1982 Diesel Fuel Injection

BOSCH — PEUGEOT & VOLVO

Peugeot 504, 505, 505 Turbo, 604 Turbo, Volvo Diesel

DESCRIPTION

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

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

OPERATION

FUEL INJECTION PUMP

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. The main pump increases this pressure to approximately 1800 psi (126 kg/cm²).

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

INJECTION NOZZLES

Peugeot engines use DNO SD 251 nozzles with KCA 17S38/4 holders. Opening pressure is 1645-1788 psi (115-125 kg/cm²) on Non-Turbo models or 1788-1930 (125-135 kg/cm²) on Turbo models. Volvo engines use DNO SD 193 nozzles with KCA 30 SD 27/4 holders. Opening pressure is 1706-1849 (120-130 kg/cm²).

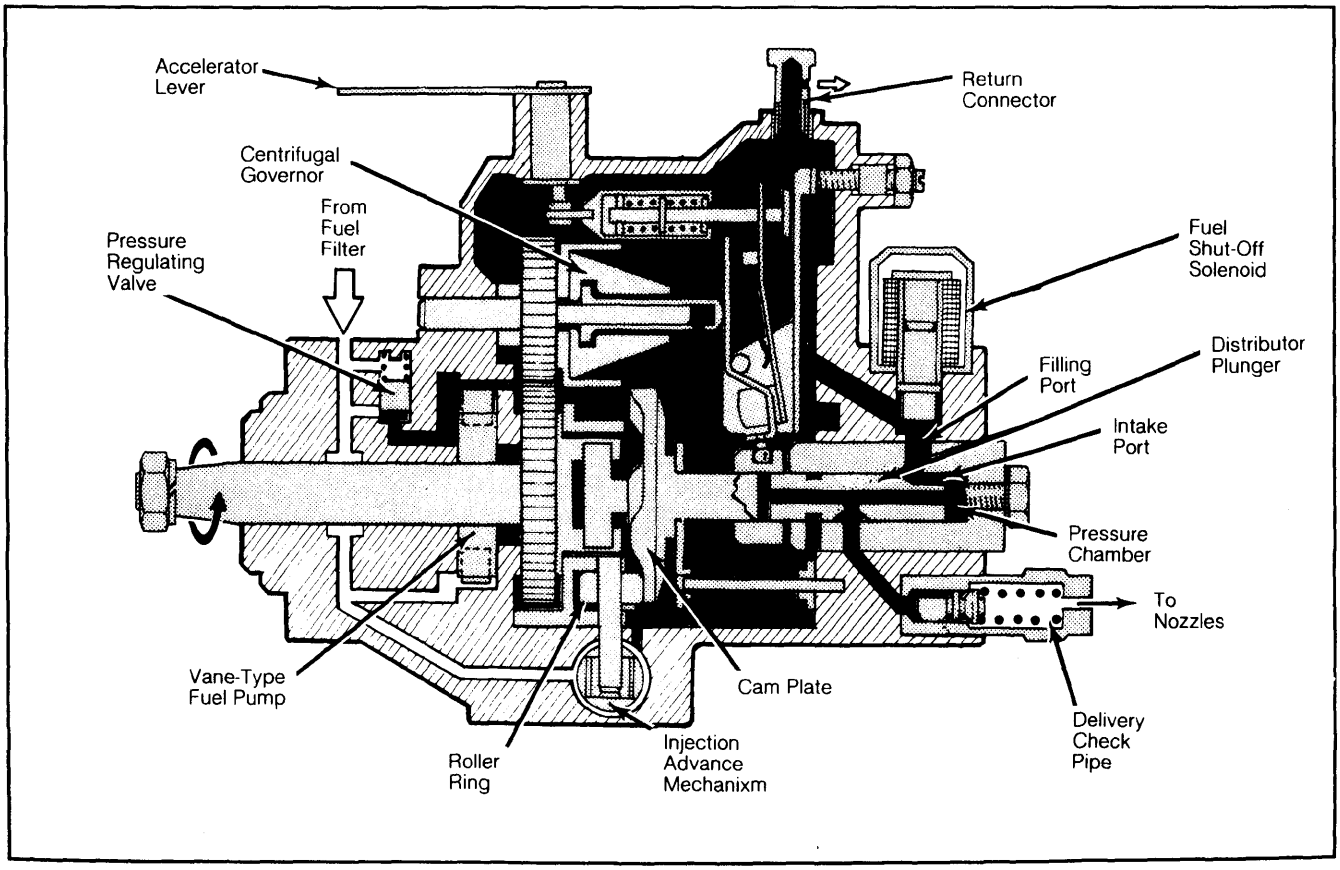
A pressurized mist of fuel is injected into a round swirl chamber. Fuel swirls around the chamber mixing with hot air, compressed at 23:1 for Non-Turbo models or 21:1 for Turbo models.

