E-NOTES on
Thermodynamics-2

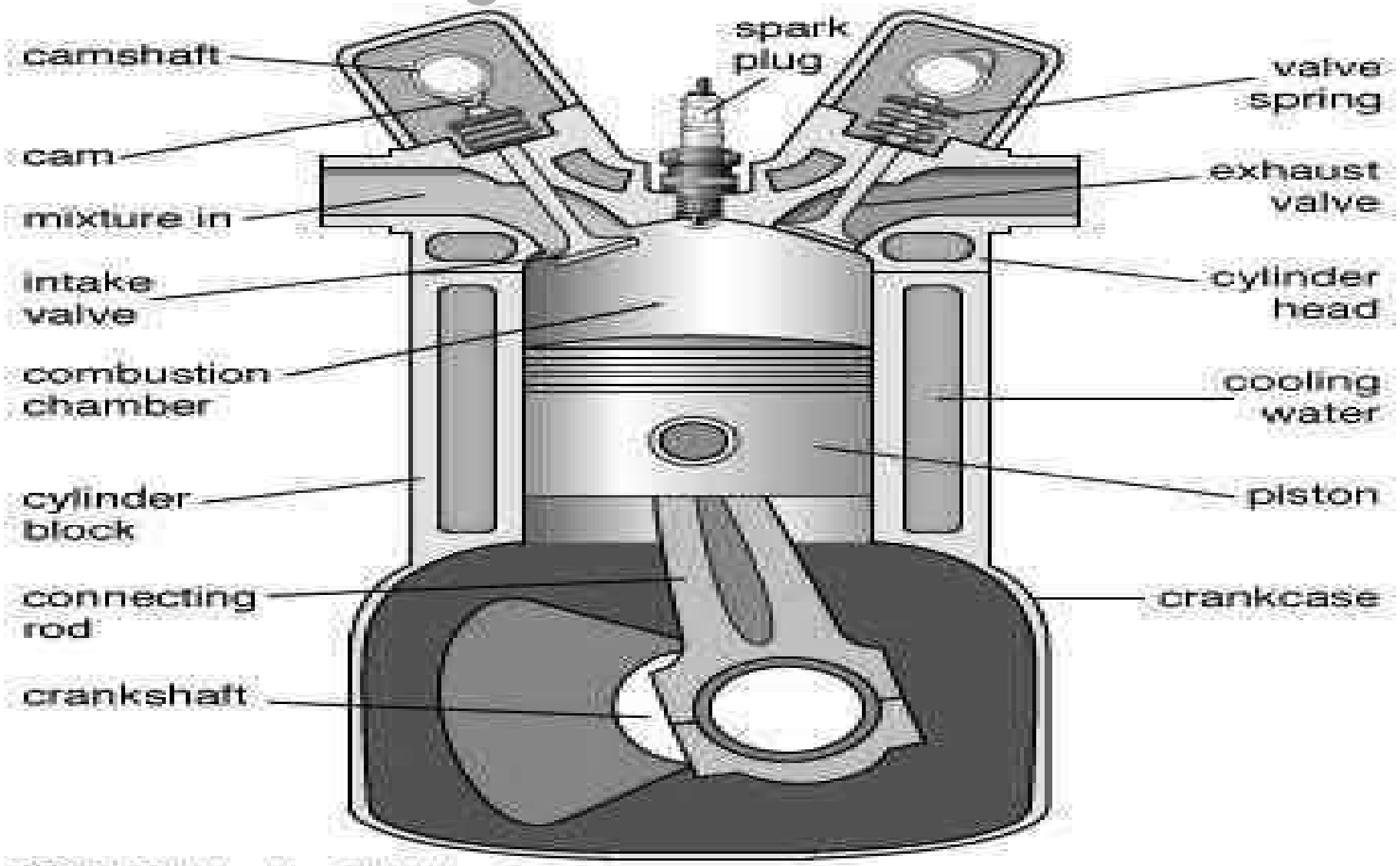
DEPARTMENT OF MECHANICAL ENGINEERING

Basics

- A four-stroke engine:
  - Is an internal combustion engine
  - Converts gasoline into motion
  - Is the most common car engine type
  - Is relatively efficient
  - Is relatively inexpensive

- In an **Internal combustion engine**, combustion takes place within working fluid of the engine, thus fluid gets contaminated with combustion products.
  - Petrol engine is an example of internal combustion engine, where the working fluid is a mixture of air and fuel .
- In an **External combustion engine**, working fluid gets energy using boilers by burning fossil fuels or any other fuel, thus the working fluid does not come in contact with combustion products.
  - Steam engine is an example of external combustion engine, where the working fluid is steam.

Basic Components of Four-Stroke Engines



Engine Terminology :

Figure 3, shows the pressure volume diagram of ideal engine cycle along with engine terminology as follows:

- **Top Dead Center (TDC):** Position of the piston when it stops at the furthest point away from the crankshaft.
  - Top because this position is at the top of the engines (not always), and dead because the piston stops as this point. Because in some engines **TDC** is not at the top of the engines(e.g: horizontally opposed engines, radial engines,etc,.) Some sources call this position **Head End Dead Center (HEDC).**
  - Some source call this point **TOP Center (TC).**
  - When the piston is at TDC, the volume in the cylinder is a minimum called the clearance volume.

- **Bottom Dead Center (BDC):** Position of the piston when it stops at the point closest to the crankshaft.
  - Some sources call this **Crank End Dead Center (CEDC)** because it is not always at the bottom of the engine.Some source call this point **Bottom Center (BC).**
- **Stroke :** Distance traveled by the piston from one extreme position to the other : TDC to BDC or BDC to TDC.
- **Bore :**It is defined as cylinder diameter or piston face diameter; piston face diameter is same as cylinder diameter(minus small clearance).
- **Swept volume/Displacement volume :** Volume displaced by the piston as it travels through one stroke.
  - Swept volume is defined as stroke times bore.
  - Displacement can be given for one cylinder or entire engine (one cylinder times number of cylinders).

- **Clearance volume :** It is the minimum volume of the cylinder available for the charge (air or air fuel mixture) when the piston reaches at its outermost point (top dead center or outer dead center) during compression stroke of the cycle.
  - Minimum volume of combustion chamber with piston at TDC.
- **Compression ratio :** The ratio of total volume to clearance volume of the cylinder is the compression ratio of the engine.
  - Typically compression ratio for SI engines varies form 8 to 12 and for CI engines it varies from 12 to 24

