AUTOMOBILE POWER PLANTS

UNIT - 1

ENGINE CONSTRUCTION, INLET & EXHAUST SYSTEM

Introduction to Engines:

An engine or motor is a device which is designed to convert one form of energy into another form of energy.

Eg: Heat engines, Electric engines, Electric motors etc.

History of Automobiles:

In 1769, A French engineer, Captain Nicholas Cugnot built the first road vehicle propelled by its own power. In 1880, German and French efforts developed an internal combustion engine vehicle, which was used to carry fruits. In 1985, Benz in Germany built a tricycle propelled by an internal combustion engine. In 1895, Panhard & Levassor named French people made modifications that engine is placed in front of the chassis, hooked up to a sliding gear and incorporate break peddles, clutch and accelerator. In India, the first motor car appeared at Bombay in 1897.

Definition of Automobile:

An automobile is a self-propelled vehicle which is used for the transportation of passengers and cargo on the ground. Automobile or Automotive means one which itself can move. Car, Bus, Truck, Jeep, Tractor, Scooter, Motor cycle etc. are the examples of Automobiles.

Types of Automobiles:

The automobiles are categorized in several ways.

1) Purpose:
   A) Passenger Vehicles - - car, jeep, bus
   B) Goods Vehicles - - truck
2) Capacity :
   A) Light Motor Vehicles - - car, motor cycle, scooter.
   B) Heavy Motor Vehicles - - bus, coach, tractor.

3) Fuel used :
   A) Petrol used Vehicles - - car, jeep, motor cycle, scooter.
   B) Diesel used Vehicles - - truck, bus, tractor, bulldozer.
   C) Electric Cab - - Battery truck, fork lift.
   D) Steam Carriages - - steam road rollers.
4) Number of wheels :
   A) Two wheeler - - Mopeds, scooters, motor cycles.
   B) Three wheeler - - Tempos, Road rollers.
   C) Four Wheeler - - car, bus, Tractor.
   D) Six wheeler - - Truck, tankers, Gun carriage vehicle.
   E) Eight or More wheelers - - car transporting vehicle, rocket transporters.

1.1 Engines:

Engine is a prime mover which works with the help of heat energy obtained from the fuel, which is converted into mechanical energy. Simply, Engine is one which converts heat energy (chemical energy) into mechanical energy.

Types of Engines:

In general the Engines are two types, based on the location of combustion process taking place.

External combustion Engines:

If the process of combustion is taking place outside of the engine, then it is External combustion engines.

Eg : Steam engines, Coal fired power plants , Stirling engines etc.

Internal combustion Engines:

If the process of combustion is taking place inside of the engine, then it is Internal combustion engines.

Eg: Petrol engines, Diesel engines etc.

Engine Parts:

1. Cylinder Block:

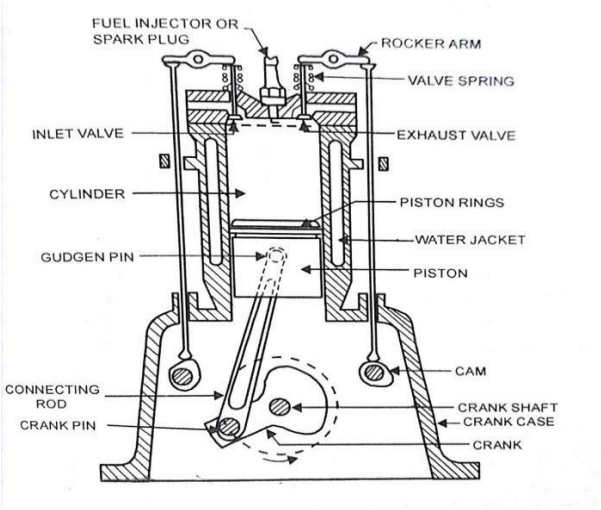

Fig. 1.1 Engine parts (Cross Section)

The basic frame of the engine is formed by cylinder block. It houses the cylinders and pistons. Around the cylinders there are passages for the circulation of cooling water. Cylinder block also carries lubrication oil to various components through drilled passages. At the lower end Crank case is cast integral with the block. At the top of the cylinder block, cylinder head is attached.

