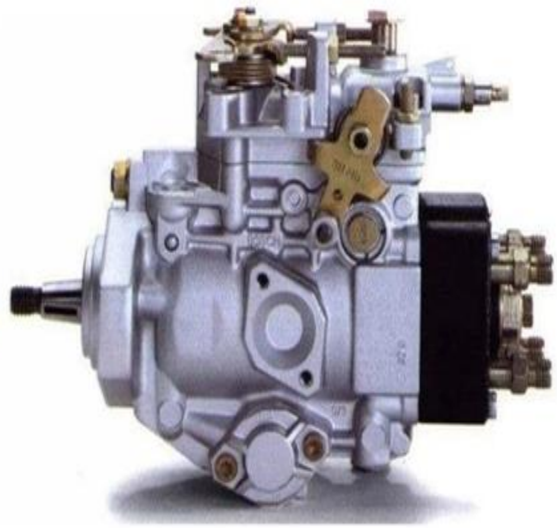
AUTOMOTIVE MECHANICS

LEVEL – III

Based on October 2023, Curriculum Version II



Module Title: Overhauling Conventional Fuel System

Module Code: EIS AUM3 M01 1023

Nominal Duration: 60 Hours

Prepared by: Ministry of Labor and Skill

October, 2023

Addis Ababa, Ethiopia

Table of Contents

Acronym

EFI	Electronic fuel Injection
ECU	Electronic Control Unit
HC	Hydrocarbon
CO_2	Carbon dioxide
H_2O	Water
NOX	Oxide of nitrogen
EECS	Evaporative emission control system
D-EFI	Manifold pressure controlled
L-EFI	Air flow controlled
IAC	Idler air control
IAC	AIdle air control valve
EDIC	Electrical diesel injection control
EEC	Electrical Electronic control
EGR	Exhaust Gas Regulator

Acknowledgment

The Ministry of Labor and skill wishes to thank and appreciation to MoLS leaders and experts, Regional Labor and skill/training Bureaus leader, experts, TVT College Deans, Instructors and industry experts who contribute their time and professional experience to the development of this Training Module.

Introduction to Module

In automotive Mechanics field, servicing Overhauling Conventional Fuel System is very important for the overall health of the car. It helps to know basic Overhauling Conventional Fuel System concepts, methods of Overhauling Conventional Fuel System servicing and testing and also including removing and replacing procedures of Overhauling Conventional Fuel System. Due to the Overhauling Conventional Fuel System nature of most vehicles today, the Overhauling Conventional Fuel System not only helps the car to be functional but also keeps safe when on the road.

This module is designed to meet the industry requirement under the Automotive Mechanics occupational standard, particularly for the unit of competency: Overhauling Conventional Fuel System Components.

This module covers the units:

- Overview of conventional fuel system
- Overhauling Conventional Gasoline Fuel System
- Overhauling Conventional Diesel Fuel System

Learning Objective of the Module

- Overview of conventional fuel system
- Overhauling Conventional Gasoline engine fuel system
- Overhauling Conventional Diesel Fuel System

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the "LAP test" giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit One: Overview of Conventional Fuel System

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Servicing Gasoline engine fuel system
- Servicing Conventional Diesel Fuel System

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Service Gasoline engine fuel system
- Service Conventional Diesel Fuel System

1.1 Gasoline fuel system

The function of both the carburetor fuel system and the fuel injection system is to supply a combustible mixture of air and fuel to the engine. Major elements of the gasoline fuel supply system include the following: fuel tank and cap, fuel system emission controls, fuel lines, fuel pump, fuel filter, carburetor or fuel injection system, air cleaner, and exhaust system. Before discussing the components of a gasoline fuel system, you should understand the composition and properties of gasoline.

Gasoline is a highly volatile flammable liquid of hydrocarbon mixture used as a fuel for internal-combustion engines. A comparatively economical fuel, gasoline is the primary fuel for automobiles worldwide. Chemicals, called additives, such as lead, detergents, and anti-oxidants, are mixed into gasoline to improve its operating characteristics.

1.1.1 Octane Rating

A gasoline that detonates easily is called low octane gasoline. A gasoline that resists detonation is called high octane gasoline. The octane rating of a gasoline is a measurement of the ability of the fuel to resist knock or ping. A high octane rating indicates the fuel will NOT knock or ping easily. It should be used in a high compression or turbo-charged engine. A low octane gasoline is suitable for a low compression engine.

Octane numbers give the antiknock value of gasoline. A higher octane number (91) will resist ping better than a gasoline with a low octane number (83). Each manufacturer recommends an octane number for their engine.

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1.1.2 Air-Fuel Ratio

For proper combustion and engine performance, the right amounts of air and fuel must be mixed together. If too much fuel or too little fuel is used, engine power, fuel economy, and efficiency are reduced. For a gasoline engine, the perfect air to fuel ratio is 15:1 (15 parts air to 1 part fuel by weight). Under constant engine conditions, this ratio can help assure that all fuel is burned during combustion. The fuel system must change the air-fuel ratio with the changes in engine-operating conditions.

- **Lean Air-Fuel Mixture**

A lean air-fuel mixture contains a large amount of air. For example, 20:1 would be a very lean mixture. A slightly lean mixture is desirable for high gas mileage and low exhaust emissions. Extra air in the cylinder ensures that all the fuel will be burned; however, too lean of a mixture can cause poor engine performance (lack of power, missing, and even engine damage).

- **Rich Air-Fuel Mixture**

A rich air-fuel mixture contains a little more fuel mixed with the air. For gasoline, 8:1(8 parts air to 1 part fuel) is a very rich mixture. A slightly rich mixture tends to increase power; however, it also increases fuel consumption and exhaust emissions. An overly rich mixture will reduce engine power, foul spark plugs, and cause incomplete burning (black smoke at engine exhaust).

1.1.3 Gasoline Combustion

For gasoline or any other fuel to burn properly, it must be mixed with the right amount of air. The mixture must then be compressed and ignited. The resulting combustion produces heat, expansion of the gases, and pressure.

A. Normal Combustion

Normal gasoline combustion occurs when the spark plug ignites the fuel and burning progresses smoothly through the fuel mixture. Maximum cylinder pressure should be produced after a few degrees of crank rotation after the piston passes TDC on the power stroke.

Normal combustion only takes about 3/1,000 of a second. This is much slower than an explosion. Dynamite explodes in about 1/50,000 of a second. Under some undesirable conditions, however, gasoline can be made to bum quickly, making part of the combustion like an explosion.

B. Abnormal Combustion

Abnormal combustion occurs when the flame does not spread evenly and smoothly through the combustion chamber. The lean air-fuel mixture, high-operating temperatures, low octane, and unleaded fuels used today make abnormal combustion a major problem that creates unfavorable conditions, such as the following:

a) Detonation

Detonation results when part of the unburned fuel mixture explodes violently. This is the most severe engine damaging type of abnormal combustion. Engine knock is a symptom of detonation because pressure rises so quickly that parts of the engine vibrate. Detonation sounds like a hammer hitting the side of the engine. It can crack cylinder heads, blow head gaskets, burn pistons, and shatter spark plugs.

b) Pre-Ignition

Pre-ignition results when an overheated surface in the combustion chamber ignites the fuel mixture. Termed surface ignition, a hot spot (overheated bit or carbon, sharp edge, hot exhaust valve) causes the mixture to burn prematurely. A ping or mild knock is a light tapping noise that can be heard during pre-ignition. Pre-ignition is similar to detonation, but the action is reversed. Detonation begins after the start of normal combustion, and pre-ignition occurs before the start of normal combustion. Pre-ignition is common to modern vehicles. Some manufacturers say that some pre-ignition is normal when accelerating under a load.

c) Dieseling

Dieseling, also called after-running or run-on, is a problem when the engine keeps running after the key is turned off. A knocking, coughing, or fluttering noise may be heard, as the fuel ignites and the crankshaft spins. When dieseling, the engine ignites the fuel from heat and pressure, somewhat like a diesel engine. With the key off, the engine runs without voltage to the spark plugs. The most common
causes of dieseling are high idle speed, carbon deposits in the combustion chambers, low octane fuel, overheated engine, or spark plugs with too high of a heat range.

d) Spark knock

Spark knock is another combustion problem caused by the spark plug firing too soon in relation to the position of the piston. The spark timing is advanced too far, causing combustion to slam into the upward moving piston. This causes maximum cylinder pressures to form before TDC, not after TDC as it should. Spark knock and pre-ignition both produce about the same symptoms—pinging under load. To find its cause, first check ignition timing. If ignition timing is correct, check other possible causes.

1.1.4 Gasoline Fuel System Components

A gasoline fuel system) draws fuel from the tank and forces it into the fuel-metering device (carburetor, gasoline injectors), using either a mechanical (engine-driven) or electric fuel pump. The basic parts of a fuel supply system include the following:

A. Fuel Tank

An automotive fuel tank must safely hold an adequate supply of fuel for prolonged engine operation. The location of the fuel tank should be in an area that is protected from flying debris, shielded from collision damage, and one that is not subject to bottoming. A fuel tank can be located just about anywhere in the vehicle that meets these requirements.

The general construction of a fuel tank used on automotive equipment. Fuel tanks are usually made of thin sheet metal or plastic. The main body of a metal tank is made by soldering or welding two formed pieces of sheet metal together. Other parts (filer neck, fuel tank cap, and baffles) are added to the form to complete the fuel tank assembly. A lead-tin alloy is normally plated to the sheet metal to prevent the tank from rusting.

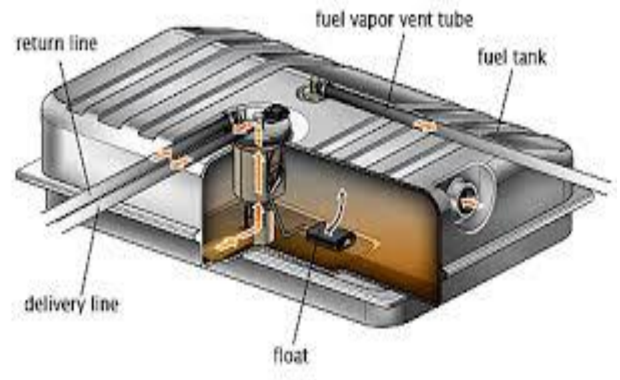


Figure 1.1 Fuel tanks with top cut away

In vehicles requiring unleaded fuel, a fuel neck restrictor is used inside the filler neck. This prevents the accidental use of leaded gasoline in an engine designed for unleaded. The restrictor is too small to accept the larger leaded fuel type pump nozzle.

Modern fuel tank caps are sealed to prevent escape of fuel and fuel vapors (emissions) from the tank. The cap has pressure and vacuum valves that only open under abnormal conditions of high pressure or vacuum. Fuel tank baffles are placed inside the tank to prevent the fuel from sloshing or splashing around in the tank. The baffles are metal plates that restrict fuel movement when the vehicle accelerates, decelerates, or turns corners. Fuel tanks give little or no trouble, and generally require no servicing other than an occasional draining and cleaning.

B. Fuel pumps

I. Mechanical Fuel Pump

Gasoline fuel pump is a device, which delivers fuel from the tank to the carburetor. Fuel pumps are generally of two types: Mechanical and Electrical pumps. Four stroke spark ignition engines are in most cases equipped with a mechanical diaphragm type pump. The main distinction between the various types of diaphragm pump is the drive principle: they can be operated by a cam and lever, by levers from pushrod or by a plunger.

pump, consists of a spring laded flexible diaphragm, usually made from laminated synthetic rubber and nylon fabric, sandwiched between an upper valve- chamber housing and a lower pull-rod housing which is attached to the engine. Built into the upper chamber there are pair of inlet and outlet valves.

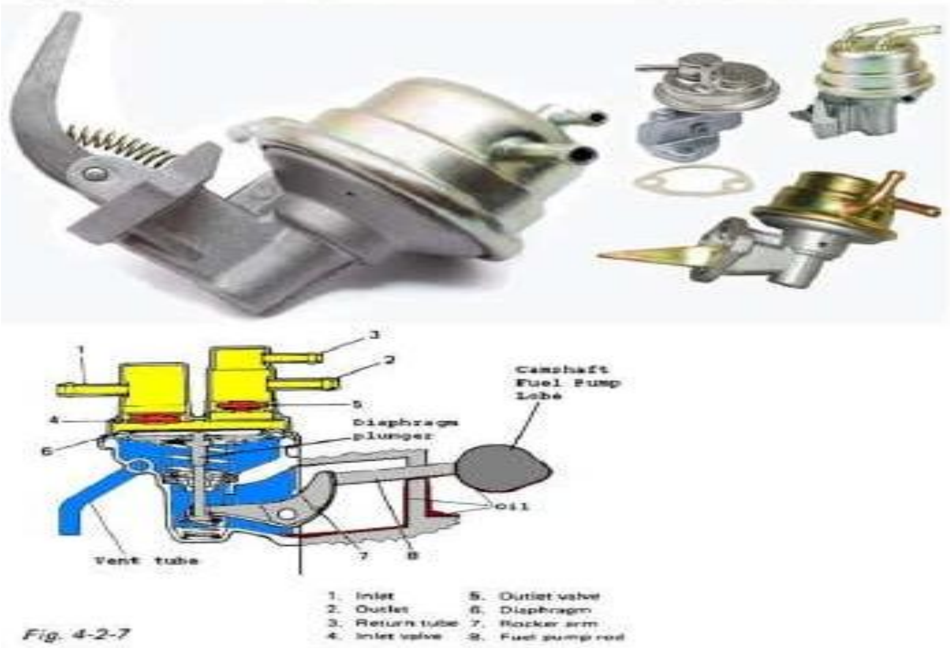


Figure 1.2 Mechanical fuel pump

An eccentric lobe driven from the camshaft or a separate jack-shaft can operate either a bell-crank lever or a pushrod to provide the necessary inward diaphragm stroke movement, the out ward displacement is achieved by the diaphragm return spring.

II. Suction stroke

As the cam moves the actuating lever up, the pump diaphragm is pulled down against its spring. This increases the size of the internal cavity and generates a partial vacuum so that the suction valve opens and fuel flows from the fuel tank through the fuel line into the pump-filling chamber.

III. Pressure or discharge stroke

As the actuating lever runs back down the cam, the pump diaphragm is forced back up by its spring. The suction valve also closes by spring loading, but the pressure or discharge valve opens against its spring, so that the fuel can flow from the filling chamber to the pressure chamber and thence along the supply line to the carburetor. When the carburetor has received sufficient fuel, the float rises in its chamber and closes the float needle valve. This prevents further fuel from leaving the fuel pump. The pump diaphragm remains in the position it has reached and actuating lever moves away from the diaphragm rod (off-load position). This limits the pressure stroke to the delivery volume needed by the engine. In normal operation, the diaphragm moves only by a few tenths of a millimeter.

IV. Electrical fuel pumps

Electrical fuel pumps have certain advantages over mechanical fuel pumps. Fuel is at the carburetor as soon as the ignition switch is turned on. The pump can deliver more fuel than the engine will require even under maximum operating conditions. Thus, the engine will never be fuel – starved. They are, therefore, used in many high performance and heavy-duty application. There are various types of electric fuel pumps. One of the latest types is mounted in the fuel tank. It contains an impeller driven by an electric motor. This pushes fuel through the fuel line to the carburetor. Other types are mounted in the engine compartment.

V. Type Electrical Fuel Pumps

- **Diaphragm or bellows**

The pumping chamber is similar to that in the mechanical fuel pump. The pump body contains an electric solenoid, which receives current from the ignition switch through a pair of contact breakers in the pump. One of the contacts is stationary and the other is connected to the diaphragm by a control rod, figure 3.4. When the contacts are closed, current flows through the solenoid and creates a magnetic field, which attracts an iron disc called an armature.

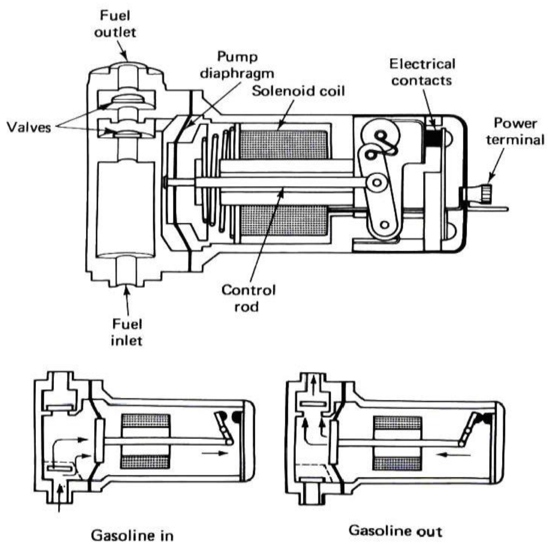


Figure 1.3 Diaphragm type electrical

This disc is attached to the underside of the diaphragm. When the disc is attracted to the solenoid, the diaphragm (bellows) is also drawn inwards; the volume in the pumping Chamber is increased, and so fuel flows from the tank to fill the space. During this time the control rod has moved with the diaphragm and has opened the contacts. The solenoid is no longer activated. The diaphragm return spring now forces the diaphragm. Out wards, expelling fuel through the outlet valve to the carburetor. The control rod moves back with the diaphragm and closes the contacts: thus the whole cycle is repeated.

If no fuel is needed by the float chamber, the diaphragm remains in a mid-position as in the case of mechanical fuel pumps. When the spring has pushed all the fuel out of the chamber the contacts are again 'made' and pumping resumes.

- **Roller- type electrical fuel pump**

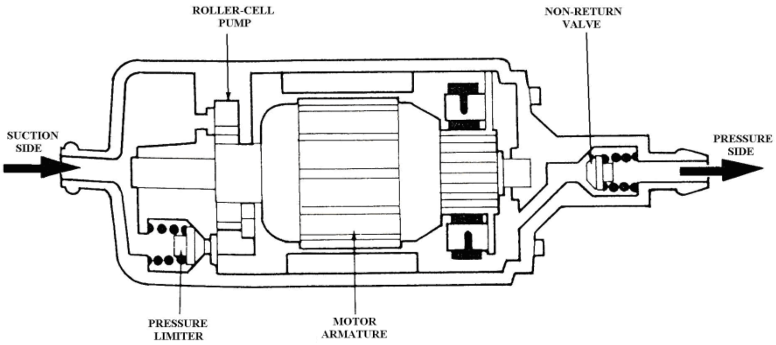


Figure 1.4 Roller- type electrical fuel pump

The roller assembly spins, fuel enters from the suction side of the pump. Atmospheric pressure pushes fuel from the tank to the low-pressure area created within the pump. As the roller continues to spin, the fuel is pushed into an increasingly smaller area created within the pump. As this happens, the fuel is pressurized and forced out the pump discharge outlet and into the fuel lines.

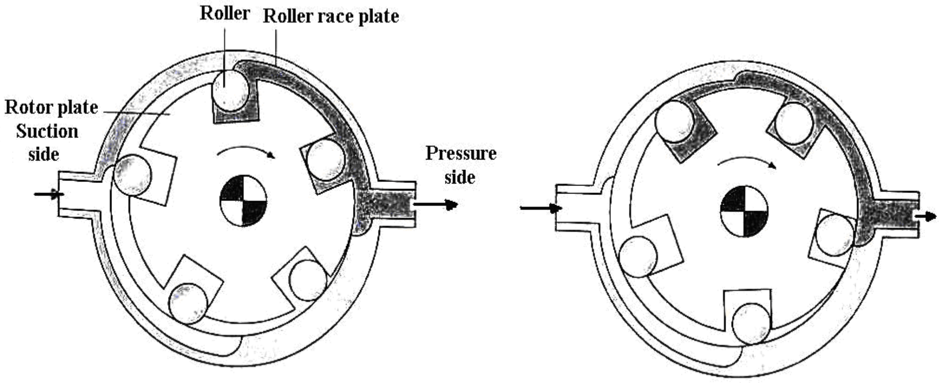


Figure 1.5 Operation of Roller- type electrical fuel pump

A fuel pump relay is mounted on the fuse box. The relay acts as a safety device. In the event the car is in an accident, the relay breaks the electrical circuit to the fuel pump, and prevents fuel from being pumped. This reduces the chance of a fire. Two vales are generally located inside the pump. These are check valve and relief valve. The check valve maintains system rest pressure for several hours when the engine is shut down. This helps to assure quick start and eliminates vapor lock. The relief valve is designed to dump fuel pressure back into the tank due to blockage in the system.

C. Fuel Filters

Fuel filters stop contaminants (rust, water, corrosion, and dirt) from entering the carburetor, throttle body, injectors, injections pumps, and any other parts that may be damaged by foreign matter. Fuel filters can be located in the following locations:

Figure 1.6 Typical fuel filter location

- A fuel strainer is also located in the fuel tank on the end of the pickup tube.
- In the fuel line right after the electric fuel pump.
- Under the fuel line fitting in the carburetor.
- Inside the fuel pump.
- In the fuel line before the carburetor or fuel injectors.

When in doubt about the location of the fuel filter, refer to the service manual. Fuel filters operate by passing the fuel through a porous filtering medium. The openings in the porous material are very small, and, therefore, any particles in the fuel that are large enough to cause problems are blocked. In addition to the filtering medium, the filter, in some cases, also serves as a sediment bowl. The fuel, as it passes through the filter, spends enough time in the sediment bowl to allow large particles and water to settle out of it.

Figure 1.8 Types of Fuel Filters

Several types of fuel filters are used today. They are the replaceable in-line, the replaceable in-line in the carburetor, and the glass bowl The most common configuration is the replaceable in-line filter. These are in-line filter elements that fit in the carburetor inlet or inside the fuel tank. Fuel filter elements can be made from treated paper, ceramics, sintered bronze or metal screen However, there is one filter element that differs from the others. It consists of a stacked pile of laminated disks that are spaced 0.0003 inches apart. As the fuel passes between the disks, foreign matter is blocked out. These filters are replaced when the flow of fuel is restricted.

Figure 1.9 Fuel filter elements

Always refer to the service manual for information concerning service intervals, cleaning, and replacement of all system filters.

D. Fuel Lines and Hoses

Fuel lines and hoses carry fuel from the tank to the engine. The main fuel line allows the fuel pump to draw fuel out of the tank. The fuel is pulled through this line to the pump and then to the carburetor, or metering section of the injection system. Fuel lines are normally made of double wall steel tubing. For fire safety, a fuel line must be able to withstand the constant and severe vibration produced by the engine and road surface. Lines are placed away from exhaust pipes, mufflers, and manifolds, so that excessive heat will not cause vapor lock. They are attached to the frame, the engine, and other units, so the effects of vibration will be minimized. Fuel hoses, made

of synthetic rubber, are used where severe movement occurs between parts. A flexible hose can absorb movement without breaking. Hose clamps are required to secure fuel hoses to the fuel lines or to metal fittings.

Figure 1.10 Fuel Lines and Hoses

Note: Most fuel injection systems have very high fuel pressure. Follow recommended procedures for bleeding or releasing pressure before disconnecting a fuel line or fitting. This action will prevent fuel spray from possibly causing injury or a fire.

E. **Carburetor**

A carburetor is basically a device for mixing air and fuel in the correct amounts for efficient combustion. The carburetor bolts to the engine intake manifold. The air cleaner fits over the top of the carburetor to trap dust and dirt.

Carburetor size is stated in CPM (cubic feet of air per minute). This is the amount of air that can flow through the carburetor at wide, open throttle. CPM is an indication of the maximum air flow capacity. Usually, small CPM carburetors are more fuel-efficient than larger carburetors. Air velocity, fuel mixing, and atomization are better with small throttle bores. A larger CPM rating is desirable for high engine power output.

A. Principles of carburetor

The principles of carburetion are presented so you may better understand the inner workings of a carburetor and how the other components of the fuel system function to provide a combustible mixture or air and fuel to the engine cylinders.

Venturi effect

The venture effect is used by the carburetor to mix air with the gasoline. The basic carburetor has an hourglass-shaped tube called a throat. The most constricted part of the throat is called the venture. A tube, called the discharge nozzle, is positioned in the venturi. The discharge nozzle is connected to a reservoir of gasoline called the float bowl. The negative pressure that exists in the combustion chamber is due to the downward intake stroke of the piston, causing atmospheric pressure to create an air flow through the throat. This air flow must increase temporarily in speed,

as it passes through the venture due to its deceased size. The increased speed of air flow results in a corresponding decrease in pressure within the venture and at the end of the discharge nozzle. This action permits the atmospheric pressure on the surface of the gasoline in the float bowl to force the gasoline out through the discharge nozzle. This gasoline then sprays and atomizes in the passing air flow to form the air-fuel mixture.

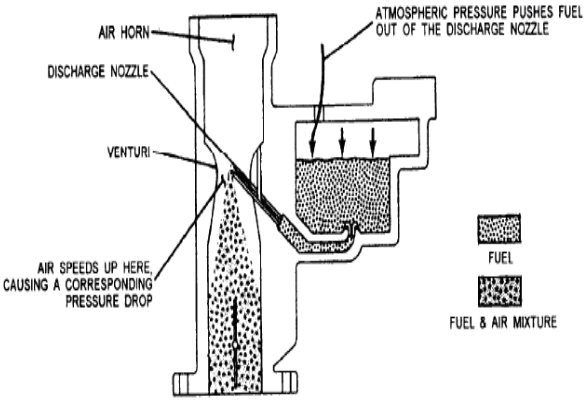


Figure 1.13 Venture effect

B. Components of Carburetor

The basic carburetor consists of the following parts:

- ***Carburetor body***. The carburetor body is a cast metal housing for the carburetor components.
- Usually the main body houses the fuel bowl, main jets, air bleeds, power valve, pump checks, diaphragm type accelerator pump, venturis, circuit passages, and float mechanism. The body is flanged on the bottom to allow the carburetor to be bolted to the intake manifold.
- ***Air horn***. The air horn is also called the throat or barrel. It routes outside air into the engine intake manifold. It contains the throttle valve, the venturi, and the outlet end of the main discharge tube. The parts which often fasten to the air horn body are as follows: the choke, the hot idle compensator, the fast idle linkage rod, the choke vacuum break, and sometimes the float and pump mechanisms.
- ***Throttle valve*** This disc-shaped valve controls air flow through the air horn.

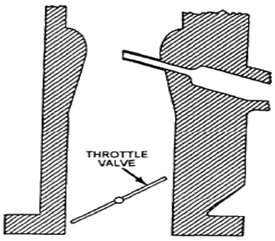


Figure 1.14 simple carburetors with throttle valve

- When closed, it restricts the flow of air and fuel into the engine, and when opened, air flow, fuel flow, and engine power increase.

- ***Venturi.*** The venturi produces sufficient suction to pull fuel out of the main discharge tube.
- ***Main discharge tube***. The main discharge tube is also called the main fuel nozzle. It uses venture vacuum to feed fuel into the air horn and engine. It is a passage that connects the fuel bowl to the center of the venturi.
- ***Fuel bowl***. The fuel bowl holds a supply of fuel that is NOT under fuel pump pressure.

