BOSCH DIESEL INJECTION – MERCEDES-BENZ

Mercedes-Benz
240 Series
300 Series

DESCRIPTION

Fuel injection system consists of the following components. See *Fig. 1:*

- Pre-filter
- Main Fuel Filter
- Fuel Injection Pump with Fuel Pump
- Mechanical Centrifugal Governor
- Automatic Altitude Compensating Device
- Vacuum Control Unit
- Injection Nozzles
- Glow Plugs
- Key-starting System

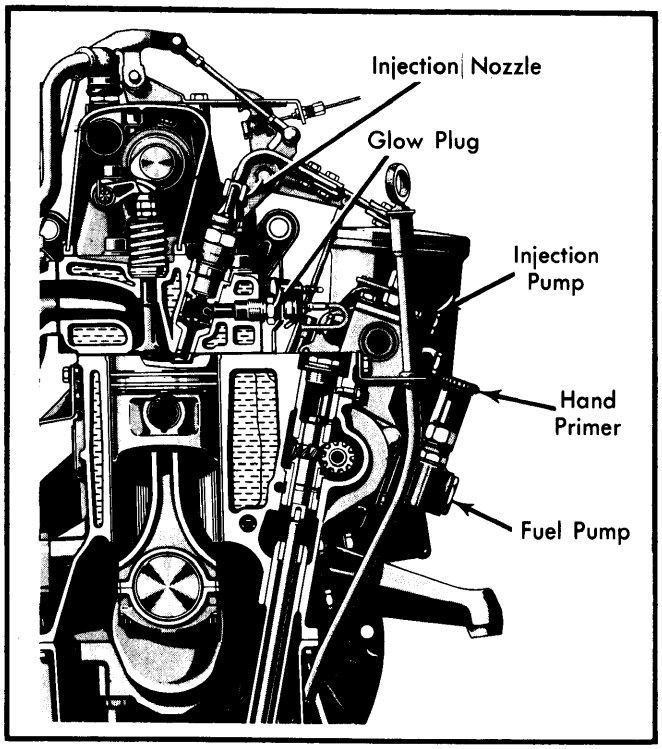

Fig. 1 Components of Typical Bosch Diesel Fuel Injection System for Mercedes-Benz

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.

When pressure stroke is completed, spring-loaded valves close pressure lines. Plungers return to original position.

TESTING

Manufacturer recommends that ALL tests be conducted on an injection pump test stand, using tests sheets furnished by manufacturer.

SYSTEM COMPONENTS

FUEL INJECTION PUMP

Injection pumps used on 240 and 300 series diesel engines are similar. See *Fig. 2*. The major difference is the number of pumping elements, five on the 300 series and four on the 240D – one for each cylinder.

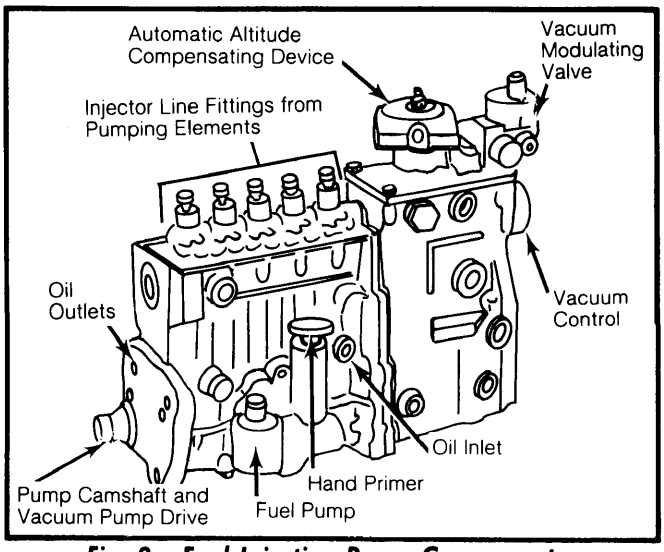

Fig. 2 Fuel Injection Pump Components

Built-in mechanical centrifugal governor has eliminated need for previously-used throttle valve in intake manifold. Engine shut-off is achieved by vacuum control unit. Pumps are lubricated by engine lubrication system. Note oil inlet and outlets. See *Fig. 2*.

An automatic altitude compensating device has been added to governor housing to meet exhaust emission standards at varying altitudes.

Fuel pump, attached to fuel injection pump, is driven by injection pump camshaft and features a hand primer pump.

Injection pumps featuré new control levers, full load stop screws and idle adjusting screws. See *Fig. 3*. On the 240D engine, control pressure rod for automatic transmission is connected to end of control lever. See *arrow in Fig. 3*.

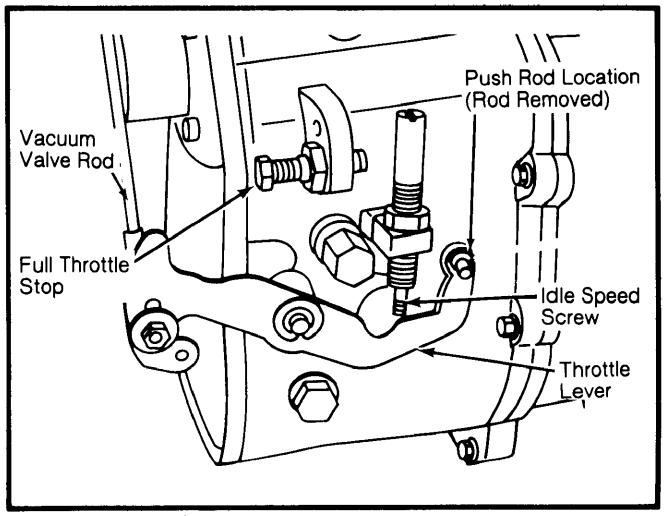

Fig. 3 Control Lever and Adjusting Screws

BOSCH DIESEL INJECTION – MERCEDES-BENZ (Cont.)

GOVERNOR

Governor is an idle-maximum RPM control. *See Fig. 4.* Springs are designed and adjusted so no regulating takes place in intermediate range except for compensation. Between idle and maximum RPM cutout, main rack is operated only by accelerator pedal. Pedal is connected, through linkage, with fulcrum lever of governor.

When engine RPM increases, flyweights move outward as soon as centrifugal force exceeds spring pressure. Movement of flyweights is transmitted through the angle lever, adjusting screws and control lever to main rack.

