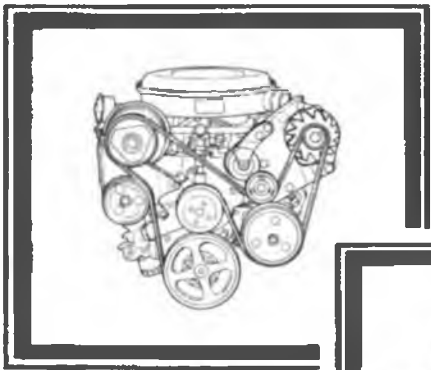
CHEVROLET
DIESEL FUEL SYSTEMS



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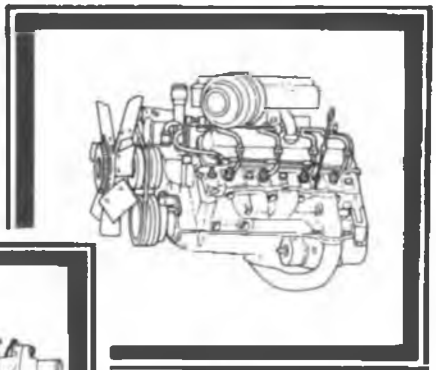

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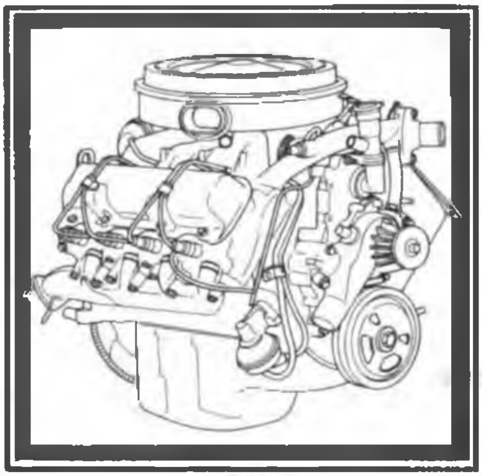

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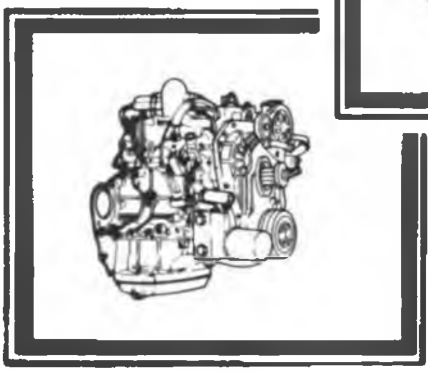

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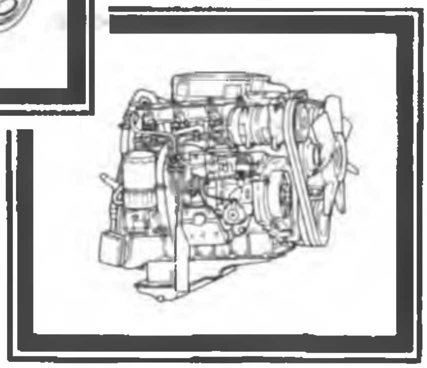


2.2L

OPERATION, DIAGNOSIS AND REPAIR MANUAL

CHEVROLET GM

ST-371-82

FOREWORD

This supplemental manual is designed to provide dealer service personnel with information on diagnosing, maintaining and servicing the diesel fuel injection systems used in Chevrolet passenger cars and light-duty trucks equipped with diesel engines.

When reference is made to a specific tool, number or brand name, an equivalent product may be used in place of the recommended item.

All information, specifications and illustrations contained in this manual are based on the latest product information at the time of publication. The right is reserved to make product or publication changes, at any time, without notice.

Portions of this manual were produced with the aid of Stanadyne Inc., Diesel Systems Group; Lucas CAV, a division of Lucas Industries, Inc.; and Diesel Kiki U.S.A. Co., Ltd.

CONTENTS

SECTION 1

DIESEL FUEL FAMILIARIZATION

Diesel fuel covers a broad group of petroleum-based fuels ranging from crude oil to kerosene. Depending on the engine and its operation, these fuels will burn in a diesel engine. The major difference in gas engines and diesel engines is in fuel source, compression ratio and fuel-air mix. (Fig. 1-1)

	Compression Ratio	Fuel Source	Fuel-Air Mix (intake)
Gasoline Engines	8:1	Carbureted	air-fuel mist
Diesel Engines	20:1	Injected	air only

Fig. 1-1

Because of their design and use, Chevrolet diesel engines use a narrow range of diesel fuels. These fuels are rated at No. 1-D, No. 2-D and Winterized or Blended No. 2-D.

A characteristic of diesel fuel rating is Pour Point and Cloud Point. Paraffin or wax is a component of diesel fuel. The Cloud Point represents the temperature when the wax in diesel fuel begins to crystalize and separate from the fuel. The Pour Point represents the temperature when the wax crystals interlock and fuel cannot be pumped. The fuel is held in suspension like a sponge holds water.

No. 1-D fuel has the lowest cloud point and pour point (−20°F/−40°F). No. 2-D has a higher cloud point and pour point (20°F/0°F). Blended or winterized No. 2-D varies between the two based on the blend.

Chevrolet recommends No. 2-D whenever ambient (outside) temperatures are above 20°F. During cold weather months, No. 1-D should be used. If blended or winterized No. 2-D is available, it can be used instead of No. 1-D. (Fig. 1-2)

Rated Fuel	Ambient Temperature	
	Above 20°F	Below 20°F
No. 1-D		Approximately Cloud Point (−20°) Pour Point (−40°)
No. 2-D	Approximately Cloud Point (20°) Pour Point (0°)	
Blended No. 2-D		Cloud Point (Varies) Pour Point (Varies)

Fig. 1-2

DIESEL FUEL CONDITIONERS

A number of diesel fuel conditioners or modifiers are commercially available. Chevrolet does not recommend their use in cars and light duty trucks. Also, the practice of mixing unleaded gasoline with diesel fuel to reduce cloud point/pour point is not recommended, regardless of previous information that suggested it.

VISCOSITY

Viscosity is an important physical property of a diesel fuel affecting injection pump internal leakage and lubrication and injector lubrication and atomization.

The minimum viscosity is limited by the need for adequate injector and injection pump lubrication. Lower viscosity fuels are thinner and therefore will cause a higher rate of internal pump and injector leakage and injector dribblings which can lead to loss of power or smoke problems.

Since viscosity influences the size of the fuel droplets, it governs the degree of atomization and penetration of the fuel spray. These are major factors in obtaining sufficient mixing of fuel and air essential for proper combustion. If the viscosity is too high, the fuel droplets will be too large for proper mixing and poor combustion will result. Also, the droplets may strike the relatively cold cylinder wall and fail to burn. If the viscosity is too low, the fuel spray will not travel across the combustion chamber and the poor mixing will result in improper combustion. Poor combustion results in loss of power and excessive exhaust smoke.

CETANE

Technicians should be aware of cetane ratings for diesel fuel. Cetane ratings should not be confused with octane ratings for gasoline. Cetane can be thought of as the ignition quality of diesel fuel. Generally speaking, the higher the cetane rating, the better the ignition quality. A high cetane rated fuel ignites quickly with short delay or lagging. Conversely, a low cetane rated fuel will take much longer to ignite, and may cause excessive knock and roughness.

The diesel engines currently used by Chevrolet are for the most part insensitive to cetane ratings, due to the use of glow plugs for a starting aid. However, the consistent use of a high cetane rate diesel fuel will aid in the prevention of engine knock.

FUEL TRANSFER AND FILTERING SYSTEM

There is little difference in the fuel tank and fuel transfer system between diesel and gasoline cars and light duty trucks. Tank location and filler neck construction is essentially the same. One difference is in fuel tank caps. The diesel fuel cap has a two-way valve which allows built up hot air to bleed off. It also prevents fuel spills in the event of a rollover. This cap is not interchangeable with gasoline caps, although the gasoline caps will fit the filler neck of the diesel fuel tank.

The fuel tank pickup unit is somewhat different. A water sensor, mentioned earlier, is included on most units. A saran filter or mesh sock is fitted to the end of the pickup tube. This sock filters large particles from the fuel and strains most of the water out of the fuel. (Fig. 1-3)

The sock can become clogged when diesel fuel cools below the cloud point. A check valve at the top of the sock opens when the sock is clogged, allowing fuel to pass. If the fuel level drops below the check valve opening, a no start/

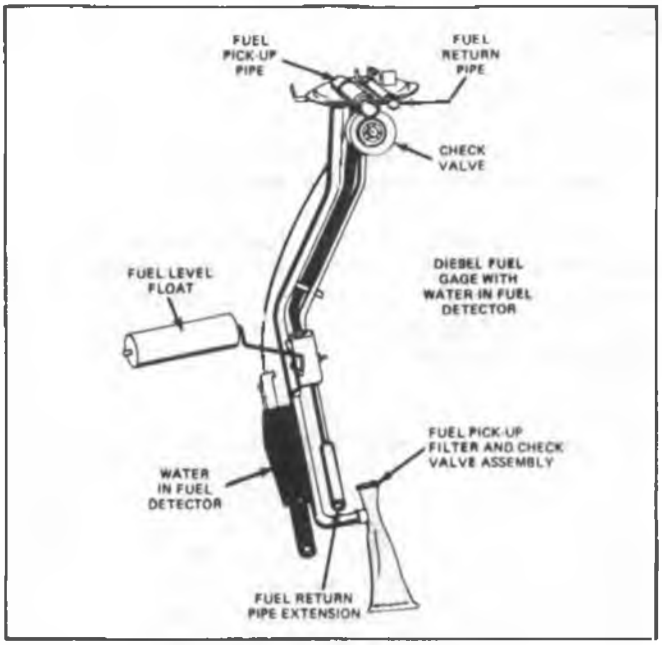


Fig. 1-3 Fuel Tank Pick Up Unit

out of fuel condition will occur. Therefore, drivers must keep at least a quarter tank of fuel in the vehicle during winter months.

NOTE: The LUV truck is not equipped with a check valve at the sock on the fuel pickup unit.

FUEL PUMPS

Fuel pumps or fuel lift pumps draw fuel from the fuel tank and pump it into the fuel injection system. Fuel pumps must keep fuel flow constant when the engine is running. Chevrolet uses two types of pumps; a conventional mechanical/diaphram type and an electric type.

The mechanical/diaphram type is found on the 6.2 and 5.7 liter diesel engines. They are located on the front, lower right side of the block. The 6.2 liter pump is driven by an eccentric lobe on the camshaft through a pushrod. The 5.7 liter pump is driven by a lever off the crankshaft. (Fig. 1-4)

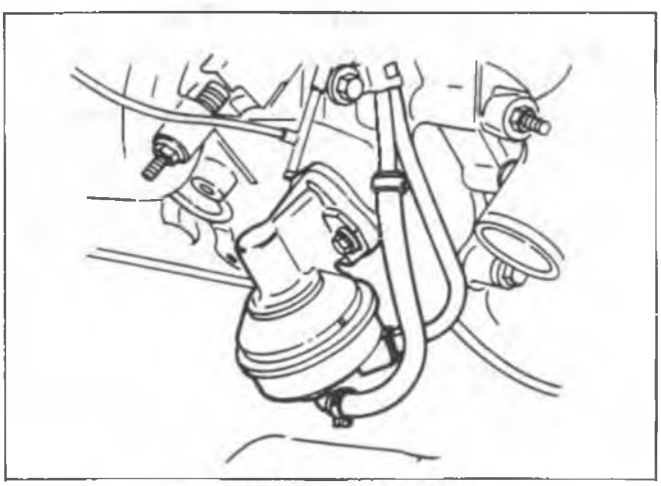


Fig. 1-4 Fuel Pump 6.2L Engine

The electric pump is used on the 4.3 liter engine. It receives battery current anytime the ignition switch is in the "run" or "start" position. The ground circuit is completed through the pump mounting bracket or through a lead wire to the threaded screw. The mounting surface must be clean and tight for proper pump operation. Maximum operating current is 3.0 AMPS. At the pump's maximum pressure, it will shut off. It will again turn on at it's minimum pressure. The pump is mounted to a stud bolt on the left bank of the engine. (Fig. 1-5)

NOTE: No external mechanical or electric fuel pump is needed on the 2.2 or 1.8 liter engines, since the supply pump in the injection pump assembly is adequate. There is however, a hand-operated priming pump incorporated in the fuel separator on the 2.2 and 1.8 liter engines.

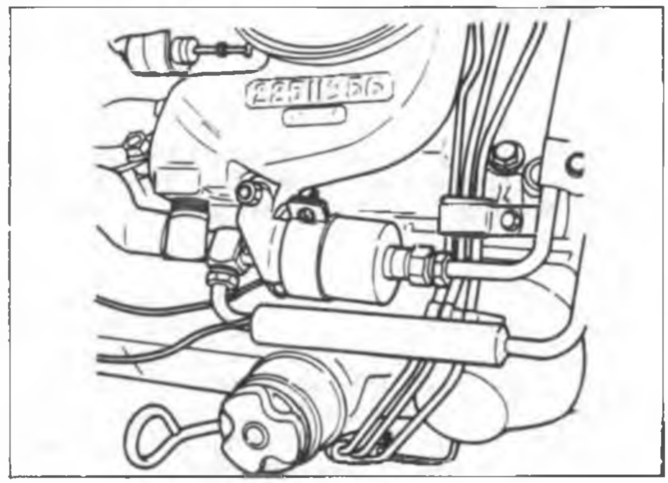


Fig. 1-5 Electric Fuel Pump

FUEL FILTERS

Fuel filters strain contaminants from the fuel prior to the fuel reaching the injection pump. All diesel engine cars and light trucks have a primary fuel filter. The 6.2 liter diesel engine also has a secondary filter.

The primary filter for the 6.2 liter engine is mounted to the cowl. A drain petcock is located on the top and bottom of the filter. Opening these petcocks will drain any water accumulated in the filter. A short length of hose is attached to the lower petcock to direct fluid away from the engine compartment.

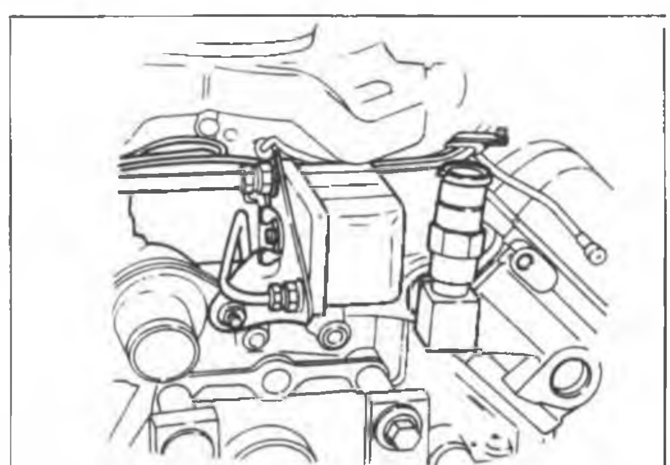


Fig. 1-6 Stanadyne Fuel Filter

The secondary fuel filter for the 6.2 liter engine is located rearward of the fuel injection pump. Fuel flows from the primary through the fuel pump to the secondary filter. The secondary filter further guards against contaminants entering the fuel injection pump.

The 5.7 and 4.3 liter engines share similar primary fuel filters. They have a micronic paper element to strain contaminants and are bracket mounted to the intake manifold, just aft of the air crossover. (Fig. 1-6)

The fuel filters for the 2.2 and 1.8 liter engines have a water separator included in them. There is also a replaceable filter element in the unit. The filter is mounted on the right fender wall of the engine compartment.

NOTE: Check the maintenance schedule in the owner's manual for replacement intervals of all fuel filters.

WATER IN FUEL

Water exists in diesel fuel. By law, .5% or ½ of 1% of water by volume is allowable in diesel fuel. Such small quantities of water are harmless to diesel engines and the fuel injection system. However, larger amounts of water have the potential for damaging the fuel injection pump.

Water in diesel fuel tends to accumulate in refinery storage tanks, tanker trucks, service station storage tanks and on-car fuel tanks. Every time diesel fuel is transferred from one tank to another, it has the potential for picking up more water. This does not mean every time a customer fills the fuel tank that water is being pumped in, only that it can and does happen.

Water in diesel fuel appears in two states, as ice crystals and as a liquid. Water in these forms is referred to as free and dispersed and as dissolved, respectively.

Most diesel fuels will have some dissolved water or moisture. This small amount of moisture remains in suspension in the diesel fuel and will pass harmlessly through the fuel injection system.

The water that accumulates is another matter. Since water does accumulate in fuel tanks, Chevrolet has included a Water-In-Fuel Indicator system on all diesel engine cars and light trucks. This system incorporates a water sensor on the fuel tank pickup unit. (Fig. 1-3). When a certain amount of water is present in the fuel tank, the sensor activates a Water-In-Fuel light in the instrument panel. The diesel engine Chevette and LUV truck has an additional Water-In-Fuel indicator in the fuel filter.

GENERAL SERVICE

WATER REMOVAL PROCEDURES

1.8 Liter Chevette/2.2 Liter LUV Truck

The water separator incorporated in the 1.8 and 2.2 liter diesel engines is part of the fuel filter. It is mounted to the fender wall, under the hood and next to the battery. The separator contains a sensing switch at the bottom of the unit. When the amount of water in the fuel reaches a predetermined level, before it is pumped into the fuel injection pump, the sensor sends a signal to the appropriate indicator lamp in the instrument panel. When the lamp is lit, the water must be purged from the system.

To drain the water from the separator, perform the following steps:

1. Unscrew the drain valve on the separator about six turns.
2. Place a container under the drain hose to catch the water and fuel.
3. Push down a number of times on the priming button at the top of the separator unit. (Fig. 1-7)
4. When clear fuel begins to flow, the water has been purged from the filter.
5. Stop pushing the priming button and close the drain valve.
6. Pump the priming button until resistance is felt. This purges air from the system.

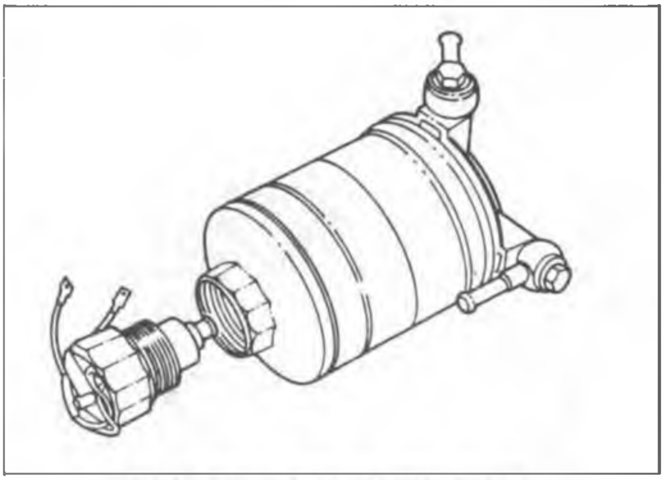


Fig. 1-7 Primary Filter with Water Sensor

NOTE: A water in fuel sensor is also incorporated on the fuel pickup unit in the fuel tank of Chevettes. This sensor warns the driver of large quantities of water in the fuel tank. When this sensor is activated, the water in the tank must be drained.

ALTERNATE WATER REMOVAL PROCEDURE

1. Disconnect the fuel return line from the fuel injection pump.
2. Connect a pump or siphon to the fuel return line and siphon the fuel into a suitable container.
3. When all water is removed, reconnect the fuel return line to the injection pump.

NOTE: A drain plug is incorporated in the fuel tank of the LUV truck. To drain the fuel tank, place a suitable container beneath the tank and remove the drain plug. When all water is removed, replace the drain plug.

CAUTION: Never drain diesel fuel in an open container, due to the possibility of fire or explosion.

6.2 Liter Light-Duty Trucks

The water-in-fuel sensor for Chevrolet Light-Duty Trucks with the 6.2 Liter diesel engine is located on the fuel pickup unit in the fuel tank. It operates on the same principle as the Chevette water-in-fuel sensor.

To remove water from fuel in light-duty trucks, perform both of the following procedures. Refer to Fig. 1-8 for primary filter location.

PRIMARY FUEL FILTER — WATER DRAIN

If water is detected or suspected in the fuel tank, the primary filter must also be checked for water as follows:

1. Remove the fuel tank fuel cap.
2. Place a container below the drain hose.
3. Open the petcock on the bottom of the filter.
4. Open the petcock on the top of the filter housing. Allow not more than ½ cup of fuel to drain out — close both petcocks.
5. Start the engine and operate at high idle for two to three minutes to purge air from the filter.
6. If water or emulsion is present in the drained fuel repeat steps 2. through 5.
7. If more than a pint of water is removed from the primary filter both the primary and secondary filter should be replaced.

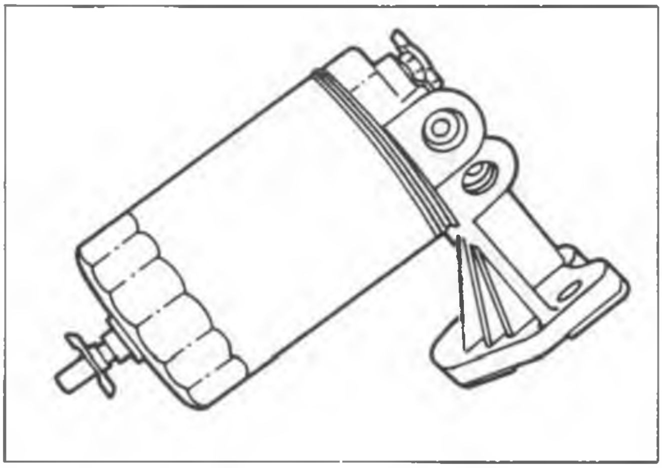


Fig. 1-8 Primary Filter 6.2L Engine

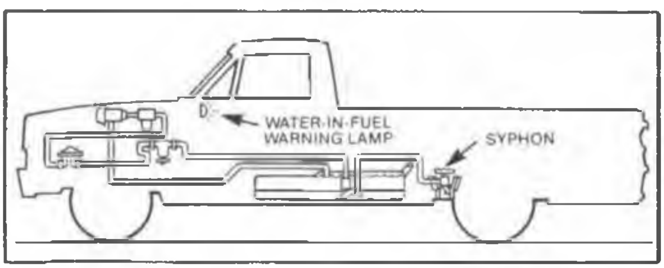


Fig. 1-9 Fuel System Siphon Light Truck

REMOVAL FROM FUEL TANK SIPHON SYSTEM

A siphoning system is incorporated on light truck models to provide for easier fuel removal. On pickups, the siphon valve is located at the rear spring hanger. On Suburbans and Blazers, it is at the mid way point of the right frame rail. (Fig. 1-9).

WATER REMOVAL

Fuel Tank —

1. Park vehicle in a relatively level attitude. The water pick up is in the approximate center of tank.
2. Connect siphon hose to the petcock (drain valve) located on the right frame rail approximately one foot forward of the front of fuel tank.
3. Open the petcock. Siphon or drain until all water is removed.
4. If compressed air is available, water may be drained by slightly pressurizing the tank as follows: with the fuel fill cap installed properly, apply low pressure (1-2 psi maximum) air through the fuel drain back hose, at the injection pump. The tank is designed to retain 1-2 psi pressure, allowing water to be forced out of the tank via the petcock and drain hose.
5. Close the petcock tightly and remove drain hose. NOTICE: Petcock must be closed tightly to prevent siphon action or fuel leakage.
6. Install fuel cap if previously removed.

5.7 and 4.3 Liter Engine Passenger Cars and Light Trucks

The water-in-fuel sensor for all diesel engine passenger cars and some early model trucks is located on the pickup unit in the fuel tank. When the sensor activates the water-in-fuel lamp in the instrument panel, the water must be drained from the fuel tank. To do this, perform the following procedure:

1. Remove fuel cap.
2. Disconnect the fuel return line where it is connected to the ¼" fuel return hose near the fuel pump.
3. Connect a length of hose or a pump to the fuel return line and direct the hose to a suitable container.
4. Begin siphoning/pumping fuel from the tank. When clear fuel begins to flow, water has been removed from the tank. Stop siphoning/pumping.
5. Remove the length of hose from the fuel return line and reconnect the fuel return line to the fitting at the top of the fuel injection pump.

ALTERNATE WATER REMOVAL PROCEDURE

1. Remove fuel tank cap.
2. Connect a pump or siphon hose to the ¼-inch fuel return hose above the rear axle. (This is the smaller of the two fuel lines.)
3. Siphoning should continue until all the water is drained from the fuel tank.
4. Reinstall the fuel return line and the fuel cap.

IN LINE FUEL HEATER

The in line fuel heater is a cold weather operational aid. It is designed to prevent paraffin from clogging the final fuel filter, either a primary or secondary, depending on the engine. The heater is electric and has an internal thermostat limiting temperature to approximately 50°F.

The heater is standard equipment on the 6.2 liter engine and is available as an option on the 5.7 and 4.3 liter engines. Customers living in cold climates are urged to include the heater on their cars.

WATER IN FUEL DETECTOR DIAGNOSIS

OPERATION

THE DIESEL "WATER IN FUEL" SYSTEM USES AN ELECTRONIC WATER DETECTOR MOUNTED INSIDE THE FUEL TANK ON THE FUEL GAGE SENDER. THE DETECTOR WILL WARN THE DRIVER WHEN 1 2½ GALLONS OF WATER ARE PRESENT IN THE FUEL TANK BY LIGHTING A "WATER IN FUEL" LIGHT ON THE INSTRUMENT PANEL. THE LIGHT WILL ALSO COME ON FOR 2 5 SECONDS EACH TIME THE IGNITION IS TURNED ON. THIS BULB CHECK ASSURES THE DRIVER THE LIGHT IS WORKING.

WHEN WATER IS DETECTED IT CAN BE DRAINED THROUGH THE FUEL RETURN LINE WITHOUT REMOVING THE FUEL TANK.

✱ TORONADO HAS A 3 WIRE CONNECTOR.

WATER IN FUEL LIGHT ON AT ALL TIMES

With ignition on disconnect 2 wire (yel/blk-pink) connector✱ at rear of fuel tank and check water in fuel light.

- LIGHT ON → Locate and repair short to ground in yel/blk wire from 2 wire connector to IP water in fuel lamp.
- LIGHT OFF → Purge fuel tank per purging instructions. Connect 2 wire connector✱ and check water in fuel light.
  - LIGHT ON → Remove tank unit. Check wires for short circuits. If OK, replace detector.
  - LIGHT OFF → Normal - fuel had water in it.

WATER IN FUEL LIGHT DOES NOT COME ON DURING BULB CHECK

With ignition on disconnect 2 wire (yel/blk-pink) connector✱ at rear of fuel tank and ground the yel/blk wire in the body harness. Check water in fuel light.

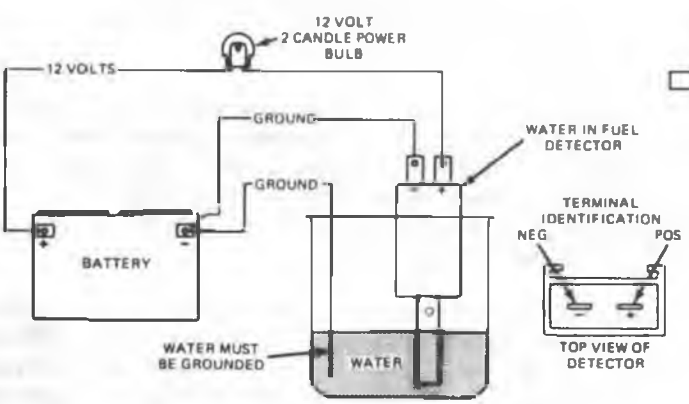
- LIGHT ON → Remove fuel gage tank unit and check yel/blk wire for opens. Check connections to water in fuel detector and mounting screw- must be tight. If OK, replace water in fuel detector.
- LIGHT OFF → Check water in fuel bulb. If OK, check for open circuit in yel/blk wire from 2 wire connector at rear of tank to IP water in fuel lamp socket.

FUEL TANK PURGE PROCEDURE

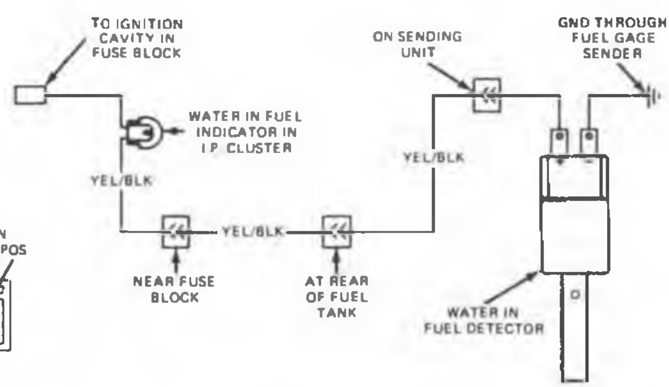
Cars which have a "Water in Fuel" light may have the water removed from the fuel tank with a pump or by siphoning. The pump or siphon hose should be hooked up to the 1/4 inch fuel return hose (smaller of the two fuel hoses) above the rear axle or under the hood near the fuel pump. Siphoning should continue until all water is removed from the fuel tank. Use a clear plastic line or observe filter bowl on draining equipment to determine when clear fuel begins to flow. Be sure to remove the cap on fuel tank while using this purge procedure. Replace the cap when finished. The same precautions for handling gasoline should be observed when purging diesel fuel tanks.

TESTING WATER IN FUEL DETECTOR

Connect water in fuel detector as shown using a 12 V 2 C. P. bulb. There must be a ground circuit to the water for the detector to work. The light will turn on for 2-5 seconds then dim out. It will then turn back on (after 15-20 second delay) when about 3/8" of the detector probe is in the water. Refer to illustration for test set-up.



TEST SET UP



WATER IN FUEL DETECTOR CIRCUIT

Fig. 1-10 Water in Fuel Tank Unit Diagnosis

NOTE: The in line fuel heater is currently not available for the 2.2 or 1.8 liter engines.

The heater on the 6.2 liter engine is located between the fuel pump and secondary filter. On the 5.7 and 4.3 liter engines, it is located between the fuel pump and primary filter. (Fig. 1-11)

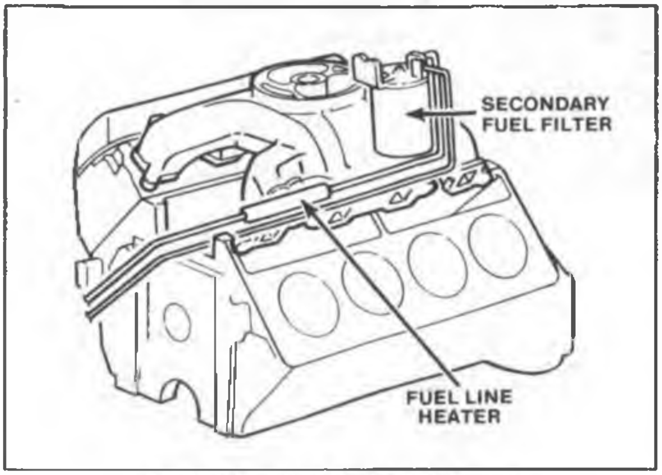


Fig. 1-11 Fuel Line Heater 6.2L Engine

The in line fuel heater is available for retro-fit. The retro-fit kit is available through GMWDD. Installation is as follows:

5.7 Liter Engine

1. Disconnect negative battery cables.
2. Remove air cleaner and air crossover and install air crossover screens.
3. Remove the air compressor brace on A/C equipped cars or the upper alternator brace on non-A/C equipped cars.
4. Disconnect the TV cable at the bell crank and the TV cable bracket. Move these over the top of the fuel line.
5. Disconnect and/or move any vacuum lines or electrical wires routed over the top of the fuel line.
6. On 1981 5.7 liter engines, remove the crankcase vent pipe from the rear of the manifold.
7. On 1980 and 81 models, disconnect the fuel return line and move aside.
8. Disconnect the fuel line at the fuel pump and fuel filter. If necessary, the fuel line can be cut out.
9. Remove the right attaching bolt to the water outlet and replace with a stud bolt if not already in place.
10. On 1978, 79 and 80 models, bend the tab that holds the electrical sheath to the right bank valve cover to a 90 degree angle to provide clearance.
11. Install the fuel line heater. It may be necessary to loosen the wing nut that attaches the fuel filter to the intake manifold in order to start the threads.
12. Two clips are included in the kit to keep the fuel line from moving. Attach one to the stud bolt at the water outlet, the other to the TV cable bracket when reinstalling.
13. Connect the female electrical connector from the heater to the injection pump solenoid and connect the fuel solenoid connector to the pigtail on the fuel line heater.
14. On 1981 models, disconnect the EGR switch lead and connect the heater to this circuit.
15. Reassemble engine components in reverse order.

4.3 Liter Engine

1. Disconnect negative battery cable'
2. Disconnect the existing fuel line ,om the primary fuel filter to the fuel pump.
3. Loosen the retainer to the fı .l pump feed line and remove the fuel line.
4. Install the fuel heater betw.en the fuel pump and primary filter.
5. Connect the female electrical connector from the heater to the injection pump solenoid and connect the fuel solenoid connector to the pigtail on the fuel line heater.
6. Tighten the retainer to the fuel feed line.
7. Reconnect the negative battery cables.

ENGINE BLOCK HEATER

All Chevrolet diesel engine cars and light duty trucks are equipped with an electric engine block heater. The heater warms the coolant in the engine to aid cold starts in severe weather. (Fig. 1-12)

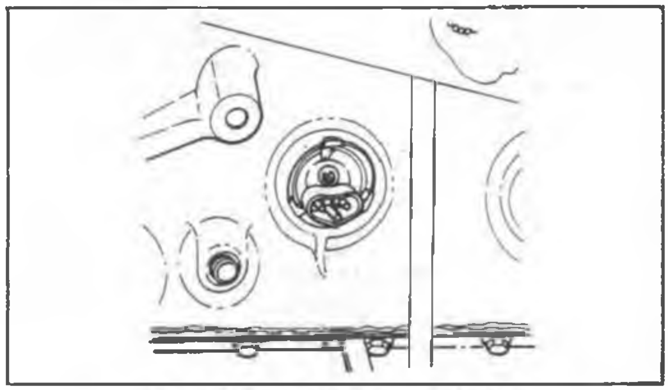


Fig. 1-12 Engine Block Heater Typical

The block heater has a conventional 3-prong, 120 volt plug and cord, usually coiled and strapped to the front of the engine compartment.

DIESEL ENGINE OILS

Engine oils are labeled on the containers with various API (American Petroleum Institute) designations of quality. Use an oil labeled with both designations SF and CD; or, with both designations SF and CC. Using any quality oils other than those recommended could cause engine damage. Do not use oils labeled only SA, SB, SC, SD, SE, CA, CC or CD; or oils with a combination of any of these letters—such as "SE/CD."

Engine oil viscosity has an effect on fuel economy. Lower viscosity engine oils can provide better fuel economy; however, higher temperature weather conditions require higher viscosity engine oils for satisfactory lubrication. Using any viscosity oils other than those recommended could cause engine damage.

When choosing an oil, consider the range of temperature the vehicle will be operated in before the next oil change. For temperatures above 32°F, SAE 30 is the preferred viscosity grade. SAE 30 oil is also preferred for continuous duty driving and all driving where temperatures will not be less than 32°F.

Check the owner's manual to the particular car or light truck being serviced for oil change intervals.

SECTION 2
STANADYNE INJECTION PUMP

STANADYNE PUMPS

The Stanadyne pumps are an opposed plunger, inlet metered, positive displacement, distributor-type pump. They are mechanically linked to the camshaft, and therefore operate at camshaft speed, or one half of engine speed.

The injection pump on the 6.2 liter engine is mounted below the intake manifold in the cylinder head valley. A gear bolted directly to the pump drive shaft is driven by a gear to the camshaft. Both gears are in the front cover assembly (Fig. 2-1).

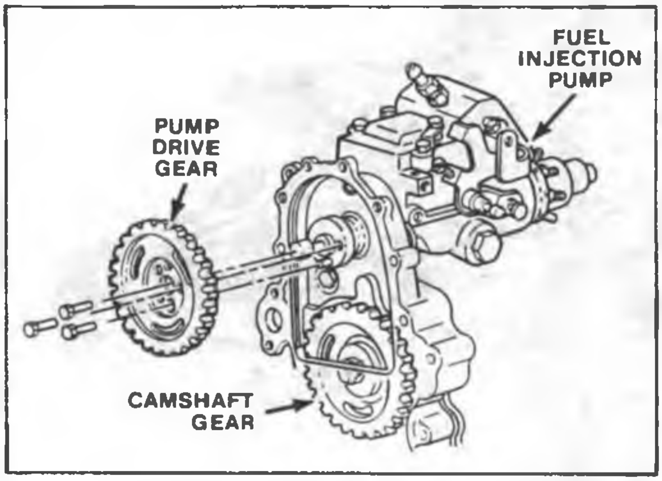


Fig. 2-1 Pump Drive Gear 6.2L Engine

The pumps used on the 5.7 and 4.3 liter engines are mounted through the intake manifold. The drive shaft to both of these pumps has a large offset tang on the end which fits into a slotted extension of a driven gear. The driven gear is mounted through a bore in the cylinder block at an angle, so that the gear meshes with the camshaft gear (Fig. 2-2).

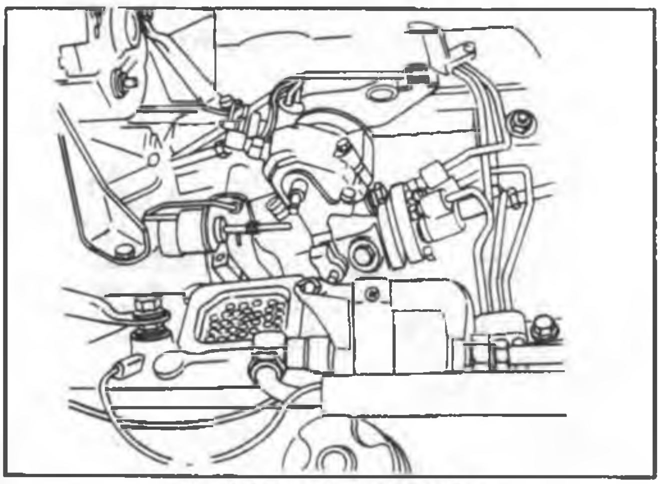


Fig. 2-2 Pump in Engine Valley

INJECTION PUMP OPERATION

It is necessary to become familiar with the function of the main components to understand the basic operating principles of the injection pump. Figures 2-3 and 2-4 will show the main components.

The main rotating components are the drive shaft (1), transfer pump blades (5), distributor rotor (2), and governor (12).

The drive shaft engages the distributor rotor in the hydraulic head. The drive end of the rotor incorporates two pumping plugers.

The plungers are actuated toward each other simultaneously by an internal cam ring through rollers and shoes which are carried in slots at the drive end of the rotor. The number of cam lobes equals the number of engine cylinders.

The hydraulic head contains the bore in which the rotor revolves, the metering valve bore, the charging ports and the head discharge fittings. The high pressure injection lines to the nozzles are fastened to these discharge fittings.

FUEL FLOW

The fuel flow schematic in Figures 2-3 and 2-4 show the major components and their relationships.

Fuel is drawn through a strainer in the tank by the fuel pump. Fuel under pressure flows through the fuel filter into the transfer pump and pressure regulator suction side.

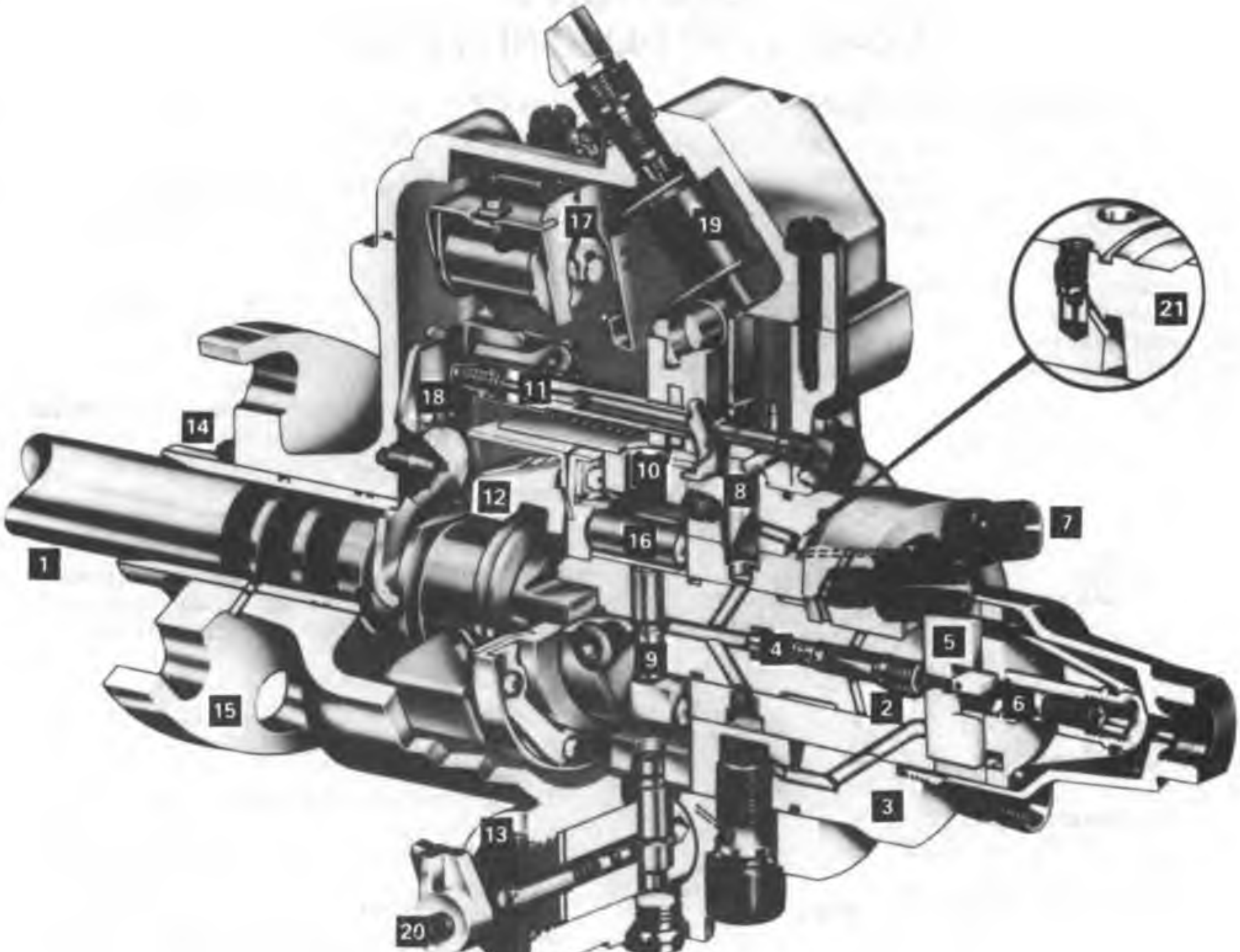
Fuel under transfer pressure now splits into several directions. To the pressure side of the pressure regulator, to the head passage where four radial passages lead to the vent wire assembly, the pressure tap hole plug, the advance mechanism and the metering value.

The metering valve is the equivalent of throttle plates in a carburetor. It controls fuel flow to the pumping plungers.

The vent wire assembly is threaded into the top of the hydraulic head assembly next to the metering valve. It allows air and a controlled amount of fuel to escape to the housing where it will flow back to the fuel tank via the return oil circuit. The vent wire assembly is made up of a screw with a hole through it into which a wire is positioned.

The wire is free to vibrate and resists plugging by debris. Fuel, which flows through the vent wire assembly, circulates in the housing to cool and lubricate the internal pump components. A selection of screw assemblies containing different wire sizes is available to obtain the correct amount of return flow.

The housing pressure regulator is a ballcheck fitting in the governor cover which maintains even housing pressure and allows fuel to return to the fuel tank. This recirculation of fuel maintains normal operating temperature. At full load conditions, approximately half of the fuel which enters the pump is injected into the engine cylinders while the other half is returned to the fuel tank.



COMPONENTS:

1 DRIVE SHAFT
2 DISTRIBUTOR ROTOR
3 HYDRAULIC HEAD
4 DELIVERY VALVE
5 TRANSFER PUMP
6 PRESSURE REGULATOR
7 DISCHARGE FITTING
8 METERING VALVE
9 PUMPING PLUNGERS
10 INTERNAL CAM RING
11 MIN-MAX GOVERNOR
12 GOVERNOR WEIGHTS
13 ADVANCE
14 DRIVE SHAFT BUSHING
15 HOUSING
16 ROLLERS
17 ELECTRIC SHUT-OFF
18 TEMPERATURE IDLE COMPENSATOR
19 HOUSING PRESSURE COLD ADVANCE
20 MECHANICAL LIGHT LOAD ADVANCE LEVER
21 VENT WIRE ASSEMBLY

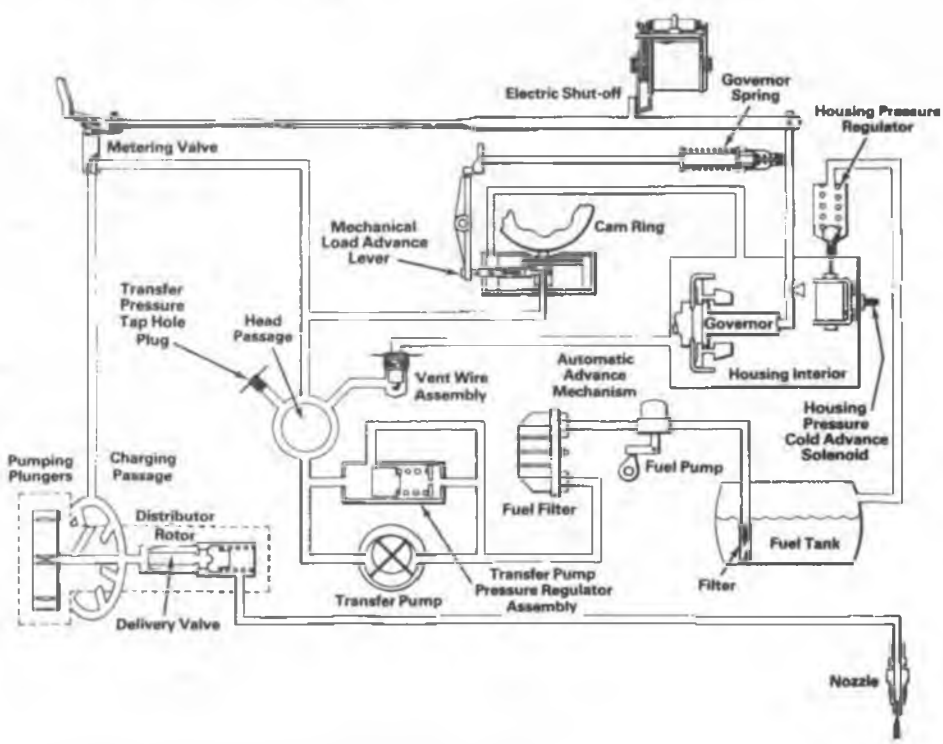


Fig. 2-3 Stanadyne DB2 with H.P.C.A. Typical 1982

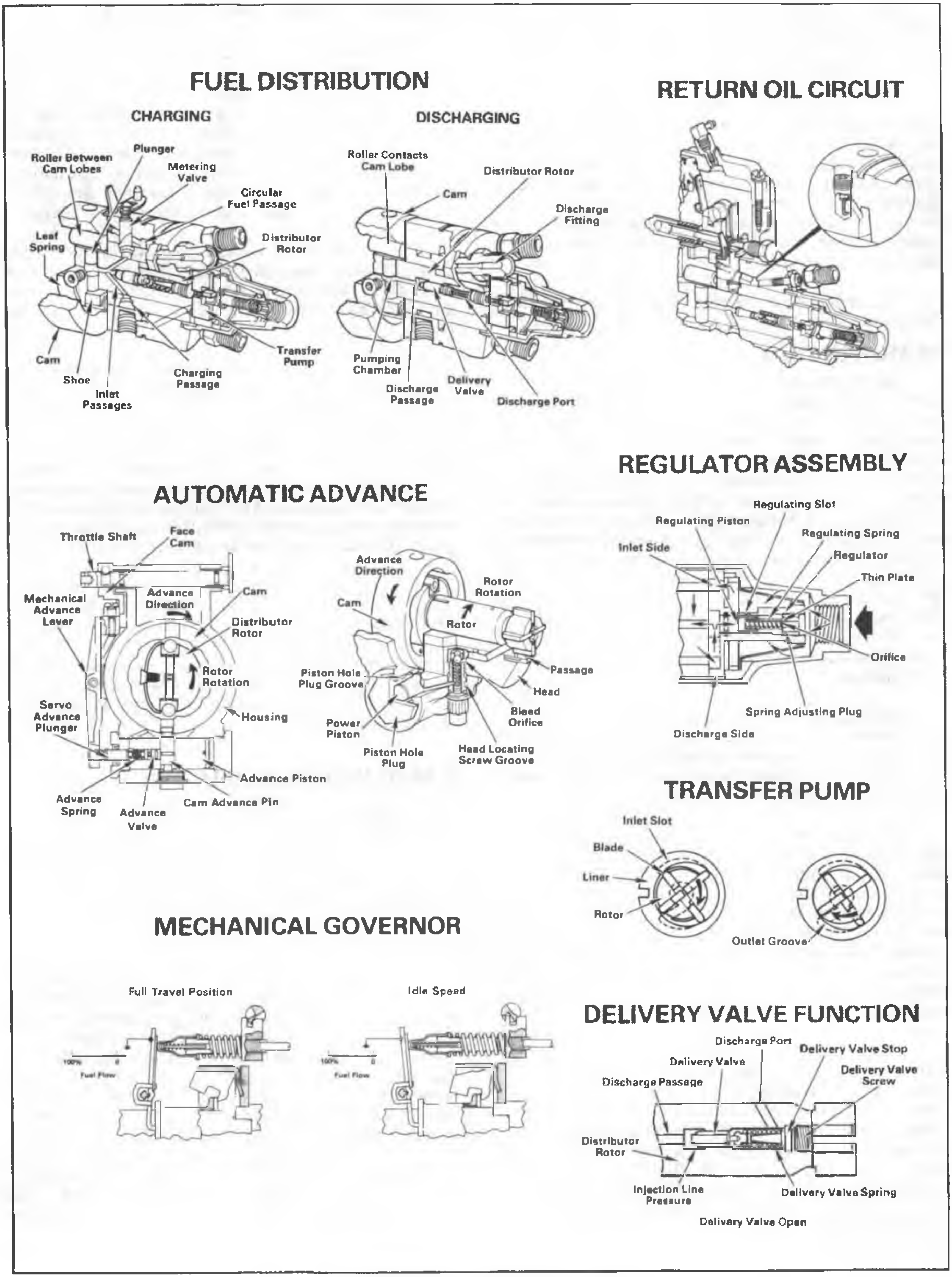


Fig. 2-4 Operating Principles Typical 1982

Fuel in the head passage also flows through a bore leading to the metering valve. The metering valve allows a varying amount of fuel to pass by, depending on its position, to charge the pumping plungers.

As the rotor revolves, the rotor inlet passage registers with the charging ports in the hydraulic head, allowing fuel to flow into the pumping chamber. With further rotation, the inlet passages move out of registry and the discharge port of the rotor registers with one of the head outlets. While the discharge port is opened, the rollers contact the cam lobes forcing the plungers together. Fuel trapped between the plungers is then pressurized and delivered by the nozzle to the combustion chamber.

Self-lubrication of the pump is an inherent feature of the pump.

TRANSFER PUMP

The transfer pump at the rear of the rotor is of the positive displacement vane type and is enclosed in the end cap. The end cap also houses the fuel inlet strainer and transfer pump pressure regulator. The face of the regulator assembly is compressed against the liner and distributor rotor and forms an end seal for the transfer pump. The injection pump is designed so that end thrust is against the face of the transfer pump pressure regulator. The distributor rotor incorporates two charging ports and a single axial bore with one discharge port to service all head outlets to the injection lines. The transfer pump consists of a stationary liner and spring loaded blades which are carried in slots in the rotor. Since the inside diameter of the liner is eccentric to the rotor axis, rotation causes the blades to move in the rotor slots. This blade movement changes the volume between the blade segments.

Transfer pump output volume and pressure increases as pump speed increases. Since displacement and pressure of the transfer pump can exceed injection requirements, some of the fuel is recirculated by means of the transfer pump regulator to the inlet side of the transfer pump.

The operation is shown under Operating Principles in Figures 2-3 and 2-4. Radial movement causes fuel to be drawn into the kidney shaped inlet slot. As the blades rotate in the eccentric liner they move outward and the volume increases until the leading blade passes out of the registry with the slot. At this point, the rotor has reached a position where outward movement of the blades is negligible and volume is not changing, as the rotation continues. The fuel between the blades is carried to the bottom of the transfer pump liner and enters the outlet groove.

As the leading blade passes the opening of the kidney shaped outlet groove, the eccentric liner compresses the blades in an inward direction. As a result, the volume between the blades is reduced and pressurized fuel is delivered through the groove of the regulator assembly, through the transfer pump, through the rotor, past the rotor retainers and into a channel on the rotor leading to the hydraulic head passages. Volume between the blades continues to decrease, pressurizing the fuel in the quadrant, until the trailing blade passes the opening in the outlet groove.

PRESSURE REGULATOR ASSEMBLY

The Operating Principles Charts in Figures 2-3 and 2-4 show the operation of the pressure regulating piston. Fuel output from the discharge side of the transfer pump forces the piston in the regulator against the regulating spring. As flow increases, the regulating spring is compressed until the edge of the regulating piston starts to uncover the pressure regulating slot. Since fuel pressure on the piston is opposed by the regulating spring, the delivery pressure of the transfer pump is controlled by the spring rate and size of the regulating slot. Therefore, pressure increases with speed.

The transfer pump works equally well with different grades of diesel fuel and varying temperatures, both of which affect fuel viscosity. A unique and simple feature of the regulating system offsets pressure changes caused by viscosity difference.

Located in the spring adjusting plug is a thin plate incorporating a sharp-edged orifice. The orifice allows fuel leakage past the piston to return to the inlet side of the pump. Flow through a short orifice is virtually unaffected by viscosity changes. The biasing pressure exerted against the back side of the piston is determined by the leakage through the clearance between the piston and the regulator bore and the pressure drop through the sharp edged orifice. With cold or viscous fuels, very little leakage occurs past the piston. The additional force of the back side of the piston from the viscous fuel pressure is slight. With hot or light fuels, leakage past the piston increases, fuel pressure in the spring cavity increases also, since flow past the piston must equal flow through the orifice. Pressure rises due to increased piston leakage and pressure rises to force more fuel through the orifice. This variation in piston position compensates for the leakage which would occur with thin fuels and design pressures are maintained over a broad range of viscosity changes.

CHARGING AND DISCHARGING

Charging Cycle

As the rotor revolves, as shown in Figures 2-3 and 2-4, the two inlet passages in the rotor register with ports of the circular charging passage. Fuel under pressure from the transfer pump, controlled by the opening of the metering valve, flows into the pumping chamber forcing the plungers apart.

The plungers move outward a distance proportionate to the amount of fuel required for injection of the following stroke. If only a small quantity of fuel is admitted into the pumping chamber, as at idling, the plungers move out a short distance. Maximum plunger travel and, consequently, maximum fuel delivery is limited by the leaf spring which contacts the edge of the roller shoes. Only when the engine is operating at full load will the plungers move to the most outward position. Note that while the angled inlet passages in the rotor are in the registry with the ports in the circular charging passage, the rotor discharge port is not in registry with a head outlet. Note also that the rollers are off the cam lobes. Compare their relative positions by observing the discharging diagram.

Discharge Cycle

As the rotor continues to revolve, the inlet passages move out of registry with the charging ports. The rotor discharge port opens to one of the head outlets. The rollers then contact the cam lobes forcing the shoes in against the plungers and high pressure pumping begins.

Beginning injection varies according to load (volume of charging fuel) and the rollers do not strike the cam at the same position. Further rotation of the rotor moves the rollers up the cam lobe ramps pushing the plungers inward. During the discharge stroke the fuel trapped between the plungers flows through the axial passage of the rotor and discharge port to the injection line. Delivery to the injection line continues until the rollers pass the innermost point on the cam lobe and begin to move outward. The pressure in the axial passage is then reduced, allowing the nozzle to close. This is the end of delivery.

Delivery Valve (Fig. 2-3 and 2-4)

The delivery valve rapidly decreases injection line pressure after injection to a predetermined value lower than that of the nozzle closing pressure. This reduction in pressure permits the nozzle valve to return rapidly to its seat, achieving sharp delivery cut-off and preventing improperly atomized fuel from entering the combustion chamber.

The delivery valve operates in a bore in the center of the distributor rotor. The valve requires no seat—only a stop to limit travel. Sealing is accomplished by the close clearance between the valve and bore into which it fits. Since the same delivery valve performs the function of retraction for each injection line, the result is a smooth running engine at all loads and speeds.

When injection starts, fuel pressure moves the delivery valve slightly out of its bore and adds the volume of its displacement to the delivery valve spring chamber. Since the discharge port is already opened to a head outlet, the retraction volume and plunger displacement volume are delivered under high pressure to the nozzle. Delivery ends when the pressure on the plunger side of the delivery valve is quickly reduced, due to the cam rollers passing the highest point on the cam lobe.

Following this, the rotor discharge port closes completely and a residual injection line pressure is maintained. Note that the delivery valve is only required to seal while the discharge port is opened. Once the port is closed, residual line pressures are maintained by the seal of the close fitting head and rotor. It is possible that the residual pressure may vary between injection lines. Because of this variance, a noticeable chuggle or feeling of slight engine misfire became apparent in vehicles equipped with standard transmissions and torque converter clutch equipped vehicles. This condition was dampened completely in the standard torque converters on earlier models.

To combat this condition of secondary injections, the 4.3 liter longitudinal engine uses snubber valves in each discharge fitting.

SNUBBER VALVES—Snubber valves are available which will prevent secondary injections and cavitation erosion of the high pressure system by weakening reflected pressure waves. A flat check, orifice type snubber valve is installed in each discharge fitting. During the pumping event, the snubber valve opens and allows unrestricted flow to the injection line. At the termination of pumping, the snubber valve is closed by the upstream pressure drop. The effective retraction velocity and resultant negative pressure wave is reduced by the restriction of the snubber valve orifice. This reduces the cavitation erosion potential. In addition, pressure waves reflected from the nozzle are partially, rather than totally, reflected as they pass through the snubber orifice. Weakening of the reflected pressure waves in this manner eliminates secondary injection with less retraction volume than would normally be required.

The 4.3 liter transverse engine uses a trailing port snubber with an equalizer groove to prevent secondary injections by de-amplifying reflected pressure waves and resonating them. The equalizer groove balances residual line pressure. Neither of the two 4.3 liter engines will use the vented rotor (residual balance ports).

RETURN OIL CIRCUIT

Fuel under transfer pump pressure is discharged into a vent passage in the hydraulic head (Fig. 2-3 and 2-4). Flow through the passage is restricted by a vent wire assembly to prevent excessive return oil and undue pressure loss. The amount of return oil is controlled by the size of wire used in the vent wire assembly, i.e. the smaller the wire the greater the flow and vice versa. The vent wire assembly is available in several sizes in order to meet the return oil quantities called for on the specification. Note that this assembly is accessible by removing only the governor cover. The vent passage is located behind the metering valve bore and connects with a short vertical passage containing the vent wire assembly and leads to the governor compartment.

Should a small quantity of air enter the transfer pump, it immediately passes to the vent passage as shown. Air and a small quantity of fuel then flow from the housing to the fuel tank and via the return line.

Housing pressure is maintained by a spring loaded ballcheck return fitting in the governor cover of the pump.

Approximately 10 psi of fuel pressure is maintained to provide a bias for the transfer pump to provide the balance needed for proper timing.

MIN-MAX GOVERNOR

The governor mechanism consists of a cage with flyweights mounted on the rotor and a system of linkages which control engine speed at idle and provide complete and rapid governor cutoff to prevent engine overspeed. At all other loads and speeds, however, it acts as a solid link between the accelerator and the metering valve. To accomplish this, the governor spring is assembled to the governor under a pre-load. Deflection of the main governor spring will only occur at pump cutoff speed. Hence, it is called min-max, indicating governor spring control at minimum and maximum speeds only.

In the full throttle position view shown in Fig. 2-3 and 2-4 the governor is in the high speed cutoff position. With the throttle in the full position, the engine (without load on it) and pump speed increases until the governor weights have generated enough force to deflect the main governor spring. Governor arm movement turns the metering valve to the shutoff position, restricting fuel delivery and preventing engine overspeed.

The low idle throttle position view shows the relationship of the governor parts when the pump is running at low idle. Notice that the throttle shaft is in the low idle position, the balance between the idle spring force and governor force positions the metering valve for low idle fuel delivery.

FUEL TEMPERATURE COMPENSATOR FOR IDLE SPEED

Because the injection pump is located in the center of the "vee," retention of heat is a critical factor in fuel thinning particularly after a high ambient heat soak. As the hotter, thinner fuel passes through the pump, internal leakage increases and therefore reduces pump output. In order to prevent engine stalling from too small an output, a bimetal compensator strip is added to the governor arm to deflect relative to the governor arm. This motion increases the metering valve opening and provides a compensated idle speed curve.

