FUEL SYSTEMS (GASOLINE)

FUEL DELIVERY

FUEL SYSTEM IDENTIFICATION

Application	Fuel System
Blackwood & Navigator W/5.4L 4V, Crown Victoria, Econoline & Pickup W/4.2L & 4.6L, Econoline, Excursion & Pickup W/6.8L, Expedition 4.6L, Grand Marquis, F150 Lightning 5.4L SC, Town Car & Windstar	(1) Returnable
Econoline, Expedition, Excursion, Navigator & Pickup W/5.4L 2V, Explorer, Explorer Sport, Explorer Sport Trac, Mountaineer & Ranger	(2) Mechanical Returnless
All Others	(3) Electronic Returnless

(1) See **RETURNABLE FUEL SYSTEM**.

(2) See **MECHANICAL RETURNLESS FUEL SYSTEM**.

(3) See **ELECTRONIC RETURNLESS FUEL SYSTEM**.

There are 3 different types of fuel systems that are used:

Returnable Fuel System

Returnable fuel system consists of a fuel tank with a reservoir, fuel pump module, fuel supply lines, fuel filter (s), Schrader/pressure test port, fuel rail, fuel injectors, and fuel pressure regulator. The following list of components and their specific operation corresponds to numbers in illustration. See **Fig. 34**.

1. The fuel delivery system uses Crankshaft Position (CKP) sensor to signal PCM that engine is either cranking or running.
2. The fuel pump logic is defined in Fuel System control strategy and is executed in PCM. PCM will ground fuel pump relay for one second during Key On Engine Off. During cranking, fuel pump relay is grounded as long as PCM receives a CKP signal.
3. The fuel pump relay has a primary and a secondary circuit. Primary side is controlled by PCM and secondary side provides battery voltage (B+) to fuel pump circuit when relay is energized.
4. The Inertia Fuel Shutoff (IFS) switch is used to de-energize fuel delivery secondary circuit in the event of a collision. IFS switch is a safety device that should only be reset after a thorough inspection of the vehicle (following a collision). For additional IFS information, see **INERTIA FUEL SHUTOFF SWITCH (ALL FUEL SYSTEMS)**.
5. The fuel injector is a solenoid operated valve that meters fuel flow to each cylinder. Fuel injector is opened and closed a constant number of times per crankshaft revolution. Amount of fuel is controlled by length of time fuel injector is held open. Fuel injector is normally closed and is operated by a 12-volt VPWR signal from power relay. The ground signal is controlled by PCM. For additional fuel injector information, see **FUEL INJECTORS** under FUEL CONTROL.
6. A pressure test point valve (Schrader valve) is located on fuel rail. This is used to measure fuel injector supply pressure for service and diagnostic procedures. On vehicles not equipped with a Schrader valve, use Rotunda Fuel Pressure Test Kit (134-R0087) or equivalent.

7. The fuel pressure regulator is attached to fuel rail downstream of fuel injectors. It regulates fuel pressure supplied to fuel injectors. Fuel pressure regulator is a diaphragm operated relief valve. See **Fig. 35**. One side of diaphragm senses fuel pressure and the other side is connected to intake manifold vacuum. Fuel pressure is established by a spring preload applied to diaphragm. Balancing one side of diaphragm with manifold vacuum maintains a constant fuel pressure drop across fuel injectors. Fuel pressure is high when engine vacuum is low. Excess fuel is by-passed through fuel pressure regulator and returned through a fuel return line to fuel tank.
8. There are 4 filtering or screening devices in fuel delivery system. Fuel intake sock or screen is a fine, nylon mesh mounted on intake side of fuel pump. See **Fig. 36**. There is a fuel filter screen located at fuel rail side of fuel injector. A fuel filter/screen is located in the inlet side of fuel pressure regulator. The fuel filter assembly is located between fuel pump and pressure test point/Schrader valve.
9. The Fuel Pump (FP) module is a device that contains both fuel pump and fuel sender assembly. The fuel pump is located inside reservoir and supplies fuel through fuel pump module manifold to engine and fuel pump module jet pump. See **Fig. 37**. The fuel pump also has a discharge check valve to maintain system pressure during shutdowns and to minimize starting problems. The reservoir prevents fuel flow interruptions during extreme vehicle maneuvers with low tank fill levels.