2. Cylinder Head:

Cylinder head is attached to the top of the cylinder block by means of studs. The gaskets are used to provide a tight leak proof joint at the interface of the head and the cylinder block. The cylinder head forms a combustion chamber above each cylinder. It also contains holes for spark plug and cooling water jackets. Besides valve openings are provided upon which complete valve operating mechanism is arranged.

3. Cylinder:

The cylinder houses the cylinder liners, piston and connecting rod. The piston moves up and down in the cylinder. When piston is moving in the cylinder, the walls of cylinder, wear. To avoid these cylinder liners are arranged in cylinder. These cylinders are replaced when they are worn out. Two types of cylinder liners are used. One is Dry liner and other is Wet liner.

4. Piston: The functions of the piston are

1. To transmit the pores of explosion to the crank shaft.
2. To form a seal so that high pressure gases in the combustion chamber do not escape into the crank case.
3. To serve as a guide and bearing for small end of the connecting rod.

The top of the piston is called head or crown. It has groves to house the piston rings. Two types of piston rings are used. One is Compression rings and the other is Oil rings. Piston has a piston pin. The small end of the connecting rod is connected to the piston pin.

5. Connecting Rod:

The function of the connecting rod is to convert the reciprocating motion of the piston into rotary motion of the crank shaft. The small end of the connecting rod is connected to the piston pin. The big end of the connecting rod is connected to the crank shaft.

6. Crank Shaft:

Crank shaft receives the power from the connecting rod and supply to the fly-wheel.

7. Crank Case:

The bottom part of the cylinder block is called Crank case. It houses the crank shaft and crank pin. It also acts as a reservoir for lubricating oil.

8. Cam Shaft:

The cam shaft is driven by the crank shaft by means of timing gears. The speed of the cam shaft is half the speed of the crank shaft. It operates inlet valve and outlet valve.

9. Inlet Valve:

The inlet valve is used to suck the charge into the cylinder.

10. Outlet Valve:

The outlet valve is used to send out the hot gases from cylinder to atmosphere through muffler.

11. Fly Wheel:

Fly-wheel is used to store the power at power-stroke and supply the power to other strokes.

12. Piston Rings:

In order to seal the gases in the top of the cylinder and prevent their leaking down the side of the piston, piston rings installed in the grooves turned in the piston crown are used. It is desirable that the ring gap should be as small as possible, and it is equally important that it should never close completely.

Piston Ring failures:

- Insufficient piston ring and groove clearance, which causes the ring to jam in the groove at working temperatures, as a result blow-by occurs and the ring may break.
- Insufficient cylinder lubrication.
- Large amount of wear in cylinder liner.
- Excessive diametrical clearance between the piston and cylinder liner.

Combustion chamber:

Combustion chamber is the space enclosed between the piston head and cylinder head when the piston is the top dead centre position.

Types of combustion chambers:

1. Direct Injection type or Open type
2. Turbulent or swirl type
3. Pre-chamber type.

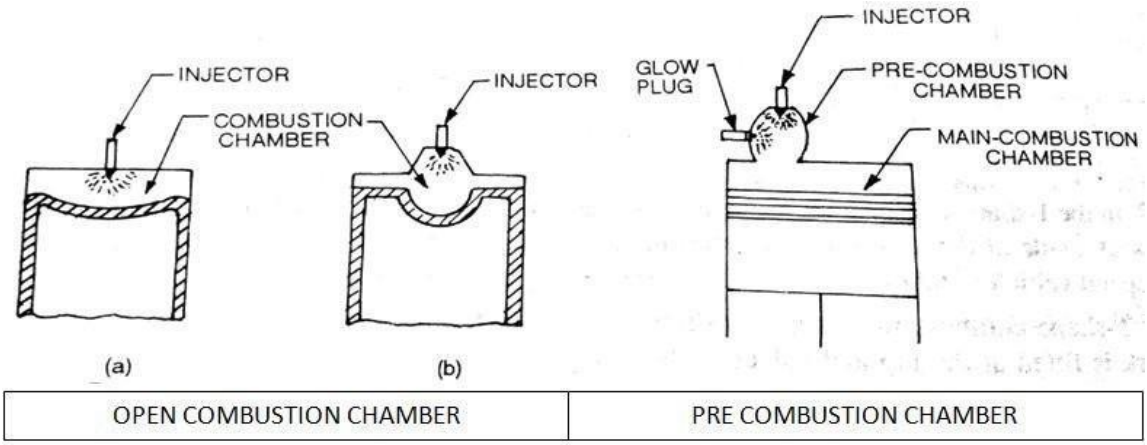

Fig 1.2 Types of Combustion Chambers

Valve Operating Mechanisms:

Side Valve Mechanism:

This mechanism is used in L,T and F type engine heads. The valve stem slides up and down with the help of valve stem guide. The valve spring is fitted between the engine block and spring retainer. It keeps the valve closed tightly on the valve seat. The valve tappet is lifted by the cam.

