BOSCH DIESEL FUEL INJECTION – AUDI & VOLKSWAGEN

Audi
5000
Volkswagen
Dasher
Pickup
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 the injection pump, supplies fuel from tank to fuel filter to injection pump. Injection pump supplies fuel to nozzles under high pressure, according to the 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, and an electrical fuel shut-off solenoid. *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).

INJECTION NOZZLES

Bosch DNOSD 193 injection nozzles, mounted in KDA SD 27/4 sockets, inject fuel at 1706-1850 psi (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 a 23:1 ratio. Heat shields protect each injector.

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

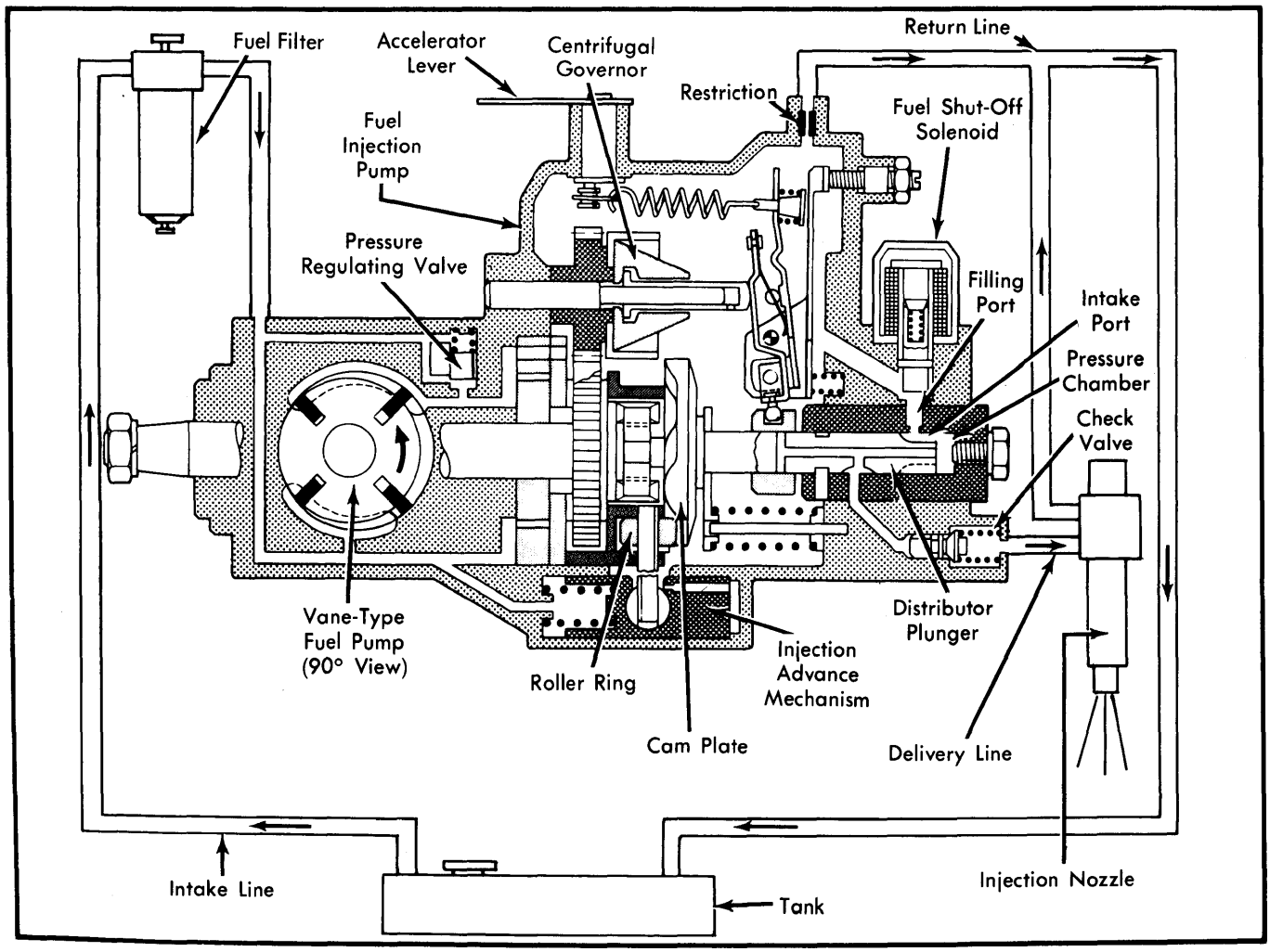

Fig. 1 Diesel Fuel Supply System

