1982 Diesel Fuel Injection

GENERAL MOTORS

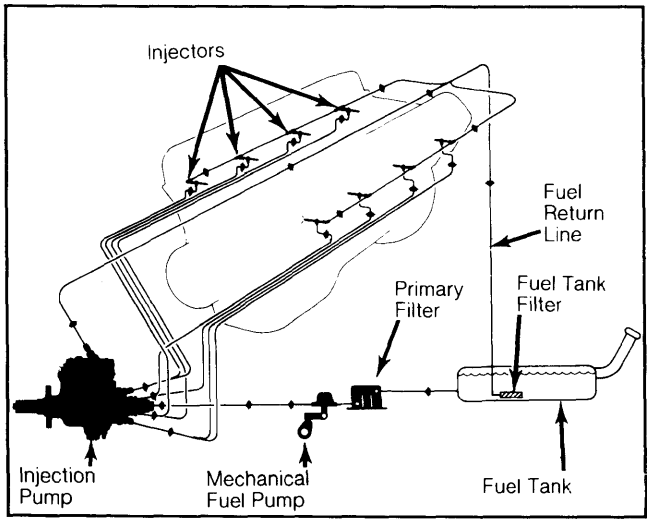
DESCRIPTION

Diesel mechanical fuel injection systems differ greatly from electronic fuel injection systems. In this diesel system, a mechanical high pressure rotary pump is gear driven by the camshaft at camshaft speed. Through this method the pump injects a precisely metered amount of fuel into each cylinder at the proper time. The pump is mounted on top of the engine and provides necessary timing advance under all operating conditions.

Eight high pressure fuel pipes carry fuel from pump to an injection nozzle in each cylinder. All 8 pipes are exactly the same length to ensure that there is no variance in timing. Engine RPM is controlled by a rotary fuel metering valve. As the accelerator pedal is pushed down, a throttle cable opens the metering valve and allows increased fuel delivery. A mechanical fuel pump located on the right side of the engine, draws fuel from the fuel tank and delivers it to the injection pump.

Three fuel filters are used to remove foreign material which could damage injection pump. The fuel tank filter screens out water from the fuel and allows it to collect at the bottom of the tank below the fuel pickup. When the water reaches a level where it could be drawn into the fuel supply, a dash-mounted warning lamp is energized. When the lamp is energized, water collected in the tank can be siphoned off at the shut off point. The primary fuel filter is located between the mechanical fuel pump and the fuel tank (mounted on firewall). The secondary fuel filter is located between the mechanical pump and injection pump (mounted on side of engine block). Any excess fuel is returned to the tank by a fuel return system.

Fig. 1: Diesel Injection System Fuel Circuit



Secondary fuel filter is mounted on side of engine block.

OPERATION

AIR INDUCTION SYSTEM

The intake manifold is always open to atmospheric pressure. The intake manifold has a single inlet for drawing air through an air filter assembly mounted above. The manifold consists of 8 branches, one leading to each cylinder.

FUEL TANK-TO-PUMP SYSTEM

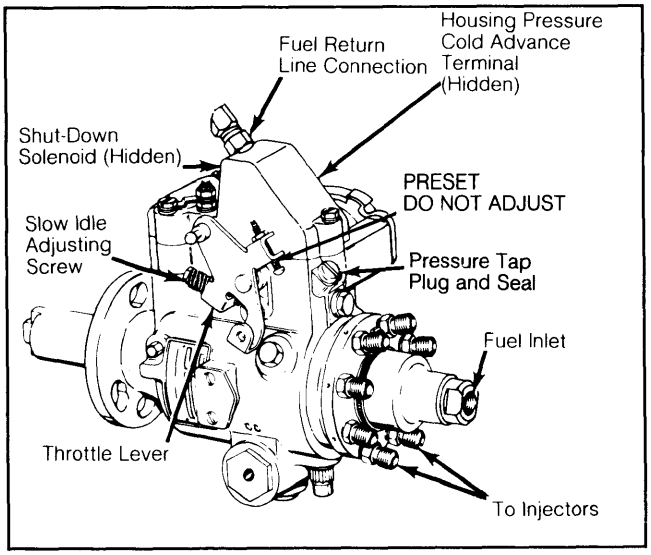
Diesel fuel, NOT gasoline, is drawn from the fuel tank by an engine mounted mechanical fuel pump. This pump is driven by an eccentric cam mounted on the crankshaft and puts out about 5 ½-6 ½ psi to the injection pump. A small screen type filter is located in the fuel tank at the pickup. Diesel fuel arrives at the center inlet fitting on the injection pump after leaving the filter. A fuel return line is provided to return any excess fuel to the tank.

DIESEL INJECTION PUMP

The high pressure diesel injection pump is mounted to the top of the engine below the intake manifold. The pump is cam driven at speed equal to the camshaft. Because of this, the pump can precisely govern time and amount of fuel injected.

A built-in fuel pressure regulator and transfer pump picks up fuel at the pump inlet, and pushes it through a passage to the pump head. The pump head distributes fuel, still at transfer pump pressure (8-12 psi), to metering valve, governor and automatic advance mechanisms. Fuel then passes to the rotary fuel metering valve and into a charging passage. As the pump shaft rotates, fuel is fired, under high pressure, through each delivery pipe to an injector. The pump is not serviceable and must be exchanged in case of a malfunction.

Fig. 2: Diesel Injection Pump



Injection pump is not serviceable; exchange in case of malfunction.

FUEL INJECTION LINES

Eight high pressure fuel injection lines are routed from injection pump to an injector in each cylinder. The lines are of equal length but are bent differently to maintain equal length, prevent any difference in timing from cylinder-to-cylinder and aid installation. Lines are not interchangeable and are pre-bent by the manufacturer.

GLOW PLUGS

Glow plugs are threaded into each cylinder combustion chamber. Glow plugs are small heaters that assist in cold starting. The glow plug controller and relay cycle 12 volts to these 6 volt heaters, which causes them

1982 Diesel Fuel Injection

GENERAL MOTORS (Cont.)

to heat rapidly. After the engine starts, the glow plugs remain on for short time then shut off.

