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Cooling System Troubleshooting 20.00

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General Description

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 coolant plumbing for your vehicle, refer to the applicable figure from the list below:

- For a Cummins B Series engine, **see Fig. 1.**
- For a Mercedes-Benz OM 366LA engine, **see Fig. 2.**
- For a Detroit Diesel Series 50 engine, **see Fig. 3.**
- For a Dodge Magnum V-8 engine, **see Fig. 4.**
- For a Caterpillar CFE Series engine, **see Fig. 5.**
- For a Cummins M11 engine, **see Fig. 6.**

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, 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.

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.

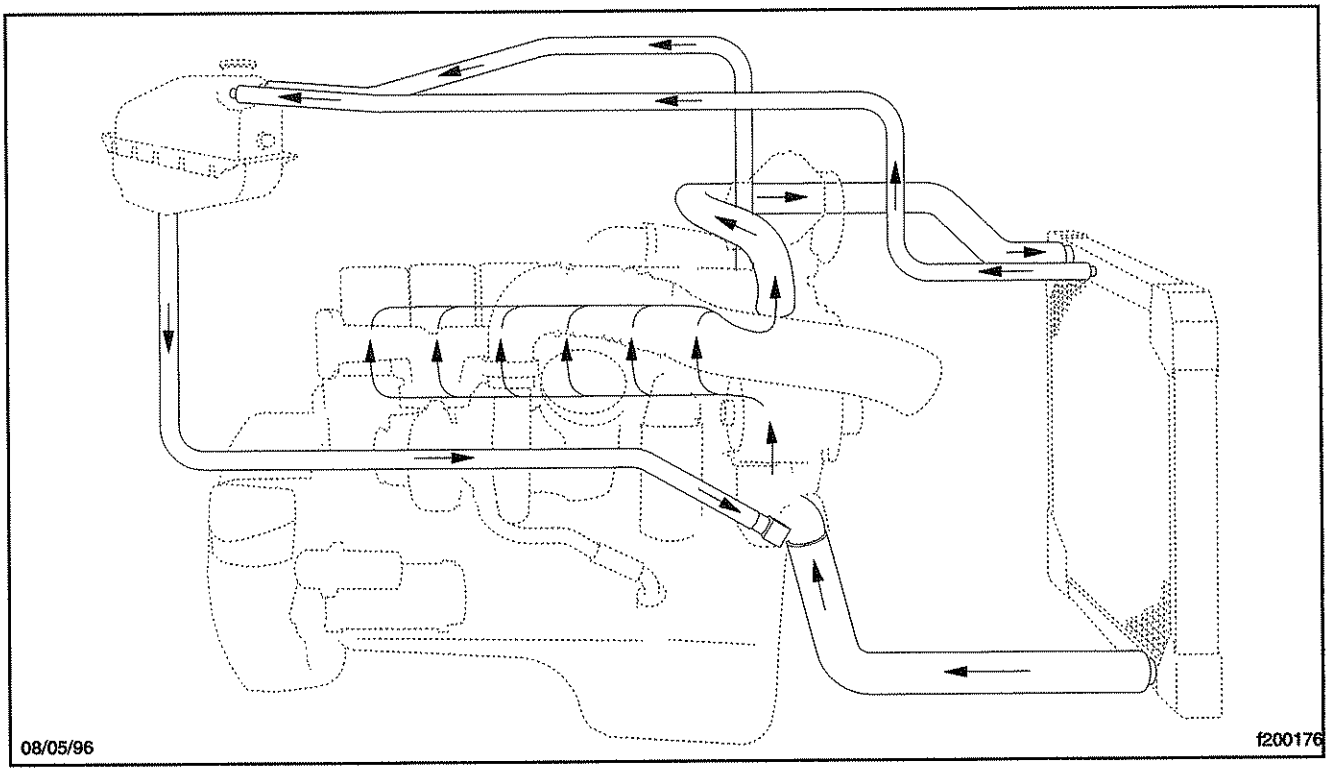


Fig. 1, Coolant Plumbing for a Cummins B Series Engine

General Description

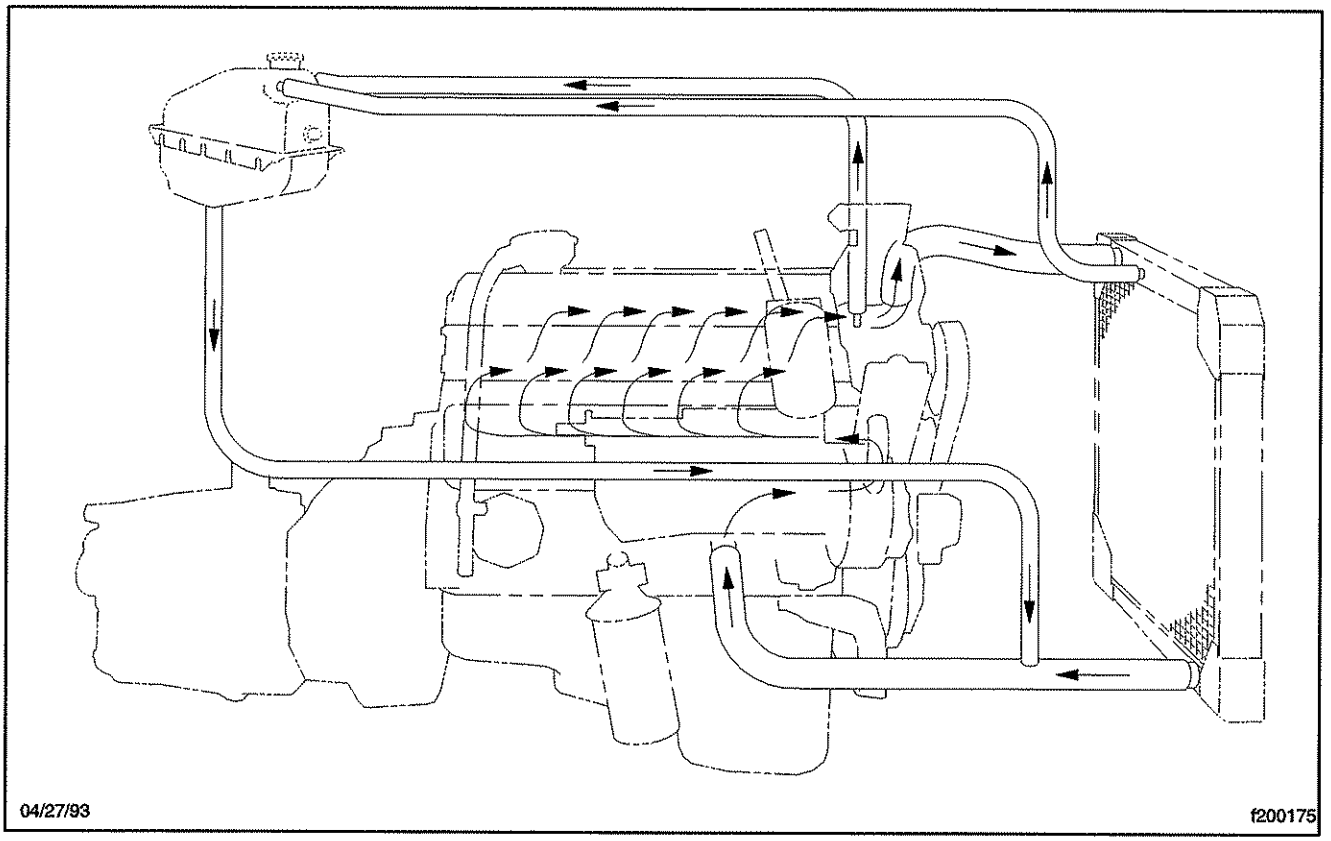


Fig. 2, Coolant Plumbing for a Mercedes-Benz OM 366LA Engine

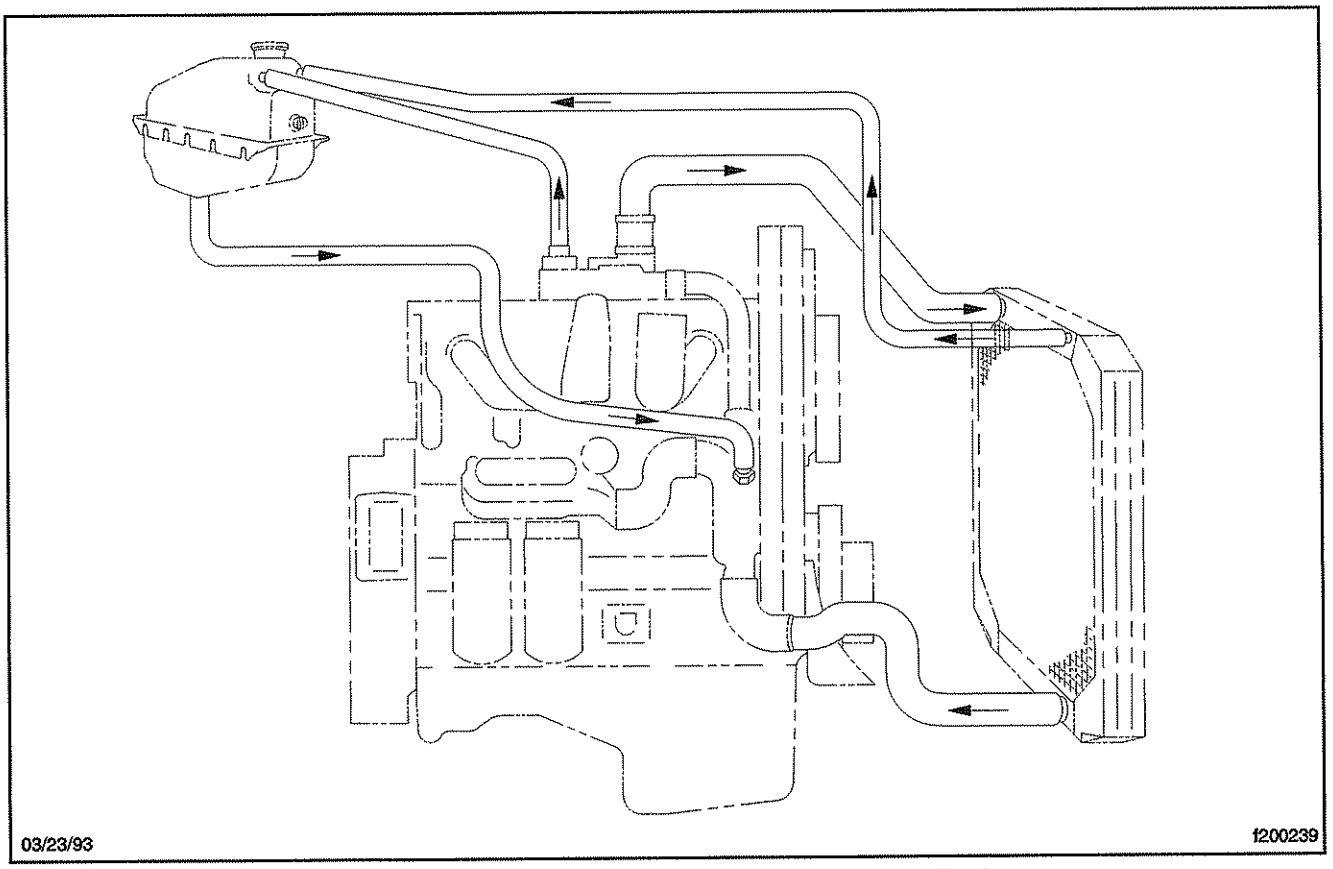
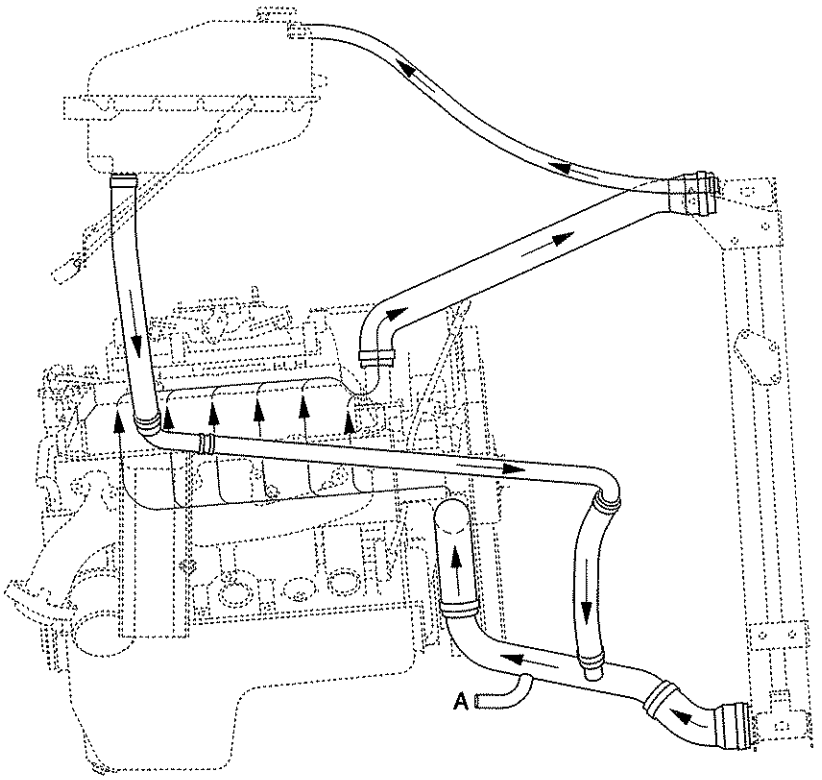


Fig. 3, Coolant Plumbing for a Detroit Diesel Series 50 Engine

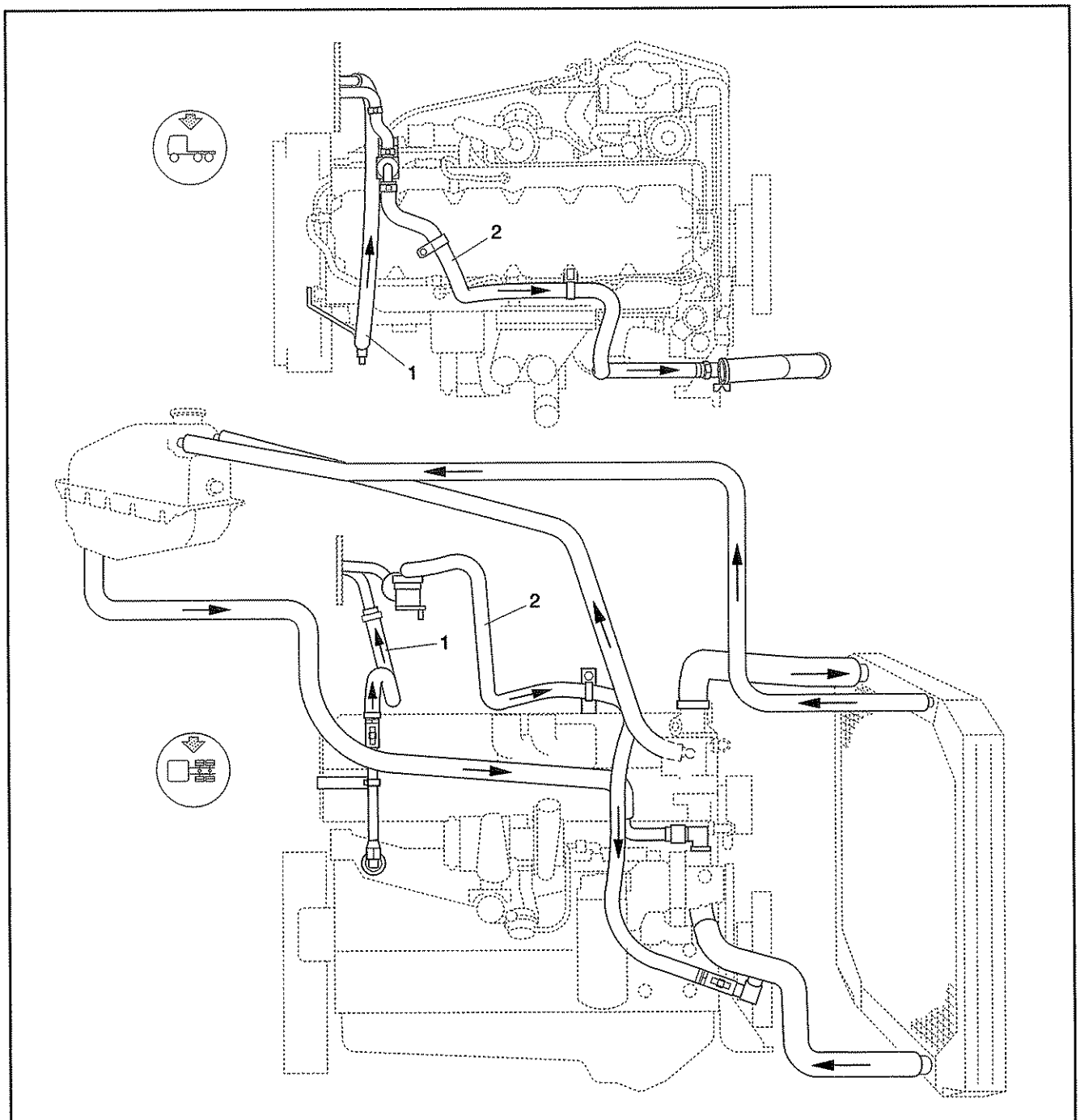
General Description



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A. To the optional engine oil cooler.

Fig. 4, Coolant Plumbing for a Dodge Magnum Engine

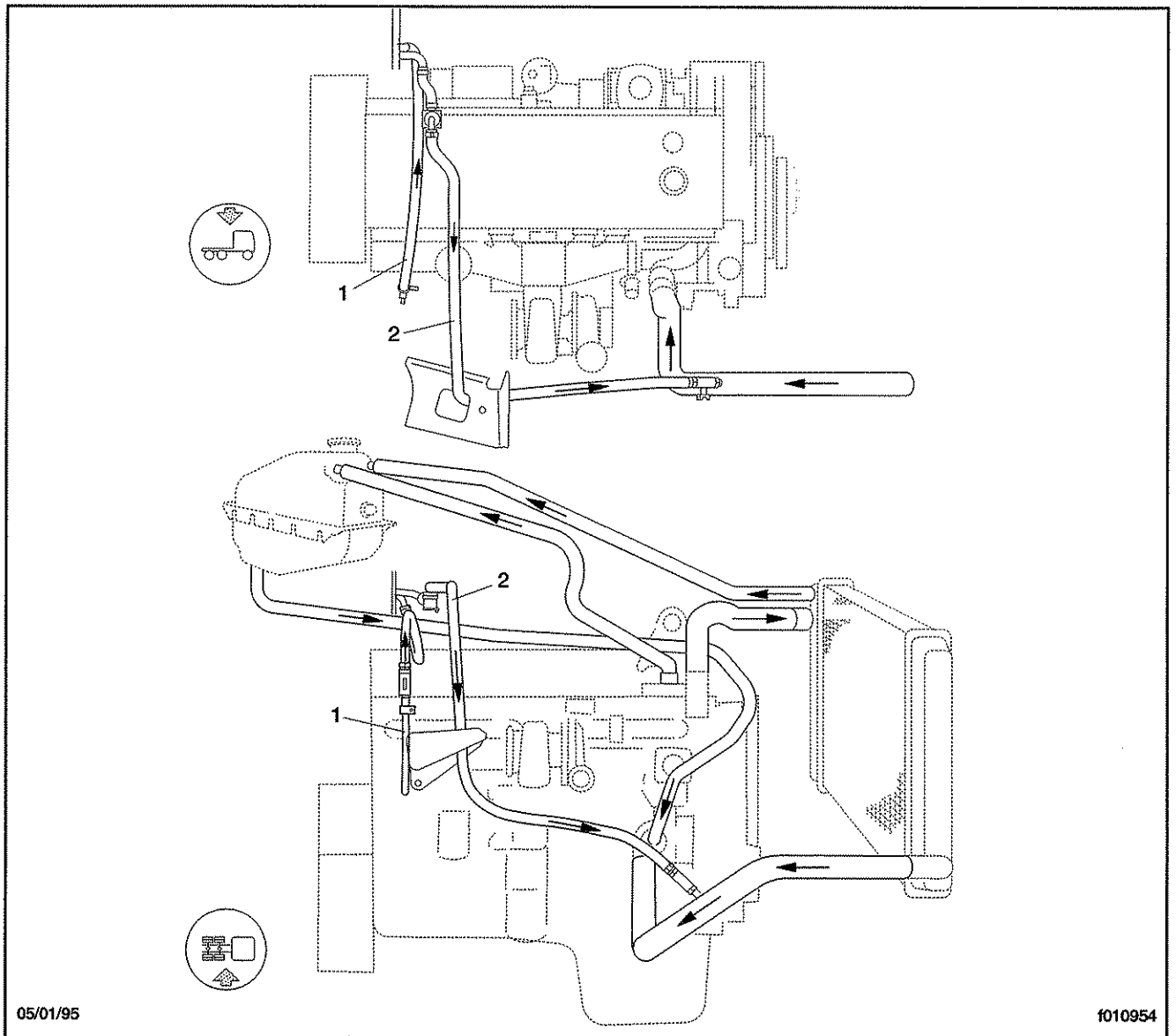


NOTE: Optional heater hose shut-off valves shown here.

1. Heater Supply Hose
2. Heater Return Hose

Fig. 5, Coolant Plumbing for a Caterpillar CFE Series Engine

General Description



NOTE: Optional heater hose shut-off valves shown here.

1. Heater Supply Hose
2. Heater Return Hose

Fig. 6, Coolant Plumbing for a Cummins M11 Engine

Possible causes of abnormally high or low coolant temperatures are listed below. For repairs, refer to other sections of this manual or to the engine and component manufacturer's service publications.

This subject contains the following troubleshooting tables:

- Coolant Temperature Above Normal
- Coolant Temperature Below Normal

Problem—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. Refer to the vehicle maintenance manual for coolant specifications.
The temperature gauge is not working.	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.
The radiator, aftercooler, or condenser fins are clogged.	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.
A radiator hose is collapsed or plugged.	Replace the hose(s).
A fan belt or water pump belt is loose.	Adjust belt tension.
The cooling fan shroud is damaged.	Repair or replace the shroud.
The radiator cap is incorrect or malfunctioning.	Make sure the correct radiator cap is installed. If the cap does not hold the correct pressure, replace it.
The viscous fan drive is 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.
The engine oil level is incorrect.	Fill to the high (H) mark on the dipstick.
There is too much antifreeze in the system.	Clean and flush the cooling system. Refill the system with the correct mixture of antifreeze and water.
The thermostat is incorrect or inoperative.	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.
The water pump is not working correctly.	Repair or replace the water pump.

Troubleshooting

Possible Cause	Remedy
The radiator core is internally plugged or damaged.	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 are entering the cooling system.	Check the cylinder heads, head gaskets, cylinder liners, and aftercooler for leaks. Repair or replace parts, as necessary.
The aftercooler is internally plugged or damaged.	Repair or replace the aftercooler.
The oil cooler is internally plugged or damaged.	Repair or replace the oil cooler.
The engine is receiving too much fuel.	Refer to the engine manufacturer's fuel delivery system adjustment procedures.
The wrong replacement fan was installed.	Install the correct fan.
There is exhaust blockage.	Remove the blockage.
Coolant is frozen in the radiator due to subfreezing temperatures.	Use the proper antifreeze-to-water ratio needed for winter temperatures.

Problem—Coolant Temperature Below Normal

Possible Cause	Remedy
The temperature gauge is not working.	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.
The viscous fan drive operates continuously.	Refer to the viscous fan clutch section in this group for fan clutch inspection procedures and operation tests. Replace the fan drive if necessary.
The thermostat is incorrect or inoperative.	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.

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General Description

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 cap. **See Fig. 1, Fig. 2, Fig. 3, or Fig. 4.**

The surge tank provides extra 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 extra space in 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.

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

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

- 695 square inches
- 720 square inches
- 850 square inches
- 1000 square inches
- 1200 square inches

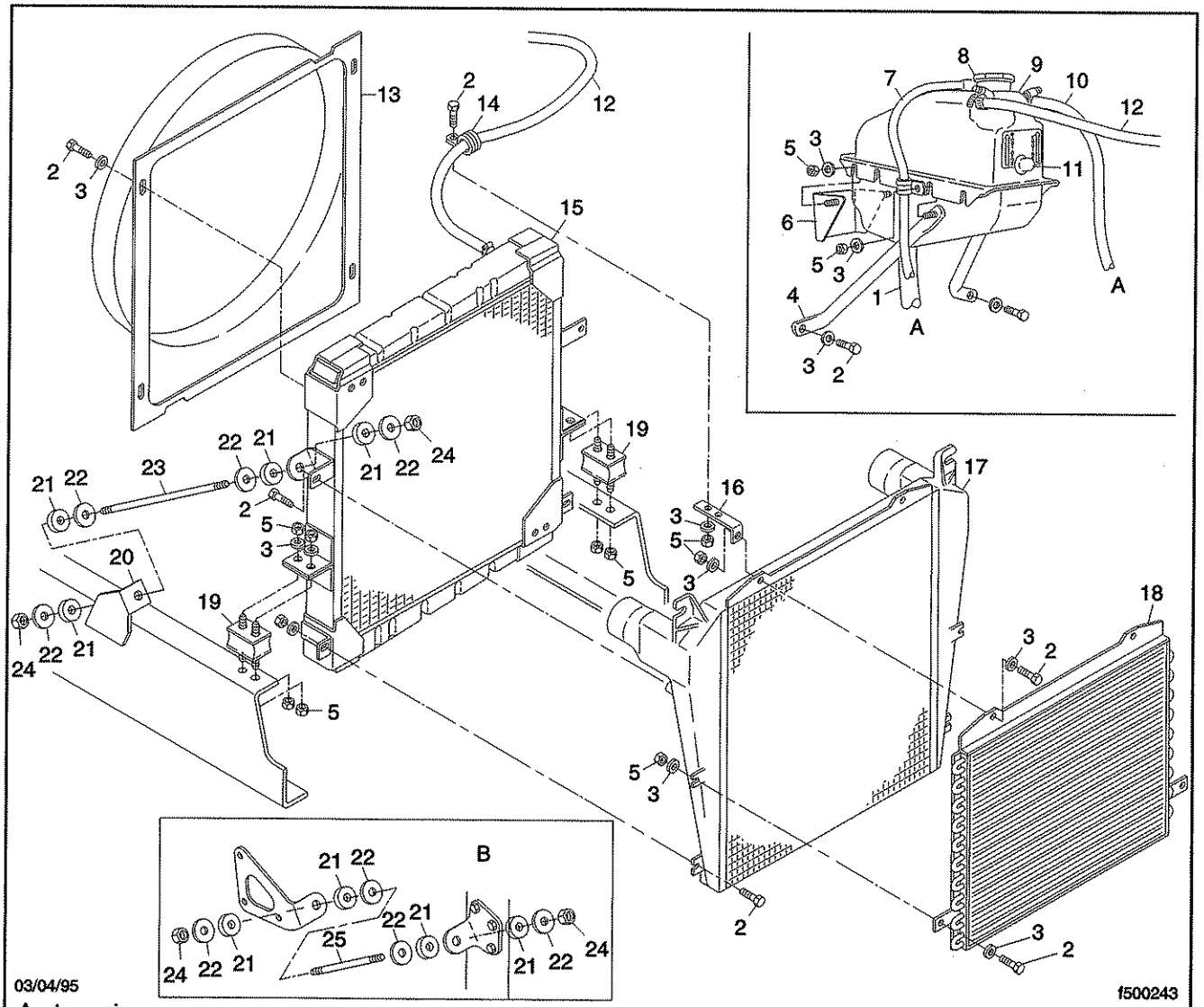
The core of the smallest radiator is soldered to brass top and bottom tanks, and the tanks and radiator core are held in steel side channels that mount on the frame rails. **See Fig. 5.**

The larger radiators use glass-filled nylon top and bottom or side tanks. The edges of the radiator core header are compressed in a "dimple wave lock" crimp (**see Fig. 6**) that holds the tanks on the radiator core, and the tanks and core are held in steel channels that mount on the frame rails. On the largest radiators, with 850, 1000, or 1200 square inches of front area, the radiator is also secured by brace rods 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.

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

The surge tank cap (**Fig. 1, Fig. 2, Fig. 3,** or **Fig. 4**) limits system pressure to about 9 kPa (62 psi), which raises the boiling point of the coolant. If the cooling system overheats, excess coolant is released through the overflow tube.

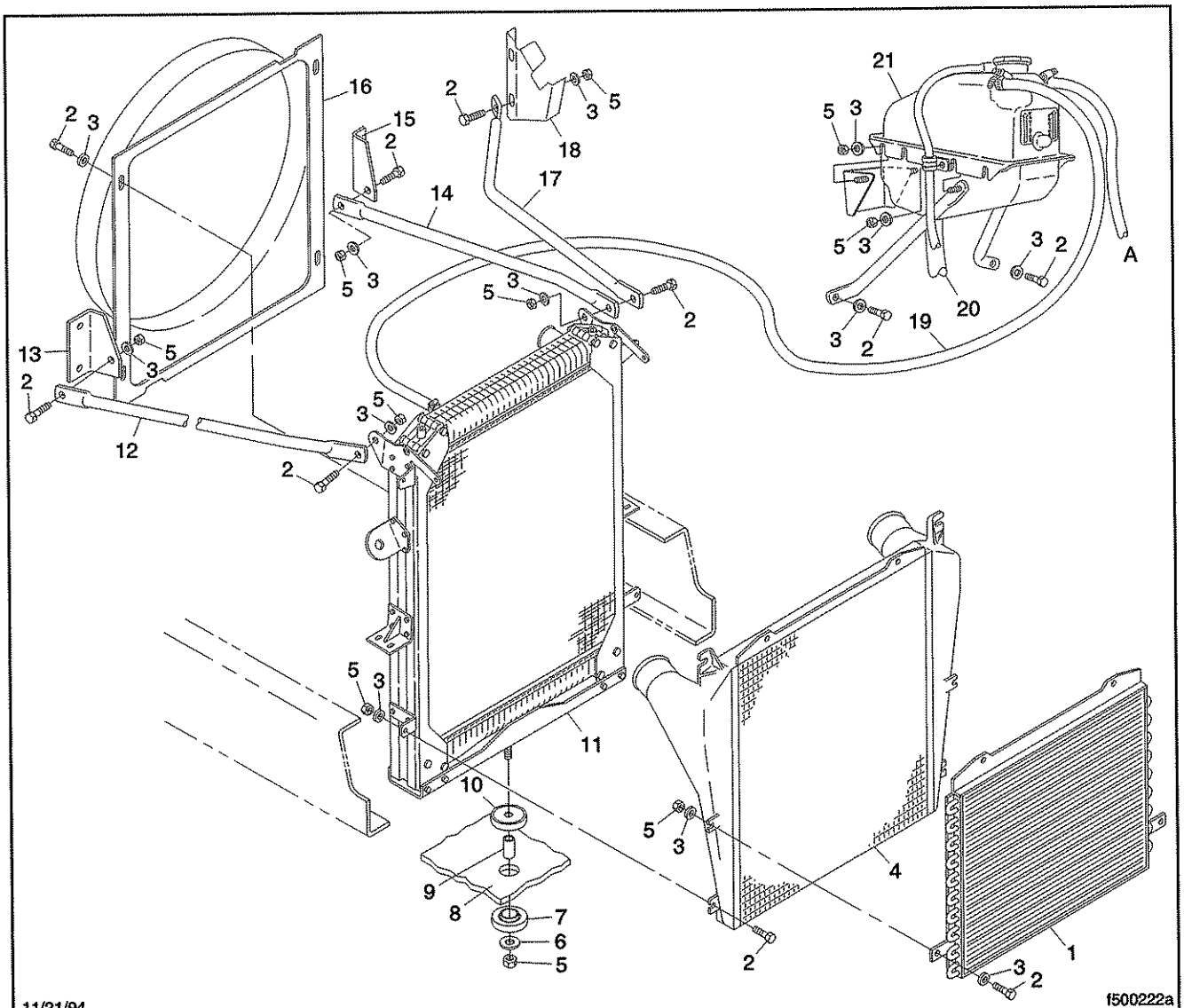
General Description



A. to engine
B. Right-Side Strut Installation, Caterpillar CFE Engines

1. Fill Hose
2. Bolt
3. Washer
4. Surge Tank Strut
5. Nut
6. Surge Tank Mounting Bracket
7. Surge Tank Overflow Tube
8. Surge Tank Cap
9. Surge Tank
10. Engine Vent Hose
11. Surge Tank Sight Glass
12. Radiator Vent Hose
13. Fan Shroud
14. Hose Cushion Clamp
15. Radiator
16. Stand-off Bracket
17. Aftercooler
18. Condensor
19. Radiator Mounting Stud
20. Radiator Strut Bracket
21. Radiator Strut Isolator
22. Hardened Washer
23. Radiator Strut
24. Radiator Strut Nut
25. Shortened Right-Side Strut, Used with Caterpillar CFE Engines

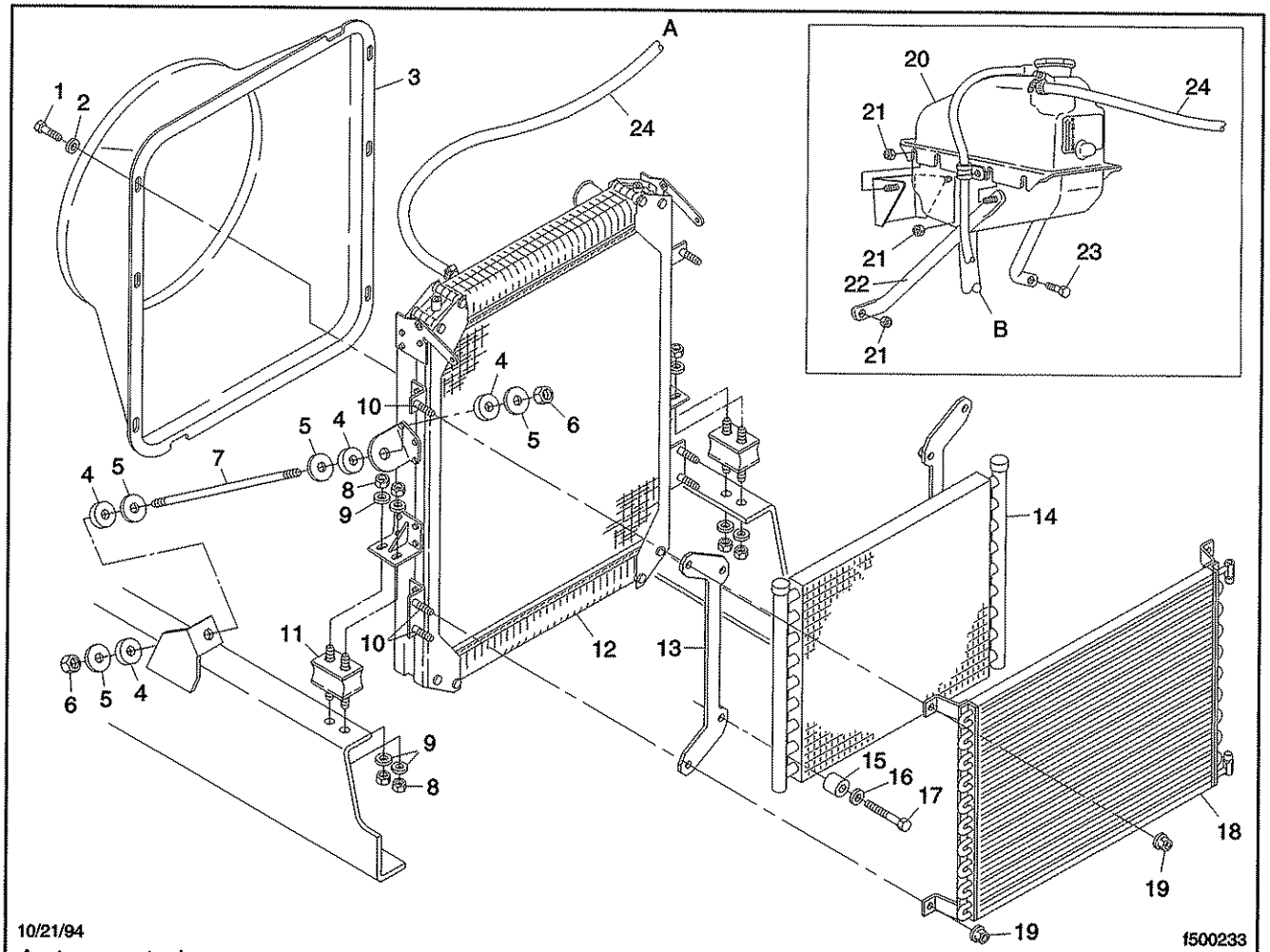
Fig. 1, Radiator Installation for Caterpillar, Cummins B and C series, and Mercedes-Benz Engines



A. to engine
1. Condensor
2. Bolt
3. Washer
4. Aftercooler
5. Nut
6. Washer
7. Lower Radiator Isolator
8. Radiator Underslung Support
9. Spacer Tube
10. Radiator Upper Isolator
11. Radiator
12. Radiator Left Brace Rod
13. Left Brace Rod Bracket
14. Radiator Center Brace Rod
15. Center Brace Rod Bracket
16. Fan Shroud
17. Radiator Right Brace Rod
18. Right Brace Rod Bracket
19. Radiator Vent Hose
20. Fill Hose
21. Surge Tank

Fig. 2, Radiator Installation for Detroit Diesel Engines

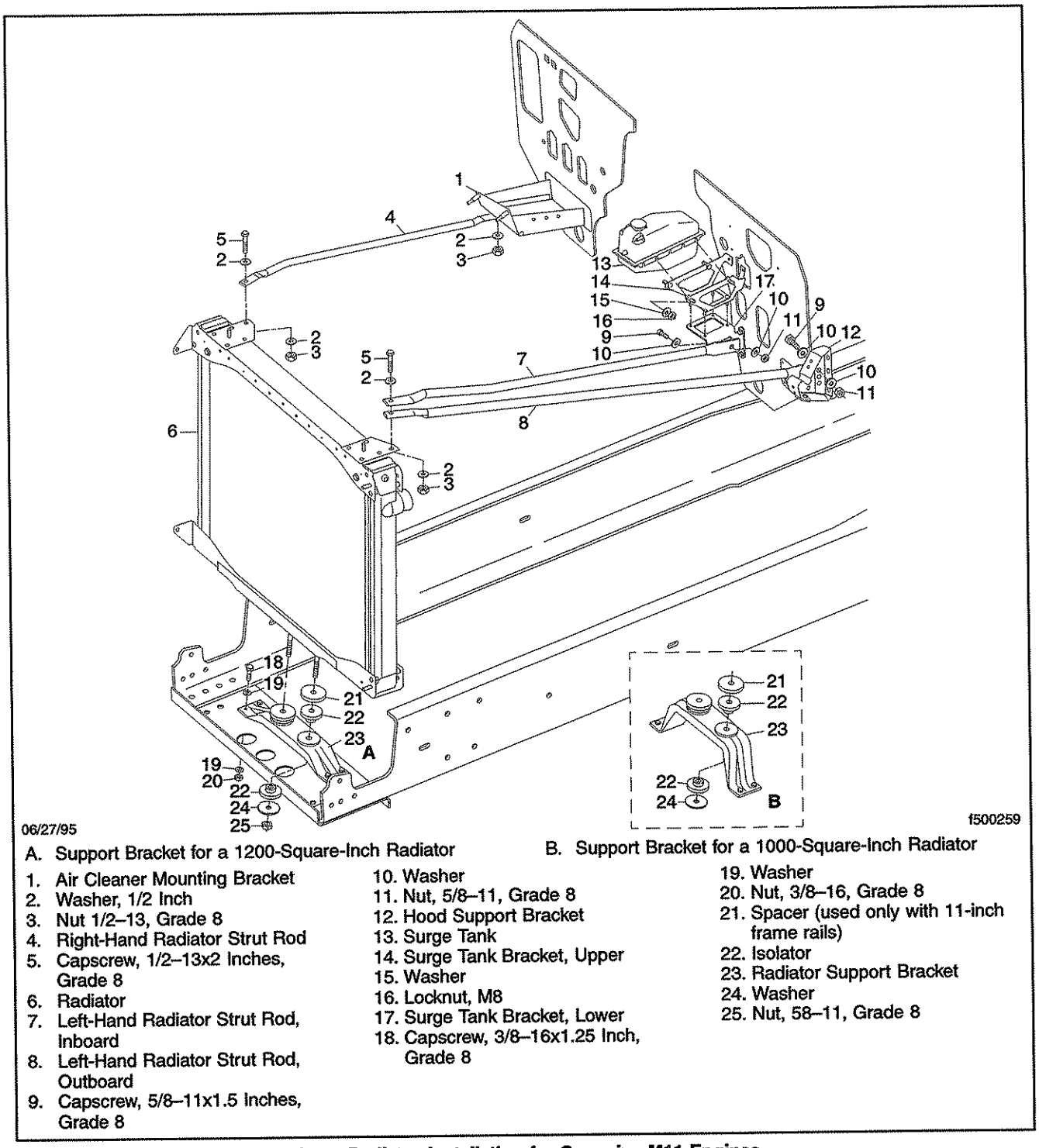
General Description



A. to surge tank
B. to water pump

1. 1/4-20 Screw
2. 1/4 Inch Washer
3. Fan Shroud
4. Radiator Strut Isolator
5. 15/32-Inch Inside Diameter Washer
6. 7/16-14 Hex Nut
7. Radiator Strut
8. 3/8-16 Hex Nut
9. 3/8 Inch Washer
10. 5/16-18 Stud
11. Radiator Mount Isolator and Studs
12. 720-Square-Inch Radiator
13. Transmission Oil Cooler Mounting Bracket
14. Transmission Oil Cooler
15. Transmission Oil Cooler Isolator
16. 5/16 Inch Washer
17. 5/16-18 Capscrew
18. Condensor
19. 5/16-18 Hex Nut
20. Surge Tank
21. M10 Nut
22. Surge Tank Brace
23. M10x20 Flanged Head Bolt
24. Radiator Vent Hose

Fig. 3, Radiator Installation for Dodge Magnum Engines



A. Support Bracket for a 1200-Square-Inch Radiator

B. Support Bracket for a 1000-Square-Inch Radiator

1. Air Cleaner Mounting Bracket
2. Washer, 1/2 Inch
3. Nut 1/2–13, Grade 8
4. Right-Hand Radiator Strut Rod
5. Capscrew, 1/2–13x2 Inches, Grade 8
6. Radiator
7. Left-Hand Radiator Strut Rod, Inboard
8. Left-Hand Radiator Strut Rod, Outboard
9. Capscrew, 5/8–11x1.5 Inches, Grade 8
10. Washer
11. Nut, 5/8–11, Grade 8
12. Hood Support Bracket
13. Surge Tank
14. Surge Tank Bracket, Upper
15. Washer
16. Locknut, M8
17. Surge Tank Bracket, Lower
18. Capscrew, 3/8–16x1.25 Inch, Grade 8
19. Washer
20. Nut, 3/8–16, Grade 8
21. Spacer (used only with 11-inch frame rails)
22. Isolator
23. Radiator Support Bracket
24. Washer
25. Nut, 58–11, Grade 8

Fig. 4, Radiator Installation for Cummins M11 Engines

General Description

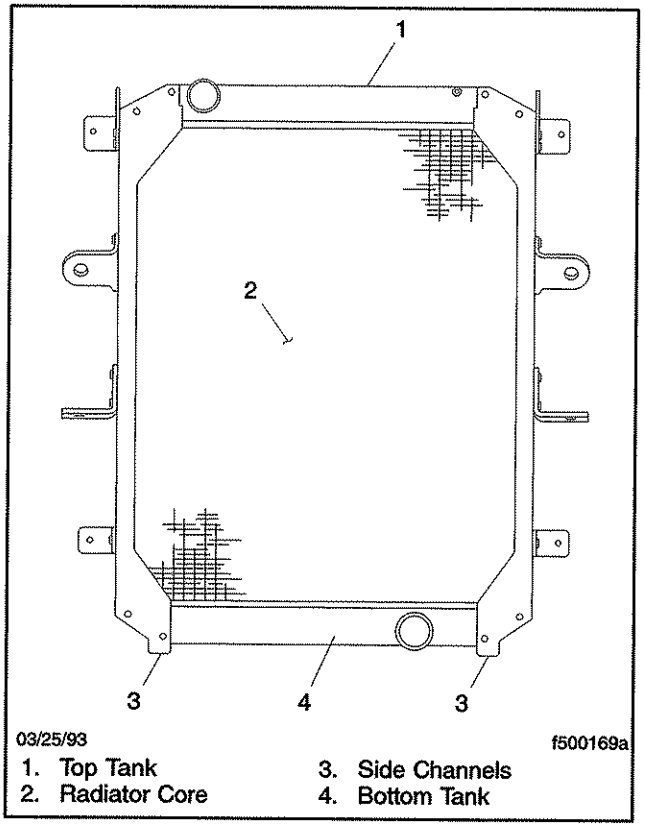


Fig. 5, Radiator Components

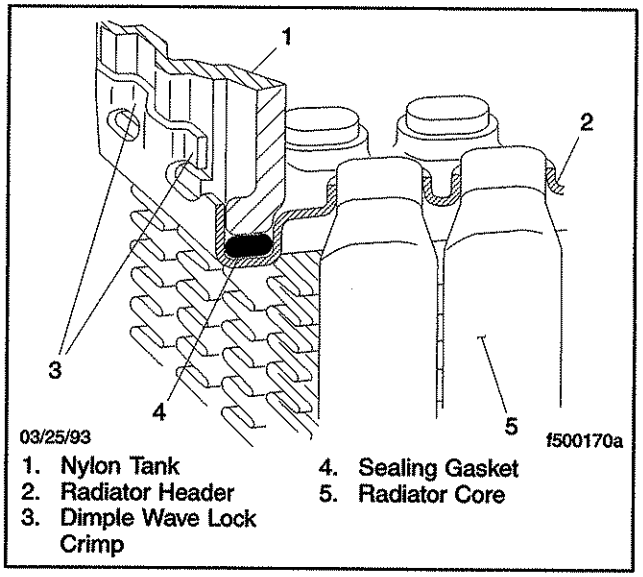


Fig. 6, Radiator Crimping

Radiator Removal and Installation

NOTE: There are three types of radiator installations for Medium Trucks:

- *For Caterpillar, Cummins B and C series, Dodge, and Mercedes-Benz engines using the 695- or 720-square-inch radiators,* the radiators are mounted to the frame rails.
- *For Detroit Diesel engines using the 850-square-inch radiator,* the bottom of the radiator is mounted to an underslung support. Brace rods run from the top of the radiator to the firewall to brace the radiator.
- *For Cummins M11 engines using the 1000- or 1200-square-inch radiator,* the bottom of the radiator is mounted to a bracket on the front, closing crossmember. Brace rods run from the top of the radiator to the firewall to brace the radiator.