C. Carburetor System

A carburetor system or circuit is a network of passages and related parts that help control the air-fuel ratio under specific engine-operating conditions. The seven basic carburetor systems are the following: Float system, Idle system, Off idle system, Acceleration system, High-speed system, Full-power system, and Choke system

Understanding each of these systems is important. It will help you when diagnosing and repairing carburetor problems**.**

a) Float System

The float system maintains a steady working supply of gasoline at a constant level in the carburetor. This action is critical to the proper operation of the carburetor. Since the carburetor uses differences in pressure to force fuel into the air horn, the fuel bowl must be kept at atmospheric pressure. The float system keeps the fuel pump from forcing too much gasoline into the carburetor bowl**.**

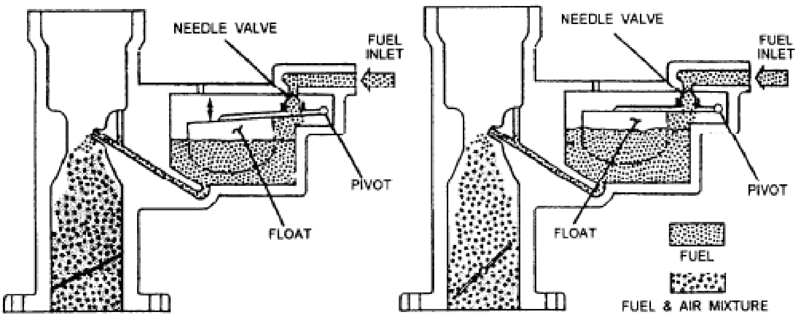


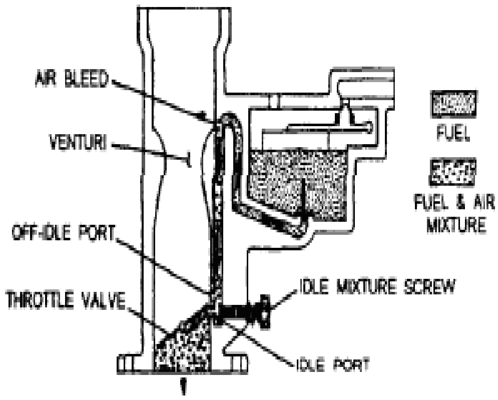
Figure 1.15 Float system

An excessively high float level will cause fuel to flow too freely from the discharge tube, causing an overly rich mixture, whereas an excessively low float level will cause an overly lean mixture. The basic parts of the float system are the fuel bowl, the float, the needle valve, the needle seat, the bowl vent, and the hinge assembly.

Basic float system operation is as follows:

- When engine speed or load increases, fuel is rapidly pulled out of the fuel bowl and into the venture. This action causes the fuel to drop in the bowl. The needle valve also drops away from its seat. The fuel pump can then force more fuel into the bowl.
- As the fuel level in the bowl rises, the float pushes the needle valve against its seat. When the fuel level is high enough, the float closes the opening between the needle valve and the seat by the rising float, as the fuel reaches the desired level in the fuel bowl.

With the engine running, the needle valve usually lets some fuel leak into the bowl. As a result, the float system maintains a stable quantity of fuel in the bowl.



b) Idle System

The carburetor idle system provides the air-fuel mixture at speeds below approximately 800 rpm. When the engine is idling, the throttle is almost closed Air flow through the air horn is restricted to produce enough vacuum in the venturi. Since venturi vacuum is too low to pull fuel from the main discharge tube, the high intake manifold vacuum BELOW the throttle plate and the idle circuit are used to feed fuel into the air horn.

The fundamental parts of the carburetor idle system include a section of the main discharge tube, a low-speed jet, an idle air bleed, a bypass, an idle passage, an economizer, an idle screw port, and an idle mixture screw.

- The *low-speed jet* is a restriction in the idle passage that limits maximum fuel flow in the idle system. It is placed in the fuel passage before the idle air bleed and economizer.
- The *idle air bleed* works with the economizer and bypass to add air bubbles in the fuel flowing to the idle port. The air bubbles help break up or atomize the fuel. This makes the air-fuel mixture burn more efficiently once it is in the engine.
- The *idle passage* carries the mixture of liquid and air bubbles to the idle screw port.
- The *idle screw port* is an opening into the air horn below the throttle valve.
- The *idle mixture screw* allows adjustment of the size of the opening in the idle screw port. Turning the screw **in** reduces the size of the idle port and the amount of fuel entering the horn. Turning the screw **out** increases the size of the idle port and enriches the fuel mixture at idle.

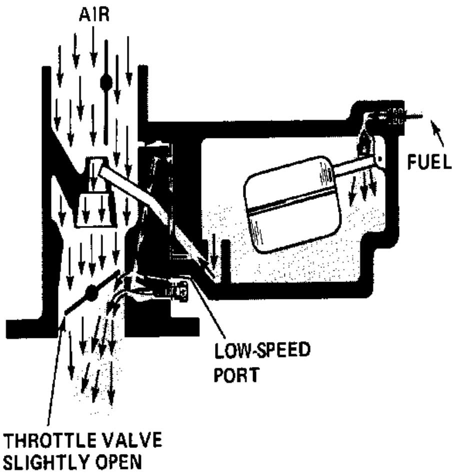
The basic operation of the idle system is as follows:

- At idle, fuel flows out of the fuel bowl, through the main discharge tube, and into the low-speed jet. The low-speed jet restricts maximum fuel flow.

- At the bypass, outside air is pulled into the idle system. This partially atomizes the fuel into slurry. As the air and fuel bubbles pass through the economizer, the air bubbles are reduced in size to further improve mixing.
- The fuel and air slurry then enters the idle screw port. The setting of the idle screw controls how much fuel enters the air horn at idle.
- With the throttle plate closed, high intake manifold pressure pulls fuel out of the idle system.

c) Speed System

If the throttle valve is open just a little for low speed, the edge of the throttle valve moves past the idle port. More air can flow past the throttle valve now, reducing the vacuum in the intake manifold. So less fuel flows from the idle port. However, the low speed port now comes into action. The throttle valve has moved past and above the low speed port. *The* ***vacuum in the intake manifold can act on the low speed port as well as on the idle port.*** Both ports discharge fuel to maintain required amount of air-fuel mixture for low speed.



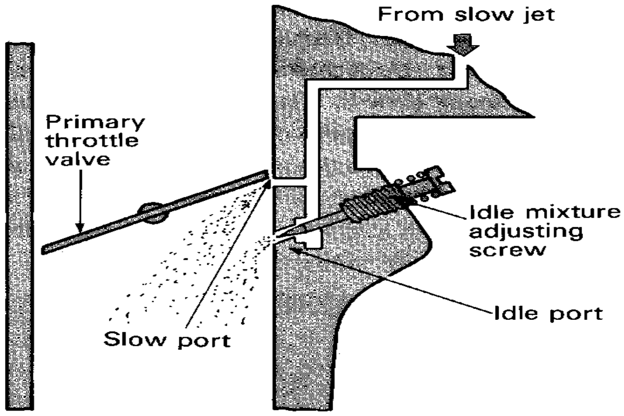


Figure 1.17 Speed System

d) Off Idle System

The off idle, also known as the part throttle, feeds more fuel into the air horn when the throttle plate is partially open. It is an extension of the idle system. It functions above approximately 800 rpm. Without the off idle system, the fuel mixture would become too lean slightly above idle.

Basic off idle system operation is as follows:

- The driver presses down on the accelerator and cracks open the throttle plate. As the throttle plate swings open, the off idle ports are exposed to intake manifold vacuum.
- Vacuum then begins to pull fuel out of the idle screw and the off idle port. This action provides enough extra fuel to mix with the additional air flowing around the throttle plate.

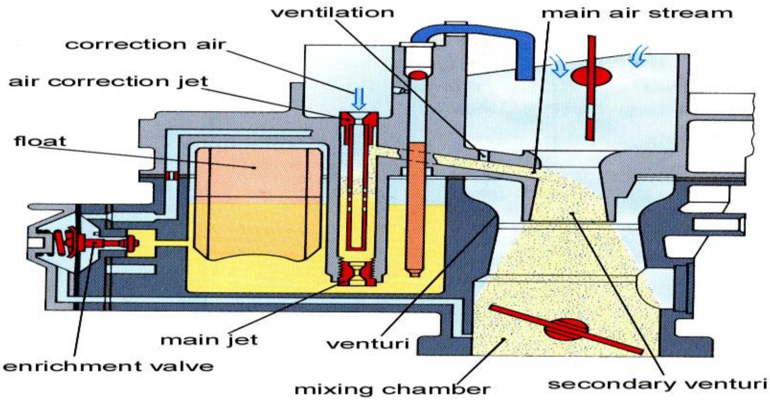


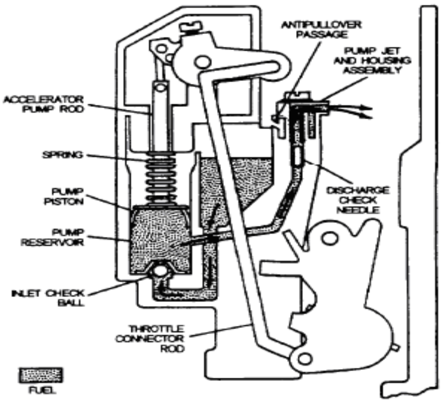
Figure 1.18 Off Idle System

e) Acceleration System

The carburetor acceleration system, like the off idle system, provides extra fuel when changing from the idle system to the high-speed system. The acceleration system squirts a stream of fuel into the air horn when the fuel pedal is pressed and the throttle plates swing open. Without the acceleration system, too much air would rush into the engine, as the throttle quickly opened. The mixture would become too lean for combustion and the engine would stall or hesitate. The acceleration system prevents a lean air-fuel mixture from upsetting a smooth increase in engine speed.

The basic parts of the acceleration system are the pump linkage, the accelerator pump, the pump check ball, the pump reservoir, the pump check weight, and the pump nozzle.

The accelerator pump develops the pressure to force fuel out of the pump nozzle and into the air horn. There are two types of accelerator pumps—piston and diaphragm type and



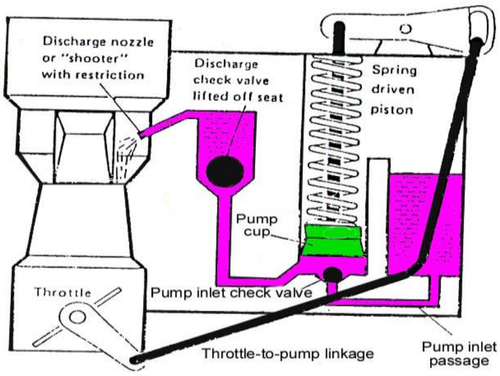


Figure 1.19 Piston accelerator pump

Figure 1.20 Diaphragm accelerator pump

- The *pump check ball* only allows fuel to flow into the pump reservoir. It stops fuel from flowing back into the fuel bowl when the pump is actuated.
- The *pump check weight* prevents fuel from being pulled into the air horn by venturi vacuum. Its weight seals the passage to the pump nozzle and prevents fuel siphoning.
- The *pump nozzle*, also known as the pump jet, has a fixed opening that helps control fuel flow out of the pump. It also guides the fuel stream into the center of the air horn.

The basic operation of the acceleration system is as follows:

- The pump piston or diaphragm is pushed down in the pump chamber, as the throttle plate is opened, forcing fuel through the outlet passage.
- At the same moment, the pump check ball will seat, keeping fuel from being pumped back into the float bowl.
- The pump check weight will be forced off its seat, allowing fuel to pass to the pump discharge nozzle, and then discharged into the carburetor.

- The pump piston or diaphragm is raised in the pumping chamber when the throttle plate is closed, causing the pump check weight to seat blocking the outlet passageway.
- At the same time, the pump check ball is pulled off its seat and fuel is pulled into the pump chamber from the float bowl.
- The pump chamber is filled with fuel and ready for discharge whenever the throttle plate is opened

The linkage between the accelerator pump and the throttle cannot be solid. If it were, the pump would act as a damper, not allowing the throttle to be opened and closed readily. The linkage activates the pump through a slotted shaft. When the throttle is closed, the pump is held by its linkage. When the throttle is open, the pump is activated by being pushed down by a spring that is called a duration spring The tension of the duration spring controls the length of time that the stream of fuel lasts. The spring is calibrated to specific applications. Too much spring pressure will cause fuel to be discharged too quickly, resulting in reduced fuel economy. Too little spring pressure will result in the fuel being discharged too slowly, causing engine hesitation.

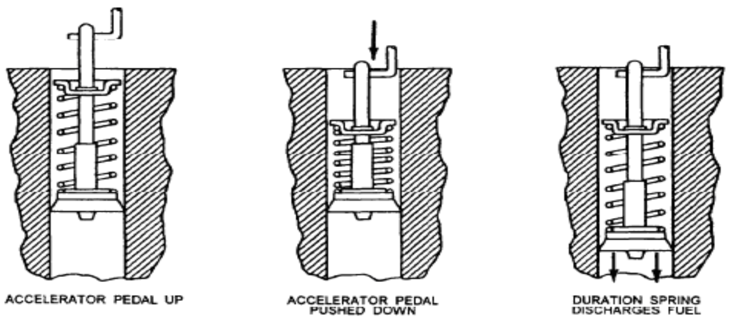


Figure 1.21 Duration spring

f) High-Speed System

The, high-speed system, also called the main metering system, supplies the engine air-fuel mixture at normal cruising speeds. This system begins to function when the throttle plate is opened wide enough for the venture action. Air flow through the carburetor must be relatively high for venture vacuum to draw fuel out of the main discharge tube. The high-speed system provides the leanest, most fuel efficient air-fuel ratio. It functions from about 2,000 to 3,000 rpm.

The high-speed system is the simplest system. It consists of the high-speed jet, the main discharge passage, the emulsion tube, the air bleed, and the venture.

- The *high-speed jet* is a fitting with a precision hole drilled into the center. This fitting screws into a threaded hole in the fuel bowl. One jet is used for each air horn. The hole size determines how much fuel flows through the system. A number is stamped on the high-speed jet to denote the diameter of the hole. Since jet numbering systems vary, refer to the manufacturer's manual for information on jet size.
- The *emulsion tube* and *air bleed* add air to the fuel flowing through the main discharge tube. The premixing of air with fuel helps the fuel atomize, as it is discharged into the air horn.
- The *venturi* is the hourglass shape, formed in the side of the carburetor air horn. One or two booster venturis can be added inside the primary venturi to increase vacuum at lower engine speeds.

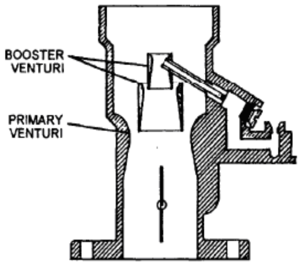


Figure 1.22 Booster venture

The basic operation of the high-speed system is as follows:

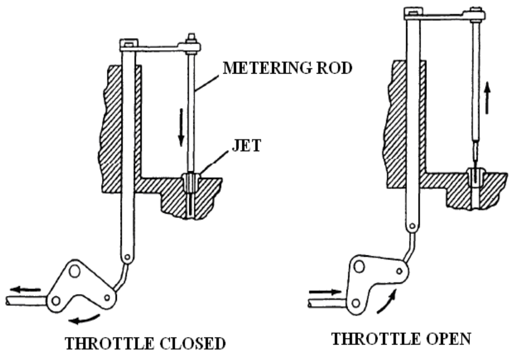
1. When the engine speed is high enough, air flow through the carburetor forms a high vacuum in the venturi. The vacuum pulls fuel through the main metering system.
2. The fuel flows through the main jet that meters the amount of fuel entering the system. The fuel then flows into the main discharge tube and emulsion tube.
3. The emulsion tube causes air from the air bleed to mix with the fuel. The fuel, mixed with air, is finally pulled out the main nozzle and into the engine.

g) Full-Power System

The full-power system provides a means of enriching the fuel mixture for high-speed, high-power conditions. This system operates, for example, when the driver presses the fuel pedal to pass another vehicle or to climb a steep hill. The full-power system is an addition to the high-speed system. Either a metering rod or a power valve (jet) can be used to provide variable, high-speed air-fuel ratio.

A metering rod is a stepped rod that moves in and out of the main jet to alter fuel flow. When the rod is down inside the jet, flow is restricted and a leaner fuel mixture results. When the rod is pulled out of the jet, flow is increased and a richer fuel mixture results for more power output. The metering rod is either mechanical-linkage or engine-vacuum operated.

- The *mechanical linkage metering rod* is linked to the throttle lever. Whenever the throttle is opened wide, the linkage lifts the metering rod out of the jet. When the throttle is closed, the linkage lowers the metering rod into the jet.



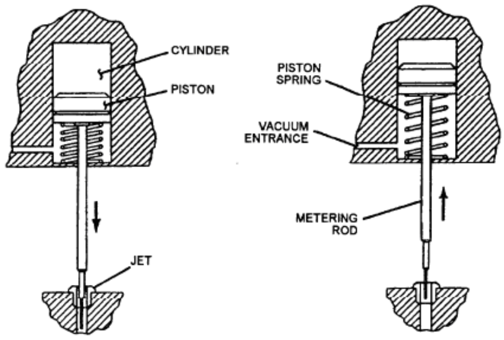
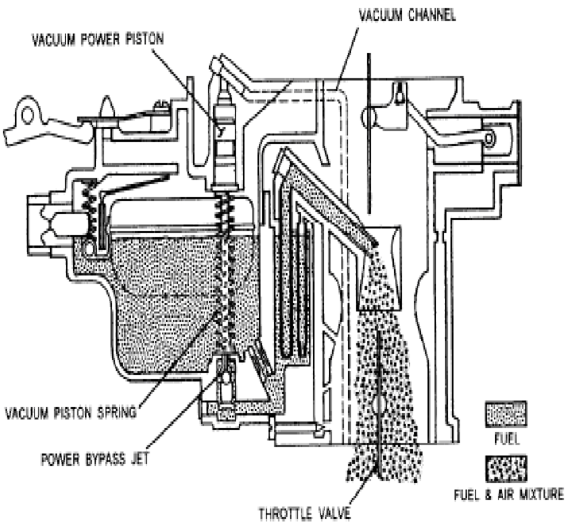


Figure 1.23 Mechanically operated metering rod Figure 1.24 Vacuum operated metering rod

- The *vacuum operated metering rod* that is controlled by engine vacuum is connected to a diaphragm. At steady speeds, power demands are low and engine vacuum is high, and the piston pushes the metering rod into the jet against spring pressure, restricting the flow to the discharge tube. When the load increases, vacuum decreases, causing the piston spring to lift the metering rod out of the jet, progressively increasing the flow of fuel to the discharge tube.

A vacuum power jet valve also known as an economizer, performs the same function as a metering rod; it provides a variable high-speed fuel mixture. A power jet valve consists of a fuel valve, a vacuum diaphragm, and a spring. The spring holds the power valve in the normally OPEN position. A vacuum passage runs to the power valve diaphragm. When the power valve is open, it serves as an extra jet that feeds fuel into the high-speed system.

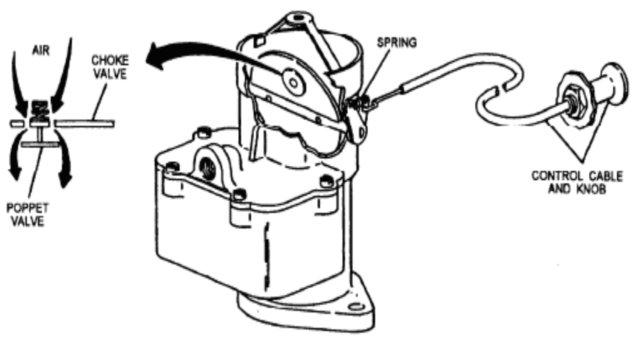


When the engine is cruising at normal highway speeds, engine intake manifold vacuum is high. This vacuum acts on the power valve diaphragm and pulls the fuel valve closed. No additional fuel is added to the metering system under normal conditions; however, when the throttle plate is swung open for passing or climbing a hill, engine vacuum drops. The spring in the power valve can push the fuel valve open. Fuel flows through the power valve and into the main metering system, adding more fuel for more engine power.

h) Choke System

When the engine is cold, the fuel tends to condense into large drops in the manifold, rather than vaporizing. By supplying a richer mixture (8:1 to 9:1), there will be enough vapor to assure complete combustion. The carburetor is fitted with a choke system to provide this richer mixture. The choke system provides a very rich mixture to start the engine and to make the mixture less rich gradually, as the engine reaches operating temperature. The two types of choke systems are the manual and automatic:

- The manual choke system was once the most popular way of controlling the choke plate; however, because of emissions regulations the possible danger when used with catalytic converters and technological advances in automatic choke systems, manual chokes are not often used today. In the manual choke system, the choke plate is



operated by a flexible cable that extends into the operator's compartment. As the control is pulled out, the choke plate will be closed, so the engine can be started. As the control is pushed back in, the position of the choke plate is adjusted to provide the proper mixture. The following are two features that are incorporated into the manual choke to reduce the possibility of the engine flooding by automatically admitting air into the engine.

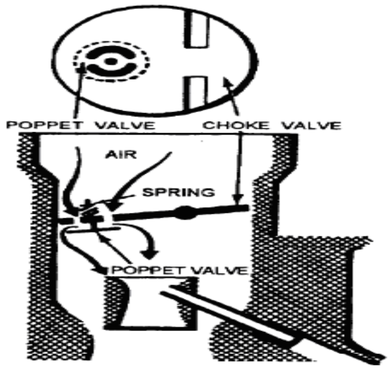
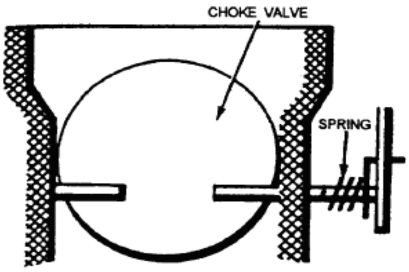


Figure 1.27 Manual choke system **Figure 1.256 Spring-loaded poppet valve**

- A spring-loaded poppet valve that is automatically pulled open by the force of the engine intake strokes.
- An off-center choke valve that creates a pressure differential between the two sides of the choke plate when it is subjected to engine intake, causing it to be pulled open against the force of spring loaded linkage.



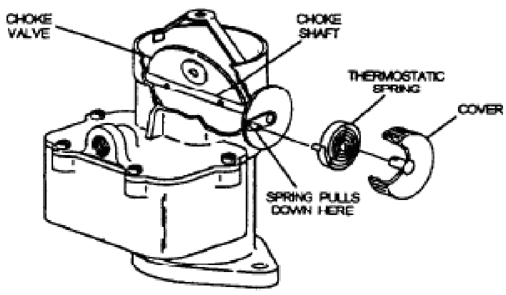


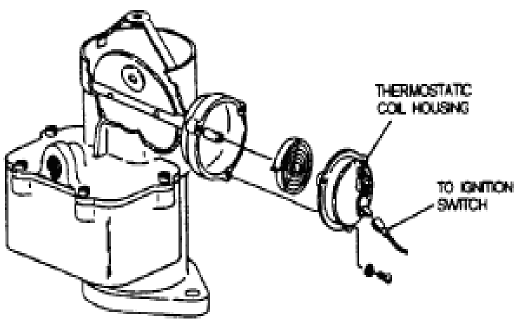
Figure 1.28 Off center choke valve **Figure 1.29 Automatic choke**

- Automatic chokes have replaced the conventional manual choke. They control the air-fuel ratio for quick starting at low temperature and also provide for the proper amount of choking to enrich the air-fuel mixture for all conditions of engine operation during the warm-up period. An automatic choke system has a choke plate (valve), a thermostatic spring, and other parts depending upon choke design.

The basic operation of the automatic choke system is as follows:

- With the engine cold, the thermostatic spring holds the choke closed. When the engine is started, the closed choke causes high vacuum in the carburetor air horn. This pulls a large amount of fuel out of the main discharge tube.
- As the engine and thermostatic spring warm, the spring uncoils and opens the choke plate. ‘This action produces a leaner mixture. A warm engine will not run properly if the choke were to remain closed.
- Various methods are used to control the warming of the choke thermostatic spring. The four methods of providing controlled heat to the thermostatic spring are as follows: electric, engine coolant, well-type heated, and exhaust manifold.

Electric uses an electric coil to heat the thermostatic spring. The heating coil is switched on with the ignition switch. Some systems use a control unit that prevents power from reaching the electric coil until the engine compartment reaches a desired temperature.



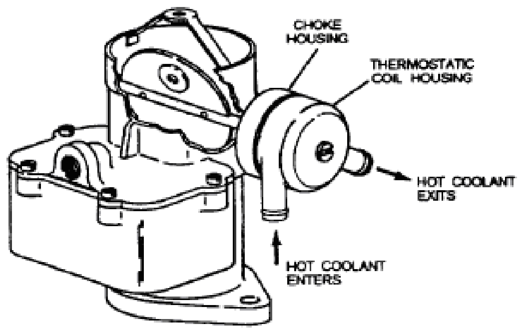
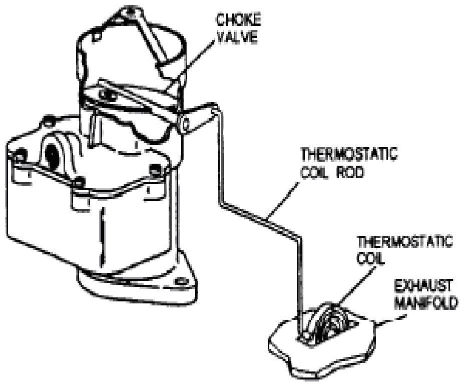


Figure 1.30 Electric choke **Figure 1.31 Engine coolant heated choke**

Engine Coolant uses a passage in the thermostat housing to circulate engine coolant for heating the thermostatic spring.

Well-Type Heated mounts the thermostatic spring in the top of the exhaust manifold. As the engine and manifold warms, the thermostatic spring uncoils to open the choke.



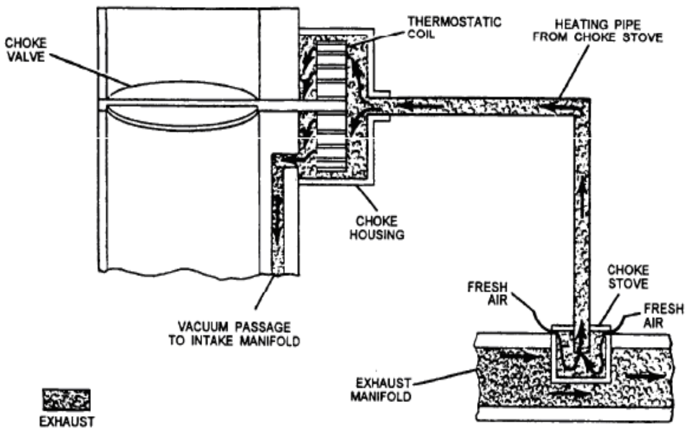
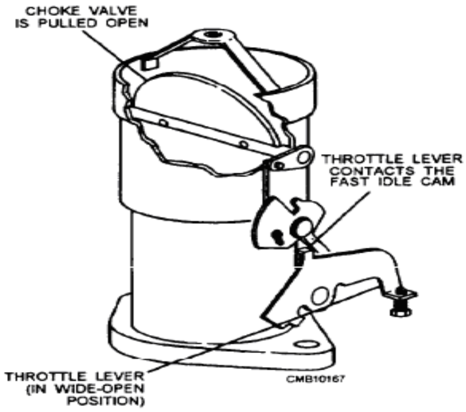


Figure 1.32 Well-type exhaust-heated choke   Figure 1.33 Exhaust-manifold heat-tube choke

The **EXHAUST MANIFOLD** uses heat from the exhaust manifold to heat the thermostatic spring. The exhaust heat is brought to the choke through the means of a heat tube. The heat tube passes through the exhaust manifold, so as it takes in fresh air via the choke stove, it picks up heat from the exhaust without sending any actual exhaust fumes to the choke mechanism. When the choke system is operating during warm-up, the engine must run at a faster idle speed to improve drivability and prevent flooding. To accomplish this, the carburetor is fitted with a fast idle cam that is operated by linkage from the choke.



