Fuel and feed system

Objectives: At the end of this lesson you shall be able to
- **explain the types of fuel**
- **explain the specification and characteristics of fuel**
- **state the different types of fuel feed systems**
- **draw the layout of the fuel the flow system in a petrol engine vehicle**
- **state constructional features of the fuel tank.**

Different types of fuel feed systems

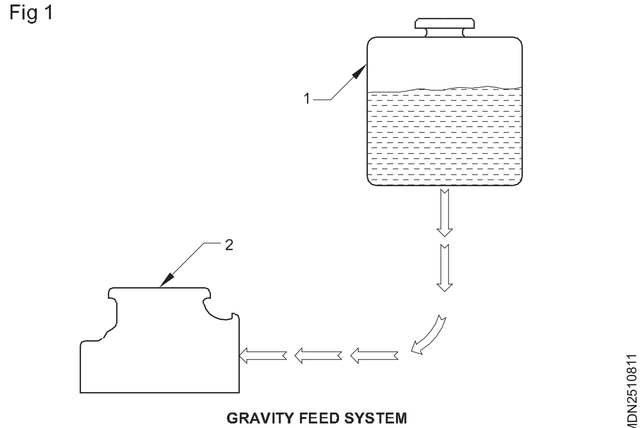
There are three types of fuel feed systems.

- Gravity feed system
- Vacuum feed system
- Forced feed system

Gravity feed system (Fig.1)

In the gravity feed system, the fuel tank (1) is kept at a higher level than the carburettor. The fuel flows to the carburettor (2) by its own gravity. This system is used in motor cycles, scooters and stationary engines. This is a simple and less expensive system.

Fig 1



GRAVITY FEED SYSTEM

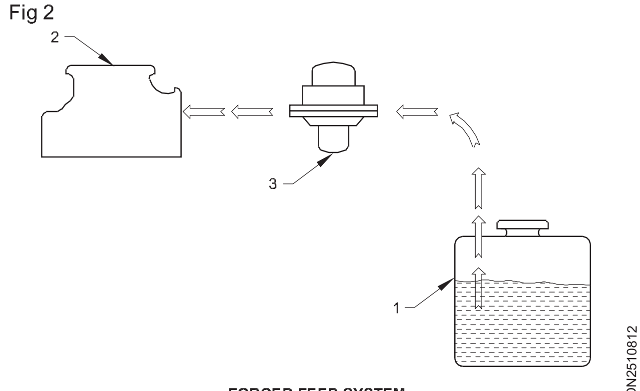
Vacuum feed system

In this system the fuel tank is placed below the level of the carburettor. The fuel from the tank is sucked by a separate unit (auto-vac) with the assistance of the inlet manifold vacuum. Then the fuel is fed to the carburettor by gravity.

Forced feed system (Fig.2)

In this system, the fuel tank (1) is placed at a distance and also below the level of the carburettor (2). A fuel pump (3) is used to pump the fuel from the tank to the carburettor. This system is used in almost all the vehicles, except two wheelers.

Fig 2

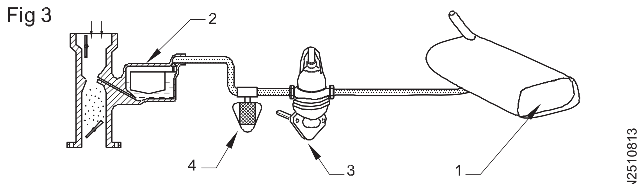


FORCED FEED SYSTEM

Layout of the fuel feed system (Fig.3)

The fuel from the tank (1) is pumped to the carburettor (2) by the fuel pump (3) through the fuel filter (4). In fuel pipes connecting between tank and pump are called suction pipe (5) .

Fig 3



LAYOUT OF THE FUEL FEED SYSTEM

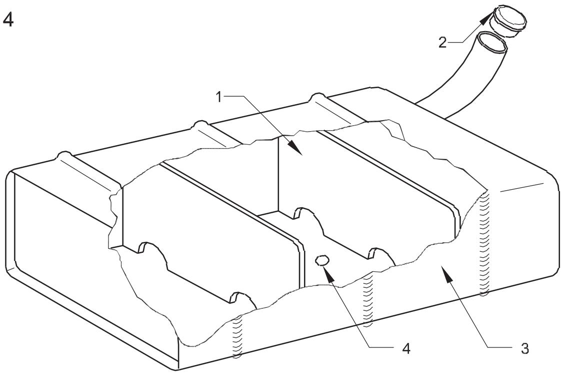
Components of the fuel feed system

The fuel pipe between feed pump to pump is called pressure pipes (6)

Petrol tank (Figs 4 &5)

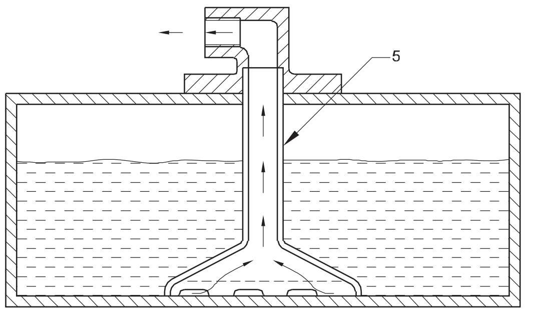
Location: The location of the fuel tank on the vehicle varies from vehicle to vehicle. It may be fixed in the rear, under the seat or in the front etc. The tank should be protected from flying stones when the vehicle is moving.

