FORD MOTOR CO. ELECTRONIC FUEL INJECTION

DESCRIPTION

The Ford electronic fuel injection system (EFI) basically consists of 4 sub-assemblies: Fuel delivery, air induction, engine sensors and the Electronic Engine Control (EEC-III) system computer (ECA). The fuel delivery system includes an in-tank high pressure fuel pump, a primary fuel filter, a secondary fuel filter, fuel supply and return lines, fuel injectors and fuel pressure regulator.

The air induction system includes the throttle body, intake manifold and the cold engine speed control. Engine sensors are as follows: Throttle position sensor (TPS), barometric and manifold absolute pressure sensors (B/MAP), engine coolant temperature sensor (ECT), manifold charging temperature sensor (MCT), EGR valve position sensor (EVP), crankshaft position sensor (CP) and the exhaust gas oxygen sensor (EGO).

The ECA is a micro-computer which computes the sensor signals to engine demand and efficiency information. This computer is the main control component of the EEC-III system.

OPERATION

FUEL DELIVERY

A high pressure electric fuel pump, located inside fuel tank, supplies fuel to the injectors. The pump receives power through a vacuum controlled by-pass relay, a fuel pump relay, and an inertia switch. The vacuum controlled relay is activated by a vacuum switch connected to manifold vacuum. This supplies power to the fuel pump relay only when engine is running and vacuum is present in manifold.

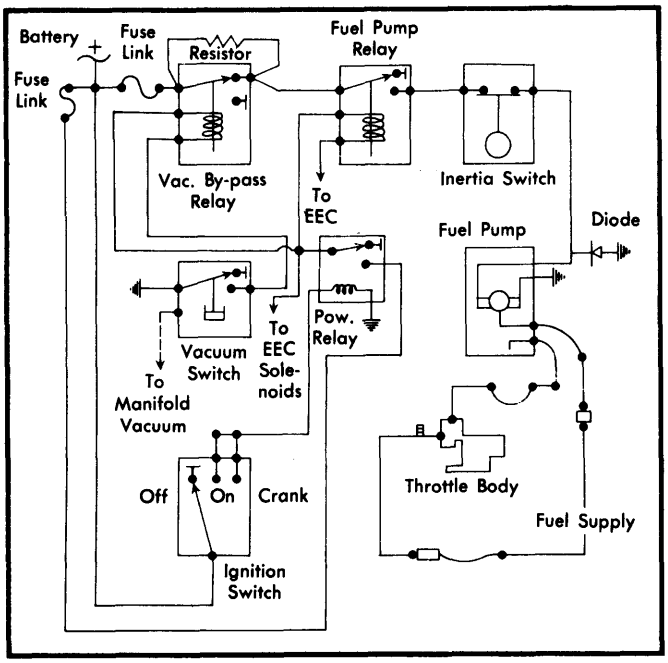

Fig. 2 Fuel Pump Wiring Diagram

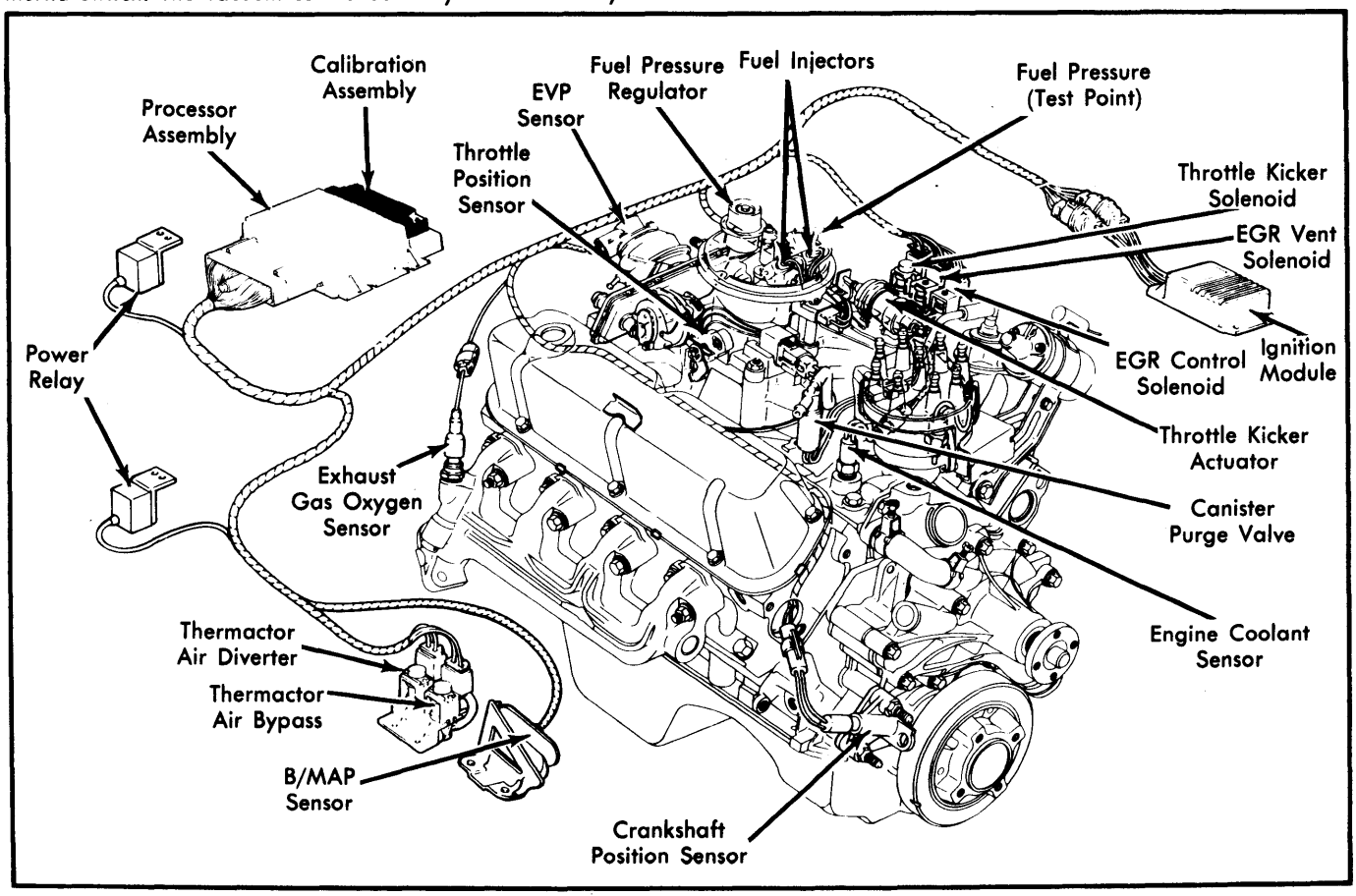

Fig. 1 View of Engine Showing EEC-III/EFI Components

FORD MOTOR CO. ELECTRONIC FUEL INJECTION (Cont.)

The fuel pump relay is activated by the ECA with the ignition switch in the "ON" or "START" mode. When the ignition switch is turned to the "ON" position, both relays are activated for approximately 1 second to supply initial line pressure to the system. If the engine stalls or is not started within 1 second the ECA will shut off power to fuel pump.

The inertia switch, located in the trunk, is designed to open the fuel pump power circuit in the event of a collision. This switch is reset by pushing both buttons, on switch, simultaneously. The inertia switch should not be reset until fuel system has been inspected for damage or leaks.

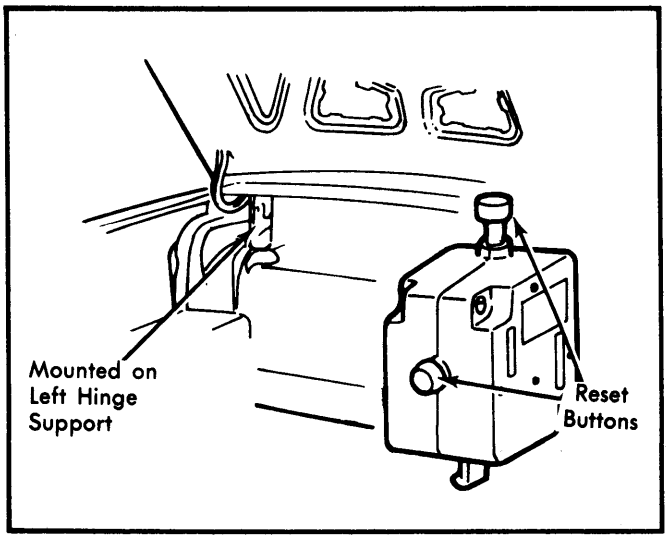

Fig. 3 Inertia Switch Location

Fuel is pumped through fuel filters to the fuel injectors and pressure regulator mounted on throttle body. The fuel pressure regulator controls fuel pressure to 39 psi across the fuel injectors. Fuel in excess of that used to maintain constant pressure is returned to fuel tank through the fuel return line.

