Chapter 5
Engine electrical systems

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Specifications

General

Firing order	
Four-cylinder engine	1-3-4-2
V6 engine	1-4-2-5-3-6
Cylinder numbering (from drivebelt end to transaxle end)	
Four-cylinder engine	1-2-3-4
V6 engine	
Rear bank	1-2-3
Front bank	4-5-6
Ignition timing	Not adjustable

1 General information, precautions and battery disconnection

The engine electrical systems include all ignition, charging and starting components. Because of their engine-related functions, these components are discussed separately from chassis electrical devices such as the lights, the instruments, etc. (which are included in Chapter 12).

Precautions

Always observe the following precautions when working on the electrical system:

a) *Be extremely careful when servicing engine electrical components. They are easily damaged if checked, connected or handled improperly.*
b) *Never leave the ignition switched on for long periods of time when the engine is not running.*
c) *Never disconnect the battery cables while the engine is running.*
d) *Maintain correct polarity when connecting battery cables from another vehicle during jump starting - see the* "Booster battery (jump) starting" *Section at the front of this manual.*
e) *Always disconnect the negative cable from the battery before working on the electrical system, but read the following battery disconnection procedure first.*

It's also a good idea to review the safety-related information regarding the engine electrical systems located in the *"Safety first!"* Section at the front of this manual, before beginning any operation included in this Chapter.

Battery disconnection

The battery is located in the engine compartment on all vehicles covered by this manual. To disconnect the battery for service procedures that require battery disconnection, simply disconnect the cable from the *negative* battery terminal. Make sure that you isolate the cable to prevent it from coming into contact with the battery negative terminal.

Some vehicle systems (radio, alarm system, power door locks, windows, etc.) require battery power all the time, either to enable their operation or to maintain control unit memory (Powertrain Control Module, automatic transaxle control module, etc.), which would be lost if the battery were to be disconnected. So before you disconnect the battery, note the following points:

a) *Before connecting or disconnecting the cable from the negative battery terminal, make sure that you turn the ignition key and the lighting switch to their OFF positions. Failure to do so could damage semiconductor components.*
b) *On a vehicle with power door locks, it is a wise precaution to remove the key from the ignition and to keep it with you, so that it does not get locked inside if the power door locks should engage accidentally when the battery is reconnected!*
c) *After the battery has been disconnected, then reconnected (or a new battery has been installed) on vehicles with an automatic transaxle, the Transaxle Control Module (TCM) will need some time to relearn its adaptive strategy. As a result, shifting might feel firmer than usual. This is a normal condition and will not adversely affect the operation or service life of the transaxle. Eventually, the TCM will complete its adaptive learning process and the shift feel of the transaxle will return to normal.*
d) *The engine management system's PCM will lose some of the information stored in its "map" (program) when the battery is disconnected. Whenever the battery has been disconnected, the Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy before the vehicle returns to its optimal driveability and performance. To initiate this process, refer to "Relearning the idle and fuel trim strategy after battery disconnection" below.*

Memory savers

Devices known as "memory savers" (typically, small 9-volt batteries) can be used to avoid some of the above problems. A memory saver is usually plugged into the cigarette lighter, and then you can disconnect the vehicle battery from the electrical system. The memory saver will deliver sufficient current to maintain security alarm codes and - maybe, but don't count on it! - PCM memory. It will also run "unswitched" (always on) circuits such as the clock and radio memory, while isolating the car battery in the event that a short circuit occurs while the vehicle is being serviced.

Warning: *If you're going to work around any airbag system components, disconnect the battery and do not use a memory saver. If you do, the airbag could accidentally deploy and cause personal injury.*

Caution: *Because memory savers deliver current to operate unswitched circuits when the battery is disconnected, make sure that the circuit that you're going to service is actually open before working on it!*

Relearning the idle and fuel trim strategy after battery disconnection

Caution: *Failure to perform the following procedure after battery reconnection could adversely affect the idle quality of the engine until it eventually relearns its idle trim.*

1 With the vehicle stationary, apply the parking brake.
2 Put the shift lever in PARK, turn off all accessories and then start the engine.
3 Allow the engine to warm up to its normal operating temperature.
4 Allow the engine to idle for at least one minute.
5 Turn on the air conditioning system and allow the engine to idle for at least another minute.
6 Drive the vehicle at least 10 miles.
7 The vehicle should now have relearned its idle and fuel trim strategy.

2 Battery - emergency jump starting

Refer to the *Booster battery (jump) starting* procedure at the front of this manual.

3 Battery - check, removal and installation

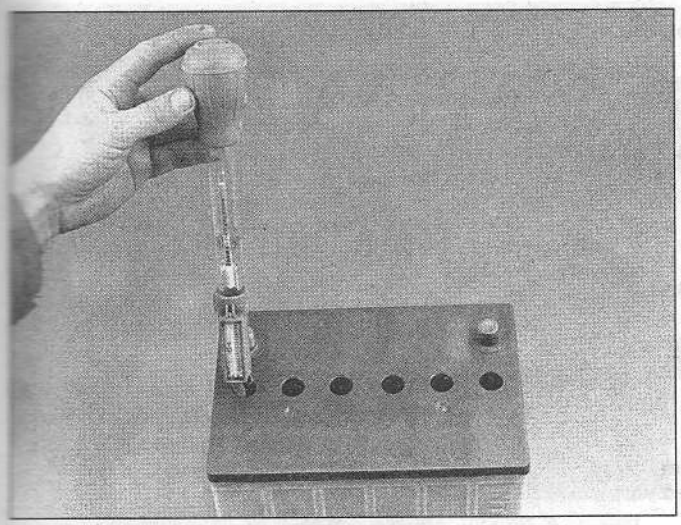
Warning: *Hydrogen gas is produced by the battery, so keep open flames and lighted cigarettes away from it at all times. Always wear eye protection when working around a battery. Rinse off spilled electrolyte immediately with large amounts of water.*

Check

Refer to illustrations 3.1a, 3.1b and 3.1c

1 A battery cannot be accurately tested until it is at or near a fully charged state. Disconnect the negative battery cable from the battery and perform the following tests:

a) ***Battery state of charge test*** *- Visually inspect the indicator eye (if equipped) on the top of the battery. If the indicator eye is dark in color, charge the battery as described in Chapter 1. If the battery is equipped with removable caps, check the battery electrolyte. The electrolyte level should be above the upper edge of the plates. If the level is low, add distilled water. DO NOT OVERFILL. The excess electrolyte may spill over during periods of heavy charging. Test the specific gravity of the electrolyte using a hydrometer* **(see illustration)**. *Remove the caps and extract a sample of the electrolyte and observe the float inside the barrel of the hydrometer. Follow the instructions from the tool manufacturer and determine the specific gravity of the electrolyte for each cell. A fully charged battery will indicate approximately 1.270 (green zone) at 68-degrees F (20-degrees C). If the specific gravity of the electrolyte is low (red zone), charge the battery as described in Chapter 1.*
b) ***Open circuit voltage test*** *- Using a digital voltmeter, perform an open circuit voltage test* **(see illustration)**. *Connect the negative probe of the voltmeter to the negative battery post and the positive probe to the positive battery post. The battery voltage should be greater than 12.5 volts. If the battery is less than the specified voltage, charge the battery before proceeding to the next test. Do not proceed with the battery load test until the battery is fully charged.*



3.1a Use a battery hydrometer to draw electrolyte from the battery cell; this hydrometer is equipped with a thermometer to make temperature corrections

