

BASIC CIVIL AND MECHANICAL ENGINEERING

UNIT IV - INTERNAL COMBUSTION ENGINES

PART A

1. What are IC engines? Give examples.

IC engines are internal combustion engines. The combustion of the fuel takes place in the combustion chamber. *Examples: Two wheelers, trucks, cars etc.*

2. What are EC engines? Give example.

EC engines are External combustion engines. The steam produced separately in the boiler, and the steam is supplied the cylinder in which the piston reciprocates. *Example. Steam engine.*

3. What are the various classifications of IC engines?

According to the type of fuel used

(a) Petrol engine (b) Diesel engine (c) Gas engine

According to the cooling system

(a) Air cooled engine (b) Water cooled engine

According to the cycle of operation

(a) Otto cycle (b) Diesel cycle (c) Dual combustion cycle

According to the number of cylinder

(a) Single cylinder (b) Multi cylinder engine.

According to the number of strokes

(a) Two stroke (b) Four stroke

4. Define Compression ratio.

Compression ratio is defined as the ration between total cylinder volume to the clearance volume.

$$\text{i.e. } r = \frac{V_s + V_c}{V_c}$$

Where

V_s = Stroke volume

V_c = Clearance volume

r = Compression ratio

5. What is the function of a carburetor?

The main function of a carburetor is to evaporate the liquid petrol and to mix with the correct of air and supply the air fuel mixture I the desired ratio at all speeds and loads.

6. What is the function of a spark plug?

In petrol engine, as the temperature at the end of compression is not enough to ignite the petrol air mixture a spark is provided at the right time by means of a spark plug. Hence a spark plug ignites the fuel at the end of compression and starts the combustion.

7. Write down the differences between air cooling and water cooling system.

S. No.	Air cooling system	Water cooling system
1	Design is simple	System is complicated
2	Weight of engine is less	Weight of engine is more
3	Cost of engine is less	Cost of engine is more
4	Since water is not used, no leakage of water	Possibility of leakage of water
5	More noise from the engine	Less noise, as water dampers the vibration
6	Control of temperature is difficult	Temperature can be controlled by thermostat

8. What are the main functions of a lubrication system in IC engines?

- (i) To reduce the friction between moving parts and to reduce the wear and tear
- (ii) To reduce the temperature produced due to friction
- (iii) To reduce noise between the moving parts
- (iv) To act as a sealing between the cylinder and piston and to prevent the leakage of gases

9. What are the various types of lubrication used in IC engines?

- (i) Splash lubrication
- (ii) Pressure lubrication
- (iii) Petroil method

10. What is the major function of a fuel injector?

Fuel injector is used in Diesel engine, to spray the fuel as tiny droplets on the hot compressed air, at the end of compression stroke. When the diesel rushes out through the fine hole of the injector, it gets atomized and mixes with compressed air in the combustion chamber.

11. Write down the differences between diesel injection and petrol injection.

S.No.	Diesel Injection	Petrol Injection
1	Fuel is directly injected into the cylinder	Fuel is injected in the inlet manifold
2	High injection pressure	Injection pressure is low
3	Fuel is injected at the end of compression stroke	Fuel is injected during the induction stroke

12. Write short notes on scavenging.

Scavenging is the process of cleaning or removing the burnt exhaust gas by the incoming compressed air-fuel (*petrol*) mixture.

13. What are the major functions of a fuel supply system?

- (i) To supply required amount of fuel at the correct time.
- (ii) To properly atomize the fuel for a homogeneous mixing with atmospheric air.
- (iii) To maintain sharp beginning and closing of the injection.

14. What are the requirements of good lubricating oil?

- (i) Non corrosive.
- (ii) Good detergent quality to keep the rubbing surfaces clean.
- (iii) Able to maintain the thin film of oil even at high load.
- (iv) High flash point and low pour point temperatures.

15. Write short notes on crank case compression.

It happens only in two stroke engines. The fresh air fuel mixture enters into the crank case when the inlet port is opened (when the piston moves up). When the piston comes down, it compresses the air fuel mixture partially, because the size of piston is smaller when compared to the size of crank case. The mixture is compressed in the crank case partially, and it enters into the combustion chamber through transfer port. This process is known as crank case compression.