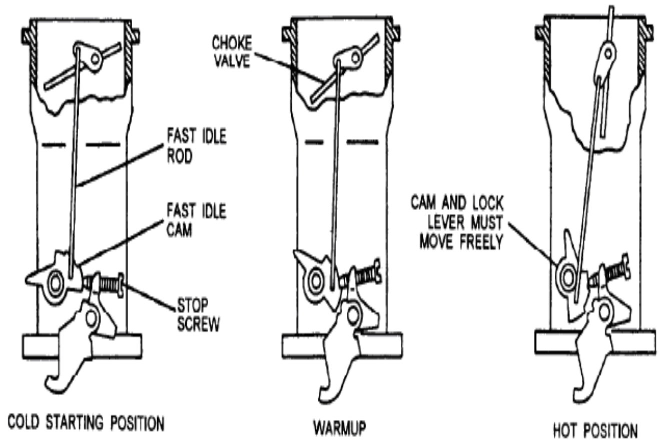


Figure 1.34 Fast idle cam operation **Figure 1.35 Choke un loader**

When the choke closes, the fast idle cam swings around in front of the fast idle screw. As a result, the fast idle cam and fast idle screw prevent the throttle plate from closing. Engine idle speed is increased to smooth cold engine operation and prevents stalling. As soon as the engine warms, the choke opens and the fast idle cam is deactivated. When the throttle is opened, the choke linkage swings away from the fast idle screw and the engine returns to curb idle (normal, hot idle speed).

If for some reason the engine should flood when it is cold, a device is needed to open the choke, so air may be admitted to correct the condition. This is accomplished by the choke un loader The choke un loader can be either mechanical- or vacuum-operated.

A mechanical choke un loader physically opens the choke plate any time the throttle swings fully open. It uses a metal lug on the throttle lever. When the throttle lever moves to the fully opened position, the lug pushes on the choke linkage (fast idle linkage). This provides the operator a means of opening the choke. Air can then enter the air horn to help clear a flooded engine (engine with too much liquid fuel in the cylinders and intake manifold).

A vacuum choke un loader also called a choke brake, uses engine vacuum to crack open the choke plate as soon as the engine starts. It automatically prevents the engine from flooding.

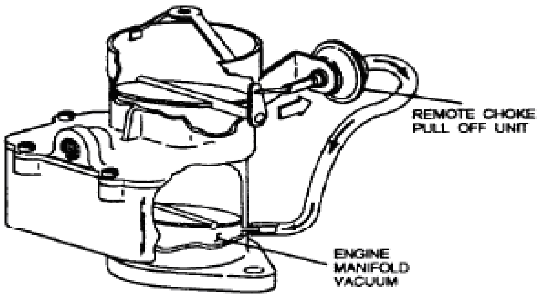


Figure 1.36 choke brake

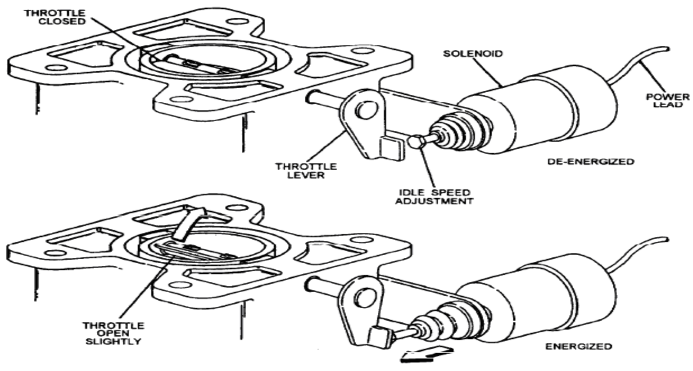
Before the engine starts, the choke spring holds the choke plate almost completely closed. This action primes the engine with enough fuel for starting. Then as the engine starts, the intake manifold vacuum acts on the choke brake diaphragm. The diaphragm pulls the choke linkage and lever to swing the choke plate open slightly. This action helps avoid an overly rich mixture and improves cold engine drivability.

D. Carburetor Accessories

There are several devices used on carburetors to improve drivability and economy. These devices are as follows: the fast idle solenoid, the throttle return dashpot, the hot idle compensator, and the altitude compensator. Their applications vary from vehicle to vehicle.

a) Fast Idle Solenoid

A fast idle solenoid, also known as an anti-dieseling solenoid opens the carburetor throttle plates during engine operation but allows the throttle plates to close as soon as the engine is turned off. In this way, a faster idle speed can be used while still avoiding dieseling (engine keeps running even though the ignition key is turned off). This is a particular problem with newer emission controlled vehicles due to higher operating temperatures, higher idle speeds, leaner fuel mixtures, and lower octane fuel.



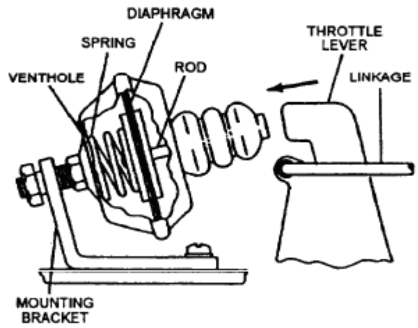


Figure 1.37 Anti dieseling solenoid operation   Figure 1.38 Throttle return dashpot

When the engine is running, current flows to the fast idle solenoid, causing the plunger to move outward. The throttle plates are held open to increase engine speed. The plunger is adjustable, so the idle speed can be adjusted. When the engine is turned off, current flow to the solenoid stops. The solenoid plunger retracts and the throttle plates are free to swing almost closed.

b) Throttle Return Dashpot

The throttle return dashpot, also known as an anti   dashpot acts as a damper to keep the throttle from closing too quickly when the accelerator pedal is suddenly released. It is commonly used on carburetors for automatic transmission equipped vehicles. Without the throttle return dashpot, the engine could stall when the engine quickly returned to idle. The drag of the automatic transmission could kill the engine.

The throttle return dashpot works something like a shock absorber. It uses a spring-loaded diaphragm mounted in a sealed housing. A small hole is drilled into the diaphragm housing to prevent rapid movement of the dashpot plunger and diaphragm. Air must bleed out of the hole slowly.

When the vehicle is traveling down the road (throttle plates open), the spring pushes the dashpot plunger forward. When the engine returns to idle, the throttle lever strikes the extended dashpot plunger, and air leaks out of the throttle return dashpot, returning the engine slowly to curb idle. This action gives the automatic transmission enough time to disconnect (torque converter releases) from the engine without the engine stalling.

c) Hot Idle Compensator

A hot idle compensator is a thermostatically controlled device that prevents engine stalling or a rough idle under high engine temperatures. The temperature sensitive valve admits extra air into the engine to increase idle speed and smoothness.

At normal engine temperatures, the hot-idle compensator valve remains closed, and the engine idles normally. When temperatures are high (prolonged idling periods, for example), fuel vapors can enter the air horn and enrich the air-fuel mixture. The hot idle compensator opens to allow extra air to enter the intake manifold. This action compensates for the extra fuel vapors and corrects the air-fuel mixture.

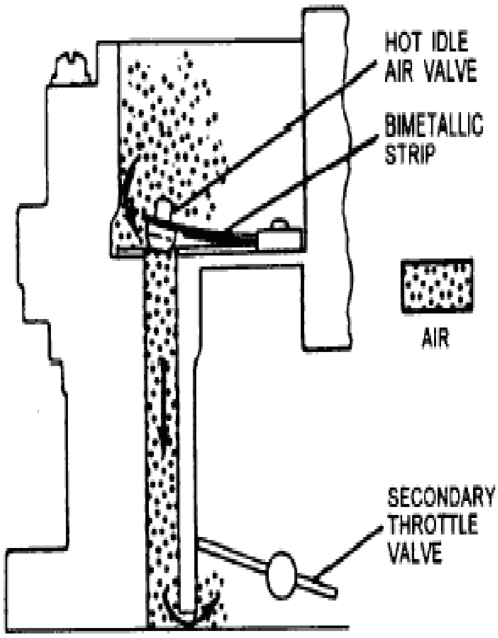


Figure 1.39 hot idle compensator

d) Altitude Compensator

An altitude compensator is used to change the air-fuel mixture in the carburetor with changes in the vehicle height above sea level. Normally the compensator is an aneroid device (bellows device that expands and contracts with changes in atmospheric pressure).As a vehicle is driven up a mountain, the density of the air decreases. This condition tends to make the air-fuel mixture richer. The reduced air pressure causes the aneroid to expand, opening an air valve. Extra air flows into the air horn and the air-fuel mixture becomes leaner.

1.2 Diesel fuel system

1.2.1 Characteristics Diesel Fuel

A. Viscosity of Diesel Fuel

Viscosity is an important property of the fuel that is used in a diesel engine. If the viscosity is too high, the fuel becomes injected into the combustion chamber in large particles, with poorer dissipation qualities, thus resulting in poorer combustion. Because diesel fuel has an additional function to lubricate the fuel system, including injection pump and nozzles, those parts will not receive enough lubrication if the viscosity of the fuel is too low, and they might even seize as a result.

B. Sulfur Contained In Diesel Fuel

During combustion, the sulfur that is contained in fuel converts into sulfuric dioxide and sulfuric anhydride. These gases combine with the water that is created during combustion and converts into sulfuric acid, which has highly corrosive properties. In addition, because sulfur compounds have poor ignitability create black smoke and contaminate the engine oil.

C. Volatility Of Diesel Fuel

Diesel fuel has a high boiling point and is practically not volatile at room temperature. However, during the combustion process in a diesel engine, diesel fuel gasifies first before mixing with air. Combustion occurs when the density of this mixture comes within the combustion range. Thus, it is preferable that the diesel fuel provides some level of volatility.

D. Diesel Knock

If the ignition delay is prolonged, or if too much fuel vaporizes during the ignition delay period, there will be an excessive amount of mixture burning at one time during the second (flame propagation) stage, causing too rapid a pressure rise in the cylinder and thus, noticeable vibration and noise. This is known as diesel knock.

The following methods are employed:

a. Using fuel with a high cetane value,

b. Raising the air temperature and pressure at the start of injection,

c. Reducing the injection volume at the start of fuel injection,

d. Raising the combustion chamber temperature (especially in the immediate area of fuel injection)

To reduce diesel knock, spontaneous ignition is made to occur as soon as possible. (In the gasoline engine, on the contrary, means must be taken to prevent spontaneous ignition.)

The diesel fuel injection system is a major component of a properly operating engine. An engine out of adjustment can cause excessive exhaust smoke, poor fuel economy, heavy carbon buildup within the combustion chambers, and short engine life.

Like the gasoline engine, the diesel engine is an internal combustion engine using either a two- or four-stroke cycle. Burning or combustion of fuel within the engine cylinders obtains power. The diesel engine does not use a carburetor because the diesel fuel is mixed in the cylinder with compressed air. Compression ratios in the diesel engine range between 14:1 and 22:1. This high ratio causes increased compression pressures of 3000-5600Kpa and cylinder temperature reach 7000c to 9000c. At the proper time, the diesel fuel is injected into the cylinder by a fuel injection system, which usually consists of a pump, fuel line, and injector or nozzle. When the fuel oil enters the cylinder, it will ignite because of the high temperatures. The diesel engine is known as a compression-ignition engine, while the gasoline engine is a spark-ignition engine. Mechanically, the diesel engine is similar to the gasoline engine. The intake, compression, power, and exhaust strokes occur in the same order. The arrangement of the pistons, connecting rods, crankshaft, and engine valves is about the same.

In comparison to the gasoline engine, the diesel engine produces more power per Kg of fuel, is more reliable, has lower fuel consumption per horsepower per hour, and presents less of a fire hazard. These advantages are partially offset by higher initial cost, heavier construction needed for its high compression pressures, and the difficulty in starting which results from these pressures.

1.2.2 Functions of Diesel fuel injection systems

Diesel fuel injection systems must accomplish five particular functions: meter, inject, time, atomize, and create pressure. A description of these functions follows:

You can remember these functions by the initials, MITAC. All five of these functions are necessary for complete and efficient combustion

Metering Accurate;- metering or measuring of the fuel means that, for the same fuel control setting, the same quantity of fuel must be delivered to each cylinder for each power stroke of the engine. Only in this way can the engine operate at uniform speed with uniform power output. Smooth engine operation and an even distribution of the load between the cylinders depend upon the same volume of fuel being admitted to a particular cylinder each time it fires and upon equal volumes of fuel being engine.

A. Injection Control:-A fuel system must also control the rate of injection. The rate at which fuel is injected determines the rate of combustion. The rate of injection at the start should be low enough that excessive fuel does not accumulate in the cylinder during the initial ignition delay (before combustion begins). Injection should proceed at such a rate that the rise in combustion pressure is not great, yet the rate of injection must be such that fuel is introduced as rapidly as possible to obtain complete combustion. An incorrect rate of injection affects engine operation in the same way as improper timing. When the rate of injection is too high, the results are similar to those caused by an injection that is too early; when the rate is too low, the results are similar to those caused by an injection that is too late.

B. Timing In addition to measuring the amount of fuel injected, the system must properly time injection to ensure efficient combustion so that maximum energy can be obtained from the fuel. When the fuel is injected too early in the cycle, ignition may be delayed because the temperature of the air, at this point, is not high enough. An excessive delay, on the other hand, gives rough and noisy operation of the engine. It also permits some fuel to be lost due to the wetting of the cylinder walls and piston head. This, in turn, results in poor fuel economy, high exhaust gas temperature, and smoke in the exhaust. When fuel is injected too late in the cycle, all the fuel will not be burned until the piston has traveled well past top center. When this happens, the engine does not develop enough power, the exhaust is smoky, and fuel consumption is high.

C. Atomization of Fuel:-As used in connection with fuel injection, atomization means the breaking up of the fuel, as it enters the cylinder into small particles, which form a mist like spray. Atomization of the fuel must meet the requirements of the type of combustion chamber in use. Some chambers require very fine atomization; while others function with coarser atomization. Properly atomization makes it easier to start the burning process and ensures that each minute particle of fuel is surrounded by particles of oxygen with which it can combine.

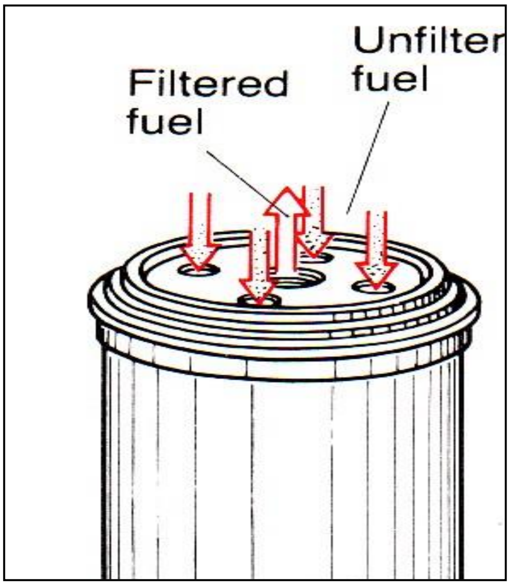
D:-Creating Pressure:-A fuel injection system must increase the pressure of the fuel to overcome compression pressure and to ensure proper dispersion of the fuel injected into the combustion space. Proper dispersion is essential if the fuel is to mix thoroughly with the air and burn efficiently. While pressure is a chief contributing factor, the dispersion of the fuel is influenced, in part, by atomization and penetration of the fuel. (Penetration is the distance through which the fuel particles are carried by the motion given them, as they leave the injector or nozzle.)

1.2.3 Components of Diesel Fuel System

A. Fuel Filters

Since the injection pump and the injectors are manufactured to very high standards of precision (1 /1000 mm (1 /40 in.)), even the smallest particle of dirt or other foreign body would cause severe wear or damage within a short time, and render the item concerned unserviceable. It is therefore a more economical proposition in the long run to keep the fuel filter in good working order than to be obliged to renew expensive pump elements or injectors.

✓ **type fuel filters element**



In addition to filters with replaceable elements, box-type filters are being used increasingly today. A sheet-metal box containing the paper element is screwed to the filter cover. The filter box has inlet holes for the unfiltered fuel, and 1 outlet hole for the filtered fuel. The outlet hole is tapped, and is also used to screw the filter box to the cover. The complete box is renewed when the filter element becomes unserviceable. It is unscrewed from the cover and discarded, after which a new box is screwed on hand tight until the sealing ring makes firm contact. It is then given another quarter-turn to tighten it finally. The old filter elements must be scrapped, as they cannot be cleaned. This also eliminates the risk of damage to the fuel injection system if replaceable filter elements were to be installed again after incorrect or careless cleaning

Paper is the material mostly used for filter elements. Depending on the arrangement of the paper for the filter element, we distinguish between wrapped filter elements and star-shaped filter elements (see Figure above). The paper of a wrapped-type element is wound round a tube .The fuel flows through the filter axially, from top to bottom, so that dirt particles are trapped in the V-shaped pockets. After purification, the fuel flows back up through the central tube.

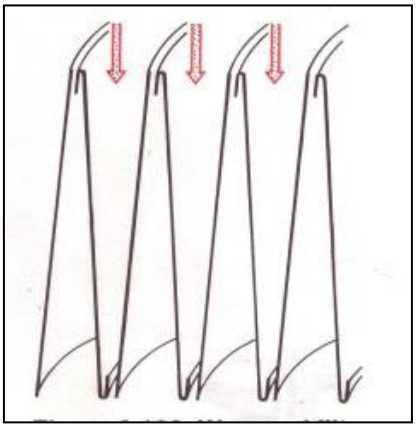


Figure 1.42 Wrapped filter

The star-shaped filter element is placed in position round a perforated tube. The fuel flows radially through the filter, from the outside inwards, so that dirt particles are trapped in the folds of the element or drop to the bottom. The filtered fuel flows through the perforations and up the central tube.

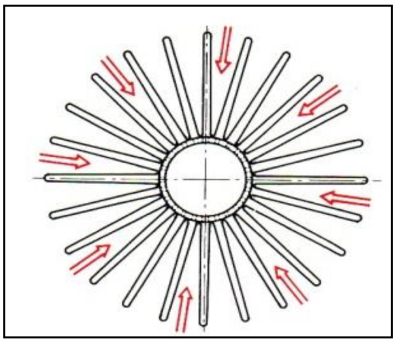
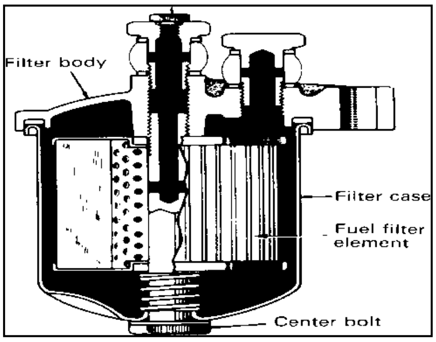


Figure1.43 Star pattern filter

- ✓ **Single-stage fuel filters and multi-stage fuel filters**

Single stage filter consists of the filter cover with tapped holes for the fuel IN and OUT a center bolt for the filter can.



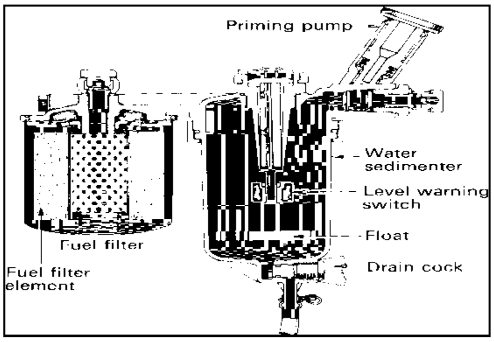


Fig.1.44 Fuel filter (single stage) Fig.1.45 Fuel filter and sedimentary (Two stage filter)

To eliminate water, which may have entered the fuel as a result of careless refueling, incorrect storage of the fuel or the formation of condensate in the fuel tank, a water trap is provided on the filter. The water, which collects here, can be removed from the system by unscrewing a drain plug.

In the two-stage fuel filter the fuel first passes through the course filter to the fine filter. The fuel filter for the distributor type injection pumps is often combined with a priming pump and a water sediment. The priming pump is a manual unit containing a reciprocating piston used to draw in diesel fuel to bleed air or water from the fuel system. It is normally locked to prevent it from operating while the engine is running.

- ✓ **Water Sediment.**

The water sediment separates water from the diesel fuel by using the difference in specific gravities between it and the diesel fuel. When the water level and the float rise beyond a specified limit, a magnet inside the float closes a reed switch. This lights an indicator lamp on the combination meter to warn the driver that water has accumulated in the water sedimentary. The sedimentary has a cock underneath.

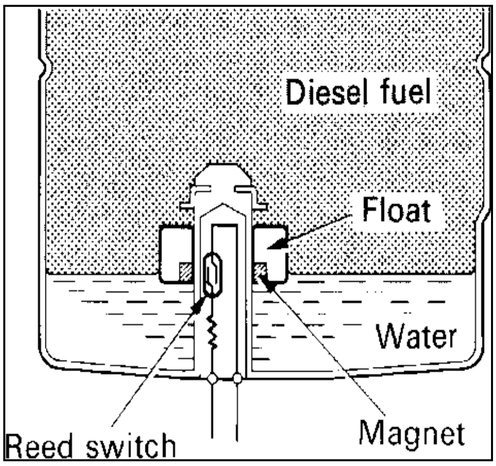


Fig.1.46 Water level detection switch

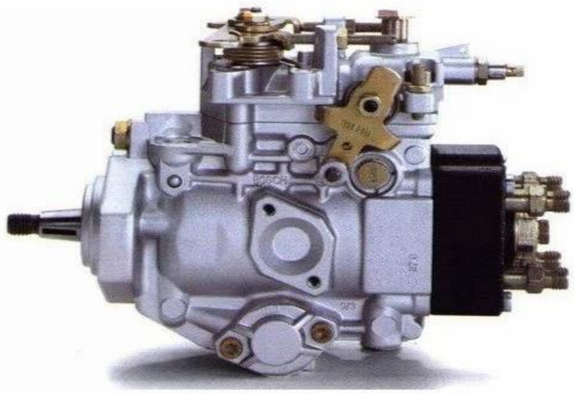
Water can be removed by un tightening the cock and operating the priming pump. Water is heavier than the diesel fuel and so sinks to the bottom. The float is lighter than water but heavier than the diesel fuel. Therefore, the float rises as the water level under the fuel increases. When it reaches the water level detection switch (a reed switch), the magnet inside the float turns the switch on to issue a warning.

B. Distributor Type Injection Pump (VE Type)

VE in the name of the Bosch pump used in many diesel engines stands for "Verteiler", which is German for distributor or divider. The other common kind of injection pump is the inline pump. The difference between them is that the VE pump has one fuel-metering plunger, and a mechanism (distributor) to send the fuel to the right cylinder.

The inline pump has one plunger for each cylinder. The Bosch VE has comparatively few moving parts, but what does move does so in a complex way Today's high speed-diesel engines have been making great progress towards higher fuel economy while maintaining drivability and performance. In addition to meeting these demands, it has been necessary to reduce the size and the weight of the fuel injection pump as well as increase it's reliability.

The VE-type/distributor pump differs from the conventional/In-line pump in several ways. The main difference is that the VE pump uses only one pumping plunger for all engine cylinders while the In-line type pump has one pumping element for each cylinder. This feature alone allows for fewer parts as well as



reduced size.

Features

The following design features of VE-type pump has made it more suitable than the conventional Inline type pump for the modern high-speed diesel engine.

1) Compact And Lightweight With Fewer Parts: The four cylinder VE pump is slightly smaller than a four cylinder Incline pump, while the six cylinder VE pump is about half the size of a six cylinder Incline pump..

2) Uniform Fuel Delivery: By using a single plunger to distribute fuel to all the cylinders, less cylinder-to-cylinder variation is achieved. One advantage to uniform fuel delivery is the reduction of engine noise levels.

3) Improved Starting: A start spring (leaf type) in the pump acts to provide additional fuel when starting the engine. This feature facilitates engine starting in cold weather, especially when used on engines that incorporate a pre-combustion design.

4) Idle Stability: Uniform fuel delivery ensures stability and smoother engine idle speeds.

5) Lubrication: The filtered diesel fuel that is supplied by the feed pump lubricates the internal working parts of the pump. This design eliminates the need for engine oil type lubrication of the injection pump.

6) External Fuel Adjustment: Ease of adjustment is achieved by the external location of the maximum fuel delivery adjustment screw.

7) Shut-Off Solenoid: The fuel supply is shut-off by merely turning off the engine ignition switch.

8) Combined Capability: As a unit the VE pump incorporates the combined features of an injection pump, a feed pump, and a hydraulic timing device.

9) Non-Reversing: Due to internal pump design the engine will not run in the reverse direction.

10) Additional Devices: Several control devices may be fitted to the VE pump to achieve different fuel delivery characteristics as may be desired. (Automatic Cold Start Device, Load Sensing Timer, etc.)

11) Versatile Mounting: The VE pump may be mounted to an engine either horizontally or vertically.

Constructions and Operation

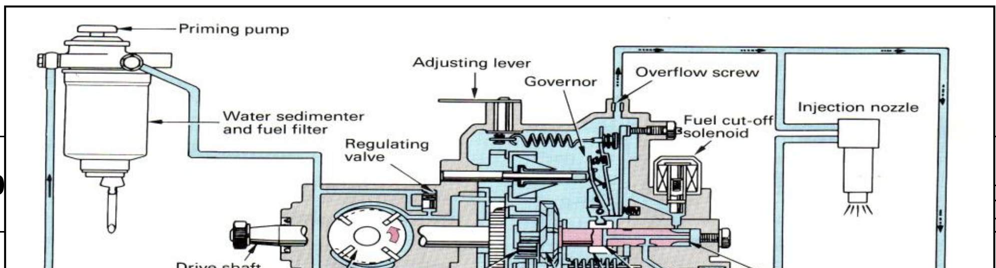


Fig. 1.47 Fuel system for Distributor (VE type) fuel injection pump

The engine drives the VE pump drive shaft. The drive shaft runs in bearings in the pump housing and drives the vane-type fuel feed pump, and cam plate and plunger. The feed pump draws fuel from the fuel tank through the fuel filter and sedimentary.

