1982 Diesel Fuel Injection

BOSCH — AUDI & VOLKSWAGEN

Audi 4000, 5000, Volkswagen Jetta, Pickup, Quantum, Rabbit, Vanagon

DESCRIPTION

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 injection pump, supplies fuel from tank to fuel filter and then to injection pump. Injection pump supplies fuel to nozzles under high pressure, according to firing order (1-3-4-2 on Volkswagen and 1-2-4-5-3 on Audi). Excess fuel is returned to fuel tank by return lines.

OPERATION

FUEL INJECTION PUMP

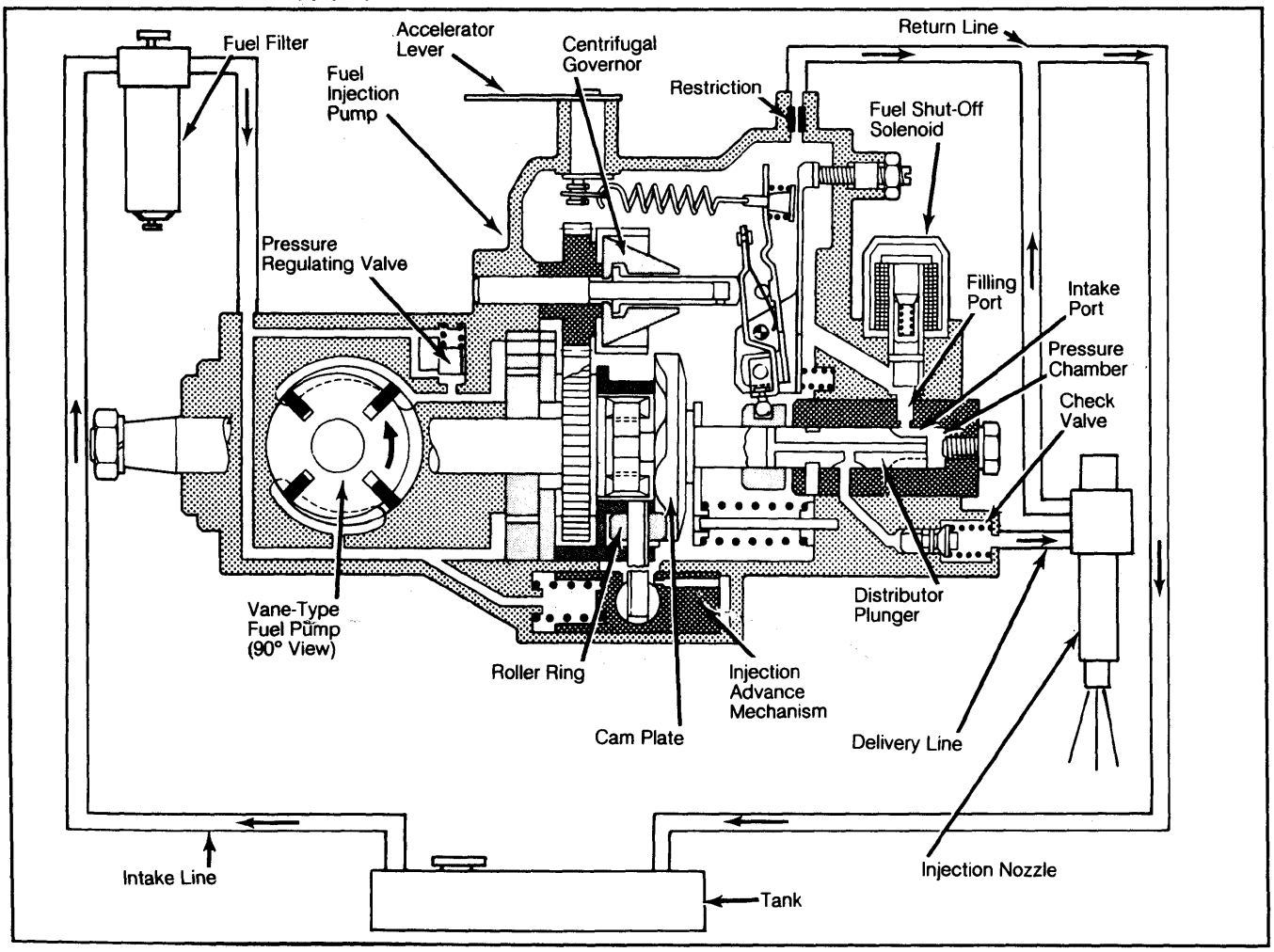
The Bosch single plunger mechanical pump consists of a low-pressure, vane-type fuel pump, a high-pressure distributor plunger injection pump, a centrifugal governor, an injection timing mechanism, an electrical fuel shut-off solenoid and a manual injection pump shut-off valve. *See Fig. 1.*

As the vane pump rotor turns, centrifugal force holds the vanes against the walls of the pump's pressure chamber. The off-center design of the rotor and pressure chamber squeezes trapped fuel between vanes and forces it out the delivery port. Vane pressure is 42.7-99.6 psi (3-7 kg/cm²). The main pump increases this pressure to approximately 1800 psi (126 kg/cm²).