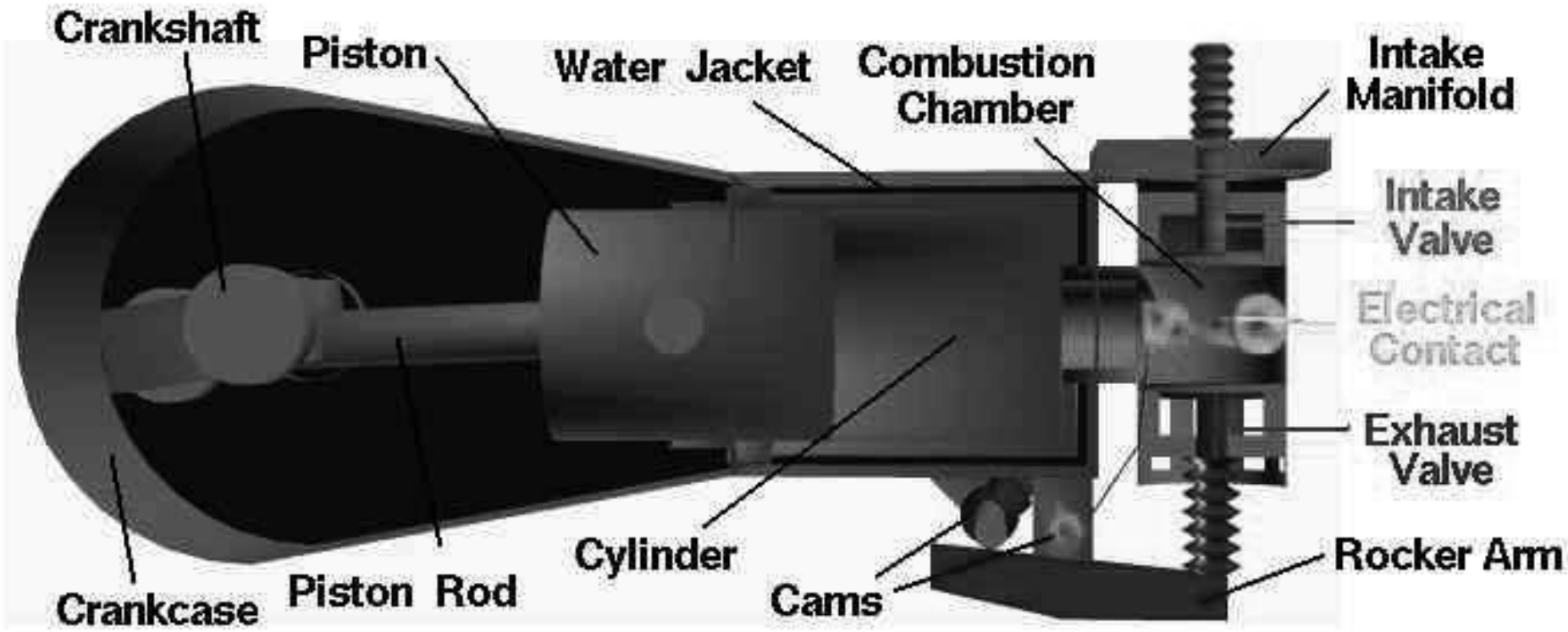


Figure: Engine components

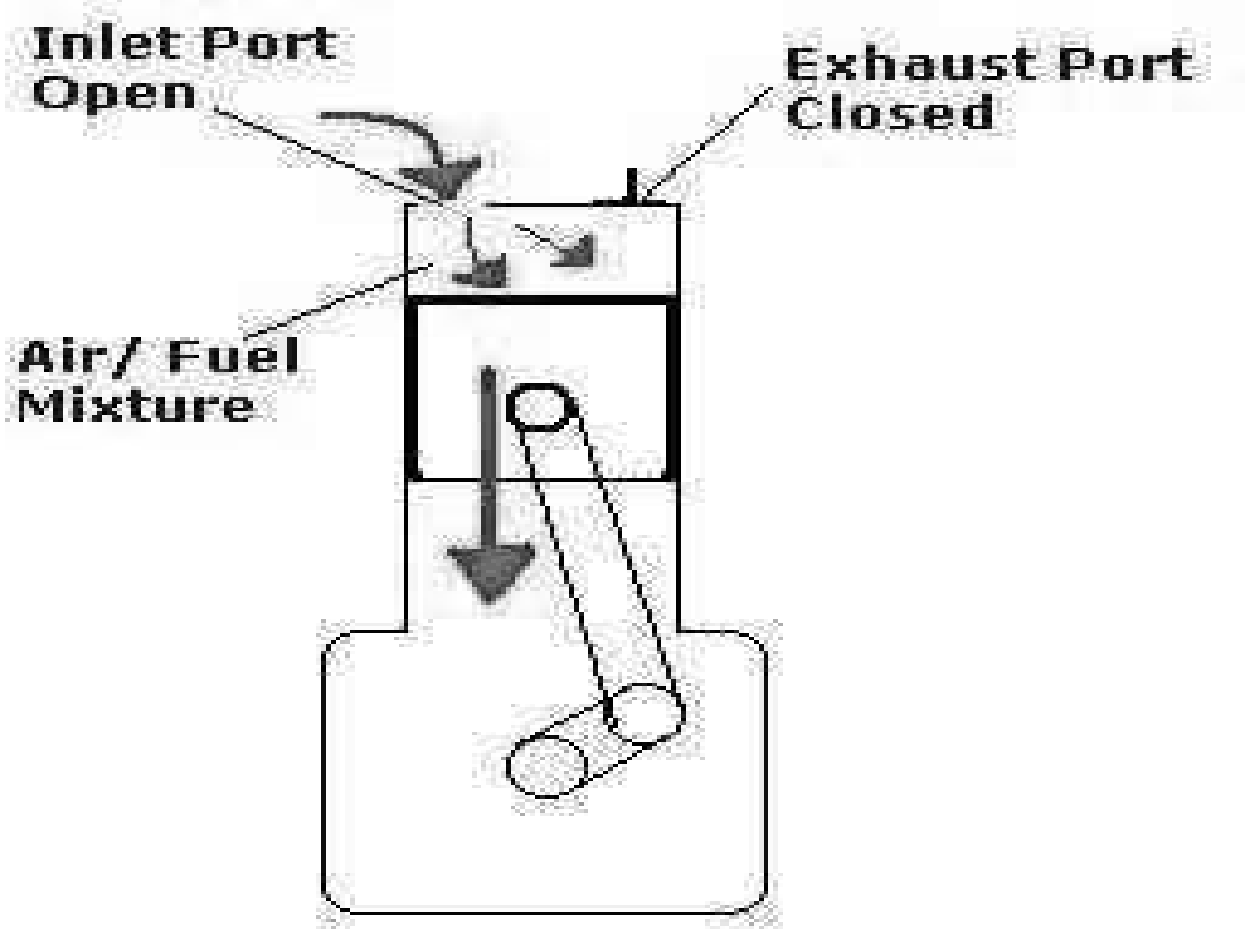


Figure: Suction stroke

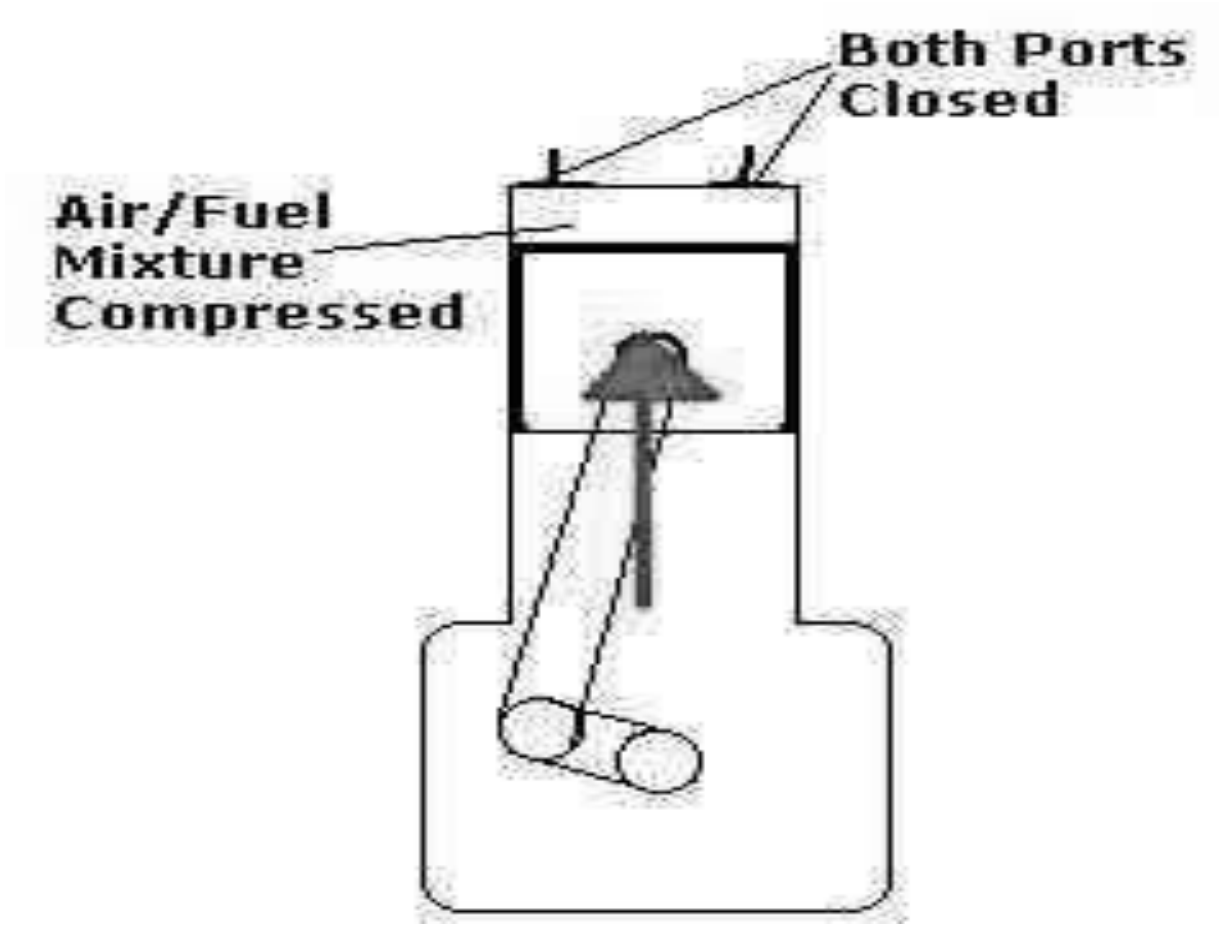


Figure: Compression Stroke

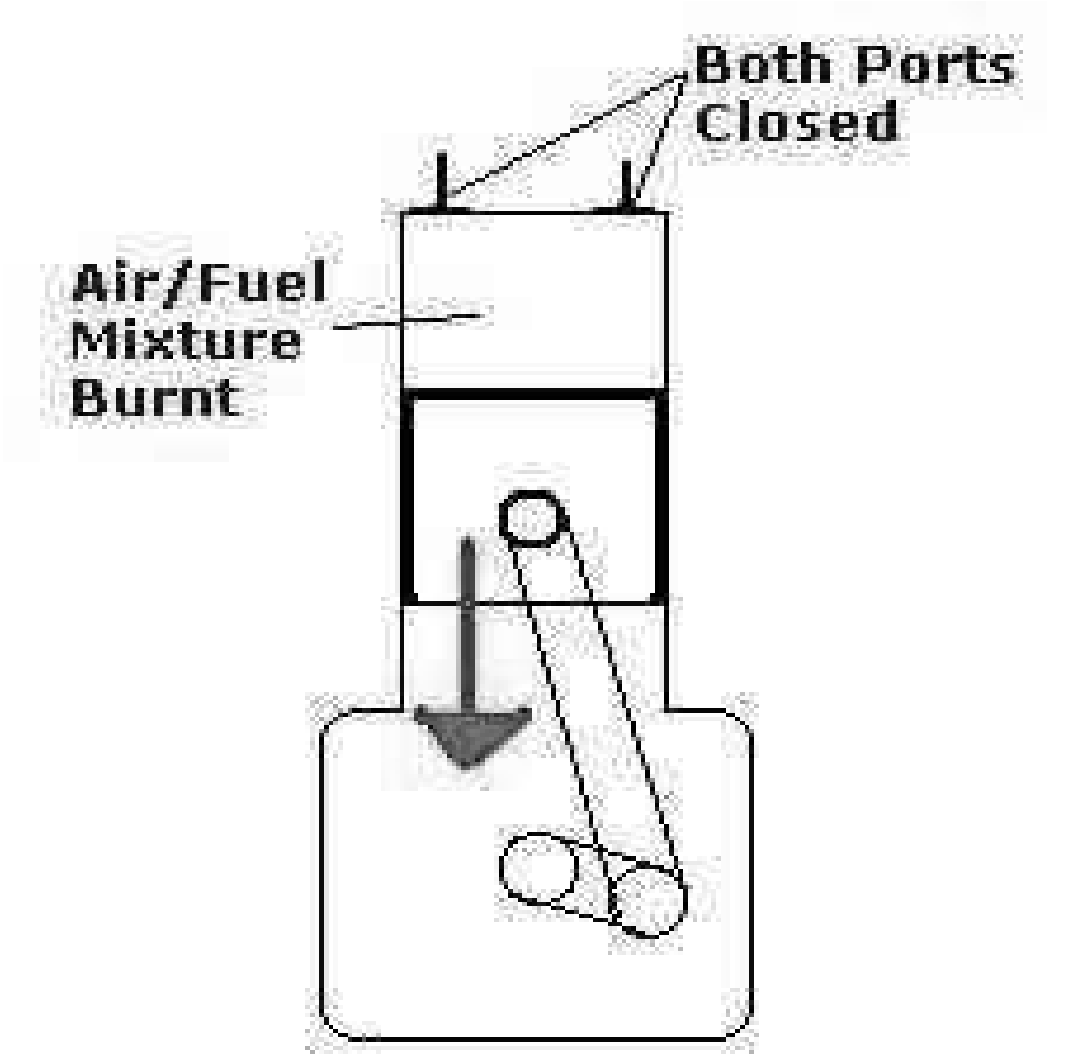


Figure: Combustion followed by Expansion stroke.

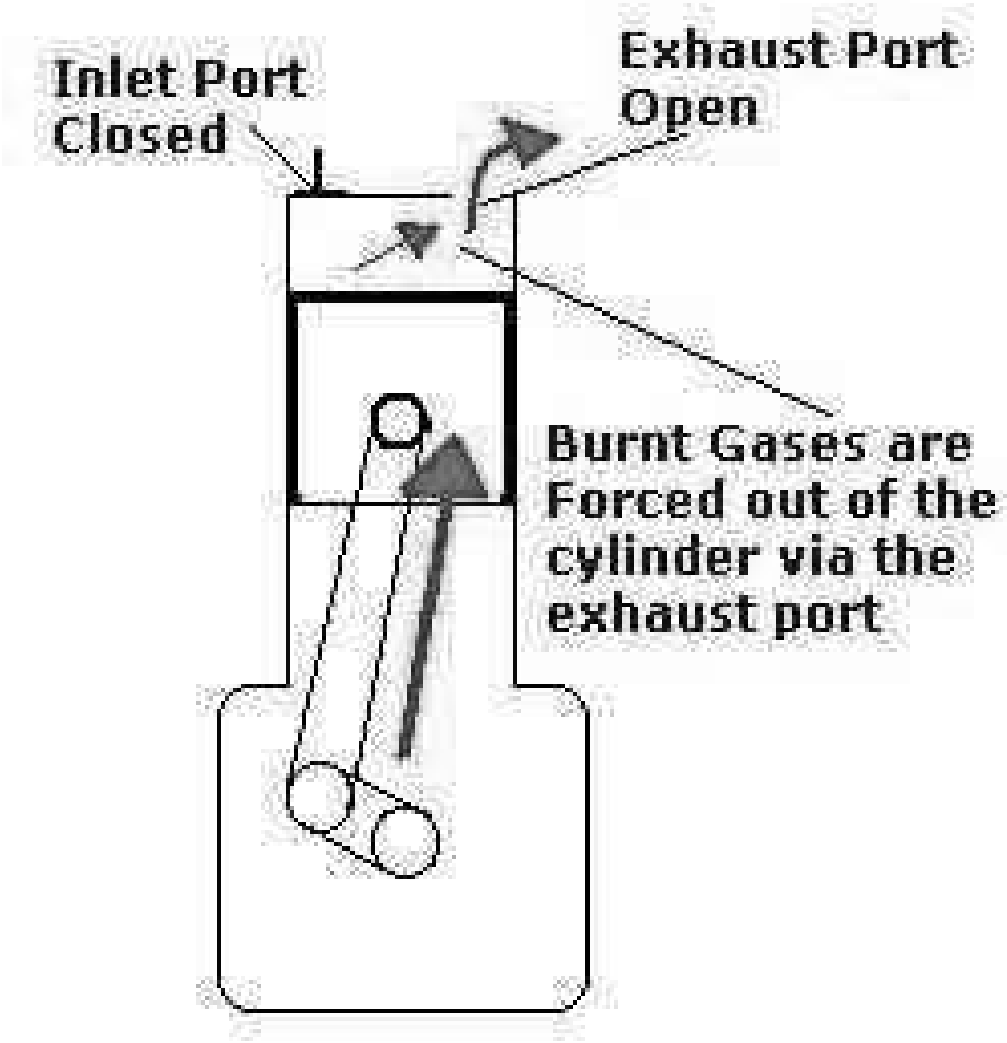
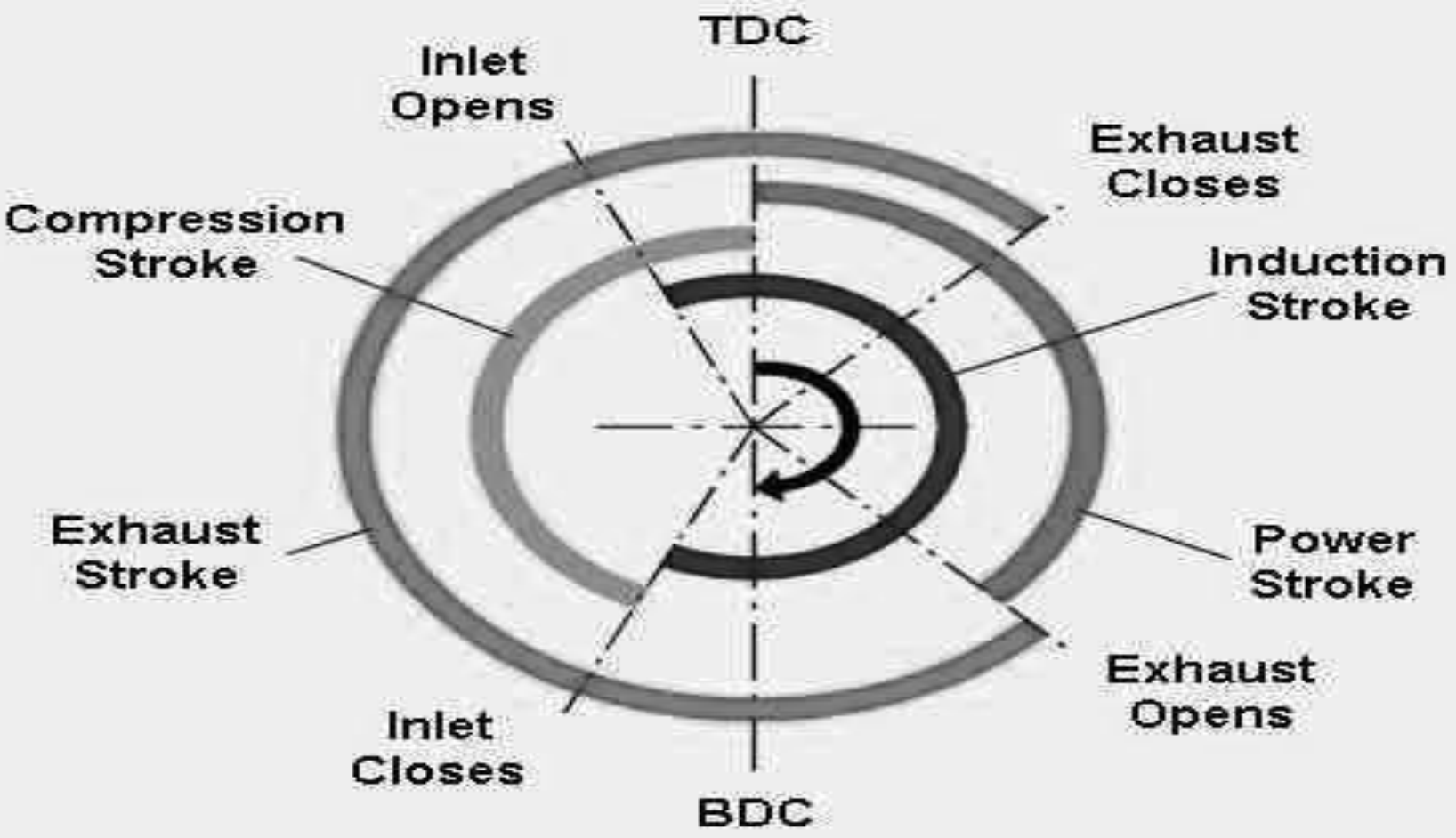


Figure: Exhaust blowdown followed by Exhaust stroke

VALVE TIMING CHART



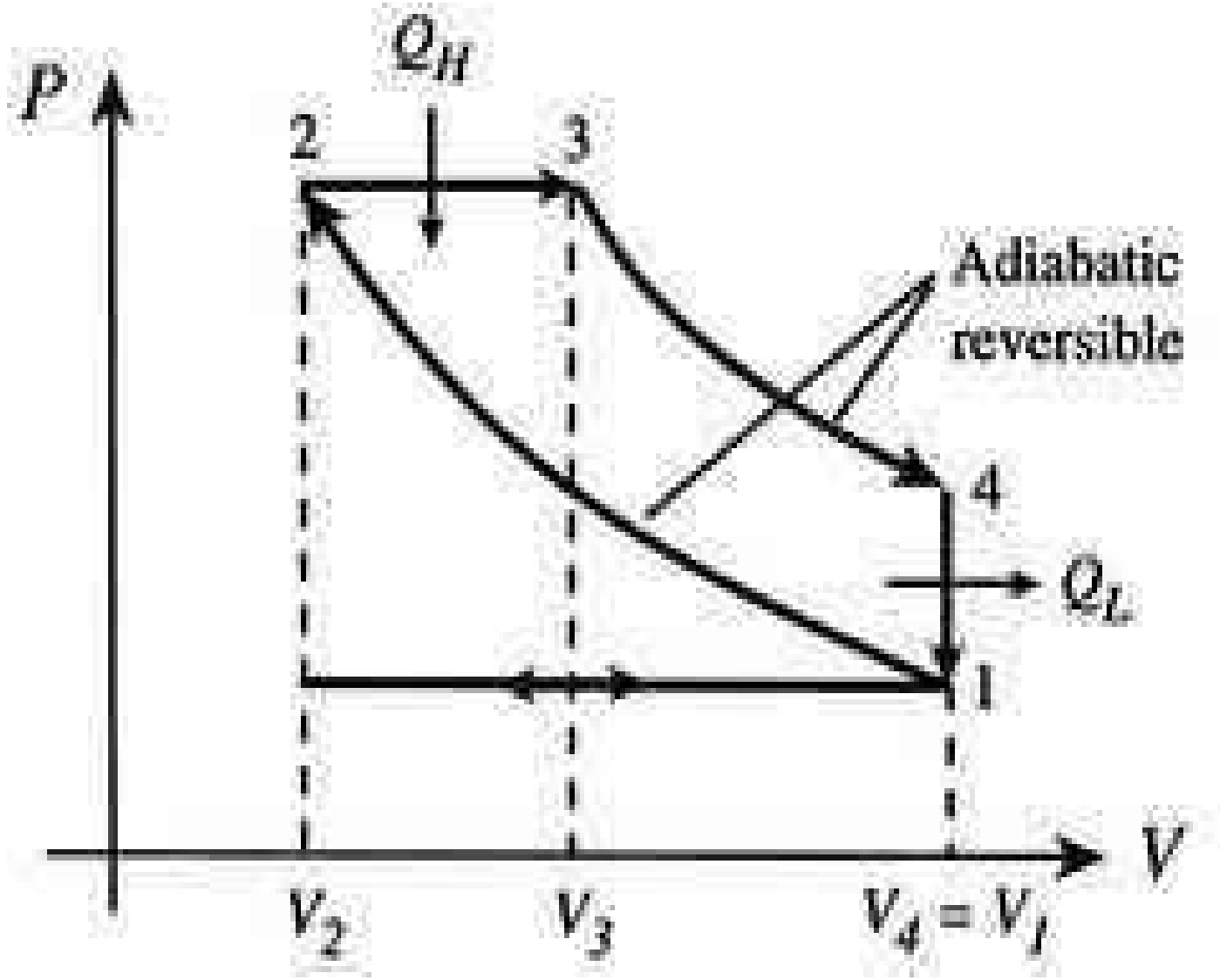


Figure: Ideal diesel cycle P-V Diagram.