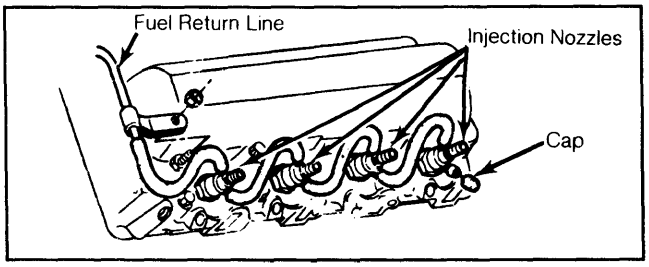
Controller failure, as in the case of prolonged preheat (more than 9 seconds of initial glow plug activation), would cause a circuit breaker to open in the controller. When this takes place, glow plug circuit fails to operate completely.

NOTE: Any attempt to by-pass relay with jumper wire or rewire for manual control may result in glow plug failure.

INJECTION NOZZLES

Each engine cylinder combustion chamber is equipped with 1 injection nozzle. The injection nozzle has a single fuel inlet fitting and 2 fuel return fittings (1 on each side of fuel inlet fitting). The nozzle is threaded into the cylinder head. Injection nozzles are spring loaded and calibrated to open at a specified fuel line pressure. The combustion chamber end of the nozzle has a replaceable compression seal and carbon stop seal.

Fig. 3: Injection Nozzle Installation



Last nozzle on cylinder bank has 1 fuel return fitting plugged.

VACUUM PUMP

Vacuum to operate accessory systems on diesel vehicles is provided by a vacuum pump which is located at the rear of the block and driven by the cam. The engine should never be operated without the vacuum pump in place as it is also the oil pump drive.

HOUSING PRESSURE COLD ADVANCE (HPCA)

The HPCA circuit is used to improve cold starting and aid emission control. The circuit is controlled by a temperature switch located on right rear head bolt. The circuit advances injection timing about 4° when the engine is cold.

When engine temperature is below 125°F (45°C), the circuit decreases housing pressure from 10 psi to zero. At the same time, the fast idle solenoid is activated. When the temperature switch opens, the HPCA circuit is de-energized and housing pressure rises, retarding pump timing. The temperature switch will close again when engine temperature falls below 95°F (35°C).

DIESEL FUEL HEATER

This option is used to heat the fuel during low temperature operation, below 20°F (− 5°C). This prevents wax crystals from building up and blocking the fuel filters. The heater is located along the right side of the intake manifold and uses a resistance wire spiralled around the fuel line.

ADJUSTMENT

NOTE: For all on-vehicle adjustments, see TUNE-UP SERVICE PROCEDURES.

TROUBLE SHOOTING

NOTE: Trouble shooting charts should be used only after ensuring that the glow plug system is properly installed. Check that all connectors are properly installed and that all connections are clean and tight.

THERMAL CONTROLLER CHECK

With connector removed from controller the controller heater circuits may be checked using a high impedance ohmeter. However, this check will not determine shorted switches within the controller.

Pin 3 – Pin 2	.40 to .75 Ω	Pin 5 – Pin 1	130 Ω ± 10%
Pin 4 – Pin 5	27 Ω ± 3 Ω	Pin 2 – Pin 6 ("O" ohms)	Continuity

"GLOW PLUGS" LAMP CYCLES ON & OFF WITH WARM ENGINE

This condition can be caused by an open circuit in 25 circuit from generator telltale output to pin 1 of controller, or by generator output failure. Check generator operation.

ENGINE CONTINUES TO RUN WITH IGNITION OFF

ENGINE CONTINUES TO RUN

↓

Disconnect pink wire at injection pump solenoid.

ENGINE CONTINUES TO RUN	ENGINE STOPS
↓	↓
Remove injection pump for repair.	Check ignition switch adjustment. If OK, replace ignition switch. Check ign. sw. assoc. wiring.

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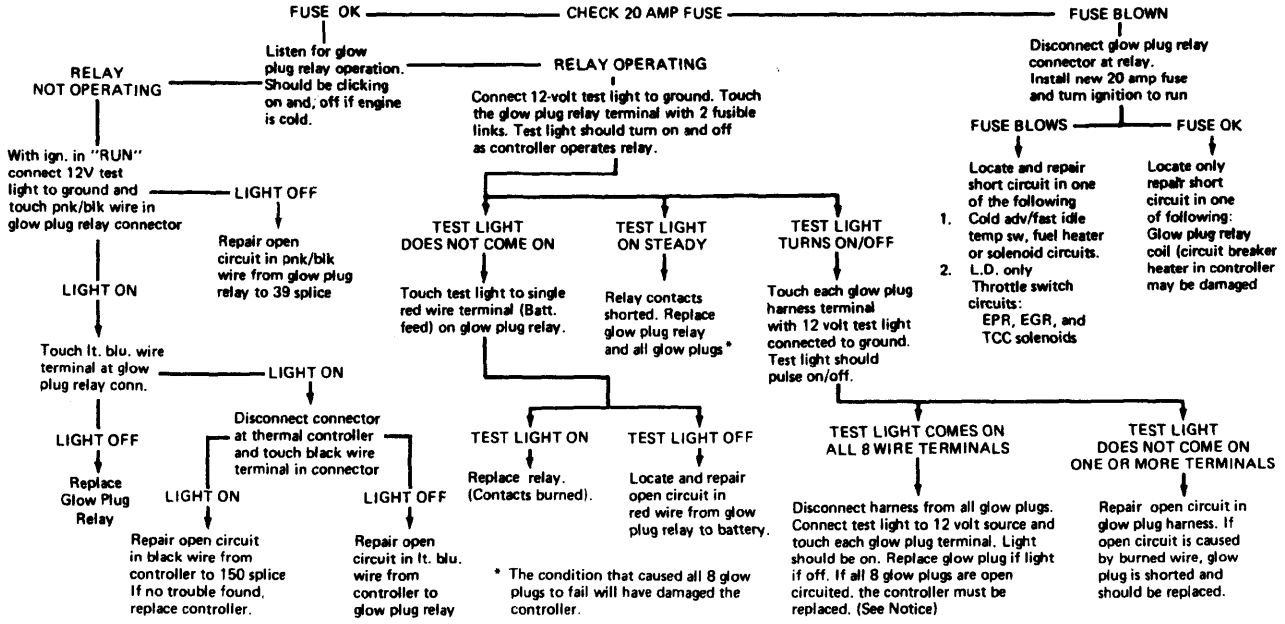
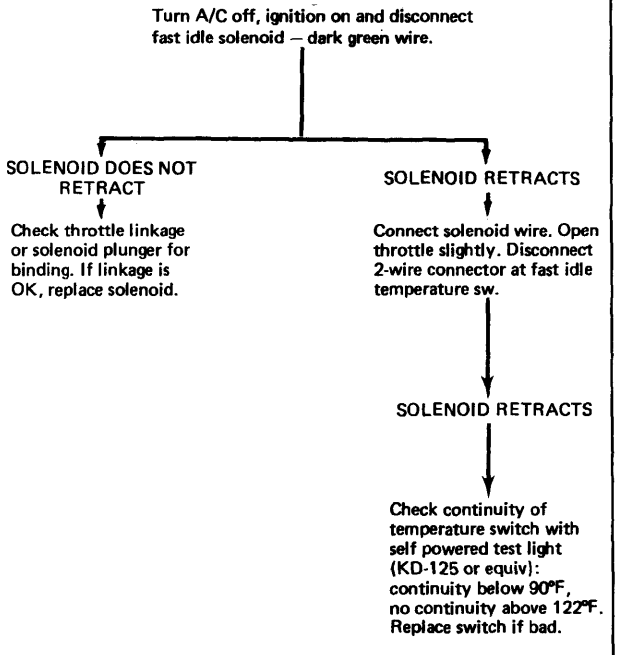
ENGINE DOES NOT START COLD

