MERCEDES-BENZ DIESEL TYPE

Mercedes Benz 190DC (1962-65)
Mercedes Benz 200D (1965-68)
Mercedes Benz 220D (1967-73)

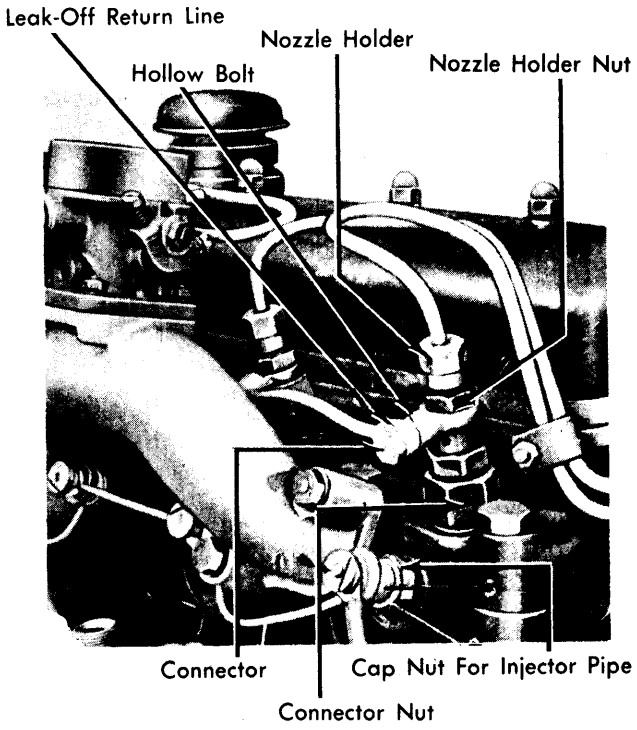
DESCRIPTION

A fuel pump, which is driven by the injection pump, draws fuel from fuel tank. After passing through a pre-filter, fuel is forced through a main filter into suction chamber of injection pump. An overflow valve mounted to end section of injection pump suction chamber maintains permanent pressure on fuel in suction chamber which is supplied by fuel pump. At a minimum pressure of 11.7 psi (0.8 atm), surplus fuel at end of suction chamber flows back into fuel tank via overflow valve. In any case, fuel pump will deliver more fuel than is necessary for injection into engine in order to prevent bubble formation and to ensure that suction chamber is filled with pressurized fuel.

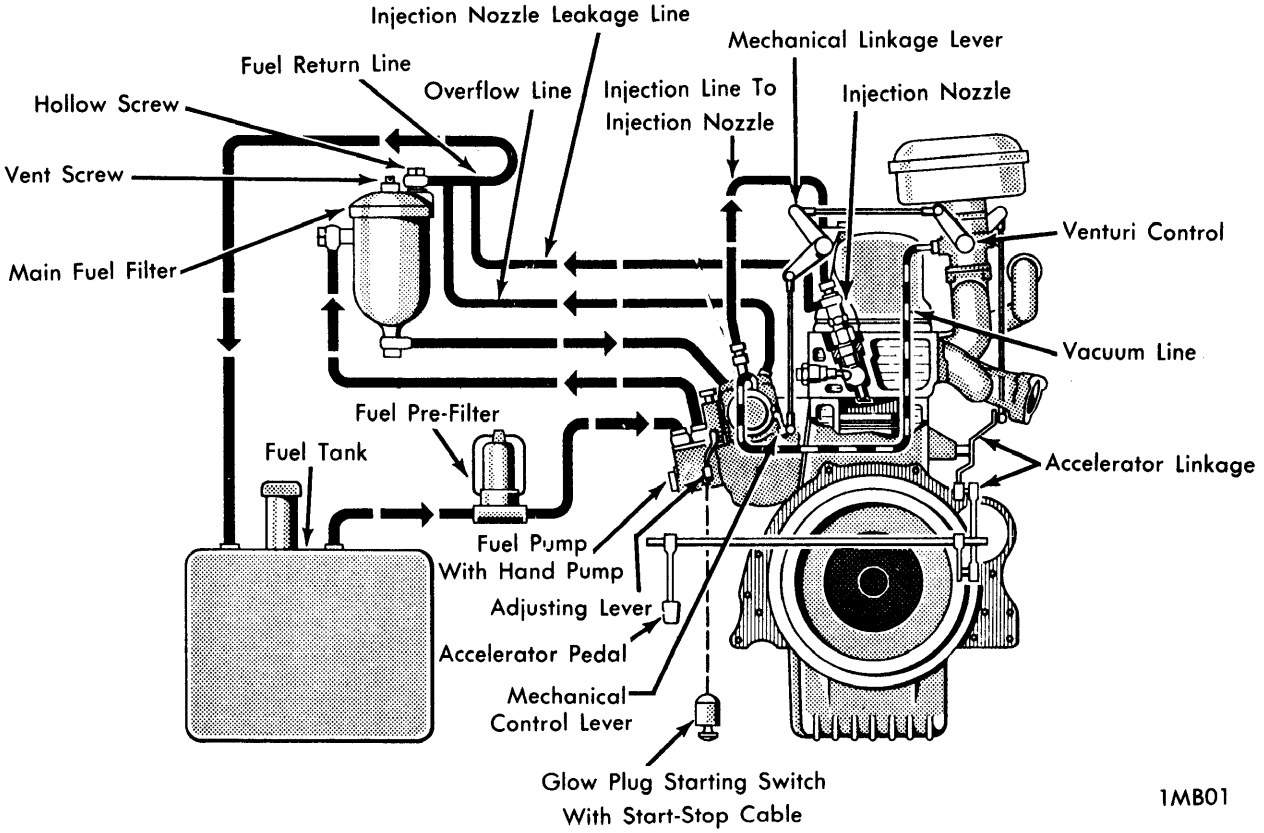
Plungers of four injection pump elements force fuel, contained in vacuum chamber, through injection pump pressure valves into injection lines, and from there to injection nozzles. Through injection nozzle, which operate at spray pressure ratings of 161.7 to 176.4 psi (11.0 to 12.0 atm), fuel reaches prechambers and finally, main combustion chamber of diesel.

Fuel leaking from injection nozzles is returned to fuel tank via a leakage line and fuel return line.

Control of amount of fuel injected is dependent upon position of accelerator pedal, and upon engine load and speed, and is affected by a governor (mounted to rear of injection pump).



NOZZLE HOLDER WITH FUEL RETURN LINE



DIESEL INJECTION SYSTEM (TYPICAL)

MERCEDES-BENZ DIESEL TYPE (Cont.)

