Internal Combustion Engine

Lecture 03+04
Engr. Mansoor Ali Zaheer
Assistant Professor
Mechanical Engineering Department
University of Sargodha

What is a Carburetor?

- It is a device (Use in Internal combustion engine) for **mixing air with fuel in a system for the proper burn of fuel**.
- The carburetor is only used in a **petrol engine**, where **spark ignition** happens.

Functions of a Carburetor

- The main function of carburetor is to mix air and gasoline and provides a high combustion mixture.
- It controls the engine speed.
- It also regulates the air-fuel ratio.
- Increase or decrease the amount of mixture according to the engine speed and load changing.
- To keep certain head of fuel in the float chamber all the time.
- Vaporize the fuel and mix to air to a homogeneous air-fuel mixture.
- To supply the correct amount of air-fuel mixture at the correct strength under all conditions of load and speed of the engine.

A Simple or elementary Carburetor

Fig. 11.5, shows a schematic diagram of a simple or elementary carburettor.

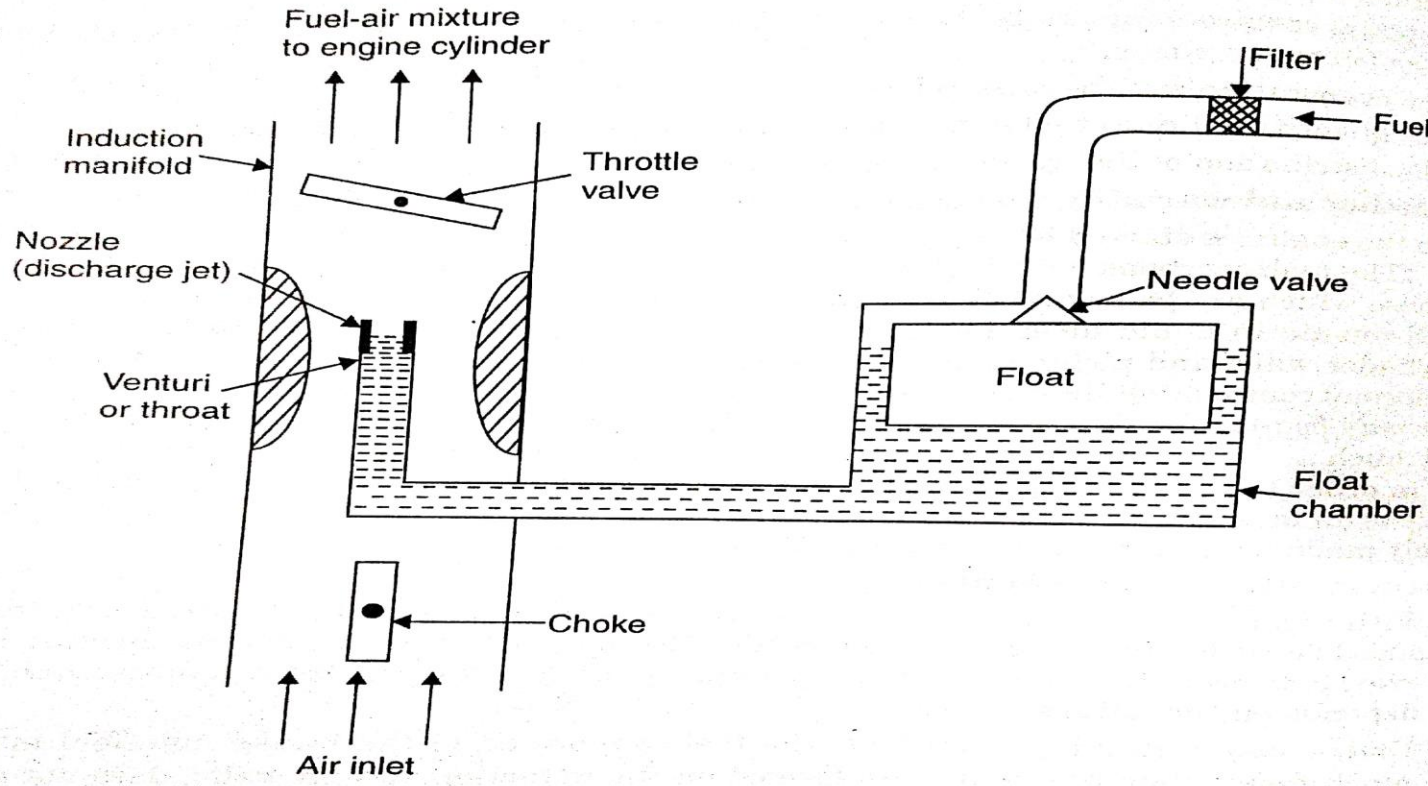


Fig. 11.5. A simple or elementary carburettor.

