2

ENGINE ELECTRICAL

DISTRIBUTOR IGNITION

For information on understanding electricity and troubleshooting electrical circuits, please refer to Section 6 of this manual.

Distributors are used in the Town Car with a 5.0L engine up until the 1991 model year. The Mark VII employed a distributor until the end of the model run in 1992. The 3.8L Continental also incorporated the TFI-IV ignition system and the use of a distributor until 1994.

General Information

THICK FILM INTEGRATED (TFI-IV) IGNITION SYSTEM

See Figures 1, 2, 3, 4 and 5

The Thick Film Integrated (TFI-IV) ignition system uses a camshaft driven distributor with no centrifugal or vacuum advance. The distributor has a diecast base, incorporating a Hall effect stator assembly. The TFI-IV system module is mounted on the distributor base, it has 6 pins and uses an E-Core ignition coil, named after the shape of the laminations making up the core.

The TFI-IV module supplies voltage to the Profile Ignition Pick-up (PIP) sensor, which sends the crankshaft position information to the TFI-IV module. The TFI-IV module then sends this information to the EEC-IV module, which determines the spark timing and sends an electronic signal to the TFI-IV ignition module to turn off the coil and produce a spark to fire the spark plug.

The operation of the universal distributor is accomplished through the Hall effect stator assembly, causing the ignition coil to be switched off and on by the EEC-IV computer and TFI-IV modules. The vane switch is an encapsulated package consisting of a Hall sensor on one side and a permanent magnet on the other side.

A rotary vane cup, made of ferrous metal, is used to trigger the Hall effect switch. When the window of the vane cup is between the magnet and the Hall effect device, a magnetic flux field is completed from the magnet through the Hall effect device back to the magnet. As the vane passes through the opening, the flux lines are shunted through the vane and back to the magnet. A voltage is produced while the vane passes through the opening. When the vane clears the opening, the window causes the signal to go to 0 volts. The signal is then used by the EEC-IV system for crankshaft position sensing and the computation of the desired spark advance based on the engine demand and calibration. The voltage distribution is accomplished through a conventional rotor, cap and ignition wires.

Diagnosis and Testing

SECONDARY SPARK TEST

See Figures 6, 7, 8 and 9

The best way to perform this procedure is to use a spark tester (available at most automotive parts stores). Three types of spark testers are commonly available. The Neon Bulb type is connected to the spark plug wire and flashes with each ignition pulse. The Air Gap type must be adjusted to the individual spark plug gap specified for the engine. The last type of spark plug tester looks like a spark plug with a grounding clip on the side, but there is no side electrode for the spark to jump to. The last two types of testers allows the user to not only detect the presence of spark, but also the intensity (orange/yellow is weak, blue is strong).

1. Disconnect a spark plug wire at the spark plug end.
2. Connect the plug wire to the spark tester and ground the tester to an appropriate location on the engine.
3. Crank the engine and check for spark at the tester.
4. If spark exists at the tester, the ignition system is functioning properly.
5. If spark does not exist at the spark plug wire,

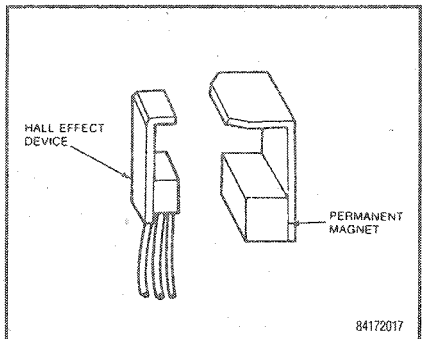


Fig. 1 Hall effect vane switch assembly

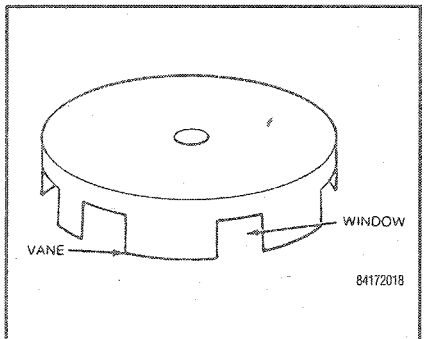


Fig. 2 Rotary vane cup

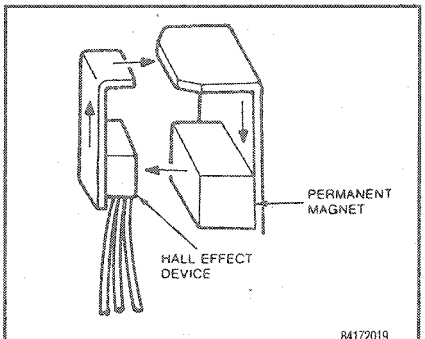


Fig. 3 Hall effect response to vane cup window

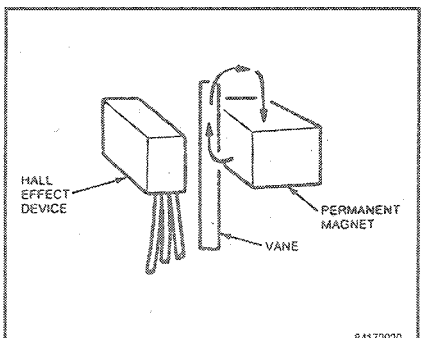


Fig. 4 Hall effect response to vane

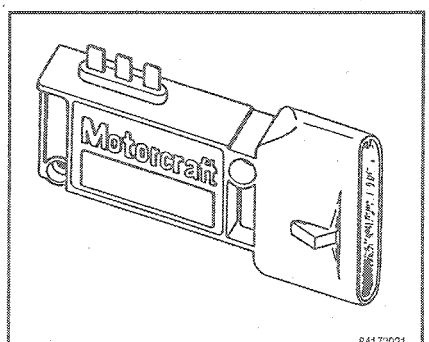


Fig. 5 TFI-IV module

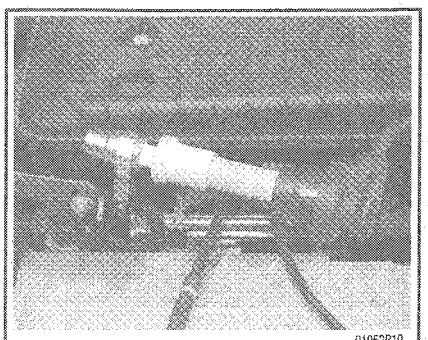
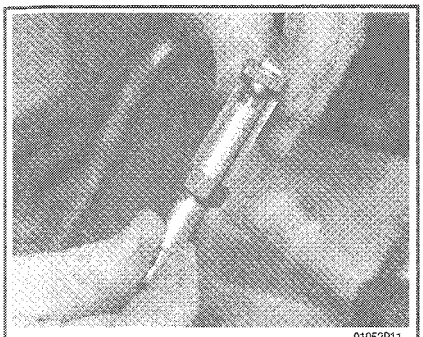


Fig. 6 This spark tester looks just like a spark plug, attach the clip to ground and crank the engine to check for spark



91052P11

Fig. 7 This spark tester has an adjustable air-gap for measuring spark strength and testing different voltage ignition systems

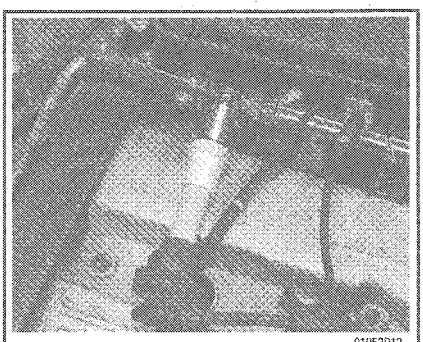


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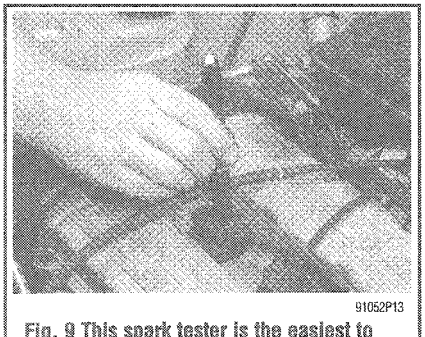
Fig. 8 Attach the clip to ground and crank the engine to check for spark



91052P13

Fig. 9 This spark tester is the easiest to use just place it on a plug wire and the spark voltage is detected and the bulb on the top will flash with each pulse

perform diagnosis of the ignition system using individual component diagnosis procedures.