3.1b To test the open-circuit voltage of the battery, connect the black probe of a voltmeter to the negative terminal and the red probe to the positive terminal of the battery; if the battery is fully charged, the voltmeter should indicate about 12.5 volts (depending on the outside air temperature)

c) ***Battery load test*** *- An accurate check of the battery condition can only be performed with a load tester (available at most auto parts stores). This test evaluates the ability of the battery to operate the starter and other accessories during periods of heavy amperage draw (load). Install a special battery load-testing tool onto the battery terminals* **(see illustration)**. *Load test the battery according to the tool manufacturer's instructions. This tool utilizes a carbon pile to increase the load demand (amperage draw) on the battery. Maintain the load on the battery for 15 seconds and observe that the battery voltage does not drop below 9.6 volts. If the battery condition is weak or defective, the tool will indicate this condition immediately.* **Note:** *Cold temperatures will cause the minimum voltage requirements to drop slightly. Follow the chart given in the tool manufacturer's instructions to compensate for cold climates. Minimum load voltage for freezing temperatures (32 degrees F/0-degrees C) should be approximately 9.1 volts.*

d) ***Battery drain test*** *- This test will indicate whether there's a constant drain on the vehicle's electrical system that can cause the battery to discharge. Make sure all accessories are turned Off. If the vehicle has an underhood light, verify it's working properly, then disconnect it. Connect one lead of a digital ammeter to the disconnected negative battery cable clamp and the other lead to the negative battery post. A drain of approximately 100 milliamps or less is considered normal (due to the engine control computers, clocks, digital radios and other components that normally cause a key-off battery drain). An excessive drain (approximately 500 milliamps or more) will cause the battery to discharge. The problem circuit or component can be located by removing the fuses, one at a time, until the excessive drain stops and normal drain is indicated on the meter.*

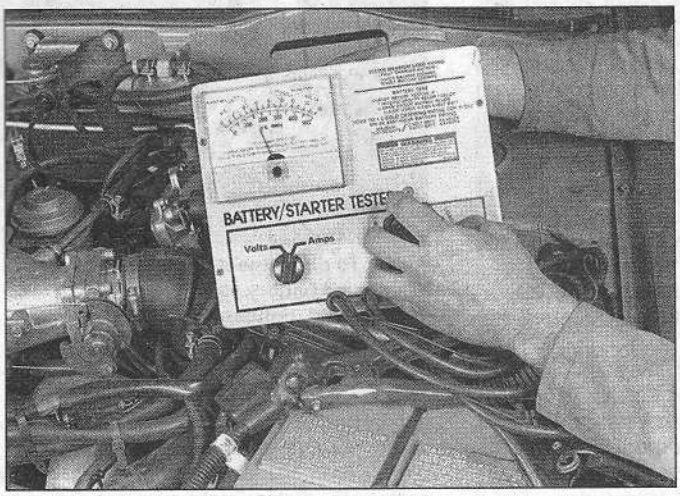
Replacement

Refer to illustrations 3.2 and 3.5

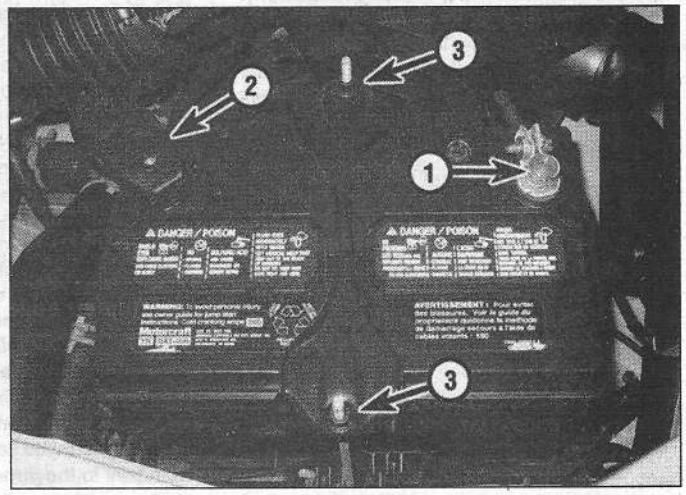
2 Remove the protective cover from the positive battery terminal. Then disconnect both cables from the battery terminals **(see illustration)**. **Warning:** *Always disconnect the negative cable first and connect it last, or you might accidentally short the battery with the tool you're using to loosen the cable clamps.*

3 Remove the hold-down nuts and the hold-down bracket **(see illustration 3.2)**.

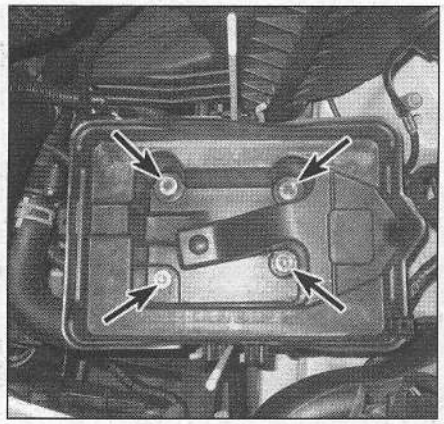
4 Lift out the battery. Use a battery lifting strap that attaches to the battery posts to lift the battery safely and easily.



3.1c Some battery load testers are equipped with an ammeter, which enables you to impose a precise load on the battery (less expensive testers have only a load switch and a voltmeter)



3.2 To remove the battery from the battery tray, disconnect the negative battery cable (1), then the positive cable (2); then remove the two hold-down nuts (3) and remove the hold-down bracket



3.5 To remove the battery tray, remove these four mounting bolts

5 If you need to access components located underneath the battery tray, remove the four bolts that secure the battery tray **(see illustration)** and remove the tray.

6 Installation is the reverse of removal. **Warning:** *When connecting the battery cables, always connect the positive cable first and the negative cable last to avoid a short circuit caused by the tool used to tighten the cable clamps.*

7 After you're done, the Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Section 1 for this procedure).

4 Battery cables - replacement

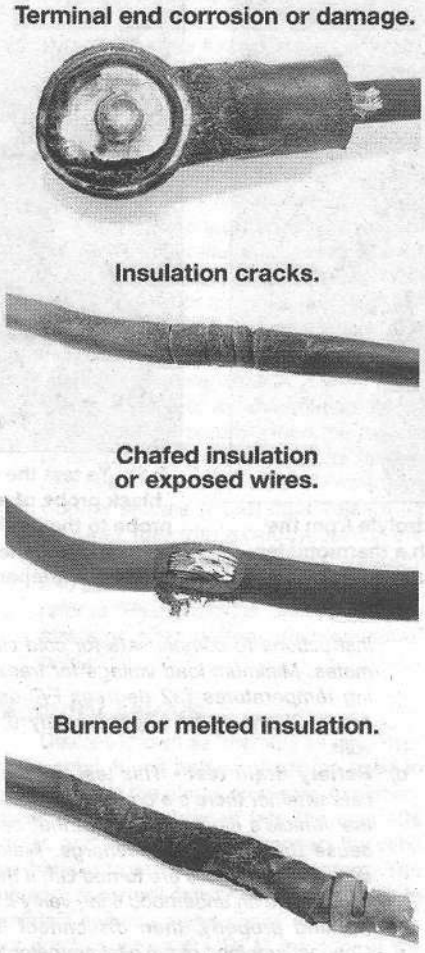
Refer to illustrations 4.2, 4.4a, 4.4b and 4.4c

1 Periodically inspect the entire length of each battery cable for damage, cracked or burned insulation and corrosion. Poor battery cable connections can cause starting problems and decreased engine performance.

2 Check the cable-to-terminal connections at the ends of the cables for cracks, loose wire strands and corrosion **(see illustration)**. The presence of white, fluffy deposits under the insulation at the cable terminal connection is a sign that the cable is corroded and should be replaced. Check the terminals for distortion, missing mounting bolts and corrosion (see Chapter 1 for further information regarding battery cable maintenance).

3 When removing the cables always disconnect the negative cable from the negative battery post first and hook it up last or the tool used to loosen the cable clamps may short the battery. Even if only the positive cable is being replaced, be sure to disconnect the negative cable from the negative battery post first.

4 Disconnect the old cables from the battery (see Section 3), then disconnect each of them at the other end. It might also be necessary to detach the cables from cable brackets or clips before they can be removed. Trace each cable from the battery all the way down to its opposite end and detach the cables from any cable brackets or clips as necessary **(see illustrations)**. If either cable is bundled together with other wiring harnesses, look for the other end of the cable where it comes out of the harness. The negative or ground cable is usually bolted to the engine or transaxle and the positive cable is connected to the starter motor solenoid. (If you're unable to trace the ground cable to its lower end, you might have to remove the protective sheath from the harness and separate the cable from the other wires.) Note the routing of both cables to ensure correct installation.