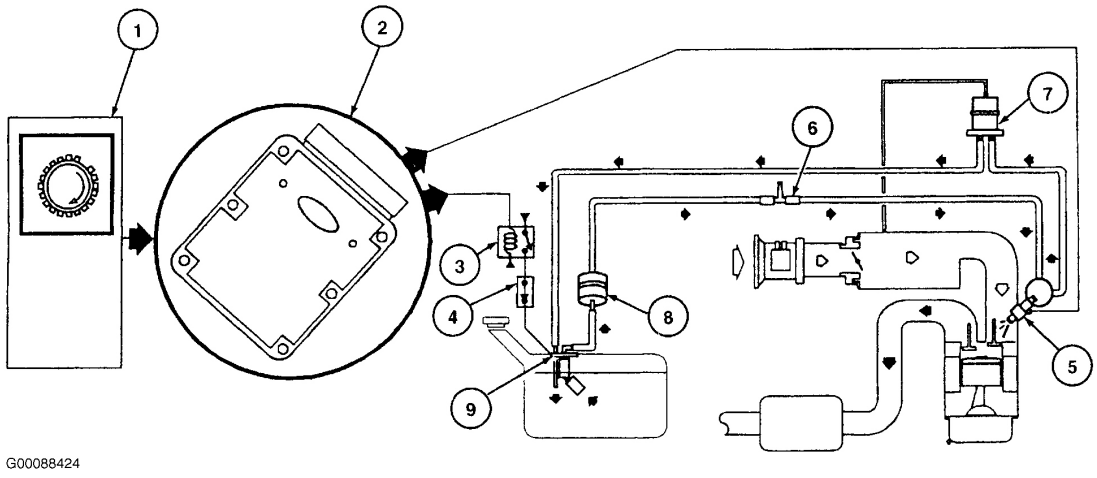

Fig. 34: Identifying Returnable Fuel System Components & Circuits
Courtesy of FORD MOTOR CO.

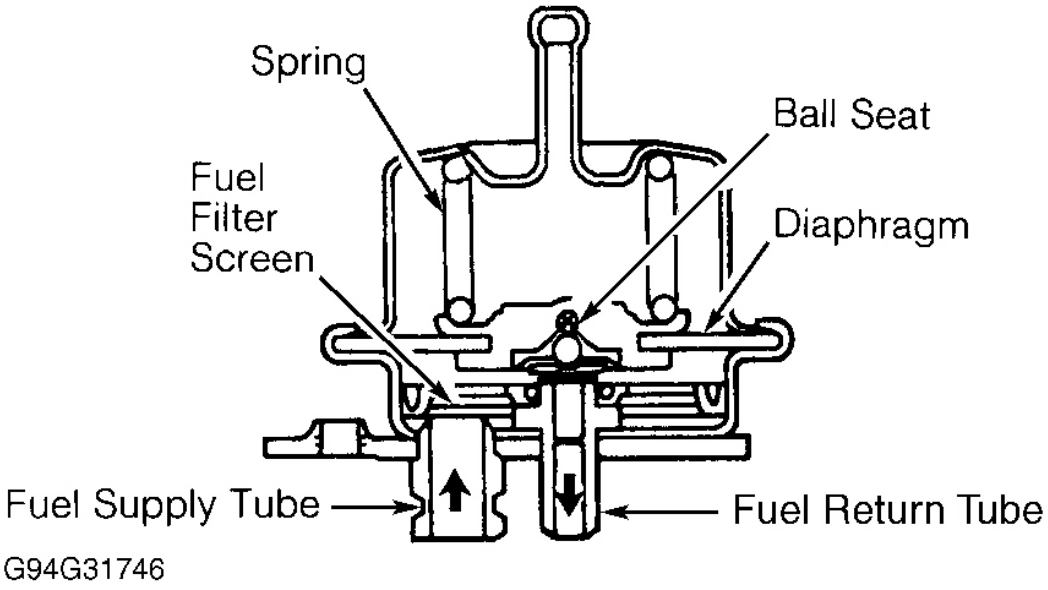

Fig. 35: Cross-Sectional View Of Pressure Regulator Components (Returnable System)
Courtesy of FORD MOTOR CO.