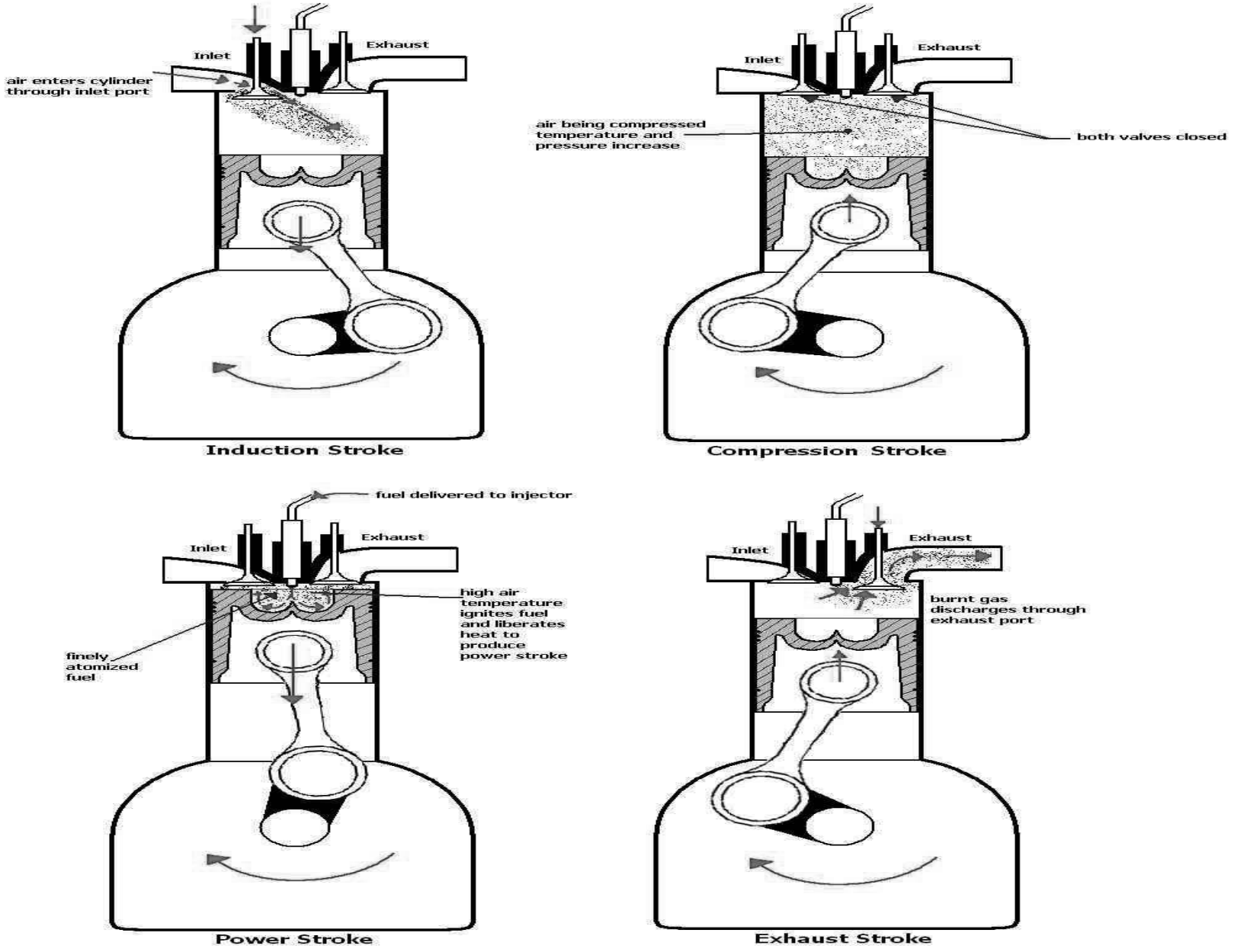


Figure: Four strokes of ideal Diesel cycle.