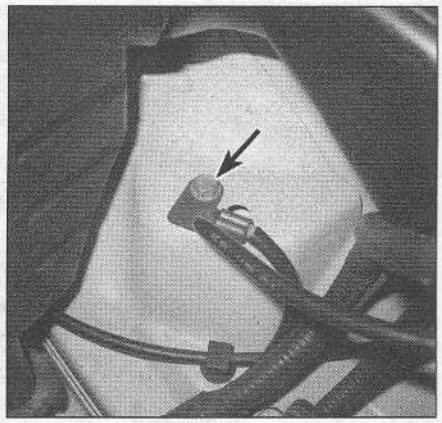


4.2 Typical battery cable problems

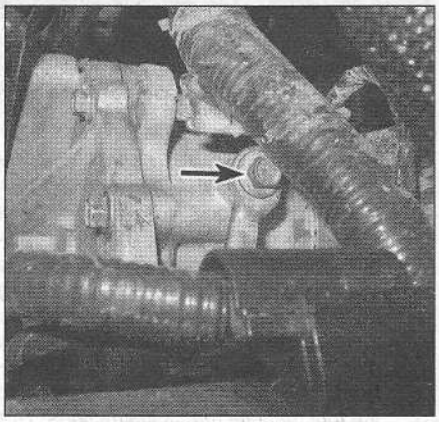
5 Positive cables are almost always red and larger in cross-section; ground cables are usually black and smaller in cross-section. But if you're replacing either or both of the cables, take them with you when buying new cables. It is vitally important that you replace the cables with the *identical* parts.

6 Clean the threads of the starter solenoid and/or ground connection with a wire brush to remove rust and corrosion. Apply a light coat of battery terminal corrosion inhibitor or petroleum jelly to the threads to prevent future corrosion.

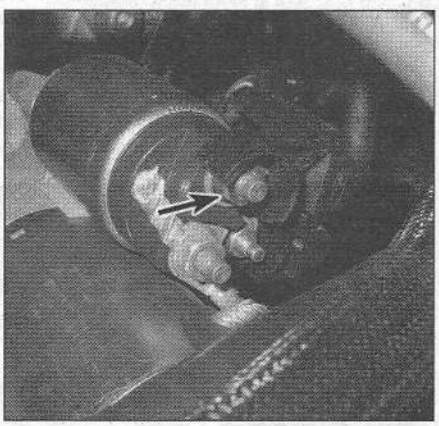
7 *Attach the lower ends of the cables first,* then connect the positive cable to the positive battery post (don't reconnect the ground cable to the negative battery post until you're completely finished). Before connecting a new cable to the battery, make sure that it reaches the battery post without having to be stretched.



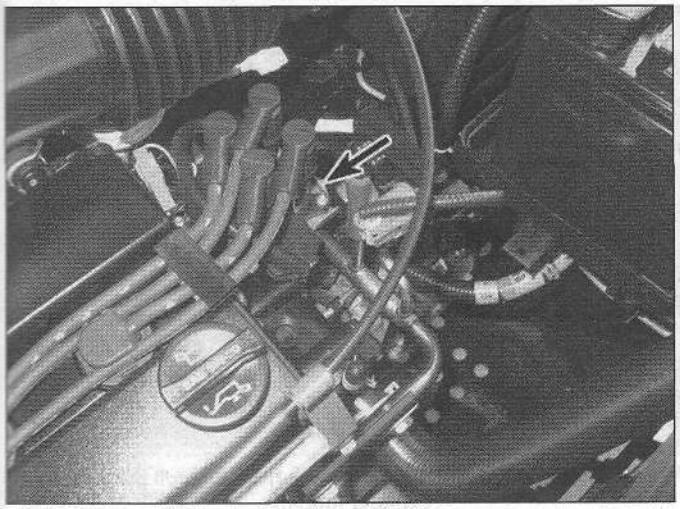
4.4a To detach the ground cable from the left fender, remove this bolt



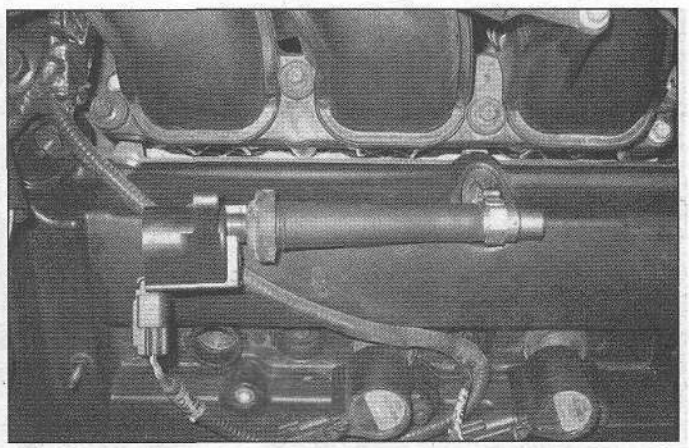
4.4b To detach the lower end of the ground cable from the transaxle, remove this bolt (V6 model shown, other models similar)



4.4c To disconnect the lower end of the positive battery cable from the starter solenoid, remove this nut (V6 model shown, other models similar)



5.2 The ignition coil pack on four-cylinder models is located at the left end of the valve cover



6.3 To use a spark tester, disconnect a spark plug wire (or on V6 models, as shown, an ignition coil), clip the tester to a convenient ground (like a valve cover bolt), and operate the starter. If enough voltage is present to fire the plug, sparks will be visible between the electrode tip and the tester body

8 If either cable is supposed to be secured to the engine compartment by any brackets or clips, make sure that you reattach them.

9 After both cables are completely installed, reconnect the ground cable to the negative battery post.

10 After you're done, the Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Section 1 for this procedure).

5 Ignition system - general information

Refer to illustration 5.2

The ignition system consists of the ignition coils, the Crankshaft Position (CKP) sensor, the Camshaft Position (CMP) sensor, the Powertrain Control Module (PCM), the spark plug wires and the spark plugs. None of the vehicles covered by this manual are equipped with a distributor nor do any of these vehicles use a separate ignition control module. "Coil drivers" inside the PCM handle the control module function based on data from the CKP and CMP sensors. (For more information on the CKP and CMP sensors, refer to Chapter 6.)

2.0L four-cylinder models employ a coil pack **(see illustration)** mounted at the left end of the valve cover, consisting of two ignition coils. Each coil supplies ignition voltage to two cylinders. The firing order of a four-cylinder engine is 1-3-4-2. The PCM fires one coil for each pair of cylinders (1 and 4, or 3 and 2) that are at Top Dead Center (TDC) at the same time. These cylinder pairs are known as "companion cylinders," or "running mates." Each time either coil fires, it sends ignition voltage to *both* of its paired cylinders. One cylinder is on its compression stroke, so that cylinder gets most of the voltage (because pressure, and therefore resistance, is higher in that cylinder). The other cylinder is on its exhaust stroke, so it gets very little of the voltage (because pressure, and therefore resistance, is low in that cylinder). In effect, the spark in the cylinder on its exhaust stroke is wasted. So this type of ignition system is known as a "waste spark" system.

Each waste-spark coil is in series with its two spark plugs. As the coil fires, secondary current creates a high-voltage spark across the gaps of both plugs. One plug fires with the traditional forward polarity of an ignition system: negative (–) to positive (+). The other plug fires with opposite polarity: positive (+) to negative (–). Thus, one plug always fires with what has always been called "reversed polarity." The voltage capacity of a the coil pack is high enough, however, to ensure that the available voltage is always high enough to fire the plug with reversed polarity when it is on the compression stroke.

2.3L four-cylinder and 3.0L V6 engines use an individual coil for each cylinder. There are no spark plug wires. Each coil is mounted directly above the plug that it fires, and is connected to the plug by a coiled high-tension lead housed inside a long rubber boot that protects it from the elements. When the engine is first cranked over, the PCM fires two cylinders at once, one on compression and one as a waste spark, just like the coil-pack on the four-cylinder engine. However, once the engine starts, cylinders are only fired one at a time, on their compression stroke.

Base ignition timing for all models is nominally 8 to 12 degrees Before Top Dead Center (BTDC), but it cannot be checked or adjusted.