Use the removal and installation procedures applicable to the vehicle.

Removal

FRAMERAIL-MOUNTED 695- OR 720-SQUARE-INCH RADIATORS

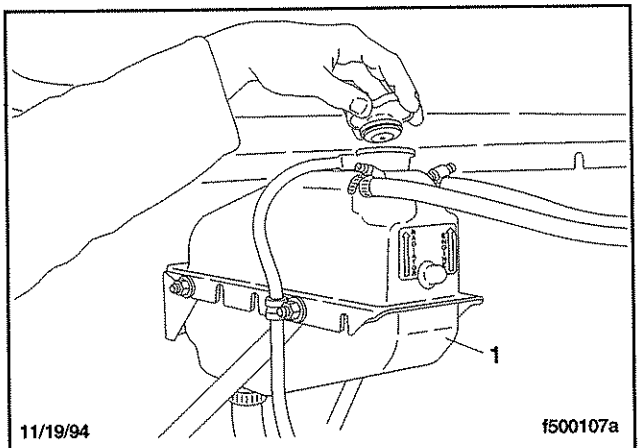
1. Park the vehicle, apply the parking brakes, and chock the tires.

   Tilt the hood.

⚠ WARNING

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.

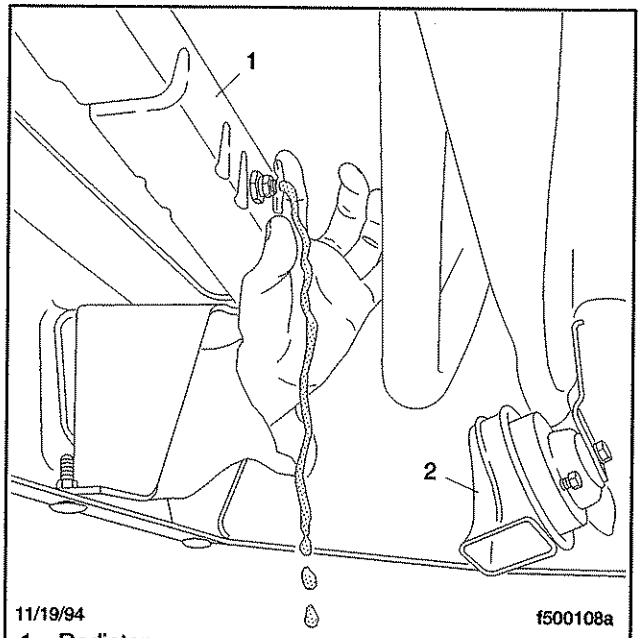
2. Drain the radiator.
   - 2.1 Remove the radiator surge tank cap. See **Fig. 1**
   - 2.2 Open the petcock at the bottom of the radiator to drain the engine coolant. See **Fig. 2.**
3. Remove the hood. For instructions, refer to **Group 88** in the vehicle service manual.
4. Move the condensor aside.
   - 4.1 Remove the clamp securing the refrigerant lines to the left radiator support strut. See **Fig. 3.**
   - 4.2 Remove the air recirculation shield from the charge air cooler left mounting tab. See **Fig. 4.**
   - 4.3 Remove the four bolts securing the condensor and the radiator vent hose bracket. See **Fig. 5** and **Fig. 6.**
5. Remove the condensor, wrap it in a protective blanket, and secure it out of the way. See **Fig. 7.**
6. Remove the radiator and charge air cooler assembly.
   - 6.1 Remove the air hoses from the charge air cooler. See **Fig. 8.**
   - 6.2 Remove the radiator vent hose and coolant inlet hose from the radiator. See **Fig. 8.**
   - 6.3 Remove the coolant outlet hose from the bottom of the radiator.
   - 6.4 Using lifting chains, secure the radiator and charge air cooler assembly to a crane.
   - 6.5 Remove the radiator mount nuts and washers. See **Fig. 9.**
   - 6.6 Remove the radiator strut nuts, washers, and rubber isolators. See **Fig. 9.**
   - 6.7 Using the crane, lift the radiator and charge air cooler assembly from the vehicle. See



1. Surge Tank

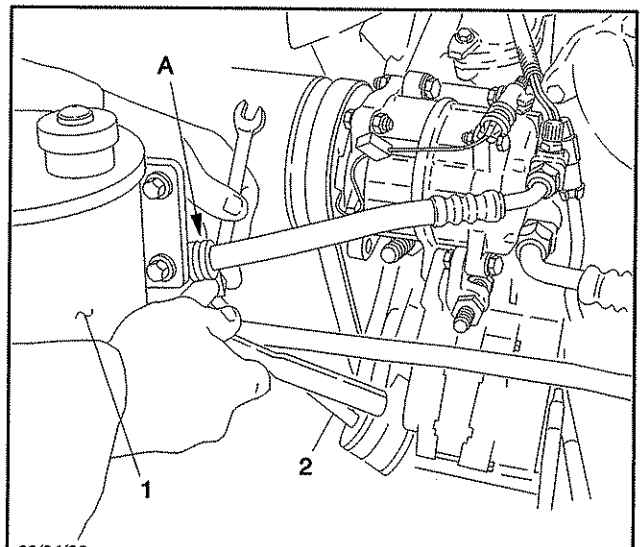
Fig. 1, Remove the Surge Tank Cap

Radiator Removal and Installation



1. Radiator
2. Horn

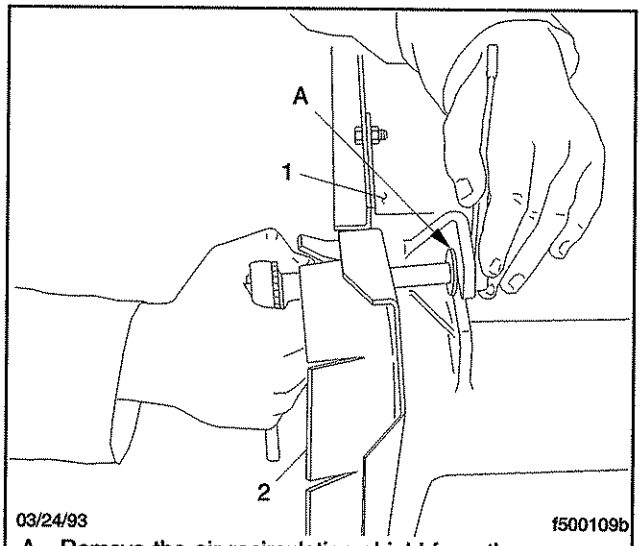
Fig. 2, Drain the Radiator



A. Remove the hose clamp from the strut.

1. Power Steering Fluid Reservoir
2. Left Radiator Strut

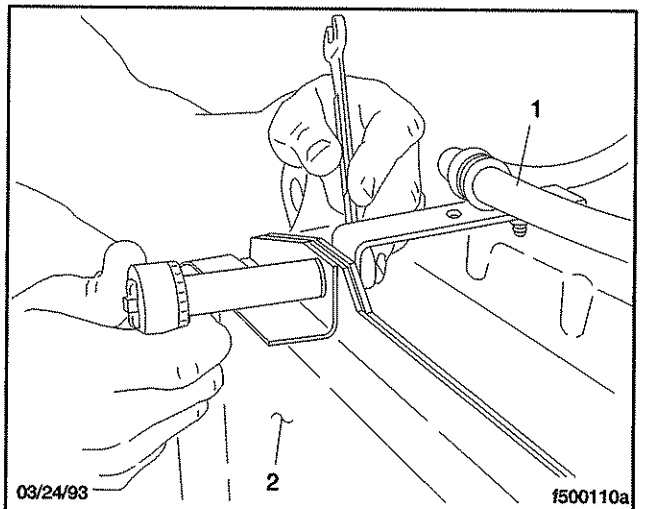
Fig. 3, Hose Clamp Location



A. Remove the air recirculation shield from the mounting tab.

1. Charge Air Cooler
2. Air Recirculation Shield

Fig. 4, Shield Mounting Tab



1. Radiator Vent Hose
2. Condensor

Fig. 5, Vent Hose Bracket

Fig. 10. Place the assembly charge air cooler-down on a work bench.

7. Disassemble the radiator and charge air cooler assembly.

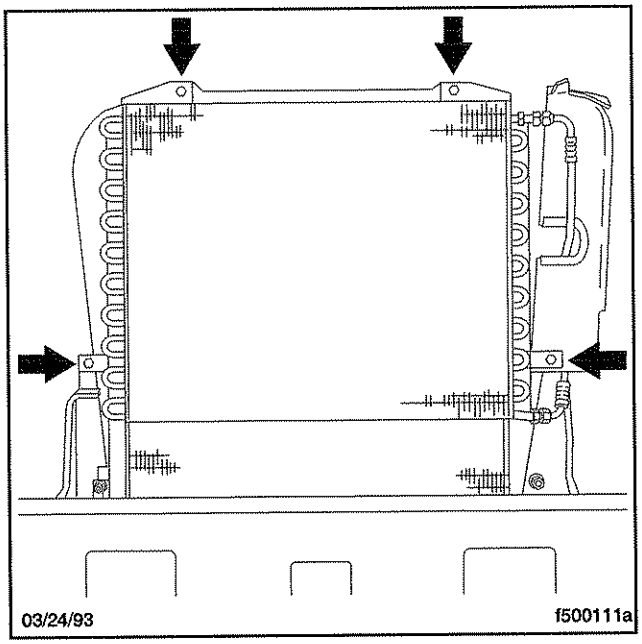


Fig. 6, Condensor Mounting Bolts

7.1 Remove the four sheet metal bolts that secure the fan shroud to the radiator. See **Fig. 11.** Remove the fan shroud.

7.2 Remove the four bolts holding the radiator to the charge air cooler. See **Fig. 12.**

7.3 Remove the hood cable brackets from the radiator. See **Fig. 13.**

7.4 Remove the radiator from the charge air cooler. See **Fig. 14.**

CROSSMEMBER-MOUNTED 850- TO 1200-SQUARE-INCH RADIATORS (See Fig. 15 or Fig. 16)

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

⚠ WARNING

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.

3. Drain the radiator

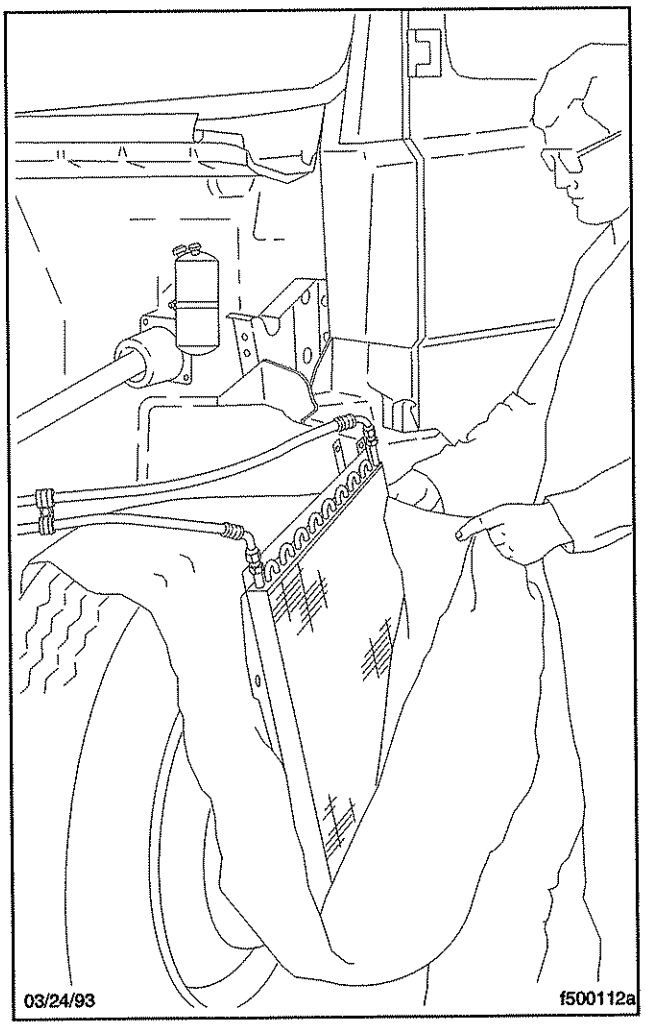


Fig. 7, Condensor Moved Aside

3.1 Remove the radiator surge tank cap.

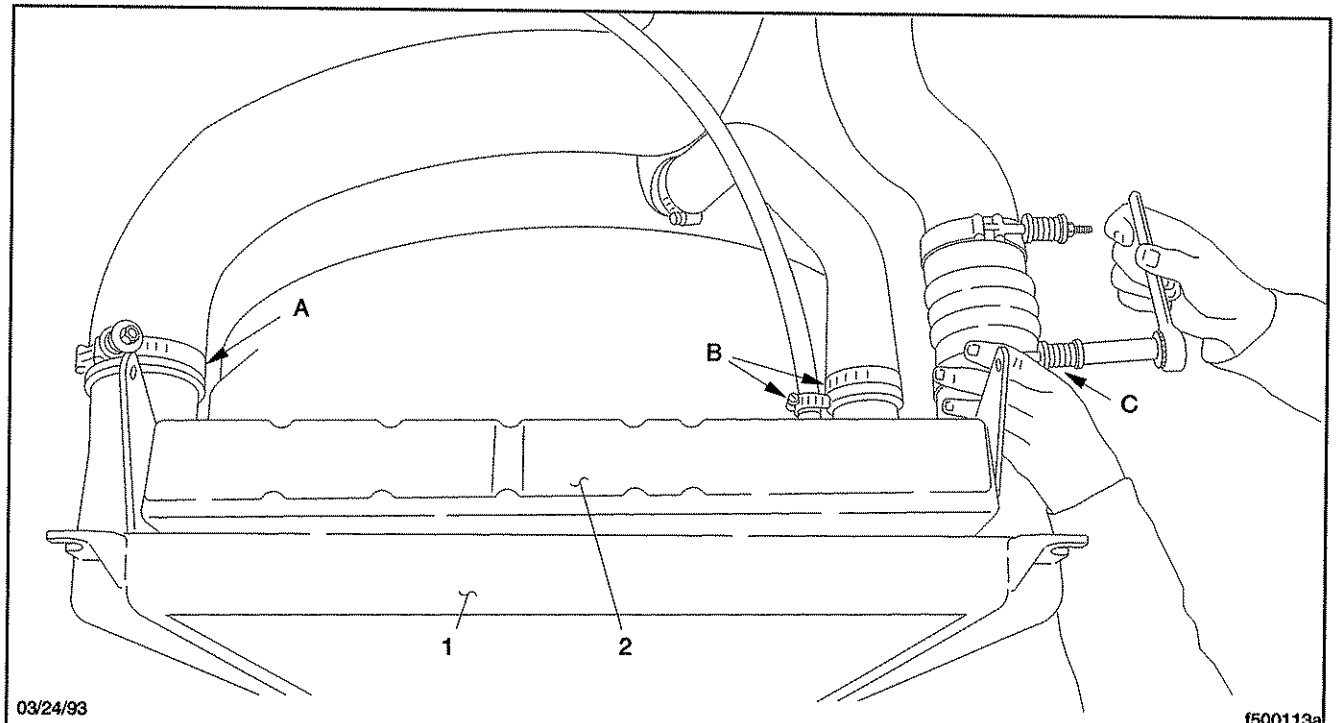
3.2 Open the petcock at the bottom of the radiator to drain the engine coolant.

4. Remove the hood. For instructions, refer to **Group 88** in this service manual.
5. Move the condensor aside.

5.1 Free the refrigerant lines from any routing clamps between the compressor and the condensor and between the condensor and the receiver dryer.

5.2 Remove the four bolts securing the condensor.

Radiator Removal and Installation



A. Remove the charge air cooler outlet hose.
B. Remove the coolant hoses from the radiator.
C. Remove the charge air cooler inlet hose.
1. Charge Air Cooler
2. Radiator

Fig. 8, Radiator and Charge Air Cooler Hoses

5.3 Move the condensor aside, wrap it in a protective blanket, and use tie straps to secure it out of the way.

6. Remove the radiator and charge air cooler assembly.

6.1 Remove the air recirculation shields from the radiator. For instructions, refer to **Group 09** in this service manual.

6.2 Remove the air hoses from the charge air cooler.

6.3 Disconnect the radiator inlet and outlet lines and the radiator vent line.

6.4 Remove the screws that hold the fan shroud to the radiator, amd move the shroud back, against the engine.

6.5 Using lifting chains, secure the radiator and charge air cooler assembly to a crane.

6.6 Remove the nuts that holds the bottom of the radiator to the support bracket.

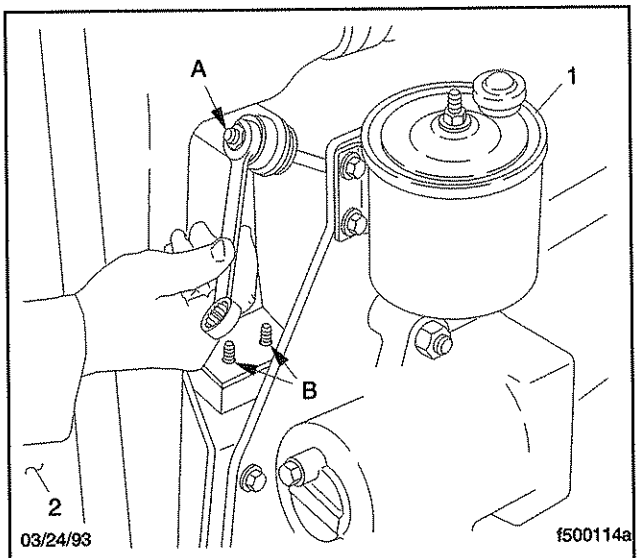
6.7 Remove the nuts and bolts that hold the brace rods to the top of the radiator.

6.8 Using the crane, lift the radiator and charge air cooler assembly from the vehicle, and place the assembly, charge air cooler up, on a work bench.

7. Disassemble the radiator and charge air cooler assembly.

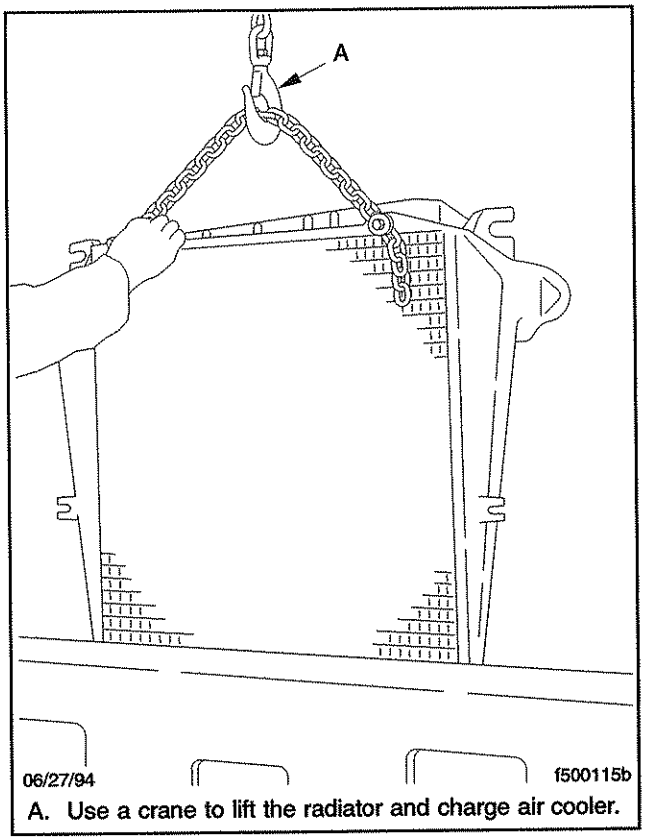
7.1 Remove the four bolts holding the charge air cooler to the radiator.

7.2 Remove the charge air cooler from the radiator.



A. Remove radiator strut nuts.
B. Remove radiator mount nuts.
1. Power Steering Fluid Reservoir
2. Charge Air Cooler

Fig. 9, Radiator Mounts (left side)



A. Use a crane to lift the radiator and charge air cooler.

Fig. 10, Lifting the Radiator

Installation

FRAMERAIL-MOUNTED 695- OR 720-SQUARE-INCH RADIATORS

1. Assemble the radiator and charge air cooler assembly.
   - 1.1 On a work bench, place the radiator on the charge air cooler (**Fig. 14**), and secure it with four bolts and washers. Tighten the bolts 20 N·m (15 lbf·ft). See **Fig. 12.**
   - 1.2 Install the hood cable brackets on the radiator, and tighten the bracket bolts 540 N·cm (48 lbf·in).
   - 1.3 Install the fan shroud with the four sheet metal bolts and washers. Do not tighten the bolts.
2. Install the radiator and charge air cooler assembly.
   - 2.1 Secure a lifting chain to the charge air cooler, and lift the assembly with a crane.
   - 2.2 Position the radiator and charge air cooler assembly on the radiator mounting studs. Secure the assembly to the mounts with nuts and washers, and tighten the nuts 40 N·m (30 lbf·ft). See **Fig. 9.**
   - 2.3 Secure the radiator support struts with rubber isolators, washers, and nuts, and tighten the nuts 47 N·m (35 lbf·ft). See **Fig. 9.**
   - 2.4 Remove the lifting chain from the radiator assembly.
   - 2.5 Connect the coolant outlet hose at the bottom of the radiator.
   - 2.6 Connect the radiator vent hose and coolant inlet hose to the radiator. See **Fig. 8.**
   - 2.7 Remove the seals from the coolant hose ends, and connect the hoses. Your hose clamps can be either T-bolt clamps (**Fig. 17**) or Breeze Constant-Torque clamps (**Fig. 18**).

Radiator Removal and Installation

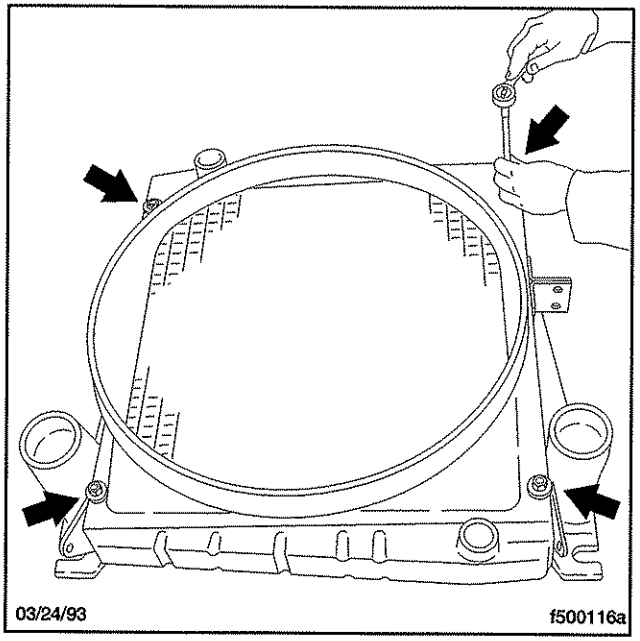
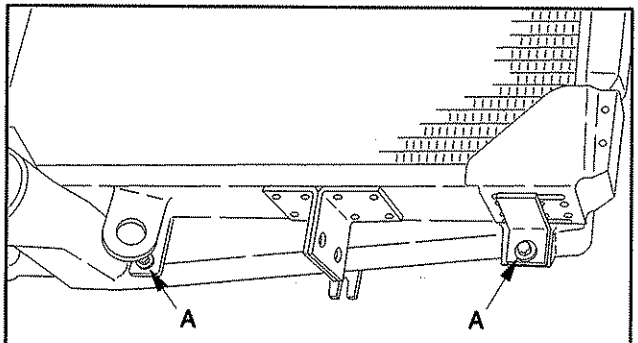
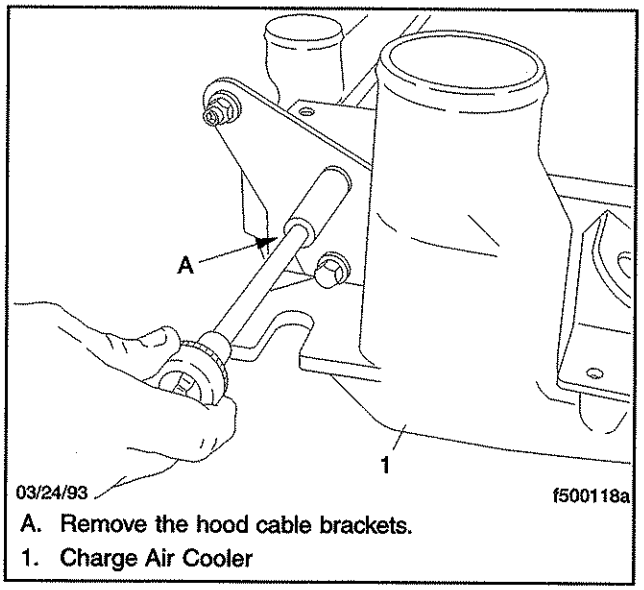


Fig. 11, Removing the Fan Shroud



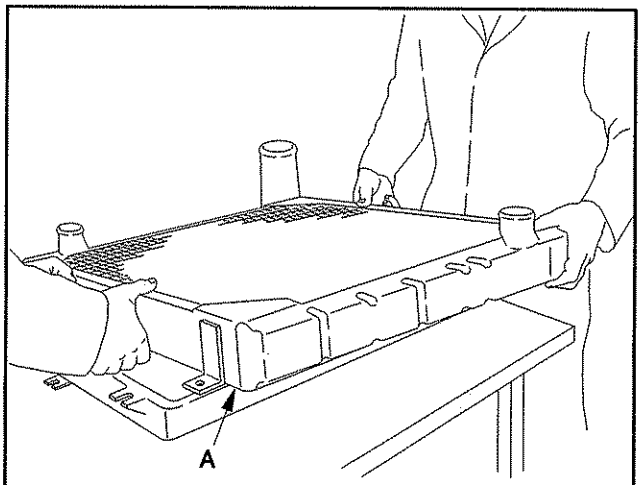
A. Remove the bolts securing the charge air cooler to the radiator.

Fig. 12, Removing the Charge Air Cooler



A. Remove the hood cable brackets.
1. Charge Air Cooler

Fig. 13, Hood Cable Brackets



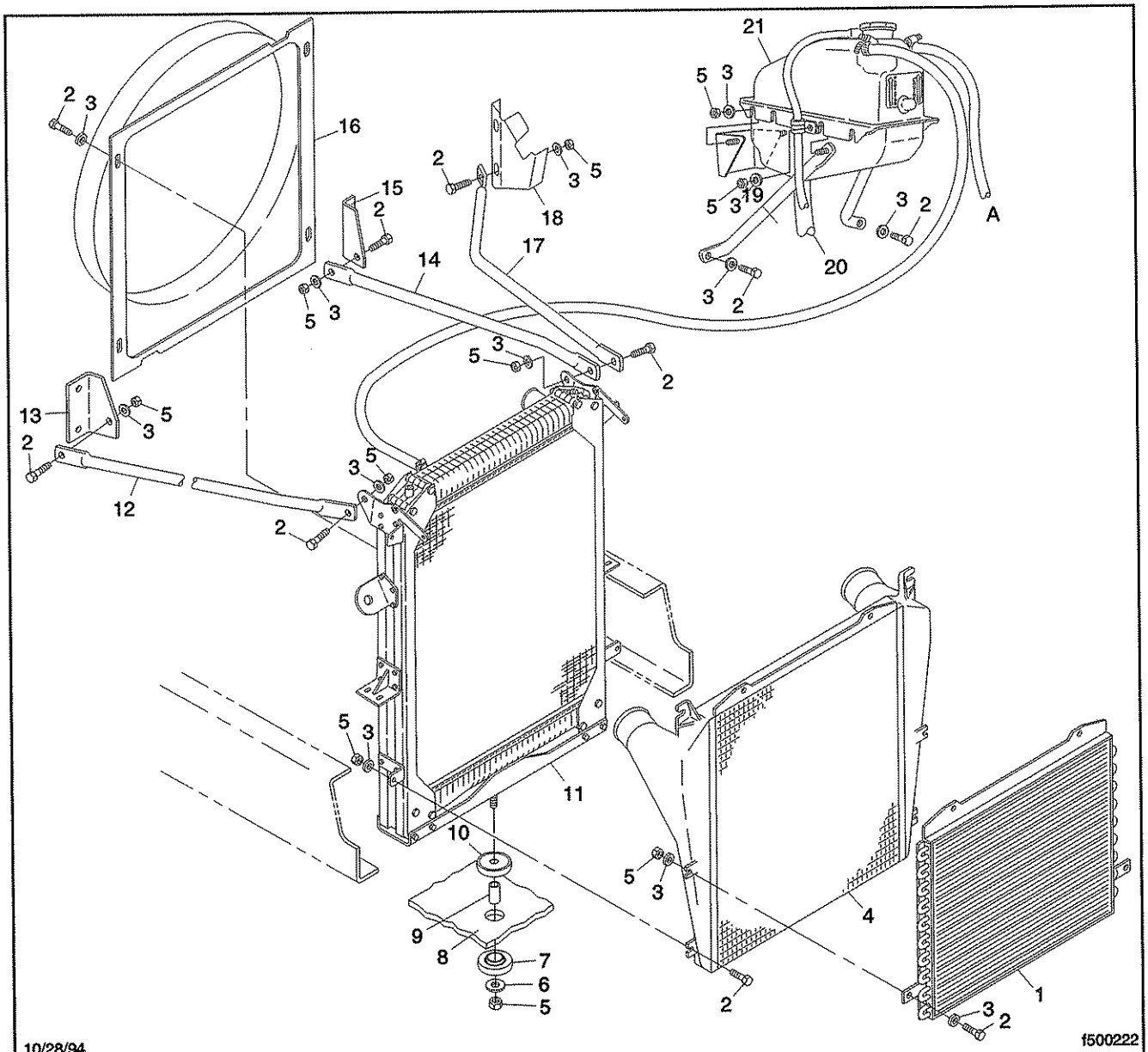
A. Remove the radiator from the charge air cooler.

Fig. 14, Radiator Loose from Charge Air Cooler

When working with T-bolt type hose clamps, tighten the clamps 620 N·cm (55 lbf·in). These clamps are now standard on hoses with an inside diameter greater than 51 mm (2 inches).

When installing the Breeze Constant-Torque hose clamps, the clamps must be tightened to the correct torque. The screw tip of the clamp must extend about 6 mm (1/4 inch) from the clamp housing, and the belleville washer stacks must be collapsed almost flat. Use a torque wrench to install these hose clamps correctly. The correct installation torque for Breeze Constant-Torque hose clamps is as follows:

For Breeze Constant-Torque hose clamps with a 5/16-inch tightening screw hex: 620 N·cm (55 lbf·in).

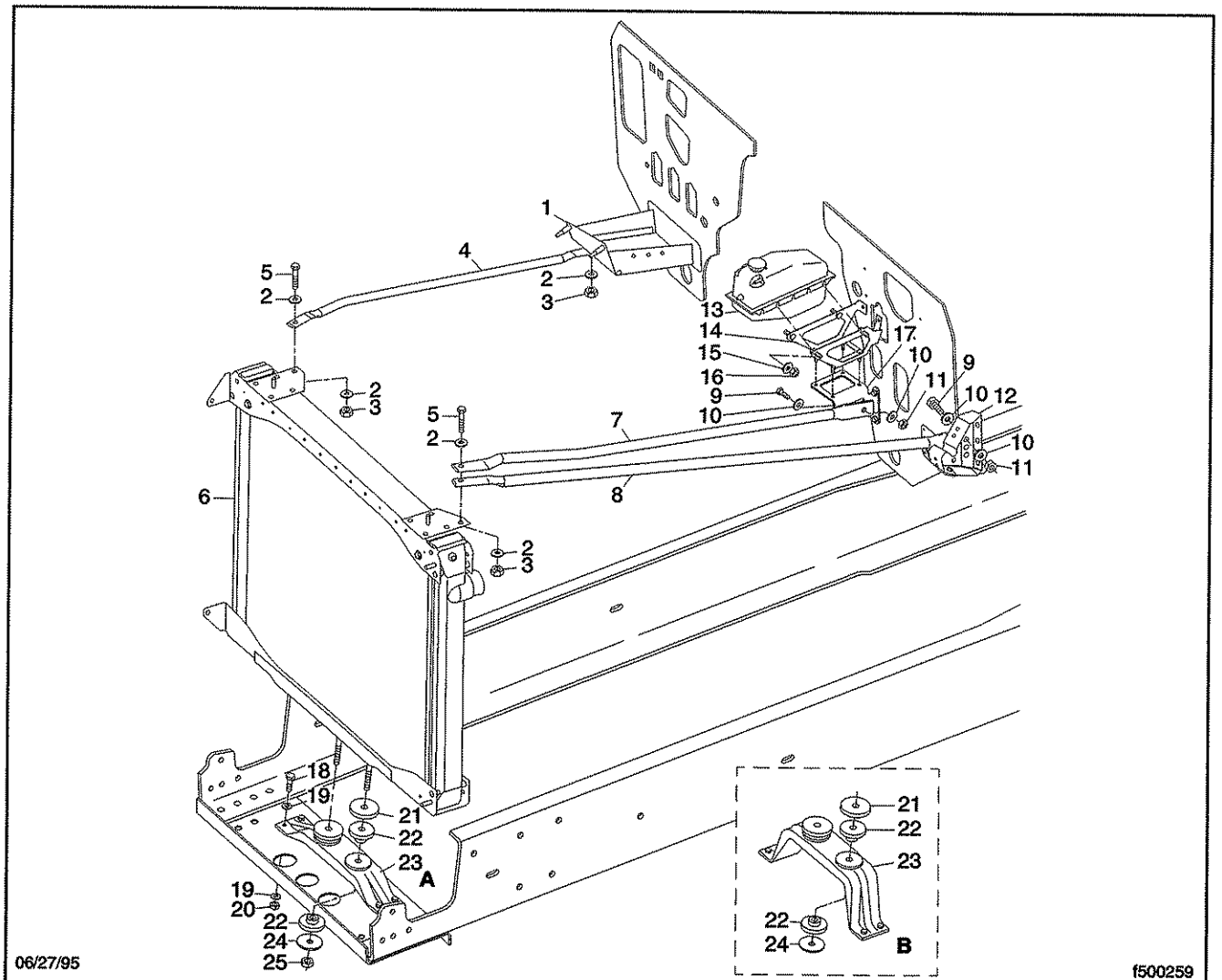


A. to engine

1. Condensor
2. Bolt
3. Washer
4. Charge Air Cooler
5. Nut
6. Washer
7. Lower Radiator Isolator
8. Radiator Underslung Support
9. Spacer Tube
10. Radiator Upper Isolator
11. Radiator
12. Radiator Left Strut
13. Left Strut Bracket
14. Radiator Center Strut
15. Center Strut Bracket
16. Fan Shroud
17. Radiator Right Strut
18. Right Strut Bracket
19. Radiator Vent Hose
20. Fill Hose
21. Surge Tank

Fig. 15, Radiator Installation for Detroit Diesel Engines

Radiator Removal and Installation



A. Support Bracket for a 1200-Square-Inch Radiator

B. Support Bracket for a 1000-Square-Inch Radiator

1. Air Cleaner Mounting Bracket
2. Washer, 1/2 Inch
3. Nut 1/2–13, Grade 8
4. Right-Hand Radiator Strut Rod
5. Capscrew, 1/2–13x2 Inches, Grade 8
6. Radiator
7. Left-Hand Radiator Strut Rod, Inboard
8. Left-Hand Radiator Strut Rod, Outboard
9. Capscrew, 5/8–11x1.5 Inches, Grade 8
10. Washer
11. Nut, 5/8–11, Grade 8
12. Hood Support Bracket
13. Surge Tank
14. Surge Tank Bracket, Upper
15. Washer
16. Locknut, M8
17. Surge Tank Bracket, Lower
18. Capscrew, 3/8–16x1.25 Inch, Grade 8
19. Washer
20. Nut, 3/8–16, Grade 8
21. Spacer (used only with 11-inch frame rails)
22. Isolator
23. Radiator Support Bracket
24. Washer
25. Nut, 58–11, Grade 8

Fig. 16, Radiator Installation for Cummins M11 Engines

For Breeze Constant-Torque hose clamps with a 3/8-inch tightening screw hex: 1020 N·cm (90 lbf·in).

NOTE: All hose clamps will lose torque after installation due to "compression set." However, when correctly installed, Breeze Constant-Torque clamps will hold enough torque to automatically adjust and keep consistent sealing pressure. During vehicle operation and shutdown, the screw tip may adjust according to temperature and pressure changes. The torque may need to be adjusted for individual applications.

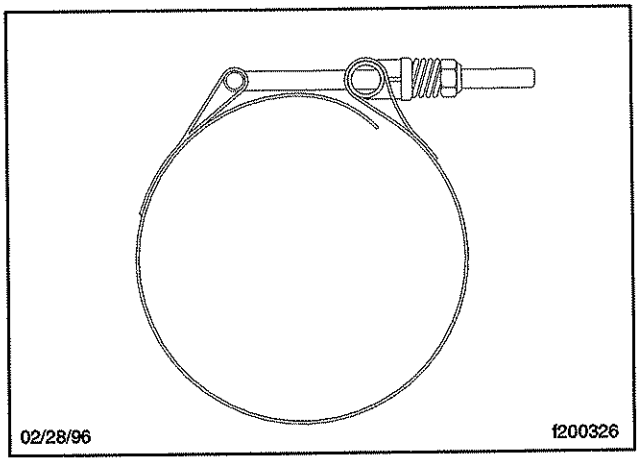
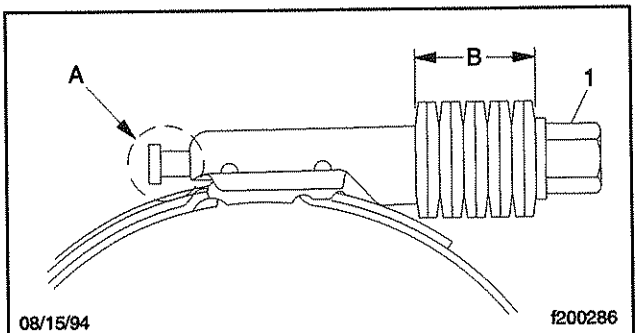


Fig. 17, T-Bolt Type Hose Clamp



A. The screw tip must extend about 6 mm (1/4 inch).
B. The belleville washer stacks must be collapsed almost flat.
1. Tightening Screw Hex

Fig. 18, Breeze Constant-Torque Hose Clamp Installation

2.8 Connect the air hoses to the charge air cooler. Tighten the constant torque hose clamps 680 N·cm (60 lbf·in). See **Fig. 8.**

3. Secure the fan shroud.

3.1 Adjust the vertical clearance between the top of the fan blade and the fan shroud opening. It should be equal within 1/8 inch (3 mm) to the clearance between the bottom of the blade and the shroud opening.

3.2 Tighten the screws 1220 N·cm (108 lbf·in).

4. Install the condensor.

4.1 Install the condensor on the charge air cooler, and secure it with the four mounting bolts. Install the radiator vent hose bracket with the top, right mounting bolt. See **Fig. 5** and **Fig. 6.** Tighten the bolts 20 N·m (15 lbf·ft).

4.2 Install the air recirculation shield on the charge air cooler left mounting tab. See **Fig. 4.** Tighten the bolt 20 N·m (15 lbf·ft).

4.3 Clamp the refrigerant lines to the left radiator support strut. See **Fig. 3.**

5. Install the hood. For instructions, refer to **Group 88** in the vehicle service manual.

6. Fill the coolant system, and install the surge tank cap.

7. Start the engine and check for coolant leaks. Repair any leaks. After idling the engine for 15 to 20 minutes, add more coolant if necessary.

8. Lower the hood, and remove the chocks from the tires.

CROSSMEMBER-MOUNTED 850- TO 1000-SQUARE-INCH RADIATORS (See Fig. 15)

1. Assemble the radiator and charge air cooler assembly.

1.1 On a work bench, place the radiator on the charge air cooler, and secure it with four bolts and washers.

1.2 Tighten the bolts 20 N·m (15 lbf·ft).

Radiator Removal and Installation

2. Install the radiator and charge air cooler assembly.

   2.1 Place the fan shroud in position around the fan.

   2.2 Secure a lifting chain to the charge air cooler, and lift the assembly with a crane.

   2.3 Place the upper radiator isolator and washer on the hole in the support bracket, and position the radiator and charge air cooler assembly on the support. Hold the lower radiator isolator and washer in position, and secure the assembly to the support with locknuts.