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hot. A temperature sensor connected to a time circuit in 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 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.* 2.

To drain water from filter, open vent screw on top of filter flange. If there is no vent screw, remove 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 reattach return line).

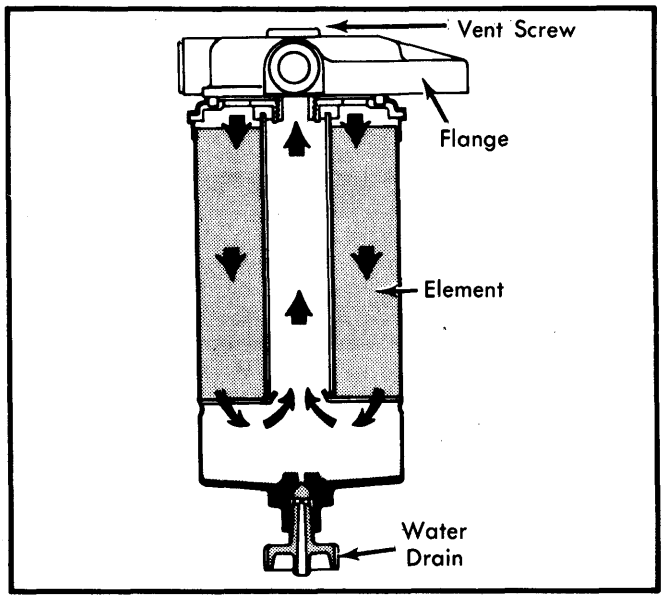

Fig. 2 Components of Fuel Filter

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

Injection nozzle problems 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) 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. Use special tool (US 2775) to remove injection nozzles. To disassemble, place upper part in vise and loosen lower part. Then reverse position and carefully remove parts from lower part. 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.

