

BOSCH DIESEL FUEL INJECTION – PEUGEOT & VOLVO

Peugeot
504
505
Volvo

DESCRIPTION

The diesel fuel injection systems consist of the fuel tank, fuel filter, distributor-type injection pump, glow plugs, throttle pinle injection nozzles and a centrifugal governor. See Fig. 1.

A vane-type fuel pump, built into the injection pump, supplies fuel from tank to fuel filter to injection pump. See Fig. 2. Injection pump supplies fuel to nozzles under high pressure, according to firing sequence (1-3-4-2 on Peugeot and 1-5-3-6-2-4 on Volvo). Excess fuel is returned to fuel tank by return lines.

SYSTEM COMPONENTS

FUEL INJECTION PUMP

Peugeot vehicles use a Bosch VE 4/9 F2250 R50 pump; Volvo, a Bosch VE 6/10 F2400 L32 (manual transmission) or L32-1 (automatic transmission). Pumps are distributor-type pumps, signified by the "V" designation. The letter "E" is the power rating of the pump. The numbers "4" and "6" denote the number of outlets or engine cylinders. The numbers "9" and "10"

indicate piston diameter in millimeters. The letter "F" indicates use of a mechanical governor. The numbers "2250" or "2400" indicate maximum adjusted load speed and the letters "L" or "R" indicate direction of rotation. The remaining numbers are design numbers.

The Bosch single plunger mechanical pump consists of a low-pressure, vane-type fuel pump, a high-pressure distributor-type plunger injection pump, a centrifugal governor, and an injection timing advance mechanism. Both pumps are equipped with an electrical fuel shut-off solenoid. See Fig. 1.

As the vane type pump rotor turns, centrifugal force holds the vanes against the walls of the pump's pressure chamber. The offset design of the rotor and pressure chamber, squeezes trapped fuel between vanes and forces it out the delivery port. Vane pressure of the Peugeot pump is 65-73 psi (4.6-5.1 kg/cm²) at 1600 RPM or 87-94 psi (6.1-6.6 kg/cm²) at 2200 RPM.

NOTE — Vane pressures are given at pump speed, not engine speed and were not available for Volvo models.

The injection pump drive shaft turns the vane-type fuel pump, distributor plunger and cam plate as a unit. The injection pump is driven by the camshaft at one-half engine speed. The fuel pump lubricates all moving parts of the injection pump with diesel fuel and supplies fuel to the distributor plunger for pressurization and metering to injection nozzles.