When the cam is rotated to 90° the tappet is moving up with the help of valve spring and valve stem guide. The valve is open. When the cam is rotated to 0°.The valve tappet moving down. With the help of valve spring , the valve is closed.

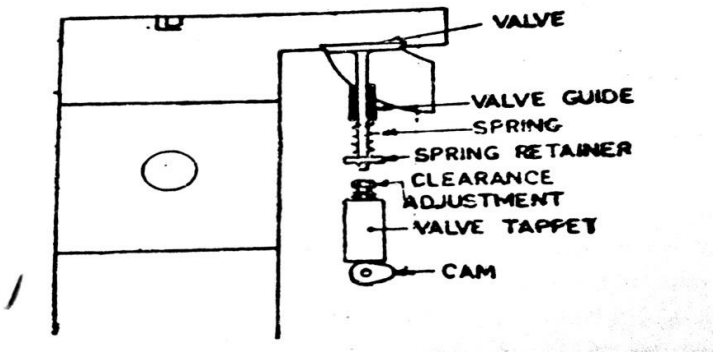

Fig 1.3 Side Valve Mechanism

The valve operating mechanism consists of a cam ring or camshaft equipped with lobes that work against a cam roller or a cam follower. The cam follower pushes a push rod and ball socket, actuating a rocker arm, which in turn opens the valve. Springs, which slip over the stem of the valves and are held in place by the valve-spring retaining washer and stem key, close each valve and push the valve mechanism in the opposite direction.

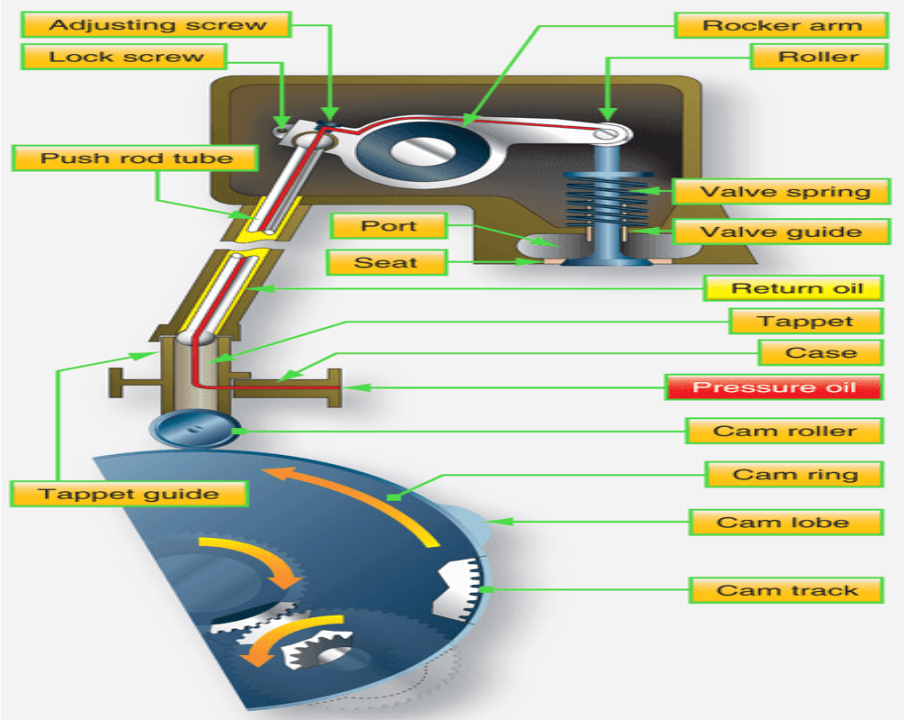

Fig 1.4 Valve Mechanism

Cylinder arrangements:

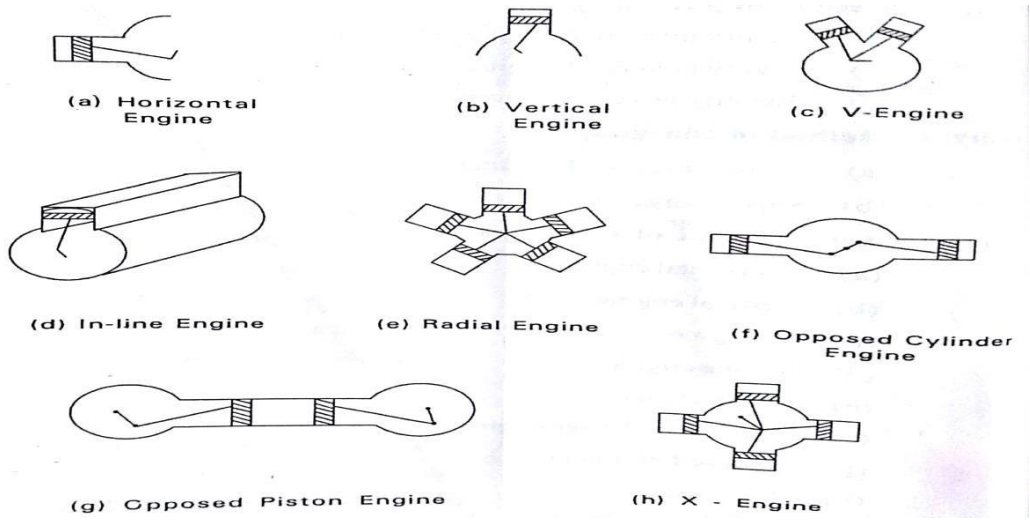

Fig 1.5 Various Cylinder Arrangements

Based on number of cylinders and motion of the piston we have different types of engines used for different types of applications.

Valve Timing Diagram:

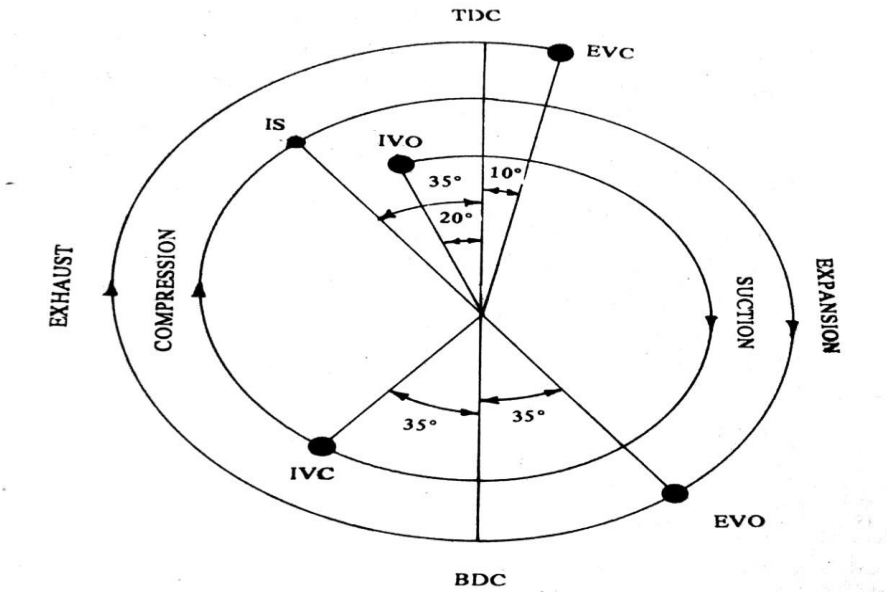

Fig 1.6 Valve Timing Diagram for 4-s Engine

In four-stroke cycle engines and some two-stroke cycle engines, the valve timing is controlled by the camshaft. It can be varied by modifying the camshaft, or it can be varied during engine operation by variable valve timing. An engine will have a period of "valve overlap" at the end of the exhaust stroke, when both the intake and exhaust valves are open. The intake valve is opened before the exhaust gases have completely left the cylinder, and their considerable velocity assists in drawing in the fresh charge.

Engine designers aim to close the exhaust valve just as the fresh charge from the intake valve reaches it, to prevent either loss of fresh charge or unscavenged exhaust gas.