CYLINDER DROP TEST

See Figures 10, 11 and 12

The cylinder drop test is performed when an engine misfire is evident. This test helps determine which cylinder is not contributing the proper power. The easiest way to perform this test is to remove the plug wires one at a time from the cylinders with the engine running.

1. Place the transmission in **P**, engage the emergency brake, and start the engine and let it idle.
2. Using a spark plug wire removing tool, preferably, the plier type, carefully remove the boot from one of the cylinders.

CAUTION

Make sure your body is free from touching any part of the car which is metal. The secondary voltage in the ignition system is high and although it cannot kill you, it will shock you and it does hurt.

3. The engine will sputter, run worse, and possibly nearly stall. If this happens reinstall the plug wire and move to the next cylinder. If the engine runs no differently, or the difference is minimal, shut the engine off and inspect the spark plug wire, spark plug, and if necessary, perform component diagnostics as covered in this section. Perform the test on all cylinders to verify which cylinders are suspect.

Adjustments

The only adjustment available on the TFI-IV system is the timing. Refer to Section 1 for Timing inspection and adjustment.

Ignition Coil

TESTING

Primary Coil

See Figures 13, 14 and 15

The first check of the primary ignition coil is to verify that there is battery voltage at the **BATT** ter-

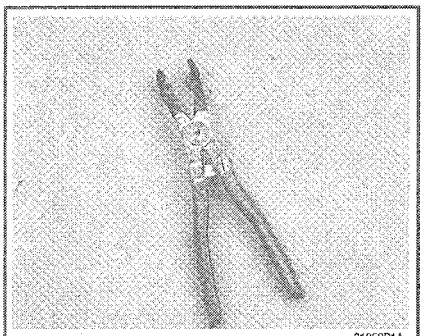


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Fig. 10 These pliers are insulated and help protect the user from shock as well as the plug wires from being damaged

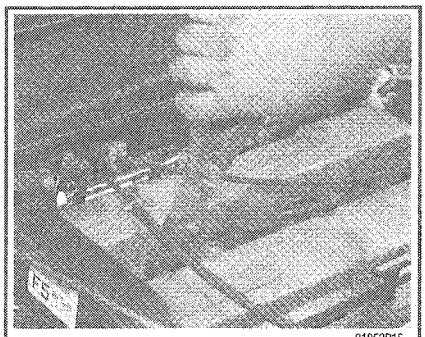

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Fig. 11 To perform the cylinder drop test, remove one wire at a time and . . .

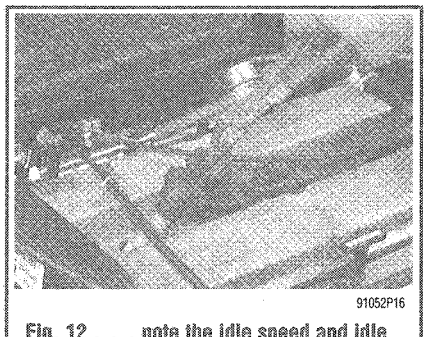

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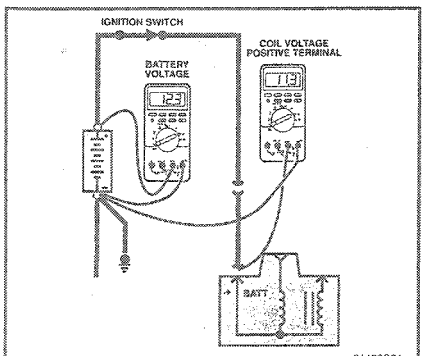
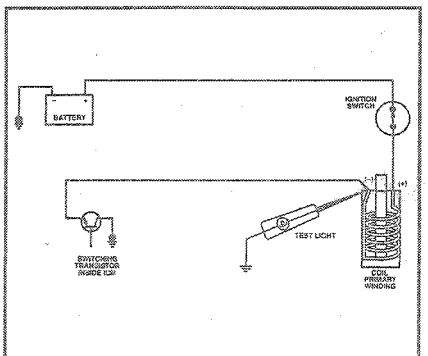
Fig. 12 . . . note the idle speed and idle characteristics of the engine. The cylinder(s) with the least drop is the non-contributing cylinder(s)



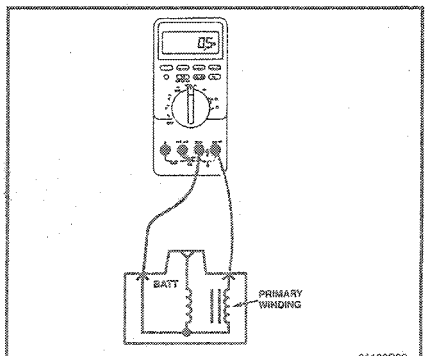
91192G01

Fig. 13 Testing the coil supply voltage



91192G02

Fig. 14 Testing the primary circuit ground



91192G03

Fig. 15 Testing the primary coil resistance

minal on the coil. A DVOM is recommended to test for voltage. Turn the ignition switch to the **RUN** position and connect the negative lead of the DVOM to a ground or the negative post/cable clamp on the battery. Connect the other lead of the DVOM to the **BATT** terminal on the coil. The voltage measured should be within 1 volt of the battery voltage as measure across the posts of the battery.

After verifying there is battery voltage present, the next check is to verify the operation of the coil primary ground which is received at the coil from the ICM (Ignition Control Module). This check is accomplished using a test lamp and connecting the lead of the test lamp to the ground or the battery negative post/cable clamp. Connect the test lamp to the ground side of the coil (the connection opposite the **BATT** terminal on the coil on the other side of the coil tower) and crank the engine. The light should blink on and off repeatedly as long as the engine cranks or runs. If the light does not blink the problem is either in the ICM or the **PIP** signal generated by the sensor inside the distributor.

The final check of the primary coil is to check the resistance of the coil. This is accomplished by using a DVOM and probing the **BATT** terminal and the coil ground terminal. Measure the resistance between the two terminals. If the resistance is between 0.3 and 1.0 ohm, the primary ignition coil is within specifications. If the reading differs from this specification, replace the coil and retest.

Secondary Windings

See Figure 16

The coil secondary resistance is the final check of the ignition coil. Use a DVOM to measure the resistance between the **BATT** terminal to the high voltage terminal of the ignition coil. If the reading is between 6,500–11,500 ohms, the ignition coil is OK. If the reading is less than 6,500 or more than 11,500 ohms, replace the ignition coil. If the secondary windings are within specifications and the primary circuit also tests within specifications, inspect and test the spark plug wires and the spark plugs, refer to Section 1.

REMOVAL & INSTALLATION

See Figures 17, 18, 19 and 20

1. Disconnect the negative battery cable.
2. Disengage the TFI-IV harness or the engine control sensor wiring connector from the ignition coil, as applicable.
3. On the 3.8L engine, disengage the engine control wiring connector from the radio ignition interference capacitor.
4. Remove the ignition coil retaining screws and the ignition coil and radio interference capacitor (if equipped) from the ignition coil mounting bracket.
5. Remove the ignition coil cover from the ignition coil by releasing the locking tabs on both sides of the cover, then remove the ignition coil.

To install:

6. Install the ignition coil, then attach ignition coil cover, making sure the cover is firmly in place.
7. If removed, connect the ignition coil and radio interference capacitor, then install the ignition coil retaining screws. Tighten the retaining screws to 25–35 inch lbs. (3–4 Nm).
8. Connect the coil wire, then engage any electrical connectors that were removed.
9. Connect the negative battery cable.