   For 850-square-inch radiators: tighten the locknuts 327 N·m (241 lbf·ft).

   For 1000-square-inch radiators: tighten the locknuts 122 N·m (90 lbf·ft).

   2.4 Secure the radiator brace rods to the top of the radiator with bolts, washers, and locknuts.

   For 850-square-inch radiators, tighten the locknuts 92 N·m (68 lbf·ft).

   For 1000-square-inch radiators, tighten the locknuts 122 N·m (90 lbf·ft).

   2.5 Remove the lifting chain from the radiator assembly.

   2.6 Connect the coolant inlet and outlet hoses and the vent hose to the radiator.

   2.7 Connect the radiator vent hose and coolant inlet hose to the radiator.

   2.8 Remove the seals from the coolant hose ends, and connect the hoses. Your hose clamps can be either T-bolt clamps (**Fig. 17**) or Breeze Constant-Torque clamps (**Fig. 18**).

   When working with T-bolt type hose clamps, tighten the clamps 620 N·cm (55 lbf·in). These clamps are now standard on hoses with an inside diameter greater than 51 mm (2 inches).

   When installing the Breeze Constant-Torque hose clamps, the clamps must be tightened to the correct torque. The screw tip of the clamp must extend about 6 mm (1/4 inch) from the clamp housing, and the belleville washer stacks must be collapsed almost flat. Use a torque wrench to install these hose clamps correctly. The correct installation torque for Breeze Constant-Torque hose clamps is as follows:

   For Breeze Constant-Torque hose clamps with a 5/16-inch tightening screw hex: 620 N·cm (55 lbf·in).

   For Breeze Constant-Torque hose clamps with a 3/8-inch tightening screw hex: 1020 N·cm (90 lbf·in).

   NOTE: All hose clamps will lose torque after installation due to "compression set." However, when correctly installed, Breeze Constant-Torque clamps will hold enough torque to automatically adjust and keep consistent sealing pressure. During vehicle operation and shutdown, the screw tip may adjust according to temperature and pressure changes. The torque may need to be adjusted for individual applications.

   2.9 Connect the air hoses to the charge air cooler. Tighten the constant torque hose clamps 680 N·cm (60 lbf·in).

3. Secure the fan shroud.

   3.1 Adjust the vertical clearance between the top of the fan blade and the fan shroud opening. It should be equal within 1/8 inch (3 mm) to the clearance between the bottom of the blade and the shroud opening.

   3.2 Tighten the screws 1220 N·cm (108 lbf·in).

4. Install the condensor on the charge air cooler, and secure it with the four mounting bolts. Tighten the bolts 20 N·m (15 lbf·ft).

5. Route and clamp the refrigerant lines.

6. Install the hood. For instructions, refer to **Group 88** in the vehicle service manual.

7. Fill the coolant system, and install the surge tank cap.

8. Start the engine and check for coolant leaks. Repair any leaks. After idling the engine for 15 to 20 minutes, add more coolant if necessary.

9. Lower the hood, and remove the chocks from the tires.

Radiator Disassembly and Assembly

IMPORTANT: Disassembling and assembling nylon top- and bottom-tank radiators requires the special tools listed in **Table 1:**

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

Order these tools from:

RAD PAL
2381 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 the radiator group of the vehicle maintenance manual. Clean and check the exterior of the radiator, following the instructions in the vehicle driver's manual.

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

⚠ CAUTION

CAUTION: Use care when handling or supporting the nylon top and bottom tanks. Failure to do so could damage the tanks.

2. Remove the side channels from the radiator assembly.
   - 2.1 Remove the eight spring clips that hold the side channel mounting pins in position. **See Fig. 1.** 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 eight mounting pins. **See Fig. 2.**
   - 2.3 Slip the side channels off the radiator core and tank assembly. **See Fig. 3.**
3. Leak test the radiator core and tank assembly.
   - 3.1 Securely plug all tank ports.

⚠ CAUTION

CAUTION: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 138 kPa (20 psi) 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 7.5 cm (3 inches) of the tank, remove the tank before repairing the leak. If the leak is in the tank, replace the tank.
4. Remove the top and bottom tanks.

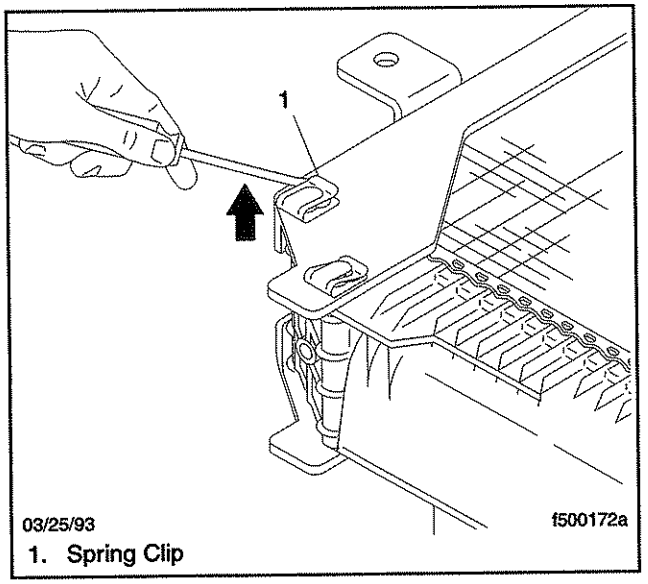


Fig. 1

Radiator Disassembly and Assembly

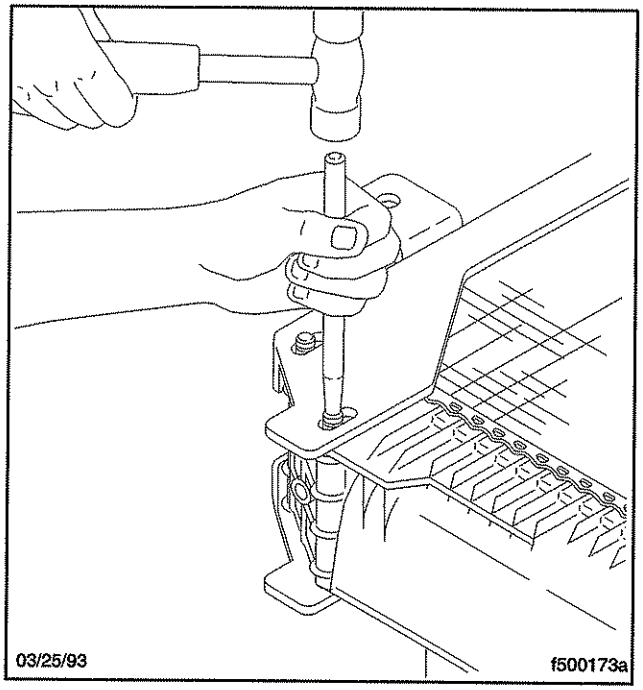
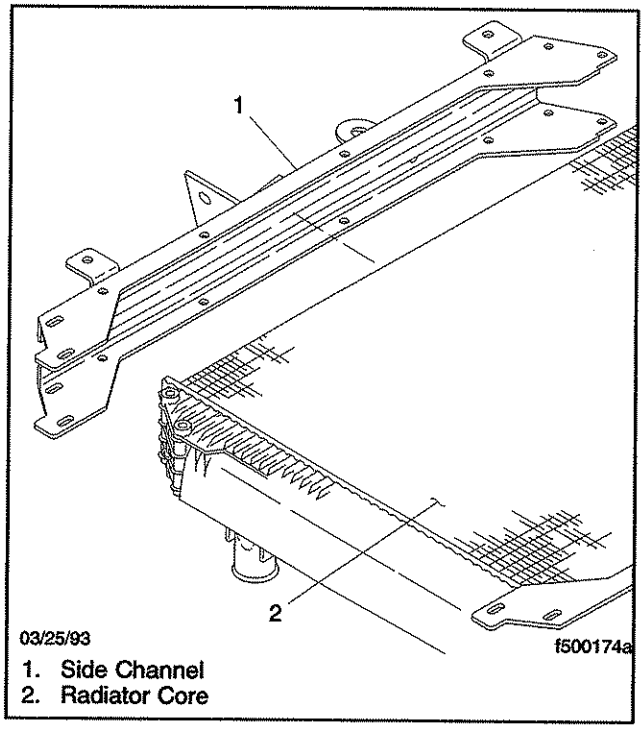


Fig. 2



1. Side Channel
2. Radiator Core

Fig. 3

4.1 Place the radiator core and tank assembly in the disassembly/assembly fixture, and clamp the assembly securely in place. **See Fig. 4**

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.

⚠ CAUTION

CAUTION: 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.

⚠ CAUTION

CAUTION: 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. 5.**

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. 5.**

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.

5. 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.

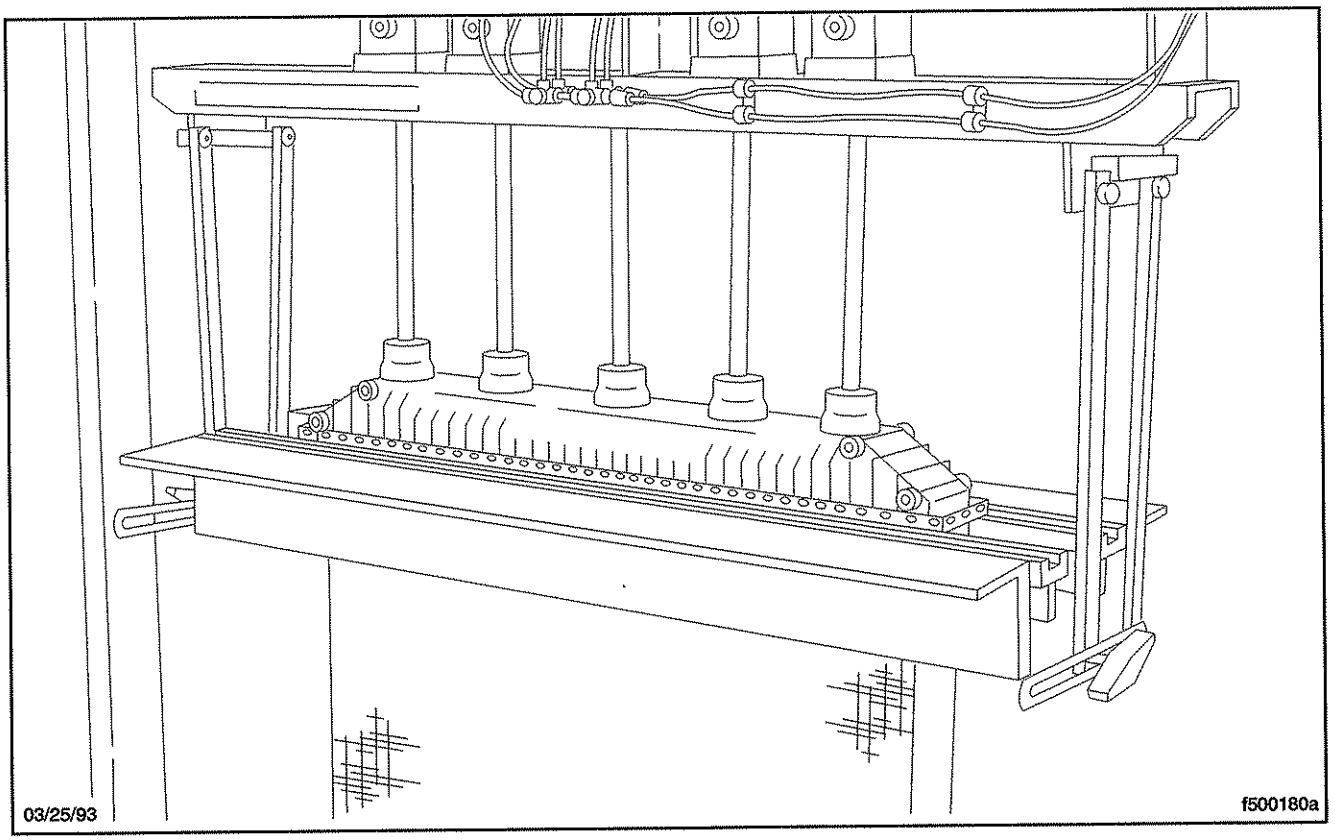


Fig. 4

⚠ CAUTION

CAUTION: 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. 6.**

5.3 Remove the sealing gasket from the sealing surface of the radiator core header. **See Fig. 7.**

5.4 Clean the sealing surface of the radiator core header.

5.5 Repair any leaks marked during leak testing, step 3.

5.6 Repeat steps 4 and 5 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 top and bottom 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 sealing surface is free of any dents, tool marks, or foreign particles.

Radiator Disassembly and Assembly

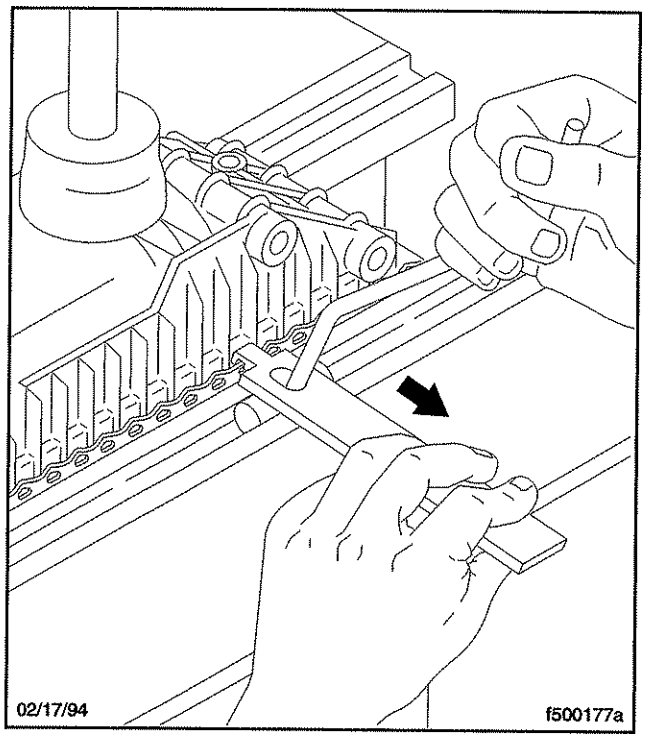


Fig. 5

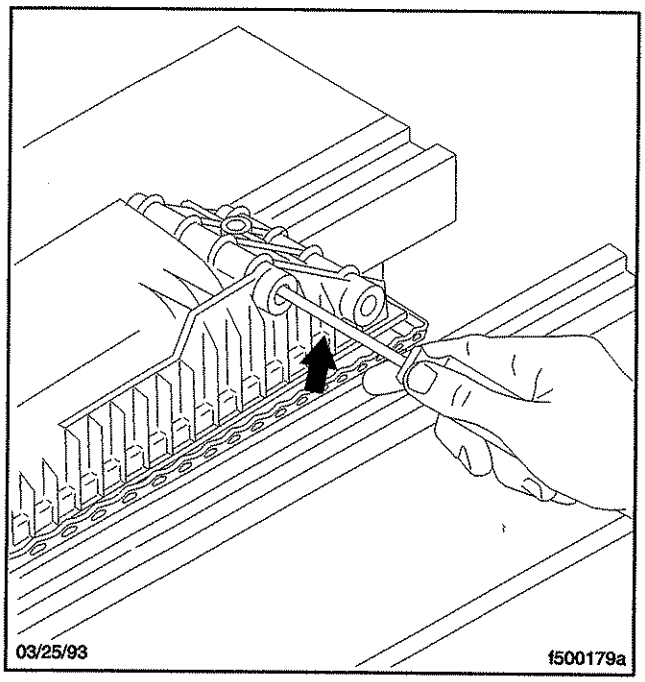
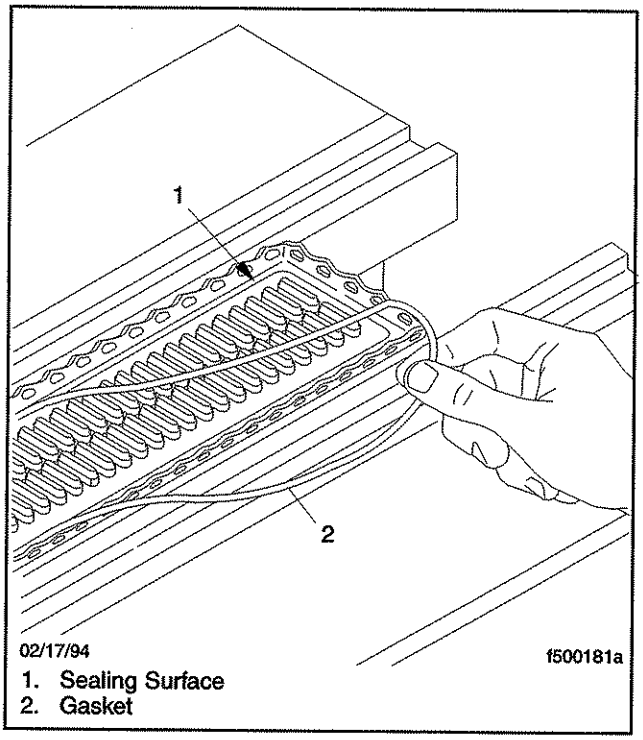


Fig. 6



1. Sealing Surface
2. Gasket

Fig. 7

1.2 Lubricate a new sealing gasket with a soap and water solution, and position the gasket on the header sealing surface. **See Fig. 7.** 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. 4.**

⚠ CAUTION

CAUTION: 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.

⚠ CAUTION

CAUTION: 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. 8.**

1.10 Slide the tools down the T-bar groove to the next wave crimp slot, and repeat steps 1.8 and 1.9 until all the wave crimps are crimped.

⚠ CAUTION

CAUTION: 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 step 1 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.

3.1 Slide the side channels onto the radiator core and tank assembly.

3.2 Using a rubber mallet and a punch, install the eight mounting pins through the side channel holes and tank bosses. **See Fig. 9.**

3.3 Install the eight spring clips to secure the mounting pins in position. **See Fig. 10.** 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.

4. Install the radiator in the vehicle. For instructions, **refer to Subject 100.**

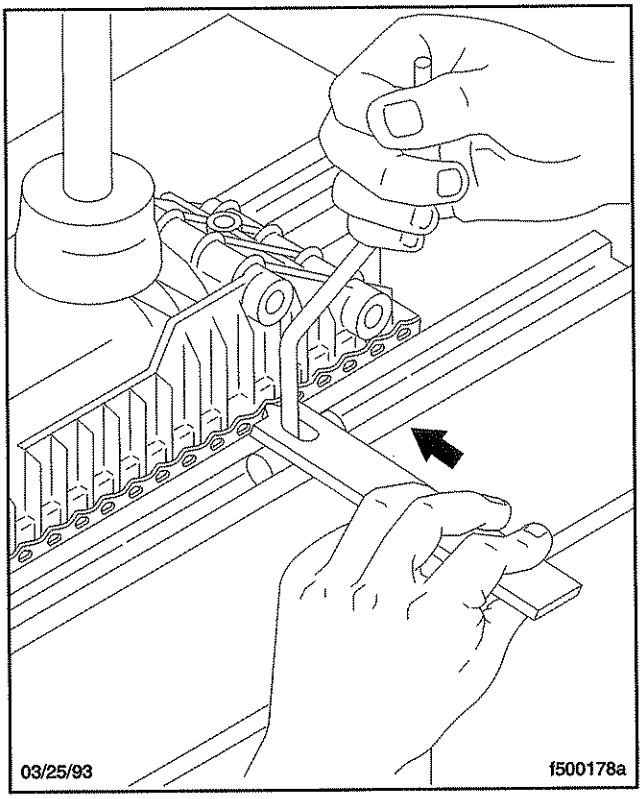


Fig. 8

Radiator Disassembly and Assembly

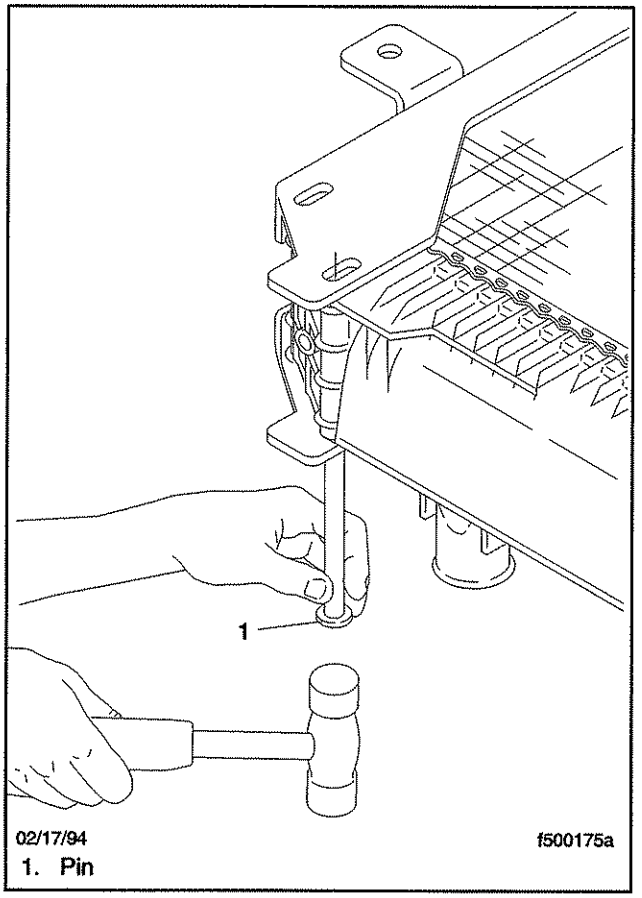


Fig. 9

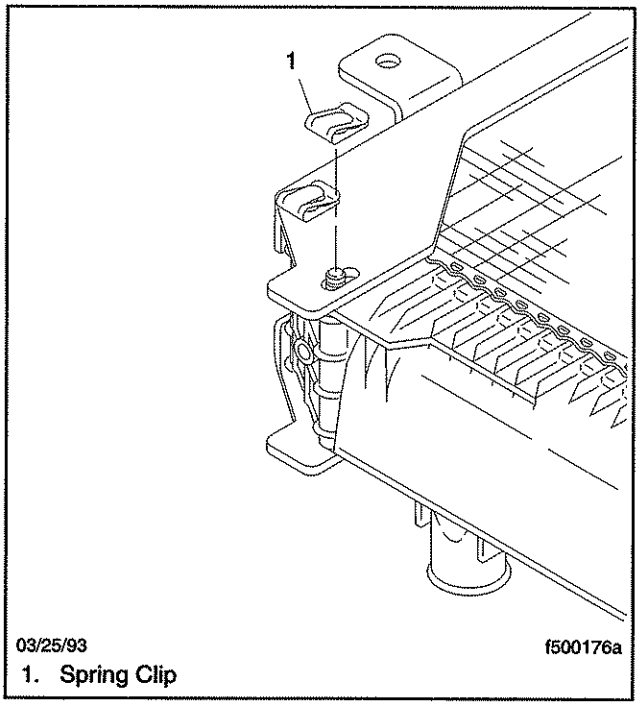


Fig. 10

Surge Tank Removal and Installation

Removal

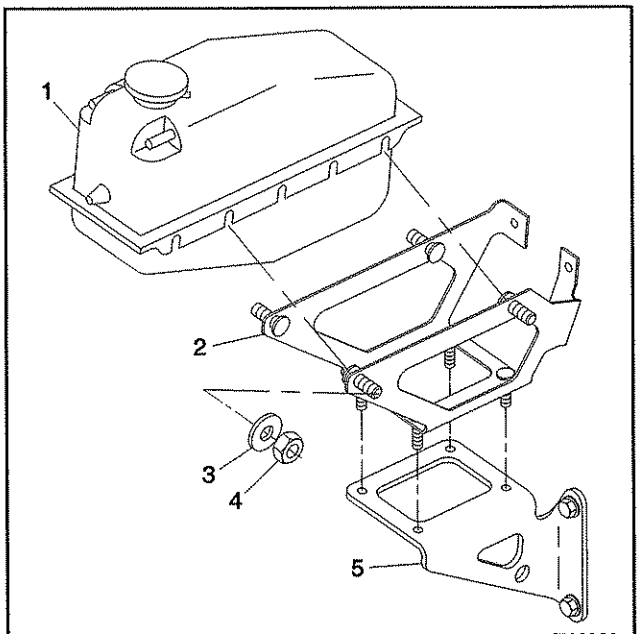
NOTE: In Business Class vehicles, Freightliner mounts the remote surge tank in two ways. In vehicles equipped with Cummins M11 or Detroit Diesel Series 55 engines, the surge tank is mounted on the driver's side of the bulkhead. **See Fig. 1.** In vehicles equipped with other engines, the surge tank is mounted on the passenger's side of the bulkhead. **See Fig. 2.**

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

⚠ 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.

3. Drain the radiator.



1. Surge Tank
2. Surge Tank Bracket, Upper
3. Washer
4. Locknut, M8
5. Surge Tank Bracket, Lower

Fig. 1, Surge Tank Mounting for a Cummins M11 or a Detroit Diesel Series 55 Engine

3.1 Remove the surge tank cap.

3.2 Open the petcock or remove the drain plug 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.

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

4.1 Disconnect the engine and radiator vent line from the front of the surge tank.

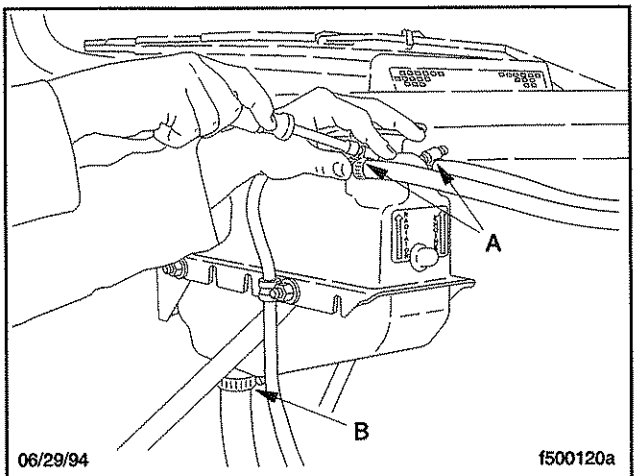
4.2 Disconnect the fill hose from the bottom of the surge tank.

4.3 *On M11 and Detroit Diesel Series 55 engines,* remove the nuts that hold the tank to the bracket. **See Fig. 1.** Then, lift the tank out of the bracket.

On other engines, remove the two surge tank support struts. **See Fig. 3.**

Then, loosen the surge tank mounting nuts (**see Fig. 4**), and remove the tank by lowering the front end first. **See Fig. 5.** Lift the rear end off the mounting bracket, and remove the tank.

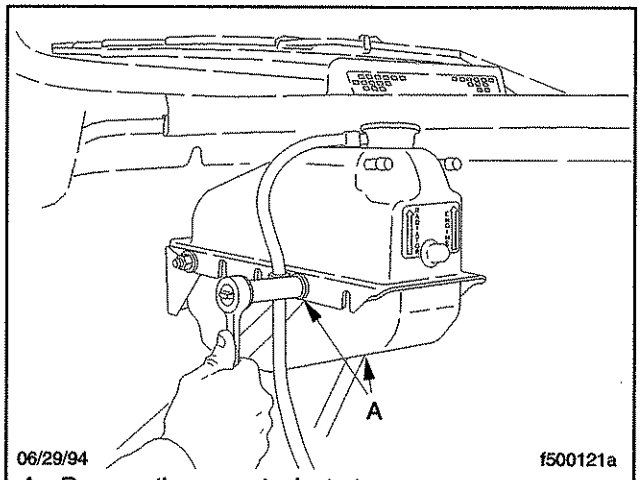
5. Turn the sight glass counterclockwise to remove it.



A. Disconnect the engine and radiator vent hoses.
B. Disconnect the fill hose.

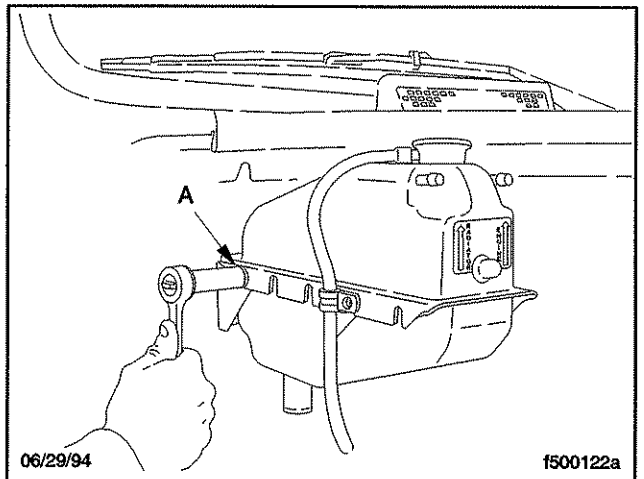
Fig. 2, Surge Tank Mounting for All Engines Except a Cummins M11 or a Detroit Diesel Series 55 Engine

Surge Tank Removal and Installation



A. Remove the surge tank struts.

Fig. 3, Surge Tank Struts

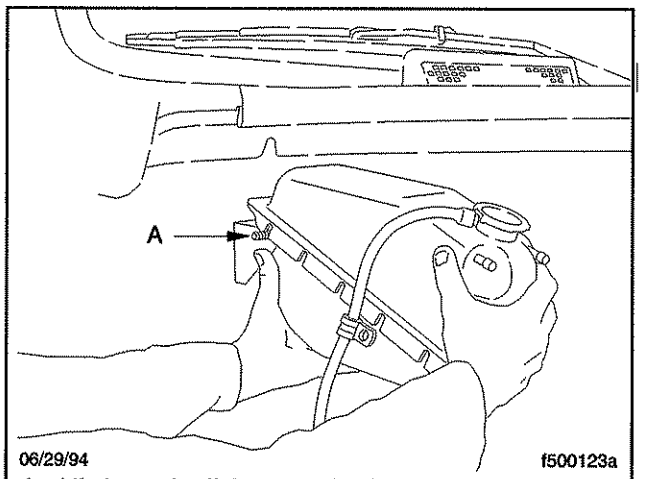


A. Loosen the mounting nuts.

Fig. 4, Surge Tank Mounting Nuts

Installation

1. If the surge tank sight glass has been removed, replace it by twisting it into the sight glass hole clockwise. Make sure the rubber seal ring is in place on the sight glass.
2. Install the surge tank.
   - 2.1 *On M11 and Detroit Diesel Series 55 engines,* place the surge tank in the bracket. **See Fig. 1.** Then, secure the tank with nuts, and tighten the nuts 30 lbf·ft (40 N·m).



A. Lift the tank off the mounting bracket.

Fig. 5, Removing the Surge Tank

   - 2.2 *On other engines,* install the surge tank on its mounting bracket by placing the two rear mounting studs in the bracket notches and installing the mounting nuts. **See Fig. 4.** Tighten the nuts 30 lbf·ft (40 N·m).
   - 2.3 Install the two support struts. **See Fig. 3.** Tighten the strut nuts 30 lbf·ft (40 N·m).
3. Connect the hoses to the tank.
   - 3.1 Connect the surge tank fill hose. **See Fig. 2.**
   - 3.2 Connect the engine and radiator vent hoses to the front of the tank.
4. Fill the coolant system, and install the surge tank cap.
5. Start the engine and check for coolant leaks. Repair any leaks.
6. Lower the hood, and remove the chocks from the tires.

Pressure Testing

1. Remove the radiator. For instructions, **refer to "Radiator Removal and Installation, 100."**
2. Pressure test the radiator as follows:
   - 2.1 Leaving the coolant inlet port open, plug the outlet, and all other ports on the radiator.
   - 2.2 Using the necessary adaptor, connect a pressure regulator and a gauge on the coolant inlet port. Use a hand pump to apply 138 kPa (20 psi) air pressure through the inlet port.

⚠ CAUTION

CAUTION: Don't apply a higher amount of air pressure; too much pressure will damage the radiator core.

   - 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 testing gauge. Repair the radiator, if necessary.
3. Install the radiator. For instructions, **refer to "Radiator Removal and Installation, 100."**

NOTE: For additional troubleshooting information, refer to Section 20.00.

Visual Check

It's a sound service practice to give the cooling system a quick visual check whenever you tilt the hood. Look for signs of visible leaks (or the stains they leave), especially on the engine block. A final check is to look at the inside of the oil breather cap for signs of a milky substance —which means that coolant is leaking into the oil.

Air Conditioner Condensor and Air-to-Air Aftercooler

Since the condensor and aftercooler are right in front of the radiator, air must pass through them to get to the radiator. For the heat transfer process to take place, the fins of the radiator , the condensor, and the aftercooler must be free of blockages and deposits such as dirt or bugs. Clean the surfaces with compressed air or water and a mild laundry soap.

Also remember that because the three heat-transfer parts are so close to each other, heat will pass between them. A blocked condensor will transfer its heat to the aftercooler and a hot aftercooler will transfer its heat to the radiator.

Radiator Cap

The radiator cap is the most often ignored part in the cooling system. If it's suspect, replace it. An inspection means checking the cap with a pressure tester. A radiator cap in good condition will not open below 62 kPa (9 psi). A visual check is also in order: look for signs of deterioration on the inner gasket. Also look for cracks or breaks in the spring retainer in the cap and for corrosion or deposits on the spring itself. If the spring is not in perfect condition, it has probably lost tension; replace it.

Engine Coolant

Check the level of the coolant at the surge tank. It should be up to the sight glass.

If the engine coolant is dirty or its color is beginning to fade, change it. It should also be replaced if it has a dead fish smell.

Be sure that the mixture is correct. Refer to the maintenance manual for specifications.

Radiator

Radiator problems are limited to external leaks, which can be spotted visually, and internal blockages, assuming that there is good airflow and that the radiator is large enough to do the job.

To check for blockages, warm the engine to normal operating temperature. Shut down the engine, and pass your hand in front of 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, however, is to be expected.

Fan

Refer to the applicable section in this group for fan and fan clutch checks.

Specifications

Description	Grade	Size	Torque	
			N·m (lbf·ft)	N·cm (lbf·in)
Aftercooler-to-Radiator Mounting Bolts	5	5/16 inch	20 (15)	—
Hood Cable Bracket Bolts	8.8	10 mm	—	540 (48)
Fan Shroud Mounting Bolts	8	1/4 inch	—	1220 (108)
Radiator Mount Nuts	5	3/8-16	40 (30)	—
Radiator Strut Nuts	2	1/2-13	47 (35)	—
Aftercooler Hose Clamps	5	6.3 mm	—	680 (60)
Condensor Mounting Bolts	5	5/16 inch	20 (15)	—
Air Recirculation Shield Bolts	5	5/16 inch	20 (15)	—
Surge Tank Mounting Bolts	5	10 mm	40 (30)	—
Surge Tank Strut Nuts	5	10 mm	40 (30)	—
Radiator Isolator Bolt Locknut	8	3/4 inch	327 (241)	—
Radiator Brace Rod Locknuts	8	1/2 inch	92 (68)	—

Table 1, Fastener Torques

Eaton Viscous Clutch Fan Drive 20.02

Contents

Subject	Subject Number
General Description	050
Service Operations	
Fan Clutch Inspection and Operation Checking	100
Fan Clutch Removal and Installation	110
Specifications	400

General Description (See Fig. 1)

The fan drive senses the air temperature behind the radiator core, and engages or disengages the fan depending on that temperature. An increase or decrease in the amount of heat from the radiator coolant causes a change in the air temperature behind the radiator core. A coiled metal heat sensor (Ref. 1) on the fan drive detects the temperature change; it engages the fan clutch when more cooling (airflow) is needed, and disengages it when the engine is sufficiently cooled.

The fan clutch consists of two basic parts: the input plate and shaft (Refs. 2 and 3), and the output plate (Ref. 6). The input shaft is mounted to the fan hub so it and the input plate are constantly turning as the engine runs. The output plate carries the fan blades (Ref. 7) but engages with the input plate only when extra engine cooling is needed.

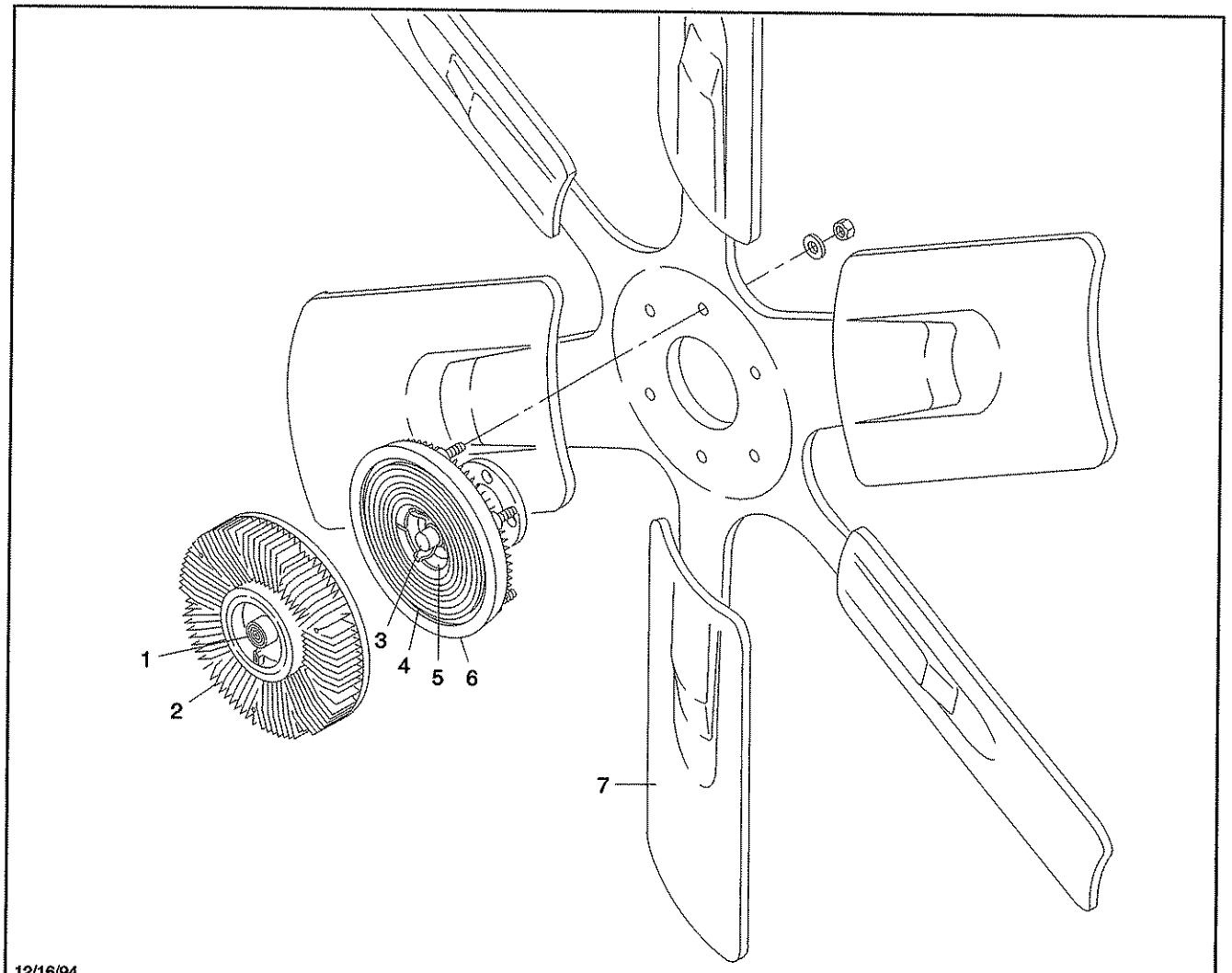
When the fan is disengaged, a single bearing allows the output plate and fan to free-wheel in relation to the input shaft and plate. Both the output and input plates are lined with concentric grooves (Ref. 4) which intermesh with very close tolerance.

To engage the fan, the heat sensor on the front of the clutch opens a valve in the clutch's drive chamber (Ref. 5). The centrifugal force of the turning input plate forces the viscous (thick) silicone fluid stored in the drive chamber to flow out. The fluid flows between the concentric grooves of the input and output plates, creating friction between the two plates. As that friction increases, the output plate and fan begin 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, which 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's beyond the grooves. There, at the outer edge of the clutch, it returns through a passage in the input plate to the drive chamber.

Again, without the fluid to create friction between the two plates, the output plate and fan free-wheel in relation to the input plate and input shaft.

General Description



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NOTE: The Eaton 660 fan clutch is shown here. The 610 fan clutch has four studs for mounting the fan. The Eaton Tempatrol 575 fan clutch (used on Dodge Magnum V-8 engines) has four threaded holes for mounting the fan with capscrews and lockwashers.

1. Heat Sensor
2. Input Plate
3. Input Shaft
4. Concentric Grooves
5. Drive Chamber
6. Output Plate
7. Fan Blade

Fig. 1

Fan Clutch Inspection and Operation Checking

Inspection

⚠ CAUTION

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

The fan drive is only one part of the cooling system and will function well only if all other parts of the system are working right. All parts of the system should be checked if there is a cooling problem. Do all the checks in the cooling system troubleshooting 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.

1. With the engine off, rotate the fan at least one full turn by hand. It should have a smooth, steady drag. If it doesn't, replace the fan clutch.
2. Check for physical damage to the fan or fan shroud.
3. Inspect the fan clutch mounting.
   - 3.1 Check the torque of the nuts holding the fan input shaft to the fan hub or mounting adapter (diesel engines), or the torque of the internally threaded fan hub nut to the engine shaft (gasoline engines). They should be tightened as follows:
     - Fan clutch input shaft to fan hub, Cummins B Series engine: 61 N·m (45 lbf·ft);
     - Fan clutch input shaft to fan hub, Cummins C Series engine: 46 N·m (34 lbf·ft);
     - Fan clutch input shaft to adapter, Mercedes-Benz OM 366LA engine: 61 N·m (45 lbf·ft);
     - Fan clutch mounting adapter to fan hub, Mercedes-Benz OM 366LA engine: 35 N·m (25 lbf·ft);
     - Internally threaded fan hub nut to engine shaft, Dodge Magnum V-8 engine: 50 to 62 N·m (37 to 46 lbf·ft).
   - 3.2 Check for wear of the fan clutch bearings. There should be no side-to-side or in-and-out movement of the fan clutch.

Operation Checking

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

1. Coolant temperature in the radiator should be below 60°C (140°F) before the start of the test; the outside temperature should be above 10°C (50°F). Ideally, a temperature probe placed about 13 mm (1/2 inch) from the fan clutch sensor is needed to see if the fan clutch engages at the right temperature.
2. Disconnect any hydraulic pumps (such as the power steering pump) to prevent oil overheating.
3. Get a piece of cardboard that is large enough to block the entire front of the radiator. Cut a round 18-centimeter (7-inch) hole in the cardboard; locate the hole so that it lines up with the fan clutch. Don't put the cardboard in front of the radiator yet.

⚠ WARNING

WARNING: Before starting the engine, make sure people's hands and all other objects are away from the fan blades. 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. Don't try to restrict the fan blade rotation when the engine is on.

4. Turn off the air conditioner, if so equipped. Start the engine, and let it idle until the oil pressure is normal.
5. 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 eight 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 five minutes or less, when the fan clutch disengages.

Fan Clutch Inspection and Operation Checking

6. After the fan clutch disengages, put the cardboard in front of the radiator.
7. 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.
8. 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 fan should be fully engaged when the air at the fan clutch sensor rises to about:

   Diesel Engines: 68° to 74°C (155°to 165°F).

   Gasoline Engines: 74° to 80°C (165°to 180°F).

