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Pulley and Drive Belt Inspection

Inspection

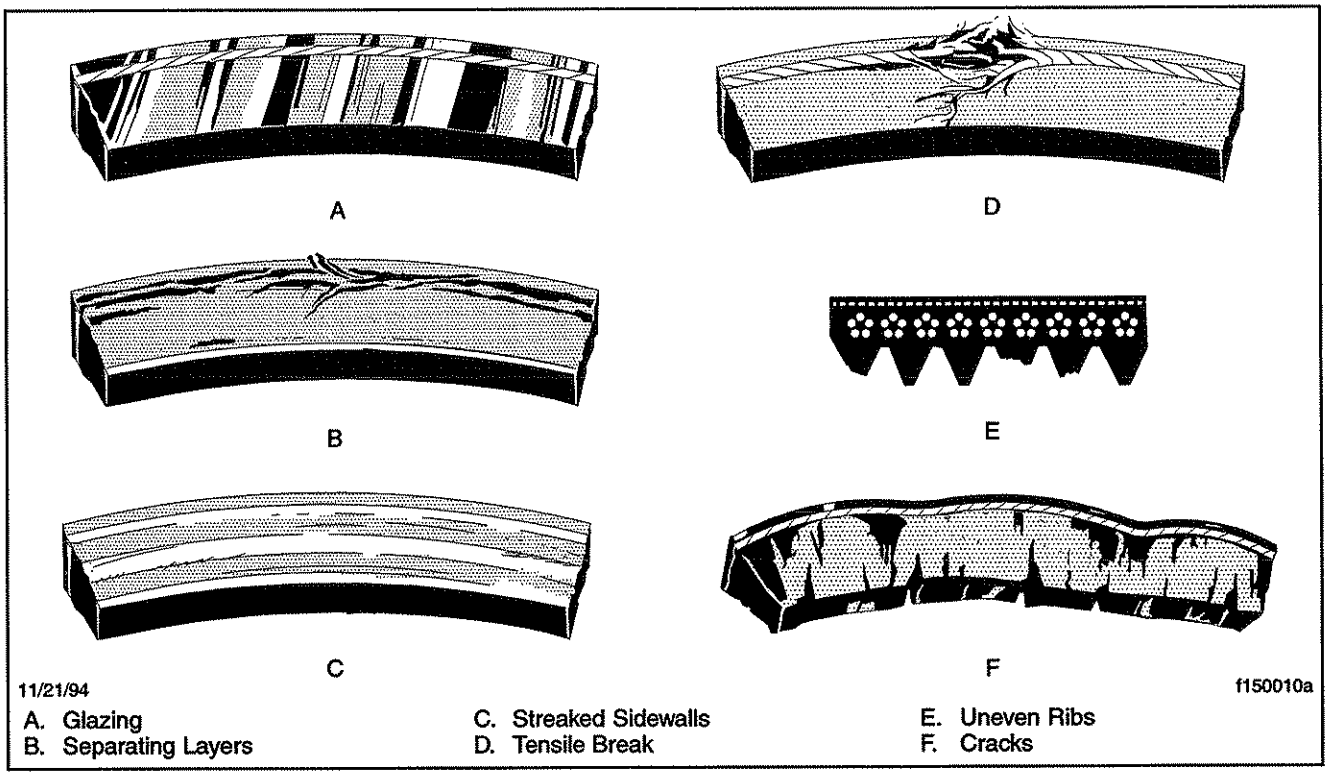
Inspect all used drive belts (including those that are being replaced). **See Fig. 1.**

NOTE: For an installed belt, gently twist it about 90 degrees so you can see the sidewalls and bottom.

Replace a belt if any problem is found. Replace both belts of a set, at the same time. Matched belts must be from the same manufacturer.

1. Inspect for glazing (shiny sidewalls). See Ref. A. Glazing is caused by friction created when a loose belt slips in the pulleys. It can also be caused by oil or grease on the pulleys.
2. Inspect for separating layers. See Ref. B. Oil, grease, or belt dressings can cause the belt to fall apart in layers. If engine parts are leaking, repair the leaks. Do *not* use belt dressings on any belt.
3. Check for jagged or streaked sidewalls. See Ref. C. These are the result of a foreign object (such as sand or small gravel) in the pulley, or a rough pulley wall surface.
4. Check for tensile breaks (breaks in the cord body). See Ref. D. Cuts in a belt are usually caused by large foreign objects in the pulley, or by prying or forcing the belt during installation or removal.
5. On poly-V belts, check for uneven ribs. See Ref. E. Foreign objects in the pulley will erode the undercord ribs, causing the belt to lose its gripping power.
6. Inspect for cracks. See Ref. F. Small, irregular cracks are usually signs of an old belt.

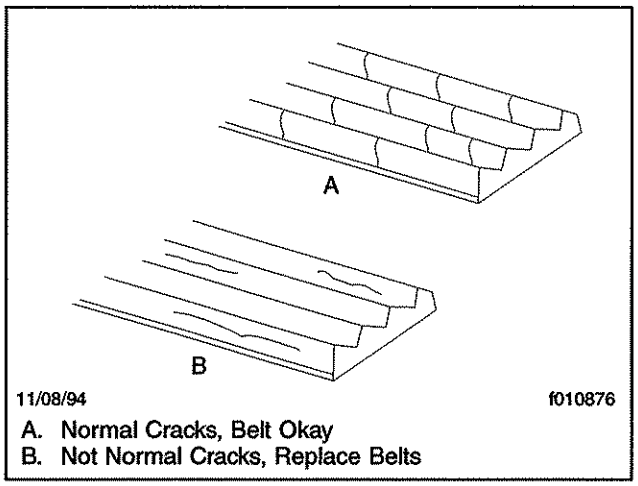
   When inspecting serpentine drive belts (used on Dodge gasoline engines), look for cracks that run along the ribs. **See Fig. 2.** These are not normal. Replace any belt with cracks running along the ribs. Small cracks that run across the ribbed surface are normal.
7. Check all pulley bearings for roughness. Replace the bearings if they're rough.
8. Inspect all pulleys for foreign objects, oil, or grease in the grooves. Use a non-flammable cleaning



A. Glazing
B. Separating Layers
C. Streaked Sidewalls
D. Tensile Break
E. Uneven Ribs
F. Cracks

Fig. 1

Pulley and Drive Belt Inspection



A. Normal Cracks, Belt Okay
B. Not Normal Cracks, Replace Belts

Fig. 2

solvent to remove oils. Use a wire brush to remove rust, and a file to remove burrs.

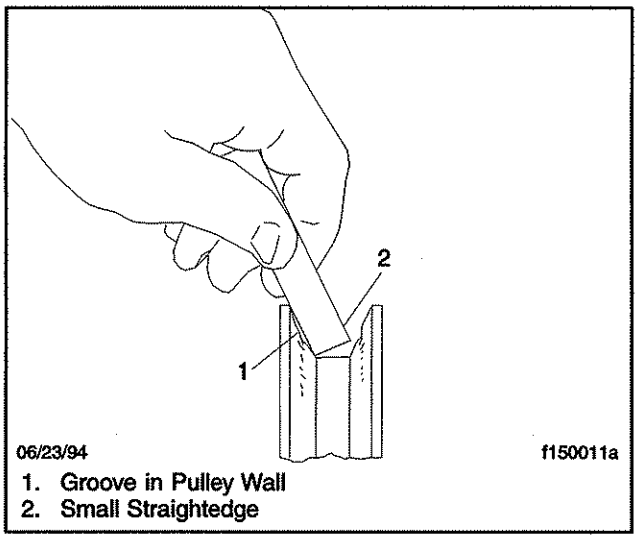
9. Inspect the pulleys for wear on the inner walls. Hold a small straightedge against the inside of the pulley walls **(Fig. 3)**, or use your little finger or fingernail to find grooves in the inner walls. If there are any grooves, replace the pulley.

10. Check the alignment of pulleys. **See Fig. 4.** Use a thin straightedge that is longer than the longest span between the pulleys. Place the straightedge into the V-grooves of two pulleys at a time. The straightedge should be parallel to the outer edges of the pulleys; if not, the pulleys are misaligned.

    Pulley misalignment must not be more than 1.6 mm for each 305 mm (1/16-inch for each foot) of distance between the centers of the pulleys.

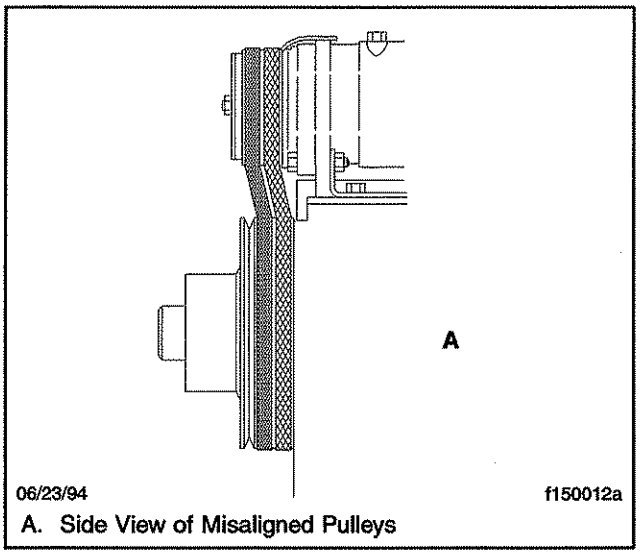
    If the pulleys are misaligned, adjust them or their brackets if possible. Replace bent or broken pulleys, pulley brackets, or shafts.

11. Check all drive component mounting parts for loose fasteners, cracks, or other damage. Tighten loose fasteners. Repair or replace cracked or damaged brackets.



1. Groove in Pulley Wall
2. Small Straightedge

Fig. 3



A. Side View of Misaligned Pulleys

Fig. 4

Air Compressor Belt Replacement, Mercedes-Benz OM 366LA Engine

Replacement (See Fig. 1)

1. Loosen the belt tensioner.
   - 1.1 Loosen the bolt (Ref. A) in the center of the belt tensioning assembly.
   - 1.2 Loosen the pinch-bolt (Ref. B) in the tensioning assembly clamp.
   - 1.3 Back off the adjusting nut (Ref. C) until the tensioning assembly is drawn up off the air compressor belts.
2. Remove the belts from the air compressor and fan pulleys.
3. Inspect the pulleys and belts (even if installing new belts) as instructed under **"Pulley and Drive Belt Inspection, 100."**
4. Loop the belts around the fan and air compressor pulleys.
5. Tighten the belts to the correct belt tension.
   - 5.1 Tighten the adjusting nut (Ref. C) against the tensioning assembly clamp until the assembly is forced down against the belts.

     Check the belt tension while turning the nut, use your thumb to apply about 11 kg (25 lb) of force at the center of the longest belt free-span until the belt deflection equals one belt thickness per 305 mm (1 ft) of pulley-center distance.
   - 5.2 Install belt tension gauges at the center of the belts' longest free-spans.

     Turn the adjusting nut (Ref. C) against the tensioning assembly clamp to move the assembly down and tension the belts.

     Tighten the belts to 23 kg (50 lb).

   IMPORTANT: Do not overtighten the belts; too much tension shortens belt and bearing life.
   - 5.3 Tighten the tensioning assembly clamp pinch bolt (Ref. B) 80 N·m (59 lbf·ft).
   - 5.4 Tighten the bolt through the tensioning assembly (Ref. A) 80 N·m (59 lbf·ft).
6. Check the belt tension again, and adjust if needed.
7. If installing new belts, operate the engine for about 20 minutes, then check the belt tension. All new belts will lose tension after 20 minutes of operation. If necessary, adjust the belts to 23 kg (50 lb).

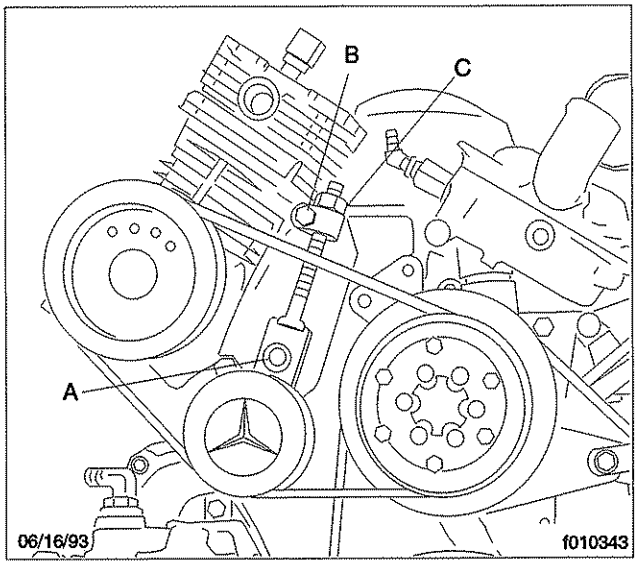


Fig. 1

Fan and Alternator Belt Replacement, Cummins B Series Engine

Replacement

1. If the vehicle is equipped with air conditioning, remove the refrigerant compressor belt. For instructions, see **Refrigerant Compressor Belt Replacement, Cummins B Series Engine, 120.**
2. Insert a 3/8-inch breaker bar in the belt tensioner (see **Fig. 1**), and rotate the tensioner up and off the belt (see **Fig. 2**).
3. Holding the belt tensioner up, remove the belt from the alternator pulley.
4. Slowly release the belt tensioner, and remove the breaker bar.
5. Lower the belt, and take it off the vibration damper.
6. Raise the belt, and take it off over the fan.

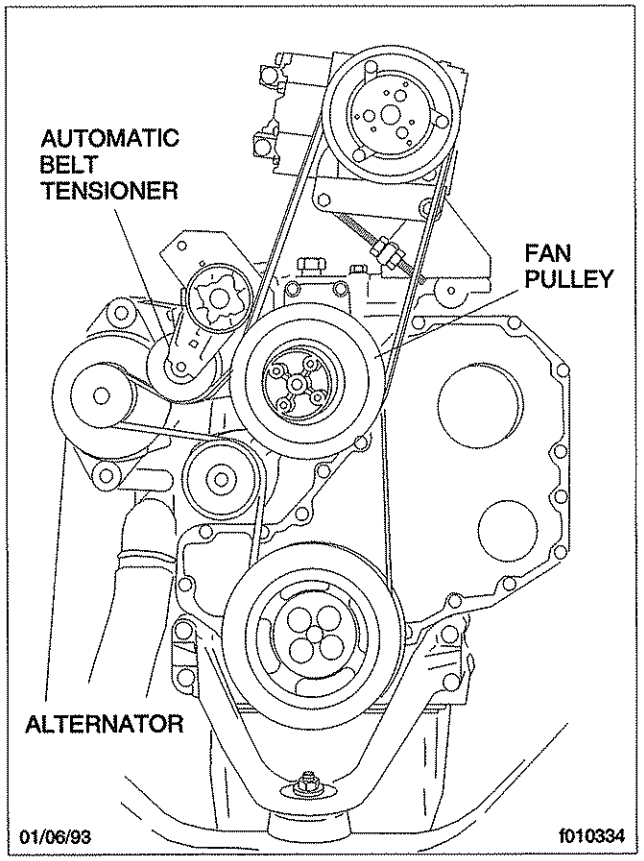


Fig. 1

7. Inspect the pulleys and the belt (even if installing a new belt) as instructed under **Pulley and Drive Belt Inspection, 100.**
8. Loop the belt around the fan and align it in the rear channel of the fan pulley (see **Fig. 2**).
9. Loop the belt down and around the vibration damper pulley.
10. Insert a 3/8-inch breaker bar in the belt tensioner (see **Fig. 2**), and rotate the tensioner up while installing the belt on the alternator pulley.
11. Slowly release the tensioner assembly onto the belt. The tensioner automatically tightens the belt to the correct tension.
12. Remove the breaker bar from the tensioner.
13. The Cummins belt tensioner automatically adjusts the fan and alternator belt to the correct tension. If the belt slips, repair or replace the tensioner. For instructions, see the *Cummins Shop Manual B Series Engines.*

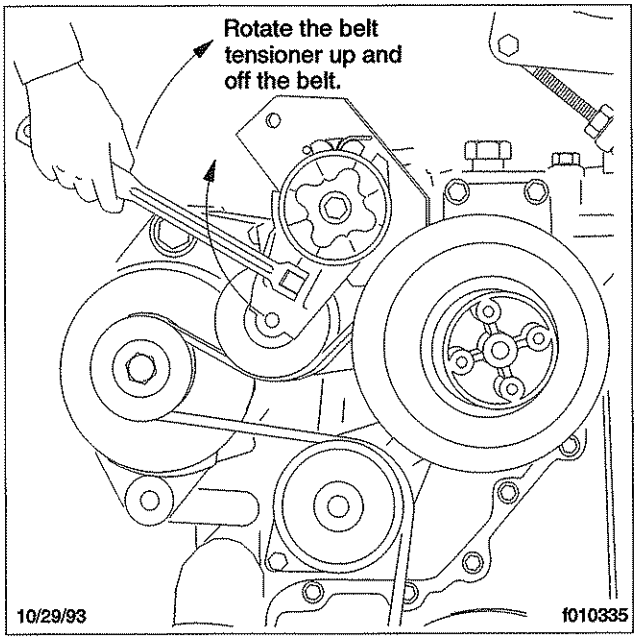


Fig. 2

Fan and Alternator Belt Replacement, Mercedes-Benz OM 366LA Engine

Replacement (See Fig. 1)

1. If the vehicle is equipped with air conditioning, remove the refrigerant compressor belt. For instructions, refer to **"Refrigerant Compressor Belt Replacement, Mercedes-Benz OM 366LA Engine, 125."**
2. If the vehicle is equipped with air brakes, remove the air compressor belt. For instructions, refer to **"Air Compressor Belt Replacement, Mercedes-Benz OM 366LA Engine, 105."**
3. Loosen the alternator mounting nut (Ref. C).
4. Back off the alternator adjusting rod nut (Ref. A).
5. Loosen the capscrew on the adjusting rod guide (Ref. B).
6. Rotate the alternator inward, and remove the belt from the alternator pulley.
7. Loop the belt down and off the vibration damper pulley.
8. Loop the belt up and off the fan pulley.
9. Inspect the pulleys and the belt (even if installing a new belt) as instructed under **"Pulley and Drive Belt Inspection, 100."**
10. Loop the belt around the fan and align it in the front channel of the large, two-channel fan pulley.

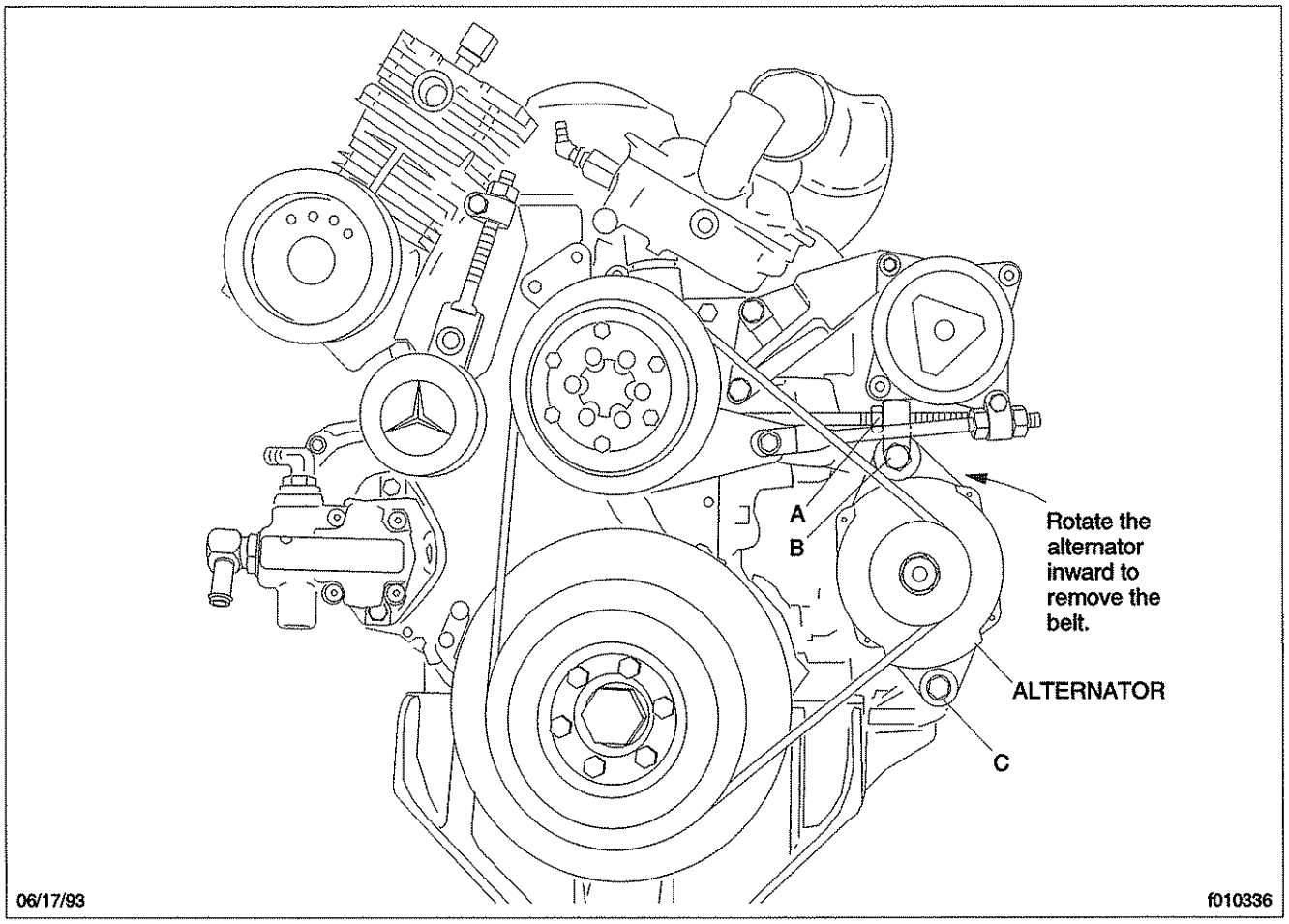


Fig. 1

Fan and Alternator Belt Replacement, Mercedes-Benz OM 366LA Engine

11. Loop the belt down and around the vibration damper pulley. Align the belt in the front channel of the two large pulley channels.
12. To install the belt on the alternator, rotate the alternator inward along its adjusting rod.
13. Loop the belt onto the alternator pulley, and align it in the front channel of the two alternator pulley channels.
14. Tighten the belt by turning the adjusting rod nut (Ref. A) against the adjusting rod guide until the alternator rotates outward against the belt.

    Check the tension while turning the nut, use your thumb to apply about 11 kg (25 lb) of force at the center of the longest belt free-span until the belt deflection equals one belt thickness per 305 mm (1 ft) of pulley-center distance.
15. Install a belt tension gauge at the center of the belt's longest free-span.
16. Turn the alternator adjusting rod nut (Ref. A) against the adjusting rod guide to move the alternator outward and tension the belt.
17. Tighten the belt to 75 kg (160 lb).

IMPORTANT: Do not overtighten the belt; too much tension shortens belt and bearing life.

18. Tighten the capscrew securing the adjusting rod guide (Ref. B) 80 N·m (59 lbf·ft).
19. Tighten the alternator mounting nut (Ref. C) 80 N·m (59 lbf·ft).
20. Check the belt tension again, and adjust if needed.
21. If installing a new belt, operate the engine for about 20 minutes, then check the belt tension. All new belts will lose tension after 20 minutes of operation.

    If necessary, adjust the belt to 75 kg (160 lb).

Refrigerant Compressor Belt Replacement, Cummins B Series Engine

Replacement (See Fig. 1)

1. Loosen the refrigerant compressor mounting nuts (Ref. A).
2. Loosen the adjusting rod locknut (Ref. C), then back off the adjusting rod nut (Ref. B) until the belt can be removed.
3. Remove the belt. Don't pry or roll it off the pulleys.
4. Inspect the pulleys and the used belt (even if installing a new belt) as instructed under **"Pulley and Drive Belt Inspection, 100."**
5. Loop the belt around the fan and the compressor, and align it in the front channels of the pulleys.
6. Tighten the belt by turning the adjusting rod nut (Ref. B) against the compressor mount until the compressor moves up.

   Check the belt tension while turning the nut, use your thumb to apply about 11 kg (25 lb) of force at the center of the longest belt free-span until belt deflection equals one belt thickness per 305 mm (1 ft) of pulley-center distance.
7. Install a belt tension gauge at the center of the belt's longest free-span.
8. Tighten the compressor belt, by turning the adjusting rod nut (Ref. B) against the compressor mount to rotate the compressor up and away from the fan pulley. Tighten the belt to 45 kg (100 lb).

IMPORTANT: Do not overtighten the belts; too much tension shortens belt and bearing life.

9. Tighten the adjusting rod jam nut (Ref. C) against the compressor mount 80 N·m (59 lbf·ft).
10. Tighten the compressor mounting nuts (Ref. A) 80 N·m (59 lbf·ft).
11. Check the belt tension again, and adjust if needed.
12. If installing a new compressor belt, operate the engine for about 20 minutes, then check the belt tension. All new belts will lose tension after 20 minutes of operation.

    If necessary, adjust the belt to 45 kg (100 lb).

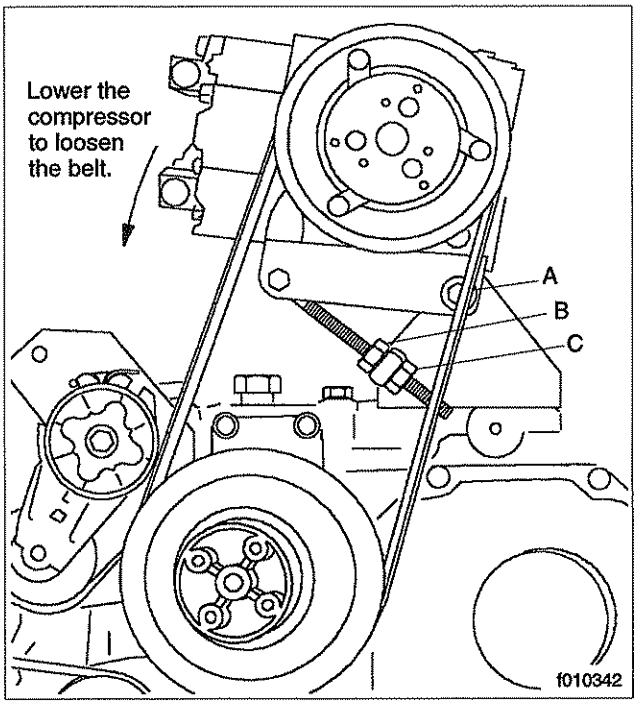


Fig. 1

Refrigerant Compressor Belt Replacement, Mercedes-Benz OM 366LA Engine

Replacement (see Fig. 1)

1. Remove the refrigerant compressor belt.
   - 1.1 Loosen the compressor mounting nuts (Ref. A), and back off the adjusting rod nut (Ref. D).
   - 1.2 Loosen the nut on the adjusting rod guide bolt (Ref. B).
   - 1.3 Lower the compressor by sliding the guide down along the adjusting rod. Remove the belt from the compressor and vibration damper pulleys.
2. If removed, install and adjust the fan and alternator belt. For instructions, refer to **Fan and Alternator Belt Replacement, Mercedes-Benz OM 366LA Engine, 115.**
3. Inspect the pulleys and the belt (even if installing a new belt) as instructed under **Pulley and Drive Belt Inspection, 100.**

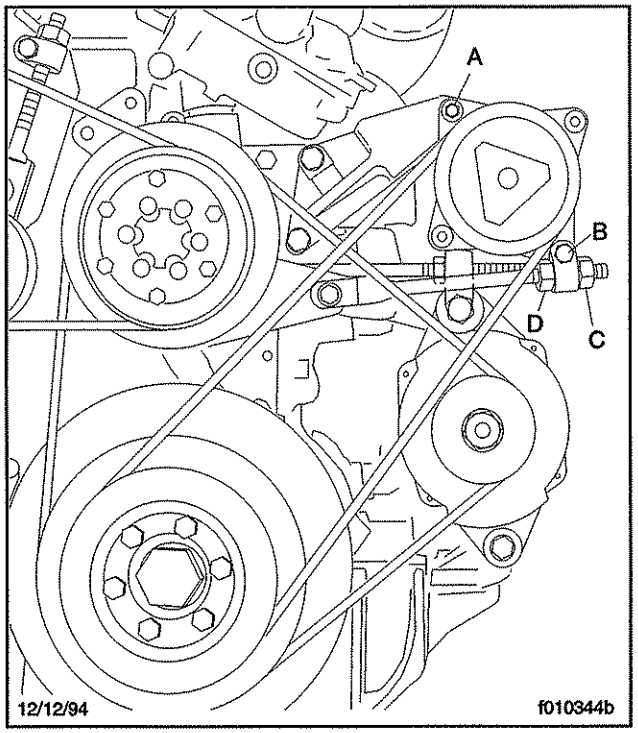


Fig. 1

4. Loop the belt around the small vibration damper pulley.
5. Loop the belt around the compressor pulley, and align it in the rear channel of the two pulley channels.
6. Tighten the belt by turning the adjusting rod nut (Ref. D) against the adjusting rod guide until the compressor rises against the belt.

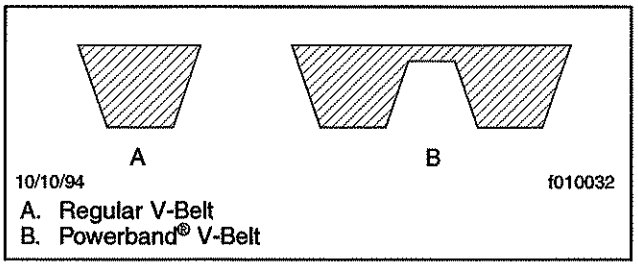
   Check the belt tension while turning the nut, use your thumb to apply about 11 kg (25 lb) of force at the center of the longest belt free-span until belt deflection equals one belt thickness per 305 mm (1 ft) of pulley-center distance.
7. Install a belt tension gauge at the center of the belt's longest free-span.
8. Turn the adjusting rod nut (Ref. D) against the adjusting rod guide to rotate the compressor upward and tension the belt.
9. For a regular V-belt, tighten the belt to 45 kg (100 lb). For a Powerband® V-belt (**see Fig. 2**), tighten the belt to 64 kg (140 lb).

IMPORTANT: Do not overtighten the belt; too much tension shortens belt and bearing life.

10. Tighten the nut on the adjusting rod guide (Ref. B) 45 N·m (33 lbf·ft).
11. Tighten the refrigerant compressor mounting nuts (Ref. A) 45 N·m (33 lbf·ft).
12. Tighten the adjusting rod jam nut (Ref. C) 190 N·m (140 lbf·ft).
13. Check the belt tension again, and adjust if needed.
14. If installing a new belt, operate the engine for about 20 minutes, then check the belt tension. All new belts will lose tension after 20 minutes of operation.

    If necessary, adjust the belt to 45 kg (100 lb).

Refrigerant Compressor Belt Replacement, Mercedes-Benz OM 366LA Engine



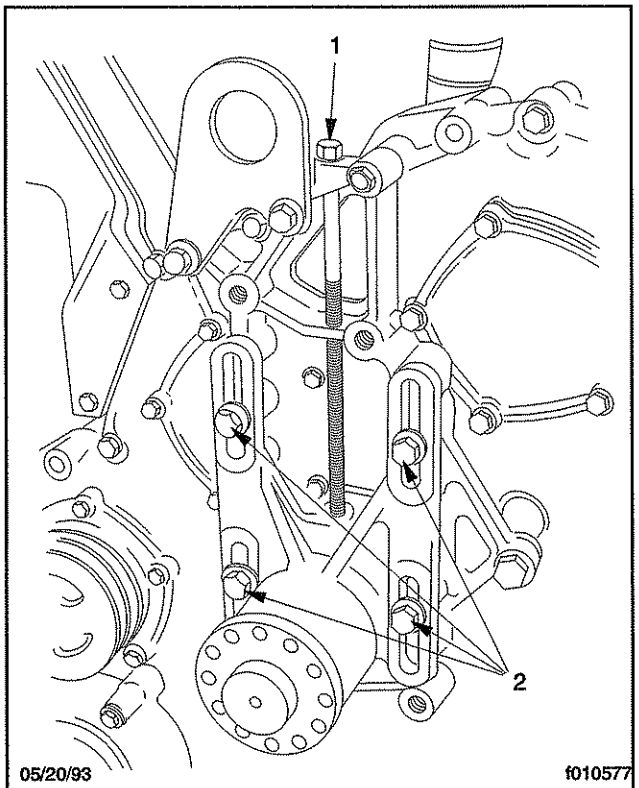
A. Regular V-Belt
B. Powerband® V-Belt

Fig. 2, Drive Belts, Cross Sections Shown

Fan Belt Replacement, Detroit Diesel Series 50 Engine

Replacement(See Fig. 1)

1. Loosen the four mounting capscrews that attach the fan hub to the engine.
2. Loosen the adjusting rod to relieve tension from the belts.
3. Remove the belts by slipping them off the pulleys and working them over one fan blade at a time. On some vehicles, it may be necessary to remove the fan blade. For instructions, refer to the engine cooling section of this manual. Don't roll or pry the belts off the pulleys; the distance between the pulley centers must be short enough to allow belt removal without using force.
4. Inspect the pulleys and belts (even if installing new belts) as instructed in **"Pulley and Drive Belt Inspection."**



1. Adjusting Rod
2. Mounting Capscrews

Fig. 1, Fan Belt Adjustment

5. Work the belts over the fan blades, one blade at a time. Install the belts on the pulleys without prying or rolling them into place.
6. While keeping the belts seated in the pulley grooves, turn the adjusting rod to increase belt tension. Use your thumb to apply about 25 lb (11 kg) of force at the center of the longest belt free-span to check the tension while turning the adjusting rod.
7. When belt deflection is about 1/2 to 3/4 inch (13 to 19 mm), install a belt tension gauge at the center of the belt's longest free-span.
8. Turn the adjusting rod to increase or decrease belt tension. Final tension must be 60 to 80 lb (27 to 36 kg).

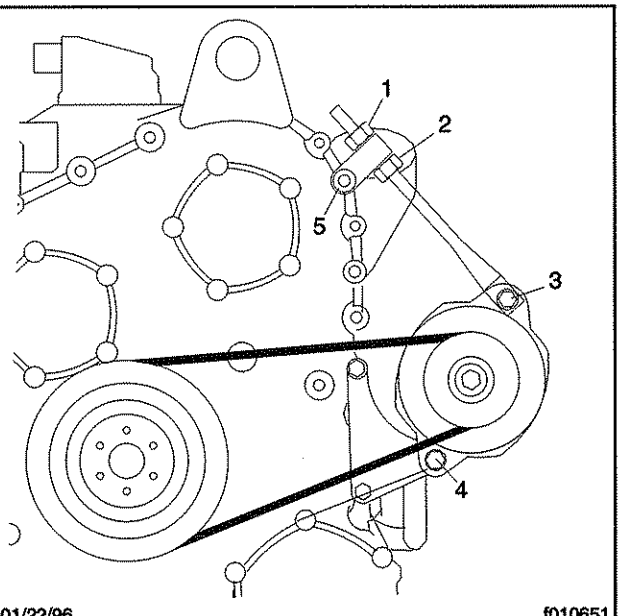
IMPORTANT: Do not overtighten the belts; too much tension shortens belt and bearing life.

9. Tighten the fan hub mounting capscrews 75 to 83 lbf·ft (100 to 112 N·m).
10. Check the belt tension and adjust it if needed.
11. Operate the engine for about 30 minutes (or 15 miles), then check the belt tension. Check again after 8 hours (or 250 miles). Adjust belt tension as needed.

Alternator Belt Replacement, Detroit Diesel Series 50 Engine

Replacement(Refer to Fig. 1)

1. Back off the adjusting rod nut.
2. Loosen the adjusting rod guide mounting bolt.
3. Loosen the adjusting rod mounting bolt.
4. Loosen the alternator mounting bolt.
5. Turn the adjusting rod jam nut to rotate the alternator up and toward the engine. Turn the nut until the alternator is close enough to the engine to allow belt removal. Remove the belts by slipping them off the pulleys and working them over one fan blade at a time. Don't roll or pry the belts off the pulleys; the distance between the pulley centers must be short enough to allow belt removal without using force.
6. Inspect the pulleys and used belts (even if installing new belts) as instructed in **"Pulley and Drive Belt Inspection."**



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1. Adjusting Rod Jam Nut
2. Adjusting Rod Nut
3. Adjusting Rod Mounting Bolt
4. Alternator Mounting Bolt
5. Adjusting Rod Guide Mounting Bolt

Fig. 1, Alternator Belt Adjustment

7. Work the belts over the fan blades, one blade at a time. Install the belts on the pulleys without prying or rolling them into place.
8. Install a belt tension gauge at the center of the belt's longest free-span.
9. While keeping the belts seated in the pulley grooves, turn the adjusting rod nut to rotate the alternator away from the engine and increase belt tension. Turn the adjusting rod nut until final belt tension is 60 to 80 lb (27 to 36 kg).

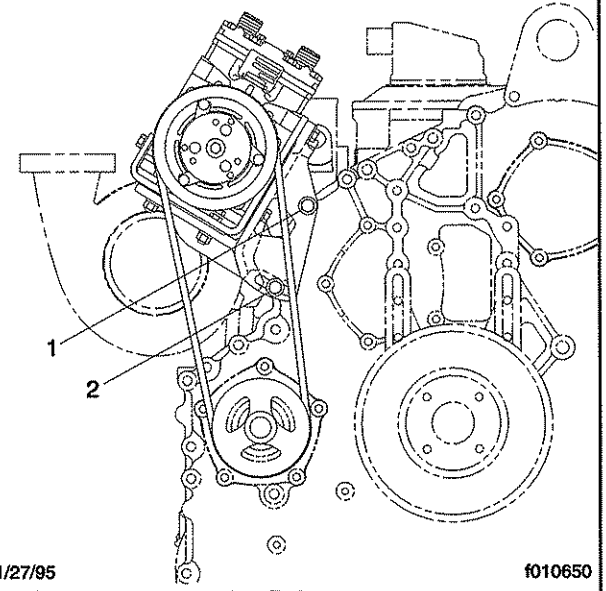
IMPORTANT: Do not overtighten the belts; too much tension shortens belt and bearing life.

10. Tighten the adjusting rod jam nut 176 N·m (130 lbf·ft).
11. Tighten the alternator mounting bolt and the adjusting rod mounting bolt 123 N·m (91 lbf·ft).
12. Tighten the adjusting rod guide mounting bolt 46 N·m (34 lbf·ft).
13. Operate the engine for about 30 minutes (or 15 miles), then check the belt tension. Check again after 8 hours (or 250 miles). Adjust belt tension as needed.

Refrigerant Compressor Belt Replacement, Detroit Diesel Series 50 Engine

Replacement(See Fig. 1)

1. Loosen the compressor mounting bolt and the compressor adjustment bolt that attach the compressor bracket to the engine.
2. Rotate the compressor downward, toward the engine to allow belt removal without using force.
3. Remove the belt without prying or rolling it off the pulleys.
4. Inspect the pulleys and belts (even if installing new belts) as instructed in **"Pulley and Drive Belt Inspection."**
5. Loop the belt around the pulleys.
6. Install a belt tension gauge at the center of the belt's longest free-span.
7. While keeping the belt seated in the pulley grooves, rotate the compressor up and away from the engine until the belt is tensioned 41 to 45 kg (90 to 100 lb).



1. Compressor Mounting Bolt
2. Compressor Adjustment Bolt

Fig. 1, Refrigerant Compressor Belt Adjustment

IMPORTANT: Do not overtighten the belts; too much tension shortens belt and bearing life.

8. Tighten the compressor mounting and adjustment capscrews 46 N·m (34 lbf·ft).
9. Operate the engine for about 30 minutes (or 15 miles), then check the belt tension. Check again after 8 hours (or 250 miles). Adjust belt tension as needed.

Accessory Drive Belt Replacement, Dodge Magnum Engines

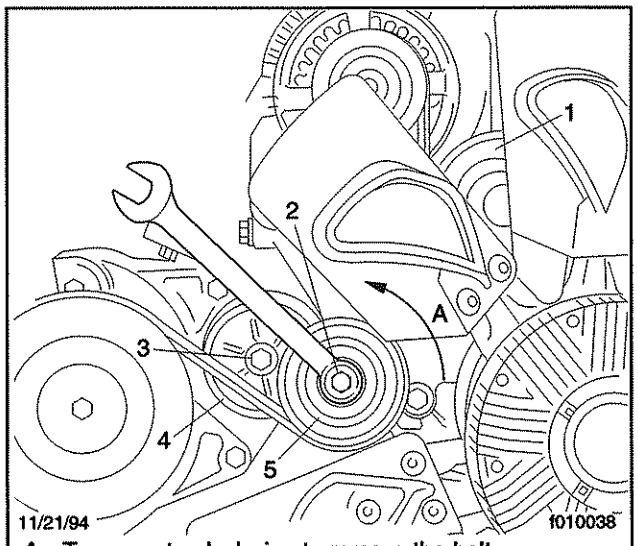
Replacement

1. Place a 5/8-inch wrench over the pulley bolt on the automatic belt tensioner, and turn the wrench counterclockwise to relax the belt tensioner. **See Fig. 1.**
2. Remove the engine accessory drive belt.
3. Inspect the pulleys and the drive belt (even if installing a new belt) as instructed in **Subject 100**.

⚠ CAUTION

CAUTION: When installing a serpentine accessory drive belt, route the belt correctly. If the belt is not routed correctly, the water pump pulley may rotate in the wrong direction, allowing the engine to overheat.

NOTE: If the pulley must be removed from the automatic belt tensioner: The pulley bolt has left hand threads.



A. Turn counterclockwise to remove the belt.
1. Idler Pulley
2. Tensioner Pulley Bolt
3. Tensioner Mounting Bolt
4. Tensioner
5. Tensioner Pulley

Fig. 1, Relieving Belt Tension

4. Position the drive belt over all the pulleys *except the drive belt tensioner.* For the correct belt routing, **see Fig. 2** and **Fig. 3.**
5. Place a 5/8-inch wrench over the pulley bolt on the automatic belt tensioner, and turn the wrench counterclockwise to relax the belt tensioner. Finish installing the belt. **See Fig. 1.**
6. Correct drive belt tension is required for optimum performance of belt-driven engine accessories. If the specified belt tension is not maintained, check and repair the following:

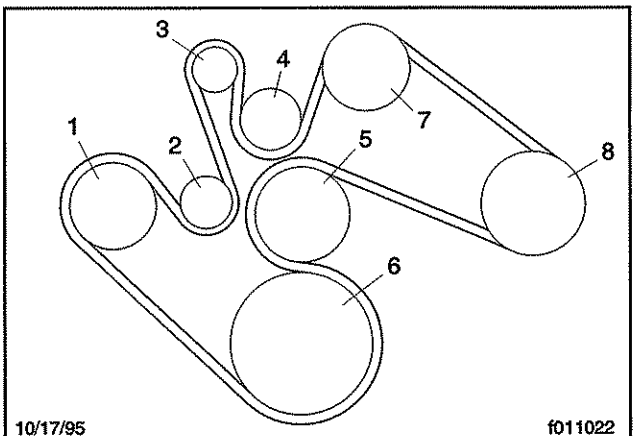
   Make sure the correct belt is installed.

   Make sure the belt is routed correctly.

   Check for worn bearings on all the engine accessory pulleys.

   Check for a loose engine accessory pulley.

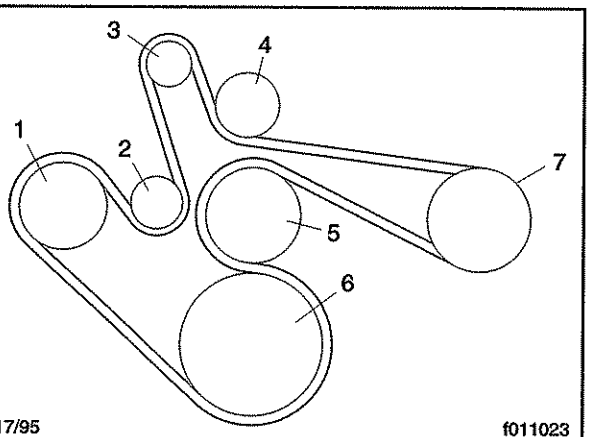
   Check for misalignment between accessory pulleys.



1. Air Injection Pump
2. Automatic Tensioner
3. Alternator
4. Idler
5. Water Pump
6. Crank Pulley
7. Refrigerant Compressor
8. Power Steering Fluid Pump

Fig. 2, Drive Belt Routing with a Refrigerant Compressor

Accessory Drive Belt Replacement, Dodge Magnum Engines



1. Air Injection Pump
2. Automatic Tensioner
3. Alternator
4. Idler Pulley
5. Water Pump
6. Crank Pulley
7. Power Steering Fluid Pump

Fig. 3, Drive Belt Routing without a Refrigerant Compressor

Accessory Drive Belt Replacement, Caterpillar CFE Series Engine

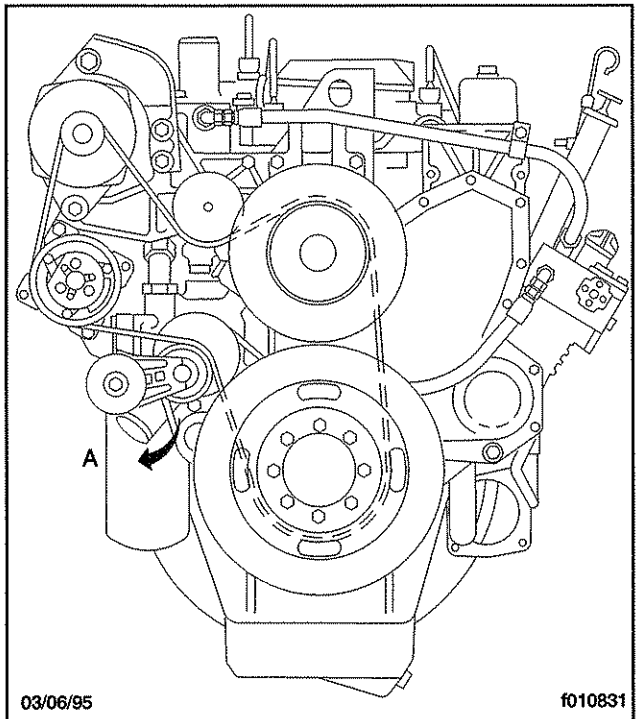
Replacement

1. Insert a 1/2-inch rachet drive into the square hole in the belt tensioner, and turn the tensioner clockwise. **See Fig. 1.**
2. Remove the engine accessory drive belt.
3. Inspect the pulleys and the drive belt (even if installing a new belt) as instructed in **Subject 100.**

⚠ CAUTION

CAUTION: When installing a serpentine accessory drive belt, route the belt correctly. If the belt is not routed correctly, the water pump pulley may rotate in the wrong direction, allowing the engine to overheat.

4. Position the drive belt over all the pulleys *except the drive belt tensioner.* For the correct belt routing, **see Fig. 1.**



A. Turn the belt tensioner clockwise, off the belt.

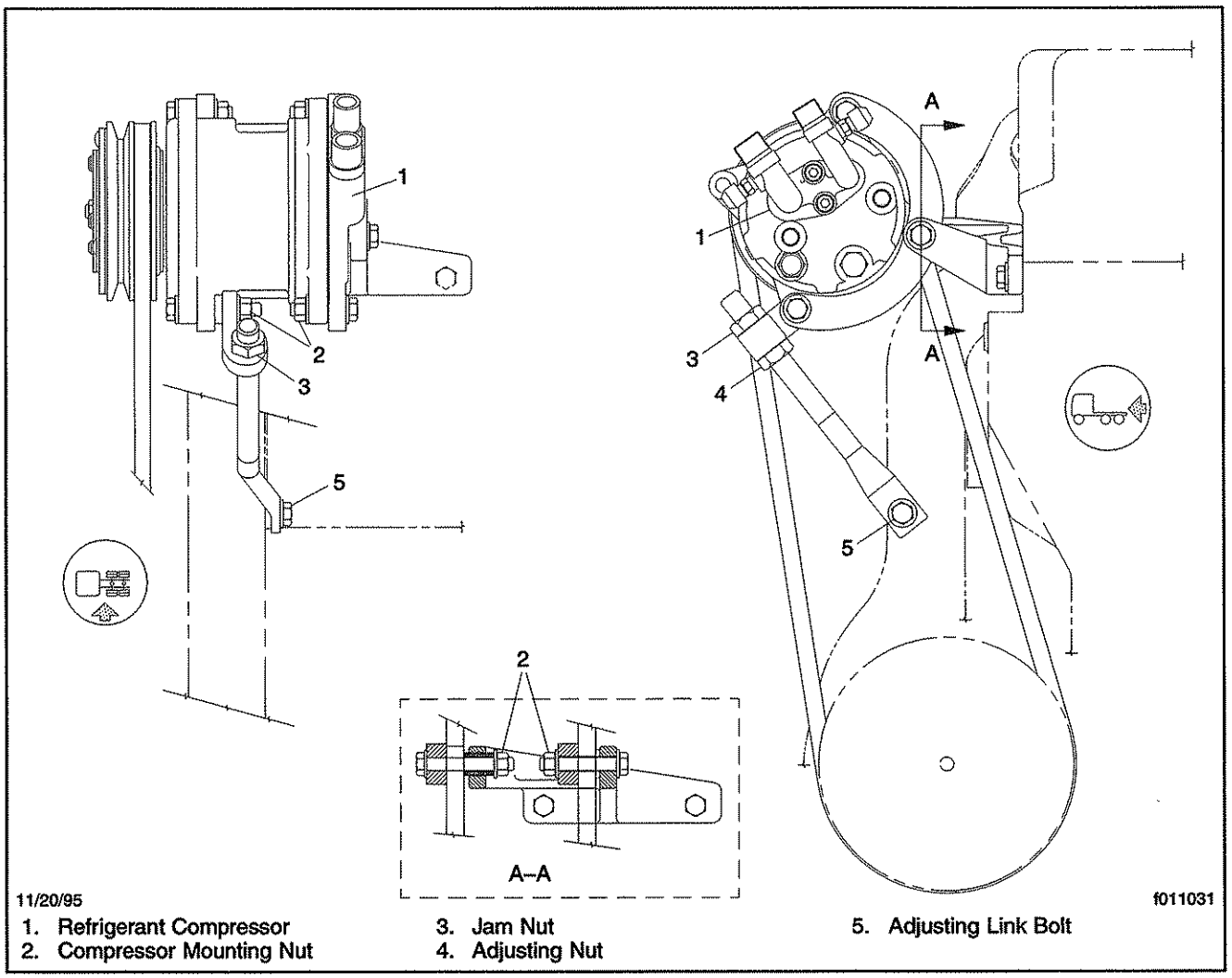
Fig. 1, Accessory Drive Belt, Caterpillar CFE Series Engine

5. Insert a 1/2-inch rachet drive into the square hole in the belt tensioner, and turn the tensioner clockwise. **See Fig. 1.**
6. Position the tensioner against the belt, and remove the rachet drive from the tensioner.

Refrigerant Compressor Belt Replacement, Cummins M11 Engine

Replacement (See Fig. 1 or Fig. 2)

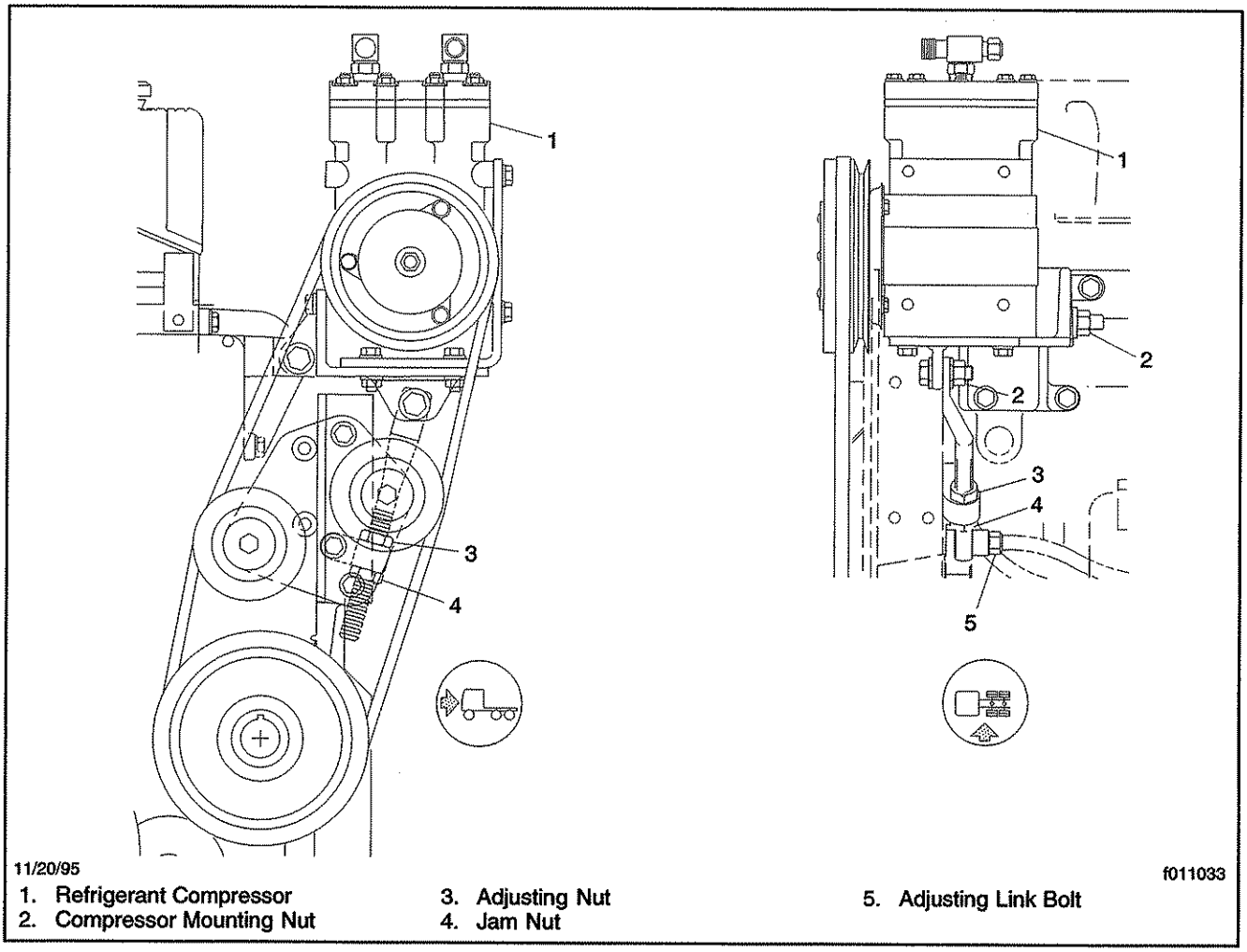
1. Remove the belt.
   - 1.1 Back off the adjusting nut. Loosen the mounting nuts and the adjusting link bolt just enough to allow movement of the compressor.
   - 1.2 Push the loosened compressor toward the drive pulley until the distance between them is short enough to allow belt removal without using force.
   - 1.3 Remove the belt, without prying or rolling it off of the pulleys.
2. Install the belt.
   - 2.1 Inspect the pulleys and used refrigerant compressor belt (even if a new belt is being installed) as instructed in **Subject 100**.
   - 2.2 Make sure the distance between the pulleys is short enough to allow belt installation without using force.
   - 2.3 Install the belt on the pulleys without prying or rolling it into place.



1. Refrigerant Compressor
2. Compressor Mounting Nut
3. Jam Nut
4. Adjusting Nut
5. Adjusting Link Bolt

Fig. 1, Rotary-Type Compressor Installation

Refrigerant Compressor Belt Replacement, Cummins M11 Engine



1. Refrigerant Compressor
2. Compressor Mounting Nut
3. Adjusting Nut
4. Jam Nut
5. Adjusting Link Bolt

Fig. 2, Piston-Type Compressor Installation

2.4 Back off the jam nut to the end of the adjusting rod.

2.5 While keeping the belt seated in the pulley grooves, turn the adjusting nut against the adjusting link to increase belt tension. Use your thumb to apply about 11 kg (25 lbs) of force at the center of the belt free-span to check the tension while turning the nut. When belt deflection equals one belt thickness per 305 mm (1 foot) of pulley-center distance, stop.

3. Adjust the belt.

3.1 If not already done, back off the adjusting link jam nut to the end of the adjusting rod, and loosen the mounting nuts and adjusting link bolt just enough to allow movement of the compressor.

3.2 Install a belt tension gauge at the center of the belt free-span.

3.3 Turn the adjusting nut to adjust the tension to a reading of 59 kg (130 lbs) for a new belt, or 36 to 45 kg (80 to 100 lbs) for a used belt. A used belt is any belt that has been in operation more than ten minutes.

IMPORTANT: Do not overtighten the belt; too much tension shortens belt life and bearing life.

Refrigerant Compressor Belt Replacement, Cummins M11 Engine

3.4 Tighten the adjusting link jam nut 210 N·m (155 lbf·ft).

3.5 Tighten the compressor mounting nuts 41 N·m (30 lbf·ft), and the adjusting link bolt 88 N·m (65 lbf·ft).

3.6 Check the belt tension, and adjust it if needed.

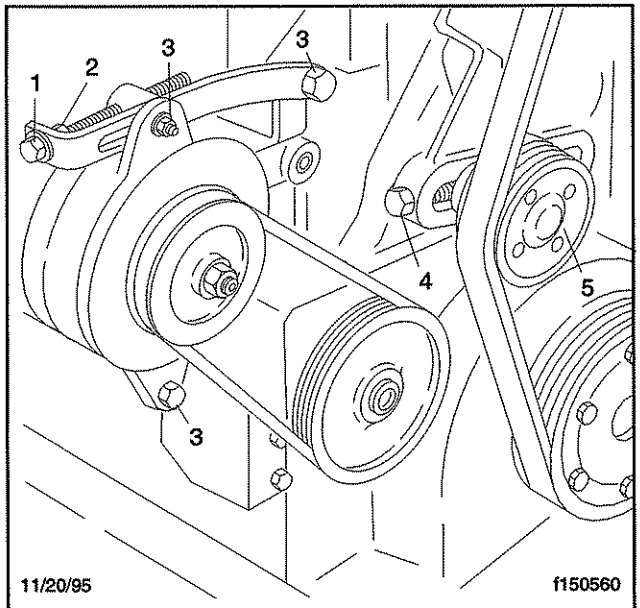
3.7 If a new refrigerant compressor belt was installed, operate the engine for about 20 minutes, then check the belt tension. All new belts will lose tension after 20 minutes of operation.

3.8 If the refrigerant compressor belt tension is not between 36 to 45 kg (80 and 100 lbs), adjust the tension to 45 kg (100 lbs).

Fan Belt Replacement, Cummins M11 Engine

Replacement (See Fig. 1)

1. Remove the belt.
   - 1.1 Loosen the locknut that secures the idler pulley to the fan bracket.
   - 1.2 Turn the idler pulley adjustment capscrew until there is minimal distance between the pulley centers.
   - 1.3 Remove the fan belt by slipping it off of the pulleys and working it over one fan blade at a time. Don't roll or pry the belt off of the pulleys; the distance between the pulley centers must be short enough to allow belt removal without using force.
2. Install the belt.
   - 2.1 Inspect the pulleys and used fan belt (even if a new belt is being installed) as instructed in **Subject 100.**



1. Adjusting Screw
2. Adjusting Screw Jam Nut
3. Alternator Mounting Fastener
4. Idler Pulley Adjustment Capscrew
5. Idler Pulley

Fig. 1, Fan and Alternator Belt Installation

   - 2.2 Make sure the distance between the pulleys is short enough to allow belt installation without using force.
   - 2.3 Work the belt over the fan blades, one blade at a time. Install the belt on the pulleys without prying or rolling it into place. Be sure the ribs on the belt are seated in the grooves on each pulley.
   - 2.4 While keeping the belt seated in the pulley grooves, turn the idler pulley adjustment capscrew to increase the belt tension. Use your thumb to apply about 11 kg (25 lbs) of force at the center of the belt free-span to check the tension while turning the capscrew. When belt deflection equals one belt thickness per 305 mm (1 foot) of pulley-center distance, stop.
3. Adjust the belt.
   - 3.1 If not already done, loosen the locknut that secures the idler pulley to the fan bracket.
   - 3.2 Install a belt tension gauge at the center of the belt's longest free-span.
   - 3.3 Turn the idler pulley adjustment capscrew to increase or decrease belt tension, but do not adjust the tension to the full value with the idler pulley adjustment capscrew; belt tension can increase when the idler pulley locknut is tightened. Final tension must be 36 to 45 kg (80 and 100 lbs).

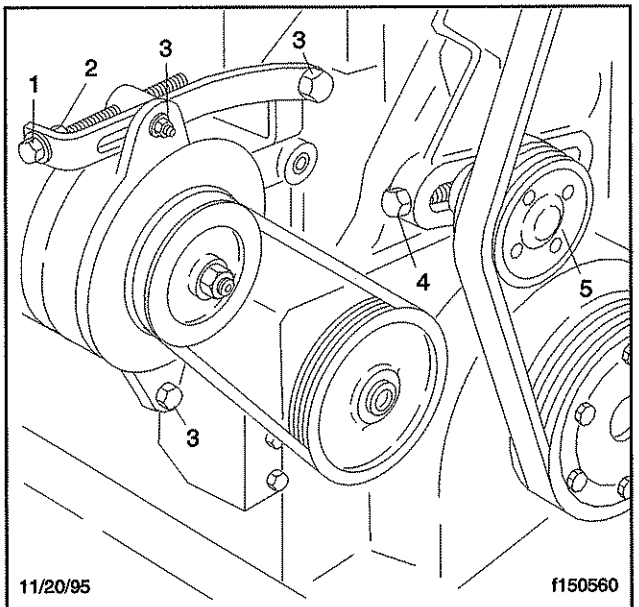
IMPORTANT: Do not overtighten the belt; too much tension shortens belt life and bearing life.

   - 3.4 Tighten the idler pulley locknut 163 to 190 N·m (120 to 140 lbf·ft).
   - 3.5 Loosen the idler pulley adjustment capscrew one-half turn, to prevent breakage.
   - 3.6 Check the belt tension, and adjust it if needed.
   - 3.7 If a new fan belt was installed, operate the engine for about 20 minutes, then check the belt tension. All new belts will lose tension after 20 minutes of operation.
   - 3.8 If the fan belt tension is not between 36 to 45 kg (80 and 100 lbs), adjust the tension.

Alternator Belt Replacement, Cummins M11 Engine

Replacement (See Fig. 1)

1. Remove the belt.
   - 1.1 Loosen the three mounting fasteners just enough to allow movement of the alternator.
   - 1.2 Loosen the adjusting screw jam nut.
   - 1.3 Turn the adjusting screw counterclockwise, backing off the alternator toward the drive pulley far enough to allow belt removal without using force.
   - 1.4 Remove the belt, without prying or rolling it off of the pulleys.
2. Install the belt.
   - 2.1 Inspect the pulleys and used alternator belt (even if a new belt is being installed) as instructed in **Subject 100.**



1. Adjusting Screw
2. Adjusting Screw Jam Nut
3. Alternator Mounting Fastener
4. Idler Pulley Adjustment Capscrew
5. Idler Pulley

Fig. 1, Alternator and Fan Belt Installation

   - 2.2 Make sure the distance between the pulleys is short enough to allow belt installation without using force.
   - 2.3 Install the belt on the pulleys without prying or rolling it into place. Be sure the ribs on the belt are seated in the grooves on each pulley.
   - 2.4 While keeping the belt seated in the pulley grooves, turn the adjusting screw clockwise to increase the belt tension. Use your thumb to apply about 11 kg (25 lbs) of force at the center of the belt free-span to check the tension while turning the adjusting screw. When belt deflection equals one belt thickness per 305 mm (1 foot) of pulley-center distance, stop.
3. Adjust the belt.
   - 3.1 If not already done, loosen the adjusting screw locknut, and loosen the three mounting fasteners, just enough to allow movement of the alternator.
   - 3.2 Install a belt tension gauge at the center of the belt free-span.
   - 3.3 Turn the adjusting screw to adjust the tension to a reading of 36 to 45 kg (80 and 100 lbs).

IMPORTANT: Do not overtighten the belt; too much tension shortens belt life and bearing life.

   - 3.4 Tighten the adjusting screw locknut 129 N·m (95 lbf·ft).
   - 3.5 Tighten the alternator mounting fastener 81 N·m (60 lbf·ft), the adjusting block nut 47 N·m (35 lbf·ft), and the adjusting arm bolt 75 N·m (55 lbf·ft).
   - 3.6 Check the belt tension, and adjust it if needed.
   - 3.7 If a new alternator belt was installed, operate the engine for about 20 minutes, then check the belt tension. All new belts will lose tension after 20 minutes of operation.
   - 3.8 If the alternator belt tension is not 36 to 45 kg (80 and 100 lbs), adjust the tension.

Specifications

This subject contains the following tables:

- Fastener Torques, Cummins B Series Engine
- Fastener Torques, Mercedes-Benz OM 366LA Engine
- Drive Belt Tensions, Cummins B Series Engine
- Drive Belt Tensions, Mercedes-Benz OM 366LA Engine

Description	Grade	Size	Torque N·m (lbf·ft)
Refrigerant Compressor Mounting Nuts	5	1/2–13	80 (59)
Refrigerant Compressor Adjusting Rod Jam Nut	5	1/2–13	80 (59)

Table 1, Fastener Torques, Cummins B Series Engine

Description	Grade	Size	Torque N·m (lbf·ft)
Alternator Adjusting Rod Guide Capscrew	8	1/2–13	80 (59)
Alternator Mounting Nuts	8	1/2–13	80 (59)
Air Compressor Tensioning Assembly Clamp Pinch Bolt	8.8	M12 x 1.5	80 (59)
Air Compressor Tensioning Assembly Bolt	8.8	M12	80 (59)
Refrigerant Compressor Adjusting Rod Guide Bolt Nut	8	3/8–16	45 (33)
Refrigerant Compressor Mounting Nuts	8	3/8–16	45 (33)
Refrigerant Compressor Adjusting Rod Jam Nut	5	5/8–18	190 (140)

Table 2, Fastener Torques, Mercedes-Benz OM 366LA Engine

Description	Tension kg (lb)
Refrigerant Compressor Belt	45 (100)

Table 3, Drive Belt Tensions, Cummins B Series Engine

Description	Tension kg (lb)
Refrigerant Compressor Belt	45 (100)
Air Compressor Belts	23 (50)
Fan/Alternator Belt	75 (160)

Table 4, Drive Belt Tensions, Mercedes-Benz OM 366LA Engine

Contents

Subject	Subject Number
General Description	050
Service Operations	
Removal and Installation	100
Specifications	400

NOTE: Refer to the *Cummins B Series Operation and Maintenance Manual, Cummins Troubleshooting and Repair Manual B Series*, and *Cummins Workshop Manual B Series* for additional information on B Series engine service operations.

General Description

The Cummins B Series engine **(see Fig. 1 and Fig. 2)** is supported by three engine mounts: two are at the rear of the engine— one on each side— and fastened to the frame rails. The other is at the front of the engine, fastened to the underslung crossmember.

Because the engine provides the main support for the transmission, removing them as an assembly is easier than disconnecting them, if the engine has to be removed.

For detailed repair procedures and other engine service not covered in this section, refer to the *Cummins B Series Operation and Maintenance Manual* , *Cummins Troubleshooting and Repair Manual B Series* , and *Cummins Workshop Manual B Series* .

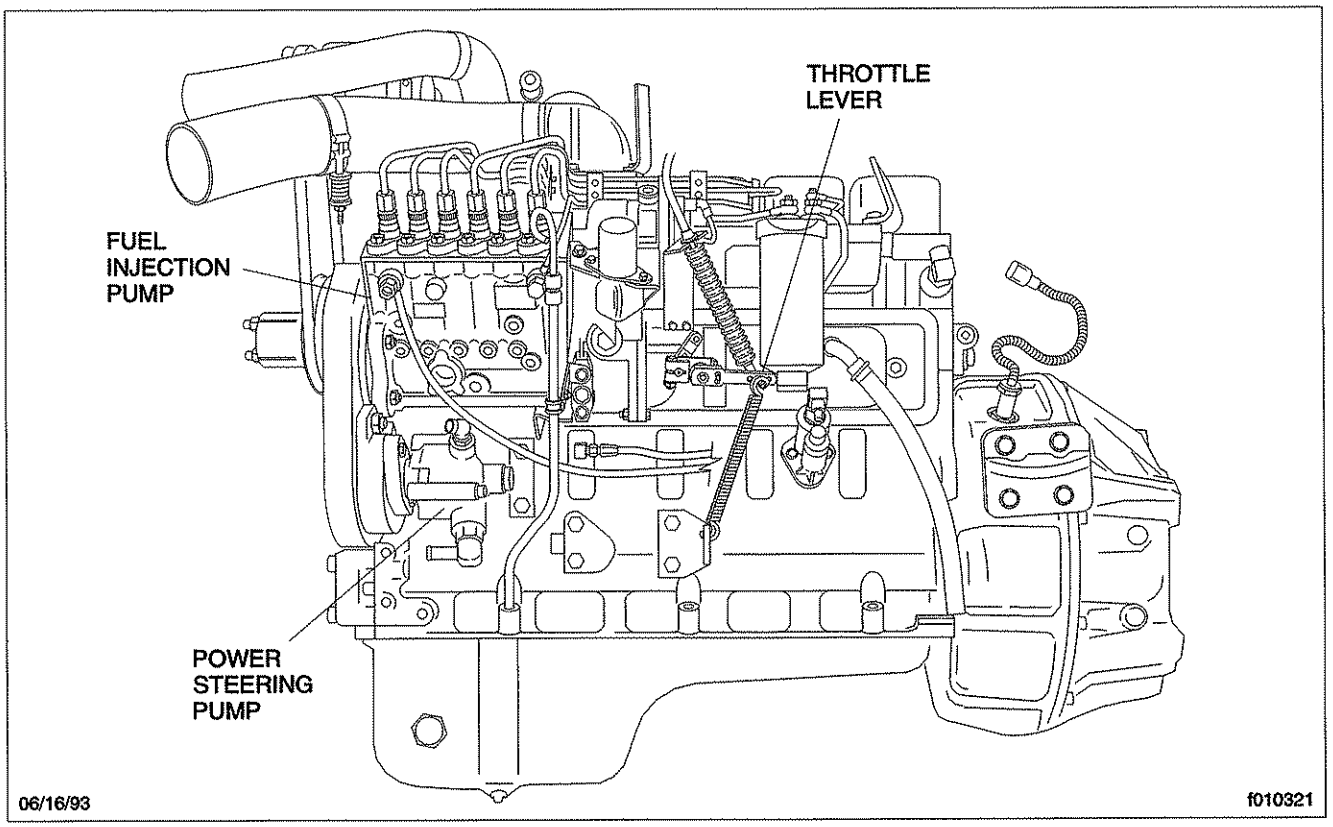


Fig. 1

General Description

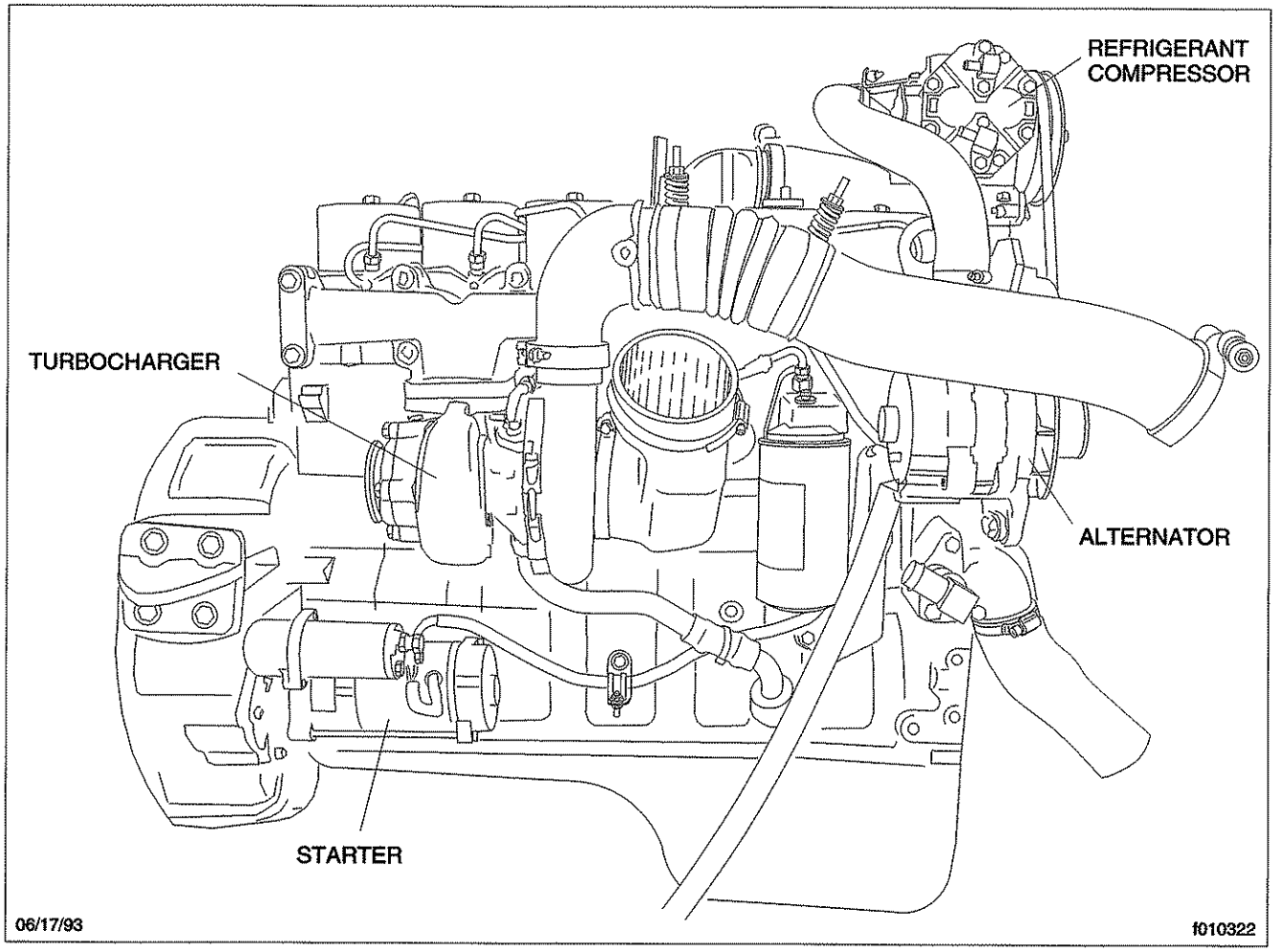


Fig. 2

Removal

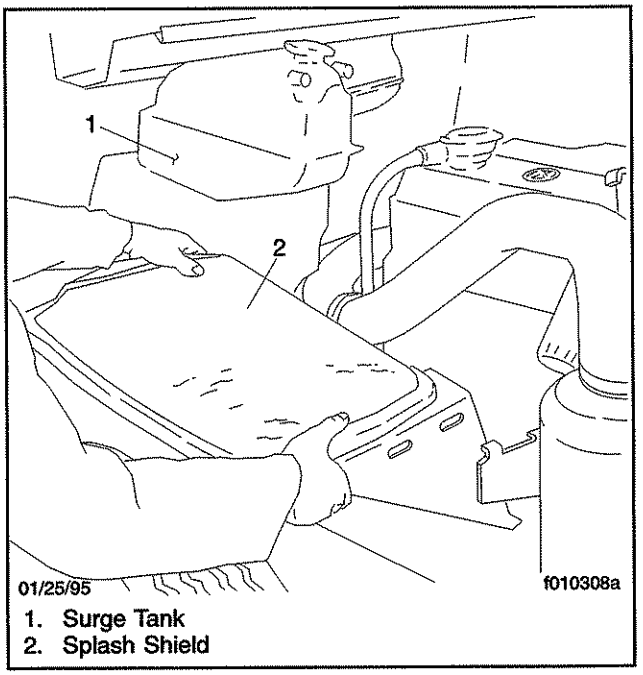
NOTE: Because the transmission is supported entirely by the engine, removing them as an assembly (as described below) is easier than disconnecting them and removing the engine only.

1. 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.
   - 2.1 Disconnect the battery ground cable at the vehicle frame.
   - 2.2 Disconnect the positive battery cable from the batteries.
3. Remove the hood and bumper. For instructions, see **Group 88**.
4. Drain the radiator.

⚠ WARNING

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

   - 4.1 Open the petcock at the bottom of the radiator to drain the engine coolant.
   - 4.2 Loosen the surge tank cap.
5. Remove the right fender splash shield. See **Fig. 1**.
6. Remove the air cleaner.
   - 6.1 Remove the air intake pipe from the top of the air cleaner. See **Fig. 2**.
   - 6.2 Remove the four nuts from the inside of the air cleaner mounting bracket. See **Fig. 3**.
   - 6.3 Remove the air cleaner from its mounting bracket.
7. Disconnect or remove the air intake, exhaust pipe, and hoses.
   - 7.1 If the vehicle is equipped with air brakes, disconnect the air compressor outlet line.
   - 7.2 If the vehicle is equipped with air brakes, disconnect the two air signal lines from the air governor at the top of the compressor.
   - 7.3 Disconnect the air inlet and outlet hoses from the charge air cooler. See **Fig. 4**.
   - 7.4 Disconnect the air intake pipe from the turbocharger. See **Fig. 2**.
   - 7.5 Disconnect the V-clamp connecting the exhaust pipe to the rear of the turbocharger. Remove the pipe from the turbocharger.
8. Disconnect the coolant hoses.
   - 8.1 Disconnect the coolant inlet and outlet hoses from the radiator. See **Fig. 4**.
   - 8.2 Disconnect the vent hose from the radiator, and remove the hose bracket from the condenser mounting bolt. See **Fig. 4**.
   - 8.3 Disconnect the fill hose from the bottom of the surge tank.
   - 8.4 Disconnect the heater inlet hose at the valve near the firewall. See **Fig. 5**.
   - 8.5 Disconnect the heater outlet hose at the firewall. See **Fig. 5**.
9. Remove the refrigerant compressor and condenser.



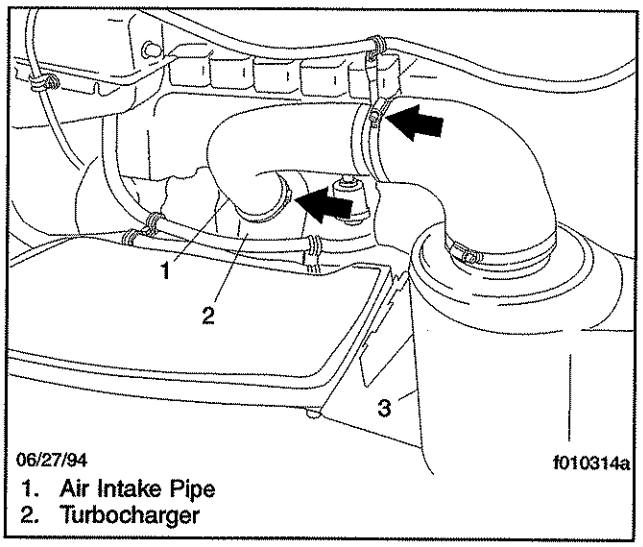
1. Surge Tank
2. Splash Shield

Fig. 1, Remove the Right Fender Splash Shield

Removal and Installation

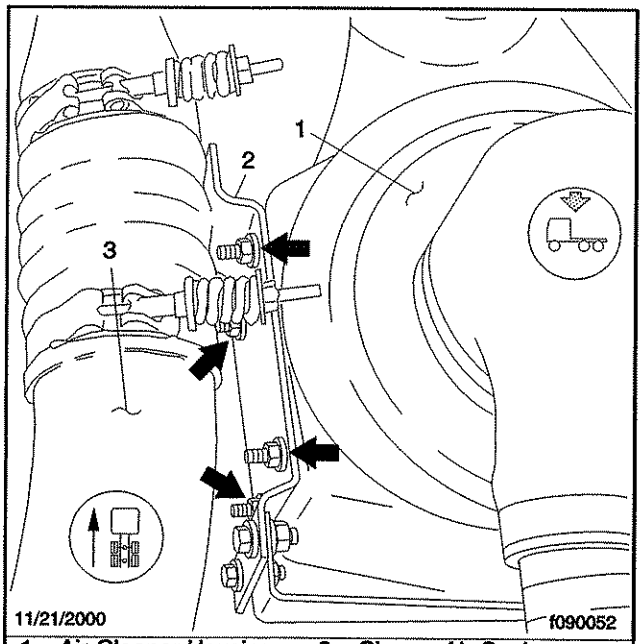
9.1 Disconnect the compressor electrical connectors.

9.2 Remove the adjusting rod jam nut. See **Fig. 6**, Ref. 3.



1. Air Intake Pipe
2. Turbocharger

Fig. 2, Air Intake Pipe



1. Air Cleaner Housing
2. Mounting Bracket
3. Charge Air Cooler Outlet Hose

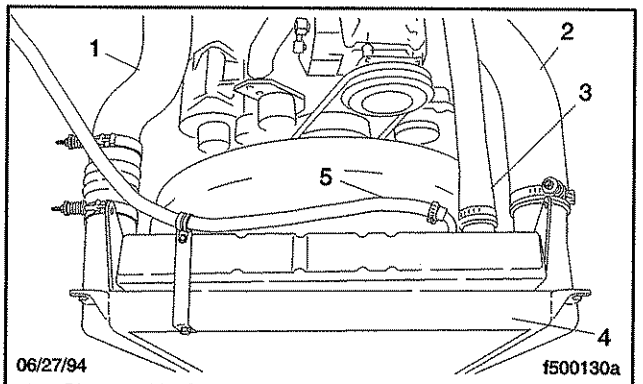
Fig. 3, Air Cleaner Housing Mounting Fasteners

9.3 Back off the adjusting nut (**Fig. 6**, Ref. 2), and remove the belt running between the compressor and the vibration damper.

9.4 Remove the two bolts securing the compressor to its mount. See **Fig. 6**, Ref. 1.

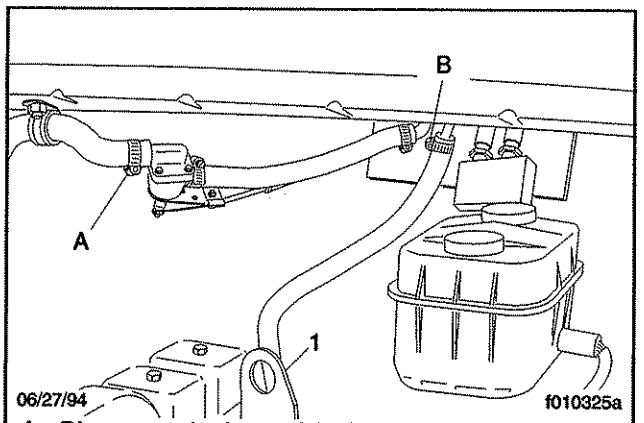
9.5 Remove the four bolts holding the condenser to the charge air cooler. See **Fig. 7**.

9.6 To keep the refrigerant system intact, with no leaks and no need for purging and



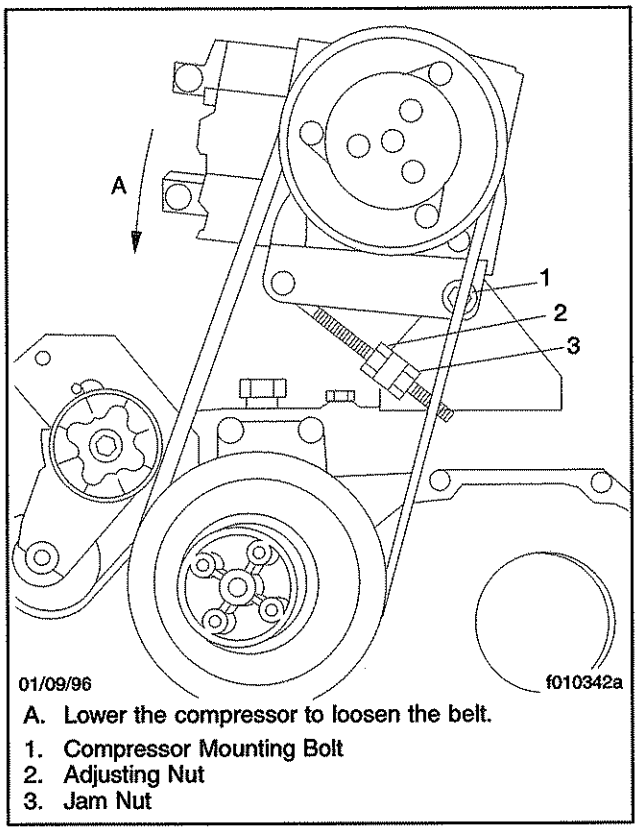
1. Charge Air Cooler Inlet Hose
2. Charge Air Cooler Outlet Hose
3. Radiator Inlet Hose
4. Charge Air Cooler
5. Radiator Vent Hose

Fig. 4, Top View of Radiator



A. Disconnect the heater inlet hose at the valve.
B. Disconnect the heater outlet hose at the firewall.
1. Rear Lifting Eye

Fig. 5, Disconnecting the Heater Hoses



A. Lower the compressor to loosen the belt.
1. Compressor Mounting Bolt
2. Adjusting Nut
3. Jam Nut

Fig. 6, Removing the Refrigerant Compressor

recharging, move the condenser and the refrigerant compressor to the side at the same time. See **Fig. 8**.

9.7 Wrap the condenser in a protective blanket, or sandwich it between two sheets of cardboard or wood to prevent damage to the condenser fins. Secure the compressor and condenser out of the way with wire. See **Fig. 9**.

10. Remove the radiator and charge air cooler assembly.

10.1 Remove the left air recirculation shield from the left charge air cooler mounting tab. See **Fig. 10**.

10.2 Hook a lifting chain to the radiator and charge air cooler assembly (see **Fig. 11**), and fasten the chain to a crane.

10.3 Remove the nuts, washers, and rubber isolators from the forward ends of the radiator struts. See **Fig. 12**.

10.4 Remove the nuts and washers from the radiator mounts. See **Fig. 12**.

10.5 Lift the radiator and charge air cooler from the vehicle as a single unit. See **Fig. 11**.

11. Remove the two power steering pump mounting bolts, and move the pump aside while keeping the steering fluid system intact.

12. Disconnect the engine fuel and oil system components.

12.1 Disconnect the fuel delivery line below the fuel filter. See **Fig. 13**.

12.2 Disconnect both ends of the throttle return springs. See **Fig. 13**.

12.3 Disconnect the throttle cable from the cable bracket and the engine throttle lever. See **Fig. 13**.

12.4 Disconnect the fuel return line from the injection pump. See **Fig. 14**.

12.5 Disconnect the oil pressure gauge line under the fuel injection pump. See **Fig. 14**.

12.6 Disconnect the turbocharger oil return line at the turbocharger.

13. Disconnect the engine electrical connections.

13.1 Disconnect the ground strap from the engine.

13.2 Disconnect the wires from the starter and label them for reassembly. See **Fig. 15**.

13.3 Disconnect the engine wiring harness from the rear of the alternator, then the coolant temperature sensors, the refrigerant compressor clutch, the fuel shutoff solenoid, and other applicable options.

