FUEL SYSTEMS

CONTENTS

GENERAL INFORMATION

Throughout this group, references are made to a particular vehicle by letter designation. A chart showing the breakdown of these designations is included in the Introduction Section at the front of this service manual.

The Fuel System consists of the fuel tank, fuel pump, fuel filter, throttle body, fuel injectors, fuel lines and vacuum lines.

The Fuel Delivery System consists of the fuel pump, fuel filter, fuel lines and fuel hoses.

The Fuel Tank Assembly consists of the fuel tank, filler tube, a fuel gauge sending unit assembly and a pressure-vacuum filler cap.

Also, the Evaporation Control System is part of the fuel system. The evaporation control system is designed to reduce the emission of fuel vapor into the atmosphere.

The description and function of the Evaporation Control System is found in Group 25 of this manual.

FUEL REQUIREMENTS

Your vehicle was designed to meet all emission regulations and provide excellent fuel economy when using high quality unleaded gasoline.

VEHICLES WITHOUT TURBOCHARGED ENGINES

Use unleaded gasoline having a minimum octane rating of 87.

VEHICLES WITH TURBOCHARGED ENGINES—EXCEPT 16 VALVE 2.2L ENGINES

These vehicles will operate satisfactorily on both regular unleaded gasoline having a minimum octane rating or 87, and premium unleaded gasoline having a minimum octane rating of 91. The use of premium unleaded gasoline will improve performance.

VEHICLES WITH 2.2L 16 VALVE ENGINES

The use of premium unleaded gasoline having a minimum octane of 91 is recommended. If premium unleaded is not available, then unleaded gasoline with a minimum octane of 87 may be used. However, the use of lower octane gasoline will result in reduced performance.

THE FOLLOWING IS APPLICABLE TO ALL VEHICLES

Light spark knock at low engine speeds is not harmful to your engine. However, continued heavy spark knock at high speeds can cause damage and should be reported to your dealer immediately. Engine damage resulting from operating with a heavy spark knock may not be covered by the new vehicle warranty.

In addition to using unleaded gasoline with the proper octane rating, gasolines that contain detergents, corrosion and stability additives are recommended. Using gasolines that have these additives will help improve fuel economy, reduce emissions, and maintain vehicle performance. Generally, premium unleaded gasolines contain more additive than regular unleaded.

Poor quality gasoline can cause problems such as hard starting, stalling, and stumble. If you experience these problems, try another brand of gasoline before considering service for the vehicle.

GASOLINE/OXYGENATE BLENDS

Some fuel suppliers blend gasoline with materials that contain oxygen such as alcohol, MTBE (Methyl Tertiary Butyl Ether) and ETBE (Ethyl Tertiary Butyl Ether). The type and amount of oxygenate used in the blend is important.

The following are generally used in gasoline blends:

Ethanol - (Ethyl or Grain Alcohol) properly blended, is used as a mixture of 10 percent ethanol and 90 percent gasoline. Gasoline blended with ethanol may be used in your vehicle.

Methanol - (Methyl or Wood Alcohol) is used in a variety of concentrations when blended with unleaded gasoline. You may find fuels containing 3 percent or more methanol along with other alcohols called cosolvents.

Do not use gasolines containing Methanol.

Use of methanol/gasoline blends may result in starting and driveability problems and damage critical fuel system components.

Problems that are the result of using methanol/gasoline blends are not the responsibility of Chrysler Motors and may not be covered by the new vehicle warranty.

MTBE/ETBE - Gasoline and MTBE (Methyl Tertiary Butyl Ether) blends are a mixture of unleaded gasoline blended and up to 15 percent MTBE. Gasoline and ETBE (Ethyl Tertiary Butly Ether) are blends of gasoline and up to 17 percent ETBE. Gasoline blended with MTBE or ETBE may be used in your vehicle.

Clean Air Gasoline

Many gasolines are now being blended that contribute to cleaner air, especially in those areas of the country where pollution levels are high. These new blends provide a cleaner burning fuel and some are referred to as reformulated gasoline.

In areas of the country where carbon monoxide levels are high, gasolines are being treated with oxygenated materials such as ETBE, MTBE and ethanol. The use of gasoline blended with these materials also contributes to cleaner air.

Chrysler Corporation supports these efforts toward cleaner air and recommends that you use these gasolines as they become available.

Materials Added to Fuel

Indiscriminate use of fuel system cleaning agents should be avoided. Many of these materials intended for gum and varnish removal may contain active solvents of similar ingredients that can be harmful to fuel system gasket and diaphragm materials.

FUEL DELIVERY SYSTEM

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GENERAL INFORMATION

FUEL SYSTEM PRESSURE RELEASE PROCEDURE

(1) Loosen fuel filler cap to release fuel tank pressure.

(2) Disconnect injector wiring harness from engine or main harness.

(3) Connect a jumper wire from terminal Number 1 (ground) of the injector harness (Fig. 1) to engine ground.

(4) Connect one end of a jumper wire to terminal Number 2 (positive) of the injector harness (Fig. 1). Connect the other end to the positive post of the battery for no longer than 5 seconds. This releases system pressure.

(5) Remove jumper wires.

(6) Continue fuel system service.

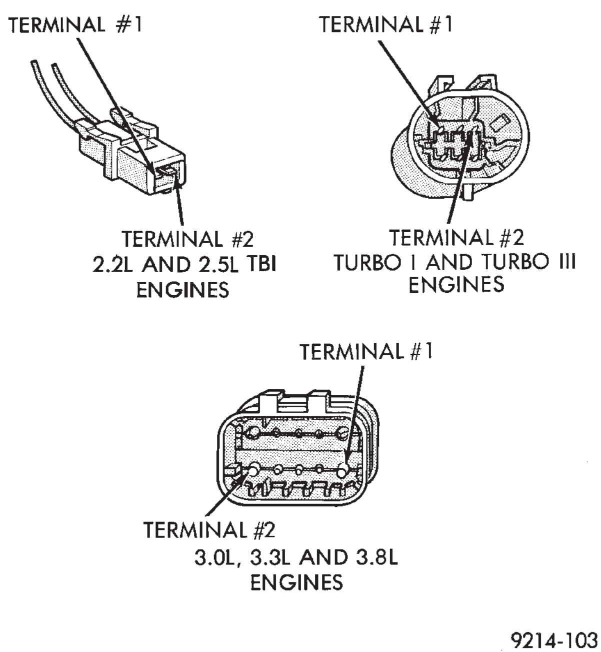

Fig. 1 Injector Harness Connections

FUEL HOSES, CLAMPS, AND QUICK CONNECT FITTINGS

HOSES AND CLAMPS

Inspect all hose connections (clamps and quick connect fittings) for completeness and make sure they are not leaking. Hoses that are cracked, scuffed, swelled, rub against other vehicle components or show any sign of wear, should be replaced.

Fuel injected vehicles use specially constructed hoses. When replacing hoses, only use hoses marked EFM/ EFI.

When installing hoses, ensure they are routed away from contact with other vehicle components that could rub against them and cause failure. Avoid contact with clamps or other components that cause abrasions or scuffing. Ensure that rubber hoses are properly routed and avoid heat sources.

The hose clamps have rolled edge to prevent the clamp from cutting into the hose. Only use clamps that are original equipment or equivalent. Other types of clamps may cut into the hoses and cause high pressure fuel leaks. Tighten hose clamps to 1 N●m (10 in. lbs.) torque.

QUICK CONNECT FITTINGS

Some fuel lines have quick connect fittings. The fittings are designed to speed up the installation and removal of the fuel lines (Fig. 2).

Quick connect fittings consist of a metal casing, a black plastic release ring, a metal locking retainer, and internal O-rings.

TUBE/FITTING DISASSEMBLY

WARNING: FUEL SYSTEM PRESSURE MUST BE RELEASED BEFORE DISCONNECTING ANY FUEL SYSTEM COMPONENT.

(1) Disconnect the negative battery cable.

(2) Remove the fuel tank gas cap to release fuel tank pressure.

(3) Perform the Fuel System Pressure Release Procedure.

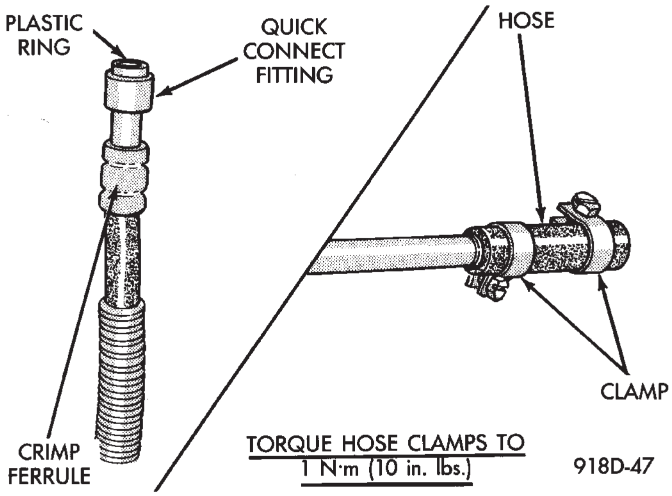

Fig. 2 Quick Connect Fuel Fittings

(4) Remove any loose dirt from quick connect fittings.

WARNING: WRAP SHOP TOWELS AROUND HOSES TO CATCH ANY GASOLINE SPILLAGE.

(5) To remove the fuel tube nipple from a quick connect fitting, pull back on the fitting while pushing in on the plastic ring (Fig. 2). To aid in disassembly, an open end wrench may be used to push the plastic ring in.

(6) Cover the quick connector to prevent contamination.

TUBE/FITTING ASSEMBLY

(1) Inspect the quick connect fitting to ensure the black plastic release ring is in the **OUT** position. If the locking retainer is stuck in the **RELEASE** position due to mushrooming of the release ring or dirt accumulation, the fitting should be replaced.

Fuel tube nipples must be lubricated with clean 30 weight engine oil prior to reconnecting the quick-connect fitting.

(2) Lubricate the fuel tube nipple with clean 30 weight engine oil.

(3) Insert fuel tube nipple into the quick connector fitting. When the fuel tube nipple enters the quick-connect fitting, the nipple shoulder is held in place by the locking retainer. The internal O-rings seal the tube.

(4) Pull back on the quick connect fitting to verify the connection is secure. The tube should be locked in place. If the connection is not complete, make sure the black plastic release is not causing the locking retainer to jam in the release position.

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(5) Use the DRB II ASD Fuel System Test to pressurize the fuel system. Check for leaks.

TUBE/FITTING SERVICE

If a quick connect fitting needs service, the following procedure must be followed:

(1) Disconnect the battery negative battery cable.

(2) Perform the Fuel System Pressure Release Procedure.

WARNING: WRAP SHOP TOWELS AROUND HOSES TO CATCH ANY GASOLINE SPILLAGE.

(3) Remove the quick connect fitting from the fuel tube by pushing in on the plastic ring located on the end of the fitting. Gently pull the fitting from the fuel tube.

(4) Cut off the crimp ferrules at each end of the hose, taking care not to damage the quick connect fitting or the fuel tube.

(5) Discard the ferrules and hose. Discard the quick connect fitting if it is defective.

(6) Replace the hose using hose marked EFM/EFI.

(7) Replace the quick connect fittings (if necessary) with the correct size and type.

(8) Attach the replacement hose to the quick connect fitting and fuel tube using the correct hose clamps. Original equipment hose clamps have a special rolled edge construction to prevent the edge of the clamp cutting into the hose. Only original equipment clamps or equivalent may be used in this system. Other types of clamps may cut into the hoses and cause high pressure fuel leaks.

(9) Tighten hose clamps to 1 N●m (10 in. lbs.) torque.

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(10) Use the DRB II ASD Fuel System Test to pressurize the fuel system. Check for leaks.

FUEL PUMP ASSEMBLY

The fuel pump assembly consists of the fuel pump and the reservoir body.

The reservoir body takes the place of an internal fuel tank reservoir. The reservoir maintains fuel at the pump inlet during all driving conditions, especially when the fuel level is low.

The system uses a positive displacement, gerotor gear, immersible pump with a permanent magnet electric motor (Fig. 3). The pump draws fuel through a strainer and pushes it through the electric motor to the outlet. The pump contains three check valves. One valve relieves internal fuel pump pressure and regulates maximum pump output. Another valve, inside the pump assembly in the fuel return circuit, prevents fuel tank leakage if the line is damaged during an accident. The third valve, in the pump outlet, maintains pump pressure during engine off conditions. The fuel pump relay provides voltage to the fuel pump.

All front wheel drive car fuel systems, except Turbo III vehicles, use the same fuel pump. The pump has a maximum unregulated pressure output of approximately 930 kPa (135 psi). Fuel Pressure is regulated at the fuel rail or throttle body by a fuel pressure regulator. Refer to the Fuel System Pressure Chart for pressure specifications.

Release fuel system pressure before servicing the fuel tank, fuel pump, fuel lines, fuel filter, or parts of the fuel rail. Follow the Fuel System Pressure Release procedure to relieve fuel system pressure.

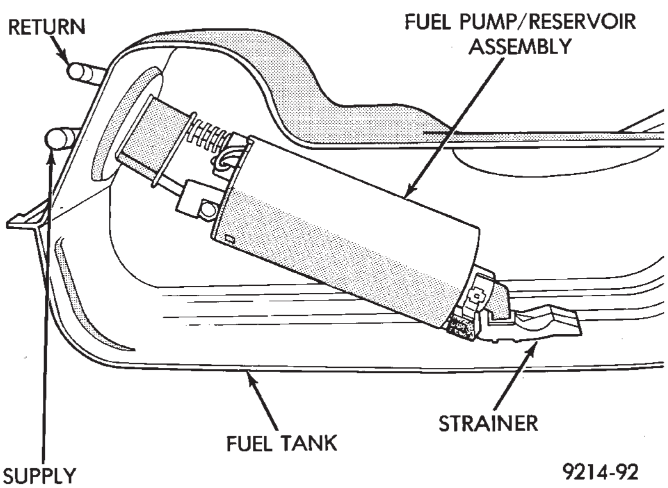

Fig. 3 Fuel Pump

FUEL SYSTEM PRESSURE

SYSTEM	PRESSURE
2.2L TBI	265 kPa (39 psi)
2.5L TBI	265 kPa (39 psi)
2.5L Turbo I	380 kPa (55 psi)
2.2L Turbo III	380 kPa (55 psi)
3.0L MPI	330 kPa (48 psi)
3.3L MPI	330 kPa (48 psi)
3.8L MPI	330 kPa (48 psi)

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FUEL PUMP PRESSURE TEST—ALL EXCEPT 2.2L/2.5L TBI AND 3.0L MPI

The specifications in the Fuel Pressure chart reflect system pressure with the vacuum hose removed from the pressure regulator.

(1) Remove the vacuum hose from the pressure regulator before checking fuel pressure.

(2) Release fuel system pressure. Refer to the Fuel System Pressure Release procedure in this group.

(3) Connect Fuel Pressure Gauge C-4799 to service port on fuel rail (Fig. 4).

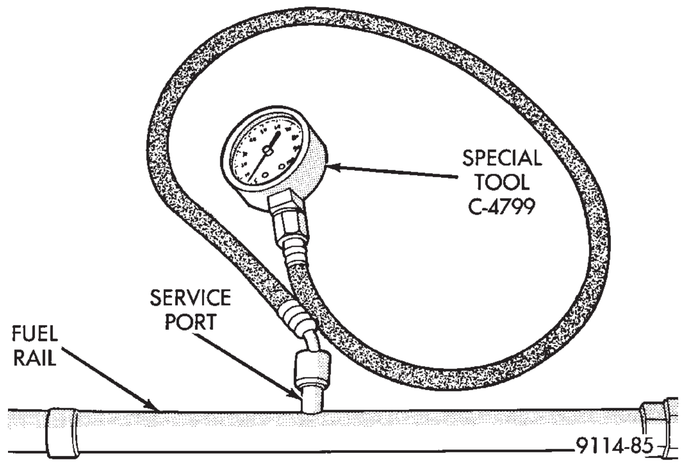

Fig. 4 Fuel Pressure Testing—Engines With Service Ports

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(4) Place the ignition key in the ON position. Using the DRB II tester, access ASD Fuel System Test. The ASD Fuel System Test will activate the fuel pump and pressurize the system.

If the gauge reads the specification listed in the Fuel System Pressure chart, further testing is not required. If pressure is not correct, record the pressure and remove gauge. Use the DRB II ASD Fuel System Test to pressurize the system. Ensure fuel does not leak from the fuel rail service valve. Install protective cover on fuel rail service valve.

If pressure is below specifications, proceed to **Fuel System Pressure Below Specifications** . If pressure is above specifications, proceed to **Fuel System Pressure Above Specifications**.

Fuel System Pressure Below Specifications

If the fuel pressure reading in step (4) was below specifications, test the system according to the following procedure.

WARNING: RELEASE FUEL SYSTEM PRESSURE BEFORE DISCONNECTING A FUEL SYSTEM HOSE OR COMPONENT.

(a) Perform Fuel Pressure Release procedure.

(b) Install Fuel Pressure Gauge C-4799 and Fuel Pressure Test Adapter 6539 in the fuel supply line between the fuel tank and fuel filter at the rear of vehicle (Fig. 5).

(c) Using the DRB II, with the ignition key in the ON position, repeat the ASD Fuel System Test.

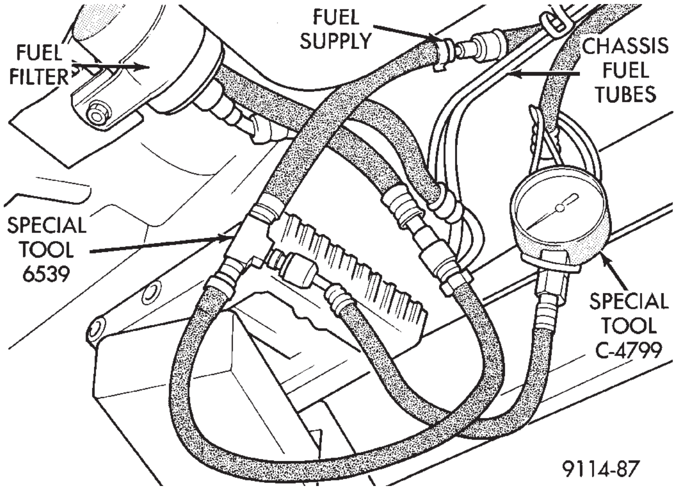

Fig. 5 Fuel Pressure Test

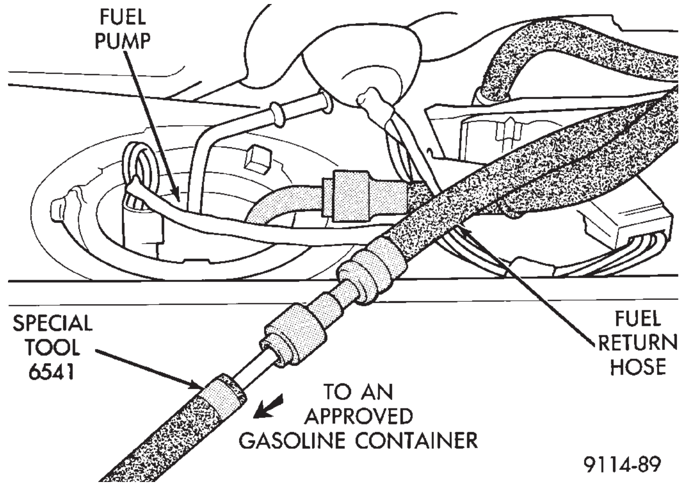

Fig. 6 Fuel Pressure Return Test

• If pressure is at least 5 psi higher than reading recorded in step (4), replace fuel filter.

• If no change is observed, gently squeeze the return hose. If fuel pressure increases, replace pressure regulator. If gauge reading does not change while squeezing the return hose, the problem is either a plugged inlet strainer or defective fuel pump.

Fuel System Pressure Above Specifications

If the fuel pressure reading in step (4) was above specifications, test the system according to the following procedure.

WARNING: RELEASE FUEL SYSTEM PRESSURE BEFORE DISCONNECTING A FUEL SYSTEM HOSE OR COMPONENT.

(a) Perform Fuel Pressure Release procedure.

(b) Remove the fuel return line hose from the fuel pump at fuel tank.

(c) Connect Fuel Pressure Test Adapter 6541 to the return line (Fig. 6). Place the other end of adapter 6541 into an approved gasoline container (minimum 2 gallon size). All return fuel will flow into container.

(d) Using the DRB II, with the ignition key in the ON position, repeat the ASD Fuel System Test.

• If pressure is now correct, replace fuel pump assembly.

• If pressure is still above specifications, remove fuel return hose from chassis fuel tubes (at engine). Attach Fuel Pressure Test Connect Adapter 6541 to the fuel return hose and place other end of hose in clean container (Fig. 7). Repeat test. If pressure is now correct, check for restricted fuel return line. If no change is observed, replace fuel pressure regulator.

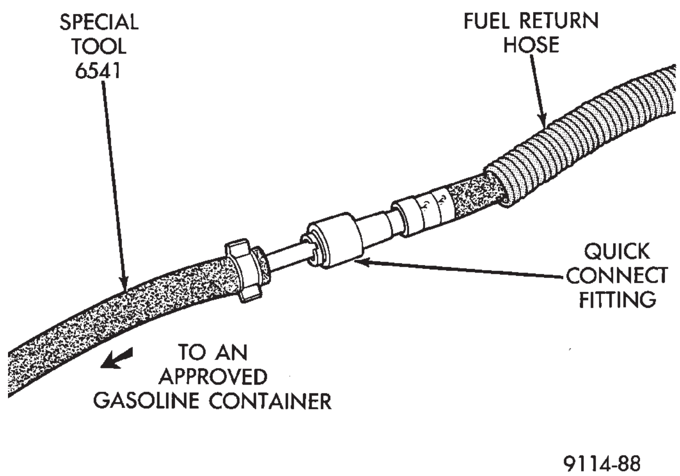

Fig. 7 Fuel Return Connection

FUEL PUMP PRESSURE TEST—2.2L/2.5L TBI and 3.0L MPI ENGINES

WARNING: RELEASE FUEL SYSTEM PRESSURE BEFORE DISCONNECTING A FUEL SYSTEM HOSE OR COMPONENT.

The specifications in the Fuel Pressure chart reflect system pressure with the vacuum hose removed from the pressure regulator. Remove the vacuum line from the pressure regulator on 3.0L engines before testing fuel system pressure. The pressure regulators on 2.2L/2.5L TBI engines are not vacuum assisted.

(1) Perform fuel system pressure release.

(2) Remove fuel supply hose quick connector from the chassis lines (at the engine).

(3) Connect Fuel Pressure Gauge C-4799 to Fuel Pressure Test Adapter 6539 (Fig. 8). Install the adapter between fuel supply hose and chassis fuel line assembly.

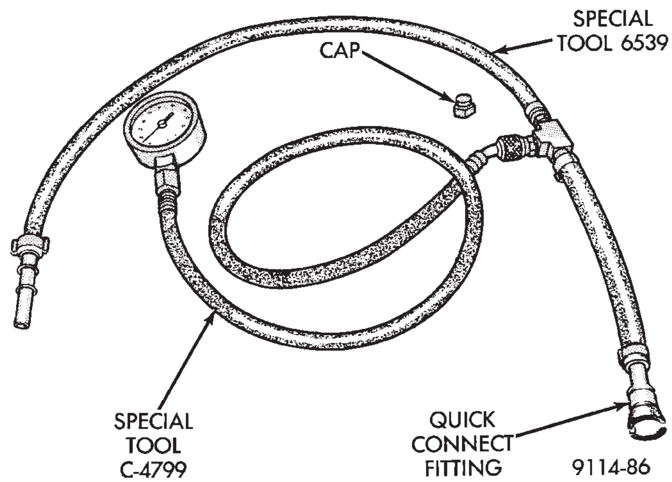

Fig. 8 Fuel Pressure Gauge and Adapter

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(4) Place the ignition key in the ON position. Using the DRB II tester, access ASD Fuel System Test. The ASD Fuel System Test will activate the fuel pump and pressurize the system.

If the gauge reads the pressure shown in the Fuel System Pressure chart, further testing is not required. If pressure is not correct, record the pressure and remove gauge.

If pressure is below specifications, proceed to **Fuel System Pressure Below Specifications**. If pressure is above specifications, proceed to **Fuel System Pressure Above Specifications**.

Fuel System Pressure Below Specifications

If the fuel pressure reading in step (4) was below specifications, test the system according to the following procedure.

WARNING: RELEASE FUEL SYSTEM PRESSURE BEFORE DISCONNECTING A FUEL SYSTEM HOSE OR COMPONENT.

(a) Perform Fuel Pressure Release procedure.

(b) Install Fuel Pressure Gauge C-4799 and Fuel Pressure Adapter 6433 in the fuel supply line (Fig. 5) between the fuel tank and fuel filter.

(c) Using the DRB II, with the ignition key in the ON position, repeat the ASD Fuel System Test.

• If pressure is at least 5 psi higher than reading recorded in step (4), replace fuel filter.

• If no change is observed, gently the squeeze return hose. If fuel pressure increases, replace pressure regulator. If the gauge reading does not change while squeezing the return hose, the problem is either a plugged inlet strainer or defective fuel pump.

Fuel System Pressure Above Specifications

If the fuel pressure reading in step (4) was above specifications test the system according to the following procedure.

WARNING: FUEL SYSTEM PRESSURE MUST BE RELEASED BEFORE A FUEL SYSTEM HOSE OR COMPONENT IS DISCONNECTED.

(a) Perform Fuel Pressure Release procedure.

(b) Install Fuel Pressure Gauge C-4799 and Fuel Pressure Adapter 6433 in the fuel supply line between the fuel tank and fuel filter (Fig. 5).

(c) Remove the fuel return line hose from the fuel pump at fuel tank. Connect Fuel Pressure Test Adapter 6541 to the return line (Fig. 6). Place the other end of adapter 6541 into an approved gasoline container (minimum 2 gallon size). All return fuel will flow into container.

(d) Using the DRB II, with the ignition key in the ON position, repeat the ASD Fuel System Test.

• If pressure is now correct, replace fuel pump assembly.

• If pressure is still above specifications, remove fuel return hose from chassis fuel tubes (at engine). Attach Fuel Pressure Test Connect Adapter 6541 to the fuel return hose and place other end of hose in clean approved gasoline container (Fig. 7). Repeat test. If pressure is now correct, check for restricted fuel return line. If no change is observed, replace fuel pressure regulator.

MECHANICAL MALFUNCTIONS

Mechanical malfunctions are more difficult to diagnose with this system. The engine controller compensates for some mechanical malfunctions. If engine performance problems are encountered, and no fault codes are displayed, the problem may be mechanical rather than electronic.

FUEL PUMP REMOVAL

Remove the fuel tank to service the fuel pump. Refer to Fuel Tank Section for fuel tank removal.

(1) Using a hammer and a brass drift punch carefully tap lock ring counter clockwise to release pump (Fig. 9).

(2) Remove fuel pump and O-ring seal from tank. Discard old seal.

FUEL PUMP STRAINER SERVICE

REMOVAL

(1) Bend locking tabs on fuel pump reservoir assembly to clear locking tangs on the fuel pump strainer (Fig. 10).

(2) Pull strainer off.

(3) Remove strainer O-ring from the fuel pump reservoir body.

(4) Remove any contaminants by washing the inside of the fuel tank.

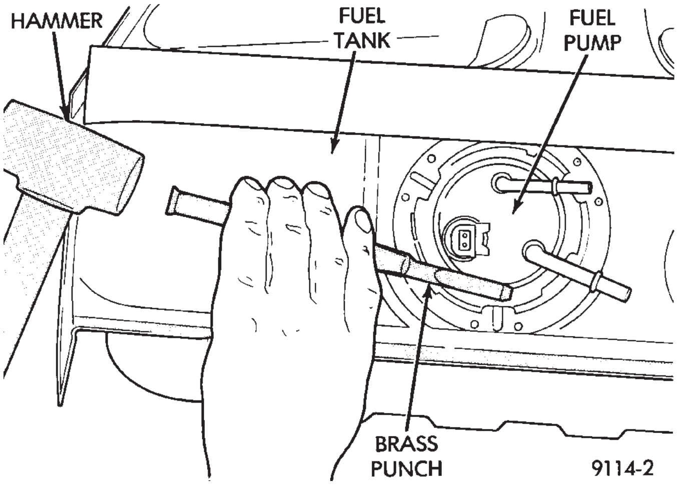

Fig. 9 Fuel Pump Service

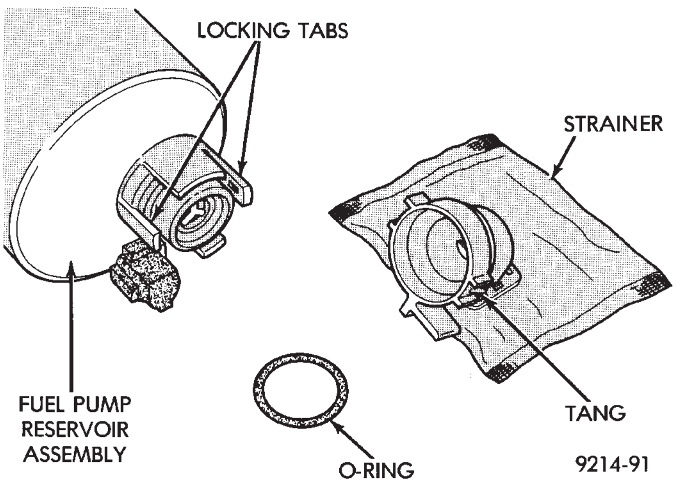

Fig. 10 Fuel Strainer Service

INSTALLATION

(1) Lubricate the strainer O-ring with Mopar Silicone Spray Lube.

(2) Insert strainer O-ring into outlet of strainer so that it sits evenly on the step inside the outlet.

(3) Push strainer onto the inlet of the fuel pump reservoir body. Make sure the locking tabs on the reservoir body lock over the locking tangs on the strainer.

FUEL PUMP INSTALLATION

(1) Wipe seal area of tank clean and place a new O-ring seal in position on pump.

(2) Position fuel pump in tank with locking ring.

(3) Using a hammer and brass drift punch drive ring around clockwise to lock pump in place.

CAUTION: Over tightening the pump lock ring may result in a leak.

(4) Install tank. Refer to the Fuel Tank Section in this Group.

FUEL FILTER—ALL VEHICLES

REMOVAL

WARNING: FUEL SYSTEM PRESSURE MUST BE RELEASED BEFORE THE FUEL FILTER IS REMOVED.

(1) Perform the Fuel System Pressure Release procedure.

(2)) Remove the fuel filter retaining screw (Fig. 11). Remove fuel filter from mounting plate.

(3) Wrap a shop towel around hoses to absorb fuel. Remove quick-connect fittings at filter and fuel supply tube. Refer to Quick-Connect Fittings in this section.

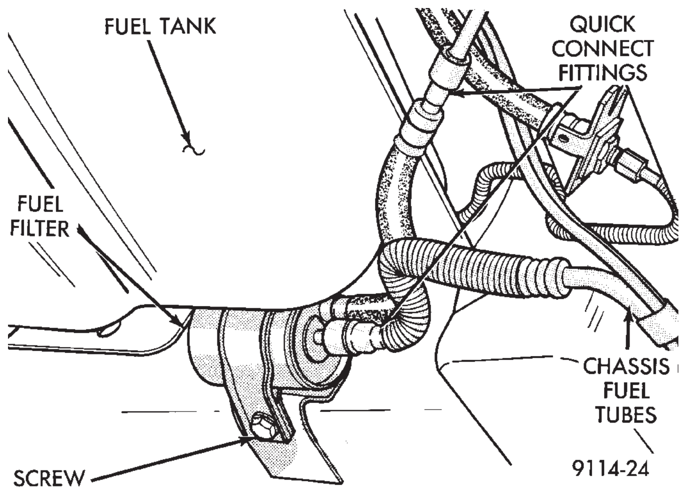

Fig. 11 Fuel Filter

INSTALLATION

(1) Connect quick-connect fuel fittings to the filter and fuel supply line. Refer to Quick-Connect Fittings in this section.

(2) Position filter assembly on mounting plate and tighten mounting screw to 8 N●m (75 in. lbs.) torque.

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(3) Place the ignition key in the ON position. Using the DRB II tester, access ASD Fuel System Test. The ASD Fuel System Test will activate the fuel pump and pressurize the system. Inspect for leaks.

CHASSIS FUEL TUBES

figure 12 shows fuel system component locations and chassis fuel tube routings.

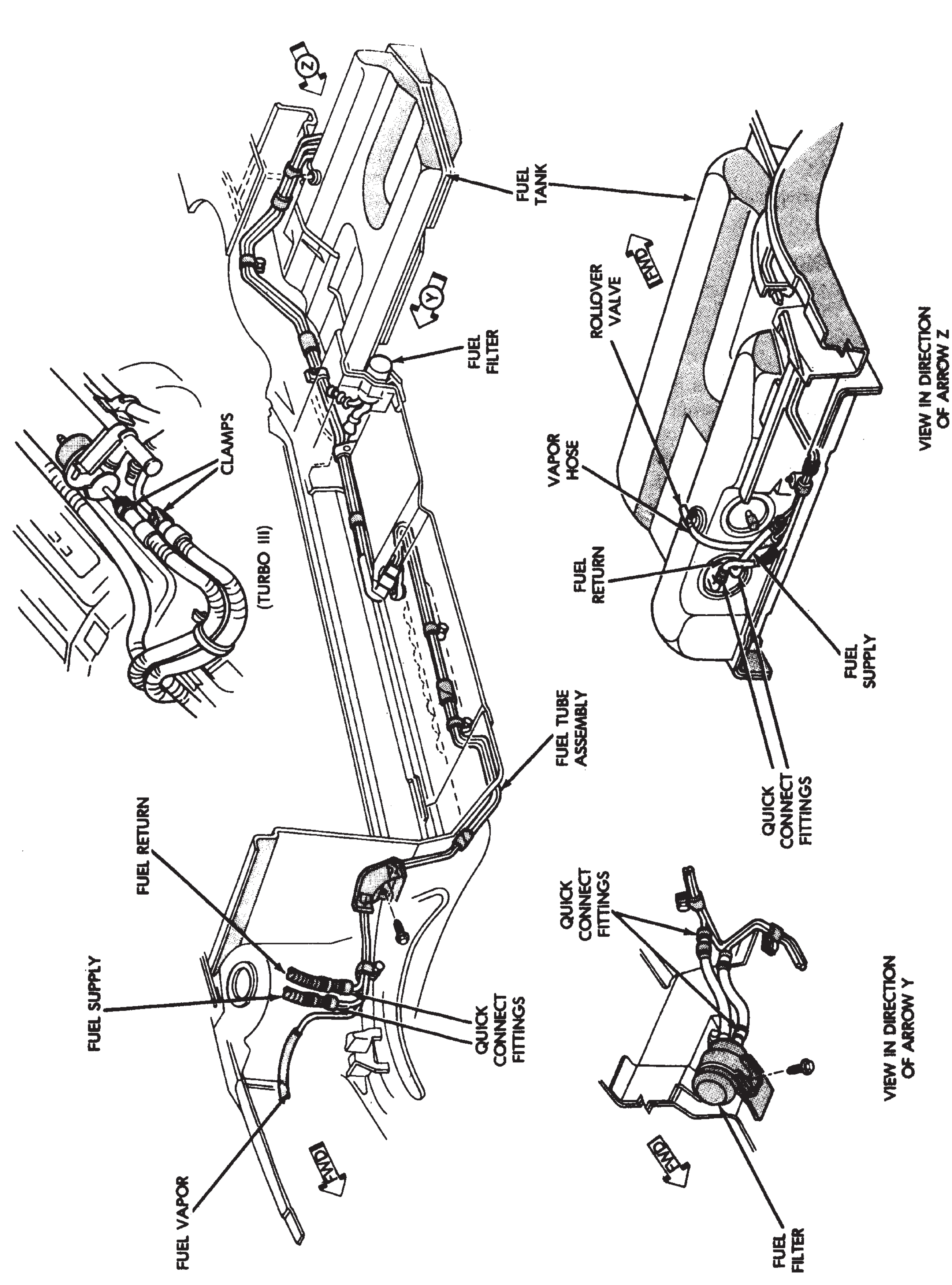

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Fig. 12 Fuel Tank, Filter, and Chassis Line Routing

FUEL TANKS

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GENERAL INFORMATION

The fuel tanks of Chrysler Corporation built vehicles are equipped with fuel and vapor controls that allow the vehicle to pass a full 360° rollover without fuel leakage.

The fuel delivery system used on front wheel drive vehicles contains a fuel tank pressure relief/rollover valve. The valve mounts on the top of the fuel tank. The valve functions as a pressure relief valve while the vehicle is upright. The valve also contains a check valve that prevents fuel from escaping from the fuel tank if the vehicle turns over.

The fuel filler cap also acts as a pressure/vacuum valve. When pressure inside the fuel tank gets too high or too low, the fuel filler cap opens to relieve the difference in air pressure.

An evaporation control system restricts fuel evaporation into the atmosphere and reduces unburned hydrocarbons. Vapors from the fuel tank are collected in a charcoal filled canister. The vapors are held in the canister until the engine is operating. When the engine operates, vapors are drawn through the intake manifold into the combustion chambers.

FUEL TANK FILLER TUBE

As a reminder, a label that reads Unleaded Fuel Only is attached to the instrument panel under the fuel gauge. A similar label is located near the fuel tank filler.

PRESSURE VACUUM FILLER CAPS

The loss of any fuel or vapor out of the filler neck is prevented by the use of a safety filler cap. The cap releases only under significant pressure 10.9 to 13.45 kPa (1.58 to 1.95 psi). The vacuum release for all gas caps is between .97 and 2.0 kPa (.14 and .29 psi). The cap must be replaced by a similar unit in order for the system to remain effective.

WARNING: REMOVE FILLER CAP TO RELIEVE TANK PRESSURE BEFORE REMOVING OR REPAIRING FUEL SYSTEM COMPONENTS.

FUEL TANK CAPACITIES

Vehicle	Liters	U.S. Gallons
AG, AJ, AP	53.0	14.0
AA, AC, AY	60.0	16.0

Nominal refill capacities are shown. A variation may be observed from vehicle to vehicle due to manufacturing tolerance and refill procedure.

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FUEL SYSTEM PRESSURE RELEASE PROCEDURE

The 2.2L/2.5L TBI engine fuel system is regulated to a constant pressure of approximately 270 kPa (39 psi). The fuel systems of 3.0L and 3.3L engines are regulated to a constant pressure of approximately 330 kPa (48 psi). The 2.2L Turbo III and 2.5L Turbo I fuel system pressure is regulated to approximately 55 psi.

Fuel system pressure must be released before servicing any fuel system component.

(1) Remove fuel filler cap to release fuel tank pressure.

(2) Disconnect injector wiring harness from engine or main harness.

(3) Connect a jumper wire from terminal Number 1 (ground) of the injector harness (Fig. 1) to engine ground.

(4) Connect one end of a jumper wire to terminal Number 2 (positive) of the injector harness (Fig. 1). Connect the other end to the positive post of the battery for no longer than 5 seconds. This releases system pressure.

(5) Remove jumper wires.

(6) Continue fuel system service.

FUEL TANK

DRAINING FUEL TANK

(1) Remove fuel filler cap.

(2) Perform the Fuel System Pressure Release procedure.

(3) Remove ground cable from battery.

(4) Raise vehicle on hoist.

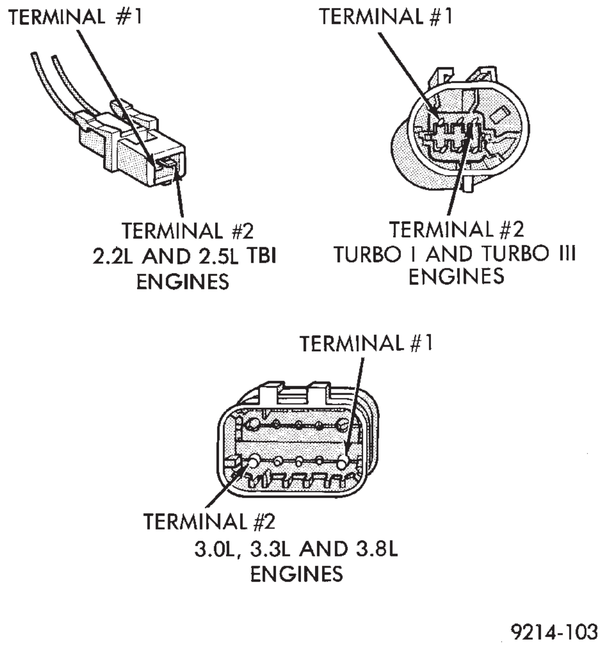

Fig. 1 Injector Harness Connectors

(5) Remove rubber cap from drain tube. The tube is located on rear of fuel tank. Connect either a portable holding tank or a siphon hose to the drain tube (Fig. 2).

(6) Drain fuel tank, until dry, into holding tank or a properly labeled **Gasoline** safety container.

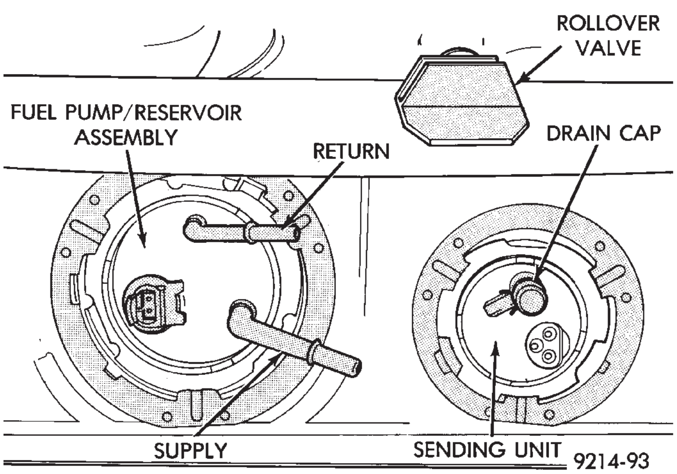

Fig. 2 Drain Tube Connection Location

FUEL TANK REMOVAL

(1) Perform fuel system pressure release.

(2) Drain fuel tank. Refer to Draining Fuel Tank in this section.

(3) Remove fuel filler tube to quarter panel screws (Fig. 3).

(4) Raise vehicle on hoist. Some models will require removal of the right rear wheel to access the fuel filler tube.

WARNING: WRAP SHOP TOWELS AROUND HOSES TO CATCH ANY GASOLINE SPILLAGE.

(5) Disconnect fuel pump and gauge sending unit electrical connectors.

(6) Disconnect the fuel supply and return hoses from fuel pump. Refer to Quick Connect Hoses in the Fuel Delivery section of this group.

(7) Support tank with transmission jack. Loosen tank mounting straps and lower tank slightly. Remove hose from pressure relief/rollover valve.

(8) Carefully work fuel filler tube from tank.

(9) Remove tank mounting straps and lower tank.

INSTALLATION

(1) Position fuel tank on transmission jack. Connect vapor separator/rollover valve hose and position insulator pad on fuel tank. Position vapor vent so that it is not pinched between tank and floor pan during installation.

(2) Raise tank and fuel filler tube carefully into position. Use a light coating of power steering fluid to ease fuel filler tube installation. Ensure filler tube grommet is not damaged. Verify that the tube is installed correctly.

(3) Tighten fuel tank strap nuts to 23 N●m (250 in. lbs.) torque. Remove transmission jack. Ensure straps are not twisted or bent.

(4) Lubricate the metal tubes on the fuel pump with clean 30 weight engine oil. Install the quick connect fuel fittings. Refer to Tube/Fitting Assembly in the Fuel Delivery section of this Group.

(5) Lower the vehicle.

(6) Attach filler tube to filler neck opening in quarter panel. Tighten quarter panel screws to 2 N●m (17 in. lbs.) torque.

(7) Fill fuel tank, install filler cap, and connect battery cable.

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(8) Use the DRB II tester ASD Fuel System Test to pressurize the fuel system. Check for leaks.

FUEL PUMP

Refer to the Fuel Delivery section for fuel pump service.

FUEL RESERVOIR

The fuel reservoir is internal to the fuel pump assembly. The purpose is to provide fuel at the fuel pump intake during all driving conditions, especially when low fuel levels are present.

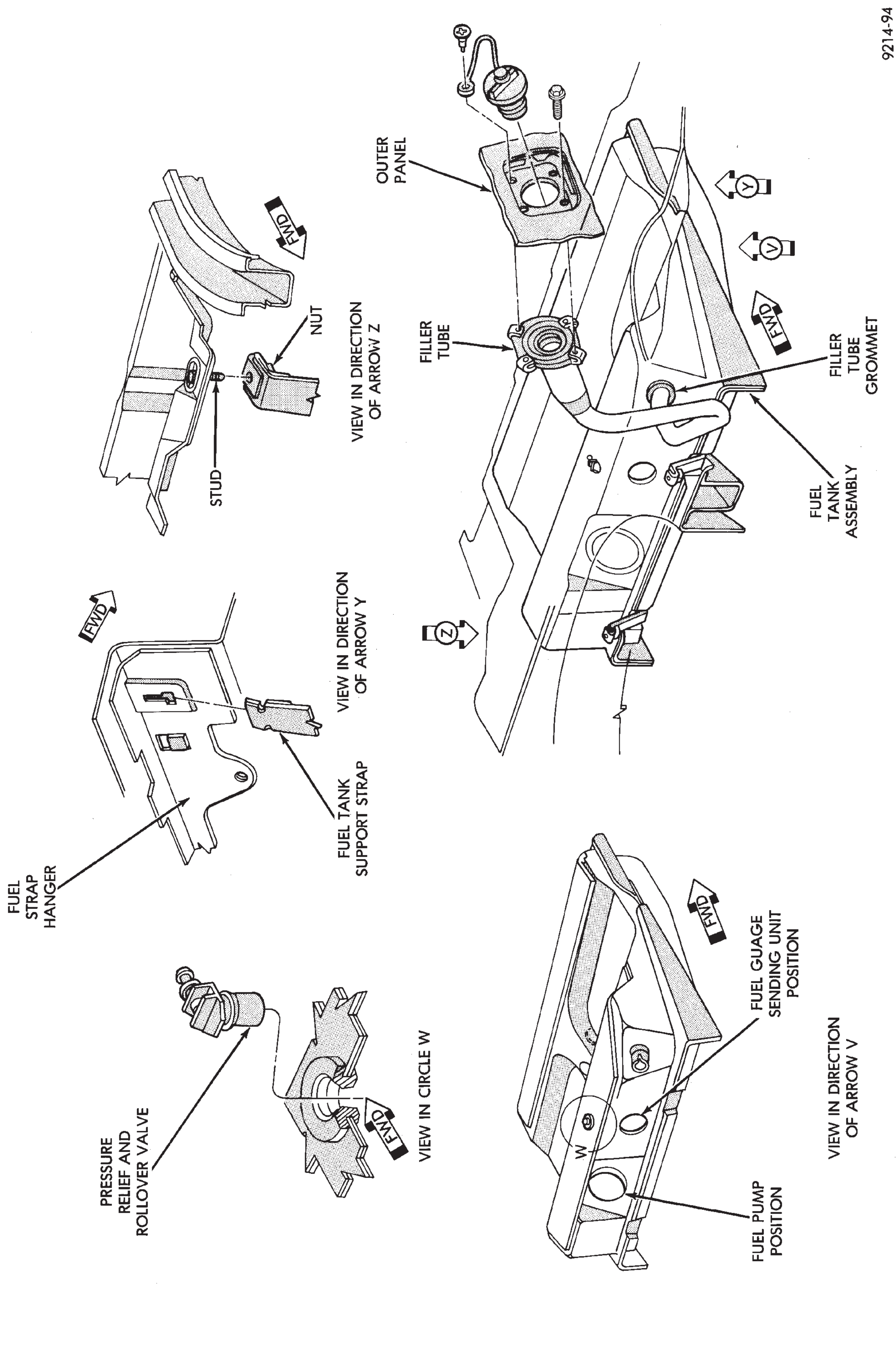

Fig. 3 Fuel Tank Assembly

FUEL LEVEL SENDING UNIT

DIAGNOSIS

Refer to Group 8—Electrical

REMOVAL

The fuel tank must be removed to service the fuel sending unit. Refer to Fuel Tank Removal in this section.

(1) Using a hammer and brass drift punch, carefully tap lock ring counterclockwise to release sending unit.

(2) Lift level unit and O-ring away from tank (Fig. 4).

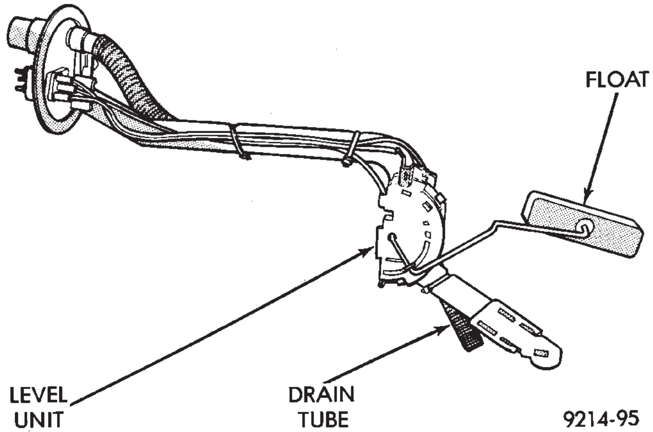

Fig. 4 Fuel Tank Sending Unit

INSTALLATION

(1) Wipe seal area of tank clean and place a new O-ring seal in position.

(3) Place sending unit in tank. Position lock ring in place. Using a brass drift and hammer, tap ring in a clockwise direction (Fig. 5).

(4) Install tank.

FUEL TANK PRESSURE RELIEF AND ROLL-OVER VALVE

REMOVAL

(1) Remove fuel tank. Refer to Fuel Tank Removal in this section.

(2) Wedge the blade of a screwdriver between the rubber grommet and the fuel tank where the support rib is located (Fig. 6). **Do not wedge between the valve and the grommet. This could damage the valve during removal.**

(3) Use a second screwdriver as a support to pry the valve and grommet assembly from the tank.

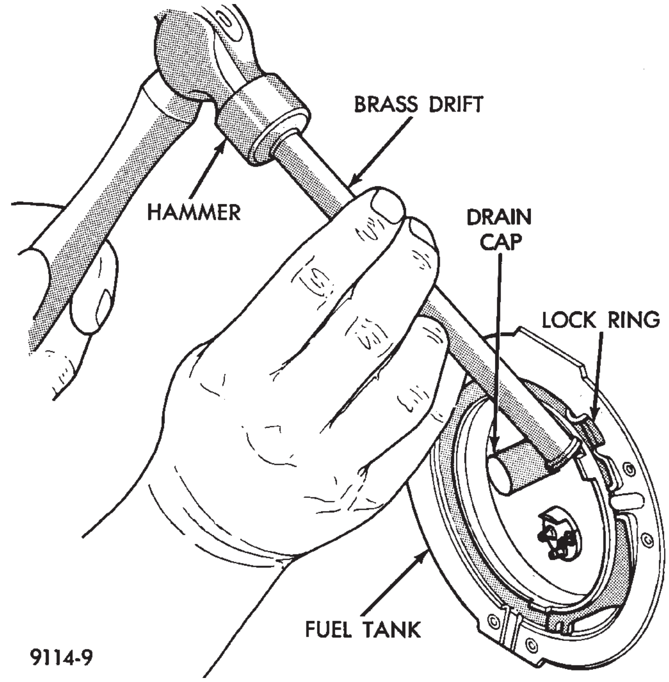

Fig. 5 Servicing Sending Unit

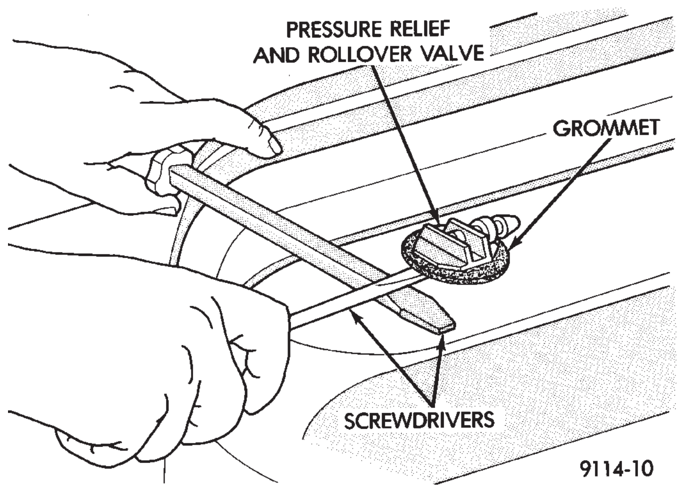

Fig. 6 Removing Pressure Relief/Rollover Valve

(4) Place the valve upright on a flat surface. Push down on the grommet and peel it off the valve.

INSTALLATION

(1) Install the rubber grommet in the fuel tank by working it around the curled lip of the tank (Fig. 7).

CAUTION: Only use power steering fluid to lubricate the pressure relief/rollover valve grommet.

(2) Lightly lubricate the grommet with power steering fluid only and push the valve downward into the grommet. Twist valve until properly positioned.

(3) Install fuel tank (refer to fuel tank installation).

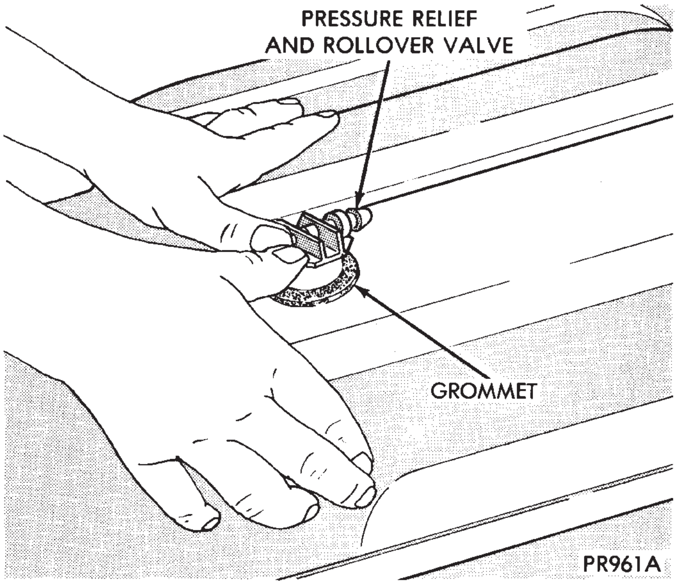

Fig. 7 Installing Pressure Relief/Rollover Valve

ACCELERATOR PEDAL AND THROTTLE CABLE

INDEX

ACCELERATOR PEDAL

CAUTION: When servicing the accelerator pedal, throttle cable or speed control cable, do not damage or kink the control cable core wire.

REMOVAL

(1) Working from the engine compartment, hold the throttle body throttle lever in the wide open position. Remove the throttle cable from the throttle body cam.

(2) From inside the vehicle, hold up the pedal and remove the cable retainer and throttle cable from the upper end of the pedal shaft (Fig. 1 and Fig. 2).

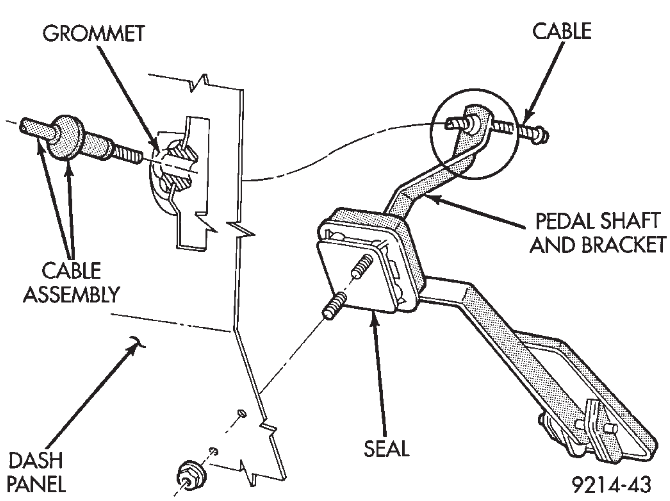

Fig. 1 Accelerator Pedal and Throttle Cable—Front View

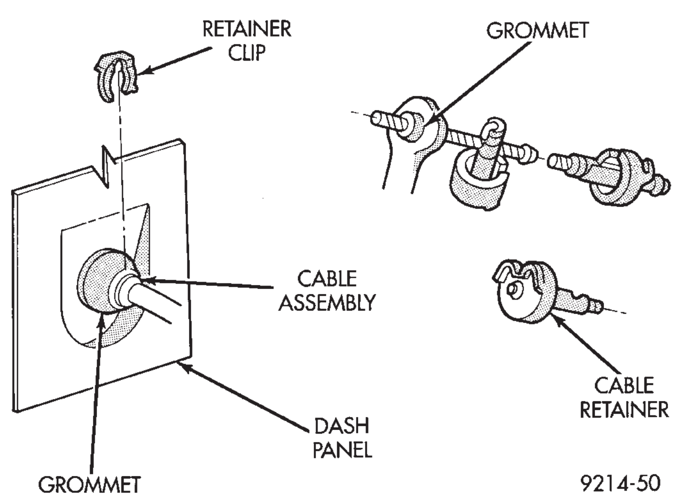

Fig. 2 Accelerator Pedal and Throttle Cable—Rear View

(3) Working from the engine compartment, remove nuts from accelerator pedal assembly studs (Fig. 1). Remove assembly from vehicle.

INSTALLATION

(1) Position accelerator pedal assembly on dash panel. Install retaining nuts. Tighten retaining nuts to 12 N●m (105 in. lbs.) torque.

(2) From inside the vehicle, hold up the pedal and install the throttle cable and cable retainer in the upper end of the pedal shaft.

(3) From the engine compartment, hold the throttle body lever in the wide open position and install the throttle cable.

THROTTLE CABLE

REMOVAL

(1) Working from the engine compartment, hold throttle lever in the wide open position and remove the throttle cable from the throttle body cam (Fig. 3, 4, 5, 6 and 7).

(2) From inside the vehicle, hold the throttle pedal up and remove the cable retainer and cable from upper end of pedal shaft (Fig. 1 and Fig. 2).

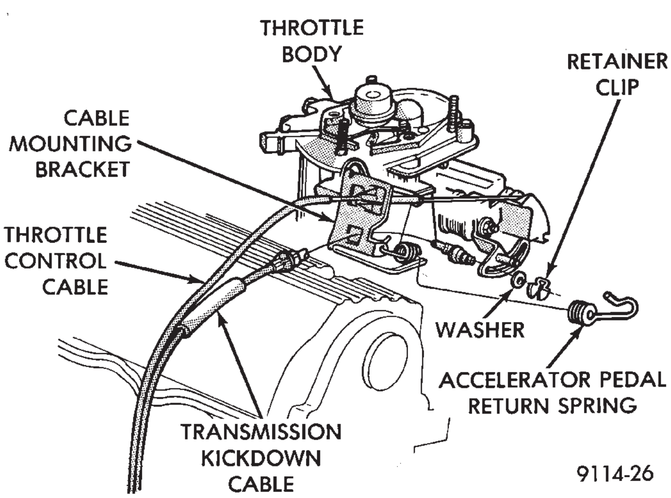

Fig. 3 Throttle Cable Attachment to Throttle Body—TBI Engine

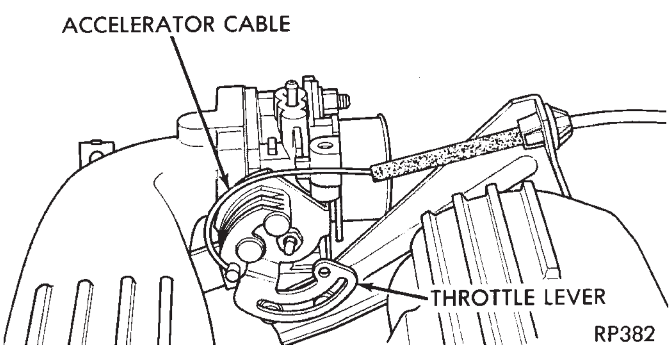

Fig. 4 Throttle Cable Attachment to Throttle Body—Turbo I Engine

(3) Remove retainer clip from throttle cable and grommet at the dash panel (Fig. 2).

(4) From the engine compartment, pull the throttle cable out of the dash panel grommet. The grommet should remain in the dash panel.

(5) Remove the throttle cable from the throttle bracket by carefully compressing both retaining tabs simultaneously. Gently pull throttle cable from throttle bracket.

INSTALLATION

(1) From the engine compartment, push the housing end fitting into the dash panel grommet.

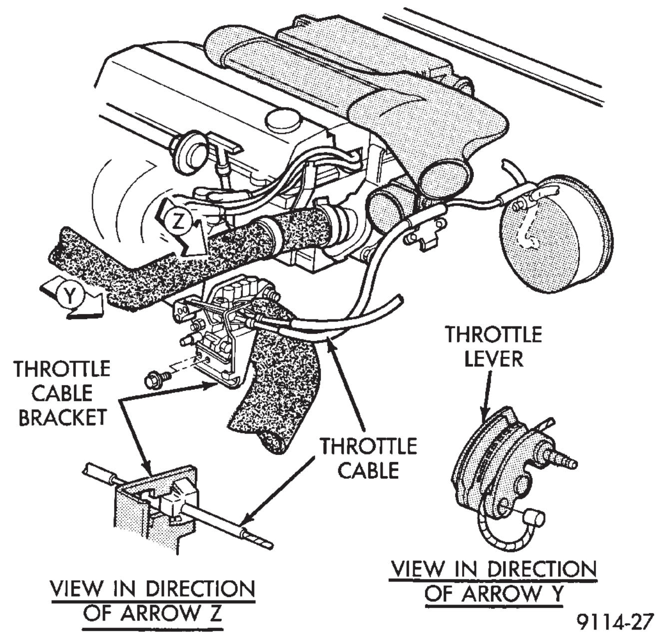

Fig. 5 Throttle Cable Attachment to Throttle Body—Turbo III Engine

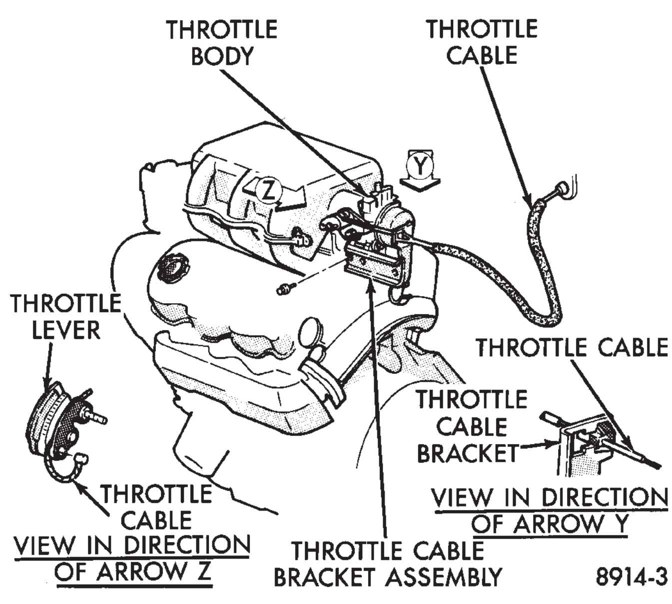

Fig. 6 Throttle Cable Attachment to Throttle Body—3.0L Engine

(2) Install cable housing (throttle body end) into the cable mounting bracket on the engine.

(3) From inside the vehicle, hold up pedal and feed throttle cable core wire through hole in upper end of the pedal shaft. Install cable retainer (Fig. 2).

(4) Install cable retainer clip (Fig. 2).

(5) From the engine compartment, rotate the throttle lever to the wide open position and install throttle cable.

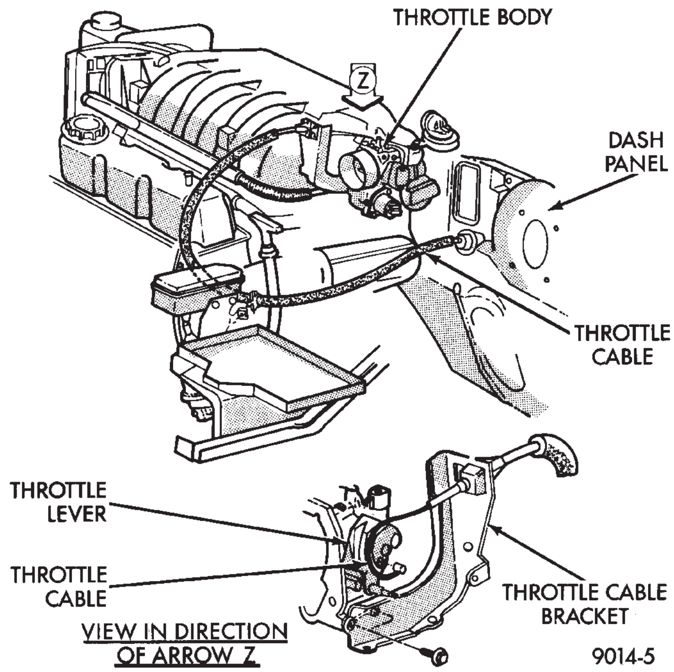

Fig. 7 Throttle Cable Attachment to Throttle Body—3.3L and 3.8L Engines

2.2L/2.5L SINGLE POINT FUEL INJECTION—SYSTEM OPERATION

INDEX

GENERAL INFORMATION

The computer regulated, Electronic Fuel Injection System (Fig. 1) provides a precise air/fuel ratio for all driving conditions. The fuel injection system is controlled by the Single Board Engine Controller II (SBEC II), **referred to in this manual as the engine controller**.

The engine controller is a pre-programmed digital computer.

The engine controller regulates ignition timing, air-fuel ratio, emission control devices, cooling fan, charging system, speed control, and idle speed. The engine controller can adapt its requirement to meet changing operating conditions.

system, the information is stored in memory. Technicians can display fault information through the instrument panel Check Engine lamp or by connecting the Diagnostic Readout Box II (DRB II). For fault code information, refer to On Board Diagnostics in 2.2L/2.5L Single Point Fuel Injection—General Diagnosis section of this group.

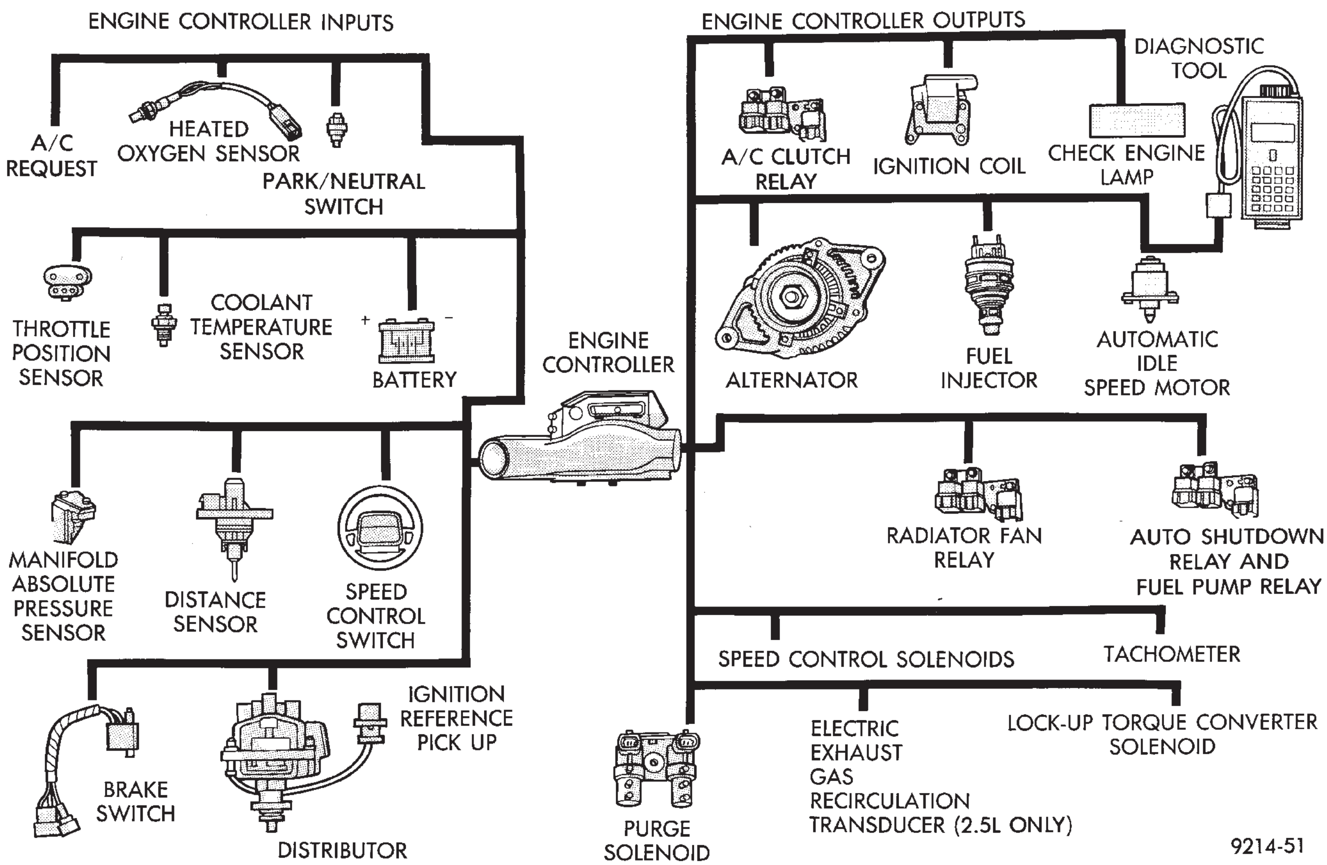

Fig. 1 Electronic Fuel Injection Components

Various sensors provide the inputs necessary for the engine controller to correctly regulate fuel flow at the fuel injector. These include the manifold absolute pressure, throttle position, oxygen sensor, coolant temperature, and vehicle distance sensors. In addition to the sensors, various switches and relays provide important information and system control. The inputs include the park/neutral switch and air conditioning clutch switch. The outputs include the auto shutdown relay and fuel pump relay.

All inputs to the engine controller are converted into signals. Based on these inputs the engine controller adjusts air-fuel ratio, ignition timing and other controlled outputs. The engine controller adjusts the air-fuel ratio by changing the injector pulse width. Injector pulse width is the period of time the injector is energized.

SYSTEM DIAGNOSIS

The engine controller tests many of its own input and output circuits. If a fault is found in a major

CCD BUS

Various controllers and modules exchange information through a communications port called the CCD Bus. The engine controller transmits vehicle load data on the CCD Bus.

ENGINE CONTROLLER

The engine controller is a digital computer containing a microprocessor (Fig. 2). The controller receives input signals from various switches and sensors that are referred to as Engine Controller Inputs. Based on these inputs, the controller adjusts various engine and vehicle operations through devices that are referred to as Engine Controller Outputs.

Engine Controller Inputs:
- Air Conditioning Controls
- Battery Voltage
- Brake Switch
- Coolant Temperature Sensor
- Distributor (Hall Effect) Pick-up
- Manifold Absolute Pressure (MAP) Sensor

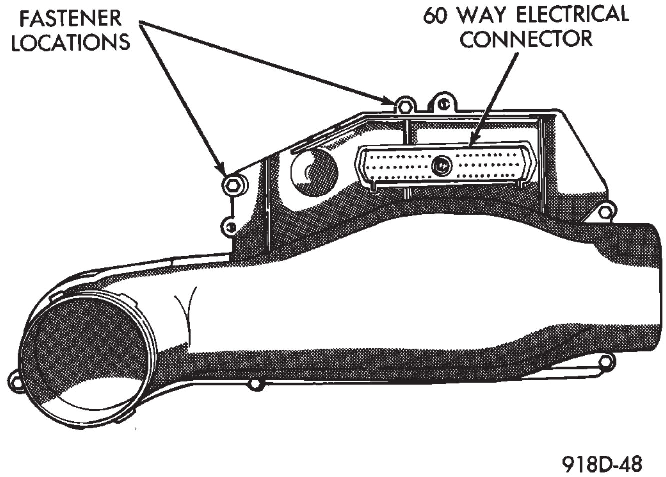

Fig. 2 Engine Controller

- Oxygen Sensor
- SCI Receive
- Speed Control System Controls
- Throttle Position Sensor
- Park/Neutral Switch (automatic transmission)
- Vehicle Distance (Speed) Sensor

Engine Controller Outputs:

- Air Conditioning Clutch Relay
- Alternator Field
- Automatic Idle Speed (AIS) Motor
- Auto Shutdown (ASD) Relay
- Canister Purge Solenoid
- Check Engine Lamp
- Diagnostic Connector
- Electronic EGR Transducer
- Fuel Injector
- Ignition Coil
- Part Throttle Unlock Solenoid (Automatic Transmission)
- Radiator Fan Relay
- Speed Control Solenoids
- Tachometer Output

Based on inputs it receives, the engine controller adjusts fuel injector pulse width, idle speed, ignition spark advance, ignition coil dwell and canister purge operation. The engine controller regulates operation of the EGR, cooling fan, A/C and speed control systems. The controller changes alternator charge rate by adjusting the alternator field.

The engine controller adjusts injector pulse width (air-fuel ratio) based on the following inputs.

- battery voltage
- coolant temperature
- exhaust gas content
- engine speed (distributor pick-up)
- manifold absolute pressure
- throttle position

The engine controller adjusts ignition timing based on the following inputs.

- coolant temperature
- engine speed (distributor pick-up)
- manifold absolute pressure
- throttle position

The Auto Shutdown (ASD) and Fuel Pump relays are mounted externally, but turned on and off by the engine controller through the same circuit.

The distributor pick-up signal is sent to the engine controller. If the engine controller does not receive a distributor signal within approximately one second of engine cranking, it de-activates the ASD relay and fuel pump relay. When these relays are deactivated, power is shut off from the fuel injector, fuel pump, ignition coil, and oxygen sensor heater element.

The engine controller contains a voltage converter that changes battery voltage to a regulated 9.0 volts to power the distributor pick-up and vehicle speed sensor. The controller also provides a 5.0 volts supply for the coolant temperature sensor, manifold absolute pressure sensor and throttle position sensor.

AIR CONDITIONING SWITCH SENSE—ENGINE CONTROLLER INPUT

When the air conditioning or defrost switch is put in the ON position and the low pressure and high pressure switches are closed, the engine controller receives an input indicating that the air conditioning has been selected. After receiving this input, the engine controller activates the A/C compressor clutch by grounding the A/C clutch relay. The engine controller also adjusts idle speed to a scheduled RPM to compensate for increased engine load.

BATTERY VOLTAGE—ENGINE CONTROLLER INPUT

The engine controller monitors the battery voltage input to determine fuel injector pulse width and alternator field control.

If battery voltage is low the engine controller will increase injector pulse width.

BRAKE SWITCH—ENGINE CONTROLLER INPUT

When the brake switch is activated, the engine controller receives an input indicating that the brakes are being applied. After receiving the input, the controller vents the speed control servo. Venting the servo turns the speed control system off.

COOLANT TEMPERATURE SENSOR—ENGINE CONTROLLER INPUT

The coolant temperature sensor is installed behind the thermostat housing and ignition coil in the hot box. The sensor provides an input voltage to the engine controller (Fig. 3). As coolant temperature varies, the sensors resistance changes, resulting in a different input voltage to the engine controller.

The engine controller demands slightly richer air-fuel mixtures and higher idle speeds until the engine reaches normal operating temperature.

This sensor is also used for cooling fan control.

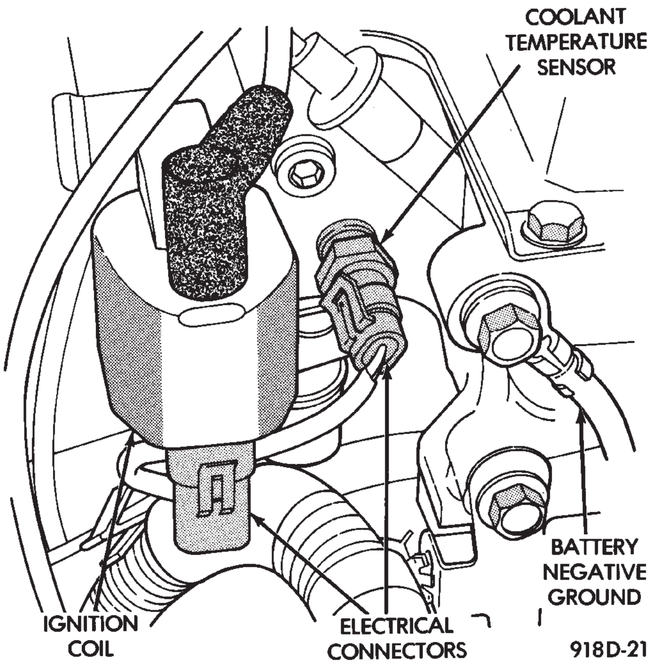

Fig. 3 Coolant Temperature Sensor

DISTRIBUTOR (HALL EFFECT) PICK-UP—ENGINE CONTROLLER INPUT

The distributor pick-up supplies engine speed to the engine controller. The distributor pick-up is a Hall Effect device (Fig. 4).

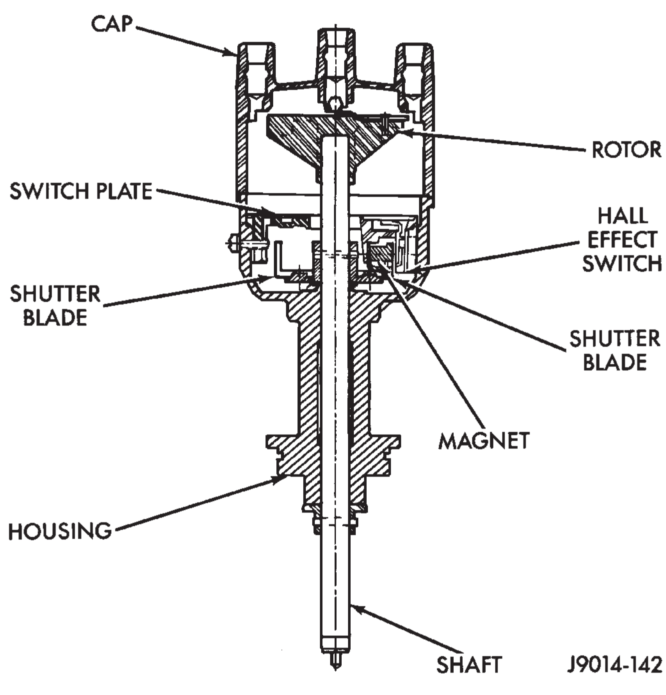

Fig. 4 Distributor Pick-Up—Typical

A shutter (sometimes referred to as an interrupter) is attached to the distributor shaft. The shutter contains four blades, one per engine cylinder. A switch plate is mounted to the distributor housing above the shutter. The switch plate contains the distributor pick-up which is a Hall Effect device and magnet. The shutter blades rotate through the distributor pick-up. As the shutter blades pass through the pick-up, they interrupt the magnetic field. The Hall effect device in the pick-up senses the change in the magnetic field and switches on and off (which creates pulses), generating the input signal to the engine controller. The engine controller calculates engine speed through the number of pulses generated.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—ENGINE CONTROLLER INPUT

The engine controller supplies 5 volts to the MAP sensor. The MAP sensor converts intake manifold pressure into voltage. The engine controller monitors the MAP sensor output voltage. As vacuum increases, MAP sensor voltage decreases proportionately. Also, as vacuum decreases, MAP sensor voltage increases proportionately.

During cranking, before the engine starts running, the engine controller determines atmospheric air pressure from the MAP sensor voltage. While the engine operates, the controller determines intake manifold pressure from the MAP sensor voltage.

Based on MAP sensor voltage and inputs from other sensors, the engine controller adjusts spark advance and the air/fuel mixture.

The MAP sensor mounts on the dash panel (Fig. 5). A vacuum hose connects the sensor to the throttle body.

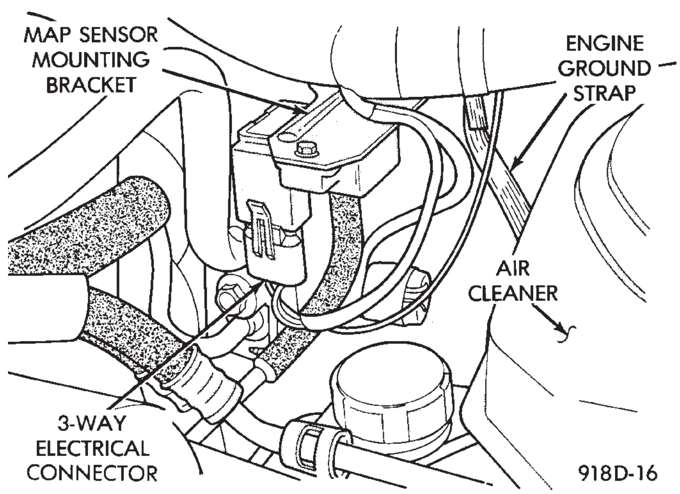

Fig. 5 Manifold Absolute Pressure (MAP) Sensor Location

OXYGEN SENSOR (O_2 SENSOR)—ENGINE CONTROLLER INPUT

The O_2 sensor is located in the exhaust manifold and provides an input voltage to the engine controller. The input tells the engine controller the oxygen content of the exhaust gas (Fig. 6). The engine controller uses the information to fine tune the air-fuel ratio by adjusting injector pulse width.

The O_2 sensor produces voltages from 0 to 1 volt, depending upon the oxygen content of the exhaust

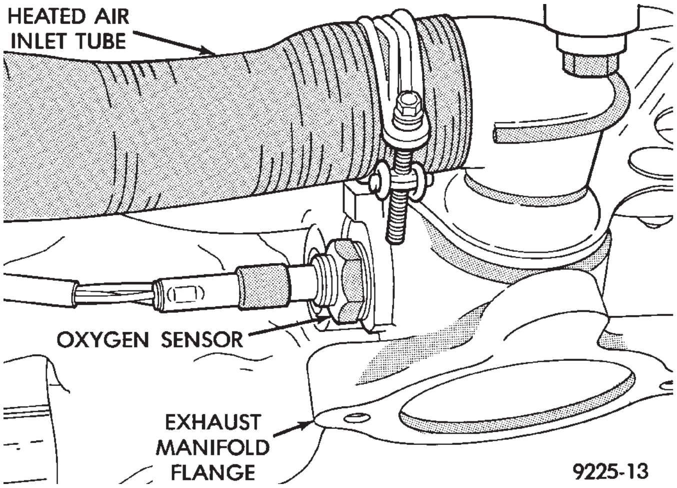

Fig. 6 Oxygen Sensor

gas. When a large amount of oxygen is present (caused by a lean air-fuel mixture), the sensor produces a low voltage. When there is a lesser amount present (rich air-fuel mixture), it produces a higher voltage. By monitoring the oxygen content and converting it to electrical voltage, the sensor acts as a rich-lean switch.

The oxygen sensor is equipped with a heating element that keeps the sensor at proper operating temperature during all operating modes. Maintaining correct sensor temperature at all times allows the system to enter into closed loop operation sooner. Also, it allows the system to remain in closed loop operation during periods of extended idle.

In Closed Loop operation the engine controller monitors the O_2 sensor input (along with other inputs) and adjusts the injector pulse width accordingly. During Open Loop operation the engine controller ignores the O_2 sensor input. The controller adjusts injector pulse width based on a preprogrammed (fixed) oxygen sensor input value and inputs from other sensors.

SPEED CONTROL—ENGINE CONTROLLER INPUT

The speed control system provides four separate voltages (inputs) to the engine controller. The voltages correspond to the On/Off, Set, and Resume.

The speed control ON voltage informs the engine controller that the speed control system has been activated. The speed control SET voltage informs the controller that a fixed vehicle speed has been selected. The speed control RESUME voltage indicates the previous fixed speed is requested. The speed control OFF voltage tells the controller that the speed control system has deactivated. Refer to Group 8H for further speed control information.

TRANSMISSION PARK/NEUTRAL SWITCH—ENGINE CONTROLLER INPUT

The park/neutral switch is located on the automatic transmission housing (Fig. 7). Manual transmissions do not use park neutral switches. The switch provides an input to the engine controller. The input indicates whether the automatic transmission is in Park, Neutral, or a drive gear selection. This input is used to determine idle speed (varying with gear selection), fuel injector pulse width, and ignition timing advance. The park neutral switch is sometimes referred to as the neutral safety switch.

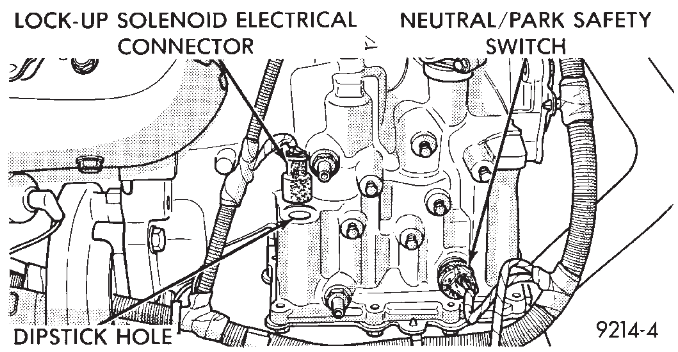

Fig. 7 Park/Neutral Switch

THROTTLE POSITION SENSOR (TPS)—ENGINE CONTROLLER INPUT

The Throttle Position Sensor (TPS) is mounted on the throttle body and connected to the throttle blade shaft (Fig. 8). The TPS is a variable resistor. The sensor provides an input signal (voltage) to the engine controller representing throttle blade position. As the position of the throttle blade changes, the resistance of the TPS changes.

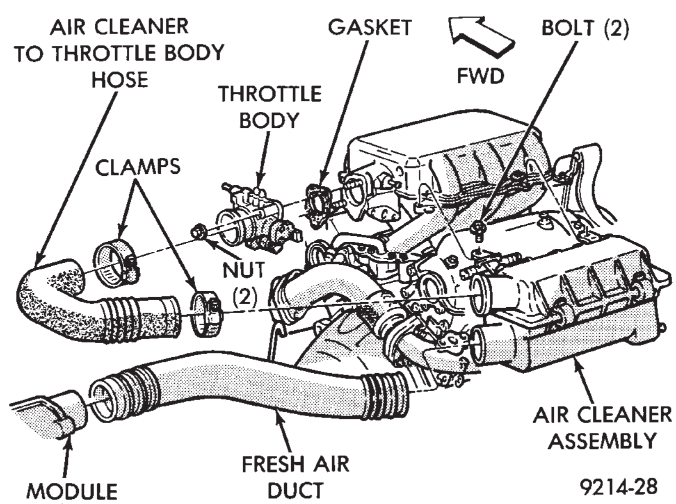

Fig. 8 Throttle Position Sensor

The engine controller supplies approximately 5 volts to the TPS. The TPS output voltage (input signal to the engine controller) represents the throttle blade position. The engine controller receives an input signal voltage from the TPS varying in an approximate range of from 1 volt at minimum throttle opening (idle) to 4 volts at wide open throttle. Along with inputs from other sensors, the engine controller uses the TPS input to determine current engine operating conditions. The controller adjusts fuel injector pulse width and ignition timing based on these inputs.

VEHICLE DISTANCE (SPEED) SENSOR—ENGINE CONTROLLER INPUT

The distance sensor is located in the transmission extension housing (Fig. 9). The sensor input is used by the engine controller to determine vehicle speed and distance traveled.

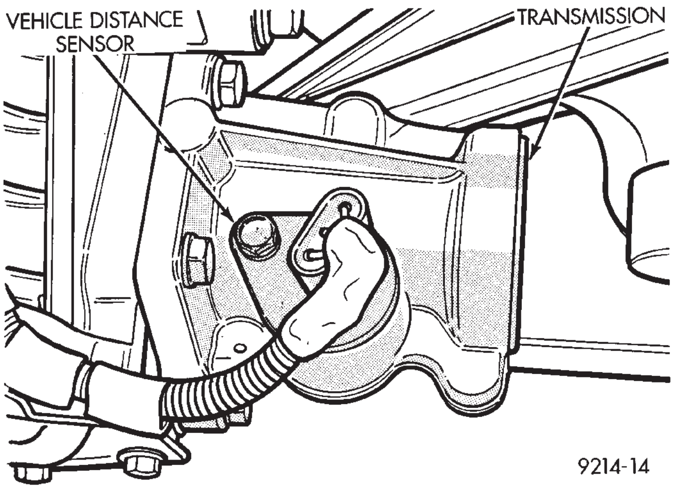

Fig. 9 Vehicle Distance (Speed) Sensor — Typical

The distance sensor generates 8 pulses per sensor revolution. These signals, along with a closed throttle signal from the TPS, determine if a closed throttle deceleration or normal idle condition (vehicle stopped) exists. Under deceleration conditions, the engine controller adjusts the AIS motor to maintain a desired MAP value. Under idle conditions, the engine controller adjusts the AIS motor to maintain a desired engine speed.

AIR CONDITIONING (A/C) CLUTCH RELAY—ENGINE CONTROLLER OUTPUT

The engine controller operates the air conditioning clutch relay ground circuit. The radiator fan relay supplies battery power to the solenoid side of the A/C clutch relay. The air conditioning clutch relay will not energize unless the radiator fan relay energizes. The engine controller energizes the radiator fan relay when the air conditioning or defrost switch is put in the ON position and the low pressure and high pressure switches close.

With the engine operating, the engine controller cycles the air conditioning clutch on and off when the A/C switch closes with the blower motor switch in the on position. When the engine controller senses low idle speeds or wide open throttle through the throttle position sensor, it de-energizes the A/C clutch relay. The relay contacts open, preventing air conditioning clutch engagement.

On AC, AG and AJ models, the A/C clutch is located in the power distribution center. Refer to the Wiring and Component Identification section of Group 8W.

ON AA and AP models, the A/C clutch relay is mounted to the inner fender panel, next to the drivers side strut tower (Fig. 10).

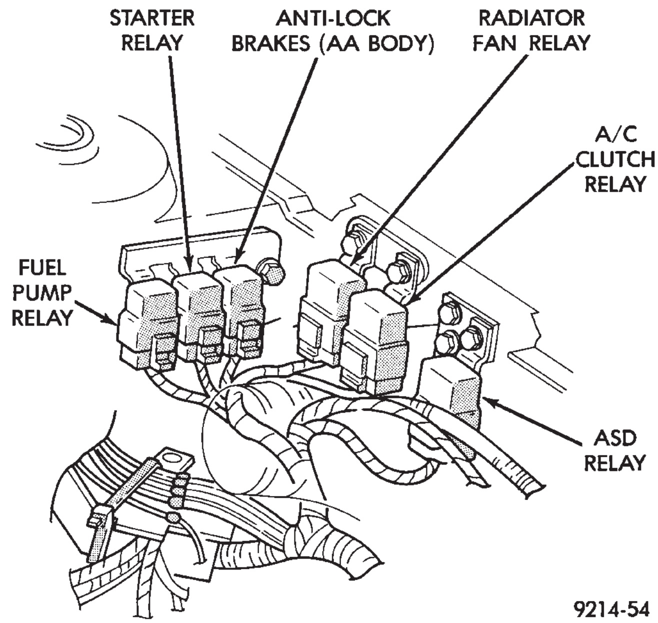

Fig. 10 Relay Identification

ALTERNATOR FIELD—ENGINE CONTROLLER OUTPUT

The engine controller regulates the charging system voltage within a range of 12.9 to 15.0 volts. Refer to Group 8A for charging system information.

AUTO SHUTDOWN (ASD) RELAY AND FUEL PUMP RELAY—ENGINE CONTROLLER OUTPUT

The engine controller operates the auto shutdown (ASD) relay and fuel pump relay through one ground path. The controller operates the relays by switching the ground path on and off. Both relays turn on and off at the same time.

The ASD relay connects battery voltage to the fuel injector and ignition coil. The fuel pump relay connects battery voltage to the fuel pump and oxygen sensor heating element.

The engine controller turns the ground path off when the ignition switch is in the Off position. Both relays are off. When the ignition switch is in the On or Crank position, the engine controller monitors the distributor pick-up signal. From the distributor signal, the controller determines engine speed and ignition timing (coil dwell). If the engine controller does not receive a distributor signal when the ignition switch is in the Run position, it will de-energize both relays. When the relays are de-energized, battery voltage is not supplied to the fuel injector, ignition coil, fuel pump and oxygen sensor heating element.

On AC, AG and AJ models, the ASD relay and fuel pump relay are located in the power distribution center. Refer to the Wiring and Component Identification section of Group 8W.

On AA and AP models, the ASD relay and fuel pump relay are mounted on the drivers side fender well, next to the strut tower (Fig. 10).

AUTOMATIC IDLE SPEED (AIS) MOTOR—ENGINE CONTROLLER OUTPUT

The automatic idle speed stepper motor is mounted on the throttle body (Fig. 11). The engine controller operates the AIS motor. The engine controller adjusts engine idle speed through the AIS to compensate for engine load or ambient conditions.

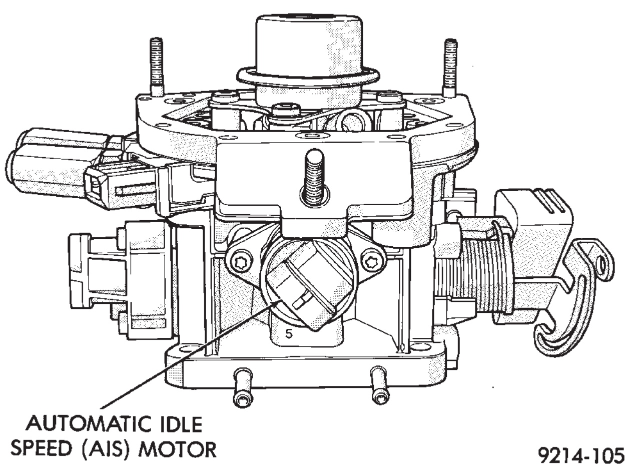

Fig. 11 Automatic Idle Speed Motor

The throttle body has an air bypass passage that provides air for the engine at idle (the throttle blade is closed). The AIS motor pintle protrudes into the air bypass passage and regulates air flow through it.

The engine controller adjusts engine idle speed by moving the AIS motor pintle in and out of the bypass passage. The adjustments are based on inputs the controller receives from the throttle position sensor, speed sensor (distributor pick-up coil), coolant temperature sensor, and various switch operations (brake, park/neutral, air conditioning). Deceleration die out is also prevented by increasing airflow when the throttle is closed quickly after a driving (speed) condition.

CANISTER PURGE SOLENOID—ENGINE CONTROLLER OUTPUT

Vacuum for the Evaporative Canister is controlled by the Canister Purge Solenoid (Fig. 12). The solenoid is controlled by the engine controller.

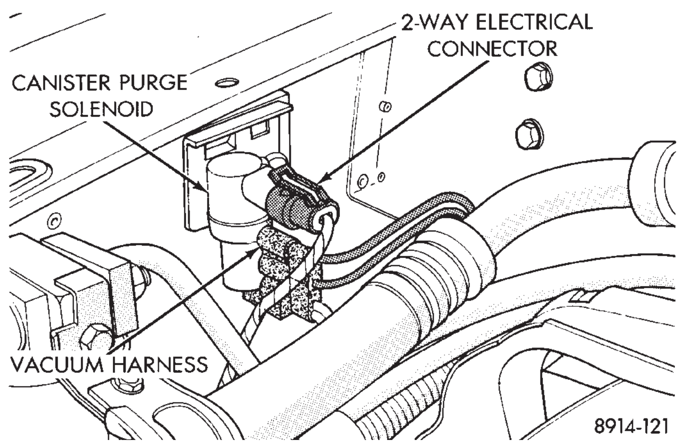

Fig. 12 Canister Purge Solenoid

The engine controller operates the solenoid by switching the ground circuit on and off based on engine operating conditions. When grounded, the solenoid energizes and prevents vacuum from reaching the evaporative canister. When not energized, the solenoid allows vacuum to flow to the canister.

During warm-up and for a specified time period after hot starts, the engine controller grounds the purge solenoid. Vacuum does not operate the evaporative canister valve.

The engine controller removes the ground to the solenoid when the engine reaches a specified temperature and the time delay interval has occurred. When the solenoid is de-energized, vacuum flows to the canister purge valve. Vapors are purged from the canister and flow to the throttle body.

The purge solenoid is also energized during certain idle conditions to update the fuel delivery calibration.

CHECK ENGINE LAMP—ENGINE CONTROLLER OUTPUT

The Check Engine Lamp comes on each time the ignition key is turned ON and stays on for 3 seconds as a bulb test. The Check Engine Lamp warns the operator that the engine controller has entered a Limp-in mode. During Limp-in-Mode, the controller attempts to keep the system operational. The check engine lamp signals the need for immediate service. In limp-in mode, the engine controller compensates for the failure of certain components that send incorrect signals. The controller substitutes for the incorrect signals with inputs from other sensors.

Signals that can trigger the Check Engine Lamp.

- Coolant Temperature Sensor
- Manifold Absolute Pressure Sensor
- Throttle Position Sensor
- Battery Voltage Input
- An Emissions Related System
- Charging system

The Check Engine Lamp can also be used to display fault codes. Cycle the ignition switch on, off, on, off, on, within five seconds and any fault codes stored in the Engine controller will be displayed. Refer to On Board Diagnostics in the General Diagnosis — 2.5L TBI Engines section of this Group for Fault Code Descriptions.

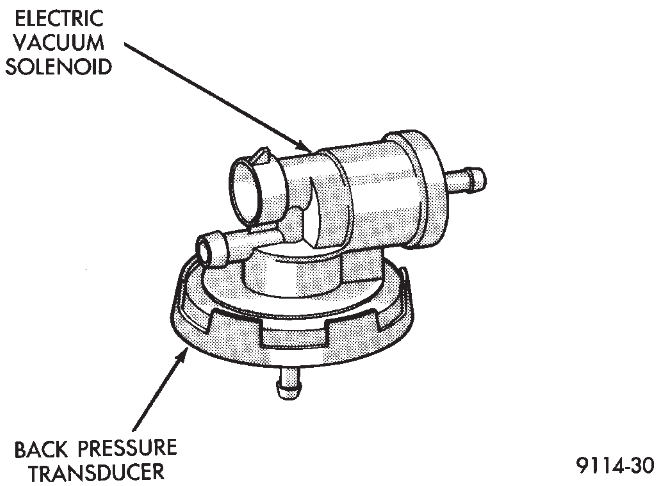

Fig. 13 Electronic EGR Transducer

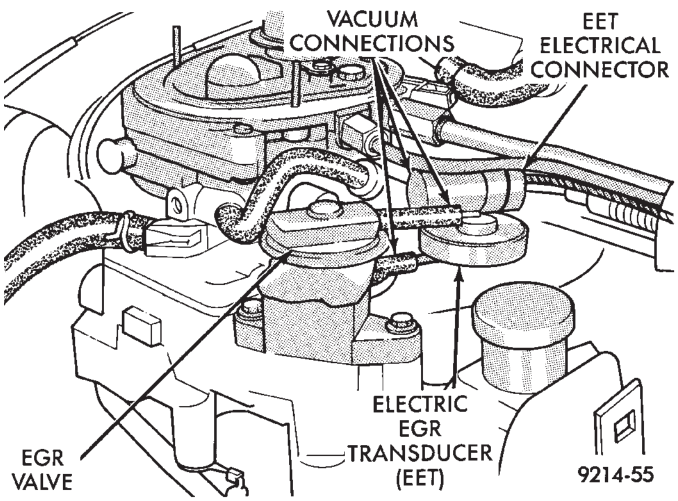

Fig. 14 EGR Valve and Electric EGR Transducer

DIAGNOSTIC CONNECTOR—ENGINE CONTROLLER OUTPUT

The diagnostic connector provides the technician with the means to connect the DRB II tester to diagnosis the vehicle.