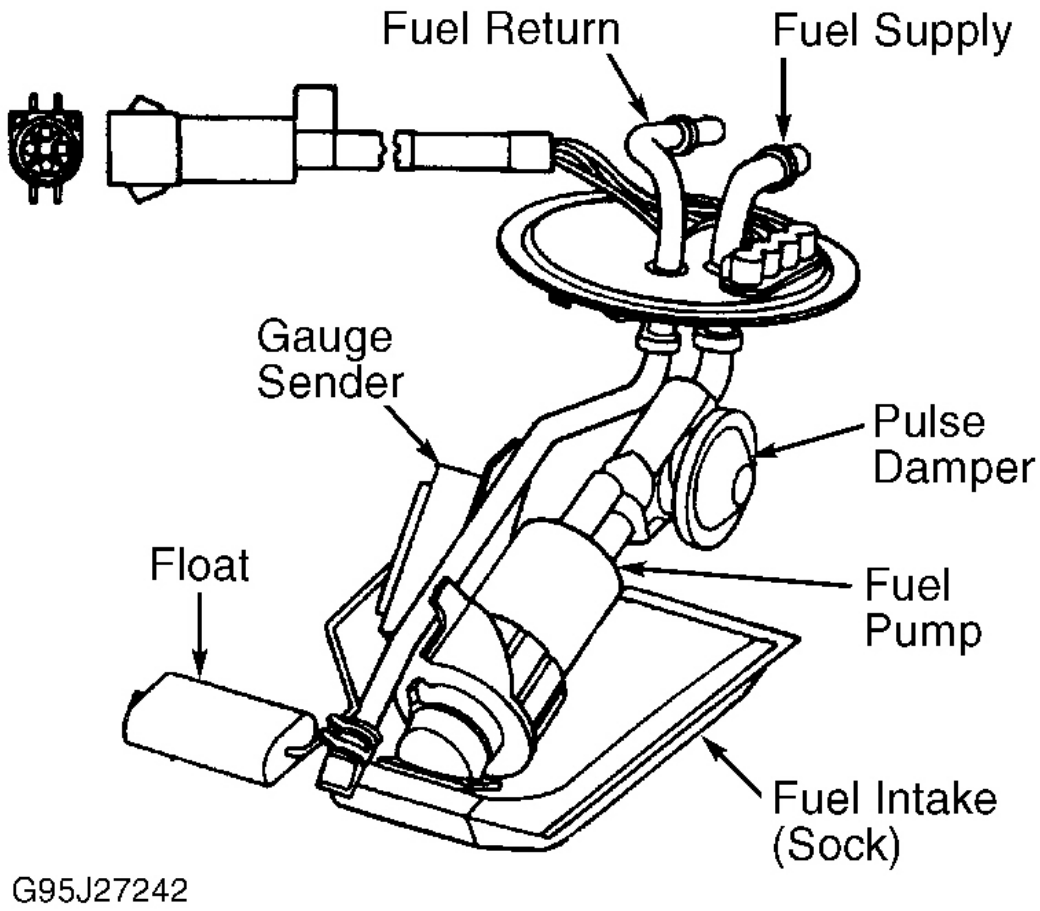

Fig. 36: Identifying Fuel Pump Assembly (Returnable Fuel System)
Courtesy of FORD MOTOR CO.

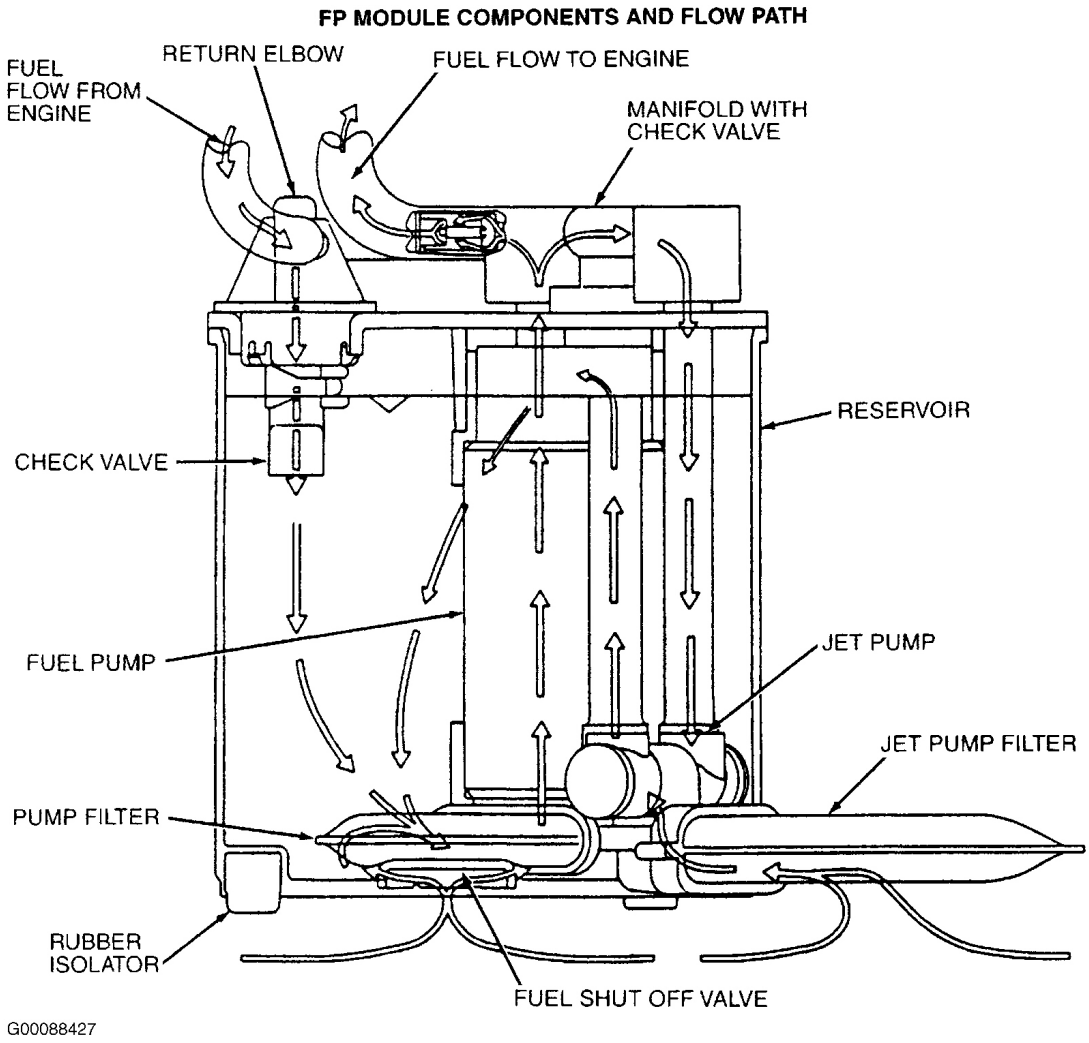

Fig. 37: Cross-Sectional View Of Fuel Pump Assembly (Returnable & Electronic Returnless Fuel System) Courtesy of FORD MOTOR CO.