13.4 Remove the heat shield from the wiring harness routed above the exhaust pipe.

13.5 Disconnect the wiring harness brackets secured to the firewall. See **Fig. 16**.

13.6 Remove the engine wiring harness from the engine.

Removal and Installation

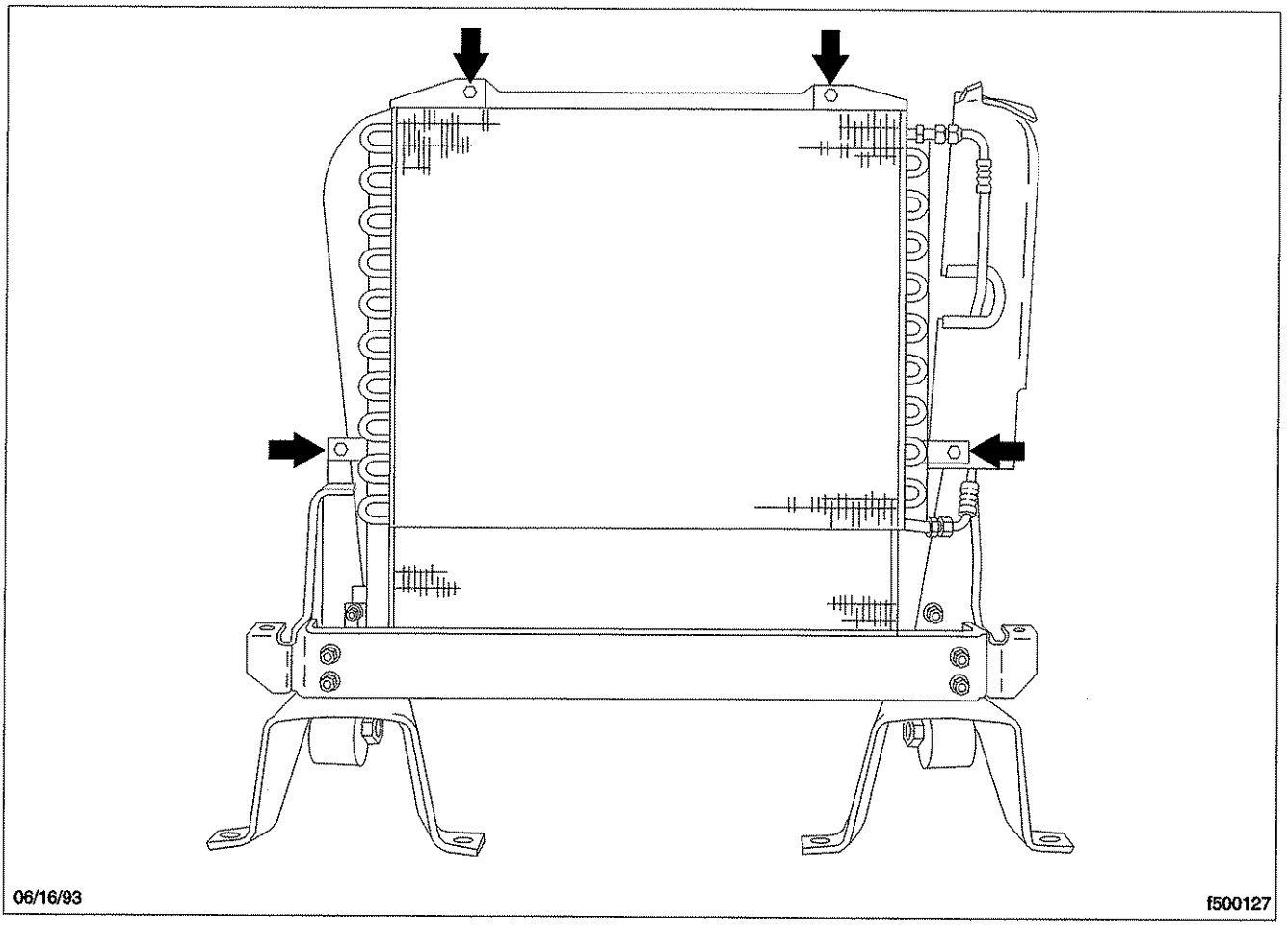
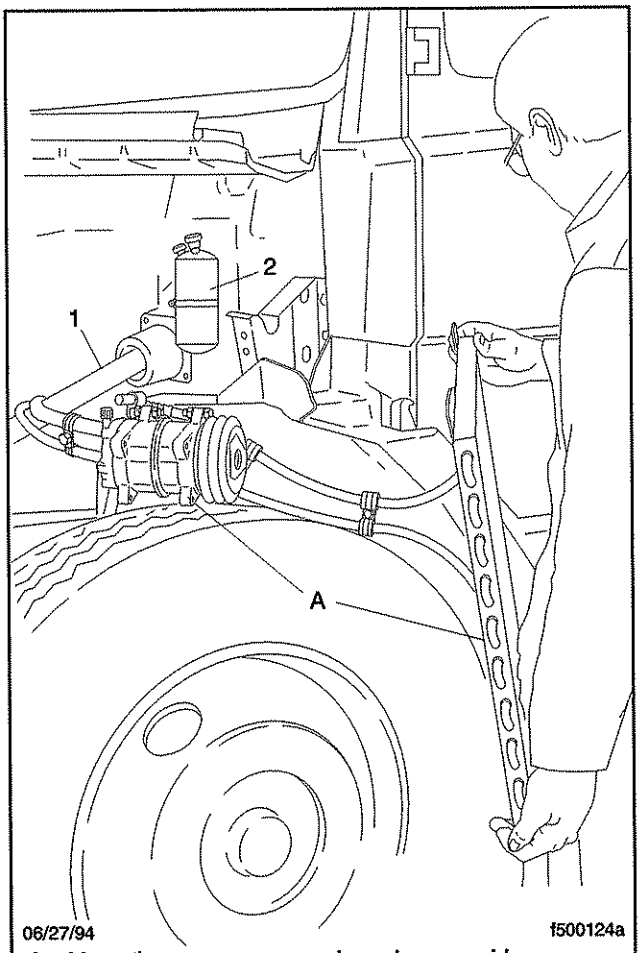


Fig. 7, Condenser Mounting Bolts

14. Disconnect the top of the left front shock absorber, and remove the top shock absorber mount from the frame rail.
15. Disconnect the transmission-mounted components.
    - 15.1 Disconnect the tachometer sensor at the engine flywheel. See **Fig. 13**.
    - 15.2 Disconnect the speedometer sensor at the transmission output.
    - 15.3 If the vehicle is equipped with hydraulic brakes, release the parking brake, and disconnect the parking brake cable from the parking brake. See **Fig. 17**.
    - 15.4 Remove the shift tower from the transmission. See **Fig. 18**. Cover the shift tower hole in the top of the transmission with a piece of cardboard, and secure the cover by screwing the tower bolts back through it.
    - 15.5 Remove the clevis pin from the clutch release lever (see **Fig. 19**), then remove the clutch slave cylinder from its mounting bracket on the right side of the transmission. See **Fig. 20**.
    - 15.6 At the transmission bell housing, remove the bracket that supports the exhaust pipe. See **Fig. 19**.



A. Move the compressor and condenser aside.
1. Steering Driveline
2. Receiver-Dryer

Fig. 8, Moving the Air Conditioner Components

15.7 Remove the driveshaft from the transmission output end yoke. For instructions, see **Group 41.**

16. Remove the engine from the vehicle.

⚠ WARNING

The crane and lifting chains used to remove the engine must be capable of safely lifting and supporting two metric tons. Once the engine mounts are disconnected, do not get under the engine until it is securely supported on engine stands. An unsecured engine may fall, causing personal injury or death, and component damage.

16.1 Attach a chain to the two engine lifting eyes (see **Fig. 21**), and position a crane to lift the engine. Attach the chain to the crane, and raise the chain to remove any slack.

16.2 Remove the bolt from the front engine mount. See **Fig. 22.**

16.3 Remove the bolts from the two rear engine mounts. See **Fig. 23** and **Fig. 24.**

16.4 Carefully lift the engine and pull it forward to remove it from the engine compartment. See **Fig. 25.**

Installation

1. Examine all engine support components for damage and extreme wear. Replace components as necessary.
2. Install the engine in the vehicle.

⚠ WARNING

The crane and lifting chains used to install the engine must be capable of safely lifting and supporting two metric tons. Once the engine is removed from the engine stands, do not get under the engine until it is securely installed on the engine mounts. An unsecured engine may fall, causing personal injury or death, and component damage.

2.1 Attach a chain to the lifting eyes of the engine. Attach the chain to a crane, and raise the chain to remove any slack.

2.2 Carefully lower the engine, and push it back onto the engine mounts. See **Fig. 25.**

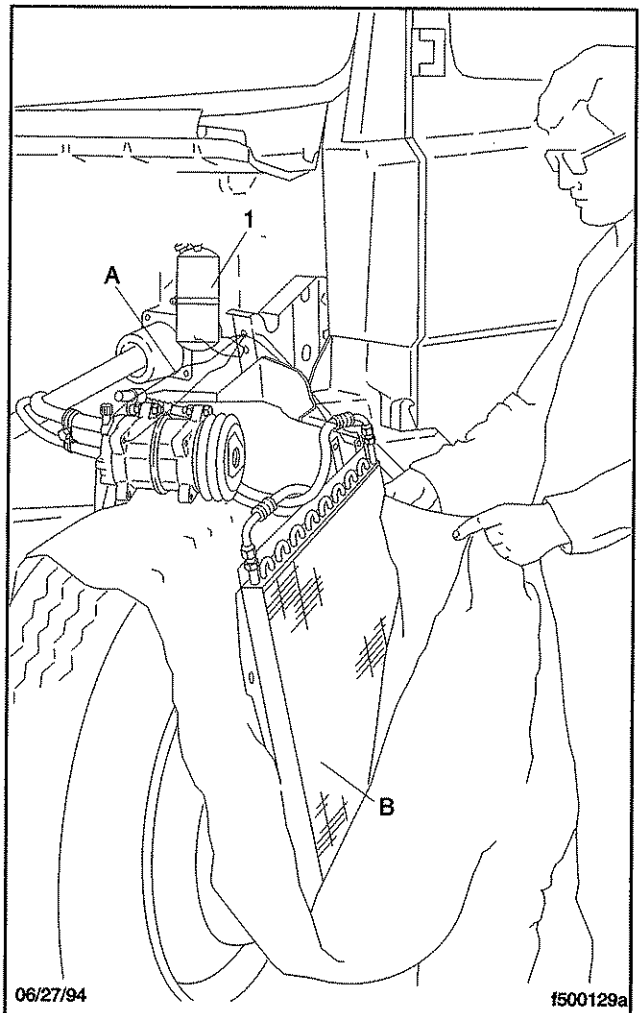
2.3 Install the bolts in the two rear engine mounts, and tighten them 241 lbf·ft (327 N·m).

2.4 Install the bolt in the front engine mount and tighten it 150 lbf·ft (203 N·m).

2.5 Remove the lifting chain from the two engine lifting eyes.

3. Install the heat shield over the wiring harness where it passes over the exhaust pipe.

Removal and Installation



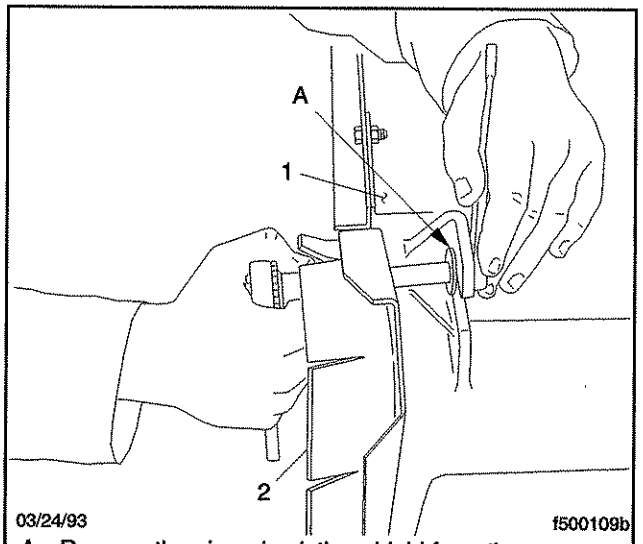
A. Secure the compressor and the condenser with wire.
B. Wrap the condenser to protect it.
1. Receiver-Dryer

Fig. 9, Securing the Air Conditioner Components

4. Install the upper, front shock absorber mount on the left frame rail. Tighten the mounting bolts 135 lbf·ft (183 N·m). Install the shock on the mount, and tighten the shock mounting bolt 240 lbf·ft (325 N·m).

5. Connect the transmission-mounted components.

   5.1 Connect the driveline to the transmission output end yoke. See **Group 41** for instructions.



A. Remove the air recirculation shield from the mounting tab.
1. Charge Air Cooler
2. Air Recirculation Shield

Fig. 10, Side View

   5.2 Install the exhaust pipe bracket on the transmission bell housing. See **Fig. 19**.

   5.3 Connect the clutch release lever with a new clevis pin (see **Fig. 19**), and install the clutch slave cylinder on the bracket at the right side of the transmission. See **Fig. 20**.

   5.4 Install the transmission shift tower.

   5.5 Connect the parking brake cable to the parking brake. See **Fig. 17**.

   5.6 Connect the speedometer sensor at the transmission output.

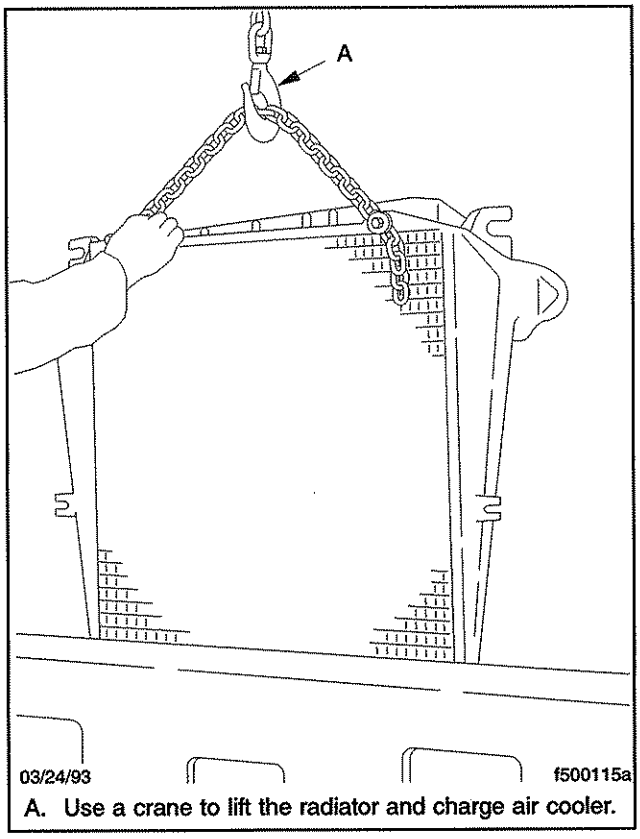
   5.7 Connect the tachometer sensor at the engine flywheel. See **Fig. 13**.

6. Connect the engine electrical connections.

   6.1 Route the engine wiring harness, attaching it at the injection pump, then the fuel shutoff solenoid, the coolant temperature sensors, the rear of the alternator, and at any other applicable options.

   6.2 Connect the wiring harness brackets to the firewall. See **Fig. 16**.

   6.3 Connect the starter wires. See **Fig. 15**.



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

Fig. 11, Lifting the Radiator

6.4 Connect the engine ground strap to the frame rail.

7. Connect the fuel and oil components.

7.1 Connect the oil pressure gauge line at the fuel injection pump. See **Fig. 14.**

7.2 Connect the fuel return line at the injection pump. See **Fig. 14.**

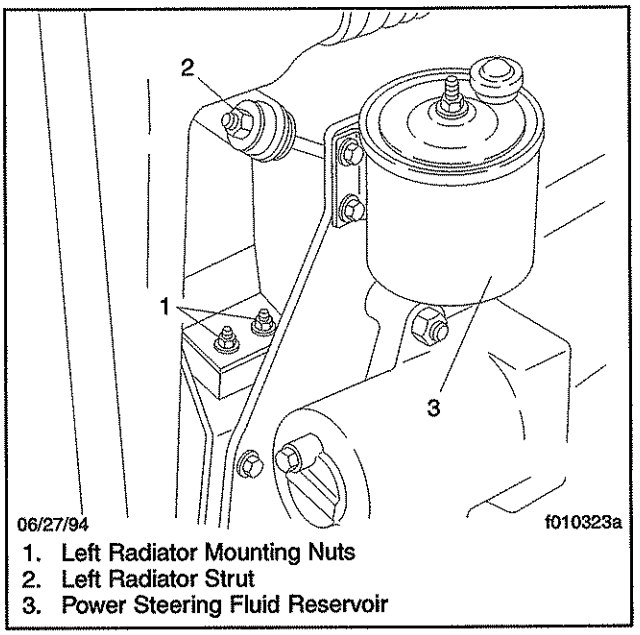
7.3 Connect the throttle cable to the engine throttle arm. See **Fig. 13.**

7.4 Connect both ends of the throttle return springs. See **Fig. 13.**

7.5 Connect the fuel delivery line below the fuel filter. See **Fig. 13.**

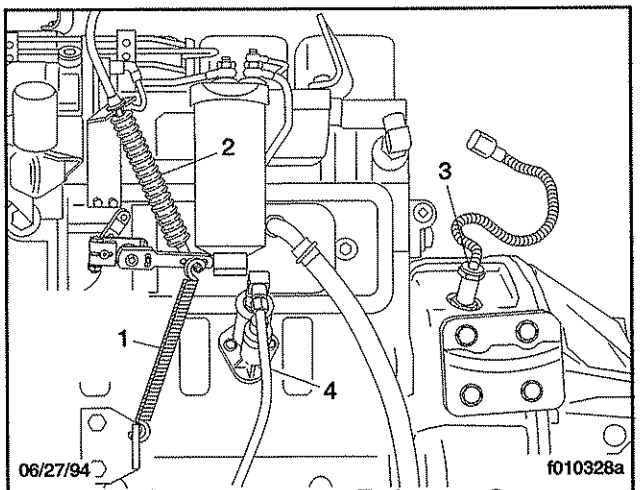
7.6 Connect the oil return line to the turbocharger.

8. Install the power steering pump on the engine, and tighten the mounting bolts 28 lbf·ft (38 N·m).



1. Left Radiator Mounting Nuts
2. Left Radiator Strut
3. Power Steering Fluid Reservoir

Fig. 12, Left Radiator Strut Location



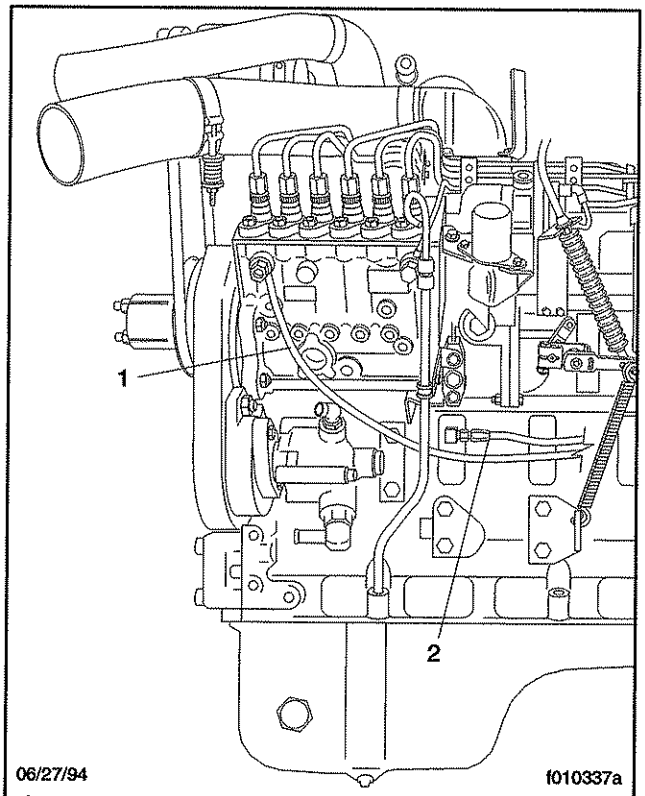
1. Throttle Return Springs
2. Throttle Cable
3. Tachometer Sensor
4. Fuel Delivery Line

Fig. 13, Left-Side View

9. Install the radiator and charge air cooler assembly.

9.1 Using a crane and lifting chains, lift the radiator and charge air cooler as a single assembly. Position the assembly on the radiator mounting studs.

Removal and Installation



A.
1. Fuel Return Line
2. Oil Pressure Gauge Line

Fig. 14, Left-Side View

9.2 Install the nuts and washers on the radiator mounting studs. See **Fig. 12.** Tighten the nuts 30 lbf·ft (40 N·m).

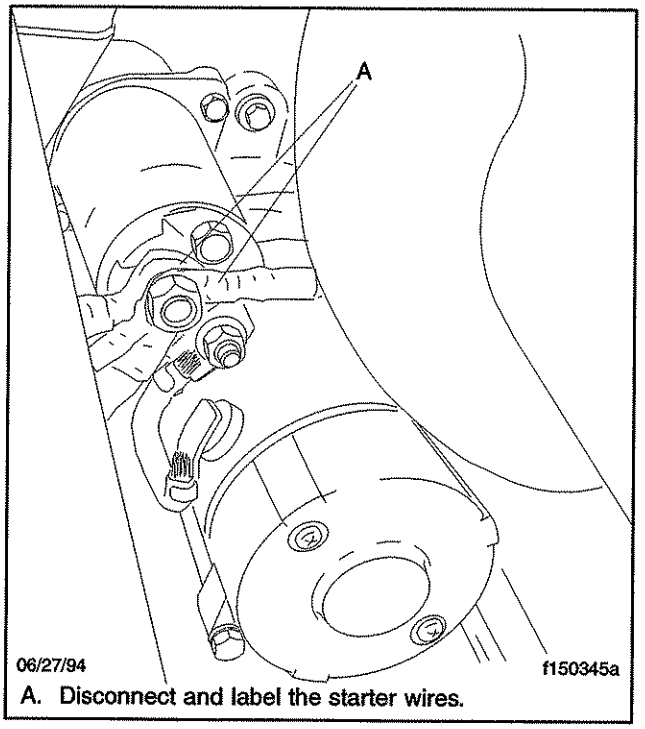
9.3 Install the washers, rubber isolators, and nuts on the radiator struts. See **Fig. 12.** Tighten the nuts 35 lbf·ft (47 N·m).

9.4 Remove the lifting chain from the assembly.

9.5 Install the air recirculation shield over the left charge air cooler mounting tab, and tighten the shield bolt 15 lbf·ft (20 N·m). See **Fig. 10.**

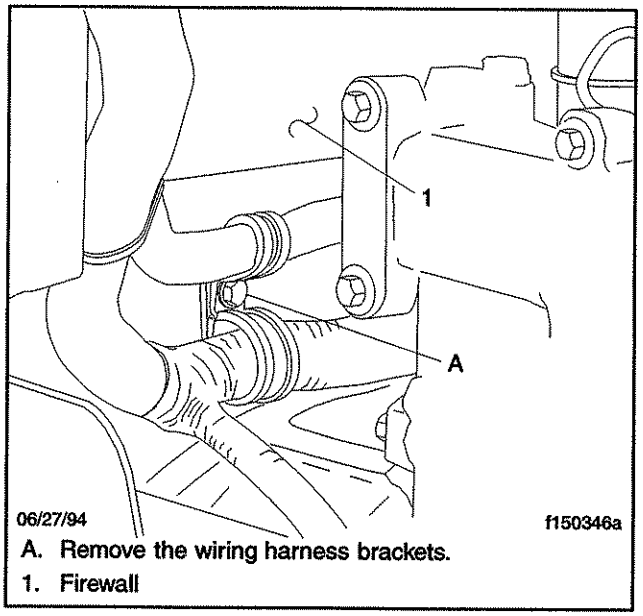
10. Install the air conditioning components on the engine.

10.1 Carefully move the refrigerant compressor and condenser back into place.



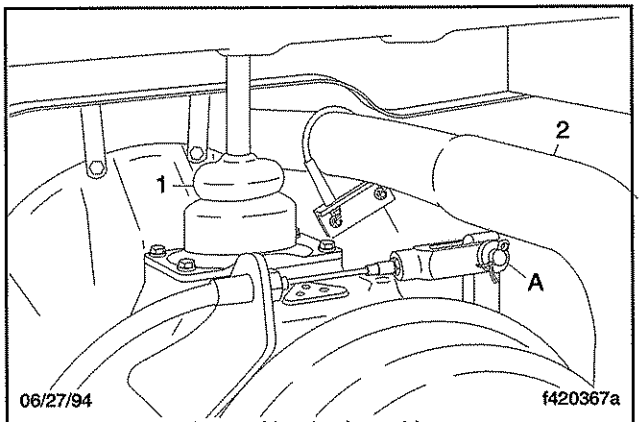
A. Disconnect and label the starter wires.

Fig. 15, Starter Wires



A. Remove the wiring harness brackets.
1. Firewall

Fig. 16, Right Wiring Harness Bracket



A. Disconnect the parking brake cable.
1. Shift Tower
2. Exhaust Pipe

Fig. 17, Parking Brake Cable Location

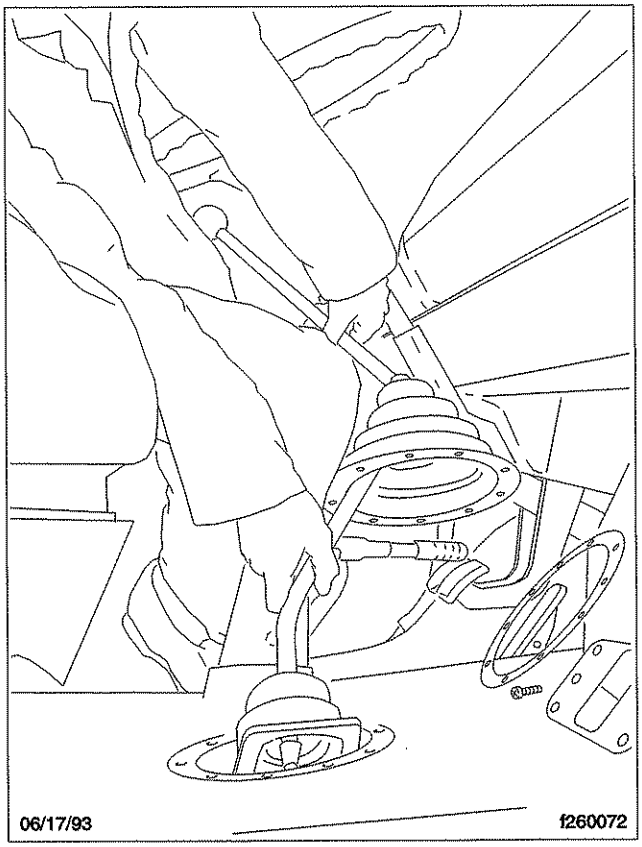
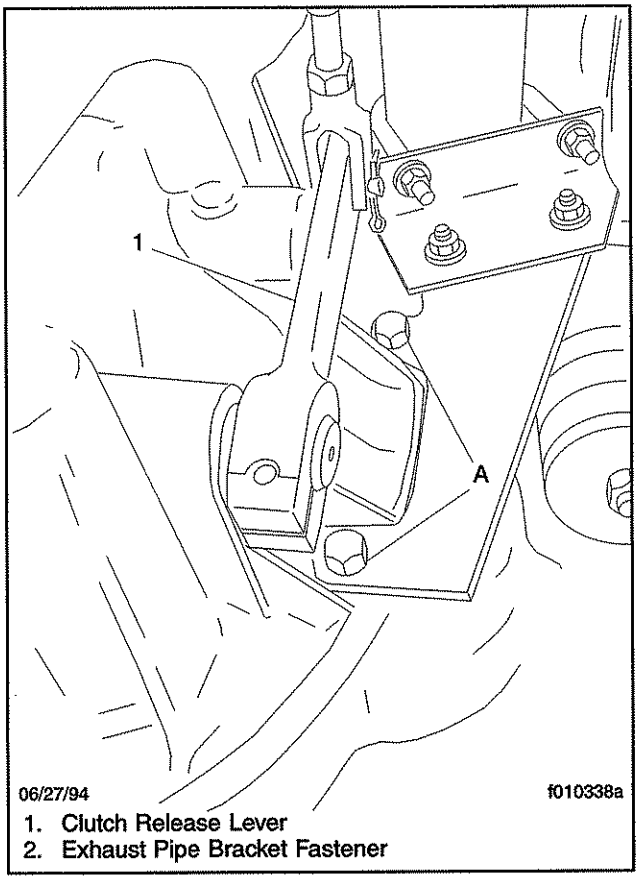


Fig. 18, Removing the Shift Lever



1. Clutch Release Lever
2. Exhaust Pipe Bracket Fastener

Fig. 19, Removing the Exhaust Pipe Bracket

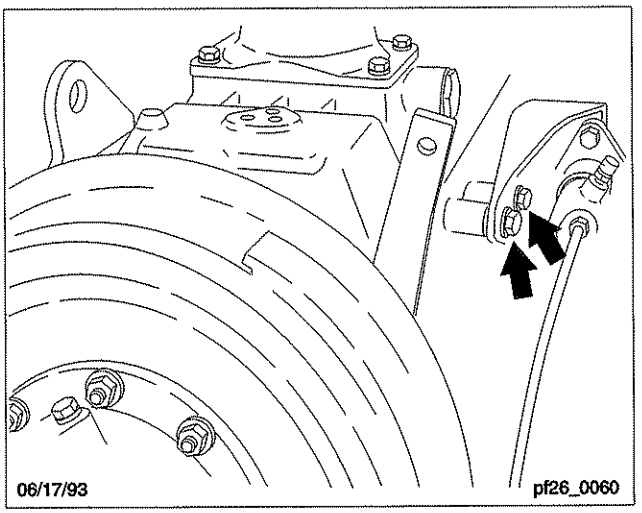


Fig. 20, Mounting Bracket Bolts

Removal and Installation

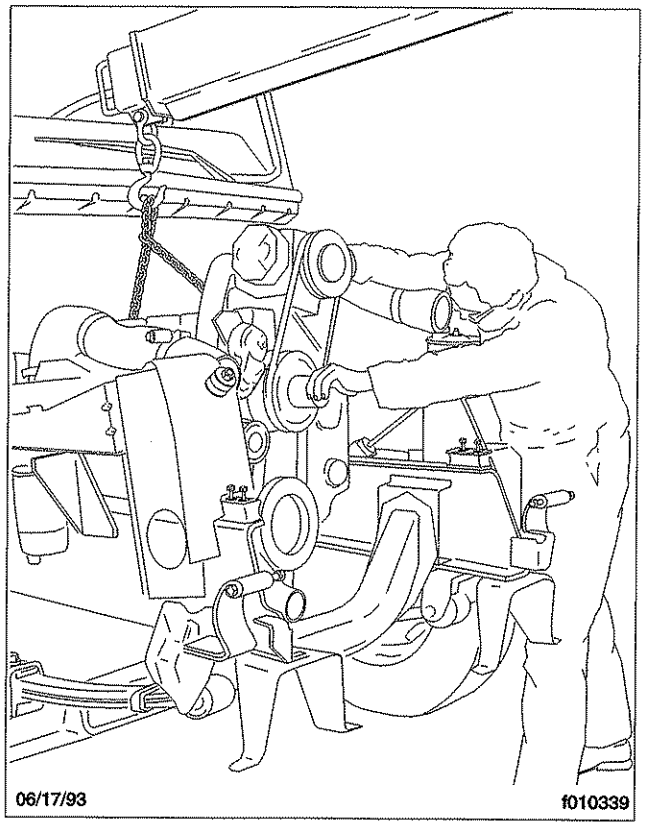


Fig. 21, Attaching Lifting Chains

10.2 Install the four bolts to hold the condenser in place over the charge air cooler. See **Fig. 7**. Tighten the bolts 15 lbf·ft (20 N·m).

10.3 Position the compressor on its mount, and insert the two mounting bolts. See **Fig. 6**, Ref. A.

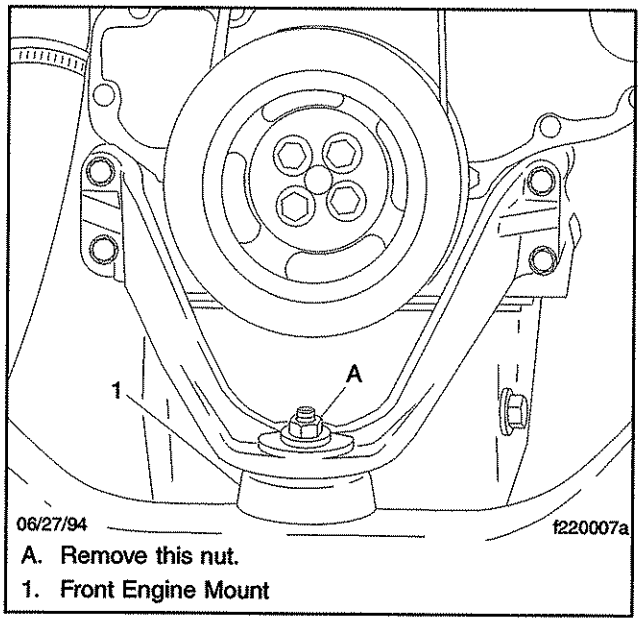
10.4 Insert the adjusting rod through the compressor mount. See **Fig. 6**.

10.5 Install the compressor drive belt on the compressor pulley and tighten the belt. For instructions, refer to "Drive Belts" in this group. Tighten the adjusting rod jam nut 59 lbf·ft (80 N·m). See **Fig. 6**, Ref. C.

10.6 Tighten the compressor mounting bolt nuts 59 lbf·ft (80 N·m). See **Fig. 6**, Ref. A.

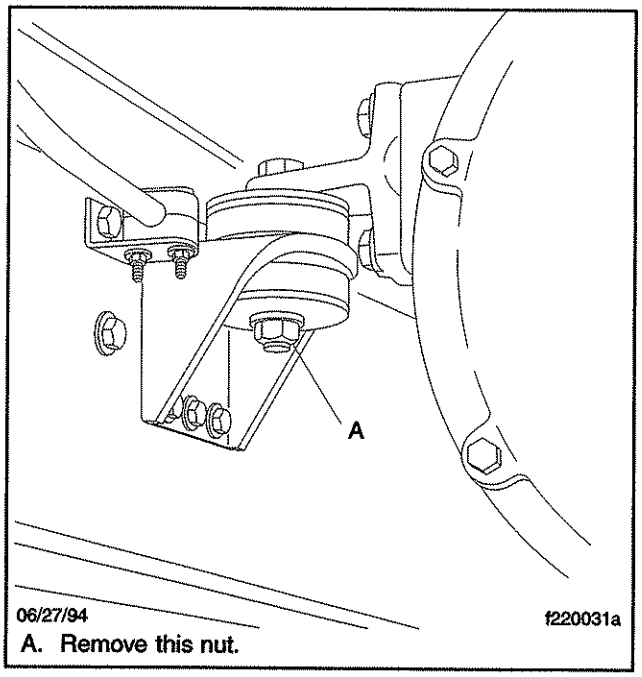
10.7 Connect the compressor electrical connectors to the wiring harness.

11. Connect the coolant hoses.



A. Remove this nut.
1. Front Engine Mount

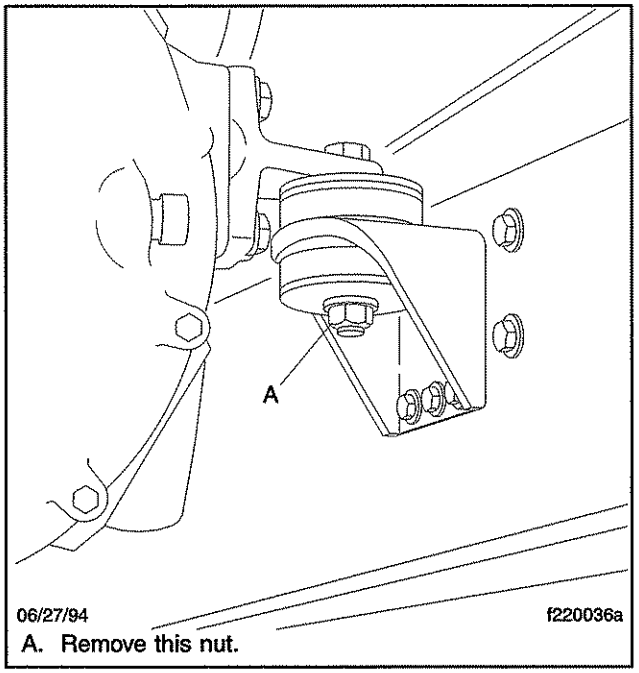
Fig. 22, Front Engine Mount



A. Remove this nut.

Fig. 23, Left Rear Engine Mount

11.1 Connect the heater outlet hose at the firewall. See **Fig. 5**.



A. Remove this nut.

Fig. 24, Right Rear Engine Mount

11.2 Connect the heater inlet hose at the valve near the firewall. See **Fig. 5.**

11.3 Connect the vent hose to the radiator. See **Fig. 4.** Connect the hose bracket at the condenser.

11.4 Connect the coolant inlet and outlet hoses to the radiator. See **Fig. 4.**

11.5 Connect the fill hose to the bottom of the surge tank.

12. Connect or install the air intake, exhaust pipe, and hoses.

12.1 Connect the air inlet and outlet hoses to the charge air cooler. See **Fig. 4.** Tighten the hose clamps 60 lbf·in (680 N·cm).

12.2 Connect the exhaust pipe to the rear of the turbocharger, and install the V-clamp that secures the pipe. Tighten the V-clamp 85 lbf·in (940 N·cm).

12.3 Install the air intake pipe on the turbocharger. See **Fig. 2.**

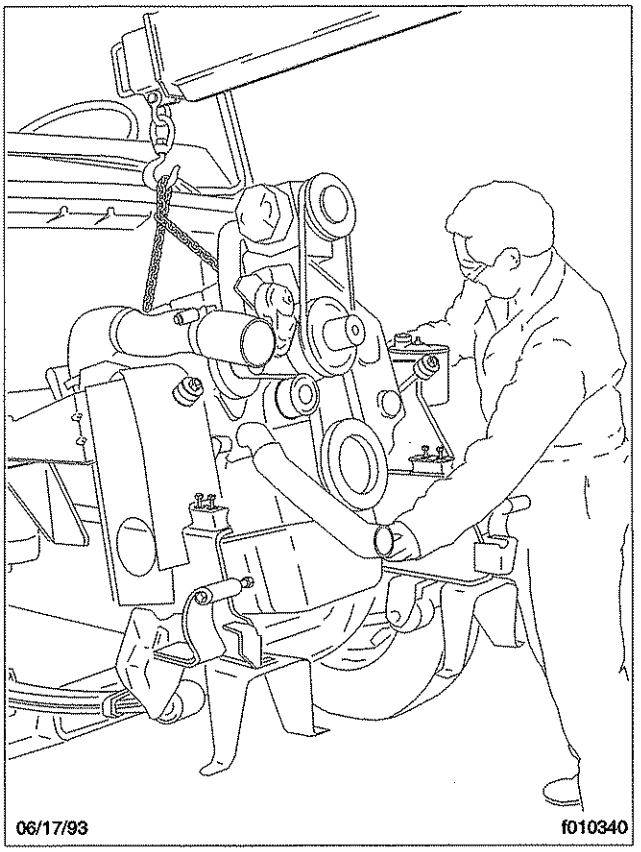


Fig. 25, Removing the Engine

12.4 If the vehicle is equipped with air brakes, connect the air outlet line to the air compressor.

12.5 If the vehicle is equipped with air brakes, connect the two air signal lines to the air governor on top of the compressor.

13. Install the air cleaner.

13.1 Position the air cleaner on its bracket, and secure the cleaner with four nuts. See **Fig. 3.** Tighten the nuts 28 lbf·ft (38 N·m).

13.2 Connect the air intake pipe to the top of the air cleaner. See **Fig. 2.**

14. Install the right fender splash shield. See **Fig. 1.**

15. Install the bumper and hood. For instructions, see **Group 88.**

16. Connect the batteries or, if the vehicle is equipped with a battery shutoff switch, turn on the switch.

Removal and Installation

16.1 Connect the positive battery cable to the batteries.

16.2 Connect the battery ground cable to the vehicle frame.

17. Fill the engine coolant system.

17.1 Close the petcock on the bottom of the radiator.

17.2 Fill the system with coolant at the surge tank. For coolant specifications, see the vehicle maintenance manual.

17.3 Tighten the surge tank cap.

18. Start the engine and check for leaks. Eliminate any leaks.

19. After the engine has run for about 20 minutes, check the coolant level and add coolant if needed.

20. Fill and bleed the power steering system as needed. For instructions, see **Group 46**.

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

Specifications

Description	Grade	Size	Torque	
			N·m (lbf·ft)	N·cm (lbf·in)
Rear Engine Mount Bolt	8	3/4 inch	244-325 (180-240)	—
Front Engine Mount Bolt	8	5/8 inch	163-203 (120-150)	—
Radiator Strut Nuts	2	1/2–13	47 (35)	—
Radiator Mount Nuts	5	3/8–16	40 (30)	—
Air Recirculation Shield Bolt	5	5/16 inch	20 (15)	—
Shock Absorber Mounting Bolt	8	3/4 inch	325 (240)	—
Shock Absorber Mount Mounting Bolts	8	5/8 inch	183 (135)	—
Refrigerant Compressor Adjusting Rod Jam Nut	5	1/2 inch	80 (59)	—
Refrigerant Compressor Mounting Nuts	5	1/2 inch	80 (59)	—
Condenser Mounting Bolts	5	5/16 inch	20 (15)	—
Aftercooler Hose Clamps	5	6.3 mm	—	680 (60)
Air Cleaner Mounting Nuts	5	3/8–16	38 (28)	—
Power Steering Pump Mounting Bolts	8.8	25 mm	38 (28)	—

Table 1, Fastener Torques

Contents

Subject	Subject Number
General Description	050
Service Operations	
Removal and Installation	100
Specifications	400

NOTE: Refer to the vehicle maintenance manual and the *Mercedes-Benz Engine Model OM 366LA Workshop Manual* for additional information on OM 366LA engine service operations.

General Description

The Mercedes-Benz OM 366LA engine **(see Fig. 1 and Fig. 2)** is supported by three engine mounts: two are at the rear of the engine— one on each side— and fastened to the frame rails. The other is at the front of the engine, fastened to the underslung crossmember.

Because the engine provides the main support for the transmission, removing them as an as-sembly is easier than disconnecting them, if the engine has to be removed. To further save time and expense, the refrigerant system remains intact simply by moving the refrigerant compressor and condenser out of the way, before lifting out the engine.

For detailed repair procedures and other engine service not covered in this section, refer to the Mercedes-Benz *Engine Model OM 366LA Workshop Manual* .

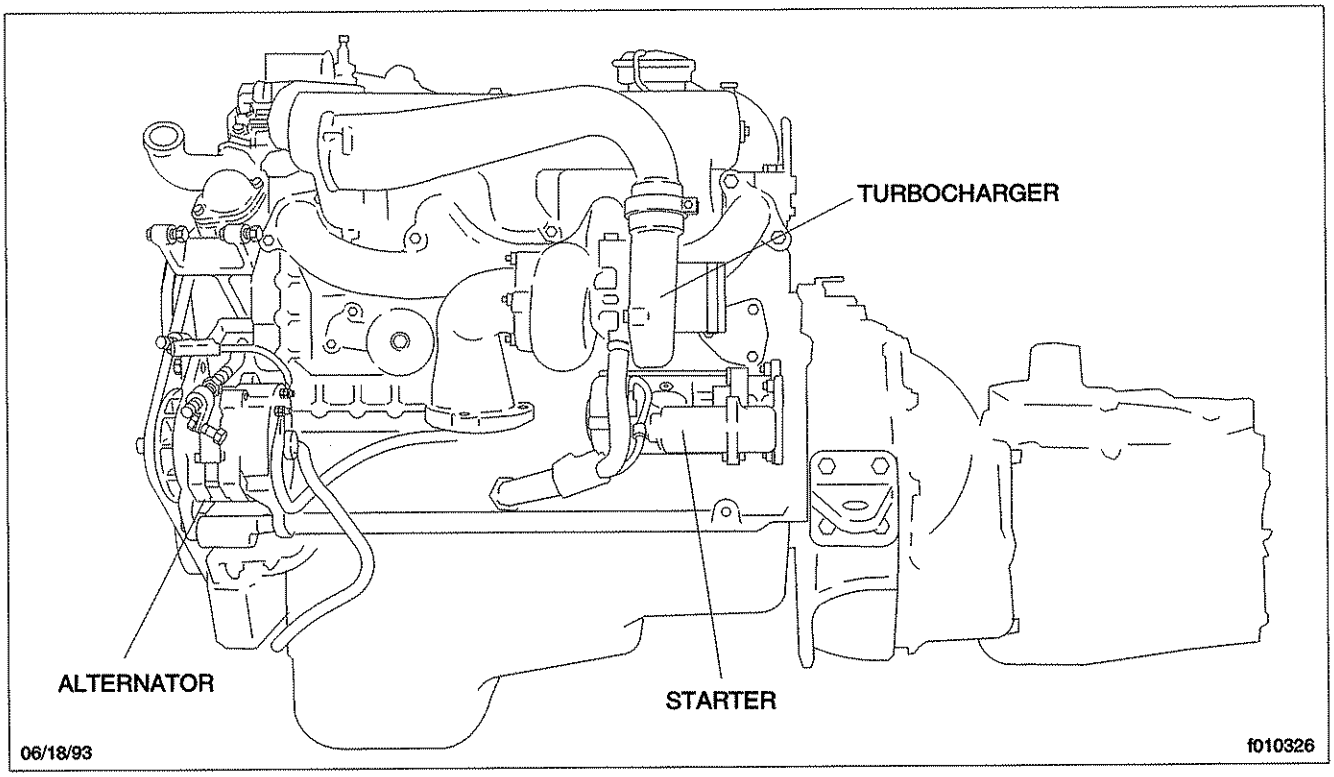


Fig. 1

General Description

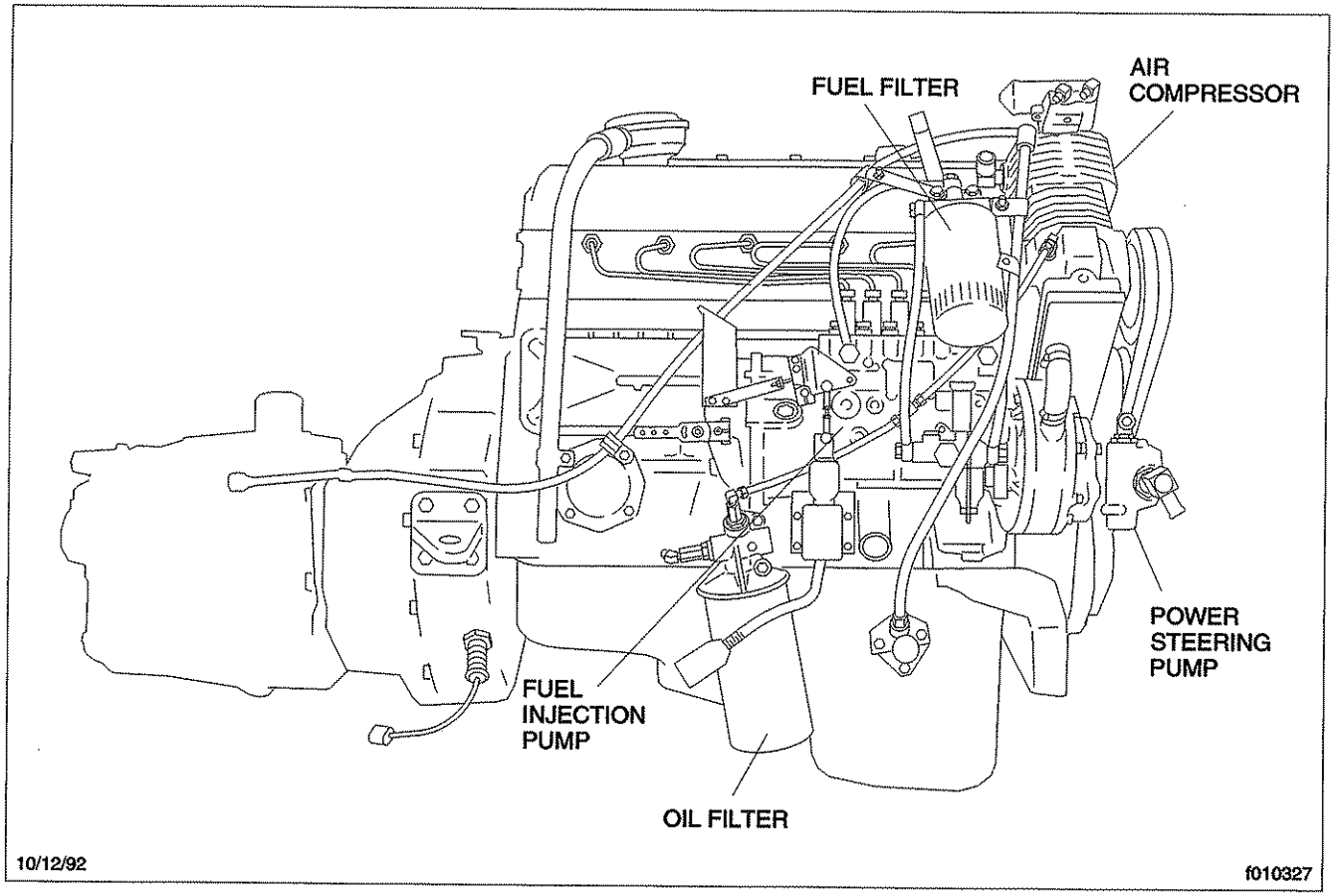


Fig. 2

Removal

NOTE: Because the transmission is supported entirely by the engine, removing them as an assembly (as described below) is easier than disconnecting them and removing the engine only.

1. Apply the parking brakes, chock the tires, and (if applicable) drain the air brake system.
2. Disconnect the batteries or, if the vehicle is equipped with a battery shutoff switch, turn off the switch.
   - 2.1 Disconnect the battery ground cable at the vehicle frame.
   - 2.2 Disconnect the positive battery cable from the batteries.

⚠ 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.
   - 3.1 Open the petcock at the bottom of the radiator to drain the engine coolant.
   - 3.2 Loosen the surge tank cap.
4. Remove the hood and bumper. For instructions, see **Group 88.**
5. Remove the right fender splash shield. See **Fig. 1.**
6. Remove the air cleaner.
   - 6.1 Remove the air intake pipe from the top of the air cleaner. See **Fig. 2.**
   - 6.2 Remove the four nuts from the inside of the air cleaner mounting bracket. See **Fig. 3.**
   - 6.3 Remove the air cleaner from its mounting bracket.
7. Disconnect or remove the air intake, exhaust pipe, and hoses.
   - 7.1 If the vehicle is equipped with air brakes, disconnect the compressor air intake hose from the air intake pipe. See **Fig. 4.**
   - 7.2 If the vehicle is equipped with air brakes, disconnect the air signal lines from the air governor on top of the air compressor. See **Fig. 5,** Ref. A.
   - 7.3 Disconnect the compressor outlet line. See **Fig. 6.**
   - 7.4 Remove the air intake pipe from the pipe around the rear of the engine.
   - 7.5 Remove the air intake pipe routed around the rear of the engine to the turbocharger. Two screws secure the pipe to the rear of the engine, and a clamp holds it to the turbocharger. See **Fig. 7.**
   - 7.6 Disconnect the air inlet and outlet hoses from the aftercooler. See **Fig. 8.**
   - 7.7 Disconnect the exhaust pipe from the rear of the turbocharger. Remove the bracket holding the exhaust pipe to the engine. See **Fig. 9.**
8. Disconnect or remove the coolant hoses.
   - 8.1 Disconnect the fill hose from the bottom of the surge tank and the heater inlet hose from the valve at the firewall. See **Fig. 10** and **Fig. 11.** With the heater and fill hoses attached, remove the coolant outlet hose between the engine and the bottom of the radiator. See **Fig. 12.**

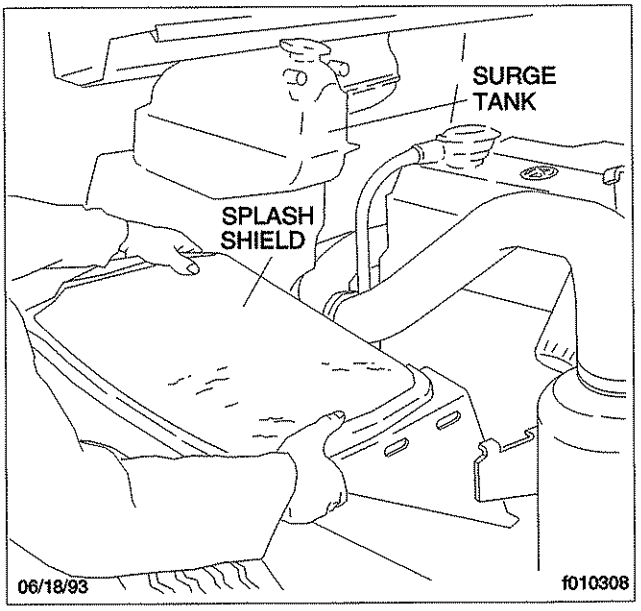


Fig. 1, Remove the Right Fender Splash Shield

Removal and Installation

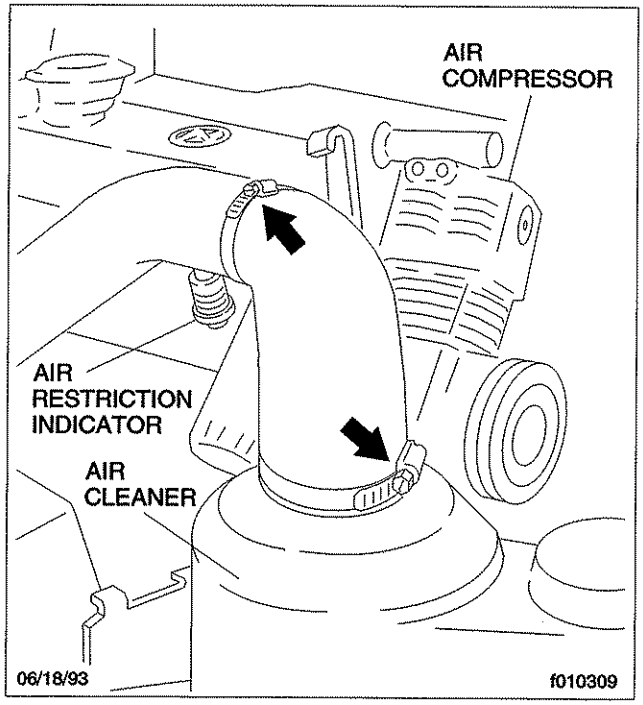
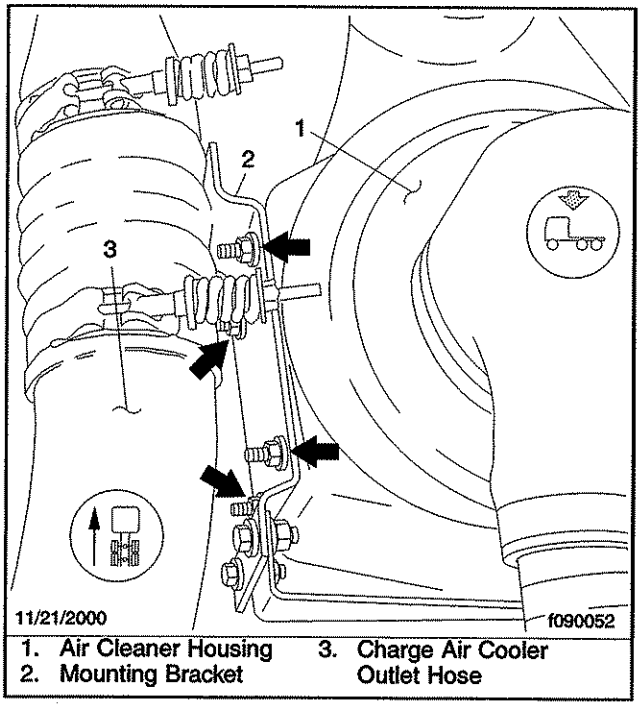


Fig. 2, Remove the Air Intake Pipe



1. Air Cleaner Housing
2. Mounting Bracket
3. Charge Air Cooler Outlet Hose

Fig. 3, Air Cleaner Housing Mounting Fasteners

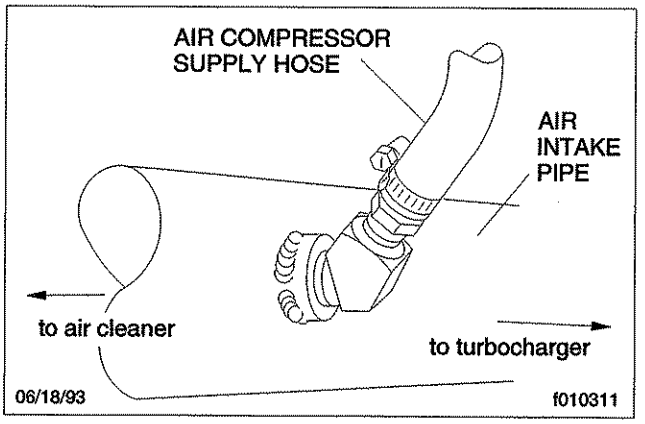


Fig. 4, Disconnect the Air Compressor Intake Hose

8.2 Disconnect the radiator inlet hose between the engine thermostat and the radiator. See **Fig. 8.**

8.3 Disconnect the surge tank vent hose from the radiator (see **Fig. 13**), and remove the hose bracket from the condenser. Disconnect the surge tank vent hose from the engine. See **Fig. 13.**

8.4 Disconnect the heater outlet hose running between the firewall and the engine (just behind the engine thermostat). See **Fig. 14.**

9. Remove the refrigerant compressor and condenser (see **Fig. 15**).

9.1 Disconnect the compressor electrical connectors.

9.2 Remove the adjusting rod guide from the adjusting rod.

9.3 Remove the belt running between the rear pulley of the compressor and the front pulley of the vibration damper.

9.4 Remove the two bolts securing the compressor to its mount.

9.5 Remove the four bolts holding the condenser to the aftercooler. See **Fig. 16.**

9.6 To keep the refrigerant system intact, with no leaks and no need for purging and recharging, move the condenser and the

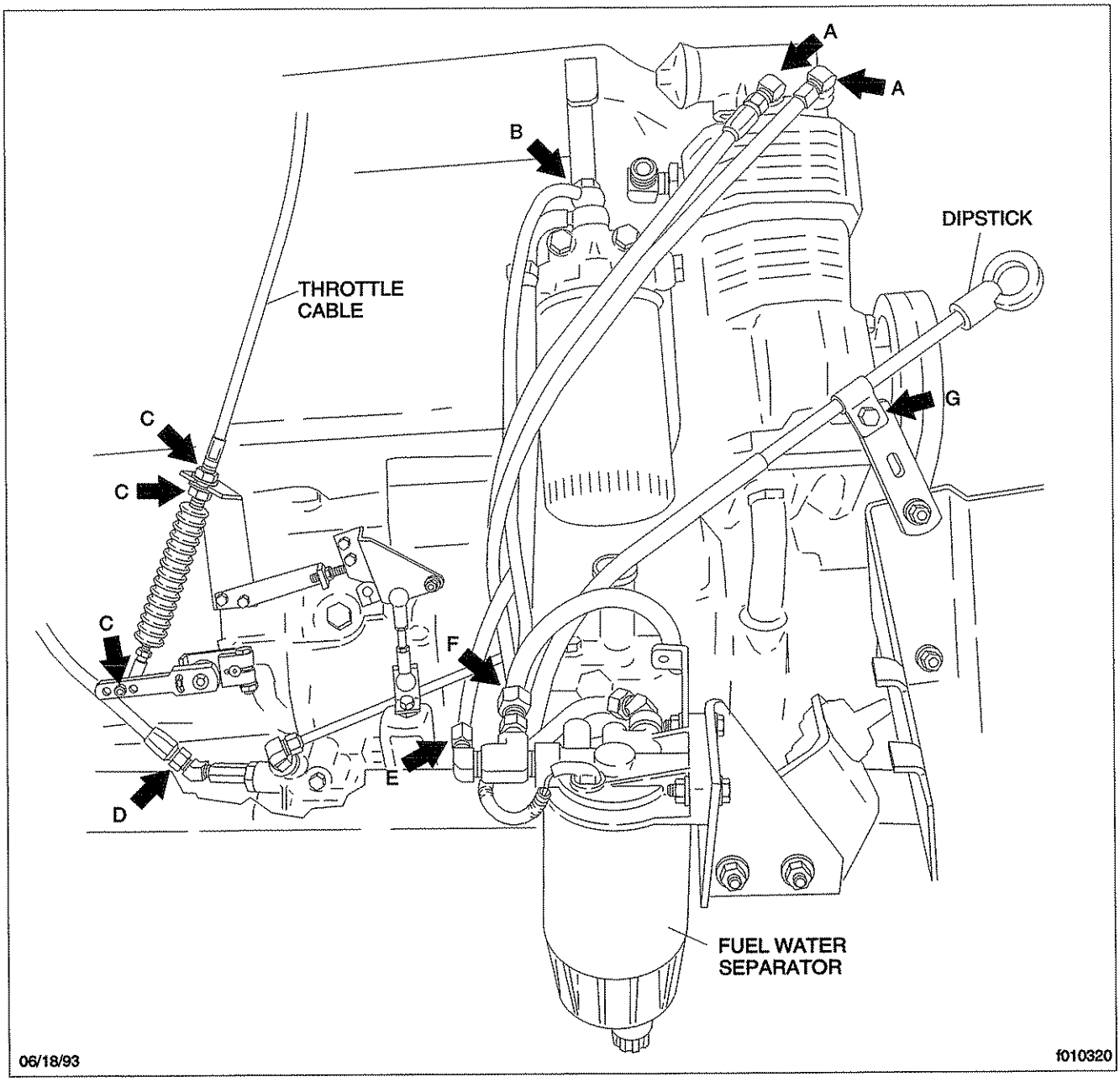


Fig. 5

refrigerant compressor to the side at the same time. See **Fig. 17.**

9.7 Wrap the condenser in a protective blanket, or sandwich it between two sheets of cardboard or wood to prevent damage to the condenser fins. Secure the compressor and condenser out of the way with wire. See **Fig. 18.**

10. Remove the radiator and aftercooler assembly.

Removal and Installation

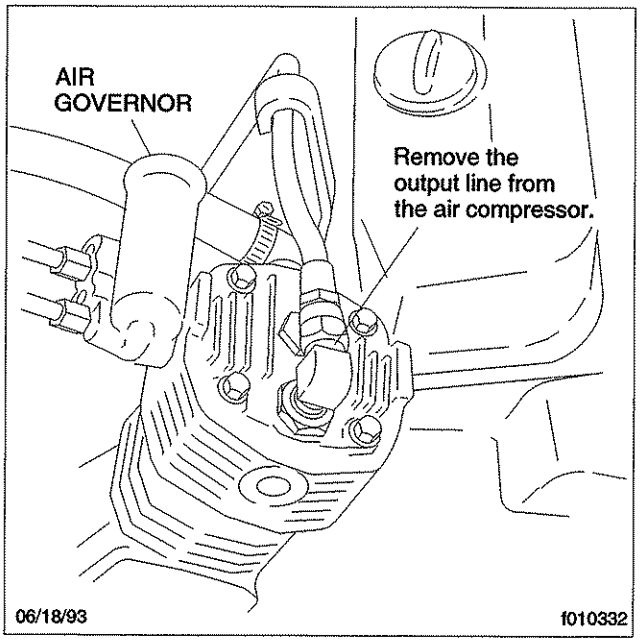


Fig. 6

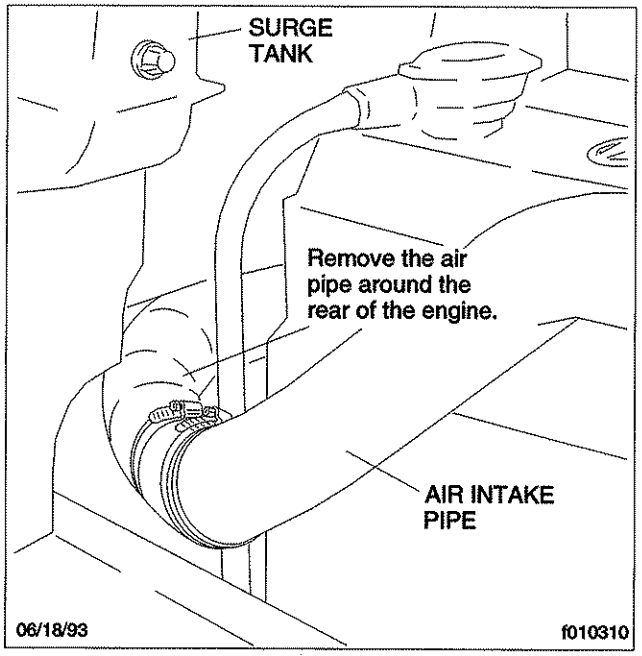


Fig. 7

10.1 Remove the left air recirculation shield to uncover the left aftercooler mounting tab. See **Fig. 19**.

10.2 Hook a lifting chain to the radiator and aftercooler assembly (see **Fig. 20**), and fasten the chain to a crane.

10.3 Remove the nuts, washers, and rubber isolators from the forward ends of the radiator struts. See **Fig. 21**.

10.4 Remove the nuts and washers from the radiator mounts. See **Fig. 21**.

10.5 Lift the radiator and aftercooler from the vehicle as a single unit. See **Fig. 20**.

11. Remove the two power steering pump mounting bolts, and move the pump aside while keeping the steering fluid system intact.

12. Disconnect the engine fuel and oil system components.

12.1 Remove the dipstick tube from the air cleaner mounting bracket. See **Fig. 5**, Ref. G.

12.2 Disconnect the throttle cable from the engine throttle arm and the throttle cable bracket. See **Fig. 5**, Ref. C.

12.3 Disconnect the oil pressure gauge line from the rear of the oil filter housing. See **Fig. 5**, Ref. D.

12.4 Disconnect the fuel return line running between the engine and the fuel water separator. See **Fig. 5**, Ref. E.

12.5 Disconnect the fuel delivery line from the fuel water separator. See **Fig. 5**, Ref. F.

12.6 Disconnect the fuel return line from the fuel filter. See **Fig. 5**, Ref. B.

12.7 Disconnect the turbocharger oil return line at the turbocharger.

13. Disconnect the engine electrical connections.

13.1 Disconnect the wiring connector for the fuel shutoff solenoid.

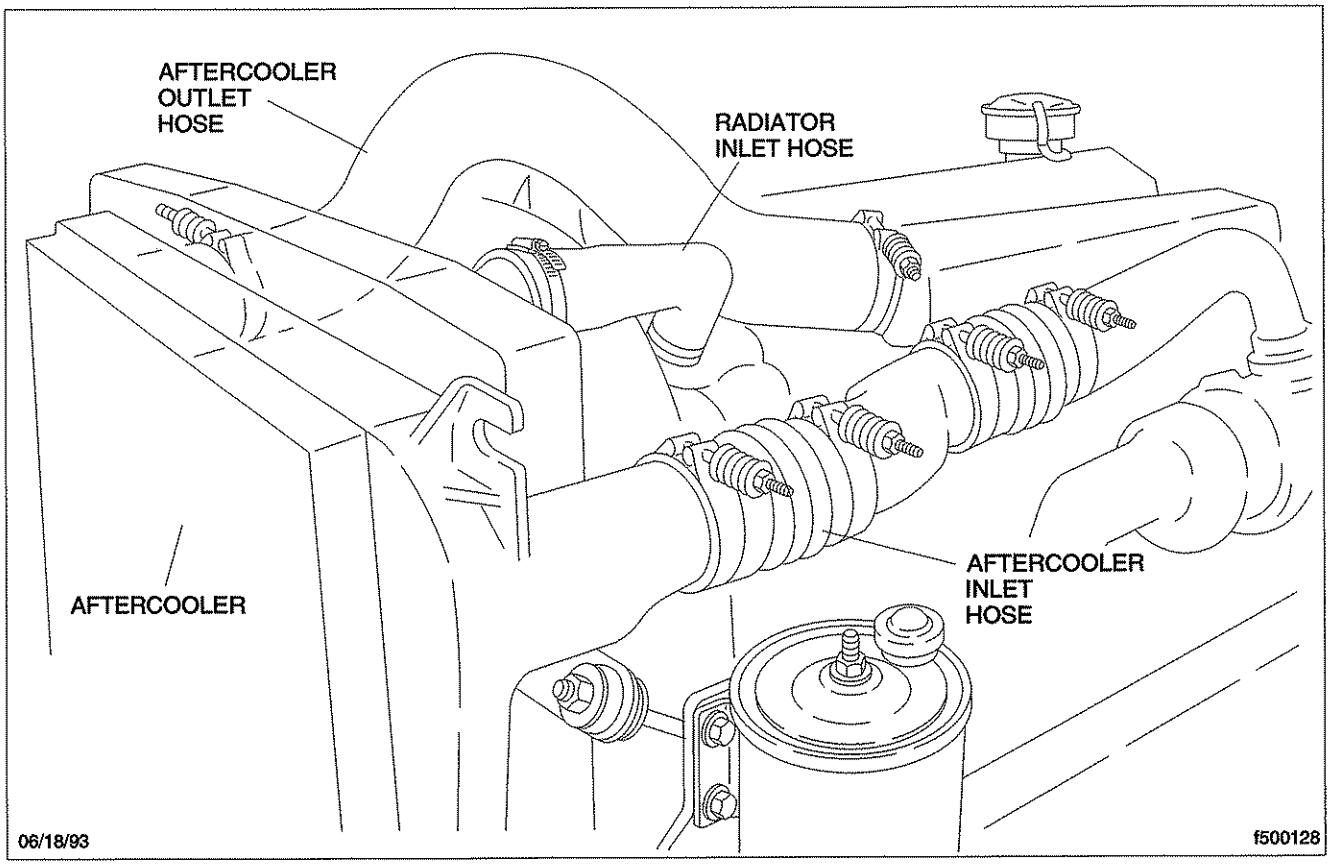


Fig. 8, Disconnect the Aftercooler Hoses and Radiator Inlet Hose

13.2 Remove the wiring ring terminals from the starter, and label them for reassembly. See **Fig. 22.**

13.3 Remove the alternator ground wire and engine ground strap from the frame rail.

13.4 Disconnect the engine wiring harness from the flame start (and other options as applicable), the coolant temperature sensors, and the alternator. Pull the harness off to the right side, away from the engine.

14. Disconnect the top of the left front shock absorber, and remove the top shock absorber mount from the frame rail.

15. Disconnect the transmission-mounted components.

15.1 Remove the shift tower from the transmission. See **Fig. 23.** Cover the shift tower hole in the top of the transmission.

15.2 Disconnect the back-up alarm sensor at the rear of the transmission. See **Fig. 24.**

15.3 Disconnect the tachometer sensor at the engine flywheel. See **Fig. 24.**

15.4 Disconnect the speedometer sensor at the transmission output. See **Fig. 24.**

15.5 Remove the clevis pin from the clutch release lever, then remove the clutch slave cylinder from the clutch housing. See **Fig. 25.**

15.6 Remove the driveshaft from the transmission output end yoke. For instructions, see **Group 41.**

15.7 If the vehicle is equipped with air brakes, disconnect the air compressor outlet line from the chassis air delivery line, and remove the outlet line from the bracket

Removal and Installation

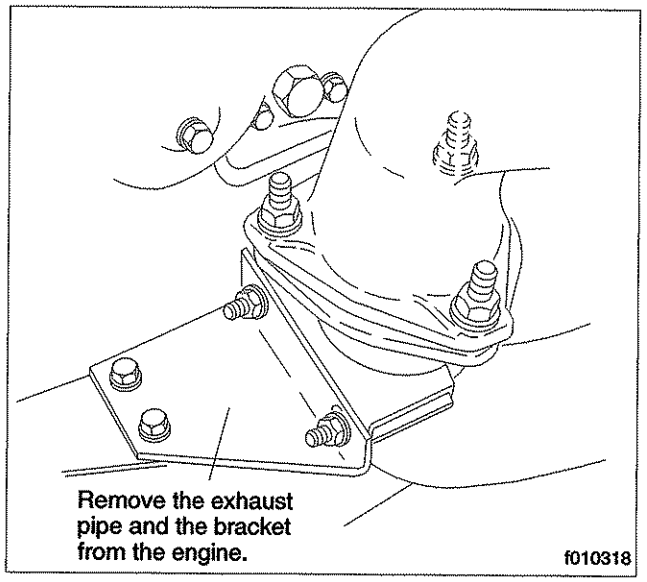


Fig. 9

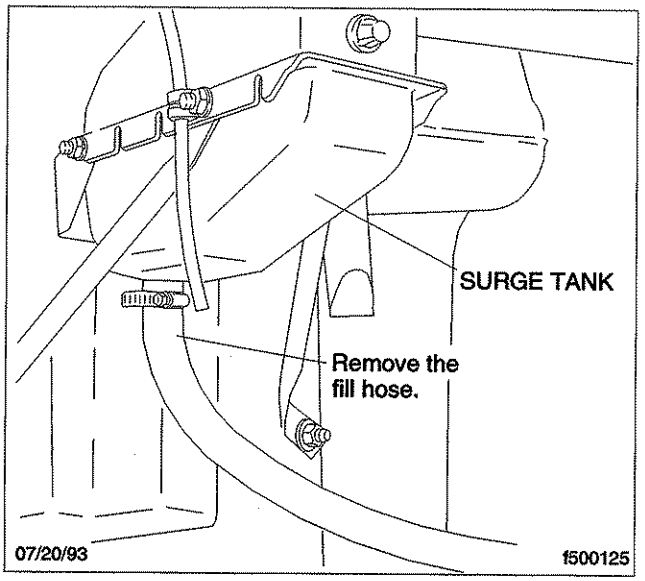


Fig. 10

mounted on the transmission bell housing. See **Fig. 24.**

16. Remove the engine from the vehicle.

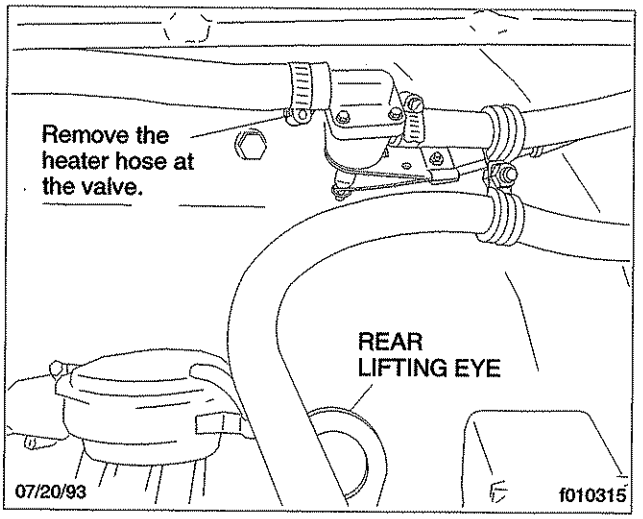


Fig. 11

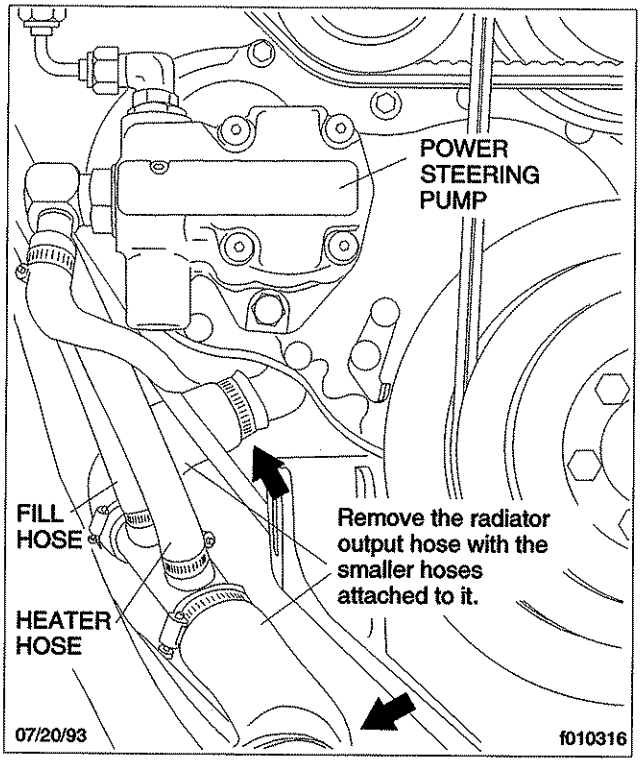


Fig. 12

⚠ WARNING

The crane and lifting chains used to remove the engine must be capable of safely lifting and sup-

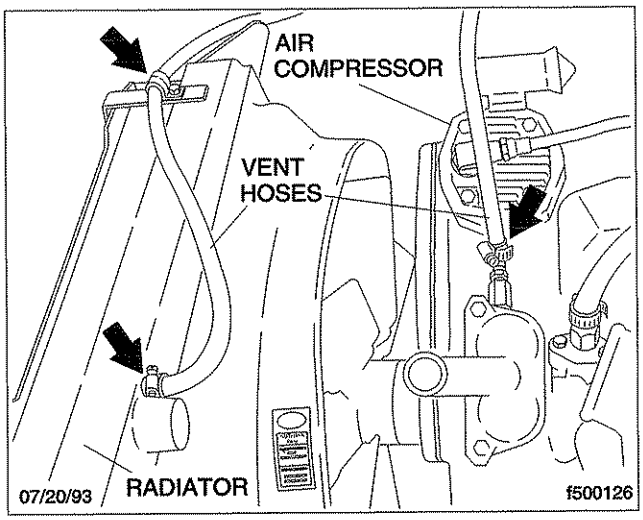


Fig. 13, Disconnect the Vent Hoses

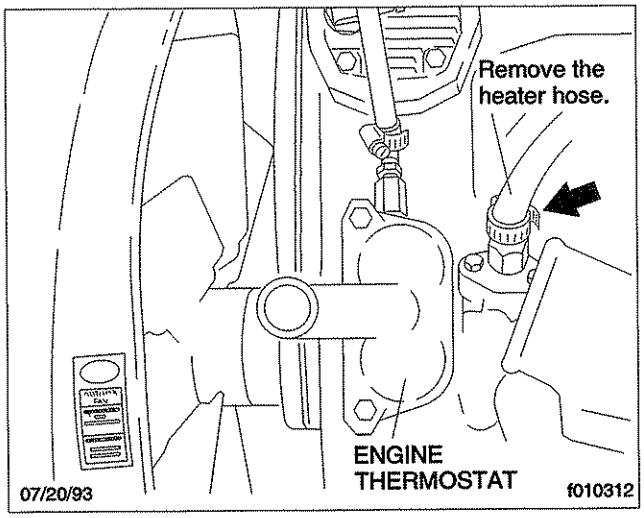


Fig. 14

porting two metric tons. Once the engine mounts are disconnected, do not get under the engine until it is securely supported on engine stands. An unsecured engine may fall, causing personal injury or death, and component damage.

16.1 Attach a chain to the engine lifting eye at the rear of the engine and to the lifting hook at the front. See **Fig. 26**. Attach the chain to a crane, and raise the chain to remove any slack.

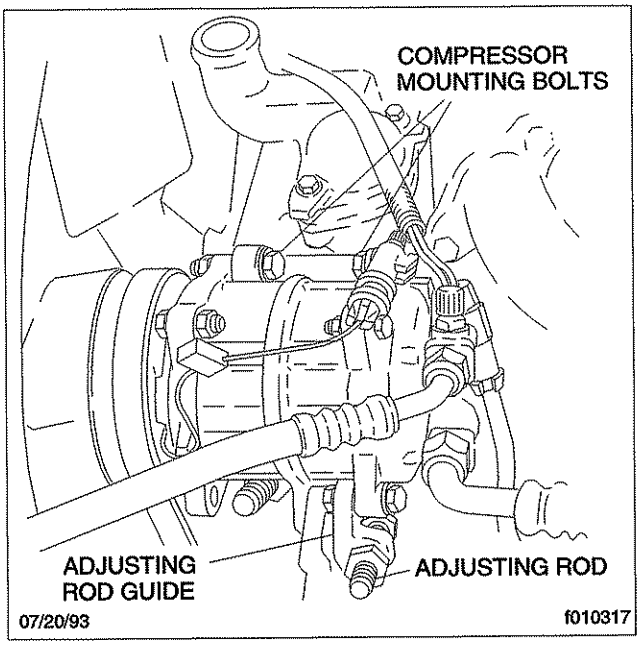


Fig. 15, Refrigerant Compressor

16.2 Remove the bolt from the front engine mount. See **Fig. 27**.

16.3 Remove the bolts from the two rear engine mounts. See **Fig. 28** and **Fig. 29**.

16.4 Gradually lift the engine and pull it forward to remove it from the engine compartment.

NOTE: If necessary to lift the engine, remove the blow-by vent from the engine cover. See **Fig. 30**.

Installation

1. Examine all engine support components for damage and extreme wear. Replace components as necessary.
2. Install the engine in the vehicle.

⚠ WARNING

The crane and lifting chains used to install the engine must be capable of safely lifting and supporting two metric tons. Once the engine is removed from the engine stands, do not get under the engine until it is securely installed on the engine

Removal and Installation

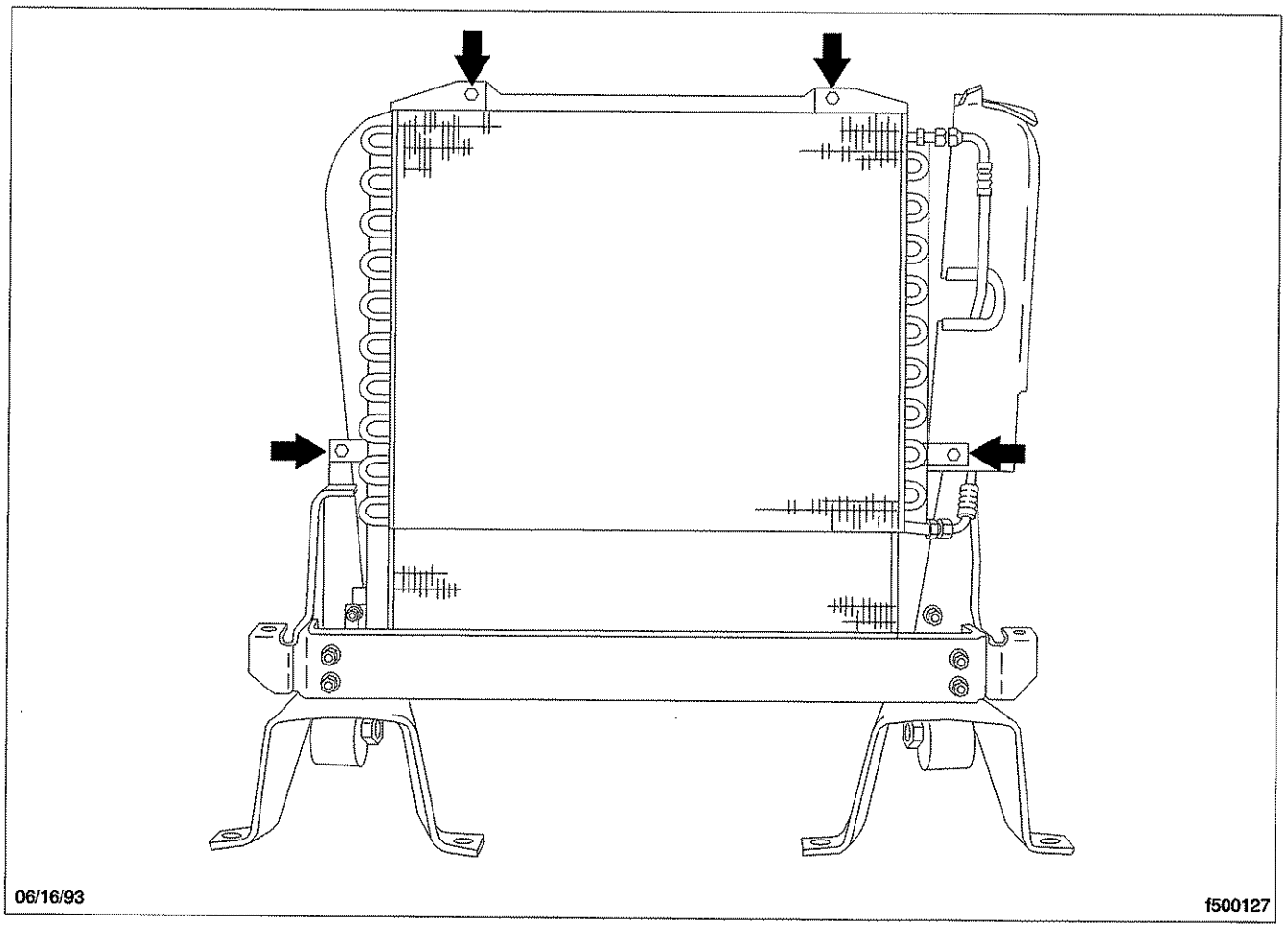


Fig. 16, Condenser Mounting Bolts

mounts. An unsecured engine may fall, causing personal injury or death, and component damage.

2.1 Attach a chain to the lifting eye at the rear of the engine and to the lifting hook at the front. See **Fig. 26**. Attach the chain to a crane, and raise the chain to remove any slack.

2.2 Carefully lower the engine and push it back onto the engine mounts.

2.3 Install the bolts in the two rear engine mounts, and tighten the bolts 327 N·m (241 lbf·ft).

2.4 Install the bolt in the front engine mount, and tighten it 203 N·m (150 lbf·ft).

2.5 Remove the lifting chain from the engine lifting eye and hook.

2.6 If it was removed for engine removal, install the blow-by vent on the engine cover. See **Fig. 30**.

3. Install the upper, front shock absorber mount on the left frame rail. Tighten the mounting bolts 183 N·m (135 lbf·ft). Install the shock on the mount, and tighten the shock mounting bolt 325 N·m (240 lbf·ft).

4. Connect the transmission-mounted components.

4.1 Connect the driveshaft to the transmission output end yoke. For instructions, see **Group 41**.

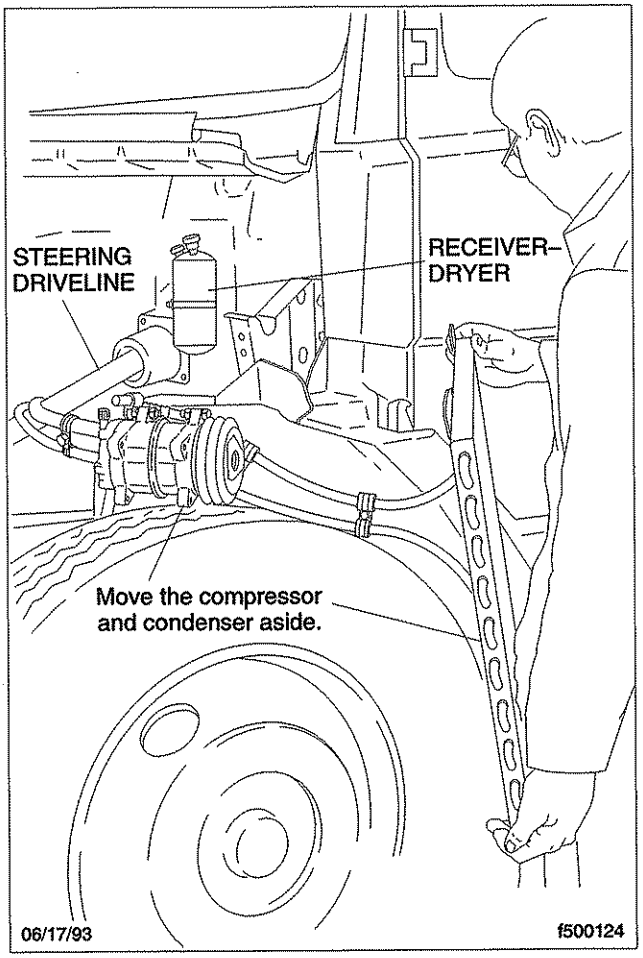


Fig. 17

4.2 If the vehicle is equipped with air brakes, connect the air compressor outlet line to the chassis air delivery line, and secure the outlet line to the bracket on the transmission bell housing. See **Fig. 24.**

4.3 Connect the clutch release lever with a new clevis pin, and install the clutch slave cylinder on the clutch housing. See **Fig. 25.**

4.4 Connect the speedometer sensor at the transmission output. See **Fig. 24.**

4.5 Connect the tachometer sensor at the engine flywheel. See **Fig. 24.**

4.6 Connect the back-up alarm sensor at the rear of the transmission. See **Fig. 24.**

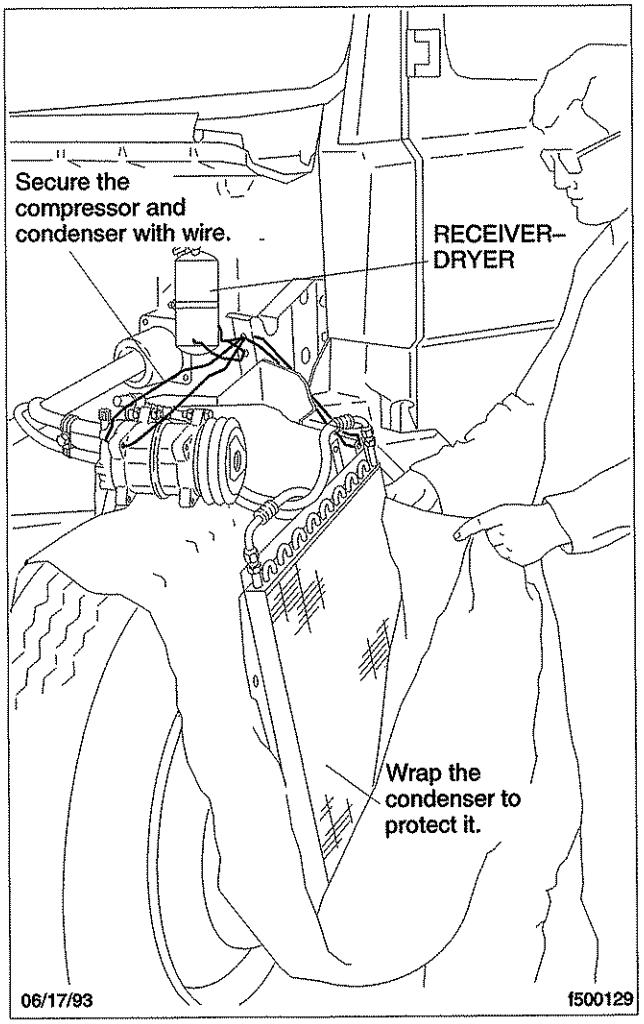


Fig. 18

4.7 Install the shift tower on the transmission. See **Fig. 23.**

5. Connect the engine electrical connections.

5.1 Connect the engine wiring harness at the alternator, the coolant temperature sensors, the flame start, and other options as applicable.