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

GLOW PLUGS

Glow plugs are used during cold starts to preheat swirl chambers. The system is switched "ON" when the key switch is turned to position "2". Preheating time depends on a coolant temperature switch connected

Fig. 1: Cutaway View of Volvo Fuel Injection Pump



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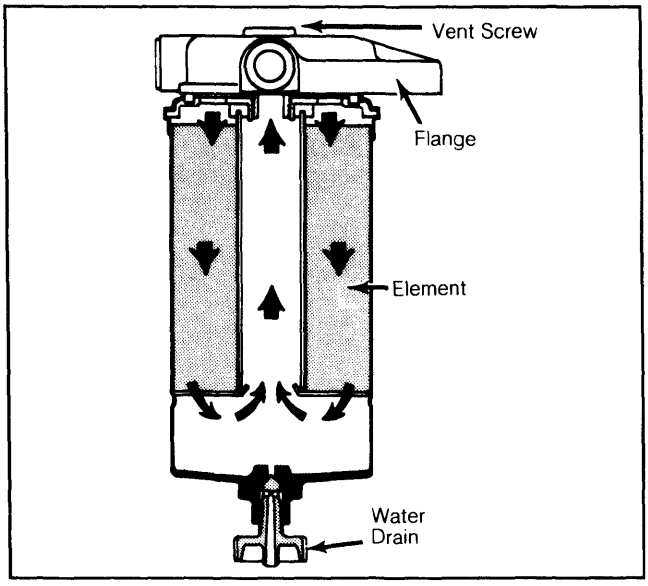
to time circuit in the glow plug relay. Glow plugs remain on approximately 10-25 seconds after the dashboard indicator light has gone out.

Glow plugs operate when starter motor is rotating (key position "3") and cut 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. 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. A water separator is built into the filter, as diesel systems are highly susceptible to water damage. For example, diesel fuel is used to lubricate the injection pump, and water would cause contamination and corrosion.

Fig. 2: Cutaway View 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 sleeve position is determined by a centrifugal governor, and accelerator linkage. A large quantity of fuel is supplied during starting, and less at idle. No fuel is allowed to pass when the engine exceeds a predetermined maximum RPM.

TESTING

INJECTION NOZZLES

Problems with injection nozzles usually are accompanied by knocking in 1 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:

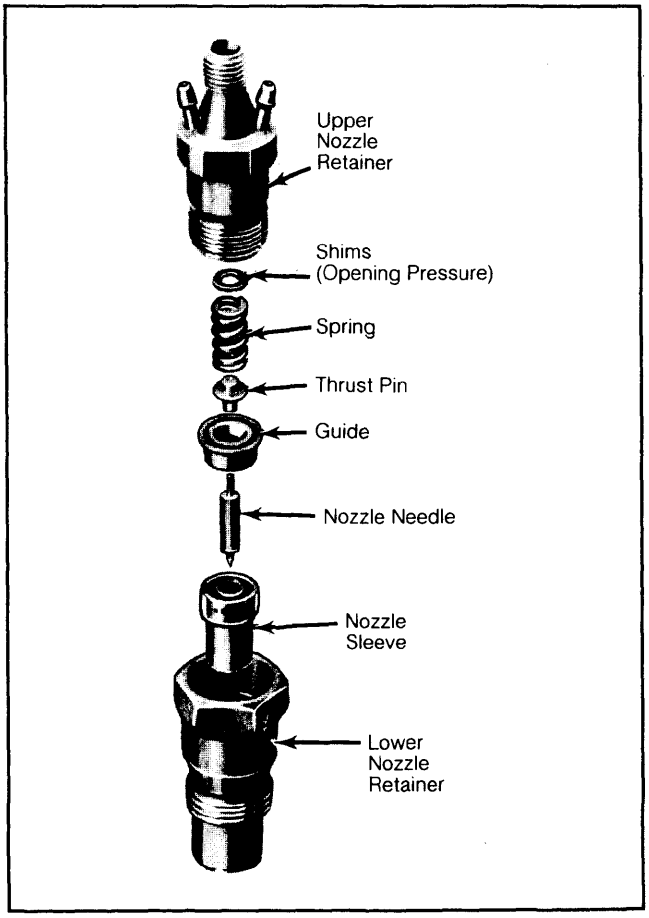
1) Remove vacuum pump and plunger. Loosen line unions on each injection nozzle, one at a time with engine running at fast idle. If engine speed remains constant with line removed, that nozzle is defective.