When reaching maximum RPM, main rack is moved toward the cutout position, reducing the amount of fuel and limiting engine RPM. As engine RPM decreases, the function is reversed.

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.

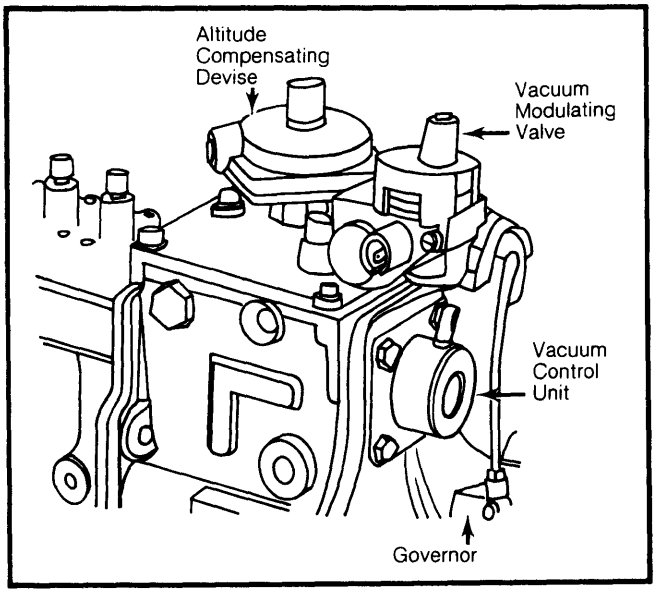

Fig. 5 Automatic Altitude Compensating Device and Vacuum Control Unit

AUTOMATIC ALTITUDE COMPENSATING DEVICE

Governor is equipped with an automatic altitude compensating device to control exhaust emissions at varying altitudes. On the 300SD (turbocharged engine) models, this aneroid is equipped with an inlet from the intake manifold to sense increased (boosted) manifold pressure. *See Figs. 5 and 6.*

With increasing altitude, atmospheric pressure is decreased. This causes two aneroid (non-fluid) compensators to expand. At specified atmospheric pressure, internal force of compensators becomes greater than pretension of aneroid compression spring. Push rod moves downward, moving linkage. This causes main rack to move in direction "d", allowing less fuel to be injected. During increased manifold pressures on 300SD engines, the pressure in the aneroid cavity is increased causing the compensator and main rack to move in opposite direction, allowing more fuel to be injected while turbocharger boosts engine compression. *See Fig. 6.*

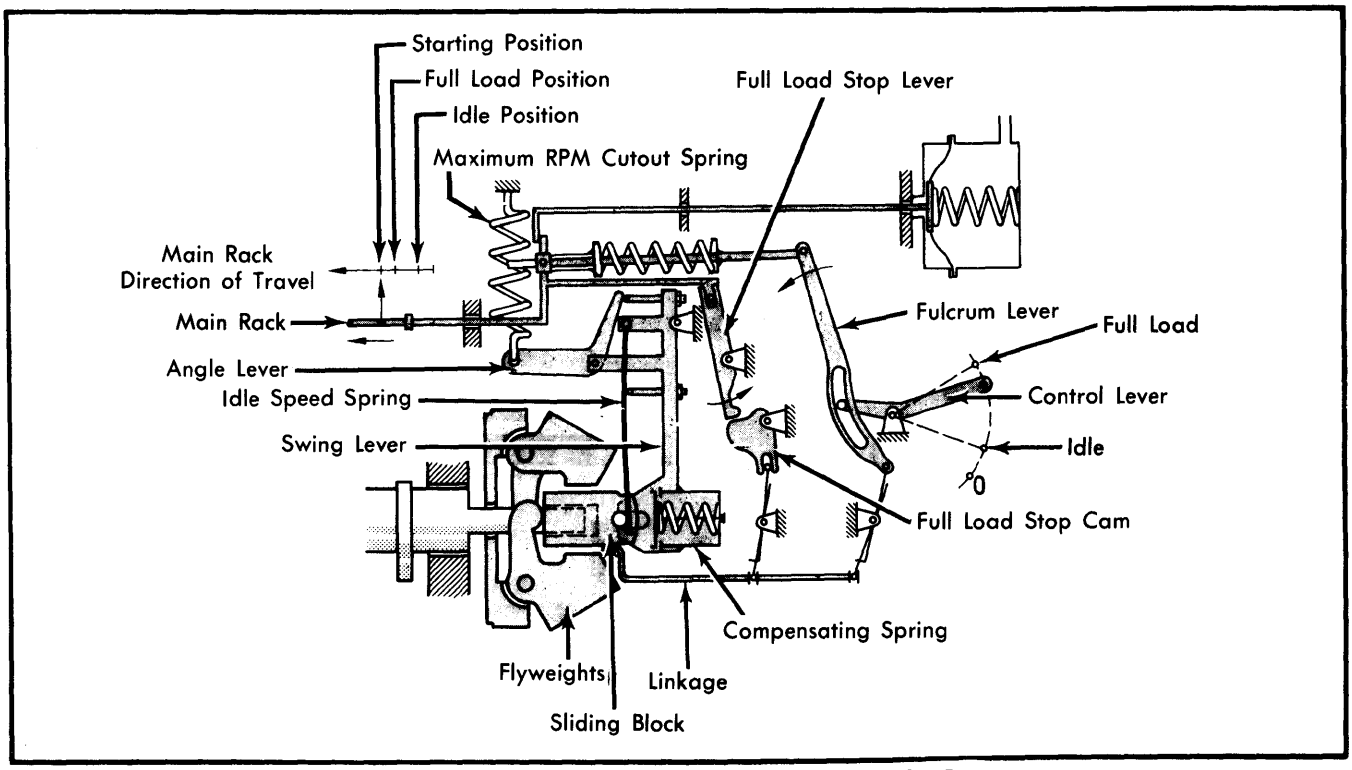

Fig. 4 Typical Governor Linkage for Mercedes-Benz (Start Position Illustrated)

BOSCH DIESEL INJECTION – MERCEDES-BENZ (Cont.)