OPERATION

INJECTION PUMP

A single acting pump which contains one pump element (consisting of a cylinder and plunger for each cylinder). Pump plungers are directly seated on roller tappets. Camshaft causes tappets to move delivery pump up. As a result, fuel is forced through ressure valve, (in injection pump), through pressure lines, and into injection nozzles. Injection quantity is regulated by turning pump plungers, thus resetting a metering land in each. This is accomplished by a control sleeve mounted lever arm, which engages with a pin in slot of an adjustable clamping piece in control rod, transmitting movement on control sleeve and pump plunger. Depending upon position to which plungers are turned, discharge rate of pump may be varied from zero to maximum.

PRESSURE VALVE

Pressure valve closes off top of pressure space and relieves pressure line. This is necessary to allow a fast closing of nozzle needle and to prevent dribbling of fuel into combustion chamber.

GOVERNOR

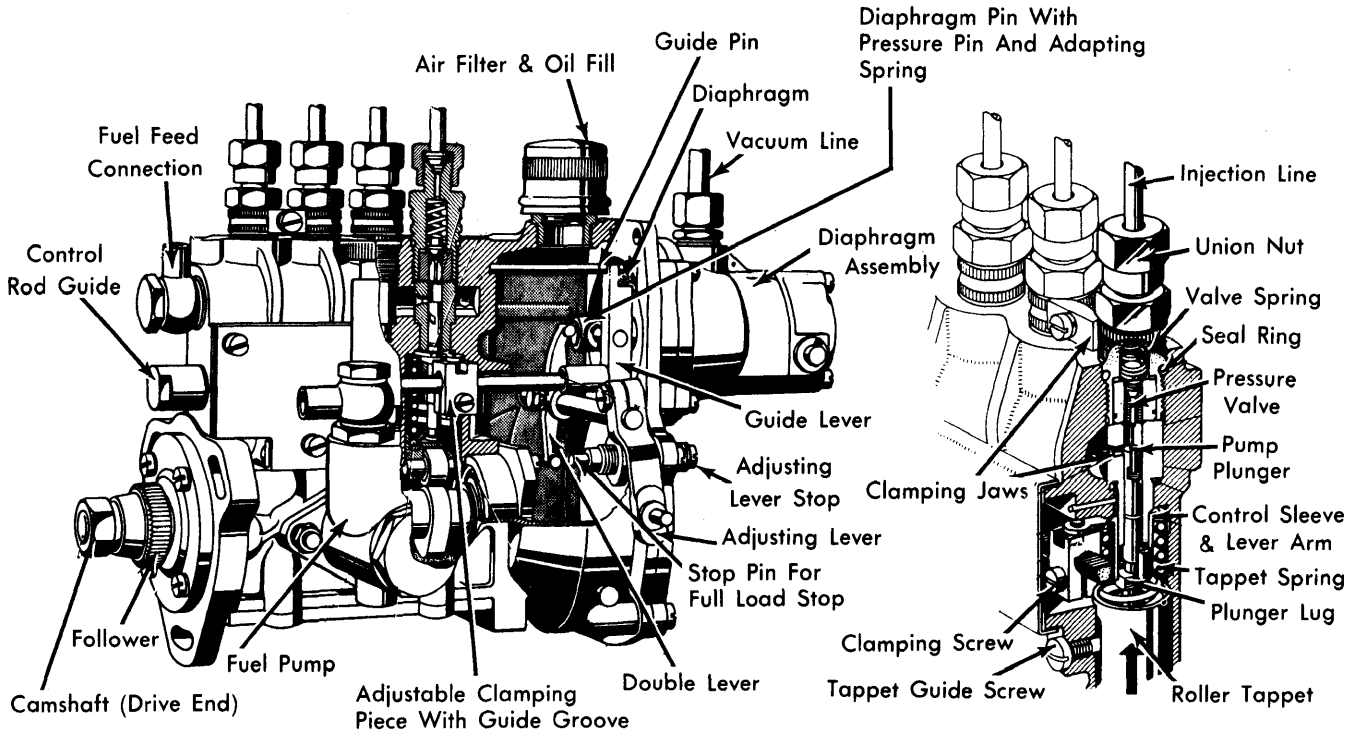
In connection with throttle duct, governor controls idling, maximum speed, partial load and full load. Corresponding to respective accelerator position, load and speed, it adjusts fuel quantity, shuts off injection quantity when vehicle is coasting, and prevents engine exceeding maximum RPM.

Engine vacuum is supplied to vacuum chamber of governor via a vacuum line mounted on throttle duct. Atmospheric chamber of governor is connected to ambient air via an air filter. A diaphragm separates both chambers (air tight from one another). Control rod, mounted to diaphragm, is moved by differential pressure between atmospheric chamber and consequently controls injection quantity.

A control spring presses diaphragm and control rod in "Full" direction, up to double lever (full load), which contacts full load stop with its other end. Full load stop adjusts maximum permissable injection quantity. Stop is spring seated so that during starting (via Bowden cable), lever can be pulled beyond full load position, into starting position. For starting, engine is supplied with a larger injection quantity than at full load.

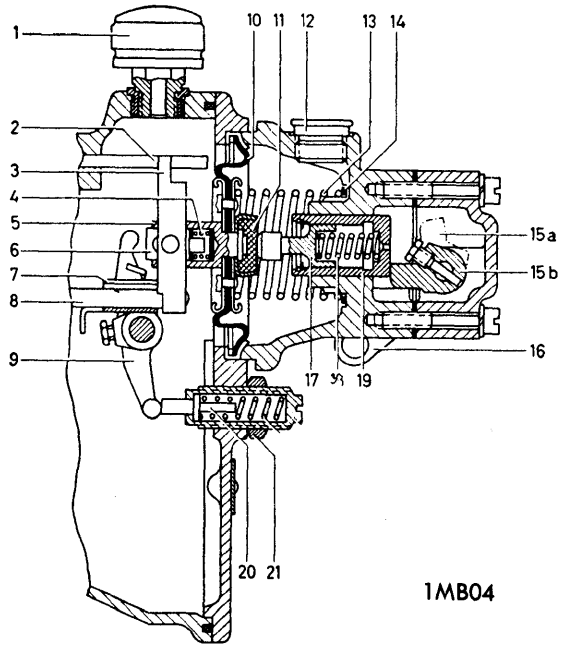
A stop pin is also installed in vacuum chamber. It serves as an additional mechanical control for idling and partial load ranges. Its function is to limit variations of control rod lower speed and load range movement (consequently it avoids faltering of engine). In idling and partial load ranges, control rod is balanced between forces of vacuum, control spring, and stop pin.