5.2 Connect the alternator ground wire and the engine ground strap to the frame rail.

5.3 Connect the wiring ring terminals to the starter. See **Fig. 22.**

Removal and Installation

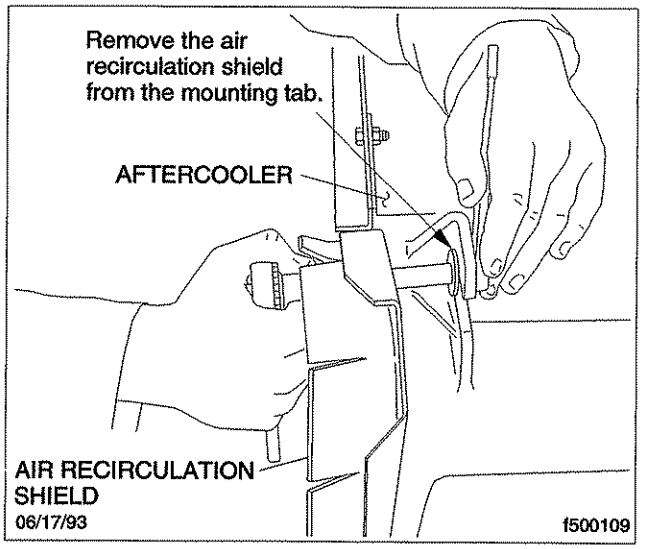


Fig. 19

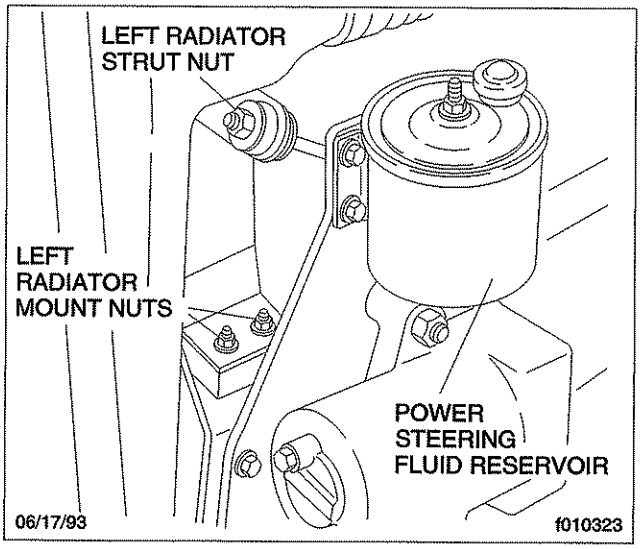


Fig. 21

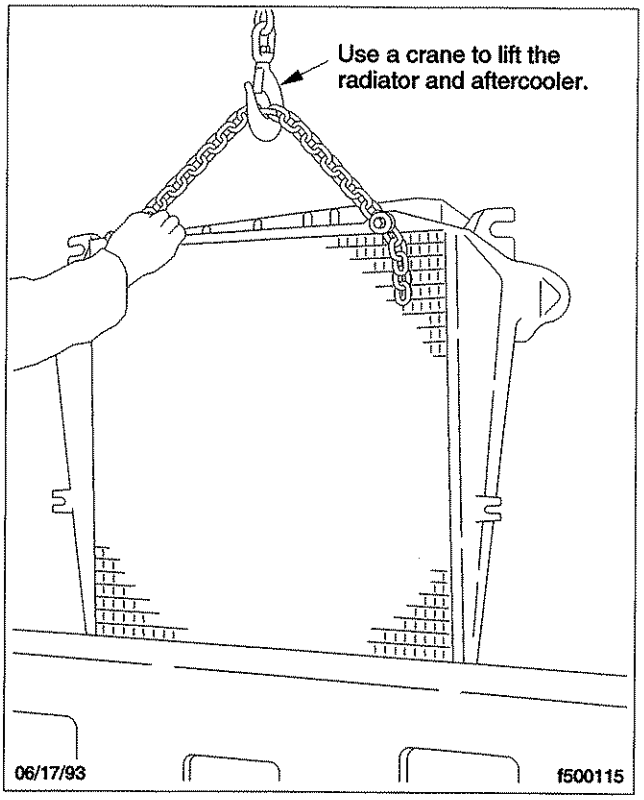


Fig. 20

5.4 Connect the wiring connector to the fuel shutoff solenoid.

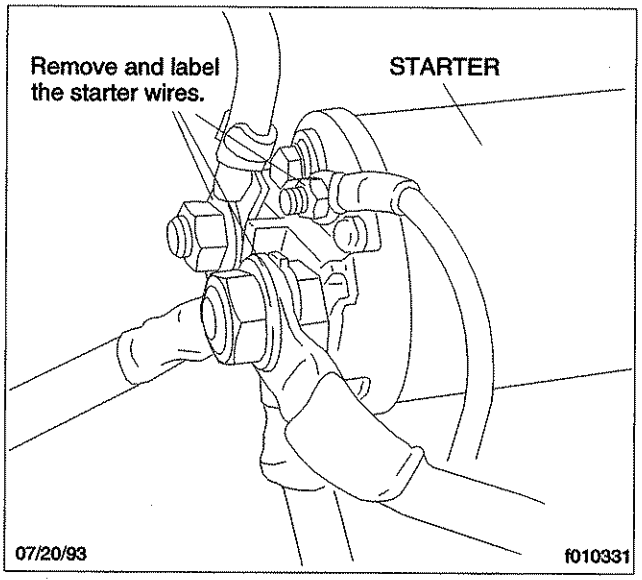


Fig. 22

6. Connect the fuel and oil system components.

   6.1 Connect the fuel return line to the fuel filter. See **Fig. 5**, Ref. B.

   6.2 Connect the fuel delivery line to the fuel water separator. See **Fig. 5**, Ref. F.

   6.3 Connect the fuel return line running between the engine and the fuel water separator. See **Fig. 5**, Ref. E.

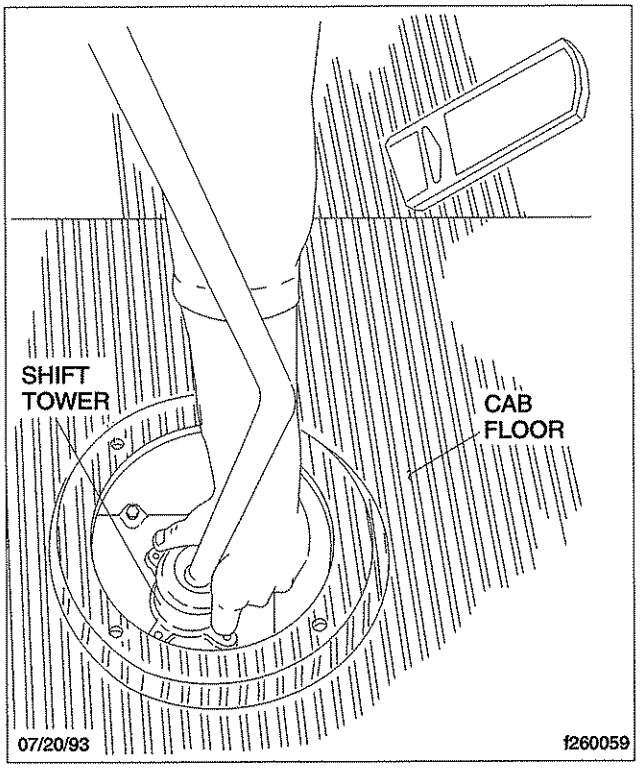


Fig. 23

6.4 Connect the oil pressure gauge line at the rear of the oil filter housing. See **Fig. 5**, Ref. D.

6.5 Connect the throttle cable to the engine throttle lever and the throttle cable bracket. See **Fig. 5**, Ref. C.

6.6 Connect the dipstick tube to the air cleaner mounting bracket. See **Fig. 5**, Ref. G.

6.7 Connect the oil return line to the turbocharger.

7. Install the power steering pump on the engine, and tighten the mounting bolts 38 N·m (28 lbf·ft).

8. Install the radiator and aftercooler assembly.

8.1 Using a crane and lifting chains, lift and install the radiator and aftercooler as a single unit on the radiator mounting studs. For stability, leave the radiator attached to the crane until the radiator mounting fasteners are secure.

8.2 Install the nuts and washers on the radiator mounting studs, and tighten the nuts 40 N·m (30 lbf·ft). See **Fig. 21**.

8.3 Install the nuts, washers and rubber isolators on the radiator struts and tighten the nuts 47 N·m (35 lbf·ft). See **Fig. 21**.

8.4 Remove the lifting chains and crane from the assembly.

8.5 Install the air recirculation shield over the left aftercooler mounting tab. See **Fig. 19**. Tighten the shield bolt 20 N·m (15 lbf·ft).

9. Install the air conditioning system on the engine.

9.1 Carefully move the refrigerant compressor and condenser back into place.

9.2 Install the four bolts to hold the condenser in place over the aftercooler. See **Fig. 16**. Tighten the bolts 20 N·m (15 lbf·ft).

9.3 Position the compressor on its mount, and insert the two mounting bolts. See **Fig. 15**.

9.4 Place the adjusting rod guide on the adjusting rod.

9.5 Install the compressor drive belt on the compressor pulley and tighten the belt. For instructions, see "Drive Belts" in this group. Tighten the adjusting rod guide capscrew 45 N·m (33 lbf·ft).

9.6 Tighten the compressor mounting bolt nuts 45 N·m (33 lbf·ft).

9.7 Connect the compressor electrical connectors to the wiring harness.

10. Connect and install the coolant hoses.

10.1 Connect the heater return hose between the firewall and the engine (just behind the engine thermostat). See **Fig. 14**.

10.2 Connect the vent hose to the radiator. Secure the hose bracket at the top, right condenser mounting bolt. See **Fig. 13**.

10.3 Connect the vent hose to the engine. See **Fig. 13**.

10.4 Install the radiator inlet hose between the engine thermostat and the radiator. See **Fig. 8**.

Removal and Installation

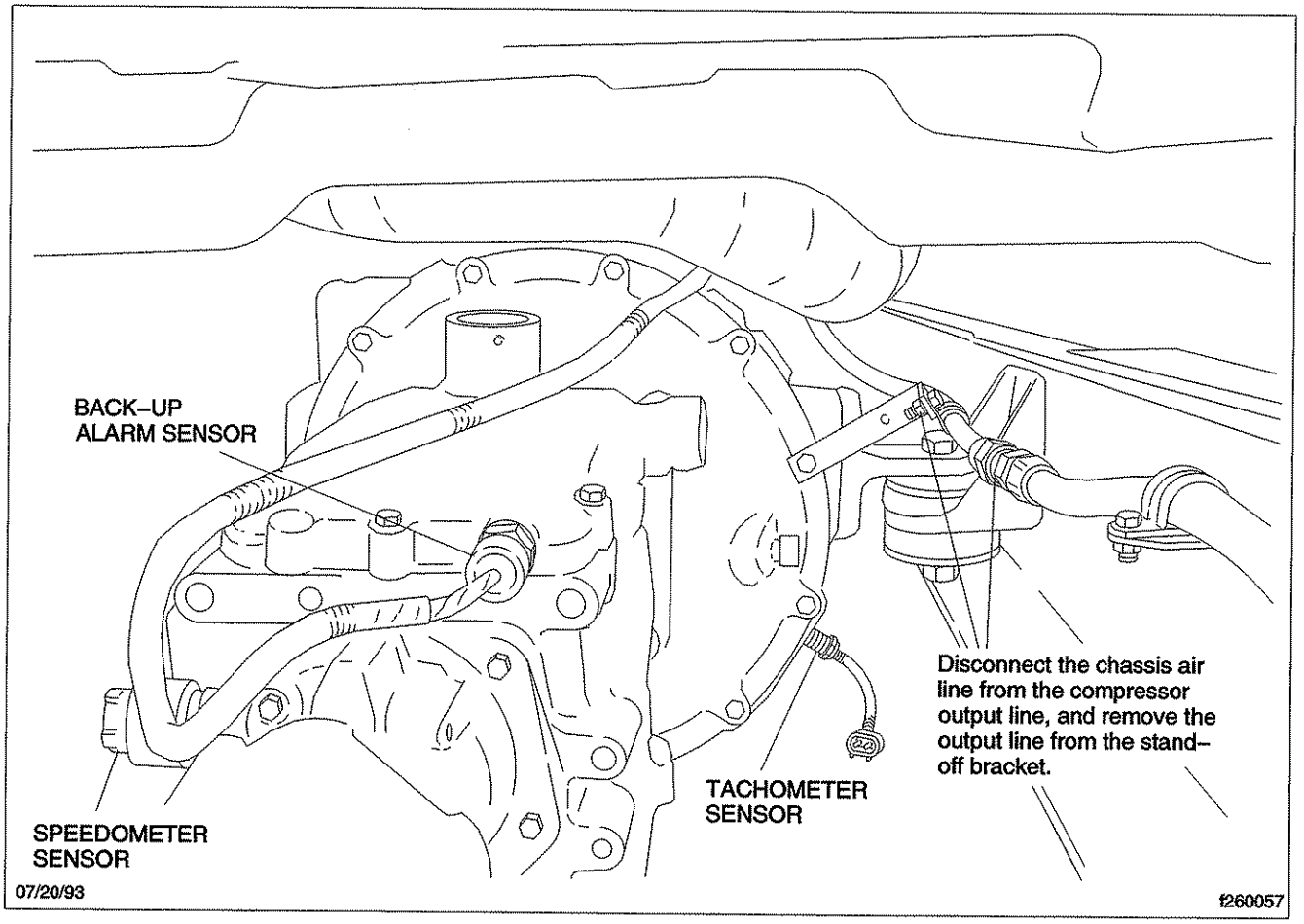


Fig. 24, View Under Back of Cab

10.5 Install the radiator outlet hose between the bottom of the radiator and the engine. Of the two hoses branching from that hose, connect the shorter branch hose to the bottom of the surge tank, and connect the longer to the heater water valve at the firewall. See **Fig. 10**, **Fig. 11**, and **Fig. 12**.

11. Connect or install the air intake, exhaust pipes and hoses.

11.1 Install the air intake pipe around the rear of the engine. See **Fig. 7**. Secure it to the engine with two screws, and clamp it to the turbocharger.

11.2 Connect the exhaust pipe to the rear of the turbocharger. Secure the exhaust pipe bracket to the engine. See **Fig. 9**.

11.3 If the vehicle is equipped with air brakes, connect the two air signal lines to the air governor at the top of the air compressor. See **Fig. 5**, Ref. A.

11.4 If the vehicle is equipped with air brakes, connect the air compressor outlet line to the top of the air compressor. See **Fig. 6**.

11.5 Connect the air inlet and outlet hoses to the aftercooler. See **Fig. 8**. Tighten the constant torque hose clamps 680 N·cm (60 lbf·in).

11.6 Install the air intake pipe from the air cleaner to the air intake pipe routed around the rear of the engine. See **Fig. 7**. If the vehicle is equipped with air brakes, connect

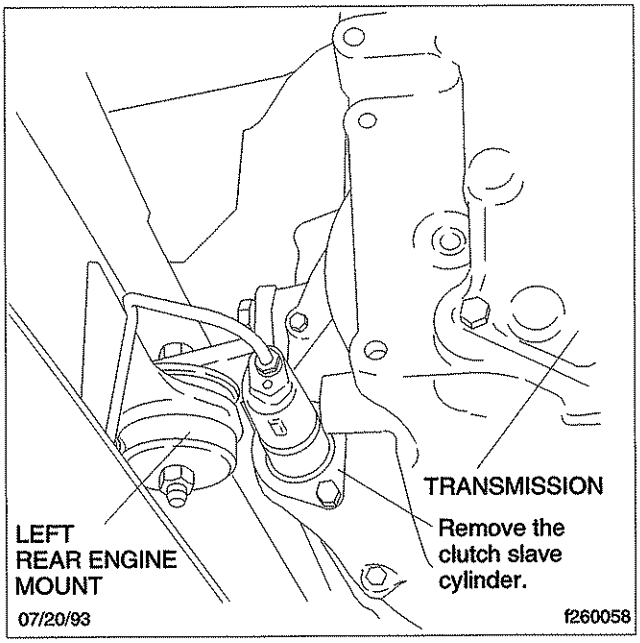


Fig. 25

the air compressor air intake hose to the air intake pipe. See **Fig. 4.**

12. Install the air cleaner.

    12.1 Position the air cleaner on its mounting bracket, and install the four nuts on the air cleaner mounting studs. See **Fig. 3.** Tighten the nuts 38 N·m (28 lbf·ft).

    12.2 Install the air intake pipe on the top of the air cleaner. See **Fig. 2.**

13. Install the right fender splash shield. See **Fig. 1.**

14. Install the bumper and hood. For instructions, see **Group 88**

15. Connect the batteries or, if the vehicle is equipped with a battery shutoff switch, turn on the switch.

    15.1 Connect the positive battery cable to the batteries.

    15.2 Connect the battery ground cable to the vehicle frame.

16. Fill the engine coolant system.

    16.1 Close the petcock on the bottom of the radiator.

    16.2 Fill the system with coolant at the surge tank. For coolant specifications, see the vehicle maintenance manual.

    16.3 Tighten the surge tank cap.

17. Start the engine and check for leaks. Eliminate any leaks.

18. After the engine has run for about 20 minutes, check the coolant level and add coolant if needed.

19. Fill and bleed the power steering system as necessary. For instructions, see **Group 46.**

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

Removal and Installation

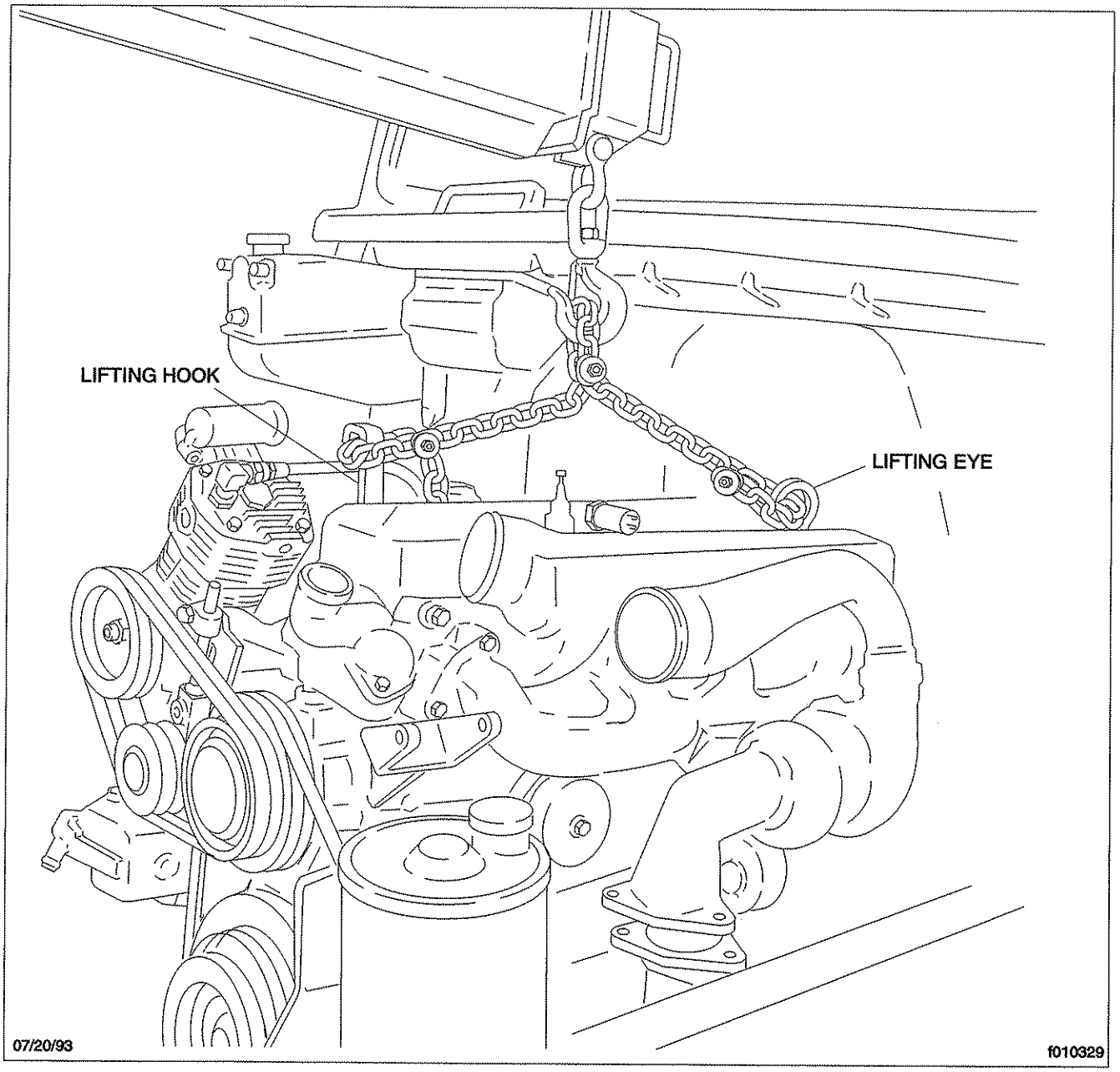


Fig. 26, Lifting the Engine

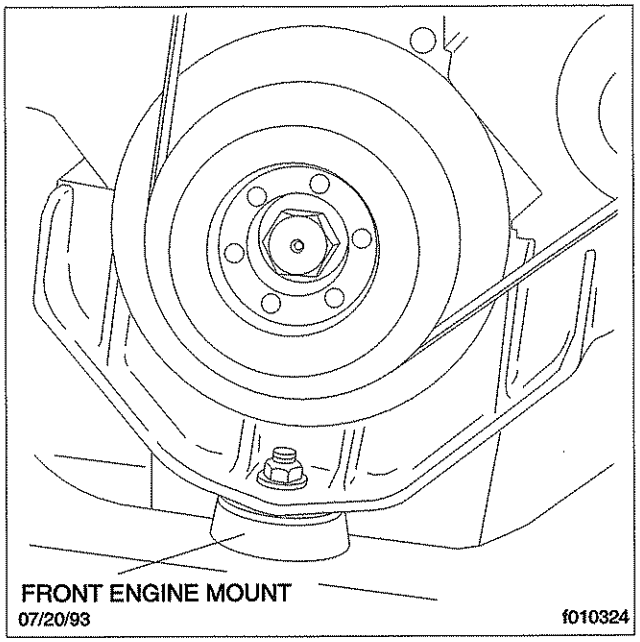


Fig. 27

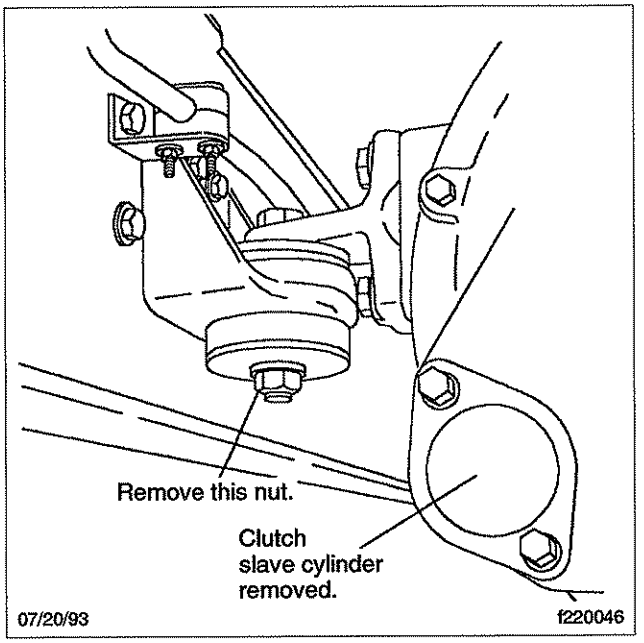


Fig. 29, Left Rear Engine Mount

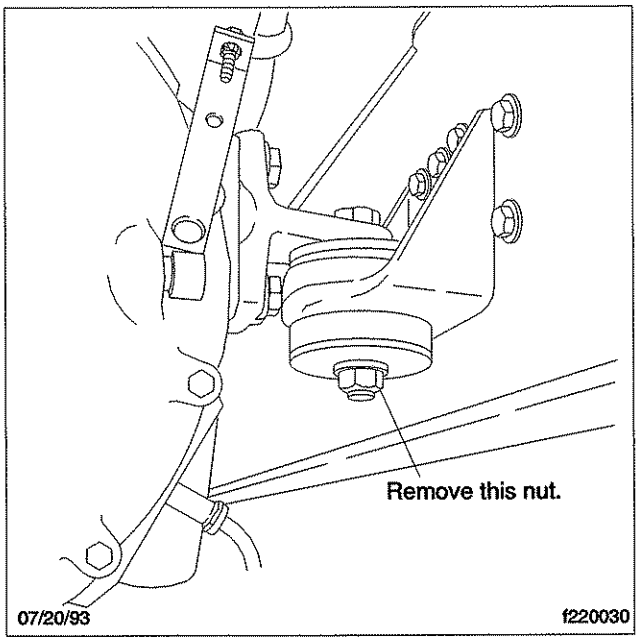


Fig. 28, Right Rear Engine Mount

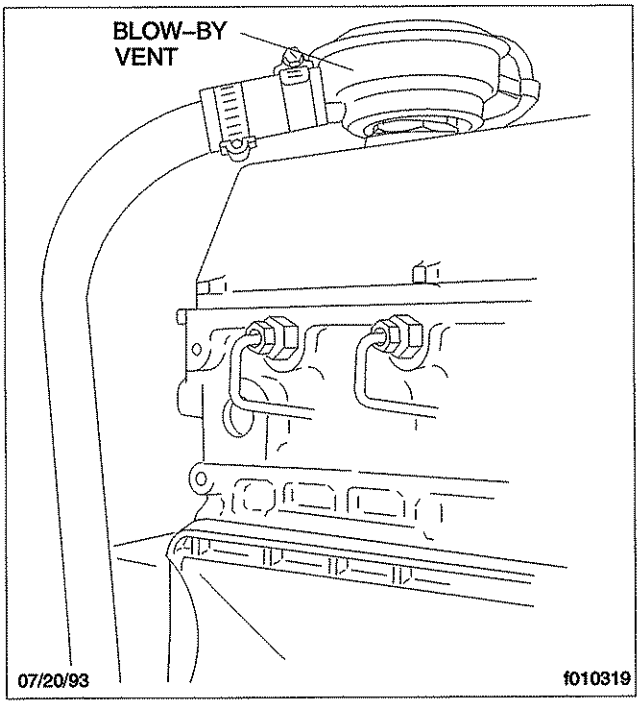


Fig. 30

Description	Grade	Size	Torque	
			N·m (lbf·ft)	N·cm (lbf·in)
Rear Engine Mount Bolts	8	3/4 inch	244-325 (180-240)	—
Front Engine Mount Bolt	8	5/8 inch	163-203 (120-150)	—
Radiator Strut Nuts	2	1/2–13	47 (35)	—
Radiator Mount Nuts	5	3/8–16	40 (30)	—
Air Recirculation Shield Bolt	5	5/16 inch	20 (15)	—
Refrigerant Compressor Adjusting Rod Guide Capscrew	8	3/8 inch	45 (33)	—
Refrigerant Compressor Mounting Nuts	8	3/8 inch	45 (33)	—
Shock Absorber Mounting Bolt	8	3/4 inch	325 (240)	—
Shock Absorber Mount Mounting Bolts	8	5/8 inch	183 (135)	—
Condenser Mounting Bolts	5	5/16 inch	20 (15)	—
Aftercooler Hose Clamps	5	6.3 mm	—	680 (60)
Air Cleaner Mounting Nuts	5	3/8–16	38 (28)	—
Power Steering Pump Mounting Bolts	8.8	25 mm	38 (28)	—

Table 1, Fastener Torques

Contents

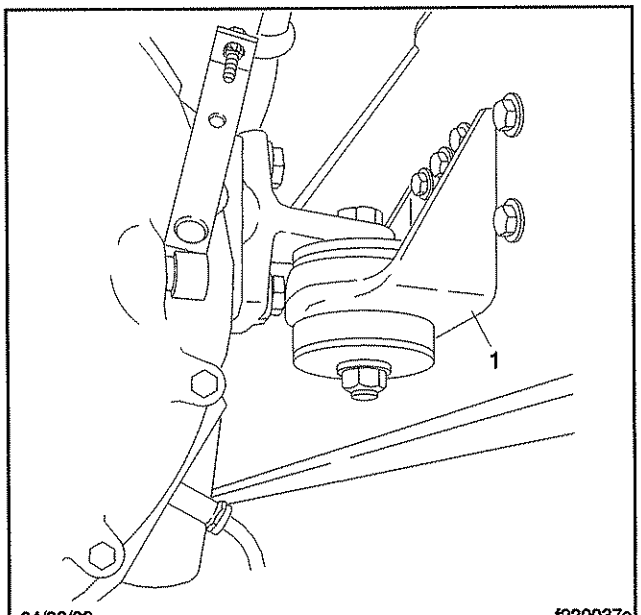
Subject	Subject Number
General Description	050
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Front Engine Mount Replacement, Diesel Engines	110
Rear Engine Mount Isolator Replacement, Diesel Engines	120
Front Engine Mount Isolator Replacement, Diesel Engines	130
Front Engine Mount Replacement, Gasoline Engines	140
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General Description

Three mounts support the engine and transmission, holding a total of almost 816 kg (1800 lb). *On diesel engines,* two of the engine mounts support the rear of the engine and transmission assembly. The third supports the front of the assembly. *On gasoline engines,* two of the engine mounts support the front of the engine and transmission assembly. The third supports the rear of the assembly.

On diesel engines, each of the rear engine mounts (**Fig. 1**, **Fig. 2** or **Fig. 3**) is bolted to the inside of the frame rail near the flywheel housing. These mounts support legs which are bolted to the flywheel housing. Caterpillar, Cummins B and C series and Mercedes-Benz engines use a rear engine leg which rests flat on the mount; Detroit Diesel and Cummins M11 engines use a V-shaped rear engine leg which sets into a V-shaped rear engine mount.

The front engine mount is an underslung crossmember under the front of the engine. It supports a bracket (**Fig. 4** and **Fig. 5**) which is bolted to the engine at each side of the vibration damper pulley.



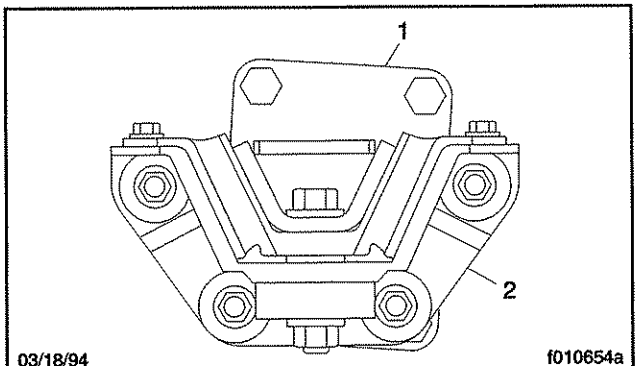
NOTE: Right mount shown.

1. Rear Engine Mount

Fig. 1, Rear Engine Mount, Caterpillar, Cummins and Mercedes-Benz Engines

To isolate the engine and transmission from road shock, and to isolate the vehicle frame from engine vibration, the engine mounts are sandwiched between rubber isolator cushions (sometimes called restriction pads). Steel snubbers protect the cushions from wearing on the engine support brackets, and a single bolt runs through the mount, cushions, and snubbers to hold the assembly together and hold the engine on the mount.

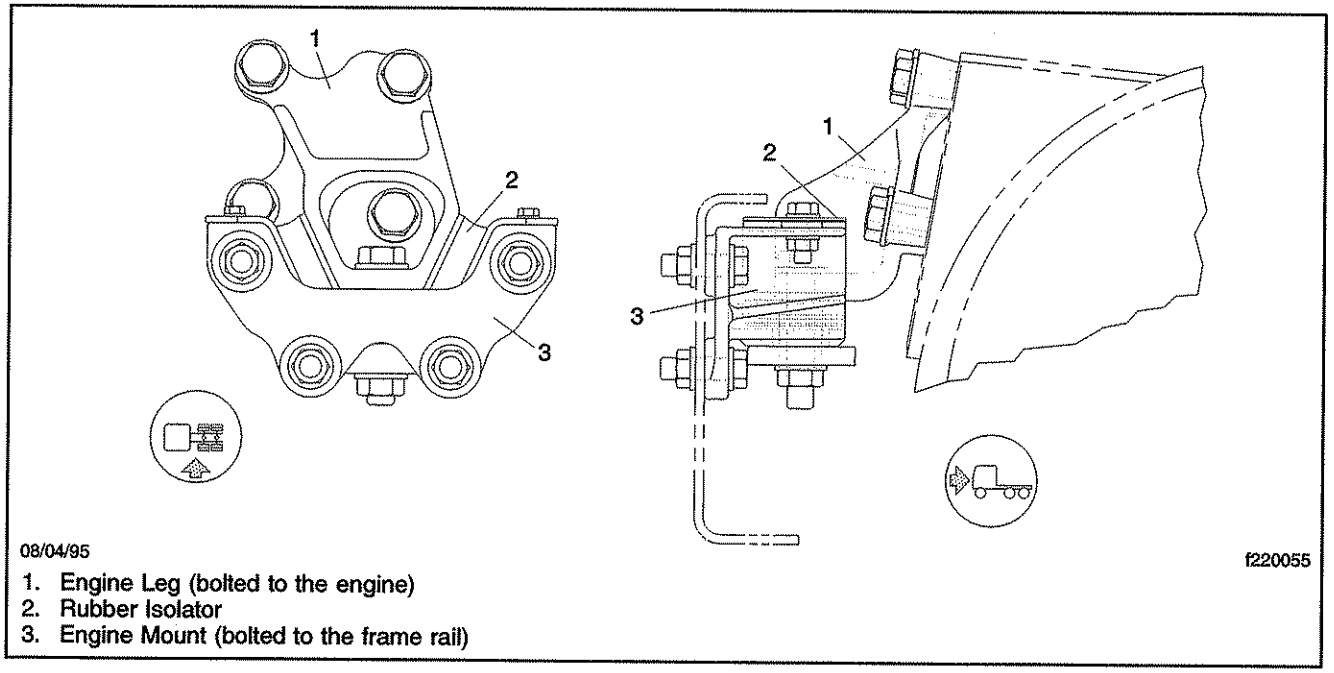
On gasoline engines, the forward engine mounts (**see Fig. 6**) are bolted to the inside of the frame rails near the center of each exhaust manifold. These mounts support brackets which are bolted to the engine. A bolt runs through the mount and the engine bracket to hold the two together (**Fig. 7** and **Fig. 8**), and rubber cushions (also called restriction pads) isolate the engine and transmission from road shock and isolate the vehicle frame from engine vibration. The rear engine mount is an underslung crossmember under the transmission. It supports a bracket (**Fig. 9**) bolted to the underside of the transmission. A rubber isolator pad between the bracket and the crossmember protects the transmission from road shock.



1. Engine Leg (bolted to the engine)
2. Engine Mount (bolted to the frame rail)

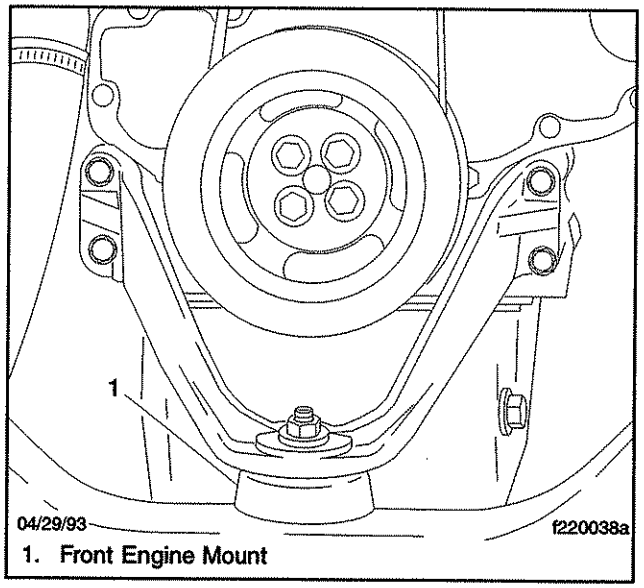
Fig. 2, Rear Engine Mount, Detroit Diesel Series 50 Engine

General Description



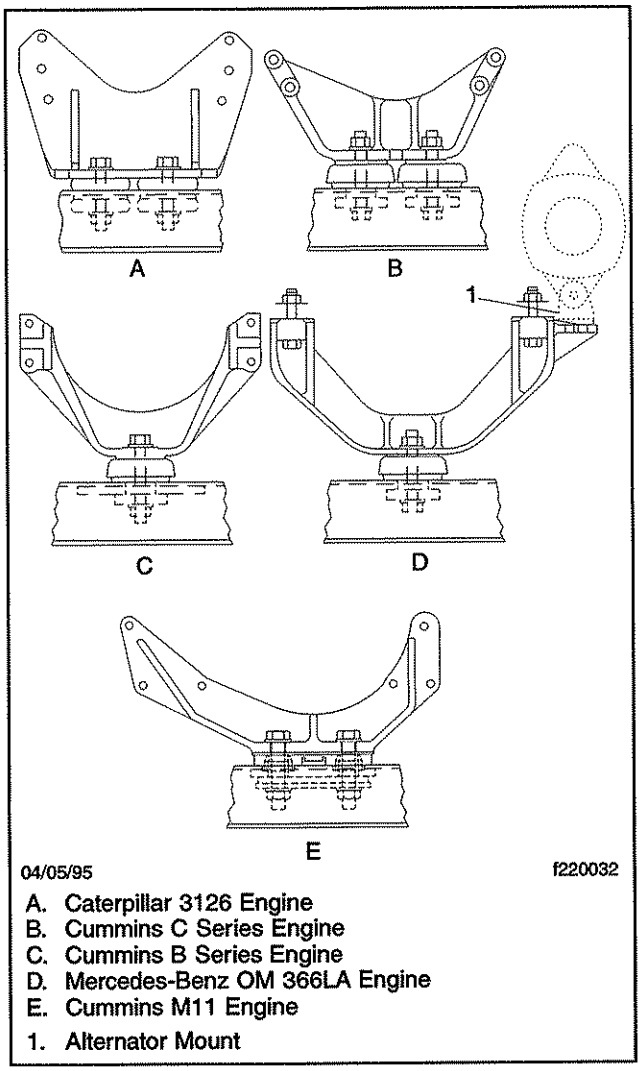
1. Engine Leg (bolted to the engine)
2. Rubber Isolator
3. Engine Mount (bolted to the frame rail)

Fig. 3, Rear Engine Mount, Cummins M11 Engine



1. Front Engine Mount

Fig. 4, Front Engine Mount, Cummins B Series Engine Shown



A. Caterpillar 3126 Engine
B. Cummins C Series Engine
C. Cummins B Series Engine
D. Mercedes-Benz OM 366LA Engine
E. Cummins M11 Engine
1. Alternator Mount

Fig. 5, Front Engine Support Brackets, Caterpillar, Cummins and Mercedes-Benz Engines

General Description

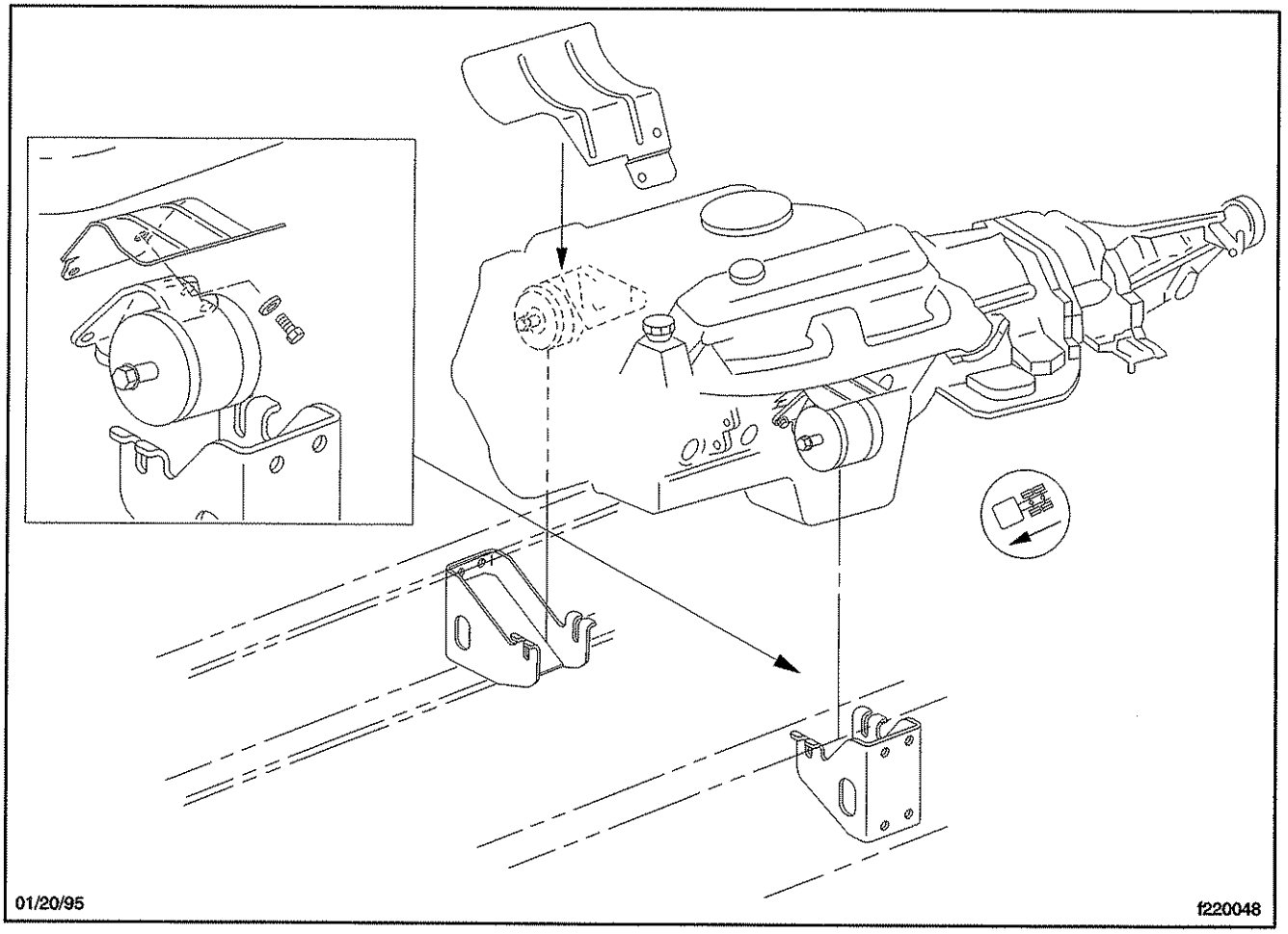
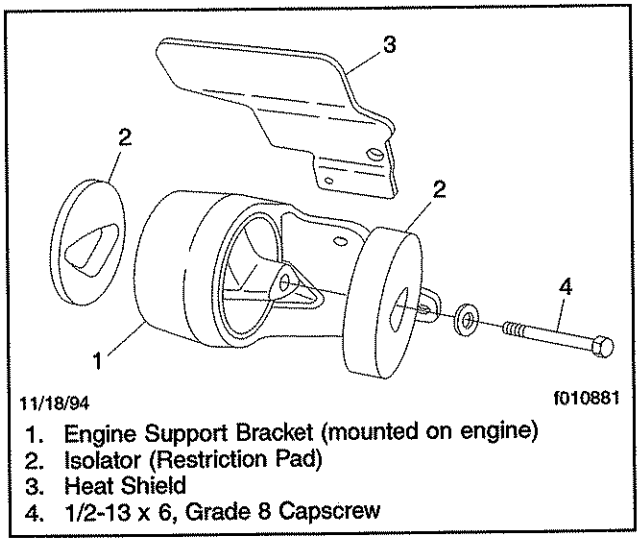


Fig. 6, Front Engine Mounts, Dodge Magnum Engine



1. Engine Support Bracket (mounted on engine)
2. Isolator (Restriction Pad)
3. Heat Shield
4. 1/2-13 x 6, Grade 8 Capscrew

Fig. 7, Front Engine Support Bracket Assembly, Exploded, Dodge Magnum Engine

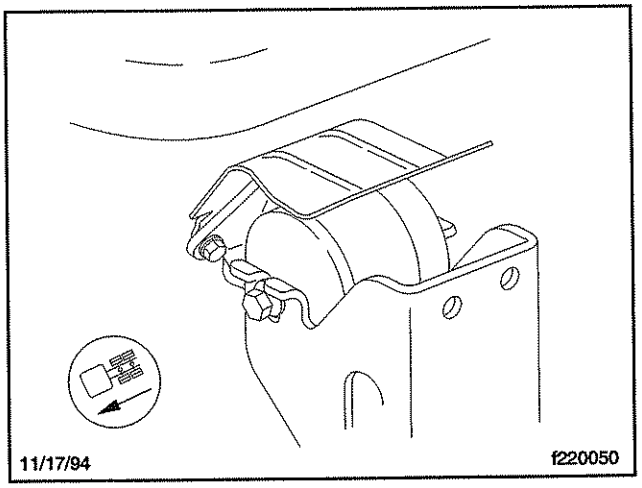
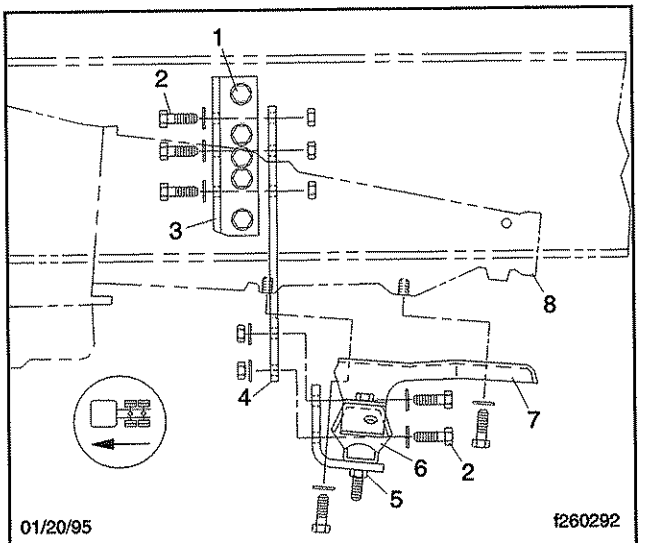


Fig. 8, Front Engine Support Bracket Assembly, Assembled, Dodge Magnum Engine



1. Capscrew, 5/8-11, Grade 8
2. Capscrew, 1/2-13, Grade 8
3. Engine Support Crossmember Bracket (mounted on the framerail)
4. Engine Support Crossmember
5. Locknut, M10
6. Rubber Isolator
7. Transmission Support Bracket
8. Transmission

Fig. 9, Rear Engine Mount and Support Bracket Assembly, Exploded, Dodge Magnum Engine

Rear Engine Mount Replacement, Diesel Engines

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

1. Apply the parking brakes, chock the tires, and (if applicable) drain the air brake system.

⚠ WARNING

WARNING: The jack used to lift the engine must be capable of safely lifting and supporting two metric tons. Once the engine mount is disconnected, do not get under the engine until it is securely supported on engine stands. An unsecured engine may fall, causing personal injury or death, and component damage.

2. Disconnect the engine from the right rear engine mount.
   - 2.1 Place a jack under the rear of the engine, and raise the jack until it's braced against the engine.
   - 2.2 Remove the bolt from the right rear engine mount. Save the fasteners, rubber isolator cushions, and snubbers.
   - 2.3 Lift the engine slightly to take its weight off the right rear engine mount. Place engine stands under the engine to keep it off the engine mount.
3. Remove the bolts which secure the mount to the frame rail. Remove the mount from the frame rail.

   If necessary, remove the four bolts which secure the right engine support bracket to the flywheel housing, and remove the bracket from the engine.
4. Place a new engine mount against the inside of the frame rail, and secure it with bolts, washers, and nuts. Tighten the nuts as follows:

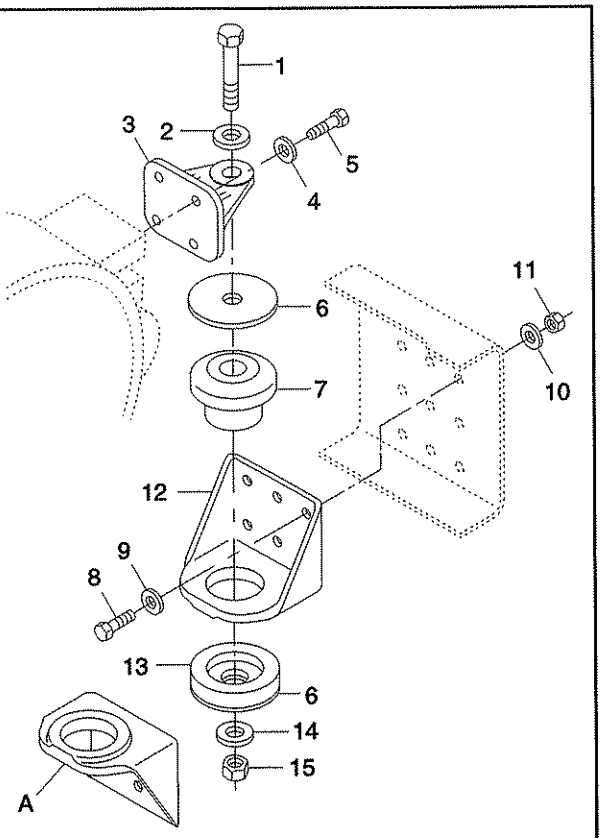
   For Caterpillar engines: tighten the nuts 61 N·m (45 lbf·ft).

   For Cummins B and C Series and Mercedes-Benz engines: tighten the nuts 108 N·m (80 lbf·ft).

   For Cummins M11 engines: tighten the nuts 183 N·m (135 lbf·ft).

   For Detroit Diesel engines: tighten the nuts 92 N·m (68 lbf·ft).
5. If removed, install the engine support bracket on the right side of the flywheel housing. Apply thread lock compound to the bracket mounting bolts, and tighten them as follows:

   On Caterpillar engines: tighten the bolts 136 N·m (100 lbf·ft).



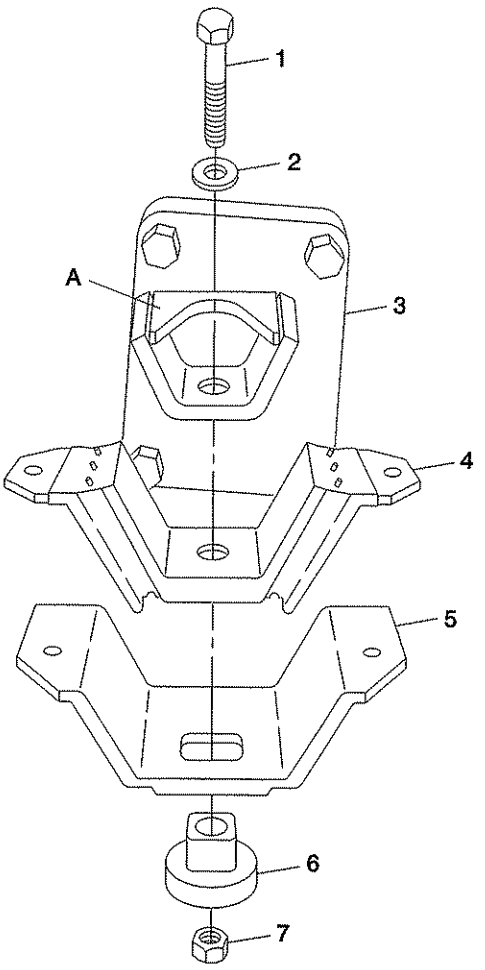
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A. Engine mount inverted for Cummins B Series engine.

1. Bolt
2. Hardened Washer
3. Engine Support Bracket
4. Hardened Washer
5. Bolt
6. Snubber
7. Upper Isolator
8. Bolt
9. Hardened Washer
10. Hardened Washer
11. Nut
12. Rear Engine Mount
13. Lower Isolator
14. Hardened Washer
15. Nut

Fig. 1, Rear Engine Mount Assembly for Caterpillar, Cummins B and C Series, and Mercedes-Benz Engines

Rear Engine Mount Replacement, Diesel Engines



03/18/94 f010652a

A. Earlier Medium Trucks may not have this reinforcing plate.

1. Bolt
2. Hardened Washer
3. Engine Support Bracket
4. Upper Isolator
5. Rear Engine Mount
6. Lower Isolator
7. Nut

Fig. 2, Rear Engine Mount Assembly for Detroit Diesel Engines

On Cummins B and C Series engines: tighten the bolts 75 to 88 N·m (55 to 65 lbf·ft). Cummins B Series engines used with Allison automatic transmissions have an iron flywheel housing instead of the standard aluminum housing. On B Series engines with iron flywheel housings, tighten the support bracket bolts 81 to 103 N·m (60 to 76 lbf·ft).

On Cummins M11 engines: tighten the bolts 327 N·m (241 lbf·ft).

On Detroit Diesel Series 50 engines: tighten the capscrews 184 N·m (136 lbf·ft).

On Mercedes-Benz OM 366LA engines: tighten the bolts 177 to 224 N·m (130 to 165 lbf·ft).

6. Inspect the engine mount rubber isolators for wear or damage and replace them if necessary.

⚠ CAUTION

CAUTION: Do not lubricate the components with oil, grease, or silicone lubricants; they will deteriorate the rubber isolators.

7. Install the upper isolator in the engine mount. If applicable, place the snubber on the isolator.

⚠ WARNING

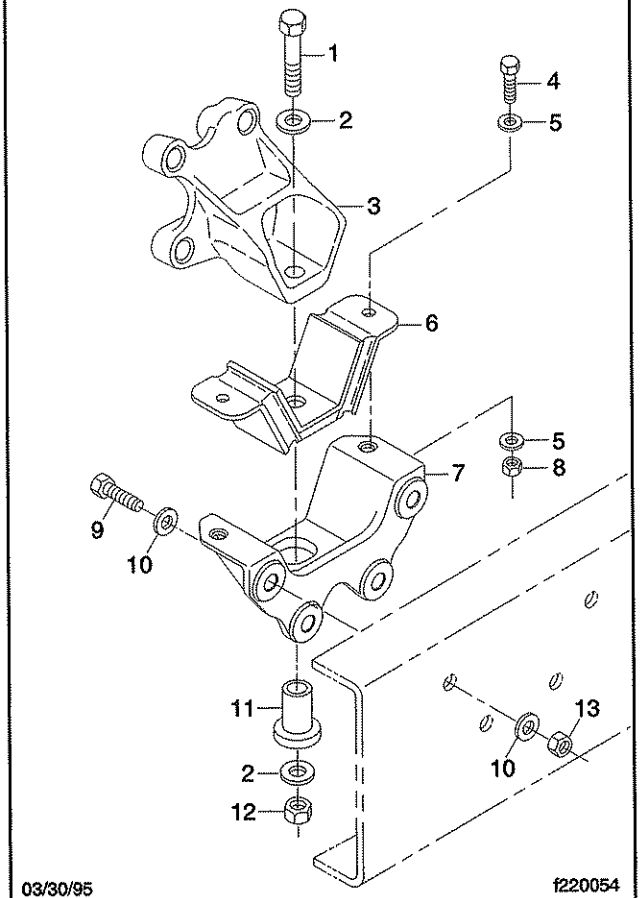
WARNING: The jack used to lower the engine must be capable of safely lifting and supporting two metric tons. Once the engine is removed from the engine stands, do not get under the engine until it is securely installed on the engine mount. An unsecured engine may fall, causing personal injury or death, and component damage.

8. Secure the engine to the engine mounts.
   - 8.1 If not in place, set a jack under the rear of the engine and raise the jack until it is braced against the engine.
   - 8.2 Lift the engine slightly to remove the engine stands. Remove the stands, and carefully lower the engine onto the engine mount.
   - 8.3 Holding the lower isolator and snubber in place, install the bolt in the right rear engine mount, and secure it with the nut and hardened washer. Tighten the nut 327 N·m (241 lbf·ft).

⚠ WARNING

WARNING: The jack used to lift the engine must be capable of safely lifting and supporting two metric

Rear Engine Mount Replacement, Diesel Engines



1. Capscrew, 3/4-10 x 4.5 Inch, Grade 8
2. Washer
3. Engine Leg
4. Capscrew, 5/16-18 x 1 Inch, Grade 8
5. Washer
6. Upper Isolator
7. Rear Engine Mount
8. Nut, 5/16-18
9. Capscrew, 5/8-11 x 2.5 Inch, Grade 8
10. Washer
11. Lower Isolator
12. Nut, 3/4-10
13. Nut, 5/8-11

Fig. 3, Rear Engine Mount Assembly for Cummins M11 Engines

tons. Once the engine mount is disconnected, do not get under the engine until it is securely supported on engine stands. An unsecured engine may fall, causing personal injury or death, and component damage.

9. Disconnect the engine from the left rear engine mount.

   9.1 Place a jack under the rear of the engine, and raise the jack until it's braced against the engine.

   9.2 Remove the bolt from the left rear engine mount. Save the fasteners, rubber isolator cushions, and snubbers.

   9.3 Lift the engine slightly to take its weight off the left rear engine mount. Place engine stands under the engine to keep it off the engine mount.

10. Remove the capscrews which secure the mount to the frame rail. Remove the mount from the frame rail.

    If necessary, remove the four capscrews which secure the left engine support bracket to the flywheel housing, and remove the bracket from the engine.

11. Place a new engine mount against the inside of the frame rail, and secure it with bolts, washers, and nuts. Tighten the nuts as follows:

    For Caterpillar engines: tighten the nuts 61 N·m (45 lbf·ft).

    For Cummins B and C Series and Mercedes-Benz engines: tighten the nuts 108 N·m (80 lbf·ft).

    For Cummins M11 engines: tighten the nuts 183 N·m (135 lbf·ft).

    For Detroit Diesel engines: tighten the nuts 92 N·m (68 lbf·ft).

12. If removed, install the engine support bracket on the right side of the flywheel housing. Apply thread lock compound to the bracket mounting bolts, and tighten them as follows:

    On Caterpillar engines: tighten the bolts 136 N·m (100 lbf·ft).

    On Cummins B and C Series engines: tighten the bolts 75 to 88 N·m (55 to 65 lbf·ft). Cummins B Series engines used with Allison automatic transmissions have an iron flywheel housing instead of the standard aluminum housing. On B Series engines with iron flywheel housings, tighten the support bracket bolts 81 to 103 N·m (60 to 76 lbf·ft).

Rear Engine Mount Replacement, Diesel Engines

On Cummins M11 engines: tighten the bolts 327 N·m (241 lbf·ft).

On Detroit Diesel Series 50 engines: tighten the capscrews 184 N·m (136 lbf·ft).

On Mercedes-Benz OM 366LA engines: tighten the bolts 177 to 224 N·m (130 to 165 lbf·ft).

13. Inspect the engine mount rubber isolators for wear or damage and replace them if necessary.

⚠ CAUTION

CAUTION: Do not lubricate the components with oil, grease, or silicone lubricants; they will deteriorate the rubber isolators.

14. Install the upper isolator in the engine mount. If applicable, place the snubber on the isolator.

⚠ WARNING

WARNING: The jack used to lower the engine must be capable of safely lifting and supporting two metric tons. Once the engine is removed from the engine stands, do not get under the engine until it is securely installed on the engine mount. An unsecured engine may fall, causing personal injury or death, and component damage.

15. Secure the engine to the engine mounts.
    - 15.1 If not in place, set a jack under the rear of the engine and raise the jack until it is braced against the engine.
    - 15.2 Lift the engine slightly to remove the engine stands. Remove the stands, and carefully lower the engine onto the engine mount.
    - 15.3 Holding the lower isolator in place, install the bolt in the left rear engine mount, and secure it with the nut and hardened washer. Tighten the nut 327 N·m (241 lbf·ft).
16. Remove the jack from under the engine, and remove the chocks from the tires.

Front Engine Mount Replacement, Diesel Engines

Replacement (See Fig. 1, Fig. 2, Fig. 3, Fig. 4, or Fig. 5)

1. Apply the parking brakes, chock the tires, and (if applicable) drain the air brake system.

⚠ WARNING

The lifting device and chain used to lift the engine must be capable of safely lifting and supporting two metric tons. Once the engine mount is disconnected, do not get under the engine until it is securely supported on engine stands. An unsecured engine may fall, causing personal injury or death, and component damage.

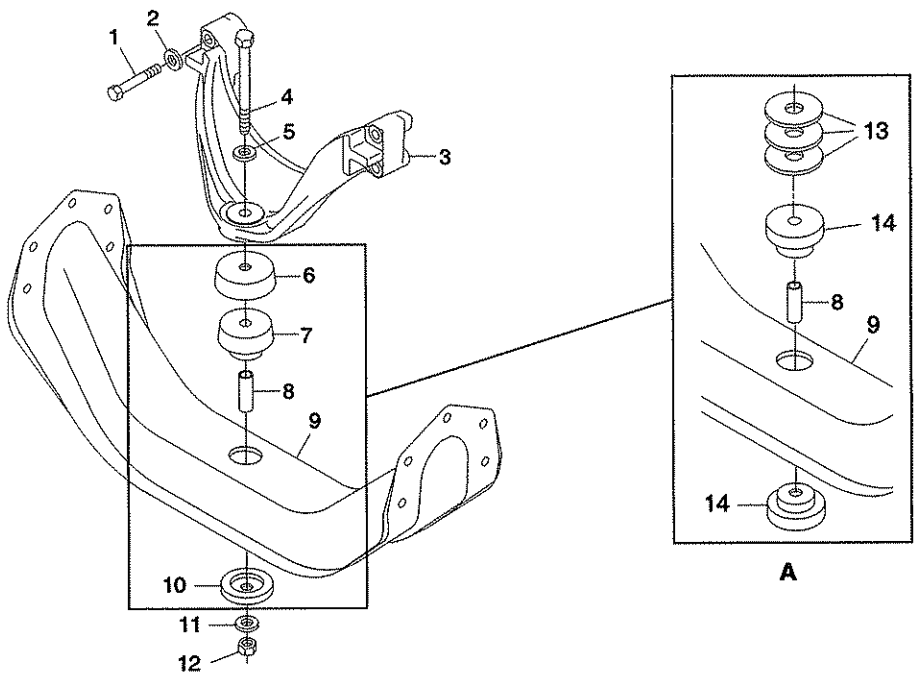
2. Disconnect the engine from the front engine mount.

   2.1 Attach a chain to the front engine lifting hook(s), and position a lifting device to lift the engine. Attach the chain to the lifting device, and raise the chain to remove any slack.

   2.2 Remove the bolt(s) from the front engine mount. Save the fasteners, rubber isolator cushions, and snubber(s).

NOTE: In order to raise the front of the engine, you may have to loosen the bolts that run through the rear engine mounts.

   2.3 Lift the engine slightly to take its weight off the front engine mount. Place engine stands under the engine to keep it off the engine mount.

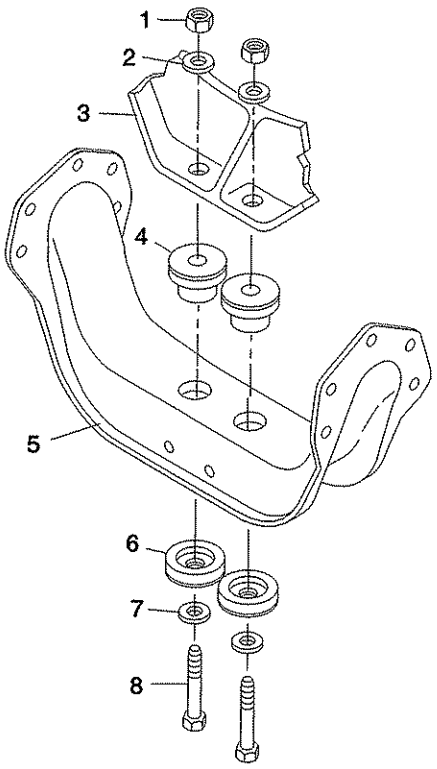


A. Cummins ISB Engine

1. Hexbolt, M12
2. Hardened Washer
3. Front Engine Support Bracket
4. Hexbolt, 5/8–11
5. Hardened Washer
6. Snubber
7. Upper Isolator
8. Isolator Sleeve
9. Front Underslung Crossmember
10. Lower Isolator
11. Hardened Washer
12. Nut
13. Spacers
14. Isolator

Fig. 1, Front Mount Assembly, Cummins B Series and ISB Engines

Front Engine Mount Replacement, Diesel Engines



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1. Hexnut, 5/8–11 (2 qty.)
2. Hardened Washer (2 qty.)
3. Front Engine Support Bracket
4. Upper Isolator
5. Front Underslung Crossmember
6. Lower Isolator (2 qty.)
7. Flatwasher (2 qty.)
8. Hexbolt, 5/8–11 (2 qty.)

Fig. 2, Front Mount Assembly, Cummins C Series and ISC Engines

3. If necessary, remove the bolts which secure the engine support bracket to the front of the engine. Remove the bracket from the engine.

   On vehicles equipped with Mercedes-Benz OM 366LA engines, remove the alternator and exhaust mount fasteners that tie in with the left end of the engine support bracket.

4. If necessary, install a new engine support bracket on the front of the engine. Secure it with two bolts at each side of the vibration damper pulley, and tighten the bolts as follows:

   For Cummins B Series/ISB engines: tighten the bolts 55 to 65 lbf·ft (75 to 88 N·m).

   For Cummins C Series/ISC engines: tighten the bolts 75 to 90 lbf·ft (102 to 122 N·m).

   For Detroit Diesel Series 50 engines: tighten the bolts 118 to 148 lbf·ft (160 to 200 N·m).

   For Mercedes-Benz OM 366LA engines: tighten the bolts 90 to 110 lbf·ft (122 to 150 N·m).

   For MBE900 engines: tighten the bolts 100 lbf·ft (136 N·m).

   On vehicles equipped with Mercedes-Benz OM 366LA engines, install the alternator and exhaust mount fasteners that tie in with the ends of the engine support bracket.

5. Inspect the engine mount rubber isolators for wear or damage and replace them if necessary.

⚠ CAUTION

Do not lubricate the components with oil, grease, or silicone lubricants; they will deteriorate the rubber isolators.

6. Install the upper isolator(s) in the engine mount. If applicable, place the snubber(s) on the isolator(s).

⚠ WARNING

The lifting device and chain used to lower the engine must be capable of safely lifting and supporting two metric tons. Once the engine is removed from the engine stands, do not get under the engine until it is securely installed on the engine mount. An unsecured engine may fall, causing personal injury or death, and component damage.

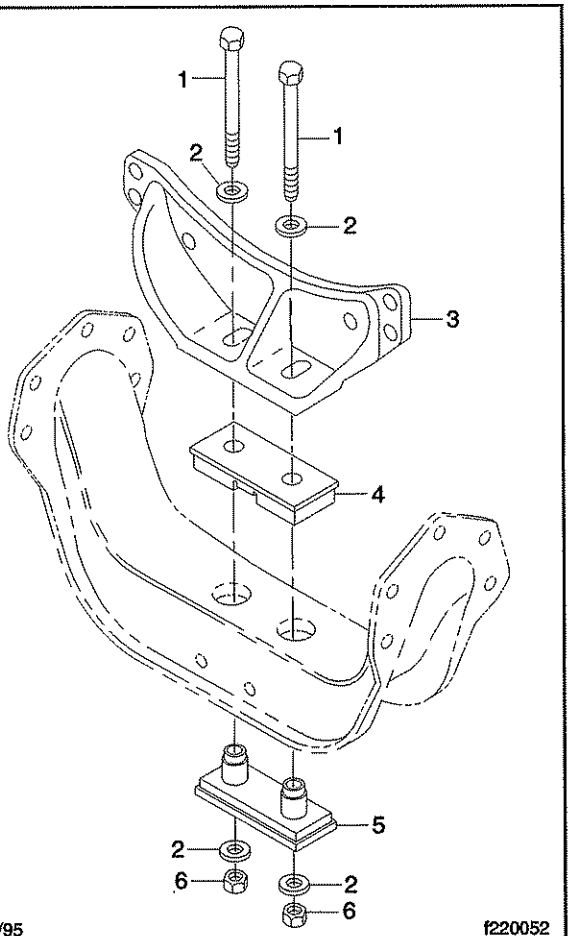
7. Secure the engine to the front engine mount.

   7.1 Attach a chain to the front engine lifting hook(s). Attach the chain to a lifting device, and raise the chain to remove any slack.

   7.2 Lift the engine slightly to remove the engine stands. Remove the stands, and carefully lower the engine onto the engine mount.

   7.3 Holding the lower isolator(s) and tube(s) in place, install the bolt(s) in the front engine

Front Engine Mount Replacement, Diesel Engines



1. Capscrew, 3/4-10 x 4 Inch, Grade 8
2. Washer
3. Front Engine Support Bracket
4. Upper Isolator
5. Lower Isolator
6. Nut, 3/4-10

Fig. 3, Front Engine Mount Assembly, Cummins M11 and ISM Engines

mount and secure it with the nut(s) and washer(s). Tighten the nut(s) as follows:

For Caterpillar engines: tighten the nuts 136 lbf·ft (184 N·m).

For Cummins B Series/ISB engines: tighten the nuts 136 lbf·ft (184 N·m).

For Cummins C Series/ISC engines: tighten the nuts 68 lbf·ft (92 N·m).

For Cummins M11/ISM engines: tighten the nuts 241 lbf·ft (327 N·m).

For Detroit Diesel engines: tighten the nuts 241 lbf·ft (327 N·m).

For Mercedes-Benz OM 366LA engines: tighten the nuts 150 lbf·ft (203 N·m).

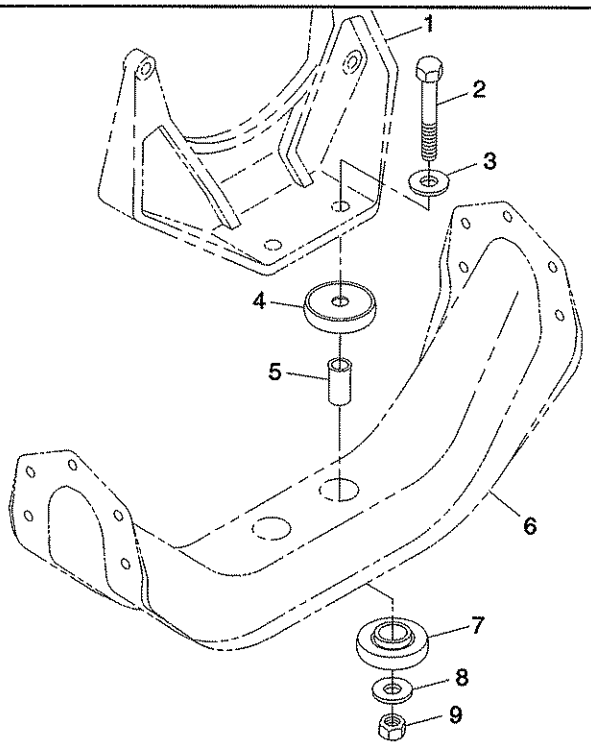
For MBE900 engines: tighten the nuts 136 lbf·ft (184 N·m).

NOTE: If you loosened the bolts that run through the rear engine mounts, tighten those bolts 241 lbf·ft (327 N·m) for all engines.

7.4 Remove the lifting chain from the engine lifting hooks.

8. Remove the chocks from the tires.

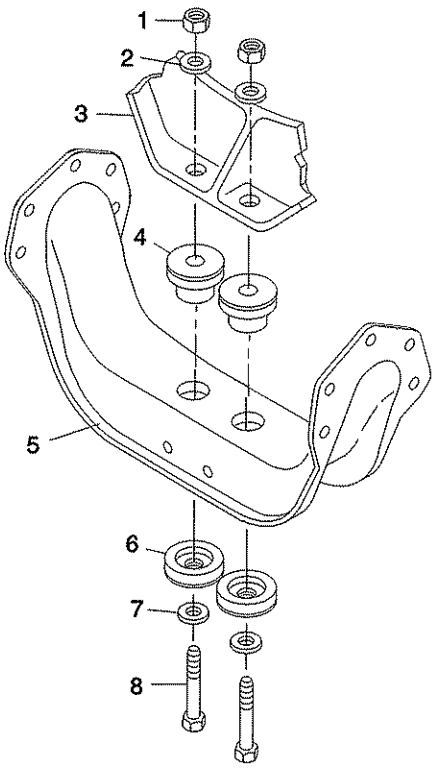
Front Engine Mount Replacement, Diesel Engines



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1. Front Engine Support Bracket
2. Bolt
3. Hardened Washer
4. Upper Isolator
5. Tube
6. Front Underslung Crossmember
7. Lower Isolator
8. Hardened Washer
9. Nut

Fig. 4, Front Engine Mount Assembly, Detroit Diesel Series 50 Engine



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1. Front Engine Support Bracket
2. Hexnut, 5/8–11
3. Hardened Washer
4. Upper Isolator
5. Isolator Sleeve
6. Crossmember
7. Lower Isolator
8. Hexbolt, 5/8–11

Fig. 5, Front Mount Assembly, MBE900 Engines

Rear Engine Mount Isolator Replacement, Diesel Engines

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

1. Apply the parking brakes, chock the tires, and (if applicable) drain the air brake system.

⚠ WARNING

WARNING: The jack used to lift the engine must be capable of safely lifting and supporting two metric tons. Once the engine mount is disconnected, do not get under the engine until it is securely supported on engine stands. An unsecured engine may fall, causing personal injury or death, and component damage.

2. Disconnect the engine from the right rear engine mount.
   - 2.1 Place a jack under the rear of the engine, and raise the jack until it's braced against the engine.
   - 2.2 Remove the bolt from the right rear engine mount. Save the fasteners and snubbers. Discard the rubber isolators.

     To remove the top isolator from a Detroit Diesel or Cummins M11 engine mount, remove the two capscrews that hold the ends of the isolator to the engine mount.
   - 2.3 Lift the engine slightly to take its weight off the right rear engine mount. Place engine stands under the engine to keep it off the engine mount.
3. Inspect the new engine mount rubber isolators for wear or damage and replace them if necessary.

⚠ CAUTION

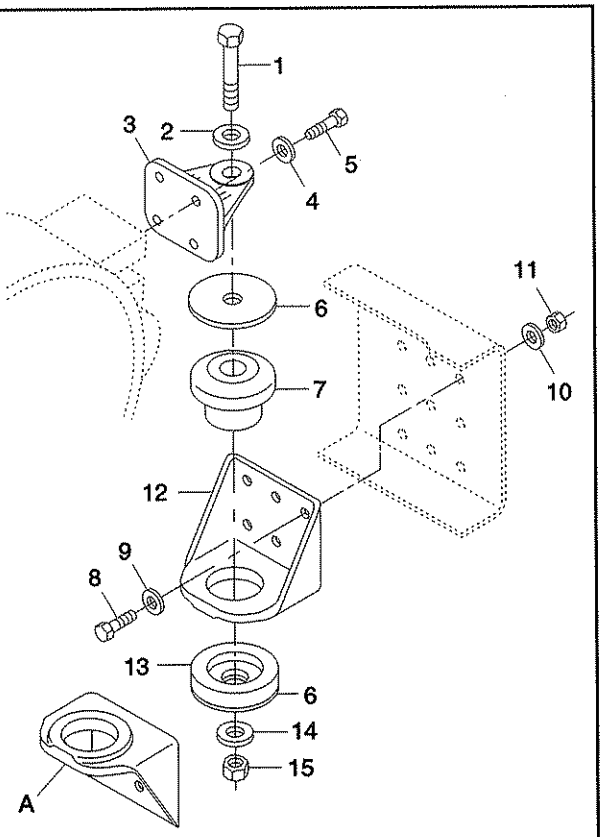
CAUTION: Do not lubricate the new components with oil, grease, or silicone lubricants; they will deteriorate the rubber isolators.

4. Install the new upper isolator in the engine mount. If applicable, place the snubber on the isolator.

   If replacing the upper isolator on a Detroit Diesel or Cummins M11 engine mount, secure the isolator to the mount with two capscrews and locknuts, tighten the locknuts 22 N·m (16 lbf·ft).

⚠ WARNING

WARNING: The jack used to lower the engine must be capable of safely lifting and supporting two metric tons. Once the engine is removed from the engine stands, do not get under the engine until it is securely installed on the engine mount. An



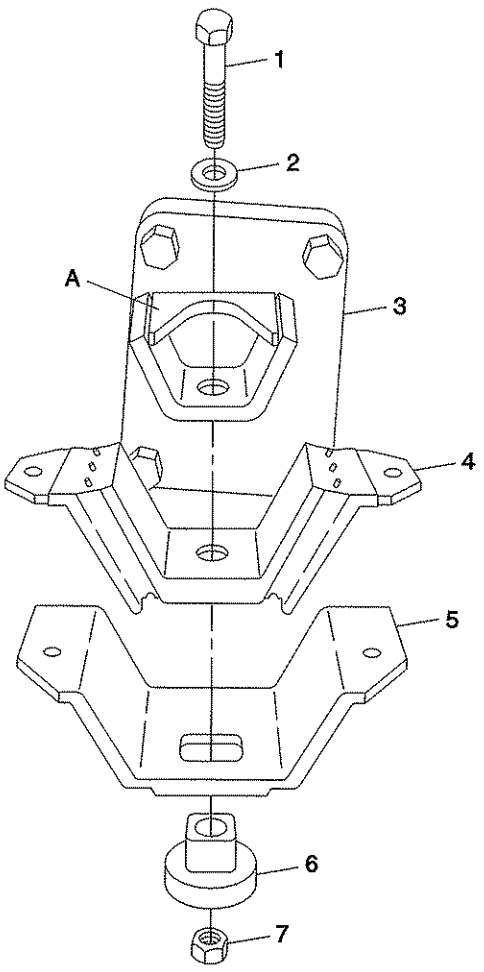
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A. Framerail mount inverted for Cummins B Series engine.

1. Bolt
2. Hardened Washer
3. Engine Support Bracket
4. Hardened Washer
5. Bolt
6. Snubber
7. Upper Isolator
8. Bolt
9. Hardened Washer
10. Hardened Washer
11. Nut
12. Rear Engine Mount
13. Lower Isolator
14. Hardened Washer
15. Nut

Fig. 1, Rear Engine Mount Assembly, Caterpillar, Cummins B and C Series, and Mercedes-Benz Engines

Rear Engine Mount Isolator Replacement, Diesel Engines



03/18/94 f010652a

A. Earlier Medium Trucks may not have this reinforcing plate.

1. Bolt
2. Hardened Washer
3. Engine Support Bracket
4. Upper Isolator
5. Rear Engine Mount
6. Lower Isolator
7. Nut

Fig. 2, Rear Engine Mount Assembly, Detroit Diesel Engines

unsecured engine may fall, causing personal injury or death, and component damage.

5. Secure the engine to the engine mount.

5.1 If not in place, set a jack under the rear of the engine and raise the jack until it is braced against the engine.

5.2 Lift the engine slightly to remove the engine stands. Remove the stands, and carefully lower the engine onto the engine mount.

5.3 Holding the lower isolator in place, install the bolt in the right rear engine mount, and secure it with the nut and hardened washer. Tighten the nut 327 N·m (241 lbf·ft).

⚠ WARNING

WARNING: The jack used to lift the engine must be capable of safely lifting and supporting two metric tons. Once the engine mount is disconnected, do not get under the engine until it is securely supported on engine stands. An unsecured engine may fall, causing personal injury or death, and component damage.

6. Disconnect the engine from the left rear engine mount.

6.1 Place a jack under the rear of the engine, and raise the jack until it's braced against the engine.

6.2 Remove the bolt from the left rear engine mount. Save the fasteners and snubbers. Discard the rubber isolators.

To remove the upper isolator from a Detroit Diesel or a Cummins M11 engine mount, remove the two capscrews that hold the ends of the isolator to the engine mount.

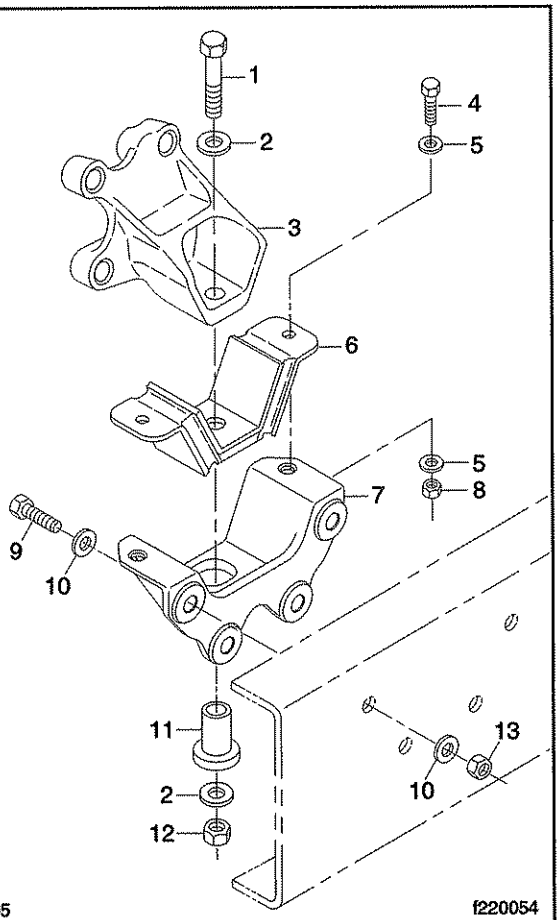
6.3 Lift the engine slightly to take its weight off the left rear engine mount. Place engine stands under the engine to keep it off the engine mount.

7. Inspect the new engine mount rubber isolators for wear or damage and replace them if necessary.

⚠ CAUTION

CAUTION: Do not lubricate the new components with oil, grease, or silicone lubricants; they will deteriorate the rubber isolators.

Rear Engine Mount Isolator Replacement, Diesel Engines



1. Capscrew, 3/4-10 x 4.5 Inch, Grade 8
2. Washer
3. Engine Leg
4. Capscrew, 5/16-18 x 1 Inch, Grade 8
5. Washer
6. Upper Isolator
7. Rear Engine Mount
8. Nut, 5/16-18
9. Capscrew, 5/8-11 x 2.5 Inch, Grade 8
10. Washer
11. Lower Isolator
12. Nut, 3/4-10
13. Nut, 5/8-11

Fig. 3, Rear Engine Mount Assembly, Cummins M11 Engines

8. Install the new upper isolator in the engine mount. If applicable, place the snubber on the isolator.

   If replacing the upper isolator on a Detroit Diesel or Cummins M11 engine mount, secure the isolator to the mount with two capscrews and locknuts, tighten the locknuts 22 N·m (16 lbf·ft).

⚠ WARNING

WARNING: The jack used to lower the engine must be capable of safely lifting and supporting two metric tons. Once the engine is removed from the engine stands, do not get under the engine until it is securely installed on the engine mount. An unsecured engine may fall, causing personal injury or death, and component damage.

9. Secure the engine to the engine mount.

   9.1 If not in place, set a jack under the rear of the engine and raise the jack until it is braced against the engine.

   9.2 Lift the engine slightly to remove the engine stands. Remove the stands, and carefully lower the engine onto the engine mount.

   9.3 Holding the lower isolator in place, install the bolt in the left rear engine mount, and secure it with the nut and hardened washer. Tighten the nut 327 N·m (241 lbf·ft).

10. Remove the jack from under the engine, and remove the chocks from the tires.

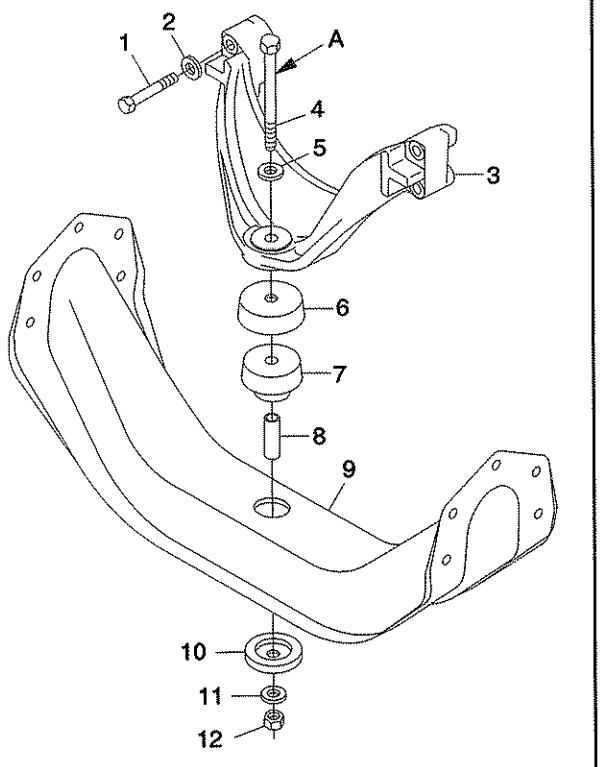
Front Engine Mount Isolator Replacement, Diesel Engines

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

1. Apply the parking brakes, chock the tires, and (if applicable) drain the air brake system.

⚠ WARNING

WARNING: The lifting device and chain used to lift the engine must be capable of safely lifting and supporting two metric tons. Once the engine mount is disconnected, do not get under the engine until it is securely supported on engine stands. An unsecured engine may fall, causing personal injury or death, and component damage.



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A. The bolt runs up through the mounting assembly for Cummins C Series and Mercedes-Benz OM 366LA engines.

1. Bolt
2. Hardened Washer
3. Front Engine Support Bracket
4. Bolt
5. Hardened Washer
6. Snubber
7. Upper Isolator
8. Tube
9. Front Underslung Crossmember
10. Lower Isolator
11. Hardened Washer
12. Nut

Fig. 1, Front Mount Assembly, Cummins B Series Engine

2. Disconnect the engine from the front engine mount.

   2.1 Attach a chain to the front engine lifting hook(s), and position a lifting device to lift the engine. Attach the chain to the lifting device, and raise the chain to remove any slack.

   2.2 Remove the bolt(s) from the front engine mount. Save the fasteners, tube(s), and snubber(s). Discard the rubber isolator cushions.

   NOTE: In order to raise the front of the engine, you may have to loosen the bolts that run through the rear engine mounts.

   2.3 Lift the engine slightly to take its weight off the front engine mount. Place engine stands under the engine to keep it off the engine mount.

3. Inspect the new front engine mount rubber isolators for wear or damage and replace them if necessary.

⚠ CAUTION

CAUTION:Do not lubricate the new components with oil, grease, or silicone lubricants; they will deteriorate the rubber isolators.

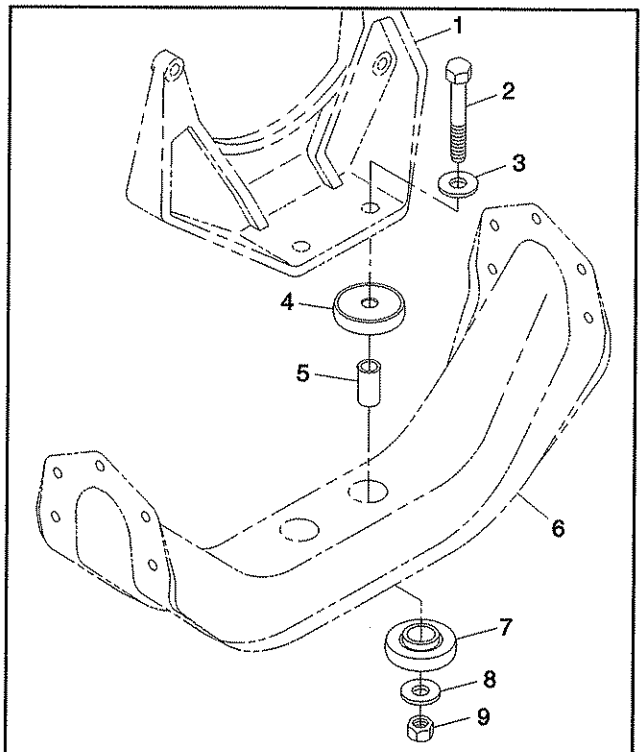
4. Install the upper isolator(s) in the engine mount.

⚠ WARNING

WARNING: The lifting device and chain used to lower the engine must be capable of safely lifting and supporting two metric tons. Once the engine is removed from the engine stands, do not get under the engine until it is securely installed on the engine mount. An unsecured engine may fall, causing personal injury or death, and component damage.

5. Secure the engine to the front engine mount.

Front Engine Mount Isolator Replacement, Diesel Engines



1. Front Engine Support Bracket
2. Bolt
3. Hardened Washer
4. Upper Isolator
5. Tube
6. Front Underslung Crossmember
7. Lower Isolator
8. Hardened Washer
9. Nut

Fig. 2, Front Engine Mount Assembly, Detroit Diesel Series 50 Engine

5.1 Attach a chain to the front engine lifting hook(s). Attach the chain to a lifting device, and raise the chain to remove any slack.

5.2 Lift the engine slightly to remove the engine stands. Remove the stands, and carefully lower the engine onto the engine mount.

5.3 Holding the lower isolator(s) and tube(s) in place, install the bolt(s) in the front engine mount and secure it with the nut(s) and washer(s). Tighten the nut(s) as follows:

For Caterpillar engines: tighten the bolts 184 N·m (136 lbf·ft).

For Cummins B and C Series and Mercedes-Benz engines: tighten the bolts 203 N·m (150 lbf·ft).

For Cummins M11 engines: tighten the bolts 327 N·m (241 lbf·ft).