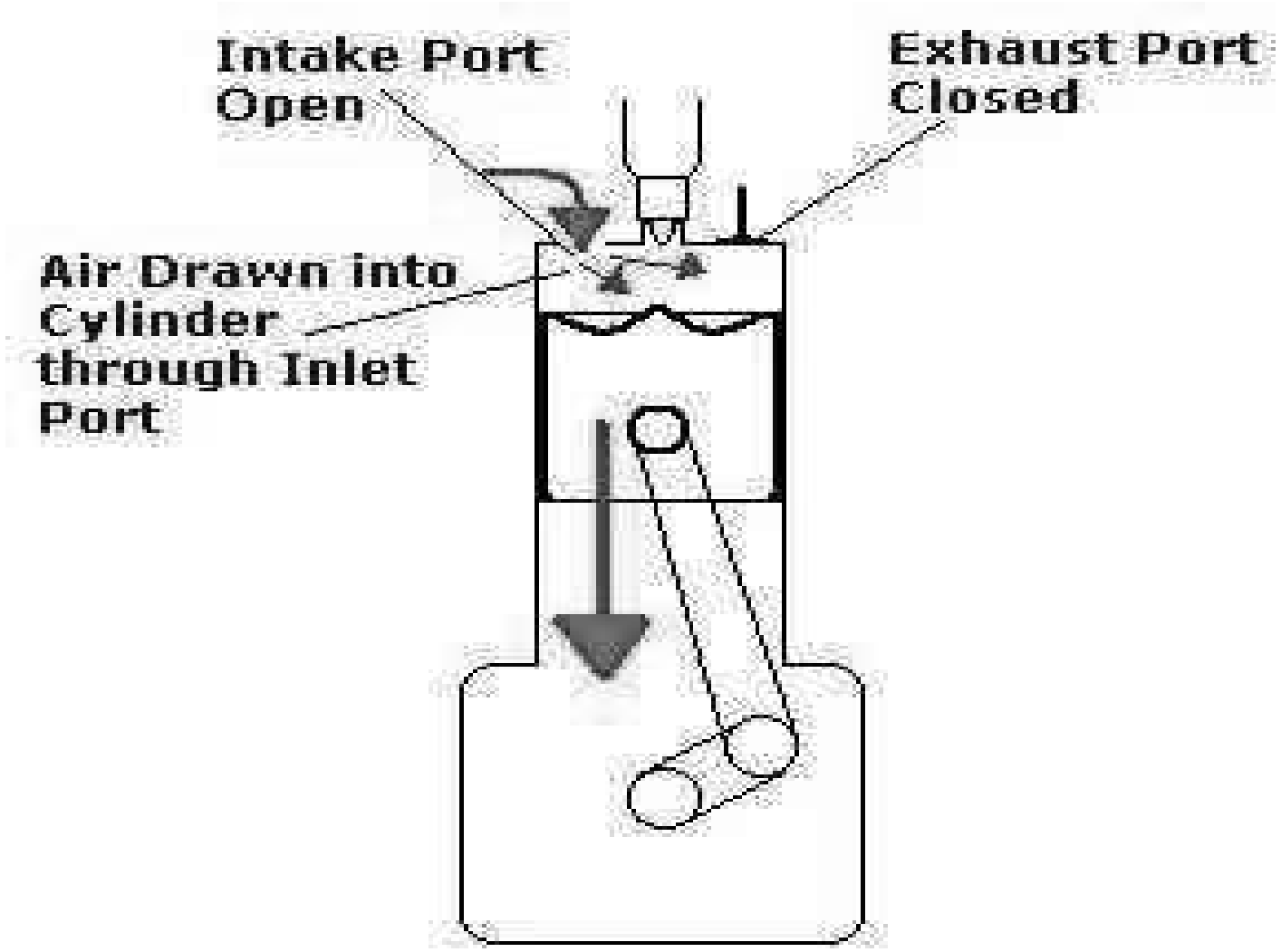


Figure:Suction stroke

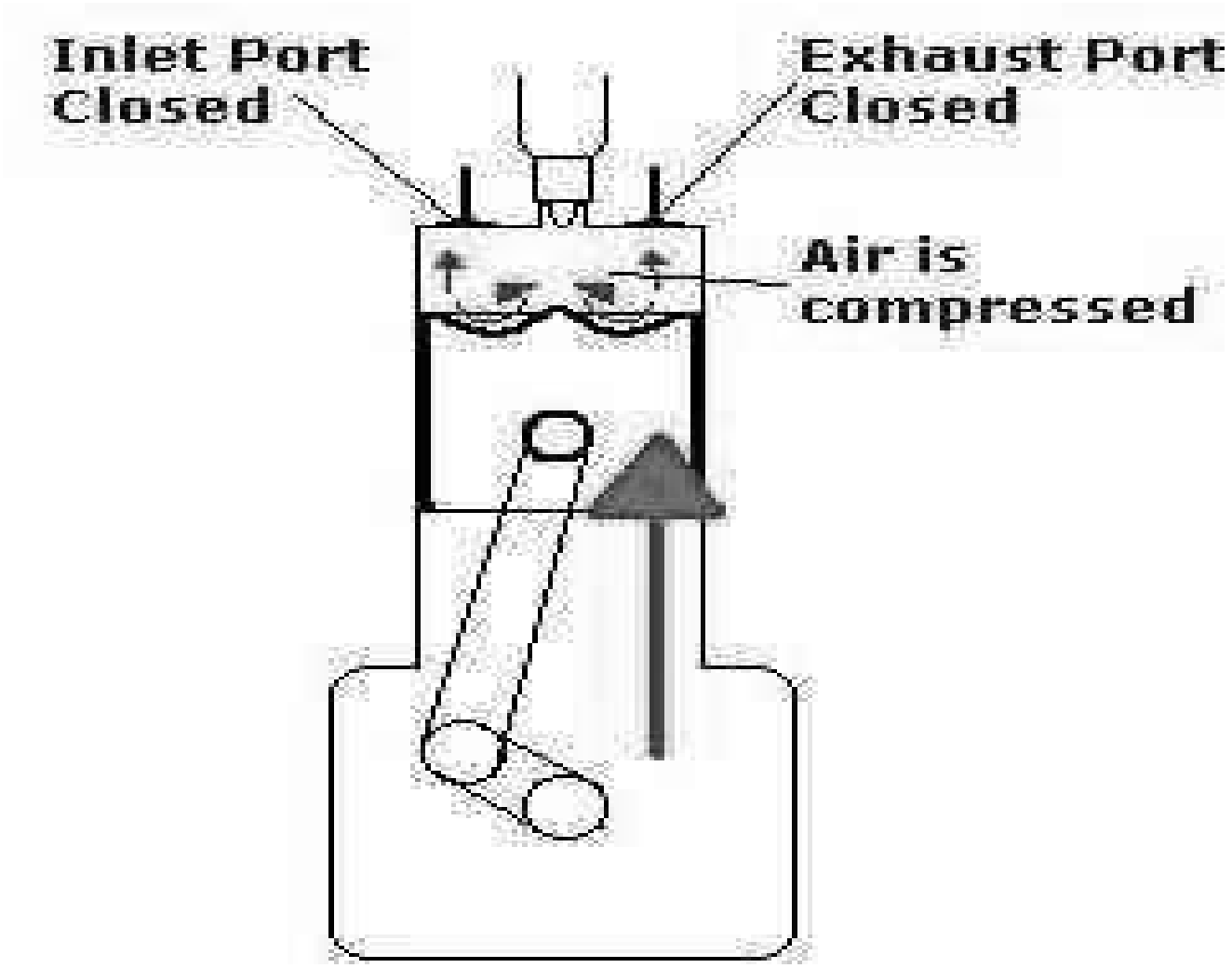


Figure: Compression stroke

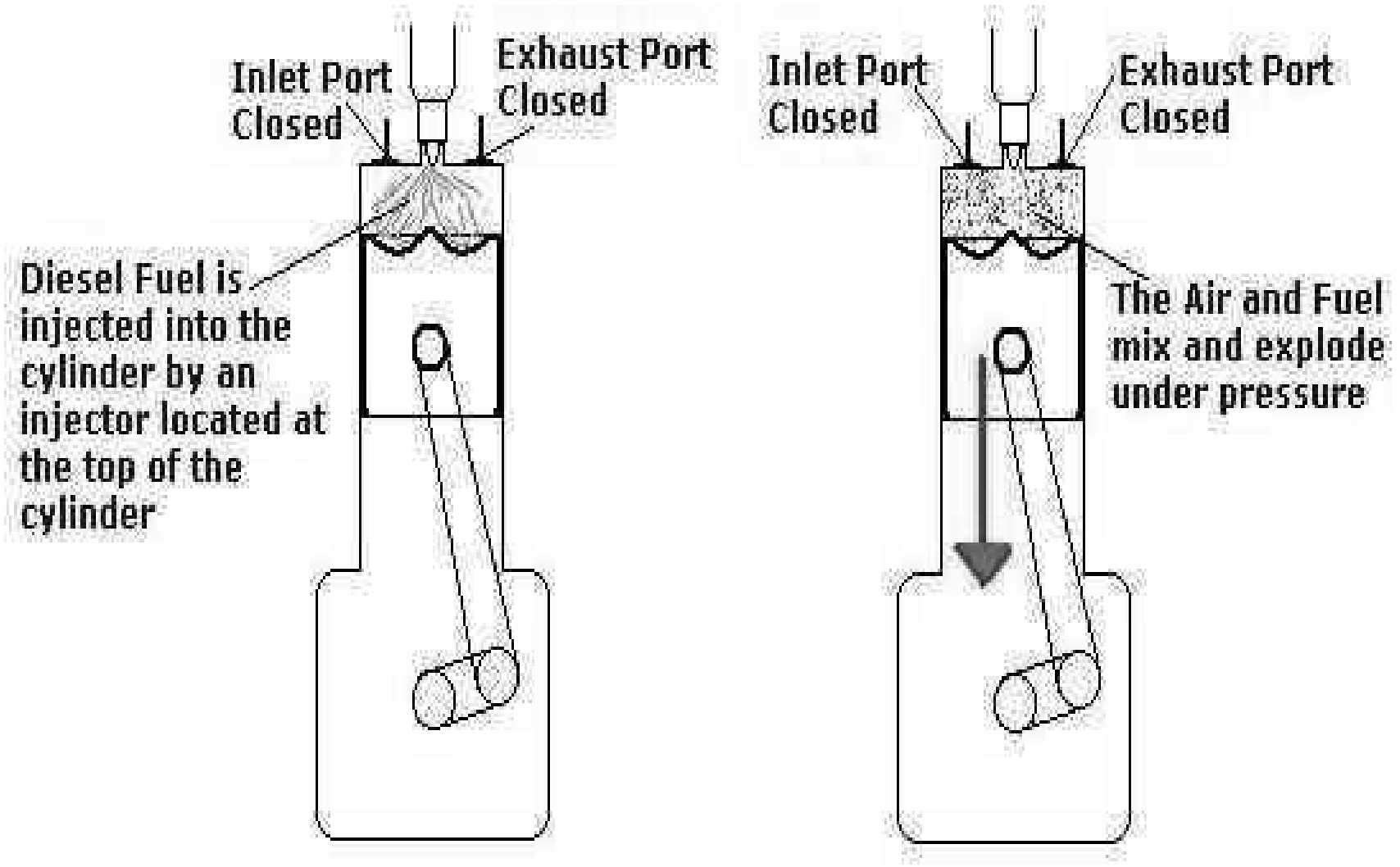


Figure12:Fuel injection and combustion followed by Expansion stroke

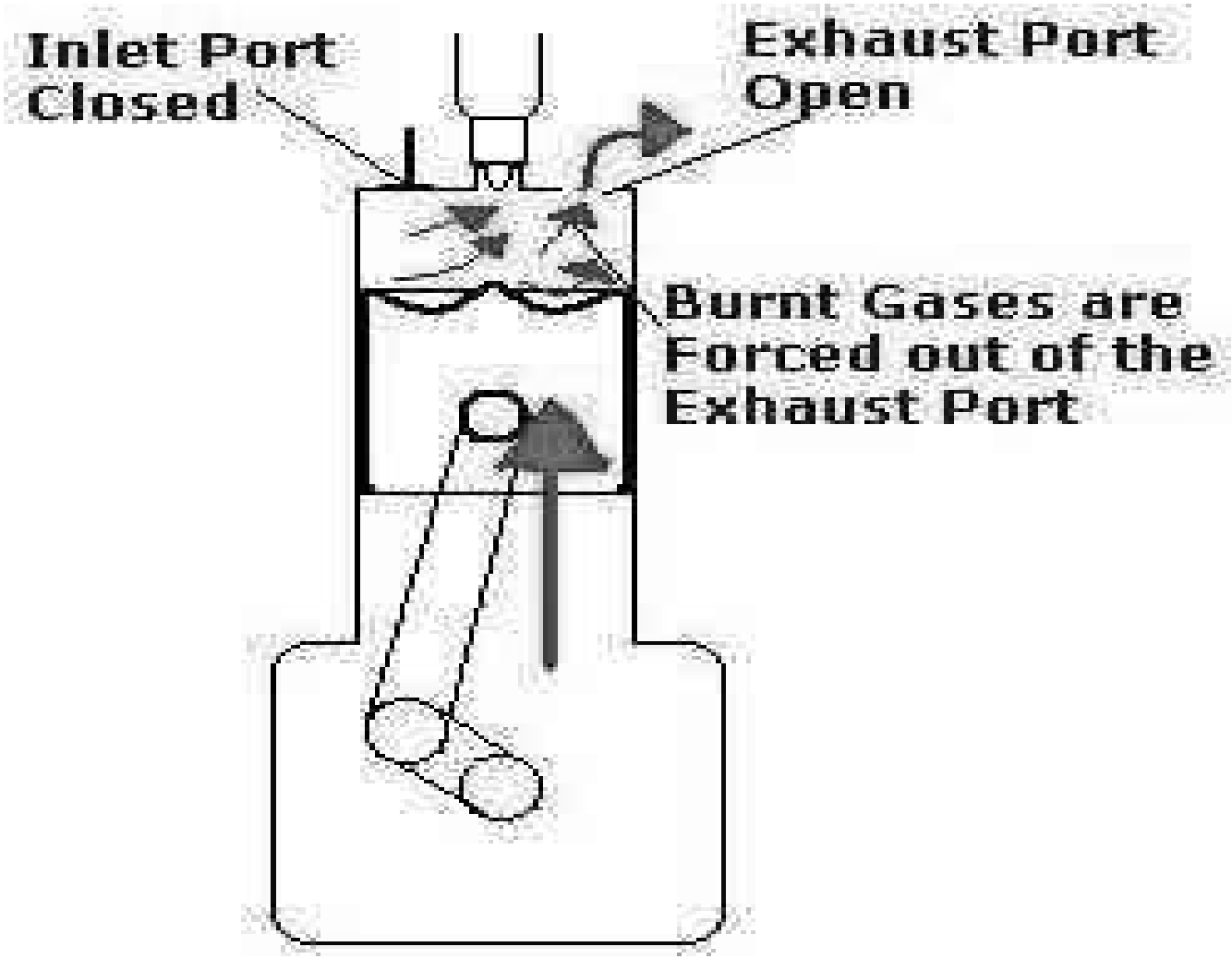
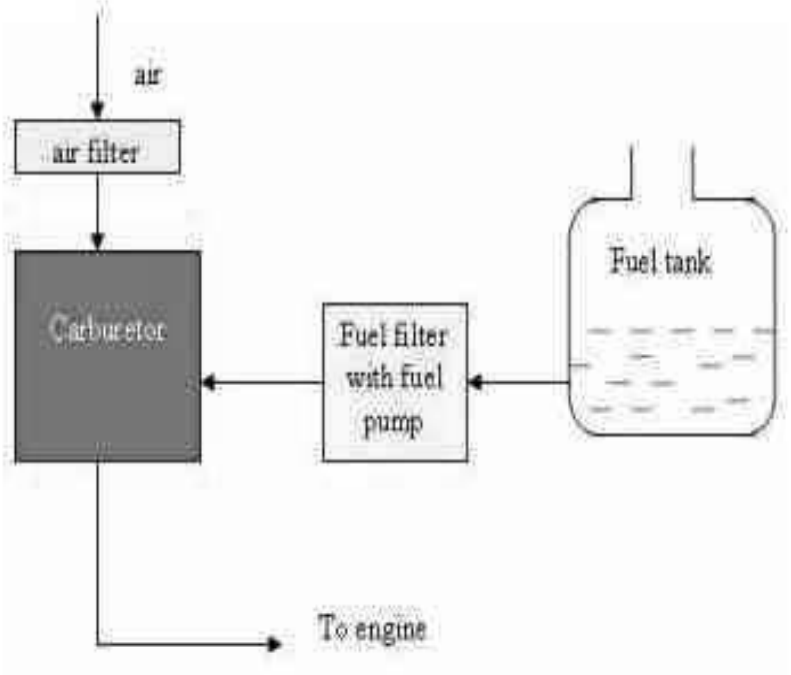
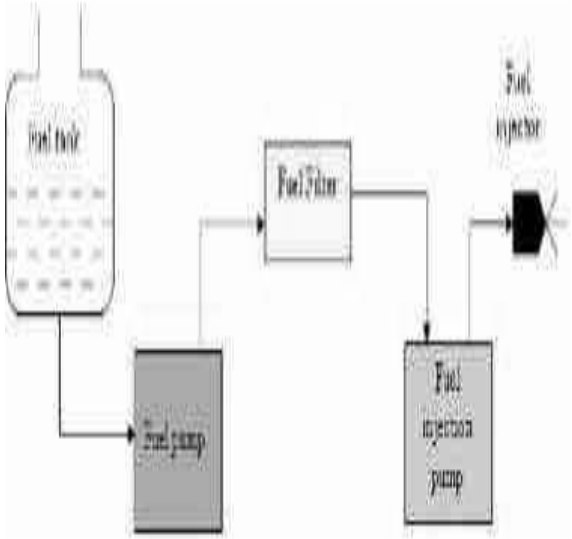


Figure: Exhaust stroke followed by exhaust blowdown.

Fuel Supply System Of SI & CI Engine



a)

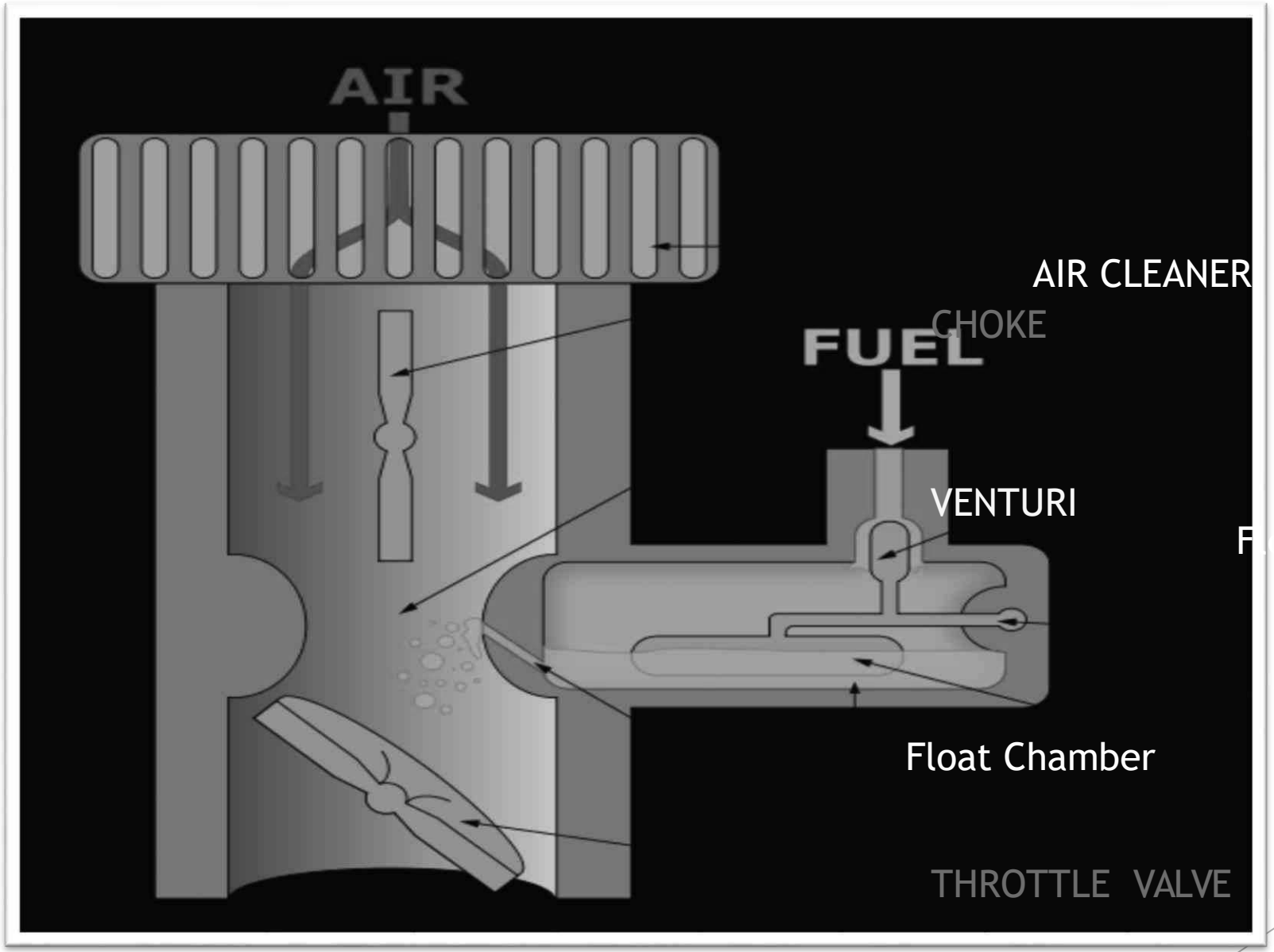


b)

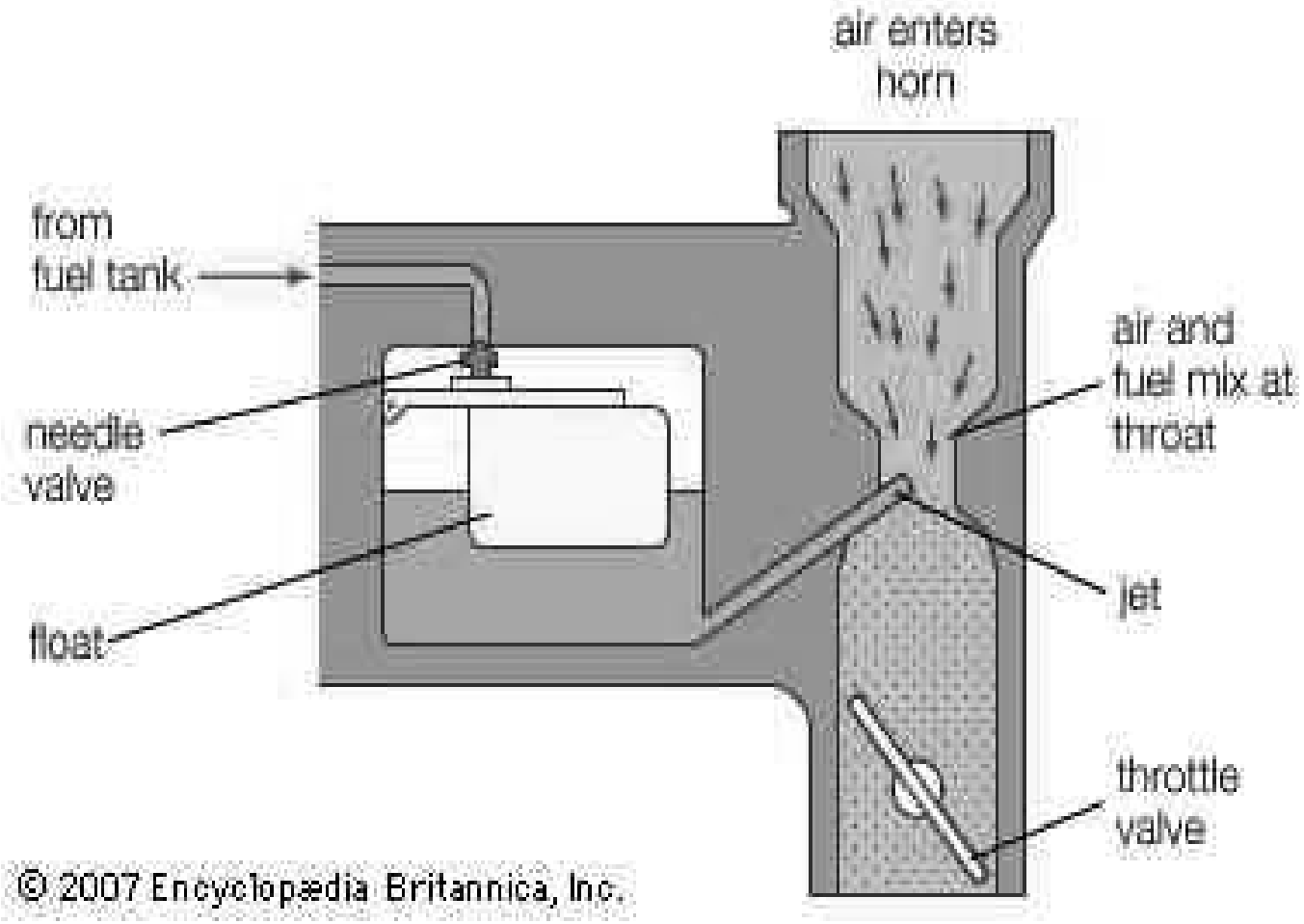
Fig a)Fuel Supply System Of SI Engine b)Fuel supply of CI Engine

CARBURETTOR

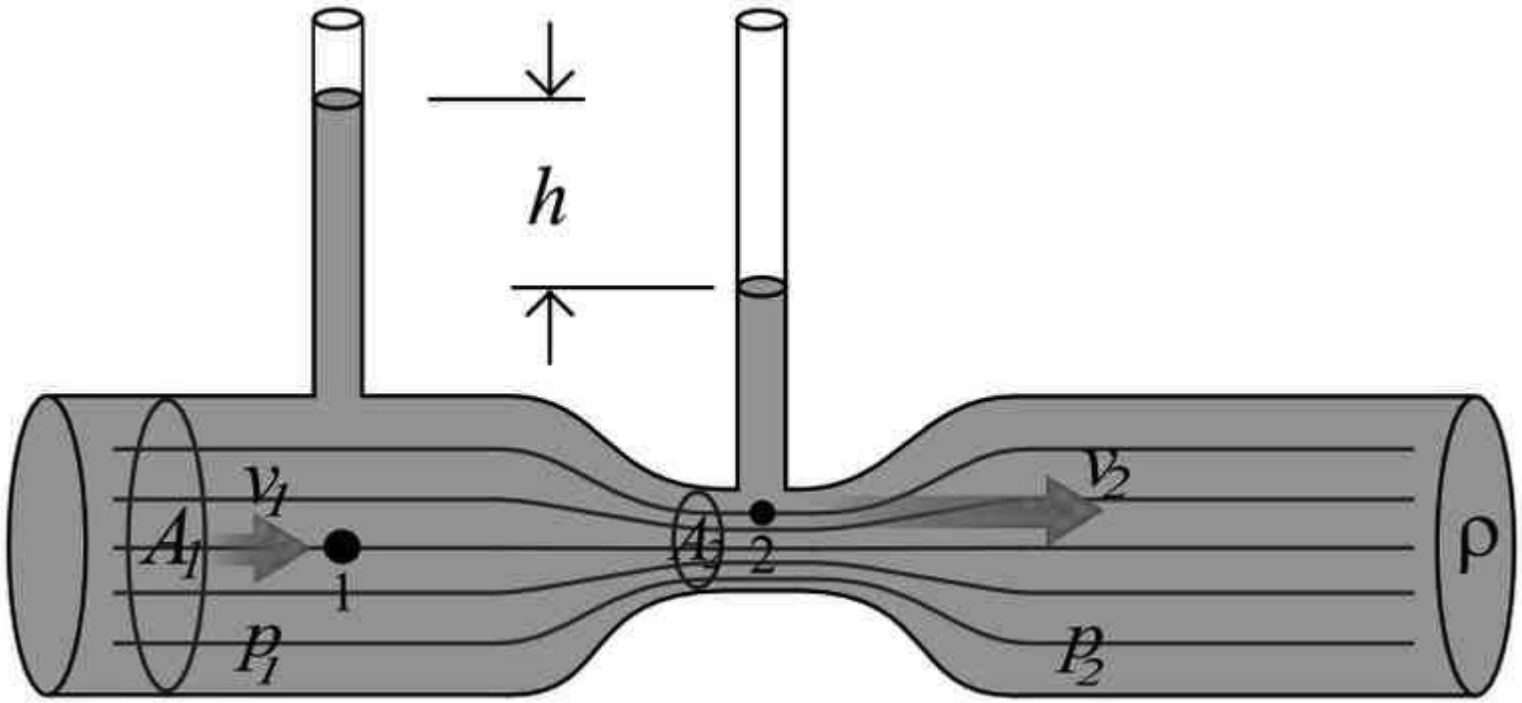
- Carburettor is the device that mixes petrol and air in correct propotions and supplies to the combustion chamber in right quantity.
- A Carburettor atomises, vaporises and mixes the petrol in correct propotions with air as required by the engine and supplies the right quantity of the mixture to the engine.