2) To remove nozzle, detach injector line after cleaning connection. Plug all openings to keep dirt out of fuel system.

3) To disassemble, place upper section in vise and loosen lower section, then reverse position and carefully remove parts from lower section. Do not interchange parts from 1 injector to another.

4) Clean all parts in diesel oil. Install new heat shields with recess in shield pointing upward. On Peugeot, use new copper gaskets. Tighten nozzles to specified torque.

Fig. 3: Disassembled View of Injector Nozzle



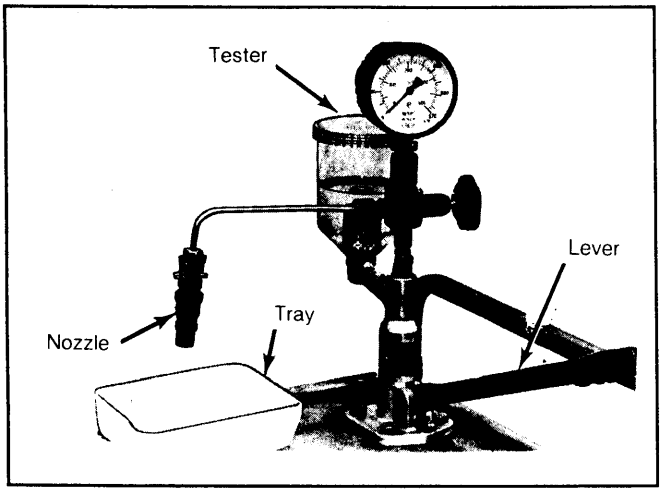
Spray Pattern

Install injector in tester. 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.

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

BOSCH — PEUGEOT & VOLVO (Cont.)

Fig. 4: Injection Nozzle Test Gauge Installation



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 1645-1788 psi (115-125 kg/cm²) on Peugeot Non-Turbo models, 1788-1930 psi (125-135 kg/cm²) on Peugeot Turbo models, or 1706-1849 psi (120-130 kg/cm²) on Volvo models. If opening pressure is incorrect, perform leak test before adjusting.

Leak Test

With pressure gauge still engaged, wipe injector nozzle. Pump pressure up to 1493 psi (105 kg/cm²) on Peugeot Non-Turbo models, 1645 (115 kg/cm²) on Peugeot Turbo models, or 1560 psi (110 kg/cm²) on Volvo models. Hold pressure for 10 seconds. There must be no fuel drip from injector nozzle, though a moist nozzle is acceptable.

Opening Pressure Adjustment

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). A .002" (.05 mm) shim will increase opening pressure by approximately 71 psi (5 kg/cm²).

PEUGEOT GLOW PLUG SYSTEM

Current to glow plugs flows through starter relay to Pre-Heat Control Box (located at center of firewall). A timer in control box provides power to glow plugs for 10-90 seconds, depending on ambient temperature. The following check can be made on this system:

1) Check system ground between terminal 2 on control box and frame. Check condition of glow plug bulb and ground connection in instrument panel.

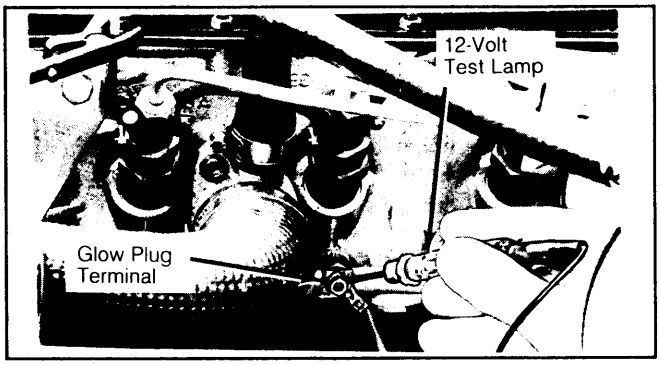
2) To locate shorted glow plugs, remove connecting straps between plugs. Connect a heavy jumper wire between terminal 5 of control box and each plug, 1 at a time.

3) Leave jumper wire connected for about 2 seconds. If glow plugs are bad, glow plug relay will cycle rapidly on and off. Replace shorted glow plugs.