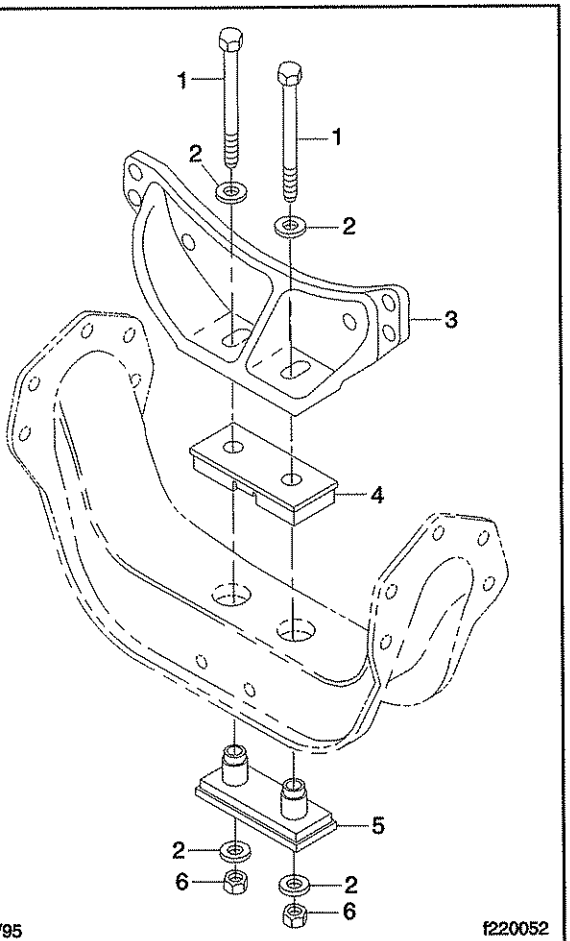
For Detroit Diesel engines: tighten the nuts 327 N·m (241 lbf·ft).

NOTE: If you loosened the bolts that run through the rear engine mounts, tighten those bolts 327 N·m (241 lbf·ft).

5.4 Remove the lifting chain from the engine lifting hook(s).

6. Remove the chocks from the tires.

Front Engine Mount Isolator Replacement, Diesel Engines



1. Capscrew, 3/4-10 x 4 Inch, Grade 8
2. Washer
3. Front Engine Support Bracket
4. Upper Isolator
5. Lower Isolator
6. Nut, 3/4-10

Fig. 3, Front Engine Mount Assembly, Cummins M11 Engine

Front Engine Mount Replacement, Gasoline Engines

Replacement (See Fig. 1)

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

⚠ WARNING

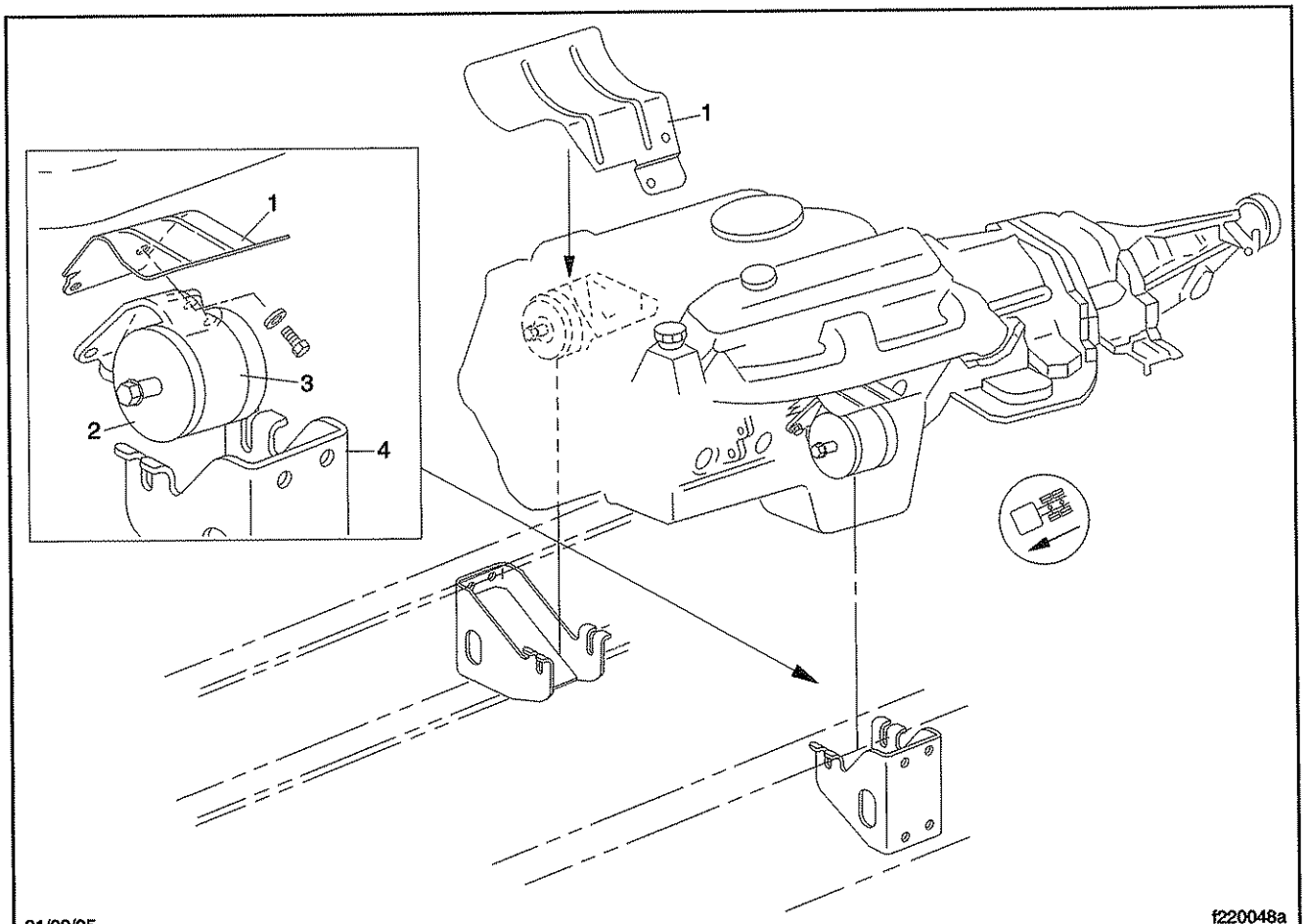
WARNING: Do not lift the engine by the intake air manifold. Lifting the engine by the manifold could result in the engine falling and causing personal injury or property damage.

2. Lift the engine slightly.

⚠ WARNING

WARNING: The crane, lifting eyes, and lifting chain used to remove the engine must be capable of safely lifting and supporting two metric tons. Once the engine mounts are disconnected, do not get under the engine until it is securely supported on engine stands. An unsecured engine, or an engine lifted with unsuitable tools may fall, causing personal injury or death, and component damage.

2.1 Remove and save the upper inboard hexbolt from the power steering pump bracket; then install a 3/8-inch x 1-3/4-inch



1. Heat Shield
2. Isolator Cushion (Restriction Pad)
3. Engine Support Bracket
4. Front Engine Mount (Driver's Side Mount)

Fig. 1, Front Engine Mounts, Dodge Magnum Engine

Front Engine Mount Replacement, Gasoline Engines

hexbolt and lifting eye in its place. Tighten the bolt firmly. **See Fig. 2.**

2.2 Attach a lifting chain to the lifting eye.

2.3 Attach the chain to a suitable lifting device, and raise the chain to lift the engine *slightly*.

3. Remove the bolts that run through the front engine mounts, rubber isolator cushions, and engine support brackets. **See Fig. 3.**
4. If necessary, remove the bolts that hold the engine support brackets and heat shields to the engine.
5. Remove the bolts which secure the mount to the frame rail. Remove the mount from the frame rail.
6. Place a new engine mount against the inside of the frame rail, and secure it with bolts, washers, and nuts. Tighten the nuts 61 N·m (45 lbf·ft).
7. If the engine support brackets were removed from the engine, install the brackets and heat shields back on the engine using new mounting bolts. Tighten the bolts 81 N·m (60 lbf·ft).

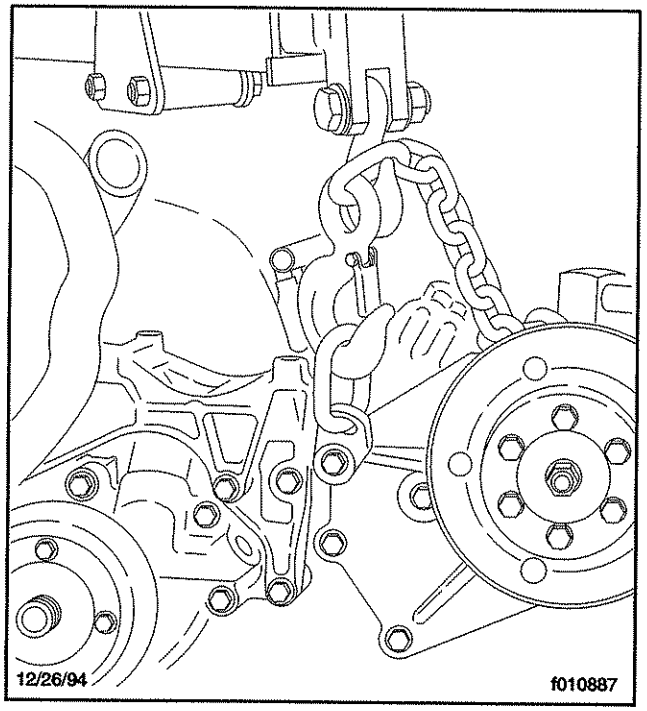
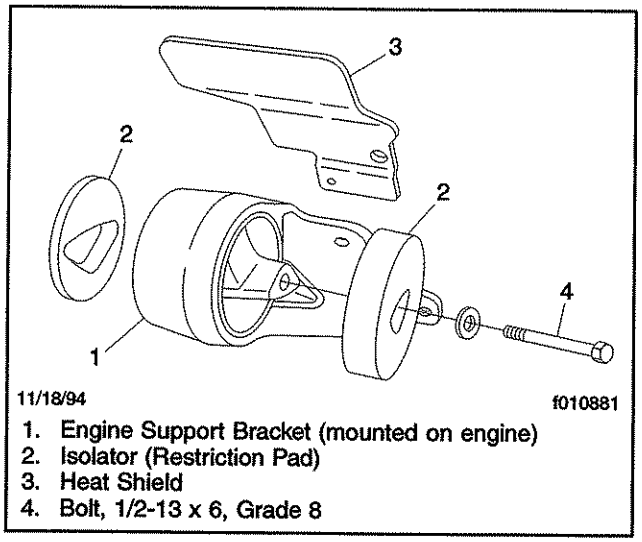


Fig. 2, Front Engine Lifting Eye

8. Install the bolts through the rubber isolator cushions and engine support brackets, but do not install the nuts on the bolts.
9. Lower the engine, while making sure the bolt through each engine support bracket settles in the notch in the engine mount.
10. Install a nut on each of the bolts running through the front engine mounts and engine support brackets, and tighten the nuts 68 N·m (50 lbf·ft). **See Fig. 4.**
11. Remove the lifting eye and chain from the engine, and install the bolt removed earlier from the power steering pump bracket.
12. Remove the chocks from the tires.



1. Engine Support Bracket (mounted on engine)
2. Isolator (Restriction Pad)
3. Heat Shield
4. Bolt, 1/2-13 x 6, Grade 8

Fig. 3, Front Engine Support Bracket Assembly, Exploded, Dodge Magnum Engine

Front Engine Mount Replacement, Gasoline Engines

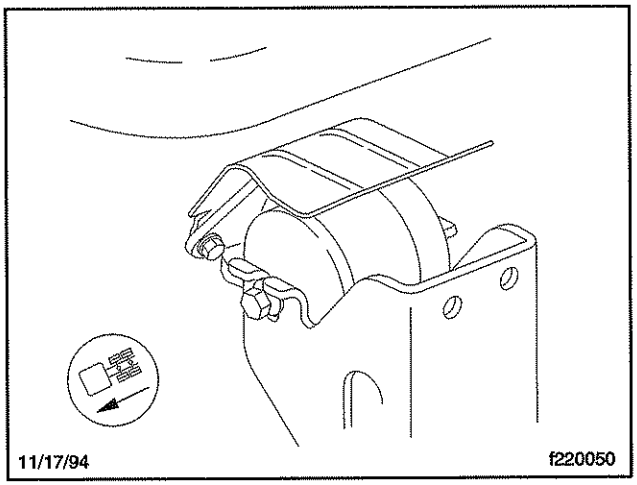


Fig. 4, Front Engine Support Bracket Assembly, Assembled, Dodge Magnum Engine

Rear Engine Mount Replacement, Gasoline Engines

Replacement (See Fig. 1)

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

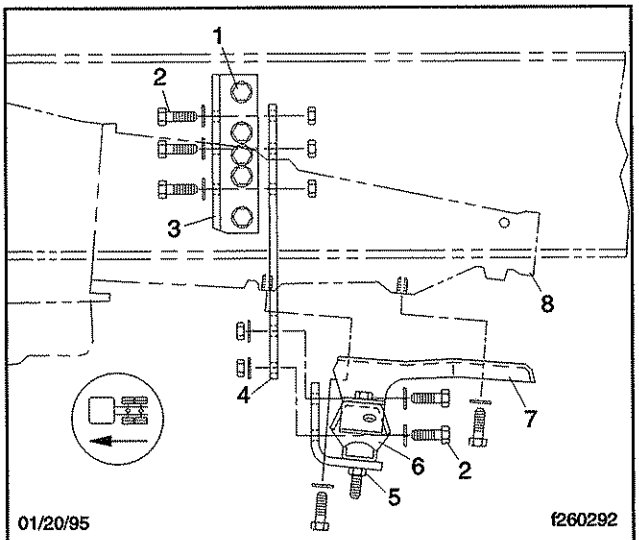
⚠ WARNING

WARNING: Do not lift the engine by the intake air manifold. Lifting the engine by the manifold could result in the engine falling and causing personal injury or property damage.

2. Lift the rear of the engine and transmission assembly slightly.

⚠ WARNING

WARNING: The jack used to lift the engine must be capable of safely lifting and supporting two metric tons. Once the engine mount is disconnected, do not get under the engine until it is securely supported on engine stands. An unsecured engine may fall, causing personal injury or death, and component damage.



1. Capscrew, 5/8-11, Grade 8
2. Capscrew, 1/2-13, Grade 8
3. Engine Support Crossmember Bracket (mounted on the framerail)
4. Engine Support Crossmember
5. Locknut, M10
6. Rubber Isolator
7. Transmission Support Bracket
8. Transmission

Fig. 1, Rear Engine Mount and Support Bracket Assembly, Exploded, Dodge Magnum Engine

2.1 Position a transmission jack under the transmission.

2.2 Remove the locknuts that hold the rubber isolator to the engine support crossmember.

2.3 Use the transmission jack to raise the rear of the engine and transmission assembly *slightly*.

3. Remove the bolts that hold the rubber isolator to the transmission support bracket.
4. If necessary, remove the bolts that hold the transmission support bracket to the transmission.
5. If the transmission support bracket was removed from the transmission, install it with new bolts, and tighten the bolts 102 N·m (75 lbf·ft).
6. Install the rubber isolator on the underside of the transmission support bracket and tighten the mounting nuts 47 N·m (35 lbf·ft).
7. Using the transmission jack, lower the transmission and rubber isolator onto the engine support crossmember.
8. Install the locknuts that hold the isolator on the crossmember, and tighten the locknuts 47 N·m (35 lbf·ft).
9. Remove the transmission jack.
10. Remove the chocks from the tires.

Specifications

Engine Mount Torque for Diesel Engines			
Description	**Grade**	**Size**	**Torque lbf.ft (N.m)**
Rear Engine-Mount to Support-Bracket, All Engines	8	3/4–10	241 (327)
Rear Engine Mount to Frame Rail Bolts:			
Caterpillar Engines	8	1/2–13	45 (61)
Cummins B Series/ISB, C Series/ISC, and Mercedes-Benz Engines	8	1/2 –13	68 (92)
Cummins M11/ISM Engines	8	5/8–11	135 (183)
Detroit Diesel Engines	8	1/2–13	68 (92)
MBE 900 Engines	8	1/2–13	68 (92)
Rear Support Bracket to Engine Bolts:			
Caterpillar Engines	10.9	M14 x 35	100 (136)
Cummins B Series/ISB and C Series/ISC Engines	10.9	M12	55 to 65 (75 to 88)
Cummins M11/ISM Engines	8	3/4–10	241 (327)
Detroit Diesel Engines	8	5/8–11	136 (184)
Mercedes-Benz Engines	10.9	M16	130 to 165 (177 to 224)
MBE 900 Engines	10.9	M16	155 (210)
Front Support Bracket to Engine Bolts:			
Cummins B Series/ISB Engines	10.9	M12	55 to 65 (75 to 88)
Cummins C Series/ISC Engines	10.9	M12	75 to 90 (102 to 122)
Detroit Diesel Engines	—	—	118 to 148 (160 to 200)
Mercedes-Benz Engines	10.9	M12	90 to 110 (122 to 150)
MBE 900 Engines	10.9	M14	100 (136)
Front Engine Mount Bolt:			
Caterpillar Engines	8	5/8–11	136 (184)
Cummins B Series/ISB and Mercedes-Benz Engines	8	5/8–11	136 (184)
Cummins C Series/ISC Engines	8	1/2–13	68 (92)
Cummins M11/ISM Engines	8	3/4–10	241 (327)
Detroit Diesel Engines	8	3/4–10	241 (327)
MBE 900 Engines	8	5/8–11	136 (184)

Table 1, Engine Mount Torques for Diesel Engines

Engine Mount Torques for Gasoline Engines			
Description	**Grade**	**Size**	**Torque lbf.ft (N.m)**
Bolt Through Front Engine Mount and Engine Support Bracket	8	1/2–13 x 6 inch	50 (68)
Front Engine Mount to Frame Rail Bolt	8	1/2–13 x 1.75 inch	45 (61)

Specifications

Engine Mount Torques for Gasoline Engines			
Description	**Grade**	**Size**	**Torque lbf·ft (N·m)**
Engine Support Bracket (and heat shield) Mounting Bolt	—	—	60 (81)
Rear Engine Mount (transmission support bracket) to Underslung Crossmember Mounting Locknut	—	M10	35 (47)
Transmission Support Bracket to Transmission Mounting Bolt	—	—	75 (102)
Rubber Isolator Cushion to Transmission Support Bracket Mounting Nuts	—	—	35 (47)

Table 2, Engine Mount Torques for Gasoline Engines

Contents

Subject	Subject Number
General Description	050
Service Operations	
Oil Pan Heater Element Removal and Installation	100
Troubleshooting	300

General Description

The Phillips Temro oil pan heater keeps the crankcase oil about 32°C (90°F) warmer than the ambient air temperature. In cold weather, the heater helps prevent water from condensing in the oil, it creates a better seal in the combustion chambers for start-up, and it keeps the oil free-flowing for instant lubrication.

The heater consists of a 150-or 300-watt element that screws into the side of the engine oil pan. **See Fig. 1.** A cord plugs onto the outside end of the element, and the cord runs to a receptacle mounted below the driver's door. **See Fig. 2.**

NOTE: When a vehicle is also equipped with an engine block heater, the engine block heater is wired in tandem with the oil pan heater. The cord from the oil pan heater element, and the receptacle below the driver's door, provide power to the engine block heater.

To turn on the heater, open the spring-loaded cover on the receptacle, and connect a power source to the receptacle. The element has no thermostat.

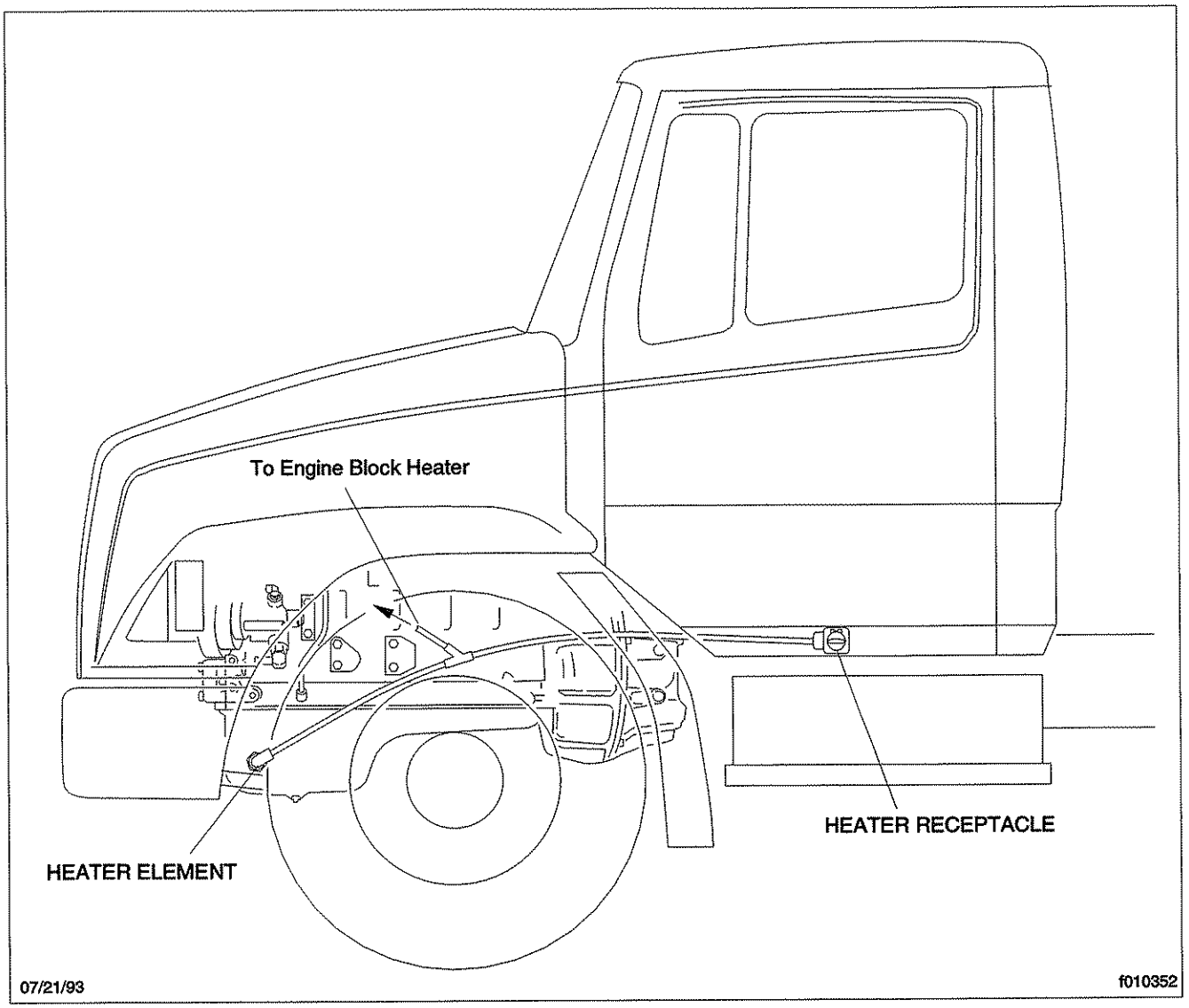


Fig. 1, Cummins B Series Engine Shown

General Description

Heat dissipating from the crankcase prevents oil overheating.

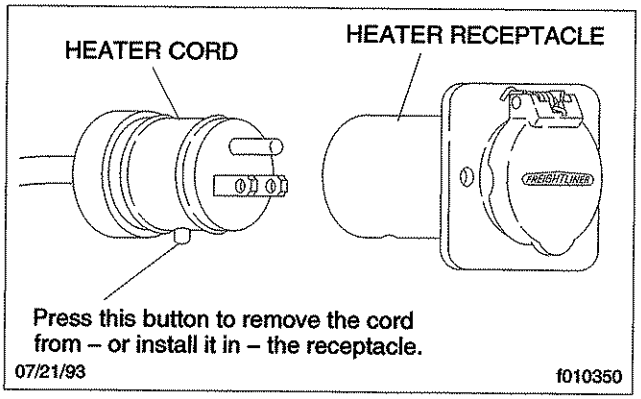


Fig. 2

Oil Pan Heater Element Removal and Installation

Removal

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

⚠ WARNING

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

   3.1 Place a suitable container under the oil pan drain plug.

   3.2 Remove the plug, and allow the oil to drain.

4. Unscrew the threaded cover that secures the cord to the element. See **Fig. 1**.
5. Pull the cord off the element.
6. Unscrew the element from the oil pan port.

Installation

1. Screw the element into the port until finger-tight. Then, use a wrench to tighten the element one more turn.
2. Plug the cord onto the element and secure it by screwing the threaded cover in place. See **Fig. 1**.
3. Install the oil drain plug in the crankcase, and fill the engine with oil. For recommended oil types and engine oil capacities, see the vehicle maintenance manual.
4. Start the engine and check for leaks. Repair any leaks as necessary.

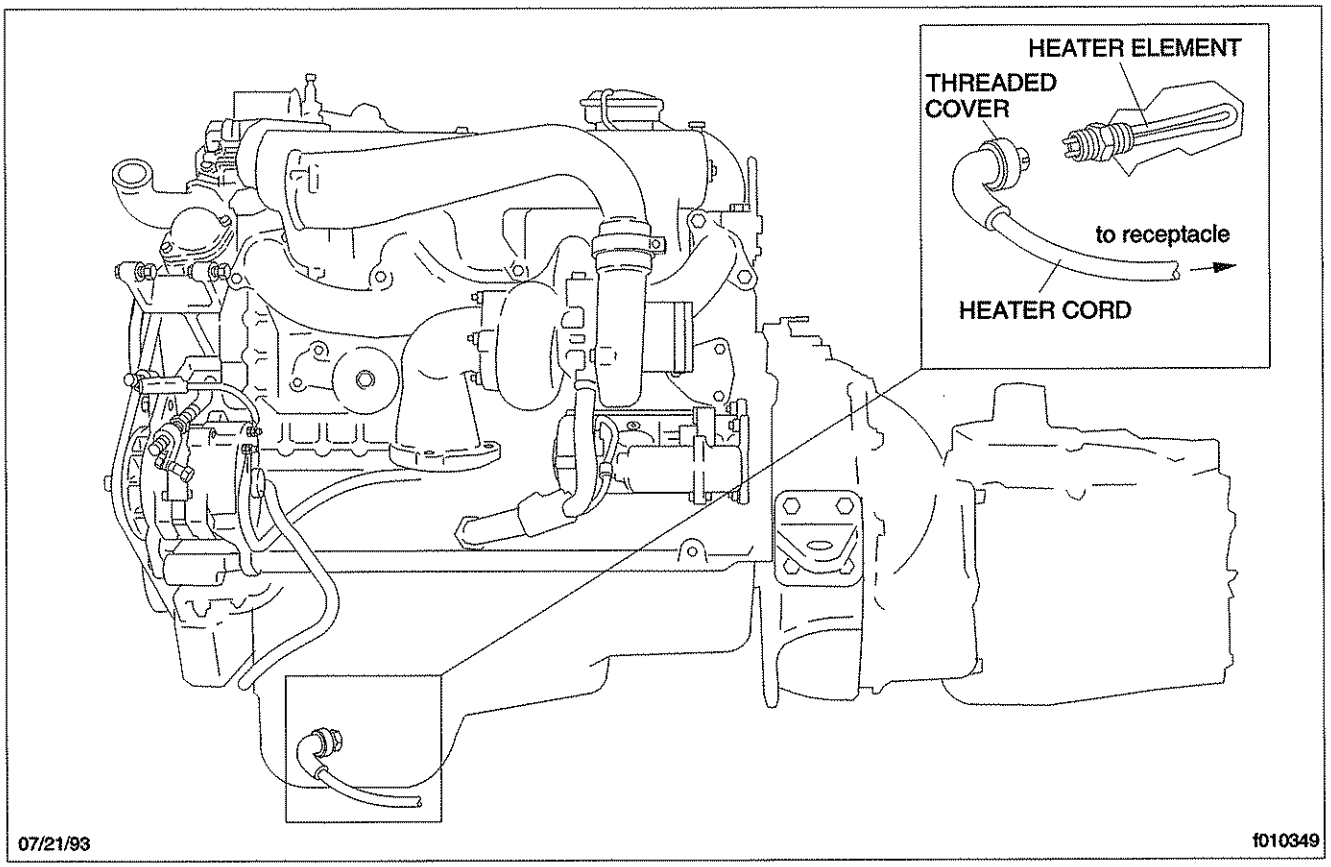


Fig. 1, Mercedes-Benz OM 366LA Engine Shown

Oil Pan Heater Element Removal and Installation

5. To test the heater, plug a wattmeter into a power source, and connect the heater cord in the receptacle to the meter. A reading on the meter will indicate the heater is working.

Troubleshooting

Use the following procedures to check for the most common oil pan heater problems.

WIRING PROBLEMS

1. Park the vehicle, apply the parking brakes, and chock the tires.
2. Tilt the hood.
3. Unscrew the threaded cover that secures the cord to the element. See **Fig. 1**. Pull the cord off the element.
4. Using an ohmmeter, check the continuity between the two poles of the element. On Cummins B Series and Mercedes-Benz OM 366LA engines, the resistance should be about 96 ohms. On Cummins C Series engines, the resistance should be about 48 ohms. If there is no reading, the element is burnt out.
5. If the element is good, check the cord. Plug the cord onto the element and secure it by screwing the cover in place. See **Fig. 1**.
6. Using an ohmmeter at the receptacle, check the continuity between the two power terminals. On Cummins B Series and Mercedes-Benz OM 366LA engines, the resistance should be about 96 ohms. On Cummins C Series engines, the resistance should be about 48 ohms. If there is no reading or a very high reading, the cord is damaged. Replace the cord.
7. Check the continuity between each power terminal and the ground terminal. There should be no ohmmeter reading. If there is a reading, replace the cord.

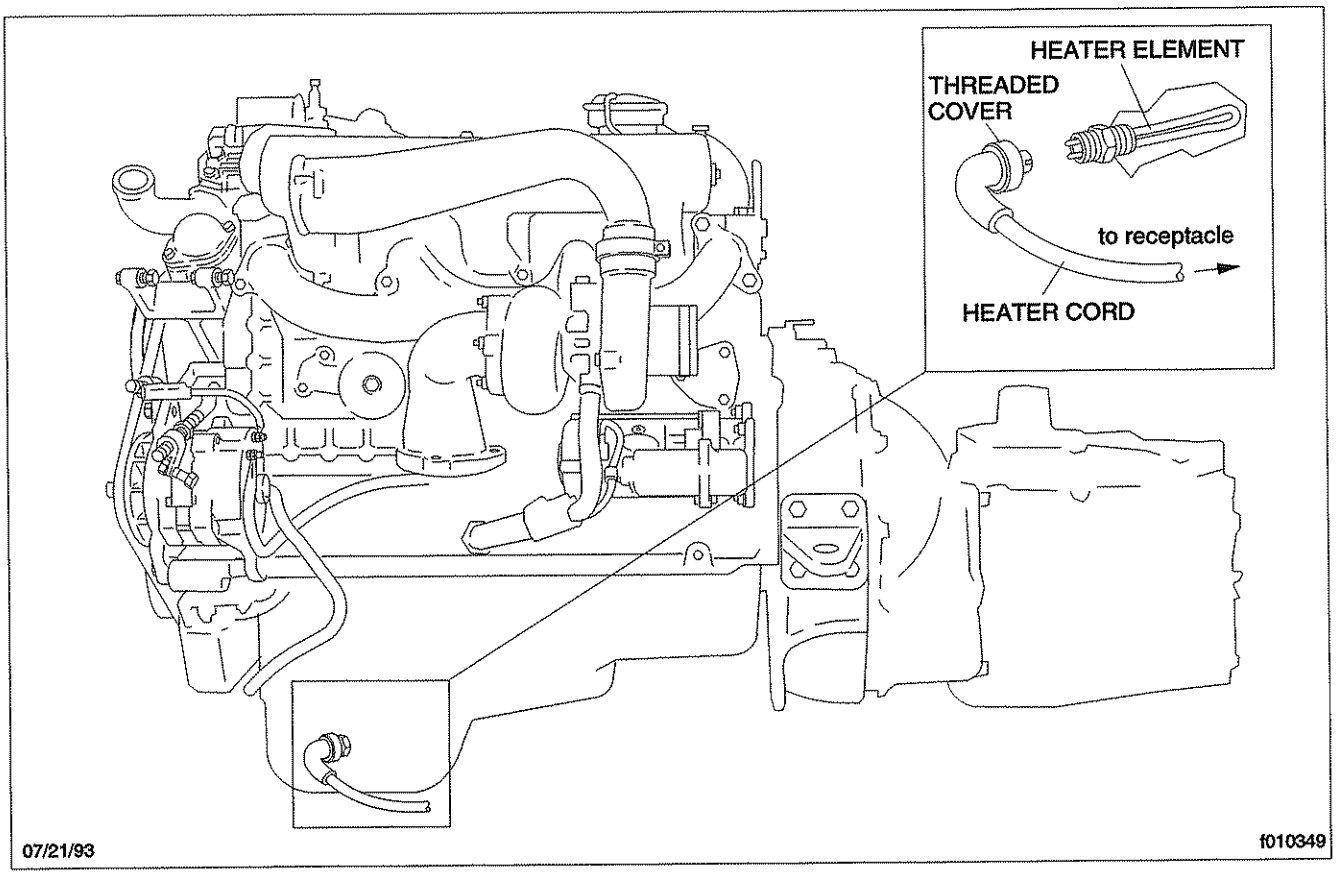


Fig. 1, Mercedes-Benz OM 366LA Engine Shown

Troubleshooting

8. Check the ohmmeter reading between the ground terminal and a good vehicle ground. The reading should be zero. If not, replace the cord.

FOULED ELEMENT

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

⚠ WARNING

WARNING: Drain the oil pan only when the oil and engine are cool. Draining it when they are hot could cause severe personal injury due to scalding.

3. Drain the oil.
   - 3.1 Place a suitable container under the oil pan drain plug.
   - 3.2 Remove the plug, and allow the oil to drain.
4. Unscrew the threaded cover that secures the cord to the element. See **Fig. 1**. Pull the cord off the element.
5. Unscrew the element from the oil pan port.
6. Inspect the element for charred oil that may insulate it. If burnt oil is present, replace the element, and change the engine oil and oil filter.

Engine Block Heater 01.05

Contents

Subject	Subject Number
General Description	050
Service Operations	
Engine Block Heater Element Removal and Installation	100
Troubleshooting	300
Specifications	400

General Description

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

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

The heater consists of an element that bolts into the side of the engine water jacket. **See Fig. 1.** A cord plugs into the outside end of the element, and the cord runs to a receptacle mounted below the driver's door. **See Fig. 2.**

NOTE: When a vehicle is also equipped with an oil pan heater, the oil pan heater is wired in tandem with the engine block heater. The cord from the engine block heater element, and the receptacle below the driver's door, provide power to the oil pan heater.

To turn on the heater, open the spring-loaded cover on the receptacle, and connect a power source to the receptacle. The element has no thermostat. Heat dissipating from the engine block prevents coolant overheating.

General Description

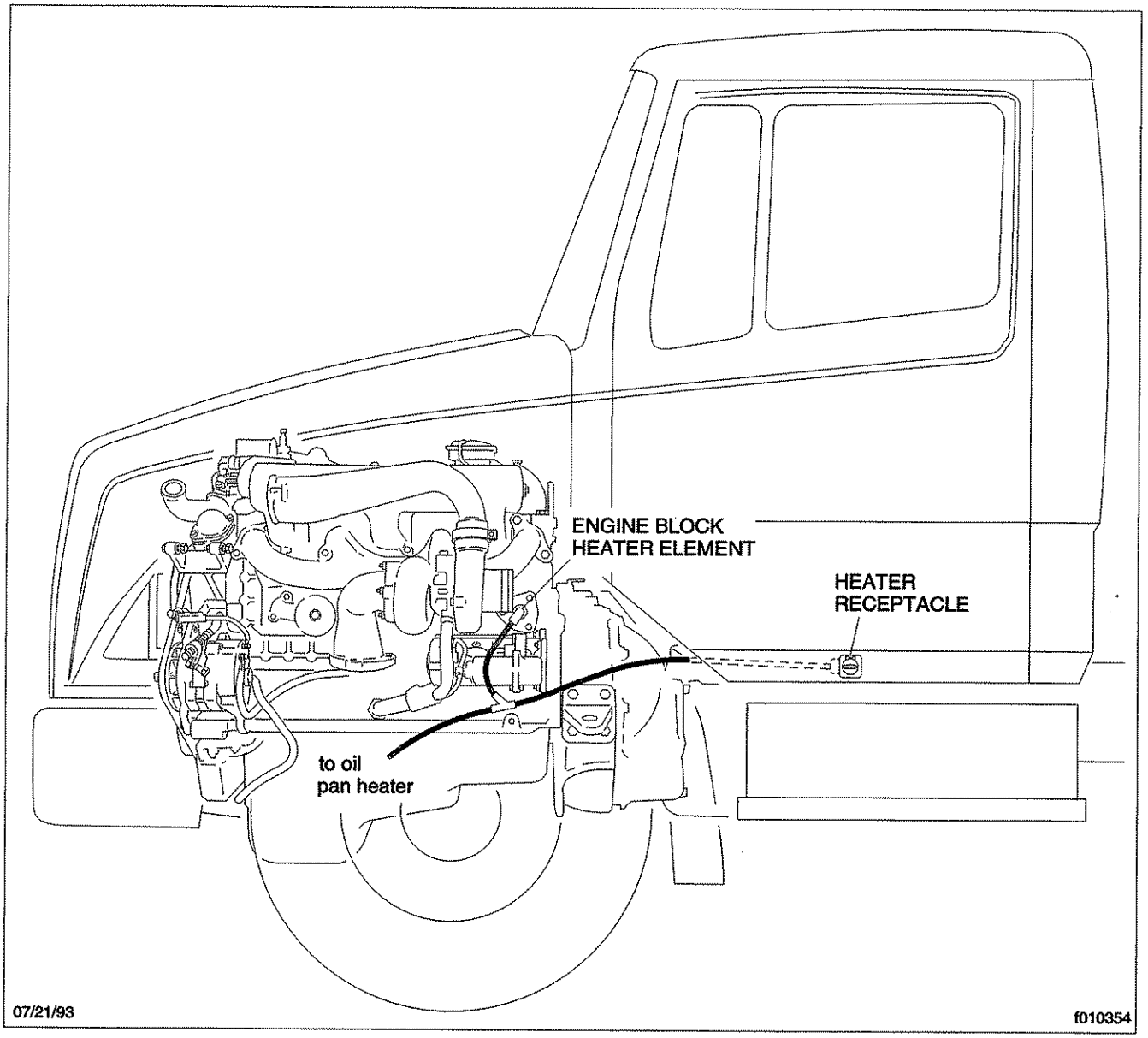


Fig. 1, Mercedes-Benz OM 366LA Engine Shown

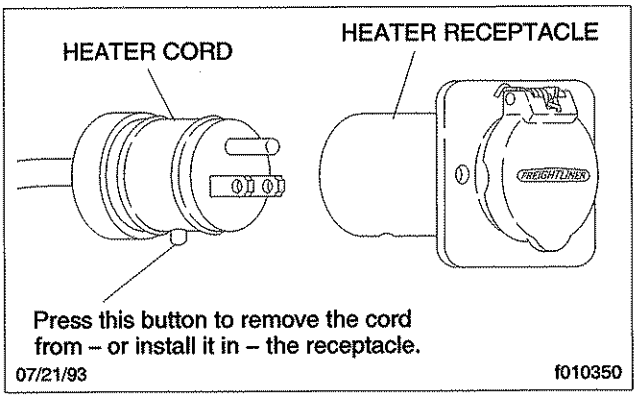

HEATER CORD
HEATER RECEPTACLE
FREIGHTLINER
Press this button to remove the cord
from – or install it in – the receptacle.
07/21/93
f010350

Fig. 2

Engine Block Heater Element Removal and Installation

Removal

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

⚠ 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.

3.1 Loosen the surge tank cap.

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

4. Unscrew the threaded cover that secures the cord to the element. **See Fig. 1.**
5. Pull the cord off the element.
6. Remove the element from the engine block.

   On Mercedes-Benz OM 366LA engines, remove the three bolts that hold the element cover to the block, and pull out the element.

   On Cummins B Series engines, loosen the capscrew in the center of the element cover, and pull out the element.

Installation

1. Install the heater element in the engine block.

   On Mercedes-Benz OM 366LA engines, secure the element in the block with three bolts. Tighten the bolts 20 N·m (15 lbf·ft).

   On Cummins B Series engines, secure the element in the block by tightening the capscrew 13 N·m (10 lbf·ft).

2. Plug the cord into the element and secure it by screwing the threaded cord cover in place. **See Fig. 1.**
3. Fill the cooling system. For recommended coolants and coolant system capacities, refer to the vehicle maintenance manual.
4. Start the engine and check for leaks. Repair any leaks as necessary. Run the engine for half an hour to purge any air from the coolant system.
5. To test the heater, plug a wattmeter into a power source, and connect the heater cord in the receptacle to the meter. A reading on the meter will indicate the heater is working.

Engine Block Heater Element Removal and Installation

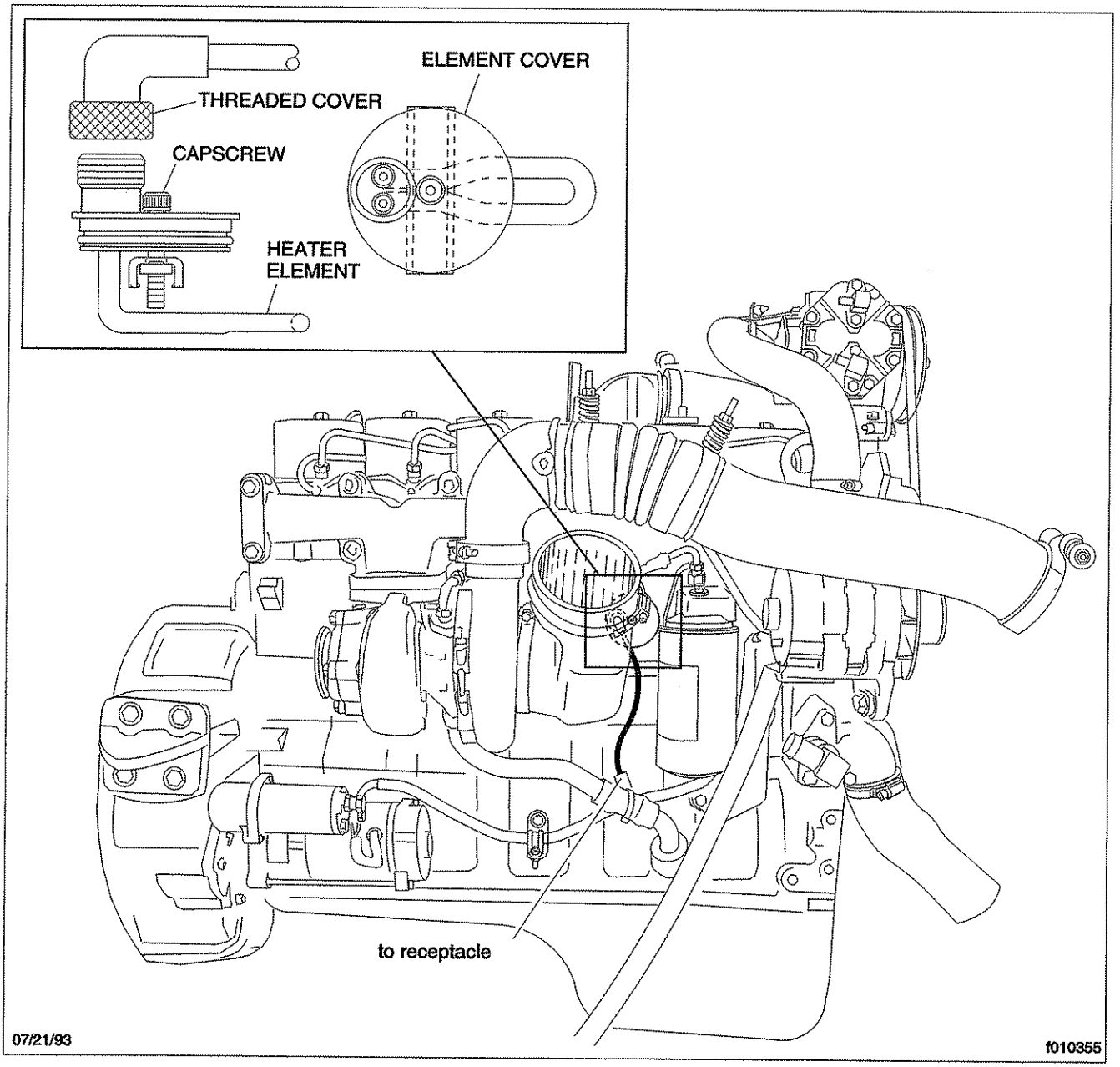


Fig. 1, Cummins B Series Engine Shown

Troubleshooting

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

WIRING PROBLEMS

1. Park the vehicle, apply the parking brakes, and chock the tires.
2. Tilt the hood.
3. Unscrew the threaded cover that secures the cord to the element. **See Fig. 1.** Pull the cord off the element.
4. Using an ohmmeter, check the continuity between the two poles of the element. The resistance should be very low, typically between 9 and 10 ohms. If there is no reading, the element has burned out, and if the reading is very high, the element is about to burn out.
5. If the element is good, check the cord. Plug the cord into the element and secure it by screwing the threaded cover in place. **See Fig. 1.**
6. Using an ohmmeter at the receptacle, check the continuity between the two power terminals. The resistance should be low, typically between 9 and 10 ohms. If there is no reading or a very high reading, the cord is damaged. Replace the cord.
7. Check the continuity between each power terminal and the ground terminal. There should be no ohmmeter reading. If there is a reading, replace the cord.
8. Check the ohmmeter reading between the ground terminal and a good vehicle ground. The reading should be zero. If not, replace the cord.

FOULED ELEMENT

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

⚠ 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.

   3.1 Loosen the surge tank cap.

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

4. Unscrew the threaded cover that secures the cord to the element. **See Fig. 1.** Pull the cord off the element.
5. Remove the element from the engine block. On Mercedes-Benz OM 366LA engines, remove the three bolts that hold the element cover to the block, and pull out the element. On Cummins B Series engines, loosen the capscrew in the center of the element cover, and pull out the element.
6. Inspect the element for residue deposits, discoloration, or damage.

   Greenish residue indicates the coolant solution contains too much antifreeze. Replace the element, and refer to the vehicle maintenance manual for the recommended antifreeze/water ratio.

   Gray or black residue indicates anti-leak coolant additives have been added to the system. Replace the element, and refer to the vehicle maintenance manual for the recommended coolant additives.

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

   Holes in the element indicate the coolant solution contains too little antifreeze. The weak solution is boiling inside the engine block and causing pitting of the element and block. Replace the element, and refer to the vehicle maintenance manual for the recommended antifreeze to water concentrations.

Troubleshooting

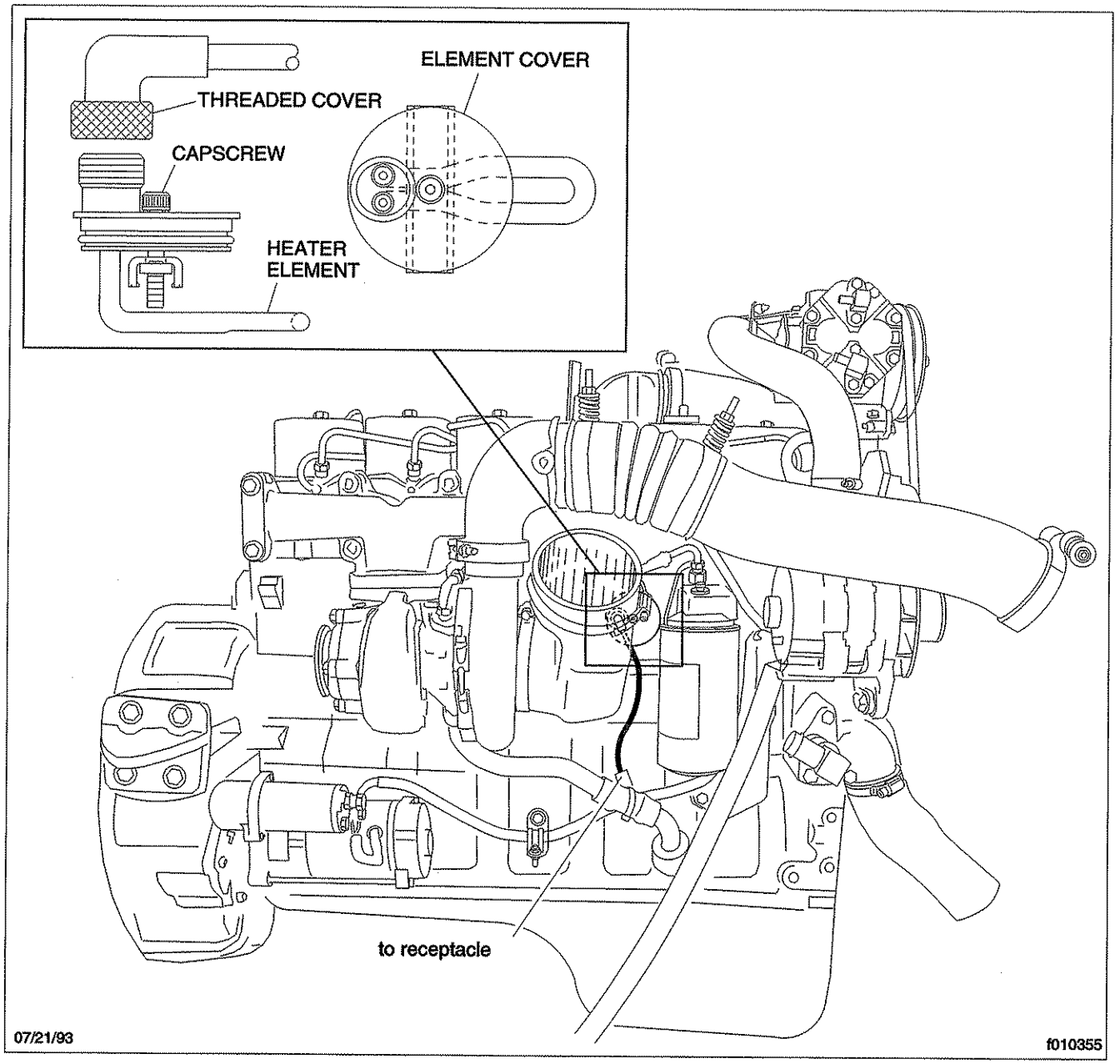


Fig. 1, Cummins B Series Engine Shown

Specifications

Description	Grade	Size	Torque N·m (lbf·ft)
Element Bolts, OM 366LA Engine	8	M8 x 1.5	20 (15)
Element Capscrew, Cummins B Series Engine	8	1/4–20	13 (10)

Table 1, Fastener Torques

KBi® Starting Fluid System 01.06

Contents

Subject	Subject Number
General Description	050
Service Operations	
Fluid Cylinder Replacement	100
Starting System Removal and Installation	110
Troubleshooting	300
Specifications	400

General Description

During cold weather starts, the KBi starting fluid system injects vaporized ether into the engine manifold to help ignite the diesel fuel in the cylinders. The diesel normally ignites on the compression stroke of each piston, when the compressed air within the cylinder reaches about 385°C (725°F). However, during cold weather starts, the heat of the compressed air dissipates into the surrounding engine block so the diesel may never reach the temperature it needs to ignite. Ether ignites at 182°C (360°F). Therefore, ether vapor injected with the engine intake air ignites at the lower cylinder temperature, and the burning ether ignites the diesel.

Using the starting fluid system reduces the necessary cranking time in cold weather, and it prevents excessive wear on the battery and starter.

When the engine is cold, the KBi system begins injecting ether when the starter is cranked. The system continues injecting ether vapor into the manifold for a short time to prevent stalling. The system consists of the starting fluid cylinder, the ether injection nozzle in the engine manifold, and the engine temperature sensor. **See Fig. 1.**

The starting fluid cylinder **(see Fig. 2)** is mounted with the receiver-dryer against the firewall. It fits into the Dieselmatic® valve and Blockor® fitting which measure, hold, and release a controlled amount of fluid for each start attempt.

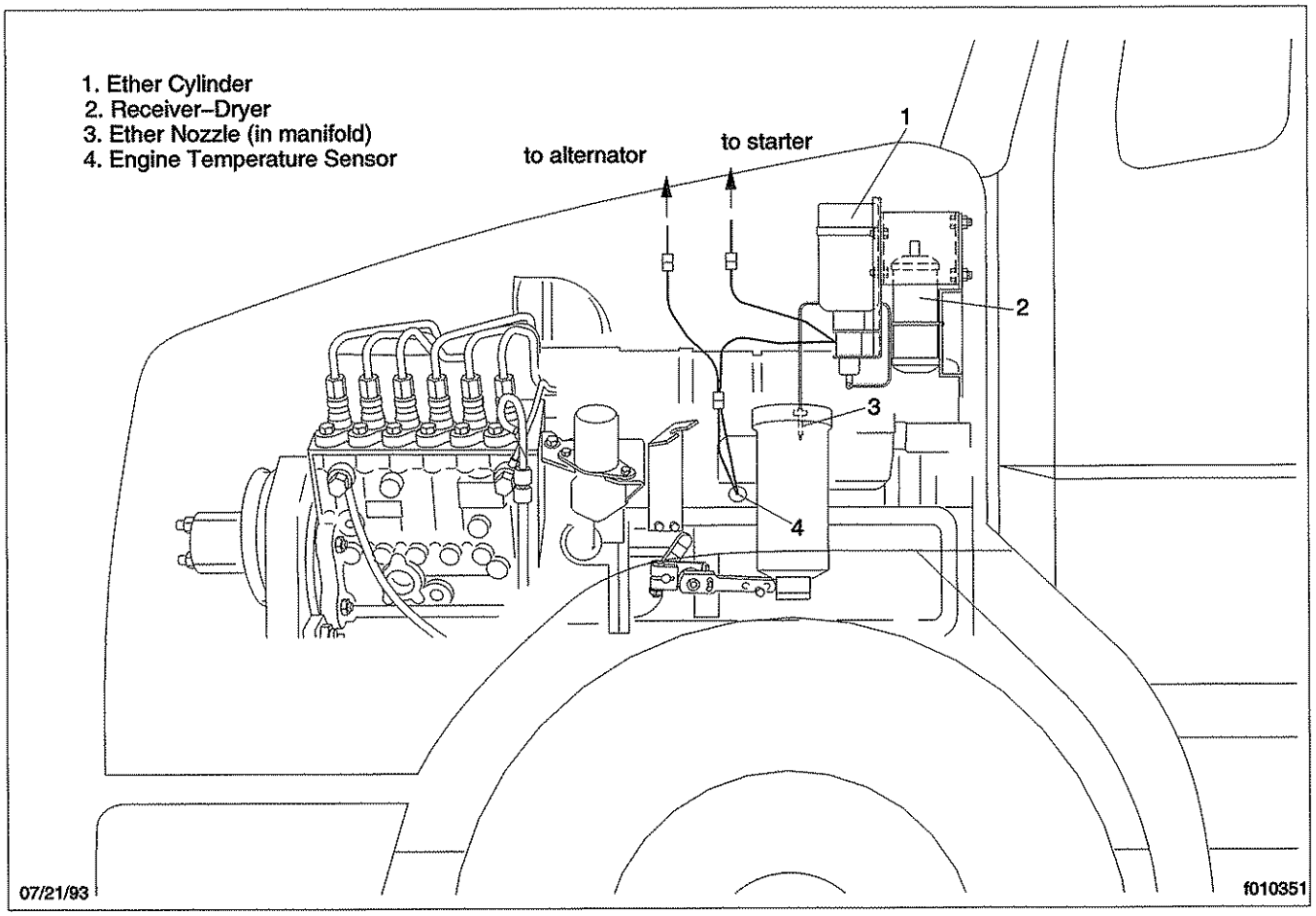


Fig. 1

General Description

Ether travels through plastic tubing to the engine manifold where it sprays through the injection nozzle into the engine intake air. Inside the manifold, vaporized ether fills the cylinders and ignites.

If the weather is warm, or the engine is already warmed, the engine temperature sensor mounted in the engine water jacket prevents the KBi from injecting ether vapor. The system will inject ether only if the engine is cooler than about 4°C (40°F).

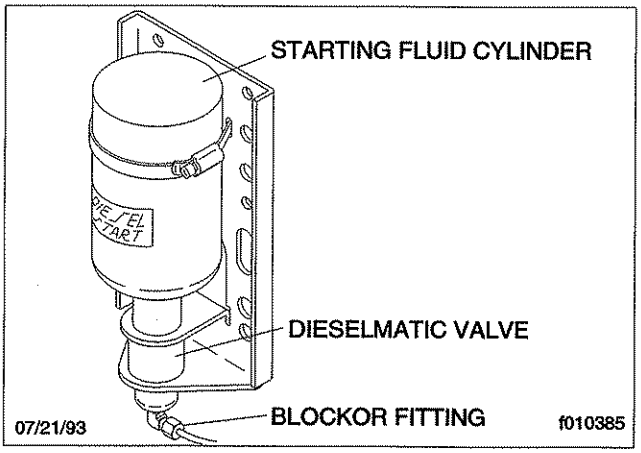


Fig. 2

Fluid Cylinder Replacement

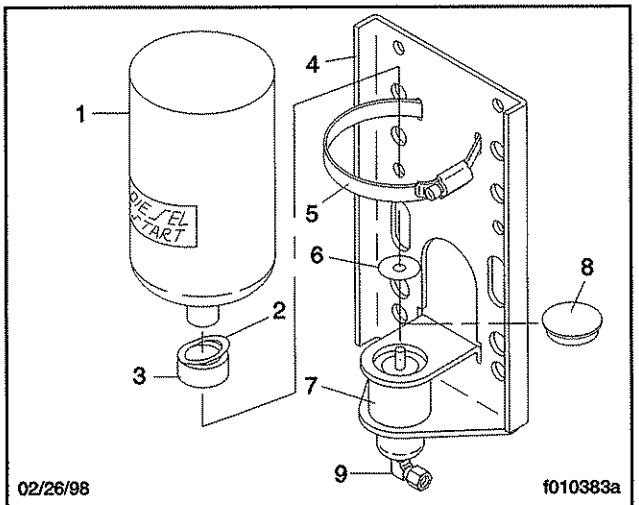
Replacement (See Fig. 1)

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

⚠ WARNING

Service starting fluid systems only in a well-ventilated area away from sparks and open flames. The ethyl ether in these systems is flammable and toxic. Wear protective gloves and glasses, and avoid breathing ether fumes. Failure to take these precautions could result in personal injury or property damage.

3. Remove the old cylinder (Ref. 1).
   - 3.1 Clean all dirt from the neck of the cylinder and the top of the Dieselmatic® valve before removing the cylinder.
   - 3.2 Loosen the cylinder clamp.
   - 3.3 Pry the dirt eliminator collar (Ref. 3) off the neck of the cylinder.
   - 3.4 Unscrew the cylinder from the Dieselmatic valve.



1. Starting Fluid Cylinder
2. Paper Backing
3. Dirt Eliminator Collar
4. Mounting Plate
5. Cylinder Clamp
6. Valve Gasket
7. Dieselmatic Valve
8. Valve Cap
9. Blockor Fitting

Fig. 1, KBi Ether Start System

NOTE: If not replacing the cylinder immediately, place the valve cap (Ref. 8) in the valve to prevent dirt or other debris from entering the system.

4. Remove the old dirt eliminator collar from the valve assembly.
5. Replace the Dieselmatic valve gasket (Ref. 6). Spread the new gasket with a light film of clean oil.
6. Place a new dirt eliminator collar, adhesive-side up, on the valve assembly. Peel off the collar's paper backing (Ref. 2) to expose the adhesive.
7. Install the new cylinder.
   - 7.1 Place the new cylinder into the Dieselmatic valve and hand tighten it firmly.
   - 7.2 Slide the dirt eliminator collar up so it sticks to the cylinder.
   - 7.3 Tighten the clamp around the cylinder 680 N·cm (60 lbf·in).
8. If the ambient temperature is below 4°C (40°F), test the starting fuel system.
9. Lower the hood, and remove the chocks from the tires.

Starting System Removal and Installation

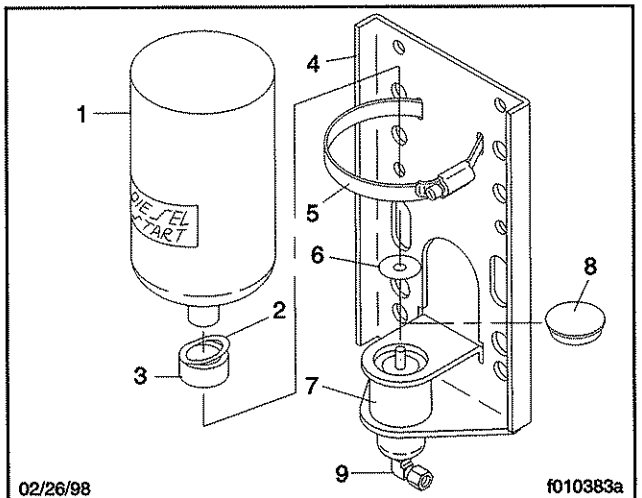
Removal

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

⚠ WARNING

Service starting fluid systems only in a well-ventilated area away from sparks and open flames. The ethyl ether in these systems is flammable and toxic. Wear protective gloves and glasses, and avoid breathing ether fumes. Failure to take these precautions could result in personal injury or property damage.

3. Remove the starting fluid cylinder. See **Fig. 1.**
   - 3.1 Clean all dirt from the neck of the cylinder and the top of the Dieselmatic® valve before removing the cylinder.
   - 3.2 Loosen the cylinder clamp.
   - 3.3 Pry the dirt eliminator collar off the neck of the cylinder.



1. Starting Fluid Cylinder
2. Paper Backing
3. Dirt Eliminator Collar
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8. Valve Cap
9. Blockor Fitting

Fig. 1, KBi Ether Start System

   - 3.4 Unscrew the cylinder from the Dieselmatic valve.

NOTE: If not replacing the cylinder immediately, place the valve cap in the valve to prevent dirt or other debris from entering the valve.

4. Remove the old dirt eliminator collar from the valve assembly.
5. Remove the mounting plate and valve assembly. See **Fig. 2.**
   - 5.1 Disconnect the wires running from the assembly to the "M" terminal of the starter and to the engine temperature sensor.
   - 5.2 Disconnect the ether tubing from the nozzle in the engine manifold.
   - 5.3 Remove the four bolts that hold the mounting plate to the mounting bracket, and remove the plate and the valve assembly from the vehicle.
6. Remove the engine temperature sensor. See **Fig. 2.**
   - 6.1 Disconnect the sensor ground wire at the alternator ground terminal.
   - 6.2 Unscrew the sensor from the engine block, and seal the port with an appropriate water jacket plug.
7. Remove the ether nozzle from the engine manifold, and seal the hole in the manifold with an appropriate plug.

Installation

⚠ WARNING

Service starting fluid systems only in a well-ventilated area away from sparks and open flames. The ethyl ether in these systems is flammable and toxic. Wear protective gloves and glasses, and avoid breathing ether fumes. Failure to take these precautions could result in personal injury or property damage.

Do not install a starting fluid system on a vehicle with an air intake warmer, for example, a glow plug or a flame start system. An air intake warmer could prematurely ignite the starting fluid and cause an

Starting System Removal and Installation

explosion in the air intake manifold resulting in personal injury and property damage.

1. Remove the plug in the engine intake manifold and screw the ether nozzle in place. See **Fig. 2.**
2. Install the engine temperature sensor. See **Fig. 2.**
   - 2.1 Remove the plug from the water jacket, and screw the sensor in place until finger-tight. Using a wrench, tighten the sensor one more turn.
   - 2.2 Connect the ground wire from the sensor to the alternator ground terminal.
3. Install the mounting plate and valve assembly. See **Fig. 2.**
   - 3.1 Place the mounting plate against the mounting bracket, and secure it with four bolts. Tighten the bolts 30 N·m (22 lbf·ft).
   - 3.2 Connect the ether tubing to the injection nozzle in the intake manifold. Tighten the nozzle fitting finger-tight, then, using a wrench, tighten the nozzle one more turn.
   - 3.3 Connect the black wire from the valve assembly to the engine temperature sensor.
   - 3.4 Connect the remaining wire from the assembly to the "M" terminal of the starter.
4. Install the starting fluid cylinder. See **Fig. 1.**
   - 4.1 Replace the Dieselmatic valve gasket. Spread the new gasket with a light film of clean oil.

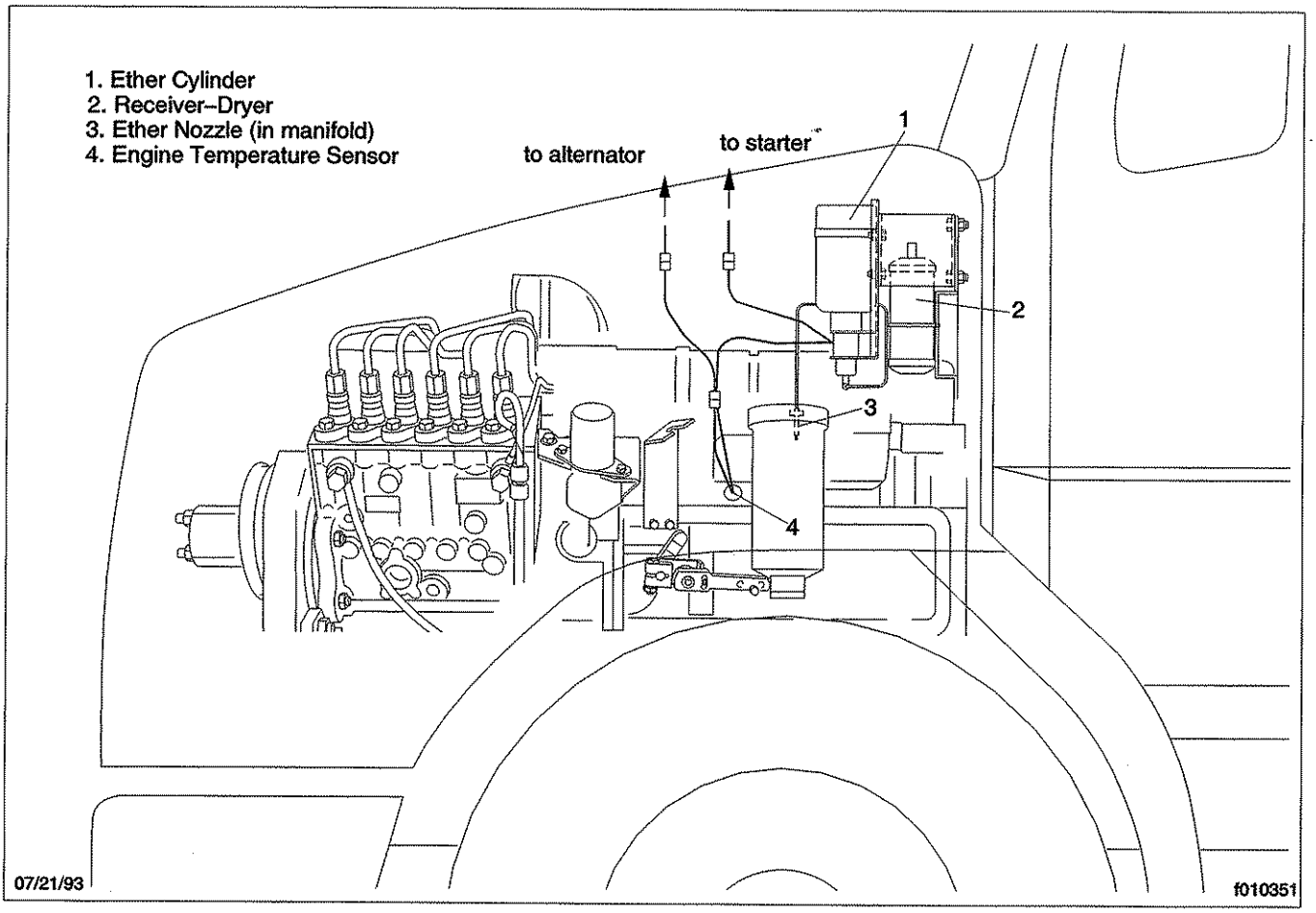


Fig. 2

4.2 Place a new dirt eliminator collar, adhesive-side up, on the valve assembly. Peel off the collar's paper backing to expose the adhesive.

4.3 Place the new cylinder into the Dieselmatic valve and hand-tighten it firmly.

4.4 Slide the dirt eliminator collar up so it sticks to the cylinder.

4.5 Tighten the clamp around the cylinder 680 N·cm (60 lbf·in).

5. If the ambient temperature is below 4°C (40°F), test the starting fuel system.

Troubleshooting

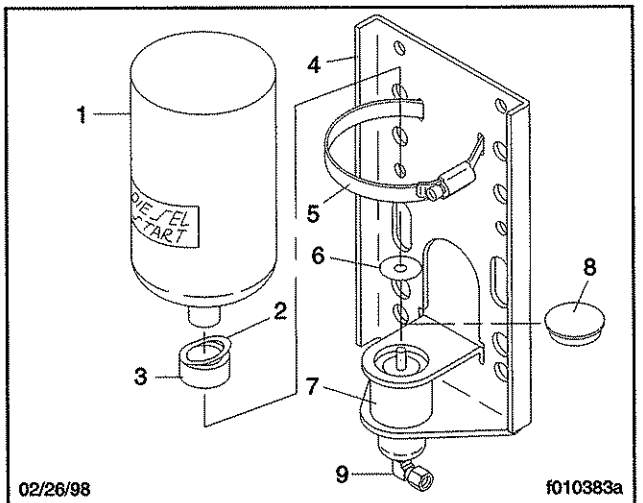
Use the following procedures to check for most common problems that may prevent starting fluid delivery.

⚠ WARNING

Service starting fluid systems only in a well-ventilated area away from sparks and open flames. The ethyl ether in these systems is flammable and toxic. Wear protective gloves and glasses, and avoid breathing ether fumes. Failure to take these precautions could result in personal injury or property damage.

EMPTY FLUID CYLINDER(See Fig. 1)

1. Remove the old cylinder.
   - 1.1 Clean all dirt from the neck of the cylinder and the top of the Dieselmatic® valve before removing the cylinder.
   - 1.2 Loosen the cylinder clamp.
   - 1.3 Pry the dirt eliminator collar off the neck of the cylinder.



1. Starting Fluid Cylinder
2. Paper Backing
3. Dirt Eliminator Collar
4. Mounting Plate
5. Cylinder Clamp
6. Valve Gasket
7. Dieselmatic Valve
8. Valve Cap
9. Blockor Fitting

Fig. 1, KBi Ether Start System

   - 1.4 Unscrew the cylinder from the Dieselmatic valve.
   - 1.5 Remove the cylinder from the mounting plate. Cover the top of the valve after the cylinder is removed.
   - 1.6 Remove the old dirt eliminator collar from the valve assembly.
2. Weigh the cylinder to see if it is empty. See **Table 1** for the weight of each cylinder size.

Cylinder Size: oz (g)	Empty Weight: oz (g)	Full Weight: oz (g)
21 (595)	16 (455)	37 (1050)
18 (510)	15 (425)	33 (935)
8 (225)	10 (285)	18 (510)

Table 1, Ether Cylinder Weights

3. Replace the Dieselmatic valve gasket. Spread the new gasket with a light film of clean oil.
4. If the cylinder is good, install it; if not, replace it.
   - 4.1 Place a new dirt eliminator collar, adhesive-side up, on the valve assembly. Peel off the collar's paper backing to expose the adhesive.
   - 4.2 Place the new cylinder into the Dieselmatic valve and hand-tighten it firmly.
   - 4.3 Slide the dirt eliminator collar up so it sticks to the cylinder.
   - 4.4 Tighten the clamp around the cylinder 680 N·cm (60 lbf·in).

CLOGGED ETHER NOZZLE

1. Disconnect the ether tubing from the nozzle, and cover the nozzle fitting. See **Fig. 2.**
2. Disconnect the black ground wire from the engine temperature sensor, and ground it.

⚠ WARNING

When testing the starting fluid system, wear protective gloves and glasses, and spray the vaporized ether into a container. Failure to do so could result in personal injury.

Troubleshooting

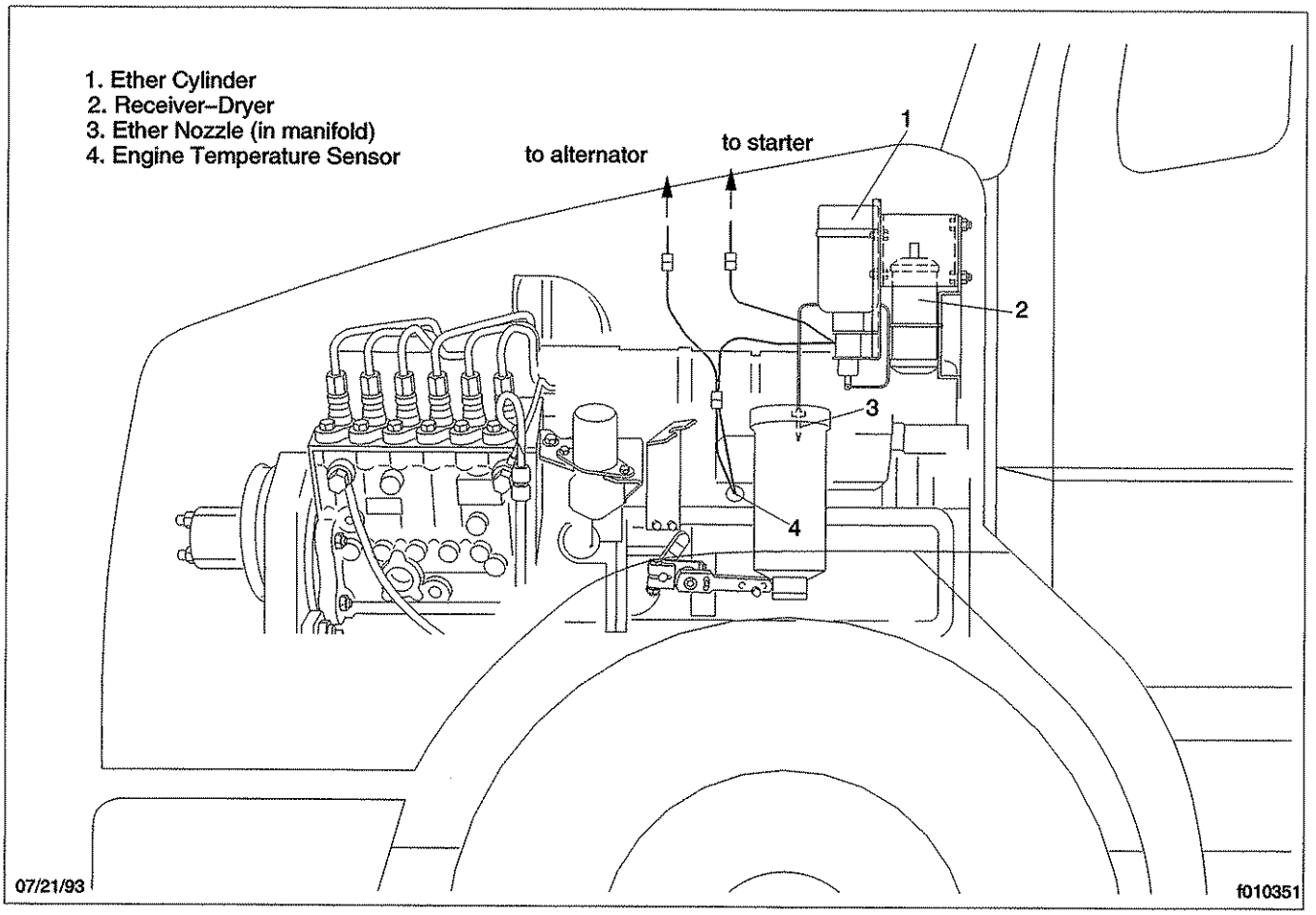


Fig. 2

3. Start the engine, and look for ether to spray from the tubing.

⚠ CAUTION

Do this test only two times. Activating the starting fluid system in this manner more than twice could result in damage to the system.

4. If no ether sprays from the tubing, disconnect the tubing at the Blockor® fitting in the base of the cylinder assembly. See **Fig. 1.**
5. Start the engine, and look for ether to spray from the Blockor fitting in the base of the cylinder assembly.

⚠ CAUTION

Do this test only two times. Activating the starting fluid system in this manner more than twice could result in damage to the system.

6. If ether sprays from the fitting, but not from the tubing, check for kinks or blockages in the ether tubing and the nozzle. Repair or replace the tubing and nozzle, as needed.

   If no ether sprays from the fitting or tubing, check the Blockor fitting for blockages. Repair or replace the fitting, as needed.

ELECTRICAL PROBLEMS

1. Check for a blown fuse, and for loose wiring connections, shorts, and broken wires.

2. Check that the black ground wire from the valve assembly is connected to the engine temperature sensor, and that the ground wire from the sensor is connected to the alternator ground terminal.
3. Check that the second wire from the valve assembly is connected to the "M" terminal of the starter.

⚠ WARNING

When testing the starting fluid system, wear protective gloves and glasses, and spray the vaporized ether into a container. Failure to do so could result in personal injury.

4. Test the valve.
   - 4.1 Remove the starting fluid cylinder.
   - 4.2 If the ambient air temperature is over 4°C (40°F), remove the black ground wire from the engine temperature sensor, and ground it.
   - 4.3 Crank the starter, and look for the valve plunger (see **Fig. 3**) to move up and stay up while the starter is cranked.

⚠ CAUTION

Do this test only two times. Activating the starting fluid system in this manner more than twice could result in damage to the system.

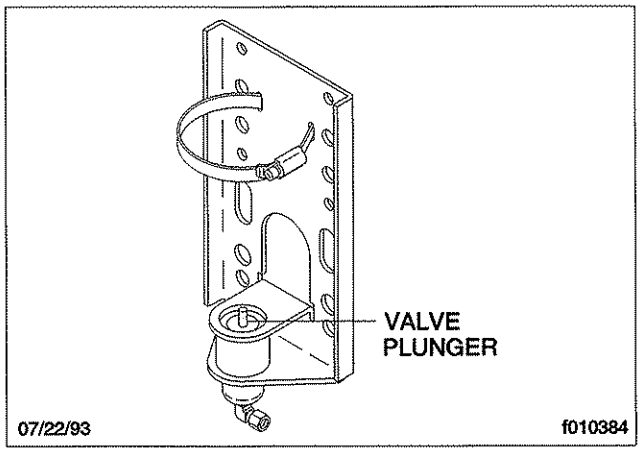


Fig. 3

5. If the plunger does not move, disconnect both valve assembly wires and momentarily touch the leads across battery terminals. If the valve plunger still does not move up, replace the valve.
6. If the valve operates correctly, check the engine temperature sensor.
   - 6.1 Connect the appropriate wire to the "M" terminal of the starter.
   - 6.2 Remove the sensor from the engine water jacket, and chill it to below freezing for at least ten minutes.
   - 6.3 Install the sensor, grounding it at the alternator ground terminal.
   - 6.4 Connect the black ground wire from the valve assembly to the sensor.
   - 6.5 Crank the engine, and look for the valve plunger to move up and stay up while the starter is cranked.

⚠ CAUTION

Do this test only two times. Activating the starting fluid system in this manner more than twice could result in damage to the system.

7. If the plunger does not move, replace the sensor.

Specifications

Description	Grade	Size	Torque	
			N·m (lbf·ft)	N·cm (lbf·in)
Starting Fluid Cylinder Clamp	—	—	—	680 (60)
Mounting Plate Mounting Bolts	8	5/16–18	30 (22)	—

Table 1, Fastener Torques

Cylinder Size oz (g)	Weight	
	Empty oz (g)	Full oz (g)
21 (595)	16 (455)	37 (1050)
18 (510)	15 (425)	33 (935)
8 (225)	10 (285)	18 (510)

Table 2, Starting Fluid Cylinder Weights

Contents

Subject	Subject Number
General Description	050
Service Operations	
Removal and Installation	100
Specifications	400

NOTE: Refer to the *Cummins C Series Operation and Maintenance Manual, Cummins Troubleshooting and Repair Manual C Series*, and *Cummins Workshop Manual C Series* , for additional information on C Series engine service operations.

General Description

The Cummins C Series engine **(see Fig. 1 and Fig. 2)** is supported by three engine mounts: two mounts with a single rubber isolator apiece are at the rear of the engine—one on each side of the flywheel housing. The third mount is an underslung crossmember that supports the front of the engine with two rubber isolators.

For detailed repair procedures and other engine service not covered in this section, refer to the *Cummins C Series Operation and Maintenance Manual, Cummins Troubleshooting and Repair Manual C Series,* and *Cummins Workshop Manual C Series.*

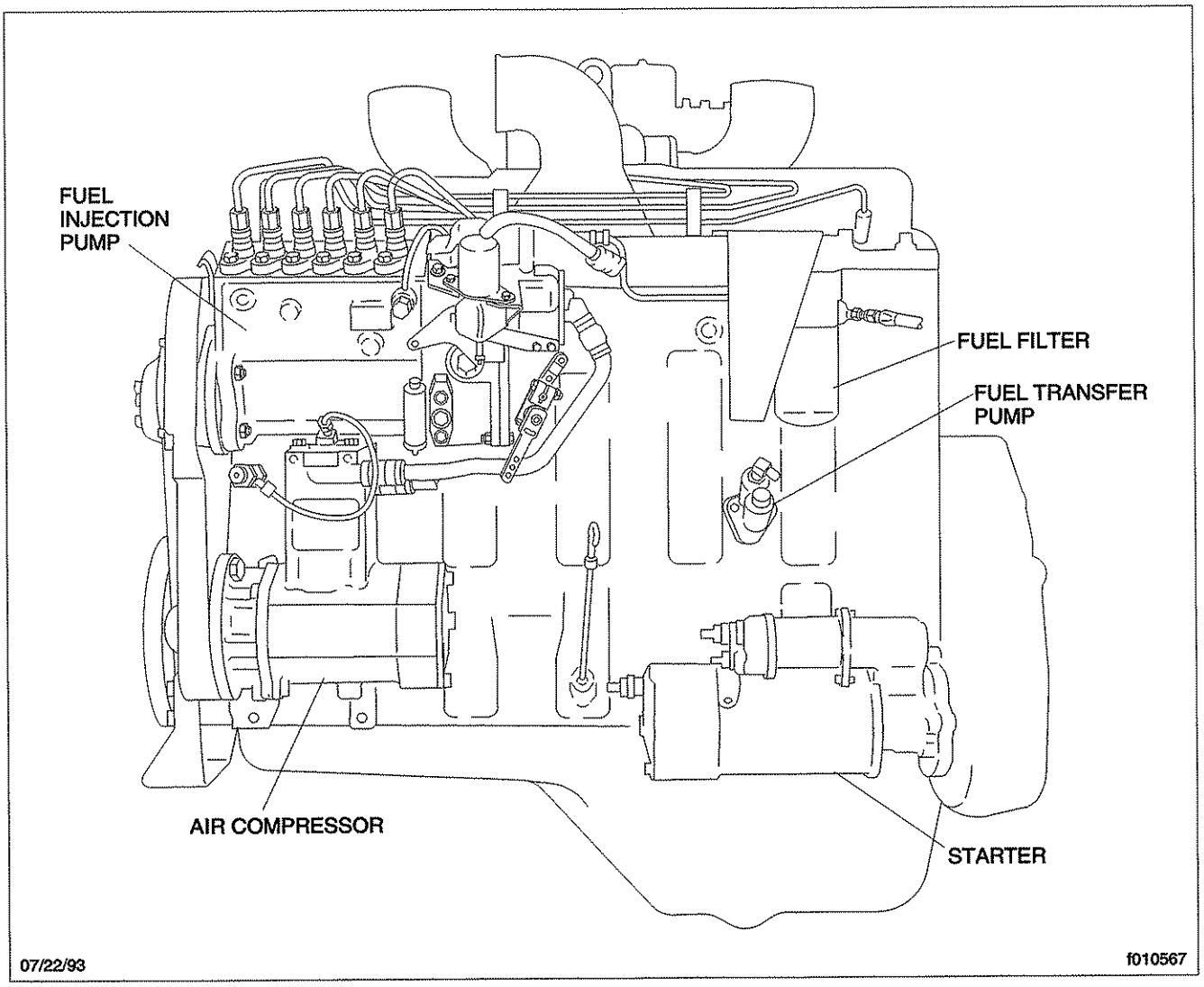


Fig. 1

General Description

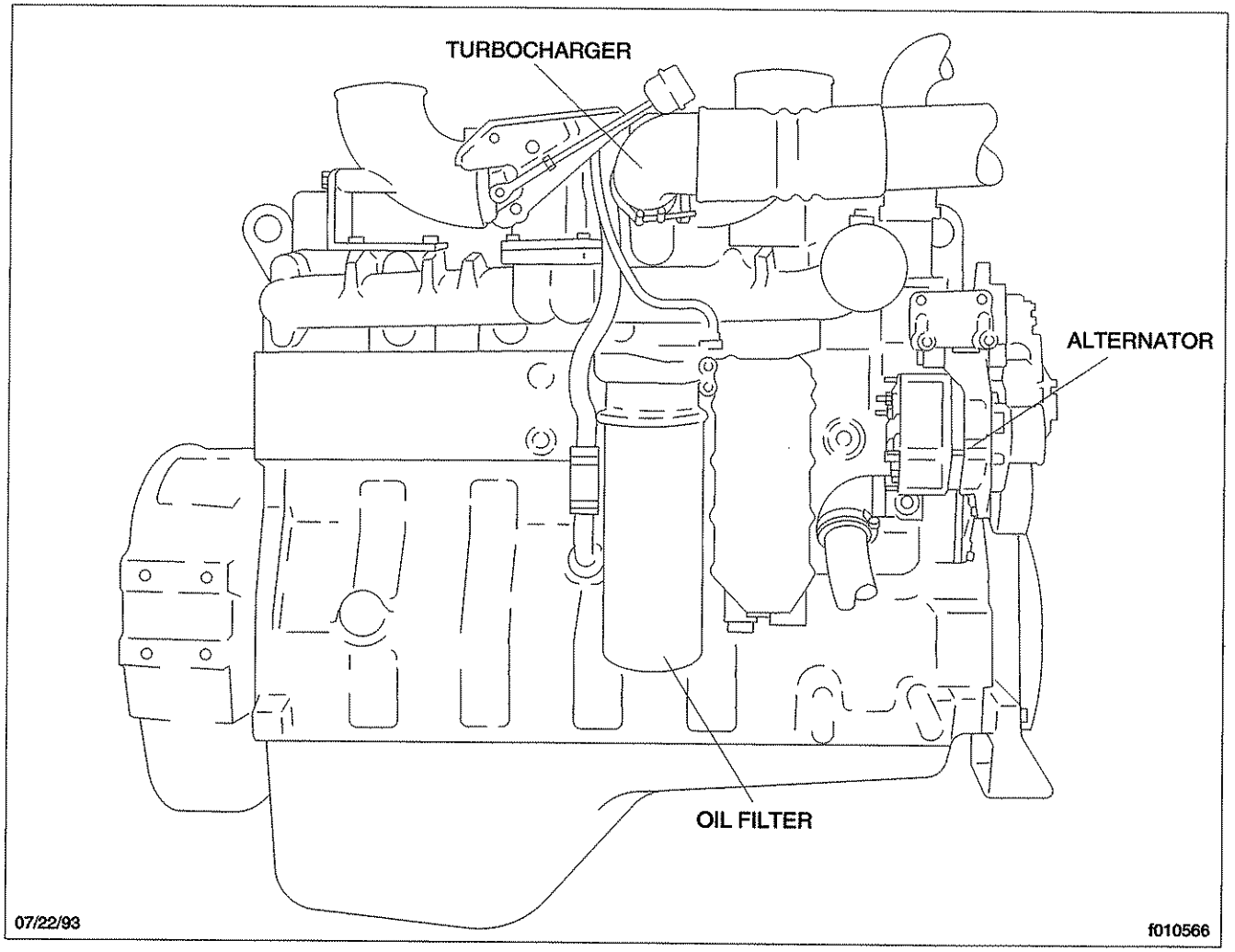


Fig. 2

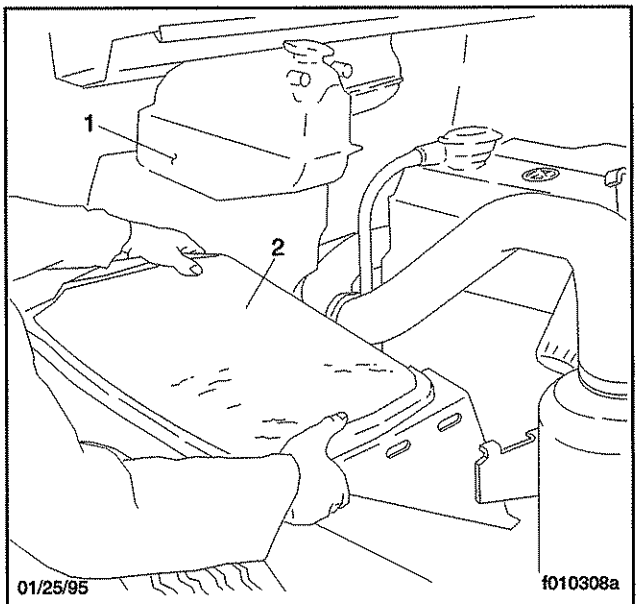
Removal

1. Apply the parking brakes, chock the tires, and (if applicable) drain the air system.
2. If the vehicle is equipped with a battery shutoff switch, turn off the switch; otherwise, disconnect the batteries.
   - 2.1 Disconnect the battery ground cable at the vehicle frame.
   - 2.2 Disconnect the positive battery cable from the batteries.
3. Remove the transmission. For instructions, see **Group 26**.
4. Remove the hood and bumper. For instructions, see **Group 88**.

⚠ 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.