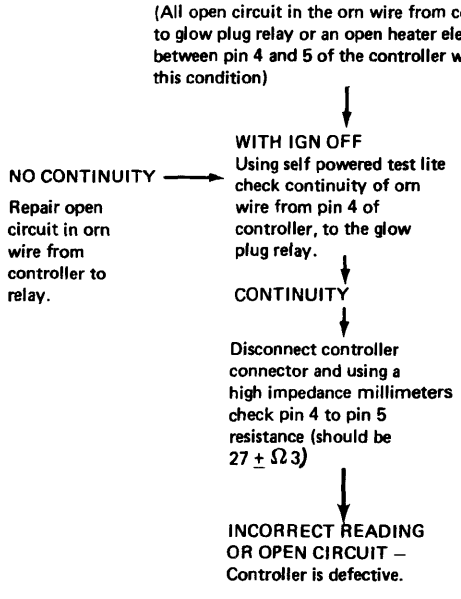
- "Glow Plugs" lamp may or may not come on.
- Fuel system okay.
- Battery voltage is 12.4 volts or more with ignition off.
- Cranking speed okay (100 RPM or more).



ENGINE REMAINS ON FAST IDLE



ENGINE RUNS ROUGH ON COLD START GLOW PLUGS NOT CYCLING ON & OFF AFTER ENGINE STARTS (20 AMP FUSE OKAY)



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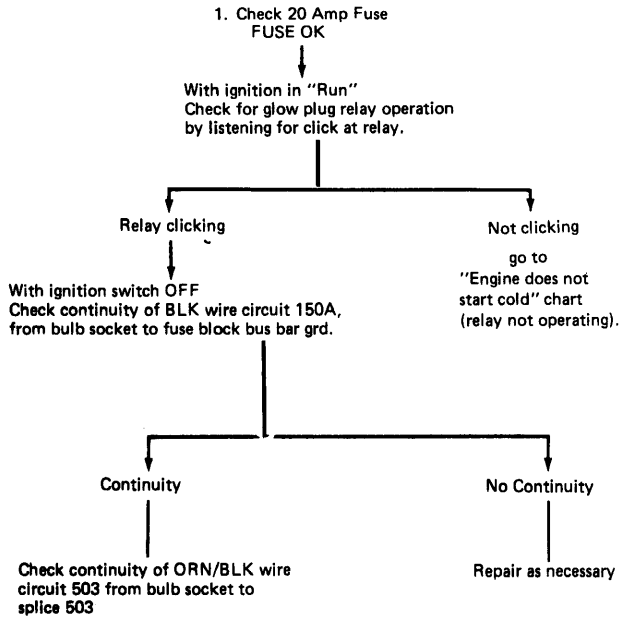
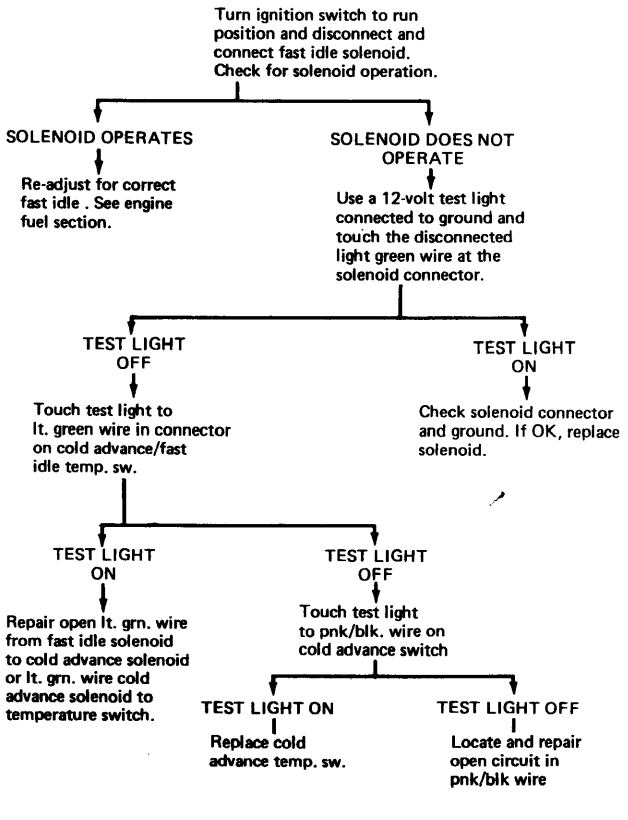
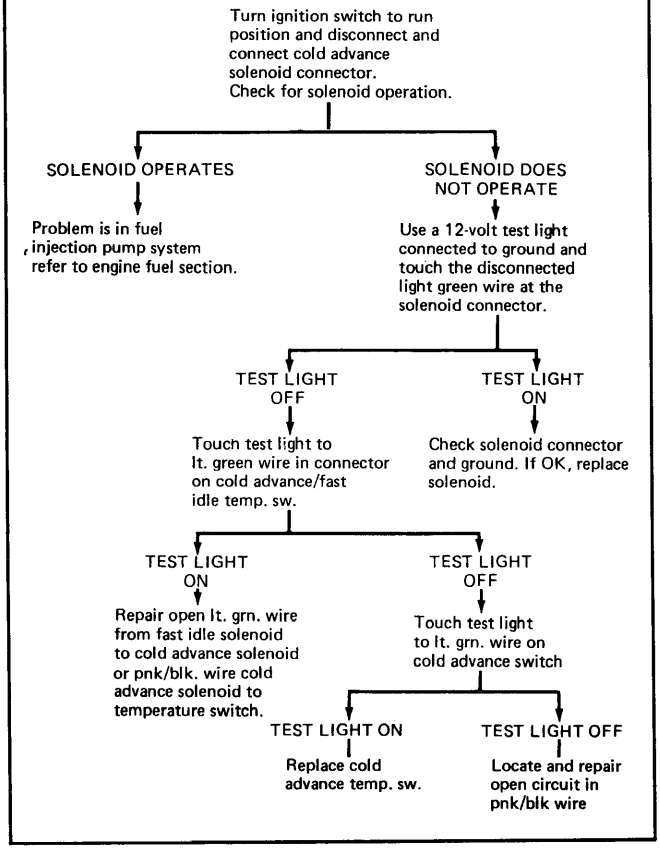
NO "GLOW PLUGS LAMP"