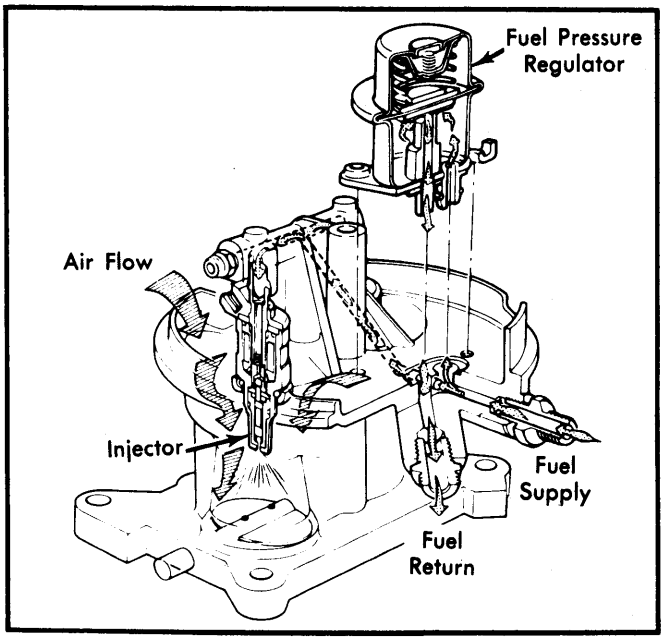

Fig. 4 Fuel Charging Operation

Injectors are actuated, spraying calculated amount of fuel into engine, at twice the crankshaft speed. Only open time varies to satisfy fuel requirements.

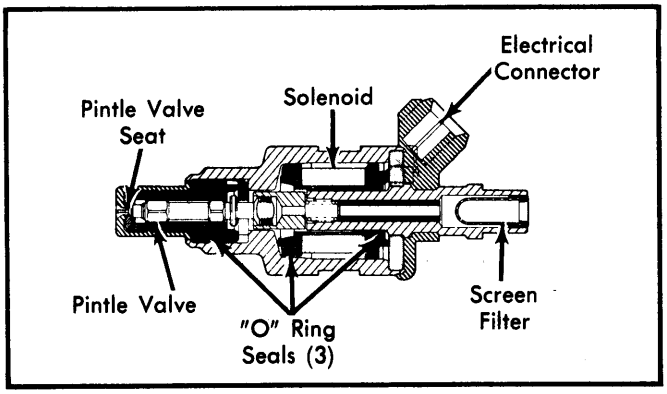

Fig. 5 Cutaway View of Injector Valve

AIR INDUCTION

Air enters the engine through the throttle body at a rate controlled by the throttle valves, which are connected to the accelerator linkage. Fast idle speed position of the throttle valves is controlled by a fast idle cam connected to and positioned by a bimetal spring (similar to a conventional automatic choke bimetal). The fast idle cam drops, reducing fast idle, as bimetal is heated by an electric heating element and is assisted by a vacuum controlled kickdown mechanism.

ENGINE SENSORS

Throttle Position Sensor (TPS) – The TPS is mounted on the side of throttle body directly connected to throttle shaft. The TPS senses throttle movement and position and transmits appropriate electrical signal to ECA. These signals are used by the ECA to determine proper fuel/air mixture, spark and EGR operation.

Barometric & Manifold Absolute Pressure Sensors (B/MAP) – The B/MAP sensor assembly is located on the right fender panel in the engine compartment. The barometric sensor signals ECA of changes in atmospheric pressure and density to regulate calculated air flow into engine. The MAP sensor monitors and signals ECA of changes in intake manifold pressure which result from engine load, speed and atmospheric pressure changes.

Engine Coolant Temperature Sensor (ECT) – The ECT, threaded into intake manifold water jacket directly above water pump by-pass hose, monitors and signals ECA of water temperature. The ECA uses these signals for mixture enrichment during cold operation, ignition timing and EGR operation.

Manifold Charging Temperature Sensor (MCT) – The MCT, threaded into intake manifold air runner directly below accelerator linkage, monitors and signals ECA of air/fuel charge temperatures. This signal is used by ECA to correct fuel enrichment for air density changes.

EGR Valve Position Sensor (EVP) – The EVP, mounted to EGR, signals ECA of EGR opening so ECA can subtract EGR flow from total flow into manifold. This excludes EGR flow from being computed into mixture requirements.

FORD MOTOR CO. ELECTRONIC FUEL INJECTION (Cont.)

Crankshaft Position Sensor (CP) – To provide ECA with an accurate ignition timing reference (when piston reaches 10° BTDC) and injector operation (twice each crankshaft revolution), the crankshaft vibration damper is fitted with a four lobe "pulse ring". As the crankshaft rotates, the pulse ring lobes interrupt magnetic field at tip of CP sensor (mounted on right front of engine).

Exhaust Gas Oxygen Sensor (EGO) – The EGO monitors oxygen content of exhaust gases and sends a constantly changing voltage signal to ECA. The ECA analyizes signal and changes air/fuel mixture accordingly.

ELECTRONIC CONTROL ASSEMBLY (ECA)

The ECA is a solid state micro-computer consisting of a processor assembly and a calibration assembly. This unit is located in the passenger compartment under the instrument panel, to the left of the steering column. The ECA is the "brain" of the EEC-III/EFI system.

Processor Assembly – The processor assembly is housed in an aluminium case and contains circuits designed to continuously sample input signals from sensors, calculate and sends out proper control signals to adjust air/fuel ratio, spark timing and emission system operation. The processor also provides a continuous reference voltage of 8.0 to 10.0 volts to some of the sensors (BMAF, EVF, ECT and TPS).

Calibration Assembly – The calibration assembly is contained in a black plastic housing which plugs into the top of the processor assembly. It contains the "memory" and programming used to provide the processor assembly with operating information for that particular vehicle and recalls information from its memory when required.

NOTE – *Different calibration information is used in different vehicle applications, such as 49 States and California.*

TESTING & DIAGNOSIS

► *TESTING OF FORD MOTOR CO. EEC-III ELECTRONIC FUEL INJECTION SYSTEM* – Due to the complexity of the EEC-III/EFI system, a special diagnostic tester is required. The tester consists of a computer tester (test selection box) and a digital volt/ohm meter (DVOM). The DVOM plugs into the computer tester with a special 12 pin plug. This test equipment checks function and specifications of ECA, sensors and emission control devices that effect engine operation and performance. Other items needed to perform tests are; test fixtures to retain continuity of sensors, inductive timing light, accurate tachometer, accurate vacuum gauge, vacuum pump and accurate pressure gauge (0-100 psi).

Without special test equipment, this system cannot be fully tested, but a number of preliminary checks can be made in the case of an "intermittent" or "no start" condition.

BASIC EEC-III/EFI TROUBLE SHOOTING

1) Perform basic ignition system and fuel system checks to ensure there is fuel and spark.

2) Remove air cleaner assembly and inspect all vacuum and Pressure hoses for proper connection to fittings, or any broken, cracked or pinched conditions.

3) Inspect EFI sub-system wiring harnesses for proper connections to the EGR solenoid valves. Red wire to both, yellow wire to vacuum solenoid and dark green wire to vent solenoid.

4) Check for any loose or detached connectors, broken or detached wires. Ensure all terminals are seated firmly and are not corroded. Check for partially broken or frayed wires or any shorting between wires.

5) Inspect sensors for physical damage. Inspect vehicle electrical system. Check battery for full charge and battery cable connections for tightness.

6) Inside passenger compartment, check to make sure the ECA power relay is securely attached and making a good ground connection.