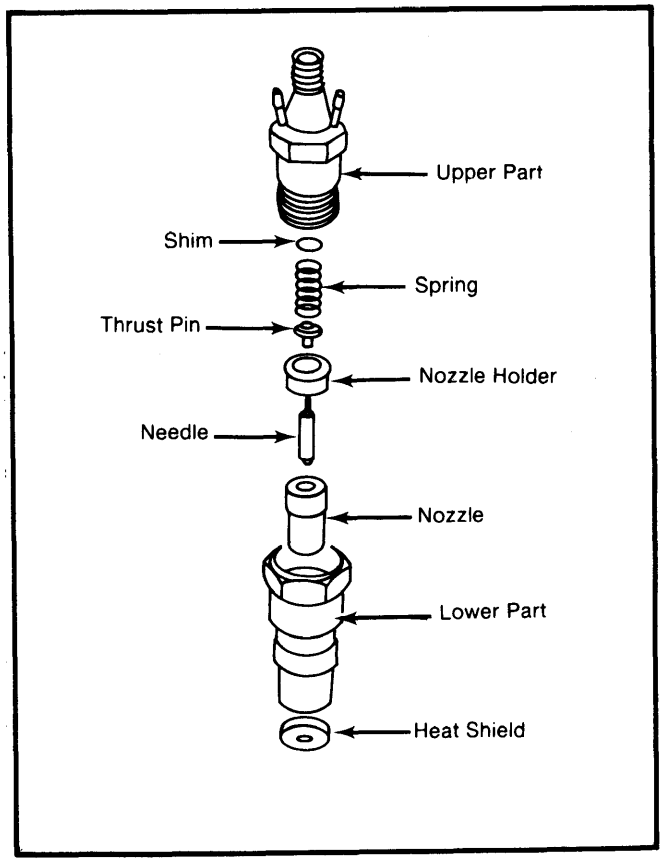

Fig. 3 Exploded View of Injection Nozzle

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Spray Formation Test – Isolate special testing gauge (US1111). 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 working pressure will cause fuel oil to penetrate the skin.*

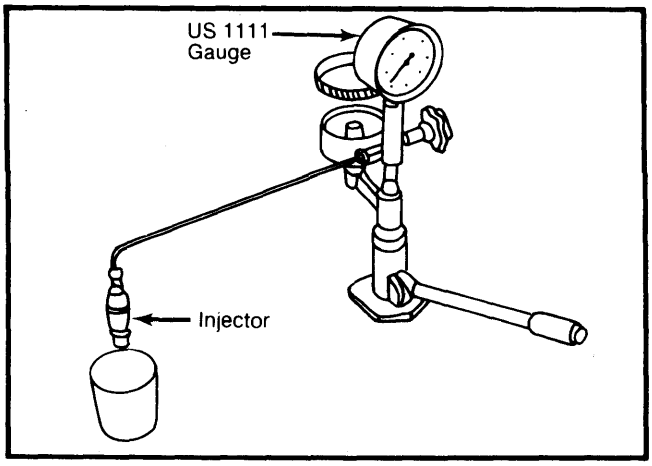

Fig. 4. Injection Nozzle Test Gauge

Noise Test – Isolate 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 gauge (US 1111) working, move pump lever down slowly. Note pressure at which injection nozzle releases fuel. Adjust, if necessary, by changing shims until working pressure reaches 1706-1850 psi (120-130 kg/cm²). Thicker shims increase pressure, thinner shims decrease pressure.

NOTE – *A shim thickness 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 gauge working, 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 glow plugs (one at a time) and battery positive terminal. Test lamp will light if glow plugs are good. If not, 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 the 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.

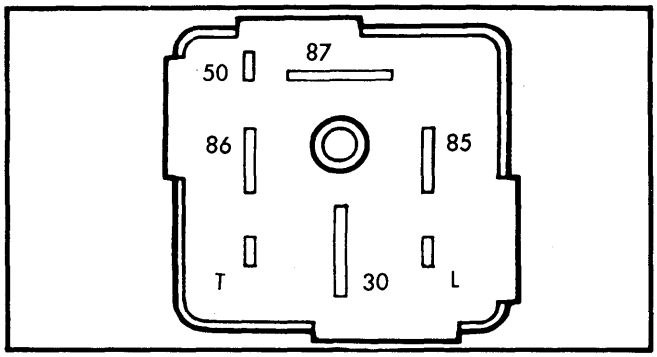

Fig. 5 Glow Plug Relay Terminals

4) If voltage is present, relay is not working. Connect test lamp to terminal No. 86 on relay and turn ignition switch to glow plug position. If lamp lights up, repair connection from terminal No. 85 to ground, or from terminal No. 87 to glow plugs, or replace 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 and align marks on flywheel and clutch housing and injection pump sprocket and mounting plate. Install special tool (2064) to lock injection pump sprocket securely. Lock vacuum pump belt pulley and injection pump drive sprocket with special tool (3036). Loosen and remove retaining bolt and remove drive sprocket and drive belt. Proceed to step **4)**.