Fig 4



PETROL TANK

Fig 5



PETROL TANK

Construction: The fuel tank is made of galvanised mild steel sheets coated with lead/tin alloy to protect against rusting. Some tanks are made of aluminium and plastics such as polythene. Internal baffles (1) with a passage for fuel transfer are provided to avoid fuel slashing (strikings against the walls of the tank).

A filler cap (2) is provided to seal the tank (3). A vent hole is provided either in the filler neck or in the cap to have atmospheric pressure in the tank above the fuel. The tank is mounted on a frame by straps. A drain plug (4) is provided to drain the sediments and condensed water periodically. A fuel line tube (5) is provided in the tank. The tube (5) inlet is kept at least 1/2" above from the bottom of the tanks to avoid suction of water, if it has been deposited in the tank.

Fuel feed pump and filter

Objectives: At the end of this lesson you shall be able to
- **list out the different types of the fuel feed pump (petrol engine)**
- **state the functions of a mechanical type fuel feed pump**
- **state the function of an electrical type fuel feed pump**
- **state the functions of fuel filters.**

Function

The function of the fuel feed pump is to pump the fuel from the tank to the carburettor.

Types

There are two types of fuel feed pumps.

- Mechanical
- Electrical

Mechanical type feed pump

A mechanical pump is mounted on the engine and is operated by a camshaft. This pump consists of an air chamber divided in the centre by a flexible diaphragm.

Operation of feed pump (Fig.1)

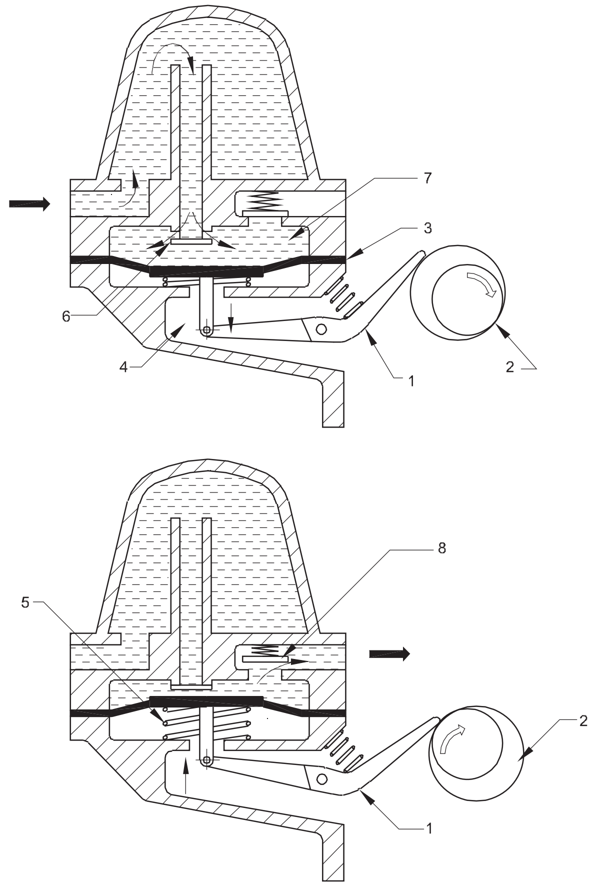
The rocker arm (1) is actuated by the camshaft (2) and moves to and fro. This makes the diaphragm (3) to move up and down along with the spindle (4) and the spring (5). During the downward motion of the diaphragm, a partial vacuum is created and the inlet valve (6) opens, allowing the fuel to be sucked into the top chamber (7).

When the diaphragm moves upward, the inlet valve (6) closes and the fuel is forced through the outlet valve (8) into the pipe line to the carburettor float chamber. The pressure developed is 0.18 kg/cm^2 to 0.3 kg/cm^2.

Idling action (Fig.2 &3)

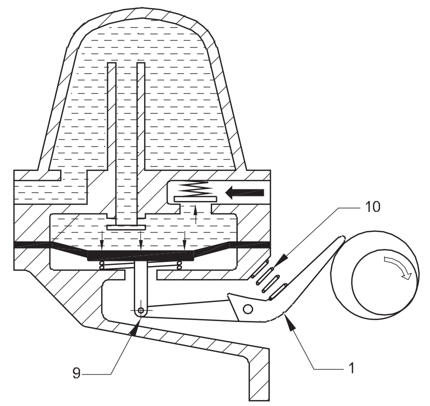
When the carburettor float chamber is full, the pumping action has to be stopped, to avoid flooding of the carburettor. At this condition the needle value in the float chamber remains closed and a back pressure develops in the pipeline. This pressure keeps the diaphragm depressed and the link (9) remains in the downward position. The rocker arm (1) moves without affecting the motion of the diaphragm.