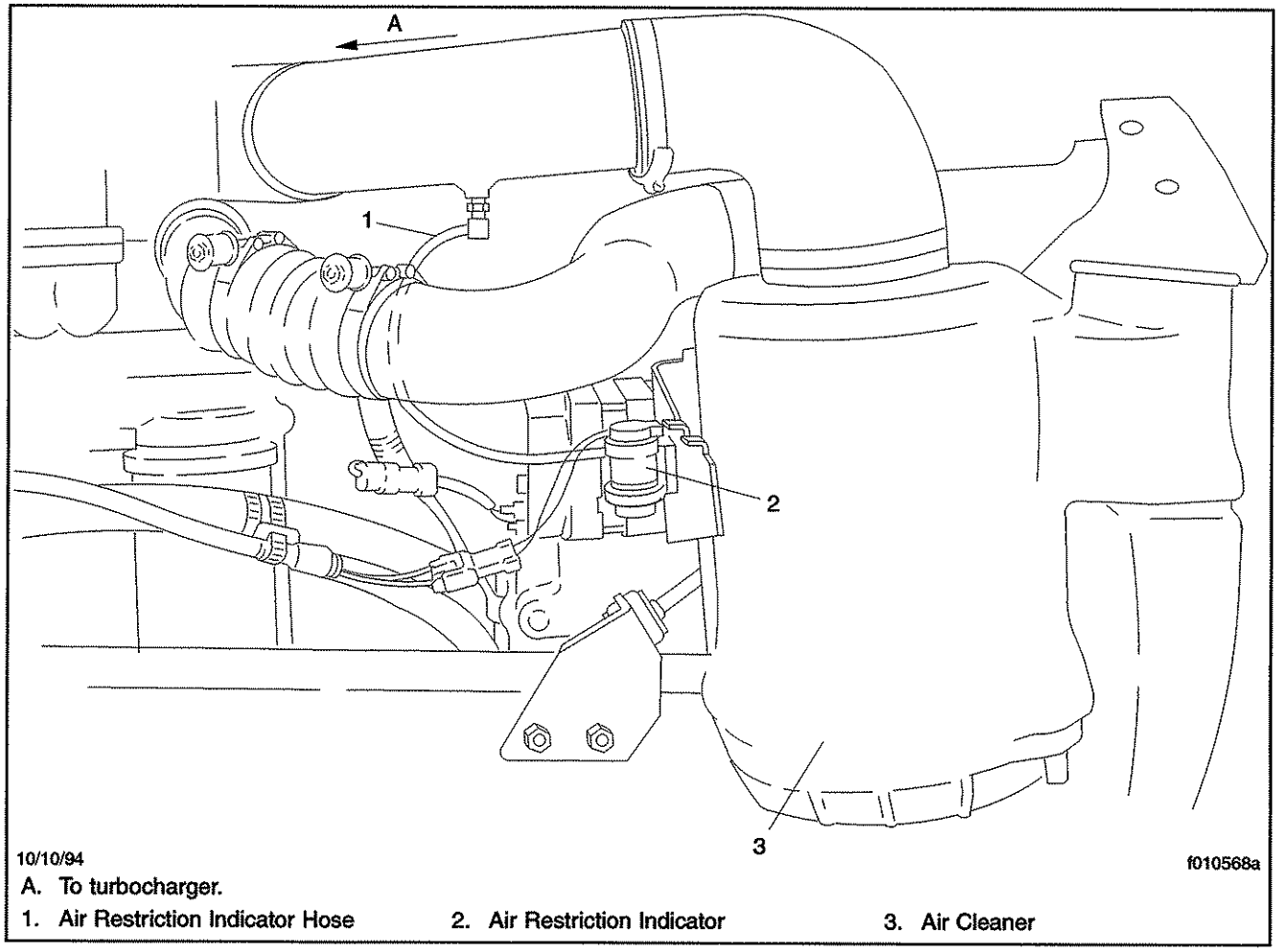
5. Drain the radiator.
   - 5.1 Open the petcock at the bottom of the radiator to drain the engine coolant.
   - 5.2 Loosen the surge tank cap.
6. Remove the right fender splash shield. See **Fig. 1**.
7. Remove the air cleaner. See **Fig. 2**.
   - 7.1 Remove the air intake ducting from the top of the air cleaner.
   - 7.2 Remove the four nuts (**Fig. 3**) from the inside of the air cleaner mounting bracket.
   - 7.3 Remove the air cleaner from the mounting bracket.
8. Disconnect or remove the air intake and exhaust ducting, and the air hoses.
   - 8.1 Disconnect the air restriction indicator hose (**Fig. 2**), and remove the air intake ducting between the air cleaner and the front of the turbocharger.
   - 8.2 Loosen the V-band clamp (**Fig. 4**) that holds the forward end of the exhaust pipe to the rear of the turbocharger.
   - 8.3 Loosen the wide-band clamp that holds the rear end of the exhaust pipe to the flex pipe.
   - 8.4 Remove the exhaust pipe from the vehicle.
   - 8.5 Remove the air ducting between the turbocharger and the charge air cooler.
   - 8.6 Disconnect the air outlet hose from the charge air cooler.
   - 8.7 If the vehicle is equipped with air brakes, disconnect the air compressor outlet line (**Fig. 5**), and the two air signal lines (**Fig. 5**) at the air compressor and the air governor.
9. Disconnect the coolant hoses.
   - 9.1 Disconnect the coolant inlet and outlet hoses from the radiator.
   - 9.2 Disconnect the vent hoses (**Fig. 6**) from the radiator and the engine block.
   - 9.3 Disconnect the fill hose (**Fig. 7**) from the engine coolant inlet hose.



1. Surge Tank
2. Splash Shield

Fig. 1, Right Fender Splash Shield

Removal and Installation



A. To turbocharger.
1. Air Restriction Indicator Hose
2. Air Restriction Indicator
3. Air Cleaner

Fig. 2, Air Cleaner Removal

9.4 Disconnect the heater outlet hose (**Fig. 7**) from the engine coolant inlet hose.

9.5 Disconnect the heater inlet hose (**Fig. 8**) from the engine block.

10. Remove the refrigerant compressor and condenser.

10.1 Disconnect the compressor electrical connector.

10.2 Remove the six bolts that hold the compressor in the compressor mounting bracket.

10.3 Lower the compressor and remove the belt from the refrigerant compressor pulley.

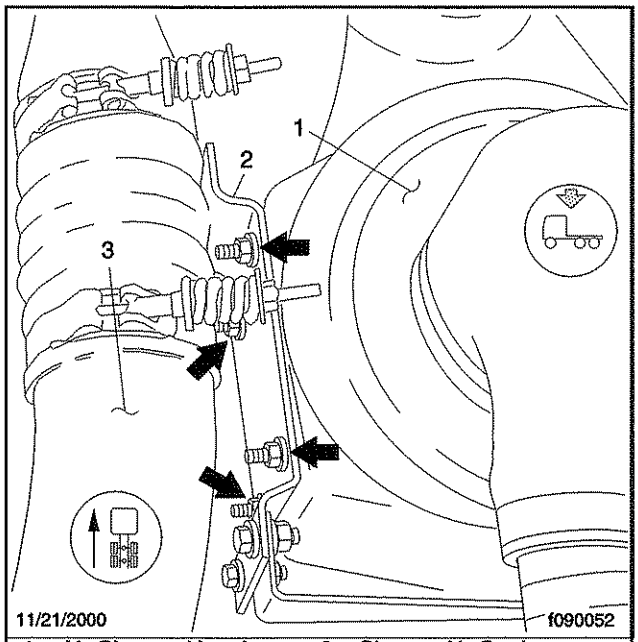
NOTE: If replacing the engine, remove the four capscrews that hold the compressor mounting bracket to the engine, and remove the bracket for installation on the new engine.

10.4 Remove the air recirculation shield (**Fig. 9**) from the left side of the charge air cooler and radiator.

10.5 Disconnect the refrigerant lines from the stand-off bracket above the power steering fluid reservoir.

10.6 Remove the four bolts (**Fig. 9**) that hold the condenser on the charge air cooler.

10.7 To keep the refrigerant system intact, with no leaks and no need for purging and



1. Air Cleaner Housing
2. Mounting Bracket
3. Charge Air Cooler Outlet Hose

Fig. 3, Air Cleaner Housing Mounting Fasteners

recharging, move the refrigerant compressor and condenser to the side at the same time.

10.8 Wrap the condenser in a protective blanket, or sandwich it between two sheets of cardboard or wood to prevent damage to the condenser fins. Secure the compressor and condenser out of the way with wire.

11. Remove the radiator and charge air cooler assembly.

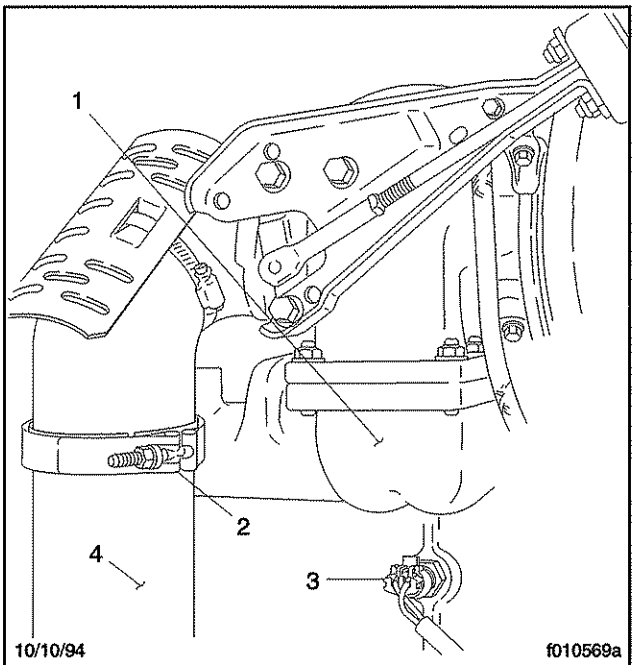
11.1 Hook a lifting chain to the radiator and charge air cooler assembly, and fasten the chain to a crane.

11.2 Remove the nuts, washers, and rubber isolators from the forward ends of the radiator struts. See **Fig. 10.**

11.3 Remove the nuts and washers from the radiator mounts. See **Fig. 10.**

11.4 Lift the radiator and charge air cooler from the vehicle as a single unit. See **Fig. 11.**

12. Remove the two bolts that hold the power steering pump to the rear of the air compressor, and



1. Turbocharger
2. V-Band Clamp
3. Coolant Temperature Sensor
4. Exhaust Pipe

Fig. 4, V-Band Clamp Location

move the pump aside while keeping the steering fluid system intact.

13. Disconnect the engine fuel and oil system components.

13.1 Disconnect the fuel delivery line at the fuel transfer pump, below the fuel filter. See **Fig. 12.**

13.2 Disconnect the throttle cable from the throttle lever, and compress the push-snap fitting to remove the cable from the cable bracket. See **Fig. 5.**

13.3 Disconnect the fuel return line (**Fig. 5**) from the injection pump.

13.4 Disconnect the oil pressure gauge line from the fitting below the fuel filter.

14. Disconnect the engine electrical connections.

14.1 Disconnect the engine ground strap from the starter.

Removal and Installation

14.2 Disconnect the wires from the starter, and label them for reassembly.

14.3 Disconnect the harness wiring connector at the coolant temperature sensor behind the oil filter. See **Fig. 4.**

14.4 Disconnect the harness wiring connector at the coolant temperature sensor (**Fig. 13**) behind the alternator.

14.5 Disconnect the harness from the alternator, and label the alternator connections for reassembly.

14.6 Disconnect the harness wiring connector at the engine shutdown solenoid. See **Fig. 5.**

14.7 Disconnect the wiring connector for the tachometer sensor, at the upper left side of the engine flywheel housing.

14.8 Disconnect the engine wiring harness from any additional options, and label the wiring connectors for reassembly.

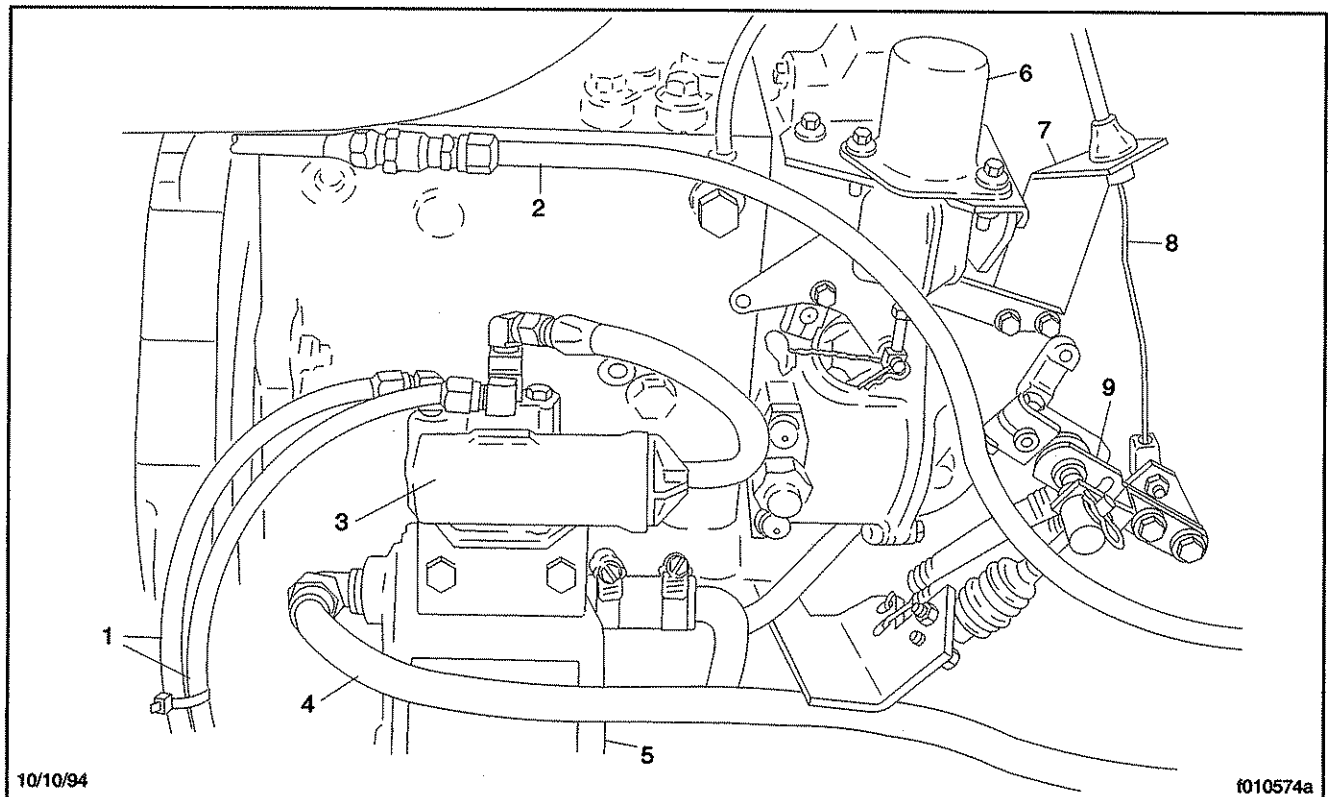
14.9 Disconnect the harness from the stand-off bracket on the rear of the engine intake manifold.

14.10 Pull the harness off to the left side of the engine where it will be out of the way.

15. Remove the engine from the vehicle.

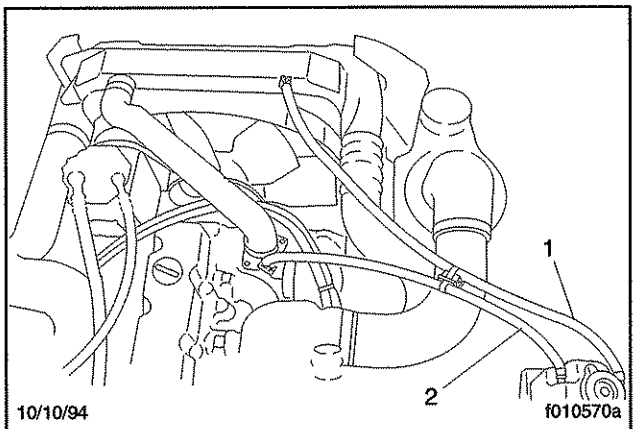
⚠ WARNING

The crane and lifting chains used to remove the engine must be capable of safely lifting and supporting two metric tons. Once the engine mounts are disconnected, do not get under the engine until it is securely supported on engine stands. An un-



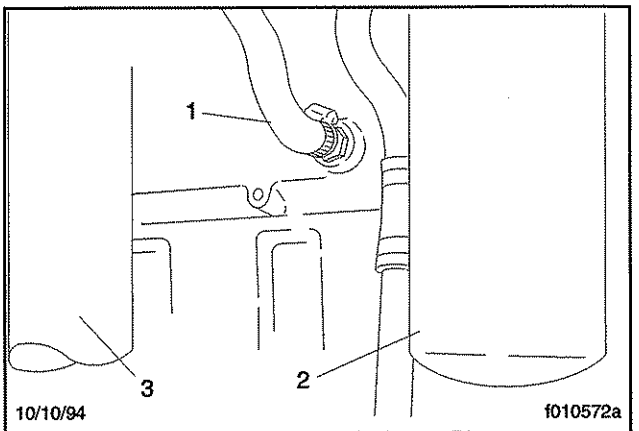
1. Signal Lines
2. Fuel Return Line
3. Air Governor
4. Air Compressor Outlet Line
5. Air Compressor
6. Engine Shutdown Solenoid
7. Throttle Cable Bracket
8. Throttle Cable
9. Throttle Lever

Fig. 5, Throttle Cable Location



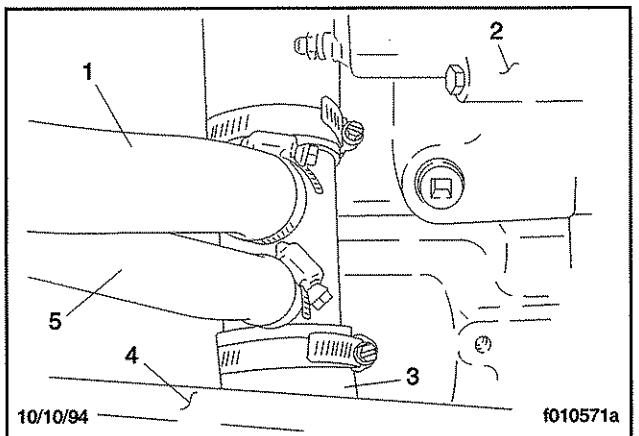
1. Radiator Vent Hose
2. Engine Vent Hose

Fig. 6, Engine and Radiator Vent Hoses



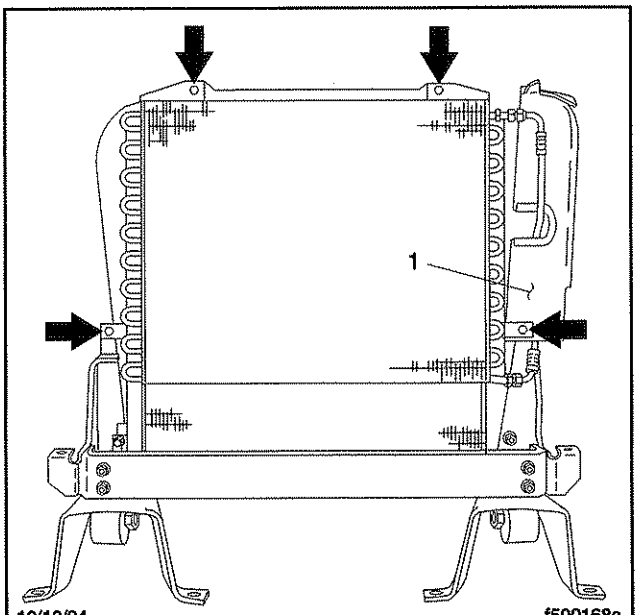
1. Heater Inlet Hose
2. Oil Filter
3. Exhaust Pipe

Fig. 8, Heater Inlet Hose Location



1. Fill Hose
2. Alternator
3. Engine Coolant Inlet Hose
4. Frame Rail
5. Heater Outlet Hose

Fig. 7, Coolant Hoses



1. Air Recirculation Shield

Fig. 9, Air Conditioning Condenser Bolts

secured engine may fall, causing personal injury or death, and component damage.

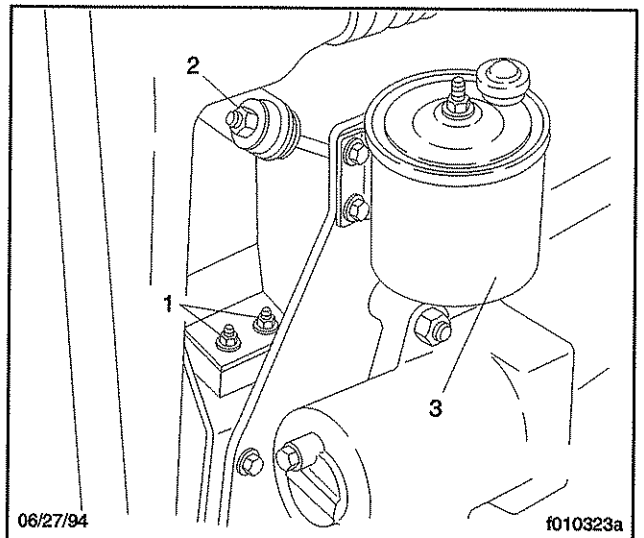
15.1 Securely attach a lifting chain to the engine. Attach the chain to a crane, and raise the chain to remove any slack.

15.2 Remove the two bolts from the front engine mount isolators.

15.3 Remove the bolt from each of the two rear engine mount isolators.

15.4 Carefully lift the engine, and pull it forward to remove it from the engine compartment.

Removal and Installation



1. Left Radiator Mount Nuts
2. Left Radiator Strut Nuts
3. Power Steering Fluid Reservoir

Fig. 10, Radiator Strut and Mount Fasteners

Installation

1. Examine all engine support components for damage and extreme wear. Replace components as necessary.
2. Install the engine in the vehicle.

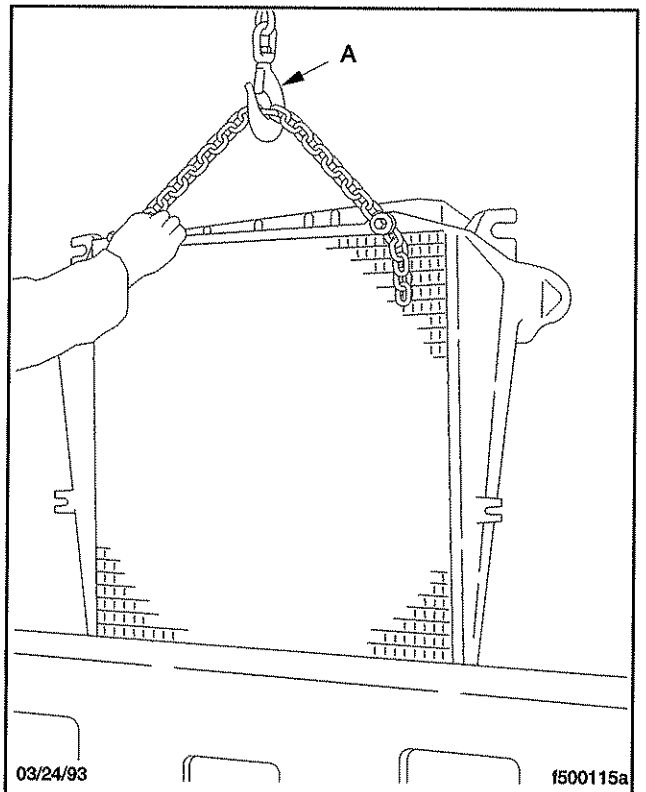
⚠ WARNING

The crane and lifting chains used to install the engine must be capable of safely lifting and supporting two metric tons. Once the engine is removed from the engine stands, do not get under the engine until it is securely installed on the engine mounts. An unsecured engine may fall, causing personal injury or death, and component damage.

2.1 Securely attach a lifting chain to the engine. Attach the chain to a crane, and raise the chain to remove any slack.

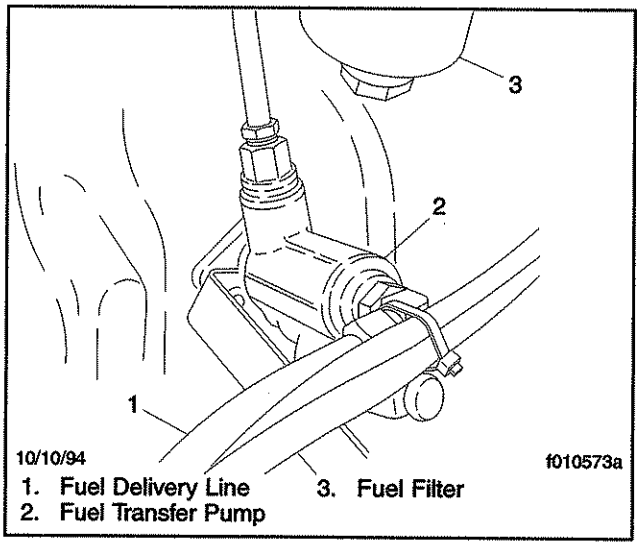
2.2 Lift the engine from the engine stands, and carefully lower the engine onto the engine mounts.

2.3 Install the bolts in the two rear engine mounts, and tighten them 241 lbf·ft (327 N·m).



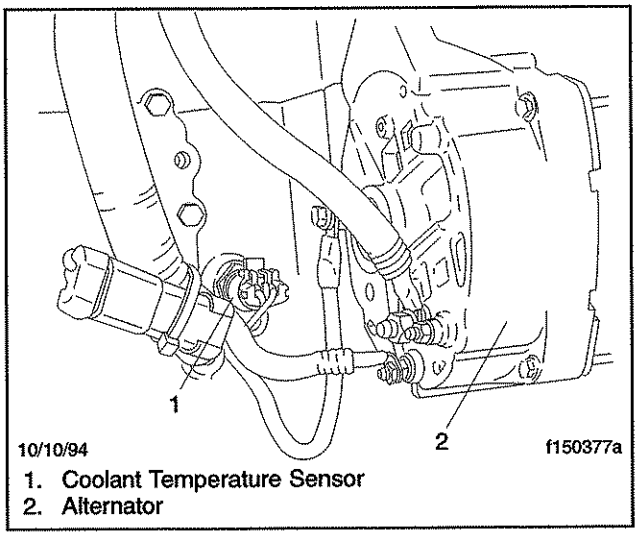
A. Use a crane to lift the radiator and charge air cooler.

Fig. 11, Lifting the Radiator and Charge Air Cooler



1. Fuel Delivery Line
2. Fuel Transfer Pump
3. Fuel Filter

Fig. 12, Fuel Lines



1. Coolant Temperature Sensor
2. Alternator

Fig. 13, Alternator Harness

2.4 Install the two bolts in the front engine mount, and tighten them 150 lbf·ft (203 N·m).

2.5 Remove the lifting chain from the engine.

3. Connect the engine electrical connections.

3.1 Route the engine wiring harness across the engine from the left side and connect the harness connector to the coolant temperature sensor behind the oil filter. See **Fig. 4.**

3.2 Connect the harness connector to the coolant temperature sensor behind the alternator. See **Fig. 13.**

3.3 Connect the harness to the alternator. If the alternator wires are not labeled for reassembly, see **Group 15** for alternator wiring instructions.

3.4 Connect the harness wiring connector to the engine shutdown solenoid. See **Fig. 5.**

3.5 Connect the wiring connector to the tachometer sensor, on the left side of the engine flywheel housing.

3.6 Connect the engine wiring harness to any additional options.

3.7 Connect the harness to the wiring stand-off bracket on the rear of the engine intake manifold.

3.8 Connect the wires to the starter. If the wires are not labeled for reassembly, see **Group 15** for starter wiring instructions.

3.9 Connect the engine ground strap to the starter.

4. Connect the engine fuel and oil system components.

4.1 Connect the oil pressure gauge line to the fitting below the fuel filter.

4.2 Connect the fuel return line to the injection pump. See **Fig. 5.**

4.3 Thread the throttle cable down through the throttle cable bracket, and connect the cable to the throttle lever. Compress the push-snap fitting to install the cable in the cable bracket. See **Fig. 5.**

4.4 Connect the fuel delivery line at the fuel transfer pump, below the fuel filter. See **Fig. 12.**

5. Install the power steering pump on the rear of the air compressor, and tighten the two mounting bolts 28 lbf·ft (38 N·m).

6. Install the radiator and charge air cooler assembly.

6.1 Hook a lifting chain to the radiator and charge air cooler assembly, and fasten the chain to a crane.

6.2 Lift the assembly, and carefully lower it into place on the radiator mounts. Install the nuts and washers on the radiator mounting studs. See **Fig. 10.** Tighten the nuts 30 lbf·ft (40 N·m).

6.3 Install the washers, rubber isolators, and nuts on the radiator struts. See **Fig. 10.** Tighten the nuts 35 lbf·ft (47 N·m).

6.4 Remove the lifting chain from the assembly.

7. Install the refrigerant compressor and condenser.

7.1 If it was removed, install the refrigerant compressor mounting bracket, and tighten the four capscrews 27 lbf·ft (37 N·m).

7.2 Carefully move the refrigerant compressor and condenser back into place.

7.3 Install the four bolts that hold the condenser to the charge air cooler. See **Fig. 9**. The lower, left bolt also holds the lower end of the left air recirculation shield. Tighten the bolts 15 lbf·ft (20 N·m).

7.4 Install the bolt that holds the top of the air recirculation shield, and tighten the bolt 15 lbf·ft (20 N·m).

7.5 Install the refrigerant compressor on the compressor mounting bracket. Install the belt on the compressor, and lift the compressor in its bracket to tension the belt 100 lb (45 kg). Tighten the six compressor mounting capscrews 28 lbf·ft (38 N·m).

7.6 Connect the compressor electrical connector.

7.7 Connect the refrigerant hoses to the stand-off bracket above the power steering fluid reservoir.

8. Connect the coolant hoses.

8.1 Connect the heater inlet hose to the engine block. See **Fig. 8**.

8.2 Connect the heater outlet hose to the engine coolant inlet hose. See **Fig. 7**.

8.3 Connect the fill hose to the engine coolant inlet hose. See **Fig. 7**.

8.4 Connect the vent hoses to the radiator and the engine block. See **Fig. 6**.

8.5 Connect the coolant inlet and outlet hoses to the radiator.

9. Connect or install the air intake and exhaust ducting, air hoses, and air cleaner.

9.1 Connect the air outlet hose to the charge air cooler. Tighten the charge air cooler hose clamp 60 lbf·in (680 N·cm).

9.2 Install the air ducting between the turbocharger and the charge air cooler, and tighten the charge air cooler hose clamp 60 lbf·in (680 N·cm).

9.3 If the vehicle is equipped with air brakes, connect the air compressor outlet line and the two air signal lines to the air compressor and the air governor. See **Fig. 5**.

9.4 Connect the rear of the exhaust pipe to the flex pipe, and connect the forward end of the exhaust pipe to the rear of the turbocharger. See **Fig. 4**.

9.5 Tighten the wide band clamp that holds the exhaust pipe to the flex pipe.

9.6 Tighten the V-band clamp that holds the exhaust pipe to the turbocharger 85 lbf·in (940 N·cm). Tap the V-band clamp all the way around with a rubber hammer, and tighten the clamp again.

9.7 Position the air cleaner on its bracket, and secure the cleaner with four nuts. See **Fig. 3**. Tighten the nuts 28 lbf·ft (38 N·m).

9.8 Install the air intake ducting between the front of the turbocharger and the air cleaner.

9.9 Connect the air restriction indicator hose to the air intake ducting. See **Fig. 2**.

10. Install the right fender splash shield. See **Fig. 1**.

11. Install the bumper and hood. For instructions, see **Group 88**.

12. If the vehicle is equipped with a battery shutoff switch, turn on the switch; otherwise, connect the batteries.

12.1 Connect the positive battery cable to the batteries.

12.2 Connect the battery ground cable to the vehicle frame.

13. Fill the engine coolant system.

13.1 Close the petcock on the bottom of the radiator.

13.2 Fill the system with coolant at the surge tank. For coolant specifications, see the vehicle maintenance manual.

13.3 Install and tighten the surge tank cap.

14. Start the engine and check for leaks.

15. After the engine has run for about 20 minutes, check the coolant level and add coolant if needed. If a new refrigerant compressor belt was installed, check the belt tension. All new belts will lose

tension after 20 minutes of operation. If necessary, tighten the belt 45 kg (100 lb).

16. Fill and bleed the power steering system as needed. For instructions, see **Group 46.**
17. Lower the hood, and remove the chocks from the tires.

Description	Grade	Size	Torque	
			N·m (lbf·ft)	N·cm (lbf·in)
Rear Engine Mount Bolt	8	3/4 inch	327 (241)	—
Front Engine Mount Bolts	8	5/8 inch	203 (150)	—
Exhaust (Header) Pipe V-Band Clamp	—	—	81 (71)	—
Radiator Strut Nuts	2	1/2–13	47 (35)	—
Radiator Mount Nuts	5	3/8–16	40 (30)	—
Air Recirculation Shield Top Bolt	5	5/16 inch	20 (15)	—
Refrigerant Compressor Bracket Mounting Capscrews	8	3/8–16	37 (27)	—
Refrigerant Compressor Mounting Capscrews	8.8	10 mm	38 (28)	—
Condenser Mounting Bolts	5	5/16 inch	20 (15)	—
Aftercooler Hose Clamps	5	6.3 mm	—	680 (60)
Air Cleaner Mounting Nuts	5	3/8–16	38 (28)	—
Power Steering Pump Mounting Bolts	8.8	25 mm	38 (28)	—

Table 1, Fastener Torques

Detroit Diesel Electronic Controls (DDEC II®) 01.08

Contents

Subject	Subject Number
General Description and Principles of Operation	050

General Description and Principles of Operation

(See Fig. 1and Fig. 2)

The DDEC II system is an electronic engine control system that is available on all Detroit Diesel Series 50 engines. The system controls engine timing and fuel injection, and monitors various engine functions. The DDEC II system is self-diagnostic, providing the operator with codes to indicate both malfunctioning components and engine-related problems. If potentially damaging engine conditions are detected, the system is capable (depending on installed options) of limiting engine operation, or completely shutting down the engine.

The center of the system is a microprocessor called the electronic control module (ECM), which controls and monitors the system. The ECM receives data from the various sensors on or near the engine, and sends commands to the electronic unit injectors on the engine, thus controlling engine speed and fuel consumption.

The driver controls the system by using the electronic foot pedal assembly (EFPA), which operates like a standard, mechanical accelerator pedal.

The "Eng Chk" light (ECL), and the "Engine Down" light inform the driver of potential problems. The ECL can also be used to read diagnostic engine codes.

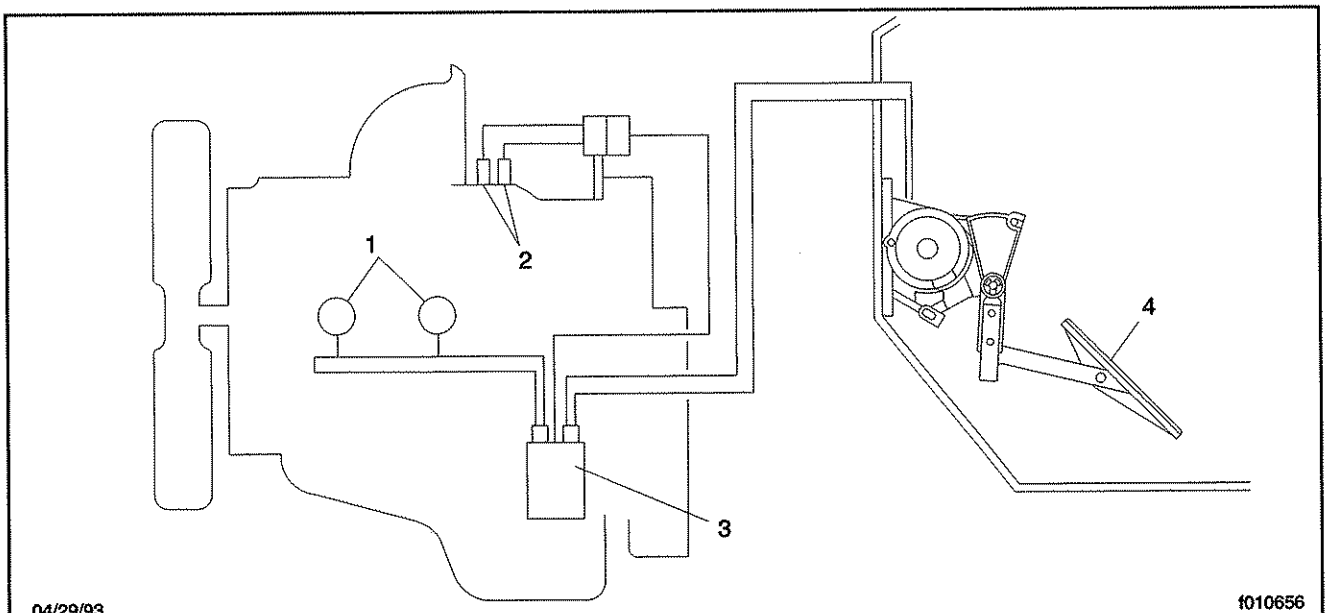
ELECTRONIC CONTROL MODULE (ECM)

The electronic control module **(Fig. 3)** is the center of the system. It is a microprocessor that controls and monitors the system, sending commands to the various engine components, and receiving data from them. The ECM contains an electrically eraseable, programmable read-only memory (EEPROM), which is encoded with engine performance data such as rated horsepower, torque curve, maximum engine speed, and optional protection features.

The ECM is located on the lower left side of the engine.

ELECTRONIC FOOT PEDAL ASSEMBLY

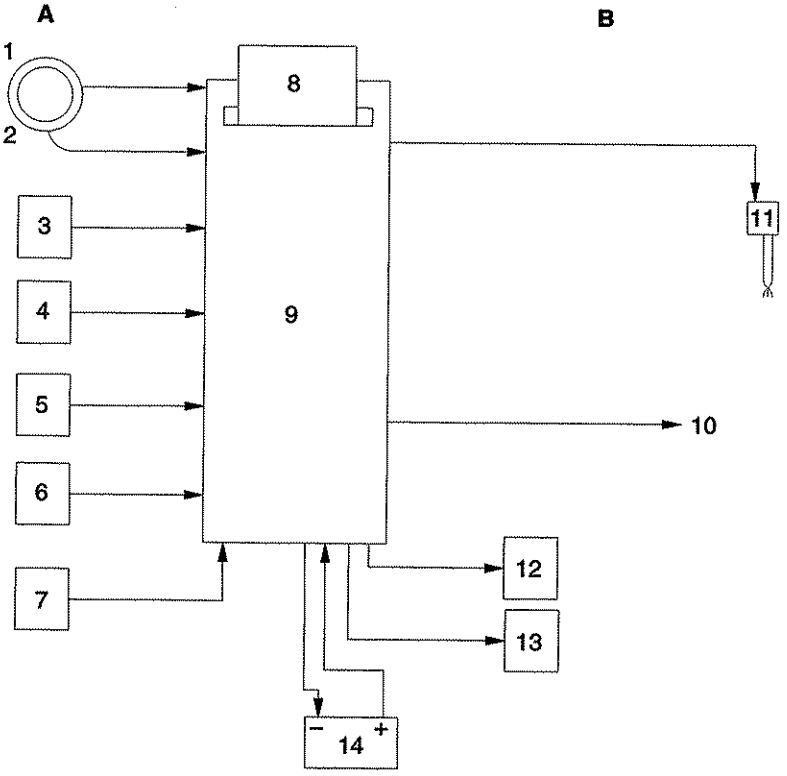
The electronic accelerator pedal operates similar to a mechanical accelerator pedal, controlling the amount of fuel injected into the cylinders, and thus engine



1. Electronic Unit Injectors
2. Sensors
3. Electronic Control Module (ECM)
4. Electronic Foot Pedal Assembly (EFPA)

Fig. 1, DDEC Components

General Description and Principles of Operation



08/13/93 f010123a

A. Inputs
B. Outputs
1. Timing Reference
2. Synch Reference
3. Turbo-Boost Pressure
4. Throttle Position
5. Oil Temperature
6. Oil Pressure
7. Coolant Level
8. EEPROM
9. Electronic Control Module
10. Diagnostic Data Link (DDL)
11. Injectors
12. Shutdown Light
13. Engine Check Light
14. Battery

Fig. 2, ECM Diagram

speed. There is no mechanical throttle linkage in the DDEC II system.

ELECTRONIC UNIT INJECTORS

The electronic unit injectors are located under the valve cover of the engine, and are not externally visible. They are controlled by the ECM, via the electronic foot pedal assembly.

SYNCHRONOUS REFERENCE SENSOR

The synchronous reference sensor, located at the rear of the engine gear case, senses when the number one piston reaches about 45 degrees before top-dead-center (BTDC). This information is sent to the ECM, which uses it to determine engine speed.

TIMING REFERENCE SENSOR

The timing reference sensor, located near the teeth of the timing wheel, senses when each piston reaches 10 degrees before BTDC. The ECM uses this information to monitor engine rpm.

TURBO BOOST PRESSURE SENSOR (TBS)

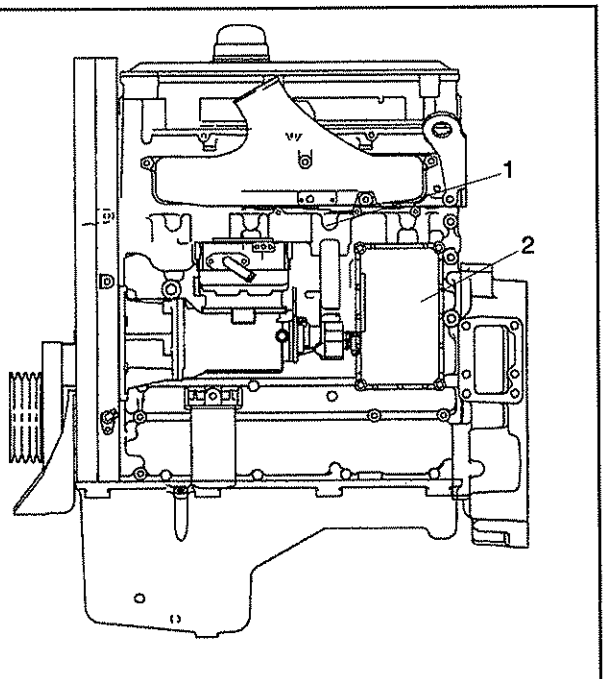
The turbo boost pressure sensor **(Fig. 3)** , located on the intake manifold, monitors the amount of air entering the engine, and transmits this information to the ECM. The ECM uses this information to regulate the fuel supply in order to control engine smoke.

OIL PRESSURE SENSOR

The oil pressure sensor (**Fig. 4**), which is connected to the main oil gallery, sends continuous electrical signals to the ECM, telling what the oil pressure is at any given speed. If a low oil pressure signal is detected by the ECM for more than seven seconds, the ECM signals the dash warning light ("Engine Down"), and if the system is so equipped, begins to shut down the engine.

OIL TEMPERATURE SENSOR

The oil temperature sensor monitors the temperature of the engine oil, and relays this information to the ECM. The ECM changes the engine speed according to this information, improving cold weather starts and providing faster warm-ups. If the oil temperature is too high for more than two seconds, the "Engine Down" dash light will come on, and if the vehicle is equipped with engine shutdown options, the engine will shut down.



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1. Turbo-Boost Pressure Sensor
2. ECM

Fig. 3

COOLANT LEVEL SENSOR (CLS)

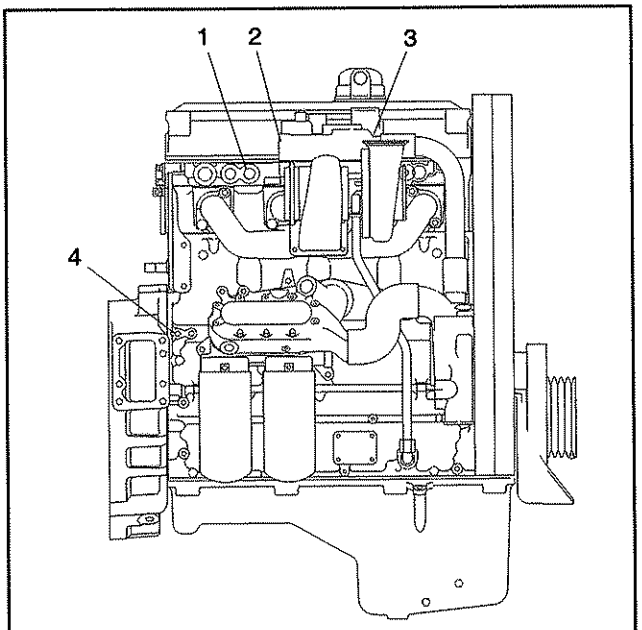
The coolant level sensor, which is located on the surge tank **(see Fig. 5)** , monitors the level and temperature of the coolant in the surge tank, and relays this information to the ECM. If the coolant level is too low, the ECM will turn

on the dash "Engine Down" light, and if the vehicle is equipped with an engine shutdown option, the engine will shut down.

DASH LIGHTS AND CONTROLS

There are two standard dash lights, the amber "Eng Chk" light and the red "Engine Down" light. Both are located on the dashboard lightbar **(see Fig. 6)** , and both light up when the ignition is turned on. If the DDEC II system and the engine are functioning normally, both lights will go out after three to eight seconds.

If the vehicle is equipped with cruise control, the cruise control system is connected to the main DDEC II system; it doesn't operate as a separate system. **See**

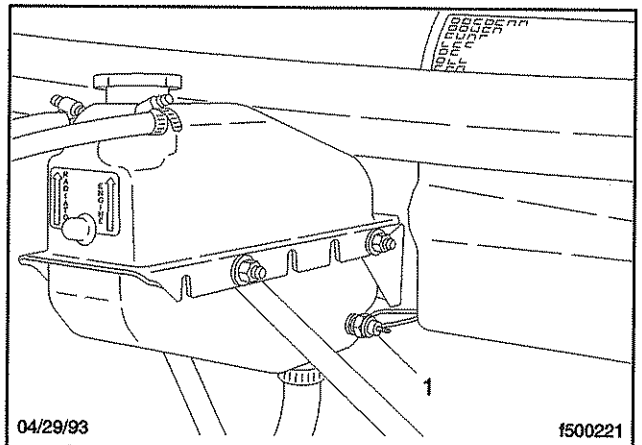


01/22/96 f010658

1. Coolant Temperature Light Switch Port
2. Coolant Temperature Gauge Port
3. Fan Control Switch Port
4. Oil Pressure Gauge Port

Fig. 4

General Description and Principles of Operation



1. Coolant Level Sensor

Fig. 5

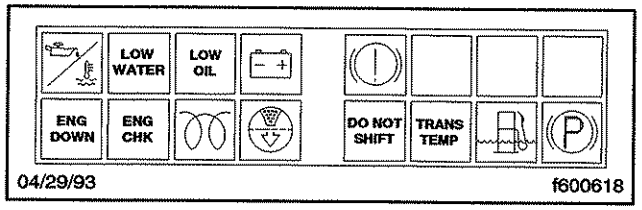
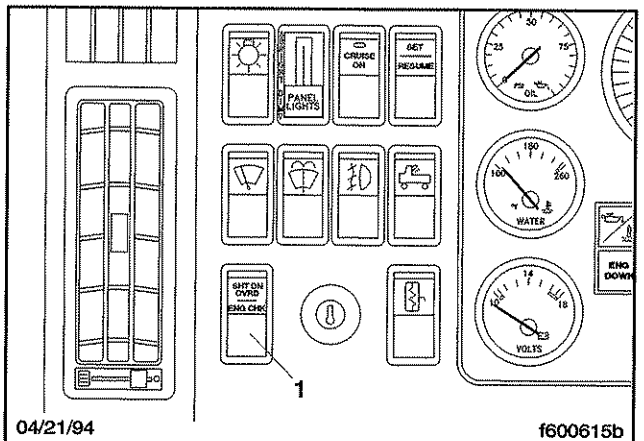


Fig. 6

Fig. 7 for the location of the cruise control switches on the dash.

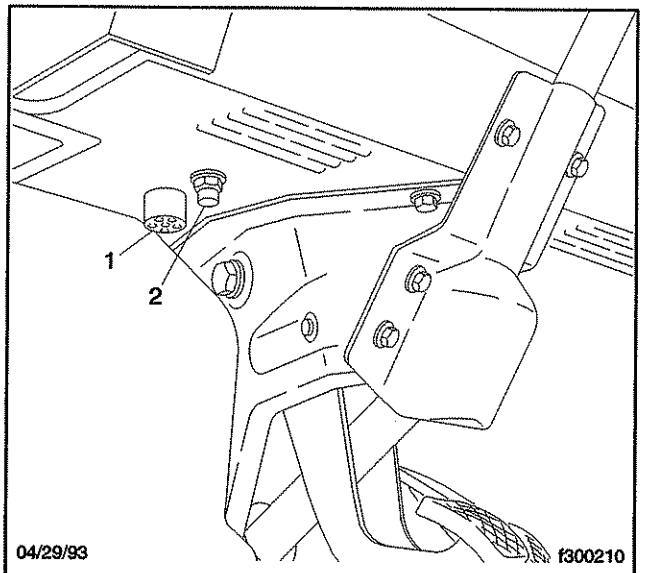
The "Eng Chk" button **(Fig. 8)** , on the bottom side of the lower left dash panel, is used to read the diagnostic codes from the "Eng Chk" light.

On vehicles with the engine shutdown option, an "Override" button allows the driver to get the vehicle off the road if the engine begins to shut down. It is on the left-side dash panel **(see Fig. 7)** .



1. Cruise Control Switch
2. Cruise Control Set/Resume Switch
3. Engine Shutdown Override Switch

Fig. 7



1. 6-Pin DDL Connector
2. Engine Check Button

Fig. 8

Detroit Diesel Electronic Controls (DDEC III®) 01.09

Contents

Subject	Subject Number
General Description	050

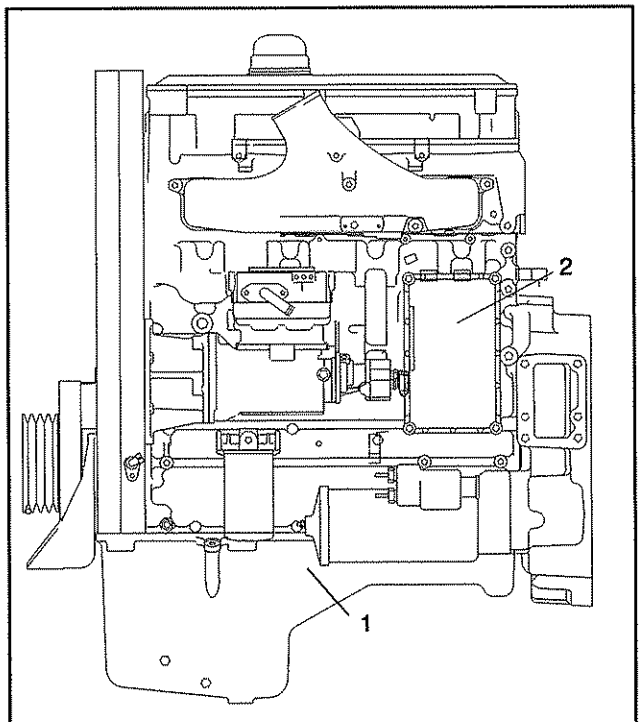
NOTE: For the DDEC III wiring diagrams, refer to the applicable section in group 54 of this manual. For troubleshooting procedures, refer to the *Detroit Diesel DDEC III Troubleshooting Guide*.

General Description

This is a general description of, first, the standard features of the Detroit Diesel Electronic Control System (DDEC III) as installed on Freightliner vehicles, and second, the components that make up DDEC III. This section has a brief description of different ways to troubleshoot the DDEC III, but doesn't have the actual troubleshooting procedures. For troubleshooting procedures and specifications, refer to the *Detroit Diesel DDEC III Troubleshooting Guide*.

To tell if an engine is equipped with DDEC II or DDEC III, find the Electronic Control Module (ECM) on the left side of the engine. **See Fig. 1.** A DDEC II Electronic Control Module has two 30-pin connectors, two 5-pin connectors, and a 6-pin connector, and all five connectors plug into *one* end of the ECM.

A DDEC III ECM has wiring harnesses plugged into *two* ends: The Detroit Diesel wiring harnesses (one 30-pin connector and two smaller connectors) plug into one end of the ECM; the Freightliner wiring harnesses (one 30-pin connector, plus a 5-pin and a 6-pin connector) plug into the opposite end of the ECM. A short, pigtail harness branches off the harness coming from the 30-pin connector on the Detroit Diesel side of the ECM. This pigtail harness wraps around the ECM and ends in a 3-pin connector near the Freightliner side. The pigtail harness connects with the Freightliner electrical engine harness.



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1. Detroit Diesel Series 50 Engine
2. Electronic Control Module (ECM)

Fig. 1, Electronic Control Module Location

FEATURES

The Detroit Diesel Electronic Control System (DDEC III) controls and monitors Detroit Diesel Series 50 engines installed in Freightliner vehicles. DDEC III, first offered with Detroit Diesel 1994 engines, can protect the engines from serious damage caused by:

- High Coolant Temperature
- High Oil Temperature
- Low Coolant Level
- Low Oil Pressure

If coolant or oil temperatures rise too high, or if coolant level or oil pressure drop too low, dash warning lights will light and a buzzer will sound. If this engine condition continues, the standard DDEC III system is programmed to shut down the engine.

The brain of the DDEC III system is an electronic control module (ECM). The ECM receives information from the engine sensors provided on the engine by Detroit Diesel, and information from the electronic throttle pedal, vehicle speed sensor, and coolant level sensor provided by Freightliner. Comparing this information with the calibration tables in its memory, the ECM controls the fuel timing and quantity of fuel that the electronic unit (fuel) injectors deliver to the engine. This control improves fuel economy and lowers exhaust emissions.

The DDEC III system also provides limiting and variable speed governing. The Limiting Speed Governor fuels the engine according to the driver's use of the throttle. An optional Variable Speed Governor will hold the engine at a constant requested speed (within engine capabilities) regardless of load changes such as hills or winds. The Variable Speed Governor is usually used to provide steady, even power to a PTO (controlled with the cruise control switches while the vehicle is parked), and it will hold the engine speed constant without increased use of the hand throttle or throttle pedal.

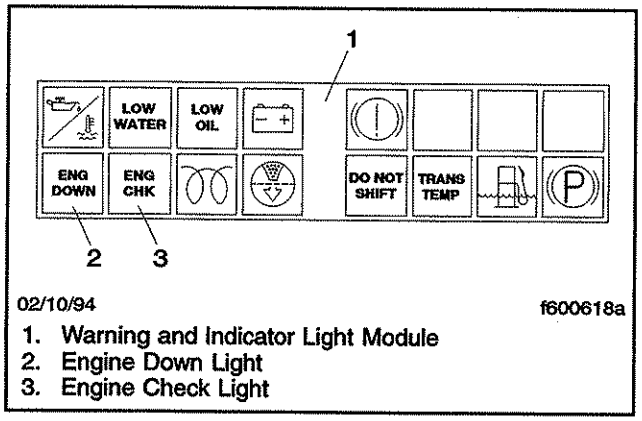
General Description

While controlling fuel delivery to the unit injectors, the ECM also monitors sensor reports about oil temperature, fuel temperature, etc. If any of the sensors report a problem, the ECM activates first the "Engine Check" light and then the "Engine Down" light in the warning and indicator light module. **See Fig. 2.** The Engine Check light will come on if the problem is minor enough that it can be solved as soon as convenient. If the problem resolves itself, for example, if the coolant temperature drops back down into the acceptable range, the Engine Check light will go out. However, if the problem gets worse: For example, if the coolant or oil temperature continues to rise, the ECM will reduce engine power by cutting the fuel to the injectors. As the problem gets worse, the ECM will continue to cut fuel until engine power is reduced by 30 percent. At that point, (if the engine is programmed with the shutdown option) the ECM will turn on the Engine Down light. Thirty seconds after that, the ECM will shut down the engine by not delivering any fuel to the injectors.

NOTE: If the driver cannot move the vehicle to safety within thirty seconds, the driver must press the Shutdown Override/Engine Check switch immediately after the Engine Down light comes on. Pressing the switch just before shutdown will keep the engine running for thirty more seconds.

If the engine is not programmed to shut down, the ECM will continue to cut fuel delivery to the injectors until the engine is running at 40 percent of original power.

After an emergency engine shutdown, the Shutdown Override/Engine Check switch allows the driver to re-start the engine for thirty seconds and move the vehicle to a new location. Turn the ignition off and then on, and press the override switch. **See Fig. 3.** For additional time, the driver must press the override switch again, every thirty seconds. Emergency engine warning, power derate, and engine shutdown are standard on engines equipped with DDEC III, but an engine can be programmed to give a warning and then cut engine power without shutting down. To re-program engine options, contact your nearest Freightliner or Detroit Diesel dealer.



1. Warning and Indicator Light Module
2. Engine Down Light
3. Engine Check Light

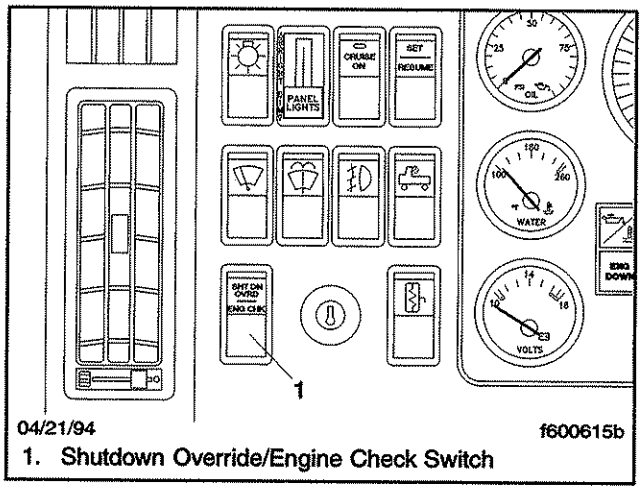
Fig. 2, DDEC III Light Module

Diagnostics

If the DDEC III reports an engine problem, you have two ways to diagnose it:

- Press the Shutdown Override/Engine Check switch (on the left dash panel) and watch the codes flashed by the Engine Check and Engine Down light. Two types of flash codes represent engine problems. The first type, active codes, represent existing problems and keep the Engine Check or Engine Down light lighted. The second type, historical codes, represent problems that are logged in the ECM but are not active.

  If the Engine Check light and Engine Down light stay on, the engine has a problem, and the DDEC III has a flash code ready to represent that problem. To read the flash code, turn on the ignition or idle the engine, and wait for five seconds. Then press and hold the Shutdown Override/Engine Check switch. The Engine Down light will flash a number of times to represent the code for the problem. For



1. Shutdown Override/Engine Check Switch

Fig. 3, Shutdown Override/Engine Check Switch

example, the code 13 would be one Engine Down light flash followed by a pause, then three more flashes. If the engine has more than one problem, a code for each of the problems will flash with a pause of several seconds between them. **See Fig. 4.** After all the active codes have flashed, or if there are no active codes, the Engine Down light will flash code 25. After that, the Engine Check light will flash any historical codes for problems that are not active but are logged in the ECM. After all the historical codes have flashed, or if there are no historical codes, the Engine Check light will flash code 25. For the meaning of the flash codes, refer to the *Detroit Diesel DDEC III Troubleshooting Guide.*

- Use a hand-held Diagnostic Data Reader (DDR) equipped with a DDEC III cartridge. With the ignition turned on or the engine idling, connect the reader to the Deutsch six-pin connector under the lower, left dash panel. If using a DDR, choose reader Mode 01 to read the active codes, and choose Mode 02 to read the historical codes.

Idle Shutdown Timer

The same system that shuts down the engine during a problem also shuts down the engine if the customer requests the optional idle shutdown time. With an idle shutdown timer, the engine automatically shuts down after idling for a predetermined number of minutes. That length of time can be set anywhere between two minutes and 99 minutes. To start the engine after the idle shutdown timer has shut it down, turn the key all the way off, then turn the key on. To make the engine idle longer than the predetermined length of time, release and immediately re-apply the parking brake, or press the throttle pedal while the engine is idling and rev the engine slightly. Ninety seconds before the engine shuts down, the Engine Check light will flash. Step on the throttle pedal and rev the engine during this time, and the engine will idle indefinitely.

COMPONENTS

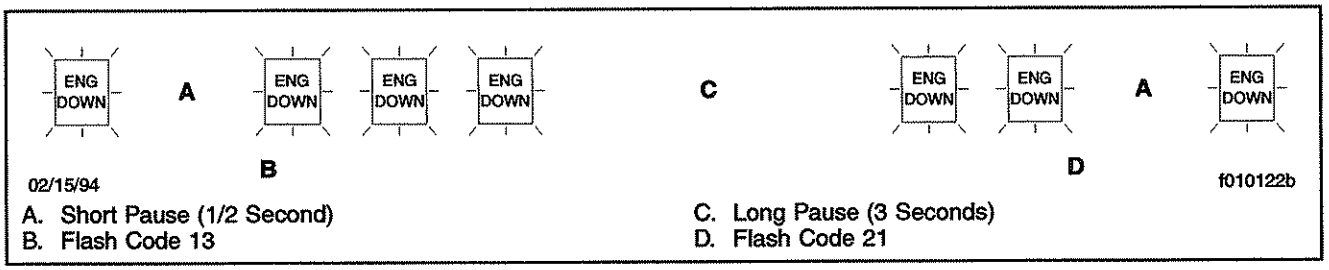
Electronic Control Module

The Electronic Control Module (ECM) is mounted on the lower left side of Detroit Diesel Series 50 engines. Four wiring harnesses connect to the ECM. Two Detroit Diesel harnesses plug into one end of the ECM; two Freightliner harnesses plug into the opposite end.

On the Freightliner end, the first harness, the power harness, runs from the batteries to the ECM, and includes a single 15 amp fuse. **See Fig. 5** and **Fig. 6.** The fuse is mounted on the battery box, and if the fuse fails, the engine will not run. At the engine, the five-pin power harness connector plugs into the ECM, and the harness's single-pin connector plugs into a connector on the Freightliner electrical engine wiring harness.

NOTE: Before troubleshooting the DDEC III system, make sure the fuses and circuit breaker for the power harness and the ignition circuit are good.

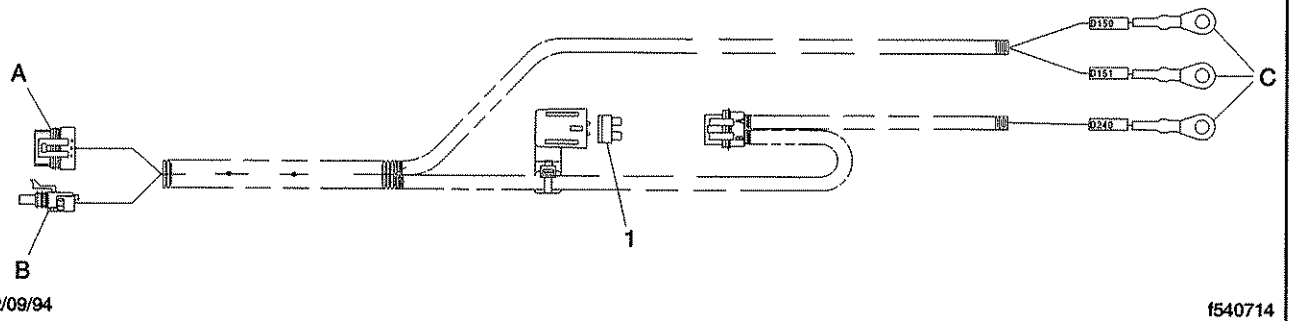
The second harness, the Freightliner electrical engine wiring harness, connects the ECM and the sensors installed by Freightliner (the low coolant level sensor and the vehicle speed sensor) to the cab wiring. **See Fig. 6** and **Fig. 7.** This engine wiring harness also connects the ECM to the tachometer. Three of the wiring harness's connectors plug into the ECM. Two of these connectors, the 30-pin connector and the six-pin connector plug into the Freightliner end of the ECM; the third connector, the 3-pin connector, plugs into a short pigtail harness that is routed around from the opposite end of the ECM. A fourth connector near the ECM, plugs into the single-pin connector on the power harness. At the firewall, the cab interface connector plugs the harness into the cab wiring harness. The low coolant level sensor branch of the harness plugs into the sensor in the radiator surge tank. The vehicle



A. Short Pause (1/2 Second)
B. Flash Code 13
C. Long Pause (3 Seconds)
D. Flash Code 21

Fig. 4, DDEC III Flash Codes

General Description



A. Connect to the ECM.
B. Connect to the Freightliner electrical engine harness.
C. Connect to the batteries.
1. 15-Amp Fuse

Fig. 5, Freightliner Power Harness

speed sensor branch of the harness plugs into the sensor at the transmission output.

On the Detroit Diesel end of the ECM are one 30-pin connector and two smaller connectors.

The 30-pin connector is on the third wiring harness: The harness that connects the ECM to the turbo boost pressure sensor, the timing and synchronous reference sensors, the temperature sensors for the air, oil, fuel, and coolant, and pressure sensors for the fuel, oil, and coolant. **See Fig. 8.** This harness includes a smaller pigtail harness that runs from the Detroit Diesel end of the ECM and ends in a 3-pin connector near the Freightliner end. This pigtail harness connects to a 3-pin connector at the end of the Freightliner electrical engine wiring harness.

The two smaller wiring connectors plugged into the Detroit Diesel end of the ECM belong to the fourth wiring harness. This harness connects the ECM to the electronic fuel injectors.

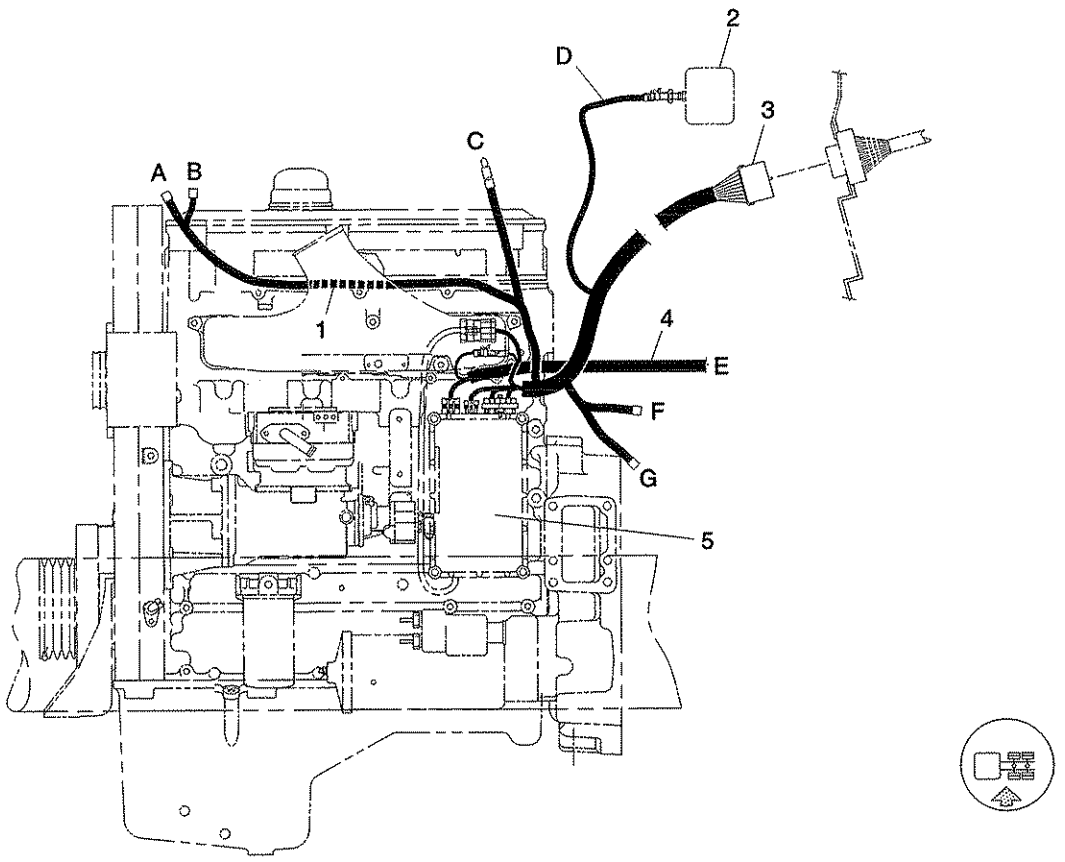
A fifth wiring harness, the Freightliner non-electronic component wiring harness (**Fig. 9** and **Fig. 10**), connects cab and chassis wiring at the bulkhead connectors to parts within the engine compartment, including:

- The air conditioning pressure switch
- The magnetic switch
- The starter
- The back-up light and alarm switch
- The transmission oil temperature sender
- The ether start system
- The fan solenoid
- The alternator
- The ammeter shunt

The ECM makes continuous self-diagnostic checks and monitors the DDEC III system from ignition through all engine operating modes. The ECM contains an Electronically Erasable Programmable Read Only Memory (EEPROM), which controls the basic engine functions, including:

- Rated Speed and Power
- Fuel Injection Timing
- Engine Governing
- Torque Shaping
- Cold Start Logic
- Transient Fuel Delivery
- Diagnostics
- Engine Protection

For precise fuel delivery and improved fuel economy, the control logic uses calibration tables to determine the duration and timing of fuel delivery to the electronic unit injectors.



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A. Connect to the fan solenoid.
B. Connect to the Freightliner non-electronic component wiring harness.
C. Connect to the air conditioning switch.
D. Connect to the low coolant level sensor.
E. Route to the batteries.
F. Connect to the tachometer.
G. Connect to the vehicle speed sensor.

1. Freightliner Electrical Engine Harness
2. Surge Tank
3. Bulkhead Connector
4. Freightliner Power Harness
5. Electronic Control Module

Fig. 6, Freightliner Electrical Engine and Power Harnesses

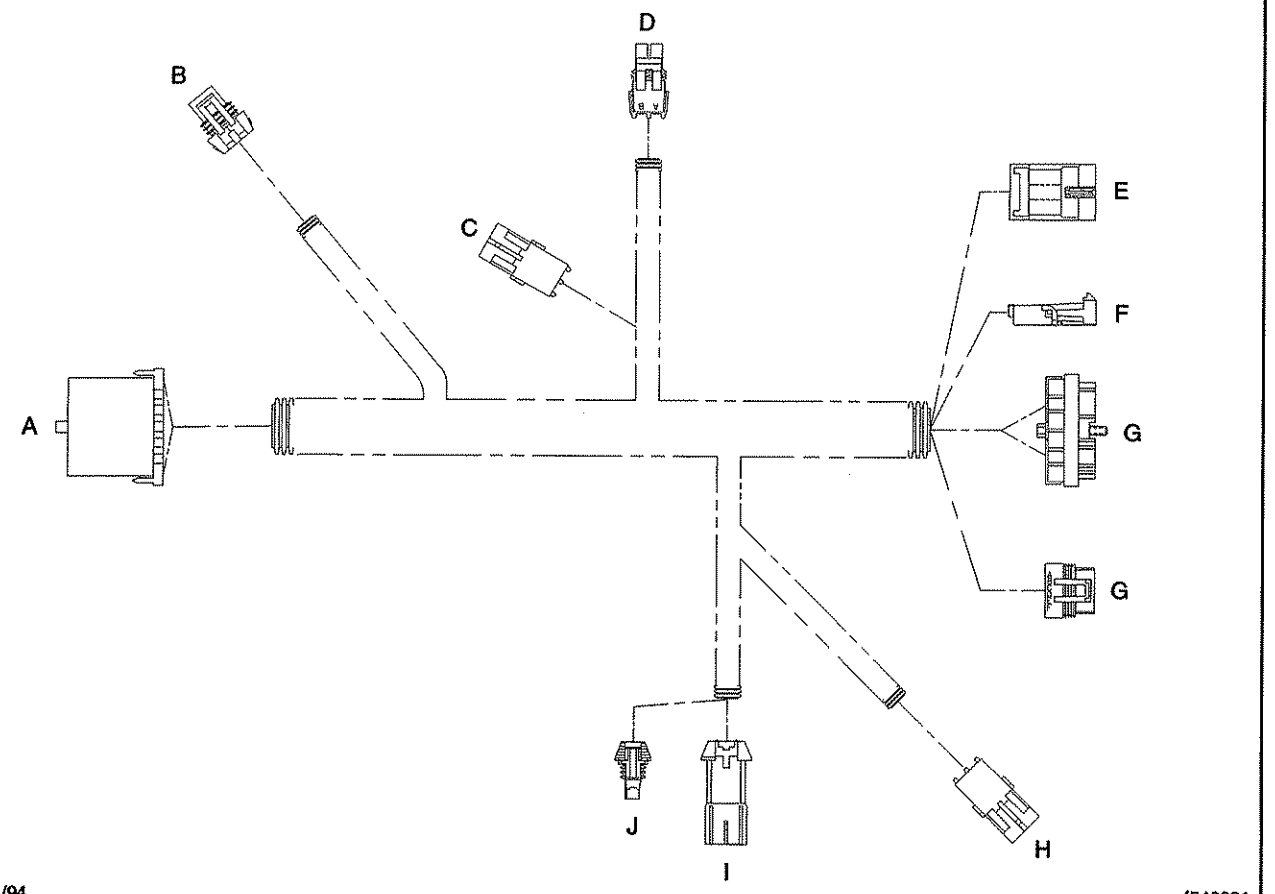
ECM Programming

In production, Freightliner programs the Electronically Erasable Programmable Read Only Memory (EEPROM) with the standard engine operating features and any options the customer has specified. Currently, the standard program includes engine shutdown, but the option is available to only cut engine power in emergency situations. To re-program the EEPROM, take the vehicle to the nearest Freightliner or Detroit Diesel dealership.

Electronic Unit Injectors

The Electronic Unit (fuel) Injectors (EUI) operate the same as Detroit Diesel mechanical unit injectors: the cam/rocker arm system powers the high fuel delivery pressure. However, on the EUI, a solenoid controlled by the ECM controls fuel injection timing and fuel quantity. When the solenoid valve closes, fuel injection begins. When the solenoid opens, fuel injection ends. As long as the ECM keeps the solenoid closed, the unit injector injects fuel into the cylinder.

General Description



A. Connect to the cab interface connector.
B. Connect to the low coolant level sensor.
C. Connect to the tachometer.
D. Connect to the vehicle speed sensor.
E. Connect to the ECM (the short pigtail harness from the Detroit Diesel end of the module).
F. Connect to the power harness.
G. Connect to the ECM (Freightliner side of the module).
H. Connect to the air conditioning switch.
I. Connect to the fan solenoid.
J. Connect to the Freightliner non-electronic component wiring harness.

Fig. 7, Freightliner Electrical Engine Wiring Harness

Timing and Synchronous Reference Sensors

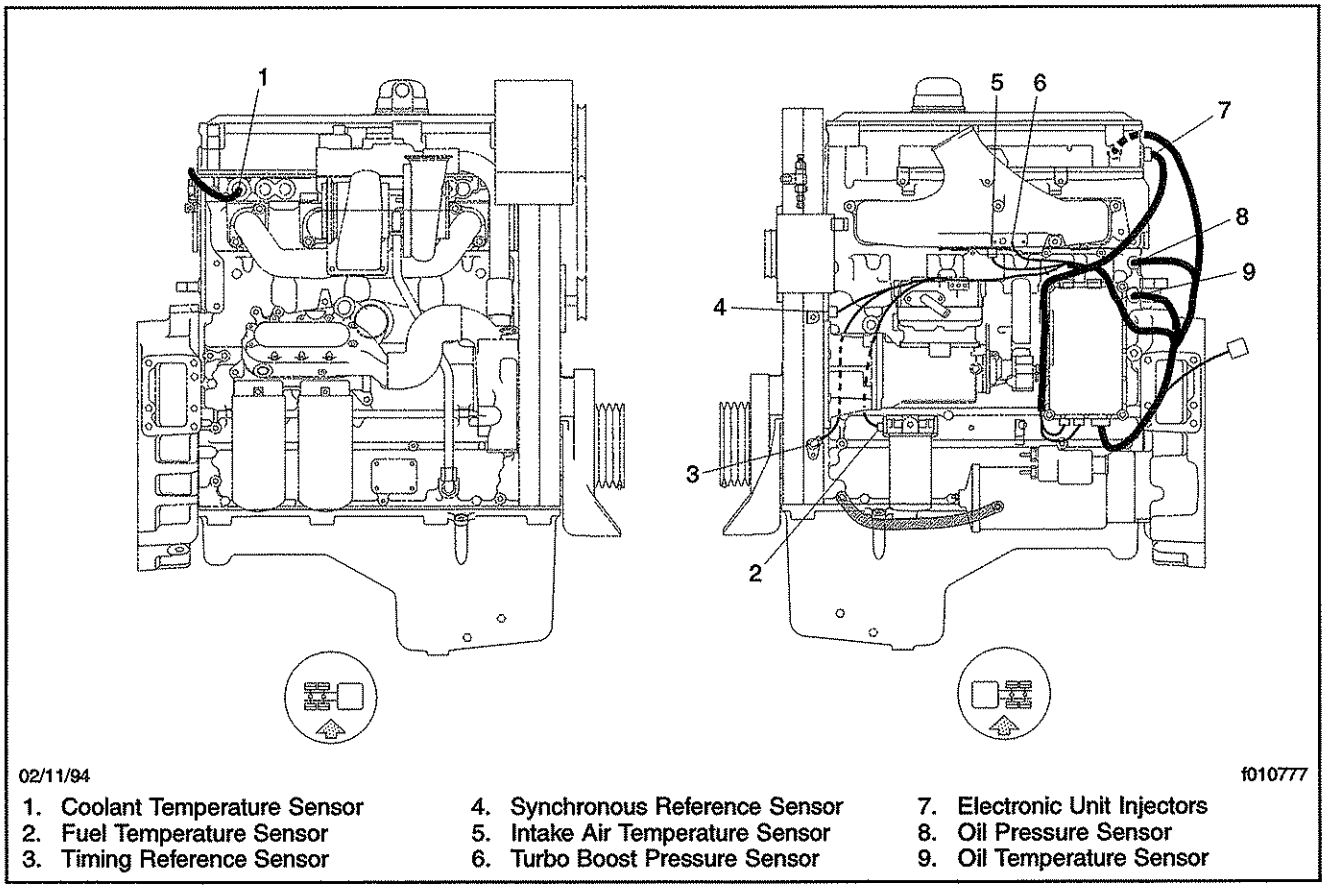
The timing reference sensor (TRS) tells the ECM the engine rpm. This sensor is installed in front of the air compressor, below the air compressor drive. **See Fig. 8.** The synchronous reference sensor (SRS) indicates a specific cylinder in the firing order. It is installed in front of the air compressor, above the air compressor drive.

Turbo Boost Pressure Sensor

The Turbo Boost Sensor (TBS) is installed in the side of the air intake manifold, and monitors the pressure of the engine intake air after it has been pressurized by the turbocharger and cooled by the aftercooler. **See Fig. 8.** The ECM uses information from the TBS to control engine smoke.

Oil Pressure Sensor (See Fig. 8)

The oil pressure sensor is installed in the engine block, right below the rear end of the air intake manifold. This



1. Coolant Temperature Sensor
2. Fuel Temperature Sensor
3. Timing Reference Sensor
4. Synchronous Reference Sensor
5. Intake Air Temperature Sensor
6. Turbo Boost Pressure Sensor
7. Electronic Unit Injectors
8. Oil Pressure Sensor
9. Oil Temperature Sensor

Fig. 8, Detroit Diesel Wiring Harnesses and Sensors on Series 50 Engine With DDEC III

sensor tells the ECM the engine oil pressure in the gallery, and the ECM compares this pressure to the engine rpm. **See Fig. 11.** If oil pressure falls too low in relation to engine rpm, the ECM turns on the Engine Check light and Engine Down light, and an engine oil pressure switch turns on the low oil pressure warning light and buzzer. Thirty seconds later, the ECM shuts down the engine (if the engine is programmed with shutdown protection).

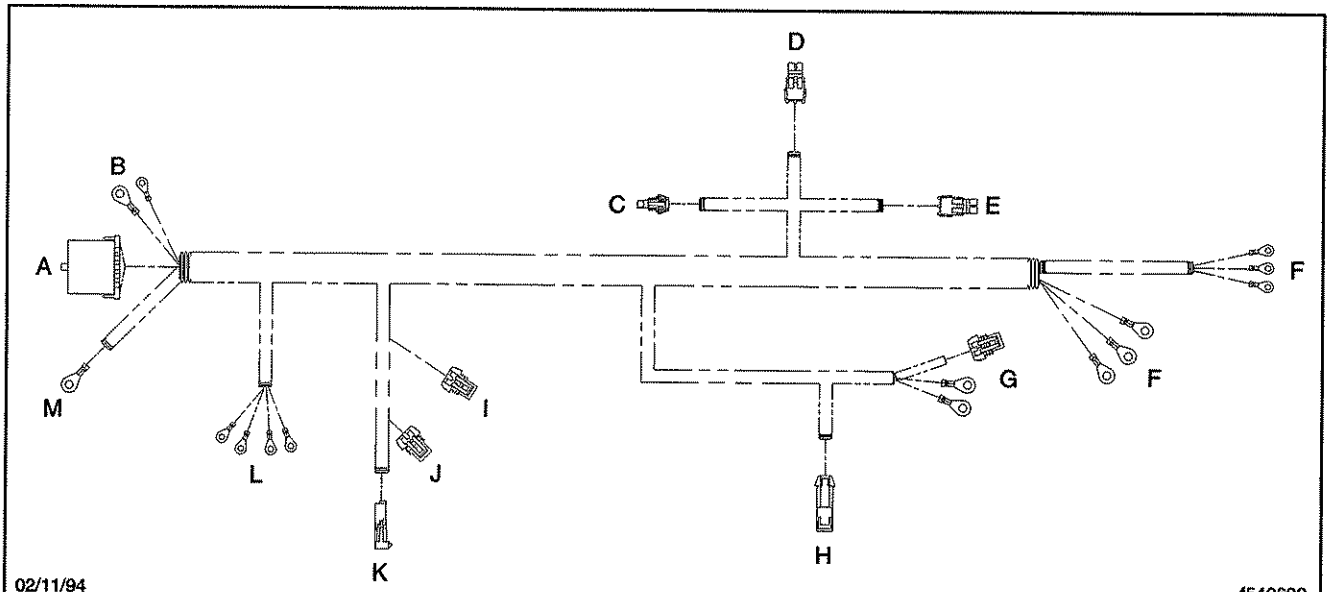
Fuel, Air, Coolant, and Oil Temperature Sensors (See Fig. 8)

The fuel temperature sensor, installed in the secondary fuel filter, measures fuel temperatures for the ECM to use when calculating fuel consumption and fuel input compensation. If the fuel temperature rises above 100°F (38°C), the ECM will increase fuel delivery to the injectors. This increase in volume compensates for the warmer, less dense fuel. If the fuel temperature rises to 140°F (60°C), the ECM will no longer increase the fuel delivery to the injectors. The ECM drops fuel delivery back to the original rate because, at this temperature, the fuel and engine are too hot.

The intake air temperature sensor, installed in the under-side of the air intake manifold, reports engine intake air temperature to the ECM so the ECM can vary the hot idle speed and injection timing for better cold starts and less white smoke.

The coolant temperature sensor, installed in the coolant jacket above the rear end of the exhaust manifold, tells the ECM if coolant temperature exceeds 217°F (103°C). At that temperature, a coolant temperature switch turns on the high coolant temperature light and buzzer, and the ECM turns on the Engine Check light and begins to cut engine power. If the coolant reaches 223°F (106°C), the ECM turns on the Engine Down light and shuts down the engine (if the engine is programmed with shutdown protection).

General Description



A. Connect to cab interface.
B. Connect to ground stud.
C. Connect to back-up light switch harness.
D. Connect to the vehicle speed sensor.
E. Connect to the tachometer.
F. Connect to the starter.
G. Connect to the alternator.
H. Connect to the electronic engine harness (fan).
I. Connect to the coolant high temperature sender.
J. Connect to the coolant high temperature switch.
K. Connect to the refrigerant compressor.
L. Connect to the magnetic switch.
M. Connect to the power stud.

Fig. 9, Freightliner Non-Electronic Component Wiring Harness, Detroit Diesel Series 50 Engine

The oil temperature sensor is installed below the oil pressure sensor, below the rear end of the intake air manifold. **See Fig. 8.** It reports oil temperature to the ECM so the ECM can vary idle speed and injection timing for better cold starts and less white smoke. If oil temperature exceeds 250°F (121°C), the ECM activates the Engine Check light and begins to cut engine power. If the oil temperature reaches 260°F (127°C) the ECM turns on the Engine Down light and shuts down the engine (if the engine is programmed with shutdown protection).

Throttle Position Sensor

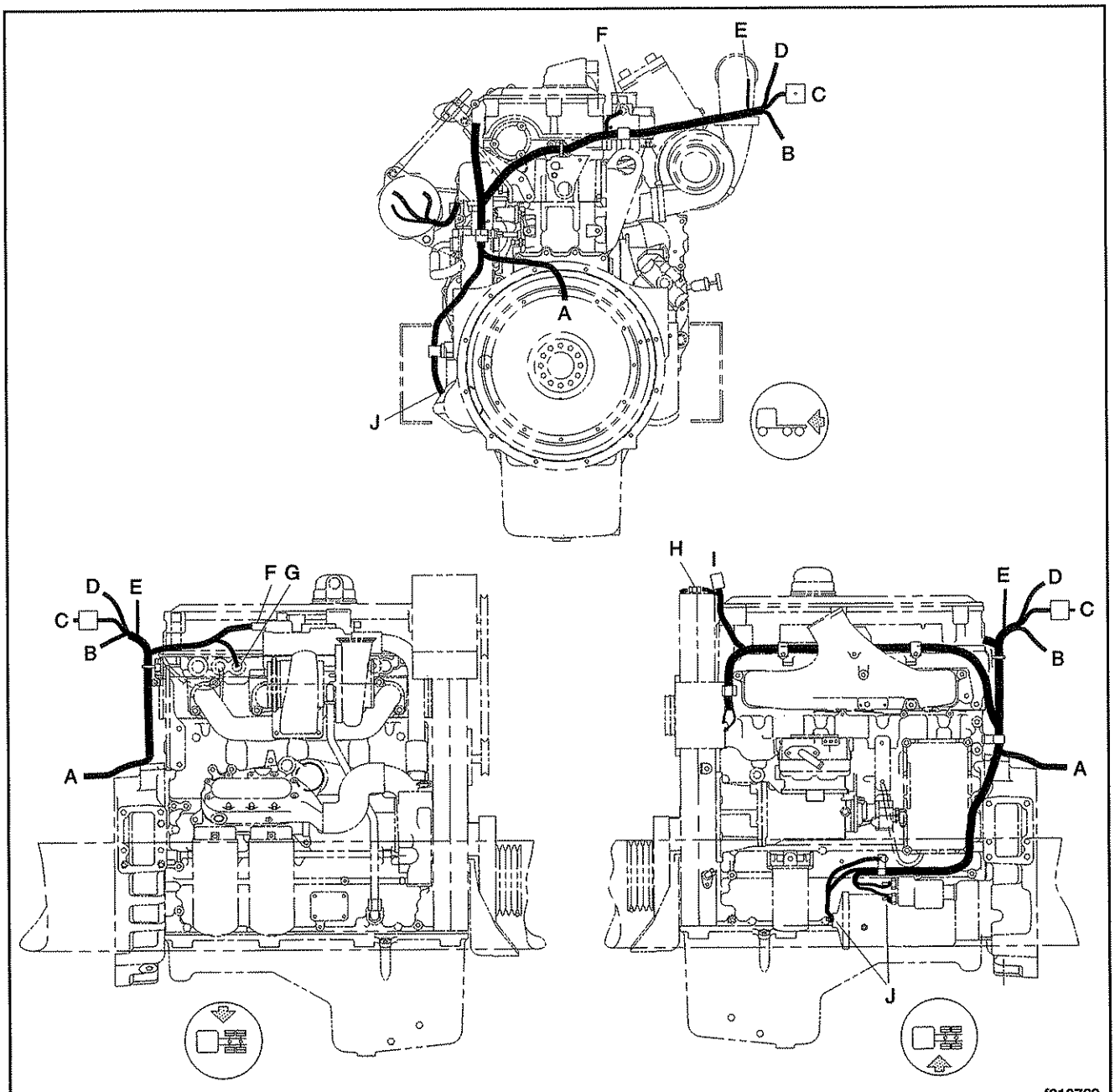
The throttle position sensor is part of the electronic foot pedal assembly. Freightliner uses the Williams Electronic throttle pedal with DDEC III systems. There is no mechanical throttle linkage.

NOTE: Williams throttle pedals made to work with DDEC II will work with DDEC III, but the reverse is not true.

Coolant Level Sensor (See Fig. 12)

Freightliner installs the coolant level sensor in the radiator surge tank. The coolant grounds the sensor, so if the coolant level drops below the sensor for more than seven to ten seconds, the low coolant level warnings begin. The warning means more than 10% of the engine coolant is missing, and this early warning will prevent coolant aeration and water jacket cavitation.

NOTE: If a vehicle is equipped with an optional transmission retarder, and the ECM is reprogrammed by Detroit Diesel, the low coolant level warning light may come on when the transmission retarder is on. For these two functions (coolant level and transmission retarder), Freightliner uses different pin locations on the 30-pin ECM connectors than are specified by Detroit Diesel. This is not a problem because Freightliner also programs the ECM; however, if Detroit Diesel reprograms the ECM, the coolant level and transmission retarder functions will be switched back to the connector pins that Detroit Diesel specifies. If this happens,



A. Route to the transmission.
B. Route to the ground stud.
C. Route to the bulkhead connector.
D. Route to the power stud.
E. Route to the magnetic switch.
F. Route to the coolant temperature gauge sender.
G. Route to the high coolant temperature lamp switch.
H. Route to the electronic engine harness.
I. Route to the refrigerant compressor.
J. Route to the starter.