ELECTRONIC EGR TRANSDUCER—ENGINE CONTROLLER OUTPUT

The electronic exhaust gas recirculation transducer (EET) is a back pressure transducer/electric vacuum solenoid assembly (Fig. 13). The EET assembly mounts above the EGR valve (Fig. 14).

The solenoid turns the vacuum supply to the transducer on and off. The electric vacuum solenoid portion of the EET energizes when the engine controller provides a ground path. When the solenoid energizes, vacuum is prevented from flowing to the transducer. When the solenoid de-energizes, vacuum flows to the transducer. The solenoid energizes during engine warm-up, closed throttle (idle or cruise), wide open throttle, and rapid acceleration/deceleration. **If the solenoid wire connector is disconnected, the EGR valve will operate at all times.**

FUEL INJECTOR—ENGINE CONTROLLER OUTPUT

The Fuel Injector is an electric solenoid operated by the engine controller (Fig. 15).

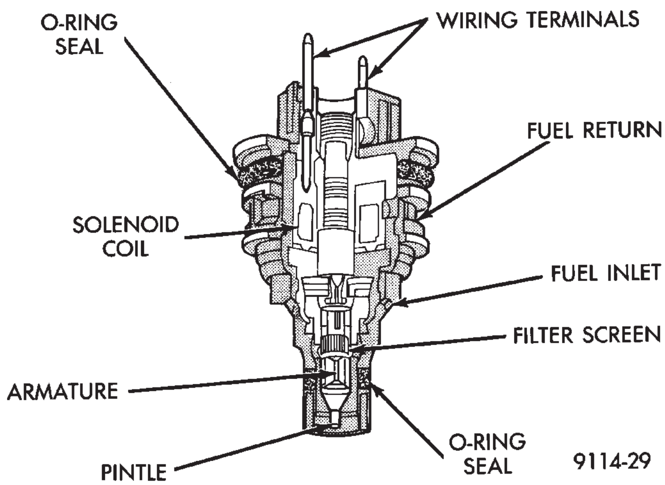

Fig. 15 Fuel Injector

Based on sensor inputs, the engine controller determines when and how long the fuel injector should operate.

The amount of time the injector fires is referred to as injector pulse width. The auto shutdown (ASD) relay supplies battery voltage to the injector. The engine controller supplies the ground path. By switching the ground path on and off, the engine controller adjusts injector pulse width. When the controller supplies a ground path, a spring loaded needle or armature lifts from its seat. Fuel flows through the orifice and deflects off the sharp edge of the injector nozzle. The resulting fuel sprays forms a 45° cone shaped pattern before entering the air stream in the throttle body.

Fuel is supplied to the injector constantly at regulated 270 Kpa (39 psi). Unused fuel returns to the fuel tank.

IGNITION COIL—ENGINE CONTROLLER OUTPUT

The engine controller provides a ground contact (circuit) for energizing the ignition coil. When the controller breaks the contact, the energy in the coil primary transfers to the secondary causing the spark. The engine controller will de-energize the ASD relay if it does not receive an input from the distributor pick-up. Refer to Auto Shutdown (ASD) Relay/Fuel Pump Relay—Engine Controller Output in this section for relay operation.

The ignition coil is mounted on the hot box next to the thermostat housing (Fig. 16).

PART THROTTLE UNLOCK SOLENOID—ENGINE CONTROLLER OUTPUT

Three-speed automatic transaxles use a part throttle unlock solenoid. The engine controller controls the lock-up of the torque convertor through the part throttle unlock solenoid. The transmission is locked up only in direct drive mode. Refer to Group 21 for transmission information.

RADIATOR FAN RELAY—ENGINE CONTROLLER OUTPUT

The radiator fan is energized by the engine controller through the radiator fan relay. The engine controller grounds the radiator fan relay when engine coolant reaches a predetermined temperature. For more information, refer to Group 7, Cooling Systems.

On AC, AG and AJ models, the radiator fan relay is located in the power distribution center. Refer to the Wiring and Component Identification section of Group 8W.

On AA and AP models, the radiator fan relay is mounted on the drivers side fender well, next to the strut tower (Fig. 10).

SPEED CONTROL SOLENOIDS—ENGINE CONTROLLER OUTPUT

The speed control vacuum and vent solenoids are operated by the engine controller. When the engine controller supplies a ground to the vacuum solenoid, the speed control system opens the throttle plate. When the controller supplies a ground to the vent solenoid, throttle blade closes. The engine controller balances the two solenoids to maintain the set speed. Refer to Group 8H for speed control information.

TACHOMETER—ENGINE CONTROLLER OUTPUT

The engine controller supplies engine RPM to the instrument panel tachometer. Refer to Group 8 for tachometer information.

MODES OF OPERATION

As input signals to the engine controller change, the engine controller adjusts its response to the out-

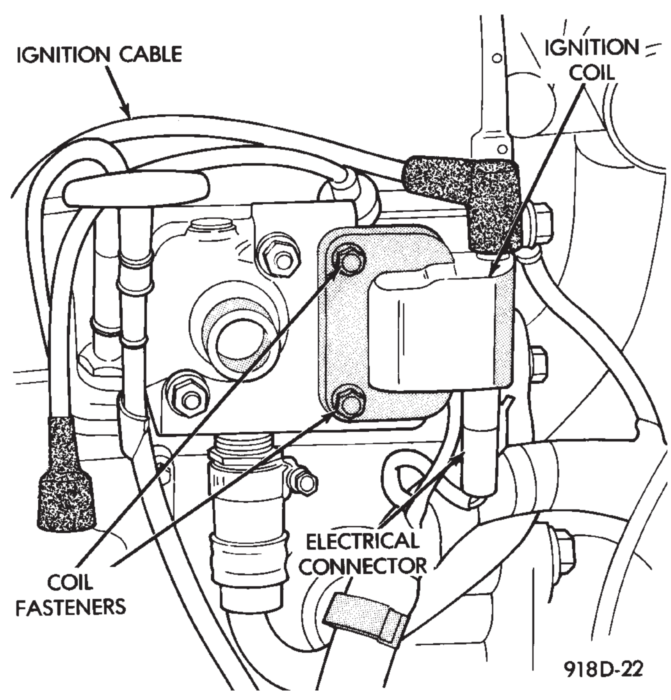

Fig. 16 Ignition Coil

put devices. For example, the engine controller must calculate a different injector pulse width and ignition timing for idle than it does for wide open throttle (WOT). There are several different modes of operation that determine how the engine controller responds to the various input signals.

There are two different areas of operation, OPEN LOOP and CLOSED LOOP.

During OPEN LOOP modes, the engine controller receives input signals and responds according to preset engine controller programming. Input from the oxygen (O_2) sensor is not monitored during OPEN LOOP modes.

During CLOSED LOOP modes, the engine controller does monitor the oxygen (O_2) sensor input. This input tells the controller if the calculated injector pulse width results in an air-fuel ratio of 14.7 to 1. By monitoring the exhaust oxygen content, the can controller fine tune injector pulse width for optimum fuel economy and low emissions.

The single point fuel injection system has the following modes of operation:

- Ignition switch ON - Zero RPM
- Engine start-up
- Engine warm-up
- Cruise (Idle)
- Acceleration
- Deceleration
- Wide Open Throttle
- Ignition switch OFF

The engine start-up (cranking), engine warm-up, and wide open throttle modes are OPEN LOOP modes. The acceleration, deceleration, and cruise modes, **with the engine at operating temperature** are CLOSED LOOP modes (under most operating conditions).

IGNITION SWITCH ON (ZERO RPM) MODE

When the single point fuel injection system is activated by the ignition switch, the following actions occur:

- The engine controller determines atmospheric air pressure from the MAP sensor input to calculate basic fuel strategy.
- The engine controller monitors the coolant temperature sensor and throttle position sensor inputs. The engine controller modifies fuel strategy based on these inputs.

When the key is in the ON position and the engine is not running, the (ASD) and fuel pump relays are not energized. Therefore, battery voltage is not supplied to the fuel pump, ignition coil, fuel injector or oxygen sensor heating element.

ENGINE START-UP MODE

This is an OPEN LOOP mode. The following actions occur when the starter motor is engaged.

If the engine controller receives a distributor signal it energizes the auto shutdown (ASD) relay and fuel pump relay to supply battery voltage to the fuel injector, ignition coil and oxygen sensor heating element. If the engine controller does not receive a distributor input, it de-energizes the ASD and fuel pump relays after approximately one second.

When the engine idles within ±64 RPM of the target RPM, the controller compares the current MAP value with the atmospheric pressure value it received during the Ignition Switch On (Zero RPM) Mode. If a minimum difference between the two is not detected, a MAP sensor fault is set into memory.

Once the ASD relay and fuel pump relay have energized, the engine controller:

- Supplies a ground path to the injector. The injector is pulsed four times per engine revolution instead of the normal two pulses per revolution.
- Determines injector pulse width based on coolant temperature, MAP sensor input, throttle position, and the number of engine revolutions since cranking was initiated.
- Monitors the coolant temperature sensor, distributor pick-up, MAP sensor, and throttle position sensor to determine correct ignition timing.

ENGINE WARM-UP MODE

This is a OPEN LOOP mode. The following inputs are received by the engine controller:

- coolant temperature
- manifold absolute pressure (MAP)
- engine speed (distributor pick-up)
- throttle position
- A/C switch
- battery voltage

The engine controller provides a ground path for the injector to precisely control injector pulse width (by switching the ground on and off) and fires the injector twice per engine revolution. The engine controller regulates ignition timing. It also adjusts engine idle speed through the automatic idle speed motor.

CRUISE OR IDLE MODE

When the engine is at operating temperature this is a CLOSED LOOP mode. During cruising speed and at idle the following inputs are received by the engine controller:

- coolant temperature
- manifold absolute pressure
- engine speed
- throttle position
- exhaust gas oxygen content
- A/C control positions
- battery voltage

The engine controller provides a ground path for the injector to precisely control injector pulse width and fires the injector twice per engine revolution. The engine controller controls engine idle speed and ignition timing. The engine controller controls the air/fuel ratio according to the oxygen content in the exhaust gas.

ACCELERATION MODE

This is a CLOSED LOOP mode. The engine controller recognizes an abrupt increase in throttle position or MAP pressure as a demand for increased engine output and vehicle acceleration. The engine controller increases injector pulse width in response to increased fuel demand.

DECELERATION MODE

This is a CLOSED LOOP mode. During deceleration the following inputs are received by the engine controller:

- coolant temperature
- manifold absolute pressure
- engine speed
- throttle position
- exhaust gas oxygen content
- A/C control positions
- battery voltage

The engine controller may receive a closed throttle input from the throttle position sensor (TPS) at the same time it senses an abrupt decrease in manifold pressure from the manifold absolute pressure (MAP) sensor. This indicates a hard deceleration. The engine controller may reduce injector firing to once per engine revolution. This helps maintain better control of the air-fuel mixture (as sensed through the O_2 sensor).

During a deceleration condition, the engine controller grounds the exhaust gas recirculation transducer (EET) solenoid. EGR stops when the controller grounds the solenoid.

WIDE OPEN THROTTLE MODE

This is an OPEN LOOP mode. During wide open throttle operation, the following inputs are received by the engine controller:

- coolant temperature
- manifold absolute pressure
- engine speed
- throttle position

When the engine controller senses a wide open throttle condition through the throttle position sensor (TPS) it will:

- De-energize the air conditioning relay. This disables the air conditioning system.
- Provide a ground path for the electric EGR transducer (EET) solenoid, preventing the EGR system from functioning.

The exhaust gas oxygen content input is not accepted by the engine controller during wide open throttle operation. The engine controller will adjust injector pulse width to supply a predetermined amount of additional fuel.

IGNITION SWITCH OFF MODE

When the ignition switch is turned to the OFF position, the following occurs:

- All outputs are turned off.
- No inputs are monitored.
- The engine controller shuts down.

FUEL PRESSURE REGULATOR

The pressure regulator is a mechanical device located at the top of the throttle body (Fig. 17). Its function is to maintain a constant 270 kPa (39 PSI) across the fuel injector tip.

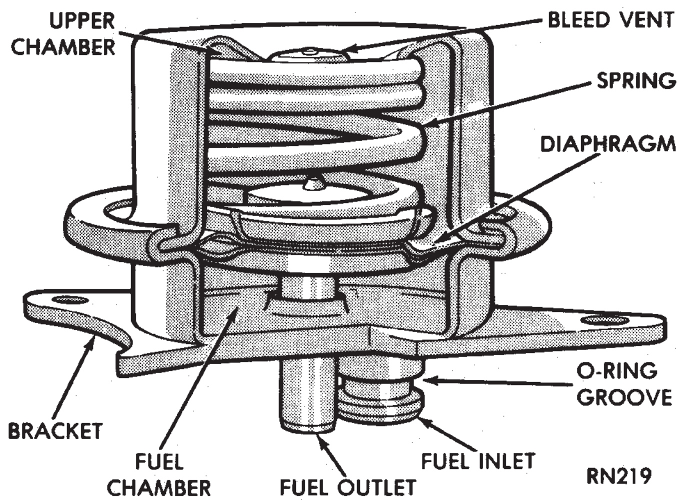

Fig. 17 Fuel Pressure Regulator

The regulator uses a spring loaded rubber diaphragm to uncover a fuel return port. When the fuel pump becomes operational, fuel flows past the injector into the regulator, and is restricted from flowing any further by the blocked return port. When fuel pressure reaches 270 kPa (39 PSI) it pushes on the diaphragm, compresses the spring, and uncovers the fuel return port. The diaphragm and spring constantly move from an open to closed position keeping fuel pressure consistent.

THROTTLE BODY

The throttle body assembly (Fig. 18) is mounted on top of the intake manifold. It contains the fuel injector, pressure regulator, throttle position sensor and automatic idle speed motor. Air flow through the throttle body is controlled by a cable operated throttle blade located in the base of the throttle body. The throttle body itself provides the chamber for metering, atomizing, and mixing fuel with the air entering the engine.

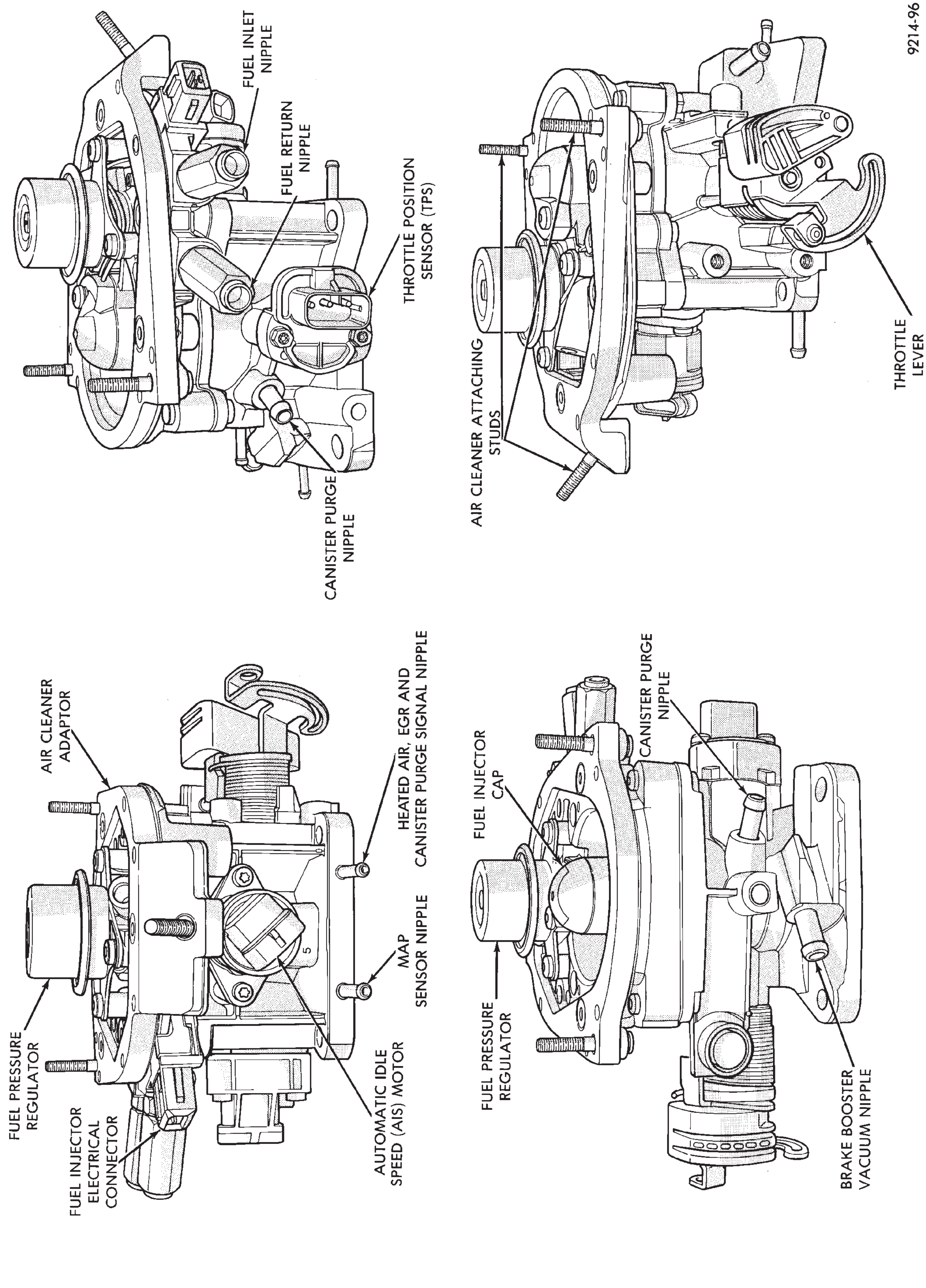

Fig. 18 Throttle Body

2.2L/2.5L SINGLE POINT FUEL INJECTION—GENERAL DIAGNOSIS

INDEX

FUEL SYSTEM DIAGRAM

The fuel injection system is managed by the engine controller. The controller receives inputs from various switches and sensors (Fig. 1). Based on these inputs the engine controller adjusts ignition timing and idle speed through output devices. Refer to the Single Point Fuel Injection System Operation section of this group for system and component descriptions.

VISUAL INSPECTION

Perform a visual inspection for loose, disconnected, or misrouted wires and hoses before diagnosing or servicing the fuel injection system. A visual check helps save unnecessary test and diagnostic time. A thorough visual inspection includes the following checks:

(1) Check Ignition Coil Electrical Connections (Fig. 2).

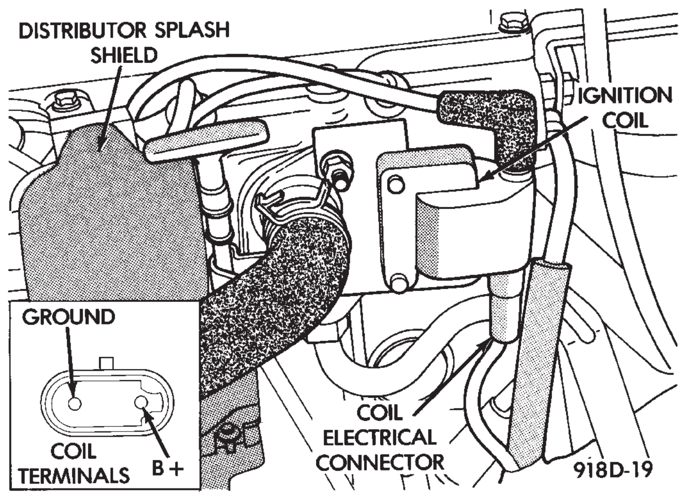

Fig. 2 Ignition Coil

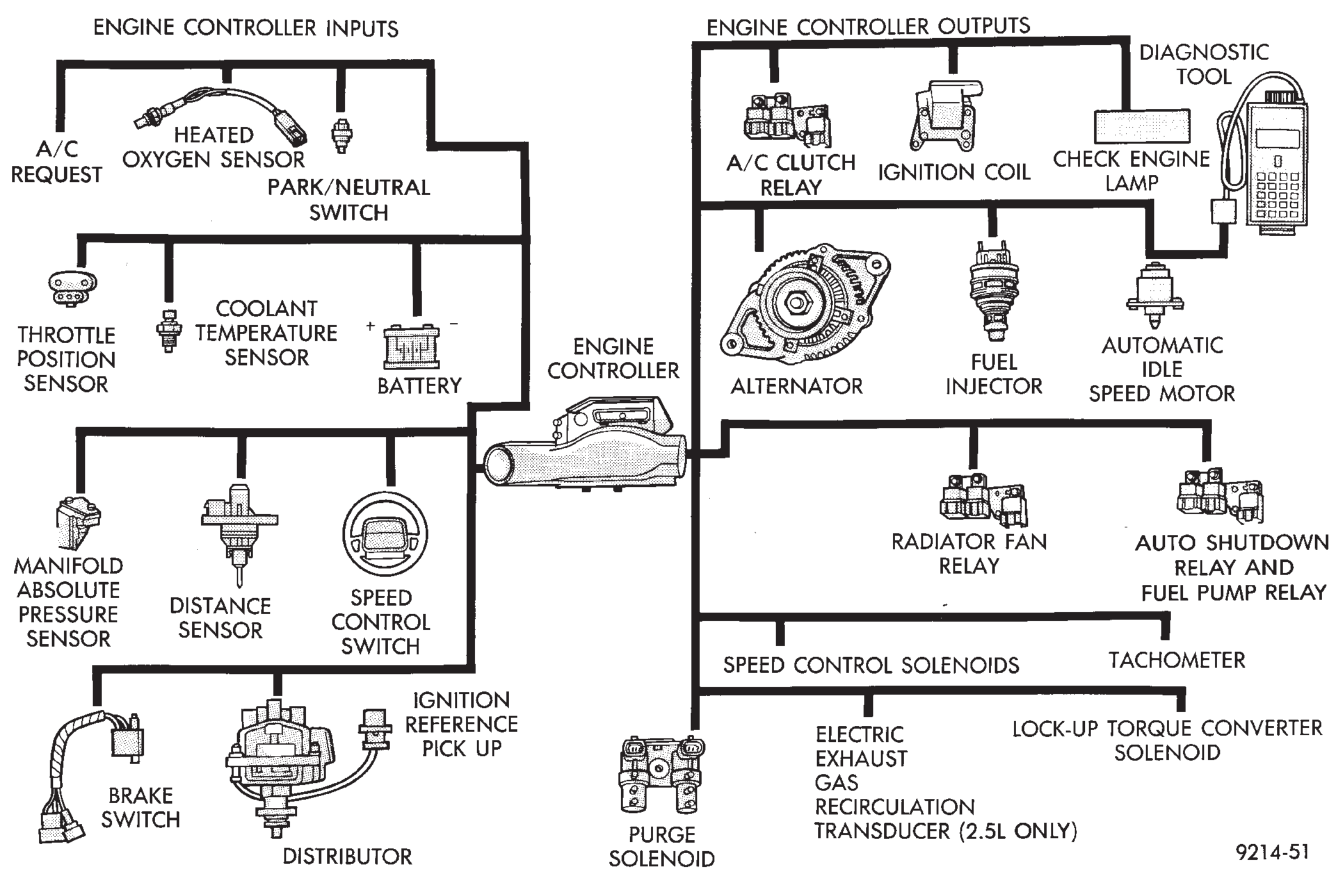

Fig. 1 Single Point Fuel Injection Components

(2) Verify the electrical connector is attached to the Canister Purge Solenoid (Fig. 3).

(3) Verify vacuum connection at Canister Purge Solenoid is secure and not leaking.

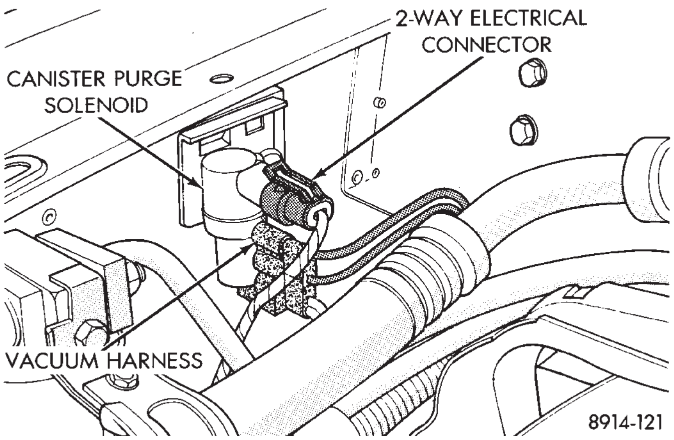

Fig. 3 Canister Purge Solenoid

(4) Verify the wiring connector is attached to the Electric EGR Transducer (EET) solenoid (Fig. 4).

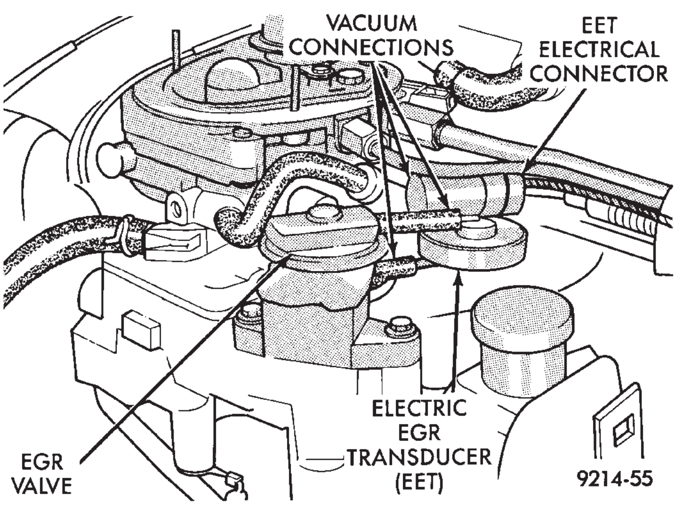

Fig. 4 Electric EGR Transducer (EET) Assembly

(5) Verify vacuum connection at the Electric EGR Transducer is secure and not leaking (Fig. 4).

(6) Verify the connector is attached to the MAP sensor (Fig. 5).

(7) Verify the vacuum hose is attached to the MAP sensor (Fig. 5).

(8) Verify the alternator wiring and belt are correctly installed and tightened.

(9) Verify hoses are securely attached to vapor canister (Fig. 6).

(10) Verify the throttle body wiring connection to main harness is attached (Fig. 7).

(11) Verify the electrical connector is attached to AIS motor (Fig. 8).

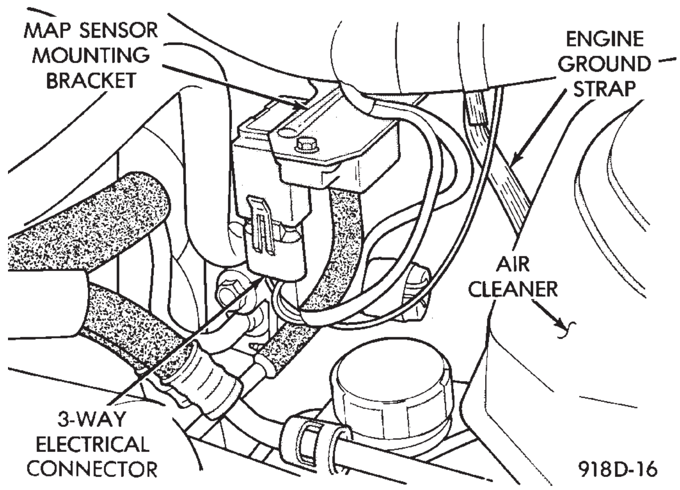

Fig. 5 Manifold Absolute Pressure (MAP) Sensor

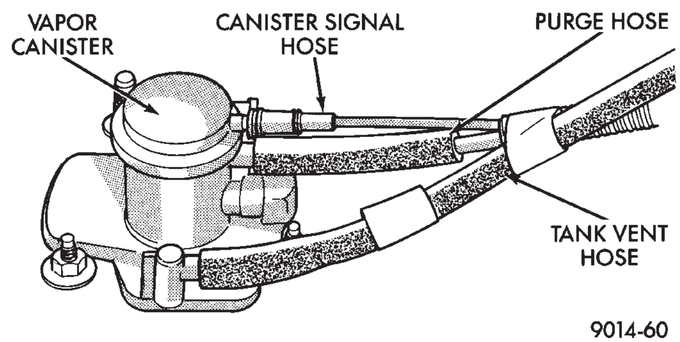

Fig. 6 Vapor Canister

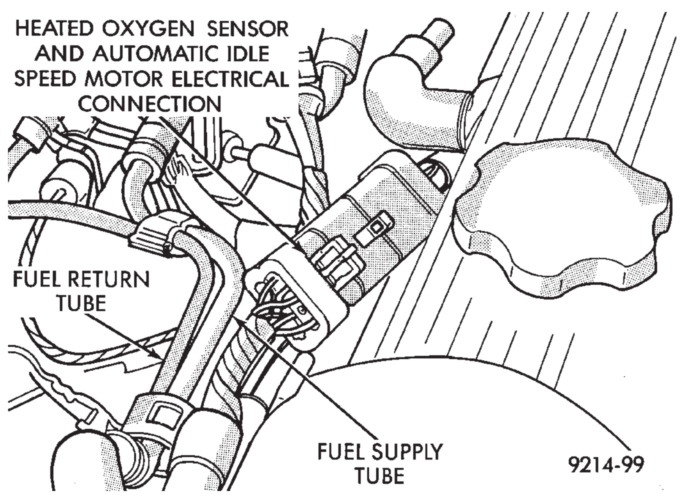

Fig. 7 Throttle Body Wiring Connection to Main Harness

(12) Verify the electrical connector is attached to the throttle position sensor (Fig. 8).

(13) Verify the electrical connector is attached to the fuel injector (Fig. 8).

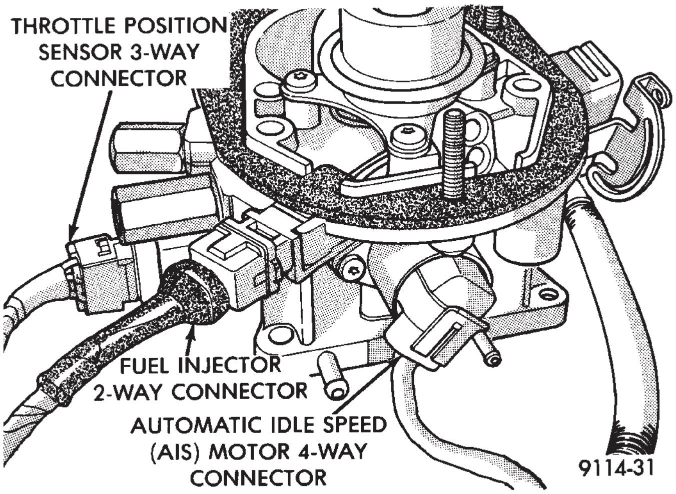

Fig. 8 Throttle Body Wiring Connections

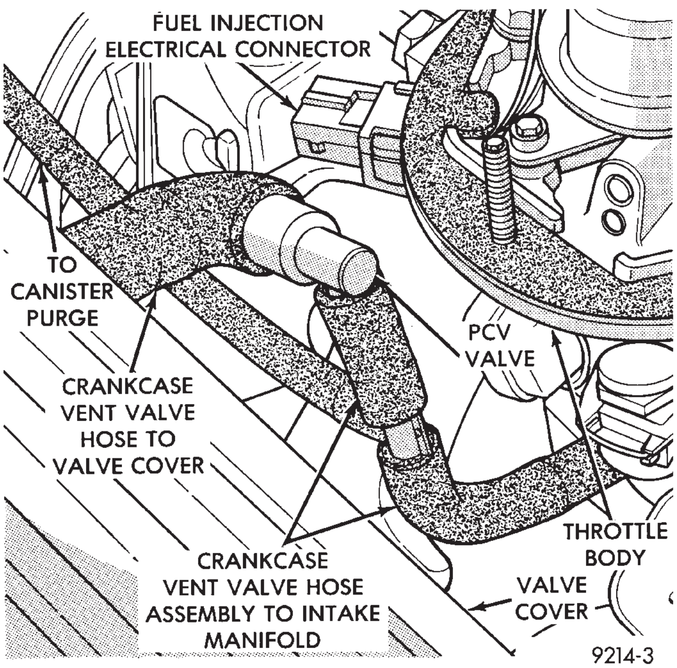

Fig. 9 Vacuum Hose from Intake Manifold to PCV Valve

(14) Verify the hose from PCV valve is securely attached to the intake manifold vacuum port (Fig. 9).

(15) Verify vacuum connections on the front and rear of Throttle Body are secure and not leaking (Figs. 10 and 11).

(16) Verify hoses are attached to back pressure transducer or electric EGR transducer (EET) (Fig. 11).

(17) Verify heated air door vacuum connection is connected and not leaking.

(18) Verify power brake and speed control vacuum connectors are tight (Fig. 12).

(19) Verify all ignition cables are in correct order and seated into place (Fig. 13).

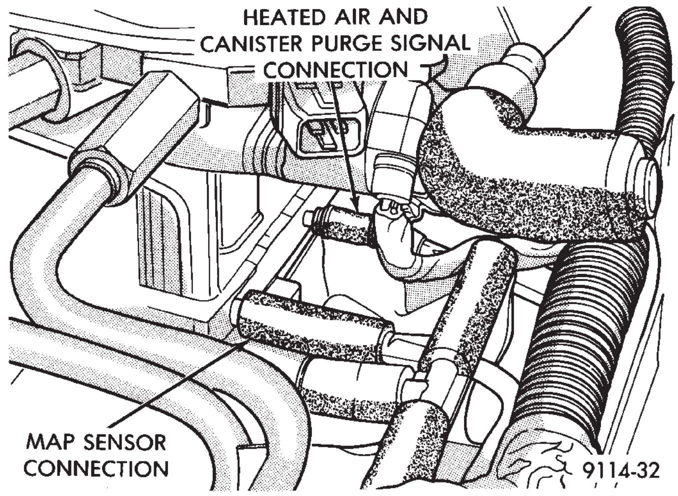

Fig. 10 Throttle Body Vacuum Ports—Front

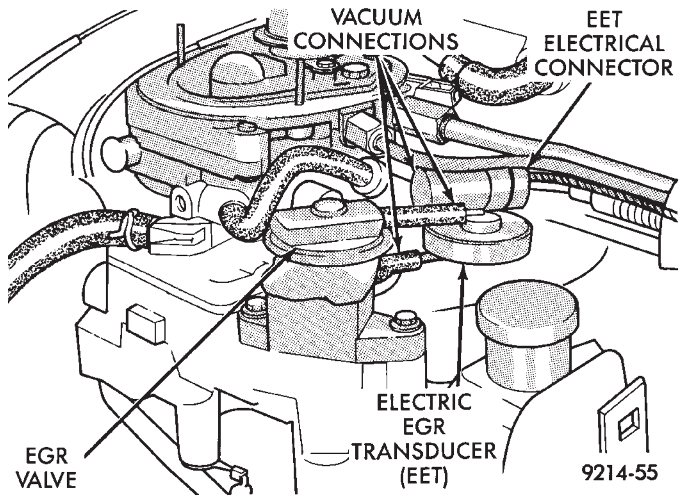

Fig. 11 Throttle Body Vacuum Ports—Rear

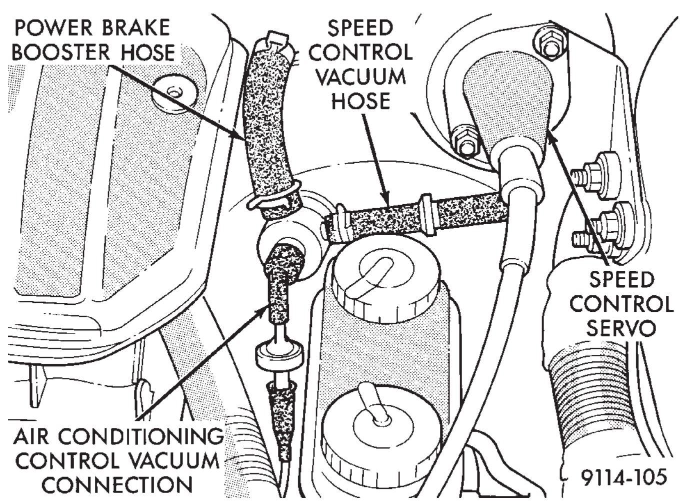

Fig. 12 Power Brake and Speed Control Vacuum Connection

(20) Verify the electrical connector is attached to coolant temperature sensor (Fig. 14).

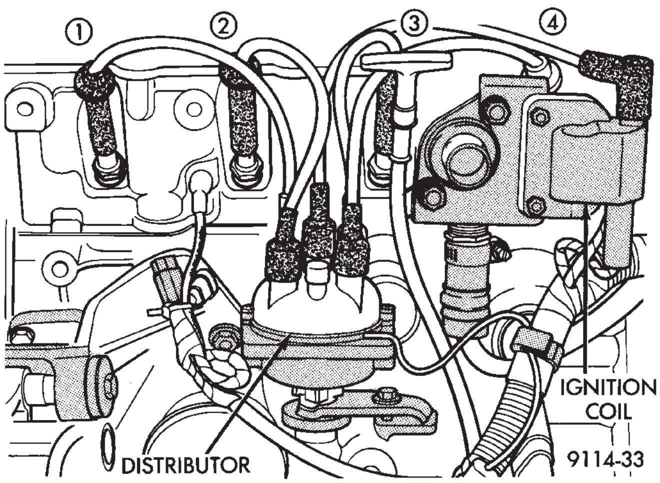

Fig. 13 Ignition Cable Routing and Connection

(21) Verify battery negative ground eyelet is mounted to the cylinder head (Figs. 14).

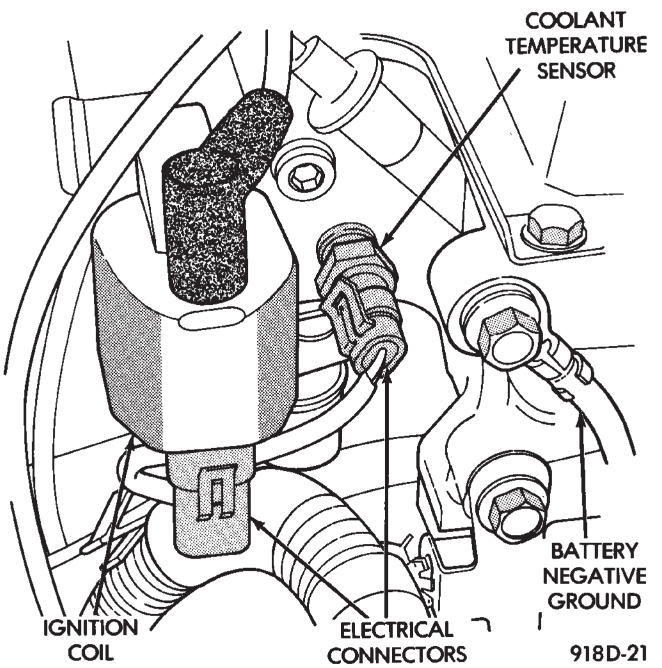

Fig. 14 Coolant Temperature Sensor

(22) Verify electrical connector is attached to distributor (Fig. 15).

(23) Verify radiator fan electrical connector is attached to the harness (Fig. 15).

(24) Verify oil pressure switch electrical connector is attached to the switch (Fig. 15).

(25) On automatic transmission equipped vehicles, verify the neutral safety switch electrical connector is attached to the switch (Fig. 16).

(26) On automatic transmission equipped vehicles, check the torque convertor lockup solenoid electrical connection (Fig. 16).

(27) Verify the 60-way connector is fully inserted into the socket on the Engine Controller (Fig. 17).

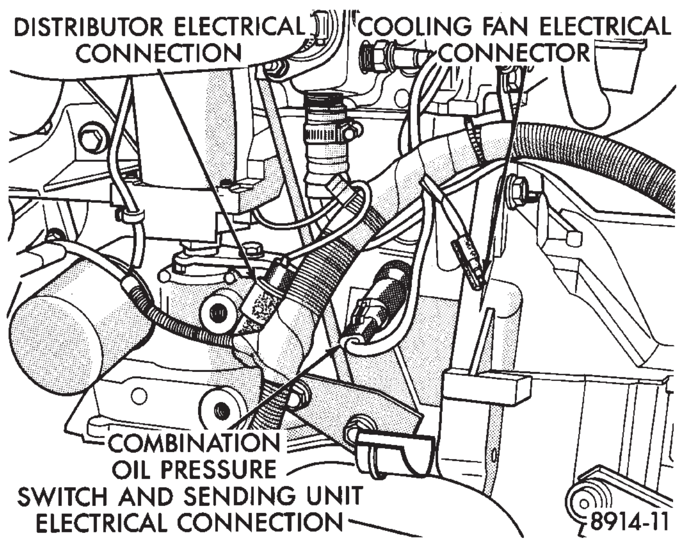

Fig. 15 Distributor, Oil Pressure Switch, and Radiator Fan Electrical Connections

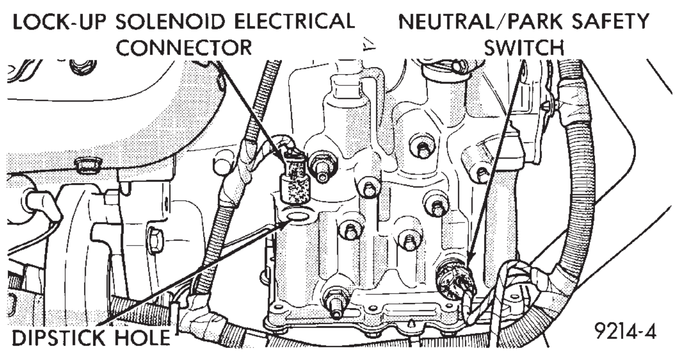

Fig. 16 Automatic Transmission Electrical Connections

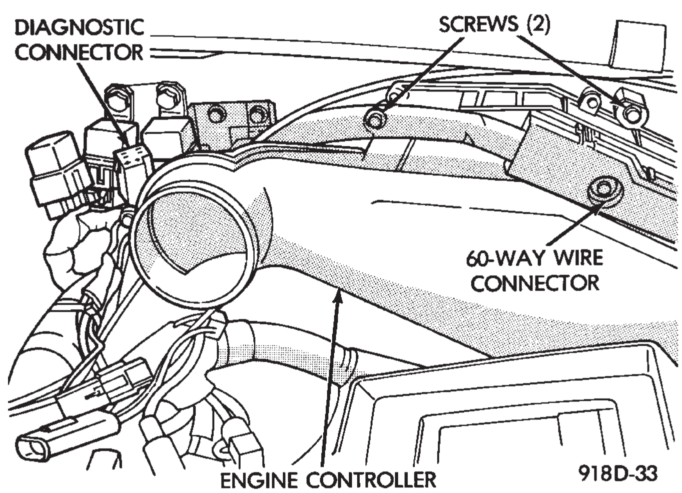

Fig. 17 Engine Controller Electrical Connector

(28) Verify all electrical connectors are fully inserted into relays and that battery connections are clean and tight (Figs. 18, 19, 20, 21, and 22).

(29) Verify engine harness to main harness connections are fully inserted.

(30) Check the distance sensor connector (Fig. 23).

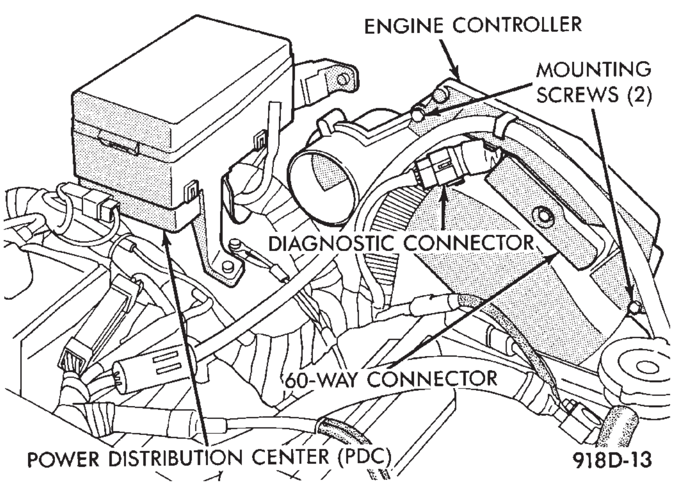

Fig. 18 Power Distribution Center (PDC) (AC Body)

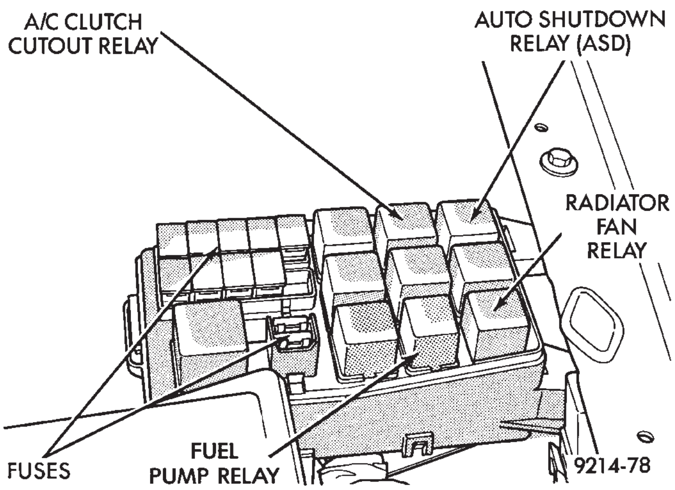

Fig. 19 Relay Identification (AC Body)

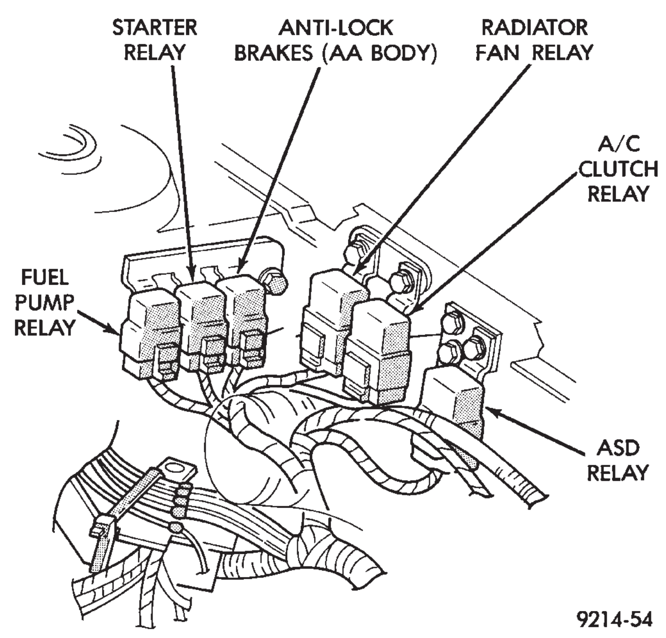

Fig. 20 Relay Identification (AA and AP Bodies)

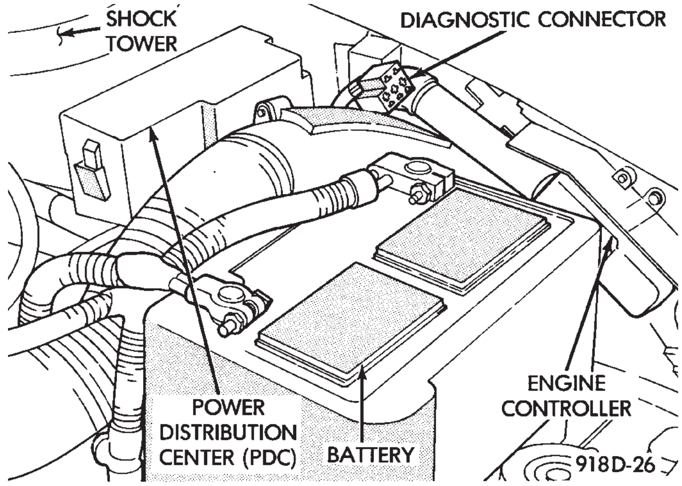

Fig. 21 Power Distribution Center (PDC) (AG and AJ Body)

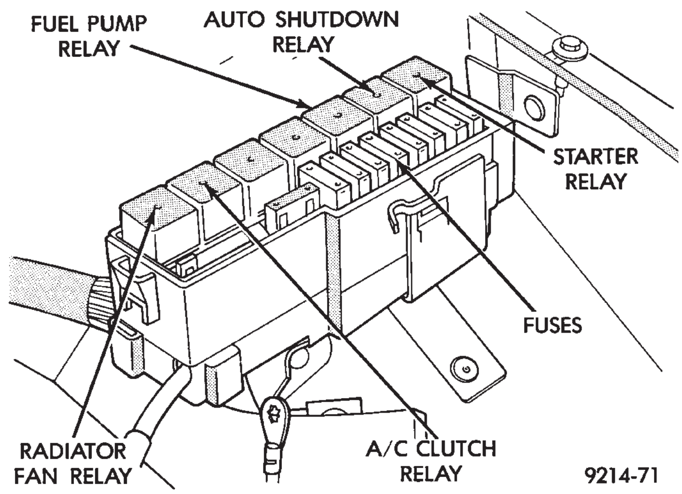

Fig. 22 Relay Identification (AG and AJ Body)

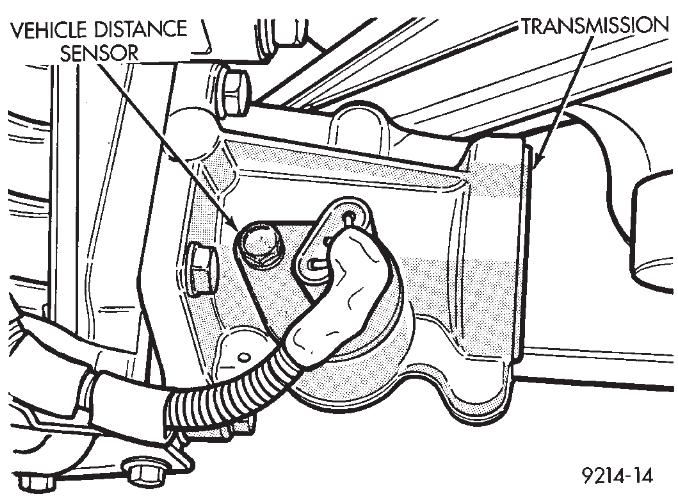

Fig. 23 Distance Sensor Wiring Connection

(31) Verify engine ground strap is attached at the engine and dash panel (Figs. 24 and 25).

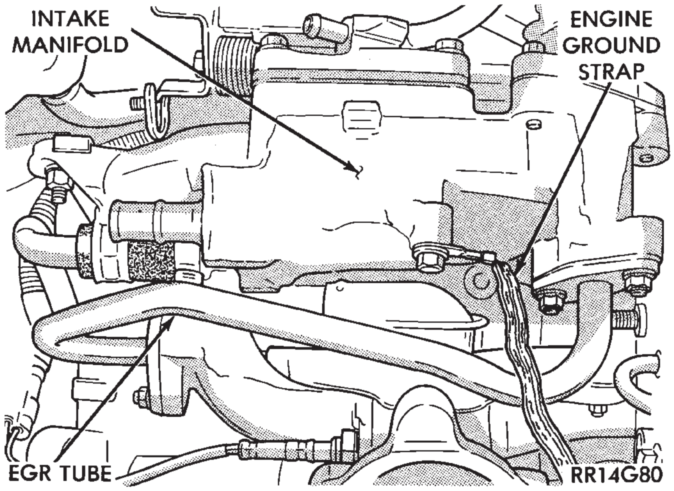

Fig. 24 Engine Ground Strap at Intake Manifold

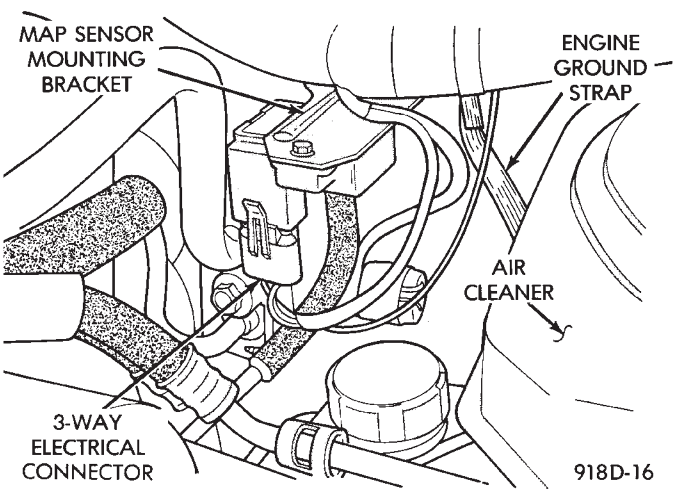

Fig. 25 Engine Ground Strap to Dash Panel

(32) Verify oxygen sensor electrical connector is attached to the sensor (Fig. 26).

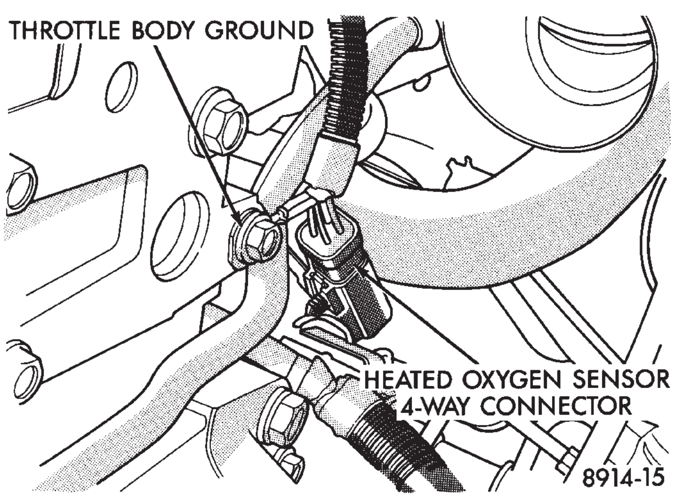

Fig. 26 Heated Oxygen Sensor Electrical Connection

(33) Check Hose and Wiring Connections at Fuel Pump. Check that wiring connector is making contact with terminals on pump.

ON BOARD DIAGNOSTICS

The engine controller has been programmed to monitor many different circuits of the fuel injection system. If a problem is sensed with a monitored circuit often enough to indicate an actual problem, the controller stores a fault. If the problem is repaired or ceases to exist, the controller cancels the Fault Code after 50 to 100 vehicle key on/off cycles.

Certain criteria must be met for a fault code to be entered into engine controller memory. The criteria may be a specific range of engine RPM, engine temperature, and/or input voltage to the engine controller.

It is possible that a fault code for a monitored circuit may not be entered into memory even though a malfunction has occurred. This may happen because one of the fault code criteria for the circuit has not been met. **For example,** assume that one of the fault code criteria for the MAP sensor circuit is that the engine must be operating between 750 and 2000 RPM to be monitored for a fault code. If the MAP sensor output circuit shorts to ground when engine RPM is above 2400 RPM (resulting in a 0 volt input to the engine controller) a fault code will not be entered into memory. This is because the condition does not occur within the specified RPM range.

There are several operating conditions that the engine controller does not monitor and set fault codes for. Refer to Monitored Circuits and Non-Monitored Circuits in this section.

Stored fault codes can be displayed by cycling the ignition key On - Off - On - Off - On. Also, the technician can display fault information using the Diagnostic Readout Box II (DRB II). The DRB II connects to the diagnostic connector in the vehicle (Fig. 27, 28 or 29).

MONITORED CIRCUITS

The engine controller can detect certain fault conditions in the fuel injection system.

Open or Shorted Circuit - The engine controller can determine if the sensor output (input to controller) is within proper range, and if the circuit is open or shorted.

Output Device Current Flow - The engine controller senses whether the output devices are hooked up. If there is a problem with the circuit, the controller senses whether the circuit is open, shorted to ground, or shorted high.

Oxygen Sensor - The engine controller can determine if the oxygen sensor is switching between rich and lean once the system has entered closed loop. Refer to Modes of Operation in this section for an explanation of closed loop operation.

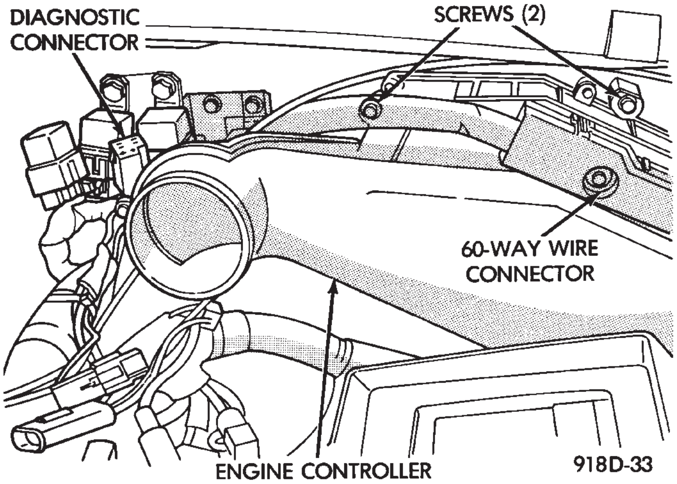

Fig. 27 Diagnostic Connector Location—AA and AP Vehicles

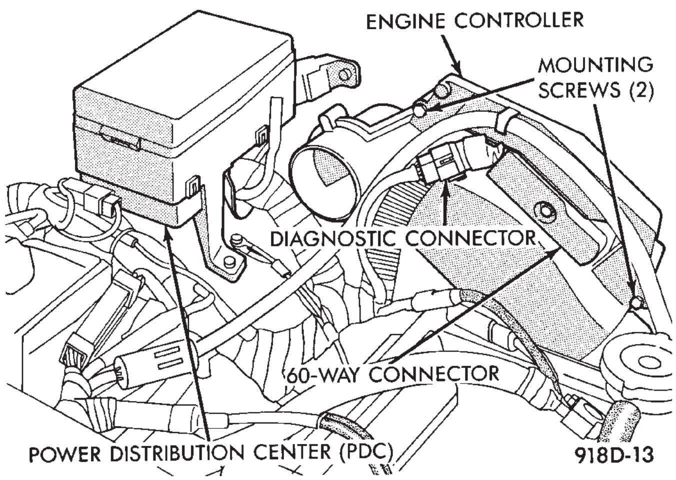

Fig. 28 Diagnostic Connector Location—AC Vehicles

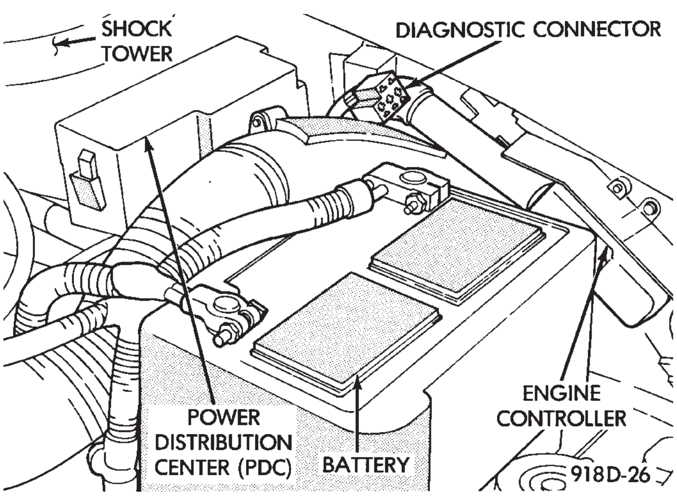

Fig. 29 Diagnostic Connector Location—AG and AJ Vehicles

NON-MONITORED CIRCUITS

The engine controller does not monitor the following circuits, systems and conditions that could have malfunctions that result in driveability problems. Fault codes may not be displayed for these conditions. However, problems with these systems may cause fault codes to be displayed for other systems. For example, a fuel pressure problem will not register a fault directly, but could cause a rich or lean condition. This could cause an oxygen sensor fault to be stored in the engine controller.

Fuel Pressure - Fuel pressure is controlled by the fuel pressure regulator. The engine controller cannot detect a clogged fuel pump inlet filter, clogged in-line fuel filter, or a pinched fuel supply or return line. However, these could result in a rich or lean condition causing an oxygen sensor fault.

Secondary Ignition Circuit - The engine controller cannot detect an inoperative ignition coil, fouled or worn spark plugs, ignition cross firing, or open spark plug cables.

Engine Timing - The engine controller cannot detect an incorrectly indexed timing chain, camshaft sprocket and crankshaft sprocket. The engine controller also cannot detect an incorrectly indexed distributor. However, these could result in a rich or lean condition causing an oxygen sensor fault to be stored in the engine controller.

Cylinder Compression - The engine controller cannot detect uneven, low, or high engine cylinder compression.

Exhaust System - The engine controller cannot detect a plugged, restricted or leaking exhaust system.

Fuel Injector Malfunctions - The engine controller cannot determine if the fuel injector is clogged, the pintle is sticking or the wrong injector is installed. However, these could result in a rich or lean condition causing an oxygen sensor fault to be stored in the engine controller.

Excessive Oil Consumption - Although the engine controller monitors the exhaust stream oxygen content through the oxygen sensor when the system is in closed loop, it cannot determine excessive oil consumption.

Throttle Body Air Flow - The engine controller cannot detect a clogged or restricted air cleaner inlet or filter element.

Evaporative System - The engine controller will not detect a restricted, plugged or loaded evaporative purge canister.

Vacuum Assist - Leaks or restrictions in the vacuum circuits of vacuum assisted engine control system devices are not monitored by the engine controller. However, these could result in a MAP sensor fault being stored in the engine controller.

Engine Controller System Ground - The engine controller cannot determine a poor system ground. However, a fault code may be generated as a result of this condition.

Engine Controller Connector Engagement - The engine controller cannot determine spread or damaged connector pins. However, a fault code may be generated as a result of this condition.

HIGH AND LOW LIMITS

The engine controller compares input signal voltages from each input device with established high and low limits that are programmed into it for that device. If the input voltage is not within specifications and other fault code criteria are met, a fault code will be stored in memory. Other fault code criteria might include engine RPM limits or input voltages from other sensors or switches that must be present before a fault condition can be verified.

FAULT CODE DESCRIPTION

When a fault code appears, it indicates the engine controller has recognized an abnormal condition in the system. Fault codes can be obtained from the Check Engine lamp on the Instrument Panel or from the Diagnostic Readout Box II (DRBII). Fault codes indicate the results of a failure but do not identify the failed component directly.

SYSTEMS TEST

WARNING: APPLY PARKING BRAKE AND/OR BLOCK WHEELS BEFORE PERFORMING A TEST WITH THE ENGINE OPERATING.

OBTAINING FAULT CODES

(1) Connect DRBII to the diagnostic connector located in the engine compartment near the engine controller.

(2) Start the engine if possible, cycle the transmission selector and the **A/C** switch if applicable. Shut off the engine.

(3) Turn the ignition switch on, access Read Fault Screen. Record all the fault messages shown on the DRBII. Observe the check engine lamp on the instrument panel. The lamp should light for 3 seconds then go out (bulb check).

STATE DISPLAY TEST MODE

The switch inputs used by the engine controller have only two recognized states, HIGH and LOW. For this reason, the engine controller cannot recognize the difference between a selected switch position versus an open circuit, a short circuit, or a defective switch. If the change is displayed, it can be assumed that the entire switch circuit to the engine controller is functional. From the state display screen access either State Display Inputs and Outputs or State Display Sensors.

STATE DISPLAY INPUTS AND OUTPUTS

Connect the DRB II tester to the vehicle and access the State Display screen. Then access Inputs and Outputs. The following is a list of the engine control system functions accessible through the Inputs and Outputs screen.

Park/Neutral Switch (automatic transmission only)
Speed Control Resume
Brake Switch
Speed Control On/Off
Speed Control Set
A/C Switch Sense
B1 Voltage Sense
S/C (Speed Control) Vent Solenoid
S/C (Speed Control) Vacuum Solenoid
PTU Solenoid
A/C Clutch Relay
EGR Solenoid
Auto Shutdown Relay
Radiator Fan Relay
Purge Solenoid
Check Engine Lamp

STATE DISPLAY SENSORS

Connect the DRB II tester to the vehicle and access the State Display screen. Then access Sensor Display. The following is a list of the engine control system functions accessible through the Sensor Display screen.

Battery Temp Sensor
Oxygen Sensor Signal
Coolant Temperature
Coolant Temp Sensor
Throttle Position
Minimum Throttle
Battery Voltage
MAP Sensor Reading
AIS Motor Position
Added Adaptive Fuel
Adaptive Fuel Factor
Barometric Pressure
Min Airflow Idl Spd
Engine Speed
Fault #1 Key-On Info
Module Spark Advance
Speed Control Target
Fault #2 Key-On Info
Fault #3 Key-On Info
Speed Control Status
Speed Control Switch Voltage
Charging System Goal
Theft Alarm Status
Map Sensor Voltage

Vehicle Speed
Oxygen Sensor State
MAP Gauge Reading
Throttle Opening
Total Spark Advance

CIRCUIT ACTUATION TEST MODE

The circuit actuation test mode checks for proper operation of output circuits or devices which the engine controller cannot internally recognize. The engine controller can attempt to activate these outputs and allow an observer to verify proper operation. Most of the tests provide an audible or visual indication of device operation (click of relay contacts, spray fuel, etc.). With the exception of an intermittent condition, if a device functions properly during its test, it can be assumed that the device, its associated wiring, and its driver circuit are in working order.

OBTAINING CIRCUIT ACTUATION TEST

Connect the DRB II tester to the vehicle and access the Actuators screen. The following is a list of the engine control system functions accessible through Actuators screens.

Stop All Tests
Ignition Coil #1
Fuel Injector #1
AIS Motor Open/Close
Radiator Fan Relay
A/C Clutch Relay
Auto Shutdown Relay
Purge Solenoid
S/C Servo Solenoids
Alternator Field
Tachometer Output
PTU Solenoid (Automatic Only)
EGR Solenoid
All Solenoids/Relays
ASD Fuel System Test

THROTTLE BODY MINIMUM AIR FLOW CHECK PROCEDURE

(1) Connect Diagnostic Readout Box II (DRBII).
(2) Remove air cleaner assembly. Plug the heated air door vacuum hose.
(3) Warm engine in Park or Neutral until the cooling fan has cycled on and off at least once.
(4) Hook-up timing check device and tachometer.
(5) Disconnect the coolant temperature sensor and set basic timing to 12°BTDC ± 2°BTDC.
(6) Shut off engine. Reconnect coolant temperature sensor.
(7) Disconnect the PCV valve hose from the intake manifold nipple.
(8) Attach Air Metering Fitting #6457 (Fig. 30) to the intake manifold PCV nipple.
(9) Restart the engine, allow engine to idle for at least one minute.

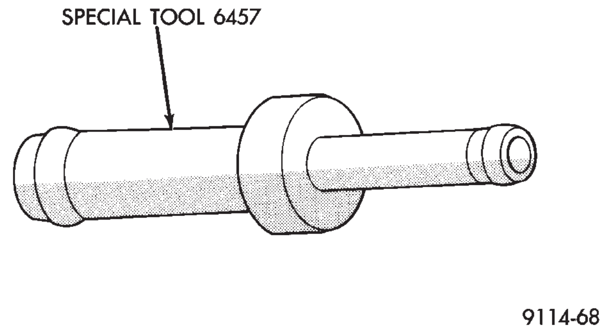

Fig. 30 Air Metering Fitting

(10) Using the DRBII, Access Min Airflow Idle Spd in the sensor read test mode.
(11) The following will then occur:
- AIS motor will fully close.
- Idle spark advance will become fixed.
- Idle fuel will be provided at a set value.
- Engine RPM will be displayed on Diagnostic Readout Box II (DRBII).

(12) Check idle RPM with tachometer. If idle RPM is within the specifications listed below, then the throttle body minimum air flow is set correctly.

IDLE SPECIFICATIONS

Odometer Reading	Engine	Idle RPM
Below 1000 Miles	2.2L	700 - 1300 RPM
	2.5L	650 - 1250 RPM
Above 1000 Miles	2.2L	1100 - 1300 RPM
	2.5L	1050 - 1250 RPM

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If idle RPM is not within specification replace throttle body.
(13) Shut off engine.
(14) Remove Special Tool number 6457 from intake manifold PCV nipple. Reinstall the PCV valve hose.
(15) Remove DRBII.
(16) Reinstall air cleaner assembly. Reinstall heated air door vacuum hose.
(17) Disconnect timing check device and tachometer.

IGNITION TIMING PROCEDURE

Refer to Group 8D Ignition System

60-WAY ENGINE CONTROLLER WIRING CONNECTOR

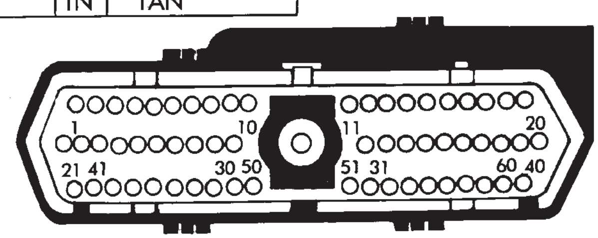
Refer to the engine controller wiring connector descriptions (Fig. 31) for information regarding wire colors and cavity numbers.

CAV	WIRE COLOR	DESCRIPTION
1	DG/RD*	MAP SENSOR SIGNAL
2	TN/BK*	COOLANT SENSOR
3	RD	DIRECT BATTERY VOLTAGE
4	BK/LB*	SENSOR RETURN
5	BK/WT*	SIGNAL GROUND
6	VT/WT*	5.0 VOLT OUTPUT (MAP AND TPS)
7	OR	9.0 VOLT OUTPUT (DISTRIBUTOR PICK-UP AND DISTANCE SENSOR)
8	WT	B1 VOLTAGE SENSE (START SIGNAL)
9	DB	A21 SUPPLY (IGNITION START/RUN)
10		
11	BK/TN*	POWER GROUND
12	BK/TN*	POWER GROUND
13		
14		
15		
16	WT/DB*	INJECTOR DRIVER
17		
18		
19	BK/GY*	IGNITION COIL
20	DG	ALTERNATOR FIELD CONTROL
21		
22	OR/DB*	THROTTLE POSITION SENSOR
23	RD/LG*	SPEED CONTROL SENSE
24	GY/BK*	IGNITION REFERENCE PICK-UP
25	PK	SCI TRANSMIT
26	VT/BR*	CCD (+) BUS
27	BR	A/C SWITCH SENSE
28		
29	WT/PK*	BRAKE SWITCH
30	BR/YL*	PARK/NEUTRAL SWITCH (AUTO TRANS.)
31	DB/PK*	RADIATOR FAN RELAY
32	BK/PK*	CHECK ENGINE LAMP
33	TN/RD*	SPEED CONTROL VACUUM SOLENOID
34	DB/OR*	A/C CLUTCH RELAY
35	GY/YL*	EGR SOLENOID
36		

CAV	WIRE COLOR	DESCRIPTION
37		
38		
39	GY/RD*	AIS STEPPER #3 DRIVER
40	BR/WT*	AIS STEPPER #1 DRIVER
41	BK/DG*	OXYGEN SENSOR SIGNAL
42		
43	GY/LB*	TACHOMETER SIGNAL OUTPUT
44		
45	LG	SCI RECEIVE
46	WT/BK*	CCD (-) BUS
47	WT/OR*	DISTANCE SENSOR SIGNAL
48		
49		
50		
51	DB/YL*	AUTO SHUTDOWN RELAY AND FUEL PUMP RELAY
52	PK/BK*	PURGE SOLENOID
53	LG/RD*	SPEED CONTROL VENT SOLENOID
54	OR/BK*	PART THROTTLE UNLOCK SOLENOID
55		
56		
57	DG/OR*	A142 CIRCUIT VOLTAGE SENSE
58		
59	VT/BK*	AIS STEPPER #4 DRIVER
60	YL/BK*	AIS STEPPER #2 DRIVER

WIRE COLOR CODES					
		LB	LIGHT BLUE	VT	VIOLET
BK	BLACK	LG	LIGHT GREEN	WT	WHITE
BR	BROWN	OR	ORANGE	YL	YELLOW
DB	DARK BLUE	PK	PINK	*	WITH TRACER
DG	DARK GREEN	RD	RED		
GY	GRAY	TN	TAN		

CONNECTOR
TERMINAL SIDE
SHOWN



9214-58

Fig. 31 Engine Controller Wiring Connector Cavity Description

FAULT CODE DESCRIPTION

FAULT CODE	DRB II DISPLAY	DESCRIPTION
11	No reference Signal During Cranking	No distributor reference signal detected during engine cranking.
13+**	Slow change in Idle MAP signal	MAP output change is slower and/or smaller than expected.
	or	
	No change in MAP from start to run	No difference recognized between the engine MAP reading and the barometric (atmospheric) pressure reading at start-up.
14+**	MAP voltage too low	MAP sensor input below minimum acceptable voltage.
	or	
	MAP voltage too High	MAP sensor input above maximum acceptable voltage.
15**	No vehicle speed signal	No vehicle distance (speed) sensor signal detected during road load conditions.
17	Engine is cold too long	Engine coolant temperature remains below normal operating temperatures during vehicle travel (thermostat).
21**	O_2 signal stays at center	Neither rich or lean condition detected from the oxygen sensor input.
	or	
	O_2 signal shorted to voltage	Oxygen sensor input voltage maintained above the normal operating range.
22+**	Coolant sensor voltage too high	Coolant temperature sensor input above the maximum acceptable voltage.
	or	
	Coolant sensor voltage too low	Coolant temperature sensor input below the minimum acceptable voltage.
24+**	Throttle position sensor voltage high	Throttle position sensor input above the maximum acceptable voltage.
	or	
	Throttle position sensor voltage low	Throttle position sensor input below the minimum acceptable voltage.
25**	Automatic idle speed motor circuits	An open or shorted condition detected in one or more of the AIS control circuits.
27	Injector control circuit	Injector output driver does not respond properly to the control signal.
31**	Purge solenoid circuit	An open or shorted condition detected in the purge solenoid circuit.
32**	EGR solenoid circuit	An open or shorted condition detected in the EGR transducer solenoid circuit.
	or	
	EGR system failure	Required change in air/fuel ratio not detected during diagnostic test.
33	A/C clutch relay circuit	An open or shorted condition detected in the A/C clutch relay circuit.

\+ Check Engine Lamp On
** Check Engine Lamp On (California Only)

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FAULT CODE DESCRIPTION

FAULT CODE	DRB II DISPLAY	DESCRIPTION
34	Speed control solenoid circuits	An open or shorted condition detected in the speed control vacuum or vent solenoid circuits.
35	Radiator fan relay circuits	An open or shorted condition detected in the radiator fan circuit
37	Torque convertor unlock solenoid CKT	An open or shorted condition detected in the torque convertor part throttle unlock solenoid circuit (automatic transmission).
41+**	Alternator field not switching properly	An open or shorted condition detected in the alternator field control circuit.
42	Auto shutdown relay control circuit	An open or shorted condition detected in the auto shutdown relay circuit.
46+**	Charging system voltage too high	Battery voltage sense input above target charging voltage during engine operation.
47+**	Charging system voltage too low	Battery voltage sense input below target charging during engine operation. Also, no significant change detected in battery voltage during active test of alternator output.
51**	O_2 signal stays below center (lean)	Oxygen sensor signal input indicates lean air/fuel ratio condition during engine operation.
52**	O_2 signal stays above center (rich)	Oxygen sensor signal input indicates rich air/fuel ratio condition during engine operation.
53	Internal controller	Engine controller internal fault condition detected.
62	EMR miles	Unsuccessful attempt to update EMR mileage in the controller EEPROM.
63	Controller Failure EEPROM write denied	Unsuccessful attempt to write to an EEPROM location by the engine controller.
55	N/A	Completion of fault code display on Check Engine lamp.

+ Check Engine Lamp On
** Check Engine Lamp On (California Only)

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2.2L/2.5L SINGLE POINT FUEL INJECTION—SERVICE PROCEDURES

INDEX

FUEL LINES AND HOSES

Perform the Fuel System Pressure Relief Procedure before servicing the fuel system. The procedure must be done to bleed fuel pressure from the system before removing clamps or hoses.

Use care when removing fuel hoses to prevent damage to hose or hose nipple. Always use new hose clamps, of the correct type, during reassembly. Tighten hose clamps to 1 N•m (10 in. lbs.) torque. **Do not use aviation style clamps on this system or hose damage may result.**

FUEL SYSTEM PRESSURE RELEASE PROCEDURE

CAUTION: Before servicing the fuel pump, fuel lines, fuel filter, throttle body, or fuel injector, the fuel system pressure must be released.

(1) Loosen fuel filler cap to release fuel tank pressure.

(2) Disconnect injector wiring harness connector (Fig. 1).

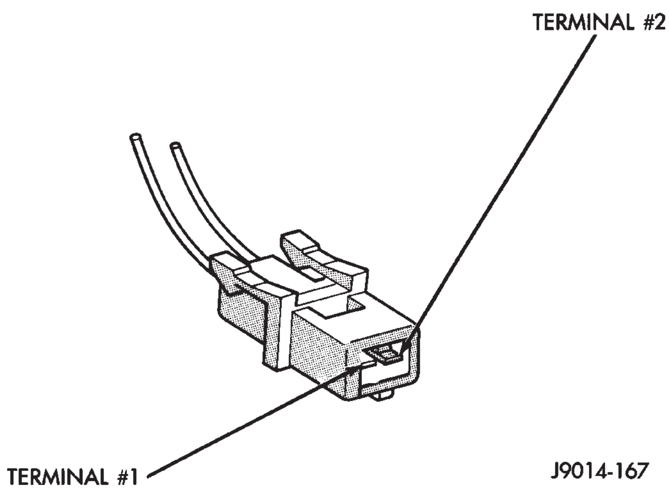

Fig. 1 Injector Harness Connector

(3) Connect a jumper wire between terminal Number 1 of the injector harness and engine ground.

(4) Connect a jumper wire to the positive terminal Number 2 of the injector harness and touch the battery positive post **for no longer than 5 seconds**. This releases system pressure.

(5) Remove jumper wires.

(6) Continue fuel system service.

THROTTLE BODY

CAUTION: The fuel system is under a constant pressure of 270 kPa (39 psi). When servicing the fuel portion of the throttle body, release fuel pressure before disconnecting any tubes. Refer to the fuel pressure release procedure.

Always reassemble throttle body components with new O-rings and seals where applicable. Never use silicone lubricants on O-rings or seals, damage may result. Use care when removing fuel tubes to prevent damage to quick connect fittings or tube ends. Refer to Fuel Hoses, Clamps, and Quick Connect Fittings in the Fuel Delivery Section of this Group.

REMOVAL

(1) Remove air cleaner (Fig. 2).

(2) Perform fuel system pressure release procedure.

(3) Disconnect negative battery cable.

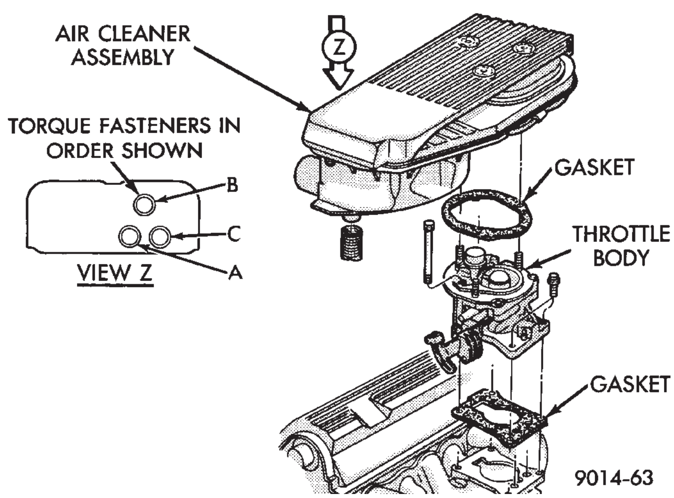

Fig. 2 Throttle Body and Air Cleaner Assembly

(4) Disconnect vacuum hoses and electrical connectors (Fig. 3).

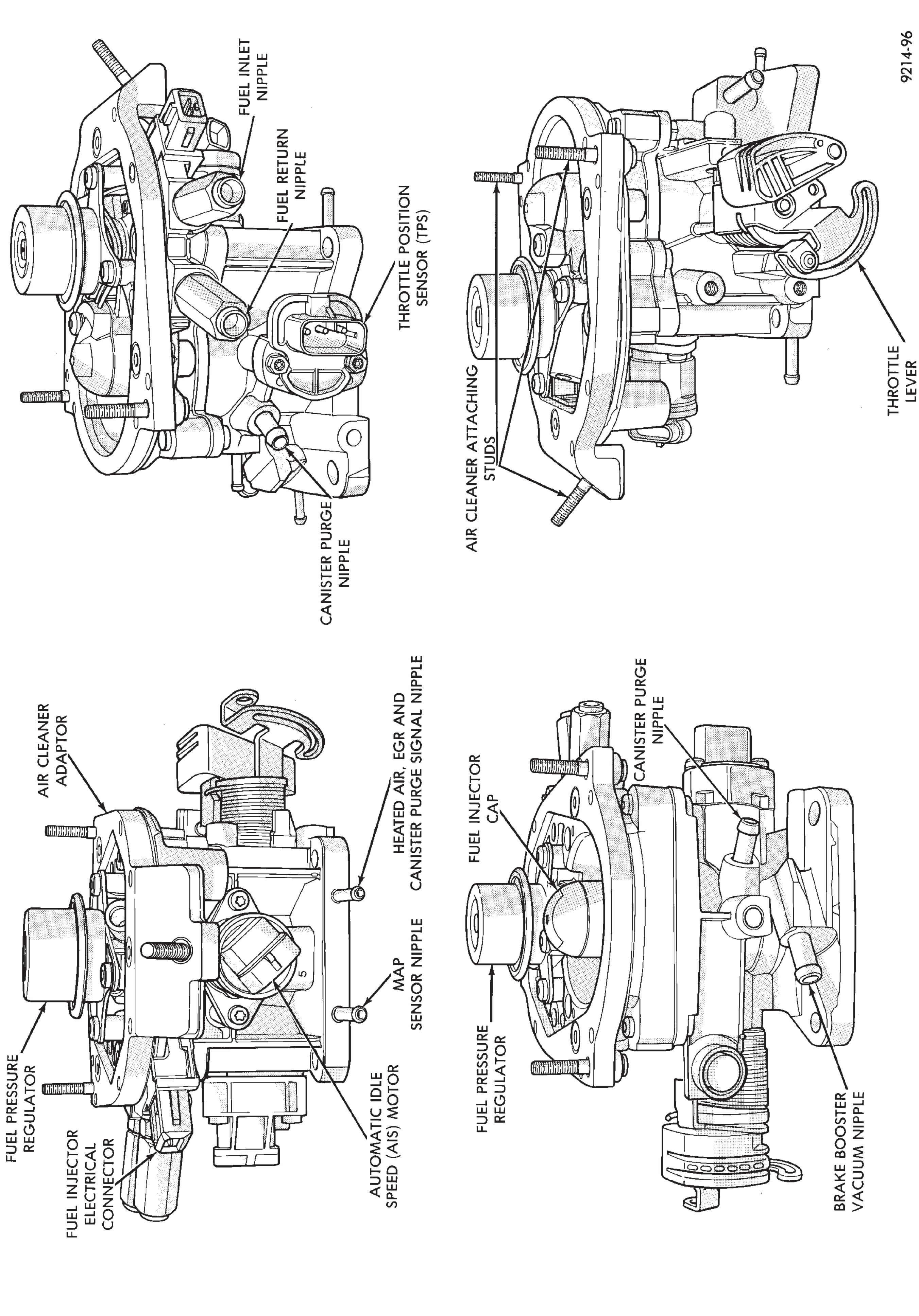

Fig. 3 Throttle Body

(5) Remove throttle cable. If equipped, remove the speed control and transmission kickdown cables.

(6) Remove return spring.

(7) Loosen fuel tube clamp on valve cover (Fig. 4).

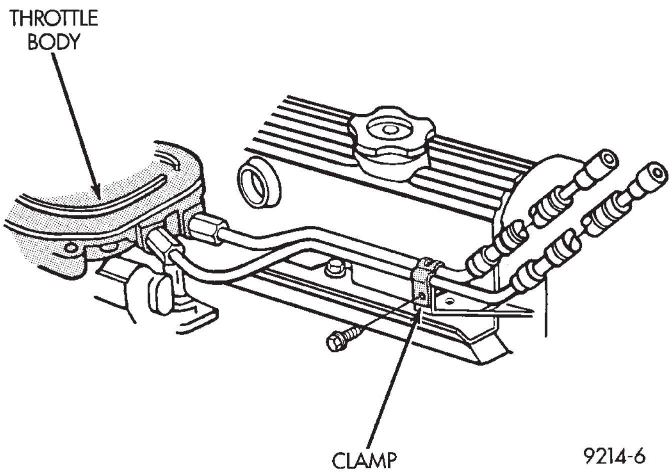

Fig. 4 Fuel Line Clamp

(8) Wipe quick connect fittings to remove any dirt. Remove fuel intake and return tubes. **Refer to Fuel Hoses, Clamps and Quick Connect Fittings in the Fuel Delivery Section of this Group.** Place a shop towel under the connections to absorb any fuel spilled.

(9) Remove throttle body mounting screws and lift throttle body from vehicle. Remove throttle body gasket from intake manifold.

INSTALLATION

(1) Using a new gasket, install throttle body and tighten mounting screws to 20 N●m (175 in. lbs.) torque.

(2) Lubricate the ends of the fuel supply and return tubes with clean 30 weight oil. Connect fuel lines to quick connect fittings. **Refer to Fuel Hoses, Clamps and Quick Connect Fittings in the Fuel Delivery Section of this Group**. After the fuel tubes are connected to the fittings, pull on the tubes to ensure that they are fully inserted and locked into position.

(3) Tighten the fuel tube clamp on the valve cover.

(4) Install return spring.

(5) Install throttle cable. If equipped, install kickdown and speed control cables.

(6) Install wiring connectors and vacuum hoses.

(7) Install air cleaner.

(8) Reconnect negative battery cable.

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(9) With the ignition key in ON position, access the DRB II ASD Fuel System Test to pressurize the fuel system. Check for leaks.

FUEL FITTING

REMOVAL

(1) Remove air cleaner assembly.

(2) Perform Fuel System Pressure Release procedure.

(3) Disconnect negative battery cable.

(4) Loosen fuel tube clamp on valve cover.

(5) Wipe any dirt from around quick connect fittings. (Fig. 5) Place a shop towel under the connections to catch any spilled fuel. Remove fuel tubes from quick connect fittings. **Refer to Fuel Hoses, Clamps and Quick Connect Fittings in the Fuel Delivery Section of this Group**.

(6) Remove each fitting from throttle body and note inlet diameter. Remove copper washers.

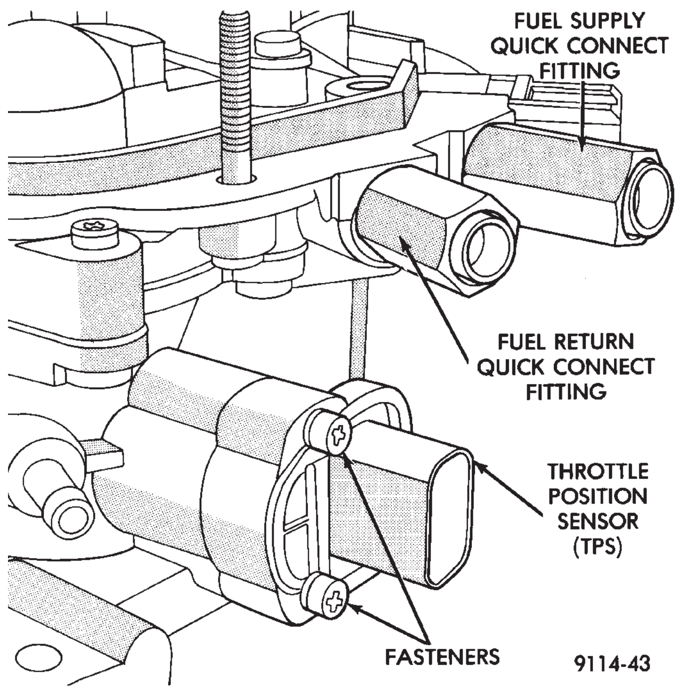

Fig. 5 Servicing Fuel Fitting

INSTALLATION

(1) Replace copper washers with new washers.

(2) Install fuel fittings in proper ports and tighten to 20 N●m (175 in. lbs.) torque.

(3) Lubricate ends of the fuel tubes with 30 weight oil. Insert the tubes into the quick connect fittings. **Refer to Fuel Hoses, Clamps and Quick Connect Fittings in the Fuel Delivery Section of this Group**. After the fuel tubes are connected to the fittings, pull on the tubes to ensure that they are fully inserted and locked into position.

(4) Tighten fuel tube clamp on valve cover.

(5) Reconnect negative battery cable.

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(6) With the ignition key in ON position, access the DRB II ASD Fuel System Test to pressurize the fuel system. Check for leaks.

(7) Reinstall air cleaner assembly.

FUEL PRESSURE REGULATOR

The fuel pressure regulator is mounted on top of the throttle body (Fig. 6).

REMOVAL

(1) Remove air cleaner assembly.

(2) Perform Fuel System Pressure Release procedure.

(3) Disconnect battery negative cable.

(4) Remove pressure regulator mounting screws (Fig. 6).

WARNING: PLACE A SHOP TOWEL AROUND FUEL INLET CHAMBER TO CONTAIN ANY FUEL REMAINING IN THE SYSTEM.

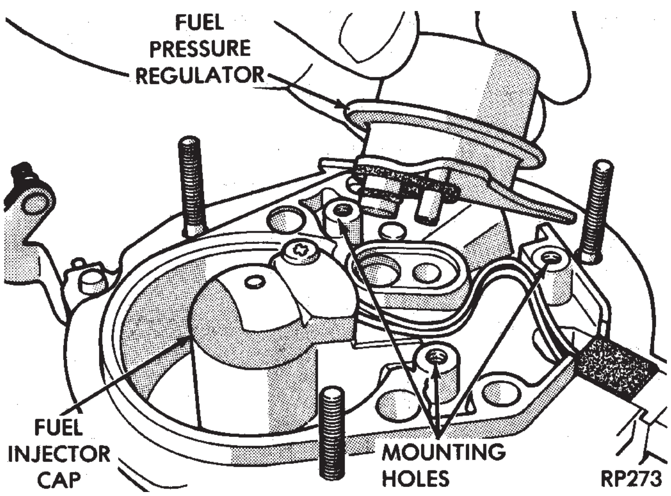

Fig. 6 Servicing Fuel Pressure Regulator

(5) Pull pressure regulator from the throttle body.

(6) Carefully remove O-ring from pressure regulator and remove gasket.

INSTALLATION

(1) Place new gasket on pressure regulator. Carefully install new O-ring.

(2) Position pressure regulator on throttle body. Press regulator into place and install mounting screws. Tighten screws to 5 N·m (40 in. lbs.) torque.

(3) Connect negative cable to battery.

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(4) With the ignition key in ON position, access the DRB II ASD Fuel System Test to pressurize the fuel system. Check for leaks.

(5) Reinstall air cleaner assembly.

FUEL INJECTOR

The fuel injector is installed in the top of the throttle body. The injector is covered by a cap.

REMOVAL

(1) Remove air cleaner assembly.

(2) Perform Fuel System Pressure Release procedure.

(3) Disconnect negative cable from battery.

(4) Remove injector cap holddown screw (Torx-head).

(5) With two small screwdrivers, lift the top off the injector using the slots provided (Fig. 7).

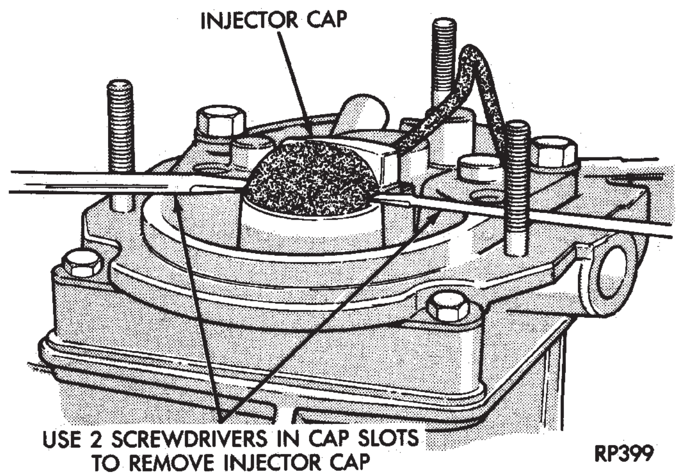

Fig. 7 Removing Injector Cap

(6) Using a small screwdriver placed in the hole in the front of the electrical connector, gently pry the injector from the pod (Fig. 8).

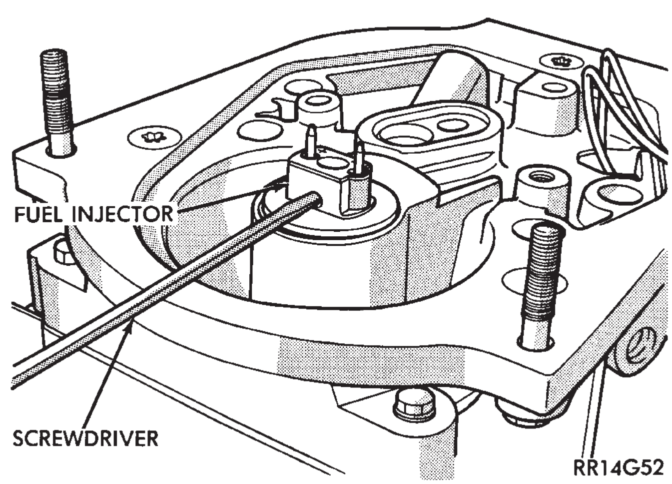

Fig. 8 Removing Fuel Injector

(7) Ensure the injector lower O-ring has been removed from the pod (Fig. 9).

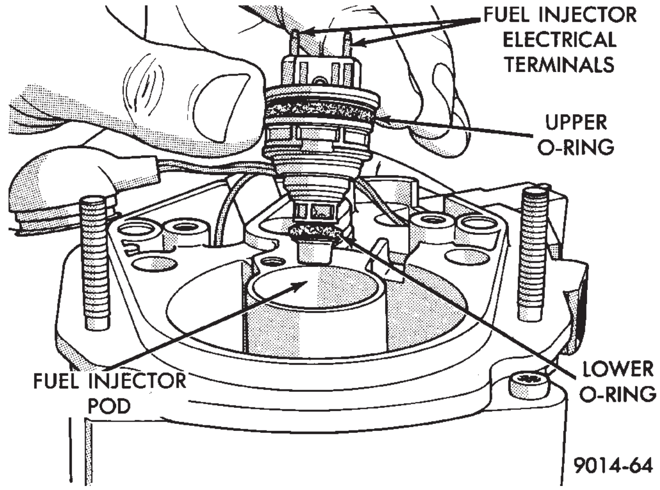

Fig. 9 Servicing Fuel Injector

INSTALLATION

(1) Apply a light coating of clean engine oil on the O-rings.

(2) Place assembly in the pod. Align the injector wiring terminals with the injector cap fastener hole (Fig. 10).

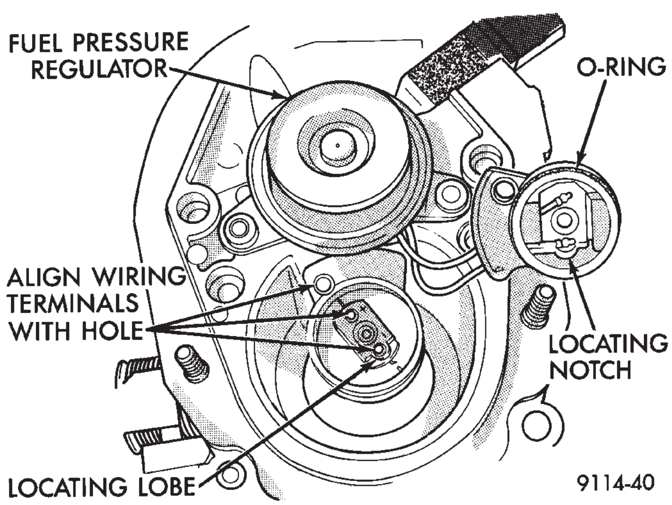

Fig. 10 Fuel Injector Installation

(3) Install injector cap with locating notch aligned with the locating lobe on the injector (Fig. 11).

(4) Push down on the cap to ensure a good seal.

(5) Rotate the cap and injector to line up the attachment hole (Fig. 12).

(6) Install injector cap holddown screw (torx-head screw). Tighten screw to 4-5 N●m (35-45 in. lbs.) torque.

(7) Connect negative cable to battery.

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized

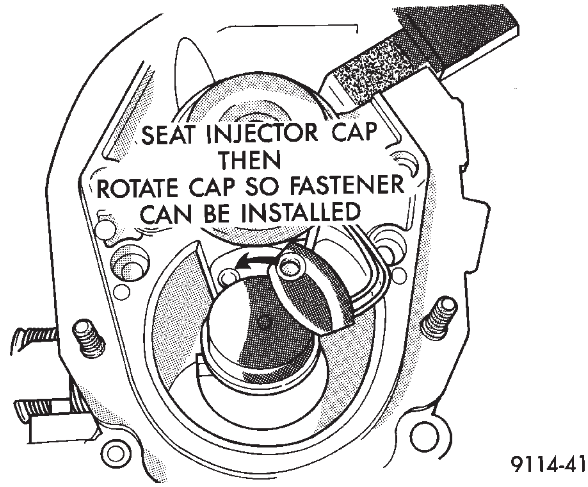

Fig. 11 Installing Fuel Injector Cap

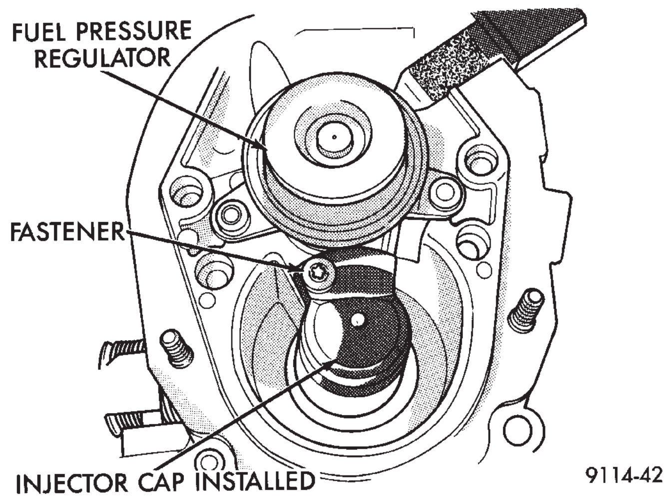

Fig. 12 Fuel Injector Installed

for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(8) With the ignition key in ON position, access the DRB II ASD Fuel System Test to pressurize the fuel system. Check for leaks.