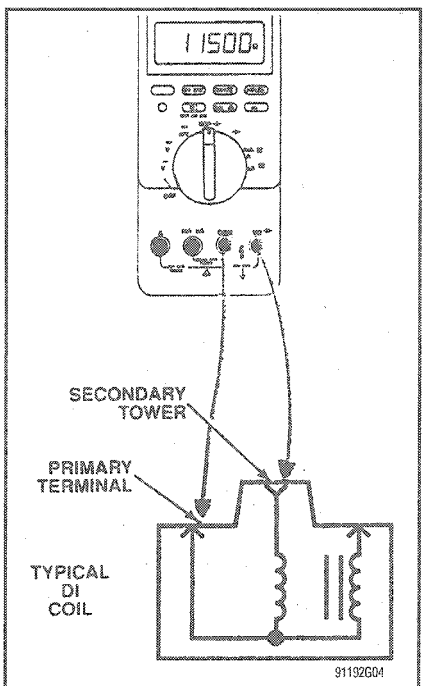


Fig. 16 Testing the coil secondary resistance

Ignition Module

➡In earlier models, the ICM was referred to as the TFI-IV Ignition Module; the name was later changed to Ignition Control Module (ICM).

REMOVAL & INSTALLATION

See Figures 21 and 22

1. Disconnect the negative battery cable.
2. Remove the screws attaching the cowl vent screen to the top of the cowl.

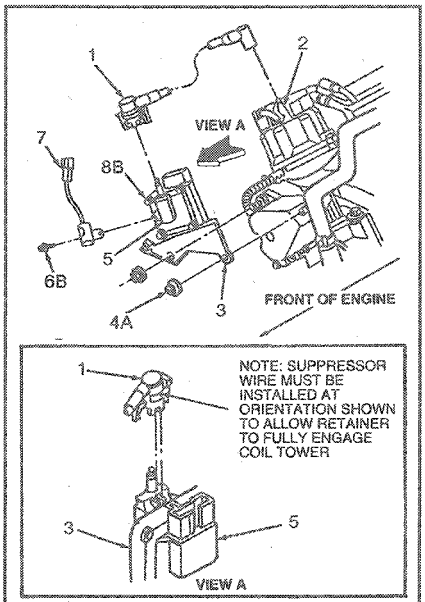


Fig. 17 Ignition coil and related components—late model 3.8L shown

Fig. 18 Remove the ignition coil retaining screws

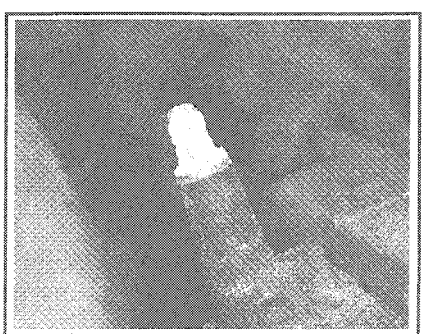


Fig. 19 If your coil has this kind of build-up, it needs a good cleaning

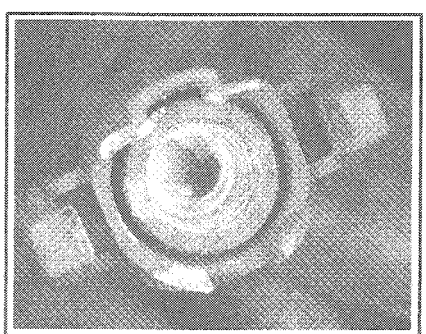


Fig. 20 This is the coil wire. Replace it if it looks like this

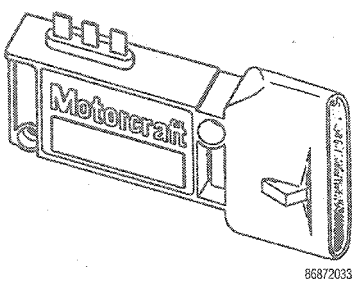


Fig. 21 The ignition control module (or TFI ignition module, as applicable), is located on the distributor—5.0L engines

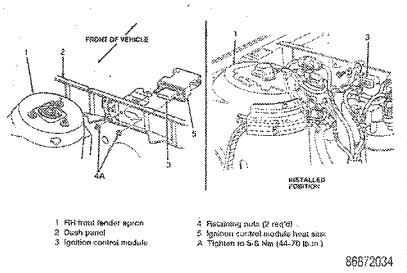


Fig. 22 Location of the ignition control module—3.8L engines only

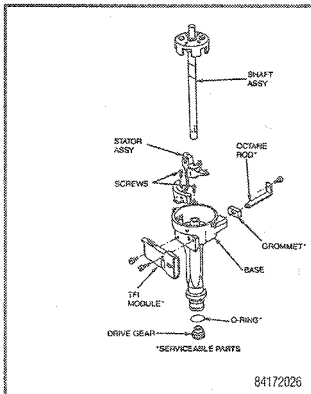


Fig. 23 Distributor assembly—5.0L

3. Separate the engine compartment cowl seal strip from the cowl vent screen and the cowl dash extension panel in the area of the ignition control module.

4. Lift the cowl vent screen off to allow access to the ignition control module/TFI module assembly.

➨The connector latch is underneath the ICM/TFI shroud. Press upward to unlatch.

5. Disengage the engine control sensor wiring connector from the ICM or TFI, as applicable.

➨The ignition control module and heatsink are mounted with the heatsink fins pointed downward.

6. Remove the two retaining nuts attaching the ICM/TFI and heatsink to the dash panel, then remove the ICM/TFI and the heatsink.

7. Remove the two module retaining screws, then remove the ICM or TFI from the heatsink.

8. While holding the module connector shroud with one hand, pull the seal off the other end of the module.

To install:

9. Coat the metal base of the ICM or TFI module uniformly with Silicone Dielectric Compound D7AZ-19A331-A or equivalent, about ½2 in. (0.79mm) thick.

10. Place the module onto the heatsink. Install the retaining screws, then tighten them to 15–35 inch lbs. (1.7–4.0 Nm).

11. Push the seal over the module connector shroud and heatsink studs with the metal part toward the heatsink.

12. Insert the module and heatsink into the cowl dash extension panel enough to have the mounting studs protrude into the engine compartment side.

13. Hand-tighten the retaining nuts to 44–70 inch lbs. (5–8 Nm).

14. Engage the engine control sensor wiring connector to the module.

15. Install the cowl vent screen and retaining screws, then install the engine compartment cowl panel and seal strip.

16. Connect the negative battery cable.

Distributor

REMOVAL & INSTALLATION

See Figure 23

1. Bring the engine to TDC on the number 1 cylinder.

2. Disconnect the negative battery cable.

3. Mark the position of the No. 1 cylinder wire tower onto the distributor base.

➨This reference is necessary in case the engine is disturbed while the distributor is removed.

4. Remove the distributor cap and position the cap and ignition wires to the side. Disconnect the wiring harness plug from the distributor connector.

5. Scribe a mark on the distributor body to indicate the position of the rotor tip. Scribe a mark on the outside base of the distributor housing and the engine block to indicate the position of the distributor in the engine.

6. Remove the hold-down bolt and clamp located at the base of the distributor. Remove the distributor from the engine. Note the direction the rotor tip points as it moves from the No. 1 position when the drive gear disengages. For reinstallation purposes, the rotor should be at this point to insure proper gear mesh and timing.

7. Cover the distributor opening in the engine to prevent the entry of dirt or foreign material.

8. Avoid turning the engine, if possible, while the distributor is removed. If the engine is disturbed, the No. 1 cylinder piston will have to be brought to Top Dead Center (TDC) on the compression stroke before the distributor is installed.

➨Before installing, visually inspect the distributor. The drive gear should be free of nicks, cracks and excessive wear. The distributor drive shaft should move freely, without binding. If equipped with an O-ring, it should fit tightly and be free of cuts.

Timing Not Disturbed

1. Position the distributor in the engine, aligning the rotor and distributors housing with the marks that were made during removal. If the distributor does not fully seat in the engine block or timing cover, it may be because the distributor is not engaging properly with the oil pump intermediate shaft. Remove the distributor and, using a screwdriver or similar tool, turn the intermediate shaft until the distributor will seat properly.

2. Install the hold-down clamp and bolt. Snug the mounting bolt so the distributor can be turned for ignition timing purposes.

3. Install the distributor cap and connect the distributor to the wiring harness.

4. Connect the negative battery cable. Check and, if necessary, set the ignition timing. Tighten the distributor hold-down clamp bolt to 17–25 ft. lbs. (23–34 Nm). Recheck the ignition timing after tightening the bolt.