VOLVO GLOW PLUG SYSTEM

1) Connect 12-volt test lamp across glow plug terminal and ground. Check test lamp and indicator light on instrument panel. *See Fig. 6.*

Fig. 6: Volvo Glow Plug Test with Test Lamp

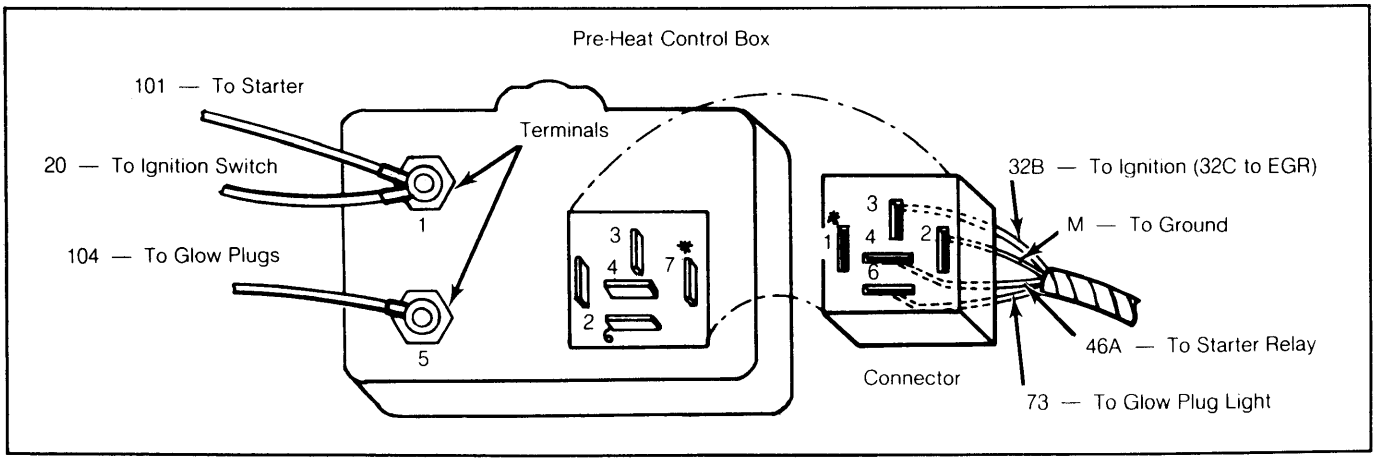


2) If indicator light is on, but test lamp is out, glow plug relay is defective. If indicator light is out, but test lamp is on, check coolant temperature sender or control unit. If both are out, control unit is defective.

3) If both indicator light and test lamp are on, check the amount of time they stay on. Indicator light time should vary with coolant temperature.

4) Test lamp should stay on 10-25 seconds longer than indicator. If not enough time is noted, replace temperature sender or control unit.

Fig. 5: Peugeot Pre-Heat Control Box Connections



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5) 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.

6) If there is voltage, control unit is defective. If no voltage, check for open circuit between connector and control unit.

7) If test light was on during starter operation, check glow plugs 1 at a time. Place key switch in position "O". Remove bar between glow plug terminals.

8) Connect test lamp across battery positive terminal and 1 glow plug. If light is out at 1 or more glow plugs, glow plugs are faulty. If test lamp and indicator fail to light, replace control unit.

9) If indicator light and test lamp are both out, check terminal 15 (Blue/Red wire) of control unit for voltage. If no voltage, check for open circuit between fuse box and control unit.

10) Check terminal 31 (Black wire) of control unit for voltage (test lamp connected to battery positive terminal and terminal 31). If no voltage, check for faulty ground. If voltage, check for defective control unit.

11) If indicator light is on, but test lamp is out, check terminal 86 (Red wire) of glow plug relay for voltage (test lamp connected to battery positive terminal and terminal 86).

12) Voltage indicates faulty glow plug relay. No voltage indicates incorrect ground connection. Check terminal G (Blue wire) of control unit for voltage. No voltage indicates faulty control unit.

13) Check terminal 30 (Blue wire) of blocking relay for voltage. No voltage indicates open circuit in wire between control unit and blocking relay.

14) Check terminal 87 (Red wire) of blocking relay for voltage. Voltage indicates open circuit in wire between blocking relay and glow plug relay.

15) Check terminal 86 (Blue/Red wire) of blocking relay for voltage. No voltage indicates open circuit in wire between fuse box and blocking relay.

16) Check terminal 85 (Red wire) of blocking relay for voltage (connect test lamp between fuse box positive and terminal 85). No voltage indicates faulty blocking relay.

17) Voltage indicates open circuit in wire between blocking relay and instrument panel or defect in instrument panel printed circuit.

18) If indicator light is out, but test lamp is on, this usually indicates a failure of either the temperature sender or control unit.

19) Disconnect wire at temperature sender. Indicator light should now be on. If so, this indicates circuit from sender to indicator light is okay, but sender is defective.