Damping in upper speed range is not required and a stop pin which cannot be disengaged (still in effect in partial load range), will prevent governing, when maximum speed is exceeded. This spring loaded stop pin has a sliding seat and is controlled through a cam which is actuated by additional control linkage so that it is moved into respective position corresponding to throttle position.



DIESEL INJECTION PUMP (TYPICAL)

MERCEDES-BENZ DIESEL TYPE (Cont.)



1 – Air Filter
2 – Guide Pin
3 – Guide Lever
4 – Adapting Spring
5 – Diaphragm Pin
6 – Pressure Pin Of Adapting Spring
7 – Stop For Starting Quantity
8 – Control Rod
9 – Double Lever
10 – Diaphragm
11 – Rubber Buffer
12 – Vacuum Chamber Connection
13 – Control Spring
14 – Spacer Ring
15 – Engaging Cam (Full Load Position)
16 – Engaging Cam (Idling Position)
17 – Lever For Mechanical Control
18 – Stop Pin For Full Load Stop
19 – Attaching Nut
20 – Spring
21 – Full Load Stop Screw

GOVERNOR ASSEMBLY

THROTTLE DUCT

Throttle duct transfers intake vacuum to diaphragm unit and controls vaccum and engine speed by respective position of throttle butterfly. By moving throttle butterfly with accelerator vacuum, governor is influenced by vacuum and consequently engine speed is controlled. Throttle duct is a venturi pipe, meaning it becomes gradually wider in direction of intake (starting at narrowest point). Throttle butterfly is connected to accelerator pedal by linkage and adjusting lever.

A calibrated air jet (for vacuum connection) is installed in auxiliary venturi pipe. Bore diameter and protruding length of air jet influences vacuum and therefore governor. Air jet should not be modified.

Velocity of air flow in throttle duct increases or decreases according to position of throttle butterfly valve and speed of engine. This is also true for vacuum behind throttle duct and in vacuum chamber. If vacuum is strong enough to overcome pressure of control spring governor is in operation.

Position of diaphragm and control rod depends on difference in pressure between vacuum chamber and chamber open to atmosphere. Difference in pressure is controlled by position of throttle butterfly and engine speed.

AUXILIARY VENTURI PIPE

Auxiliary venturi pipe serves to boost vacuum and protects engine from racing during reverse operation (running backward). If engine is operated incorrectly, it is possible that engine will start in reverse rotation and keep on running, which cannot be prevented by governor. An auxiliary pipe, however, prevents over-speeding and makes it possible that reverse running engine can be stopped, provided that stop cable control has been properly adjusted. An engine started in this way must be stopped immediately.

If auxiliary venturi pipe were not installed in throttle duct, a high dynamic pressure would be produced in intake manifold while engine is running backward with throttle butterfly closed. This dynamic pressure would forcefully move diaphragm in direction "full" via vacuum line and vacuum chamber. Engine would increase its speed quickly and start racing.

An auxiliary venturi pipe, mounted in throttle duct above vacuum connector passes through throttle butterfly and is therefore located in flow of intake air, allows exit of exhaust gases through auxiliary venturi pipe and through air filter while engine is running in opposite direction, even if throttle butterfly is closed.

During this process, air contained in vacuum chamber is sucked out; a certain vacuum thus created in chamber returns control rod to partial load position.

DIAPHRAGM UNIT

While engine is in operation, position of diaphragm and control rod, depends on difference in pressure on either side of diaphragm. If engine is loaded or unloaded (while throttle valve is in certain position), speed of engine decreases or increases and vacuum changes. If vacuum is weaker than pretension of control spring, then control rod is pressed against its full load stop. If vacuum becomes stronger, outer (atmospheric) air pressure moves diaphragm against pressure of spring, so that control rod is moved in direction of "stop".

Vacuum necessary for governing is produced in throttle duct by velocity of air flow. Governing starts as soon as vacuum can overcome pressure of control spring or vice versa. Diameter of throttle is designed for full engine output and control spring has been chosen accordingly, so that maximum permissible speed is reached with throttle butterfly fully open. Effectiveness of governor ranges from idling to maximum speed.

SPEED RANGES

Full Load Maximum Speed – Full load maximum speed, also called rated speed, is speed which engine should reach during maximum output. Throttle butterfly is then opened completely. During low speed, there is only a weak vacuum in vacuum chamber. Vacuum necessary for governing and force required to pull back control rod in direction "stop" will only be reached during full load maximum speed with throttle butterfly fully opened. As soon as engine has reached its full load maximum speed, return of control rod in direction "stop" begins, and with it, limiting of full load maximum speed (beginning of governing).

MERCEDES-BENZ DIESEL TYPE (Cont.)

No Load Maximum Speed – This is speed which engine can possibly reach (without endangering engine), but should never be sustained for long periods of time. If for instance throttle is opened fully while stationary (or during downhill drive), and speed rises beyoud maximum, vacuum becomes so strong that diaphragm is lifted off full load stop and is pulled further in direction of "stop" against stop pin. Governing begins when diaphragm leaves full load stop (injection rate becomes lower) but engine speed still increases due to small load. Speed increases until diaphragm is drawn so far back that pump plunger passes through partial load and idling position into no-delivery range. During this operation the additional spring (stop pin) is compressed by diaphragm. Diaphragm and/or control rod then travel beyond idling position into no-delivery range of injection pump, which is exactly similar to stopping operation of engine. A further increase of speed is not possible while engine is stationary (end of governing).

Idling Speed – This is lowest speed at which engine without load continues to run without stalling. Engine at idle requires only a low injection rate. This is automatically adjusted by governor, as soon as throttle butterfly is returned to idling position.

INJECTION NOZZLE

Nozzle injects fuel delivered by injection pump at a high pressure in a most favorable spray pattern and at proper moment into combustion chamber. Nozzle is controlled by fuel pressure. During discharge stroke of plunger, pressure impulse is transferred through pressure chamber in injection nozzle. If discharge pressure becomes stronger than force of tension spring, nozzle needle is lifted off its seat and fuel is injected through injection hole into pre-combustion chamber and main combustion chamber to produce a combustible mixture.

Toward end of discharge stroke, fuel pressure becomes weaker than tension spring, spring pressure will return nozzle to its seat and injection is completed. Nozzle is now closed (until actuated again by next discharge stroke), and excess fuel (drip oil) returns, via passage, to fuel tank.