Timing Disturbed (Engine Rotated)

1. Disconnect the No. 1 cylinder spark plug wire and remove the No. 1 cylinder spark plug.

2. Place a finger over the spark plug hole and crank the engine slowly until compression is felt.

3. Align the TDC mark on the crankshaft pulley with the pointer on the timing cover. This places the piston in No. 1 cylinder at TDC on the compression stroke.

4. Turn the distributor shaft until the rotor points to the distributor cap No. 1 spark plug tower.

5. Install the distributor in the engine, aligning the rotor and distributor housing with the marks that were made during removal. If the distributor does not fully seat in the engine block or timing cover, it may be because the distributor is not engaging properly with the oil pump intermediate shaft. Remove the distributor and, using a screwdriver or similar tool, turn the intermediate shaft until the distributor will seat properly.

6. Install the hold-down clamp and bolt. Snug the mounting bolt so the distributor can be turned for ignition timing purposes.

7. Install the No. 1 cylinder spark plug and connect the spark plug wire. Install the distributor cap and connect the distributor to the wiring harness.

8. Connect the negative battery cable and set the ignition timing.

9. After the timing has been set, tighten the distributor hold-down clamp bolt to 17–25 ft. lbs. (23–34 Nm). Recheck the ignition timing after tightening the bolt.

DISTRIBUTORLESS IGNITION SYSTEM

General Information

ELECTRONIC DISTRIBUTORLESS IGNITION SYSTEM (EDIS)

See Figure 24

The Integrated Electronic Ignition (EI) system consists of a Crankshaft Position (CKP) Sensor, coil packs, connecting wiring and the PCM. The Coil On Plug (COP) Integrated EI System eliminates the need for spark plug wires but does require input from the Camshaft Position (CMP) Sensor. Operation of the components is as follows:

⇒Electronic ignition engine timing is entirely controlled by the PCM. Electronic ignition engine timing is NOT adjustable. Do not attempt to check base timing. You will receive false readings.

1. The CKP Sensor is used to indicate crankshaft position and speed by sensing a missing tooth on a pulse wheel mounted to the crankshaft. The CMP Sensor is used by the COP Integrated EI System to identify top dead center of compression of cylinder #1 to synchronizer the firing of the individual coils.
2. The PCM uses the CKP signal to calculate a spark target and then fires the coil packs to that target. The PCM uses the CMP sensor on COP Integrated EI System to identify top dead center of the compression of cylinder #1 to synchronizer the firing of the individual coils.
3. The coils and coil packs receive their signal from the PCM to fire at a calculated spark target. Each coil within the pack fires two spark plugs at the same time. The plugs are paired so that as one fires during the compression stroke the other fires during the exhaust stroke. The next time the coil is fired the situation is reversed. The COP system fires only one spark plug per coil and only on the compression stroke.

The PCM acts as an electronic switch to ground in the coil primary circuit. When the switch is closed, battery power applied to the coil primary circuit builds a magnetic field around the primary coil;. When the switch opens, the power is interrupted and the primary field collapses inducing the high voltage in the secondary coil windings and the spark plug is fired. A kickback voltage spike to generate an Ignition Diagnostic Monitor (IDM) signal. IDM communicates information by pulse width modulation in the PCM.

4. The PCM processes the CKP signal and uses it to drive the tachometer as the Clean Tach Out signal.

OBD II—EEC V

The clean air act of 1990 requires that all vehicles sold in the United States meet On-Board Diagnostic (OBD)II requirements by the 1996 model year. Ford's fifth generation of electronic engine control systems, known as EEC V, is designed to meet OBD II requirements. The primary difference between EEC IV and EEC V are the monitors. EEC IV monitors are designed to detect system and component failure. EEC V monitors are designed to monitor the efficiency of engine and emission systems. The Malfunction Indicator Lamp (MIL) illuminates if the vehicle emissions exceed 1.5 times the allowable standard based on federal test procedures. If any single component or strategy failure permits emissions to exceed this level, the MIL illuminates to alert the operator and a Diagnostic Trouble Code (DTC) will be stored the Powertrain Control Module (PCM).

Lincoln vehicles produced by Ford in North America could come equipped (depending on the year) with either of two types of ignition systems. A (DI) distributor ignition (discussed earlier in this section), or an (EI) electronic ignition. EI systems are Distributorless. They contain multiple coils, known as coil packs. Secondary voltage is delivered directly from the coils to the spark plugs via spark plug wires. This ignition system also uses the EEC system to control spark timing.

There are two types of EI ignition systems:

- Low data rate
- High data rate

The vehicles discussed here use a high data rate system, on the 4.6L engine.

There are many similarities between the EI—low data rate and high data rate ignition systems. Both systems have the following similar features:

- Coil packs that contain multiple coils
- Spark plugs that are fired in paired cylinders
- Do not use distributors to distribute secondary voltage.

The components in the EI—high data rate system include:

- The PCM
- An Ignition Control Module (ICM)
- The Crankshaft Position (CKP) sensor
- A Trigger wheel
- Coil packs
- The Secondary Wires (Spark Plug Wires)
- The Spark plugs

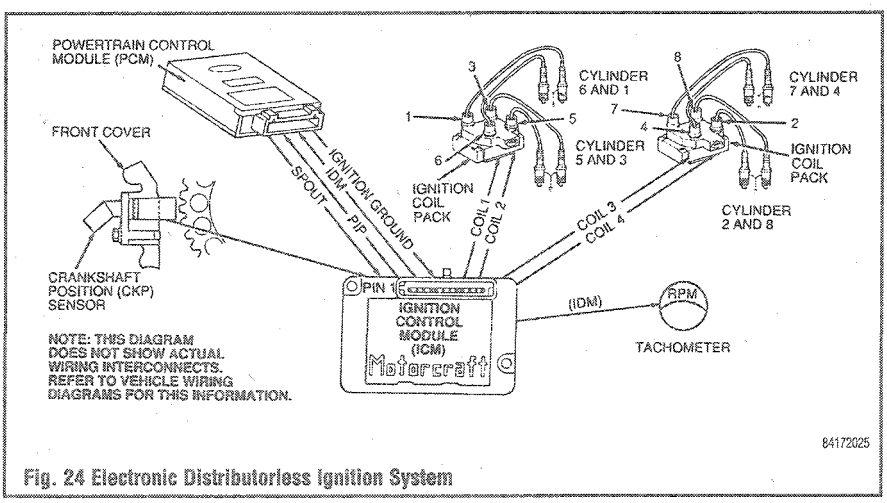


Fig. 24 Electronic Distributorless Ignition System

Diagnosis and Testing

Refer to Diagnosis and Testing under Distributor Ignition in this section.

Adjustments

All adjustments in the ignition system are controlled by the Powertrain Control Module (PCM) for optimum performance. No adjustments are possible.

Ignition Coil Pack

TESTING

Primary Winding Resistance

See Figure 25

1. Turn the ignition **OFF**.
2. Disconnect the negative battery cable.
3. Disconnect the wiring harness from the ignition coil.
4. Check for dirt, corrosion or damage on the terminals and repair as necessary.
5. Measure coil primary resistance between ignition coil pin 2 (B+) and pins 1 (coil 2), 2 (coil 3) and 3 (coil 1).
6. Resistance should be 0.3–1.0 ohms. If resistance is out of specifications, replace the coil pack. If resistance is within specifications, proceed to secondary windings testing.

Secondary Winding Resistance

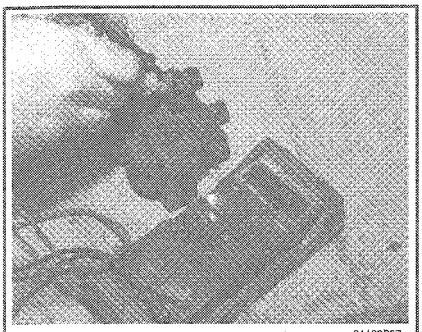
See Figure 26

1. Measure coil secondary resistance between the corresponding spark plug wire towers on the coil.
   - Coil 1—cylinders 1 and 6
   - Coil 2—cylinders 3 and 5
   - Coil 3—cylinders 4 and 7
   - Coil 4—cylinders 2 and 8
2. Resistance should be 12.8–13.1 kilohms. If secondary resistance is not within specification, replace the coil pack.