Part B

1. Explain briefly about the major components of an internal combustion engine.

Cylinder Head:

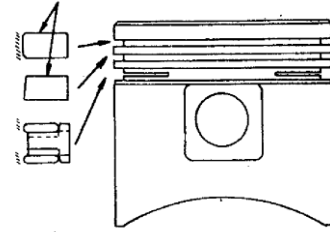
- The cylinder head is bolted to the cylinder Block by means of studs.
- The water jackets are provided for cooling water circulation.
- The materials used for cylinder head are cast iron, aluminium alloy etc.,
- This is also generally made of single cast iron.

Cylinder Liners:

- The liner is a sleeve which is fitted into the cylinder bore.
- It provides wear resisting surface for the cylinder bores.

Crankcase :

- It may be cast integral with the cylinder block.
- Some times, it is cast separately
- and then attached to the block.



Oil pan or oil sump:

- Oil sump is the bottom part of the engine.
- It contains lubricating oil.
- A drain plug is provided in the oil sump to drain out the oil.

Piston :

- It acts as a movable gas tight seal to keep the gases inside the cylinder
- It transmits the force of explosion in the cylinder to the crankshaft through the connecting rod.
- Some of the materials used for piston are cast iron, aluminium alloy, chrome nickel alloy, nickel iron alloy and cast steel.

Piston rings :

Piston rings are inserted in the grooves provided in the piston. Two types of piston rings are used in the piston.

- Compression rings
- Oil rings or oil control rings

Compression rings :

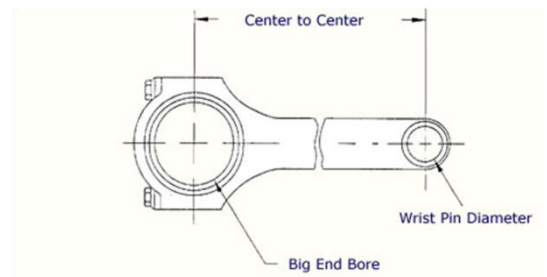
- Compression rings provide an effective seal for the high pressure gases inside the cylinder.
- They prevent the leakage of high pressure gases from the combustion chamber into the crank case.
- Each piston is provided with atleast two compression rings.

Oil rings :

- Oil rings wipe off the excess oil from the cylinder walls.
- It also returns excess oil to the oil sump, through the slots provided in the rings.

Connecting Rod:

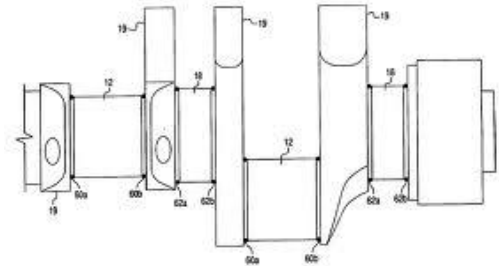
- It connects the piston and crank shaft.
- It transmits the force of explosion during power stroke to the crankshaft.
- The connecting rod has bearings at both ends.
- The small end of the connecting has a solid or split eye and contains a bush.
- This end is connected to the piston by means of a gudgeon pin.
- The other end is called as big end of the connecting rod.
- The connecting rods must withstand heavy thrusts.
- Hence it must have strength and rigidity.



- They are usually drop forged I sections.
- The materials used are plain carbon steel, aluminium alloys, nickel alloy steels etc,

Crank Shaft :

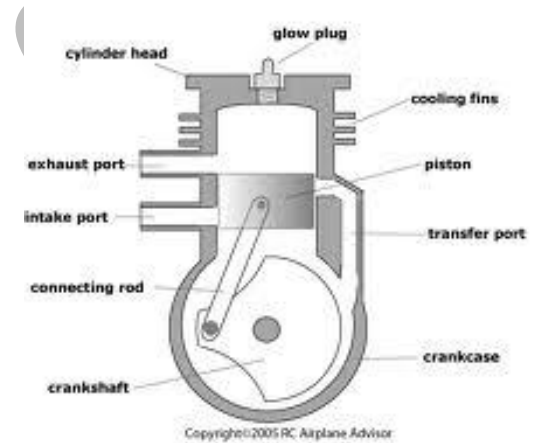
- It is the main rotating shaft of the engine.
- Power is obtained from the crank shaft.
- The crank shaft is combination with connecting rod converts reciprocating motion of the piston into rotary motion.
- The crank shaft is held in position by the main bearings.
- There are two main bearings to support the crank shaft.
- The materials used for crank shaft are billet steel, carbon steel, nickel chrome and other heat treated alloy steels.