TESTING NOTES & CAUTIONS

NOTE – *Ohmmeter, used in conjunction with special tester, uses low voltage in ohm test circuit (0.1999 volts across maximum scale resistance value between test leads and proportionally less voltage across lesser scale resistance). Any resistance tests performed on this system must be done using equivalent ohmmeter.*

NOTE – *No repairs or adjustments can be made to the ECA components. If diagnosis shows Processor or Calibration unit failure, they must be replaced.*

CAUTION – *Shorting wiring harness across a solenoid valve can burn out circuitry in the ECA that controls solenoid valve actuator.*

REMOVAL & INSTALLATION

CAUTION – *Fuel system is under approximately 39 psi; therefore, valve at end of fuel rail should be covered when relieving pressure in fuel lines.*

THROTTLE BODY ASSEMBLY

Removal – Remove air cleaner assembly. Relieve fuel pressure at shrader valve on end of injector rail. Remove all throttle control linkage, vacuum lines, fuel lines and electrical connections. Remove throttle body retaining nuts and throttle body.

Installation – Install throttle body assembly in reverse order of removal, using new gasket between throttle body and intake manifold.

FUEL INJECTORS & FUEL PRESSURE REGULATOR

Removal – 1) Remove throttle body assembly. Place on suitable stand, in inverted position. Remove 4 screws from base of throttle body and remove throttle body from upper fuel charging body.

2) Remove 3 fuel pressure regulator retaining screws and remove regulator. Remove nut holding injector retaining bracket to upper body and remove retaining bracket. Disconnect wiring harness from injectors and remove injectors from upper body, noting location of each.

FORD MOTOR CO. ELECTRONIC FUEL INJECTION (Cont.)

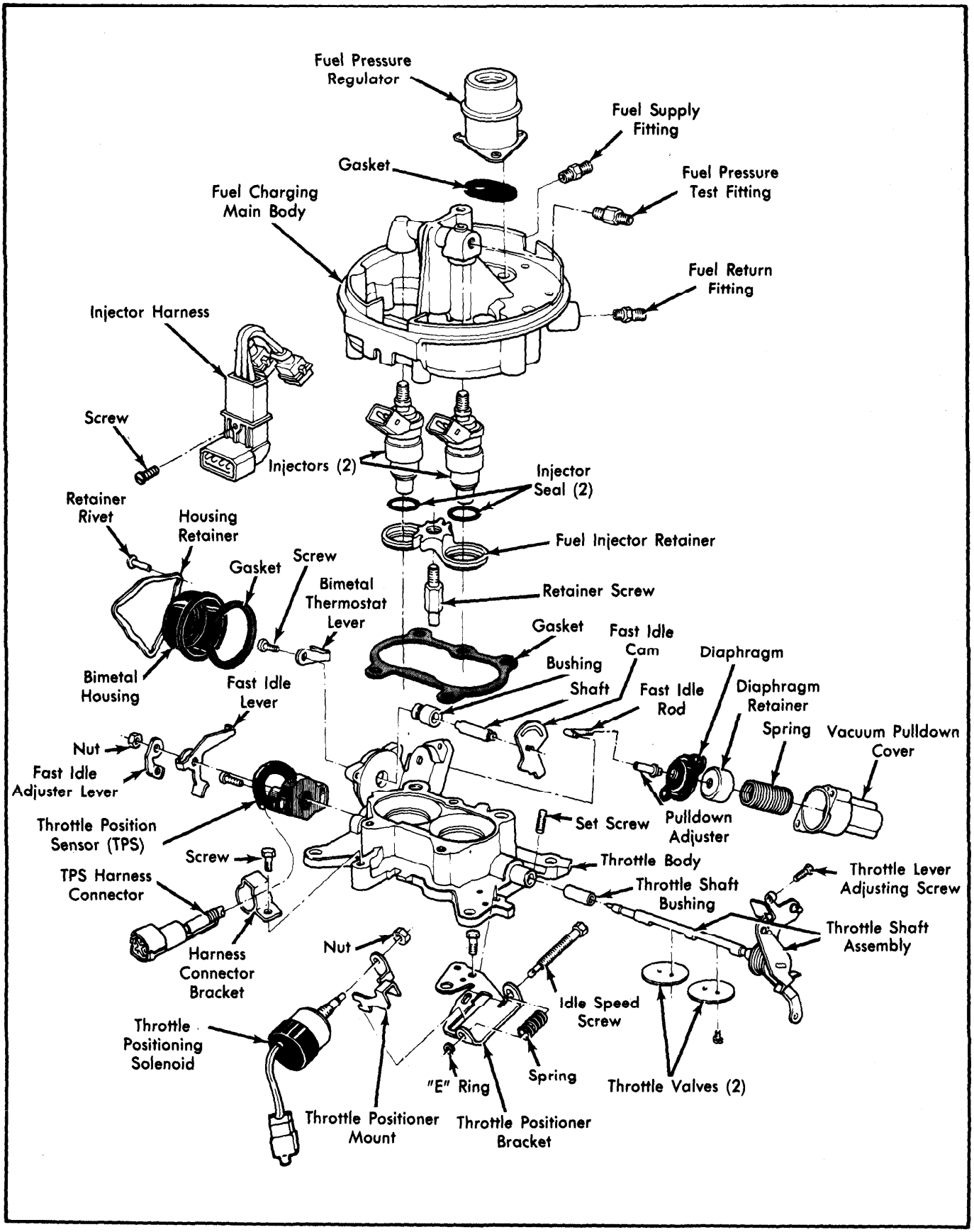

Fig. 6 Exploded View of Throttle Body and Fuel Charging Assembly

FORD MOTOR CO. ELECTRONIC FUEL INJECTION (Cont.)

Installation – 1) Replace injector "O" rings and lubricate with light oil. Push injectors into their original location, install retainer bracket and nut.

2) Replace Pressure regulator "O" ring and gasket and lubricate "O" ring with light oil. Install pressure regulator and 3 screws. Install connectors to injectors and install throttle body to manifold.

FAST IDLE BIMETAL & PULLDOWN ASSEMBLY

Removal – 1) Drill rivet heads from bimetal cover retaining ring with a .128" (No. 30) drill. Drive remaining portion of rivet body from housing. Remove bimetal cover retaining ring and cover.

2) Remove 2 screws and fast idle pulldown cover. Remove spring, spring retainer and pulldown diaphragm.

Installation – 1) Install pulldown diaphragm with vacuum passage in diaphragm toward top of housing. Holding spring and spring retainer on diaphragm, carefully install pulldown cover and screws.

2) Install fast idle control bimetal to original position. Position cap retainer on cap, making sure all holes line up. Install new retaining rivets (⅛" diameter by ½" long by ¼" head).

FUEL PUMP

Removal – With fuel tank removed, disconnect supply and return lines and electrical connector. Using suitable tool, turn fuel pump lock ring counterclockwise and remove. Remove fuel pump assembly and seal. Discard seal.

NOTE – *Whenever the fuel pump is removed from the tank, the rubber hoses, clamps and mounting gasket must be replaced. If not replaced, hoses could become brittle and deteriorate.*

Installation – Install new seal and hold in place with heavy grease. Install gasket, pump unit and locking ring, making sure seal does not move. Reconnect fuel lines and electrical connector. Install fuel tank.

THROTTLE POSITION SENSOR (TPS)

Removal – Remove retaining nut from fast idle side of throttle shaft. Remove fast idle cam adjuster lever, fast idle actuating lever and "E" clip from throttle shaft. Scribe a locating mark on TPS and throttle body, remove TPS retaining screws and TPS.

Installation – Install TPS with scribe mark at 12 o'clock position. Holding firmly against throttle body, rotate into original position and install screws. Install "E" clip, fast idle levers and retaining nut.

ELECTRONIC CONTROL ASSEMBLY (ECA) & SENSORS

NOTE – *No removal and installation procedures available from manufacturer. If engine sensors are removed, install using sealing compound on threads. Refer to Description and Operation in this story for locations.*

ADJUSTMENTS

See appropriate article in TUNE-UP SERVICE PROCEDURES.

TIGHTENING SPECIFICATIONS

Application	INCH Lbs.
Throttle Body-to-Intake Manifold	120
Fuel Pressure Regulator	27-40
Injector Bracket	36-60
Fast Idle Lever Nut	16-21
Pulldown Diaphragm Cover	13-19
Fuel Line Fittings	120-180

GENERAL MOTORS ELECTRONIC FUEL INJECTION

Cadillac
Eldorado & Seville
(California Only)

DESCRIPTION

This electronic fuel injection system (EFI) basically consists of four sub-systems: Fuel delivery, air induction, engine sensors and the electronic control unit (ECU). The fuel delivery system includes a chassis mounted electric fuel pump, an in-tank boost pump, engine mounted fuel filter, fuel rail, injectors, fuel pressure regulator and fuel supply and return lines.