REMOVAL & INSTALLATION

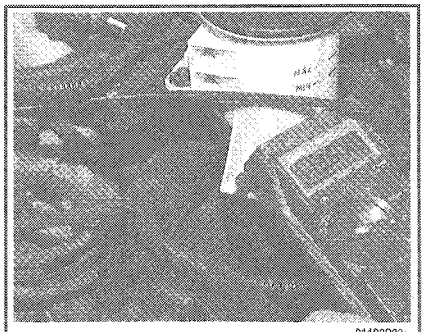
See Figures 27, 28, 29 and 30

⇒Two ignition coil packs are used, one for each bank of cylinders. This procedure is for removing 1 ignition coil pack, but the procedure remains the same for either side.



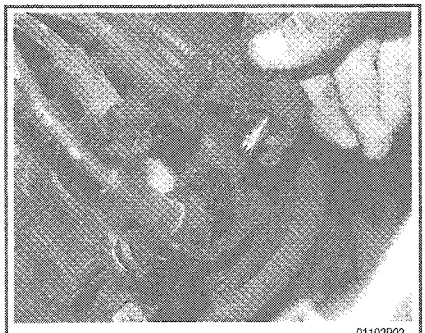
91192P07

Fig. 25 Testing the primary ignition coil resistance–4.6L engine



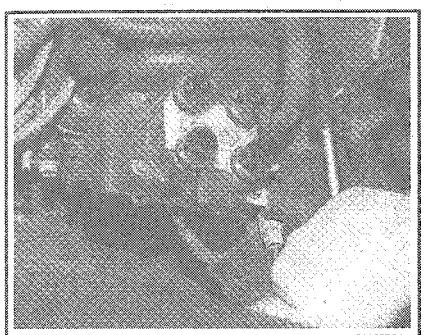
91192P03

Fig. 26 Testing the secondary ignition coil resistance–4.6L engine



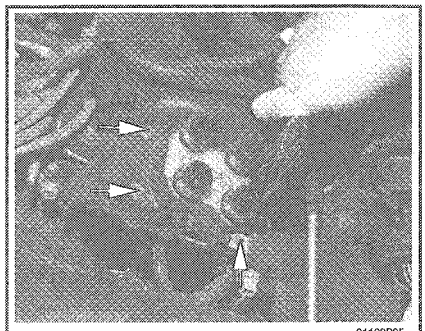
91192P02

Fig. 27 Remove the ignition wires from the coil pack by squeezing the retaining tabs and carefully lifting up



91192P04

Fig. 28 Detach the connector for the coil pack



91192P05

Fig. 29 Remove the four coil pack retaining screws and . . .

91192P06

Fig. 30 . . . remove the coil pack from the bracket

1. Disconnect the negative battery cable.
2. Detach the ignition coil and radio ignition interference capacitor electrical harness connectors.
3. Tag the ignition wires and note their location on the coil pack before removing. Remove the ignition wires by squeezing the locking tabs to release the coil boot retainers and twisting while pulling upward.
4. Remove 4 ignition coil retaining screws and remove the ignition coil and radio capacitor.
5. If replacing the ignition coil, save the radio capacitor for installation on the new ignition coil.

To install:

6. Place the ignition coil and radio capacitor on the mounting bracket.
7. Install 4 retaining screws and tighten to 40–61 inch lbs. (5–7 Nm).
8. Install the ignition wires to their proper terminals on the ignition coil. Apply silicone dielectric compound to the ignition wire boots prior to installation.
9. Connect the electrical harness connectors to the ignition coil and the radio ignition interference capacitor.
10. Connect the negative battery cable.
11. Road test the vehicle and check for proper engine operation.

Ignition Module

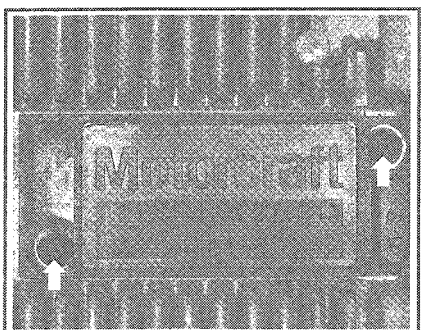
REMOVAL & INSTALLATION

See Figures 31, 32 and 33

1. Disconnect the negative battery cable.
2. Remove the module retaining screws and remove the module from the fender.

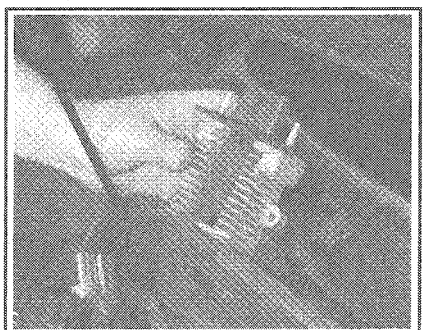
93142P21

Fig. 31 Detach the electrical connectors at the module by pushing in on the connector finger ends while grasping the connector body and pulling away from the module



93142P20

Fig. 32 Remove the module retaining screws and . . .



93144P03

Fig. 33 . . . remove the module from the fender

3. Detach the electrical connector at the module by pushing in on the connector finger ends while grasping the connector body and pulling away from the module.

To install:

4. Attach the electrical connector to the module by pushing until the connector fingers are locked over the locking wedge feature on the module.

5. Install the module and the retaining screws. Tighten the screws to 24–35 inch lbs. (3–4 Nm).

➨Locking the connector is important to ensure sealing of the connector/module interface.

6. Connect the negative battery cable.

Crankshaft and Camshaft Position Sensors

For procedures on the position sensors, please refer to Section 4 in this manual.

FIRING ORDERS

◗ See Figures 34, 35 and 36

➨To avoid confusion, remove, and tag the spark plug wires one at a time, for replacement.

If a distributor is not keyed for installation with only one orientation, it could have been removed previously and rewired. The resultant wiring would hold the correct firing order, but could change the relative placement of the plug towers in relation to the engine. For this reason, it is imperative that you label all wires before disconnecting any of them. Also, before removal, compare the current wiring with the accompanying illustrations. If the current wiring does not match, make notes in your book to reflect how your engine is wired.

On the 3.8L and 5.0L engine's ignition system, the distributor is driven off the camshaft and uses no centrifugal or vacuum advance. The distributor operates by using a Hall effect vane switch assembly, causing the ignition coil to be switched on and off by the EEC-IV and TFI-IV modules.

The 4.6L Engine uses no distributor. The ignition system is the EDIS system, which consists of a crankshaft sensor, ignition module ignition coil pack, the spark angle portion of the Powertrain control Module (PCM),and the related wiring. The EDIS eliminates the need for a distributor by using multiple ignition coils.

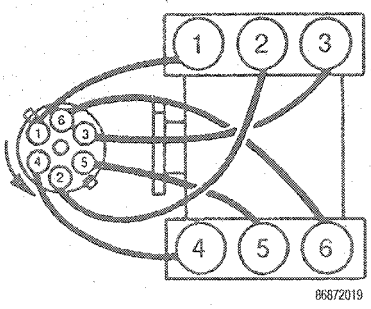


Fig. 34 3.8L Engine
Firing Order 1-4-2-5-3-6
Distributor rotation: Counterclockwise

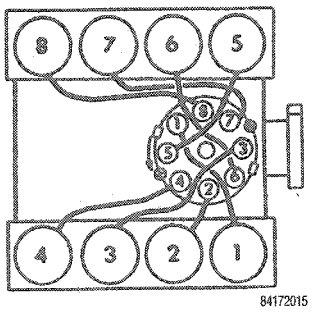


Fig. 35 5.0L Engine
Firing Order1-5-4-2-3-6-7-8
Distributor rotation: Counterclockwise

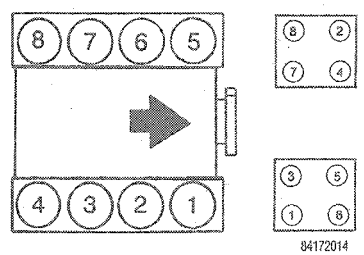


Fig. 36 4.6L Engine
Engine Firing Order 1-3-7-2-6-5-4-8
Distributorless ignition system

CHARGING SYSTEM

Alternator Precautions

Several precautions must be observed when performing work on alternator equipment.