A Simple or elementary Carburetor

- It consists of a *float chamber, nozzle with metering orifice, venturi* and *throttle valve.*

  – The **float chamber** is meant for storage of fuel. The fuel supplied under gravity action or by fuel pump enters the float chamber through a filter. The arrangement is such that when oil reaches a particular level the *needle/float valve* blocks the inlet passage and thus cuts off the fuel oil supply. On the fall of oil level, the *float* descends down, consequently intake passage open and again the chamber is filled with oil. Then the float and the needle/float valve maintains a constant fuel oil level in the float chamber. There is a *nozzle (discharge jet)* from which the fuel is sprayed into the air stream as it enters the inlet and passes through the venturi or throat. *The fuel level is slightly below the outlet of the jet when the carburettor is inoperative.*

A Simple or elementary Carburetor

- As the piston moves down in the engine cylinder, suction is produced in the cylinder as well as in the induction manifold as a result of which air flows through the carburettor. *The velocity of air increases as it passes through the constriction at the venturi and the pressure decreases due to conversion of a portion of pressure head into kinetic energy.* Due to decreased pressure at the venturi and hence by virtue of difference in pressure (between the float chamber and the venturi) the jet issues fuel oil into air stream. Since the jet has a fine bore, the oil issuing from the jet is in the form of *fine spray* ; it vaporises quickly and mixes with air. The air-fuel mixture enters the engine cylinder ; *it quantity being controlled by the position of the "throttle valve".*

Advantages of the Carburetor:

- Carburetor parts are not as expensive as that of fuel injectors.
- With the use of a carburetor, you get more air and fuel mixture.
- In terms of a road test, carburetors have more power and precision.
- Carburetors are not restricted by the amount of fuel pumped from the fuel tank which means that cylinders may pull more fuel through the carburetor that would lead to the denser mixture in the chamber and greater power as well.

Disadvantages of the carburetor:

- At very low speed, the mixture supplied by a carburetor is so weak that, it will not ignite properly and for its enrichment, at such conditions, some arrangement in the carburetor is required.
- The working of a carburetor is affected by changes in atmospheric pressure.
- More fuels are consumed since carburetors are heavier than fuel injectors.
- More air emissions than fuel injectors.
- The maintenance costs of a carburetor are higher than the fuel injection system.

11.8. COMPLETE CARBURETTOR

For meeting the demand of the engine under all conditions of operation, the following additional devices/systems are added to the simple carburettor :

1. Main metering system
2. Idling system
3. Power enrichment or economiser system
4. Acceleration pump system
5. Choke.

1. Main metering system :

The main metering system of a carburettor should be so designed as to supply a *nearly constant fuel-air ratio over a wide range of operation.* This F/A ratio is approximately equal to 0.064 (A/F ratio ≈ 15.6) for best economy at full throttle. In order to correct the tendency of the simple carbu-

rettor to give progressively richer mixtures with load speed, the following *automatic compensating devices* are incorporated in the main metering system :

(*i*) Compensating jet device.

(*ii*) Emulsion tube or air bleeding device.

(*iii*) Back suction control or pressure reduction method.

(*iv*) Auxiliary valve carburettor.

(*v*) Auxiliary port carburettor.

These devices are explained below :

(*i*) ***Compensating jet device :***

A schematic diagram of a compensating jet device is shown in Fig. 11.6.

