BOSCH DIESEL FUEL INJECTION – 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 (1-3-4-2 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

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/cm^2) at 1600 RPM or 87-94 psi (6.1-6.6 kg/cm) at 2200 RPM. The main pump increases this pressure to approximately 1800 psi (126 kg/cm^2).

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

INJECTION NOZZLES

The Peugeot engines use DNO SD 1510 nozzles with KCA 17S38/4 holders. Opening pressure is 1775-1917 psi (124.8-134.8 kg/cm^2). Volvo engines use DNO SD 193 nozzles with KCA 30 SD 27/4 holders. Opening pressure is 1706-1849 (120-130 kg/cm^2).

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

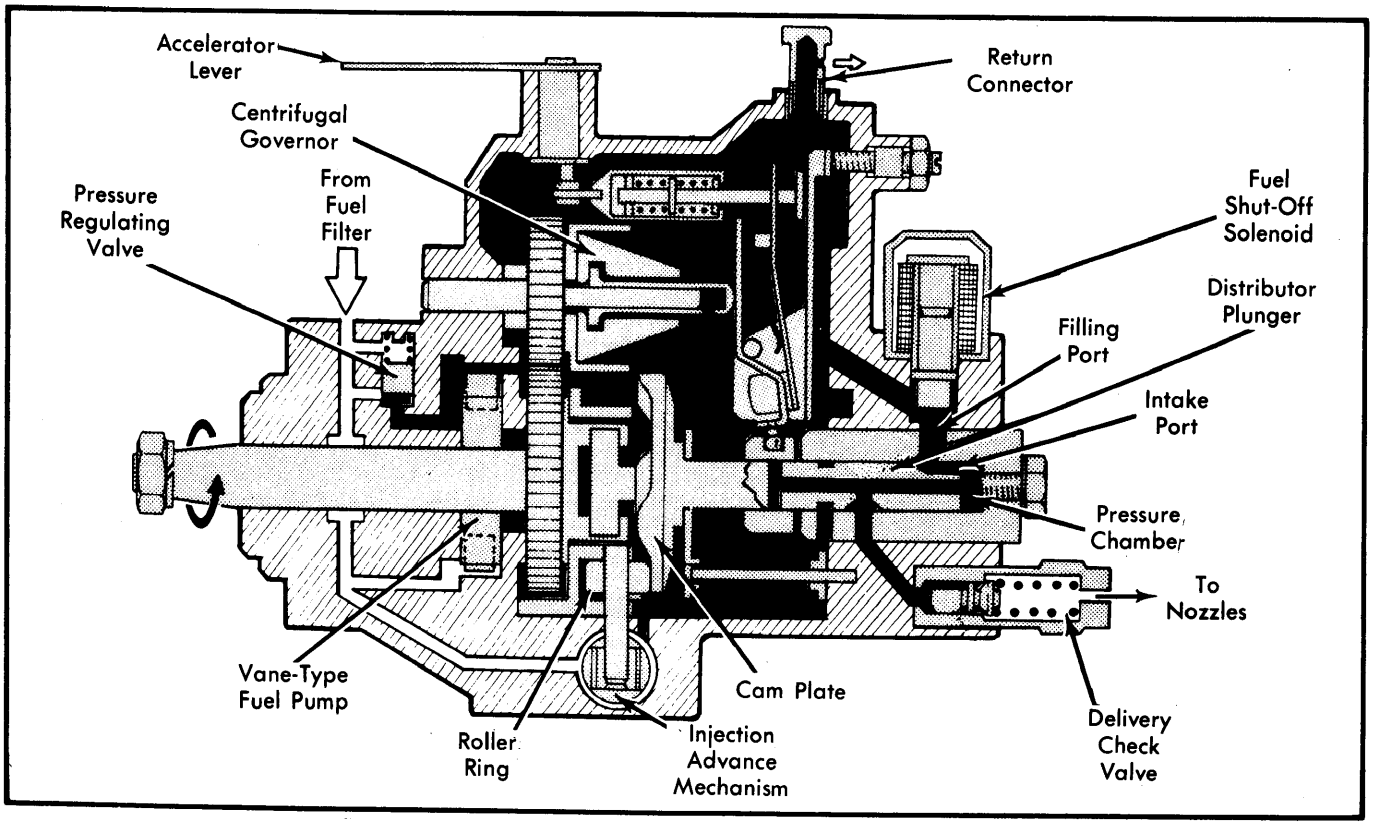