The air induction system consists of throttle body, fast idle valve, idle air compensator and intake manifold. Engine sensors are as follows: Manifold absolute pressure (MAP), throttle position switch, coolant and air temperature sensors, and a speed sensor. The fourth system is the ECU.

This combination of sub-systems, working together, creates a two group timed port injection system. The two groups are based upon engine firing order; the first group consists of cylinders 1, 2, 7 and 8; the second group is made up of the center four cylinders, 3, 4, 5 and 6. All four injectors in either group are actuated at the same time and the separate groups are actuated alternately.

Seville models include a solenoid operated idle air compensator to control idle speed when the A/C compressor is operating. All models use a "Closed Loop" fuel injection system. This system uses an oxygen sensor, located in the left side exhaust manifold, to sense oxygen content in exhaust gases. Differently calibrated ECUs are used for each model and cannot be interchanged.

OPERATION

GENERAL

The amount of air entering the engine is measured by monitoring the intake manifold absolute pressure, the intake air temperature, and the engine speed. This information allows the electronic control unit to compute the flow rate of fuel required to achieve the desired air/fuel ratio for the particular engine operating condition. Each of the injector groups are activated once for every revolution of the camshaft or once for every two revolutions of crankshaft. The ECU converts the multi-variable information (see illustration) into an injector pulse width which opens the injectors for the proper duration and at proper time with respect to cylinder firing sequence.

CLOSED LOOP EFI SYSTEM

Closed Loop EFI system is used on all models. The closed loop system uses an oxygen sensor, in exhaust manifold, to sense oxygen content in exhaust gases. The oxygen sensor is an electromechanical device which produces a variable voltage depending upon oxygen content in exhaust gases. The variable voltage is sent to the ECU to signal it to regulate the amount of fuel injected. With this system, air/fuel ratio is maintained at the ideal ratio of 14.7 to 1.

AIR INDUCTION SYSTEM

Air for combustion enters engine through throttle body at a rate controlled by the throttle valves, which are connected to

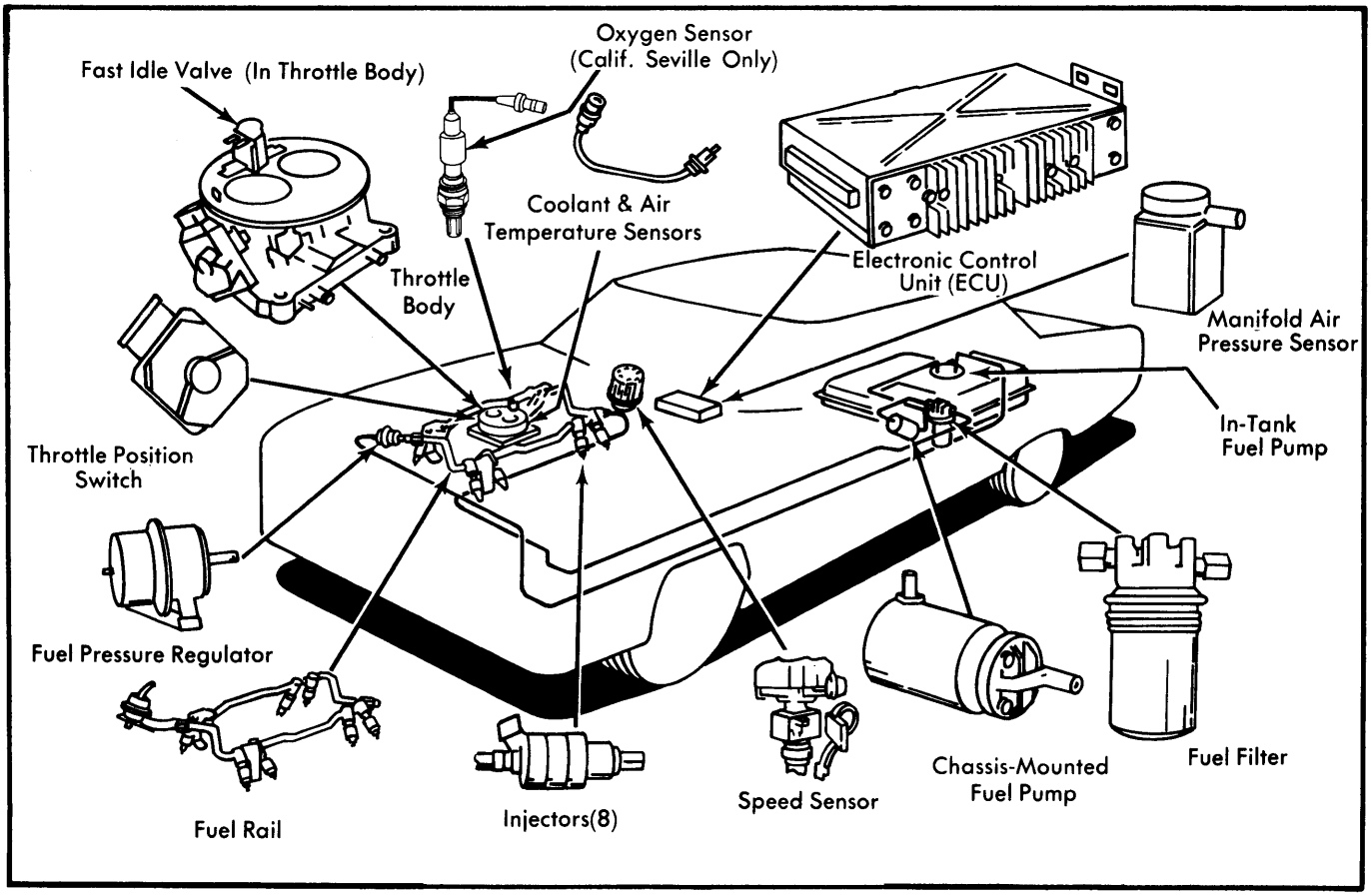

Fig. 1 Electronic Fuel Injection System Components & Locations (Typical)

GENERAL MOTORS ELECTRONIC FUEL INJECTION (Cont.)

accelerator pedal linkage. An adjustable idle by-pass air passage is incorporated within the throttle body that allows a regulated amount of air to by-pass the throttle valves. The throttle valves are pre-set to slightly open position, even when throttle lever is resting against the idle stop position.

NOTE – *This pre-set position is not adjustable.* Additional air for cold starting is provided through an electrically operated (controlled) fast idle valve which is incorporated into top of throttle body.

Idle air bypass adjusting screw is a spring-loaded slot-head type. A solenoid operated idle air compensator is used on Sevilles to aid in smooth idle with A/C compressor engaged.

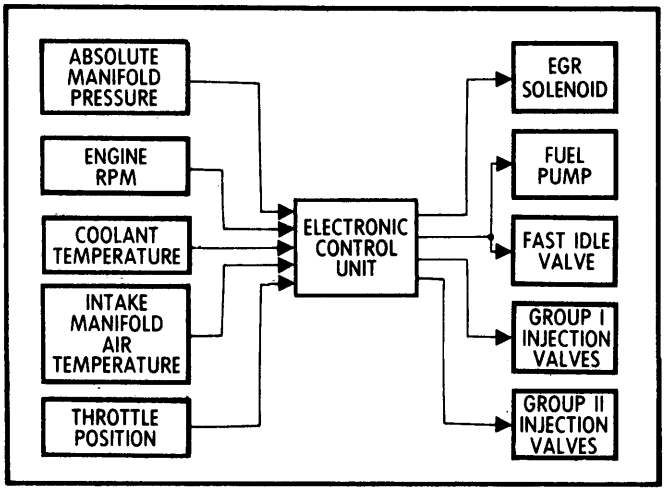

Fig. 2 Block Diagram Of EFI Electronic Functions

FUEL DELIVERY

Fuel Pumps – Two electric fuel pumps are used on vehicles with EFI system. Located inside fuel tank, as an integral part of fuel gauge sending unit, the in-tank pump is used to supply fuel to chassis-mounted (main) pump. Purpose of this pump is to prevent vapor lock at suction side of main pump. The chassis-mounted main pump is constant displacement roller-vane type pump. This main pump has flow rate of 33 gallons per hour at 39 psi. Both fuel pumps are actuated by electronic control unit when ignition switch is "ON" and engine is either cranking or running.