AIR
AIR CLEANER
CHOKE
FUEL
VENTURI
Float Chamber
THROTTLE VALVE

Simple Carburettor

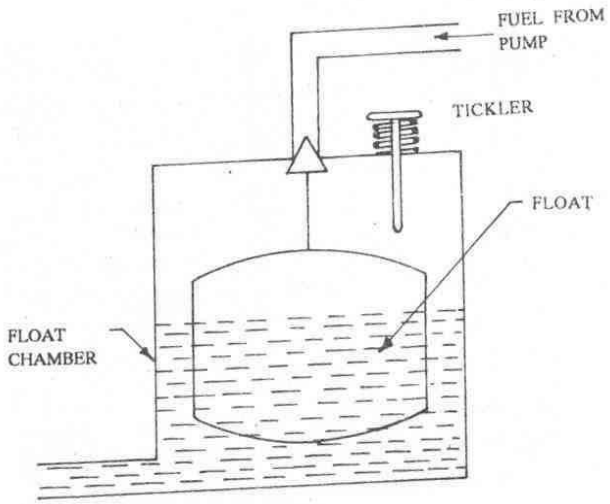


Venturi Principle

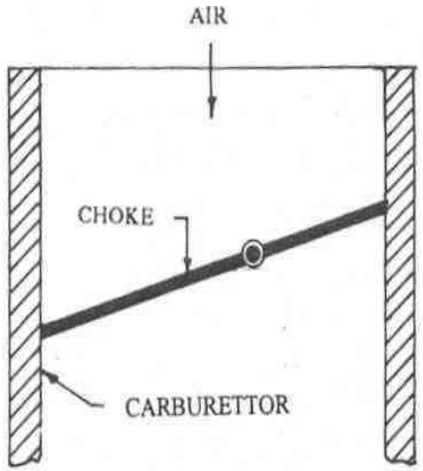


The pressure at "1" is higher than at "2" because the fluid speed at "1" is lower than at "2".

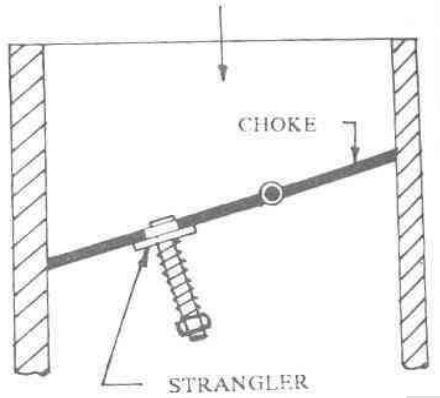
Starting difficulty Methods



TICKLERS



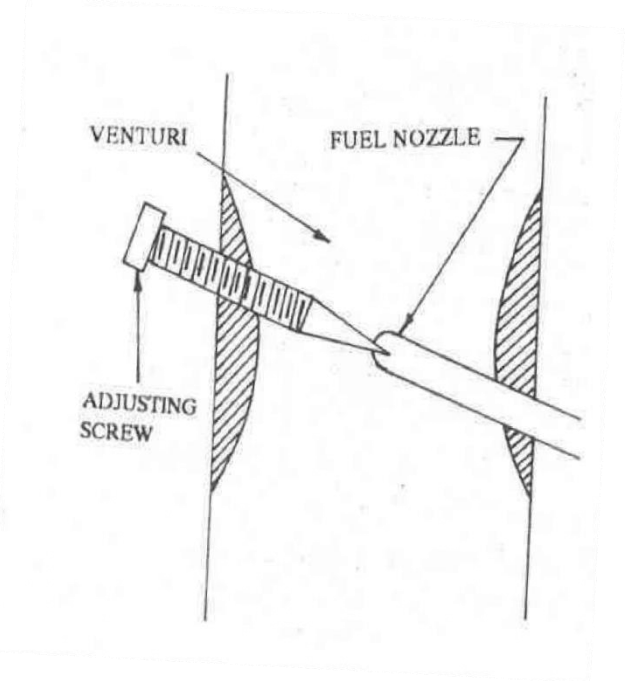
ECCENTRIC CHOKE

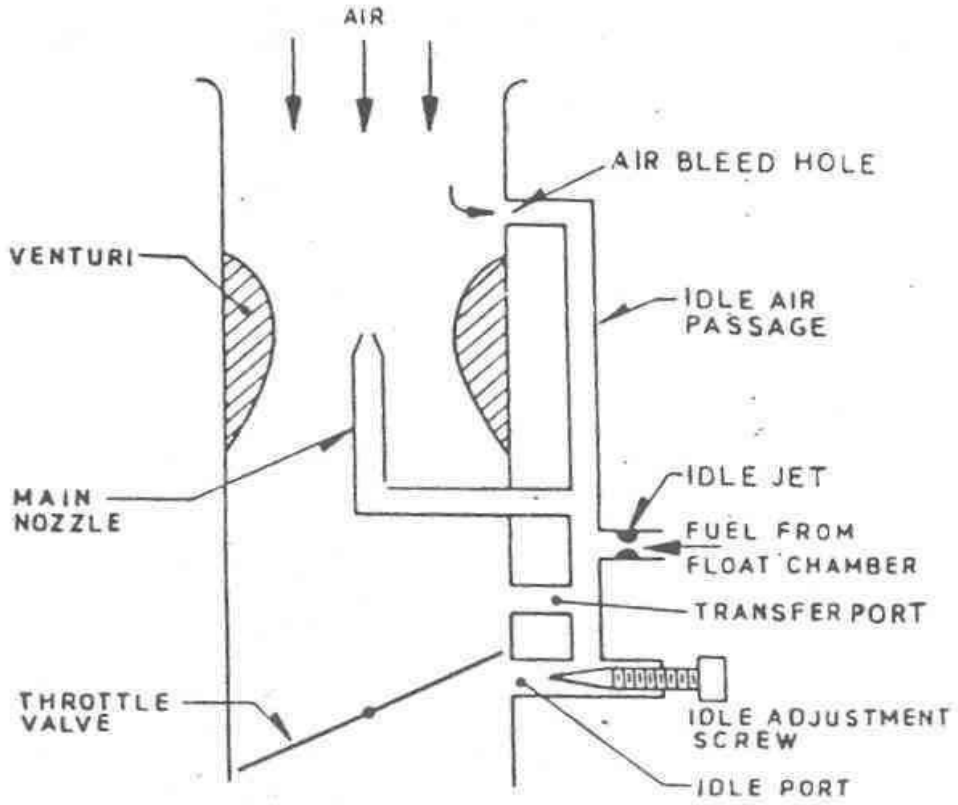


CHOKE WITH STRANGLER VALVE

Adjustable Area Jet:

A long tapered needle is used which is screwed into the jet as shown in the figure. For starting the screw is loosened so that the jet area providing fuel is increased and thus rich mixture is provided for the start.

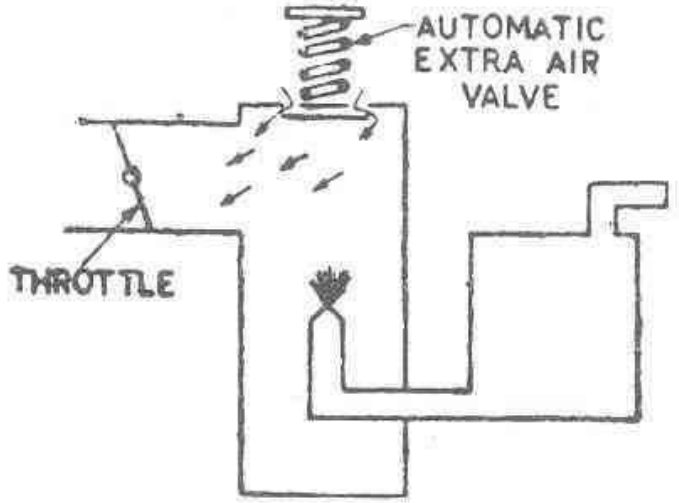




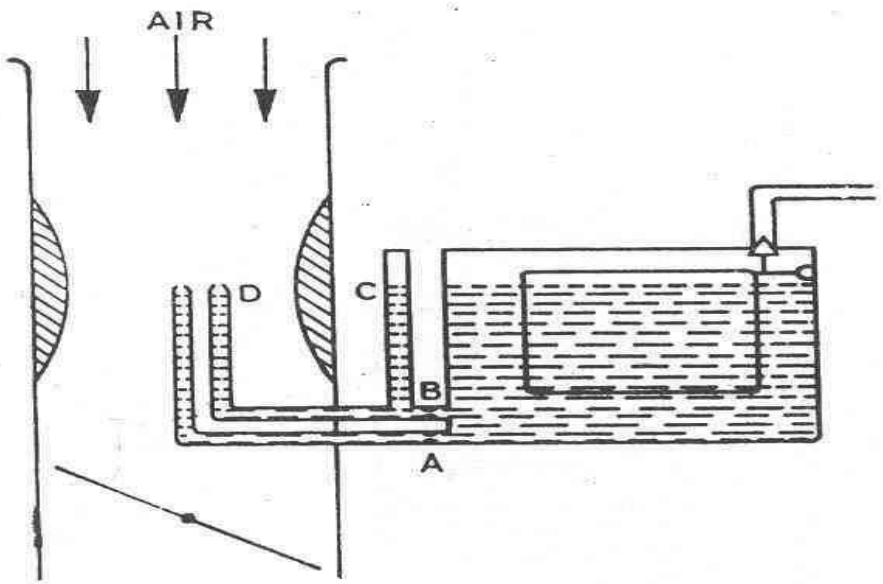
IDLING CIRCUIT

Extra Air valve

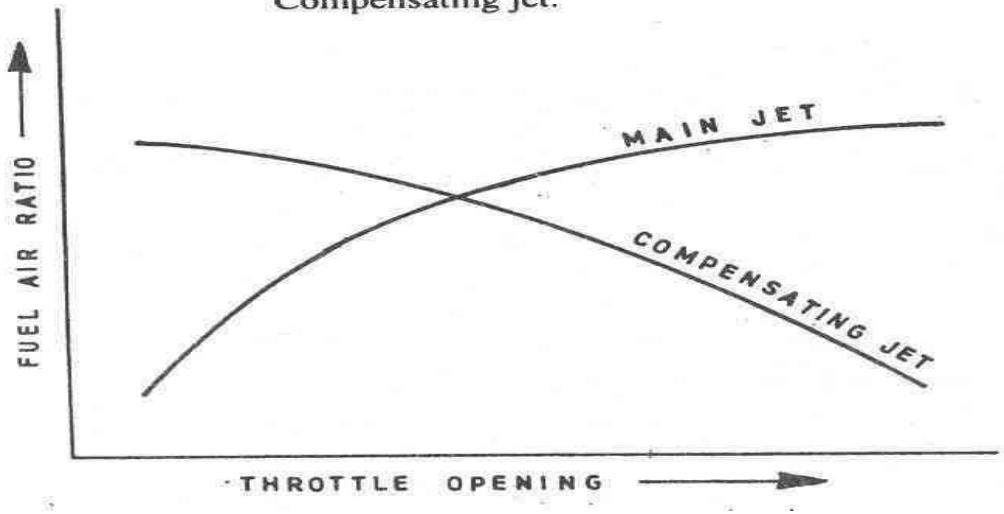
- This is a spring loaded valve arranged to open by means of engine suction as shown in the figure. It is thus controlled by the spring stiffness and engine suction



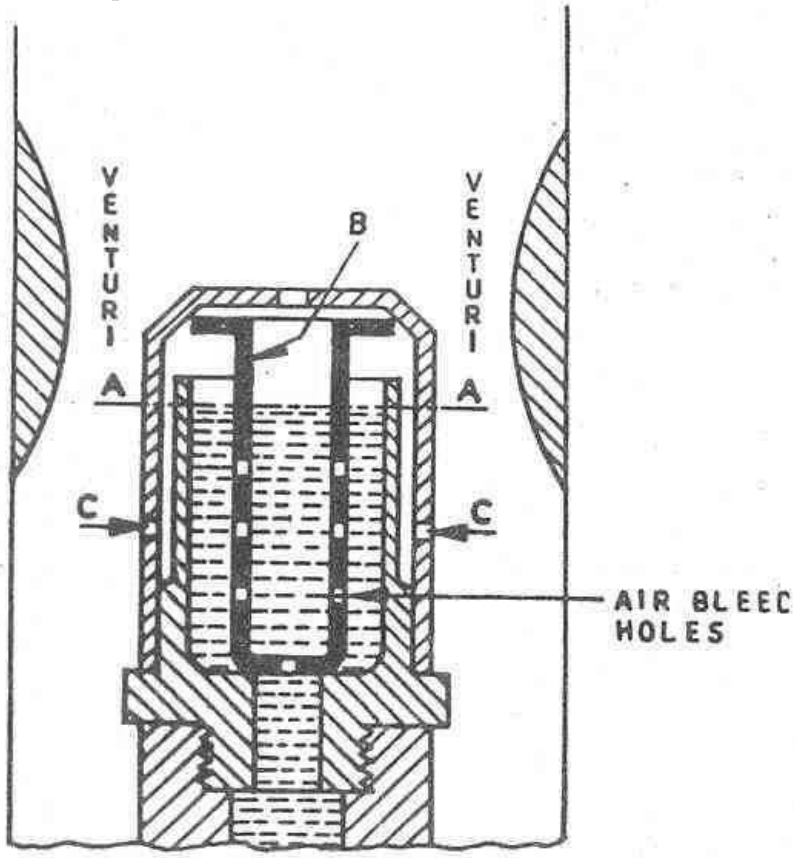
Compensating Jet



Compensating jet.



