **Subject 130** for sensor location.

- 1. Shut down the engine and chock the tires.
- 2. Allow the engine to cool down to ambient temperature.
- 3. Drain the coolant below the sensor if needed.
- 4. Disconnect the electrical sensor by releasing the locking tab, then pressing on the retaining tab.
- 5. Twist the large, black locknut counterclockwise until it disengages from the reservoir.
- 6. Remove the sensor.

Installation

Complete the following instructions to install the coolant level sensor.

- Lubricate the o-ring of the new sensor using a small amount of light silicone grease, or a bit of coolant.
- 2. Align the new sensor. Make sure the tabs are aligned at tangent to the surge tank neck.
- 3. Twist the large, black locknut clockwise until the sensor securely engages into the reservoir.
- 4. Connect the eletrical connector to the sensor.
- 5. Add coolant as needed.

Cooling System Inspection and Flushing

Inspection

Refer to the vehicle's Driver's Manual for daily inspection of the cooling system.

Refer to the vehicle's Maintenance Manual for periodic maintenance of the coolant system.

- NOTICE -

Coolant must be inhibited with the recommended supplemental coolant additives (SCA) listed in the engine manufacturer's service literature. Failure to check and maintain SCA levels at required concentrations will result in severe damage (corrosion) to the engine cooling system and related components.

If a vehicle's cooling system is not functioning correctly, it may be contaminated. Inspect the system as follows.

- Park the vehicle on a level surface, shut down the engine, and set the parking brakes. Chock the tires.
- 2. If equipped, check the coolant filter housings for signs of leakage. For repair procedures, refer to the engine manufacturer's service literature.
- Inspect the coolant in the surge tank for signs of contamination.
- 4. Remove the coolant filter cap and filter, and inspect the coolant filter for contamination.

If the coolant filter is clean (no white flakes or gel present) replace the original filter and check the rest of the cooling system.

If there is a visible gel built up on the filter, replace the filter. Refer to the engine manufacturer's service literature for coolant filter replacement. Continue to check the rest of the cooling system. See **Fig. 1**.

Inspect the under side of the filter for white residue.

If there is a buildup of white residue and gel on the filter and in the filter housing, follow the "Repair Procedure" below. See **Fig. 2** for white residue build up with gel.

After making repairs, flush the system follow the procedure in "Flushing" below.

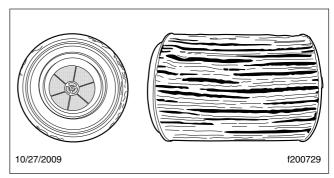


Fig. 1, Filter With Gel Only (gel may be clear or have a slight green tint)

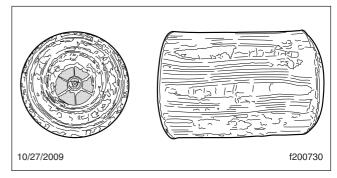


Fig. 2, Filter with Gel and White Residue

Repair Procedure

 Install the original filter and cap, then pressure test the entire cooling system. For instructions, refer to Group 20 of the vehicle's workshop manual.

If leaks are found, repair as needed, then go to the next step.

If no leaks are found, go to the next step.

Pressure test the radiator cap and fill cap to verify that they hold the correct rated pressure.

If either pressure cap will not hold the rated pressure, replace the effected cap(s) and go to the next step.

If the pressure caps are functioning properly, go to the next step.

3. Drain the coolant from the radiator, and from the block drain. For instructions, refer to **Group 20** of the vehicle's workshop manual.

Cooling System Inspection and Flushing

- 4. Remove the water pump and inspect the water pump and the module for damage.
 - If there is no damage, install the water pump and replace the coolant filter.
 - If there is damage present on any component, replace the affected component(s) and the thermostat.
- 5. Thoroughly flush the cooling system to remove all white residue. See "Flushing" below.

Flushing

- Park the vehicle on a level surface, shut down the engine, and set the parking brakes. Chock the tires.
- Drain the cooling system as follows.
 - 2.1 Place the transmission in neutral.
 - 2.2 Remove the coolant reservoir cap.
 - 2.3 Loosen the coolant drain plug located on the left side of the engine block and attach a hose to the plug.
 - 2.4 Collect the used antifreeze in a suitable container. Always dispose of used coolant in accordance with local, state, and federal Environmental Protection Agency (EPA) regulations.
 - 2.5 Close the drain plug. Tighten 22 lb·ft (30 N·m).
- If equipped, remove the coolant filter and O-rings, then install the filter housing without the filter. For instructions, refer to the engine manufacturer's service literature.
- 4. Flush the cooling system using an approved cleaning compound. Refer to the engine manufacturer's service literature for a list of approved cleaning products.
 - 4.1 Fill the cooling system with soft, clean water and a cleaning compound.
 - 4.2 Start the engine and operate it for 15 minutes at 1000 to 1200 RPM after the thermostat has opened to thoroughly circulate the water.
 - 4.3 Stop the engine and allow it to cool. Drain the unit completely.

- Flush the system with clean water to remove cleaning compound residue.
 - 5.1 Fill the cooling system slowly with clean water.
 - 5.2 Start the engine and operate for 15 minutes at 1000 to 1200 RPM after the thermostats have opened.
 - 5.3 Stop the engine and allow it to cool.
 - 5.4 With the engine cool, drain the water and cleaner residue from the cooling system.

NOTE: If excessive contaminants are found, repeat the flushing process as needed until the system is clean.

 Install the coolant filter. Refer to the engine manufacturer's service literature for coolant filter replacement.

- NOTICE -

In some cases, hoses, o-rings, and seals may need to be replaced after flushing the cooling system. Before filling the cooling system with coolant, refer to the engine manufacturer's service literature for recommendations. Failure to do so may lead to system failure.

- Fill the cooling system with the recommended coolant mixture for the conditions the vehicle is operating in.
 - 7.1 With the engine off (ignition OFF), fill the cooling system with coolant at a constant minimum rate (typically 6 to 8 liters per minute) until it reaches the top of the filler neck, or the "Cold Max" or "Full" level on the surge tank.
 - 7.2 With the pressure cap removed from the surge tank, start the engine and idle for one minute. Increase the engine speed slowly to 100 to 1200 RPM and hold for one minute. Then reduce engine speed to idle and cycle up and down between idle and 100 to 1200 RPM for one additional minute.
 - 7.3 Stop the engine and add coolant as required to achieve "Cold Max" or "Full" level. If a second top-off is needed, start the engine and idle the engine for one additional minute.

Cooling System Inspection and Flushing

- 7.4 Stop the engine and add coolant as required to achieve the "Cold Max" or "Full" level. Install the pressure cap.
- 8. Start the engine and check for leaks. Repair as needed.

Radiator Assembly 20.01

Specifications

Fastener Torques					
Description	Crado	Cina	Torque		
Description	Grade	Size	lbf·ft (N·m)	lbf⋅in (N⋅cm)	
Radiator Lower-Bracket Stud Hexnuts	8	1/2–13	68 (92)	_	
Fan Shroud Mounting Screws	_	1/4-20 x 3/4	_	108 (1220)	
Radiator Strut Nuts	8	1/2–13	68 (92)	_	

Table 1, Fastener Torques

Coolant Capacities*				
Engine Make and Model Coolant Volume: quarts (liters)				
MBE900 (6.4L)	37 (35)			

 $^{^{\}ast}$ The total coolant volume is dependent on the number and location of optional passenger heaters.

Table 2, Coolant Capacities

Approved Coolants					
Engine Type Coolant Manufacturer Coolant Designation					
Diesel	Texaco	JC04 Antifreeze			
	Van Waters and Rogers Ltd. (Canada)	Diesel Antifreeze No. 6038			

^{*} Freightliner-approved antifreeze must meet one of the following conditions: A. Ethylene glycol solution that meets GM 6038–M Engineering Standards. B. Ethylene glycol solution that has less than 0.1% anhydrous sodium metasilicate and meets either GM 1825–M or GM 1899–M Engineering Standards.

Table 3, Approved Coolants

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General Information

General Information

An engine block heater keeps the engine coolant about 80°F (27°C) warmer than the ambient air temperature. In cold weather, the heater helps engine starting and reduces wear on the piston walls.

When starting the engine, the diesel normally ignites on the compression stroke of each piston, when the compressed air within the cylinder reaches about 725°F (385°C). However, during cold weather starts, the heat of the compressed air dissipates into the surrounding engine block so the diesel may never reach the temperature it needs to ignite. Using the engine block heater, the engine block is already warm, so heat is held in the cylinder to ignite the diesel. To reduce engine wear, the block heater warms the oil film on the piston walls and reduces piston drag caused by cold oil film.

The Phillips 1000W heater consists of an element that screws into the side of the engine water jacket. See **Fig. 1**. A cord plugs into the outside end of the element, and the cord runs to a plug below the front bumper.

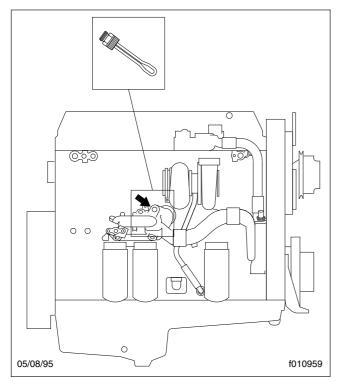


Fig. 1, Block Heater Element Installation (typical)

To turn on the heater, connect the heater cord to a power source. The element has no thermostat. Heat dissipating from the engine block prevents coolant overheating.