   With the clutch engaged, the coolant temperature will keep rising, at a slower rate, as long as the radiator is blocked with cardboard.
9. Remove the cardboard from in front of the radiator. Keep watching the coolant temperature while the clutch is engaged; you should notice a decrease after the cardboard is removed.
10. The fan should disengage when the air temperature at the fan clutch sensor drops to about:

    Diesel Engines: 49° to 54°C (120°to 130°F).

    Gasoline Engines 57° to 79°C (135°to 175°F).

    If the coolant temperature keeps rising, even though the fan is engaged and the cardboard has been removed, the fan clutch may be working okay; 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, then 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 okay, 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

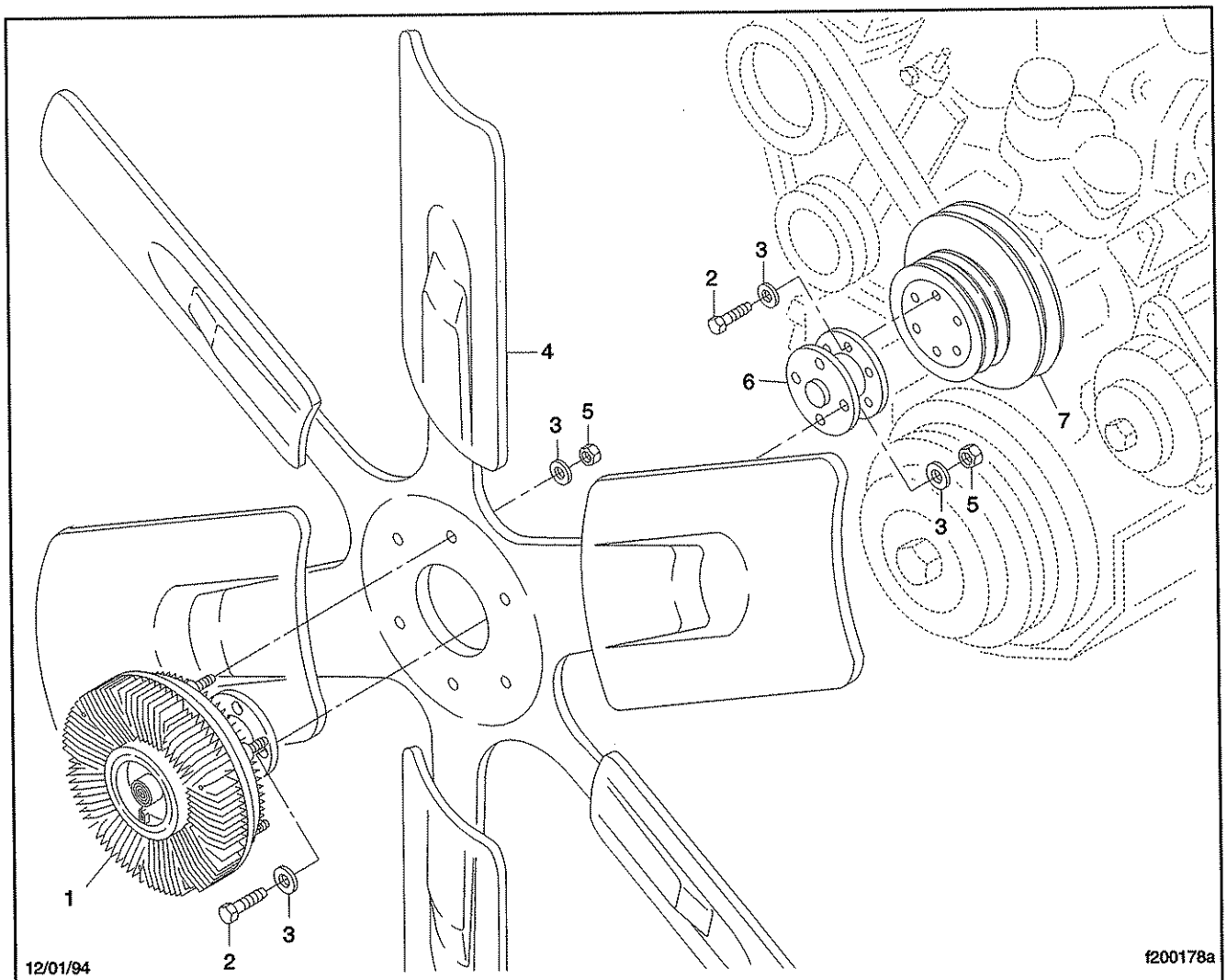
Fan speed must be at least 2009 rpm when the fan clutch is fully engaged.

Fan Clutch Removal and Installation

Removal (See Fig. 1, Fig. 2, or Fig. 3)

1. Shut down the vehicle, apply the parking brakes, chock the tires, and (if applicable) drain the air system.
2. 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.

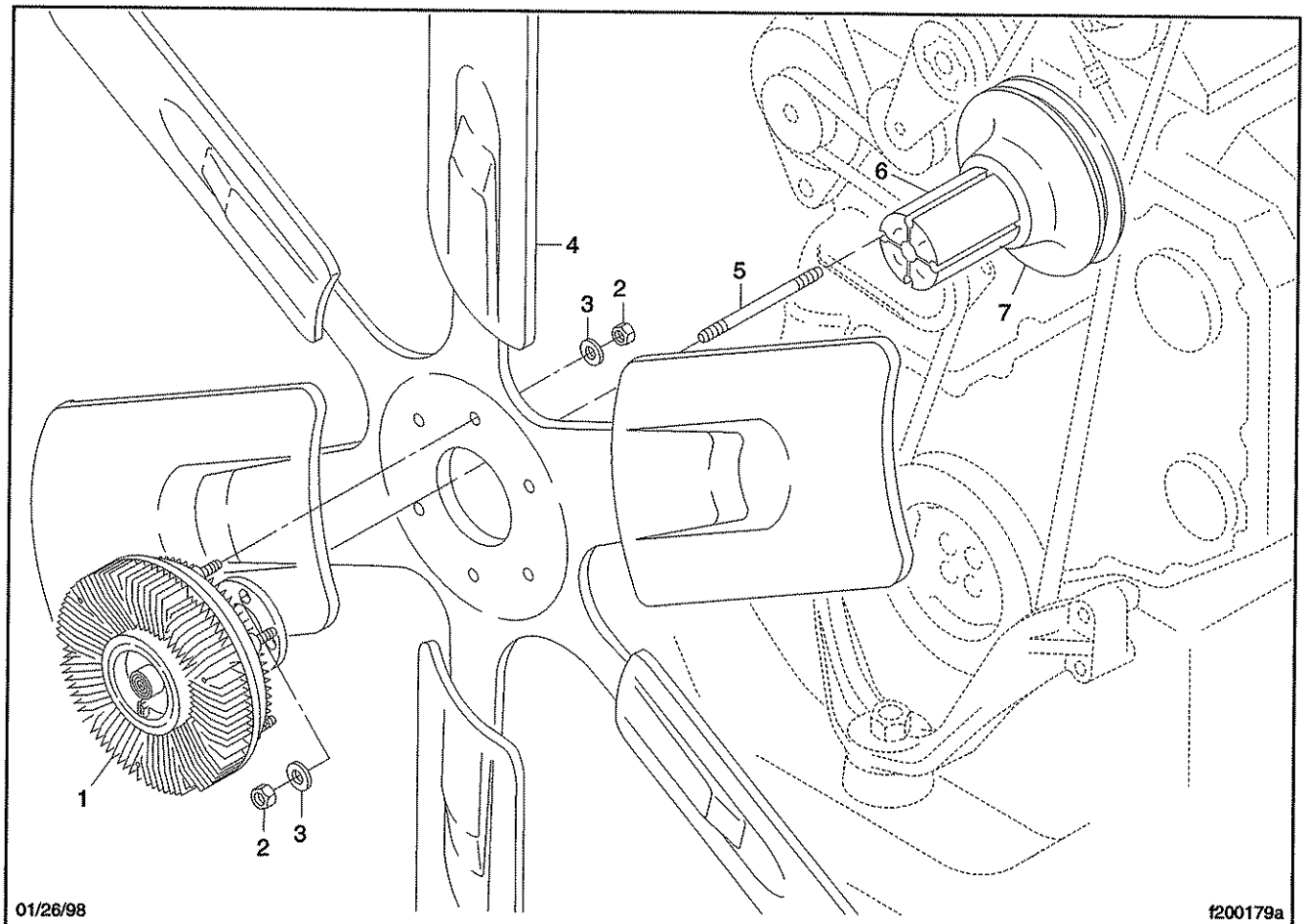


NOTE: The Eaton 660 viscous fan clutch is shown here.

1. Fan Clutch Assembly
2. Capscrew
3. Lockwasher
4. Fan Blade
5. Locknut
6. Fan Clutch Adapter
7. Fan Hub

Fig. 1, Fan Clutch Mounting for Mercedes-Benz OM 366LA Engine

Fan Clutch Removal and Installation



NOTE: The Eaton 660 viscous fan clutch is shown here.

1. Fan Clutch Assembly
2. Locknut
3. Lockwasher
4. Fan Blade
5. Stud
6. Spacer
7. Fan Hub

Fig. 2, Fan Clutch Mounting for Cummins B Series Engine

4. *On diesel engines:* remove the capscrews and lockwashers (**Fig. 1**, Refs. 2 and 3), or locknuts and lockwashers (**Fig. 2**, Refs. 2 and 3) that hold the clutch to the fan hub. Remove the clutch from the engine.

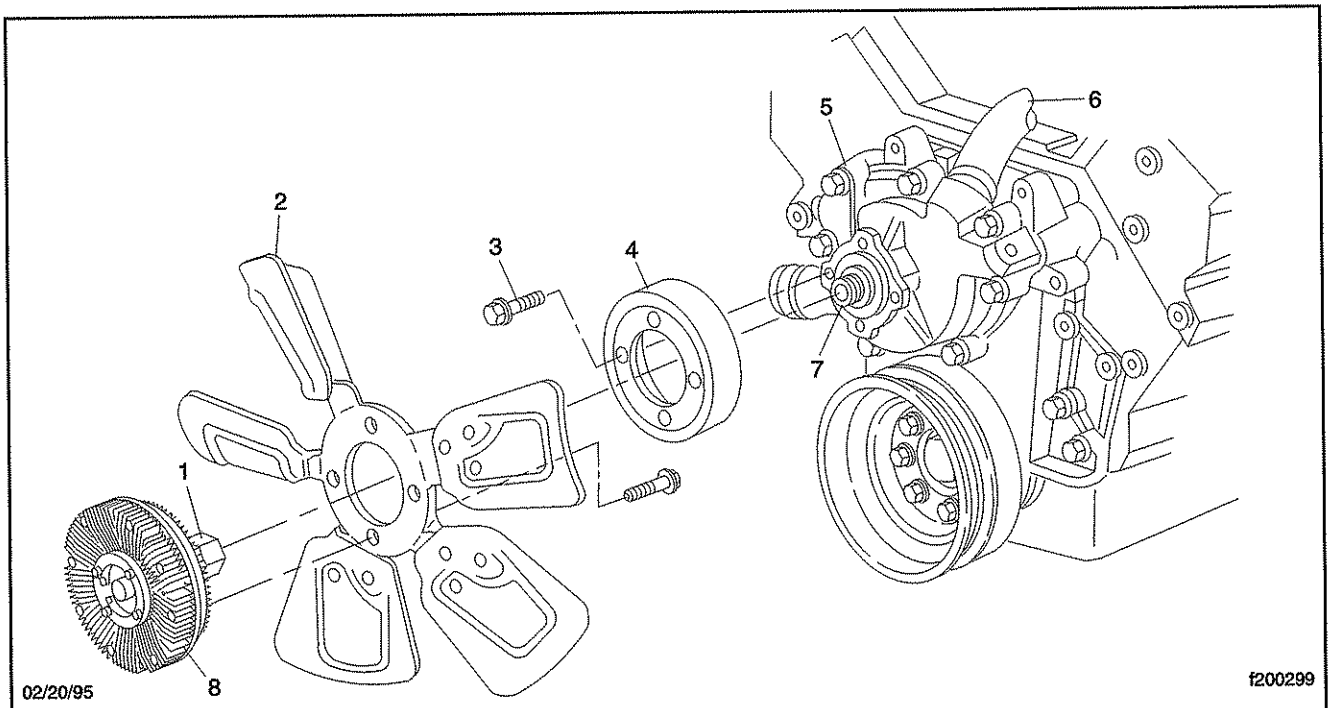
   If necessary, on Mercedes-Benz OM 366LA engines, remove the capscrews and lockwashers (**Fig. 1**, Refs. 2 and 3) that secure the fan clutch adapter (Ref. 6) to the fan hub. Remove the adapter from the fan hub.

5. *On gasoline engines:* place a bar or screwdriver between the water pump pulley bolts to keep the pulley from turning. Then, use a wrench to turn the fan hub nut counterclockwise as viewed from the front of the vehicle.

   Unscrew the fan hub nut from the engine shaft, and remove the fan clutch from the engine.

6. Remove the nuts and lockwashers (diesel engines), or capscrews and lockwashers (gasoline engines) that hold the fan blade to the clutch. Remove the blade.

Fan Clutch Removal and Installation



NOTE: The Eaton 575 viscous fan clutch is shown here.

1. Fan Hub Nut
2. Fan Blade
3. Pulley Bolts
4. Water Pump Pulley
5. Water Pump
6. Coolant Bypass Hose
7. Threaded Engine Shaft (Water Pump Hub)
8. Viscous Fan Clutch Assembly

Fig. 3, Fan Clutch Mounting for Dodge Magnum V-8 Engine

Installation (See Fig. 1, Fig. 2, or Fig. 3)

1. Install the fan blade on the fan clutch. Tighten the fan mounting locknuts as follows:
   - Model 610: 54 N·m (40 lbf·ft);
   - Model 660: 30 N·m (22 lbf·ft);
   - Model 575: 20 to 27 N·m (15 to 20 lbf·ft).

NOTE: Use only approved fans, as specified in the *Freightliner Parts Technical Information Manual.* 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. On Mercedes-Benz OM 366LA engines (**see Fig. 1**), if the fan clutch adapter (Ref. 6) was removed, mount it on the fan hub. Tighten the mounting capscrews 35 N·m (25 lbf·ft).
3. Install the fan clutch assembly. Tighten the fasteners as follows:
   - Mercedes-Benz OM 366LA engines (**Fig. 1**, Ref. 2): 61 N·m (45 lbf·ft);
   - Cummins B Series engines (**Fig. 2**, Ref. 2): 61 N·m (45 lbf·ft);
   - Cummins C Series engines: 46 N·m (34 lbf·ft);
   - Dodge Magnum V-8 engines (**Fig. 3**, Ref. 1): 50 to 62 N·m (37 to 46 lbf·ft).
4. Lower the hood, connect the batteries, and remove the chocks from the tires.

Specifications

Description	Grade	Size	Torque: lbf·ft (N·m)
Fan Mounting Locknuts: Model 610 Clutch	8	3/8	40 (54)
Model 660 Clutch	8	5/16	22 (30)
Model 575 Clutch	—	—	15–20 (20–27)
Fan Clutch Input Shaft to Fan Hub Locknut, Cummins B Series Engine	10.9	M10	45 (61)
Fan Clutch Input Shaft to Fan Hub Locknut, Cummins C Series Engine	10	M10	34 (46)
Fan Clutch Input Shaft to Adapter Capscrew, Mercedes-Benz OM 366LA Engine	10.9	M10	45 (61)
Fan Clutch Mounting Adapter to Fan Hub Capscrew, Mercedes-Benz OM 366LA Engine	10.9	M8	25 (35)
Fan Hub Nut to Engine Shaft, Chrysler V-8 Engine	5	5/16–18	37–46 (50–62)

Table 1, Fastener Torques

Horton EC450/Corsair On/Off Fan Clutch 20.03

Contents

Subject	Subject Number
General Information	050
Service Operations	
Fan Clutch Replacement	100
Temperature Switch/Sensor Replacement	110
Refrigerant Pressure ("Override") Switch Replacement	120
Kysor Temperature Transducer Module (TTM) Removal and Installation	130
Fan Clutch Relay Replacement	140
Troubleshooting	300
Specifications	400

General Information (See Fig. 1)

The Horton EC450 fan clutch (previously marketed as the Corsair fan clutch) is an electromagnetic on/off-style engine cooling fan clutch. The fan clutch is electrically operated, and is not connected to the vehicle's air system.

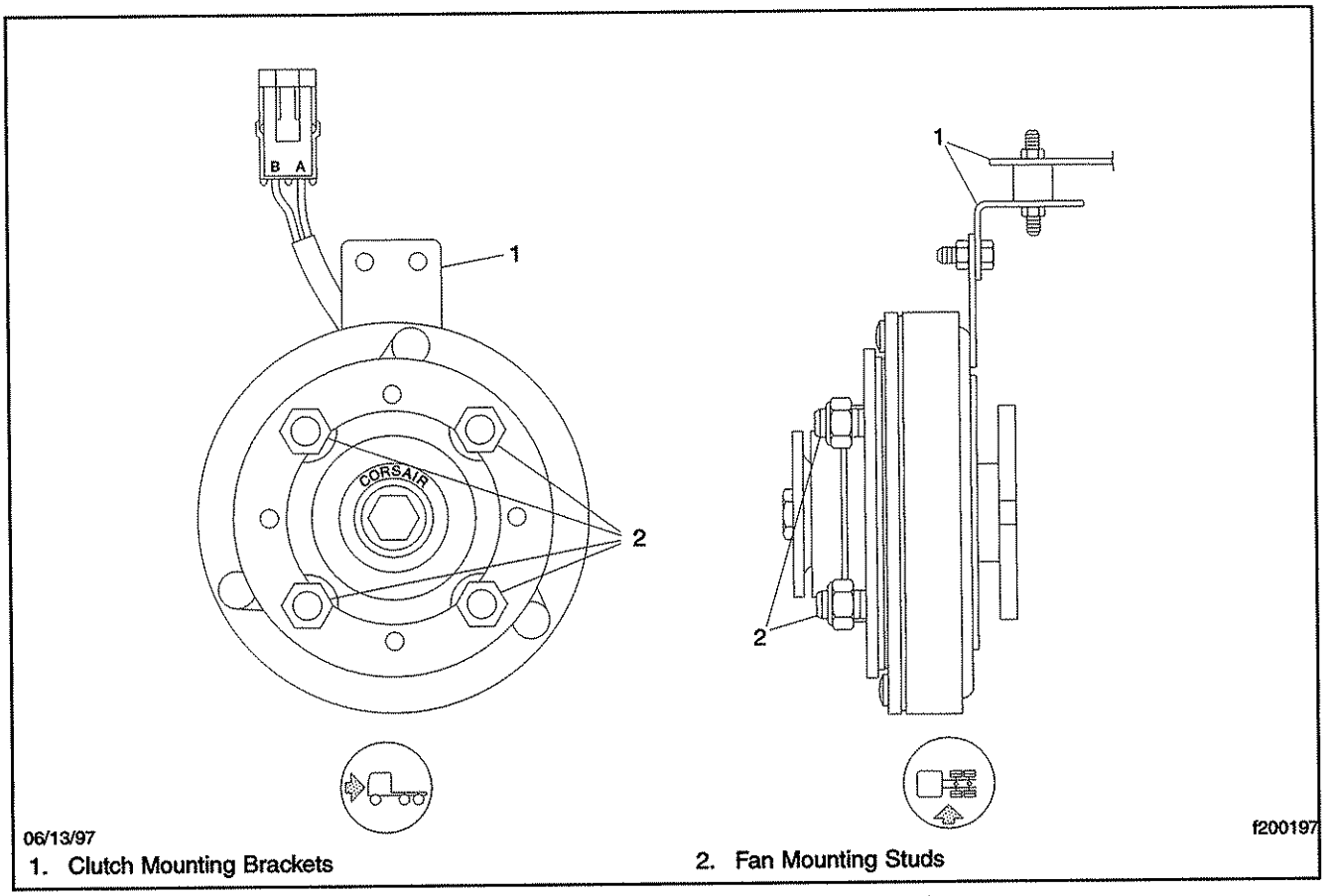
When vehicle motion (ram air effect) provides enough airflow through the radiator to keep engine coolant temperature within operating limits, the fan is disengaged by de-energizing the fan clutch. Disengaging the fan saves fuel, lowers power consumption and engine noise, and—for cold starts—allows the engine and the cab to warm up faster.

When the vehicle is stationary, or whenever extra air flow through the radiator is necessary, the fan clutch is engaged to connect the fan with the fan drive pulley and provide extra engine cooling. On most vehicles, this extra cooling is seldom needed—the clutch is deactivated and the fan is not turning 90 to 95 percent of the time.

There are several different methods of fan control depending on whether or not the vehicle is equipped with air conditioning, and whether or not it is equipped with an engine protection system.

WITHOUT AIR CONDITIONING OR ENGINE PROTECTION SYSTEM

If the vehicle isn't equipped with air conditioning or an engine protection system, a single switch (see **Fig. 2**) in the engine water jacket controls the fan clutch. The switch is "open" until engine coolant temperature rises above a preset limit, usually 200°F (93°C) or 205°F (96°C). Then, the switch closes, energizing the electromagnetic clutch, which engages the fan.



1. Clutch Mounting Brackets
2. Fan Mounting Studs

Fig. 1, Horton EC450 Electromagnetic Fan Clutch

General Information

When coolant temperature drops below a preset point, usually about seven degrees below the switch closing point, the switch again "opens" to deactivate the fan.

WITH AIR CONDITIONING, WITHOUT ENGINE PROTECTION SYSTEM

When the vehicle is equipped with air conditioning, but not an engine protection system, coolant temperature on/off control of the fan is the same as mentioned above. With air conditioning added, however, a normally-open refrigerant pressure switch (an "override" switch), is installed on the receiver-drier. See **Fig. 3**. When refrigerant system high-side pressure rises above a preset limit, usually about 275 psi (1896 kPa) the switch closes and activates the fan, regardless of engine coolant temperature. When pressure drops to about 225 psi (1551 kPa), the switch "opens" to deactivate the fan.

WITHOUT AIR CONDITIONING, WITH ENGINE PROTECTION SYSTEM

If the vehicle is equipped with an engine protection system, the coolant temperature sensor is installed in the engine water jacket port that would otherwise be used for the fan clutch control. Instead of finding another location for the fan switch, the method of controlling the fan (and other functions) is changed.

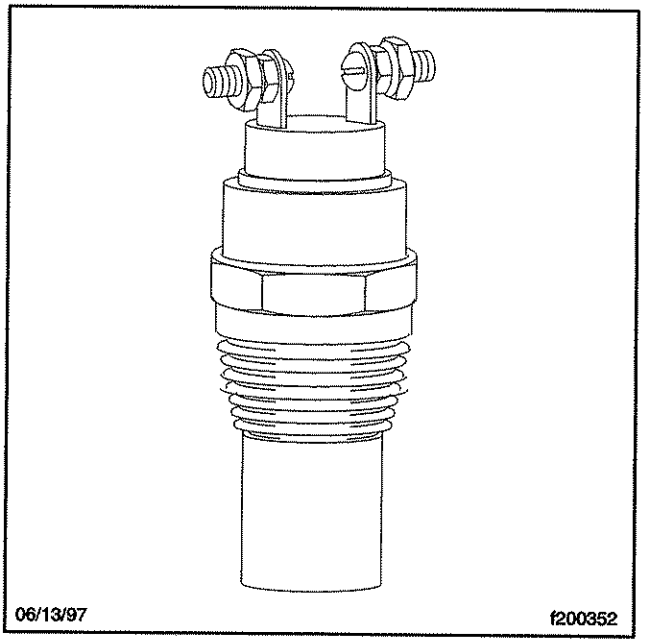


Fig. 2, Coolant Temperature Switch

A Kysor Temperature Transducer Module (TTM), installed behind the instrument panel, is used to control the fan clutch, the engine protection system, and the coolant temperature gauge. See **Fig. 4**. The TTM controls all three of these functions using a single coolant temperature transducer, which is installed in the standard coolant temperature gauge sender port.

NOTE: While all TTMs look the same, they are programmed differently and are not interchangeable. Identify a particular TTM using the part number that appears on the module top surface.

The temperature transducer (**Fig. 5**) is a positive temperature coefficient (PTC) thermistor; as coolant temperature increases, transducer resistance increases. Conversely, as coolant temperature decreases, transducer resistance decreases.

While the TTM drives the coolant temperature gauge and the engine protection system warning lamp and/or buzzer directly, fan clutch current draw is high enough to require use of a fan clutch relay. This relay is mounted behind the instrument panel, in the fuse/relay/circuit breaker panel.

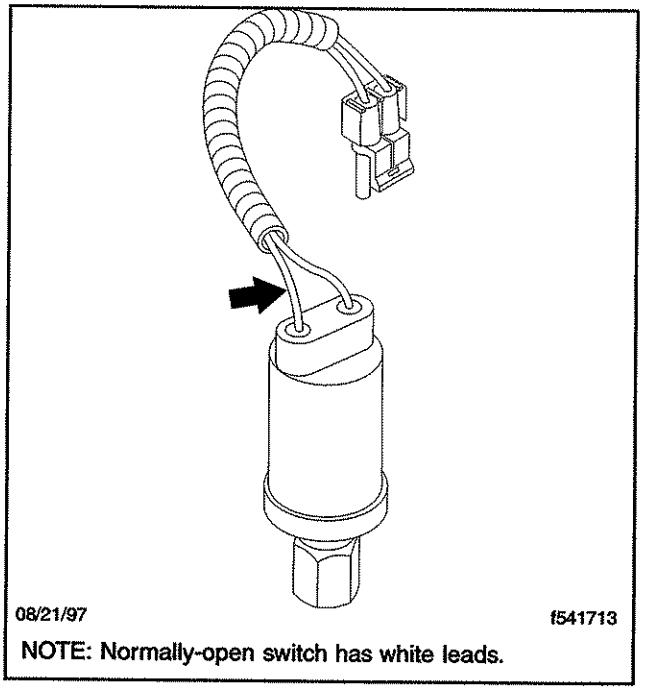
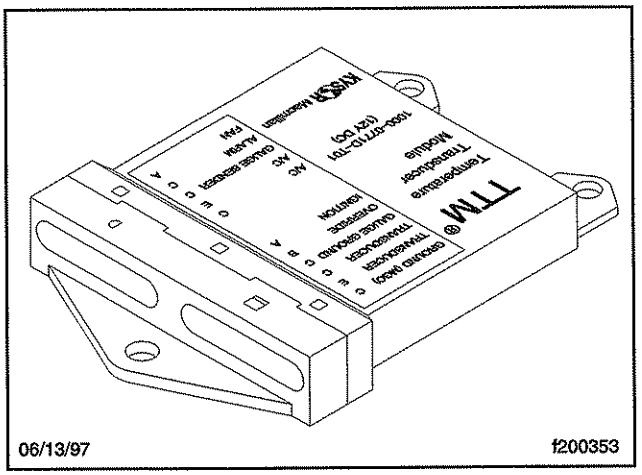
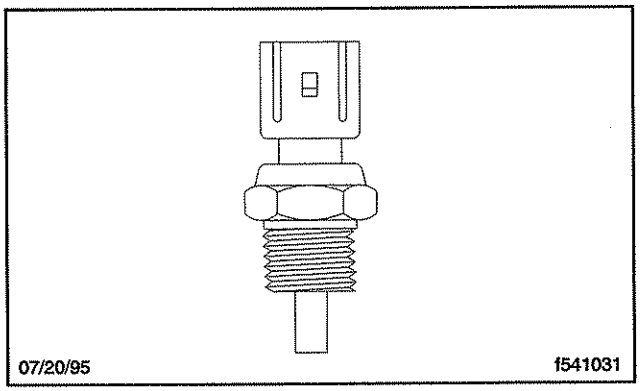


Fig. 3, A/C Override Switch, Without Engine Protection System



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Fig. 4, Temperature Transducer Module (TTM)



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Fig. 5, Coolant Temperature Transducer

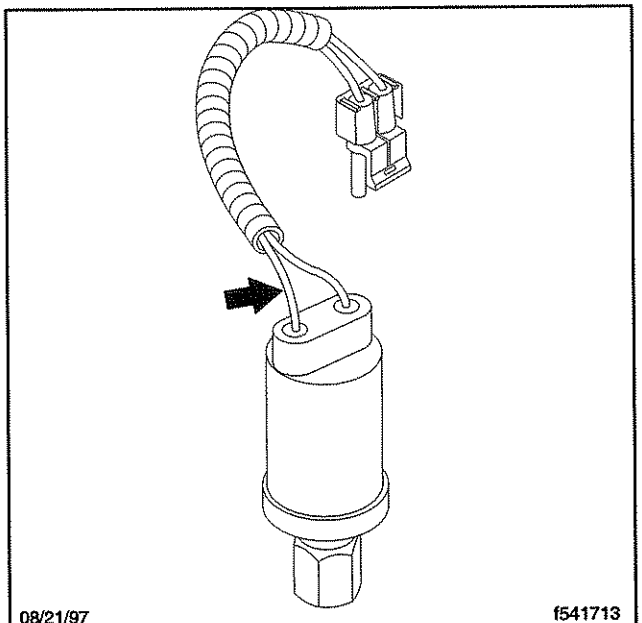
The fan circuit is wired so that the relay, when *de-energized*, is directing power to the fan clutch. When energized by the TTM, the relay interrupts power to the fan clutch.

WITH AIR CONDITIONING AND ENGINE PROTECTION SYSTEM

Fan control circuitry for a vehicle equipped with both an engine protection system and air conditioning is almost the same as fan control circuitry for a vehicle with only an engine protection system. A Kysor Temperature Transducer Module (TTM) is still installed behind the instrument panel (but in a slightly different location), and used to control the fan clutch, the engine protection system, and the coolant temperature gauge as described previously.

An A/C override switch (**Fig. 6**) also provides information to the TTM, but the switch is a *normally closed* switch. The switch contacts "open" when the refrigerant system high-side pressure rises above a preset limit, usually about 275 psi (1896 kPa). The TTM then engages the fan. When pressure drops to about 225 psi (1551 kPa), the switch closes again, but the TTM does not immediately disengage the fan. Instead, it keeps it engaged for about 36 seconds more to ensure adequate fan run time, and reduce fan cycling.

Additional circuitry in the TTM is used to provide override switch monitoring. If the TTM detects an intermittent "open" in the override switch circuit while the fan is operating, it assumes that a fault is present in the circuit. The TTM will then keep the fan engaged for about 5 minutes to alert the driver that there is a fault in the fan control circuit.

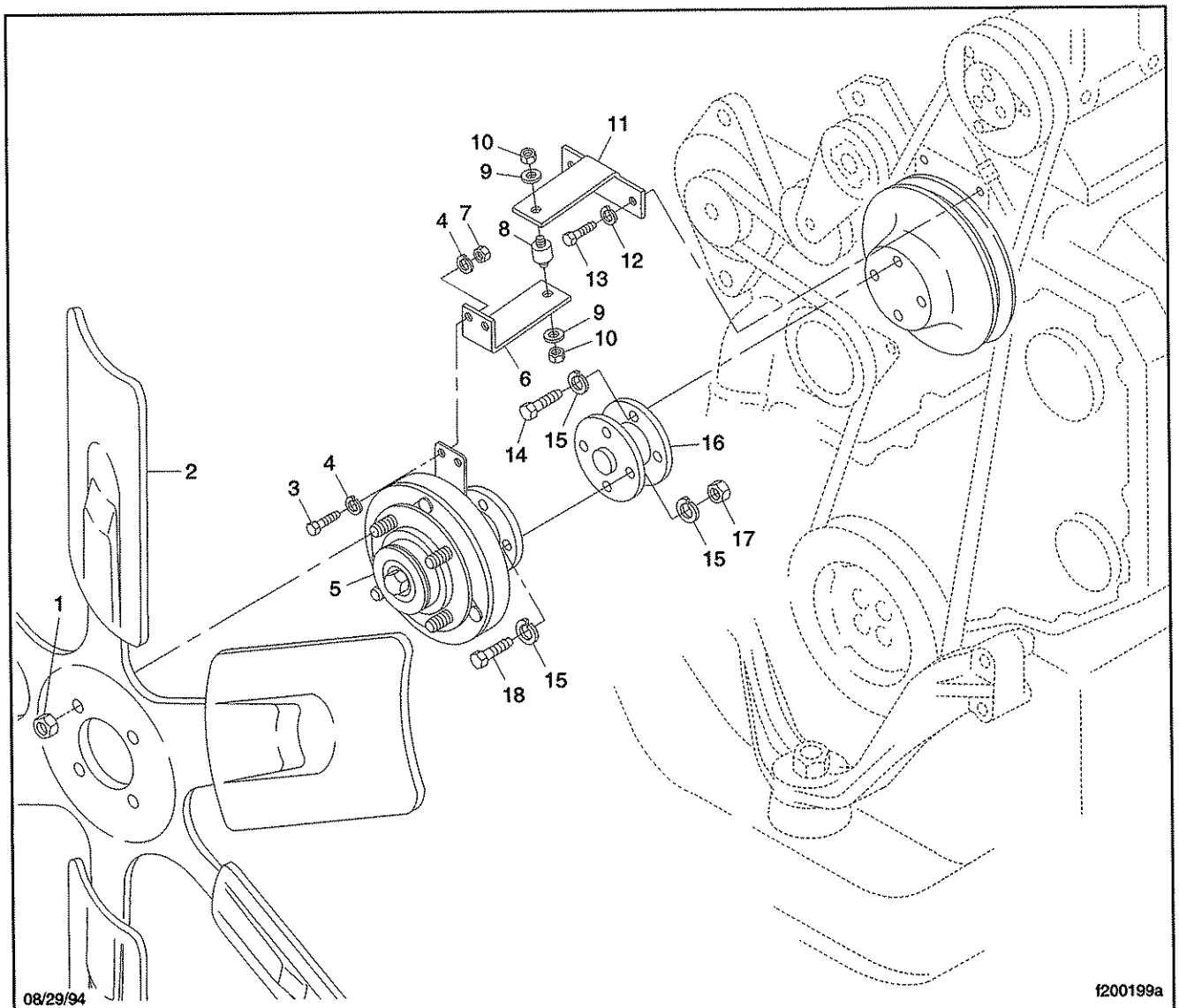


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NOTE: Normally-closed switch has yellow leads.

Fig. 6, A/C Override Switch, With Engine Protection System

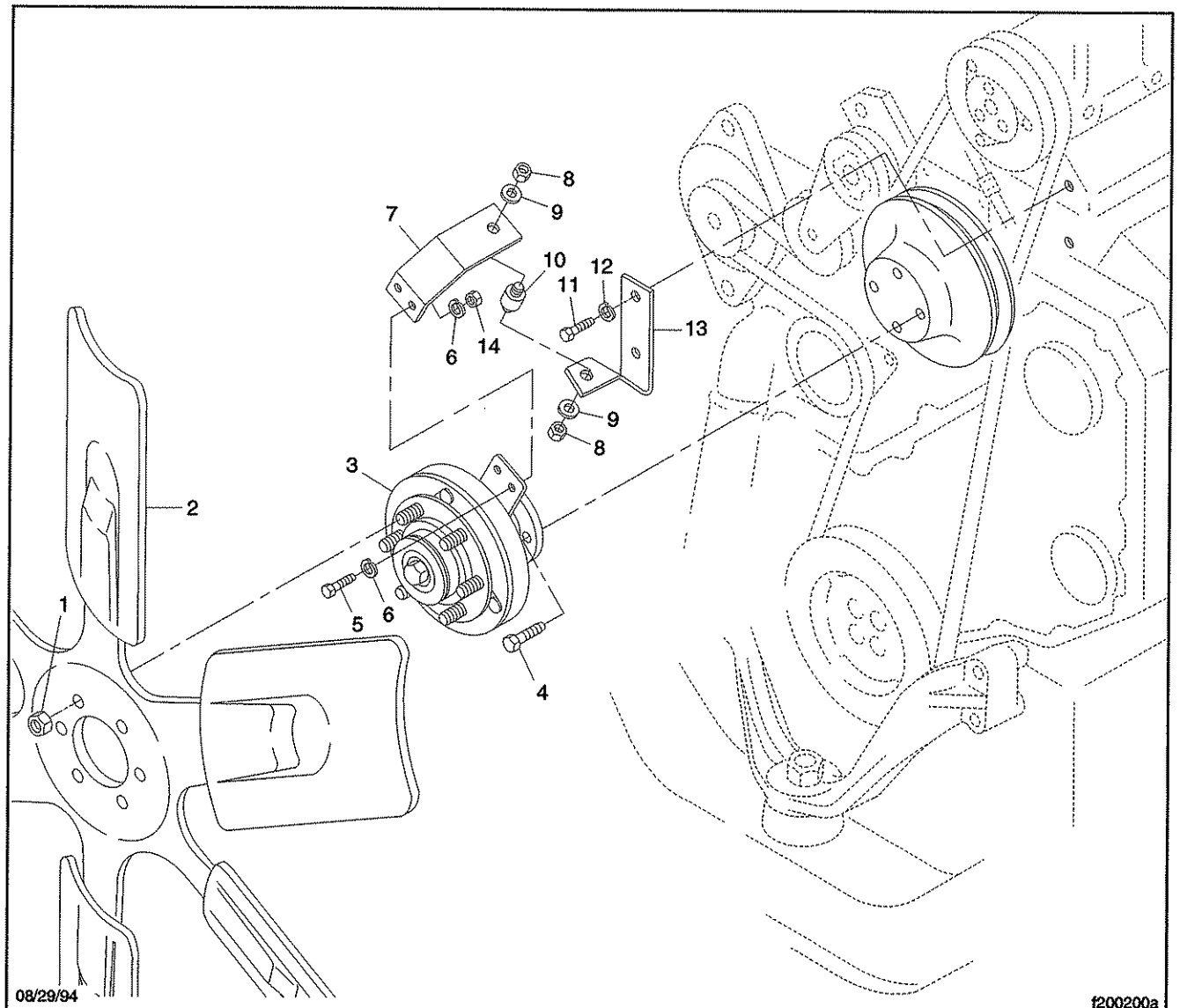
Replacement (See Fig. 1 or Fig. 2)



1. Locknut
2. Fan
3. Capscrew, M6 x 20
4. Lockwasher
5. Fan Clutch
6. Clutch Mounting Bracket, Clutch Side
7. Hexnut, M6
8. Mounting Spacer
9. Flatwasher
10. Hexnut
11. Clutch Mounting Bracket, Engine Side
12. Lockwasher
13. Capscrew, M8 x 45
14. Capscrew, M10 x 25
15. Lockwasher
16. Fan Clutch Adaptor
17. Hexnut, M10
18. Capscrew, M10 x 30

Fig. 1, Fan Clutch Mounting, Cummins B Series Engine

Fan Clutch Replacement



1. Locknut
2. Fan
3. Fan Clutch
4. Capscrew, M10 x 20
5. Capscrew, M6 x 20
6. Lockwasher
7. Clutch Mounting Bracket, Clutch Side
8. Hexnut
9. Flatwasher
10. Mounting Spacer
11. Capscrew, M8 x 20
12. Lockwasher
13. Clutch Mounting Bracket, Engine Side
14. Hexnut, M6

Fig. 2, Fan Clutch Mounting, Cummins C Series Engine

1. Apply the parking brakes, chock the tires, and (if applicable) drain the air system.
2. Disconnect the battery ground cable at the vehicle frame, or if the vehicle is equipped with a battery shutoff switch, turn off the switch.
3. Tilt the hood.

4. Remove the fan clutch.
   - 4.1 Disconnect the fan clutch field coil connector.
   - 4.2 Remove the locknuts from the fan clutch studs.
   - 4.3 Remove the fan from the fan clutch.
   - 4.4 Remove the two capscrews, lockwashers, and hexnuts that hold the clutch-side clutch mounting bracket to the fan clutch.
   - 4.5 Remove the four capscrews that hold the fan clutch to the fan clutch adaptor or the fan hub.
   - 4.6 Remove the fan clutch from the vehicle.
5. Install the new fan clutch.
   - 5.1 Position the fan clutch on the fan clutch adaptor or the fan hub.
   - 5.2 Secure the fan clutch with four capscrews. For Cummins B Series engines, use new split lockwashers. Tighten the capscrews 34 lbf·ft (46 N·m).
   - 5.3 Secure the clutch-side clutch mounting bracket to the fan clutch with two capscrews. Use new split lockwashers, and tighten the capscrews 62 lbf·in (700 N·cm).
   - 5.4 Position the fan on the fan clutch, and secure it with new locknuts.

     For a Cummins C Series engine, tighten the locknuts 16 lbf·ft (22 N·m).

     For a Cummins B Series engine, tighten the locknuts 38 lbf·ft (52 N·m).
   - 5.5 Connect the fan clutch field coil wiring to the engine wiring harness.
6. Test the fan clutch operation by running the engine until the coolant temperature is above 200°F (93°C). The fan clutch should engage.
7. Lower the hood, and remove the chocks from the tires.

Temperature Switch/Sensor Replacement

Replacement

1. Shut down the engine, apply the parking brake, and chock the tires.
2. Open the hood and locate the temperature switch/sensor. See **Fig. 1** or **Fig. 2**.

⚠ WARNING

Don't drain the cooling system while the engine is hot. To avoid personal injury from scalding coolant, wait until the engine has cooled down before draining the system.

3. Drain coolant from the system until the coolant level drops below the temperature switch/sensor location.
   - 3.1 With the engine cool, loosen the radiator cap to release pressure from the radiator, then tighten the cap.
   - 3.2 Place a clean drain pan under the drain plug or petcock located at the bottom of the radiator left end-tank. See **Fig. 3**. Remove the drain plug or open the petcock. If necessary, use a deflector to channel coolant away from the front springs and into the drain pan.
   - 3.3 Install the drain plug or tighten the petcock.
4. Disconnect the wires from the temperature switch (or unplug the wiring harness connector from the temperature sensor), and unscrew the switch/sensor from the engine.
5. Clean old sealant residue from the threads of the switch/sensor port in the engine.
6. Apply pipe thread sealant to the threads of the new switch/sensor, and install it in the engine port. Tighten the switch/sensor until it is snug.