AUTOMATIC ADVANCE MECHANISM (Fig. 2-3 and 2-4)

The automatic advance is a hydraulic mechanism which advances or retards the pumping cycle.

It is powered by fuel pressure from the transfer pump, to rotate the cam slightly and vary delivery timing. The advance mechanism advances or retards start of fuel delivery in response to engine speed changes.

Compensating inherent injection lag improves high speed performance. Starting delivery of fuel to the nozzle earlier when the engine is operating at higher speeds insures that combustion takes place when the piston is in its most effective position to produce optimum power with minimum specific fuel consumption and minimum smoke.

The advance pistons located in a bore in the housing engage the cam advance screw or pin and move the cam (when fuel pressure moves the power piston) opposite the direction of rotor rotation. Fuel under transfer pump pressure is fed through a drilled passage in the hydraulic head which registers with the bore of the head locating screw. Fuel is then directed past the spring loaded ballcheck in the bore of the head locating screw. It then enters the groove on the outside diameter of the screw which registers with a drilled passage in the housing leading to the power piston side of the automatic advance assembly.

A groove around the power piston plug and a drilled passage allow the fuel to enter the advance piston bore. Fuel pressure against the piston must overcome the opposing spring force plus the dynamic injection loading on the cam in order to change the cam position. The spring loaded ballcheck in the bore of the head locating screw prevents the normal tendency of the cam to return to the retard position during injection by trapping the fuel in the piston chamber. When engine speed decreases, the hydraulic pressure is reduced and the spring returns the cam to a retarded position in proportion to the reduction in speed. The fuel in the piston chamber is allowed to bleed off through a control orifice located below the ballcheck valve in the head locating screw.

At low speeds, because transfer pump pressure is comparatively low, the cam remains in the retarded position. When engine speed increases, transfer pump pressure rises and moves the piston in the advanced direction. Advance piston movement is related to speed. Speed advance operation is shown in Fig. 2-5.

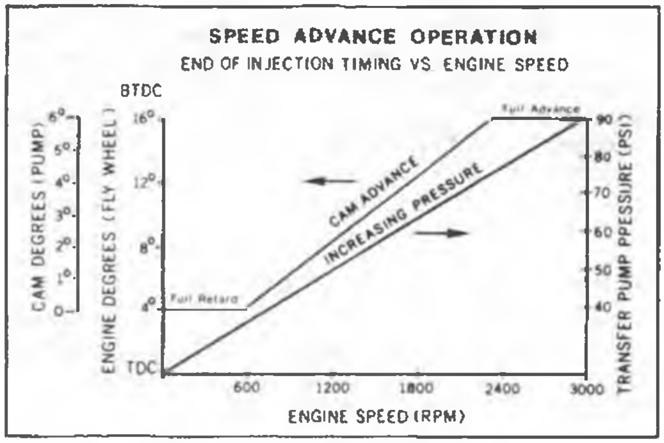


Fig. 2-5 Speed Advance Operation

On all earlier models and some current models, a "trimmer screw" is provided to adjust advance spring preload which controls start of cam movement. It can only be adjusted on a test bench while running (Fig. 2-7).

On many later models beginning with 1980, in addition to the normal speed advance, a mechanical light load advance is furnished as a function of throttle angle. The mechanism consists of a face cam attached to the throttle shaft, an external pivot lever and a pushrod which goes into the trimmer side of the timing advance bore. The purpose of this mechanism is to reduce emissions. It provides proper advance for light loads when the transfer pump pressure is low and cam ring is in the retard position.

Light load advance is provided by changing the reference point of the servo valve spring. A face cam, attached to the throttle shaft causes an external lever to pivot. The lower end of this lever contacts a pushrod which is also the servo valve spring seat. This mechanism translates rotational motion of the throttle shaft into axial motion of the servo valve spring. Transfer pump pressure, applied to the inboard side of the servo valve and opposed by the servo valve spring, provides speed advance. As the servo valve moves in the advance direction, fuel flows through radial and axial passages to the power side of the advance piston. This action moves the advance piston until it reaches the servo valve and covers the radial supply passage. The advance curve obtained with the servo advance system is essentially independent of the pumping reaction.

MECHANICAL LIGHT LOAD ADVANCE DESCRIPTION

Two subsystems are combined to form the mechanical/light load advance. The first is a servo advance mechanism which is operated by transfer pump pressure and which positions the cam ring in response to throttle setting and engine load. The major component parts of the advance are the servo advance piston (standard or oversize), the cam advance pin, the servo advance valve, the servo advance plunger, and the mechanical/light load advance spring. This system is housed in the standard DB2 advance boss location and receives transfer pump pressure from the head locating screw.

The second subsystem is the mechanical link between the throttle shaft and the servo advance plunger. This link is composed of a face cam connected to the end of the throttle shaft and a rocker lever assembly connected to the side of the pump housing by a pivot pin. A roller is attached to the upper end of the lever and rides on the surface of the face cam. The lower end of the lever contacts the protruding end of the servo advance plunger.

During pump operation, a rotary force is imparted to the cam ring by the cam rollers during injection. It acts in the direction of rotor movement and is transmitted through the cam advance pin to the servo advance piston. This force continually urges the piston toward the retard position.

An opposing force is supplied by transfer pump pressure acting on one end of the servo advance piston. The position of the servo advance valve in the piston bore regulates this force and determines the degree of advance achieved at any throttle setting or load. It is, in turn, the differential between mechanical/light load spring force and transfer pump pressure applied across the servo advance valve that locates the valve in the piston bore. Additional advance at low throttle settings is provided by the face cam to rocker lever action which changes the reference point of the spring.

Housing pressure acting on the spring side end of the advance piston forms a resistance to its movement at all speeds. If housing pressure is reduced at speeds below full advance, further advance piston movement will occur. This effect is used in the housing pressure cold advance system for 1982 models.

To help understand the following description of mechanical/light load advance operation, refer to sub figures 6A-6F in Fig. 2-6.

Sub-figure 6A shows the cam ring and advance mechanism in the retard position as it would be at cranking. The advance piston (1) is moved toward the power plug side and the servo advance valve (2) is in the position shown. With the throttle closed, the roll (3) rides on the low portion of the face cam (4) and no change is made in the reference point of the mechanical/light load advance spring (5).

As the engine accelerates, increasing transfer pump pressure is directed through the head locating screw (6) to the housing passage (7) shown in Figure 6B. This passage empties into an elongated groove (8) in the advance piston. Fuel then flows around the groove to the cam advance pin (9) and into the piston bore.

With the servo valve in the position shown in Figure 6C, fuel enters the transverse passages (10) in the advance piston and fills the single longitudinal passage (11) which extends to the piston end. An orifice screw (12) is located at this point to restrict the flow of fuel and to eliminate fluctuations caused by the varying amounts of cam loading during each pumping cycle. Fuel then fills the cavity between the advance piston and the power piston plug (13); the pressure acts on the surface of the piston and urges it, against cam loading force, toward the spring side plug (14). This linear piston motion is converted to a rotary motion of cam (15) which advances the beginning of pumping. See Figure 6D. Advance piston

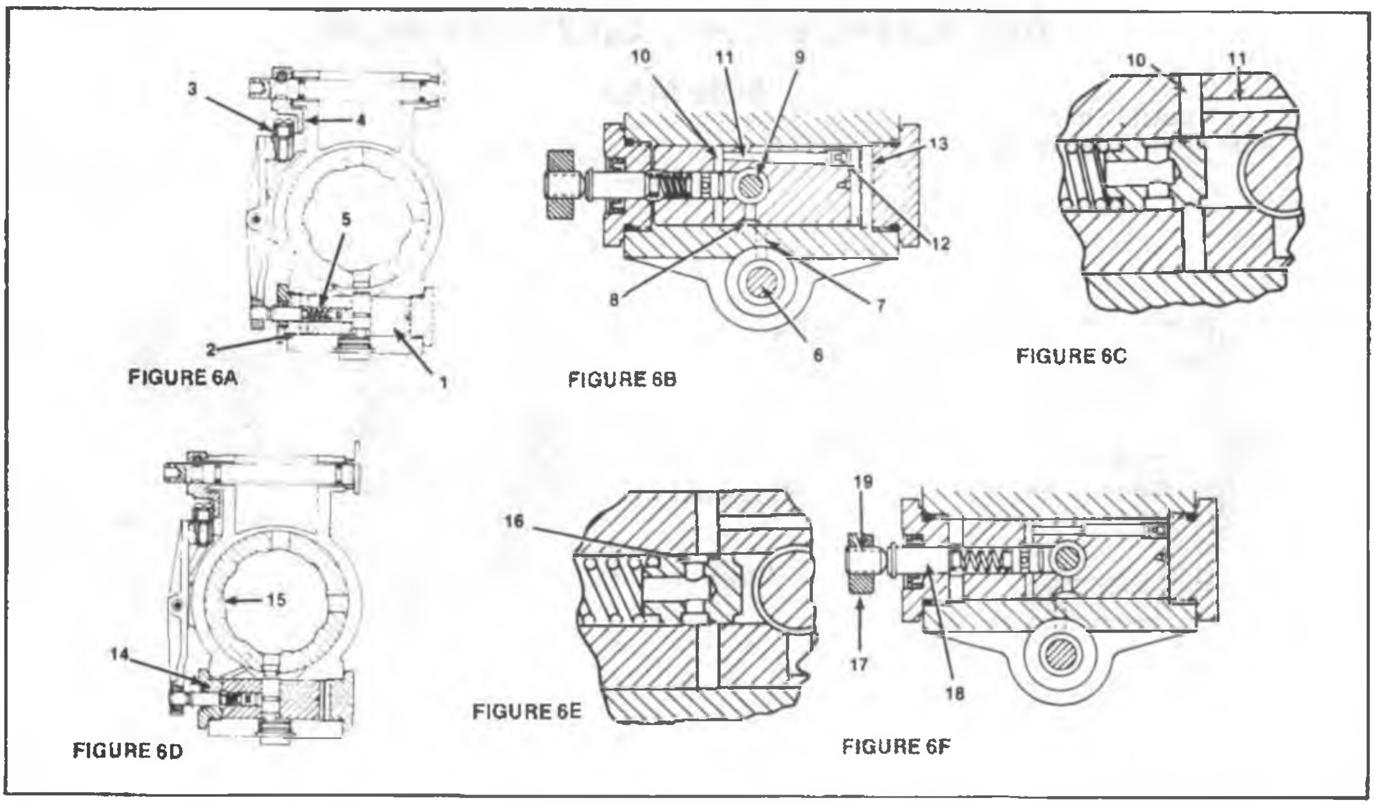
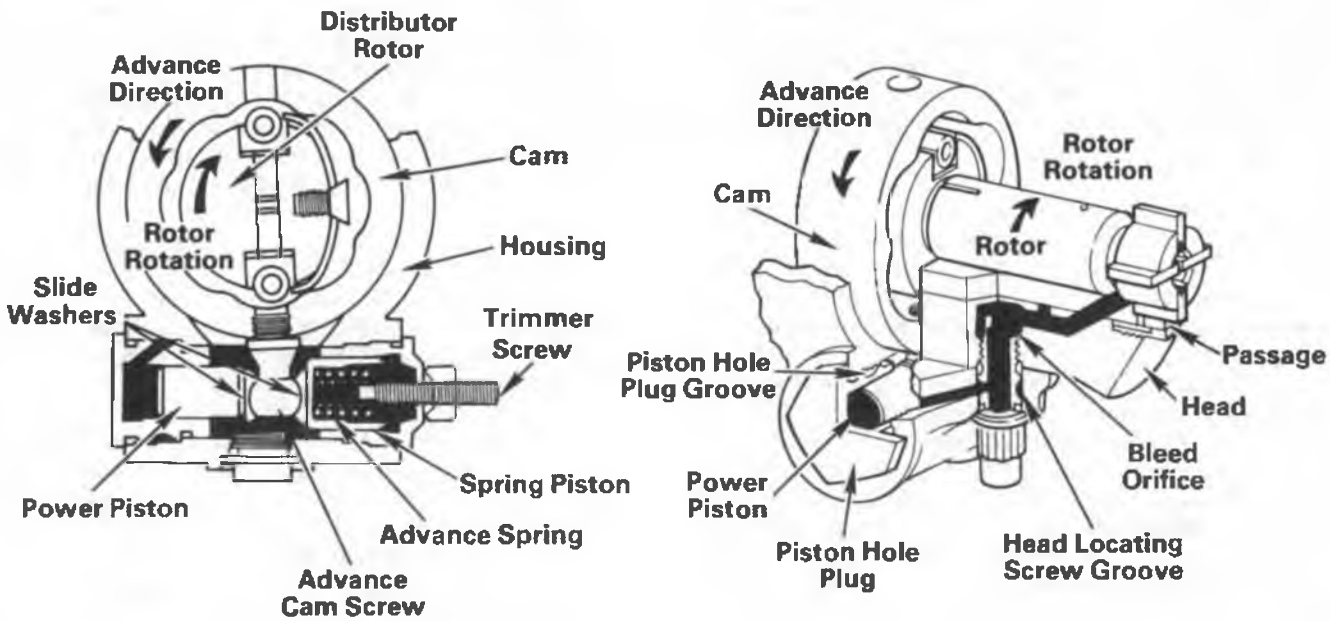


Fig. 2-6 Light Load Advance

AUTOMATIC ADVANCE



MECHANICAL GOVERNOR

MIN-MAX

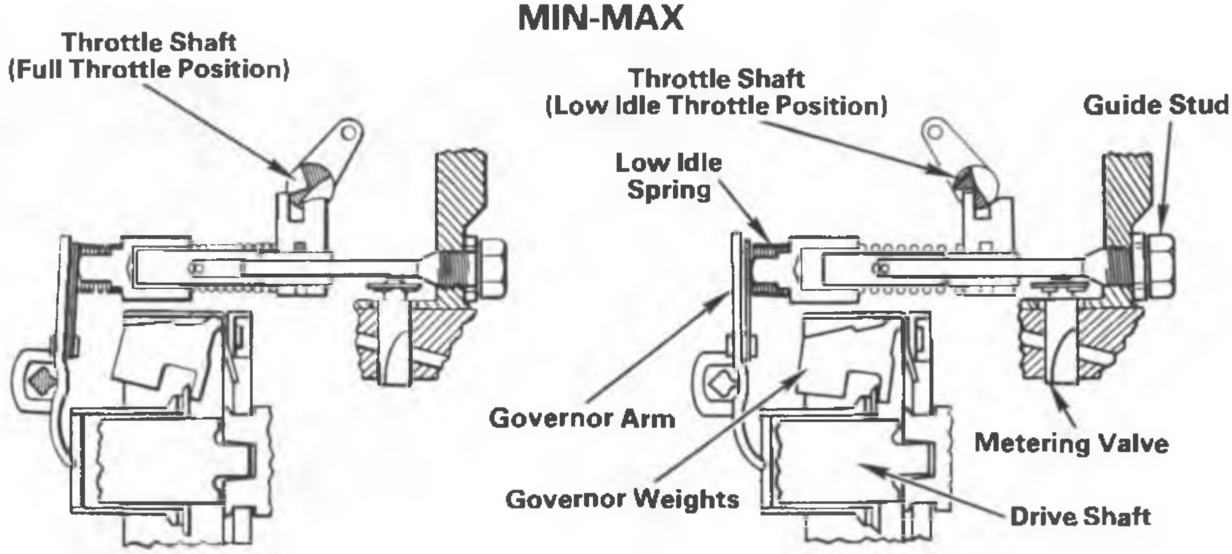


Fig. 2-7 Mechanical Light Load Principles

movement and cam ring rotation will continue as long as pump speed and transfer pump pressure increase. When pump speed stabilizes, the force of cam loading will balance the power piston force, and piston movement will cease. The servo valve, which has been moved toward the spring side end plug by the force of transfer pump pressure, tends to hover over the transverse passage due to the balancing spring force. At stable pump speed, the valve's forward edge contacts the edge of the transverse passage, sealing transfer pump pressure in the longitudinal passage and piston cavity. Increased pump speed, or transfer pump pressure, will again move the valve, against spring force, to open the transverse passage and permit further advance action.

If the pump speed is decreased, transfer pump pressure also decreases. The reduced force on the servo valve allows the advance spring to move the valve toward the cam advance pin and align the transverse passages (16) in the valve with the passages in the piston. See Figure 6E. Fuel then flows through the valve and into the piston bore. Pressure in the power plug side piston cavity is reduced and the cam loading force urges the valve toward the retard position as shown in Figure 6F. Fuel in the piston bore is vented into the housing. This action continues until the movement of the piston relative to the now stationary servo valve repositions the two parts as shown in Figure 6C and the piston transverse passages are opened to transfer pump pressure.

During the initial degrees of throttle travel, the face cam and lever assembly (17) positions the advance spring at its outboard location. This permits greater movement of the advance piston and cam ring before the servo valve begins to close the transverse passages; increased advance action at low throttle settings is then achieved. As the throttle travel angle is expanded, the ramp on the face cam actuates the lever assembly, moving the plunger (18) and the spring reference point toward the cam pin.

At a predetermined throttle angle, the surface of the face cam becomes a flat plane and the spring reference point becomes fixed. Advance action after this point is regulated by the spring rate. It should be emphasized that the action of the face cam and lever assembly does not change the rate of the action spring or its loading, only its reference point.

A system adjusting screw (19) is provided in the plunger end of the lever assembly.

HOUSING PRESSURE COLD ADVANCE (1982 PRODUCTION)

The HPCA feature is designed to advance the injection timing about 3° during cold operation. The main purpose is the reduction of engine smoke, roughness, noise and emissions during cold start-up by advancing the fuel delivery system. Through the use of an engine mounted switch, the same switch that operates the fast idle solenoid below 125°, a solenoid located in the pump cover pushes the return fitting check ball away from its seat.

NOTE: On 6.2 liter engine, advance is 4° and switch is set at 115°.

Since approximately 10 psi housing pressure which accompanies advance spring pressure in the timing advance bore is relieved, transfer pump pressure will advance timing an additional 3° which initiates combustion sooner and results in a slower, more complete burning of the fuel. Above 125°, the switch opens, de-energizing the solenoid and housing pressure is returned back to 10 psi. The switch again closes when the temperature falls below 95°F. An improved cold idle and better cold starting also results.

HPCA operates from 2 to 10 minutes depending on engine temperature.

When changing the fuel filter or when the car has run out of fuel, disconnect the connector from the temperature switch and jumper connector terminals. This will aid in purging air from the pump. This procedure is necessary only on a hot engine, as the circuit will always be closed when the engine is cold.

ELECTRIC SHUT OFF

The pump is equipped with an electric shut off solenoid which, through the governor linkage, will push the metering valve into a closed position shutting off fuel for engine shut down when voltage is removed. When the solenoid is energized, internal spring pressure inside the solenoid is overcome and through the governor linkage the metering valve is allowed to operate freely throughout its throttle range.

Coil temperature has an effect on pull-in voltage required to operate the solenoid. Figure 2-8 will show the maximum production limits. This pull-in voltage requirement should always be considered when diagnosing no start conditions. Low battery voltage may be the cause. Pull-in voltage can be tested with a Voltmeter at the pump solenoid terminal during normal starting operations. Hold in is approximately 2 to 3 volts.

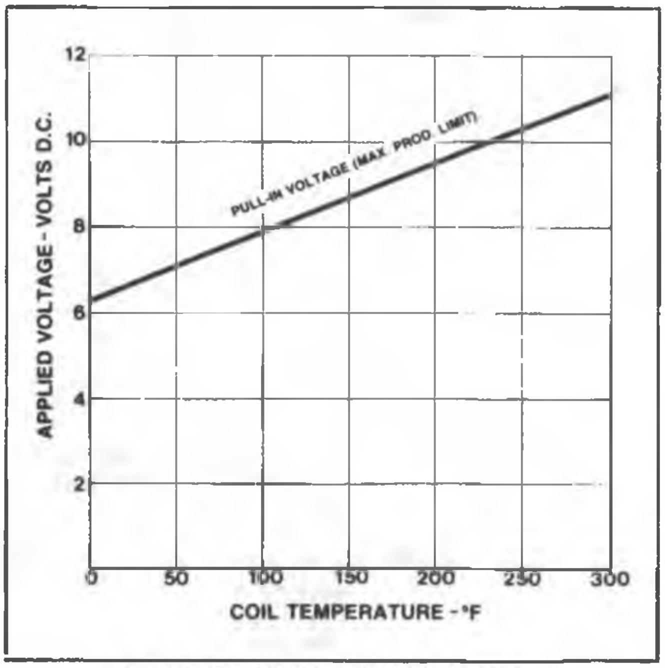


Fig. 2-8 Electric Solenoid Pull in Voltage

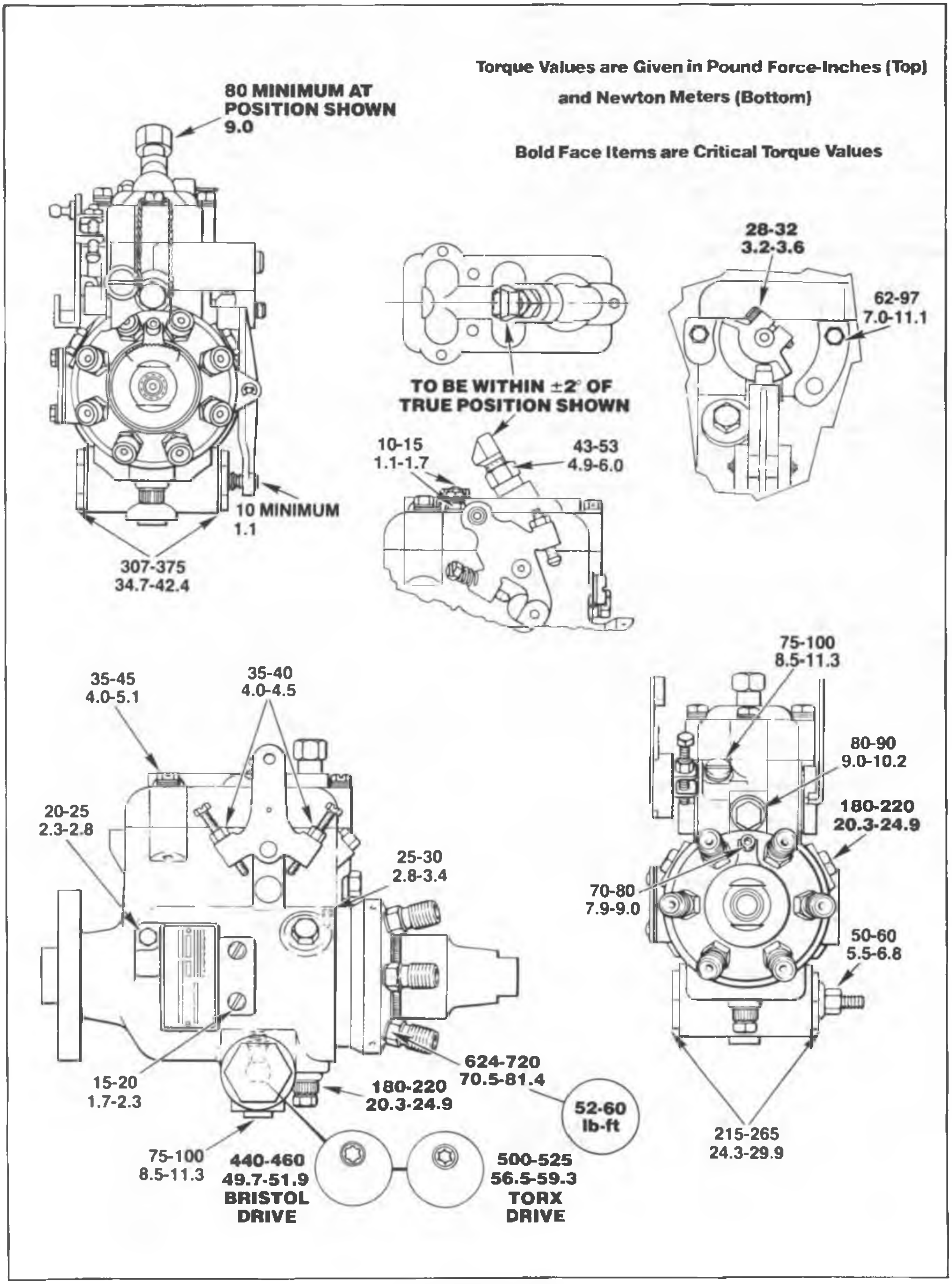


Fig. 2-9 Torque Values

STANADYNE SERVICE PROCEDURES: ON VEHICLE

FUEL INJECTION PUMP SERVICE

The following service procedures are not intended as a guide for complete pump overhaul. The procedures are for service that will not require calibration on a test bench. Any other service procedures will require sending the pump to a manufacturer's authorized service facility.

This section includes minor repairs both on and off vehicle. Injection pump removal and reinstallation procedures are also contained in this section.

PUMP COVER SEAL AND/OR GUIDE STUD SEAL REPLACEMENT

1. Disconnect the negative cables from both batteries.
2. Remove the air cleaner and air crossover. Install screens J-29657 (4.3L) or J-26996-10 (5.7L) in the intake manifold.
3. On 6.2L, remove the air cleaner and intake. Install screens J-29664 in the cylinder head.
4. Disconnect the injection pump fuel solenoid and housing pressure cold advance wires and the fuel return pipe.
5. On 6.2L, remove top attaching bolt and loosen lower attaching bolts on fast idle solenoid and move solenoid aside.
6. Clean the injection pump cover, upper portion of the pump and the guide stud area. Place several rags in engine valley to catch fuel.
7. Remove injection pump cover and remove screws from the cover.
   NOTICE: Extreme care must be exercised to keep foreign material out of the pump when the cover is off. If any objects are dropped into the pump, they must be removed before the engine is started or injection pump damage or engine damage could occur. STEPS 7, 8 and 9 ARE FOR GUIDE STUD SEAL REPLACEMENT ONLY.
8. Observe position of metering valve spring over the top of the guide stud. This position must be exactly duplicated during reassembly.
9. Remove the guide stud and washer. Note location of parts prior to removal. If washer is solid aluminum, discard washer and replace with new one. If washer has a red rubber insert, re-use during reassembly.
10. Reinstall the guide stud with a new washer making certain that the upper extension of the metering valve spring rides on top of the guide stud. Torque the guide stud to 9.5 N•m (85 in. lbs.). Overtorquing the stud may strip the aluminum threads in the housing.
11. Hold the throttle in the idle position.
12. Install new pump cover seal. Make sure the screws are not in the cover and position the cover about ¼ inch forward (toward shaft end) and about ⅛ inch above the pump.
13. Move the cover rearward and downward into position, being careful not to cut the seal and reinstall the cover screws. Be careful not to drop or lose flat washer and internal lock washer with each screw. Flat washer must be against pump cover. Torque to 3.7 N•m (33 in. lbs.). See Fig. 2-9.
14. Reconnect the negative cables to both batteries.
15. Turn the ignition switch to the run position and touch the pink solenoid wire to the solenoid. A clicking noise should be heard as the wire is connected and disconnected. If this clicking is not observed, the linkage may be jammed in a wide open throttle position and the engine MUST NOT be started, go to Step 16. If clicking is observed, connect the pump solenoid and housing pressure cold advance wires, then proceed to Step 17.
16. Remove the cover. Ground the solenoid lead (opposite the hot lead) and connect the pink wire. With the ignition switch in the run position, the solenoid in the cover should move the linkage. If not, the solenoid must be replaced. Minimum voltage across solenoid terminals must be 12.0.
17. Reinstall the cover and repeat Step 12, 13, 14, and 15.
18. Reinstall the fuel return pipe and the throttle cable and return springs, and reposition fast idle solenoid.
19. Start the engine and check for leaks.
20. Idle roughness may be observed due to the air in the pump; give it plenty of time to purge which it will do by allowing the engine to idle. It may be necessary to shut the engine down for several minutes to allow air bubbles to rise to the top of the pump where they will be purged.
21. Remove the intake manifold screens, then reinstall the intake and air cleaner on the 6.2L.
22. Remove the intake manifold screens, then reinstall the air crossover and air cleaner on the 5.7 and 4.3L.

THROTTLE SHAFT SEAL REPLACEMENT

1. Disconnect the negative cables from both batteries.
2. Remove the air cleaner and intake from the 6.2L and install screens J-29664. On the 5.7L and 4.3L, remove the air cleaner and air crossover and install screens J-26996-10 (5.7L) or J-29657 (4.3L).
3. Disconnect the injection pump fuel solenoid and housing pressure cold advance wires and the fuel return pipe.
4. Using a straight edge and a scribe, etch a line across the pump housing and the VRV valve. This will be used as an alignment mark when replacing the valve. Remove the VRV valve. When replacing the valve, realign the

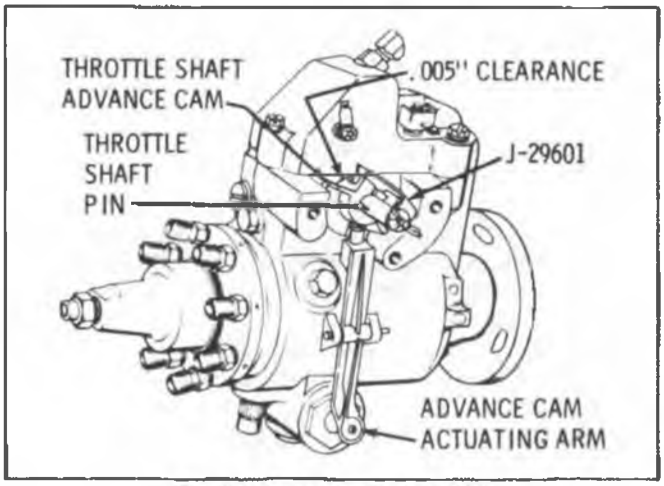


Fig. 2-10 Face Cam Tool, J-29601

valve with the etched line. Doing so will avoid having to readjust the valve on installation. Remove the T.P.S. switch if so equipped, the throttle rod and return springs. Loosen and move aside the fast idle solenoid.

5. Remove the throttle cable bracket (V-8 only).
6. Install tool J-29601 over the throttle shaft with slots of tool engaging pin. Put the spring clip over the throttle shaft advance cam and tighten the wing nut. Without loosening the wingnut, pull the tool off the shaft. (This provides the proper alignment on reassembly.) (Fig. 2-10.)
7. Drive the pin from the throttle shaft and remove the throttle shaft advance cam and fiber washer. Remove any burrs from the shaft that may have resulted from pin removal.
8. Clean the injection pump cover, upper portion of the pump, the throttle shaft and the guide stud area. Place several rags in the engine valley to catch fuel.
9. Remove injection pump cover and remove screws from the cover.
   NOTICE: Extreme care must be exercised to keep foreign material out of the pump when the cover is off. If any objects are dropped into the pump, they must be removed before the engine is started or injection pump damage or engine damage may occur.
10. Observe position at metering valve spring over the top of the guide stud. This position must be exactly duplicated during reassembly. (Fig. 2-11).

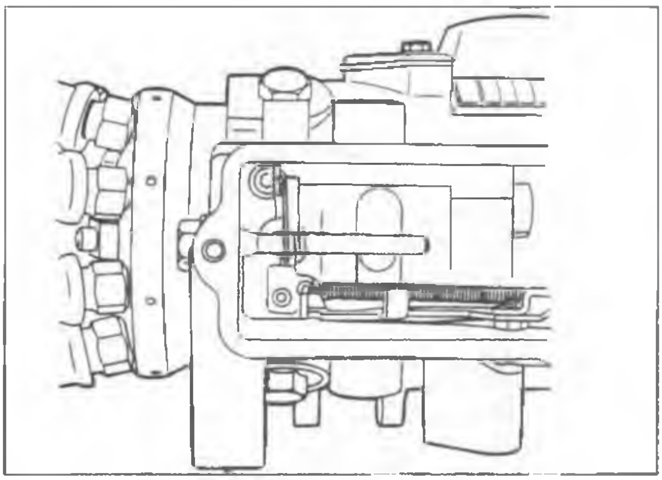


Fig. 2-11 Valve Spring Over Guide Stud

11. Remove the guide stud and washer. Note location of parts prior to removal.
12. Rotate the min-max governor assembly up to provide clearance and remove from the throttle shaft. If idle governor spring becomes disengaged from throttle block, it must be reinstalled with tightly wound coils toward throttle block.
13. Remove the throttle shaft assembly. It may be necessary to loosen the nuts at the injection pump mounting flange and rotate the pump slightly to allow the throttle shaft assembly to clear the intake manifold on the 5.7L and 4.3L engines.
14. Examine the throttle shaft and bushings in the pump housing for any evidence of damage or unusual wear and leaks. Remove the pump and send to the local Stanadyne dealer if bushing replacement is necessary.
15. Remove the throttle shaft seals. Do not attempt to cut the seals to remove, as nicks in the seal seat will cause leakage.
16. Install new shaft seals using care not to cut the seals on the sharp edges of the shaft. Apply a light coating of clean chassis grease on the seals, or J-33198 Synkut oil.
17. Carefully slide the throttle shaft back into the pump to the point where the min-max governor assembly will slide back onto the throttle shaft.
18. Rotate the min-max governor assembly downward, hold in position and slide the throttle shaft and governor into position.
19. Install a new mylar washer, the throttle shaft advance cam, (do not tighten cam screw at this time), and a new throttle shaft drive pin (Fig. 2-12).
20. Align the throttle shaft advance cam so tool J-29601 can be reinstalled over the throttle shaft, pin in the slots and the spring clip over the advance cam.
21. Insert a .005" feeler gage between the white washer on the throttle shaft and the pump housing. Squeeze the throttle shaft and tighten the cam screw. Torque to 3.1 N·m (30 in. lbs.) and secure with Locktite 290. Remove tool J-29601 (Fig. 2-12).

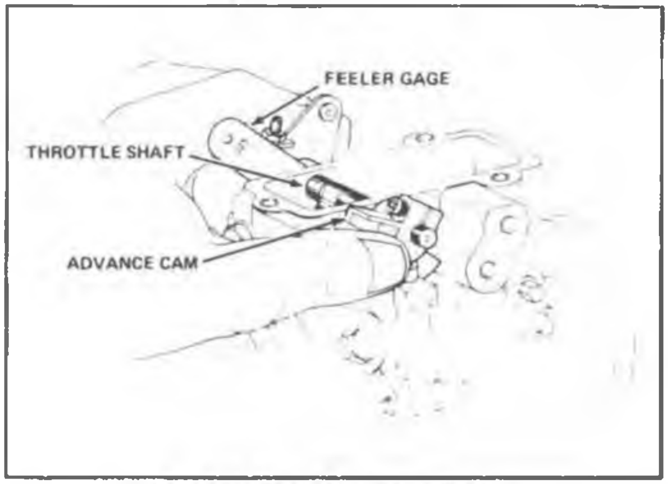


Fig. 2-12 Feeler Gauge Installation

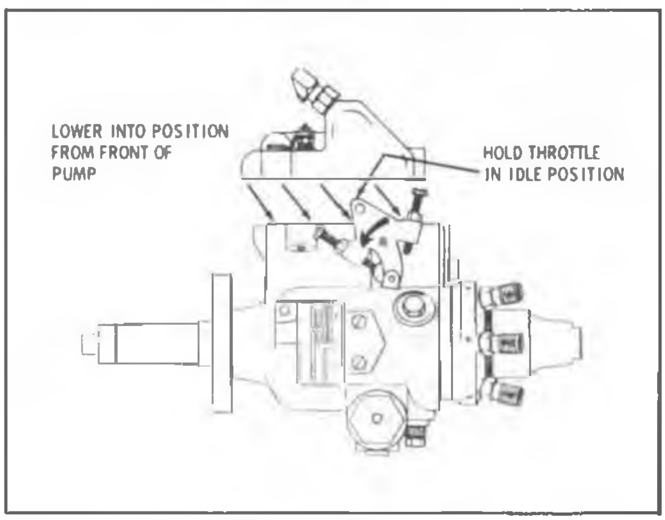


Fig 2-13 Governor Cover Installation

22. Reinstall the guide stud with a new washer, making certain that the upper extension of the metering valve spring rides on top of the guide stud. Torque the guide stud to 9.5 N·m (85 in. lbs.). Overtorquing the guide stud may strip the aluminum threads in the housing.
23. Hold the throttle in the idle position.
24. Install new pump cover seal. Make sure the screws are not in the cover and position the cover about ¼ inch forward (toward shaft end) and about ⅛ inch above the pump (Fig. 2-13).
25. Move the cover rearward and downward into position, being careful not to cut the seal and reinstall the cover screws. Be careful not to drop and lose flat washer and internal lock washer with each screw. Flat washer must be against pump cover. Torque to 3.7 N·m (33 in. lbs.). Install vacuum regulator valve or T.P.S. switch.
26. Reconnect the negative cables to both batteries.
27. Turn the ignition switch to the run position and touch the pink solenoid wire to the solenoid. A clicking noise should be heard as the wire is connected and disconnected. If this clicking is not observed, the linkage may be jammed in a wide open throttle position and the engine MUST NOT be started. If clicking is observed, connect the pump solenoid and housing pressure cold advance wires, then proceed to Step 30.
28. Remove the cover. Ground the solenoid lead (opposite the hot lead) and connect the pink wire. With the ignition switch in the run position, the solenoid in the cover should move the linkage. If not, the solenoid must be replaced. Minimum voltage across solenoid terminals must be 12.0.
29. Reinstall the cover and repeat Step 27.
30. Reinstall throttle cable bracket, detent cable and fast idle solenoid.
31. Reinstall the throttle cable and return springs. Make sure the timing mark on the pump and housing are aligned and make sure the nuts attaching pump to the housing are tight. Install fuel return pipe.
32. Start the engine and check for leaks.
33. Idle roughness may be observed due to the air in the pump, give it plenty of time to purge which it will do by allowing the engine to idle. It may be necessary to shut the engine down for several minutes to allow air bubbles to rise to the top of the pump where they will be purged.
34. Adjust the T.P.S. switch. See "Throttle Position Switch Adjustment."
35. Remove the head screens, then reinstall the intake and air cleaner on the 6.2L and the air crossover and air cleaner on the 4.3L and 5.7L.

SOLENOIDS

Removal

1. Remove the pump cover, see "Pump Cover Seal."
2. Remove the terminal contact nut(s) and remove the solenoid from the cover, noting the position of any insulating washers.

Installation

1. Place the solenoid in the cover making certain on the shut off solenoid that the linkage is free and on the housing pressure cold advance solenoid that the plunger is centered so that it will contact the fitting check ball.
2. Place the insulating washers on the terminal studs (where used) and install the terminal nuts. Torque the nuts to 1.0-1.5 N·m (10-15 in. lbs.).
3. Check the operation of the solenoid prior to installing the pump cover with the use of a 12V (min) DC power source. Make certain that the shut off linkage is free if that solenoid was replaced.
4. Install the pump cover, see "Pump Cover Seal," Steps 9 through 19.

SIDE COVER GASKET

Removal

1. Remove the two screws, cover and gasket.

Installation

1. Install the gasket, cover and two screws, torque the screws to 1.5-2.5 N·m (15-20 in. lbs.).

GOVERNOR WEIGHT RETAINER RING CHECK

1. Disconnect the negative battery cables from both batteries.
2. On the 6.2L, remove the air cleaner and intake and install screens J-29644. On the 5.7L and 4.3L, remove the air cleaner and air crossover and install screens J-26996-10 (5.7L) or J-29657 (4.3L).
3. Disconnect the injection pump fuel solenoid and housing pressure cold advance wire and the fuel return pipe.
4. Clean the injection pump cover, upper portion of the pump, the throttle shaft and the guide stud area. Place several rags in the valley to catch any spilled fuel.
5. Remove the injection pump cover and remove the screws (3) from the cover.
   NOTICE: Extreme care must be exercised to keep foreign material out of the pump when the cover is off. If any objects are dropped into the pump, they must be removed before the engine is started, or injection pump damage could result.
6. Try to rotate the governor weight retainer with your fingers or a small screwdriver. It should not rotate more than 1/16 inch either left or right. The retainer should return to its original position when released.
7. If the retainer moves more than 1/16 inch, and/or does not return to its original position, the governor weight retainer ring has failed and will have to be replaced.
8. Replace the governor cover and refer to Governor Weight Retainer Ring Replacement procedure.

THROTTLE POSITION SWITCH ADJUSTMENT (6.2L)

1. Loosen the throttle position switch assembly at the injection pump, keeping the throttle lever in the closed position.
2. Attach a continuity meter across the IGN (pink) and EGR (yellow) terminals or wires (Fig. 2-14).
3. Insert the proper "switch closed" gage block between the gage boss on the injection pump and the wide open stop screw on the throttle shaft.
4. Rotate and hold the throttle lever against the gage block.
5. Rotate the throttle position switch clockwise (facing the throttle switch) until continuity just occurs (high meter reading) across the IGN and EGR terminals or wires. Hold the switch body at this position and tighten the mounting screws to the specified torque.
   NOTICE: Switch point must be set only while rotating in the clockwise position.

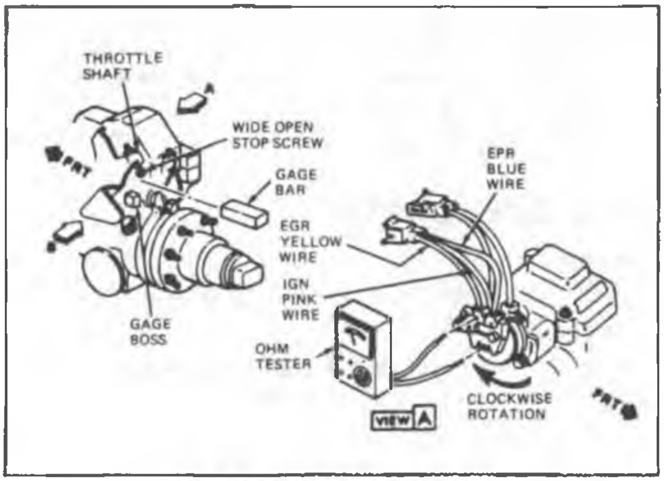


Fig. 2-14 LH6 TPS Adjustment

6. Release the throttle lever and allow it to return to the idle position. Remove the "switch closed" gage bar and insert the "switch open" gage bar. There should be no continuity across the IGN and EGR terminals or wires (meter reads "0"). If no continuity exists, the switch is properly set. However, if there is continuity, the switch must be reset by returning to step one and repeating the entire procedure.

TRANSMISSION VACUUM REGULATOR VALVE ADJUSTMENT—6.2L

1. Attach the vacuum regulator valve snugly, but loosely to the fuel injection pump. The switch body must be free to rotate on the pump.
2. Attach vacuum source of 67±5 kPa (20" Hq.) to inboard vacuum nipple. Attach vacuum gage to outboard vacuum nipple.
3. Insert vacuum regulator valve gage bar between the gage boss on the injection pump and the wide open stop screw on the throttle lever.
4. Rotate and hold the throttle shaft against the gage bar.
5. Slowly rotate the vacuum regulator valve body clockwise (facing valve) until vacuum gage reads 39±2 kPa (11.5" Hq.). Hold valve body at this position and tighten mounting screws.
   NOTICE: Valve must be set while rotating valve body in clockwise direction only.
6. Check by releasing the throttle shaft allowing it to return to the idle stop position. Then rotate throttle shaft back against the gage bar to determine if vacuum gage reads within 39±2 kPa (11.5" Hq.). If vacuum is outside limits, reset valve.

VACUUM REGULATOR VALVE ADJUSTMENT—5.7L and 4.3L

1. Remove the air crossover. Install the screened covers in the intake manifold openings; J-26996-10 on V-8 and J-29657 on the V-6.
2. Disconnect the throttle rod from the pump on the V-8 and disconnect the throttle cable and detent/T.V. cable from the pump throttle lever on the V-6.
3. Loosen the vacuum regulator valve to injection pump bolts.
4. Install BT-7944 or J-26701-15 carburetor angle gage adapter to the injection pump throttle lever. Place angle gage BT-7704 or J-26701 on adapter.

NOTICE: On the V-6 pumps it may be necessary to rework tool BT-7944 or J-26701-15 by filing the tool so that it can fit on the V-6 pump's thicker throttle lever.

5. Rotate throttle lever to the wide open throttle position and set angle gage to zero degrees (Fig. 2-15).

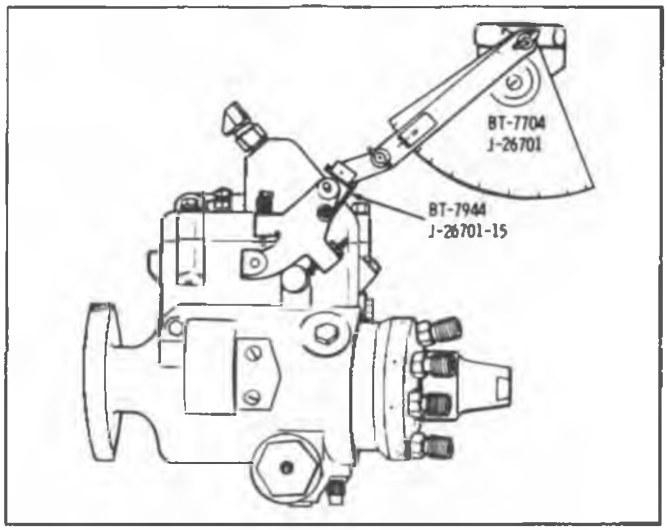


Fig. 2-15 Vacuum Regulator Valve Adjustment

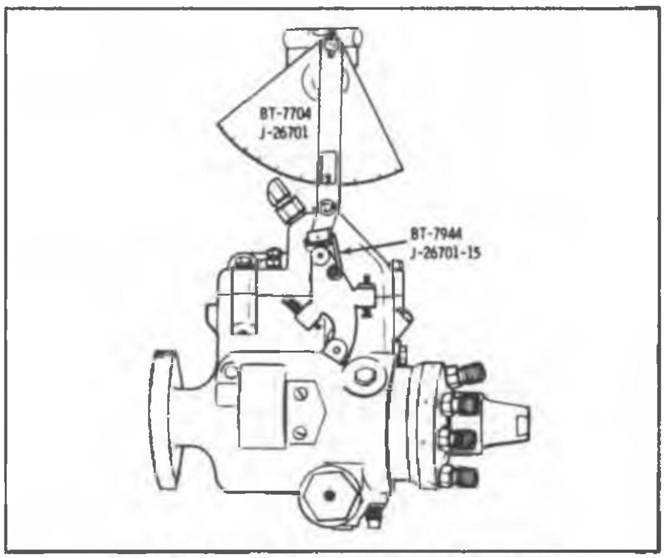


Fig. 2-16 Vacuum Regulator Valve Adjustment

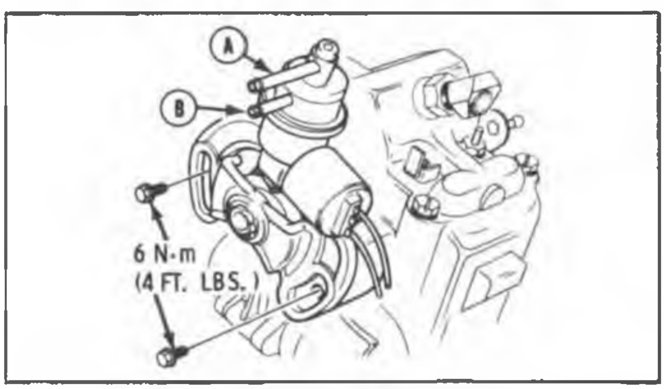


Fig. 2-17 Vacuum Regulator Valve

6. Center bubble in level.
7. Set angle gage to 58 degrees on the V-8, and 49 degrees on the V-6.

8. Rotate throttle lever so level bubble is centered (Fig. 2-16).
9. Attach vacuum source such as BT-7517 or J-2378 vacuum pump to port A. Install vacuum gage to port B. Apply 61-74 kPa (18-24 inches) of vacuum to port A (Fig. 2-17).
10. Rotate vacuum valve clockwise to obtain 36 kPa (10.6 inches) of vacuum.
11. Tighten vacuum valve bolts. Remove vacuum source and vacuum gage.
12. Connect the throttle rod to the pump throttle lever on the V-8 and connect the throttle cable and detent/T.V. cables to the pump throttle lever on the V-6.
13. Remove the intake manifold screened covers.
14. Install the air crossover.

THROTTLE LINKAGE ADJUSTMENTS—V-8

1. If equipped with Cruise Control, remove clip from Cruise Control throttle rod and disconnect the rod from the throttle lever assembly.
2. Disconnect the transmission T.V. (or detent) cable from the throttle assembly.
3. Loosen the lock nut on the pump rod and shorten rod several turns.
4. Rotate the bellcrank lever assembly to the full throttle position and hold in that position.
5. Lengthen the pump rod until the injection pump lever just contacts the full throttle stop.
6. Release the bellcrank assembly and tighten the pump rod lock nut.
7. Depress and hold the metal lock tab on the cable upper end. Move the slider through the fitting in the direction away from the bellcrank lever assembly until the slider stops against the metal fitting. Release the metal tab.
8. Reconnect the transmission T.V. or detent cable.
9. Rotate the bellcrank lever assembly to the full throttle stop and release the lever assembly.
10. Reconnect the Cruise Control throttle rod, if so equipped.
11. Adjust the vacuum regulator valve. See "Vacuum Regulator Adjustment."
12. Remove the connector from the fast idle switch and bridge the harness connector with a jumper. Do not allow the jumper to touch ground.
13. With the driving wheels blocked and the parking brake on, start the engine and adjust the solenoid (energized) to the specification listed on the Emission Control Information Label.
14. Check and adjust the slow idle speed with the engine at operating temperature. To check idle speeds, it will be necessary to insert the probe of the magnetic pickup tack, J-26925, in the timing indicator hole.
15. Adjust the slow idle screw on the injection pump to the specification shown on the Emission Control Information Label.
16. If equipped with cruise control, adjust the servo throttle rod to minimum slack (engine off) then put the clip in the first free hole closest to the bellcrank, but within the servo bail.

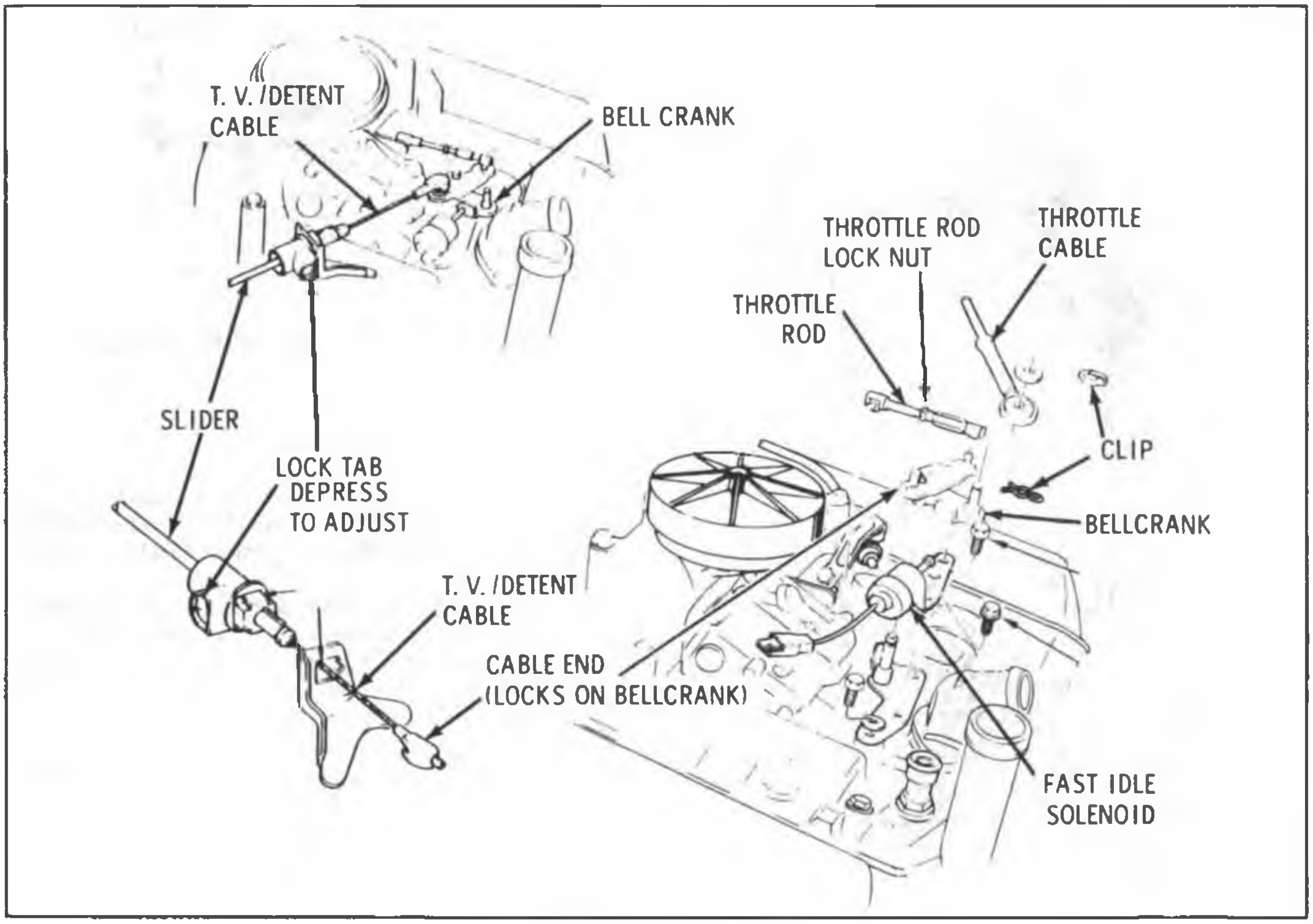


Fig. 2-18 V-8 Throttle Linkage

INJECTION PUMP REMOVAL AND REINSTALLATION PROCEDURES—6.2L

Removal

1. Remove intake manifold.
2. Remove fuel lines.
3. Disconnect accelerator cable at injection pump, and detent cable where applicable.
4. Disconnect necessary wires and hoses at injection pump (Fig. 2-19).
5. Disconnect fuel return line.
6. Disconnect fuel line at pump.
7. Remove A/C hose retainer bracket if equipped with A/C.
8. Remove oil fill tube, including PCV vent hose assembly (Fig. 2-20).
9. Scribe or paint an alignment mark on the pump flange and front cover (Fig. 2-21).
10. It will be necessary to rotate engine in order to gain access to injection pump retaining bolts through the oil filler neck hole (Fig. 2-22).
11. Remove injection pump to front cover attaching nuts.
12. Remove pump and cap all open lines and nozzles.

Installation

1. Replace gasket.
2. Align locating pin on pump hub with slot in injection pump gear. At the same time, align timing marks.
3. Attach injection pump to front cover, torque nuts to 40 N·m (30 ft. lbs.).

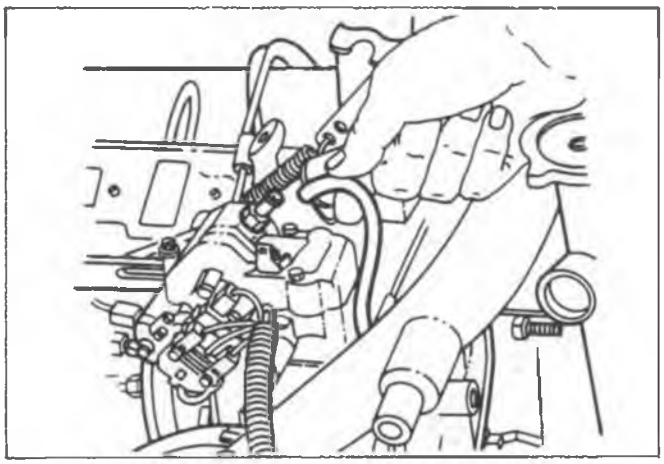


Fig. 2-19 Disconnecting Hose from Injection Pump

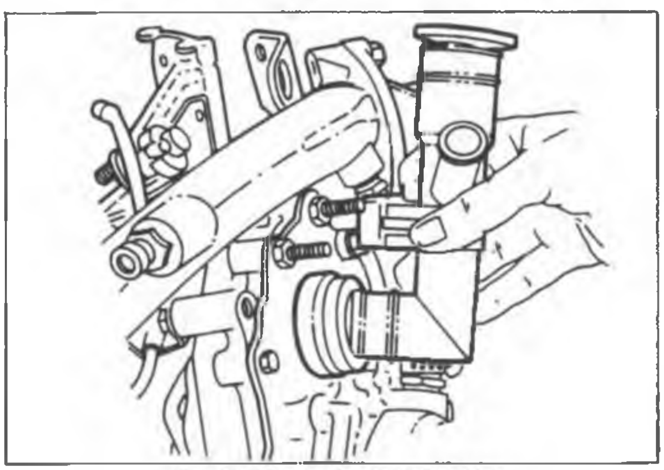


Fig. 2-20 Removing Oil Filler Pipe

4. Attach pump to drive gear, torque bolts to 25 N·m (20 ft. lbs.).
5. Install oil fill tube, including PCV vent hose assembly.
6. Install A/C hose retainer bracket if equipped.
7. Install fuel line at pump, torque to 25 N·m (20 ft. lbs.).
8. Install fuel return line.
9. Connect necessary wires and hoses.
10. Connect accelerator cable.
11. Connect injection lines.
12. Install intake manifold.

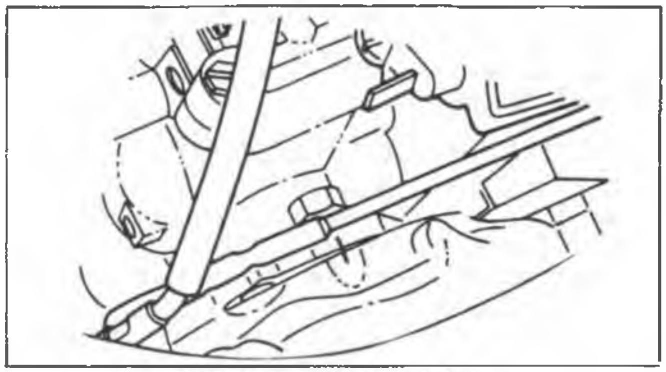


Fig. 2-21 Pump Alignment Marks

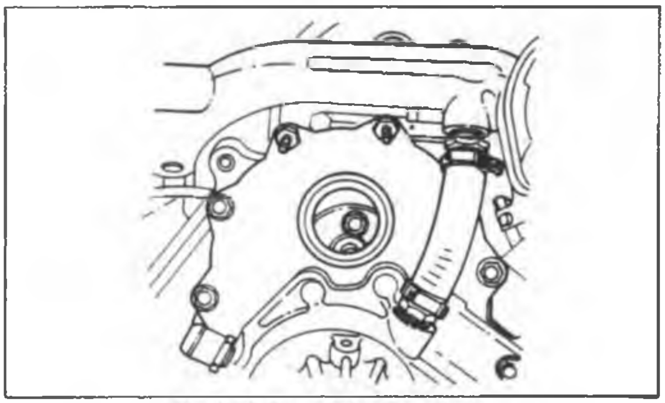


Fig. 2-22 Pump Drive Gear Bolts

5.7 AND 4.3 LITER (Longitudinal) ENGINE

Removal

1. Remove the air cleaner assembly.
2. Remove the crankcase ventilation filter(s) and pipes from the valve covers and air crossover.
3. Remove the air crossover and install intake manifold screened covers J-26996-10 on the V-8 or J-29657 on the V-6. On the V-6 disconnect or remove fuel lines and fuel pump.
   A. On the V-8, disconnect the throttle rod and throttle return spring. Remove the throttle bellcrank.
   B. On the V-6, disconnect the throttle cable and T.V./detent cable from the pump throttle lever. Disconnect the throttle return spring.
4. Remove the throttle and T.V./detent cables from the intake manifold brackets. Position the cables away from the engine.
5. Remove the fuel filter and fuel filter to injection pump line.
6. On the V-8, disconnect fuel line at fuel pump. If A/C equipped, remove rear compressor brace. Remove fuel line.

7. Disconnect the fuel return line from the injection pump.
8. Using two wrenches, disconnect injection pump lines at the nozzles.
9. On the V-8, remove 3 nuts retaining injection pump, using tool J-26987. On the V-6, remove the 2 bolts retaining the injection pump.
10. Remove pump and cap all open lines and nozzles. Discard the pump to adapter "O" ring.

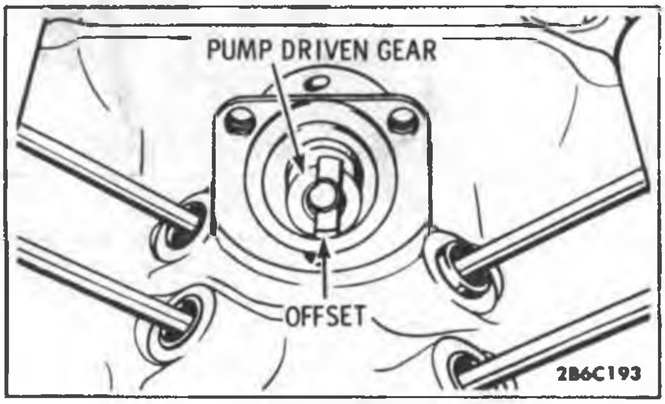


Fig. 2-23 Pump Offset

Installation

1. Position engine No. 1 cylinder to firing position by aligning the mark on the balancer with zero mark on the indicator located on the front of the engine. The index of the pump driven gear is offset to the right when number one is at T.D.C. (Fig. 2-23).
2. Remove protective caps, then line up offset tang on pump driveshaft with the pump driven gear. Install a new pump to adapter "O" ring, then install the pump fully seating pump by hand.
3. If a new adapter (V-8) or intermediate adapter (V-6) is installed, set the injection pump at the center of slots in the pump mounting flange.