Fig. 1 Cutaway View of Volvo Fuel Injection Pump

BOSCH DIESEL FUEL INJECTION – PEUGEOT & VOLVO (Cont.)

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. 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.

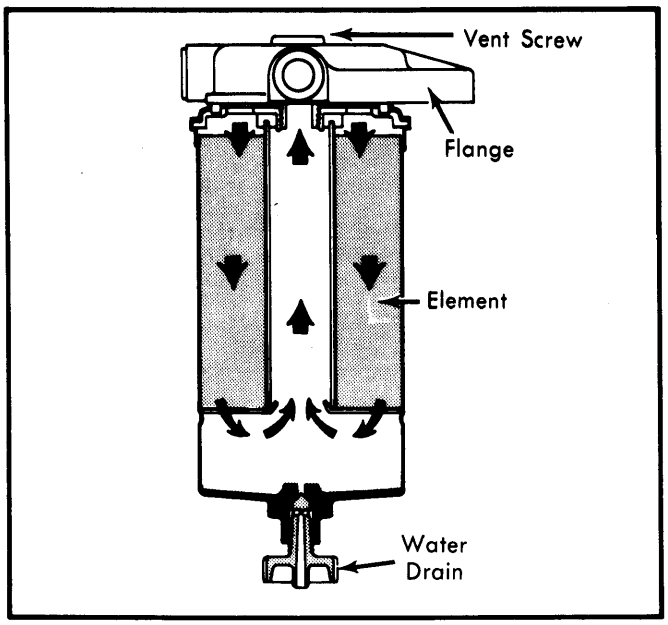

Fig. 2 Components of Fuel Filter

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 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 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. 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 one injector to another.

3) 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 secified torque.

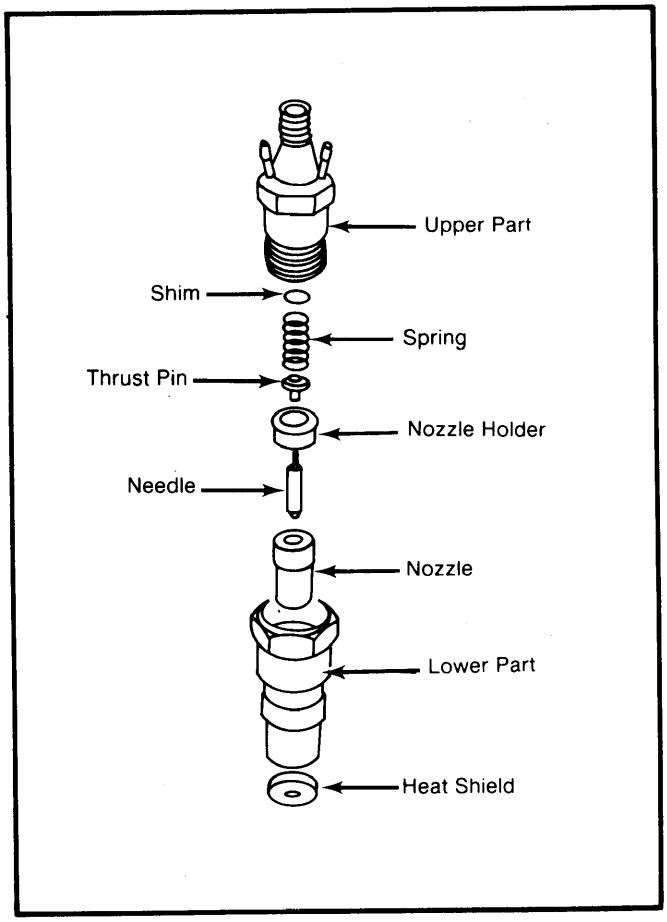

Fig. 3 Disassembled View of Injector Nozzle

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 DIESEL FUEL INJECTION – PEUGEOT & VOLVO (Cont.)