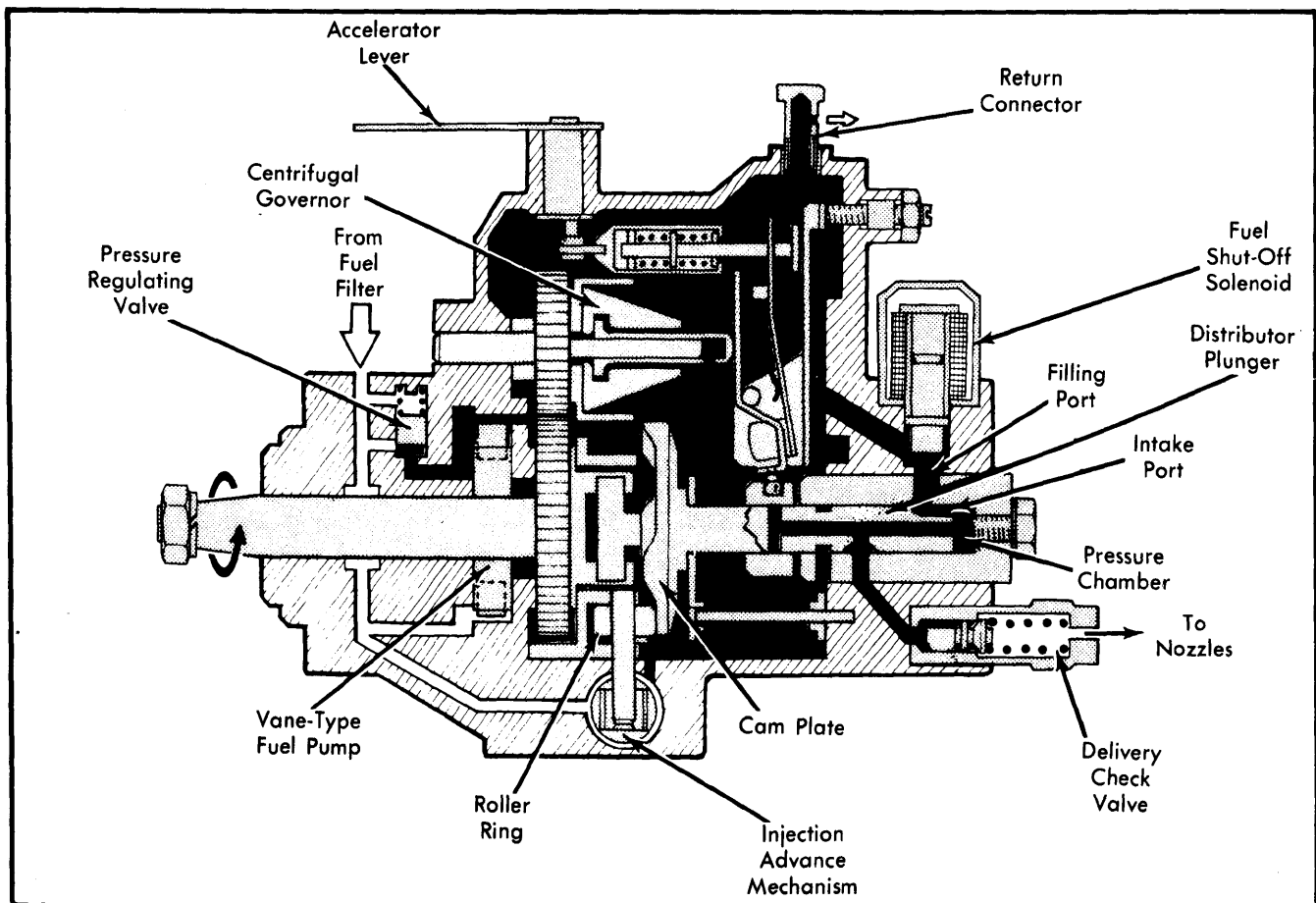


Fig. 1 Cutaway View of Volvo Fuel Injection Pump

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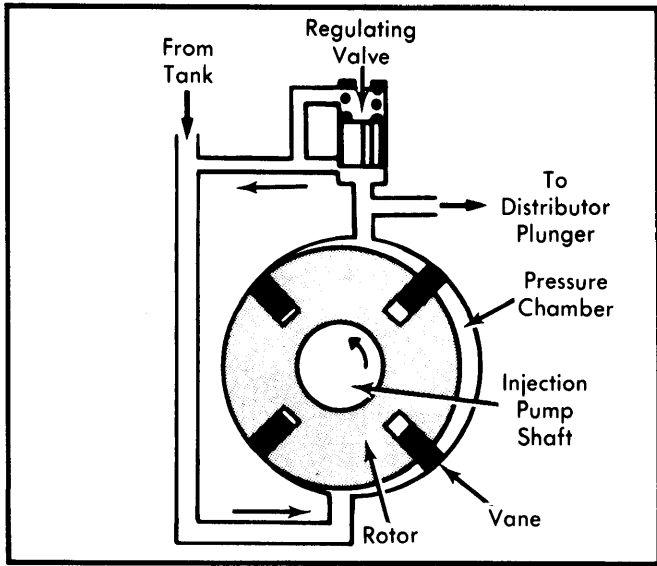


Fig. 2 Vane-Type Fuel Pump

Springs hold the cam plate and distributor plunger against stationary rollers. See Figs. 1 and 3. This causes the plunger, not only to rotate, but also move back and forth in its cylinder. Whenever an intake port in the plunger becomes aligned with a filling port in the pump body, fuel from the vane-type fuel pump fills the pressure chamber.

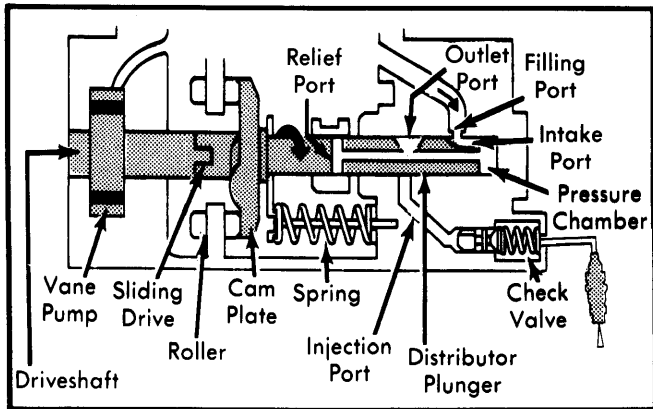


Fig. 3 Operation of Distributor Plunger

As the plunger rotates, the intake port is covered and fuel is trapped in the pressure chamber. As the cam plate and rollers push against the distributor plunger, the fuel is pressurized to approximately 1800 psi (126.6 kg/cm²). As the plunger continues to turn, the single outlet port in the plunger becomes aligned with one of the 4 or 6 injection ports in the pump body (one per cylinder). This pressurized fuel opens the delivery check valve and supplies high pressure fuel to the appropriate injection nozzle.

An injection timing mechanism is located on the lower side of the injection pump. See Fig. 4. As engine speed increases, stroke time becomes shorter and injection time becomes longer. Burning must therefore begin sooner and ensure peak combustion pressures still occur at the most efficient point after TDC.

As engine speed increases, fuel pressure from the vane pump also increases, pushing the hydraulic piston to the side against its spring. This causes the roller housing to turn slightly as the peg is moved. Since the cam plate is turning in the opposite direction, the ramps on the cam plate engage with the rollers sooner.

For cold start and warm-up periods, a lever and cam act against a hydraulic piston, advancing injection timing. See Fig. 4. This provides more time for fuel to burn, improving performance and preventing black exhaust smoke during cold start and warm-up periods.

INJECTION NOZZLES

The Peugeot engines use DNO SD 1510 nozzles with KCA 17S38/4 holders. Opening pressure is 1668-1813 psi (117.3-127.5 kg/cm²). Volvo uses DNO SD 193 nozzles with KCA 30 SD 27/4 holders. Opening pressure is 1706-1849 psi (120-130 kg/cm²).

A pressurized mist of fuel is injected into a round swirl chamber. See Fig. 5. Fuel swirls around the chamber, mixing with hot air, compressed at a 23:1 ratio for Peugeot or 23.5:1 for Volvo.

Combustion actually begins in the rich swirl chamber and continues on through a small passageway and into the leaner main chamber. As peak cylinder pressures build in swirl chamber, loads on connecting rods and crankshaft are reduced.