The pressure-regulating valve that is located in the upper part of the feed pump controls the fuel feed pressure.

The plunger moves inside the distributor head, which is bolted to the pump housing. The motion of the distributor plunger, within the distributor head, delivers high-pressure fuel to the combustion chamber of each cylinder. Installed in the distributor head are the electrical fuel shutoff device, the screw plug with vent screw, and the delivery valves with their holders.

The hydraulic injection-timing device is located at the bottom of the pump at right angles to the pump's longitudinal axis

The governor cover forms the top of the distributor pump, and also contains the full-load adjusting screw, the overflow restriction or the overflow valve, and the engine-speed adjusting screw. On the governor mechanism's topside is the governor spring, which engages with the external control lever through the control-lever shaft. The control lever is connected to the accelerator pedal.

. Subassemblies:

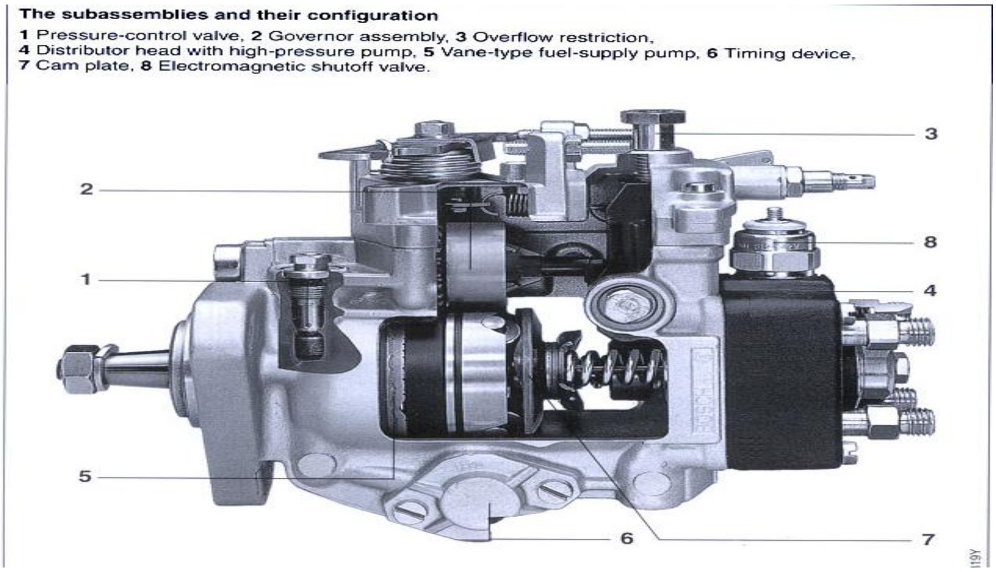


Fig 1.48 Sub-assemblies of the VE pump

- The distributor pump's closed housing contains the following functional groups:
- Vane-type fuel-supply pump and regulating valve,
- High-pressure pump with distributive head,
- Mechanical (flyweight) governor
- Shutoff device,
- Hydraulic timing device,
- Additional devices.

The additional devices facilitate adaptation to the specific requirements of the diesel engine in question.

Pump drive:

For 4-stroke engines, the pump is driven at exactly half the engine crankshaft speed, in other words at camshaft speed. The VE pump must be positively driven so that it's drive shaft is synchronized to the engine's piston movement.

This positive drive is implemented by means of toothed belts, gear wheel or chain.

Feed Pump & Regulating Valve:

On the leftmost end of the pump section is the fuel feed pump. The vane type feed pump has four blades and is driven by the drive shaft. Its purpose is to suck fuel from the tank and deliver it to the pump sing under pressure.

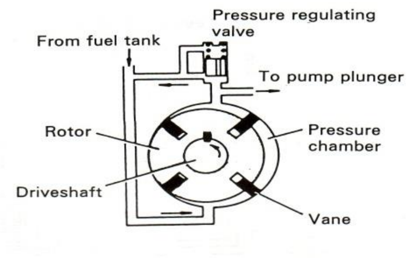


Fig. 49 Feed pump.

The regulating valve regulates fuel Pressure inside the injection pump in proportion to engine rpm.

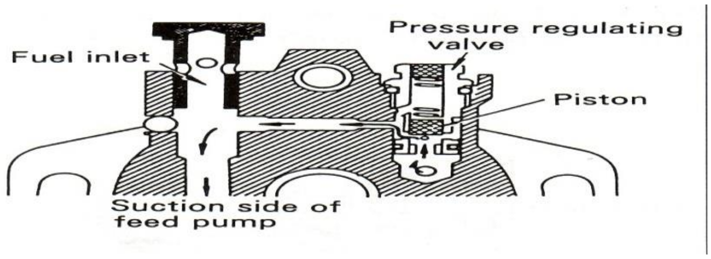
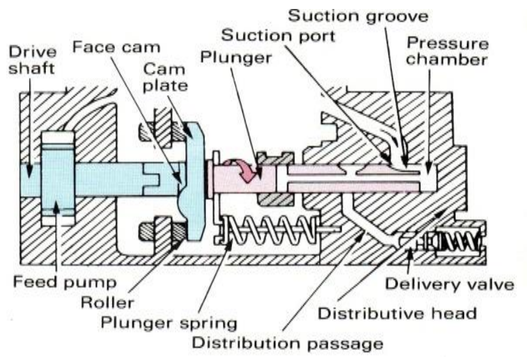


Fig. 1.50 regulating valve.

Pumping and Distribution Unit

Construction: All the things shown on the right in the pump section have to do with the pumping, metering, and distribution of fuel delivery. The figure below shows this part in detail. The cam plate is driven by the drive shaft. As illustrated, the cam plate has four face cams (one for each cylinder) and rides on four rollers. As the face cam and the distributor plunger rotate, they reciprocate back and forth over the rollers. Therefore, with one turn of the cam plate, the plunger makes one complete turn and reciprocates four times, one at 0, 90, 180 and 270 degrees.



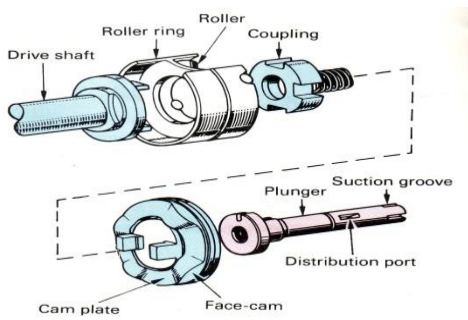


Fig.1.51 Pumping and distributing unit

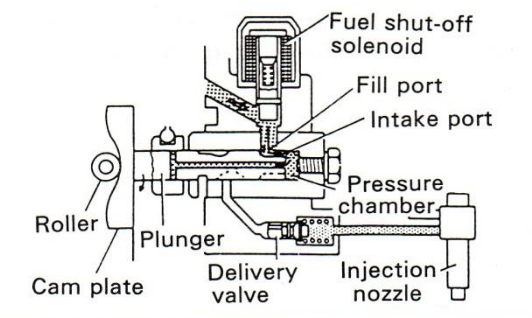
Fig.1.52 Plunger drive

Some of the fuel through spill ports, and thus changing the effective stroke. This is done by uncovering a spill port under the control sleeve at a particular angle of rotation.

Operation:

Intake stroke: When the pump plunger moves to the left, one of the four suction grooves in the pump plunger will align with the suction port and fuel will be drawn into the pressure chamber and from there into the passage in the plunger.

Injection stroke: As the cam plate and plunger turn, the suction port is closed off and the distribution port of the plunger will be aligned with one of the four distribution passages in the distributive head. As the cam plate rides onto the rollers, the plunger turns and moves to the right, causing the fuel to be compressed. When the fuel is pressurized to the predetermined value, it is injected from the



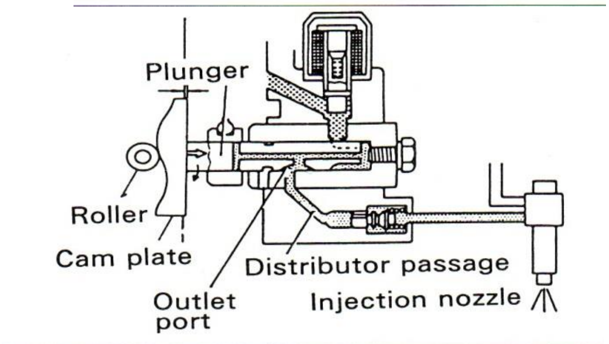
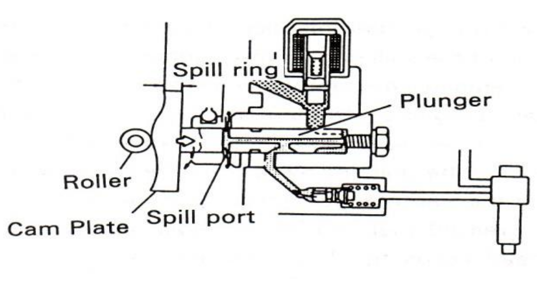


Fig. 1.52 Intake stroke Fig.1.53 Injection stroke



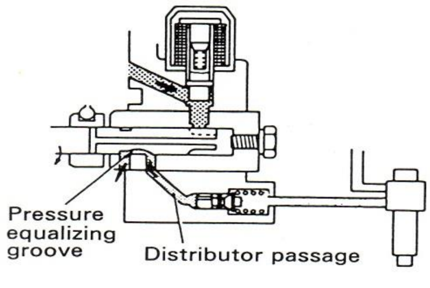


Figure 1.54 End of injection Figure 1.55 End of injection: (Termination)

When the pump plunger moves even further toward the right, the two plunger spill ports will move out from under the spill ring and the fuel, under pressure, will be forced back into the pump housing through these spill ports. Thus, fuel pressure will suddenly drop and injection will be terminated.

Pressure equalization: When the plunger has turned 180° after delivery, the pressure-equalizing groove on the plunger aligns with the distribution passage in order to equalize the pressure of the fuel in the passage and that in the pump housing. This pressure equalization minimizes fuel delivery spread between cylinders and allows for a smoother running engine.

Fuel Cut of Solenoid:

Engine cut-off is accomplished by stopping the fuel supply. The passage from the pump housing is closed and delivery of pressurized fuel is terminated by the fuel cut-off solenoid, which is designed to close the passage when the engine starter switch is turned off (to the lock position). This allows the engine to be turned off in the same manner as a gasoline engine. With the ignition switch in the off position, shut-off is accomplished by an electric solenoid located on the top of the distributor head.

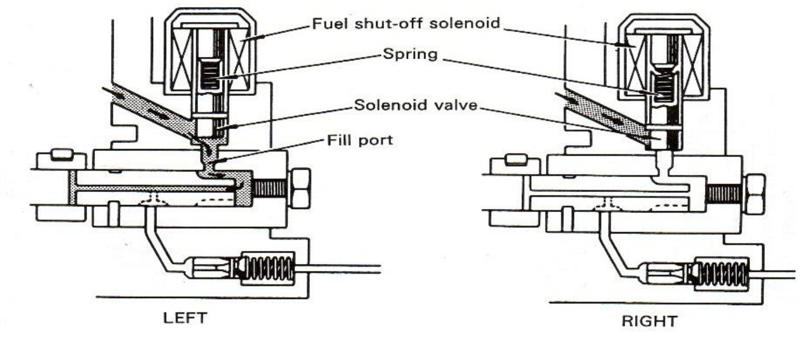


Fig. 1.57 Operation Automatic Timer (Injection Timing Control)

As in the case of gasoline engine ignition timing, diesel engine injection timing must be advanced in accordance with the engine speed in order to obtain optimum performance. For this, the VE type injection pump incorporates an automatic timer, which is operated by the fuel pressure, advancing or retarding the injection timing in proportion to increases or decreases in engine speed.

Construction and Operation:

The hydraulic injection-timing device is located at the bottom of the pump at right angles to the pump's longitudinal axis. The timer piston slides in accordance with the balance of the fuel pressure and timer spring tension.

The slide pin converts the lateral motion of the timer piston into the rotational motion of the roller ring.

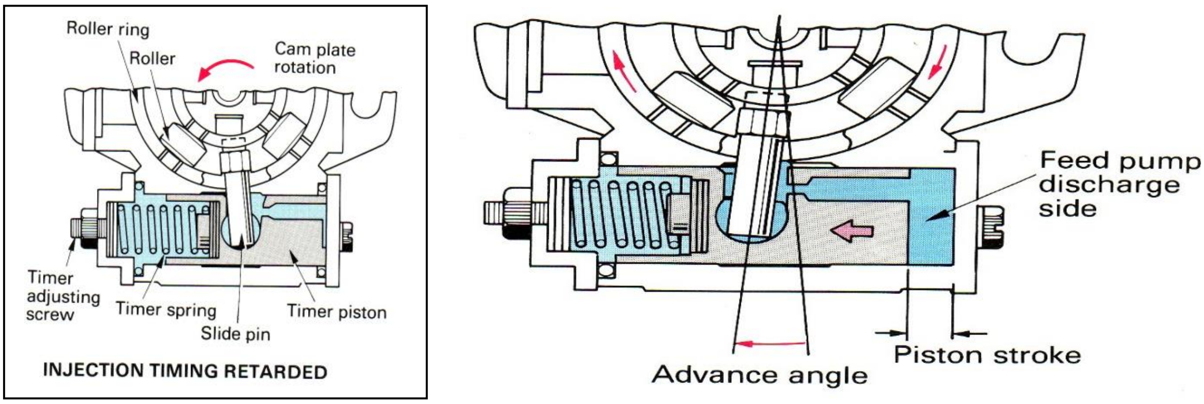


Fig. 1.58 Advancing

The timer spring attempts to force the timer piston to move in the injection "retard" direction (to the right). However, as engine rpm rises, fuel pressure also rises, so the piston overcomes the timer spring tension and moves to the left. In accordance with the piston movement, the roller ring moves in the direction opposite that of pump plunger rotation, thus advancing injection timing relative to the cam plate position.

Governor (For Ve Injection Pump)

The main purpose of a governor is to control the engine speed, within limits, during various load conditions.

The governor is built into the upper part of the VE type pump, incorporating a centrifugal flyweight type of arrangement, a governor lever, a control spring, and adjusting lever. (See Fig below)

The VE Type Pump Uses Two Types Of Governor, The "All-Speed" And "Min. / Max. Speed."

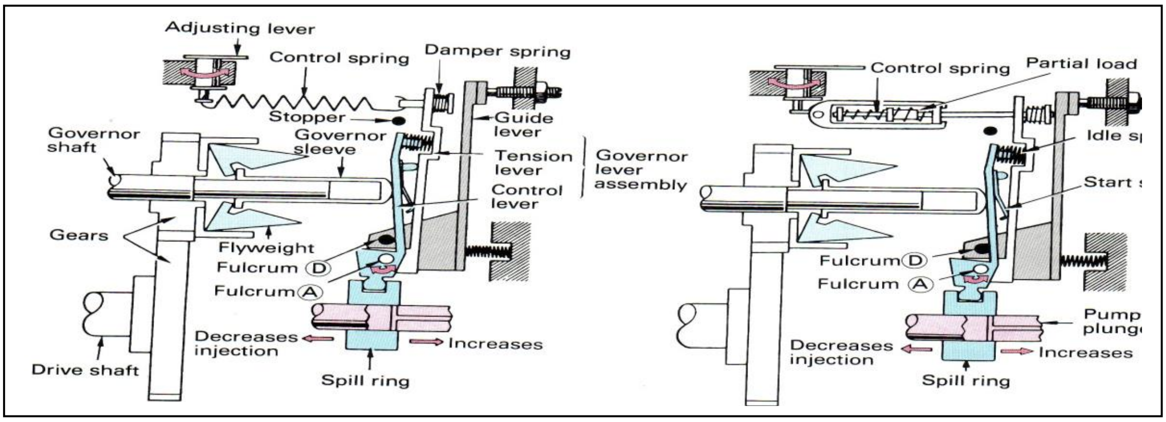


Figure 1.59 All speed governor (left) and Min/ Max speed governor (right)

Principle of Operation:

The flyweight assembly, located on the governor shaft is rotated approximately 1.6 times the speed of the pump drive shaft. As the driveshaft rotates it spins the flyweight assembly causing the flyweights to move outward. The four flyweights move against the thrust washer and, governor sleeve on the governor shaft. The governor sleeve acts on the governor lever assembly.

The governor lever assembly adjusts the position of the spill ring in accordance with engine speed and load. It is composed of the guide lever, the control lever, and the tension lever; these levers are all linked at fulcrum A, which is free-floating. The guide lever further pivots around fulcrum D, which is fixed to the governor housing.

The control spring tension varies with the load (i.e., how far the accelerator pedal is de-pressed). The damper spring and idle spring prevent governor "hunting" by pushing slightly against the tension lever and control lever (respectively) as these levers move to the right (i.e., in the direction of decreased injection).

All speed governor:

The all-speed governor controls the speed at which breakaway or governor control takes place, at any all speeds between idle and maximum speed.

Operation of the all speed governor

Starting: Moving the adjusting lever to the full fuel position put tension on the control spring, pulling the governor lever assembly against the stopper. The start spring (leaf type spring) holds the control lever against the governor sleeve at the low cranking speed. This holds flyweights closed while providing maximum travel of the spill ring and creating maximum effective of the plunger.

Idling: Once the engine has started, the adjusting lever is returned to the idle position. With little or no tension on the control spring, the centrifugal force of flyweight is counterbalanced by the force of the idle and damper springs. This balance of force is sufficient to maintain stability, under normal conditions, at idling speed.

Full load: With the adjusting lever moved to the full load position, the control spring tension is increased. The effective stroke is immediately increased and engine speed increases. As the flyweights move outward, due to increasing engine speed, they force the governor sleeve to overcome the tension of the start spring, the damper spring, and the idle spring. The spill ring is thus held in the full fuel position.

Maximum speed control: When engine speed overcomes the predetermined maximum speed, flyweight force overcomes the tension of the control spring. At this point, the governor lever assembly pivots to move the spill ring toward a "no fuel position." With this action engine maximum speed is controlled

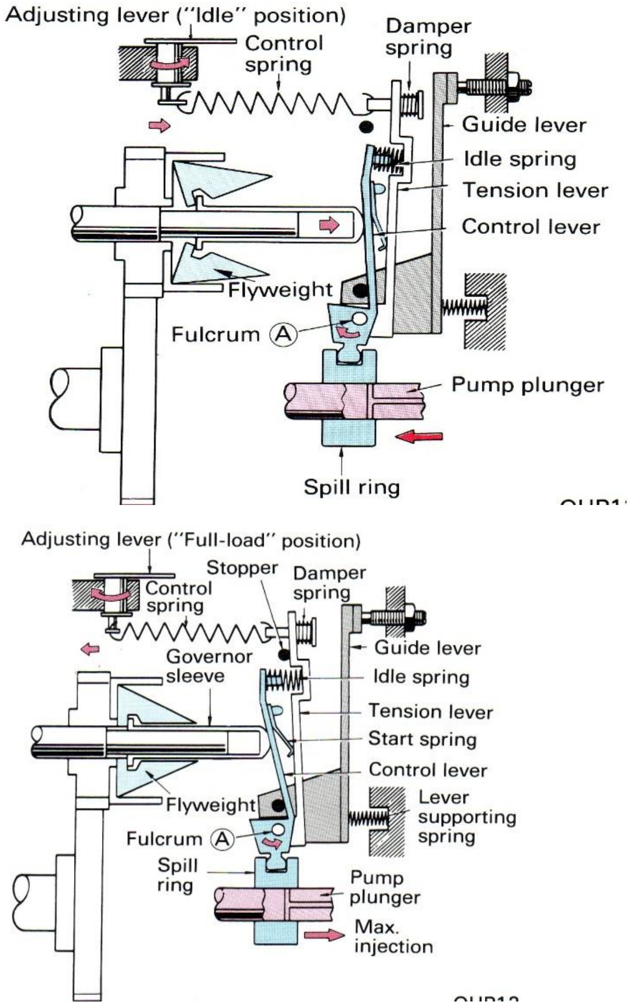
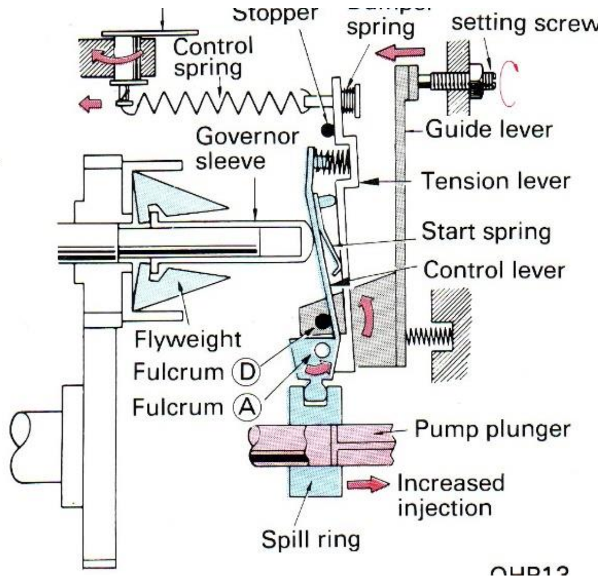


Fig. 1.60 **Idling**:



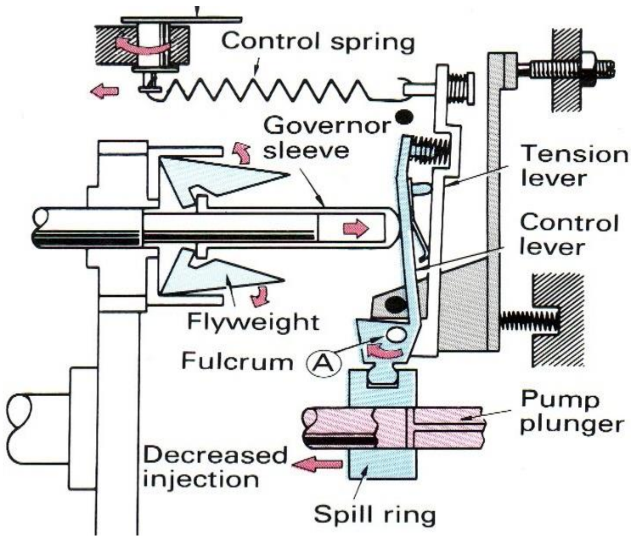


Fig. 1.61 Full load **Fig. 1.62 Maximum speed**

Minimum Maximum Speed Governor:

Operation:

1. Starting: As the accelerator pedal is depressed, the adjusting lever will move toward the "Full-load" position. The spring holder pulls the tension lever until it comes into contact with the stopper. Since the engine is still stopped, the flyweights are not in motion and the control lever is pushed against the governor sleeve by the slight tension of the start spring so that the flyweights are in the fully closed position. At this time, the control lever revolves counterclockwise around fulcrum A and moves the spill ring to the start position. In this manner, the necessary quantity of fuel is supplied to the engine for starting

2. Idling: After the engine is started, the accelerator pedal is released and the adjusting lever returns to the "Idle" position. In this position, the control spring is fully extended, so it does not pull on the tension lever. Therefore even though rpm is low, the flyweights begin to move outward. This causes the governor sleeve to move to the right, pushing the control and tension levers to the right against the tension of the start, idle, and damper springs. The control lever therefore turns clockwise around fulcrum A, moving the spill ring to the idle position. The balance thus maintained between the centrifugal force of the flyweights and the tension of the start, idle, and damper springs provides stable rpm during idling.

3. Full Load: As the accelerator pedal is depressed, the adjusting lever moves to the "Full-load" position, the spring holder is pulled to the left and the partial load and damper springs are fully contracted. The tension lever therefore contacts the stopper and remains stationary. Furthermore, as the governor sleeve pushes the control lever, it contacts the tension lever so the spill ring maintains the full load position.

4. Maximum Speed: As the engine speed rises under a full load, the thrust of the flyweights become stronger than the control spring tension. The tension lever and control lever will therefore revolve clockwise together around fulcrum A, thereby moving the spill ring to the left, decreasing injection volume in order to prevent engine overrun.

5. Partial Load: When the adjusting lever is located between the "Full-load" and "Idle" positions, the partial load spring contracts due to the centrifugal force of the flyweights. The entire control lever therefore revolves clockwise around fulcrum A, causing the spill ring to move to the left, and decreasing injection volume. For this reason, compared with the full-load characteristics, the injection volume tends to gradually decrease toward the right so that the injection volume varies in closer accordance with the amount the accelerator is depressed.

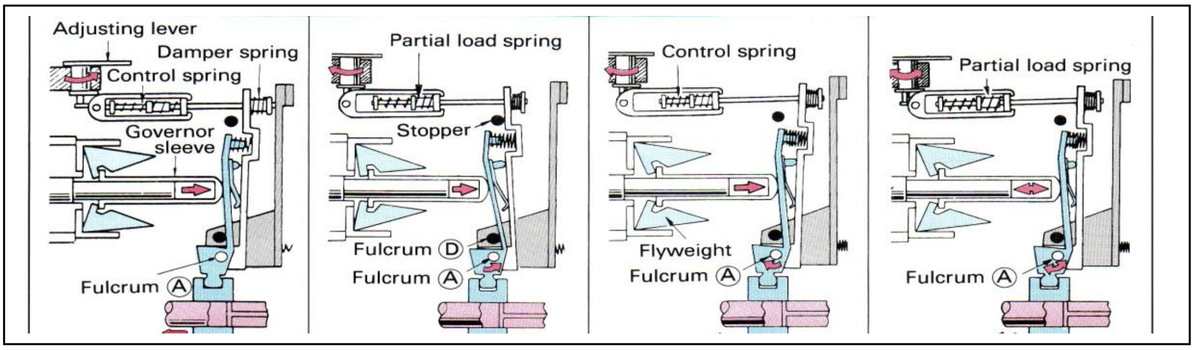
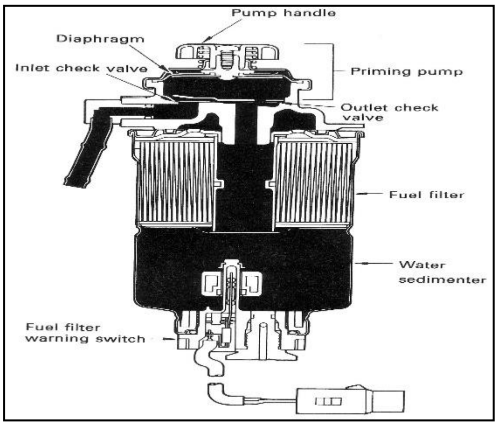


Fig. 1.63 Min/Max Speed Governor

C. Priming Pump

If the tank runs out of fuel, or when the fuel filter or injection nozzles, etc., is replaced, air can get into the fuel system.



If this air is allowed to remain in the fuel system, it will be impossible for the feed pump or the plunger of the injection pump to deliver fuel when starting of the engine is attempted, so the engine will not start.