NOTE – *Both fuel pumps will deactivate in about one second if engine stalls or starter is not engaged.*

Fuel Pressure Regulator – This unit maintains a constant 39 psi, above intake manifold absolute pressure, to the injectors. Excess fuel is returned to fuel tank via return lines. The regulator is located toward front of engine on fuel rail.

Injectors – Injectors are solenoid-operated pintle valves which meter fuel to each cylinder. To furnish adequate fuel under different engine operating conditions, the ECU controls length of time pintle is retracted and fuel is being injected.

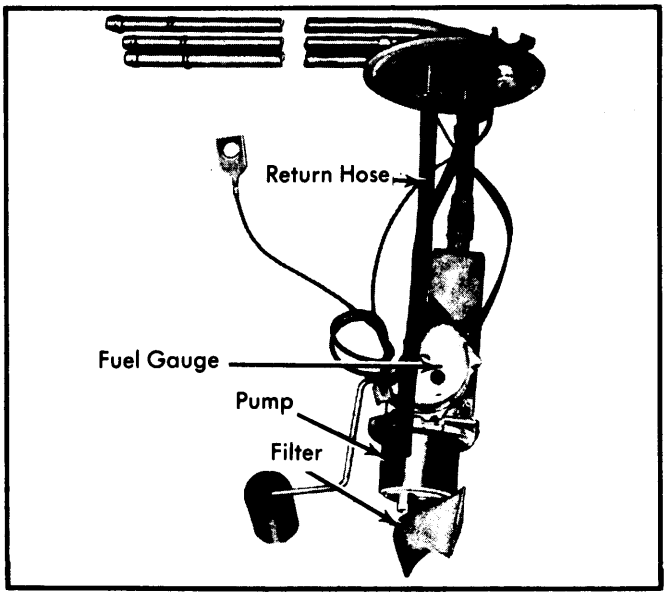

Fig. 3 View Of In-Tank Boost Pump

ENGINE SENSORS

Each sensor furnishes an electronic signal to ECU, modifying the injection time commands which changes the fuel injection rate to conform with operating conditions of engine. These sensors are explained as follows:

Manifold Absolute Pressure (MAP) – This sensor monitors changes in intake manifold pressure which results from engine load, speed and barometeric pressure variations. As intake manifold pressure increases, additional fuel is required. MAP sends this information to ECU so that the pulse width is increased (time injector is open). Conversely, as manifold pressure decreases, pulse width is shortened.

Throttle Position Switch – This slide switch is mounted on side of throttle body and connected directly to throttle shaft. This switch senses shaft movement and positions and transmits appropriate electrical signals to ECU. Four basic signals are sent to ECU. First, when throttle is closed (idle position) signal sent to ECU helps to determine basic pulse width. Second signal is sent to ECU when accelerating and ECU provides additional pulses to enrichen fuel mixture. Third signal is needed for wide open throttle. Fourth signal is also wide open throttle, but with engine not running. This wide open throttle (W.O.T.) signal provides for clearing a flooded engine.

Temperature Sensors – Both coolant temperature sensor and air temperature sensor are exactly same and therefore interchangeable. These sensors consist of a coil of high temperature nickel wire which changes internal resistance according to temperature. Low temperature produces low resistence.

Speed Sensor – Located just below base plate of HEI distributor, the speed sensor consists of two components. First component is two reed switches mounted within a plastic housing, second component is plastic rotor with two magnets (called flags), attached to and rotating with distributor shaft. Each flag furnishes signal for each injection group. As flags rotate

GENERAL MOTORS ELECTRONIC FUEL INJECTION (Cont.)

past reed switches, the switches open and close and this information is sent to ECU. This type of signal is basically a tachometer reading for each group of injectors.

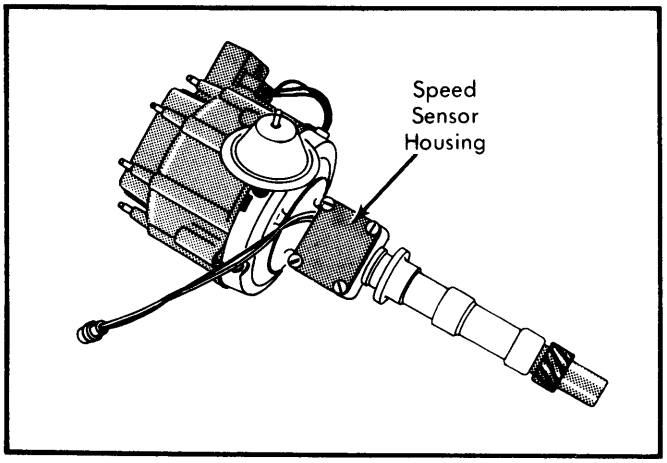

Fig. 4 HEI Distributor With Speed Sensor (Trigger)

ELECTRONIC CONTROL UNIT (ECU)

The ECU is a preprogrammed analog computer which is installed behind instrument panel on the right side. It is electrically connected to vehicle power supply and to the components of the EFI system. As signals are received from sensors, the ECU processes the signals and commands injectors to open for a specific time duration. The duration of an injection (pulse width) varies as the engine operating conditions change. The desired air fuel ratios for any possible combination of driving or atmospheric conditions is programmed into the ECU.

TROUBLE SHOOTING

NOTE – *The fuel injection analyzer (J-25400) will functionally test each component of the system as well as the ECU. However, there are many problems which can be solved (without this analyzer) by following the diagnostic procedure. To aid in diagnosis, the table below indicates the approximate relationship between basic carburetor components and electronic fuel injection components.*

NOTE – *A driveability problem on an EFI equipped vehicle may sometimes be the fault of an improperly positioned EGR valve gasket or having the wrong gasket installed.*

Carburetor-to-EFI Comparison

Carburetor	EFI Component
Accelerator Pump	Throttle Position Switch
Fast Idle Cam	Electric Fast Idle Valve
Float	Fuel Pressure Regulator
Power Valve/Metering Rods	MAP Sensor
Metering Jets/Idle System	Injection Valves/ECU
Idle Solenoid	Idle Air Compensator

ENGINE CRANKS BUT WILL NOT START

1) Blown 20 amp. fuse at fuse block. Turn ignition switch to "ON" (not "START") position and listen for 1 second pump whine.

NOTE – *Use only 20 amp. fuses (not "SLOW-BLOW"). These fuses are of flat wafer type and must be replaced with equivalent. Use of larger amperage fuses may damage expensive ECU unit.*

2) If fuse continually blows, check for short circuit in light blue wire at ECU. Light blue wire showing short should be disconnected at fuel pump connections and retested. If no short is found in wire, check chasis mounted fuel pump, wire to in-tank fuel pump and in-tank fuel pump for short circuits.

3) Open circuit in purple or brown wire between starter solenoid and blue connector at ECU. Listen for a 1 second whine of fuel pump when ignition switch is turned to "ON" position.

4) Poor connection at ECU terminal connectors, fuel pump jumper harness, engine temperature sensors or at distributor trigger (speed sensor). To check engine temperature sensors, connect an ohmmeter across each sensor connector (disconnted). If ohmmeter reading is not between 600 and 1600 ohms (the higher the temperature the higher the ohm reading), replace sensor.

5) Malfunction in chassis mounted fuel pump. Check voltage of wire at pump connection.

6) Malfunction of throttle position switch. To check, disconnect switch and engine should start.

CAUTION – *Fuel system is under approximately 39 psi; therefore, the following procedure should be followed when relieving pressure from fuel system: remove protection cap from pressure fitting of fuel pressure valve and loosely install special tool (J-5420) on fitting. Arrange shop towel or suitable container so that discharged fuel will be contained. Slowly tighten special tool until pressure is relieved.*

7) Fuel flow restriction. Check by disconnecting pump outlet line and turning ignition switch to "ON" position, if fuel flow is abnormal, continue disconnecting fuel supply lines until fuel tank is reached.

HARD STARTING

1) Engine coolant temperature sensor has open circuit. Indication of this condition is that it will start normally when engine is hot, but is hard to start when engine is cold or only partially warm. To check sensor, connect an ohmmeter across sensor connector (disconnected). If ohmmeter reading is more than 1600 ohms, replace sensor.