Fig 1



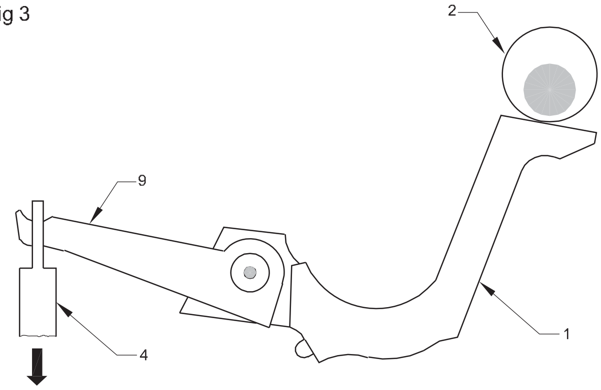
OPERATION OF FEED PUMP

Fig 2



IDLING ACTION

Fig 3



IDLING ACTION

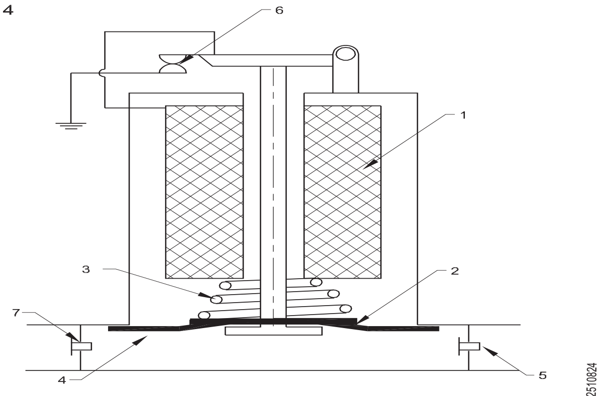
A spring (10) is provided between the rocker arm (1) and the pump body to avoid any rattling noise of the rocker arm (1) during the idling operation.

Electrical type fuel feed pump (Fig.4)

A battery operated fuel feed pump can be mounted at any convenient position. These are of two types.

- Diaphragm type
- Bellow type

Fig 4



ELECTRICAL TYPE FUEL FEED PUMP

When the ignition is switched on, the solenoid (1) of the pump is energised and the armature (2) is attracted to the magnetic core against the spring's (3) tension. This causes the diaphragm/bellow (4) to flex. It creates a partial vacuum in the pumping chamber. Petrol is sucked in the pump chamber through the inlet valve (5) from the petrol tank. When the armature (2) reaches its stop position, the bronze plunger opens the contact points (6) and cuts off the electric connections to the solenoid (1).

This results in de-energisation of the solenoid (1). Now the spring's (3) pressure moves the armature along with the diaphragm/bellows (4) downwards, and the fuel in the chamber flows out to the carburettor through the outlet valve (7). This movement of the armature makes the contact points close and again the cycle is repeated at the rate of 50 to 60 times per minute till the float chamber is filled up.

Idling action of the pump

Once the float chamber is full, the needle valve in the float chamber closes the inlet passage of the carburettor. This results in back pressure being developed in the pipeline.

Due to this back pressure, the armature is always pressed in the upward position which keeps the contact points open. This keeps the pump out of action till the fuel level in the float chamber goes down.

Carburettor systems

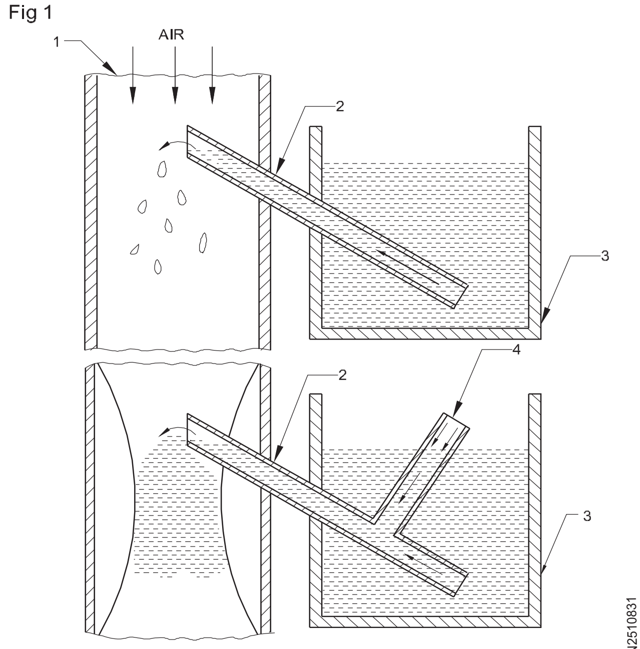
Objectives: At the end of this lesson you shall be able to
- **state the principle of carburettor**
- **list out the different types of carburettors**
- **state the various circuits in the carburettor**
- **state the function of various circuits in a solex carburettor.**

Carburettor

Principle of carburation (Fig.1)

The carburettor is a device for atomising and vapourising fuel and mixing it with air in varying proportions to suit the changing operating conditions such as varying engine speed, load and operating temperature of the motor vehicle engines.