   If the original adapter (V-8) or intermediate adapter (V-6) is being retained, align the pump timing mark with the mark on the adapter or intermediate adapter. Install the 3 nuts and washers (V-8) or 2 bolts and washers (V-6) retaining the pump and torque to 24 N·m (18 ft. lbs.) V-8, and 47 N·m (35 ft. lbs.) on the V-6.
4. Remove the protective caps from the openings and connect the injection lines to the pump. Install the disconnected line clamps.
5. Connect the fuel return line.
6. On the V-8, reconnect the fuel line at the fuel pump. If A/C equipped, install the rear compressor brace.
7. Install the fuel filter to injection pump and fuel filter line.
8. Install the throttle and T.V./detent cables into the intake manifold brackets.
   A. On the V-8, connect the throttle rod and throttle return spring. Adjust the throttle linkage, see "Throttle Linkage Adjustment V-8."
   B. On the V-6, connect the throttle cable and T.V./detent cable to the pump throttle lever. Connect the throttle return spring. Adjust the T.V./detent cable.
9. Install all remaining fuel lines and fuel filter.
10. Start the engine and check for leaks.
11. Check and, if necessary, reset the pump timing.
12. Adjust the vacuum regulator valve, as necessary.
13. Adjust the idle speeds, as necessary.
14. Remove screened covers from intake manifold, then install air crossover.
15. Install tubes and hoses in the air crossover and ventilation filters in the valve covers.
16. Install the air cleaner, being certain to reconnect the EGR valve hose.

STANADYNE SERVICE PROCEDURES: OFF VEHICLE

The following special tools are required to perform the following service procedures:

Kent Moore Tool J-29748-A Advance Screw Hole Plug Wrench

Kent Moore Tool J-29746 Wrench

Kent Moore Tool J-29747-A Advance Screw Plug Hole Bushing

Kent Moore Tool J-22745-A Driveshaft Seal Installer

Kent Moore Tool J-22998 Mounting Fixture or

Kent Moore Tool J-29692 Mounting Fixture

Kent Moore Tool J-29601 Face Cam Tool

Kent Moore 33198 Synkut Oil (or equivalent)

GOVERNOR WEIGHT RETAINER RING REPLACEMENT PROCEDURE

Disassembly

1. With the cover installed, install plugs in the discharge ports, fuel inlet port and return line. Clean the pump thoroughly on the outside. Any cleaner that does not irritate the skin should be satisfactory. If nothing else, immerse in fuel oil and brush to clean, blow dry.
2. Install pump in holding fixture so that rear of pump is tilted downward.
3. Keep all gaskets with parts removed until reassembly. Some gaskets are similar, identification will be easier by comparing gaskets when reassembling.
4. Remove the timing line cover (side of pump).

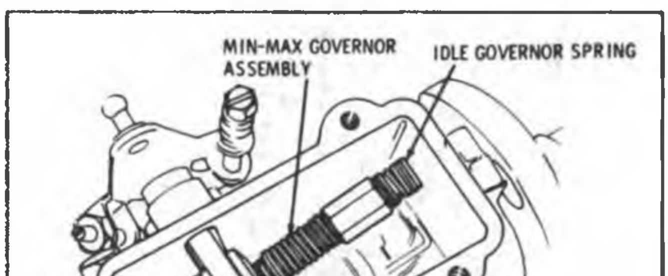


Fig. 2-24 Min-Max Governor Removal

5. Remove three (3) governor cover screws and governor cover (top of pump).
6. Remove guide stud and guide stud washer.
7. Remove min-max governor assembly (Fig. 2-24).
8. On all models without external advance lever, remove the vacuum drive pin, retaining ring and seal washer from the throttle shaft assembly.
9. (A.) On all models with external advance lever, install the tool J-29601 on the throttle shaft, tighten the thumb screw, and remove the tool and the vacuum switch drive pin (Fig. 2-25).

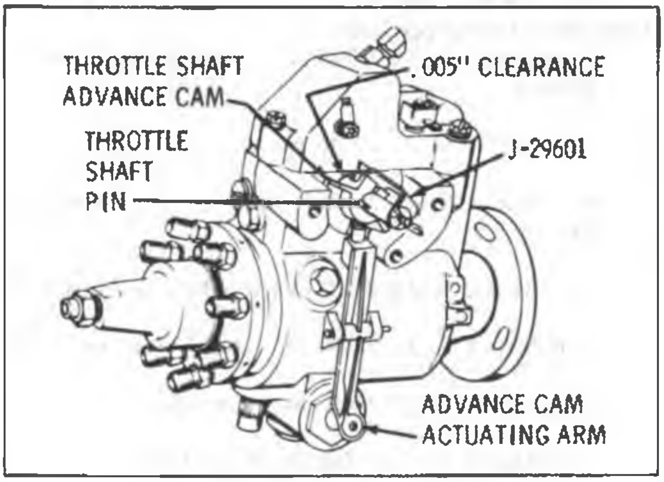


Fig. 2-25 Face Cam Tool, J-29601

(B.) Remove the face cam screw.
10. Remove the throttle shaft assembly.
11. Lift out the face cam and mylar washer on models so equipped.
12. Lift up the governor linkage hook assembly and remove the metering valve. (NOTICE: DO NOT DISTURB LINKAGE HOOK ADJUSTMENT.) (Figs. 2-26 and 2-27).

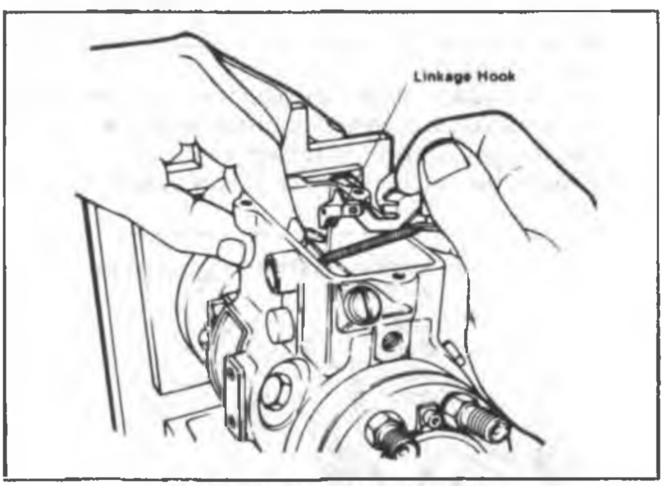


Fig. 2-26 Linkage Hook Assembly

13. Remove the housing vent screw assembly (Fig. 2-28).
14. Remove one (1) head locking screw and loosen the other.
15. Turn pump upside down and remove head locating screw.
16. Remove advance screw hole plug, using J-29748-A wrench (Fig. 2-29). On 1982 model pumps, removal is made with an allen wrench.

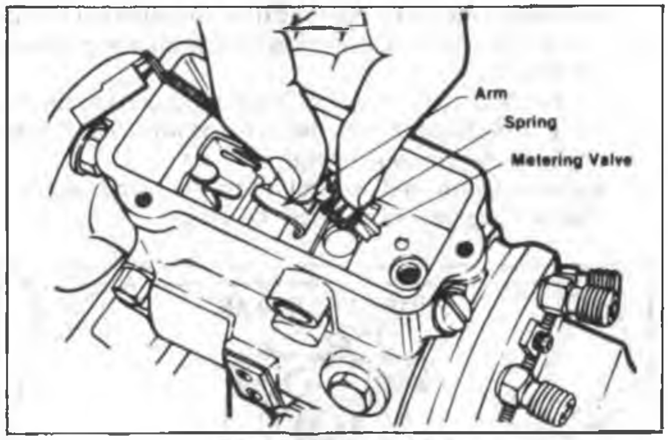


Fig. 2-27 Metering Valve

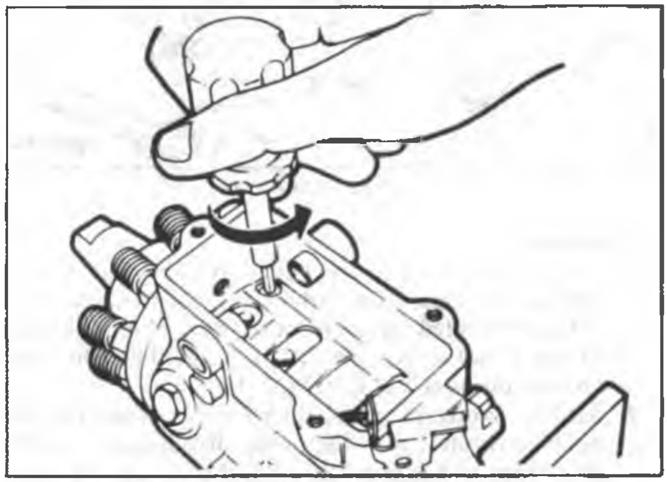


Fig. 2-28 Housing Vent Screw Assembly

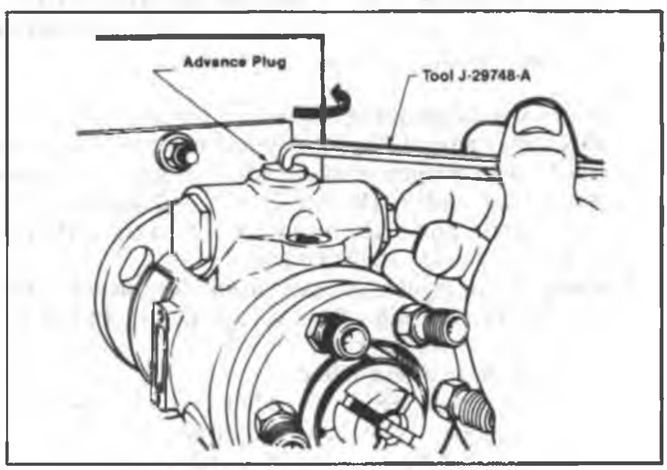


Fig. 2-29 Advance Screw Hole Plug

17. (A.) On all models without external advance, remove piston hole plug (trimmer side), slide washer, advance piston and outer spring.
(B.) Remove piston hole plug (power side), slide washer and power piston.
(C.) Install tool J-29747-A and tool J-29748-A and remove the cam advance screw. Be sure to fully seat tool into the ball end to reduce the possibility of breakage (Fig. 2-34). Some tools were manufactured with a 30° chamfer on the end of the tool. The life of the tool can be extended by grinding a 60° chamfer on the tool. All tools now have a 60° chamfer.

18. On external advance models, lift out cam advance pin.
19. Turn pump right side up.
20. Remove the remaining head locking screw.
21. Remove the head and rotor assembly, governor weights, thrust sleeve, and thrust washer (Fig. 2-30). Take care that head and rotor assembly doesn't roll off workbench onto floor.

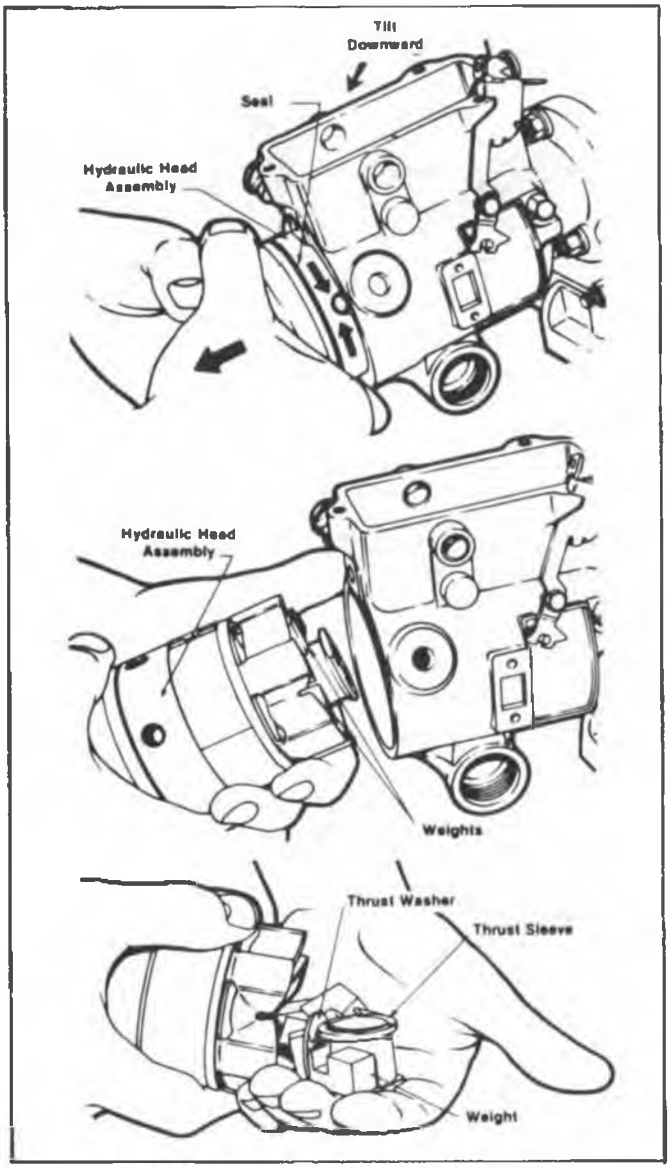


Fig. 2-30 Head, Rotor and Governor Weights

22. Remove governor cage retaining snap ring (Fig. 2-31).
23. Remove governor weight retainer assembly. Inspect the pins on the weight retainer for wear, pins can be worn by the slots in the drive plate after the ring has disintegrated. The base of the pin can be worn ½ the distance to the pin and still be satisfactory as long as there are no sharp edges to cut the ring. Using a .038 feeler gage, check the clearance of the pins. If necessary, use an ignition point file to get acceptable clearance. If the pins are worn excessively, bent, loose or sharp edges cannot be removed, the retainer should be replaced (Fig. 2-32).
24. Remove elasticast ring by pulling ring off of pins. Slight forceable action will be required.

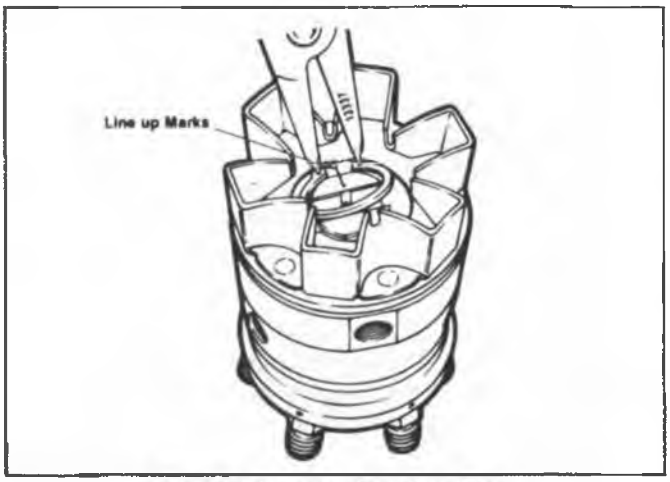


Fig. 2-31 Governor Cage Snap Ring

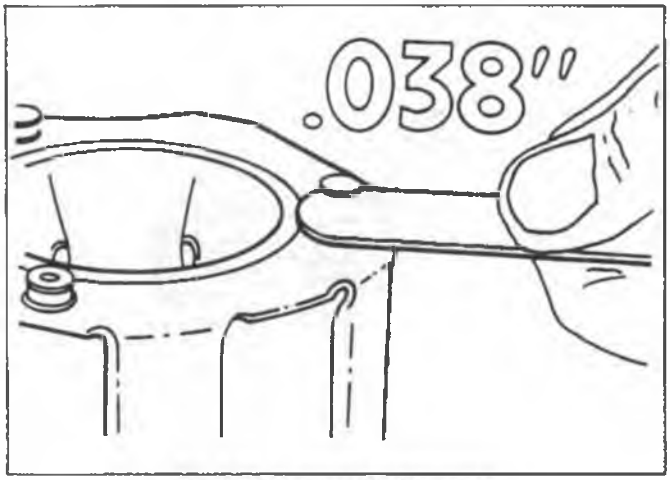


Fig. 2-32 Retainer Pin Clearance

25. Flush and clean the pump and all parts—except the head assembly, examine the cam ring, shoes and rollers and remove particles. Do not disturb leaf spring attaching screw as this is a critical adjustment which is performed with special equipment. Also take care not to remove pumping plungers. Be sure they remain in their bore. Consider using an air siphon gun with a suitable solvent. Clean advance mechanism parts governor assembly parts, inside of pump housing and inside the check valve.

Absolute cleanliness is necessary.

ASSEMBLY

NOTICE: It has been determined that some 1981 5.7 Liter diesel injection pumps were manufactured with the arrow on the cam ring going in the wrong direction. When replacing governor weight retainer rings, it is possible that the cam ring could be installed backwards by matching the arrow on the cam ring with the arrow on the pump housing.

Pumps affected are between Serial Numbers 2797021 through 2798039 and Serial Numbers 2816298 through 2817858.

Place the cam ring on a work bench so that the timing line bisects the allen head screw hole on the right. This is the correct position for the cam ring when installing. Failure to observe this precaution could result in improper pump timing.

1. Install new pellethane governor weight retainer ring using #22 Truarc snap ring pliers or equivalent. This operation will take some practice. Stretch holes in pellethane ring over governor weight retainer cage pin and walk into place with circular motion, and install cam ring.
2. Align timing marks on retainer assembly and rotor and install governor weight retainer assembly (Fig. 2-31).
3. Install governor cage retainer ring (snap ring).
4. Install new hydraulic head seal and lubricate with Synkut oil.
5. Install governor weights, thrust washer (if chamfered, chamfered edge up) and thrust sleeve to the head and rotor assembly (Fig. 2-33).

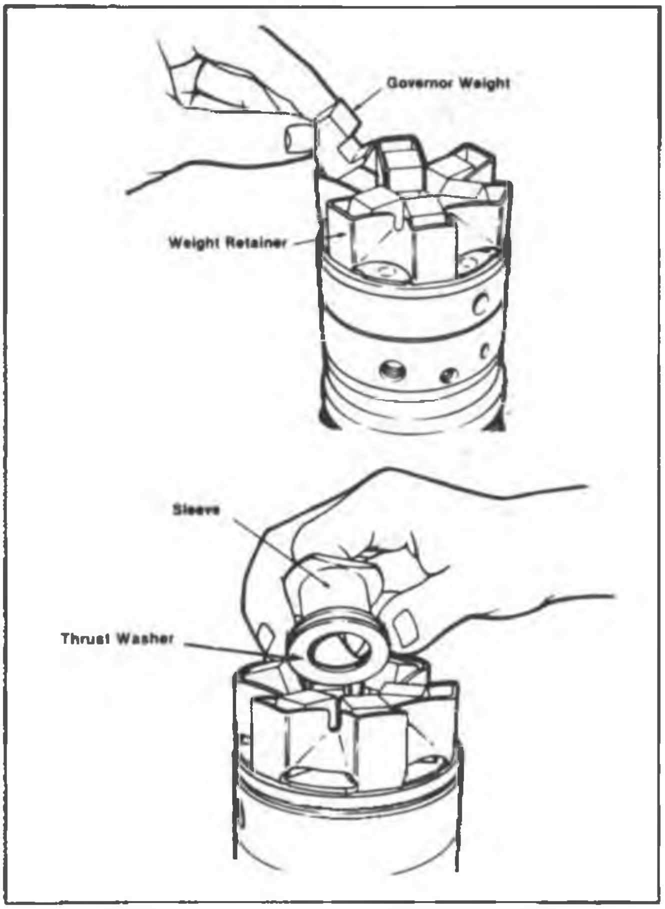


Fig. 2-33 Governor Weights, Thrust Washer and Sleeve

6. Install the entire head and rotor assembly, making certain that the drive shaft is properly engaged (with "T" mark on drive shaft up, align dots on drive shaft tang and rotor slot). Reverse the action shown in Figure 2-30. To check for correct hole alignment, insert one of the locking head bolts into the head locating screw hole. If it does not fit, alignment is correct. Remove the locking head bolt and use it and the other locking head bolt to retain the head assembly in place (hand tighten only).

   NOTICE: Insertion of the head too far into the pump may cut the housing seal at the vent screw area. If the head goes in further than the locating screw holes, check the housing to see if seal is exposed. If it is, remove and replace the seal.
7. Turn pump upside down and install head locating screw using new head locating screw seals. Torque 15-18 ft. lbs. Then torque the two (2) head locking screws to 15-18 ft. lbs.

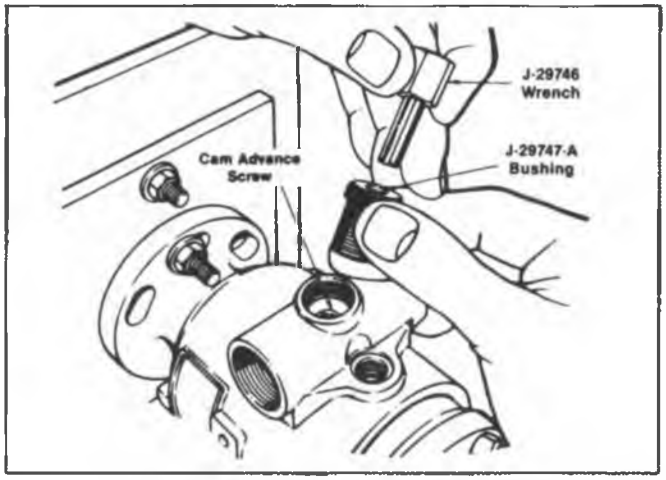


Fig. 2-34 Cam Advance Screw and Tools

8. On all models without external advance, install the cam advance screw using tool J-29747. Torque to 37-38 ft. lbs. (Fig. 2-34). Check for freedom of movement on cam ring. If it binds, tap lightly with a plastic mallet and re-check. Use grease to hold advance piston side washers in place and install the advance screw components, piston hole plug (power side) and piston hole plug (trimmer side), using new seals and lubricate. Torque plugs to 18-22 ft. lbs.
9. On models with external advance install cam pin.
10. Install advance screw hole plug using new seal and lubricate. Torque 75-100 in. lbs. or 6-8 ft. lbs. Reverse the action shown in Figure 2-29.
11. Rotate the drive shaft until timing lines come into alignment. While viewed through timing line opening, check drive shaft to be sure "T" mark is up.
12. Turn pump right side up and install housing vent screw assembly.
13. Install metering valve (Fig. 2-27).
14. Hook the governor linkage assembly to the metering valve (Fig. 2-26). Check linkage for freedom.
15. (A.) On external advance models, hold face cam and mylar washer in place and install the throttle shaft assembly, using new throttle shaft seals, and lubricate.
    (B.) Install face cam screw and vacuum module drive pin.
16. (A.) On all models without external advance, install the throttle shaft using new throttle shaft seals and lubricate.
    (B.) Install a new throttle shaft seal washer and reinstall retainer ring.
    (C.) Install new vacuum module drive pin.
    (D.) On external advance models, install tool J-29601 to position face cam and insert a .005" feeler gage between the white washer and housing (Fig. 2-25). Push throttle shaft into housing to remove clearance and torque face cam screw to 31 N·m (30 in. lbs. and secure with Loc-tite 290 or equivalent.
17. Install the min-max governor assembly (Fig. 2-24).

18. Install the guide stud using a new guide stud washer if aluminum (or re-use rubber insert washer). Torque to 80-90 in. lbs. Be sure the wire spring on the metering valve assembly rests on the top of the guide stud shaft.
19. Examine check ball in return line fitting for approximately 1/16 inches movement when depressed. If check ball doesn't move, it may be seized by governor weight retainer ring particles and must be cleaned or replaced.
20. Install governor cover with new governor cover gasket. (Fig. 2-35). Test solenoid with 12 volts, listening for audible click when energized. If no click can be heard, remove and reinstall cover and retest until click can be heard signifying proper shut off operation. Without the click the metering valve would be jammed open and if the engine were started, an instant runaway engine would result.

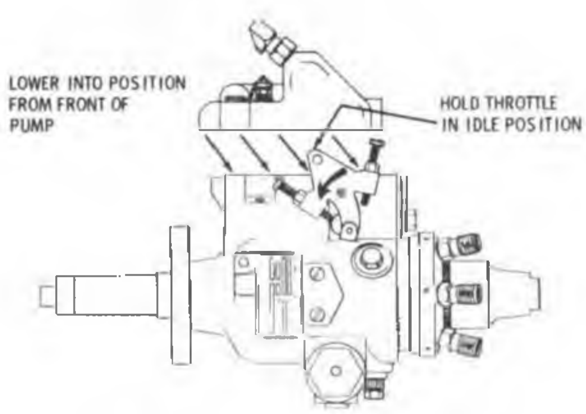


Fig. 2-35 Governor Cover Installation

21. Install the timing line cover using new timing line cover gasket.
22. Install new pilot tube seal.

PRESSURE TESTING

1. Drain all fuel from the pump.
2. Connect an air line to the pump inlet connection. Be certain that the air supply is clean and dry.
3. Seal off the return line fitting and completely immerse the pump in a bath of clean test oil.
4. Raise the air pressure in the pump to 137.9 kPa (20 psi). Leave the pump immersed in the oil for 10 minutes to allow any trapped air to escape.
5. Watch for leaks after the 10 minute period, if the pump is not leaking, reduce the air pressure to 13.8 kPa (2 psi) for 30 seconds. If there is still no leak increase the pressure to 137.9 kPa (20 psi). If still no leaks are seen, the pump is ready for use.

DRIVE SHAFT SEAL REPLACEMENT: 6.2L Engine

Removal

1. Disconnect necessary wires, hoses and cables from the injection pump.
2. Remove the injection pump as outlined previously.
3. Mount the pump in holding fixture J-29692-B, and tilt the pump slightly towards you.
4. Remove the fast idle solenoid bracket.
5. Clean the injection pump cover upper portion of the pump.
6. Remove (3) three governor cover hold down screws and the governor cover. Discard the governor cover gasket.
7. **NOTICE:** Extreme care must be exercised to keep foreign material out of the pump when the cover is off. If any objects are dropped into the pump, they must be removed before the cover is installed or injection pump or engine damage could occur.
8. Observe the position of the metering valve spring. The spring should be over the top of the guide stud. This position must be exactly duplicated during reassembly.
9. Remove the guide stud and guide stud washer. Discard the guide stud washer.
10. Remove the min-max governor by rotating the throttle shaft.
11. Rotate the drive shaft until the hump on the retaining clip is visible. This will aid in removing the retaining clip.
12. Using tool J-9553-01, pull the drive shaft retaining clip off of the drive shaft. The retaining clip will become straightened and must be discarded.
13. Remove the drive shaft (alignment pin at top).
14. Remove and discard the drive shaft seals.

Installation

1. Install new seals using tool J-29745-A.
2. Lubricate the seal installer with Synkut oil J-33198 or the equivalent.
3. Install one black seal.
4. Relubricate the seal installer and install the red seal.
5. Relubricate the seal installer and install the last black seal.
6. Install a new retaining clip on the drive shaft. Do not spread the clip so large that it becomes loose in the drive shaft retaining clip slot.
7. Carefully install the drive shaft, making sure that the drill points on the drive shaft end and the rotor are matched.
8. Install the min-max governor.
9. Install the guide stud using a new guide stud washer. Be sure the guide stud is under the metering valve spring.
10. Install the governor cover using the new governor cover gasket.
11. Install the fast idle solenoid bracket.
12. Install the pump as previously outlined.

DRIVE SHAFT SEAL REPLACEMENT: 5.7 AND 4.3 LITER ENGINES

NOTICE: This procedure applies only to the Stanadyne Injection Pumps on the 5.7 liter engine and the 4.3 liter longitudinal engine.

1. Drive the shaft retaining pin out of the pilot tube from the small hole through the large hole. 1981 and later model drive shafts are held in pace by an "O" ring. Pull on the shaft with circular motion until shaft comes out.
2. Remove the shaft and remove the seals.
3. Clean the shaft.
4. Lubricate the seal installer tool with J-22198 or equivalent. Polish seal tools with #400 grit paper before first use. This will aid installation of seals.
5. Install one black seal.
6. Relubricate the seal installation tool, and install the red seal.
7. Install the last black seal.

8. Lubricate the seals and reinstall the shaft, making sure that the drill points on the shaft end and the rotor are matched. Use circular motion while seals enter bore area and be sure seals don't fold backwards during installation.
9. Install new shaft retaining pin, driving it through the small hole to the big hole. The pin should not protrude out of either hole. Stone the area if necessary to remove any burrs.
10. Re-test for leaks.

HYDRAULIC HEAD SEAL

Removal

1. Remove the throttle shaft and seals, see "Throttle Shaft Seal Replacement."
2. Remove the metering valve.
3. Remove the housing vent screw assembly.
4. Remove the advance pin hole plug. See "Advance Pin Hole Plug."
5. Remove the advance pin.
6. Locate the pump assembly and holding fixture so that the rear of the pump is sloping down and remove the head locating screws and seal.
7. Using a twisting motion, remove the hydraulic head assembly. Remove the "O" ring seal.

Installation

1. Install a new hydraulic head seal and lube it.
2. Install the head assembly into the pump housing, lube and install the two head locking screws finger tight. Turn the pump upside down.
3. Lube and install a new seal on the head locating screw and install the screw torquing it to 20-25 N·m (15-18 ft. lbs.).
4. Torque the head locking screws to 20-25 N·m (15-18 ft. lbs.).
5. Install the advance pin.
6. Install the advance pin hole plug and seal. See "Advance Pin Hole Plug."
7. Move the pump so the cover opening is up, and install the metering valve.
8. Install the throttle shaft, seals and pump cover. See "Throttle Shaft and Seals."

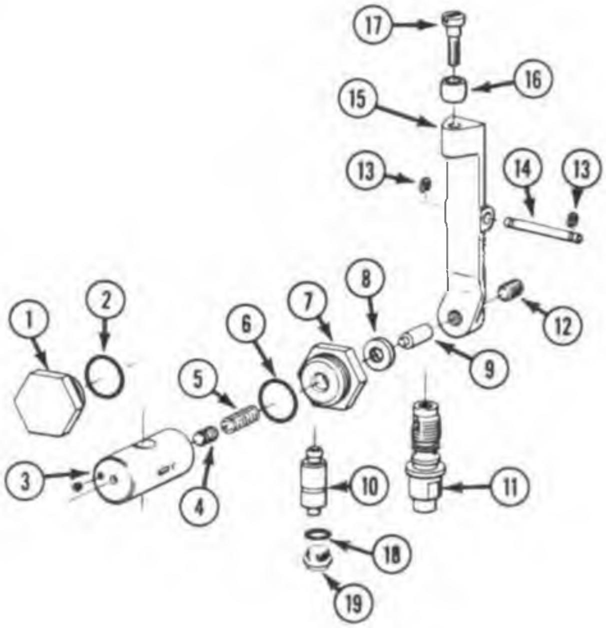
ADVANCE PIN HOLE PLUG SEAL (Fig. 2-36)

Removal

1. Tap the advance pin hole plug lightly with a hammer to loosen.
2. Loosen and remove the plug, remove the seal and do not reuse it.

Installation

1. Lube a new seal and install it on the plug.
2. Install the plug and torque it to 8.5-11.0 N·m (75-100 in. lbs.).



1. Power Side Plug
2. "O" Ring Seal
3. Piston Assembly
4. Servo Advance Valve
5. Mechanical Light Load
6. "O" Ring Seal
7. Spring Side Plug
8. Washer
9. Servo Advance Plunger
10. Cam Advance Pin
11. Head Locating Screw
12. Servo Advance Adjusting Screw (DO NOT ADJUST)
13. Retaining Ring
14. Rocker Lever Pin
15. Rocker Lever
16. Roller
17. Screw
18. "O" Ring
19. Cam Advance Pin Hole Plug

Fig. 2-36 Stanadyne Automatic Advance Group

AUTO ADVANCE SEALS (Fig. 2-36)

Removal

1. Remove the advance pin hole plug as stated in "Advance Pin Hole Plug."
2. Remove the spring side advance piston hole plug.
3. Remove the plug, piston, spring and slide washer.
4. Remove the power side advance piston hole plug.
5. Remove the plug, piston and slide washer.
6. Disassemble both plugs and pistons.

Installation

1. Lube the new seals and reassemble as shown in Figure 2-36.
2. Torque the plugs to 27 N·m (20 ft. lbs.).
3. Install the advance screw hole plug using a new seal. Torque to 8.5-11.0 N·m (75-100 in. lbs.).

SECTION 3
LUCAS CAV INJECTION PUMP

The Lucas CAV injection pump is similar to the Stanadyne pump. This pump will be used on the 4.3 liter transverse mounted engine. It is a single cylinder, opposed plunger, inlet metering, distributor-type pump. The pump also uses a tang drive shaft that fits into a slotted extension of a driven gear. The driven gear is mounted through an angled bore in the engine block, where it meshes with the camshaft drive gear. Like the Stanadyne pump, this pump is mounted through the intake manifold (Fig. 3-3).

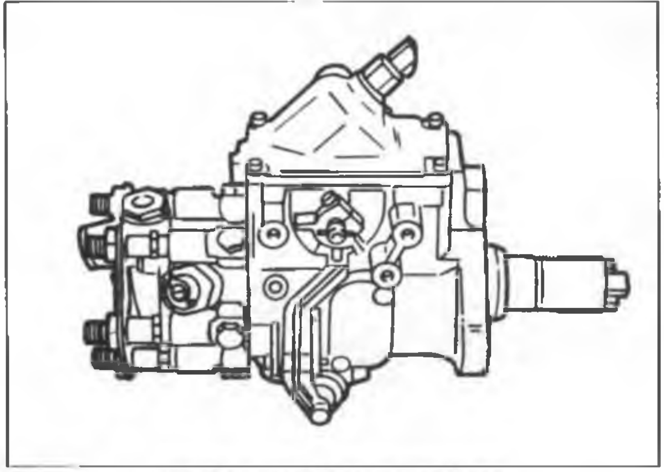


Fig. 3-3 Lucas CAV Injection Pump

GENERAL CONSTRUCTION

The main features of the pump and the method of functioning are best seen in a part sectional illustration (Fig. 3-1). First, note that there are three main rotating units arranged on a common axis so that they rotate as one. These comprise a drive shaft, a pumping and distributing rotor, and a fuel transfer pump of the sliding vane type. The distributor rotor is driven by a drive shaft, splined at both ends, which couples the rotor to a drive hub located in the end of the pump housing. Master splines are provided on both ends of the drive shaft, the drive hub, and on the drive plate secured to the end of the rotor.

The rotor comprises two parts, a pumping section and a distributing section. The latter is a close rotating fit in a stationary steel cylindrical body called the hydraulic head.

The pumping section of the rotor is larger in diameter than the distributing section, and has a transverse bore or cylinder containing two opposed plain plungers; these are the pumping plungers, and their disposition in this way removes any hydraulic side-thrust reaction on the rotor, which would be experienced with a single plunger.

The plungers are operated by means of a cam ring, which is carried in the pump housing, through rollers and shoes which are carried in slots in the periphery of the rotor flange. The cam ring has as many internal lobes as there are cylinders to be served, the lobes being equally spaced round the circumference.

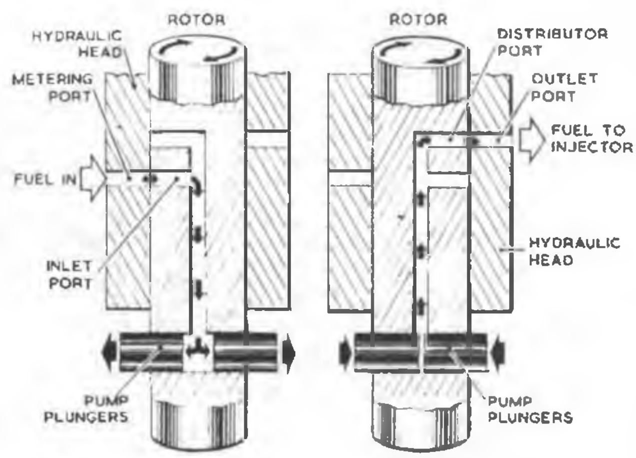


Fig. 3-4A Fig. 3-4B

Fig. 3-4 A & B DPA Pumping Plungers

The distributing section of the rotor contains a central axial passage which connects the pumping space between the plungers with ports which are drilled radially in the rotor and provide for fuel inlet and delivery. One radial hole in the rotor is the distributing port. As the rotor turns, the distributing port aligns successively with a number of outlet ports in the hydraulic head, from which the injectors are fed via external high pressure pipes. Only one outlet port is shown in the figure 3-4B, but there are as many ports as there are engine cylinders to be served.

At an intermediate level, a number of radial holes are equally spaced round the rotor circumference; these are the inlet ports, and they are also equal in number to the number of engine cylinders. As the rotor turns, the inlet ports align successively with a dual port in the hydraulic head. This is the fuel inlet or metering port, and is drilled obliquely.

The top end of the rotor carries the transfer pump which is of the continuous discharge vane type. It is housed in the hydraulic head and is covered by an endplate which contains the inlet connection through which fuel enters the pump from the main supply, and a by-pass valve which controls the transfer pump pressure.

Fuel entering the injection pump flows first to the transfer pump, which raises its pressure to an intermediate level, and then flows down a passage in the hydraulic head, round an annular groove in the rotor to a radial bore in the head which connects with the oblique metering port. The entrance to the metering port constitutes the metering orifice, and this is variable for control purposes by means of a metering valve which is a close sliding fit in the radial bore. (See Fig. 3-2)

PRINCIPLE OF OPERATION

Before considering the operation of the pump in detail, the working of the main parts may be followed by reference to simple diagrams.

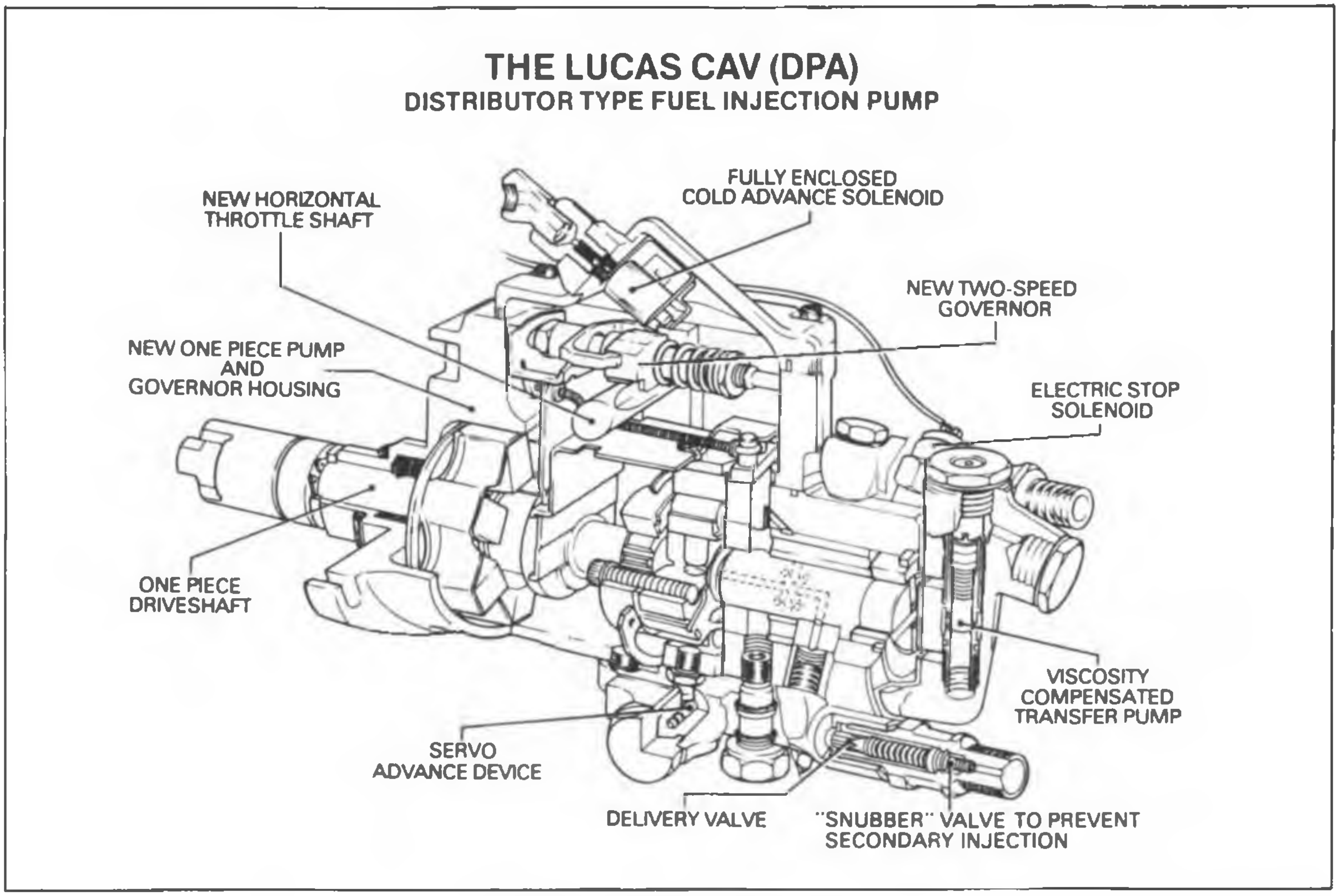


Fig. 3-1 Lucas CAV Pump Cut Away

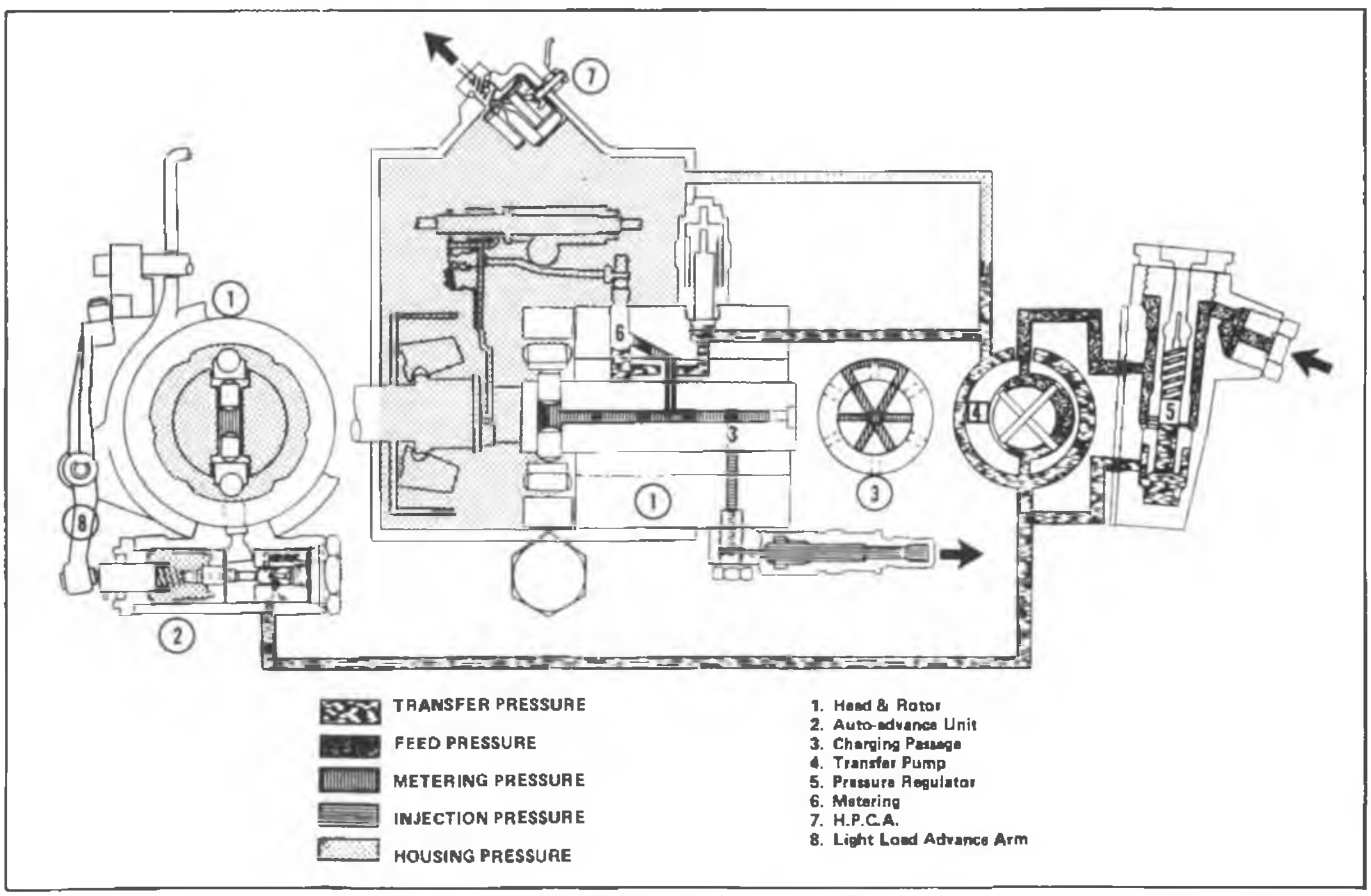


Fig. 3-2 DPA Fuel Pump Schematic

The action of the pump plungers is shown in Figs. 3-4 A & B. As the rotor turns, one of the inlet ports in the rotor opens to the metering port in the head, and fuel at metering pressure enters the rotor and separates the plungers (Fig. 3-4A). (Note that there are no springs forcing the plungers in). As the rotor continues to turn, the inlet closes off again, and shortly afterwards the distributor port aligns with one of the fuel outlets. Both rollers then contact opposing cam lobes and the plungers are forced in towards each other (as in Fig. 3-4B). This is the injection stroke, and the fuel trapped between the plungers is forced back through the rotor and out to the injector.

Fuel displacement ceases when the plungers reach the limit of inward travel imparted by the cam lobes, and shortly afterwards the distributor port closes, sealing off the fuel pipe to the injector.

As the rotation of the rotor continues, the cycle just described repeats itself, the pump discharging through each of the outlet connections in turn.

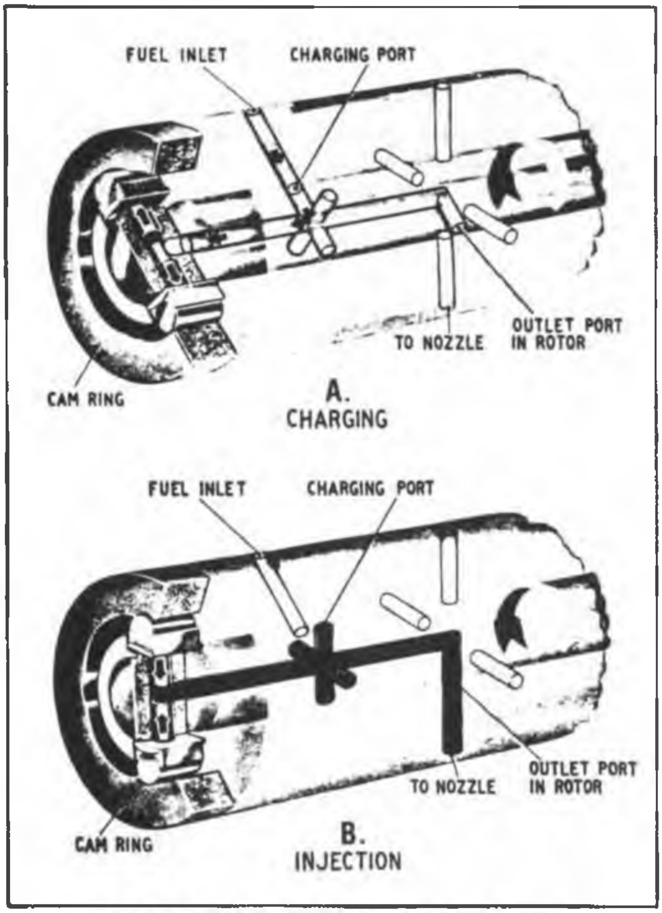


Fig. 3-5 Cross Section of CAV Pumping Plungers

The functioning of the distributor rotor is also shown in the perspective diagrams (Fig. 3-5 A & B). For the sake of simplicity, these figures depict a pumping section suitable for a 4 cylinder engine. The only difference for a 6 cylinder engine would be in the porting e.g. 6 inlet ports—6 outlet ports and 6 cam lobes on the cam ring. In Fig. A. the rotor is in the 'charging' or inlet position. The rollers have reached their most outward position, being off the cam lobes, allowing the plungers to move as far apart as they can under the pressure of fuel from the transfer pump. The inlet or metering port is shown in register with one of the inlet or charging ports in the rotor, while the distributor outlet port is well out of register with the outlet port in the head.

With further rotation of the rotor, the relationships change, until the 'discharge' or injection position is reached, as seen in Fig. B. Here the rollers have reached the slopes of the opposite cam lobes, forcing the plungers together and discharging the fuel. Note that the disbributor port in the rotor is in register with one of the fuel outlets, while the inlet ports in the rotor are out of register with the metering port.

HYDRAULIC HEAD AND ROTOR

The hydraulic head and rotor is a mated assembly 'match ground' to within ± 1 micron. This is to minimize leakage while allowing sufficient bearing clearance.

The hydraulic head comprises a barrel and a sleeve. The hydraulic head outlet ports (where the banjo assemblies are located) are equally spaced and positioned radially on the outside diameter and register in turn with the rotor distributor outlet port through passages in the sleeve. The sleeve also contains one or two inlet ports which register with the rotor filling ports. Two inlet ports are used to provide a multi-filling capability.

The end of the hydraulic head remote from the cam ring is counter bored to provide a recess to house the transfer pump. This recess contains a self venting orifice which removes any air bubbles from the fuel via a drilling to the cam box before fuel flows to the pumping plungers.

The distributor rotor has two plungers opposing each other which pump simultaneously against the opposite lobes of the cam ring. The plunger diameters are 7.5 mm.

The rotor comprises a number of filling and distributor drillings as described under **Pumping and Distribution of Fuel.**

PUMPING AND DISTRIBUTION OF FUEL

As the rotor turns, the two filling ports in the hydraulic head align with the two charging ports in the rotor and fuel at metered pressure flows into the central passage in the rotor and forces the pumping plungers apart. The amount of plunger displacement is determined by the amount of fuel which can flow into the element while the ports are aligned.

With continued rotation, the fuel entering the two filling ports in the hydraulic head is cut off by the charging ports as the single fuel delivery port in the rotor registers with an outlet port in the hydraulic head. At the same time, the pumping plungers are forced inwards by the rollers in contact with the internal lobes of the cam ring and fuel at injection pressure passes through the central passage of the rotor and through the ports and to one of the injectors.

With further rotation, the charging and injection cycles are repeated in sequence with the rotor alternately charging through a pair of filling ports and discharging into each successive outlet port. The number of outlet ports in the hydraulic head are equal to the number of cylinders on the engine.

TRANSFER PUMP AND REGULATING VALVE

The regulating valve performs two separate functions. First, it controls fuel pressure by maintaining a definite relationship between transfer pressure and speed of rotation. Second, it provides a means of by-passing the transfer pump when the engine is stationary, so that the fuel passages in the hydraulic head can be primed (Fig. 3-6A).

Fuel entering the main inlet connection at feed pressure is raised to a higher pressure known as 'transfer pressure' by a displacement type transfer pump consisting of a rotor, rigid blades and eccentric liner.

The rotor is screwed on to the end of the distributor rotor; the direction of the screw thread being opposite to the direction of the rotation of the injection pump so that it tends to tighten when running.

Two rigid blades at 90° to one another slide freely in the grooves of the rotor and follow the internal profile of the eccentric liner.

Fuel entering the end plate at feed pressure passes to the inlet side of the transfer pump through the nylon filter and upper fuel passage of the regulating valve.

Transfer pressure is transmitted to the underside of the regulating piston through the lower fuel passage to force the piston upwards. The force is opposed by the pressure exerted on the upper face of the piston by the regulating spring.

As transfer pressure rises with increased engine speed, the piston is forced upwards and the regulating spring is compressed. Such movement of the piston progressively uncovers the regulating port and transfer pressure is reduced by permitting a metered flow of fuel back to the inlet side of the transfer pump. The effective area of the regulating port is thus increased as engine speed is raised or reduced as engine speed falls (Fig. 3-6B).

The regulating valve also provides a secondary function of providing means of by-passing the blades of the transfer pump when the pump is stationary, so that the fuel passages in the hydraulic head can be primed (Fig. 3-2).

When priming the pump, fuel entering the end plate cannot pass through the transfer pump and into the fuel passages in the hydraulic head in the normal way. Fuel at priming pressure enters the regulating sleeve and acts on the upper face of the regulating piston. The pistion is forced to the lower end of the sleeve, compressing the priming spring and uncovering the priming ports. Fuel then passes through the priming ports and the lower fuel passage to the outlet side of the transfer pump and then into the fuel passages within the hydraulic head.

FUEL METERING

Metering is effected by regulating the volume of fuel which enters the element at each charging stroke. The volume of the charge is governed by two principal factors: the fuel pressure at the inlet port, and the time available for fuel to flow into the element while the inlet ports in the rotor

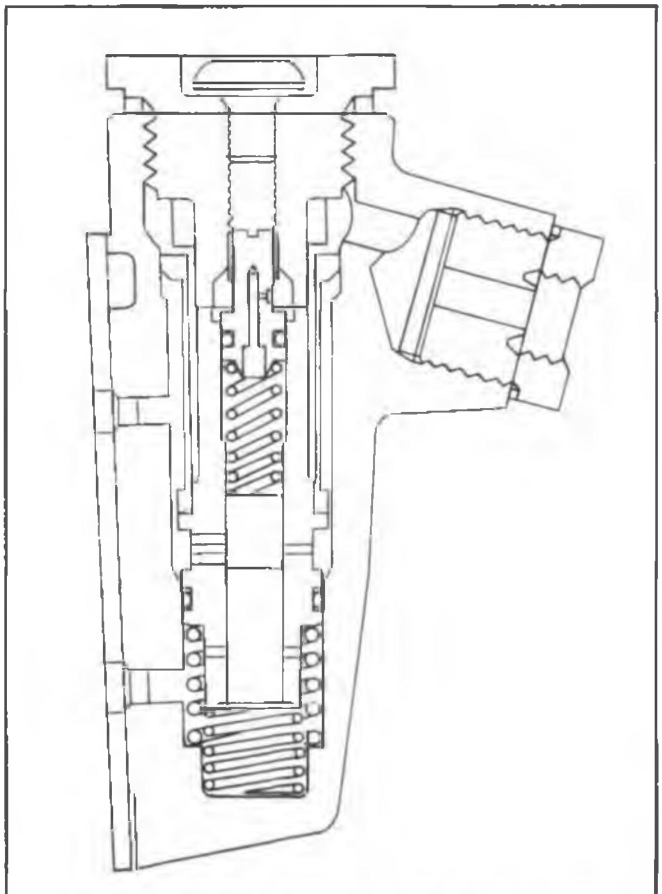


Fig. 3-6 A Regulating Valve Closed (Engine Cranking)

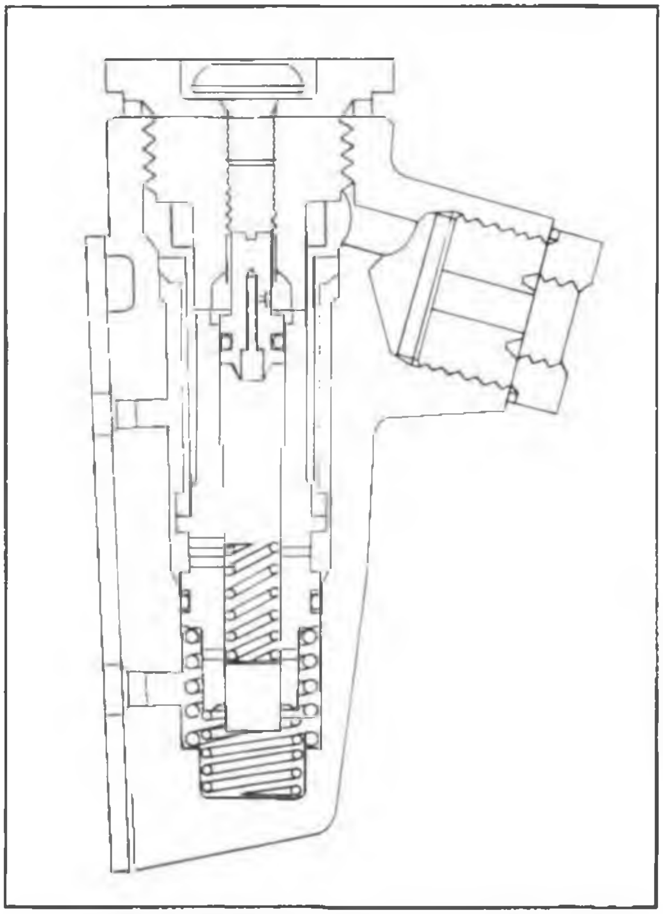


Fig. 3-6 B Regulating Valve Open (Air Venting Pump Stationary)

and the hydraulic head are in register. It is by controlling the pressure at the inlet port that accurate metering is achieved.

Fuel oil enters the fuel injection pump at feed pressure and passes into the transfer pump, which raises the pressure to a level known as transfer pressure.

Transfer pressure is related to engine speed, and rises as the speed of rotation is increased. A pre-determined relationship between transfer pressure and the speed of rotation is maintained by a regulating valve situated in the end plate of the pump.

Fuel at transfer pressure passes through passages in the hydraulic head to the metering valve which controls the flow of fuel through the metering port. The effective area of the metering port is controlled by moving the metering valve, which is connected by suitable control linkage to the accelerator pedal and to the governor.

A pressure drop occurs as fuel passes through the metering orifice, reducing the fuel pressure to a level known as metering pressure. The smaller the metering orifice the greater will be the decrease in pressure and vice versa.

Fuel at metering pressure passes to a semi-annulus in the sleeve and from there via two drillings into the rotor inlet ports, therefore allowing a multi-filling capability (Fig. 3-2).

At idling speeds both transfer pressure and metering pressure are at their minimum value. Depression of the accelerator moves the metering valve to a position where the effective area of the metering port is increased. This brings about an increase in metering pressure and consequent increase in the quantity of fuel entering the pumping element at each charging stroke. The engine will then accelerate in response to increased fuelling until a speed corresponding to the position of the accelerator pedal is attained.

If the pedal is then released, the effective area of the metering orifice is reduced, and engine speed will fall as the result of decreased fuelling.

When the engine is running at low idle speed setting the governor controls the position of the metering valve, and maintains the selected speed within close limits by causing compensating changes of fuelling.

MAXIMUM FUEL ADJUSTMENT

Maximum fuel settings are made by limiting the maximum outward travel of the pumping plungers at a point where the desired fuelling is obtained.

The cam rollers are carried in shoes against which the pumping plungers are pressed by the incoming fuel. The shoes slide in guides machined in the rotor, and are retained in an endwise sense by top and bottom adjusting plates. "Ears," integral with the roller shoes, project into eccentrically cut slots in both adjusting plates. The "Ears" are shaped to match the contour of the slots (Fig. 3-7).

The bottom adjusting plate is rigidly clamped between the drive plate and the end of the rotor. The screws which secure the drive plates pass through elongated holes in the

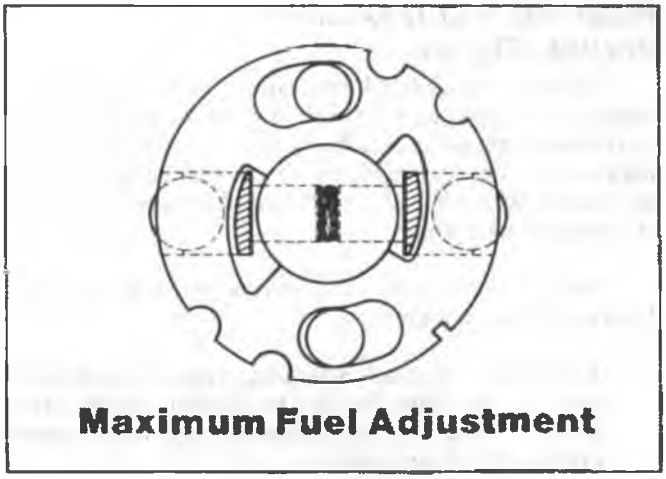


Fig. 3-7 Maximum Fuel Adjusting Plates

adjusting plate so that the adjusting plates can be moved when the screws are slackened. Top and bottom plates are located one to the other by lugs integral with the top plate.

The plungers reach their outward limit of travel when the "Ears" on the roller shoes contact the curved sides of the slots in the adjusting plates.

The adjusting plates are shown in the position which would provide the lowest possible maximum fuel setting. Since the slots in the adjusting plates are eccentric, maximum plunger travel will be increased if the adjusting plates are moved in a clock-wise direction in relation to the rotor. The movement provided permits a wide range of maximum fuel settings.

Satisfactory adjustment of the maximum fuel setting can be made only while the pump is on the test bench, and should not be altered except on the recommendation of the engine manufacturer.