The injection pump on Turbo Diesel models is also equipped with an boost pressure enrichment device. *See Fig. 2.* Since the turbocharger supplies more air to the engine, the boost pressure enrichment device is needed to increase the amount of fuel delivered to the engine.

At full throttle, when turbocharger boost pressure is low, no enrichment is needed. As turbocharger boost pressure increases, the pressure begins to work on the enrichment device diaphragm, forcing it down. This turns the bell crank which in turn moves the control ring further to the right. In this manner, the effective stroke of the distributor plunger is lengthened which increases the amount of fuel delivered to the injectors.

Fig. 1: Bosch Diesel Fuel Supply System



All except Turbo Diesel models.

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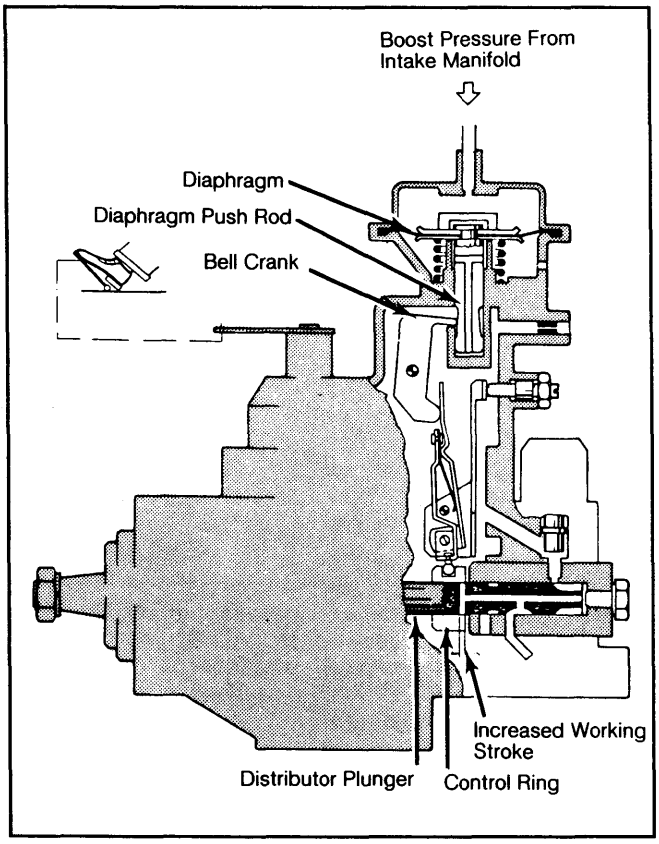
Fig. 2: Bosch Diesel Fuel Injection Pump



Turbo Diesel models only.

INJECTION NOZZLES

Bosch DNOSD 193 injection nozzles, mounted in KDA SD 27/4 sockets, inject fuel at 2248-2364 psi (158-166 kg/cm²) for Turbo Diesel models or at 1706-1850 psi (120-130 kg/cm²) for all other models.

A pressurized mist of fuel is injected into a round swirl chamber. Fuel swirls around the chamber, mixing with hot air that is compressed to a ratio of 23:1. Heat shields protect each injector.

Combustion begins in the rich swirl chamber, continues on through a small passageway, and then into a 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

During cold starts, glow plugs are used to preheat swirl chambers. When current is applied, glow plugs become red hot. A temperature sensor connected to a time circuit in glow plug relay controls pre-heating time.

To start a cold engine, pull out cold start knob to left of steering column (Volkswagen only). Turn ignition switch to glow plug position (No. 2). When light goes out, crank the engine. At below freezing temperatures, depress accelerator pedal while cranking. About 2 minutes after engine starts, push cold start knob in fully.

NOTE: Cold starting device of Audi 4000 and 5000 is automatically controlled by engine coolant passing over a thermostat. When engine is cold, thermostat pulls on advance lever advancing injection timing.