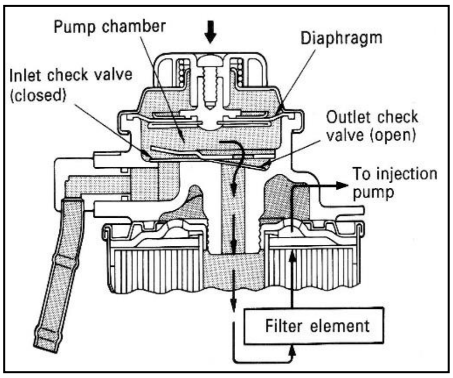
Therefore, in such a case, it is necessary to use a priming pump to bleed the air out of the fuel system before starting the engine.

There are two types of priming pump, one for distributor type injection pump and one for inline type injection pump.

Here, we will explain the priming pump for the distributor type injection pump.

Fuel Filter with Priming Pump (For Distributor Type Injection Pump)

1. Operation

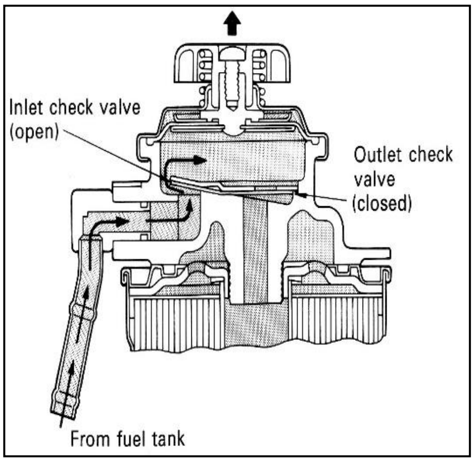


Pushing the pump handle pushes the diaphragm down and the fuel (or air) in the pump chamber opens the outlet check valve and flows to the fuel filter.

At the same time, the inlet check valve closes and the reverse flow of fuel is prevented.

When the pump handle is released, the force of the spring returns the diaphragm to its original position and creates a vacuum inside the pump chamber. This results in the inlet check valve being opened by the vacuum and fuel being drawn into the pump chamber. At the same time, the outlet check valve closes to prevent the reverse flow of fuel. Repeating this up and down operation causes the fuel to be sent to the fuel filter.

Feed Pump



Ordinarily, the fuel tank and the engine of an automobile diesel engine system are located apart from each other, with the tank located lower than the injection pump. The fuel filter, which contains filter paper with minute pores that prevent even extremely small impurities from passing through, also applies resistance to fuel flow. Meanwhile, the fuel chamber of the injection pump must be always filled with fuel.

Driven by the camshaft of the injection pump, the fuel feed pump draws up fuel from the tank. Then, the fuel feed pump applies sufficient pressure for the fuel to overcome the resistance of the fuel filter, thus delivering clean fuel to the injection pump.

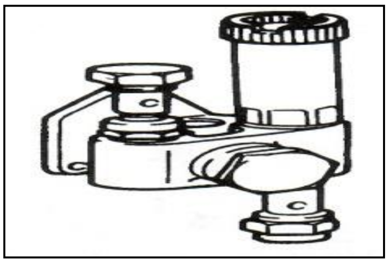
The piston-type fuel feed pumps that are used on an in-line injection pump can be broadly classified into the two types described below.

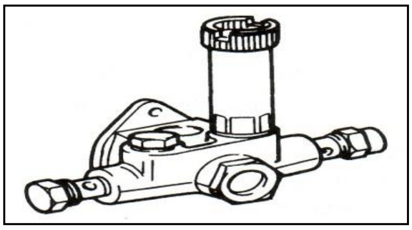
a. Single action piston type (possessing a relatively small plunger diameter, this type of pump delivers a relatively low injection volume)
b. Double action piston type (applicable on large pumps with multiple cylinders and a high injection volume)

a. Single-Action Piston Type

There are two types of single-action type pumps (see fig below), and the type of fuel pipe routing that is used determines their application.

The first type is primarily used on PES type (flange mounted) injection pumps with a relatively small area for attaching fuel pipes. The fuel suction and discharge ports are fitted vertically.





Construction:

- A manual-priming pump for air bleeding is mounted on the feed pump housing.
- A suction valve located below the priming pump is pushed in place by a spring.
- A piston in the center of the housing is pushed in place by a piston spring .
- A blind plug holds the piston spring in place. A pushrod located opposite to the blind plug pushes the piston.

- A tappet roller pushes the pushrod in place.
- A discharge valve is located opposite to the suction valve.

Thus, the feed pump consists of two functions: The mechanically driven portion, which effects fuel suction and discharge during periods when the engine is operating. And the priming pump portion, which manually effects fuel suction and discharge, to bleed air from the fuel piping system, without having the engine operating.

The basic construction of the two single action feed pump types is the same.

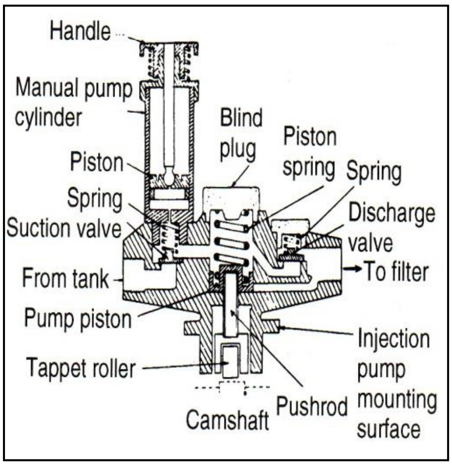


Fig.1.65 Feed pump construction (single acting)

Operation (single-action type):

a. Preparatory Stroke

When the cam rotates to "high cam" position to push the tappet downward, the tappet and pushrod cause the piston to move against the piston spring and compress it. This movement forces the fuel out of the suction chamber, through the discharge valve, and into the pressure chamber (partially to the injection pump). Toward the end of the intermediate stroke, the discharge valve closes again.

b. Suction and Discharge Stroke

When the cam rotates to the "low cam" position, piston spring pressure causes the piston, pushrod and tappet to follow the cam. This movement of the piston pushes the fuel from the pressure chamber, and delivers it to the fuel filter and injection pump. At the same time, piston suction pressure is permitting fuel to enter the suction chamber through the suction valve. With the suction chamber charged with fuel, the pumping cycle begins again.

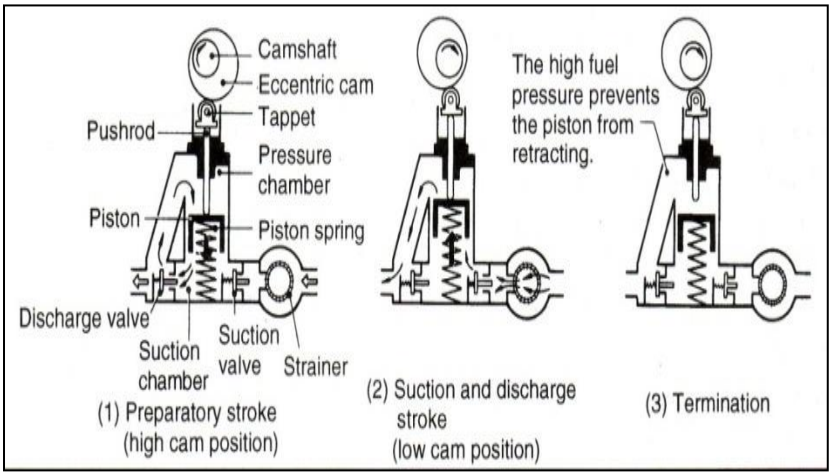


Fig 1.66 feed pump operation (single-action)

c. Termination

If the discharge pressure of fuel rises above approximately 2.5kg/cm^2 (35.6psi), the discharge pressure causes the piston to remain in intermediate stroke position, compressing the piston spring.

b. Double-Action Piston Type Feed Pump

As shown in fig below this type of feed pump contains two fuel suction and delivery valves each.

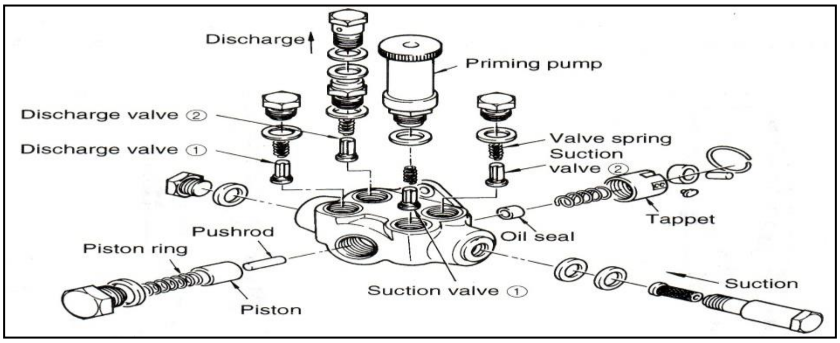
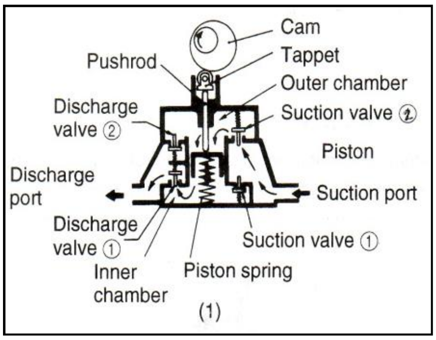


Fig. 1.67 Exploded view of the double-action type feed Pump

OPERATION:

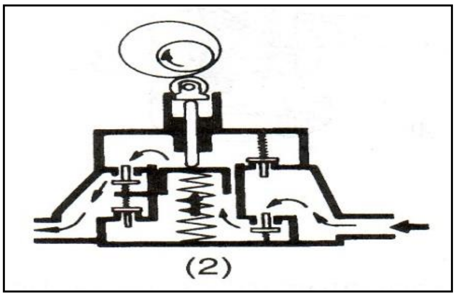
a. Piston Spring Compression Stroke

As shown in Fig above, when the cam applies a downward force to the piston via the feed pump tappet, the discharge valve (1) opens to allow the fuel in the inner chamber to be discharged through the discharge port. At the same time, the suction valve (2) opens to draw fuel into the outer chamber.



b. Piston Spring Retraction Stroke

Then, after the cam rotates to the position shown in fig above (2), the piston is returned to the upper position by the force of the piston spring. At this time, the discharge valve (2) opens to discharge the fuel in the outer chamber, while the suction valve (1) opens to draw fuel into the inner chamber.



The feed pump effects the processes described above to pump fuel during both downward and upward strokes of the piston. Because this type of feed pump generates an extremely high discharge pressure when the cam pushes the piston downward, an overflow valve must be provided in the delivery system.

- ✓ **Diesel Fuel Systems With Distributor Type Injection Pump**

Diesel fuel is drawn from the fuel tank through the sediment or/water separator and fuel filter by the feed pump, which is incorporated in the front of the injection pump. The feed pump not only supplies fuel to the injection pump, but also circulates fuel to lubricate the moving parts of the pump. The single pump plunger meters and distributes the fuel (under pressure) through the nozzle to the combustion chamber, and does so in the correct combustion order. Excess fuel from the pump and nozzles returns to the tank by way of the overflow valve and pipeline. This system of fuel circulation cools and lubricates the injection pump while warming the fuel in the tank to help prevent fuel waxing in cold weather.

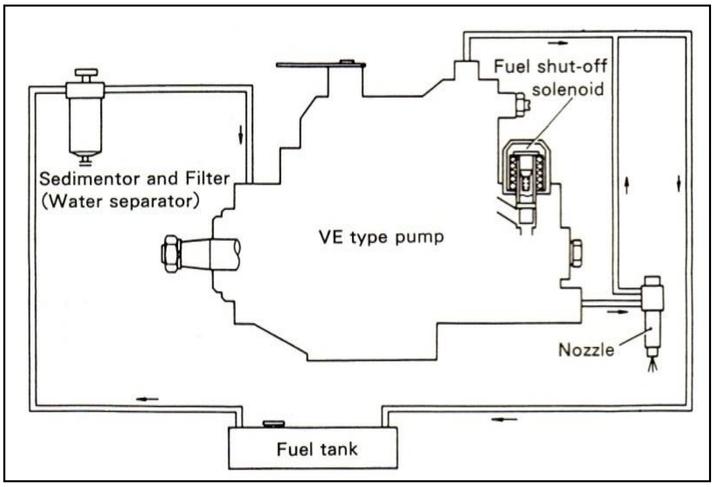


Figure.1.68 Fuel system for Distributor (VE type) fuel injection pump

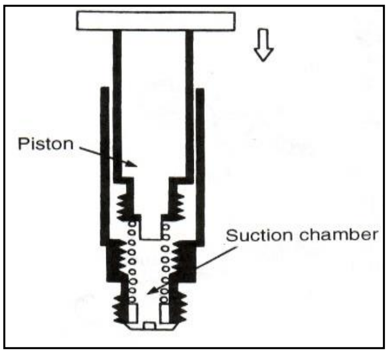
Priming Pump

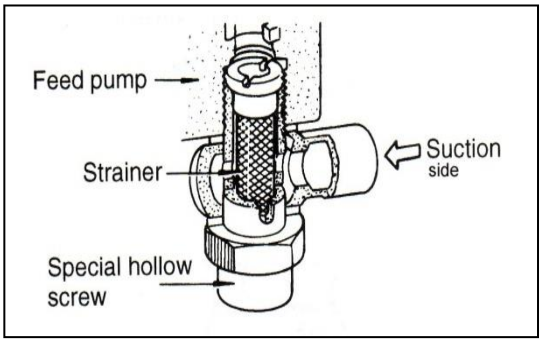
If the tank runs out of fuel, or when the fuel filter or injection nozzles, etc., is replaced, air can get into the fuel system.

If this air is allowed to remain in the fuel system, it will be impossible for the feed pump or the plunger of the injection pump to deliver fuel when starting of the engine is attempted, so the engine will not start. Therefore, in such a case, it is necessary to use a priming pump to bleed the air out of the fuel system before starting the engine.

There are two types of priming pump, one for distributor type injection pump and one for inline type injection pump.

The priming pump for the in-line type injection pump and the feed pump are a single unit mounted on the injection pump body.





Fuel System (For Inline/Multi Plunger Injection Pump System)

The diesel engine fuel system consists of the parts shown on the picture below. The fuel that is drawn from the fuel tank by the feed pump is filtered through the fuel filter, and is delivered to the injection pump.

The fuel that is delivered to the injection pump is pressurized into a highly compressed state, and is delivered via the injection steel pipe to the nozzle. The fuel is then injected in an atomized state into the combustion chamber, where combustion takes place.

A portion of the fuel that is delivered to the nozzle lubricates the sliding portion of the nozzle and returns to the fuel tank via the overflow pipe. To prevent the fuel delivered to the injection pump from becoming excessively pressurized, an overflow valve is provided in the fuel filter or in the injection pumps itself. If the feed pressure from the feed pump exceeds a prescribed value, the overflow valve opens to allow excess fuel to return to the fuel tank via the overflow pipe. The inline injection pump consists of the pump unit with the governor, timer, feed pump, and coupling attached to it.

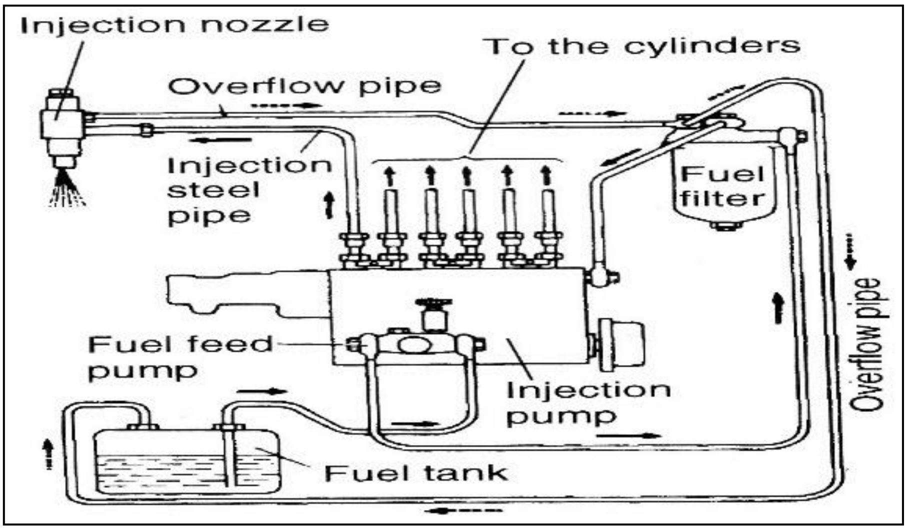
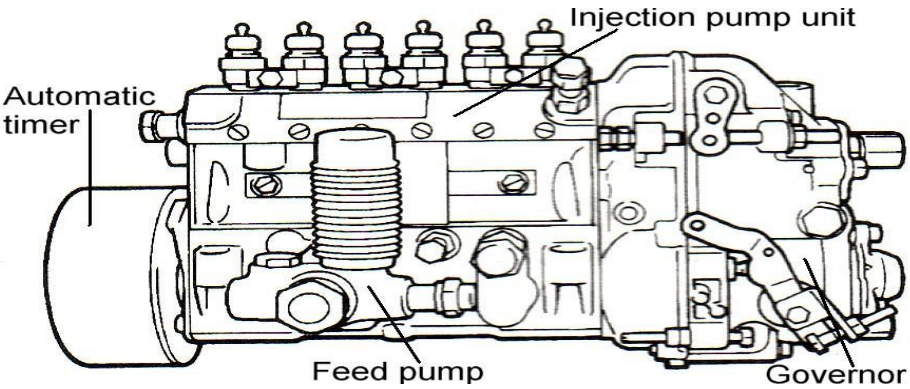


Fig.1.72 Pump components



- **In-Line Injection Pump**

Comparison between Distributor and Inline Type Injection Pumps

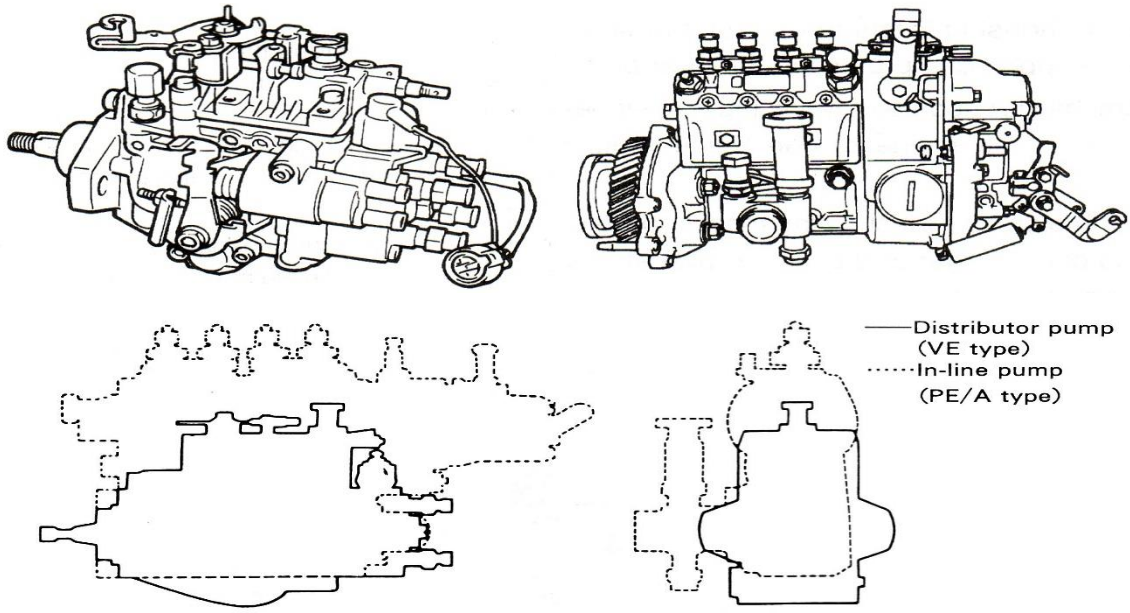


Fig.1.73 Comparison of dimensions of distributor and Inline injection pumps

Types of Inline Injection Pumps

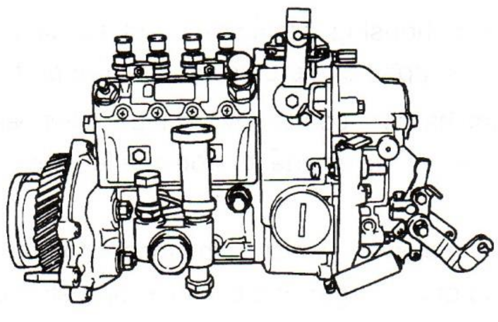


Fig. 1.74 A type

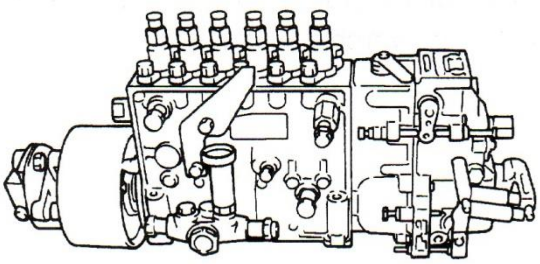


Fig. 1.75 P type

There are three types of in-line pumps, which are manufactured by Nipondenso: A type, NB type, and P type

(1) A Type

Among the types of in-line pumps, this is the most widely used and thus is the most representative of the in-line pumps.

(2) NB Type

To accommodate the use of the direct injection system on medium-size diesel engines, and to comply with exhaust gas emission regulations, injection pumps must meet high injection pressure and high injection rate requirements. To meet these requirements, BOSCH has developed the MW type injection pump, which have achieved improvements in their allowable injection pressure and their allowable injection rate in spite of their compactness, with the same size as the A type pumps.

P Type

Larger diesel engines require injection pumps that can deliver a larger injection quantity and can withstand heavier loads. The P type pumps have been designed to meet these needs. Normally, a strainer for cleaning the fuel is provided at the suction side of the feed pump.

Self-check 1

Directions: Answer all the questions listed below.

Part - 1

Say True or False

1. Gasoline is a highly volatile flammable liquid of hydrocarbon mixture used as a fuel for internal-combustion engines.
2. A gasoline that resists detonation is called high octane gasoline.
3. The linkage between the accelerator pump and the throttle cannot be solid.
4. Viscosity is an important property of the fuel that is used in a diesel engine.
5. Diesel fuel has a high boiling point and is practically volatile at room temperature.

Part II: Choose the appropriate answer from

1. Technician A says that the diesel engine compresses air alone on the compression stroke. Technician B says the fuel is ignited by the heat of compression. Who is right?

A. A only A B. Only B C. Both A and B D. Neither A nor

2. All the following are true about diesel engines EXCEPT

A. No throttle valve B. high compression ratio C. speed and power controlled by quantity of fuel injected D. spark plugs make starting easier

2. Technician A says cetane number is the same as octane rating. B. Technician B says cetane number is the opposite of octane rating. Who is right?

A. A only B. B only C. Both A and B D. Neither A nor B

3. The distributor injection pump has

A. a rotor that sends fuel to the injection nozzles B. a barrel-and-plunger assembly for each cylinder C. a helix cut in each plunger D. a control rod attached to the accelerator pedal

4. All the following are true about governors EXCEPT

A. A throttle valve in the air intake indicates a pneumatic governor B. Moving the accelerator pedal changes the setting of the governor

C. Air-fuel ratio at full load is about 20:1

D. All automotive diesel engines use a constant-speed governor

5. The purpose of the glow plug is to

A. control engine idle speed D. provide sparks to ignite the compressed air-fuel mixture

C. warm the fuel D. add heat to the pre-combustion chamber

6. Warming the fuel with a fuel heater reduces the possibility that

A. wax in the fuel will plug the filters B. the glow plugs will overheat C. the coolant will freeze D. the engine will start

7. All the following are true about servicing injection lines EXCEPT

A. cap all lines to prevent dirt from entering

B. wrap a shop towel around the connection to absorb leaking fuel

C. a kinked line can be straightened and reused

D. new lines are preformed

8. Technician A says a sticking injection nozzle may cause the diesel engine to miss at all speeds. Technician B says an injection nozzle sticking open may cause a puff of smoke each time the engine misfires. Who is right?

A. A only B. B only C. Both A and B D. Neither A nor B

9. How much amount of fuel must be measured out in a fuel injection system?

A) Very high B) Very Small C) High D) Medium

10. When is the choke used in the engine?

A) When the vehicle is idling B) When the vehicle is accelerating C) When the engine is cold D) When the engine is hot

Unit Two: Overhauling Gasoline Fuel System

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Servicing fuel tank
- Servicing Fuel Line
- Servicing Fuel Pump
- Servicing Carburetor

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Service fuel tank
- Service Fuel Line
- Service Fuel Pump
- Service Carburetor

2.1 Servicing Fuel Tank

2.1.1 Removing Fuel Tank

Fuel tank removal may not seem at first necessary, but it can be. Within tank electric fuel pumps, common on many late model cars, it is often necessary to remove a tank to cure a fuel pump problem. Also, dirt, water and other contamination in the fuel tank can cause filtration and delivery problems. Such problems can be particularly critical for diesel and gasoline injection systems. Often the only way to cure chronic fuel contamination is to remove and clean the tank.

Fuel tank installations vary from car to car, but the methods for removing and replacing a tank share the common points outlined below. If you can obtain the carmaker's drawing of the tank installation, study it before you start the job to determine the locations of lines, vent hoses, electrical connectors, and mounting straps.

Warning

Explosive vapors are present in an empty fuel tank. Because of the air and fuel vapor mixture, an empty tank can be more explosive than a full one. Observe all fuel and electrical safety precautions to keep heat, spark, and flame away from a fuel tank.

Remove the filler cap to equalize air pressure in the tank and disconnect the battery ground cable. Depressurize a fuel injection system according to the carmaker's procedures.

Most tanks are under the rear of the vehicle. Following the carmaker's lifting instructions; raise the vehicle on a hoist or with a jack and stands to a convenient working height.

Drain remaining fuel in the tank into a metal or plastic container by:

a. Removing a drain plug from the tank

Disconnecting the fuel line at the inlet of the fuel pump and using a hand operated siphon pump to siphon fuel from the tank.

If electrical connectors for the fuel gauge sending unit and an in -tank electric pump are accessible, disconnect them. You may have to wait until the tank is partly lowered form the car to reach some connectors.

Disconnect fuel supply and return lines and EEC vapor hoses from the tank. You may have to remove a vapor separator from the tank. Separate the tank from the filler tube or separate the filler tube from the car body

If the filler tube is connected to the tank with a hose and clamps, disconnect it at this point.

If the tube is soldered to th4 tank and fastened to the body by a clamping flange, remove the flange screws.

If the tube is fastened to the tank by a clamping flange, disconnect it at this point.

Some filler tubes do not have to be removed from the car once they are separated from the tank. This is good point to check the carmaker's installation drawing.

Many station wagon tanks are located in rear fender wells. Remove the wheel and tire for access to such a tank.

Remove any shields, shock absorbers, or other chassis parts that may block tank removal.