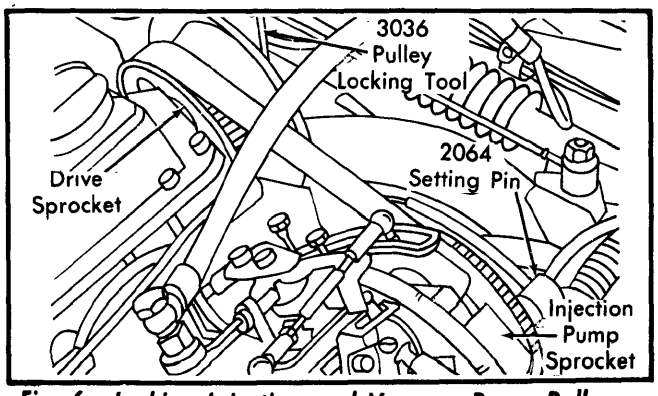

Fig. 6 Locking Injection and Vacuum Pump Pulleys (Audi)

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

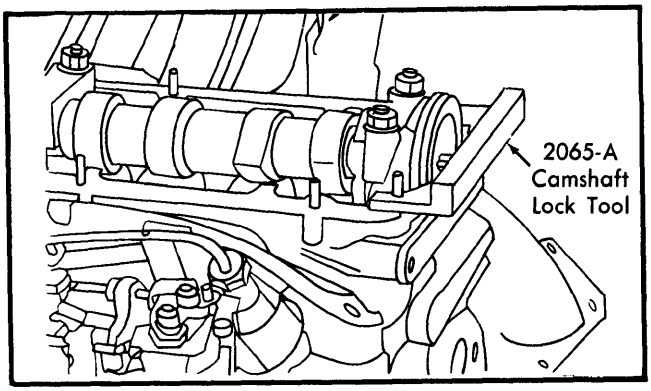

Fig. 7 Camshaft Locking Tool Installation (Volkswagen Shown)

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

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

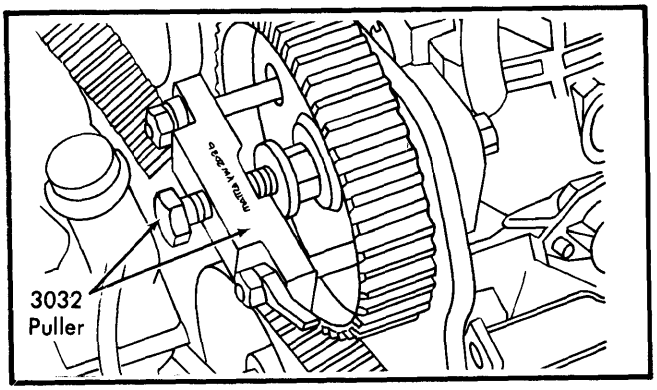

Fig. 8 Fuel Injection Pump Gear Removal (Audi Shown)

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. Remove pump mounting bolts. Support and remove pump.

Installation — 1) Install pump, aligning marks on pump and mounting plate. For Volkswagen vehicles, install injection pump sprocket. Tighten pump mounting bolts and fuel pipes to 18 ft. lbs. (24 N.m) and pump sprocket to 33 ft. lbs. (45 N.m). Adjust injection pump/valve timing and injection timing.

2) On Audi vehicles, align rear support so it contacts cylinder block and injection pump free of tension. Tighten support mounting bolts. Install injection pump sprocket and turn it until marks on sprocket and mounting plate are in line.