Fig 1



PRINCIPLE OF CARBURATION

During the suction stroke air is drawn through the air cleaner and it passes through the air horn (1). A discharge tube (2) is connected between the air horn (1) and the fuel bowl (3). When the air passes through the air horn (1) it creates a vacuum at the tip of the discharge tube (2), and sucks fuel from the fuel bowl (3).

An air bleed (4) is provided on the jet tube (2) which helps in breaking the fuel particles into very fine particles. This is known as atomising. The fuel and air mixture is then sucked into the cylinder.

This process of breaking up fuel and mixing it with air is called carburation.

Types of carburettors

Carburettors are divided into two types.

- Constant choke
- Constant vacuum

Again they are classified as stated below. As per draft

- Up draft
- Down draft
- Horizontal draft.

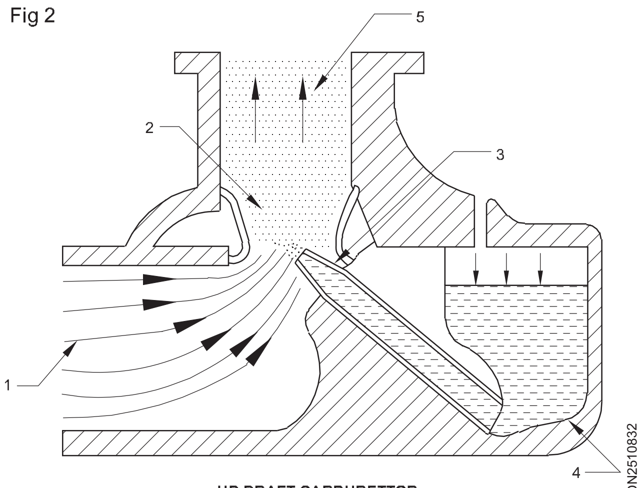
As per venturi arrangement

- Single venturi
- Double venturi
- Triple venturi
- Multi-venturi

Up draft Carburettor (Fig.2)

This type of carburettor is fitted under the inlet manifold. The air enters through the pipe (1). Air is drawn upwards through the venturi (2) due to the suction stroke. Because of the venturi, high velocity and high vacuum is created. The fuel is sucked from the nozzle (3) which is connected to the fuel bowl (4). The fuel thus sucked gets the vapourised and gets mixed with air in the chamber (5). This air/fuel mixture is then sucked into the cylinder.

Fig 2

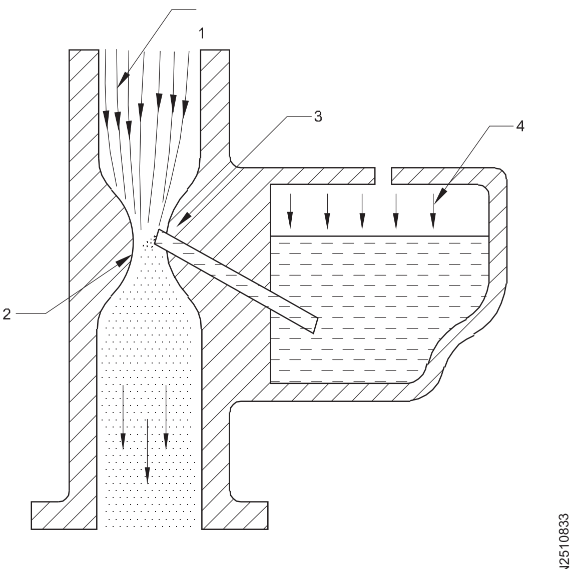


UP DRAFT CARBURETTOR

Down draft (Fig.3)

This type of carburettor is fitted on the inlet manifold. The air enters through the chamber (1), moves downwards and passes through the venturi (2). It sucks fuel from the float chamber (4) through the nozzle (3). The fuel/air mixture is sucked into the cylinder during the suction stroke.