20) Check ground connection at terminal K (Yellow wire) of control unit for voltage (connect test lamp from battery positive terminal to terminal K).

21) 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.

22) If no voltage exists, either the control unit is defective or wire between temperature sender and control unit is grounded.

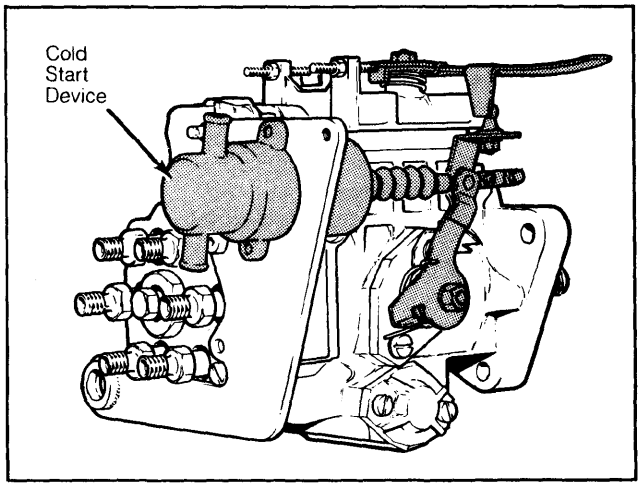
23) If indicator light comes on when engine is warm, disconnect wire at temperature sender and ground it. Turn key switch to driving position "2" and check indicator light.

24) 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.

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.

Fig. 7: Volvo Cold Start Device Location



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. Check idle speed with engine cold and at normal operating temperature.

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 approximately 750-850 RPM.

3) The cold start lever should clear lever on injection pump. If idle speeds do not vary as specified, cold start device is defective.

REMOVAL & INSTALLATION

PEUGEOT FUEL INJECTION PUMP

Removal

1) Remove the battery. On the pump, disconnect fuel supply and return lines. Disconnect control cables, fuel shut-off electrovalve wire, and load sensor harness (if equipped).

2) Remove injector pipes. Remove 2 front mounting bolts and pump rear support. Remove the pump and cap all fuel openings.

Installation

1) Remove engine valve cover. Bring valves of No. 1 cylinder to a rocking position. Turn engine back approximately 90°. Using a valve spring compressor, compress No. 4 exhaust valve spring and move rocker arm to 1 side.

2) Rotate engine back to rocking position of No. 1 cylinder. Remove half cones, washers and springs from No. 4 exhaust valve. Using supports (8.0177 ZZ), install a dial indicator onto No. 4 exhaust valve stem.

3) Bring engine to TDC at No. 4 cylinder. Zero the dial indicator. Rotate engine backwards to .28" (7 mm) BTDC. Clean hydraulic head on injection pump and remove inspection plug.

4) Turn pump shaft to bring double tooth of injection pump in line with double groove of engine pump hub pinion.

5) Coat a new gasket with grease and install on pump flange. Install pump on engine and install mounting bolts without tightening. Adjust timing as outlined in *Adjustments*.

VOLVO FUEL INJECTION PUMP

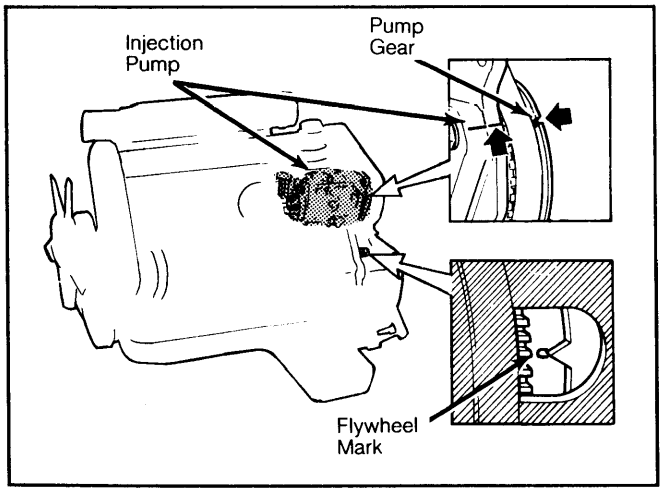
NOTE: As injectors are manufactured to extremely small tolerances (pump cylinder and bore clearance is .00004-.00008" (.001-.002 mm), extreme cleanliness is a necessity. Clean all injection pump and nozzle unions before removal.

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.

2) Disconnect wire at fuel shut-off solenoid. Remove rear timing gear cover. Clean fuel line connections at injection pump. Disconnect fuel supply and return lines at pump.

Fig. 8: Volvo Injection Pump Timing Mark Alignment



Check before removing pump.