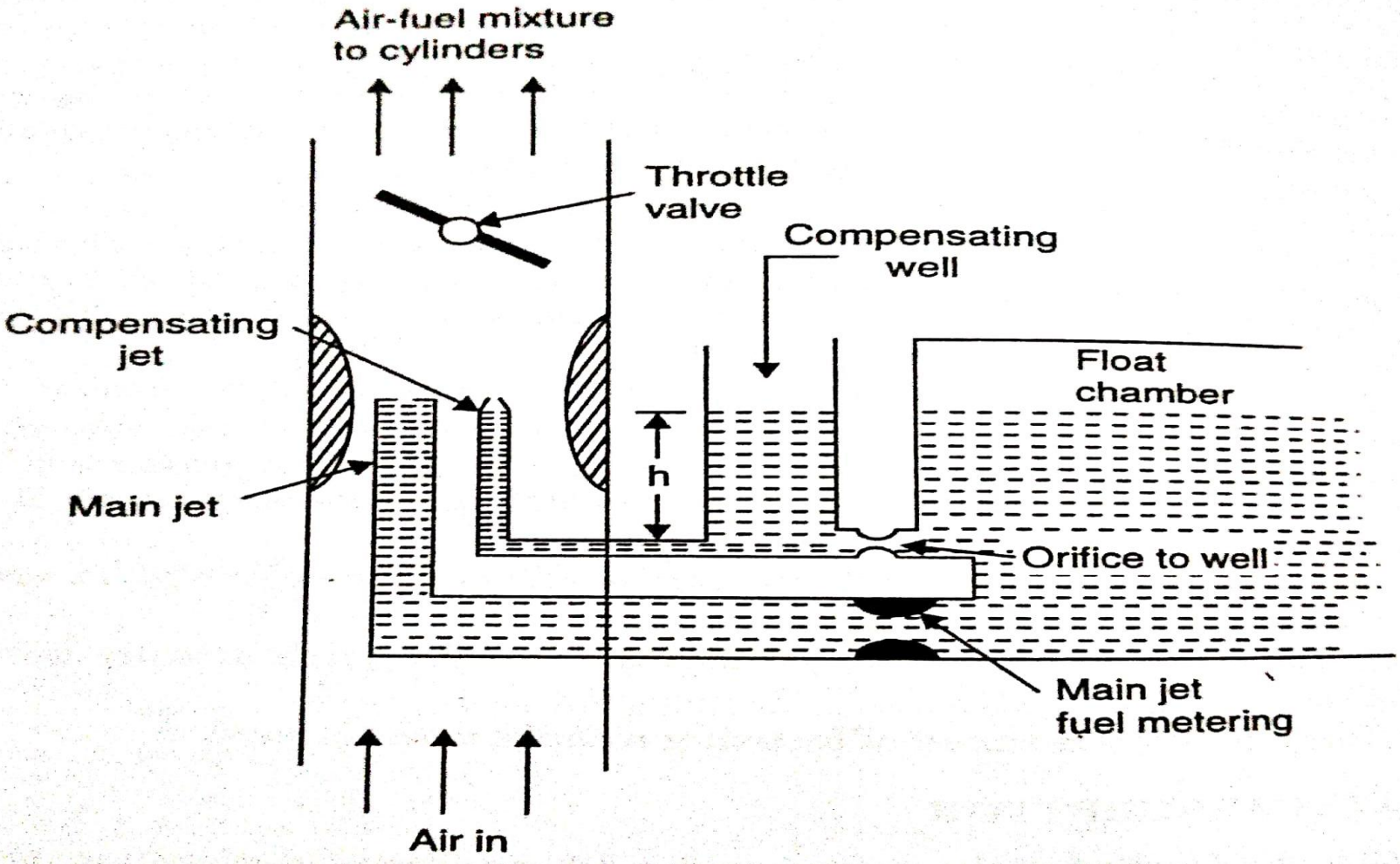


Fig. 11.6. A compensating jet device.

- In this device, in addition to the main jet, a compensating jet is provided which is in communication with a compensating well. The compensating well is also vented to atmosphere (like the main float chamber) ; it is supplied with fuel from the main float chamber through a restricting orifice.
- As the air flow increases, the level of fuel in the compensating well decreases, thus reducing the fuel supply through the compensating jet. The compensating jet thus progressively makes the mixture leaner as the main jet progressively makes the mixture richer, the sum of the two remaining constant as shown in Fig 11.7. The main jet and compensating curves are more less reciprocals of each other.