Air bleed compensation

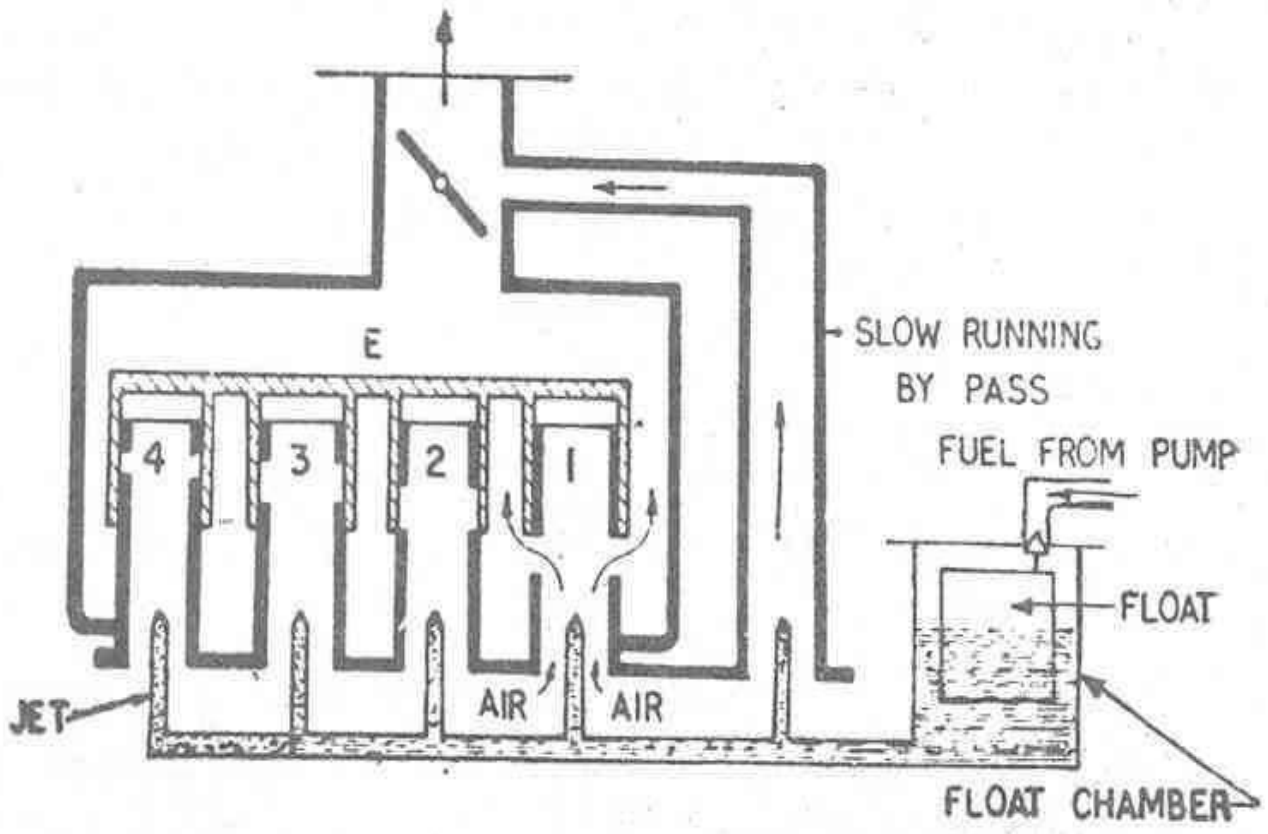


A-A: no load

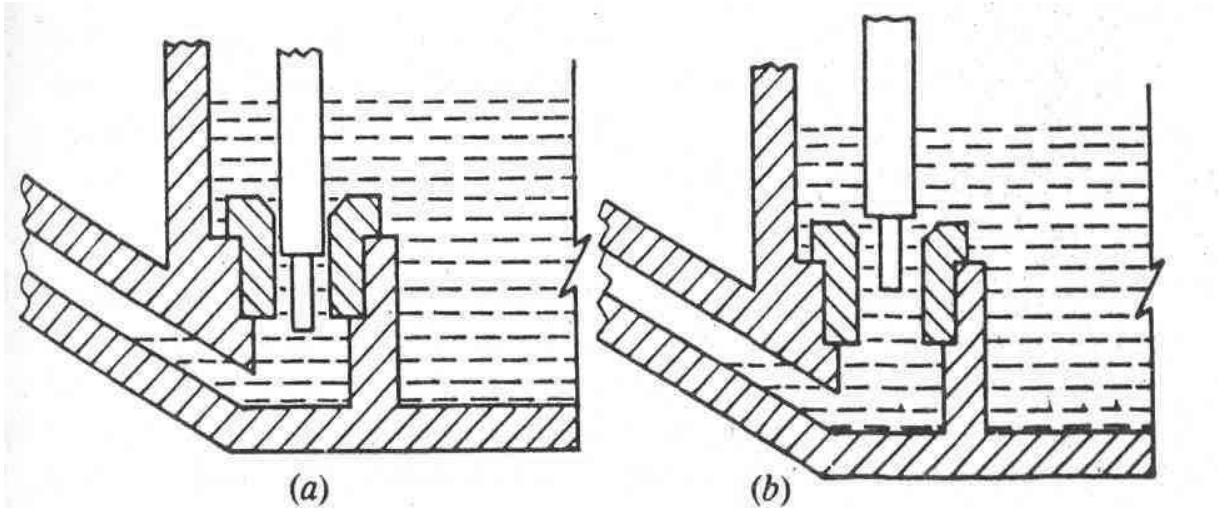
B-jet tube having air bleed holes

C -holes communicating the air bleed holes to atmosphere

Multiple Jet Compensation



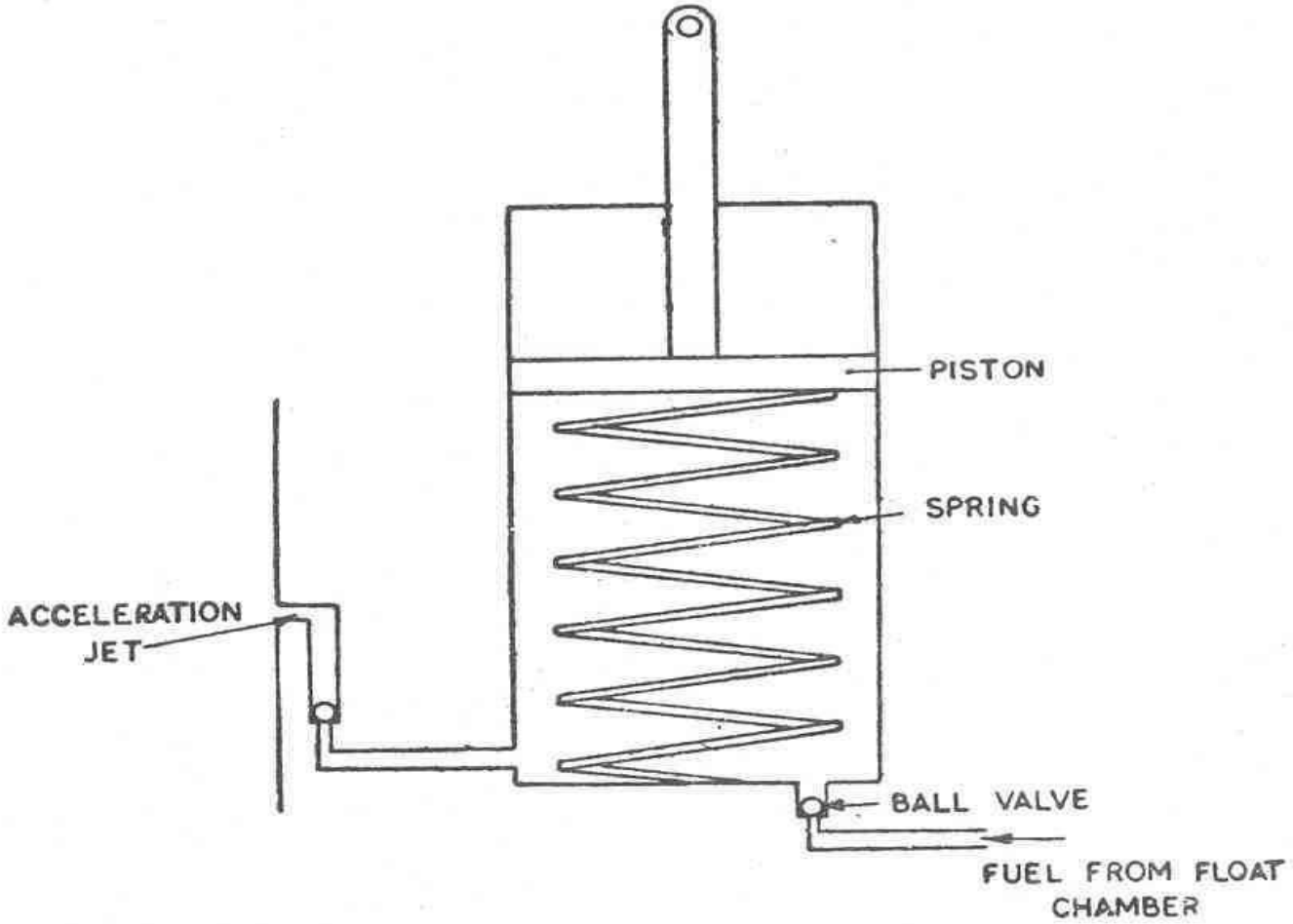
Difficulty at high speeds



Low speeds

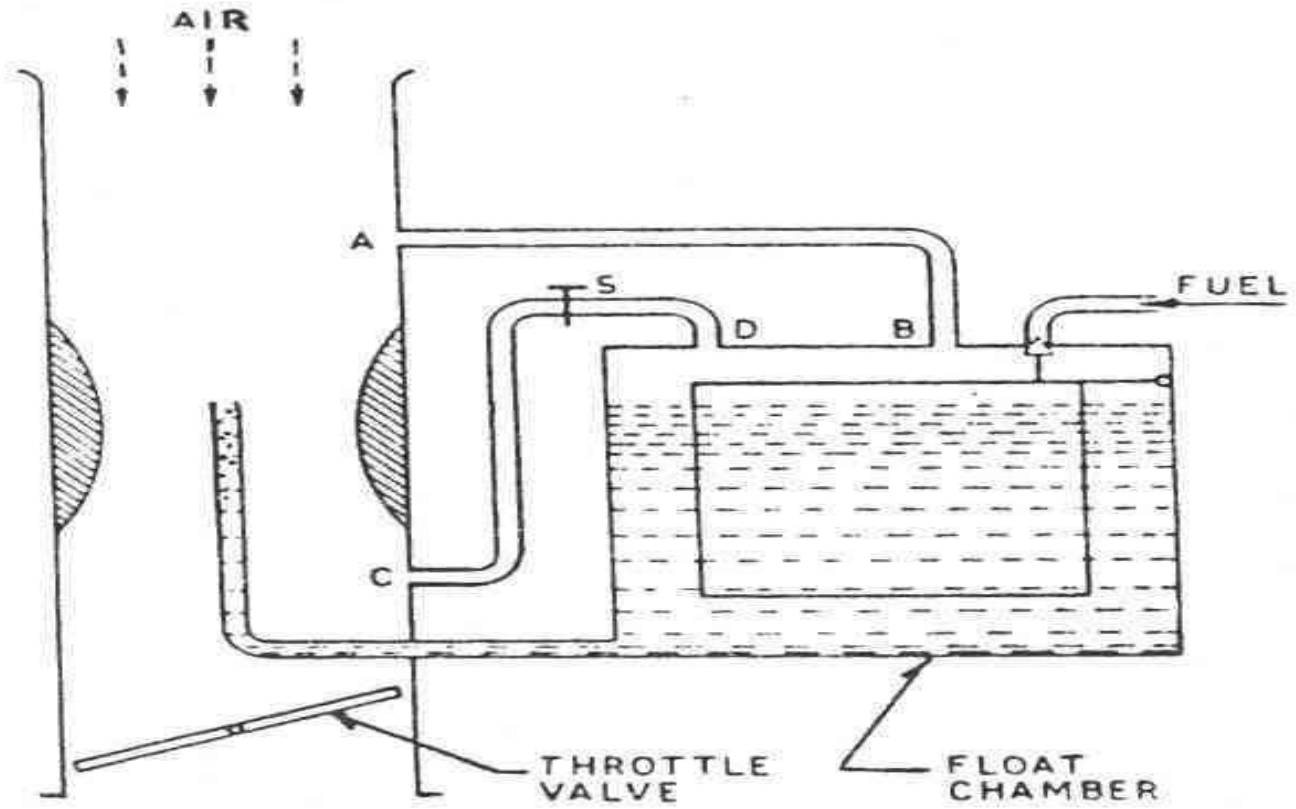
High speeds

- Weak air-fuel mixtures supplied by the single jet carburettor will not give enough power at High speeds.
- A metering rod with stepped diameter end in the main jet is used for this purpose.
- At high speeds metering rod is pulled up so that small dia meter part is in the well supplying more fuel



Acceleration Pump

Influence of Altitude



Types of Carburettor

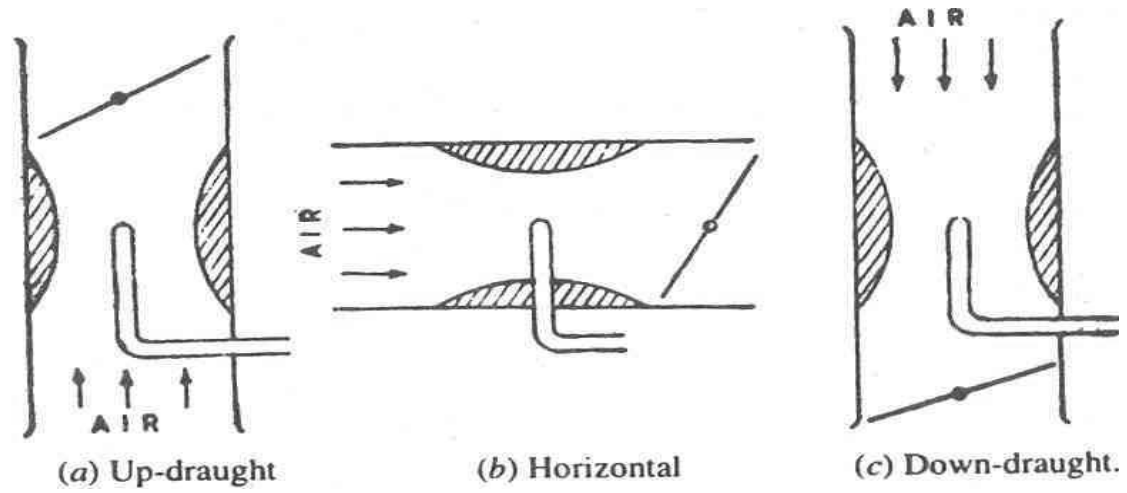
Depending on the choke area carburettors are classified As:

1.Open Choke or constant choke carburettor

2.Variable Choke or Constant depression carburettor

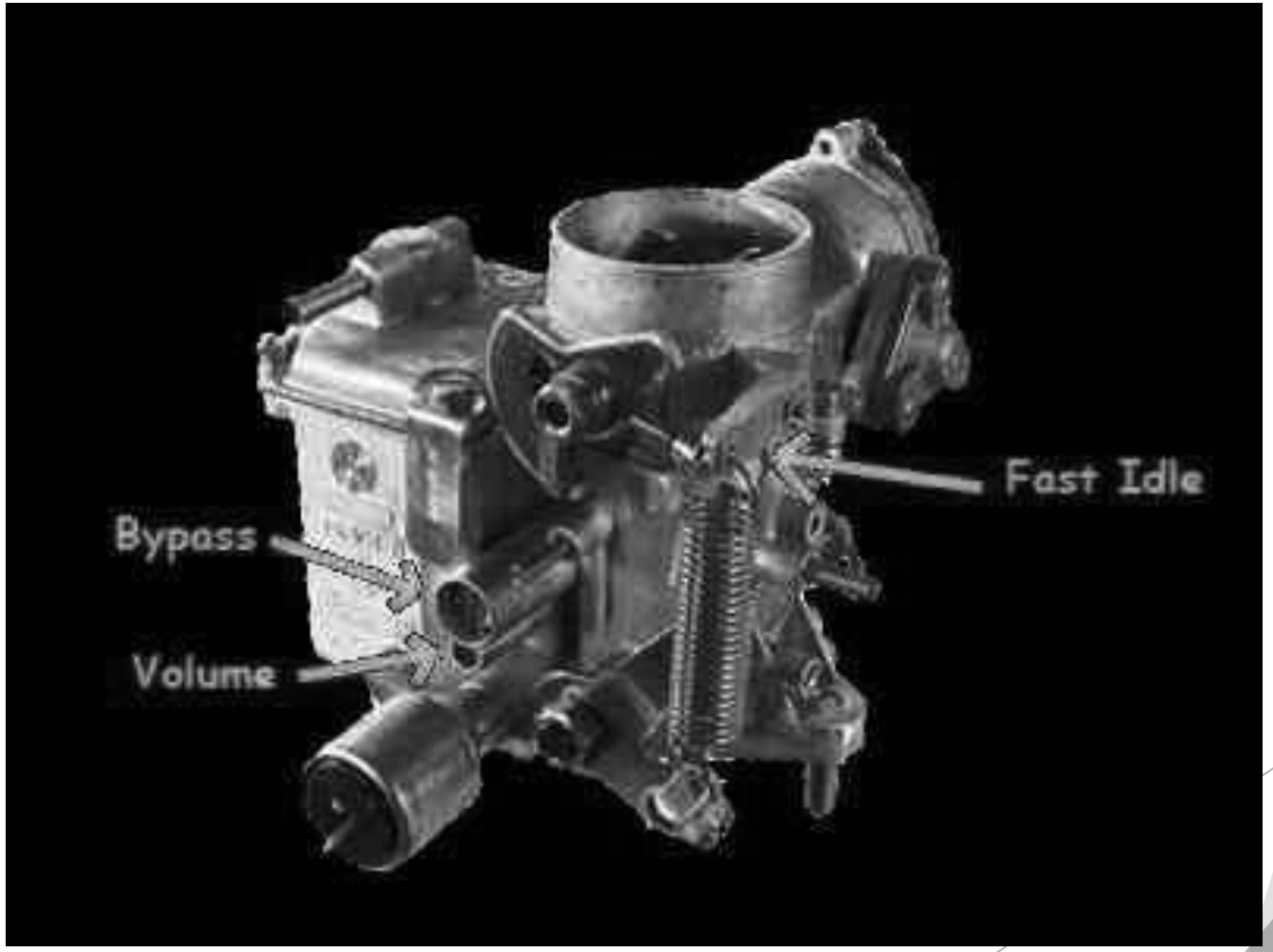
Carburettors are also classified as

a) Up-drought b)Horizantal c) Down-drought Carburettors.