2) Malfunction in throttle switch. To check, disconnect switch and engine should start normally.

CAUTION – *Fuel system is under approximately 39 psi; therefore, the following procedure should be followed when relieving pressure from fuel system: remove protection cap from pressure fitting of fuel pressure valve and loosely install special tool (J-5420) on fitting. Arrange shop towel or suitable container so that discharged fuel will be contained. Slowly tighten special tool until pressure is relieved.*

3) Malfunction in pump or pressure regulator. To check, test pressure of fuel supply system.

GENERAL MOTORS ELECTRONIC FUEL INJECTION (Cont.)

POOR FUEL ECONOMY

1) Disconnected or leaking MAP sensor. Replace or repair as necessary.

2) Disconnected vacuum hose at fuel pressure regulator or at throttle body. Check all vacuum connections.

3) Malfunction of air temperature sensor. Check for closed (shorted) circuit in temperature sensor by connecting an ohmmeter across connector terminals. If sensor resistance is less than 600 ohms, replace sensor.

ENGINE STALLS AFTER STARTING

1) Check for open circuit in pink (gray at ECU) wire from ignition switch to black connector at ECU or for poor connection at ECU terminal connectors, which is located below instrument panel near ECU.

2) Check for poor connection at engine coolant sensor. Check for open circuit in sensor wire or in sensor wiring connector. To check for open circuit in sensor, connect ohmmeter across disconnected sensor terminals, if resistence is greater than 1600 ohms, replace sensor.

3) Check idle air compensator for stalling after start or at idle. When compensator is working properly, an increase in air noise will be heard when A/C compressor cuts in. Idle RPM with A/C ON and transmission in DRIVE should be within about 30 RPM of the normal A/C OFF idle speed. Under extremely warm conditions, this difference in RPM may be greater. If electrical connections to compensator and compressor are good, compensator valve may be sticking and should be replaced.

ROUGH IDLE

1) Check for disconnected or leaking MAP sensor hose.

NOTE – *If plastic harness line requires replacing, replace entire EFI engine harness.*

2) On cold engine only, check for poor connection at temperature sensors or for possible open circuit at sensors. To check for open circuit, connect ohmmeter across disconnected sensor terminals, if resistance is greater than 1600 ohms, replace sensor.

3) Check for poor connection at injector wiring.

4) Check engine coolant sensor for shorted (closed) circuit. To check, connect ohmmeter across disconnected sensor terminals. If resistance is less than 600 ohms, replace sensor.

5) Speed sensor harness located too close to secondary ignition wires.

PROLONGED FAST IDLE

1) Check for possible poor connection at fast idle valve or for an open circuit in fast idle valve heating element.

2) Check adjustment of throttle position switch.

3) Check for possible vacuum leaks.

NO FAST IDLE

Check for bent fast idle valve micro-switch causing heater to malfunction and drive valve section down to locked closed position.

ENGINE HESITATES OR STUMBLES ON ACCELERATION

1) Check for disconnected, leaking or pinched MAP sensor hose.

NOTE – *If plastic harness line requires replacing, replace entire EFI engine harness.*

2) Check for electrical malfunction or mechanical alignment malfunction of throttle position switch.

3) Check for intermittent malfunction of distributor trigger (speed sensor).

4) Check 6 Pin connector, on ECU, for loose connection. Check EGR solenoid for loose connection or open circuit (cold engine only).

LACK OF HIGH SPEED PERFORMANCE

1) Check throttle position switch for proper alignment at wide open throttle (W.O.T.). Also check for any other malfunctions in throttle positioning switch.

2) Check for malfunction of chassis mounted fuel pump.

3) Check for intermittent malfunction of distributor trigger (speed sensor).

CAUTION – *Fuel system is under approximately 39 psi; therefore, the following procedure should be followed when relieving pressure from fuel system: remove protection cap from pressure fitting of fuel pressure valve and loosely install special tool (J-5420) on fitting. Arrange shop towel or suitable container so that discharged fuel will be contained. Slowly tighten special tool until pressure is relieved.*

4) Check fuel system for restriction.

5) Check for open circuit in purple wire between ECU and starter solenoid.

GENERAL MOTORS ELECTRONIC FUEL INJECTION (Cont.)

REMOVAL & INSTALLATION

CAUTION – *Fuel system is under approximately 39 psi; therefore, the following procedure should be followed when relieving pressure from fuel system: remove protection cap from pressure fitting of fuel pressure valve and loosely install special tool (J-5420) on fitting. Arrange shop towel or suitable container so that discharged fuel will be contained. Slowly tighten special tool until pressure is relieved.*

ELECTRONIC CONTROL UNIT

Removal – Disconnect battery negative cable. Remove instrument panel lower cover. Remove mounting screw from front of ECU. Remove screws (2) attaching ECU to instrument lower panel. Disconnect harness connectors and MAP hose.

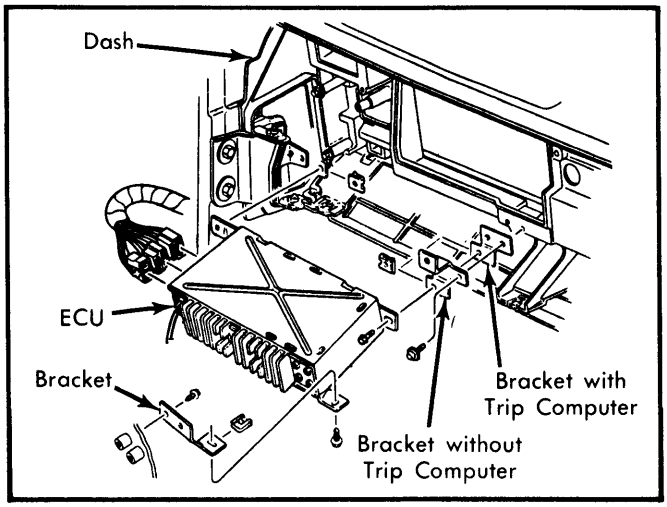

Fig. 5 ECU Mounting Location

Installation – Connect harness connectors and MAP hose to ECU. Attach ECU to instrument lower panel and install front screw to ECU. Install instrument panel lower cover and connect negative battery cable.

THROTTLE BODY ASSEMBLY

Removal – 1) Remove air cleaner, disconnect throttle return springs and if equipped, remove retainer from cruise control. Remove hairpin clip, to disconnect throttle cable from throttle lever. Remove left rear throttle body mounting screws which holds throttle bracket to intake manifold. Disengage downshift switch from throttle lever and move switch and bracket out of the way. Disconnect throttle position switch electrical connection, idle air compensator solenoid valve wire and fast idle valve connection.

2) Slide fast idle valve wiring out of notch in throttle body. Using back-up wrench, remove power brake vacuum line. From nipples on throttle body, remove vacuum hoses. Remove remaining throttle body mounting screws and remove throttle body. Remove gasket material from intake manifold and bottom of throttle body. Clean all foreign material from around intake throttle bores, on intake manifold.

Installation – 1) Position new throttle body gasket to intake manifold, with identification tag to left. Install throttle position switch to right of throttle body and adjust switch. Position throttle body on intake manifold and loosely install both front and rear mounting screws. Move throttle linkage bracket into position over left rear mounting screw and install throttle body mounting screw.

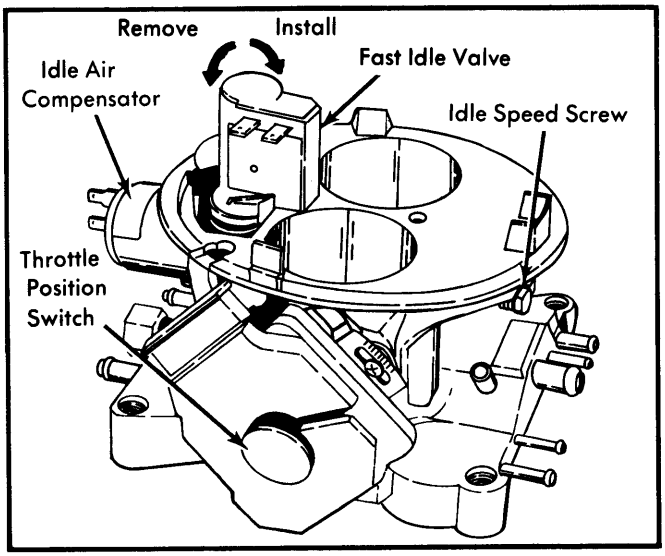

Fig. 6 External View of Throttle Body Assembly

2) Install additional bracket mounting screw and tighten all screws to specifications. Position throttle cable to throttle lever and secure cable with hairpin clip. Check operation of transmission downshift switch. Check for proper operation and wide open throttle (W.O.T.). On vehicles so equipped, position cruise control chain to throttle lever and secure with clip. Install power brake vacuum fitting to rear of throttle body and tighten bracket while using back-up wrench.