NO FAST IDLE WITH COLD ENGINE (TEMPERATURE BELOW 90°F) (20 AMP FUSE OKAY)



NO COLD ADVANCE ON COLD ENGINE



TESTING

GLOW PLUG RESISTANCE TEST

CAUTION: The following test requires a high impedance ohmmeter (J-29125 or equivalent). Select scale values as follows: Left-hand switch - "OHMS" position; Right-hand switch - fully counterclockwise (200 ohms); Slide center switch - left position ("DC-LOW")

1) Start engine, turn on heater and allow engine to warm up. Remove all electrical feed wires at glow plugs.

2) Using a magnetic pickup tachometer (Mag-Tach J-26925 or equivalent), adjust engine speed. Turn idle speed screw on side of injection pump until engine idle is at roughest speed. About 860 RPM is desirable, but do not exceed 900 RPM.

3) Allow engine to run for 1 minute at roughest idle. Thermostat must be open and upper radiator hose hot.

4) Attach jumper wire between voltmeter ground lead and engine lift point on left side of intake manifold. DO NOT use any other point for ground connection. This ground wire must remain in position until all tests have been completed.

5) Check resistance by touching positive lead of voltmeter to glow plug terminal (with engine running). Record value obtained in firing order sequence (1-8-7-2-6-5-4-3).

6) If ohm reading on any cylinder is about 1.2-1.3 ohms, make a compression check on that cylinder before continuing fuel injection diagnosis. Most cylinders should measure between 1.8-3.4 ohms. If more than .3 ohms difference is observed between 2 consecutive cylinders in firing order, remove injectors and check opening pressure.

7) To improve rough idle, switch nozzles as necessary. Install nozzles with a higher opening pressure to lower ohm reading, and a lower opening pressure to raise ohm reading.

8) Repeat procedure to confirm idle improvement. Be sure to check glow plug resistance at the same idle speed both times. If no improvement is observed, injection line replacement or injection pump calibration may be necessary.

INJECTION PUMP HOUSING FUEL PRESSURE

1) Remove injection pump and drain all fuel. Connect an air supply line to fuel inlet fitting. Be sure air supply is clean and dry.

2) Seal the return line fitting. Completely immerse pump assembly in a container of clean test oil.

3) Apply 20 psi (1.4 kg/cm²) to pump. Leave pump immersed for 10 minutes to allow any trapped air to escape. Watch for leaks after 10 minutes.

4) If no leaks are noticed after 10 minutes, reduce air pressure to 2 psi (.14 kg/cm²) for 30 seconds. If there are still no leaks, increase pressure to 20 psi (1.4 kg/cm²) again.

5) If no leaks are observed, pump is serviceable. If leaks are observed, pump must be exchanged for replacement unit.

INJECTION NOZZLE

CAUTION: When testing nozzles, keep spray contained to avoid serious injury. DO NOT allow injector to release line pressure on hands, arms or any part of body. Pressure of atomized test spray has sufficient penetrating power to puncture flesh.

Test Preparation

1) Remove injection nozzle from engine. Clean carbon from tip area of nozzle with soft brass brush. Do not use steel brush or motorized brush to clean nozzle tip. Damage to nozzle tip may result.

2) Connect nozzle assembly to injection nozzle tester. Close tester shut off valve to pressure gauge. Fill tester with test fluid. Fill and flush nozzle assembly with test oil by operating tester lever briskly and repeatedly. This purges air from nozzle and coats all parts with test fluid.

Opening Pressure Test

1) Open tester shut off valve to pressure gauge ¼ turn. Slowly depress tester lever and observe pressure gauge. Note pressure at which needle stopped, indicating pressure increase (nozzle does not chatter) or at which pressure the pressure dropped substantially (nozzle chatters).