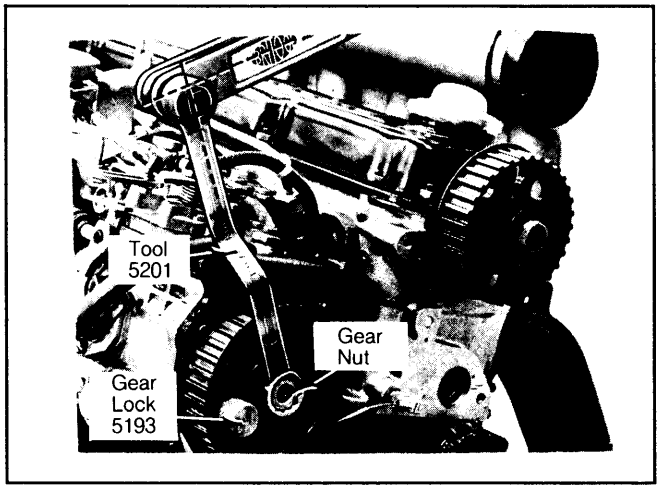
3) Plug open connections to prevent dirt from entering fuel system. Remove vacuum pump and pump plunger. Remove injection pump delivery pipes. Plug all openings.

4) Set cylinder No. 1 at TDC on compression stroke. Timing marks should align. Remove injection pump drive belt, after relieving tension by loosening injection pump bracket bolts. Tighten 1 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). Remove gear nut with special tool (5201). Remove pump gear with puller (5204). Remove injection pump front bracket bolts and rear retaining bolts. Lift off pump and front bracket.

Fig. 9: Volvo Injection Pump Gear Removal



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.

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).

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.

6) Attach wire to fuel shut-off solenoid. Connect accelerator cable and, if equipped, the kickdown cable. Adjust accelerator control.

FUEL FILTER

1) Service is limited to draining water periodically and normal filter replacement. To drain water, loosen bleed screw on top several turns with screw driver. Loosen drain screw by hand and drain fluid until only clean fuel runs out.

2) On Peugeot, close drain screw and actuate manual primer pump until fuel flows without bubbles at bleed screw. Retighten bleed screw. On Volvo, close both screws.

ADJUSTMENTS

PEUGEOT FUEL INJECTION PUMP TIMING

1) With pump mounting bolts loose, dial indicator attached to No. 4 cylinder exhaust valve, and engine at .28" (7 mm) BTDC, rotate injection pump body away from engine. *See Peugeot Fuel Injection Pump Installation.*

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2) Using adapters (8.0117T, P, and S), install dial indicator to pump. Turn engine and locate BDC and TDC points on the dial indicator. At BDC, the pump dial indicator should have some preload.

3) Zero the pump dial indicator at BDC. Bring piston No. 4 to TDC of compression stroke. Check zero point of engine dial indicator. Turn engine 90° in reverse. Recheck pump dial indicator.

4) Turn engine in normal direction of rotation and bring No. 4 piston to .038" (.97 mm) BTDC for Non-Turbo models or .016" (.40 mm) BTDC for Turbo models.

5) Rotate pump towards the engine until pump dial indicator indicates a pump lift of .020" (.50 mm). Tighten pump mounting bolts, front and rear.

6) Check timing by rotating engine 2 turns in normal direction. Turn engine back approximately 90°. Rotate engine slowly in normal direction while watching pump dial indicator.

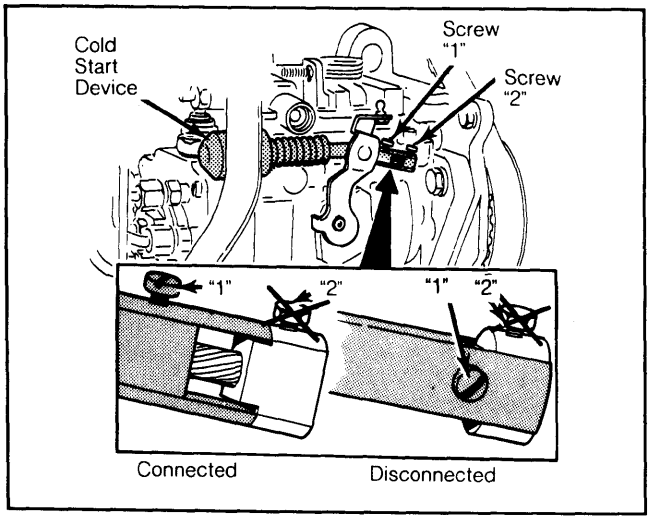
7) Stop turning engine when indicator shows a lift of .020" (.50 mm). No. 4 piston should then be at .038" (.97 mm) BTDC for Non-Turbo models, and .016" (.40 mm) BTDC for Turbo models. If readjustment is necessary, rotate pump.