Block Heater Element Replacement

Removal

- Park the vehicle, apply the parking brakes, and chock the tires.
- 2. Tilt the hood.



Drain the coolant only when the coolant and engine are cool. Draining it when these are hot could cause severe personal injury due to scalding.

- Drain the radiator. For instructions, refer to Section 20.01.
- 4. If applicable, unscrew the threaded cover that secures the cord to the element. See Fig. 1.

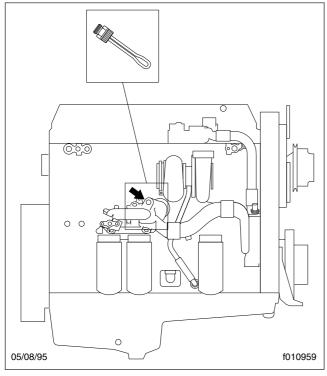


Fig. 1, Block Heater Element Installation (typical)

- 5. Pull the cord from the element.
- 6. Remove the element from the engine block by loosening the jam nut (if applicable) and unscrewing the element from the engine block.

Installation

- Position the heater element in the engine block.
 Coat the threads of the element with a small amount of sealant. For the approved sealants, refer to Specifications, 400.
- 2. Secure the heater element in the engine block by screwing the element into the engine block hand tight, then use a wrench to turn the element 1-1/2 turns more.
- 3. Plug the cord into the element and (if applicable) secure it by screwing the threaded cord cover in place.
- Fill the cooling system. For instructions, refer to Section 20.01.
- 5. Start the engine and check for leaks. Repair any leaks as necessary. Run the engine for half an hour to purge any air from the coolant system.
- To test the heater, plug a wattmeter into a power source, and connect the heater cord to the meter. A reading on the meter will indicate the heater is working.

Troubleshooting

Troubleshooting

Use the following procedures to check for the most common engine block heater problems.

Wiring Problems

- Park the vehicle, apply the parking brakes, and chock the tires.
- 2. Tilt the hood.
- Unscrew the threaded cover that secures the cord to the element. Pull the cord off the element.
- 4. Using an ohmmeter, check the continuity between the two poles of the element. The resistance should be very low, typically between 9 and 10 ohms. If there is no reading, the element has burned out, and if the reading is very high, the element is about to burn out.
- 5. If the element is good, check the cord. Plug the cord into the element and secure it by screwing the threaded cover in place.
- 6. Using an ohmmeter at the receptacle, check the continuity between the two power terminals. The resistance should be low, typically between 9 and 10 ohms. If there is no reading or a very high reading, the cord is damaged. Replace the cord.
- 7. Check the continuity between each power terminal and the ground terminal. There should be no ohmmeter reading. If there is a reading, replace the cord.
- 8. Check the ohmmeter reading between the ground terminal and a good vehicle ground. The reading should be zero. If not, replace the cord.

Fouled Element

- Park the vehicle, apply the parking brakes, and chock the tires.
- 2. Tilt the hood.



Drain the coolant only when the coolant and engine are cool. Draining it when these are hot could cause severe personal injury due to scalding.

- Drain the radiator. For instructions, refer to Section 20.01.
- Unscrew the threaded cover that secures the cord to the element. Pull the cord off the element.
- Remove the element from the engine block. For instructions, refer to Subject 100 in this section.
- Inspect the element for residue deposits, discoloration, or damage.

Coolant dye residue indicates the coolant solution contains too much antifreeze. Replace the element, and refer to Group 20 of the *Business Class M2 Maintenance Manual* for the recommended antifreeze/water ratio.

Gray or black residue indicates anti-leak coolant additives have been added to the system. Replace the element, and refer to Group 20 of the *Business Class M2 Maintenance Manual* for the recommended coolant additives.

Blue or black discoloration on the element indicates the coolant system needs more coolant. Replace the element, and fill the coolant system until coolant is visible in the surge tank sight glass.

Holes in the element indicate the coolant solution contains too little antifreeze. The weak solution is boiling inside the engine block and causing pitting of the element and block. Replace the element, and refer to Group 20 of the *Business Class M2 Maintenance Manual* for the recommended antifreeze-to-water concentrations.

For element installation instructions, refer to **Subject 100**.

Specifications

APPROVED SEALANTS

- Loctite 567
- Henkel 790 Pipegrip
- Perma-Loc LH-150

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General Information

General Information

The fan clutch senses the air temperature behind the radiator core, and engages or disengages the fan depending on that temperature. It spins the fan when more cooling airflow is needed, and disengages it when the radiator is sufficiently cooled.

The Eaton 690 viscous fan clutch drive consists of two basic parts: the input plate and shaft, and the output plate. See **Fig. 1**. The input shaft is mounted to the fan hub, so they turn together as the engine runs. The output plate is attached to the fan, but engages with the input plate only when extra engine cooling is needed.

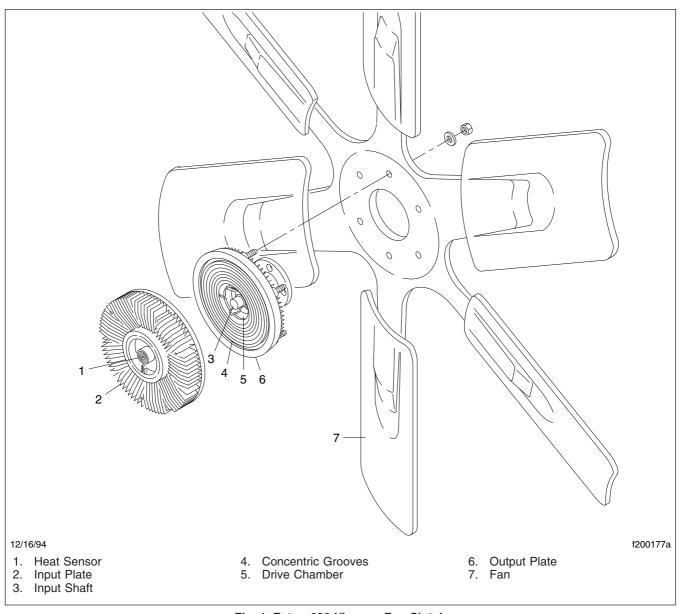


Fig. 1, Eaton 690 Viscous Fan Clutch

General Information

To spin the fan, the heat sensor on the front of the clutch opens a valve in the clutch drive chamber. The centrifugal force of the turning input plate forces the thick silicone fluid, stored in the drive chamber, to flow out through tightly meshing grooves between the input and output plates. this creates friction between them. As that friction increases, it causes the output plate and fan to turn with the input plate. The fluid continues to spread out between more grooves, increasing the friction between the plates until they spin at about the same speed.

When air passing through the radiator is cool enough, the heat sensor disengages the fan clutch. It does this by closing the valve in the drive chamber. That stops the flow of silicone fluid to the input and output plates. For the fluid already between the plates, centrifugal force continues to push it outward until it has moved beyond the grooves. There, at the outer edge of the clutch, it returns through a passage in the input plate to the drive chamber.

With only a small amount of fluid to create friction between the two plates, the fan turns much slower than the input plate and the input shaft.

When the fan is disengaged, a single bearing allows the output plate and fan to free-wheel in relation to the input shaft and plate.

Inspection and Operation Check

Inspection



If the fan drive assembly is damaged, replace the unit as soon as possible. Operating a vehicle with a seized or otherwise damaged clutch reduces fuel economy, and could cause serious engine damage.

The fan clutch is only one part of the cooling system and will function well only if all other parts of the system are working correctly. All parts of the system should be checked if there is a cooling problem. Do each of the checks in the cooling system trouble-shooting section in this group, and pay special attention to the fuel flow rate and exhaust temperature. Over-fueling can cause engine overheating and high exhaust temperatures.

- Park the vehicle on a level surface and set the parking brake. Shut down the engine. Chock the rear tires.
- With the engine off, rotate the fan at least one full turn by hand. It should have a smooth, steady drag. If it does not, replace the fan clutch.
- Check for physical damage to the fan or fan shroud.
- 4. Inspect the fan clutch mounting.
 - 4.1 Check the torque of the nuts holding the fan input shaft to the fan hub. They should be tightened 28 lbf·ft (38 N·m).
 - 4.2 Check for wear of the fan clutch bearings. There should be no side-to-side or in-and-out movement of the fan clutch.
- 5. Remove the chocks from the tires.

Operation Check

Use the following procedure to check for correct engagement and disengagement of the fan clutch:

- Park the vehicle on a level surface and set the parking brake. Shut down the engine. Chock the rear tires.
- Coolant temperature in the radiator should be below 140°F (60°C) before the start of the test; the outside temperature should be above 50°F (10°C). Ideally, a temperature probe placed

- about 1/2 inch (13 mm) from the fan clutch sensor is needed to see if the fan clutch engages at the right temperature.
- 3. Disconnect any hydraulic pumps (such as the power steering pump) to prevent oil overheating.
- 4. Use a piece of cardboard large enough to block the entire front of the radiator. Cut a round 7-inch (18-centimeter) hole in the cardboard; locate the hole so that it lines up with the fan clutch. Do not put the cardboard in front of the radiator yet.



Before starting the engine, make sure your hands and all other objects are away from the fan blades. Do not try to restrict the fan blade rotation when the engine is on. It is extremely dangerous to get too close to the fan blades when the engine is on, because the fan could start operating without warning. This could result in serious personal injury.