FUEL FILTER

The fuel filter allows unrestricted flow of fuel from the tank to the injection pump, but stops any dirt or water. A replaceable element, similar to an oil filter cartridge, threads onto a removable flange. *See Fig. 3.*

Fig. 3: Components of Fuel Filter

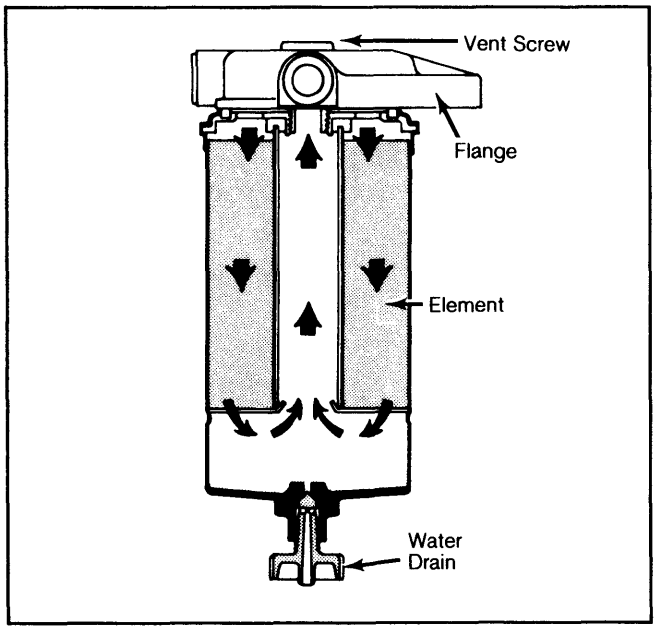


Illustration also shows fuel flow through filter.

To drain water from filter, open vent screw on top of filter flange. If there is no vent screw, disconnect fuel return line at injection pump. Remove flange mounting nuts and lift filter. Open water drain on bottom of filter. Drain until clean fuel runs out. Close water drain and vent screw (or reconnect return line).

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. Once the engine obtains a predetermined maximum RPM, fuel flow can no longer be increased.

TESTING

INJECTION NOZZLES

Preliminary Testing

Injection nozzle problems are usually 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) With the engine running at fast idle, loosen line unions on each injection nozzle one at a time. If engine speed remains constant with a line removed, that nozzle is defective.

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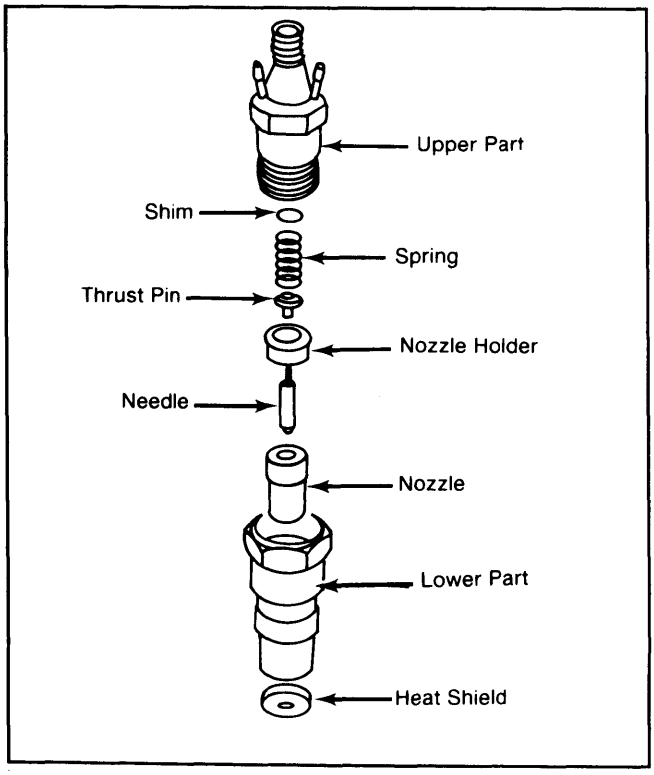
2) To remove nozzle, detach injector line. Use special extra-deep socket (US 2775) to remove injection nozzles. To disassemble, place upper part of nozzle in a vise and loosen lower part. Then reverse position of nozzle in vise and carefully remove internal parts from lower part of nozzle. Do not interchange parts from one injector to another.

3) To install, insert new heat shield with recess pointing upward. Tighten nozzles to 51 ft. lbs. (69 N.m) and lines to 18 ft. lbs (24 N.m). Bleeding is not necessary.