Mechanical Returnless Fuel System

NOTE: Fuel rail pulse damper used on mechanical returnless fuel systems should not be confused with a fuel pressure regulator. Both are visually similar, but the fuel rail pulse damper does not regulate fuel pressure. Damper is used to reduce fuel system noise. Vacuum port on fuel rail pulse damper is connected to manifold vacuum to avoid fuel spillage if damper diaphragm ruptures.

Electronic returnless fuel system consists of a fuel tank with reservoir, fuel pump, fuel pressure regulator, fuel filter, fuel supply line, fuel rail, fuel rail pulse damper, fuel injectors, and Schrader/pressure test port. The following list of components and their specific operation corresponds to numbers in illustration. See **Fig. 38**.

1. The fuel delivery system is enabled during crank or running mode once PCM receives a Crankshaft

Position (CKP) sensor signal.

2. The fuel pump logic is defined in the fuel system control strategy and is executed by PCM.
3. The PCM grounds fuel pump relay, which provides Vehicle Power (VPWR) to fuel pump.
4. The Inertia Fuel Shutoff (IFS) switch is used to de-energize fuel delivery secondary circuit in the event of a collision. IFS switch is a safety device that should only be reset after a thorough inspection of the vehicle (following a collision). For additional IFS information, see **INERTIA FUEL SHUTOFF SWITCH (ALL FUEL SYSTEMS)**.
5. A pressure test point valve (Schrader valve) is located on fuel rail. This is used to measure fuel injector supply pressure for service and diagnostic procedures. On vehicles not equipped with a Schrader valve, use Rotunda Fuel Pressure Test Kit (134-R0087) or equivalent.
6. The fuel rail pulse damper is located on fuel rail to reduce fuel system noise caused by pulsing of fuel injectors. The vacuum port located on damper is connected to manifold vacuum to avoid fuel spillage in the event pulse damper diaphragm were to rupture. Pulse damper should not be confused with a fuel pressure regulator.
7. The fuel injector is a solenoid-operated valve that meters fuel flow to each cylinder. Fuel injector is opened and closed a constant number of times per crankshaft revolution. Amount of fuel is controlled by length of time fuel injector is held open. Fuel injector is normally closed and is operated by a 12-volt VPWR signal from power relay. The ground signal is controlled by PCM. For additional fuel injector information, see **FUEL INJECTORS** under FUEL CONTROL.
8. There are 3 filtering or screening devices in fuel delivery system. The intake sock is a fine, nylon mesh screen mounted on intake side of fuel pump. See **Fig. 39**. There is a fuel filter screen located at fuel rail side of fuel injector, and the fuel filter assembly is located between fuel pump and pressure test point/Schrader valve.
9. The Fuel Pump (FP) module contains fuel pump, fuel pressure regulator and fuel sender assembly. The fuel pump has a discharge check valve to maintain system pressure during shutdowns and to minimize starting problems. Fuel pressure regulator is attached to fuel pump in fuel pump module located in fuel tank. It regulates fuel pressure supplied to fuel injectors. The fuel pressure regulator is a diaphragm operated relief valve, wherein fuel pressure is established by a spring preload applied to diaphragm. Excess fuel is by-passed through regulator and returned to fuel tank.

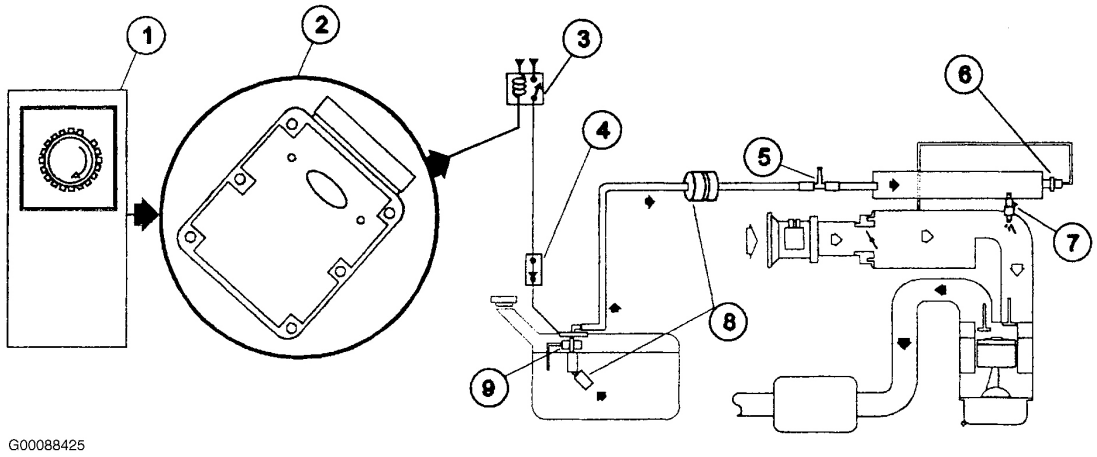

Fig. 38: Identifying Mechanical Returnless Fuel System Components & Circuits

Courtesy of FORD MOTOR CO.