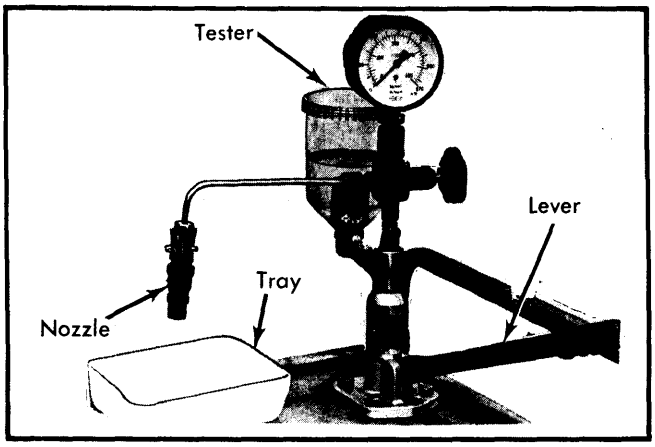

Fig. 4 Injection Nozzle Test Gauge

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 1775-1917 psi (124.8-134.8 kg/cm²) on Peugeot and 1706-1849 psi (120-130 kg/cm²) on 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) on Volvo, 1632 psi (114.7 kg/cm²) on Peugeot. Hold pressure for 10 seconds. There must be no fuel drip from injector nozzle, though 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).*

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.*

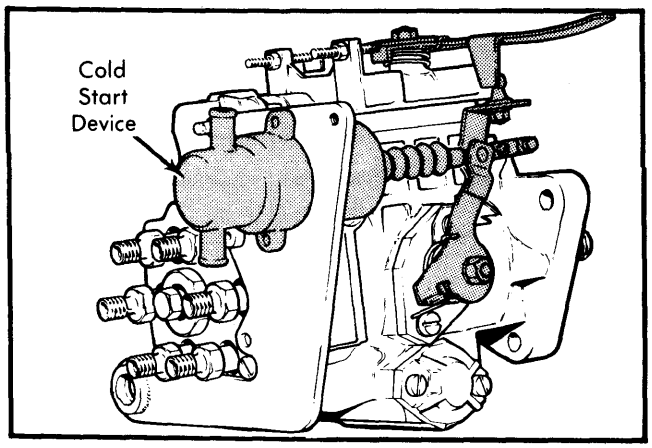

Fig. 5 Volvo Cold Start Device Check

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 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. Check test lamp and indicator light on instrument panel. If both are out, control unit is defective. If indicator light is on, but test lamp is not, glow plug relay is defective. If indicator light is out, but test lamp is on, check coolant temperature sender or control unit.

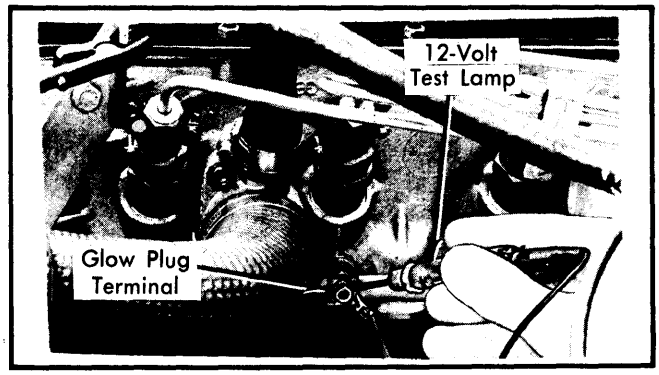

Fig. 6 Testing Glow Plugs with Test Lamp

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

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 postion "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:

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- 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.