Fig. 4: Exploded View of Injection Nozzle



Spray Formation Test

Isolate special testing gauge (US 1111). Use short rapid strokes of testing pump lever (4-6 strokes per second). Spray should be even and stop cleanly. Nozzles should not drip.

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

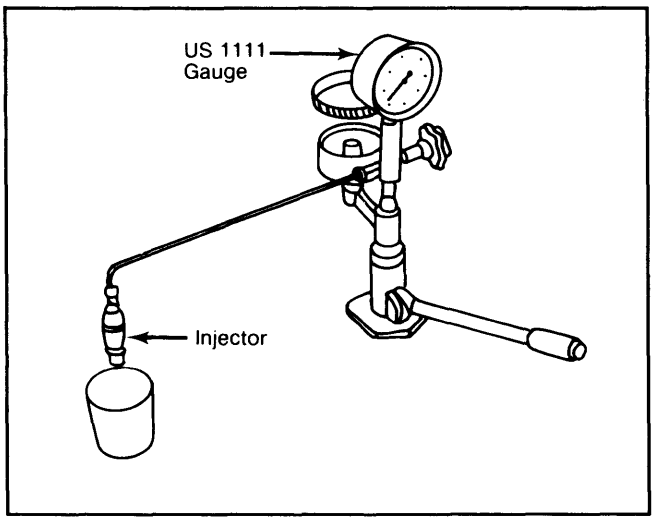
Noise Test

Isolate special testing gauge (US 1111). Use long, slow strokes of testing pump lever (1-2 strokes per second). If nozzle is working properly, it will "ping" as fuel emerges.

Opening Pressure Test

With testing gauge (US 1111) still connected to injector, move pump lever down slowly. Note pressure at which injection nozzle releases fuel. Adjust, if necessary, by changing shims until working pressure reaches 2248-2364 psi (158-166 kg/cm²) for Turbo Diesel models or 1706-1850 psi (120-130 kg/cm²) for all other models. Thicker shims increase pressure, thinner shims decrease pressure.

Fig. 5: Injection Nozzle Test Gauge



NOTE: A shim thickness increase of .0019" (0.05 mm) increases pressure by 71 psi (5.0 kg/cm²). Shims are available in thicknesses of .039-.070" (1.00-1.95 mm) in .0019" (0.05 mm) increments.

Leakage Test

With nozzle connected to gauge, press pump lever down slowly and hold pressure at about 1564 psi (110 kg/cm²) for 15 seconds. No fuel should leak from nozzle tip.

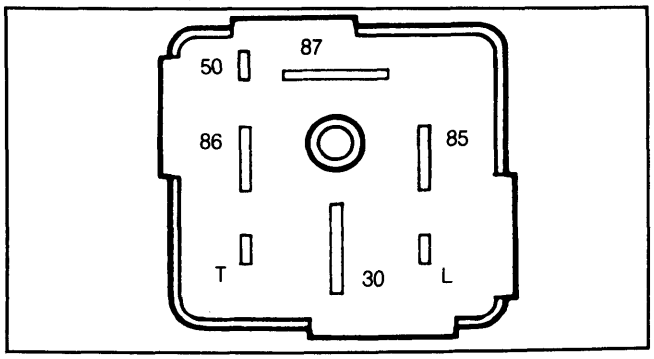
GLOW PLUGS

1) To check glow plug condition, remove glow plug wire and bus bar connector. Connect test lamp between each glow plug and battery positive terminal (one at a time). Test lamp will light if glow plugs are good. If test lamp does not light, replace all glow plugs.

2) To check voltage supply, reconnect wires and bus bar connector. Connect test light between ground and cylinder No. 4 glow plug. Turn ignition switch to glow plug position and lamp should light. If not, check for a defective glow plug fuse located to the left of steering column behind instrument panel.

3) If fuse is OK, check terminal No. 30 of glow plug relay for voltage. If voltage is not present, check for defective relay plate or break in wiring from relay plate terminal No. 30 to relay terminal No. 30.

Fig. 6: Glow Plug Relay Terminals



4) If voltage is present, relay is not working. Connect test lamp to ground and to terminal No. 86 on relay and turn ignition switch to glow plug position. If test lamp lights up, repair connection from terminal No. 85 to ground, or from terminal No. 87 to glow plugs. If terminal connections are okay, replace glow plug relay. If lamp does not light, repair connection from relay plate to relay terminal No. 86, or replace relay plate.