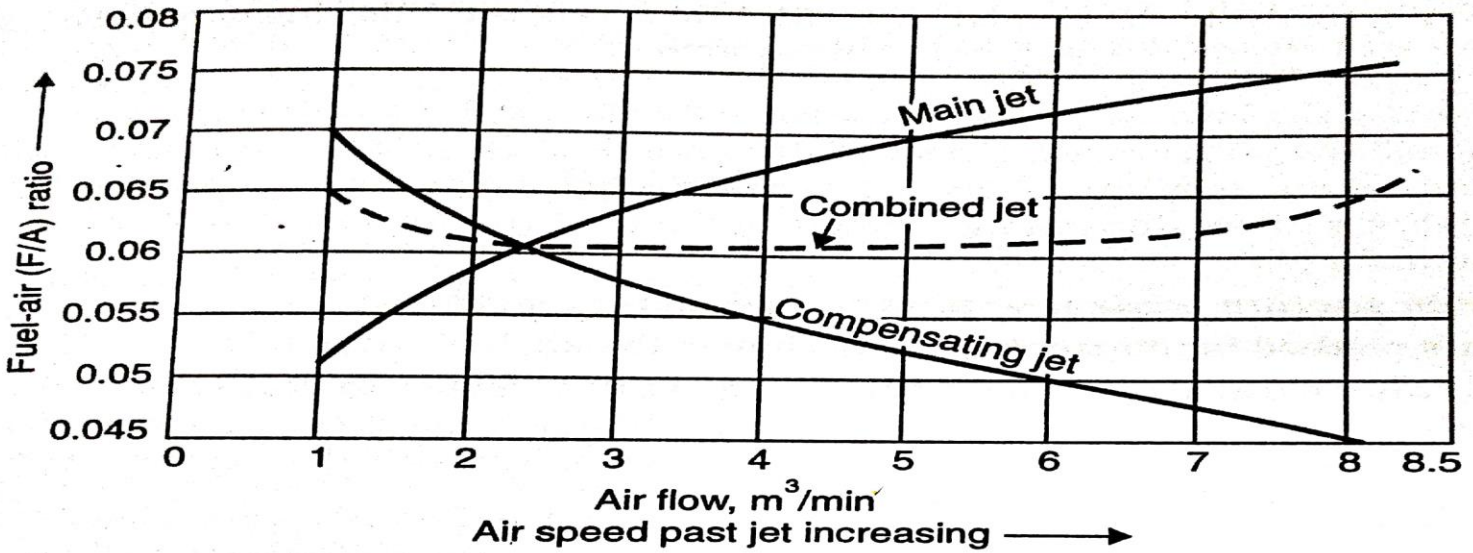


Fig. 11.7. Variation of F/A ratio vs. air flow with main and compensating jets.

— At even higher *rates* of air flow, when the compensating jet has been emptied, *air is bled through the compensating jet to continue the leaness effect*, and incidently to assist in *atomisation of fuel*.

2. Idling system :

- As earlier discussed that at idling and low load an engine requires a rich mixture having about air-fuel ratio 12 : 1. The main metering system not only fails to supply enrich the mixture at low air flows but also cannot supply any fuel during idling operation. It is due to this reason that a separate idling jet must be incorporated in the basic carburettor.

- Fig. 11.12 shows an idling jet. It consists of a small fuel line from the float chamber to a point on the engine side of the throttle ; this line contains a fixed fuel orifice.
  - When *throttle is practically closed,* the full manifold suction operates on the outlet to this jet. Besides local suction is increased due to very high velocity past the throttle valve. Fuel therefore can be lifted by the additional height upto the discharge point, but this *occurs only at very low rates of air flow.*