Injection is influenced by shape of spray pin of nozzle needle and throttle bore in nozzle head. Nozzle needle first opens only a narrow annular gap, through which can only pass a lettle fuel (very finely sprayed). On further opening (caused by increased pressure) passage cross section becomes larger, and main portion of fuel is injected toward end of needle stroke. Combustion and engine performance is made smoother, because there is a slower increase of pressure in combustion chamber.

FUEL PUMP

Pump is a single action pump, driven by camshaft of injection pump. Fuel is discharged from pressure space through main filter into injection pump. At same time, fuel is drawn from fuel tank through pre-filter and vacuum valve into vacuum space. Discharge and vacuum stroke is executed by a pre-loaded plunger spring. An intermediate stroke discharges fuel from vacuum space into pressure space.

System can be primed by hand pump attached to fuel pump (while engine is not running). Pump may also be used to bleed injection system. After using hand pump tightly screw in handle against rubber seal, otherwise fuel leak will occur, when engine is in operation.

GLOW PLUG SYSTEM

Glow plugs make possible starting of a cold engine by increasing temperature of compressed air and by igniting fuel droplets on surface of glow plug elements.

Glow plugs are supplied with a heating current from a 12 volt battery via a push-pull switch. They are arranged in series with a glow plug indicator, in such a way that the sum of all rated component voltages (including voltage drop in all leads) corresponds to rated voltage of battery.

Duration of preheating depends on temperature of engine and ambient temperature. Preheating at ambient temperature of +68°F (+20°C) would require about 10 seconds, and about 20 seconds at +32°F (0°C). When engine is at normal operating temperature, preheating is not necessary.

GLOW START SWITCH (PUSH-PULL)

An electro-mechanical push-pull switch with four positions: stop, drive, preheat and start. Ignition switch must be turned "ON" to actuate glow plug system. A control cable connected to push-pull switch also controls position of adjusting lever on injection pump.

Stop Position – In this position, button of push-pull switch is fully pushed in and adjusting lever on injection pump is pushed completely forward by cable control. In this position of adjusting lever, control rod is in "stop" direction; when turned off, engine receives no more fuel because plungers of pump elements are at zero delivery.

Drive Position – In this position, control cable with slot is in a position relative to adjusting lever so that slot is not in contact with adjusting lever bolt (lever not actuated). After switch button has been pulled out of stop position, it engages in next stop and remains in this position as long as engine is running.

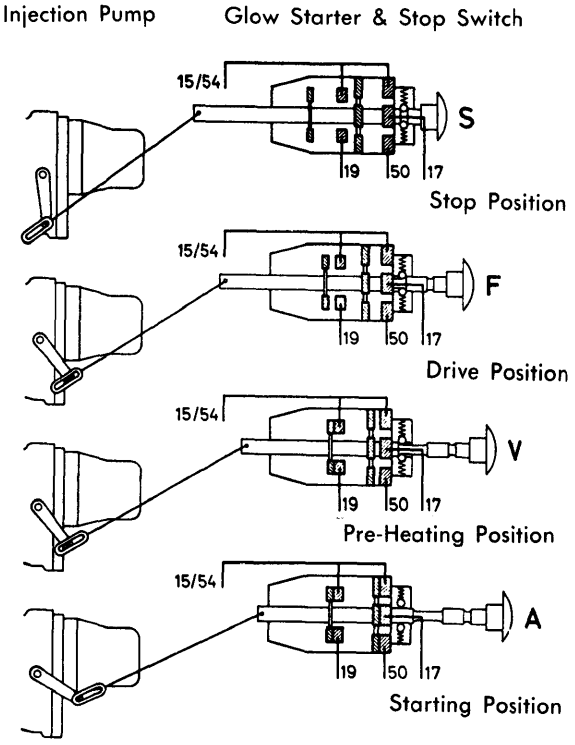
Preheating Position – When switch is in preheating position, same applies to cable control and adjusting lever as for "drive position". After button of switch has been pulled into drive position, a slight resistance is felt. Switch must be held in this position until preheating has been completed (dependent on ambient temperature and temperature of engine). Current supplied by switch in this position causes plug filament to glow.

GLOW PLUG

Current is supplied via a contact bar, or a connecting cable (depending on location of plug), to the center electrode (or collar of outer electrode). Center electrode and outer electrode are connected together by the filament. The two electrodes are separated by an insulator and also insulated from plug body. At top of glow plug, a further plastic insulator is installed between center and outer electrodes. A connection insulator separates the two leads. A convex washer incorporated into the insulator secures knurled nut.

Glow plug life largely depends on condition of injection nozzles and on combustion pattern. Excessively low injection pressure, jamming nozzle needles, carboned up and dripping nozzles and injection delivery too early may cause premature fracture of plug filament. Formation of carbon deposits on plug may lead to grounding of filament and consequent fusing.

MERCEDES-BENZ DIESEL TYPE (Cont.)

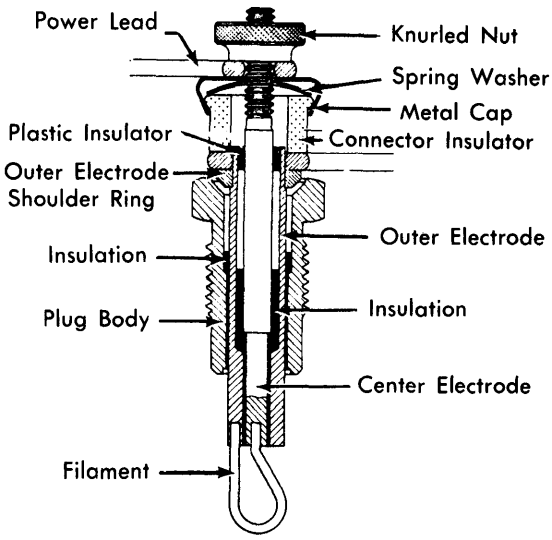


GLOW START & STOP SWITCH

Starting Position – On completion of preheating, against the slight resistance, switch button is pulled out as far as it will go and held there until engine starts.

When switch is in starting position, bolt of adjusting lever is at opposite side of slot (as compared with switch in stop position), and draws adjusting lever completely to rear. This shifts control rod beyond full-load stop and injection pump is on starting delivery.

Starter is operated by this switch. Current continues to be supplied to glow plugs when switch is in starting position. Since glow indicator is shorted out during starting, glow plugs receive more current and starting is made easier. When push-pull switch is released, after engine is started, switch is automatically returned to drive position by a spring.