REMOVAL & INSTALLATION

FUEL INJECTION PUMP

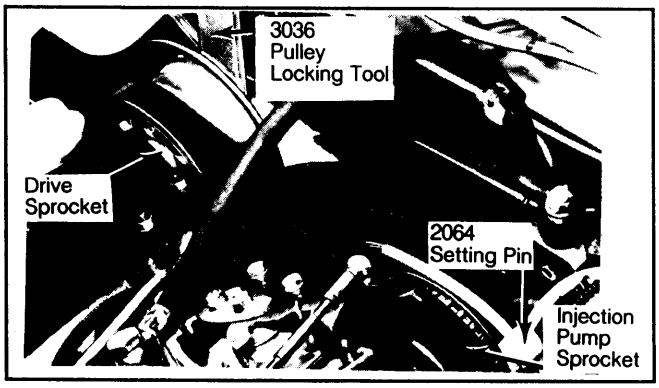
NOTE: When working on an injection system, keep all components clean. Clean injection line unions before loosening.

Removal

1) If injection pump is faulty, it must be replaced. Special test equipment and service tools are necessary for making repairs. For Audi Vehicles, continue to step **2)**. For Volkswagen vehicles, proceed to step **3)**.

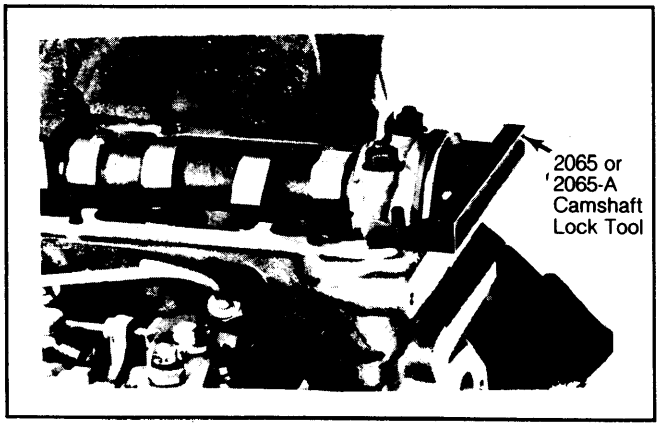
2) For Audi vehicles, remove vacuum pump pulley, and drive belt and injection pump drive belt cover. Set crankshaft at TDC for No. 1 cylinder. Align marks on flywheel and clutch housing, and injection pump sprocket and mounting plate. Install special setting pin (2064) to lock injection pump driven sprocket securely. *See Fig. 7.* Lock vacuum pump belt pulley and injection pump drive sprocket with special pulley locking tool (3036). *See Fig. 7.* Loosen and remove retaining bolt and remove drive sprocket and drive belt. Proceed to step **4)**.

Fig. 7: Locking Injection and Vacuum Pump Pulleys



Audi pulley identification and tool location.

Fig. 8: Camshaft Locking Tool Installation



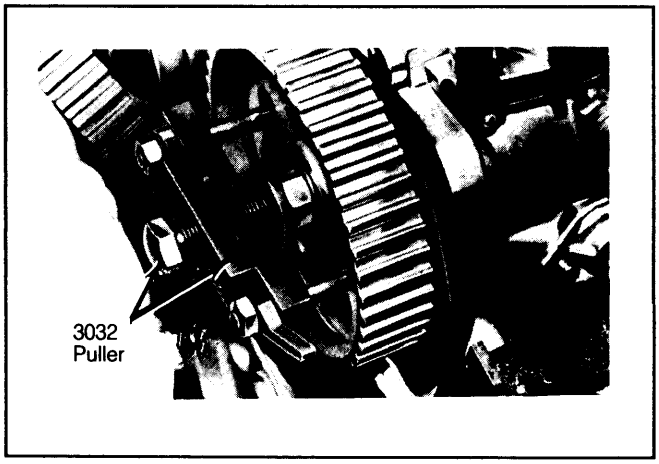
Volkswagen models only.

3) For Volkswagen vehicles, turn engine to TDC on No. 1 cylinder. Lock camshaft with special setting bar (2065 or 2065-A). *See Fig. 8.* Remove drive belt. Proceed to step **4)**.

4) Loosen injection pump driven sprocket retaining nut approximately one turn. On Audi vehicles, remove special setting pin (2064) from pump driven sprocket.

5) Attach puller (VW203B for Volkswagen; 3032 for Audi) to injection pump sprocket and apply light tension to puller. *See Fig. 9.* Tap lightly on puller spindle head until sprocket loosens from pump shaft.

Fig. 9: Fuel Injection Pump Driven Gear Removal



Audi models shown, Volkwagen similar.

