## BOSCH DIESEL INJECTION – MERCEDES-BENZ

**240D**
**300D**
**300CD**
**300SD**
**300TD**

### DESCRIPTION

The fuel injection system used on Mercedes diesel models includes the following components:

- Pre-Filter and Main Filter
- Fuel Injection Pump with mechanical governor
- Altitude Compensating Device
- Vacuum Control Shut-off Unit
- Injection Nozzles
- Glow Plug System

### OPERATION

Fuel is pumped from fuel tank, through a pre-filter and main fuel filter into suction chamber of injection pump. Pump's camshaft operates injection pump plungers, which force fuel through delivery valves, reverse-flow dampening valves, and pressure lines to fuel injection nozzles.

#### FUEL INJECTION PUMP

All engines use the same type of injection pump, though 5-cylinder models have one more pump element. Turbo models have a connection from the turbocharger to the altitude compensator which allows that unit to enrich the mixture during boost operation.

The vacuum shut-off unit stops fuel delivery when the key is turned off. If it fails, a manual "STOP" lever is provided on the side of the pump. A mechanical fuel pump draws fuel from the tank and supplies it to the high pressure section of the injection pump. The pump is lubricated by engine oil.

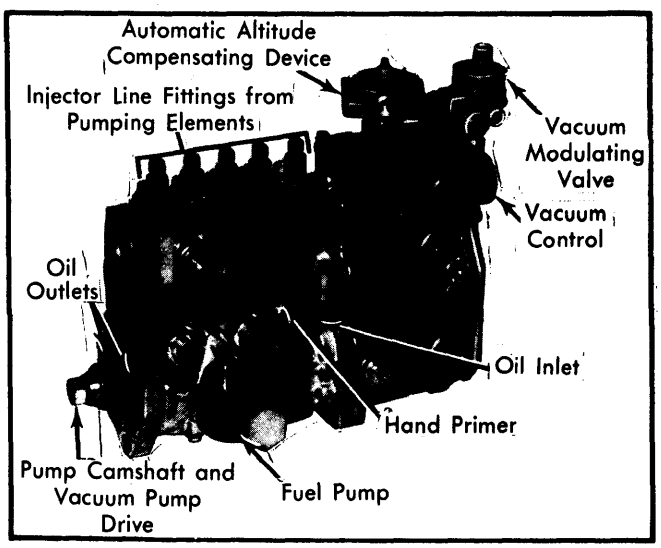


***Fig. 1 Fuel Injection Pump Components***

#### GOVERNOR

The governor controls idle and maximum RPM. Internal design enables the governor to have no effect on pump operation during normal operating speed range, when the accelerator is directly connected to the injection pump fuel rack. The altitude compensator does modify injection slightly during this range, compensating for air pressure variations with altitude.

Through governor action, engine RPM is held constant at idle speed, regardless of engine operating conditions – cold engine, air conditioner operation, power steering, or automatic transmission. At 5000-5100 RPM, governor limits RPM by pulling main rack back, until balance exists between engine RPM and fuel delivery.

#### AUTOMATIC ALTITUDE COMPENSATING DEVICE

Governor is equipped with an altitude compensating device to control emissions at various altitudes. On Turbo engines the device is connected to the intake manifold to sense boost pressure variations as well.

As altitude increases, air pressure decreases, the push rod in the compensator moves downward and pushes the main rack, slightly decreasing the amount of fuel injected (leans out the mixture). When Turbo models are operating under boost, the rack is pushed in the other direction and more fuel is injected. Injection pump and governor operation are not affected by the compensator when the vehicle is operating near sea level (except Turbo) or idle RPM.