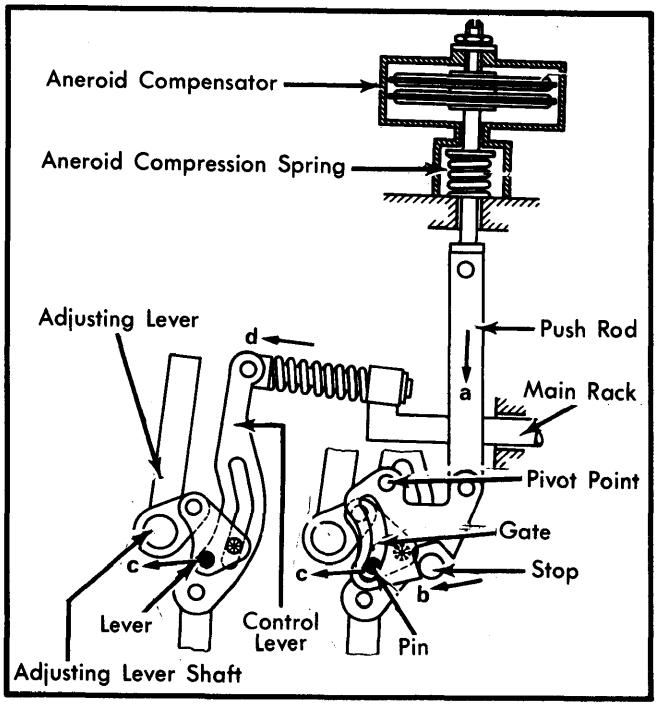

Fig. 6 Diagram of Automatic Compensating Device and Linkage

As adjusting lever moves closer to idle stop, compensating adjustment in partial load range is gradually reduced. At idle it is almost completely eliminated. At low altitudes, governor settings are not affected by compensators.

MAIN FUEL FILTER

Main fuel filter is composed of a throwaway-type filter element, which is part of lower filter housing. *See REMOVAL AND INSTALLATION.*

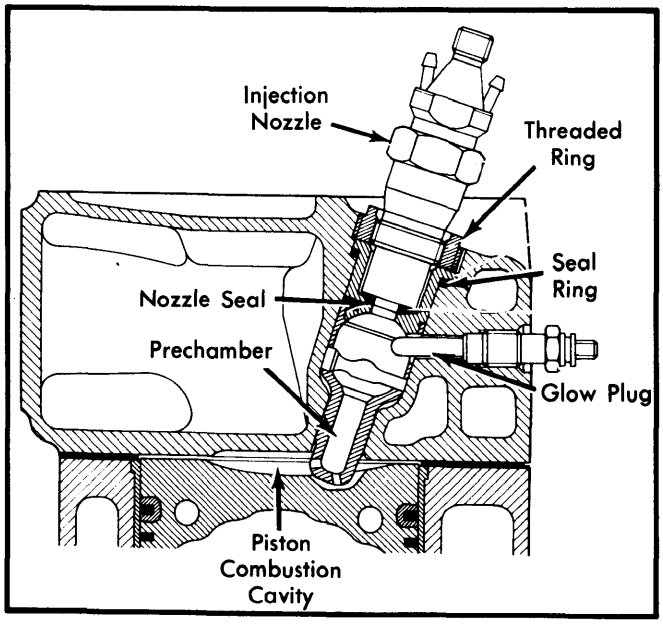

Fig. 7 View Showing Injector, Glow Plug and Prechamber

INJECTION NOZZLES

Injection nozzles are used to spray fuel into the cylinder under the proper pressure and spray pattern for optimum combustion. *See Fig. 7.*

PRE GLOW 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 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). *See Fig. 8.*

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.*

These 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 fender of engine compartment. This relay is protected by an 80 ampere fusible link mounted on its cover. It is equipped with a safety cutout circuit to turn off preglow current if no attempt to start vehicle is made within 40-60 seconds after turning ignition to position "2, Preglowing".

Certain malfunctions of preglow system are indicated through preglow indicator light on instrument panel as follows:

1) Preglow light blinks for approximately 30 seconds with ignition switch in position "2" – Main power circuit is interrupted. Blown 80 ampere fusible link or defective power relay in preglow time relay.

2) Preglow light fails to light but engine can be started – Inspect preglow indicator light circuit and check for open in circuit between temperature sensor and preglow time relay.

3) Preglow light blinks for approximately 30 seconds after engine is started – Disconnect 8-pin plug from preglow time relay and measure ohms between engine ground and harness terminals leading to glow plugs. High or infinite ohm reading indicates open in glow plug, cable to glow plug or terminal connections.

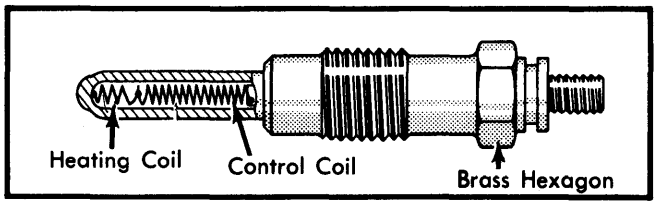

Fig. 8 Quick Preglow Pin-Type Glow Plug

ENGINE SHUT-DOWN (All Models)

To shut off engine, turn key to position "1" or "0". A cam-operated valve, attached to starter switch opens, connecting the vacuum line from the vacuum pump to the injection pump. *See Fig. 11.*

BOSCH DIESEL INJECTION – MERCEDES-BENZ (Cont.)