(9) Reinstall the air cleaner assembly.

THROTTLE POSITION SENSOR

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove air cleaner.

(3) Disconnect harness connector from throttle position sensor (Fig. 13).

(4) Remove throttle position sensor mounting screws.

(5) Remove throttle position sensor from throttle shaft.

INSTALLATION

(1) Install throttle position sensor to throttle body, position toward the front of the vehicle. Tighten screws to 2 N●m (20 in. lbs.) torque.

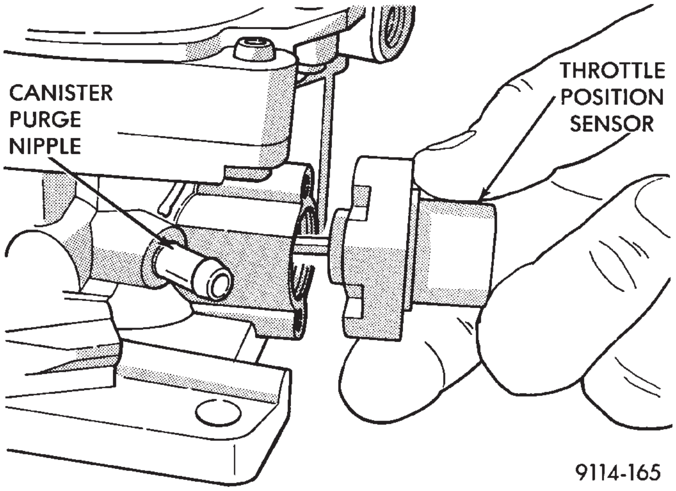

Fig. 13 Servicing Throttle Position Sensor

(2) Connect 3 way connector at throttle position sensor.
(3) Install air cleaner.
(4) Connect negative cable to battery.

AUTOMATIC IDLE SPEED (AIS) MOTOR

The automatic idle speed (AIS) motor is mounted on the throttle body (Fig. 14).

REMOVAL

(1) Remove air cleaner.
(2) Disconnect negative cable from battery.
(3) Disconnect AIS motor connector.
(4) Remove AIS motor mounting screws (Torx head screws, 25 mm long).
(5) Remove AIS motor from throttle body housing. Ensure O-ring is with AIS (Fig. 14).

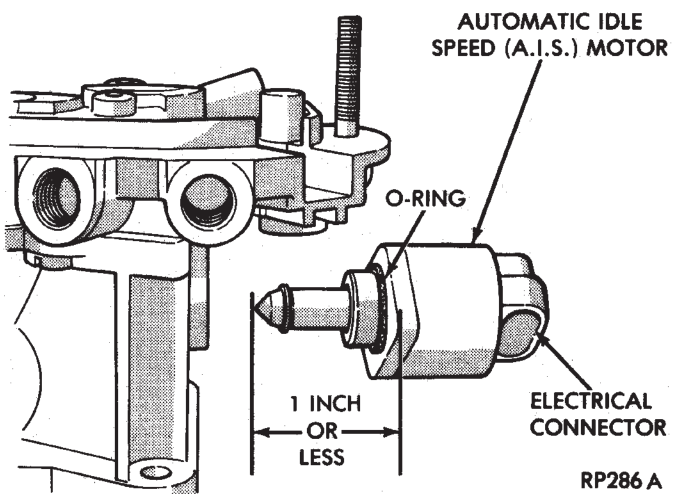

Fig. 14 Servicing Automatic Idle Speed (AIS) Motor

INSTALLATION

(1) Ensure that AIS motor pintle is in the retracted position. **If pintle measures more than 1 inch (25 mm)** as shown in Fig. 14, it must be retracted. Use the DRB II Actuate Outputs Test, AIS MOTOR OPEN/CLOSE (battery must be connected for this operation).
(2) Install new O-ring on AIS.
(3) Install AIS motor into housing, ensuring the O-ring is in place.
(4) Tighten mounting screws to 2 N●m (20 in. lbs.) torque.
(5) Connect harness electrical connector to AIS motor.
(6) Connect negative cable to battery.

MANIFOLD ABSOLUTE PRESSURE SENSOR

The MAP sensor is mounted underhood on the dash panel (Fig. 15)

REMOVAL

(1) Remove vacuum hose and electrical connector from sensor (Fig. 15).
(2) Remove sensor mounting screws. Remove sensor.
(3) Reverse the above procedure for installation. Check the vacuum hose and electrical connections to the sensor.

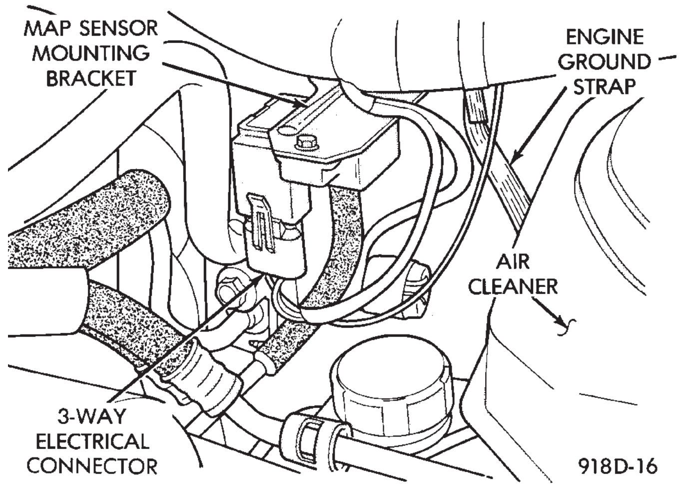

Fig. 15 Manifold Absolute Pressure (MAP) Sensor

CANISTER PURGE SOLENOID

(1) Remove vacuum hose and electrical connector from solenoid (Fig. 16).
(2) Depress tab on top of solenoid and slide the solenoid downward out of mounting bracket.
(3) Reverse the above procedure for installation.

ELECTRIC EXHAUST GAS RECIRCULATION TRANSDUCER (EET) SERVICE

REMOVAL

(1) Disconnect the electrical connector from the electronic EGR transducer solenoid (Fig. 17).
(2) Disconnect vacuum hoses.

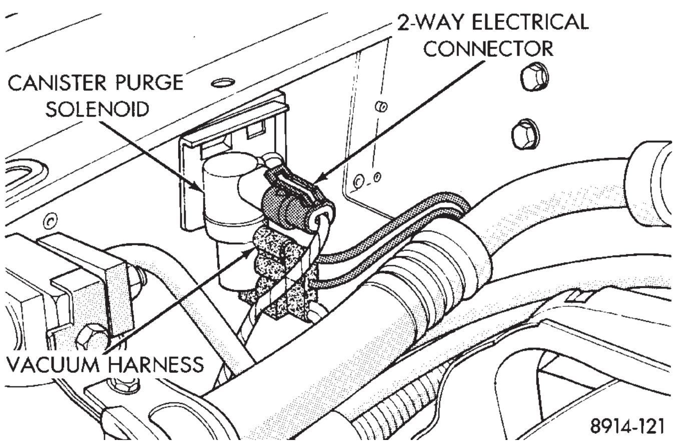

Fig. 16 Canister Purge Solenoid

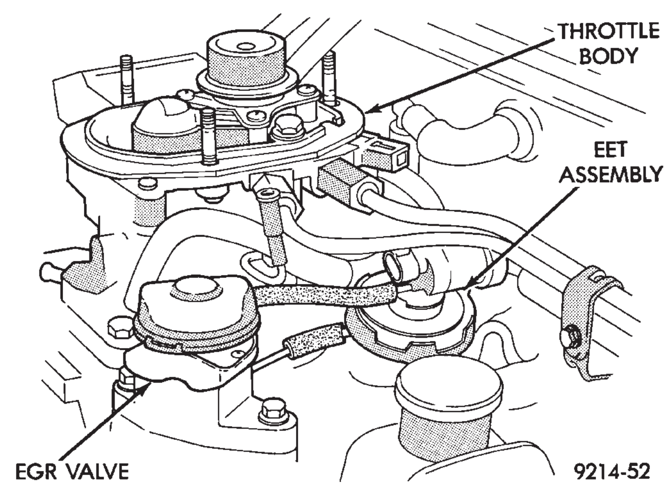

Fig. 17 Electric EGR Transducer

INSTALLATION

(1) Connect vacuum hoses.

(2) Connect electrical connector.

ENGINE CONTROLLER SERVICE

(1) Remove air cleaner duct from engine controller.

(2) Remove battery.

(3) Remove controller mounting screws (Fig. 18).

(4) Remove wiring connector from the controller. Remove the controller.

(5) Reverse the above procedure for installation.

OXYGEN SENSOR (O_2 SENSOR)

The oxygen sensor is installed in the exhaust manifold (Fig. 19).

CAUTION: Do not pull on the oxygen sensor wire when disconnecting the electrical connector.

WARNING: THE EXHAUST MANIFOLD MAY BE EXTREMELY HOT. USE CARE WHEN SERVICING THE OXYGEN SENSOR.

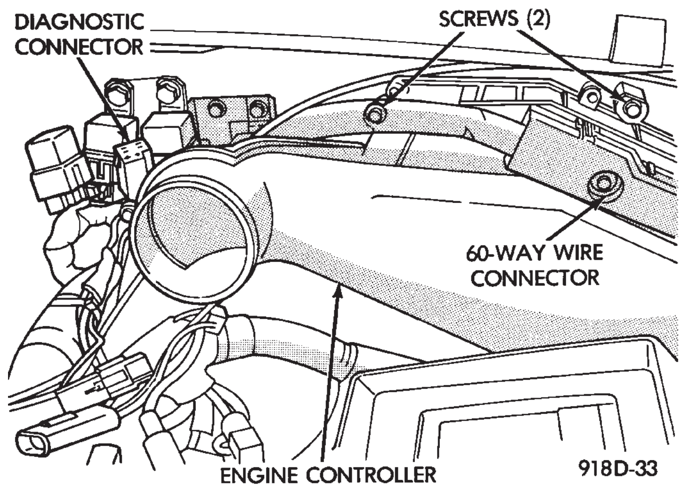

Fig. 18 Engine Controller

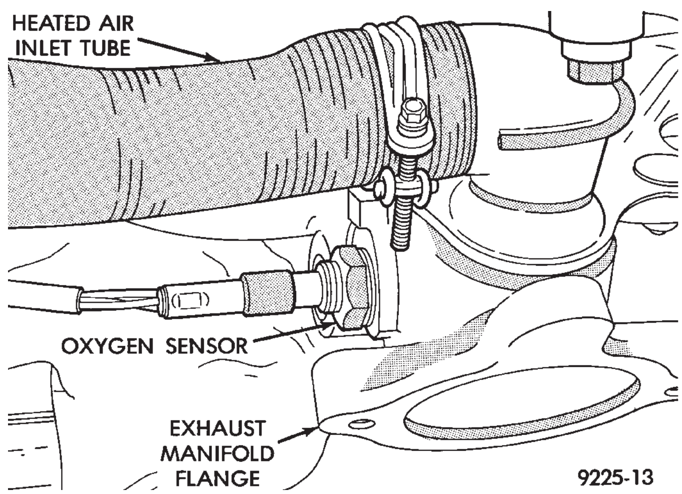

Fig. 19 Heated Oxygen Sensor

(1) Disconnect oxygen sensor electrical connector (Fig. 20).

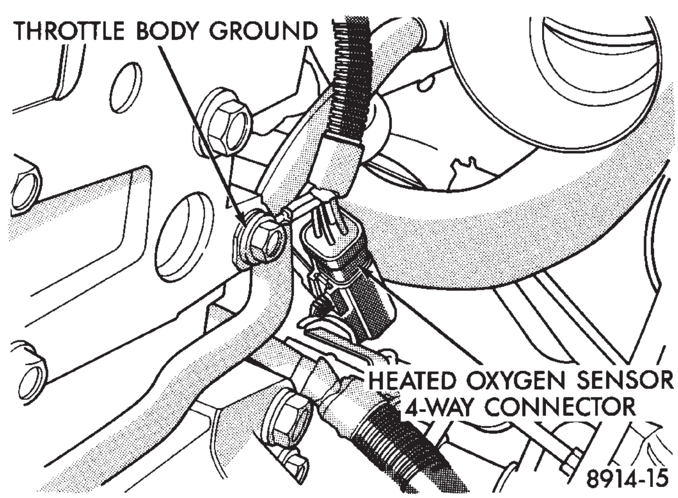

Fig. 20 Oxygen Sensor Electrical Connection

(2) Remove sensor using Tool C-4907 (Fig. 21).

When the sensor is removed, the exhaust manifold threads must be cleaned with an 18 mm X 1.5 + 6E tap. If the same sensor is to be reinstalled, the sensor threads must be coated with an anti-seize compound such as Loctite 771-64 or equivalent. New sensors are packaged with compound on the threads and do not require additional compound. The sensor must be tightened to 27 N●m (20 ft. lbs.) torque.

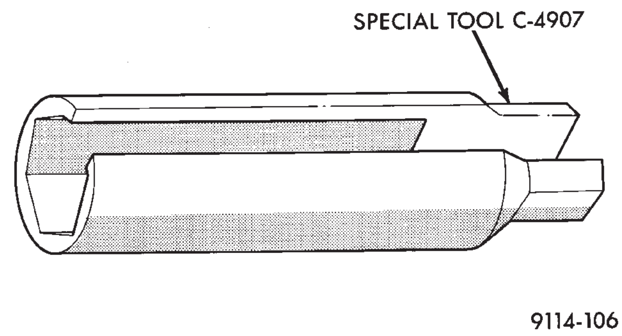

Fig. 21 Oxygen Sensor Socket

2.5L TURBO I MULTI-POINT FUEL INJECTION—SYSTEM OPERATION

INDEX

GENERAL INFORMATION

The turbocharged multi-point electronic fuel injection system combines an electronic fuel and spark advance control system with a turbocharged intake system (Fig. 1). The fuel injection system is controlled by the Single Board Engine Controller II (SBEC II), **referred to in this manual as the engine controller**.

The engine controller regulates ignition timing, air-fuel ratio, emission control devices, cooling fan, charging system, speed control, turbocharger wastegate and idle speed. The engine controller adapts its requirement to meet changing operating conditions.

Various sensors provide the inputs necessary for the engine controller to correctly regulate fuel flow at the fuel injector. These include the manifold absolute pressure, throttle position, oxygen sensor, coolant temperature, detonation, and vehicle distance sensors. In addition to the sensors, various switches and relays provide important information and system control. The inputs include the park/neutral switch and air conditioning clutch switch. The outputs include the auto shutdown relay and fuel pump relay.

All inputs to the engine controller are converted into signals. Based on these inputs the engine controller adjusts air-fuel ratio, ignition timing, turbocharger wastegate and other controlled outputs. The

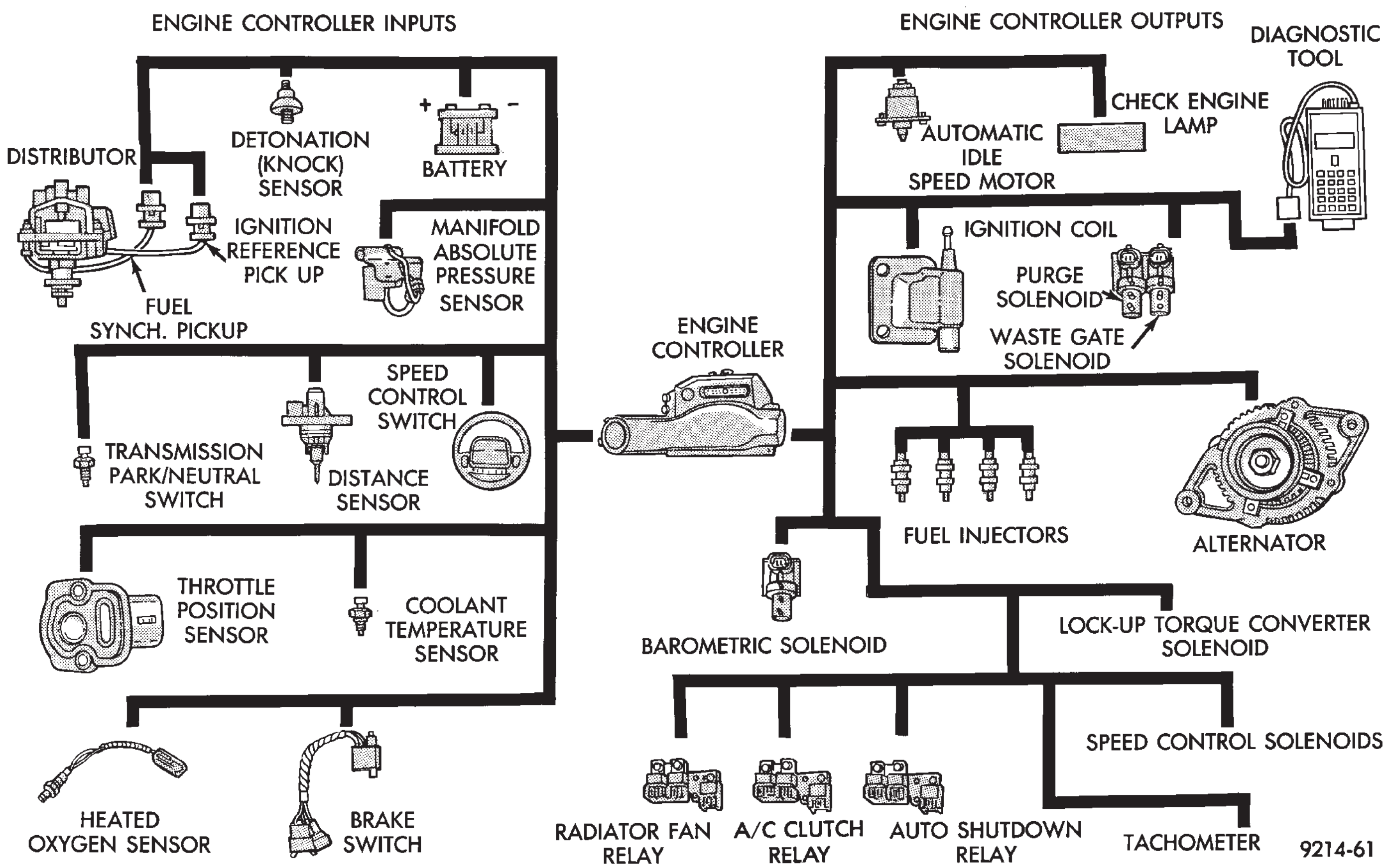

Fig. 1 Electronic Fuel Injection Components

engine controller adjusts the air-fuel ratio by changing injector pulse width. Injector pulse width is the time an injector is energized.

SYSTEM DIAGNOSIS

The engine controller tests many of its own input and output circuits. If a fault is found in a major system, the information is stored in memory. Technicians can display fault information through the instrument panel Check Engine lamp or by connecting the Diagnostic Readout Box II (DRB II). For fault code information, refer to On Board Diagnostics in 2.5L Turbo I Multi-Point Fuel Injection—General Diagnosis section of this group.

CCD BUS

Various controllers and modules exchange information through a communications port called the CCD Bus. The engine controller transmits vehicle load data on the CCD Bus.

ENGINE CONTROLLER

The engine controller is a digital computer containing a microprocessor (Fig. 2). The controller receives input signals from various switches and sensors that are referred to as Engine Controller Inputs. Based on these inputs, the controller adjusts various engine and vehicle operations through devices that are referred to as Engine Controller Outputs.

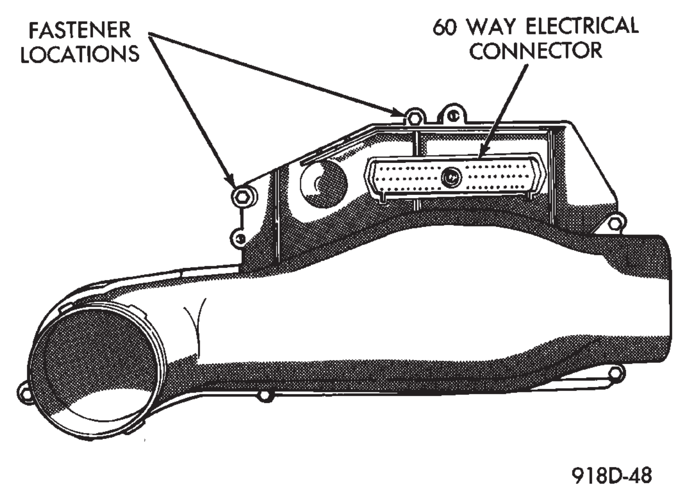

Fig. 2 Engine Controller

Engine Controller Inputs:
- Air Conditioning Controls
- Battery Voltage
- Brake Switch
- Coolant Temperature Sensor
- Detonation (Knock) Sensor
- Distributor (Hall Effect) Pick-up
- Manifold Absolute Pressure (MAP) Sensor

- Oxygen Sensor
- SCI Receive
- Speed Control System Controls
- Throttle Position Sensor
- Park/Neutral Switch (automatic transmission)
- Vehicle Distance (Speed) Sensor

Engine Controller Outputs:

- Air Conditioning Clutch Relay
- Alternator Field
- Automatic Idle Speed (AIS) Motor
- Auto Shutdown (ASD) Relay
- Barometric Read Solenoid
- Canister Purge Solenoid
- Check Engine Lamp
- Diagnostic Connector
- Fuel Injector
- Ignition Coil
- Part Throttle Unlock Solenoid (Automatic Transmission)
- Radiator Fan Relay
- Speed Control Solenoids
- Tachometer Output
- Wastegate Solenoid

Based on inputs it receives, the engine controller adjusts fuel injector pulse width, idle speed, ignition spark advance, ignition coil dwell and canister purge operation. The engine controller regulates operation of the cooling fan, A/C and speed control systems. The controller changes alternator charge rate by adjusting the alternator field.

The engine controller adjusts injector pulse width (air-fuel ratio) based on the following inputs.

- battery voltage
- coolant temperature
- detonation sensor
- exhaust gas content
- engine speed (distributor pick-up)
- manifold absolute pressure
- throttle position

The engine controller adjusts ignition timing based on the following inputs.

- coolant temperature
- engine speed (distributor pick-up)
- manifold absolute pressure
- throttle position

The auto shutdown (ASD) and fuel pump relays are mounted externally. The engine controller turns both relays on and off through the same circuit.

The distributor pick-up signal is sent to the engine controller. If the engine controller does not receive a distributor signal within approximately one second of engine cranking, the ASD relay and fuel pump relay are deactivated. When these relays are deactivated, power is shut off from the fuel injector, fuel pump, ignition coil, and oxygen sensor heater element.

The engine controller contains a voltage converter that changes battery voltage to a regulated 9.0 volts to power the distributor pick-up and vehicle speed sensor. The controller also provides a 5.0 volts supply for the coolant temperature sensor, manifold absolute pressure sensor and throttle position sensor.

AIR CONDITIONING SWITCH SENSE—ENGINE CONTROLLER INPUT

When the air conditioning or defrost switch is put in the ON position and the low pressure and high pressure switches are closed, the engine controller receives an input indicating that the air conditioning has been selected. After receiving this input, the engine controller activates the A/C compressor clutch by grounding the A/C clutch relay. The engine controller also adjusts idle speed to a scheduled RPM to compensate for increased engine load.

BATTERY VOLTAGE—ENGINE CONTROLLER INPUT

The engine controller monitors the battery voltage input to determine fuel injector pulse width and alternator field control.

If battery voltage is low the engine controller will increase injector pulse width (period of time that the injector is energized).

BRAKE SWITCH—ENGINE CONTROLLER INPUT

When the brake switch is activated, the engine controller receives an input indicating that the brakes are being applied. After receiving the input, the controller vents the speed control servo. Venting the servo turns the speed control system off.

COOLANT TEMPERATURE SENSOR—ENGINE CONTROLLER INPUT

The coolant temperature sensor is installed behind the thermostat housing and ignition coil in the hot box. The engine controller supplies 5 volts to the coolant temperature sensor. The sensor provides an input voltage to the engine controller (Fig. 3). As coolant temperature varies, the coolant temperature sensor resistance changes resulting in a different input voltage to the engine controller.

The engine controller demands slightly richer air-fuel mixtures and higher idle speeds until the engine reaches normal operating temperature.

This sensor is also used for cooling fan control.

DETONATION SENSOR (KNOCK SENSOR)—ENGINE CONTROLLER INPUT

The detonation sensor generates a signal when spark knock occurs in the combustion chambers. The sensor is mounted on the intake manifold (Fig. 4). The sensor provides information used by the engine controller to modify spark advance and boost schedules in order to eliminate detonation.

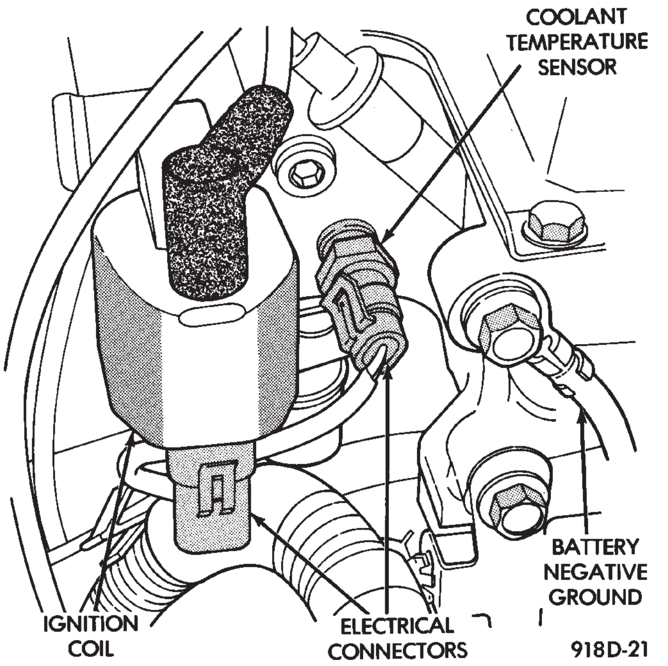

Fig. 3 Coolant Temperature Sensor

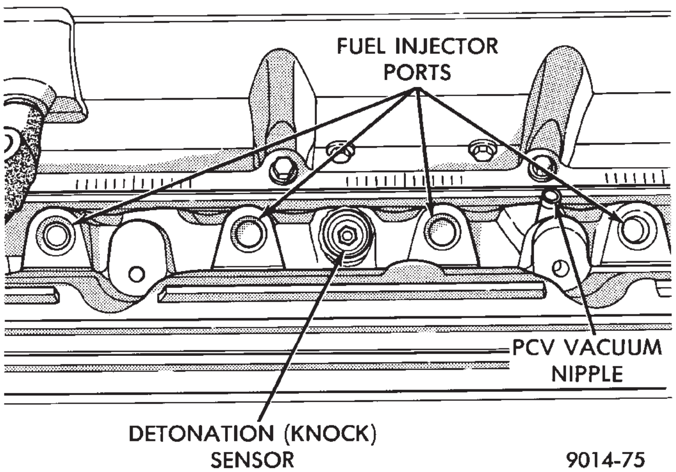

Fig. 4 Detonation Sensor

DISTRIBUTOR (HALL EFFECT) PICK-UP—ENGINE CONTROLLER INPUT

The distributor pick-up supplies engine speed to the engine controller. The distributor pick-up is a Hall Effect device (Fig. 5).

A shutter (sometimes referred to as an interrupter) is attached to the distributor shaft. The shutter contains four blades, one per engine cylinder. A switch plate is mounted to the distributor housing above the shutter. The switch plate contains the distributor pick-up (a Hall Effect device and magnet) through which the shutter blades rotate. As the shutter blades pass through the pick-up, they interrupt the magnetic field. The Hall effect device in the pick-up senses the change in the magnetic field and switches on and off (which creates pulses), generating the input signal to the engine controller. The engine controller calculates engine speed through the number of pulses generated.

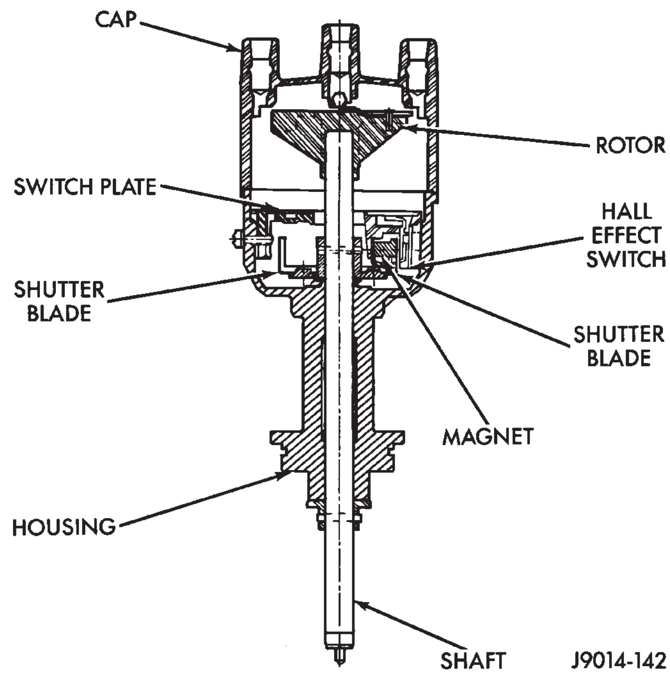

Fig. 5 Distributor Pick-Up—Typical

One of the shutter blades has a window cut into it. The window tells the engine controller which injector to energize. Also, the controller uses the input for control of detonation.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—ENGINE CONTROLLER INPUT

The engine controller supplies 5 volts to the MAP sensor. The MAP sensor converts intake manifold pressure into voltage. The engine controller monitors the MAP sensor output voltage. As vacuum increases, MAP sensor voltage decreases proportionately. Also, as vacuum decreases, MAP sensor voltage increases proportionately.

During cranking, before the engine starts running, the engine controller determines atmospheric air pressure from the MAP sensor voltage. While the engine operates, the controller determines intake manifold pressure from the MAP sensor voltage.

Based on MAP sensor voltage and inputs from other sensors, the engine controller adjusts spark advance and the air/fuel mixture.

The MAP sensor mounts on the dash panel inside the engine compartment (Fig. 6). A vacuum hose connects the sensor to the throttle body.

OXYGEN SENSOR (O_2 SENSOR)—ENGINE CONTROLLER INPUT

The O_2 sensor is located in the exhaust manifold and provides an input voltage to the engine controller (Fig. 7). The input tells the engine controller the oxygen content of the exhaust gas. The engine con-

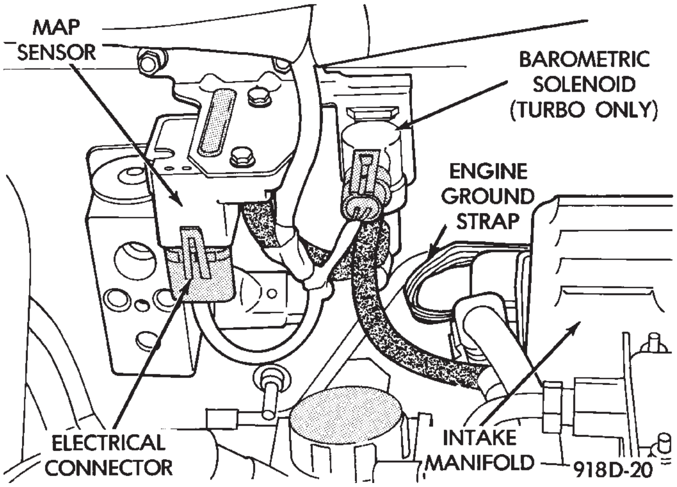

Fig. 6 Manifold Absolute Pressure (MAP) Sensor Location

troller uses this information to fine tune the air-fuel ratio by adjusting injector pulse width.

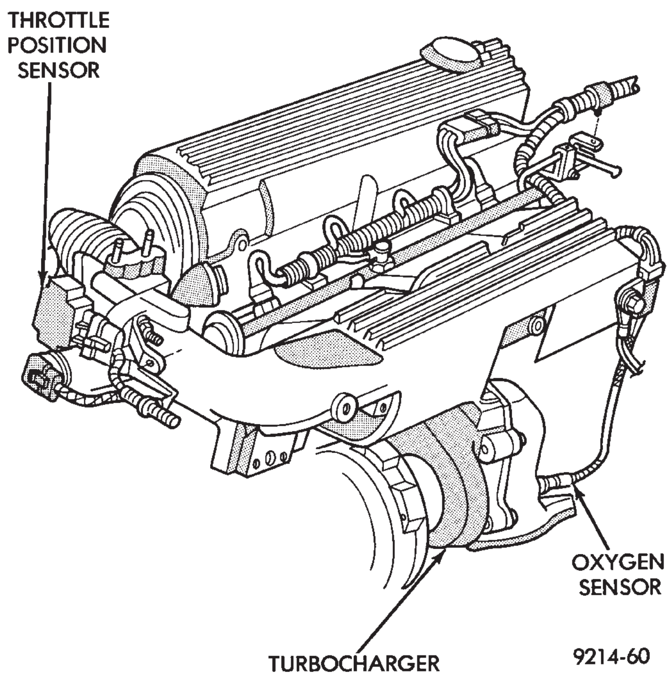

Fig. 7 Oxygen Sensor

The O_2 sensor produces voltages from 0 to 1 volt, depending upon the oxygen content of the exhaust gas in the exhaust manifold. When a large amount of oxygen is present (caused by a lean air-fuel mixture), the sensor produces a low voltage. When there is a lesser amount present (rich air-fuel mixture) it produces a higher voltage. By monitoring the oxygen content and converting it to electrical voltage, the sensor acts as a rich-lean switch.

The oxygen sensor is equipped with a heating element that keeps the sensor at proper operating temperature during all operating modes. Maintaining correct sensor temperature at all times allows the system to enter into closed loop operation sooner. Also, it allows the system to remain in closed loop operation during periods of extended idle.

In Closed Loop operation the engine controller monitors the O_2 sensor input (along with other inputs) and adjusts the injector pulse width accordingly. During Open Loop operation the engine controller ignores the O_2 sensor input. The controller and adjusts injector pulse width based on a preprogrammed (fixed) oxygen sensor input value and inputs from other sensor.

SPEED CONTROL—ENGINE CONTROLLER INPUT

The speed control system provides four separate voltages (inputs) to the engine controller. The voltages correspond to the On/Off, Set, and Resume.

The speed control ON voltage informs the engine controller that the speed control system has been activated. The speed control SET voltage informs the controller that a fixed vehicle speed has been selected. The speed control RESUME voltage indicates the previous fixed speed is requested. The speed control OFF voltage tells the controller that the speed control system has deactivated. Refer to Group 8H for further speed control information.

TRANSMISSION PARK/NEUTRAL SWITCH—ENGINE CONTROLLER INPUT

The park/neutral switch is located on automatic transmission housing (Fig. 8). Manual transmission do not use park/neutral switches. The switch provides an input to the engine controller. The input indicates if the automatic transmission is in Park, Neutral, or a drive gear selection. The input is used to determine idle speed (varying with gear selection), fuel injector pulse width, and ignition timing advance. The park neutral switch is sometimes referred to as the neutral safety switch.

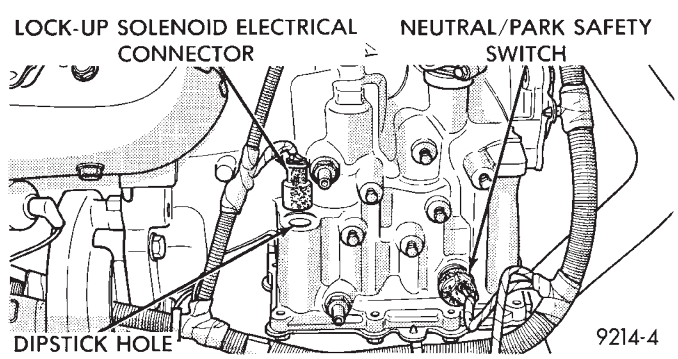

Fig. 8 Park Neutral Switch

THROTTLE POSITION SENSOR (TPS)—ENGINE CONTROLLER INPUT

The Throttle Position Sensor (TPS) is mounted on the throttle body and connected to the throttle blade shaft (Fig. 9). The TPS is a variable resistor. The sensor provides the engine controller with an input signal (voltage) representing throttle blade position. As the position of the throttle blade changes, the resistance of the TPS changes.

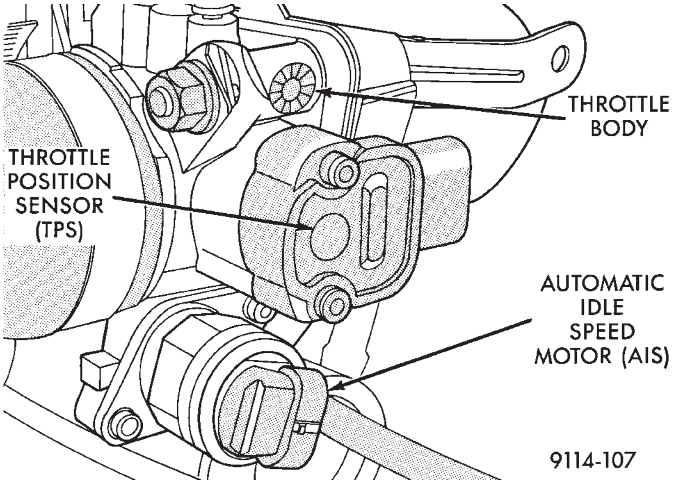

Fig. 9 Throttle Position Sensor (TPS) and Automatic Idle Speed Motor (AIS)

The engine controller supplies approximately 5 volts to the TPS. The TPS output voltage (input signal to the engine controller) represents the throttle blade position. The engine controller receives an input signal voltage from the TPS varying in an approximate range of from 1 volt at minimum throttle opening (idle) to 4 volts at wide open throttle. Along with inputs from other sensors, the engine controller uses the TPS input to determine current engine operating conditions. The engine controller adjusts fuel injector pulse width and ignition timing based on these inputs.

VEHICLE DISTANCE (SPEED) SENSOR—ENGINE CONTROLLER INPUT

The distance sensor (Fig. 10) is located in the transmission extension housing. The sensor input is used by the engine controller to determine vehicle speed and distance traveled.

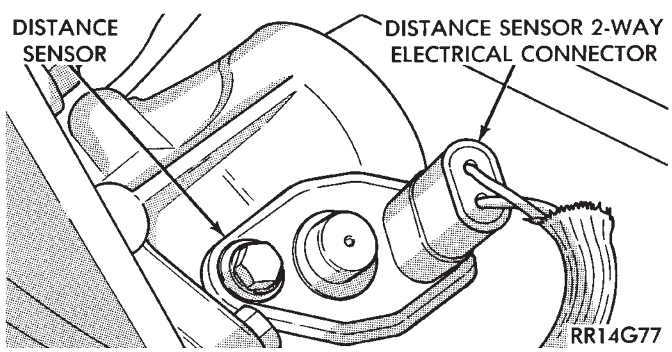

Fig. 10 Vehicle Distance (Speed) Sensor

The distance sensor generates 8 pulses per sensor revolution. These signals, along with a closed throttle signal from the TPS, determine if a closed throttle deceleration or normal idle condition (vehicle stopped) exists. Under deceleration conditions, the engine controller adjusts the AIS motor to maintain a desired MAP value. Under idle conditions, the engine controller adjusts the AIS motor to maintain a desired engine speed.

AIR CONDITIONING (A/C) CLUTCH RELAY—ENGINE CONTROLLER OUTPUT

The engine controller operates the air conditioning clutch relay ground circuit. The radiator fan relay supplies battery power to the solenoid side of the A/C clutch relay. The air conditioning clutch relay will not energize unless the radiator fan relay energizes. The engine controller energizes the radiator fan relay when the air conditioning or defrost switch is put in the ON position and the low pressure and high pressure switches close.

With the engine operating, the engine controller cycles the air conditioning clutch on and off when the A/C switch closes with the blower motor switch in the on position. When the engine controller senses low idle speeds or wide open throttle through the throttle position sensor, it de-energizes the A/C clutch relay. The relay contacts open, preventing air conditioning clutch engagement.

On AG and AJ models, the A/C clutch relay is located in the power distribution center. Refer to the Wiring and Component Identification section of Group 8W.

ON AA and AP models, the A/C clutch relay is mounted to the inner fender panel, next to the drivers side strut tower (Fig. 11).

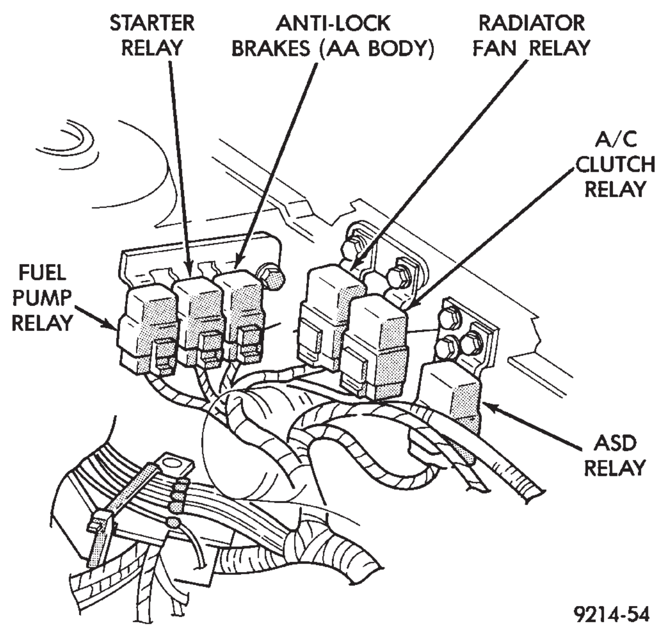

Fig. 11 Relay Identification

ALTERNATOR FIELD—ENGINE CONTROLLER OUTPUT

The engine controller regulates the charging system voltage within a range of 12.9 to 15.0 volts. Refer to Group 8A for charging system information.

AUTO SHUTDOWN (ASD) RELAY AND FUEL PUMP RELAY—ENGINE CONTROLLER OUTPUT

The engine controller operates the auto shutdown (ASD) relay and fuel pump relay through one ground path. The controller operates the relays by switching the ground path on and off. Both relays turn on and off at the same time.

The ASD relay connects battery voltage to the fuel injector and ignition coil. The fuel pump relay connects battery voltage to the fuel pump and oxygen sensor heating element.

The engine controller turns the ground path off when the ignition switch is in the Off position. Both relays are off. When the ignition switch is in the On or Crank position, the engine controller monitors the distributor pick-up signal to determine engine speed and ignition timing (coil dwell). If the controller does not receive a distributor signal when the ignition switch is in the Run position, it de-energizes both relays. Battery voltage is not supplied to the fuel injector, ignition coil, fuel pump and oxygen sensor heating element.

On AG and AJ models, the ASD relay and fuel pump relay are located in the power distribution center. Refer to the Wiring and Component Identification section of Group 8W.

On AA and AP models, the ASD relay and fuel pump relay are mounted on the drivers side fender well, next to the strut tower (Fig. 11).

AUTOMATIC IDLE SPEED (AIS) MOTOR—ENGINE CONTROLLER OUTPUT

The idle speed stepper motor is mounted on the throttle body and is controlled by the engine controller (Fig. 9). The engine controller adjusts engine idle speed through the AIS motor to compensate for engine load or ambient conditions.

The throttle body has an air bypass passage that provides air for the engine at idle (the throttle blade is closed). The AIS motor pintle protrudes into the air bypass passage and regulates air flow through it.

The engine controller adjusts engine idle speed by moving the AIS motor pintle in and out of the bypass passage. The adjustments are based on inputs the controller receives from the throttle position sensor, speed sensor (distributor pick-up coil), coolant temperature sensor, and various switch operations (brake, park/neutral, air conditioning). Deceleration die out is also prevented by increasing airflow when the throttle is closed quickly after a driving (speed) condition.

BAROMETRIC READ SOLENOID—ENGINE CONTROLLER OUTPUT

The barometric pressure read solenoid is tied into the manifold absolute pressure (MAP) sensor vacuum hose (Fig. 6). The barometric read solenoid switches the pressure supply to the MAP sensor from either barometric pressure (atmospheric) or manifold vacuum. The engine controller operates the solenoid.

Atmospheric pressure is periodically supplied to the MAP sensor to measure barometric pressure. This occurs at closed throttle, once per throttle closure but no more often than once every 3 minutes and within a specified RPM band. Barometric information is used primarily for boost control.

CANISTER PURGE SOLENOID—ENGINE CONTROLLER OUTPUT

Vacuum for the Evaporative Canister is controlled by the Canister Purge Solenoid (Fig. 12). The solenoid is controlled by the engine controller.

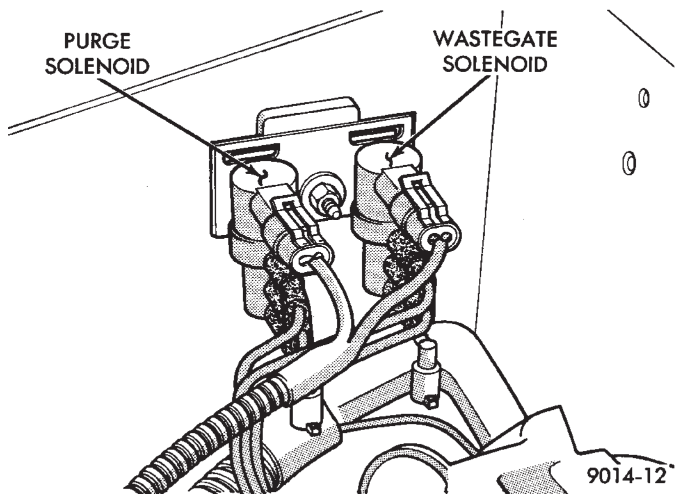

Fig. 12 Canister Purge Solenoid and Wastegate Control Solenoid

The engine controller operates the solenoid by switching the ground circuit on and off. When energized, the solenoid prevents vacuum from reaching the evaporative canister. When not energized the solenoid allows vacuum to flow to the canister.

During warm-up and for a specified time period after hot starts, the controller grounds the purge solenoid. When the solenoid energizes, vacuum does not operate the evaporative canister valve.

The engine controller removes the ground to the solenoid when the engine reaches a specified temperature and the time delay interval has occurred. When the solenoid is de-energized, vacuum flows to the canister purge valve. Vapors are purged from the canister and flow to the throttle body.

The purge solenoid will also be energized during certain idle conditions, in order to update the fuel delivery calibration.

CHECK ENGINE LAMP—ENGINE CONTROLLER OUTPUT

The Check Engine Lamp comes on each time the ignition key is turned ON and stays on for 3 seconds as a bulb test. The Check Engine Lamp warns the operator that the engine controller has entered a Limp-in mode. During Limp-in-Mode, the controller attempts to keep the system operational. The check engine lamp signals the need for immediate service. In limp-in mode, the Engine controller compensates for the failure of certain components that send incorrect signals. The controller substitutes for the incorrect signals with inputs from other sensors.

Signals that can trigger the Check Engine Lamp.

- Coolant Temperature Sensor
- Manifold Absolute Pressure Sensor
- Throttle Position Sensor
- Battery Voltage Input
- An Emissions Related System
- Charging system

The Check Engine Lamp can also be used to display fault codes. Cycle the ignition switch on, off, on, off, on, within five seconds to display any fault codes stored in the controller. Refer to On Board Diagnostics in the General Diagnosis—2.5L Turbo I Engines section of this Group for Fault Code Descriptions.

DIAGNOSTIC CONNECTOR—ENGINE CONTROLLER OUTPUT

The diagnostic connector provides the technician with the means to connect the DRB II tester to diagnosis the vehicle.

FUEL INJECTOR—ENGINE CONTROLLER OUTPUT

The Fuel Injectors are electric solenoids driven by the engine controller (Fig. 13).

Based on sensor inputs, the engine controller determines when and how long the fuel injector should operate. The amount of time an injector fires is referred to as injector pulse width. The auto shutdown (ASD) relay supplies battery voltage to the injector. The engine controller supplies the ground path. By switching the ground path on and off, the engine controller adjusts injector pulse width.

When the controller supplies a ground path, a spring loaded needle or armature lifts from its seat. Fuel flows through the orifice and deflects off the sharp edge of the injector nozzle. The resulting fuel sprays forms a cone shaped pattern before entering the air stream.

Fuel is constantly supplied to the injector at regulated 380 Kpa (55 psi). Unused fuel returns to the fuel tank.

IGNITION COIL—ENGINE CONTROLLER OUTPUT

The engine controller provides a ground contact (circuit) for energizing the ignition coil. When the controller breaks the contact, the energy in the coil primary transfers to the secondary causing the spark. The engine controller will de-energize the ASD relay if it does not receive an input from the distributor pick-up. Refer to Auto Shutdown (ASD) Relay/Fuel Pump Relay—Engine Controller Output in this section for relay operation.

The ignition coil is mounted on the hot box next to the thermostat housing (Fig. 14).

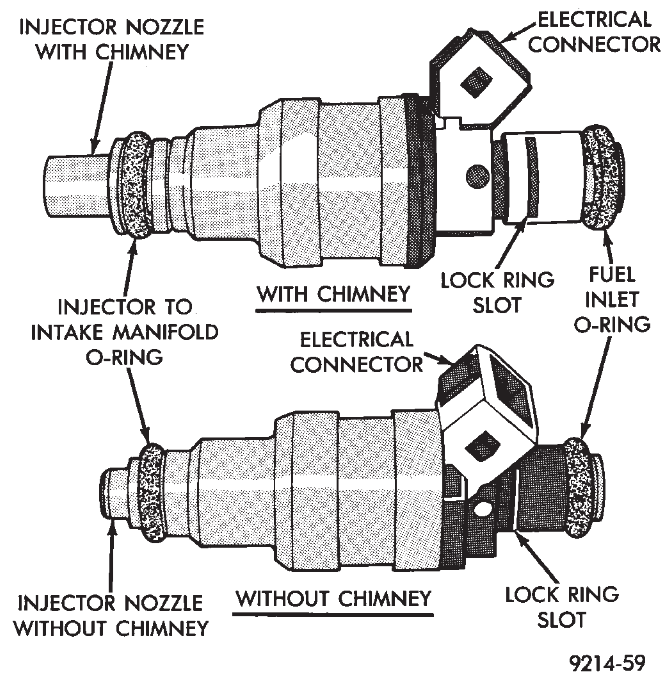

Fig. 13 Fuel Injector

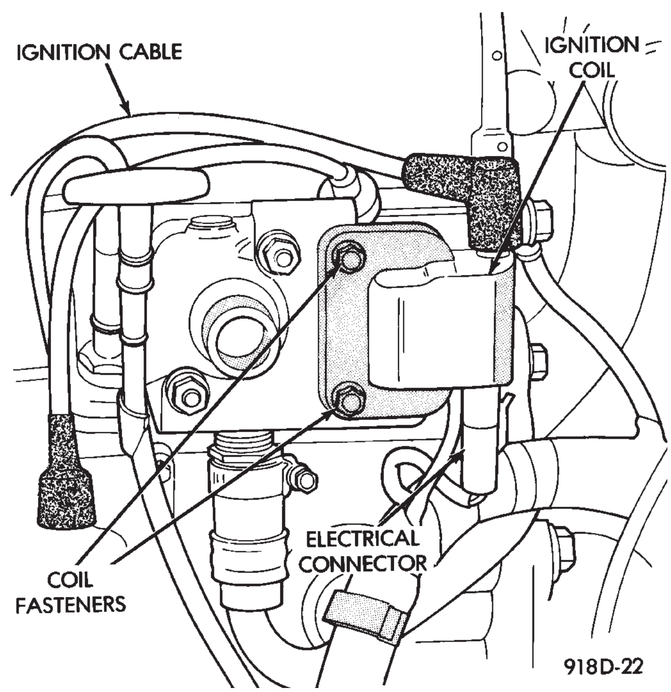

Fig. 14 Ignition Coil

PART THROTTLE UNLOCK SOLENOID—ENGINE CONTROLLER OUTPUT

Three-speed automatic transaxles use a part throttle unlock solenoid. The engine controller controls the lock-up of the torque convertor through the part throttle unlock solenoid. The transmission is locked up only in direct drive mode. Refer to Group 21 for transmission information.

RADIATOR FAN RELAY—ENGINE CONTROLLER OUTPUT

The radiator fan is energized by the engine controller through the radiator fan relay. The engine controller grounds the radiator fan relay when engine coolant reaches a predetermined temperature. For more information, refer to Group 7, Cooling Systems.

On AG and AJ models, the radiator fan relay is located in the power distribution center. Refer to the Wiring and Component Identification section of Group 8W.

On AA and AP models, the radiator fan relay is mounted on the drivers side fender well, next to the strut tower (Fig. 11).

SPEED CONTROL SOLENOIDS—ENGINE CONTROLLER OUTPUT

The speed control vacuum and vent solenoids are operated by the engine controller. When the engine controller supplies a ground to the vacuum solenoid, the speed control system opens the throttle plate. When the controller supplies a ground to the vent solenoid, throttle blade closes. The engine controller balances the two solenoids to maintain the set speed. Refer to Group 8H for speed control information.

TACHOMETER—ENGINE CONTROLLER OUTPUT

The engine controller supplies engine RPM to the instrument panel tachometer. Refer to Group 8 for tachometer information.

WASTEGATE CONTROL SOLENOID—ENGINE CONTROLLER OUTPUT

The engine controller operates the wastegate control solenoid. The controller adjusts maximum boost to varying engine conditions by changing the amount of time the solenoid is energized. The solenoid mounts to the passenger side inner fender panel, next to the strut tower (Fig. 12).

MODES OF OPERATION

As input signals to the engine controller change, the engine controller adjusts its response to the output devices. For example, the engine controller must calculate a different injector pulse width and ignition timing for idle than it does for wide open throttle (WOT). There are several different modes of operation that determine how the engine controller responds to the various input signals.

There are two different areas of operation, Open Loop and Closed Loop.

During Open Loop modes, the engine controller receives input signals and responds according to preset engine controller programming. Input from the oxygen (O_2) sensor is not monitored during Open Loop modes.

During CLOSED LOOP modes, the engine controller does monitor the oxygen (O_2) sensor input. The input indicates if the calculated injector pulse width results in an ideal air-fuel ratio of 14.7 parts air to 1 part fuel. By monitoring the exhaust oxygen content through the O_2 sensor, the engine controller can fine tune the injector pulse width to achieve optimum fuel economy combined with low emissions.

The 2.5L Turbo I multi point fuel injection system has the following modes of operation:

- Ignition switch ON - Zero RPM
- Engine start-up
- Engine warm-up
- Cruise (Idle)
- Acceleration
- Deceleration
- Wide Open Throttle
- Ignition switch OFF

The engine start-up (crank), engine warm-up, and wide open throttle modes are OPEN LOOP modes. The acceleration, deceleration, and cruise modes, **with the engine at operating temperature** are CLOSED LOOP modes (under most operating conditions).

IGNITION SWITCH ON (ZERO RPM) MODE

When the ignition switch activates the fuel injection system the following actions occur:

- The engine controller calculates basic fuel strategy by determining atmospheric air pressure from the MAP sensor input.
- The engine controller monitors the coolant temperature sensor and throttle position sensor input. The engine controller modifies fuel strategy based on this input.

When the key is in the ON position and the engine is not running, the auto shutdown (ASD) relay and fuel pump relay are not energized. Therefore battery voltage is not supplied to the fuel pump, ignition coil, fuel injector or oxygen sensor heating element.

ENGINE START-UP MODE

This is an OPEN LOOP mode. The following actions occur when the starter motor is engaged.

If the engine controller receives a distributor signal it energizes the auto shutdown (ASD) relay and fuel pump relay. These relays supply battery voltage to the fuel injector, ignition coil and oxygen sensor heating element. If the engine controller does not receive a distributor input, it de-energizes the ASD and fuel pump relays after approximately one second.

With the engine idling within ±64 RPM of the target RPM, the controller compares the current MAP value with the atmospheric pressure value it received during the Ignition Switch On (Zero RPM) Mode. If a minimum difference between the two is not detected, a MAP sensor fault is set into memory.

Once the ASD relay and fuel pump relay have energized, the engine controller:

- Supplies a ground path to each injector. The injectors are pulsed four times per engine revolution instead of the normal two pulses per revolution.
- Determines injector pulse width based on coolant temperature, MAP sensor input, throttle position, and the number of engine revolutions since cranking was initiated.
- Monitors the coolant temperature sensor, distributor pick-up, MAP sensor, and throttle position sensor to determine correct ignition timing.

ENGINE WARM-UP MODE

This is a OPEN LOOP mode. The following inputs are received by the engine controller:

- coolant temperature
- detonation sensor
- manifold absolute pressure (MAP)
- engine speed (distributor pick-up)
- throttle position
- A/C switch
- battery voltage

The engine controller provides a ground path for the injectors to precisely control injector pulse width (by switching the ground on and off). The engine controller regulates engine idle speed by adjusting the automatic idle speed motor. Also, the controller adjusts ignition timing.

CRUISE OR IDLE MODE

When the engine is at operating temperature, this is a CLOSED LOOP mode. During cruising speed the following inputs are received by the engine controller:

- coolant temperature
- detonation sensor
- manifold absolute pressure
- engine speed
- throttle position
- exhaust gas oxygen content
- A/C control positions
- battery voltage

The engine controller provides a ground path for the injectors to precisely control injector pulse width. The engine controller controls engine idle speed and ignition timing. The engine controller controls the air/fuel ratio according to the oxygen content in the exhaust gas.

ACCELERATION MODE

This is a CLOSED LOOP mode. The engine controller recognizes an abrupt increase in throttle position or MAP pressure as a demand for increased engine output and vehicle acceleration. The engine controller increases injector pulse width in response to increased fuel demand.

DECELERATION MODE

This is a CLOSED LOOP mode. During deceleration the following inputs are received by the engine controller:

- coolant temperature
- detonation sensor
- manifold absolute pressure
- engine speed
- throttle position
- exhaust gas oxygen content
- A/C control positions
- battery voltage

The engine controller may receive a closed throttle input from the throttle position sensor (TPS) at the same time it senses an abrupt decrease in manifold pressure from the manifold absolute pressure (MAP) sensor. This indicates a hard deceleration. The engine controller may modify the injector firing sequence. Modifying the injector firing sequence helps maintain better control of the air-fuel mixture (as sensed through the O_2 sensor).

WIDE OPEN THROTTLE MODE

This is an OPEN LOOP mode. During wide open throttle operation, the following inputs are received by the engine controller:

- coolant temperature
- detonation sensor
- manifold absolute pressure
- engine speed
- throttle position

When the controller senses a wide open throttle condition, it de-energizes the air conditioning clutch relay. This disables the air conditioning system.

The exhaust gas oxygen content input is not accepted by the engine controller during wide open throttle operation. The engine controller will enrichen the air/fuel ratio to increase performance and compensate for increased combustion chamber temperature.

IGNITION SWITCH OFF MODE

This is an OPEN LOOP mode. When the ignition switch is turned to the OFF position, the following occurs:

- All outputs are turned off.
- No inputs are monitored.
- The engine controller shuts down.

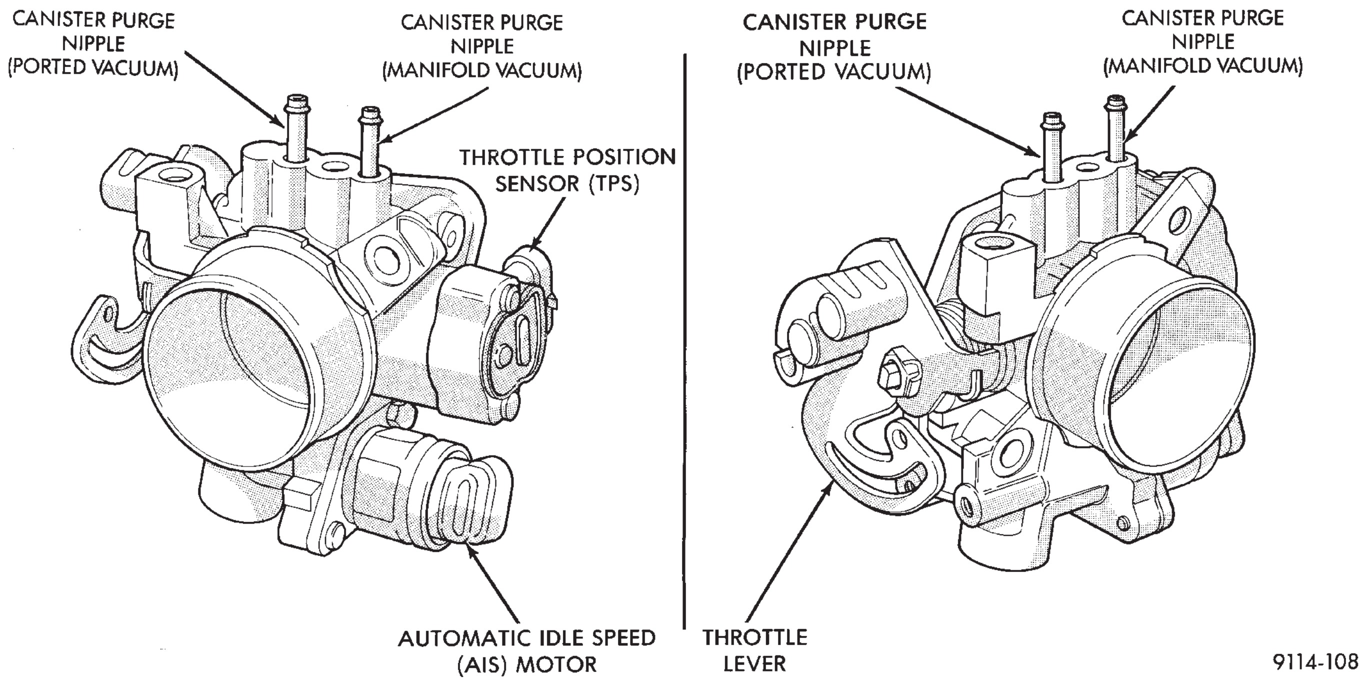

Fig. 15 Throttle Body

THROTTLE BODY

The throttle body is located between the turbocharger and intake manifold (Fig. 15). The throttle body houses the throttle position sensor (TPS) and the automatic idle speed (AIS) motor. Air flow through the throttle body is controlled by a cable operated throttle blade in the base of the throttle body.

FUEL SUPPLY CIRCUIT

Fuel is pumped to the fuel rail by an electrical pump in the fuel tank. A filter, attached to the pump inlet, prevents water and other contaminants from entering the fuel supply circuit.

The vacuum assisted fuel pressure regulator keeps fuel pressure at 380 kPa (55 psi). The regulator uses intake manifold pressure at the vacuum tee as a reference.

FUEL INJECTORS AND FUEL RAIL ASSEMBLY

Four fuel injectors are retained in the fuel rail by lock rings (Fig. 16). The rail and injector assembly bolts in position with the injectors inserted into recessed holes in the intake manifold.

FUEL PRESSURE REGULATOR

The pressure regulator is located downstream of the fuel injector on the fuel rail (Fig. 17). The regulator maintains constant 380 kPa (55 PSI) fuel pressure across the fuel injector tip.

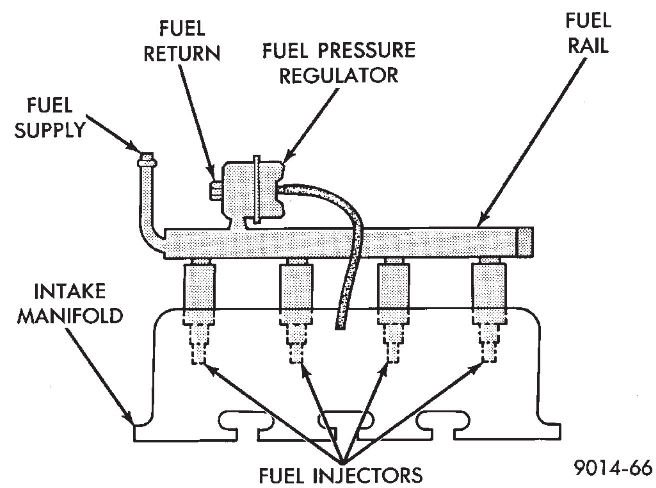

Fig. 16 Fuel Supply System

The regulator has a spring loaded rubber diaphragm that uncovers a fuel return port. When the fuel pump operates, fuel flows past the injector into the regulator. Fuel is restricted from flowing any further by the blocked return port. When fuel pressure reaches 380 kPa (55 PSI), it pushes on the diaphragm, compresses the spring, and uncovers the fuel return port. The diaphragm and spring continually move from an open to closed position keeping the fuel pressure consistent.

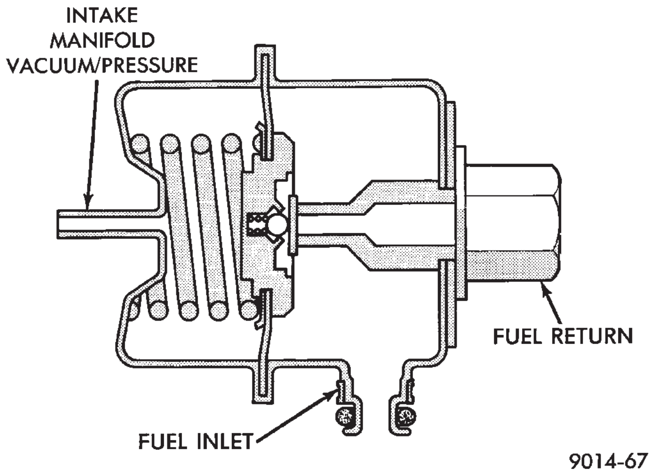

Fig. 17 Fuel Pressure Regulator

2.5L TURBO I MULTI-POINT FUEL INJECTION—GENERAL DIAGNOSIS

INDEX

FUEL SYSTEM DIAGRAM

Refer to the Component Identification portion of this section for a more complete description of the components shown in Figure 1.

VISUAL INSPECTION

Perform a visual inspection for loose, disconnected, or misrouted wires and hoses before diagnosing or servicing the fuel injection system. A visual check helps save unnecessary test and diagnostic time. A thorough visual inspection includes the following checks:

(1) Check Ignition Coil Electrical Connections (Fig. 2).

(2) Verify the electrical connector is attached to the Canister Purge Solenoid (Fig. 3).

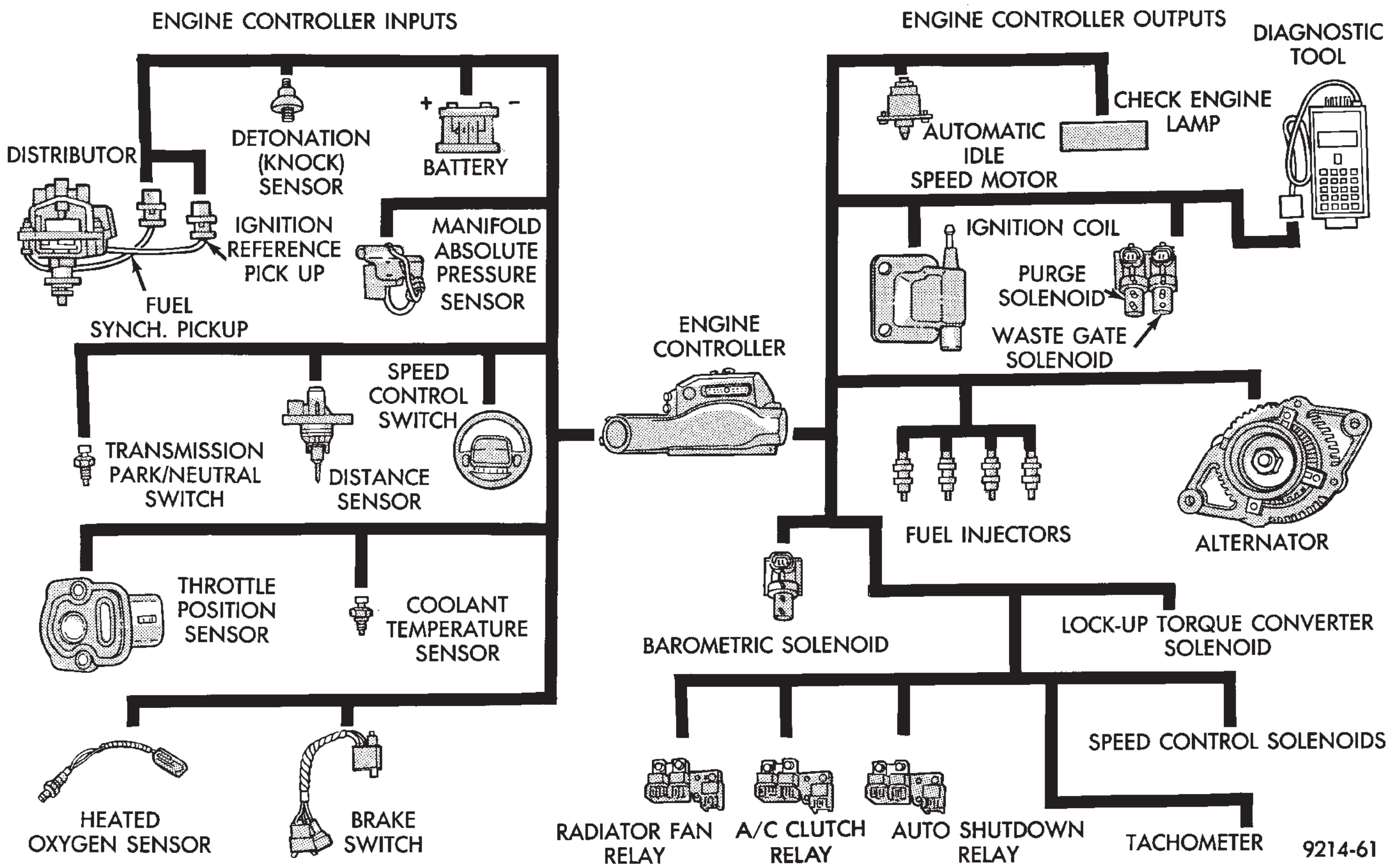

Fig. 1 Multi-point Fuel Injection Components

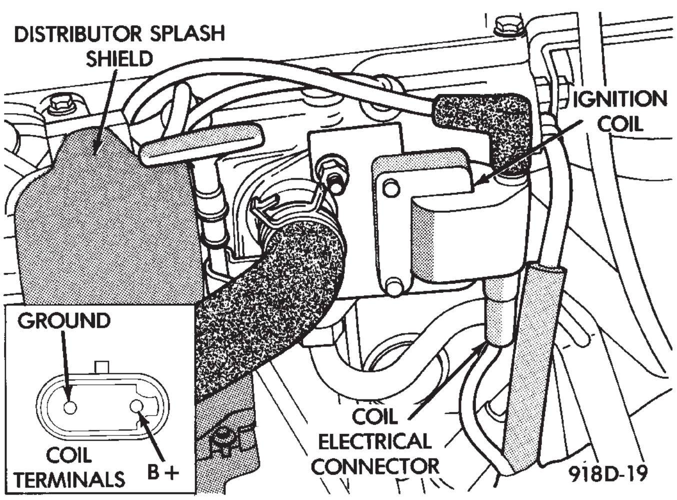

Fig. 2 Ignition Coil Electrical Connection

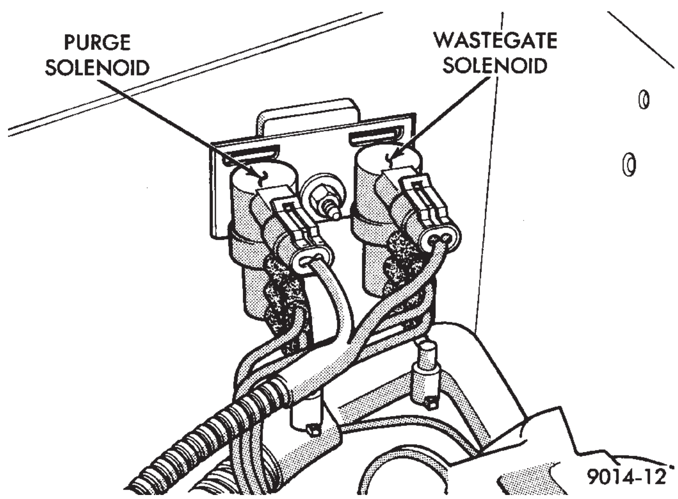

Fig. 3 Solenoid Connections Turbo I

(3) Verify the electrical connector is attached to the Wastegate solenoid (Fig. 3).

(4) Check vacuum hose connections between vacuum source and canister purge, wastegate and barometric read solenoids (Fig. 3 and 4).

(5) Verify the electrical connector is attached to the MAP sensor (Fig. 4).

(6) Verify hoses are securely attached to vapor canister (Fig. 5).

(7) Verify alternator wiring and belt are correctly installed and tighten.

(8) Check Ignition Cable Routing and Attachment (Fig. 6).

(9) Inspect the oil pressure sending unit electrical connector (Fig. 7).

(10) Check both electrical connectors at the distributor (Fig. 7).

(11) Check radiator fan electrical connector.

(12) Check the coolant temperature sensor electrical connection. Inspect battery ground cable connection (Fig. 8).

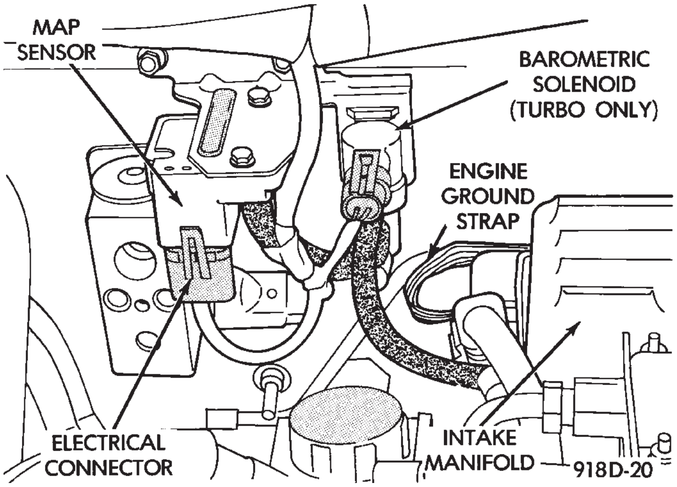

Fig. 4 MAP and Barometric Solenoid Connections

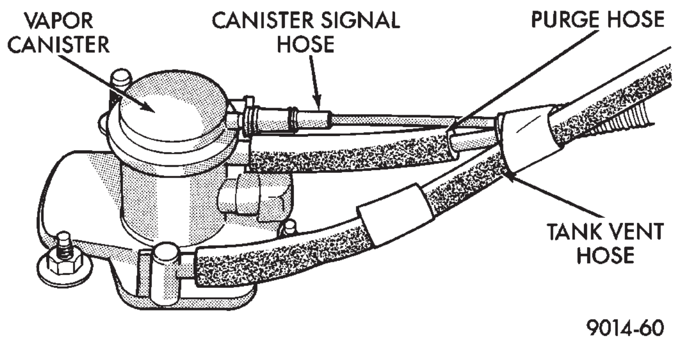

Fig. 5 Vapor Canister

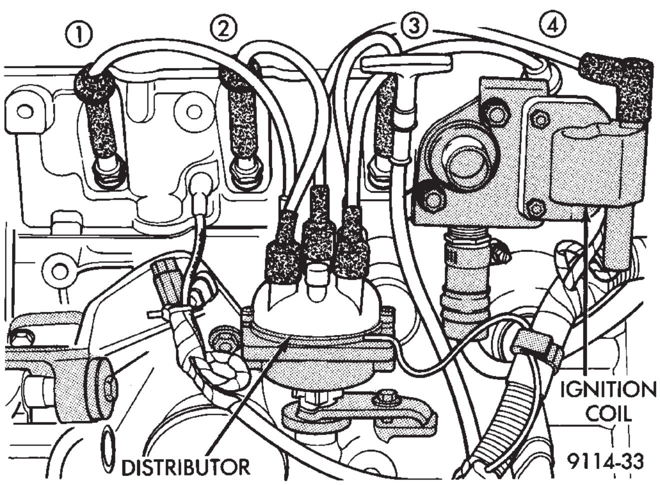

Fig. 6 Ignition Cable Mounting and Attachment

(13) Inspect the engine temperature sensor electrical connection (Fig. 9).

(14) Check power brake booster and speed control vacuum connections (Fig. 10).

(15) Check engine harness to main harness electrical connections.

(16) Check park/neutral switch wiring connection (Fig. 11).

(17) Ensure relay and battery connections are clean and tight (Figs. 12, 13, and 14).

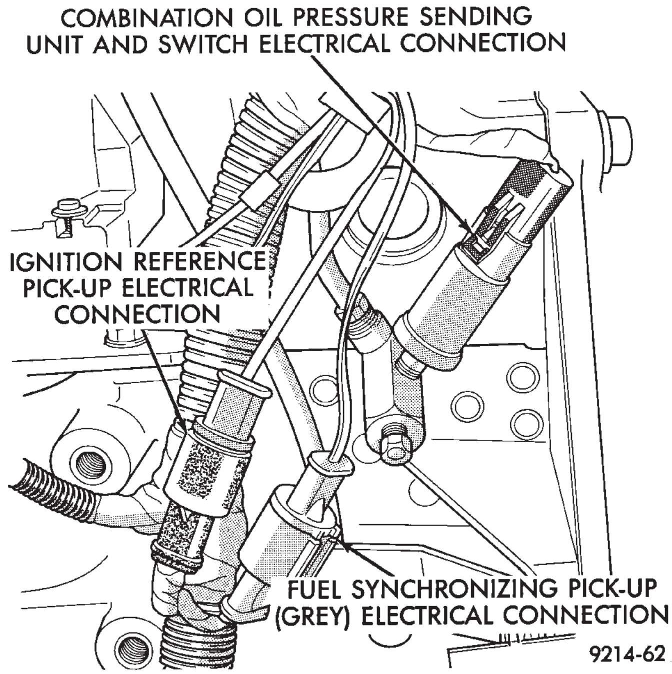

Fig. 7 Oil Pressure Sending Unit Electrical Connection

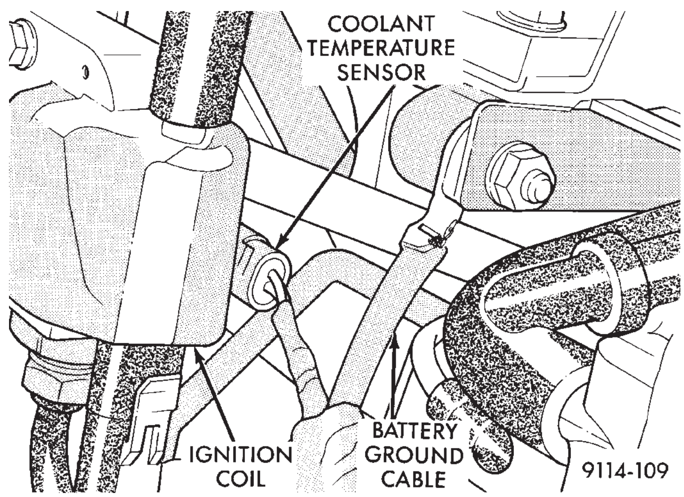

Fig. 8 Coolant Temperature Sensor

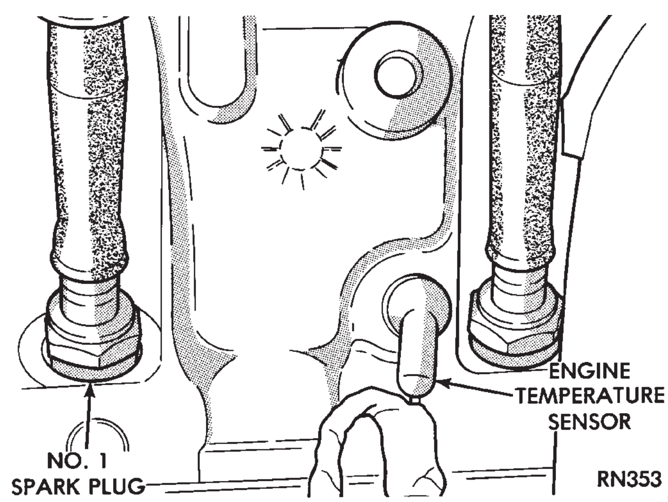

Fig. 9 Engine Temperature Sensor Electrical Connection

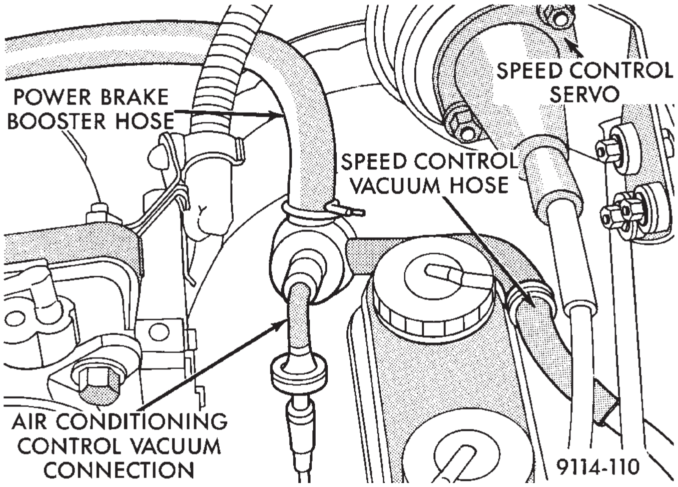

Fig. 10 Power Brake Booster and Speed Control Vacuum Hose Connections

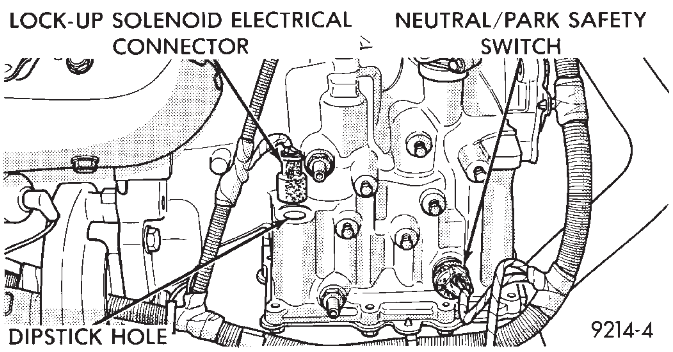

Fig. 11 Automatic Transmission Electrical Connections

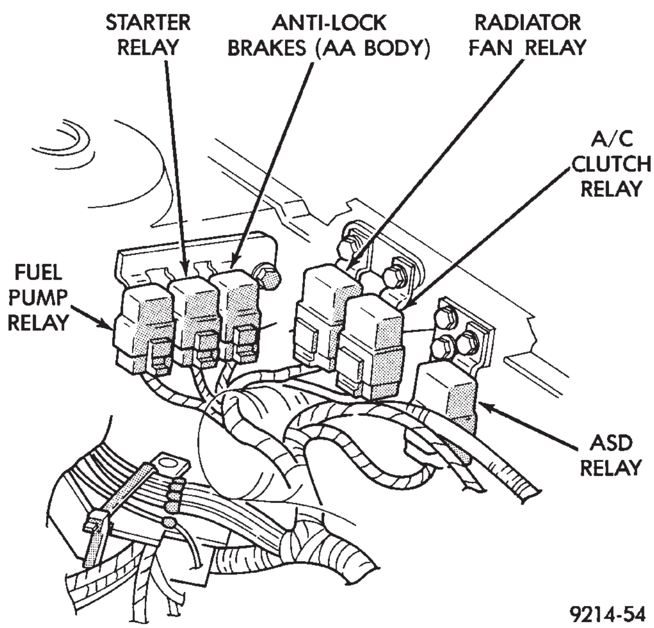

Fig. 12 Relay Identification—AA and AP Bodies

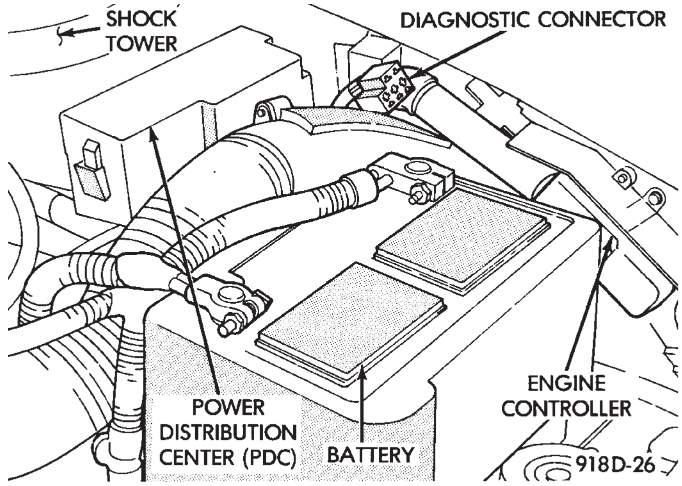

Fig. 13 Power Distribution Center—AG and AJ Bodies

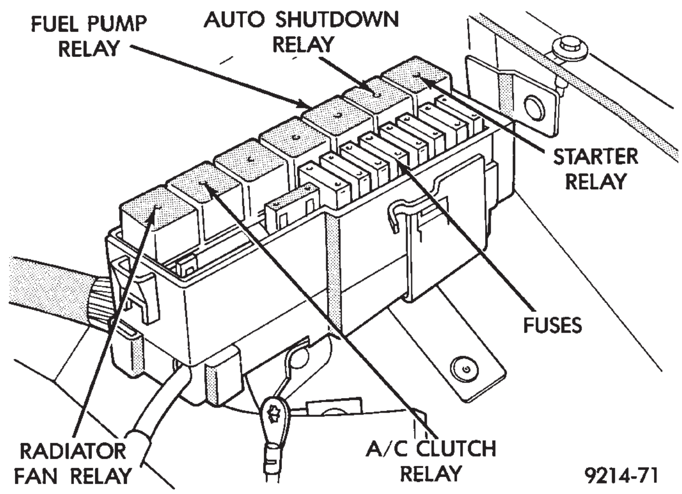

Fig. 14 Relay Identification—AG and AJ Bodies

(18) Ensure the 60-way connector is fully inserted into the socket on the Engine Controller (Fig. 15). Make sure the wires are not stretched or pulled out of the connector.

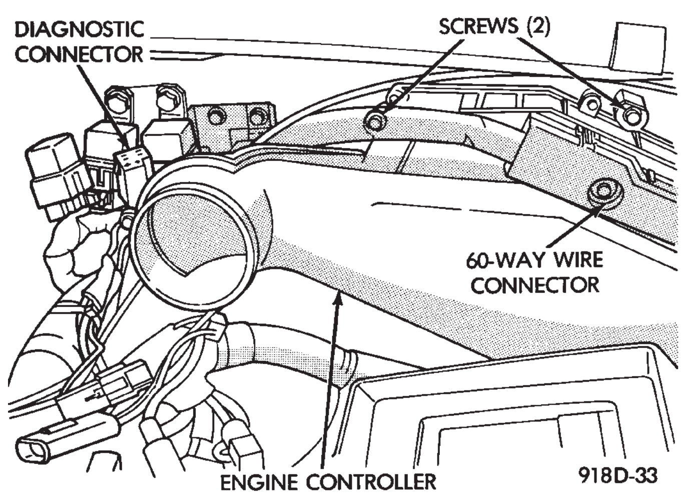

Fig. 15 Engine Controller Electrical Connector

(19) Verify the harness connector is attached to AIS motor (Fig. 16).

(20) Verify the harness connector is attached to the throttle position sensor (Fig. 16).

(21) Check hose connections at throttle body (Fig. 16).

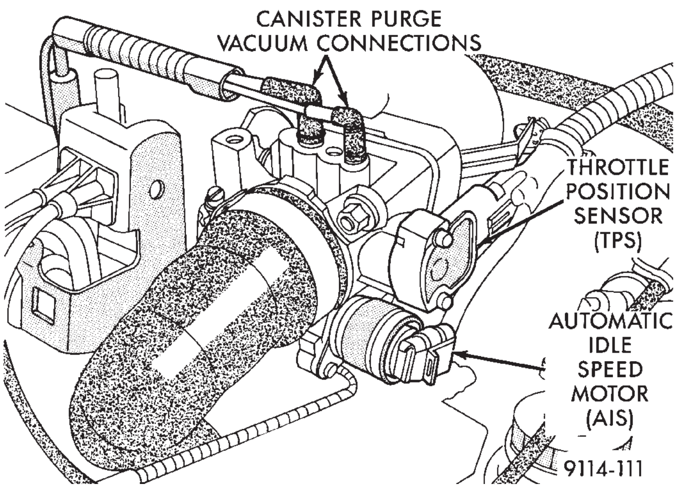

Fig. 16 Throttle Body Electrical and Vacuum Hose Connections

(22) Verify hose from PCV valve is securely attached to the intake manifold vacuum port (Fig. 17).

(23) Check vacuum hose connection between vacuum source and fuel pressure regulator (Fig. 17).

(24) Check Fuel Injectors Wiring Connector and Detonation Sensor connector (Fig. 17).

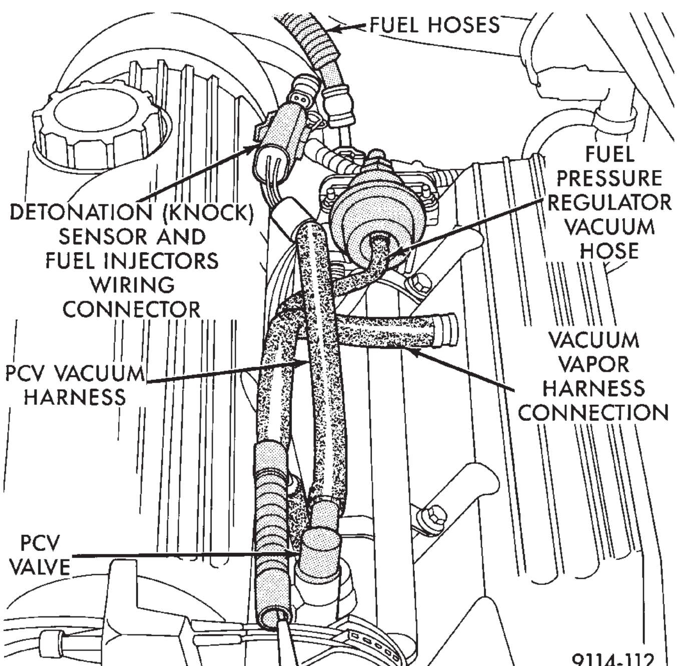

Fig. 17 Electrical, Fuel, and Vacuum Connections

(25) Check Heated Oxygen Sensor connector (Fig. 18).

(26) Verify engine ground strap is attached to the intake manifold and the dash panel (Fig. 18).

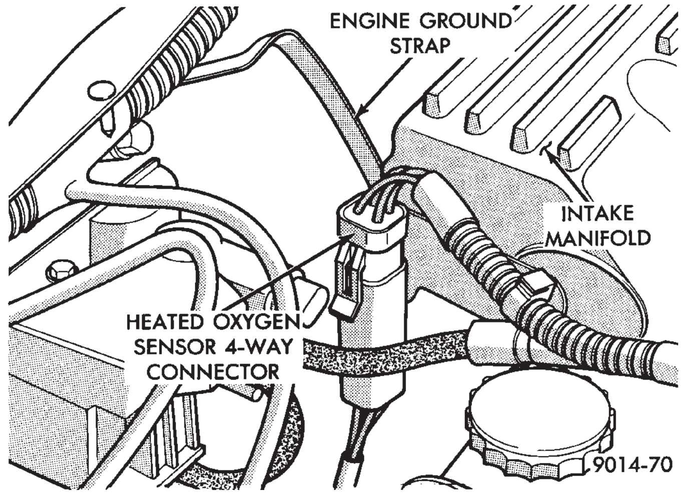

Fig. 18 Heated Oxygen Sensor

(27) Verify the vacuum and pressure connections on the turbo charger are secure (Fig. 19).

(28) Check the turbo bypass valve hose connection (Fig. 19).

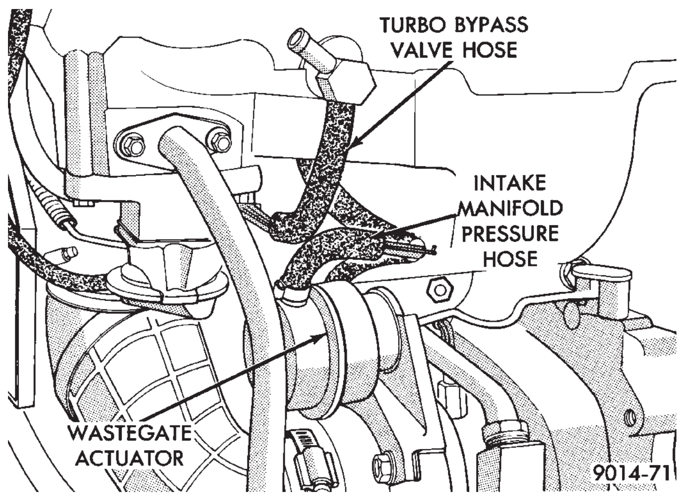

Fig. 19 Hose Connections

(29) Check all vacuum harness connections.

(30) Verify the harness connector is attached to distance sensor (Fig. 20).

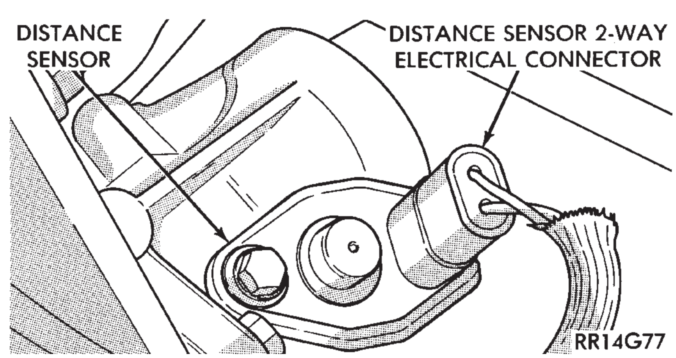

Fig. 20 Distance Sensor Wiring Connector

(31) Check Hose and Wiring Connections at Fuel Pump. Check that wiring connector is making contact with terminals on pump.

ON BOARD DIAGNOSTICS

The engine controller has been programmed to monitor many different circuits of the fuel injection system. If a problem is sensed with a monitored circuit often enough to indicate an actual problem, the controller stores a fault. If the problem is repaired or ceases to exist, the engine controller cancels the Fault Code after 51 vehicle key on/off cycles.

Certain criteria must be met for a fault code to be entered into engine controller memory. The criteria may be a specific range of engine RPM, engine temperature, and/or input voltage to the engine controller.

It is possible that a fault code for a monitored circuit may not be entered into memory even though a malfunction has occurred. This may happen because one of the fault code criteria for the circuit has not been met. **For example**, assume that one of the fault code criteria for the MAP sensor circuit is that the engine must be operating between 750 and 2000 RPM. If the MAP sensor output circuit shorts to ground when engine RPM is above 2400 RPM (resulting in a 0 volt input to the engine controller) a fault code will not be entered into memory. This is because the condition does not occur within the specified RPM range.

There are several operating conditions for which the engine controller does not monitor and set fault codes. Refer to Monitored Circuits and Non-Monitored Circuits in this section.

Stored fault codes can be displayed either by cycling the ignition key On - Off - On - Off - On, or through use of the Diagnostic Readout Box II (DRB II). The DRB II connects to the diagnostic connector in the vehicle (Figure 21 or 22).

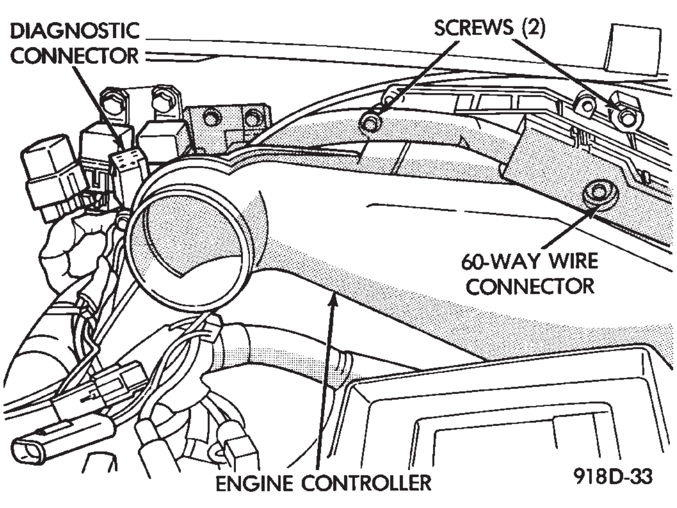

Fig. 21 Diagnostic Connector Location—AA and AP Vehicles

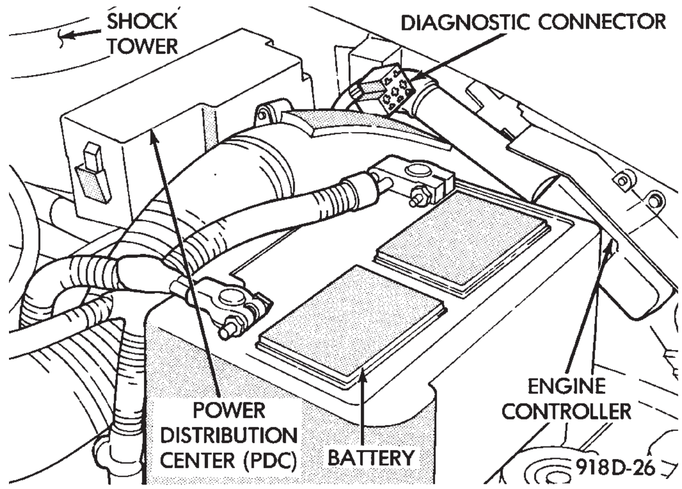

Fig. 22 Diagnostic Connector Location—AG and AJ Vehicles

MONITORED CIRCUITS

The engine controller can detect certain fault conditions in the fuel injection system.