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 checks 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, one at a time. Leave jumper wire connected for about 2 seconds.

3) If glow plugs are bad, glow plug relay will cycle rapidly on and off. Replace shorted glow plugs.

REMOVAL & INSTALLATION

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.

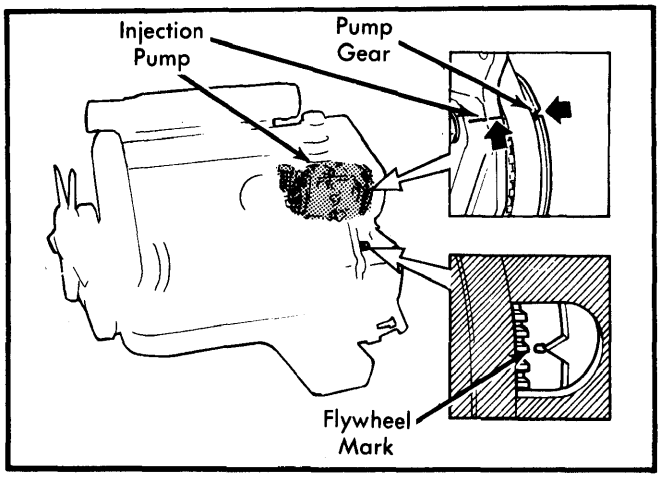

Fig. 8 Volvo Injection Pump Timing Mark Alignment (Check Before Removing Pump)

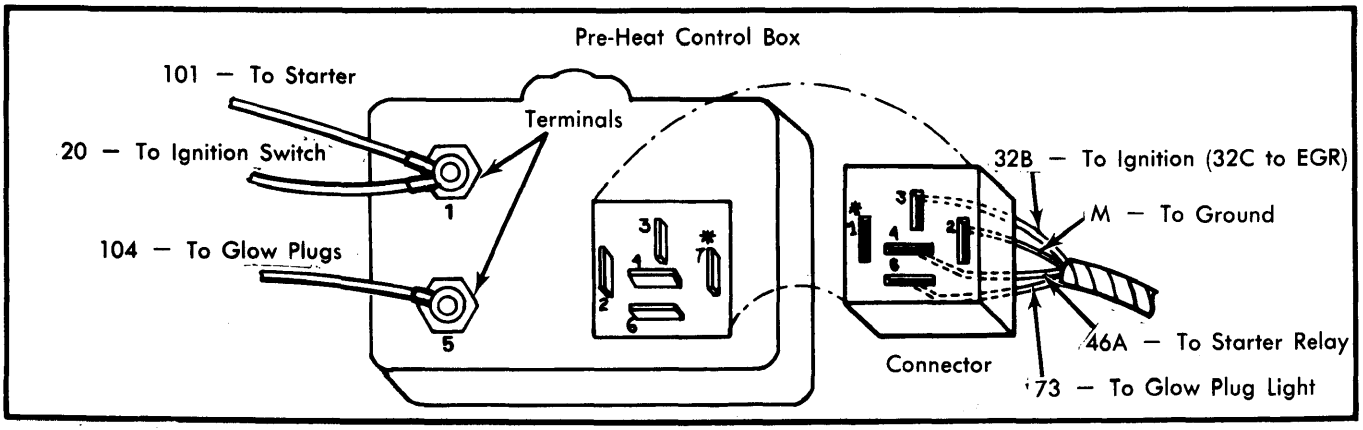

Fig. 7 Peugeot Pre-Heat Control Box Connections

BOSCH DIESEL FUEL INJECTION – PEUGEOT & VOLVO (Cont.)