- Turn off the air conditioner, if so equipped. Start the engine and let it idle until the oil pressure is normal.
- 6. As soon as there is normal oil pressure, bring the engine up to high idle (about 80 percent of governed engine speed) and lock the throttle at this speed.
 - If the engine has been idle for more than 8 hours, the fan clutch may engage as soon as the engine is started. If this happens, the usual noise from the fan will be heard; the noise will stop after 5 minutes or less, when the fan clutch disengages.
- 7. After the fan clutch disengages, put the cardboard in front of the radiator.
- 8. Look at the temperature gauge and note at what point the engine thermostat opens. As the engine warms up, the coolant temperature will rise steadily and then seem to level off after the thermostat opens. It will then start rising again, before the fan clutch engages.
- Keep watching the coolant temperature and, if possible, the temperature of the air in front of the fan clutch, until the clutch engages. Note the temperature(s) at which the clutch engages. The

Inspection and Operation Check

fan should be fully engaged when the air at the fan clutch sensor rises to about 155 to 165°F (68 to 74°C).

With the clutch engaged, the coolant temperature will keep rising, at a slower rate, as long as the radiator is blocked with cardboard.

- Remove the cardboard. Keep watching the coolant temperature while the clutch is engaged; you should notice a decrease after the cardboard is removed.
- 11. The fan should disengage when the air temperature at the fan clutch sensor drops to about 120 to 130°F (49 to 54°C).

If the coolant temperature keeps rising, even though the fan is engaged and the cardboard has been removed, the fan clutch may be working properly; the problem is probably in another part of the cooling system.

IMPORTANT: If the air temperature in front of the clutch is being tested, and it does not rise as the coolant temperature rises, the problem could be a clogged radiator or a stuck engine thermostat.

If the engine still overheats during operation, even though everything described above checks out properly, use a stroboscope to check peak fan speed. The fan speed should be at least 93 percent of the fan pulley speed when the clutch is fully engaged.

Example: 2160 = fan pulley speed x . 93 = 2009 = 93 percent of fan pulley speed.

Fan speed must be at least 2009 rpm when the fan clutch is fully engaged.

12. Remove the chocks from the tires.

Removal and Installation

Removal

- Park the vehicle on a level surface and set the parking brake. Shut down the engine. Chock the rear tires.
- Disconnect the batteries or, if the vehicle is equipped with a battery shutoff switch, turn off the switch.
 - Disconnect the battery ground cable at the vehicle frame.
- 3. Tilt the hood.
- Disconnect the radiator struts from the radiator side-channels.
- 5. If so equipped, disconnect the left-side charge air cooler hose from the charge air cooler.
- 6. Disconnect the fan clutch from the fan hub. See Fig. 1.

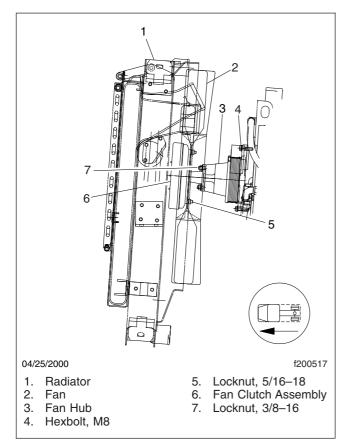


Fig. 1, Viscous Fan Clutch Mounting, Caterpillar 3126 Engine

- 6.1 Holding the fan to keep it from turning, remove the four locknuts or four capscrews holding the fan clutch to the fan hub.
- 6.2 Remove the fan (with the fan clutch attached to it) from the fan hub, and push them forward into the fan shroud.
- 7. Remove the serpentine drive belt.
 - 7.1 Using a 1/2-inch breaker bar, move the belt tensioner clockwise
 - 7.2 Remove the belt from the various engine and component pulleys.
- 8. Remove the fan hub from the engine.
 - 8.1 Remove the top two bolts holding the fan hub to the engine block. Then loosen the bottom two bolts. It is not necessary to remove them.
 - 8.2 Remove the fan hub from the engine block.
- Remove the fan and the attached fan clutch from the vehicle.
- 10. Remove the locknuts and washers that hold the fan clutch to the fan. Remove the clutch.

Installation

1. Install the fan clutch onto the fan. Tighten the 5/16–18 locknuts 15 lbf·ft (20 N·m).

NOTE: Use only approved fans. Never go over the maximum input speeds, and do not make changes to the engine that will raise the operating speed of the fan.

- 2. Install the fan hub onto the engine. See Fig. 1.
 - 2.1 Put the hub in place on the engine so the lower mounting ears fit over the lower two bolts on the engine block.
 - 2.2 Install the two upper hexbolts and washers. Tighten all the hexbolts 15 lbf-ft (20 N·m).
- 3. Install the fan clutch assembly onto the fan hub. Tighten the 3/8–16 locknuts 28 lbf·ft (38 N·m).
- 4. Install the serpentine drive belt.

Removal and Installation

- 5. Connect the left-side charge air cooler hose to the charge air cooler.
- 6. Connect the radiator struts to the radiator sidechannels. Tighten the fasteners firmly.
- 7. Lower the hood and connect the batteries.
- 8. Remove the chocks from the tires.

Specifications

Fastener Torques				
Description	Grade	Size	Torque: lbf⋅ft (N⋅m)	
Fan Clutch-to-Fan Hub Locknuts	8	3/8—16	28 (38)	
Fan Hub-to-Engine Hexbolts	10.9	M8	15 (20)	
Fan Clutch-to-Fan Locknuts	G	5/16—18	21 (28)	

Table 1, Fastener Torques

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General Information

General Information

The Horton DriveMaster® fan clutch is a temperature-controlled, air-operated clutch for the engine cooling fan. It is spring engaged, and controls the engine temperature by engaging or disengaging the fan.

When the coolant temperature is below a specified range, air pressure keeps the fan disengaged to save engine power. When the coolant temperature rises above the specified range, air pressure to the fan clutch is cut off and internal spring pressure engages the fan.

Air pressure to the fan clutch is controlled by a solenoid valve; the solenoid valve is controlled by a temperature switch installed in the thermostat housing. The temperature switch is connected to the engine ECM, which controls the solenoid valve. See **Fig. 1**. When you start a cold engine, the solenoid valve allows air pressure to the fan clutch and the clutch remains disengaged. When the coolant temperature rises to the temperature switch setting, the switch provides power to the solenoid valve and the valve cuts off compressed air to engage the fan.

On vehicles with air conditioning, the fan clutch solenoid valve is connected to a fan cycling switch at the receiver-dryer. If the refrigerant pressure exceeds the setting of the fan cycling switch, the switch supplies power to the solenoid valve, which cuts off air to the fan clutch, engaging the fan.

General Information

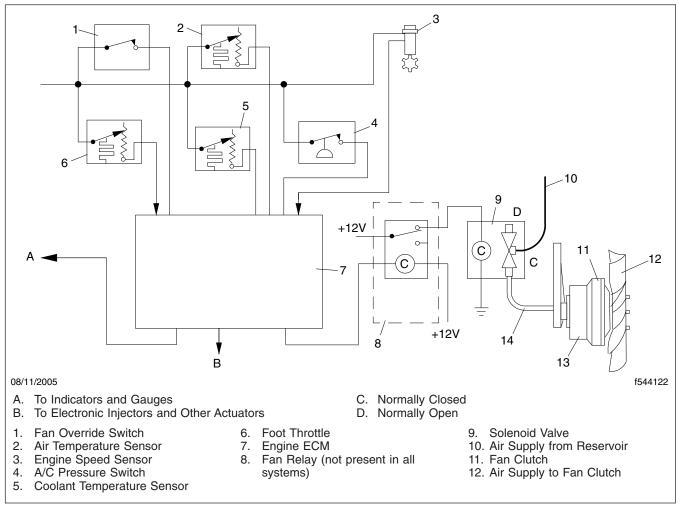


Fig. 1, Fan Clutch Schematic (engine ECM controlled)

Removal and Installation

Removal

 Park the vehicle on a level surface, shut down the engine, set the parking brakes, and chock the tires.

A WARNING

Wear safety goggles when draining the air system or disconnecting an air line because dirt and sludge could fly out at high speeds. Don't direct the airstreams at anyone. Don't disconnected pressurized air lines, as they may whip as air escapes. Failure to take all necessary precautions could result in personal injury.

- 2. Drain the air tanks.
- 3. Tilt the hood.
- Disconnect the left-side hose from the charge air cooler.
- 5. Remove the drive belts from the engine.
- 6. Disconnect the air line from the fan hub.
- 7. Remove the fan.
- Remove the fan clutch assembly from the engine. See Fig. 1.

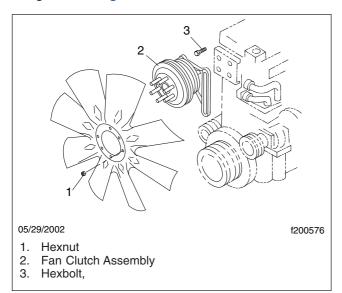


Fig. 1, Fan Clutch Removal (typical)

8.1 If equipped with a metal fan ring, remove the two top fasteners holding the upper mounting bracket for the fan ring.

8.2 Remove the fasteners holding the fan clutch mounting bracket to the front of the engine.

A WARNING

The fan clutch assembly may weigh up to 55 lbs. (25 kg). Be careful when lifting it. Use a helper or a hoist, if necessary. Failure to use care when lifting the fan clutch could cause the assembly to fall, which could result in injury or component damage.