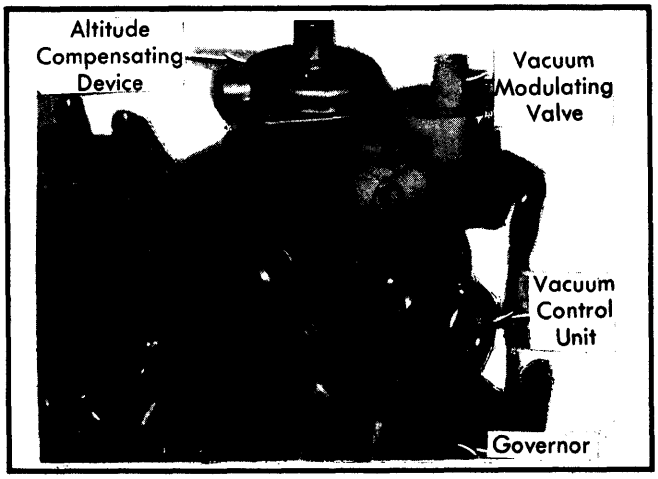


***Fig. 2 Altitude Compensation & Vacuum Units***

#### MAIN FUEL FILTER

The main fuel filter is a disposable cartridge which is screwed onto the filter assembly. After filter is replaced, system must be bled of air.

#### INJECTION NOZZLES

Injection nozzles are used to spray fuel into the cyinders under the proper pressure and spray pattern for optimum combustion. Nozzles can be disassembled for cleaning and adjustment of opening pressure.

#### GLOW PLUG SYSTEM

All engines are equipped with pin-type glow plugs which are connected in parallel. The parallel connection allows glow plugs to operate independently of each other and provides 11 volts to each plug during the preglow process. A dual material

## BOSCH DIESEL INJECTION – MERCEDES-BENZ (Cont.)

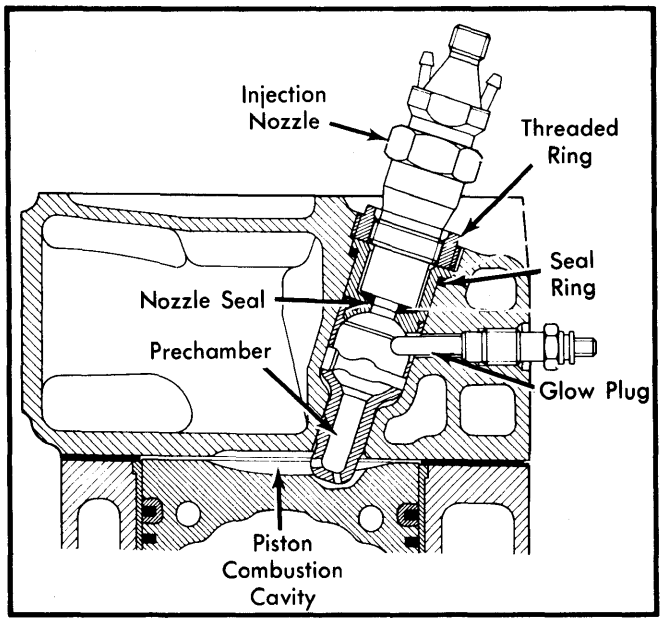


***Fig. 3 Cross Section of Cylinder Head***

heating element which consists of a heating coil and a control coil has allowed the heating process to be shortened to 5-7 seconds at 32°F (0°C).

NOTE – *This type plug is called the "Quick-Preglow" plug and is identified by a brass hexagon. It must not be interchanged with glow plugs used in previous models.*

The glow plugs are grounded directly to the cylinder head through plug body. Each receives separate power directly from preglow time relay (total initial current draw is approximately 200 amperes).

The preglow time relay is located on the left inner fenderwell. The relay is protected by an 80A fusible link, mounted outside on the cover of the relay. The relay contains a temperature sensitive resistor which replaces the coolant temperature sensor used with previous relays.

A safety cutout in the relay turns off glow plug power 20-35 seconds after the glow plug light goes off when no attempt has been made to start the engine. This keeps battery drain to a minimum and protects the glow plugs.

A switch in the relay is triggered if one or more glow plugs fail. This turns off the indicator lamp and signals a need for repair. The indicator will normally come on for at least one second even if engine is warm.

### OVER-BOOST PROTECTION (TURBO MODELS ONLY)

Turbo models are equipped with an over-boost protection circuit, consisting of a pressure switch, switch-over valve and wiring. When boost pressure exceeds 16 psi (1.12 kg/cm$^2$), the pressure switch closes, grounding the switch-over valve. The valve vents manifold pressure which would otherwise affect the aneroid compensator on the injection pump. This reduces the quantity of fuel injected and engine speed.

## TROUBLE SHOOTING

### INTERMITTENT BLACK SMOKE

Uneven nozzle operation. Opening pressures, nozzle seals and poor injection pipe sealing.