Fig. 10, Freightliner Non-Electronic Component Wiring Harness, Detroit Diesel Series 50 Engine

General Description

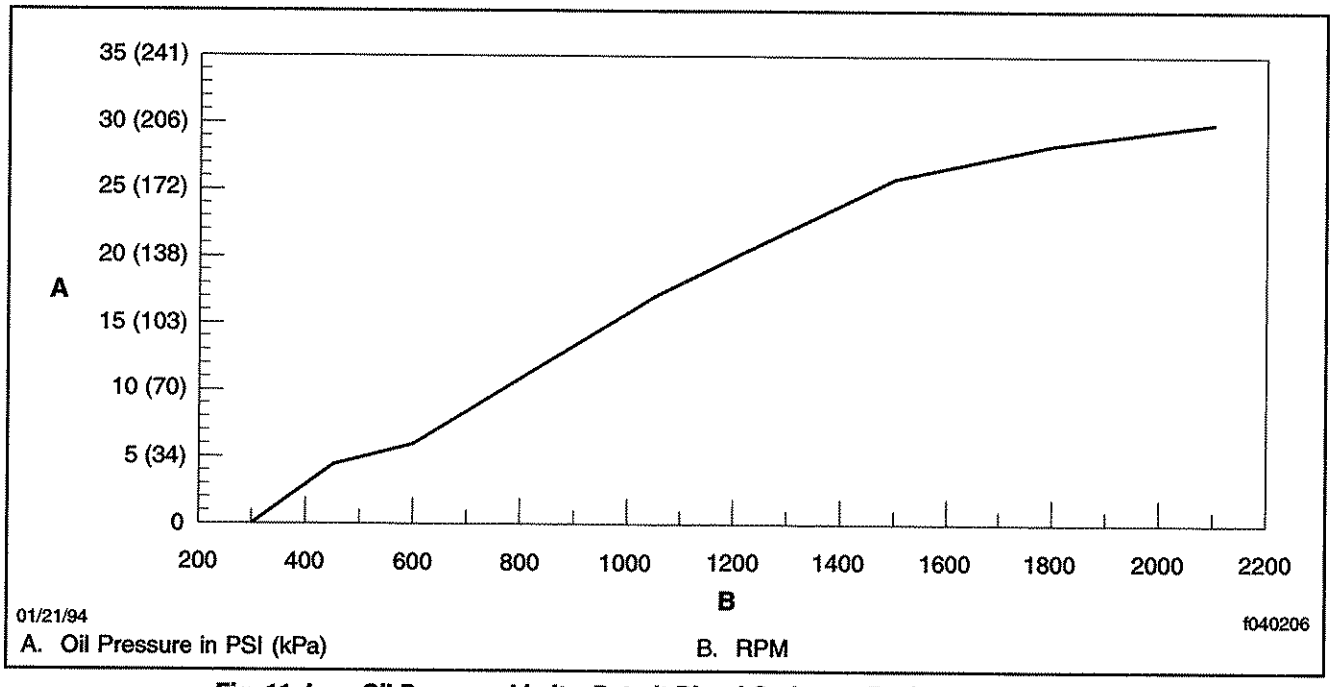


Fig. 11, Low Oil Pressure Limits, Detroit Diesel Series 50 Engines with DDEC III

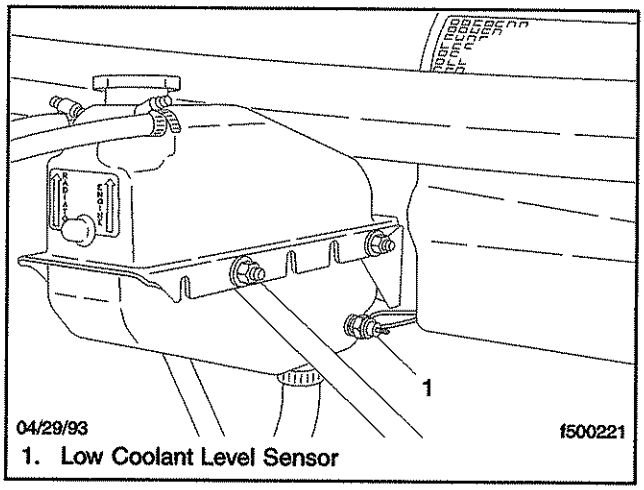


Fig. 12, Sensor Location in Surge Tank

the low coolant level warning light will come on when the transmission retarder is on. If Detroit Diesel reprograms the ECM for a new exhaust brake, the low coolant level light may stay on continuously. For specific circuits and wiring schematics, refer to the DDEC section in **Group 54** of this manual.

Vehicle Speed Sensor

The vehicle speed sensor is installed in the transmission output, and sends vehicle speed signals to the speedometer and to the ECM. The ECM uses this signal for cruise control and for vehicle speed limiting.

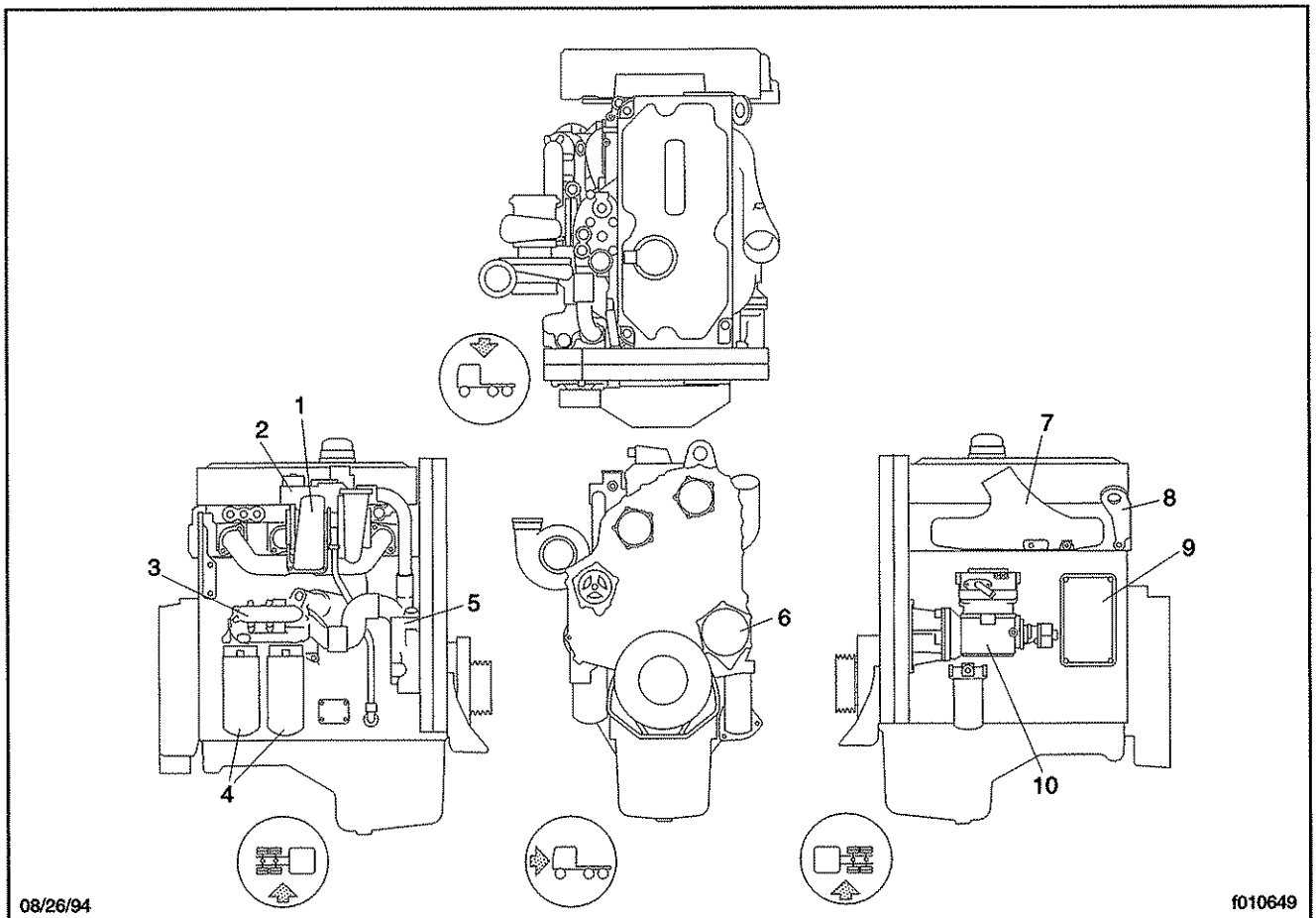
Contents

Subject	Subject Number
Service Operations	
Removal and Installation	100

Removal (See Fig. 1)

1. Apply the parking brakes, chock the tires, and drain the air system.
2. If the vehicle is equipped with a battery shutoff switch, turn off the switch; otherwise, disconnect the batteries.
   2.1 Disconnect the battery ground cable at the vehicle frame.
   2.2 Disconnect the positive battery cable from the batteries.
3. Disconnect the transmission. For instructions, refer to **Group 26** in this service manual.

NOTE: To remove the transmission from a Detroit Diesel Series 50 engine in a Medium Truck, it may be necessary to remove the air regulator from the transmission and lower the transmission or raise the rear of the vehicle so that the transmission will clear the crossmember directly behind it.



1. Turbocharger
2. Thermostat Housing
3. Oil Cooler
4. Oil Filters
5. Water Pump
6. Accessory Drive (Power Steering Fluid Pump)
7. Air Intake Manifold
8. Rear Engine Lifting Eye
9. Electronic Control Module
10. Air Compressor

Fig. 1, Detroit Diesel Series 50 Engine Components

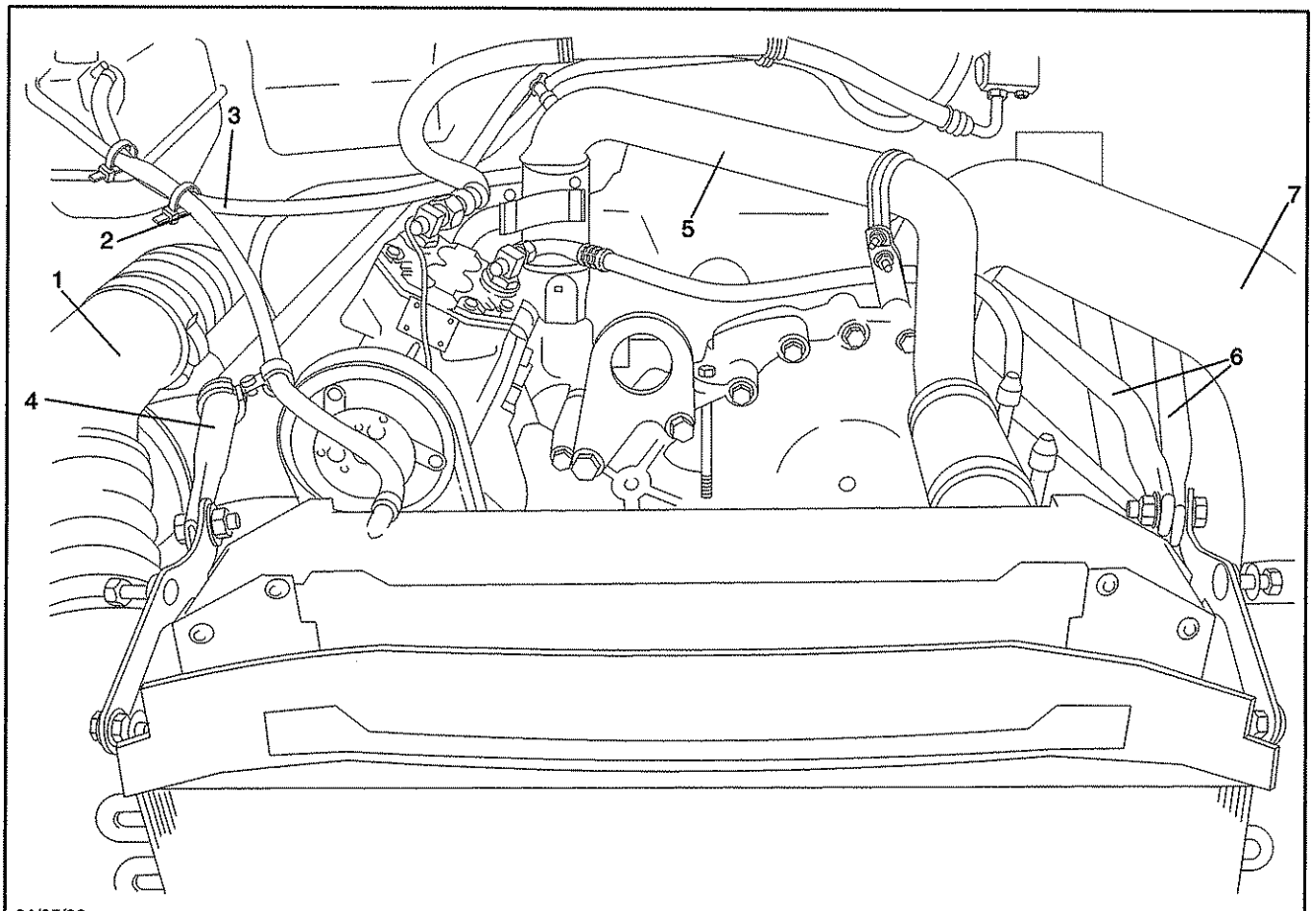
Removal and Installation

4. Remove the hood, bumper and left front half-fender. For instructions, refer to the cab group in the vehicle service manual.

⚠ 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.

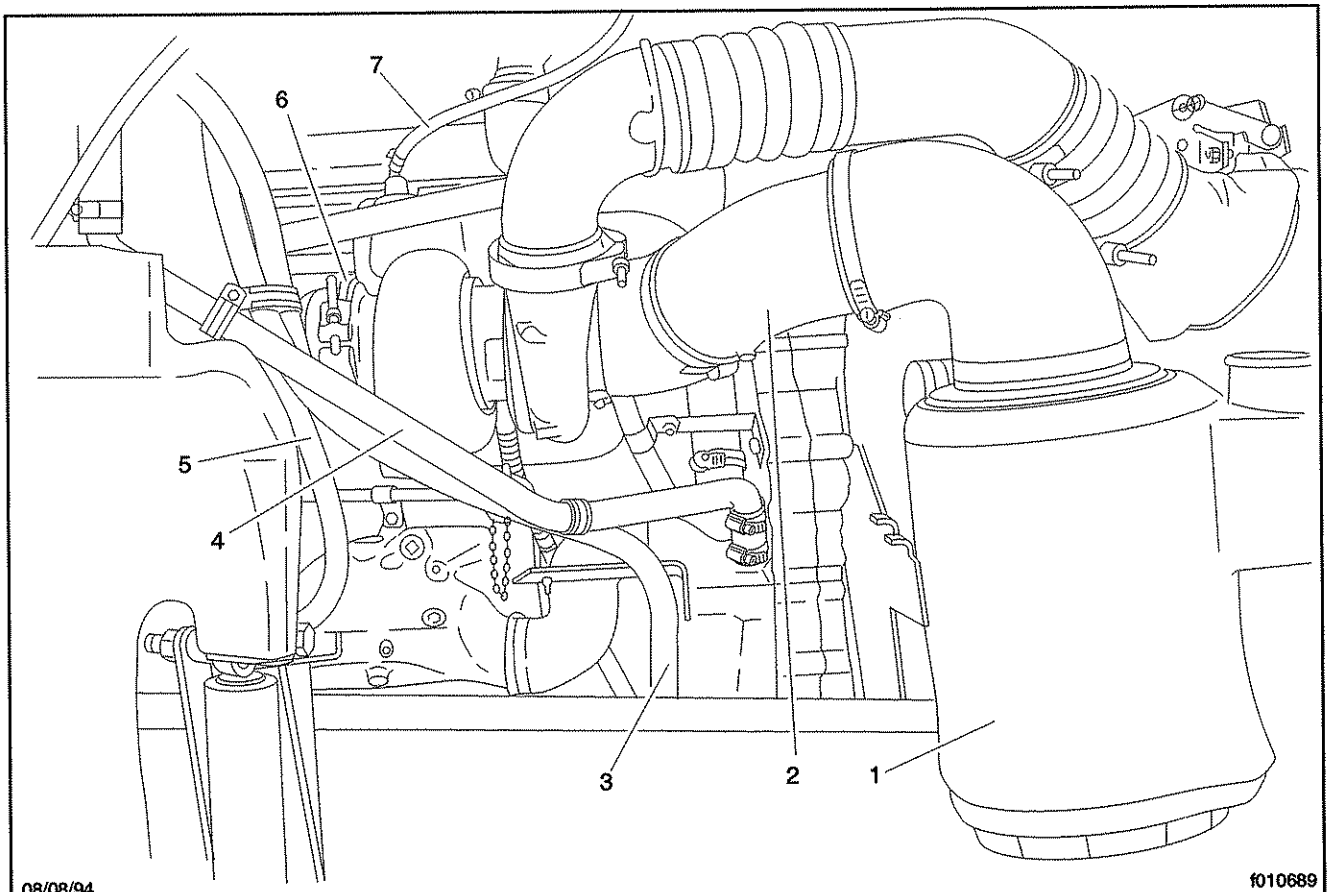
5. Drain the radiator.
   - 5.1 Open the coolant drain at the bottom of the radiator.
   - 5.2 Loosen the surge tank cap.
   - 5.3 To drain the coolant from the engine block, remove the water jacket plug at the bottom of the water pump, on the inboard side of the coolant inlet from the radiator.
6. Remove the right fender splash shield.
7. Remove the air cleaner and intake air ducting. See **Fig. 2** and **Fig. 3**.
   - 7.1 Remove the hoses and convoluted tubing that run between the turbocharger and the aftercooler, and between the aftercooler



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1. Intake Air Ducting, Turbocharger-to-Aftercooler
2. Radiator Vent Hose
3. Engine Vent Hose
4. Radiator Brace Rod Strut, Right-Side
5. Radiator Inlet Pipe
6. Radiator Brace Rod Struts, Left-Side
7. Intake Air Ducting, Aftercooler-to-Engine

Fig. 2, Air Cleaner and Air Ducting



1. Air Cleaner Housing
2. Air Intake Ducting, Air Cleaner-to-Turbocharger
3. Heater Supply Hose
4. Coolant Fill Pipe
5. Heater Return Hose
6. V-Band Clamp
7. Engine Vent Line

Fig. 3, Coolant Hoses

and the engine intake manifold. Cover the turbocharger inlet with a clean shop rag.

7.2 Remove the ducting that runs between the air cleaner and the turbocharger.

7.3 Disconnect the right-side air recirculation shield from the radiator, and remove the shield with the air cleaner. See **Fig. 4.**

7.4 Remove the fasteners that hold the air cleaner mounting bracket to the frame rail, and remove the bracket and the air cleaner housing, together.

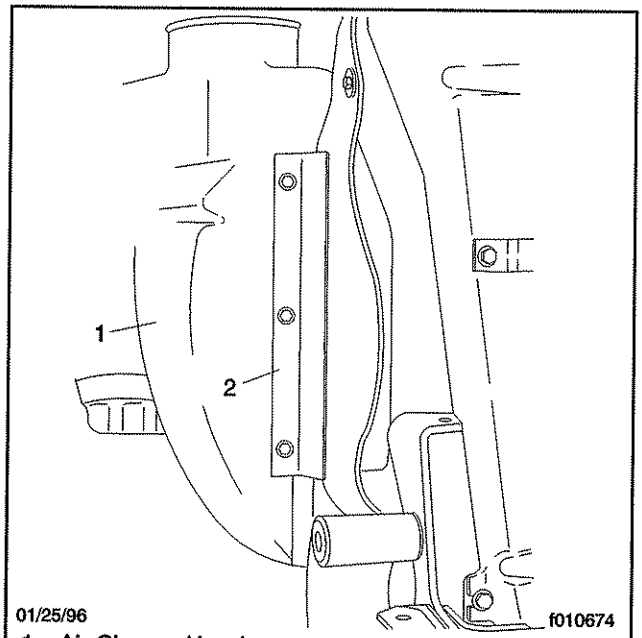
8. Remove the exhaust ducting.

8.1 Loosen the V-band clamp that holds the forward end of the exhaust ducting to the rear of the turbocharger. See **Fig. 3.**

8.2 Loosen the clamp that holds the rear end of the exhaust ducting to the exhaust flex pipe.

8.3 Remove the exhaust duct support bracket that shares mounting fasteners with the rear engine lifting eye, and remove the exhaust duct and bracket from the vehicle.

Removal and Installation



1. Air Cleaner Housing
2. Air Recirculation Shield, Right-Side

Fig. 4, Air Recirculation Shield

⚠ WARNING

After removing the exhaust duct support bracket, re-install all the engine lifting eye fasteners and tighten them securely. If the fasteners are not re-installed and tightened, the engine lifting eye will be unstable. Lifting the engine with an unstable lifting eye can lead to the engine falling, possibly causing personal injury and property damage.

8.4 Install the rear lifting eye fasteners and tighten them securely.

9. Disconnect the coolant hoses. See **Fig. 2** and **Fig. 3**.

9.1 Disconnect the coolant inlet and outlet hoses from the radiator.

9.2 Disconnect the vent hoses from the radiator and the engine.

9.3 Disconnect the coolant fill pipe from the top of the water pump.

9.4 Disconnect the heater outlet hose from the oil cooler.

9.5 Disconnect the heater inlet hose from the bottom of the water pump, near the radiator outlet hose.

10. Relocate the refrigerant compressor.

10.1 Disconnect the compressor clutch electrical connector.

10.2 Remove the clamps that secure the refrigerant lines within the engine compartment.

10.3 Remove the two bolts that hold the refrigerant compressor mounting bracket to the engine. See **Fig. 5**.

10.4 To keep the refrigerant system intact, with no leaks and no need for purging and recharging, carefully move the refrigerant compressor over the left frame rail, and secure it out of the way with tie straps. See **Fig. 6**.

11. Remove the power steering pump from the front of the engine, and (without breaking the steering fluid lines) move the pump over the left frame rail and secure it out of the way with tie straps.

12. Loosen the alternator mounting fasteners, and roll the alternator up, inboard, so that it clears the power steering reservoir when the engine is pulled forward during removal. Secure the alternator against the engine with tie straps.

13. Relocate the condenser.

13.1 Remove the capscrews that hold the left-side air recirculation baffle to the radiator.

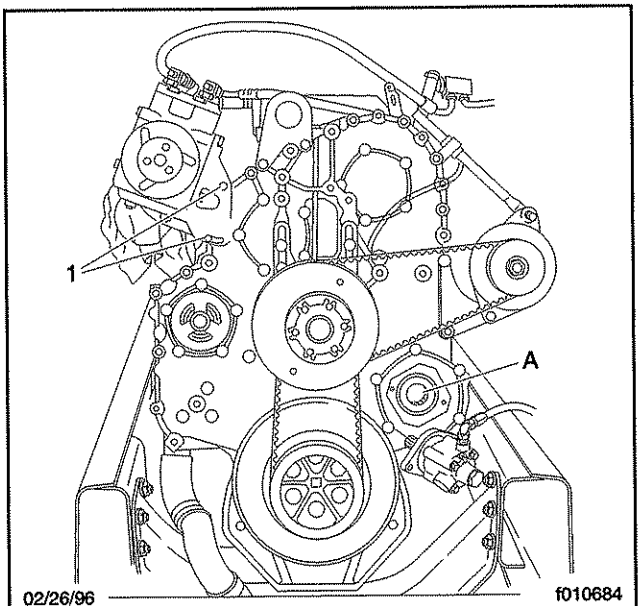
13.2 Disconnect the radiator struts from the upper corners of the radiator. See **Fig. 2**.

13.3 Remove the nuts and bolts that hold the condenser to the aftercooler.

13.4 To keep the refrigerant system intact, with no leaks and no need for purging and recharging, carefully move the condenser over the left frame rail.

13.5 Wrap the condenser in a protective blanket, or sandwich it between two sheets of cardboard to prevent damage to the condenser fins. Secure the condenser out of the way with tie straps. See **Fig. 6**.

14. Disconnect the air compressor. See **Fig. 7**.



A. Remove the power steering fluid pump.
1. Refrigerant Compressor Mounting Bolts

Fig. 5, Compressor Mounting Fasteners

14.1 Disconnect the air compressor outlet line from the top of the compressor.

14.2 Disconnect the air signal lines from the air governor.

15. Remove the radiator and aftercooler assembly.

15.1 Hook a lifting chain to the radiator and aftercooler assembly, and fasten the chain to a crane. Raise the crane until there is no slack in the chain. See **Fig. 8.**

15.2 Remove the nut from the radiator mounting stud that passes through the underslung support bracket at the bottom of the radiator. See **Fig. 9.**

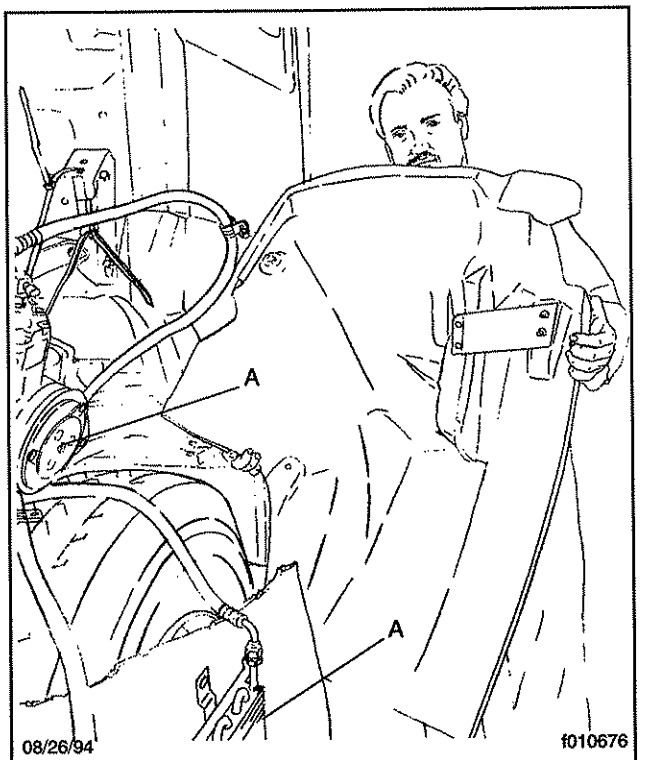
15.3 Lift the radiator and aftercooler from the vehicle as a single unit.

15.4 Remove the fan blades from the engine.

16. Disconnect the engine fuel and oil components.

16.1 Disconnect the fuel supply line at the fuel transfer pump. See **Fig. 10.**

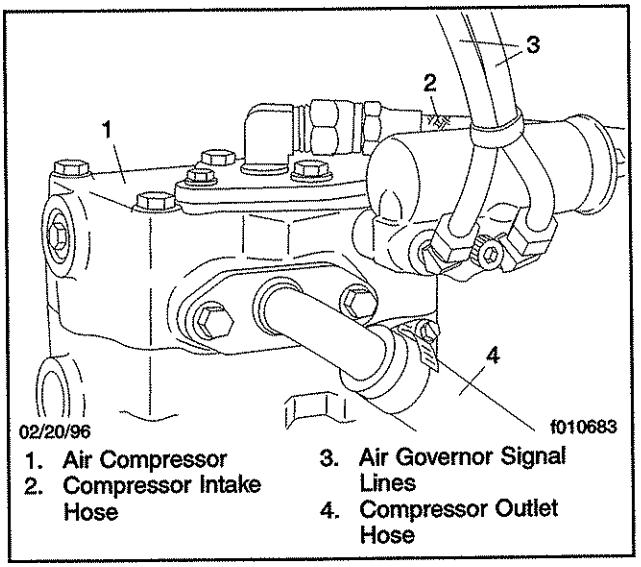
16.2 Disconnect the oil pressure gauge line behind the alternator.



A. Remove the air conditioning components and move them outside of the left frame rail.

Fig. 6, Moving the Air Conditioning Components

17. Disconnect the engine electrical connectors.



1. Air Compressor
2. Compressor Intake Hose
3. Air Governor Signal Lines
4. Compressor Outlet Hose

Fig. 7, Disconnecting the Air Compressor

Removal and Installation

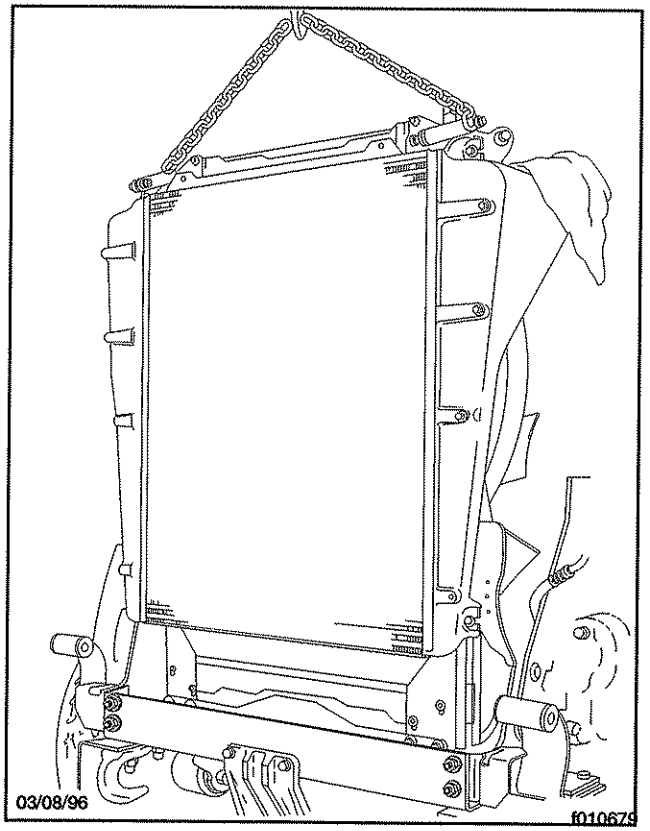


Fig. 8, Removing the Radiator

17.1 Disconnect the horn stand-off bracket and pull the horn and its wiring harness off to the side, out of the way. See **Fig. 11**.

17.2 Disconnect the wiring connectors from the rear of the alternator, and label the wires for reassembly. See **Fig. 12**.

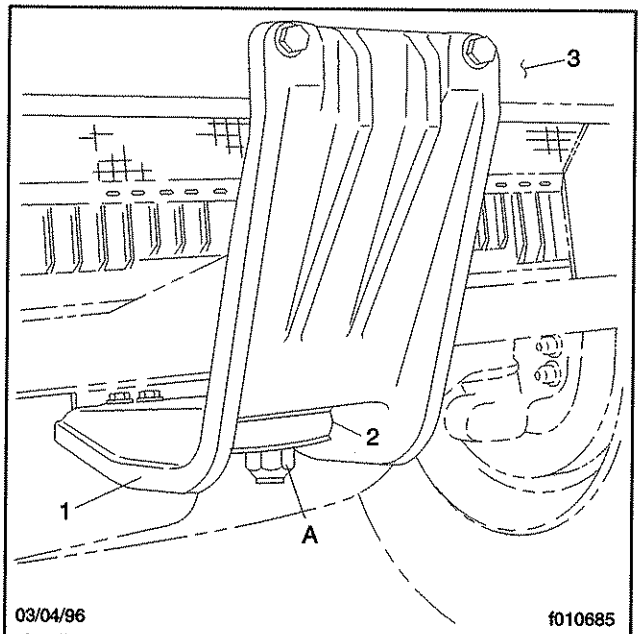
17.3 Disconnect the wiring connectors from the starter, and label the wires for reassembly.

17.4 Disconnect the wiring connectors from the electronic control module (ECM), and label the wires for reassembly. See **Fig. 13**.

17.5 Disconnect the wiring connector from the tachometer sensor on the engine flywheel housing.

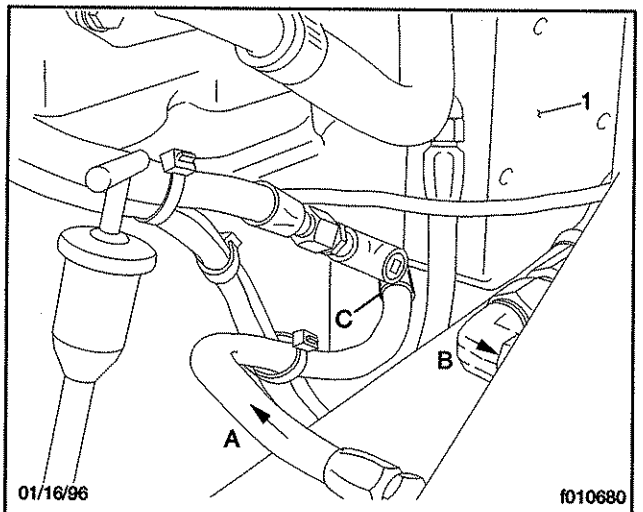
17.6 Disconnect the wiring from the coolant temperature light switch port. See **Fig. 14**.

17.7 Disconnect the wiring from the coolant temperature gauge port. See **Fig. 14**.



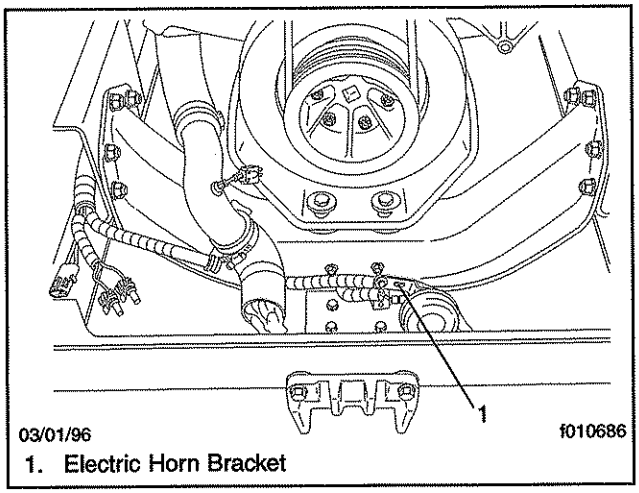
A. Remove the nut from the radiator mounting stud.
1. Radiator Underslung Support Bracket
2. Radiator Lower Isolator
3. Front Crossmember

Fig. 9, Radiator Mounting Fasteners



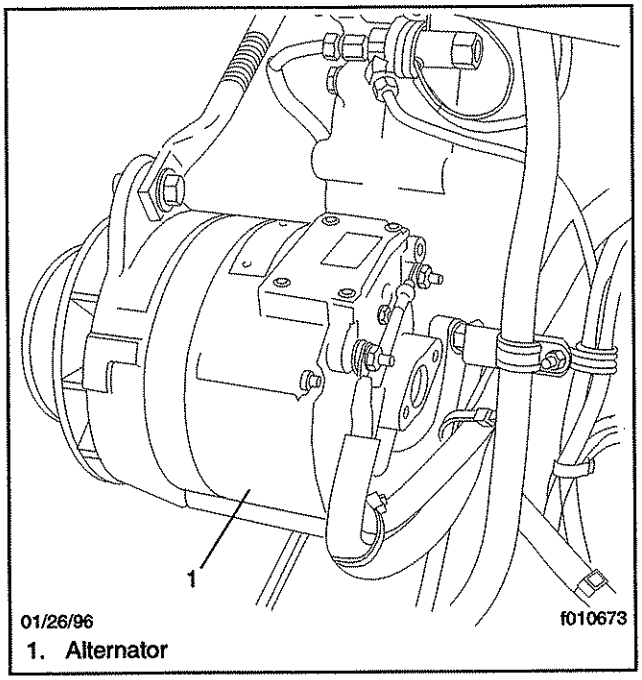
A. Fuel Flow From Filter to Pump
B. Fuel Flow From Tanks to Filter
C. Disconnect the fuel supply line at the transfer pump.
1. Electronic Control Module

Fig. 10, Fuel Lines



1. Electric Horn Bracket

Fig. 11, Disconnecting the Electric Horn



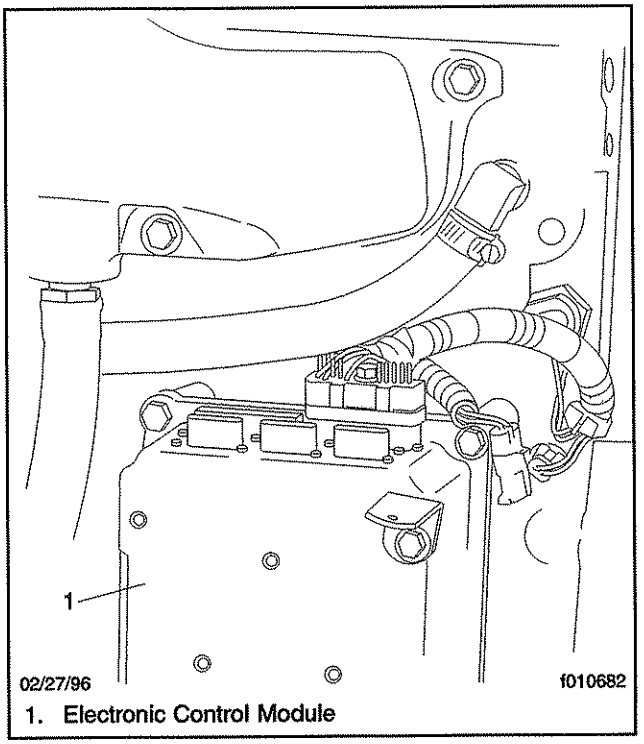
1. Alternator

Fig. 12, Alternator Wiring

18. Remove the windshield wiper pan. See **Fig. 15.**

18.1 Remove the windshield wiper arms. For instructions, refer to the cab group of this manual.

18.2 Remove the screws that hold the wiper pan to the firewall.

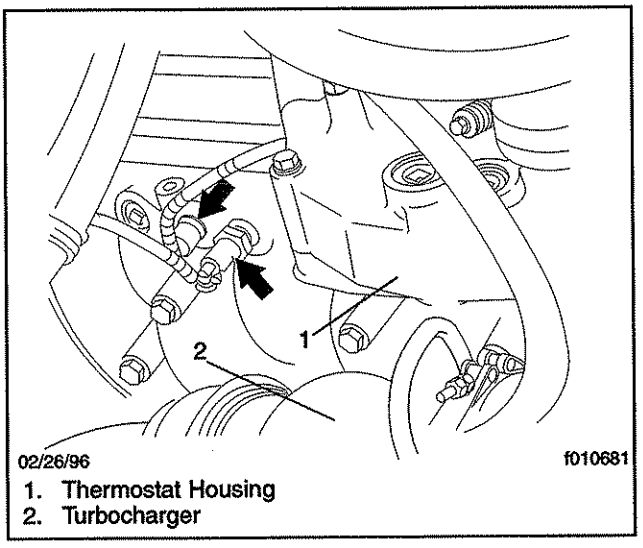


1. Electronic Control Module

Fig. 13, ECM Wiring

18.3 Remove the surge tank. For instructions, refer to the radiator group in this manual.

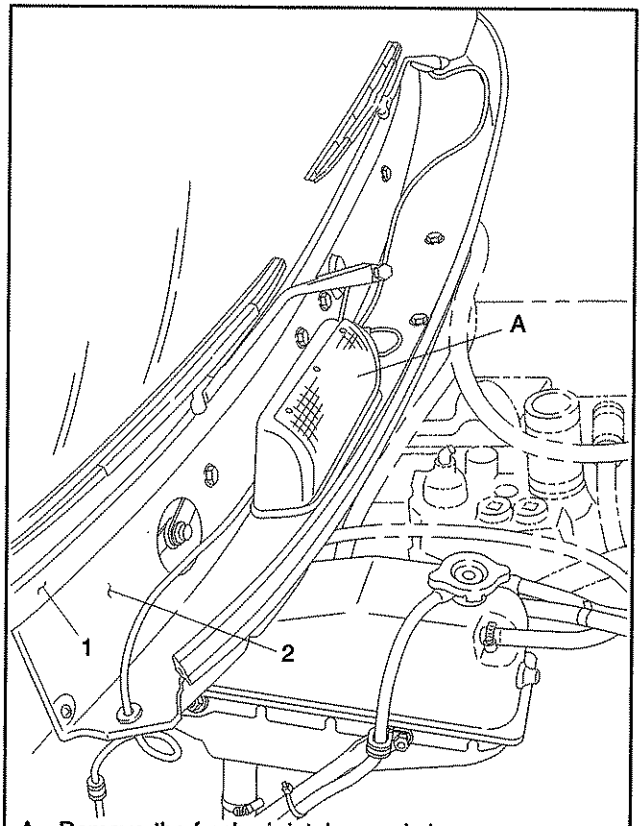
18.4 Remove the fresh air intake snorkel.



1. Thermostat Housing
2. Turbocharger

Fig. 14, Coolant Temperature Light Switch Wiring

Removal and Installation



A. Remove the fresh air intake snorkel.
1. Windshield Trim
2. Windshield Wiper Pan

Fig. 15, Removing the Windshield Wiper Pan

18.5 Remove the wiper pan by pulling the pan down, out from under the lower edge of the windshield trim.

19. Remove the front crossmember with the underslung radiator mounting bracket. See **Fig. 16.**

19.1 Remove the fasteners that hold the rear of the radiator support bracket to the underslung cross member that supports the front of the engine. See **Fig. 17.**

19.2 Remove the fasteners that hold the front crossmember to the frame rails. See **Fig. 18.** Then, pull the crossmember forward until it's free of the frame rails.

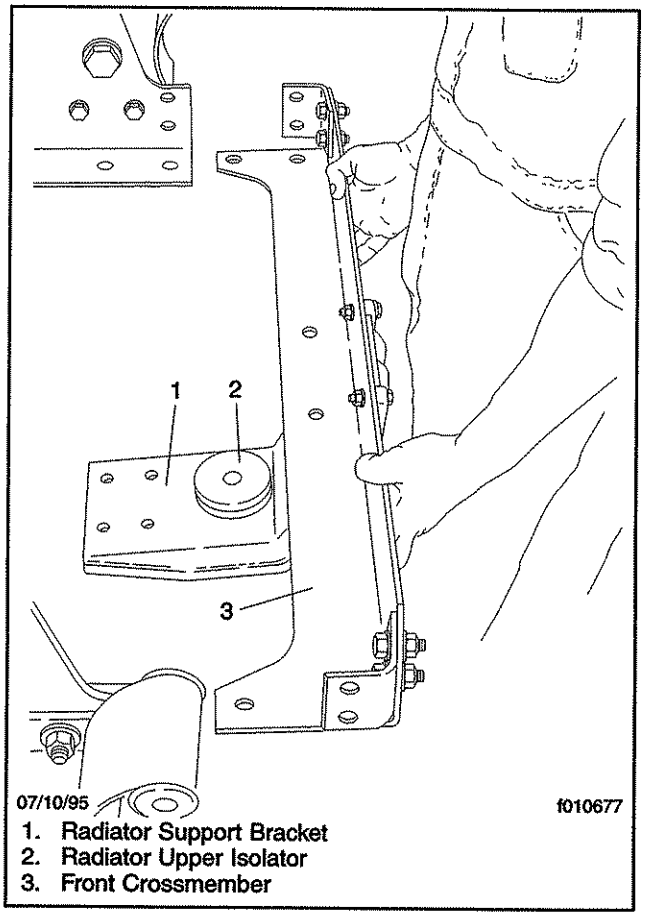
20. Attach a three-point lifting chain to the engine, and lift the engine enough to take all weight off of the front engine mount. See **Fig. 19.**

⚠ WARNING

The crane and lifting chains used to remove the engine must be capable of safely lifting and supporting two metric tons. Once the engine mounts are disconnected, do not get under the engine until it is securely supported on engine stands. An unsecured engine may fall, causing personal injury or death, and component damage.

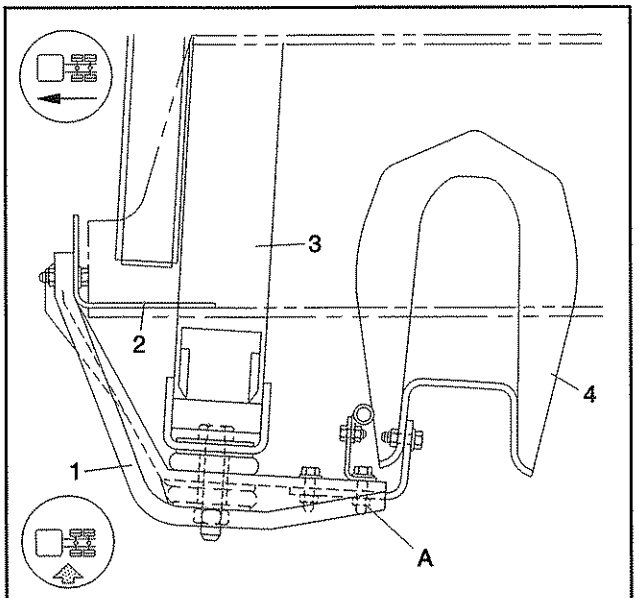
20.1 Attach the chain to the existing lifting hooks at the front and the rear of the engine.

20.2 With all three engine lifting points connected by chain to the crane, raise the



1. Radiator Support Bracket
2. Radiator Upper Isolator
3. Front Crossmember

Fig. 16, Front Crossmember



08/08/94 f500226

A. Remove these capscrews.
1. Radiator Support Bracket
2. Front Crossmember
3. Radiator
4. Underslung Crossmember (Front Engine Mount)

Fig. 17, Radiator Support Bracket Fasteners

crane enough to tighten the chains, but not enough to lift the front of the vehicle.

21. Disconnect the engine from the rear engine mounts.

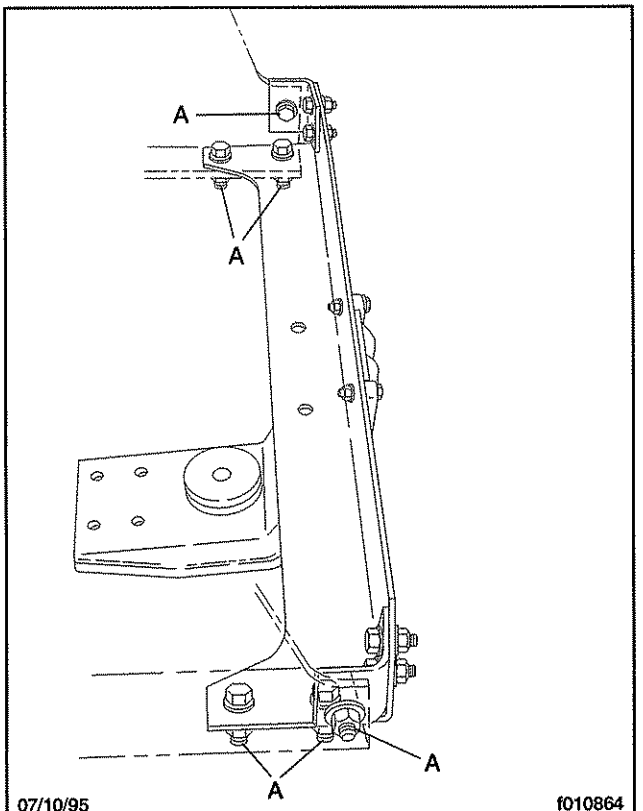
    21.1 With the engine securely supported by the crane, lifting chains, and the engine stands, disconnect the rear engine legs from the engine mounts mounted on the frame rails.

    21.2 On each engine leg, remove the nut from the bolt that runs down through the engine leg, rubber isolators, and engine mount. Save the fasteners and isolators.

22. Disconnect the engine from the front engine mount. See **Fig. 20**.

    22.1 Remove the nuts from the bolts that fasten the front engine bracket to the underslung crossmember.

    22.2 Using the crane, lift the engine until all weight is removed from the front engine mount.



07/10/95 f010864

A. To remove or install the front crossmember, remove or install these capscrews.

Fig. 18, Front Crossmember Fasteners

    22.3 Remove the bolts and washers that hold the front engine bracket to the crossmember, and save the nuts, bolts, washers, and isolators.

23. Remove the underslung crossmember.

    23.1 Remove the fasteners that hold each end of the crossmember to the frame rails. See **Fig. 21**.

    23.2 Pull the crossmember forward to remove it from the vehicle.

24. Remove the engine from the vehicle.

    24.1 Using the crane, lift the engine and pull it forward.

    24.2 Once the engine is clear of the vehicle, place the engine on engine stands.

Removal and Installation

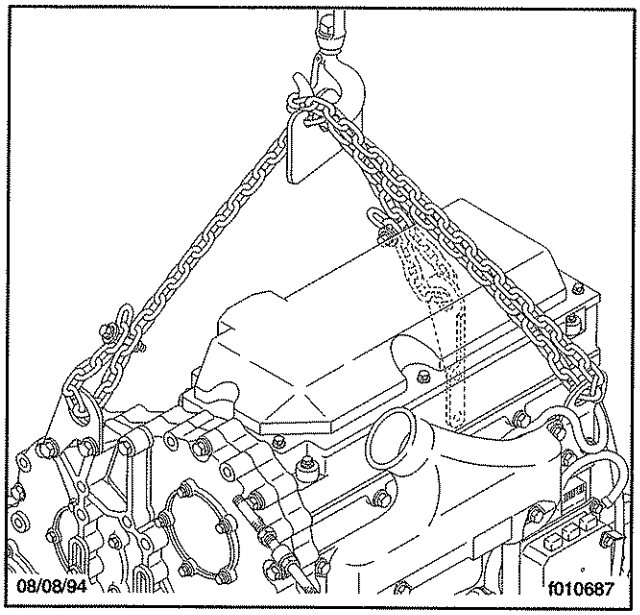


Fig. 19, Three-Point Lifting Chain

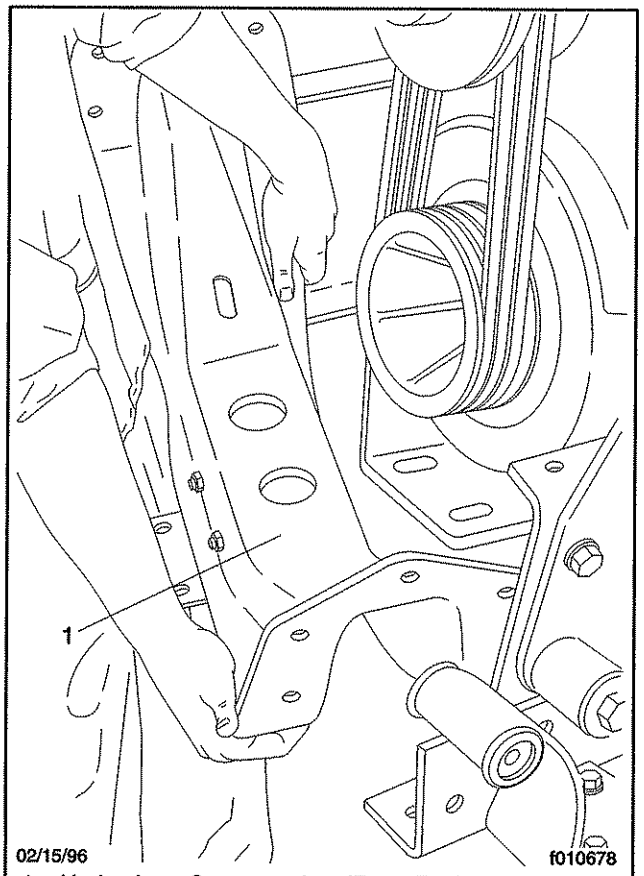
Installation

1. Install the underslung crossmember that serves as the front engine mount. See **Fig. 21**. Tighten the crossmember-to-frame rail fasteners 68 lbf·ft (92 N·m), and place the upper isolators in the engine mount holes.

⚠ WARNING

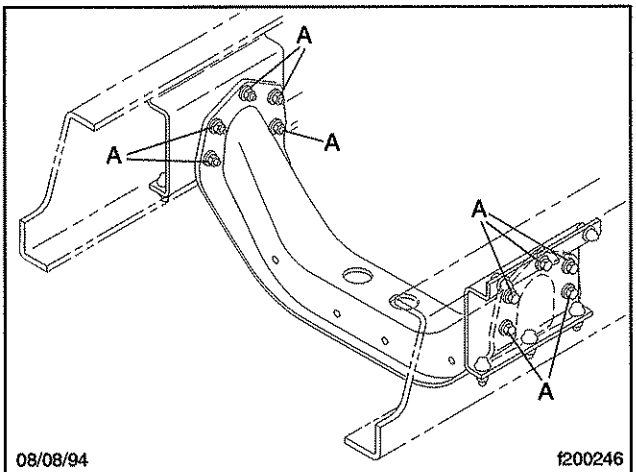
The crane and lifting chains used to install the engine must be capable of safely lifting and supporting two metric tons. Once the engine stands are removed, do not get under the engine until it is securely supported on the engine mounts. An unsecured engine may fall, causing personal injury or death, and component damage.

2. Attach a three-point lifting chain to the engine, and lift the engine off the engine stands. See **Fig. 19**.
3. Install the engine in the engine compartment.
   - 3.1 Place the upper rubber isolators in the rear engine mounts.
   - 3.2 Using the crane, place the engine in the engine compartment. Keeping the front of the engine raised, slightly, push the engine back until it rests squarely on the two rear engine mounts.
   - 3.3 For the rear engine mounts, run a bolt down through each engine leg, the upper isolator, the engine mount, and the lower isolator. Install a nut on each bolt, and tighten each nut finger-tight.
   - 3.4 Using the crane, lower the engine until it rests squarely on the front engine mount.
   - 3.5 Run the bolts down through the front engine support bracket, the upper isolator, the engine mount, and the lower isolator. Install the nut on each bolt, and tighten each nut 241 lbf·ft (327 N·m).
   - 3.6 Tighten the nuts on the rear engine mount bolts 241 lbf·ft (327 N·m).



1. Underslung Crossmember (Front Engine Mount)

Fig. 20, Front Engine Mount



A. To remove or install this crossmember, remove or install these capscrews.

Fig. 21, Underslung Crossmember

3.7 With the engine securely installed on all three engine mounts, remove the crane.

4. Install the front crossmember and the underslung radiator mount. See **Fig. 17.**

4.1 Position the front crossmember between the frame rails so that it is aligned with the fastener holes. Install the capscrews, washers, and nuts removed and tighten the nuts 136 lbf·ft (184 N·m).

4.2 Use 3/8-16 1.37-inch bolts, washers and nuts to fasten the rear of the underslung radiator support bracket to the forward edge of the bracket fastened to the underslung crossmember. Tighten the nuts 28 lbf·ft (38 N·m).

5. Install the windshield wiper pan. See **Fig. 15.**

5.1 Position the pan by tucking it up under the lower edge of the windshield trim.

5.2 Install the fresh air intake snorkel.

5.3 Install the screws that hold the pan to the firewall.

5.4 Install the surge tank. For instructions, refer to the engine cooling group of this manual.

5.5 Install the wiper arms. For instructions refer to the cab group of this manual.

6. Install the power steering pump. See **Fig. 5.**

7. Remove the tie straps that hold the alternator against the engine, and adjust the alternator drive belt to the correct tension. For adjustment instructions, refer to the drive belt section in this service manual group.

8. Install the fan blades on the engine. For the applicable fastener torque, refer to **Group 20** of this service manual.

9. Connect the engine electrical connectors.

9.1 Connect the wiring harness to the coolant temperature gauge sensor. See **Fig. 14.**

9.2 Connect the wiring harness to the coolant temperature warning light switch. See **Fig. 14.**

9.3 Connect the wiring harness to the tachometer sensor on the engine flywheel housing.

9.4 Connect the wiring harness to the ECM. See **Fig. 13.**

9.5 Connect the wiring harness to the starter motor and solenoid.

9.6 Connect the wiring harness to the alternator. See **Fig. 12.**

9.7 Install the horn and horn stand-off bracket. See **Fig. 11.**

10. Connect the fuel and oil components.

10.1 Connect the oil pressure gauge sensor line behind the alternator.

10.2 Connect the fuel supply line at the fuel transfer pump. See **Fig. 10.**

11. Install the radiator and aftercooler assembly.

NOTE: Before lifting the radiator and aftercooler, be sure the upper radiator isolator is in the underslung radiator mount.

11.1 Hook a lifting chain to the top of the radiator and aftercooler assembly, and fasten the chain to a crane. Lift the radiator and aftercooler, and position the assembly on the radiator mount. See **Fig. 8.**

Removal and Installation

11.2 Install the lower radiator isolator, and install the nut on the radiator mounting stud. Tighten the nut 241 lbf·ft (327 N·m).

11.3 Install the right-side radiator brace strut.

11.4 Remove the lifting chains from the radiator and aftercooler assembly.

12. Connect the air compressor. See **Fig. 7**.

12.1 Connect the air outlet line to the top of the compressor.

12.2 Connect the two air signal lines to the air governor.

13. Install the refrigerant compressor and condenser.

13.1 Remove the tie straps and protective coverings, and carefully move the compressor and condenser back into their operating positions.

13.2 Install the fasteners that hold the condenser to the aftercooler. Tighten the fasteners 15 lbf·ft (20 N·m).

13.3 Install the fasteners that hold the compressor mounting bracket to the engine. See **Fig. 5**. Connect and adjust the compressor drive belt. For instructions, refer to the drive belt section in this manual.

13.4 Connect the radiator brace rods to the top left corner of the radiator. See **Fig. 2**. Tighten the mounting fasteners 68 lbf·ft (92 N·m).

13.5 Secure the power steering and refrigerant lines with clamps.

13.6 Install the left-side air recirculation baffle on the radiator.

14. Connect the coolant hoses. See **Fig. 2** or **Fig. 3**.

14.1 Connect the heater inlet hose to the bottom of the water pump.

14.2 Connect the heater outlet hose to the oil cooler.

14.3 Connect the coolant fill pipe to the top of the water pump.

14.4 Connect the vent hoses to the radiator and the engine.

14.5 Connect the coolant inlet and outlet hoses to the radiator.

15. Install the exhaust ducting.

15.1 Remove the lower mounting bolt from the rear engine lifting eye, and install the exhaust duct support bracket and the length of duct between the turbocharger and the exhaust flex pipe.

15.2 Connect the duct to the exhaust flex pipe, and tighten the wide band clamp.

15.3 Connect the duct to the rear of the turbocharger and tighten the V-band clamp 85 lbf·in (940 N·cm). See **Fig. 3**.

16. Install the air cleaner and air intake ducting.

16.1 Position the air cleaner on its mounting bracket, and secure it with four nuts and washers. Tighten the nuts 28 lbf·ft (38 N·m).

16.2 Fasten the right-side air recirculation shield to the air cleaner housing.

16.3 Install the hose and metal duct between the air cleaner and the turbocharger.

16.4 Install the hoses and convoluted tubing between the turbocharger and the aftercooler, and between the aftercooler and the engine intake manifold. Tighten the constant-torque hose clamps 60 lbf·in (680 N·cm).

17. Install the right fender splash shield.

18. Make sure the coolant drains in the water pump and the radiator are closed, and then fill the engine and cooling system with coolant. Refer to the vehicle maintenance manual for the correct coolant type and quantity.

19. Install the hood, bumper, and left front half-fender. For instructions, refer to the applicable group in this service manual.

20. Install the transmission on the engine. For instructions, refer to **Group 26** in this service manual.

21. Connect the batteries, or if applicable, turn on the battery shutoff switch.

22. Start the engine, and check for leaks. Repair any leaks found.

23. Test drive the vehicle.

Contents

Subject	Subject Number
Service Operations	
Engine Removal and Installation	100

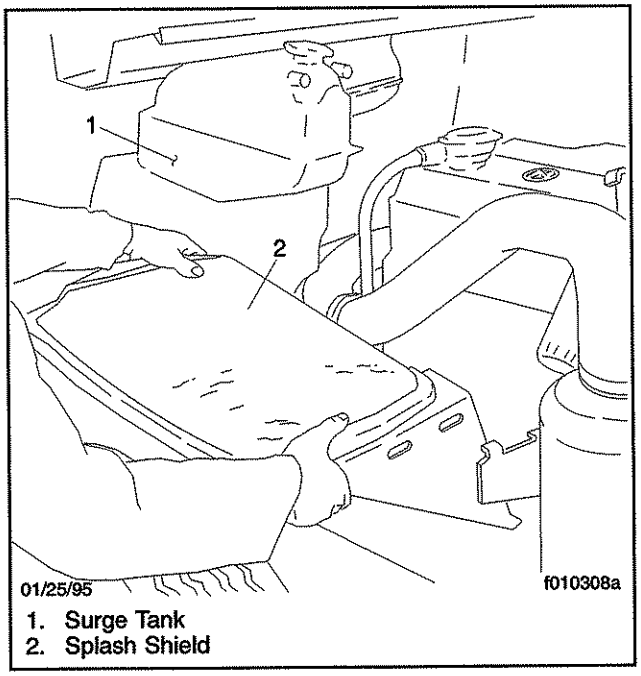
Removal

⚠ WARNING

WARNING: The fuel system is under pressure whether or not the engine is running or shut down. Always release the pressure from the fuel system before servicing any fuel supply or fuel return system component. Servicing a pressurized system could cause fuel to spray, leading to personal injury or property damage.

IMPORTANT: Before beginning this procedure, get a Chrysler fuel pressure gauge tool set 5069. You will need these tools to release the fuel system pressure.

1. Park the vehicle, apply the parking brakes, and chock the tires.
2. Disconnect the batteries.
3. Remove the hood. For instructions, see **Group 88**.
4. Remove the right fender splash shield. See **Fig. 1**.
5. Remove right and left bumper extensions.



1. Surge Tank
2. Splash Shield

Fig. 1, Right Fender Splash Shield, Typical Installation

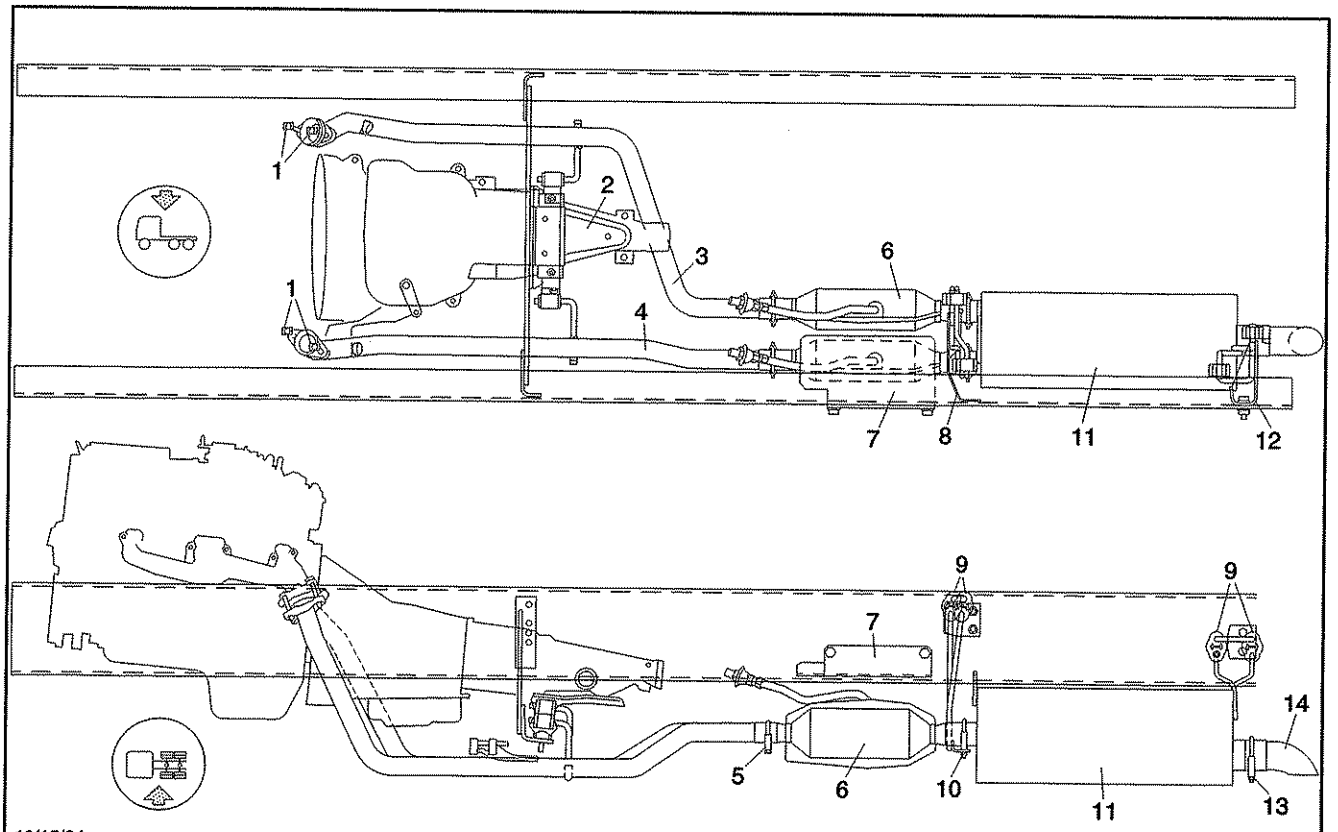
6. Use engine stands to support the rear of the engine, and remove the transmission. See **Group 26** for instructions. Removing the transmission requires removing the exhaust pipes. See **Fig. 2**.
7. Disconnect the air outlet hose from the air injection pump. See **Fig. 3**.
8. Remove the horn and bracket assembly from the right frame rail.
9. Remove the air cleaner housing. See **Fig. 4**. For complete removal instructions, see **Group 09**.
10. Disconnect the throttle cable from the throttle body cam. See **Fig. 5**.
    - 10.1 Remove the tie strap that holds the cable housing to the refrigerant line.
    - 10.2 Roll the throttle body cam, by hand, from idle to full throttle. Slip the pin on the end of the cable from the hole in the throttle body cam, and remove the cable from the cam. See **Fig. 6**.
    - 10.3 Loosen the cable clamp nuts on either side of the throttle body mounting bracket. See **Fig. 7**. Lift the cable out of the bracket, and move the cable aside.
11. Remove the fan blade and the fan shroud. See **Fig. 8**.
    - 11.1 Loosen the six self-tapping screws that hold the fan shroud to the rear of the radiator, and move the shroud back against the engine.
    - 11.2 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.
    - 11.3 Remove the fan and the fan shroud as a unit.

⚠ WARNING

WARNING: Drain the coolant only when the coolant and engine are cool. Draining it when these are

Removal and Installation



1. Nut, Bolt, and Bolt Retainer
2. Transmission/Rear Engine Mount
3. Right-Side Exhaust Pipe
4. Left-Side Exhaust Pipe
5. 2-Inch i.d. U-Bolt Clamp
6. Catalytic Converter
7. Heat Shield
8. Muffler Mounting Bracket, Forward
9. Muffler Isolators
10. 57-mm i.d. U-Bolt Clamp
11. Muffler
12. Muffler Mounting Bracket, Rear
13. 3-Inch Saddle Clamp
14. Muffler Exhaust Pipe

Fig. 2, Exhaust System, Dodge Magnum Engine

hot could cause severe personal injury due to scalding.

12. Remove the radiator. See **Fig. 9.**

12.1 Drain the radiator; then mark and disconnect the coolant hoses and vent hose from it.

12.2 Disconnect the hoses from the transmission oil cooler.

12.3 Remove the hose standoff bracket from the rear stud on the left-side radiator mount.

12.4 Support the transmission oil cooler and refrigerant condensor; then remove the four nuts that hold the cooler and condenser to the front of the radiator. Remove the transmission oil cooler, and set it aside. Keep it upright to avoid spilling any transmission fluid. Swing the condenser to the side, and out of the way.

12.5 Remove the bolts that attach the bottom of the air recirculation shields to the radiator side-channels; then remove the shields. See **Fig. 10.**

12.6 Remove the hose bracket from the right-side radiator strut.

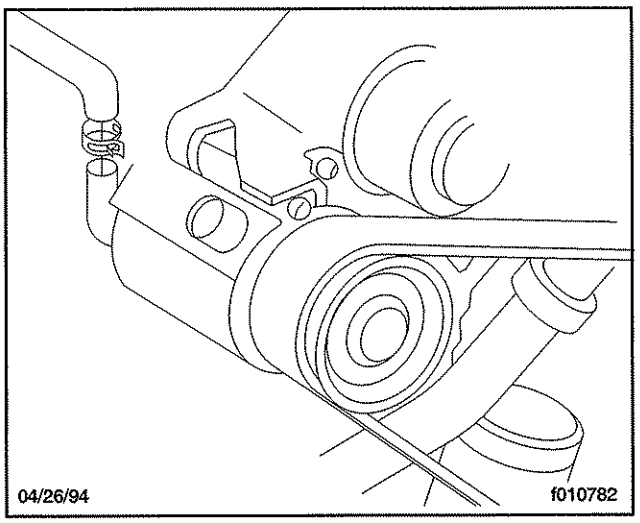


Fig. 3, Air Injection Pump Hose

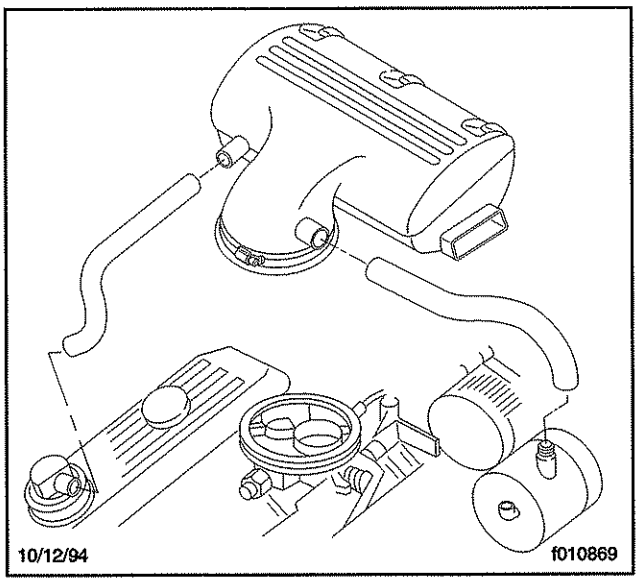


Fig. 4, Air Cleaner Installation, Dodge Magnum Engine

12.7 Disconnect the left-side radiator strut from the framerail bracket.

12.8 From underneath the vehicle, mark, then disconnect the coolant hoses from the engine oil cooler. See **Fig. 11.**

12.9 Remove the four nuts holding the radiator to the radiator-mount studs; then remove the radiator.

13. Disconnect the coolant hoses from the water pump. See **Fig. 12.**

14. Remove the accessory drive belt.

    14.1 Place a 5/8-inch wrench over the pulley bolt on the automatic belt tensioner, and turn the wrench counterclockwise to relax the belt tensioner. See **Fig. 13.**

    14.2 Remove the engine accessory drive belt.

15. Disconnect the wiring from the engine.

    15.1 Disconnect the 60-pin connector from the power train control module on the bulkhead.

    15.2 Mark, then disconnect the three multi-pin connectors and one single-pin connector at the rear, right side of the engine.

    15.3 Disconnect the ground strap from the engine block.

    15.4 Mark, then disconnect the wiring from the starter motor.

16. Disconnect the heater hoses. See **Fig. 14.**

    16.1 Disconnect the heater supply hose at the rear of the engine.

    16.2 Disconnect the heater return hose from the front of the engine.

⚠ WARNING

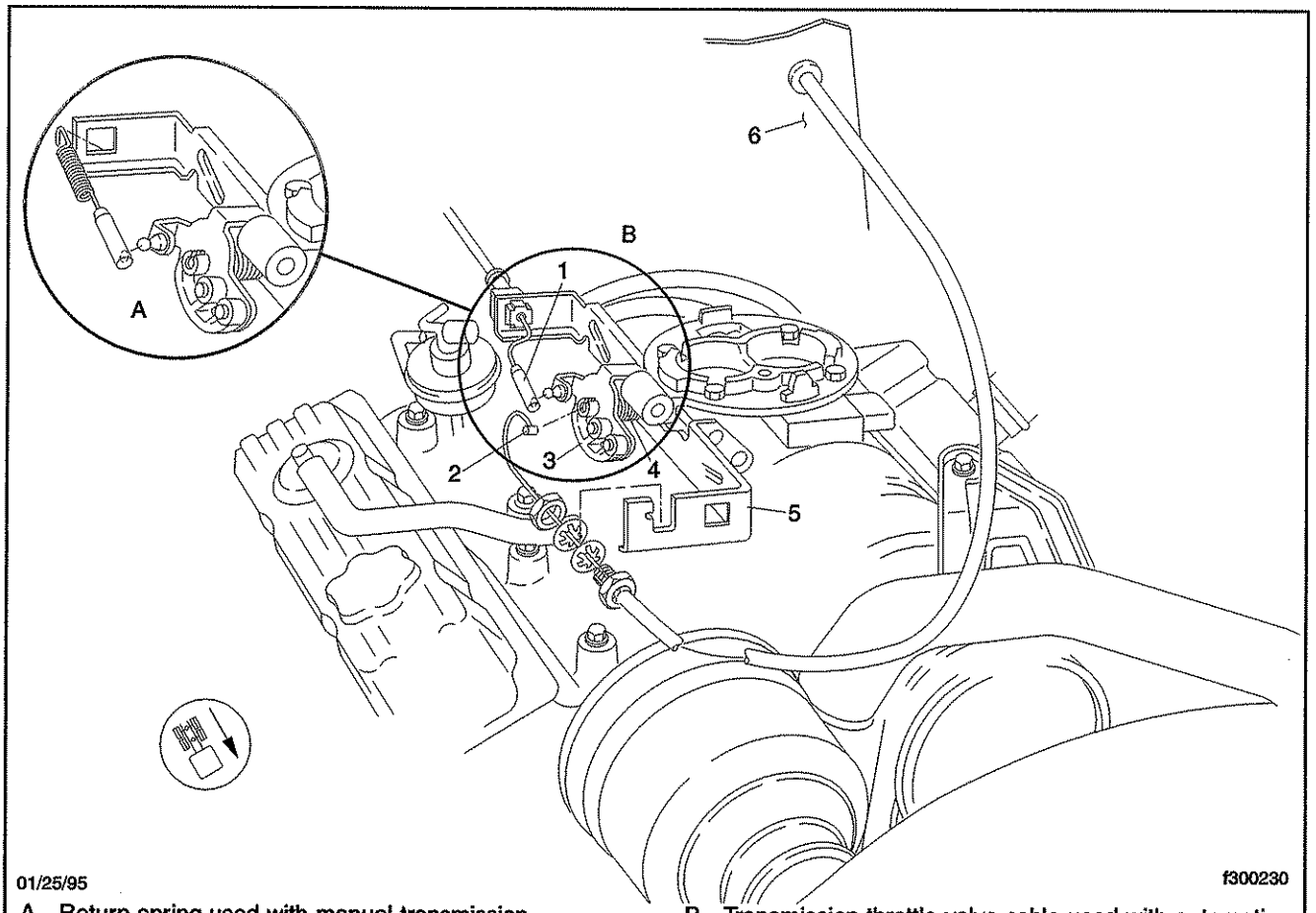
WARNING: The fuel system is under pressure whether or not the engine is running or shut down. Always release the pressure from the fuel system before servicing any fuel supply or fuel return system component. Servicing a pressurized system could cause fuel to spray, leading to personal injury or property damage.

17. If not already done, release the pressure from the fuel system, and disconnect the fuel line at the engine.

⚠ WARNING

WARNING: Wear eye protection when releasing fuel system pressure, and do not let fuel spill onto the engine intake or exhaust manifolds. Place

Removal and Installation



A. Return spring used with manual transmission.
B. Transmission throttle valve cable used with automatic transmission.

1. Transmission Throttle Valve Cable (Automatic Transmissions Only)
2. Throttle Cable
3. Throttle Body Cam
4. Throttle Pedal Return Spring
5. Throttle Body Mounting Bracket
6. Firewall

Fig. 5, Throttle Cable from Firewall To Throttle Body Lever

shop towels under and around the pressure port to absorb fuel when the pressure is released. Spilled fuel or lack of eye protection could lead to personal injury or property damage.

17.1 If not already done, disconnect the negative battery cable.

17.2 Remove the fuel tank caps to release fuel tank pressure.

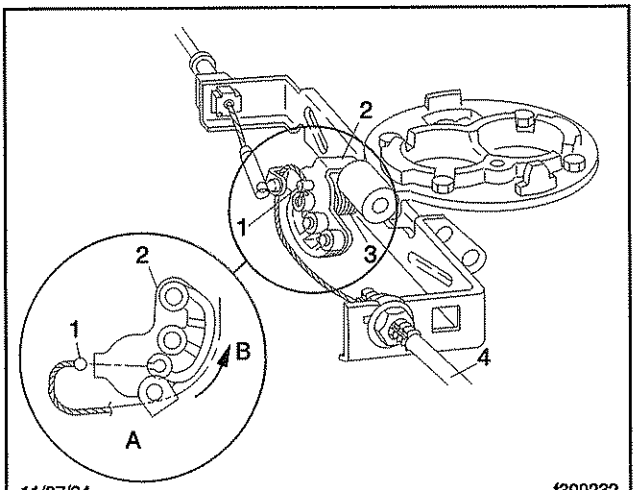
17.3 Unscrew the protective plastic cap from the pressure test port (schrader valve) on the fuel rail. See **Fig. 15**.

17.4 Obtain the fuel pressure gauge/hose assembly from a Chrysler fuel pressure gauge tool set 5069. Remove the gauge from the hose.

17.5 Place the gauge end of the hose into an approved gasoline storage container.

17.6 Place a shop towel under the test port.

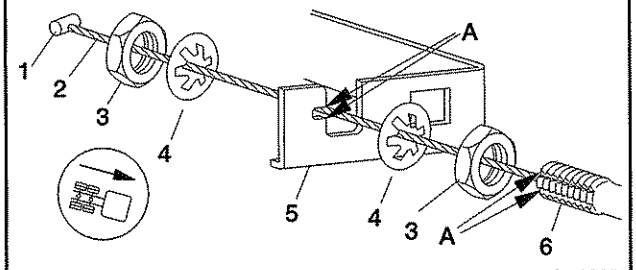
17.7 To release the fuel system pressure, screw the other end of the hose onto the fuel pressure test port.



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A. View of Wide-Open Throttle
B. Rotate to full throttle.
1. Cable Pin
2. Throttle Body Cam
3. Throttle Pedal Return Spring
4. Throttle Cable

Fig. 6, Throttle Cable Attachment to Throttle Body Cam



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A. Turn the grooves in the cable housing outboard to align with the bracket points.
1. Throttle Cable Pin
2. Throttle Cable
3. Cable Clamp Nut
4. Toothed Lockwasher
5. Throttle Body Mounting Bracket
6. Threaded Cable Housing

Fig. 7, Throttle Cable Attachment to Throttle Body Bracket

17.8 After the fuel pressure has been released, remove the hose from the test port, and install the protective cap on the fuel test port.

17.9 Disconnect the fuel supply lines from the fuel racks.

18. Disconnect the power steering hoses from the power steering pump; then remove the hose bracket from the radiator strut bracket. Move the hoses and bracket out of the way.

19. Remove the refrigerant compressor. See **Fig. 16**.

19.1 Loosen the five bolts that hold the compressor to the engine.

19.2 Mark and disconnect the wiring from the compressor.

19.3 Leaving the refrigerant hoses attached to the compressor, lift it off the engine, and move it to the side.

20. From underneath the vehicle, disconnect the oil pressure sensor line from the rear of the engine. See **Fig. 17**.

21. Attach the lifting chains to the engine.

⚠ WARNING

WARNING: The crane, lifting eyes, and lifting chain used to remove the engine must be capable of safely lifting and supporting two metric tons. Once the engine mounts are disconnected, do not get under the engine until it is securely supported on engine stands. An unsecured engine, or an engine lifted with unsuitable tools may fall, causing personal injury or death, and component damage.

21.1 Remove and save the upper inboard hexbolt from the power steering pump bracket; then install a 3/8-inch x 1-3/4-inch hexbolt and lifting eye in its place. Tighten the bolt firmly. See **Fig. 18**.

21.2 At the rear right-side of the engine, use a 3/8 x 1-1/4 inch hexbolt to install a second lifting eye in one of the blank holes on the engine head. See **Fig. 17**.

21.3 Attach a lifting chain to the lifting eyes.

21.4 Attached the chain to a suitable lifting device, and raise the chain to remove any slack.

Removal and Installation

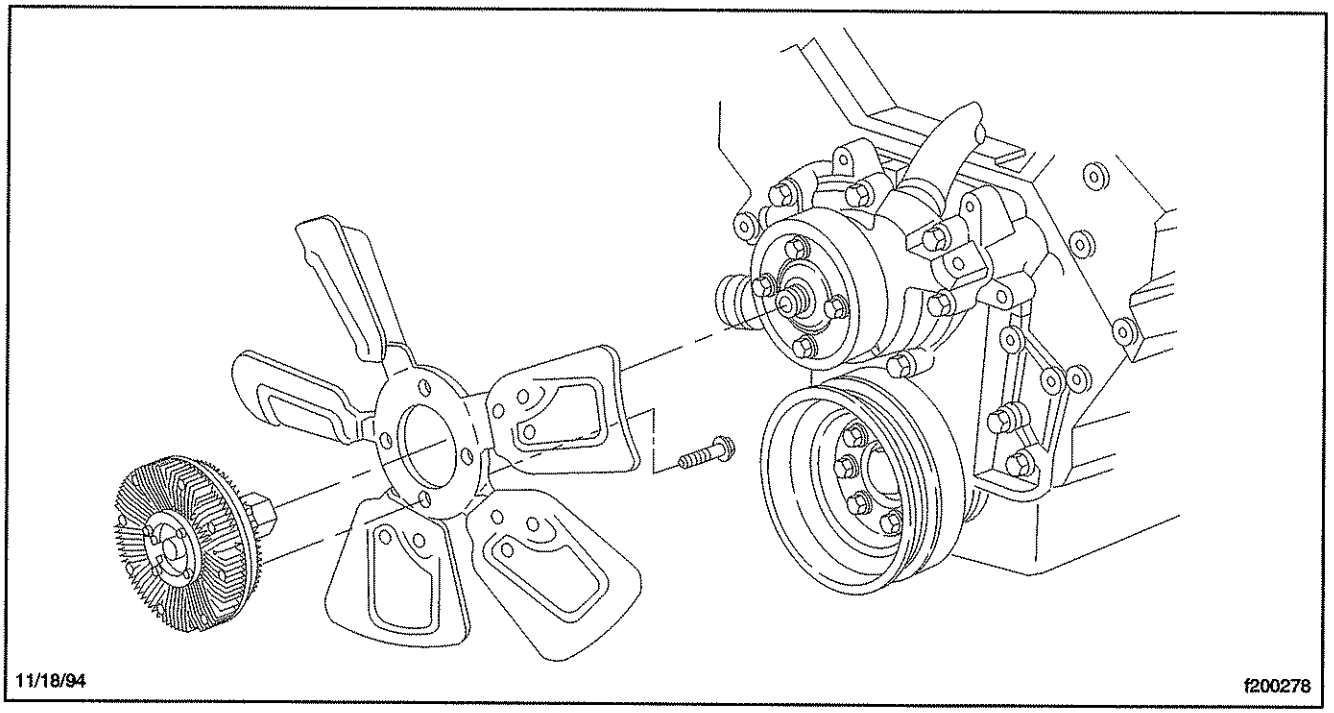


Fig. 8, Fan Clutch Mounting for Dodge Magnum V-8 Engine

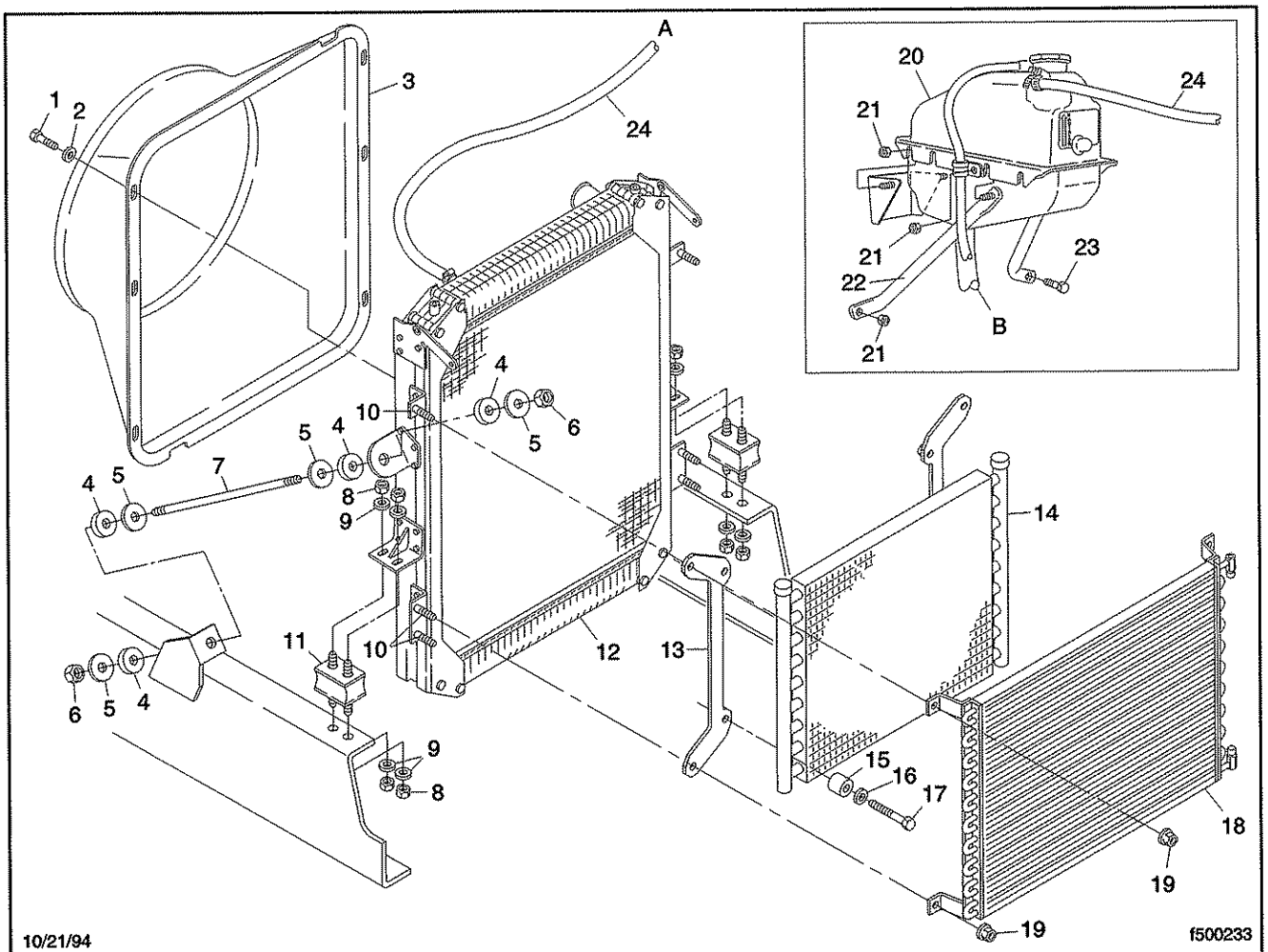
22. Disconnect the engine from the engine mounts.
    - 22.1 Remove the nut and washer from each of the two bolts that run through the engine legs, rubber isolators, and engine mounts.
    - 22.2 Back out the bolts.
23. Lift the engine from the vehicle. Lower it onto suitable stands.

Installation

⚠ WARNING

WARNING: The crane, lifting eyes, and lifting chain used to remove the engine must be capable of safely lifting and supporting two metric tons. Once the engine mounts are disconnected, do not get under the engine until it is securely supported on engine stands. An unsecured engine, or an engine lifted with unsuitable tools may fall, causing personal injury or death, and component damage.

1. Install the engine on the engine mounts.
    - 1.1 With an engine stand in place to support the rear of the engine, lower the engine into the engine compartment so the engine legs align with the engine mounts.
    - 1.2 Run bolts through the engine mounts, rubber isolators, and engine legs. See **Fig. 19** and **Fig. 20**.
    - 1.3 Secure each bolt with a flatwasher and nut, and torque each nut 54 to 68 N·m (40 to 50 lbf·ft).
    - 1.4 Install the transmission. See **Group 26** for instructions.
    - 1.5 Remove the lifting eyes and chains from the engine.
    - 1.6 Install the bolt removed earlier from the power steering pump bracket on the front of the engine.
2. Connect the air outlet hose to the air injection pump.
3. Connect the hoses to the water pump.
4. Connect the coolant lines to the oil cooler.



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. 9, Radiator Assembly

5. Connect the wiring to the engine.
   - 5.1 Install the ground strap to the engine block.
   - 5.2 Connect the three multi-pin connectors and the single-pin connector to the main wiring harness on the passenger side of the firewall.
   - 5.3 Connect the 60-pin connector to the powertrain control module (PTCM) on the bulkhead.