8.3 Remove the fan clutch assembly from the vehicle. If equipped with a metal fan ring, carefully push the ring forward to allow removal of the fan clutch assembly.

Installation

- 1. Using either a helper or a hoist, position the fan clutch assembly in place on the front of the engine, aligning the holes in the mounting bracket with those in the front of the engine.
- 2. Install the fasteners.
 - If equipped with a metal fan ring, don't tighten the upper fan clutch fasteners completely.
- 3. Install the drive belts.
- 4. Connect the air line to the fan clutch.
- 5. Install the fan. Tighten the fan mounting nuts firmly.
- 6. Tighten the M8 fan-clutch mounting fasteners 15 lbf-ft (20 N·m).
- Connect the left-side hose to the charge air cooler.
- 8. Lower the hood.
- 9. Remove the chocks from the tires.

Disassembly

NOTE: This procedure involves a major rebuild of the Horton DriveMaster® fan clutch, using parts from the manufacturer's Super Kit. If you are replacing just the seals or the air cartridge, see **Subject 120** for the minor rebuild procedure.

Refer to Fig. 1 for this procedure.

- 1. Remove the fan clutch assembly from the vehicle. For instructions, see **Subject 100**.
- 2. Put the fan clutch assembly in a vise.
- Connect a shop air hose to the fan clutch air inlet.

4. Apply 80 to 120 psi (552 to 827 kPa) to the fan clutch to lift the fan mounting disc off the spring housing/piston assembly.



Use care when placing the pry bar onto the fan mounting disc. Make sure it is secure and flat on the surface. Failure to do so make cause the pry bar to slip, which could result in damage to studs or the fan mounting disc.

- 5. Using a pry bar, wrench, and a T55 Torx® bit, loosen the jack bolt (left-hand thread) by turning it counterclockwise. See Fig. 2.
- 6. Unscrew the fan mounting disc from the jack bolt. See Fig. 3

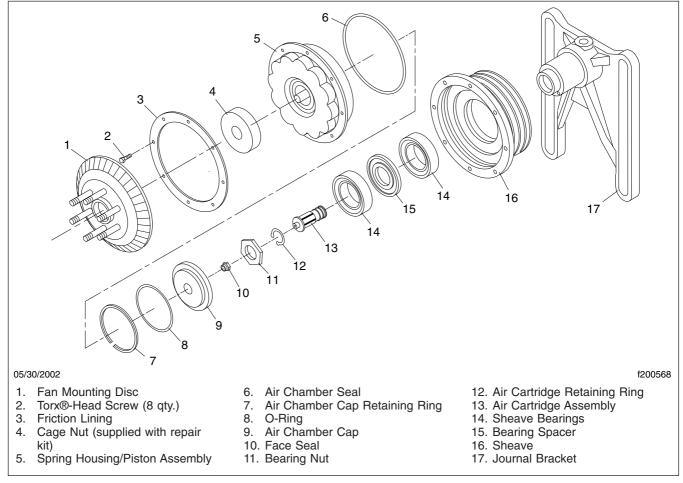
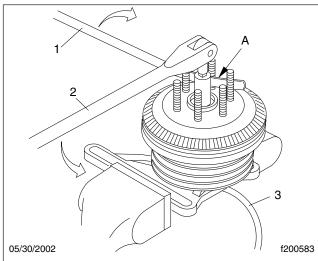
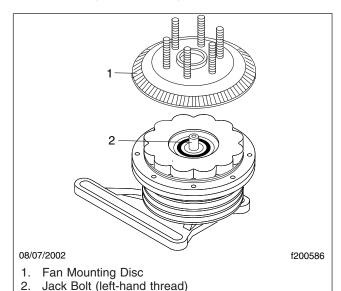


Fig. 1, Horton DriveMaster Fan Clutch



- A. Place the pry bar here.
- 1. Pry Bar (push clockwise)
- 2. Torx Bit and Wrench (turn counterclockwise)
- 3. Shop Air Hose (connected to the inlet port)

Fig. 2, Loosening the Jack Bolt



,

7. Inspect the fan mounting disc for wear or damage.

Fig. 3, Fan Mounting Disc Removal and Installation

WARNING

Do not disassemble the spring housing from the piston. The interior springs are very strong, and if released could eject the housing with considerable force, possibly resulting in serious injury. Always use the cage nut to hold the spring housing and the piston together.

8. Using a wrench and a T55 Torx bit to hold the jack bolt, install the cage nut from the kit onto the jack bolt (left-hand thread). Hand tighten it onto the spring housing.

The cage nut will keep the spring housing and piston together as an assembly. It will also maintain pressure on the internal springs after the Torx-head screws holding the friction lining in place are removed.

9. Release the air pressure from the fan clutch.

A WARNING

Release the air pressure from the fan clutch before removing the friction lining Torx-head screws. Failure to release the air pressure could result in the spring housing/piston assembly being ejected with force, which could result in personal injury.

- 10. Using a T27 Torx bit, remove the eight Torx-head screws holding the friction lining in place.
- 11. Remove the friction lining. See Fig. 4.
- Keeping the cage nut installed and tightened, remove the spring housing/piston assembly. See Fig. 5.
- 13. Remove the air chamber seal. See Fig. 6.
- 14. Examine the inside of the air chamber for signs of moisture and/or contaminants.
- 15. Remove the air chamber cap retaining ring. See Fig. 6.
- 16. Using two small screwdrivers placed 180 degrees apart, gently and evenly pry the air chamber cap out of the sheave.
- Remove the O-ring seal from the air chamber cap. See Fig. 6.
- 18. Remove the face seal. See Fig. 6.
- Inspect the face seal for signs of wear. Wear indicates that dirt may exist in the air system.

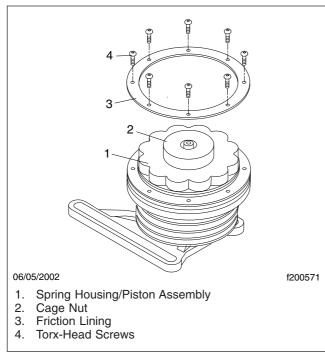


Fig. 4, Friction Lining Removal and Installation

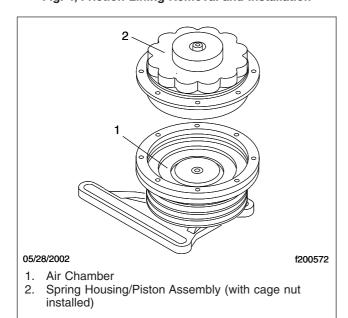


Fig. 5, Spring Housing/Piston Assembly Removal and Installation

20. Remove the bearing nut from the mounting bracket. See **Fig. 7**.

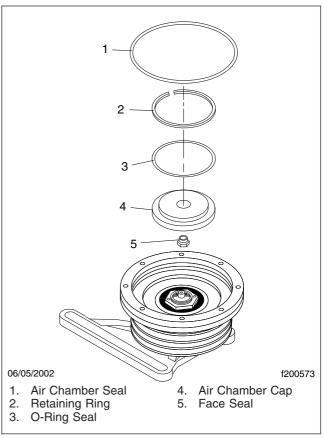


Fig. 6, Air Chamber Seal Removal and Installation

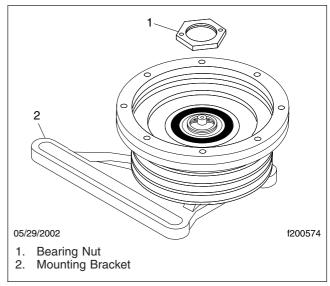


Fig. 7, Bearing Nut Removal and Installation

21. Remove the sheave from the mounting bracket. See **Fig. 8**.

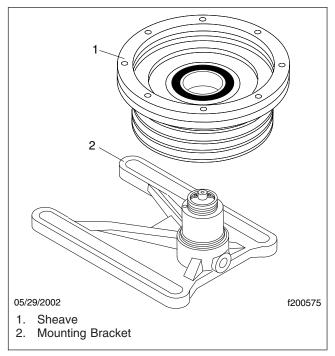


Fig. 8, Removing the Sheave

- 22. If replacing the bearings, support the sheave and press them out.
- 23. Clean and remove any dirt, debris, or corrosion that may be present.
- 24. Remove the air cartridge.
 - 24.1 Remove the retaining ring. See Fig. 9.
 - 24.2 Remove the air cartridge assembly. See Fig. 10.

Assembly

1. If necessary, clean the air cartridge bore in the mounting bracket.

NOTE: The sheave bearings do not require lubrication.

- If replacing the sheave bearings, do the following:
 - 2.1 If equipped with two bearings, assemble the bearings so the markings on their edges line up to form an arrow. See

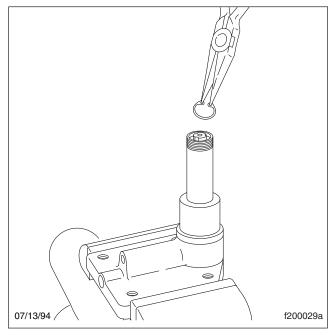


Fig. 9, Retaining Ring Removal and Installation

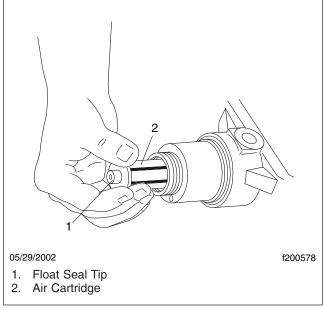


Fig. 10, Removing the Air Cartridge

Fig. 11. It doesn't matter which way the arrow faces when the bearings are installed.