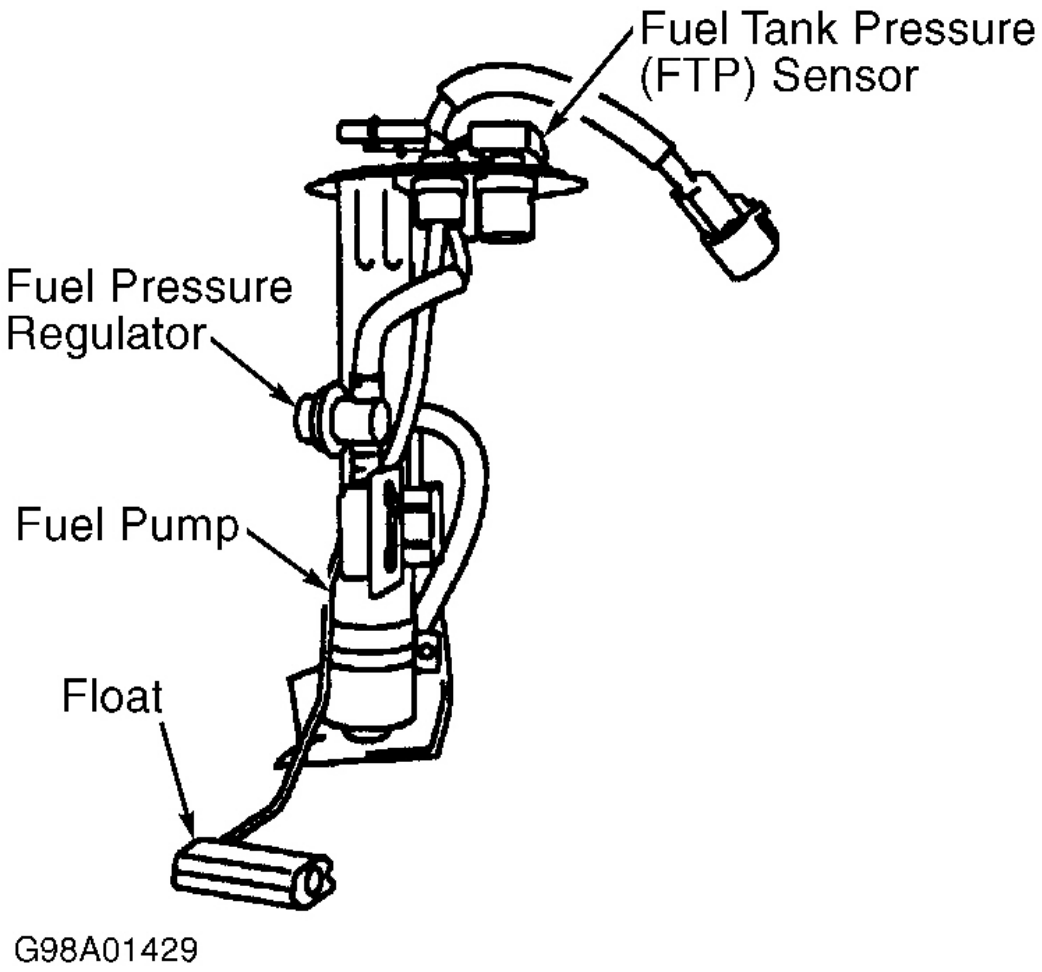

Fig. 39: Identifying Fuel Pump Assembly (Mechanical Returnless Fuel System)
Courtesy of FORD MOTOR CO.

Electronic Returnless Fuel System

Electronic returnless fuel system consists of a fuel tank with reservoir, fuel pump, fuel rail pressure sensor, fuel filter, fuel supply line, engine fuel temperature sensor, fuel rail, fuel injectors, and Schrader/pressure test point. The following list of components and their specific operation corresponds to numbers in illustration. See **Fig. 40**.

1. The fuel delivery system is enabled during crank or running mode once PCM receives a Crankshaft Position (CKP) sensor signal.
2. The fuel pump logic is defined in fuel system control strategy and is executed by PCM.