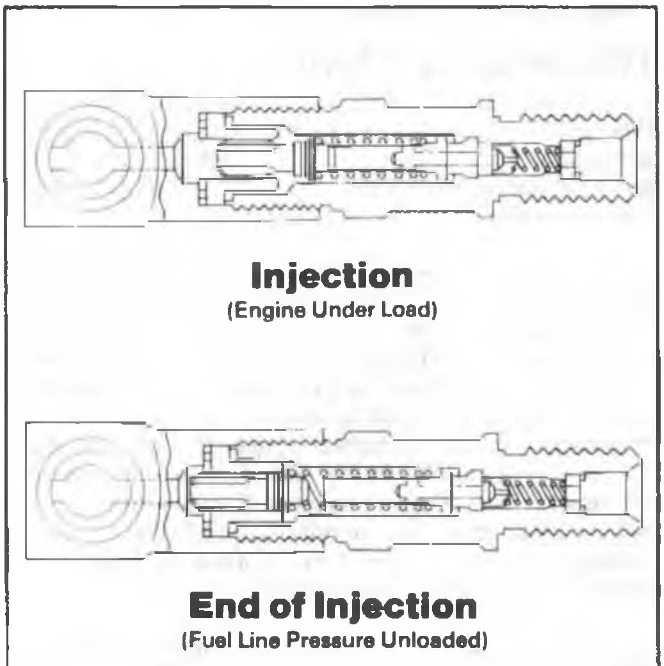


Fig. 3-8 Delivery Valve End of Injection

HIGH PRESSURE DELIVERY VALVES (Fig. 3-8)

The high pressure delivery valves, each screwed into a banjo connection, are fitted radially in the hydraulic head. Each banjo comprises a delivery valve holder, valve body, high pressure delivery valve, spring and peg. Sealing washers are used between the valve body and banjo connection and the delivery valve holder.

The valves, together with the cam lobe configuration, have two main functions:

To provide precise injection commencement and cutoff points, irrespective of engine load or speed, while maintaining a constant and accurate residual pressure in the high pressure system.

To avoid the effect of cavitation in the high pressure system inside the hydraulic head.

SNUBBER VALVES

Each delivery valve holder is fitted with a snubber valve which is comprised of a seat, valve and spring. The snubber valves prevent secondary injection by attenuating reverse pressure waves (Fig. 3-8).

SOLENOID SHUT-OFF VALVE

An electrically operated fuel shut-off valve is screwed into the top of the hydraulic head. The unit consists of a solenoid assembly which controls a spring loaded piston and is located between the transfer pump outlet and the metering valve.

When the solenoid valve is energized on starting the engine, the solenoid will lift the piston against spring pressure and allow fuel at transfer pressure to pass to the metering valve. When the solenoid is de-energized, by cutting the electrical circuit, the return spring pushes the piston back against its seat and prevents the rotor from filling thereby stopping the engine.

TWO SPEED GOVERNOR

The two speed governor is of the mechanical fly-weight type giving accurate control of the engine at idling and maximum speeds. The governor fly-weight assembly is mounted on the drive shaft and is entirely contained within the pump body.

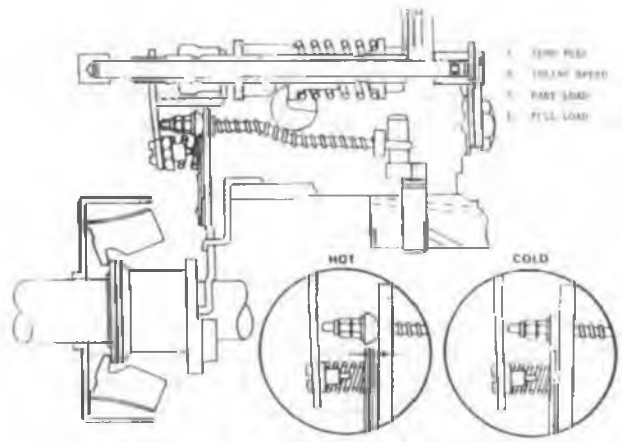
Movement of the governor fly-weights, which pivot outwards depending on the magnitude of the centrifugal force set up by rotation, actuates a thrust sleeve. The sleeve, sliding along the drive shaft, causes the governor arm to pivot about a fulcrum on the control bracket and this movement is transmitted by the governor link arm to the metering valve which rotates to change the quantity of fuel entering the pumping element. Rotating the metering valve changes the flow area between the groove in the valve and the metering port. The amount of fuel that enters the pumping element is therefore changed by varying the effective area of the metering orifice.

The governor link arm and spring is located in the upper part of the pump casing enclosed by the control cover which houses the throttle and idling shafts.

At idling speeds movement of the metering valve is controlled by the centrifugal force of the governor weights which, via the governor arm and idling carriage, compresses the idling spring until a state of equilibrium is achieved (Fig. 3-9A).

During intermediate speeds a pre-loaded main governor spring provides a direct link between the vehicle accelerator pedal and the metering valve so that the amount by which the metering valve rotates is entirely a function of the throttle lever position (Fig. 3-9B).

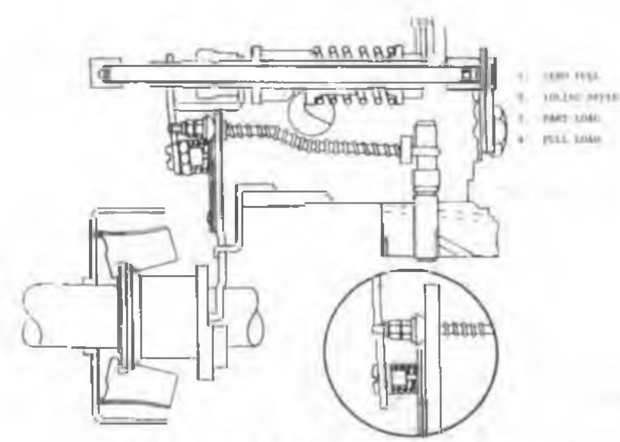
At a pre-determined speed approaching the maximum speed of the engine, the resulting centrifugal force of the governor fly-weights exceeds the pre-load of the main governor spring and the metering valve is rotated to reduce the amount of fuel delivered (Fig. 3-9D).



Idling Governor Control

(Engine Idling Speed Maintained By Governor)

Fig. 3-9 A Governor Idling Control



Part Load-Driver Control

(Between Idling and Max Full Load Engine Speed)

Fig. 3-9 B Governor Partial Load Control

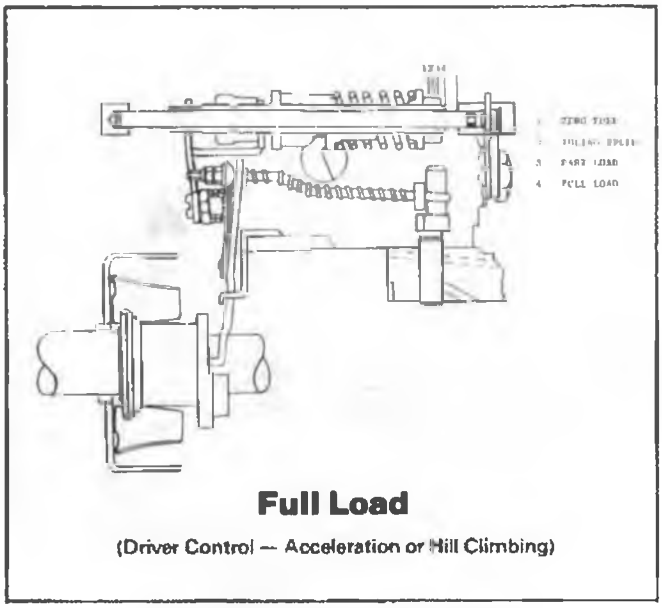


Fig. 3-9 C Full Load Governor Control

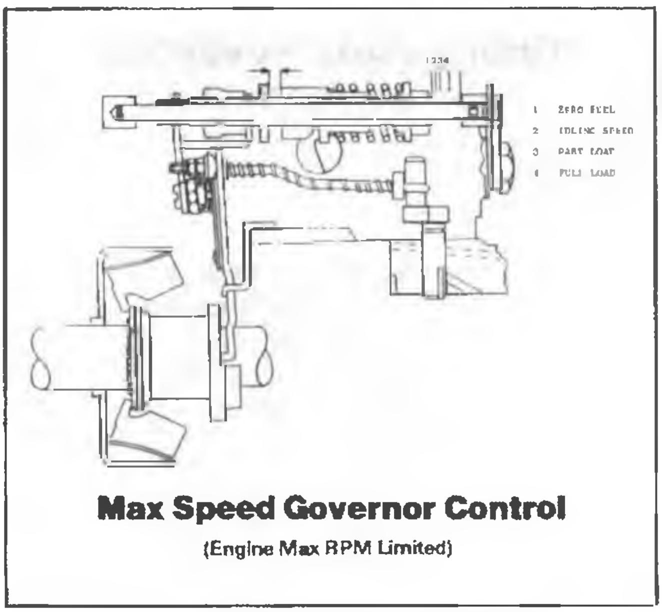


Fig. 3-9 D Governor Maximum Speed Control

CAM BOX PRESSURIZING VALVE

The pressurizing valve is screwed into the top of the governor control cover and comprises a ball, valve, upper spring and lower spring. The lower spring is located in the cavity below the valve and acts as a course filter to prevent the valve sticking (Fig. 3-10).

During running, constant pressure is maintained in the cam box by the upper spring retaining the ball on its seating. Only when pressure exceeds the loading on the upper spring at a pre-determined pressure is fuel allowed to bypass the valve.

As changes occur in engine speed, with resultant pressure differences in the cam box, the valve re-acts by lifting or closing on its seating to allow the back leakage of fuel to return to the supply tank thus maintaining a constant cam box pressure in the pump housing.

Maintaining the cam box at a constant pressure helps to prevent cavitation erosion. During cold start operation an engine temperature sensor energizes the cold advance solenoid, forcing the ball to lift off its seat thereby dropping housing pressure to zero. This collapse in pressure allows additional advance to take place, preventing excessive white smoke during the starting period (Fig. 3-11). Cambox pressure is also referred to as housing pressure.

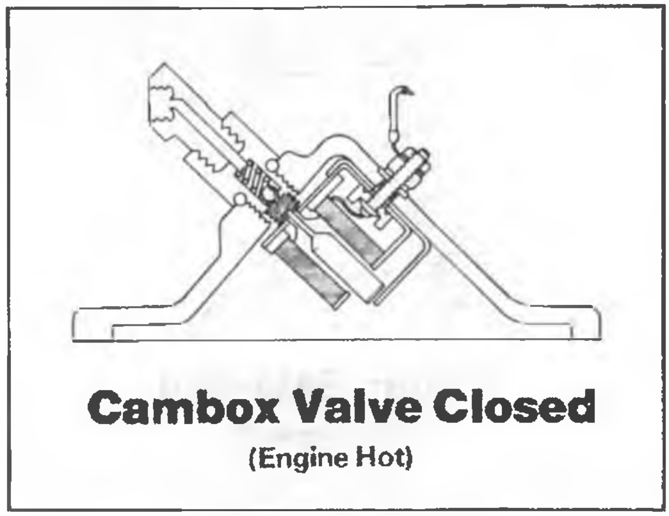


Fig. 3-10 HPCA (Engine Hot)

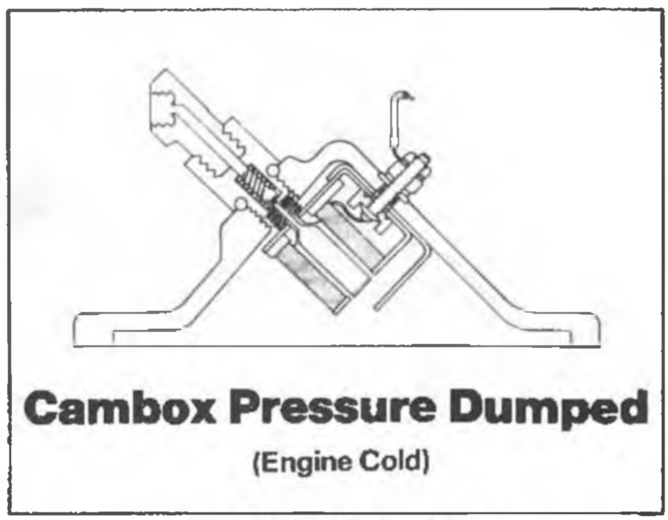
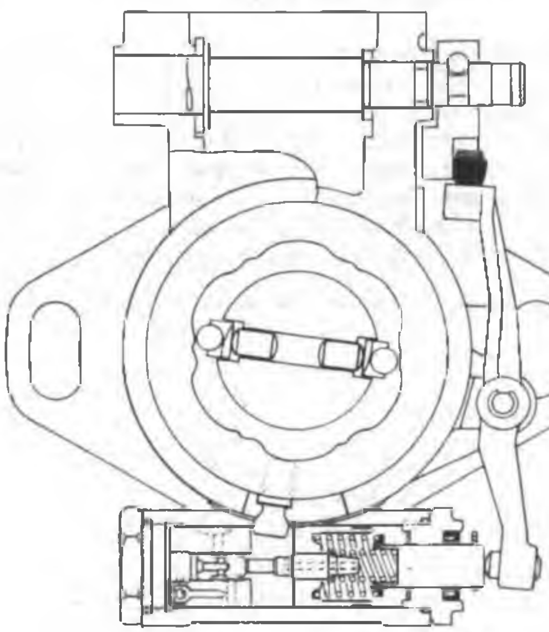


Fig. 3-11 HPCA (Engine Cold)

AUTOMATIC ADVANCE AND RETARD

The automatic advance and retard device is comprised of a servo piston operating within the advance piston, which, in turn, moves in the advance box. These three items form a mated assembly.

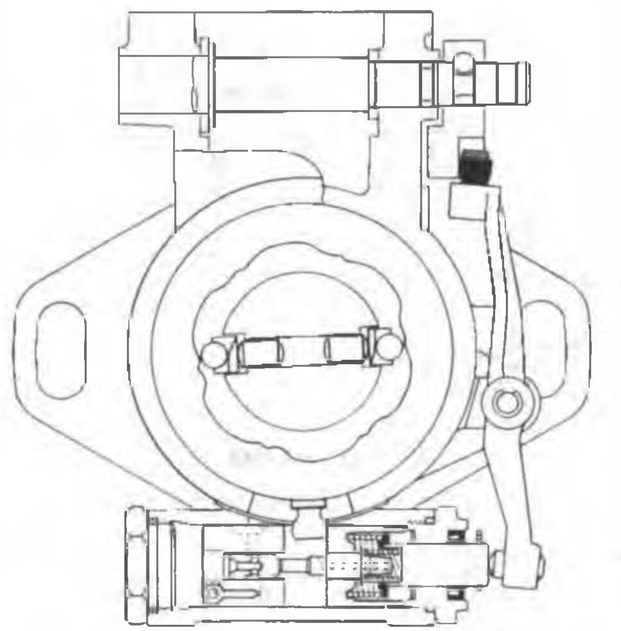
The servo piston responds to transfer pressure, advance spring load and housing pressure. The position of the servo piston is, therefore, decided by the difference between the opposing forces—the forces of transfer pressure versus advance spring load and housing pressure.



Timing Retarded

(Engine Cranking)

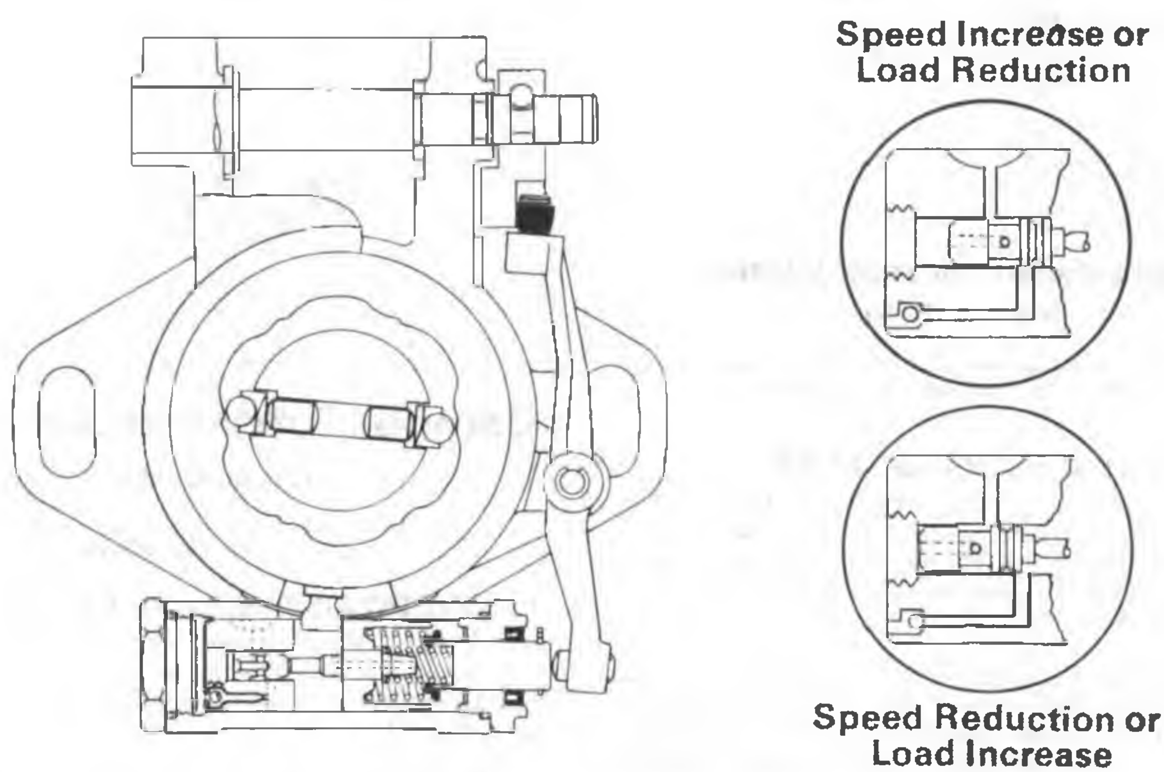
Fig. 3-12 A Timing Retarded (Engine Cranking)



Timing Fully Advanced

(Engine Approaching Max Speed)

Fig. 3-12 B Timing Fully Advanced



Timing Variable with Speed Load

(Engine Idle to 65% Full Speed)

Fig. 3-12 C Timing Variable with Speed Load

With reference to Fig. 3-12A, B, and C, it can be seen that the fuel injection pump has a clockwise direction of rotation. The advance piston, as it moves, will move the cam ring in an anti-clockwise direction of rotation; therefore, providing an advance of the point of commencement of pumping. Figure (3-12A) shows the advance device in a fully retarded position.

With rising engine speed, oil at transfer pressure, acting upon the servo piston, will cause the servo piston to move forwards. The rear land of the servo piston will expose a drilling leading to the rear face of the advance piston. Oil at transfer pressure will force the advance piston forwards until the advance port crosses across the land. A further rise in engine speed will cause this action to be repeated until eventually the advance piston contacts the spring cap—this is full advance (Fig. 3-12B).

As engine speed falls, oil at transfer pressure will reduce and the servo piston will move to a position where the front land exposes the advance port. Oil from the rear face of the advance piston will be dumped into the housing and the advance piston will move back until the advance port crosses across the front land. As speed reduces, this action will be repeated until the advance piston contacts the power piston plug—this is the full retard position (Fig. 3-12A).

A lock-off ball and seat is incorporated to eliminate the possibility of advance piston movement under the influence of cam torque. To offset the fuel injection pump's inherent light load retard characteristics, a throttle operated face cam and rocking lever is incorporated. As load is reduced, the throttle lever is rotated and the face cam allows the rocking lever to pivot reducing advance spring load allowing for additional advance (Fig. 3-12C).

LUCAS CAV SERVICE PROCEDURES: ON VEHICLE

STOP SOLENOID

Removal

1. Remove the air cleaner and install J-26996-1 cover.
2. Clean the dirt from the area around the solenoid.
3. Remove the electrical lead.
4. Remove the solenoid and "O" ring.

Installation

1. Lube and install a new "O" ring on the solenoid.
2. Install the solenoid, torquing it to 15 N·m (130 in. lbs.)
3. Reconnect electrical lead and check for audible click when the ignition switch is turned on and off.
4. Start the engine, check for leaks and shut off operation.
5. Install the air cleaner.

GOVERNOR CONTROL COVER GASKET

Removal

1. Remove the air crossover, and install J-29657 covers.
2. Clean any dirt from the injection pump cover and upper area of the pump.
3. Place several rags in the engine valley to catch spilled fuel.
4. Remove the fuel return pipe.
5. Remove the control cover screws, discarding the washers and gasket.

NOTICE: Extreme care must be exercised to keep foreign material out of the pump when the cover is off. If any objects are dropped into the pump, they must be removed before the engine is started or injection pump damage or engine damage could occur.

1. Rubber "O" ring
2. Back leakage connection
3. Elbow connection
4. Governor control cover
5. Joint (Gasket)
6. Spring filter
7. Cold advance solenoid
8. Backing washer
9. Rubber "O" ring
10. Insulating washer
11. Plain washer
12. Nut
13. Locknut
14. Tang drive hub
15. Snap ring
16. Rubber "O" ring
17. Shakeproof washer
18. Screw - dome headed
19. Inspection cover
20. Rubber sealing joint (Gasket)
21. Stop solenoid
22. Throttle lever
23. Shakeproof washer
24. Hexagon socket screw

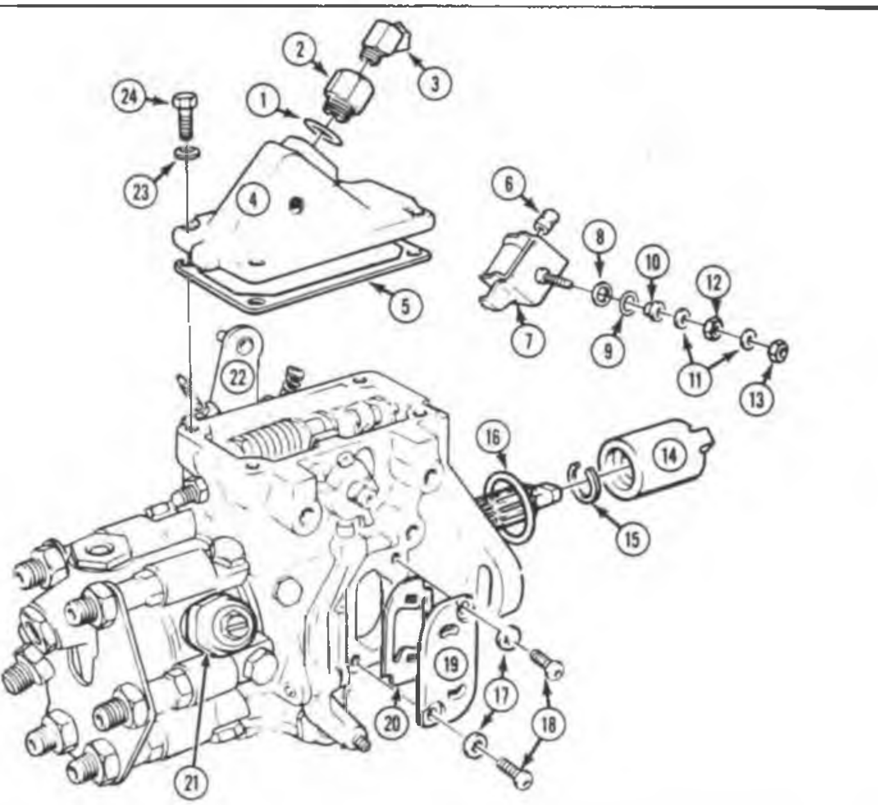


Fig. 3-13 CAV Pump Covers and Solenoids

Installation

1. Install a new gasket and install the cover.
2. Torque the screws to 2.8 N·m (25 in. lbs.)
3. Install the fuel return pipe.
4. Start the engine and check for leaks.
5. Remove the screened covers and install the air crossover.

HOUSING PRESSURE COLD ADVANCE SOLENOID

Removal

1. Remove the governor control cover, see "Governor Control Cover."
2. Remove the solenoid terminal nut, insulating washers and solenoid. Discard the gasket.

Installation

1. Install a new gasket on the solenoid, install the solenoid on the cover placing the installing washers on the stud. Torque the terminal to 2.25 N·m (20 in. lbs.) Make certain the solenoid is centered in the cover.
2. Using a 12V D.C. power supply, check the operation of the solenoid being certain the plunger does not bind in the back leakage ball fitting.
3. Install the governor control cover on the pump. See "Governor Control Cover."

END PLATE PLUG OR STOP PLUG WASHER

Removal

1. Remove the air cleaner and install J-26996-1 cover.
2. Clean any dirt from the area.
3. Remove the stop plug and/or end plate plug and discard the washer(s).
4. Replace with new washer(s) and reinstall.

FUEL INLET CONNECTION WASHER

Removal

1. Remove the air cleaner and install J-26996-1 cover.
2. Clean any dirt from the area.
3. Remove the fuel inlet pipe.
4. Remove the inlet connection and discard the washer.

Installation

1. Using a new washer, install the inlet connection on the pump. Torque to 45 N·m (33 ft. lbs.).
2. Install the fuel inlet pipe.
3. Start the engine and check for leaks.
4. Install the air cleaner.

INSPECTION COVER PLATE GASKET

Removal

1. Remove the air cleaner and install J-26996-1 cover.
2. Place several rags in the engine valley to catch fuel when the plate is removed.
3. Using a straight edge and a scribe, etch a line across the pump housing and the VRV valve. This will be used as an alignment mark when replacing the valve. Remove the VRV valve. When replacing the valve, realign the valve with the etched line. Doing so will avoid readjusting the valve on installation.
4. Clean any dirt on the pump in the inspection plate area.
5. Remove the screws from the plate and remove the plate, discard the gasket.

Installation

1. Install the inspection plate using a new gasket. Torque the screws to 2-3 N·m (20 in. lbs.).
2. Start the engine and check for leaks.
3. Install the VRV according to Step 3 under removal.
4. Install the air cleaner.

1. Rubber "O" ring
2. Idling adjuster screw
3. Thrust washer
4. "E" type circlip
5. Thrust washer
6. Rubber "O" ring
7. Clamp screw
8. Light load advance cam
9. Pin
10. Locknut and rubber "O" ring
11. Torque screw
12. Throttle shaft
13. Maximum speed adjustment screw (Do not adjust)

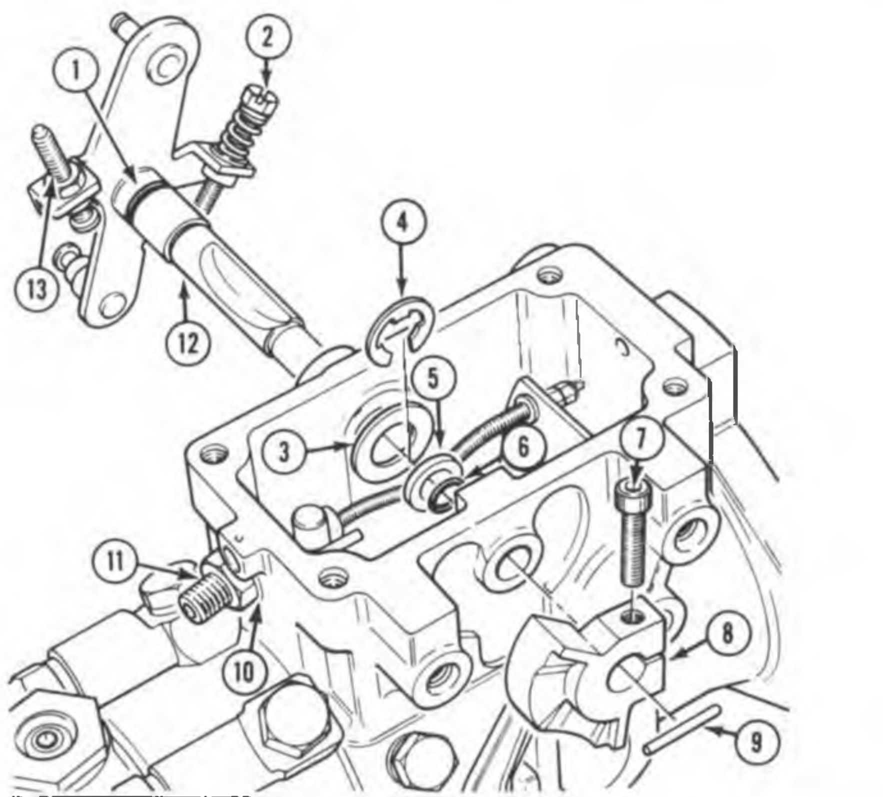


Fig. 3-14 CAV Pump Throttle Shaft and Seals

THROTTLE SHAFT SEALS

Removal

1. Remove the governor control cover and gasket, see "Governor Control Cover Gasket."
2. Remove the fast idle solenoid.
3. Using a straight edge and a scribe, etch a line across the pump housing and the VRV valve. This will be used as an alignment mark when replacing the valve. Remove the VRV valve. When replacing the valve, realign the valve with the etched line. Doing so will avoid readjusting the valve on installation.
4. Disconnect the throttle cable and T.V./detent cable.
5. Disconnect the throttle return springs.
6. Install tool J-29601 over the throttle shaft with slots of the tool engaging the VRV (drive) lock pin. Put the spring clip of the tool over the throttle shaft (light load) advance cam and tighten the wing nut. Without loosening the wing nut, pull the tool off the shaft. (This provides the proper alignment on reassembly.)
7. Remove the lock pin from the throttle shaft (Fig. 3-14).
8. Remove the locking (roll) pin from the pump housing and remove the governor support rod. Discard the support rod "O" ring (Fig. 3-15).
9. Tilt the governor carrier assembly by lifting the end nearest the drive end of the pump and ease the carrier clear of the pump housing (Fig. 3-15).
10. Remove the clamping screw from the light load cam and remove the cam. Remove any burrs on the end of the shaft (Fig. 3-14).
11. Remove the "E" circlip from the throttle shaft. Be careful not to drop it into the interior of the pump (Fig. 3-14).
12. Pull the throttle shaft out of the pump. Remove the smaller "O" ring first, thrust washers and larger "O" ring noting their position. Discard the "O" rings (Fig. 3-14).

Installation

1. Examine the throttle shaft assembly for wear or damage and replace if necessary.
2. Examine the throttle shaft bores in the governor housing for excessive wear or scoring. Remove the pump and send to the local CAV Authorized dealer if a new housing is necessary.
3. Ensure that both the maximum speed screw (13) and the idling speed screw (2) are fitted to the throttle lever.
4. Using protection sleeve J-33097, fit a new rubber "O" ring (1) into the groove on the shaft nearest the lever.
5. To avoid damage to the throttle shaft bore when fitting the rubber "O" ring (6), partially insert the throttle shaft through the side of the housing to the point where the large thrust washer (3) can be fitted, followed by the small thrust washer (5).
6. Using protection tool J-33098, which is comprised of a cap and sleeve, fit a new rubber "O" ring (6) over the tapered end of the cap.
7. Insert the cap, tapered end first, into the sleeve and slide the "O" ring (6) on to the outside diameter of the sleeve and detach the cap. Slide the sleeve with the rubber "O" ring over the end of the shaft.
8. Ease the shaft towards the opposite side of the pump until the end of the shaft is supported, then push the rubber "O" ring (6) into the groove in the shaft.
9. Keeping the shaft horizontal, withdraw the shaft sufficiently to enable the protection sleeve to be removed.
10. Push the shaft fully into engagement with the housing and secure the shaft by inserting the "E" type circlip (4) into the recess in the shaft abutting the thrust washer (3). If a new throttle shaft has been installed, it will be necessary to check the end play of the shaft and adjust by selective fitting of the thrust washer(s) if necessary. Using feeler gages, the throttle shaft should be between a maximum of 0.3 mm (0.012") and a minimum of 0.15 mm (0.006").
11. Place the light load advance cam on the shaft and insert the clamping screw but do not tighten it.
12. Install a new pin on the end of the shaft. Align the throttle shaft advance cam so tool J-29601 can be reinstalled over the throttle shaft pin with the spring clip over the advance cam. Tighten the cam screw to 4.5 N·m (40 in. lbs.) and remove tool J-29601.
13. Rotate the throttle shaft lever forward to the drive end (idling) of the pump. Tilt the governor car carrier assembly to abut the idle spring with the 1 leaf spring on the governor control arm. Lower the carrier into the housing and engage the lug on the underside of the throttle block with the cut away notch in the throttle shaft (Fig. 3-15).
14. Lubricate both the governor support rod and a new "O" ring. Install the "O" rod using J-33096.
15. Insert the plain end of the rod through the rear governor housing and into the sleeve of the carrier assembly. Fully install the support rod into the housing and install a new locking pin (Fig. 3-15).
16. Install the governor cover. See "Governor Control Cover Gasket."
17. Install the fuel return pipe.
18. Install the throttle return springs.
19. Connect the throttle cable.
20. Connect the T.V./detent cable.
21. Install the VRV valve using the alignment marks you scribed earlier on the pump housing and valve.
22. Install the fast idle solenoid.
23. Start the engine and check for leaks.
24. If no leaks are apparent, remove the intake manifold screens and install the air crossover and air cleaner.

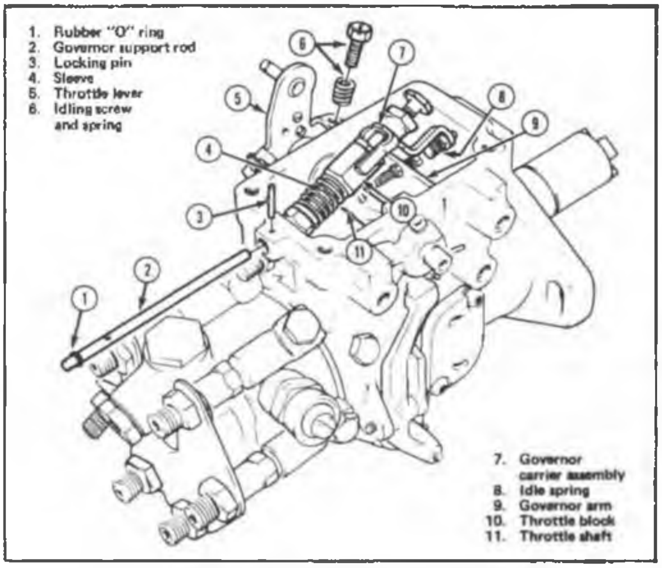


Fig. 3-15 CAV Pump Governor Carrier Assembly

1. Circlip
2. Advance plunger
3. Rubber seal
4. Spring cap
5. Rubber "O" ring
6. Spring seat
7. Advance spring
8. Servo spring
9. Shims
10. Spring piston
11. Piston
12. Head locating fitting
13. Pressure end plug
14. Rubber "O" ring
15. Rubber "O" ring
16. Rubber "O" ring
17. Auto-advance housing
18. Joint (gasket)
19. Cam advance screw
20. Advance piston
21. "Dowty" washer
22. Cap nut
23. Auto-advance housing stud
24. Head locking bolts and washers

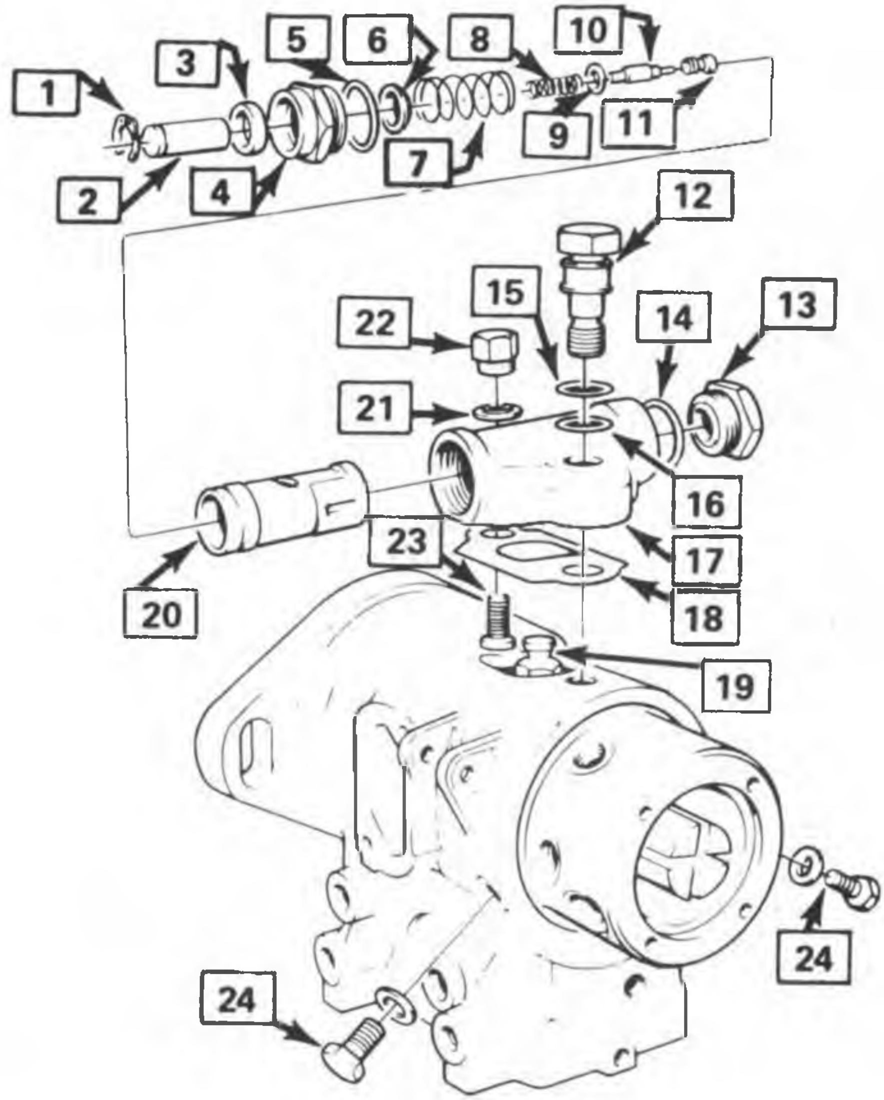


Fig. 3-16 CAV Pump Auto Advance Unit

LUCAS CAV SERVICE PROCEDURES: OFF VEHICLE

AUTO-ADVANCE PRESSURE END PLUG SEAL (Fig. 3-16)

Removal

1. Remove any dirt from the area.
2. Remove the pressure end plug and discard the "O" ring.

Installation

1. Lubricate a new "O" ring and install it on the plug.
2. Install the plug and torque it to 28 N·m (21 ft. lbs.).

AUTO-ADVANCE SPRING CAP SEALS (Fig. 3-16)

Removal

1. Remove any dirt from the area.
2. Remove 'E' type circlip from the pivot pin securing the rocker arm assembly to the pump housing. Pull out pin and remove rocker assembly.
3. Remove the spring cap from the advance housing.
4. Remove and discard "O" ring from the spring cap. If the leak was traced to the lip seal, pull out the advance plunger from the spring cap and remove the lip seal.

Installation

1. If removed, lubricate and install a new lip seal into the spring cap using J-33081 installer. Lubricate and install a new "O" ring onto the spring cap.
2. Install the spring cap into the advance housing, torque to 28 N·m (21 ft. lbs.).
3. Reposition the rocker arm to the pump housing and install the pivot pin. Install the "E" type circlip into the pivot pin recess.

AUTO-ADVANCE HOUSING GASKET (Fig. 3-16)

Removal

1. Clean all dirt from the area.
2. Remove the head locating fitting and discard the "O" rings.
3. Remove the cap nut and discard the sealing washer.
4. Remove the advance assembly from the pump and discard the gasket.

Installation

1. Install a new gasket on the pump with the straight edge on the gasket nearest the housing stud.
2. Install the advance housing by engaging the bore in the piston position with a new sealing washer and the cap nut but install the nut finger tight.
3. Lube and install new "O" rings onto the head locating fitting.
4. Install the head locating fitting and torque the fitting and cap nut alternately. 39 N·m (28 ft. lbs.) for the fitting and to 19 N·m (10 ft. lbs.) for the cap nut.
5. Remove the pressure end plug and discard the "O" ring.
6. Check that the piston moves freely in the bore.
7. Lube and install an "O" ring onto the pressure end plug, install the plug and torque to 28 N·m (20 ft. lbs.).

DRIVE SHAFT OIL SEAL OR HYDRAULIC HEAD SEAL

Removal

1. Remove all dirt from the surface of the pump using a suitable solvent.
2. Remove the fast idle solenoid mounting screws and the electrical leads to the other solenoids. Lift the fast idle solenoid with the electrical harness attached off the pump.
3. Remove the governor control cover, discard the gasket.
4. Drain the fuel from the pump into a suitable container.
5. Remove the throttle shaft and seals.
6. Unlock the tabs on the control bracket tap washer (Fig. 3-17).
7. Remove the three screws holding the control bracket to the pump housing and lift out the tab washer and keep plate. Discard the tab washer.
8. Lift out as a complete assembly, the control bracket governor arm, metering valve and spring linkage assembly.
9. Rotate the pump so that the auto-advance unit is up.
10. Remove the head locating fitting, cap nut and sealing washer from the advance housing. Remove the advance assembly and gasket. Discard all gaskets, "O" rings and sealing washers (Fig. 3-16).
11. Loosen the cam advance screw, then tap the advance screw lightly, if necessary and make certain the cam ring is not binding in the pump housing (Fig. 3-16).
12. Remove the cam screw (Fig. 3-16).
13. Rotate the pump so that the governor control housing is up.
14. Remove the head locking screws and washers. Discard the washers (Fig. 3-16).
15. With a slight twisting action in each direction withdraw the hydraulic head and rotor assembly from the pump housing complete with end plate and high pressure banjo assemblies. Remove and discard the sealing ring from the hydraulic head.
    NOTICE: If the drive shaft seals do not need replacement, go to step 11 in the Installation instruction.
16. Remove the cam ring and the thrust circlip (snap ring) from the pump housing.
17. Using puller J-28509-A, pull off the drive shaft tang drive hub.
18. Remove the drive shaft retaining circlip from the drive shaft, the thrust washer and steel ball (Fig. 3-18).
19. Rotate the pump so that the drive end is up. Push the thrust sleeve against the weight retainer to prevent the weights from falling out and remove the drive shaft and governor weight assembly from the pump housing.
20. Remove the two drive shaft oil seals and spacer from the pump housing with suitable tool that will not damage the pump housing.

Installation

All internal components should be dipped in clean test oil or diesel fuel.

1. Prior to installation, dip the two new drive shaft seals in clean test oil.
2. Insert the first (front) seal, lip first into the pump and using seal installer J-33045 fully install the seal.
3. Install the spacer with gap facing down.
4. Insert the second seal into the pump with its lip facing the rear of the pump. Fully install the seal using J-33045 installer.
5. Install J-33046 protection sleeve over the splines of the drive shaft. Place the governor weights in the cage and place the thrust washer in the groove in the weights. The thrust sleeve is then placed on top of the thrust washer. Insert the shaft into the governor cage assembly. Wrap a rubber band around the shaft to keep the thrust sleeve and weights from falling out. Remove the rubber band after completing the installation of the drive shaft and governor weight assembly.
6. Install the steel ball into the recess in the shaft and align the notch in the thrust washer with the steel ball. Install the washer with the oil grooves facing towards the pump housing (Fig. 3-18).
7. Install the circlip into the groove on the shaft and position the open ends of the circlip either side of the steel ball.
8. Install the thrust circlip into the pump housing with the opening in the circlip opposite the inspection plate opening.
9. Install the cam ring into the pump housing ensuring the directional arrow marked on one side faces in the same direction as the arrow marked on the pump housing nameplate.
10. Align the threaded hole in the cam ring with the opening for the auto-advance unit. Install the advance screw finger tight (Fig. 3-16).
11. Lube and install a new "O" ring into the groove in the hydraulic head.
12. Position the master spline on the drive shaft with the master spline on the drive plate, so that they align with each other. Then, holding the drive shaft to prevent rotation, carefully slide the hydraulic head and rotor assembly complete with end plate and high pressure banjo assemblies into the housing. If necessary slightly rotate the drive shaft until the splines engage with the drive plate. Before engaging the hydraulic head fully into the housing, rotate the head so that the metering valve bore is positioned up and visible in the hole in the top of the pump housing.
    NOTICE: Push the hydraulic head fully forward with a twisting motion to prevent possible damage to the head seal.
13. Rotate the pump so that the auto-advance opening is upward.
14. Torque the cam advance screw to 39 N·m (29 ft. lbs.). Make certain that the cam ring is not binding in the pump housing by rotating it.

1. Locknut (Do not adjust)
2. Adjuster nut (Do not adjust)
3. Washer
4. Pivot ball washer
5. Washer
6. Keep plate
7. Screw - large
8. Screw - small
9. Tab washer
10. Control bracket
11. Metering valve
12. Linkage hook
13. Spring retainer
14. Spring - link
15. Governor arm

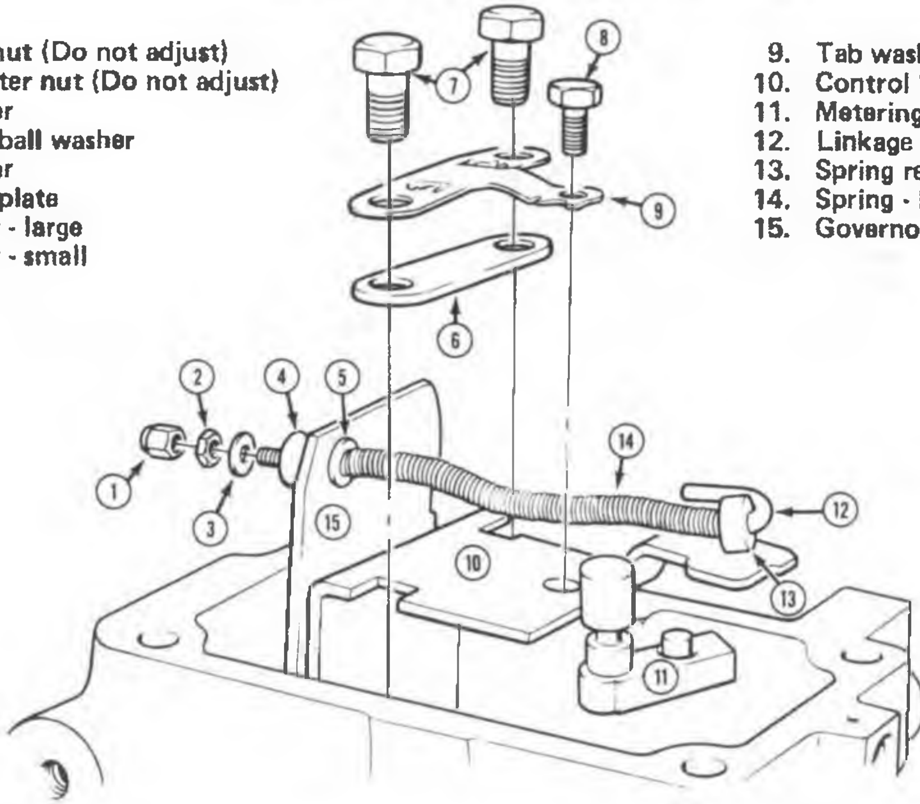


Fig. 3-17 View of Governor Arm and Control Bracket

1. Pump housing
2. Rubber "O" ring - drive end spigot
3. Steel ball
4. Thrust washer
5. Circlip
6. Snap ring
7. Protection sleeve tool
8. Drive shaft
9. Governor weight assembly
10. Governor thrust sleeve

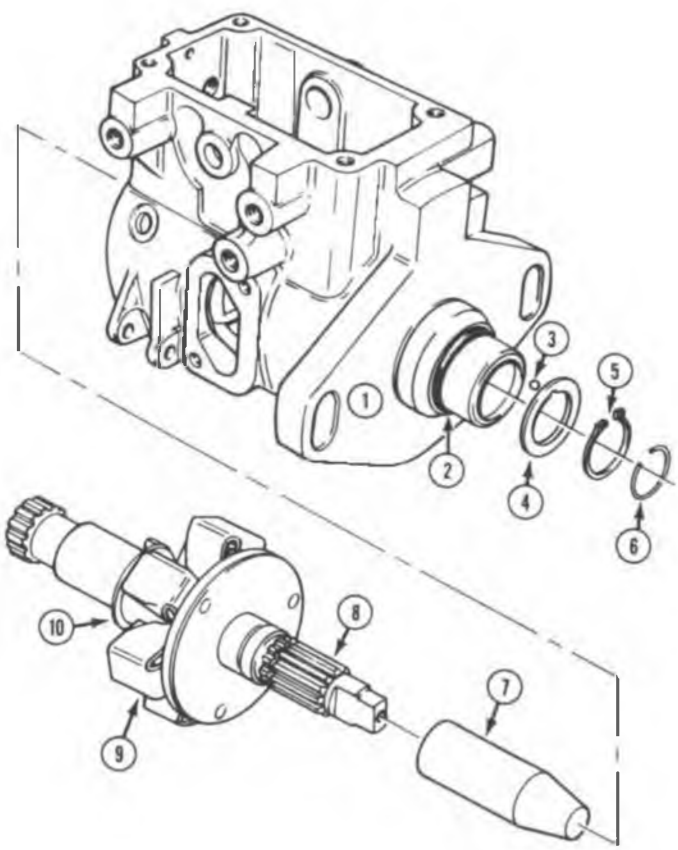


Fig. 3-18 CAV Pump Drive Shaft Assembly

15. Install a new gasket onto the pump housing with the straight edge in the gasket nearest the housing stud (Fig. 3-16).
16. Install the advance housing assembly to the pump housing engaging the bore in the piston with the cam advance screw. Lightly secure the assembly in position with a new sealing washer and cap nut (Fig. 3-16).
17. Lube and install new "O" rings to the head locating fitting. Install the locating fitting into the hydraulic head leaving it loose (Fig. 3-16).
18. Install new sealing washers to the head locking screws and loosely install the locking screws. Make certain the sealing washers are located in the counterbores in the pump housing.
19. Progressively and evenly tighten both the head locating fitting and the cap nut.
20. Torque both head locking screws to 19 N·m (14 ft. lbs.).
21. Remove the advance pressure end plug and check that the piston moves freely in its bore. Lube and install a new "O" ring to the pressure end plug, and install it to a torque of 28 N·m (21 ft. lbs.) (Fig. 3-16).
22. Rotate the pump so that the governor control housing is up.
23. Make certain that the step on the governor sleeve is pointing up, then install as an assembly, the governor arm, control bracket, metering valve and spring linkage into the pump housing (Fig. 3-17). Insert the metering valve into the valve bore in the hydraulic head and at the same time locate the governor arm on the thrust sleeve.
24. Install the keep plate and a new tap washer on the governor control bracket and torque two larger screws to 7 N·m (60 in. lbs.) and the smaller to 2 N·m (20 in. lbs.). Bend over the lock tabs and check that the linkage moves freely (Fig. 3-17).
25. Install the throttle shaft and seals.
26. Install a new governor control cover gasket and install the cover, using new washers. Torque the screws to 3 N·m (25 in. lbs.).
27. Install the fast idle solenoid and the harness leads to the other solenoids.
28. Install a new snap ring into the recess in the drive shaft. With a hide mallet force the tang drive hub into engagement with the snap ring.
29. Pressure test the pump assembly.
    NOTE: Drive shaft should be rotated after each torque tightening involving the hydraulic head.

PRESSURE TESTING

1. Drain all fuel from the pump.
2. Connect an air line to the pump inlet connection. Be certain that the air supply is clean and dry.
3. Seal off the return line fitting and completely immerse the pump in a bath of clean test oil.
4. Raise the air pressure in the pump to 137.9 kPa (20 psi). Leave the pump immersed in the oil to allow any trapped air to escape.
5. Watch for leaks. If the pump is not leaking, reduce the air pressure to 13.8 kPa (2 psi) for 30 seconds. If there is still no leak increase the pressure to 137.9 kPa (20 psi). If still no leaks are seen, the pump is ready for use.

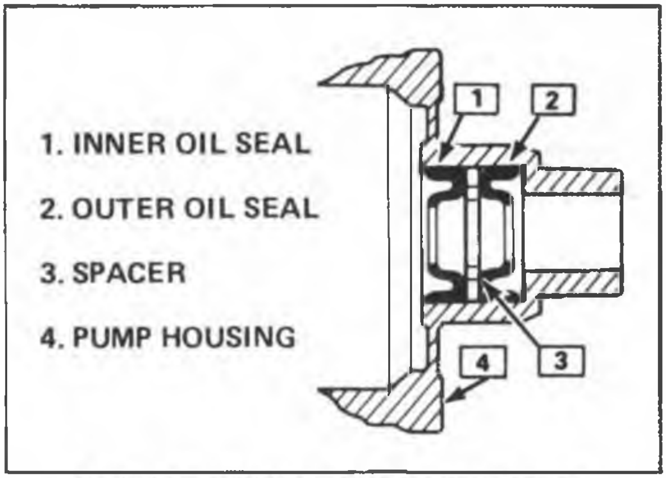


Fig. 3-19 Lucas CAV Drive Shaft Seal Cross Section

SECTION 4
DIESEL KIKI VE INJECTION PUMP

GENERAL

Both the 4FB1 and the C223 engines will use the Diesel Kiki VE type injector pump.

The VE type pump is a single plunger distributor type pump which is internally lubricated with diesel fuel.

Fuel from the tank is drawn through the water separator to the fuel injection pump by means of the feed pump built into the injection pump.

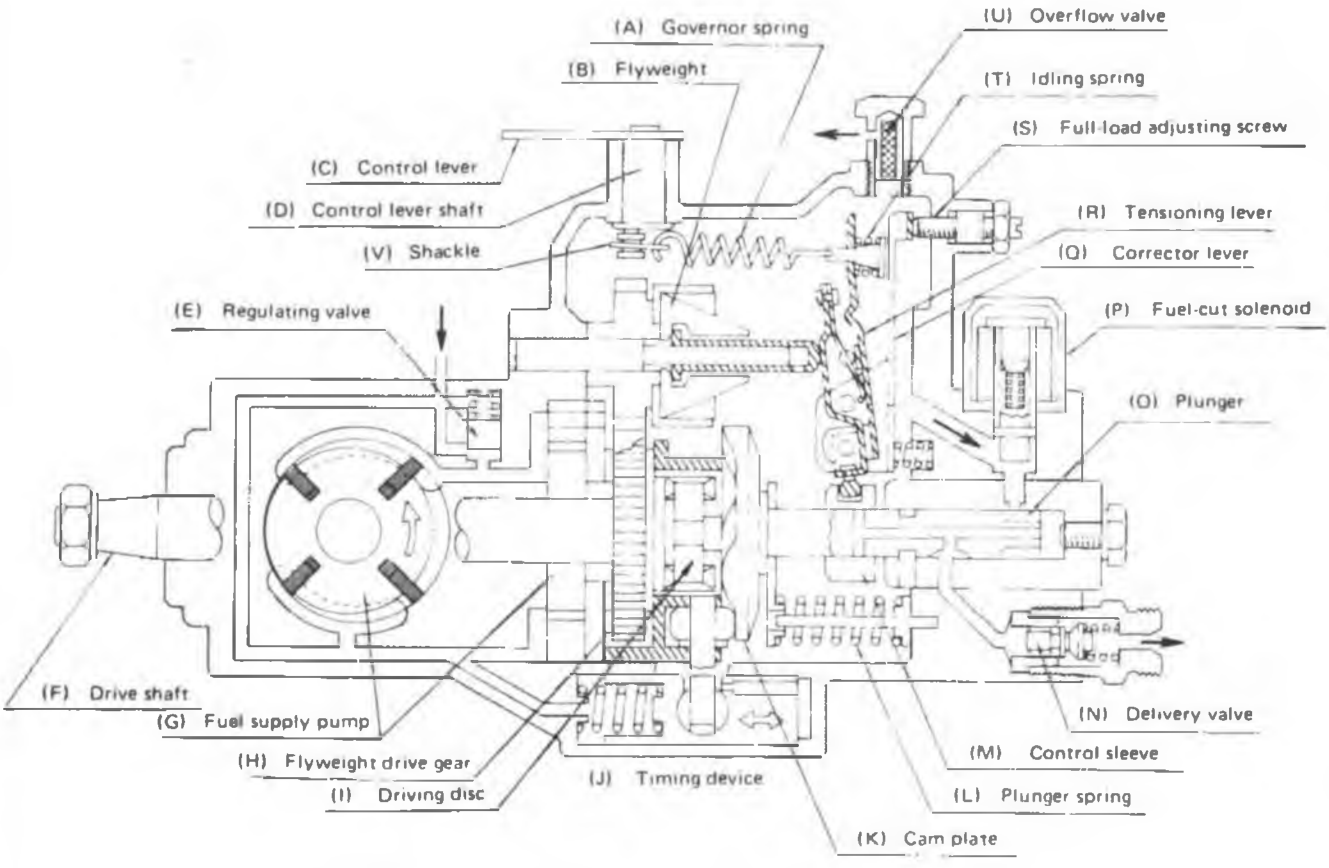
Fuel fed into the injection pump is pressurized and a metered amount of fuel is injected at the proper time into the combustion chambers in the engine by the injection nozzles.

Figures 4-1 and 4-2 show the construction and operation of the VE pump.

The type VE injection pump is driven by a drive shaft (F) which is connected to a cam plate (K) via a driving disc (I). This cam plate (K) has the same number of face cams as engine cylinders. When it is rotated by the drive shaft (F), it will ride up and down the fixed roller in a reciprocating motion, the stroke of which is equal to the cam height. At the same time, the plunger (O) is pushed against the cam plate (K) by means of the plunger spring (L), and hence the cam plate (K) will also be driven by the drive shaft (F). Consequently, the plunger (O) will reciprocate as it rotates, causing the fuel to be distributed under pressure.

The mechanical governor in the top of the injection pump consists of flyweights (B) contained in a flyweight holder which is mounted on the governor shaft. It is gear-driven from the drive shaft (F) via rubber dampers. A sliding sleeve is fitted on the governor shaft.

The timing device (J) in the bottom of the injection pump is actuated by the fuel pressure in the pump housing. The piston of the timing device moves the roller ring, causing the injection timing to be advanced by the required amount. In addition, a cold start device is incorporated into the timing device to provide additional advance to facilitate cold start.



Note: Fuel-supply pump (G) is shown in two views, one being a 90° – rotated view with the pump vanes and rotor in section and the other being a normal side view.
Timing device (J) is shown as turned around by 90°

Fig. 4-1 Schematic Diagram of VE Pump Operation

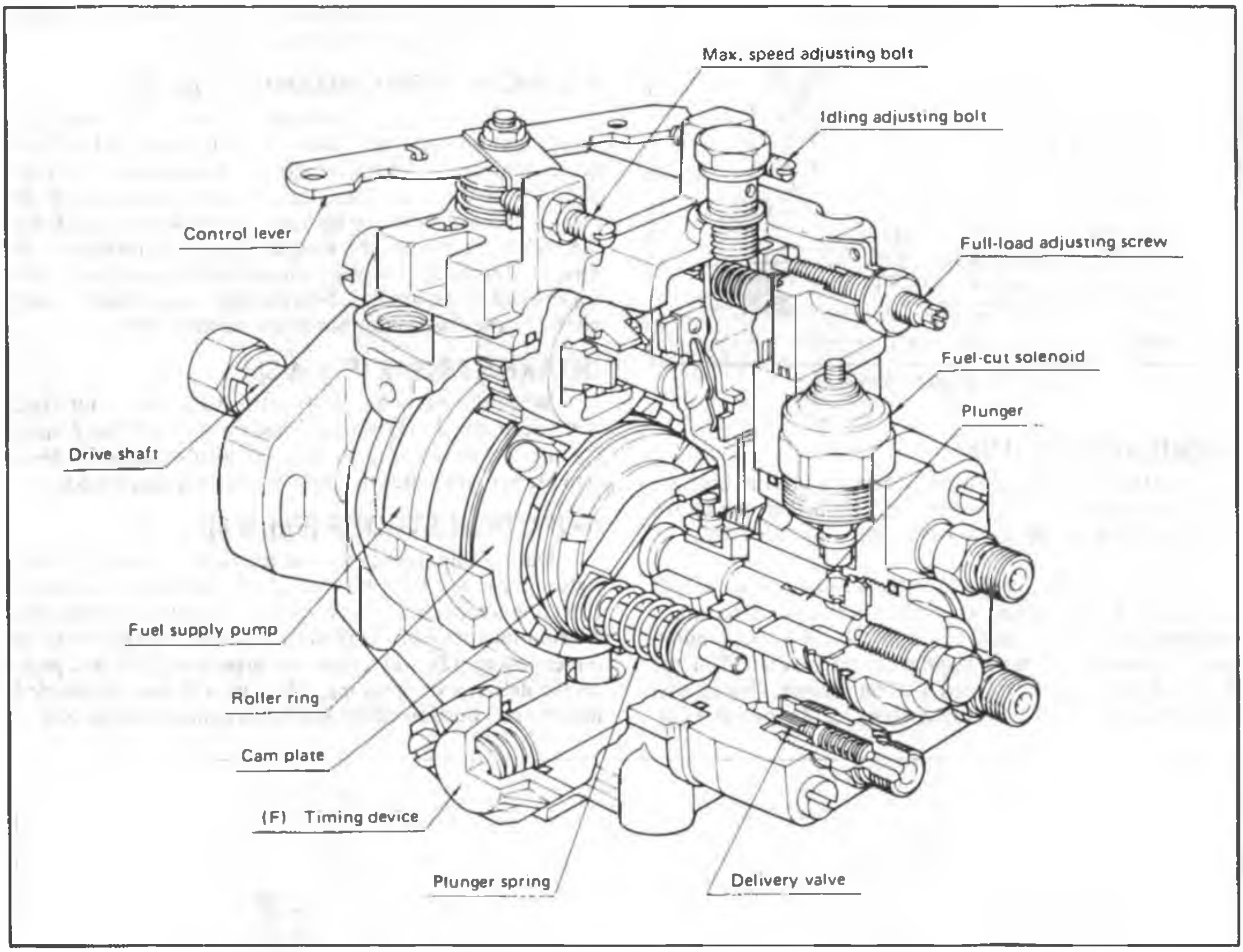


Fig. 4-2 Construction of VE Injection Pump

An air bleed screw is fitted in the plug in the middle of the distributor head. Also, a delivery valve (N) is mounted in the flange of the distributor head.