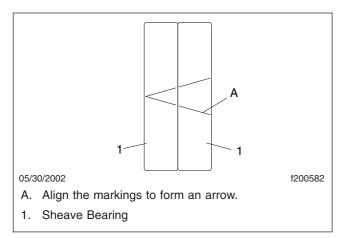


Fig. 11, Aligning the Bearings

IMPORTANT: If the fan clutch uses spacers, be sure to install them between the bearings.

- 2.2 Supporting the sheave, press the new sheave bearings and spacers, if applicable into place. Note the position of the lip inside the sheave.
- 2.3 Slide the sheave onto the mounting bracket. See **Fig. 8**.
- 2.4 Making sure that the bearing nut hex is facing up, install the bearing nut. See Fig. 12. Tighten 130 lbf·ft (176 N·m). See Fig. 7.

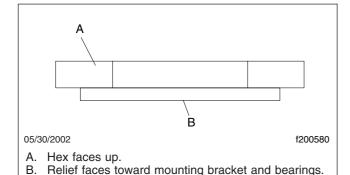


Fig. 12, Correct Bearing Nut Orientation

 Apply O-ring lubricant from the kit to the outside O-rings of the new air cartridge assembly. See Fig. 13.

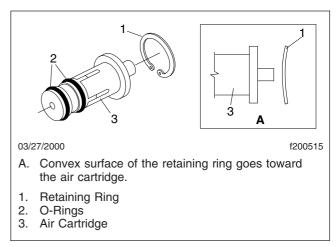
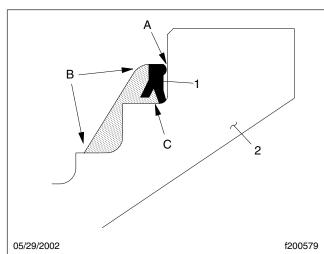


Fig. 13, Installing the Air Cartridge Retaining Ring

- Install the new air cartridge assembly into the mounting bracket.
- 5. Install the retaining ring, making sure the convex surface of the ring is toward the air cartridge. See Fig. 13.
- Using a clean, dry cloth, clean both the float seal tip of the air cartridge and the face seal of the air chamber cap.
- 7. Assemble the air chamber cap and face seal. See **Fig. 6**.

Tighten the face seal 75 to 100 lbf-in (850 to 1130 N·cm).

- 8. Lubricate the O-ring seal with the fresh lubricant from the kit.
- 9. Install the O-ring seal on the air chamber cap. See Fig. 6.
- 10. Carefully set the air chamber cap into the sheave. See **Fig. 6**.
- 11. Install the retaining ring. See Fig. 6.
- 12. Install the air chamber seal into the sheave. Be sure the seal is evenly seated against the side and bottom of the groove surfaces, and the "V" of the seal is facing down. See Fig. 14.
- Lubricate contact surfaces with the fresh lubricant from the kit.



- Seal is seated evenly against side and bottom of groove.
- B. Apply grease only between these areas.
- C. "V" of Seal Facing Down
- 1. Air Chamber Seal
- 2. Sheave

Fig. 14, Correct Installation of Air Chamber Seal (crosssection view)

A WARNING

The new spring housing/piston assembly from the kit has a cage nut installed on it. Do not remove the cage nut. This will cause the spring housing to be forcibly ejected from the piston assembly, which could result in serious injury.

- 14. Carefully set the new spring housing/piston assembly into position. See Fig. 6. Note that the new assembly has a cage nut installed on it.
- Rotate the new spring housing/piston assembly to align the mounting holes with those of the sheave.

IMPORTANT: Handle the new friction liner by the edges to avoid contamination.

- 16. Set the new friction liner from the kit into place, being careful to touch only the edges.
- 17. Using a T27 Torx bit, install the eight Torx-head screws. See **Fig. 4**. Tighten alternately 80 lbf-in (900 N·m).
- Apply a minimum of 80 psi (552 kPa) of clean air to the air inlet.

- 19. Remove the cage nut from the spring housing/ piston assembly.
- 20. Install the new fan mounting disc from kit.



Use care when placing the pry bar onto the fan mounting disc. Make sure it is secure and flat on the surface. Failure to do so make cause the pry bar to slip, which could result in damage to studs or the fan mounting disc.

- 21. Using a suitable wrench, a T55 Torx bit, and a pry bar, tighten the jack bolt (left-hand thread) 100 lbf-ft (136 N·m). Turn the wrench clockwise and push the pry bar counterclockwise.
- 22. Using shop air, actuate the fan clutch and check for correct engagement and disengagement of the fan mounting disc. If there is a problem, it must be corrected before installing the fan clutch onto the engine.
- 23. Check for air leaks at the bleed hole and around the spring housing/piston assembly.
- 24. Install the fan clutch assembly onto the engine. See **Subject 100** for instructions.

Disassembly

NOTE: This procedure involves a minor rebuild of the Horton DriveMaster® fan clutch, using parts from the manufacturer's Seal Kit. If a major rebuild of the fan clutch is needed, see **Subject 110**.

- Remove the fan clutch assembly from the vehicle. For instructions, see Subject 100.
- 2. Put the fan clutch assembly in a vise.
- Connect a shop air hose to the fan clutch air inlet.
- 4. Apply 80 to 120 psi (552 to 827 kPa) to the fan clutch to lift the fan mounting disc off the spring housing/piston assembly.



Use care when placing the pry bar onto the fan mounting disc. Make sure it is secure and flat on the surface. Failure to do so make cause the pry bar to slip, which could result in damage to studs or the fan mounting disc.

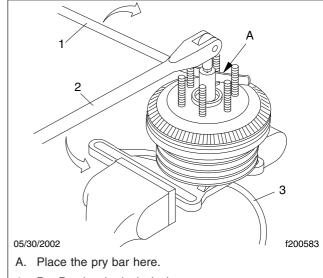
- 5. Using a pry bar, wrench, and a T55 Torx® bit, loosen the jack bolt (left-hand thread) by turning it counterclockwise. See Fig. 1.
- 6. Unscrew the fan mounting disc from the jack bolt. See Fig. 2.
- 7. Inspect the fan mounting disc for wear or damage.

WARNING

Do not disassemble the spring housing from the piston. The interior springs are very strong, and if released could eject the housing with considerable force, possibly resulting in serious injury. Always use the cage nut to hold the spring housing and the piston together.

8. Using a wrench and T55 Torx bit to hold the jack bolt, install the cage nut from the kit onto the jack bolt (left-hand thread). Hand tighten it onto the spring housing.

The cage nut will keep the spring housing and piston together as an assembly. It will also maintain pressure on the internal springs after the



- 1. Pry Bar (push clockwise)
- 2. Torx Bit and Wrench (turn counterclockwise)
- 3. Shop Air Hose (connected to the inlet port)

Fig. 1, Loosening the Jack Bolt

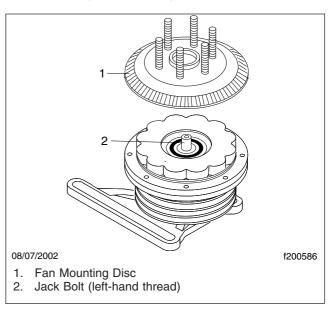


Fig. 2, Fan Mounting Disc Removal and Installation

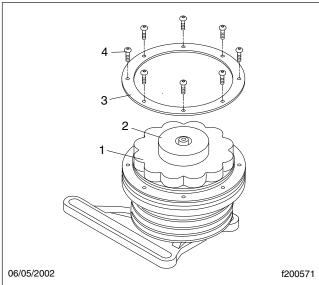
Torx-head screws holding the friction lining in place are removed.

9. Release the air pressure from the fan clutch.

WARNING

Release the air pressure from the fan clutch before removing the friction lining Torx-head screws. Failure to release the air pressure could result in the spring housing/piston assembly being ejected with force, which could result in personal injury.

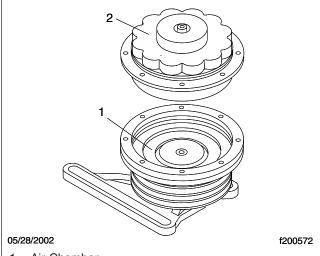
- 10. Using a T27 Torx bit, remove the eight Torx-head screws holding the friction lining in place.
- 11. Remove the friction lining. See Fig. 3.



- Spring Housing/Piston Assembly
- 2. Cage Nut
- Friction Lining
- Torx-Head Screws

Fig. 3, Friction Lining Removal and Installation

- 12. Keeping the cage nut installed and tightened, remove the spring housing/piston assembly. See Fig. 4.
- 13. Remove the air chamber seal. See Fig. 5.
- 14. Examine the inside of the air chamber for signs of moisture and/or contaminants.
- 15. Remove the air chamber cap retaining ring. See Fig. 5.
- 16. Using two small screwdrivers placed 180 degrees apart, gently and evenly pry the air chamber cap out of the sheave.



- Air Chamber
- Spring Housing/Piston Assembly (with cage nut

Fig. 4, Spring Housing/Piston Assembly Removal and Installation

- 17. Remove the O-ring seal from the air chamber cap. See Fig. 5.
- 18. Remove the face seal. See Fig. 5.
- 19. Inspect the face seal for signs of wear. Wear indicates that dirt may exist in the air system.
- Remove the air cartridge.
 - 20.1 Remove the retaining ring. See Fig. 6.
 - 20.2 Remove the air cartridge assembly. See Fig. 7.