Place a jock or suitable support under the tank to hold its weight as you remove the mounting straps.

Loosen the mounting straps and lower the tank far enough to remove any other lines or wires.

After removing all connections and clearing obstructions, remove the mounting straps and lower the tank to the tank to the ground.

2.1.2 Cleaning fuel tank

After removing the tank, you can clean it, or replace it as required. Remove the fuel gauge sending unit, any electrical pumps or water separators, and other reusable parts from the old tank (if you replace the tank). You can clean some tanks by steam cleaning or with special cleaning solutions.

Warning

Do not try to repair a tank by welding. Fuel vapors trapped in the tank may explode. A leaking tank can sometimes be repaired by soldering. Because passenger car fuel tanks are usually inexpensive, it is advisable to replace a defective tank rather than repair it.

Caution

Soldering a fuel tank is a dangerous job. Exercise caution to avoid an explosion. An empty fuel tank will explode as readily as a tank containing fuel.

a. Drain all the fuel from the tank and flush it with water until every trace of gasoline fumes is removed.

b Fill the tank with water and position it so water will not seep out of the section to be repaired.

c. Use a wire brush to clean around the spot to be repaired.

d. Scrap the surface to be soldered until it is clean and bright.

f. Solder the damaged section following the proper procedure.

Caution

Do not use a soldering iron when it is red hot. Make sure there is no glowing carbon or oxidation on the tip. Do not hold the iron in any one spot for more than a few seconds at a time.

g. Drain the water from the tank.

h. Blow compressed air into the tank to remove all traces of moisture.

i. To test the tank for leakage, close all tank openings. Then put soap suds on the repaired area and blow a small amount of air into the tank. If soap bubbles appear, the tank still leaks.

2.1.3 Installing Fuel Tank

To install a new or cleaned tank, first install al reusable parts removed from the original tank. Use new gaskets and install new rubber hoses where required. Use a jack to raise the tank into position under the car and reinstall the mounting straps, filler tube, lines, and other parts.

2.2 Fuel Line Service

2.2.1 Removing Fuel Line

The rigid steel lines and flexible rubber hoses used in fuel system may need replacement because of damage or deterioration. Rubber hoses can age and become brittle over a length of time. Steel tubing may suffer road damage or corrode from road salt.

Steel fuel and vapor lines are fastened to the chassis with screws and clamps. Most rigid lines have flexible hoses at the ends that connect to tanks and pumps to absorb vehicle vibration. Many rigid lines can be replaced as performed assemblies. Hoses secured by clamps are cut to length from bulk material.

To remove the fuel line:

1. Clean the fuel line
2. Disconnect the fuel line at the fuel pump connection using two wrenches.

2.2.2 Inspecting Fuel Line

Procedure:

1. Blow clean compressed air through the fuel line in the opposite direction to the flow of fuel until it is clean.
2. If the fuel line seems to be restricted at all, check for dents or slightly kinked spots. If it is damaged at all, it must be replaced.

3. If no damage can be detected, then continue with the process of cleaning until the compressed air makes the fuel line clean.

2.2.3 Repairing Fuel Line

A damaged length of steel tubing longer than 300mm can be cut out of a line and replaced with a comparable length of tubing spliced into the line with hoses and clamps. Tube ends must be flared or beaded for proper hose and clamp retention.

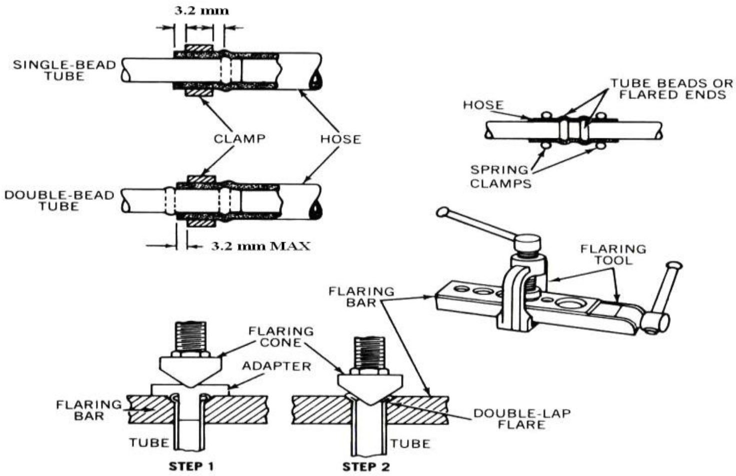


Figure 2.1 Repairing fuel lines

A damaged length of tubing shorter than 300mm can be replaced by a length of hose, secured with clamps. Cut any replacement hose long enough to ensure proper clamping beyond the flared or beaded ends of steel tubing.

Most fuel line fittings are the 45-degree flare type, but some are the compression type.

2.2.4 Installing Fuel Line

When you have finished cleaning the fuel line, fit it back into the fuel pump filter or carburetor. Do not tilt the flare nut. Ensure that it is in alignment. Tighten securely, using two wrenches.

2.3 Fuel Pump

2.3.1 Removing Mechanical Fuel Pump

Most mechanical fuel pumps are mounted low on the engine where they are driven by the camshaft or an accessory drive shaft. Some are on the side of the timing cover. In most cases, access to the pump is limited by manifolds and engine accessories. Use the following guidelines and the carmaker's instructions to remove a pump:

Most fuel pumps can be dismantled for repair. There are some exceptions, however, in which the pump is sealed unit and must be replaced if it becomes defective in any way.

Repair kits are available, to rebuild defective fuel pumps, and complete instructions are included for their use.

To repair a defective pump, the instructions given in the service manual should be followed. The procedure varies somewhat for each make and type of fuel pump. However, a few basic rules that apply to the repair of most of the fuel pumps are as follows:

1. Disconnect the battery ground cable.
2. Remove any belt – driven accessories as needed for access to the pump. You can reach some low – mounted pumps more easily from under the car.
3. Disconnect the pump inlet and outlet lines and plug or cap them. If the pump has a vapor return line, disconnect and cap it also.
4. Loosen, but do not remove, the pump mounting bolts.
5. Crank the engine until the pump rocker arm or pushrod is on the low point of the camshaft eccentric to release tension from the pump rocker arm or linkage.
6. Remove the pump from the engine.

2.3.2 Disassembling Mechanical Fuel Pump

If the pump is driven by a pushrod, remove the pushrod and check it for wear and length Use a straightedge to check its straightness.

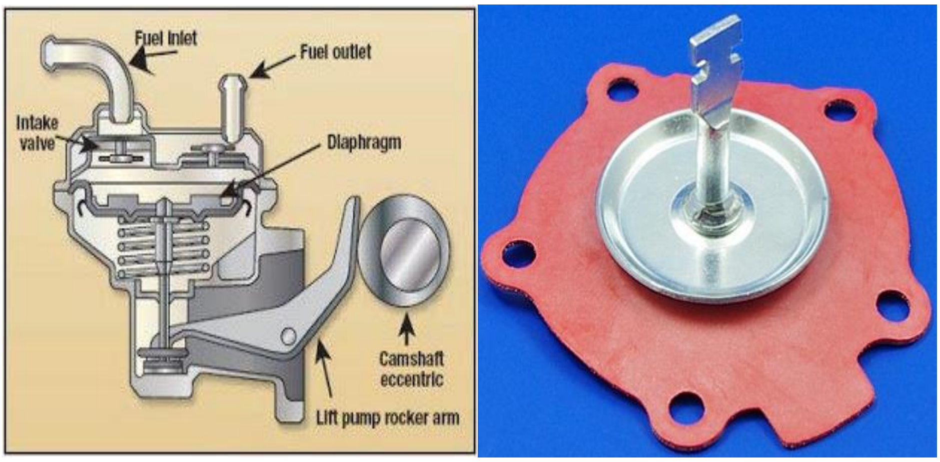


Figure 2.2 Disassembling Mechanical Fuel Pump

2.3.3 Fuel Pump Drive Types

1. Plug all openings in the pump assembly and thoroughly wash the exterior with solvent to remove all dirt and grease.
2. Scratch mark on the cover or covers and the pump body to make sure of proper alignment when the unit is reassembled.
3. Disassemble the pump according to the instructions, taking care not to damage any parts that may have to be used in the repaired unit.

2.3.4 Inspecting Parts of Fuel Pump

1. Clean the various parts of the pump with a suitable solvent and blow out all passages in the body, housing, and cover with compressed air.
2. Inspect the pump body, valve housing, and cover for cracks, burrs, or damage. Examine all screw holes for stripped or crossed threads. Replace any defective unit.
3. Inspect the valves for proper action and seating. If any part of the valve assembly is defective, replace the entire unit.
4. Inspect the diaphragm for pin holes, punctures, cracks, etc., and for torn or elongated screw hole around its circumference. Replace if any defect is found.
5. The diaphragm spring and rocker-arm spring should be replaced as they are very apt to be weak, corroded, or distorted.
6. Inspect the rocker-arm, link, and rocker arm pivot for signs of wear or distortion. Replace if necessary.

Figure 2.3 Parts of Fuel Pump

2.3.5 Assembling Fuel Pumps

Reassemble the unit, taking care that the diaphragm is centered correctly. Never use gasket compound on the diaphragm. Test the pump before installing it on the vehicle.

Installing Mechanical Fuel Pump

1. Remove old gasket material and dirt from the mounting surface on the engine.
2. Apply gasket cement to both sides of a new pump gasket and place it on the pump flange.
3. Install the pump on the engine in one of the following ways:

a. If the pump rocker arm is driven directly by the camshaft, insert the arm through the mounting hole and be sure it bears correctly on the shaft. Install the mounting bolts.

b. If the pump has a pushrod between the rocker arm and the shaft, put heavy grease on the shaft end of the pushrod and insert it in the engine, against the eccentric. The grease will hold it while you install the pump. Place the pump arm against the pushrod and install the bolts.

4. Tighten the mounting bolts alternately and evenly to the specified torque.

5. Reconnect the fuel lines and vapor return line to the pump. Use new clamps on rubber hoses and be careful not to cross thread fittings.
6. Reinstall any accessories removed for pump access and reconnect the battery ground cable. Start the engine and check for leaks.

Electric Fuel Pump Removal and Replacement

Refer to the carmaker's instructions before servicing an electric fuel pump because there are more variations in electric pump installations than in mechanical pump installations. However, removing and replacing most electric pumps will include one or more of the following tasks.

1. Depressurize a fuel injection system according to the manufacturer's instructions before opening any fuel lines.
2. If necessary, raise the vehicle on a hoist for access to a chassis – mounted or tank – mounted pump. You can remove some tank – mounted pumps through an access hatch in the car trunk and a cover on the tank.
3. If necessary, remove the fuel tank for access to an in-tank pump.
4. Refer to a wiring diagram and test all electrical circuits for continuity and switch or relay operation.
5. Use new gaskets and o- rings where required when installing a pump. It also is a good idea to replace filters when installing a new pump.

2.3.6 Testing Fuel Pump

Incorrect fuel pump pressure and volume can cause fuel – metering problems at the carburetor or injection system. If gasoline supply to a carburetor is low, the fuel level in the carburetor bowl will be low, and the engine can run lean and misfire. If fuel pressure and volume to a carburetor are too high, the flat needle (part of the carburetor which determines the level of the fuel) can be forced off its seat and the fuel level in the bowl will be too high. The engine will then run rich.

All carmakers publish pressure specifications for fuel pumps, and many also supply volume specifications.

The following pressure and volume test procedures are general methods for checking mechanical and electric pumps on carbureted engines.

A. Fuel Pump Pressure Test

1. Remove the air cleaned or air inlet duct for access to the fuel line at the carburetor or injector inlet.

2. Disconnect the fuel line at the carburetor or injector inlet and install .

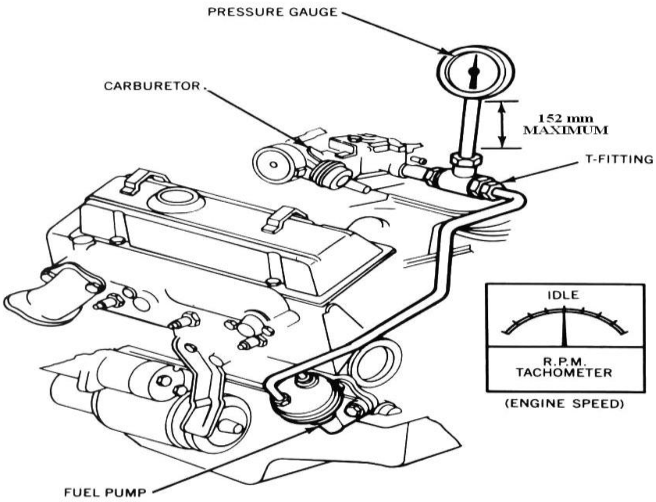


Figure 2.4 Fuel Pump Pressure Test

a. If pressure specifications are below 10 psi, connect the gauge to the tee with a length of fuel hose.

b. If pressure specifications are above 10 psi, connect the gauge with fittings and high – pressure hose or tubing to prevent leakage.

3. Test pump pressure in one of the following three ways, depending on the manufacturer’s specification.

a. If pressure is measured at cranking speed, disable the ignition and crank the engine until the gauge reading stabilizes. Do not crank the engine for more than 30 seconds to avoid overheating the starter motor.

b. If pressure is measured at idle, start the engine and run it at idle.

c. If electric pressure pump pressure is measured with the engine off, turn the engine to RUN and let the pump operate through its starting cycle, or connect the pump directly to a 12 – volt battery for 10 seconds.

4. Compare the gauge reading to specifications. Continue watching the gauge for about two minutes. If the pump valves are seating correctly, pressure should remain stable for several minutes.

5. Disconnect the gauge, remove the tee, reconnect the fuel line, and reinstall the air cleaner.

B. Fuel Pump Volume Test

For this test, you will need a graduated metal or plastic (not glass) container and the test equipment .You can also use this tester to check pump pressure on many engines. To test volume, proceed as follows:

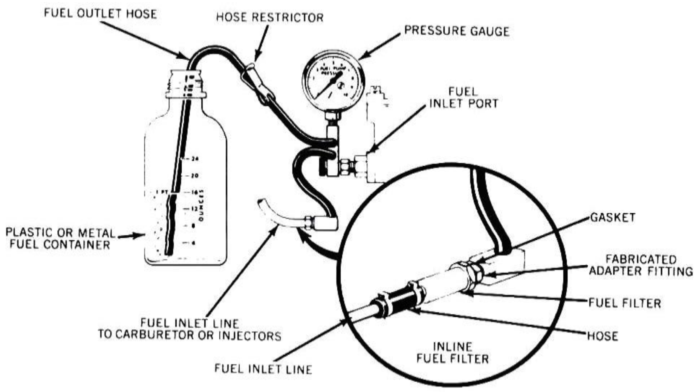


Figure 2.5 Fuel Pump Volume Test

1. Remove the air cleaner or air inlet duct and disconnect the fuel line at the carburetor or injector inlet.
2. Install the test gauge, hose, and fuel container If the pump has a vapor return line, clamp it closed.
3. Open the shut off clamp on the hose to the fuel sample container.
4. Crank or run the engine for the time specified by the manufacturer. (In most cases it 30 seconds idle speed). Measure the fuel in the container and compare it to specifications. If air bubbles appear in the sample during testing, the fuel line between the tank and the pump probably has an air leak.

Low pressure and volume are often caused by restricted filters, lines, or the fuel pick up in the tank. Always check the lines and filters for restrictions before replacing a pump to cure a low – pressure problem. In a mechanical fuel pump, a leaking diaphragm, a leaking inlet check valve, a worn pushrod or pump linkage, or a work camshaft drive eccentric also can cause low pressure. High pressure is usually caused by a defective pump check valve or diaphragm spring.

C Fuel Pump Vacuum Test

When in sufficient fuel volume is produced by the capacity test, a fuel pump vacuum test should be done.

1. Connect the vacuum gauge to the tank side of the fuel pump.
2. Plug the fuel line from the tank to keep gasoline from leaking out of the line.
3. Run the engine at idle and watch the vacuum gauge reading.

If the vacuum is low, the pump or the pump-actuating cam is faulty. A vacuum check at the tank end of the fuel line will indicate air leaks in the line that could cause low fuel – pump volume. A worn pump eccentric or plugged fuel tank filter could cause low pump capacity while still producing the required pressure and vacuum.

2.4 Carburetor

2.4.1 Carburetor Troubles

Carburetors should not be serviced for other than routine idle adjustment until an engine operation problem is positively identified as a carburetor problem. This means that when an engine is not functioning properly, all other engine systems such as ignition system and engine condition should be checked for correct operations before the carburetor is condemned.

Engine troubles can come from many other causes besides problems in the fuel system and carburetor. Troubles caused by conditions inside the carburetor itself are listed and described below.

A. Excessive fuel consumption can result from:

a. A high float or dirty float needle valve
b. A sticking or dirty float needle valve
c. Worn jets or nozzles
d. A stuck metering rod or power piston
e. Idle too rich or too fast
f. A stuck accelerator pump check valve
g. A leaky carburetor
h. A dirty air cleaner

B. Lack of engine power, acceleration, or high-speed performance can result from

a. The power step-up on the metering rod not clearing the jet
b. Dirt or gum clogging the fuel nozzle or jets
c. A stuck power piston or valve
d. A low float level
e. A dirty air cleaner
f. The choke stuck or not operating
g. Air leaks into the manifold
h. The throttle valve not fully opening
i. A rich mixture, due to causes listed under item 1, above

C. Poor Idle

a. A leaky vacuum hose
b. A stuck PCV valve
c. Retarded timing

d. An incorrectly adjusted idle mixture or speed
e. Clogged idle system
f. Causes listed under item 2

D. Failure of the engine to start unless primed

a. No gasoline in the fuel tank or carburetor
b. Wrong tank cap, or a plugged tank or cap vent, which cause a vacuum to develop in the tank, which prevents delivery of fuel to the carburetor.
c. Holes in the fuel- pump flex line, which allow air leakage and prevent fuel delivery
d. Carburetor jets or lines clogged
e. Defective choke
f. Clogged fuel filter
g. Air leaks into the manifold

E. Hard starting with the engine warm could be due to an inoperative choke
F. Slow engine warm-up could be due to a defective choke or manifold heat-control valve.
G. A smoky, black exhaust is due to an over-rich mixture. Carburetor conditions that could cause this are listed in item 1 above.
H. If the engine stalls as it warms-up, this could be due to a defective choke
I. If the engine stalls after a period of high speed driving, this could be due to malfunctioning anti percolator.
J. If the engine back fires, this could be due to an excessively rich or lean mixture. If the noise is in the exhaust system, it is usually caused by an excessively rich mixture in the exhaust gas. This results from a defective air-injection-system anti back fire valve. Lean mixture usually caused a pop back though the intake manifold to the carburetor.
K. If the engine runs but misses, the most likely cause is a vacuum leak. It may be caused by a vacuum hose or intake manifold leak. In addition, it could be that the proper amount and ratio of air and fuel are not reaching the engine. This might be due to clogged or worn carburetor jets or to an incorrect fuel level in the float bowl.
L. Some of the above conditions can be corrected by external adjustments, others require removal of the carburetor from the engine so that it can be disassembled, repaired, and reassembled.

2.4.2 Carburetor Quick Checks

- **Float Level**

With the engine idling, observe the high-speed discharge jet. If the tip of this jet is wet and fuel is dripping from the jet, then the float level is probably too high or the fuel pump pressure too great.

Idle and low speed circuits

A rough or uneven idling condition that cannot be corrected by minor adjustment of the mixture or speed screws indicates problems in the idle or low speed circuits. Rough operation at the off idle speeds indicates problems in the low speed circuit. (Remember both conditions can be caused by other engine problems, which can be determined by performing a complete engine tune-up).

High Speed Circuits

With the engine running at medium speed, slowly cover part of the air horn with a piece of stiff cardboard. If the engine increases its speed slightly, then the system is working properly. If the speed remains the same or slows down, then the system requires service.

- **Accelerator Circuit**

A small amount of fuel should spray from the accelerator discharge jet each time the throttle valve is opened. The discharge should continue for a few seconds after the movement of the throttle has been stopped. Failure of either condition indicates repairs are required.

2.4.3 Removing Carburetor

1. Disconnect all vacuum, EEC, and PCV hoses from the air cleaner and the carburetor throttle body. If the hoses are not color-coded and you do not have a vacuum diagram, tag the hoses and their connections for proper reconnection.
2. Remove the air cleaner or air intake duct from the carburetor.
3. Disconnect all electrical connectors from choke heaters and carburetor sensors, solenoids, or motors.
4. Disconnect the following devices as required, remote choke linkage, choke hot air tube, and choke coolant lines.
5. Disconnect the throttle linkage and transmission throttle valve linkage, if required.
6. Disconnect the fuel line from the carburetor and plug or cap it.
7. Remove the carburetor mounting nuts or cap screws.
8. Remove the carburetor. If it is stuck to the manifold, tap the throttle body base lightly with a small plastic or rubber hammer to loosen it. Do not pry with a screwdriver.

9. Place a clean cloth in the manifold opening to keep dirt and small parts from falling into the engine.

10. Remove the old mounting gasket and scrap the manifold base and the carburetor base to remove gasket cement and old gasket fragments.

2.4.4 Disassembling Carburetor

You do not need to separate every screw, nut and linkage part of a carburetor to clean and overhaul it effectively. For example, you do not have to remove throttles, choke plates, and fast idle linkage. If you leave some linkage parts assembled, carburetor reassembly and adjustment will be easier.

Note the positions of all linkage parts before disassembly. Follow disassembly instructions carefully, particularly for some late- model carburetors on which certain sub assemblies can not be separated, for example, screws for throttle valves are staked in place on many carburetors, and the valves and shafts can not be remove. Be sure to remove all vacuums and pump diaphragms, rubber or plastic parts, and electronic parts (mixture control solenoids, stepper motors, and idle speed motors) before putting the carburetor in cleaning solvent. Carburetor cleaners will destroy these parts.

Remove jets carefully with a jet removal tool. Avoid using screwdriver on carburetor jets. The slightest burr or scratch on a jet can upset fuel metering. Jets for many carburetors are not available as replacement parts, and you must replace the complete carburetor if you damage a jet. Keep primary and secondary jets separate during disassembly, and keep metering rods matched to their respective jets.

Use a removal tool to remove limiter caps from idle mixture screws. If mixture screw removal is necessary from a carburetor with sealed screws, follow the manufacturer's directions.

Before removing any idle mixture screw, turn it clockwise and count the number of turns needed to lightly seat it. When you reassemble the carburetor, install the mixture screw to this same position.

Be careful not to lose accelerator pump check balls. Note their positions and sizes when you remove them.

2.4.5 Cleaning Carburetor

Put the carburetor parts in basket or hang them from wires in the cleaner tank. Do not put rubber, plastic, or electronic parts into the leaner. Some carburetor cleaners act very quickly. Do not leave parts in the cleaner longer than necessary. Caustic cleaners can remove protective coating from aluminum and zinc parts and make them porous.

Warning

Wear rubber gloves when working with carburetor cleaner. Do not allow cleaner to contact your skin. Carburetor cleaners are toxic and may cause illness.

After soaking the parts in carburetor cleaner, rinse them thoroughly in running water or common cleaning solvent. Use compressed air to dry the parts and blow out passages.

Do not use wires, drills, or other hard objects to clean jets, passages, or other openings. Nicks and scratches can damage them. Do not use sandpaper, a wire brush, or steel wool on carburetor parts. Abrasives will scratch the parts and remove protective coatings.

2.4.6 Adjusting Different Systems of Carburetor

Assemble and adjust the carburetor according to the drawings and instructions in the repair kit or a carburetor overhaul manual. Be careful to install primary and secondary jets in their correct positions. Use a jet tool and do not over tighten. Keep metering rods matched with their jets. When you install accelerator pump check balls, the large one usually is for the pump inlet. Install accelerator pump and choke linkages in their original positions or in specified holes or slots. Accelerator pump linkage usually has several positions for the pump link to control pump stoke and fuel delivery.

Overhaul manuals and repair kit instructions may include a dozen or more specific illustrations and instructions for various adjustments, such as:

• Choke opening and closing
• Vacuum break operation
• Choke un loader
• Accelerator pump stroke
• Secondary throttle and air valves
• Secondary lockout linkage

Adjustment methods and specifications vary for different carburetor designs and engine applications.

Install mixture screws by turning them in until lightly seated, then backing them out the number of turns that you counted at disassembly.

Make the final mixture adjustment when the carburetor is installed. Then replace limiter caps or sealing plugs, if required.

Some carburetor makers specify that certain screws must be tightened in specific sequences to specific torque values. Air horn installation is a critical point on most carburetors. If air horn screws are tightened unevenly or over tightened, choke valve, metering rod, and accelerator pump linkage may bind the carburetor may leak, and screw holes may be stripped if the air horn is not installed properly. Most repair instructions show a specified air horn tightening sequence, Some also include screw torque valves.

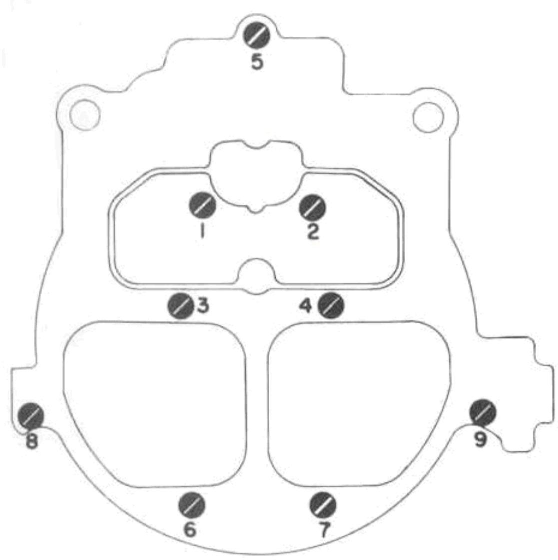


Figure 2.6 Air horn tightening sequence

Besides instructions and drawings of the carburetor, a repair kit usually contains:

1. Gaskets
2. An inlet needle and seat
3. An accelerator pump
4. A power valve diaphragm (if used)
5. Accelerator pump check balls
6. Miscellaneous small clips

A repair kit may not contain jets, metering rods, linkage parts, vacuum diaphragms, and screws. Be careful when removing these parts so that they are not lost or damaged. Many repair kits have gaskets for several variations of a carburetor model. They usually differ in vacuum passage openings. Do not throw the old gaskets away immediately. Save them to match with those in the kit to select the correct replacements.

Carburetor Float Adjustment

Float settings are critical adjustments on all carburetors. Four basic float adjustments are described below. Every carburetor requires float level adjustment. Some carburetors require one or all of the others. Follow the manufacturer's instructions for measuring at certain points and for bending the float arm or tang at specific locations. Instructions also will specify whether float measurements and adjustments are made with or without the gasket in place. When you are adjusting float position to tolerances of +1/32 inch (0.8 mm), the gasket thickness makes a critical difference.

- Float Level

Float level is the basic float adjustment. a typical adjustment for a float hung in the fuel bowl.