3) Install throttle return springs between throttle lever and pressure regulator bracket, with open end of spring on outside of throttle lever. Install vacuum hoses to nipples on throttle body. Install fast idle valve and air cleaner.

THROTTLE POSITION SWITCH

Removal – Disconnect electrical connection to throttle position switch. Remove 2 screws mounting throttle switch to throttle body and remove throttle switch.

Installation – Install throttle position switch to right side of throttle body, so that tab on switch engages with flat on throttle shaft. Install 2 mounting screws and tighten so that switch will move, but is not loose. Adjust throttle position switch.

FAST IDLE VALVE

Removal – Remove air cleaner and disconnect electrical connector from fast idle valve heater. Remove air cleaner stud. To remove fast idle valve heater, push down and twist 90° counterclockwise. Remove fast idle valve spring and seat from throttle body.

Installation – Install fast idle valve seat, spring and valve in position in throttle body. Position heater on top of fast idle valve and push down to compress spring.

GENERAL MOTORS ELECTRONIC FUEL INJECTION (Cont.)

NOTE – *Exercise care to avoid damaging micro-switch contact arm on bottom of heater housing.* Align tabs of fast idle valve heater with cutout position of throttle body and compress spring further. Rotate heater 90° clockwise and connect electrical connector. Install air cleaner.

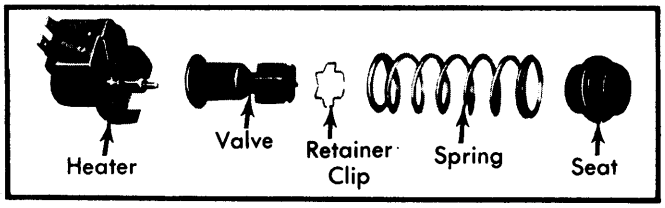

Fig. 7 Exploded View of Fast Idle Valve

INJECTION VALVE (INJECTORS)

Removal – 1) Remove front and rear fuel rails. Remove electrical conduit from injector brackets. Remove two screws holding each injector bracket to intake manifold and remove brackets and rubber grommets. Disconnect electrical connections from all injectors.

2) Remove fuel rails and injectors from engine, as a unit. NOTE – *Some injectors will stick in fuel rail, while others will remain with manifold.* Remove injectors from fuel rail and from intake manifold. Injection valves are sealed by "O" rings at both fuel rail and intake manifold, remove and discard all "O" rings.

NOTE – *Anytime EFI fuel rail fitting is separated, a new conically shaped metal gasket (part no. 1608786) should be installed. Do not reuse this gasket, replace each time a fitting is disconnected. Also, do not use teflon tape on fitting flare nuts.*

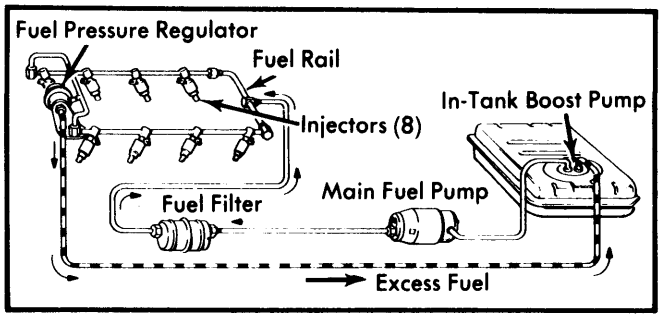

Fig. 8 Typical Cadilliac EFI Fuel Delivery System

Installation – 1) Lubricate and install all new "O" rings on fuel rail side of injectors. Install injectors into fuel rail with electrical connector facing inboard. NOTE – *Fuel rails are left and right side only and cannot be interchanged.* Lubricate and install new "O" rings into each injector port of intake manifold.

2) Install fuel rail injector assembly into intake manifold making sure that each injector is properly installed in manifold "O" rings. Install rubber grommets on fuel rail (flange down) and install injector brackets in position. Secure each bracket with two screws and tighten screws to specifications.

3) Route electrical harness along bracket and secure to bracket. NOTE – *Injectors may be rotated to provide proper harness routing.* Install front and rear fuel rails. Turn ignition switch to ON position then turn to OFF. Perform this procedure several times to ensure that fuel rail has no leaks.

FUEL PRESSURE REGULATOR

Removal – Remove vacuum hose from nipple on top of pressure regulator. Remove and discard clamps securing flexible fuel hose connecting regulator to fuel rail. Remove fuel return line. Remove nut securing pressure regulator to fuel rail. NOTE – *This nut has metric threads. Work regulator off of flexible fuel hose and out of bracket.*

Installation – 1) Install new hose clamp over flexible fuel hose. Position regulator to bracket and work flexible fuel hose-to-fuel rail over nipple on side of regulator. Secure bracket with one nut. NOTE – *This nut has metric threads.* Connect return line to fitting on end of regulator.

2) Tighten clamps securing flexible fuel hose to regulator. Install vacuum hose to remaining nipple on pressure regulator. NOTE – *Dry fuel system on vehicle with EFI may require substantial cranking before it will start.*

FUEL FILTER ASSEMBLY

Removal – Remove fuel inlet hose and discard clamp. Remove fuel outlet line from fitting of fuel filter. Remove two screws securing fuel filter assembly to bracket and remove filter. Remove inlet and outlet fittings from fuel filter assembly (if needed for new assembly). If it is necessary to remove fuel filter bracket, loosen lower mounting screw and remove upper mounting screw. Remove bracket and clean gasket surfaces.

Installation – If bracket was removed, position gasket to block (using gasket cement to hold in place) and start bottom screw. Position bracket to block, install upper mounting screw and tighten both screws. Install inlet and outlet fittings in fuel filter assembly. Position fuel filter to bracket and secure with 2 screws. Connect fuel inlet line and outlet line to fuel filter fittings.

NOTE – *Dry fuel system on vehicle equipped with EFI, may require substantial cranking before engine will start.*

CHASSIS-MOUNTED FUEL PUMP

NOTE – *Chassis-mounted fuel pump is located in front of left rear wheel on all models.*

Removal – Remove fuel inlet and outlet hoses from nipples of pump. Peel back rubber boot and remove 2 nuts; one from each electrical terminal. Remove electrical leads. NOTE – *These nuts have metric threads.* Remove 2 screws securing pump to bracket and remove pump. Disconnect inlet and outlet hoses by removing and discarding hose clamps.

Installation – Position fuel pump to mounting bracket and secure with two screws. Tighten screws to specifications. Position electrical leads to fuel pump terminals as follows: dark green wire to positive terminal and black wire to negative terminal. Secure with two nuts and reposition rubber boot.

NOTE – *Use new nuts supplied with replacement pump.* Install inlet and outlet hoses to fuel pump. Check to ensure fuel pump is resting on its two mounts and that it is not grounding against bracket or frame. NOTE – *Dry fuel system may require substantial cranking before vehicle will start.*

GENERAL MOTORS ELECTRONIC FUEL INJECTION (Cont.)