DIESEL GLOW PLUG

INJECTION TIMER

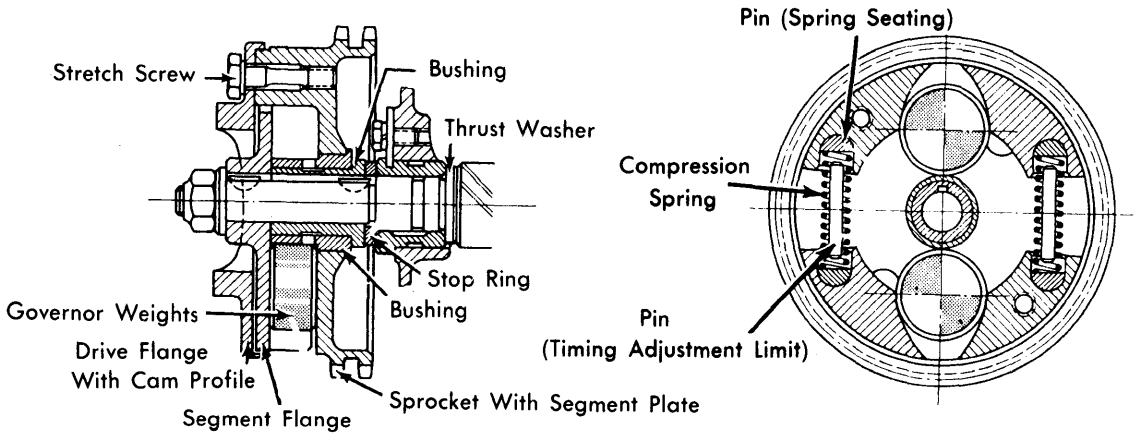
Function of injection timer is to govern injection process in relation to engine speed, thus ensuring satisfactory torque and performance together with low fuel consumption and improved smoke characteristics. During acceleration, centrifical weights slide outward due to centrifical force. Since segements flange plate is attached to drive gear, only segement flange and attached drive shaft will be shifted in direction of rotation, causing drive shaft to lead drive gear during increased speeds and the moment of pump injection is advanced.

MAINTENANCE

Injection Pump – 3,000 mi (5,000 km) – Check oil level, correct if necessary, and operate hand pump of fuel pump several times.

Air Filter (Oil Bath) – 3,000 mi (5,000 km) – Clean and fill to upper mark with clean oil (do not overfill).

Fuel Pre-Filter – 30,000 mi(50,000 km) – Clean or replace if required.



INJECTION TIMER

MERCEDES-BENZ DIESEL TYPE (Cont.)

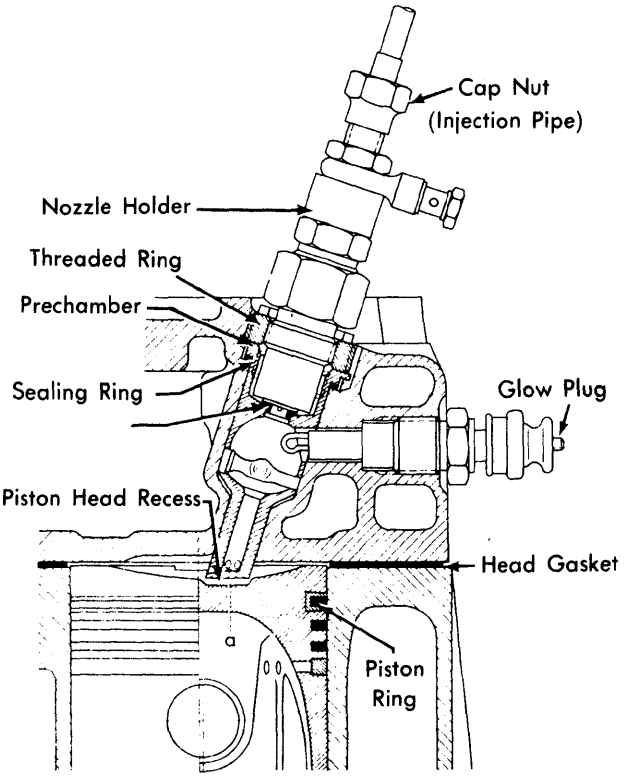
Fuel Main Filter – 30,000 mi (50,000 km) – Clean or replace if required.

Fuel Tank Filter – Twice Yearly – Clean or replace if required. *NOTE – Do not use fuel tank filter intended for gasoline models. Filters for diesel use are marked with "D" or "Diesel". Filters for gasoline models are either marked "Benzin" (gasoline) or are without identification.*

TESTING

INJECTION NOZZLE INSTALLED IN PUMP

Two separate tests must be made; first with engine at idle and again with engine running at increased idle speed. Slacken cap nuts of individual injection pipes on injection pump a half turn, one after the other, at same time paying attention to running and sound of engine. If, when a cap nut is slackened, there is no change in running or sound of engine, trouble may be caused by a defect in corresponding nozzle or inadequate sealing between pipe union and pressure valve holder. If, when cap nut is slackened, engine starts to run unevenly, corresponding nozzle is functioning properly.



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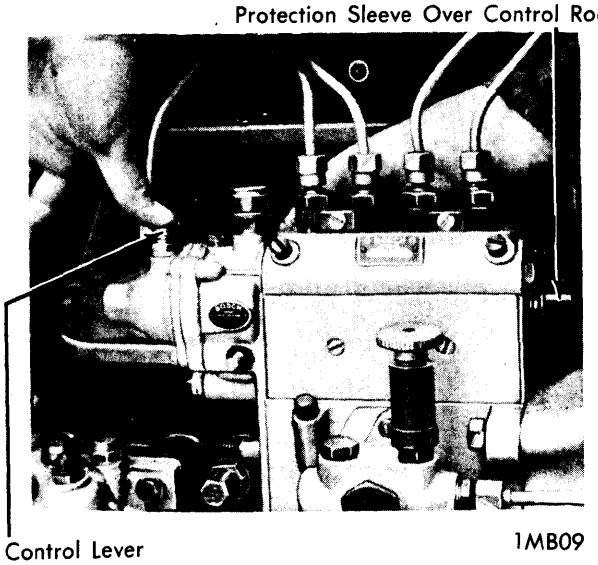
INJECTION NOZZLE HOLDER

GOVERNOR

A governor test may become necessary if engine shows too low output, heavy smoking, irregular running, faltering or lope during idling and surpassing the full load maximum speed and/or maximum permissible speed in gear ranges on a level stretch or of no-load maximum speed. This test may only be carried out on an injection pump test stand.