8) Remove dial indicators and supports. Reinstall inspection plug with a new gasket. Install springs, washer and half cones of No. 4 exhaust valve and adjust clearance. Reinstall pipes, hoses and controls. Adjust cables and bleed fuel circuit.

VOLVO FUEL INJECTION PUMP TIMING

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

Fig. 10: Volvo Cold Start Device Connections



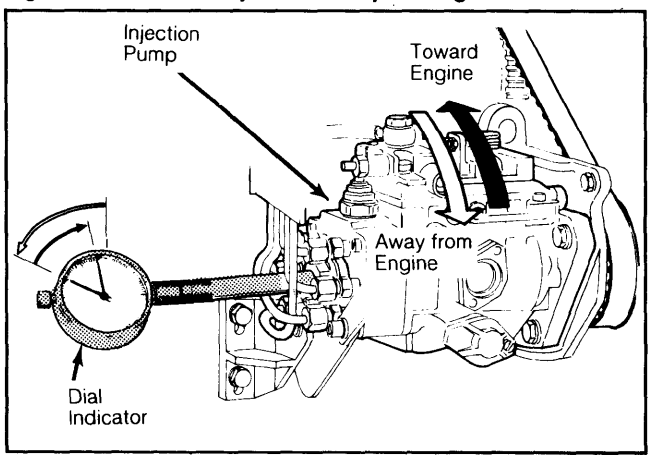
DO NOT touch screw "2".

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

3) Remove plug from injection pump cover. Install dial indicator holder (5194) and a 0-.12" (0-3 mm) dial indicator gauge.

4) Preset indicator to approximately .08" (2 mm). Turn engine counterclockwise until indicator gauge is at minimum. Set gauge to zero.

Fig. 11: Volvo Fuel Injection Pump Timing



5) 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.

6) 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.

7) 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 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.

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

9) Reconnect cold start device. DO NOT turn screw "2". Push lever forward and turn sleeve 90°. Tighten screw "1".

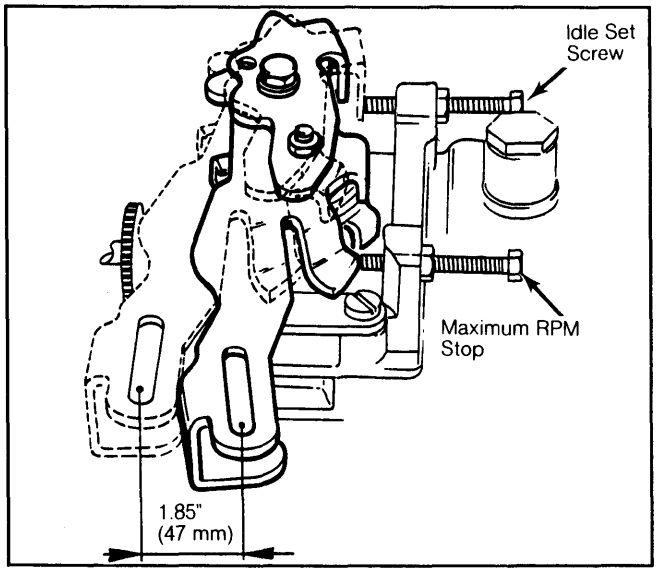
PEUGEOT ENGINE CONTROLS

Accelerator Cable

1) Warm engine to normal operating temperature. Adjust idle speed, if necessary. Position cable stop with elongated hole in order to obtain total cable travel of 1.77-1.93" (45-49 mm) between idle set screw and maximum RPM stop.

2) Place a .20" (5 mm) spacer between accelerator cable and its stop. Using a press (8.0204), depress accelerator pedal. Place throttle lever of pump in full throttle position.

Fig. 12: Peugeot Accelerator Lever Adjustment



3) Install tensioner clip so that play on cable will be taken up without compressing compensator spring on firewall. Remove pedal press and spacer.

4) Check to ensure that when at rest, throttle lever rests against idle set screw. Check that in full throttle position, compensator spring is not fully compressed.