2) The maximum pressure is the opening pressure. Lowest acceptable pressure is 1600 psi (112.5 kg/cm²). Replace any nozzle which does not meet lowest acceptable pressure. Release tester pressure.

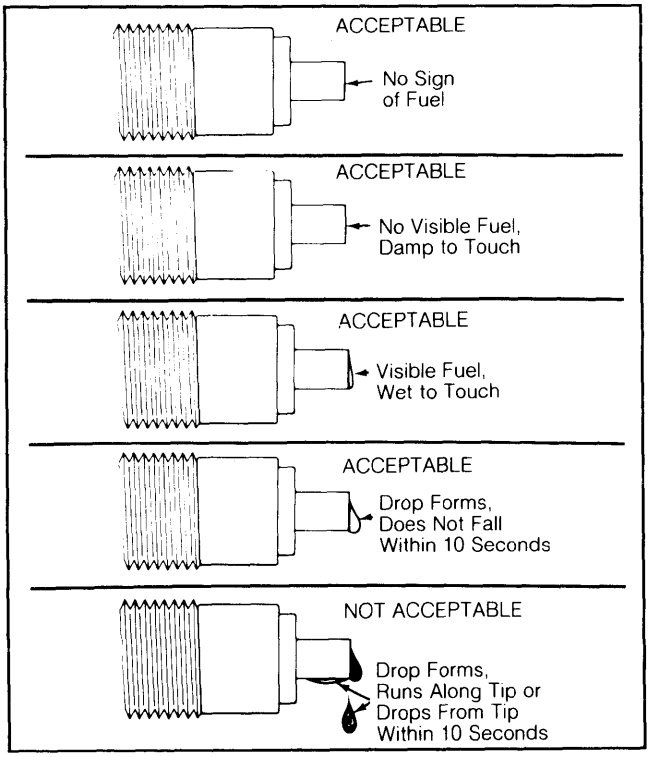
Leakage Test

1) Open tester shut off valve to pressure gauge an additional ½ to 1 ½ turns. Blow dry nozzle tip. Connect a short piece of clear plastic tubing to each fuel return fitting on nozzle.

2) Slowly depress tester lever until pressure gauge reads 1380 psi (75.9 kg/cm²). Maintain pressure for 10 seconds and observe nozzle tip.

3) Replace nozzle assembly if drop of test fluid drops from tip within 10 seconds. A drop may form but not drop off within the specified time period. *See Fig. 4.* Release tester pressure.

Fig. 4: Nozzle Leakage Test



A drop of test fluid may form but not drop off within 10 seconds.

Chatter Test

1) Close tester shut off valve to pressure gauge. Operate tester rapidly to put nozzle under extreme load conditions. Chatter should be audible and should also be felt through handle of tester.

2) Chatter does not occur in engine. It is an indication of valve freedom, proper seat width and interference angle.

3) Replace any nozzle assembly which does not chatter. Release tester pressure.

Spray Pattern Test

1) Completely close tester shut off valve to pressure gauge. Insert end of nozzle into container that permits observation and protection. *See Fig. 5.*

2) Depress tester lever abruptly and quickly. Spray pattern should have a tight, evenly shaped conical pattern which is well atomized. The pattern should be similar in shape to the nozzle axis. Replace any nozzle assembly which does not meet specifications.

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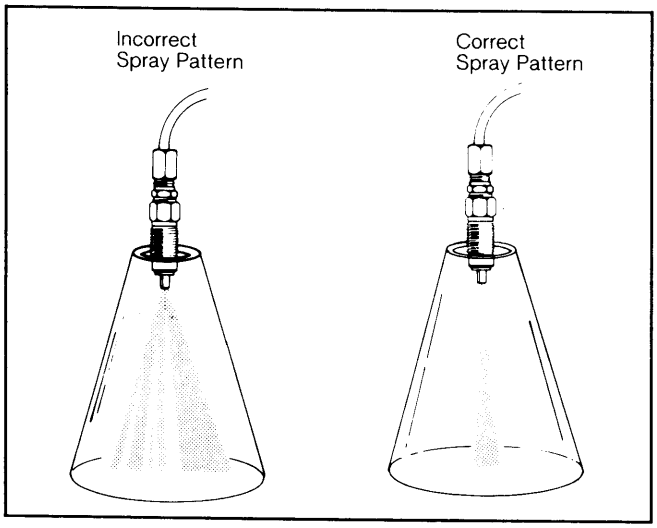
Fig. 5: Nozzle Spray Pattern Test

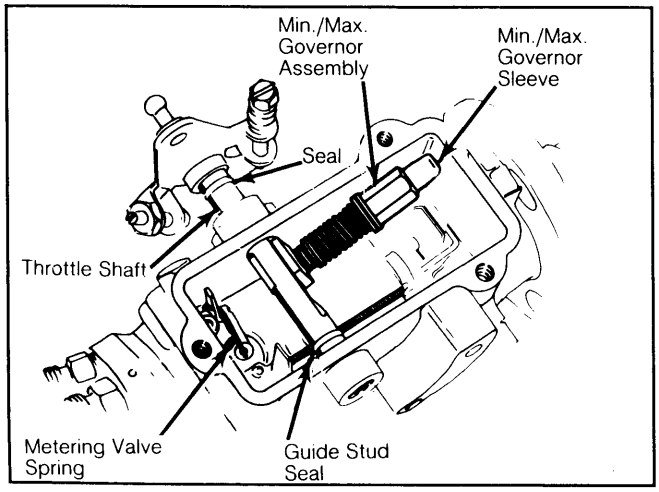


Insert end of nozzle into container that permits observation and protection.

REMOVAL & INSTALLATION

NOTE: Manufacturer does not recommend disassembly of pump. However, the following seals can be replaced with the injection pump installed on the engine. For problems not covered in this article, pump must be removed and taken to an authorized repair station.

Fig. 6: Guide Stud Seal Replacement



Metering valve spring must be installed in original position over guide stud.