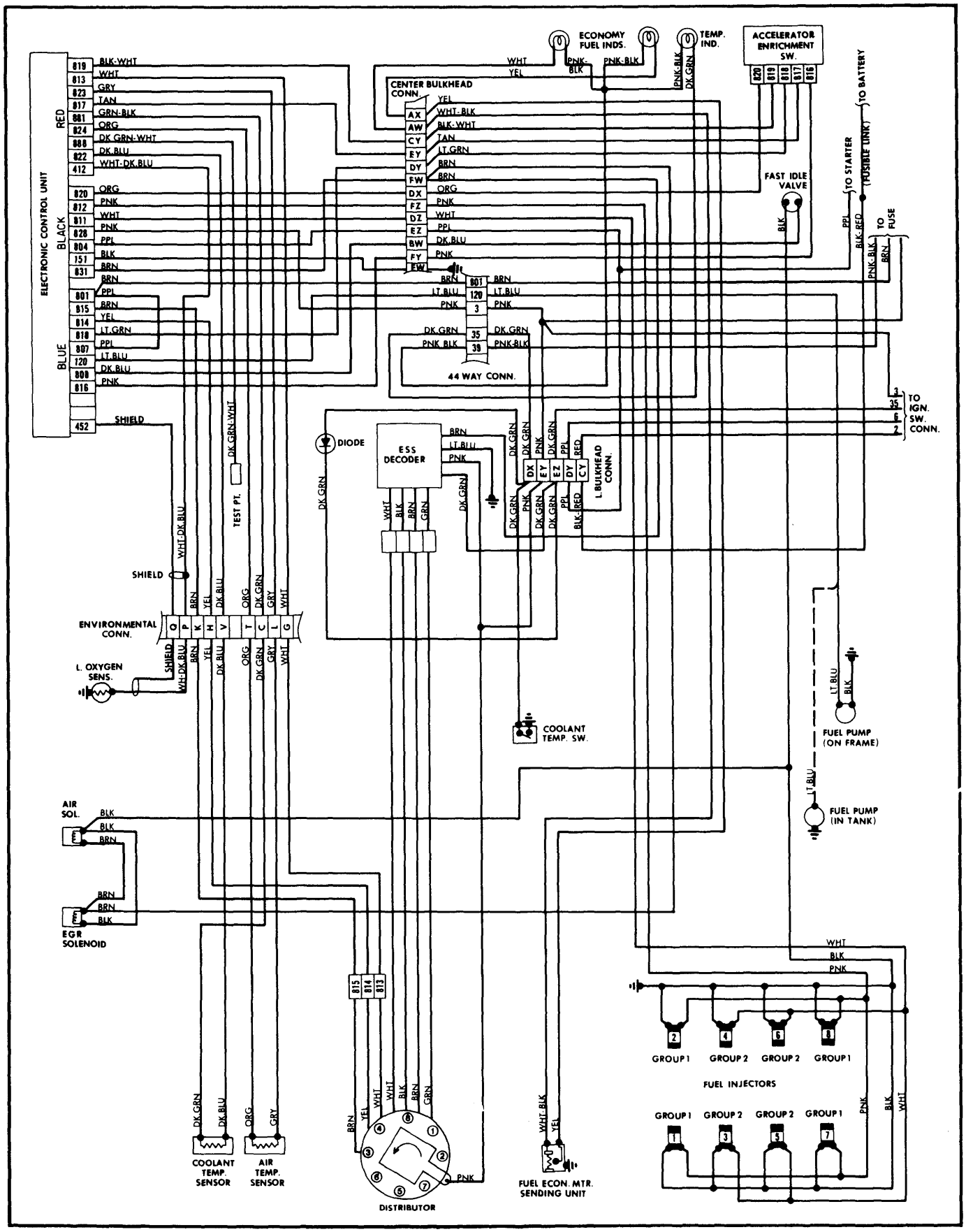

Fig. 9 General Motors Electronic Fuel Injection Wiring Diagram

GENERAL MOTORS ELECTRONIC FUEL INJECTION (Cont.)

IN-TANK FUEL PUMP

Removal – With fuel tank removed, remove locknuts securing fuel gauge tank unit and fuel pump feed wires to tank unit. Position fuel tank sending unit remover and installer (special tool J-24187) on cam locking ring, so that tool engages three tabs on ring. Install ratchet and turn counterclockwise to disengage lock ring from fuel tank. Remove tool and lift out tank unit.

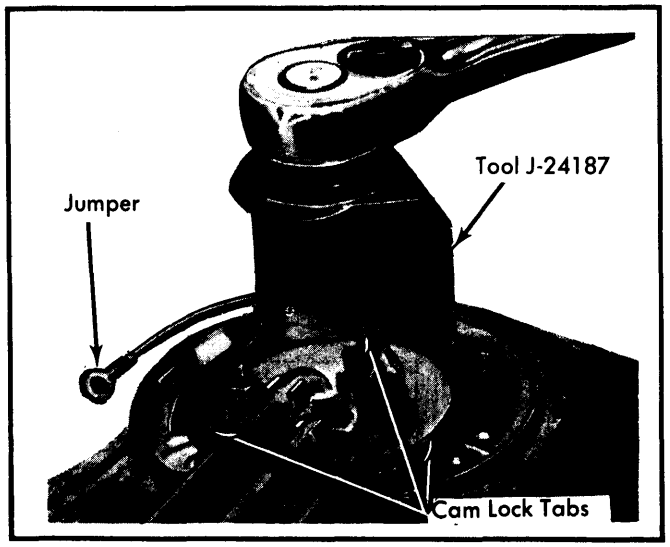

Fig. 10 Removing and Installing In-Tank Fuel Pump

Installation – Install gauge-pump unit in fuel tank. Install fuel tank sending unit remover and installer tool (J-24187). Turn tool clockwise until locking ring is fully engaged in fuel tank. Connect electrical leads to fuel gauge and secure with locknuts. Install fuel tank. NOTE – *Dry fuel system may require substantial cranking before vehicle will start.*

AIR TEMPERATURE SENSOR

Removal – Locate air temperature sensor at right rear of intake manifold and disconnect sensor from vehicle harness. Remove sensor from intake manifold.

Installation – Apply non-hardening sealer to threads of sensor and install sensor in intake manifold. Tighten sensor to specifications. Connect sensor electrical connection to vehicle harness.

COOLANT TEMPERATURE SENSOR

Removal – Drain radiator until coolant is below level of cylinder heads. Locate water temperature sensor at left front of intake manifold. Disconnect harness from sensor and remove sensor.

Installation – Apply non-hardening sealer to threads of sensor and install in sensor fitting. Tighten sensor to specifications. Connect sensor electrical connector to vehicle wiring harness. Fill radiator to proper level.

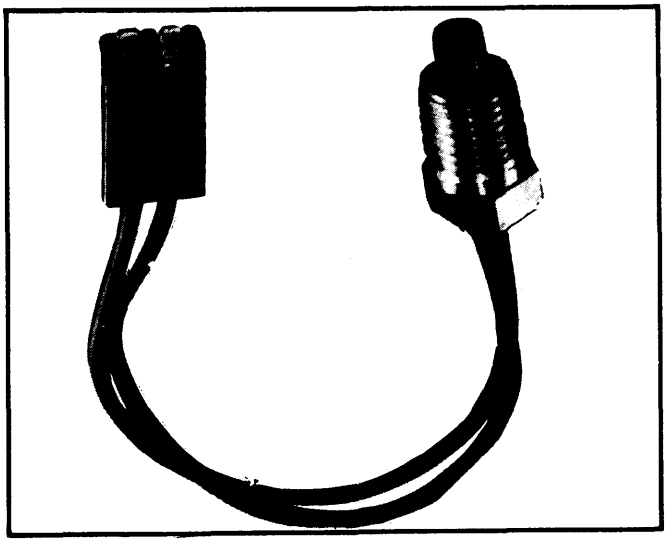

Fig. 11 Temperature Sensor

ADJUSTMENT

IDLE SPEED ADJUSTMENT

1) Disconnect distributor vacuum advance hose at distributor and plug. Disconnect parking brake hose at vacuum release cylinder and plug.

2) Engage parking brake and block wheels.

3) Connect tachometer to engine. Start engine and warm up to operating temperature in PARK.

4) Place transmission in DRIVE. Turn air conditioning OFF.

5) Adjust slotted idle bypass screw to obtain idle speed of 600 RPM.

6) Turn off engine. Disconnect tachometer. Reconnect all disconnected hoses.

THROTTLE POSITION SWITCH

To adjust, loosen two throttle position switch mounting screws just enough to permit rotation of switch. Hold throttle valve in idle position while performing the following: Turn throttle position switch carefully counterclockwise until end-stop has been reached. Tighten mounting screws. Release throttle valves and make sure that throttle valves close to throttle stop, if not, repeat procedure.

TIGHTENING SPECIFICATIONS

Application	Ft. Lbs.
Throttle Linkage Bracket-to-Manifold	30
Fuel Pump Bracket-to-Frame	20
Throttle Body Mounting Screws	15
Injector Hold Down Bracket	30
Flare Nuts on Fuel Rail	25
Sensors	15
Fuel Pump Mounting Screws	55 INCH Lbs.