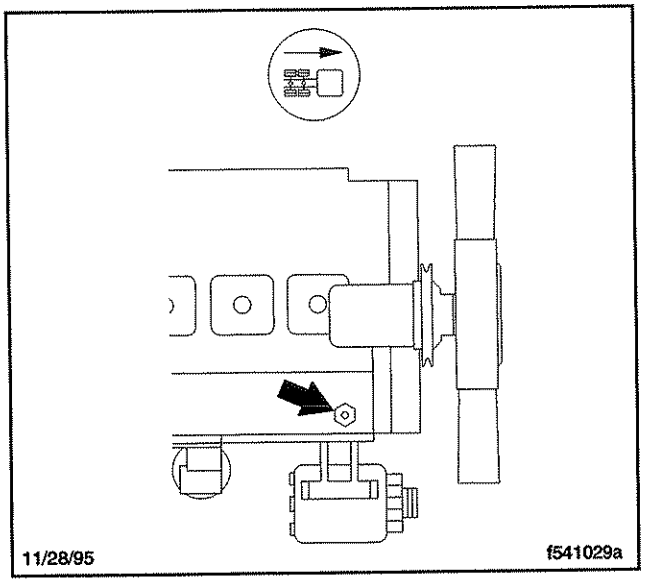


Fig. 1, Temperature Switch/Sensor Location, Cummins B Series Engine

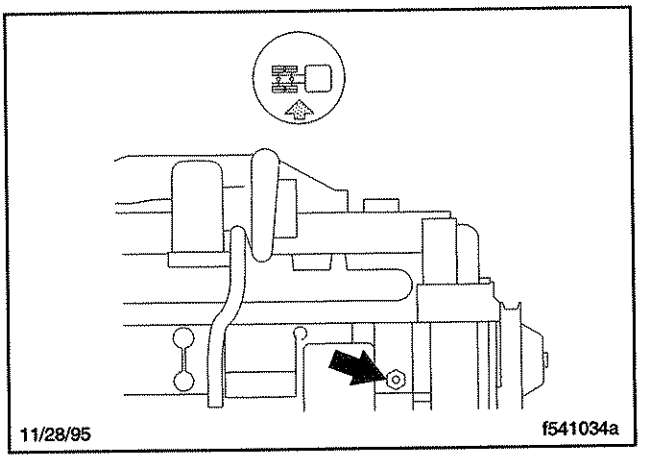


Fig. 2, Temperature Switch/Sensor Location, Cummins C Series Engine

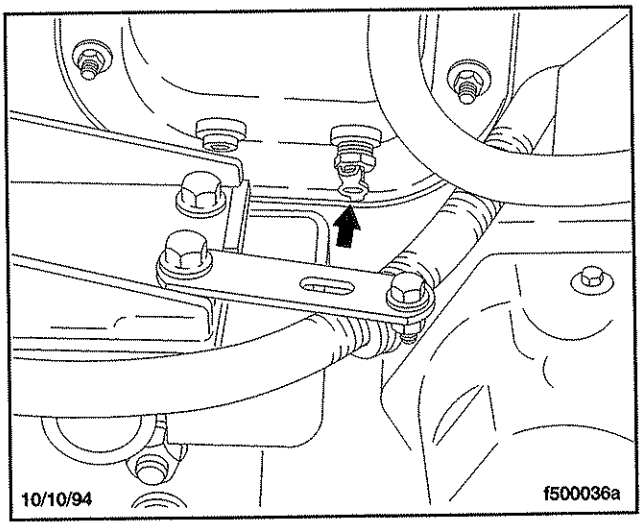


Fig. 3, Radiator Drain Location, Typical

Temperature Switch/Sensor Replacement

7. Connect the vehicle wiring harness to the temperature switch/sensor.
8. Fill the cooling system.
9. Start the engine, check for leaks, and check that the fan clutch and coolant temperature gauge are operating properly.
10. Return the hood to the operating position.
11. Remove the chocks from the tires.

Refrigerant Pressure ("Override") Switch Replacement

Replacement

1. Shut down the engine, apply the parking brake, and chock the tires.
2. Open the hood and locate the "override" pressure switch on the A/C receiver-drier. See **Fig. 1**.

NOTE: It is not necessary to recover refrigerant from the A/C system before removing the override switch. The receiver-drier fitting is equipped with a Schrader valve which closes automatically as the override switch is removed.

3. Disconnect the switch electrical connector and unscrew the switch from the receiver-drier.

IMPORTANT: Be sure that you have the correct replacement switch before installing it. Switches with yellow leads have normally-closed contacts, while switches with white leads have normally-open contacts. Installing an incorrect switch will cause the fan clutch to operate improperly.

4. Screw the override switch onto the receiver-drier fitting and tighten it securely.
5. Plug the switch connector into the vehicle wiring harness connector.
6. Start the engine, turn on the air conditioning system, and verify that the fan clutch operates properly.
7. Close the hood and remove the chocks from the tires.

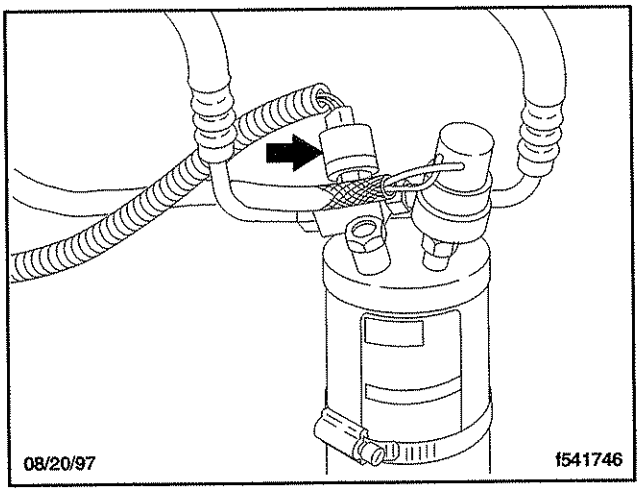


Fig. 1, Override Switch Location

Kysor Temperature Transducer Module (TTM) Removal and Installation

Removal

1. Remove the extruded rubber trim strip at the top of the dashboard. See **Fig. 1**.
2. Remove the right hand dash panel.
   - 2.1 Remove the two screws from the top of the right hand dash panel and pivot the top of the panel rearward.
   - 2.2 Lift out the dash panel. See **Fig. 2**.

NOTE: The TTM mounting location varies slightly depending on installed equipment. On vehicles equipped with an engine warning system, but without an engine shutdown system, the TTM is fastened to the top of the electrical accessories mounting bracket. On vehicles equipped with both engine warning and engine shutdown systems, the TTM is mounted to the underside of the accessories mounting bracket.

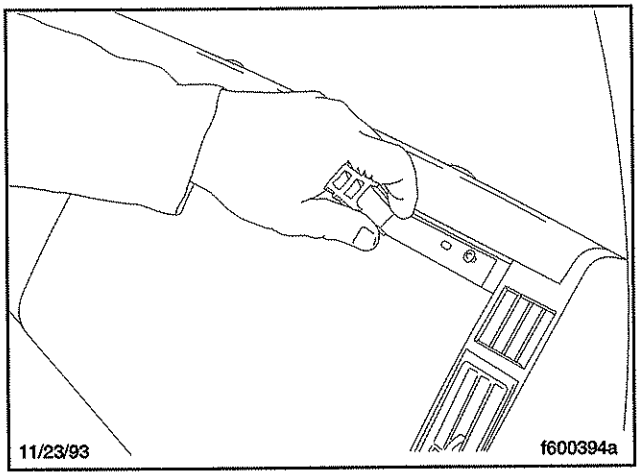


Fig. 1, Trim Strip Removal

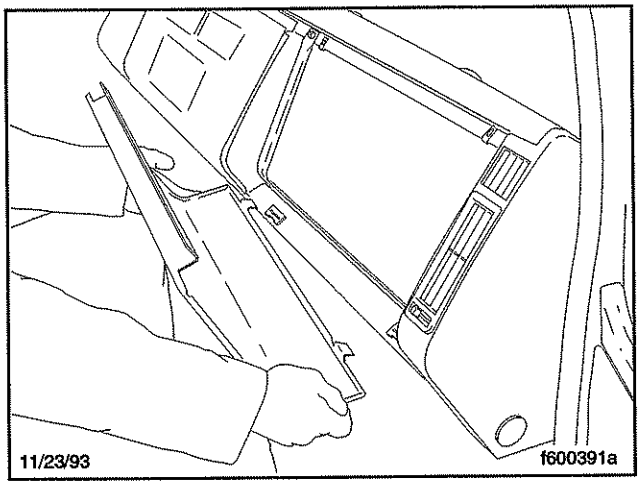


Fig. 2, Dash Panel Removal

3. If equipped with an electronically-controlled automatic transmission, remove the transmission control module fasteners and reposition the module to allow TTM access. See **Fig. 3**.
4. If necessary, reposition or remove the right-hand dash outlet air duct. See **Fig. 4**.
5. Remove the torx fasteners securing the TTM to the electrical accessories mounting bracket (**Fig. 5**). Reposition the TTM to access its electrical connectors, disconnect the connectors, and remove the TTM.

Installation

1. Place the TTM on the electrical accessories mounting bracket and connect the wiring harness connectors to the TTM.
2. Reposition the TTM as necessary to install its mounting screws and tighten the screws. See **Fig. 5**.
3. If necessary, install or reposition the right-hand dash outlet air duct. Keep the duct as straight and kink-free as possible, to prevent reduced air flow from the dash outlet.
4. If equipped with an electronically-controlled automatic transmission, move the module back into

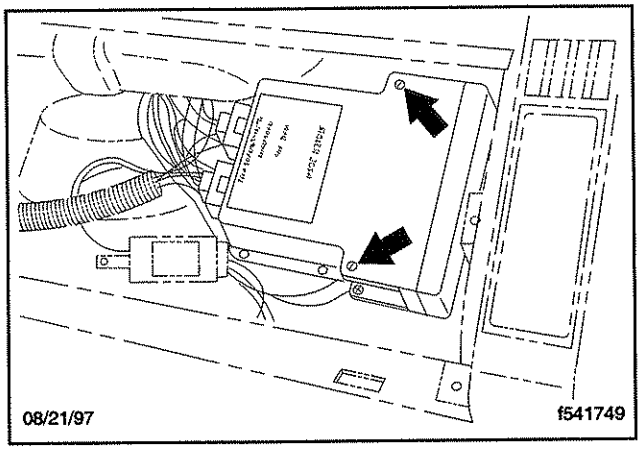


Fig. 3, Transmission Control Module Fastener Access Holes

Kysor Temperature Transducer Module (TTM) Removal and Installation

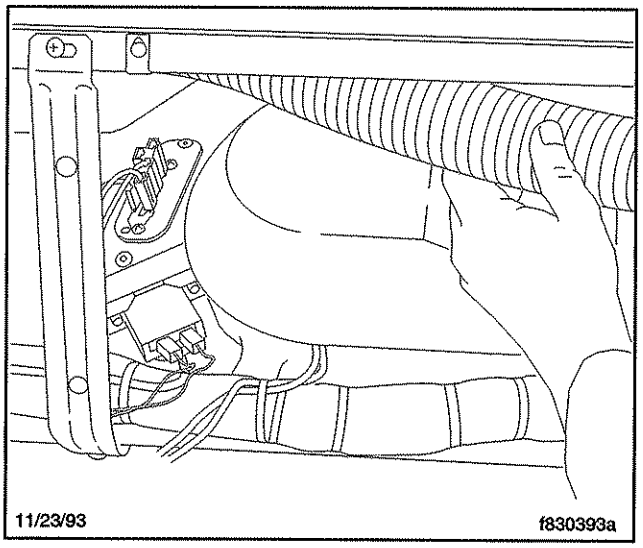


Fig. 4, Defroster Duct Repositioning

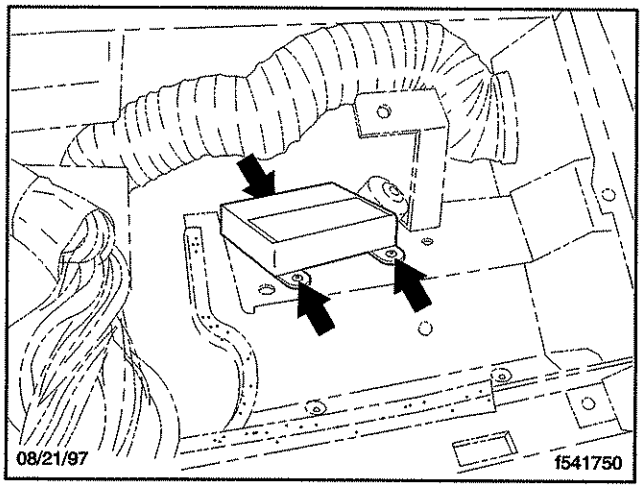


Fig. 5, Kysor TTM Fasteners

position on the electrical accessories mounting bracket. Install the module mounting screws and tighten them. See **Fig. 3.**

5. Install the right-hand dash panel.

   5.1 Insert the two tabs on the lower edge of the dash panel into the slots in the dashboard. Then, pivot the top of the panel forward until it contacts the dashboard. See **Fig. 2.**

   5.2 Install the two torx screws at the top of the dash panel and tighten them.

6. Install the extruded rubber strip into the slot at the top of the dashboard. See **Fig. 1.**

Fan Clutch Relay Replacement

Replacement

1. Remove the quarter-turn fasteners securing the fuse/relay/circuit breaker panel cover to the instrument panel and remove the cover. See **Fig. 1**.
2. Locate the fan clutch relay, which is attached to the upper edge of the fuse/circuit breaker/relay panel. See **Fig. 2**. The exact mounting location varies depending upon the number and type of electrical accessories present on the vehicle, but the fan clutch relay can be positively identified by the four circuits connected to the relay: circuits 234 (2), 234A, and 234B.
3. Unplug the old relay, and install the new one.
4. Install the fuse/relay/circuit breaker panel panel.

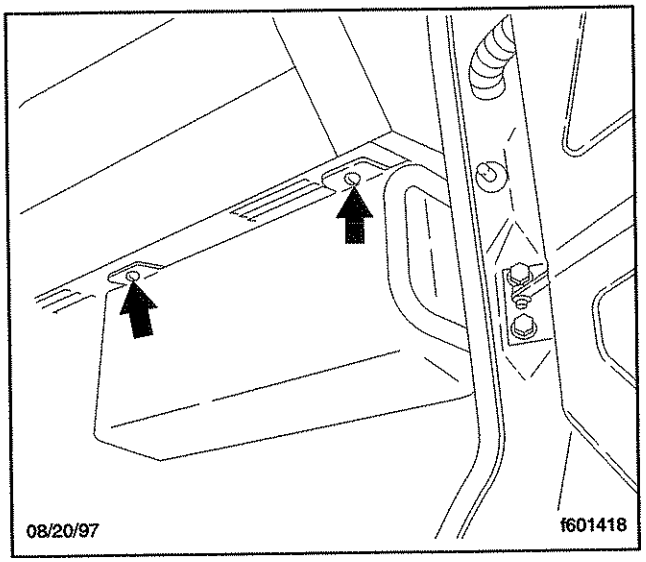
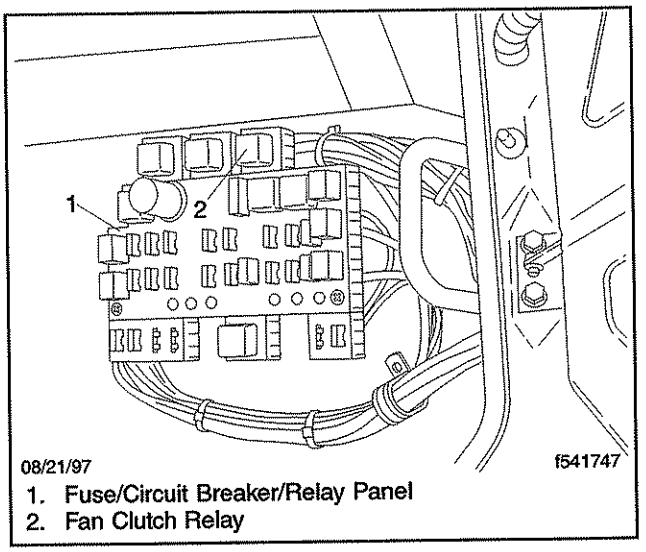


Fig. 1, Fuse/Relay/Circuit Breaker Panel Cover Fasteners



1. Fuse/Circuit Breaker/Relay Panel
2. Fan Clutch Relay

Fig. 2, Fan Clutch Relay Mounting Location (typical)

Troubleshooting Tables

WITHOUT ENGINE PROTECTION OR SHUTDOWN SYSTEM

Problem—The Fan Clutch Does Not Engage

Problem—The Fan Clutch Does Not Engage	
Possible Cause	**Remedy**
Power is not reaching the coolant temperature switch (or the A/C override switch, if equipped).	Check for a blown fuse; replace the fuse, if necessary. Check for battery voltage at the coolant temperature switch (and A/C override switch, if equipped). If voltage is not present, repair or replace wiring as required.
The coolant temperature switch is faulty or an incorrect switch has been installed.	Check the switch temperature rating and verify that the switch closes when the rated temperature is reached. This can be done by connecting a voltmeters positive lead to the switches output terminal, and the voltmeters negative lead to a good ground. Then, start the engine and monitor engine coolant temperature as the engine heats up (to monitor the temperature use the instrument panel temperature gauge, a scan tool on electronic engines, or remove the radiator cap and install a thermometer before starting the engine). When the engine reaches the switches rated temperature, the voltmeter should show battery voltage.
The A/C override switch is faulty or an incorrect switch has been installed.	Install an A/C manifold gauge set on the vehicle and check the override switch closing and opening points. If the switch contacts do not close, replace the switch.
Power is not reaching the fan clutch coil.	Use an ohmmeter to check the continuity of circuit 234A between the coolant temperature switch and the fan clutch coil connector. Repair or replace the wiring, as necessary. Use an ohmmeter to check the continuity of circuits 234E and 234A between the A/C override switch and the fan clutch coil connector. Repair or replace the wiring, as necessary.
The fan clutch coil ground circuit is faulty.	Use an ohmmeter to check the continuity of the GND circuit between the ground terminal on the engine block and the fan clutch coil connector. Clean/tighten the ground terminal, or repair/replace the wiring, as necessary.
The fan clutch coil is faulty.	Unplug the fan clutch coil connector and use an ohmmeter to measure clutch coil resistance. Infinite resistance indicates an open coil; replace the fan clutch. Resistance above 5 ohms indicates a damaged coil; replace the fan clutch.

Troubleshooting

Problem—The Fan Clutch Does Not Disengage

Problem—The Fan Clutch Does Not Disengage	
Possible Cause	**Remedy**
The coolant temperature switch is faulty or an incorrect switch has been installed.	Make sure that the coolant temperature switch is a normally open switch, not a normally closed switch. Replace the switch if it is the wrong type. Use an ohmmeter to verify that the switch is open (infinite resistance) when the engine is cold. If the ohmmeter indicates low (or no) resistance when the engine is cold, replace the coolant temperature switch.
The A/C override switch is faulty or an incorrect switch has been installed.	Make sure that the override switch is a normally open switch, not a normally closed switch. Replace the switch if it is the wrong type. Install an A/C manifold gauge set on the vehicle and check the override switch closing and opening points. If the switching points are incorrect, replace the switch.
The fan clutch is seized due to damage (overheating, improper service, etc.)	Replace the fan clutch assembly.

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 and connections; repair the circuit as needed.
An incorrect coolant temperature switch (wrong temperature rating) has been installed.	Determine the correct fan clutch switch-on temperature for the engine installed in the vehicle. Compare the specified switch-on temperature to that of the switch that is installed on the vehicle. Replace the temperature switch with one having the correct switch-on temperature, if necessary.
The coolant temperature switch is faulty.	Check the switch temperature rating and verify that the switch closes when the rated temperature is reached. This can be done by connecting a voltmeters positive lead to the switches output terminal, and the voltmeters negative lead to a good ground. Then, start the engine and monitor engine coolant temperature as the engine heats up (to monitor the temperature use the instrument panel temperature gauge, a scan tool on electronic engines, or remove the radiator cap and install a thermometer before starting the engine). When the engine reaches the switches rated temperature, the voltmeter should show battery voltage. The switch should remain closed until coolant temperature drops to about 7 degrees below the switches rated temperature. Replace the switch if it does not perform as described.
The A/C override switch switches too soon.	Install an A/C manifold gauge set on the vehicle and check the A/C override switch closing and opening points. If the switching points are incorrect, replace the A/C override switch
There is an air restriction in front of the radiator.	Check for incorrect radiator shutter operation, winterfronts, or any other air restrictions.

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.	Check for incorrect radiator shutter operation, winterfronts, or any other air restrictions.
There is a problem somewhere else in the cooling system.	See the cooling system troubleshooting section in this group.

WITH ENGINE PROTECTION OR SHUTDOWN SYSTEM

Problem—The Fan Clutch Does Not Engage

Problem—The Fan Clutch Does Not Engage	
Possible Cause	**Remedy**
Power is not reaching the fan clutch relay and/or Temperature Transducer Module (TTM). NOTE: If power is not reaching the TTM, the coolant temperature gauge, the high temperature warning lamp, and the fan clutch will be affected. If any one of these three devices is operating normally, power to the TTM is not the problem.	Check for a blown fuse; replace the fuse, if necessary. Check for battery voltage at the fan clutch relay and the Temperture Transducer Module (TTM). If voltage is not present, repair or replace wiring as required.
The fan clutch relay is faulty.	Access the TTM and the electrical mounting panel behind the right hand side of the instrument panel. With the ignition turned off, disconnect the 6 cavity connector from the TTM. Then, turn the ignition switch to run and check for battery voltage at relay terminal 87a. If battery voltage isn't present, replace the relay.
The coolant temperature transducer is faulty or the wrong type of transducer has been installed. NOTE: A faulty or incorrect temperature tranducer will affect the coolant temperature gauge, the high temperature warning lamp, and the fan clutch. If any one of these three devices is operating normally, the temperature transducer is not the problem.	Make sure that the coolant temperature transducer is a KYSOR positive temperature coefficient (PTC) transducer. A negative temperature coefficient (NTC) sensor, like the type normally used to drive the coolant temperature gauge, will not work. Replace the transducer if it is the wrong type. Check transducer resistance when the engine is at room temperature and compare to specifications. If the transducer is questionable, remove it from the engine, and place it in a water bath with a thermometer. Connect an ohmmeter to the transducer terminals and measure resistance as the water bath is heated. Resistance will increase with increasing temperature. If resistances are not within specifications, replace the transducer.
Power is not reaching the fan clutch coil.	Use an ohmmeter to check the continuity of circuits 234B and 234C between the fan clutch relay and the fan clutch coil connector. Repair or replace the wiring, as necessary.
The fan clutch coil ground circuit is faulty.	Use an ohmmeter to check the continuity of the GND circuit between the ground terminal on the engine block and the fan clutch coil connector. Clean/tighten the ground terminal, or repair/replace the wiring, as necessary.
The fan clutch coil is faulty.	Unplug the fan clutch coil connector and use an ohmmeter to measure clutch coil resistance. Infinite resistance indicates an open coil; replace the fan clutch. Resistance above 5 ohms indicates a damaged coil; replace the fan clutch.

Troubleshooting

Problem—The Fan Clutch Does Not Disengage

Problem—The Fan Clutch Does Not Disengage	
Possible Cause	**Remedy**
The coolant temperature transducer is disconnected, faulty, or an incorrect sensor has been installed.	Make sure that the coolant temperature transducer connector is connected to, and firmly seated on the transducer. Use an ohmmeter to verify that the transducer is not open (infinite resistance) at any temperature. If the ohmmeter indicates infinite resistance at any temperature, replace the transducer.
The A/C override switch is disconnected, faulty or and incorrect switch has been installed. NOTE: The TTM is programmed to keep the fan clutch engaged for 36 seconds following override switch closing. Do not mistake this for a system fault. Also, the module is programmed to respond to an override switch or circuit problem by running the fan for 5 minutes.	Make sure that the override switch is a normally closed switch, not a normally open switch. Replace the switch if it is the wrong type. Use an ohmmeter to verify that the transducer is not open (infinite resistance) when the A/C system is turned off. If the ohmmeter indicates low (or no) resistance when the system is off, replace the override switch. Install an A/C manifold gauge set on the vehicle and observe the override switch opening and closing points. If the switching points are incorrect, replace the switch.
The fan clutch relay is faulty.	Access the electrical mounting panel behind the right hand side of the instrument panel. With the ignition switch in run, connect one end of a jumper wire to the relay signal circuit (234A) and touch the other end of the jumper to a good ground. The relay should energize, disengaging the fan. If the relay does not energize, replace it.
The fan clutch is seized due to damage (overheating, improper service, etc.)	Replace the fan clutch assembly.

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.
The temperature transducer module is activating the fan too soon.	Check the fan clutch switch-on temperature for the engine installed in the vehicle. Compare the specified switch-on temperature to that of the temperature transducer module (TTM) that is installed on the vehicle. Replace the TTM with one having the correct switch-on temperature, if necessary.
The A/C override switch on the receiver-drier switches too soon.	Install an A/C manifold gauge set on the vehicle and check the A/C switch closing and opening points. If the switching points are incorrect, replace the A/C override switch.
There is an air restriction in front of the radiator.	Check for incorrect radiator shutter operation, winterfronts, or any other air restrictions.
The engine temperature transducer is faulty or the wrong type of transducer has been installed.	Check transducer resistance when the engine is at room temperature and compare to specifications. If the transducer is questionable, remove it from the engine, and place it in a water bath with a thermometer. Connect an ohmmeter to the transducer terminals and measure resistance as the water bath is heated. Resistance will increase with increasing temperature. If resistances are not within specifications, replace the transducer.

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.	Check for incorrect radiator shutter operation, winterfronts, or any other air restrictions.
There is a problem somewhere else in the cooling system.	See the cooling system troubleshooting section in this group.

Specifications

For fan clutch system wiring diagrams, see **Fig. 1**, **Fig. 2**, and **Fig. 3**.

For fan clutch engine wiring harness information for a Cummins C Series engine, see **Fig. 4**.

For fan clutch engine wiring harness information for a Cummins B Series engine, see **Fig. 5**.

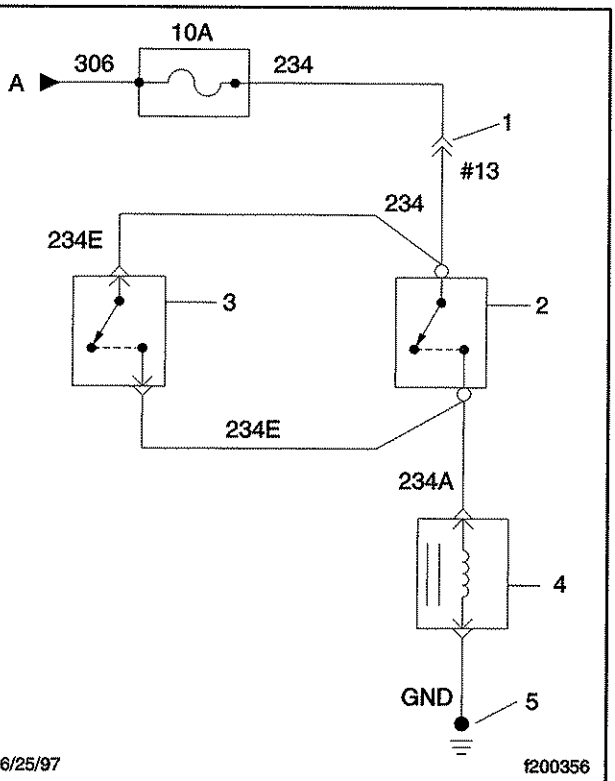
Torque Values				
Description	**Type of Engine**	**Size**	**lbf·ft (N·m)**	**lbf·in (N·cm)**
Fan to Fan Clutch Locknuts:				
4-Stud Fan Clutches	Cummins B Series	M10 x 1.5	38 (52)	—
6-Stud Fan Clutches	Cummins C Series	5/16–18	16 (22)	—
Fan Clutch Capscrews:				
Fan Clutch to Adaptor	Cummins B Series	M10	34 (46)	—
Fan Clutch to Fan Hub	Cummins C Series	M10	34 (46)	—
Fan Clutch to Fan Clutch Bracket Capscrews	—		—	62 (700)

Table 1, Torque Values

KYSOR Temperature Transducer Resistance	
Temperature °F (°C)	**Resistance (Ohms)**
70 (21)	970
80 (27)	1010
90 (32)	1060
100 (38)	1100
110 (43)	1150
120 (49)	1190
130 (54)	1240
140 (60)	1290
150 (66)	1350
160 (71)	1400
170 (77)	1450
180 (82)	1510
190 (88)	1570
195 (91)	1600
200 (93)	1630
205 (96)	1650
210 (99)	1680
215 (102)	1710
220 (104)	1740

Table 2, KYSOR Temperature Transducer Resistance

Specifications

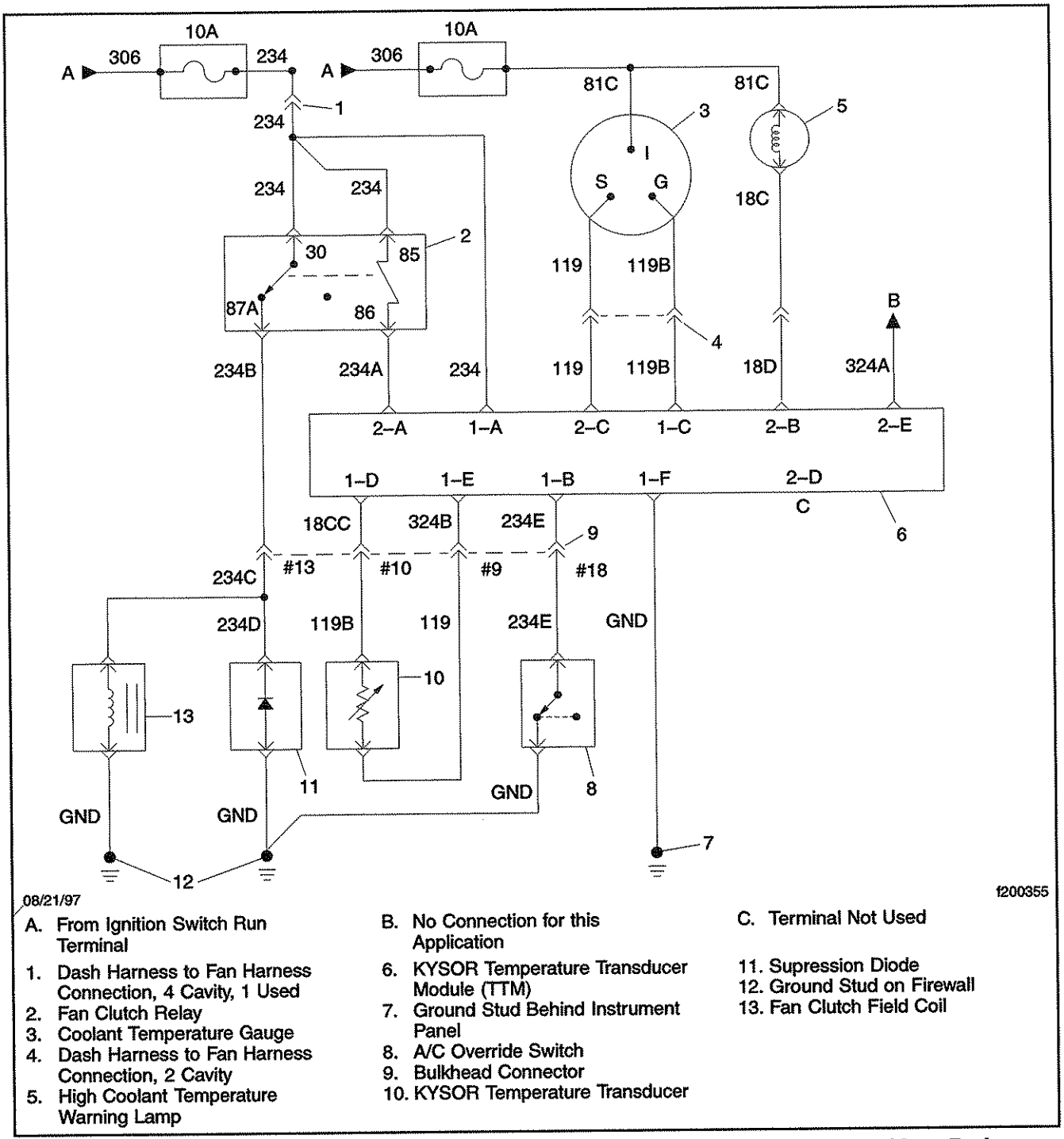


NOTE: Vehicles without air conditioning do not have an A/C override switch. On these vehicles, the wiring harness connector for the override switch is covered with a weather-tight cap.

A. From ignition switch run terminal.

1. Bulkhead Connector
2. Coolant Temperature Switch
3. A/C Override Switch
4. Fan Clutch Field Coil
5. Ground Stud on Firewall

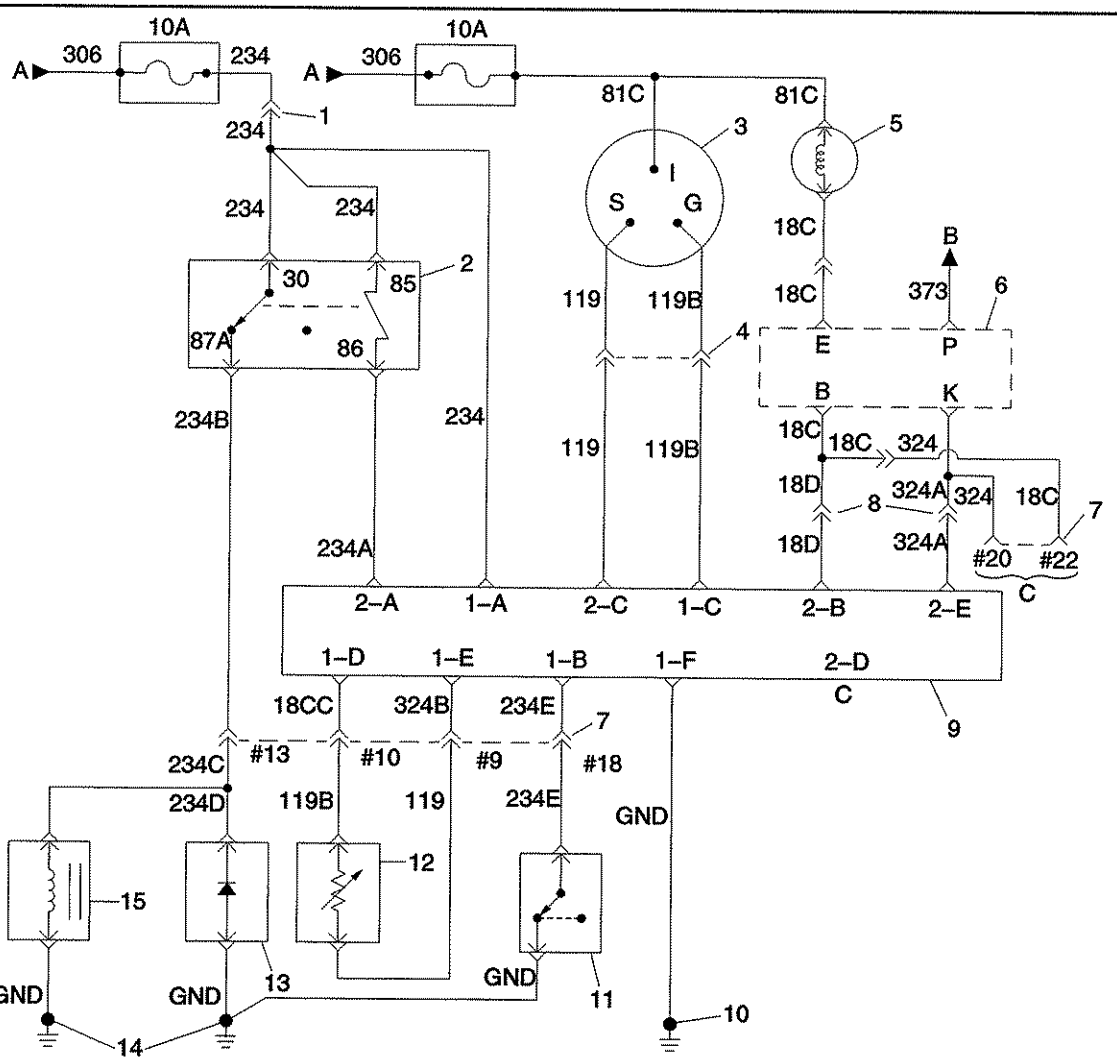
Fig. 1, Wiring Diagram, Horton EC450 Fan Clutch Control Without Engine Protection System or Engine Shutdown System



A. From Ignition Switch Run Terminal
B. No Connection for this Application
C. Terminal Not Used
1. Dash Harness to Fan Harness Connection, 4 Cavity, 1 Used
2. Fan Clutch Relay
3. Coolant Temperature Gauge
4. Dash Harness to Fan Harness Connection, 2 Cavity
5. High Coolant Temperature Warning Lamp
6. KYSOR Temperature Transducer Module (TTM)
7. Ground Stud Behind Instrument Panel
8. A/C Override Switch
9. Bulkhead Connector
10. KYSOR Temperature Transducer
11. Supression Diode
12. Ground Stud on Firewall
13. Fan Clutch Field Coil

Fig. 2, Wiring Diagram, Horton EC450 Fan Clutch Control With Engine Protection System, Without Engine Shutdown System

Specifications

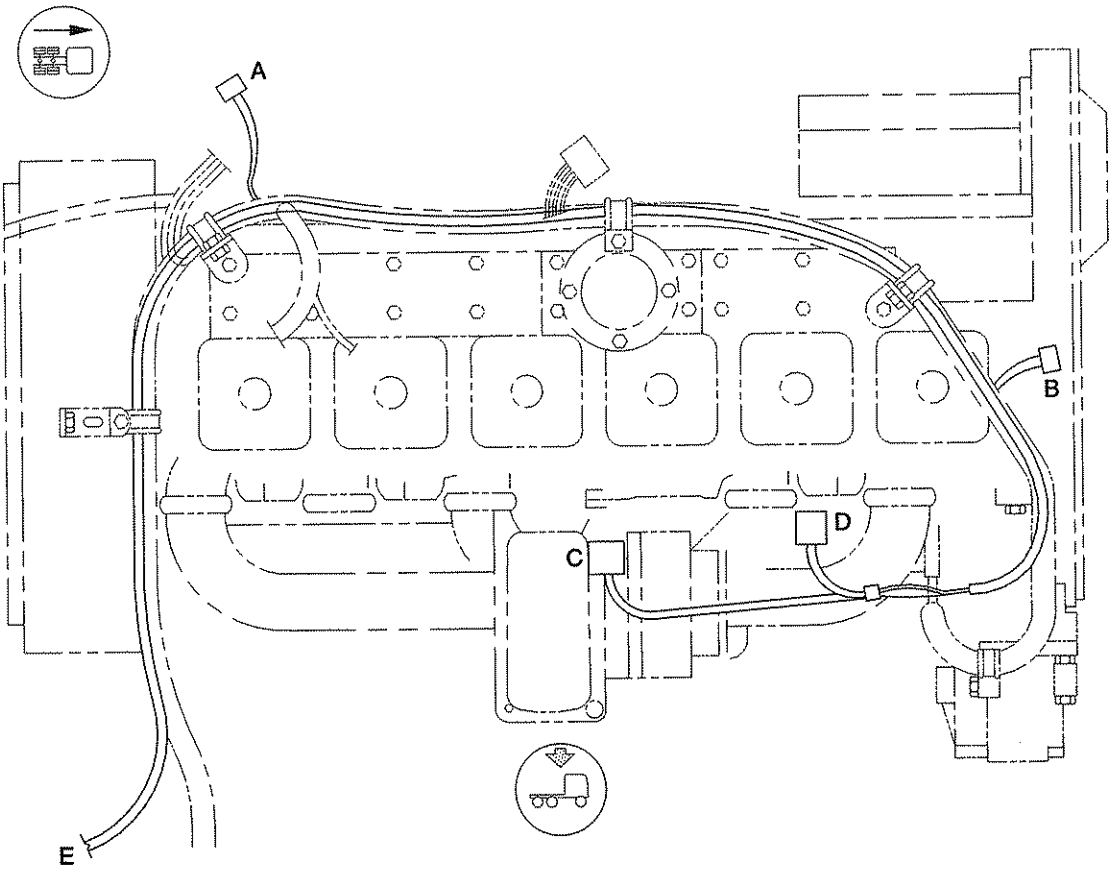


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A. From Ignition Switch Run Terminal
B. To Engine Shutdown Relay
C. Not Used

1. Dash Harness to Fan Harness Connection, 4 Cavity, 1 Used
2. Fan Clutch Relay
3. Coolant Temperature Gauge
4. Dash Harness to Fan Harness Connection, 2 Cavity
5. High Coolant Temperature Warning Lamp
6. KYSOR Shutdown Module
7. Bulkhead Connector
8. Fan Harness to Shutdown Harness Connections, 1 cavity each
9. KYSOR Temperature Transducer Module (TTM)
10. Ground Stud Behind Instrument Panel
11. A/C Override Switch
12. KYSOR Temperature Transducer
13. Supression Diode
14. Ground Stud on Firewall
15. Fan Clutch Field Coil

Fig. 3, Wiring Diagram, Horton EC450 Fan Clutch Control With Engine Shutdown System



08/12/93 f200203

A. Connection to A/C override switch on receiver-drier. On vehicles without air conditioning or an engine protection/shutdown system, the wiring harness connector is covered by a weather-tight cap. On vehicles without air conditioning, but with an engine protection/shutdown system, connector terminals are bridged by a jumper and covered by a weather-tight cap.

B. Connection to Horton EC450 fan clutch.

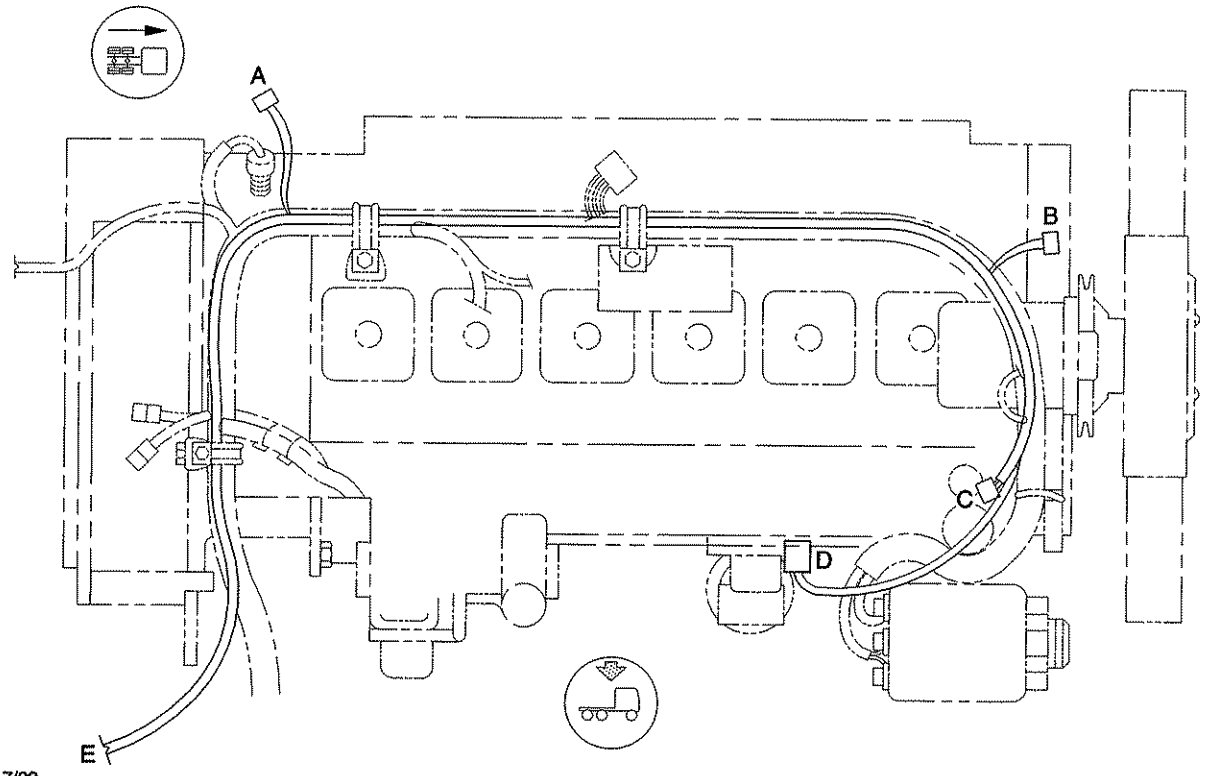
C. On vehicles without an engine protection/shutdown system, wires connect to the coolant temperature switch.

D. On vehicles equipped with an engine protection/shutdown system, wiring connects to the Kysor temperature transducer, which is installed in place of the standard gauge sender.