(a) Up-draught (b) Horizontal (c) Down-draught.

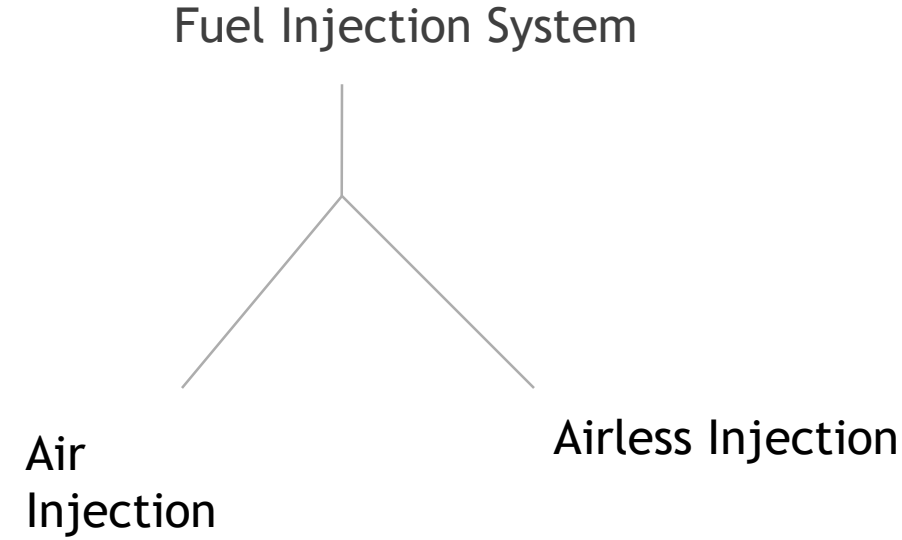
Solex Carburettor



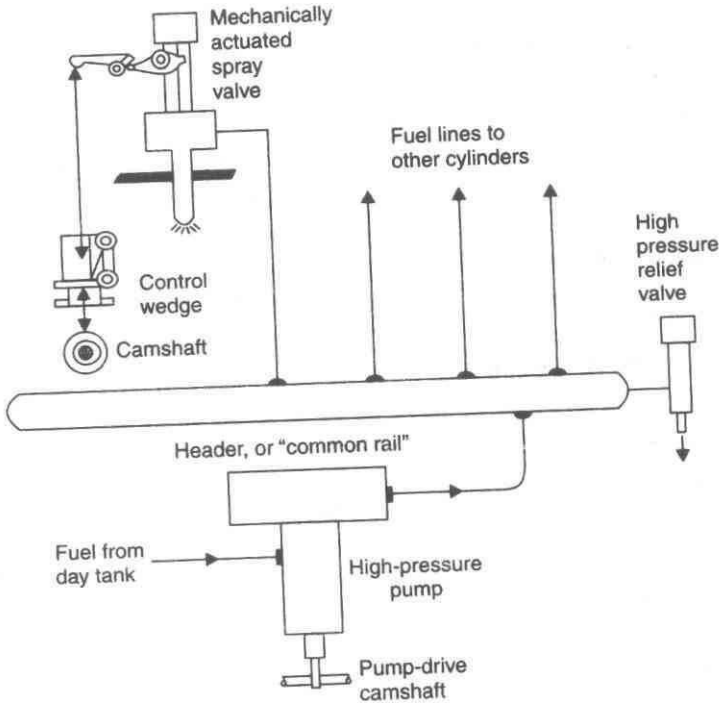
Diesel Engine Fuel Injection Systems

Functions of a Fuel injection system:

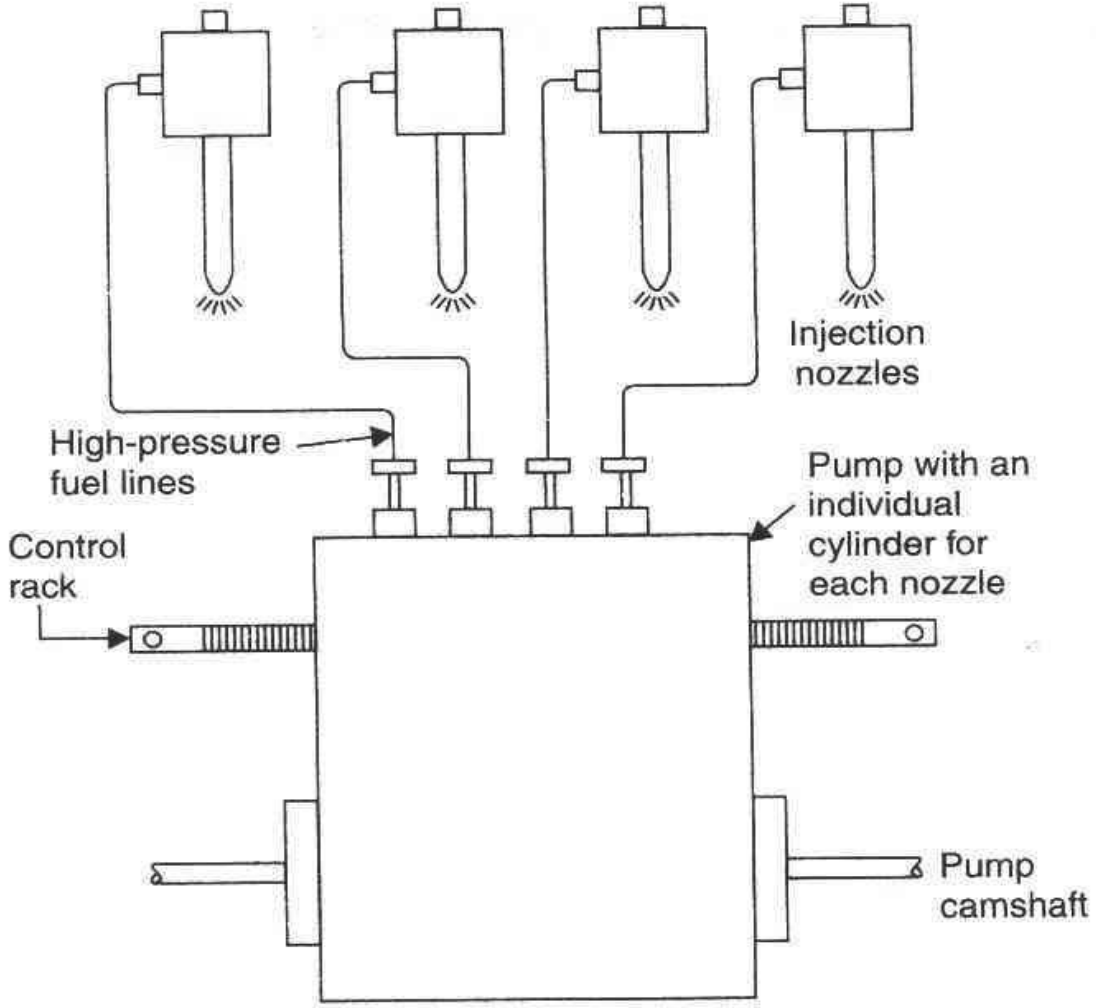
- Filter the fuel
- Measure the correct quantity of fuel to be injected
- Time the fuel injection
- Control the rate of fuel injection
- Atomize the fuel
- Distribute the fuel in the combustion chamber