3) Remove vacuum pump and pump plunger. Remove injection pump delivery pipes. Plug all openings. Set cylinder No. 1 at TDC on compression stroke. 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). 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.

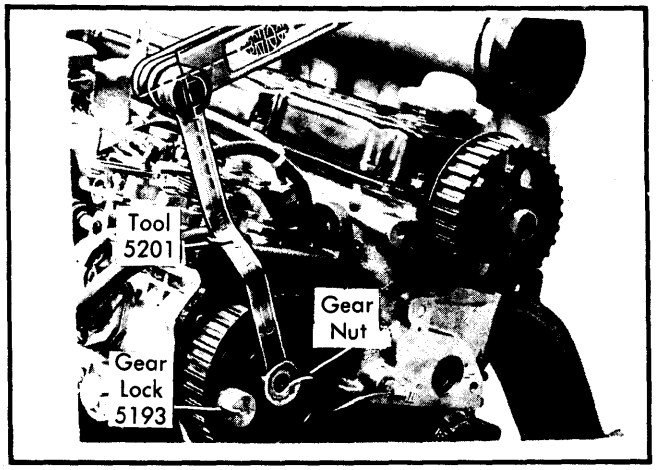

Fig. 9 Removing Injection Pump Gear (Volvo Shown)

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

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, then turn engine back approximately 90°. Using a valve spring compresssor, compress No. 4 exhaust valve spring and move rocker arm to one side.

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

3) Bring the engine to TDC at No. 4 cylinder. Zero the dial indicator. Rotate the engine backwards to 7 mm BTDC. Clean the hydraulic head on the injection pump and remove the inspection plug. Turn the pump shaft to bring the double tooth of the injection pump in line with the double groove of the engine pump hub pinion.

4) 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*.

FUEL FILTER

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

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°. DO NOT touch screw "2". If it is loosened, cold start device must be reset on a test bench.

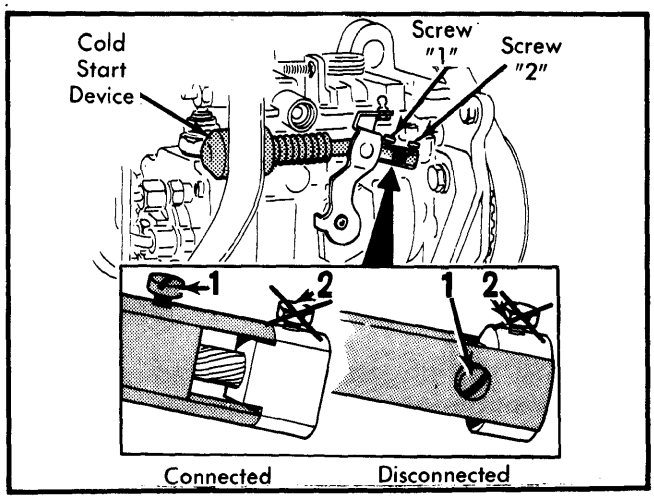

Fig. 10 Disconnecting and Connecting Cold Start Device (Volvo Shown)

BOSCH DIESEL FUEL INJECTION – PEUGEOT & VOLVO (Cont.)

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. 3.*

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

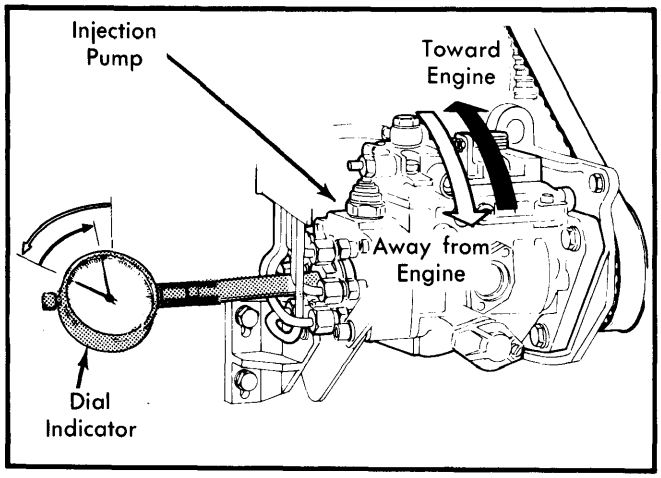

Fig. 11 Timing Volvo Fuel Injection Pump

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.