Port Timing Diagram:

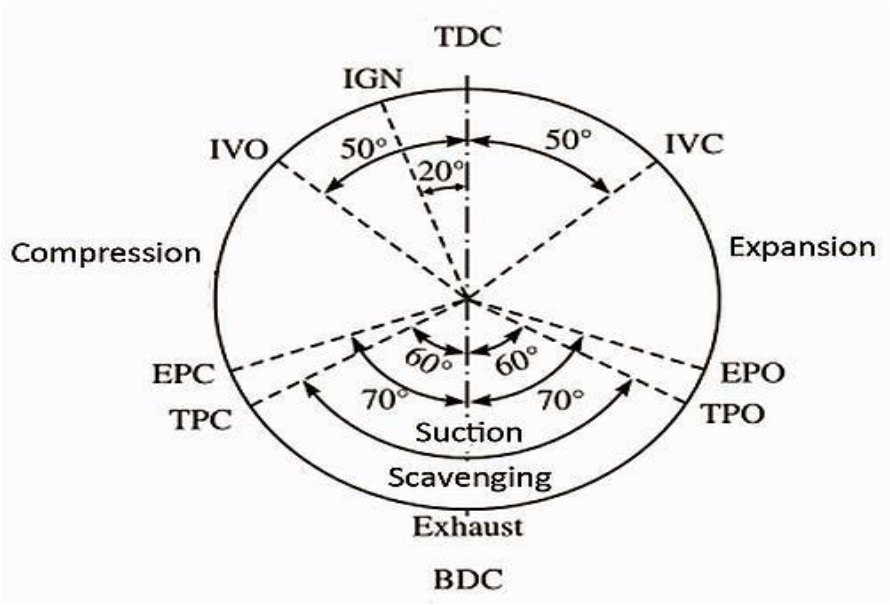

Fig 1.7. Port Timing Diagram

1.5.2 Valve Clearance:

In the case of straight poppet valve, a slight clearance is kept between the valve tappet and the valve stem is called valve clearance. In the case of over-head poppet valve, a slight clearance is kept between rocker arm and valve stem is called valve clearance. This clearance allows for expansion of the valve stem when the engine becomes heated. If sufficient clearance is not given the valve will not seat properly.

1.6 Timing Gears:

The cam shaft rotates at half the crank shaft speed so as to open and close the valves in every two revolutions of crank shaft. The drive from the crank shaft to the cam shaft is done by using timing gears. There are timing marks on the gears of the cam shaft and crank shaft to ensure correct volume timing.

Firing Order:

The sequence in which the power impulses are occurred in an engine is called the "Firing Order" of the engine.

Four Cylinder Engine	:	1-3-4-2 (or) 1-4-3-2.
Six Cylinder Engine	:	1-5-3-6-2-4
V-8 Engine	:	1-5-4-2-6-3-7-8

Introduction to Inlet & Exhaust system

The exhaust system collects the exhaust gases from the cylinders, removes harmful substances, reduces the level of noise and discharges the purified exhaust gases at a suitable point of the vehicle away from its occupants. The exhaust system can consist of one or two channels depending on the engine.

Necessity of manifolds:

The primary function of the intake manifold is to evenly distribute the combustion mixture (or just air in a direct injection engine) to each intake port in the cylinder heads. It may also serve as a mount for the Carburetor, throttle body, fuel injectors and other components of the engine.

The exhaust manifold acts as a funnel and is used to collect all of the engine's emissions (from however many cylinders your vehicle has). Then once they are in one place and completely burnt, the manifold sends the emissions into the rest of the exhaust system.

Types of manifolds:

There are two types of manifolds:

1. Inlet manifold
2. Exhaust manifold.

1. Inlet manifold:

The inlet manifold carries air fuel mixture from the Carburetor to the cylinder. The shape and size of the manifold must be such as to prohibit the formation of fuel droplets without restricting the air flow. On-in-line engines the inlet manifold is usually mounted on the same side of the engine on which exhaust manifold is located. This method is very effective in that the heat transfer takes place as soon as the engine is started.