Fig 3

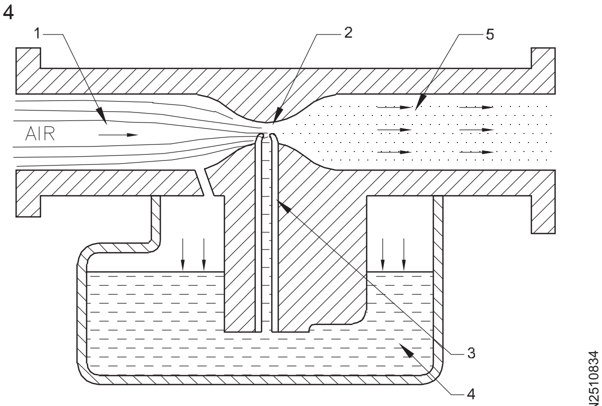


DOWN DRAFT

Horizontal/natural draft (Fig.4)

In this type the carburettor is fitted in line with the manifold. Due to suction, air flows from the chamber (1) to the chamber (5) through the venturi (2), and sucks fuel from the float chamber (4) through the nozzle (3). This air/fuel mixture is then sucked into the cylinder.

Fig 4



HORIZONTAL / NATURAL DRAFT

Venturi arrangements

Different types of venturies and more than one venturi are also provided in a carburettor. Each type is designed to provide decreased pressure, to draw fuel from the discharge jet and to create a vacuum to help vapourisation. Multiple venturies also help to keep the fuel away from the carburettor walls to reduce condensation.

Functions of a carburettor

The functions of a carburettor are to:

- atomise fuel into small drop lets
- vaporize the small droplets of fuel and mix it with air to make a homogeneous air/ fuel mixture
- supply fuel to the engine continuously in the required quantity according to load, r.p.m. etc.

To carry out the above functions, the carburettors are made up of jets and different circuits to supply correct air/ fuel mixture according to the needs of the engine at different loads and speeds.

The following are the different circuits in carburettors.

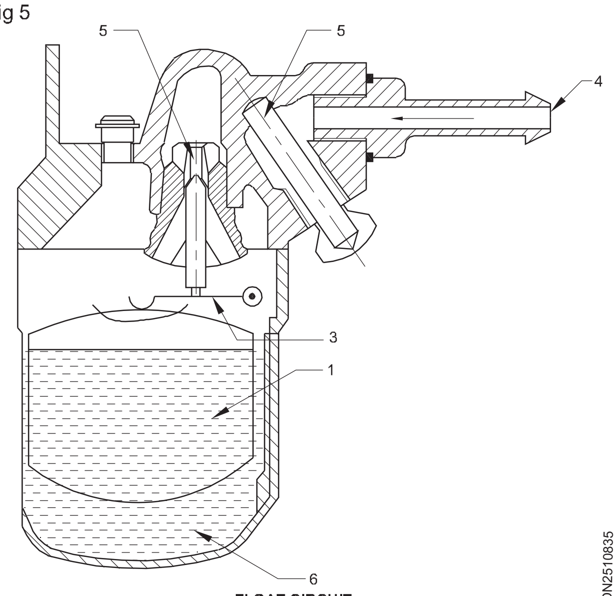
- Float circuit
- Starting circuit
- Idling and low speed circuit
- High speed main circuit
- Accelerator pump circuit
- Power circuit.

Carburettor (solex)

Float circuit (Fig.5)

The float system regulates the fuel supply in the carburetor. It controls the static head above the main jet and the level of petrol in the spraying well.

Fig 5



FLOAT CIRCUIT

The correct setting of the fuel level is determined by three main factors.

- The weight of the float (1)
- The size of the needle valve (2)
- The thickness of the fibre washer

The needle valve (2) is offset and the float movement is transmitted via the float toggle (3).

Petrol is fed through the inlet (4) and is filtered by the fine filter (5) before passing through the needle valve assembly (2) to the float chamber (6).

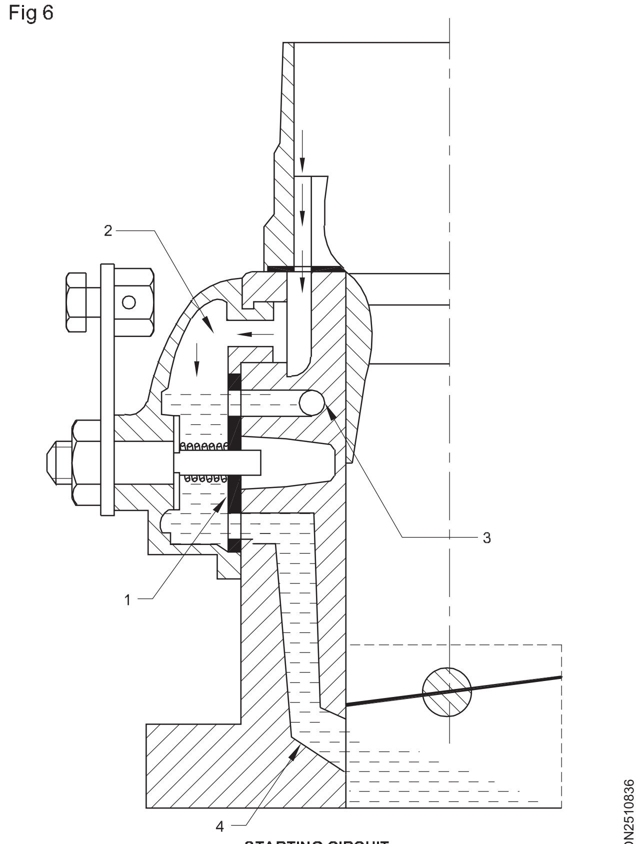
When the fuel level rises in the float chamber ,the float (1) is lifted and it presses the needle valve (2) against the float valve seat and cuts off the flow of fuel to the chamber. When the fuel is consumed, the level in the float chamber drops; the needle valve (2) leaves its seat and fuel flows again into the float chamber.