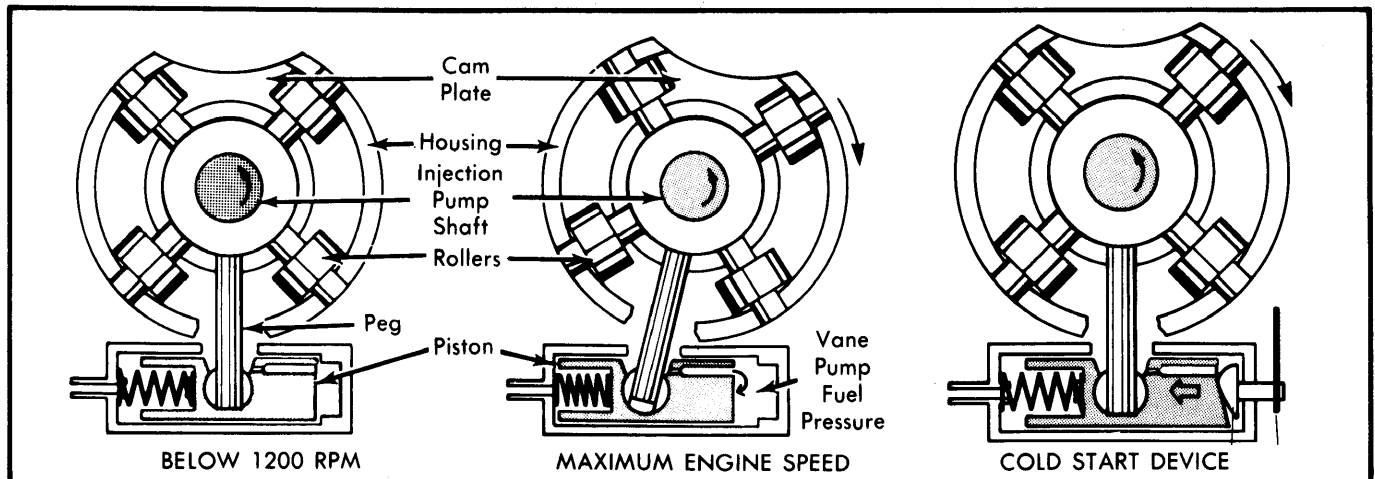


Fig. 4 Injection Advance Mechanism and Cold Start Device

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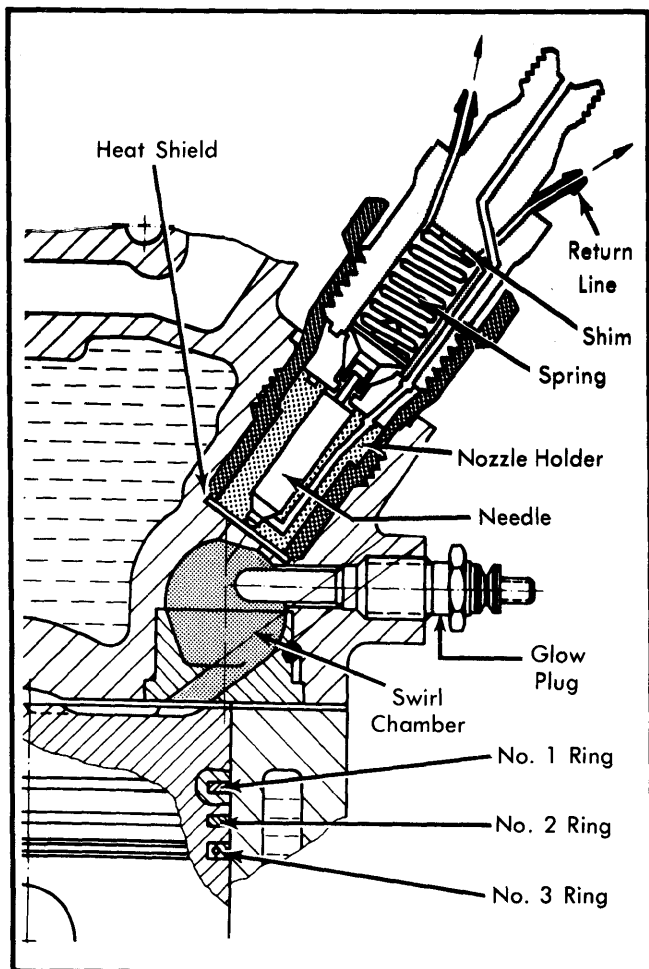


Fig. 5 Cutaway View Showing Relationship of Injection Nozzle, Glow Plug and Swirl Chamber to Piston

GLOW PLUGS

Glow plugs are used during cold starts to preheat swirl chambers. See Fig. 5. The system is switched "ON" when the key switch is turned to position 2. Preheating time depends on a coolant temperature switch connected to a time circuit in the glow plug relay. Glow plugs remain on approximately 10-25 seconds after the dashboard indicator light has gone out.

Glow plugs operate when starter motor is rotating (key position 3) and cut out when engine starts and start key is released back to position 2. To repeat starting attempt, key switch must first be returned to position 1. A blocking relay is incorporated in the system to interrupt electrical circuit between the control unit and glow plug relay when alternator starts charging.

NOTE – Automatic cold starting devices are also incorporated into the injection pump to assist starting by advancing injection timing.

FUEL FILTER

The fuel filter is a cartridge type filter, with the housing and filter being replaced as a unit. See Fig. 6. A water separator is

built into the filter, as diesel systems are highly susceptible to water. For example, diesel fuel is used to lubricate the injection pump and water would cause contamination and corrosion.

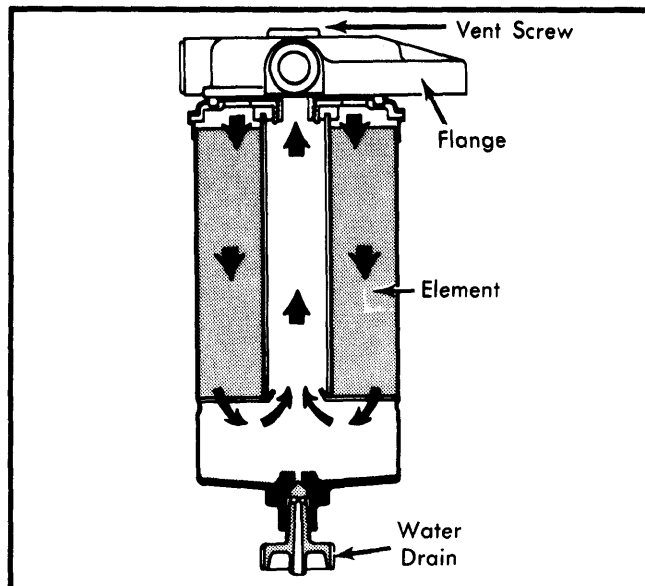


Fig. 6 Components of Fuel Filter

CENTRIFUGAL GOVERNOR

The amount of fuel injected is controlled by changing the injection cut-off point according to engine speed and load conditions. The cut-off point is controlled by the position of the metering sleeve around the distributor plunger. The sleeve normally covers a relief port in the plunger. Uncovering the port stops injection.