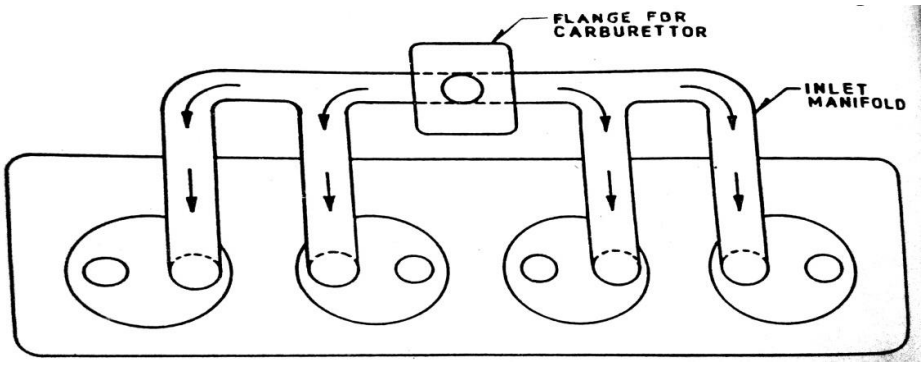

Fig 1.8. Intake Manifold of IC Engine

2. Exhaust Manifold:

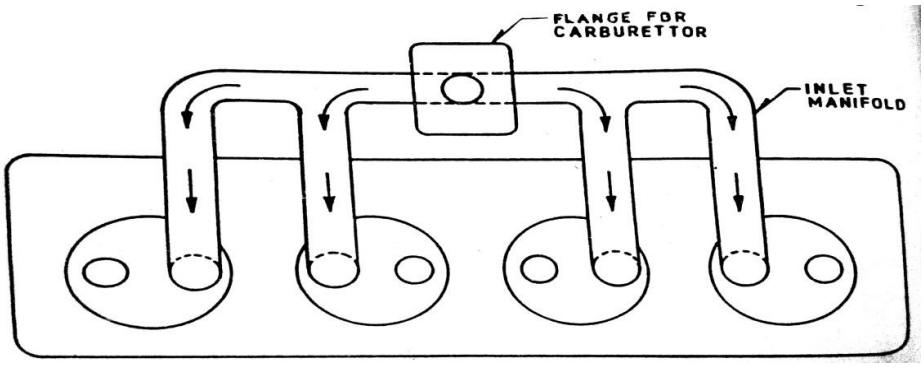

Fig 1.9 Exhaust Manifold of IC Engine

The exhaust manifold is the set of pipes carrying exhaust gases from the cylinder head to the exhaust system. The exhaust manifold is bolted to the side of the cylinder block on L-head engines. In I head engines it is bolted side of the cylinder head. In V-engines manifold is connected to a separate exhaust pipe, muffler and tail pipe.

Consideration for a good manifold design:

The points to be considered for design of manifold:

1. The amount of charge required to the engine cylinder.
2. The amount of charge entering into the cylinder.
3. The fuel should enter into cylinder smoothly and easily.
4. The manifolds with stand high temperature.
5. The material used for manifold should be transfer the exhaust heat to the surroundings.

Muffler:

If the high pressure exhaust gases were allowed to enter atmosphere directly from the exhaust manifold. A load unpleasant noise would be heard like firing of gun. This noise is due to large difference in pressure between the exhaust gases and atmosphere. To avoid this muffler or silencer I used. A muffler is connected between the engine exhaust pipe and the tail or outlet pipe.

The muffler is to reduce the pressure of the exhaust gases sufficiently to permit them to be discharged to the atmosphere silently.

Types of Muffler:

The types of muffler are:

1. Baffle type Muffler
2. Wave cancellation type Muffler
3. Resonance type Muffler
4. Absorber type Muffler
5. Combined resonance and absorber type.

1. Baffle Type Muffler:

It is generally cylindrical in shape with a number of baffles spot welded in side. It has closing in every direction passage for gas.