6 Ignition system - check

Refer to illustration 6.3

Warning: *Because of the very high voltage generated by the ignition system (approximately 40,000 volts), use extreme care whenever performing an operation involving ignition components. This not only includes the coil and spark plug wires, but related items connected to the system as well, such as the electrical connectors, tachometer and any test equipment.*

Note: *The ignition system components on these models are difficult to diagnose. In the event of ignition system failure, if the checks do not clearly indicate the source of the ignition system problem, have the vehicle tested by a dealer service department or other qualified auto repair facility.*

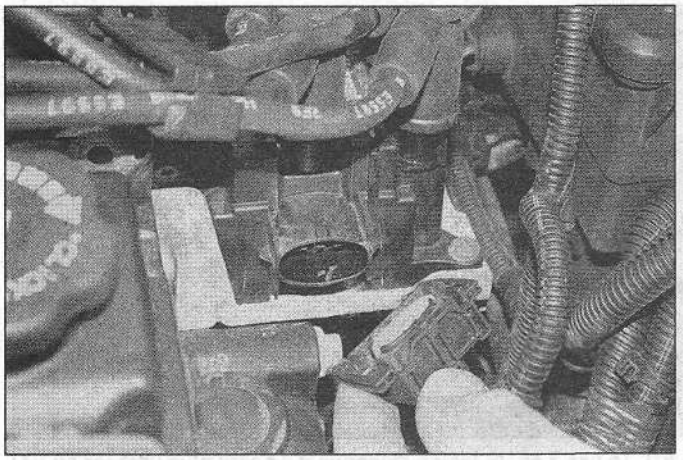
1 If a malfunction occurs and the vehicle won't start, do not immediately assume that the ignition system is causing the problem. First, check the following items:

a) *Make sure the battery cable clamps, where they connect to the battery, are clean and tight.*
b) *Test the condition of the battery* (see Section 3). *If it does not pass all the tests, replace it with a new battery.*
c) *Check the external ignition coil (if equipped) wiring and connections.*
d) *Check the related fuses inside the fuse box* (see Chapter 12). *If they're burned, determine the cause and repair the circuit.*

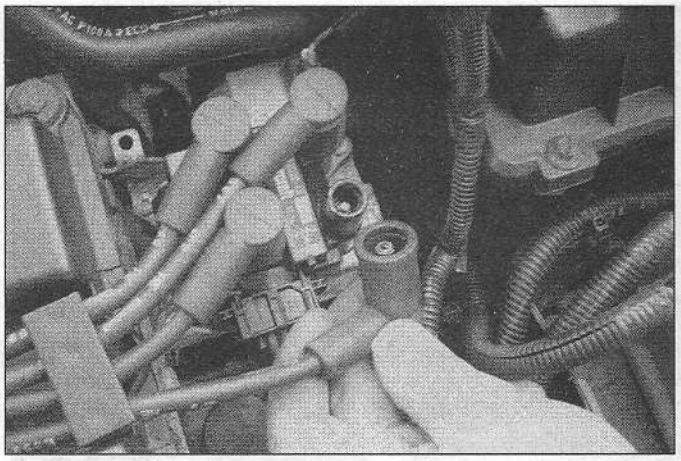
2 If the engine turns over but won't start, make sure there is sufficient secondary ignition voltage to fire the spark plug.

3 Disconnect the spark plug wire (four-cylinder models) or ignition coil (V6 models) from a spark plug and attach it to a calibrated ignition tester (available at most auto parts stores) **(see illustration)**. Connect the clip on the tester to a bolt or metal bracket on the engine.

Note: *On 2.0L four-cylinder models, each ignition coil fires two cylinders (*see Section 5 *for a complete description of this type of ignition system). Because the coil assembly actually fires two spark plugs simultaneously, you must check the spark at both high-tension terminals to test for sufficient secondary voltage. Testing at only one terminal will not conclusively tell you that one of these coils is operating correctly because there could be an open, or high*



7.2 Disconnect the electrical connector from the coil pack (four-cylinder models)



7.3 Disconnect the spark plug wires from the coil pack (four-cylinder models)

resistance, in the circuit between the winding and the high tension terminal that you didn't test. So be sure to test both terminals of each coil on these models.

4 Relieve the fuel pressure (see Chapter 4). Keep the fuel system disabled while performing the ignition system checks.

5 Crank the engine and watch the end of the tester to see if bright blue, well-defined sparks occur (weak spark or intermittent spark is the same as no spark).

6 If sparks occur, sufficient voltage is reaching the spark plug to fire it (repeat the check at the remaining spark plug wires or ignition coils to verify that all the ignition coils are functioning). However, the plugs themselves may be fouled, so remove and check them as described in Chapter 1 or install new ones.

7 If no sparks or intermittent sparks occur, check for battery voltage to the ignition coils (refer to the wiring diagrams at the end of Chapter 12). If battery voltage is present, the ignition coils are probably defective. Have the coils tested by a dealer service department.

8 Also, if no sparks or intermittent sparks occur, check the ignition wires to each spark plug (four-cylinder models) (see Chapter 1).

9 If the checks are all correct, the Camshaft Position (CMP) sensor or Crankshaft Position (CKP) sensor might be defective (see Chapter 6 for CMP and CKP sensor replacement procedures).

7 Ignition coils - replacement

2.0L four-cylinder engines

Refer to illustrations 7.2 and 7.3

1 Disconnect the cable from the negative battery terminal (see Section 1).

2 Disconnect the ignition coil pack electrical connector **(see illustration)**.

3 Disconnect all the spark plug wires from the ignition coil pack **(see illustration)**. Pull on the spark plug wire *boots*, not on the wires.

4 Remove the four bolts that secure the coil pack to its mounting bracket and remove the coil pack.

5 Installation is the reverse of the removal procedure with the following additions:

a) Before installing the spark plug wire connector into the ignition coil, coat the entire interior of the rubber boot with silicone dielectric compound.

b) Insert each spark plug wire into the proper terminal of the ignition coil. Push the wire into the terminal and make sure the boots are fully seated and both locking tabs are engaged properly.

*c) After you're done, the Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (*see Section 1 *for this procedure).*

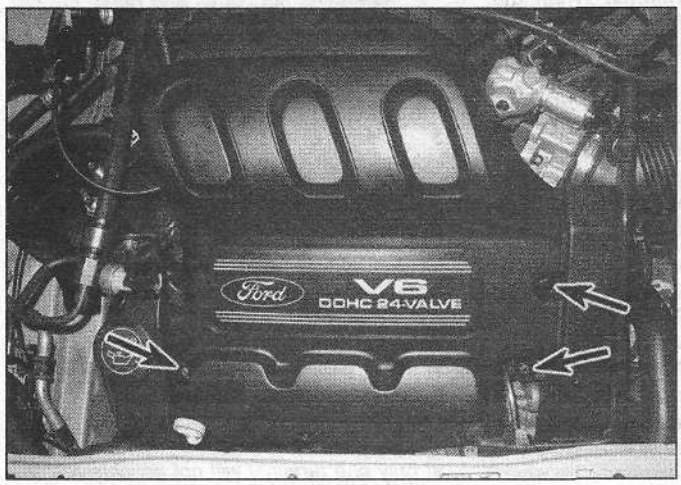
2.3L four-cylinder and 3.0L V6 engines

Refer to illustrations 7.7, 7.8, 7.9, 7.10 and 7.11

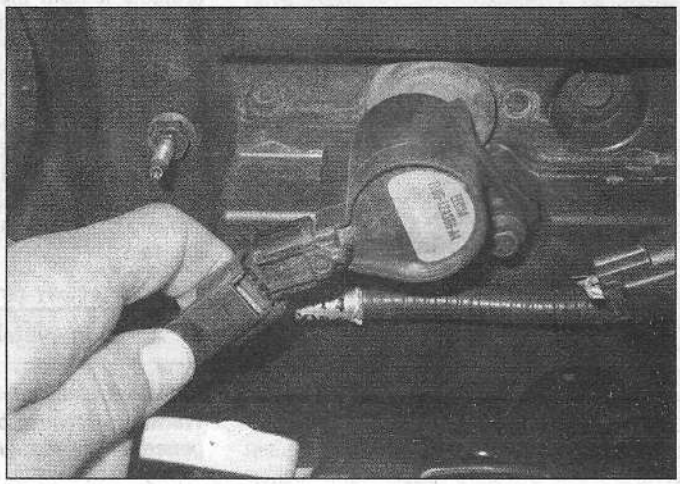
6 Disconnect the cable from the negative battery terminal (see Section 1).

7 Remove the engine cover **(see illustration)**. And, if you're going to remove an ignition coil from the rear valve cover, remove the upper intake manifold (see Chapter 2B).