3. The PCM commands a duty cycle to Fuel Pump Driver Module (FPDM).
4. The FPDM modulates voltage to Fuel Pump (FP) to achieve proper fuel pressure. Voltage for fuel pump is supplied by power relay or FPDM power supply relay. For additional FPDM information, see **FUEL PUMP DRIVER MODULE** under COMPUTERIZED ENGINE CONTROLS.
5. The Fuel Rail Pressure (FRP) sensor provides PCM with current fuel rail pressure. PCM uses this information to vary duty cycle output to FPDM to compensate for varying loads.
6. The Engine Fuel Temperature (EFT) sensor measures current fuel temperatures in fuel rail. This information is used to vary fuel pressure and avoid fuel system vaporization.
7. The fuel injector is a solenoid-operated valve that meters fuel flow to each cylinder. Fuel injector is opened and closed a constant number of times per crankshaft revolution. Amount of fuel is controlled by length of time fuel injector is held open. Fuel injector is normally closed and is operated by a 12-volt VPWR signal from power relay. The ground signal is controlled by PCM. For additional fuel injector information, see **FUEL INJECTORS** under FUEL CONTROL.
8. A pressure test point valve (Schrader valve) is located on fuel rail. This is used to measure fuel injector supply pressure for service and diagnostic procedures. On vehicles not equipped with a Schrader valve, use Rotunda Fuel Pressure Test Kit (134-R0087) or equivalent.
9. There are 3 filtering or screening devices in fuel delivery system. The intake sock is a fine, nylon mesh screen mounted on intake side of fuel pump. See **Fig. 41**. There is a fuel filter screen located at fuel rail side of fuel injector, and the fuel filter assembly is located between fuel pump and pressure test point/Schrader valve.
10. The Fuel Pump (FP) module is a device that contains fuel pump and fuel sender assembly. The fuel pump has a discharge check valve to maintain system pressure during shutdowns and to minimize starting problems. Fuel pump is located inside reservoir and supplies fuel through fuel pump module manifold to engine and fuel pump module jet pump. The reservoir prevents fuel flow interruptions during extreme vehicle maneuvers with low tank fill levels.
11. The Inertia Fuel Shutoff (IFS) switch is used to de-energize fuel delivery secondary circuit in the event of a collision. IFS switch is a safety device that should only be reset after a thorough inspection of the vehicle (following a collision). For additional IFS information, see **INERTIA FUEL SHUTOFF SWITCH (ALL FUEL SYSTEMS)**.

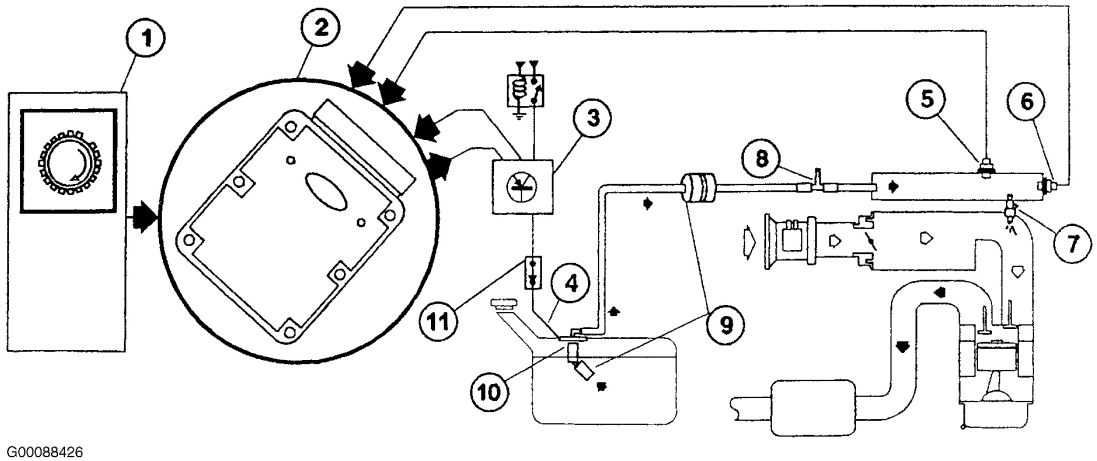

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Fig. 40: Identifying Electronic Returnless Fuel System Components & Circuits
Courtesy of FORD MOTOR CO.