INJECTION PUMP SEAL REPLACEMENT

Pump Cover Seal & Guide Stud Seal

1) Disconnect ground cables from both batteries. Remove air cleaner and intake manifold. Install screens (J-29664) in cylinder heads to prevent entrance of dirt. Disconnect fuel return line and wiring from injection pump.

2) Remove throttle cable and return springs. Remove top fast idle solenoid attaching bolt. Loosen lower bolt and move solenoid aside. Clean injection pump cover and area around throttle rod and guide stud. Place rags in engine valley to catch fuel. Remove injection pump cover and remove screws from cover.

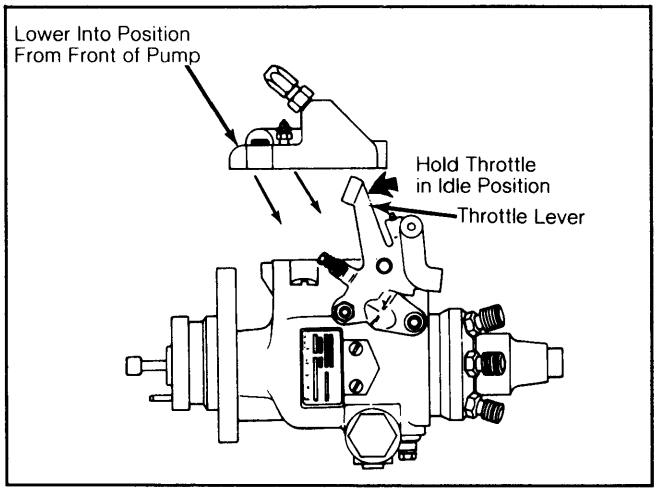
NOTE: After removing injection pump cover, extreme care must be exercised to prevent entrance of foreign material.

3) Observe position of metering valve spring over top of guide stud. This position must be exactly duplicated during reassembly. Before removing guide stud and washer, note location. Remove guide stud and washer. *See Fig. 6.*

4) Install guide stud with new washer. Make sure that upper extension of metering valve spring rides on top of guide stud. Carefully tighten guide stud.

5) Hold throttle in idle position. Install new pump cover seal. Make sure cover screws are removed from cover. Position cover about ¼" forward (toward shaft end) and about ⅛" above pump. *See Fig. 7.*

Fig. 7: Injection Pump Cover Installation



Screws must be removed from cover before installing cover to prevent screws from falling into pump.

6) Using care not to cut seal, move cover rearward and downward into position. Install cover screws with flat washer against cover. Use care not to drop lock washers or flat washers into pump. Tighten screws.

7) Reconnect negative battery cables to both batteries. Turn ignition switch to "run" position. Momentarily touch Pink solenoid wire to solenoid. A clicking noise should be heard as the wire is connected and disconnected at solenoid. If clicking noise is heard, go to step **10)**. If not, go to step **8)**.

8) If clicking noise is not heard, the linkage may be jammed in a wide open throttle position. Engine MUST NOT be started. Remove cover.

9) Ground solenoid lead (opposite "hot" lead) and connect Pink wire. With ignition switch in "run" position, solenoid in cover should move the linkage. If not, replace solenoid and cover. Repeat steps **5)** through **7)**. Minimum voltage across solenoid terminals should be 12 volts.

10) If clicking noise is heard, connect the pump solenoid and HPCA wires. Install fuel return line, throttle cable and return springs. Reposition fast idle solenoid.

11) Start engine and check for leaks. Idle roughness may occur due to air in the fuel system. Allow plenty of time for air to be purged from system. Engine may have to be stopped to allow air in injection pump to rise to top of pump for purging.

12) Remove cylinder head screens. Install intake manifold and air cleaner.

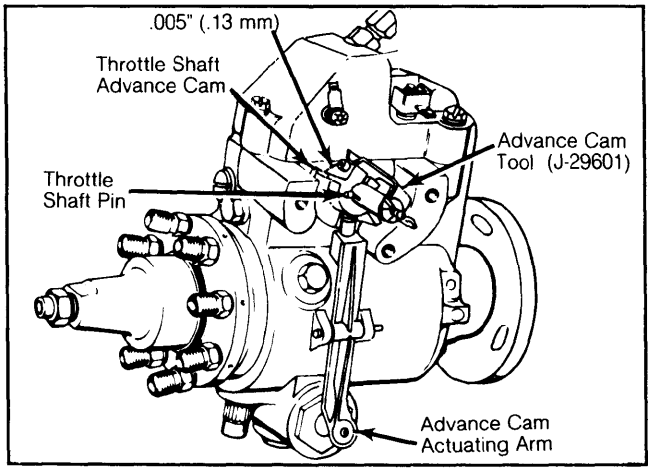
Throttle Shaft Seal

1) Disconnect ground cables from both batteries. Remove air cleaner and intake manifold. Install screens (J-29664) in cylinder heads to prevent entrance of dirt. Disconnect fuel return line and wiring from injection pump.

2) Remove throttle position switch (TPS) or vacuum regulator valve. Remove throttle rod and return springs. Loosen fast idle solenoid and move aside. Remove throttle cable bracket.

3) Install advance cam tool (J-29601) over throttle shaft with slots of tool engaging pin. Place spring clip over throttle shaft advance cam and tighten wing nut. Without loosening wing nut, pull tool off throttle shaft to provide alignment for reassembly. *See Fig. 8.*

Fig. 8: Advance Cam Tool Installed on Injection Pump



Advance cam tool provides proper alignment of throttle shaft advance cam for reassembly.

4) Drive pin from throttle shaft. Remove throttle shaft advance cam and fiber washer. Remove any burrs from throttle shaft after removing cam. Clean injection pump cover, upper portion of pump, throttle shaft and guide stude area. Remove injection pump cover and remove screws from cover.

NOTE: Do not allow any dirt or foreign objects to drop into injection pump after cover is removed. Engine damage may result.

5) Note position of metering valve spring over top of guide stud for reassembly reference. Note position of guide stud and washer, remove guide stud and washer. *See Fig. 6.*

6) Rotate min./max. governor assembly up to provide clearance and remove from throttle shaft. If idle governor spring becomes disengaged from throttle block, reinstall with tightly wound coils toward throttle block.