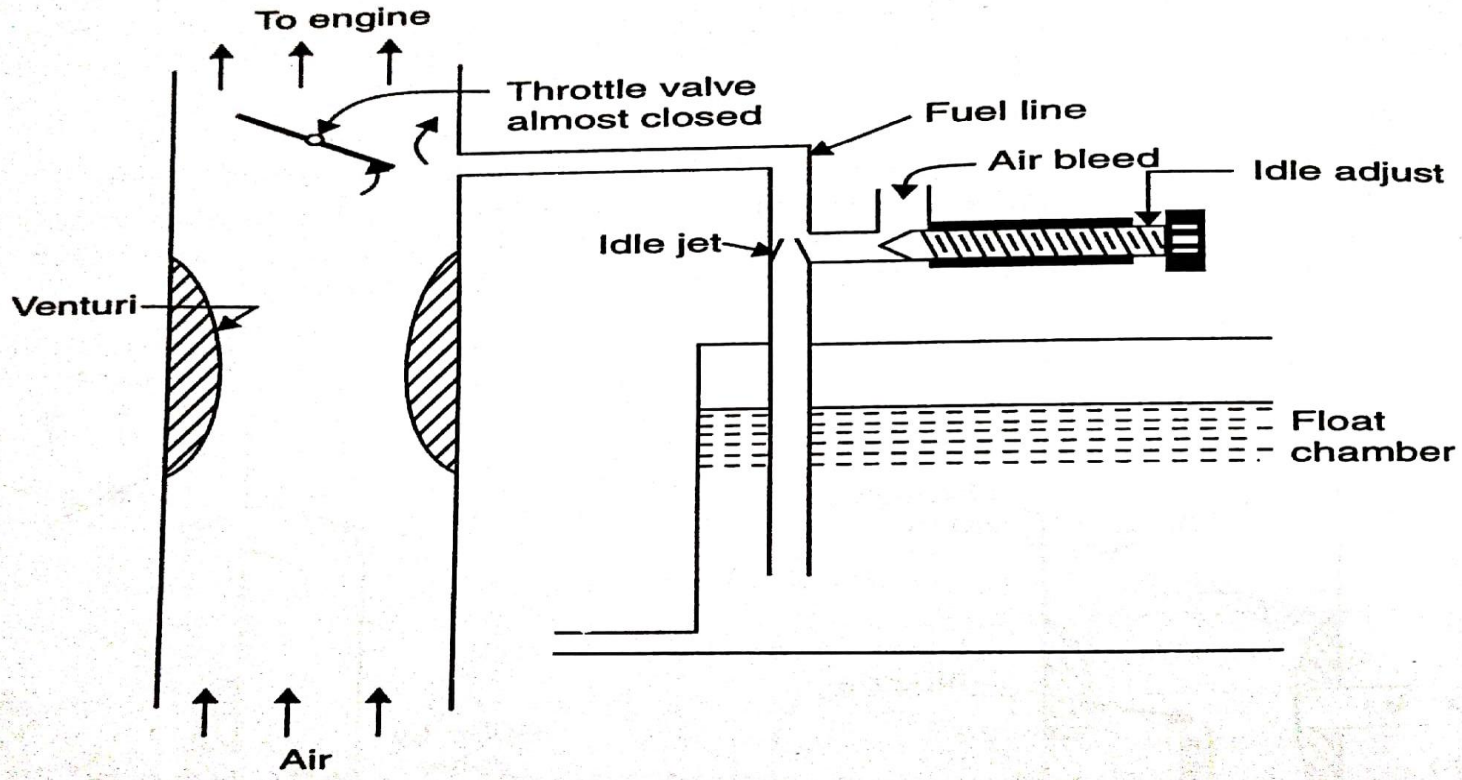


Fig. 11.12. Idling jet.

  - When the *throttle is opened,* the main jet gradually takes over and the idle jet eventually becomes ineffective.
  - The *idle adjust* (a needle valve controlling the air bleed, which is manually operated) *regulates the desired A/F ratio for the idling jet.*

4. Acceleration pump system :

- Acceleration is a transient phenomenon. In order to accelerate the engine rapidly, a very rich mixture is required which a simple carburettor may not be able to supply. Rapid opening of throttle will be immediately followed by an increased air flow, but the inertia of liquid fuel (gasoline) will give momentarily lean mixture. Thus acceleration mixture required may not be met with in practice. To overcome this difficult situation an *acceleration pump is incorporated.*
- Fig. 11.14 shows an *acceleration pump.* It consists of a spring-load plunger. Also is provided a linkage mechanism so that when throttle is rapidly opened the plunger moves into the cylinder and forces an additional jet of fuel into the venturi. An arrangement is also provided which ensures that when throttle is opened slowly, the fuel in the pump cylinder is not forced into the venturi but leaks past plunger or some holes into the float chamber.
  - In some carburettors, instead of providing mechanical linkages, an arrangement is made so *that the pump plunger is held up by manifold vacuum.* Whenever this vacuum is reduced by rapid opening of throttle a spring forces the plunger down pumping the fuel through the jet.