A cover is fitted to the top of the injection pump. This cover has a control lever shaft (D) mounted on it. The governor spring (A) is coupled to the control lever shaft (D) via a shackel (V). An idling spring (T) is fitted on the idling pin on the opposite side.

The control lever (C) is fitted to the control lever shaft (D) on the top part of the cover. The positions of the control lever (C) are adjusted by means of the maximum speed adjusting bolt and the idle adjusting bolt to control the respective speeds.

FUEL-SUPPLY PUMP

A vane-type fuel-supply pump is mounted in the housing on the drive shaft side. It is used to raise fuel from the tank and feed it under pressure to the pump housing.

When the rotor is driven by the drive shaft, the vanes are thrown outwards by centrifugal force, forming chambers between adjacent vanes. Consequently, as the rotor turns, the volume of the chamber at the fuel intake side will gradually increase, causing the pressure in the chamber to decrease. This will allow additional fuel to enter the pump. As the rotor continues to turn, the volume of the chamber will start to decrease, causing the fuel inside to be pressurized. Finally, the pressurized fuel is ejected from the outlet under pressure (Fig. 4-3).

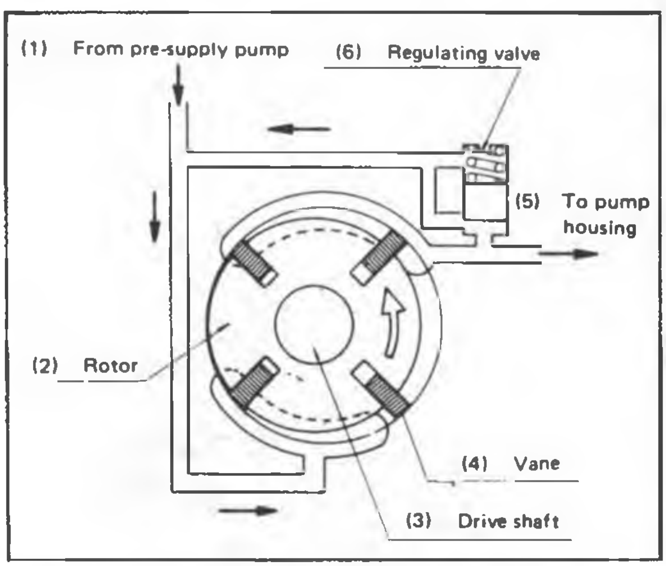


Fig. 4-3 Schematic of Fuel Supply Pump

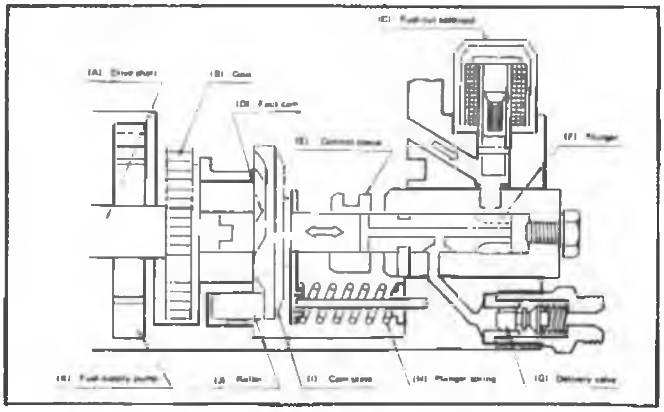


Fig. 4-4 Plunger Performance

REGULATING VALVE

The fuel from the fuel-supply pump is several times the injection quantity. Excessive fuel is returned to the intake side of the fuel supply pump via a regulating valve (B).

Feed or supply pressure is related to engine speed and rises as the speed of rotation is increased. A pre-determined relationship between feed of supply pressure and pump speed is maintained by a regulating valve situated in the flange of the pump. The speed/fuel oil pressure characteristics are determined by the spring of the regulating valve (B).

The pressure characteristics will in turn control the movement of the piston of the timing device.

PLUNGER PERFORMANCE (Fig. 4-4)

The drive shaft (A) simultaneously drives the fuel-supply pump (K), cam plate (I) and plunger (F). Cam projections are provided on the front surface of the cam plate (I) in the axial direction. When the cam plate (I) rotates, the movement of the cam plate ramp up and down the roller (J), causes the plunger (F) to reciprocate as it rotates. This reciprocating motion enables the fuel to be transferred to the nozzles. Fuel distribution is made to each nozzle by the distributing slit in the center of the nozzle.

INTAKE STROKE (Fig. 4-5)

When the intake port (6) on the barrel comes into line with the intake slit (5) during the downstroke of the plunger (1), the fuel pressurized by the fuel supply pump will flow into the high pressure chamber (4) and the plunger body (1).

INJECTION STROKE (Fig. 4-6)

During this stroke, the plunger will be pushed to the right as it rotates. First, the intake port will close, causing the fuel to be compressed. As the plunger continues moving, the distributing slit (1) on the plunger will come into line with the outlet passage (2), whereupon the pressurized fuel will push up the delivery valve spring. The fuel will then be injected into the combustion chamber of the engine via the nozzle.

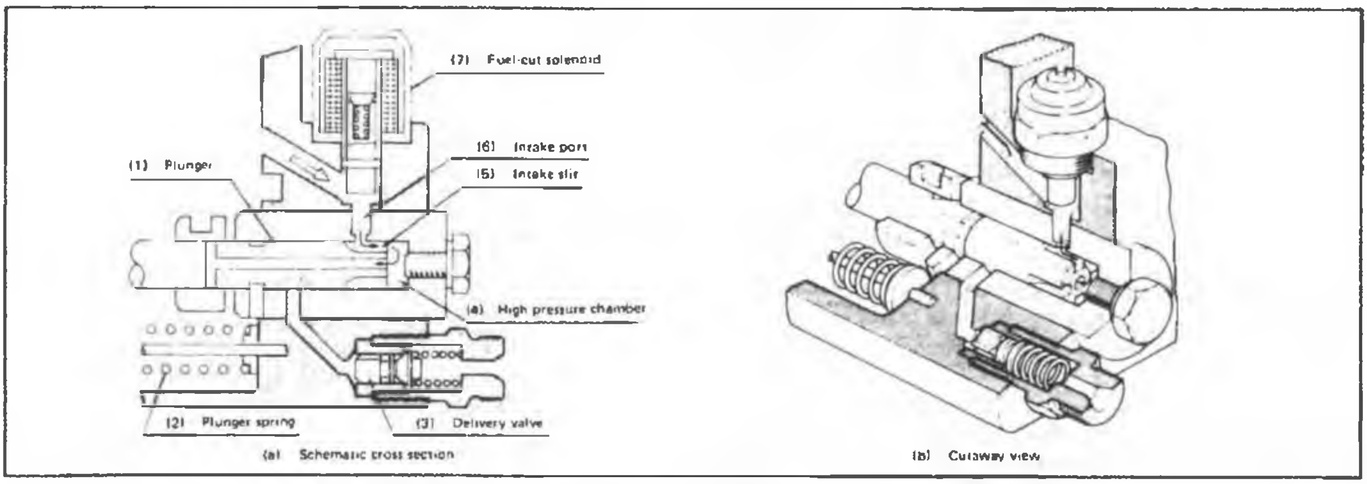


Fig. 4-5 Intake Stroke

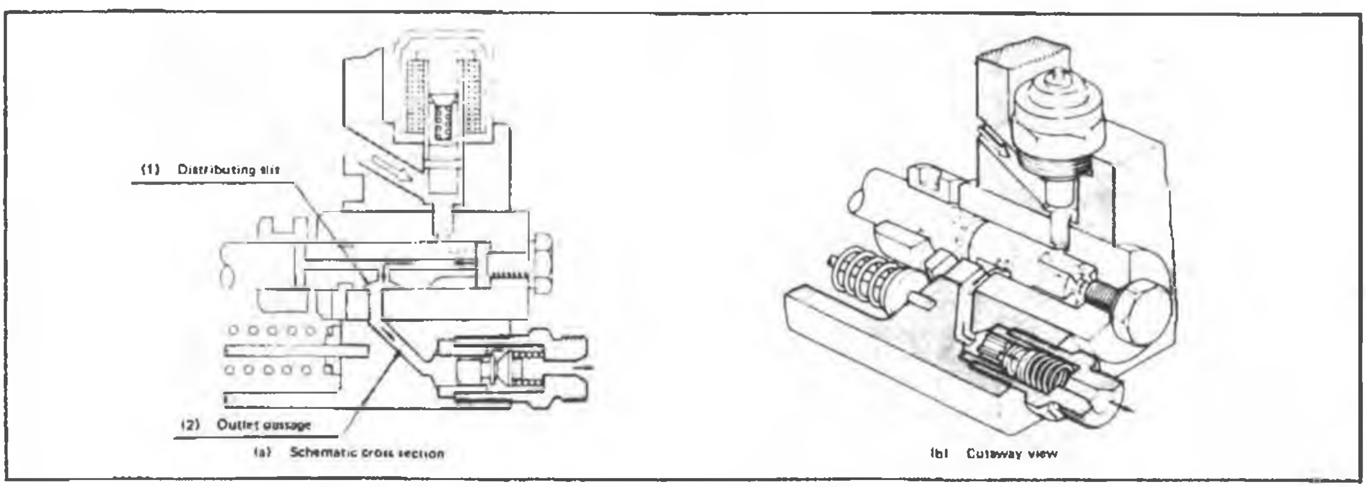
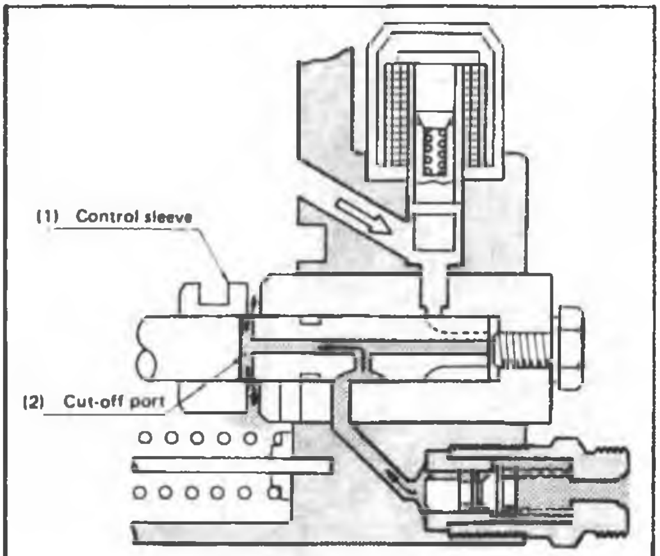


Fig. 4-6 Beginning of Injection Stroke



(a) Schematic cross section

Fig. 4-7 End of Delivery

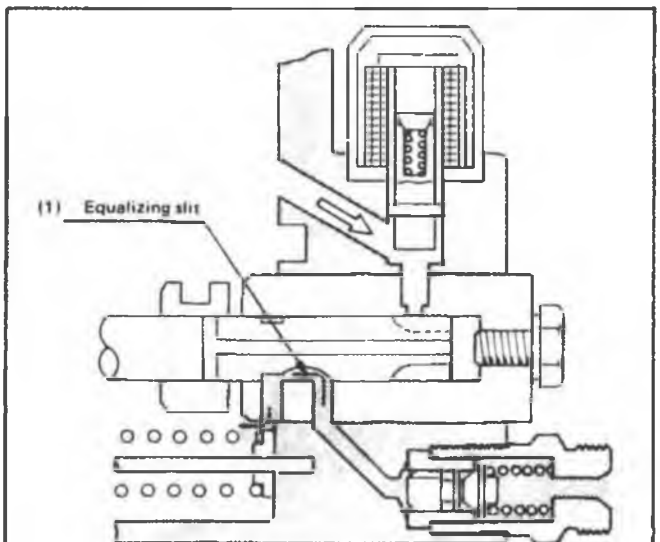
END OF DELIVERY (Fig. 4-7)

As the plunger continues moving to the right, the cut-off port (2) in the plunger will be connected with the pump housing, causing the pressurized fuel to flow from the cut-off port (2) into the pump housing. This will reduce the pressure of the fuel, thereby cutting off the feed. This ends injection.

EQUALIZING STROKE (Fig. 4-8)

As the plunger continues to rotate after the end of delivery, the equalizing slit (1) will come into line with the outlet passage. This causes the pressure in the passage up to the delivery valve to be restored to the feed pressure.

The equalizing stroke prevents pressure interference between the fuel supplied to the various delivery valves, making for stable injection performance. The equalizing slit is 180 degrees from the distributing slit. Equalization, therefore, takes place after one crankshaft revolution.



(a) Schematic cross section

Fig. 4-8 Equalizing Stroke

REVERSE ROTATION PREVENTION (Fig. 4-9)

Assuming the plunger rotates in the normal direction, during the intake stroke (left), the intake port will open, causing fuel to enter the plunger. During the subsequent stroke (right) the intake port will close, and fuel will be forced through the distributing slit on the plunger, and into one of the outlet passages.

If the plunger rotates in the reverse direction, during the injection stroke (right), the intake port will open up, preventing the pressure from rising. As a result, injection will not take place and the engine will stop.

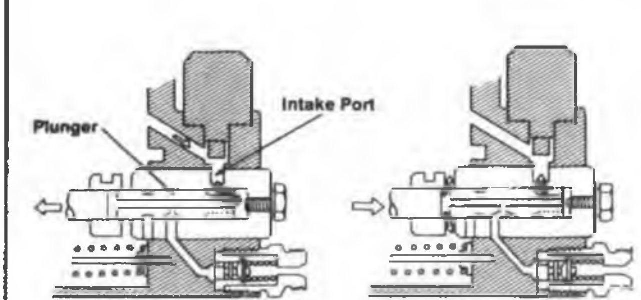


Fig. 4-9 Reverse Rotation Prevention

INJECTION QUANTITY CONTROL (Fig. 4-10)

Fuel control is effected by sliding the control sleeve (1). Shifting the control sleeve causes the effective stroke (plunger stroke from the beginning to the end of fuel feed) to change.

When the control sleeve is moved to the left, the effective stroke will decrease, reducing the injection quantity. Conversely, when the collar (1) is moved to the right, the injection quantity will be increased. In this way, the beginning of injection is always constant, while the termination of injection is varied by means of the control sleeve to regulate the overall injection quantity.

DELIVERY VALVE (Fig. 4-11)

While the plunger is pressurizing the fuel, the pressure increases and overcomes the force of the delivery valve spring (1). The spring is thus compressed, causing the valve (2) to become unseated. The fuel will then flow through the injection pipe to the nozzle holder and be injected from the tip of the nozzle into the combustion chamber of the engine. Next, the plunger will advance to the right while rotating and uncover the cut-off port which reduces the pressure holding the delivery valve open. The pressure in the line, plus the spring pressure will act to close the delivery valve. The valve (2) will be forced back onto the seat (3) by the spring (1), preventing reverse flow of fuel oil.

As shown in figure 4-11, this valve incorporates a piston (4) arrangement. When the valve is pushed against the seat (3), the retraction of the piston in the delivery valve reduces the pressure in the injection pipe, cleanly cutting off injection and preventing dribble.

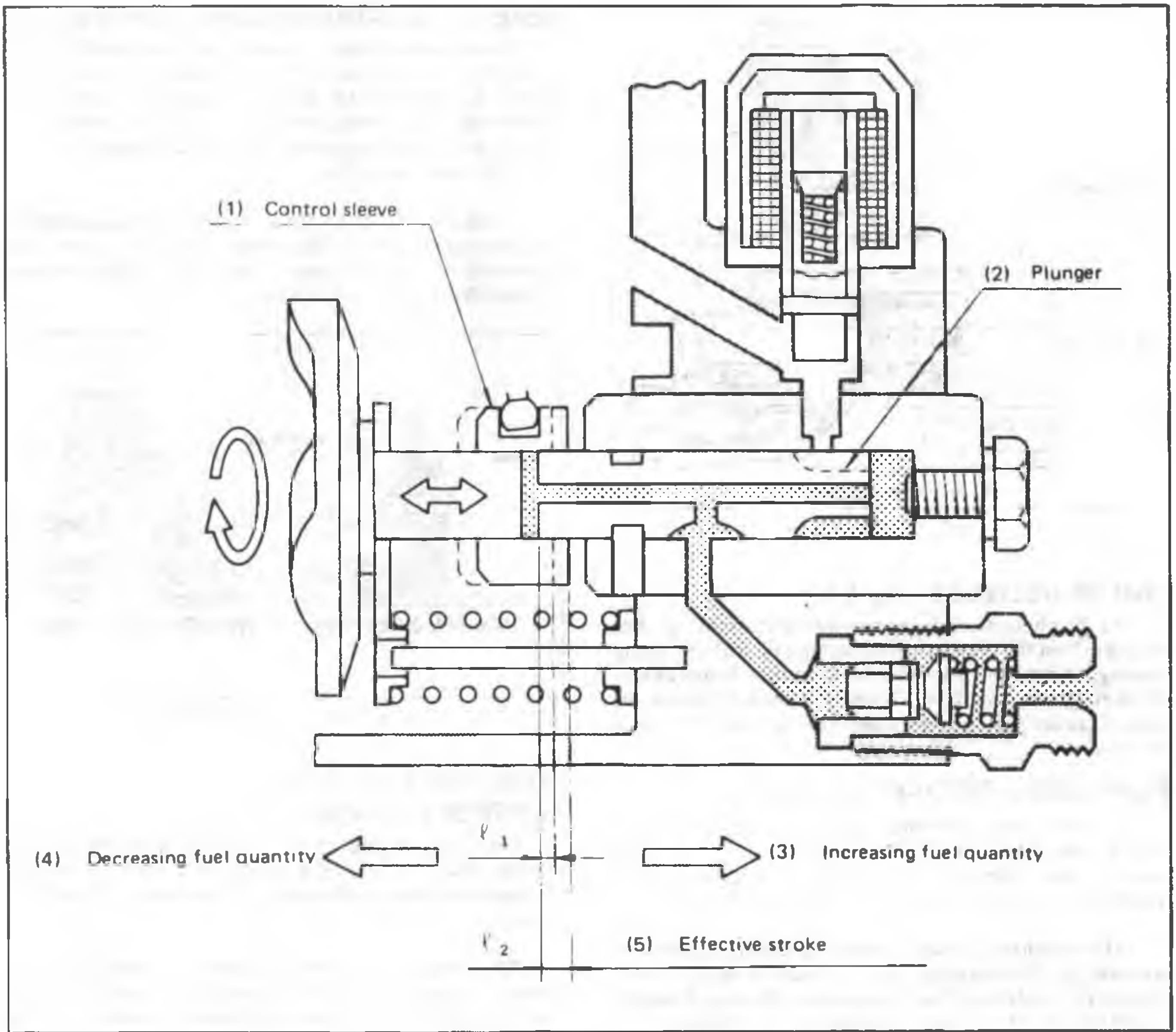


Fig. 4-10 Effective Plunger Stroke

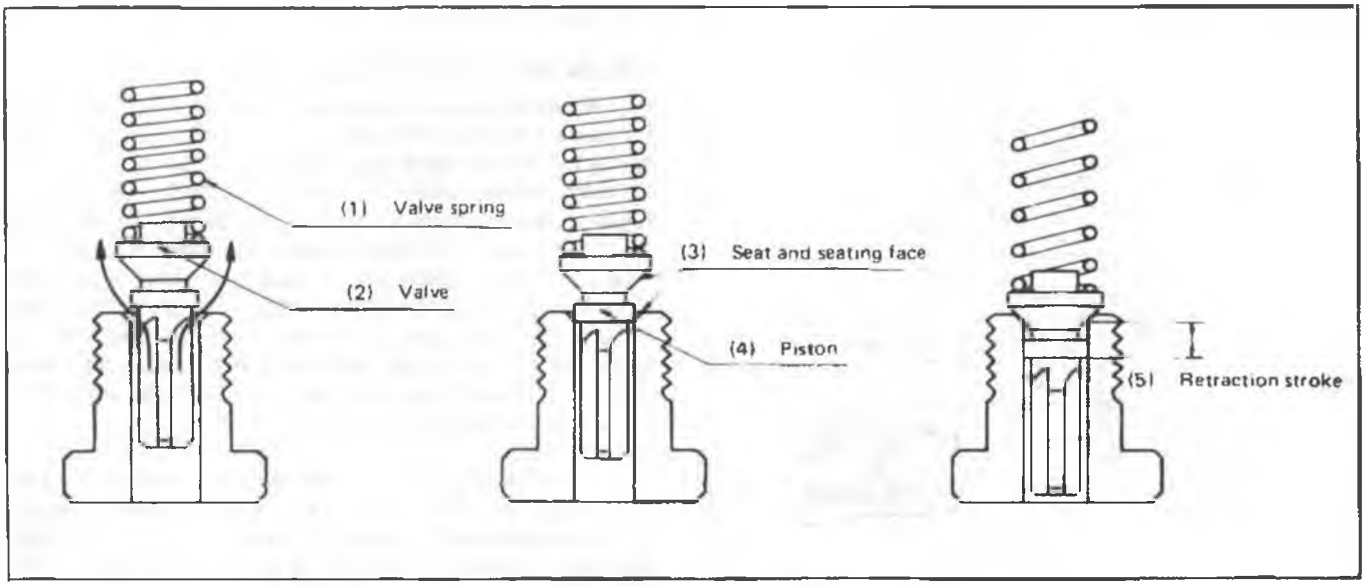


Fig. 4-11 Delivery Valve Action

MIN-MAX GOVERNOR OPERATION (Fig. 4-12)

The governor consists of a centrifugal speed regulator employing four flyweights (mechanical governor). The flyweight holder is integrated with a driven gear and both are mounted on the governor shaft. The driven gear meshes with a drive gear on the driveshaft to drive the flyweights. The flyweights, when driven, are acted on by centrifugal force, causing them to open outwards and push against the governor sleeve.

The governor lever assembly is supported from the outside of the housing by two pivot pins (M-1). The extreme outer part of this lever is called the corrector lever. The bottom part of the corrector lever is pushed by two support springs, hence the lever is pushed against the full load adjusting screw, pivoted about point M-1. The governor lever assembly is an integrated assembly. A tension lever and starting lever are fitted to the inside of the corrector lever and are supported by the common shaft (M-2) at its bottom part.

Between the tension lever and starting lever is a starting spring (leaf spring) and start idling spring.

At the bottom of the governor lever assembly is a ball head pin which is fitted into the pinhole of the control sleeve to transmit the motion of the governor sleeve. In addition, the control sleeve is guided by the plunger to control the injection quantity.

In the control shaft assembly, the governor spring and partial load spring are fitted in the yoke under a predetermined load. The tension of these springs determines the control speed.

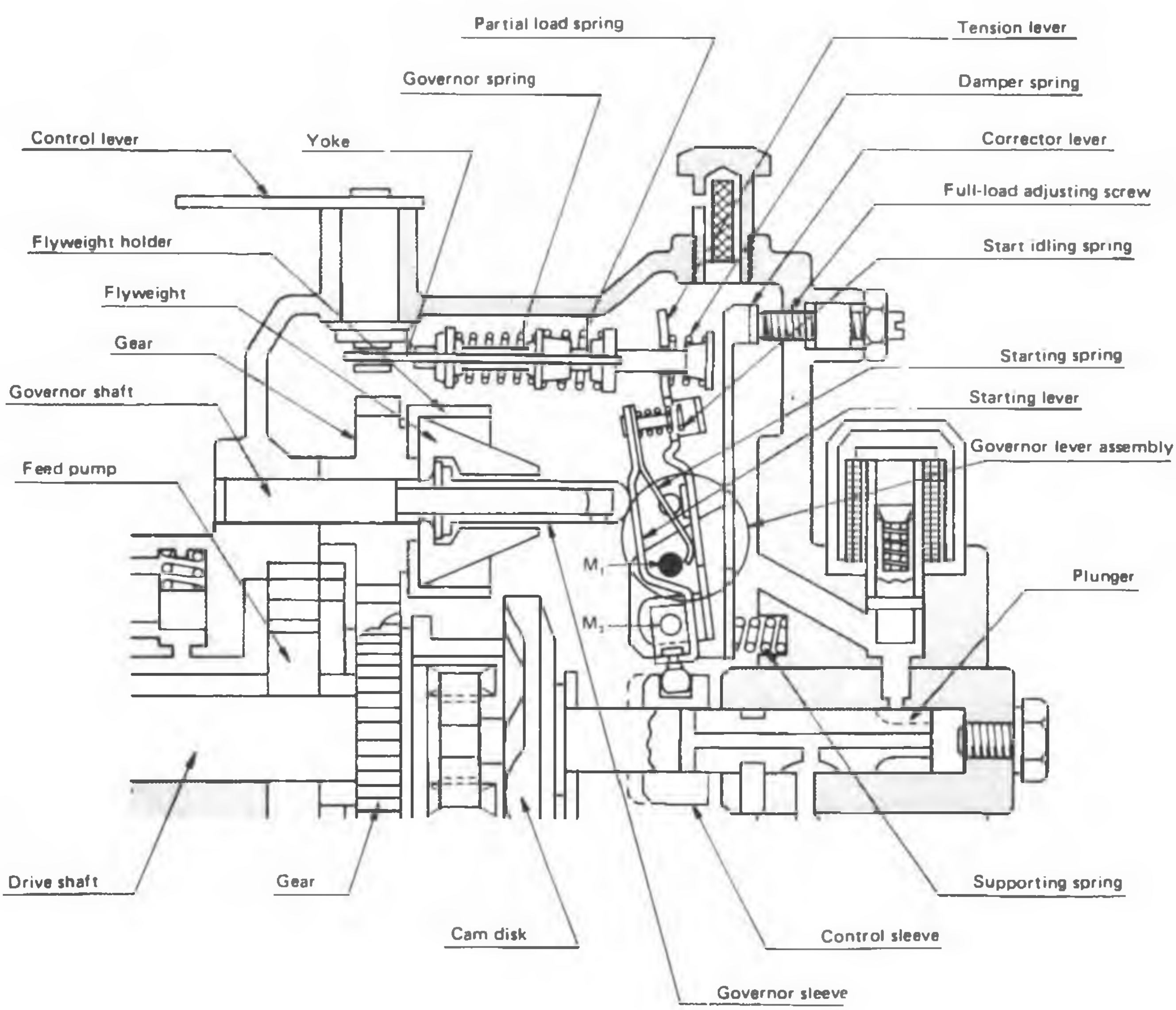


Fig. 4-12 Min-Max Governor Construction

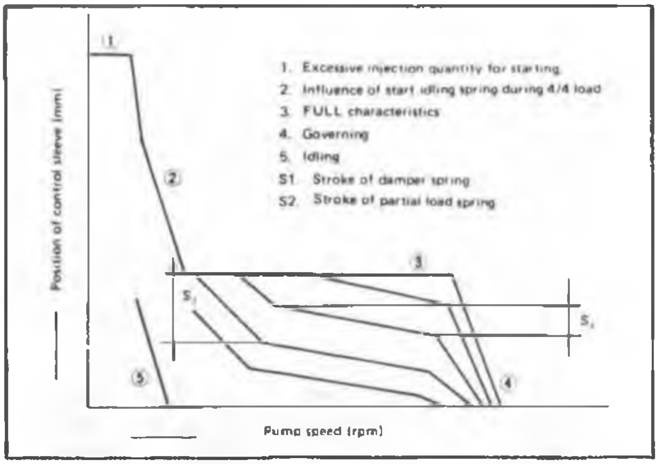


Fig. 4-13 Min-Max Governor Characteristics

MIN-MAX GOVERNOR CHARACTERISTICS

Refer to figure 4-13 for the following operating characteristics.

STARTING (Fig. 4-14)

During starting when turning the control lever toward full direction, the starting lever will be pushed left under the action of the starting spring (leaf spring). At the same time, the governor sleeve will be shifted.

The control sleeve will be moved to the right, pivoted around the common shaft M-2 of the governor lever assembly. In this way, the control sleeve will be put in the maximum injection quantity setting to supply additional fuel, in order to facilitate engine starting.

When the engine starts, the flyweights will open out under the centrifugal force generated. This will cause the governor sleeve to be pushed. This in turn causes the starting lever to be pushed until it overcomes the force of the starting spring and moves to the right.

As a result, the control sleeve will shift to the left, shortening the effective stroke and thereby reducing the fuel supply.

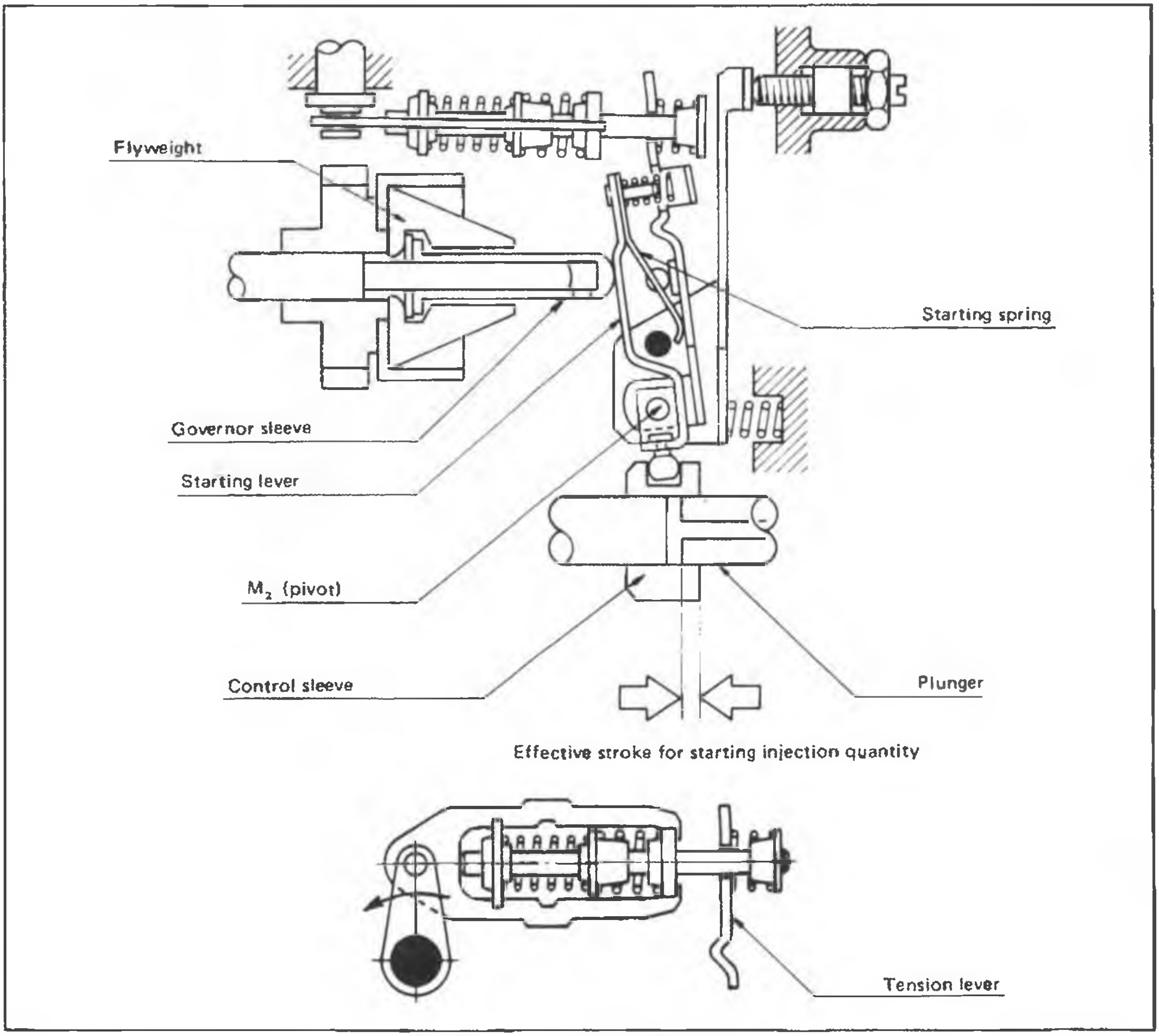


Fig. 4-14 Governor Operation During Starting

IDLING (Fig. 4-15)

When the engine starts up, centrifugal force will act on the flyweights, causing the governor sleeve to move to the right. As a result, the starting lever and starting spring will continue to be pushed until smooth idling is obtained. This happens when the combined tension force of the start idling spring and the starting spring are balanced against the centrifugal force of the flyweights.

Consequently, the control sleeve will be shifted to the left, pivoted about the common shaft M-2 of the governor lever assembly. When it reaches the idling position, the fuel will be reduced.

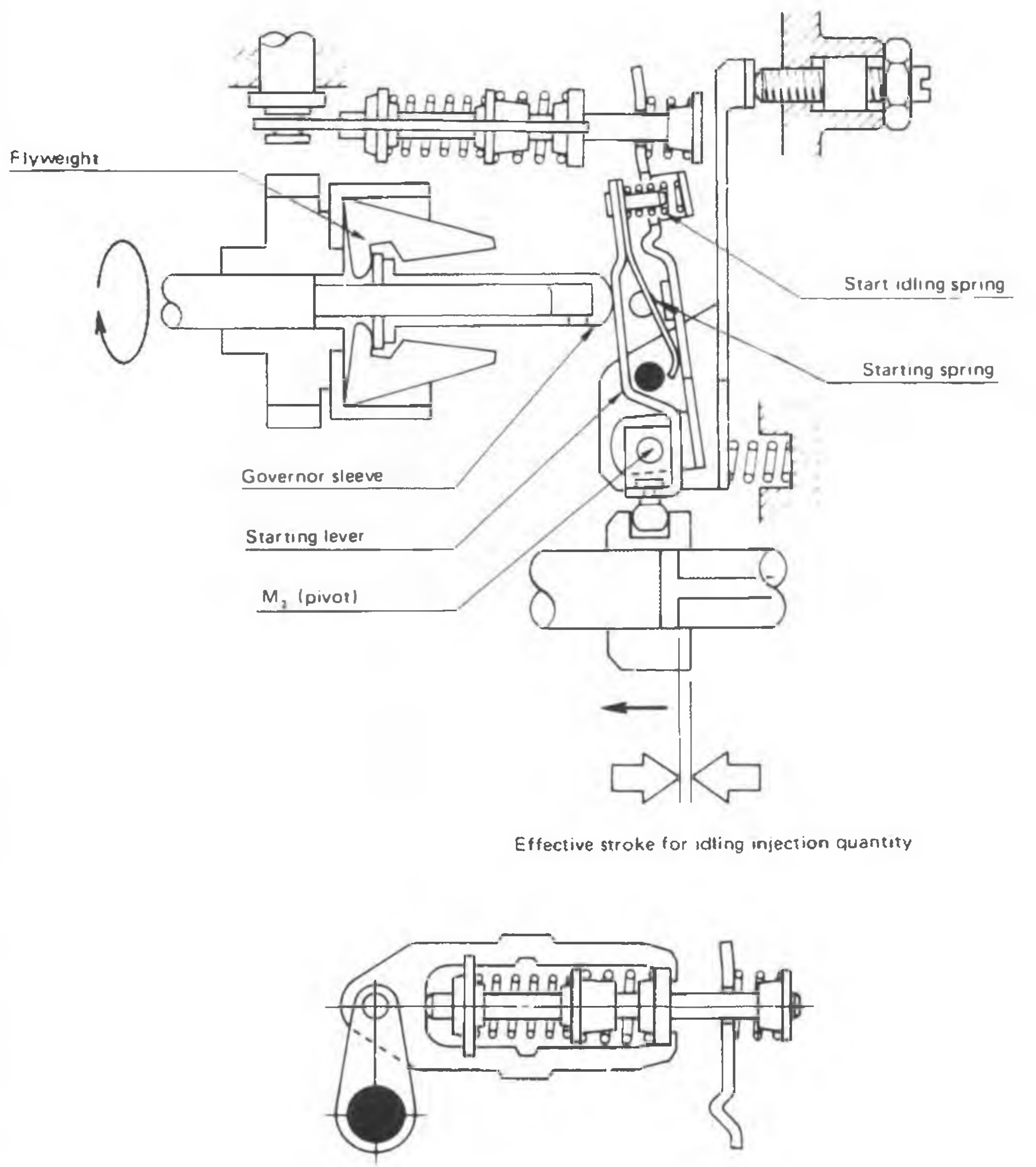


Fig. 4-15 Governor Operation During Idling

PARTIAL LOADING (Fig. 4-16)

The control lever moves together with the accelerator pedal to which it is interlocked.

If the control lever is put in any medium speed running position, the compression force on the spring in the yoke will increase. This happens while the tension lever is being pulled to the left, overcoming the force of the damper spring. As a result, the injection quantity will increase and the engine speed will rise.

At the same time, the centrifugal force on the flyweights will increase, causing the governor sleeve to be pushed to the right. Consequently, the starting lever will be pushed to the right until it touches the raised part of the tension lever, (point A on the diagram). It will then move together with the tension lever.

As a result, the centrifugal force on the flyweights will cause the partial load spring to compress until the compression force balances the centrifugal force. The tension lever will shift to the right by the amount of movement as indicated at S-2 in Figure 4-16. At this point, the damper spring will already be in a non-operational condition.

As a result of the above, the control sleeve will move to the left, pivoted about the common shaft M-2 of the governor lever assembly, and the fuel injection quantity will be reduced.

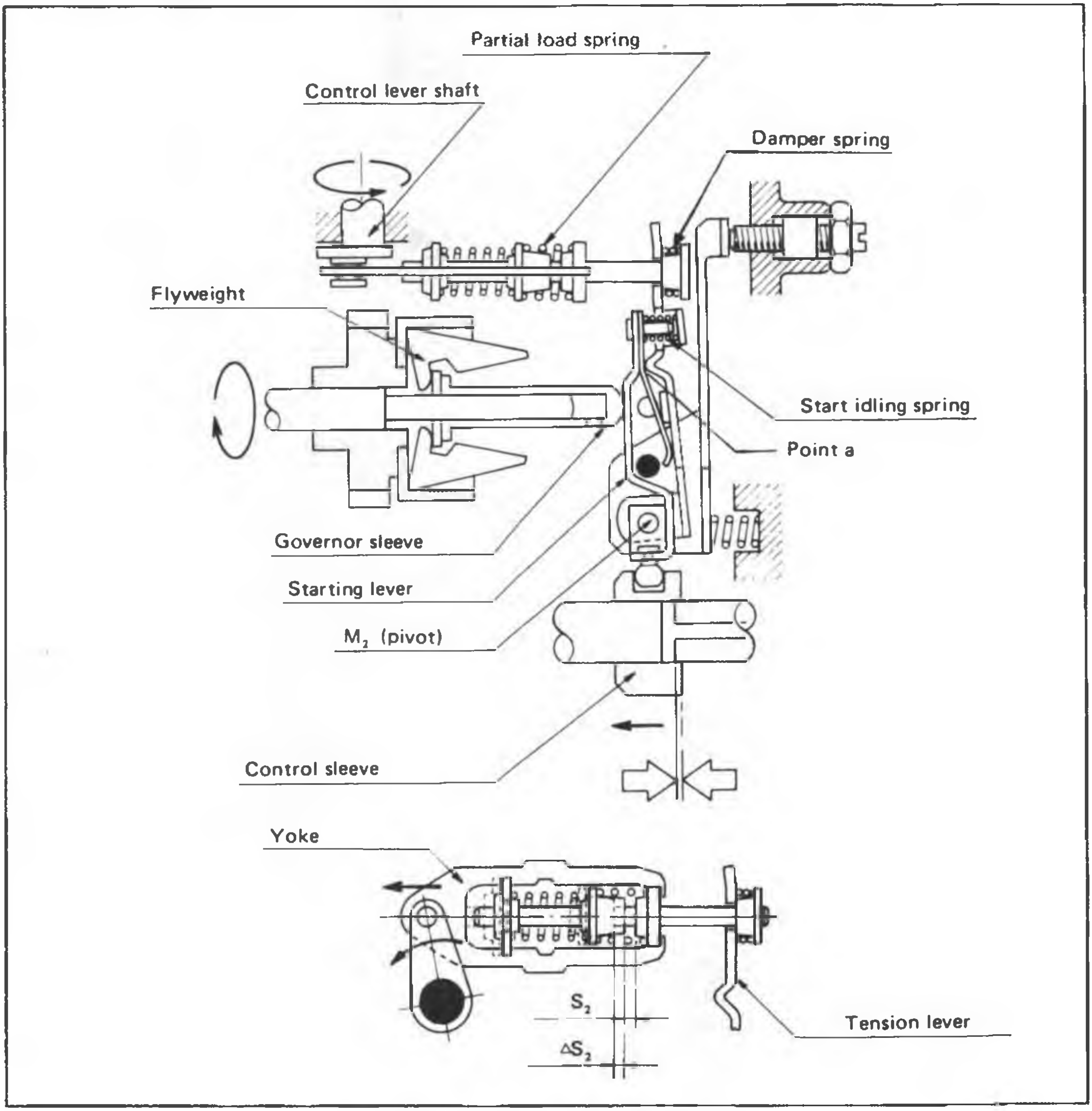


Fig. 4-16 Governor Operation During Partial Loading

FULL LOAD MAXIMUM SPEED (Fig. 4-17)

The control lever is moved from a partial load position to the full load maximum speed postion (i.e. until it touches the external maximum speed stop bolt). The yoke will be pulled completely to the left so that the compression force acting on the partial load spring in the yoke will increase. This in turn will cause the tension lever to be drawn to the left until it touches the stopper pin (M-3) and comes to rest.

The movement of the control lever will put the partial load spring into a non-operational condition. The governor spring is now being compressed to act against the governor.

Consequently, the centrifugal force on the flyweights will balance against the governor spring at this position, enabling full load and maximum speed to be obtained.

If the full load adjusting screw is screwed inwards, the collector lever will turn counterclockwise about M-1. The control sleeve will move towards the right to increase the fuel supply.

M-1 consists of two pivot pins which support the corrector lever on both sides, thus supporting the governor lever assembly from the outside of the housing.

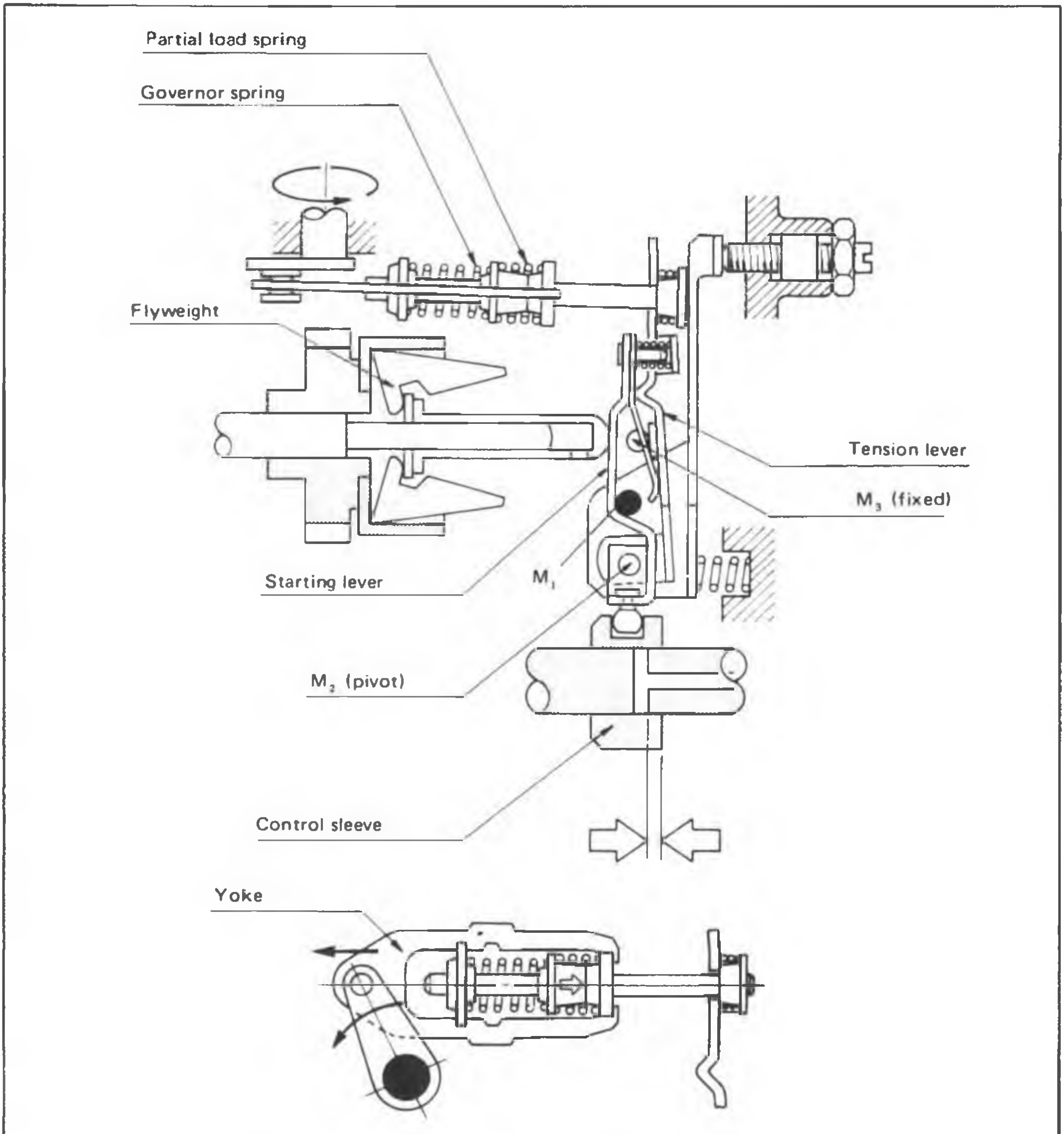


Fig. 4-17 Governor Operation at Full Load Maximum Speed

NO-LOAD MAXIMUM SPEED (Fig. 4-18)

When the engine speed is raised past the full-load maximum speed, the centrifugal force on the flyweights will become maximum. This overcomes the tension of the yoke spring which pulls the tension lever. The governor sleeve will move to the right, push the tension lever and compress the governor spring. The centrifugal force of the flyweights will balance them with the governor spring tension to obtain the no-load maximum position.

The tension lever will pivot at shaft M-2 to move the control sleeve. The control sleeve will move to the left until the cutoff port of the plunger opens into the pump chamber. The fuel will then be returned to the pump chamber, preventing the engine speed from raising.

SPEED TIMER (Fig. 4-19)

Adjustment of fuel injection timing is performed by rotating the roller ring (2) to the start of injection commencement position with respect to the crank angle on the engine side.

As the speed of the injection pump increases, the feed pressure in the fuel supply pump will also increase. This causes the piston (4) of the timing device to move against the force of the timer spring.

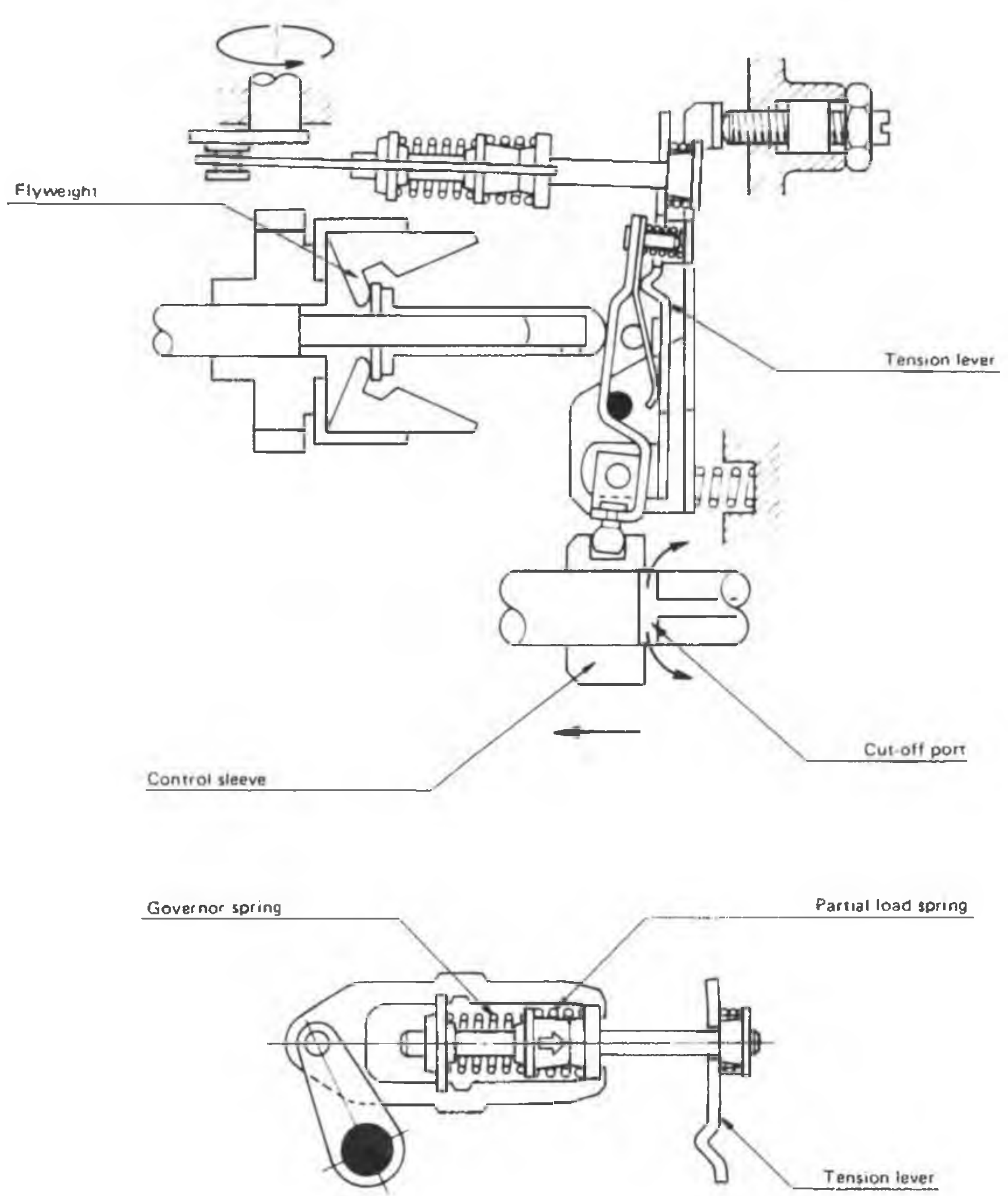


Fig. 4-18 Governor Operation at No Load Maximum Speed

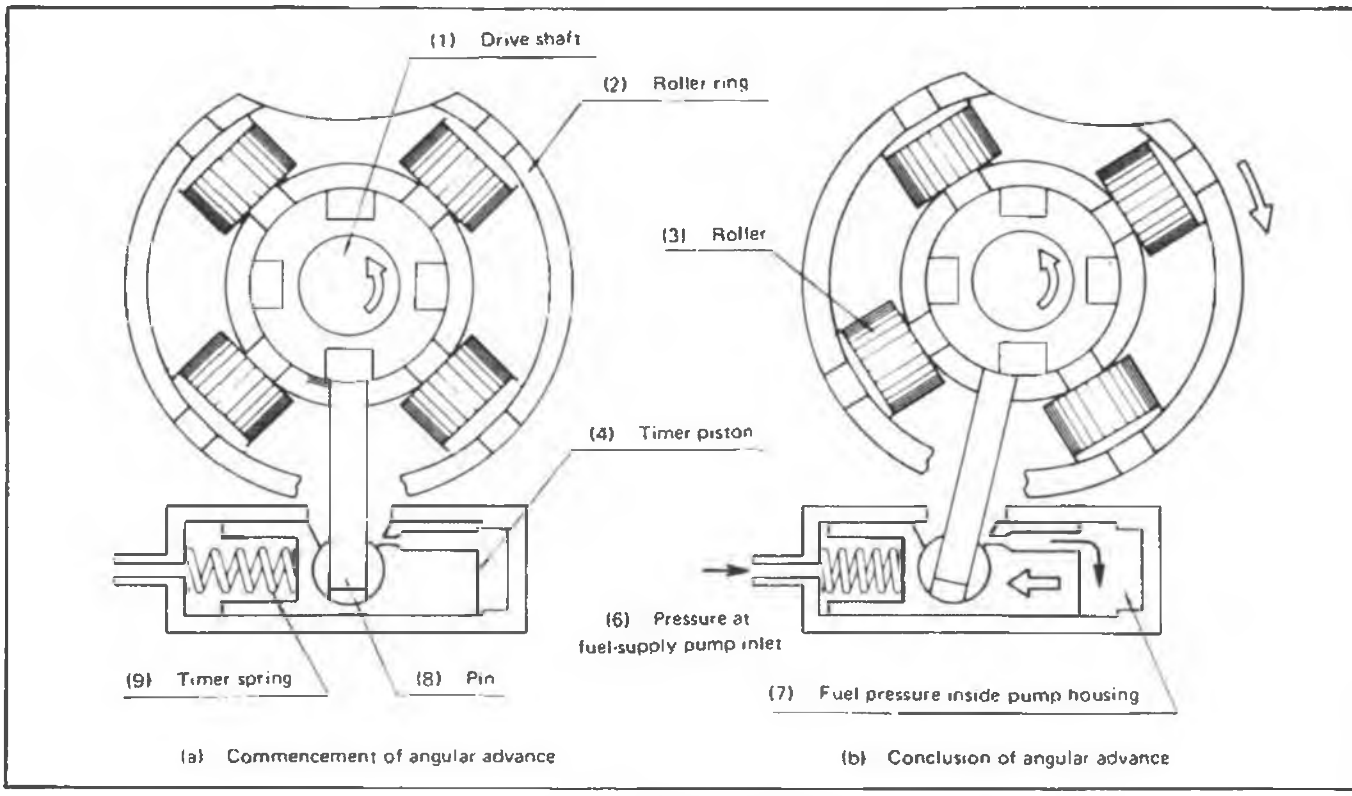


Fig. 4-19 Speed Timer Operation

The piston will move perpendicular to the drive shaft (1) and its movement will be transmitted via a pin (8) to cause the cylindrical roller ring (2) to rotate in the opposite direction of the drive shaft rotation. This will result in cam plate riding up on the roller (3) at an earlier point in time, thereby advancing the injection timing.

Thus, this timer operates hydraulically on the fuel pressure of the pump housing, which is controlled by the regulating valve.

Besides this timer, there is also a load timer which adjusts injection timing in accordance with load fluctuations. Normally, it is used in combination with the speed control type timer.

CSD: COLD START DEVICE

Engine starting under a cold climate condition is very difficult. Therefore, the CSD has been developed to initially advance the fuel injection timing to facilitate engine starting. It operates during any starting of the engine, hot or cold. The duration of operation is dependent upon fuel temperature. The CSD assembly is fitted to the high pressure side housing of the hydraulic timer.

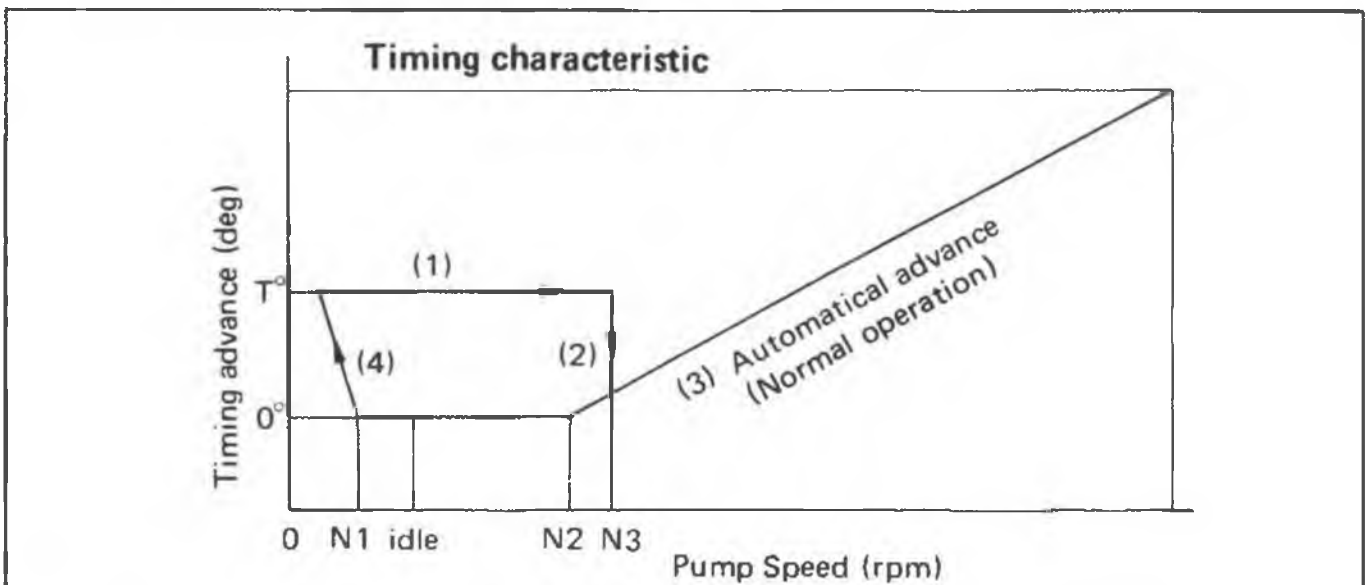


Fig. 4-20 CSD Performance

CSD PERFORMANCE:

Figure 4-20 gives the CSD performance ranges of the timing characteristics curve.

Range (1) The CSD is engaged.
Range (2) The CSD is disengaged.
Range (3) Timer is engaged after the CSD disengage.
Range (4) During this process, the CSD piston spring force is becoming stronger than fuel pressure in the pump housing. The pressure is becoming lower due to pump revolution decrease. (The CSD is re-engaged.)

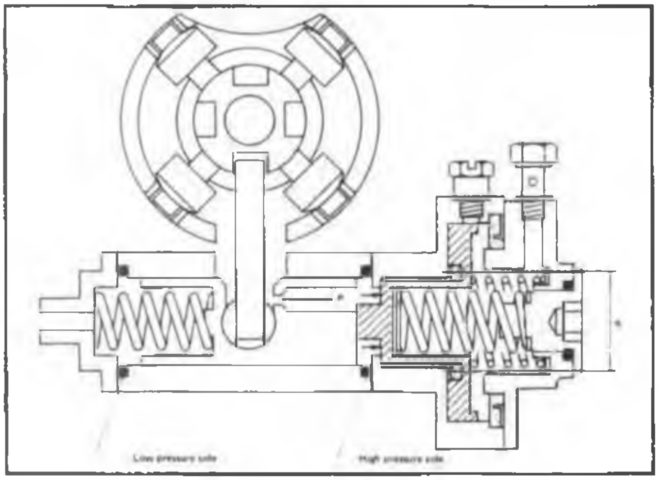


Fig. 4-21 CSD Engaged (Range 1)

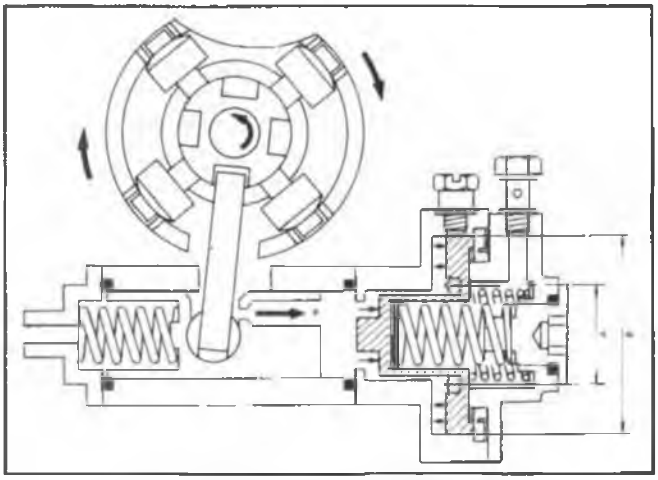


Fig. 4-22 CSD Disengaged (Range 2)

Range 1: CSD is engaged

When engine speed is between 0 and N-1 (700 rpm), the fuel pressure (P) is applied to the surface area "A" in Figure 4-20. This pressure is smaller than the force of the CSD springs. The CSD piston is pushed in the advance direction (towards the left), with the force of the CSD springs. This rotates the roller holder clockwise for the maximum advance angle "T" (6 degrees) shown Figure 4-19.

Range 2: CSD is disengaged

As engine speed rises up to N-3 rpm (between 700-1000 rpm), the fuel pressure applied to the CSD piston surface area "A" increases. This pushes the piston far enough to allow fuel pressure to act on surface area "B." Pressure is now being applied to both area "A" & "B". This starts to balance against the force of the CSD springs. When the engine speed exceeds the N-3 rpm, the fuel pressure is high enough to compress the CSD springs (Fig. 4-21).