Open or Shorted Circuit - The engine controller can determine if the sensor output (input to controller) is within proper range. Also, the controller can determine if the circuit is open or shorted.

Output Device Current Flow - The engine controller senses whether the output devices are hooked up. If there is a problem with the circuit, the controller senses whether the circuit is open, shorted to ground, or shorted high.

Oxygen Sensor - The engine controller can determine if the oxygen sensor is switching between rich and lean once the system has entered closed loop. Refer to Modes of Operation in this section for an explanation of closed loop operation.

NON-MONITORED CIRCUITS

The engine controller does not monitor the following circuits, systems and conditions that could have malfunctions that result in driveability problems. Fault codes may not be displayed for these conditions. However, problems with these systems may cause fault codes to be displayed for other systems. For example, a fuel pressure problem will not register a fault directly, but could cause a rich or lean condition. This could cause an oxygen sensor fault to be stored in the engine controller.

Fuel Pressure - Fuel pressure is controlled by the fuel pressure regulator. The engine controller cannot detect a clogged fuel pump inlet filter, clogged in-line fuel filter, or a pinched fuel supply or return line. However, these could result in a rich or lean condition causing an oxygen sensor fault.

Secondary Ignition Circuit - The engine controller cannot detect an inoperative ignition coil, fouled or worn spark plugs, ignition cross firing, or open spark plug cables.

Engine Timing - The engine controller cannot detect an incorrectly indexed timing chain, camshaft sprocket and crankshaft sprocket. The engine controller also cannot detect an incorrectly indexed distributor. However, these could result in a rich or lean condition causing an oxygen sensor fault to be stored in the engine controller.

Cylinder Compression - The engine controller cannot detect uneven, low, or high engine cylinder compression.

Exhaust System - The engine controller cannot detect a plugged, restricted or leaking exhaust system.

Fuel Injector Malfunctions - The engine controller cannot determine if the fuel injector is clogged, the pintle is sticking or the wrong injector is installed. However, these could result in a rich or lean condition causing an oxygen sensor fault to be stored in the engine controller.

Excessive Oil Consumption - Although the engine controller monitors exhaust stream oxygen content when the system is in closed loop, it cannot determine excessive oil consumption.

Throttle Body Air Flow - The engine controller cannot detect a clogged or restricted air cleaner inlet or filter element.

Evaporative System - The engine controller will not detect a restricted, plugged or loaded evaporative purge canister.

Vacuum Assist - Leaks or restrictions in the vacuum circuits of vacuum assisted engine control system devices are not monitored by the engine controller. However, these could result in a MAP sensor fault being stored in the engine controller.

Engine Controller System Ground - The engine controller cannot determine a poor system ground. However, a fault code may be generated as a result of this condition.

Engine Controller Connector Engagement - The engine controller cannot determine spread or damaged connector pins. However, a fault code may be generated as a result of this condition.

HIGH AND LOW LIMITS

The engine controller compares input signal voltages from each input device with established high and low limits. If the input voltage is not within the limits and other fault code criteria are met, a fault code will be stored in memory. Other fault code criteria might include engine RPM limits or input voltages from other sensors or switches that must be present before a fault condition can be verified.

FAULT CODE DESCRIPTION

When a fault code appears, it indicates that the Engine Controller has recognized an abnormal condition in the system. Fault codes can be obtained from the Check Engine lamp on the Instrument Panel or from the Diagnostic Readout Box II (DRBII). Fault codes indicate the results of a failure but do not identify the failed component directly.

FAULT CODE DESCRIPTION

Fault Code	DRB II Display	Description
11	No reference Signal During Cranking	No distributor reference signal detected during engine cranking.
13+**	No change in MAP from start to run	No difference recognized between the engine MAP reading and the barometric (atmospheric) pressure reading at start-up.
14+**	MAP voltage too low or MAP voltage too High	MAP sensor input below minimum acceptable voltage. MAP sensor input above maximum acceptable voltage.
15**	No vehicle speed signal	No vehicle distance (speed) sensor signal detected during road load conditions.
17	Engine is cold too long	Engine coolant temperature remains below normal operating temperatures during vehicle travel (thermostat).
21**	O_2 signal stays at center or O_2 signal shorted to voltage	Neither rich or lean condition detected from the oxygen sensor input. Oxygen sensor input voltage maintained above the normal operating range.
22+**	Coolant sensor voltage too high or Coolant sensor voltage too low	Coolant temperature sensor input above the maximum acceptable voltage. Coolant temperature sensor input below the minimum acceptable voltage.
24+**	Throttle position sensor voltage high or Throttle position sensor voltage low	Throttle position sensor input above the maximum acceptable voltage. Throttle position sensor input below the minimum acceptable voltage.
25**	Automatic idle speed motor circuits	An open or shorted condition detected in one or more of the AIS control circuits.
27	Injector control circuit (DRB II)	Injector output driver does not respond properly to the control signal (DRB II specifies the injector by cylinder number).
31**	Purge solenoid circuit	An open or shorted condition detected in the purge solenoid circuit.
33	A/C clutch relay circuit	An open or shorted condition detected in the A/C clutch relay circuit.
34	Speed control solenoid circuits	An open or shorted condition detected in the speed control vacuum or vent solenoid circuits.

+ Check Engine Lamp On
** Check Engine Lamp On (California Only)

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FAULT CODE DESCRIPTION (CON'T)

FAULT CODE	DRB II DISPLAY	DESCRIPTION
35	Radiator fan relay circuits	An open or shorted condition detected in the radiator fan circcuit
36+**	Wastegate solenoid circuit	An open or shorted condition detected in the turbocharger wastegate solenoid circuit.
37	Torque convertor unlock solenoid CKT	An open or shorted condition detected in the torque convertor part throttle unlock solenoid circuit (automatic transmission).
41+**	Alternator field not switching properly	An open or shorted condition detected in the alternator field control circuit.
42	Auto shutdown relay control circuit	An open or shorted condition detected in the auto shutdown relay circuit.
45	Turbo boost limit exceeded	MAP sensor reading above overboost limit detected during engine operation.
46+**	Charging system voltage too high	Battery voltage sense input above target charging voltage during engine operation.
47+**	Charging system voltage too low	Battery voltage sense input below target charging during engine operation. Also, no significant change detected in battery voltage during active test of alternator output.
51**	O_2 signal stays below center (lean)	Oxygen sensor signal input indicates lean air/fuel ratio condition during engine operation.
52**	O_2 signal stays above center (rich)	Oxygen sensor signal input indicates rich air/fuel ratio condition during engine operation.
53	Internal controller	Engine controller internal fault condition detected.
54	No sync pick-up signal	No fuel sync signal detected during engine rotation.
61**	Baro read solenoid circuit	An open or shorted condition detected in the baro read solenoid circuit.
62	Controller Failure EMR miles not stored	Unsuccessful attempt to update EMR milage in the controller EEPROM.
63	Controller Failure EEPROM write denied	Unsuccessful attempt to write to an EEPROM location by the engine controller.
55	N/A	Completion of fault code display on Check Engine lamp.

+ Check Engine Lamp On
** Check Engine Lamp On (California Only)

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SYSTEM TESTS

WARNING: APPLY PARKING BRAKE AND/OR BLOCK WHEELS BEFORE PERFORMING ANY TEST WITH THE ENGINE OPERATING.

OBTAINING FAULT CODES

(1) Connect DRBII to the diagnostic connector located in the engine compartment (Fig. 21 or Fig. 22).

(2) Start the engine if possible, cycle the trans mission selector and the **A/C** switch if applicable. Shut off the engine.

(3) Turn the ignition switch on, access Read Fault Screen. Record all the fault messages shown on the DRBII. Observe the check engine lamp on the instrument panel. The lamp should light for 2 seconds then go out (bulb check).

Fault code erasure: access erase fault code data.

STATE DISPLAY TEST MODE

The switch inputs used by the engine controller have only two recognized states, HIGH and LOW. For this reason, the engine controller cannot recognize the difference between a selected switch position versus an open circuit, a short circuit, or a defective switch. If the change is displayed, it can be assumed that the entire switch circuit to the engine controller is functional. From the state display screen access either State Display Inputs and Outputs or State Display Sensors.

STATE DISPLAY INPUTS AND OUTPUTS

Connect the DRB II tester to the vehicle and access the State Display screen. Then access Inputs and Outputs. The following is a list of the engine control system functions accessible through the Inputs and Outputs screen.

Park/Neutral Switch (automatic transmission only)
Speed Control Resume
Brake Switch
Speed Control On/Off
Speed Control Set
A/C Switch Sense
Z2 Voltage Sense
S/C Vent Solenoid
S/C Vacuum Solenoid
A/C Clutch Relay
Baro Read Solenoid
Wastegate Solenoid
Auto Shutdown Relay
Radiator Fan Relay
Purge Solenoid
Check Engine Lamp

STATE DISPLAY SENSORS

Connect the DRB II tester to the vehicle and access the State Display screen. Then access Sensor Display. The following is a list of the engine control system functions accessible through the Sensor Display screen.

Battery Temp Sensor
Oxygen Sensor Signal
Coolant Temperature
Coolant Temp Sensor
Throttle Position
Minimum Throttle
Detonation (Knock) Sensor Signal
Battery Voltage
MAP Sensor Reading
AIS Motor Position
Adaptive Fuel Factor
Barometric Pressure
Min Airflow Idl Spd
Engine Speed
Fault #1 Key-On Info
Module Spark Advance
Cyl 1 Knock Retard
Cyl 2 Knock Retard
Cyl 3 Knock Retard
Cyl 4 Knock Retard
Boost Pressure Goal
Speed Control Target
Fault #2 Key-on Info
Fault #3 Key-on Info
Speed Control Status
Charging System Goal
Theft Alarm Status
Wastegate Duty Cycle
Map Sensor Voltage
Vehicle Speed
Oxygen Sensor State
Baro Read Update
MAP Gauge Reading
Throttle Opening
Total Spark Advance

CIRCUIT ACTUATION TEST MODE

The purpose of the circuit actuation test mode is to check for the proper operation of output circuits or devices which the engine controller cannot internally recognize. The engine controller can attempt to activate these outputs and allow an observer to verify proper operation. Most of the tests available in this mode provide an audible or visual indication of device operation (click of relay contacts, spray fuel, etc.). With the exception of an intermittent condition, if a device functions properly during its test, it can be assumed that the device, its associated wiring, and its driver circuit are in working order.

OBTAINING CIRCUIT ACTUATION TEST

Connect the DRB II tester to the vehicle and access the Actuators screen. The following is a list of the engine control system functions accessible through Actuators screens.

Stop All Tests
Ignition Coil #1
Fuel Injector #1
Fuel Injector #2
Fuel Injector #3
AIS Motor Open/Close
Radiator Fan Relay
A/C Clutch Relay
Auto Shutdown Relay
Purge Solenoid
S/C Serv Solenoids
Alternator Field
Tachometer Output
Wastegate Solenoid
Baro Read Solenoid
All Solenoids/Relays
ASD Fuel System Test
Fuel Injector #4

THROTTLE BODY MINIMUM AIR FLOW CHECK PROCEDURE

(1) Warm engine in Park or neutral until the cooling fan has cycled on and off at least once.

(2) Hook-up timing check device and Tachometer.

(3) Disconnect the coolant temperature sensor and set basic timing to 12° BTDC ± 2° BTDC.

(4) Shut off engine. Connect harness connector to coolant temperature sensor.

(5) Disconnect the PCV valve hose from the nipple on the intake manifold.

(6) Attach Air Metering Fitting #6457 (0.125 in. orifice) to the intake manifold PCV nipple (Fig. 23).

(7) Disconnect 3/16 inch manifold vacuum purge line from the top of the throttle body. Cap the 3/16 inch throttle body nipple.

(8) Connect Diagnostic Readout Box II (DRB II).

(9) Restart engine. Allow engine to idle for at least one minute.

(10) Using the DRB II, access Min. Airflow Idle Spd. The following will then occur:

- AIS motor will fully close.
- Idle spark advance will become fixed.

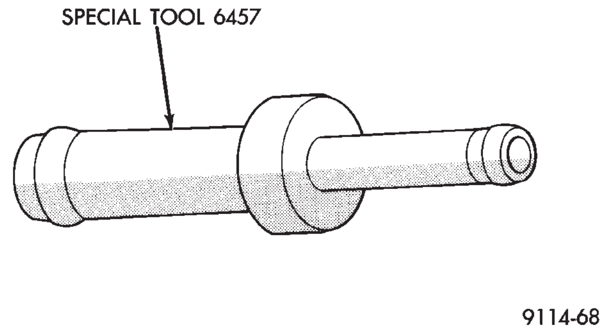

Fig. 23 Air Metering Fitting, Special Tool 6457

- Engine RPM will be displayed on Diagnostic Readout Box II (DRB II).

(11) Check idle RPM with tachometer, if idle RPM is within the below specification then the throttle body minimum airflow is set correctly.

IDLE SPECIFICATIONS

Odometer Reading	Idle RPM
Below 1000 miles	650-1400 RPM
Above 1000 miles	700-1400 RPM

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If the idle RPM is not within specification, replace the throttle body.

(12) Shut off engine.

(13) Remove Air Metering Fitting #6457 from the intake manifold PCV nipple. Reinstall the PCV valve hose.

(14) Remove DRB II.

(15) Disconnect timing check device and tachometer.

(16) Reconnect purge line to throttle body.

IGNITION TIMING PROCEDURE

Refer to Group 8D Ignition System.

60-WAY ENGINE CONTROLLER WIRING CONNECTOR

Refer to the engine controller wiring connector diagram (Fig. 24) for information regarding wire colors and cavity numbers.

CAV	WIRE COLOR	DESCRIPTION
1	DG/RD*	MAP SENSOR
2	TN/BK*	COOLANT SENSOR
3	RD	DIRECT BATTERY VOLTAGE
4	BK/LB*	SENSOR RETURN
5	BK/WT*	SIGNAL GROUND
6	VT/WT*	5-VOLT OUTPUT (MAP AND TPS)
7	OR	9-VOLT OUTPUT (DISTRIBUTOR PICK-UP AND DISTANCE SENSOR)
8		
9	DB	A21 SUPPLY (IGNITION START/RUN)
10		
11	BK/TN*	POWER GROUND
12	BK/TN*	POWER GROUND
13	LB/BR	INJECTOR DRIVER #4
14	YL/WT*	INJECTOR DRIVER #3
15	TN	INJECTOR DRIVER #2
16	WT/DB*	INJECTOR DRIVER #1
17		
18		
19	BK/GY*	IGNITION COIL DRIVER #1
20	DG	ALTERNATOR FIELD CONTROL
21		
22	OR/DB*	THROTTLE POSITION SENSOR (TPS)
23	RD/LG*	SPEED CONTROL SENSE
24	GY/BK*	IGNITION REFERENCE PICK-UP
25	PK	SCI TRANSMIT
26		
27	BR	A/C SWITCH SENSE
28		
29	WT/PK*	BRAKE SWITCH
30	BR/YL*	PARK/NEUTRAL SWITCH (AUTO TRANS.)
31	DB/PK*	RADIATOR FAN RELAY
32	BK/PK*	CHECK ENGINE LAMP
33	TN/RD*	SPEED CONTROL VACUUM SOLENOID
34	DB/OR*	A/C CLUTCH RELAY
35	GY/YL*	EGR SOLENOID (CALIFORNIA ONLY)
36	LG/BK*	WASTEGATE SOLENOID

CAV	WIRE COLOR	DESCRIPTION
37		
38		
39	GY/RD*	AIS STEPPER DRIVER #3
40	BR/WT*	AIS STEPPER DRIVER #1
41	BK/DG*	OXYGEN SENSOR SIGNAL
42	BK/LG*	DETONATION SENSOR SIGNAL
43	GY/LB*	TACHOMETER SIGNAL OUTPUT
44	TN/YL*	FUEL SYNC. PICK-UP
45	LG	SCI RECEIVE
46		
47	WT/OR*	DISTANCE SENSOR SIGNAL
48		
49		
50		
51	DB/YL*	AUTO SHUTDOWN (ASD) RELAY AND FUEL PUMP RELAY
52	PK/BK*	PURGE SOLENOID
53	LG/RD*	SPEED CONTROL VENT SOLENOID
54	LG/WT*	PART THROTTLE UNLOCK SOLENOID
55	LB	BARO. PRESS. READ SOLENOID
56		
57	DG/OR*	A142 CIRCUIT VOLTAGE SENSE
58		
59	VT/BK*	AIS STEPPER DRIVER #4
60	YL/BK*	AIS STEPPER DRIVER #2

WIRE COLOR CODES					
BK	BLACK	LB	LIGHT BLUE	VT	VIOLET
BR	BROWN	LG	LIGHT GREEN	WT	WHITE
DB	DARK BLUE	OR	ORANGE	YL	YELLOW
DG	DARK GREEN	PK	PINK	*	WITH TRACER
GY	GRAY	RD	RED		
		TN	TAN		

CONNECTOR TERMINAL SIDE SHOWN

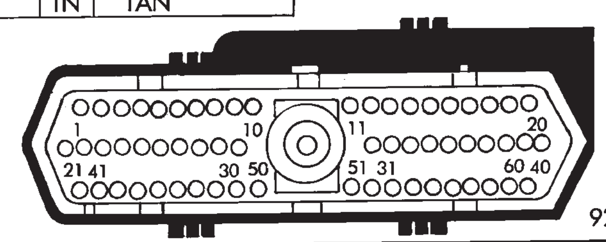

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Fig. 24 60-Way Engine Controller Wiring Connector

2.5L TURBO I MULTI-POINT FUEL INJECTION—SERVICE PROCEDURES

INDEX

THROTTLE BODY

When servicing throttle body components, always reassemble components with new O-rings and seals where applicable. (Fig. 1) Never use lubricants on O-rings or seals, damage may result. If assembly of component is difficult, use water to aid assembly. Use care when removing hoses to prevent damage to hose or hose nipple.

FUEL SYSTEM PRESSURE RELEASE PROCEDURE

CAUTION: Before servicing the fuel pump, fuel lines, fuel filter, throttle body, or fuel injectors, the fuel system pressure must be released.

(1) Loosen fuel filler cap to release fuel tank pressure.

(2) Disconnect injector wiring harness connector (Fig. 2).

(3) Connect a jumper wire between terminal Number 1 of the injector harness and engine ground.

(4) Connect a jumper wire to the positive terminal Number 2 of the injector harness and touch the battery positive post **for no longer than 5 seconds**.

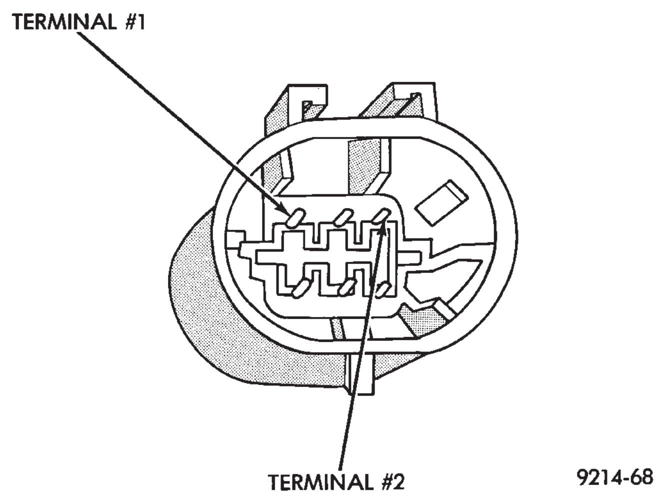

Fig. 2 Injector Harness Connector

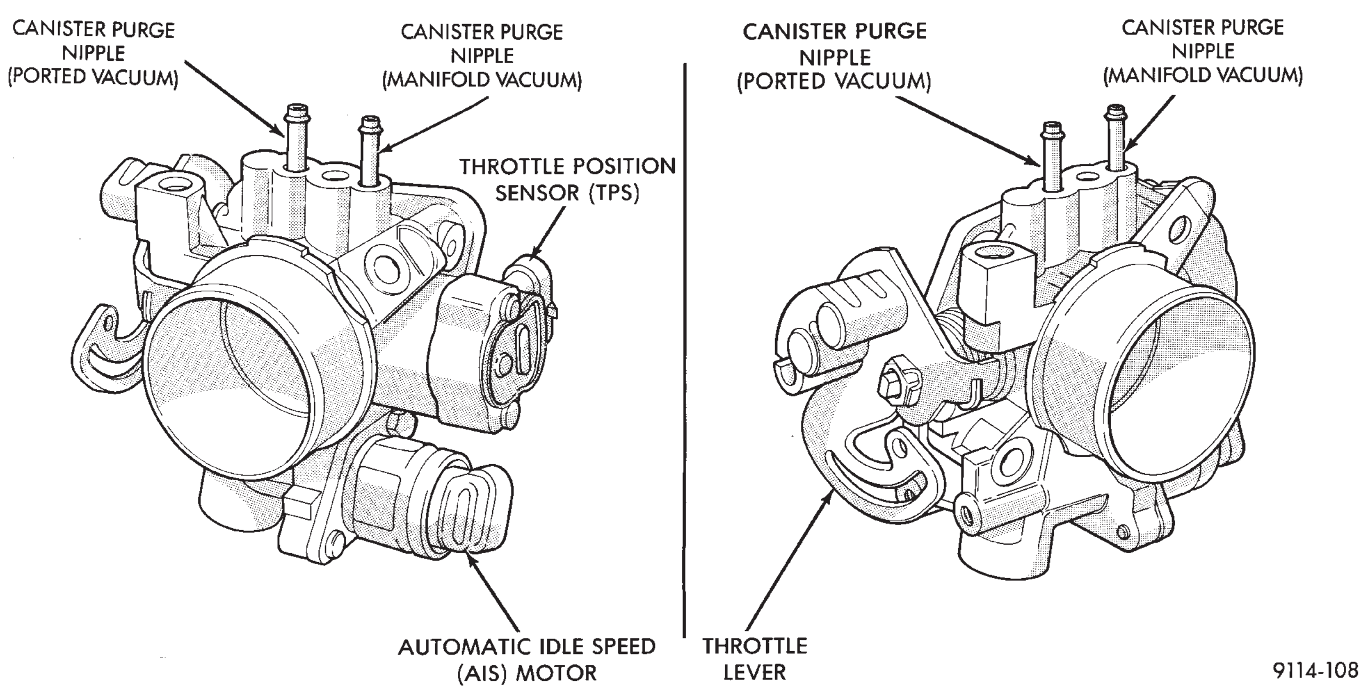

Fig. 1 Throttle Body

This releases system pressure.
(5) Remove jumper wires.
(6) Continue fuel system service.

THROTTLE POSITION SENSOR (TPS)

REMOVAL

(1) Disconnect the negative cable from the battery.
(2) Disconnect harness connector from throttle position sensor (Fig. 3).
(3) Remove throttle position sensor mounting screws.
(4) Lift throttle position sensor off throttle shaft.

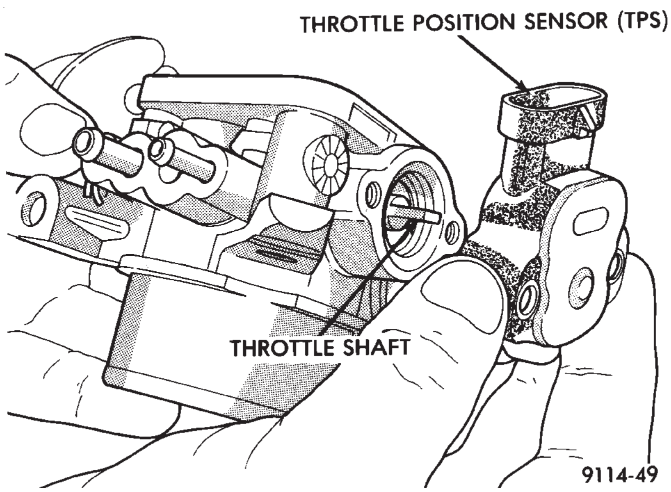

Fig. 3 Servicing Throttle Position Sensor

INSTALLATION

(1) Install throttle position sensor on throttle shaft. Install mounting screws. Tighten screws to 2 N●m (17 in. lbs.) torque.
(2) Attach harness connector to sensor.
(3) Connect negative cable to negative post of the battery.

AUTOMATIC IDLE SPEED (AIS) MOTOR

REMOVAL

(1) Disconnect negative cable from battery.
(2) Disconnect harness connector from AIS (Fig. 4).
(3) Remove AIS motor mounting screws.
(4) Remove the AIS motor from throttle body (make certain that the O-ring is on the AIS motor).

INSTALLATION

(1) New AIS motors have a new O-ring installed on them. If pintle measures more than 1 inch (25 mm) it must be retracted. Use the AIS MOTOR OPEN/CLOSE mode of the DRBII (battery must be reconnected for this operation).
(2) Carefully place AIS motor into throttle body.
(3) Install 2 mounting screws. Tighten screws to 2 N●m (17 in. lbs.) torque.
(4) Connect harness connector to AIS motor.

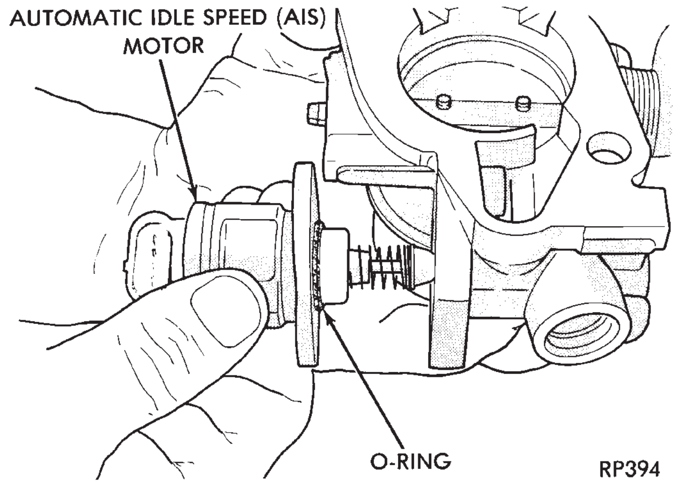

Fig. 4 Servicing Automatic Idle Speed (AIS) Motor

(5) Connect negative cable to battery.

THROTTLE BODY REMOVAL

(1) Disconnect negative cable from battery.
(2) Remove clamp from air hose. Remove hose (Fig. 5).
(3) Remove accelerator cable.
(4) Disconnect automatic idle speed (AIS) motor and throttle position sensor (TPS) electrical connectors.
(5) Disconnect vacuum hoses from throttle body.
(6) Remove throttle body to intake manifold attaching nuts (2).
(7) Remove throttle body and gasket.
(8) Reverse the above procedures for installation.

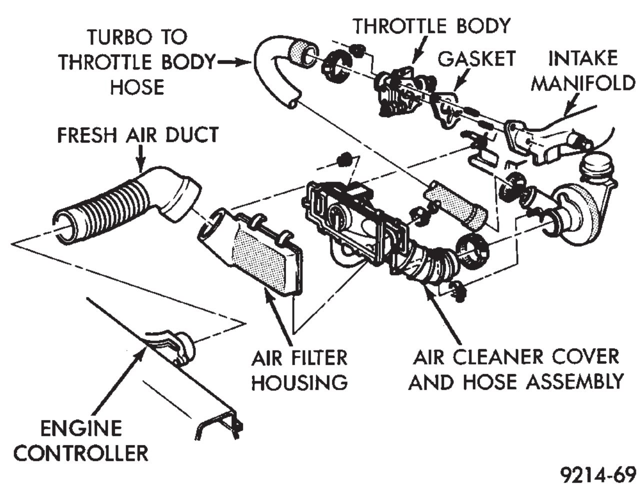

Fig. 5 Air Cleaner and Throttle Body Assembly

FUEL INJECTOR RAIL ASSEMBLY

WARNING: THE 2.5L TURBO I FUEL SYSTEM IS UNDER A CONSTANT PRESSURE OF APPROXIMATELY 380 KPA (55 PSI). PERFORM FUEL PRESSURE RELEASE PROCEDURE BEFORE SERVICING THE FUEL RAIL OR FUEL INJECTORS.

REMOVAL

(1) Perform fuel system pressure release procedure.

(2) Disconnect negative cable from battery.

(3) Disconnect the fuel injector harness connector from the main harness (Fig. 6).

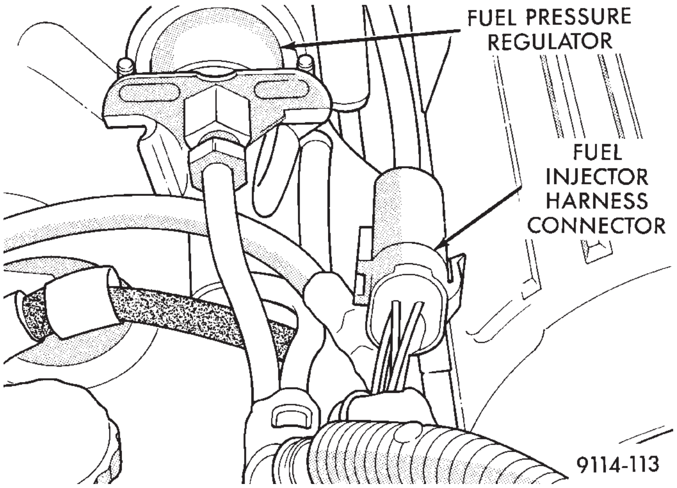

Fig. 6 Injector Harness Connections

(4) Remove the quick connect fittings from the chassis fuel tubes. Refer to Fuel Hoses, Clamps, and Quick Connect Fittings in the Fuel Delivery section of this group.

(5) Remove vacuum and vapor hose connections (Fig. 7).

(6) Disconnect vacuum hose from the pressure regulator (Fig. 7).

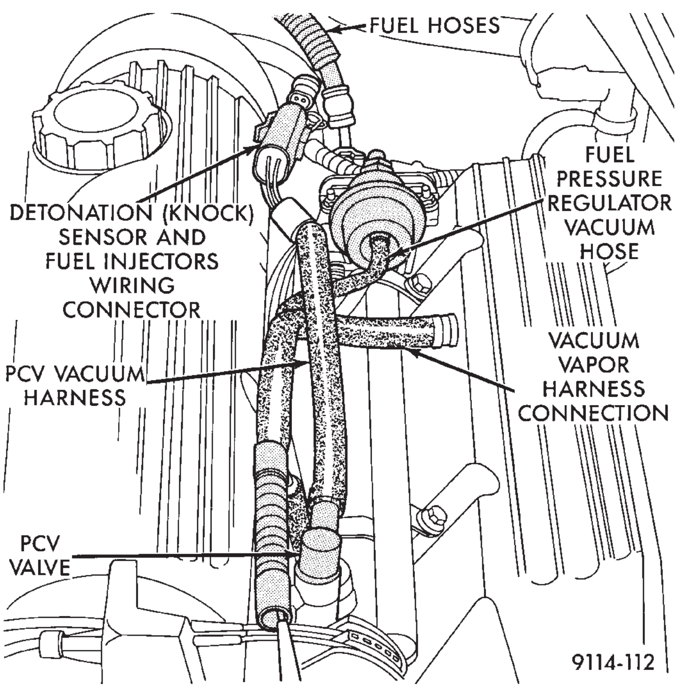

Fig. 7 Electrical, Fuel, and Vacuum Connections

(7) Remove screw from the fuel tube clamp (Fig. 8).

(8) Remove fuel rail mounting screws (Fig. 8).

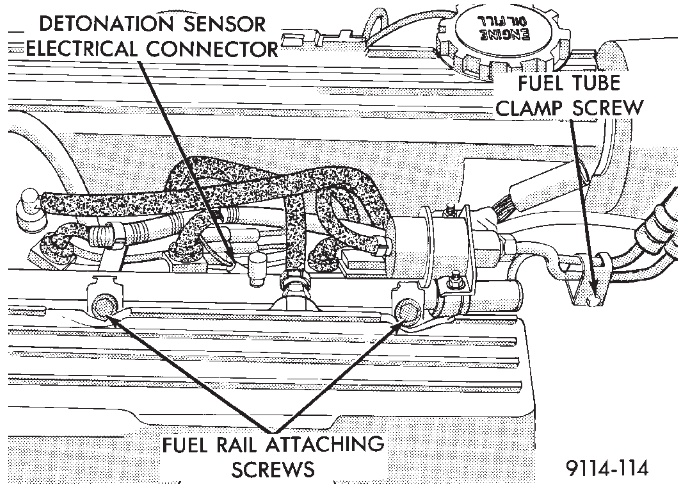

Fig. 8 Fuel Rail Attaching Screws

(9) Pull up on the injector rail. The injectors will pull straight out of the ports. Do not damage the injector O-rings.

(10) Remove fuel rail assembly from vehicle. Do not remove fuel injectors until fuel rail assembly has been completely removed from vehicle.

(11) Plug or cover intake manifold injector ports to prevent dirt from entering the openings (Fig. 9).

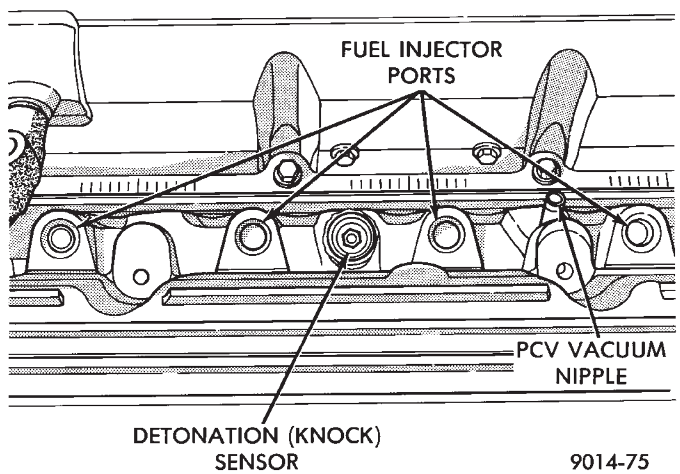

Fig. 9 Fuel Injector Ports

INSTALLATION

(1) Ensure injectors are seated into the receiver cup, with lock ring in place.

(2) Attach harness connectors to injectors. Fasten the harness into wiring clips.

(3) Ensure the injector holes are clean and all plugs have been removed.

(4) Lubricate the injector O-rings with a drop of clean engine oil to ease installation.

(5) Install the injector assembly into their holes. Install mounting screws. Fuel rail assembly must be drawn into the intake manifold evenly making sure each injector enters its own hole. Once all injectors are seated, tighten bolts to 22.5 N●m (200 in. lbs) torque (Fig. 8).

(6) Connect electrical connector to detonation (knock) sensor (Fig. 8).

(7) Connect vacuum hose to fuel pressure regulator. Replace clamp.

(8) Close fuel tube clip around fuel tubes and install fastener.

(9) Lubricate the ends of the chassis fuel tubes with clean 30 weight engine oil. Connect fuel supply and return hoses to chassis fuel tube assembly. Pull back on the quick connect fittings to ensure complete insertion. Refer to Fuel Hoses, Clamps, and Quick Connect Fittings in the Fuel Delivery section of this group.

(10) Install vacuum, vapor hose onto intake manifold nipple. Replace clamp (Fig. 7).

(11) Connect negative cable to battery.

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(12) With the DRB II use the ASD Fuel System Test to pressurize system and check for leaks.

FUEL INJECTOR

The fuel rail must be removed to service the injectors. Refer to Fuel Injector Rail Assembly in this section.

REMOVAL

(1) Disconnect electrical connector from injector (Fig. 10).

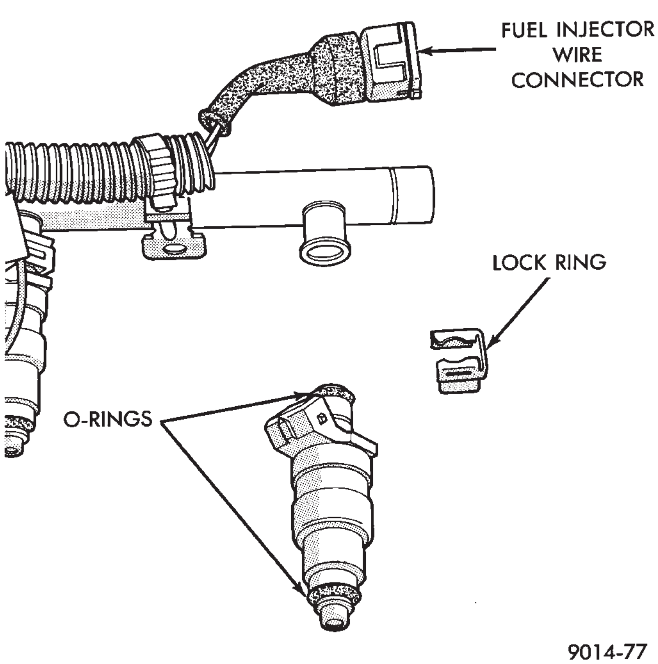

Fig. 10 Servicing Fuel Injectors

(2) Position fuel rail assembly so that the fuel injectors are easily accessible (Fig. 11).

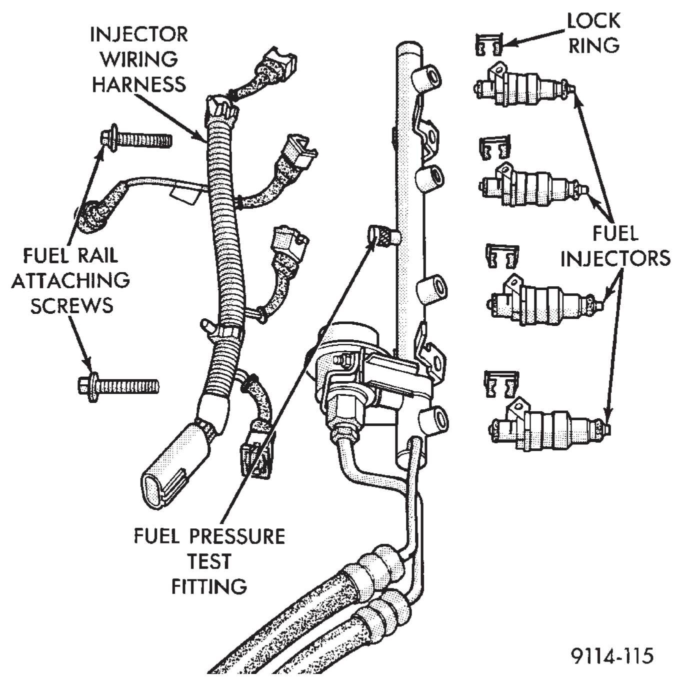

Fig. 11 Fuel Rail and Injector Assembly

(3) Remove injector lock ring from fuel rail and injector. Pull injector straight out of fuel rail receiver cup.

(4) Check injector O-ring for damage. Replace damaged O-rings. If injector is reused, install a protective cap on the injector tip to prevent damage.

(5) Repeat steps for remaining injectors.

INSTALLATION

(1) Before installing an injector, the rubber O-ring must be lubricated with a drop of clean engine oil to aid in installation.

(2) Being careful not to damage the O-ring, install injector top end into fuel rail receiver cup.

(3) Install injector lock ring by sliding open end into slot of the injector and onto the receiver cup ridge into the side slots of ring (Fig. 10).

(4) Repeat steps for remaining injectors.

(5) Install injector wiring harness to injectors and fasten into wiring clips (Fig. 12).

FUEL PRESSURE REGULATOR

WARNING: THE 2.5L TURBO I FUEL SYSTEM IS UNDER A CONSTANT PRESSURE OF APPROXIMATELY 380 KPA (55 PSI). PERFORM FUEL PRESSURE RELEASE PROCEDURE BEFORE SERVICING THE FUEL PRESSURE REGULATOR.

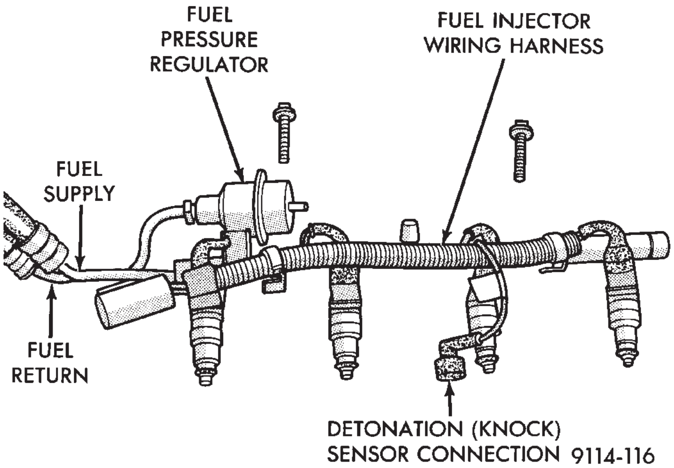

Fig. 12 Fuel Rail Assembly

REMOVAL

(1) Perform fuel system pressure release procedure.

(2) Disconnect negative cable from battery.

(3) Disconnect vacuum hose from fuel pressure regulator (Fig. 13).

Place a shop towel under fuel pressure regulator to absorb any fuel spillage.

(4) Using 2 open end wrenches, one on the fuel pressure regulator and the other on the fuel return tube nut, loosen tube nut. **The 2 wrenches must be used, otherwise damage will occur (Fig. 13).**

(5) Remove fuel pressure regulator mounting nuts. Remove fuel pressure regulator from rail (Fig. 14). Check O-Ring for damage. Replace damaged O-Rings.

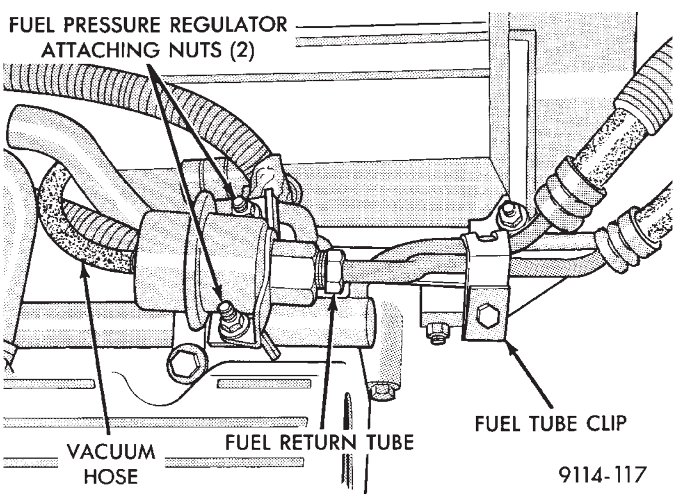

Fig. 13 Servicing Fuel Pressure Regulator

INSTALLATION

(1) Lubricate O-ring with a drop of clean engine oil. Install O-ring into the receiver cup on fuel rail.

(2) Install mounting nuts. Tighten nuts to 7 N●m (65 in. lbs.) torque.

(3) Connect fuel return tube to pressure regulator. Using a wrench to hold the fuel pressure regulator, tighten the nut to 28 N●m (250 in. lbs.) torque (Fig. 13).

(4) Connect vacuum hose to pressure regulator. Replace clamp.

(5) Connect negative cable to battery.

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(6) With the DRB II use the ASD Fuel System Test to pressurize system and check for leaks.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR SERVICE

(1) Remove vacuum hose and remove mounting screws from sensor (Fig. 14).

(2) Remove wiring harness and remove sensor.

(3) Reverse the above procedure for installation.

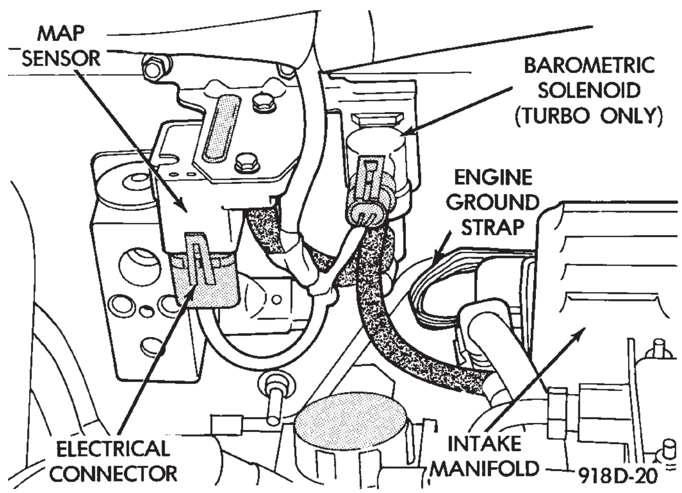

Fig. 14 Manifold Absolute Pressure Sensor

WASTEGATE SOLENOID AND CANISTER PURGE SOLENOID

(1) Remove vacuum hose and electrical connector from solenoids (Fig. 15).

(2) Remove solenoid pack mounting nut. Remove solenoid pack.

(3) Depress tab on top of solenoid to be replaced and slide the solenoid downward out of mounting bracket.

(4) Reverse above procedure for installation.

ENGINE CONTROLLER SERVICE

(1) Remove air cleaner duct from engine controller.

(2) Remove battery.

(3) Remove engine controller mounting screws (Fig. 16).

(4) Remove 60 way wiring connector from module and remove module.

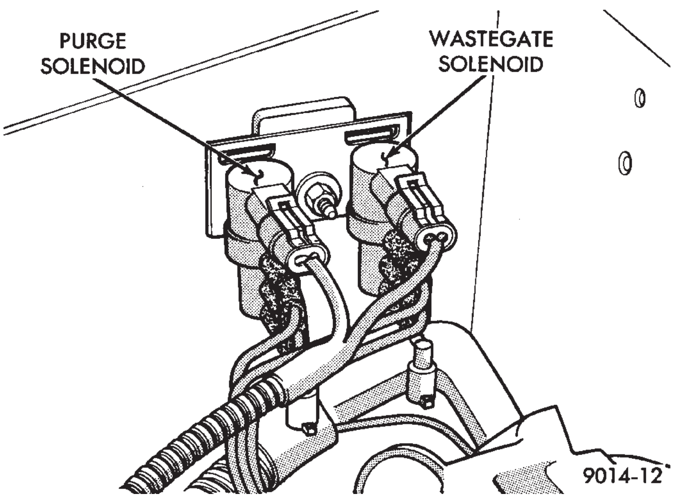

Fig. 15 Solenoid Mounting Turbo I Engines

(5) Reverse the above procedure for installation.

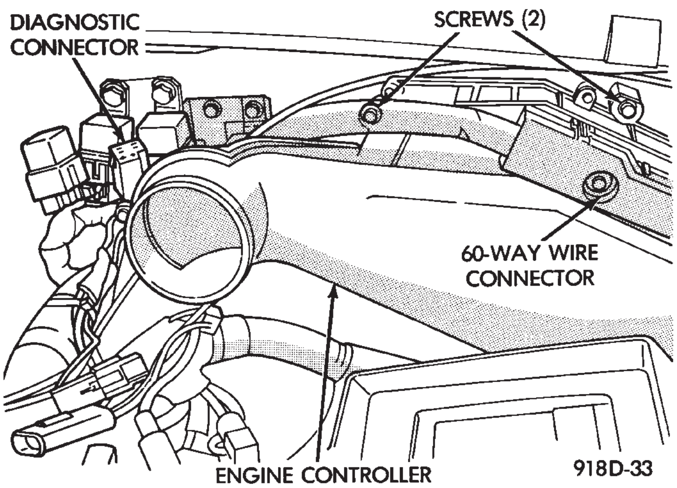

Fig. 16 Engine Controller Removal

HEATED OXYGEN SENSOR (O_2 SENSOR)

The oxygen sensor is installed in the exhaust manifold (Fig. 17).

CAUTION: Do not pull on the oxygen sensor wires when disconnecting the electrical connector.

WARNING: THE EXHAUST MANIFOLD MAY BE EXTREMELY HOT. USE CARE WHEN SERVICING THE OXYGEN SENSOR.

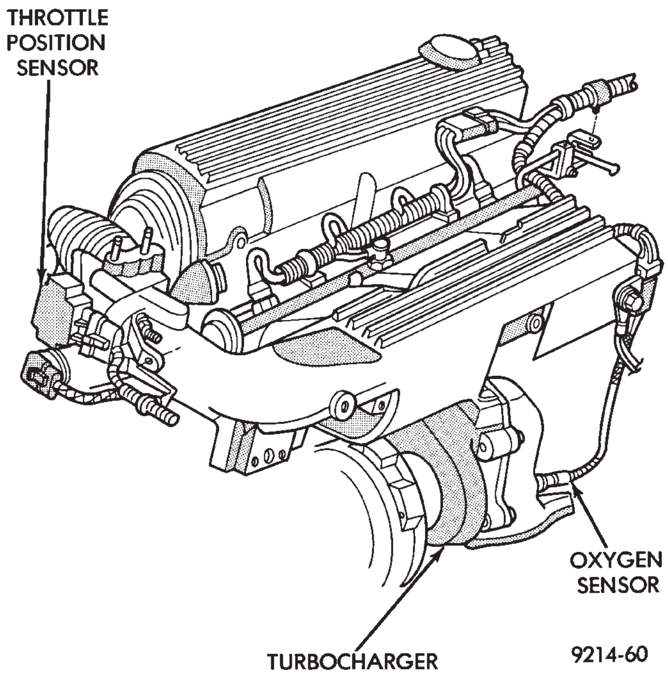

Fig. 17 Oxygen Sensor

(1) Disconnect oxygen sensor electrical connector.

(2) Remove sensor using Tool C-4907 (Fig. 18).

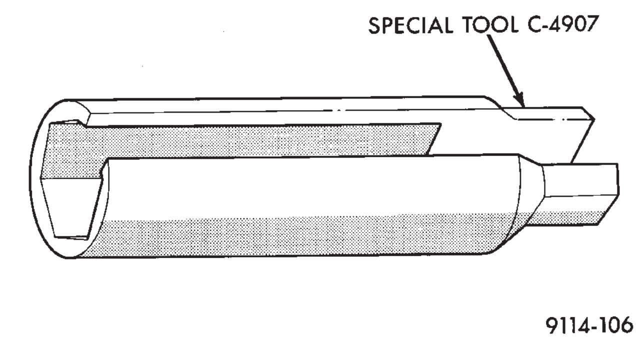

Fig. 18 Oxygen Sensor Socket

When the sensor is removed, the exhaust manifold threads must be cleaned with an 18 mm X 1.5 + 6E tap. If using original sensor, coat the threads with Loctite 771-64 anti-seize compound or equivalent. New sensors are packaged with compound on the threads and do not require additional compound. The sensor must be tightened to 27 N●m (20 ft. lbs.) torque.

2.2L TURBO III MULTI-POINT FUEL INJECTION—SYSTEM OPERATION

INDEX

GENERAL INFORMATION

The turbocharged multi-point electronic fuel injection system combines an electronic fuel and spark advance control system with a turbocharged intake system (Fig. 1). The fuel injection system is controlled by the Single Board Engine Controller II (SBEC II), **referred to in this manual as the engine controller**.

The engine controller regulates ignition timing, air-fuel ratio, emission control devices, cooling fan, charging system, speed control, turbocharger wastegate and idle speed. The engine controller adapts its requirement to meet changing operating conditions.

Various sensors provide the inputs necessary for the engine controller to correctly regulate fuel flow at the fuel injector. These include the manifold absolute pressure, throttle position, oxygen sensor, coolant temperature, detonation, and vehicle distance sensors. In addition to the sensors, the air conditioning clutch switch and various relays provide important information and system control. The outputs include the auto shutdown relay and fuel pump relay.

All inputs to the engine controller are converted into signals. Based on these inputs the engine controller adjusts air-fuel ratio, ignition timing, turbocharger wastegate and other controlled outputs. The engine controller adjusts the air-fuel ratio by changing injector pulse width. Injector pulse width is the time an injector is energized.

SYSTEM DIAGNOSIS

The engine controller tests many of its own input and output circuits. If a fault is found in a major system, the information is stored in memory. Technicians can display fault information through the instrument panel Check Engine lamp. Also, the technician can read fault information by connecting the Diagnostic Readout Box II (DRB II) to the diagnostic connector. For fault code information, refer to On Board Diagnostics in 2.2L Turbo III Multi-Point Fuel Injection—General Diagnosis section of this group.

CCD BUS

Various controllers and modules exchange information through a communications port called the CCD Bus. The engine controller transmits vehicle load data on the CCD Bus.

ENGINE CONTROLLER

The engine controller is a digital computer containing a microprocessor (Fig. 2). The controller receives input signals from various switches and sensors that are referred to as Engine Controller Inputs. Based on these inputs, the controller adjusts various engine and vehicle operations through devices that are referred to as Engine Controller Outputs.

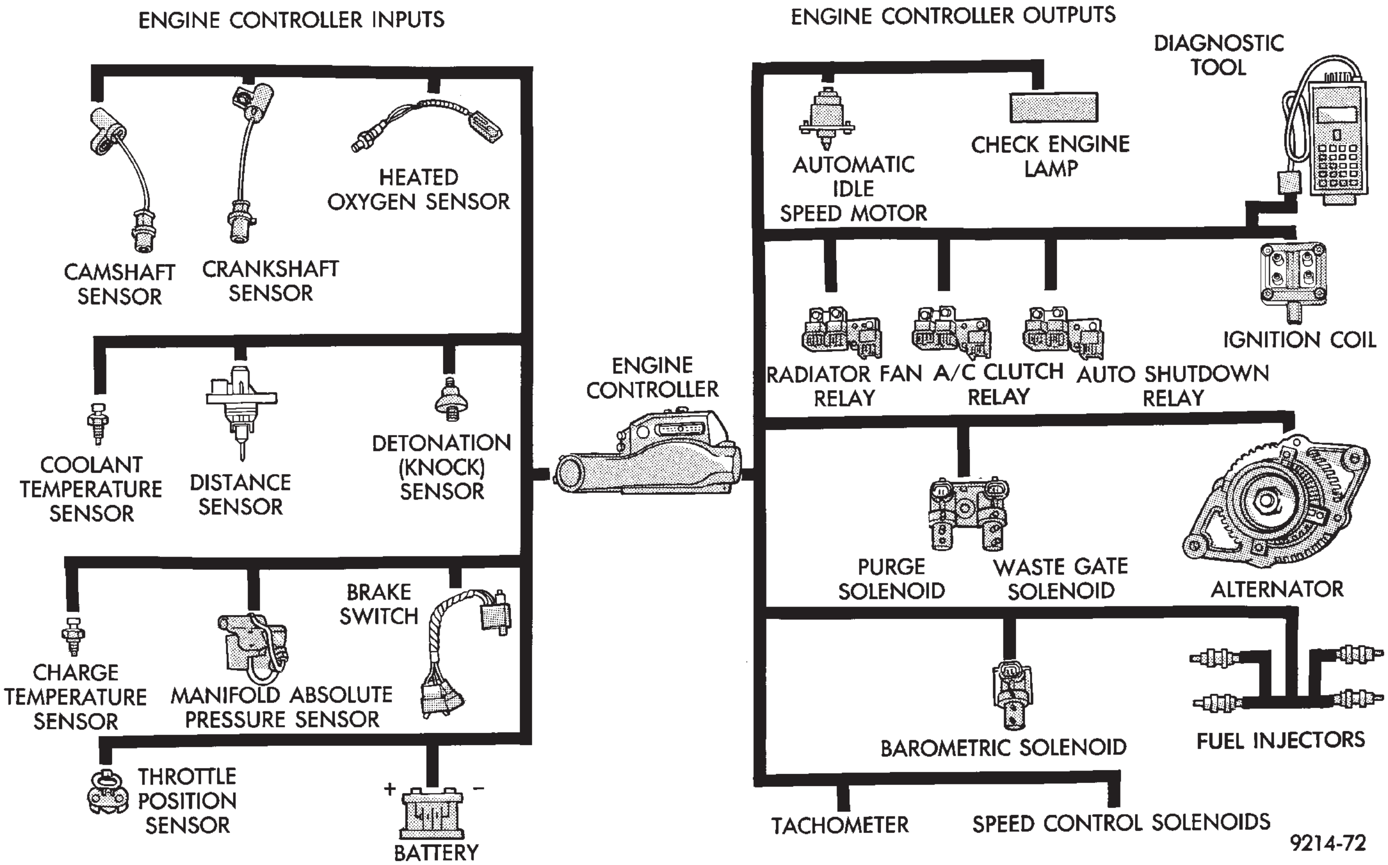

Fig. 1 Electronic Fuel Injection Components

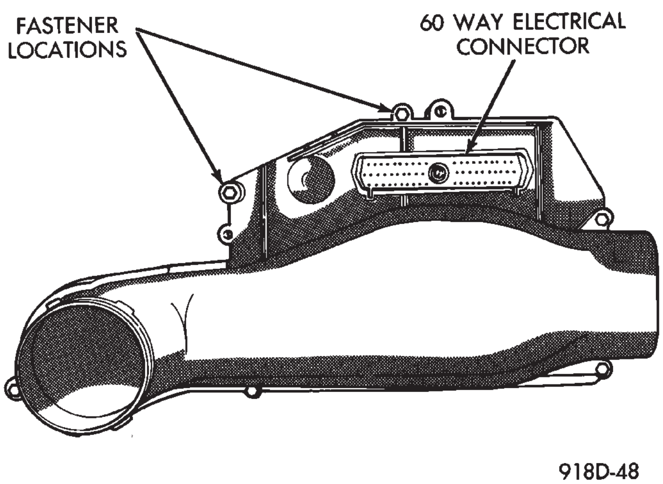

Fig. 2 Engine Controller

Engine Controller Inputs:
- Air Conditioning Controls
- Battery Voltage
- Brake Switch
- Camshaft Sensor
- Crankshaft Sensor
- Charge Air Temperature Sensor
- Coolant Temperature Sensor
- Detonation Sensor
- Manifold Absolute Pressure (MAP) Sensor
- Oxygen Sensor
- SCI Receive
- Speed Control System Controls
- Throttle Position Sensor
- Vehicle Distance (Speed) Sensor

Engine Controller Outputs:
- Air Conditioning Clutch Relay
- Alternator Field
- Automatic Idle Speed (AIS) Motor
- Auto Shutdown (ASD) Relay
- Barometric Read Solenoid
- Canister Purge Solenoid
- Check Engine Lamp
- Diagnostic Connector
- Fuel Injectors
- Ignition Coil
- Radiator Fan Relay
- Speed Control Solenoids
- Tachometer Output
- Wastegate Solenoid

Based on inputs it receives, the engine controller adjusts fuel injector pulse width, idle speed, ignition spark advance, ignition coil dwell and canister purge operation. The engine controller regulates operation of the cooling fan, A/C and speed control systems. The controller changes alternator charge rate by adjusting the alternator field.

The engine controller adjusts injector pulse width (air-fuel ratio) based on the following inputs.

- battery voltage
- coolant temperature
- exhaust gas content
- engine speed (crankshaft sensor)
- manifold absolute pressure
- throttle position

The engine controller adjusts ignition timing based on the following inputs.

- coolant temperature
- detonation sensor
- engine speed (crankshaft sensor)
- manifold absolute pressure
- throttle position

The Automatic Shut Down (ASD) and Fuel Pump relays are mounted externally, but turned on and off by the engine controller through the same circuit.

The ignition pick-up signals, (camshaft and crankshaft) are sent to the engine controller. If the engine controller does not receive both signals within approximately one second of engine cranking, it deactivates the ASD relay and fuel pump relay. When these relays are deactivated, power is shut off to the fuel injector, ignition coil, oxygen sensor heating element and fuel pump.

The engine controller contains a voltage converter that changes battery voltage to a regulated 9.0 volts. The 9.0 volts power the camshaft sensor, crankshaft sensor and vehicle speed sensor. The controller also provides a 5.0 volts supply for the coolant temperature sensor, manifold absolute pressure sensor and throttle position sensor.

AIR CONDITIONING SWITCH SENSE—ENGINE CONTROLLER INPUT

When the air conditioning or defrost switch is put in the ON position and the low pressure and high pressure switches are closed, the engine controller receives an input for air conditioning. After receiving this input, the engine controller activates the A/C compressor clutch by grounding the A/C clutch relay. The engine controller also adjusts idle speed to a scheduled RPM to compensate for increased engine load.

BATTERY VOLTAGE—ENGINE CONTROLLER INPUT

The engine controller monitors the battery voltage input to determine fuel injector pulse width and alternator field control. If battery voltage is low the engine controller will increase injector pulse width (period of time that the injector is energized).

BRAKE SWITCH—ENGINE CONTROLLER INPUT

When the brake switch is activated, the engine controller receives an input indicating that the brakes are being applied. After receiving this input, the engine controller vents the speed control servo. Venting the servo turns the speed control system off. The brake switch is mounted on the brake pedal support bracket.

CAMSHAFT SENSOR—ENGINE CONTROLLER INPUT

Fuel injection synchronization and cylinder identification are provided through the camshaft reference sensor (Fig. 3). The sensor generates pulses. The pulse are the input sent to the engine controller. The engine controller interprets the camshaft sensor input along with the crankshaft sensor input to determine crankshaft position. The engine controller uses crankshaft position reference to determine injector sequence and ignition timing.

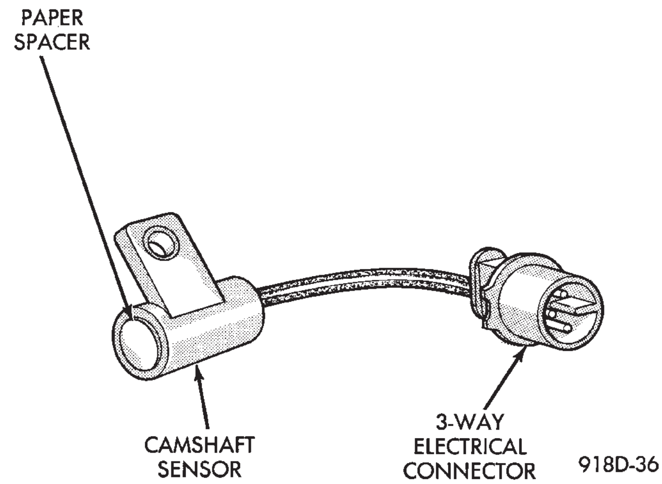

Fig. 3 Camshaft Sensor

The camshaft sensor senses when a slot in the camshaft gear passes beneath it (Fig. 4). When a slot is sensed, the input voltage from the sensor to the engine controller switches from high (5 volts) to low (less than .3 volts). As the slot or window passes, the input voltage is switched back to high (5 volts).

The camshaft sensor is mounted on the top of the cylinder head (Fig. 5). The bottom of the sensor is positioned above the camshaft sprocket. **The distance between the bottom of sensor and the camshaft sprocket is critical to the operation of the system. When servicing the camshaft sensor, refer to the 2.2L Turbo III Multi-Point Fuel Injection—Service Procedures section in this Group.**

CHARGE TEMPERATURE SENSOR—ENGINE CONTROLLER INPUT

The Charge Temperature Sensor is mounted to intake manifold. The sensor measures the temperature of the air-fuel mixture (Fig. 6). This information is used by the engine controller to modify air/fuel mixture and turbocharger boost level.

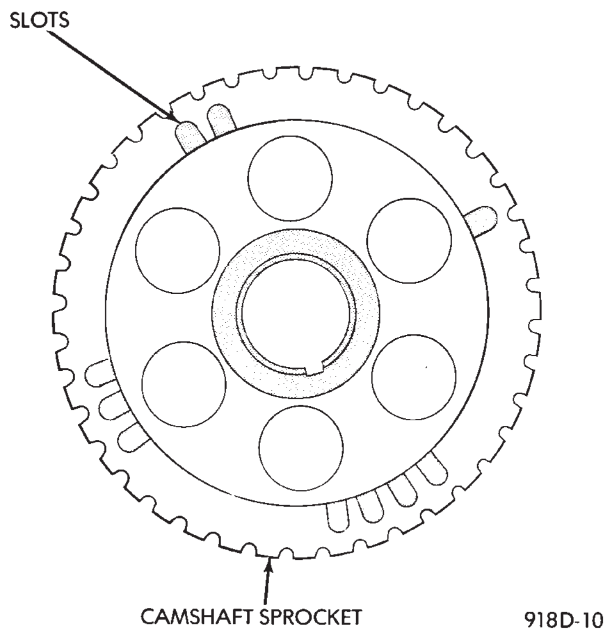

Fig. 4 Camshaft Gear

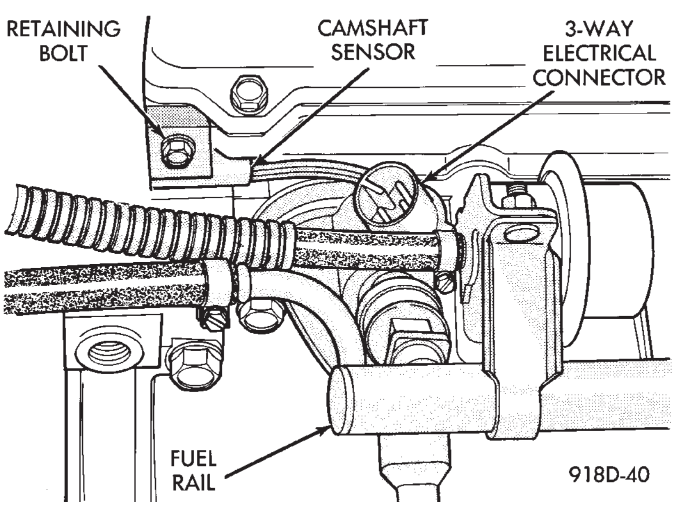

Fig. 5 Camshaft Sensor Location

COOLANT TEMPERATURE SENSOR—ENGINE CONTROLLER INPUT

The coolant temperature sensor is a variable resistor with a range of -40°C to 128°F (-40°F to 265°F). The sensor is installed into the thermostat housing (Fig. 7).

The engine controller supplies 5.0 volts to the coolant temperature sensor. The sensor provides an input voltage to the engine controller. The engine controller determines engine operating temperature from this input. As coolant temperature varies, the sensor resistance changes resulting in a different input voltage to the engine controller.

Based on the coolant sensor and charge air temperature sensor inputs the controller changes certain operating schedules until the engine reaches operating temperature. While the engine warms up, the

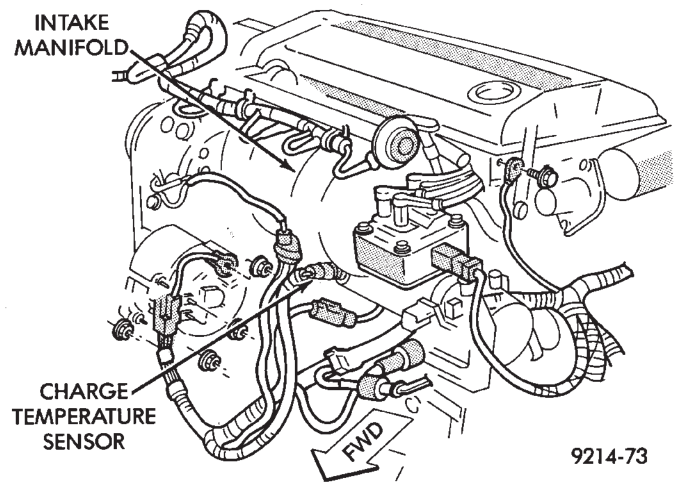

Fig. 6 Charge Temperature Sensors

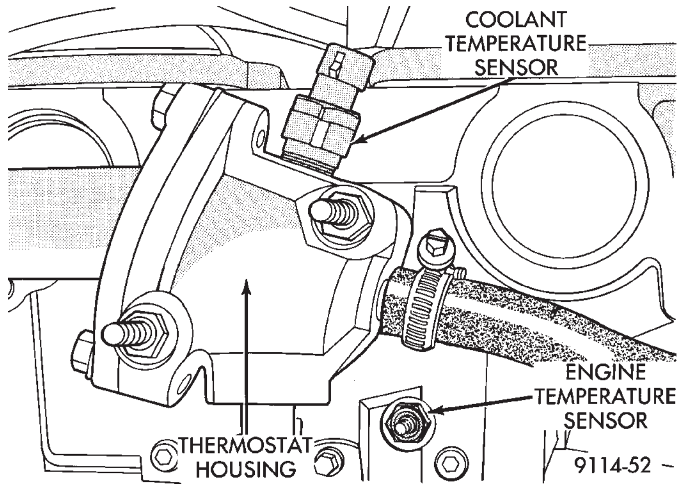

Fig. 7 Coolant Temperature Sensor

controller demands slightly richer air-fuel mixtures, lower boost levels, revised spark advance and higher idle speeds.

CRANKSHAFT SENSOR—ENGINE CONTROLLER INPUT

The crankshaft sensor (Fig. 8) senses slots cut into the flywheel. There are a 2 sets of slots. Each set contains 4 slots, for a total of 8 slots (Fig. 9). Basic timing is set by the position of the last slot in each group. Once the engine controller senses the last slot, it determines crankshaft position (which piston will next be at TDC) from the camshaft sensor input. It may take the controller one engine revolution to determine crankshaft position. The Turbo III engine uses a fixed ignition system. Base timing is not adjustable.

The engine controller uses the crankshaft position reference to determine injector sequence and ignition timing. Once crankshaft position has been determined, the engine controller begins energizing the injectors in sequence.

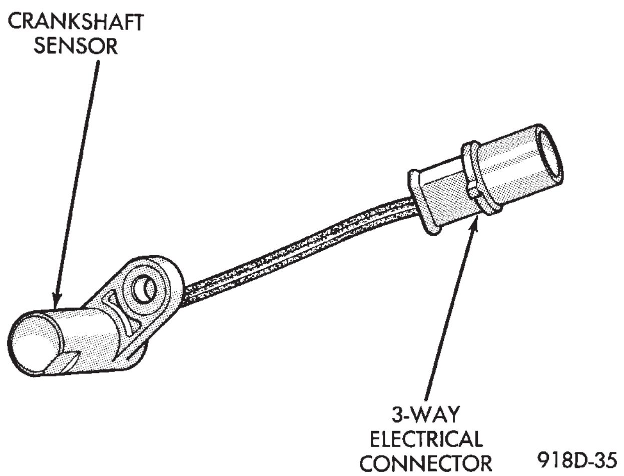

Fig. 8 Crankshaft Sensor

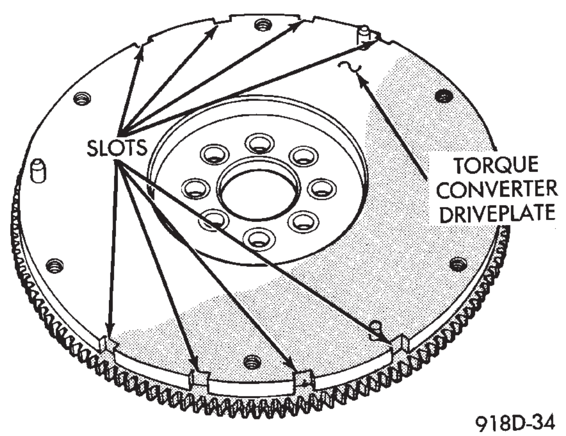

Fig. 9 Timing Slots

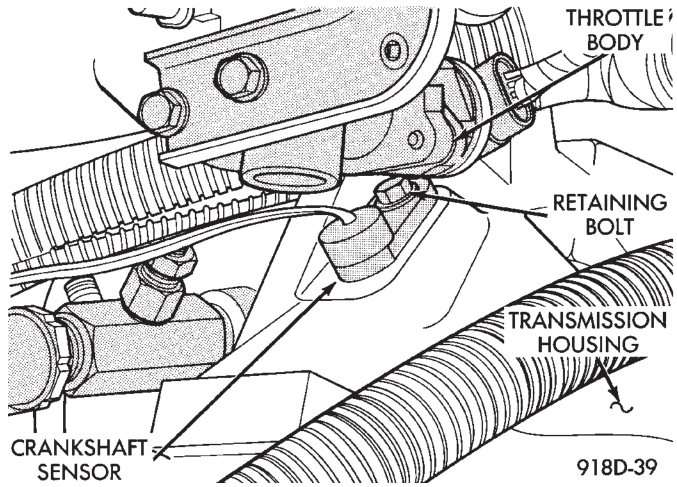

Fig. 10 Crankshaft Sensor Location

The crankshaft sensor is located in the transmission housing, below the throttle body (Fig. 10). The bottom of the sensor is positioned next to the drive plate. **The distance between the bottom of sensor and the drive plate is critical to the operation of the system. When servicing the crankshaft sensor, refer to the 2.2L Turbo III Multi-Point Fuel Injection—Service Procedures section in this Group.**

DETONATION SENSOR (KNOCK SENSOR)—ENGINE CONTROLLER INPUT

The detonation sensor generates a signal when spark knock occurs in the combustion chambers. The sensor can detect detonation in the cylinders. The sensor provides information used by the engine controller to modify spark advance and boost schedules in order to eliminate detonation.

The detonation sensor is installed into the engine, behind the PCV breather/separator (Fig. 11).

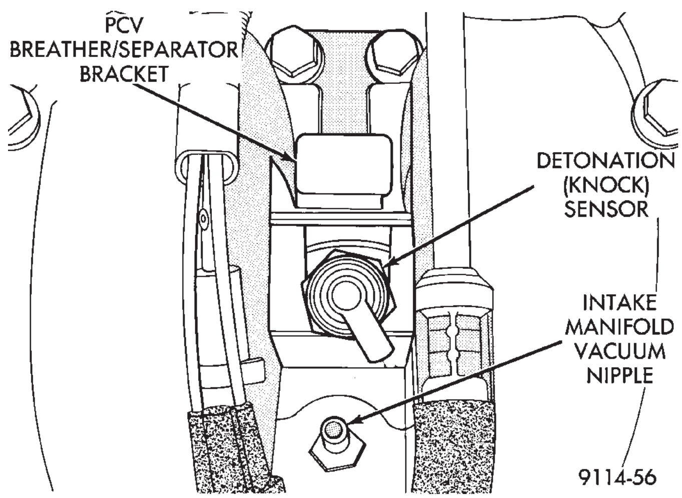

Fig. 11 Detonation (Knock) Sensor

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—ENGINE CONTROLLER INPUT

The engine controller supplies 5 volts to the MAP sensor. The Map sensor converts intake manifold pressure into voltage. The engine controller monitors the MAP sensor output voltage. As vacuum increases, MAP sensor voltage decreases proportionately. Also, as vacuum decreases, MAP sensor voltage increases proportionately.

During cranking, before the engine starts running, the engine controller determines atmospheric air pressure from the MAP sensor voltage. While the engine operates, the controller determines intake manifold pressure and barometric pressure from the MAP sensor voltage. Based on MAP sensor voltage and inputs from other sensors, the engine controller adjusts spark advance, air/fuel mixture and controls the turbocharger wastegate.

The MAP sensor (Fig. 12) mounts underhood on the right side of the engine compartment. The sensor connects electrically to the engine controller.

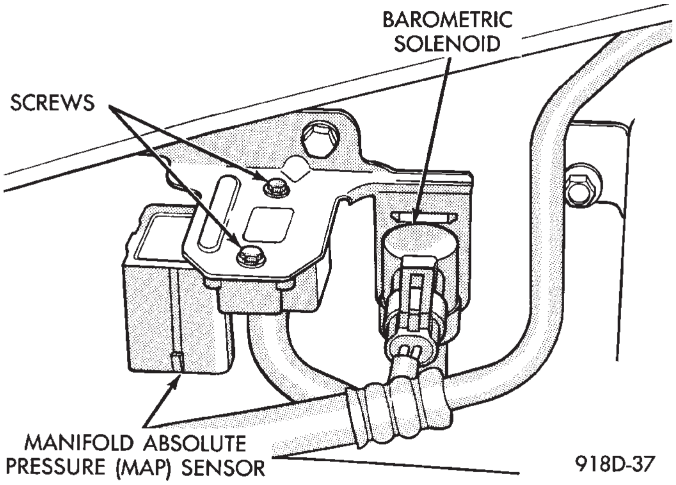

Fig. 12 MAP Sensor

OXYGEN SENSOR (O_2 SENSOR)—ENGINE CONTROLLER INPUT

The O_2 sensor is located in the turbocharger outlet and provides an input voltage to the engine controller (Fig. 13). The input tells the engine controller the oxygen content of the exhaust gas. The engine controller uses this information to fine tune the air-fuel ratio by adjusting injector pulse width.

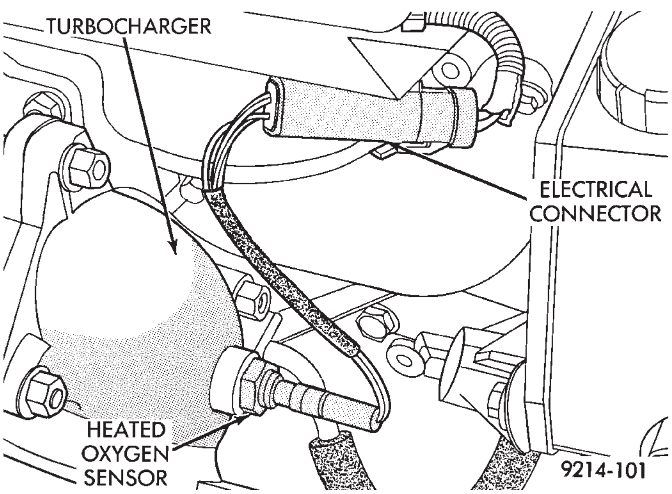

Fig. 13 Oxygen Sensor

The O_2 sensor produces voltages from 0 to 1 volt, depending upon the oxygen content of the exhaust gas in the exhaust manifold. When a large amount of oxygen is present (caused by a lean air-fuel mixture), the sensor produces a low voltage. When there is a lesser amount present (rich air-fuel mixture) it produces a higher voltage. By monitoring the oxygen content and converting it to electrical voltage, the sensor acts as a rich-lean switch.

The oxygen sensor is equipped with a heating element that keeps the sensor at proper operating temperature during all operating modes. Maintaining correct sensor temperature at all times allows the system to enter into closed loop operation sooner. Also, it allows the system to remain in closed loop operation during periods of extended idle.

In Closed Loop operation the engine controller monitors the O_2 sensor input (along with other inputs) and adjusts the injector pulse width accordingly. During Open Loop operation the engine controller ignores the O_2 sensor input. The controller adjusts injector pulse width based on preprogrammed (fixed) values and inputs from other sensors.

SPEED CONTROL—ENGINE CONTROLLER INPUT

The speed control system provides four separate voltages (inputs) to the engine controller. The voltages correspond to the On/Off, Set, and Resume.

The speed control ON voltage informs the engine controller that the speed control system has been activated. The speed control SET voltage informs the controller that a fixed vehicle speed has been selected. The speed control RESUME voltage indicates the previous fixed speed is requested. The speed control OFF voltage tells the controller that the speed control system has deactivated. Refer to Group 8H for further speed control information.

THROTTLE POSITION SENSOR (TPS)—ENGINE CONTROLLER INPUT

The Throttle Position Sensor (TPS) is mounted on the throttle body and connected to the throttle blade shaft (Fig. 14). The TPS is a variable resistor that provides the engine controller with an input signal (voltage) representing throttle blade position. As the position of the throttle blade changes, the resistance of the TPS changes.

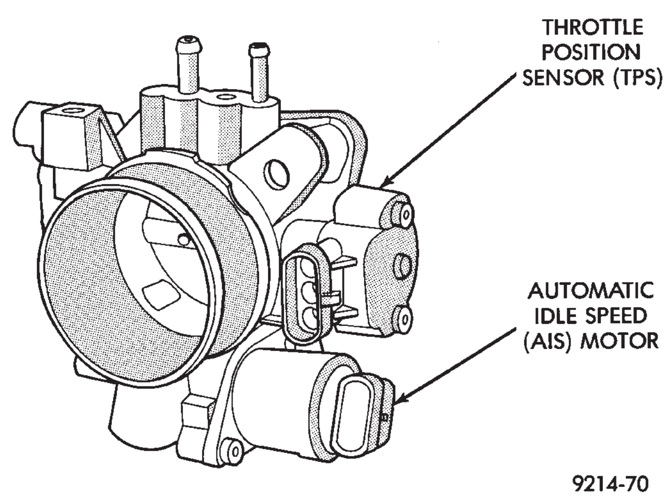

Fig. 14 Throttle Position Sensor and AIS Motor

The engine controller supplies approximately 5 volts to the TPS. The TPS output voltage (input signal to the engine controller) represents the throttle blade position. The TPS output voltage to the controller varies from approximately 0.5 volt at minimum throttle opening (idle) to 4 volts at wide open throttle. Along with inputs from other sensors, the engine controller uses the TPS input to determine current engine operating conditions and adjust fuel injector pulse width and ignition timing.

VEHICLE DISTANCE (SPEED) SENSOR—ENGINE CONTROLLER INPUT

The distance sensor (Fig. 15) is located in the transmission extension housing. The sensor input is used by the engine controller to determine vehicle speed and distance traveled.

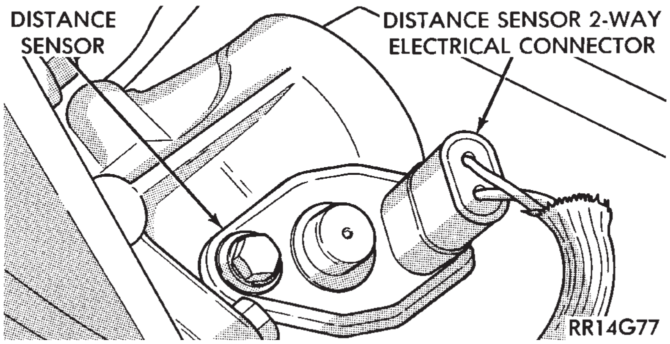

Fig. 15 Vehicle Distance (Speed) Sensor

The distance sensor generates 8 pulses per sensor revolution. These signals, along with a closed throttle signal from the TPS, determine if a closed throttle deceleration or normal idle condition (vehicle stopped) exists. Under deceleration conditions, the engine controller adjusts the AIS motor to maintain a desired MAP value. Under idle conditions, the engine controller adjusts the AIS motor to maintain a desired engine speed.

AIR CONDITIONING CLUTCH RELAY—ENGINE CONTROLLER OUTPUT

The engine controller operates the air conditioning clutch relay ground circuit. The radiator fan relay supplies battery power to the solenoid side of the A/C clutch relay. The air conditioning clutch relay will not energize unless the radiator fan relay energizes. The engine controller energizes the radiator fan relay when the air conditioning or defrost switch is put in the ON position and the low pressure and high pressure switches close. When the engine controller senses wide open throttle through the throttle position sensor, or low engine RPM it will de-energize the A/C clutch relay, open it's contacts and prevent air conditioning clutch engagement.

On AA body vehicles, the relay is located on the drivers side inner fender panel (Fig. 16). On AG Body vehicles, the relay is located in the power distribution center (Fig. 17).

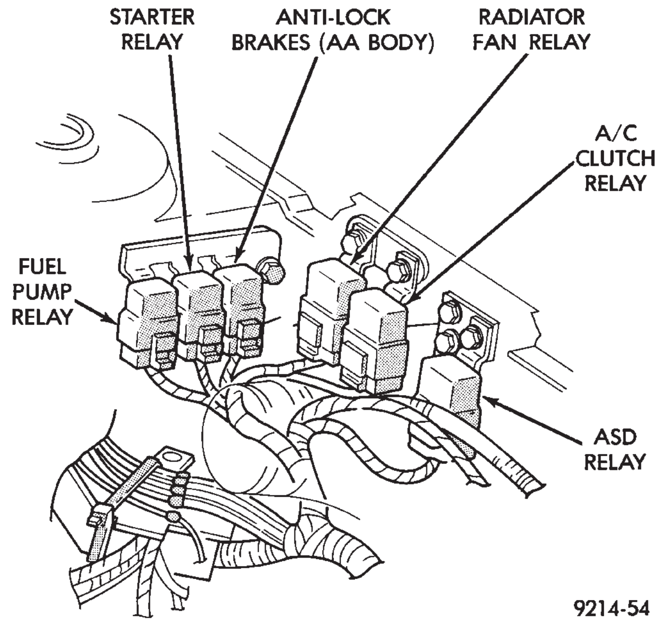

Fig. 16 Relay Location—AA Body

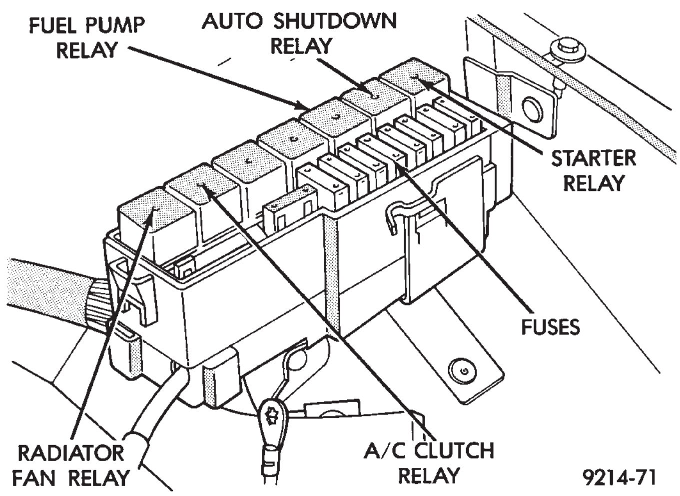

Fig. 17 Relay Location—AG Body

ALTERNATOR FIELD—ENGINE CONTROLLER OUTPUT

The engine controller regulates the charging system voltage within a range of 12.9 to 15.0 volts. Refer to Group 8A for charging system information.

AUTO SHUTDOWN (ASD) RELAY AND FUEL PUMP RELAY—ENGINE CONTROLLER OUTPUT

The engine controller operates the auto shutdown (ASD) relay and fuel pump relay through one ground path. The controller operates the relays by switching the ground path on and off. Both relays turn on and off at the same time.

The ASD relay connects battery voltage to the fuel injector and ignition coil. The fuel pump relay connects battery voltage to the fuel pump and oxygen sensor heating element.

The engine controller turns the ground path off when the ignition switch is in the Off position. Both relays are off. When the ignition switch is in the On or Crank position, the controller monitors the crankshaft and camshaft sensor signals to determine engine speed and ignition timing (coil dwell). If the engine controller does not receive the crankshaft and camshaft signals when the ignition switch is in the Run position, it will de-energize both relays. When the relays are de-energized, battery voltage is not supplied to the fuel injector, ignition coil, fuel pump and oxygen sensor heating element.

On AA body vehicles, the ASD relay and fuel pump relay are mounted on the drivers side fender well (Fig. 16).

On AG body vehicles, the ASD relay and fuel pump relay are located in the power distribution center (Fig. 17).

AUTOMATIC IDLE SPEED (AIS) MOTOR—ENGINE CONTROLLER OUTPUT

The idle speed stepper (AIS) motor is mounted on the throttle body (Fig. 14). The engine controller operates the AIS motor. The engine controller adjusts engine idle speed through the AIS to compensate for engine load or ambient conditions.

The throttle body has an air bypass passage that provides air for the engine at idle (the throttle blade is closed). The AIS motor pintle protrudes into the air bypass passage and regulates air flow through it.

The engine controller adjusts engine idle speed by moving the AIS motor pintle in and out of the bypass passage. The adjustments are based on inputs the controller receives. The inputs are from the throttle position sensor, camshaft sensor, crankshaft sensor, coolant temperature sensor, and various switch operations (brake and air conditioning). Deceleration die out is also prevented by increasing airflow when the throttle is closed quickly after a driving (speed) condition.

BAROMETRIC READ SOLENOID—ENGINE CONTROLLER OUTPUT

The barometric pressure read solenoid is spliced into the manifold absolute pressure (MAP) sensor vacuum hose (Fig. 12). The barometric read solenoid switches the pressure supply to the MAP sensor from either barometric pressure (atmospheric) or manifold vacuum. The engine controller operates the solenoid.

Atmospheric pressure is periodically supplied to the MAP sensor to measure barometric pressure. This occurs at closed throttle, once per throttle closure but no more often than once every 3 minutes and within a specified RPM band. Barometric information is used primarily for boost control and start fuel enrichment at various altitudes.

CANISTER PURGE SOLENOID—ENGINE CONTROLLER OUTPUT

Vacuum for the Evaporative Canister is controlled by the Canister Purge Solenoid (Fig. 18). The solenoid is controlled by the engine controller.

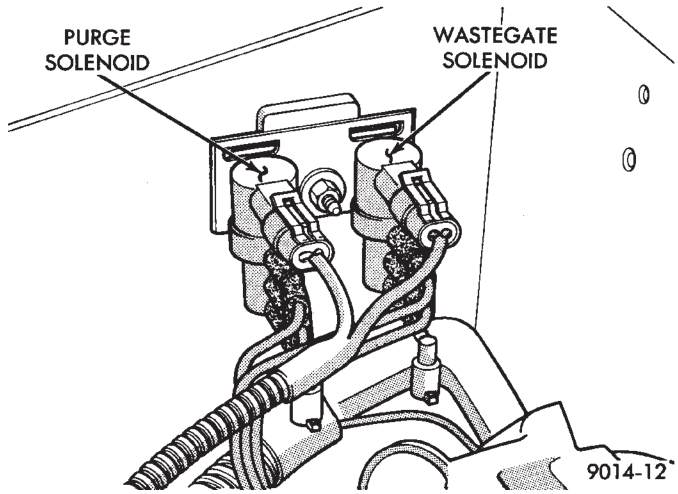

Fig. 18 Canister Purge Solenoid and Wastegate Control Solenoid

The engine controller operates the solenoid by switching the ground circuit on and off. When grounded, the solenoid energizes and prevents vacuum from reaching the evaporative canister. When not energized the solenoid allows vacuum to flow to the canister.

During warm-up and for a specified time period after hot starts the engine controller grounds the purge solenoid. Vacuum does not operate the evaporative canister valve.

The engine controller removes the ground to the solenoid when the engine reaches a specified temperature and the time delay interval has occurred. When the solenoid is de-energized, vacuum flows to the canister purge valve. Vapors are purged from the canister and flow to the throttle body.

The purge solenoid will also be energized during certain idle conditions, in order to update the fuel delivery calibration.

CHECK ENGINE LAMP—ENGINE CONTROLLER OUTPUT

The Check Engine Lamp comes on each time the ignition key is turned ON and stays on for 3 seconds as a bulb test. The Check Engine Lamp warns the operator that the engine controller has entered a Limp-in mode. During Limp-in-Mode, the controller attempts to keep the system operational. The check engine lamp signals the need for immediate service. In limp-in mode, the Engine controller compensates for the failure of certain components that send incorrect signals. The controller substitutes for the incorrect signals with inputs from other sensors.

Signals that can trigger the Check Engine Lamp.

- Coolant Temperature Sensor
- Manifold Absolute Pressure Sensor
- Throttle Position Sensor
- Battery Voltage Input
- An Emissions Related System
- Charging system

The Check Engine Lamp can also be used to display fault codes. Cycle the ignition switch on, off, on, off, on, within five seconds and any fault codes stored in the Engine controller will be displayed. Refer to On Board Diagnostics in the General Diagnosis—2.2L Turbo III Engines section of this Group for Fault Code Descriptions.

DIAGNOSTIC CONNECTOR—ENGINE CONTROLLER OUTPUT

The diagnostic connector provides the technician with the means to connect the DRB II tester to diagnosis the vehicle.

FUEL INJECTOR—ENGINE CONTROLLER OUTPUT

The Fuel Injectors are electric solenoids driven by the engine controller (Fig. 19).

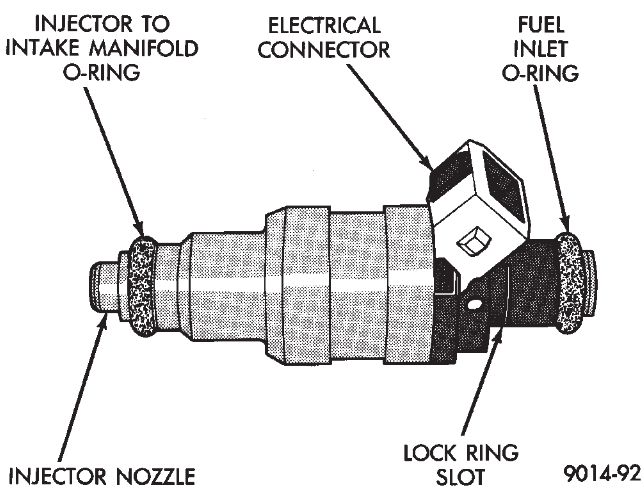

Fig. 19 Fuel Injector

Based on sensor inputs, the engine controller determines when and how long the fuel injector should operate. The amount of time an injector fires is referred to as injector pulse width. The auto shutdown (ASD) relay supplies battery voltage to the injector. The engine controller supplies the ground path. By switching the ground path on and off, the engine controller adjusts injector pulse width.

When the controller supplies a ground path, a spring loaded needle or armature lifts from its seat. Fuel flows through the orifice and deflects off the sharp edge of the injector nozzle. The resulting fuel sprays forms a cone shaped pattern before entering the air stream.

Fuel is constantly supplied to the injector at regulated 380 Kpa (55 psi). Unused fuel returns to the fuel tank.

IGNITION COIL—ENGINE CONTROLLER OUTPUT

The Direct Ignition System (DIS) uses a molded coil (Fig. 20). The coil is mounted on the front of the engine. High tension leads route to each cylinder from the coil. The coil fires two spark plugs every power stroke. One plug is the cylinder under compression, the other cylinder fires on the exhaust stroke. The engine controller determines which of the coils to charge and fire at the correct time.

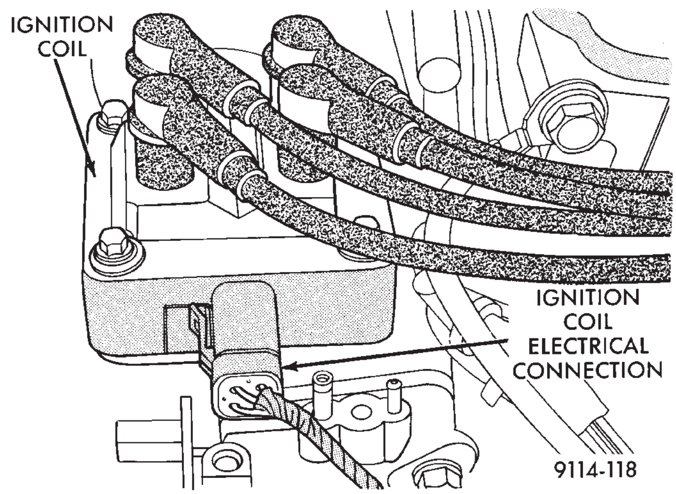

Fig. 20 Ignition Coil

The auto shutdown (ASD) relay provides battery voltage to the ignition coil. The engine controller provides a ground contact (circuit) for energizing the coil. When the controller breaks the contact, the energy in the coil primary transfers to the secondary causing the spark. The engine controller will de-energize the ASD relay if it does not receive the crankshaft sensor and camshaft sensor inputs. Refer to Auto Shutdown (ASD) Relay/Fuel Pump Relay—Engine Controller Output in this section for relay operation.

RADIATOR FAN RELAY—ENGINE CONTROLLER OUTPUT

The radiator fan is energized by the engine controller through the radiator fan relay. The engine controller grounds the radiator fan relay when engine coolant reaches a predetermined temperature. For more information, refer to Group 7, Cooling Systems.

On AG body vehicles, the radiator fan relay is located in the power distribution center (Fig. 17). Refer to the Wiring and Component Identification section of Group 8W.

On AA body vehicles, the radiator fan relay is mounted on the drivers side fender well, next to the strut tower (Fig. 16).

SPEED CONTROL SOLENOIDS—ENGINE CONTROLLER OUTPUT

The speed control vacuum and vent solenoids are operated by the engine controller. When the engine controller supplies a ground to the vacuum solenoid, the speed control system opens the throttle plate. When the controller supplies a ground to the vent solenoid, throttle blade closes. The engine controller balances the two solenoids to maintain the set speed. Refer to Group 8H for speed control information.

TACHOMETER—ENGINE CONTROLLER OUTPUT

The engine controller supplies engine RPM to the instrument panel tachometer. Refer to Group 8 for tachometer information.

WASTEGATE CONTROL SOLENOID—ENGINE CONTROLLER OUTPUT

The engine controller operates the wastegate control solenoid. The controller adjusts maximum boost to varying engine conditions by changing the amount of time the solenoid is energized. The solenoid mounts to the passenger side inner fender panel, next to the strut tower (Fig. 18).

MODES OF OPERATION

As input signals to the engine controller change, the engine controller adjusts its response to the output devices. For example, the engine controller must calculate a different injector pulse width and ignition timing for idle than it does for wide open throttle (WOT). There are several different modes of operation that determine how the engine controller responds to the various input signals.

There are two different areas of operation, OPEN LOOP and CLOSED LOOP.

During OPEN LOOP modes, the engine controller receives input signals and responds according to preset engine controller programming. Input from the oxygen (O_2) sensor is not monitored during OPEN LOOP modes.

During CLOSED LOOP modes, the engine controller does monitor the oxygen (O_2) sensor input. This input indicates to the engine controller whether or not the calculated injector pulse width results in the ideal air-fuel ratio of 14.7 parts air to 1 part fuel. By monitoring the exhaust oxygen content through the O_2 sensor, the engine controller can fine tune the injector pulse width to achieve optimum fuel economy combined with low emissions.

The 2.2L Turbo III multi-point fuel injection system has the following modes of operation:

- Ignition switch ON - Zero RPM
- Engine start-up
- Engine warm-up
- Cruise (Idle)
- Acceleration
- Deceleration
- Wide Open Throttle
- Ignition switch OFF

The engine start-up (crank), engine warm-up, and wide open throttle modes are OPEN LOOP modes. The acceleration, deceleration, and cruise modes, **with the engine at operating temperature** are CLOSED LOOP modes (under most operating conditions).

IGNITION SWITCH ON (ZERO RPM) MODE

When the ignition switch activates the fuel injection system the following actions occur:

- The engine controller calculates basic fuel strategy by determining atmospheric air pressure from the MAP sensor input.
- The engine controller monitors the coolant temperature sensor and throttle position sensor input. The engine controller modifies fuel strategy based on this input.

When the key is in the ON position and the engine is not running, the auto shutdown (ASD) relay and fuel pump relay are not energized. Therefore battery voltage is not supplied to the fuel pump, ignition coil, fuel injector or oxygen sensor heating element.

ENGINE START-UP MODE

This is an OPEN LOOP mode. The following actions occur when the starter motor is engaged.

If the engine controller receives the camshaft and crankshaft signals, it energizes the auto shutdown (ASD) relay and fuel pump relay. These relays supply battery voltage to the fuel pump, fuel injectors, ignition coil, and oxygen sensor heating element. If the engine controller does not receive the camshaft and crankshaft signals within approximately one second, it de-energizes the ASD relay and fuel pump relay.

The engine controller energizes all injectors until it determines crankshaft position from the camshaft and crankshaft signals. The controller determines crankshaft position within 1 engine revolution.

After determining crankshaft position, the controller begins energizing the injectors in sequence. The controller adjusts injector pulse width and controls injector synchronization by turning the individual ground paths to the injectors On and Off.