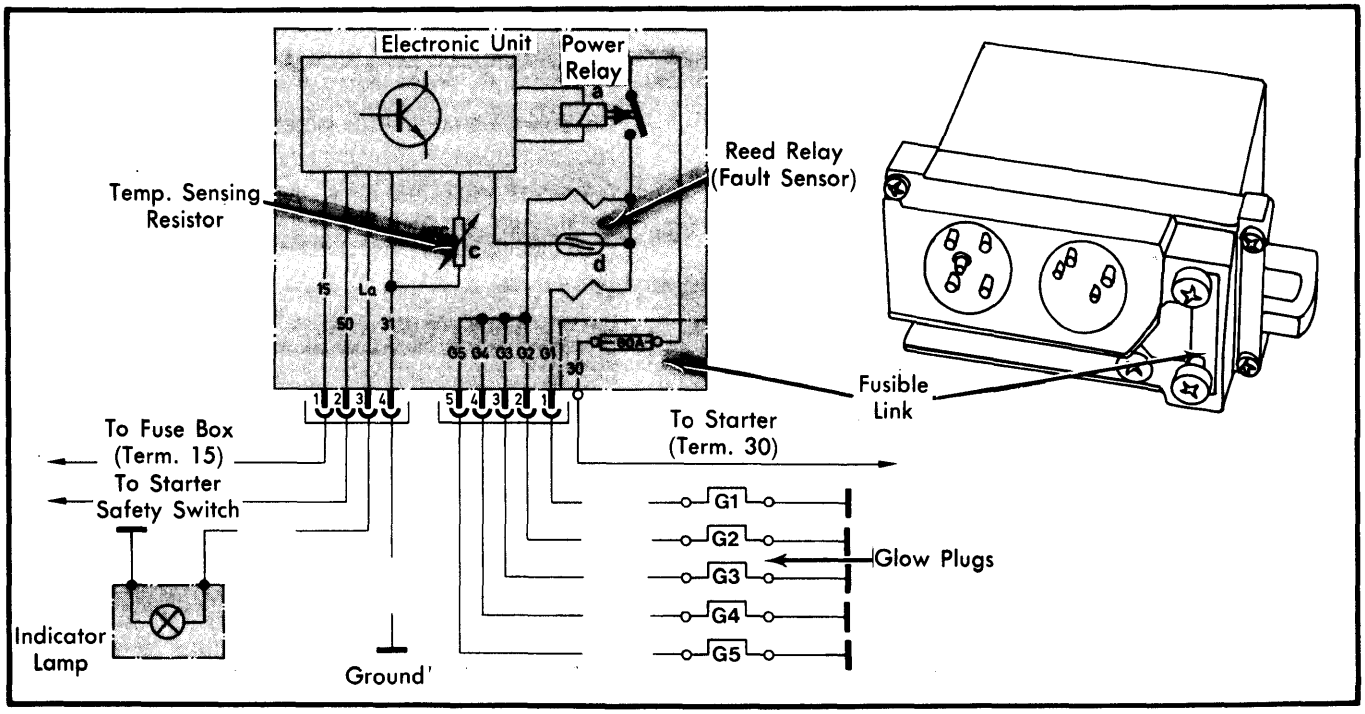


***Fig. 4 Glow Plug Relay & Wiring Diagram***

## BOSCH DIESEL INJECTION – MERCEDES-BENZ (Cont.)

### KNOCKING SOUND

Incorrect fuel. Injection pump delivery timing. Valve adjustment. Nozzle spray pattern and opening pressures. Reverse flow dampening valves. Poor compression.

### ENGINE DOES NOT STOP

Defective vacuum control unit. Vacuum valve in ignition lock. Poor connections or vacuum leaks.

### GLOW PLUG INDICATOR DOES NOT LIGHT ENGINE STARTS

Burned out bulb. Broken wire to indicator.

### GLOW PLUG INDICATOR DOES NOT LIGHT ENGINE WILL NOT START

Fusible link burned out. Defective preglow relay.

### GLOW PLUG INDICATOR DOES NOT LIGHT ENGINE STARTS WITH DIFFICULTY & MISSES

Glow plug in cylinder No. 1 defective or broken wire. One or more of glow plugs in cylinders 2 through 4 or 5 defective.