2. Explain the construction and working principle of two stroke petrol engine.

Construction :

- A piston reciprocates inside the cylinder
- It is connected to the crankshaft by means of connecting rod and crank
- There are no valves in two stroke engines, instead of valves ports are cut on the cylinder walls.
- There are three ports, namely inlet, exhaust and transfer ports.
- The closing and opening of the ports are obtained by the movement of piston. The crown of piston is made in to a shape to perform this.
- A spark plug is also provided



First Stroke : (Compression, ignition and inductance)

(Upward stroke of piston)

(a) compression:

- The piston moves up from Bottom Dead Centre (BDC) to Top Dead Centre (TDC) Both transfer and exhaust ports are covered by the piston.
- Air fuel mixture which is transferred already into the engine cylinder is compressed by moving piston.
- The pressure and temperature increases at the end of compression.

(b) Ignition and Inductance:

- Piston almost reaches the top dead centre
- The air fuel mixture inside the cylinder is ignited by means of an electric spark produced by a spark plug
- At the same time, the inlet port is uncovered by the plane.
- Fresh air fuel mixture enters the crankcase through the inlet port.

Second Stroke: (Downward Stroke of the engine) :

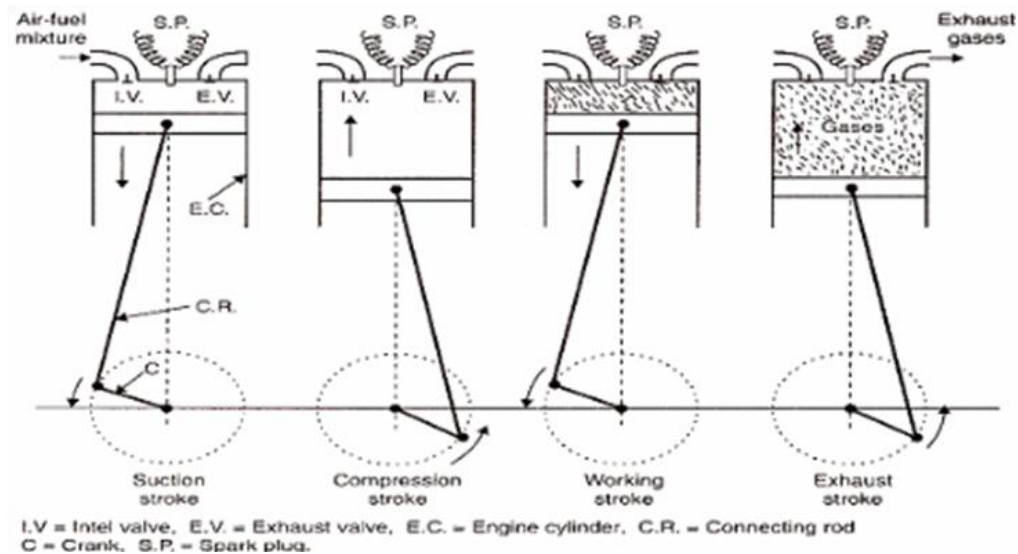
(c)Expansion and Crankcase compression

- The burning gases expand in the cylinder
- The burning gases force the piston to move down. Thus useful work is obtained.
- When the piston moves down, the air fuel mixture in the crankcase is partially compressed.
- This compression is known as *Crank case compression*.

(d)Exhaust and transfer:

- At the end of expansion, exhaust port is uncovered.
- Burnt gases escape to the atmosphere.
- Transfer port is also opened. The partially compressed air fuel mixture enters the cylinder through the transfer port.
- The crown of the piston is made of a deflected shape. So the fresh charge entering the cylinder is deflected upwards in the cylinder.
- Thus the escape of fresh charge along with the exhaust gases is reduced.