DIAPHRAGM & VACUUM HOUSING

Remove protecting cap from control rod. Disconnect vacuum line. With adjusting lever, move control rod fully in direction "stop". Seal vacuum connection with one finger; release adjusting lever and watch control rod. If diaphragm and vacuum housing are sealing properly, control rod will only be pushed out a short distance by control spring and will be held there by vacuum produced in vacuum housing. If control rod does not remain there, either diaphragm or housing is leaking.



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VACUUM TEST OF HOUSING & DIAPHRAGM

VENTURI CONTROL UNIT

Loose control valves and worn-out control valve shafts lead to jamming of throttle linkage and, in some cases, to uneven running of engine. Vacuum line connection and attaching flange of venturi control unit must be air tight because a leak in vacuum system influences injection control. This would result in retarded governing, increased fuel consumption and heavy exhaust smoke. Control valve must be checked to make sure it is properly seated on control valve shaft; it should also be determined that closed control valve is properly seated in control unit and does not bind.

FUEL PUMP

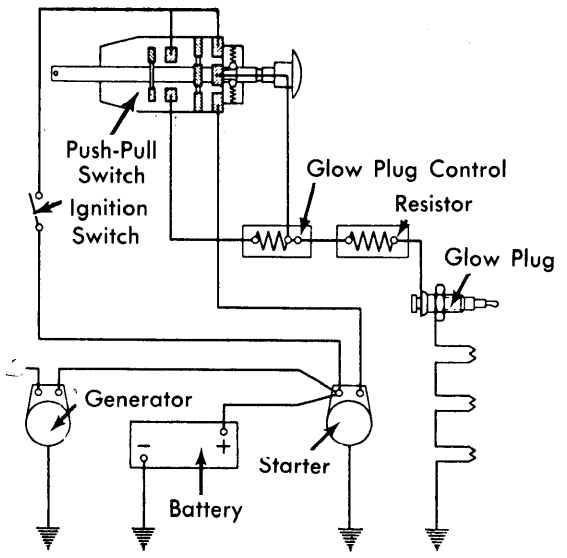
Fuel pressure tests are made with gauge installed between injection pump and main fuel filter. Fuel pressure and final pressure is tested at idle speed and at 3000 RPM (See "Specifications"). Fuel pump vacuum tests are made with gauge installed in front of pump entry. Test is made at idle speed (See "Specifications").

GLOW PLUG

A glow indicator with same rated voltage as glow plug system is provided in instrument panel for monitoring glow plug system. During preheating, glow indicator glows bright red and provides an indication of condition of plugs. If glow indicator does not glow, filament of a glow plug is usually broken or fused because of grounding.

MERCEDES-BENZ DIESEL TYPE (Cont.)

To find glow plug at fault, taking each plug in turn, connect the two contact bars with a screwdriver blade. Set push-pull switch to preheating position. If glow indicator glows when a plug is short circuited, that plug is faulty. If glow plug system is shorted to ground, glow indicator glows much more quickly and brightly. If glow indicator continues to glow after ground cable of glow plug system has been disconnected, system is shorted to ground. In this event, check contact bars for short circuiting with cylinder head. If contact bars are not at fault, one of glow plugs may be short circuited to ground. To find faulty plug, switch on glow plug system and disconnect contact bars one at a time, starting at ground side. When contact bars are disconnected from glow plug with short circuit to ground, flow of current is interrupted and glow indicator stops glowing.



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GLOW START & STOP CIRCUIT

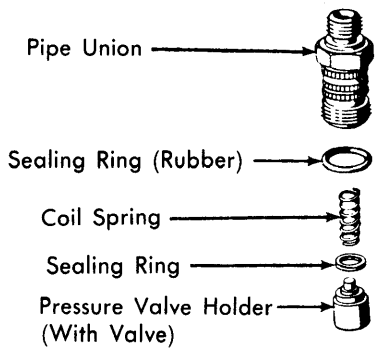
ADJUSTMENT

INJECTION PUMP START OF DELIVERY STROKE

1) Turn crankshaft in direction of rotation until 26° (for models 190DC and 200D) or 24° (for model 220D) BTDC mark coincides with alignment pointer. Piston of first cylinder must be in compression stroke position.

2) While making tests and adjustments, crankshaft must ONLY be turned in direction of rotation to ensure that injection timer flyweights are not forced from their initial positions and that chain is kept tensioned.

3) Unscrew injection line at pipe union of first pump cylinder, remove pipe union, take out rubber sealing ring, coil spring, and pressure valve. Replace pipe union and screw on overflow pipe.



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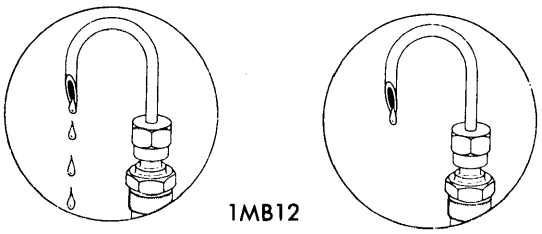
PRESSURE VALVE & PIPE UNION

4) Detach start-and-stop cable from timing lever of injection pump. Place timing lever and control rod in **full power** position. *NOTE – When checking start of delivery it is imperative for control rod to be in full power position since it is only in this position that start of delivery is constant in injection pumps that have a double control edge.*

5) Connect fuel container to injection pump, fill with clean fuel and open valve. Fuel now flows out of overflow pipe. *NOTE – It is not absolutely essential for fuel container to be connected up if only a simple check is required. All that is required here is to unscrew bleeder screw on main fuel filter. Fuel supply is sufficient for one, possible two, checks. Main filter should be refilled with fuel by means hand operated fuel pump as many times as necessary.*

6) Turn crankshaft slowly in direction of rotation until fuel is just ceasing to drip. After approximately 15-20 seconds another drop may form. At this point, injection pump is at the start of delivery point. If timing pointer now coincides with appropriate graduation mark on dynamic balancer, start of delivery is matched to position of crankshaft.

7) To repeat check, turn crankshaft **exactly two turns** in direction of rotation. At end of second turn continue to turn slowly until fuel just ceases to run, or drip, out of overflow pipe.