7) Remove throttle shaft and inspect. If damaged or worn, replace. Inspect throttle shaft bushings for damage, wear or leaks. If bushing replacement is required, pump must be sent to authorized repair station.

8) Remove throttle shaft seals. Do not cut seals for removal. A nick on shaft will cause leakage. Lightly coat new seals with grease. Install seals on shaft without cutting seals on sharp edges of shaft.

9) Carefully slide shaft into pump until min./max. governor assembly will slip onto throttle shaft. Rotate governor downward and hold in position. Slide shaft and governor into place.

10) Install new fiber washer, throttle shaft advance cam (do not tighten cam screw) and throttle shaft drive pin. Align advance cam so advance cam tool can be reinstalled over throttle shaft. Install pin in slots and spring clip over advance cam.

11) Insert a .005" (.13 mm) feeler gauge between fiber washer and cam. Tighten cam screw. Remove advance cam tool.

12) Install guide stud with new washer. Ensure that upper extension of metering valve spring rides on top of guide stud. Tighten guide stud.

13) Hold throttle in idle position. Install new pump cover seal. Make sure cover screws are removed from cover. Position cover about ¼" forward (toward shaft end) and about ⅛" above pump. *See Fig. 7.*

14) Using care not to cut seal, move cover rearward and downward into position. Install cover screws with flat washer against cover. Use care not to drop lock washers or flat washers into pump. Tighten screws. Install vacuum regulator or TPS.

15) Reconnect negative battery cables to both batteries. Turn ignition switch to "run" position. Momentarily touch Pink solenoid wire to solenoid. A clicking noise should be heard as the wire is connected and disconnected at solenoid. If clicking noise is heard, go to step **18)**. If not, go to step **16)**.

16) If clicking noise is not heard, the linkage may be jammed in a wide open throttle position. Engine MUST NOT be started. Remove cover.

17) Ground solenoid lead (opposite "hot" lead) and connect Pink wire. With ignition switch in "run" position, solenoid in cover should move the linkage. If not, replace solenoid and cover, and repeat step **15)**. Minimum voltage across solenoid terminals should be 12 volts.

18) If clicking noise is heard, connect the pump solenoid and HPCA wires. Install fuel return line, throttle cable, throttle cable bracket and return springs. Reposition fast idle solenoid.

19) Start engine and check for leaks. Idle roughness may occur due to air in the fuel system. Allow plenty of time for air to be purged from system. Engine may have to be stopped to allow air in injection pump to rise to top of pump for purging.

20) Remove cylinder head screens. Install intake manifold and air cleaner. Perform on-vehicle adjustments.

NOTE: The following seals must be replaced with the injection pump removed from the engine. For problems not covered in this article, pump must be removed and taken to an authorized repair station.

Advance Pin Hole Plug Seal

1) Tap advance pin hole plug lightly with a hammer to loosen. Remove plug. Remove and discard seal. *See Fig. 9.*

2) Lubricate and install new seal. Install and tighten plug.

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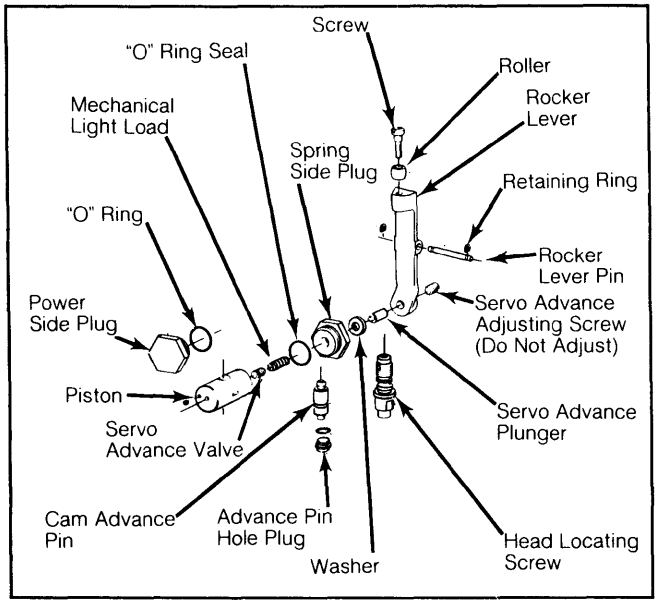
Fig. 9: Exploded View of Automatic Advance Assembly



Seals must be replaced with injection pump removed from engine.

Automatic Advance Seals

1) Remove advance pin hole plug as previously described. Remove spring side advance piston hole plug. Remove plug, piston, spring and washer.

2) Remove power side advance piston hole plug. Remove plug, piston and washer. Disassemble plugs and pistons. Discard seals.

3) Lubricate and install new seals. Reverse removal procedure and tighten plugs. *See Fig. 9.*

Hydraulic Head Seal

1) Remove throttle shaft and seals as previously described. Remove metering valve. Remove housing vent screw assembly. Remove advance pin hole plug and advance pin.

2) Install pump in holding fixture so that rear of pump is tilted downward. Remove hydraulic head locating screw. Remove 2 hydraulic head locking screws and discard seals.

3) Using a twisting motion, remove hydraulic head from pump assembly. Remove and discard "O" ring seal.

4) Lubricate and install new seal. Install hydraulic head into pump assembly. Lubricate and install 2 locking screw seals. Install locating screw. Install and tighten locking screws.

5) Install advance pin, advance pin seal and advance pin hole plug. Position pump so cover opening is up, and install metering valve. Install throttle shaft, seals and pump cover.

FUEL INJECTION LINES

Removal

1) Disconnect negative battery cables. Disconnect air cleaner bracket from valve cover. Remove crankcase vent bracket and move aside. Disconnect secondary filter lines. Remove secondary filter adapter.

2) Loosen vacuum pump hold-down clamp. Rotate pump to gain access to intake manifold bolt. Remove intake manifold. Install screens (J-29664) in cylinder heads.