When the engine idles within ± 64 RPM of its target RPM, the controller compares current MAP sensor value with the atmospheric pressure value received during the Ignition Switch On (zero RPM) mode. If the controller does not detect a minimum difference between the two values, it sets a MAP fault into memory.

Once the ASD and fuel pump relays have been energized, the engine controller:

• Determines injector pulse width based on coolant temperature, manifold absolute pressure (MAP) and the number of engine revolutions since cranking was initiated.
• Monitors the coolant temperature sensor, camshaft sensor, crankshaft sensor, MAP sensor, and throttle position sensor to determine correct ignition timing.

ENGINE WARM-UP MODE

This is a OPEN LOOP mode. The following inputs are received by the engine controller:

• coolant temperature
• detonation sensor
• manifold absolute pressure (MAP)
• engine speed (crankshaft sensor)
• throttle position
• A/C switch
• battery voltage

The engine controller provides a ground path for the injectors to precisely control injector pulse width (by switching the ground on and off). The engine controller adjusts engine idle speed through the automatic idle speed motor. Also, the controller regulates ignition timing.

CRUISE OR IDLE MODE

When the engine is at operating temperature, this is a CLOSED LOOP mode. During cruising speed the following inputs are received by the engine controller:

• coolant temperature
• detonation sensor
• manifold absolute pressure
• engine speed (crankshaft sensor)
• throttle position
• exhaust gas oxygen content
• A/C control positions
• battery voltage

The engine controller provides a ground path for the injectors to precisely control injector pulse width. The engine controller adjusts engine idle speed and ignition timing. The engine controller controls the air/fuel ratio according to the oxygen content in the exhaust gas.

ACCELERATION MODE

This is a CLOSED LOOP mode. The engine controller recognizes an abrupt increase in throttle position or MAP pressure as a demand for increased engine output and vehicle acceleration. The engine controller increases injector pulse width in response to increased fuel demand.

DECELERATION MODE

This is a CLOSED LOOP mode. During deceleration the following inputs are received by the engine controller:

• coolant temperature
• detonation sensor
• manifold absolute pressure
• engine speed (crankshaft sensor)
• throttle position
• exhaust gas oxygen content
• A/C control positions
• battery voltage

The engine controller may receive a closed throttle input from the throttle position sensor (TPS) at the same time it senses an abrupt decrease in manifold pressure. This indicates a hard deceleration. The engine controller modifies the injector sequence. This helps maintain better control of the air-fuel mixture.

WIDE OPEN THROTTLE MODE

This is an OPEN LOOP mode. During wide-open-throttle operation, the following inputs are received by the engine controller:

• coolant temperature
• detonation sensor
• manifold absolute pressure
• engine speed (crankshaft sensor)
• throttle position

When the engine controller senses a wide open throttle condition it will de-energize the air conditioning relay. This disables the air conditioning system.

The exhaust gas oxygen content input is not accepted by the engine controller during wide open throttle operation. The engine controller will enrichen the air/fuel ratio to increase performance and compensate for increased combustion chamber temperature.

IGNITION SWITCH OFF MODE

This is an OPEN LOOP mode. When the ignition switch is turned to the OFF position, the following occurs:

• All outputs are turned off.
• No inputs are monitored.
• The engine controller shuts down.

THROTTLE BODY

The throttle body assembly is located on the left end of the intake manifold plenum (Fig. 21). The throttle body houses the throttle position sensor and the automatic idle speed motor. Air flow through the throttle body is controlled by a cable operated throttle blade located in the base of the throttle body.

FUEL SUPPLY CIRCUIT

Fuel is pumped to the fuel rail by an electrical pump in the fuel tank. The pump inlet is fitted with

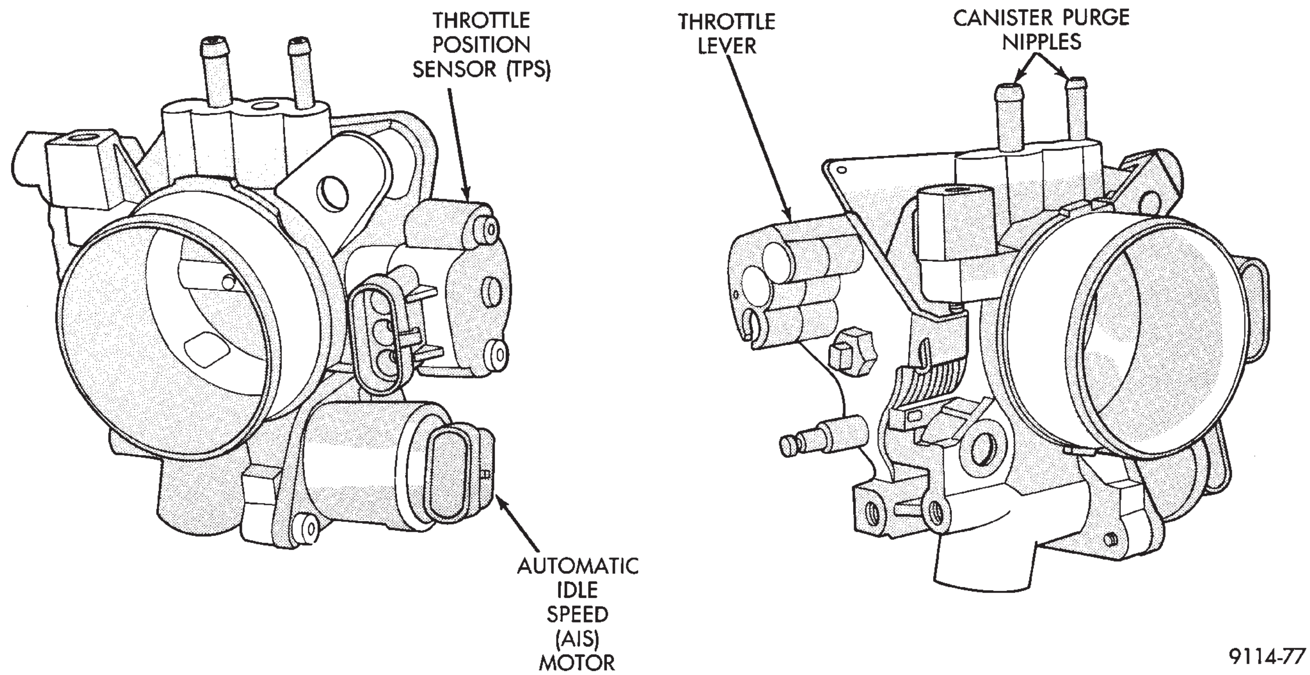

Fig. 21 Throttle Body

a strainer to prevent water and other contaminants from entering the fuel supply circuit.

Fuel pressure is controlled to a preset level above intake manifold pressure by a pressure regulator. The regulator is mounted on the fuel rail (Fig. 22). The regulator uses intake manifold pressure as a reference.

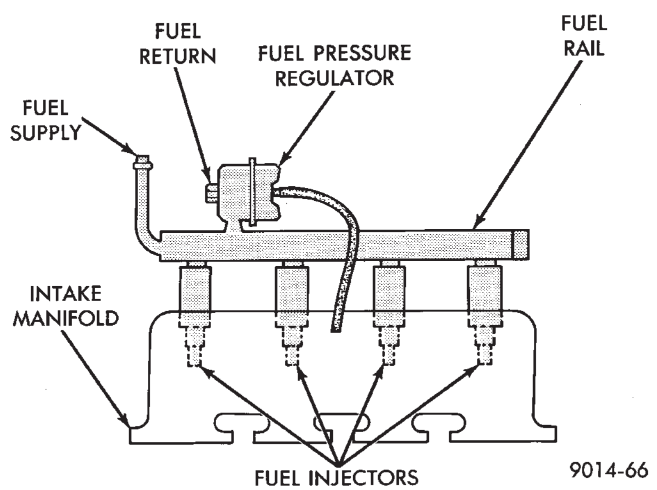

Fig. 22 Fuel Supply Circuit

FUEL INJECTORS AND FUEL RAIL ASSEMBLY

Four fuel injectors are retained in the fuel rail by lock rings. The rail and injector assembly are installed with the injectors inserted into recessed holes in the intake manifold.

FUEL PRESSURE REGULATOR

The pressure regulator is a mechanical device located on the fuel rail, downstream of the fuel injectors (Fig. 23). The regulator maintains a constant 380 kPa (55 psi) across the fuel injector tip.

The regulator contains a spring loaded rubber diaphragm that covers the fuel return port. When the fuel pump is operating, fuel flows past the injectors into the regulator, and is restricted from flowing any further by the blocked return port. When fuel pressure reaches 380 kPa (55 psi) it pushes on the diaphragm, compresses the spring, and uncovers the fuel return port. The diaphragm and spring constantly move from an open to closed position to keep the fuel pressure constant.

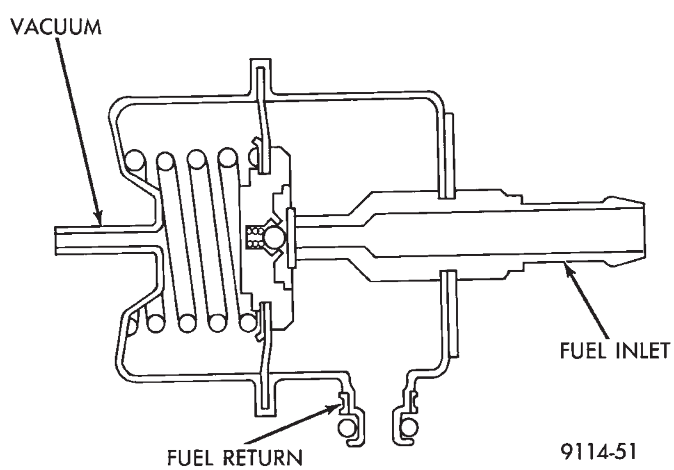

Fig. 23 Fuel Pressure Regulator

2.2L TURBO III MULTI-POINT FUEL INJECTION—GENERAL DIAGNOSIS

INDEX

FUEL SYSTEM DIAGRAM

Refer to the System Operation portion of this section for descriptions of the components shown in Fig. 1.

VISUAL INSPECTION

Perform a visual inspection for loose, disconnected, or misrouted wires and hoses before diagnosing or servicing the fuel injection system. A visual check helps save unnecessary test and diagnostic time. A thorough visual inspection includes the following checks:

(1) Check the ignition coil electrical connections (Fig. 2).

(2) Verify the harness connector is attached to the canister purge solenoid (Fig. 3).

(3) Verify the harness connector is attached to the wastegate solenoid (Figs. 3).

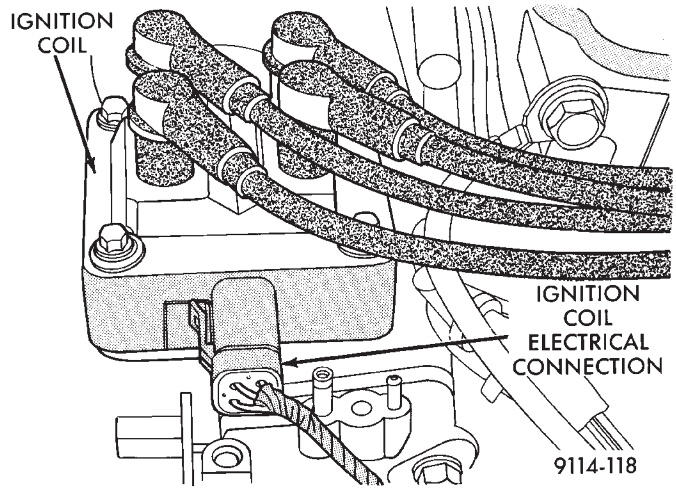

Fig. 2 Ignition Coil Electrical Connection

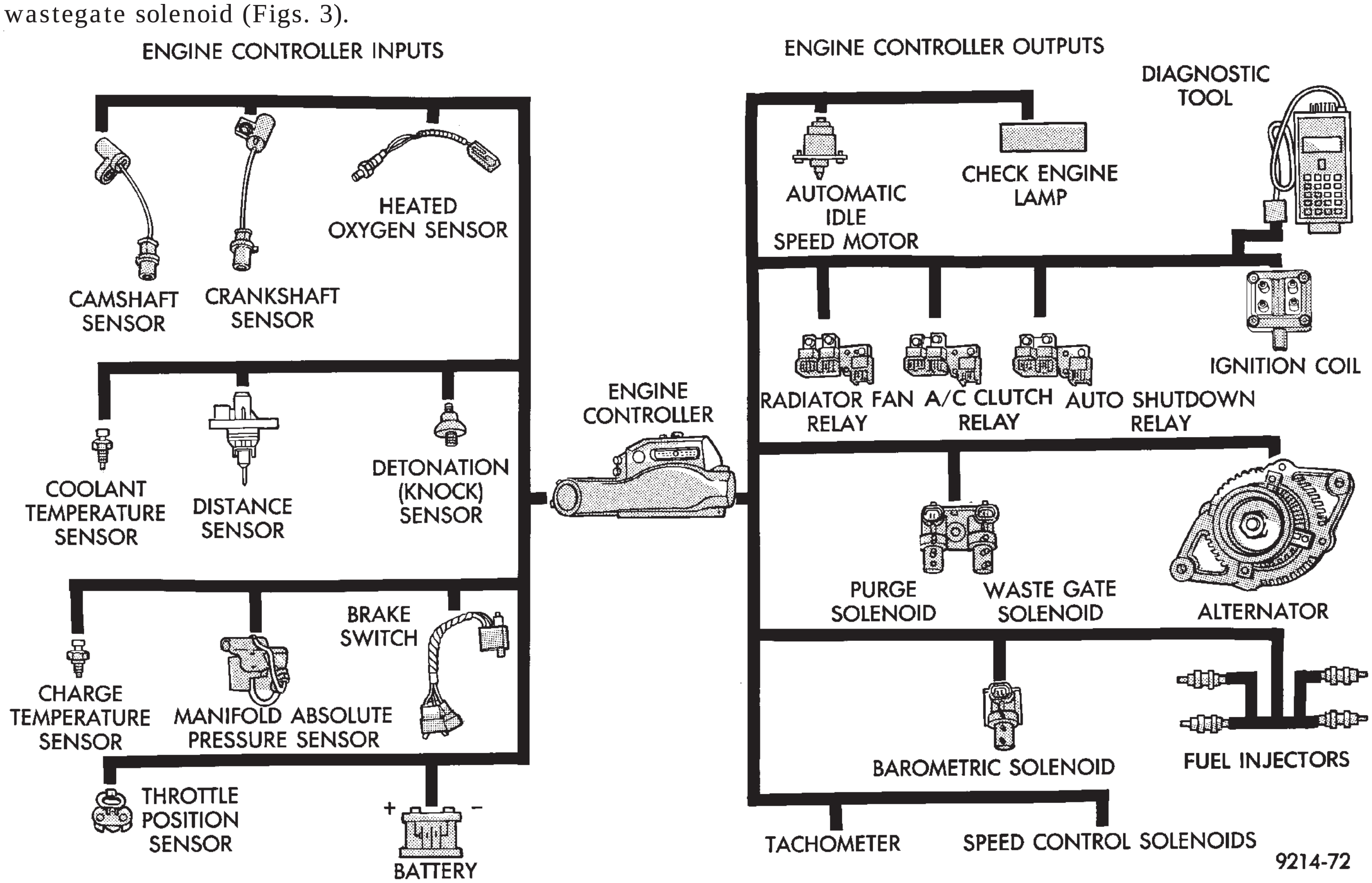

Fig. 1 Multi-point Fuel Injection Components

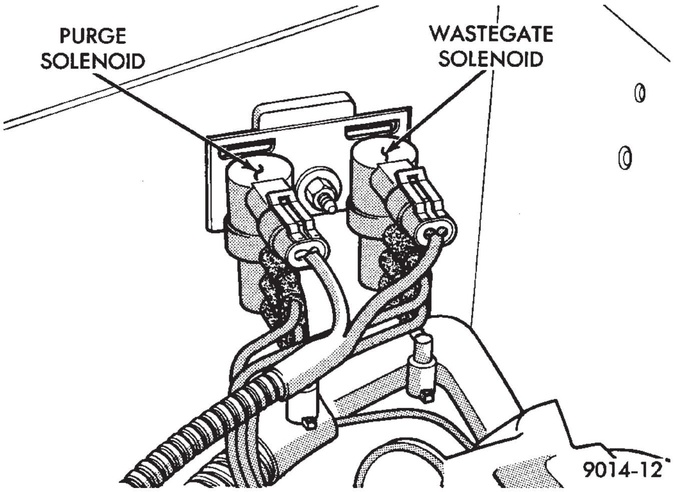

Fig. 3 Solenoid Connections

(4) Verify the harness connector is attached to the MAP sensor (Fig. 4).

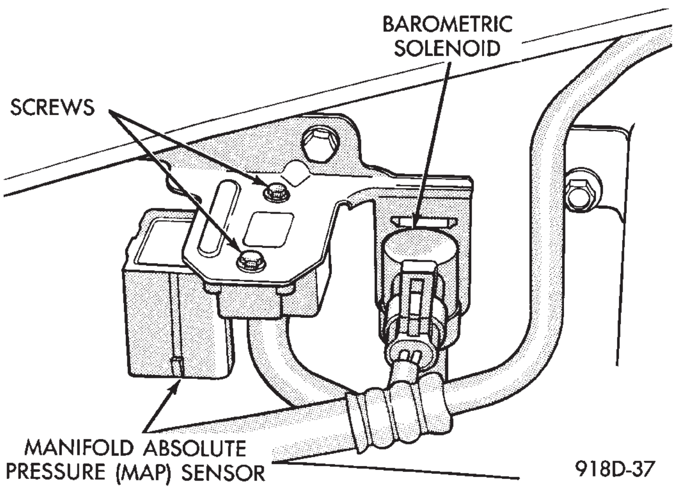

Fig. 4 Baro/MAP Solenoid Hose Connections

(5) Check vacuum hose connections between vacuum source and canister purge, wastegate, and barometric read solenoids (Figs. 3 and 4).

(6) Verify hoses are securely attached to vapor canister (Fig. 5).

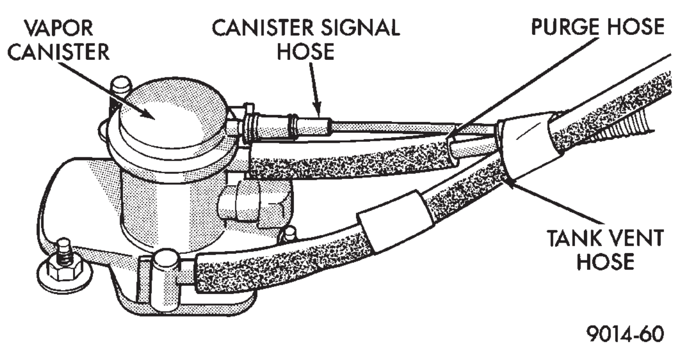

Fig. 5 Vapor Canister

(7) Verify the alternator wiring and belt are correctly installed and tightened.

(8) Check ignition cable routing and attachment (Fig. 6).

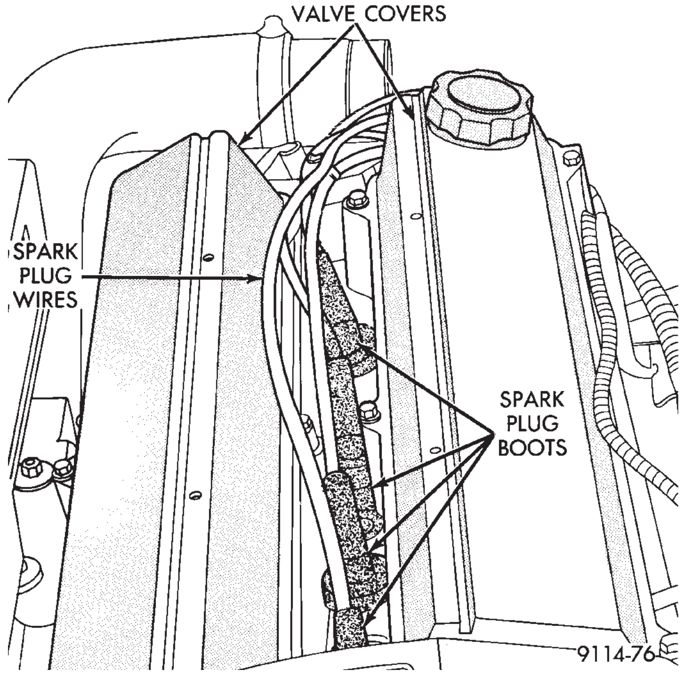

Fig. 6 Ignition Cable Mounting and Attachment

(9) Check oil pressure sending unit electrical connection (Fig. 7).

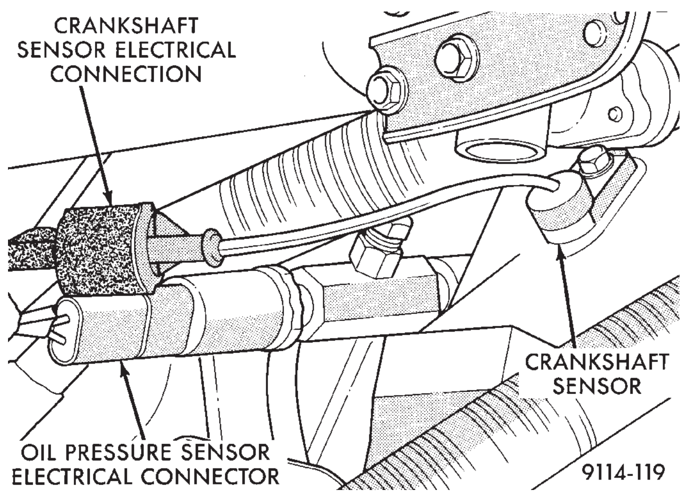

Fig. 7 Oil Pressure Sending Unit and Crankshaft Sensor Electrical Connections

(10) Check the camshaft and crankshaft sensor electrical connections (Figs. 7 and 8).

(11) Check radiator fan electrical connector.

(12) Check electrical connector at the coolant temperature sensor (Fig. 9).

(13) Inspect the engine temperature sensor electrical connection (Fig. 9).

(14) Check the power brake booster and speed control connections (Fig. 10).

(15) Inspect the engine and fuel injector harness to main harness electrical connections.

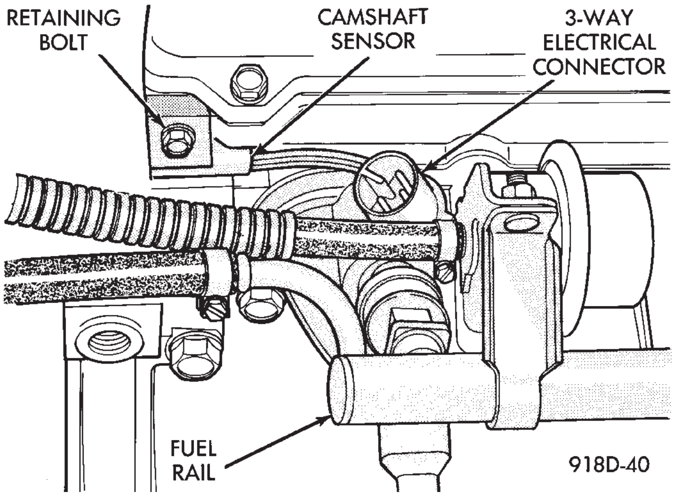

Fig. 8 Camshaft Electrical Connection

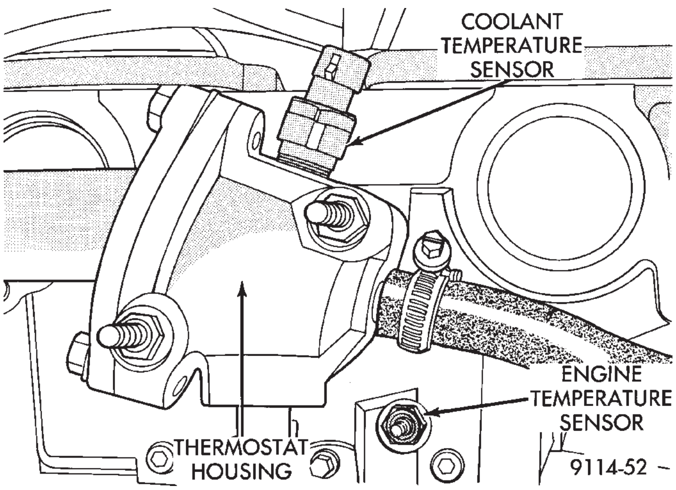

Fig. 9 Coolant Temperature and Engine Temperature Sensor

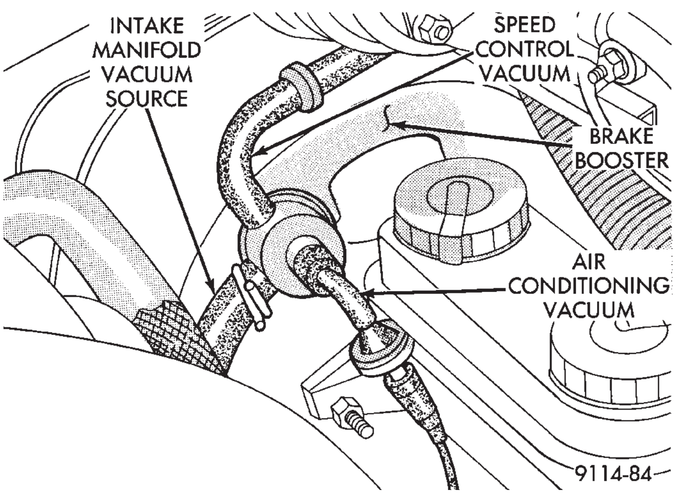

Fig. 10 Power Brake Booster and Speed Control Vacuum Hose Connections

(16) Verify that all electrical connectors are fully inserted into relays and that battery connections are clean and tight (Fig. 11 or Fig. 12).

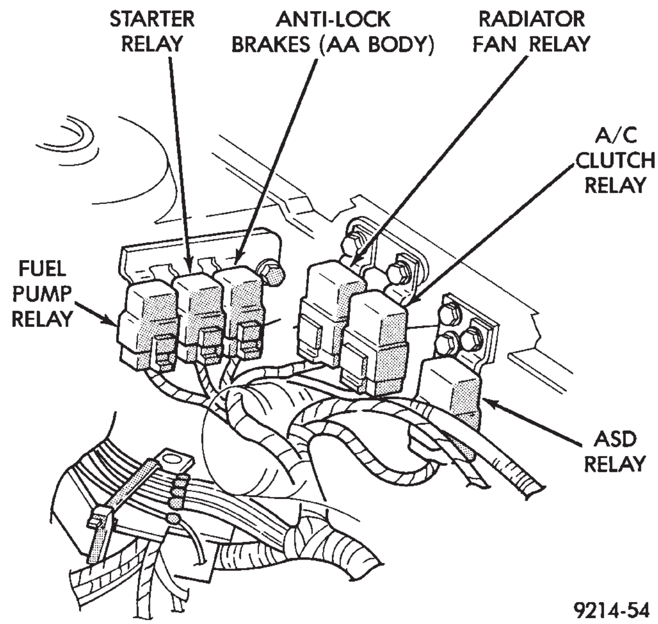

Fig. 11 Engine Compartment Relay Identification AA Body

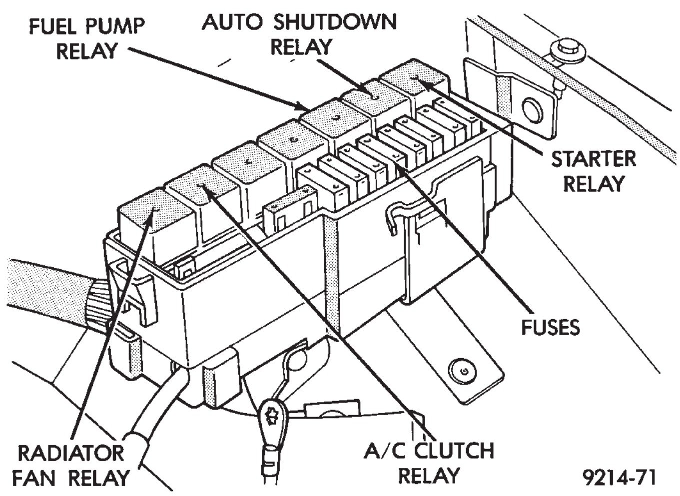

Fig. 12 Power Distribution Center AG Body

(17) Check the 60-way electrical connection at the engine controller for damage or spread terminals. Verify that the 60-way connector is fully inserted into the socket on the engine controller (Fig. 13). Ensure that wires are not stretched or pulled out of the connector.

(18) Verify the harness connector is attached to AIS motor. (Fig. 14).

(19) Verify the harness connector is attached to the throttle position sensor. (Fig. 14).

(20) Inspect the hose connections at throttle body (Fig. 14).

(21) Verify all hose connections at the intake manifold are secure (Fig. 15).

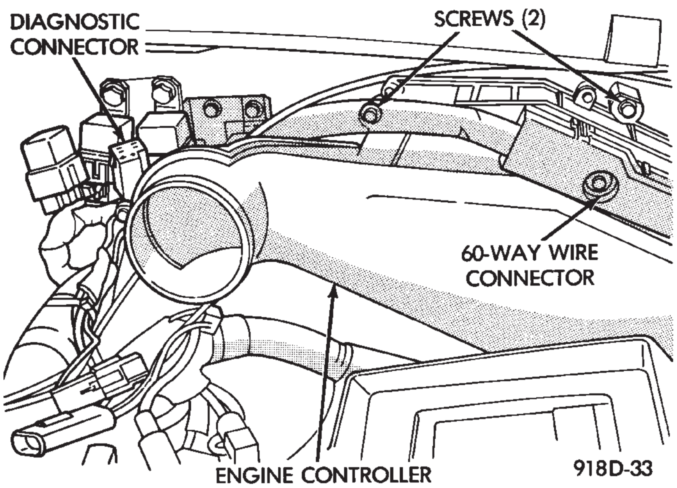

Fig. 13 Engine Controller Electrical Connector

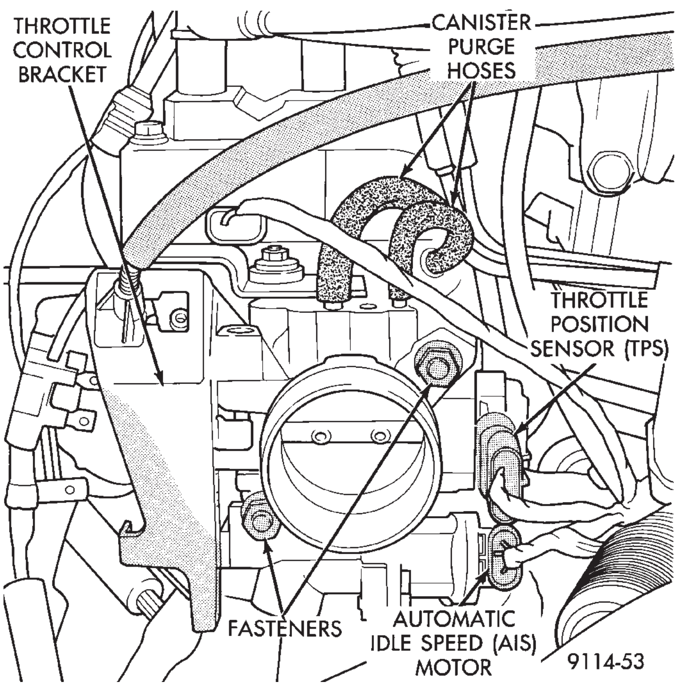

Fig. 14 Throttle Body Electrical and Vacuum Hose Connections

(22) Check vacuum hose connection between vacuum source and fuel pressure regulator (Fig. 16).

(23) Inspect the charge temperature sensor electrical connector (Fig. 16).

(24) Inspect fuel injectors wiring connectors (Fig. 16).

(25) Inspect the detonation (knock) sensor electrical connector (Fig. 17).

(26) Inspect the heated oxygen sensor electrical connector (Fig. 18).

(27) Verify engine ground strap is attached to the engine and the dash panel.

(28) Verify the hose connections on the turbo charger are secure (Fig. 19).

(29) Check the turbocharger bypass valve hose connections.

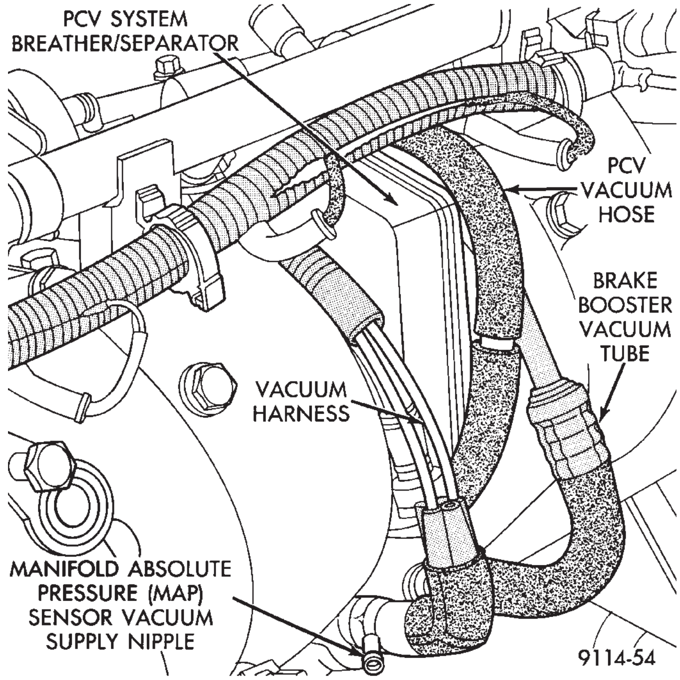

Fig. 15 Intake Manifold Vacuum Connections

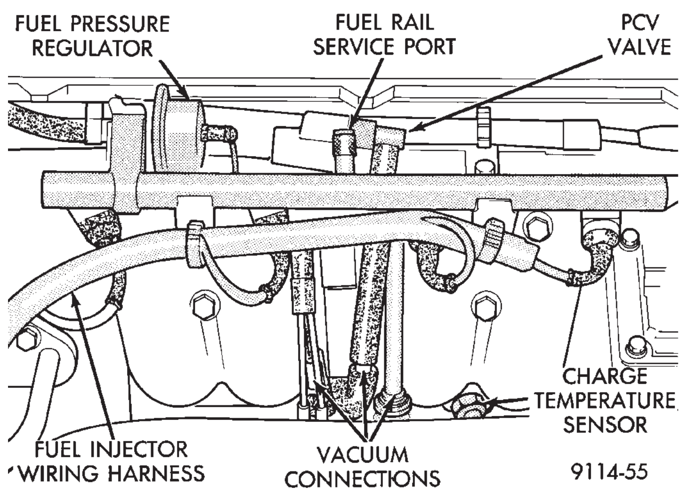

Fig. 16 Vacuum and Electrical Connections

(30) Verify 2-way connector is attached to Distance Sensor (Fig. 20).

(31) Check hose and wiring connections at fuel pump. Check that wiring connector is making contact with terminals on pump.

ON BOARD DIAGNOSTICS

The engine controller has been programmed to monitor many different circuits of the fuel injection system. If a problem is sensed with a monitored circuit often enough to indicate an actual problem, the controller stores a fault. If the problem is repaired or ceases to exist, the engine controller cancels the Fault Code after 51 vehicle key on/off cycles.

Certain criteria must be met for a fault code to be entered into engine controller memory. The criteria

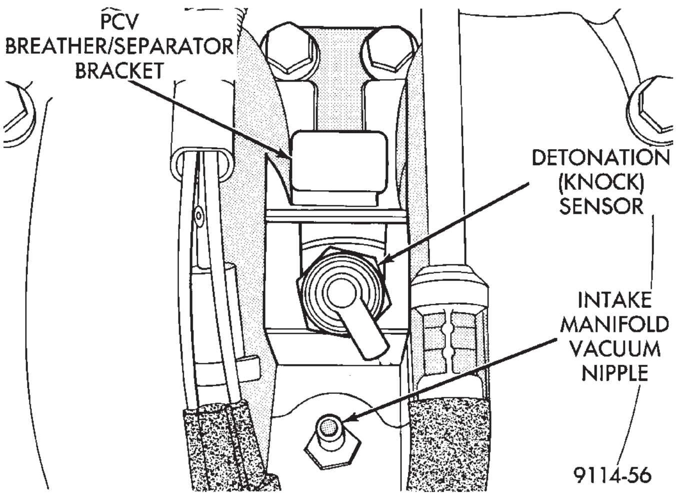

Fig. 17 Detonation (Knock) Sensor Electrical Connector

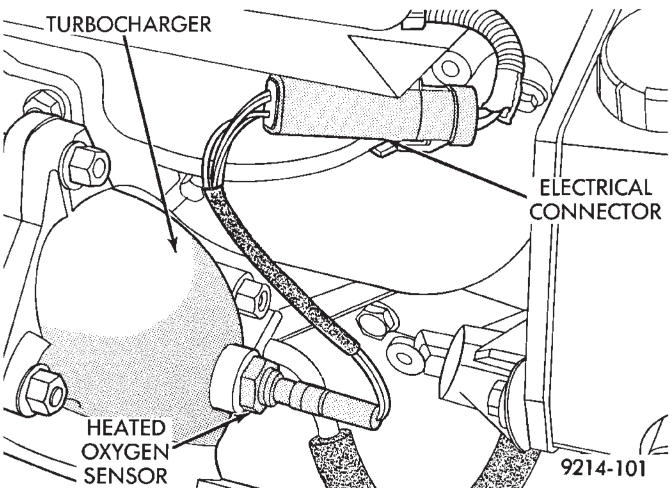

Fig. 18 Heated Oxygen Sensor

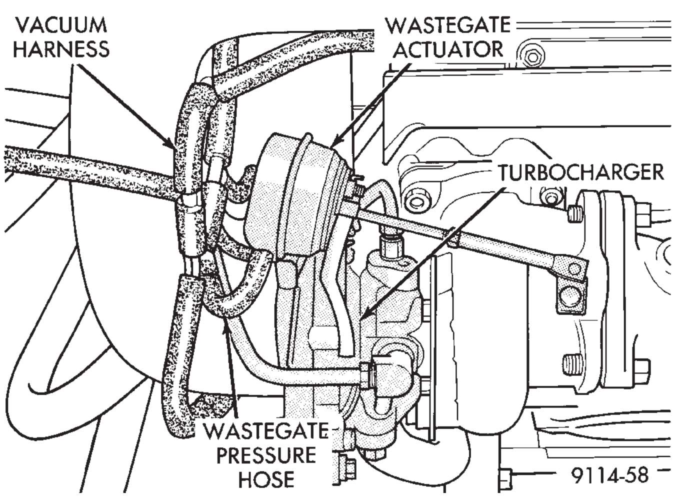

Fig. 19 Hose Connections

may be a specific range of engine RPM, engine temperature, and/or input voltage to the engine controller.

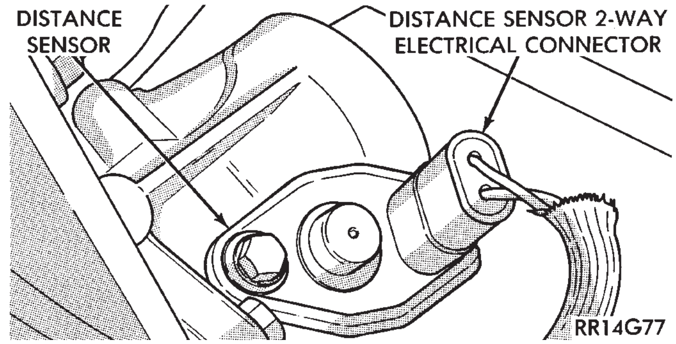

Fig. 20 Distance Sensor Wiring Connector

It is possible that a fault code for a monitored circuit may not be entered into memory even though a malfunction has occurred. This may happen because one of the fault code criteria for the circuit has not been met. **For example**, assume that one of the fault code criteria for the MAP sensor circuit is that the engine must be operating between 750 and 2000 RPM. If the MAP sensor output circuit shorts to ground when engine RPM is above 2400 RPM (resulting in a 0 volt input to the engine controller) a fault code will not be entered into memory. This is because the condition does not occur within the specified RPM range.

There are several operating conditions for which the engine controller does not monitor and set fault codes. Refer to Monitored Circuits and Non-Monitored Circuits in this section.

Stored fault codes can be displayed either by cycling the ignition key On - Off - On - Off - On, or through use of the Diagnostic Readout Box II (DRB II). The DRB II connects to the diagnostic connector in the vehicle (Fig. 21 or Fig. 22).

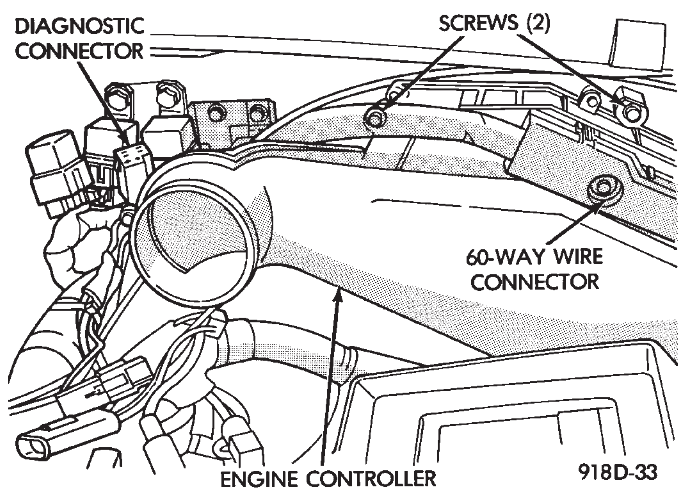

Fig. 21 Diagnostic Connector Location—AA Body

MONITORED CIRCUITS

The engine controller can detect certain fault conditions in the fuel injection system.

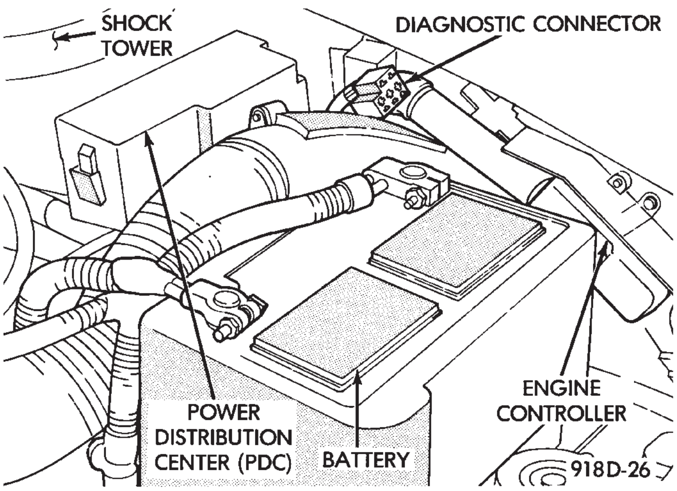

Fig. 22 Diagnostic Connector Location—AG Body

Open or Shorted Circuit - The engine controller can determine if the sensor output (input to controller) is within proper range. Also, the controller can determine if the circuit is open or shorted.

Output Device Current Flow - The engine controller senses whether the output devices are hooked up. If there is a problem with the circuit, the controller senses whether the circuit is open, shorted to ground, or shorted high.

Oxygen Sensor - The engine controller can determine if the oxygen sensor is switching between rich and lean once the system has entered closed loop. Refer to Modes of Operation in this section for an explanation of closed loop operation.

NON-MONITORED CIRCUITS

The engine controller does not monitor the following circuits, systems and conditions that could have malfunctions that result in driveability problems. Fault codes may not be displayed for these conditions. However, problems with these systems may cause fault codes to be displayed for other systems. For example, a fuel pressure problem will not register a fault directly, but could cause a rich or lean condition. This could cause an oxygen sensor fault to be stored in the engine controller.

Fuel Pressure - Fuel pressure is controlled by the fuel pressure regulator. The engine controller cannot detect a clogged fuel pump inlet strainer, clogged in-line fuel filter, or a pinched fuel supply or return line. However, these could result in a rich or lean condition causing an oxygen sensor fault to be stored in the engine controller.

Secondary Ignition Circuit - The engine controller cannot detect an inoperative ignition coil, fouled or worn spark plugs, ignition cross firing, or open spark plug cables.

Engine Timing - The engine controller cannot detect an incorrectly indexed timing chain, camshaft sprocket and crankshaft sprocket. However, these could result in a rich or lean condition causing an oxygen sensor fault.

Cylinder Compression - The engine controller cannot detect uneven, low, or high engine cylinder compression.

Exhaust System - The engine controller cannot detect a plugged, restricted or leaking exhaust system.

Fuel Injector Malfunctions - The engine controller cannot determine if the fuel injector is clogged, the pintle is sticking or the wrong injector is installed. However, these could result in a rich or lean condition causing an oxygen sensor fault to be stored in the engine controller.

Excessive Oil Consumption - Although the engine controller monitors exhaust stream oxygen content when the system is in closed loop, it cannot determine excessive oil consumption.

Throttle Body Air Flow - The engine controller cannot detect a clogged or restricted air cleaner inlet or filter element.

Evaporative System - The engine controller will not detect a restricted, plugged or loaded evaporative purge canister.

Vacuum Assist - Leaks or restrictions in the vacuum circuits of vacuum assisted engine control system devices are not monitored by the engine controller. However, these could result in a MAP sensor fault being stored in the engine controller.

Engine Controller System Ground - The engine controller cannot determine a poor system ground. However, a fault code may be generated as a result of this condition.

Engine Controller Connector Engagement - The engine controller cannot determine spread or damaged connector pins. However, a fault code may be generated as a result of this condition.

HIGH AND LOW LIMITS

The engine controller compares input signal voltages from each input device with established high and low limits that are programmed into it for that device. If the input voltage is not within specifications and other fault code criteria are met, a fault code will be stored in memory. Other fault code criteria might include engine RPM limits or input voltages from other sensors or switches that must be present before a fault condition can be verified.

FAULT CODE DESCRIPTION

When a fault code appears, it indicates the engine controller has recognized an abnormal condition in the system. Fault codes can be obtained from the Check Engine lamp on the Instrument Panel or from the Diagnostic Readout Box II (DRBII). Fault codes indicate the results of a failure but do not identify the failed component directly.

FAULT CODE DESCRIPTION

FAULT CODE	DRB II DISPLAY	DESCRIPTION
11	No reference Signal During Cranking	No distributor reference signal detected during engine cranking.
13+**	Slow change in Idle MAP signal	MAP output change is slower and/or smaller than expected.
	or	
	No change in MAP from start to run	No difference recognized between the engine MAP reading and the barometric (atmospheric) pressure reading at start-up.
14+**	MAP voltage too low	MAP sensor input below minimum acceptable voltage.
	or	
	MAP voltage too High	MAP sensor input above maximum acceptable voltage.
15**	No vehicle speed signal	No vehicle distance (speed) sensor signal detected during road load conditions.
17	Engine is cold too long	Engine coolant temperature remains below normal operating temperatures during vehicle travel (thermostat).
21**	O_2 signal stays at center	Neither rich or lean condition detected from the oxygen sensor input.
	or	
	O_2 signal shorted to voltage	Oxygen sensor input voltage maintained above the normal operating range.
22+**	Coolant sensor voltage too high	Coolant temperature sensor input above the maximum acceptable voltage.
	or	
	Coolant sensor voltage too low	Coolant temperature sensor input below the minimum acceptable voltage.
23	Charge Temperature voltage low	Charge temperature sensor input below the minimum acceptable voltage.
	or	
	Charge Temperature voltage high	Charge temperature sensor input above the maximum acceptable voltage.
24+**	Throttle position sensor voltage high	Throttle position sensor input above the maximum acceptable voltage.
	or	
	Throttle position sensor voltage low	Throttle position sensor input below the minimum acceptable voltage.
25**	Automatic idle speed motor circuits	An open or shorted condition detected in one or more of the AIS control circuits.
27	Injector control circuit (DRB II)	Injector output driver does not respond properly to the control signal (DRB II specifies the injector by cylinder number).
31**	Purge solenoid circuit	An open or shorted condition detected in the purge solenoid circuit.

+ Check Engine Lamp On
** Check Engine Lamp On (California Only)

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FAULT CODE DESCRIPTION (CON'T)

FAULT CODE	DRB II DISPLAY	DESCRIPTION
33	A/C clutch relay circuit	An open or shorted condition detected in the A/C clutch relay circuit.
34	Speed control solenoid circuits	An open or shorted condition detedted in the speed control vacuum or vent solenoid circuits.
35	Radiator fan relay circuits	An open or shorted condition detected in the radiator fan circuit
36+**	Wastegate solenoid circuit	An open or shorted condition detected in the turbocharger wastegate solenoid circuit.
41+**	Alternator field not switching properly	An open or shorted condition detected in the alternator field control circuit.
42	Auto shutdown relay control circuit	An open or shorted condition detected in the auto shutdown relay circuit.
43	Ignition coil #1 primary circuit	Peak primary circuit current not achieved with maximum dwell time.
	or	
	Ignition coil #2 primary circuit	Peak primary circuit current not achieved with maximum dwell time.
45	Turbo boost limit exceeded	MAP sensor reading above overboost limit detected during engine operation.
46+**	Charging system voltage too high	Battery voltage sense input above target charging voltage during engine operation.
47+**	Charging system voltage too low	Battery voltage sense input below target charging during engine operation. Also, no significant change detected in battery voltage during active test of alternator output.
51**	O_2 signal stays below center (lean)	Oxygen sensor signal input indicates lean air/fuel ratio condition during engine operation.
52**	O_2 signal stays above center (rich)	Oxygen sensor signal input indicates rich air/fuel ratio condition during engine operation.
53	Internal controller	Engine controller internal fault condition detected.
54	No sync pick-up signal	No fuel sync signal detected during engine rotation.
61**	Baro read solenoid circuit	An open or shorted condition detected in the baro read solenoid circuit.

\+ Check Engine Lamp On
** Check Engine Lamp On (California Only)

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FAULT CODE DESCRIPTION (CON'T)

FAULT CODE	DRB II DISPLAY	DESCRIPTION
63	Controller Failure EEPROM write denied	Unsuccessful attempt to write to an EEPROM location by the engine controller.
55	N/A	Completion of fault code display on Check Engine lamp.

\+ Check Engine Lamp On
** Check Engine Lamp On (California Only)

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SYSTEM TESTS

Apply parking brake and/or block wheels before performing idle check or adjustment, or any engine running tests.

OBTAINING FAULT CODES

(1) Connect DRBII to the diagnostic connector (Fig. 21 or Fig. 22).

(2) Start the engine if possible, cycle the trans mission selector and the **A/C** switch if applicable. Shut off the engine.

(3) Turn the ignition switch on, access Read Fault Screen. Record all the fault messages shown on the DRBII. Observe the check engine lamp on the instrument panel. The lamp should light for 2 seconds then go out (bulb check).

Fault code erasure: access erase fault code data.

STATE DISPLAY TEST MODE

The switch inputs used by the engine controller have only two recognized states, HIGH and LOW. For this reason, the engine controller cannot recognize the difference between a selected switch position versus an open circuit, a short circuit, or a defective switch. If the display changes, assume the entire switch circuit to the engine controller is functional. From the state display screen access either State Display Inputs and Outputs or State Display Sensors.

STATE DISPLAY INPUTS AND OUTPUTS

Connect the DRB II tester to the vehicle and access the State Display screen. Then access Inputs and Outputs. The following is a list of the engine control system functions accessible through the Inputs and Outputs screen.

Speed Control Resume
Brake Switch
Speed Control On/Off
Speed Control Set
A/C Switch Sense
Z1 Voltage Sense
S/C Vent Solenoid
S/C Vacuum Solenoid
A/C Clutch Relay
Baro Read Solenoid
Wastegate Solenoid
Auto Shutdown Relay
Radiator Fan Relay
Purge Solenoid
Check Engine Lamp

STATE DISPLAY SENSORS

Connect the DRB II tester to the vehicle and access the State Display screen. Then access Sensor Display. The following is a list of the engine control system functions accessible through the Sensor Display screen.

Battery Temp Sensor
Oxygen Sensor Signal
Coolant Temperature
Coolant Temp Sensor
Throttle Position
Minimum Throttle
Knock Sensor Signal
Battery Voltage
MAP Sensor Reading
AIS Motor Position
Adaptive Fuel Factor
Barometric Pressure
Min Airflow Idl Spd
Engine Speed
DIS Sensor Status
Fault #1 Key-On Info
Module Spark Advance
Cyl 1 Knock Retard
Cyl 2 Knock Retard
Cyl 3 Knock Retard
Cyl 4 Knock Retard
Boost Pressure Goal
Charge Temperature
Charge Temp Sensor
Speed Control Target
Fault #2 Key-on Info
Fault #3 Key-on Info
Speed Control Status
Charging System Goal
Theft Alarm Status
Wastegate Duty Cycle
Map Sensor Voltage

Vehicle Speed
Oxygen Sensor State
Baro Read Update
MAP Gauge Reading
Throttle Opening
Total Spark Advance

CIRCUIT ACTUATION TEST MODE

The purpose of the circuit actuation test mode is to check for the proper operation of output circuits or devices which the engine controller cannot internally recognize. The engine controller can attempt to activate these outputs and allow an observer to verify proper operation. Most of the tests available in this mode provide an audible or visual indication of device operation (click of relay contacts, spray fuel, etc.). With the exception of an intermittent condition, if a device functions properly during its test, assume the device, its associated wiring, and its driver circuit are in working order.

OBTAINING CIRCUIT ACTUATION TEST

Connect the DRB II tester to the vehicle and access the Actuators screen. The following is a list of the engine control system functions accessible through Actuators screens.

Stop All Tests
Ignition Coil #1
Ignition Coil #2
Fuel Injector #1
Fuel Injector #2
Fuel Injector #3
AIS Motor Open/Close
Radiator Fan Relay
A/C Clutch Relay
Auto Shutdown Relay
Purge Solenoid
S/C Serv Solenoids
Alternator Field
Tachometer Output
Wastegate Solenoid
Baro Read Solenoid
All Solenoids/Relays
ASD Fuel System Test
Fuel Injector #4

THROTTLE BODY MINIMUM AIR FLOW CHECK PROCEDURE

(1) Warm the engine in neutral until the cooling fan has cycled on and off at least once.
(2) Shut off engine.
(3) Hook-up Tachometer.
(4) Disconnect the PCV valve hose from the nipple on the intake manifold.
(5) Attach air metering fitting, special tool 6457 (0.125 inch orifice), to the intake manifold PCV nipple.
(6) Disconnect 3/16 inch manifold vacuum purge line from the top of the throttle body. Cap the 3/16 inch throttle body nipple.
(7) Connect Diagnostic Readout Box II (DRB II).
(8) Restart engine. Allow engine to idle for at least one minute.
(9) Using the DRB II, access Min. Airflow Idle Spd. The following will then occur:

- AIS motor will fully close.
- Idle spark advance will become fixed.
- Engine RPM will be displayed on Diagnostic Readout Box II (DRB II).

(10) Check idle RPM with tachometer, if idle RPM is within the below specification then the throttle body minimum airflow is set correctly.

IDLE SPECIFICATIONS

Odometer Reading	Idle RPM
Below 1000 Miles	600-1150 RPM
Above 1000 Miles	650-1150 RPM

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If the idle RPM is not within specification, replace the throttle body.
(11) Shut off engine.
(12) Remove air metering fitting 6457 from the intake manifold PCV nipple. Connect the PCV hose to the nipple.
(13) Remove DRB II.
(14) Disconnect tachometer.
(15) Reconnect purge line to throttle body.

IGNITION TIMING PROCEDURE

Ignition timing cannot be changed or set on the Turbo III engine. Refer to Group 8D for a description of the Direct Ignition System (DIS).

60-WAY ENGINE CONTROLLER WIRING CONNECTOR

Refer to the engine controller wiring connector diagram (Fig. 23) for information regarding wire colors and cavity numbers.

CAV	WIRE COLOR	DESCRIPTION
1	DG/RD*	MAP SENSOR
2	TN/BK*	COOLANT SENSOR
3	RD/WT*	DIRECT BATTERY VOLTAGE
4	BK/LB*	SENSOR RETURN
5	BK/WT*	SIGNAL GROUND
6	VT/WT*	5.0 VOLT OUTPUT (MAP AND TPS)
7	OR	9.0 VOLT OUTPUT
8		
9	DB	A21 SUPPLY (IGNITION START/RUN)
10		
11	BK/TN*	POWER GROUND
12	BK/TN*	POWER GROUND
13	LB/BR	INJECTOR DRIVER #4
14	YL/WT*	INJECTOR DRIVER #3
15	TN	INJECTOR DRIVER #2
16	WT/DB*	INJECTOR DRIVER #1
17	DB/TN*	IGNITION COIL DRIVER #2
18		
19	BK/GY*	IGNITION COIL DRIVER #1
20	DG	ALTERNATOR FIELD CONTROL
21	BK/RD*	CHARGE TEMPERATURE SENSOR
22	OR/DB*	THROTTLE POSITION SENSOR (TPS)
23	RD/LG*	SPEED CONTROL SENSE
24	GY/BK*	CRANKSHAFT SENSOR
25	PK	SCI TRANSMIT
26	VT/BR*	CCD BUS (+)
27	BR	A/C SWITCH SENSE
28		
29	WT/PK*	BRAKE SWITCH
30		
31	DB/PK*	RADIATOR FAN RELAY
32	BK/PK*	CHECK ENGINE LAMP
33	TN/RD*	SPEED CONTROL VACUUM SOLENOID
34	DB/OR*	A/C CLUTCH RELAY
35		
36	LG/BK*	WASTEGATE SOLENOID

CAV	WIRE COLOR	DESCRIPTION
37		
38		
39	GY/RD*	AIS STEPPER DRIVER #3
40	BR/WT*	AIS STEPPER DRIVER #1
41	BK/DG*	OXYGEN SENSOR SIGNAL
42	BK/DG*	DETONATION (KNOCK) SENSOR SIGNAL
43	GY/LB*	TACHOMETER SIGNAL OUTPUT
44	TN/YL*	CAMSHAFT SENSOR PICK-UP
45	LG	SCI RECEIVE
46	WT/BK*	CCD BUS (-)
47	WT/OR*	DISTANCE SENSOR SIGNAL
48		
49		
50		
51	DB/YL*	AUTO SHUTDOWN (ASD) RELAY
52	PK/BK*	PURGE SOLENOID
53	LG/RD*	SPEED CONTROL VENT SOLENOID
54		
55	LB	BARO. PRESS. READ SOLENOID
56		
57	DG/OR*	A142 CIRCUIT VOLTAGE SENSE
58		
59	VT/BK*	AIS STEPPER DRIVER #4
60	YL/BK*	AIS STEPPER DRIVER #2

WIRE COLOR CODES					
		LB	LIGHT BLUE	VT	VIOLET
BK	BLACK	LG	LIGHT GREEN	WT	WHITE
BR	BROWN	OR	ORANGE	YL	YELLOW
DB	DARK BLUE	PK	PINK	*	WITH TRACER
DG	DARK GREEN	RD	RED		
GY	GRAY	TN	TAN		

CONNECTOR TERMINAL SIDE SHOWN

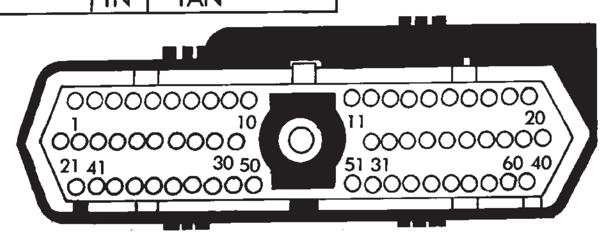

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Fig. 23 60-Way Engine Controller Wiring Connector

2.2L TURBO III MULTI-POINT FUEL INJECTION—SERVICE PROCEDURES

INDEX

THROTTLE BODY

When servicing throttle body components, always reassemble components with new O-rings and seals where applicable. (Fig. 1) Never use lubricants on O-rings or seals, damage may result. If assembly of component is difficult, use water to aid assembly. Use care when removing hoses to prevent damage to hose or hose nipple.

FUEL SYSTEM PRESSURE RELEASE PROCEDURE

CAUTION: The fuel system is under a constant pressure of approximately 380 kPa (55 psi). Before servicing the fuel pump, fuel lines, fuel filter, throttle body, or fuel injectors, the fuel system pressure must be released.

(1) Loosen fuel filler cap to release fuel tank pressure.

(2) Disconnect injector wiring harness connector (Fig. 2).

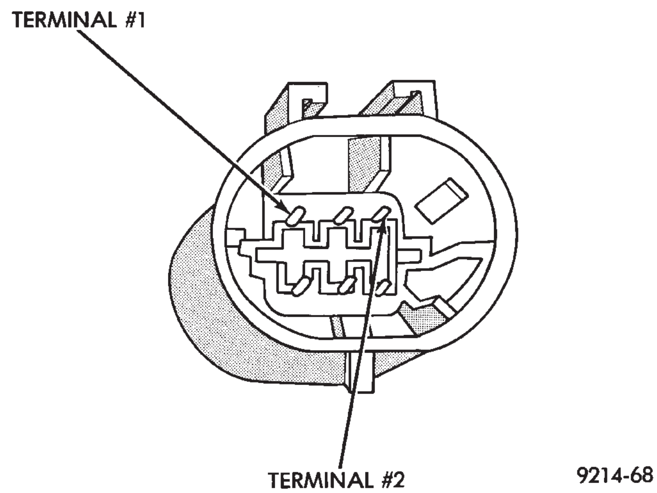

Fig. 2 Injector Harness Connector

(3) Connect a jumper wire between terminal Number 1 of the injector harness and engine ground.

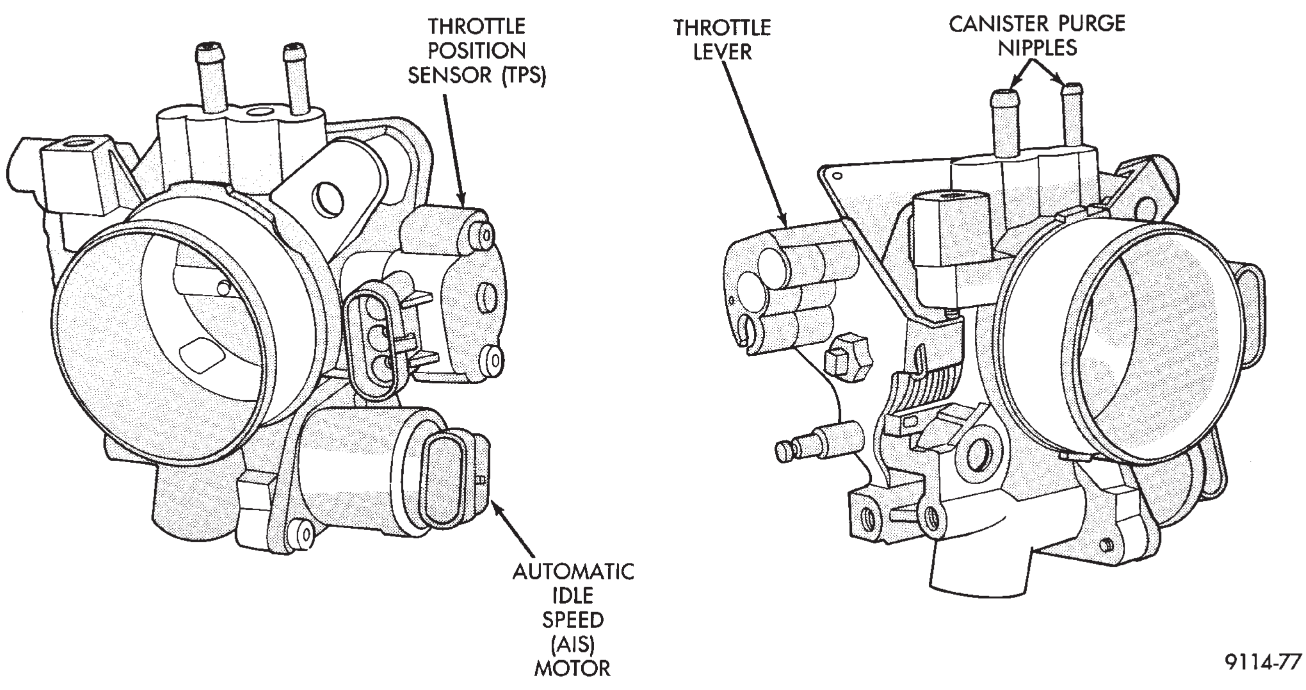

Fig. 1 Throttle Body

(4) Connect a jumper wire to the positive terminal Number 2 of the injector harness and touch the battery positive post **for no longer than 5 seconds.** This releases system pressure.

(5) Remove jumper wires.

(6) Continue fuel system service.

THROTTLE POSITION SENSOR (TPS)

REMOVAL

(1) Disconnect the negative cable from the battery.

(2) Disconnect harness connector from throttle position sensor (Fig. 3).

(3) Remove throttle position sensor mounting screws.

(4) Lift throttle position sensor off throttle shaft.

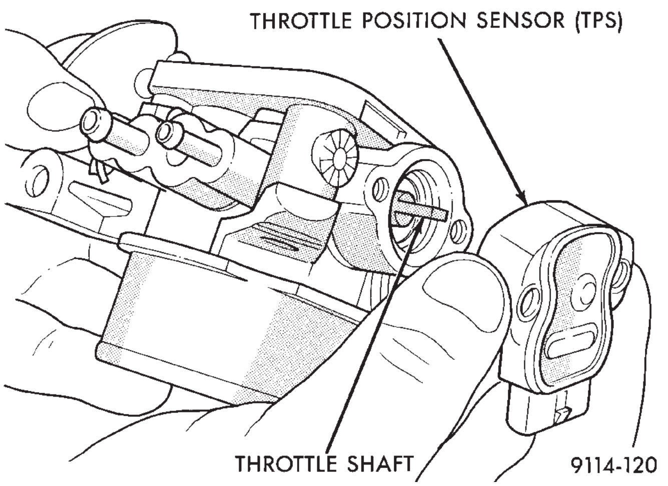

Fig. 3 Throttle Position Sensor

INSTALLATION

(1) Install throttle position sensor on throttle shaft. Install mounting screws. Tighten screws to 2 N·m (17 in lbs.) torque.

(2) Attach harness connector to sensor.

(3) Connect negative cable to negative post of the battery.

AUTOMATIC IDLE SPEED (AIS) MOTOR

REMOVAL

(1) Disconnect negative cable from battery.

(2) Disconnect harness connector from AIS (Fig. 4).

(3) Remove AIS motor mounting screws.

(4) Remove the AIS motor from throttle body (make certain that the O-ring is on the AIS motor).

INSTALLATION

(1) New AIS motors have a new O-ring installed on them. If pintle measures more than 1 inch (25 mm) it must be retracted by using the AIS MOTOR OPEN/CLOSE mode of the DRBII (battery must be reconnected for this operation).

(2) Carefully place AIS motor into throttle body.

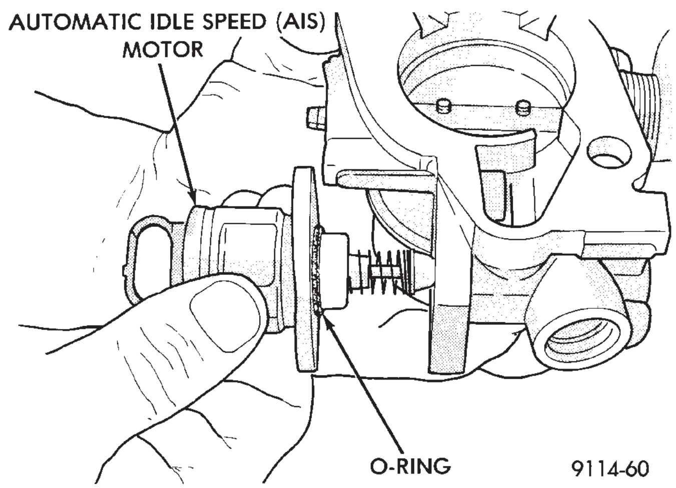

Fig. 4 Servicing Automatic Idle Speed (AIS) Motor

(3) Install mounting screws. Tighten screws to 2 N·m (17 in. lbs.) torque.

(4) Connect harness connector to AIS motor.

(5) Connect negative cable to battery.

THROTTLE BODY REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove clamp from air hose. Remove hose (Fig. 5).

(3) Remove accelerator cable.

(4) Disconnect automatic idle speed (AIS) motor and throttle position sensor (TPS) electrical connectors (Fig. 6).

(5) Disconnect vacuum hoses from throttle body.

(6) Remove throttle body to intake manifold attaching nuts (2).

(7) Remove throttle body and gasket.

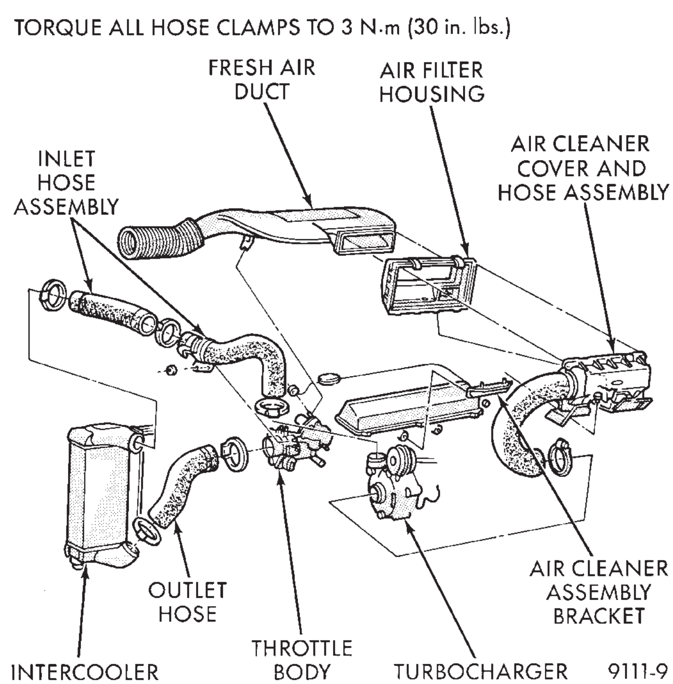

Fig. 5 Air Cleaner Assembly

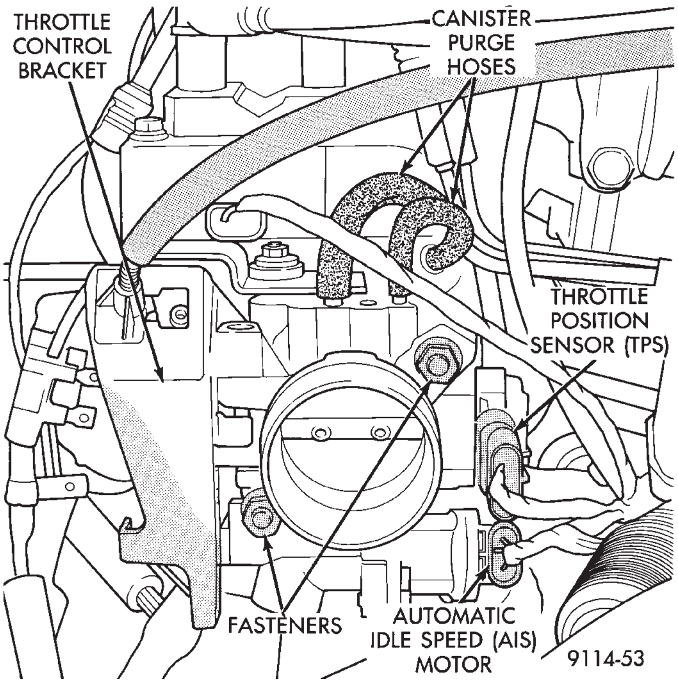

Fig. 6 Throttle Body Assembly

INSTALLATION

(1) Install throttle body with new gasket.

(2) Install throttle body attaching nuts. Tighten nuts to 25 N●m (225 in. lbs.) torque.

(3) Connect vacuum hoses to the throttle body.

(4) Attach harness connectors to the throttle position sensor (TPS) and the automatic idle speed (AIS) motor.

(5) Install throttle and speed control cables (if applicable).

(6) Install throttle body intake air hose. Tighten clamp to 4 N●m (30 in. lbs.) torque.

(7) Connect negative cable to battery.

FUEL INJECTOR RAIL ASSEMBLY

WARNING: THE 2.5L TURBO I FUEL SYSTEM IS UNDER A CONSTANT PRESSURE OF APPROXIMATELY 380 KPA (55 PSI). PERFORM FUEL PRESSURE RELEASE PROCEDURE BEFORE SERVICING THE FUEL RAIL OR FUEL INJECTORS.

REMOVAL

(1) Perform fuel system pressure release procedure.

(2) Disconnect negative battery cable.

CAUTION: Place a shop towel should under the fuel hoses to catch any fuel spillage.

(3) Remove quick connect fittings from the chassis fuel tubes (Fig. 7). Refer to Quick Connect Fittings in the Fuel Delivery Section of this manual.

(4) Disconnect the vacuum hose from the fuel pressure regulator (Fig. 8).

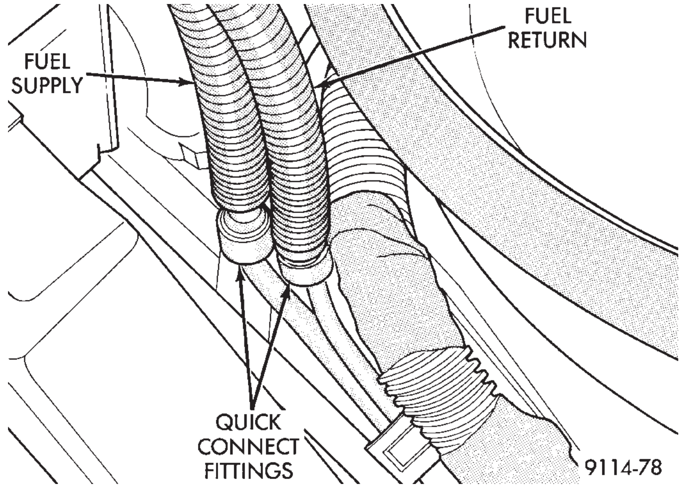

Fig. 7 Quick Connect Fittings

(5) Disconnect the fuel injector wiring harness from the main harness.

(6) Place oil separator bracket out of the way and remove the fuel rail support bracket screws.

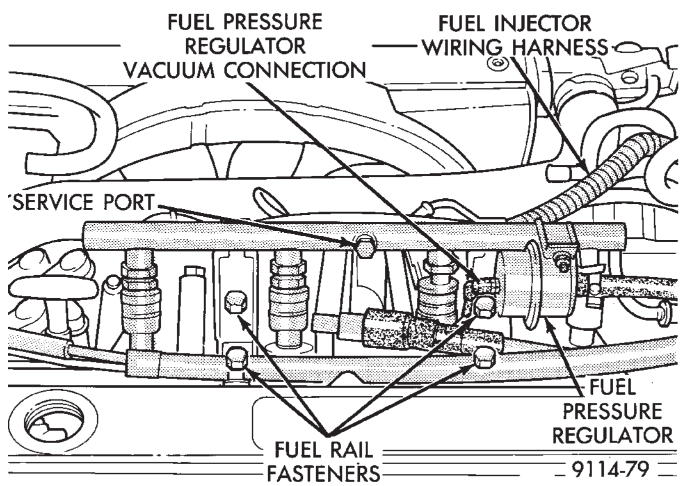

Fig. 8 Fuel Rail Fasteners

(7) Remove the fuel rail and injector assembly by pulling rail so that the injectors come straight out of their ports. Do not damage the rubber injector O-rings after removing the fuel rail.

Do not remove fuel injectors until fuel rail assembly has been completely removed from the vehicle.

(8) Cover or plug the injector ports with while servicing the injectors (Fig. 9).

INSTALLATION

(1) Ensure the injectors are seated into the receiver cup, with the lock ring in place.

(2) Ensure the injector wiring connectors are fully inserted into the fuel injectors.

(3) Make sure the injector holes are clean and all plugs have been removed (Fig. 9).

(4) Lubricate the injector O-rings with a drop of clean engine oil.

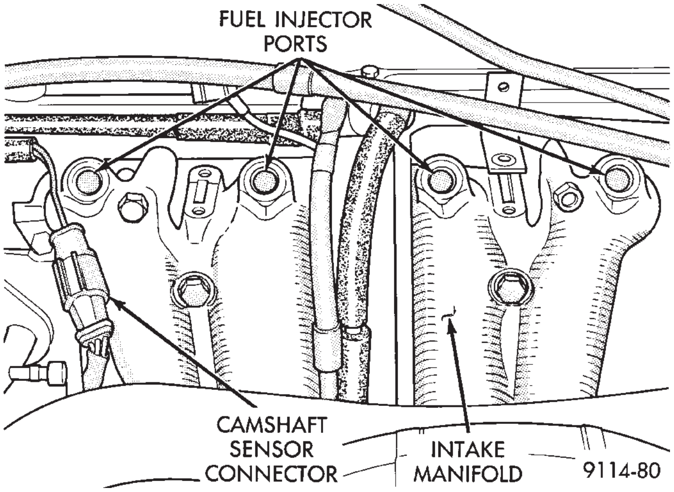

Fig. 9 Fuel Injector Ports

(5) Install the injector assemblies into their holes and install the attaching bolts. Draw the fuel rail assembly evenly into the intake manifold, making sure each injector enters its own hole. The oil separator bracket must be on top of the fuel rail bracket (Fig. 8).

(6) Once all injectors are evenly seated, tighten the fuel rail attaching bolts to 23 N●m (200 in. lbs.) torque.

(7) Connect the fuel injector wiring harness to the main harness.

(8) Lubricate the ends of the chassis tubes with clean 30 weight engine oil.

(9) Connect fuel hose quick connect fittings to the chassis fuel tubes. Pull on the fittings to ensure complete connection.

Refer to Quick Connect Fittings in the Fuel Delivery Section of this group.

(10) Connect the vacuum hose to the fuel pressure regulator.

(11) Connect negative cable to battery.

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(12) With the DRB II use the ASD Fuel System Test to pressurize the fuel system to check for leaks.

FUEL INJECTORS

Remove the fuel rail to service the injectors. Refer to Fuel Injector Rail Assembly in this section.

REMOVAL

(1) Disconnect injector electrical connector from injector. (Fig. 10).

(2) Position fuel rail assembly so that the fuel injectors are easily accessible (Fig. 11).

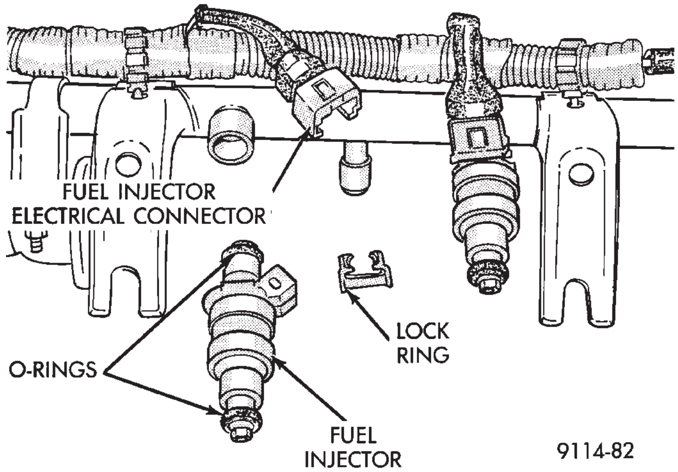

Fig. 10 Fuel Rail and Injector Assembly

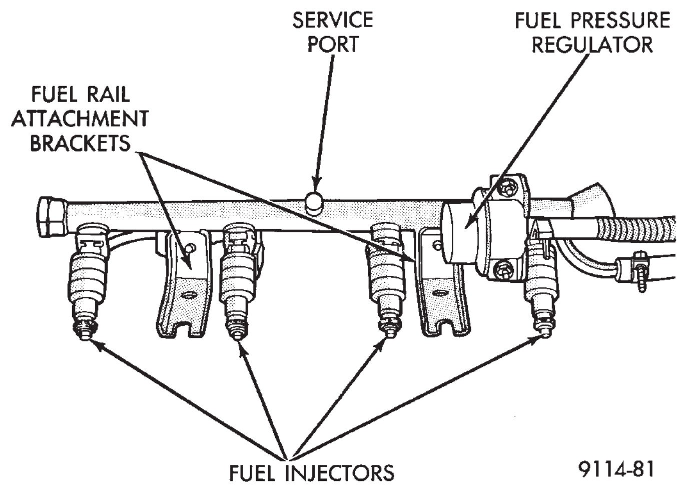

Fig. 11 Servicing Fuel Injectors

(3) Remove injector lock ring off the fuel rail and injector. Pull injector straight out of fuel rail receiver cup (Fig. 11).

(4) Check injector O-ring for damage. If O-ring is damaged, it must be replaced. If injector is reused, a protective cap must be installed on the injector tip to prevent damage.

(5) Repeat for remaining injectors.

INSTALLATION

(1) Before installing an injector, the rubber O-ring must be lubricated with a drop of clean engine oil to aid in installation.

(2) Being careful not to damage the O-ring, install injector top end into fuel rail receiver cup.

(3) Install injector lock ring by sliding open end into slot of the injector and onto the receiver cup ridge into the side slots of ring (Fig. 11).

(4) Repeat steps for remaining injectors.

(5) Install injector wiring harness to injectors. Place harness into retaining clips.

FUEL PRESSURE REGULATOR

WARNING: THE 2.5L TURBO I FUEL SYSTEM IS UNDER A CONSTANT PRESSURE OF APPROXIMATELY 380 KPA (55 PSI). PERFORM FUEL PRESSURE RELEASE PROCEDURE BEFORE SERVICING THE FUEL PRESSURE REGULATOR.

REMOVAL

(1) Perform fuel system pressure release procedure.

(2) Disconnect negative cable from battery.

(3) Disconnect vacuum hose from fuel pressure regulator (Fig. 12).

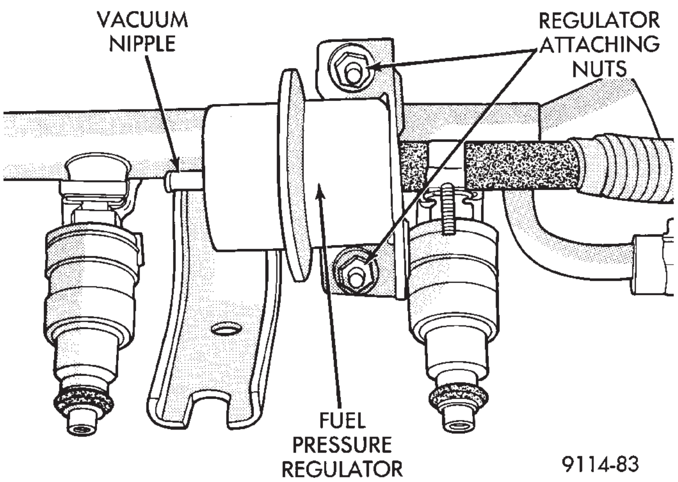

Fig. 12 Servicing Fuel Pressure Regulator

Place a shop towel under fuel pressure regulator to absorb any fuel spillage.

(4) Loosen fuel hose clamp and remove fuel return hose.

(5) Remove fuel pressure regulator mounting nuts. Remove fuel pressure regulator from rail (Fig. 12). Check O-Ring for damage. If O-Ring is damaged it must be replaced.

INSTALLATION

(1) Lubricate O-ring with a drop of clean engine oil. Install O-ring into the receiver cup on fuel rail.

(2) Install fuel pressure regulator mounting nuts. Tighten nuts to 7 N•m (65 in. lbs.) torque.

(3) Connect fuel return hose to pressure regulator. Tighten hose clamp to 1 N•m (10 in. lbs.) torque (Fig. 12).

(4) Install vacuum hose on fuel pressure regulator.

(5) Connect negative cable to battery.

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(6) With the DRB II use the ASD Fuel System Test to pressurize system and check for leaks.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR SERVICE

(1) Remove vacuum hose from MAP sensor (Fig. 13)

(2) Remove MAP sensor mounting screws (Fig. 13).

(3) Remove electrical connector. Remove sensor.

(4) Reverse the above procedure for installation.

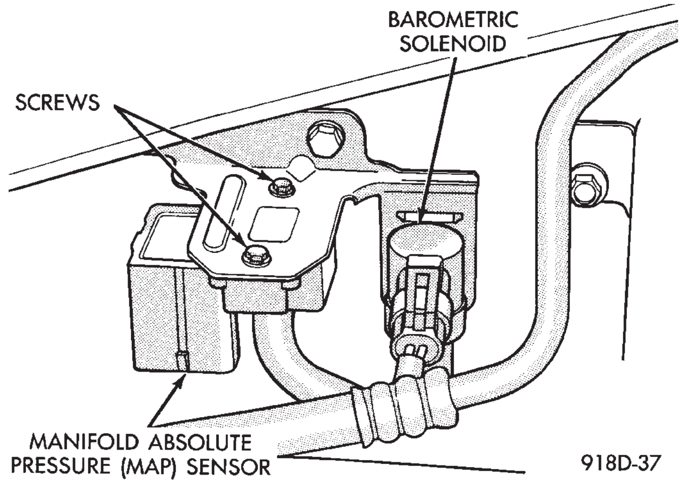

Fig. 13 Manifold Absolute Pressure Sensor

WASTEGATE AND CANISTER PURGE SOLENOID SERVICE

(1) Remove vacuum hoses from sensors (Fig. 14).

(2) Disconnect electrical connector from solenoids (Fig. 14).

(3) Remove solenoid pack mounting nut. Remove solenoid pack.

(4) Depress tab on top of solenoid to be replaced and slide the solenoid downward out of mounting bracket.

(5) Reverse above procedure to install.

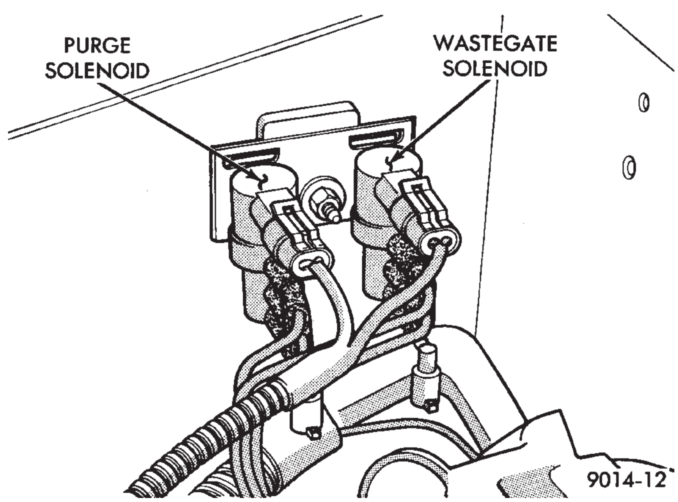

Fig. 14 Solenoid Mounting

ENGINE CONTROLLER SERVICE

(1) Remove air cleaner duct from engine controller.

(2) Remove battery.

(3) Remove engine controller mounting screws (Fig. 15).

(4) Disconnect the 60-way wiring connector. Remove the engine controller.

(5) Reverse the above procedure for installation.

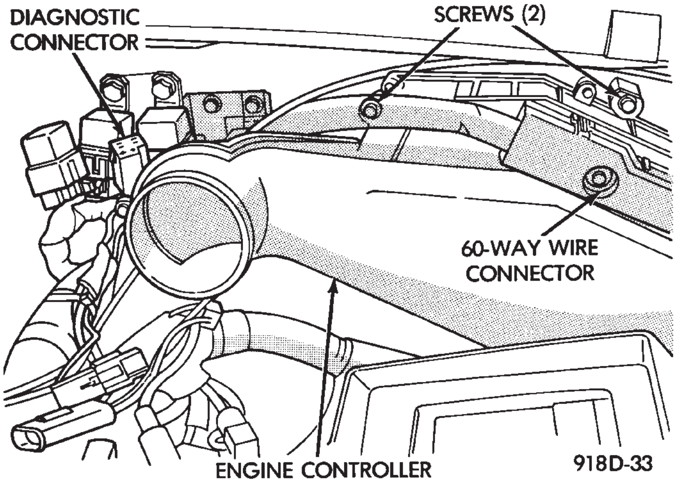

Fig. 15 Engine Controller

HEATED OXYGEN SENSOR (O_2 SENSOR)

The oxygen sensor is installed in the exhaust manifold (Fig. 16).

CAUTION: Do not pull on the oxygen sensor wires when disconnecting the electrical connector.

WARNING: THE EXHAUST MANIFOLD MAY BE EXTREMELY HOT. USE CARE WHEN SERVICING THE OXYGEN SENSOR.

(1) Disconnect oxygen sensor electrical connector.

(2) Remove sensor using Tool C-4907 (Fig. 17).

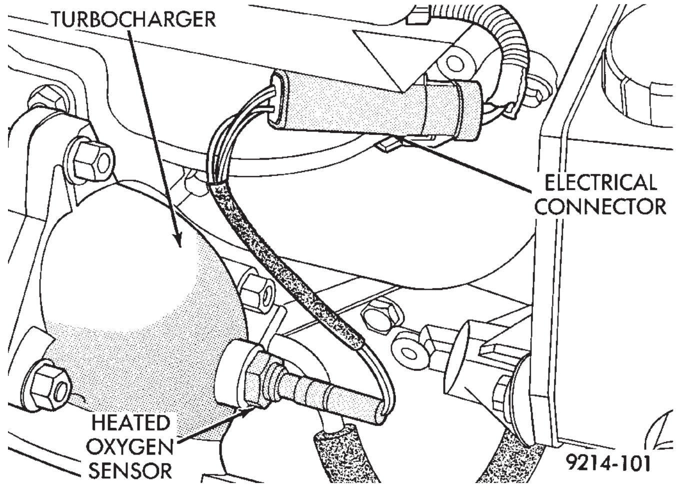

Fig. 16 Oxygen Sensor

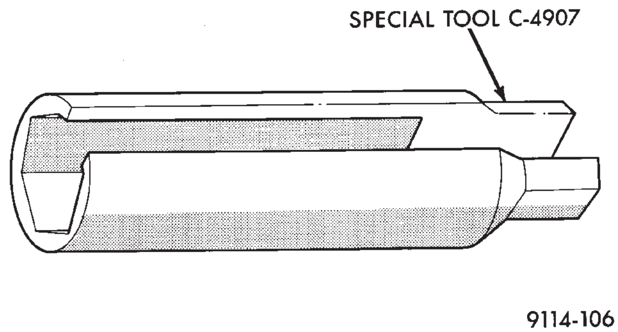

Fig. 17 Oxygen Sensor Socket

When the sensor is removed, the exhaust manifold threads must be cleaned with an 18 mm X 1.5 + 6E tap. If using original sensor, coat the threads with Loctite 771-64 anti-seize compound or equivalent. New sensors are packaged with compound on the threads and do not require additional compound. Tighten the sensor to 27 N●m (20 ft. lbs.) torque.

3.0L MULTI-POINT FUEL INJECTION—SYSTEM OPERATION

INDEX

GENERAL INFORMATION

The 3.0L engine uses a sequential Multi-Point Electronic Fuel Injection system (Fig. 1). The MPI system is computer regulated and provides precise air/fuel ratios for all driving conditions.

The MPI system is operated by the Single Board Engine Controller II (SBEC II), **referred to in this manual as the engine controller.**

The engine controller regulates ignition timing, air-fuel ratio, emission control devices, cooling fan, charging system, idle speed and speed control. Various sensors provide the inputs necessary for the engine controller to correctly operate these systems. In addition to the sensors, various switches also provide inputs to the engine controller.

All inputs to the engine controller are converted into signals. The engine controller can adapt its programming to meet changing operating conditions.

Fuel is injected into the intake port above the intake valve in precise metered amounts through electrically operated injectors. The engine controller fires the injectors in a specific sequence. The controller maintains an air fuel ratio of 14.7 parts air to 1 part fuel by constantly adjusting injector pulse width. Injector pulse width is the length of time the injector is energized.

The engine controller adjusts injector pulse width by opening and closing the ground path to the injector. Engine RPM (speed) and manifold absolute pressure (air density) are the primary inputs that determine injector pulse width.

SYSTEM DIAGNOSIS

The engine controller tests many of its own input and output circuits. If a fault is found in a major system, the information is stored in memory. Technicians can display fault information through the instrument panel Check Engine lamp or by connecting the Diagnostic Readout Box II (DRB II). For fault code information, refer to On Board Diagnostics in 3.0 Multi-Point Fuel Injection—General Diagnosis section of this group.

CCD BUS

Various controllers and modules exchange information through a communications port called the CCD Bus. The engine controller transmits the check engine lamp On/Off signal, engine RPM and vehicle load data on the CCD Bus.

ENGINE CONTROLLER

The engine controller is a digital computer containing a microprocessor (Fig. 2). The controller receives input signals from various switches and sensors that are referred to as Engine Controller Inputs. Based on these inputs, the controller adjusts various engine and vehicle operations through devices referred to as Engine Controller Outputs.

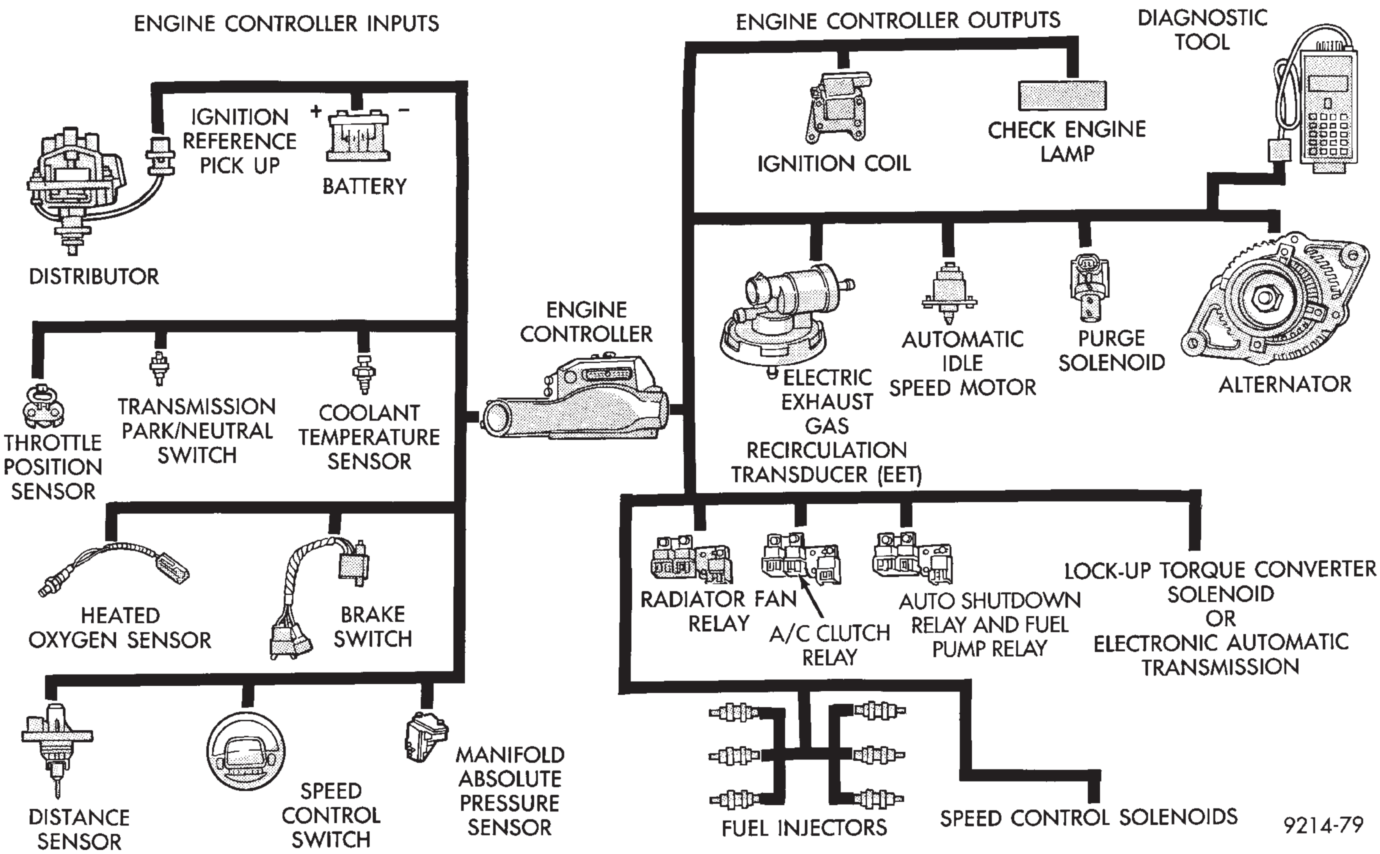

Fig. 1 Multi-Point Fuel Injection Components

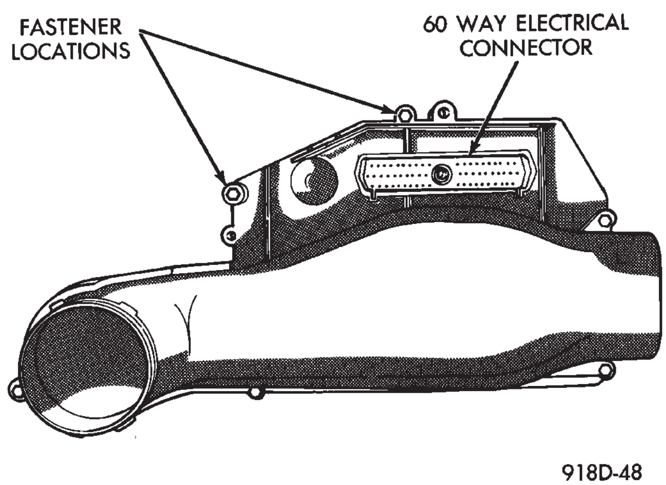

Fig. 2 Engine Controller

Engine Controller Inputs:
- Air Conditioning Controls
- Battery Voltage
- Brake Switch
- Coolant Temperature Sensor
- Distributor Pick-up
- Manifold Absolute Pressure (MAP) Sensor
- Oxygen Sensor
- SCI Receive
- Speed Control System Controls
- Throttle Position Sensor
- Park/Neutral Switch (automatic transmission)
- Vehicle Distance (Speed) Sensor

Engine Controller Outputs:
- Air Conditioning Clutch Relay
- Alternator Field
- Automatic Idle Speed (AIS) Motor
- Auto Shutdown (ASD) and Fuel Pump Relays
- Canister Purge Solenoid
- Check Engine Lamp
- Diagnostic Connector
- Electric EGR Transducer (EET)
- Fuel Injectors
- Ignition Coil
- Part Throttle Unlock (PTU) Solenoid
- Radiator Fan Relay
- Speed Control Solenoids
- Tachometer Output

Based on inputs it receives, the engine controller adjusts fuel injector pulse width, idle speed, ignition spark advance, ignition coil dwell and canister purge operation. The engine controller regulates the cooling fan, air conditioning and speed control systems. The controller changes alternator charge rate by adjusting the alternator field.