The valve regulates the flow of petrol into the float chamber. It is maintained at a constant level.

Starting circuit (Fig.6)

While starting the engine, a rich mixture is required. The starting circuit provides the necessary mixture to the engine.

Fig 6



STARTING CIRCUIT

It has three positions.

- Starter lever fully home - no action.
- Starter lever half pulled out - warm up.
- Starter lever fully pulled out - cold starting.

The operation of the starter is activated by rotation of the starter valve (1). It is connected to the dashboard by a lever and a flexible cable. When the dashboard knob is fully pulled out for cold starting, air is drawn though the float chamber cover via the starter air jet (2) and petrol via the starter petrol jet (3). Petrol is mixed with air from the starter air jet (2). The air and petrol pass through (4) and finally go to the cylinder.

Idling /slow speed circuit (Fig.7)

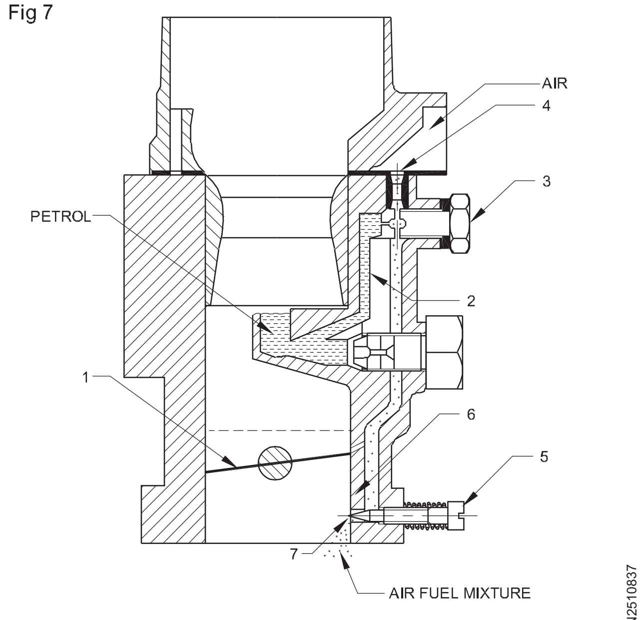
The combined idling and transfer system supply the petrol and air mixture to the engine when the throttle (1) is closed and when the throttle progressively opens for the purpose of driving the vehicle.

The vacuum created underneath the throttle when the engine is idling causes petrol to flow from the reserve well (2) to the pilot jet (3), and pass through the orifice (7).

The quantity of petrol is controlled by the pilot jet (3) and the air quantity by the air bleeder (4).

The volume of air/fuel mixture in idling is controlled by the position of the volume control screw (5).

Fig 7



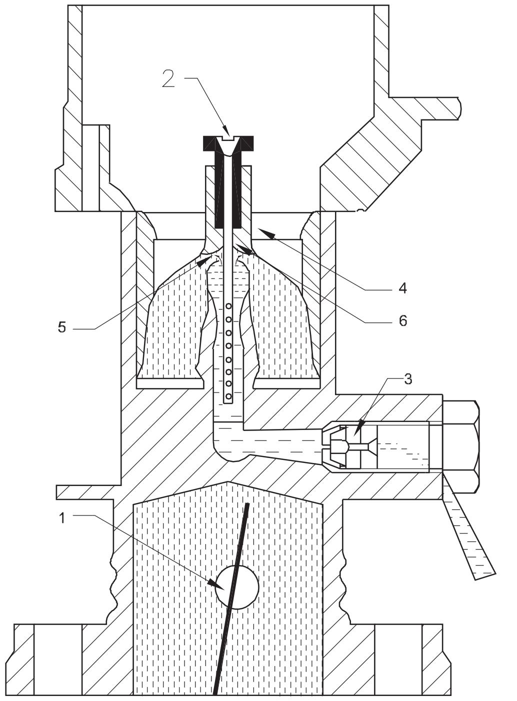
IDLING / SLOW SPEED CIRCUIT

Loosening of the volume control screw increases the volume of air/fuel mixture passing below the throttle. The adjusting screw for slow running controls the idling speed. For specified setting of the idling speed, it is necessary to use both the volume control screw for air/fuel mixture strength and the slow running adjustment screw for speed. When the accelerator pedal is pressed, the throttle (1) opens and the vacuum reaches to the bypass orifice (6). The bypass orifice (6) then discharges the mixture into the air stream passing through the throttle (1). This adds air to the mixture discharged through the orifice (7). This allows the engine to accelerate smoothly from the idling position.