### GLOW PLUG INDICATOR LIGHTS ENGINE STARTS WITH DIFFICULTY & MISSES

One or more of glow plugs in cylinders 2 through 4 or 5. (Indicator may light if just 1 glow plug is defective. Disconnect 2 glow plugs and retest. If no light, preglow relay is okay).

## TESTING

### FUEL PUMP

**Delivery Pressure Check** – 1) Install pressure tester between main fuel filter and injection pump (Bosch Part No. 000 589 49 21 00). Check for air bubbles in fuel and bleed filter and tester until no bubbles are present.

2) With engine idling, pressure should be 8.5-11.4 psi (0.6-0.8 kg/cm$^2$). With engine at 3000 RPM, pressure should be 11.4 psi (0.8 kg/cm$^2$). If not, check by-pass valve in pump or for damaged fuel lines.

3) During pressure checks, watch for bubbles in sight glass tube on tester. If bubbles appear, check system carefully for leaks. Repair or replace fittings, hoses and clamps as necessary.

4) Check delivery end (final) pressure. Clamp fuel return hose closed and see how high pressure builds. At idle, pressure should be at least 15.6 psi (1.1 kg/cm$^2$); at 3000 RM pressure should be at least 18.5 psi (1.3 kg/cm$^2$).

5) If pressures are not correct, clean or replace by-pass valve or fuel pump.

### INJECTION NOZZLES

1) At idle, loosen each injection pipe cap nut (in turn) one-half turn. If sound of engine does not change, part of problem is a defective nozzle or inadequate sealing between pipe union and nozzle holder.

2) Raise engine RPM above idle speed and repeat test procedure. If engine still does not run erratically with nut loosened, repair or replace that particular nozzle. If engine runs erratically when nut is loosened, nozzle is operating properly. Tighten one-half turn and check next nozzle.

3) Remove each injection nozzle and check opening pressure using injection nozzle tester. Spray patterns should be even and fine. If nozzle spurts or sprays drops, replace it.

4) After determining opening pressures, pump pressures up slowly until it is 280 psi (19.7 kg/cm$^2$) BELOW opening pressure. Nozzle should not leak or drip for 10 seconds.

NOTE – *Nozzle opening pressure can be adjusted by changing shims. Increasing shim thickness by .002" (.05 mm) will increase injection pressure by about 45 psi (3 kg/cm$^2$). Shims are available in thicknesses from .039-.070" (1.0-1.8 kg/cm$^2$) in increments of .002" (.05 mm).*

5) When replacing nozzles, always install new seal between nozzle and prechamber. Tighten nozzles carefully to specified torque.

**Injection Nozzle Opening Pressures①**

| Application | psi (kg/cm$^2$) |
|---|---|
| Turbo Models | |
| New | 1960-2075 (135-143) |
| Used | 1740 (120) |
| Non-Turbo Models | |
| New | 1670-1785 (115-123) |
| Used | 1450 (100) |

① – Maximum pressure variation in one engine cannot exceed 71 psi (5 kg/cm$^2$).

## REMOVAL AND INSTALLATION

### FUEL INJECTION PUMP

**Removal** – 1) Remove battery and battery frame. Clean pump and fuel lines to prevent entrance of dirt into system. Disconnect all injection, vacuum, fuel and oil lines at injection pump. Plug injection lines and fuel hose unions at pump.

2) Remove connecting rods and cable from pump. On Turbo models, unscrew upper part of oil filter. Remove all engine oil lines at the filter body, then remove filter body from crankcase. Ensure no gasket parts fall into crankcase.

3) On all models, remove 4 hex head bolts at supporting bracket, adjustment bolt, and 3 mounting bolts. Remove injection pump rearward.