Fuel Injection System
Air Injection
Airless Injection

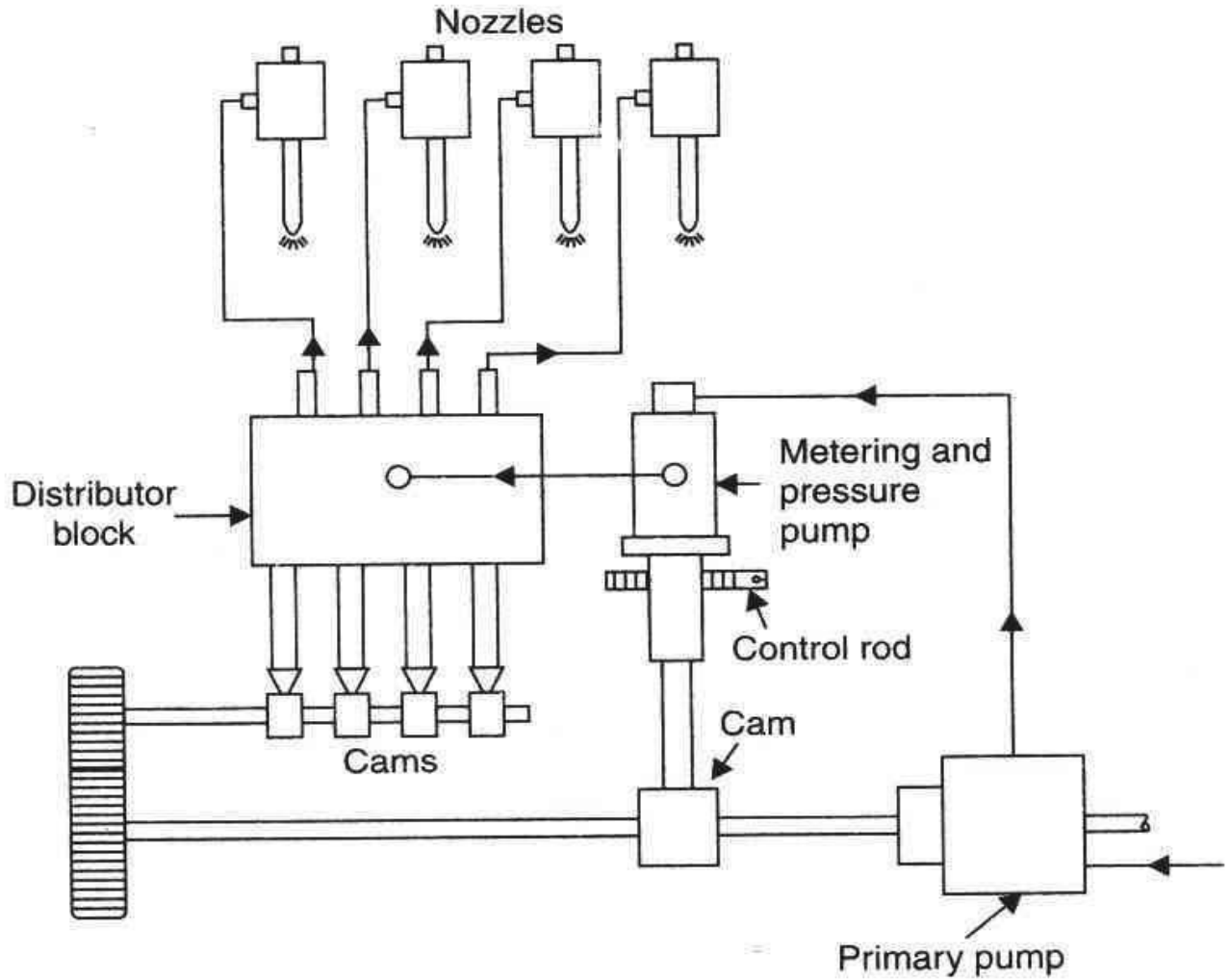
Common Rail Injection System



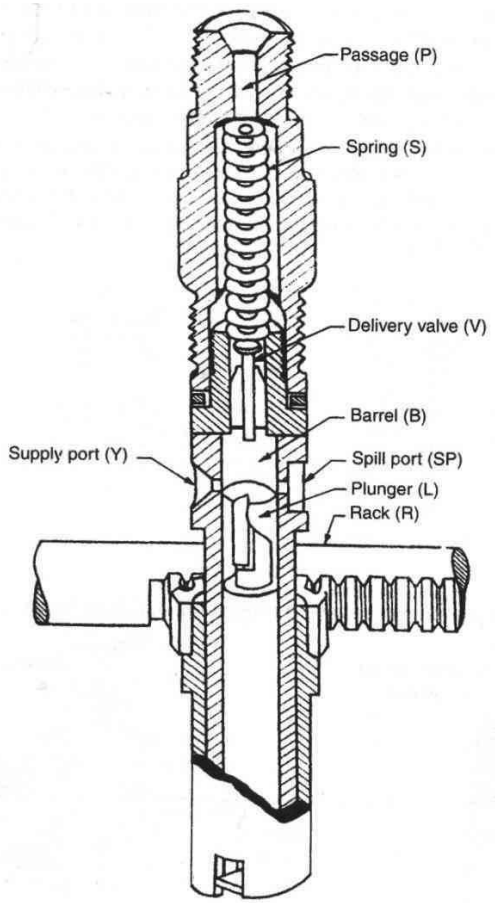
Individual pump injection system



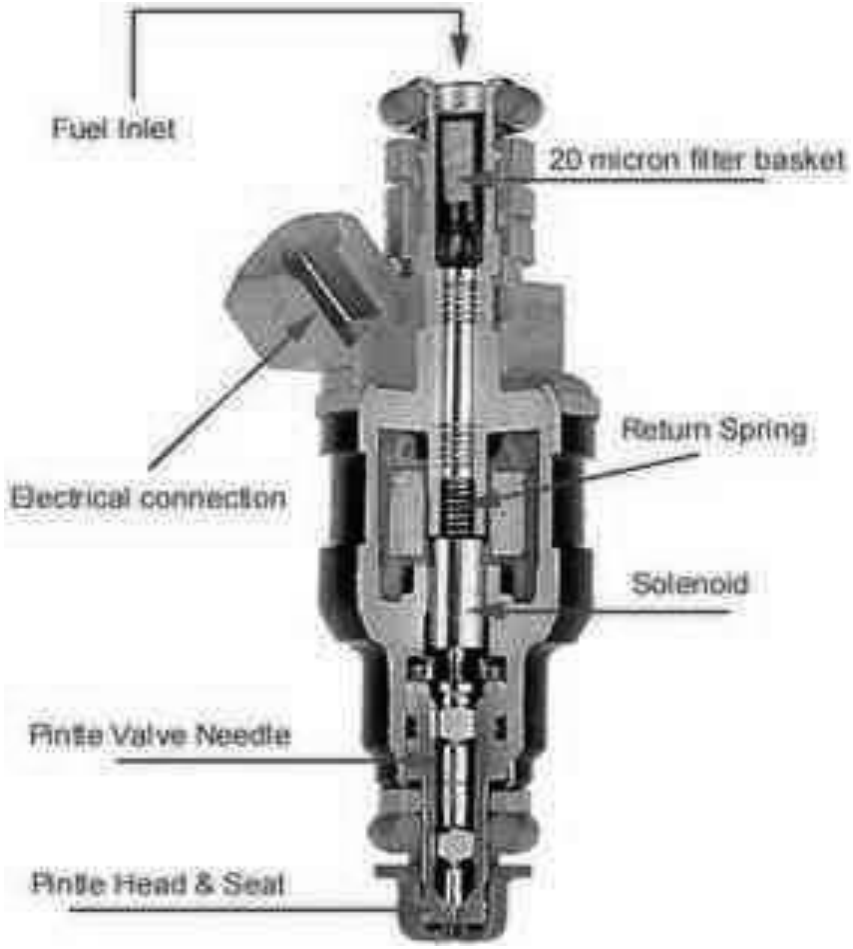
Distributor System



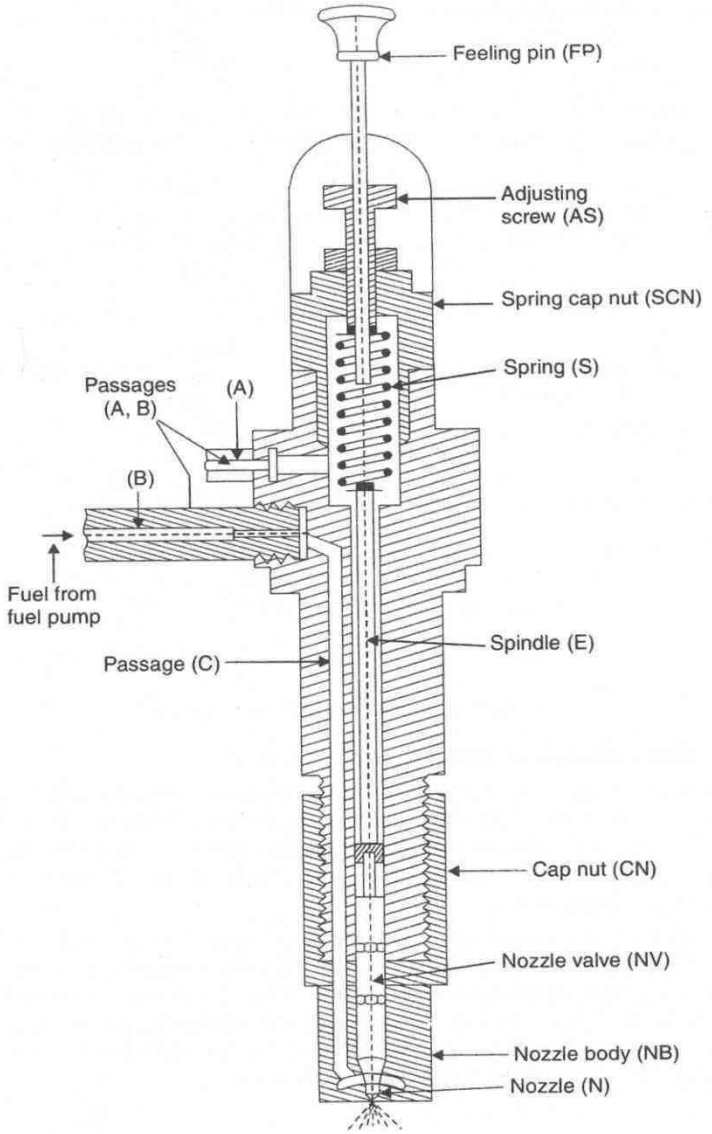
Fuel Pump


Passage (P)
Spring (S)
Delivery valve (V)
Barrel (B)
Supply port (Y)
Spill port (SP)
Plunger (L)
Rack (R)

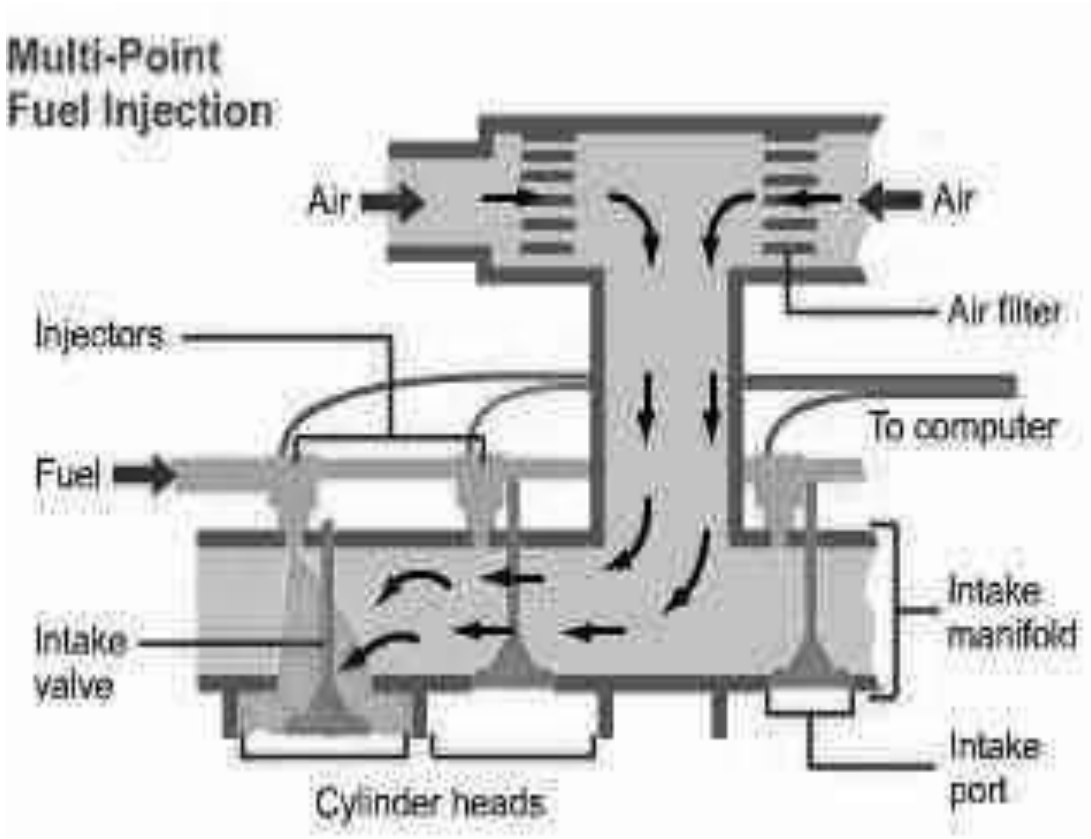
Fuel Injector



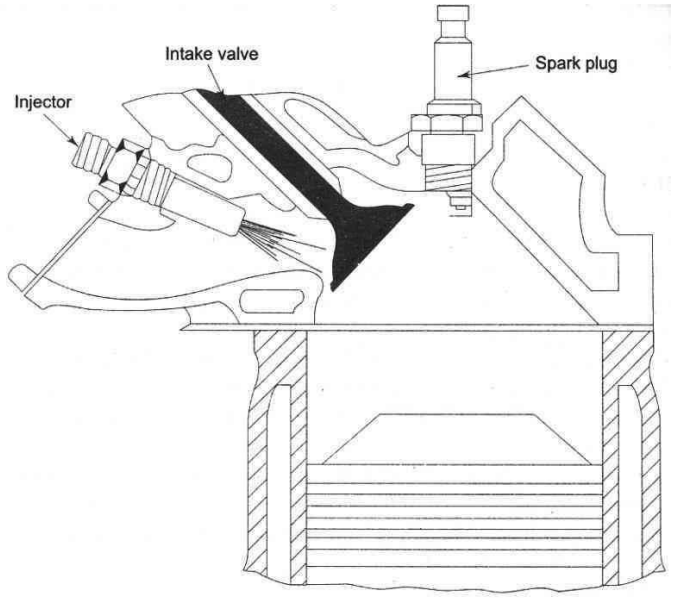
Fuel Injector

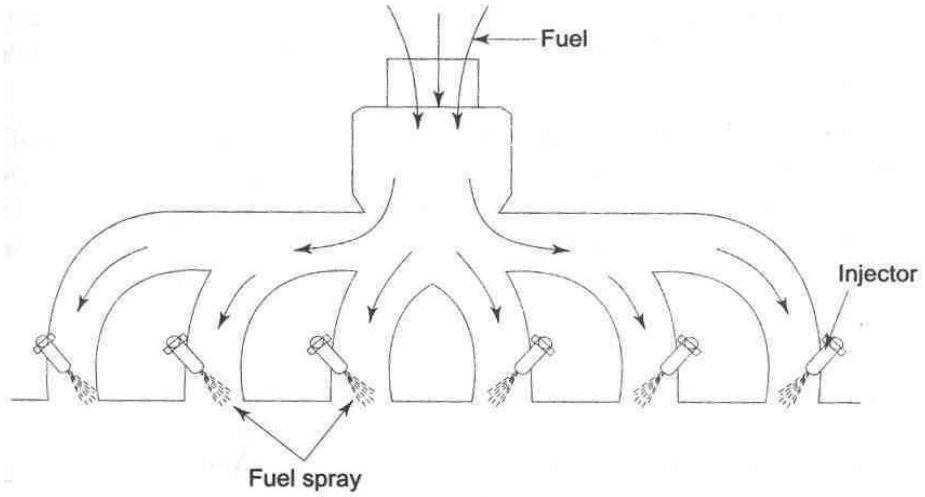


Multi-point fuel injection

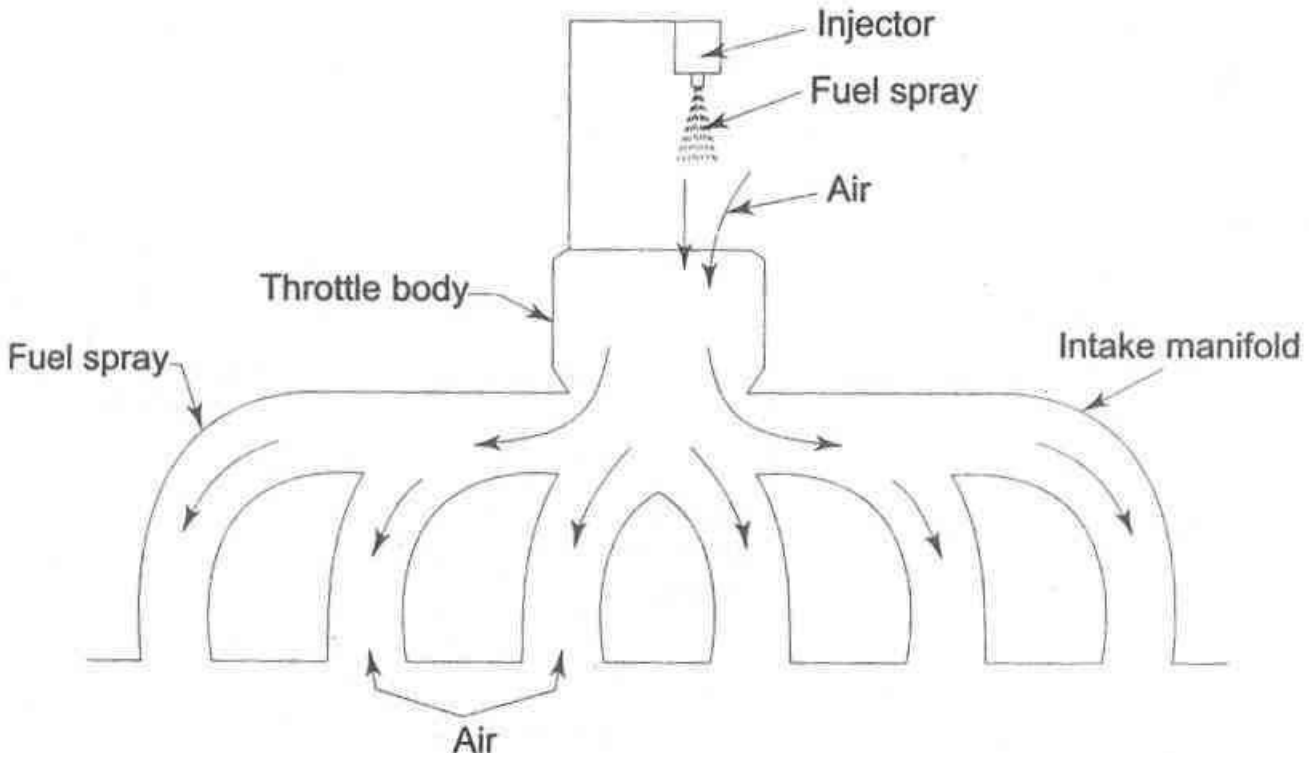


Port Injection System

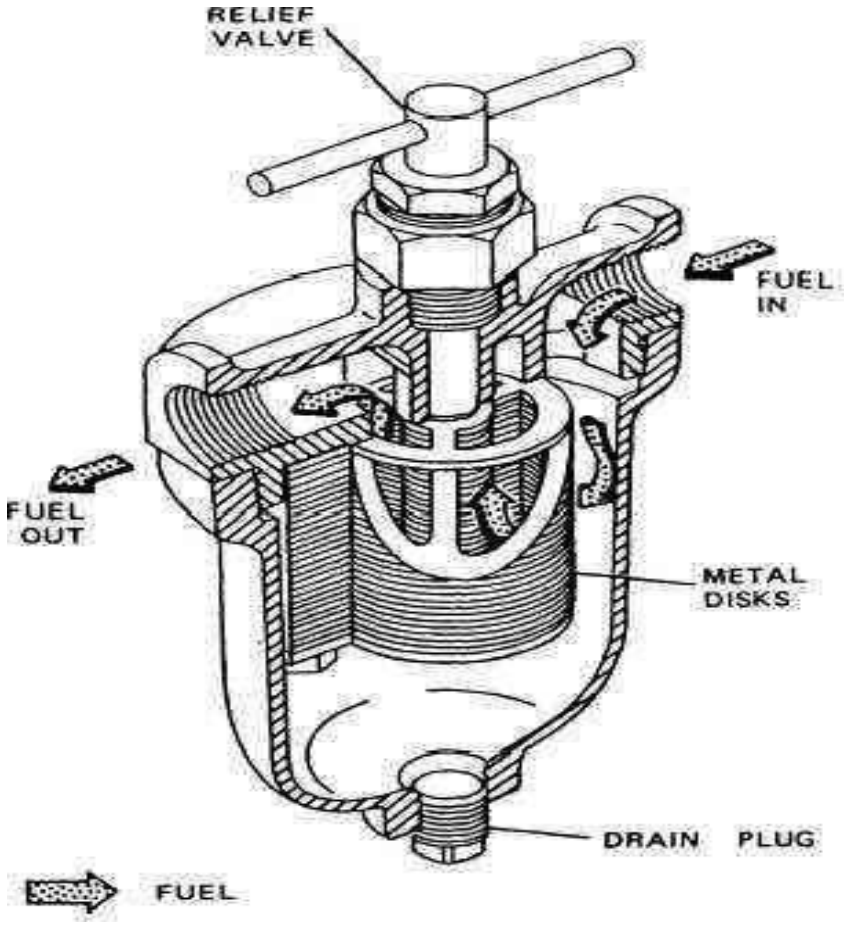




Throttle body Injection



Fuel Filters



THANK YOU