The position of the metering sleeve is controlled by linkage connected to the centrifugal governor inside the injection pump and to the accelerator pedal. See Fig. 7.

When engine is starting, the leaf spring pushes starting lever to left, so metering sleeve moves right. Injection lasts longer, as the plunger must move further before uncovering relief port in plunger. More fuel is supplied during starting.

At idle speed, governor weights are partly expanded. The governor sleeve moves to the right, starting lever is pushed against control lever, and metering sleeve moves to the left. The distributor plunger moves only a short distance before relief port is uncovered, stopping injection. A small amount of fuel is supplied at idle speed.

During acceleration the control lever is pulled to the left by accelerator pedal linkage. The metering sleeve is moved to the right so more fuel is injected before relief port is exposed. Engine speed increases until governor movement neutralizes the effect of pedal linkage.

At maximum speed, the governor is spinning with enough centrifugal force for governor sleeve to act against governor spring, stretching it, and forcing control lever to the right. The metering sleeve moves to the left uncovering relief port at beginning of each distributor plunger stroke. There is no

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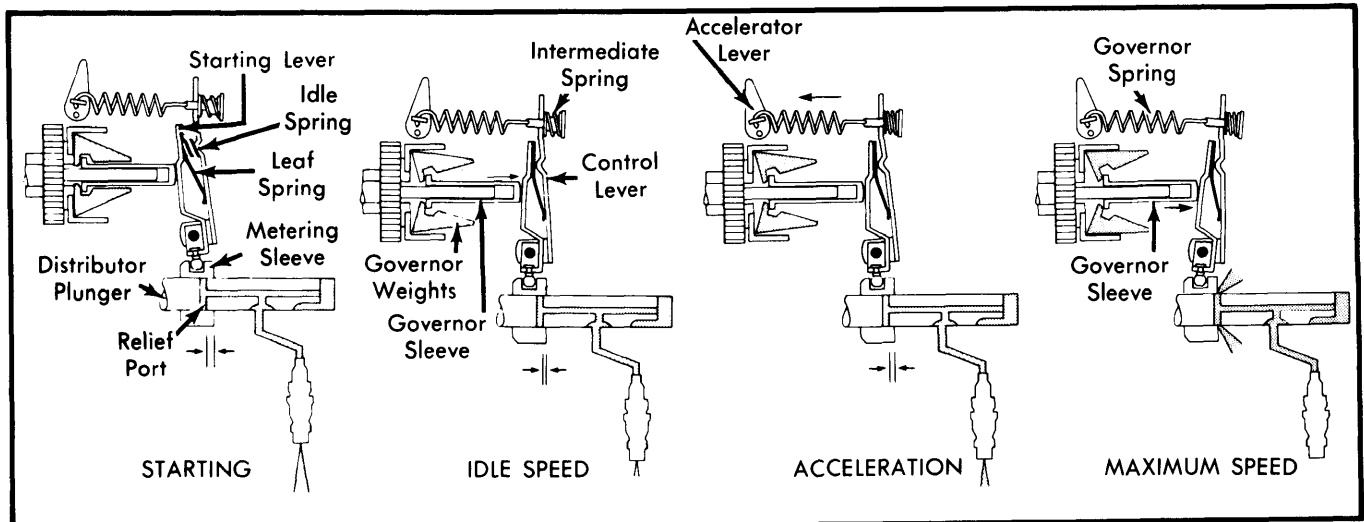


Fig. 7 Operation of Injection Pump Centrifugal Governor

pressure for injection until engine speed drops and metering sleeve moves to the right again. This acts as a speed limiter, causing the engine performance to "flatten out."

SERVICING COMPONENTS

VOLVO FUEL INJECTION PUMP

NOTE — As injectors are manufactured to extremely small tolerances (pump cylinder and bore clearance is .00004-.00008" or .001-.002 mm), extreme cleanliness is a necessity. Clean all injection pump and nozzle unions before removal.

Removal — 1) Use clamping pliers to pinch off coolant hoses for cold start device. Disconnect hoses at cold start device. Disconnect accelerator cable and kickdown cable (automatic transmission) from cable pulley. Disconnect wire at fuel shut-off solenoid.

2) Remove rear timing gear cover. Clean fuel line connections at injection pump. Disconnect fuel supply and return lines at pump. Plug open connections to prevent dirt from entering fuel system.

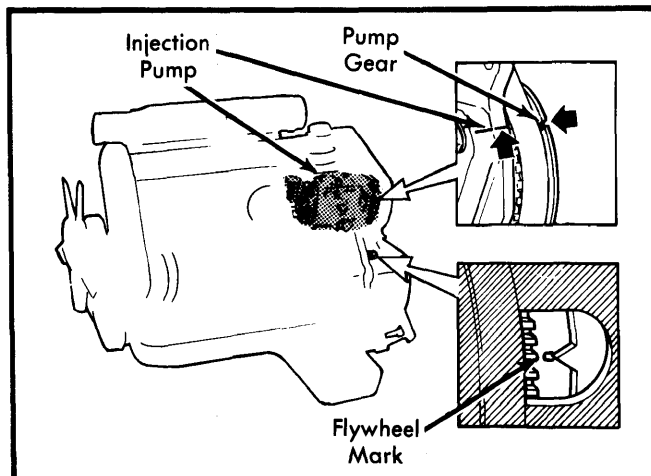


Fig. 8 Aligning Timing Marks Prior to Fuel Injection Pump Removal

3) Remove vacuum pump and pump plunger. Remove injection pump delivery pipes. Plug all openings. Set cylinder No. 1 at TDC and injection. See Fig. 8. Timing marks should align.

4) Remove injection pump drive belt, after relieving tension by loosening injection pump bracket bolts. Tighten one bolt to retain injection pump in upper position.

5) Loosen camshaft rear gear, using special tool (5199) to hold gear while loosening with special tool (5201). Camshaft must not rotate. Loosen bolts only enough to let gear rotate on camshaft.

6) Lock injection pump gear with stop (5193) See Fig. 9. Remove gear nut with special tool (5201). Remove pump gear with puller (5204). Remove injection pump front bracket bolts and rear pump retaining bolts. Lift off pump and front bracket.