The engine controller adjusts injector pulse width (air-fuel ratio) based on the following inputs.
- battery voltage
- coolant temperature

- exhaust gas content
- engine speed (distributor pick-up)
- manifold absolute pressure
- throttle position

The engine controller adjusts ignition timing based on the following inputs.

- coolant temperature
- engine speed (distributor pick-up)
- manifold absolute pressure
- throttle position

The Automatic Shut Down (ASD) and Fuel Pump relays are mounted externally, but turned on and off by the engine controller through the same circuit.

The distributor pick-up signal is sent to the engine controller. If the engine controller does not receive a distributor signal within approximately one second of engine cranking, the ASD relay and fuel pump relay are deactivated. When these relays are deactivated, power is shut off to the fuel injector, ignition coil, oxygen sensor heating element and fuel pump.

The engine controller contains a voltage converter that changes battery voltage to a regulated 9.0 volts. The 9.0 volts power the distributor pick-up and vehicle speed sensor. The controller also provides a 5.0 volts supply for the coolant temperature sensor, manifold absolute pressure sensor and throttle position sensor.

AIR CONDITIONING SWITCH SENSE (AA, AG, AJ BODY)—ENGINE CONTROLLER INPUT

When the air conditioning or defrost switch is in the ON position and the low pressure and high pressure switches are closed, the controller receives an input for air conditioning. After receiving this input, the engine controller activates the A/C compressor clutch by grounding the A/C clutch relay. The engine controller also adjusts idle speed to a scheduled RPM to compensate for increased engine load.

AIR CONDITIONING SWITCH SENSE (AC BODY)—ENGINE CONTROLLER INPUT

When the air conditioning or defrost switch is in the ON position and the low pressure, high pressure and ambient temperature switches are closed, the controller receives an input for air conditioning. After receiving this input, the engine controller activates the A/C compressor clutch by grounding the A/C clutch relay. The engine controller also adjusts idle speed to a scheduled RPM to compensate for increased engine load.

BATTERY VOLTAGE—ENGINE CONTROLLER INPUT

The engine controller monitors the battery voltage input to determine fuel injector pulse width and alternator field control. If battery voltage is low, the engine controller will increase injector pulse width.

BRAKE SWITCH—ENGINE CONTROLLER INPUT

When the brake switch is activated, the engine controller receives an input indicating that the brakes are being applied. After receiving this input the engine controller maintains idle speed to a scheduled RPM through the automatic idle speed motor. The brake switch is mounted on the brake pedal support bracket.

COOLANT TEMPERATURE SENSOR—ENGINE CONTROLLER INPUT

The coolant temperature sensor is a variable resistor with a range of -40° to 265°. The sensor is installed next to the thermostat housing.

The engine controller supplies 5.0 volts to the coolant temperature sensor. The sensor provides an input voltage to the engine controller (Fig. 3). As coolant temperature varies, the sensors resistance changes, resulting in a different input voltage to the engine controller.

The engine controller demands slightly richer air-fuel mixtures and higher idle speeds until the engine reaches normal operating temperature.

This sensor is also used for cooling fan control.

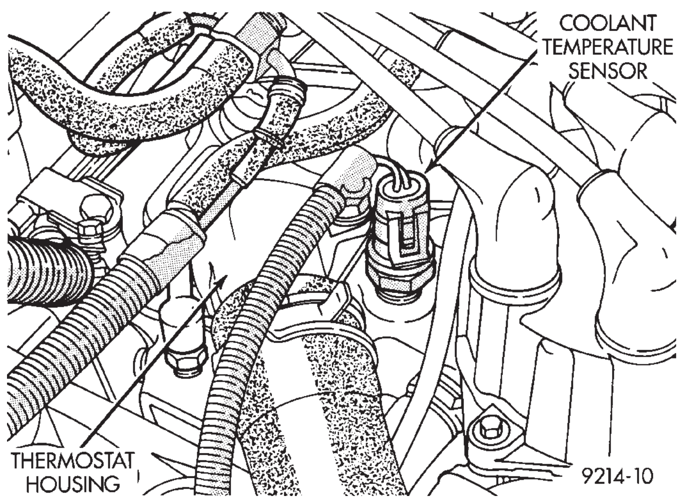

Fig. 3 Coolant Temperature Sensor

DISTRIBUTOR PICK-UP—ENGINE CONTROLLER INPUT

The distributor pick-up provides two inputs to the engine controller. From one input the engine controller determines RPM (engine speed). From the other input it derives crankshaft position. The engine controller regulates injector synchronization and adjusts ignition timing and engine speed based on these inputs.

The distributor pick-up contains two signal generators. The pick-up unit consists of 2 light emitting diodes (LED), 2 photo diodes, and a separate timing disk. The timing disk contains two sets of slots. Each set of slots rotates between a light emitting diode and a photo diode (Fig. 4). The inner set contains 6 large slots, one for each cylinder. The outer set contains several smaller slots.

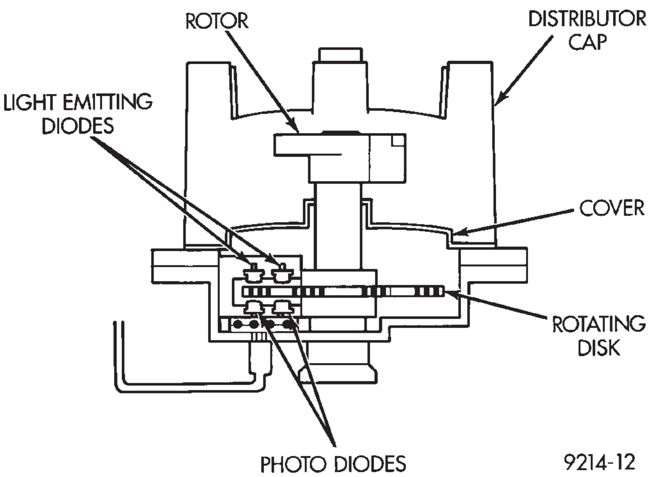

Fig. 4 Distributor Pick-up

The outer set of slots on the rotating disk represents 2 degrees of crankshaft rotation. Up to 1200 engine RPM, the controller uses the input from the outer set of slots to increase ignition timing accuracy.

The outer set of slots contains a 10 degree flat spot (Fig. 5). The flat spot tells the engine controller that the next piston at TDC will be number 6. The position of each piston is referenced by one of the six inner slots (Fig. 5).

As each slot on the timing disk passes between the diodes, the beam from the light emitting diode is interrupted. This creates an alternating voltage in each photo diode which is converted into on-off pulses. The pulses are the input to the engine controller.

During cranking, the controller cannot determine crankshaft position until the 10 degree flat spot on the outer set of slots passes through the optical unit. Once the flat spot is detected, the controller knows piston number 6 will be the next piston at TDC.

Since the disk rotates at half crankshaft speed, it may take 2 engine revolutions during cranking for the controller to determine the position of piston number 6. For this reason the engine controller will energize all six injectors at the same time until it senses the position of piston number 6.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—ENGINE CONTROLLER INPUT

The engine controller supplies 5 volts to the MAP sensor. The Map sensor converts intake manifold pressure into voltage. The engine controller monitors the MAP sensor output voltage. As vacuum increases, MAP sensor voltage decreases proportionately. Also, as vacuum decreases, MAP sensor voltage increases proportionately.

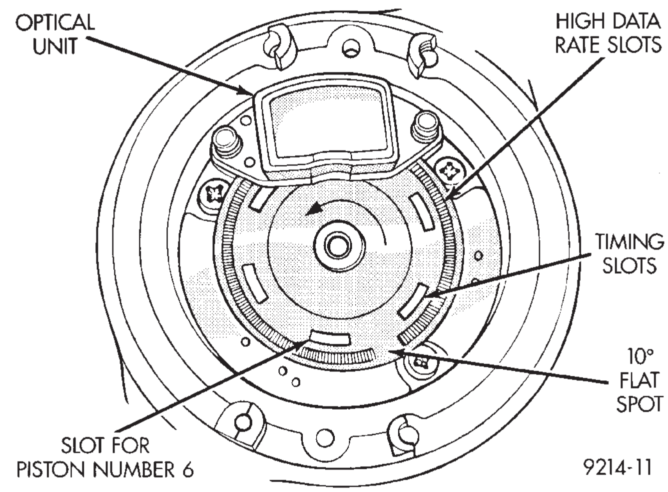

Fig. 5 Inner and Outer Slots of Rotating Disk

During cranking, before the engine starts running, the engine controller determines atmospheric air pressure from the MAP sensor voltage. While the engine operates, the controller determines intake manifold pressure from the MAP sensor voltage.

Based on MAP sensor voltage and inputs from other sensors, the engine controller adjusts spark advance and the air/fuel mixture.

The MAP sensor (Fig. 6) mounts on a bracket attached to the alternator bracket. The sensor is connected to the throttle body with a vacuum hose and to the engine controller electrically.

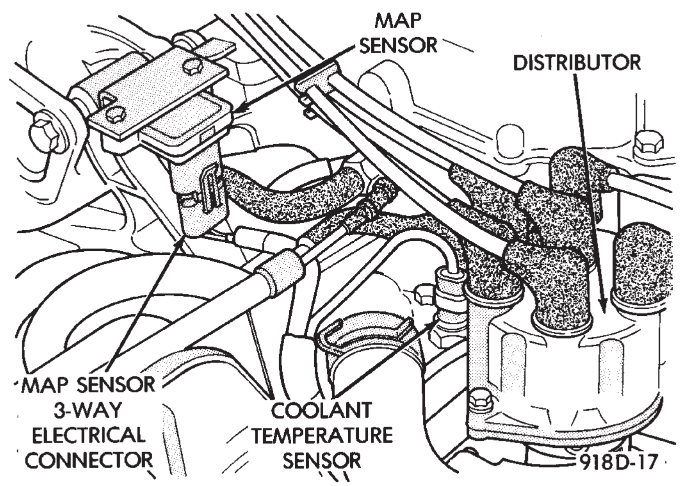

Fig. 6 Map Sensor

OXYGEN SENSOR (O_2 SENSOR)—ENGINE CONTROLLER INPUT

The O_2 sensor is located in the exhaust manifold and provides an input voltage to the engine controller. The input tells the engine controller the oxygen content of the exhaust gas (Fig. 7). The engine controller uses this information to fine tune the air-fuel ratio by adjusting injector pulse width.

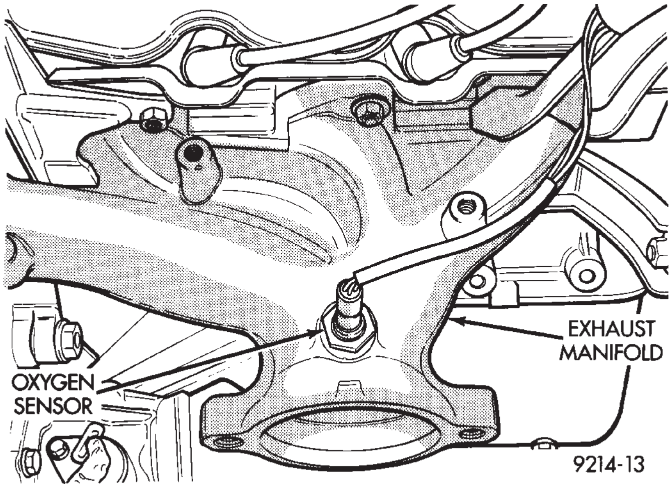

Fig. 7 Oxygen Sensor—3.0L Engine

The O_2 sensor produces voltages from 0 to 1 volt, depending upon the oxygen content of the exhaust gas. When a large amount of oxygen is present (caused by a lean air-fuel mixture), the sensor produces a low voltage. When there is a lesser amount present (rich air-fuel mixture) it produces a higher voltage. By monitoring the oxygen content and converting it to electrical voltage, the sensor acts as a rich-lean switch.

The oxygen sensor is equipped with a heating element that keeps the sensor at proper operating temperature during all operating modes. Maintaining correct sensor temperature at all times allows the system to enter into Closed Loop operation sooner. Also, it allow the system to remain in Closed Loop operation during periods of extended idle.

In Closed Loop operation the engine controller monitors the O_2 sensor input (along with other inputs) and adjusts the injector pulse width accordingly. During Open Loop operation the engine controller ignores the O_2 sensor input. The controller adjusts injector pulse width based on preprogrammed (fixed) values and from inputs of other sensors.

SPEED CONTROL—ENGINE CONTROLLER INPUT

The speed control system provides four separate voltages (inputs) to the engine controller. The voltages correspond to the On/Off, Set, and Resume.

The speed control ON voltage informs the engine controller that the speed control system has been activated. The speed control SET voltage informs the controller that a fixed vehicle speed has been selected. The speed control RESUME voltage indicates the previous fixed speed is requested. The speed control OFF voltage tells the controller that the speed control system has deactivated. Refer to Group 8H for further speed control information.

TRANSMISSION PARK/NEUTRAL SWITCH—ENGINE CONTROLLER INPUT

The park/neutral switch is located on the transmission housing (Fig. 8 or Fig. 9). It provides an input to the engine controller indicating whether the automatic transmission is in Park, Neutral, or a drive gear selection. This input is used to determine idle speed (varying with gear selection), fuel injector pulse width, and ignition timing advance. The park/neutral switch is sometimes referred to as the neutral safety switch.

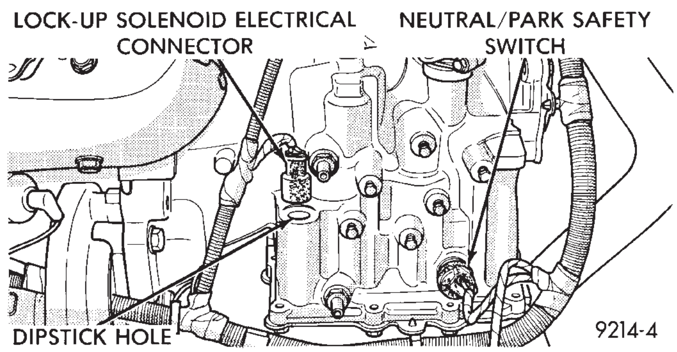

Fig. 8 Park Neutral Switch—3-Speed Automatic Transaxle

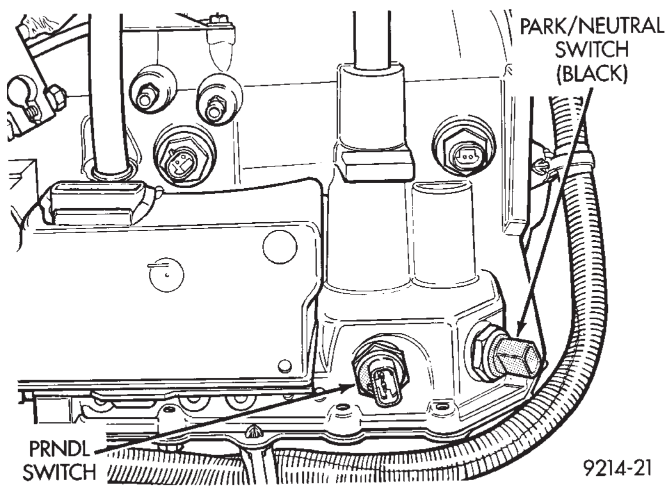

Fig. 9 Park Neutral Switch—4-Speed Electronic Automatic Transaxle

THROTTLE POSITION SENSOR (TPS)—ENGINE CONTROLLER INPUT

The Throttle Position Sensor (TPS) is mounted on the throttle body and connected to the throttle blade shaft (Fig. 10). The TPS is a variable resistor that provides the engine controller with an input signal (voltage) representing throttle blade position. As the position of the throttle blade changes, the resistance of the TPS changes.

The engine controller supplies approximately 5 volts to the TPS. The TPS output voltage (input signal to the engine controller) represents throttle blade position. The TPS output voltage to the controller

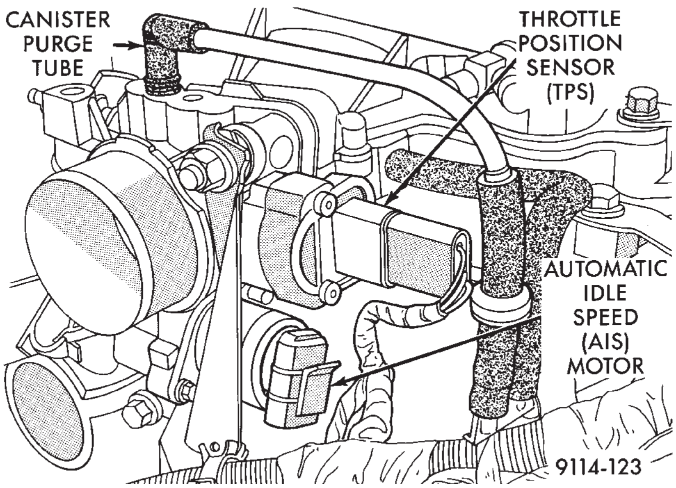

Fig. 10 Throttle Position Sensor

varies from approximately 0.5 volt at minimum throttle opening (idle) to 3.5 volts at wide open throttle. The wide open throttle input is approximately 3 volts more than the minimum throttle opening value.

Along with inputs from other sensors, the engine controller uses the TPS input to determine current engine operating conditions. After determining the current operating conditions, the controller adjust fuel injector pulse width and ignition timing.

VEHICLE DISTANCE (SPEED) SENSOR—ENGINE CONTROLLER INPUT

The distance sensor (Fig. 11) is located in the transmission extension housing. The sensor input is used by the engine controller to determine vehicle speed and distance traveled.

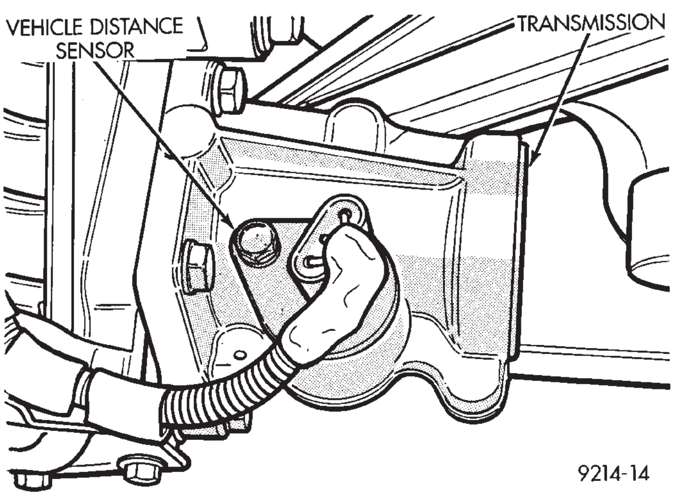

Fig. 11 Vehicle Distance (Speed) Sensor—Typical

The distance sensor generates 8 pulses per sensor revolution. These signals, along with a closed throttle signal from the TPS, determine if a closed throttle deceleration or normal idle condition (vehicle stopped) exists. Under deceleration conditions, the engine controller adjusts the AIS motor to maintain a desired MAP value. Under idle conditions, the engine controller adjusts the AIS motor to maintain a desired engine speed.

AIR CONDITIONING (A/C) CLUTCH RELAY (AC BODY)—ENGINE CONTROLLER OUTPUT

The engine controller operates the air conditioning clutch relay ground circuit. The ignition switch supplies battery power to the solenoid side of the relay. The A/C fan relay is operated independently of the engine controller by the Fan Cutout switch. When the A/C clutch relay energizes, battery voltage powers the A/C compressor clutch.

With the engine operating and the blower motor switch in the On position, the controller turns the A/C clutch on when the A/C switch closes. When the engine controller senses low idle speeds or wide open throttle through the throttle position sensor, it de-energizes the A/C clutch relay. The relay contacts open, preventing air conditioning clutch engagement.

On AC body vehicles, the relay is located in the power distribution center (Fig. 12).

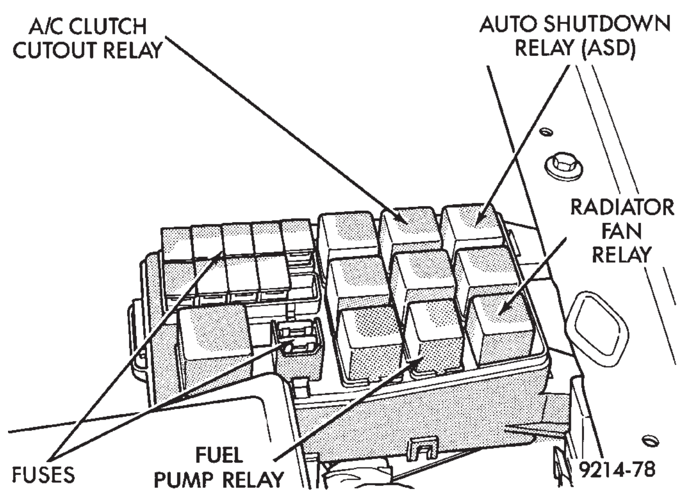

Fig. 12 Relay Identification (AC Body)

AIR CONDITIONING (A/C) CLUTCH RELAY (AA, AG, AJ BODY)—ENGINE CONTROLLER OUTPUT

The engine controller operates the air conditioning clutch relay ground circuit. The ignition switch supplies battery power to the solenoid side of the relay. When the A/C clutch relay energizes, battery voltage powers the A/C compressor clutch.

With the engine operating and the blower motor switch in the On position, the engine controller cycles the air conditioning clutch on and off when the A/C switch closes. When the engine controller senses low idle speeds or wide open throttle through the throttle position sensor, it de-energizes the A/C clutch relay. The relay contacts open, preventing air conditioning clutch engagement.

On AA body vehicles, the relay is located next to the drivers side strut tower (Fig. 13).

On AG and AJ body vehicles, the relay is located in the power distribution center (Fig. 14).

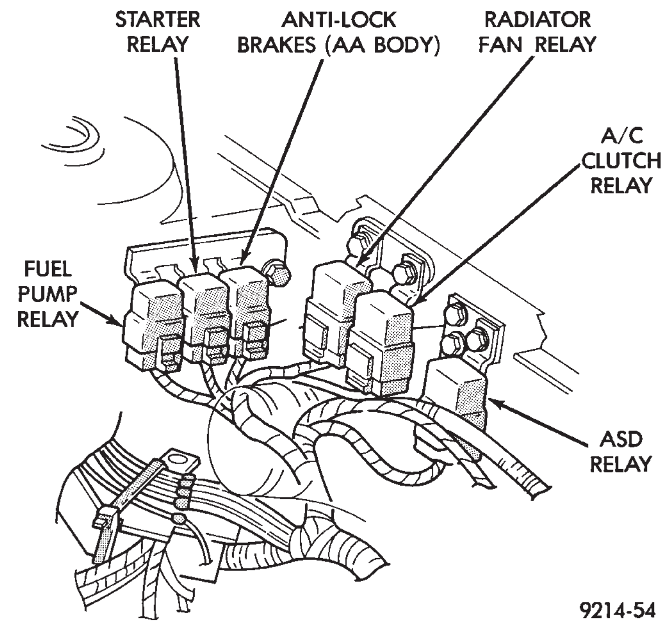

Fig. 13 Relay Identification (AA Body)

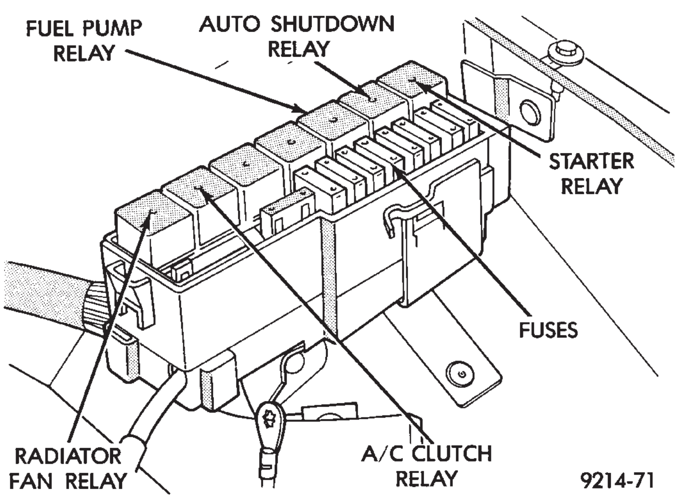

Fig. 14 Relay Identification (AG and AJ Body)

ALTERNATOR FIELD—ENGINE CONTROLLER OUTPUT

The engine controller regulates the charging system voltage within a range of 12.9 to 15.0 volts. Refer to Group 8A for charging system information.

AUTO SHUTDOWN (ASD) RELAY AND FUEL PUMP RELAY—ENGINE CONTROLLER OUTPUT

The engine controller operates the auto shutdown (ASD) relay and fuel pump relay through one ground path. The controller operates the relays by switching the ground path on and off. Both relays turn on and off at the same time.

The ASD relay connects battery voltage to the fuel injector and ignition coil. The fuel pump relay connects battery voltage to the fuel pump and oxygen sensor heating element.

The engine controller turns the ground path off when the ignition switch is in the Off position. Both relays are off. When the ignition switch is in the On or Crank position, the engine controller monitors the distributor pick-up signal to determine engine speed and ignition timing (coil dwell). If the engine controller does not receive a distributor signal when the ignition switch is in the Run position, it will de-energize both relays. When the relays are de-energized, battery voltage is not supplied to the fuel injector, ignition coil, fuel pump and oxygen sensor heating element.

On AA body vehicles, the relays are located next to the drivers side strut tower (Fig. 13).

On AC, AG and AJ body vehicles, the relays are located in the power distribution center (Fig. 12 or Fig. 14).

AUTOMATIC IDLE SPEED (AIS) MOTOR—ENGINE CONTROLLER OUTPUT

The idle speed stepper motor is mounted on the throttle body and is controlled by the engine controller (Fig. 10). The engine controller adjusts engine idle speed through the AIS to compensate for engine load or ambient conditions.

The throttle body has an air bypass passage that provides air for the engine at idle (the throttle blade is closed). The AIS motor pintle protrudes into the air bypass passage and regulates air flow through it.

The engine controller adjusts engine idle speed by moving the AIS motor pintle in and out of the bypass passage. The adjustments are based on inputs the controller receives. The inputs are from the throttle position sensor, engine speed sensor (distributor pick-up coil), coolant temperature sensor, and various switch operations (brake, park/neutral, air conditioning). Deceleration die out is also prevented by increasing airflow when the throttle is closed quickly after a driving (speed) condition.

CANISTER PURGE SOLENOID—ENGINE CONTROLLER OUTPUT

Vacuum for the evaporative canister is controlled by the Canister Purge Solenoid (Fig. 15). The solenoid is controlled by the engine controller.

The engine controller operates the solenoid by switching the ground circuit on and off. The controller turns the ground path on and off based on engine operating conditions. When grounded, the solenoid energizes and prevents vacuum from reaching the evaporative canister. When not energized the solenoid allows vacuum to flow to the canister.

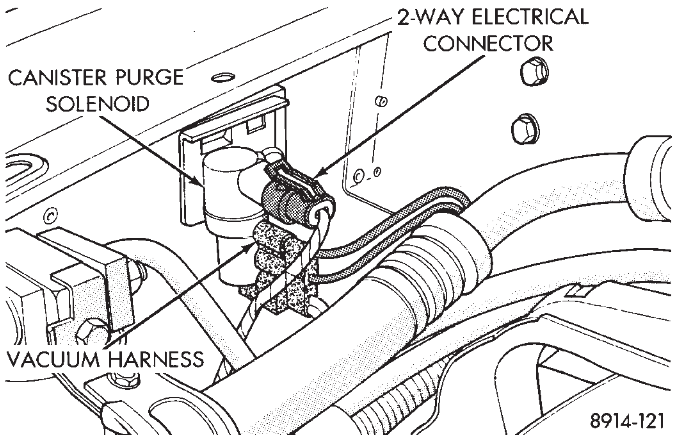

Fig. 15 Canister Purge Solenoid

During warm-up and for a specified time period after hot starts the engine controller grounds the purge solenoid. Vacuum does not operate the evaporative canister valve.

The engine controller removes the ground to the solenoid when the engine reaches a specified temperature and the time delay interval has occurred. When the solenoid is de-energized, vacuum flows to the canister purge valve. Vapors are purged from the canister and flow to the throttle body.

The purge solenoid is energized during certain idle conditions to update the fuel delivery calibration.

CHECK ENGINE LAMP—ENGINE CONTROLLER OUTPUT

The check engine lamp comes on each time the ignition key is turned ON and stays on for 3 seconds as a bulb test. The check engine lamp warns the operator that the engine controller has entered a Limp-in mode. During Limp-in Mode, the controller attempts to keep the system operational. The check engine lamp signals the need for immediate service. In limp-in mode, the Engine controller compensates for the failure of certain components that send incorrect signals. The controller substitutes for the incorrect signals with inputs from other sensors.

Signals that can trigger the Check Engine Lamp.

- Coolant Temperature Sensor
- Manifold Absolute Pressure Sensor
- Throttle Position Sensor
- Battery Voltage Input
- An Emission Related System (California vehicles)
- Charging system

The Check Engine Lamp displays fault codes. Cycle the ignition switch on, off, on, off, on, within five seconds to display any fault codes stored in the controller. Refer to On Board Diagnostics in the General Diagnosis—Multi-Point Fuel Injection, 3.0L Engine section of this Group for Fault Code Descriptions.

DIAGNOSTIC CONNECTOR—ENGINE CONTROLLER OUTPUT

The diagnostic connector provides the technician with the means to connect the DRB II tester to diagnosis the vehicle.

ELECTRONIC AUTOMATIC TRANSAXLE CONTROLLER—ENGINE CONTROLLER OUTPUT

The engine controller supplies the following information to the electronic automatic transmission controller through the CCD Bus:

- battery temperature
- brake switch input
- coolant temperature
- manifold absolute pressure (MAP)
- speed control information

FUEL INJECTORS—ENGINE CONTROLLER OUTPUT

The fuel injectors are electrical solenoids (Fig. 16). The injector contains a pintle that closes off an orifice at the nozzle end. When electric current is supplied to the injector, the armature and pintle move a short distance against a spring, allowing fuel to flow out the orifice. Because the fuel is under high pressure, a fine spray is developed in the shape of a hollow cone. The spraying action atomizes the fuel, adding it to the air entering the combustion chamber.

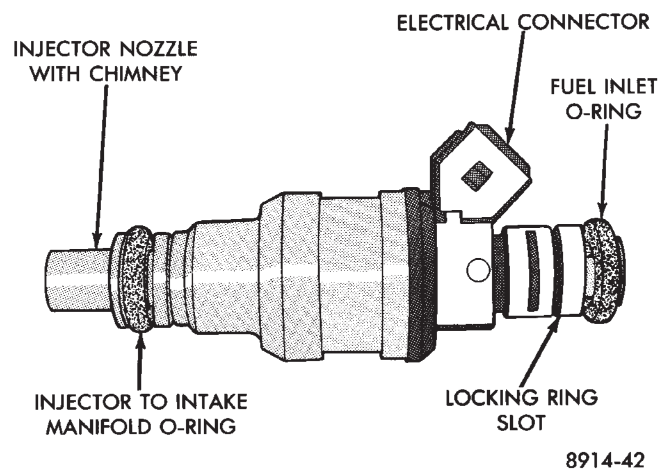

Fig. 16 Fuel Injector—3.0L Engine

The injectors are positioned in the intake manifold with the nozzle ends directly above the intake valve port (Fig. 16).

The fuel injectors are operated by the engine controller. They are energized in a sequential order during all engine operating conditions except start up. The controller initially energizes all injectors at the same time. Once the engine controller determines crankshaft position, it begins energizing the injectors in sequence.

Battery voltage is supplied to the injectors through the ASD relay. The engine controller provides the

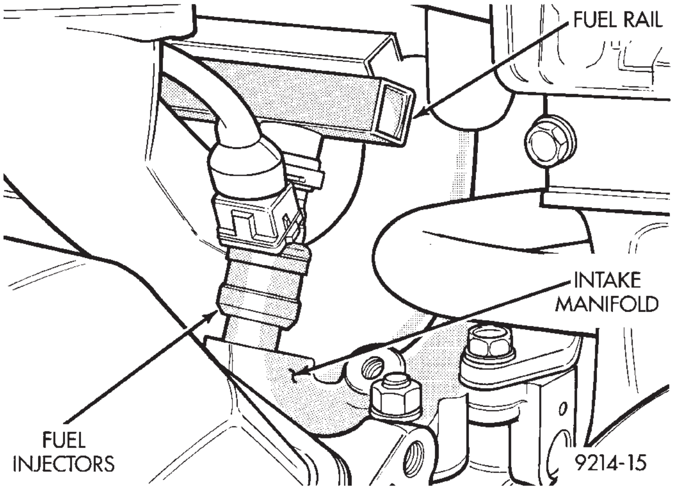

Fig. 17 Fuel Injector Location

ground path for the injectors. By switching the ground path on and off, the controller adjusts injector pulse width. Pulse width is the amount of time the injector is energized. The controller adjusts injector pulse width based on inputs it receives.

IGNITION COIL—ENGINE CONTROLLER OUTPUT

The auto shutdown (ASD) relay provides battery voltage to the ignition coil. The engine controller provides a ground contact (circuit) for energizing coil. When the controller breaks the contact, the energy in the coil primary transfers to the secondary causing the spark. The engine controller will de-energize the ASD relay if it does not receive an input from the distributor pick-up. Refer to Auto Shutdown (ASD) Relay/Fuel Pump Relay—Engine Controller Output in this section for relay operation.

The ignition coil is mounted on a bracket next to the air cleaner (Fig. 18).

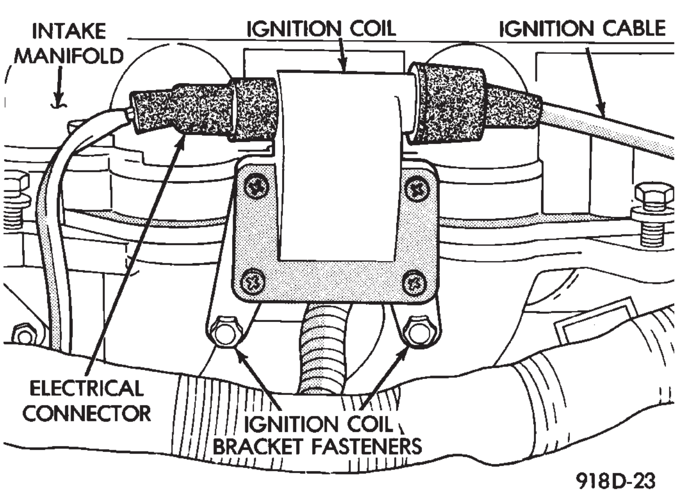

Fig. 18 Ignition Coil

PART THROTTLE UNLOCK SOLENOID—ENGINE CONTROLLER OUTPUT

Three-speed automatic transaxles use a part throttle unlock solenoid. The engine controller controls the lock-up of the torque convertor through the part throttle unlock solenoid. The transmission is locked up only in direct drive mode. Refer to Group 21 for transmission information.

RADIATOR FAN RELAY—ENGINE CONTROLLER OUTPUT

The radiator fan is energized by the engine controller through the radiator fan relay. The radiator fan relay is located on the drivers side fender well near to the engine controller. The controller grounds the relay when engine coolant reaches a predetermined temperature or the air conditioning system turns on.

On AA body vehicles, the relay is located next to the drivers side strut tower (Fig. 13).

On AC, AG and AJ body vehicles, the relay is located in the power distribution center (Fig. 12 or Fig. 14).

SPEED CONTROL SOLENOIDS—ENGINE CONTROLLER OUTPUT

The speed control vacuum and vent solenoids are operated by the engine controller. When the engine controller supplies a ground to the vacuum solenoid, the speed control system opens the throttle plate. When the controller supplies a ground to the vent solenoid, the throttle blade closes. The engine controller balances the two solenoids to maintain the set speed. Refer to Group 8H for speed control information.

TACHOMETER—ENGINE CONTROLLER OUTPUT

The engine controller supplies engine RPM to the instrument panel tachometer through the CCD Bus. The CCD Bus is a communications port. Various modules use the CCD Bus to exchange information. Refer to Group 8E for more information.

MODES OF OPERATION

As input signals to the engine controller change, the engine controller adjusts its response to the output devices. For example, the engine controller must calculate a different injector pulse width and ignition timing for idle than for wide open throttle (WOT). There are several different modes of operation that determine how the engine controller responds to the various input signals.

There are two different areas of operation, OPEN LOOP and CLOSED LOOP.

During OPEN LOOP modes the engine controller receives input signals and responds according to preset engine controller programming. Input from the oxygen (O_2) sensor is not monitored during OPEN LOOP modes.

During CLOSED LOOP modes the engine controller does monitor the oxygen (O_2) sensor input. This input indicates to the controller if the injector pulse width results in an air-fuel ratio of 14.7 parts air to 1 part fuel. By monitoring the exhaust oxygen content through the O_2 sensor, the engine controller can fine tune the injector pulse width. Fine tuning injector pulse width allows the engine controller to achieve optimum fuel economy combined with low emissions.

The 3.0L sequential MPI system has the following modes of operation:

- Ignition switch ON—Zero-RPM
- Engine start-up
- Engine warm-up
- Cruise (Idle)
- Acceleration
- Deceleration
- Wide Open Throttle
- Ignition switch OFF

The engine start-up (crank), engine warm-up, and wide open throttle modes are OPEN LOOP modes. The acceleration, deceleration, and cruise modes, **with the engine at operating temperature** are CLOSED LOOP modes (under most operating conditions).

IGNITION SWITCH ON (ZERO RPM) MODE

When the multi-point fuel injection system is activated by the ignition switch, the following actions occur:

- The engine controller determines atmospheric air pressure from the MAP sensor input to determine basic fuel strategy.
- The engine controller monitors the coolant temperature sensor and throttle position sensor input. The engine controller modifies fuel strategy based on these inputs.

When the key is in the ON position and the engine is not running (zero rpm), the auto shutdown (ASD) relay and fuel pump relay are not energized. Therefore battery voltage is not supplied to the fuel pump, ignition coil, fuel injectors or oxygen sensor heating element.

ENGINE START-UP MODE

This is an OPEN LOOP mode. The following actions occur when the starter motor is engaged.

If the engine controller receives a distributor signal, it energizes the auto shutdown (ASD) relay and fuel pump relay. These relays supply battery voltage to the fuel pump, fuel injectors, ignition coil, and oxygen sensor heating element. If the engine controller does not receive a distributor input, the ASD relay and fuel pump relay will be de-energized after approximately one second.

The engine controller energizes all six injectors until it determines crankshaft position from the distributor pick-up signals. The controller determines crankshaft position within 2 engine revolutions.

After determining crankshaft position, the engine controller begins energizing the injectors in sequence. The controller adjusts injector pulse width and controls injector synchronization by turning the individual ground paths to the injectors On and Off.

When the engine idles within ±64 RPM of its target RPM, the controller compares current MAP sensor value with the atmospheric pressure value received during the Ignition Switch On (zero RPM) mode. If the controller does not detect a minimum difference between the two values, it sets a MAP fault into memory.

Once the ASD and fuel pump relays have been energized, the engine controller:

- determines injector pulse width based on coolant temperature, manifold absolute pressure (MAP) and the number of engine revolutions since cranking was initiated.
- monitors the coolant temperature sensor, distributor pick-up, MAP sensor, and throttle position sensor to determine correct ignition timing.

ENGINE WARM-UP MODE

This is a OPEN LOOP mode. The following inputs are received by the engine controller:

- coolant temperature
- crankshaft position (distributor pick-up)
- manifold absolute pressure (MAP)
- engine speed (distributor pick-up)
- throttle position
- A/C switch
- battery voltage

The controller adjusts injector pulse width and controls injector synchronization by turning the individual ground paths to the injectors On and Off.

The engine controller adjusts engine idle speed by regulating the automatic idle speed motor and ignition timing.

CRUISE OR IDLE MODE

When the engine is at operating temperature this is a CLOSED LOOP mode. During cruising speed the following inputs are received by the engine controller:

- coolant temperature
- crankshaft position (distributor pick-up)
- manifold absolute pressure
- engine speed (distributor pick-up)
- throttle position
- exhaust gas oxygen content
- A/C control positions
- battery voltage

The controller adjusts injector pulse width and controls injector synchronization by turning the individual ground paths to the injectors On and Off.

The engine controller adjusts engine idle speed and ignition timing. The engine controller controls the air/fuel ratio according to the oxygen content in the exhaust gas.

ACCELERATION MODE

This is a CLOSED LOOP mode. The engine controller recognizes an abrupt increase in throttle position or MAP pressure as a demand for increased engine output and vehicle acceleration. The engine controller increases injector pulse width in response to increased fuel demand.

DECELERATION MODE

This is a CLOSED LOOP mode. During deceleration the following inputs are received by the engine controller:

- coolant temperature
- crankshaft position (distributor pick-up)
- manifold absolute pressure
- engine speed (distributor pick-up)
- throttle position
- exhaust gas oxygen content
- A/C control positions
- battery voltage

The engine controller may receive a closed throttle input from the throttle position sensor (TPS) when it senses an abrupt decrease in manifold pressure. This indicates a hard deceleration. The engine controller may reduce injector firing to once per engine revolution. This helps maintain better control of the air-fuel mixture.

During a deceleration condition, the engine controller grounds the exhaust gas recirculation (EGR) solenoid. When the controller grounds the solenoid, preventing EGR.

WIDE OPEN THROTTLE MODE

This is an OPEN LOOP mode. During wide-open-throttle operation, the following inputs are received by the engine controller:

- coolant temperature
- crankshaft position (distributor pick-up)
- manifold absolute pressure
- engine speed (distributor pick-up)
- throttle position

When the engine controller senses wide open throttle condition through the throttle position sensor (TPS) it will:

- Provide a ground for the electrical EGR transducer (EET) solenoid. When the controller grounds the solenoid, the EGR system stops operating.
- De-energize the air conditioning relay. This disables the air conditioning system.

The exhaust gas oxygen content input is not accepted by the engine controller during wide open throttle operation. The engine controller will adjust injector pulse width to supply a predetermined amount of additional fuel.

IGNITION SWITCH OFF MODE

When the ignition switch is turned to the OFF position, the following occurs:

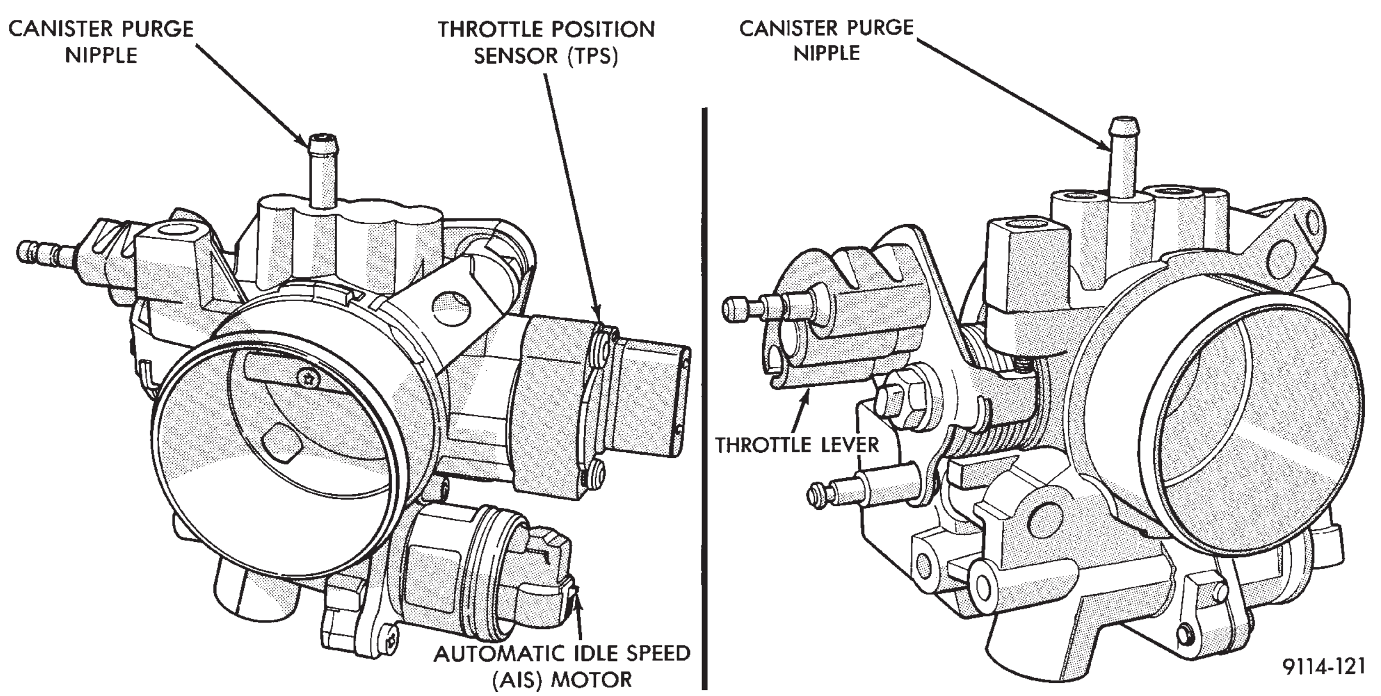

Fig. 19 Throttle Body

- All outputs are turned off.
- No inputs are monitored.
- The engine controller shuts down.

THROTTLE BODY

The throttle body assembly (Fig. 19) is located at the left end of the air intake plenum. The throttle body houses the throttle position sensor and the automatic idle speed motor. Air flow through the throttle body is controlled by a cable operated throttle blade located in the base of the throttle body.

FUEL SUPPLY CIRCUIT

Fuel is supplied to the fuel rail by an electric pump mounted in the fuel tank. The pump inlet is fitted with a strainer to prevent water and other contaminants from entering the fuel supply circuit.

Fuel pressure is controlled to a preset level above intake manifold pressure by a pressure regulator. The pressure regulator is mounted on the fuel rail. The regulator uses intake manifold pressure as a reference.

FUEL PRESSURE REGULATOR

The pressure regulator is a mechanical device located on the fuel rail, downstream of the fuel injectors (Fig. 20). The regulator maintains a constant 328 kPa (47.6 psi) across the fuel injector tip.

The regulator contains a spring loaded rubber diaphragm that covers the fuel return port. When the fuel pump is operating, fuel flows past the injectors into the regulator. Fuel is restricted from flowing any further by the blocked return port. When fuel pressure reaches 328 kPa (47.6 psi) it pushes on the diaphragm, compresses the spring, and uncovers the fuel return port. The diaphragm and spring constantly move from an open to closed position to keep the fuel pressure constant.

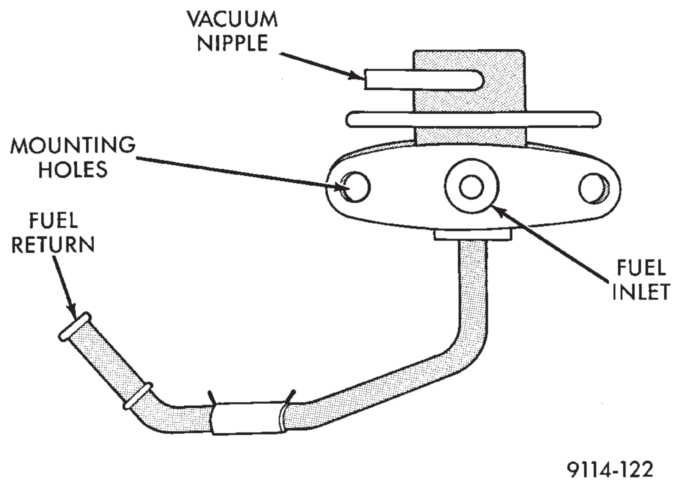

Fig. 20 Fuel Pressure Regulator

3.0L MULTI-POINT FUEL INJECTION—GENERAL DIAGNOSIS

INDEX

FUEL SYSTEM DIAGRAM

The 3.0L MPI system is managed by the engine controller. The controller receives inputs from various switches and sensors (Fig. 1). Based on these inputs, the engine controller adjusts ignition timing and idle speed through various output devices. Refer to the Multi-Point Fuel Injection—3.0L Engine section of this group for system and component descriptions.

VISUAL INSPECTION

Perform a visual inspection for loose, disconnected, or misrouted wires and hoses before diagnosing or servicing the fuel injection system. A visual check saves unnecessary test and diagnostic time. A thorough visual inspection includes the following checks:

(1) Check for correct spark plug cable routing. Ensure the cables are completely connected to the spark plugs and distributor.

(2) Check ignition coil electrical connections (Fig. 2).

(3) Verify the electrical connector is attached to the Purge Solenoid (Fig. 3).

(4) Verify vacuum connection at Purge Solenoid is secure and not leaking (Fig. 3).

(5) Verify the electrical connector is attached to the MAP sensor (Fig. 4).

(6) Check MAP sensor hose at MAP Sensor Assembly (Fig. 4), and at Vacuum Connection at Intake Plenum Fitting.

(7) Check alternator wiring connections. Ensure the accessory drive belt has proper tension.

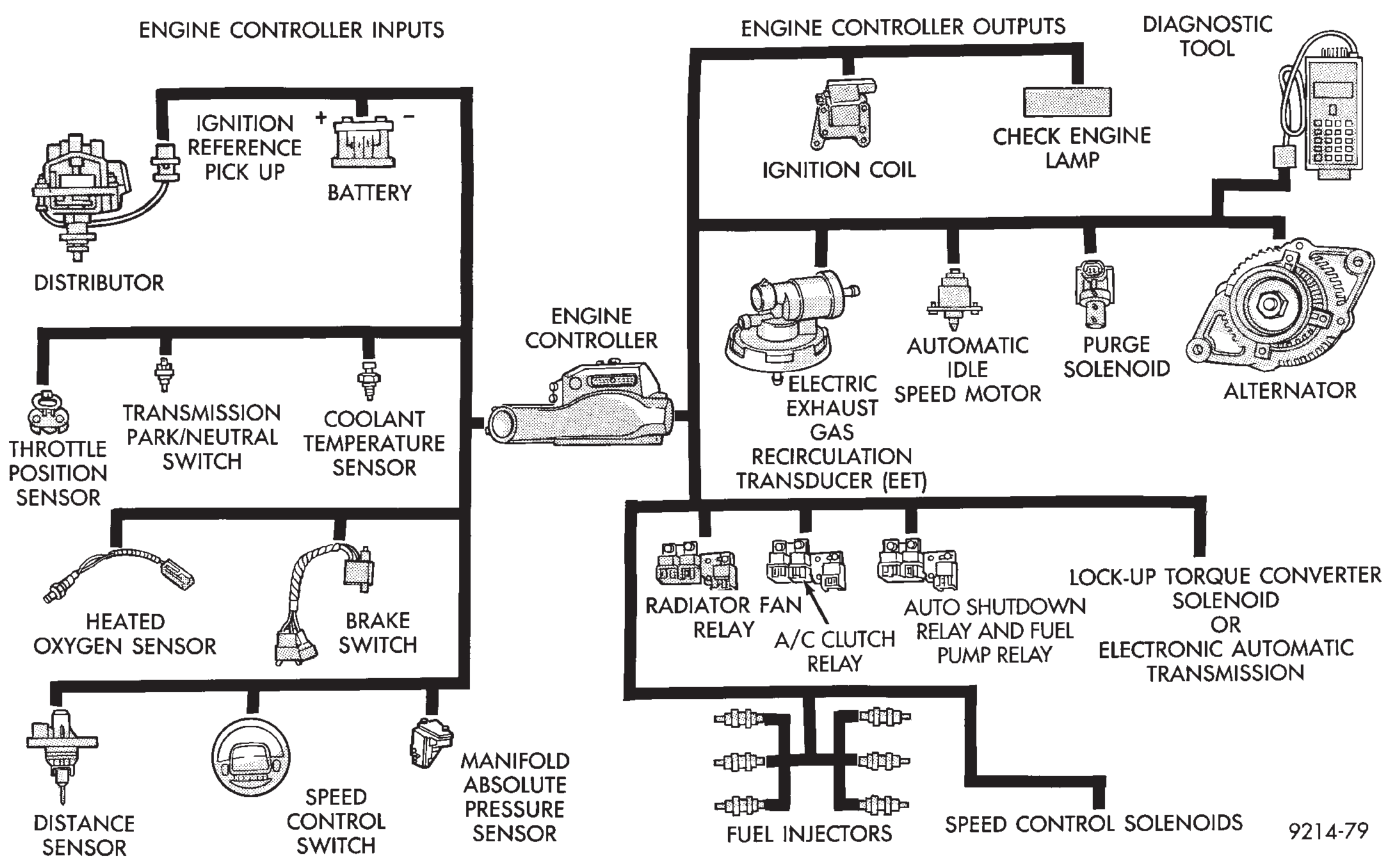

Fig. 1 Multi-Point Fuel Injection Components

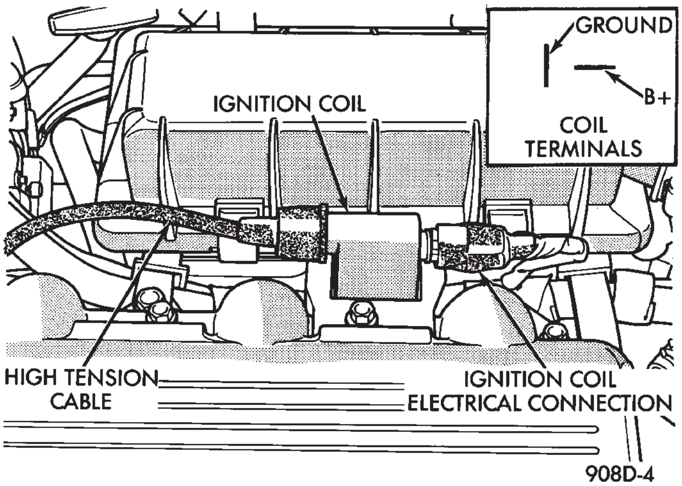

Fig. 2 Ignition Coil Electrical Connection

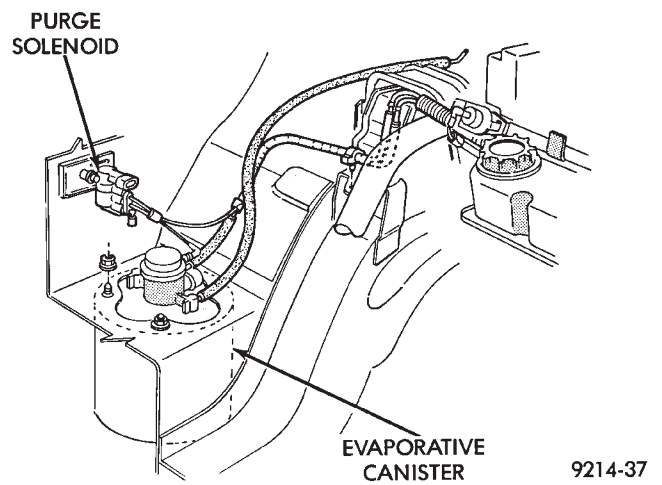

Fig. 3 Electrical Connector Canister Purge Solenoid

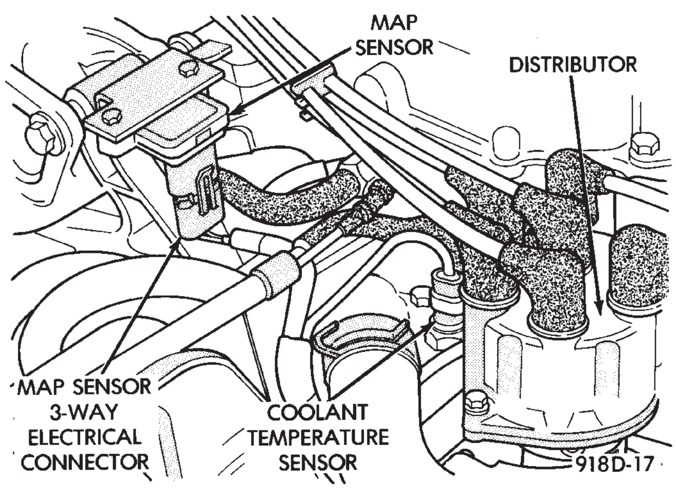

Fig. 4 Map Sensor Electrical and Vacuum Connections

(8) Verify hoses are securely attached to the vapor canister (Fig. 5).

(9) Verify the engine ground strap is attached at the engine and dash panel (Fig. 6).

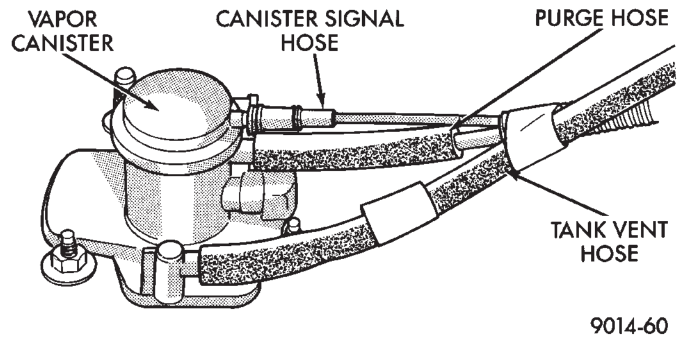

Fig. 5 Vapor Canister

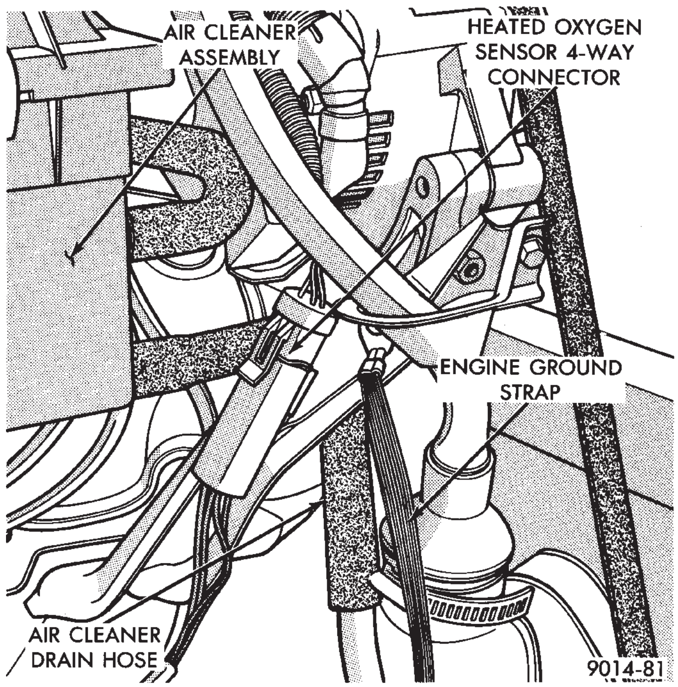

Fig. 6 Oxygen Sensor Connector

(10) Ensure the heated oxygen sensor connector is connected to the harness connector (Fig. 6).

(11) Verify the distributor connector is connected to the harness connector (Fig. 7).

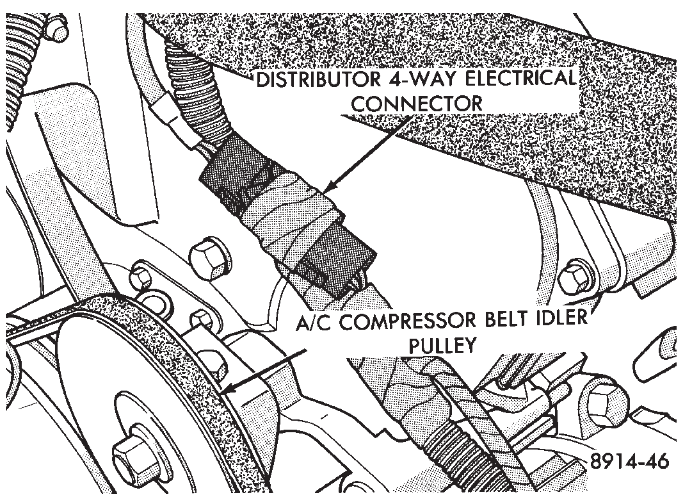

Fig. 7 Distributor Connector

(12) Verify the coolant temperature sensor connector is connected to the harness connector (Fig. 8).

(13) Check vacuum hose connection at fuel pressure regulator and intake plenum connector (Fig. 8).

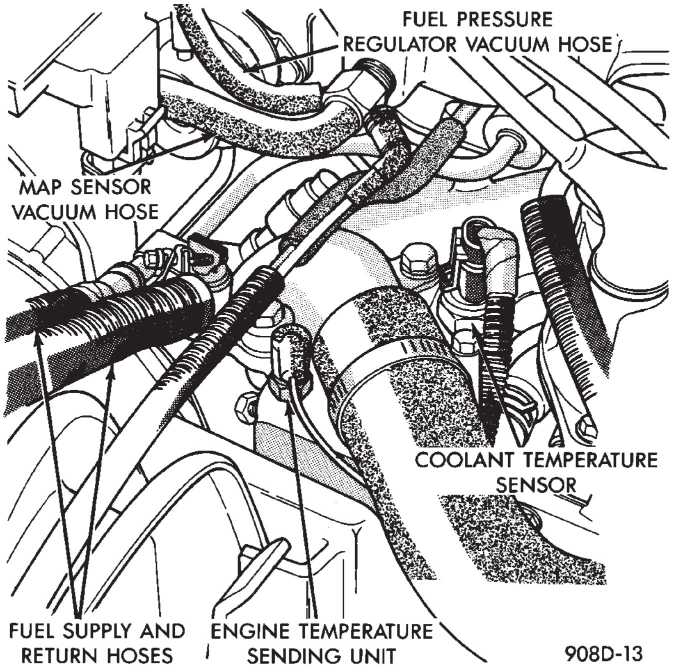

Fig. 8 Coolant Temperature Sensor and Vacuum Connections

(14) Ensure the harness connector is securely attached to each fuel injector.

(15) Check the oil pressure sending unit electrical connection (Fig. 9).

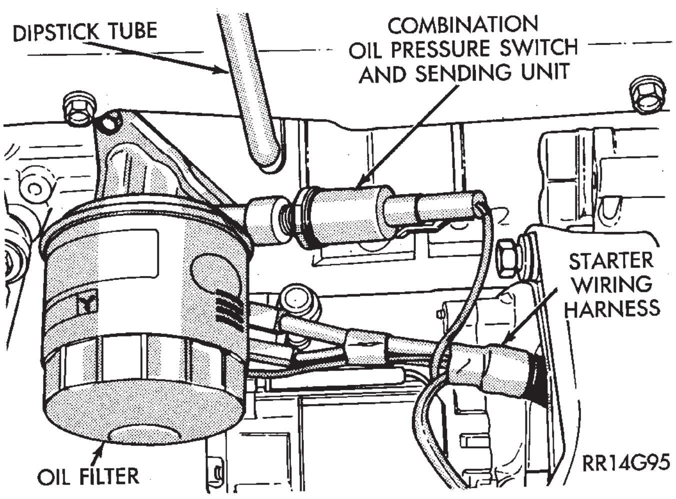

Fig. 9 Oil Pressure Sending Unit Electrical Connection

(16) Check hose connections at throttle body (Fig. 10).

(17) Check throttle body electrical connections (Fig. 10).

(18) Check PCV hose connections (Fig. 11).

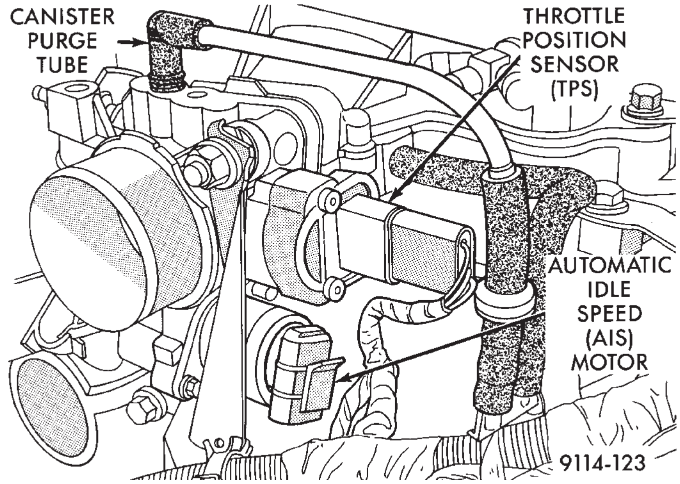

Fig. 10 Throttle Body Electrical and Vacuum Hose Connections

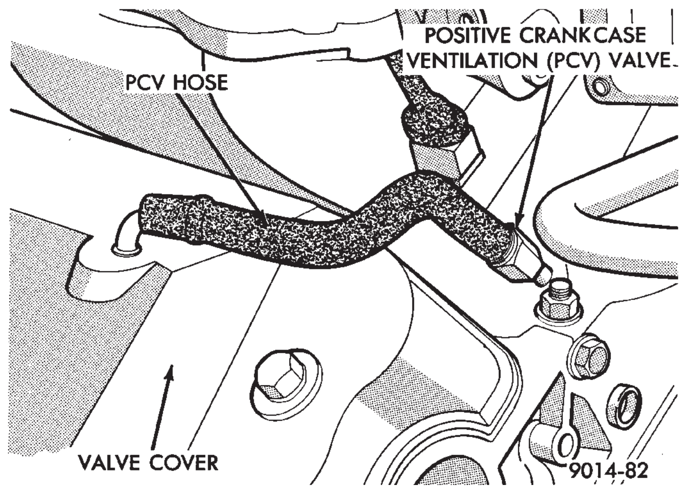

Fig. 11 Positive Crankcase Ventilation (PCV) System

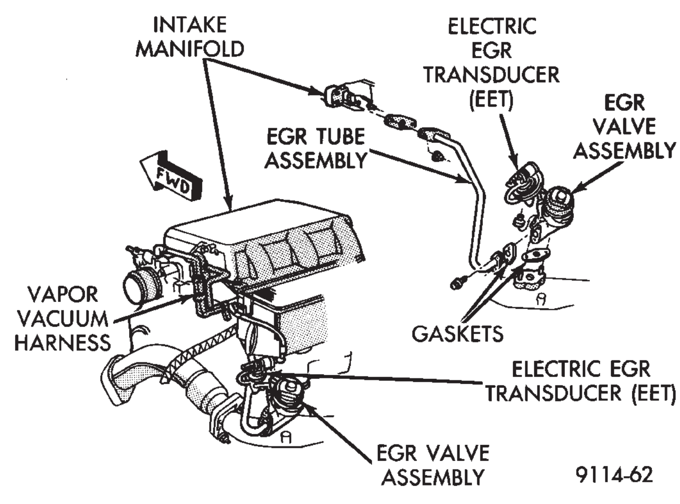

Fig. 12 EGR System Vacuum Hose Connections

(19) If equipped, check EGR system vacuum hose connections (Fig. 12).

(20) If equipped, check EGR tube to intake plenum connections (Fig. 12).

(21) Inspect the electronic EGR transducer solenoid electrical connector.

(22) Ensure the vacuum connections at the electronic EGR transducer is secure and not leaking.

(23) Check Power Brake Booster and Speed Connections (Figs. 13 and 14).

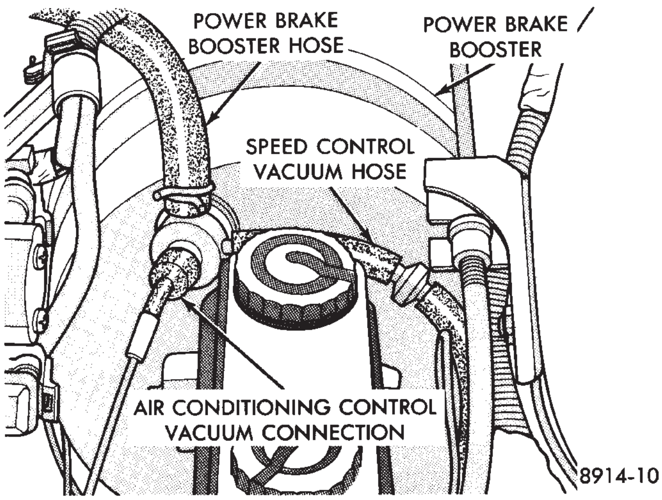

Fig. 13 Power Brake Booster and Speed Control Vacuum Hose Connections (Without Anti-lock Brakes)

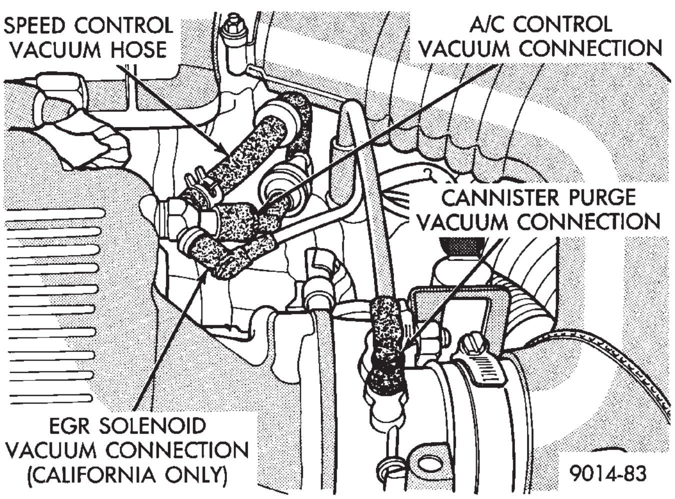

Fig. 14 Speed Control Vacuum Hose Connection (With Anti-lock Brakes)

(24) Inspect engine harness to main harness connections.

(25) Check all automatic transmission electrical connections (Fig. 15).

(26) Check the distance sensor electrical connection (Fig. 16).

(27) Inspect the engine controller 60-way electrical connector for damage or spread terminals. Verify the 60-way connector is fully inserted into the socket of the engine controller. Ensure wires are not stretched or pulled out of the connector (Figs. 17, 18, and 19).

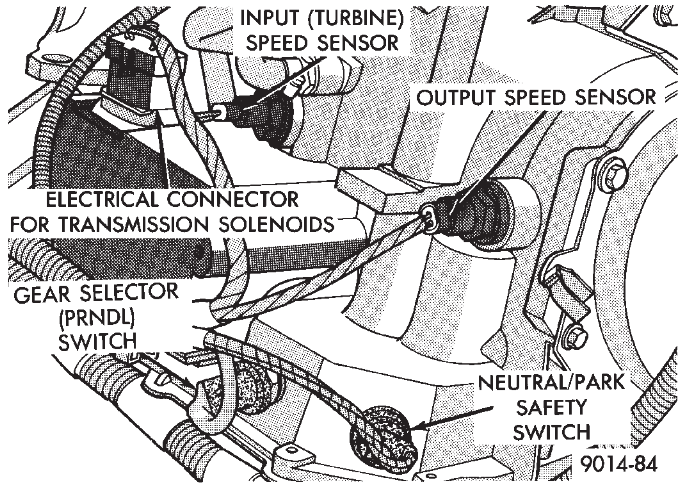

Fig. 15 Automatic Transmission Electrical Connections

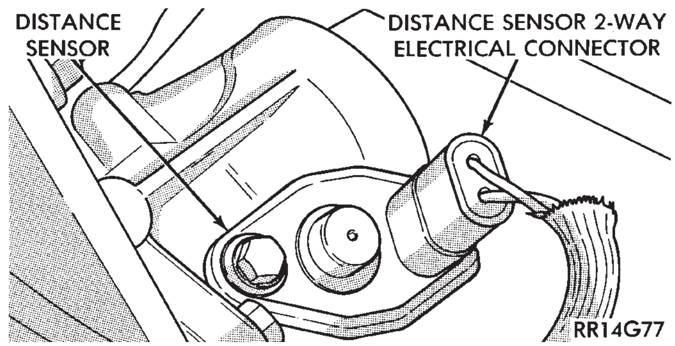

Fig. 16 Distance Sensor Electrical Connector

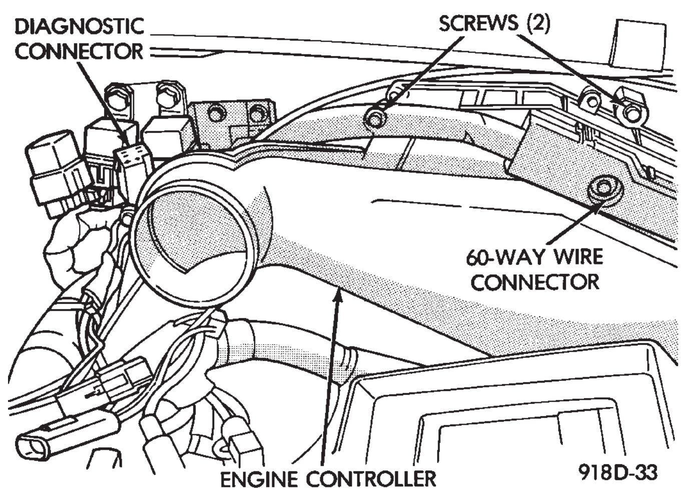

Fig. 17 Engine Controller—AA Body

(28) Check the air conditioning, starter, ASD, fuel pump and radiator fan relay connections (Figs. 20, 21, and 22).

(29) Check battery cable connections.

(30) Check hose and electrical connections at fuel pump. Ensure connector is making contact with terminals on pump.

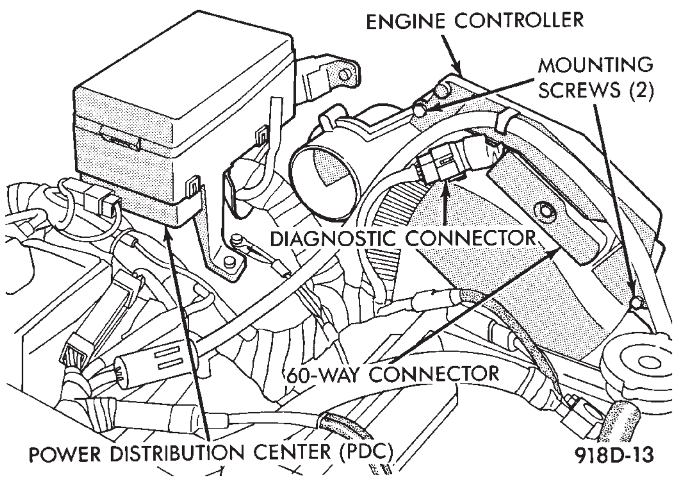

Fig. 18 Engine Controller—AC Body

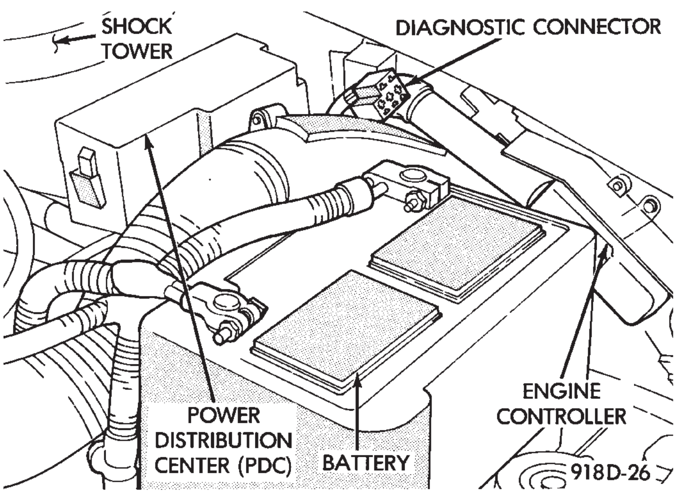

Fig. 19 Engine Controller—AG and AJ Bodies

ON BOARD DIAGNOSTICS

The engine controller has been programmed to monitor many different circuits of the fuel injection system. If a problem is sensed with a monitored circuit often enough to indicate an actual problem, the controller stores a fault. If the problem is repaired or ceases to exist, the engine controller cancels the Fault Code after 51 vehicle key on/off cycles.

Certain criteria must be met for a fault code to be entered into engine controller memory. The criteria may be a specific range of engine RPM, engine temperature, and/or input voltage to the engine controller.

It is possible a fault code for a monitored circuit may not be entered into memory even though a malfunction has occurred. This may happen because one of the fault code criteria for the circuit has not been met. **For example**, assume one of the fault code criteria for the MAP sensor circuit is the engine must be operating between 750 and 2000 RPM. If the MAP sensor output circuit shorts to ground when engine RPM is above 2400 RPM (resulting in a 0 volt input to the engine controller) a fault code will not be entered into memory. This is because the condition does not occur within the specified RPM range.

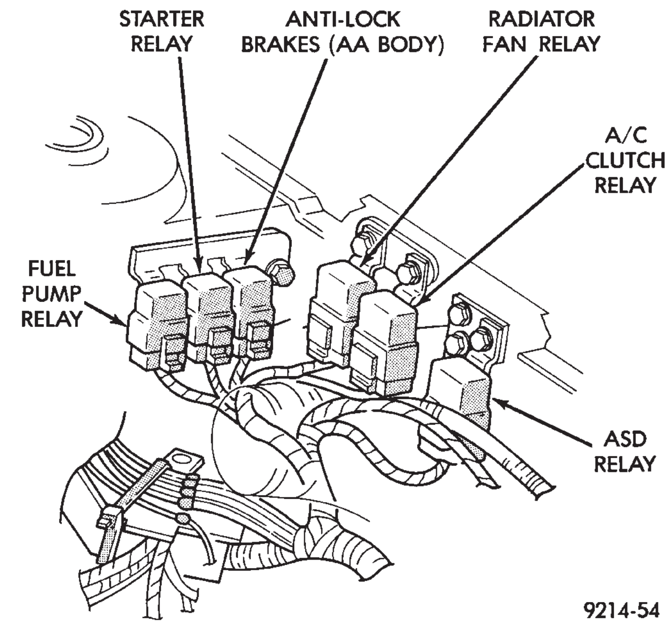

Fig. 20 Relay Identification—AA Body

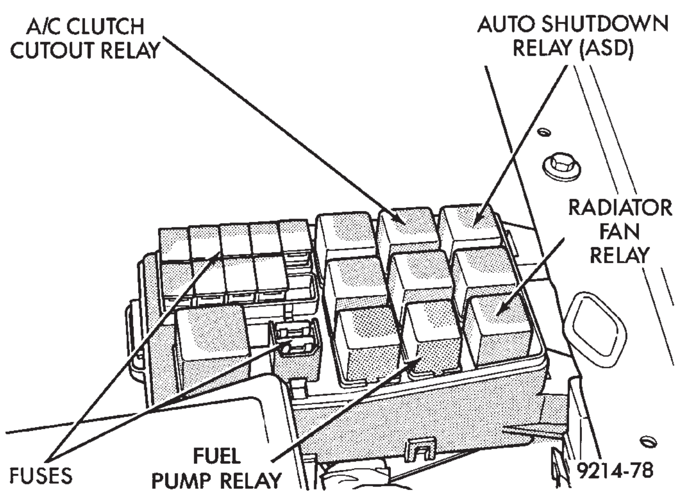

Fig. 21 Relay Identification—AC Body

There are several operating conditions that the engine controller does not monitor and set fault codes for. Refer to Monitored Circuits and Non-Monitored Circuits in this section.

Stored fault codes can be displayed either by cycling the ignition key On - Off - On - Off - On, or through use of the Diagnostic Readout Box II (DRB II). The DRB II connects to the diagnostic connector in the vehicle (Fig. 17, Fig. 18 or Fig. 19).

MONITORED CIRCUITS

The engine controller can detect certain fault conditions in the fuel injection system.

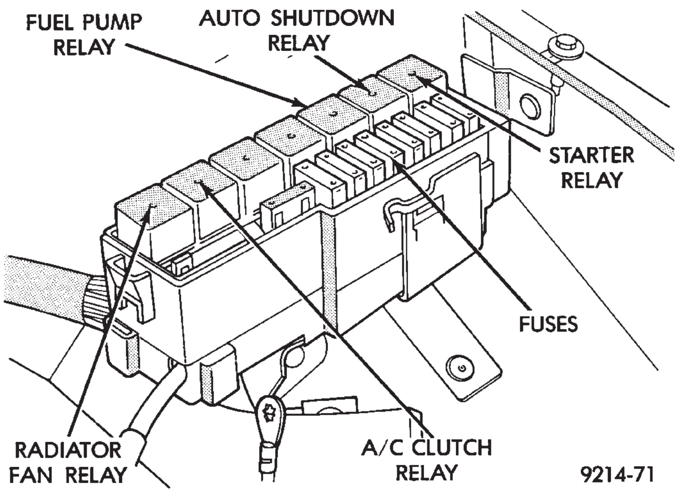

Fig. 22 Relay Identification—AG and AJ Bodies

Open or Shorted Circuit - The engine controller can determine if the sensor output (input to controller) is within proper range. Also, the controller can determine if the circuit is open or shorted.

Output Device Current Flow - The engine controller senses whether the output devices are hooked up. If there is a problem with the circuit, the controller senses whether the circuit is open, shorted to ground, or shorted high.

Oxygen Sensor - The engine controller can determine if the oxygen sensor is switching between rich and lean once the system has entered closed loop. Refer to Modes of Operation in this section for an explanation of closed loop operation.

NON-MONITORED CIRCUITS

The engine controller does not monitor the following circuits, systems and conditions that could have malfunctions that result in driveability problems. Fault codes may not be displayed for these conditions. However, problems with these systems may cause fault codes to be displayed for other systems. For example, a fuel pressure problem will not register a fault directly, but could cause a rich or lean condition. This could cause an oxygen sensor fault to be stored in the engine controller.

Fuel Pressure - Fuel pressure is controlled by the vacuum assisted fuel pressure regulator. The engine controller cannot detect a clogged fuel pump inlet filter, clogged in-line fuel filter, or a pinched fuel supply or return line. However, these could result in a rich or lean condition causing an oxygen sensor fault.

Secondary Ignition Circuit - The engine controller cannot detect an inoperative ignition coil, fouled or worn spark plugs, ignition cross firing, or open spark plug cables.

Engine Timing - The engine controller cannot detect an incorrectly indexed timing chain, camshaft sprocket and crankshaft sprocket. The engine controller also cannot detect an incorrectly indexed distributor. However, these could result in a rich or lean condition causing an oxygen sensor fault to be stored in the engine controller.

Cylinder Compression - The engine controller cannot detect uneven, low, or high engine cylinder compression.

Exhaust System - The engine controller cannot detect a plugged, restricted or leaking exhaust system.

Fuel Injector Malfunctions - The engine controller cannot determine if the fuel injector is clogged, the pintle is sticking or the wrong injector is installed. However, these could result in a rich or lean condition causing an oxygen sensor fault to be stored in the engine controller.

Excessive Oil Consumption - Although the engine controller monitors exhaust stream oxygen content when the system is in closed loop, it cannot determine excessive oil consumption.

Throttle Body Air Flow - The engine controller cannot detect a clogged or restricted air cleaner inlet or filter element.

Evaporative System - The engine controller will not detect a restricted, plugged or loaded evaporative purge canister.

Vacuum Assist - Leaks or restrictions in the vacuum circuits of vacuum assisted engine control system devices are not monitored by the engine controller. However, these could result in a MAP sensor fault being stored in the engine controller.

Engine Controller System Ground - The engine controller cannot determine a poor system ground. However, a fault code may be generated as a result of this condition.

Engine Controller Connector Engagement - The engine controller cannot determine spread or damaged connector pins. However, a fault code may be generated as a result of this condition.

HIGH AND LOW LIMITS

The engine controller compares input signal voltages from each input device with established high and low limits that are programmed into it for that device. If the input voltage is not within specifications, and other fault code criteria are met, a fault code will be stored in memory. Other fault code criteria might include engine RPM limits or input voltages from other sensors or switches that must be present before a fault condition can be verified.

FAULT CODE DESCRIPTION

When a fault code appears, it indicates that the Engine Controller has recognized an abnormal condition in the system. Fault codes can be obtained from the Check Engine lamp on the Instrument Panel or from the Diagnostic Readout Box II (DRBII). Fault codes indicate the results of a failure but do not identify the failed component directly.

FAULT CODE DESCRIPTION

FAULT CODE	DRB II DISPLAY	DESCRIPTION
11	No reference Signal During Cranking	No distributor reference signal detected during engine cranking.
13+**	Slow change in Idle MAP signal or No change in MAP from start to run	MAP output change is slower and/or smaller than expected. No difference recognized between the engine MAP reading and the barometric (atmospheric) pressure reading at start-up.
14+**	MAP voltage too low or MAP voltage too High	MAP sensor input below minimum acceptable voltage. MAP sensor input above maximum acceptable voltage.
15**	No vehicle speed signal	No vehicle distance (speed) sensor signal detected during road load conditions.
17	Engine is cold too long	Engine coolant temperature remains below normal operating temperatures during vehicle travel (thermostat).
21**	O_2 signal stays at center or O_2 signal shorted to voltage	Neither rich or lean condition detected from the oxygen sensor input. Oxygen sensor input voltage maintained above the normal operating range.
22+**	Coolant sensor voltage too high or Coolant sensor voltage too low	Coolant temperature sensor input above the maximum acceptable voltage. Coolant temperature sensor input below the minimum acceptable voltage.
24+**	Throttle position sensor voltage high or Throttle position sensor voltage low	Throttle position sensor input above the maximum acceptable voltage. Throttle position sensor input below the minimum acceptable voltage.
25**	Automatic idle speed motor circuits	An open or shorted condition detected in one or more of the AIS control circuits.
27	Injector control circuit	Injector output driver does not respond properly to the control signal.
31**	Purge solenoid circuit	An open or shorted condition detected in the purge solenoid circuit.
32**	EGR solenoid circuit or EGR system failure	An open or shorted condition detected in the EGR transducer solenoid circuit. Required change in air/fuel ratio not detected during diagnostic test.
33	A/C clutch relay circuit	An open or shorted condition detected in the A/C clutch relay circuit.

+ Check Engine Lamp On
** Check Engine Lamp On (California Only)

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FAULT CODE DESCRIPTION (CON'T)

FAULT CODE	DRB II DISPLAY	DESCRIPTION
34	Speed control solenoid circuits	An open or shorted condition detected in the speed control vacuum or vent solenoid circuits.
35	Radiator fan relay circuits	An open or shorted condition detected in the radiator fan circuit.
37	Torque convertor unlock solenoid CKT	An open or shorted condition detected in the torque convertor part throttle unlock solenoid circuit (automatic transmission).
41+**	Alternator field not switching properly	An open or shorted condition detected in the alternator field control circuit.
42	Auto shutdown relay control circuit	An open or shorted condition detected in the auto shutdown relay circuit.
46+**	Charging system voltage too high	Battery voltage sense input above target charging voltage during engine operation.
47+**	Charging system voltage too low	Battery voltage sense input below target charging voltage during engine operation. Also, no significant change detected in battery voltage during active test of alternator output.
51**	O_2 signal stays below center (lean)	Oxygen sensor signal input indicates lean air/fuel ratio condition during engine operation.
52**	O_2 signal stays above center (rich)	Oxygen sensor signal input indicates rich air/fuel ratio condition during engine operation.
53	Internal controller	Engine controller internal fault condition detected.
54	No sync pick-up signal	No fuel sync signal detected during engine rotation.
62	Controller Failure EMR miles not stored	Unsuccessful attempt to write to an EEPROM location by the engine controller.
63	Controller Failure EEPROM write denied	Unsuccessful attempt to write to an EEPROM location by the engine controller.
55	N/A	Completion of fault code display on Check Engine lamp.

+Check Engine Lamp On
**Check Engine Lamp ON (California Only)

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SYSTEM TESTS

WARNING: APPLY PARKING BRAKE AND/OR BLOCK WHEELS BEFORE PERFORMING ANY TEST ON AN OPERATING ENGINE.

OBTAINING FAULT CODES

(1) Connect DRBII to the diagnostic connector located in the engine compartment near the engine controller.

(2) Start the engine if possible, cycle the transmission selector and the **A/C** switch if applicable. Shut off the engine.

(3) Turn the ignition switch on, access Read Fault Screen. Record all the fault messages shown on the DRBII. Observe the check engine lamp on the instrument panel. The lamp should light for 3 seconds then go out (bulb check).

Fault code erasure; access erase fault code data

STATE DISPLAY TEST MODE

The switch inputs used by the engine controller have only two recognized states, HIGH and LOW. For this reason, the engine controller cannot recognize the difference between a selected switch position versus an open circuit, a short circuit, or a defective switch. If the change is displayed, it can be assumed that the entire switch circuit to the engine controller is functional. From the state display screen access either State Display Inputs and Outputs or State Display Sensors.

STATE DISPLAY INPUTS AND OUTPUTS

Connect the DRB II tester to the vehicle. Access the State Display screen. Then access Inputs and Outputs. The following is a list of the engine control system functions accessible through the Inputs and Outputs screen.

Park/Neutral Switch
Speed Control Resume
Brake Switch
Speed Control On/Off
Speed Control Set
A/C Switch Sense
Z2 Voltage Sense
S/C Vent Solenoid
S/C Vacuum Solenoid
A/C Clutch Relay
EGR Solenoid
Auto Shutdown Relay
Radiator Fan Relay
Purge Solenoid
PTU Solenoid
Check Engine Lamp

STATE DISPLAY SENSORS

Connect the DRB II tester to the vehicle and access the State Display screen. Then access Sensor Display. The following is a list of the engine control system functions accessible through the Sensor Display screen.

Battery Temp Sensor
Oxygen Sensor Signal
Coolant Temperature
Coolant Temp Sensor
Throttle Position
Minimum Throttle
Battery Voltage
MAP Sensor Reading
AIS Motor Position
Adaptive Fuel Factor
Barometric Pressure
Min Airflow Idle Speed
Engine Speed
Fault #1 Key-On Info
Module Spark Advance
Speed Control Target
Fault #2 Key-on Info
Fault #3 Key-on Info
Speed Control Status
Speed Control Switch Voltage
Charging System Goal
Theft Alarm Status
Map Sensor Voltage
Vehicle Speed
Oxygen Sensor State
MAP Gauge Reading
Throttle Opening
Total Spark Advance

CIRCUIT ACTUATION TEST MODE

The circuit actuation test mode checks for proper operation of output circuits or devices which the engine controller cannot internally recognize. The engine controller can attempt to activate these outputs and allow an observer to verify proper operation. Most of the tests provide an audible or visual indication of device operation (click of relay contacts, spray fuel, etc.). Except for intermittent conditions, if a device functions properly during testing, assume the device, its associated wiring, and driver circuit working correctly.

OBTAINING CIRCUIT ACTUATION TEST

Connect the DRB II tester to the vehicle and access the Actuators screen. The following is a list of the engine control system functions accessible through Actuators screens.

Stop All Tests
Ignition Coil #1
Fuel Injector #1
Fuel Injector #2
Fuel Injector #3
Fuel Injector #4
Fuel Injector #5
Fuel Injector #6
AIS Motor Open/Close
Radiator Fan Relay
A/C Clutch Relay
Auto Shutdown Relay
Fuel Pump Relay
Purge Solenoid
S/C Serv Solenoids
Alternator Field
All Solenoids/Relays
ASD Fuel System Test

THROTTLE BODY MINIMUM AIR FLOW CHECK PROCEDURE

(1) Warm engine in Park or Neutral until the cooling fan has cycled on and off at least once.

(2) Ensure that all accessories are off.

(3) Hook-up the timing check device and tachometer.

(4) Disconnect the coolant temperature sensor and set basic timing to 12° BTDC ± 2° BTDC.

(5) Shut off engine. Reconnect coolant temperature sensor wire.

(6) Disconnect the PCV valve hose from the PCV valve (Fig. 23).

(7) Plug the PCV valve nipple.

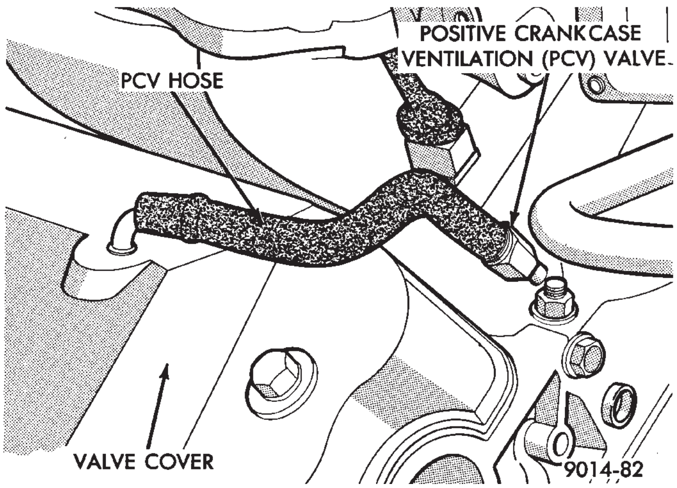

Fig. 23 3.0L PCV Valve

(8) Disconnect the idle purge hose from the engine vacuum harness tee (Fig. 24).

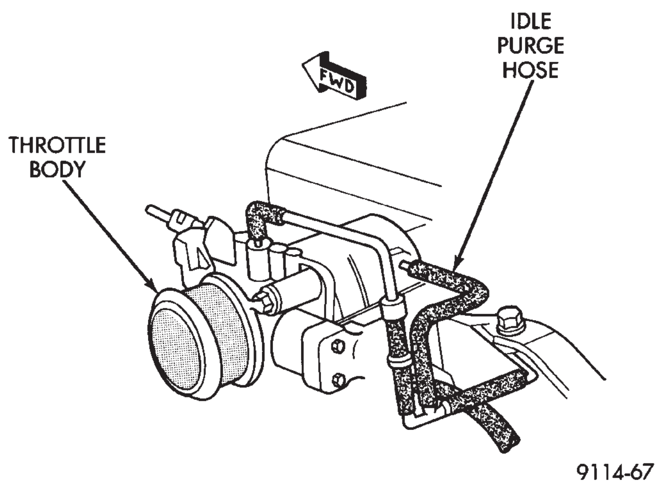

Fig. 24 3.0L Idle Purge Hose

(9) Install Air Metering Fitting #6457 (0.125 inch orifice) in the intake manifold mounted idle purge hose (Fig. 25).

(10) Connect Diagnostic Readout Box II (DRB II).

(11) Restart the engine, allow engine to idle for at least one minute.

(12) Using the DRBII, access Min. Airflow Idle Speed.

(13) The following will then occur:

- AIS motor will fully close.
- Idle spark advance will become fixed.
- Engine RPM will be displayed on Diagnostic Readout Box II (DRB II)

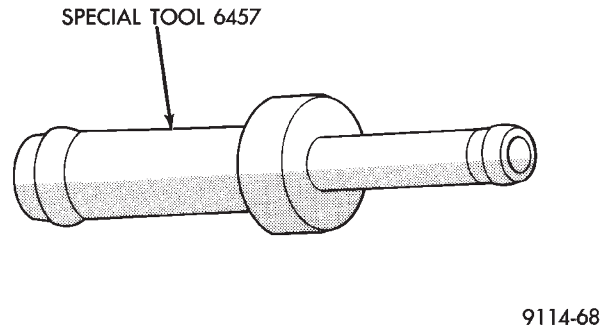

Fig. 25 Air Metering Fitting, Special Tool 6457

(14) Check idle RPM with tachometer, if idle RPM is within the below specification then the throttle body min. air flow is set correctly.

IDLE SPECIFICATIONS

Odometer Reading	Idle RPM
Below 1000 Miles	625-950 RPM
Above 1000 Miles	750-950 RPM

9114-69

(15) If idle RPM is not within specifications, shut off the engine and clean the throttle body as follows:

(a) Remove the throttle body from engine.

WARNING: CLEAN THROTTLE BODY IN A WELL VENTILATED AREA. WEAR RUBBER OF BUTYL GLOVES, DO NOT LET MOPAR PARTS CLEANER COME IN CONTACT WITH EYES OR SKIN. AVOID INGESTING THE CLEANER. WASH THOROUGHLY AFTER USING CLEANER.

(b) While holding the throttle open, spray the entire throttle body bore and the manifold side of the throttle plate with Mopar Parts Cleaner. **Only use Mopar Parts Cleaner to clean the throttle body.**

(c) Using a soft scuff pad, clean the top and bottom of throttle body bore and the edges and manifold side of the throttle blade. **The edges of the throttle blade and portions of the throttle bore that are closest to the throttle blade when is closed, must be free of deposits.**

(d) Use compressed air to dry the throttle body.

(e) Inspect throttle body for foreign material.

(f) Install throttle body on manifold.

(g) Repeat steps 1 through 14. If the minimum air flow is still not within specifications, the problem is not caused by the throttle body.

(16) Shut off engine.

(17) Remove Air Metering Fitting #6457 from the intake manifold idle purge hose. Reconnect the hose to the engine vacuum harness tee.

(18) Remove the plug from the PCV valve. Reconnect the PCV valve hose to the PCV valve.

(19) Disconnect the DRB II.

IGNITION TIMING PROCEDURE

Refer to Group 8D Ignition System.

60-WAY ENGINE CONTROLLER WIRING CONNECTOR

Refer to the engine controller wiring connector description (Fig. 26) for information regarding wire colors and cavity numbers.