3. Explain with a neat sketch the working of four stroke petrol engine.



Suction stroke: During suction stroke, the inlet valve opens and fuel-air mixture is sucked in the engine cylinder. Thus the piston moves from top dead centre (T.D.C.) to bottom dead centre (B.D.C.). The exhaust valve remains closed throughout the stroke.

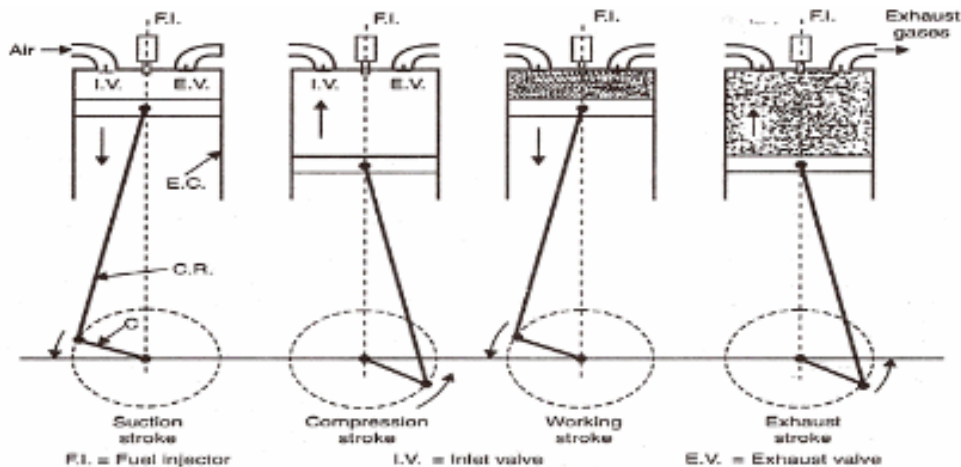
Compression stroke: During this stroke both the inlet and exhaust valves remain closed. The piston moves towards (T.D.C.) and compresses the enclosed fuel-air mixture drawn. At the end

of this stroke the operating plug initiates a spark which ignites the mixture and combustion takes place at constant pressure.

Power stroke or Expansion stroke: In this stroke both the valves remain closed during the start of this stroke but when the piston just reaches the B.D.C. the exhaust valve opens. When the mixture is ignited by the spark plug the hot gases are produced which drive or throw the piston from T.D.C. to B.D.C. and thus the work is obtained in this stroke.

Exhaust stroke: During the exhaust stroke, the gases from which the work has been collected become useless after the completion of the expansion stroke and are made to escape through exhaust valve to the atmosphere. This removal of gas is accomplished during this stroke. The piston moves from B.D.C. to T.D.C. and the exhaust gases are driven out of the engine cylinder.

4. Explain with a neat sketch, the four stroke diesel engine.



Suction stroke: During the suction stroke, the piston moves from TDC to BDC., the inlet valve opens and the air at atmospheric pressure is drawn inside the engine cylinder. The exhaust valve remains closed during this stroke..

Compression stroke: The air drawn at atmospheric pressure during the suction stroke is compressed to high pressure and temperature as the piston moves from B.D.C. to T.D.C. Both the inlet and exhaust valves do not open during any part of this stroke.

Power stroke or Expansion stroke: As the piston starts moving from T.D.C to B.D.C, the quantity of fuel is injected into the hot compressed air in fine sprays by the fuel injector and it (fuel) starts burning at constant pressure.

The fuel is injected at the end of compression stroke but in actual practice the ignition of the fuel starts before the end of the compression stroke. The hot gases of the cylinder expand thus doing the work on the piston.

Exhaust stroke: The piston moves from the B.D.C. to T.D.C. and the exhaust gases escape to the atmosphere through the exhaust valve. When the piston reaches the T.D.C. the exhaust valve closes and the cycle is completed.