Kickdown Cable

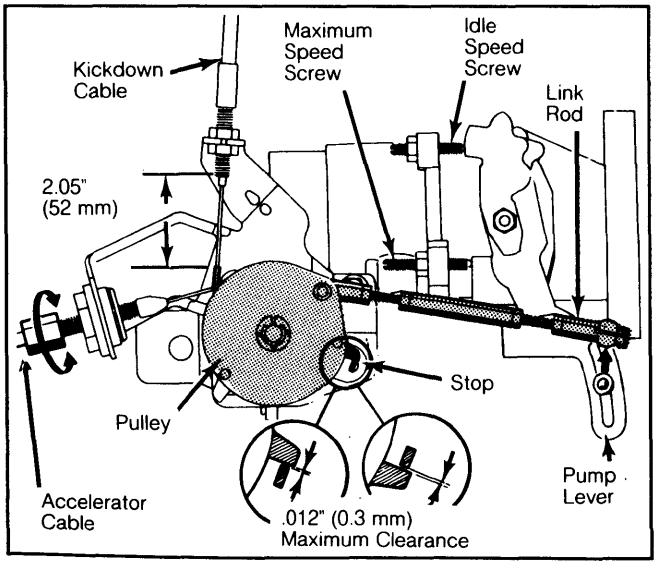
1) Warm engine to normal operating temperature. Adjust idle speed, if necessary. Install cable end clip in slot which will allow for straightest routing of cable. Loosen locknut of tensioner.

2) Adjust tensioner to obtain .004-.020" (0.1-0.5 mm) play between end clip and end of tensioner. Retighten locknut while immobilizing tensioner.

VOLVO ENGINE CONTROLS

1) Disconnect cold start device. 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.

Fig. 13: Volvo Control Cable Adjustments



2) Depress accelerator pedal fully. Pulley should touch full speed stop. Adjust kickdown cable on Auto. Trans. models. Depress accelerator pedal to floor. Kickdown cable should move approximately 2.05" (52 mm) between end positions.

3) 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).

4) 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 maximum speed adjusting screw.

5) 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.

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

PEUGEOT IDLE SPEED

1) With engine warm, attach tachometer. Check that accelerated idle stop is not in contact with throttle lever and that accelerator cable is released. Adjust set screw to obtain idle speed specifications.

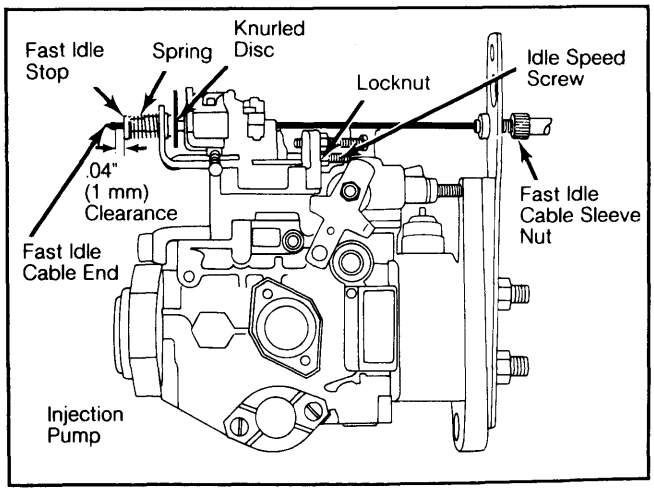
PEUGEOT IDLE SPEED SPECIFICATIONS

Application	Idle RPM
504 & 505	
With A/C	830-860
Without A/C	730-830
505 & 604 Turbo	
With A/C	800-860
Without A/C	780-840

2) Turn fast idle cable sleeve nut to obtain a clearance of .04" (1 mm) between fast idle cable end and fast idle stop. Start engine and warm to normal operating temperature.

3) Compress fast idle stop and check idle speed. Engine speed should be 1200-1400 RPM. Adjust if necessary, using knurled disc. Readjust clearance and accelerator cable.

Fig. 14: Peugeot Idle Speed Adjustment Locations



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VOLVO IDLE SPEED

With engine warm, attach tachometer. Check that idle speed is between 750-850 RPM. If not, loosen locknut and adjust with outer screw. Tighten locknut and apply tamperproof seal after adjustment.

PEUGEOT MAXIMUM SPEED

Accelerate engine to full throttle and quickly adjust maximum speed screw to obtain 4800 RPM. Tighten locknut after adjustment.

NOTE: DO NOT race engine any longer than necessary.

VOLVO MAXIMUM SPEED

Maximum speed setting should be 5100-5300 RPM. If not, loosen locknut and adjust inner screw. Tighten locknut and apply tamperproof seal after adjustment.

TIGHTENING SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Glow Plugs	16 (22)
Fuel Injection Line Unions	18 (25)
Injector Nozzle (Upper-to-Lower Part)	51 (70)
Injector Nozzle-to-Socket	51 (70)
Injection Pump Mounting Bolts	15 (20)