Assembly

- 1. Clean the mounting bracket bore if necessary.
- 2. Apply O-ring lubricant from the kit to the outside O-rings of the new air cartridge assembly. See Fig. 8.
- 3. Install the new air cartridge assembly into the mounting bracket.
- 4. Install the retaining ring, making sure the convex surface of the ring is toward the air cartridge. See Fig. 8.
- 5. Using a clean, dry cloth, clean both the float seal tip of the air cartridge and the face seal of the air chamber cap.

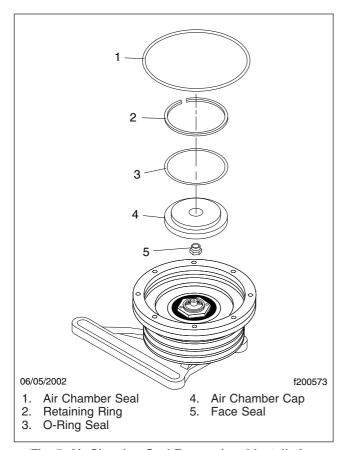


Fig. 5, Air Chamber Seal Removal and Installation

- 6. Assemble the air chamber cap and face seal. See Fig. 5.
 - Tighten the face seal 75 to 100 lbf·in (850 to 1130 N·cm).
- 7. Lubricate the O-ring seal with the fresh lubricant from the kit.
- 8. Install the O-ring seal on the air chamber cap. See Fig. 5.
- 9. Carefully set the air chamber cap into the sheave. See **Fig. 5**.
- 10. Install the retaining ring. See Fig. 5.
- 11. Install the air chamber seal into the sheave. Be sure the seal is evenly seated against the side and bottom of the groove surfaces, and the "V" of the seal is facing down. See Fig. 9.
- Lubricate contact surfaces with the fresh lubricant from the kit.

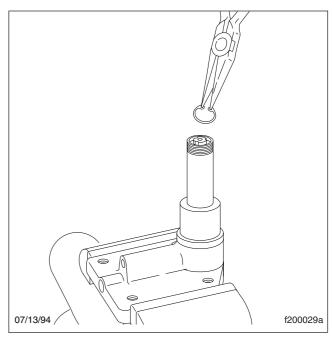


Fig. 6, Retaining Ring Removal and Installation (sheave not shown)

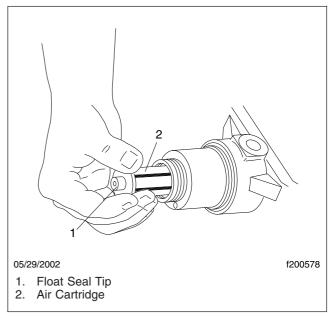
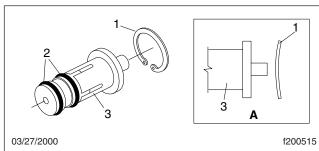
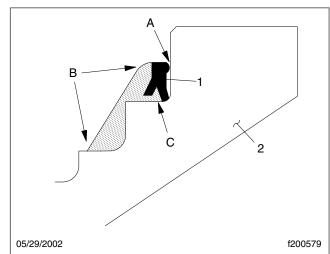


Fig. 7, Removing the Air Cartridge (sheave not shown)



- Convex surface of the retaining ring goes toward the air cartridge.
- 1. Retaining Ring
- 2. O-Rings
- 3. Air Cartridge

Fig. 8, Installing the Air Cartridge Retaining Ring



- Seal is seated evenly against side and bottom of groove.
- B. Apply grease only between these areas.
- C. "V" of Seal Facing Down
- Air Chamber Seal
- 2. Sheave

Fig. 9, Correct Installation of Air Chamber Seal (crosssection view)

A WARNING

The new spring housing/piston assembly from the kit has a cage nut installed on it. Do not remove the cage nut. This will cause the spring housing to be forcibly ejected from the piston assembly, which could result in serious injury.

- Carefully set the new spring housing/piston assembly into position. See Fig. 4. Note that the new assembly has a cage nut installed on it.
- Rotate the new spring housing/piston assembly to align the mounting holes with those of the sheave.
- 15. Set the friction liner from the kit into place, being careful to touch only the edges.
- 16. Using a T27 Torx bit, install the eight Torx-head screws. See **Fig. 3**. Tighten alternately 80 lbf⋅in (900 N⋅cm).
- Apply a minimum of 80 psi (552 kPa) of clean air to the air inlet.
- 18. Remove the cage nut from the spring housing/ piston assembly.

$-oldsymbol{lack}$ CAUTION --

Use care when placing the pry bar onto the fan mounting disc. Make sure it is secure and flat on the surface. Failure to do so make cause the pry bar to slip, which could result in damage to studs or the fan mounting disc.

- 19. Using a suitable wrench, a T55 Torx bit, and a pry bar, tighten the jack bolt (left-hand thread) 100 lbf-ft (136 N·m). Turn the wrench clockwise and the pry bar counterclockwise.
- 20. Using shop air, actuate the fan clutch and check for correct engagement and disengagement of the fan mounting disc. If there is a problem, it must be corrected before installing the fan clutch onto the engine.
- 21. Check for air leaks at the bleed hole and around the spring housing/piston assembly.
- 22. Install the fan clutch assembly onto the engine. See **Subject 100** for instructions.

Troubleshooting

Troubleshooting Tables

Problem—Air Is Leaking from the Fan Clutch

Problem—Air Is Leaking from the Fan Clutch		
Possible Cause Remedy		
The face seal or air cartridge is damaged or worn.	Install a new seal kit.	
The O-ring seals are damaged or worn.	Install a new seal kit.	

Problem—The Fan Clutch Fails to Engage

Problem—The Fan Clutch Fails to Engage		
Possible Cause Remedy		
There's no power to the fan clutch control circuit.	Check all electrical connections, and repair or replace wiring as needed. Check the circuit breaker for the engine fan and repair or replace as needed.	
The engine temperature switch is damaged or an incorrect sensor has been installed.	Make sure the switch is normally open, not normally closed. Replace the switch if it is damaged or if the switch is the wrong type.	
The solenoid valve is malfunctioning.	Replace the solenoid valve.	
The solenoid is not exhausting.	Make sure the solenoid exhaust port is not plugged.	

Problem—The Fan Clutch Does Not Disengage

Problem—The Fan Clutch Does Not Disengage		
Possible Cause	Remedy	
The engine temperature switch is damaged or an incorrect sensor has been installed.	Make sure the switch is normally open, not normally closed. Replace the switch if it is damaged or if the switch is the wrong type.	
A restricted air line doesn't allow air supply to the clutch.	Make sure the air lines are not pinched or plugged. Repair the air lines as needed.	
The fan clutch is leaking.	Install a new seal kit.	
The air supply to the fan clutch is restricted.	Make sure the fan clutch air lines are not leaking or pinched. Repair the lines as needed.	
The piston is seized due to contamination or dry seals.	Clean the air supply. Do a major rebuild.	

Problem—The Fan Clutch Cycles Frequently

Problem—The Fan Clutch Cycles Frequently		
Possible Cause Remedy		
The fan clutch control circuit has a loose connection or is poorly grounded.	Check all wiring connections, and repair the circuit as needed. Check the circuit breaker for the engine fan and repair or replace as needed.	
The temperature control settings are incorrect.	Check the fan clutch control setting of the temperature switch, according to the engine installed in the vehicle. Repair or replace the temperature switch as needed.	

Troubleshooting

Problem—The Fan Clutch Cycles Frequently		
Possible Cause	Remedy	
The fan cycling switch at the receiver-dryer is set too low.	Check the switch at the receiver-dryer, and if needed, replace the switch with a switch with a higher setting. Check the ACPU switch and unit.	
There is an air restriction in front of the fan clutch.	Check for incorrect radiator shutter operation, winterfronts, or any other air restrictions.	
The engine temperature is too high.	Check the programmable engine control parameters, and reprogram as needed.	
The temperature switch is malfunctioning.	Replace the temperature switch.	

Problem—The Fan Clutch Engages, But the Engine Still Overheats

Problem—The Fan Clutch Engages, But the Engine Still Overheats		
Possible Cause Remedy		
There is an air restriction in front of the fan clutch.	Check for incorrect radiator shutter operation, winterfronts, or any other air restrictions.	
There is a problem somewhere else in the cooling system.	Refer to the cooling system troubleshooting section, Section 20.00.	

Specifications

Horton DriveMaster® Repair Kits			
Kit Description * Part Number When Used		When Used	
Super Kit HOR994347 Fan Clutch Major Rebuild			
Seal Kit HOR994346 Replacing Seals and Air Cartridge			
Friction Disc Kit	HOR994348	Replacing Fan Mounting Disc and Friction Lining	
Friction Liner Kit HOR994349 Replacing Friction Lining Only			

^{*} All kits are available from the PDCs.