- If the battery is removed for any reason, make sure that it is reconnected with the correct polarity. Reversing the battery connections may result in damage to the one-way rectifiers.
- Never operate the alternator with the main circuit broken. Make sure that the battery, alternator, and regulator leads are not disconnected while the engine is running.
- Never attempt to polarize an alternator.
- When charging a battery that is installed in the vehicle, disconnect the negative battery cable.
- When utilizing a booster battery as a starting aid, always connect it in parallel; negative to negative, and positive to positive.
- When arc (electric) welding is to be performed on any part of the vehicle, disconnect the negative battery cable and alternator leads.
- Never unplug the PCM while the engine is running or with the ignition in the **ON** position. Severe and expensive damage may result within the solid state equipment.

Alternator

TESTING

Voltage Test

1. Make sure the engine is **OFF**, and turn the headlights on for 15–20 seconds to remove any surface charge from the battery.
2. Using a DVOM set to volts DC, probe across the battery terminals.
3. Measure the battery voltage.
4. Write down the voltage reading and proceed to the next test.

No-Load Test

1. Connect a tachometer to the engine.

⚠ CAUTION

Ensure that the transmission is in PARK and the emergency brake is set. Blocking a wheel is optional and an added safety measure.

2. Turn off all electrical loads (radio, blower motor, wipers, etc.)
3. Start the engine and increase engine speed to approximately 1500 rpm.
4. Measure the voltage reading at the battery with the engine holding a steady 1500 rpm. Voltage should have raised at least 0.5 volts, but no more than 2.5 volts.
5. If the voltage does not go up more than 0.5 volts, the alternator is not charging. If the voltage goes up more than 2.5 volts, the alternator is overcharging.

➨Usually under and overcharging is caused by a defective alternator, or its related parts (regulator), and replacement will fix the problem; however, faulty wiring and other problems can cause the charging system to malfunction. Further testing, which is not covered by this book, will reveal the exact component failure. Many automotive parts stores have alternator bench testers available for use by customers. An alternator bench test is the most definitive way to determine the condition of your alternator.

6. If the voltage is within specifications, proceed to the next test.

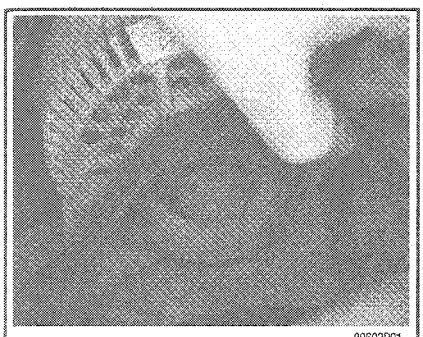

89602P01

Fig. 37 Rotate the tensioner and remove the belt from around the alternator pulley

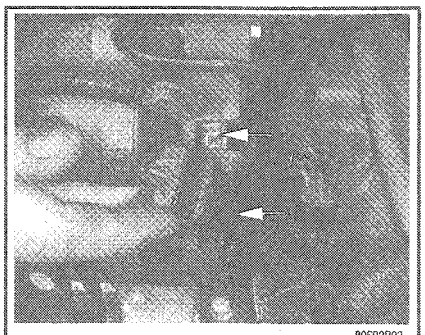

89602P02

Fig. 38 Detach the 2 connectors from the alternator

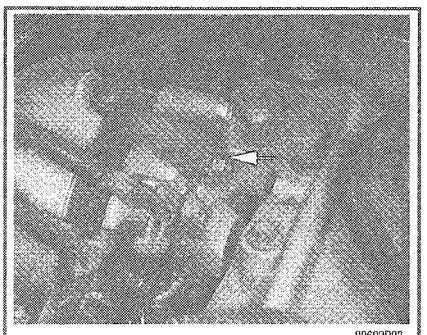

89602P03

Fig. 39 Slide the boot up to access the battery cable on the rear of the alternator

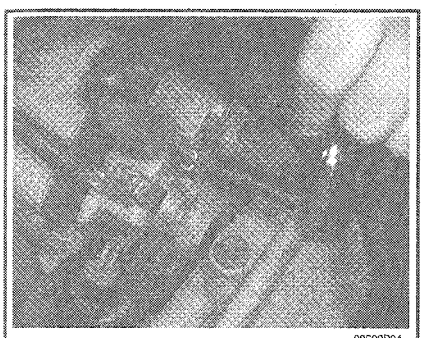

89602P04

Fig. 40 Remove the nut retaining the battery cable and . . .

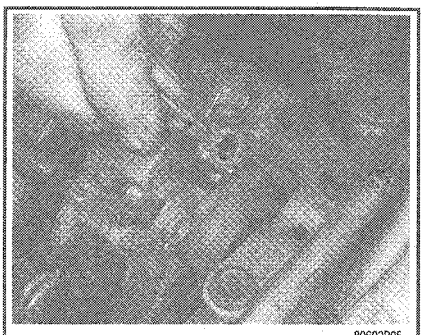

89602P05

Fig. 41 . . . remove the battery cable from the post on the rear of the alternator

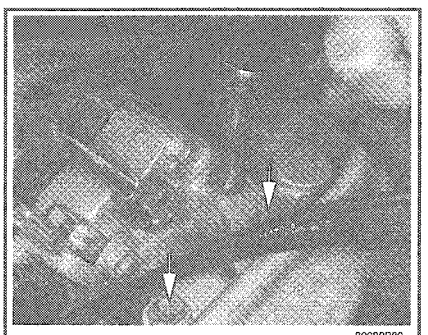

89602P06

Fig. 42 Remove the three alternator rear mounting bolts

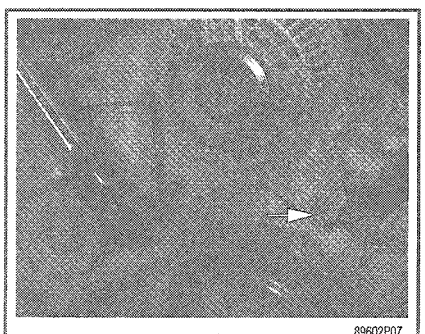

89602P07

Fig. 43 Remove the two front alternator mounting bolts

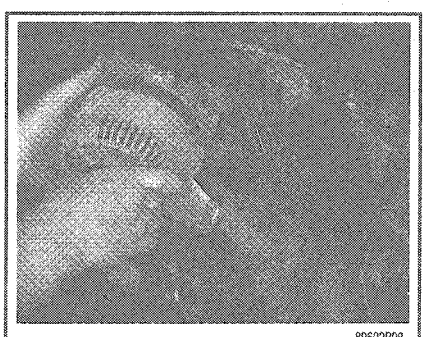

89602P08

Fig. 44 Remove the alternator from the engine by carefully lifting it up and out of the engine compartment

Load Test

1. With the engine running, turn on the blower motor and the high beams (or other electrical accessories to place a load on the charging system).
2. Increase and hold engine speed to 2000 rpm.
3. Measure the voltage reading at the battery.
4. The voltage should increase at least 0.5 volts from the voltage test. If the voltage does not meet specifications, the charging system is malfunctioning.

➡Usually under and overcharging is caused by a defective alternator, or its related parts (regulator), and replacement will fix the problem; however, faulty wiring and other problems can cause the charging system to malfunction. Further testing, which is not covered by this book, will reveal the exact component failure. Many automotive parts stores have alternator bench testers available for use by customers. An alternator bench test is the most definitive way to determine the condition of your alternator.

REMOVAL & INSTALLATION

◗ See Figures 37 thru 44

1. Disconnect the negative battery cable.
2. Tag and disconnect the wiring connectors from the rear (or side) of the alternator. To disconnect push-on type terminals, depress the lock tab and pull straight off.
3. On 3.8L and 4.6L engines, rotate the automatic tensioner away from the drive belt and disengage the drive belt from the alternator pulley. Remove the alternator brace.
4. On 3.8L engines, remove the alternator pivot bolts, top and bottom and remove the alternator.
5. On 5.0L engines, loosen the alternator pivot bolt and remove the adjusting bolt. Disengage the drive belt from the alternator pulley.
6. On 3.8L and 5.0L engines, remove the alternator pivot bolt and the alternator. On 4.6L engines, remove the alternator mounting bolts and remove the alternator.
7. Installation is the reverse of the removal procedure. On 4.6L engines, tighten the alternator mounting bolts to 15–22 ft. lbs. (20–30 Nm) and the alternator brace bolts to 70–106 inch lbs. (8–12 Nm). In addition, on 5.0L engines, adjust the drive belt tension (refer to Section 1).