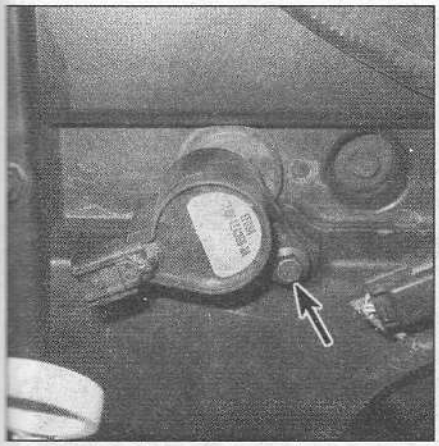
8 Disconnect the electrical connector from the ignition coil **(see illustration)**.



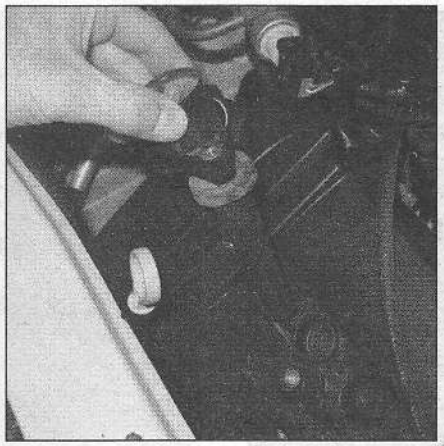
7.7 To detach the engine cover, remove these three nuts (V6 models)



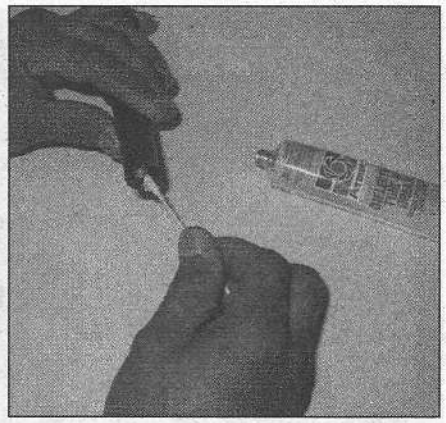
7.8 Disconnect the electrical connector from the ignition coil



7.9 To detach an ignition coil from the valve cover, remove this bolt



7.10 To remove an ignition coil from the valve cover, pull it straight up



7.11 Before pushing the spark plug boot back onto the spark plug, coat the inside of the boot with silicone dielectric compound

9 Remove the coil mounting bolt **(see illustration)**.

10 Remove the ignition coil **(see illustration)**.

11 Coat the inside of the spark plug boot with silicone dielectric compound **(see illustration)**.

12 Installation is otherwise the reverse of removal.

13 After you're done, the Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Section 1 for this procedure).

8 Charging system - general information and precautions

Refer to illustration 8.2

The charging system supplies electrical power for the ignition system, the lights, the radio, the electronic control systems and all other electrical components on the car. The charging system consists of the battery, the alternator (with an integral voltage regulator), a charge indicator or warning lamp on the instrument panel, a 120-amp main fuse (located in the engine compartment fuse and relay box) and the wiring between all the components. The 120-amp fuse is the main circuit protection device for the entire vehicle electrical system. There's another smaller (15-amp) fuse in the engine compartment fuse and relay box and, on V6 models, a third fuse (also 15 amps) in the passenger compartment fuse and relay box inside the vehicle. These smaller fuses protect the circuits between the alternator and the fuse and relay boxes.

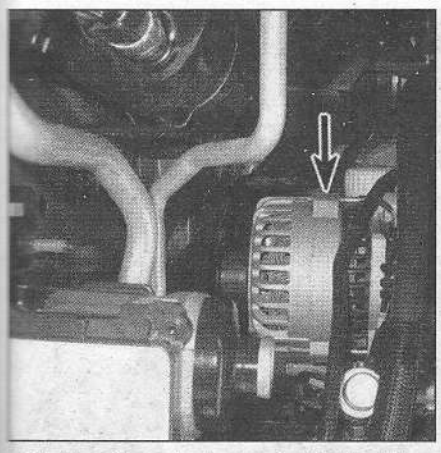
The alternator generates alternating current (ac) that is rectified to direct current (dc) to charge the battery and supply power to other electrical systems. The alternator is driven by a drivebelt at the front of the engine (right side of the vehicle). On four-cylinder models, the alternator is located on the backside of the engine **(see illustration)**. It's also located in the same place on V6 models. The voltage regulator limits the alternator charging voltage by regulating the current supplied to the alternator field circuit. The regulator is a solid-state electronic assembly mounted inside the alternator. The regulator is not separately replaceable on these vehicles. If it's defective, you must replace the alternator.

The alternator drivebelt, the battery, and all charging system wires and connections should be inspected at the intervals listed in Chapter 1.

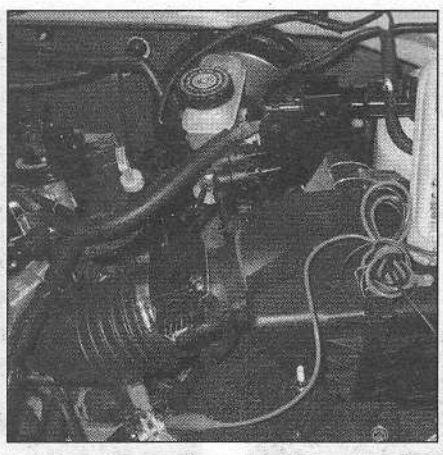
Be very careful when making any circuit connections and note the following:

a) Never start the engine with a battery charger connected.

b) Always disconnect both battery cables before using a battery charger: negative cable first, positive cable last. After you're done, the Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Section 1 for this procedure).



8.2 The alternator is located behind the right end of the engine on all models (four-cylinder model shown)



9.2 Battery voltage should be at least 12 volts with the engine off. When the engine is running, regulated voltage should be 13.5 to 15 volts

9 Charging system - check

Refer to illustration 9.2

1 If the charging system malfunctions, don't immediately assume that the alternator is causing the problem. First check the following items:

a) Ensure that the battery cable connections at the battery are clean and tight.

b) If the battery is not a maintenance-free type, check the electrolyte level and specific gravity. If the electrolyte level is low, add clean, mineral-free tap water. If the specific gravity is low, charge the battery.

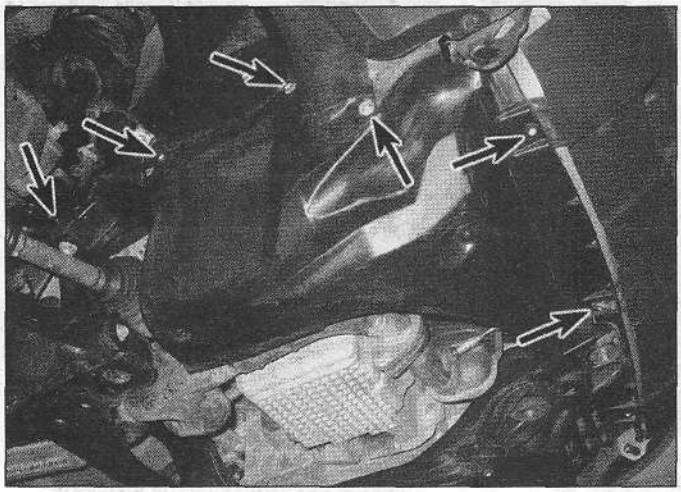
c) Check the alternator wiring and connections.

d) Check the drivebelt condition and tension (see Chapter 1).

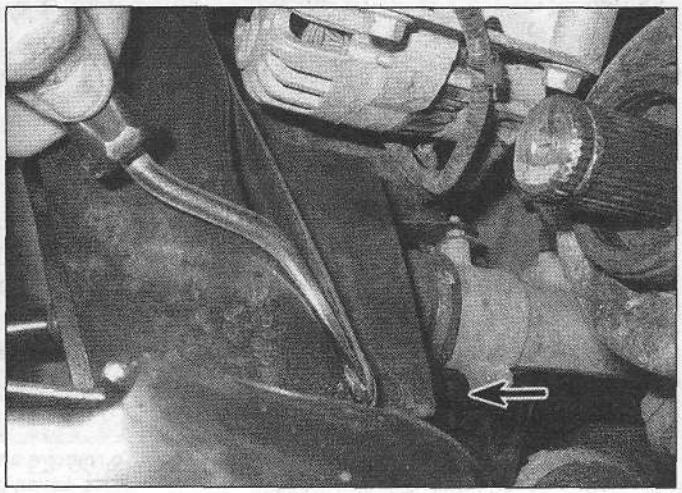
e) Check the alternator mounting bolts for looseness.

f) Run the engine and check the alternator for abnormal noise.