## BOSCH DIESEL INJECTION – MERCEDES-BENZ (Cont.)

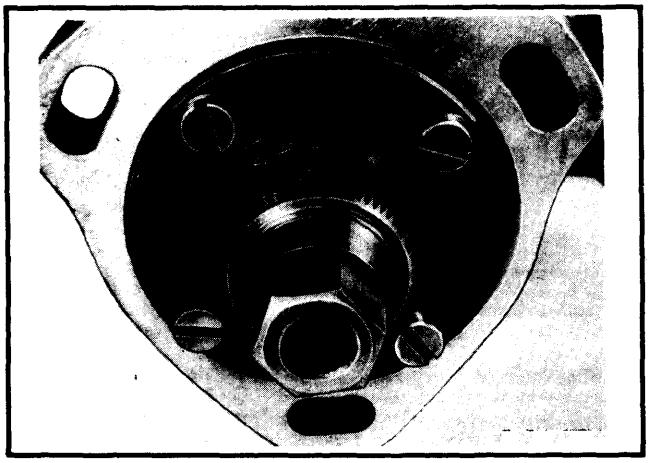

*Fig. 5 Injection Pump Mark Alignment*

**Installation** – 1) Remove plug on side of pump and add ½ pint engine oil for initial lubrication. Move throttle lever to full throttle stop. Vacuum valve rod should be adjusted so operating lever has .020" (.5 mm) clearance from lever stop. See *Fig. 11*.

2) Attach supporting holder to new pump and turn crankshaft to 24° BTDC. Using new gasket, install pump with shaft and flange marks aligned. See *Fig. 5*.

3) Adjust injection pump timing, then tighten mounting bolts. Install oil and fuel lines, then reinstall oil filter base and filter. Bleed fuel system.

### FUEL LINE FITTINGS

**Removal & Installation** – 1) If leakage occurs between pipe connection fitting (union) and injection pump adjusting plate, install new seals with "grooved" fittings. DO NOT loosen adjusting plate, or pump recalibration will be necessary.

2) Install new copper gasket whenever fittings are removed. Grooved end of valve carrier should be installed downward. Install other components, then oil fittings and install, tightening smoothly.

3) Install injection lines and operate primer pump until by-pass valve is heard to open. Operate engine and check for leaks.

### FUEL FILTER

**Removal & Installation** – 1) Replace filter every 30,000 miles. Loosen mounting bolt and pull downward on element and lower housing. See *Fig. 6*.

2) Install new lower housing and element. Tighten mounting bolt. Loosen hollow bolt and operate hand pump (on side of injection pump) until fuel emerges free of bubbles.

3) Retighten hollow bolt and pump until by-pass valve in injection pump opens, signalled by buzzing sound. Start engine and check for leaks.

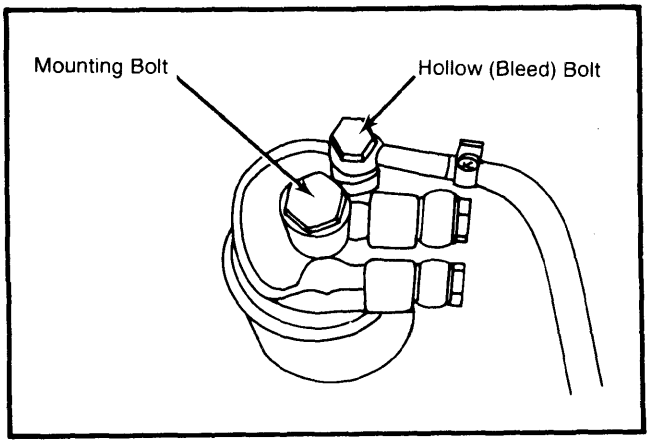


*Fig. 6 Fuel Filter Replacement*

### VACUUM CONTROL UNIT

**Removal** – 1) Unscrew lower right-hand mounting screw from vacuum control unit. See *Fig. 7*.

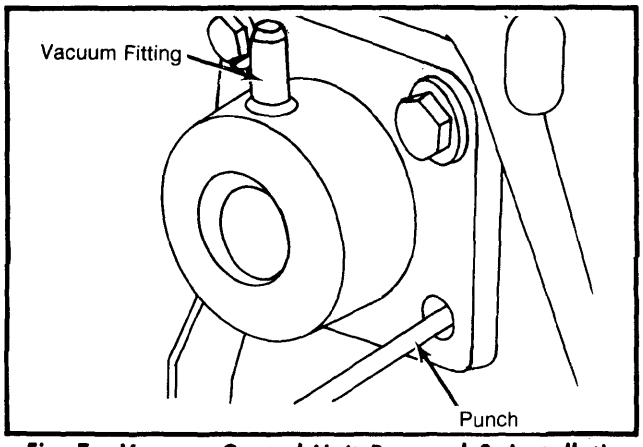


*Fig. 7 Vacuum Control Unit Removal & Installation*

2) Depress "stop" lever on cylinder head cover. Measure position of main rack by inserting punch into screw bore until it touches main rack. Mark this position on punch.