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. Readjust as necessary. Remove dial indicator and holder. Install rear timing gear cover.

8) Reconnect cold start device, remembering not to turn screw "2". Push lever forward and turn sleeve 90°. Tighten screw "1".

Peugeot – 1) With pump mounting bolts loose, dial indicator attached to No. 4 cylinder exhaust valve, and engine at 7 mm BTDC, rotate the injection pump body away from the engine. *See Injection Pump Installation.* Install dial indicator to pump using suitable adapters (8.0117T, P and S).

2) Turn engine and locate BDC and TDC points on the dial indicator. At BDC the pump dial indicator should have some preload. Zero the pump dial indicator at BDC. Bring piston No. 4 to TDC of compression stroke. Check zero point of engine dial indicator.

3) Turn engine 90° in reverse, and recheck pump dial indicator. Turn engine in normal direction of rotation and bring No. 4 piston to .038" (.97 mm) BTDC for non-Turbo models, and to .016" (.40 mm) BTDC for Turbo models. Rotate the pump towards the engine until the pump dial indicator indicates a pump lift of .020" (.50 mm).

4) Tighten pump mounting bolts, front and rear. Check timing by rotating the engine the normal direction 2 turns. Turn engine back approximately 90°. Rotate engine slowly in normal direction while watching the pump dial indicator. Stop turning the engine when indiator shows a lift of .020" (.50 mm).

5) 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 the pump. 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 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.

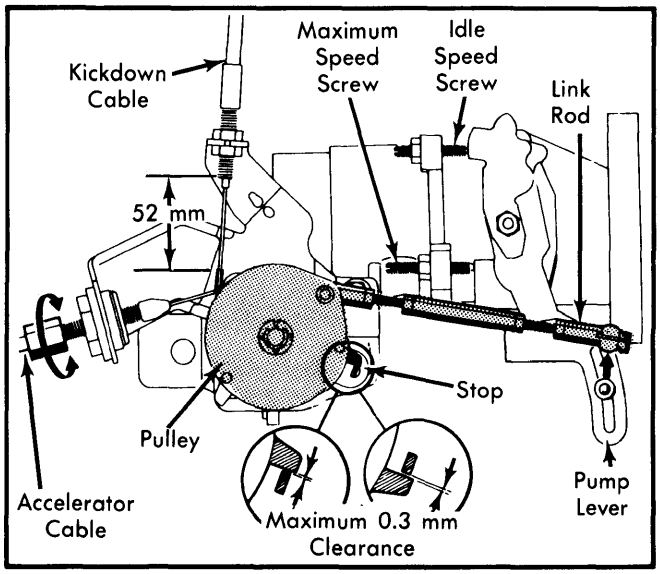

Fig. 12 Adjusting Volvo Control Cables

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).

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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.

PEUGEOT ENGINE CONTROLS

Accelerator Cable – **1)** With warm engine and idle speed adjusted, position the cable stop within the elongated hole in order to obtain total cable travel of 1.85±.08" (47±2 mm) between idle set screw and maximum RPM stop.