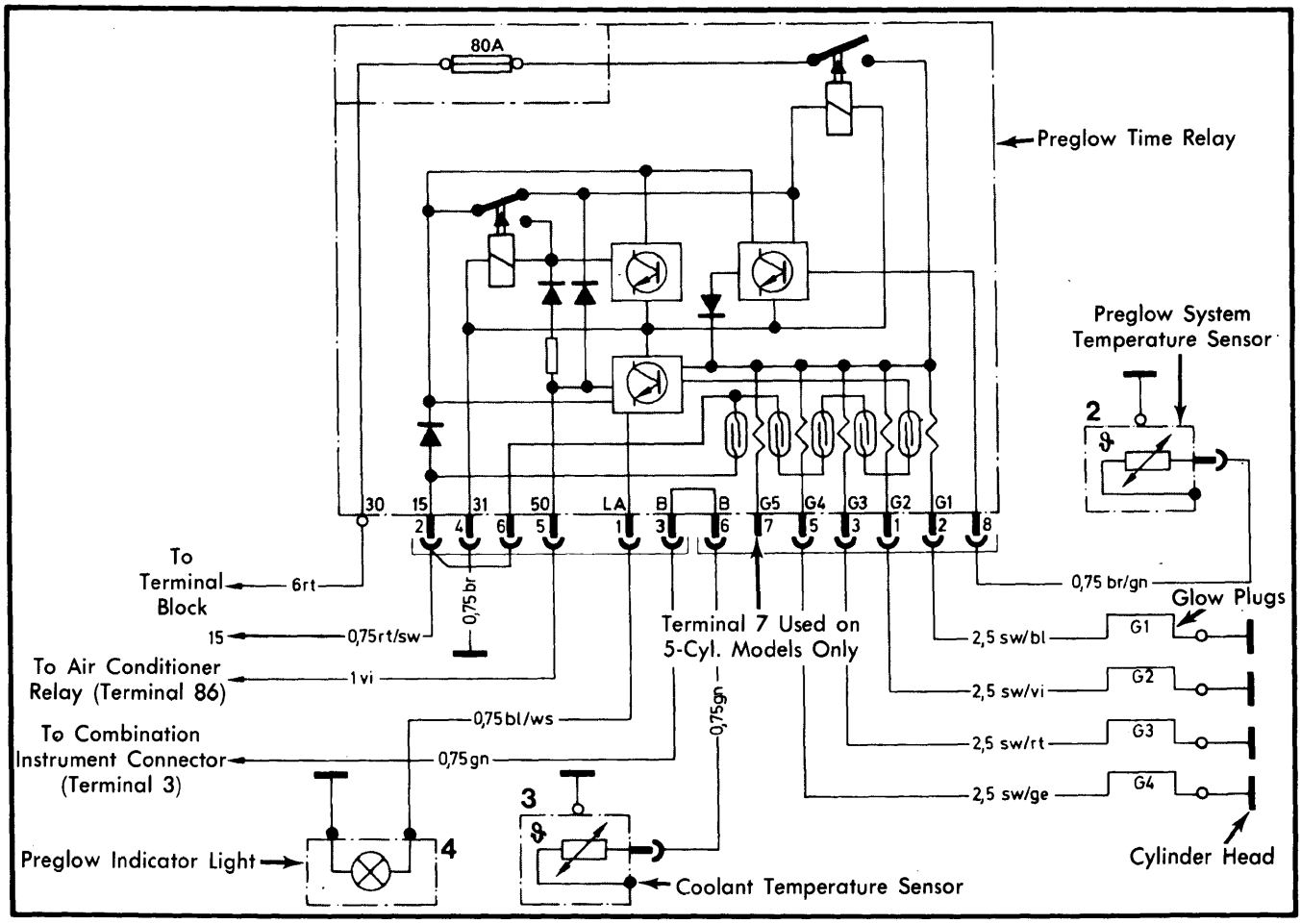

Fig. 9 Wiring Diagram of "Quick-Preglow" System

Diaphragm of pump-mounted vacuum control unit reacts, pulling main rack to "stop" position.. If engine fails to stop, push "stop" lever on cylinder head. This manually moves main rack to "stop" position. *See REMOVAL AND INSTALLATION, VACUUM CONTROL UNIT and Fig. 10.*

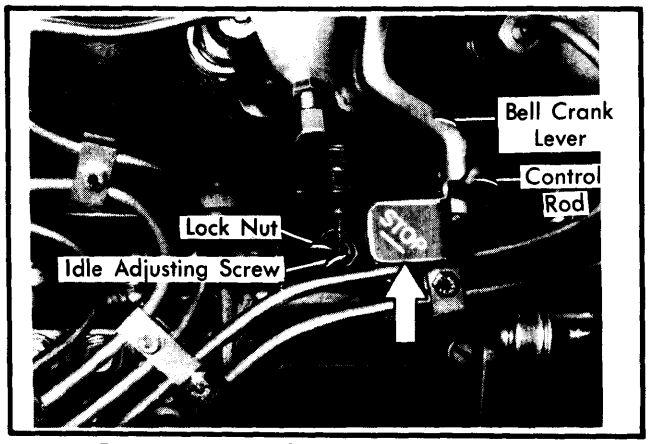

Fig. 10 Manual "Stop" Lever Controlling Injection Pump Main Rack

Starting Lock Position

To lock engine, so vehicle cannot be started by towing or coasting downhill, remove key or turn key to position "1" or "0". Vacuum control unit will then pull main rack to "stop" position.

REVERSE FLOW DAMPENING VALVE

The disc-type reverse flow dampening valve is crimped into place above each delivery valve compression spring. Valves permit free fuel flow toward injection nozzles, opening in direction of nozzles.

Closing needle valve in nozzle causes a pressure wave to return toward injection pump. Since delivery valve is already closed, pressure wave would normally return to injection nozzle and open it briefly again. This would cause higher HC content of exhaust gases.

Pressure wave is eliminated, however, by orifice in dampening valve disc, preventing secondary injection.

SERVICING COMPONENTS

INJECTION NOZZLES

If exhaust gives off intermittent clouds of black smoke, this usually means one or more nozzles are operating unevenly. If exhaust offers a rumbling noise, it usually indicates one cylinder is partly or completely out of action. To determine problem, check injection nozzles as follows:

BOSCH DIESEL INJECTION – MERCEDES-BENZ (Cont.)