6) Remove puller and nut and remove sprocket by hand. Disconnect all fuel pipes from pump. Cover unions with clean cloth. Disconnect wire from fuel shut-off solenoid and detach accelerator cable. On Turbo Diesel models, remove boost pressure intake line from boost pressure enrichment device on injection pump. Support injection pump and remove pump mounting bolts. Carefully remove pump.

Installation

1) Install pump, aligning marks on pump and mounting plate. On Volkswagen models, install injection pump sprocket. Tighten pump mounting bolts and fuel pipes to 18 ft. lbs. (24 N.m).

2) On Audi models, align rear support so it contacts cylinder block and injection pump without tension. Tighten support mounting bolts. Install injection pump sprocket and turn it until marks on sprocket and mounting plate are in line. *See Fig. 10.*

3) On all models, lock pump driven sprocket with special setting pin (2064) and tighten driven sprocket retaining nut to 33 ft. lbs. (45 N.m). *See Fig. 10.* Install drive belt and injection pump drive sprocket. Tighten drive sprocket retaining bolt so that sprocket can still be turned by hand. Check drive belt tension with VW 210 scale. Value should register 12-13 on scale.

4) If not, adjust drive belt tension by loosening bolts and moving mounting plate with pump. Check if TDC mark on flywheel is still aligned with reference mark. Tighten injection pump drive sprocket bolt, using special pulley locking tool (3036), to 72 ft. lbs (98 N.m). Remove

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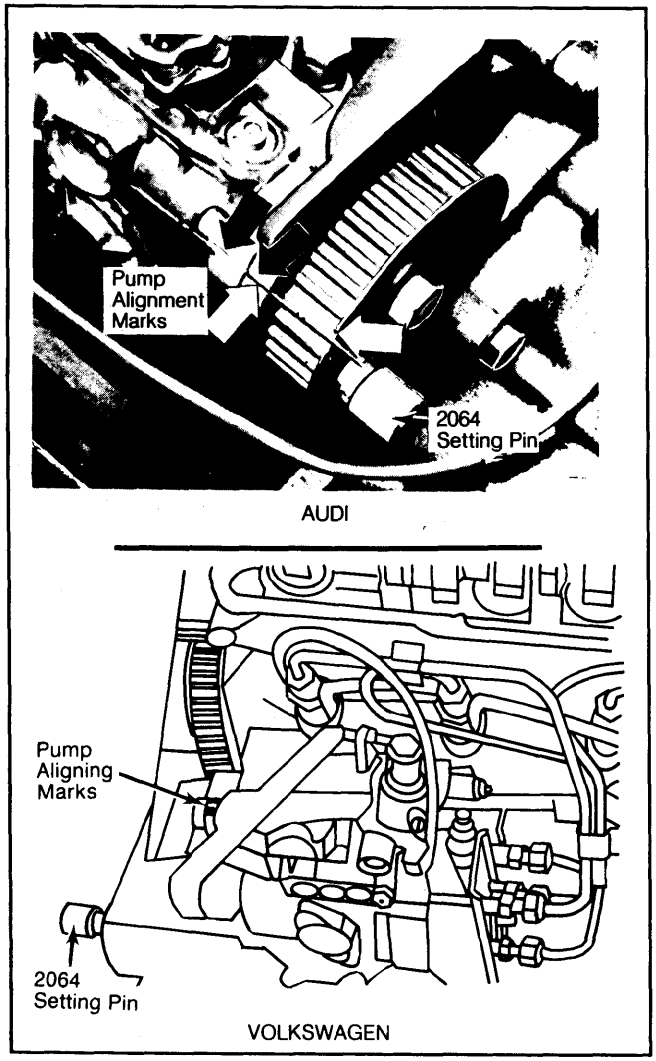
special setting pin and pulley locking tool. Check injection pump/valve timing and injection timing.

5) Reinstall fuel pipes, drive belt cover, and vacuum pump pulley and drive belt. Reattach accelerator cable and wire to fuel shut-off solenoid. On Turbo Diesel models, reinstall boost pressure intake line to boost pressure enrichment device on injection pump.

Fig. 10: Aligning Injection Pump Reference Marks



FUEL FILTER

Service is limited to replacing filter at proper interval and draining water, when present. Bleeding is not required.