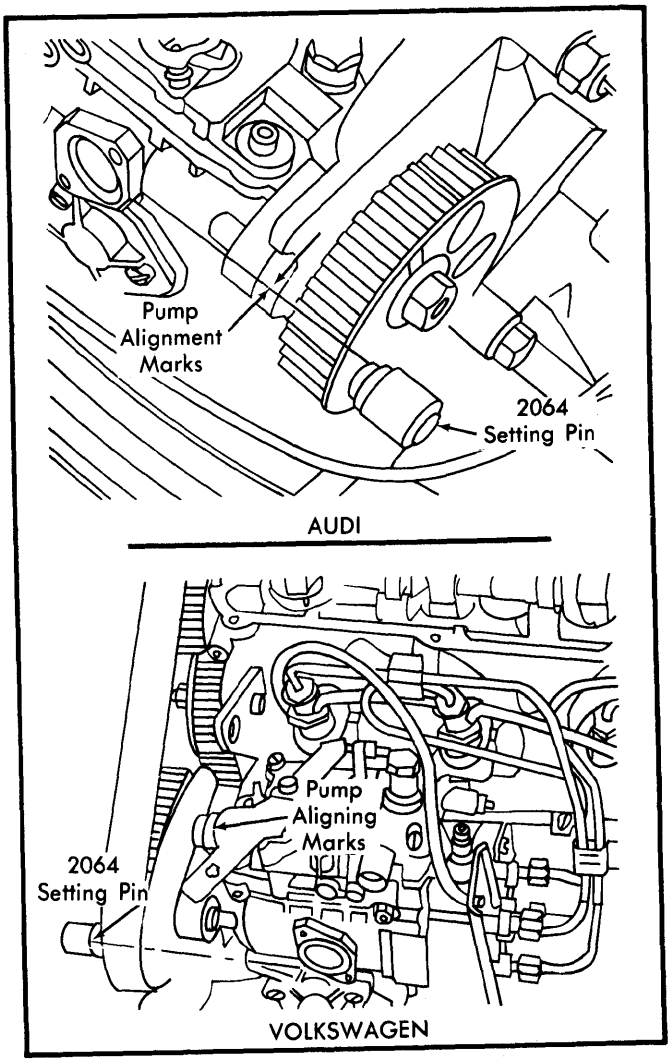

Fig. 9 Aligning Injection Pump Reference Marks

3) Lock pump with special tool (2064) and tighten retaining nut to 33 ft. lbs. (45 N.m). 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 using special tool (3036), tightening bolt to 72 ft. lbs. (98 N.m). Remove special tool (2064). 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.

FUEL FILTER

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

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ADJUSTMENTS

INJECTION PUMP TIMING

All Models (Engine Removed) – 1) Set engine to TDC on No. 1 cylinder. Adjust special tool (2068/A) to 125.5 mm reference mark on Audi, to 112.8 mm mark on Dasher, to 5 mm mark on Rabbit and Rabbit Pickup, and to 100 mm mark on Vanagon. Left notch of vernier scale is reference point. Screw in tool as shown in *Fig. 10*.

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).*

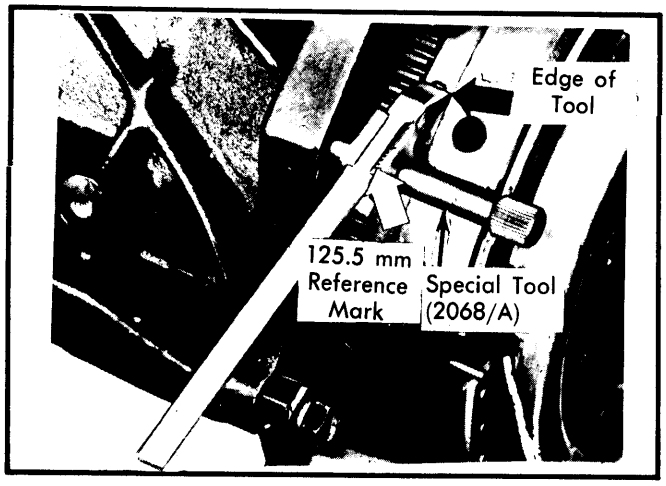

Fig. 10 Adjusting No. 1 Cylinder to TDC With Engine Removed (Audi Shown)

2) Turn crankshaft until TDC mark on flywheel is aligned with edge of special tool (2068/A) at black arrow and marks on injection pump sprocket align with mounting plate.

All Models (Engine Installed) – 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*.