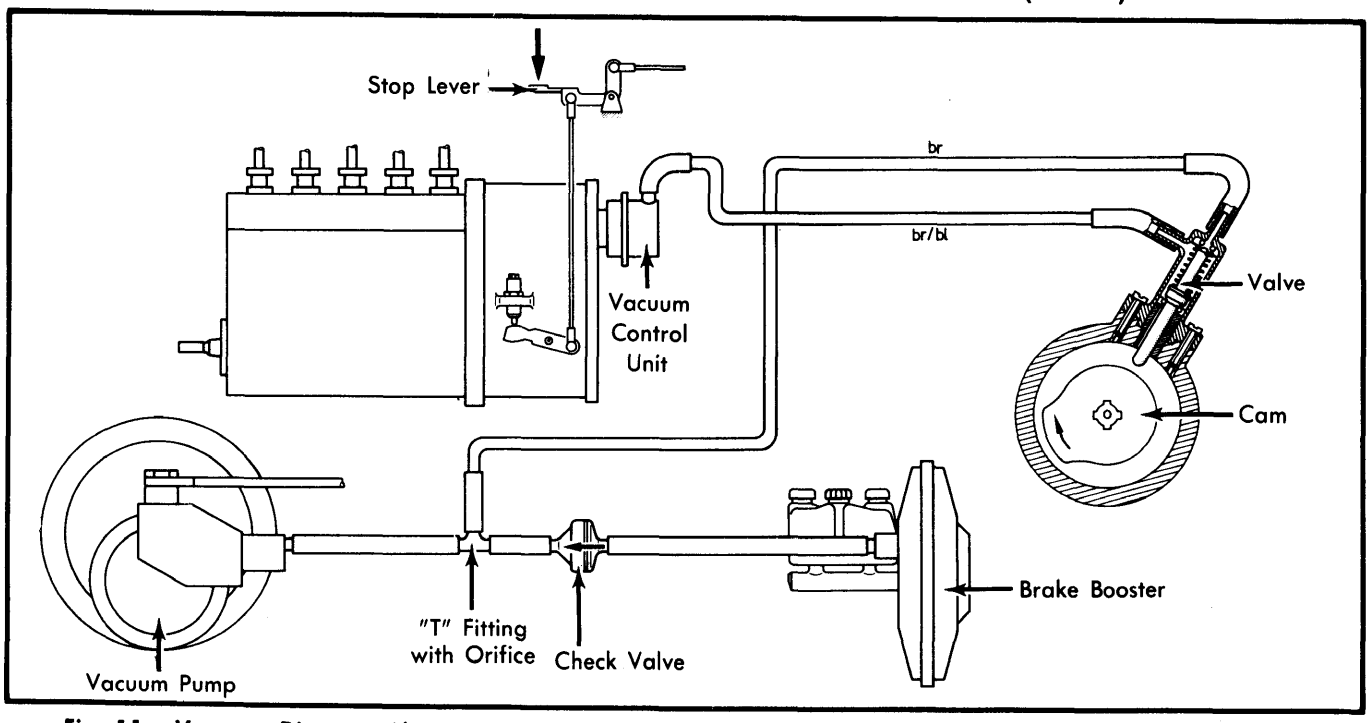

Fig. 11 Vacuum Diagram Showing Vacuum Pump, Valve, and Vacuum Control Unit on Injection Pump

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.

Nozzle Opening Pressures

The DNOSD 240 nozzles used on unsupercharged engines should have an opening pressure of 1668-1784 psi (115-123 kg/cm²) for new nozzles and at least 1450 psi (100 kg/cm²) for used nozzles. Turbocharged models use DNOSD 2400 nozzles with opening pressure of 1958-2074 psi (135-143 kg/cm²) for new nozzles and at least 1740 psi (120 kg/cm²) for used nozzles. Difference in opening pressures in one engine should not exceed 71 psi (5 kg/cm²).

When testing injection nozzles, the most important factors in order of importance are:

- Correct nozzle opening pressure setting.
- Tightness of valve seat to minimum 280 psi (19.7 kg/cm²) below opening pressure of nozzle.
- Correct spray pattern.

Always install new seal between nozzle and prechamber. Tighten nozzles to specified torque. Use accurate torque wrench so seals and nozzles are not damaged. Coked-up seals speed clogging of nozzle throttling gaps, causing distorted spray pattern and diesel knock.

FUEL PUMP

Fuel pump must deliver fuel under constant pressure and without bubbles. Insufficient pressure could cause engine problems. Pressure is kept constant by a by-pass valve which does not open until specified pressure is reached.

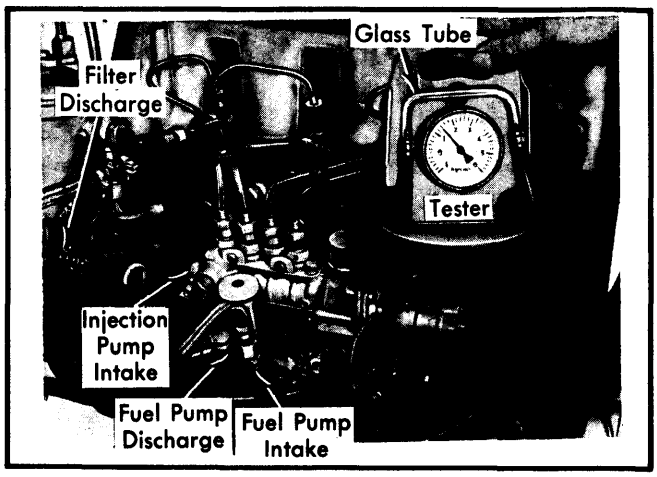

Fig. 12 Pressure Tester (000 589 49 21 00) Hook-Up (Earlier Model Injection Pump Shown)

Checking Delivery Pressures

1) Install a suitable tester (000 589 49 21 00) between main fuel filter and fuel injection pump. See *Fig. 12*. Check for proper delivery pressure, delivery end (final) pressure, and opening pressure of by-pass valve.

2) Using tester's glass tube, check for air bubbles in fuel at same time pressure is read.

BOSCH DIESEL INJECTION – MERCEDES-BENZ (Cont.)

3) Bleed tester and fuel system. See *REMOVAL AND INSTALLATION, Main Fuel Filter.* Check pressure at tester with engine running at idle speed. Pressure should be 8.5-11.4 psi (0.6-0.8 kg/cm²).

4) Raise engine speed up to 3000 RPM. Pressure should read 11.4 psi (0.8 kg/cm²). If pressure is much higher or lower, check that by-pass valve is opening properly. If excessively high, check for crushed or restricted fuel lines.

NOTE – *When making pressure tests, observe glass tube for air bubbles. If bubbles appear, check system thoroughly for leaks. Check hose porosity, hairline cracks in fuel lines or hoses, deteriorated or scuffed hoses, or slack hose clips.*

5) Next, check delivery end (final) pressure. Using fingers, squeeze hose between tester and injection pump. If pump is working properly, pressure should be at least 15.6 psi (1.1 kg/cm²) at idle and at least 18.5 psi (1.3 kg/cm²) at 3000 RPM.

6) If pressure is lower than specified, either the valve requires replacing, or pump requires repair or replacement.

7) If pressure is higher than specified, and opening pressure of by-pass valve is greater than 11.4 psi (0.8 kg/cm²), remove, clean and check by-pass valve for leaks. Replace valve if necessary.