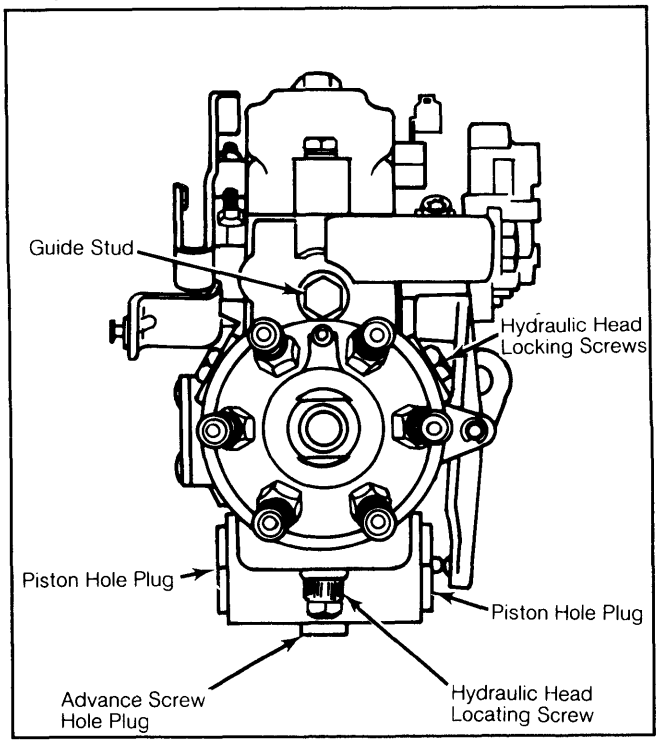
3) Remove injection line clamps. Remove injection lines at injection nozzles. Remove lines at pump. Tag lines for reassembly reference. Cap open lines.

Installation

1) Remove caps from lines and loosely install injection lines. Ensure lines are properly positioned.

2) Reverse removal procedures to complete installation. After installation, start engine and check for leaks.

Fig. 10: Injection Pump Hydraulic Head Components Location



Pump assembly must be mounted in holding fixture to remove hydraulic head assembly.

INJECTION PUMP

Removal

1) Disconnect negative battery cables. Remove fan, shroud, air cleaner and intake manifold. Install screens in cylinder heads. Remove fuel injection lines as previously described.

2) Disconnect throttle cable, return springs and detent cable (if equipped). Disconnect wires, fuel return line, fuel supply line and fuel injection lines at pump. Cap all fuel lines.

3) Remove oil filler tube and PCV vent hose assembly. Remove A/C hose retainer bracket, if equipped. Scribe or paint an alignment mark on front cover and injection pump.

4) Rotate engine to remove injection pump retaining bolts that are accessible through oil filler neck hole. Remove injection pump-to-front cover bolts. Remove injection pump and gasket.

Installation

1) Install injection pump gasket. Position cylinder No. 1 at TDC by lining up crankshaft pulley mark with indicator. Align locating pin on injection pump hub with slot in injection pump driven gear. At the same time, align injection pump timing marks. *See Fig. 11.*

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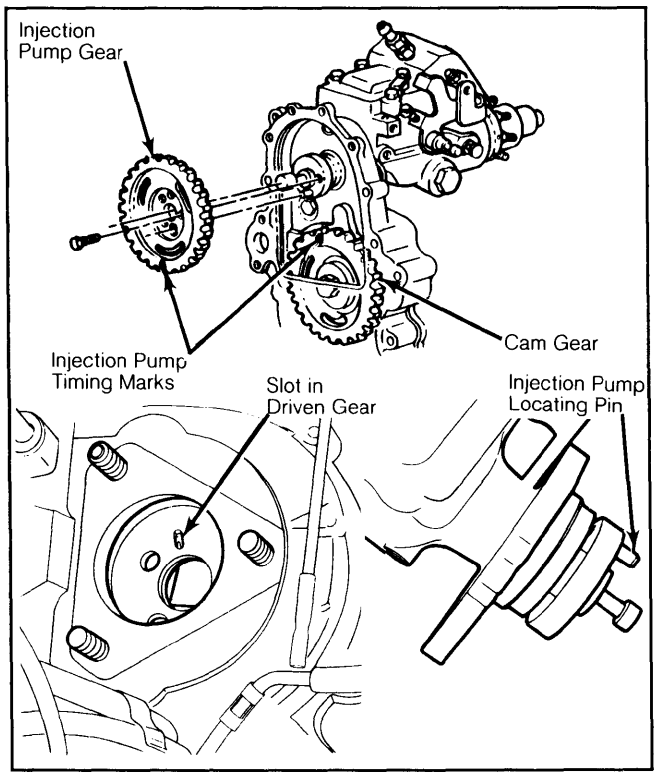
Fig. 11: Injection Pump Timing Mark Locations



Cylinder No. 1 must be set at TDC.

2) Attach injection pump to front cover. Alignment marks made during removal must be aligned. Tighten nuts. Attach pump to drive gear and tighten bolts.

3) To complete installation, reverse removal procedure. Check timing and perform on-vehicle adjustments, if required.

INJECTION NOZZLES

Removal

1) Disconnect battery negative cables. Remove fuel line clip. Remove fuel return line from nozzle without bending line out of the way. Remove fuel injection line.

2) Using injector tool (J-29873), remove injection nozzle. Always remove injector by placing remover on the 30 mm hex flats of injector body to prevent damage to injector body. Cap injector and lines.

Installation

1) Use new compression seal and install nozzle. Tighten nozzle with injector tool.

2) Install fuel injection line. Install fuel return line. Start engine and check for leaks.

TIGHTENING SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Injection Pump-to-Front Cover Nuts	30 (40)
Fuel Injection Lines	20 (27)
Application	**INCH Lbs. (N.m)**
Injection Pump Guide Stud	85 (9)
Inj. Pump Hydraulic Head Bolts	5-18 (20-24)
Inj. Pump Auto. Advance Plugs	75-100 (8-11)