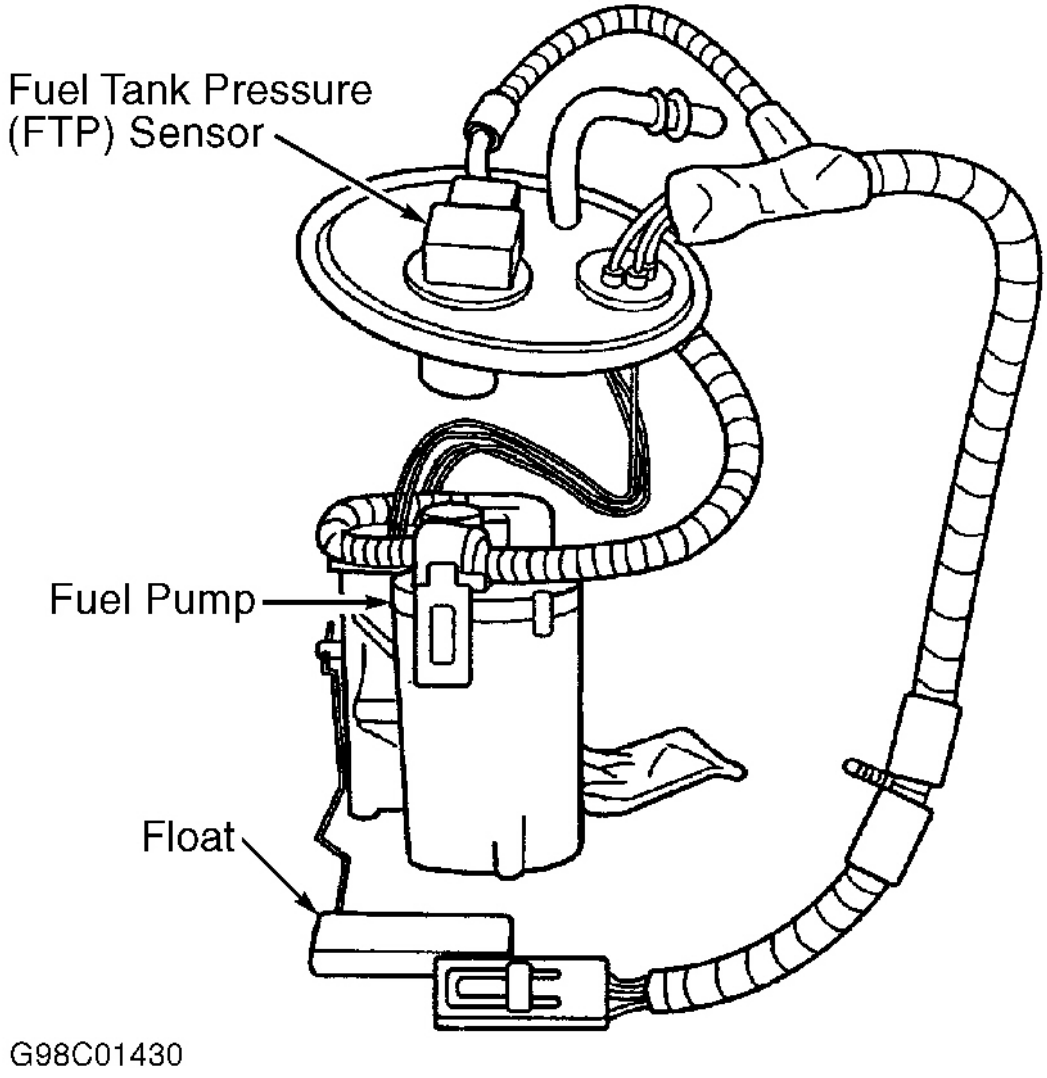

Fig. 41: Identifying Fuel Pump Assembly (Electronic Returnless Fuel System)
Courtesy of FORD MOTOR CO.

Inertia Fuel Shutoff Switch (All Fuel Systems)

WARNING: DO NOT reset IFS switch until complete fuel system has been inspected for leaks.

In the event of a collision or vehicle rollover, electrical contacts within the Inertia Fuel Shutoff (IFS) switch are

tripped open when the internal steel ball breaks loose of the switch magnet. See **Fig. 42**. Once loose, the steel ball rolls up a conical ramp and makes contact with the target plate which creates an open in the electrical circuit to electric fuel pump. If the electrical circuit is opened, it is not possible to restart the vehicle until the switch is reset. A reset button is located on top of IFS switch assembly.

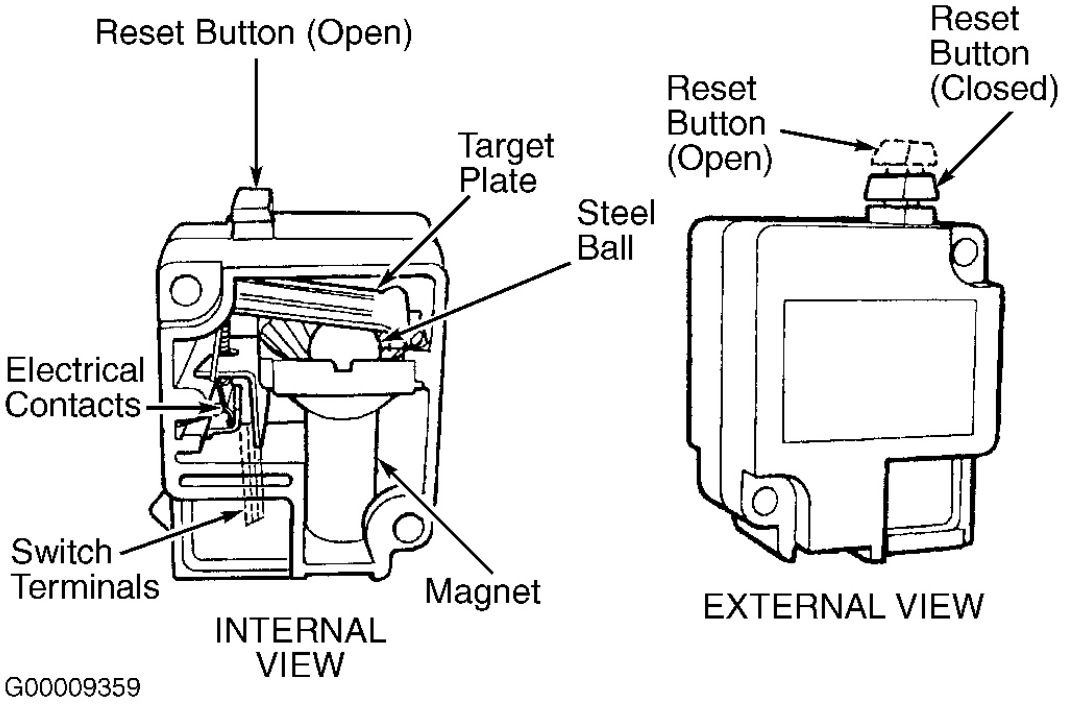

Fig. 42: Identifying Inertia Fuel Shutoff Switch
Courtesy of FORD MOTOR CO.