CAV	WIRE COLOR	DESCRIPTION
1	DG/RD*	MAP SENSOR
2	TN/BK*	COOLANT SENSOR
3	RD/WT*	DIRECT BATTERY VOLTAGE
4	BK/LB*	SENSOR RETURN
5	BK/WT*	SIGNAL GROUND
6	VT/WT*	5-VOLT OUTPUT (MAP AND TPS)
7	OR	9-VOLT OUTPUT (DISTRIBUTOR PICK-UP AND DISTANCE SENSOR)
8		
9	DB	A21 SUPPLY (IGNITION START/RUN)
10		
11	BK/TN*	POWER GROUND
12	BK/TN*	POWER GROUND
13	LB/BR*	INJECTOR DRIVER #4
14	YL/WT*	INJECTOR DRIVER #3
15	TN	INJECTOR DRIVER #2
16	WT/DB*	INJECTOR DRIVER #1
17		
18		
19	BK/GY*	IGNITION COIL DRIVER #1
20	DG	ALTERNATOR FIELD CONTROL
21		
22	OR/DB*	THROTTLE POSITION SENSOR (TPS)
23	RD/LG*	SPEED CONTROL SENSE
24	GY/BK*	DISTRIBUTOR REFERENCE PICK-UP
25	PK	SCI TRANSMIT
26	VT/BR*	CCD BUS (+)
27	BR	A/C SWITCH SENSE
28		
29	WT/PK*	BRAKE SWITCH
30	BR/YL*	PARK/NEUTRAL SWITCH
31	DB/PK*	RADIATOR FAN RELAY
32	BK/PK*	CHECK ENGINE LAMP
33	TN/RD*	SPEED CONTROL VACUUM SOLENOID
34	DB/OR*	A/C CLUTCH RELAY
35	GY/YL*	EGR SOLENOID (CALIFORNIA ONLY)
36		

CAV	WIRE COLOR	DESCRIPTION
37		
38	GY	INJECTOR DRIVER #5
39	GY/RD*	AIS STEPPER DRIVER #3
40	BR/WT*	AIS STEPPER DRIVER #1
41	BK/DG*	OXYGEN SENSOR SIGNAL
42		
43		
44	TN/YL*	HIGH DATA RATE PICK-UP
45	LG	SCI RECEIVE
46	WT/BK	CCD BUS (-)
47	WT/OR*	DISTANCE SENSOR SIGNAL
48		
49		
50		
51	DB/YL*	AUTO SHUTDOWN (ASD) RELAY
52	PK/BK*	PURGE SOLENOID
53	LG/RD*	SPEED CONTROL VENT SOLENOID
54		
55		
56		
57	DG/OR*	A142 CIRCUIT VOLTAGE SENSE
58	BR/DB*	INJECTOR DRIVER #6
59	VT/BK*	AIS STEPPER DRIVER #4
60	YL/BK*	AIS STEPPER DRIVER #2

WIRE COLOR CODES					
		LB	LIGHT BLUE	VT	VIOLET
BK	BLACK	LG	LIGHT GREEN	WT	WHITE
BR	BROWN	OR	ORANGE	YL	YELLOW
DB	DARK BLUE	PK	PINK	*	WITH TRACER
DG	DARK GREEN	RD	RED		
GY	GRAY	TN	TAN		

CONNECTOR TERMINAL SIDE SHOWN

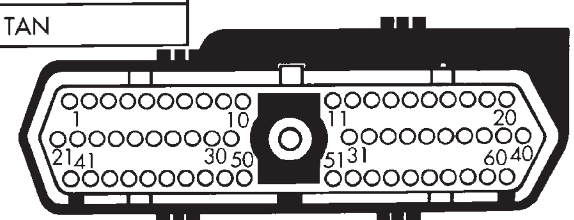

Fig. 26 60-Way Engine Controller Wiring Connector—3.0L Engine

3.0L MULTI-POINT FUEL INJECTION—SERVICE PROCEDURES

INDEX

THROTTLE BODY SERVICE

(1) Disconnect negative battery cable.

(2) Remove air cleaner hose clamp to throttle body and remove hose. (Fig. 1)

(3) Remove throttle cable and transaxle linkage.

(4) Disconnect automatic idle speed (AIS) motor and throttle position sensor (TPS) wiring connectors.

(5) Disconnect vacuum hoses from throttle body.

(6) Remove throttle body to intake manifold attaching nuts. Remove engine harness wiring bracket.

(7) Remove throttle body and gasket.

(8) Reverse the above procedures for installation. Tighten throttle body mounting nuts to 25 N●m (225 in. lbs.) torque.

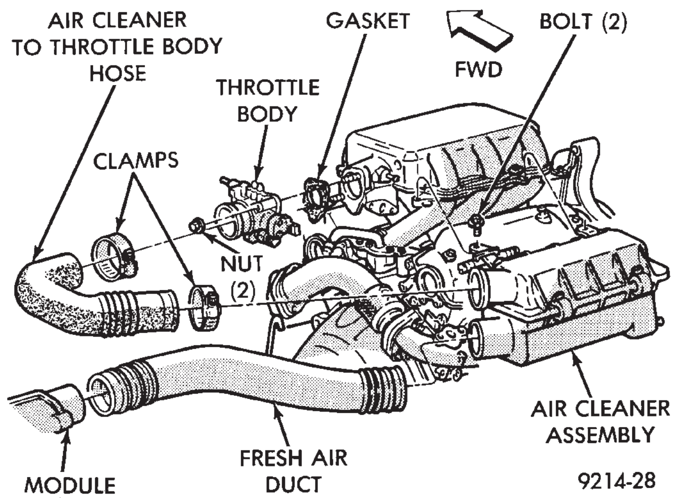

Fig. 1 Throttle Body Assembly

THROTTLE BODY

When servicing body components, always assemble components with new O-rings and seals where applicable (Fig. 2). Never use lubricants on O-rings or seals, damage may result. If assembly of component is difficult, use water to aid assembly. Use care when removing hoses to prevent damage to hose or hose nipple.

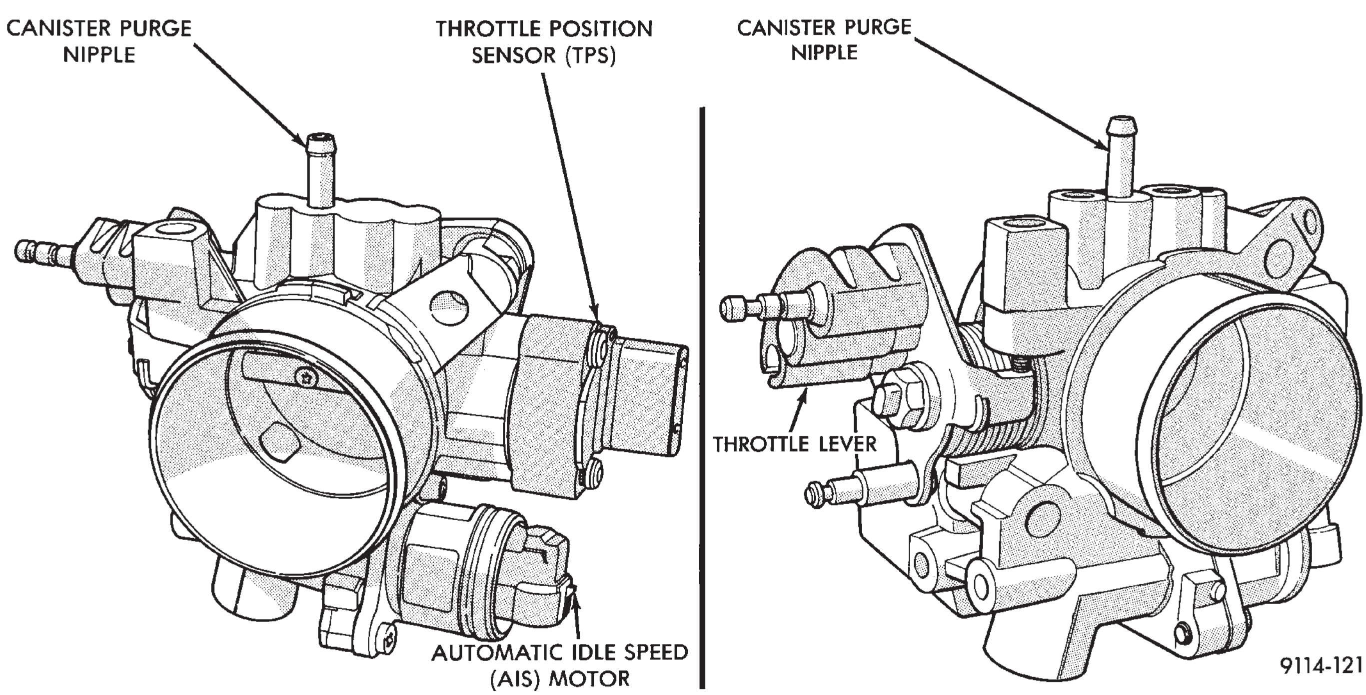

Fig. 2 Throttle Body 3.0L

FUEL SYSTEM PRESSURE RELEASE PROCEDURE

The 3.0L MPI fuel system is under a constant pressure of approximately 330 kPa (48 psi). Before servicing the fuel pump, fuel lines, fuel filter, throttle body or fuel injectors, the fuel system pressure must be released.

(1) Loosen fuel filler cap to release fuel tank pressure.

(2) Disconnect injector wiring harness from engine harness (Fig. 3).

(3) Connect a jumper wire between terminal Number 1 of one injector harness and engine ground.

(4) Connect a jumper wire to the positive terminal Number 2 of the injector harness and touch the battery positive post for no longer than 5 seconds. This releases system pressure.

(5) Remove jumper wires.

(6) Continue fuel system service.

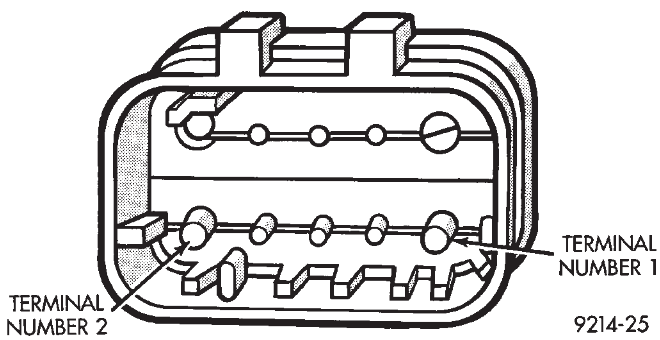

Fig. 3 Injector Harness Connector

THROTTLE POSITION SENSOR

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove electrical connector from throttle position sensor.

(3) Remove throttle position sensor mounting screws (Fig. 4).

(4) Lift throttle position sensor off throttle shaft.

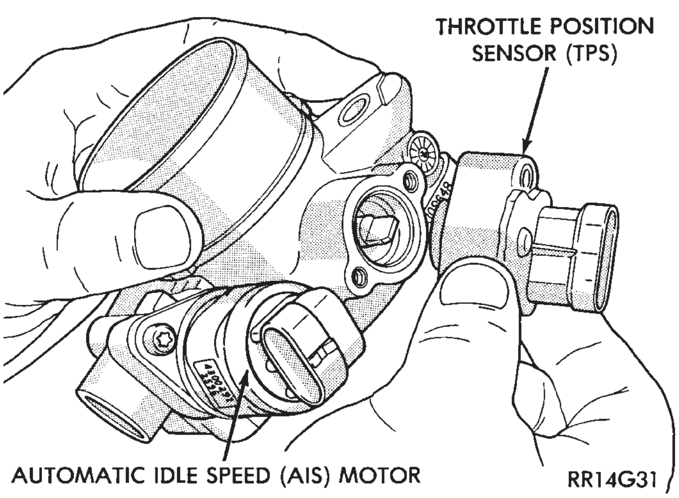

Fig. 4 Servicing Throttle Position Sensor

INSTALLATION

(1) Install throttle position sensor on throttle shaft. Install mounting screws. Tighten screw to 2 N●m (17 in. lbs.) torque.

(2) Connect electrical connector to throttle position sensor.

(3) Connect negative cable to battery.

AUTOMATIC IDLE SPEED (AIS) MOTOR

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove electrical connector from automatic idle speed (AIS) motor.

(3) Remove AIS motor mounting screws (Fig. 5).

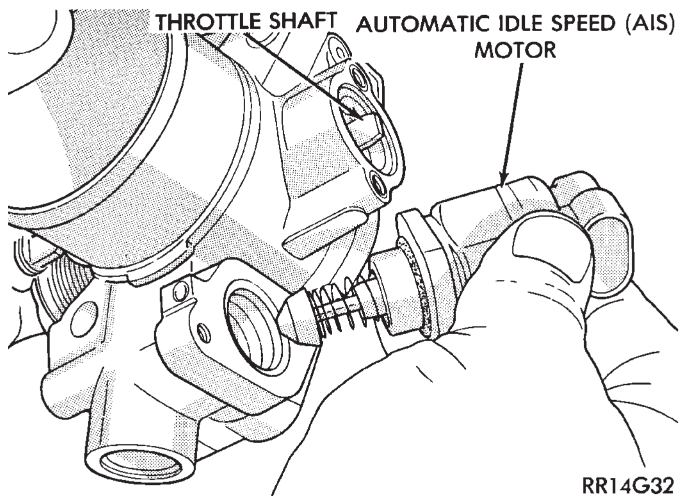

Fig. 5 Servicing Automatic Idle Speed Motor

(4) Remove AIS motor from throttle body. Ensure the O-ring is removed with the AIS motor.

INSTALLATION

(1) The new AIS motor has a new O-ring installed on it. If pintle measures more than 1 inch (25 mm) it must be retracted. Use the DRB II AIS Motor Open/Close Test to retract the pintle (battery must be connected.)

(2) Carefully place AIS motor into throttle body.

(3) Install mounting screws. Tighten screws to 2 N●m (17 in. lbs.) torque.

(4) Connect electrical connector to AIS motor.

(5) Connect negative cable to battery.

FUEL INJECTOR RAIL ASSEMBLY

REMOVAL

WARNING: THE 3.0L MPI FUEL SYSTEM IS UNDER A CONSTANT PRESSURE OF APPROXIMATELY 330 KPA (48 PSI). PERFORM FUEL PRESSURE RELEASE PROCEDURE BEFORE SERVICING THE FUEL RAIL OR FUEL INJECTORS.

(1) Perform the Fuel Pressure Release Procedure.

(2) Disconnect negative cable from battery.
(3) Remove air cleaner to throttle body hose.
(4) Remove throttle cable (Fig. 6).

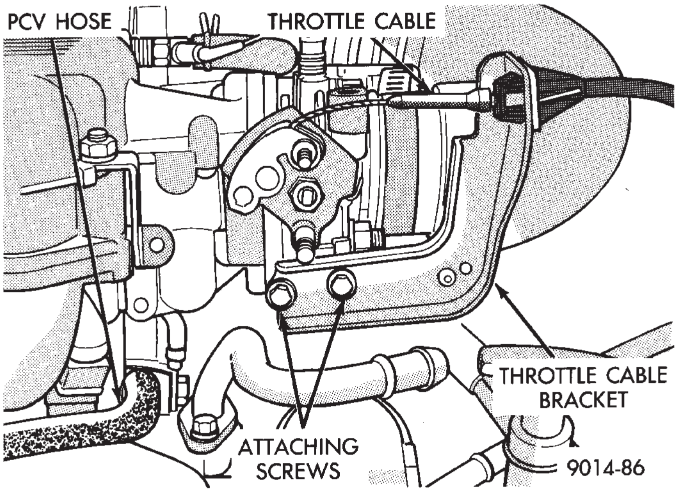

Fig. 6 Throttle Cable Attachment

(5) Disconnect electrical connectors from the automatic idle speed (AIS) motor and throttle position sensor (TPS).
(6) Remove vacuum hose harness from throttle body (Fig. 7).
(7) Remove vacuum hoses from air intake plenum (Fig. 7).

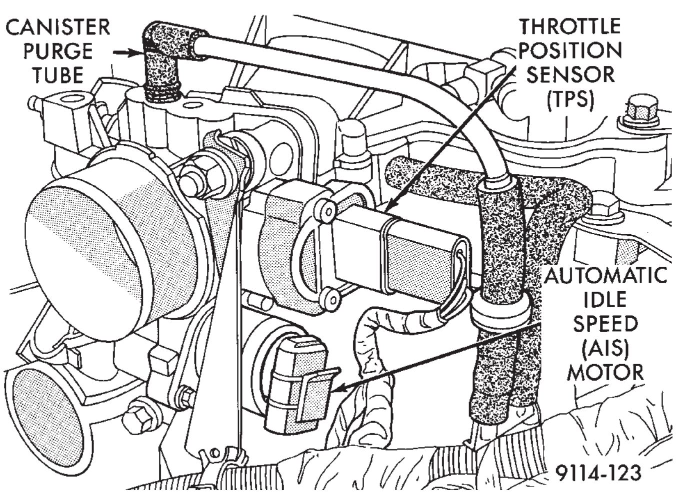

Fig. 7 Electrical and Vacuum Connection to Throttle Body

(8) IF equipped with EGR, remove the EGR tube flange from intake plenum (Fig. 8).
(9) Remove the wiring connector from the coolant temperature sensor (Fig. 9).
(10) Remove vacuum connections from air intake plenum vacuum connector (Fig. 9).
(11) Remove fuel hoses from fuel rail (Fig. 9).
(12) Remove air intake plenum to intake manifold mounting fasteners (Fig. 10).
(13) Remove ignition coil.
(14) Remove air intake plenum (Fig. 11).

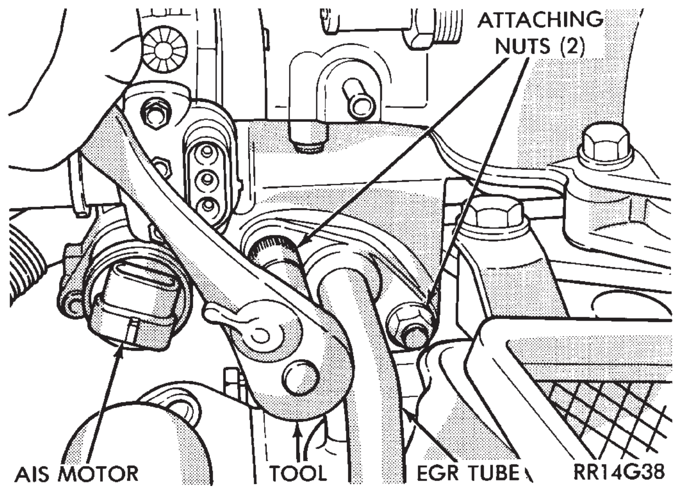

Fig. 8 EGR Tube to Intake Plenum

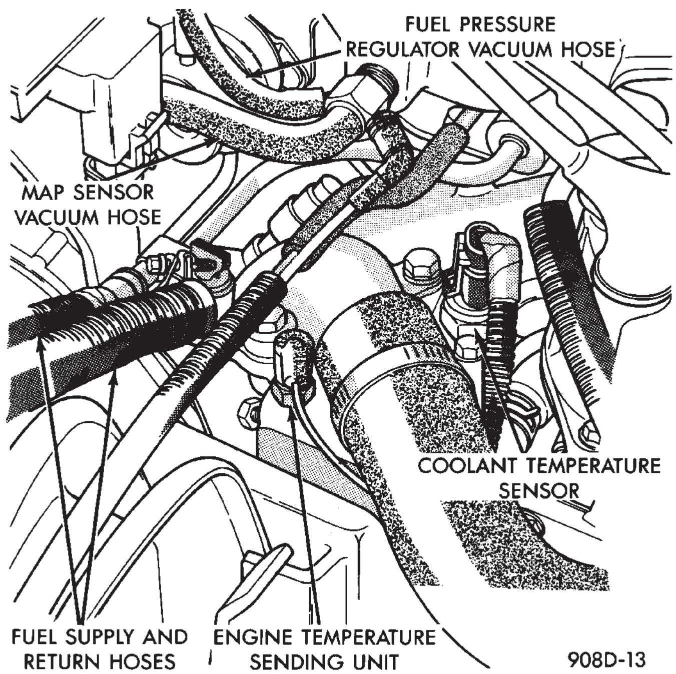

Fig. 9 Coolant Temperature Sensor

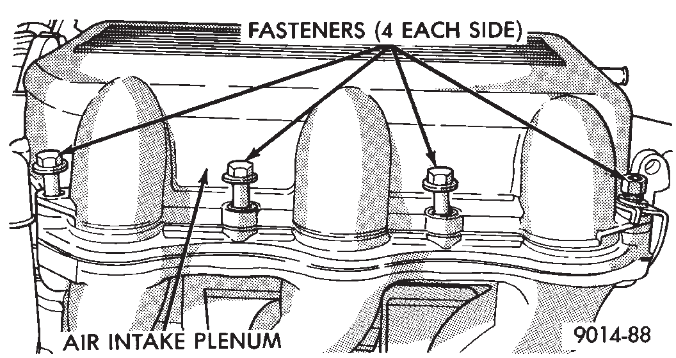

Fig. 10 Air Intake Plenum to Intake Manifold Attaching Fasteners

(15) Cover intake manifold while servicing injector fuel rail (Fig. 12).
(16) Remove vacuum hoses from fuel rail (Fig. 12).

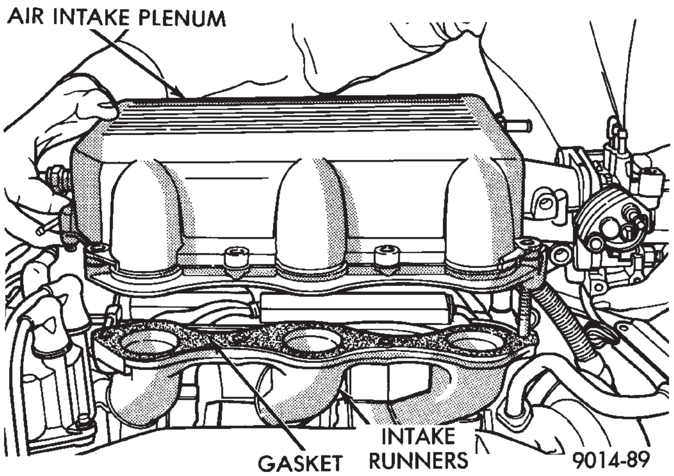

Fig. 11 Removing Air Intake Plenum

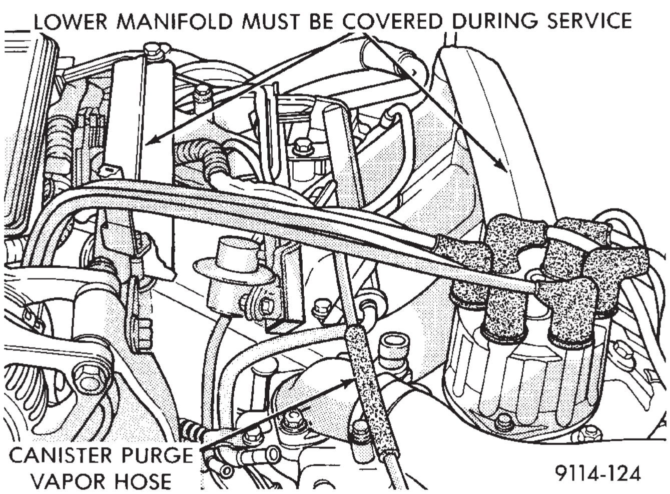

Fig. 12 Vacuum Connections at the Fuel Rail

(17) Disconnect fuel injector wiring harness from engine wiring harness (Fig. 13).

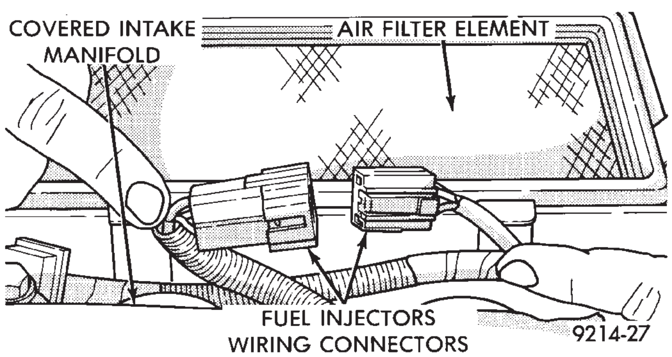

Fig. 13 Fuel Injector Wiring Harness

CAUTION: Do not damage the injector O-Rings when removing the injectors and fuel rail assembly..

(18) Remove fuel rail mounting bolts. Lift fuel rail assembly off of intake manifold.

INSTALLATION

(1) Be sure injectors are seated into the receiver cup with lock ring in place.

(2) Make sure the injector holes are clean and all plugs have been removed.

(3) To ease installation, lubricate injector O-ring with a drop of clean engine oil.

(4) Put the tip of each injector into their ports. Push the assembly into place until the injectors are seated in the ports.

(5) Install fuel rail attaching bolts. Tighten bolts to 13 N●m (115 in. lbs.) torque.

(6) Install fuel supply and return tube holddown bolt and the vacuum crossover tube holddown bolt. Tighten bolts to 10 N●m (95 in. lbs.) torque.

(7) Connect fuel injector wiring harness to engine wiring harness.

(8) Connect vacuum harness to fuel rail assembly.

(9) Remove covering from lower intake manifold and clean surface.

(10) Place intake manifold gaskets **with beaded sealer up** on lower manifold. Put air intake in place. Install ignition coil. Install attaching fasteners and tighten to 13 N●m (115 in. lbs.) torque.

(11) Connect fuel lines to fuel rail. Tighten hose clamps to 1 N●m (10 in. lbs.) torque.

(12) Connect vacuum harness to air intake plenum and fuel pressure regulator.

(13) Connect coolant temperature sensor electrical connector to sensor.

(14) Connect EGR tube flange to intake plenum. Tighten mounting nuts to 22 N●m (200 in. lbs.) torque.

(15) Connect PCV and brake booster supply hose to intake plenum.

(16) Connect automatic idle speed (AIS) motor and throttle position sensor (TPS) electrical connectors.

(17) Connect vacuum vapor harness to throttle body.

(18) Install throttle cable.

(19) Install air inlet hose assembly.

(20) Connect negative cable to battery.

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(21) With the ignition key in ON position, access the DRB II ASD Fuel System Test to pressurize the fuel system. Check for leaks.

FUEL PRESSURE REGULATOR SERVICE

REMOVAL

WARNING: THE 3.0L MPI FUEL SYSTEM IS UNDER A CONSTANT PRESSURE OF APPROXIMATELY 330 KPA (48 PSI). PERFORM FUEL PRESSURE RELEASE PROCEDURE BEFORE SERVICING THE FUEL PRESSURE REGULATOR.

(1) Perform the Fuel Pressure Release Procedure.
(2) Disconnect negative cable from battery.
(3) Loosen fuel return hose clamp and remove fuel return hose from nipple.
(4) Remove vacuum hose from fuel pressure regulator. (Fig. 14)
(5) Remove screw holding fuel return tube to the intake manifold.
(6) Remove fuel pressure regulator screws. Remove fuel pressure regulator from engine.

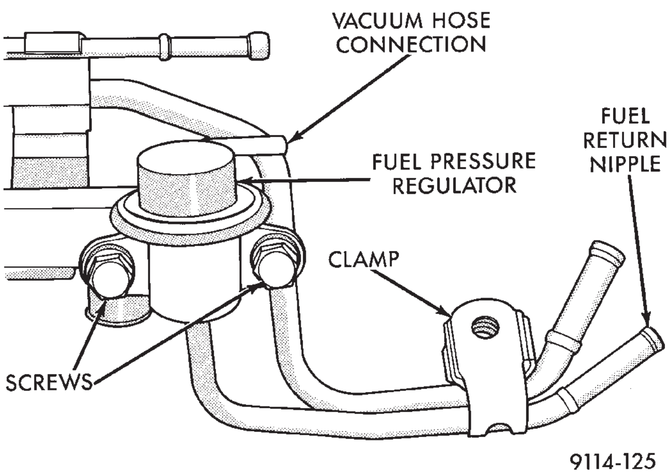

Fig. 14 Fuel Pressure Regulator

INSTALLATION

(1) Lubricate O-ring on fuel pressure regulator with clean 30 weight engine oil.
(2) Install fuel pressure regulator into fuel rail. Tighten screws to 10 N●m (90 in. lbs.) torque.
(3) Install screw holding fuel return tube clamp in place. Tighten screw to 10 N●m (95 in. lbs.) torque.
(4) Connect vacuum hose to fuel pressure regulator.
(5) Connect fuel return hose to fuel return tube. Tighten hose clamp to 1 N●m (10 in. lbs.) torque.
(6) Connect negative battery cable.

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(7) With the ignition key in ON position, access the DRB II ASD Fuel System Test to pressurize the fuel system. Check for leaks.

FUEL INJECTORS

WARNING: THE 3.0L MPI FUEL SYSTEM IS UNDER A CONSTANT PRESSURE OF APPROXIMATELY 330 KPA (48 PSI). PERFORM FUEL PRESSURE RELEASE PROCEDURE BEFORE SERVICING THE FUEL INJECTORS.

REMOVAL

(1) Perform the Fuel Pressure Release Procedure.
(2) Disconnect negative cable from battery.
The fuel rail must be removed first to service the injectors. Refer to Fuel Injector Rail Assembly Removal in this section.
(3) Label each injector connector with its cylinder number. Disconnect electrical connector from injector.
(4) Position fuel rail assembly so that the fuel injectors are easily accessible.
(5) Remove injector clip from fuel rail and injector (Fig. 15).

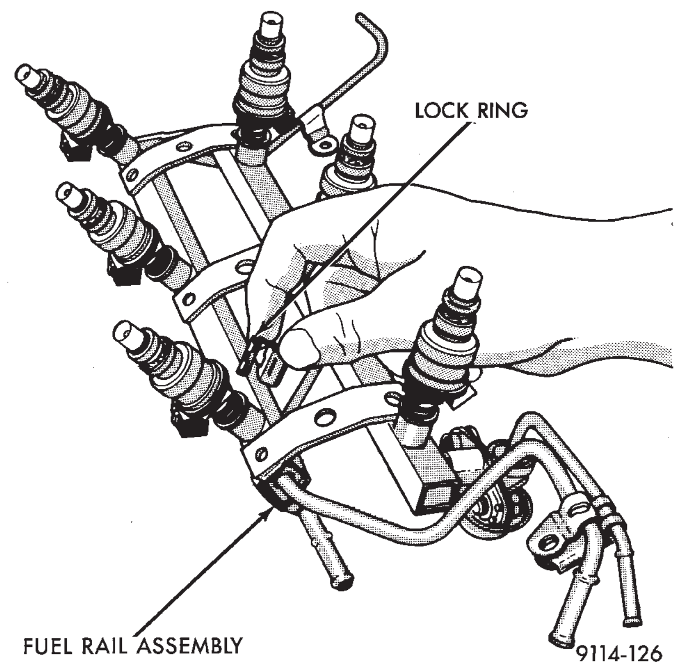

Fig. 15 Fuel Injector and Rail

(6) Pull injector straight out of fuel rail receiver cup (Fig. 16).
(7) Check injector O-ring for damage. If O-ring is damaged, it must be replaced. If injector is to be reused, a protective cap must be installed on the injector tip to prevent damage.
(8) Repeat procedure for remaining injectors.

INSTALLATION

(1) Before installing an injector, the rubber O-ring must be lubricated with a drop of clean engine oil to aid in installation.

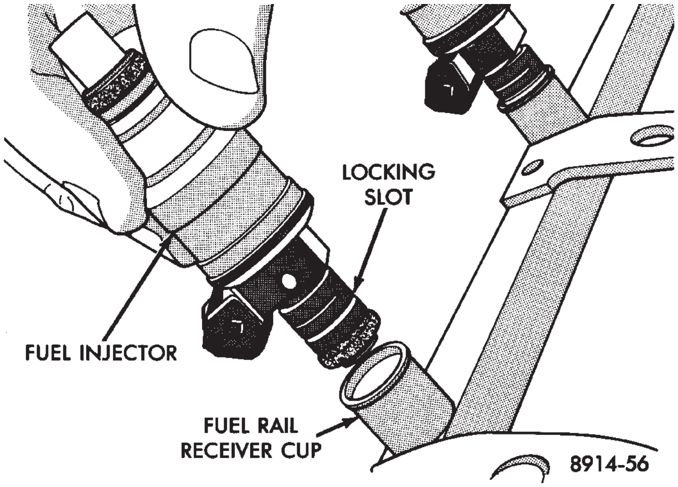

Fig. 16 Servicing Fuel Injector

(2) Being careful not to damage O-ring, install injector nozzle end into fuel rail receiver cap (Fig. 16).

(3) Install injector clip by sliding open end into **top slot** of the injector. The edge of the receiver cup will slide into the side slots of clip (Fig. 15).

(4) Repeat steps for remaining injectors.

(5) Install fuel rail assembly. Refer to Fuel Rail Assembly Installation in this section.

(6) Connect electrical connectors to injectors in correct order.

(7) Connect negative battery cable.

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(8) With the ignition key in ON position, access the DRB II ASD Fuel System Test to pressurize the fuel system. Check for leaks.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

(1) Remove vacuum hose and mounting screws from manifold absolute pressure (MAP) sensor (Fig. 17).

(2) Disconnect electrical connector from sensor. Remove sensor.

(3) Reverse the above procedure for installation.

CANISTER PURGE SOLENOID SERVICE

(1) Remove vacuum hose and electrical connector from solenoid (Fig. 18).

(2) Depress tab on top of solenoid and slide the solenoid downward out of mounting bracket.

(3) Reverse above procedure to install.

ENGINE CONTROLLER

(1) Remove air cleaner duct from engine controller.

(2) Disconnect negative cable from battery. Disconnect positive cable from battery.

(3) Remove battery holddown. Remove battery.

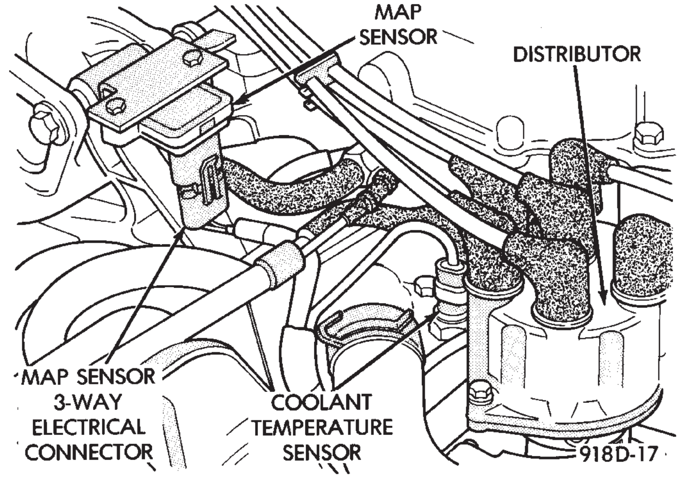

Fig. 17 Manifold Absolute Pressure Sensor

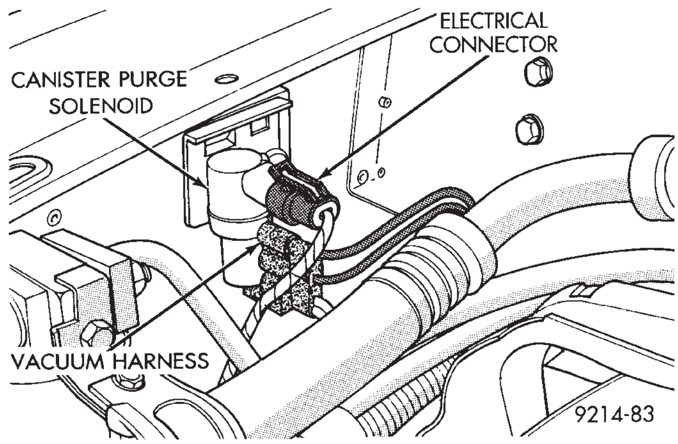

Fig. 18 Canister Purge Solenoid

(4) Remove engine controller mounting screws (Fig. 19, Fig. 20 or Fig. 21).

(5) Remove the electrical connector from engine controller. Remove engine controller.

(6) Reverse the above procedure for installation.

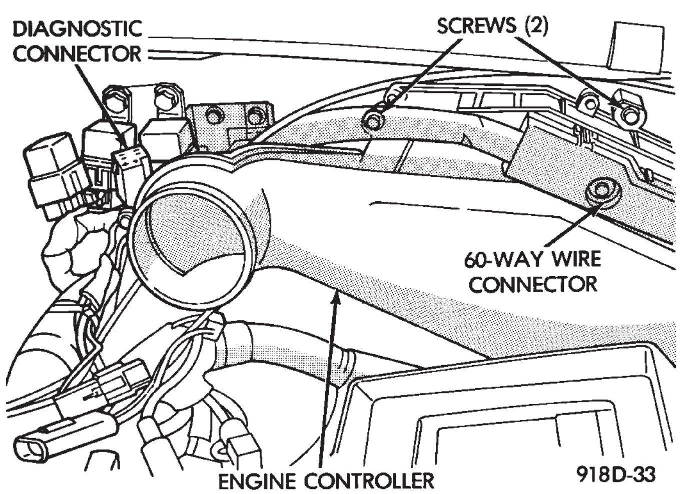

Fig. 19 Engine Controller—AA Body

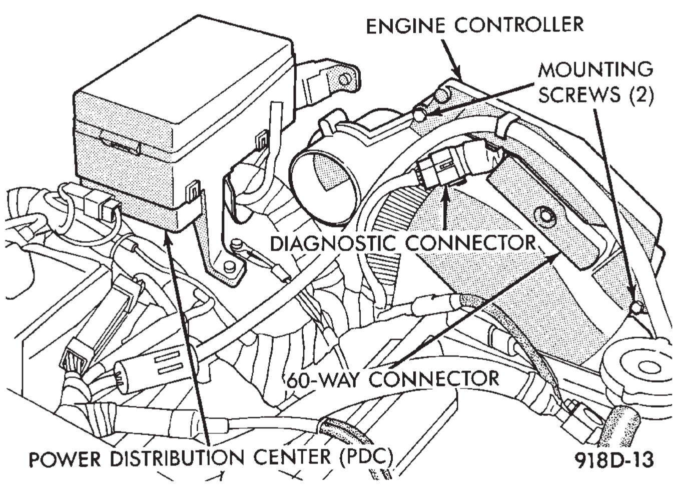

Fig. 20 Engine Controller—AC Body

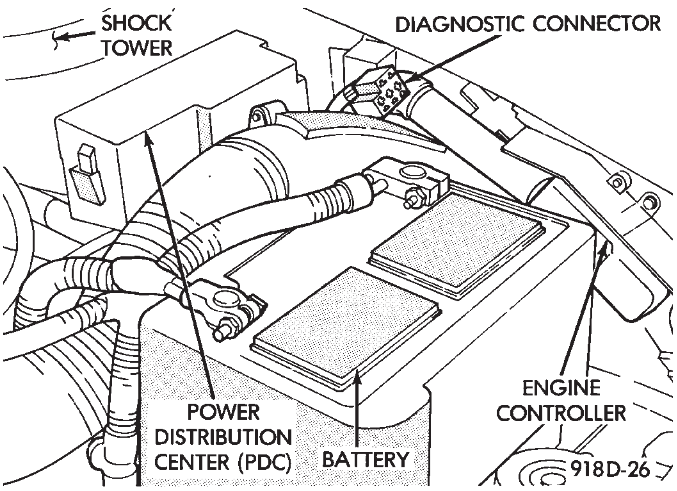

Fig. 21 Engine Controller—AG and AJ Bodies

HEATED OXYGEN SENSOR (O_2 SENSOR)

The oxygen sensor is installed in the exhaust manifold (Fig. 22).

CAUTION: Do not pull on the oxygen sensor wires when disconnecting the electrical connector.

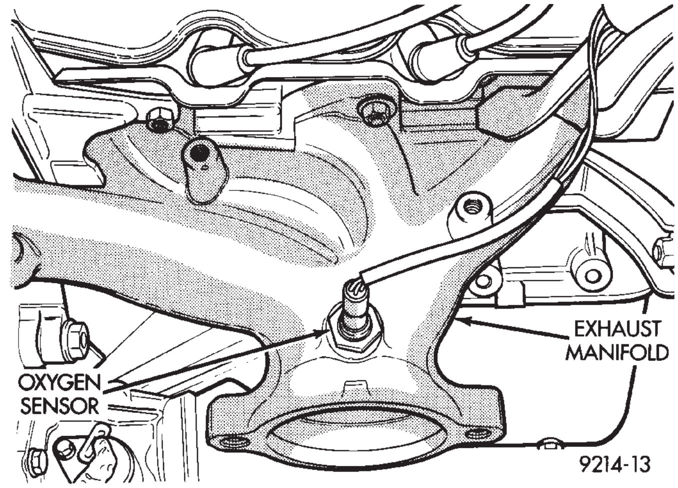

Fig. 22 Heated Oxygen Sensor

WARNING: THE EXHAUST MANIFOLD MAY BE EXTREMELY HOT. USE CARE WHEN SERVICING THE OXYGEN SENSOR.

(1) Disconnect oxygen sensor electrical connector.
(2) Remove sensor using Tool C-4907 (Fig. 23).

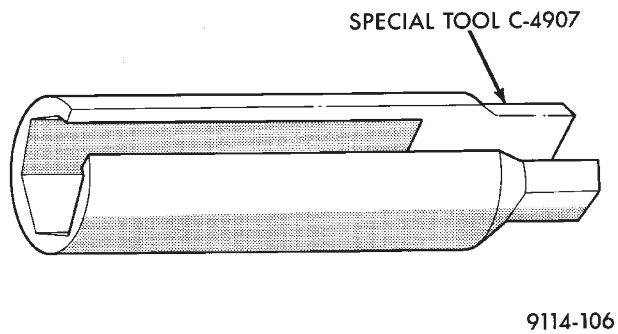

Fig. 23 Oxygen Sensor Socket

When the sensor is removed, the exhaust manifold threads must be cleaned with an 18 mm X 1.5 + 6E tap. If using original sensor, coat the threads with Loctite 771-64 anti-seize compound or equivalent. New sensors are packaged with compound on the threads and do not require additional compound. The sensor must be tightened to 27 N•m (20 ft. lbs.) torque.

3.3L AND 3.8L MULTI-POINT FUEL INJECTION—SYSTEM OPERATION

INDEX

GENERAL INFORMATION

3.3L and 3.8L engines use a sequential Multi-point Electronic Fuel Injection system (Fig. 1). The MPI system is computer regulated and provides precise air/fuel ratios for all driving conditions.

The MPI system is operated by the Single Board Engine Controller II (SBEC II), **referred to in this manual as the engine controller.**

The engine controller regulates ignition timing, air-fuel ratio, emission control devices, cooling fan, charging system, idle speed and speed control. Various sensors provide the inputs necessary for the engine controller to correctly operate these systems. In addition to the sensors, various switches also provide inputs to the engine controller.

All inputs to the engine controller are converted into signals. The engine controller can adapt its programming to meet changing operating conditions.

Fuel is injected into the intake port above the intake valve in precise metered amounts through electrically operated injectors. The engine controller fires the injectors in a specific sequence. The controller maintains an air fuel ratio of 14.7 parts air to 1 part fuel by constantly adjusting injector pulse width. Injector pulse width is the length of time the injector is energized.

The engine controller adjusts injector pulse width by opening and closing the ground path to the injector. Engine RPM (speed) and manifold absolute pressure (air density) are the primary inputs that determine injector pulse width.

SYSTEM DIAGNOSIS

The engine controller tests many of its own input and output circuits. If a fault is found in a major system, the information is stored in memory. Technicians can display fault information through the instrument panel Check Engine lamp or by connecting the Diagnostic Readout Box II (DRB II). For fault code information, refer to On Board Diagnostics in 3.3L/3.8L Multi-Point Fuel Injection—General Diagnosis section of this group.

CCD BUS

Various controllers and modules exchange information through a communications port called the CCD Bus. The engine controller transmits engine RPM and vehicle load information on the CCD Bus.

ENGINE CONTROLLER

The engine controller is a digital computer containing a microprocessor (Fig. 2). The controller receives input signals from various switches and sensors that are referred to as Engine Controller Inputs. Based on these inputs, the controller adjusts various engine and vehicle operations through devices that are referred to as Engine Controller Outputs.

Engine Controller Inputs:

- Air Conditioning Controls

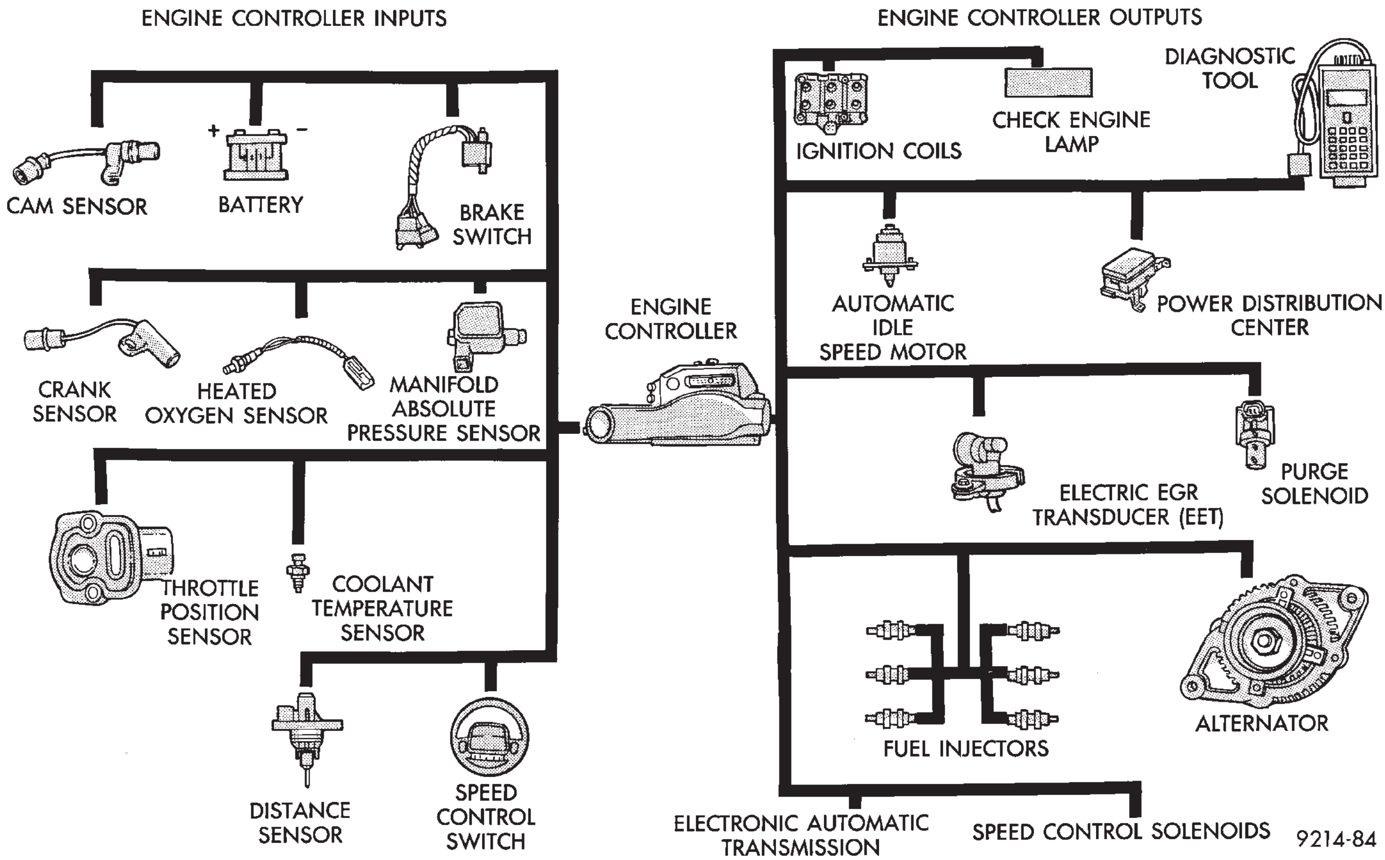

Fig. 1 Multi-Point Fuel Injection Components

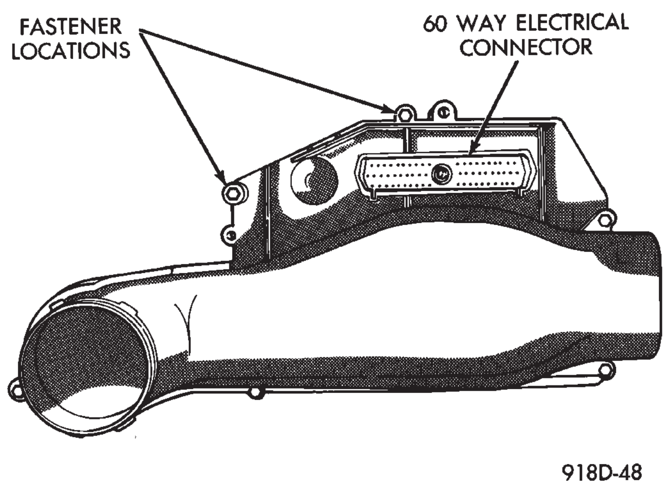

Fig. 2 Engine Controller

- Battery Voltage
- Brake Switch
- Camshaft Sensor
- Crankshaft Sensor
- Coolant Temperature Sensor
- Manifold Absolute Pressure (MAP) Sensor
- Oxygen Sensor
- SCI Receive
- Speed Control System Controls
- Throttle Position Sensor
- Transmission Park/Neutral Switch (automatic transmission)
- Vehicle Distance (Speed) Sensor

Engine Controller Outputs:

- Air Conditioning Clutch Relay
- Alternator Field
- Automatic Idle Speed (AIS) Motor
- Auto Shutdown (ASD) and Fuel Pump Relays
- Canister Purge Solenoid
- Check Engine Lamp
- Diagnostic Connector
- Electronic EGR Transducer
- Fuel Injectors
- Ignition Coil
- Radiator Fan Relay
- Speed Control Solenoids
- Tachometer Output

Based on inputs it receives, the engine controller adjusts the EGR system, fuel injector pulse width, idle speed, ignition spark advance, ignition coil dwell and canister purge operation. The engine controller regulates the cooling fan, air conditioning and speed control systems. The controller changes alternator charge rate by adjusting the alternator field.

The engine controller adjusts injector pulse width (air-fuel ratio) based on the following inputs.

- battery voltage
- coolant temperature

- exhaust gas oxygen content (oxygen sensor)
- engine speed (crankshaft sensor)
- manifold absolute pressure
- throttle position

The engine controller adjusts ignition timing based on the following inputs.

- coolant temperature
- engine speed (crankshaft sensor)
- manifold absolute pressure
- throttle position
- transmission gear selection (park/neutral switch)

The engine controller also adjusts engine idle speed through the automatic idle speed (AIS) motor based on the following inputs.

- brake switch
- coolant temperature
- engine speed (crankshaft sensor)
- throttle position
- transmission gear selection (park/neutral switch)
- vehicle distance (speed)

The auto shutdown (ASD) and fuel pump relays are mounted externally, but turned on and off by the engine controller through the same circuit.

The camshaft and crankshaft signals are sent to the engine controller. If the controller does not receive both signals within approximately one second of engine cranking, it deactivates the ASD and fuel pump relays. When these relays are deactivated, power is shut off to the fuel injector, ignition coil, oxygen sensor heating element and fuel pump.

The engine controller contains a voltage converter that changes battery voltage to a regulated 9.0 volts. The 9.0 volts power the camshaft sensor, crankshaft sensor and vehicle speed sensor. The controller also provides a 5.0 volts supply for the coolant temperature sensor, manifold absolute pressure sensor and throttle position sensor.

Beginning in this model year, the 3.3L and 3.8L engines use sequential fuel injection. The engine controllers for these model year differs from previous model years. Do not use an engine controller from a previous model year to test the system.

AIR CONDITIONING SWITCH SENSE—ENGINE CONTROLLER INPUT

When the air conditioning or defrost switch is put in the ON position and the low pressure, high pressure and ambient temperature switches are closed, the engine controller receives an input for air conditioning. After receiving this input, the engine controller activates the A/C compressor clutch by grounding the A/C clutch relay.

BATTERY VOLTAGE—ENGINE CONTROLLER INPUT

The engine controller monitors the battery voltage input to determine fuel injector pulse width and alternator field control. If battery voltage is low the engine controller will increase injector pulse width.

BRAKE SWITCH—ENGINE CONTROLLER INPUT

When the brake switch is activated, the engine controller receives an input indicating that the brakes are being applied. After receiving this input the engine controller maintains idle speed to a scheduled RPM through control of the Automatic Idle Speed Motor. Also, the brake signal cancels speed control and unlocks the torque convertor. The brake switch is mounted on the brake pedal support bracket.

CAMSHAFT SENSOR—ENGINE CONTROLLER INPUT

Fuel injection synchronization and cylinder identification are provided through the camshaft reference sensor (Fig. 3). The sensor generates pulses that are an input sent to the engine controller. The engine controller interprets the camshaft sensor input along with the crankshaft sensor input to determine crankshaft position. The engine controller uses camshaft position reference to determine injector sequence and ignition timing.

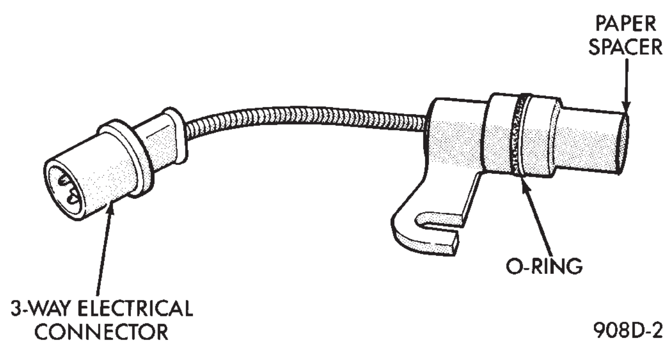

Fig. 3 Camshaft Sensor

The camshaft sensor senses when a slot in the camshaft gear passes beneath it (Fig. 4). When a slot is sensed, the input voltage from the sensor to the engine controller switches from high (5 volts) to low (less than .3 volts). As the slot or window passes, the input voltage is switched back to high (5 volts).

The camshaft sensor is mounted to the top of the timing case cover (Fig. 5). The bottom of the sensor is positioned above the camshaft sprocket. **The distance between the bottom of sensor and the camshaft sprocket is critical to the operation of the system. When servicing the camshaft sensor, refer to the 3.3L and 3.8L Multi-Point Fuel Injection—Service section in this Group.**

COOLANT TEMPERATURE SENSOR—ENGINE CONTROLLER INPUT

The coolant temperature sensor is a variable resistor with a range of -40°F to 265°F. The sensor is installed next to the thermostat housing (Fig. 6).

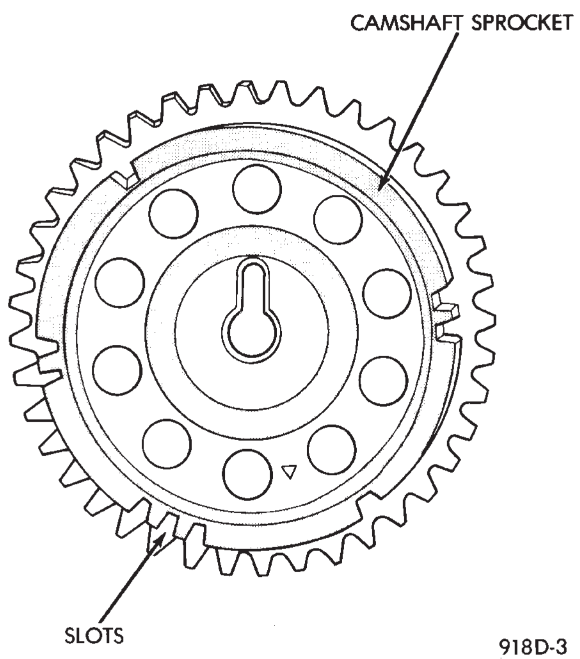

Fig. 4 Camshaft Gear

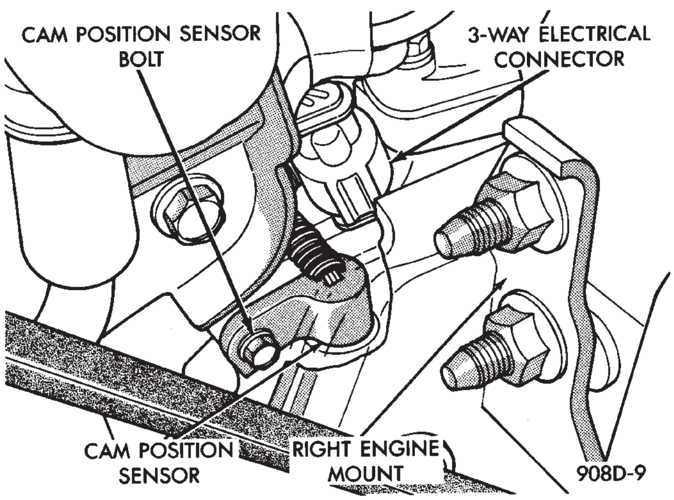

Fig. 5 Camshaft Sensor Location

The engine controller supplies 5.0 volts to the coolant temperature sensor. The sensor provides an input voltage to the engine controller. As coolant temperature varies, the sensor resistance changes resulting in a different input voltage to the engine controller.

When the engine is cold, the engine controller will demand slightly richer air-fuel mixtures and higher idle speeds until normal operating temperatures are reached.

The coolant sensor is also used for cooling fan control.

CRANKSHAFT SENSOR—ENGINE CONTROLLER INPUT

The crankshaft sensor (Fig. 7) senses slots cut into the transmission driveplate extension. There are a 3

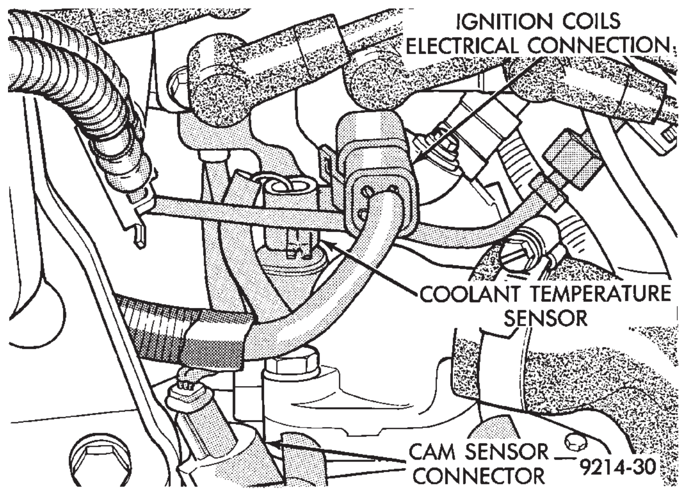

Fig. 6 Coolant Temperature Sensor

sets of slots. Each set contains 4 slots, for a total of 12 slots (Fig. 8). Basic timing is determined by the position of the last slot in each group. Once the engine controller senses the last slot, it determines crankshaft position (which piston will next be at TDC) from the camshaft sensor input. It may take the controller one engine revolution to determine crankshaft position during cranking.

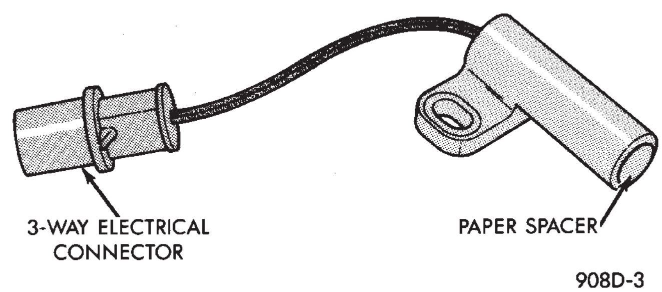

Fig. 7 Crankshaft Sensor

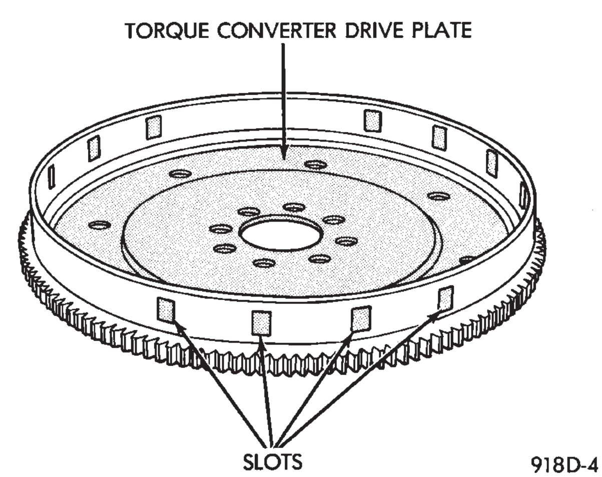

Fig. 8 Timing Slots

The engine controller uses the camshaft reference sensor to determine injector sequence. The controller determines ignition timing from the crankshaft timing sensor. Once crankshaft position has been determined, the engine controller begins energizing the injectors in sequence.

The crankshaft sensor is located in the transmission housing, above the vehicle distance sensor (Fig. 9). The bottom of the sensor is positioned next to the drive plate. **The distance between the bottom of sensor and the drive plate is critical to the operation of the system. When servicing the crankshaft sensor, refer to the Multi-Point Fuel Injection Service Procedures—3.3L Engine section in this Group.**

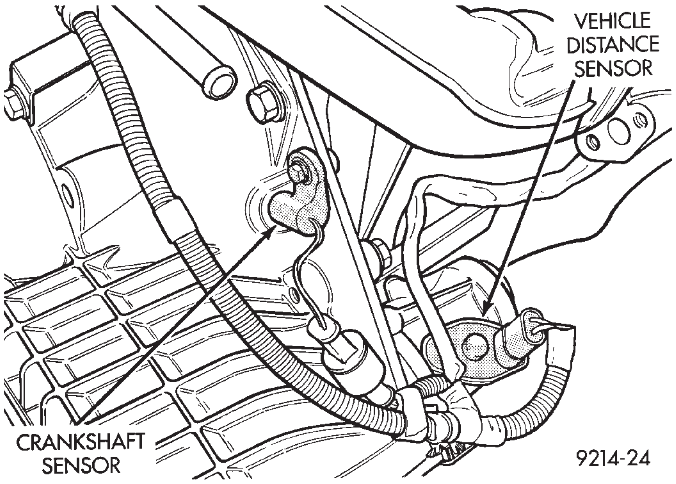

Fig. 9 Crankshaft Sensor Location

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—ENGINE CONTROLLER INPUT

The engine controller supplies 5 volts to the MAP sensor. The Map sensor converts intake manifold pressure into voltage. The engine controller monitors the MAP sensor output voltage. As vacuum increases, MAP sensor voltage decreases proportionately. Also, as vacuum decreases, MAP sensor voltage increases proportionately.

During cranking, before the engine starts running, the engine controller determines atmospheric air pressure from the MAP sensor voltage. While the engine operates, the controller determines intake manifold pressure from the MAP sensor voltage.

Based on MAP sensor voltage and inputs from other sensors, the engine controller adjusts spark advance and the air/fuel mixture.

The MAP sensor (Fig. 10) mounts to the side of the intake manifold, below the positive crankcase ventilation (PCV) valve. The sensor connects electrically to the engine controller.

OXYGEN SENSOR (O_2 SENSOR)—ENGINE CONTROLLER INPUT

The O_2 sensor is located in the exhaust manifold and provides an input voltage to the engine controller. The input tells the engine controller the oxygen content of the exhaust gas (Fig. 11). The engine control-

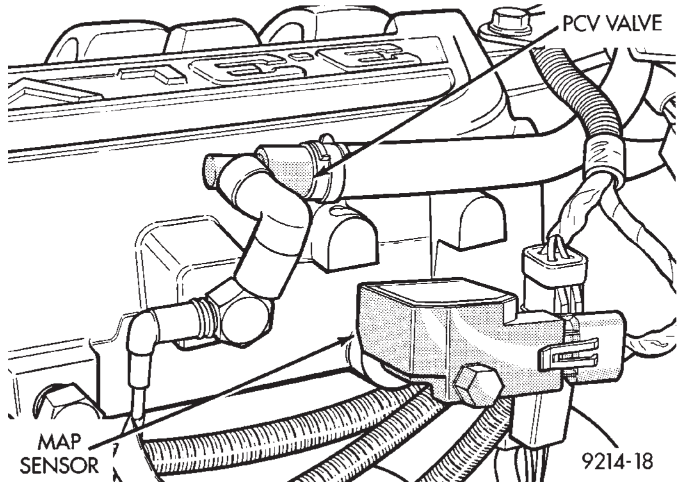

Fig. 10 Map Sensor

ler uses this information to fine tune the air-fuel ratio by adjusting injector pulse width.

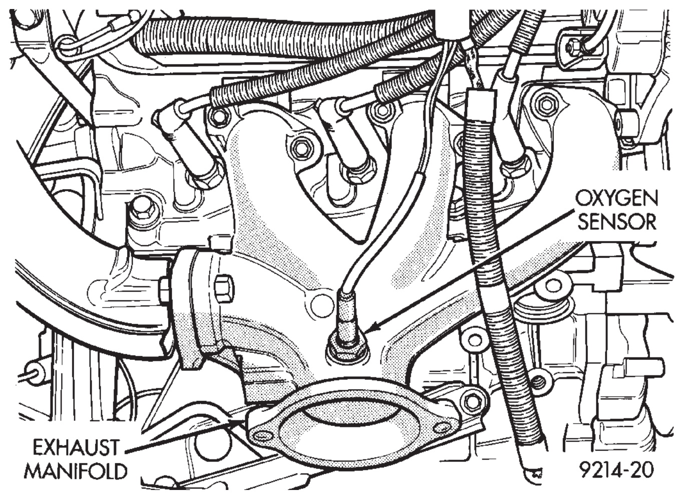

Fig. 11 Oxygen Sensor—3.3L Engine

The O_2 sensor produces voltages from 0 to 1 volt, depending upon the oxygen content of the exhaust gas in the exhaust manifold. When a large amount of oxygen is present (caused by a lean air-fuel mixture), the sensor produces a low voltage. When there is a lesser amount present (rich air-fuel mixture) it produces a higher voltage. By monitoring the oxygen content and converting it to electrical voltage, the sensor acts as a rich-lean switch.

The oxygen sensor is equipped with a heating element that keeps the sensor at proper operating temperature during all operating modes. Maintaining correct sensor temperature at all times allows the system to enter into closed loop operation sooner. Also, it allows the system to remain in closed loop operation during periods of extended idle.

In Closed Loop operation the engine controller monitors the O_2 sensor input (along with other inputs) and adjusts the injector pulse width accordingly. During Open Loop operation the engine controller ignores the O_2 sensor input. The controller adjusts injector pulse width based on preprogrammed (fixed) values and inputs from other sensors.

SPEED CONTROL—ENGINE CONTROLLER INPUT

The speed control system provides four separate voltages (inputs) to the engine controller. The voltages correspond to the On/Off, Set, and Resume.

The speed control ON voltage informs the engine controller that the speed control system has been activated. The speed control SET voltage informs the controller that a fixed vehicle speed has been selected. The speed control RESUME voltage indicates the previous fixed speed is requested. The speed control OFF voltage tells the controller that the speed control system has been deactivated. Refer to Group 8H for further speed control information.

TRANSMISSION PARK/NEUTRAL SWITCH—ENGINE CONTROLLER INPUT

The park/neutral switch is located on the transmission housing (Fig. 12). It provides an input to the engine controller indicating whether the automatic transmission is in Park, Neutral, or a drive gear selection. This input is used to determine idle speed (varying with gear selection) and ignition timing advance. The park neutral switch is sometimes referred to as the neutral safety switch.

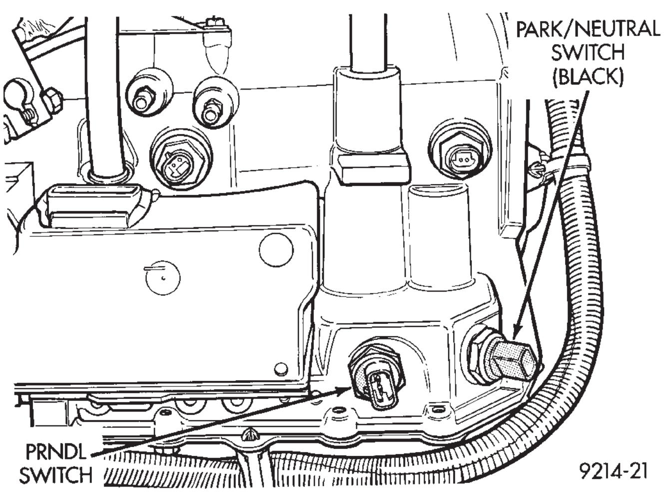

Fig. 12 Park Neutral Switch—4-Speed Electronic Automatic Transaxle

THROTTLE POSITION SENSOR (TPS)—ENGINE CONTROLLER INPUT

The Throttle Position Sensor (TPS) is mounted on the throttle body and connected to the throttle blade shaft (Fig. 13). The TPS is a variable resistor that provides the engine controller with an input signal (voltage). The signal represents throttle blade position. As the position of the throttle blade changes, the resistance of the TPS changes.

The engine controller supplies approximately 5 volts to the TPS. The TPS output voltage (input signal to the engine controller) represents the throttle blade position. The TPS output voltage to the controller varies from approximately 0.5 volt at minimum throttle opening (idle) to 3.5 volts at wide open throttle. Along with inputs from other sensors, the engine controller uses the TPS input to determine current engine operating conditions. The controller also adjust fuel injector pulse width and ignition timing based on these inputs.

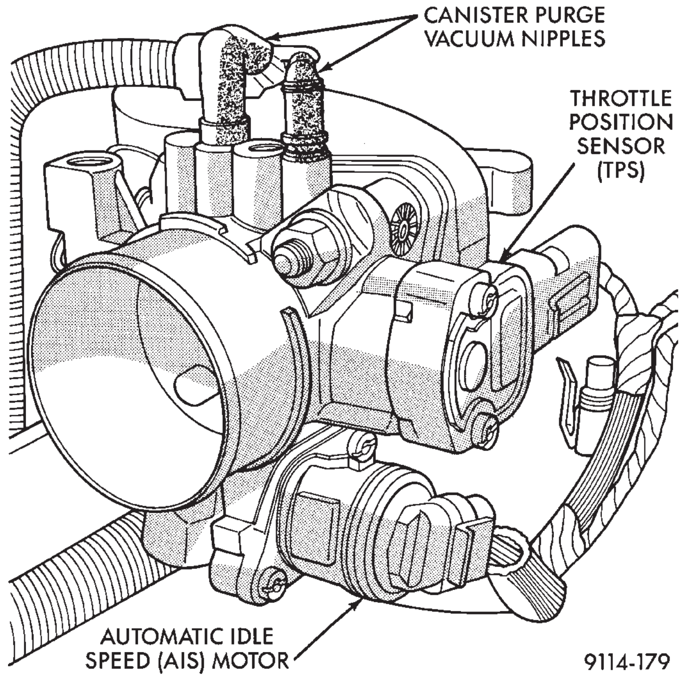

Fig. 13 Throttle Position Sensor

VEHICLE DISTANCE (SPEED) SENSOR—ENGINE CONTROLLER INPUT

The distance sensor (Fig. 14) is located in the transmission extension housing. The sensor input is used by the engine controller to determine vehicle speed and distance traveled.

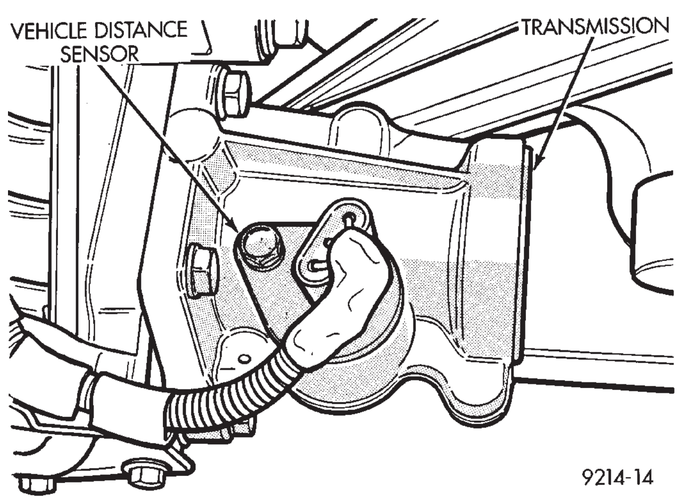

Fig. 14 Vehicle Distance (Speed) Sensor

The distance sensor generates 8 pulses per sensor revolution. These signals, along with a closed throttle signal from the TPS, determine if a closed throttle deceleration or normal idle condition (vehicle stopped) exists. Under deceleration conditions, the engine controller adjusts the AIS motor to maintain a desired MAP value. Under idle conditions, the engine controller adjusts the AIS motor to maintain a desired engine speed.

AIR CONDITIONING (A/C) CLUTCH RELAY—ENGINE CONTROLLER OUTPUT

The engine controller operates the air conditioning clutch relay ground circuit (Fig. 15). The ignition switch supplies battery voltage to the solenoid side of the relay. When the A/C clutch relay energizes, battery voltage powers the A/C compressor clutch.

With the engine operating and the blower motor switch in the On position, the engine controller cycles the air conditioning clutch on and off when the A/C switch closes. When the engine controller senses low idle speeds or wide open throttle through the throttle position sensor, it de-energizes the A/C clutch relay. The relay contacts open, preventing air conditioning clutch engagement.

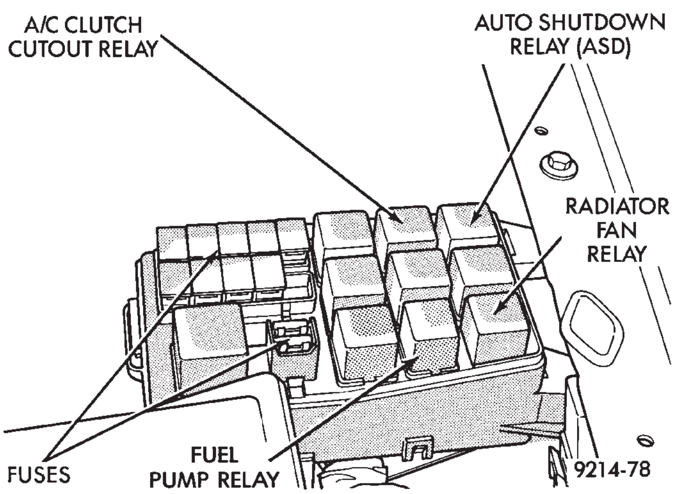

Fig. 15 Relay Identification

ALTERNATOR FIELD—ENGINE CONTROLLER OUTPUT

The engine controller regulates the charging system voltage within a range of 12.9 to 15.0 volts. Refer to Group 8A for charging system information.

AUTO SHUTDOWN (ASD) RELAY AND FUEL PUMP RELAY—ENGINE CONTROLLER OUTPUT

The engine controller operates the auto shutdown (ASD) relay and fuel pump relay through one ground path. The controller operates the relays by switching the ground path on and off. Both relays turn on and off at the same time.

The ASD relay connects battery voltage to the fuel injector and ignition coil. The fuel pump relay connects battery voltage to the fuel pump and oxygen sensor heating element.

The engine controller turns the ground path off when the ignition switch is in the Off position. Both relays are off. When the ignition switch is in the On or Crank position, the engine controller monitors the crankshaft and camshaft sensor signals to determine engine speed and ignition timing (coil dwell). If the engine controller does not receive the crankshaft and camshaft signals when the ignition switch is in the Run position, it de-energizes both relays. When the relays are de-energized, battery voltage is not supplied to the fuel injector, ignition coil, fuel pump and oxygen sensor heating element.

The ASD relay and fuel pump relay are located in the power distribution center (Fig. 15).

AUTOMATIC IDLE SPEED (AIS) MOTOR—ENGINE CONTROLLER OUTPUT

The idle speed stepper (AIS) motor is mounted on the throttle body. The engine controller operates the AIS motor (Fig. 13). The engine controller adjusts engine idle speed through the AIS to compensate for engine load or ambient conditions.

The throttle body has an air bypass passage that provides air for the engine at idle (the throttle blade is closed). The AIS motor pintle protrudes into the air bypass passage and regulates air flow through it.

The engine controller adjusts engine idle speed by moving the AIS motor pintle in and out of the bypass passage. The adjustments are based on inputs the controller receives. The inputs are from the throttle position sensor, crankshaft sensor, coolant temperature sensor, and various switch operations (brake, park/neutral, air conditioning). Deceleration die out is also prevented by increasing airflow when the throttle is closed quickly after a driving (speed) condition.

CANISTER PURGE SOLENOID—ENGINE CONTROLLER OUTPUT

Vacuum for the Evaporative Canister is controlled by the Canister Purge Solenoid (Fig. 16). The solenoid is controlled by the engine controller.

The engine controller operates the solenoid by switching the ground circuit on and off based on engine operating conditions. When energized, the solenoid prevents vacuum from reaching the evaporative canister. When not energized the solenoid allows vacuum to flow to the canister.

The engine controller grounds the purge solenoid. When grounded, the solenoid is energized and vacuum does not operate the evaporative canister valve.

The engine controller removes the ground to the solenoid when the engine reaches a specified temperature and the time delay interval has occurred.

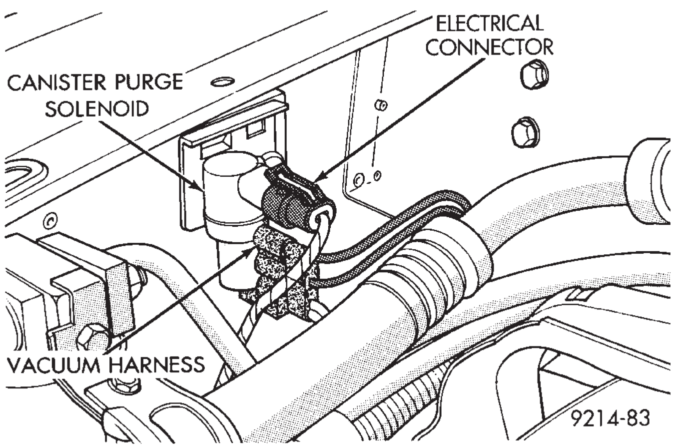

Fig. 16 Canister Purge Solenoid

When the solenoid is de-energized, vacuum flows to the canister purge valve. Vapors are purged from the canister and flow to the throttle body.

The purge solenoid will also be energized during certain idle conditions, in order to update the fuel delivery calibration.

CHECK ENGINE LAMP—ENGINE CONTROLLER OUTPUT

The Check Engine Lamp comes on each time the ignition key is turned ON and stays on for 3 seconds as a bulb test. The Check Engine Lamp warns the operator that the engine controller has entered a Limp-in mode. During Limp-in Mode, the controller attempts to keep the system operational. The check engine lamp signals the need for immediate service. In limp-in mode, the Engine controller compensates for the failure of certain components that send incorrect signals. The controller substitutes for the incorrect signals with inputs from other sensors.

Signals that can trigger the Check Engine Lamp.

- Coolant Temperature Sensor
- Manifold Absolute Pressure Sensor
- Throttle Position Sensor
- Battery Voltage Input
- An Emission Related System (California vehicles)
- Charging system

The Check Engine Lamp can also display fault codes. Cycle the ignition switch on, off, on, off, on, within five seconds and any fault codes stored in the Engine controller will be displayed. Refer to On Board Diagnostics in the 3.3L and 3.8L Multi-Point Fuel Injection General Diagnosis section of this Group for Fault Code Descriptions.

DIAGNOSTIC CONNECTOR—ENGINE CONTROLLER OUTPUT

The diagnostic connector provides the technician with the means to connect the DRB II tester to diagnosis the vehicle.

ELECTRONIC AUTOMATIC TRANSAXLE CONTROLLER—ENGINE CONTROLLER OUTPUT

The engine controller supplies the following information to the electronic automatic transmission controller through the CCD Bus:

- battery temperature
- brake switch input
- coolant temperature
- manifold absolute pressure (MAP)
- speed control information

ELECTRIC EGR TRANSDUCER (EET) SOLENOID—ENGINE CONTROLLER OUTPUT

The electronic EGR transducer (EET) contains an electrically operated solenoid and a back-pressure transducer (Fig. 17). The engine controller operates the solenoid. The controller determines when to energize the solenoid. Exhaust system back-pressure controls the transducer.

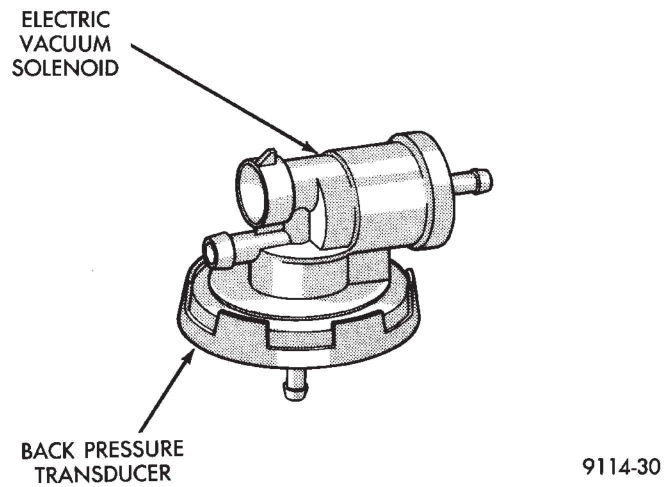

Fig. 17 Electric EGR Transducer (EET) Assembly

When the controller energizes the solenoid, vacuum does not reach the transducer. Vacuum flows to the transducer when the controller de-energizes the solenoid.

When exhaust system back-pressure becomes high enough, it fully closes a bleed valve in the transducer. When the controller de-energizes the solenoid and back-pressure closes the transducer bleed valve, vacuum flows through the transducer to operate the EGR valve.

De-energizing the solenoid, but not fully closing the transducer bleed hole (because of by low back-pressure), varies the strength of vacuum applied to the EGR valve. Varying the strength of the vacuum changes the amount of EGR supplied to the engine. This provides the correct amount of exhaust gas recirculation for different operating conditions.

FUEL INJECTORS—ENGINE CONTROLLER OUTPUT

The fuel injectors are electrical solenoids (Fig. 18). The injector contains a pintle that closes off an orifice at the nozzle end. When electric current is supplied to the injector, the armature and needle move a short distance against a spring, allowing fuel to flow out the orifice. Because the fuel is under high pressure, a fine spray is developed in the shape of a hollow cone. The spraying action atomizes the fuel, adding it to the air entering the combustion chamber. The injectors are positioned in the intake manifold.

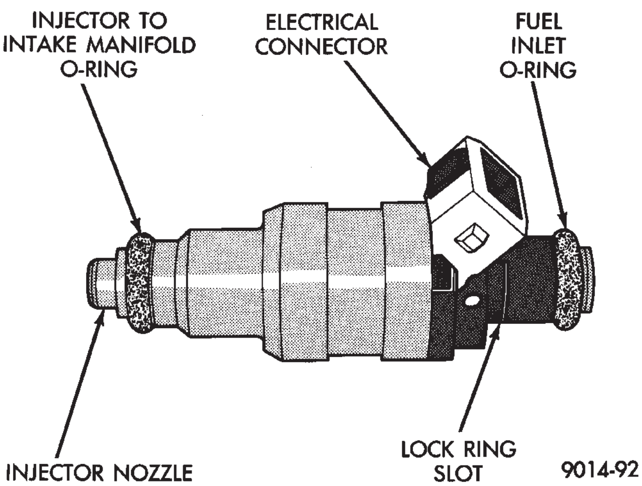

Fig. 18 Fuel Injector—3.3L Engine

The fuel injectors are operated by the engine controller. They are energized in a sequential order during all engine operating conditions except start up. The engine controller initially energizes all injectors at the same time. Once the engine controller determines crankshaft position, it begins energizing the injectors in sequence.

The auto shutdown (ASD) relay supplies battery voltage to the injectors. The engine controller provides the ground path for the injectors. By switching the ground path on and off, the controller adjusts injector pulse width. Pulse width is the amount of time the injector is energized. The controller adjusts injector pulse width based on inputs it receives.

IGNITION COIL—ENGINE CONTROLLER OUTPUT

The coil assembly consists of 3 molded coils together (Fig. 19). The coil assembly is mounted on the intake manifold. High tension leads route to each cylinder from the coil. The coil fires two spark plugs every power stroke. One plug is the cylinder under compression, the other cylinder fires on the exhaust stroke. The engine controller determines which of the coils to charge and fire at the correct time.

The auto shutdown (ASD) relay provides battery voltage to the ignition coil. The engine controller provides a ground contact (circuit) for energizing the coil. When the controller breaks the contact, the energy in the coil primary transfers to the secondary, causing the spark. The engine controller will de-energize the ASD relay if it does not receive the crankshaft sensor

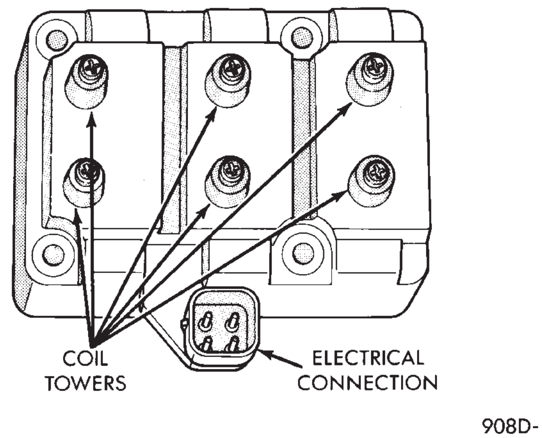

Fig. 19 Coil Pack—3.3L Engine

and camshaft sensor inputs. Refer to Auto Shutdown (ASD) Relay/Fuel Pump Relay—Engine Controller Output in this section for relay operation.

RADIATOR FAN RELAY—ENGINE CONTROLLER OUTPUT

The radiator fan is energized by the engine controller through the radiator fan relay. The radiator fan relay is located on the drivers side fender well near the engine controller (Fig. 15). The controller grounds the radiator fan relay when engine coolant reaches a predetermined temperature or the A/C system head pressure is high.

SPEED CONTROL SOLENOIDS—ENGINE CONTROLLER OUTPUT

The speed control vacuum and vent solenoids are operated by the engine controller. When the engine controller supplies a ground to the vacuum solenoid, the speed control system opens the throttle plate. When the controller supplies a ground to the vent solenoid, the throttle blade closes. The engine controller balances the two solenoids to maintain the set speed. Refer to Group 8H for speed control information.

TACHOMETER—ENGINE CONTROLLER OUTPUT

The engine controller supplies engine RPM to the instrument panel tachometer through the CCD Bus. The CCD Bus is a communications port. Various modules use the CCD Bus to exchange information. Refer to Group 8E for more information.

MODES OF OPERATION

As input signals to the engine controller change, the engine controller adjusts its response to output devices. For example, the engine controller must calculate a different injector pulse width and ignition timing for idle than it does for wide open throttle (WOT). There are several different modes of operation that determine how the engine controller responds to the various input signals.

There are two different areas of operation, Open Loop and Closed Loop.

During Open Loop modes the engine controller receives input signals and responds according to preset engine controller programming. Input from the oxygen (O_2) sensor is not monitored during Open Loop modes.

During Closed Loop modes the engine controller does monitor the oxygen (O_2) sensor input. This input indicates to the engine controller whether or not the calculated injector pulse width results in the ideal air-fuel ratio of 14.7 parts air to 1 part fuel. By monitoring the exhaust oxygen content through the O_2 sensor, the engine controller can fine tune the injector pulse width. Fine tuning injector pulse width allows the engine controller to achieve optimum fuel economy combined with low emissions.

The 3.3L multi-point fuel injection system has the following modes of operation:

- Ignition switch ON (Zero RPM)
- Engine start-up
- Engine warm-up
- Cruise (Idle)
- Acceleration
- Deceleration
- Wide Open Throttle
- Ignition switch OFF

The engine start-up (crank), engine warm-up, and wide open throttle modes are OPEN LOOP modes. Under most operating conditions, the acceleration, deceleration, and cruise modes, **with the engine at operating temperature** are CLOSED LOOP modes.

IGNITION SWITCH ON (ZERO RPM) MODE

When the multi-point fuel injection system is activated by the ignition switch, the following actions occur:

- The engine controller determines atmospheric air pressure from the MAP sensor input to determine basic fuel strategy.
- The engine controller monitors the coolant temperature sensor and throttle position sensor input. The engine controller modifies fuel strategy based on this input.

When the key is in the ON position and the engine is not running (zero rpm), the auto shutdown (ASD) relay and fuel pump relay are not energized. Therefore battery voltage is not supplied to the fuel pump, ignition coil, fuel injectors or oxygen sensor heating element.

ENGINE START-UP MODE

This is an OPEN LOOP mode. The following actions occur when the starter motor is engaged.

If the engine controller receives the camshaft and crankshaft signals, it energizes the auto shutdown (ASD) relay and fuel pump relay. These relays supply battery voltage to the fuel pump, fuel injectors, ignition coil, and oxygen sensor heating element. If the engine controller does not receive the camshaft and crankshaft signals within approximately one second, it de-energizes the ASD relay and fuel pump relay.

The engine controller energizes all six injectors until it determines crankshaft position from the camshaft and crankshaft signals. The controller determines crankshaft position within 1 engine revolution.

After determining crankshaft position, the controller begins energizing the injectors in sequence. The controller adjusts injector pulse width and controls injector synchronization by turning the individual ground paths to the injectors On and Off.

When the engine idles within ± 64 RPM of its target RPM, the controller compares current MAP sensor value with the atmospheric pressure value received during the Ignition Switch On (Zero RPM) mode. If the controller does not detect a minimum difference between the two values, it sets a MAP fault into memory.

Once the ASD and fuel pump relays have been energized, the engine controller:

- Determines injector pulse width based on coolant temperature, engine rpm and the number of engine revolutions since cranking was initiated.

ENGINE WARM-UP MODE

This is a OPEN LOOP mode. The following inputs are received by the engine controller:

- coolant temperature
- manifold absolute pressure (MAP)
- engine speed (crankshaft position sensor)
- throttle position
- A/C switch
- battery voltage

The controller adjusts injector pulse width and controls injector synchronization by turning the individual ground paths to the injectors On and Off.

The engine controller adjusts ignition timing and engine idle speed. Engine idle speed is adjusted through the automatic idle speed motor.

CRUISE OR IDLE MODE

When the engine is at operating temperature this is a CLOSED LOOP mode. During cruising speed the following inputs are received by the engine controller:

- coolant temperature
- manifold absolute pressure
- engine speed (crankshaft position sensor)
- throttle position

- exhaust gas oxygen content
- A/C control positions
- battery voltage

The controller adjusts injector pulse width and controls injector synchronization by turning the individual ground paths to the injectors On and Off.

The engine controller adjusts engine idle speed and ignition timing. The engine controller adjusts the air/fuel ratio according to the oxygen content in the exhaust gas.

ACCELERATION MODE

This is a CLOSED LOOP mode. The engine controller recognizes an abrupt increase in throttle position or MAP pressure as a demand for increased engine output and vehicle acceleration. The engine controller increases injector pulse width in response to increased fuel demand.

DECELERATION MODE

This is a CLOSED LOOP mode. During deceleration the following inputs are received by the engine controller:

- coolant temperature
- manifold absolute pressure
- engine speed
- throttle position
- exhaust gas oxygen content
- A/C control positions
- battery voltage

The engine controller may receive a closed throttle input from the throttle position sensor (TPS) when it senses an abrupt decrease in manifold pressure. This indicates a hard deceleration. The engine controller will reduce injector pulse width. This helps maintain better control of the air-fuel mixture (as sensed through the O_2 sensor).

During a closed throttle deceleration condition, the engine controller grounds the exhaust gas recirculation (EGR) solenoid. When the solenoid is grounded, EGR function stop.

WIDE OPEN THROTTLE MODE

This is an OPEN LOOP mode. During wide-open-throttle operation, the following inputs are received by the engine controller:

- coolant temperature
- manifold absolute pressure
- engine speed
- throttle position

When the engine controller senses wide open throttle condition through the throttle position sensor (TPS) it will:

- De-energize the air conditioning relay. This disables the air conditioning system.
- Provide a ground for the electrical EGR transducer (EET) solenoid. When the controller grounds the solenoid, the EGR system stops operating.

The exhaust gas oxygen content input is not accepted by the engine controller during wide open throttle operation. The engine controller will adjust injector pulse width to supply a predetermined amount of additional fuel.

IGNITION SWITCH OFF MODE

When the ignition switch is turned to the OFF position, the following occurs:

- All outputs are turned off.

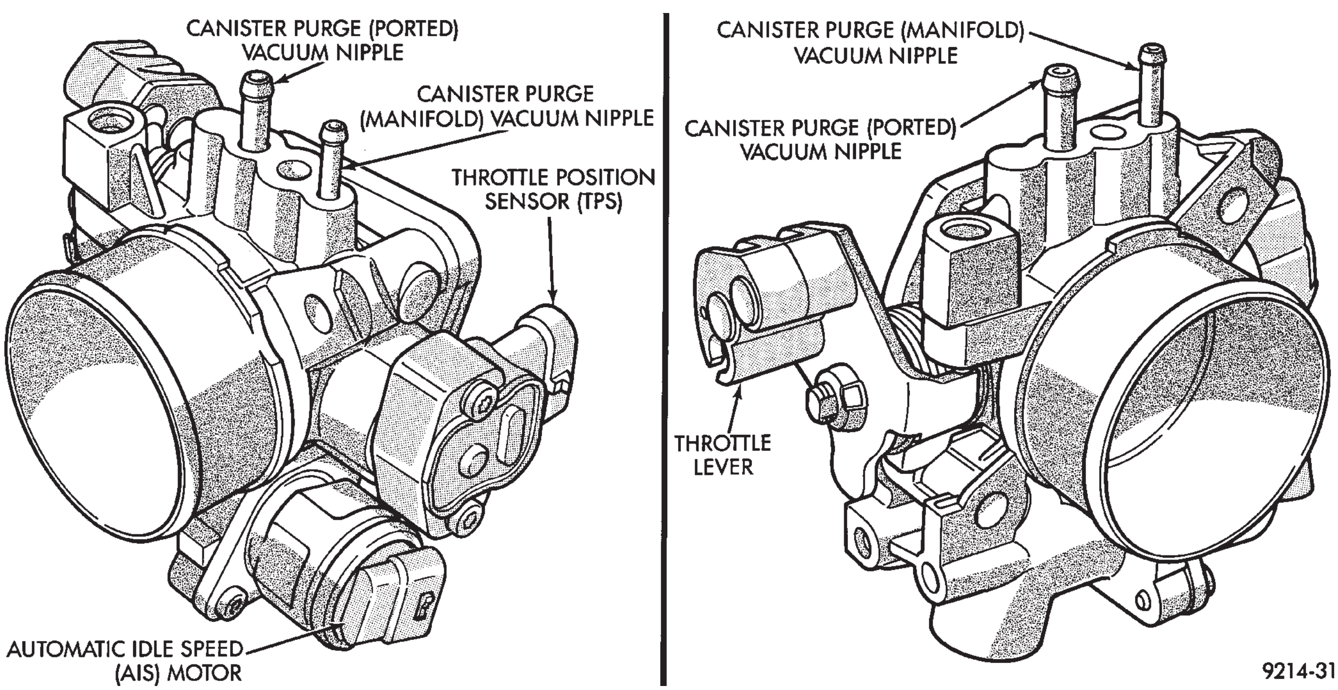

Fig. 20 Throttle Body

- No inputs are monitored.
- The engine controller shuts down.

THROTTLE BODY

The throttle body assembly is located on the left side of the intake manifold plenum (Fig. 20). The throttle body houses the throttle position sensor and the automatic idle speed motor. Air flow through the throttle body is controlled by a cable operated throttle blade located in the base of the throttle body.

FUEL SUPPLY CIRCUIT

Fuel is pumped to the fuel rail by an electrical pump in the fuel tank. The pump inlet is fitted with a strainer to prevent water and other contaminants from entering the fuel supply circuit.

Fuel pressure is controlled to a preset level above intake manifold pressure by a pressure regulator. The regulator is mounted on the fuel rail. The regulator uses intake manifold pressure as a reference.

FUEL INJECTORS AND FUEL RAIL ASSEMBLY

Six fuel injectors are retained in the fuel rail by lock rings (Fig. 21). The rail and injector assembly is installed in position with the injectors inserted in recessed holes in the intake manifold.

FUEL PRESSURE REGULATOR

The pressure regulator is a mechanical device located on the fuel rail, downstream of the fuel injectors (Fig. 22). The regulator maintains a constant 330 kPa (48 psi) across the fuel injector tip.

The regulator contains a spring loaded rubber diaphragm that covers the fuel return port. When the fuel pump is operating, fuel flows past the injectors into the regulator, and is restricted from flowing any further by the blocked return port. When fuel pressure reaches 330 kPa (48 psi) it pushes on the diaphragm, compresses the spring, and uncovers the fuel return port. The diaphragm and spring constantly move from an open to closed position keeping fuel pressure consistent.

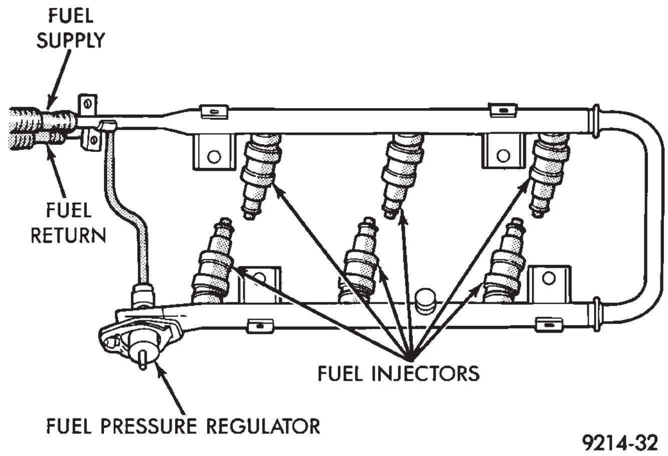

Fig. 21 Fuel Rail Assembly

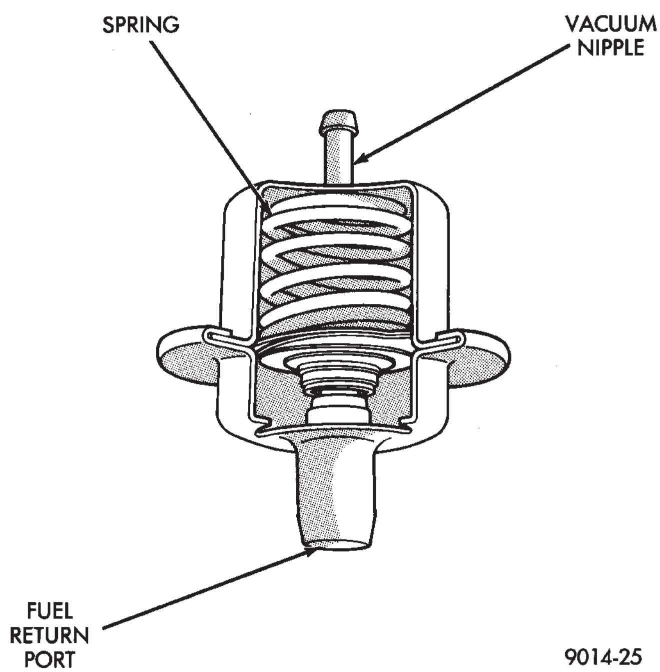

Fig. 22 Fuel Pressure Regulator

3.3L AND 3.8L MULTI-POINT FUEL INJECTION—GENERAL DIAGNOSIS

INDEX

FUEL SYSTEM DIAGRAM

Refer to the Component Identification portion of this section for a more complete description of the components shown in Fig. 1.

VISUAL INSPECTION

Perform a visual inspection for loose, disconnected, or misrouted wires and hoses before diagnosing or servicing the fuel injection system. A visual check saves unnecessary test and diagnostic time. A thorough visual inspection includes the following checks:

(1) Check ignition cable routing from the coil pack to the spark plugs. Verify the cable are routed in the correct order and are fully seated to the coil and spark plug.

(2) Check direct ignition system (DIS) coil electrical connection for damage and a complete connection to the coil (Fig. 2).

(3) Verify the camshaft sensor electrical connector is connected to the harness and not damaged (Fig. 3).

(4) Ensure the engine temperature sensor electrical connector is connected to the sensor and not damaged (Fig. 3).