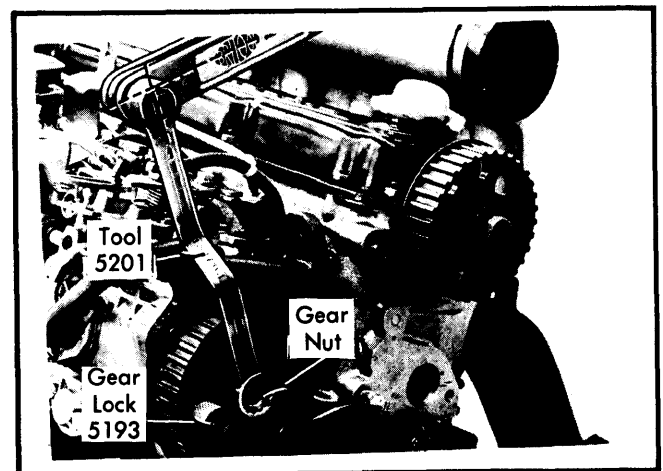


Fig. 9 Removing Injection Pump Gear

Installation — 1) Position injection pump. Install retaining bolts finger tight, so pump position can still be adjusted. Set pump so mark on injection pump and pump bracket align. Tighten retaining bolts.

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2) Make sure injection pump shaft key is correctly installed. Install gear, washer and nut. Lock gear with special tool (5193) and tighten nut with special tool (5201). See Fig. 9.

3) Set injection pump timing. Fill injection pump with diesel fuel if pump has been emptied or a new pump is being installed. Install rear timing gear cover.

4) Connect fuel supply and return lines. Do not mix connection screws. Screw for return line has a small hole and is marked "OUT".

5) Install fuel delivery pipes. Install vacuum pump plunger and vacuum pump. Connect hoses to cold start devices, removing clamping pliers. Attach wire to fuel shut-off solenoid, connect accelerator cable and, if equipped, the kickdown cable. Adjust accelerator control.

PEUGEOT FUEL INJECTION PUMP

NOTE – No information was available at time of publication on correct removal and installation of the Peugeot fuel injection pump.

INJECTION NOZZLES

Problems with injection nozzles usually are accompanied by knocking in one or more cylinders, engine overheating, loss of power or performance, black exhaust smoke and increased fuel consumption. To locate and correct faulty injectors, proceed as follows:

1) Remove vacuum pump and vacuum pump plunger. Loosen line unions on each injection nozzle, one at a time with engine running at fast idle. If engine speed remains constant with line removed, that nozzle is defective.

2) To remove nozzle, detach injector line after cleaning connection. Plug all openings to keep dirt out of fuel system. Remove injectors and heat shields. When installing injection nozzles, use new heat shields with recess pointing upward. Install delivery pipes. Install vacuum pump plunger and vacuum pump.

FUEL FILTER

Service is limited to draining water periodically and normal filter replacement. See Fig. 6.

To drain water from filter, place a tray under filter drain screw in bottom of filter. Loosen bleed screw on top several turns with a screwdriver. Loosen drain screw by hand. Drain until only clean fuel runs out. Tighten drain screw and bleed screw and remove tray.

ADJUSTMENTS

FUEL INJECTION PUMP TIMING

Volvo – 1) Remove rear timing gear cover. Disconnect cold start device by loosening screw "1", pushing lever forward and rotating it 90°. See Fig. 10. Do NOT touch screw "2". If it is loosened, cold start device must be reset on a test bench.

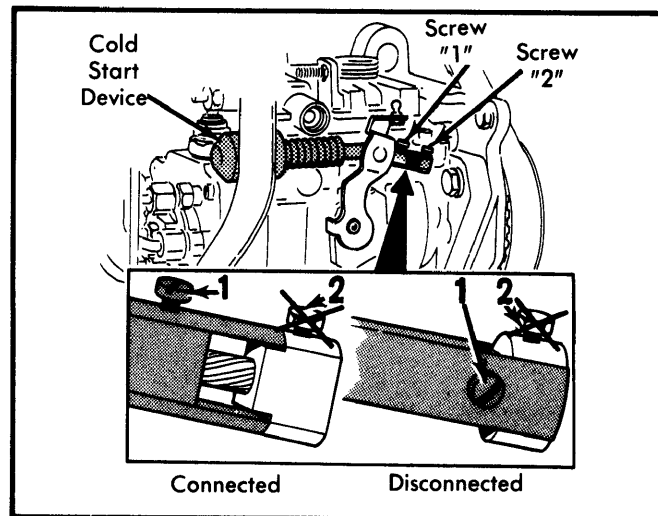


Fig. 10 Disconnecting and Connecting Cold Start Device

2) Set cylinder No. 1 at top dead center and injection. See Fig. 8. Both cam lobes should point up at equally large angles. Flywheel timing mark should be at "0".

3) Remove the plug from injection pump cover. Install dial indicator holder (5194) and a 0-.12" (0-3 mm) dial indicator gauge. See Fig. 11. Preset indicator to approximately .08" (2 mm). Turn engine counterclockwise until indicator gauge is at minimum. Set gauge to zero.

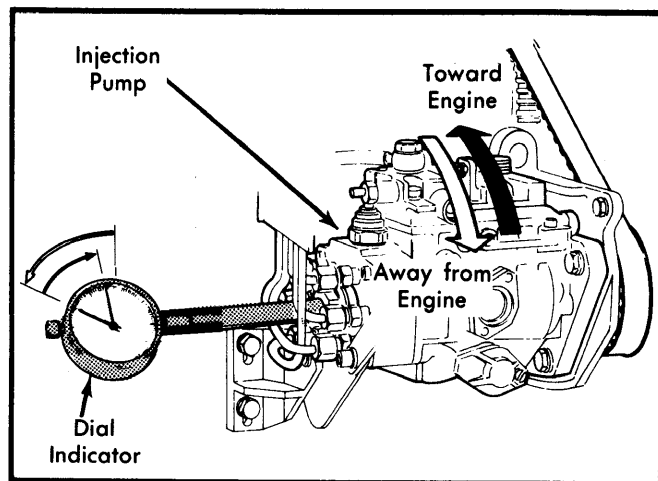


Fig. 11 Timing Volvo Fuel Injection Pump

4) Turn engine clockwise until flywheel "0" mark aligns with arrow. Indicator gauge should now read .0256-.0287" (.65-.73 mm).