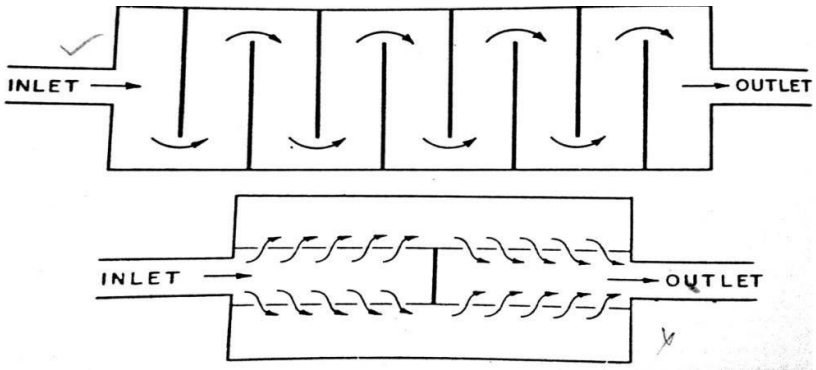

Fig 1.10 Baffle Type Muffler

2. Wave Cancellation Type Muffler:

In this type exhaust gases are divided in to two parts .the lengths of these paths are so adjusted that after they come out of the muffler, the crests of one wave coincide with the troughs of the second wave, thus cancelling each other and reducing the noise to zero.

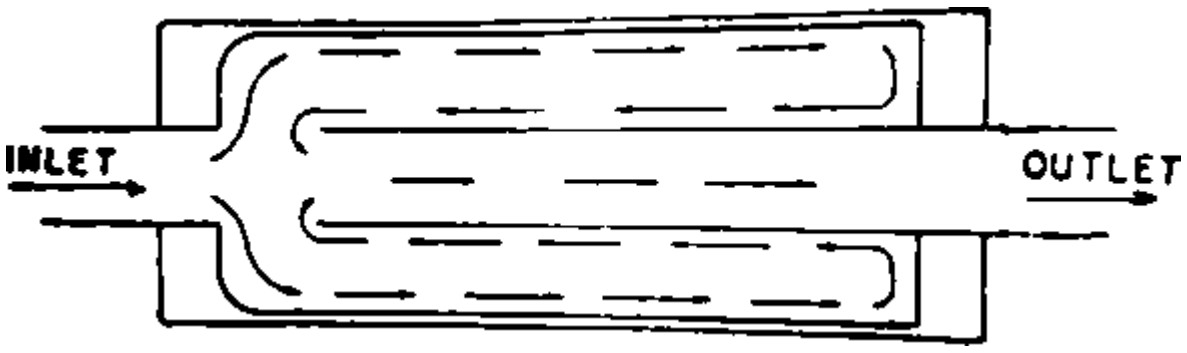

Fig 1.11 Wave Type Muffler

3. Resonance type Muffler:

These are also called Helmohtlz type. It consist a number of resonators in series through which a pipe containing access ports passes . the exhaust gases flow through this type .

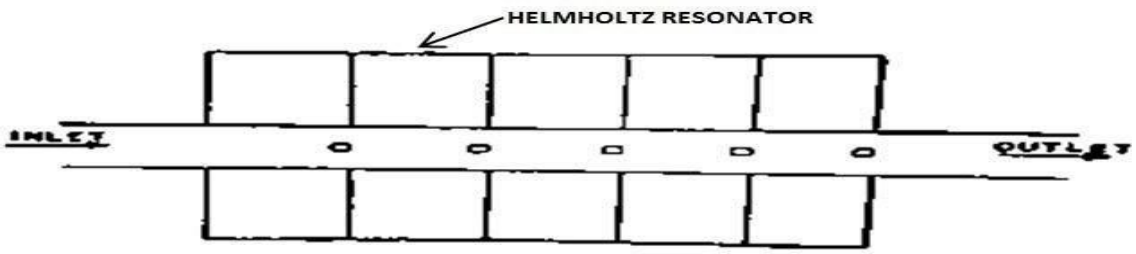

Fig 1.12 Resonance Type Muffler

4. Absorber Type Muffler:

The sound absorbing material usually fibre glass is placed around the perforated tube through which the exhaust gases pass. During the high pressure fluctuation the gases pass through the perforations to the sound absorbing material. These are reducing the noise.