The CSD piston compresses the CSD spring strongly because the fuel pressure applied to the surface area "B" is about three times larger than surface area "A." By this action, the CSD is disengaged.

Once disengaged, the CSD piston keeps in a stationary state when the engine speed is above the N-3 rpm (1100 rpm). This is because of the ratio of surface area "A" and "B."

Range 3: Timer is engaged after the CSD disengagement

After the CSD is disengaged, a normal timing advance is obtained in Range 3. This occurs by a balance between the fuel pressure applied to the high pressure side of the timer piston and the timer spring force.

Range 4: Re-engagement of CSD

When engine speed decreases down along Range 3 in Figure 4-20, and approaches idling, the pressure applied to area "B" of the CSD piston falls. Consequently, the CSD spring force will overcome the CSD piston pressure.

This pushes the timer piston to the left, in the advance direction. In other words, the injection timing will advance along Range 4 in Figure 4-20 until it reaches an angle of T degrees (6 degrees). Thus, the CSD returns to the engaged position.

ANEROID COMPENSATOR (Fig. 4-23)

The type VE pump is equipped with an aneroid compensator on the LUV truck. It is mounted on the top of the VE pump proper and it is designed to control the fuel injection to match the altitude. This prevents the deterioration of the exhaust emissions.

As the altitude increases, the atmospheric pressure will decrease. The bellows (1) force eventually becomes larger than the spring (2) setting, expanding and pushing downward on the adjusting rod (3).

The pin (4) contacting the adjusting rod will push the top end of the lever (5) to the left. This motion will be transmitted via pivot (A) so that the bottom end of the lever pushes the tension lever (6) to the right. This motion will in turn be transmitted about the pivot (B) of the tension lever causing the control sleeve (7) to move in the fuel decrease direction. The fuel decrease direction is to the left.

FUEL CUT SOLENOID (Fig. 4-24)

The fuel cut solenoid is controlled by the ignition switch. It is used to open or close the fuel intake passage (2) to the intake port (3).

When the engine is running, the fuel cut solenoid valve is open, so that the armature connected to the valve is drawn in the passage to the plunger inlet hole on the head. Conversely, when the engine is off, the solenoid is de-energized. As a result, the valve is forced against the seat by the spring, cutting off the fuel supply to the plunger.

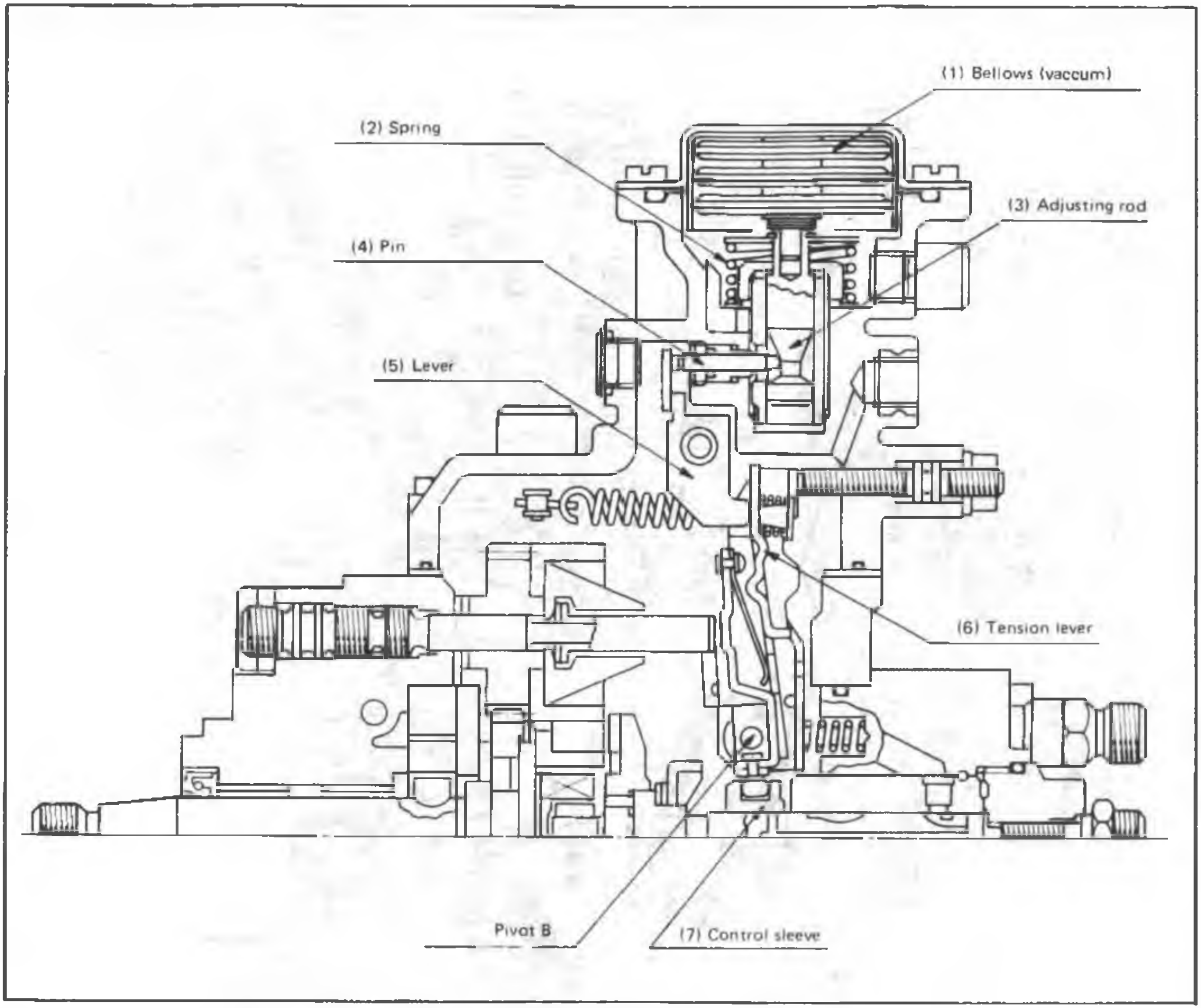


Fig. 4-23 Aneroid Compensator (LUV Truck)

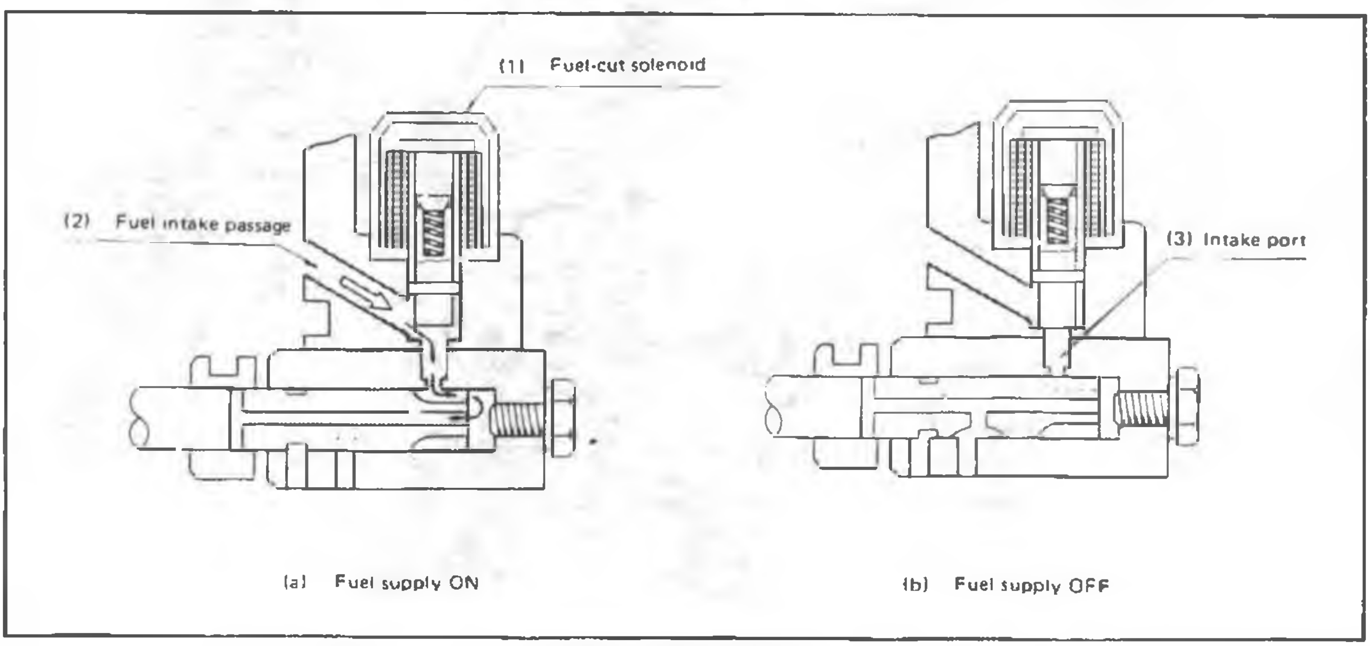


Fig. 4-24 Fuel Cut-Off Solenoid

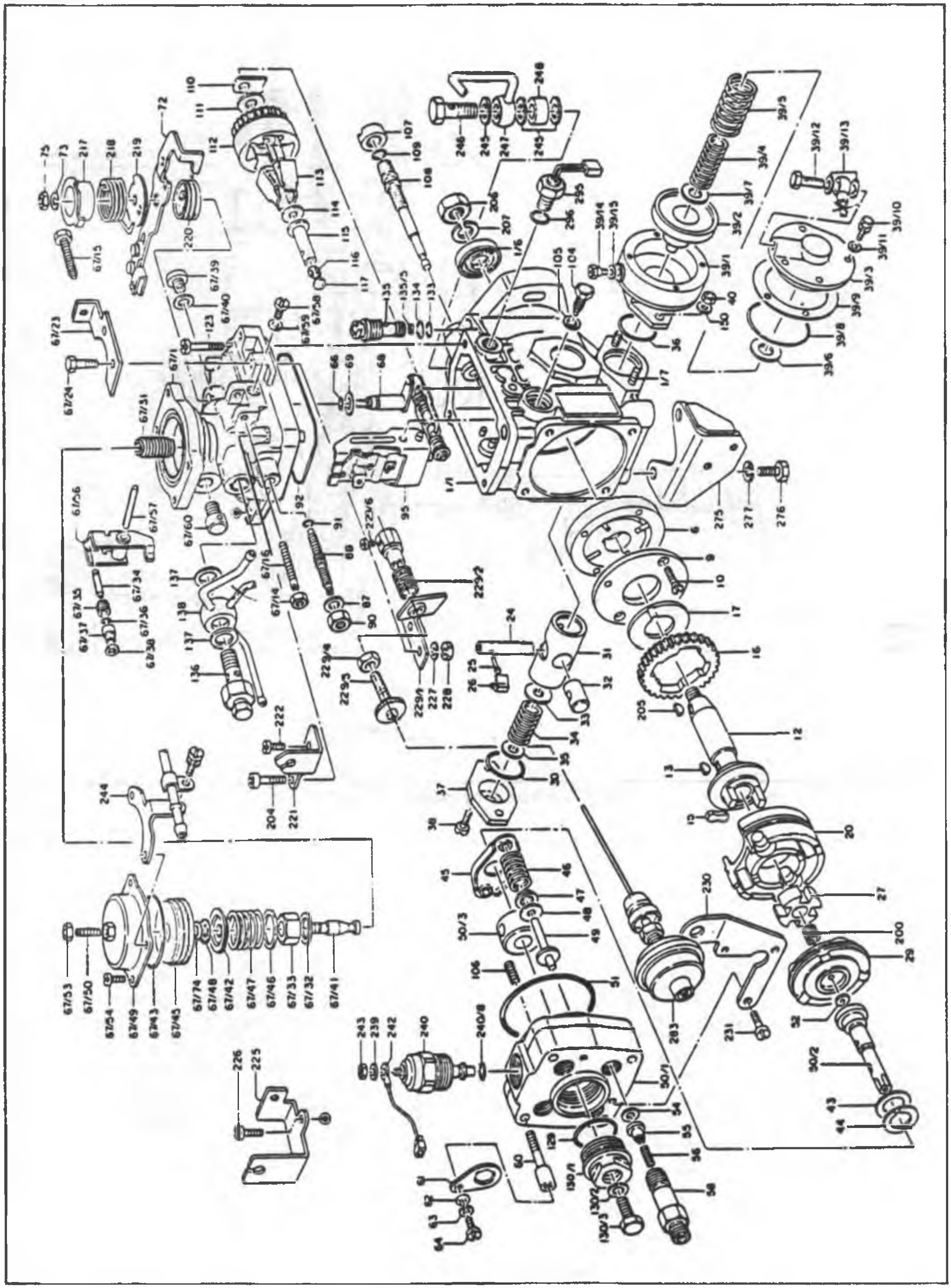


Fig. 4-25 Disassembly Diagram

DIESEL KIKI SERVICE PROCEDURES: ON VEHICLE

NOTICE: Thoroughly clean the fuel injection pump with a suitable cleaner and blow dry before beginning any service procedures. Failure to do so can result in damage to the injection pump.

FUEL RETURN PIPE GASKETS

2.2 Liter Engine

Removal

1. Disconnect and remove battery.
2. Remove A/C belt if so equipped.
3. Remove A/C compressor if so equipped and lay aside.
4. Disconnect fuel hoses.
5. Remove accelerator cable clip and remove cable from bracket.
6. Remove fuel return pipe and gaskets (137).
7. Replace gaskets and reverse removal procedures for installation.

1.8 Liter Engine

Removal

1. Disconnect battery.
2. Remove coolant recovery tank.
3. Disconnect fuel hoses.
4. Remove fuel return pipe and gaskets (137).
5. Replace gaskets and reverse removal procedures for installation.

FUEL INLET PIPE GASKETS

2.2 Liter Engine

Removal

1. Disconnect battery.
2. Remove A/C belt if so equipped.
3. Remove A/C compressor if so equipped and lay aside.
4. Disconnect fuel inlet hose.
5. Remove fuel inlet pipe and gaskets (245).
6. Replace gasket and reverse removal procedure for installation.

1.8 Liter Engine

Removal

1. Disconnect battery.
2. Disconnect fuel inlet hose.
3. Remove fuel inlet pipe and gaskets (245).
4. Replace gaskets and reverse removal procedures for installation.

TACH PLUG "O" RING

2.2 Liter Engine

Removal

1. Disconnect and remove battery.
2. Remove A/C belt if so equipped.
3. Remove A/C compressor if so equipped and lay aside.
4. Remove tack plug and replace "O" ring (296).
5. Reverse removal procedures for installation and torque to 10 N·m (8 ft. lbs.).

1.8 Liter Engine

1. Disconnect battery.
2. Remove coolant recovery tank and lay aside.
3. Remove tach plug and replace "O" ring (296).
4. Reverse removal procedures for installation and torque to 10 N·m (8 ft. lbs.).

MAX FUEL ADJUSTMENT SCREW/LOAD SCREW "O" RING

2.2 Liter Engine

Removal

1. Disconnect and remove battery.
2. Remove A/C compressor if so equipped.
3. Remove fuel return hose.
4. Remove fuel return pipe.
5. Remove staking wire.
6. Disconnect accelerator cable.
7. Install a M8.0 x 1 jamb nut against the full load adjusting screw lock nut. Tighten the two nuts together. This will preserve this critical dimension.
8. Remove the full load adjusting screw.
9. Remove and replace "O" ring (91).

Installation

1. Install the full load adjusting screw and torque the jamb nut to 8 N·m (6 ft. lbs.). Be careful not to disturb the full load setting.
2. Remove the jamb nut.
3. Reverse the remainder of the removal procedures for installation.

1.8 Liter Engine

Removal

1. Disconnect battery.
2. Remove taking wire.
3. Install a M8.0 × 1 jamb nut against the full load adjusting screw lock nut. Tighten the two nuts together. This will preserve this critical dimension.
4. Remove the full load adjusting screw.
5. Remove and replace "O" ring (91).

Installation

1. Install the full load adjusting screw and torque the jamb nut to 8 N·m (6 ft. lbs.). Be careful not to disturb the full load setting.
2. Remove the jamb nut.
3. Reverse the remainder of the removal procedures for installation.

REGULATING VALVE "O" RING

1.8 Liter Engine

Removal

1. Disconnect battery.
2. Remove regulating valve.
3. Remove and discard both "O" rings (133 and 134).

Installation

1. Install new "O" rings on regulating valve and lubricate with clean diesel fuel or test oil.
2. Install regulating valve and torque to 8 N·m (6 ft. lbs.).
3. Connect battery.

   NOTE: Regulating Valve "O" Ring replacement procedure for 2.2 Liter Engine must be performed with the pump off the vehicle. Refer to "Off Vehicle Service" for this procedure.

HIGH PRESSURE PLUG "O" RING

2.2 Liter Engine

Removal

1. Disconnect and remove battery.
2. Remove the A/C belt if so equipped.
3. Remove A/C compressor if so equipped and lay aside.
4. Remove fuel injection lines as an assembly.
5. Remove high pressure plug using tool J-33309 (Fig. 4-26).

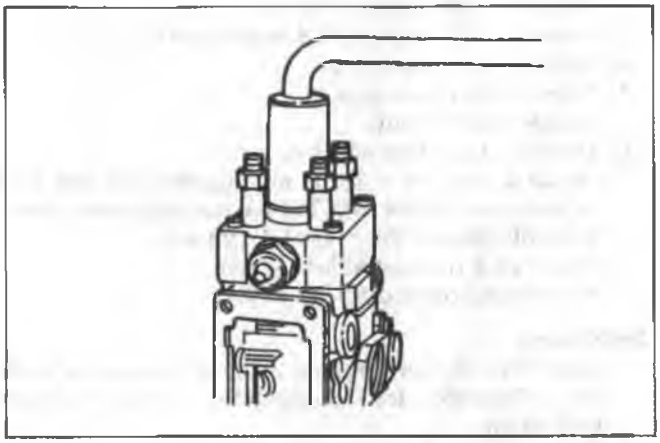


Fig. 4-26 High Pressure Plug Removal

6. Remove "O" ring (129).
7. Install a new "O" ring and reverse removal procedures for installation. Torque plug to 68 N·m (50 ft. lbs.).

1.8 Liter Engine

Removal

1. Disconnect battery.
2. Remove fuel injection lines as an assembly.
3. Remove high pressure plug using tool J-33309 (Fig. 4-26).
4. Remove "O" ring (129).
5. Reverse removal procedures for installation. Torque plug to 68 N·m (50 ft. lbs.).

DELIVERY VALVE HOLDER GASKET

2.2 Liter Engine

Removal

1. Disconnect and remove battery.
2. Remove A/C belt if so equipped.
3. Remove A/C compressor if so equipped and lay aside.
4. Remove injection lines as an assembly.
5. Using a deep well 14mm socket or a 14mm wrench, remove one or more of the delivery valve holders.
6. Remove the delivery valve and seat assembly (55). The delivery valve and seat are match-ground, so they must be kept together.
   NOTICE: The letters A, B...etc., are engraved on each cylinder of the distributor head (50) for identification. Remove each delivery valve, etc., according to the sequence of these letters so to ensure that they can be remounted in the same cylinder.
7. Remove the delivery valve gasket.

Installation

1. Fit the delivery valve gasket (54), delivery valve assembly (55), delivery valve spring (56), washer (57) and delivery valve holder (58) to the distributor head assembly (Fig. 4-28).

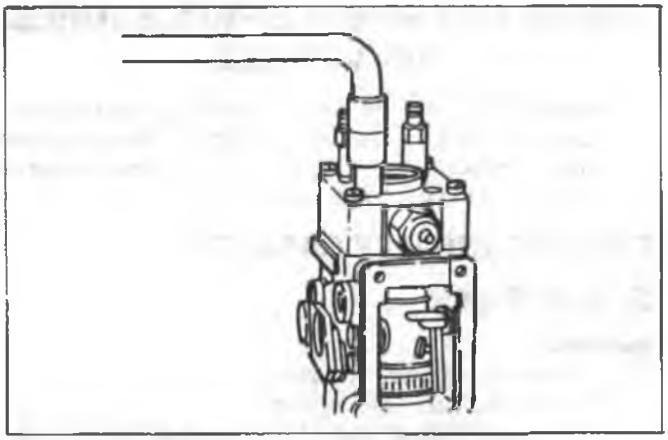


Fig. 4-27 Removing Delivery Valve Holder

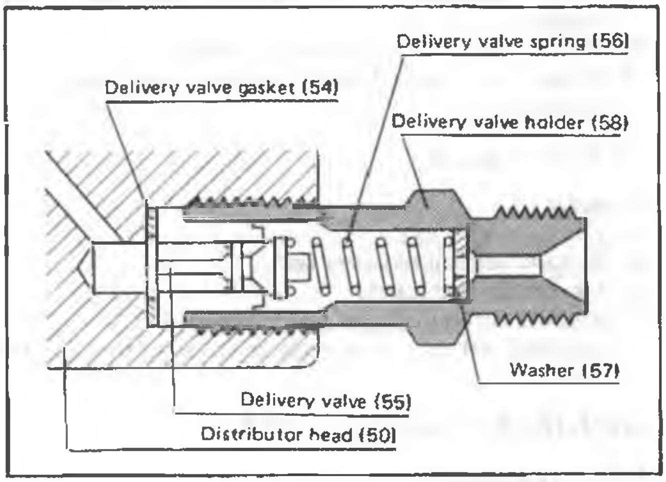


Fig. 4-28 Delivery Valve

2. Tighten the whole assembly with a deep well 14mm socket and torque to 40 N·m (28 ft. lbs.).
3. Reverse the removal procedures for installation.

1.8 Liter Engine

Removal

1. Disconnect battery.
2. Remove fuel injection lines as an assembly.
3. Using a deep well 14mm socket or a 14mm wrench, remove one or more of the delivery valve holders.
4. Remove the delivery valve and seat assembly (55). The delivery valve and seat are match ground, so they must be kept together.
   NOTICE: The letters A, B...etc., are engraved on each cylinder of the distributor head (50) for identification. Remove each delivery valve, etc., according to the sequence of these letters so to ensure that they can be remounted in the same cylinder.
5. Remove the delivery valve gasket.

Installation

1. Fit the delivery valve gasket (54), delivery valve assembly (55), delivery valve spring (56), washer (57) and delivery valve holder (58) to the distributor head assembly (Fig. 4-28).
2. Tighten the whole assembly with a deep well 14mm socket and torque to 40 N·m (28 ft. lbs.).
3. Reverse removal procedures for installation.

DIESEL KIKI VE INJECTION PUMP REMOVAL AND INSTALLATION

2.2 Liter Engine

Removal

1. Raise engine hood.
2. Disconnect the battery ground cable.
3. Remove the battery assembly.
4. Remove the under cover.
5. Drain the cooling system by opening the drain plugs on the radiator and on the cylinder block.
6. Disconnect the upper water hose at the engine side.
7. Loosen the compressor drive belt by moving the power steering oil pump or idler. (If so equipped.)
8. Remove the cooling fan and fan shroud.
9. Disconnect the lower water hose at the engine side and remove radiator.
10. Remove the air conditioner compressor. (If so equipped.)
11. Remove the fan belt.
12. Remove the crankshaft pulley.
13. Remove the timing pulley housing covers "A, B."
14. Remove the tension spring and fixing bolt, then remove the tension center and pulley.
15. Remove the timing belt.
16. Remove the engine control cable and wiring harness of the fuel cut-off solenoid.
17. Remove the fuel hoses and injection pipes. Use a wrench to hold the delivery holder when loosening the sleeve nuts on the injection pump side.
18. Install a M6.0 × 1.25 bolt into threaded hole in the timing pulley housing through the hole in pulley to prevent turning of the pulley. Remove the bolts from the injection pump timing pulley. Remove the injection pump pulley using puller J-29801 and remove the lock bolt.
19. Remove injection pump flange fixing nuts and rear bracket bolts, then remove the injection pump.

Installation

1. Install the injection pump by aligning notched line on the flange with the line on the front bracket.
2. Install the injection pump timing pulley by aligning it with the key groove.
3. Bring the piston in No. 1 cylinder to top dead center on compression stroke.
4. Check that the setting marks on the crank pulley, injection pump timing pulley, and camshaft timing pulley are in alignment, then install the timing belt in sequence of crankshaft timing pulley, camshaft timing pulley, and injection pump timing pulley. Make an adjustment, so that slackness of the belt is taken up by the tension pulley. When installing the belt, care should be taken so as not to damage the belt.
5. Install the tension center and tension pulley, making certain the end of the tension center is in proper contact with two pins on the timing pulley housing.
6. Hand-tighten the nut, so that tension pulley can slide freely.
7. Install the tension spring correctly and semitighten the tension pulley fixing nut.
8. Turn the crankshaft 2 turns in normal direction of rotation to permit seating of the belt. Further rotate the crankshaft 90 degrees beyond top dead center to settle the injection pump. Never attempt to turn the crankshaft in reverse direction.
9. Loosen the tension pulley fixing nut completely, allowing the pulley to take up looseness of the belt. Then, tighten the nut to 79-94 ft. lbs.
10. Install the flange on the injection pump pulley.

    The hole in the outer circumference of the flange should be aligned with the timing mark "Δ" on the injection pump pulley.
11. Turn the crankshaft 2 turns in normal direction of rotation to bring the piston in No. 1 cylinder to top dead center on compression stroke and check that the mark "Δ" on the timing pulley is in alignment with the hole in the flange.
12. The belt tension should be checked at a point between the injection pump pulley and crankshaft pulley using Tool J-29771. Correct tension is 33-55 lbs. (15-25 kg).
13. Check the injection timing.
14. To install remaining parts, follow the removal steps in reverse order.

1.8 Liter Engine

Removal

1. Disconnect battery negative cable.
2. Drain cooling system.
3. Remove fan shroud.
4. Remove radiator.
5. Remove coolant recovery bottle.
6. Remove upper dust cover.
7. Loosen tension pulley and plate bolt. Remove tension spring.
8. Remove the nut attaching the pump gear.
9. Remove injection pump gear using tool J-22888.
10. Disconnect necessary wires, hoses and cables. Use care so as not to spill fuel within the fuel hoses.
11. Remove fuel filter at bracket.
12. Remove injector lines at pump and nozzles and remove injector lines.
13. Remove 4 bolts attaching the pump rear bracket and remove the rear bracket (Fig. 4-30).
14. Remove the nuts attaching the injection pump flange and remove the injection pump together with the fast idle device and return spring.

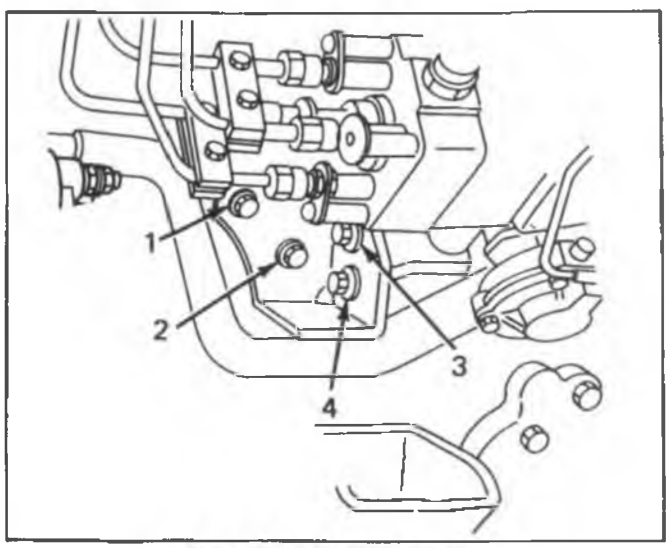


Fig. 4-29 Rear Bracket Bolts

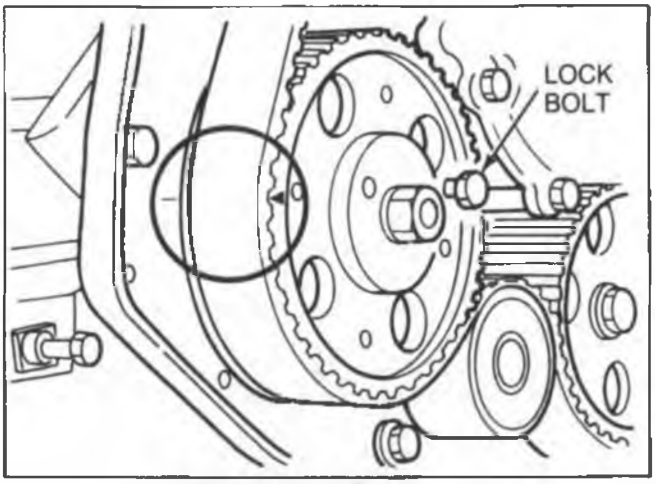


Fig. 4-30 Alignment Mark and Lock Bolt

Installation and Adjustments

Timing Belt

1. Install the injection pump.
2. Tighten the 4 bolts in sequence as shown in Figure 4-29. No clearance should be provided between the rear bracket and injection pump bracket.
3. Install the injection pump pulley by aligning it with the key groove. Align the mark on the gear with the mark on the front plate (Fig. 4-30). Then install lock bolt (M8×1.25). Tighten the nut using the lock bolt to prevent turning of pulley, torque nut to 60 N·m (45 ft. lbs.).
4. Remove cam cover.
5. With piston in number 1 position T.D.C., install J-29761 fixing plate to slot in the rear of camshaft. This is to prevent the camshaft from rotating.
6. Remove the bolt attaching camshaft gear.
7. Using puller J-22888, remove cam gear.
8. Re-install cam gear loosely so the gear can be turned smoothly by hand.
9. Install the timing belt with the following noted:
   - Belt should be properly tensioned between pulleys.
   - Cogs on belt and pully should be engaged properly.
   - Crankshaft should not be turned.
   - Concentrate belt looseness on tension pulley. Depress tension pulley with finger and install tension spring.
10. Semi-tighten bolts in numerical sequence to prevent movement of tension pulley (Fig. 4-31).

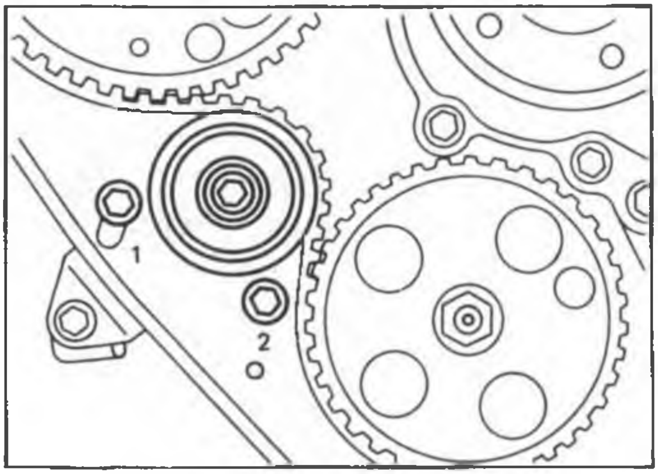


Fig. 4-31 Tension Pulley Bolts

11. Tighten camshaft pulley bolt to 60 N·m (45 ft. lbs.).
12. Remove injection pump gear lock bolt.
13. Remove fixing plate on end of camshaft.
14. Check that piston is in number 1 T.D.C. position. Do not turn the crankshaft in an attempt to make an adjustment.
15. Check to make certain that the mark on the injection pump pulley is in alignment with the mark on the plate.
16. Fixing plate should fit smoothly into slot at rear of camshaft, then remove the fixing plate.
17. Loosen tensioner pulley and plate bolts. Concentrate looseness of belt on tensioner, then tighten bolts in numerical sequence as shown (Fig. 4-32).

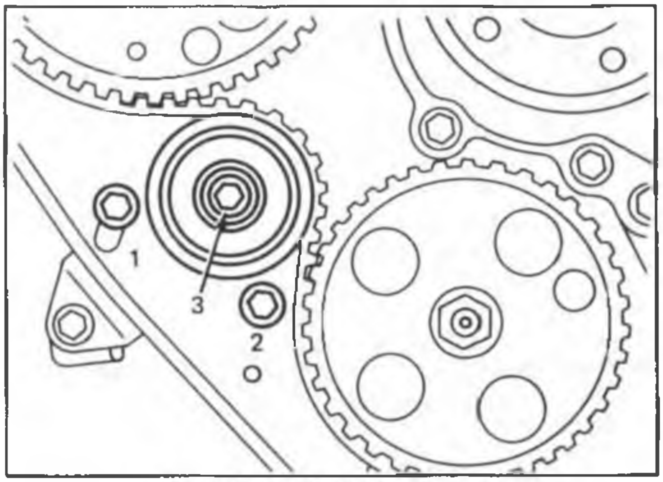


Fig. 4-32 Bolt Tightening Sequence

18. Belt tension should be checked at a point between the camshaft gear and the injection pump gear.
19. Install cam cover.
20. Install injection lines.
21. Install fuel filter.
22. Connect necessary wires and hoses.
23. Install the upper dust cover.
24. Install coolant recovery bottle.
25. Install radiator.
26. Install fan shroud.
27. Refill coolant.
28. Adjust engine idle speed, fast idle speed, and TV cable adjustment as necessary.

DIESEL KIKI SERVICE PROCEDURES: OFF VEHICLE

NOTICE: The following procedures must be performed with the pump mounted horizontally in a modified J-29692-A pump holding fixture. All part numbers in parentheses refer to parts listed in Figure 4-25.

GOVERNOR COVER

Removal

NOTICE: All part numbers in parentheses are referenced in Figure 4-25.

1. Install an M8.0×1 jamb nut against the full load adjusting screw lock nut. Tighten the two nuts together. This will preserve this critical dimension.

2. Remove the full-load adjusting screw (88) with a 6mm wrench or socket.
3. Loosen the screws (123) retaining the governor cover, remove the governor cover and the seal ring (92) together.
   NOTICE: Because the governor control shaft is connected to the governor lever (67/5), it will be necessary to lift the cover straight up and push rearward while removing (Fig. 4-33).

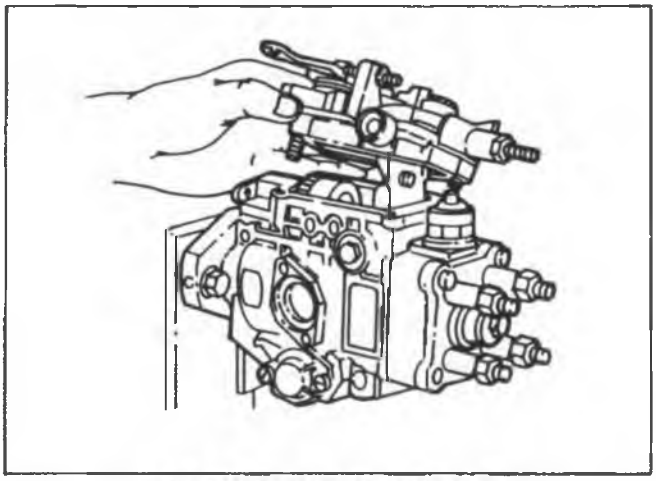


Fig. 4-33 Governor Cover Removal

4. Remove the M10×6 nut (67/7) from the control lever (67/5) slowly while holding the lever. Do not allow the lever to come off the throttle shaft until you scribe a reference mark on the throttle shaft (67/2) and control lever (67/5). Each serration on the throttle shaft will change the lever angle by 15 degrees. If the lever and shaft are not returned in exactly the same position, the full load reference will be off and the pump will have to be sent to an authorized repair station. The full load reference is adjusted on the test stand.
5. Push the throttle shaft (67/2) and control shaft out of the governor cover.
6. Remove and discard the "O" ring (67/3).

Installation

1. Install the shim (67/4) on the throttle shaft.
2. Using clean diesel fuel, synkut oil or test fluid, install a new "O" ring (67/3) on the throttle shaft.
3. Press the throttle shaft assembly into the governor cover, using only slight hand pressure.
4. Install the throttle shaft lever and spring on the throttle shaft, making sure to line up the scribe marks.
5. Torque the throttle shaft nut to 7 N·m (5 ft. lbs.)
6. Install a new governor cover "O" ring (92).
7. With the throttle lever in the idle position, lower the governor cover onto the housing. Engage the control shaft to the tension lever by putting the square cut portion of the control shaft into the slot in the tension lever. Be sure the damper spring washer is on the distributor side of the tension lever.
8. Check through the overflow pipe to see that the control shaft is fully bottomed in the tension lever slot.
9. Push the governor cover forward toward the drive shaft and down into place on the dowel pin.
10. Install the four governor cover screws and tighten to 8 N·m (6 ft. lbs.).
11. Install a new "O" ring on the full-load adjusting screw.
12. Install the full-load adjusting screw and torque the jamb nut to 8 N·m (6 ft. lbs.). Be very careful not to disturb the full-load setting.
13. Remove the back-up jamb nut previously installed.

COLD START DEVICE (CSD)

Removal

1. Use a 10mm hex drive to remove the center plug in the CSD cover. Remove this slowly because there is a spring under pressure behind the cover.
2. Remove and discard the "O" ring and note the number of shims between the plug and small spring.
3. Remove the small spring (Fig. 4-34).
4. Loosen and remove the cover bolts taking note of the number of shims between the cover and the large spring.
5. Remove the timer spring, washer and piston in this order.
6. Remove and discard the cover seal.
7. Remove the two housing securing nuts and remove the housing and "O" ring (Fig. 4-35).

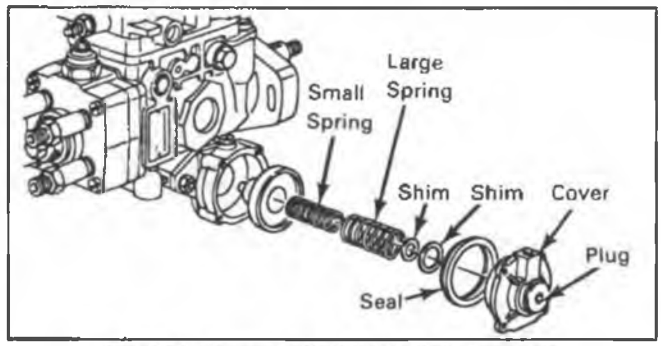


Fig. 4-34 Removing CSD Internal Components

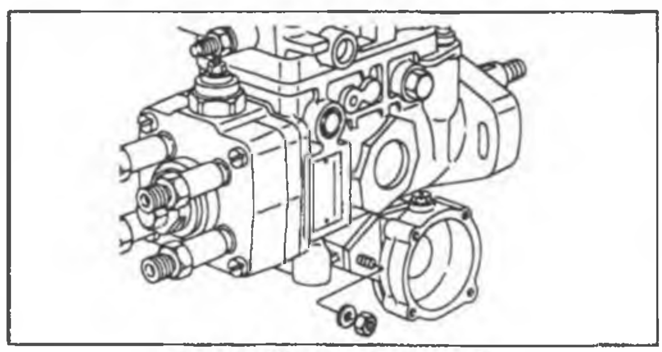


Fig. 4-35 CSD Housing Removal

Installation

1. Install a new "O" ring (36).
2. Install the CSD housing and torque the bolts to 7 N·m (5 ft. lbs.).
3. Install the large CSD spring, the shim and the piston. Be sure to install the exact number of shims between the cover and the large spring.
4. Install a new cover seal.
5. Install the cover and torque to 7 N·m (5 ft. lbs.).
6. Install a new "O" ring on the plug. Be sure to install the exact number of shims between the plug and the small spring.
7. Install the plug and torque to specifications.

DISTRIBUTOR HEAD "O" RING

Removal

1. Remove the governor cover. Refer to previous governor cover removal procedure.
2. Move the pump to a vertical position.
3. Rotate the drive shaft so that the woodruff key is straight up, perpendicular to the pump centerline.
4. Remove the delivery valve clamps, if so equipped.
5. Use a wide blade screw driver to remove the 4 head screws (60).
6. Remove the distributor head (50/1) from the pump housing together with the "O" ring (51). During this operation, be careful not to lose the two springs (106), guide pin (49), shim (48) or spring seat (47).
   NOTICE: Do not remove the plunger (50/2) unless it has been disturbed. If it is disturbed, remove it with the control sleeve (50/3), plunger spring (46), spring seat (45), shim (43) and washer (44) (Fig. 4-36).
7. Remove and discard the distributor head "O" ring.

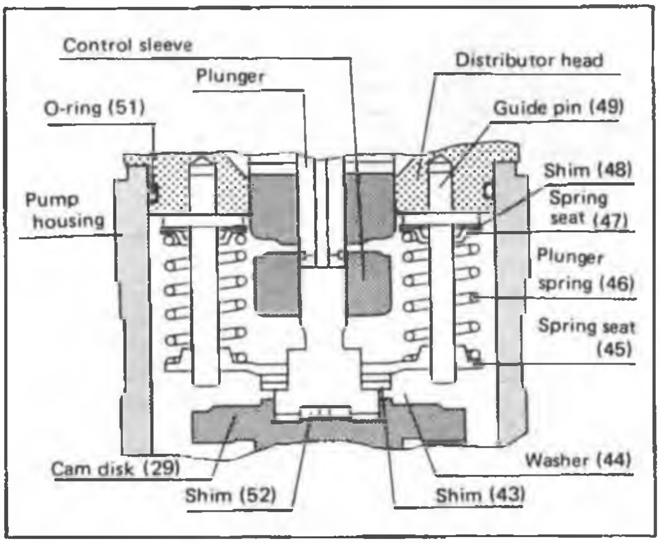


Fig. 4-36 Plunger Shims

Installation

1. Fit the shim (43), washer (44) with the oil groove and spring seat (45) to the plunger in that order. Then mount the control sleeve on the plunger.
   NOTICE: Mount the control sleeve so that the small hole at the bottom faces downwards (i.e. towards the cam disc). Be sure that the small shim (52) between the plunger and the cam disc is inserted in the bottom of the plunger using light oil. Do not apply grease to the shim (52).
2. Install the assembled plunger, together with the previously selected shim (52), in the pump housing. This is done by inserting the ball pin of the lever assembly (95) into the control sleeve hole and then inserting the groove at the bottom of the plunger into the knock pin of the cam disc (29).
3. Mount the plunger spring (46) on the spring seat (45). Fit the "O" ring (51) to the distributor head and then, while applying grease, assemble the guide pin (49), shim (48) and spring seat (47), in that order, onto the distributor head. Next apply grease to the spring (106) and fit it onto the distributor head.
4. Carefully fit the assembled distributor head onto the pump housing after orienting the spring (106) so that it faces the governor lever assembly. During this operation, be careful not to damage the "O" ring (51). Also, check that the one end of the guide pin (49) is properly seated in the guide hole of the spring seat (45), the ball pin of the governor lever assembly (95) is inserted in the hole of the control sleeve and the shim (52) is properly inserted in the recess in the bottom of the flange of the plunger.
   NOTICE: The knock pin on the cam disc must be in line with the drive shaft key. Also, the plunger slides closely inside the distributor barrel which is pressed onto the distributor head (50/1) and the control sleeve. Since it is lapped with a close tolerance, it must be handled with care.
5. Push the distributor head by hand and check that it goes as far as the mounting part of the "O" ring using J-33309 socket on the high pressure plug as a pushing tool.
6. Install the 4 distributor head screws and torque uniformly to 13 N·m (9 ft. lbs.).
7. After torquing, operate the governor lever assembly and check that the control sleeve follows the movement of the lever smoothly.
8. Rotate the drive shaft and check by means of the rotation of the plunger (through the high pressure plug hole) that the knock pin is securely seated in the plunger flange groove.

DRIVE SHAFT SEAL

Removal

1. Remove the woodruff key (205).
2. Using an awl or a thin blade screw driver, remove the drive shaft seal (1/6).

Installation

1. Install oil seal protector J-33308 on the drive shaft.
2. Lubricate the protector with diesel fuel, test fluid or vaseline.
3. Install a new seal over the protector and drive it flush with the pump housing. A deep-well socket may be used to drive the seal flush.

ADVANCE MECHANISM

Removal

1. Remove the overflow pipe, eye bolt, fuel inlet pipe and related copper gaskets.
2. Loosen the screw (38) and remove the cover (37) together with the timer spring (34) and seal ring (30). The cover is under spring tension, but screw (38) has sufficient height to allow complete release of spring tension.
   NOTICE: There should always be a shim on each side of the timer spring, but there may be more than one shim on each side of the spring. During this procedure, be careful not to lose the shim (35) inside the cover.

Installation

1. Replace the "O" ring (30) with a new one.
2. Reverse the above procedures for reassembly.

REGULATING VALVE "O" RING

2.2 Liter Engine

Removal

1. Remove pump from vehicle.
2. Remove regulator valve.
3. Remove and discard both "O" rings (133 and 134).

Installation

1. Install new "O" ring on regulating valve and lubricate with clean diesel fuel or test oil.
2. Install regulating valve and torque bolt to 8 N·m (6 ft. lbs.).
3. Install pump into vehicle.

FUEL CUT-OFF SOLENOID

Removal

1. Use a 24mm wrench to remove the fuel cut-off solenoid and the "O" ring. Be careful not to lose the spring and armature when removing the solenoid (Fig. 4-37).
2. Remove and discard the "O" ring.

Installation

1. Install a new "O" ring.
2. Install the fuel cut-off solenoid and torque to 4-4.5 kgm (31 ft. lbs.).

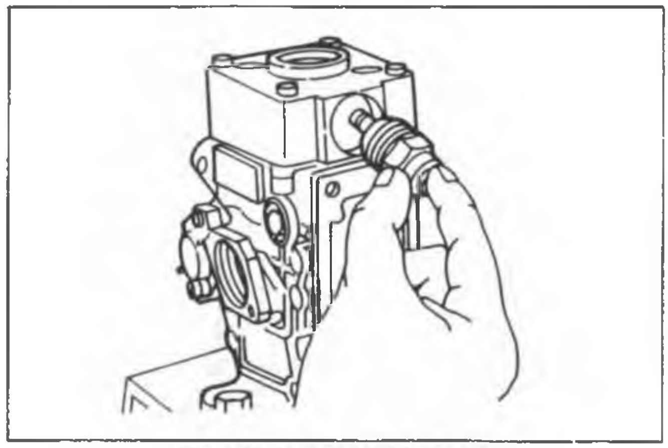


Fig. 4-37 Fuel Cut Off Solenoid

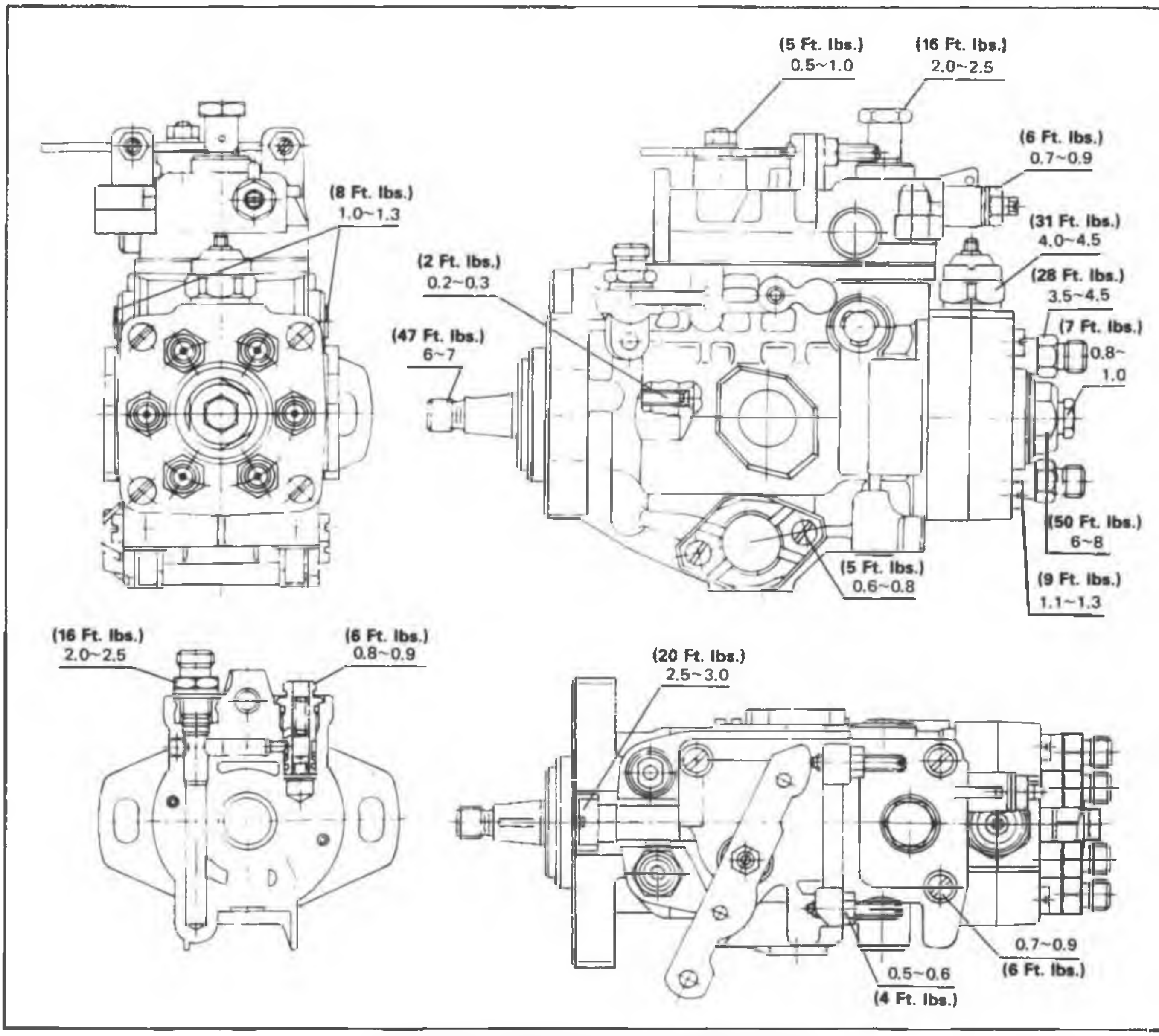


Fig. 4-38 Diesel Kiki VE Injection Pump Torque Values

SECTION 5
FUEL LINES AND NOZZLES

HIGH PRESSURE FUEL LINES

GENERAL

High pressure fuel delivery lines deliver clean, pressurized fuel from the injection pump to the injector nozzles. The lines are constructed of a thin wall alloy tubing and are slightly flared at each end. There is also a compression fitting at each end of the line for attaching to the injection pump and the injector nozzle.

There is one high pressure fuel line per cylinder. Each line is the same length, to ensure proper timing, but each line has unique contours.

HIGH PRESSURE FUEL LINES SERVICE PROCEDURES

When lines are to be removed, clean all line fittings thoroughly before loosening. Immediately cap the lines, nozzles and pump fittings to maintain cleanliness.

Removal — 6.2 Liter Engine

1. Disconnect battery.
2. Disconnect air cleaner bracket at valve cover.
3. Remove crankcase ventilator bracket and move aside.
4. Disconnect secondary filter lines.
5. Remove secondary filter adapter.
6. Loosen vacuum pump hold-down clamp and rotate pump in order to gain access to intake manifold bolt.
7. Remove intake manifold bolts. Injection line clips are retained by the same bolts.
8. Remove intake manifold.
9. Install protective covers J-29664-1.
10. Remove injection line clips at loom brackets.
11. Remove injection lines at nozzles and cover nozzles with protective caps.
12. Remove injection lines at pump and tag lines for reinstallation.
13. Remove fuel line from injection pump.

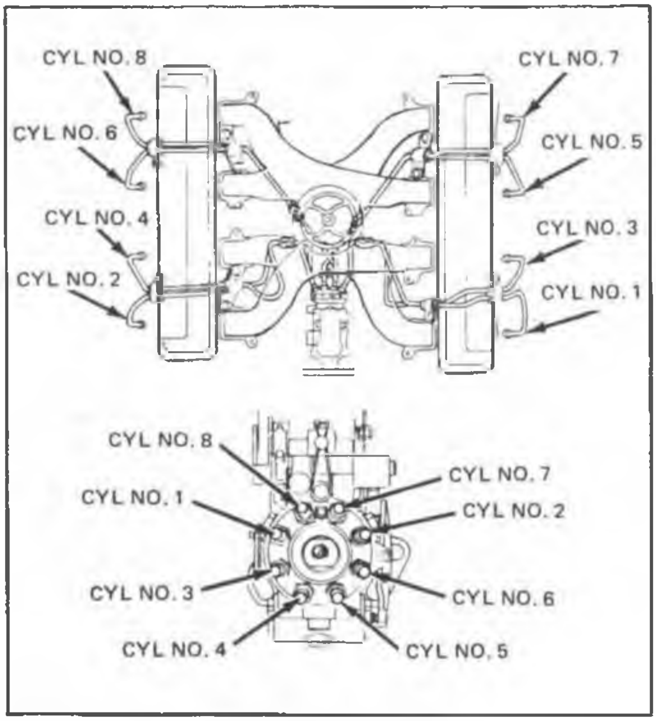


Fig. 5-1 Fuel Line Routing

Installation

1. Install injection lines as shown in Figure 5-1.
2. Remove protective covers.
3. Install intake manifold.
4. Install secondary filter and lines.
5. Tighten vacuum pump holddown clamp.
6. Install crankcase ventilator.
7. Connect air cleaner.
8. Connect battery.

TORQUE SPECIFICATIONS:

AT NOZZLE 25 N·m (20 FT LBS.)
AT PUMP 25 N·m (20 FT. LBS.)
AT BRACKET 20 N·m (15 FT. LBS.)
AT INTAKE 40 N·m (30 FT. LBS.)
CLAMPS 3 N·m (26 IN. LBS.)

Fig. 5-2 Torque Specifications 6.2L

Removal — 5.7 and 4.3 Liter Engines

1. Remove air cleaner.
2. Remove filters and pipes from valve covers and air crossover.
3. Remove air crossover and cap intake manifold with screened covers J-26996-10, V8 and J-29657, V6.
4. Remove injection pump line clamps, then remove the injection pump lines and cap open lines, nozzles, and pump fittings. Use a back-up wrench on the nozzle upper hex to prevent a fuel leak.

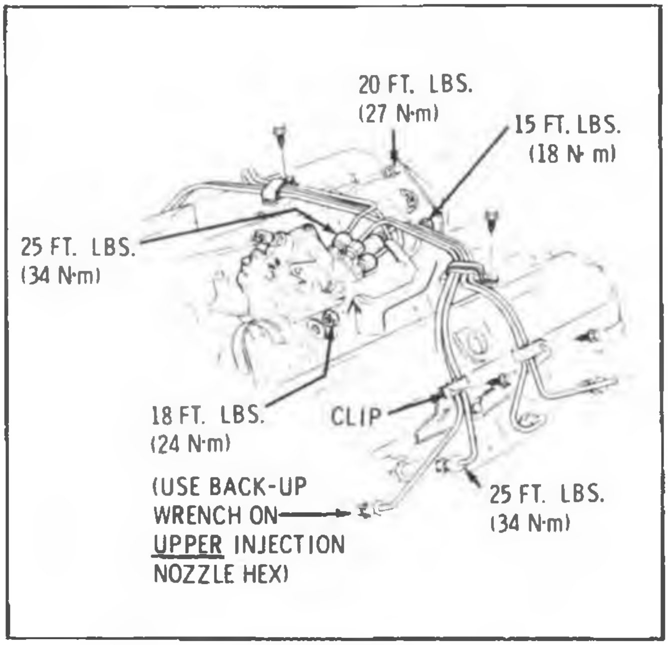


Fig. 5-3 V-8 Injection Lines

Installation

1. Install new injection pump line, install loose then torque both ends. See Figures 5-3 and 5-4 for the Torque Specifications. Use a back-up wrench on the nozzle upper hex to prevent nozzle damage. Then install clamps. If several lines are to be replaced, start with the bottom lines.
2. Start engine and check for fuel leaks.
3. Remove screened covers from intake manifold and install air crossover.
4. Start the engine and check for leaks.
5. Connect the crankcase ventilation pipes and filter(s) to the valve cover(s) and air crossover.
6. Install the air cleaner.

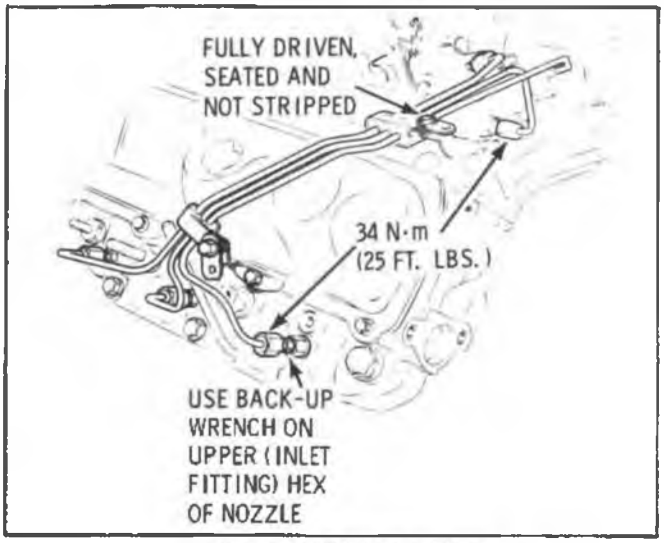


Fig. 5-4 V-6 Injection Lines

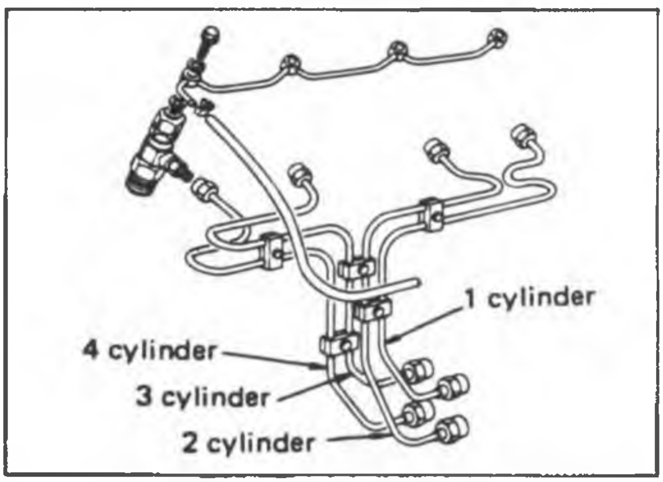


Fig. 5-5 Injection Line Installation

Removal — 2.2 and 1.8 Liter Engines (Fig. 5-5)

1. Disconnect and remove the fuel return line from the pump and the #4 nozzle.
2. Disconnect and remove the center clamp to the #2 and #3 injection lines.
3. Using line wrenches and a back-up wrench on all sleeve fittings, loosen and remove the fittings. The lines will come out as two assemblies: Lines 2 and 4 as one assembly and Lines 1 and 3 as the other.

   NOTICE: Lines may be bent slightly to facilitate removal, however, exercise extreme care so as not to kink any injection line. If kinked, it must be replaced.
4. Cap all lines, nozzles and discharge ports immediately to ensure cleanliness.

Installation

1. Install line assembly 2 and 4 first and torque to 21-31 N·m (15-22 ft. lbs.).
2. Install line assembly 1 and 3 and torque to 21-31 N·m (15-22 ft. lbs.).
3. Install the center retaining clamp to lines 2 and 3.
4. Install the fuel return line from the pump to the #4 nozzle.

FUEL INJECTION NOZZLES

GENERAL

The primary function of a nozzle is the distribution and atomization of fuel in the combustion chamber. The quality of distribution and atomization directly affects combustion efficiency and engine performance. Since nozzles are components subject to close tolerance and severe operating conditions, they require regular maintenance for optimum performance.

Four types of nozzles can be found on different Chevrolet Division cars and light trucks. These are the Robert Bosch Pintle nozzles on the 6.2 liter engine; the poppet nozles produced by LUCAS CAV and D.E.D. for the 5.7 and 4.3 liter engines; the Diesel Kiki Pintle nozzles for the 2.2 and 1.8 liter engines, and a pencil type pintle nozzle produced by Stanadyne found on earlier model cars and light trucks equipped with a 5.7 liter engine.

> **NOTICE:** When performing the following test procedures, be sure that the test area is clean and well ventilated. Nozzles are precision components made of special materials. Extreme care should be exercised when handling and/or adjusting. The smallest particle of dirt can block the nozzle holes and give incorrect test results. Continuous nozzle testing in a confined area will produce an excessive amount of finely atomized fluid in the air. **MAKE SURE TEST AREA IS VENTED.**

PINTLE INJECTION NOZZLES — 6.2L

Metered fuel, under pressure from the injection pump enters the nozzle and pressurizes the nozzle body. When the pressure in the nozzle body overcomes the spring force, the valve lifts off of its seat allowing fuel to spray into the prechamber.

During injection a small amount of fuel leaks through the clearance of the valve guide. This fuel flows through the fuel drain back nipple at the top of the nozzle and is returned to the fuel tank through the fuel return line.

The nozzle also has a bleed back path for bleeding excess fuel back to the fuel tank. The nozzle allows only the amount of fuel to pass that is needed for engine operation.