(5) Ensure the coolant temperature sensor electrical connector is connected to the sensor and not damaged (Fig. 4).

(6) Verify the quick connect fuel fittings are fully inserted on the fuel supply and return tubes.

(7) Check the vacuum hose connection at the fuel pressure regulator for damage or leakage (Fig. 5).

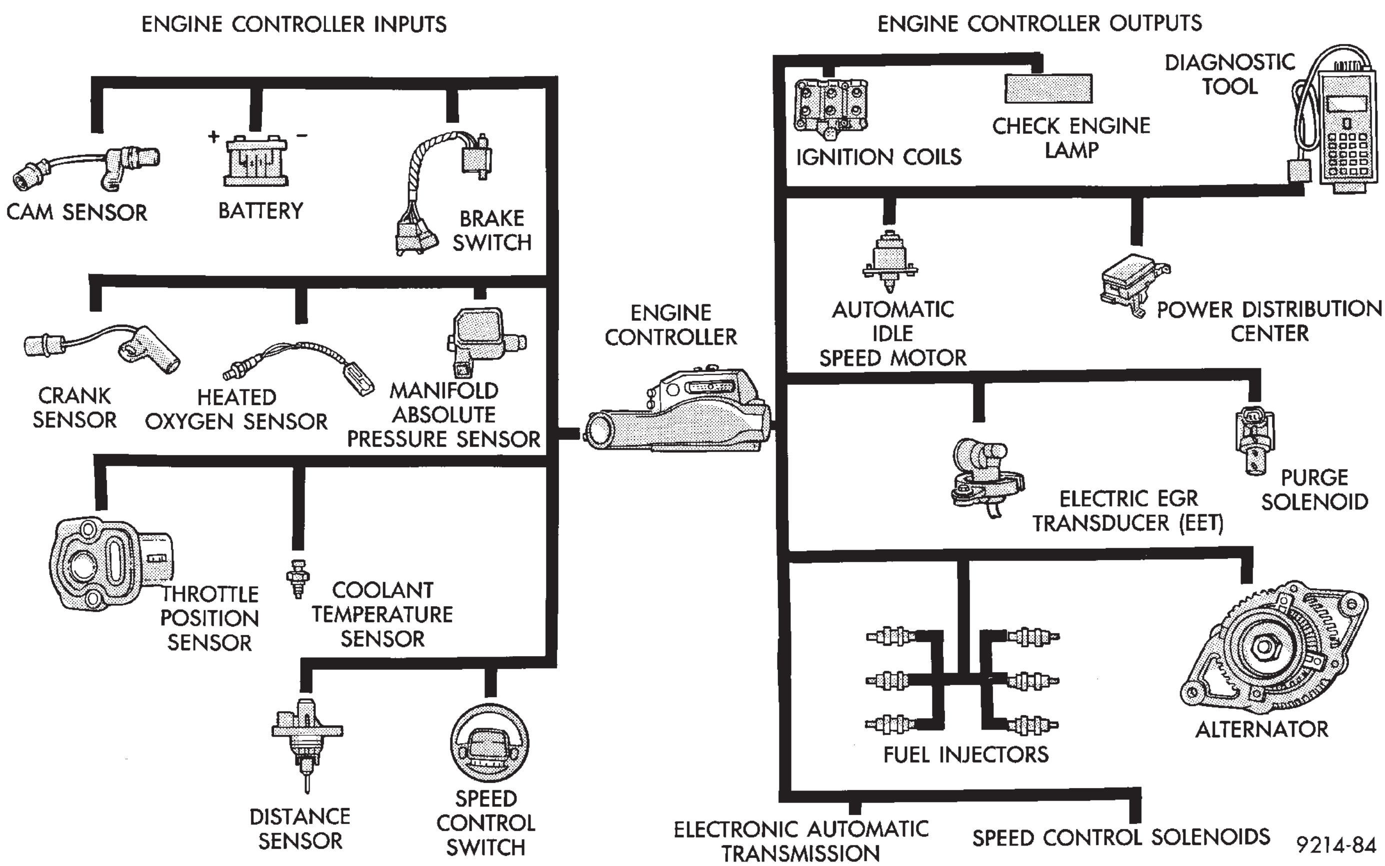

Fig. 1 Multi-Point Fuel Injection Components

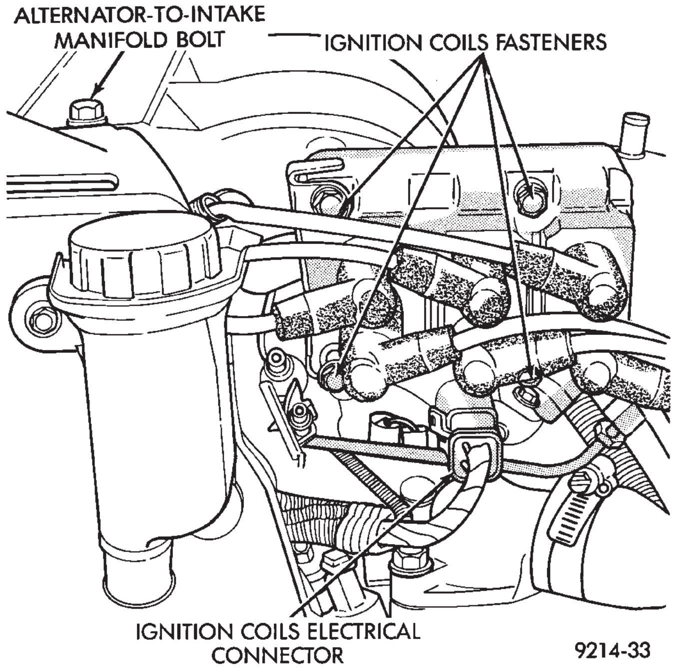

Fig. 2 Ignition Coils Electrical Connection

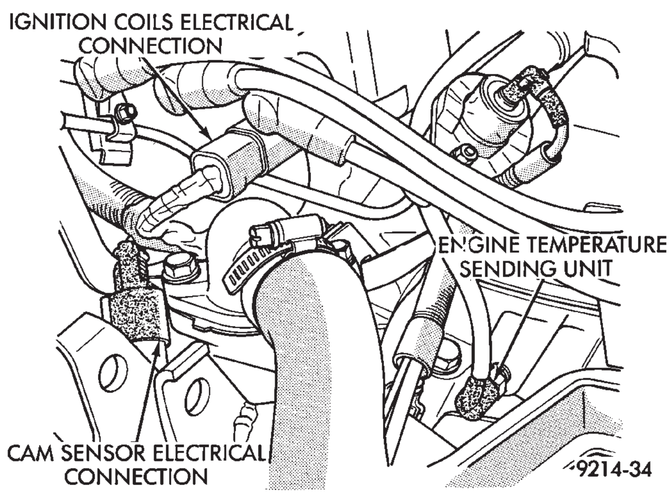

Fig. 3 Camshaft Sensor

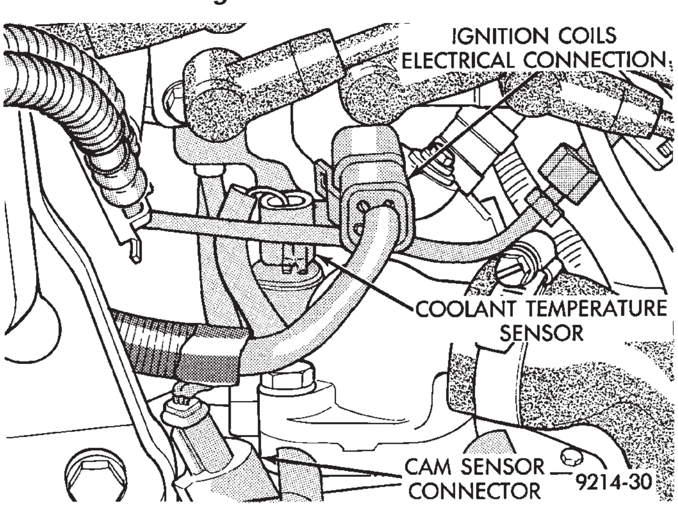

Fig. 4 Coolant Temperature Sensor

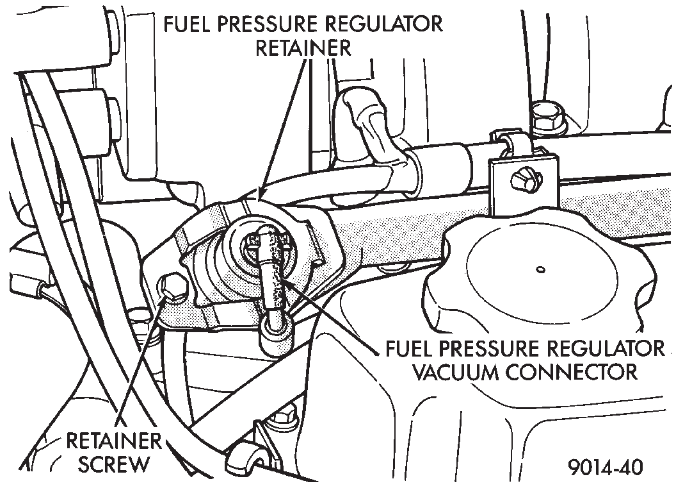

Fig. 5 Fuel Pressure Regulator Vacuum Connection

(8) Check the oil pressure sending unit electrical connection (Fig. 6).

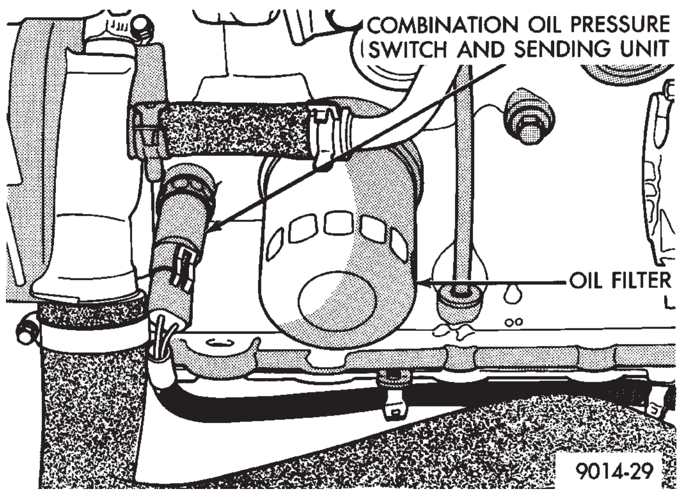

Fig. 6 Oil Pressure Sending Unit Electrical Connection

(9) Verify the electrical connector is attached to the Purge Solenoid (Fig. 7) and not damaged.

(10) Verify the vacuum connection at the purge solenoid is secure and not leaking (Fig. 7).

(11) Verify the hoses are securely attached to the vapor canister (Fig. 8).

(12) Ensure the harness connectors for the fuel injector are attached to the correct injector and not damaged.

(13) Verify the fuel injector harness and engine wiring harness connectors are fully inserted into the main wiring harness.

(14) Check the vacuum connections at the throttle body (Fig. 9).

(15) Ensure the AIS motor and TPS electrical connectors are fully seated and not damaged (Fig. 9).

(16) Verify the harness connector is attached to the electric EGR transducer solenoid (Fig. 9).

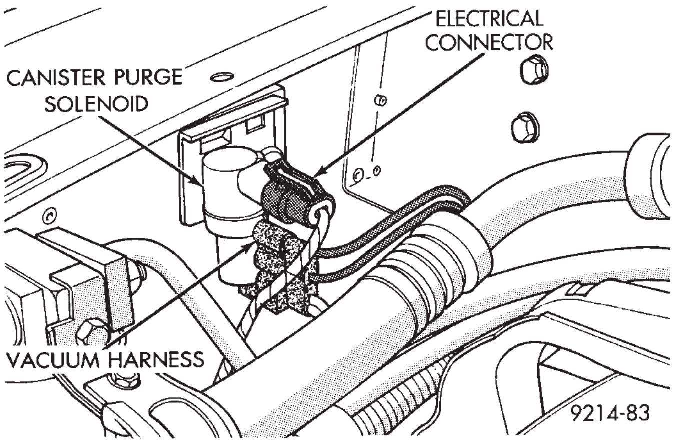

Fig. 7 Canister Purge Solenoid

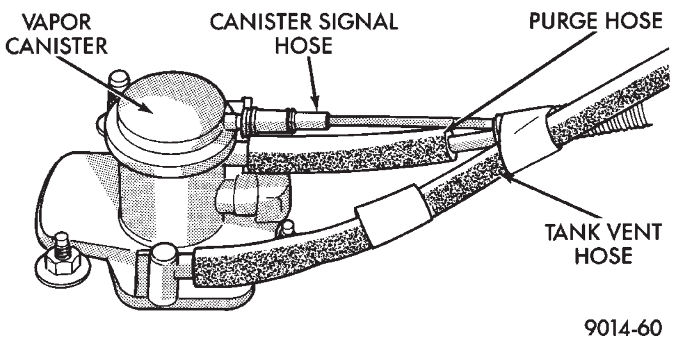

Fig. 8 Vapor Canister

(17) Verify the vacuum connections at the transducer are secure (Fig. 9). Check all EGR system vacuum hoses for secure connections. Inspect the EGR tube.

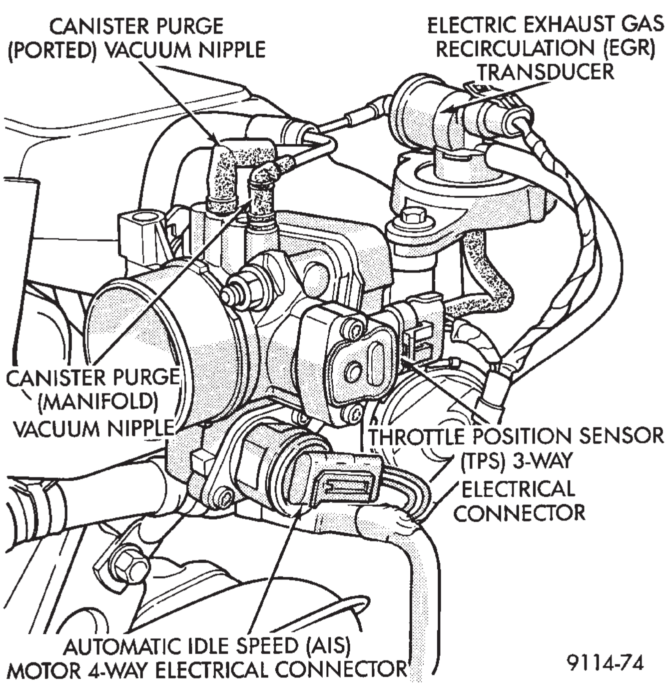

Fig. 9 Throttle Body Electrical and Vacuum Connections

(18) Inspect the park/neutral switch wiring connection for damage. Ensure the automatic transmission electrical connections are not damaged (Fig. 10).

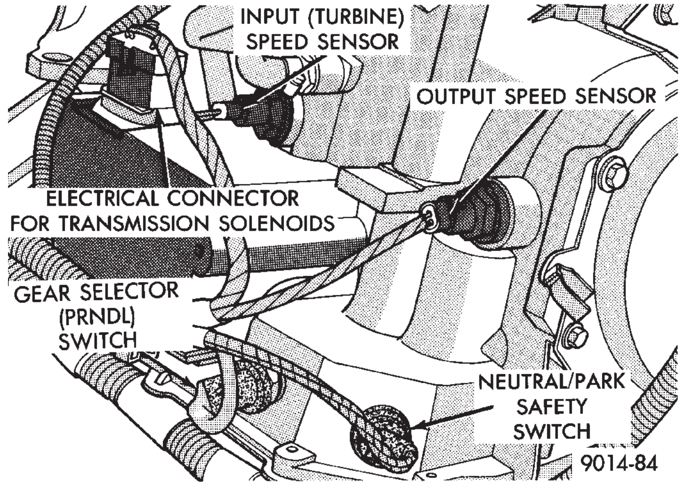

Fig. 10 Automatic Transmission Electrical Connections

(19) Check the Vacuum Hose Harness connections at the Intake Plenum (Fig. 11).

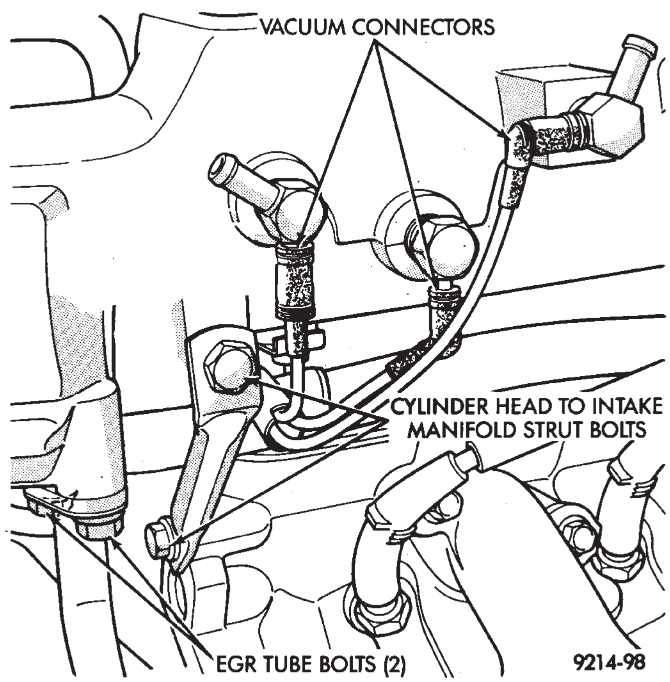

Fig. 11 Vacuum Hose Connections

(20) Inspect the PCV system connections for damage (Fig. 12).

(21) Inspect the crankshaft position sensor electrical connector for damage (Fig. 13).

(22) Ensure the distance sensor electrical connector is attached to the sensor and not damaged (Fig. 13).

(23) Verify the manifold absolute pressure (map) sensor electrical connector is attached to the sensor and not damaged (Fig. 14).

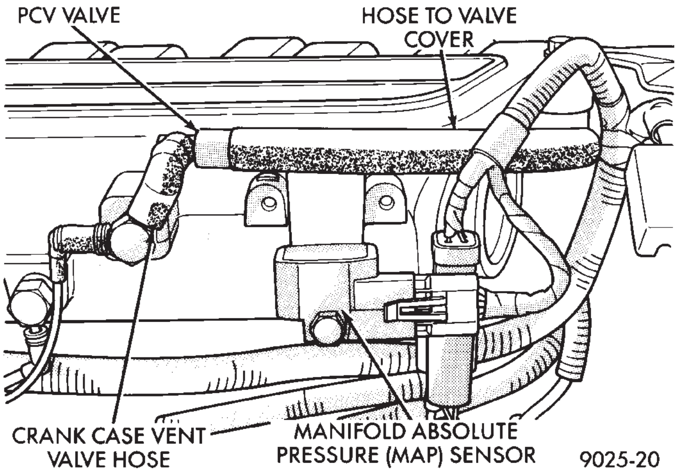

Fig. 12 PCV System

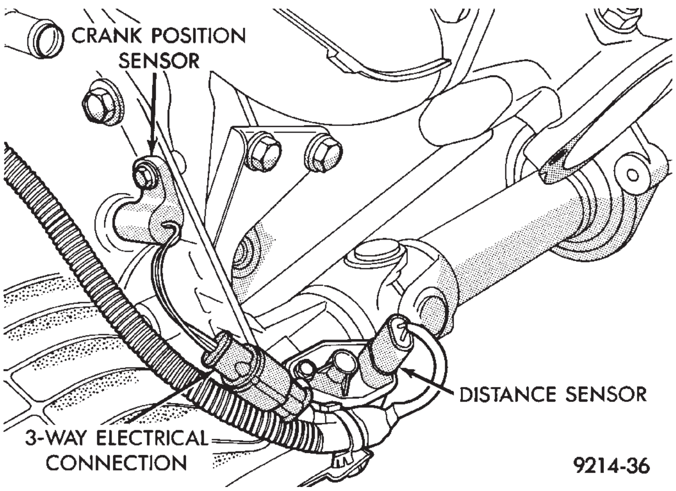

Fig. 13 Crankshaft Sensor and Vehicle Distance Sensor Electrical Connections

(24) Verify the engine ground strap is attached at the engine and dash panel (Fig. 14). Inspect the strap for corrosion or damage.

(25) Check the heated oxygen sensor electrical connector for damage (Fig. 14).

(26) Inspect the alternator wiring connections for damage.

(27) Check the accessory drive belt tension.

(28) Check the 60-way electrical connection at the Engine Controller (Fig. 15) for damage or spread terminals. Verify that the 60-way connector is fully inserted into the engine controller socket. Ensure the wires are not stretched or pulled out of the connector.

(29) Check for full insertion of the relays in the power distribution center (Fig. 16).

(30) Check battery cable connections.

(31) Check the power brake booster hose connection (without Anti-lock Brake Systems) (Fig. 17).

(32) Check the speed control vacuum connection (Fig. 18).

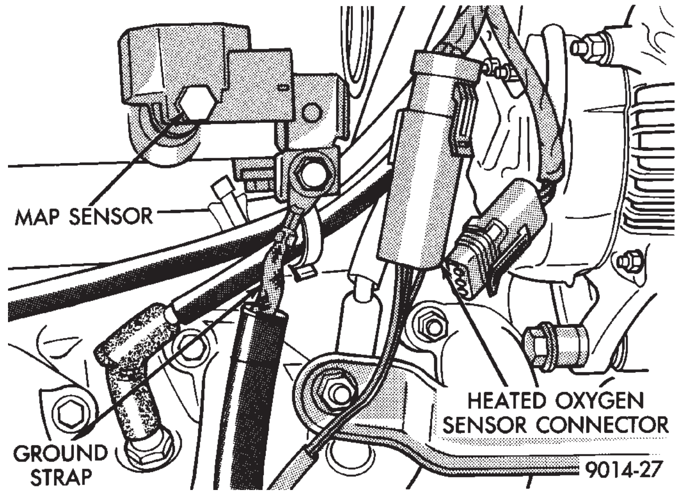

Fig. 14 MAP Sensor, Heated Oxygen Sensor, and Ground Strap

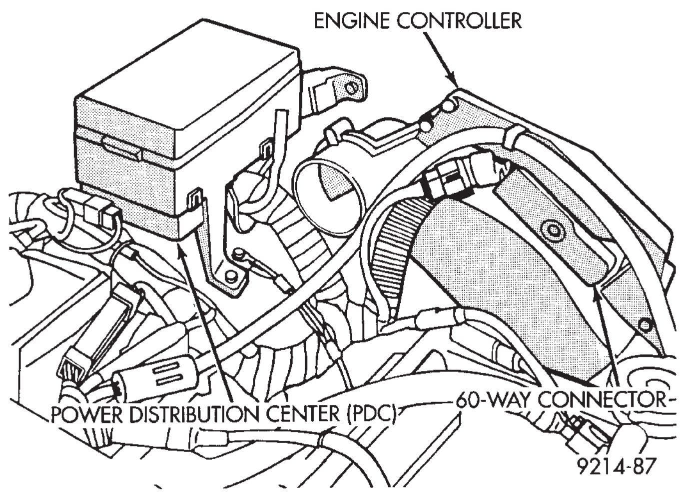

Fig. 15 Engine Controller

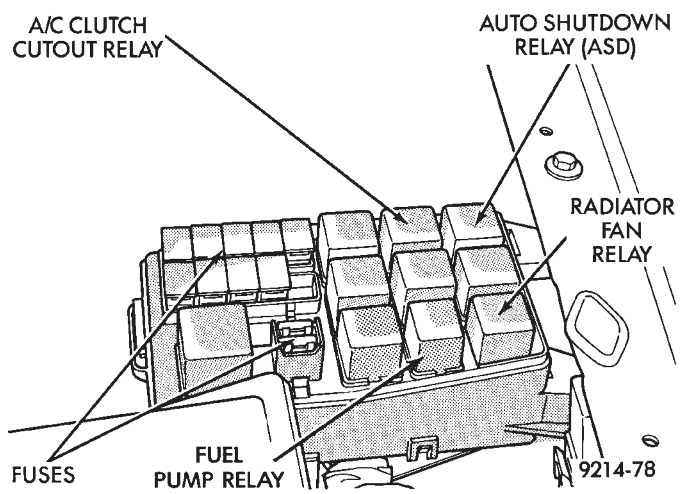

Fig. 16 Power Distribution Center

(33) Inspect hose and wiring connections at fuel pump. Check that wiring connector is making contact with terminals on pump.

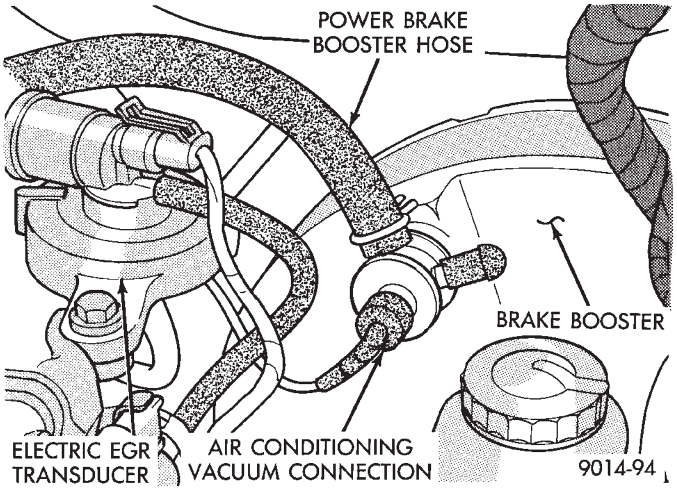

Fig. 17 Power Brake Booster Hose

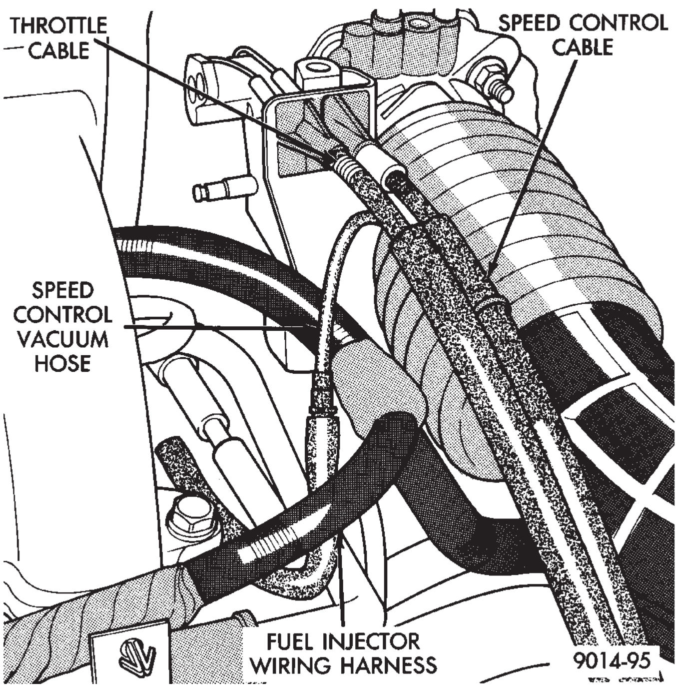

Fig. 18 Speed Control Vacuum

ON BOARD DIAGNOSTICS

The engine controller has been programmed to monitor many different circuits of the fuel injection system. If a problem is sensed with a monitored circuit often enough to indicate an actual problem, the controller stores a fault. If the problem is repaired or ceases to exist, the engine controller cancels the Fault Code after 51 vehicle key on/off cycles.

Certain criteria must be met for a fault code to be entered into the engine controller memory. The criteria may be a specific range of engine RPM, engine temperature, and/or input voltage to the engine controller.

It is possible a fault code for a monitored circuit may not be entered into memory even though a malfunction has occurred. This may happen because one of the fault code criteria for the circuit has not been met. **For example**, assume one of the fault code criteria for the MAP sensor circuit is the engine must be operating between 750 and 2000 RPM. If the MAP sensor output circuit shorts to ground when engine RPM is above 2400 RPM (resulting in a 0 volt input to the engine controller) a fault code will not be entered into memory. This is because the condition does not occur within the specified RPM range.

There are several operating conditions that the engine controller does not monitor and set fault codes for. Refer to Monitored Circuits and Non-Monitored Circuits in this section.

Stored fault codes can be displayed either by cycling the ignition key On - Off - On - Off - On, or through use of the Diagnostic Readout Box II (DRB II). The DRB II connects to the diagnostic connector in the vehicle (Fig. 15).

MONITORED CIRCUITS

The engine controller can detect certain fault conditions in the fuel injection system.

Open or Shorted Circuit - The engine controller can determine if the sensor output (input to controller) is within proper range. Also, the controller can determine if the circuit is open or shorted.

Output Device Current Flow - The engine controller senses whether the output devices are hooked up. If there is a problem with the circuit, the controller senses whether the circuit is open, shorted to ground, or shorted high.

Oxygen Sensor - The engine controller can determine if the oxygen sensor is switching between rich and lean once the system has entered closed loop. Refer to Modes of Operation in this section for an explanation of closed loop operation.

NON-MONITORED CIRCUITS

The engine controller does not monitor the following circuits, systems and conditions that could have malfunctions that result in driveability problems. Fault codes may not be displayed for these conditions. However, problems with these systems may cause fault codes to be displayed for other systems. For example, a fuel pressure problem will not register a fault directly, but could cause a rich or lean condition. This could cause an oxygen sensor fault to be stored in the engine controller.

Fuel Pressure - Fuel pressure is controlled by the vacuum assisted fuel pressure regulator. The engine controller cannot detect a clogged fuel pump inlet filter, clogged in-line fuel filter, or a pinched fuel supply or return line. However, these could result in a rich or lean condition causing an oxygen sensor fault to be stored in the engine controller.

Secondary Ignition Circuit - The engine controller cannot detect an inoperative ignition coil, fouled or worn spark plugs, ignition cross firing, or open spark plug cables.

Engine Timing - The engine controller cannot detect an incorrectly indexed timing chain, camshaft sprocket and crankshaft sprocket. However, these could result in a rich or lean condition causing an oxygen sensor fault to be stored in the engine controller.

Cylinder Compression - The engine controller cannot detect uneven, low, or high engine cylinder compression.

Exhaust System - The engine controller cannot detect a plugged, restricted or leaking exhaust system.

Fuel Injector Malfunctions - The engine controller cannot determine if a fuel injector is clogged, the needle is sticking or the wrong injector is installed. However, these could result in a rich or lean condition causing an oxygen sensor fault to be stored in the engine controller.

Excessive Oil Consumption - Although the engine controller monitors exhaust stream oxygen content when the system is in closed loop, it cannot determine excessive oil consumption.

Throttle Body Air Flow - The engine controller cannot detect a clogged or restricted air cleaner inlet or filter element.

Evaporative System - The engine controller will not detect a restricted, plugged or loaded evaporative purge canister.

Vacuum Assist - Leaks or restrictions in the vacuum circuits of vacuum assisted engine control system devices are not monitored by the engine controller. However, these could result in a MAP sensor fault being stored in the engine controller.

Engine Controller System Ground - The engine controller cannot determine a poor system ground. However, a fault code may be generated as a result of this condition.

Engine Controller Connector Engagement - The engine controller cannot determine spread or damaged connector pins. However, a fault code may be generated as a result of this condition.

HIGH AND LOW LIMITS

The engine controller compares input signal voltages from each input device with established high and low limits for the device. If the input voltage is not within limits and other fault code criteria are met, a fault code will be stored in memory. Other fault code criteria might include engine RPM limits or input voltages from other sensors or switches that must be present before a fault condition can be verified.

FAULT CODE DESCRIPTION

A fault code indicates that the engine controller has recognized an abnormal condition in the system. Fault codes can be obtained from the Check Engine lamp on the Instrument Panel or from the Diagnostic Readout Box II (DRBII). Fault codes indicate the results of a failure but do not identify the failed component directly.

SYSTEM TESTS

WARNING: APPLY PARKING BRAKE AND/OR BLOCK WHEELS BEFORE PERFORMING ANY TEST ON AN OPERATING ENGINE.

OBTAINING FAULT CODES

(1) Connect DRBII to the diagnostic connector located in the engine compartment near the driver side strut tower (Fig. 15).

(2) Start the engine if possible, cycle the transmission selector and the **A/C** switch if applicable. Shut off the engine.

(3) Turn the ignition switch on, access Read Fault Screen. Record all the fault messages shown on the DRBII. Observe the check engine lamp on the instrument panel. The lamp should light for 2 seconds then go out (bulb check).

Fault code erasure; access erase fault code data

STATE DISPLAY TEST MODE

The switch inputs used by the engine controller have only two recognized states, HIGH and LOW. For this reason, the engine controller cannot recognize the difference between a selected switch position versus an open circuit, a short circuit, or a defective switch. If the change is displayed, it can be assumed that the entire switch circuit to the engine controller is functional. From the state display screen access either State Display Inputs and Outputs or State Display Sensors.

STATE DISPLAY INPUTS AND OUTPUTS

Connect the DRB II tester to the vehicle and access the State Display screen. Then access Inputs and Outputs. The following is a list of the engine control system functions accessible through the Inputs and Outputs screen.

Park/Neutral Switch
Speed Control Resume
Brake Switch
Speed Control On/Off
Speed Control Set
A/C Switch Sense
Z2 Voltage Sense
S/C Vent Solenoid
S/C Vacuum Solenoid

A/C Clutch Relay
EGR Solenoid
Auto Shutdown Relay
Fuel Pump Relay
Radiator Fan Relay
Purge Solenoid
Check Engine Lamp

STATE DISPLAY SENSORS

Connect the DRB II tester to the vehicle and access the State Display screen. Then access Sensor Display. The following is a list of the engine control system functions accessible through the Sensor Display screen.

Battery Temp Sensor
Oxygen Sensor Signal
Coolant Temp Sensor
Throttle Position
Minimum Throttle
Battery Voltage
MAP Sensor Reading
AIS Motor Position
Adaptive Fuel Factor
Barometric Pressure
Min Airflow Idl Spd
Engine Speed
DIS Sensor Status
Fault #1 Key-On Info
Module Spark Advance
Speed Control Target
Fault #2 Key-on Info
Fault #3 Key-on Info
Speed Control Status
Speed Control Switch Voltage
Overall Knock Retard
Charging System Goal
Theft Alarm Status
Map Sensor Voltage
Vehicle Speed
Oxygen Sensor State
MAP Gauge Reading
Throttle Opening
Total Spark Advance

CIRCUIT ACTUATION TEST MODE

The circuit actuation test mode checks for proper operation of output circuits or devices which the engine controller cannot internally recognize. The engine controller can attempt to activate these outputs and allow an observer to verify proper operation. Most of the tests provide an audible or visual indication of device operation (click of relay contacts, spray fuel, etc.). Except for intermittent conditions, if a device functions properly during testing, assume the device, its associated wiring, and driver circuit working correctly.

OBTAINING CIRCUIT ACTUATION TEST

Connect the DRB II tester to the vehicle and access the Actuators screen. The following is a list of the engine control system functions accessible through Actuators screens.

Stop All Tests
Ignition Coil #1
Ignition Coil #2
Ignition Coil #3
Fuel Injector #1
Fuel Injector #2
Fuel Injector #3
Fuel Injector #4
Fuel Injector #5
Fuel Injector #6
AIS Motor Open/Close
Radiator Fan Relay
A/C Clutch Relay
Auto Shutdown Relay
Purge Solenoid
S/C Serv Solenoids
Alternator Field
EGR Solenoid
All Solenoids/Relays
ASD Fuel System Test

THROTTLE BODY MINIMUM AIR FLOW CHECK PROCEDURE

(1) Warm engine in Park or Neutral until the cooling fan has cycled on and off at least once.

(2) Ensure that all accessories are off.

(3) Shut off engine.

(4) Disconnect the PCV valve hose from the intake manifold nipple.

(5) Attach Air Metering Fitting #6457 (0.125 in. orifice) to the intake manifold PCV nipple (Fig. 19).

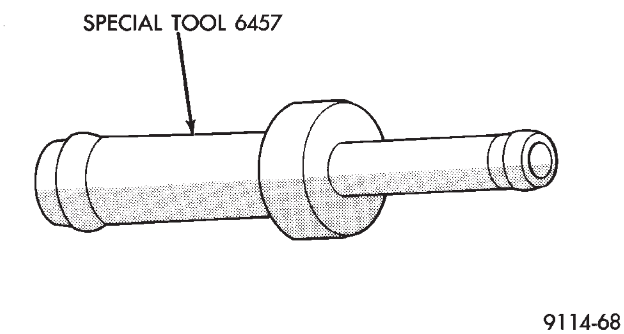

Fig. 19 Air Metering Fitting #6457

(6) Disconnect the 3/16 inch idle purge line from the throttle body nipple. Cap the 3/16 inch nipple.

(7) Connect Diagnostic Readout Box II (DRB II).

(8) Restart the engine. Allow engine to idle for at least one minute.

(9) Using the DRBII, access Min. Airflow Idle Spd.

(10) The following will then occur:

- AIS motor will fully close.
- Idle spark advance will become fixed.

• Engine RPM will be displayed on DRB II.

(11) If idle RPM is within the range shown in the Idle Specification chart, throttle body minimum airflow is set correctly.

IDLE SPECIFICATIONS

Odometer Reading	Idle RPM
Below 1000 Miles	650-950 RPM
Above 1000 Miles	700-950 RPM

9114-73

(12) If idle RPM is not within specifications, shut off the engine and clean the throttle body as follows:

(a) Remove the throttle body from engine.

WARNING: CLEAN THROTTLE BODY IN A WELL VENTILATED AREA. WEAR RUBBER OF BUTYL GLOVES, DO NOT LET MOPAR PARTS CLEANER COME IN CONTACT WITH EYES OR SKIN. AVOID INGESTING THE CLEANER. WASH THOROUGHLY AFTER USING CLEANER.

(b) While holding the throttle open, spray the entire throttle body bore and the manifold side of the throttle plate with Mopar Parts Cleaner. **Only use Mopar Parts Cleaner to clean the throttle body.**

(c) Using a soft scuff pad, clean the top and bottom of throttle body bore and the edges and manifold side of the throttle blade. **The edges of the throttle blade and portions of the throttle bore that are closest to the throttle blade when is closed, must be free of deposits.**

(d) Use compressed air to dry the throttle body.

(e) Inspect throttle body for foreign material.

(f) Install throttle body on manifold.

(g) Repeat steps 1 through 14. If the minimum air flow is still not within specifications, the problem is not caused by the throttle body.

(13) Shut off engine.

(14) Remove Air Metering Fitting #6457 from the intake manifold PCV nipple. Reinstall the PCV valve hose.

(15) Uncap the throttle body idle purge nipple and connect the idle purge line.

(16) Remove DRB II.

60-WAY ENGINE CONTROLLER WIRING CONNECTOR

Refer to the engine controller wiring connector diagram (Fig. 20) for wire colors and cavity numbers.

CAV	WIRE COLOR	DESCRIPTION
1	DG/RD*	MAP SENSOR
2	TN/BK*	COOLANT SENSOR
3	RD/WT*	DIRECT BATTERY
4	BK/LB*	SENSOR RETURN
5	BK/WT*	SIGNAL GROUND
6	VT/WT*	5-VOLT OUTPUT (MAP AND TPS)
7	OR	9-VOLT OUTPUT (DISTRIBUTOR PICK-UP AND DISTANCE SENSOR)
8		
9	DB	A21 SUPPLY (IGNITION START/RUN)
10		
11	BK/TN*	POWER GROUND
12	BK/TN*	POWER GROUND
13	LB/BR*	INJECTOR DRIVER #4
14	YL/WT*	INJECTOR DRIVER #3
15	TN	INJECTOR DRIVER #2
16	WT/DB*	INJECTOR DRIVER #1
17	DB/TN*	IGNITION COIL DRIVER #2
18	DB/GY*	IGNITION COIL DRIVER #3
19	BK/GY*	IGNITION COIL DRIVER #1
20	DG	ALTERNATOR FIELD CONTROL
21		
22	OR/DB*	THROTTLE POSITION SENSOR (TPS)
23		
24	GY/BK*	CRANKSHAFT SENSOR
25	PK	SCI TRANSMIT
26	VT/BR*	CCD BUS (+)
27	BR	A/C SWITCH SENSE
28		
29	WT/PK*	BRAKE SWITCH
30	BR/YL*	PARK/NEUTRAL SWITCH
31	DB/PK*	RADIATOR FAN RELAY
32	BK/PK*	CHECK ENGINE LAMP
33	TN/RD*	SPEED CONTROL VACUUM SOLENOID
34	DB/OR*	A/C CLUTCH RELAY
35	GY/YL*	EGR SOLENOID
36		

CAV	WIRE COLOR	DESCRIPTION
37		
38	GY	INJECTOR DRIVER #5
39	GY/RD*	AIS STEPPER DRIVER #3
40	BR/WT*	AIS STEPPER DRIVER #1
41	BK/DG*	OXYGEN SENSOR SIGNAL
42		
43		
44	TN/YL*	CAMSHAFT SENSOR
45	LG	SCI RECEIVE
46	WT/BK	CCD BUS (-)
47	WT/OR*	DISTANCE SENSOR SIGNAL
48		
49		
50		
51	DB/YL*	AUTO SHUTDOWN (ASD) RELAY
52	PK/BK*	PURGE SOLENOID
53	LG/RD*	SPEED CONTROL VENT SOLENOID
54		
55		
56		
57	DG/OR*	A142 CIRCUIT VOLTAGE SENSE
58	BR/DB*	INJECTOR DRIVER #6
59	VT/BK*	AIS STEPPER DRIVER #4
60	YL/BK*	AIS STEPPER DRIVER #2

WIRE COLOR CODES					
		LB	LIGHT BLUE	VT	VIOLET
BK	BLACK	LG	LIGHT GREEN	WT	WHITE
BR	BROWN	OR	ORANGE	YL	YELLOW
DB	DARK BLUE	PK	PINK	*	WITH TRACER
DG	DARK GREEN	RD	RED		
GY	GRAY	TN	TAN		

CONNECTOR TERMINAL SIDE SHOWN

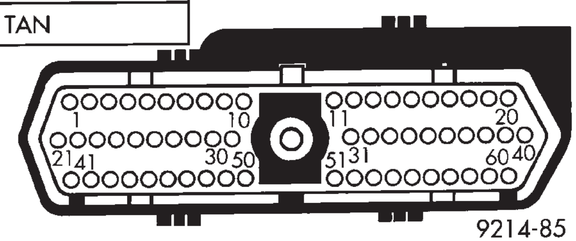

Fig. 20 60-Way Engine Controller Wiring Connector

FAULT CODE DESCRIPTION

FAULT CODE	DRB II DISPLAY	DESCRIPTION
11	No reference Signal During Cranking	No distributor reference signal detected during engine cranking.
13+**	Slow change in Idle MAP signal or No change in MAP from start to run	MAP output change is slower and/or smaller than expected. No difference recognized between the engine MAP reading and the barometric (atmospheric) pressure reading at start-up.
14+**	MAP voltage too low or MAP voltage too High	MAP sensor input below minimum acceptable voltage. MAP sensor input above maximum acceptable voltage.
15**	No vehicle speed signal	No vehicle distance (speed) sensor signal detected during road load conditions.
17	Engine is cold too long	Engine coolant temperature remains below normal operating temperatures during vehicle travel (thermostat).
21**	O_2 signal stays at center or O_2 signal shorted to voltage	Neither rich or lean condition detected from the oxygen sensor input. Oxygen sensor input voltage maintained above the normal operating range.
22+**	Coolant sensor voltage too high or Coolant sensor voltage too low	Coolant temperature sensor input above the maximum acceptable voltage. Coolant temperature sensor input below the minimum acceptable voltage.
24+**	Throttle position sensor voltage high or Throttle position sensor voltage low	Throttle position sensor input above the maximum acceptable voltage. Throttle position sensor input below the minimum acceptable voltage.
25**	Automatic idle speed motor circuits	An open or shorted condition detected in one or more of the AIS control circuits.
27	Injector control circuit	Injector output driver does not respond properly to the control signal.
31**	Purge solenoid circuit	An open or shorted condition detected in the purge solenoid circuit.
32**	EGR solenoid circuit or EGR system failure	An open or shorted condition detected in the EGR transducer solenoid circuit. Required change in air/fuel ratio not detected during diagnostic test.
33	A/C clutch relay circuit	An open or shorted condition detected in the A/C clutch relay circuit.

+ Check Engine Lamp On
** Check Engine Lamp On (California Only)

9214-56

FAULT CODE DESCRIPTION (CON'T)

Fault Code	DRB II Display	Description
35	Radiator fan relay circuits	An open or shorted condition detected in the radiator fan circuit
41+**	Alternator field not switching properly	An open or shorted condition detected in the alternator field control circuit.
42	Auto shutdown relay control circuit	An open or shorted condition detected in the auto shutdown relay circuit.
43+**	Ignition coil #1 primary circuit	Peak primary circuit current not achieved with maximum dwell time.
	or	
	Ignition coil #2 primary circuit	Peak primary circuit current not achieved with maximum dwell time.
	or	
	Ignition coil #3 primary circuit	Peak primary circuit current not achieved with maximum dwell time.
44	Battery temp voltage	An open or shorted condition exists in the coolant temperature sensor circuit or a problem exists in the engine controller's battery temperature voltage circuit.
46+**	Charging system voltage too high	Battery voltage sense input above target charging voltage during engine operation.
47+**	Charging system voltage too low	Battery voltage sense input below target charging during engine operation. Also, no significant change detected in battery voltage during active test of alternator output.
51**	O_2 signal stays below center (lean)	Oxygen sensor signal input indicates lean air/fuel ratio condition during engine operation.
52**	O_2 signal stays above center (rich)	Oxygen sensor signal input indicates rich air/fuel ratio condition during engine operation.
53	Internal controller	Engine controller internal fault condition detected.
54+**	No sync pick-up signal	No fuel sync signal detected during engine rotation.
62	Controller Failure EMR miles not stored	Unsuccessful attempt to update EMR milage in the controller EEPROM.
63	Controller Failure EEPROM write denied	Unsuccessful attempt to write to an EEPROM location by the engine controller.
55	N/A	Completion of fault code display on Check Engine lamp.

\+ Check Engine Lamp On
** Check Engine Lamp On (California Only)

9214-48

3.3L AND 3.8L MULTI-POINT FUEL INJECTION—SERVICE PROCEDURES

INDEX

THROTTLE BODY REMOVAL

(1) Disconnect negative battery cable.

(2) Remove the air cleaner to throttle body hose clamp. Remove the nut holding the air cleaner assembly to the air cleaner bracket. Remove the air cleaner (Fig. 1).

(3) Remove throttle and the speed control cables.

(4) Disconnect electrical connectors from the automatic idle speed (AIS) motor and throttle position sensor (TPS).

(5) Disconnect vacuum hoses from throttle body.

(6) Remove throttle body to intake manifold attaching nuts.

(7) Remove throttle body and gasket.

(8) Reverse the above procedure for installation.

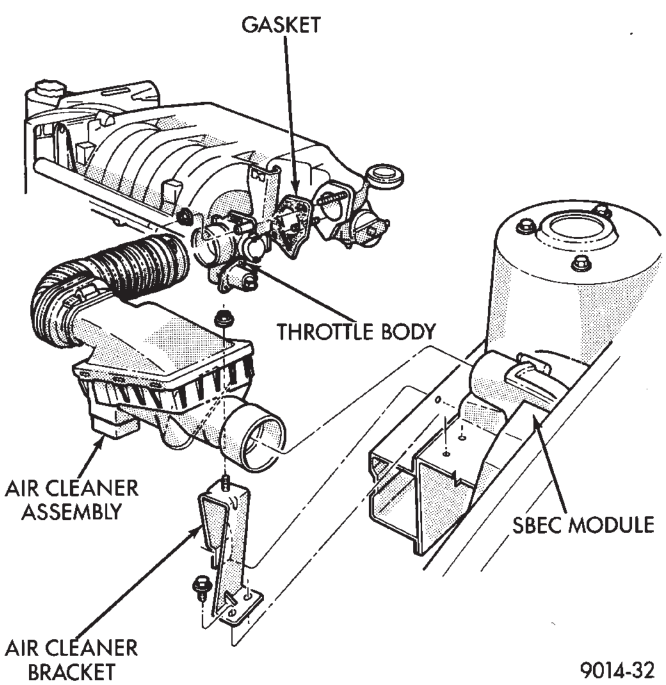

Fig. 1 Throttle Body Assembly

THROTTLE BODY

When servicing throttle body components, always reassemble components with new O-rings and seals where applicable (Fig. 2). Never use lubricants on O-rings or seals, damage may result. If assembly of component is difficult, use water to aid assembly. Use care when removing hoses to prevent damage to hose or hose nipple.

FUEL SYSTEM PRESSURE RELEASE PROCEDURE

WARNING: THE 3.3L AND 3.8L MPI FUEL SYSTEMS ARE UNDER A CONSTANT PRESSURE OF APPROXIMATELY 330 KPA (48 PSI). RELEASE FUEL SYSTEM PRESSURE BEFORE SERVICING THE FUEL PUMP, FUEL LINES, FUEL FILTER, THROTTLE BODY OR FUEL INJECTORS.

(1) Loosen fuel filler cap to release fuel tank pressure.

(2) Disconnect injector wiring harness from engine harness (Fig. 3).

(3) Connect a jumper wire between terminal Number 1 of one injector harness and engine ground.

(4) Connect a jumper wire to the positive terminal Number 2 of the injector harness and touch the battery positive post for no longer than 5 seconds. This releases system pressure.

(5) Remove jumper wires.

(6) Continue fuel system service.

THROTTLE POSITION SENSOR

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove electrical connector from throttle position sensor.

(3) Remove throttle position sensor mounting screws (Fig. 4).

(4) Lift throttle position sensor off throttle shaft.

INSTALLATION

(1) Install throttle position sensor on throttle shaft. Install mounting screws. Tighten screw to 2 N•m (17 in. lbs.) torque.

(2) Connect electrical connector to throttle position sensor.

(3) Connect negative cable to battery.

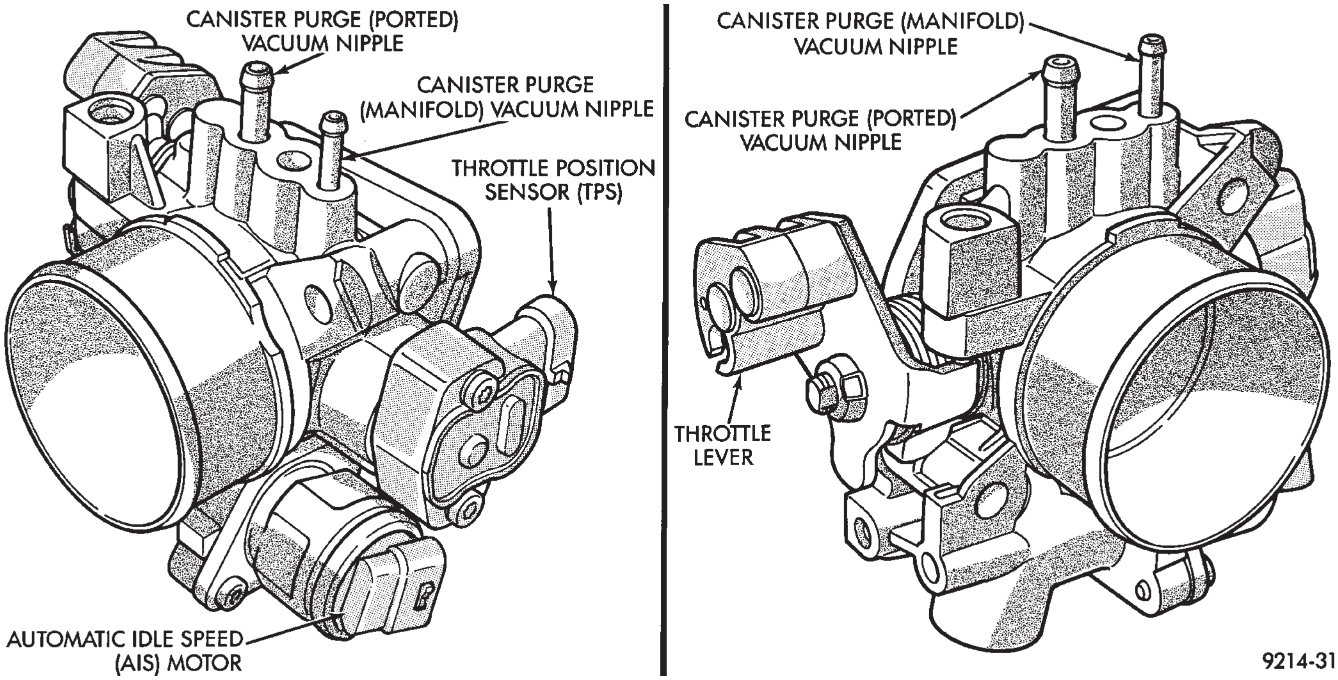

Fig. 2 Throttle Body

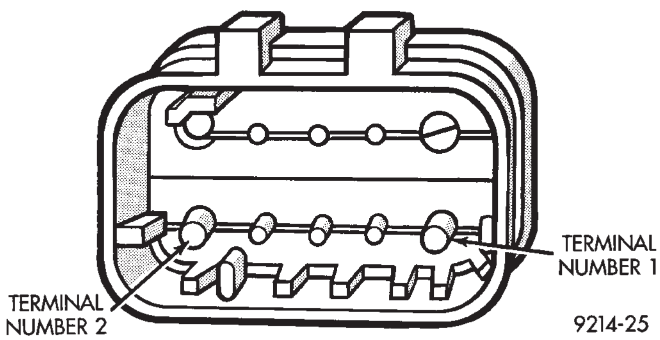

Fig. 3 Injector Harness Connector

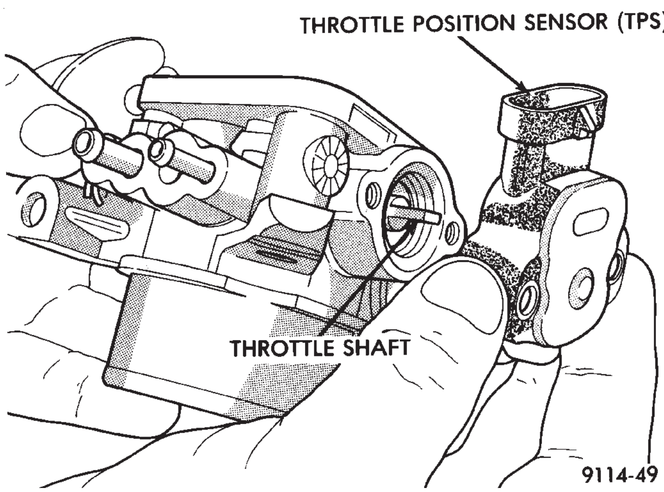

Fig. 4 Servicing Throttle Position Sensor

AUTOMATIC IDLE SPEED (AIS) MOTOR

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove electrical connector from automatic idle speed (AIS) motor.

(3) Remove AIS motor mounting screws (Fig. 5).

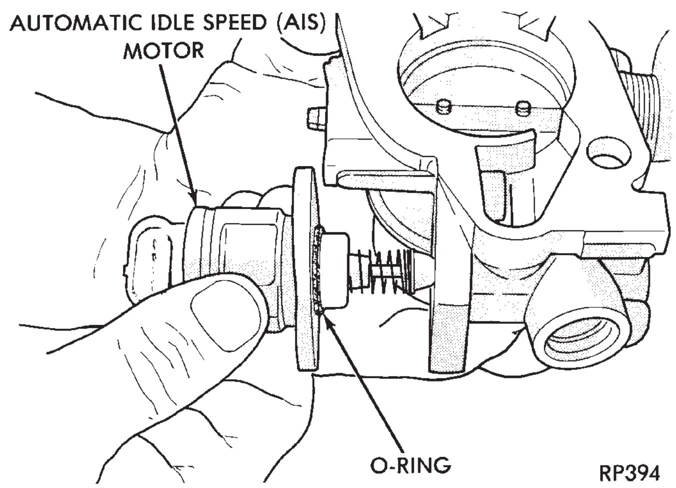

Fig. 5 Servicing Automatic Idle Speed Motor

(4) Remove AIS motor from throttle body. Ensure the O-ring is removed with the AIS motor.

INSTALLATION

(1) The new AIS motor has a new O-ring installed on it. If pintle measures more than 1 inch (25 mm) it must be retracted. Use the DRB II AIS Motor Open/Close Test to retract the pintle (battery must be connected.)

(2) Carefully place AIS motor into throttle body.

(3) Install mounting screws. Tighten screws to 2 N•m (17 in. lbs.) torque.

(4) Connect electrical connector to AIS motor.

(5) Connect negative cable to battery.

FUEL INJECTOR RAIL ASSEMBLY

REMOVAL

(1) Perform fuel system pressure release procedure **before servicing or starting repairs.** Refer to Fuel System Pressure Release Procedure in this section.

(2) Disconnect negative cable from battery.

(3) Remove air cleaner and hose assembly (Fig. 1).

(4) Remove throttle cable (Fig. 6). Remove wiring harness from throttle cable bracket and intake manifold water tube.

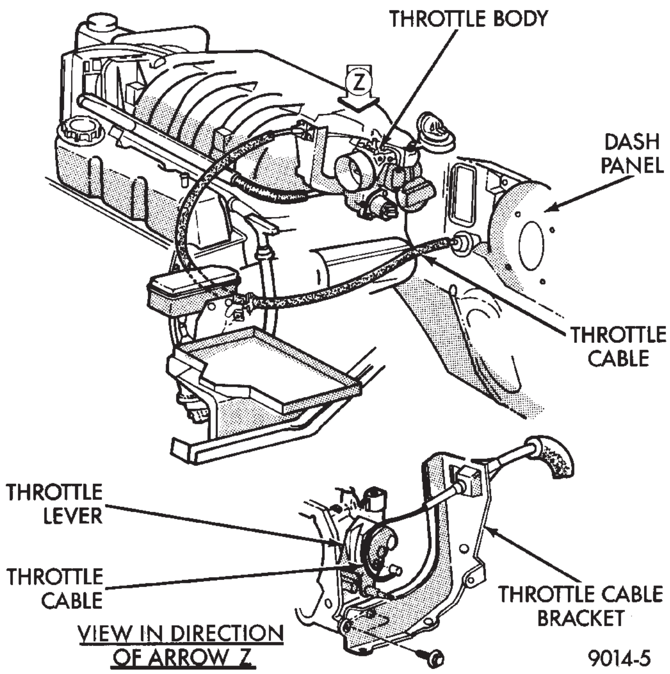

Fig. 6 Throttle Cable Attachment

(5) Disconnect automatic idles speed (AIS) motor and throttle position sensor (TPS) electrical connectors (Fig. 7). Refer to Automatic Idle Speed motor and Throttle Position Sensor in this section.

(6) Remove vacuum hose harness from throttle body (Fig. 7).

(7) Remove PCV and brake booster vacuum hoses from air intake plenum.

(8) Remove EGR tube to intake manifold flange bolts (Fig. 8).

(9) Remove vacuum harness connectors from intake plenum (Fig. 8).

(10) Remove cylinder head to intake plenum strut (Fig. 8).

(11) Disconnect electrical connectors from the MAP sensor and heated oxygen sensor electrical connection. Remove the engine mounted ground strap (Fig. 9).

WARNING: WRAP A SHOP TOWEL AROUND HOSES TO CATCH ANY GASOLINE SPILLAGE.

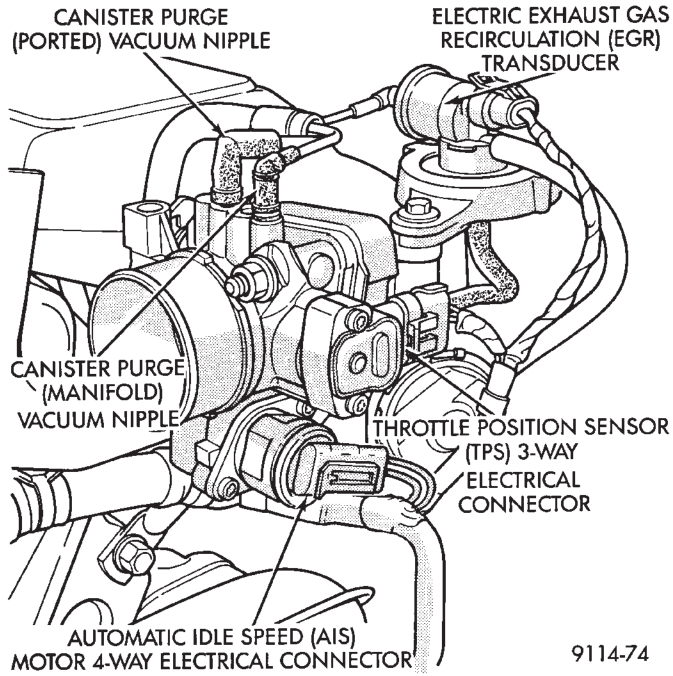

Fig. 7 Electrical and Vacuum Connection to Throttle Body

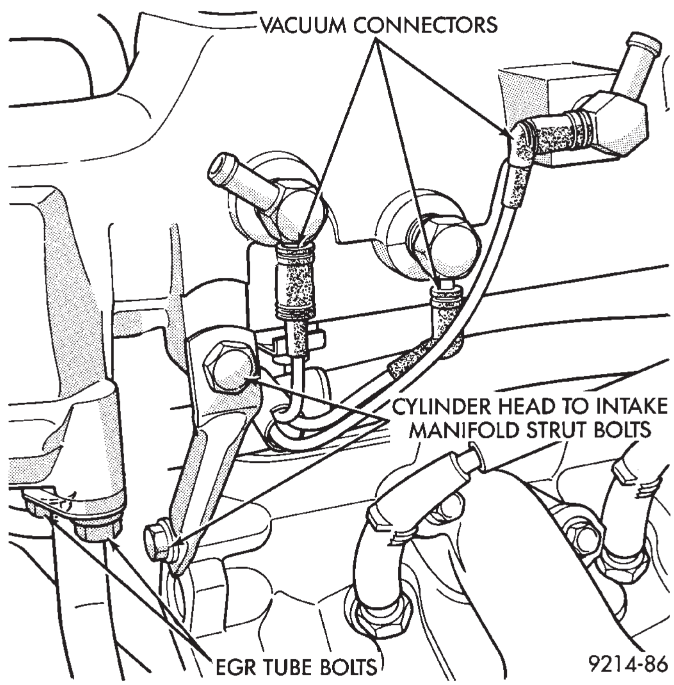

Fig. 8 EGR Tube

(12) Remove the fuel hose quick connect fittings from the chassis tubes. **Refer to Fuel Hoses, Clamps and Quick Connect Fittings in the Fuel Delivery Section of this Group.** Place a shop towel under the connections to absorb any fuel spilled. fittings.

(13) Remove direct ignition system (DIS) coils and alternator bracket to intake manifold bolt (Fig. 10).

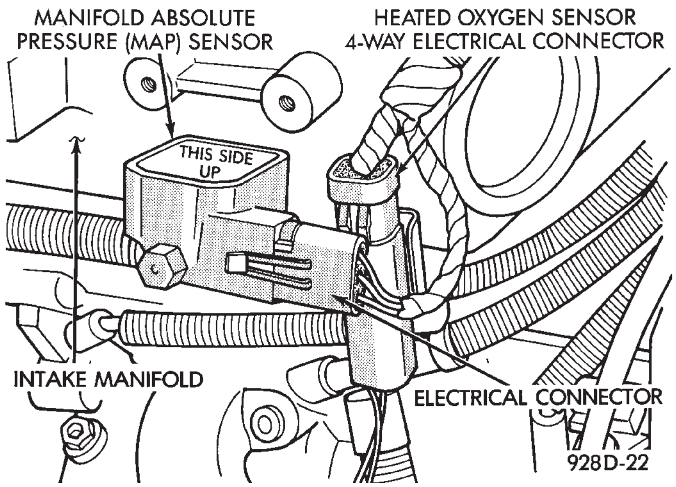

Fig. 9 MAP Sensor Electrical Connector

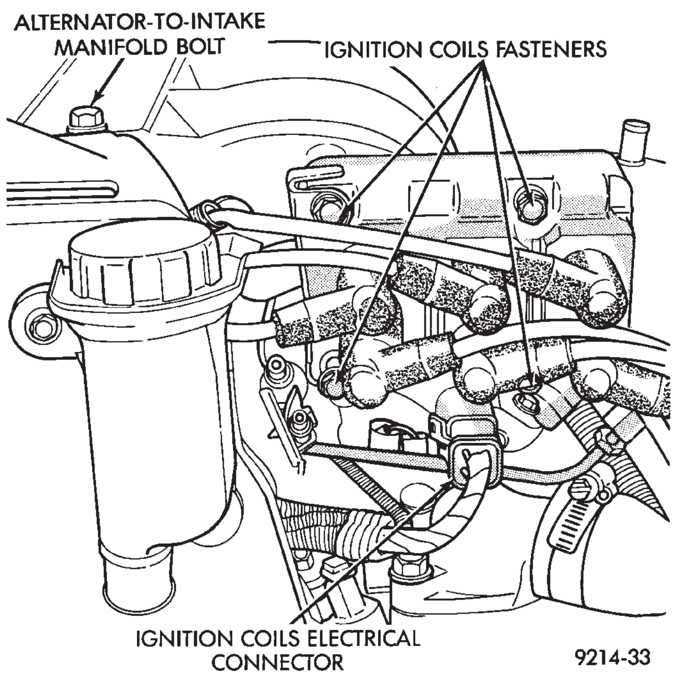

Fig. 10 Ignition Coils

(14) Remove intake mounting manifold bolts and rotate manifold back over rear valve cover (Fig. 11).

(15) Cover intake manifold with suitable cover when servicing (Fig. 12).

(16) Remove vacuum harness connector from Fuel Pressure Regulator.

(17) Remove fuel tube retainer bracket screw and fuel rail attaching bolts (Fig. 12). Spread the retainer bracket to allow fuel tube removal clearance.

(18) Remove fuel rail injector wiring clip from the alternator bracket (Fig. 13).

(19) Disconnect cam sensor, coolant temperature sensor, and engine temperature sensors (Fig. 13).

(20) Remove fuel rail. Be careful not to damage the injector O-rings upon removal from their ports (Fig. 14).

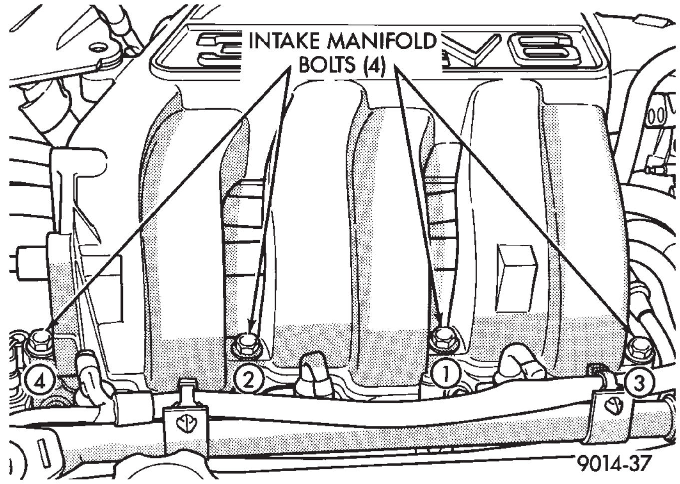

Fig. 11 Intake Manifold Bolts

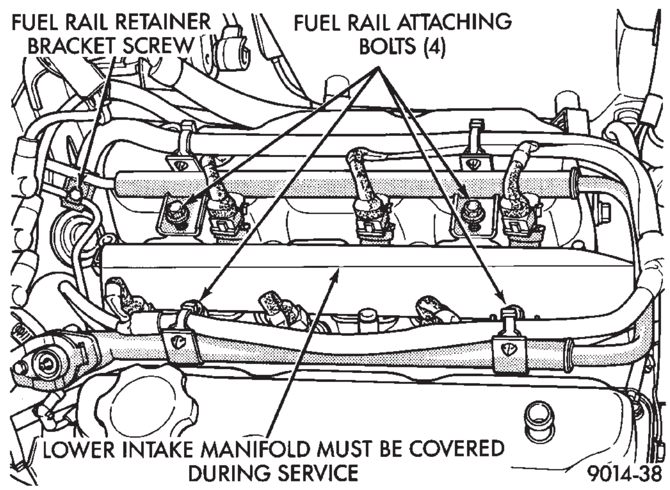

Fig. 12 Fuel Rail Attaching Bolts

INSTALLATION

(1) Ensure injector holes are clean. Replace O-rings if damaged.

(2) Lubricate injector O-rings with a drop of clean engine oil to ease installation.

(3) Put the tip of each injector into their ports. Push the assembly into place until the injectors are seated in the ports (Fig. 14).

(4) Install the fuel rail mounting bolts. Tighten bolts to 22 N●m (200 in. lbs.) torque (Fig. 12).

(5) Install fuel tube retaining bracket screw. Tighten screw to 4 N●m (35 in. lbs.) torque.

(6) Connect electrical connectors to cam sensor, coolant temperature sensor and engine temperature sensors (Fig. 13).

(7) Install fuel injector harness wiring clips on the alternator bracket and intake manifold water tube (Fig. 13).

(8) Connect vacuum line to fuel pressure regulator.

(9) Remove covering on lower intake manifold and clean surface.

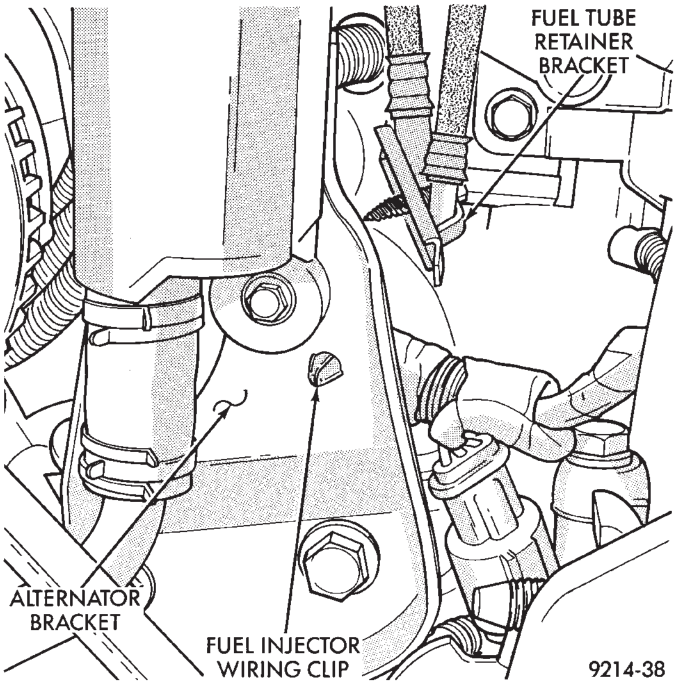

Fig. 13 Fuel Injector Wiring Clip

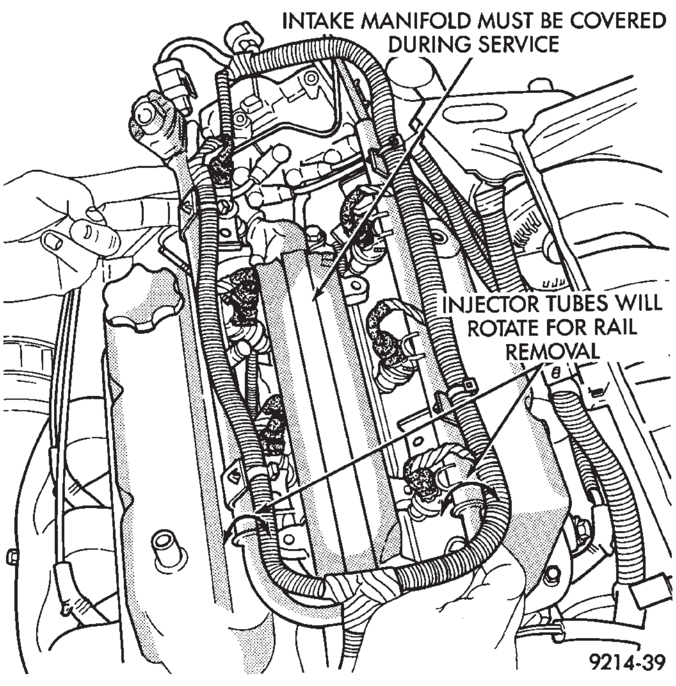

Fig. 14 Fuel Rail Removal

(10) Place intake manifold gasket on lower manifold. Put upper manifold into place and install bolts finger tight.

(11) Install the alternator bracket to intake manifold bolt and the cylinder head to intake manifold strut bolts. (Do not tighten.)

(12) Following the tightening sequence in Figure 11, tighten intake manifold bolts to 28 N●m (250 in. lbs.) torque.

(13) Tighten alternator bracket to intake manifold bolt to 54 N●m (40 ft. lbs.) torque (Fig. 13).

(14) Tighten the cylinder head to intake manifold strut bolts to 54 N●m (40 ft. lbs.) torque (Fig. 8).

(15) Connect ground strap, MAP and heated oxygen sensor electrical connectors.

(16) Connect vacuum harness to intake plenum. Connect PCV system hoses.

(17) Using a new gasket, connect the EGR tube to the intake manifold plenum. Tighten screws to 22 N●m (200 in. lbs.) torque.

(18) Clip wiring harness into the hole in the throttle cable bracket.

(19) Connect electrical connectors to the throttle position sensor (TPS) and Automatic Idle Speed (AIS) motor.

(20) Connect vacuum harness to throttle body.

(21) Install the direct ignition system (DIS) coils. Tighten fasteners to 12 N●m (105 in. lbs.) torque.

(22) Install fuel hose quick connectors fittings to chassis tubes. **Refer to Fuel Hoses, Clamps and Quick Connect Fittings in the Fuel Delivery Section of this Group.** Push the fittings onto the chassis tubes until they click into place. Pull on the fittings to ensure complete insertion. Fuel supply fitting is 5/16 inch and fuel return fitting is 1/4 inch.

(23) Install throttle cable.

(24) Install air cleaner and hose assembly.

(25) Connect negative cable to battery.

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(26) With the ignition key in ON position, access the DRB II ASD Fuel System Test to pressurize the fuel system. Check for leaks.

FUEL PRESSURE REGULATOR

REMOVAL

(1) Perform fuel system pressure release procedure before attempting any repairs. Refer to Fuel Pressure Regulator Procedure in this section.

(2) Remove fuel pressure regulator vacuum connector. (Fig. 15).

(3) Remove regulator retainer screw (Fig. 15).

(4) Remove the fuel pressure regulator retainer (Fig. 15).

WARNING: PLACE A SHOP TOWEL UNDER FUEL PRESSURE REGULATOR TO ABSORB ANY FUEL SPILLAGE.

(5) Remove fuel pressure regulator and O-rings (Fig. 16).

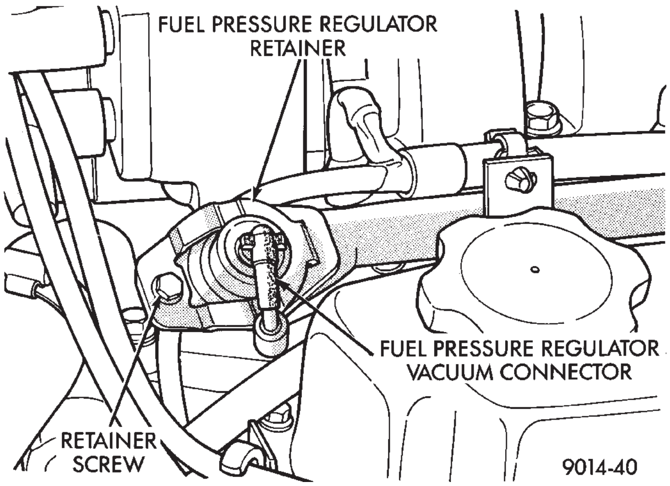

Fig. 15 Fuel Pressure Regulator

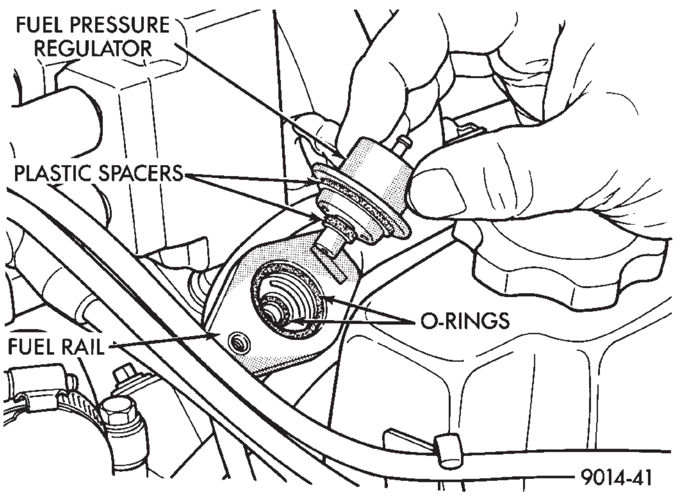

Fig. 16 Fuel Pressure Regulator Removal/Installation

INSTALLATION

(1) Ensure fuel pressure regulator has two plastic spacers (Fig. 16). Place O-rings in the fuel pressure regulator cavity (Fig. 17). Do not install O-rings on the fuel pressure regulator.

(2) Insert fuel pressure regulator into the fuel rail.

(3) Install fuel pressure regulator retainer (Fig. 15).

(4) Install retainer screw. Tighten to 7 N●m (60 in. lbs.) torque.

(5) Connect vacuum line to the fuel pressure regulator.

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(6) With the ignition key in ON position, access the DRB II ASD Fuel System Test to pressurize the fuel system. Check for leaks.

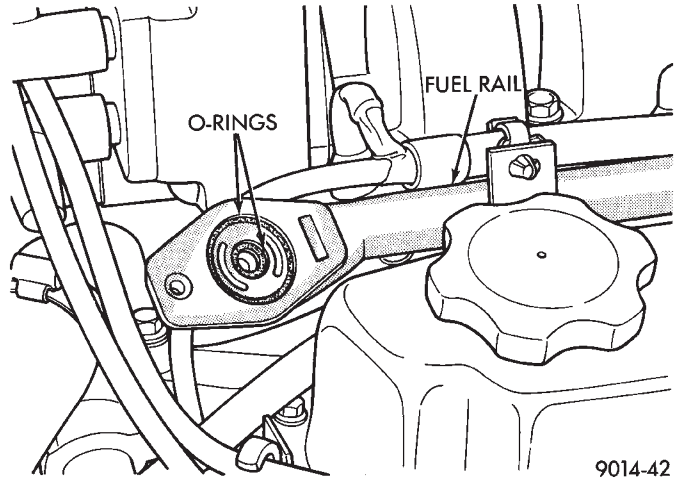

Fig. 17 Fuel Pressure Regulator O-Rings

FUEL INJECTOR

The fuel rail must be removed first. Refer to Fuel Injector Rail Assembly Removal in this section.

REMOVAL

(1) Disconnect injector wiring connector from injector.

(2) Position fuel rail assembly so that the fuel injectors are easily accessible (Fig. 18).

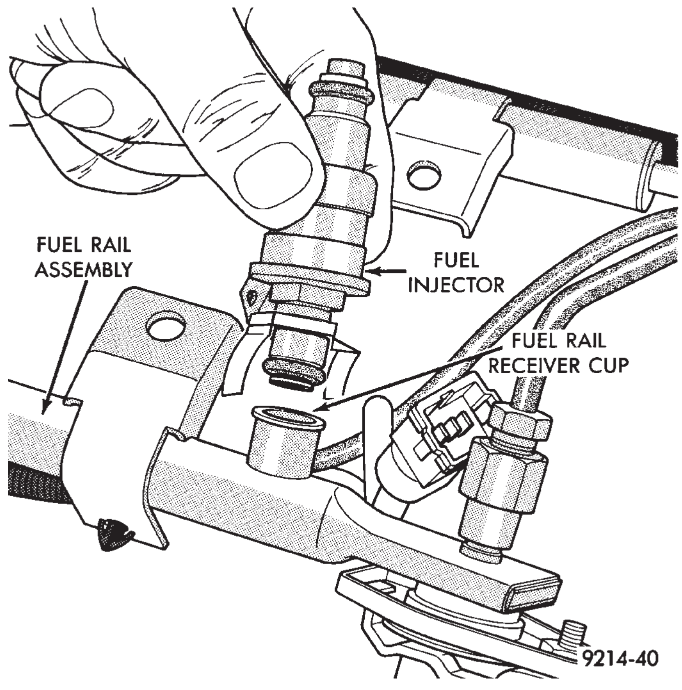

Fig. 18 Fuel Injector and Rail—Typical

(3) Rotate injector and pull injector out of fuel rail. The clip will stay on the injector.

(4) Check injector O-ring for damage. If O-ring is damaged, it must be replaced. If injector is reused, a protective cap must be installed on the injector tip to prevent damage. Replace the injector clip if it is damaged.

(5) Repeat for remaining injectors.

INSTALLATION

(1) Before installing an injector the rubber O-ring must be lubricated with a drop of clean engine oil to aid in installation.

(2) Install injector clip by sliding open end into **top slot** of the injector. The edge of the receiver cup will slide into the side slots of clip (Fig. 19).

(3) Install injector top end into fuel rail receiver cap. Be careful not to damage O-ring during installation (Fig. 19).

(4) Repeat steps for remaining injectors.

(5) Connect fuel injector wiring.

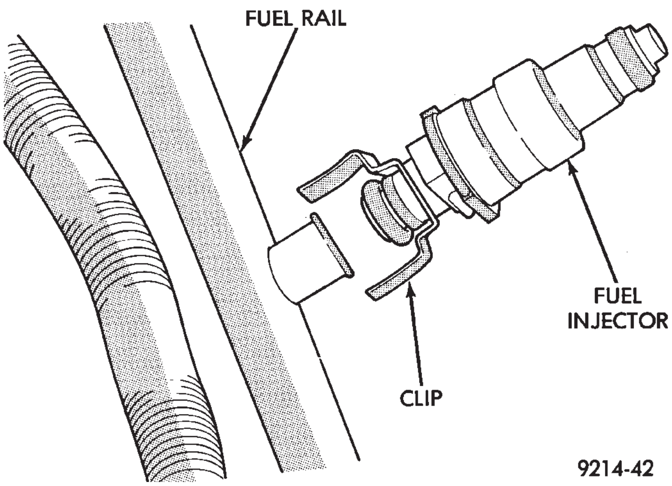

Fig. 19 Servicing Fuel Injector—Typical

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The alignment of the MAP sensor is critical to the sensors performance. The top of the sensor is marked This Side Up (Fig. 20).

(1) Disconnect electrical connector from MAP sensor.

(2) Remove sensor by unscrewing from the intake manifold (Fig. 20).

(3) Reverse the above procedure for installation.

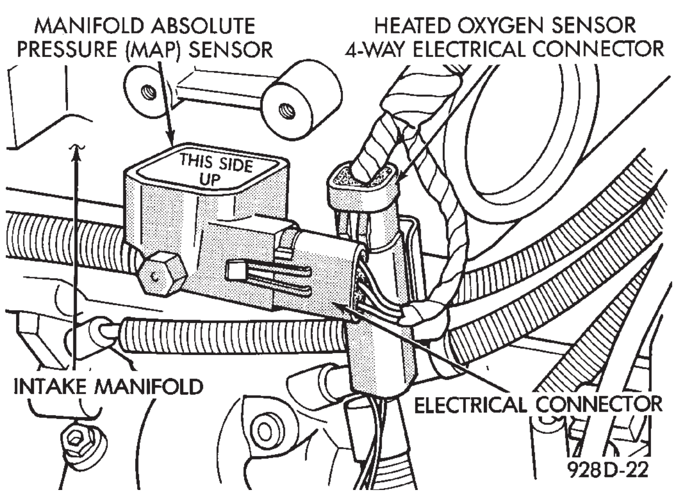

Fig. 20 Manifold Absolute Pressure Sensor

CANISTER PURGE SOLENOID SERVICE

(1) Remove vacuum hose and electrical connector from solenoid (Fig. 21).

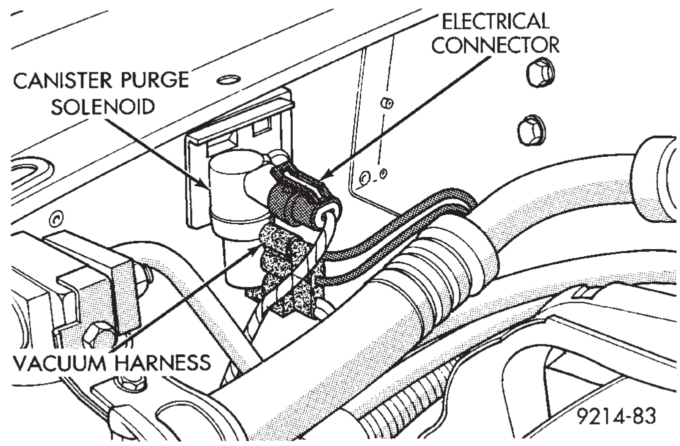

Fig. 21 Canister Purge Solenoid

(2) Depress tab on top of solenoid and slide the solenoid downward out of mounting bracket.

(3) Reverse above procedure for installation.

ENGINE CONTROLLER SERVICE

(1) Remove air cleaner duct from engine controller.

(2) Remove battery.

(3) Remove engine controller mounting screws (Fig. 22).

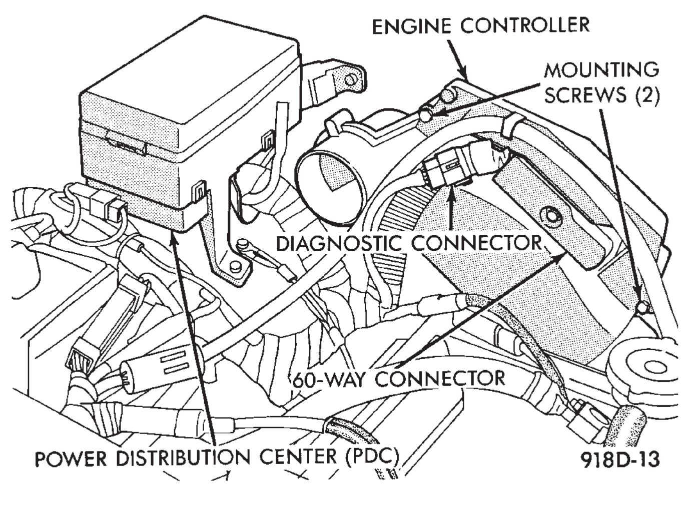

Fig. 22 Engine Controller Removal

(4) Remove 60-way electrical connector from engine controller.

(5) Reverse the above procedure for installation.

CRANKSHAFT TIMING SENSOR

REMOVAL

(1) Disconnect crankshaft timing sensor electrical connector from the wiring harness connector (Fig. 23).

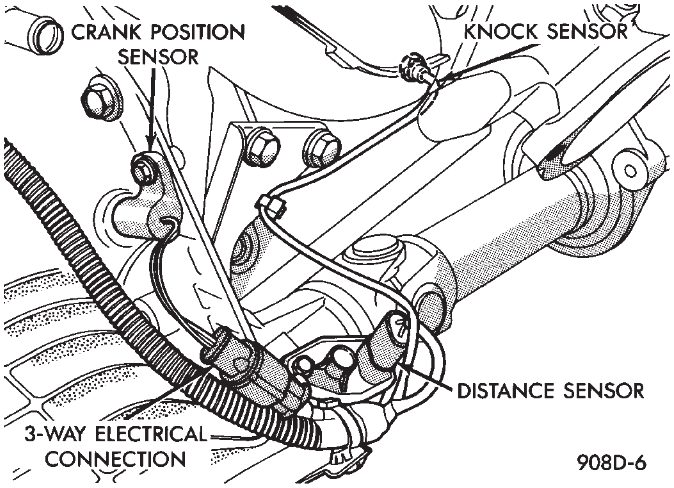

Fig. 23 Crankshaft Timing Sensor

(2) Remove crankshaft timing sensor retaining bolt.

(3) Pull crankshaft timing sensor straight up out of the transaxle housing.

INSTALLATION

If installing the original sensor, clean off the old spacer on the sensor face. A NEW SPACER must be attached to the sensor face before installation. If the sensor is being replaced, confirm that the paper spacer is attached to the face of the new sensor (Fig. 24).

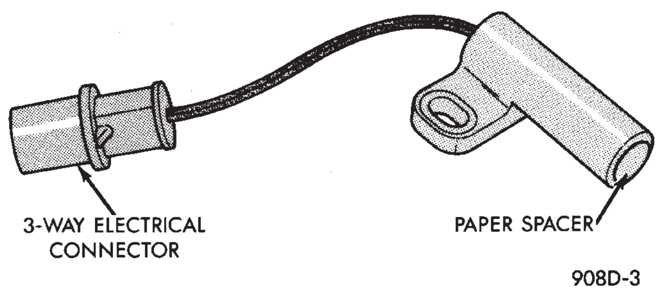

Fig. 24 Crankshaft Sensor and Spacer

(1) Install sensor in transaxle and push sensor down until contact is made with the drive plate. While holding the sensor in this position, and install and tighten the retaining bolt to 12 N●m (105 in. lbs.) torque.

(2) Connect crankshaft timing sensor electrical connector to the wiring harness connector.

CAMSHAFT SENSOR SERVICE

REMOVAL

(1) Disconnect camshaft reference sensor electrical connector from the wiring harness connector (Fig. 25).

(2) Loosen camshaft timing sensor retaining bolt enough to allow slot in sensor to slide past the bolt.

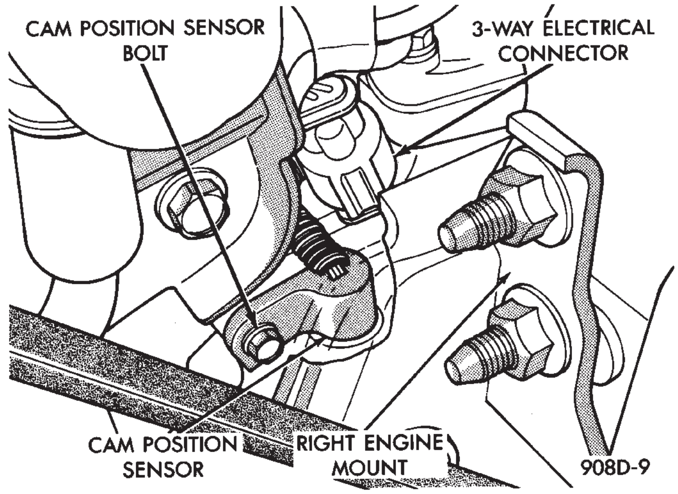

Fig. 25 Camshaft Sensor

(3) Pull sensor up out of the chain case cover. **Do not pull on the sensor lead.** There is an O-ring on the sensor case. The O-ring may make removal difficult. A light tap to top of sensor prior to removal may reduce force needed for removal.

INSTALLATION

If installing the original sensor, clean off the old spacer on the sensor face. A NEW SPACER must be attached to the face before installation. Inspect O-ring for damage, replace if necessary. If the sensor is being replaced, confirm that the paper spacer is attached to the face and O-ring is positioned in groove of the new sensor (Fig. 26).

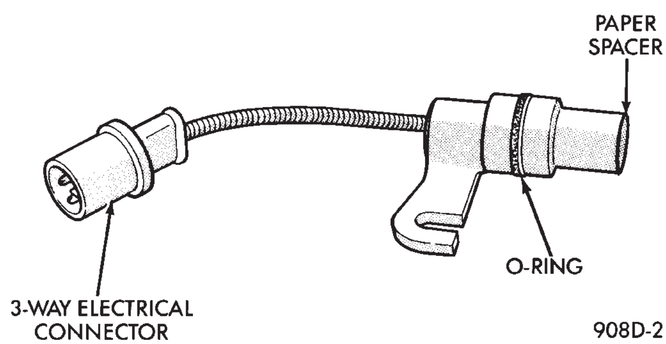

Fig. 26 Camshaft Sensor

(1) Apply a couple drops of clean engine oil to the O-ring prior to installation. Install sensor in the chain case cover and push sensor down until contact is made with the cam timing gear. While holding the sensor in this position, install and tighten the retaining bolt 12 N●m (105 in. lbs.) torque.

(2) Connect camshaft reference sensor electrical connector to harness connector. Position connector away from the accessory belt.

HEATED OXYGEN SENSOR (O_2 SENSOR) SERVICE

The oxygen sensor is installed in the exhaust manifold (Fig. 27).

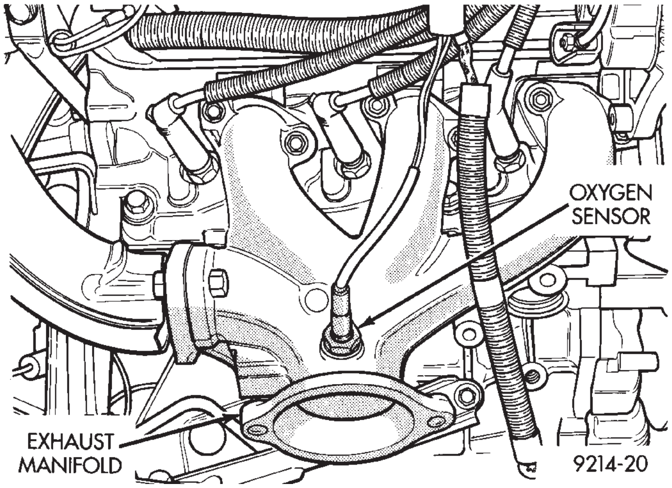

Fig. 27 Oxygen Sensor—3.3L Engine

CAUTION: Do not pull on the oxygen sensor wire when disconnecting the electrical connector.

WARNING: THE EXHAUST MANIFOLD MAY BE EXTREMELY HOT. USE CARE WHEN SERVICING THE OXYGEN SENSOR.

(1) Disconnect oxygen sensor electrical connector (Fig. 28).

(2) Remove sensor using Tool C-4907 (Fig. 29).

When the sensor is removed, the exhaust manifold threads must be cleaned with an 18 mm X 1.5 + 6E tap. If using original sensor, coat the threads with Loctite 771-64 anti-seize compound or equivalent. New sensors are packaged with compound on the threads and do not require additional compound. The sensor must be tightened to 27 N●m (20 ft. lbs.) torque.

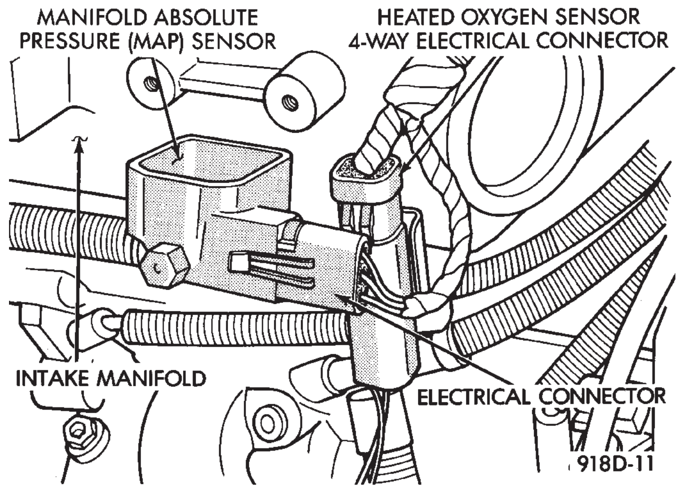

Fig. 28 Oxygen Sensor Connector

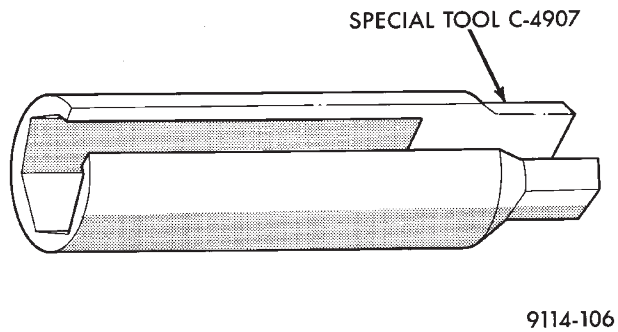

Fig. 29 Oxygen Sensor Socket

SPECIFICATIONS

TEMPERATURE SENSOR SPECIFICATIONS

Component	Number of Terminals	Resistance at F°	Thread Compound	Thread Size	Torque
Coolant Temperature Sensor	2	7,000 to 13,000 Ohms About 21°C, 70°F 700 to 1,000 Ohms About 93°C, 200°F	Preapplied (Nonrequired)	3/8-18 NPTF	27 N·m (20 ft.-lbs.) 2.5L Engines 7 N·m (60 in. lbs.) 3.0L and 3.3L Engines
Charge Temperature Sensor	2	7,000 to 13,000 Ohms About 21°C, 70°F 700 to 1,000 Ohms About 93°C, 200°F	Preapplied (Nonrequired)	3/8-18 NPTF	5.6 N·m (50 in.-lbs.)

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TORQUE

DESCRIPTION	TORQUE
Accelerator pedal mounting nuts	12 N•m (105 in. lbs.)
AIS motor	2 N•m (20 in. lbs.)
Fuel tank straps	54 N•m (40 ft. lbs.)
Fuel filter	8 N•m (75 in. lbs.)
Fuel pump module clamp	5 N•m (40 in. lbs.)
Fuel filler tube to body	2 N•m (17 in. lbs.)
Oxygen sensor	27 N•m (20 ft. lbs.)
Throttle position sensor	2 N•m (20 in. lbs.)
Throttle body fuel fittings	20 N•m (175 in. lbs.)
2.5L injector hold down clamp	5 N•m (45 in. lbs.)
2.5L throttle body	20 N•m (175 in. lbs.)
2.5L fuel pressure regulator	5 N•m (40 in. lbs.)
3.0L throttle body mounting screws	25 N•m (225 in. lbs.)
3.0L fuel injector rail	13 N•m (115 in. lbs.)
3.3L fuel rail mounting bolts	22 N•m (200 in. lbs.)

DESCRIPTION	TORQUE
3.3L ignition coil pack	12 N•m (105 in. lbs.)
3.3L fuel pressure regulator	7 N•m (60 in. lbs.)
3.3L camshaft sensor mounting screw	12 N•m (105 in. lbs.)
3.3L crankshaft sensor mounting screw	12 N•m (105 in. lbs.)
Turbo I fuel pressure regulator	7 N•m (65 in. lbs.)
Turbo I fuel rail screws	22 N•m (200 in. lbs)
Turbo III camshaft sensor bolt.	16 N•m (145 in. lbs.)
Turbo III crankshaft sensor bolt.	16 N•m (145 in. lbs.)
Turbo III fuel pressure regulator	7 N•m (65 in. lbs.)
Turbo III fuel rail screws	22 N•m (200 in. lbs)
Turbo III throttle body mounting nuts	25 N•m (225 in. lbs.)

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