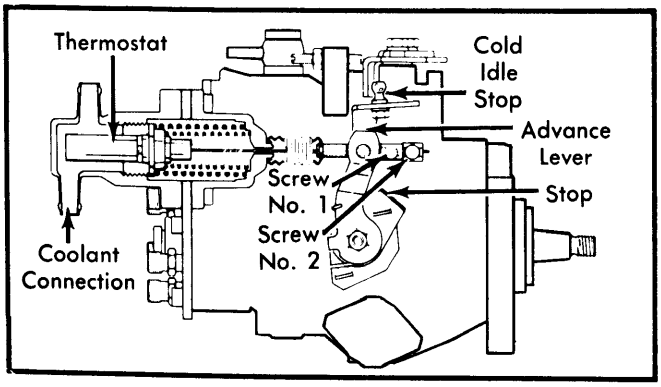

Fig. 11 Loosening Cold Start Device Screw No. 1.

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

3) Preload dial indicator to .097" (2.5 mm). Turn engine slowly counterclockwise until dial indicator needle stops moving. Zero indicator.

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

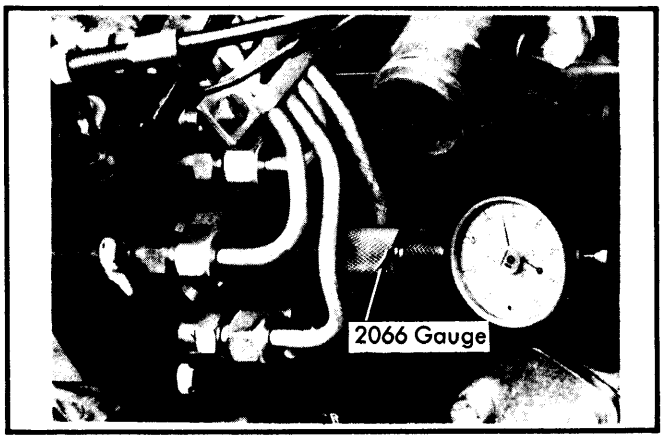

Fig. 12 Preloading Injection Pump With Dial Indicator (2066)

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.

Injection Pump Timing Specifications

Application	Dial Indicator Reading
Audi	.033" (.85 mm)
Volkswagen	
Dasher & Vanagon	.034" (.86 mm)
Rabbit & Rabbit Pickup①	.045" (1.15 mm)

① – Only those models with yellow paint mark on pump advance cover. Models without paint dot, .034" (.86 mm).

ACCELERATOR CABLE

Place accelerator pedal in full throttle position. Adjust cable with nuts until pump lever contacts stop free of strain. 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.

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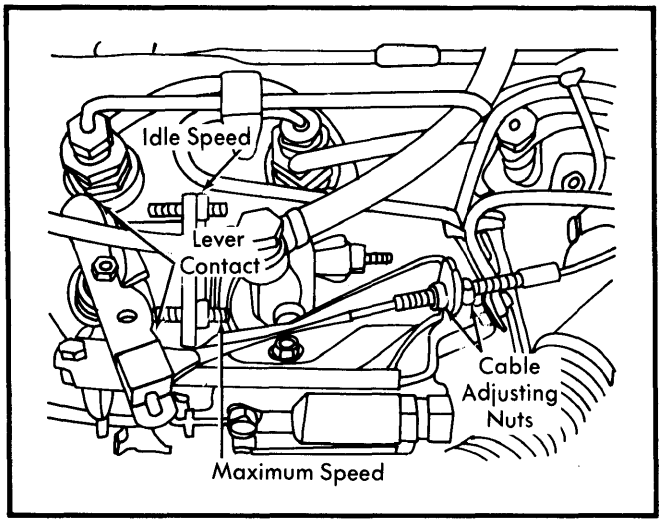