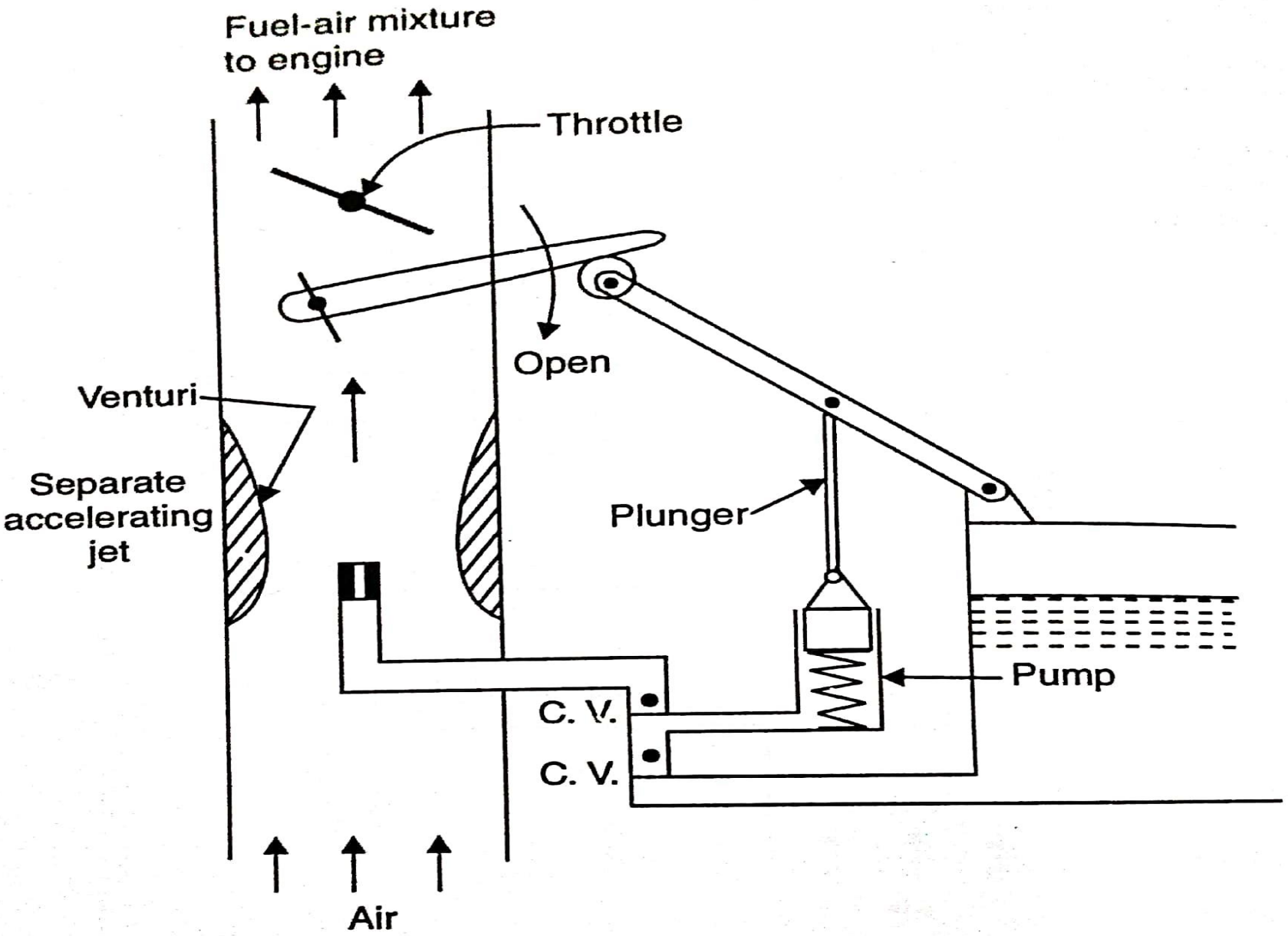


Fig. 11.14. Acceleration pump.

5. Choke :

- Starting of a vehicle which is kept stationary for a long period (may be overnight.) during cool winter seasons, is often more difficult. At low cranking speeds and intake temperatures a very rich mixture is required to initiate combustion. Sometimes as high as *five to ten times* more fuel (than usual mixtures) is required. The main reason is that very large fraction of fuel may remain liquid suspended in air even in the cylinder, and only the vapour fraction can provide a combustible mixture with air. The most popular method of providing such mixture is by the use of *choke*.
- A *choke* is simply butterfly valve located between the entrance to the carburettor and the venturi throat as shown in Fig. 11.15.
  - — When the choke is partly closed, large pressure drop occurs at the venturi throat, would normally result from the amount of air passing through the venturi throat. The very large carburettor depression at the throat inducts large amount of fuel from the main nozzle and provides a very rich mixture so that the ratio of the evaporated fuel to air in the cylinder is within the combustible limits.
- Sometimes the choke valves are made with spring-loaded by-pass to ensure that large carburettor depression and excessive choking does not persist after the engine has started, and reached a desired speed. The choke can be made to operate automatically by means of a thermostat so that choke is closed when engine is cold and goes out of operation when the engine warms up after starting.