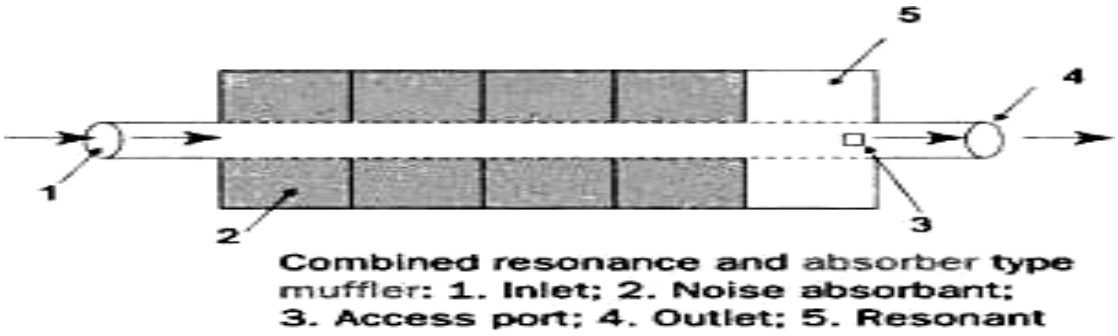

Fig 1.13 Absorber Type Muffler

Air Cleaner:

Air contains dust and dirt. If the air is enter directly to the engine. The dust particles damage the engine. To avoid this problem air cleaner are used. It cleans the air and supplied to the engine cylinder.

Types of Air Cleaner:

Air cleaners are of two types:

1. Light dirty air cleaner
2. Heavy dirty air cleaner

1. Light Duty Air cleaner:

It consists of wire mesh elements and oil reservoir at the bottom. The atmospheric air enters the air cleaner through windows, strikes the oil surface. The heavier impurities are retained by the oil and goes bottom. The air with lighter impurities passes through the wire mesh element, where the impurities are retained. The clean air passed to the engine cylinder.

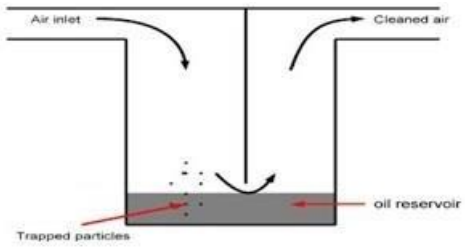

Fig 1.14 Light Duty Air Cleaner

2. Heavy Duty type Air Cleaner:

It consists of a centrifugal pre-cleaner and two filtering elements and oil reservoir. The pre-cleaner gives a whirling motion to the incoming air. The impure particles in the air to be thrown out through the slots. The pre-cleaned air passed on the oil surface. The impurities left on the oil. The air passed through wire-wool mesh. The dirty oil condenses and falls back into the reservoir. The cleaned air then passed through the second wire mesh, which retains any impurities left. The clean air is passed the engine cylinder.

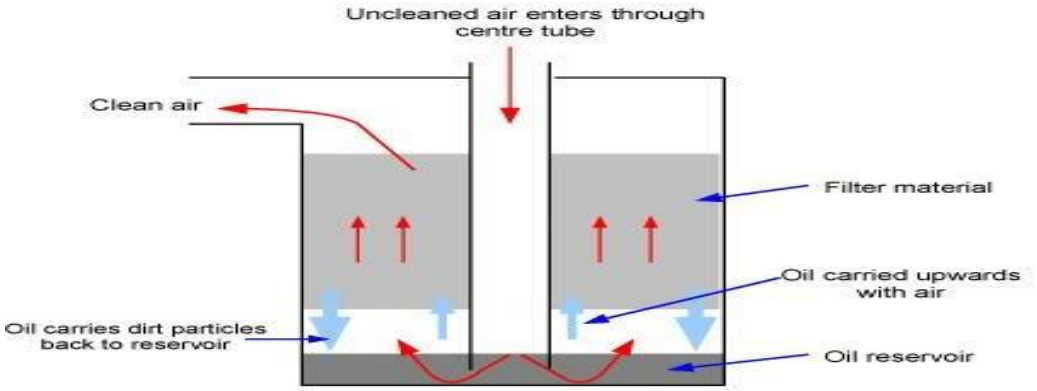

Fig 1.15 Heavy Duty Air Cleaner

Short Answer Questions

1. Write the types of automobiles.
2. Write the types of engines & give examples
3. Explain piston ring failures.
4. Draw the valve-timing diagram.
5. Write the firing order for 4-s,6-s & 8-s engines.
6. Explain the light duty air cleaner.
7. Draw heavy duty air cleaner and label the parts.

Long Answer Questions

1. Explain the parts of the engine with neat sketch.
2. Explain the types of manifolds.
3. Explain the types of mufflers.
4. Draw the types of cylinder arrangements.