2 Use a voltmeter to check the battery voltage with the engine off. It should be at least 12 volts **(see illustration)**.



10.13 To detach the right engine splash shield from the vehicle, remove these fasteners (V6 models)



10.16a To detach the alternator splash shield, remove this push fastener . . .

3 Start the engine and check the battery voltage again. It should now be approximately 14 to 15 volts.

4 If the voltage reading is less than the specified charging voltage, check the charging system fuses in the engine compartment and passenger compartment fuse and relay boxes. If a fuse is blown, replace it. If all three fuses are OK, the voltage regulator is defective. Replace the alternator (the voltage regulator cannot be replaced separately).

5 If the voltage reading is more than the specified charging voltage, the voltage regulator is defective. Replace the alternator (the voltage regulator cannot be replaced separately).

6 Some models have an ammeter on the instrument panel that indicates charge or discharge. With all electrical equipment on and the engine idling, the gauge needle may show a discharge condition. At fast idle or normal driving speeds, the needle should stay on the charge side of the gauge. The state of charge of the battery determines the amount of charging current shown by the ammeter. (The lower the battery state of charge, the farther the needle should move toward the charge side.)

7 Some models have a voltmeter on the instrument panel that indicates battery voltage with the key on and engine off and alternator charging voltage when the engine is running.

8 The charge lamp on the instrument panel lights with the key on and engine not running and should go out when the engine runs.

9 If the ammeter or voltmeter does not show a charge when it should, or the alternator light remains on, there is a fault in the system. Before inspecting the brushes or replacing the voltage regulator or the alternator, check the battery condition, alternator belt tension, and electrical cable connections.

10 If replacing the regulator doesn't restore voltage to the specified range, the problem may be in the alternator. Have the alternator tested by an automotive electrical specialist.

10 Alternator - removal and installation

Four-cylinder models

1 Disconnect the cable from the negative battery terminal (see Section 1).

2 Remove the alternator drivebelt (see Chapter 1).

3 Disconnect the electrical connectors from the alternator.

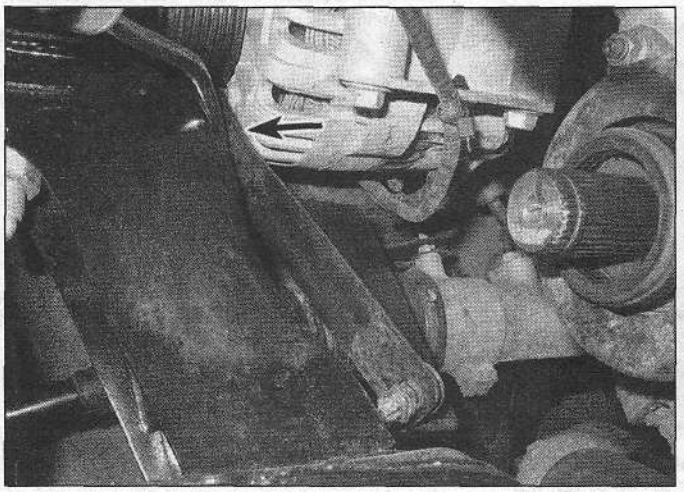
4 Raise the front of the vehicle and place it securely on jackstands.

5 Remove the lower alternator bolts.

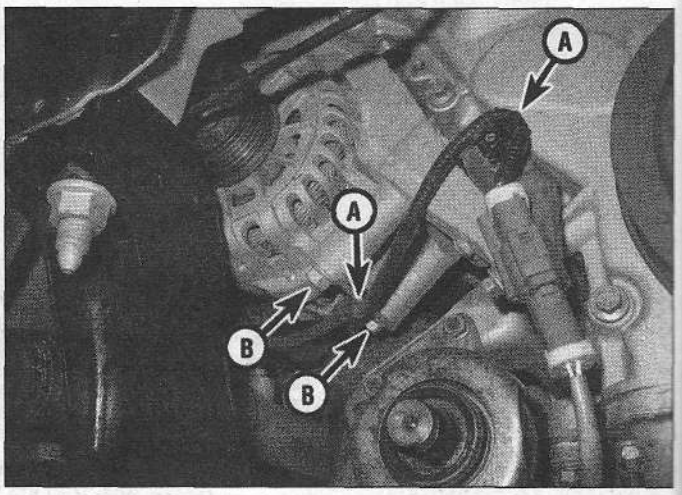
6 *Unscrew* the upper alternator bolt. (There's not enough clearance to *remove* the upper alternator bolt; it comes off with the alternator.)

7 Move the alternator to the rear, then lift it up and remove it from the engine compartment.

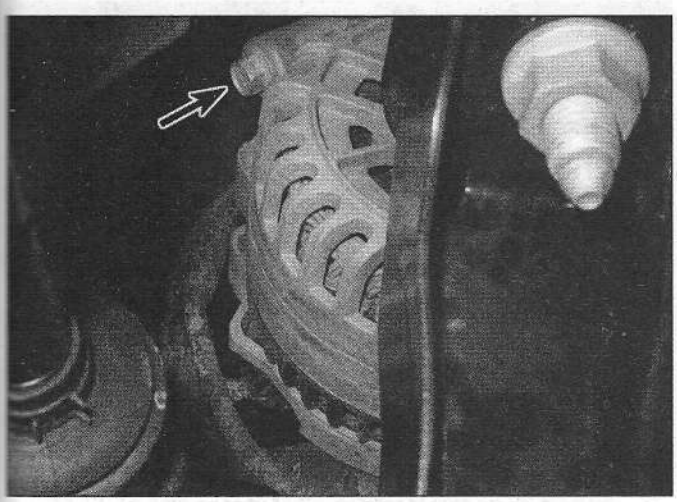
8 Before installing the alternator, insert the upper alternator bolt into its hole in the alter-



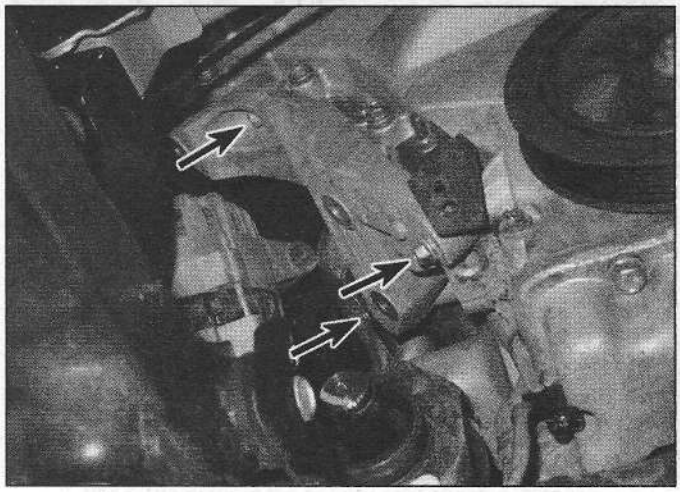
10.16b . . . and this one, then remove the splash shield (V6 models)



10.17 Detach the two wiring harness clips (A) and position the harness out of the way; to detach the lower part of the alternator from its mounting bracket, remove these two bolts (B) (V6 models)



10.18 Remove the upper alternator bolt (V6 models)



10.20 To detach the alternator mounting bracket from the engine block, remove these bolts (V6 models)

nator mounting boss (you can't install the bolt once the alternator is in place).

9 Installation is otherwise the reverse of removal.

10 After you've reconnected the battery, the Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Section 1 for this procedure).

V6 models

Refer to illustrations 10.13, 10.16a, 10.16b, 10.17, 10.18, 10.20, 10.21 and 10.23

11 Disconnect the cable from the negative battery terminal (see Section 1).

12 Loosen the driveaxle hub nut (see Chapter 8) and the wheel lug nuts. Raise the front of the vehicle and place it securely on jackstands. Remove the wheel.