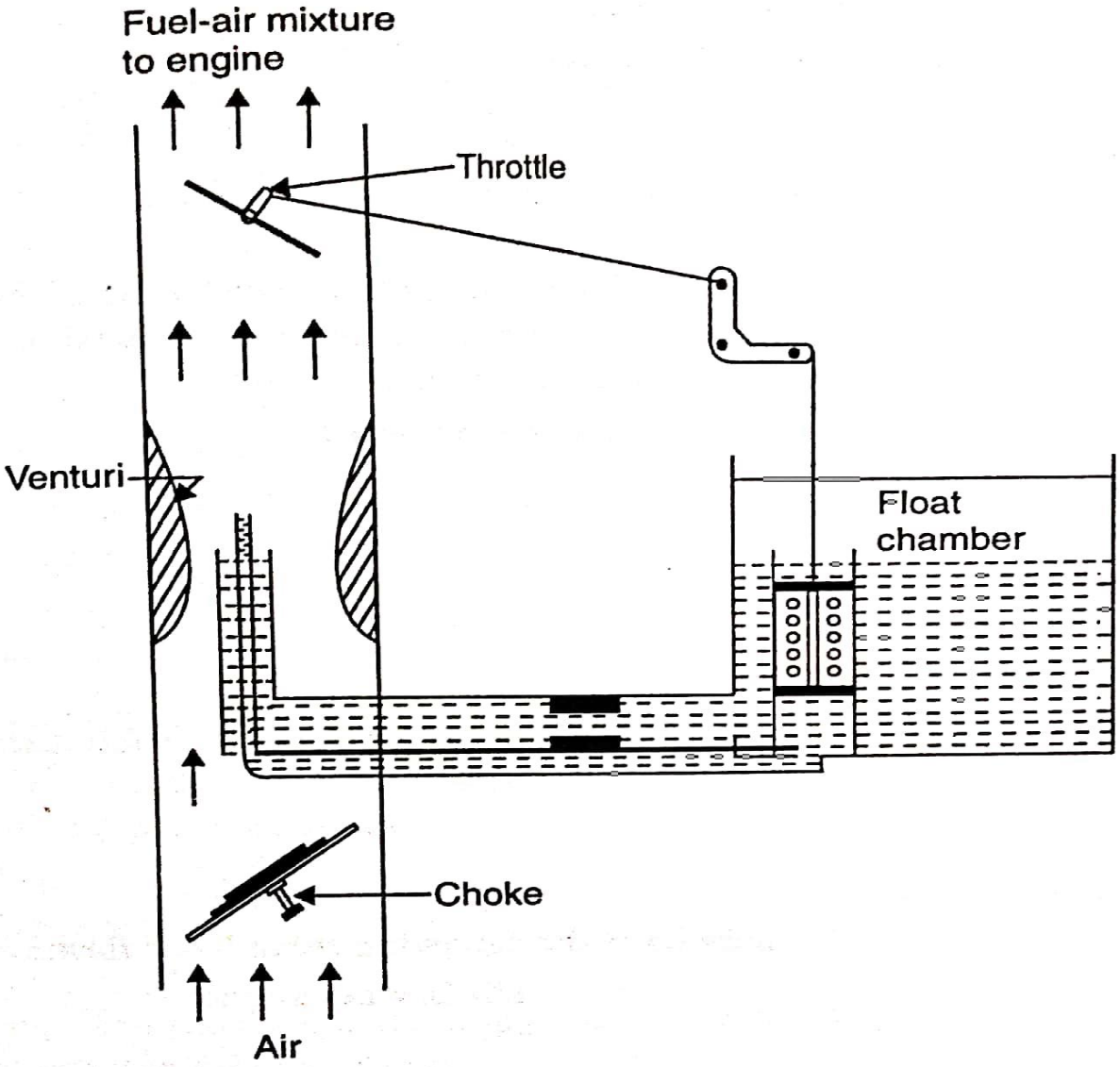


Fig. 11.15. Choke valve with spring-loaded by-pass.