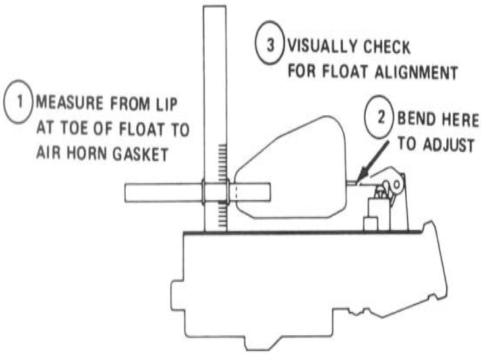


Figure 2.7 Float adjustment

Use the float level gauge supplied with the kit or a precision T-scale to measure float position exactly. If the float has two pontoons, adjust both carefully.

2. Float Alignment

The float must be parallel with the edges of the fuel bowl or they may rub on the bowl and cause the inlet needle to stick. Some floats have an alignment adjustment.

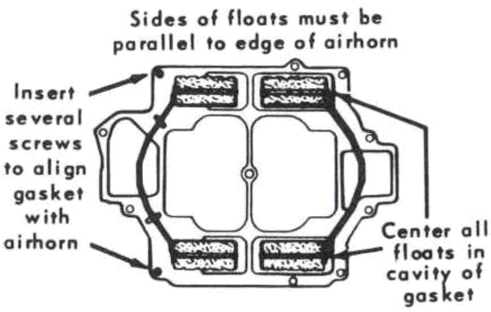


Figure 2.8 Float Alignment

3. Float Drop

If the float hangs from the air horn, it may require float drop adjustment. This is separate from float level adjustment and is made by bending a tab, or tang, on the back of the float arm.

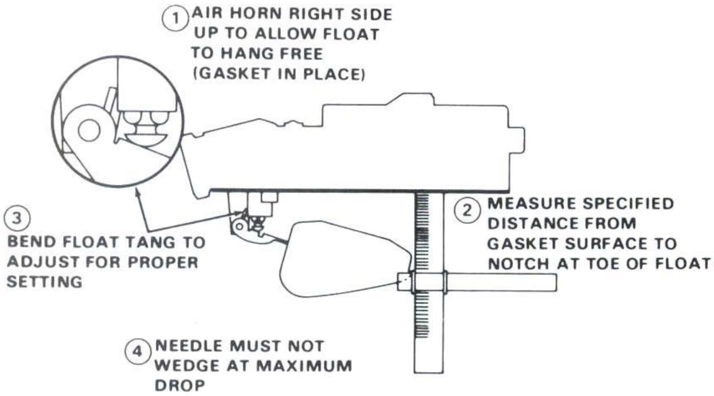


Figure 2.9 loat drop adjustment

4. Float Toe

Float toe is a third adjustment needed for some floats hung from the air horn. After adjusting float toe, recheck float level and drop to be sure they are correct.

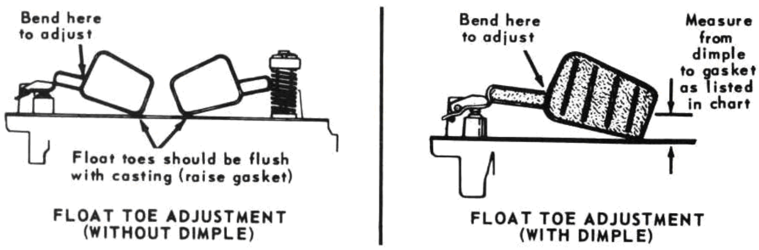


Figure 2.10 Float toe adjustment

These final precautions will help you adjust floats carefully and accurately:

1. Before installing a float, check it for buoyancy and leaks according to the manufacturer's instructions. This is very important for plastic floats. Some manufacturers recommend comparing a used float with a new float on a small balance scale to check float weight.
2. Lift the float tang away from the needle when bending an arm or tang. This prevents a false measurement and avoids damage to the needle and seat.
3. Keep the float tang parallel or perpendicular with the needle, as required. Side pressure can cause the needle to stick.
4. For a two- pontoon float, adjust each separately and equally. Keep them parallel.
5. Do not scratch a float tang during adjustment or the needle may stick.

2.4.7 Assembling Carburetor

Thoroughly clean all castings and parts in carburetor cleaner and blow out all openings with compressed air. Check all parts for wear, particularly the metering rods (step-up rods) and jets if used. Ordinary very little wear takes place in the carburetor. Therefore very few parts should need replacement other than gaskets, the accelerator pump plunger and the diaphragm type power jet.

After cleaning, carefully assemble the various subassemblies. Then assemble the subassemblies to one another except for the air horn. The float level must be checked and set before completing the final assembly. Use new gaskets throughout the carburetor when assembling it to make certain that tight joints will result. In some cases, the proper height of a nozzle or valve will depend on the gasket.

2.4.8 Installing Carburetor On The Engine

1. Remove the cloth from the manifold and place a new gasket on the manifold baser.
2. If the carburetor has an electric grid heater on an EGR valve spacer beneath it, be sure these parts are correctly installed before installing the carburetor.
3. Place the carburetor on the manifold and install the nuts or caps screws.
4. Connect the fuel line. Install a new fuel filter if required.
5. Tighten the fasteners alternately and evenly to the specified torque. Do not over tighten.
6. Connect the throttle linkage.
7. Connect the choke linkage and a hot air tube or coolant line, if required. Connect the choke heater wiring.
8. Connect all other electrical connectors and all vacuum hoses.
9. Install the air cleaner or air intake duct.
10. Start the engine, check carburetor operation, and make all necessary adjustments.

2.4.9 Adjusting Idle Speed Of The Engine

At one time, there were several adjustments that could be made on carburetors. Now the requirements of the clean Air Act regarding automotive emissions have eliminated most adjustments. Today, the only carburetor adjustment for most cars is to adjust the idle speed. The idle mixture is preset at the factory, and limiter caps, dowels, or plugs are installed to prevent tampering.

- Idle Speed and Mixture Adjustment

Idle speed and mixture adjustments vary considerably for different cars of different years. The principles explained below will help use the manufacturer’s procedure more easily. Remember that on many late model engines, the mixture screws are sealed. Also, some carburetors have electronic idle speed control, and traditional speed adjustment is not possible.

1. Generally, you will adjust idle speed first, then the mixture. After adjusting the mixture, check and readjust the speed. Then recheck the mixture adjustment.

- **Basic Idle Speed Adjustment**

You will still find some engines on which you set the idle speed simply by turning an idle speed screw on the throttle linkage. Turn the screw clockwise to increase speed, counter clockwise to decrease speed.

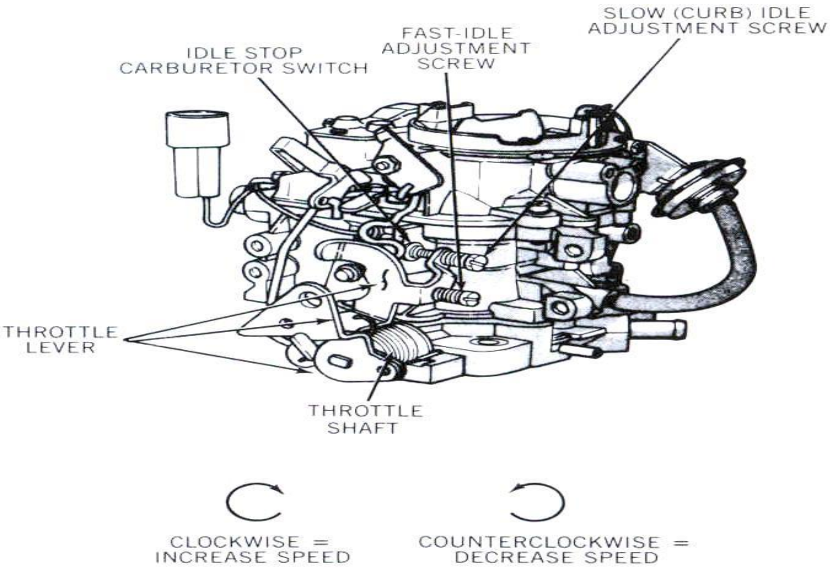


Figure 2.11 Idle speed adjustments

Adjust the idle speed on a carburetor with an idle air bypass adjustment by turning the large adjusting screw. This screw opens and closes the bypass passage to regulate idle airflow. Turn it clockwise to decrease speed, counterclockwise to increase speed.

- **Throttle Stop Solenoid Adjustment**

Most late model cars have throttle stop solenoids, or throttle position solenoids, to set the normal slow idle speed and a lower shut down idle speed. Slow idle, or curb idle is the normal idle speed of a fully warm engine. Late model engines run at high temperatures and idle speeds close to 1000 RPM. Also, they often idle with retarded timing, all these factors can cause after run, or dieseling. The throttle stays open far enough and the engine stays hot enough to draw in air and fuel and ignite the mixture after the ignition is turned off. A throttle stop solenoid prevents this.

When the ignition is on, the solenoid is energized, and the plunger extends to contact the throttle linkage. this holds the throttle in the slow idle position. When the ignition is turned off, the solenoid is de energized. The plunger retracts and lets the throttle close farther for a shutdown idle.

1. Set the parking brake and block the drive wheels

2. Run the engine to normal temperature. Be sure the choke is fully open and the throttle linkage is off the fast idle cam

3. Connect a tachometer to the engine

4. Follow the carmakers instructions to disconnect and plug the EEC canister vapor purge hose to the engine.

5. Follow the carmaker's direction on whether or not to disconnect and plug other vacuum hoses. A few carmakers specify removing the PCV valve and EEC purge hose from the engine and leaving them open to the atmosphere. You also may have to disconnect and plug an EGR vacuum line.

6. If the engine has a throttle position sensor or an idle switch, you may have to disconnect it or insulate it from the throttle screw for some idle adjustments. Check the engine decal for instructions.

7. If the carburetor has a hot idle compensator valve, hold or block it closed.

8. If the car has a vacuum release parking brake, disconnect the hose and plug it.

9. Follow the carmaker's directions regarding air cleaner position (ON or OFF), transmission position (drive or neutral), air conditioning and headlamps (ON or OFF) and other specific engine conditions.

10. Check the engine decal for idle speed specifications and basic instructions.

11. If you are using an infrared exhaust analyzer, place the probe in the tail pipe.

12. Disconnect the solenoid lead to de-energize it and retract the plunger.

13. Adjust the specified screw to get the shutdown- idle speed.

14. Reconnect the solenoid and recheck the slow idle speed.

15. These guidelines summarize basic idle speed adjustment with a throttle stop solenoid.

Note: Always refer to the carmakers procedures and specifications for proper idle speed adjustment.

Idle Mixture Adjustment

All idle mixture screws are adjusted in the same basic ways, whether they are unrestricted, have limiter caps, or are sealed. To adjust an unrestricted mixture screw, turn it clockwise (inward) to lightly seat it. Then, turn it counterclockwise (outward) a specified number of turns or until you reach a specified engine speed.

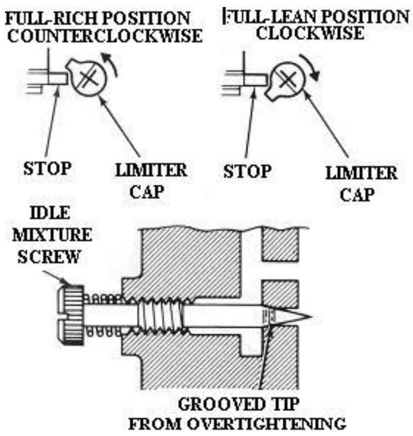


Figure 2.13 Limiter cap and idle mixture screw

Turning the screw clockwise closes the idle passage and creates a lean mixture. Turning it counterclockwise opens the passage and creates a reach mixture. If you have to remove a cap or plug from a sealed mixture screw for a major adjustment, you will still follow these principles:

• When you seat a mixture screw, do it carefully so that the tapered end just touches the seat. Over tightening will groove the needle and damage the seat.

• Adjust dual mixture needles of 2 and 4 barrel carburetors equally and alternately in small increments to balance the idle mixture.

Limiter caps restrict adjustments to one turn or less, figure 3.50. If you can't adjust the mixture with the caps in place, the carburetor may need an overhaul, or other engine problems may exist. If specified by the carmaker you may remove limiter caps for adjustment when using an infrared analyzer.

Idle mixture instructions on an engine decal or in a reference manual usually call for one of the three basic adjustment methods below. The lean best idle and one-quarter turn rich methods are most often used on older engines. Adjust idle speed to the correct RPM setting and then proceed as follows:

- **Lean Drop Method**

Adjust the mixture screws equally to get the highest speed and smoothest idle. Readjust the idle speed to specifications. Then continue turning the mixture screws clockwise (leaner) until speed decrease by a specified amount.

Lean Best Idle Method

Adjust the mixture screws equally to get the smoothest idle. Then turn the screws clockwise (leaner) until idle speed decreases. Finally, turn the screws counterclockwise (richer) equally just enough to regain the lost speed.

One- Quarter- Turn – Rich Method

Adjust the screws clockwise (leaner) past the smoothest idle until idle speed decreases slightly. Then turn the screws counterclockwise (richer) one-quarter turn.

Fast Idle Speed Adjustment

When the choke closes, its linkage moves a fast-idle cam to contact the idle speed screw or a separate fast idle screw and open the throttle slightly for fast idle during warm up. The fast idle cam has several steps, and the specified step must contact the idle speed screw or the fast idle screw when the choke closes

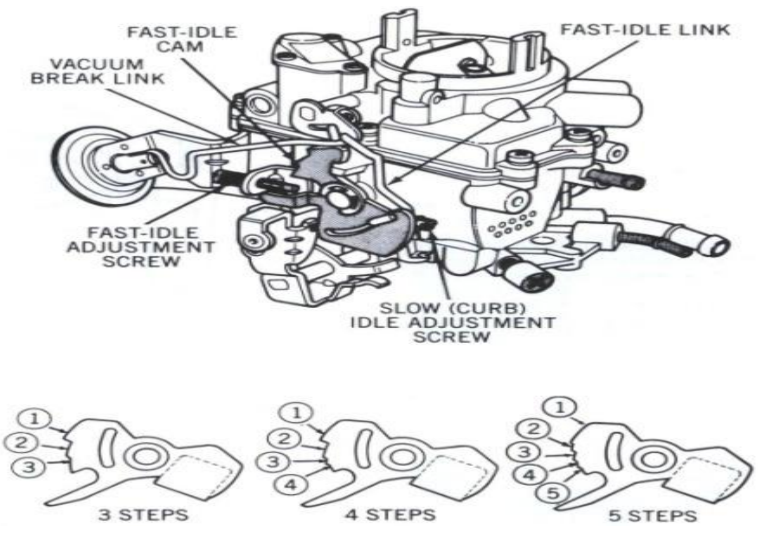


Figure 2.14 Fast Idle Speed Adjustment

Adjust the slow idle speed and mixture and the choke before adjusting fast idle speed. If the carburetor has a separate fast idle screw, place it on the specified step of the cam and turn it in or out to get the required fast idle speed.

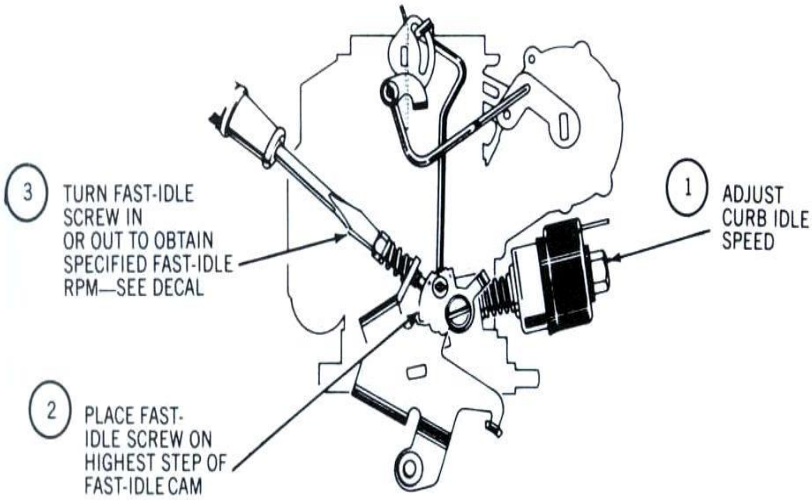


Figure 2.15 Separate fast idle screw

If the carburetor does not have a fast idle screw, place the slow idle screw or the fast idle cam follower (tang) on the specified step of the cam and check the fast idle speed. If the choke is adjusted right, its linkage should move the cam so that the correct step contacts the idle speed screw when the choke closes. If it does not, bend the linkage rod so the correct cam step contacts the screw.

Several other adjustments are possible for choke and fast idle linkage. It is important to understand that choke closing adjustment, vacuum break (pull off) adjustment, and fast-idle linkage adjustments are all related. Fast idle speed adjustment is a common part of on-car carburetor service.

The number and kinds of adjustments vary from one carburetor to another. For complete adjustment, you must follow the carmaker's procedures and adjustment sequence exactly.

Self-check 2

Directions: Answer all the questions listed below.

Part-I- Say True or False

1. A vacuum power jet valve also known as an economizer, performs the same function as a metering
2. Assemble and adjust the carburetor according to the drawings and instructions in the repair kit.
3. A manual-priming pump for air bleeding is mounted on the feed pump housing.
4. The number and kinds of adjustments vary from one carburetor to another.
5. Dirt, water and other contamination in the fuel tank can cause filtration and delivery problems.

Part II: Choose the appropriate answer from

1_____________is contains more fuel than the fuel quantity in the chemically correct mixture

a. Rich Mixture b. Line Mixture c. equal Mixture d. ALL

2. Which one is type of carburetors?

a. Variable Venture b. Fixed Venture Carburetor c. a &b d. none

3. Which times the throttle valve is open a little (small) the edge of the throttle valve moves past the idle port.

a. Low Speed System b. Power System c. main metering d. All

4. Which of the following system of fixed venture carburetor

a. Power System b. Accelerator Pump System c. Choke System d. all

5. A mixture that contains just enough air for complete combustion of the fuel is called________________.

a. Low Speed System b. Power System c. main metering d. All

6. The process of preparing combustible air fuel mixture in the petrol engine is called____

a. carburetion b. Good fuel economy c. Ensuring full torque at low speeds

7. ________________is so designed that, when the diaphragm reaches the bottom of its stroke, the linkage overthrows to open the points.

a. The rocker linkage b. The diaphragm spring c. carburetor bowl d. all

8. The electrical section (lower section), which includes

a. solenoid or electromagnetic coil b. core c . Soft iron armature d. all

Unit Three: Overhauling Diesel Engine Fuel System

This learning guide is developed to provide you the necessary information regarding the following Overhauling Injector g content coverage and topics:

- Servicing injection pump
- Servicing transfer pump
- Servicing injector nozzles
- Bleeding diesel fuel system

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

Service Injector Nozzles

- Service injection pump
- Service transfer pump
- Service injector nozzles
- Perform diesel fuel system bleeding

3.1 Servicing Injection Pump

3.1.1 Removing Injection pump

To Remove the Injection Pump:

- Disconnect both fuel pipes. Place a container under the end of the tube, to catch any fuel, which might run out.
- Remove the nut, which fit the pump to the injection Nozzle.
- Remove the nut, which fit the pump to the injection Nozzle.
- Remove the injection pump. free from dust. As an example disassemble the following Injection pump VE in the given numerical order.

Disassembling injection pump

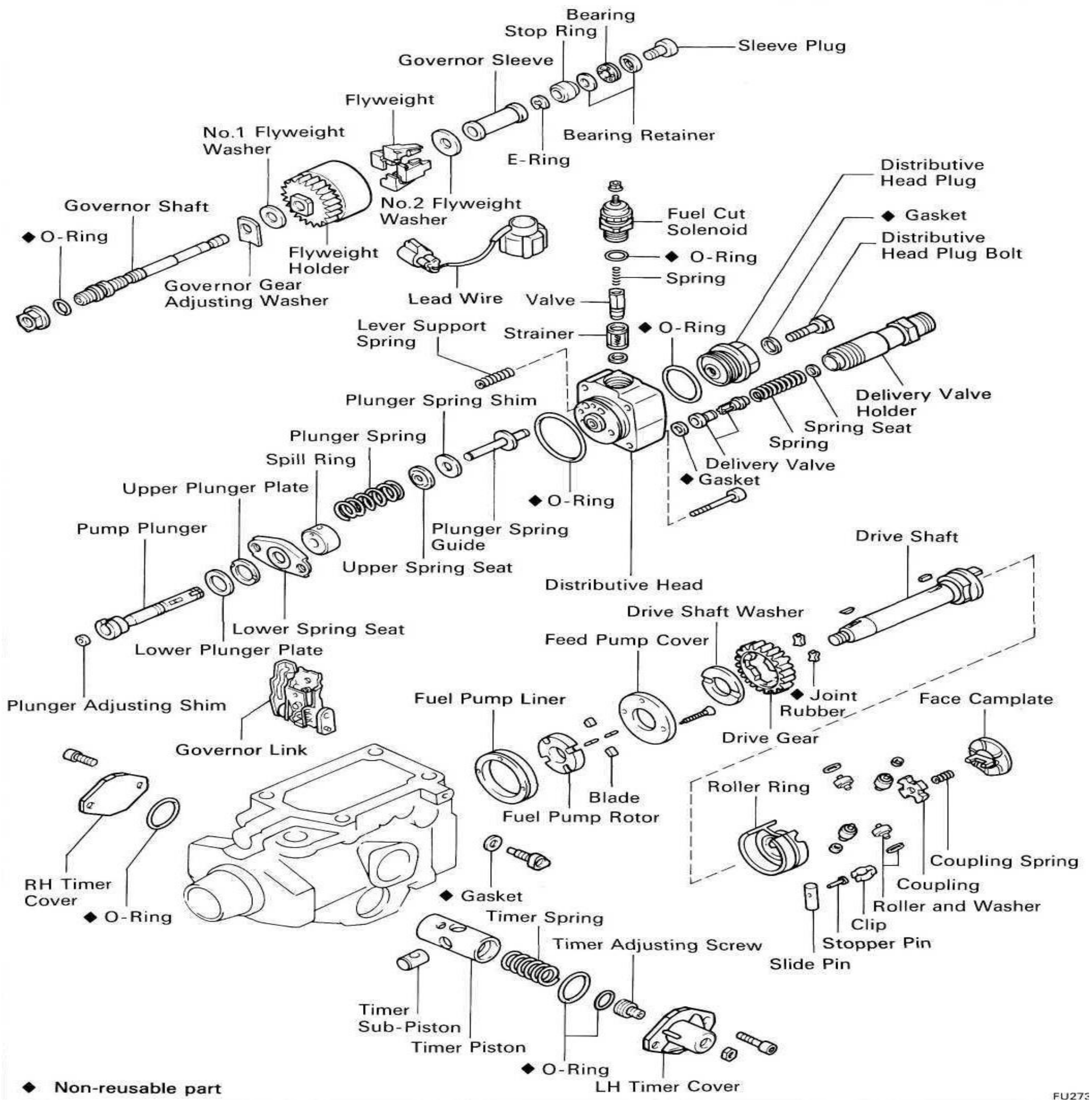


Figure 3.2 components part of injection pump VE.

3.1.2 Inspecting and Assembling Injection pump

Check the condition of the inlet and the outlet valve seats. If these are worn beyond specifications or damaged, replace housing with new

Inspect all injection pump components. If components is worn beyond specification or badly scored or scratched, replace with new.

Inspecting Inlet and Outlet Check Valves

Check inlet and outlet valve components. If seat on valves are excessively worn, scratched or scarred, replace with new.

If components are damaged or weak, replace with new

Inspecting Pump Piston and Piston Spring

If piston and its adjacent area and components are excessively worn or scarred, replace with new.

If plunger spring is weak or damaged, replace with new.

Inspecting Plunger Operating Components

Check tappet assembly parts for wear and damage, replace if excessively worn or damaged.

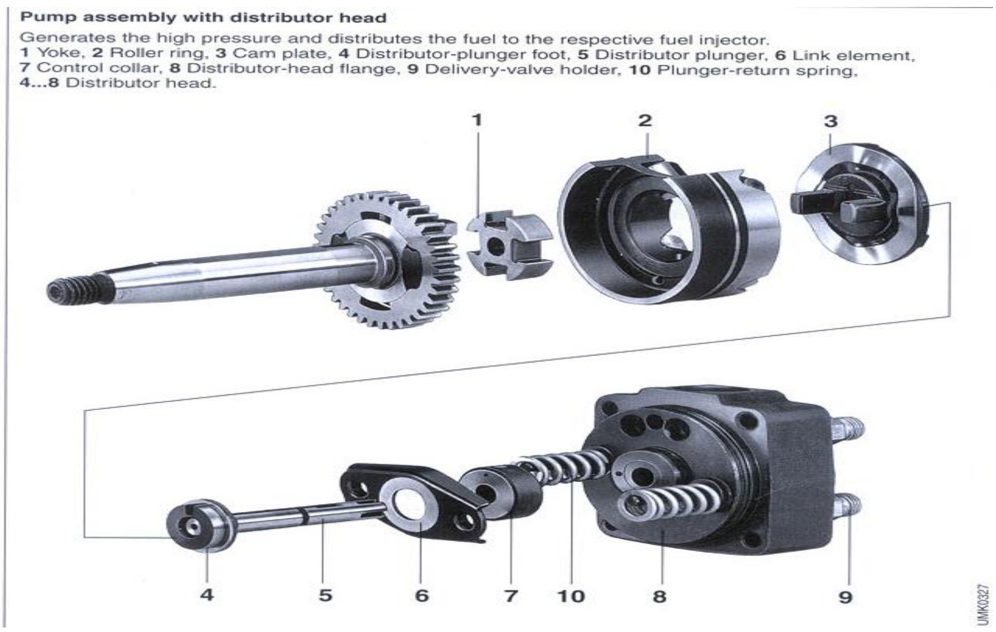


Figure 3.3 Pump assembling

Inspecting Fuel Filter and Fuel Pipe Connections

Check filters if dirty or damaged, clean with dry air or replace if required.

Check pipe connections and threads for damage

Replace pipe joint bolts or connections if required

Recondition threads if possible.

3.1.3 Assembling Injection pump

The procedure to assemble the Injection pump VE is the reverse of disassembling. Follow the reverse order of the example above..

Disassembly, Inspection, Maintenance and Assembly of Fuel in Line Injection Pump

The structure of fuel injection pump is illustrated. Rotate the flywheel until cylinder 1 Reaches compression TDC, at this point the mark on injection pump gear should be aligned to mark on injection pump flange

Servicing In-Line Pump

The pum In-line injection pumps allow high cylinder outputs at 2-to-12-cylinder engines. They are used in engines of commercial vehicles, construction and agricultural machinery as well as for stationary engines. Their name is based on the pump cylinders arranged in lines. At engines equipped with this pump, each cylinder is supplied with fuel by an own pump element and via a pressure valve and a high-pressure line. p is in unknown condition, so let's go for a good rebuild with disassembly, cleaning, and complete replacement of all seals.