3) Unscrew remaining three mounting screws and remove control unit.

**Installation** – 1) Install new gasket and steel ring. Make sure tang on vacuum control unit engages in main rack. Install last three mounting screws removed.

2) Insert punch in lower right-hand screw bore. Check main rack position with mark on punch. When punch touches main rack, press lightly on punch and move control lever on injection pump from "stop" position to "full load" stop. Punch must follow the main rack smoothly. If correct, install remaining screw.

### AUTOMATIC ALTITUDE COMPENSATING DEVICE

NOTE – *Do not attempt to remove upper cover of governor housing. Governor linkage is assembled to altitude compensating device.*

## BOSCH DIESEL INJECTION – MERCEDES-BENZ (Cont.)

**Removal** – Hold altitude compensating device by small nut while turning large nut. Unscrew device and remove shims. See *Fig. 8*.

**Installation** – Using previously removed shims, screw compensating device into place. Be sure vent tube is positioned at lowest point to drain off any possible condensation. Hold small nut and tighten large nut.

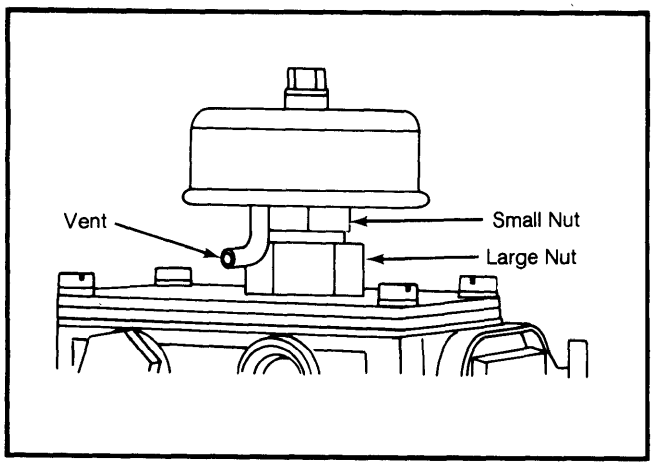


***Fig. 8 Altitude Compensating Device Removal***

## ADJUSTMENTS

### INJECTION PUMP TIMING

1) Turn crankshaft in direction of normal rotation until No. 1 cylinder is in compression stroke and 24° BTDC mark is aligned with pointer.

2) Clean pump connections. Remove vacuum hoses from pump. Remove No. 1 injection line, then unscrew pipe connection and remove compression spring and pressure valve. Leave pressure valve carrier and copper gasket in place. See *Fig. 9*.

CAUTION – *Do not unscrew element connection below pipe connection or pump recalibration will be necessary.*

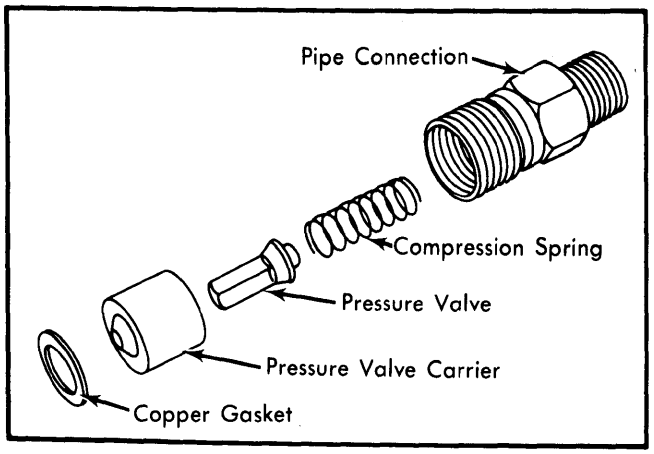


***Fig. 9 Injection Pump Pipe Connection Fittings***

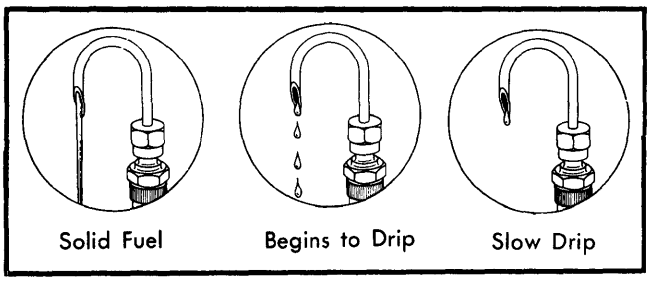


***Fig. 10 Checking Overflow Pipe Fuel Flow***

3) Reinstall pipe connection and install overflow pipe. Rotate crankcase to 24° BTDC on compression stroke of first cylinder. Open vent or hollow screw on fuel filter and use hand pump to pump fuel until it comes out of overflow pipe.