LEAKING FUEL LINE FITTINGS

If external fuel leakage occurs between pipe connection fitting (union) and adjusting plate of injection pump, install new "grooved" fittings.

1) If pump is equipped with non-grooved fittings, replace ALL fittings with new "grooved" fittings. If equipped with "grooved" fittings, replace only leaking fittings.

NOTE – *Do not loosen adjusting plate, as this would require recalibration of injection pump on a test stand.*

2) Whenever new fittings are installed or fittings are removed for any purpose, install new copper gaskets under delivery valve carriers. Grooved end of valve carrier should be installed downward. Reinstall other valve components previously removed.

3) Oil fitting threads and tighten to 29-36 ft. lbs. (4-5 mkg), using one continuous motion.

4) Install injection lines and operate hand primer until by-pass valve opens (audible sound). Run engine and check for further leaks.

DIESEL KNOCK

Diesel knock can be traced to mechanical causes, diesel fuel properties, or a combination of both. Knock is a pinging noise caused by excessive combustion pressure.

To eliminate or reduce knock, use fuel best suited for your area and check and correct the following:

- Beginning of fuel delivery to assure optimum compression temperature and air charge.
- Valve lash.
- Correct nozzle spray pattern and opening pressure.
- Reverse flow dampening valve for proper operation.
- Insufficient compression pressure (compression check and cylinder leak test).

DEFECTIVE VACUUM CONTROL UNIT

On 5-cylinder 300 series engine, engine oil can enter vacuum system through a defective diaphragm in the vacuum control unit. Sometimes vacuum pump has been mistakenly blamed. If complaints are received that engine does not shut off or shuts off with difficulty, check vacuum control unit first as follows:

1) Remove brown and blue line from vacuum control unit. Check for traces of oil. If present, replace unit and oil-filled vacuum lines. Also repair vacuum pump and replace brake booster if oil is found at connecting fitting for vacuum line.

2) If no traces of oil are found at control unit or in vacuum lines, start engine and run at idle. Pull off brown vacuum line from "T" fitting between vacuum pump and brake booster. See *Fig. 10.* Check for vacuum. If none present, remove and check "T" fitting and clean with compressed air.

3) If vacuum is present, connect vacuum control unit directly to "T" fitting (by-pass the valve). Pump is now free to act directly upon diaphragm of control unit. If engine does not shut off immediately, replace control unit.

NOTE – *When installing new unit, be sure control linkage in pump governor is properly engaged and is not holding main rack in full-load position.*

4) If engine shuts off immediately, vacuum control unit is not to blame. Problem could then be jammed vacuum valve in steering lock.

5) Be sure all vacuum lines are connected as shown in *Fig. 10.* Start engine, check vacuum control unit, valve in steering lock and injection pump for leaks.

INJECTION TIMING ADVANCE MECHANISM

In order to comply with stricter emission standards, the advancement range for injection timing has been changed to 7.5° for all models. In addition, the front plate for the vacuum pump drive has been changed from internal drive teeth to a plate with an axial lift cam. This is due to a change from a twin-diaphragm to a piston type pump.

CAUTION – *This injection timing advance mechanism can NOT be installed on previous model engines.*

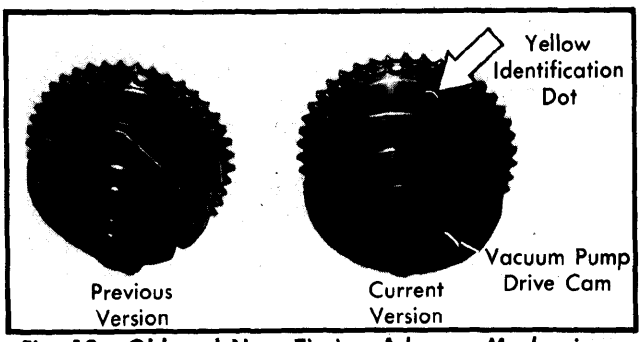

Fig. 13 Old and New Timing Advance Mechanisms

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.

BOSCH DIESEL INJECTION – MERCEDES-BENZ (Cont.)

2) Detach connecting rods and all cables from pump.

3) Remove mounting nuts at rear support and front flange, using a 13 mm (45° rebent) box wrench. Lift injection pump rearward from crankcase.

NOTE – *If drive collar is to be replaced, observe markings on flange, collar, and pump shaft for reassembly reference.*

Installation – **1)** Remove plug and fill injection pump with ½ pint of engine oil. Turn crankshaft in direction of rotation until 45° BTDC mark aligns with pointer. Piston of No. 1 cylinder must be in compression stroke.

2) Slide coupling sleeve onto drive collar of injection pump. Now, slide coupling forward onto drive shaft in crankcase.

3) Set injection pump to "start delivery" position by turning pump shaft until drive collar tooth gap aligns with pump shaft and pump flange marks. See *Fig. 14*.

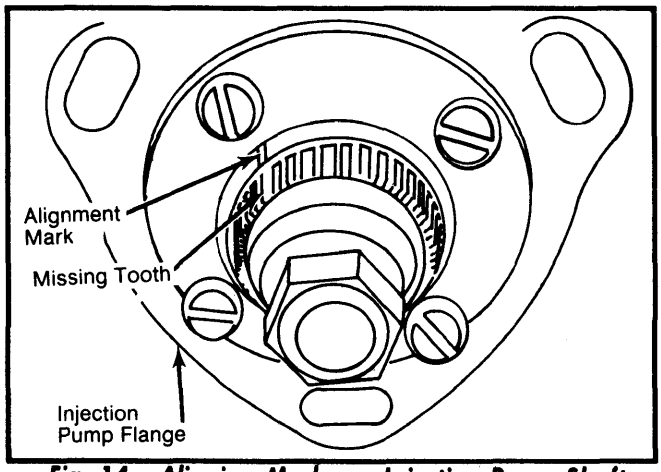

Fig. 14 Aligning Marks on Injection Pump Shaft Drive Collar and Flange

4) When applying light counterclockwise pressure (opposite direction of rotation) to drive collar, cam pressure action causes drive collar to jump back two teeth to cam base circle. Second tooth must then coincide with marking on injection pump housing.

NOTE – *Before installing pump, be sure piston of No. 1 cylinder is in compression stroke and crankshaft is 45° BTDC.*

5) Apply grease to either side of new paper gaskets and place gaskets on crankcase. Install injection pump in coupling sleeve. Be sure stud bolts are centrally positioned within slotted holes. This permits later alignment in either direction.