Removal and Installation

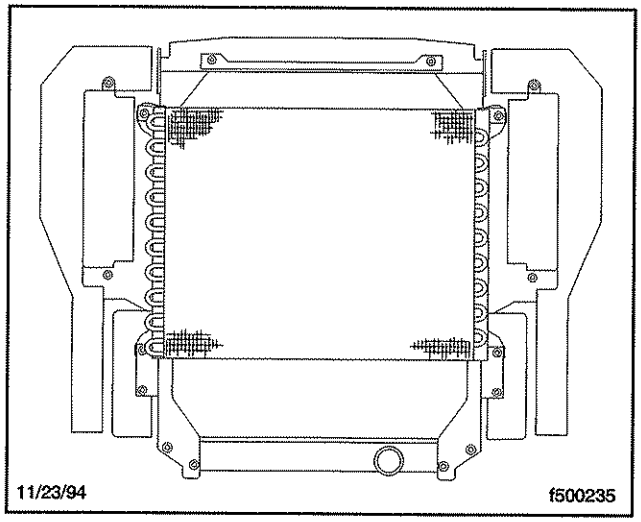
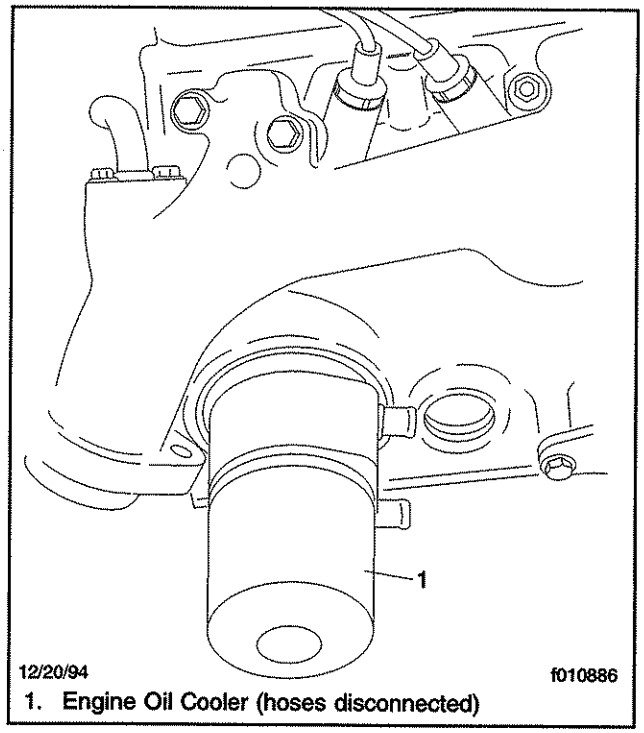


Fig. 10, Air Recirculation Shields Around the Radiator



1. Engine Oil Cooler (hoses disconnected)

Fig. 11, Engine Oil Cooler

6. Install the refrigerant compressor onto the engine. Tighten the bolts 27 N·m (20 lbf·ft).
7. Connect the wiring to the refrigerant compressor.

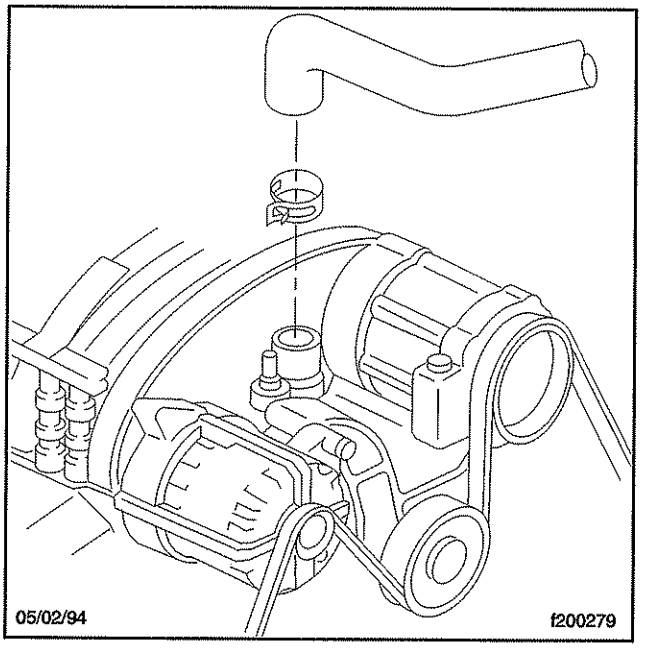
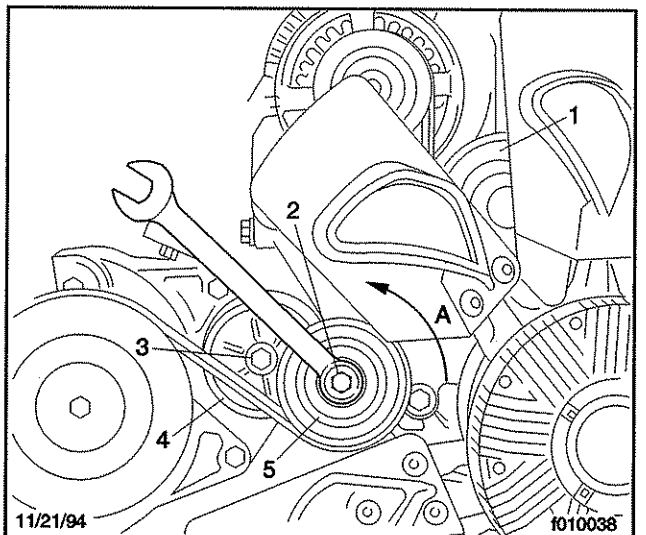


Fig. 12, Water Pump Outlet Hose, Removed



A. Turn counterclockwise to remove the belt.
1. Idler Pulley
2. Tensioner Pulley Bolt
3. Tensioner Mounting Bolt
4. Tensioner
5. Tensioner Pulley

Fig. 13, Accessory Drive Belt

8. Connect the power steering hoses to the power steering pump.

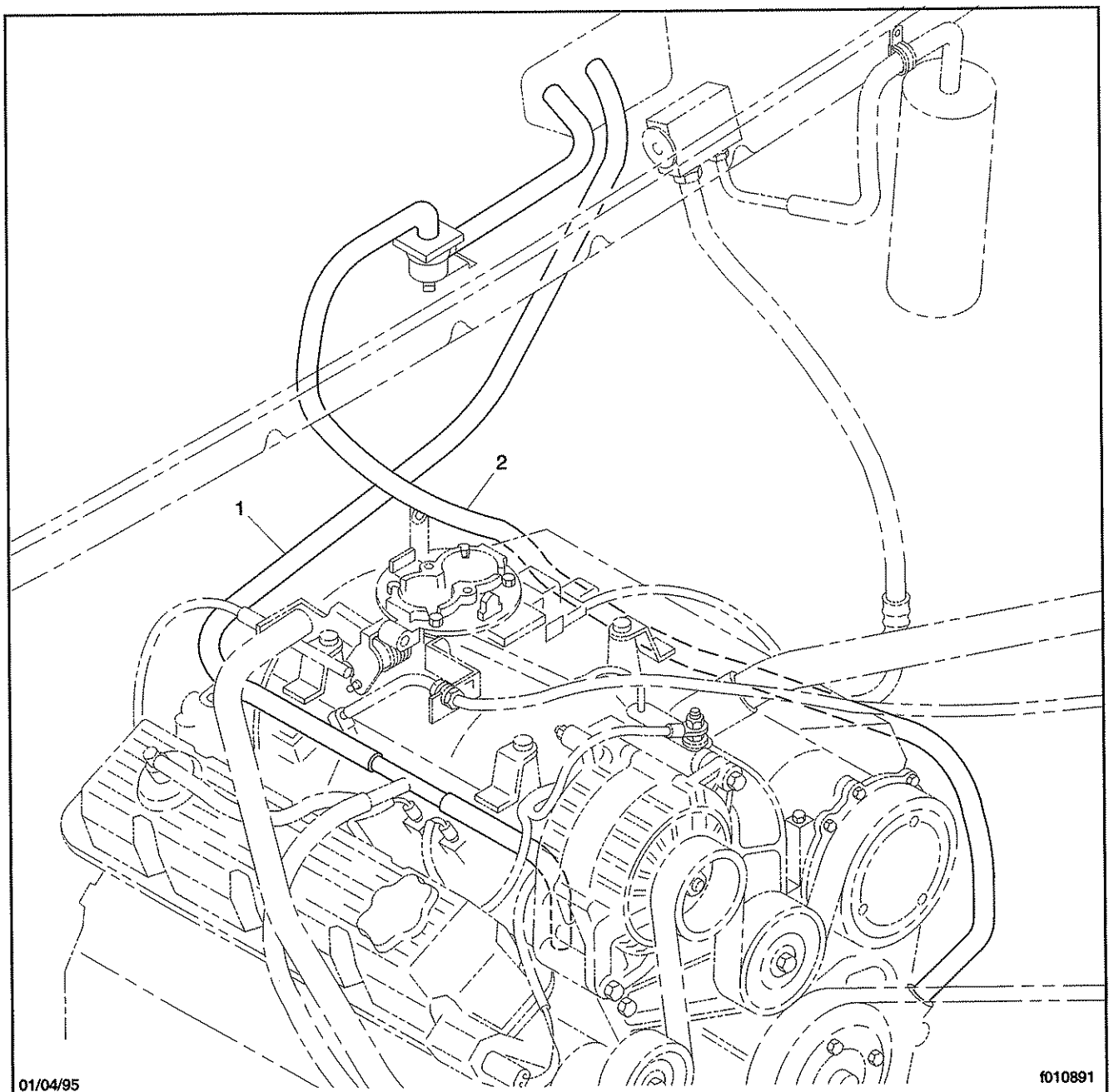
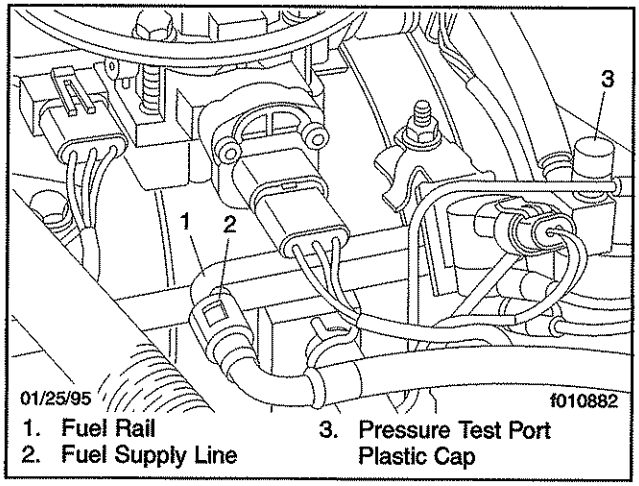


Fig. 14, Heater Hoses

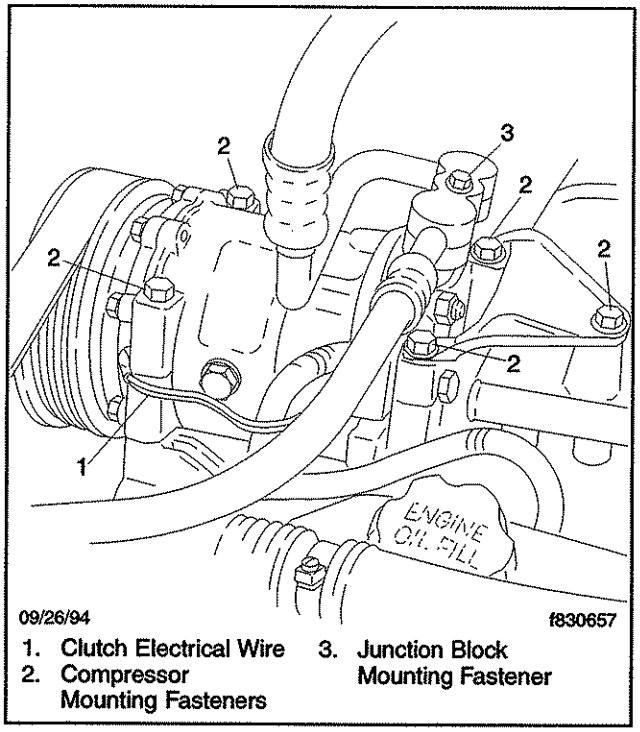
9. Connect the throttle cable to the throttle body cam.

Removal and Installation



1. Fuel Rail
2. Fuel Supply Line
3. Pressure Test Port Plastic Cap

Fig. 15, Fuel Supply Line Connection

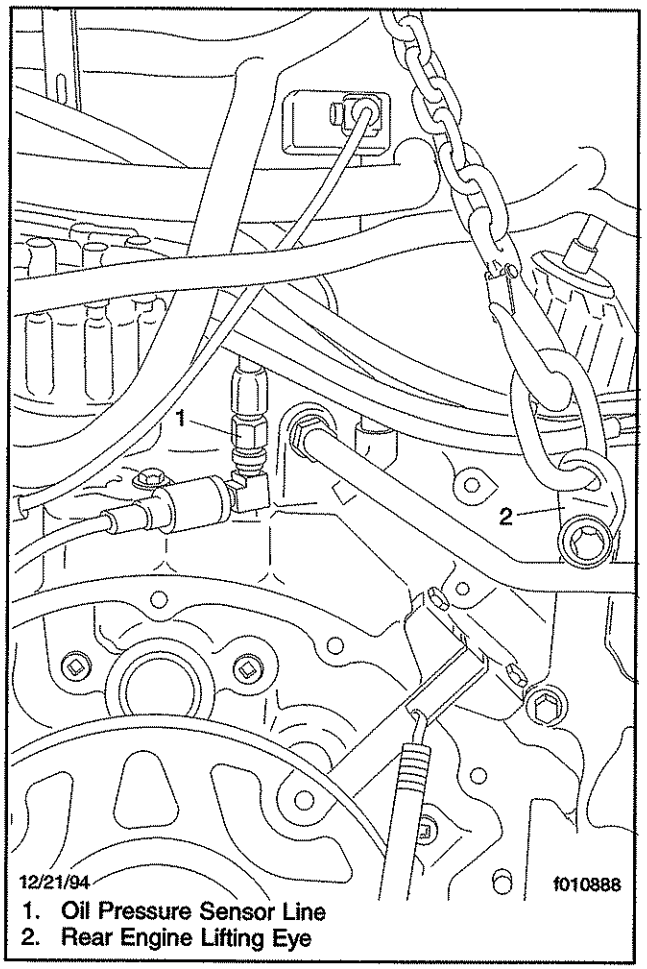


1. Clutch Electrical Wire
2. Compressor Mounting Fasteners
3. Junction Block Mounting Fastener

Fig. 16, Refrigerant Compressor Mounting

⚠ CAUTION

CAUTION: Make sure the drive belt is installed correctly. Incorrect installation could cause the water pump pulley to rotate in the wrong direction, which could result in extensive damage to the engine from overheating.



1. Oil Pressure Sensor Line
2. Rear Engine Lifting Eye

Fig. 17, Oil Pressure Sensor

10. Install the accessory drive belt. For belt routing instructions, see **Section 01.00**.
    - 10.1 Place a 5/8-inch wrench over the pulley bolt on the automatic belt tensioner, and turn the wrench counterclockwise to relax the belt tensioner. See **Fig. 13**.
    - 10.2 Install the belt.
11. Connect the fuel line to the fuel rail.
12. Connect the wiring to the starter motor.
13. Connect the power lead to the alternator. See **Fig. 21**.

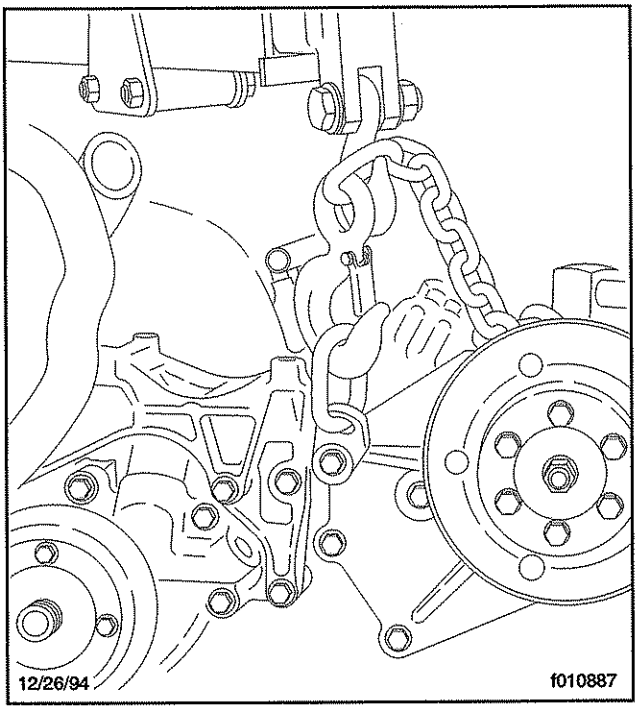


Fig. 18, Front Engine Lifting Eye

14. Put the fan and clutch assembly inside the fan shroud; then install the fan and clutch assembly onto the fan pulley. Tighten the nut 57 N·m (42 lbf·ft).
15. Install the radiator.
    - 15.1 Install the radiator onto the four mounting-bracket studs.
    - 15.2 Install the rear ends of the radiator support struts in the holes of the brackets on the frame rail.
    - 15.3 Install a rubber isolator, washer and nuts on the end of each strut. Tighten the nuts 47 N·m (35 lbf·ft).
    - 15.4 Install the four radiator mounting locknuts and washers, and tighten them 40 N·m (30 lbf·ft).
16. Install the fan shroud onto the radiator side channels, using the six self-tapping screws and washers
17. Install the air recirculation shields, the transmission oil cooler, and the condenser in front of the radiator. The upper mounting studs attach all three components to the radiator.
18. Connect the hoses to transmission oil cooler.
19. Install the transmission oil cooler hose stand-off bracket onto the rear stud of the driver's side radiator mounting bracket.
20. Connect the coolant hoses to the radiator. See **Fig. 22.**
21. Install the hose from the power steering reservoir to the power steering pump.
22. Connect the heater supply and return hoses.
23. Install the horn and mounting bracket assembly on the right frame rail. Make sure the nuts are facing outboard. Connect the wiring to the horn.
24. Install the air filter assembly and its gasket onto the throttle body. Make sure the stud on the intake manifold fits into the hole at the front underside of the air filter.
25. From behind the engine, connect the oil pressure sensor line to the engine. See **Fig. 17.**
26. Install the hood. See **Group 88** for instructions.
27. Install the bumper extensions.
28. Close the hood, then remove the chocks from the tires.

Removal and Installation

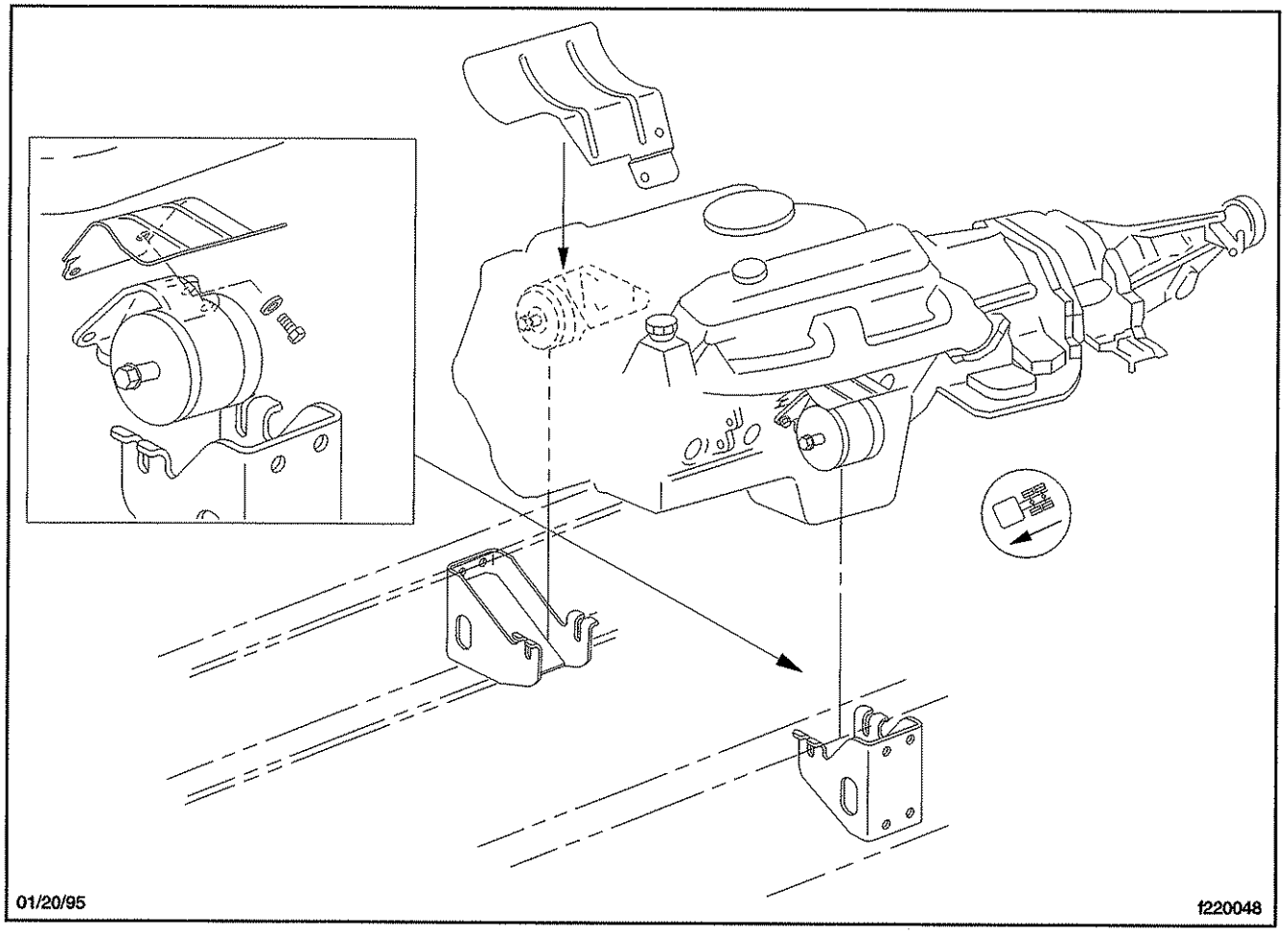
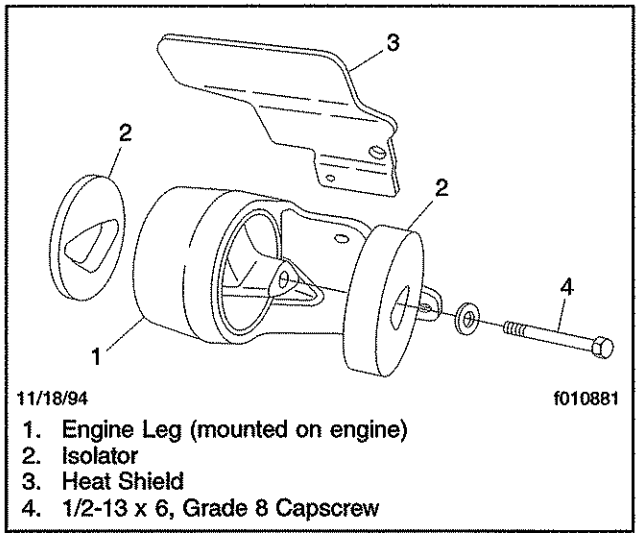
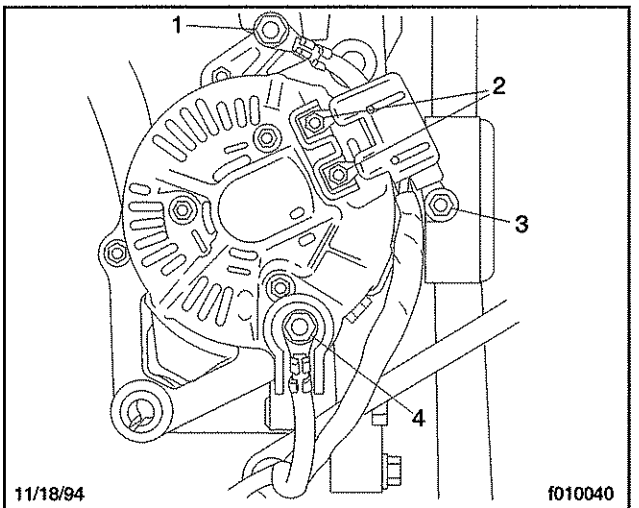


Fig. 19, Engine Placement on Front Engine Mounts



1. Engine Leg (mounted on engine)
2. Isolator
3. Heat Shield
4. 1/2-13 x 6, Grade 8 Capscrew

Fig. 20, Front Engine Mount Assembly



1. Ground Terminal
2. Field Terminals
3. Wiring Harness Holddown
4. Power Terminal

Fig. 21, Alternator Wiring Connections

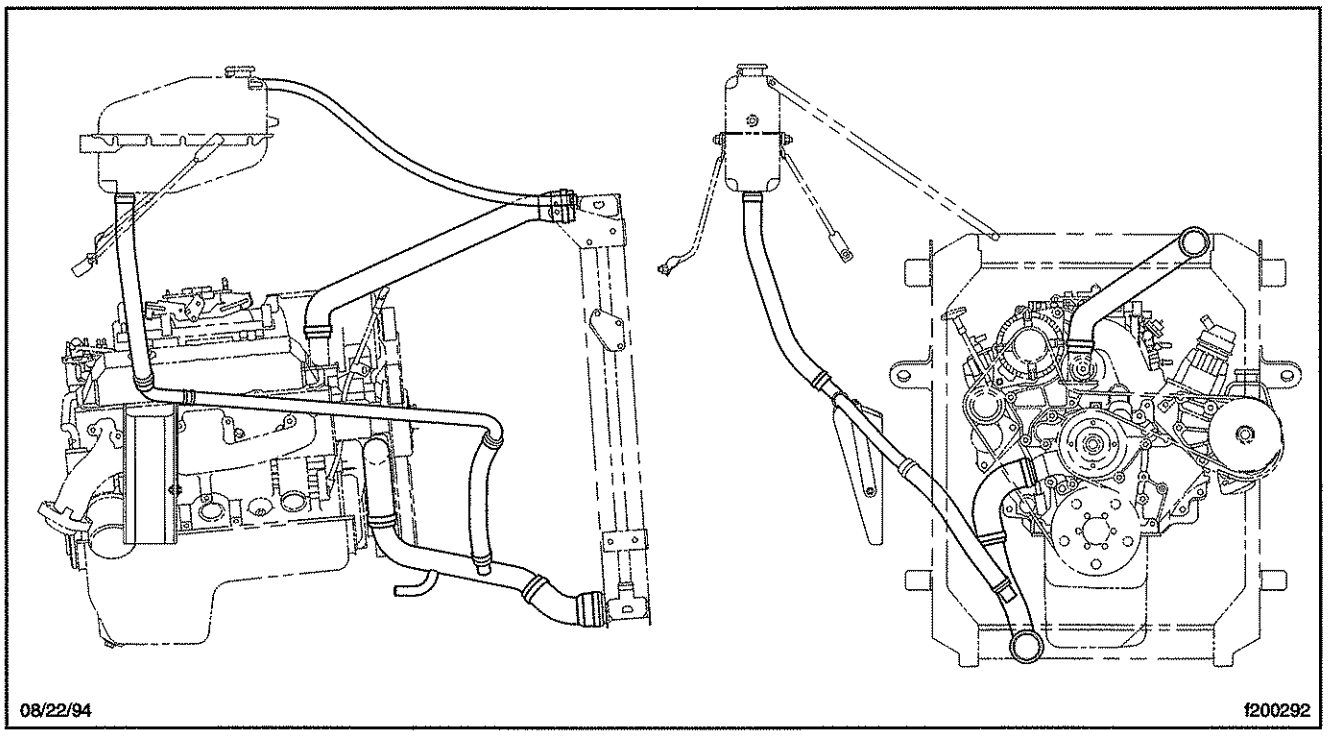


Fig. 22, Radiator Plumbing, Dodge Magnum Engine

Contents

Subject	Subject Number
Service Operations	
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NOTE: For engine wiring diagrams, refer to the applicable section in **Group 54**. For troubleshooting procedures, refer to **Section 54.02** for the Kysor Warning and Engine-Shutdown System.

Removal

NOTE: For engine wiring diagrams, refer to the applicable section in **Group 54**. For troubleshooting procedures, refer to **Section 54.02** for the Kysor Warning and Engine-Shutdown System.

1. Apply the parking brakes, chock the tires, and drain the air system.
2. Disconnect the batteries.
   - 2.1 Disconnect the battery ground cable at the vehicle frame.
   - 2.2 Disconnect the positive battery cable from the batteries.
3. Remove the hood and bumper. For instructions, refer to **Group 88** in this service manual.

⚠ WARNING

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

4. Drain the radiator.
   - 4.1 Place a suitable container under the driver's side corner of the radiator. See **Fig. 1**.
   - 4.2 Remove the surge tank cap.
   - 4.3 Unscrew the plug in the bottom of the radiator.

     After the coolant has drained, screw the plug into the radiator, and tighten it firmly.
5. Remove the air cleaner housing.
   - 5.1 Remove the right fender splash shield. See **Fig. 2**.
   - 5.2 Remove the air compressor intake hose that runs from the engine air intake hose to the compressor. See **Fig. 3**.
   - 5.3 Remove the air intake hoses that run between the air cleaner housing and the turbocharger, and remove the hoses that run between the turbocharger and the charge air cooler, and between the charge air cooler and the engine.

     Leave the A-shaped bracket that held the air intake piping to the top of the engine.
   - 5.4 Disconnect the vent lines from the radiator and the engine, and move the lines aside.
   - 5.5 Remove the radiator inlet hose from the radiator and the engine.
   - 5.6 Disconnect the radiator outlet hose from the bottom of the radiator.
   - 5.7 Disconnect the wiring to the horn.
   - 5.8 Disconnect the radiator right-hand strut from the air cleaner housing bracket.
   - 5.9 Disconnect the right-side air recirculation shield from the radiator. This includes disconnecting the two push-type fasteners that hold the shield to a bracket attached to the top of the radiator. See **Fig. 4**.
   - 5.10 Remove the four 3/4-inch bolts that hold the air cleaner housing bracket to the frame rail.

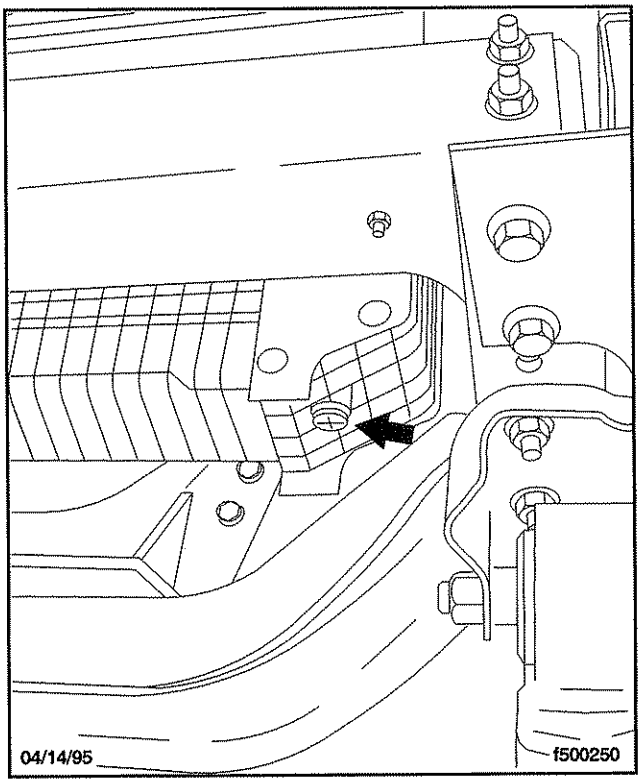
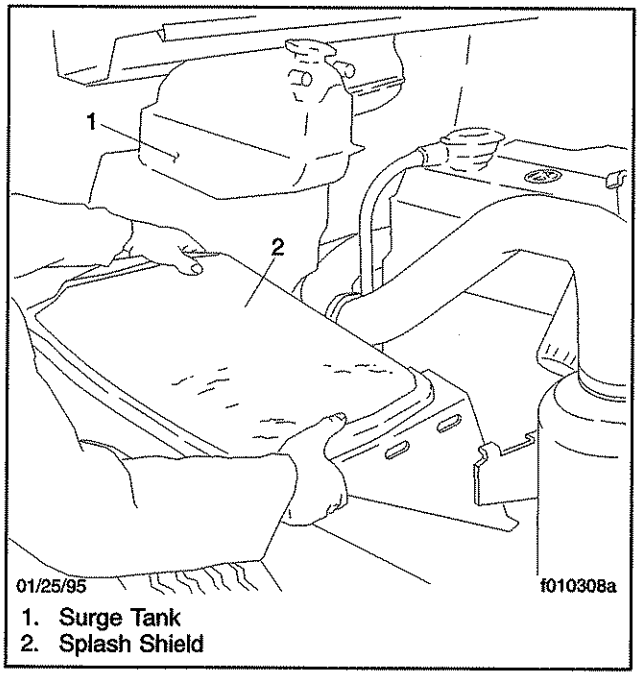


Fig. 1, Radiator Drain Plug

Engine Removal and Installation



1. Surge Tank
2. Splash Shield

Fig. 2, Right Fender Splash Shield, Typical Installation

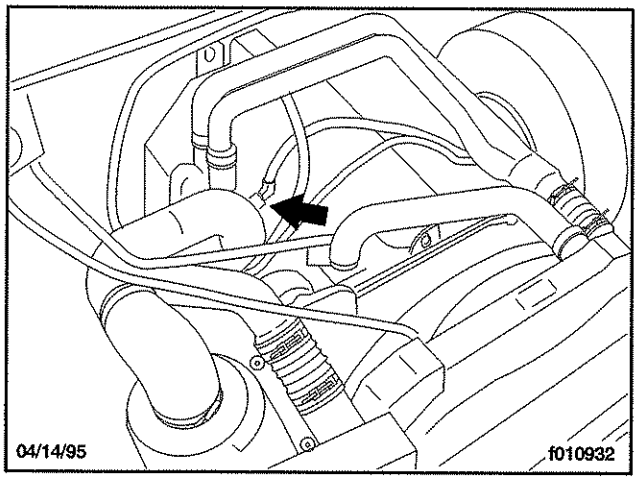


Fig. 3, Air Compressor Intake Hose

5.11 As a unit, remove the air cleaner housing, the housing bracket, the passenger side air recirculation shield, and the horn from the vehicle.

6. Remove the radiator.

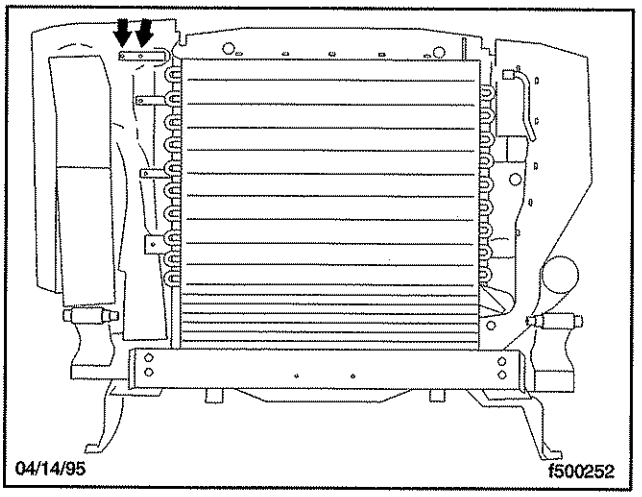


Fig. 4, Air Recirculation Shields and Fasteners

6.1 Free the refrigerant lines from all routing clamps and stand-off brackets between the compressor and the condenser. See **Fig. 5**.

6.2 Remove the condenser mounting fasteners, and move the condenser aside.

6.3 Remove the left-side air recirculation shield from the radiator/charge air cooler assembly.

6.4 Disconnect the right-side radiator strut from the radiator.

6.5 Attach a lifting chain to the two rear hood attachment studs at the top of the radiator, and attach the chain to a lifting crane. See **Fig. 6**.

6.6 Disconnect the radiator/charge air cooler from its framerail mounts.

6.7 Remove the fasteners that hold the fan shroud to the radiator, and move the shroud back against the engine.

6.8 Lift the radiator/charge air cooler assembly from the vehicle.

7. Move the refrigerant compressor aside.

7.1 Disconnect the compressor wiring.

7.2 Remove the accessory drive belt. For instructions, refer to **Section 01.00** in this service manual.

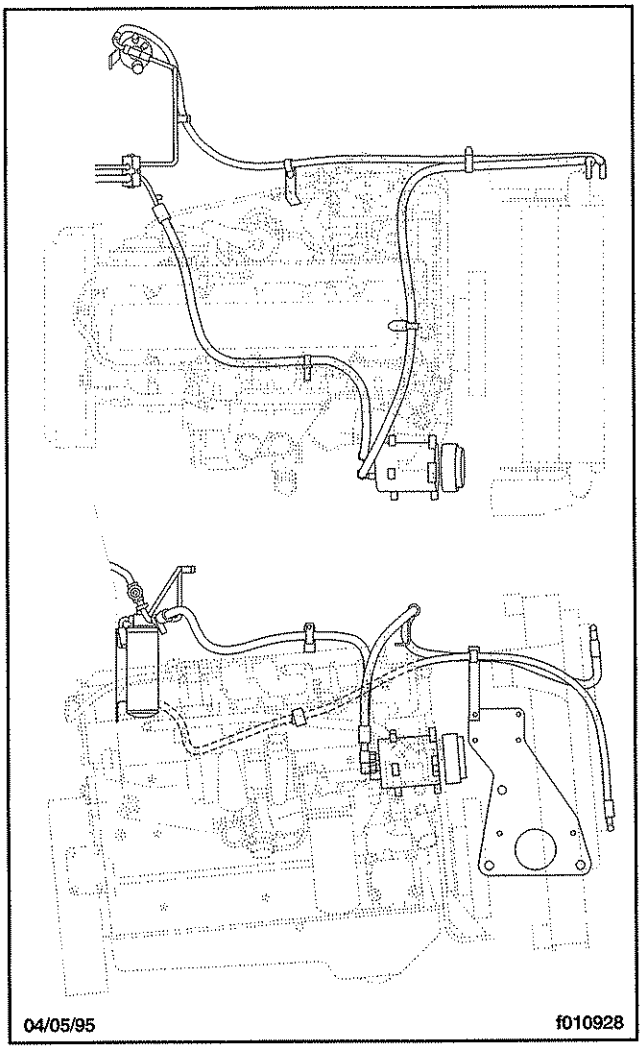


Fig. 5, Refrigerant Line Routings

7.3 Remove the compressor mounting fasteners, and move the compressor aside.

7.4 Use tie straps to secure the refrigerant compressor and condenser out of the way.

8. Disconnect the heater hoses.

8.1 Disconnect the heater return hose from the water pump, and move the hose aside. See **Fig. 7**.

8.2 Disconnect the heater supply hose from the rear of the engine block, and move the hose aside. See **Fig. 8**.

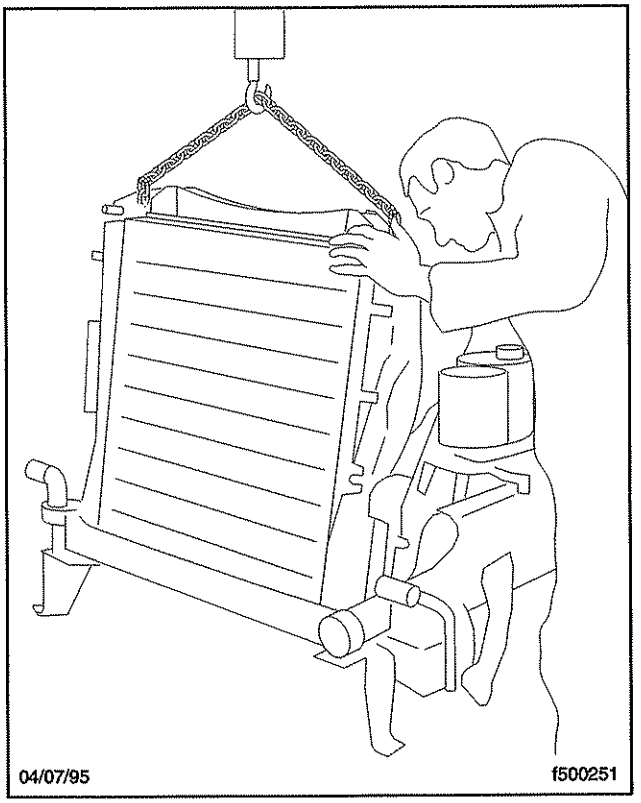


Fig. 6, Lifting the Radiator

9. Label and disconnect the wiring. See **Fig. 9**.

9.1 Disconnect the wiring from the starter. See **Fig. 10**.

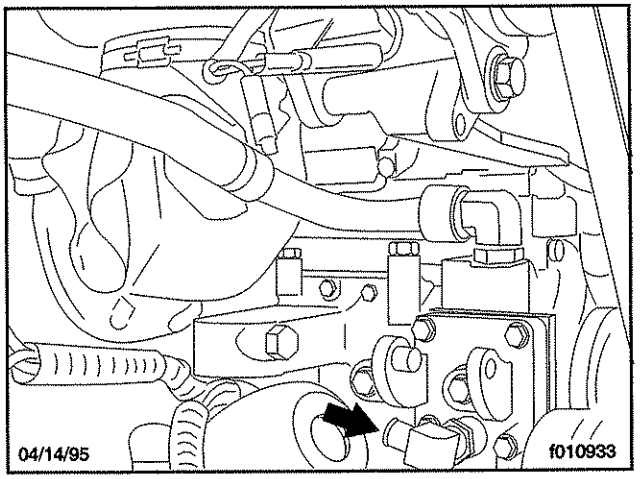
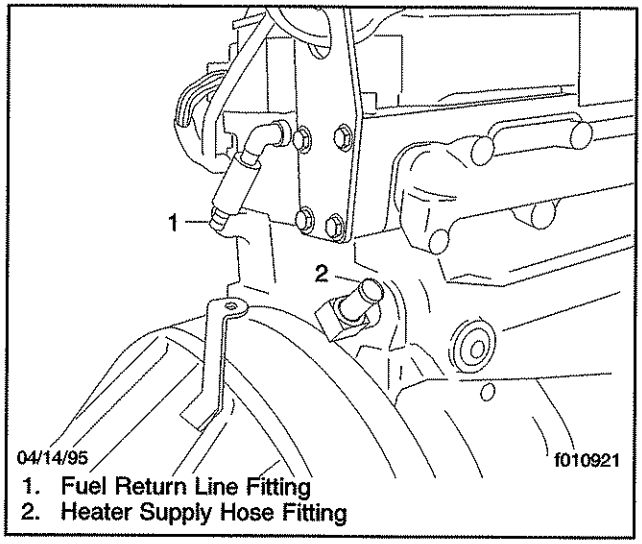


Fig. 7, Heater Return Hose Connection

Engine Removal and Installation



1. Fuel Return Line Fitting
2. Heater Supply Hose Fitting

Fig. 8, Fuel Return and Heater Supply Connections

9.2 Disconnect the ground strap from the alternator.

9.3 Disconnect the wiring from the alternator.

9.4 Disconnect the wiring from the receiver-drier.

9.5 Disconnect the wiring from the fan clutch.

9.6 Disconnect the wiring from the coolant temperature sensors.

9.7 Unplug the lower wiring harness connector from the electronic control module. See **Fig. 11**.

10. Disconnect the power steering components.

10.1 Place a suitable container under the power steering fluid reservoir, and remove the hoses from the bottom of the reservoir. Allow the fluid to drain completely.

10.2 At the power steering fluid pump, disconnect the hose that runs from the pump to the steering gear.

10.3 Secure any loose, disconnected hoses to the engine with tie straps.

11. Disconnect the air lines from the air governor on top of the air compressor.

12. At the fuel/water separator, disconnect the fuel delivery line that runs to the engine.

13. Disconnect the forward end of the clutch rod, and tie strap the rod to the engine.

14. Remove the windshield wiper pan. See **Fig. 12**.

14.1 Remove the windshield wiper arms. For instructions, refer to **Group 82** of this manual.

14.2 Remove the screws that hold the wiper pan to the firewall.

14.3 Remove the surge tank. For instructions, refer to **Group 20** in this manual.

14.4 Remove the fresh air intake snorkel with the wiper pan.

14.5 Remove the wiper pan by pulling the pan down, out from under the lower edge of the windshield trim.

15. Disconnect the air line from the fan clutch solenoid. See **Fig. 13**.

16. Remove the shift tower. For instructions, refer to **Group 26** in this service manual.

17. Remove the exhaust ducting.

17.1 Loosen the V-band clamp that holds the forward end of the exhaust ducting to the rear of the turbocharger.

17.2 Under the cab, disconnect the exhaust pipe from the saddle clamp mounted on the flywheel housing. See **Fig. 14**.

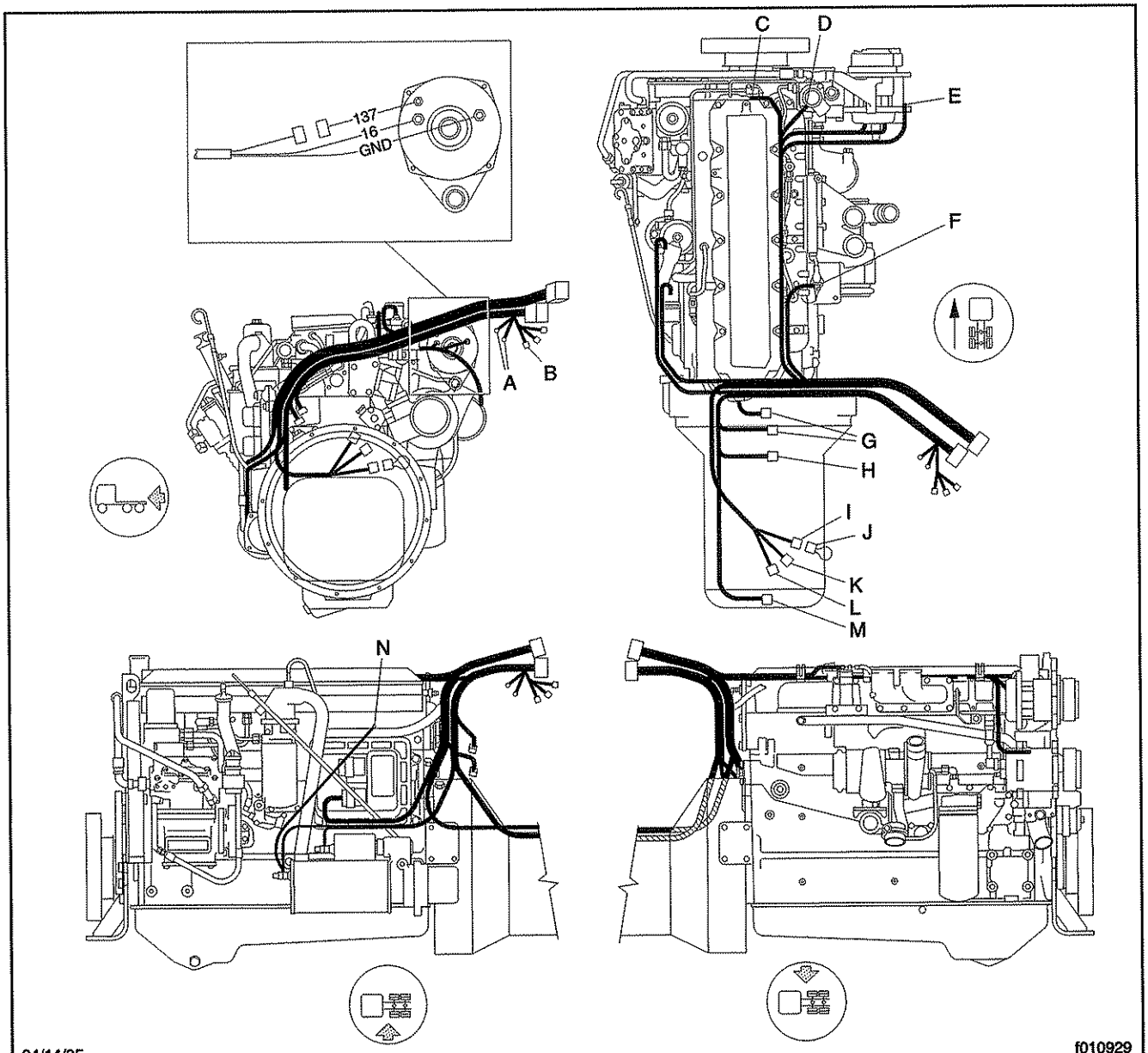
18. Disconnect the driveline from the transmission.

18.1 Place a stand under the driveline, and disconnect the driveline from the transmission. For instructions, refer to **Group 41** in this service manual.

18.2 Place a second stand under the driveline, and disconnect the driveline midship bearing bracket. See **Fig. 15**. For instructions, refer to **Group 41** in this service manual.

18.3 Move the driveline out of the way.

19. While under the vehicle, disconnect all other engine and transmission components.



A. To Cab Studs
B. To Mag Switch
C. To Fan Clutch Solenoid
D. To Coolant Temperature Switch
E. To Refrigerant Compressor
F. To Grid Heater (Intake Air Heater)
G. To Tachometer Sensor
H. To Back Up Switch Wiring Harness
I. To Neutral Start Switch
J. Jumper Assembly
K. To Vehicle Speed Sensor
L. To Speedometer
M. To Vehicle Speed Sensor
N. To Ground Stud

Fig. 9, Wiring Harnesses

Engine Removal and Installation

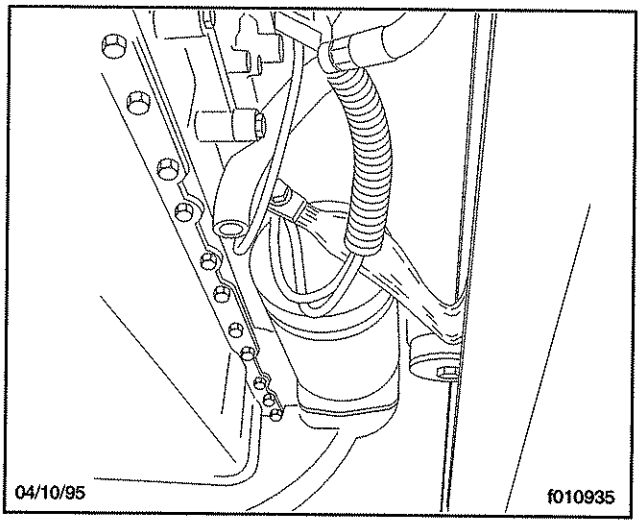


Fig. 10, Starter Wiring Connections

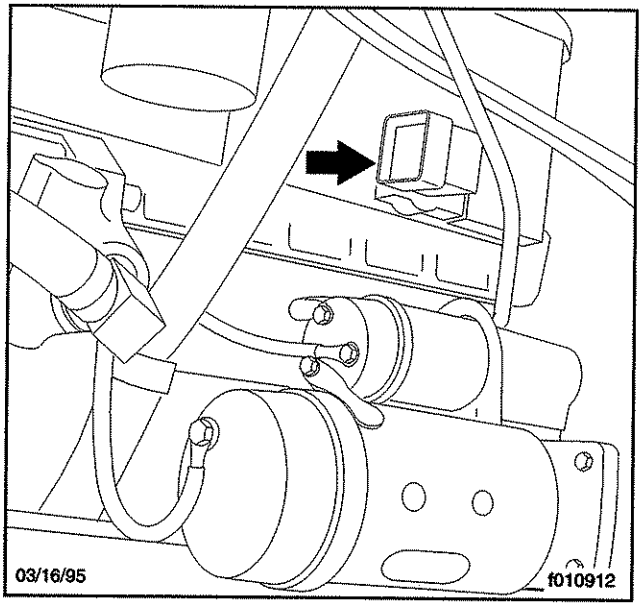
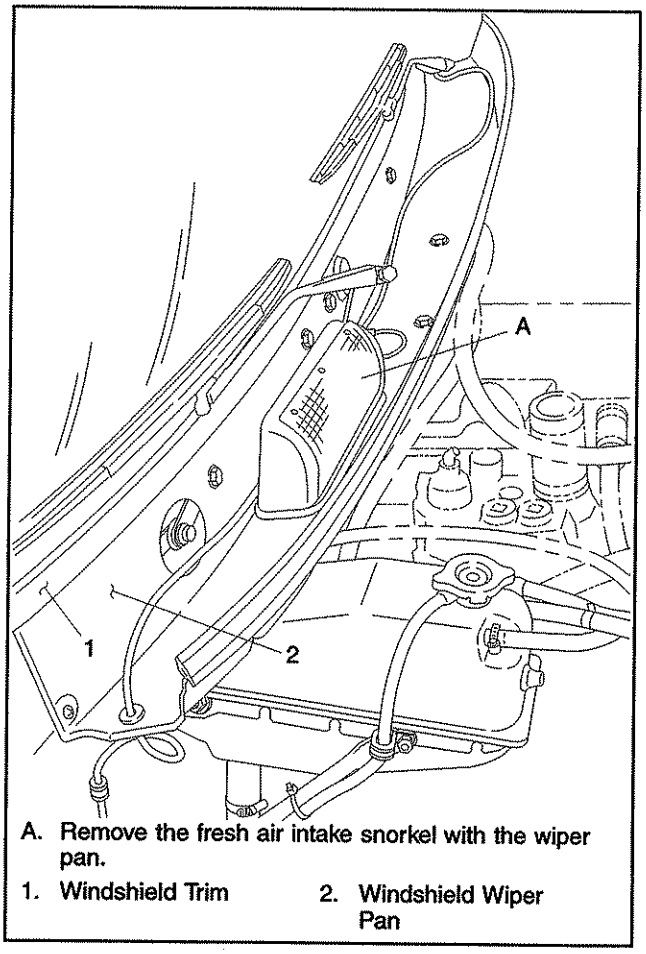


Fig. 11, Disconnect This ECM Connector

19.1 Disconnect the battery cable stand off bracket by the left rear engine mount.

19.2 Disconnect the wiring from the speedometer sensor at the transmission output.

19.3 Disconnect the wiring harness connectors from the back-up alarm switch and the neutral start switch on the transmission top cover. See **Fig. 16**.



A. Remove the fresh air intake snorkel with the wiper pan.
1. Windshield Trim
2. Windshield Wiper Pan

Fig. 12, Wiper Pan Installation

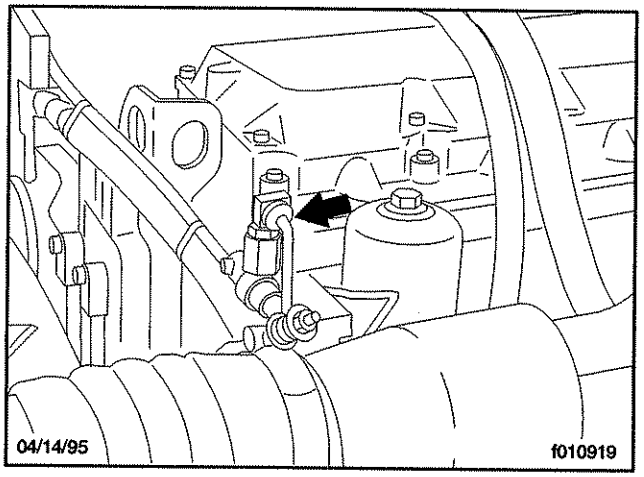


Fig. 13, Fan Clutch Solenoid

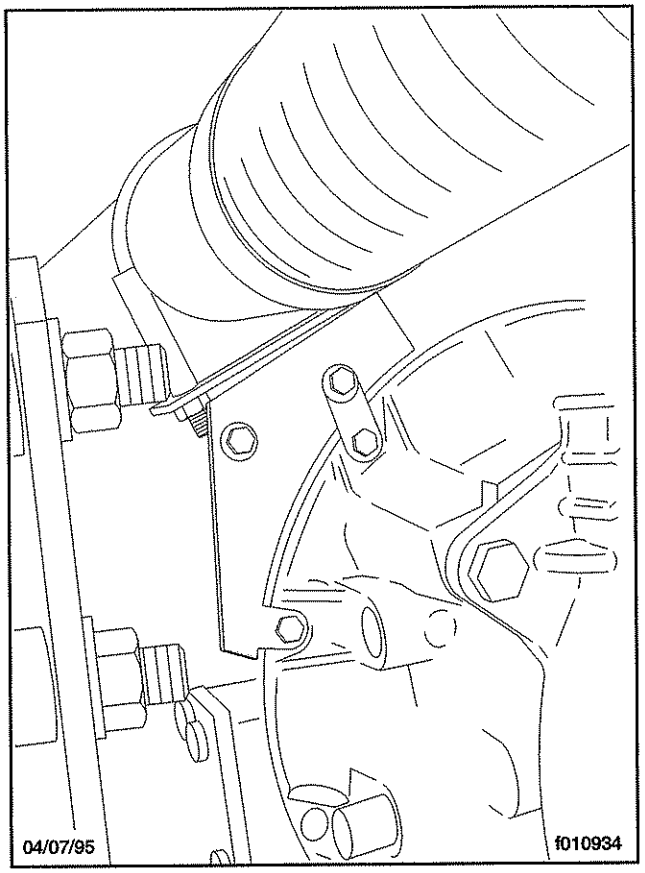


Fig. 14, Exhaust Bracket on Flywheel Housing

19.4 Remove the heat shield over the wiring harness, forward of the right, rear engine mount. See **Fig. 17.**

19.5 Disconnect the fuel supply line from the junction plate mounted on top of the transmission.

19.6 Disconnect the fuel return line from the back of the engine block. See **Fig. 8.**

19.7 Disconnect the wire-braid air compressor outlet line from the chassis air supply line.

⚠ WARNING

The crane and lifting chains used to remove the engine must be capable of safely lifting and supporting two metric tons. Once the engine mounts are disconnected, do not get under the engine until it is securely supported on engine stands. An unsecured engine may fall, causing personal injury or death, and component damage.

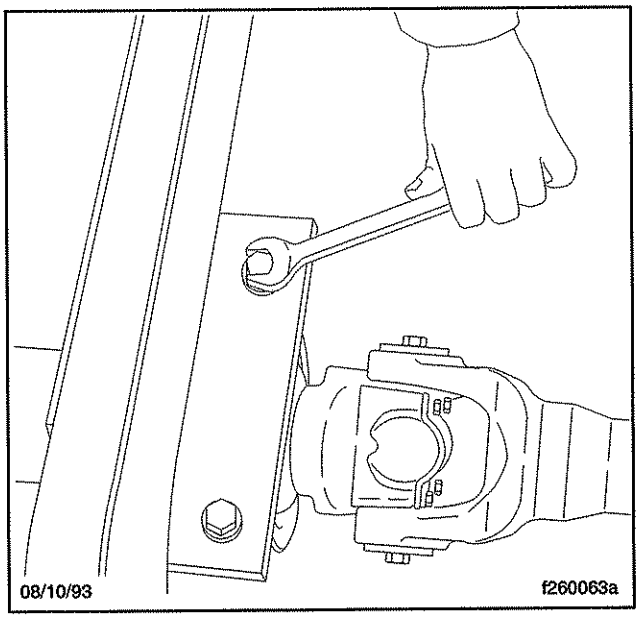


Fig. 15, Midship Bearing Bracket

20. Remove the engine from the vehicle.

20.1 Attach the chain to the existing lifting eyes at the front and the rear of the engine. See **Fig. 18.**

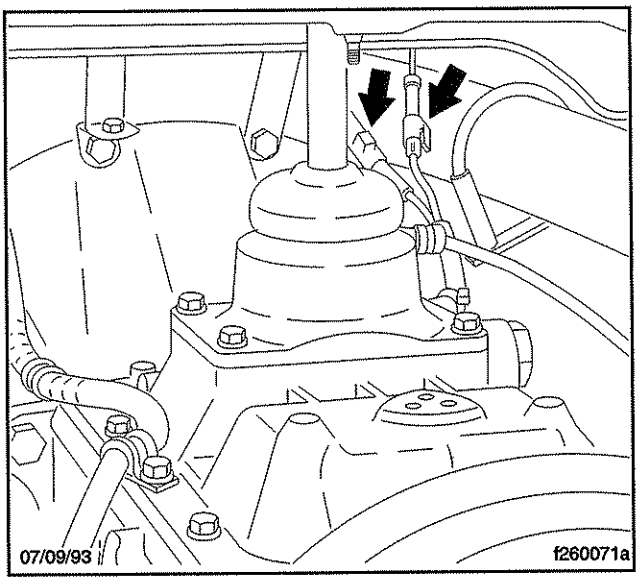


Fig. 16, Transmission Wiring Connectors

Engine Removal and Installation

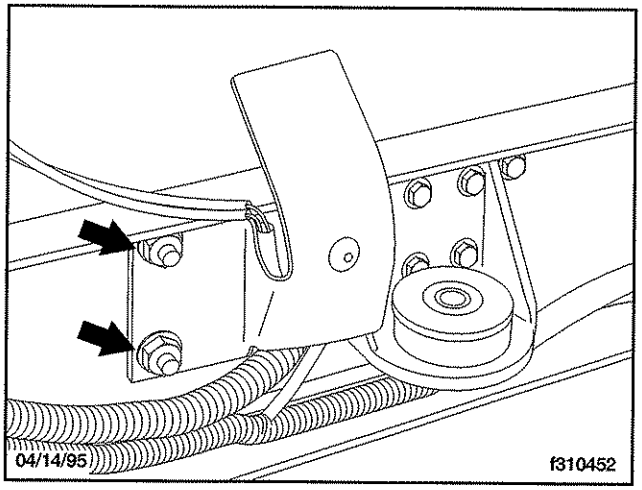


Fig. 17, Wiring Harness Heat Shield Fasteners

20.2 With the engine lifting eyes connected by chain to the crane, raise the crane enough to tighten the chains, but not enough to lift the front of the vehicle.

20.3 With the engine securely supported by the crane and lifting chains, disconnect the rear engine legs from the engine mounts on the frame rails.

On each engine leg, remove the nut from the bolt that runs down through the engine leg, rubber isolators, and engine mount. Save the fasteners and isolators.

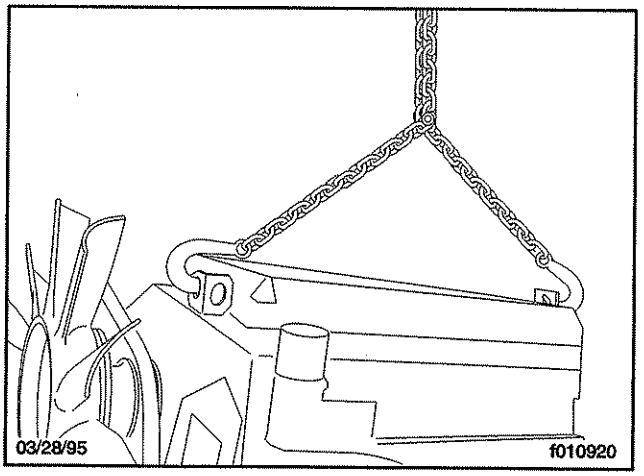


Fig. 18, Lifting Chain Installed

20.4 Remove the nuts from the bolts that fasten the front engine support bracket to the underslung crossmember. See **Fig. 19**.

20.5 Using the crane, lift the engine and pull it forward.

20.6 Once the engine and transmission are clear of the vehicle, place the engine on engine stands.

Installation

⚠ WARNING

The crane and lifting chains used to install the engine must be capable of safely lifting and supporting two metric tons. Once the engine is removed from the engine stands, do not get under the engine until it is securely supported on the engine mounts. An unsecured engine may fall, causing personal injury or death, and component damage.

1. Install the engine and transmission in the vehicle.

1.1 Attach the chain to the existing lifting eyes at the front and the rear of the engine.

1.2 With the two engine lifting eyes connected by chain to the crane, lift the engine, and position it in the engine compartment.

1.3 Connect the engine to the rear engine mounts, and tighten each bolt that runs

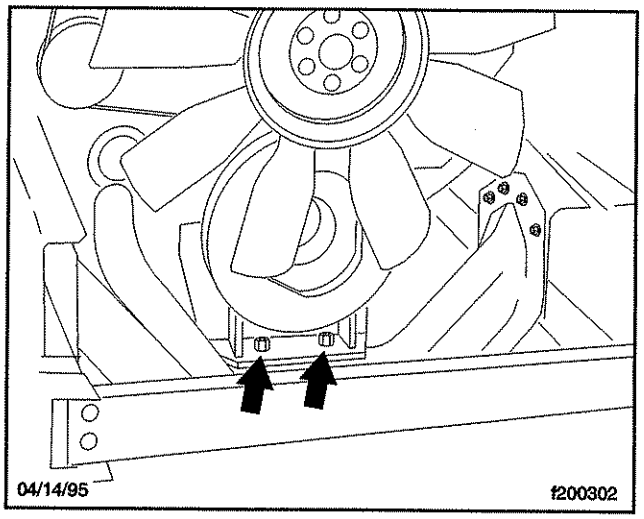


Fig. 19, Front Engine Mount Fasteners

down through the engine leg, rubber isolators, and engine mount 327 N·m (241 lbf·ft).

1.4 Assemble the lower isolator under the underslung crossmember and the front engine support bracket, and secure the front engine mount with nuts and washers. Tighten the nuts 184 N·m (136 lbf·ft).

1.5 Once the engine is securely installed in the vehicle, remove the lifting chains.

2. Under the engine and transmission, connect all engine and transmission components.

2.1 Connect the wiring to the speedometer sensor at the transmission output.

2.2 Connect the wiring harness connectors to the back-up alarm switch and the neutral start switch on the transmission top cover.

2.3 Connect the fuel supply line to the junction plate mounted on top of the transmission.

2.4 Connect the fuel return line to the back of the engine block.

2.5 Connect the wire-braid air compressor outlet line to the chassis air supply line.

2.6 Route and clamp the battery cable.

3. Connect the driveline.

3.1 Connect the driveline to the transmission. For instructions, refer to **Group 41** in this manual.

3.2 Connect the driveline midship bearing bracket. For instructions, refer to **Group 41** in this manual.

4. Install the exhaust ducting.

4.1 Under the engine, connect the exhaust pipe to the saddle clamp mounted on the flywheel.

4.2 Tighten the V-band clamp that holds the forward end of the exhaust ducting to the rear of the turbocharger 85 lbf·in (940 N·cm).

5. Install the windshield wiper pan. See **Fig. 12.**

5.1 Position the pan by tucking it up under the lower edge of the windshield trim.

5.2 Install the fresh air intake snorkel.

5.3 Install the screws that hold the pan to the firewall.

5.4 Install the surge tank. For instructions, refer to **Section 20.01** of this manual.

5.5 Install the wiper arms. For instructions refer to **Group 82** of this manual.

6. Connect the air line to the fan clutch solenoid. See **Fig. 13.**

7. At the left side of the engine, connect the air lines to the air governor on top of the air compressor.

8. At the fuel/water separator, connect the fuel delivery line that runs to the engine.

9. Connect the forward end of the clutch rod, and remove any tie straps that hold the rod to the engine.

10. Connect the power steering components.

10.1 Connect the hoses to the bottom of the power steering fluid reservoir.

10.2 At the power steering fluid pump, connect the hose that runs from the pump to the steering gear.

10.3 With all the hoses connected, fill the power steering fluid reservoir.

11. Connect the engine wiring.

11.1 Connect the wiring to the starter.

11.2 Connect the ground strap to the alternator.

11.3 Connect the wiring to the alternator.

11.4 Connect the wiring to the receiver-drier.

11.5 Connect the wiring to the fan clutch.

11.6 Connect the wiring to the coolant temperature sensors.

11.7 Plug the lower wiring harness connector into the electronic control module.

12. Connect the heater hoses.

12.1 Connect the heater return hose to the water pump.

Engine Removal and Installation

12.2 Connect the heater supply hose to the rear of the engine block.

13. Install the refrigerant compressor.

13.1 Connect the compressor wiring.

13.2 Install the compressor mounting fasteners. For instructions, refer to **Group 83** in this manual.

13.3 Install the accessory drive belt. For instructions, refer to **Section 01.00** in this manual.

14. Install the radiator.

14.1 Attach a lifting chain to the two hood attachment studs at the top of the radiator, and attach the chain to a lifting crane.

14.2 Lift the radiator/charge air cooler assembly, and position it on the radiator mounts.

14.3 Install the radiator/charge air cooler on its framerail mounts. For instructions, refer to **Section 20.01** in this manual.

14.4 Install the fan shroud on the radiator.

14.5 Connect the vent lines to the radiator and the engine.

14.6 Install the radiator inlet hose between the radiator and the engine.

14.7 Connect the radiator outlet hose to the bottom of the radiator.

14.8 Install the condenser on the radiator and charge air cooler.

14.9 Route the refrigerant lines between the compressor and the condenser, and secure the lines with clamps and stand-off brackets.

14.10 Install the driver side air recirculation shield.

15. Install the air cleaner housing.

15.1 As a unit, position the air cleaner housing, the housing bracket, the right-side air recirculation shield, and the horn on the vehicle.

15.2 Install the four 3/4-inch bolts that hold the air cleaner housing mounting bracket to the frame rail. For instructions, refer to **Group 09** in this service manual.

15.3 Connect the radiator right-hand strut to the air cleaner housing bracket.

15.4 Connect the right-side air recirculation shield to the radiator. This includes connecting the two push-type fasteners that hold the shield to a bracket attached to the top of the radiator.

15.5 Connect the air intake hoses that run between the air cleaner housing and the turbocharger, and connect the hoses that run between the turbocharger and the charge air cooler, and between the charge air cooler and the engine. Clamp the hoses to the A-shaped bracket on top of the engine.

15.6 Install the air compressor intake hose that runs from the engine air intake hose to the compressor.

15.7 Install the right fender splash shield. See **Fig. 3**.

15.8 Connect the wiring to the horn.

16. Install the shift tower.

17. Fill the radiator.

18. Install the hood and bumper. For instructions, refer to **Group 88** in this service manual.

19. Connect the batteries.

20. Remove the chocks from the tires.

21. Start the engine, and check for leaks. Repair any leaks found.

22. Test drive the vehicle.

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Removal

IMPORTANT: To remove the Cummins M11 engine from a Freightliner FL112 vehicle, you'll need a special lifting bracket for the rear of the engine.

1. Apply the parking brakes, chock the tires, and drain the air system.
2. Disconnect the batteries.
3. Remove the hood, bumper, and the left-side half fender. For instructions, refer to **Group 88** in this service manual.
4. Remove the hood tilt-assist bracket mounted on the front closing crossmember. For instructions, refer to **Group 88** in this service manual.
5. Remove the transmission. For instructions, refer to the applicable section in **Group 26** in this service manual.
6. Remove the air cleaner housing and the brackets that hold the housing to the bulkhead. See **Fig. 1**. This includes removing the heat shield between the cleaner and the turbocharger. For instructions, refer to **Group 09** in this service manual.

⚠ 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.

7. Drain the radiator.
   - 7.1 Place a suitable container under the left side corner of the radiator.
   - 7.2 Remove the surge tank cap.
   - 7.3 Unscrew the plug in the bottom of the radiator.

     After the coolant has drained, screw the plug into the radiator, and tighten it firmly.
8. Move the air conditioning components out of the way without breaking the refrigerant lines. See **Fig. 2**.
   - 8.1 Free the refrigerant lines from all routing clamps and stand-off brackets between the compressor and the condenser.

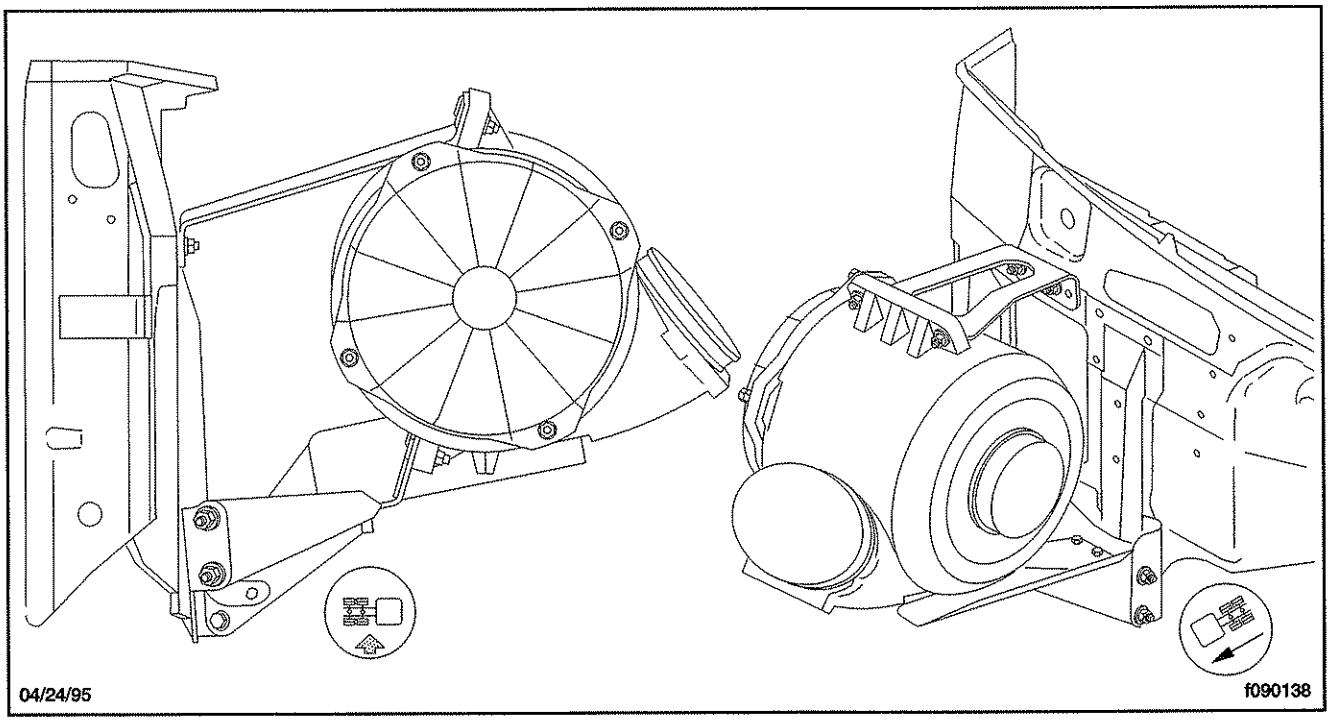
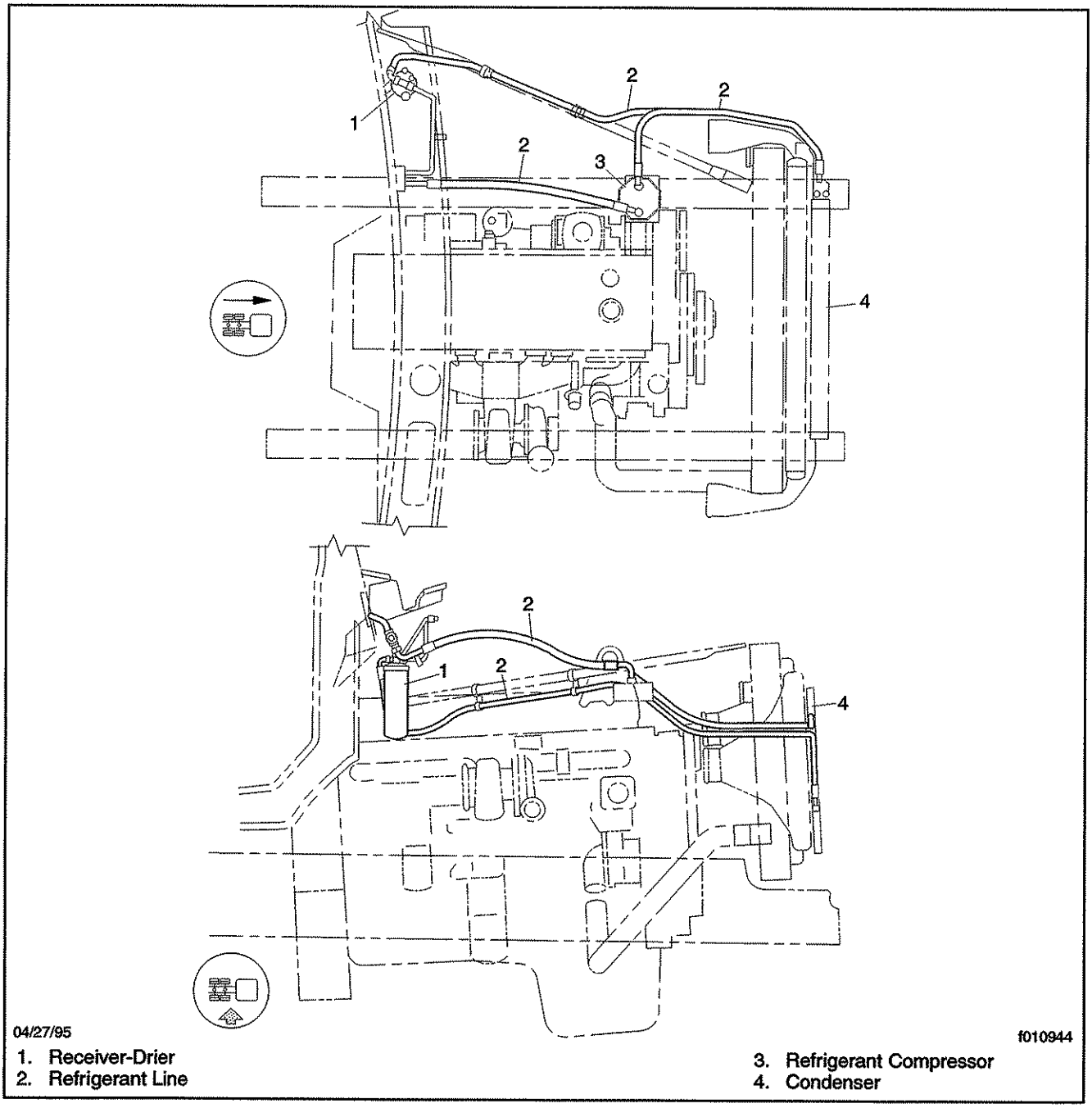


Fig. 1, Cummins M11 Engine, Air Cleaner Housing

Engine Removal and Installation



1. Receiver-Drier
2. Refrigerant Line
3. Refrigerant Compressor
4. Condenser

Fig. 2, Cummins M11 Engine, Air Conditioning Components

8.2 Free the refrigerant lines from all routing clamps and stand-off brackets between the receiver- drier and the condenser.

8.3 Remove the condenser mounting fasteners, and move the condenser aside.

8.4 Remove the refrigerant compressor and move the compressor aside.

8.5 Use tie straps to secure the refrigerant compressor and condenser out of the way.

9. Remove the air recirculation shields around the radiator and charge air cooler. For instructions, refer to **Group 09** in this service manual.

10. Remove the radiator and charge air cooler. For instructions, refer to **Group 20** in this service manual.

11. Remove the radiator mounting bracket from the front closing crossmember.

12. Disconnect or remove the remaining ducts and lines. See **Fig. 3**.

12.1 If not already removed, remove the air duct between the turbocharger and the air cleaner.

12.2 Disconnect the vent line from the engine, and move the line aside.

12.3 Disconnect the two air signal lines from the air governor on top of the compressor.

12.4 Disconnect the outlet line from the air compressor.

12.5 Disconnect the air line to the fan clutch solenoid, and free the line from routing clamps.

12.6 Disconnect the heater return hose from the radiator outlet pipe, and free the hose from the clamps that route it along the left frame rail. See **Fig. 4**.

12.7 Disconnect the heater supply hose. See **Fig. 4**.

12.8 Disconnect the oil pressure sensor line beneath the receiver-drier.

13. Remove the windshield wiper pan. See **Fig. 5**.

13.1 Remove the surge tank and mounting bracket from the bulkhead. For instructions, refer to **Group 20** in this service manual.

13.2 Remove the windshield wiper arms. For instructions, refer to **Group 82** of this manual.

13.3 Remove the screws that hold the wiper pan to the firewall.

13.4 Remove the fresh air intake snorkel with the wiper pan.

13.5 Remove the wiper pan by pulling the pan down, out from under the lower edge of the windshield trim.

14. Remove the windshield wiper linkage. For instructions, refer to **Group 82** in this service manual.

15. Label and disconnect the wiring.

15.1 Disconnect the two engine harness bulkhead connectors.

15.2 Disconnect the wiring from the power stud on the bulkhead.

15.3 Disconnect the wiring from the ground stud on the bulkhead.

15.4 Remove the two screws that hold the magnetic switch to the bulkhead, and remove the switch without disconnecting the wires from it.

15.5 Disconnect the starter ground cable from the frame rail.

15.6 Disconnect the power cables from the starter and the starter solenoid.

16. Without breaking the power steering fluid lines, remove the power steering pump, and move it aside. For instructions, refer to **Group 46** in this service manual.

17. Under the engine, disconnect or remove the remaining components.

17.1 Remove the flex pipe section of exhaust ducting that attaches to the turbocharger.

17.2 Disconnect the two fuel return lines from the equiflow bracket. For instructions, refer to **Group 47** in this service manual.

17.3 Remove the bolts that hold the engine legs to the rear engine mounts.

⚠ WARNING

The crane and lifting chains used to remove the engine must be capable of safely lifting and sup-

Engine Removal and Installation

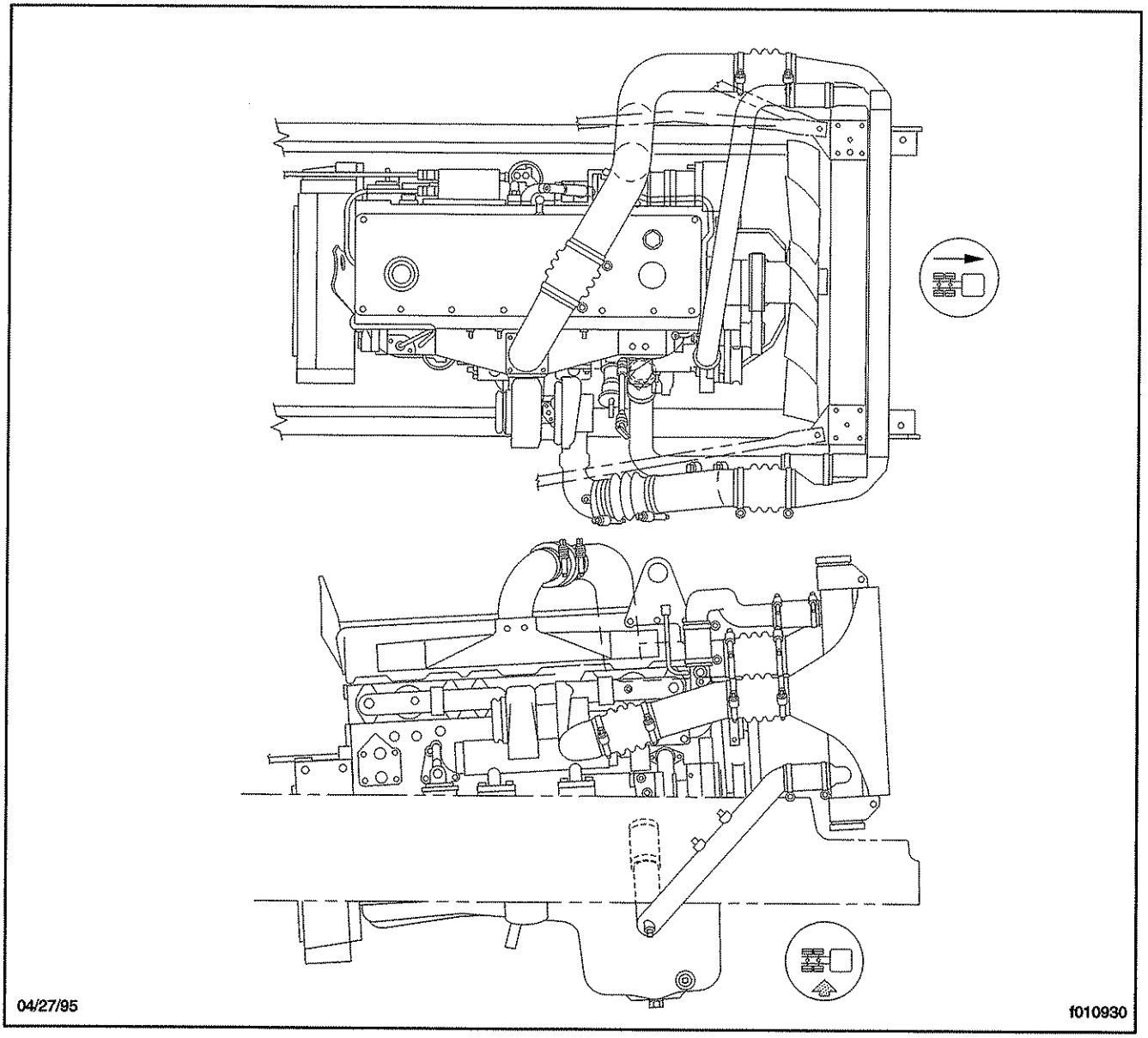


Fig. 3, Cummins M11 Engine, Radiator and Intake Air Plumbing

porting two metric tons. Once the engine mounts are disconnected, do not get under the engine until it is securely supported on engine stands. An unsecured engine may fall, causing personal injury or death, and component damage.

18. Remove the engine from the vehicle.

    NOTE: If the engine is equipped with a compression brake, remove the valve cover. For instructions, refer to the engine manufacturer's service literature.

    18.1 Attach the special lifting bracket to the rear of the engine.

    18.2 Attach the chain to the existing lifting eye at the front and the special lifting bracket at the rear of the engine.

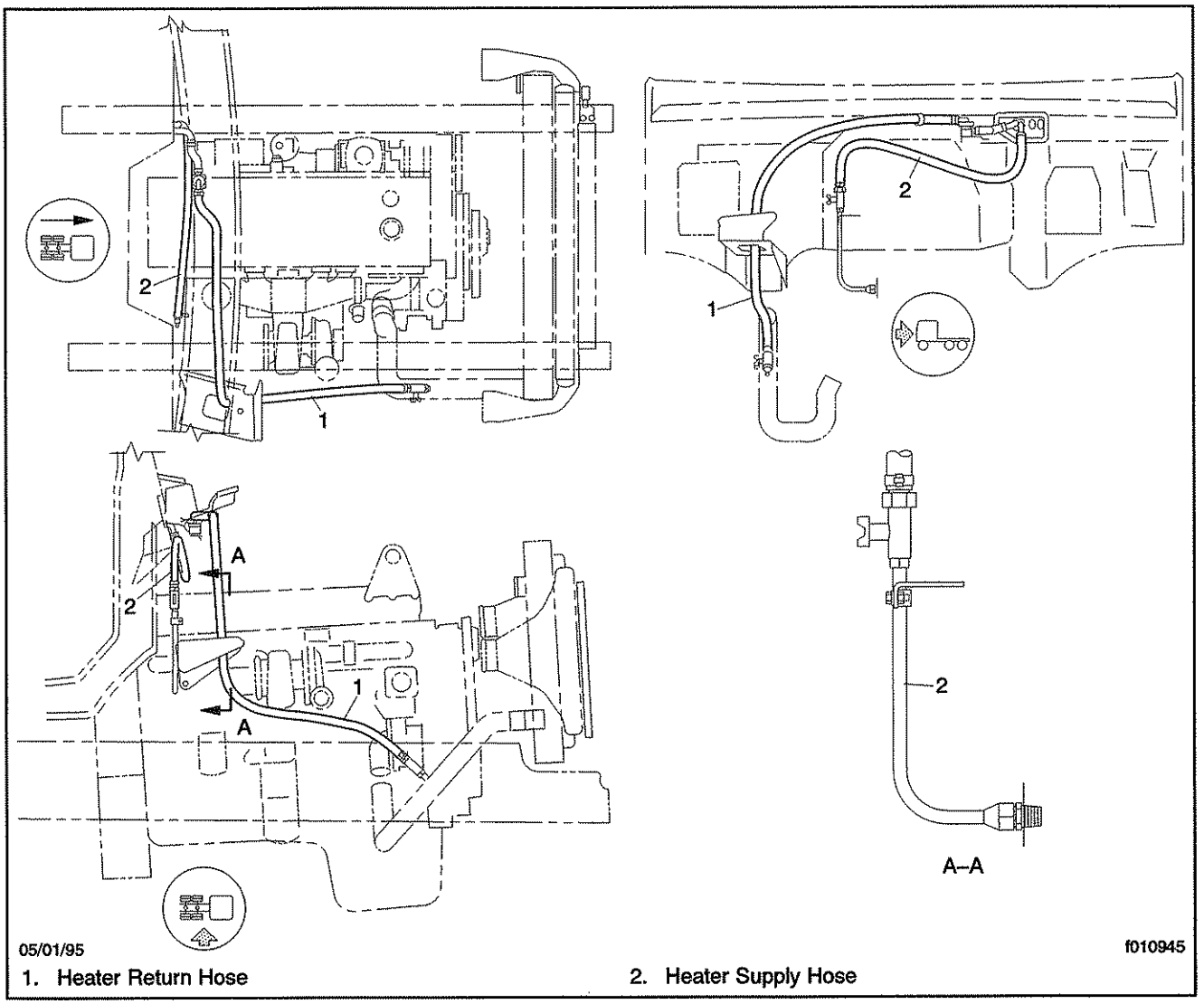


Fig. 4, Cummins M11 Engine, Heater Hoses

18.3 With the two engine lifting points connected by chain to the crane, raise the crane enough to tighten the chains, but not enough to lift the front of the vehicle.