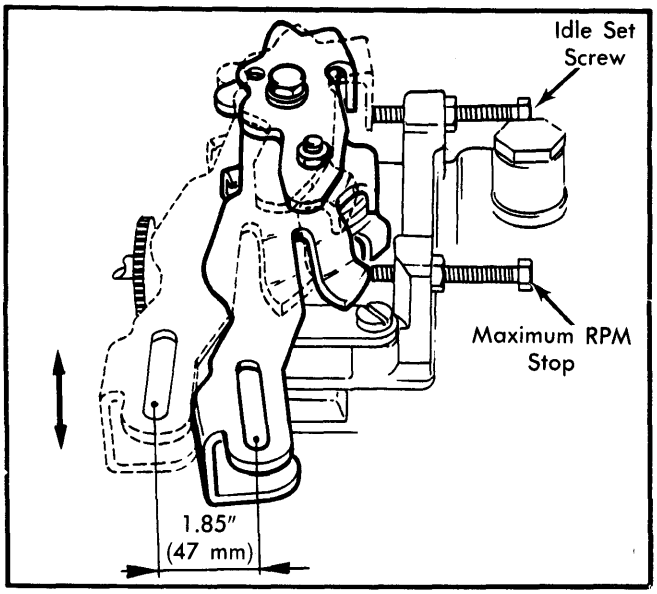

Fig. 13 Peugeot Accelerator Lever Adjustment

2) Place a .20" (5 mm) spacer between the accelerator cable and its stop and depress accelerator pedal using a press (8.0204). Place the throttle lever of the pump in the full throttle position. Install the tensioner clip so that the play on the cable will be taken up without compressing the compensator spring on the firewall.

3) Remove pedal press and spacer. Check to ensure that when at rest, the throttle lever rests against idle set screw. Check that in full throttle position, compensator spring is not fully compressed.

Kickdown Cable – With engine warm and idle adjusted, install the cable end clip in the slot which will allow for the straighest routing of the cable. Loosen locknut of the tensioner. Adjust the tensioner to obtain .004-.020" (0.1-0.5 mm) play between the end clip and the end of the tensioner. Retighten the locknut while immobilizing the tensioner.

IDLE SPEED

Volvo – Run engine to normal operating temperature. Using a Volvo Monotester and adapter (9950), or a photoelectric tachometer, check idle speed. Speed should be 750-850 RPM. Adjust outer screw to obtain correct speed. Apply tamperproof seal and lock nut after adjustment.

Peugeot – **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 as listed in table.

Peugeot Idle Speed

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 step. Start the engine and warm to operating temperature. Compress the fast idle stop and check idle speed. Engine speed should be 1200-1400 RPM. Adjust if necessary, using the knurled disc. Readjust clearance and accelerator cable.

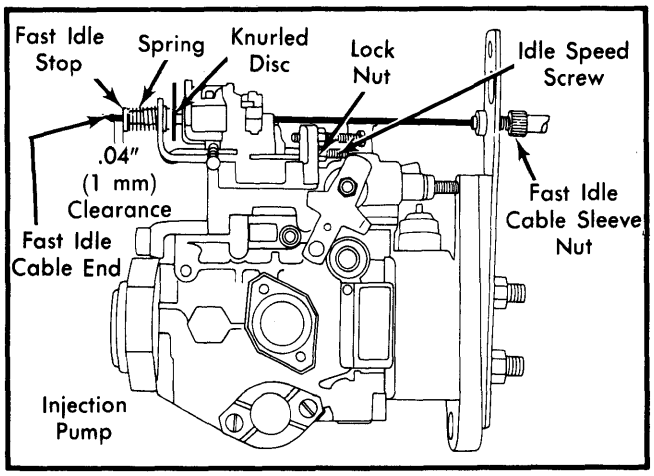

Fig. 14 Peugeot Idle Speed Adjustment Locations

MAXIMUM SPEED

Volvo – Maximum speed setting should be 5100-5300 RPM. Adjust inner screw to obtain setting. Apply tamperproof seal on screw and locknut after adjustment.

NOTE – *Do not race engine any longer than necessary.*

Peugeot – Accelerate engine to full throttle and quickly adjust maximum speed screw to obtain 4800 RPM. Tighten lock nut after adjustment.

TIGHTENING SPECIFICATIONS

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