E. Leads to the bulkhead connector.

Fig. 4, Wiring Harness Installation, Cummins C Series Engine

Specifications



A. Connection to A/C override switch on receiver-drier. On vehicles without air conditioning or an engine protection/shutdown system, the wiring harness connector is covered by a weather-tight cap. On vehicles without air conditioning, but with an engine protection/shutdown system, connector terminals are bridged by a jumper and covered by a weather-tight cap.

B. Connection to Horton EC450 fan clutch.

C. On vehicles without an engine protection/shutdown system, wires connect to the coolant temperature switch.

D. On vehicles equipped with an engine protection/shutdown system, wiring connects to the Kysor temperature transducer, which is installed in place of the standard gauge sender.

E. Leads to the bulkhead connector.

Fig. 5, Wiring Harness Installation, Cummins B Series Engine

Horton Advantage Fan Clutch 20.04

Contents

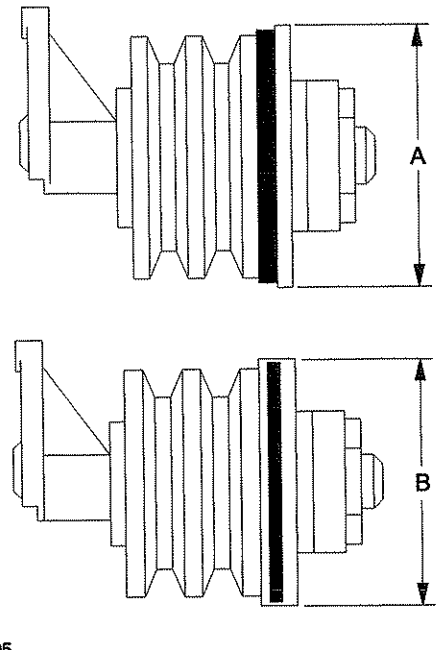
Subject	Subject Number
General Information and Principles of Operation	050
Service Operations	
Removal and Installation	100
Removal and Installation, Equipped with Detroit Diesel Series 55 Engine	105
Fan Clutch Major Rebuild	110
Fan Clutch Minor Rebuild	120
Specifications	400

General Information and Principles of Operation

The fan drive is a temperature-controlled, air-operated clutch for the engine cooling fan. It controls engine temperature by engaging or disengaging the fan. Internal spring pressure disengages the fan clutch when the coolant temperature is below the specified temperature range; internal air pressure engages the fan clutch when the coolant temperature rises above that range. Freightliner uses two models of Horton Advantage fan clutches: S Type and HT/S Type. See **Fig. 1**.

Air pressure to the fan clutch is controlled by a solenoid valve; the solenoid valve is controlled by a temperature switch that is installed in the thermostat housing. See **Fig. 2** and **Fig. 3**.

When you start a cold engine, the solenoid valve restricts air pressure to the cylinder, and the fan clutch remains disengaged.



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A. The S Type fan clutch has a 7.5 inch (187.5 mm) wide piston friction disc.
B. The HT/S Type fan clutch has a 9.5 inch (237.5 mm) wide piston friction disc.

Fig. 1, Horton Advantage Fan Clutches

When the coolant temperature rises to the temperature switch setting, the switch provides power to the solenoid valve, and the valve releases compressed air to engage the fan clutch.

When the coolant temperature drops to the temperature switch cutoff setting, the solenoid stops the compressed air, and the clutch disengages.

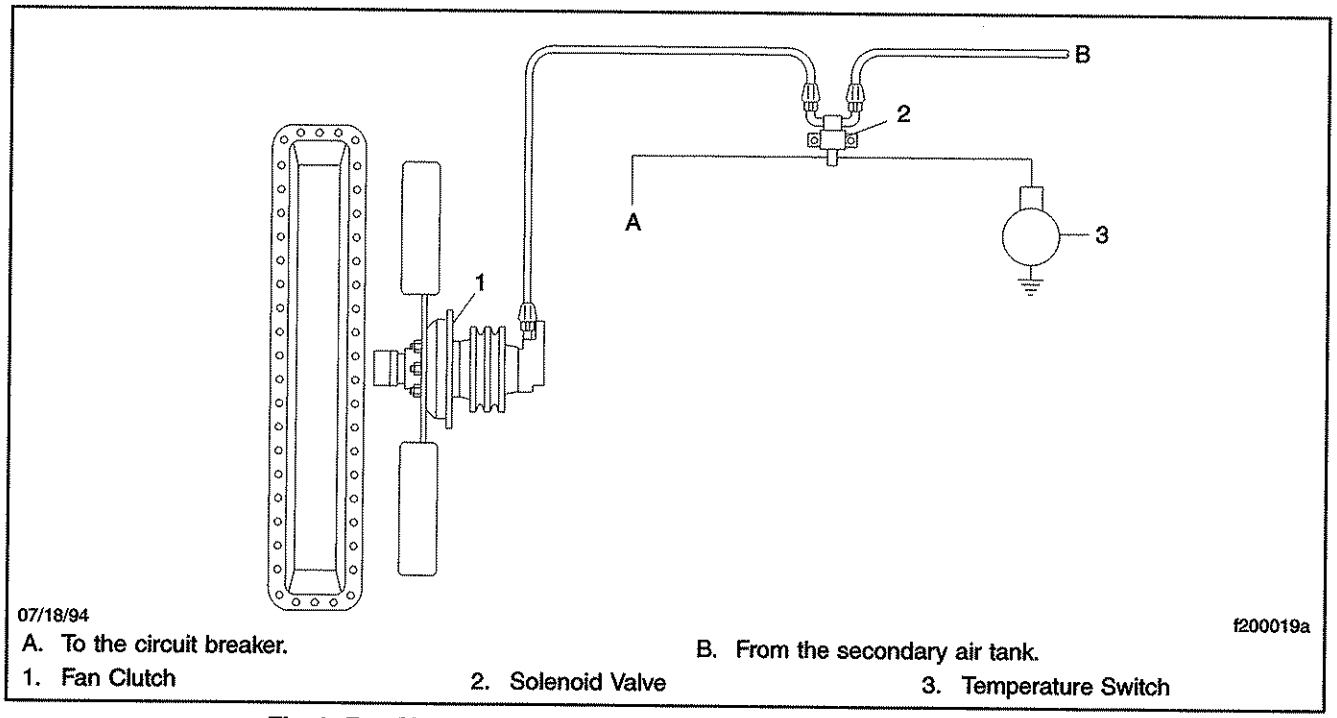
On vehicles with air conditioning, the fan clutch solenoid valve is connected to a fan cycling switch at the receiver-dryer. If the refrigerant pressure exceeds the setting of the fan cycling switch, the switch supplies power to the solenoid valve, which supplies air to engage the fan clutch.

Most Horton Advantage fan clutches include System Sentry™ fuses that protect the fan clutch from overheating. See **Fig. 4**. The System Sentry fuse is a brass fitting in the piston friction disc; the fitting uses lead alloy solder to hold a brass plug. If anything causes the fan clutch to slip excessively, heat from the slippage will melt the solder and release the plug. Air pressure inside the clutch will escape, and the clutch will release before heat build-up can damage the clutch bearings. The fuse is balanced by two counterweights.

If the fan clutch includes the System Sentry fuse, and the clutch will not engage, check to see if the fuse is melted, and check to see what might be making the fan clutch slip excessively.

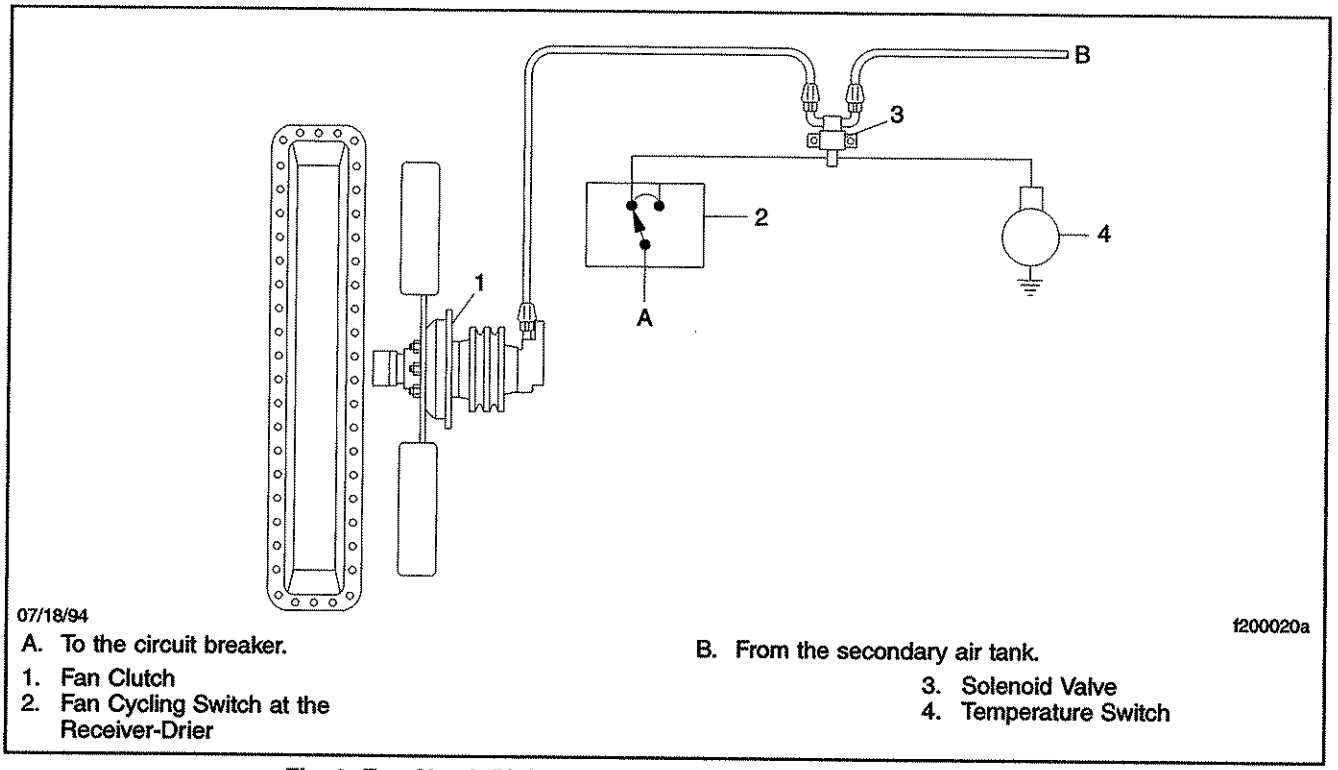
For the fan clutch model number and serial number, refer to the side of the air chamber. See **Fig. 5**.

General Information and Principles of Operation



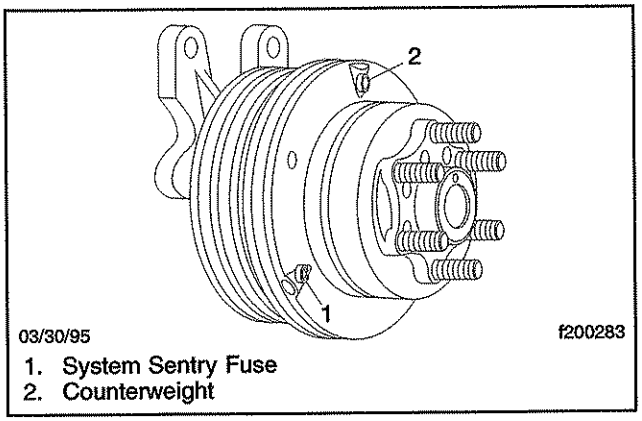
A. To the circuit breaker.
B. From the secondary air tank.
1. Fan Clutch
2. Solenoid Valve
3. Temperature Switch

Fig. 2, Fan Clutch Piping and Wiring, Vehicle Without Air Conditioning



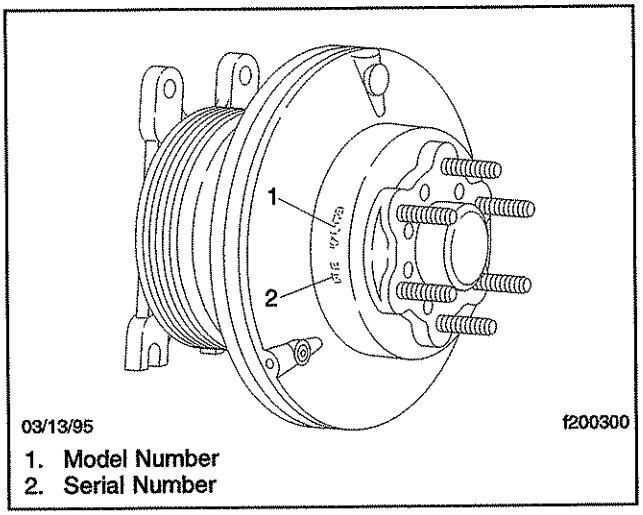
A. To the circuit breaker.
B. From the secondary air tank.
1. Fan Clutch
2. Fan Cycling Switch at the Receiver-Drier
3. Solenoid Valve
4. Temperature Switch

Fig. 3, Fan Clutch Piping and Wiring, Vehicle With Air Conditioning



1. System Sentry Fuse
2. Counterweight

Fig. 4, Horton Fan Clutch with System Sentry Fuse



1. Model Number
2. Serial Number

Fig. 5, Fan Clutch Information, Model HTS 981144 Shown

Removal (See Fig. 1)

NOTE: The following procedure pertains to vehicles equipped with all engines except Detroit Diesel Series 55 engines. For vehicles equipped with that engine, see **Subject 105.**

1. Apply the parking brakes, and chock the tires.

⚠ 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.

2. Remove the drain plug from the right side of the radiator bottom tank, and drain about seven liters (two gallons) of coolant. Install the drain plug and tighten it firmly.

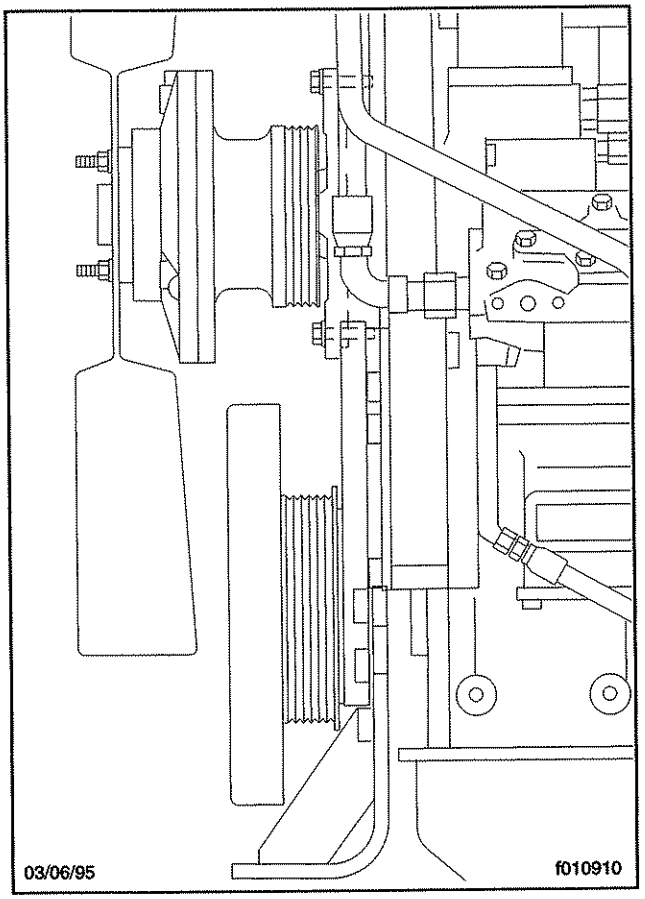


Fig. 1, Fan Clutch Installed, Cat CFE Engine Shown

3. Disconnect the radiator inlet hose and the radiator vent hose from the radiator, and move both hoses away from the radiator and fan shroud.
4. Disconnect the air intake hoses from the aftercooler, and move both hoses away from the aftercooler and fan shroud.
5. Remove the six 3/8–inch capscrews that hold the fan shroud to the radiator.
6. Loosen the fan belt. For instructions, refer to the applicable section in this manual.

⚠ WARNING

Use care when loosening the air line fitting. The line could be under pressure and may have dirt or sludge in the air stream. If quickly disconnected, the line may whip, possibly causing eye injury or other bodily injury.

7. Find the air line that runs between the fan clutch and the clutch solenoid, and disconnect the line from the solenoid. Cut any tie straps that secure the line to the engine.

⚠ WARNING

The fan clutch is heavy and lifting it from the center of a crowded engine compartment can be awkward. To avoid injury, two people should work together to lift the fan clutch from the engine.

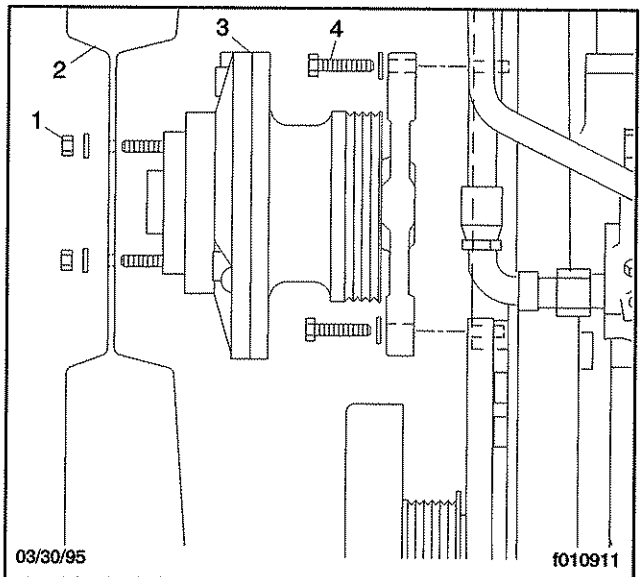
8. Remove the fan and fan clutch from the engine. **See Fig. 2.**

   NOTE: Four M8 x 35 mm capscrews hold the fan clutch to the engine. Two capscrews go through holes in the upper end of the fan clutch mounting plate, and two capscrews go through *notches* in the bottom of the mounting plate. If you loosen the lower capscrews, slightly, you can remove the two top capscrews, and the fan clutch will remain on the engine until you lift it straight up.

   8.1 Loosen the two lower capscrews that hold the fan clutch to the front of the engine.

   8.2 Remove the two upper capscrews that hold the fan clutch to the engine.

Removal and Installation



1. 3/8–Inch Locknut
2. Fan
3. Fan Clutch
4. Capscrew, M8 x 35 mm, Grade 8.8

Fig. 2, Fan Clutch, Installation Components

8.3 With a helper, lift the fan clutch and fan up and out of the engine compartment. Move the fan shroud as needed.

8.4 Place the fan clutch on a work bench, and remove the six nuts that hold the fan to the fan clutch. Remove the fan from the fan clutch.

Installation

⚠ WARNING

The fan clutch is heavy and placing it in the center of a crowded engine compartment can be awkward. To avoid injury, two people should work together to place the fan clutch on the engine.

1. Install the fan and fan clutch on the engine.

   1.1 Place the fan on the fan clutch, and secure the fan with six nuts. Tighten the nuts 15 lbf·ft (20 N·m).

   NOTE: Four M8 x 35 mm capscrews hold the fan clutch to the engine. Two capscrews go through holes in the upper end of the fan clutch mounting plate, and two capscrews go through *notches* in the bottom of the mounting plate. If you install the lower capscrews in the engine, you can position the fan clutch on the lower capscrews and the fan clutch will remain on the engine as you install the upper capscrews.

   1.2 Install the lower capscrews in the front of the engine, but don't tighten them completely.

   1.3 With a helper, position the fan and fan clutch on the two lower mounting capscrews. The notches in the bottom of the fan clutch mounting plate should slide down over the capscrews. Move the fan shroud as needed.

   1.4 Install the two upper capscrews and tighten all four capscrews 13 lbf·ft (18 N·m).

   1.5 Route the air line up, behind the alternator mount and across the front of the engine to the solenoid. Connect the air line to the solenoid, and secure the line to the engine with tie straps.

2. Work the belt over the fan, and route and adjust the belt. For instructions, refer to **Group 01** in this manual.
3. Install the fan shroud on the radiator.
4. Connect the coolant hoses to the radiator, and the air hoses to the aftercooler.
5. Take the coolant drained from the radiator, and pour it back into the surge tank.
6. Check the fan clutch for proper operation. For instructions, refer to **Group 20** in this manual.

Removal and Installation, Equipped with Detroit Diesel Series 55 Engine

Fan Clutch Removal

1. Park the vehicle, set the parking brake, then chock the tires.
2. Disconnect the batteries.
3. Drain the air tanks.
4. Tilt the hood and support it on a stand.
5. Remove the four fasteners holding the fan shroud in place.
6. Remove the fan blade, then put it inside the radiator shroud.
7. Remove the fasteners attaching the radiator struts to the sides of the radiator. Swing the struts outboard.
8. Tilt the radiator forward, then lift the fan and shroud out of the engine compartment.
9. Remove the drive belts from their pulleys.
   - 9.1 Using a wrench, loosen one belt tensioner, then rotate it back until the drive belt slips off.
   - 9.2 Repeat the procedure for the other belt tensioner.

⚠ WARNING

Use care when loosening the air line fitting. The line could be under pressure and may have dirt or sludge in the air stream. If quickly disconnected, the line may whip, possibly causing eye injury or other bodily injury.

10. Disconnect the air line from the fan clutch.

⚠ WARNING

The fan clutch is heavy, and lifting it from the center of a crowded engine compartment can be awkward. To avoid injury, two people should work together to lift the fan clutch from the engine.

11. Remove the two hexbolts and the one nut and washer holding the fan clutch to the engine. See **Fig. 1.**
12. Remove the fan clutch from the engine, along with the two drive belts.

Fan Clutch Installation

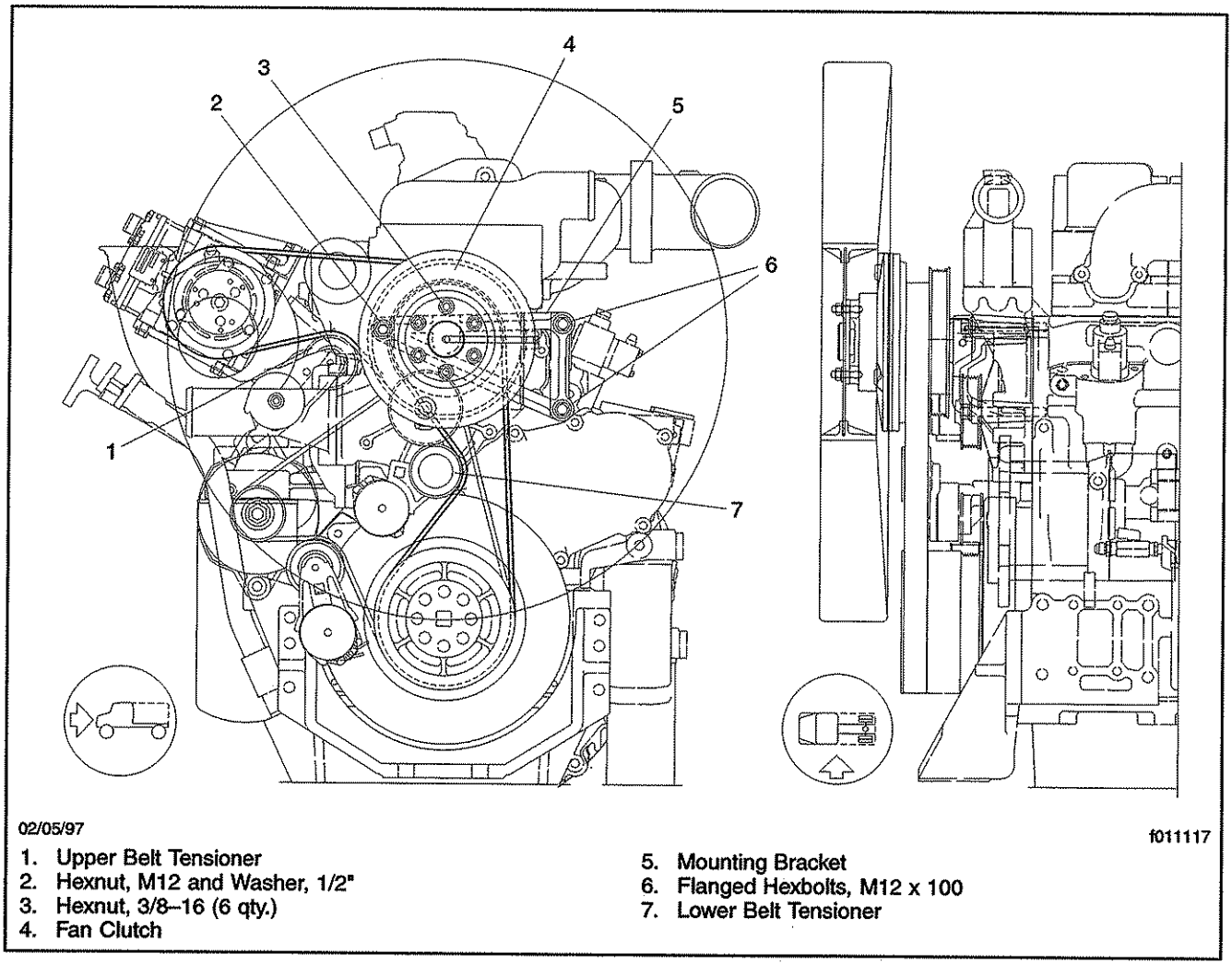
1. Install the drive belts onto the fan clutch pulleys.

⚠ WARNING

The fan clutch is heavy, and installing it in the center of a crowded engine compartment can be awkward. To avoid injury, two people should work together to install the fan clutch onto the engine.

2. Install the fan clutch with the drive belts onto the engine.
   - 2.1 Position the fan clutch on the engine, aligning the one hole with the stud on the engine, and the other two holes with holes in the engine.
   - 2.2 Install the two bolts and the one nut and washer. Tighten them 60 lbf·ft (81 N·m).
3. Install the drive belts.
   - 3.1 Install the rearward drive belt first, by putting a wrench on the upper belt tensioner, then rotating it inward. Slide the belt over the tensioner, then release the tension on it.
   - 3.2 Repeat the procedure for the other drive belt.
4. Install the fan blade. Tighten the fasteners 28 lbf·ft (38 N·m).
5. Install the fan shroud. Tighten the four fasteners loosely.
6. Install the radiator struts onto the radiator. Tighten the fasteners 90 lbf·ft (122 N·m).
7. Align the fan shroud so that the fan blade will clear it, then tighten the fan shroud fasteners 108 lbf·in (1220 N·cm).
8. Connect the air line to the fan clutch.
9. Connect the batteries.
10. Close the hood.
11. Remove the chocks from the tires.

Removal and Installation, Equipped with Detroit Diesel Series 55 Engine



1. Upper Belt Tensioner
2. Hexnut, M12 and Washer, 1/2"
3. Hexnut, 3/8–16 (6 qty.)
4. Fan Clutch
5. Mounting Bracket
6. Flanged Hexbolts, M12 x 100
7. Lower Belt Tensioner

Fig. 1, Fan Clutch Installation, DDEC Series 55 Engine

Disassembly (See Fig. 1)

NOTE: This procedure involves a major rebuild of the Horton Advantage fan clutch, using parts from the manufacturer's Major or Super Kit. If you are replacing just the air cartridge, System Sentry® fuse, or the face seal, go to **Subject 120**.

1. Remove the fan and clutch assembly from the vehicle. For instructions, refer to **Subject 100**.
2. Clamp the fan clutch in a vise. See **Fig. 2**.
3. On some vehicles, the fan clutch has threaded studs on the air chamber and the fan is attached with nuts. On other vehicles, the fan is attached to the air chamber with hexbolts.

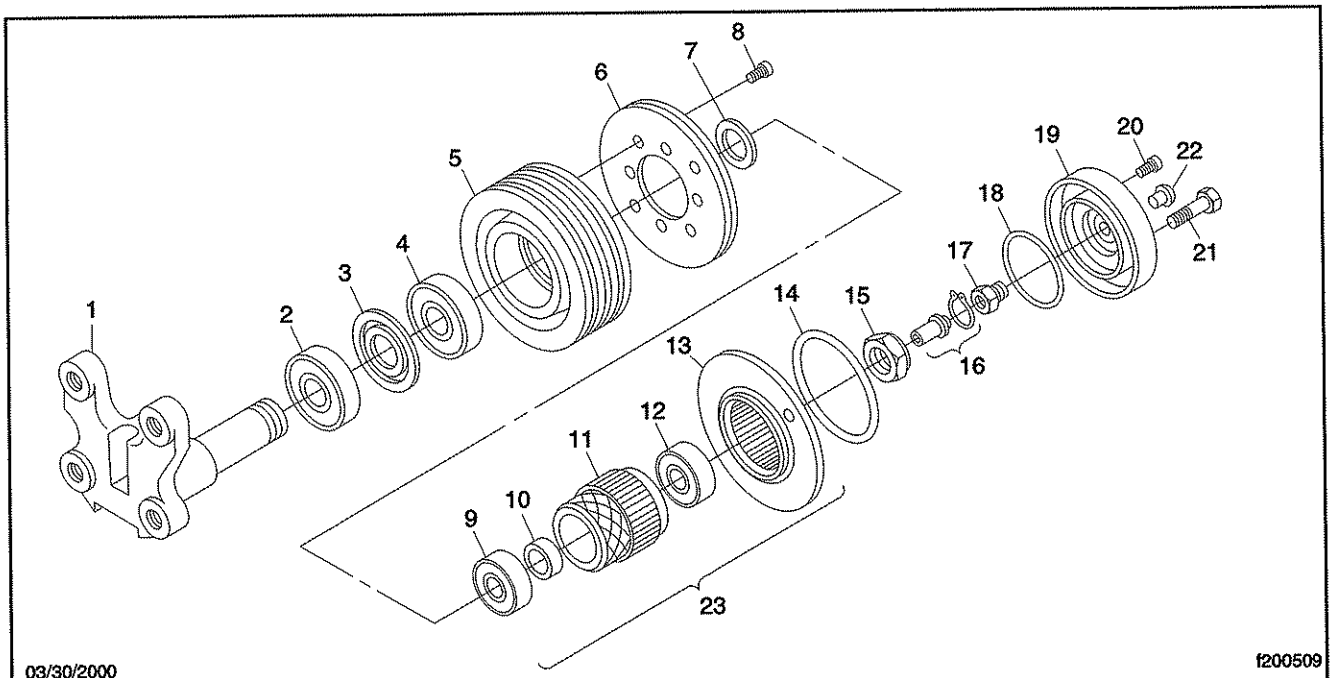
   If hexbolts were used to attach the fan, install two of the removed hexbolts in the air chamber so that a screwdriver can be used to keep the air chamber from rotating. See **Fig. 3**.

   Remove the socket-head capscrews from the air chamber.
4. If applicable, remove the two hexbolts previously installed.

⚠ WARNING

Apply air pressure slowly to the fan clutch. A sudden blast of air might blow the air chamber off the clutch, resulting in possible injury.

5. Connect a shop air hose to the cylinder inlet. See **Fig. 4**. Slowly apply air pressure, and remove the air chamber assembly.



03/30/2000

1. Mounting Bracket Assembly
2. Rear Sheave Bearing
3. Inner and Outer Bearing Spacers
4. Forward Sheave Bearing
5. Sheave
6. Friction Facing
7. Journal Spacer
8. Socket-Head Capscrew
9. Rear Hub Bearing
10. Bearing Spacer
11. Splined Hub
12. Forward Hub Bearing
13. Piston Friction Disc
14. Large O-Ring
15. Locknut
16. Air Cartridge Assembly
17. Face Seal
18. Small O-Ring
19. Air Chamber
20. Socket-Head Capscrew
21. Hexbolt (some vehicles equipped with studs)
22. Rubber Umbrella Valve
23. Disc and Piston Assembly

Fig. 1, Horton Advantage Fan Clutch

Fan Clutch Major Rebuild

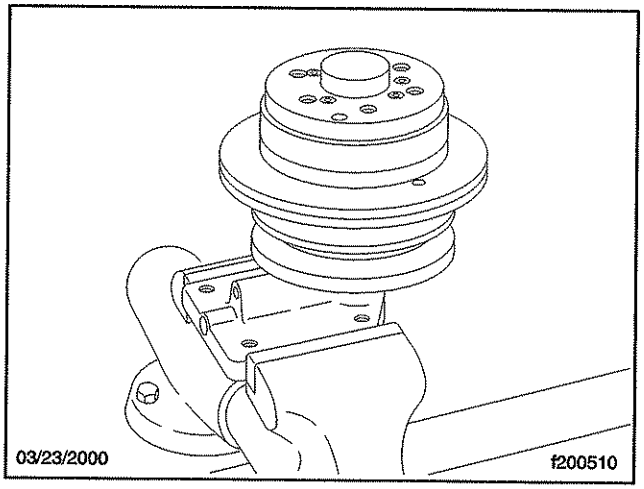


Fig. 2, Fan Clutch Placed in a Vise

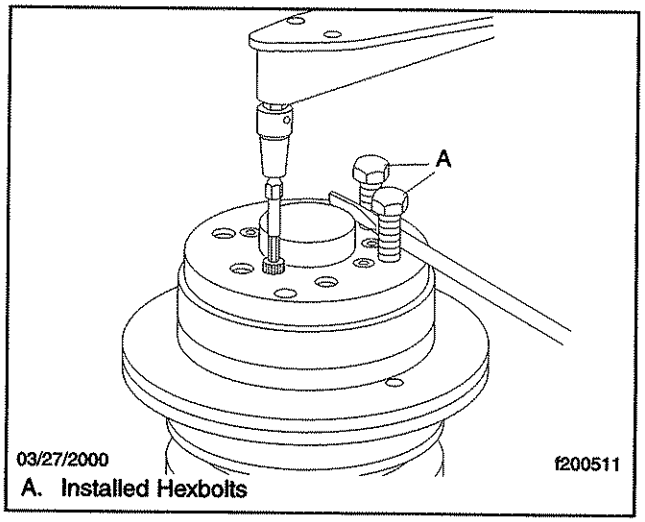


Fig. 3, Remove the Socket-Head Capscrews

6. Remove and discard the O-rings from the air chamber and the piston friction disc. Clean the O-ring contact surfaces.
7. Remove the face seal from the air chamber.
8. Remove the System Sentry fuse from the piston friction disc. *Note that it is a left-hand thread.*
9. Remove the rubber umbrella valve from the air chamber.
10. Remove the adjusting nut. See **Fig. 5**.
11. Remove the disc and piston assembly, and the journal spacer. See **Fig. 6**.
12. Slide the sheave and bearings off the mounting bracket assembly. See **Fig. 7**.
13. Remove the socket-head capscrews from the friction facing. Remove the friction facing.

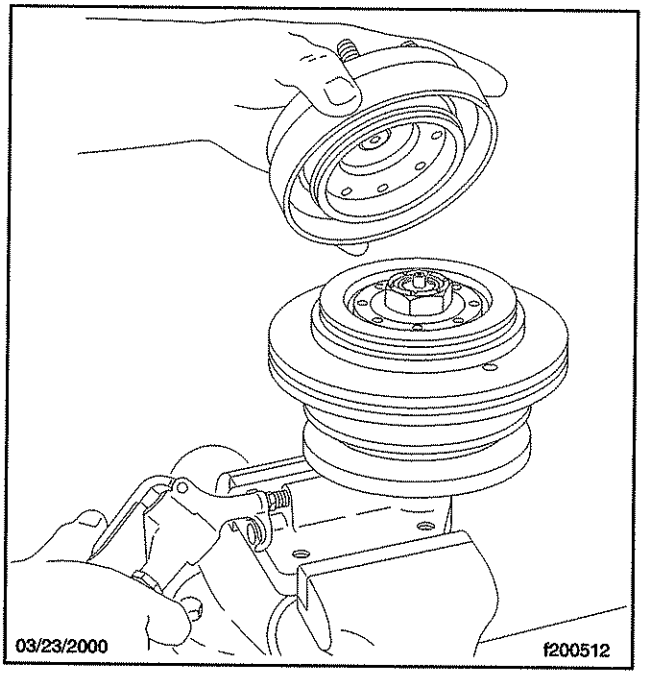


Fig. 4, Remove the Air Chamber

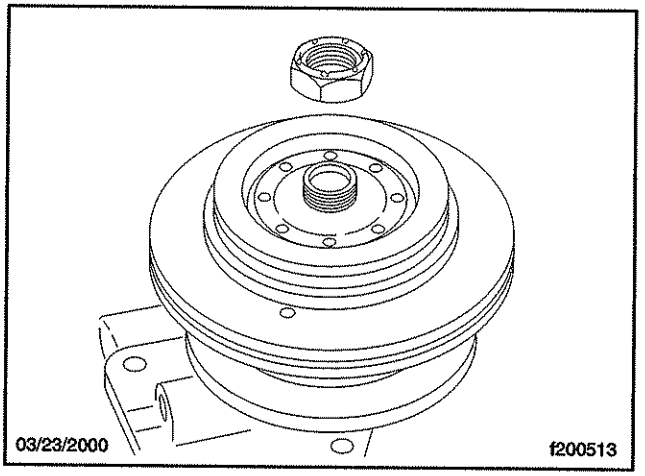


Fig. 5, Remove the Adjusting Nut

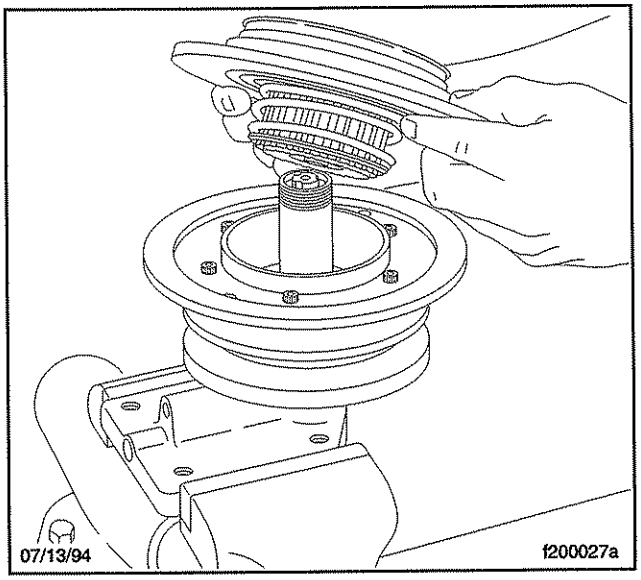


Fig. 6, Remove the Disc and Piston

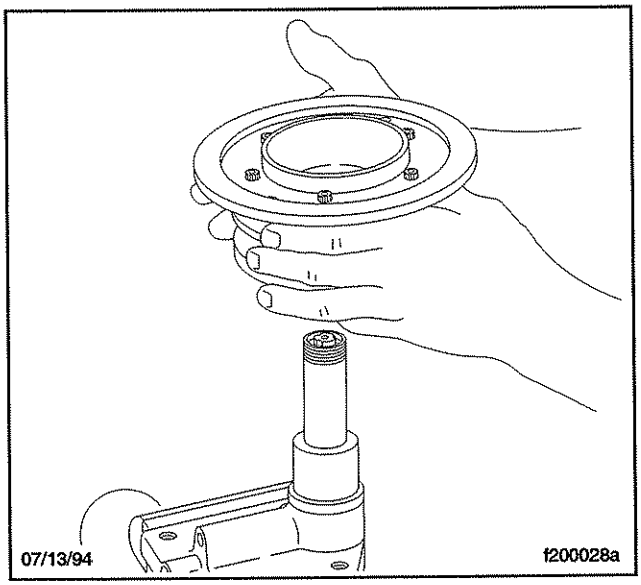


Fig. 7, Slide Off the Sheave and Bearings

14. Remove the retaining ring from the air cartridge assembly. See **Fig. 8**.

    Remove the cartridge assembly from the mounting bracket assembly. See **Fig. 9**.

15. Support the sheave and press out the bearings.

Assembly

1. Coat the new sheave bearings with grease and press them into the sheave.

NOTE: Some models have a spacer between the bearings. Install the spacer if equipped.

2. Install a new air cartridge assembly in the mounting bracket assembly. Note that the retaining ring is curved. Make sure the ring is

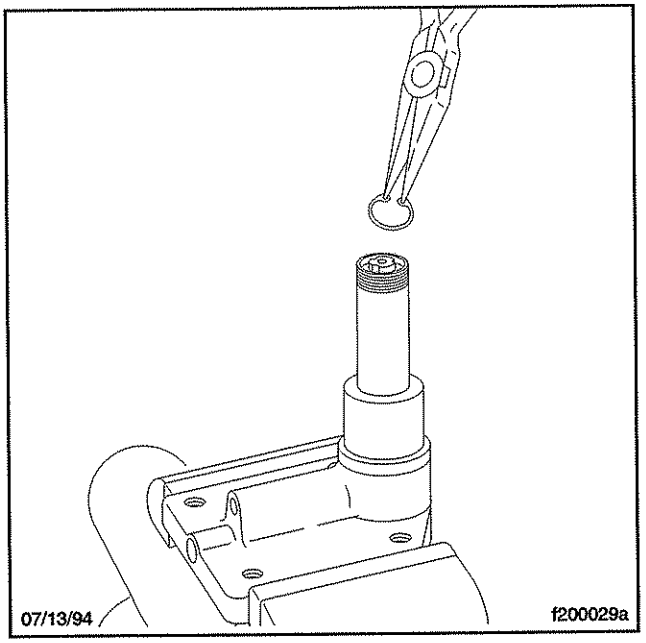


Fig. 8, Remove the Retaining Ring

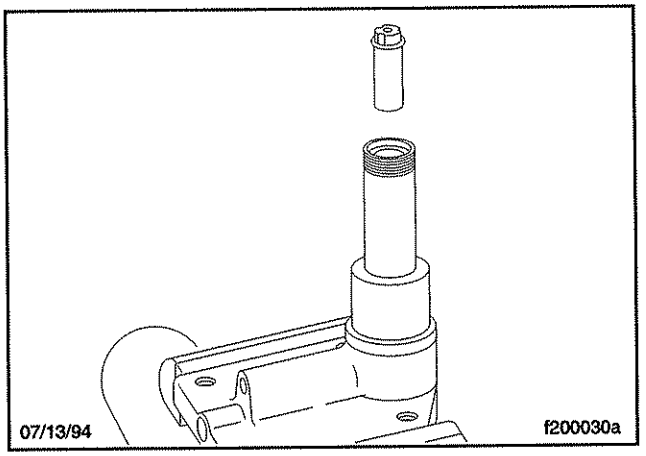


Fig. 9, Remove the Air Cartridge Assembly

Fan Clutch Major Rebuild

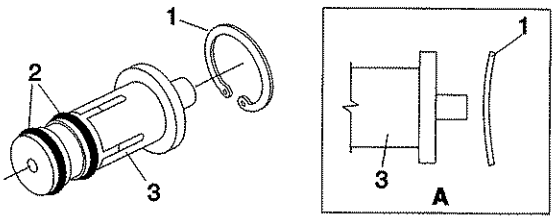
installed with the convex surface toward the air cartridge. See **Fig. 10**.

3. Slide the sheave and bearings onto the mounting bracket assembly.
4. Install a new friction facing onto the sheave. Following a star pattern, tighten the socket-head capscrews 60 lbf·in (680 N·cm).

⚠ CAUTION

Never fill more than one-third of the bearing void with grease. Too much grease can cause overheating and possible bearing damage.