NOTE – *After aligning injection pump, there must be a clearance of 3.15" (80 mm) between crankcase and center of injection line fitting. This is to permit glow plug removal.*

6) Place washers in position and slightly tighten injection pump nuts.

NOTE – *Use special spacer washer (116 990 14 40) and M8 x 16 hex head screw to fasten rear support bracket.*

Checking for Start of Delivery

1) Turn crankshaft further in direction of rotation, until 24° BTDC mark aligns with pointer. Piston of No. 1 cylinder must again be in compression stroke position.

2) Screw out pipe connection fitting (union) of first pumping element and remove valve parts. Reinstall fitting and attach overflow pipe.

NOTE – *During test adjust control lever on injection pump to full throttle (full-load) position.*

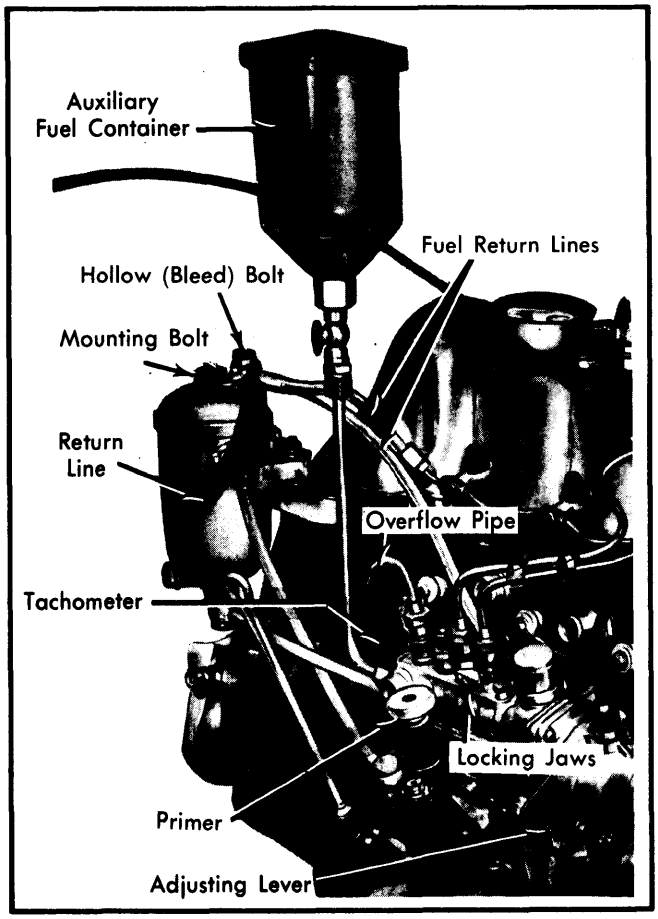

Fig. 15 Installing Auxiliary Fuel Container on Injection Pump (Typical)

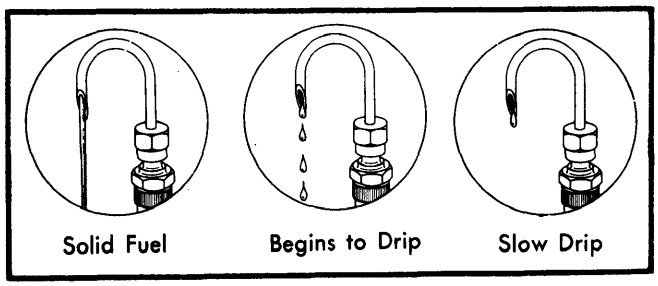

Fig. 16 Checking Fuel Dripping From Overflow Pipe

BOSCH DIESEL INJECTION – MERCEDES-BENZ (Cont.)

3) Connect auxiliary fuel container (000 589 05 23 00) to injection pump. See *Fig. 15*. Turn engine over slowly in normal direction of rotation until fuel stream from overflow pipe stops dripping. See *Fig. 16*.

NOTE – *Another drop may follow 10-15 seconds later, but this is normal.*

4) Start of delivery should occur when pipe stops dripping Crankshaft pointer should then be on 24° BTDC mark. Turn crankshaft two more full turns. Fuel should stop dripping again at end of second full turn. If so, tighten injection pump in this position.

5) If crankshaft position does not prove true, loosen injection pump mounting nuts and turn pump TOWARD engine to advance start of delivery and AWAY FROM engine to retard start of delivery. When adjustment is correct, tighten mounting nuts of pump and recheck position.

6) Remove overflow pipe and connection fitting (union). Reinstall valve parts using new gasket. Tighten fitting to 29-36 ft. lbs. (4-5 mkg) in one continuous motion. Remove auxiliary fuel container.

7) Connect all fuel, vacuum and lubricating oil lines. Install all control rods, cables, and other parts previously removed. Adjust as necessary.

8) Bleed fuel system and install battery and battery frame. Bring engine to operating temperature. Check all connections for leaks. Check idle speed and adjust as necessary. See *ADJUSTMENTS*.

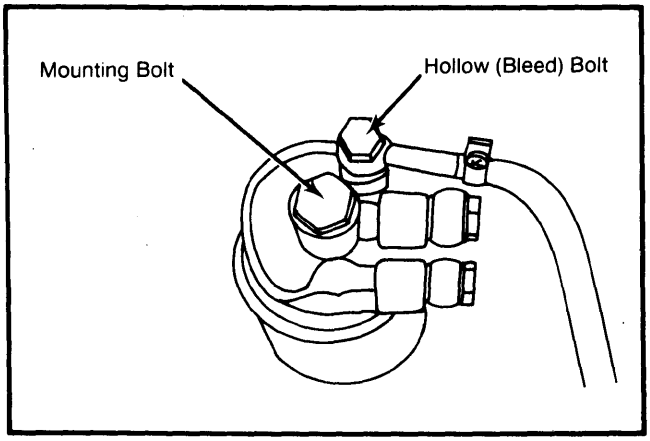

Fig. 17 Removing, Installing and Bleeding Fuel Filter

FUEL FILTER

Every 37,500 miles, the main fuel filter and lower housing should be replaced. Loosen mounting bolt. See *Fig. 17*. Pull downward on one-piece element and lower housing.

Install new lower housing and element. Tighten mounting bolt. After installation, bleed fuel filter and fuel injection pump.