Regulator

REMOVAL & INSTALLATION

External Regulator Only

1. Disconnect the negative battery cable.
2. Disconnect the regulator from the wiring harness.
3. Remove the regulator retaining screws and the regulator.
4. Installation is the reverse of the removal procedure.

STARTING SYSTEM

Starter

TESTING

Voltage Drop Test

➨The battery must be in good condition and fully charged prior to performing this test.

1. Disable the ignition system by unplugging the coil pack. Verify that the vehicle will not start.
2. Connect a voltmeter between the positive terminal of the battery and the starter **B+** circuit.
3. Turn the ignition key to the **START** position and note the voltage on the meter.
4. If voltage reads 0.5 volts or more, there is high resistance in the starter cables or the cable ground, repair as necessary. If the voltage reading is ok proceed to the next step.
5. Connect a voltmeter between the positive terminal of the battery and the starter **M** circuit.
6. Turn the ignition key to the **START** position and note the voltage on the meter.
7. If voltage reads 0.5 volts or more, there is high resistance in the starter. Repair or replace the starter as necessary.

➨Many automotive parts stores have starter bench testers available for use by customers. A starter bench test is the most definitive way to determine the condition of your starter.

REMOVAL & INSTALLATION

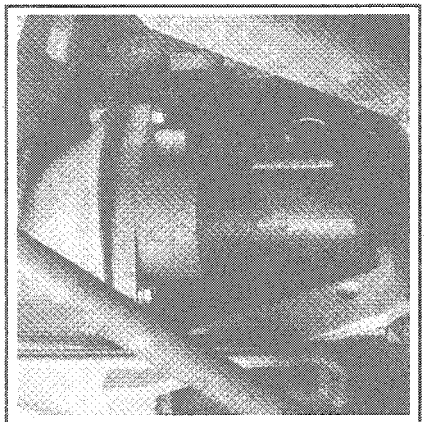
◗ See Figure 45

1. Disconnect the negative battery cable.
2. Raise the vehicle and support it safely.
3. Disconnect the starter cable from the starter. If equipped with starter mounted solenoid, disconnect the push-on connector from the solenoid.

➨To disconnect the hard-shell connector from the solenoid S terminal, grasp the plastic shell and pull off; do not pull on the wire. Pull straight off to prevent damage to the connector and S terminal.

4. Remove the starter bolts and the starter.

➨Some 3.8L applications have a starter-mounting stud that is used for engine ground.



84173025

Fig. 45 View of the starter motor—4.6L engine

Ensure this connection is tight when replacing a starter.

To install:

5. Position the starter to the engine and tighten the mounting bolts to 15–20 ft. lbs. (20–27 Nm).
6. Reconnect the electrical leads. Connect the negative battery cable.

SOLENOID/RELAY REPLACEMENT

Starter Mounted Solenoid

1. Disconnect the negative battery cable.
2. Remove the starter.
3. Remove the positive brush connector from the solenoid M terminal.
4. Remove the solenoid retaining screws and remove the solenoid.
5. Attach the solenoid plunger rod to the slot in the lever and tighten the solenoid retaining screws to 45–54 inch lbs. (5–6 Nm).
6. Attach the positive brush connector to the solenoid M terminal and tighten the retaining nut to 80–120 inch lbs. (9–14 Nm).
7. Install the starter and connect the negative battery terminal.

Relay

1. Disconnect the negative battery cable.
2. Label and disconnect the wires from the relay.
3. Remove the relay retaining bolts and remove the relay.
4. Installation is the reverse of the removal procedure.

SENDING UNITS AND SENSORS

This section describes the operating principles of sending units, warning lights and gauges. Sensors, which provide information to the Powertrain Control Module (PCM), are covered in Section 4 of this manual.

Sending Units and Sensors

Instrument panels contain a number of indicating devices (gauges and warning lights). These devices are composed of two separate components. One is the sending unit, mounted on the engine or other remote part of the vehicle, and the other is the actual gauge or light in the instrument panel.

Several types of sending units exist, however most can be characterized as being either a pressure type or a resistance type. Pressure type sending units convert liquid pressure into an electrical signal that is sent to the gauge. Resistance type sending units are most often used to measure temperature and use variable resistance to control the current flow back to the indicating device. Both types of sending units are connected in series by a wire to the battery (through the ignition switch). When the ignition is turned **ON**, current flows from the battery through the indicating device and on to the sending unit.

Coolant Temperature Sensor

TESTING

⁂ CAUTION

Never open, service, or drain the radiator or cooling system when hot; serious burns can occur from the steam and hot coolant. In addition, when draining engine coolant, keep in mind that cats and dogs are attracted to ethylene glycol antifreeze and could drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantities. Always drain coolant into a sealable container. Coolant should be reused unless it is contaminated or is several years old.

The sending unit is located in a water jacket or coolant passage near the thermostat.

1. Check the appropriate fuse before attempting any other diagnostics.
2. Make sure the cooling system is full and free of any trapped air.
3. Tape a mechanic's thermometer to the radiator return hose (upper hose) securely.
4. Disconnect the sending unit electrical harness.
5. Using an ohmmeter, check the resistance between the sending unit terminals.
6. Resistance should be high (58K ohms) with engine coolant cold 50°F (10°C) and low (2.8K ohms) with engine coolant hot 194°F (90°C).

➨It is best to check resistance with the engine cool, then start the engine, and watch the resistance change as the engine warms.

7. If resistance does not drop as engine temperature rises, the sending unit is faulty.

REMOVAL & INSTALLATION

◗ See Figure 46

1. Disconnect the negative battery cable.
2. Drain the cooling system into a suitable container.
3. Disconnect the electrical connector at the temperature sender/switch.
4. Remove the temperature sender/switch.

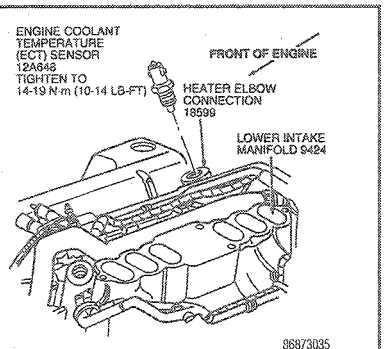


Fig. 46 Location of engine coolant temperature sensor—3.8L engine

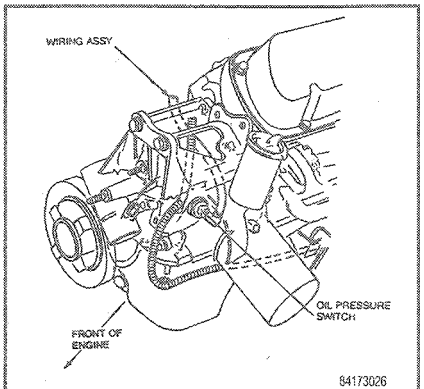


Fig. 47 Oil pressure switch—5.0L

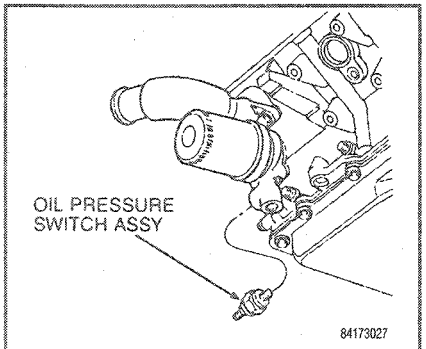


Fig. 48 Oil pressure switch—4.6L engine

To install:

5. Apply pipe sealant or Teflon® tape to the threads of the new sender/switch.
6. Install the temperature sender/switch and connect the electrical connector.
7. Connect the negative battery cable. Fill the cooling system.
8. Run the engine and check for leaks.