ADJUSTMENTS

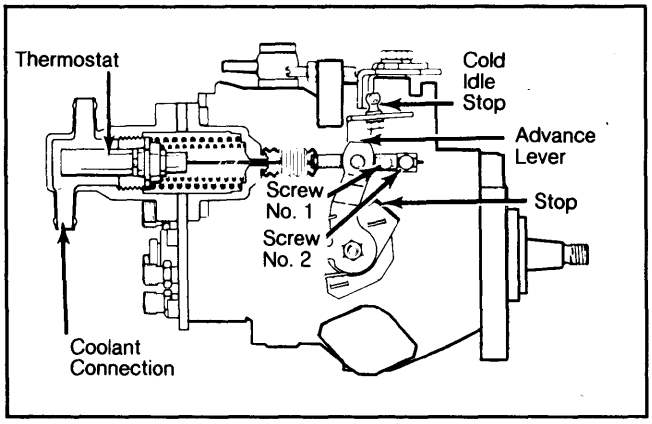
INJECTION PUMP TIMING

NOTE: Before starting timing procedure, check valve timing and drive belt tension. On Volkswagen engines, be sure cold start lever is against stop (toward drive gear on pump).

1) Set crankshaft to TDC on No. 1 cylinder and align marks on flywheel and clutch housing. Check marks on injection pump sprocket and mounting plate.

2) If timing adjustment is necessary, remove plug from injection pump cover and install adapter and dial indicator in place of plug. On Audi models only, loosen cold start device cable by loosening screw No. 1 and turning clamp 90°. *See Fig. 11.*

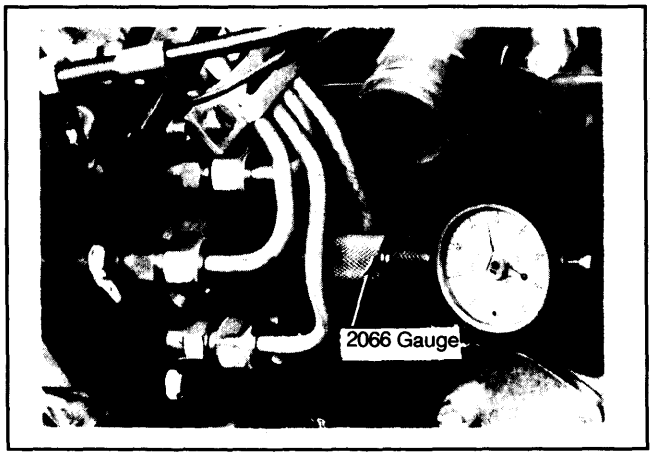
Fig. 11: Loosening Cold Start Device Screw No. 1



CAUTION: Do not loosen screw No. 2 or pump recalibration will be necessary.

3) Preload dial indicator (2066) to .097" (2.5 mm). *See Fig. 12.* Slowly turn engine counterclockwise until dial indicator needle stops moving. Zero indicator.

Fig. 12: Preloading Injection Pump With Dial Indicator



4) Turn engine clockwise until TDC mark on flywheel lines up with reference mark. Check dial indicator reading against specifications.

INJECTION PUMP TIMING SPECIFICATIONS

Application	Dial Indicator Reading
Audi	.036" (.93 mm)
Volkswagen	
Vanagon	.034" (.86 mm)
Quantum	.036" (.93 mm)
Rabbit & Rabbit Pickup	[1] .045" (1.15 mm)

[1] — Only for models with yellow paint mark on pump advance cover. Models without paint mark are .034" (.86 mm).

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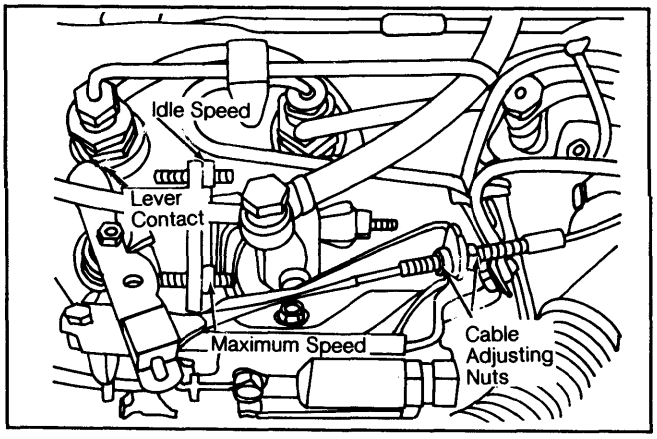
5) If necessary, loosen bolts on mounting plate and support. Turn pump to adjust timing and tighten bolts. Recheck dial indicator readings. On Audi vehicles, turn clamp on cold start device back 90° to original position and tighten screw No. 1.