Fig. 13 Accelerator Cable Adjusting Points

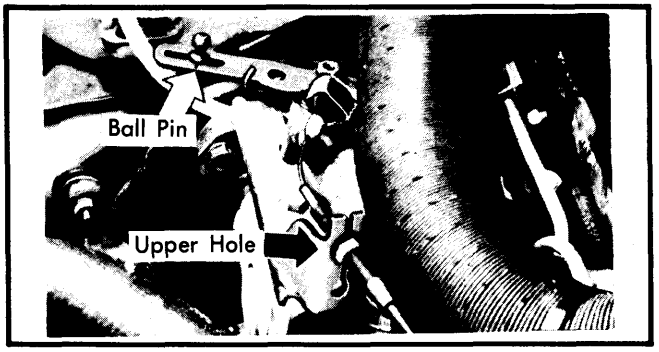

Fig. 14 Accelerator Cable Attaching Points

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. Pull cable tight and secure pin with clamping screw.

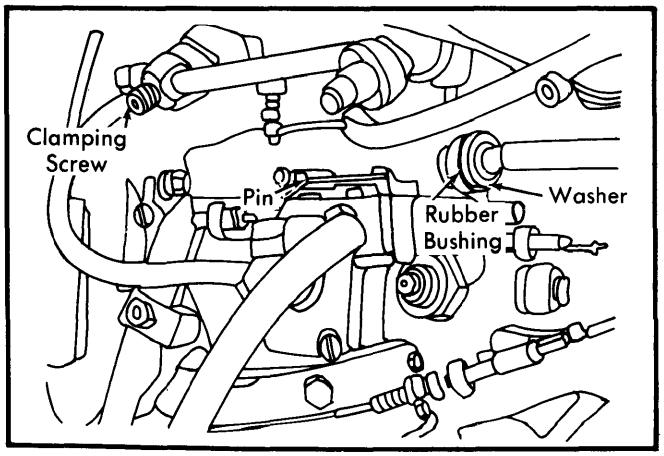

Fig. 15 Cold Starting Cable Adjustment

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 speed to 700-800 RPM by loosening lock nut, and turning screw in to raise idle speed, or out to lower idle speed. Retighten lock nut.

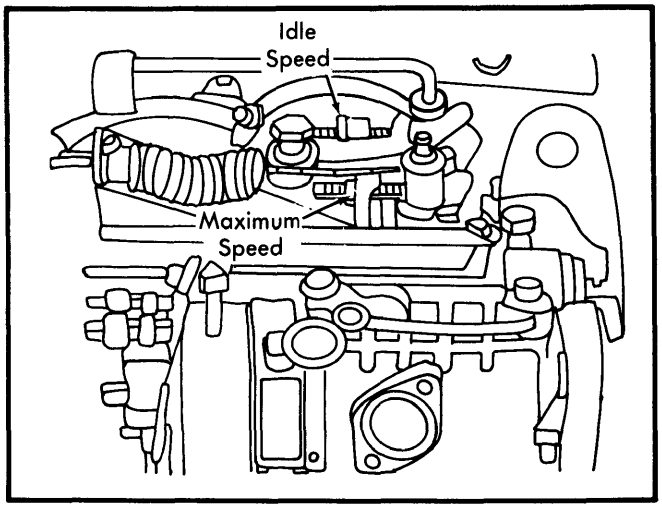

Fig. 16 Idle and Maximum Speed Adjustments (Audi)

Volkswagen – 1) Warm engine to normal operating temperature (oil temperature of 122-158°F or 50-70°C). Adjust idle speed to 925-975 RPM on Dasher, 800-850 RPM for all other models.
2) To adjust, loosen locknut 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 for Audi should be 5350-5450 RPM, for Volkswagen except Vanagon, 5300-5400 RPM and for Vanagon, 4750-4850 RPM. To adjust, loosen locknut and turn screw out to raise maximum speed, or in to lower it. Tighten locknut when adjustment is complete. Seal locknut and screw with paint.

TIGHTENING SPECIFICATIONS

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