Oil Pressure Sender/Switch

TESTING

1. Test and verify the engine oil pressure. See Section 3 for more information. If no or insufficient pressure exists, oil pressure problem exists and gauge and sensor are operational, repair oil pressure problem.
2. Check the appropriate fuse before attempting any other diagnostics.
3. Unplug the sensor electrical harness.
4. Using an ohmmeter, check continuity between the sensor terminals.
5. With the engine stopped, continuity should not exist.

➨The switch inside the oil pressure sensor opens at 6 psi or less of pressure.

6. With the engine running, continuity should exist.
7. If continuity does not exist as stated, the sensor is faulty.

REMOVAL & INSTALLATION

◗ See Figures 47 and 48

⁂ WARNING

The pressure switch used with the oil pressure warning light is not interchangeable with the sending unit used with the oil pressure gauge. If the incorrect part is installed the oil pressure indicating system will be inoperative and the sending unit or gauge will be damaged.

1. Disconnect the negative battery cable.
2. Disconnect the electrical connector and remove the oil pressure sender/switch.

To install:

3. Apply pipe sealant to the threads of the new sender/switch.
4. Install the oil pressure sender/switch and tighten to 9–11 ft. lbs. (12–16 Nm).
5. Connect the electrical connector to the sender/switch and connect the negative battery cable.
6. Run the engine and check for leaks and proper operation.

Low Oil Level Sensor

TESTING

With the oil at the FULL mark on the dipstick and the engine oil warm to ensure that the oil drains properly from the oil sensor, turn the ignition switch to the **RUN** position and start the engine. The warning indicator should come on briefly in **START** for a bulb prove-out, then go out. Turn the engine off. Drain 2 qts. of oil from the engine. Wait for five minutes, the restart the engine. The warning indicator should come on and stay on.

Sensor Test

Connect the positive lead of a DVOM to the sensor terminal and the negative lead to the sensor housing. With the sensor submerged in oil (engine full), the meter should read "open." Resistance should be greater than 100,000 ohms. With the sensor out of oil (oil drained), the resistance should be less then 1000ohms.

➨ The sensor must be horizontal when this test is conducted.

REMOVAL & INSTALLATION

◗ See Figure 49

➨It is possible for the low oil level warning light to come on in a 1995-96 Continental built through 4/15/96 when it is started while parked on an incline. Ford says this is caused by too-sensitive instrument cluster software and/or the location of the oil level sensor in the oil pan. The fix is to install either a revised instrument cluster or a revised oil pan with the sensor mounted in a different spot.

1. Here is the procedure; first obviously, make sure the oil level is okay. Then, if the light comes on only after the engine is shut off and restarted within two minutes, do this:
2. Verify the EEPROM (Electrically Erasable Programmable Read Only Memory)level of the cluster by cycling the key to **OFF** and depressing the DTE/ECON and TRIP buttons simultaneously. Hold them while turning the key to **ON**,then immediately release the buttons. Hit the Menu button until "EEPROM" is displayed. If the EEPROM level is 3 or less, replace the instrument cluster. If it is 4 or more, and the warning light comes on only when the engine is started on an incline, install the revised oil pan. (the level 4 and higher software allows 11 minutes for the oil to drain back to the pan before sensing for a low oil level.)

Note that the revised oil pan has the oil level sensor mounted 4mm lower than the original design and therefore is less susceptible to indicate a low oil level when parked on an incline.

3. Disconnect the negative battery cable.
4. Raise and safely support the vehicle.
5. Drain at least 2 quarts of oil from the engine into a suitable container.
6. Disconnect the electrical connector from the sensor.
7. Remove the sensor using a 1 in. socket or wrench.

To install:

8. Install the sensor and tighten to 15–25 ft. lbs. (20–34 Nm).
9. Connect the electrical connector.
10. Tighten the oil pan drain plug to 8–12 ft. lbs. (11–16 Nm) on 4.6L engines or 15–25 ft. lbs. (20–34 Nm) on 5.0L engines.
11. Lower the vehicle.
12. Add oil to the proper level.
13. Connect the negative battery cable, start the engine and check for leaks.

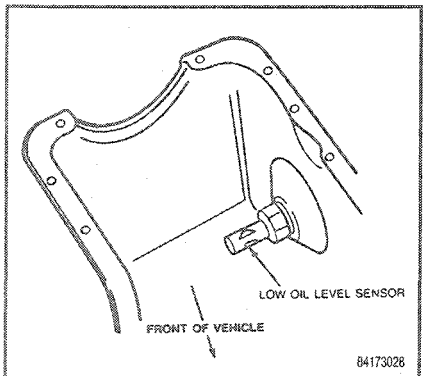


Fig. 49 Low oil level sensor—4.6L engine

Electric Fan Switch

TESTING

3.8L Engines

Checking cooling fan operation with an integrated controller.

1. Make sure the ignition key is turned off. Disconnect the integrated controller.
2. Jump pin 3 to pin 2 at the integrated controller harness connector. Does fan run?
3. If yes—Key off, disconnect the PCM, reconnect the integrated controller, turn the key on/engine off.
4. Does the fan run at a slow speed? If no—replace the integrated controller. Reconnect the PCM and re-evaluate the symptoms.
5. If no—Key off, disconnect the cooling fan connector. Disconnect the integrated controller. Jump pin 3 to pin 6 at the integrated controller vehicle harness connector
6. Using a DVOM (digital volt/ohm meter), set to the 20 volt scale, and measure the voltage at the cooling fan vehicle harness. Is the voltage is greater than 8 volts?
7. If yes—replace the fan motor, reconnect the integrated controller and re-evaluate symptom.
8. If no—Key off. Disconnect the cooling fan and the iniegrated controller. Jump pin 3 to pin 6 at the integrated controller vehicle harness connector. With a DVOM on a 20 volt scale, measure the voltage at the cooling fan harness connector, positive side and the battery negative post. Is the voltage is greater than 8 volts?
9. If yes—Service the open in the ground circuit to the fan. Reconnect all the components, and re-evaluate the symptoms.
10. If no—Service the open in the power-to-fan circuit from Pin 6 and Pin 7 of the integrated controller harness connector the cooling fan harness connector. Reconnect all the components, and re-evaluate the symptoms.

4.6L Engines

The Variable Control Relay Module (VCRM) controls

- The cooling fan motor operation and speed.
- The A/C clutch operation /.
- Other non-A/C functions.
- It also increases and decreases the cooling fan motor speed as necessary, depending on the refrigerant system high-side pressure.
- Turns off the A/C clutch circuit OFF if the high-side pressure exceeds 425psi

1. To begin testing, perform the PCM Quick test.
2. Service any codes.
3. Check for a binding/seized-cooling fan.
4. Connect Scan tool
5. Turn the Key-on Engine off (KOEO)
6. Access the output test mode on the Scan tool
7. Command the cooling fan **ON** and check for fan operation —For two speed fan applications check both fan speeds (wait 30 seconds after commanding high speed fan on).
8. Does the fan operate?
9. If no?
10. Command the cooling fan **OFF**; and disconnect the cooling fan.
11. Command the cooling fan **ON**; and measure the voltage between the power-to- fan circuit at the cooling fan vehicle harness connector and chassis ground.
12. Is voltage greater than 10.00 volts?
13. Turn the key **OFF**.
14. If voltage supply is greater than 10.00 volts (source voltage) than power is being supplied to the fan.
15. Disconnect the scan tool from the Data Link Connector (DLC).
16. Measure the resistance between the ground circuit at the cooling fan vehicle harness connector and the chassis ground.
17. If resistance is less than 5 ohms, replace the fan motor.
18. If not, service the open ground circuit; reconnect all components, verify the systems operation.

REMOVAL & INSTALLATION

3.8L Engines

1. Remove the radiator upper sight shield.
2. Disconnect the engine control sensor wiring from the CCRM electrical connector
3. Remove the retaining bolts and constant control relay module (CCRM) from its mount on the radiator support.
4. Installation is the reversal of the removal procedure.

4.6L Engines

1. Remove the radiator upper sight shield.
2. Disconnect the electrical connector .
3. Remove the variable control relay module (VCRM) retainer bracket nuts, located on the radiator support and remove the VCRM
4. To install the VCRM, reverse the removal procedures. Tighten the VCRM bracket retainer nuts to 36 in. lbs. (4 Nm).