NOTE – These specifications are for checking pump setting. When actually setting pump, reading should be exactly .028" (.70 mm). Also, when making check, if engine is turned too far past "0" mark, it must be turned back approximately ¼ turn and then clockwise again to "0" or settings will be incorrect.

5) If reading is less than .0256" (.65 mm), loosen injection pump retaining bolts. Turn injection pump inward until .028" (.70 mm) is indicated on gauge. Tighten retaining bolts.

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6) If reading is more than .0287" (.73 mm), loosen injection pump retaining bolts. Turn injection pump outward until reading is approximately .0236" (.60 mm) and then turn pump inward until it is at .028" (.70 mm). Tighten injection pump retaining bolts.

CAUTION — If adjusting allowances in steps 5) and 6) are insufficient, do not tap or knock injection pump to change setting. It may be camshaft is not in proper relationship to crankshaft and/or front or rear drive belts may be improperly tensioned. Correct this and then set injection timing.

7) After adjusting injection pump setting, turn engine twice and recheck setting. See Fig. 11. Readjust as necessary. Remove dial indicator and holder. Install rear timing gear cover.

8) Reconnect cold start device, remembering not to touch screw "2". Push lever forward and turn sleeve 90° and tighten screw "1". See Fig. 10.

Peugeot — 1) Remove valve cover and glow plugs. Rotate engine until cylinder No. 1 exhaust valve just begins to open (flywheel end). Using valve spring compressor, remove No. 4 exhaust valve rocker arm without altering its adjustment.

2) Slide rocker arm rearward and direct its nose upward. Disconnect and remove valve spring. Rotate engine clockwise until No. 1 exhaust valve closes and No. 1 intake valve opens (overlap).

3) Attach dial indicator support to front valve cover stud. Attach dial indicator with feeler gauge squarely on top of exhaust valve stem. Rotate engine back and forth to find exact TDC. Add approximately .39" (10 mm) preload. Rotate engine counterclockwise, lowering the piston .28" (7.0 mm) from TDC. The gauge should read .12" (3.0 mm).

4) Using a second dial indicator with adapters, install dial indicator in timing plug opening in hydraulic head of injection pump. Loosen pump mounting bolts, move pump fully away from the engine. Lightly tighten mounting bolts. This is BDC at the pump. Adjust a .039" (1 mm) preload on pump dial indicator.

5) Rotate engine clockwise until exhaust valve dial indicator matches specifications in table.

Exhaust Valve Dial Indicator Specifications ¹

Peugeot Engine	Inches (mm)
Federal34 (8.65) ²
Calif.36 (9.03) ²

- ① — ±.0008" (.02 mm).
- ② — .053" (1.35 mm) BTDC.
- ③ — .038" (.97 mm) BTDC.

6) Rotate pump toward the engine until pump dial indicator reads .059" (1.50 mm), an actual lift of .020" (.50 mm). Tighten pump mounting bolts.

7) Rotate engine counterclockwise .275" (7 mm) from TDC (.12" or 3 mm indicated). Rotate engine clockwise while observing pump dial indicator until exactly .059" (1.50 mm) is shown. This again is .020" (.50 mm) lift.

8) Check exhaust valve dial indicator again according to table. A tolerance of .0008" (.02 mm) is permitted. Remove dial indicators, reinstall valve components and pump cover plug.

VOLVO ENGINE CONTROLS

1) Disconnect cold start device. See Fig. 10. Disconnect link rod at lever on injection pump. Adjust accelerator cable by turning sheath until cable is stretched, but does not influence pulley position. Pulley should touch idle stop. See Fig. 12.

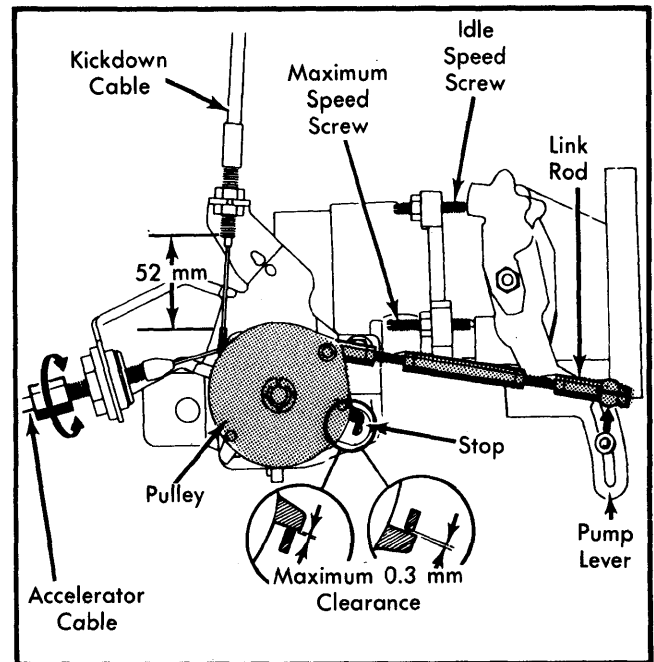


Fig. 12 Adjusting Engine Controls (Volvo Shown)

2) Depress accelerator pedal fully. Pulley should touch full speed stop. Adjust kickdown cable on automatic transmission models. Depress accelerator pedal to floor. Kickdown cable should move approximately 2.05" (52 mm) between end positions. In idle position, kickdown cable should be stretched and distance between kickdown cable clip and cable sheath should be .01-.04" (.25-1.0 mm).

3) Connect link rod to injection pump lever. Adjust link rod in maximum position by turning pulley to maximum position. Adjust link rod length so injection pump lever touches the maximum speed adjusting screw.