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TEST FLOW SEQUENCE

8) If adjustment is incorrect, loosen pump flange bolts and rotate pump on its axis to correct matching of start of delivery and position of crankshaft. *NOTE – Moving pump toward engine makes start of delivery earlier and moving it away from engine makes it later.*

9) When adjustment is correct, tighten pump to flange, remove fuel tank and overflow pipe, unscrew pipe union and install pressure valve, new sealing ring, coil spring, and

MERCEDES-BENZ DIESEL TYPE (Cont.)

an undamaged rubber sealing ring. Coat pipe union thread with tallow, install and torque to 22 Ft. Lbs. (3.0 mkg). To insure proper fit of sealing ring, loosen and retighten pipe union several times with final torque of 22-23 ½ Ft. Lbs. (3.0-3.5 mkg). *NOTE – Malfunction and faults may occur with both pump and engine if tightening torque for pipe union is either too high or too low.* Install clamping jaws between pipe unions and torque to 6 ½ Ft. Lbs. (0.9 mkg). *NOTE – Do not exceed this torque. Excessive tightening may distort housing and cause leakage of elements on low and high pressure side.* Connect injection pipe and torque to 18 Ft. Lbs. (2.5 mkg). Reconnect start-and-stop cable to adjusting lever. Run engine and check for leakage.

ADJUSTMENT OF START-AND-STOP CABLE

1) Disconnect battery ground cable.

2) Depress button of push/pull switch (stop position) and have assistant check position of adjusting lever controlling injection pump. Adjusting lever must be pushed completely forward.

3) Pull button of push-pull switch through slight resistence to end of travel (starting position), and have assistant check lever. Pin of adjusting lever must come to rest against far end of eye (as opposed to near end of stop position), with adjusting lever pulled completely back.

4) Release button of push/pull switch; switch is spring-loaded and will automatically return to driving position. In both driving and pre-glowing position, pin of adjusting lever must remain clear of eye ends with a minimum clearance of .079" (2.0 mm). *NOTE – Cable is adjustable by moving coil spring (outer sleeve) at angle bracket. Adjusting lever must be firmly mounted on injection pump shaft.*

5) Reconnect battery cable. Start engine, run for short period, turn idling control knob to extreme right and switch off engine. If adjustment should prove difficult and start stop positions cannot be set satisfactorily, starting delivery may be slightly reduced in favor of an accurate stop position.

IDLE SPEED ADJUSTMENT

NOTE – Idle speed may only be adjusted with engine hot (water temperature no less than 176°F (80° C).

1) Turn idle control knob on instrument panel to extreme right so idle adjustment cable is slack at angle relay lever in this position; if necessary disengage setting ring and refasten.

2) Connect suitable tachometer. Remove screw plug (oil pump drive) for this purpose and replace by adapter. *NOTE – If tachometer or hand revolution counter is not available to determine idle speed, adjust idle speed to point where charging light goes off.*

3) Adjust idle speed by screwing idle stop screw at venturi control unit to obtain 700 to 800 RPM. In order to obtain a smooth and even idling speed from a diesel engine it may be advisable to increase idling speed rather than to keep it low.

4) To adjust idle control cable, turn idle control knob on instrument panel to extreme right. Fasten adjusting ring on cable to provide a clearance of .004"-.008" (0.1-0.2 mm) between adjusting ring and angle relay lever so that idle stop screw comes to rest positively against stop provided at Venturi control unit.

ADJUSTMENT OF ADDITIONAL MECHANICAL CONTROL

1) Adjust idle speed.

2) Detach connecting rod between Venturi control unit and angle relay lever, adjust to a length of 12.214" (310 mm), measured center to center of ball sockets and reattach.

3) To adjust connecting rod between angle relay lever and injection pump, detach connecting rod from angle relay lever. Push it downward as far as stop and adjust connecting rod so it must be raised .039" (1.0 mm) for 200D and 220D, .157" (4.0 mm) for 190DC model, before ball socket is attached.

BLEEDING FUEL SYSTEM

Air trapped in fuel system may cause knocking, loss of power and, in some cases, starting problems. Bleeding is required when tank has been run dry, lines or fittings removed or when fuel pump takes in air during operation.

Bleeding – 1) Back off bleed screw at main fuel filter one or two threads.

2) Unlock operating cap of hand-operated fuel feed pump by a counterclockwise twist and pump until **bubble free** fuel flows from bleed screw opening. Tighten bleed screw and continue pumping until injection pump overflow valve (fuel return) opens up; this becomes evident by a rasping noise. Push operating cap of hand-operated fuel feed pump down and lock in position by a twist in clockwise direction.

3) **Do not** fail to lock operating cap of hand-operated fuel feed pump properly. Pump plunger presses against a sealing ring, sealing pump completely. If cap is left unlocked, pump will leak during operation and admit air to system.

FUEL PUMP

Delivery Pressure ①

At Idle Speed	
190DC, 200D	11.7-22.0 psi (0.8-1.5 atm)
220D (1967-70)	8.8-11.7 psi (0.6-0.8 atm)
220D (1971-73)	11.7-22.0 psi (0.8-1.5 atm)
At 3000 RPM	
190DC, 200D	32.3 psi (2.2 atm)
220D (1967-70)	13.2 psi (0.9 atm)
220D (1971-73)	32.3 psi (2.2 atm)

① – Measured between injection pump and main fuel filter.

NOTE – If pressure does not meet specifications, squeeze off hose leading to injection pump to isolate fuel pump pressure reading. Pressure reading at this time should be 29.4 psi (2.0 atm) at idle speed and 36.7 psi (2.5 atm) at 3000 RPM.

Fuel Pump Vacuum ①

At Idle Speed	
190DC, 200D	5.9-11.9 in. Hg (0.2-0.4 atm)
220D (1967-70)	2.9 in. Hg (0.1 atm)
220D (1971-73)	5.9-11.9 in. Hg (0.2-0.4 atm)

① – Measured in front of pump entry.

Replacement – 1) Turn crankshaft in direction of rotation until 45° BTDC mark coincides with alignment pointer. Piston of first cylinder must be in its compression stroke during this process.

MERCEDES-BENZ DIESEL TYPE (Cont.)

POSITION OF CRANKSHAFT FOR INJECTION PUMP START OF DELIVERY ADJUSTMENT

Model	Setting
220D	① 24° BTDC
190DC, 200D	① 26° BTDC

① — On compression stroke and with pump set to beginning of delivery stroke.