In general this work should be done under conditions of surgical cleanliness. The slightest bit of dirt will rapidly degrade the extremely high tolerance pieces once the pump is back in service. Thoroughly clean off the outside of the pump before opening anything. Start with a stiff brush and some diesel then use caustic soda and rinse well afterwards.

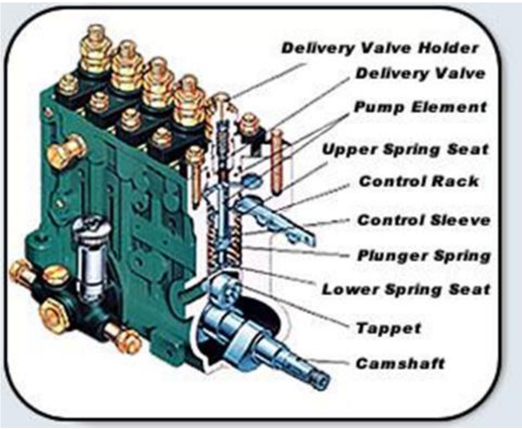


Figure. 3,3 In-Line Pump

3.2 Servicing Transfer Pump

3.2.1 Removing transfer pump

To remove the pump:

1. Disconnect both fuel pipes.
2. Place a container under the end of the tube, to catch any fuel, which might run out.
3. Remove the nut, which fit the pump to the injection pump.
4. Remove the transfer pump

3.2.2 Disassembling transfer pump

When dismantling and reassembling the fuel transfer pump manufacturer's specifications and procedures should always be taken into considerations and strictly followed in order to provide maximum of service life and to guarantee a proper and failure less operation of the component. The working area should be clean from dirt and spilled liquids and in particular free from dust. As an example disassemble the following transfer pump in the given numerical order.

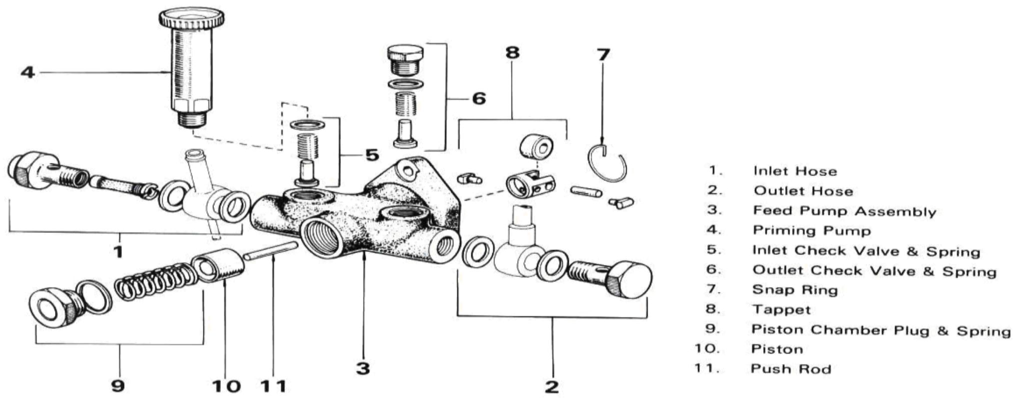


Figure 3.18 components of transfer pump

3.2.3 Inspecting and Assembling Transfer pump Components

A. Inspecting Transfer pump Housing

Check the condition of the inlet and the outlet valve seats. If these are worn beyond specifications or damaged, replace housing with new

Inspect the push rod bore. If bore is worn beyond specification or badly scored or scratched, replace valve with new

Inspecting Inlet and Outlet Check Valves

Check inlet and outlet valve components. If seat on valves are excessively worn, scratched or scarred, replace valve with new.

If valve springs are damaged or weak, replace with new

Inspecting Pump Piston and Piston Spring

If piston and its adjacent area and components are excessively worn or scarred, replace with new.

If plunger spring is weak or damaged, replace with new.

B. Inspecting Plunger Operating Components

Check tappet assembly parts for wear and damage, replace if excessively worn or damaged.

Inspecting Fuel Filter and Fuel Pipe Connections

Check filter if dirty or damaged, clean with dry air or replace if required.

Check pipe connections and threads for damage

Replace pipe joint bolts or connections if required

- Recondition threads if possible.

A. Assembling transfer pump

The procedure to assemble the transfer pump is the reverse of disassembling.

3.2.4 Testing The Transfer Pump

Testing transfer Pump Intake (Suction) Pressure

The pressure gauge is positioned into the suction side of the fuel transfer pump, figure 4.17.

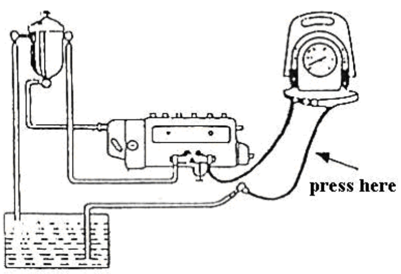


Figure 3.19 measuring suction pressure

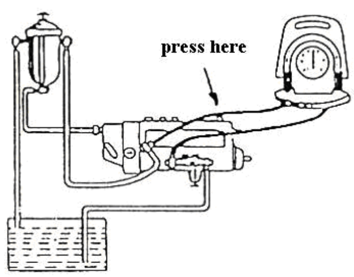


Figure 3.20 Measuring delivery pressure

Testing Procedure:

a. Bleed system after pressure gauge installation.
b. Start engine and run with idle speed until normal operation temperature is attained.
c. Measure the reduced fuel pressure in the suction line at idle speed and compare with specifications.

Under this condition, the actual reading should be very low and correspond to the suction height between fuel tank and transfer pump. The suction height of 1m ≅ 0.1bar of reduced pressure

Maximum Suction Pressure of transfer Pump

a. Clamp the suction line in front of the manometer in order to attain maximum reduced pressure reading.

b. Write down and compare with manufacturers specification.

Results

If Transfer pump is new or in good condition, a reading of 0.5 to 0.6 bar of reduced pressure should be attained.

Transfer pump is still in acceptable condition if a reading of at least 0.2 bar is attained.

If Manometer reading is below 0.2 bar, the Transfer pump is defective and the possible cause are:

Worm transfer pump piston (plunger).

Worn or defective transfer pump valves

Delivery Pressure Test

The pressure gauge is attached to the outlet side of the fuel transfer pump,

Testing Procedure

Bleed system after pressure gauge is installed using the priming pump.

Operate the engine until normal operation temperature is attained.

Take the pressure gauge reading at engine idling speed.

Result

If a check valve is installed in the system a reading of about 1.5 bar should be attained.

Maximum Delivery Pressure Test:

a. Press together the supply line after the gauge.
b. Take the reading and compare with manufacturers specification.

Results:

If Transfer pump is new or in good condition a reading taken should be between 3.5 to 4.5 bar.

Reading below 2.8 bar indicates a defective transfer pump.

Testing the Condition of Fuel Filter Unit

a. Fit the pressure gauge to the outlet side of the filter unit.
b. Bleed system and run the engine until normal operation temperature is attained.
c. Take gauge reading at idle and medium speeds and compare the result with specifications.

Result

Too low pressure reading could be caused by:-

A dirty or blocked fuel filter element.

Defective check valve where fitted

Defective transfer pump

Testing the Transfer pump When Dismounted

This is a simple transfer pump performance test and can be executed with the transfer pump dismounted.

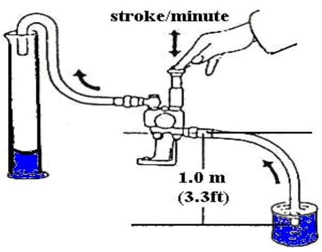


Figure 3.21 Performance test

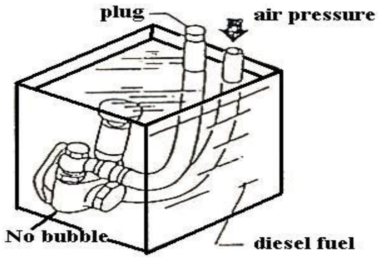


Figure 3.22 Leakage (air tightness) test

Testing Procedure

a. Connect a fuel pipe to the inlet and outlet of the transfer pump.

b. Put a fuel container underneath the transfer pump so that a suction height of 1m is maintained between fuel level and pump inlet side.

c. Operate priming pump at certain strokes per minute according to service recommendations.

d. Count the number or strokes required to suck fuel from the tank or measure the amount of fuel delivered by a defined number of strokes. Also, see manufacturer's recommendations.

e. Compare test results with manufacturer's specifications.

Air-Tightness Test of Fuel Transfer pump

Testing Procedure

a. Close the transfer pump outlet and fit a suitable pipe to the intake side.

b. Apply low air pressure (1.5 to 2.0 bar) to the intake side of the transfer pump.

c. Immerse the pump in clean kerosene or diesel fuel and observe if air bubbles appear.

Result

If continuously air bubbles show up, replace the concerning gasket or seal, or overhaul pump- assembly if necessary

Note:

The tests and procedures described above are general methods of testing the low-pressure fuel circuit. Since the testing procedures and pressure data might slightly vary depending on the manufacturers, their specifications and recommendations should always be followed!

3.2.5 Installing the transfer pump on the engine

1. Fit the transfer pump back onto its position.
2. You may have to press a little bit.
3. Fit back the nuts.
4. With one hand, press the pump firmly onto the housing of the pump and, with the other hand, tighten the nuts. This will avoid twisting the pump and/or destroying the threads.
5. Tighten the nuts to the correct torque. Finally connect the fuel lines to the transfer pump.

3.3 Servicing Injector Nozzles

The following section describes the general procedure to service injector nozzles: removing, cleaning, disassembling, inspecting parts of injection nozzle, assembling injector nozzle, testing, and installing injector nozzle on the engine

3.3.1 Removing injector nozzles

To remove injector nozzles you can follow the following general procedure.

1. Clean the injectors with an oil-removing solvent and a soft brush.
2. Blow dry with compressed air if possible. Ensure that all the parts are properly cleaned.
3. Disconnect the leak-off lines from the injectors. Take care of the sealing washers.
4. Disconnect the feed pipe from the injector. On injectors, which are provided with a separate connection nut, the feed pipe nut is disconnected by using two wrenches, one to hold the connection nut and the other to unscrew the pipe nut.
5. Cover the ends of the fuel pipes and the inlet to the injector with rubber cups, or tape, to protect the fuel system from dust and dirt.
6. Unscrew the retaining nuts /bolts holding the injectors, slackening the nuts equally, step by step before unscrewing them.
7. Use a long socket to unscrew injectors with screw attachments.
8. Withdrew the injectors and take care of the sealing washers from the injector-housing bore. Ensure that all sealing washers are removed from the bores.

Note

If the clamp-type injector holders are difficult to remove by hand, a special injector extractor must be used to pull them out.

Cover the injector bore in the cylinder head with a piece of cloth to protect the cylinder from dust and dirt.

3.3.2 Disassembling Injector nozzle

Injectors only should be disassembled, cleaned, examined, reassembled and adjusted if any of the above tests has shown an unsatisfactory result and/or recommended by the injector manufacturer.

Injector servicing is simple, providing you follow the correct procedure and have the necessary equipment and facilities to do the job. A clean workshop is the first essential. Necessary equipment for this job includes a holding rack for the injectors, trays to hold the dismantled components, wash containers, a holding vice, and tools for cleaning the components.

Note

Disassemble one injector at a time and place the components in a container filled with fuel. Nozzle bodies and needle valves are never interchangeable. They are lapped together as a unit.

1. First wash and brush off all external dirt and carbon from the injector.

Place the injector in a holding fixture.

Dismantle the injector in the correct sequence and use the proper tools according to manufacturer's recommendations.

Note

The order varies from nozzle to nozzle so follow the manual properly.

Remove the cap nut and washer first to avoid damaging the locating dowels, needle valve, and body.

Remove the locknut, spring adjusting screw, spring cap, spring seat, spring and spindle, and place them all in clean fuel.

Turn the injector upside down in the holding fixture and remove the nozzle nut and the nozzle assembly.

Note Be careful not to drop the needle valve from the nozzle assembly.

3.3.3 Cleaning Injector nozzle

Note Never use hard or sharp tools to clean the nozzle-valve body or any parts of the assembly. Use wooden stick, soft brass wire brush, clean fuel or special cleaning service tools recommended. Don't touch the needle mating surfaces with your fingers.

Cleaning Nozzle Needle

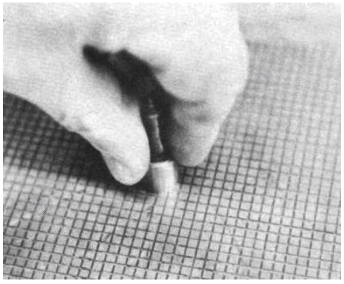
Use a wooden stick to remove carbon from the needle tip or tip area and wash in clean fuel. Check for discoloration, pitting, Nicks and scratches.

Cleaning Needle Body

First clean externally with a soft brass brush except the lapped surface.

Check for damage, corrosion and discoloration to the pressure face and spray holes.

The lapped pressure surface of the body must be clean. It must be lapped on a lapping plate and thoroughly washed in clean diesel fuel.



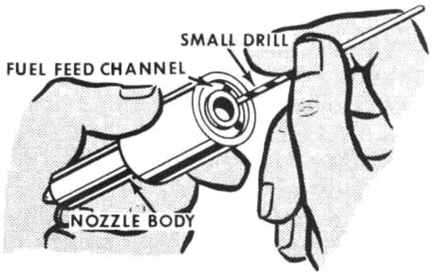


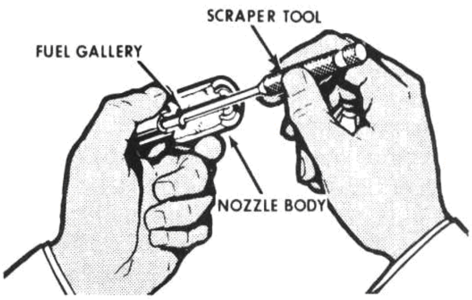
Figure 3.23 Cleaning Needle Body Figure3.24 Cleaning internal fuel duct

A. Internal fuel duct

Use a drill, soft wire or special service tools recommended to clean internal fuel duct.

B. Fuel pressure chamber cavity

Use special scraper tool provided to clean and remove carbon.



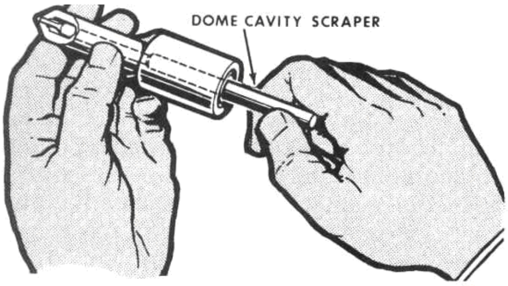
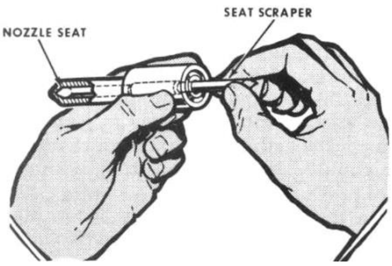


Figure 3.25 Cleaning Fuel pressure chamber cavity Figure3.26 Cleaning Dome Cavity

Select a dome cavity scraper with a suitable tip size to remove carbon.

C. Nozzle Seat

Use a bronze scraper to remove any remaining dirt and carbon from



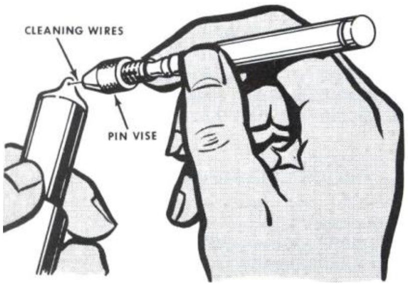


Figure 3.27 Cleaning Nozzle Seat Figure3.28 Cleaning Spray Holes

B. Spray Holes

Use a hand pin vice and the correct size wire (supplied with the cleaning kit) to remove carbon from the spray holes.

3.3.4 Inspecting and assembling parts of injection nozzle

Checking Needle Valve Freeness

Lift the needle valve about one-third of the length of its body and hold the valve body at a 450 angle. The valve should slide onto its seat by its own weight.

If the valve is sticky, then thoroughly rinse body and valve in clean diesel fuel again. If the valve continues to stick, replace the nozzle assembly.

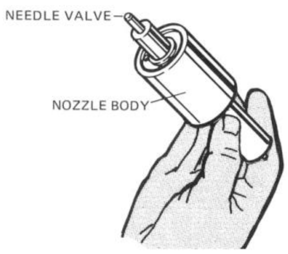


Figure 3.29 Checking Needle Valve Freeness

Nozzle Holder Service:

Clean all parts, external and internal surfaces of the holder assembly, using a soft brass brush and clean fuel.

Inspect all components for damages, pressure face for scores and corrosion, and lap if necessary. Inspect dowel pins for good condition, if used.

Assembling Injector nozzle

Reassemble in the correct sequence (according to manufacturer's recommendation), using the proper hand tools.

Use a torque wrench to tighten the nozzle cap nut to the recommended torque. Over-torqued nut can cause distortion and needle valve seizure. Under-torqued nut can cause Metered fuel to be lost.

3.3.5 Testing Injector Nozzle

before disassembling an injector an important step is to test it. The injector is connected to the pressure line of the injector tester, and tightened after the air is removed.

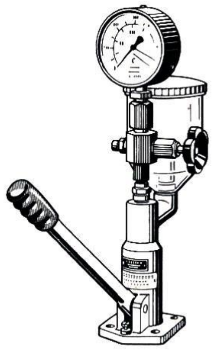


Figure 3.30 Injector nozzle tester.

Perform the testes in the Following order:-

Opening pressure test

Leakage or valve-seat test

Back leakage test

Spray pattern test

Adjusting injection nozzle Opening Pressure

Testing Procedure:

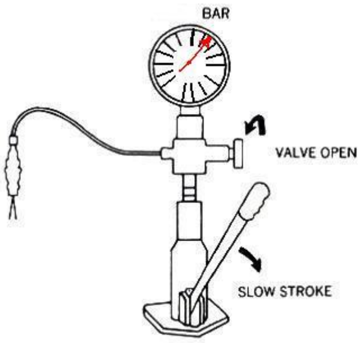


Figure 3.31 Opening pressure test.

a. Open the pressure gauge isolator after bleeding the system.

b. Operate the lever of the tester slowly until injection occurs.

c. Observe the pressure gauge and note highest reading just before injection pressure begins to drop.

d. Compare the recorded opening pressure reading with manufacturer's specification. If the actual pressure varies from the standard, the pre-tension of the pressure spring has to be adjusted. This is done by the adjustment screw provided, or by adjusting shims of various sizes. Adjusting Shims are usually available in sizes from 1.0 - 3.0mm thickness and in steps of 0.05mm.

Note If New Injection Nozzles has to be installed, adjust the opening pressure 5.0 to 10.0 bar above the specified pressure in order to compensate a pressure drop caused by the short break-in period of the needle valve.

Checking injection nozzle back Leakage Test

after the leakage or valve-seat test, some manufacturers recommend to perform a back leakage test.

Testing Procedure:

a. Open the pressure gauge isolator on the tester.

b. Slowly depress the operating lever until stated pressure is shown on gauge.

c. Release the operating lever and note the time taken for pressure to fall.

The time for the pressure drop can be influenced by: -

The fuel temperature

The viscosity of the test fluid used

The length of the pressure line used.

Results Generally, a pressure drop from 150 to 100 bar ($\Delta P \approx 50$ bar) within a time not less than 6 seconds ($T \geq 6$ second), using shelf fluid “C” and maintaining a test temperature approximately 100 up to 200c indicates a satisfactory injector.

A higher pressure drops than specified can be caused by: -

Loose fuel pipe connections

High temperatures, causing thinning of the test oil

Loose nozzle cap or nozzle holder retaining nut.

Dirty or damaged sealing surfaces of nozzle and/or nozzle holder, which allows fuel to escape.

Checking injection nozzle Leakage or Valve-Seat

Testing Procedure:

a. Open the pressure gauge isolator and wipe injector tip dry.

b. Depress the operating level of the tester slowly until the gauge indicates a pressure of about 10 to 20 bar below the before- measured opening pressure.

c. Maintain this pressure for 10 seconds and observe the injector tip.

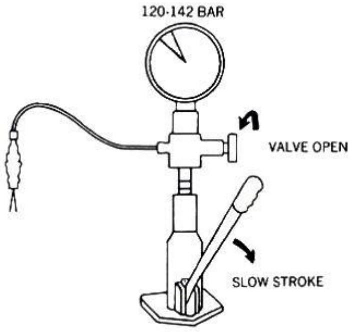


Figure 3.32 Leakage or valve-seat test

Results If no fuel drop occurs during this time, the needle-valve seat is in good condition. If there is any evidence of fuel at the tip, the needle-valve seat is defective. The nozzle assembly should be replaced or overhauled.

Checking injection nozzle Spray Pattern

Testing Procedure:

a. Close the pressure gauge isolator on the tester.

b. Move the opening lever at about 1 strokes/second and observe the spray jet. A nozzle in good condition shows a thin and even cone-shaped jet of spray without distortion and fine atomized fuel.

c. After this, gradually increase the lever movement to about 2 strokes per second.

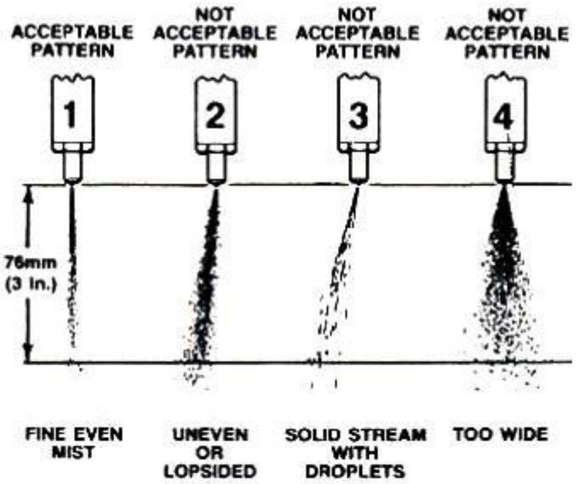


Figure 3.33 Spray Pattern Test Results

Results

Now a characteristic "chattering or humming" sound should be noticed indicating a properly working injector. This depends also very much on the test fluid used. If the injector does not atomize the fuel completely, incomplete combustion, causing black smoke, a loss in engine power and poor fuel economy, will result. Increased diesel knock, due to the longer delay period that follows poor atomization, will also be evident.

3.3.6 Installing injector nozzle on the engine

Before installing the injectors, replace the sealing washers and heat protection washers in the injector bores. Check that all old washers are removed from the bore and that the position of the new ones is correct. Be sure to check this in the manufacturer's manual.

Install the injectors in the bore and press down by hand.

Remove the protection caps or cape and connect the fuel pipe. Screw the connection nut by hand. If necessary, move the injector a little to fit the nut properly.

Tighten the nuts or bolts for the injector fixing with a torque wrench. Tighten alternate nuts in equal amounts to ensure that the injector is seated squarely.

Note

It is very important that the retaining nuts are tightened with the correct torque. Excessive tightening can cause cracks in the cylinder head.

Tighten the pipe flange nut and, at the same time, check that the flange nut at the injector is also tightened properly.

Connect the leak-off pipe

Be careful when tightening the screw because some are hollow and rather weak in construction. Use the recommended torque.

Start the engine and check that no leakage occurs from the transfer pump connections.

Note

Keep the injectors protected by placing them in a bag or box. Also make sure that the injectors are kept in order so that they can be re-fitted in the same cylinder.

Be careful not to damage the needle, which protrudes from the injector.

3.4 Bleeding the Diesel Fuel System

3.4.6. System with In-Line Pump

In general, bleeding is executed with the help of a priming pump, and follows certain steps of procedure.

a. Loosen the priming pump by turning it counterclockwise.

b. Loosen the air vent screw positioned nearest to the priming pump in the system (usually found on the fuel filter unit)

c. Operate the priming pump by hand until pure diesel fuel, free from air bubbles, comes out of the air vent screw.

d. Tighten the air vent screw

e. Now, open the air vent plug on the fuel injection pump

f. Close the air vent screw when air bubbles disappear from fuel coming out of the plug.

g. Tighten the priming pump by pushing it downwards and turning it clockwise at the same time.

With fuel systems provided with suction-side scavenging of the injection pump, the fuel manifold can be bled without opening the air vent plug on the injection pump, by cranking the engine at starter motor speed. The air escapes via the check and the fuel return line into the fuel tank. Pull the stop lever back completely to ensure that the engine will not run.

b. Crank engine until fuel escapes from the loosen pressure pipes.

c. After this, tighten injection pipe flare nuts and run the engine.

Self-check 3

Directions: Answer all the questions listed below.

Part -1

Say True or False

1. The hydraulic injection-timing device is located at the Top of the pump at right angles to the pump's longitudinal axis.

2. VE in the name of the Bosch pump used in many Gasoline engines stands.

3. Clean all parts, external and internal surfaces of the holder assembly, using a soft brass brush and clean fuel.

4. Engine cut-off is accomplished by stopping the fuel supply

5. The regulating valve regulates fuel Pressure inside the injection pump in proportion to engine rpm.

Part I: Choose the appropriate answer from

1. Manifold _____________ is eliminated due to the fuel being injected into or close to the cylinder and need not flow through the manifold.

a) Heating b) Wetting c) Cooling d) None of the mentioned

2.. ____________ of fuel is independent of cranking speed and therefore starting will be easier.

a) Ignition b) Atomization c) Condensation d) None of the mentioned

3. Better atomization and _____________ will make the engine less knock prone.

a) ignition b) Vaporization c) Condensation d) None of the mentioned

4. Formation of ice on the _____________ plate is eliminated in electronic fuel injection.

a) Throttle b) Engine c) Nozzle d) None of the mentioned

5. The following design features of VE-type pump has made it more suitable than the conventional Inline type pump for the modern high-speed diesel engine.

a. Compact And Lightweight With Fewer Parts b. Uniform Fuel Delivery

c. Improved Starting d. All

6. When the pump plunger moves even further toward the right, the two plunger spill ports will move out from under the spill ring

a. End of injection b. Pressure equalization c. Injection stroke d. all

7 which of the following is control the engine speed, within limits, during various load conditions.

a. Flyweight b. roller ring c. governor d. all

8. When engine speed overcomes the predetermined maximum speed, flyweight force overcomes the tension of the control spring

a. Maximum speed control b. Full load c. Idling d. all

9. Which of the following is component part of injection pump.

a. cam plate b. timer piston c roller ring d. all

LAP Test

Practical Demonstration

Name: ___________________________ Date: ____________

Time started: ____________________ Time finished: _______________

Instruction: Perform the following tasks

Task 1: Service diesel fuel injector nozzle

Task 2: Removing injection pump from Engine.

Task 3: Observe the injection pump condition visually

Task 4: Disassemble injection pump

Task 5: Assembling injection Nozzle

Task 6: Testing injection bench pump

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Journals/Publication/Magazines

Vehicle Maintenance and Repair

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