Main circuit/accelerating circuit (Fig.8)

For acceleration up to the maximum speed and full power performance, the fuel is fed through the main jet (3) and the air by the air correction jet (2). When the accelerator pedal is pressed the throttle (1) opens and the air velocity in the choke tube (4) increases. It creates a vacuum across the spraying orifices (5). Now the petrol is drawn through the main jet (3), and similarly the air is drawn through the air correction jet (2). An emulsion tube (6) with lateral holes helps emulsification of air and fuel. Then the spray passes through the spraying nozzle holes.

Fig 8



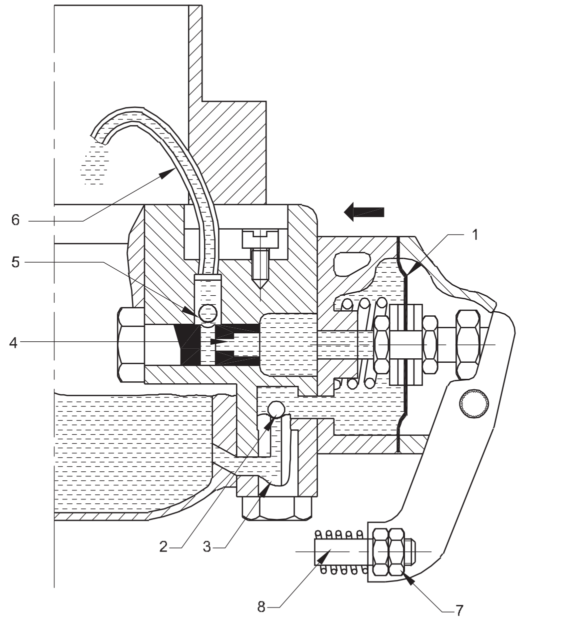
MAIN CIRCUIT / ACCELERATING CIRCUIT

Pump circuit (Fig.9)

A sudden wide opening of the throttle would allow a large amount of air to pass through the choke tube to the engine. A partial vacuum is developed in the choke tube which is not sufficient to get the necessary discharge of fuel from the main spraying well. Due to lack of petrol at this condition, the mixture becomes too weak and the engine does not pick up speed. This condition is avoided by supply of more petrol, by the accelerating pump though momentarily. The pump is actuated by a lever which is attached to the throttle spindle by a spring-loaded rod(8). When the throttle is closed, the tension of the pump spring pushes the diaphragm assembly (1) back, thus drawing the petrol to the pump chamber through the non-return ball valve (2) after passing through a fine filter (3).

On opening the throttle, the lever pushes the diaphragm (1) forward, pushing petrol out of the chamber which is metered by the pump jet (4) through the non-return ball valve (5). Finally the petrol reaches the choke tube through the injector tube (6). At the same time, the ball valve (2) is forced to its seat preventing the petrol to return to the float chamber. The travel of the lever is adjusted by the pump control rod nut (7), controls the rate of flow. This action enriches the fuel supply to give a quick and smooth acceleration.

Fig 9

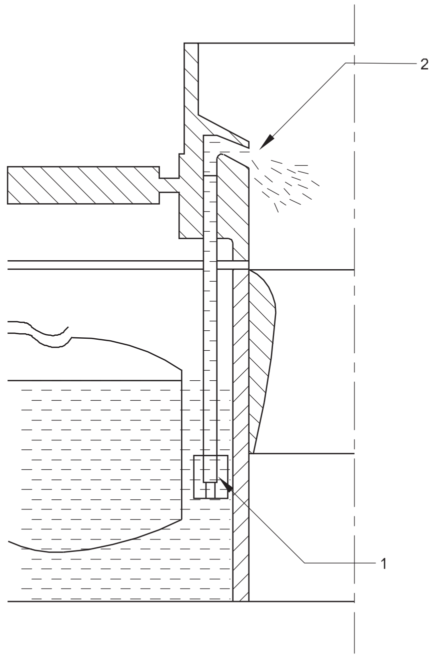


PUMP CIRCUIT

Econostat/power circuit (Fig.10)

This allows maximum fuel economy at the cruising speed range and provides accurate, metered fuel under full throttle condition. The econostat jet (1) runs through a float chamber to the injector tube (2). When enough vacuum is created at the tip of the injector tube, petrol is sucked through the econostat jet to the injector tube (2).

Fig 10



ECONOSTAT / POWER CIRCUIT

Diesel fuel

Objective: At the end of this lesson you shall be able to
- **state the fuel requirement**
- **explain fuel specification and characteristics of fuel.**

In this system at the end of compression stroke in diesel engine.