TIGHTENING SPECIFICATIONS

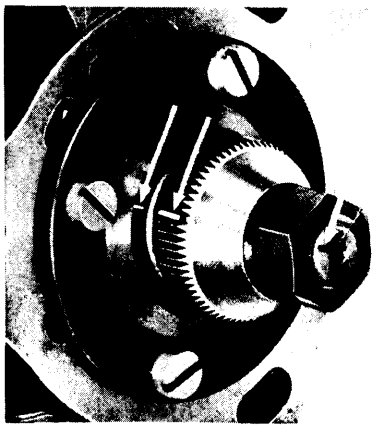
Application	Ft. Lbs.	(mkg)
Rocker Arm Cover	3.6	0.5
Glow Plugs	36.0	5.0
Precombustion Chamber	108.5+21.7	15.0+3
Nozzle in Nozzle Holder	50.6+7.2	7.0+1
Nozzle Holder in Head	50.6+7.2	7.0+1
Nozzle Holder Connector Nut	50.6-7.2	7.0-1
Injection Pump Shaft Nut	50.6	7.0
Pump Pressure Valve Pipe Union	21.7+3.6	3.0+0.5
Injection Pipe Cap Nuts	18.0	2.5

REMOVAL & INSTALLATION

INJECTION PUMP

Removal – 1) Disconnect all injection, vacuum, and fuel lines at injection pump. Plug injection line and fuel hose unions at pump. Detach connecting rod for auxiliary mechanical control as well as starting and stopping cable at injection pump adjusting lever.

2) Remove hex nut at bell shaped support and attaching nuts at front flange; then remove injection pump from crankcase. Remove coupling sleeve from injection pump drive collar or from drive shaft. *NOTE – If drive collar is to be replaced, observe markings on flange, collar and shaft for reassembly reference.*



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PUMP ALIGNMENT MARKS

Installation – 1) Turn crankshaft in direction of rotation until 47° (models 190DC and 200D) or 45° (for 220D) BTDC mark coincides with alignment pointer. Piston of first cylinder must be in its compression stroke during this process.

2) Determine whether coupling sleeve may be easily slid onto drive collar of injection pump. If this is so, slide coupling sleeve onto drive shaft in crankcase.

3) Remove plug from oil overflow pipe at rear of injection pump.

4) Set injection pump to start delivery position by turning pump shaft until drive collar tooth gap and injection pump marking coincide.

5) When applying light leftward pressure (opposite to direction of rotation) to drive collar, cam pressure action of camshaft causes drive collar to jump back by two teeth to cam base circle. The second tooth must then coincide with marking on injection pump housing. Before inserting pump, double check whether piston of first cylinder is in compression stroke and crankshaft is at 47° (190DC, 200D) or 45° (220D) BTDC respectively. *NOTE – Because drive collar jumps back by two teeth, this setting is necessary.*

NOTE – Because drive collar jumps back by two teeth, this setting is necessary.

6) Apply grease to both sides of new paper gaskets and place gaskets on crankcase. Install injection pump in coupling sleeve in such a way that stud bolts are centrally positioned within slotted holes. This way, fine adjustment is possible by shifting to either side. *NOTE – After shifting, or fine alignment of injection pump, there must be a clearance of approximately 3.15" (80 mm) between crankcase and center of injection line union in order that glow plugs may be removed.*

7) Place washers in position and slightly tighten injection pump with the two hex nuts.

8) Adjust injection pump to start of delivery stroke (See *"Adjustment"*). Reverse removal procedure to complete installation. Adjust mechanical control and starting and stopping cable as required (See *"Adjustment"*).

TROUBLE SHOOTING

GLOW INDICATOR LIGHT DOES NOT LIGHT OR STARTER DOES NOT OPERATE

1) Capacity of battery insufficient.

2) Poor contact at battery terminals.

3) Starter failure.

4) Faulty glow plugs.

5) Faulty series resistance or glow control light.

GLOW INDICATOR LIGHTS AND STARTER OPERATES BUT ENGINE FAILS TO START

1) Preheating too short.

2) Battery charge insufficient. (Starter speed should be 100 RPM, minimum.)

MERCEDES-BENZ DIESEL TYPE (Cont.)

3) No fuel, or wrong fuel in tank, or fuel main filter has run empty overnight due to leaky by-pass valve.

4) Air in fuel system.

5) Adjusting lever fails to go to starting volume.

6) No ignition in one or more cylinders. (Glow plug short circuited and does not glow.)

7) Glow plugs do not continue to glow during cranking of starter. (Cannot be observed at glow indicator light while starter operates.)

8) Insufficient compression.

9) Faulty injection nozzles.

10) Pump plunger or tappet of fuel pump sticks.

11) Control rod sticks.

12) Injection pump plunger badly worn.

13) Gum formation on pump and governor components.

ENGINE STOPS AFTER STARTING

1) Air in injection pump.

2) Fuel filter obstructed.

3) Ventilation of fuel tank obstructed.

ENGINE RUNS IRREGULARLY

1) Air or dirt in fuel system.

2) Fuel line leaks.

3) Fuel filter fouled.

4) Pressure valves and/or springs in injection pump damaged, or broken plunger spring.

5) Leaking injection nozzles or irregular injection caused by fouling.

6) Compression variance in engine cylinders.

7) Retainer on adjusting sleeve has become loose and changed feed volume.

8) Gum formation on pump and governor parts.

ENGINE DOES NOT REACH FULL POWER OUTPUT

1) Butterfly throttle not fully opened.

2) Air filter fouled.

3) Badly worn pump plungers.

4) Insufficient fuel pressure.

5) Control rod sticks.

6) Pressure valve at injection pump leaks or spring broken.

7) Engine mechanically at fault.

8) Timing device sticks in idling position.

9) Air in fuel system.

10) Starter pull controls are slightly depressed in stop position.

ENGINE KNOCKS

1) Air in fuel system.

2) Faulty fuel filter gasket (dirt in injection pump and nozzles).

3) Injection pump discharges too early or too late, or timing device sticks.

4) Wrong fuel.

5) Engine compression too low.

6) Injection pump pressure valve seals leaking, or clamping jaws of tubular connections excessively tightened.

TICKING OR KNOCKING NOISE

1) By-pass valve noisy.

2) Tappet knocks against pump plunger due to extremely high pressure in system or sticking pump plunger.

ENGINE SPEED TOO HIGH

1) Leaks at intake manifold, vacuum line, mounting flange of throttle duct, or vacuum chamber.

2) Faulty diaphragm in governor.

3) Control rod sticks in full load position when releasing accelerator pedal.

4) Incorrect butterfly throttle position. (Throttle opened too far.)

5) Auxiliary venturi pipe in throttle duct badly fouled.

6) Engine intake valves leaking.

ENGINE FAILS TO STOP

1) Cable control incorrectly adjusted.

2) Retainers on adjusting sleeve are loose.

ENGINE OVERHEATS

1) Excessive maximum speed. (Exceeds permissable no-load maximum speed.)

2) Advanced or retarded injection pump start of delivery