13 Remove the right lower engine splash shield **(see illustration)**.

14 Remove the right driveaxle (see Chapter 8). (You will also need to remove the intermediate shaft before you can remove the alternator, but don't actually remove it at this time, or gear lubricant will leak out of the transaxle!)

15 Remove the drivebelt (see Chapter 1).

16 Remove the alternator splash shield **(see illustrations)**.

17 Detach the wiring harness clips **(see illustration)** and position the harness out of the way.

18 Remove the upper alternator mounting bolt **(see illustration)**.

19 Remove the lower alternator mounting bolts **(see illustration 10.17)** and position the alternator out of the way so that you can remove the alternator mounting bracket.

20 Remove the alternator mounting bracket **(see illustration)**.

21 Disconnect the electrical connectors from the alternator **(see illustration)**.

22 Remove the driveaxle intermediate shaft (see Chapter 8). When you detach the inner splined end of the intermediate shaft from the transaxle, some gear lubricant will leak out, so put a drain pan underneath to catch the spilled fluid.

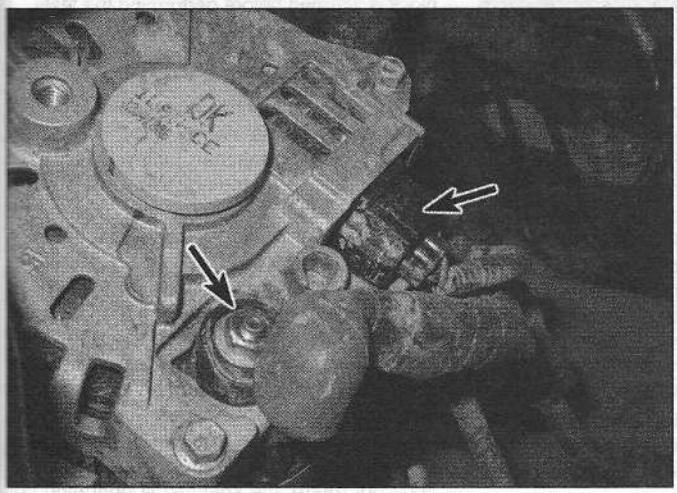
23 Remove the alternator **(see illustration)** and then install the intermediate shaft immediately to prevent the loss of any more transaxle gear lube.

24 Be sure to check the fluid level inside the transaxle and refill as necessary (see Chapter 1). Installation is otherwise the reverse of removal.

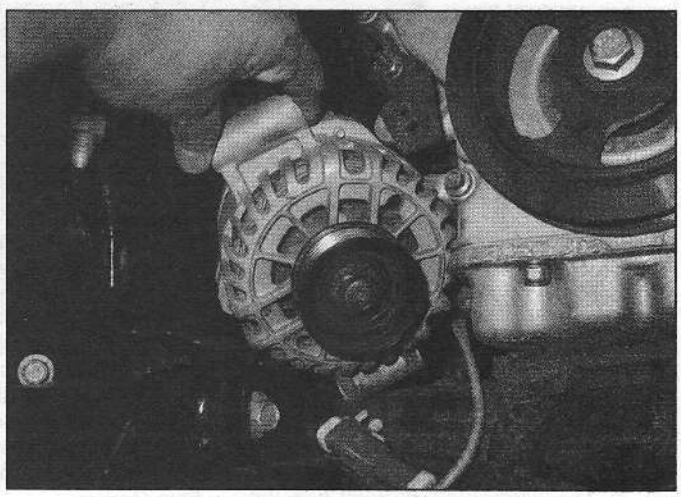
25 After you've reconnected the battery, the Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Section 1 for this procedure).

11 Starting system - general information and precautions

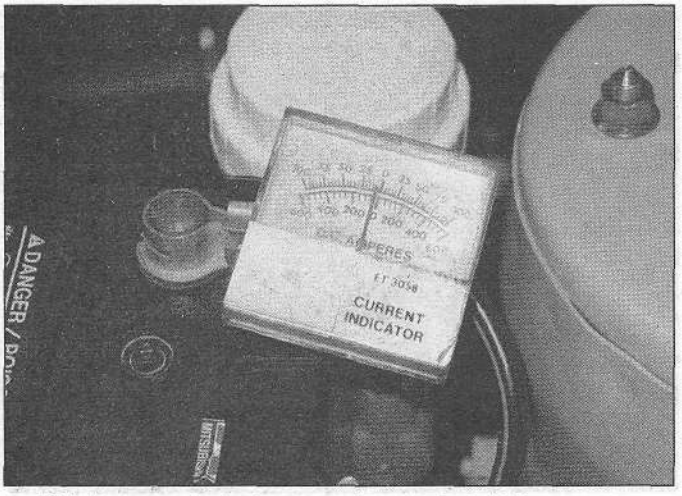
The starting system consists of the battery, the ignition switch, the starter relay, the starter relay diode, the clutch start switch (manual transaxles), the Transmission Range (TR) sensor (automatic transaxles), the starter



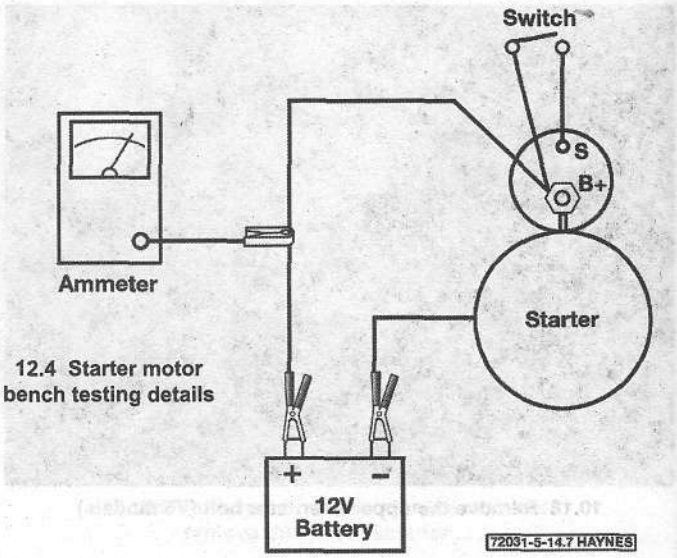
10.21 Disconnect the electrical connector from the alternator, remove the nut from the battery positive (B+) terminal and disconnect the cable from the terminal (V6 models)



10.23 To remove the alternator, lift it out through the space normally occupied by the right driveaxle and intermediate shaft (V6 models)



12.3 To use an inductive ammeter, simply hold the ammeter over the positive or negative cable (whichever cable has better clearance)



12.4 Starter motor bench testing details

motor solenoid, the starter motor and the wires that connect these components. The solenoid is located on the starter motor, which is located on the back side of the engine block (four-cylinder models) and on top of the transaxle (V6 models).

The starter motor on a vehicle with a manual transaxle can be operated only when the clutch pedal is depressed. The starter on a vehicle with an automatic transaxle can be operated only when the shift lever is in PARK or NEUTRAL. When the ignition key is turned to the START position, it closes the starter control circuit, which energizes the starter relay. (The starter relay is located in the engine compartment fuse and relay box.) The starter relay closes the actual starter circuit between the battery and the starter solenoid, which energizes the solenoid, which moves a lever that engages the starter pinion gear with the flywheel ring gear to crank the engine.