ACCELERATOR CABLE

Place accelerator pedal in full throttle position. Adjust cable with adjusting nuts until pump lever freely contacts stop. *See Fig. 13.* Be sure ball pin on pump lever is pointing upward and touching end of elongated hole. Accelerator cable should be attached at upper hole in bracket.

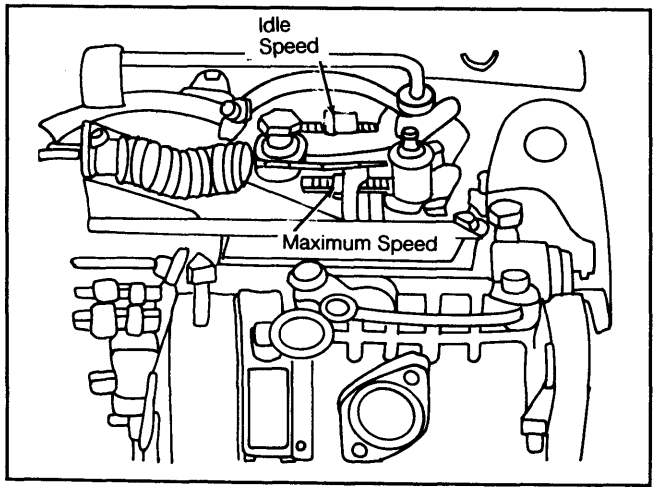
Fig. 13: Accelerator Cable Adjusting Points



COLD STARTING CABLE

On Volkswagen vehicles, insert washer onto cable and install cable into bracket with rubber bushing. Insert cable into pin. Install lock washer and move lever as far as possible in direction of arrow. *See Fig. 14.* Pull cable tight and secure pin with clamping screw.

Fig. 14: Cold Starting Cable Adjustment



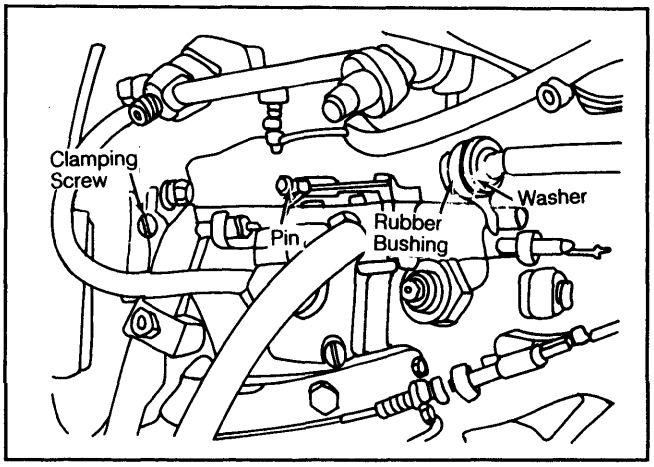
IDLE SPEED

Audi

1) Warm engine to normal operating temperature (oil temperature of 122-158°F or 50-70°C). Turn idle speed control knob on instrument panel counterclockwise to stop.

2) Connect tachometer (VW 1367 or Siemans 451) according to instructions. Adjust idle speed to 720-780 RPM by loosening lock nut, and turning screw in to raise idle speed, or out to lower idle speed. Retighten lock nut. *See Fig. 15.*

Fig. 15: Audi Idle and Maximum Speed Adjustments



Volkswagen

1) Warm engine to normal operating temperature (oil temperature of 122-158°F or 50-70°C). Adjust idle speed to 810-950 on Turbo Diesel models and 800-850 RPM for all other models.

2) To adjust, loosen lock nut and turn screw in to raise idle speed, or out to lower idle speed. Retighten lock nut and seal with paint.

MAXIMUM SPEED

Adjust idle speed to proper setting and then open throttle fully. Maximum speed should be 5050-5150 RPM for Turbo Diesel models, 5350-5450 RPM for all other Audi models, 5300-5400 RPM for all other Volkswagen models except Vanagon, and 4750-4850 for Vanagon models. To adjust, loosen lock nut and turn screw out to raise maximum speed, or in to lower it. Tighten lock nut when adjustment is complete. Seal lock nut and screw with paint.

TIGHTENING SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Camshaft Gear Bolt	33 (45)
Fuel Injection Line Unions	18 (24)
Fuel Injection Pump Gear Nut	33 (45)
Injection Nozzle-to-Socket	51 (69)
Injection Pump Drive Gear	72 (98)
Injection Pump Mounting Bolts	18 (24)
Nozzle (Upper-to-Lower Part)	51 (69)