4) Adjust link rod in idle position by returning pulley to idle stop. Move link rod ball joint in oblong hole in injection pump lever until lever touches idle adjusting screw.

5) Readjust link rod by repeating steps 3) and 4). A clearance of .012" (.3 mm) is permitted between pulley and maximum speed stop. Reconnect cold start device.

MEASURING VOLVO ENGINE SPEED

Use a Volvo Monotester and adapter (9950) or a photoelectric tachometer. Always check and adjust engine controls after adjustment.

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VOLVO IDLE SPEED

Run engine to normal operating temperature. Check low idle speed for 750-850 RPM. Adjust outer screw to obtain correct speed. Apply tamperproof seal on screw and lock nut after adjustment.

VOLVO MAXIMUM SPEED

Maximum speed setting should be 5100-5300 RPM. Adjust inner screw to obtain high idle speed. Apply tamperproof seal on screw and lock nut after adjustment.

INJECTION NOZZLES

1) To disassemble injectors, make sure parts are clean and use care not to damage any components. Do not reuse dropped needles. Make sure all injector components are kept with original injector and that parts are not mixed from one injector to another. See Fig. 13.

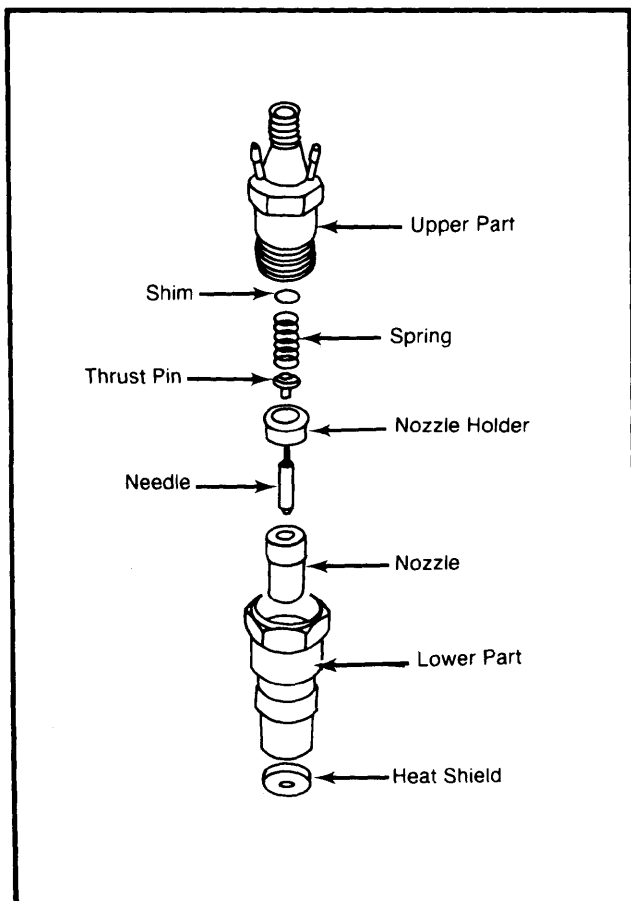


Fig. 13 Disassembling Injection Nozzles

2) Clean all parts in diesel oil. Use nozzle cleaner tool to clean nozzle needle and nozzle sleeve. Replace damaged parts. Nozzle needle and sleeve are matched assemblies and must both be replaced, if one requires replacement.

3) To assemble injectors, clean new parts with gasoline to remove storage grease. Immerse new parts in diesel oil prior to

assembly. Assemble injectors in correct order. Test injectors after reassembly.

TESTING**INJECTION NOZZLES**

CAUTION — Do not expose hands to injector spray during testing, as working pressure will cause fuel oil to penetrate the skin.

Injection nozzles should be tested for spray pattern, injection sound, opening pressure, and leakage.

Spray Pattern — Install injector in tester. See Fig. 14. Seal fuel return lines with rubber plugs and hose clamps. Disengage pressure gauge. Pump lever with short, quick strokes (4-6 per second). Spray jet should be compact and stop abruptly. Injector must not drip.

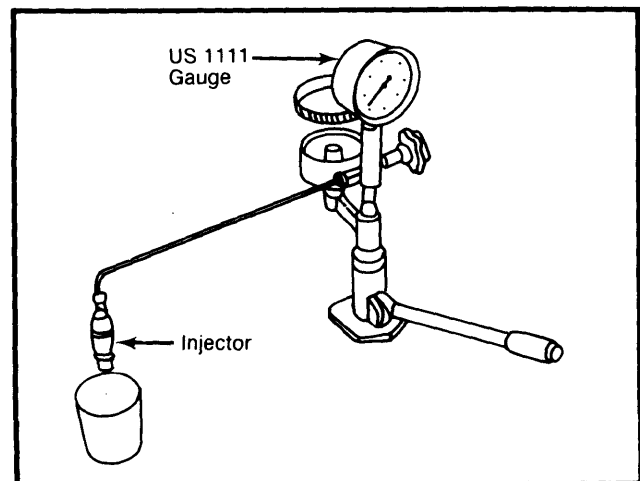


Fig. 14 Testing Injection Nozzles

Injection Sound — With gauge still disengaged, slowly depress tester lever fully (1-2 strokes per second). A good injector will whir during spray (buzzing sound).

Opening Pressure — Engage pressure gauge. Slowly depress lever and read injector opening pressure. Nozzle should open at 1668-1813 psi (117.3-127.5 kg/cm²) for Peugeot and 1706-1849 psi (120-130 kg/cm²) for Volvo. If opening pressure is incorrect perform leak test before adjusting.

Leak Test — With pressure gauge still engaged, wipe injector nozzle. Pump pressure up to 1560 psi (109.7 kg/cm²) and hold for 10 seconds. There must be no fuel drip from nozzle, although a moist nozzle is acceptable.

Adjusting Opening Pressure — To adjust opening pressure change shim thickness. Thicker shims will increase opening pressure; thinner shims will decrease it. Shims are available in thicknesses from .040-.077" (1.00-1.95 mm) in increments of .002" (.05 mm).