- The provision of *auxiliary fuel jets* that are opened manually or automatically only as required, is an *alternative to the choke.*

Types of Carburetor:

What are the types of a carburetor? There are three types of carburetors according to the direction in which the mixture is supplied.

- ***Up-draft carburetor***
- ***Horizontal type carburetor***
- ***Down-draft type carburetor***

If the air is supplied from the bottom of the mixing chamber then it is called an **up-draft type**.

If the air is supplied from one side of the carburetor then it is called **horizontal type carburetor.**

And last if the air is supplied from the above portion of the mixing chamber then it is called **down-draft carburetor.**

In most cases down-draft type carburetor is generally used because of the following advantages:

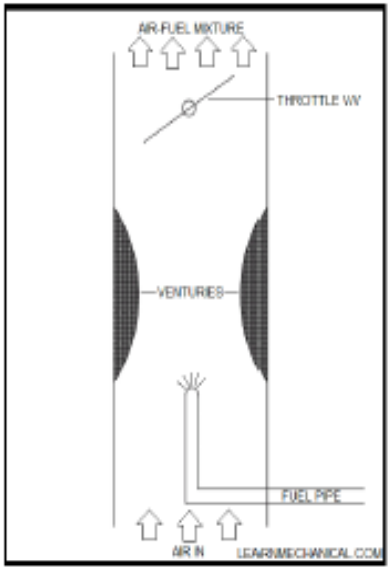
- The gravity assists the flow of the mixture. so found that the engine pulls better at lower speeds under load.
- The engine can achieve a higher value of volumetric efficiency.
- The carburetor position is rendered more accessible.

And the only disadvantage is:

The possibility of leakage going directly into the inlet manifold if the float is defective and the jet is overflowing.

Up-draft type carburetor:

In this type of Carburetor, **air goes through the bottom of the carburetor**. And fuel comes from the float chamber and due to the pressure difference within the two-chamber with the help of venturi, fuel comes out from the fuel pipe and mix with the inlet air and make a mixture of air-fuel, which is passed through the throttle valve which is directly connected with the accelerator. And goes to the engine cylinder where the combustion of charge (air+fuel) takes place.



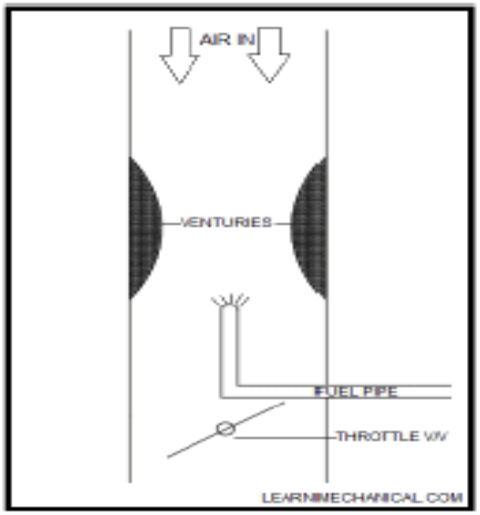
UP-DRAFT CARBURETOR

Down-draft Carburetor:

In this type of carburetor **air comes from the top of mixing chamber**, and the fuel comes from the bottom of the mixing chamber, here also the same principle works, due to low pressure created by the two venturies fuel comes out through the pipe and then the mixing of fuel and air occurred here.

The mixture of fuel and air is controlled by the choke valve, and the quantity of charge supplied to the engine cylinder is controlled by the throttling valve.

In this time most vehicles used down-draft carburetor systems

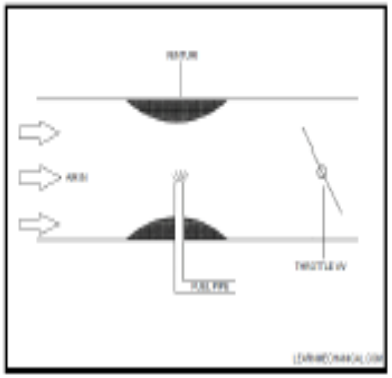


DOWN-DRAFT CARBURETOR

Horizontal Type Carburetor:

When you rotate the down-draft carburetor in the horizontal direction then its become horizontal type carburetor

The working principle of this type of carburetor is very simple. Here the carburetor stays in the horizontal position where the **air is coming in through the one end of the carburetor** shown in the below figure. And mixing with fuel to make the air-fuel mixture and then the air-fuel mixture is going to the engine cylinder for combustion.



HORIZONTAL CARBURETOR