Table 1, Horton DriveMaster Repair Kits

Torque Values				
Description	Torque			
Description	lbf⋅in (N⋅cm)	lbf⋅ft (N⋅m)		
Friction Lining Screws	80 (900)	_		
Face Seal	75 to 100 (850 to 1130)	_		
Bearing Nut	_	130 (176)		
Jack Bolt	_	100 (136)		

Table 2, Torque Values

Specifications

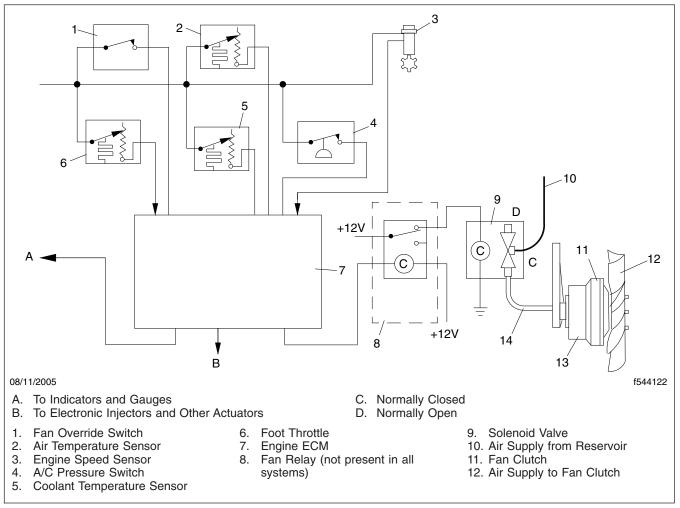


Fig. 1, Fan Clutch Schematic (engine ECM controlled)

Contents

Subject	Subject Number
General Information	
Service Operations	
Fan Clutch Removal and Installation	
Fan Clutch Minor Rebuild	
Fan Clutch Relining	
Troubleshooting	300
Specifications	400

General Information

General Information

The fan clutch is a temperature-controlled, airoperated clutch for the engine cooling fan. It is spring engaged, and controls the engine temperature by engaging or disengaging the fan.

When the coolant temperature is below a specified range, air pressure keeps the fan disengaged to save engine power. When the coolant temperature rises above the specified range, air pressure to the fan clutch is cut off and internal spring pressure engages the fan.

Air pressure to the fan clutch is controlled by a solenoid valve; the solenoid valve is controlled by a temperature switch installed in the thermostat housing. The temperature switch is connected to the engine MCM, which controls the solenoid valve. When you start a cold engine, the solenoid valve allows air pressure to the fan clutch and the clutch remains disengaged. When the coolant temperature rises to the temperature switch setting, the switch provides power to the solenoid valve and the valve cuts off compressed air to engage the fan.

On vehicles with air conditioning, the fan clutch solenoid valve is connected to a fan cycling switch at the receiver-drier. If the refrigerant pressure exceeds the setting of the fan cycling switch, the switch supplies power to the solenoid valve, which cuts off air to the fan clutch, engaging the fan.

Fan Clutch Removal and Installation

Removal

- Park the vehicle, apply the parking brakes, and chock the tires.
- 2. Tilt the hood.



Wear safety goggles when draining the air system or disconnecting an air line because dirt and sludge could fly out at high speeds. Don't direct the airstreams at anyone. Do not disconnect pressurized air lines, as they may whip as air escapes. Failure to take all necessary precautions could result in personal injury.

- 3. Drain the air tanks.
- 4. Disconnect the air line from the fan clutch.
- 5. Remove the upper fan shroud as follows.
 - 5.1 Place alignment marks on the upper and lower fan shrouds, and mark the shroudto-channel positions, so the shroud can be installed in the same position on the radiator.
 - 5.2 Remove the four fasteners that connect the upper and lower fan shrouds.
 - 5.3 Remove the fasteners that hold the upper fan shrouds to the radiator.
 - 5.4 Remove the upper fan shroud from the vehicle.
- 6. Remove the fasteners that hold the fan to the fan clutch, then remove the fan.



If the fan clutch engages during the next step, it could cause personal injury. Keep the fan clutch disengaged throughout this procedure by maintaining between 90 and 120 psi (620 and 827 kPa) of air pressure.

- 7. Align the access holes in the fan clutch with the allen screws on the fan hub. See Fig. 1.
 - 7.1 Using shop air and a suitable nozzle attachment, apply between 90 and 120 psi (620 and 827 kPa) of air pressure to the fan clutch to disengage the clutch.
 - 7.2 Line up the access holes.

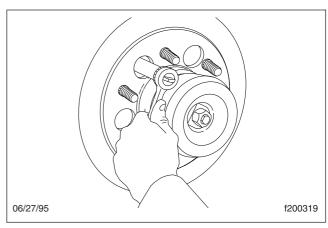


Fig. 1, Line Up the Access Holes

- 8. Remove the air pressure from the fan clutch, and allow the fan to engage.
- 9. Remove the allen screws holding the fan clutch to the fan hub.
- Remove the fan clutch from the fan clutch hub. It may be necessary to gently pry the clutch from the hub.

Installation

IMPORTANT: A new coupler must be used when installing the clutch onto the hub.

- 1. Install the fan clutch onto the fan clutch hub.
 - 1.1 Install a new coupler onto the fan hub.
 - 1.2 Position the fan clutch onto the fan hub, then push it toward the rear of the vehicle and rotate the clutch until the flats of the coupler engage the fan clutch.
 - 1.3 Line up the access holes in the clutch with the holes for the allen screws in the clutch hub.
 - 1.4 Install the allen screws, and tighten them 45 lbf-ft (61 N·m).
- 2. Install the fan.
- 3. Connect the air line to the fan clutch.
- 4. Position the upper fan shroud on the radiator; align the marks, then install the fasteners that hold it to the radiator and the lower fan shroud.

Fan Clutch Removal and Installation

5. Connect the left-side hose to the charge air cooler.

Special Tools

IMPORTANT: Special tools are are recommended, but not required for this procedure. See **Table 1** for the special tool set.

Special Tools			
Description Part Number Order From		Order From	
		Wright Brothers Enterprises	
Support and	1090- 00000-02	8171 Hibma	
Compressor (see Fig. 1)		Marion, MI 49665	
		Telephone: 231-825-2939	

Table 1, Special Tools

Rebuild

- Park the vehicle, apply the parking brakes, and chock the tires.
- Remove the fan clutch from the vehicle. For instructions, refer to Subject 100.

– NOTICE –

When caging and compressing the engagement spring of the fan clutch, depress the clutch shaft only enough to relieve the pressure on the retaining plates (about 1/16-inch, or 1.5 mm). Applying additional force after the clutch shaft bottoms in the housing will damage the housing and render it unserviceable.

NOTE: There are two methods of caging the engagement spring. One uses the special tools and a press. The other uses carriage bolts, washers, and wingnuts. Either method is effective.

3. Cage the engagement spring.

If using the special support and compressor tools, place the fan clutch in a press to cage the engagement spring. See Fig. 2.

If using the optional method of caging the engagement spring, do the following:

3.1 With the access holes in the housing assembly aligned with those in the shaft as-

- sembly, install two 3-1/2-inch (89-mm) long carriage bolts and suitable washers on opposite sides of the clutch assembly.
- 3.2 On the shaft assembly side, install about a 1/2-inch (13-mm) thickness of washers onto each carriage bolt.
- 3.3 Install a wingnut on the end of each carriage bolt and tighten the wingnuts evenly until the engagement spring is caged.
- 4. Remove the lining retaining plates and the lining. See Fig. 2 and Fig. 3.

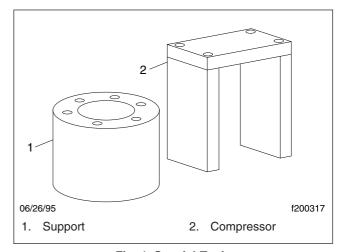


Fig. 1, Special Tools

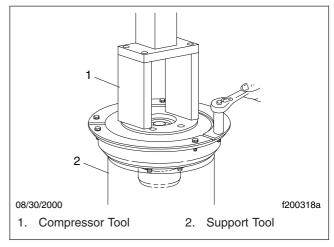
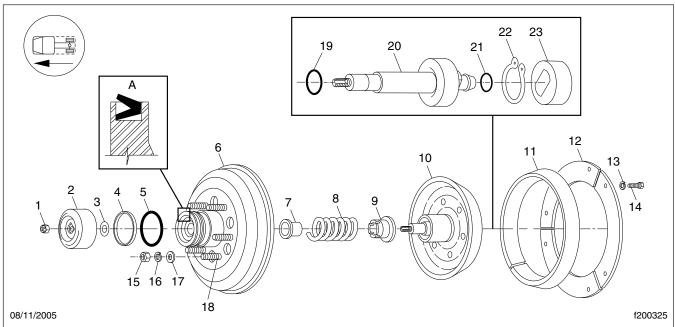


Fig. 2, Caging the Engagement Spring and Removing the Lining Retaining Plates



- A. If a lip seal is used, install it so that it faces away from the fan studs.
- Cylinder Nut
- 2. Cylinder Assembly
- 3. Piston Rod Seal Washer
- 4. Lip Seal (may be O-Ring)
- Dust Seal
- 6. Housing Assembly
- 7. Engagement Spring End Cap
- 8. Engagement Spring

- 9. Engagement Spring Carrier
- 10. Shaft Assembly
- 11. Lining
- 12. Lining Retaining Plates
- 13. Lockwasher
- 14. Screw
- 15. Fan Nut
- 16. Lockwasher

- 17. Flatwasher
- 18. Fan Stud
- 19. O-Ring
- 20. Piston Rod Assembly
- 21. O-Ring
- 22. Snap Ring
- 23. Coupling

Fig. 3, Kysor K26RA Fan Clutch (exploded view)

NOTICE -

Do not press on the cylinder during this step, or the cylinder will be damaged. Use a 5/8-inch wrench as shown in Fig. 4 on the piston rod flats.