FUEL CONTROL

CAUTION: DO NOT apply battery voltage directly to fuel injector electrical connector terminals, internal damage to fuel injector may occur.

NOTE: Fuel injectors are deposit resistant and must not be cleaned.

Fuel Injectors

The PCM controls fuel injector pulse width ("on" time) to meter fuel quantity into intake ports. PCM receives inputs from engine sensors to compute fuel flow necessary to maintain correct air/fuel ratio throughout entire engine operating range. Injector pulse width is the only controlled variable in fuel delivery system.

Each cylinder has a solenoid-operated injector that sprays fuel toward the back of each intake valve. Fuel injector nozzles are solenoid-operated valves, which meter and atomize fuel delivered to engine. Each injector

receives battery voltage through an ignition switch circuit. The PCM controlled ground circuit is used to complete the circuit and energize the injector.

Injector bodies consist of solenoid actuated pintle and needle valve assembly. See **Fig. 43**. Injector flow orifice is fixed and fuel pressure at injector tip is constant. Fuel flow to engine is regulated according to length of time solenoid is energized. Atomized spray pattern is obtained by shape of pintle.

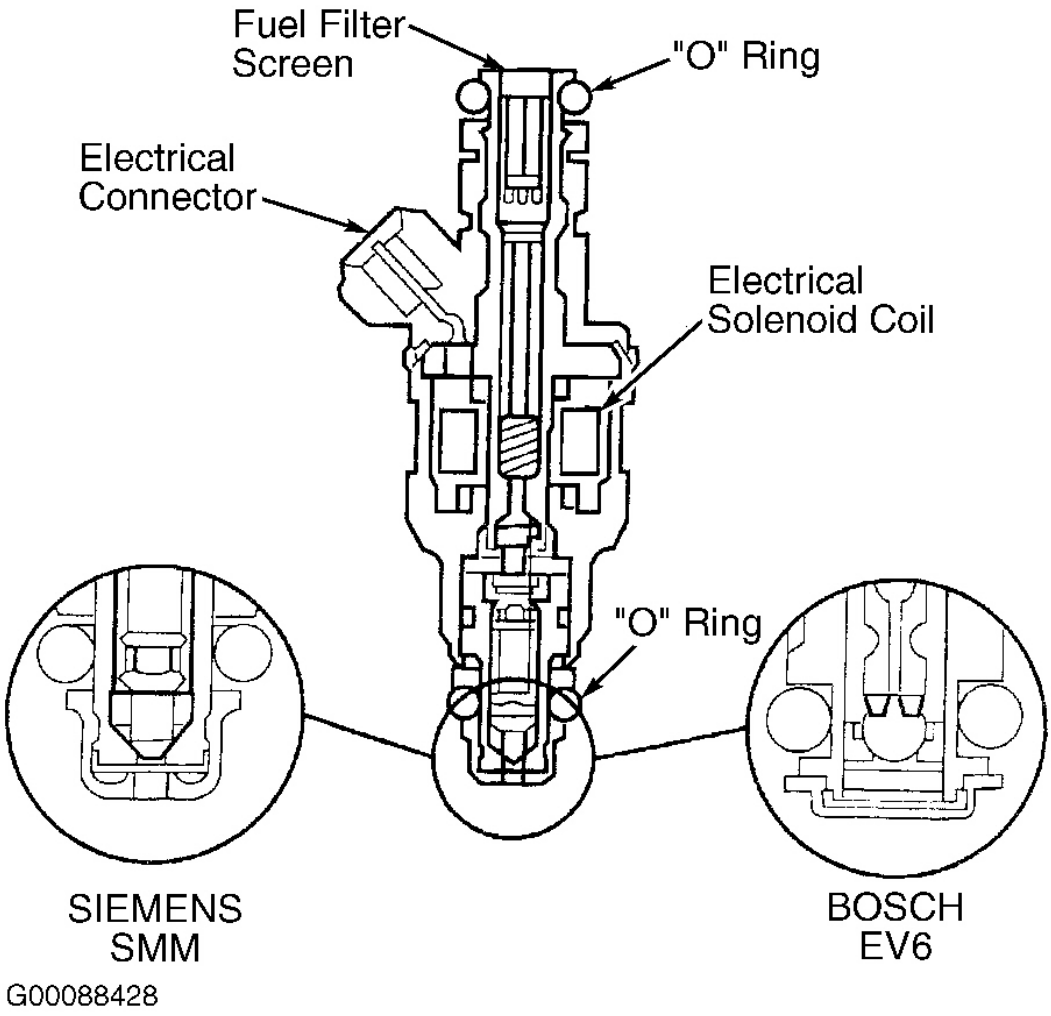

Fig. 43: Cross-Sectional View Of Fuel Injector Assembly
Courtesy of FORD MOTOR CO.