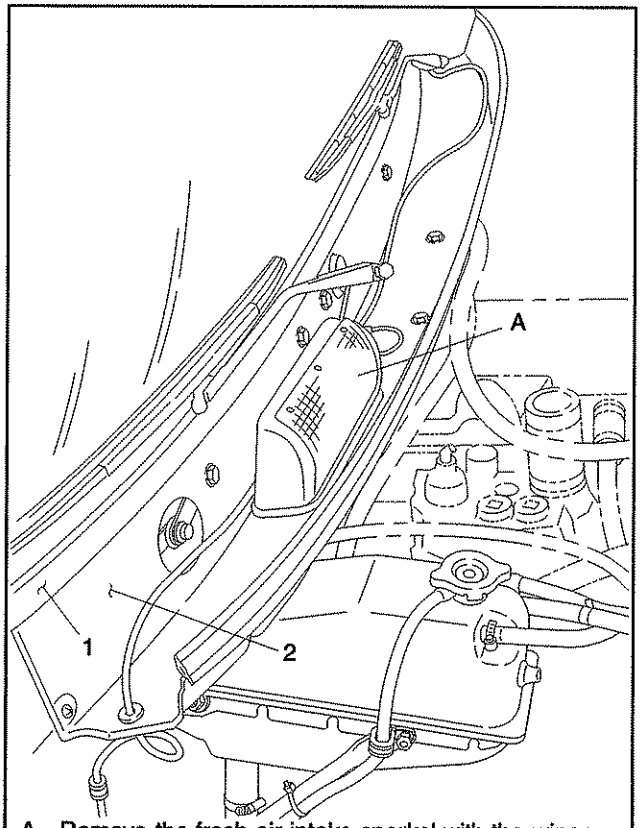
18.4 Remove the nuts from the bolts that fasten the front engine support bracket to the underslung crossmember.

18.5 Using the crane, lift the engine slightly and remove the upper isolator from the front engine mount.

18.6 Using the crane, lift the engine and pull it forward.

18.7 Once the engine is clear of the vehicle, place the engine on engine stands.

Engine Removal and Installation



A. Remove the fresh air intake snorkel with the wiper pan.
1. Windshield Trim
2. Windshield Wiper Pan

Fig. 5, Windshield Wiper Pan, Typical Installation Shown

Installation

⚠ WARNING

The crane and lifting chains used to install the engine must be capable of safely lifting and supporting two metric tons. Once the engine is removed from the engine stands, do not get under the engine until it is securely supported on the engine mounts. An unsecured engine may fall, causing personal injury or death, and component damage.

1. Install the engine in the vehicle.
   - 1.1 If not already attached. Install the special lifting bracket on the rear of the engine.
   - 1.2 Attach the chain to the existing lifting eye at the front and the special lifting bracket at the rear of the engine.
   - 1.3 With the two engine lifting points connected by chain to the crane, lift the engine, and position it in the engine compartment.
   - 1.4 Connect the engine to the rear engine mounts, and tighten the bolt that runs down through each engine leg, rubber isolators, and engine mount 327 N·m (241 lbf·ft).
   - 1.5 Assemble the lower isolator under the underslung crossmember and the front engine bracket, and secure the front engine mount with nuts and washers. Tighten the nuts 184 N·m (136 lbf·ft).
   - 1.6 Once the engine is securely installed in the vehicle, remove the lifting chains and the special lifting bracket.
   - 1.7 If the valve cover was removed, install it. For instructions, refer to the engine manufacturer's service literature.
2. Connect and install components under the engine.
   - 2.1 Connect the exhaust flex pipe to the forward end of the exhaust piping.
   - 2.2 Connect the two fuel return lines to the equiflow bracket. For instructions, refer to **Group 47** of this service manual.
3. Without breaking the power steering fluid lines, install the power steering pump. For instructions, refer to **Group 46** in this service manual.
4. Connect the wiring. For wiring harness information, refer to **Group 54** in this service manual.
   - 4.1 Connect the two engine harness bulkhead connectors.
   - 4.2 Connect the wiring to the power stud on the bulkhead.
   - 4.3 Connect the wiring to the ground stud on the bulkhead.
   - 4.4 Install the magnetic switch on the bulkhead.
   - 4.5 Connect the starter ground cable to the frame rail.

4.6 Connect the power cables to the starter and the starter solenoid.

5. Install the windshield wiper linkage. For instructions, refer to **Group 82** in this service manual.
6. Install the windshield wiper pan. See **Fig. 5**.
   - 6.1 Position the pan by tucking it up under the lower edge of the windshield trim.
   - 6.2 Install the fresh air intake snorkle.
   - 6.3 Install the screws that hold the pan to the firewall.
   - 6.4 Install the surge tank. For instructions, refer to **Group 20** of this service manual.
   - 6.5 Install the wiper arms. For instructions refer to **Group 82** of this manual.
7. Connect or install the ducts and lines. See **Fig. 3**.
   - 7.1 Install the V-band clamp that holds the forward end of the flex pipe exhaust ducting to the rear of the turbocharger. Tighten it 85 lbf·in (940 N·m).
   - 7.2 Install the air duct between the turbocharger and the air cleaner.
   - 7.3 Connect the vent line to the engine.
   - 7.4 Connect the two air signal lines to the air governor on top of the compressor.
   - 7.5 Connect the outlet line to the air compressor.
   - 7.6 Connect the air line to the fan clutch solenoid.
   - 7.7 Connect the heater return hose to the radiator outlet pipe. See **Fig. 4**.
   - 7.8 Connect the heater supply hose. See **Fig. 4**.
   - 7.9 Connect the oil pressure sensor line beneath the receiver-drier.
8. Install the radiator mounting bracket on the front closing crossmember.
9. Install the radiator, fan shroud, and charge air cooler. For instructions, refer to **Group 20** in this service manual.
10. Install the air recirculation shields around the radiator and charge air cooler. For instructions, refer to **Group 09** in this service manual.
11. Install the air conditioning components without breaking the refrigerant lines. See **Fig. 2**.
    - 11.1 Install the condenser. For instructions, refer to **Group 83** of this service manual.
    - 11.2 Install the refrigerant compressor. For instructions, refer to **Group 83** of this service manual. For instructions on installing the compressor drive belts, refer to **Section 01.00** in this service manual group.
    - 11.3 Route and clamp the refrigerant lines between the compressor and the condenser.
    - 11.4 Route and clamp the refrigerant lines between the receiver-drier and the condenser.
12. Install the air cleaner housing. For instructions, refer to **Group 09** in this service manual. Connect the intake air ducting to the air cleaner and the charge air cooler.
13. Install the transmission. For instructions, refer to the applicable section in **Group 26** in this service manual.
14. Install the hood tilt-assist bracket mounted on the forward closing crossmember. For instructions, refer to **Group 88** in this service manual.
15. Install the hood, bumper, and the left-side quarter fender. For instructions, refer to **Group 88** in this service manual.
16. Fill the radiator.
17. Connect the batteries.
18. Start the engine, and check for leaks. Repair any leaks found.
19. Test drive the vehicle.

Air Intake Heater, Cummins B Series 01.14

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General Information and Principles of Operation

This system electronically controls the two grid heating elements in the air intake manifold to assist in cold weather starts and to improve cold engine running. The electric grid heater system works in a preheat and post-heat mode. The preheat mode heats the intake air prior to starting the engine to aid in starting. The post-heat mode heats the intake air after starting to improve cold engine running. This system can be used on naturally aspirated and turbocharged engines.

The grid heater system benefits include:

- Quicker starting
- Smoother engine running after starting
- Replacement of ether as a starting aid
- Extended starter and battery life through less cranking

The grid heater starting aid will not operate unless the intake manifold temperature sensor senses a temperature below 45°F (7°C). This system is compatible with a 12-volt electrical system only, and is not compatible with a 24-volt system.

Current draw is 95 amperes per element. To prevent excessive drain on the batteries, the electric grid heater controller has incorporated a battery monitoring feature. If the battery voltage dips too low, the grid heater controller will interrupt the post-heat cycle, preventing further drain on the batteries. This battery protection feature is activated only on vehicles with weak or drained batteries.

The following is a summary of normal operations:

1. Turn the key switch to ON (intake manifold temperature sensor must read a temperature below 45°F (7°C).
2. While the wait-to-start (WTS) light is ON, the grid is in the preheat mode, see **Table 1**.
3. When the WTS light goes out, the engine is ready to start.
4. Start the engine within 10 seconds after the WTS light goes off.
5. After the engine starts, the grid is in the post-heat mode.

Intake Manifold Heater Operation

Temperature °F (°C)	Condition	Elements	Duration (seconds)	Duty Cycle % On / % Off
Below –2 (–19)	Preheat	Both	30	Continuous
	Post-Heat	Both	15	Continuous
		One	15	Continuous
		One	40	50/50
		One	106	25/75
–2 to 17 (–19 to –8)	Preheat	Both	20	Continuous
	Post-Heat	Both	20	Continuous
		One	20	Continuous
		One	40	50/50
		One	106	25/75

General Information and Principles of Operation

Intake Manifold Heater Operation				
Temperature °F (°C)	**Condition**	**Elements**	**Duration (seconds)**	**Duty Cycle % On / % Off**
–17 to 46 (–8 to 8)	Preheat	Both	10	Continuous
	Post-Heat	Both	10	Continuous
		One	10	Continuous
		One	40	50/50
		One	106	25/75
Above 46 (8)	Preheat	None	—	—
	Post-Heat	None	—	—

Table 1, Intake Manifold Heater Operation

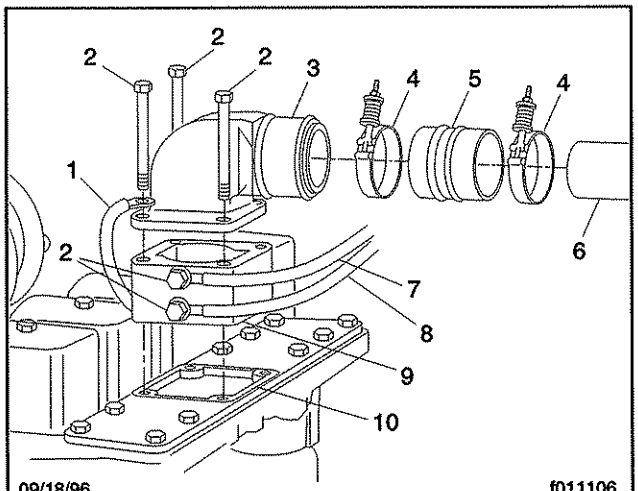
Grid Heater Element Replacement

Removal (See Fig. 1)

1. Set the parking brake, shut down the engine, and chock the tires. Disconnect the batteries.
2. Remove the air intake tube from the intake elbow by loosening the clamps.
3. Disconnect all three electrical cables from the grid heater block by removing the retaining capscrews.

IMPORTANT: Note the orientation of the heater grid block before removal, to ensure correct installation.

4. Remove the four mounting capscrews; then remove the intake elbow and the grid heater block. It may be necessary to pry between the grid heater block and the manifold to break the seal between them.
5. Place a clean cloth into the intake manifold opening to prevent any contaminants from entering.
6. Clean any gasket material or sealant from the grid heater mounting surface.



1. Ground Cable
2. Capscrew
3. Intake Elbow
4. Clamp
5. Intake Couple
6. Intake Tube
7. Positive Element Cable #1
8. Positive Element Cable #2
9. Grid Heater Block
10. Manifold Mounting Surface

Fig. 1, Intake Heater

Installation (See Fig. 1)

1. Remove the cloth from the intake manifold and carefully check the manifold to ensure that there are no foreign objects remaining.
2. Place a new gasket on the grid heater block mounting surface.
3. Position a new grid heater block on the mounting surface and place a gasket on the grid heater block. Place the intake elbow on the grid heater block and secure with the mounting capscrews. Be sure to secure the negative grid heater block cable (Ref. 1) under a capscrew. Torque the mounting capscrews to 18 lbf·ft (24 N·m).
4. Connect the positive electrical cables to the grid heater block.

NOTE: The electrical cables should be secured within 6 inches of any connection to avoid connector or ring terminal damage.

5. Position the intake tube on the intake elbow, with the intake couple and clamps in place. Tighten the clamps 75 lbf·in (800 N·cm).
6. Connect the batteries and remove the chocks from the tires.

Temperature Sensor Replacement

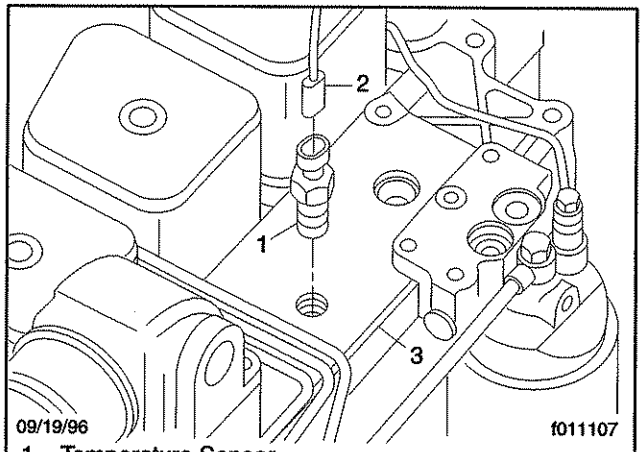
Removal (See Fig. 2)

1. Set the parking brake, shut down the engine, and chock the tires. Disconnect the batteries.
2. Disconnect the wire terminal from the sensor.
3. Remove the sensor by unscrewing it from the manifold.

Installation

1. Install the temperature sensor in the intake cover. Tighten it 25 lbf·in (35 N·m).
2. Connect the wire to the sensor.
3. Connect the batteries and remove the chocks from the tires.

Component Replacement



1. Temperature Sensor
2. Wire Terminal
3. Intake Manifold

Fig. 2, Temperature Sensor

Wait-to-Start Light Assembly Replacement

Removal (See Fig. 3)

1. Set the parking brake, shut down the engine, and chock the tires. Disconnect the batteries.
2. Loosen the dashboard panel B by removing the mounting screws.
3. Being careful not to damage the connecting wires, allow the panel to come away from the dashboard.
4. Disconnect the wires at the wait-to-start light assembly.
5. Remove the light assembly by removing the mounting screws.

Installation (See Fig. 3)

1. Position a replacement wait-to-start light assembly in the dash opening and secure it with the mounting screws.
2. Connect the wire to the light assembly.
3. Install the dashboard panel B and secure it with the mounting screws.
4. Connect the batteries and remove the chocks from the tires.

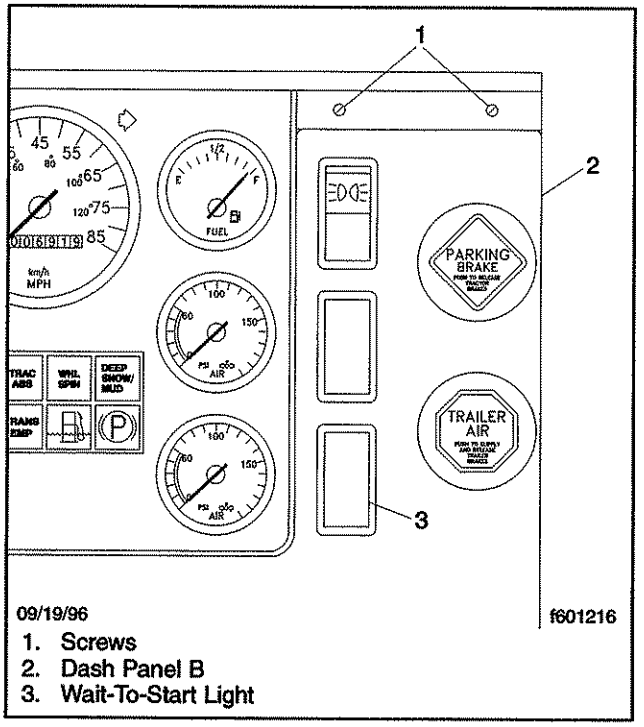
Air Intake Heater Control Module Replacement

Removal (See Fig. 4)

1. Set the parking brake, shut down the engine, and chock the tires. Disconnect the batteries.
2. Working under the hood, disconnect the main module connector and the temperature sensor connector at the intake heater module.
3. Remove the module by removing the mounting fasteners.

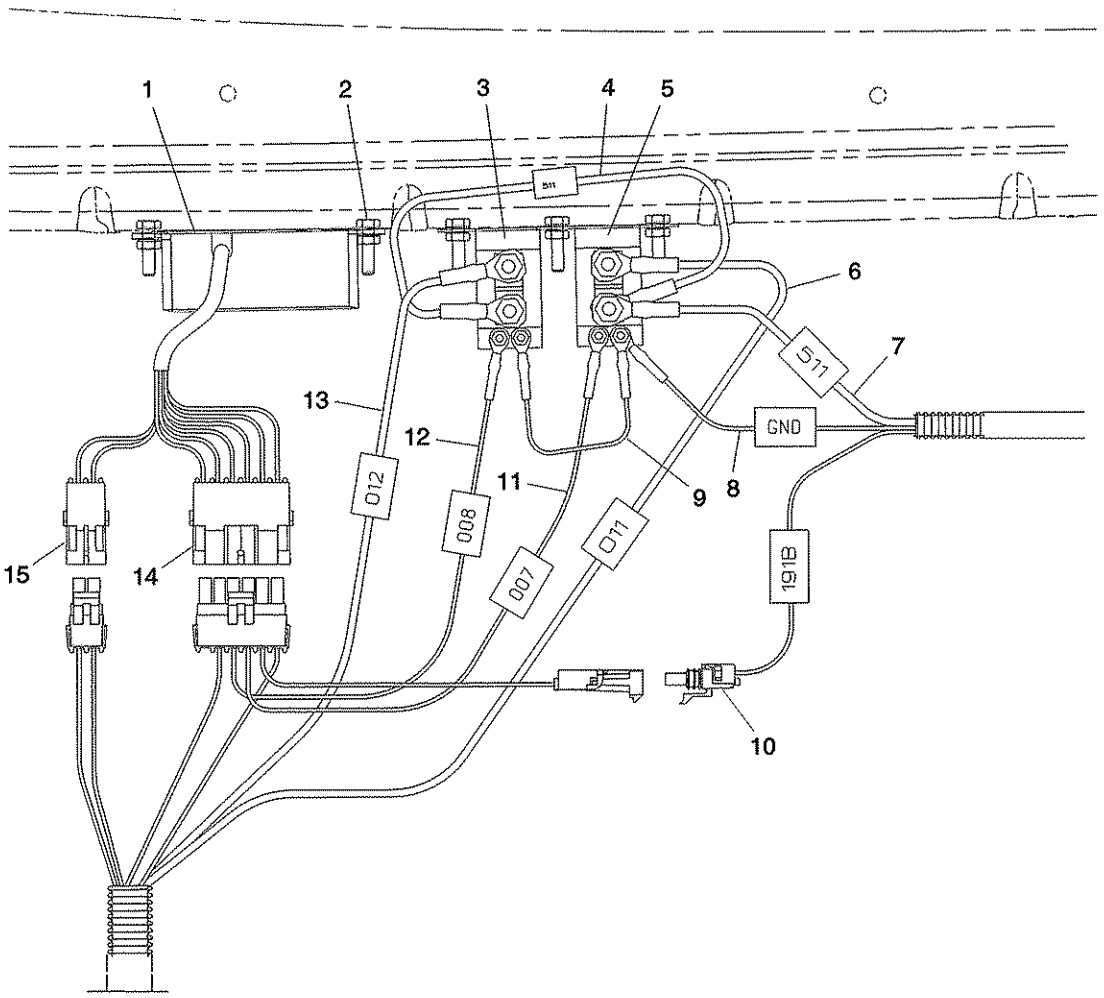
Installation (See Fig. 4)

1. Position the intake heater control module on the air intake tray.
2. Secure it with the mounting fasteners.
3. Connect the main module connector, and the temperature sensor connector to the module.
4. Connect the batteries and remove the chocks from the tires.



1. Screws
2. Dash Panel B
3. Wait-To-Start Light

Fig. 3, Wait-to-Start Light Replacement



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1. Heater Control Module
2. Mounting Fastener
3. Relay #2
4. 12-Volt Power Jumper Wire
5. Relay #1
6. Grid #1 Power Cable
7. 12-Volt Power Cable
8. Heater Harness Ground Cable
9. Ground Jumper Cable
10. Wait-To-Start Light Connector
11. Controller Module to Relay #1 Wire
12. Controller Module to Relay #2 Wire
13. Grid #2 Power Cable
14. Main Module Connector
15. Temperature Sensor Connector

Fig. 4, Intake Heater Wiring Connections

Air Intake Heater Relay #1 Replacement

Removal (See Fig. 4)

1. Set the parking brake, shut down the engine, and chock the tires. Disconnect the batteries.
2. Working under the hood, disconnect the cables (Ref. 4, 6, 7, 8, and 9) and the controller module wire (Ref. 11) from the relay.
3. Remove the relay by removing the mounting fasteners.

Component Replacement

Installation (See Fig. 4)

1. Position the relay on the air intake tray.
2. Install the fasteners.
3. Connect the cables (Ref. 4, 6, 7, 8, and 9) and the wire (Ref. 11) to the relay.
4. Connect the batteries and remove the chocks from the tires.

Air Intake Heater Relay #2 Replacement

Removal (See Fig. 4)

1. Set the parking brake, shut down the engine, and chock the tires. Disconnect the batteries.
2. Working under the hood, disconnect the cables (Ref. 4, 9 and 13) and the controller module wire (Ref. 12) from the relay.
3. Remove the relay by removing the mounting fasteners.

Installation (See Fig. 4)

1. Position the relay on the air intake tray.
2. Install the fasteners.
3. Connect the cables (Ref. 4, 9 and 13) and the wire (Ref. 12) to the relay.
4. Connect the batteries and remove the chocks from the tires.

Troubleshooting Procedures

1. Preheat Cycle—The key switch should be in the ON position. The wait-to-start (WTS) light will come on indicating that the system is in the preheat mode. When the light goes out the engine is ready to start. The engine must be cranked within 10 seconds after the WTS light goes out.

   Post-Heat Cycle—With the engine running, if white smoke is present or if the engine is running rough due to cold conditions, the operator can use the post-heat cycle. The key switch should be in the ON position. When the intake manifold heater system switch is in the ON position, the WTS light will flash indicating that the system is in the post-heat mode. See **Table 1** for operating times at given temperatures.

2. Wait-To-Start Light—Do not attempt to start the engine while the wait-to-start light is ON. When the air temperature rises above 59°F (15°C), the WTS light will go out, indicating that the engine will start. The engine must be cranked within ten seconds after the WTS light goes out, or the intake air should be warmed again. If the WTS light flashes at the rate of once per second, there is an open in the system's wiring circuit.

3. Temperature Sensor—The temperature sensor, or thermistor, is mounted in the intake manifold and sends varying resistance values to the electronic control module (ECM). The ECM in turn controls the wait-to-start light and the heater solenoids.

4. Wiring Harness—If the engine does not have a shutdown solenoid, or if it has a timer module for the shutdown solenoid, the three-pin connector "Tee" will be wired to the vehicle. The connectors on the harness have letter designations. "A" connects to the vehicle power. "B" connects to the "S" terminal on the ignition switch. "C" is the ground wire.

   If a problem is suspected in the wiring harness, check for loose connections. Also check for abrasions, and broken or worn wires. Replace or repair as necessary.

5. Contactors—The contactors, or relay coils, close the circuits to the air intake heater grid when the switch is moved to the ON position, the ignition switch is ON, and the temperature sensor senses a temperature below 59° F (17° C).

6. Fusible Links, 110A—The air intake heater system is protected by two 110 ampere fusible links—one for each of the grid heater elements. If either of the grid heater elements is suspected of not operating, both fusible links should be checked for continuity. The current draw is 95 amperes per element.

7. Controller Module—If a malfunction is suspected in the air intake heater control module, first check the wiring harness. The controller operates between 6.5 volts and 16 volts. Check the connectors for good connections. Check pin J2A for 12-volt signal.

NOTE: The controller will cancel post-heat if it senses a voltage below 9.5 volts during preheat or a delay of 10 seconds or more between the wait-to-start light going off and the start of cranking. An open in the circuit will also be detected by the controller and will also result in a cancellation of the post-heat operation.

8. Ground Circuits—Check pin J1B for ground to the controller and check the ground strap to the grid for high resistance. Repair or replace as necessary.

Intake Manifold Heater System Normal Operation		
Engine Intake Manifold Temperature °F (°C)	**Preheat Cycle Time, Ignition Key "ON", Before Crank Cycle (seconds)**	**Post-Heat Cycle Occurs, Ignition Key "ON", After Crank Cycle**
Above 59 (15)	0	No
15 to 59 (–9 to 15)	10*	Yes
0 to 15 (–18 to –9)	15	Yes
–15 to 0 (–26 to –18)	17	Yes
Below –15 (–26)	20	Yes

* Heater control modules/electronic control modules with serial numbers below 0080000A will not have a preheat cycle during this cycle.

Table 1, Intake Manifold Heater System Normal Operation

Troubleshooting

Troubleshooting Table

Problem—Wait-To-Start (WTS) light will not function

Problem—Wait-To-Start (WTS) light will not function	
Possible Cause	**Remedy**
The bulb is damaged or burned out.	Replace the bulb.
There is no power to the light.	Check the voltage to the bulb socket. If there is no voltage, check the connections and wiring from the key switch to the WTS light switch and to the light socket. Check the ground circuit from the controller. Repair as necessary. The WTS light will flash once every second if the temperature sensor detects an open circuit.

Problem—Temperature Sensor Appears Inoperative

Problem—Temperature Sensor Appears Inoperative	
Possible Cause	**Remedy**
The temperature sensor has failed.	Check the resistance across the temperature sensor pins J1A and J1B at room temperature and in an ice bath, 32°F (0°C). The resistance should be approximately 800 ohms at room temperature and 2000 ohms in the ice bath. Check the resistance to ground for an open circuit. NOTE: Make resistance checks with the key switch in the ON position to make sure there are no ground problems. Replace as necessary.
The circuit is open.	Check the circuitry connections and wiring for continuity. Replace or repair as necessary.

Problem—Relays or Contactors Appear Inoperative

Problem—Relays or Contactors Appear Inoperative	
Possible Cause	**Remedy**
The relays or contactors have failed.	An audible click should be heard from the relays or contactors during operation. Replace as necessary. Check the resistance at the relay terminals and ground. If resistance is too high, replace the relay.

Problem—Insufficient Ground Connections

Problem—Insufficient Ground Connections	
Possible Cause	**Remedy**
The circuit is open.	Check pin J1B for ground to the controller, and check the ground strap to the grid for high resistance. Repair or replace the wiring as necessary.

Problem—Controller is Malfunctioning

Problem—Controller is Malfunctioning	
Possible Cause	**Remedy**
The circuit is open.	Check pin J2A for a 12-volt signal. Inspect the wiring harness for shorting, chafing, or burning. Repair or replace the wiring as necessary. NOTE: The controller operates between 6.5 volts and 16 volts.
Low or no voltage to the controller.	The controller operates between 6.5 volts and 16 volts. Check connectors for good connections. Replace the controller if necessary.
The controller is inoperative.	The controller will cancel post-heat if it senses a voltage below 9.5 volts during preheat, a ten second delay or more between the WTS light OFF and cranking, or an open temperature circuit.

Contents

Subject	Subject Number
Service Operations	
Engine Removal and Installation	100
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Removal

1. Apply the parking brakes, chock the tires, and (if applicable) drain the air system.
2. Disconnect the battery cables at the batteries.
3. Remove the hood. For detailed instructions, see **Section 88.00**, Subject 140.
4. Drain the oil. See **Fig. 1** for the location of the oil drain plug.

⚠ 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.

5. Drain the coolant from the radiator. See **Fig. 2**.
6. Remove the coolant hose standoff bracket.
7. When the coolant has fully drained, remove all the coolant hoses from the engine. See **Fig. 3** for the coolant delivery hoses from the surge tank, **Fig. 4** for the upper coolant hose, and **Fig. 5** for the lower coolant hose.
   - 7.1 Remove the two small-diameter hoses attached to the surge tank, one going to the engine, the other to the radiator. These are the hoses that were attached to the standoff bracket.
   - 7.2 Remove the 2-inch (50-mm) inside diameter upper coolant hose attached to the front end of the crankcase, near the cylinder head.
   - 7.3 Remove the lower coolant hose assembly.
   - 7.4 Plug the openings with a clean shop towel.
8. Remove the intake air circulation pipes and hoses. See **Fig. 5**.
   - 8.1 Remove the crossover hose from the charge air inlet pipe to the charge air cooler (cold air).

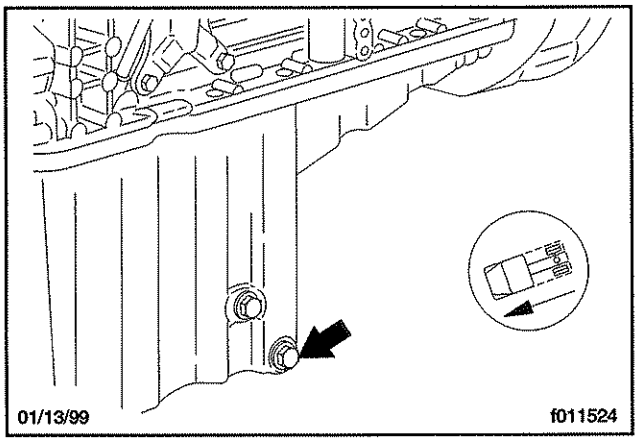


Fig. 1, Oil Drain Plug

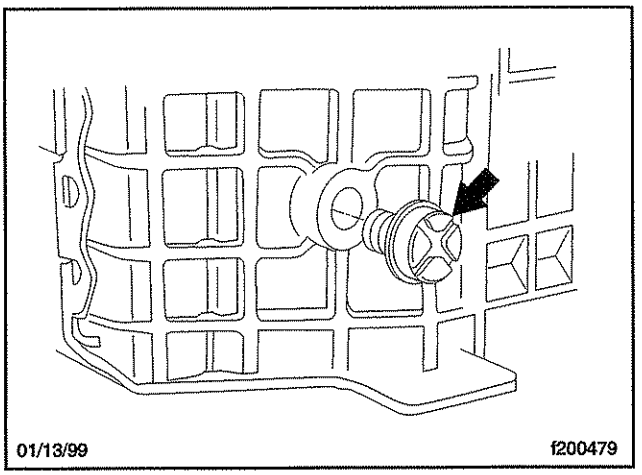
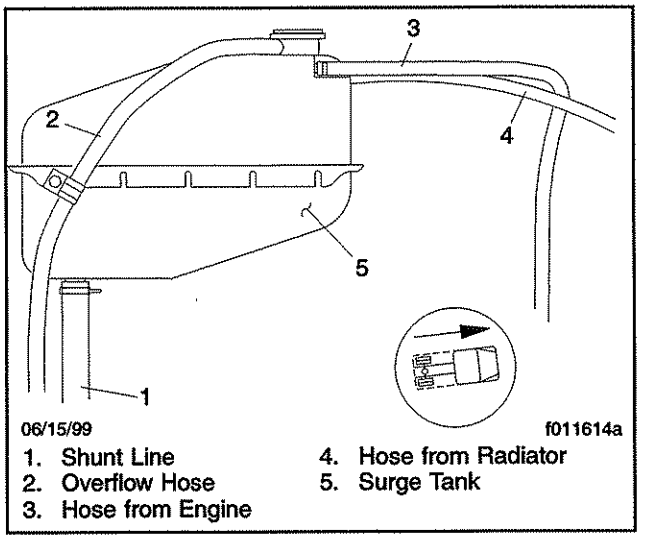


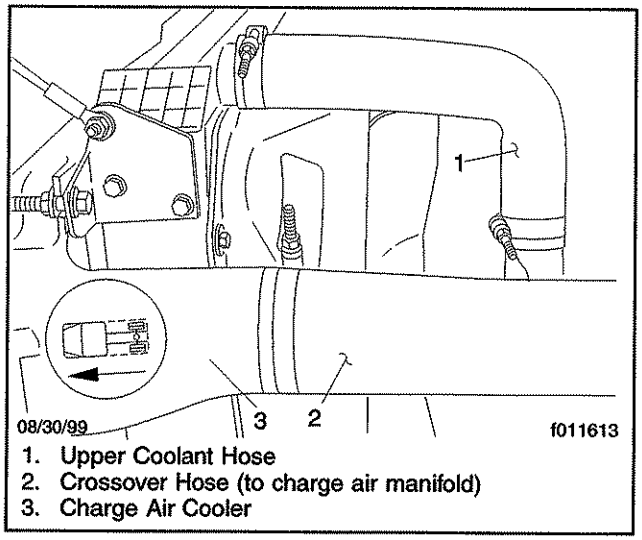
Fig. 2, Coolant Drain Plug



1. Shunt Line
2. Overflow Hose
3. Hose from Engine
4. Hose from Radiator
5. Surge Tank

Fig. 3, Coolant Hoses at the Surge Tank

Engine Removal and Installation



1. Upper Coolant Hose
2. Crossover Hose (to charge air manifold)
3. Charge Air Cooler

Fig. 4, Hoses, Left-Hand Side

8.2 Remove the convoluted hose from the turbo outlet pipe to the charge air cooler (warm air).

8.3 Remove the pipe from the air cleaner to the turbo inlet (air cleaner pipe).

8.4 Remove the crankcase breather hose from the crankcase inlet tubing.

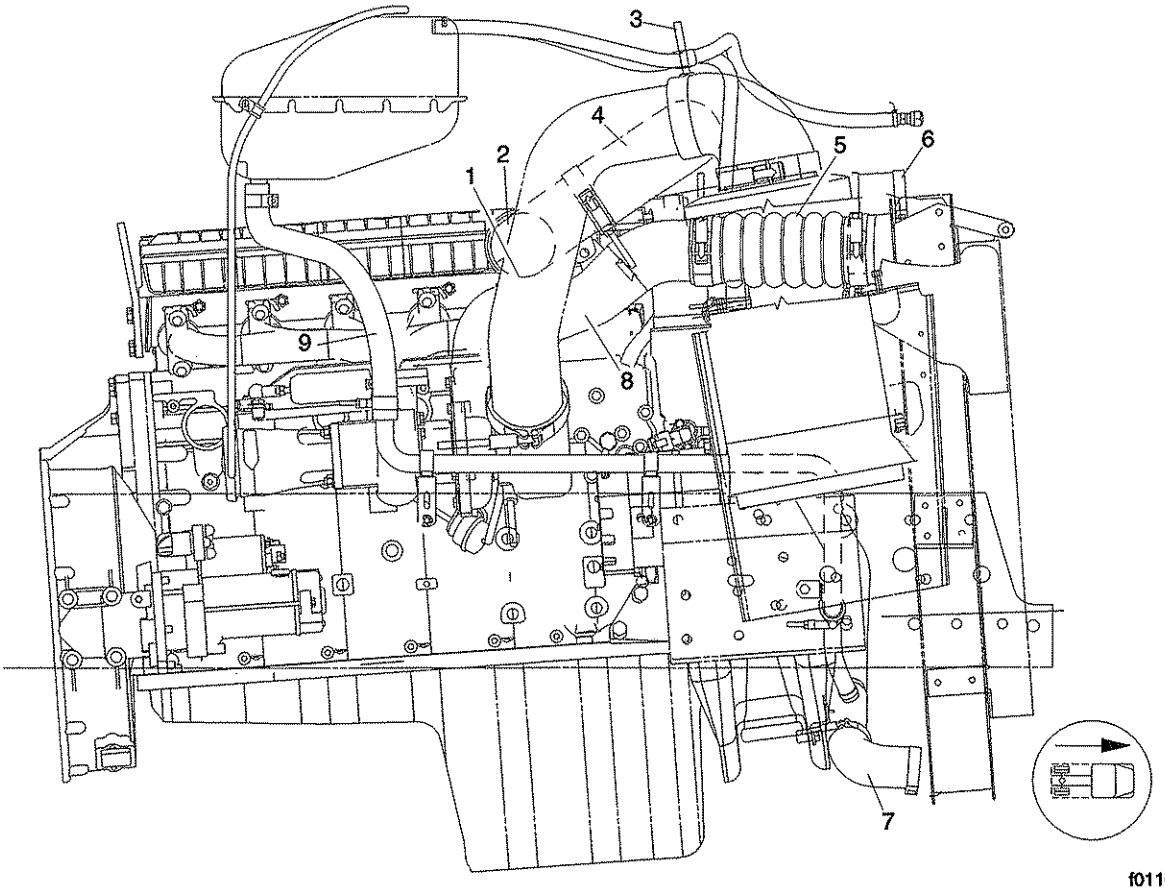
8.5 Remove the air compressor inlet hose between the air cleaner pipe and the air compressor inlet tubing.

8.6 For ease of installation, mark the outlets on each pipe with a paint pen.

8.7 Plug the openings with a clean shop towel.

IMPORTANT: Leave all air conditioning hoses attached to avoid depressurizing the A/C system.

9. Remove the air conditioning (A/C) condenser. See **Fig. 6**. Wrap the condenser, with hoses attached, in a protective blanket, and secure it out of the way.
10. Remove the charge air cooler. See **Fig. 7**. For detailed procedures, see the instructions in **Section 09.01**, Subject 100.
11. Remove the radiator assembly. See **Fig. 7**. For detailed procedures, see the instructions for frame-rail mounted radiators in **Section 20.01**, Subject 100.
12. Release the tension on the poly-V belt. See **Fig. 8**.
13. Disconnect the fuel lines from the fuel filter housing. See **Fig. 9**.
14. Remove the refrigerant compressor. See **Fig. 10**.
15. Disconnect the electrical connectors from the engine.
    - 15.1 Disconnect the engine harness connector from the PLD (engine control unit). See **Fig. 11**.
    - 15.2 Disconnect the fan solenoid connector. This connector is along the left-hand side, between the PLD and the air compressor. See **Fig. 12**.
    - 15.3 Disconnect the exhaust brake solenoid connector, if installed. This connector is on the left-hand side near the PLD. See **Fig. 12**.
16. Disconnect the power steering pump from the air compressor. Secure it, with the lines attached, up and out of the way. See **Fig. 13**.
17. Remove the air line from the exhaust brake, if installed. See **Fig. 14**.
18. Disconnect the exhaust pipe. See **Fig. 15**.
19. Remove the starter and engine ground strap. Set the starter out of the way.
    - 19.1 Remove the ground strap from the engine to the chassis.
    - 19.2 Remove the starter mounting bolts.
    - 19.3 Move the starter up and out of the way, with the cables attached. Tie the starter in place.
20. Remove the electrical leads from the back of the alternator. See **Fig. 16**.
21. Remove the transmission. For procedures, see **Group 26**.
22. Remove the hydraulic clutch line, if installed. See **Fig. 17**.
23. Remove the rain tray and wiper arms.



1. Air Cleaner Pipe
2. Charge Air Inlet Pipe (cold air)
3. Coolant Hose Standoff Bracket
4. Crossover Hose (cold air)
5. Convoluted Hose (warm air)
6. Upper Coolant Hose
7. Lower Coolant Hose
8. Turbocharger Outlet Pipe (warm air)
9. Surge Tank Shunt Line

Fig. 5, Charge Air and Coolant Pipes and Hoses

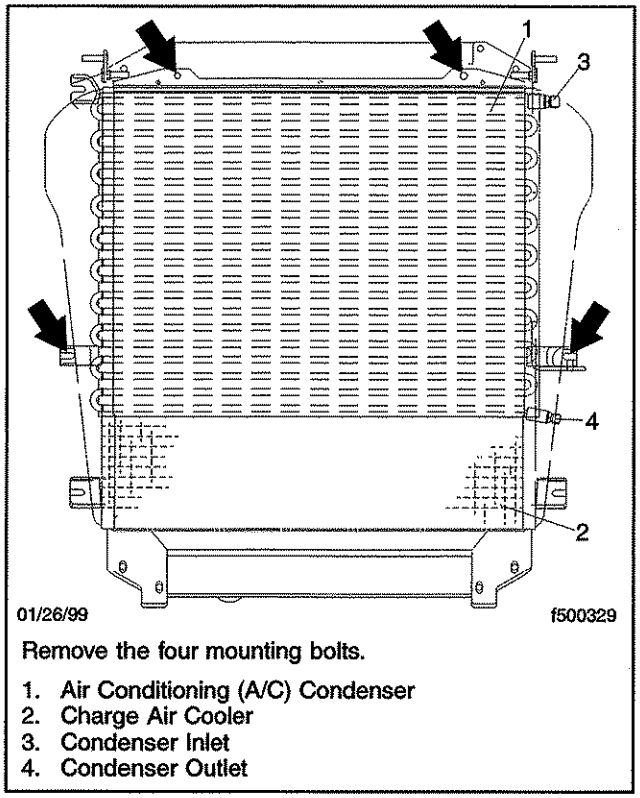
⚠ CAUTION

To avoid damage to the crankcase breather valve cover, make sure the chains on the front lifting eye provide adequate clearance.

To avoid damage to the wiper conlink, make sure the chains on the rear lifting fixture do not contact the conlink when the engine is lifted.

24. Attach a lifting hoist to the engine. Run the chains through the front lifting eye and rear lifting fixture. See **Fig. 18** for attachment to the front lifting eye and **Fig. 19** for attachment to the rear lifting fixture.
25. Loosen the engine mounts. See **Fig. 20** for the front engine mount and **Fig. 21** for the rear engine mounts.
    - 25.1 Loosen the front engine mounting bolt where it attaches to the front crossmember.
    - 25.2 Loosen the four rear engine mounting capscrews that attach the mount to the engine.
26. Support the rear of the engine with a jack.
27. Remove both rear engine mounts. For proper clearance, remove both ends of the mount.

Engine Removal and Installation



Remove the four mounting bolts.

1. Air Conditioning (A/C) Condenser
2. Charge Air Cooler
3. Condenser Inlet
4. Condenser Outlet

Fig. 6, A/C Condenser

28. Remove the front crossmember to obtain proper clearance for removal of the engine. See **Fig. 22**.

⚠ WARNING

The crane and lifting chains used to remove the engine must be capable of safely lifting and supporting two metric tons. Once the engine mounts are disconnected, do not get under the engine until it is securely supported on engine stands. An unsecured engine may fall, causing personal injury or death, and component damage.

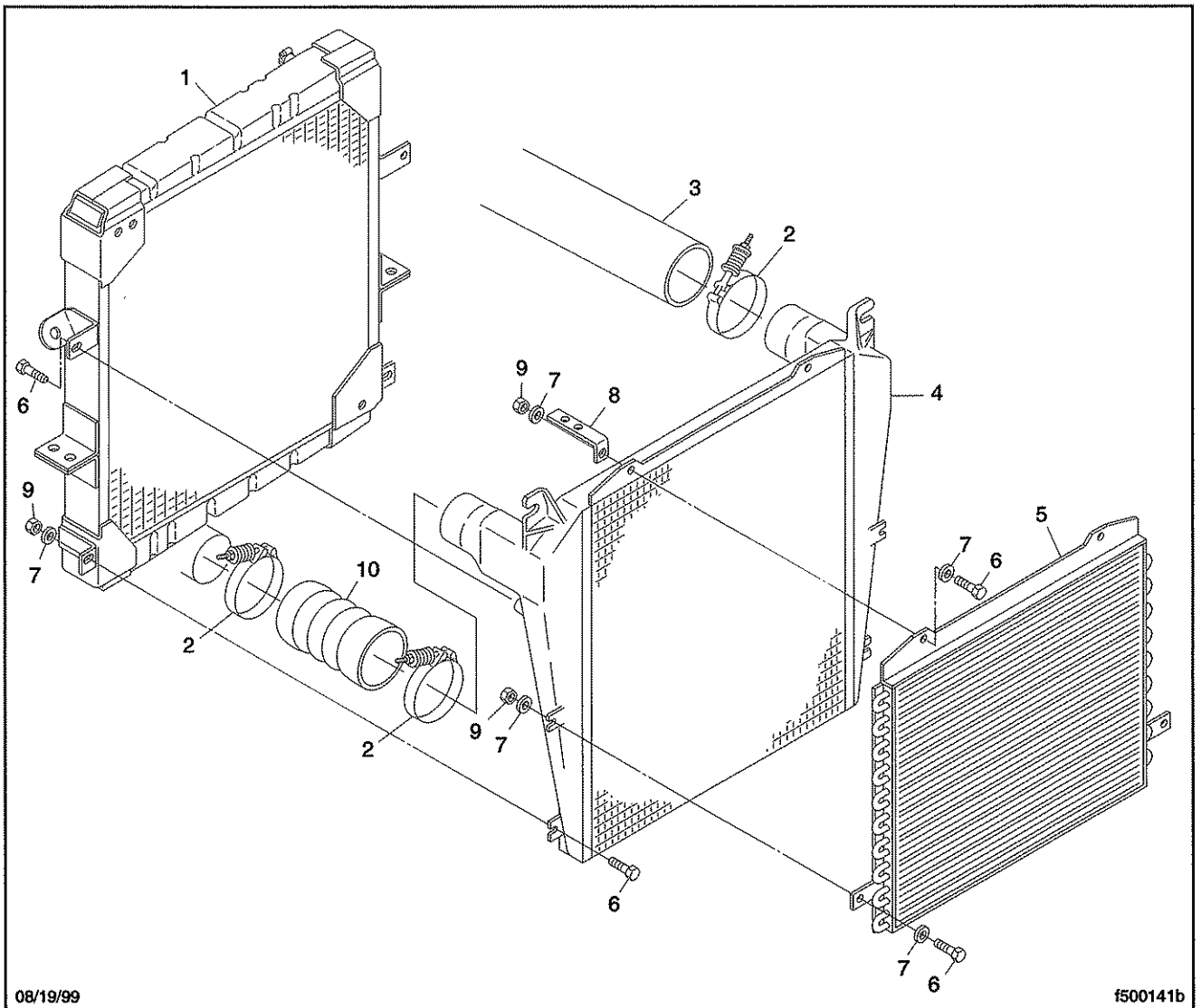
29. Remove the engine from the vehicle. See **Fig. 23**.
    - 29.1 Raise the hoist slightly until it is holding the full weight of the engine.
    - 29.2 Lower the engine just enough to allow it to move forward until it can be lifted without hitting the frontwall or wiper conlink.
    - 29.3 Pull the engine forward and up to clear the vehicle. If a new engine is to be installed, transfer all needed components from the old engine to the new engine.

Installation

⚠ WARNING

The crane and lifting chains used to remove the engine must be capable of safely lifting and supporting two metric tons. Once the engine mounts are disconnected, do not get under the engine until it is securely supported on engine stands. An unsecured engine may fall, causing personal injury or death, and component damage.

1. Using the hoist as removed, lower the engine into the engine compartment until the rear of the engine is resting on the jack used during removal. Check clearances on all sides, as removed.
2. Install the front crossmember. Tighten the locknuts on the mounting bolts 60 lbf·ft (81 N·m).
3. Install the front engine mounting bolt, isolator, and nut. Tighten the nut 136 lbf·ft (184 N·m).
    - 3.1 Position the isolator on the crossmember.
    - 3.2 Move the engine on the hoist until it rests directly on the isolator.
    - 3.3 Insert the bolt through the crossmember, isolator, and engine. Install and tighten the nut.
4. Install both rear engine mounts. See **Fig. 21** and **Fig. 24**.
    - 4.1 Install the engine mounts on the frame-mounted brackets. Tighten the mounting bolts 241 lbf·ft (347 N·m).
    - 4.2 Lower the jack under the rear of the engine slightly, until the holes in the timing case line up with the holes in the engine mounts.
    - 4.3 Insert the engine mounting capscrews and tighten them 155 lbf·ft (210 N·m).
    - 4.4 Lower and remove the jack.
5. Remove the hoist from the front lifting eye and the rear lifting fixture.
6. Install the transmission on the engine timing case. Tighten the timing case to transmission mounting



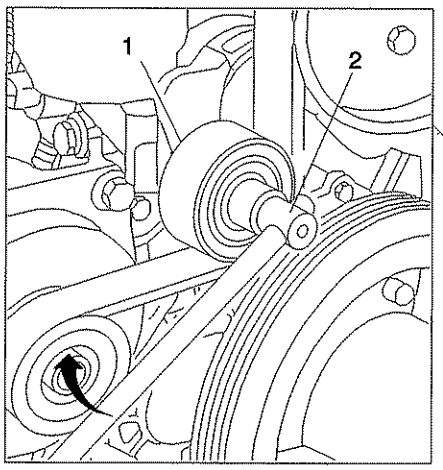
1. Radiator
2. Constant-Torque Hose Clamp
3. Charge Air Hose
4. Charge Air Cooler (CAC)
5. A/C Condenser
6. Mounting Bolt
7. Washer
8. Stand-Off Bracket
9. Nut
10. Convoluted Hose

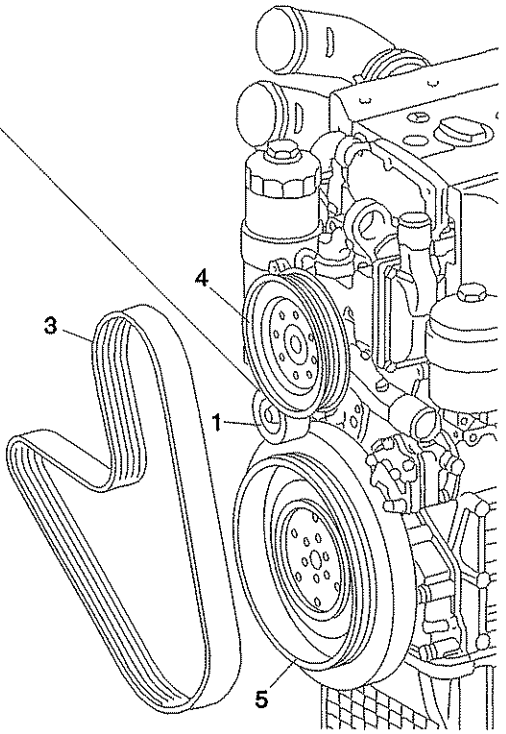
Fig. 7, Charge Air Cooler and Radiator

bolts 33 lbf·ft (45 N·m). For detailed procedures, see **Group 26.**

7. If removed, install the air line on the exhaust brake. See **Fig. 14.**
8. Connect the exhaust pipe. See **Fig. 15.**
9. Install the starter and engine ground strap.
   - 9.1 Untie the starter. Position the starter so that the starter ring gear lines up with the flywheel.
   - 9.2 Install the starter mounting bolts and tighten them 37 lbf·ft (50 N·m).

Engine Removal and Installation

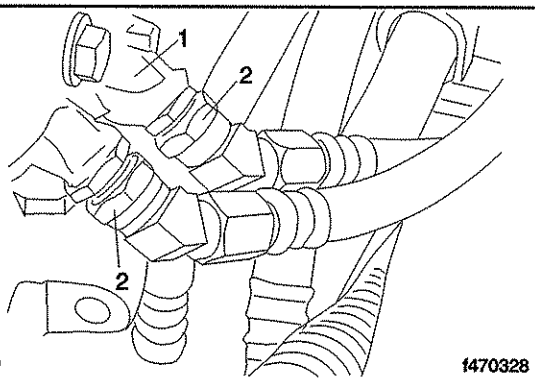




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1. Belt Tensioner
2. Socket
3. Poly-V Belt
4. Fan Pulley
5. Vibration Damper

Fig. 8, Belt Tensioner



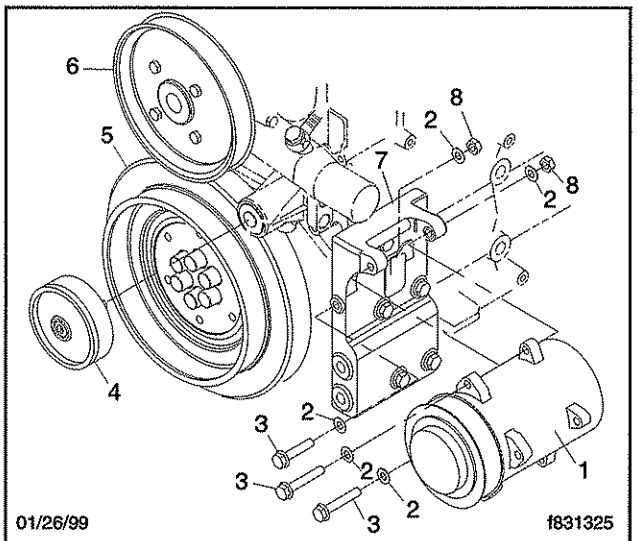
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1. Fuel Filter
2. Fuel Line Fittings

Fig. 9, Fuel Lines

9.3 Install the ground strap from the chassis to the engine.

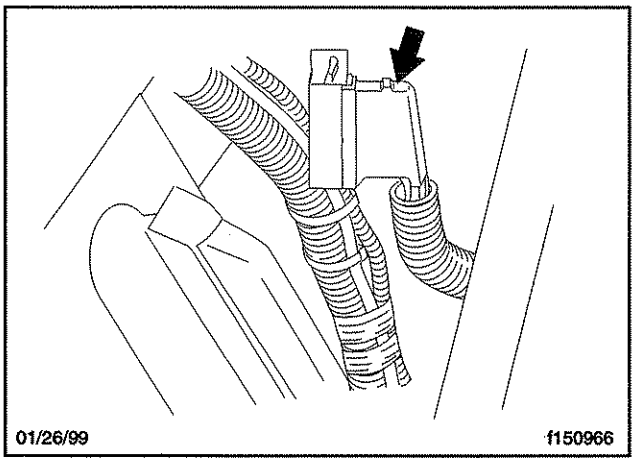
10. Install the alternator wiring on the alternator terminals. See **Fig. 16**. Tighten the output (BAT) terminal nut 100 lbf·in (1140 N·cm). Tighten the ground (G) terminal nut 65 lbf·in (740 N·cm), and the indicator light (I) terminal nut 20 lbf·in (220 N·cm).
11. Install the refrigerant compressor. See **Fig. 10**. Tighten the mounting bolts 34 lbf·ft (46 N·m).
12. Install and put tension on the poly-V belt. See **Fig. 25**.
    - 12.1 Route the belt through and around the fan, alternator, idler, and refrigerant compressor pulleys.
    - 12.2 Relax the tension on the belt tensioner.
    - 12.3 Route the belt through the belt tensioner pulley and allow the belt tensioner to tighten the belt.



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1. Refrigerant Compressor
2. Hardened Flatwasher
3. Mounting Bolt, M10
4. Idler Pulley
5. Vibration Damper
6. Fan Pulley
7. Mounting Bracket
8. Locknut, M10

Fig. 10, Refrigerant Compressor



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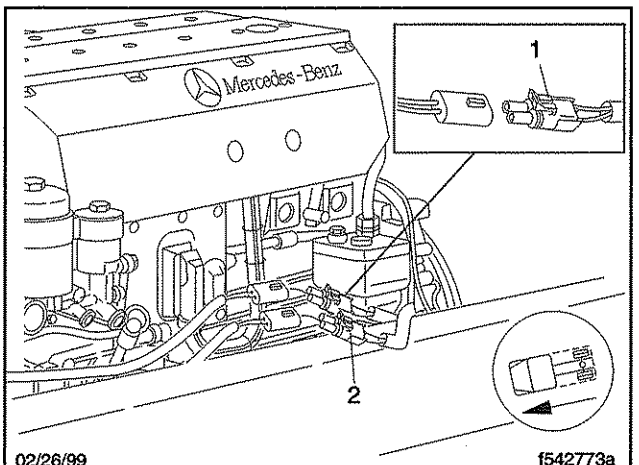
Fig. 11, Engine Harness Connector

12.4 Check all the pulleys to make sure the belt is correctly installed and aligned.

13. Connect the electrical connectors to the engine.

13.1 Connect the engine harness connector to the PLD (engine) control unit. See **Fig. 11**.

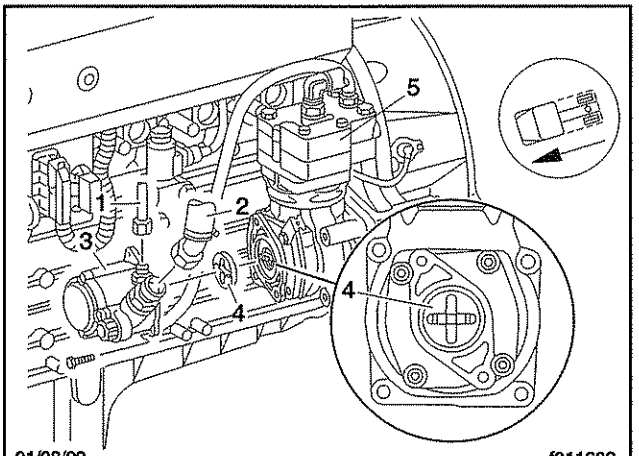
13.2 Connect the fan solenoid connector. See **Fig. 12**.



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1. Fan Solenoid Connector
2. Exhaust Brake Solenoid Connector

Fig. 12, Fan Solenoid and Exhaust Brake Solenoid Connector



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1. Pressure Line
2. Return Line
3. Power Steering Pump
4. Cross Plate
5. Air Compressor

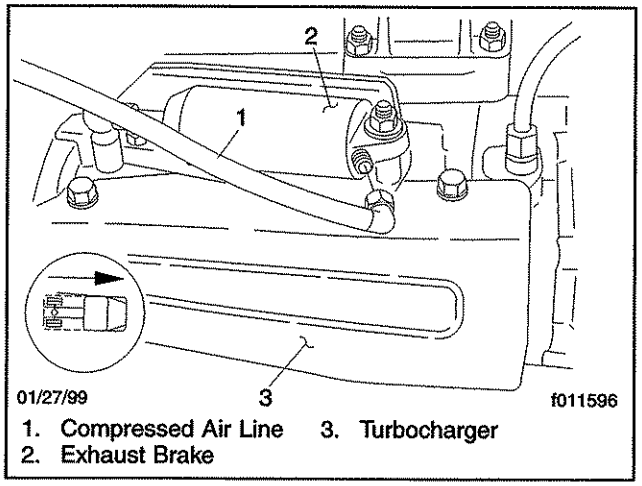
Fig. 13, Power Steering Lines

13.3 If removed, connect the exhaust brake solenoid connector. See **Fig. 12**.

14. Connect the fuel lines to the fuel filter housing. See **Fig. 9**.

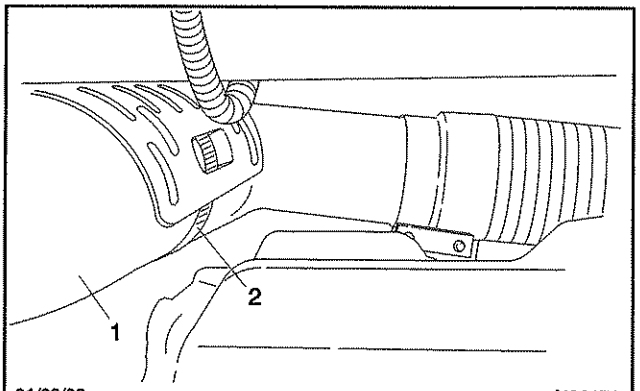
15. Connect the power steering pump to the air compressor. See **Fig. 13**.

Engine Removal and Installation



1. Compressed Air Line
2. Exhaust Brake
3. Turbocharger

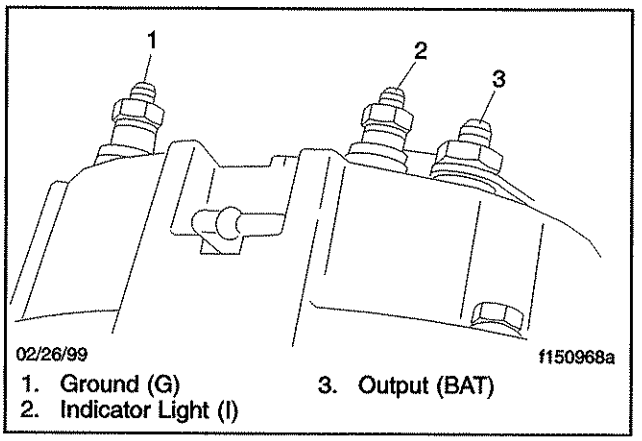
Fig. 14, Exhaust Brake Air Line



1. Exhaust Pipe
2. Clamp

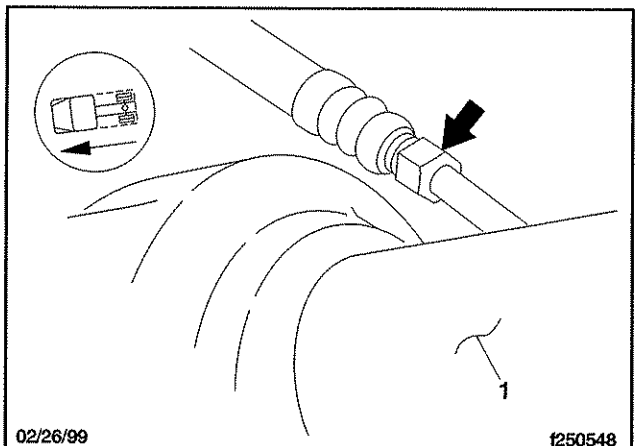
Fig. 15, Exhaust Pipe

16. Install the radiator assembly. See **Fig. 7**. For detailed instructions, see the procedures for frame-rail mounted radiators in **Section 20.01**, Subject 100. Tighten the nuts on the radiator brace isolators 25 lbf·ft (34 N·m).
17. Install the charge air cooler. See **Fig. 7**. For detailed instructions, see the procedures in **Section 09.01**, Subject 100. Tighten the mounting bolts 16 lbf·ft (22 N·m).
18. Install the A/C condenser and secure all hoses. See **Fig. 6**. Tighten the mounting bolts 16 lbf·ft (22 N·m).
19. Install the coolant hoses. See **Fig. 3**,**Fig. 4** and **Fig. 5**.



1. Ground (G)
2. Indicator Light (I)
3. Output (BAT)

Fig. 16, Alternator Terminals



Loosen the nut on the clutch line at the arrow.

1. Clutch Slave Cylinder

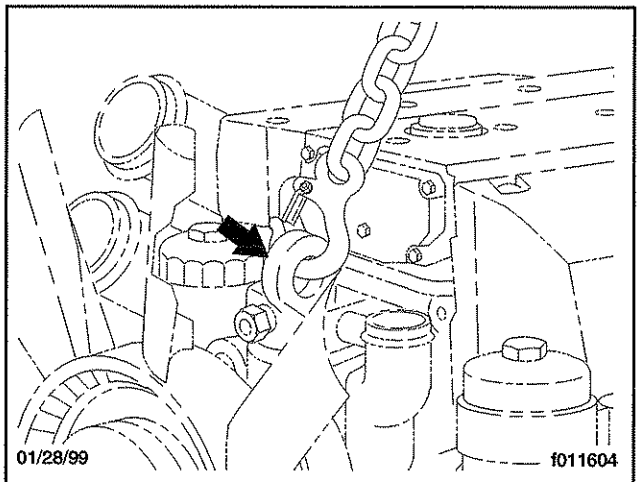
Fig. 17, Hydraulic Clutch Line

19.1 Install the two small-diameter coolant delivery hoses attached to the surge tank.

19.2 Install the medium-diameter upper coolant hose attached to the front end of the crankcase, near the cylinder head.

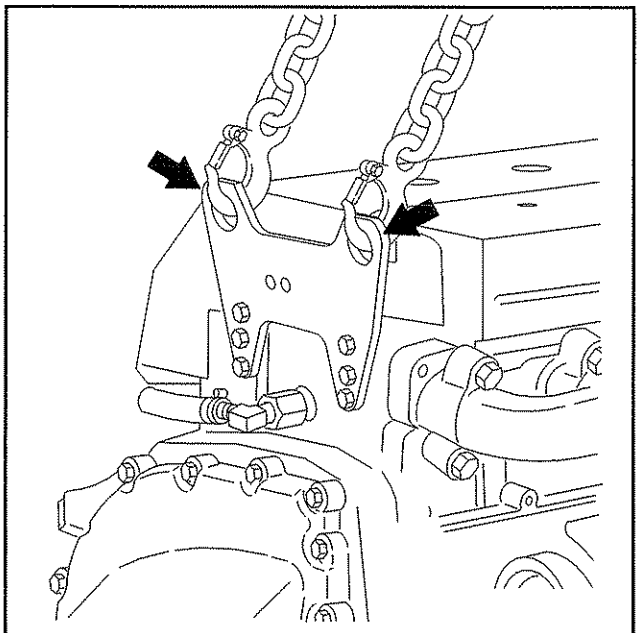
19.3 Install the lower coolant hose assembly.

20. Install the coolant hose standoff bracket.
21. Install the charge air cooler hoses, as marked on removal. Make sure the pipes fit well and the clamps are tight. Make sure the crossover hose is oriented correctly. See **Fig. 26**.



When lifting, be sure the front lifting eye is clear of the crankcase breather valve cover.

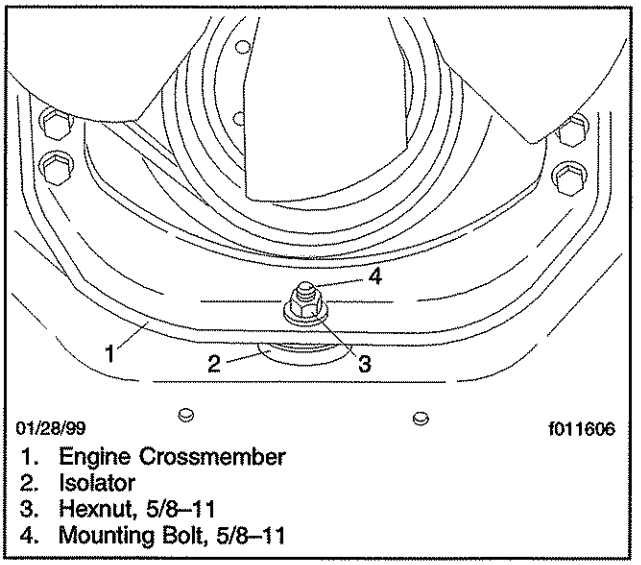
Fig. 18, Front Lifting Eye



When lifting, be sure the rear lifting fixture is clear of the frontwall and the wiper conlink.

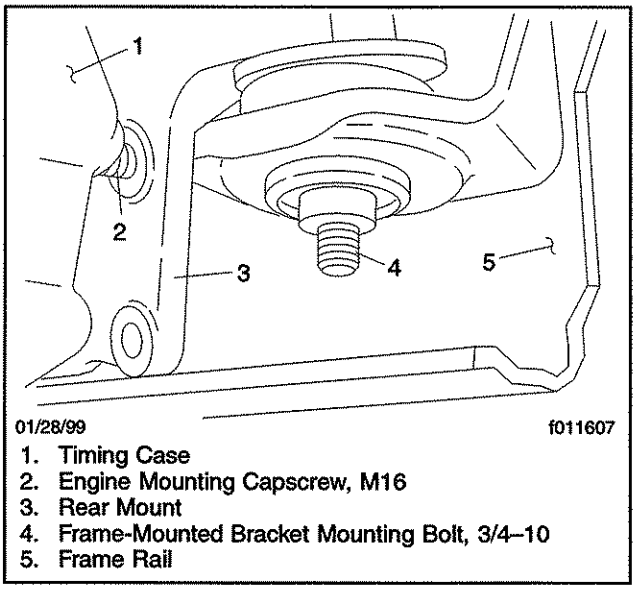
Fig. 19, Rear Lifting Fixture

21.1 Install the crossover hose leading between the charge air cooler and the charge air inlet pipe (cold air).



1. Engine Crossmember
2. Isolator
3. Hexnut, 5/8–11
4. Mounting Bolt, 5/8–11

Fig. 20, Front Engine Mount



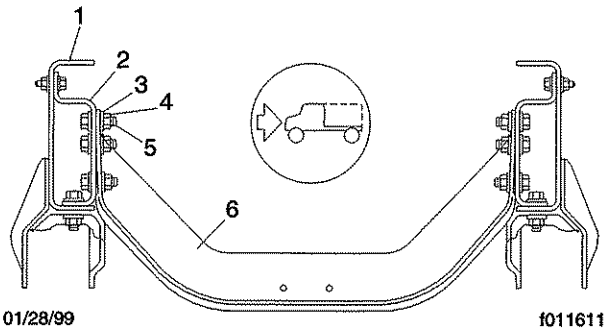
1. Timing Case
2. Engine Mounting Capscrew, M16
3. Rear Mount
4. Frame-Mounted Bracket Mounting Bolt, 3/4–10
5. Frame Rail

Fig. 21, Rear Engine Mount Removal

21.2 Install the convoluted hose between the turbo outlet pipe and the charge air cooler (warm air).

22. Install the air cleaner pipe, as marked on removal. Make sure the pipe fits well down on the inlet, is firmly connected, and the clamps are tight. See **Fig. 27** for correct fit of the air cleaner pipe to the turbo inlet.

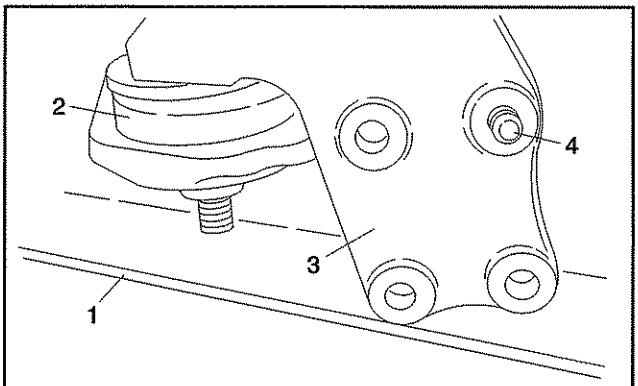
Engine Removal and Installation



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1. Frame Rail
2. Mounting Bracket
3. Bearing Washer
4. Locknut, 1/2–13
5. Mounting Bolt, 1/2–13
6. Crossmember

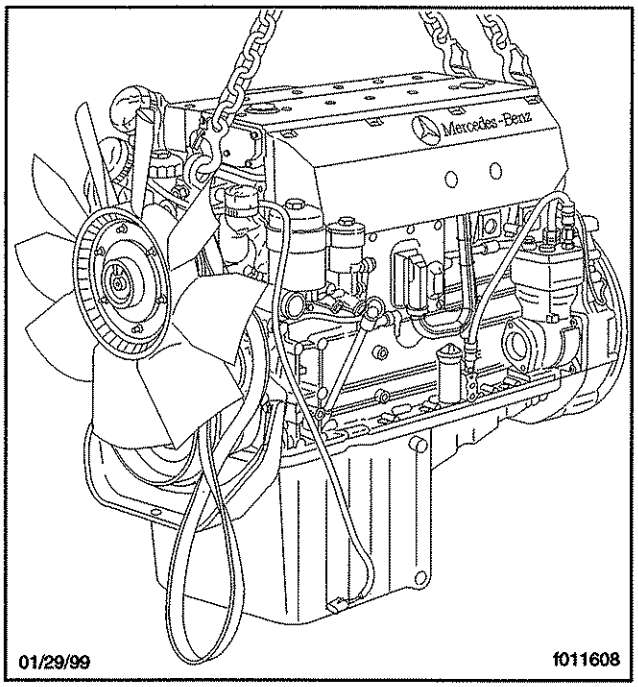
Fig. 22, Engine Crossmember



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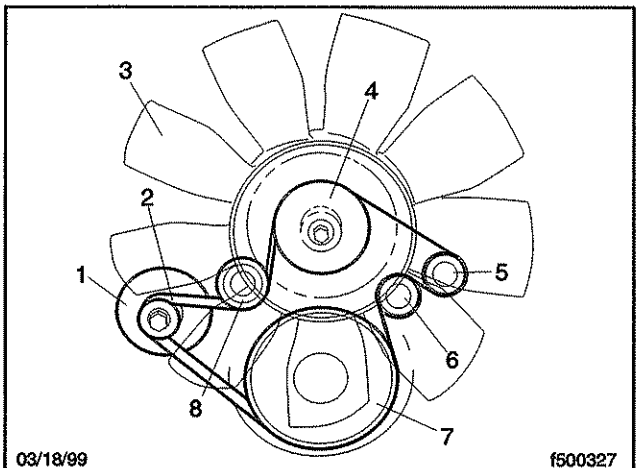
1. Frame Rail
2. Isolator
3. Rear Mount
4. Engine Mounting Capscrew, M16

Fig. 24, Rear Engine Mount Installation



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Fig. 23, Engine Removed from the Vehicle



03/18/99 f500327

1. Alternator
2. Poly-V Belt
3. Fan
4. Fan Pulley
5. Refrigerant Compressor
6. Idler Pulley
7. Vibration Damper
8. Belt Tensioner

Fig. 25, Belt Routing

23. Install the air compressor inlet hose, as marked on removal. Make sure the hose fits well down on the air compressor inlet tubing, is firmly connected, and the clamp and elbow are tight. See **Fig. 27** for correct fit of the breather hose to the inlet tubing.

24. Install the crankcase breather hose, as marked on removal. Make sure the hose fits well down on the crankcase inlet tubing, is firmly connected, and the clamp and elbow are tight. See **Fig. 27** for correct fit of the breather hose to the inlet tubing.

25. Install the rain tray and wiper arms.

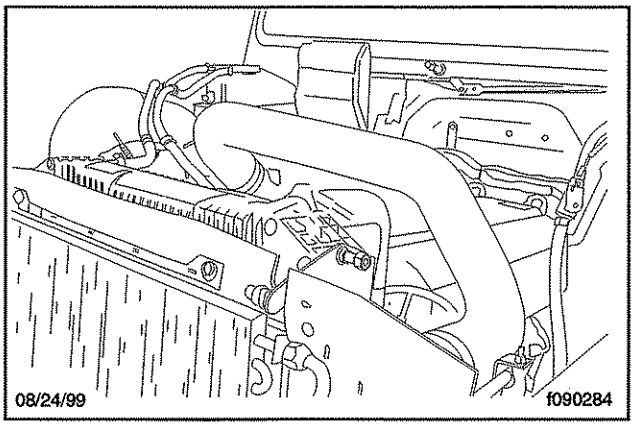
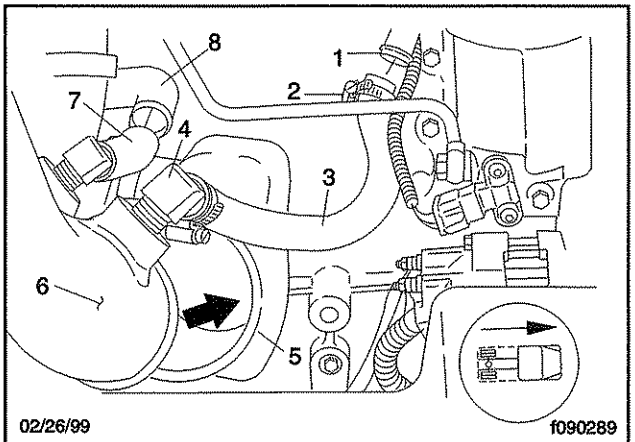


Fig. 26, Crossover Hose



1. Crankcase Inlet
2. Clamp
3. Crankcase Breather Hose
4. 90° Elbow
5. Turbo Inlet
6. Air Cleaner Pipe
7. Air Compressor Inlet Hose
8. Air Compressor Inlet

Fig. 27, Air Cleaner Pipe and Breather Hose

26. If removed, install the hydraulic clutch line and bleed the hydraulic clutch system. For detailed instructions, see **Section 25.03**, Subject 140.
27. Install the hood. For detailed instructions, see **Section 88.00**, Subject 140.
28. Install the coolant drain plug. Fill the radiator with coolant. Make sure the coolant drain plug is tight and is not leaking.
29. Install the oil drain plug and tighten it 48 lbf·ft (65 N·m). Fill the engine with oil. Make sure the oil drain plug is tight and is not leaking.
30. Connect the battery cables to the batteries.
31. Turn on the ignition keyswitch and test the engine for good operation. Pay attention to oil pressure, coolant temperature, warning lights, fluid leaks, and any other signs of a problem.
32. Remove the chocks from the tires.

Specifications

Torque Values, Engine Removal and Installation			
Description	**Size**	**lbf·ft (N·m)**	**lbf·in (N·cm)**
A/C Condenser to Charge Air Cooler Locknuts	5/16–18	16 (22)	—
Alternator Output (BAT) Terminal Nut	5/16–18	—	100 (1140)
Alternator Ground (G) Terminal Nut	1/4–20	—	65 (740)
Alternator Indicator Light (I) Terminal Nut	M4	—	20 (220)
Charge Air Cooler to Radiator Locknuts	5/16–18	16 (22)	—
Front Crossmember Mounting Bolts	1/2–13	60 (81)	—
Front Engine Mounting Nut, Gr. 8	5/8–11	136 (184)	—
Oil Drain Plug	—	48 (65)	
Radiator Isolator Mounting Nuts	7/16–14	25 (34)	—
Rear Engine Mounts: Engine Mounting Capscrews, Gr. 8	M16	155 (210)	—
Rear Engine Mounts: Frame-Mounted Bracket Mounting Bolts, Gr. 8	3/4–10	241 (347)	—
Refrigerant Compressor Mounting Bolts	M10	34 (46)	—
Starter Mounting Bolts	—	37 (50)	—
Timing Case to Transmission Mounting Capscrews	—	33 (45)	—

Table 1, Torque Values, Engine Removal and Installation

Contents

Subject	Subject Number
General Information	050
Service Operations	
Exhaust Brake Removal and Installation	100
Air Cylinder Replacement	110

General Information

The Jacobs exhaust brake uses exhaust back pressure to help slow the vehicle. It supplements the vehicle's standard service brakes to supply more efficient braking action, even with heavy loads. It is virtually silent during operation, and provides retarding power proportional to the engine rpm; that is, the higher the engine rpm, the higher the retarding horsepower.

The exhaust brake is installed in the exhaust line between the turbocharger (or turbocharger exhaust pipe) and the main exhaust pipe. The major components of the exhaust brake include a butterfly valve and an air cylinder. When the air cylinder is pressurized, a pushrod rotates an actuating lever to close the butterfly plate. A solenoid valve controls the air released to the air cylinder from the secondary air tank.

When the valve restricts the flow of exhaust gas, back pressure increases inside the engine. This higher back pressure creates resistance against the pistons, which slows the crankshaft's rotation and helps control the speed of the vehicle.

The Jacobs exhaust brake has a cast-iron housing and a butterfly plate that resists extremely high temperatures. The exhaust brake requires no adjustment or maintenance because the valve's orifice is fixed and the air cylinder is sealed to prevent contamination. The unit can be deactivated by pressing a switch on the dash.

Exhaust Brake Removal and Installation

Removal

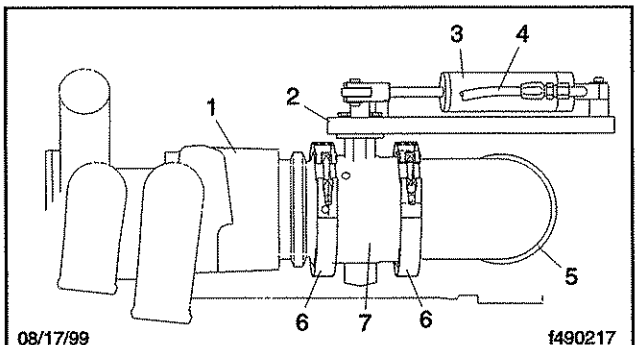
NOTE: The position of the exhaust brake and the location of the solenoid valve depend on the configuration of the vehicle. The following procedure and the illustrations are for a typical installation and may differ slightly for your application.

1. Park the vehicle, set the parking brakes, and shut down the engine. Chock the rear tires.
2. Drain the air tanks. For instructions, see **Group 42.**

⚠ WARNING

Do not work on or near the exhaust components while they are hot. To do so could result in serious personal injury from burns. Let the exhaust piping cool before you work on it.

3. Disconnect the air line from the exhaust brake cylinder. See **Fig. 1.**
4. Remove the exhaust brake from the exhaust pipe. See **Fig. 2.**
   - 4.1 Under the cab, remove the exhaust pipe from the saddle clamp mounted on the flywheel housing. See **Fig. 3.**
   - 4.2 Mark the exhaust brake and exhaust pipes (or turbocharger) where they are joined.



1. Turbocharger
2. Air Cylinder Bracket
3. Air Cylinder
4. Air Line
5. Exhaust Pipe
6. V-Clamp
7. Exhaust Brake Housing

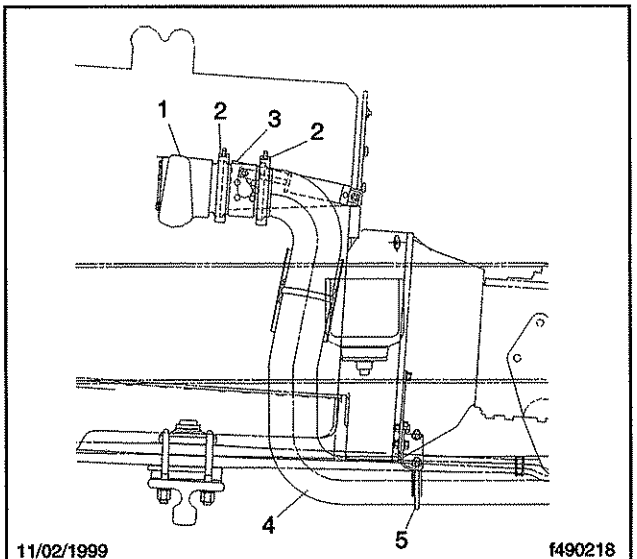
Fig. 1, Exhaust System With Jacobs Exhaust Brake (top view)

   - 4.3 Loosen and remove the two V-clamps securing the exhaust piping to each side of the exhaust brake. Your vehicle may have the exhaust brake connected directly to the turbocharger without a short connecting pipe.
   - 4.4 Pull the exhaust piping apart and remove the exhaust brake. Discard the gasket on the inlet side of the exhaust brake.

Installation

1. Connect the exhaust brake to the exhaust piping.
   - 1.1 Install a new gasket on the exhaust brake inlet.

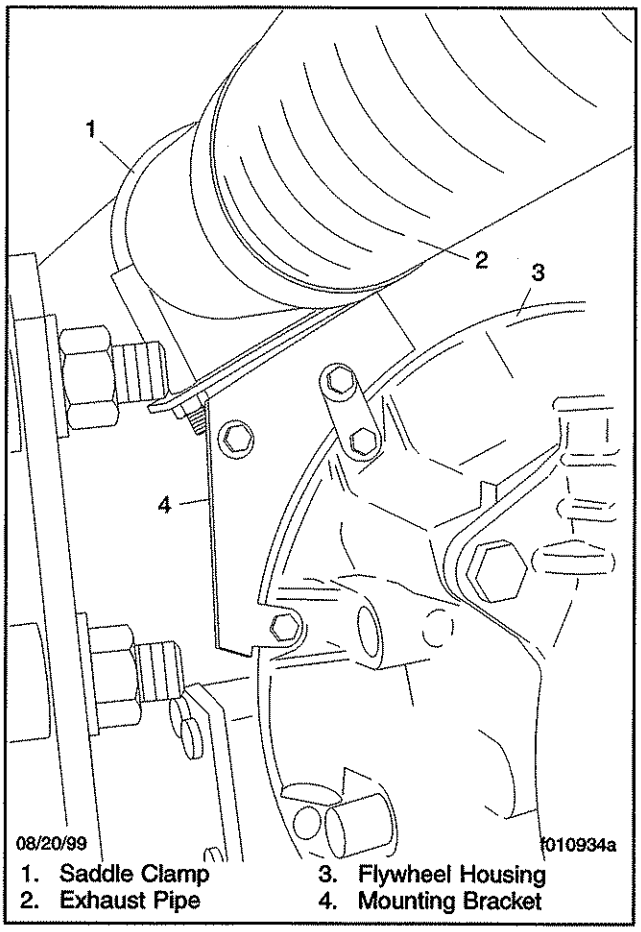
     If the short turbocharger exhaust pipe was removed, install a new gasket on the inlet side of the exhaust pipe before reinstalling it.
   - 1.2 Install the exhaust brake between the turbocharger (or short turbocharger exhaust pipe) and the main exhaust pipe, align-



1. Turbocharger
2. V-Clamp
3. Exhaust Brake Assembly
4. Exhaust Pipe
5. Saddle Clamp (on flywheel housing)

Fig. 2, Exhaust Brake Installation (typical)

Exhaust Brake Removal and Installation



1. Saddle Clamp
2. Exhaust Pipe
3. Flywheel Housing
4. Mounting Bracket

Fig. 3, Saddle Clamp on Flywheel Housing

ing the marks made during removal. See **Fig. 2**. Make sure the air cylinder bracket points downstream, away from the turbocharger.

1.3 Install the two V-clamps. Tighten each clamp 4 lbf·ft (5 N·m).

1.4 Install the saddle clamp on the exhaust pipe and secure it to the flywheel housing. Tighten the hexnuts on the saddle clamp 24 lbf·ft (33 N·m).

2. Connect the air line from the solenoid to the air cylinder. See **Fig. 1**. Tighten the connection firmly.
3. Make sure the wiring and air lines are not kinked, and are protected from abrasion and potentially hot surfaces.
4. Test the exhaust brake.
   - 4.1 Start the engine.
   - 4.2 Turn the exhaust brake switch to On.
   - 4.3 Bring the engine up to the governed rpm and release the throttle. The brake should actuate, then turn off at about 900 rpm.
5. Remove the chocks from the tires.

Replacement

NOTE: The air cylinder is the only replaceable part on the exhaust brake. Air cylinder replacement kits are available through the Caterpillar distribution system. If there is a problem with any other part, replace the entire exhaust brake assembly.

1. Park the vehicle, set the parking brakes, and shut down the engine. Chock the rear tires.
2. Drain the air tanks. For instructions, see **Group 42.**

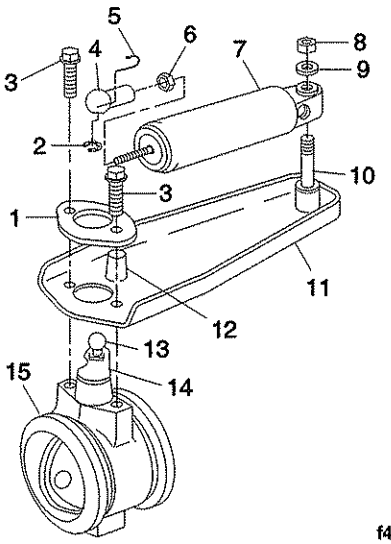
⚠ WARNING

Do not work on or near the exhaust components while they are hot. To do so could result in serious personal injury from burns. Let the exhaust piping cool before you work on it.

3. Disconnect the air line from the exhaust brake cylinder.
4. If the configuration of your vehicle provides enough clearance to remove the air cylinder from the exhaust brake housing, go to the next step.

   If access to the air cylinder is restricted, remove the entire exhaust brake assembly from the exhaust piping. See **Subject 100** for instructions.
5. Remove the air cylinder from the exhaust brake. See **Fig. 1.**
   - 5.1 Mark the air cylinder bracket below the air supply port on the air cylinder.
   - 5.2 Loosen the jam nut between the air cylinder and the ball-and-socket joint.
   - 5.3 Remove the safety clip from the socket.
   - 5.4 Pry the socket off the ball stud on the actuating lever.
   - 5.5 Remove the locknut and washer securing the air cylinder on the pivot stud. Remove the air cylinder from the bracket.
   - 5.6 Unscrew the socket and jam nut from the threaded rod on the air cylinder.
   - 5.7 Note the orientation of the air supply fittings on the air cylinder. Remove and save the fittings. Discard the air cylinder.
6. Install the new air cylinder on the exhaust brake.
   - 6.1 Install the air supply fittings in the same orientation on the new air cylinder.

   NOTE: The socket in the air cylinder kit has the internal snap ring already installed.
   - 6.2 Install the jam nut and socket on the threaded rod on the air cylinder, but do not tighten.
   - 6.3 Slide the air cylinder bushing onto the pivot stud on the air cylinder bracket. Make sure the air supply port is aligned with the mark you made on the bracket during disassembly.
   - 6.4 Install the washer and locknut on the pivot stud, but do not tighten.
7. Adjust the socket.
   - 7.1 Move the actuating lever clockwise until it contacts the positive stop. See **Fig. 1.** Hold the lever in this position.



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1. Gasket	9. Washer
2. Internal Snap Ring	10. Pivot Stud
3. Capscrew, Hexhead	11. Air Cylinder Bracket
4. Socket	12. Positive Stop
5. Safety Clip	13. Ball Stud
6. Jam Nut, M8	14. Actuating Lever
7. Air Cylinder	15. Exhaust Brake Housing
8. Locknut, M8	

Fig. 1, Jacobs Exhaust Brake

Air Cylinder Replacement

7.2 Turn the socket on the threaded rod until the pocket is aligned with the ball stud on the exhaust brake housing. Then, tighten the socket one additional turn on the air cylinder threaded rod.

NOTE: The additional turn on the socket provides the required small preload on the spring in the air cylinder. If too much preload is applied (more than 1-1/2 turns), the butterfly plate will not fully close, resulting in poor exhaust brake performance.

7.3 Press the socket on the ball of the actuating lever until it snaps in place.

7.4 Make sure the spring preload in the air cylinder holds the actuating lever tightly against the positive stop. If there is any free play in the actuating lever, readjust the socket.

8. From the air cylinder side of the socket, insert the safety clip through the holes in the socket. Snap the loop on the end of the clip into the groove in the body of the socket.
9. Tighten the jam nut against the socket 13 lbf·ft (18 N·m).
10. Tighten the prevailing-torque locknut on the pivot stud until there is no free play of the cylinder on the stud.
11. Install the exhaust brake in the exhaust piping if it was removed at the start of this procedure. See **Subject 100** for instructions.
12. Connect the air line from the solenoid to the air cylinder. Tighten the connection firmly.
13. Make sure the wiring and air lines are not kinked, and are protected from abrasion and potentially hot surfaces.
14. Test the exhaust brake.

    14.1 Start the engine.

    14.2 Turn the exhaust brake switch to On.

    14.3 Bring the engine up to the governed rpm and release the throttle. The brake should actuate, then turn off at about 900 rpm.

15. Remove the chocks from the tires.