The main purpose of the fuel nozzle is to direct and to atomize the metered fuel into the pre-combustion chamber. Fuel from the injection pump enters and pressurizes the supply passages in the injector. When the force on the lift area is greater than the spring pressure on the needle valve spindle, the needle valve is lifted off its seat and rests with its upper shoulder against a stop. Fuel is forced out into the precombustion chamber while the needle valve is lifted. The pressure required to open this injector needle valve is approximately 1850 psi. As the fuel sprays into the precombustion chamber, the pump continues to turn and instantaneously closes off fuel to the nozzle. This action causes a rapid drop in fuel line pressure and spring pressure forces the needle valve to close and seat again, sealing off fuel from the precombustion chamber. The injector nozzle injects fuel once for every 2 revolutions of the crankshaft. This means that under normal driving conditions it will open and close about 1,000 times for every mile driven. In a 10-mile drive to and from work each day each injector nozzle would open and close approximately 10,000 times. In relation to time if you are driving 60 mph, each injector nozzle will open and close 1,000 times/minute. As you can readily see, the injector nozzle is a very critical component of the 6.2L diesel engine.

The Bosch nozzle at the present time will be serviced only as an assembly.

Tool J-29873 a 30mm socket is used for R&R. There is a copper washer used to seal the outside from the combustion area. It must be replaced any time the injector is removed. Maximum pop-off is 135 bars for a new nozzle (1960 psi) 125 bars for a used nozzle (1812 psi).

1 Bar = 14.5 psi.

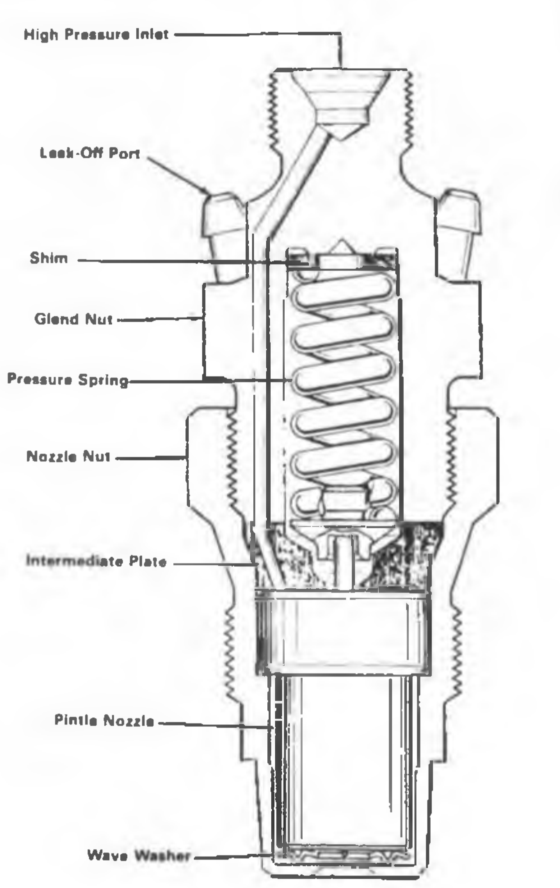


Fig. 5-6 Bosch Nozzle

INJECTION NOZZLE (Fig. 5-6)

Removal

1. Disconnect battery.
2. Disconnect fuel line clip.
3. Remove fuel return hose.
4. Remove fuel injection line.
5. Remove injection nozzle using tool J-29873.

NOTICE: When removing an injection nozzle, use tool J-29873. Be sure to remove the nozzle using the 30mm hex. Failure to do so will result in damage to the injection nozzle. Always cap the nozzle and lines to prevent damage and contamination.

Installation

1. Remove protective caps from nozzle.
2. Install nozzle and torque to 70 N·m (50 ft. lbs.).
3. Connect fuel injection line, torque nut to 25 N·m (20 ft. lbs.).

TESTING

Test is comprised of the following checks:
Nozzle Opening Pressure
Leakage
Chatter
Spray Pattern

Each test should be considered a unique test, i.e., when checking opening pressure do not check for chatter.

If all of the above tests are satisfied, the nozzle holder assembly can be again installed in the engine without any changes. If any one of the tests is not satisfied, the complete nozzle holder assembly must be replaced. The nozzle holder will then be further checked and repaired at a centralized location.

- Test Lines—6x2x400mm (1.5mm bore).
- Test Fluid per ISO 4113 (Example Shell V1399, Viscor 1487c or equivalent).
- Kinetic Viscosity at 40°C (105°F) per ISO 3104: 2.45 . . . 2.75mm^2/second.
- Test Oil Temperature during Test: 20-25°C (room temperature).
- Refer to the equipment manufacturer's instructions for exact test procedures.

CAUTION: When testing nozzles, do not place your hands or arms near the tip of the nozzle. The high pressure atomized fuel spray from a nozzle has sufficient penetrating power to puncture flesh and destroy tissue and may result in blood poisoning. The nozzle tip should always be enclosed in a receptacle, preferably transparent, to contain the spray.

Test Sequence

Preparation

1. Connect the nozzle holder assembly to the test line.
2. Place clear plastic tubes on overflow connections.
3. Close the shutoff valve to the pressure gage.
4. Fill and flush the nozzle holder assembly with test oil by activating the lever repeatedly and briskly. This will apply test oil to all functionally important areas of the nozzle and purge it of air (Fig. 5-7).

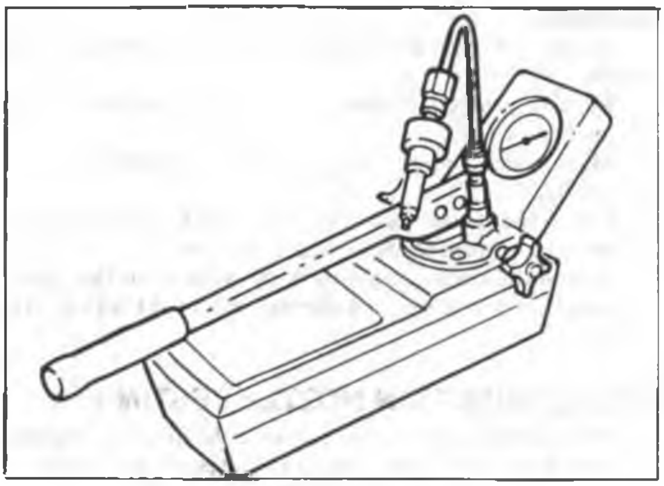


Fig. 5-7 Nozzle Testing

Obtaining Pressure Check

1. Open shutoff valve at pressure gage ¼ turn.
2. Depress lever of tester slowly. Note at what pressure the needle of the pressure gage stopped, indicating an increase in pressure (nozzle does not chatter) or at which pressure the pressure dropped substantially (nozzle chatters). The maximum observed pressure is the opening pressure.
3. The opening pressure should not fall below the lower limit of 105 bar (1500 psi on used nozzles).
4. Replace nozzles which fall below the lower limit.

Leakage Test

1. Further open shutoff valve at pressure gage (½ to 1½ turns).
2. Blow-dry nozzle tip.
3. Depress lever of manual test stand slowly until gage reads a pressure of 95 bars (1400 psi). Observe tip of nozzle. A drop may form but not fall off within a period of 10 seconds.
4. Replace the nozzle holder assembly if a droplet drops off the nozzle bottom within the 10 seconds.

Chatter Test

1. **Close shutoff lever at pressure gage.**
2. Depress lever of manual test stand slowly noting whether chatter noises can be heard.
3. If no chatter is heard, increase the speed of lever movement until it reaches a point where the nozzle chatters.
4. The chatter indicates that the nozzle needle moves freely and that the nozzle seat, guide, as well as the pintle, have no mechanical defects.
5. Replace if no chatter.

Spray Pattern

This nozzle features a longer nozzle overlap, greater pintle to body clearance, and greater needle to body clearance. This assembly also features an internal wave washer between the nozzle nut and nozzle. Because of these features objectives testing in the field is difficult. A pop tester will not deliver fuel with the velocity necessary to obtain proper spray pattern analysis.

POPPET NOZZLES — 5.7L and 4.3L

The poppet style nozzle is found on most 1980 and later model passenger cars and some light duty trucks. It is screwed directly into the cylinder head and is equipped with a nozzle having an outward opening, spring-loaded poppet valve in contrast with the inward opening valve of a conventional diesel fuel injector.

Since engine compression and combustion pressure forces on an outward opening valve are additive to that exerted by the nozzle spring, opening pressure settings of the poppet nozzle are correspondingly lower than those of conventional injectors. Furthermore, since the nozzle valve guide is not required to seal against injection pressure, this nozzle does not require a back-leakage connection.

During injection, a degree of swirl is imparted to the fuel before it emerges around the head of the valve, which forms a closely controlled annular orifice with the valve seat. The resultant high-velocity atomized spray forms a narrow cone for efficient burning of the fuel.

The assembly consists of a nozzle holder with integral edge filter, a preset nozzle assembly, a capnut and a cylinder head sealing washer (Fig. 5-8).

Fuel at injection pressure flows to the axial inlet on the nozzle holder and passes via the edge filter to the spring chamber. Feed ports in the nozzle body allow fuel to bypass the close-fitting valve guide diameter and reach the valve head via the swirl helices. The valve lifts at the opening pressure determined by spring setting pre-load and continues to move until the stop fitted below the collar abuts the nozzle body. At the end of injection, the valve returns to its seat under spring action, the seating load being augmented by engine combustion pressure.

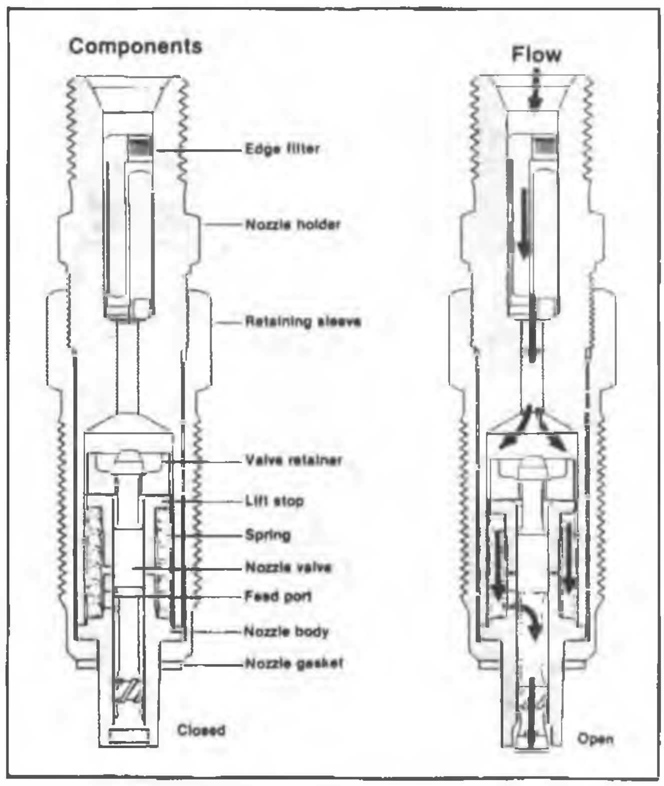


Fig. 5-8 Poppet Nozzle Cut Away

Poppet nozzles used in production come from two sources: Rochester Products Division (of GM) and C.A.V. Lucas. Both are similar in design and construction and are interchangeable. The R.P.D. nozzle compression washer is staked in place and must be destroyed for removal whereas the C.A.V. Lucas compression washer is replaceable. Figure 5-9 shows identification and torque values.

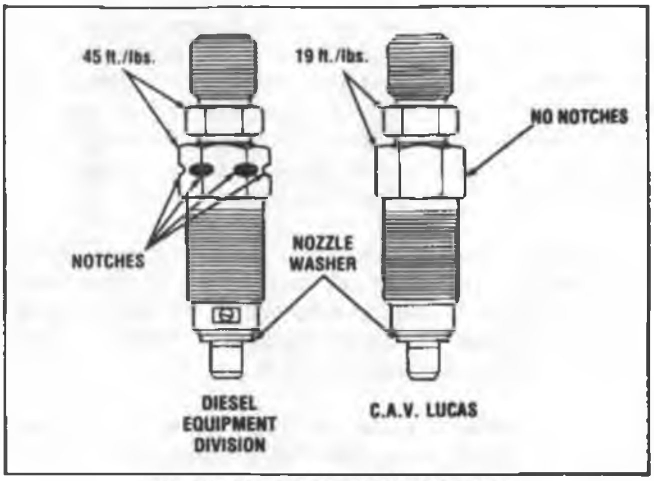


Fig. 5-9 Poppet Nozzle Identification

INJECTION NOZZLE REMOVAL

Removal

When lines are removed use a back-up wrench on the upper injection nozzle hex.

1. Remove nozzle by applying torque to the largest nozzle hex.
   NOTICE: Always cap the nozzle and lines to prevent damage or contamination.
2. Remove copper nozzle gasket from the cylinder head if the gasket did not remain on the nozzle.

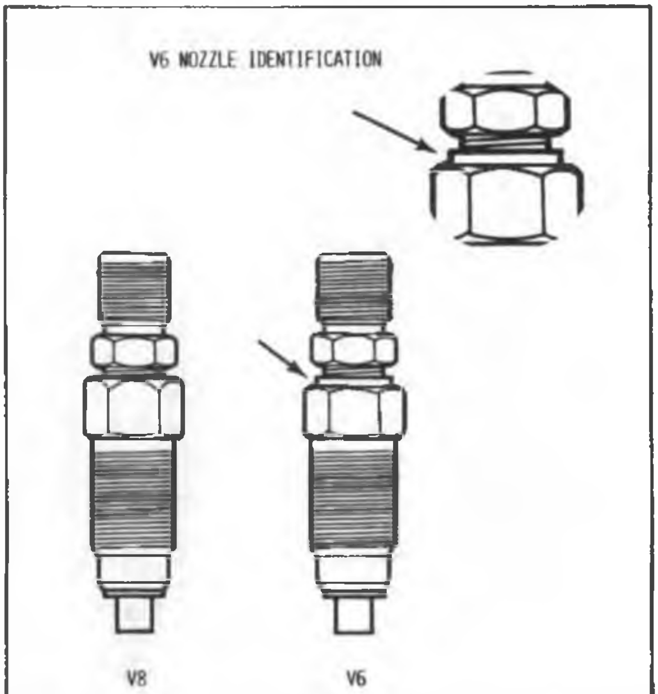


Fig. 5-10 Nozzle Identification

Installation

Refer to Figure 5-10 for the identity of V-6 and V-8 nozzles.

1. Remove protective caps from nozzle (if installed after testing).
2. Make sure copper nozzle gasket is installed on the nozzle.
3. Install the nozzle and torque to specification. Torque must be applied to the largest nozzle hex.
4. Attach the lines using a back-up wrench on the upper injection nozzle hex. Torque the line nut 34 N·m (25 ft. lbs.).

DIESEL INJECTION NOZZLE TESTING

When a malfunction occurs where the injection nozzles are suspected as the cause, they may be tested as follows:

The most important checks on nozzles are seat tightness and opening pressure. When a nozzle passes these tests the spray pattern with the nozzle in the engine is nearly always satisfactory.

1. Check the torque of the inlet fitting to nozzle body.
2. Clean the carbon from the tip of the nozzle with a soft brass wire brush.
3. Assemble nozzle to tester.
   (a.) Use SAE J967D calibrating oil at room temperature, approximately 70°F (20°C).
   CAUTION: Do not use diesel fuel. It is unstable with respect to corrosion inhibition and may cause skin problems.
   (b.) Use a connecting line from the nozzle to the tester 12" long by ¼" O.D. by ¹⁄₁₆" I.D.
   (c.) Refer to the equipment manufacturers instructions for exact test procedures.
4. TEST SPECIFICATIONS
   (a.) OPENING PRESSURE—The pressure control valve should be slightly opened and the handle of the test equipment operated at a slow rate (between three and six seconds for one full stroke) to determine the actual opening pressure of the nozzle. The minimum opening pressure on new nozzles is:

   V-6 6 895 kPa (1000 psi) Nominal
   V-8 8 446 kPa (1225 psi) Nominal

The opening pressure on a used nozzle will be about 1379 kPa (200 psi) less.

Figure 5-10 shows the differences between the V8 and V6 nozzles.

(b.) SPRAY PATTERN
NOTICE: Close the pressure gage for this test or the gage could be damaged.

CAUTION: Test fuel spray is flammable. Keep vapor away from open flames or personal injury could result.

CAUTION: When testing nozzles, do not place your hands or arms near the tip of the nozzle. The high pressure atomized fuel spray from a nozzle has sufficient penetrating power to puncture flesh and destroy tissue and may result in blood poisoning. The nozzle tip should always be enclosed in a receptacle, preferably transparent, to contain the spray. (Rags in the bottom of the container will reduce chances of splash.)

1. Operate the handle of the nozzle tester at a rate of 2 seconds per stroke.
2. Proper freedom of valve movement is characterized by a fine atomized spray pattern.

   (c.) SEAT TIGHTNESS—Slightly open the pressure gage for this test. The line pressure should first be allowed to fall to at least 290 psi (2,000 kPa) BELOW the actual opening pressure (Step 4A). Dry the nozzle tip with compressed air then increase the line pressure to 150 psi (1,034 kPa) BELOW the actual opening pressure (Step 4A). Maintain this pressure for five seconds. After 5 seconds, patterns 1, 2 and 3 are acceptable, patterns 4 and 5 are not acceptable (Fig. 5-11).

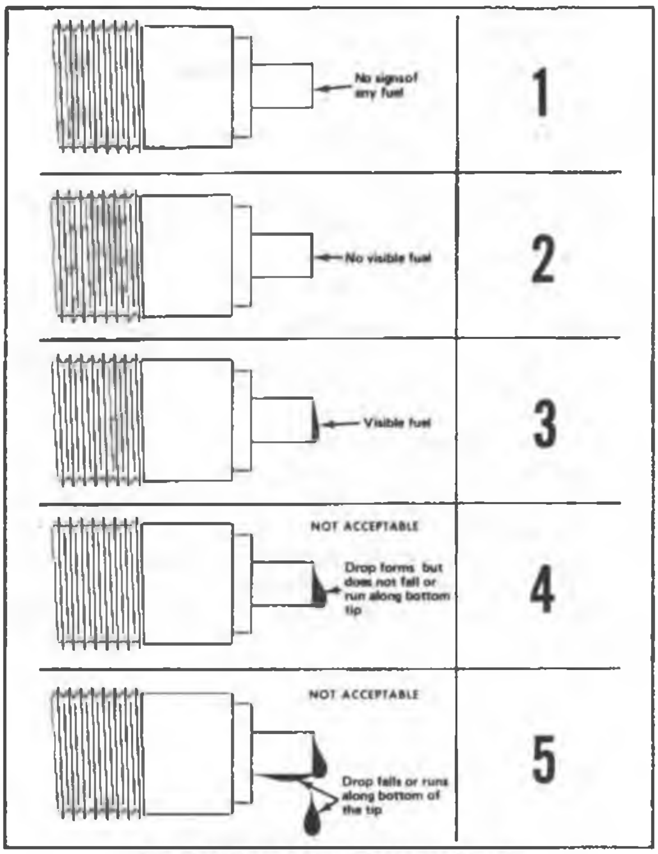


Fig. 5-11 Nozzle Seat Tightness Check

CLEANING POPPET NOZZLES

1. Remove and discard the old copper sealing washer from the tip of the injector using a pair of diagonal cutters as shown in Figure 5-12. Be careful not to damage the nozzle tip when doing this.
2. Flush the exterior of the nozzle, holding the tip up to prevent dirt from entering the inlet. Remove all loose dirt and carbon.
3. Disassemble the injection nozzle as follows:

   NOTICE: The parts of each nozzle assembly are preset and calibrated to meet certain specifications. Therefore, DO NOT mix up the parts of each nozzle.

   (a.) Unscrew the inlet fitting from the body and press the nozzle tip assembly out of the body being careful not to damage nozzle tip. (Fig. 5-13).

   (b.) Remove the retainer by sliding the retainer sideways to release the retainer from the valve.

   (c.) Remove the spring seat and spring and press the valve from the spray tip. (See Fig. 5-13).
4. Clean all of the disassembled pieces of the injection nozzle. Use a sonic bath cleaner or equivalent. If a sonic bath cleaner is used, the parts should remain in the cleaner until they are clean as evidenced by the carbon being removed from the tip of the valve.
5. The components of each injection nozzle are closely matched. DO NOT mix the components of the injection nozzle, keep each nozzle separated. (Fig. 5-14).
6. Visually inspect all of the components for cleanliness and damage. The tip of the valve and the interior of the spray tip must be examined very closely. These areas must be completely free of contamination to be satisfactory.
7. If the components are visually satisfactory, assemble the injector as follows: (Refer to Fig. 5-13).

   (a.) Insert the valve into the spray tip.

   (b.) Install the spring, spring seat and retainer.

   (c.) Using a clean, unpainted piece of steel as a base, compress the spring and lock the retainer by pushing on the retainer and sliding the retainer to a center position after the spring has been compressed. This can be done either by hand or using assembly tool BT-8018 (Fig. 5-15). After assembly, rotate the retainer with respect to the tip, by hand, to assure proper assembly.
8. Install the nozzle tip assembly into the body. Screw the inlet fitting into the body assembly and tighten to 47 N·m (35 ft. lbs.).

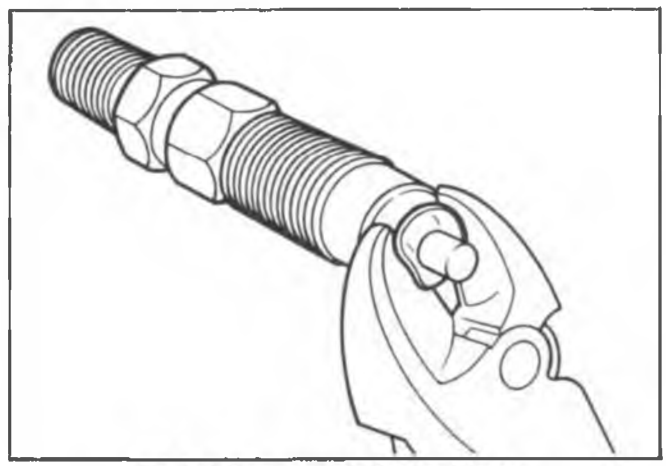


Fig. 5-12 Removing Old Sealing Washer

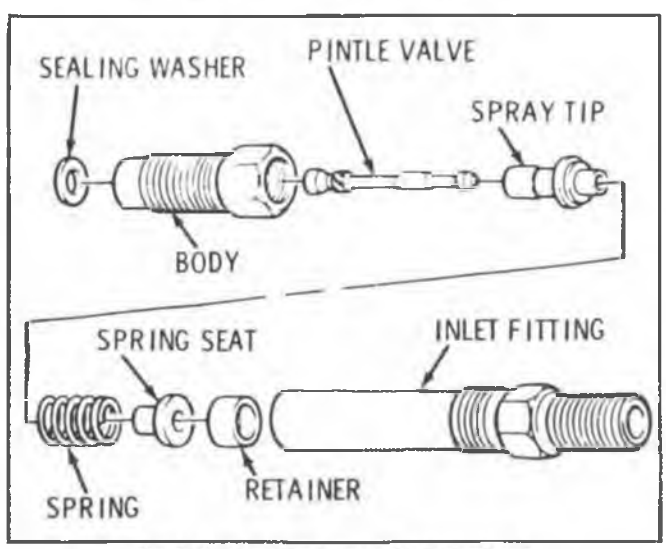


Fig. 5-13 Injection Nozzle Disassembled

9. Test the nozzle as outlined in "Nozzle Testing."
10. Install a new copper washer before assembling into the engine. It may be necessary to crimp the washer slightly to create an interference fit so that it will not fall off.

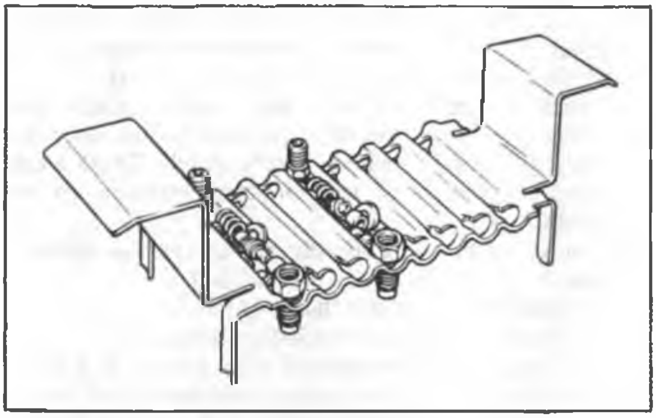


Fig. 5-14 Cleaning Nozzle

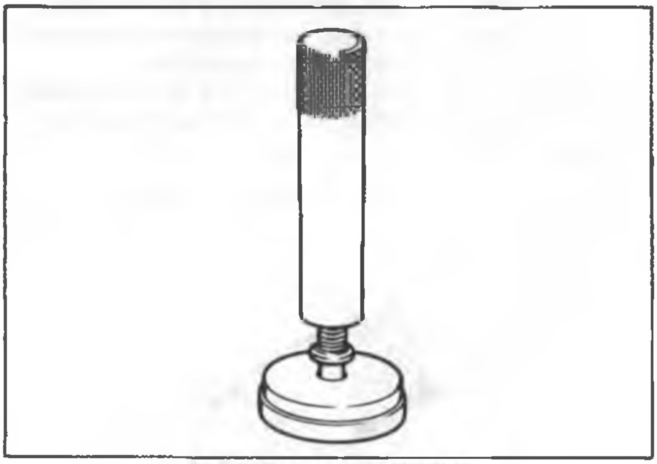


Fig. 5-15 Using Tool BT-8018

DIESEL KIKI NOZZLES: 2.2L and 1.8L

Two Diesel Kiki pintle style nozzles are currently used by the Chevrolet Division. Their primary difference is in the location of the fuel inlet. The C-223 nozzle has a side fuel inlet and is used on the 2.2 liter LUV Truck. The 4-FB-1 Nozzle has the fuel inlet located at the top of the nozzle, and is used on the 1.8 liter Chevette.

Removal

1. Disconnect the negative battery cable.
2. Remove the fresh air duct.
3. Remove the PCV hose.
4. Remove the injector lines at the injection nozzles and loosen at the pump.
5. Remove the fuel return line.
6. Remove the injection nozzle.
7. Immediately cap all lines and discharge ports.

Installation

1. Install the nozzle and torque N·m (51-58 ft. lbs.).
2. Install the fuel return line.
3. Install the injection lines and torque the fittings to 2-3 kgm (15-22 ft. lbs.). DO NOT OVER TORQUE.
4. Install the PCV hose and fresh air duct.
5. Reconnect the negative battery cable.

Disassembly and Cleaning (Figs. 5-16 and 5-17)

1. Prior to disassembly, wash the complete assembly in a clean suitable solution to remove any excess oil and dirt.
2. Clamp the nozzle holder in a vise and remove the cap nut. Caution should be exercised as not to damage the assembly by excessive clamping force.
3. On the C-223 nozzle only, remove the locknut and adjusting screw.
4. Remove the spring, spring seat and pushrod. On the 4-FB-1 nozzle, also remove the shims.
5. Clamp the nozzle holder in a vise with the nozzle in the up position.

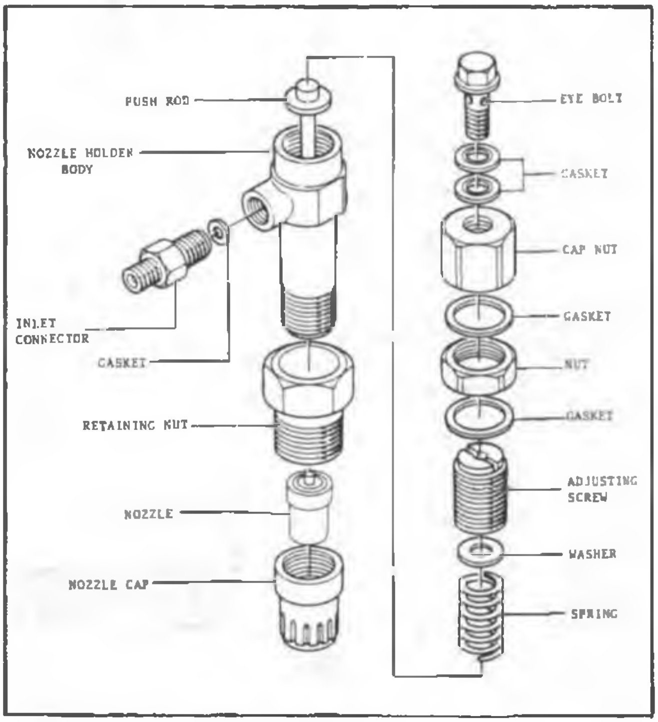


Fig. 5-16 C223 Nozzle

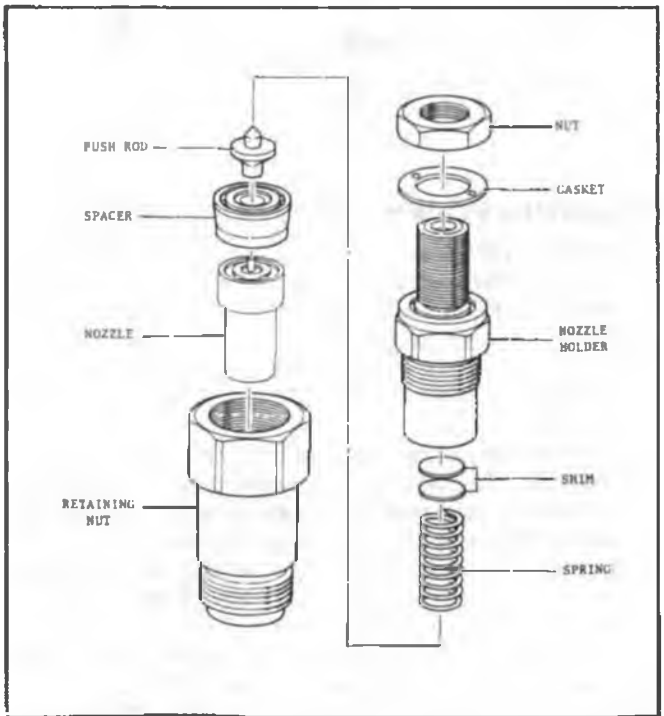


Fig. 5-17 4FB1 Nozzle

6. Remove the nozzle nut with a wrench. Remove the nozzle and needle valve using extreme care not to drop the needle valve.
7. Clean all of the disassembled pieces of the injection nozzle. Use a sonic bath cleaner or the equivalent. If a sonic bath cleaner is used, the parts should remain in the cleaner until they are clean as evidenced by the carbon being removed from the top of the valve.
8. Wash the nozzle and needle valve in test fluid of light oil.
9. The components of each injection nozzle are closely matched. DO NOT mix the components of the injection nozzle. Keep each nozzle separated.

Inspection

1. Visually inspect all parts for wear and erosion.
2. Inspect the valve seats for carbon deposits and damage. Remove carbon deposits with a carbon brush.
3. Inspect the nozzle orifices for wear.
4. Hold the nozzle body vertically and lift the needle valve up about ⅓ of its entire length and release. The needle must slide to its seat by its own weight.
5. If the needle valve does not slide smoothly, reclean the nozzle and repeat the test. If trouble persists, replace the entire nozzle assembly.

Assembly

1. Clamp the nozzle holder in a vise, exercising care to avoid crushing.
2. On the C-223 nozzle, (screw adjustment type) install the nozzle and needle valve as an assembly and torque the nozzle nut to 00 N·m (51 ft. lbs.).
3. On the 4-FB-1 nozzle, (shim adjustment type) install the spring, push rod, nozzle assembly and nozzle cap. Torque the nozzle nut to 00 N·m (51 ft. lbs.).
4. Place the assembled nozzles in a clean protective container to prevent damage during handling.

TESTING

Opening Pressure

1. A reliable tester with an accurate gage is required to perform the following test procedures. Clean test oil must be used as well. Extreme care should be exercised as not to damage the gage with excessive pressure during the test procedure.
2. Connect the test line to the nozzle holder assembly and tighten the fittings.
   NOTICE: Keep hands away from spraying nozzles. The high pressure can penetrate into the flesh and cause blood poisoning.
3. Close the gage-valve and operate the tester handle sharply several times and check for proper nozzle position (direct spray into a clean container).
4. Open gage valve and operate tester handle slowly to determine injection starting pressure. Observe the gage reading just before oil is sprayed from the tip of the nozzle. A buzzing noise will occur when the spray is injected. The minimum opening pressure is 1706 psi (11,760 kPa).
5. On the C-223 nozzle, adjust pressure by turning the adjusting nut in or out to raise or lower pressure, respectively.
6. On the 4-FB-1 nozzle, change the adjusting shims where necessary by removing shims to decrease pressure or adding shims to increase pressure. Shim thickness of 0.05 (0.0020 in.) will change pressure by approximately 85 psi.

Spray Pattern

NOTICE: Close the pressure gage for this test or the gage could be damaged.

CAUTION: Test fuel spray is flammable. Keep vapor away from open flames or personal injury can result.

1. Check spray pattern by operating handle one stroke about every two seconds and observe the spray pattern. The spray should be uniform and injected at the correct angle of the nozzle being tested (Fig. 0-00). Any solid column of fuel or small droplets forming near the tip make the pattern unacceptable.

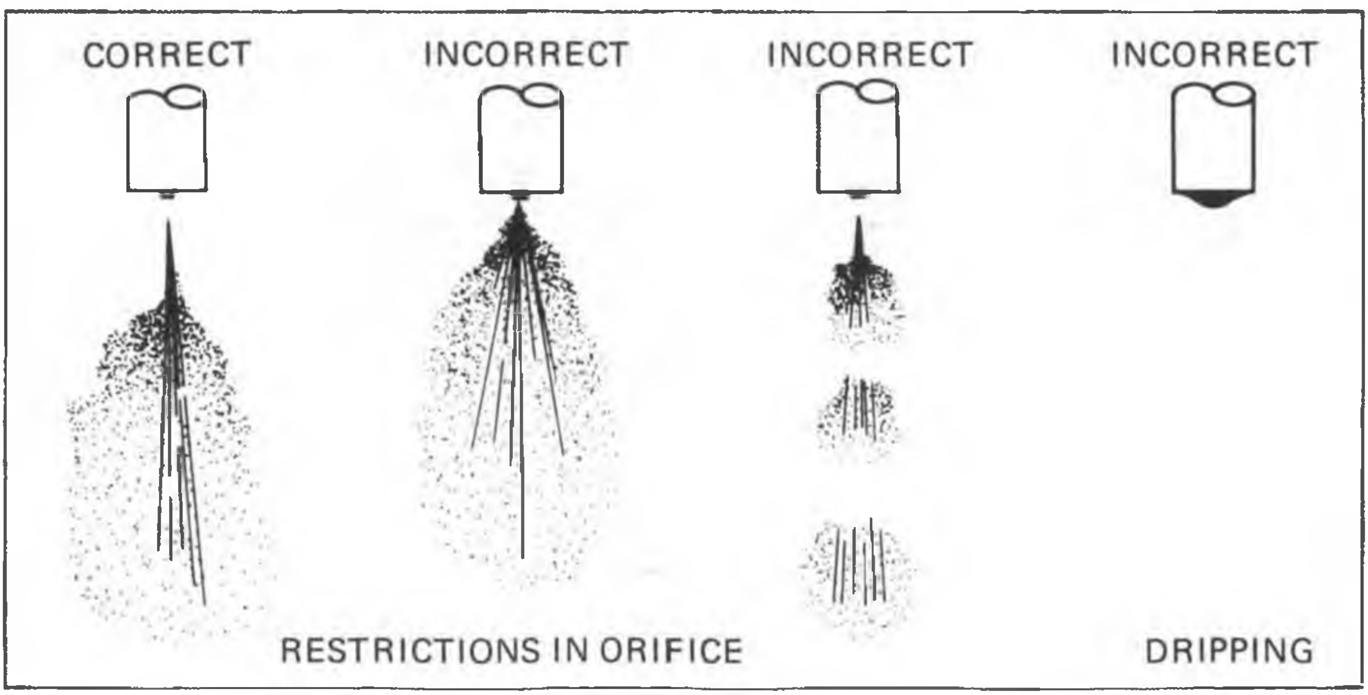


Fig. 5-18 Spray Pattern

Leakage

1. Check for nozzle leakage by applying 142 psi pressure to the nozzle. The nozzle tip should remain dry without an accumulation of fuel at the spray holes. (A slight wetting is allowed after 10 seconds if no droplets are formed.) (Fig. 5-10).

PENCIL STYLE NOZZLES

The pencil type nozzle (Fig. 5-19) is found on all Federal 1978 through 1981 light-duty trucks. It is a closed end (nozzle valve does not project through an opening in the nozzle tip), differential pressure, hydraulically operated, hole-type nozzle. The nozzle body incorporates the inlet fitting, tip and valve guide. An edge filter is located in the inlet fitting, which is designed to be a final screening for debris which may have entered while line was open such as while on workbench. The inward opening valve is spring loaded and controlled by the pressure adjusting screw and lift adjusting screw which are secured by locknuts. These adjustments are very critical and can only be adjusted on a flow meter. No attempts should be made otherwise. A nylon seal beneath the inlet fitting "banjo" prevents leakage of engine compression while a Teflon carbon dam prevents carbon accumulation in the cylinder head bore.

Metered fuel, under pressure from the injection pump, flows through the inlet, the edge filter, and around the valve, filling the nozzle body.

When fuel pressure enters the body of the nozzle and overcomes the spring force of the pressure adjusting spring, the nozzle valve lifts off its seat. As the valve raises to its predetermined lift height, high pressure fuel is allowed to flow through the spray orifices in the tip. When delivery to the nozzle ends and injection pressure drops below the preset nozzle opening pressure, the spring returns the valve to its seat.

Between injections, positive sealing is maintained by the interference angle, which results in line contact between the valve and its seat.

During injection, a small amount of fuel leaks through the clearance between the nozzle valve and its guide, lubricating and cooling all moving parts. The fuel flows through a leak-off boot at the top of the nozzle body and returns to the fuel tank.

The pencil type nozzle is installed into the cylinder head and held in place with a clamp and bolt.

Removal

1. Remove the fuel return line clamps from all nozzles on the bank where a nozzle is to be removed, then remove that fuel return line.
2. Remove nozzle spring clamp and spacer, then remove nozzle using Tool J-29082.
3. Cap the nozzle inlet line and the tip of the nozzle. **NOTE:** Always protect the tip of the nozzle to prevent damage.

Cleaning Inspection and Testing

1. Check torque of the inlet fitting to nozzle body 34 N·m (25 ft. lbs.).
2. Clean the carbon from the tip of the nozzle with a soft brass wire brush.
3. Assemble nozzle to tester (available tool).
   (a.) Use SAE J967D calibrating oil at room temperature, approximately 70°F (20°C).
   CAUTION: Do not use diesel fuel. Diesel fuel is unstable with respect to corrosion inhibition and may cause skin problems.
   (b.) Use a connecting line from the nozzle to the tester 12" long by ¼" O.D. by 1/16" I.D.
   (c.) Refer to the equipment manufacturer's instructions for exact test procedures.
4. Test specifications
   (a.) OPENING PRESSURE—The pressure control valve should be slightly opened and the handle of the test equipment operated at a slow rate (between three and six seconds for one full stroke) to determine the actual opening pressure of the nozzle. Opening pressure—1800 psi plus 100, minus 50.

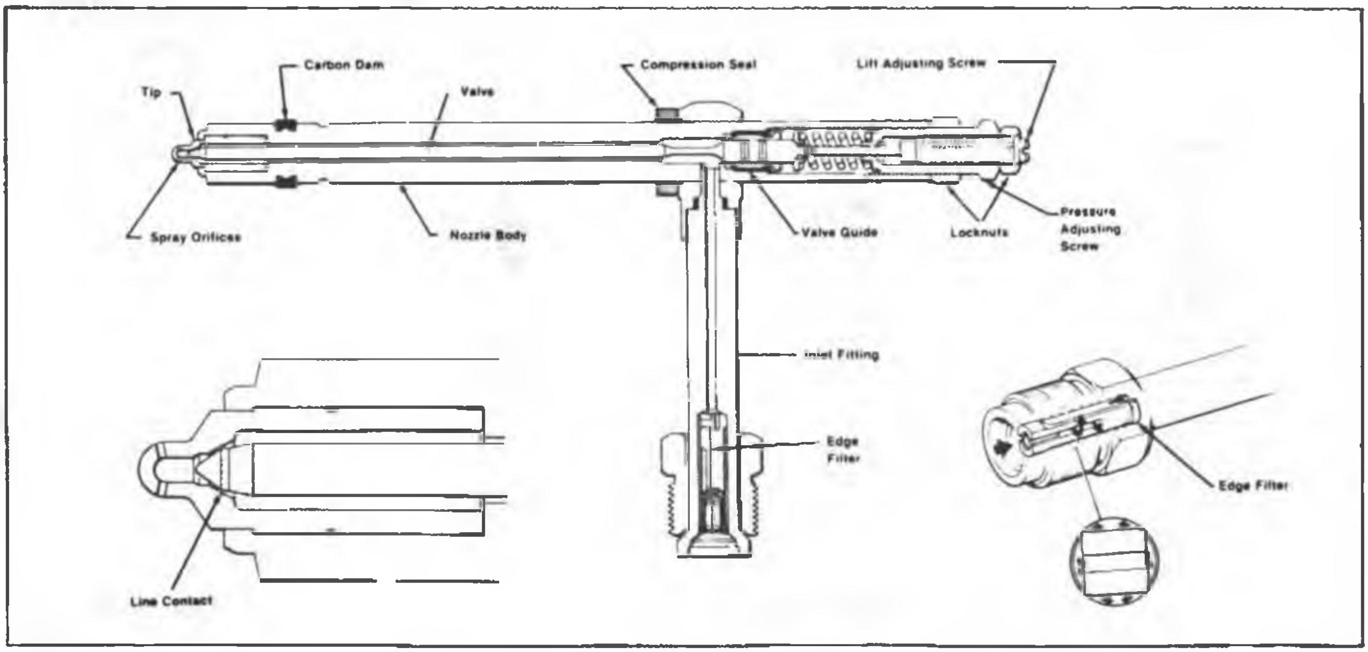


Fig. 5-19 Typical Stanadyne Pencil Type Nozzle

(b.) SPRAY PATTERN

NOTICE: Close the pressure gage for this test or the gage could be damaged.

CAUTION: Test fuel spray is flammable. Keep vapor away from open flames or personal injury could result.

CAUTION: When testing nozzles, do not place your hands or arms near the tip of the nozzle. The high pressure atomized fuel spray from a nozzle has sufficient penetrating power to puncture flesh and destroy tissue and may result in blood poisoning. The nozzle tip should always be enclosed in a receptacle, preferably transparent, to contain the spray. (Rags in the bottom of the container will reduce chances of splash).

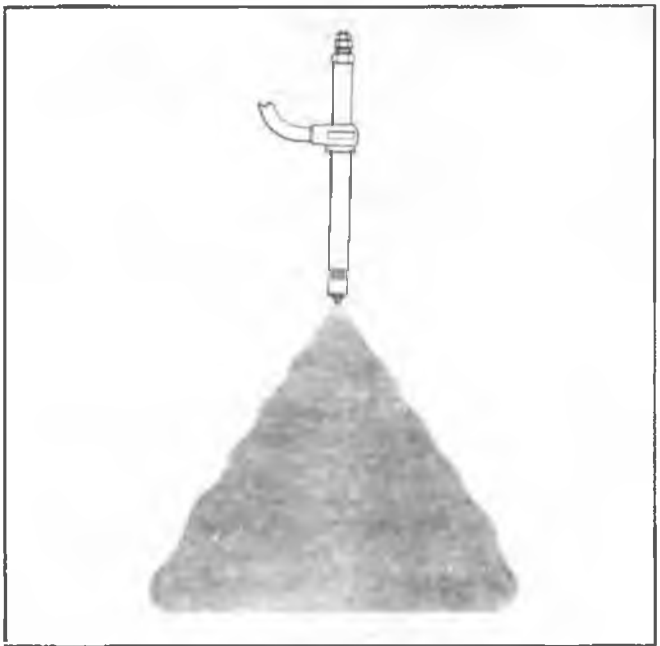


Fig. 5-20 Pencil Nozzle Spray Test

Spray pattern—operate tester at 30 strokes per minute and observe spray pattern. Nozzle should have a finely atomized cloud-like pattern as shown in Figure 1. The pattern should not be streaky with tester fluid.

(c.) SEAT TIGHTNESS—While holding pressure at 1300-1400 psi, a drop of tester fluid should not form on the tip within 10 seconds. Slight dampness is permissible with a used nozzle.

(d.) CHATTER TEST—With tester valve closed, the nozzle should chatter when the tester is operated. Chatter is rapid opening and closing of the nozzle valve while fluid is being pumped through the nozzle. This checks the nozzle under extreme load conditions. It is an audible buzzing sound and may also be felt in the handle of the tester. It is an indication of valve freedom and proper seat width and interference angle.

(e.) RETURN FUEL—Loosen connector nuts and reposition nozzle tip slightly above horizontal plane as shown in Figure 2. Retighten connector nuts and raise pressure to 1500 psi. Nozzle should not open. Observe fluid from nozzle return. After the first drop forms on the return fuel end of the nozzle, there should be 3 to 10 more drops in 30 seconds while maintaining 1500 psi.

If the nozzle fails any of these tests, it should be sent to a Stanadyne service agency for repair.

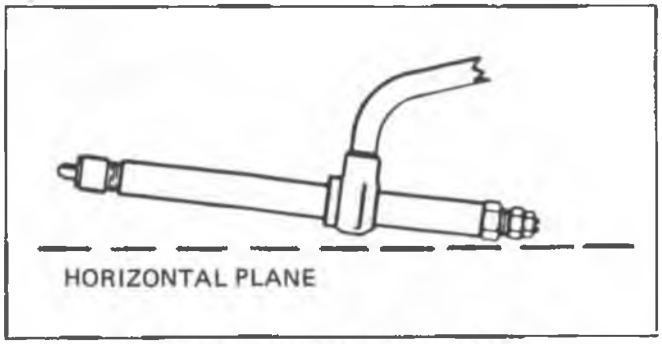


Fig. 5-21 Injection Nozzle Horizontal Plane

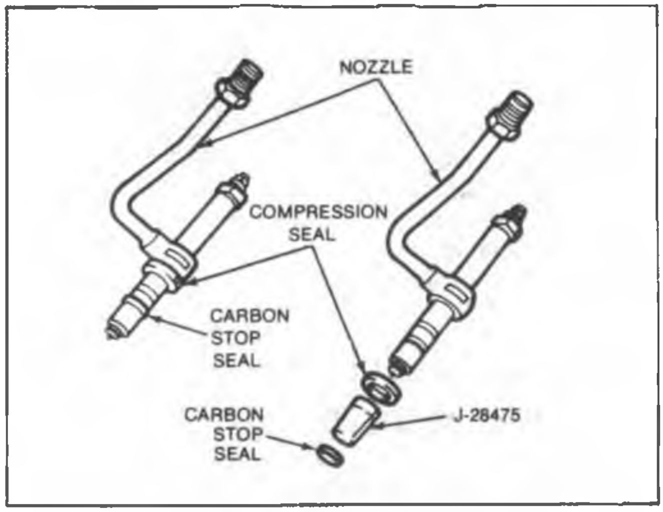


Fig. 5-22 Installation of Nozzle Seals

Installation

1. If a nozzle is to be reinstalled after removal, a new compression seal and carbon stop seal must be installed after removal of the used seals. See figure 5-19 for seal installation.
2. Remove protective caps then install injection nozzle and spring clamp and spacer. Torque bolt to 25 ft. lbs. (34 N·m) (Fig. 5-23).
3. Install fuel return line.
4. Start engine and check for leaks.

   NOTICE: Servicing of pencil-style nozzles must be done by an authorized Stanadyne Service Facility. Dealership service departments are not equipped to service these components.

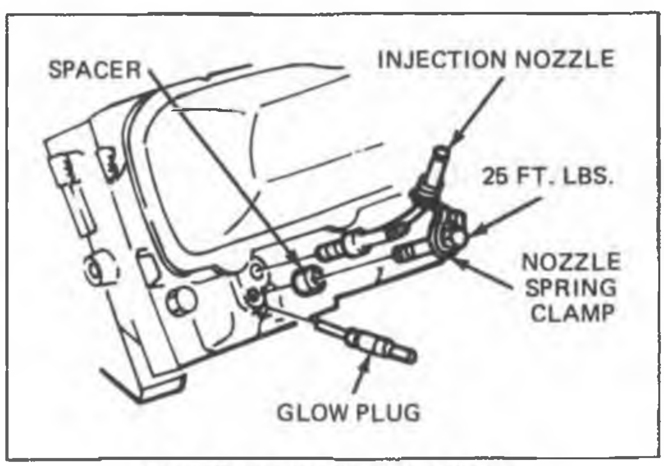


Fig. 5-23 Injection Nozzle Installation

SECTION 6
GLOW PLUG SYSTEMS

GENERAL

Glow plugs are included in Chevrolet Diesel engines as an aid in starting cold engines. There is one glow plug per cylinder. Glow plugs are electrically energized and draw directly from the batteries. When the ignition is turned on, the glow plugs immediately begin to heat up until they reach a pre-determined temperature. Although the purpose of the glow plug system is the same throughout all Chevrolet diesel engines, their individual systems are different depending on the model car in which they are used.

There are essentially two glow plug systems with minor variations found on the V-6 and V-8 diesel engines for Chevrolet. One is the electronic module system, the other is the thermal controller system (Fig. 6-1 and 6-2). The body style and engine combination are the determining factors for what system is used. Refer to the chart (Fig. 6-3) for the type of system used in the vehicle being worked on. The 2.2 and 1.8 Liter four cylinder engines use a common glow plug system which is not entered on the chart.

ELECTRONIC MODULE SYSTEM

ELECTRONIC MODULE

The module is located to the right of the steering column below the instrument panel. It monitors the glow plug voltage and engine temperature to control the glow plugs and wait light. The module also contains circuits to monitor the system for failures and hold the wait lamp on to indicate a problem in the system.

THERMISTOR (1978 System)

The thermister is a temperature sensitive resistor which is mounted in an intake manifold coolant passage. It sends a signal to the electronic module based on coolant temperature.

CONTROL SENSOR (Fast Glow System)

The control sensor is located in the front right intake manifold coolant passage. It senses engine coolant temperature to control glow plug feedback voltage to the electronic module.

GLOW PLUG RELAY

The glow plug relay is located on the right inner fender panel and is pulsed on and off by the electronic module to control current to the glow plugs. This pulsing maintains glow plug temperature and prevents overheating.

FAST IDLE RELAY

The fast idle relay is located on the cowl and when energized, provides voltage to energize the fast idle solenoid. When not energized, voltage may also pass through contact points in the fast idle relay to the fast idle solenoid anytime the A/C compressor is engaged.

ENGINE TEMPERATURE SWITCH

The engine temperature switch is located on the left rear head bolt. At engine temperatures below 95°F (39°C), this switch closes to energize the fast idle relay which then energizes the fast idle solenoid. When the engine temperature switch closes, it also energizes the housing pressure cold advance solenoid which is in the injection pump. When the engine temperature reaches about 125°F (52°C) the engine temperature switch opens, de-energizing both solenoids.

GLOW PLUGS

This system uses six-volt glow plugs. They are threaded directly into the cylinder head just below the injectors. The pulsed voltage from the glow plug relay prevents overheating of the glow plugs.

GLOW PLUG WAIT LAMP

This lamp illuminates when the glow plugs are energized and goes off when the pre-determined temperature is reached. There is no start light in this system. The lamp is located in the instrument panel.

CIRCUIT OPERATION (Fig. 6-5)

Most diesel engines have two batteries which provide extra starting power. They are directly connected to the GENERATOR BAT terminal for charging. Power distribution is made through the STARTER ASSEMBLY.

Voltage is applied at all times from right hand battery through the RED wire to the GLOW PLUG RELAY. With the IGNITION SWITCH in "Run", the following takes place:

1. Current flows through the IGNITION SWITCH, and the FUEL SOLENOID (to ground). This operates the solenoid which turns on the fuel flow. Current also flows through the FUEL LINE HEATER.
2. Current flows through the GAGES FUSE and "CHARGE" INDICATOR to pin K of the DIESEL ELECTRONICS MODULE. The "Charge" Indicator goes out when the module senses 12 volts at pin N through the Brown wire from GENERATOR terminal I.
3. Current flows through the GAGES FUSE, the "WAIT" LAMP and pin A of the module. The module provides ground for the "WAIT" LAMP and the bulb goes on.

For V-6 engines, voltage is applied through the DSL/ECM FUSE to pin G of the module and to the FUEL PUMP, the FAST IDLE RELAY, and the ENGINE TEMPERATURE SWITCH. With the ENGINE TEMPERATURE SWITCH CLOSED (below 125°F or 52°C), current flows through the switch and the coil of the FAST IDLE RELAY to ground. At the same time, current also flows through the ENGINE TEMPERATURE SWITCH and the COLD ADVANCE SOLENOID to ground.

The module provides voltage through pins F and J to the GLOW PLUG RELAY coil.

The relay is pulsed on and off by the electronic module to control current to the glow plugs. This pulsing maintains glow plug temperatures without overheating. Full BATTERY power flows through the

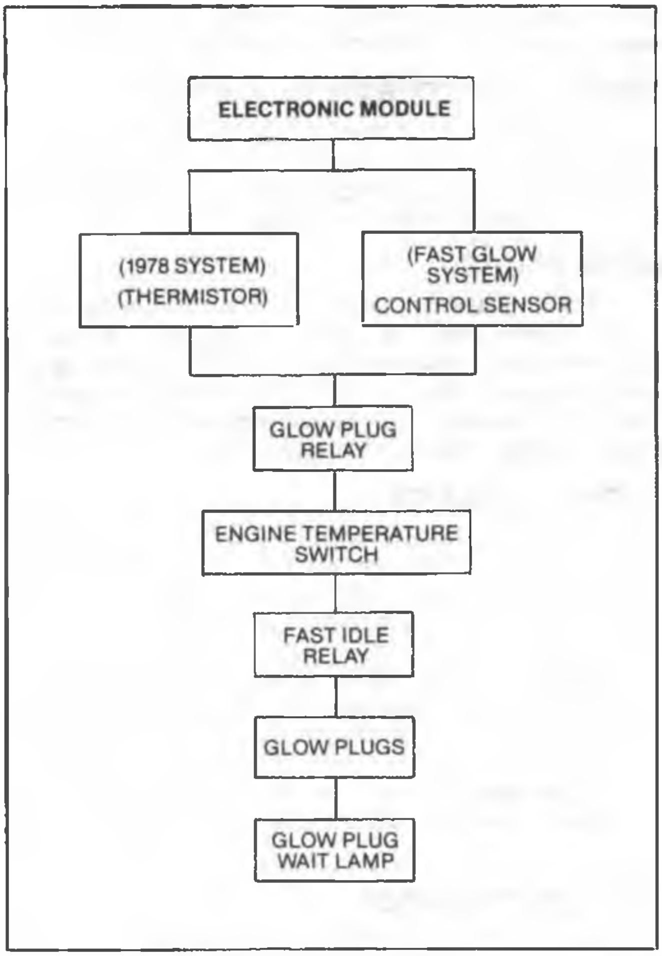


Fig 6-1 Electronic Module System

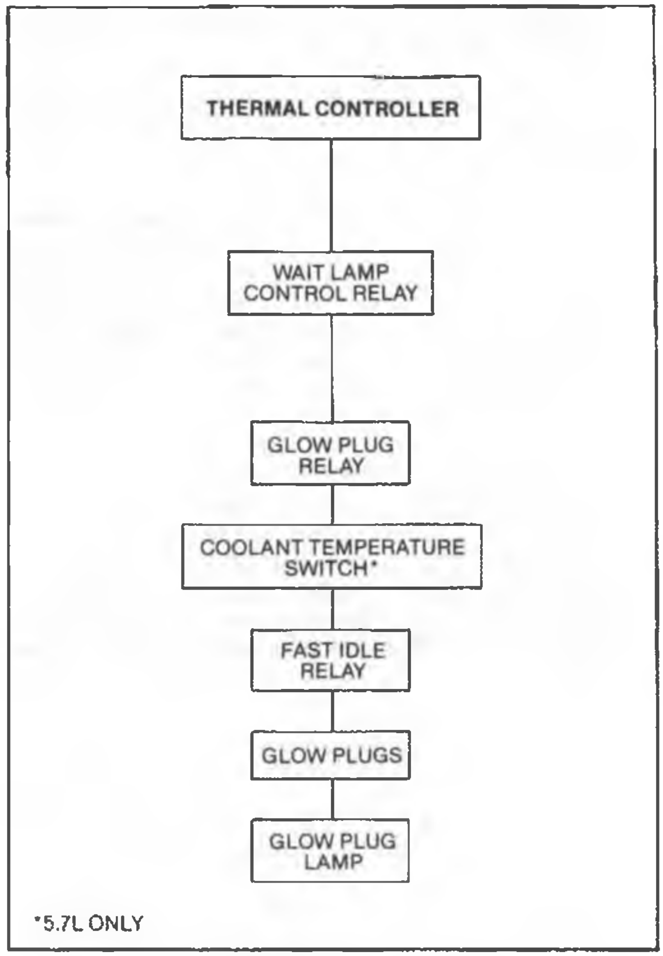


Fig. 6-2 Thermal Controller System

VEHICLE SERIES	1978	1979	1980	1981	1982	1983
A CAR	N/A	N/A	2	2	N/A	3
B CAR	N/A	N/A	3	3	3	3
G CAR	N/A	N/A	N/A	N/A	2	2
C TRUCK	1	1	2	2	4	4
K TRUCK	N/A	N/A	N/A	N/A	4	4

1 ELECTRONIC MODULE; 1978 SYSTEM
2 ELECTRONIC MODULE: FAST GLOW
3 THERMAL CONTROLLER
4 THERMAL CONTROLLER: 6.2L
N/A DIESEL ENGINE NOT AVAILABLE

Fig. 6-3 Glow Plug System Identification

RED wire, GLOW PLUG RELAY switch, and both the left and right SIDE GLOW PLUGS.

Current also flows through the ORN and ORN/BLK wires, CONTROL SENSOR terminals B and D, the resistors, thermistors and to G181.

The CONTROL SENSOR senses engine coolant temperature and current through the glow plugs to control feedback voltage to the module. The module receives these feedback signals from the sensor and controls the glow plugs and "WAIT" LAMP. The module also contains circuits to monitor the system for failures, and keeps the "WAIT" LAMP on to indicate a problem in the system.

With the IGNITION SWITCH in "Run", the WAIT LAMP and glow plugs will come on. The WAIT LAMP will remain on until the glow plugs reach temperature the first time (about 7 seconds at 0°F (−18°C) and then the bulb will go out indicating the eingine is ready to start. There is no start indicator used with this system. The glow plugs will continue to pulse on and off after the engine is started for about 25 seconds to provide after-glow.

> **NOTICE:** If the IGNITION SWITCH is turned to "Run" and the engine is not started, the glow plugs will continue to pulse on and off until the BATTERIES run down (about 4 hours).

The WAIT LAMP will stay on if the system has a problem, to warn the driver to have the system checked. In most cases the engine can still be started but the glow plug control system should be repaired.

To increase engine idle speed during cold engine operation (below 125°F or 52°C in V-8 engines the ENGINE TEMPERATURE SWITCH directs current to the FAST IDLE SOLENOID. In V-6 engines the ENGINE TEMPERATURE SWITCH directs current through the solenoid of the FAST IDLE RELAY, which activates the relay switch to close the circuit to the FAST IDLE SOLENOID. For both engines the ENGINE TEMPERATURE SWITCH opens when the engine temperature reaches about 125°F (52°C). This reduces the engine idle speed to the normal idle setting.

THERMAL CONTROLLER SYSTEM

THERMAL CONTROLLER

The thermal controller is an electro-mechanical device that controls the glow plug temperature. It is located in the front water passage of the intake manifold. It senses engine coolant temperature and glow plug voltage to the control system.

WAIT LAMP CONTROL RELAY

The wait lamp control relay is mounted to the cowl. It is controlled by the Thermal Controller and turns off the wait lamp in the instrument panel when the glow plugs are hot enough to start the engine.

GLOW PLUG RELAY

The glow plug relay is mounted to inner right fender panel and is pulsed on and off by the thermal controller. It controls the current flow to the glow plugs and prevents the glow plugs from being burned out or overheated.

COOLANT TEMPERATURE SWITCH

The coolant temperature switch is mounted on the upper left hand side of the engine. When the engine coolant reaches a predetermined temperature, the switch senses this and cuts the current to the glow plugs.

GLOW PLUGS

The glow plugs used in this system are threaded directly into the cylinder head, just below the injectors. These are 6 volt glow plugs, and are referred to as Fast or Quick glow plugs. They cannot be used in the 1978 System since they will burn out immediately. The pulsed voltage from the relay prevents the glow plugs from overheating.

GLOW PLUG LAMP

The glow plug lamp is mounted in the instrument panel. The lamp is controlled by the thermal controller. When the controller senses that the glow plugs are hot enough, the lamp will go out and the engine can be started.

> **NOTICE:** The 1978, 5.7 liter engine was equipped with a "12 volt" glow plug system. When servicing a 1978 model car or light truck, do not replace the 1978 glow plugs with the fast or quick glow plugs. These are not interchangeable! Replacing them with the new 6 volt plugs will cause immediate glow plug burn out.

CIRCUIT OPERATION

When the ignition switch is turned to the "run" position, the "Wait" and "Charge" lights will come on. Voltage is applied to the Glow Plug Relay coil through the Thermal Controller. The contacts on the Glow Plug Relay close, applying power to the left hand and right hand Glow Plugs and to the pulser in the controller. The Glow Plugs heat up and so does the controller pulser coil.