Bleeding Fuel Filter

Loosen hollow bolt. See *Fig. 17*. Pump hand primer pump until fuel emerges free of bubbles. Retighten hollow bolt.

Bleeding Injection Pump

Pump hand primer until by-pass valve on injection pump opens. You will hear a buzzing sound when this occurs. Run engine and check for leaks.

VACUUM CONTROL UNIT

Removal – 1) Unscrew lower right-hand mounting screw from vacuum control unit. See *Fig. 18*.

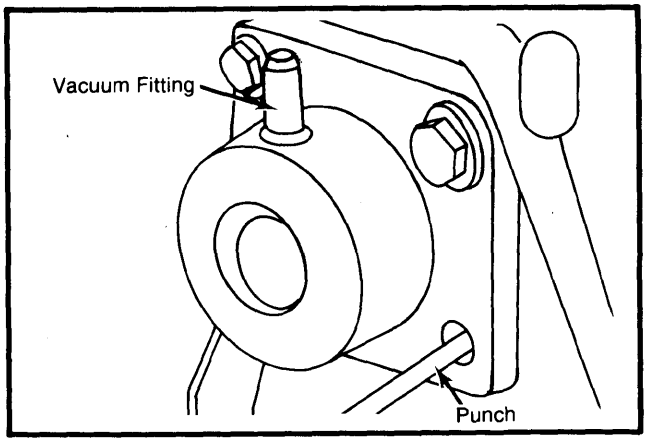

Fig. 18 Removing and Installing Vacuum Control Unit

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.*

Removal – Hold altitude compensating device by small nut, while loosening larger nut. See *Fig. 19*. Unscrew altitude compensating device and remove shims.

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.

BOSCH DIESEL INJECTION – MERCEDES-BENZ (Cont.)

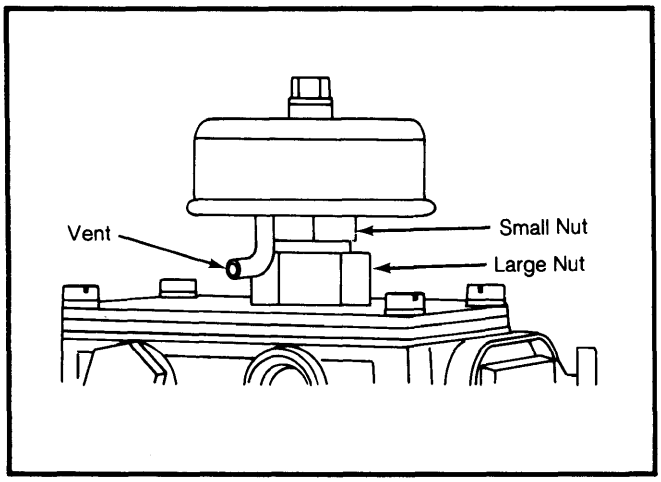

Fig. 19 Removing and Installing Automatic Altitude Compensating Device

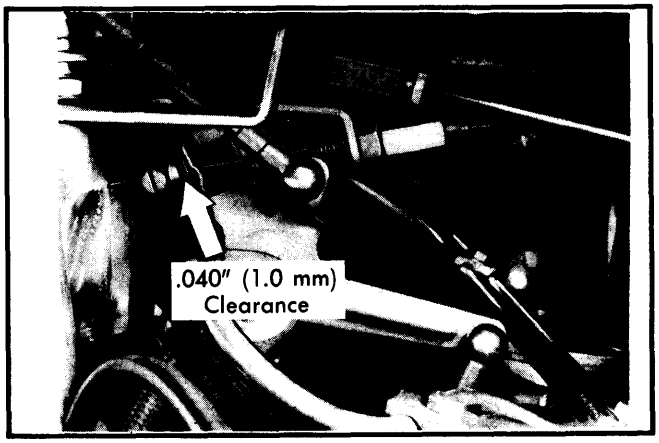

Fig. 20 Measuring Distance Between Collar and Spring

ADJUSTMENTS

IDLE SPEED AND IDLE SPEED REGULATOR

1) Check throttle linkage for free movement and wear. Run engine until oil temperature reaches 140-176°F (60-80°C). Turn idle speed regulator knob on dashboard clockwise to stop (Non-turbocharged models) and measure distance between collar and spring. Adjust collar as necessary to obtain .040" (1.0 mm). *See Fig. 20.*

NOTE – *Due to further technological development, the idle speed adjustment knob on Turbo-Diesels has been eliminated.*

2) Depress "stop" lever. *See Fig. 10.* Bowden cable of cruise control should rest tension-free against bell crank. If necessary, adjust cable with adjusting nut. Release "stop" lever. Cable should have play.

3) Disconnect control rod at bellcrank lever and check idle speed with tachometer. Loosen lock nut and adjust idle speed to 700-800 RPM with adjusting screw. *See Fig. 3.* Reconnect control rod so that it is free of tension and adjust throttle linkage if necessary.

CAUTION – *If engine speed is adjusted higher, it will be above controlled idle speed range of governor. Engine speed could automatically increase up to maximum RPM (without load).*

TIGHTENING SPECIFICATION

Application	Ft. Lbs. (mkg)
Rocker Arm Cover	3.6 (0.5)
Glow Plugs	36.0 (5.0)
Precombustion Chamber	118.5 (16.5)
Nozzle-to-Holder	54.0 (7.5)
Nozzle Holder-to-Head	54.0 (7.5)
Nozzle Holder Connector	54.0 (7.5)
Injection Pump Shaft Nut	50.6 (7.0)
Connecting Fitting (Union)	29.0-36.0 (4.0-5.0)
Injection Pipe Cap Nuts	18.0 (2.5)

SYSTEM SPECIFICATIONS

Application	Specifications
Idle Speed	700-800 RPM
Fuel Pump Delivery Pressure	
Idle Speed	8.5-11.4 psi (0.6-0.8 kg/cm²)
3000 RPM	11.4 psi (0.8 kg/cm²)
Fuel Pump Final Delivery Pressure	
Idle Speed	15.6 psi (1.1 kg/cm²)
3000 RPM	18.5 psi (1.3 kg/cm²)
Start of Delivery	24° BTDC (In Compression Stroke)
Nozzle Opening Pressure	
240D & 300D	1668-1784 psi (115-123 kg/cm²)
300SD Turbo	1958-2074 psi (135-143 kg/cm²)