- If applicable, turn the clutch over in the press, and use the special compressor tool to cage the engagement spring while removing the cylinder nut and cylinder. See Fig. 4.
- 6. Inspect the fan clutch. See Fig. 3
 - 6.1 Inspect the two surfaces where the lining rides.
 - 6.2 Inspect the needle bearing race on the
 - 6.3 Inspect the needle bearings inside the clutch housing.

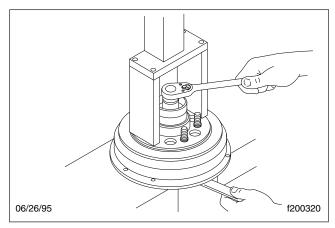


Fig. 4, Removing the Cylinder Nut and Cylinder

6.4 Inspect the piston bearing by rotating the piston.

7. If you find cracking or scoring on any surface, or if the bearings are rough, loose, or missing, replace the fan clutch.

NOTE: If you find metal particles in the existing grease, replace the fan clutch or contact Kysor for the training needed to perform a major fan clutch rebuild. Kysor will not provide parts for a major rebuild until the technician has completed rebuild training provided by Kysor.

IMPORTANT: Do not wash the clutch parts in solvent.

- 8. Using Fig. 3 as a reference, lubricate the following rebuild parts with lubricant supplied with the rebuild kit (if the lubricant is unavailable, use one of the approved lubricants listed in Specifications, 400):
 - The piston seal (pack the seal groove also)
 - The dust seal (pack the seal groove also)
 - The needle bearings inside the housing
 - The inside of the engagement spring
 - The outside of the piston rod assembly
 - The inside of the piston rod assembly
 - The inside of the cylinder assembly
 - · Pack the lip of the grease seal

$-\!\!-\!\!$ notice -

When caging and compressing the engagement spring of the fan clutch, depress the clutch shaft only enough to relieve the pressure on the retaining plates (about 1/16-inch, or 1.5 mm). Applying additional force after the clutch shaft bottoms in the housing will damage the housing and render it unserviceable.

IMPORTANT: When caging the engagment spring, compress the clutch shaft only 1/16-inch (1.5 mm).

 Assemble the fan clutch parts according to Fig. 3. Using either the special tools and a press, or carriage bolts, washers, and wingnuts, cage the engagement spring when installing the cylinder and lining. Be careful to depress the clutch shaft only 1/16-inch (1.5 mm).

The piston rod seal washer is the last item to install before the cylinder goes on. See Fig. 5.

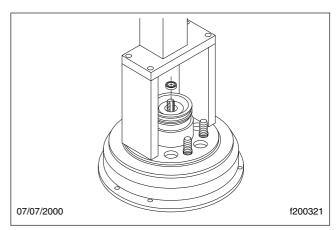


Fig. 5, Installing the Piston Rod Seal Washer

- 10. Tighten the cylinder nut 84 lbf·in (940 N·cm).
- 11. Tighten the lining screws 30 lbf·in (340 N·cm).
- 12. As applicable, remove the fan clutch from the press or remove the carriage bolts, washers, and wing nuts.
- 13. Check the front-to-rear travel of the fan clutch. For instructions, refer to **Group 20** in the *108SD* and *114SD Maintenance Manual*.
- Install the fan clutch on the engine. For instructions, refer to Subject 100.

Fan Clutch Relining

Relining

IMPORTANT: Premature wearing of the fan clutch lining is due to either insufficient air pressure necessary to fully disengage the clutch (allowing the clutch to remain partially engaged, thus increasing wear), or a problem in the control circuit for the fan. Before putting the fan clutch back in service, check the fan control and air supply systems and make any necessary repairs.

 Park the vehicle on a level surface, apply the parking brake, and shut down the engine. Chock the tires.

WARNING

If the fan clutch engages during the next step, it could cause personal injury. Keep the fan clutch disengaged throughout this procedure by maintaining between 90 and 120 psi (620 and 827 kPa) of air pressure.

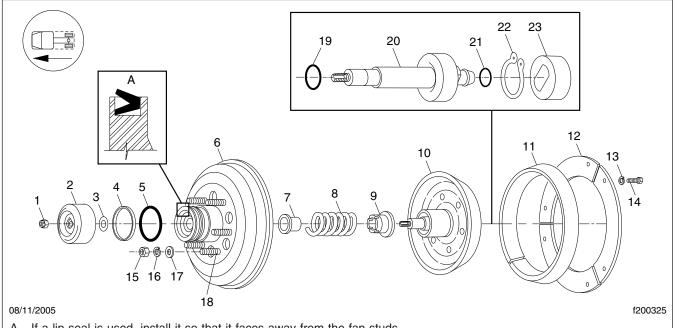
- 2. Bleed all the air from the primary and secondary tanks.
- 3. Disconnect the air line from the fan drive, and apply 90 to 110 psi (620 to 760 kPa) shop air pressure to the fan drive.
- 4. Remove the six lining plate screws, and remove the three lining plates. See **Fig. 1**.
- 5. Remove the old lining. If the lining sticks, use a hammer and a screwdriver to free it by tapping on the dividing cut in the lining.
- Inspect the clutch shaft. If lining residue is present, or if the surface appears glazed over (non-metallic), temporarily release the air pressure from the clutch to allow shaft to protrude, and use a ScotchBrite to break the glaze.

NOTE: Some applications may be too tight to spread the lining and slip it over the pulley. If necessary, the lining can be cut in half with a hacksaw for installation.

- 7. Apply air pressure to the clutch again, and install the new lining. See **Fig. 2**.
- 8. Install the new lining plates. Tighten the screws 30 lbf·in (340 N·cm).

- 9. Remove the air pressure from the fan clutch, and allow the fan to engage.
- Disconnect the shop air, and connect the air line to the fan drive.

Fan Clutch Relining



- A. If a lip seal is used, install it so that it faces away from the fan studs.
- Cylinder Nut
- Cylinder Assembly
- 3. Piston Rod Seal Washer
- Lip Seal (may be O-Ring) 4.
- 5. **Dust Seal**
- Housing Assembly
- Engagement Spring End Cap
- Engagement Spring

- 9. Engagement Spring Carrier
- 10. Shaft Assembly
- 11. Lining
- 12. Lining Retaining Plates
- 13. Lockwasher
- 14. Screw
- 15. Fan Nut
- 16. Lockwasher

- 17. Flatwasher
- 18. Fan Stud
- 19. O-Ring
- 20. Piston Rod Assembly
- 21. O-Ring
- 22. Snap Ring
- 23. Coupling

Fig. 1, Kysor K26RA Fan Clutch (exploded view)

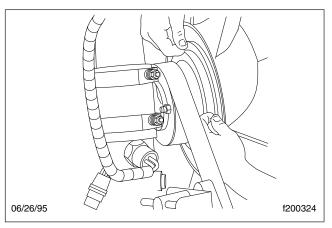


Fig. 2, Removing the Lining Plates

Troubleshooting

Fan Clutch Rock Runout Measurement

NOTE: Do not try to measure the fan rock runout at the end of the fan blade. An inaccurate reading will result.

- Park the vehicle on a level surface, shut down the engine, and set parking brake. Chock the tires.
- 2. Position the indicator on a flat surface near the outside diameter (OD) of the clutch hub section of the fan as shown in Fig. 1.

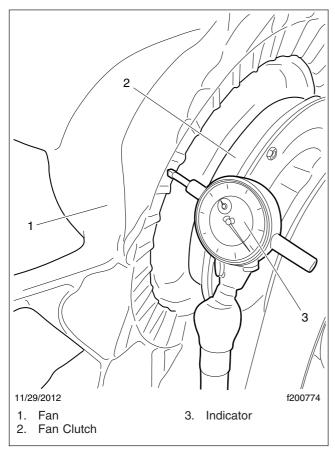


Fig. 1, Positioning the Indicator

- 3. Drain the air from the air system.
- 4. Disconnect the air line to the fan clutch.

- 5. Disengage the clutch. Apply, and maintain, 90 to 120 psi (620 to 830 kPa) shop air to the fan clutch for the test.
- 6. Grasp the fan at the hub and gently rock the fan fore and aft. See **Fig. 2**.

The total indicator reading should not exceed 0.050 in (1.27 mm).

If reading is greater than 0.050 in (1.27 mm), replace the fan clutch. For instructions, see **Subject 100**.

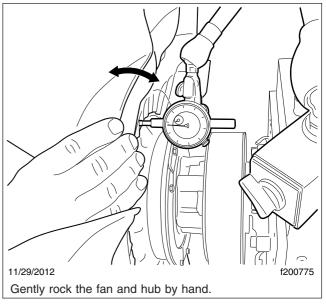


Fig. 2, Checking the Rock Runout Measurement

- 7. Remove the indicator.
- 8. Connect the air line to the fan clutch.
- 9. Pressurize the system, and check for leaks. Repair as needed.

Specifications

If the lubricant that comes with the rebuild kit for the Kysor K26RA fan clutch is unavailable, use one of the following approved lubricants:

- Aeroshell 5
- Shell Alvania R3

- Chevron SR12
- Amoco Rykon Premium #2EP
- Texaco RB Premium

Kysor K26RA Fan Clutch Torques					
Description	To	Torque			
	lbf⋅ft (N⋅m)	lbf⋅in (N⋅cm)			
Clutch-to-Hub Fasteners	45 (61)	_			
Fan-to-Clutch Fasteners	26 (35)	_			
Front Piston Nut	_	84 (950)			
Lining Plate Screws	_	30 (340)			

Table 1, Kysor K26RA Fan Clutch Torques