5. Install the journal spacer, and the disc and piston assembly. Make sure that the lip on the journal spacer is facing up. See **Fig. 11**.
6. Install the adjusting nut. Tighten 150 lbf·ft (203 N·m).
7. Remove any dust and debris from the air chamber.
8. Coat the new O-rings with an approved lubricant and install them. See **Fig. 12**.
9. Install the new face seal in the air chamber. Tighten 50 lbf·in (565 N·cm).
10. Install the new rubber umbrella valve in the air chamber.
11. Install the new System Sentry fuse in the piston friction disc. *Note that it is a left-hand thread.*



A. Convex Surface of Retaining Ring Toward the Air Cartridge
1. Retaining Ring
2. O-Rings
3. Air Cartridge

Fig. 10, Air Cartridge Assembly

12. Slide the air chamber assembly onto the clutch. If applicable, install two of the hexbolts that hold the fan in place.
13. Using a screwdriver to keep the air chamber from rotating, install the socket-head capscrews. Following a star pattern, tighten 15 lbf·ft (20 N·m).
14. If applicable, remove the two hexbolts previously installed.
15. Install the fan and clutch assembly on the engine. For instructions, refer to **Subject 100**.

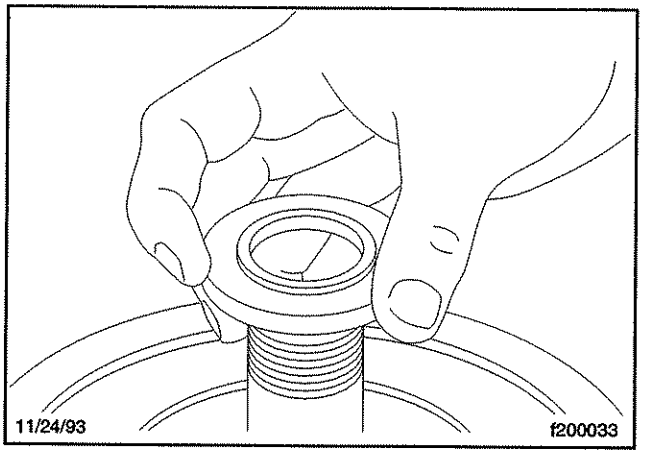


Fig. 11, Check the Journal Lip

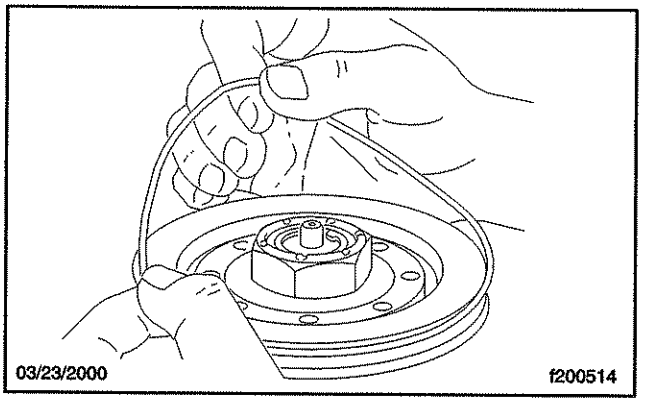


Fig. 12, Install New O-Rings

Disassembly

NOTE: This procedure involves replacing only the air cartridge, System Sentry® fuse, the face seal, and the O-rings, using parts from the manufacturer's Seal Kit. If doing a major rebuild, go to **Subject 120.**

1. Remove the fan and clutch assembly from the vehicle. For instructions, refer to **Subject 100.**
2. Clamp the fan clutch in a vise. See **Fig. 1.**
3. On some vehicles, the fan clutch has threaded studs on the air chamber and the fan is attached with nuts. On other vehicles, the fan is attached with hexbolts.

   If hexbolts were used to attach the fan, install two of the removed hexbolts in the air chamber so a screwdriver can be used to keep the air chamber from rotating. See **Fig. 2.**

   Remove the socket-head capscrews from the air chamber.
4. If applicable, remove the two hexbolts previously installed.

⚠ WARNING

Apply air pressure slowly to the fan clutch. A sudden blast of air might blow the air chamber off the clutch, resulting in possible injury.

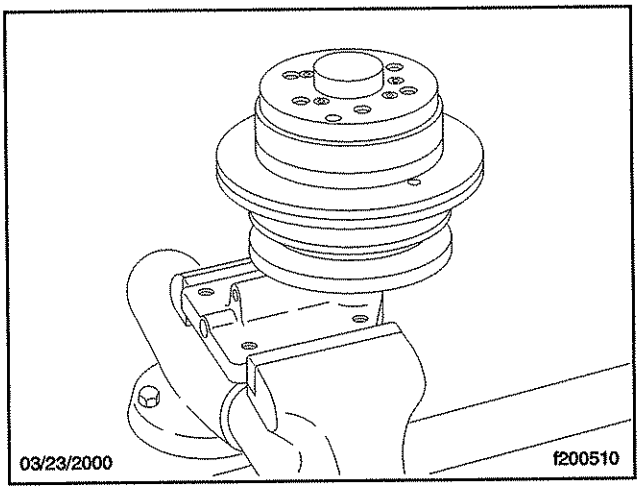


Fig. 1, Fan Clutch Placed in a Vise

5. Connect a shop air hose to the cylinder inlet. See **Fig. 3.** Slowly apply air pressure, and remove the air chamber assembly.
6. Remove and discard the O-rings from the air chamber and the piston friction disc. Clean the O-ring contact surfaces.
7. Remove the face seal from the air chamber. See **Fig. 3.**
8. Remove the System Sentry fuse from the piston friction disc. *Note that it is a left-hand thread.*
9. Remove the rubber umbrella valve from the air chamber.
10. Remove the adjusting nut. See **Fig. 4.**
11. Remove the retaining ring from the air cartridge assembly. See **Fig. 5.**

    Remove the cartridge assembly from the mounting bracket assembly. See **Fig. 6.**

Assembly

1. Install a new air cartridge assembly in the mounting bracket assembly. Note that the retaining ring is curved. Make sure the ring is installed with the convex surface toward the air cartridge. See **Fig. 7.**
2. Install the adjusting nut. Tighten 150 lbf·ft (203 N·m).

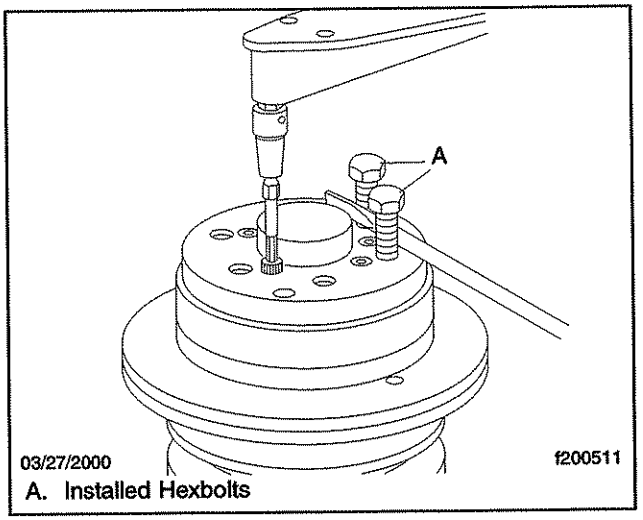
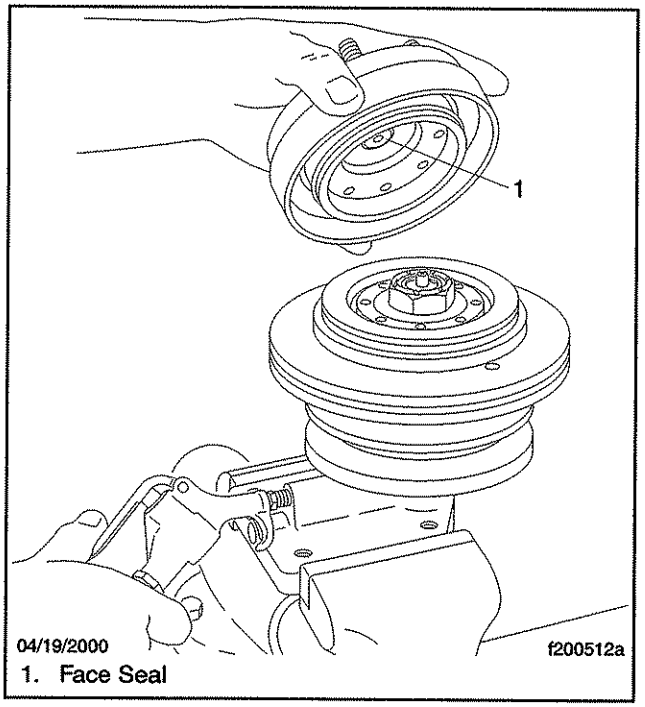


Fig. 2, Remove the Socket-Head Capscrews

Fan Clutch Minor Rebuild



1. Face Seal

Fig. 3, Remove the Air Chamber

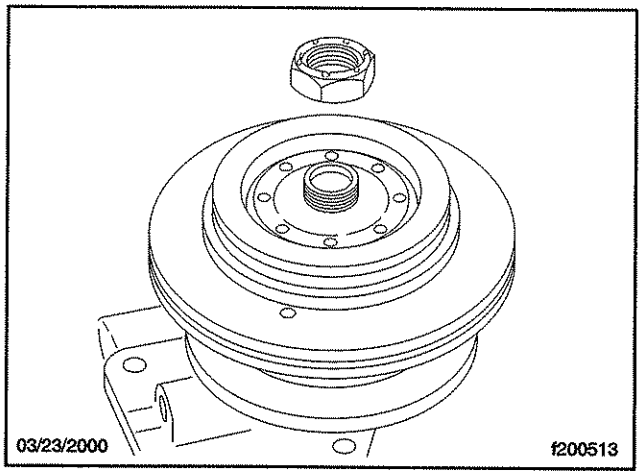


Fig. 4, Remove the Adjusting Nut

3. Remove any dust and debris from the air chamber.
4. Coat the new O-rings with an approved lubricant and install them. See **Fig. 8.**
5. Install the new face seal in the air chamber. Tighten 50 lbf·in (565 N·cm).

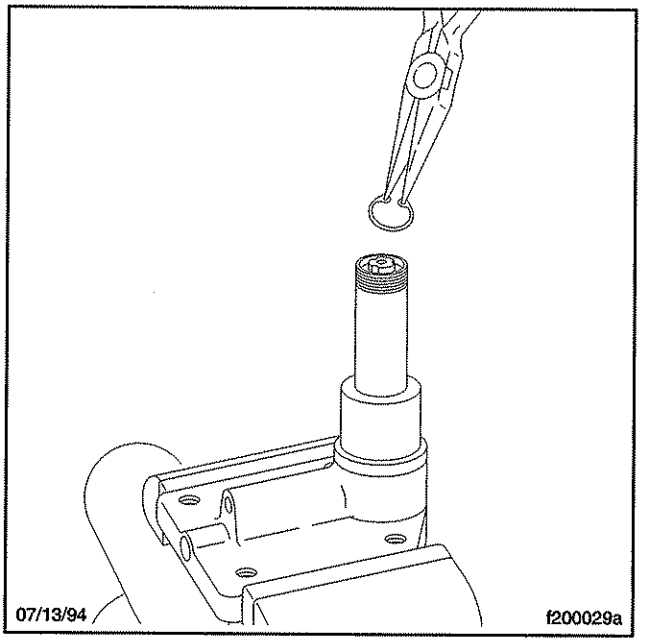


Fig. 5, Remove the Retaining Ring

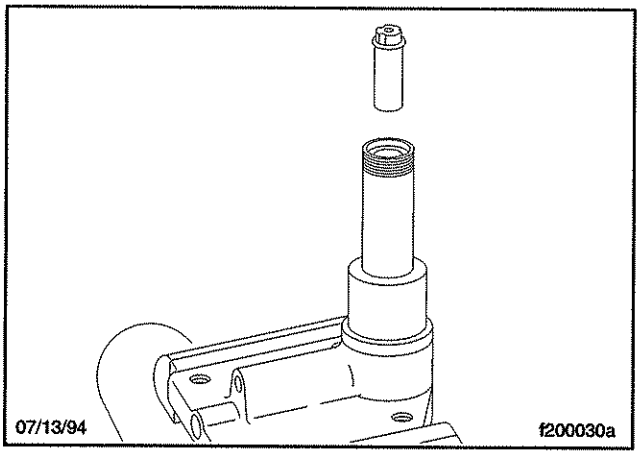
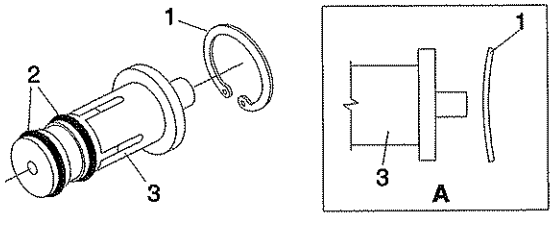


Fig. 6, Remove the Air Cartridge Assembly

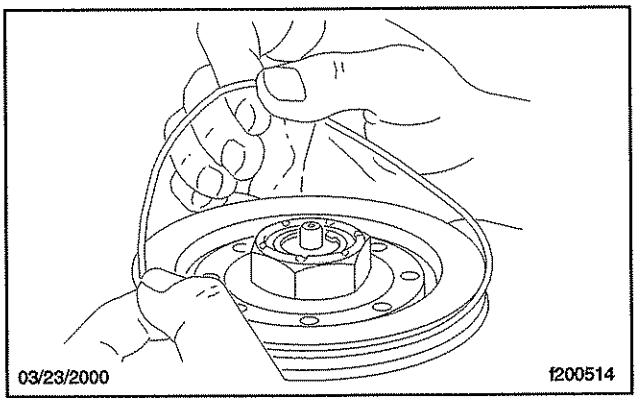
6. Install the new rubber umbrella valve in the air chamber.
7. Install the new System Sentry fuse in the piston friction disc. *Note that it is a left-hand thread.*
8. Slide the air chamber assembly onto the clutch. If applicable, install two of the hexbolts that held the fan in place.



03/27/2000 f200515

A. Convex Surface of Retaining Ring Toward the Air Cartridge
1. Retaining Ring
2. O-Rings
3. Air Cartridge

Fig. 7, Air Cartridge Assembly



03/23/2000 f200514

Fig. 8, Install New O-Rings

9. Using a screwdriver to keep the air chamber from rotating, install the socket-head capscrews. Following a star pattern, tighten 15 lbf·ft (20 N·m).
10. If applicable, remove the two hexbolts previously installed.
11. Install the fan and clutch assembly on the engine. For instructions, refer to **Subject 100**.

Fastener	Torque	
	N.m (lbf.ft)	N.cm (lbf.in)
Fan Nut	20 (15)	—
Adjusting Nut	203 (150)	—
Air Chamber Capscrew	20 (15)	—
Friction Facing Capscrew	—	680 (60)
Fan Clutch Mounting Capscrews	18 (13)	—

Table 1, Torque Values

Approved Greases

Amoco Rykon Premium No. 2 EP

Chevron SRI-2

Texaco Premium RB No. 2

Exxon Unirex No. 2

Shell Dolium Grease No. 2

Approved Lubricants

Parker O-Ring Lube

Horton O-Ring Lube No. 13220

Specifications

Wiring

See Fig. 1 for the fan clutch wiring diagram.

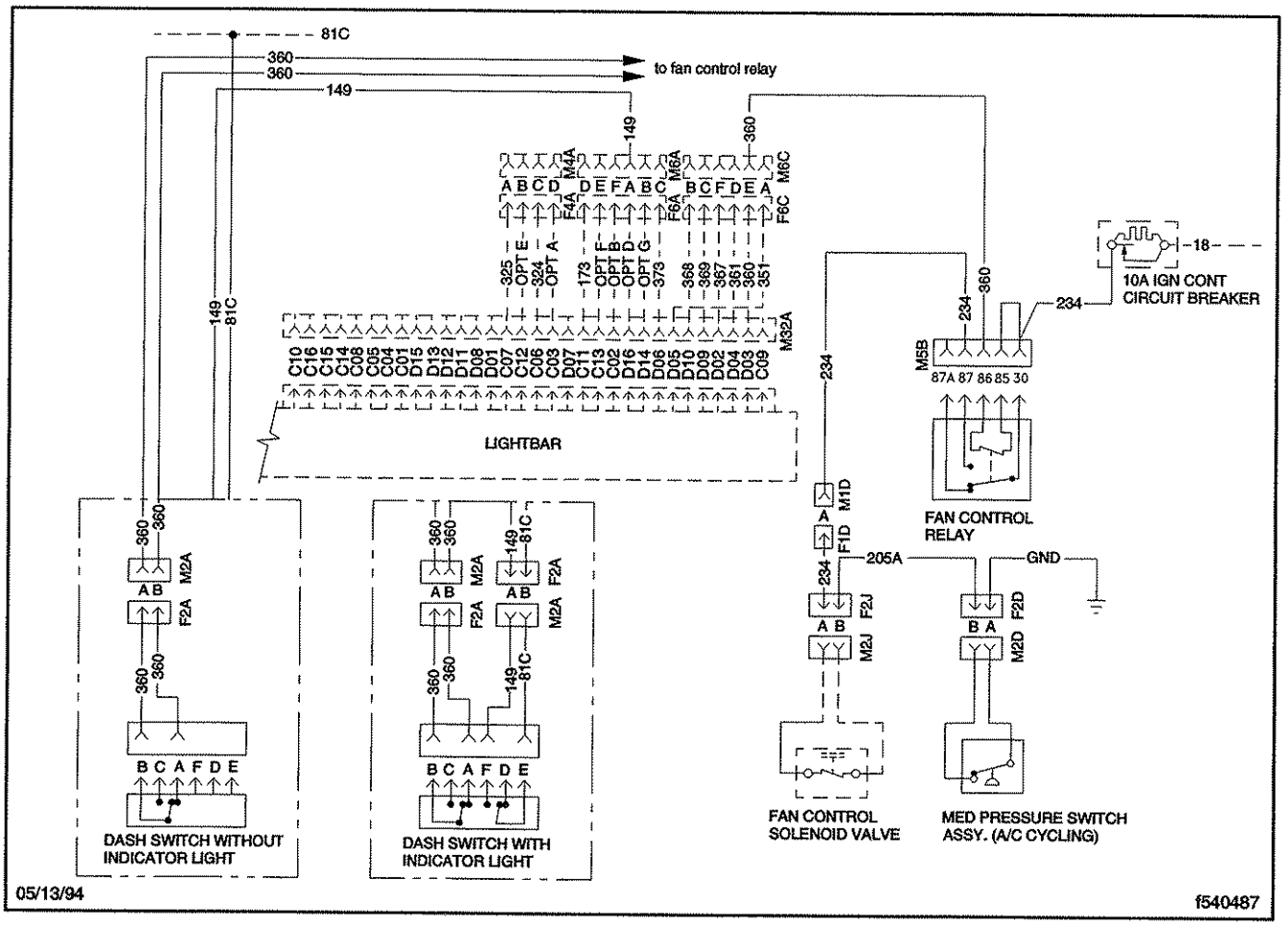


Fig. 1, Fan Clutch Wiring Diagram

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General Information

The K22RA fan drive unit is an air-operated, temperature-controlled clutch for the engine cooling fan. It is installed only on Caterpillar 3126 and Detroit Diesel Series 50 engines. Its purpose is to maintain engine temperature by engaging or disengaging the fan. The fan clutch is disengaged when the coolant temperature is at or below the specified temperature range. The fan clutch engages when the coolant temperature rises above the range.

Air pressure to the fan clutch is controlled by a solenoid valve; the solenoid valve is controlled by a temperature switch that is installed in the thermostat housing. See **Fig. 1**.

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. See **Fig. 2**.

The fan clutch is spring-loaded in the engaged position. It is disengaged when air pressure is applied to the cylinder on the front of the unit. Air pressure to the cylinder is controlled by a solenoid valve: the solenoid is controlled by a temperature switch that is immersed in the engine coolant.

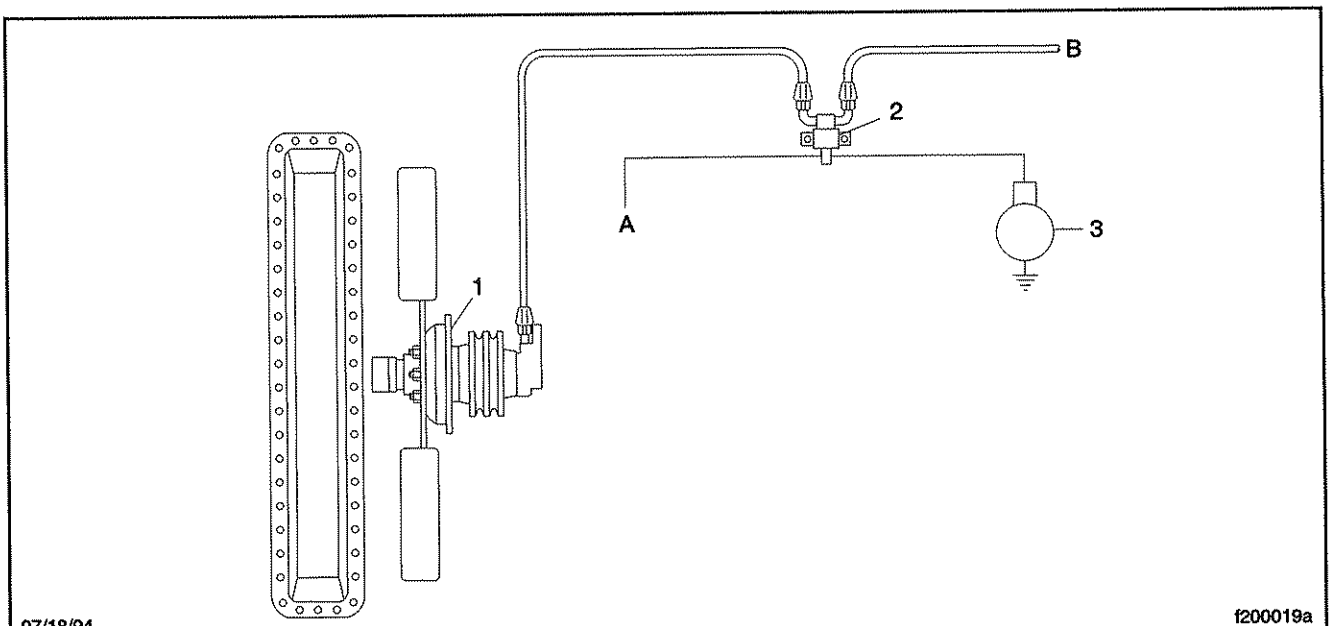
When a cold engine is started, the temperature switch is open, which activates the solenoid. The solenoid valve allows compressed air to enter the cylinder, and the fan clutch remains disengaged. The fan does not turn.

When the coolant temperature rises to the temperature switch setting, the switch closes. The solenoid valve releases the compressed air from the cylinder. The fan clutch spring engages the clutch and the fan turns.

When the coolant temperature drops to the temperature switch cutoff setting, the switch opens, activating the solenoid. Compressed air passes to the cylinder disengaging the clutch.

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 stops air flow and allows the internal spring to engage the fan clutch.

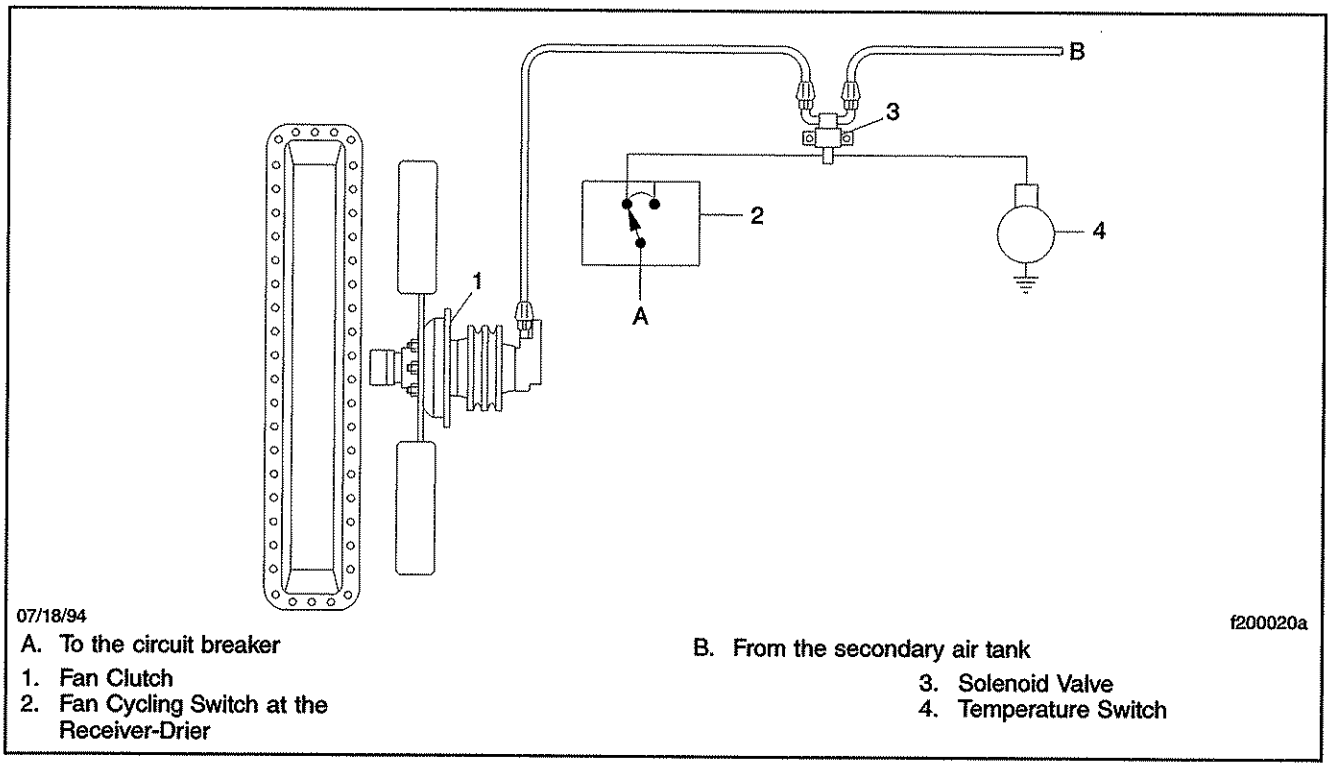
NOTE: When disengaged, it is normal for the housing and fan to spin at about 300 rpm. When the com-



A. To the circuit breaker
B. From the secondary air tank
1. Fan Clutch
2. Solenoid Valve
3. Temperature Switch

Fig. 1, Fan Clutch Piping and Wiring, Vehicle Without Air Conditioning

General Information



A. To the circuit breaker
B. From the secondary air tank
1. Fan Clutch
2. Fan Cycling Switch at the Receiver-Drier
3. Solenoid Valve
4. Temperature Switch

Fig. 2, Fan Clutch Piping and Wiring, Vehicle With Air Conditioning

pressed air is released and the clutch engages, the bearing housing and fan move forward approximately 1/10th-inch (2.5 mm).

Fan Clutch Removal and Installation, Kysor K22RA

Removal (Fig. 1)

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

⚠ WARNING

Use care when loosening the air line fitting. The line could be under pressure and may have dirt or sludge in the air stream. If quickly disconnected, the line may whip, possibly causing eye injury or other bodily injury.

3. Disconnect the air line from the fan clutch.
4. If necessary to tilt the radiator forward to gain sufficient clearance, remove the support struts from the top of the radiator.

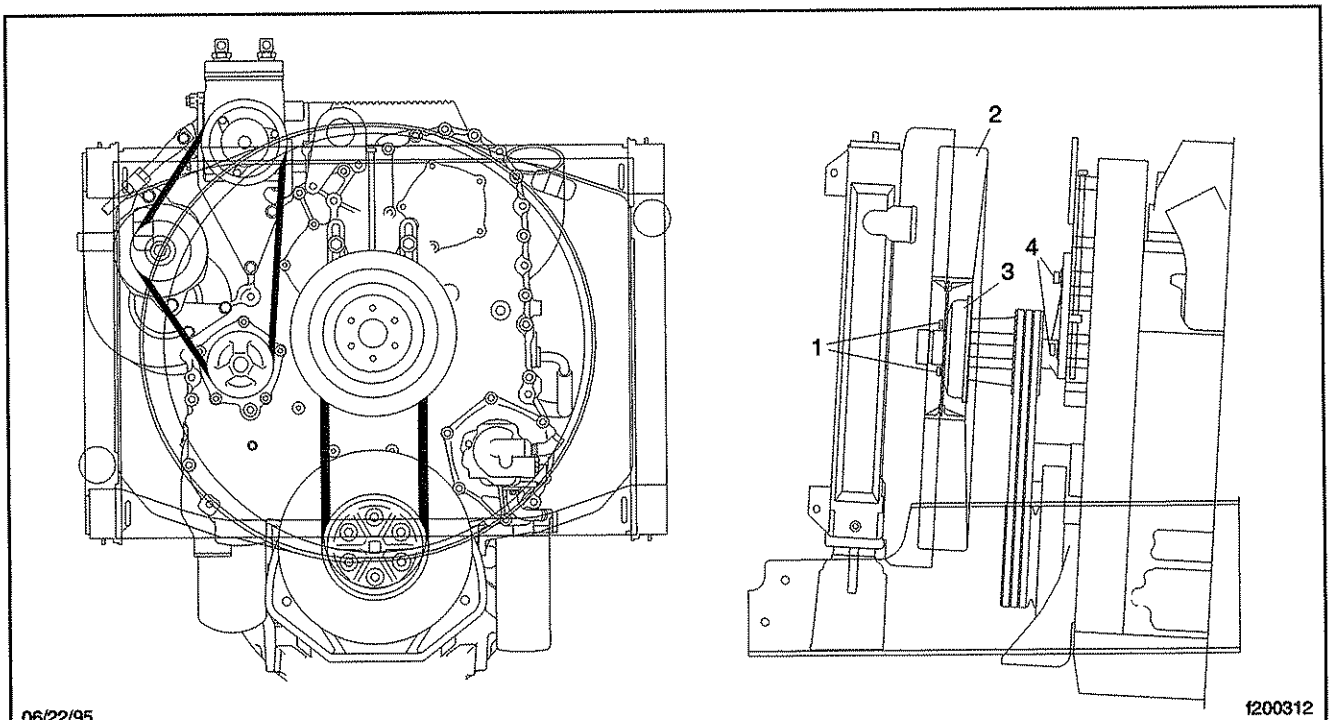
   With one person holding each side of the radiator, tilt the top of the radiator forward.
5. With the radiator tilted forward, remove the fasteners attaching the fan to the fan clutch.

⚠ 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.

6. Align the access holes in the fan clutch with the allen screws on the fan hub. See **Fig. 2.**

   6.1 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.



1. Nut 3/8–24, grade 5; Washer
2. Fan
3. Fan Clutch
4. Flanged Bolt, M12 x 35 mm, grade 10.9; Washer

Fig. 1, Kysor Fan Clutch (Detroit Diesel Series 60 engine)

Fan Clutch Removal and Installation, Kysor K22RA

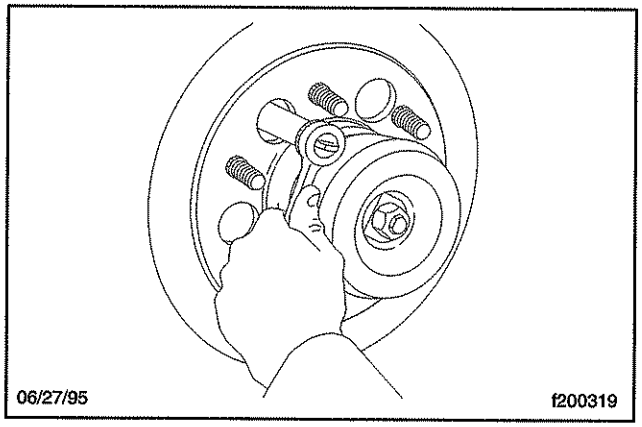


Fig. 2, Line Up the Access Holes

6.2 Line up the access holes

7. Remove the air pressure from the fan clutch, and allow it to engage.
8. Remove the allen screws holding the fan clutch to the fan hub.
9. 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 44 lbf·ft (60 N·m).
2. Install the fan. Tighten the fasteners firmly.
3. If the radiator was moved forward, position the radiator flat on its mounts, and connect the support struts to the top of the radiator.
4. Connect the air line to the fan clutch.
5. Lower the hood.
6. Remove the chocks from the tires.

Fan Clutch Minor Rebuild, Kysor K22RA

Special Tools

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

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

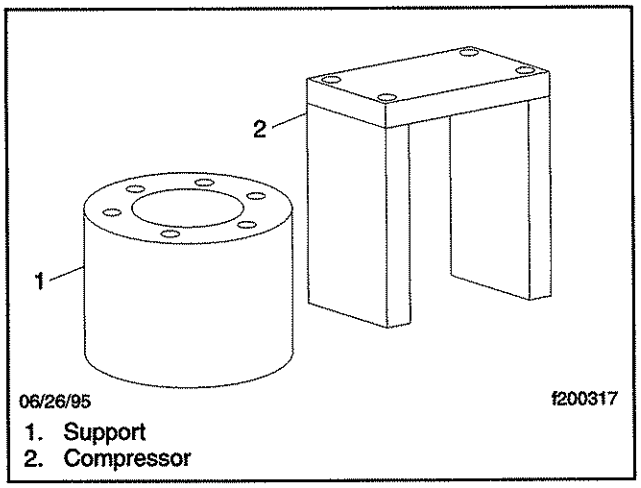
Table 1, Special Tools

Rebuild

1. Park the vehicle, apply the parking brakes, and chock the tires.
2. Remove the fan clutch from the vehicle. For instructions, refer to **Subject 110**.

⚠ CAUTION

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.



1. Support
2. Compressor

Fig. 1, Special Tools

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:

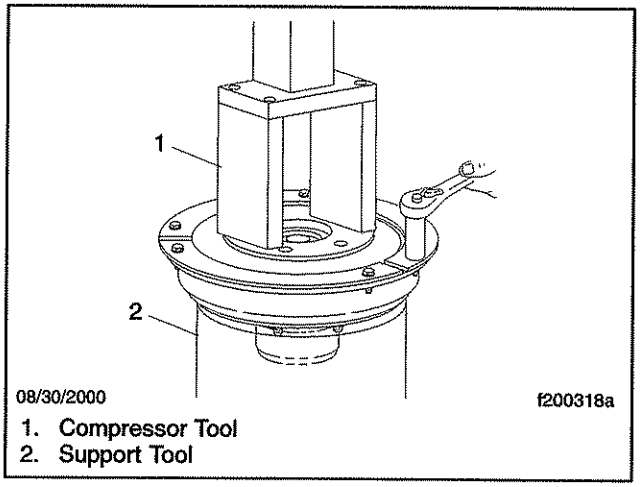
   3.1 With the access holes in the housing assembly aligned with those in the shaft assembly, install two 3-1/2-inch (89-mm) long carriage bolts and suitable washers on opposite sides of the clutch assembly.

   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**.

Fan Clutch Minor Rebuild, Kysor K22RA



1. Compressor Tool
2. Support Tool

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

⚠ CAUTION

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.

5. 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 shaft.
   - 6.3 Inspect the needle bearings inside the clutch housing.
   - 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

⚠ CAUTION

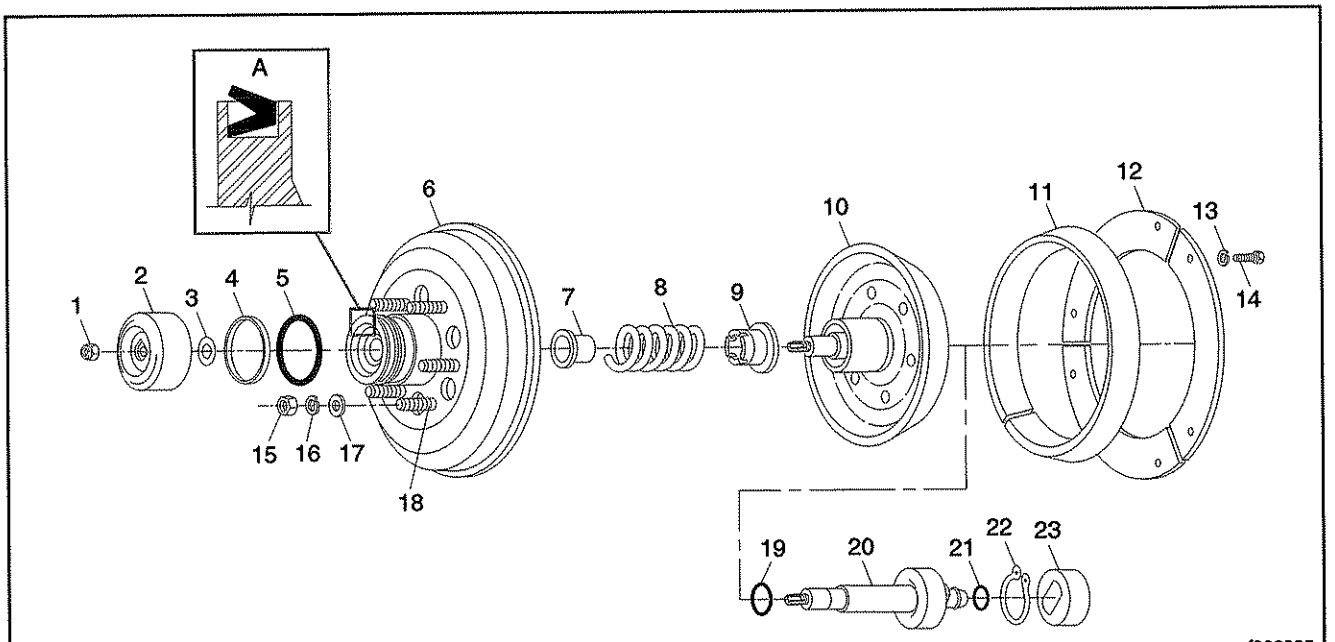
When caging the engagement spring, make sure the bottom edges of the housing assembly and the shaft assembly are flush and aligned all the way around. Failure to do so will cause the engagement spring pressure to affect the torque of the cylinder nut. This could result in the cylinder nut not being tight enough to effectively compress the piston seal washer, which could cause leakage and eventual fan clutch failure.

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

9. 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**.
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.

Fan Clutch Minor Rebuild, Kysor K22RA



A. If a lip seal is used, install it so that it faces away from the fan studs.

1. Cylinder Nut
2. Cylinder Assembly
3. Piston Rod Seal Washer
4. Lip Seal (may be O-Ring)
5. 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 K22RA Fan Clutch (exploded view)

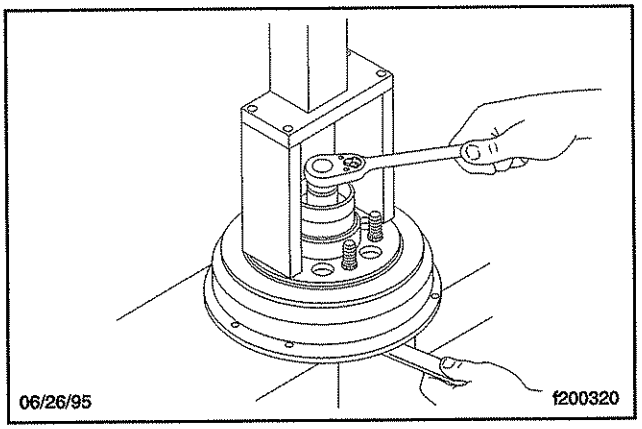


Fig. 4, Removing the Cylinder Nut and Cylinder

13. Check the front-to-rear travel of the fan clutch. For instructions, refer to **Group 20** in the *Business Class Trucks Maintenance Manual.*
14. Install the fan clutch on the engine. For instructions, refer to **Subject 110.**
15. Close the hood and remove the chocks from the tires.

Fan Clutch Minor Rebuild, Kysor K22RA

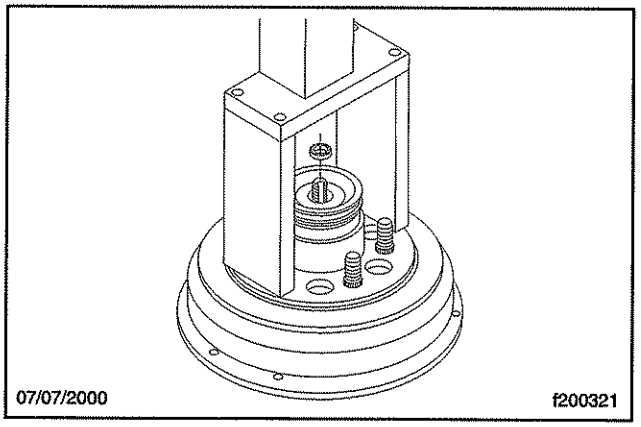


Fig. 5, Installing the Piston Rod Seal Washer

Fan Clutch Relining, Kysor K22RA

Relining (See Fig. 1)

IMPORTANT: Premature wearing of the fan clutch lining is due to either insufficient air pressure necessary to fully engage the clutch or a problem in the control circuit for the fan.

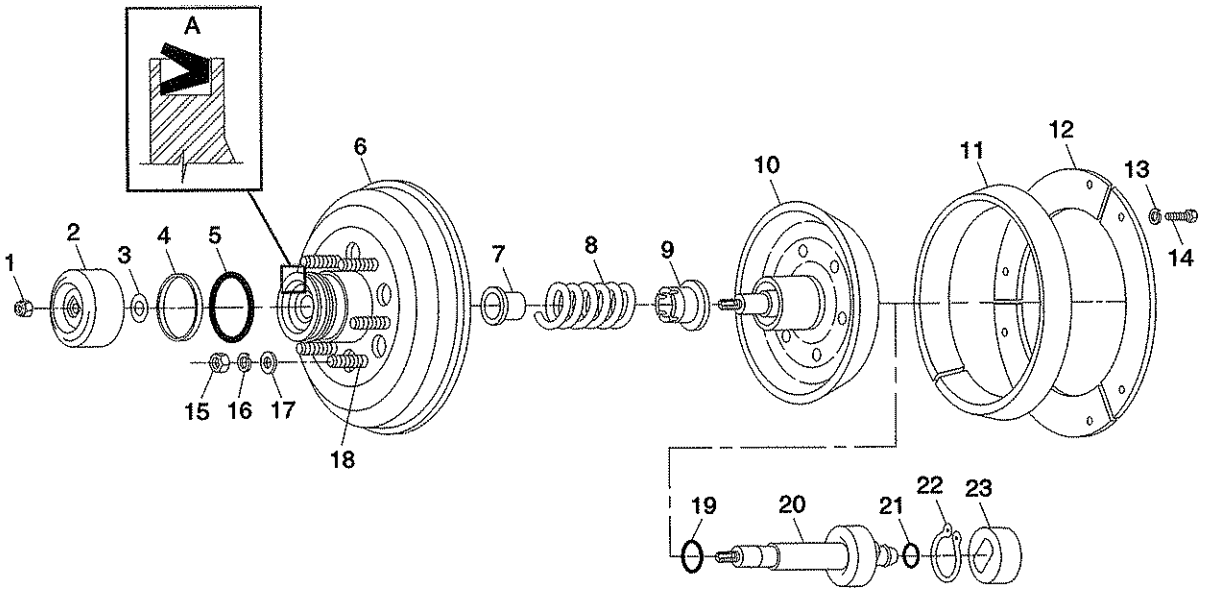
Before putting the fan clutch back in service, check the fan control and air supply systems and make any necessary repairs.

1. Park the vehicle, apply the parking brakes, and 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. Remove the six lining plate screws, and remove the three lining plates. See **Fig. 2**.
3. Replace the lining.
4. Install the new lining plates, and tighten the screws 30 lbf·in (340 N·cm).
5. Remove the air pressure from the fan clutch, and allow the fan to engage.
6. Close the hood, and remove the chocks from the tires.