NOTE – *Place throttle lever at full-throttle position while adjusting pump timing and checking overflow.*

4) Rotate crankshaft until fuel just stops dripping. One drop should fall about 3 seconds later. Note position on crankshaft pulley and adjust pump position so injection stops at 24° BTDC.

5) Turn crankshaft 2 full turns and check that fuel dripping stops with pump and crankshaft marks in correct position. Tighten pump bolts. Remove overflow pipe and install pressure valve, spring and pipe connection. Tighten fitting to 29-36 ft. lbs. (39-49 N.m) in one smooth motion.

6) Install injection line and bleed fuel system. Run engine and check for leaks. If fitting leaks, replace pipe connection and copper gasket under pressure valve carrier.

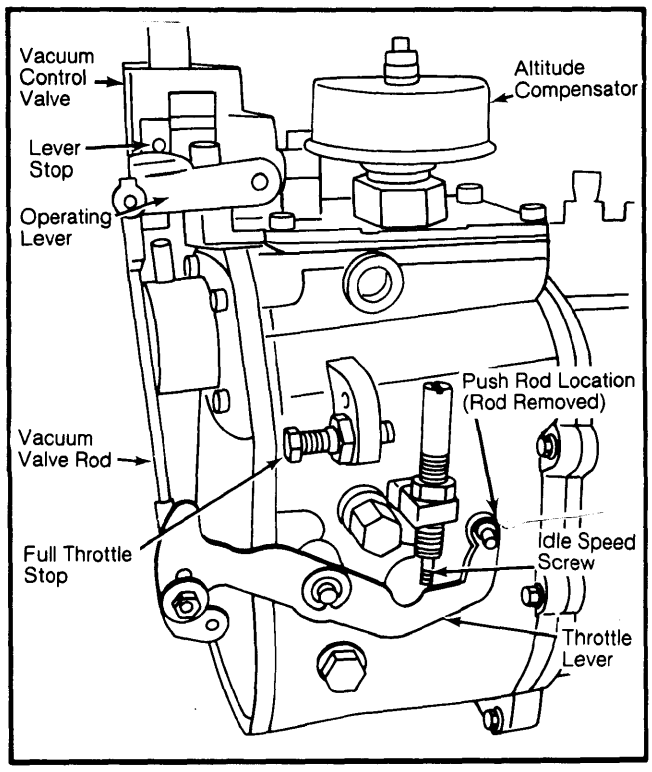


***Fig. 11 Injection Pump Adjustment Locations***

## BOSCH DIESEL INJECTION – MERCEDES-BENZ (Cont.)

### IDLE SPEED

1) Warm engine to normal operating temperature. Turn idle speed knob in dashboard clockwise to stop (if equipped). Disconnect push rod on throttle lever. *See Fig. 11.*

2) Adjust idle speed to 700-800 RPM using idle speed screw. Adjust push rod so no pressure is exerted against "Stop" lever and throttle lever is against idle speed screw. Reconnect push rod.

### MAXIMUM SPEED

Adjust full throttle stop screw so maximum engine speed does not exceed 4900-5200 RPM.

### TIGHTENING SPECIFICATIONS

| Application | Ft. Lbs. (N.m) |
|---|---|
| Rocker Arm Cover | 3.6 (5) |
| Glow Plugs | 36.0 (49) |
| Nozzle-to-Holder | 54.0 (73) |
| Nozzle Holder-to-Head | 54.0 (73) |
| Nozzle Holder Connector | 54.0 (73) |
| Injection Pump Shaft Nut | 50.6 (69) |
| Connecting Fitting (Union) | 29.0-39.0 (39-49) |
| Injection Pipe Cap Nuts | 18.0 (24) |