If the amount and rate of fuel being injected is not measured, will result in uneven running of engine and it leading to vibrations and loss of power diesel fuel injection should be fully atomized into five particles for it spreads one immediately in the combustion chamber to mix up the with hot compressed air for high combustion. The fule injection should take place at the correct time, according firing order of the engine.

Fuel system must full the following requirement

- Time the fuel injection and distribute the fule properly in the combustion chamber.
- Measure the correct quantity of fuel injected.
- Control the rate of fuel injection.
- Fully atmomize the fuel.
- Develop pressures well in excess of the combustion chamber pressure.

An engine converts heat energy of fuel into mechanical energy. The engine fuel may be solid, liquid or gas. Solid fuel (coal) is used in external combustion engine. e.g. steam engine. Liquid gases and fuel are used in internal combustion Engines.

The most common fuel used in engines are diesel and petrol.

Specification and characteristics of fuel

Octane number

It is a measure to determine the burning quality of the gasoline. It has the tendency to resist knocking in an engine. The higher the octane number the lesser the tendency to knock.

Volatility

Volatility is the ability of the gasoline to evaporate, so that its vapour will adequately mix with air for combustion. Vapourised fuel will burn easily.

Viscosity

This indicates quality of fuel to flow. Lower viscosity fuel will flow more easily than that of higher viscosity.

Sulphur content

Gasoline contains some sulphur. Sulphur present in fuel increases corrosion of engine and therefore it is reduced at the refinery to the maximum possible extent.

Additives

Several additives are put in gasoline to control harmful deposit and to increase anti-freezing quality of the engine.

Detergents are also added to clean certain critical components inside the engine

Diesel fuel

Diesel engine fuel is a highly refined distillate fuel obtained from fractional distillation of crude oils

There are light medium and heavy diesel fuel available in the market, which are used as per the recommendations of engine manufacturers.

Cetane number

Cetane number (cetane rating) is an indicator of the combustion speed of diesel fuel and compression needed for ignition. It is an inverse of the similar octane rating for gasoline. The CN is an important factor in determining the quality of diesel fuel, but not the only one; other measurements of diesel's quality include energy content, density, lubricity, cold-flow properties and sulphur content.

Concept of quiet diesel technology

Technology for quieter, smoother diesel

The combustion pressure in diesel engine cylinder rises intensely and the maximum pressure is extremely high compared with a petrol engine, because of the differences in the combustion method. As a result, diesel engines generally produce more noise, vibration and harshness (NVH) than pertrol engines, and this is a major complaint among diesel users. Efforts to reduce the NVH to the level of petrol engines by making full use of the latest technology.

Pilot injection system to reduce combustion pressure

The sudden rise in combustion pressure is a major source of diesel engine noise. By the development of the common rail high-pressure injection system and electronic fuel injection, flexible and precise control over the injection timing and amount made possible. The fuel pressure rise controlled by smoothing the combustion process by pilot injection, a method in which a small amount of fuel is injected and ignited just before the main fuel injection process. This is known as pilot injection control process.

Increased rigidity of engine structure

The maximum cylinder pressure in diessel engine is considerably high and the pressure rise during combustion is very rapid, causing the engine vibration and noise. Also, diesel engine components such as the piston are solidly built in order to endure the high pressure and pressure increase ratio. The extra weight of these components translates into increased inertia, the scale of vibration. it is possible to control noise generation by reforming the engine structure to absorb vibration and to reduce the overall level of vibration. Moreover, vibration travels from the pistion to the connecting rod, crankshaft and engine block. This form of vibration attenuated by employing a ladder frame structure with a more rigid crankshaft bearing.

Other technologies used to reduce NVH (Noice vibration and harshness.)

A secondary balancer is use to help smooth out the vibrations characteristic of four-cylinder engines.

pairs of gears or scissors gears, working side by side with the same numbers of teeth, help to reduce mechanical engine noise by reducing the gear play.

The two sides of the flywheel, which face the engine and the transmission respectively, are each fitted with a spring and damper to absorb driventrain vibration caused during changes in speed.

Clean diesel technology

Clean diesel is a new generation of diesel made up of a three part system.

1 Advanced engines

Highly efficient diesel engines

1 Cleaner diesel fuel

Ultra-low sulfur diesel

1 Effective emissions controls

Advanced emissions control

This new system ensures that advanced diesel engines will continue to play an important role in the transport of people and goods in the future, while helping meet greenhouse gas and clean air objectives in the world.

Technical innovation has helped progresively to lower vehicle emissions - over the last 15 years, nitrogen oxides (NOx) limits for diesel car engines have been reduced by 84% and particulates (PM) by 90%.

15% less CO_2 Emissions/km than equivalent petrol-powered vehicles. Diesel vehicles contribute to reducing CO_2 emissions from road transport and therefore to reduce climate change.