07/11/2000 f200325

A. If a lip seal is used, install it so that it faces away from the fan studs.

1. Cylinder Nut
2. Cylinder Assembly
3. Piston Rod Seal Washer
4. Lip Seal (may be O-Ring)
5. 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. 1, Kysor K22RA Fan Clutch (exploded view)

Fan Clutch Relining, Kysor K22RA

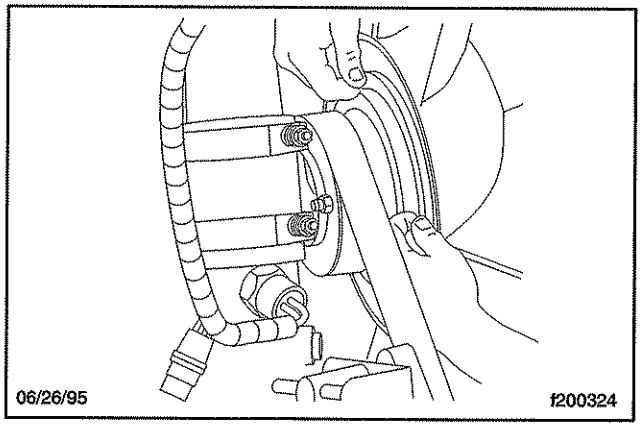


Fig. 2, Remove the Lining Plates

Problem—Fan Clutch Fails to Engage

Problem—Fan Clutch Fails to Engage	
Possible Cause	**Remedy**
There is no power to the fan clutch control circuit.	Check all electrical connections, and repair or replace wiring as needed.
The engine temperature switch is damaged or an incorrect sensor has been installed.	Make sure the switch is normally closed, not normally open. 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 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.

Problem—Fan Clutch Does Not Disengage

Problem—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 closed, not normally open. Replace the switch if it is damaged or if the switch is the wrong type.
A restricted air line does not allow air to vent from the clutch.	Make sure the air lines are not pinched or plugged. Repair the air lines as needed.
The solenoid is not exhausting.	Make sure the solenoid exhaust port is not plugged.

Problem—Fan Clutch Cycles Frequently

Problem—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.
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.
The fan cycling switch at the receiver-drier is set too low.	Check the switch at the receiver-drier and, if needed, replace the switch with a switch with a higher setting.
There is an air restriction in front of the fan clutch.	Check for incorrect radiator shutter operation, winterfronts, or any other air restrictions.
The temperature switch is malfunctioning.	Replace the temperature switch.

Problem—Fan Clutch Engages, But the Engine Still Overheats

Problem—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 "Cooling System Troubleshooting," **Section 20.00** in this group.

If the lubricant that comes with the rebuild kit for the Kysor K22RA 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 K22RA Fan Clutch Torques		
Description	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 K22RA Fan Clutch Torques

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General Information

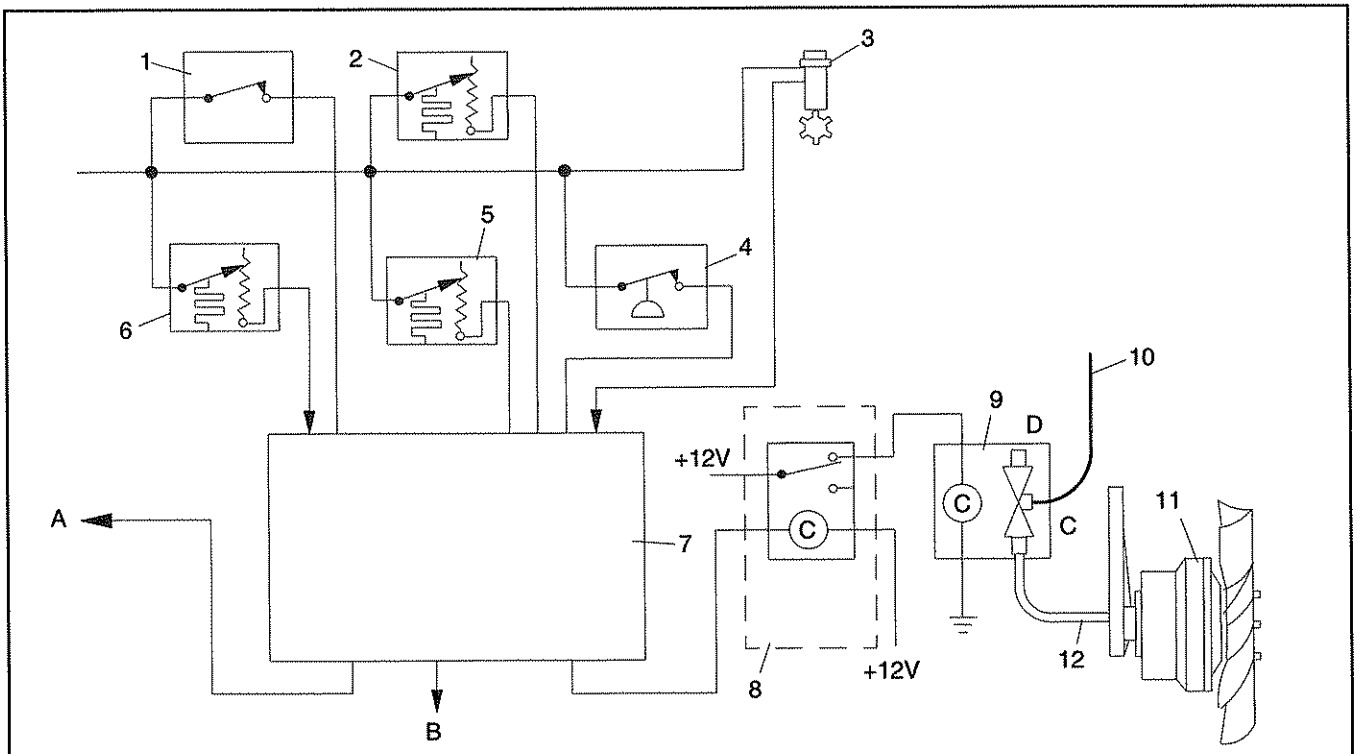
The Horton DriveMaster® fan clutch is a temperature-controlled, air-operated clutch for the engine cooling fan. It is spring engaged, and controls the engine temperature by engaging or disengaging the fan.

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.



A. To Indicators and Gauges
B. To Electronic Injectors and Other Actuators
C. Normally Closed
D. Normally Open

1. Fan Override Switch
2. Air Temperature Sensor
3. Engine Speed Sensor
4. A/C Pressure Switch
5. Coolant Temperature Sensor
6. Foot Throttle
7. Engine ECM
8. Fan Relay (not present in all systems)
9. Solenoid Valve
10. Air Supply from Reservoir
11. Fan Clutch
12. Air Supply to Fan Clutch

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

Removal

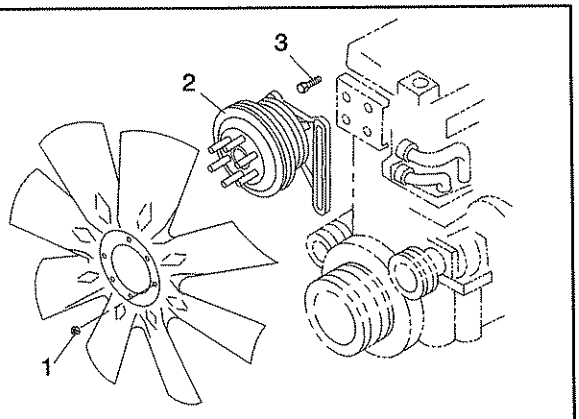
1. Park the vehicle on a level surface, shut down the engine, set the parking brakes, and chock the tires.

⚠ 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.
4. 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.
8. Remove the fan clutch assembly from the engine. See **Fig. 1**.

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



05/29/2002 f200576

1. Hexnut
2. Fan Clutch Assembly
3. Hexbolt

Fig. 1, Fan Clutch Removal (typical)

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

⚠ 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).
7. 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.

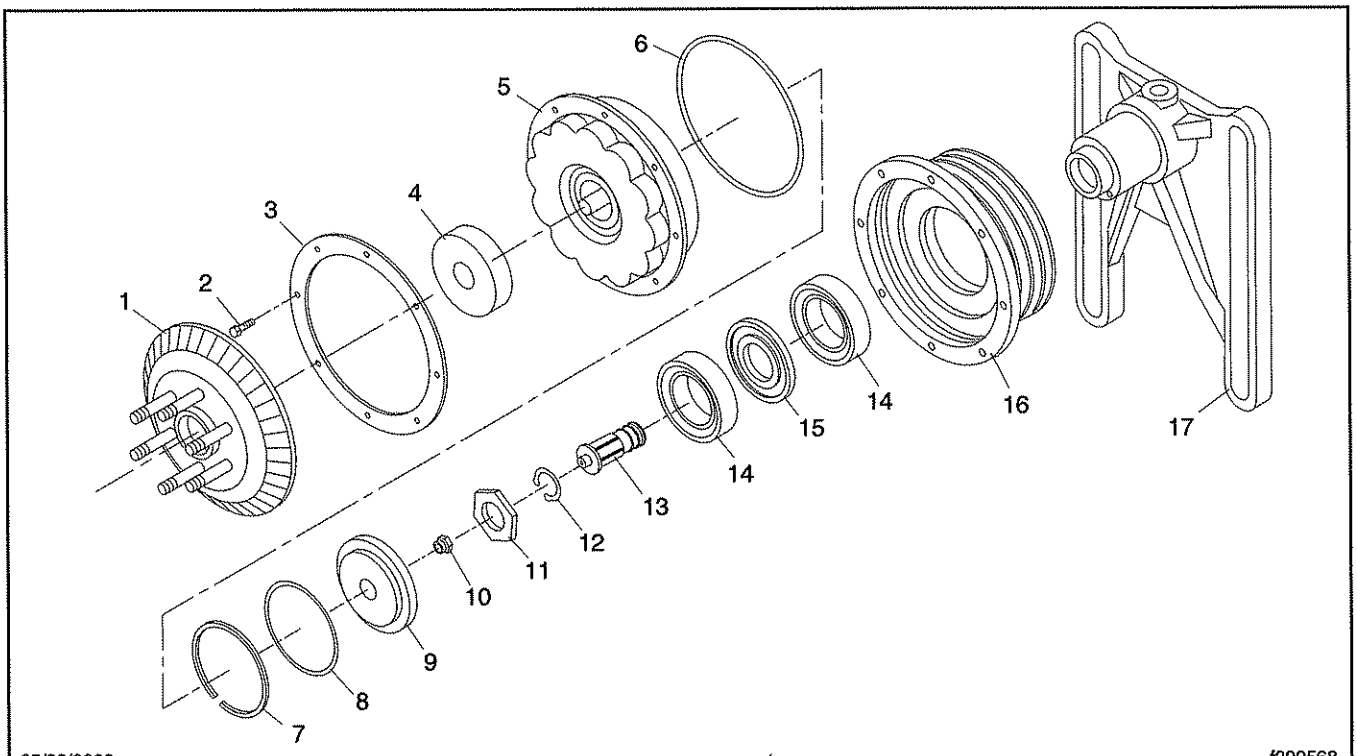
Refer to **Fig. 1** for this procedure.

1. Remove the fan clutch assembly from the vehicle. For instructions, see **Subject 100**.
2. Put the fan clutch assembly in a vise.
3. 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.

⚠ 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.

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**.



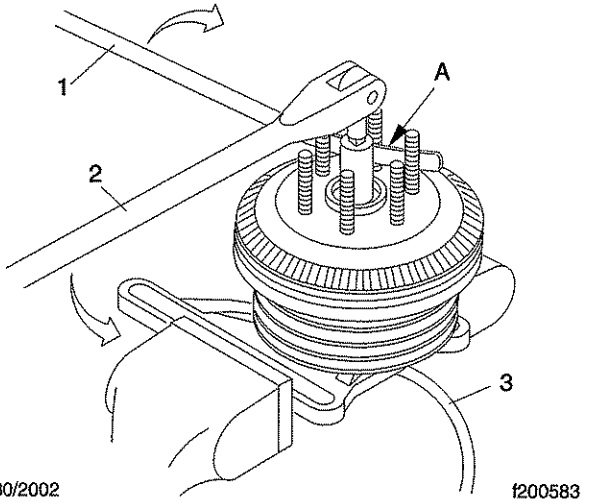
05/30/2002 f200568

1. Fan Mounting Disc
2. Torx®-Head Screw (8 qty.)
3. Friction Lining
4. Cage Nut (supplied with repair kit)
5. Spring Housing/Piston Assembly
6. Air Chamber Seal
7. Air Chamber Cap Retaining Ring
8. O-Ring
9. Air Chamber Cap
10. Face Seal
11. Bearing Nut
12. Air Cartridge Retaining Ring
13. Air Cartridge Assembly
14. Sheave Bearings
15. Bearing Spacer
16. Sheave
17. Journal Bracket

Fig. 1, Horton DriveMaster Fan Clutch

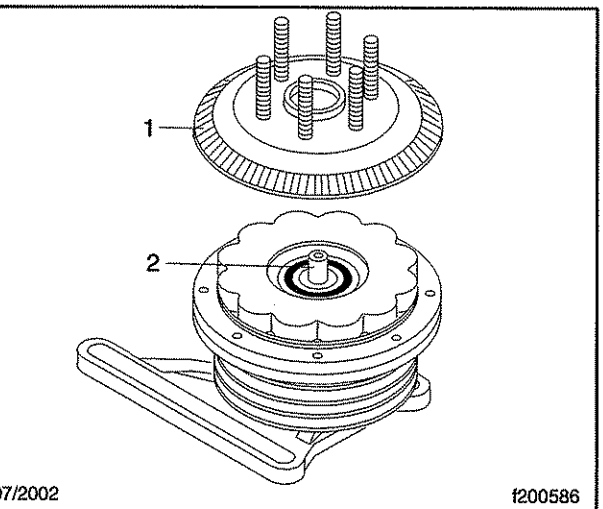
Fan Clutch Major Rebuild

6. Unscrew the fan mounting disc from the jack bolt. See **Fig. 3**
7. Inspect the fan mounting disc for wear or damage.



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



1. Fan Mounting Disc
2. Jack Bolt (left-hand thread)

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.

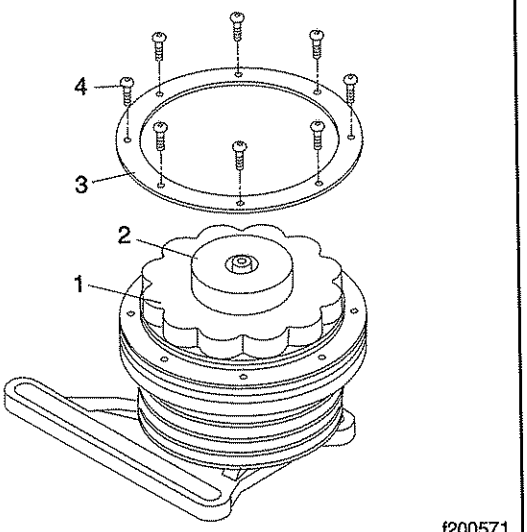
   The cage nut will keep the spring housing and piston together as an assembly. It will also maintain pressure on the internal springs after the Torx-head screws holding the friction lining in place are removed.

9. Release the air pressure from the fan clutch.

⚠ 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.

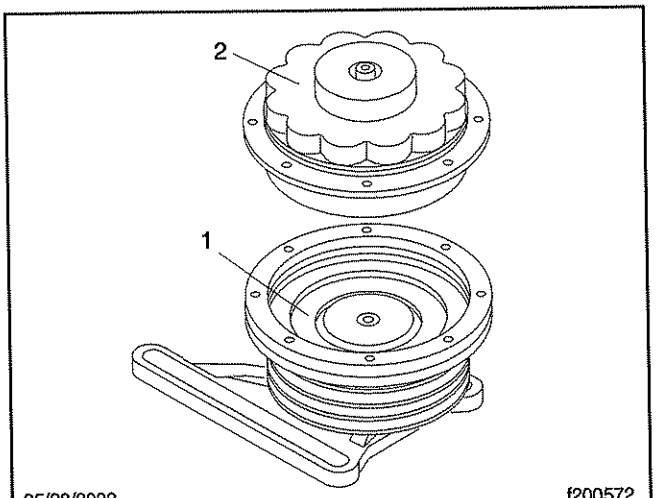
10. Using a T27 Torx bit, remove the eight Torx-head screws holding the friction lining in place.
11. Remove the friction lining. See **Fig. 4.**
12. *Keeping the cage nut installed and tightened,* remove the spring housing/piston assembly. See **Fig. 5.**
13. Remove the air chamber seal. See **Fig. 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.
17. Remove the O-ring seal from the air chamber cap. See **Fig. 6.**
18. Remove the face seal. See **Fig. 6.**



06/05/2002 f200571

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

Fig. 4, Friction Lining Removal and Installation

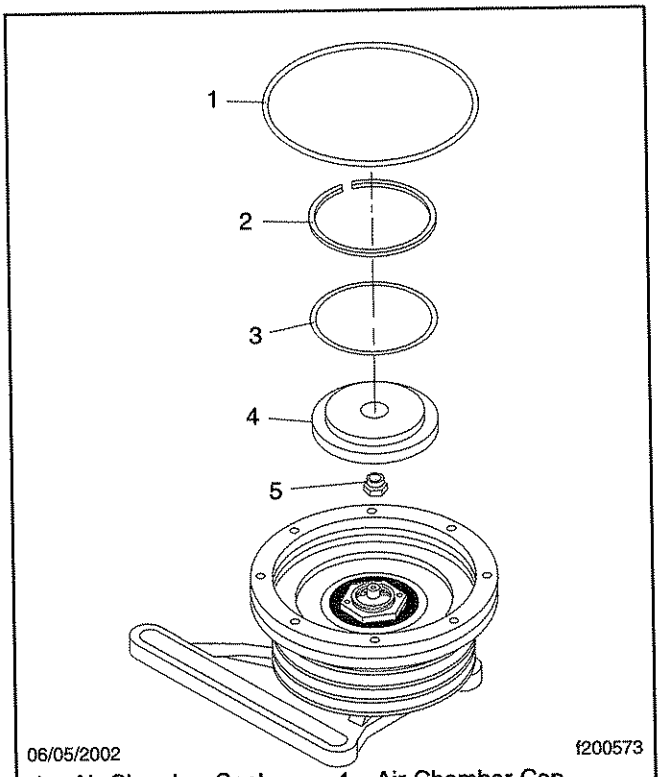


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1. Air Chamber
2. Spring Housing/Piston Assembly (with cage nut installed)

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

19. Inspect the face seal for signs of wear. Wear indicates that dirt may exist in the air system



06/05/2002 f200573

1. Air Chamber Seal
2. Retaining Ring
3. O-Ring Seal
4. Air Chamber Cap
5. Face Seal

Fig. 6, Air Chamber Seal Removal and Installation

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

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

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.

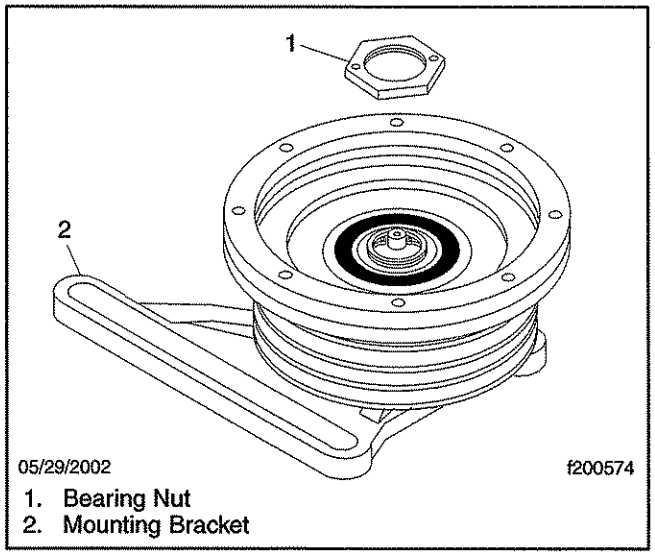
    24.1 Remove the retaining ring. See **Fig. 9**.

    24.2 Remove the air cartridge assembly. See **Fig. 10**.

Assembly

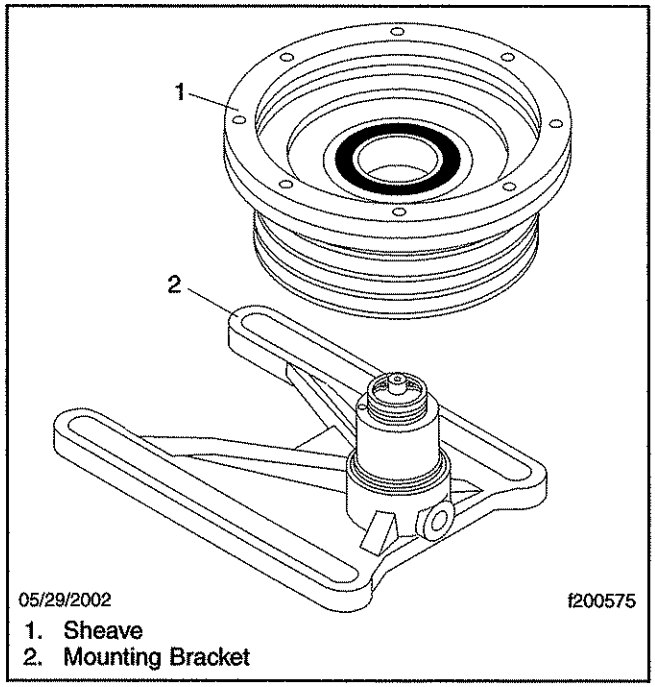
1. If necessary, clean the air cartridge bore in the mounting bracket.

Fan Clutch Major Rebuild



1. Bearing Nut
2. Mounting Bracket

Fig. 7, Bearing Nut Removal and Installation



1. Sheave
2. Mounting Bracket

Fig. 8, Removing the Sheave

NOTE: The sheave bearings do not require lubrication.

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

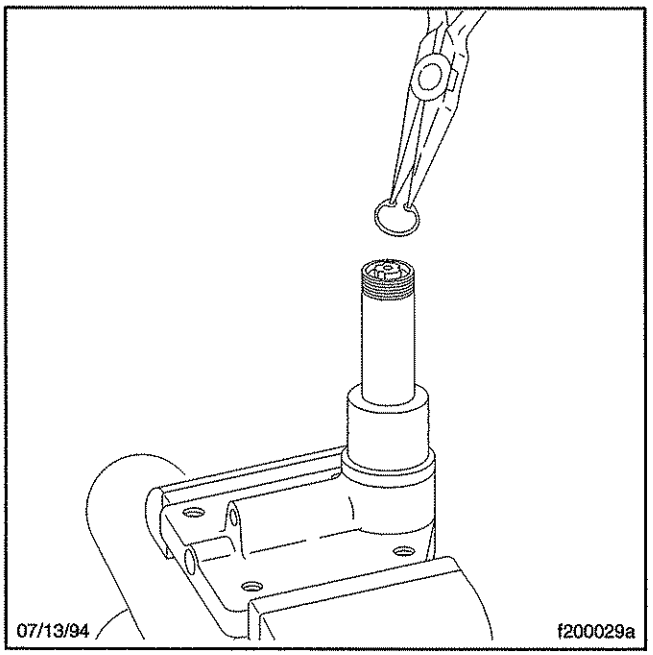
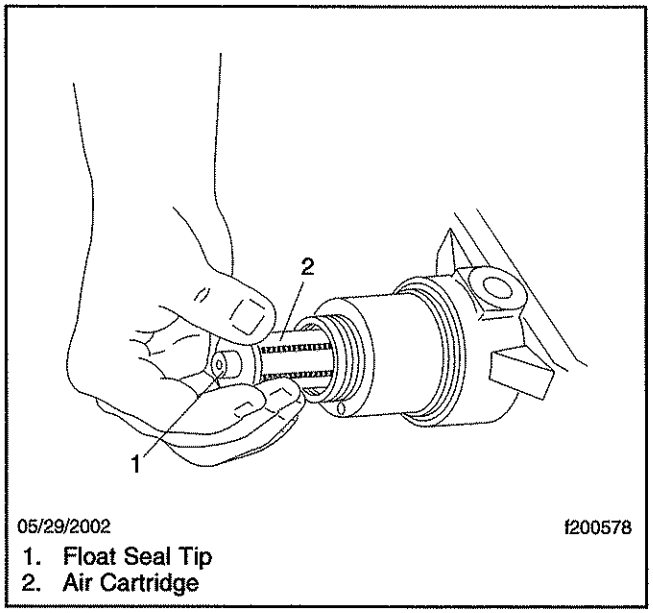


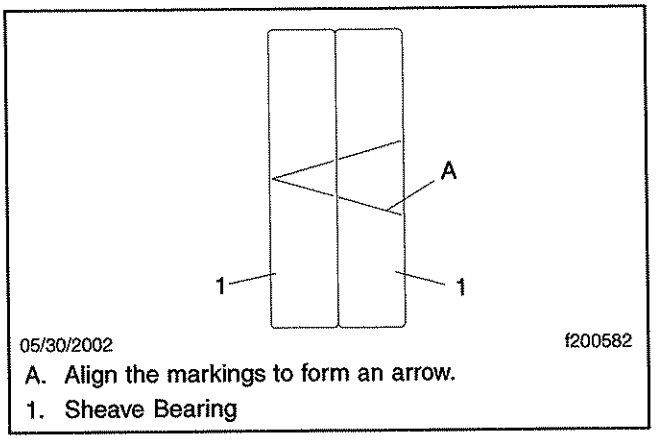
Fig. 9, Retaining Ring Removal and Installation



1. Float Seal Tip
2. Air Cartridge

Fig. 10, Removing the Air Cartridge

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



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A. Align the markings to form an arrow.
1. Sheave Bearing

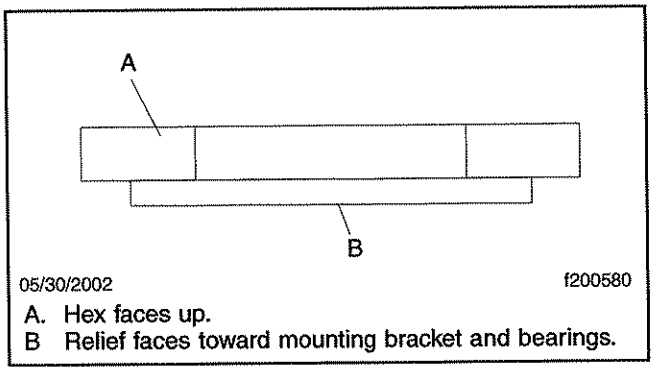
Fig. 11, Aligning the Bearings

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.**

3. Apply O-ring lubricant from the kit to the outside O-rings of the new air cartridge assembly. See **Fig. 13.**
4. 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.**



05/30/2002 f200580

A. Hex faces up.
B Relief faces toward mounting bracket and bearings.

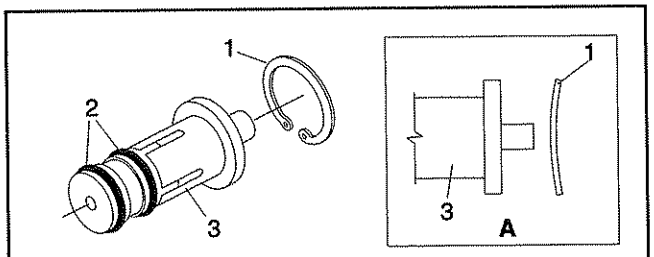
Fig. 12, Correct Bearing Nut Orientation

6. 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.**
13. Lubricate contact surfaces with the fresh lubricant from the kit.

⚠ 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.

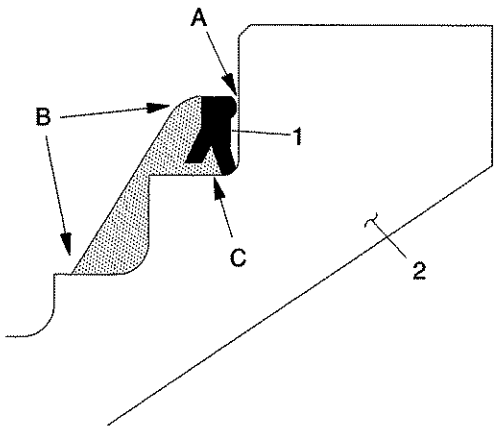


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A. Convex surface of the retaining ring goes toward the air cartridge.
1. Retaining Ring
2. O-Rings
3. Air Cartridge

Fig. 13, Installing the Air Cartridge Retaining Ring

Fan Clutch Major Rebuild



05/29/2002 f200579

A. 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 (cross-section view)

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.

15. 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·cm).

18. 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.

⚠ 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.

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.**

1. Remove the fan clutch assembly from the vehicle. For instructions, see **Subject 100.**
2. Put the fan clutch assembly in a vise.
3. 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.

⚠ 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.

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.

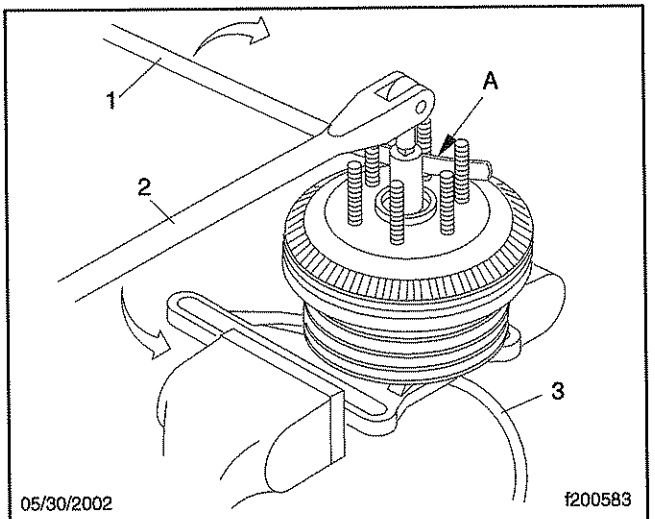
⚠ WARNING

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.

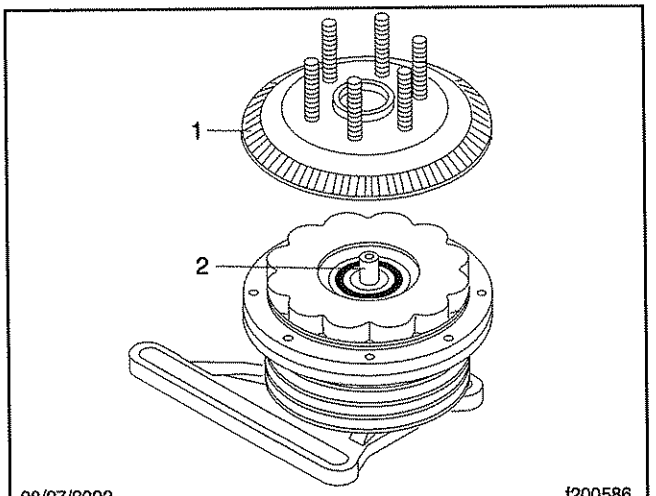
   The cage nut will keep the spring housing and piston together as an assembly. It will also maintain pressure on the internal springs after the Torx-head screws holding the friction lining in place are removed.

9. Release the air pressure from the 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. 1, Loosening the Jack Bolt



1. Fan Mounting Disc
2. Jack Bolt (left-hand thread)

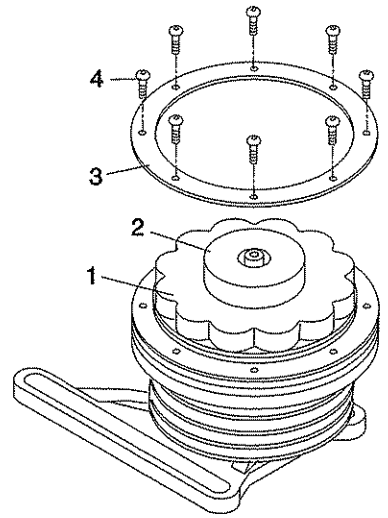
Fig. 2, Fan Mounting Disc Removal and Installation

Fan Clutch Minor Rebuild

⚠ 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**.
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.
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.
20. Remove the air cartridge.
    - 20.1 Remove the retaining ring. See **Fig. 6**.
    - 20.2 Remove the air cartridge assembly. See **Fig. 7**.



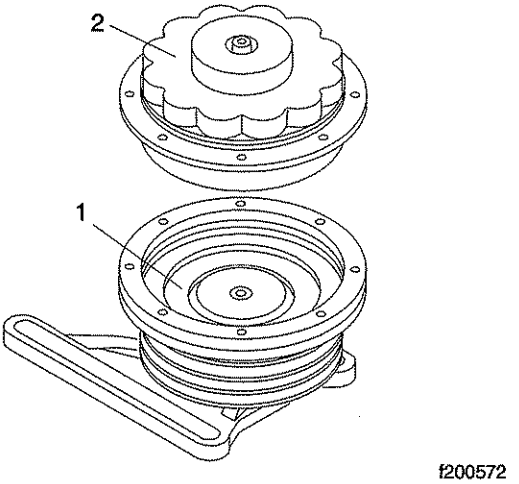
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1. Spring Housing/Piston Assembly
2. Cage Nut
3. Friction Lining
4. Torx-Head Screws

Fig. 3, Friction Lining Removal and Installation

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**.



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1. Air Chamber
2. Spring Housing/Piston Assembly (with cage nut installed)

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

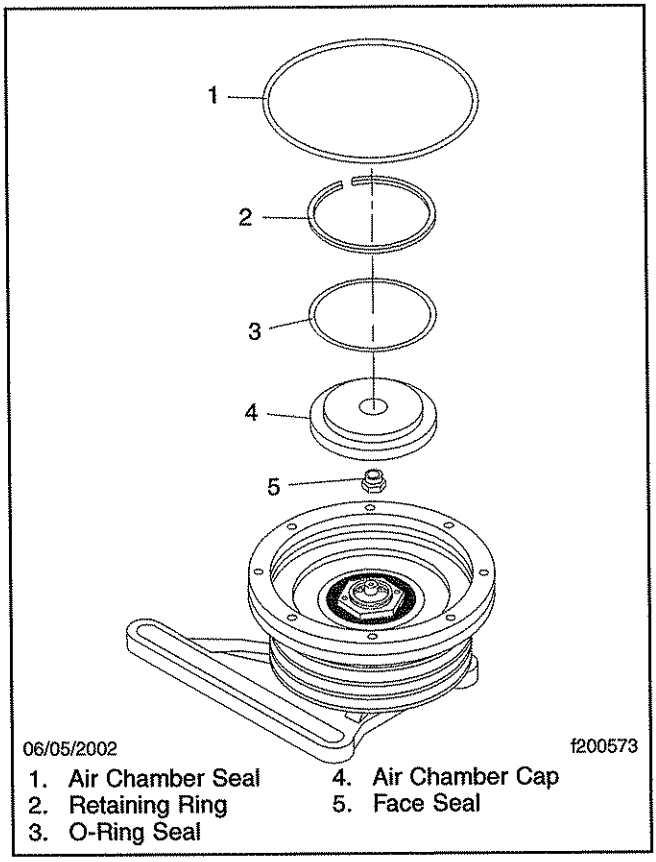


Fig. 5, Air Chamber Seal Removal and Installation

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.
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**.

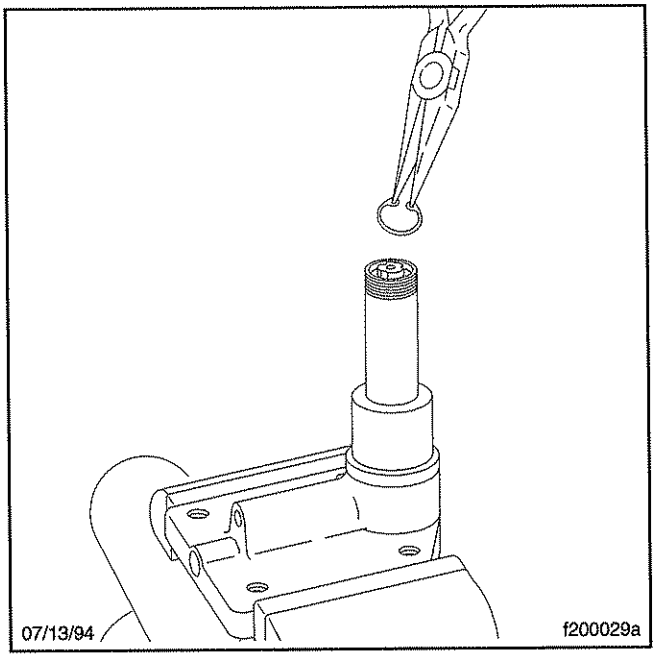


Fig. 6, Retaining Ring Removal and Installation (sheave not shown)

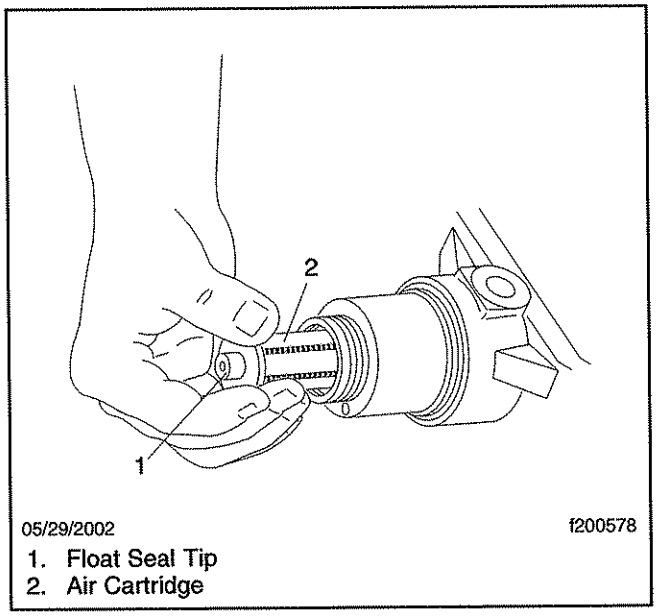
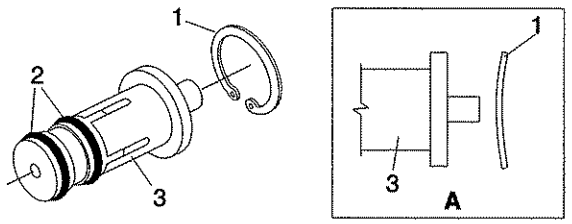


Fig. 7, Removing the Air Cartridge (sheave not shown)

Fan Clutch Minor Rebuild



03/27/2000 f200515

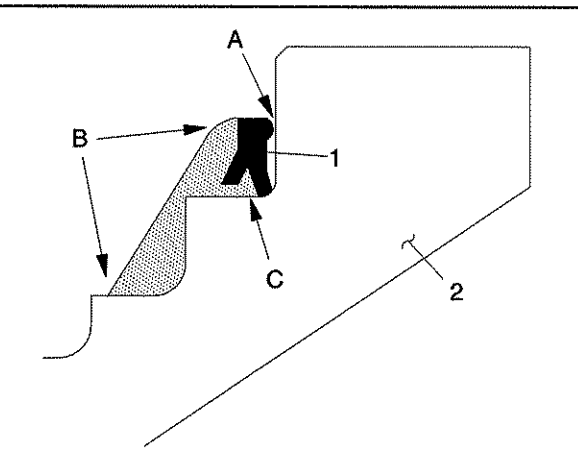
A. Convex surface of the retaining ring goes toward the air cartridge.
1. Retaining Ring
2. O-Rings
3. Air Cartridge

Fig. 8, Installing the Air Cartridge Retaining Ring

12. Lubricate contact surfaces with the fresh lubricant from the kit.

⚠ 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.



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A. 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. 9, Correct Installation of Air Chamber Seal (cross-section view)

13. 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.
14. 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).
17. 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.

⚠ 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 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.
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.

Troubleshooting

Problem — The Fan Clutch Cycles Frequently	
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.
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**
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

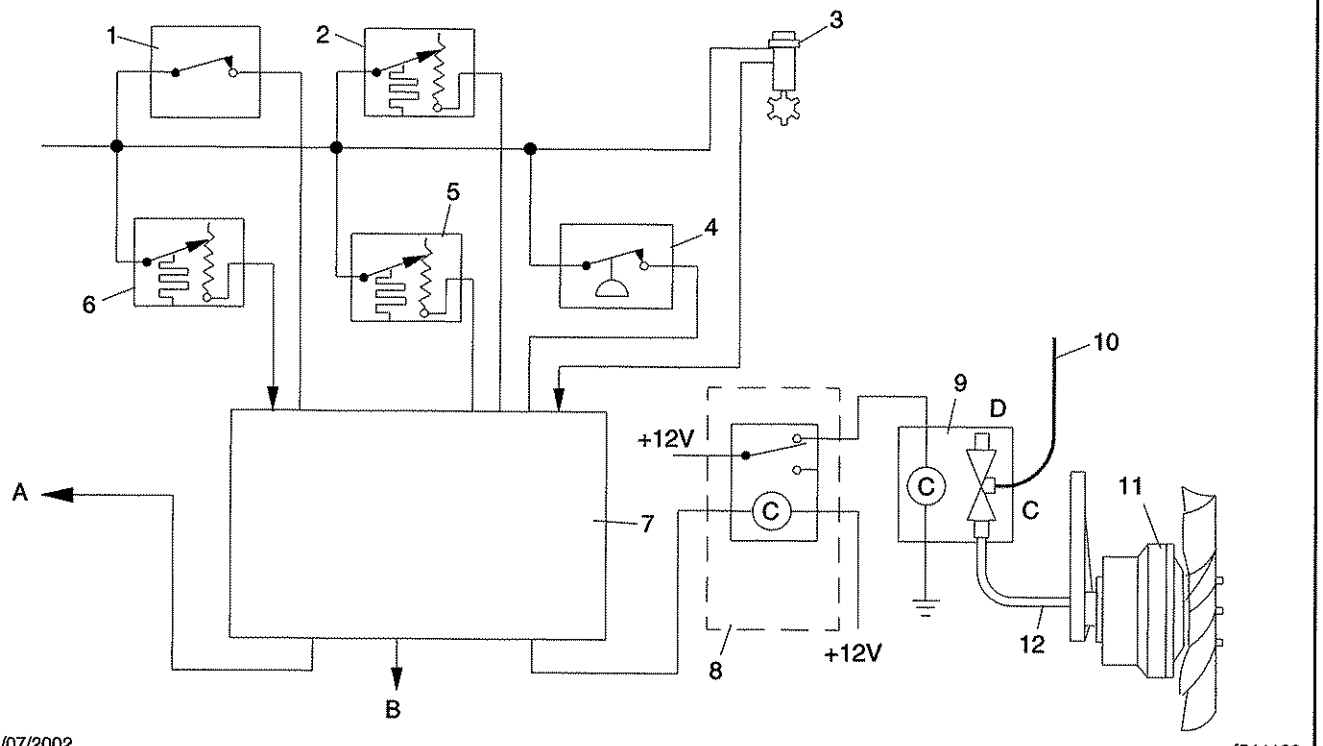
* All kits are available from the PDCs.

Table 1, Horton DriveMaster Repair Kits

Description	Torque	
	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



A. To Indicators and Gauges
B. To Electronic Injectors and Other Actuators
C. Normally Closed
D. Normally Open

1. Fan Override Switch
2. Air Temperature Sensor
3. Engine Speed Sensor
4. A/C Pressure Switch
5. Coolant Temperature Sensor
6. Foot Throttle
7. Engine ECM
8. Fan Relay (not present in all systems)
9. Solenoid Valve
10. Air Supply from Reservoir
11. Fan Clutch
12. Air Supply to Fan Clutch

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