After a period of time, the pulser switch in the controller opens. The time varies from about six seconds with engine temperature below freezing to one second or less on a warm engine.

When the pulser switch opens, power is removed from the Glow Plug Relay coil. The relay contacts open and disconnect power from the Glow Plugs and the pulser coil. With the pulser switch open, the coil of the Wait Lamp Control Relay will no longer have battery voltage on both sides. With a voltage drop across the coil, current flows through the coil and the relay will then operate. (The contacts will open, removing ground from the Wait Lamp, which will then go out.) The Glow Plugs are then warm enough and the engine can be started. The Wait Lamp Control Relay coil then has a new ground path through the closed contact which keeps the relay locked in the energized state (light off) through the circuit breaker in the Thermal Controller.

If the engine is not started right away, the pulser switch closes again, reapplying voltage to the Glow Plug Relay coil. Voltage will then be reapplied to the Glow Plugs and the pulser in the Thermal Controller. After a short time (one half to two seconds), the pulser switch reopens, removing power from the Glow Plug Relay coil. The pulser will continue pulsing power to the Glow Plugs.

> **NOTICE:** If the Ignition Switch is turned to the "Run" position and the engine is not started, the Glow Plugs will continue to pulse on and off until the batteries are run down (approximately four hours).

When the engine is started, voltage from the generator is applied through Diode "A" to the "Charge" light in the instrument panel. This balances the voltage on the fuse side of the indicator and the light then goes out.

After the Wait Lamp goes out, it is still necessary to keep the Glow Plugs hot. The combustion chambers may not be hot enough to keep the engine running smoothly. This Glow Plug "on" pulsing period is called "afterglow". The afterglow period is about one minute or less. Voltage is also applied through Diode "B" to the time limiter coil in the Thermal Controller. When the controller time limiter switch opens, the Glow Plug pulsing stops and the afterglow ends.

If the pulser circuit should fail closed, the pulser switch would not pulse the Glow Plug Relay on and off. If the Glow Plugs stay on too long (eight seconds or more), then the circuit breaker in the controller opens and removes voltage from the Glow Plug Relay and the Glow Plugs.

2.2 AND 1.8 LITER ENGINES

These in-line four cylinder engines use the same type of glow plug system containing an electronic module, two glow plug relays, dropping resistor, thermo switch, glow plugs, sensing resistor and a glow plug wait lamp (Fig. 6-4).

ELECTRONIC MODULE

The electronic module is mounted under the instrument panel. It performs four functions: controls the rapid pre-heat circuit, controls glow plug preheat indicator lamp, monitors the difference between the sensing resistance and glow plug resistance as a means of determining glow plug heating requirements, and controls the glow plug relays according to changes in engine coolant temperatures.

GLOW PLUG RELAYS (2)

The glow plug relays are mounted to the inner left fender wall in the engine compartment. The first relay is used to pre-heat the glow plugs prior to starting the engine. The second relay controls the "after-glow" process which allows the glow plugs to heat at a lower temperature as needed while the engine is operating.

> **NOTICE:** The Glow Plug Relays and the Dropping Resistor are covered with a heat shield for protection from the elements.

DROPPING RESISTOR

The dropping resistor is mounted below the two glow plug relays on the left inner fender panel. When the engine is started, the voltage to the glow plugs will be reduced via the dropping resistor and the second glow plug relay to reduce glow plug temperature for the after-glow cycle.

THERMO SWITCH

The thermo switch is located in the front right water passage of the engine. It senses coolant temperature and relays information back to the electronic module.

GLOW PLUGS

There are four glow plugs threaded into the top of the cylinder head, above the injectors. These are 6-volt, quick glow plugs and receive current from the glow plug relays.

SENSING RESISTOR

The sensing resistor is a feedback device for the electronic module. It senses glow plug temperature in terms of resistance and feeds the information back to the electronic module. The sensing resistor is mounted on the engine.

GLOW PLUG WAIT LAMP

The glow plug wait lamp is mounted in the instrument panel and receives its signal from the electronic module based on input from the sensing resistor on the engine.

CIRCUIT OPERATION (2.2L and 1.8L Engines)

The preheat (glow plug) system is a mechanism by which a strong current flows to the glow plugs shortening the preheat time required for engine start. A quick heating period is employed as well as an afterglow period. Continuous battery voltage such as the key left on and the engine not started, will drain the battery. Glow time will vary from 0 to 6 seconds, depending on ambient temperature. To protect the system, a controller automatically reduces the voltage to the plugs after a high of 1650 degrees is reached.

The system consists of a sensing resistor, thermoswitch and glow plugs which are mounted on the engine, relay #1, relay #2 and dropping resistor which are mounted in the engine compartment, and the electronic controller which is mounted under the instrument panel and glow indicator which is mounted in the instrument cluster.

Two functions are employed when engine is cold: quick heating and stabilized heating.

Quick heating: By turning the starting switch to "ON" position, glow indicator lamp comes on simultaneously activating relay #1. Electric current flows from the battery to the glow plug via relay #1 and sensing resistor, making the glow plug heat up. Glow indicator lamp goes out after approximately 3.5 seconds.

Stabilized heating: Immediately after the glow indicator lamp goes out, turn starting switch to "START" position. The engine starts. In this instance, glow indicator lamp again comes on, making relay #2 function allowing glow plug temperature to continue at a reduced rate. The sensing resistor senses glow plug temperature as it increases to a specified point and sends information to the controller which turns relay #2 "OFF."

The glow system's logic flow is shown in the chart in Figure 6-4.

When engine coolant temperature is over 122° the glow indicator lamp remains on for 0.3 seconds or thereabout. Heat mode is stabilized. The engine is ready to start.

Never jump start the electrical system with more than 12 volts.

The diagnostic connector is used on the Chevette.

COMPONENT CONTINUITY CHECKS

THERMAL CONTROLLER (6.2L Engine)

With the connector removed from the controller, the controller heater circuits may be checked using a high-impedance multimeter. However, this check will not determine shorted switches within the controller.

Pin 3 to Pin 2 = .40 to .75 ohms

Pin 4 to Pin 5 = 27 ohms (± 3 ohms)

Pin 5 to Pin 1 = 130 ohms (± 10%)

Pin 2 to Pin 6 = Continuity (0 ohms)

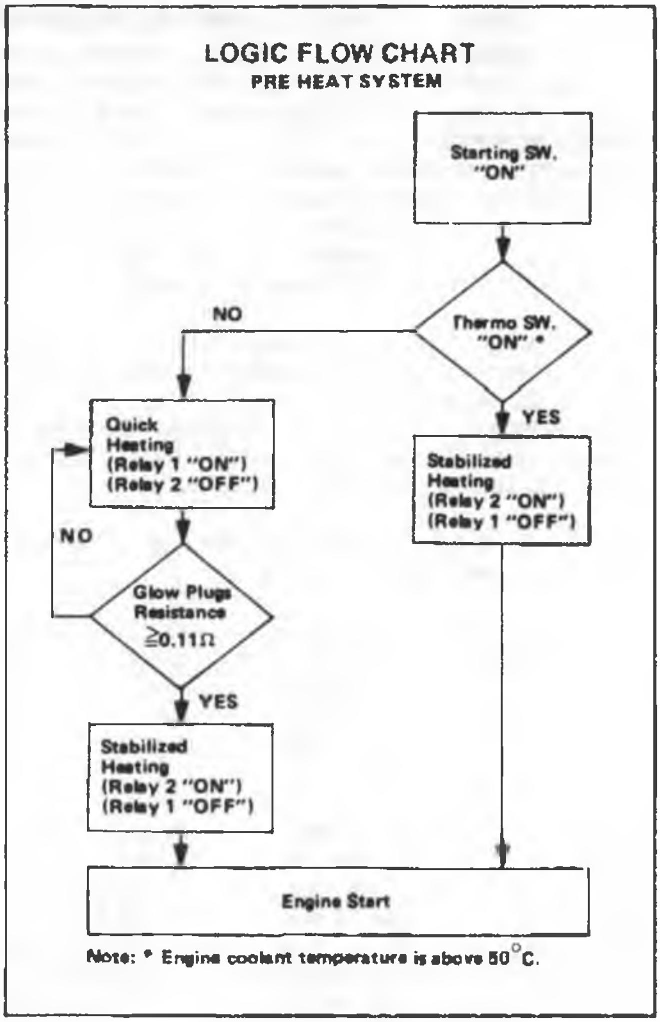


Fig. 6-4 Operational Flow Chart

GLOW PLUGS

Check for continuity across the plug terminals and body. If no continuity exists, the heater wire is broken and the glow plug must be replaced.

GLOW PLUG RELAY (6.2L, 5.7L and 4.3L Engines)

Using a high impedance multimeter, check for continuity across the terminals of the relay. With the ignition "OFF," no continuity should be indicated. With the ignition "ON," continuity should be indicated. A resistance check of the relay coil should indicate 30-40 ohms.

GLOW PLUG RELAYS (2.2L and 1.8L Engines)

With the glow plug relays disconnected, use a circuit tester to make a continuity check across Terminals C and D with battery voltage applied to terminals A and B. Continuity should be indicated. Replace the relays if no continuity is indicated.

DROPPING RESISTOR (2.2L and 1.8L Engines)

Check for continuity across terminals A and B of the dropping resistor. If no continuity is indicated, replace the resistor.

THERMO SWITCH (2.2L and 1.8L Engines)

Submerge the end of the thermo switch in water and raise the temperature of the water gradually. Check for continuity across the terminal and the body of the switch. If no continuity exists, replace the switch.

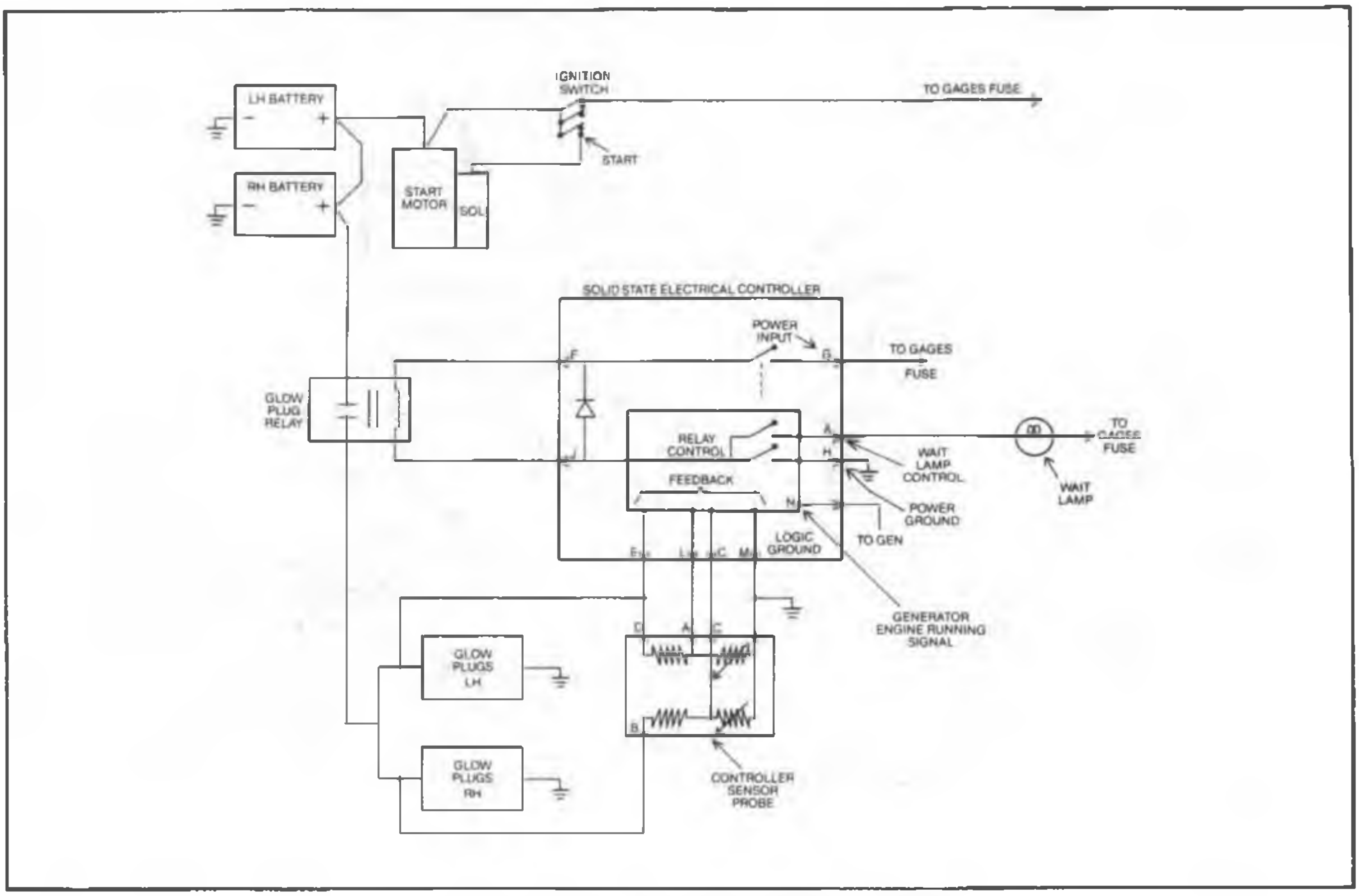


Fig. 6-5 Simplified Wiring Diagram: Electronic Module

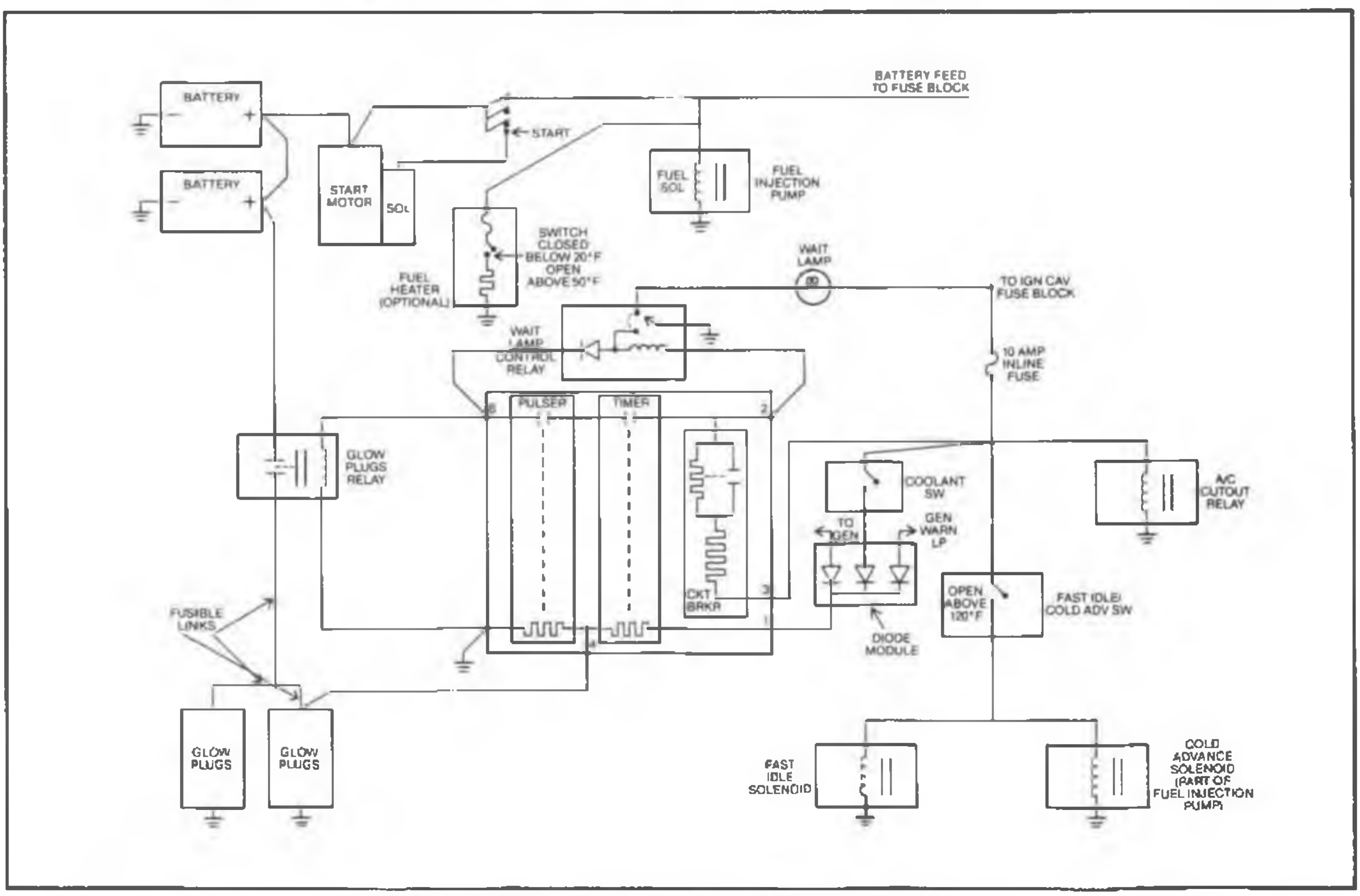


Fig. 6-6 Simplified Wiring Diagram: Thermal Controller System, 5.7L

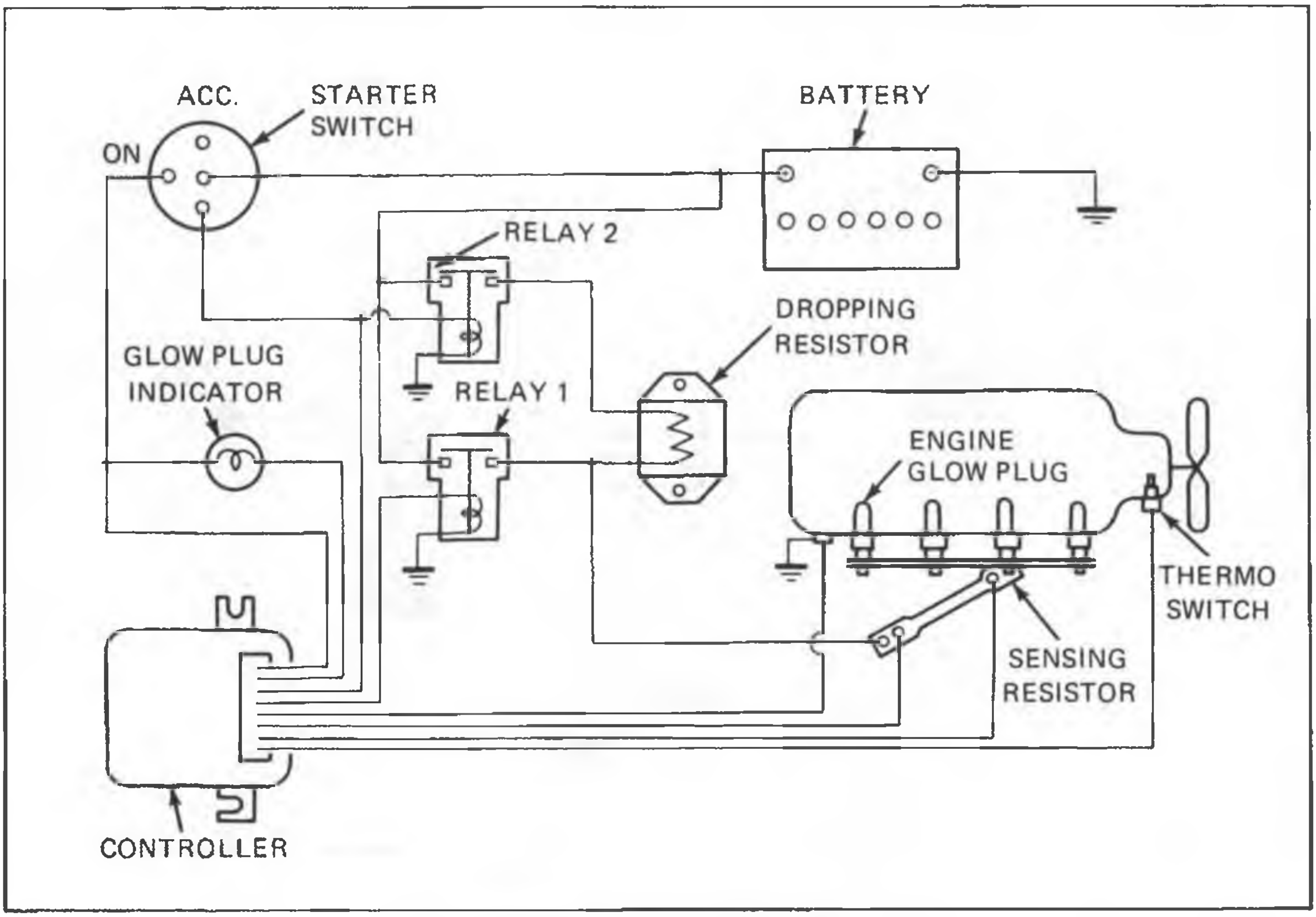


Fig. 6-7 Electrical Circuit Diagram 1.8 and 2.2 Liter Engines

SECTION 7
DIESEL ENGINE DIAGNOSIS

Diesel Engine Mechanical Diagnosis, such as noisy lifters, rod bearings, main bearings, valves, rings and pistons is the same as for a gasoline engine. This diagnosis covers only those conditions that are different for the diesel engine.

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Will Not Crank	1. Loose or Corroded Battery Cables	Check connections at batteries, engine block and starter solenoid.
	2. Discharged Batteries	Check generator output and generator belt adjustment.
	3. Starter Inoperative	Check voltage to starter and starter solenoid. If OK, remove starter for repair.
Engine Cranks Slowly – Will Not Start (Minimum Engine Cranking Speed – 100 RPM COLD, 240 RPM HOT)	1. Battery Cable Connections Loose or Corroded	Check connections at batteries, engine block and starter.
	2. Batteries Undercharged	Check charging system.
	3. Wrong Engine Oil	Drain and refill with oil of recommended viscosity.
Engine Cranks Normally – Will Not Start	1. Incorrect Starting Procedure	Use recommended starting procedure.
	2. Glow Plugs Inoperative	Refer to Simplified Wiring Diagram. For additional information refer to Service Manual.
	3. Glow Plug Control System Inoperative	Refer to Simplified Wiring Diagram. For additional information refer to Service Manual.
	4. No Fuel Into Cylinders	Remove any one glow plug. Depress the throttle part way and crank the engine for 5 seconds. If no fuel vapors come out of the glow plug hole, go to step 5. If fuel vapors are noticed remove the remainder of the glow plugs and see if fuel vapors come out of each hole when the engine is cranked. Crank the engine and check to see that fuel vapors are coming out of all glow plug holes. If fuel is coming from each cylinder, go to step 11.
	5. No Fuel To Injection Pump	Loosen the line coming out of the filter. Crank the engine, the fuel should spray out of the fitting, use care to direct fuel away from sources of ignition. If fuel sprays from the fitting go to step 10.
	6. Restricted Fuel Filter	Loosen the line going to the filter, if fuel sprays from the fitting, the filter is plugged and should be replaced. Use care to direct the fuel away from sources of ignition.
	7. Fuel Pump Inoperative	Remove inlet hose to fuel pump. Connect a hose to the pump from a separate container that contains fuel. Loosen the line going to the filter. If fuel does not spray from the fitting, replace the pump. Use care to direct the fuel away from source of ignition.
	8. Restricted Fuel Tank Filter	Remove fuel tank and check filter. (Filter for diesel fuel is blue.)

Condition	Possible Cause	Correction
	9. Plugged Fuel Return System	Disconnect fuel return line at injection pump and route hose to a metal container. Connect a hose to the injection pump connection, route it to the metal container. Crank the engine. If it starts and runs, correct restriction in fuel return lines. If it does not start, remove the ball check connector from the top of the injection pump and make sure that it is not plugged.
	10. No Voltage To Fuel Solenoid	Connect a volt meter to the wire at the injection pump solenoid and ground. The voltage should be a minimum of 9 volts. If there is inadequate voltage, refer to the ELECTRICAL DIAGNOSIS in the Service Manual for more information.
Engine Cranks Normally – Will Not Start (Contd)	11. Incorrect or Contaminated Fuel	Flush fuel system and install correct fuel.
	12. Pump Timing Incorrect	Make certain that timing mark on injection pump is aligned with mark on front cover or adapter flange. Use timing meter J-33075 if available or applicable.
	13. Low Compression	Check compression to determine cause.
	14. Injection Pump Malfunction	Remove injection pump for repair.
Engine Starts But Will Not Continue To Run At Idle	1. Slow Idle Incorrectly Adjusted	Adjust idle screw to specification.
	2. Fast Idle Solenoid Inoperative	With engine cold, start engine; solenoid should move to hold injection pump lever in "fast idle position". If solenoid does not move, refer to ELECTRICAL DIAGNOSIS in the Service Manual.
	3. Restricted Fuel Return System	Disconnect fuel return line at injection pump and route hose to a metal container. Connect a hose to the injection pump connection; route it to the metal container. Crank the engine and allow it to idle. If engine idles normally, correct restriction in fuel return line. If engine does not idle normally, remove the return line check valve fitting from the top of the pump and make sure it is not plugged.
	4. Glow Plugs Turn Off Too Soon	Refer to Simplified Wiring Diagram. For additional information see Service Manual.
	5. Pump Timing Incorrect	Make certain that timing mark on injection pump is aligned with mark on front cover or adapter flange. Use timing meter J-33075 if available or applicable.
	6. Limited Fuel To Injection Pump	Test the engine fuel pump, check for plugged filters; check fuel lines. Replace or repair as necessary.
	7. Incorrect or Contaminated Fuel	Flush fuel system and install correct fuel.
	8. Low Compression	Check compression to determine cause.
	9. Fuel Solenoid Closes In Run Position	Ignition switch out of adjustment. If OK, refer to ELECTRICAL DIAGNOSIS in Service Manual.
	10. Injection Pump Malfunction	Remove injection pump for repair.
Engine Starts, Idles Rough, WITHOUT Abnormal Noise or Smoke	1. Slow Idle Incorrectly Adjusted	Adjust slow idle screw to specification.
	2. Injection Line Leaks	Wipe off injection lines and connections. Run engine and check for leaks. Correct leaks.

	3. Restricted Fuel Return System	Disconnect fuel return line at injection pump and route hose to a metal container. Connect a hose to the injection pump connection; route it to the metal container. Start the engine and allow it to idle; if engine idles normally, correct restriction in fuel return lines. If engine does not idle normally, remove the return line check valve fitting from the top of the pump and make sure it is not plugged.
	4. Air In System	Install a section of clear plastic tubing on the fuel return fitting from the engine. Evidence of bubbles in fuel when cranking or running indicates the presence of an air leak in the suction fuel line. Locate and correct.
	5. Incorrect or Contaminated Fuel	Flush fuel system and install correct fuel.
	6. Nozzle(s) Malfunction	Remove and replace.
Engine Cold Starts and Idles Rough WITH Excessive Noise and/or Smoke But Clears Up After Warmup	1. Injection Pump Timing Incorrect	Make certain that timing mark on injection pump is aligned with mark on front cover or adapter flange. Use timing meter J-33075 if available or applicable.
	2. Insufficient Engine Break-in Time	Break-in engine 2000 or more miles.
	3. Air in System	Install a section of clear plastic tubing on the fuel return fitting from the engine. Evidence of bubbles in fuel when cranking or running indicates the presence of an air leak in the suction fuel line. Locate and correct.
	4. Nozzle(S) Malfunction	Remove and replace.
Engine Misfires Above Idle But Idles Correctly	1. Plugged Fuel Filters	Replace filters.
	2. Incorrect Injection Pump Timing	Make certain that timing mark on injection pump is aligned with mark on front cover or adapter flange. Use timing meter J-33075 if available or applicable.
	3. Incorrect or Contaminated Fuel	Flush fuel system and install correct fuel.
Engine Will Not Return To Idle	1. External Linkage Binding Or Misadjusted	Free up linkage. Adjust or replace as required.
	2. Fast Idle Malfunction	Check fast idle adjustment.
	3. Internal Injection Pump Malfunction	Remove injection pump for repair.
Fuel Leaks On Ground – No Engine Malfunction	1. Loose or Broken Fuel Line or Connection	Examine complete fuel system, including tank, and injection lines. Determine source and cause of leak and repair.
	2. Injection Pump Internal Seal Leak	Remove injection pump for repair.
Noticeable Loss Of Power	1. Restricted Air Intake	Check air cleaner element.
	2. EGR Malfunction	Refer to Service Manual Emissions Controls.
	3. Restricted or Damaged Exhaust System	Check system and replace as necessary.
	4. Plugged Fuel Filter	Replace filter.

	5. Plugged Fuel Tank Vacuum Vent In Fuel Cap	Remove fuel cap. If loud "hissing" noise is heard, vacuum vent in fuel cap is plugged. Replace cap. (Slight hissing sound is normal).
	6. Restricted Fuel Supply From Fuel Tank To Injection Pump	Examine fuel supply system to determine cause of restriction. Repair as required.
	7. Restricted Fuel Tank Filter	Remove fuel tank and check filter. (Filter for diesel fuel is blue).
	8. Pinched or Otherwise Restricted Return System	Examine system for restriction and correct as required.
	9. Incorrect or Contaminated Fuel	Flush fuel system and install correct fuel.
	10. External Compression Leaks	Check for compression leaks at all nozzles and glow plugs, using "Leak-Tec" or equivalent. If leak is found, tighten nozzle or glow plug.
	11. Plugged Nozzle(s)	Remove nozzles. Have them checked for plugging and repair or replace.
	12. Low Compression	Check compression to determine cause.
Noise – "Rap" From One or More Cylinders (Sounds Like Rod Bearing Knock)	1. Nozzle(s) Sticking Open or with very low Nozzle Opening Pressure	Remove nozzle for test and replace as necessary.
	2. Mechanical Problem	Refer to Service Manual.
Excessive Black Smoke and/or Objectionable Overall Combustion Noise	1. Timing Not Set To Specification	Make certain that timing mark on injection pump is aligned with mark on front cover or adapter flange. Use timing meter J-33075 if available or applicable.
	2. EGR Malfunction	Refer to Emission Diagnosis in Service Manual.
	3. Injection Pump Internal Problem	Remove injection pump for repair.
Engine Noise – Internal Or External	1. Engine Fuel Pump, Generator, Water Pump, Valve Train, Vacuum Pump, Bearings, Etc.	Repair or replace as necessary. If noise is internal, see Diagnosis For Noise – Rap From One or More Cylinders and Engine Starts and Idles Rough With Excessive Noise and/or Smoke.
Engine Overheats	1. Coolant System Leak, Oil Cooler System Leak or Coolant Recovery System Not Operating	Check for leaks and correct as required. Check coolant recovery jar, hose and radiator cap.
	2. Belt Slipping or Damaged	Replace or adjust as required.
	3. Thermostat Stuck Closed	Check and replace if required.
	4. Head Gasket Leaking	Check and repair as required.
Oil Warning Lamp "ON" at Idle	1. Oil Cooler or Oil or Cooler Line Restricted	Remove restriction in cooler or cooler line.
	2. Oil Pump Pressure Low	
Engine Will Not Shut Off With Key NOTE With engine at idle, pinch the fuel return line at the flexible hose to shut off engine.	1. Injection Pump Fuel Solenoid Does Not Return Fuel Valve To "OFF" Position	Refer to ELECTRICAL DIAGNOSIS in Service Manual.

DIAGNOSIS

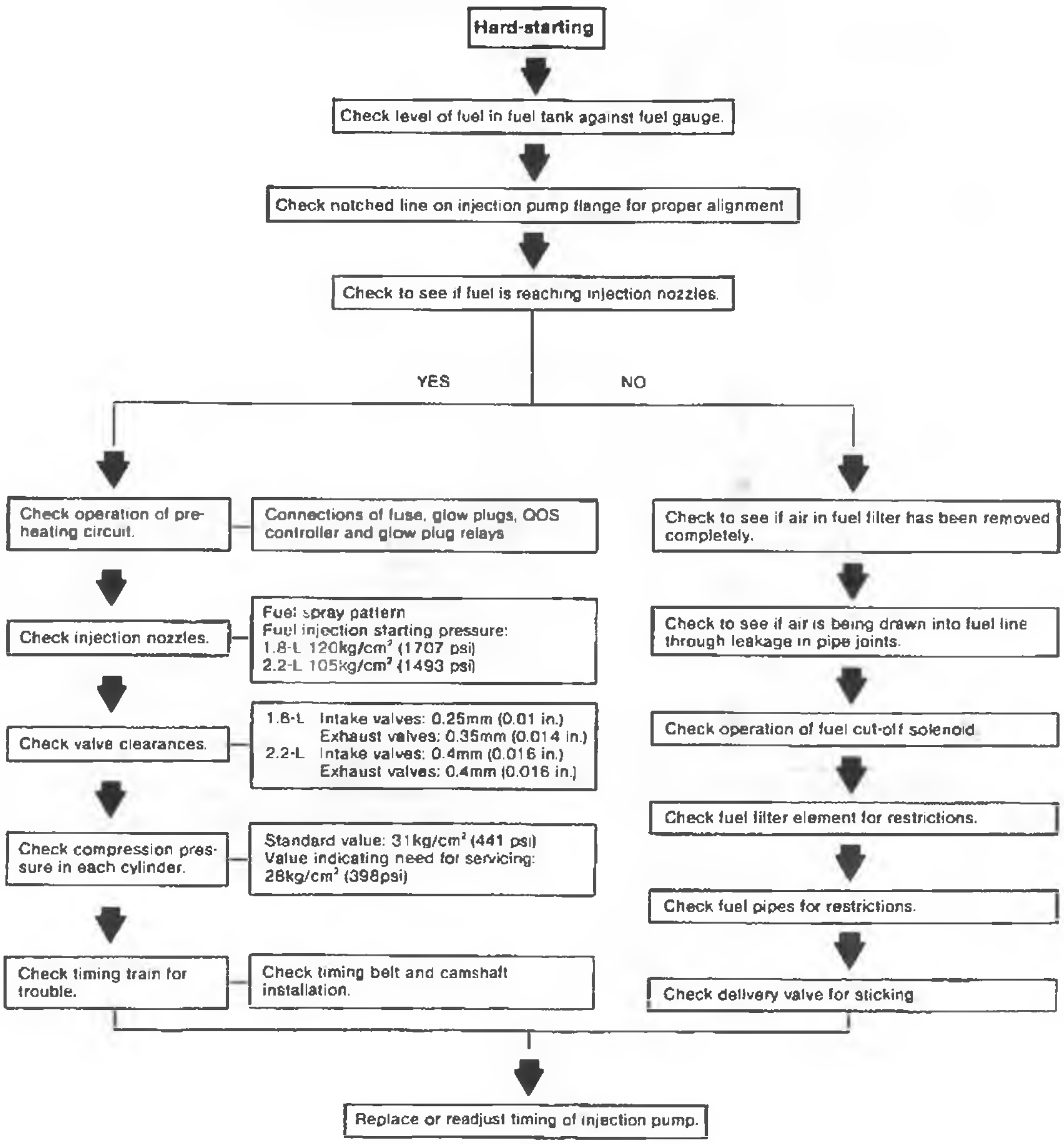
2.2L and 1.8L Engines

Hard Starting

Difficulty will not be experienced in starting a diesel engine provided sufficient power is supplied for cranking, compression pressure is sufficiently high, the preheating system is operating normally and an appropriate volume of fuel is supplied.

To check the cause of hard starting, loosen the fuel line at the nozzle and see if fuel is being supplied. If fuel is being supplied, measure the compression pressure to determine the condition of the valves and piston rings.

If the engine starts but stalls suddenly and cannot be restarted, check for air in the fuel system. Engine startability is affected by environmental conditions.



Rough Engine Idle

Rough engine idling is indicated by engine surging and sudden engine stalling at quick engine deceleration. It may be caused by the idling speed being set too low, rough plunger operation or an overtightened delivery valve holder.

If the engine operates normally at medium and high speeds, check the engine idling speed. If the engine stalls upon quick deceleration, the idling speed may have been set too low.

Rough engine idle

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Check to see if idle speed is lower than specified range.
- 1.8-L Models with MT: 625rpm
- 1.8-L Models with AT: 725rpm
- 2.2-L Models with MT: 700-800 rpm

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On models with air conditioning, check operation of fast idle device.

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Check accelerator control cable for binding or twisting.

↓

Check setting of accelerator lever for looseness.

↓

Check to see if air or water in fuel filter has been removed completely.

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Check notched line on injection pump flange for proper alignment.

↓

Check engine mounting for loosening or cracks.

↓

Check injection nozzles.
- Fuel spray pattern
- Fuel injection starting pressure:
  - 1.8-L 120kg/cm² (1707 psi)
  - 2.2-L 105kg/cm² (1493 psi)

↓

Check valve clearances.
- 1.8-L Intake valves: 0.25mm (0.01 in.)
  - Exhaust valves: 0.35mm (0.014 in.)
- 2.2-L Intake valves: 0.4mm (0.016 in.)
  - Exhaust valves: 0.4mm (0.016 in.)

↓

Check variance in compression pressure in cylinders.
- 1.8-L Standard value: 31kg/cm (441 psi)
  - Value indicating need for servicing: 26kg/cm² (370 psi)
- 2.2-L Standard value: 31kg/cm (441 psi)
  - Value indicating need for servicing: 28kg/cm² (398 psi)
  - Variance in compression pressure between cylinders should be within 1.5kg/cm² (21 psi)

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Check timing train for faults. — Belt and camshaft installation

↓

Check delivery valve for sticking.

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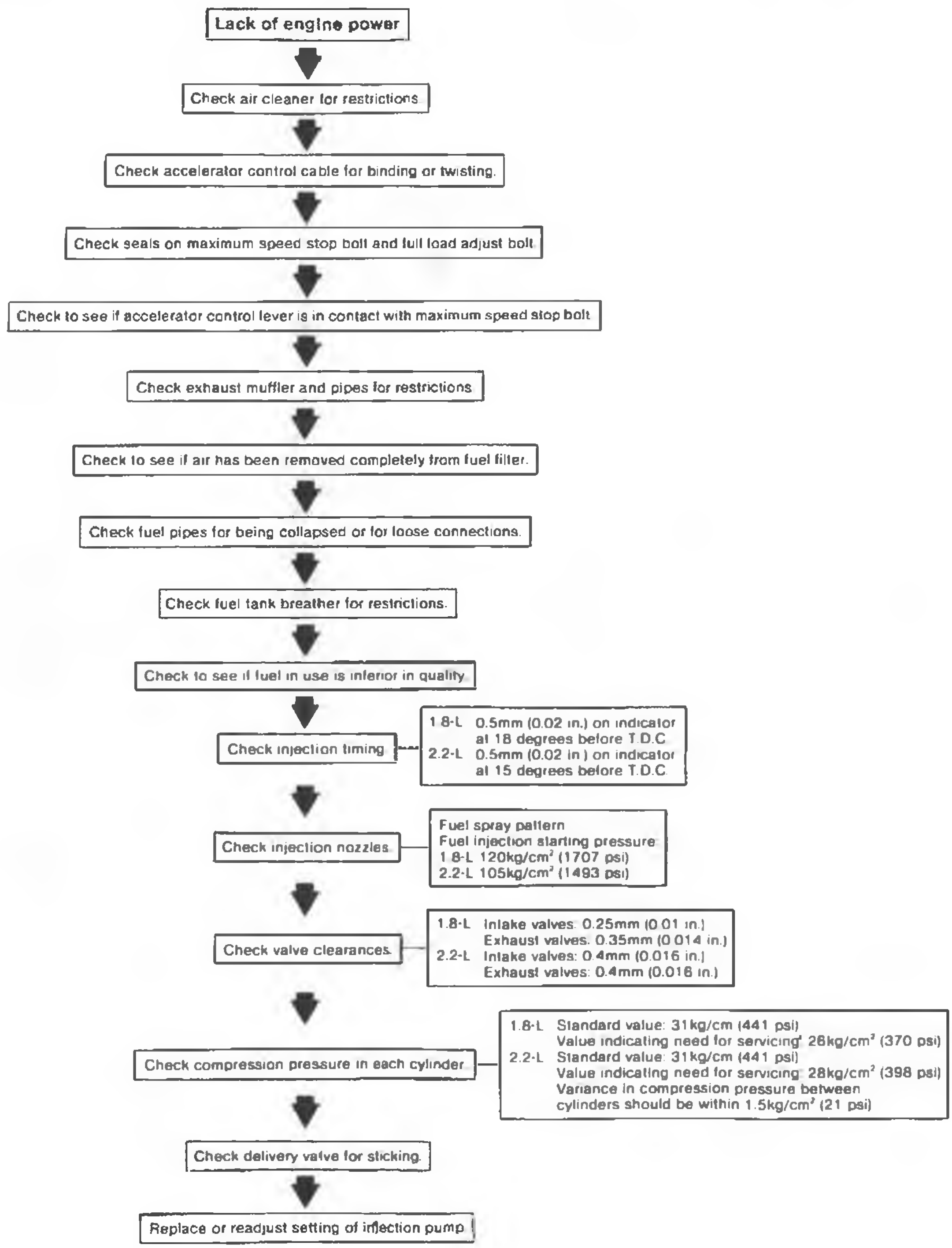
Replace or readjust setting of injection pump.

Engine Lacks Power

A lack of engine power may be caused by an insufficient volume of fuel or intake air, or low engine compression.

If the trouble is caused by an insufficient volume of fuel, check the fuel filter element (in the water separator) for restrictions and the fuel system for the presence of air. If the volume of intake air is insufficient, check the air cleaner element for restrictions and the exhaust pipe(s) for clogging.



Engine Noisy

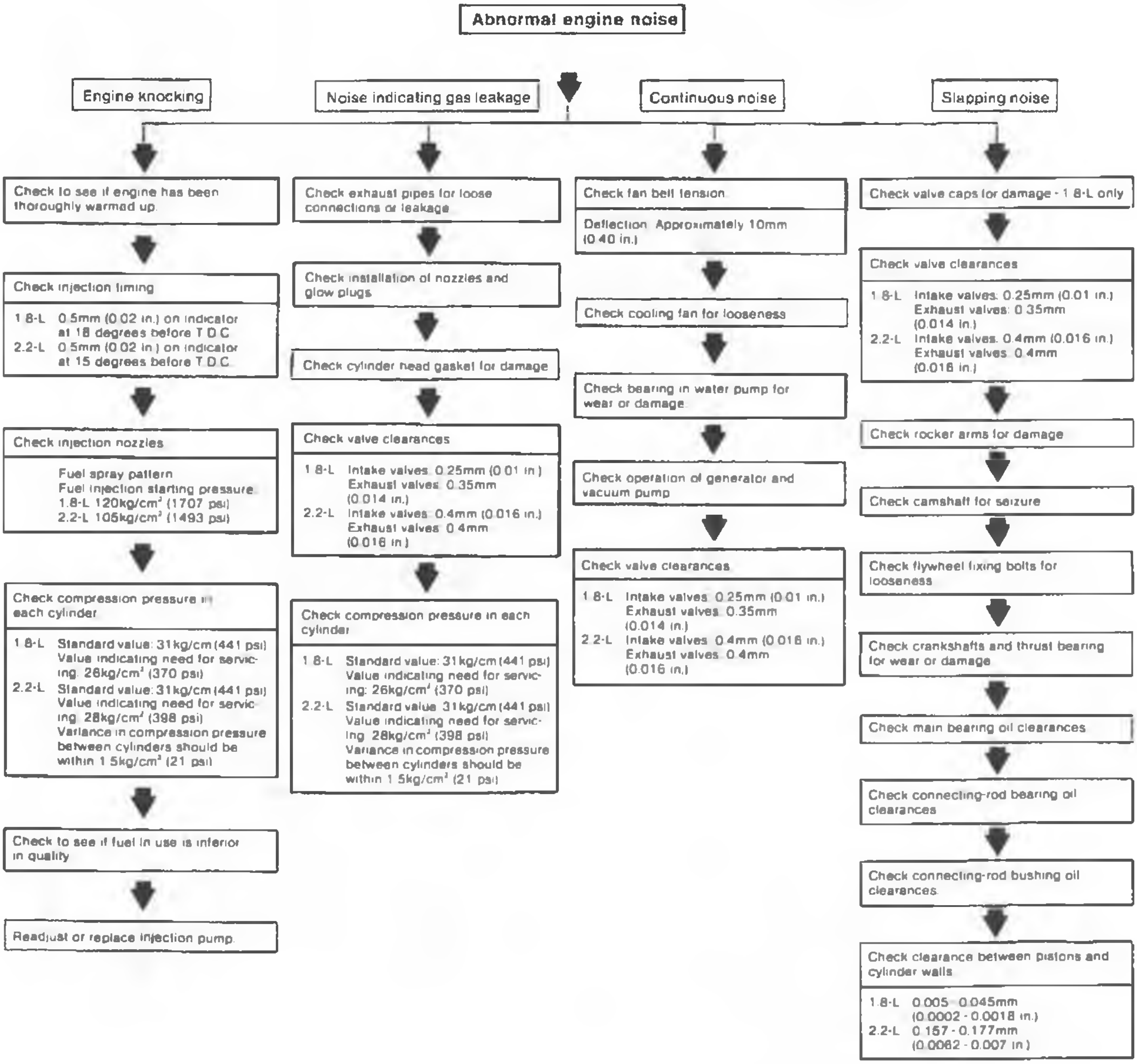
An engine is considered noisy when it emits an abnormal sound, such as a knock or piston slap.

The engine may produce a slight knocking immediately after starting which normally diminishes as the engine temperature increases.

Engine knocking is a result of rapid fuel combustion caused by a delay in the injection timing and is usually due to excessively advanced fuel injection timing or poor fuel spray conditions.

If the engine produces a continuous noise, first eliminate the other possible sources of noise, such as the generator or water pump, by removing the appropriate drive belt.

If the engine produces a slapping noise, such as caused by piston slap, damaged piston pins or connecting rod bearings, the noise can be checked by interrupting the fuel flow to each cylinder until the noise stops. The fuel flow can be interrupted by loosening the injector line at the injector. Cover the loosened line at the injector with a rag to prevent uncontrolled fuel spray.



Engine Overheating

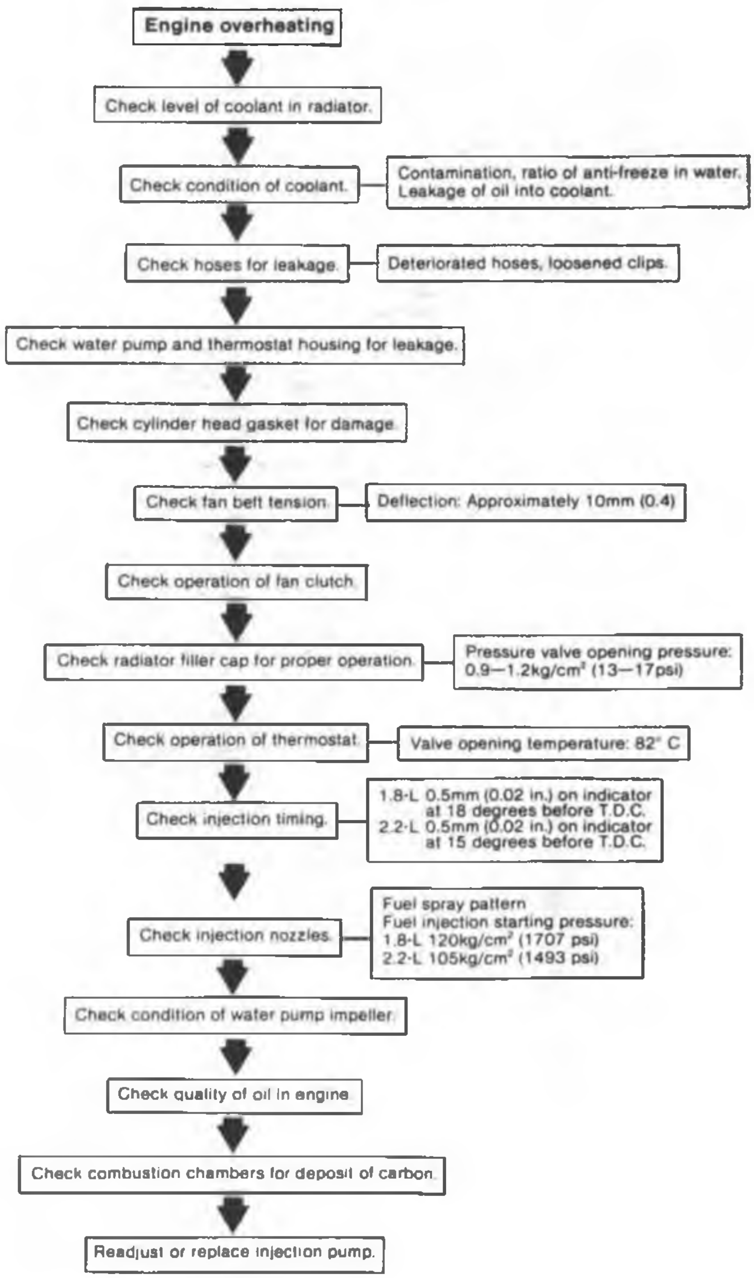
To locate the cause of engine overheating, you must first determine whether the engine is actually overheating or the temperature gage is in error.

The common causes of engine overheating in terms of frequency are:

- Leakage of coolant from the water pump
- Leakage of coolant from the radiator, hoses and thermostat housing
- A defective thermostat
- Contaminated water passages.

Some causes of engine overheating which are often overlooked are:

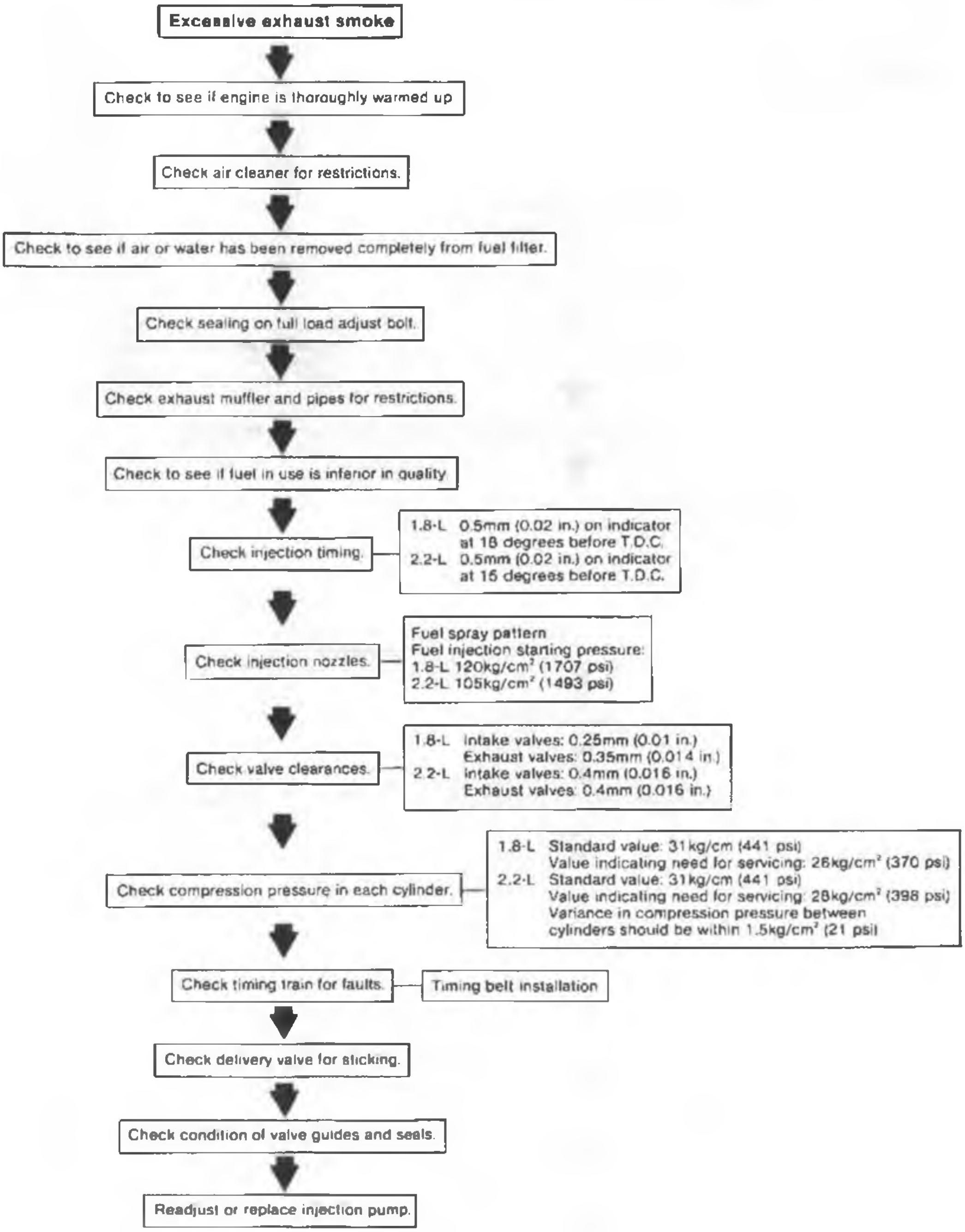
- Leaky head gasket
- An excessive volume of fuel injection
- Incorrect ignition timing
- Carbon buildup in the combustion chambers.



Excessive Exhaust Smoke

A considerable amount of dark smoke in the exhaust gases is due to an excessive amount of fuel, an insufficient volume of air, poor nozzle spray or excessively advanced ignition timing.

To determine the cause, check the seals on the injection pump, check the compression pressure, the condition of the air cleaner and the injector spray nozzles (refer to the section on nozzle testing in this booklet). When you have discounted these potential areas, check the fuel injection pump timing.

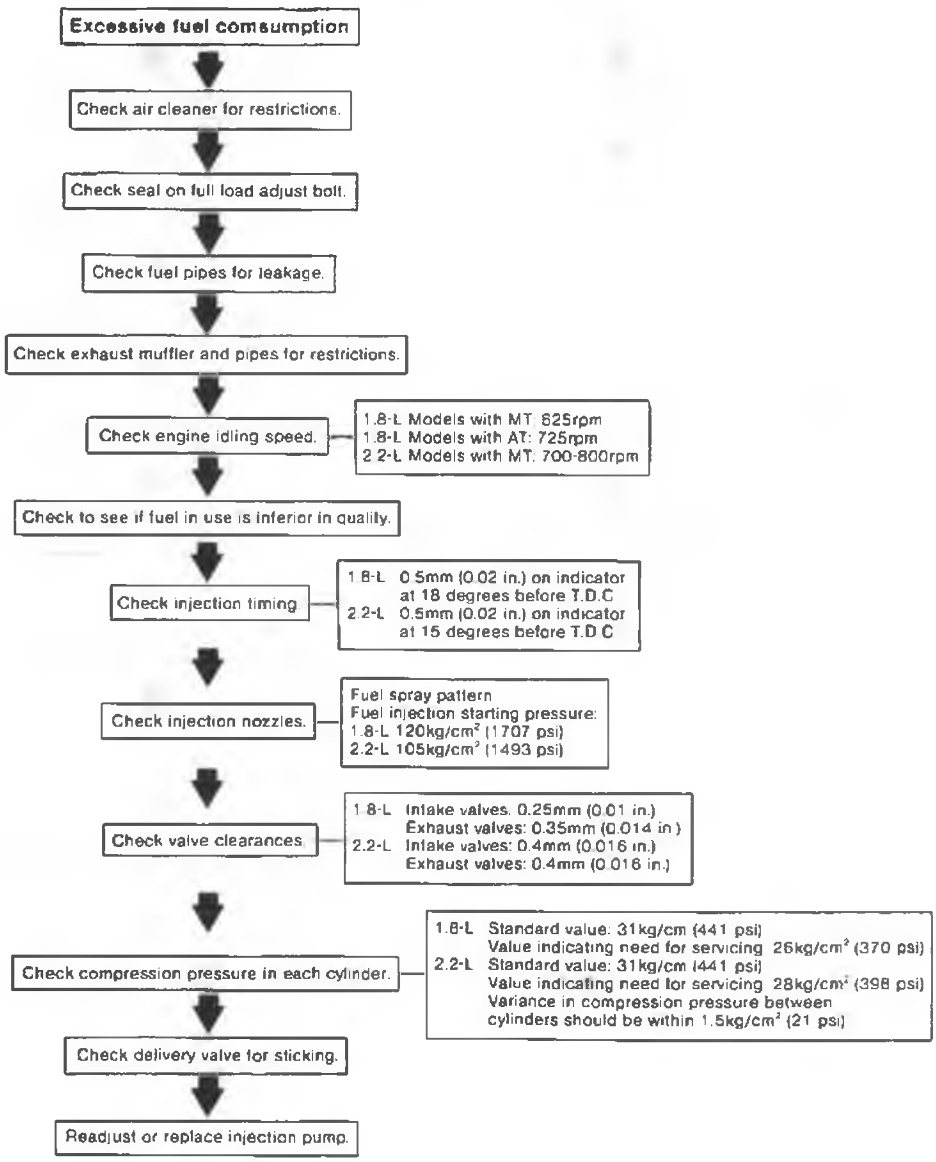


Excessive Fuel Consumption

Because fuel consumption varies greatly with driving habits, vehicle load and environmental conditions, it is necessary to determine under what type of conditions the fuel consumption occurred before it can be labeled as excessive.

To check for excessive fuel consumption, first road test the vehicle to see if the engine operates normally, giving reasonable acceleration. If the road test proves satisfactory, check the air cleaner and exhaust system for restrictions, and also check the compression pressure in the cylinders. If all these tests are satisfactory, you should suspect trouble in the fuel system.

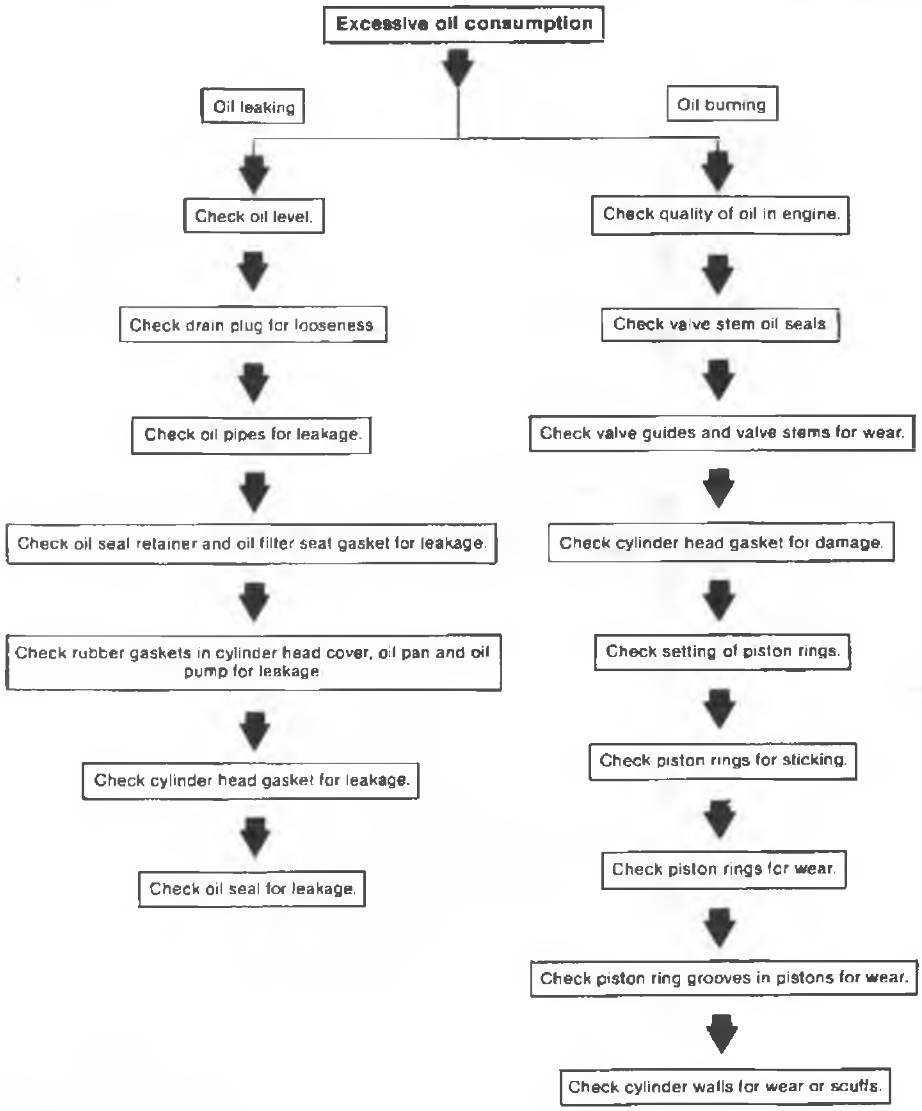
Check the fuel system by checking the fuel injection nozzle spray pattern, injection starting pressure and injection volume with an injection nozzle tester.



Excessive Oil Consumption

The major causes of engine oil consumption include oil leakage, oil burning and internal leakage of oil past the piston rings. An external engine oil leak can be detected by close visual inspection.

To determine whether the oil is burning or leaking past the piston rings, road test the vehicle. If oil is noticed in the exhaust upon acceleration, oil is leaking past the piston rings. If oil is noticed in the exhaust during deceleration, oil may be leaking past the valve stem seals or valve guides.



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