NOTE — A .002" (.05 mm) shim will increase opening pressure by approximately 71 psi (4.992 kg/cm²).

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VOLVO COLD START DEVICE

NOTE — The cold start device can only be tested on a test bench together with the injection pump, but a simple check can be made of its operation.

1) Cold start malfunction usually is indicated by hard starting of a cold engine, failure of engine to start below 14°F (–10°C), or blue-white exhaust smoke. See Fig. 15. Check idle speed with engine cold and at normal operating temperature.

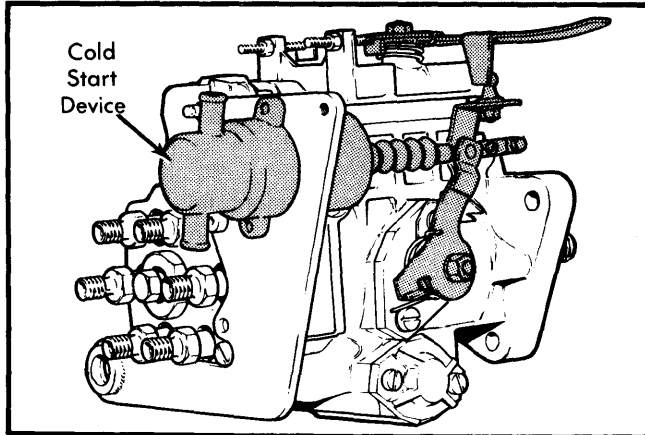


Fig. 15 Testing Cold Start Device (Volvo Shown)

2) With cold engine, below 70°F (20°C), engine should idle at approximately 950 RPM. With engine at normal operating temperature, idle speed should be lower, approximately 750-800 RPM. The cold start lever should clear lever on injection pump. If idle speeds do not vary as specified, cold start device is defective.

VOLVO GLOW PLUG SYSTEM

1) Connect 12-volt test lamp across glow plug terminal and ground. See Fig. 16. Check test lamp and indicator light on instrument panel. If indicator light and test lamp are both out, control unit is defective. If indicator light is on, but test light is not, glow plug relay is defective. If indicator light is out, but test light is on, check coolant temperature sender or control unit.

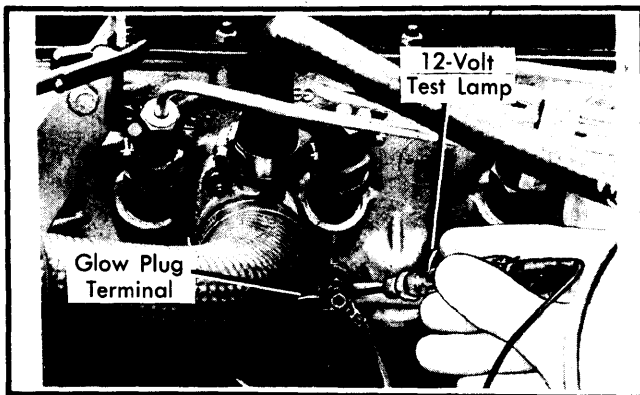


Fig. 16 Testing Glow Plugs with Test Lamp

2) If both indicator light and test lamp are on, check length of time light and lamp are on. Indicator light should vary with coolant temperature. Test lamp should stay on 10-25 seconds after indicator light goes out. If too short a time is observed, try a new control unit or temperature sender.

3) Check operation with starter motor operating. Test lamp should light, indicating voltage at glow plugs. If not, check voltage with test lamp at terminal 50 (blue-yellow wire) of control unit. If there is voltage, control unit is defective. If no voltage, check for open circuit between connector and control unit.

4) If test light was on during starter operation, check glow plugs one at a time. Place key switch in position "0". Remove bar between glow plug terminals. Connect test lamp across battery positive terminal and one glow plug. If light is out at one or more glow plugs, glow plugs are faulty. If test lamp and indicator fail to light, replace control unit.

5) If indicator light and test lamp are both out, make progressive voltage checks as indicated:

- Terminal 15 (blue-red wire) of control unit. If no voltage, check for open circuit between fuse box and control unit.
- Terminal 31 (black wire) of control unit (test lamp connected to battery positive terminal and terminal 31). If no voltage, check for faulty ground. If voltage, check for defective control unit.

6) If indicator light is on, but test lamp is out, make the following progressive voltage checks:

- Terminal 86 (red wire) of glow plug relay (test lamp connected to battery positive terminal and terminal 86). Voltage indicates faulty glow plug relay. No voltage indicates incorrect ground connection.
- Terminal G (blue wire) of control unit. No voltage indicates faulty control unit.
- Terminal 30 (blue wire) of blocking relay. No voltage indicates open circuit in wire between control unit and blocking relay.
- Terminal 87 (red wire) of blocking relay. Voltage indicates open circuit in wire between blocking relay and glow plug relay.
- Terminal 86 (blue-red wire) of blocking relay. No voltage indicates open circuit in wire between fuse box and blocking relay.
- Terminal 85 (red wire) of blocking relay (connect test lamp between fuse box positive and terminal 85). No voltage indicates faulty blocking relay. Voltage indicates open circuit in wire between blocking relay and instrument panel or defect in instrument panel printed circuit.

7) If indicator light is out, but test lamp is on, this usually indicates a failure of either the temperature sender or control unit. Disconnect wire at temperature sender. Indicator light should now be on. If so, this indicates circuit from sender to indicator light is OK, but sender is defective.

8) Check ground connection at terminal K (yellow wire) of control unit. Connect test lamp from battery positive terminal to terminal K. If voltage is indicated, indicator light on instrument panel is defective, there is a defective wire between control unit and indicator light or printed circuit is faulty. If no voltage exists, either the control unit is defective or wire between temperature sender and control unit is grounded.

9) If indicator light comes on when engine is warm, disconnect wire at temperature sender and ground it. Turn key switch to driving position "2" and check indicator light. If light is on, there is an open circuit in wire between temperature sender and control unit or control unit is defective. If indicator light is out, temperature sender is faulty.