Always observe the following precautions when working on the starting system:

a) *Excessive cranking of the starter motor can overheat it and cause serious damage. Never operate the starter motor for more than 15 seconds at a time without pausing for at least two minutes to allow it to cool.*
b) *The starter is connected directly to the battery and could arc or cause a fire if mishandled, overloaded or short-circuited.*
c) *Always detach the cable from the negative battery terminal before working on the starting system.*

12 Starter motor and circuit - check

Refer to illustrations 12.3 and 12.4

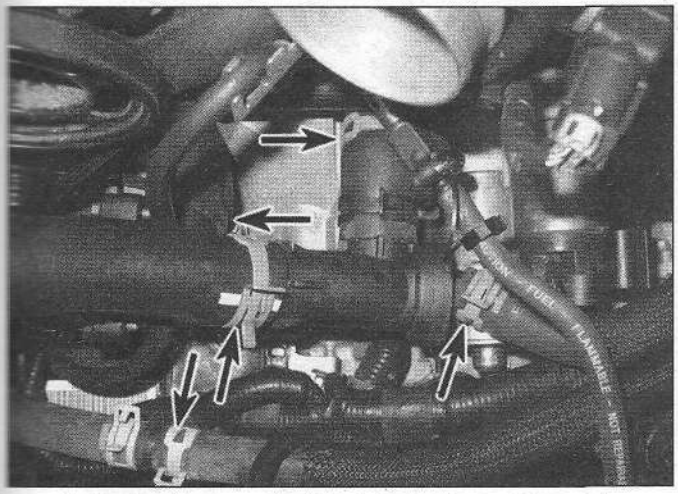
1 If a malfunction occurs in the starting circuit, do not immediately assume that the starter is causing the problem. First, check the following items:

a) *Make sure that the battery cable clamps are clean and tight where they connect to the battery.*
b) *Check the condition of the battery cables* (see Section 4). *Replace any defective battery cables with new parts.*
c) *Test the condition of the battery* (see Section 3). *If it does not pass all the tests, replace it with a new battery.*
d) *Check the starter solenoid wiring and connections. Refer to the wiring diagrams at the end of Chapter 12.*
e) *Check the starter mounting bolts for tightness.*
f) *Make sure that the shift lever is in PARK or NEUTRAL (automatic transaxle) or the clutch pedal is pressed (manual transaxle).*
g) *Check the adjustment of the Transmission Range (TR) sensor on vehicles with an automatic transaxle* (see Chapter 6). *On vehicles with a manual transaxle, make sure that the Clutch Pedal Position (CPP) switch is correctly installed.*
h) *Check the operation of the starter relay (located in the engine compartment fuse and relay box). Refer to Chapter 12 for the relay testing procedure.*

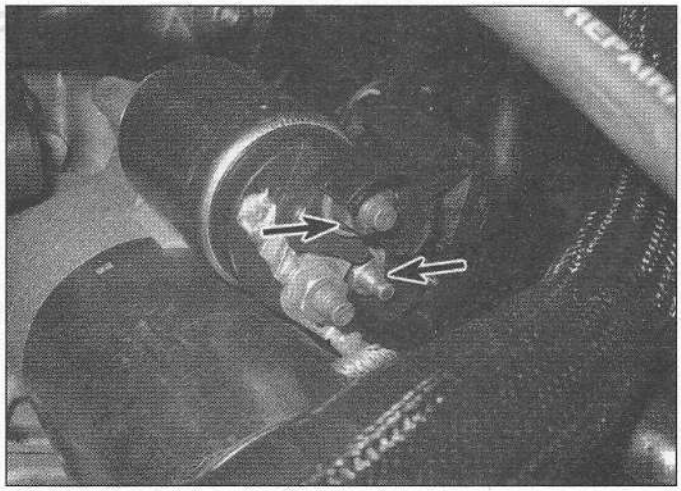
2 If the starter does not actuate when the ignition switch is turned to the start position, check for battery voltage to the solenoid. This will determine if the solenoid is receiving the correct voltage signal from the ignition switch. Connect a test light or voltmeter to the starter solenoid switched terminal (the small wire) and while an assistant turns the ignition switch to the start position. If voltage is not available, refer to the wiring diagrams in Chapter 12 and check all the fuses and relays in series with the starting system. If voltage is available but the starter motor does not operate, remove the starter from the engine compartment (see Section 13) and bench test the starter (see Step 4).

3 If the starter turns over slowly, check the starter cranking voltage and the current draw from the battery. This test must be performed with the starter assembly on the engine. Crank the engine over (for 10 seconds or less) and observe the battery voltage. It should not drop below 8.0 volts on manual transaxle models or 8.5 volts on automatic transaxle models. Also, observe the current draw using an amp meter **(see illustration)**. It should not exceed 400 amps or drop below 250 amps. **Caution:** *The battery cables might overheat because of the large amount of current being drawn from the battery. Discontinue the testing until the starting system has cooled down.* If the starter motor cranking amp values are not within the correct range, replace it with a new unit. There are several conditions that may affect the starter cranking potential. The battery must be in good condition and the battery cold-cranking rating must not be under-rated for the particular application. Be sure to check the battery specifications carefully. The battery terminals and cables must be clean and not corroded. Also, in cases of extreme cold temperatures, make sure the battery and/or engine block is warmed before performing the tests.

4 If the starter is receiving voltage but does not activate, remove and check the starter/solenoid assembly on the bench. Most likely the solenoid is defective. In some rare cases, the engine may be seized so be sure to try and rotate the crankshaft pulley (see Chapter 2) before proceeding. With the starter/solenoid assembly mounted in a vise on the bench, install one jumper cable from the negative battery terminal to the body of the starter. Install the other jumper cable from the positive battery terminal to the B+ terminal on the starter. Install a starter switch and apply battery voltage to the solenoid S terminal (for 10 seconds or less) and see if the solenoid plunger, shift lever and overrunning clutch extends and rotates the pinion drive **(see illustration)**. If the pinion drive extends but does not rotate, the solenoid is operating but the starter motor is defective. If there is no movement but the solenoid clicks, the sole-



13.12 To gain access to the starter motor on V6 models, disconnect these coolant hoses and position them out of the way (have some rags handy to catch any residual coolant that might drip onto the engine)



13.13 Disconnect the battery starter cable from the big terminal and the starter control cable from the smaller terminal (V6 models)

noid and/or the starter motor is defective. If the solenoid plunger extends and rotates the pinion drive, the starter/solenoid assembly is working properly.

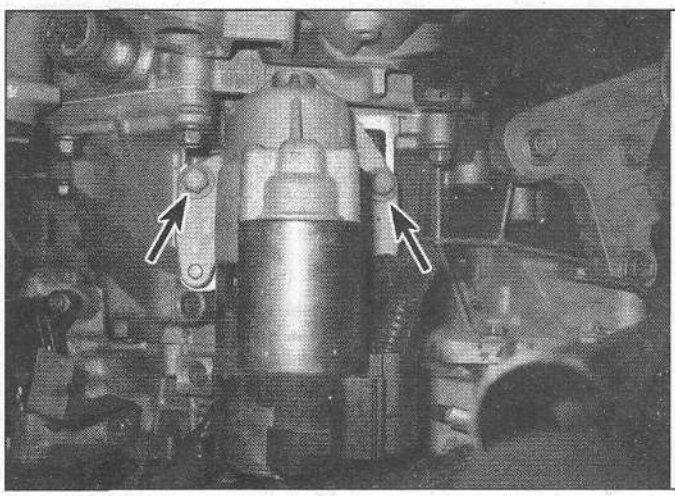
13 Starter motor - removal and installation

Four-cylinder models

1 Disconnect the cable from the negative battery terminal (see Section 1).
2 Remove the three starter motor mounting bolts.
3 Raise the front of the vehicle and place it securely on jackstands.
4 Remove the bolts from the support bracket for the intermediate shaft center bearing (see Chapter 8). (It's not necessary to remove either the right driveaxle or the intermediate shaft, but detaching the center bearing support bracket will give you enough room to pull out the starter.)
5 Disconnect the battery cable (the large cable) and the starter control electrical connector from the starter motor solenoid terminals.
6 Remove the starter.
7 Installation is the reverse of removal.
8 After you've reconnected the battery, the Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Section 1 for this procedure).

V6 models

Refer to illustration 13.12, 13.13 and 13.14
Warning: *Wait until the engine is completely cool before beginning this procedure.*
9 Disconnect the cable from the negative battery terminal (see Section 1).
10 Remove the air intake duct (see Chapter 4), then remove the air filter housing and Mass Air Flow (MAF) sensor as a single assembly (see Chapter 4). (It's not necessary to detach the MAF sensor from the air filter housing.)
11 Drain the cooling system (see Chapter 1).
12 Remove the coolant hoses located above the starter motor **(see illustration)**.
13 Disconnect the battery cable (the large cable) and the starter control electrical connector from the starter motor solenoid terminals **(see illustration)**.
14 Remove the starter motor mounting bolts **(see illustration)** and remove the starter from the engine.
15 Installation is the reverse of removal.
16 After you've reconnected the battery, the Powertrain Control Module (PCM) must relearn its idle and fuel trim strategy for optimum driveability and performance (see Section 1 for this procedure).



13.14 To detach the starter motor from the engine, remove these two bolts (V6 models)