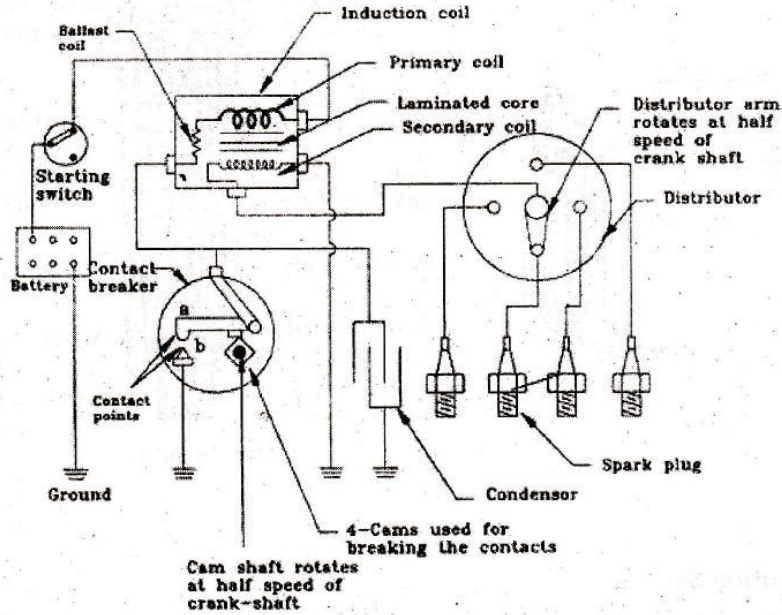
5. Differentiate between Spark Ignition (SI) and Compression Ignition (CI) Engines.

S. No	Spark Ignition Engine	Compression Ignition Engines
1.	Air-fuel mixture enters into combustion chamber during suction stroke.	Air at atmospheric enters into combustion chamber during suction stroke.
2.	Air fuel mixture is ignited by a spark plug.	Fuel is sprayed by the injector on hot compressed air.
3.	Carburetor is used for atomizing and vaporizing the fuel.	Injector is used for atomizing the fuel.
4.	Efficiency is less.	Efficiency is better.
5.	Starting the engine is easy.	Comparatively more effort is needed to start the engine.
6.	Initial cost and maintenance cost is low.	Initial cost and maintenance cost are higher when compared to SI engine.
7.	Higher fuel cost.	Fuel cost is less.
8.	Compression ration ranges from 5 to 11.	Compression ratio ranges from 11 to 22.

6. Differentiate between two stroke and four stroke engines.

S.No.	Four stroke engine	Two stroke engine
1.	Thermal efficiency is high.	Thermal efficiency is low.
2.	The cycle is completed in two revolutions of crank shaft.	The cycle is completed in one revolution of the crank shaft.
3.	One power stroke is obtained in two revolutions of crank shaft.	One power stroke is obtained in every revolution of crank shaft.
4.	Heavier fly wheel is needed.	Lighter fly when is sufficient.
5.	It contains valves and valve mechanism.	It contains ports, which is covered and uncovered by piston itself.
6.	Engine is heavy for the same power developed.	Engine is light and compact for the same power developed.
7.	Less cooling and lubrication are required.	Higher cooling and lubrication are required.
8.	Engine is complicated.	Simple in construction.

8. With a neat circuit, briefly explain about the working principle of a Battery ignition system.



The ignition system is based on the principle of mutual electromagnetic induction. The figure shows a battery ignition for a four cylinder engine. The ignition system supplies high surges of current (as high as 30000 volts) to the spark plug. This surge in current produces the electric spark.

Construction

It consists of a battery, ignition coil, condenser, contact breaker, distributor and spark plug.

Battery: The battery provides a voltage of 6 to 12volts.

Ignition coil (Induction coil)

It has two windings namely, primary winding and secondary winding. It is a transformer to step up the voltage in the ignition system.

The primary winding consists of thick wire with less number of turns. The secondary winding consists of more number of turns of thin wire. The purpose of the ignition coil is to set up the battery voltage (6 or 12 volts) to 20000 to 30000 volts required to produce spark for ignition in the spark plug.

Condenser: It is connected across the contact breaker. It serves two purposes 1) prevents excess sparking at contact breaker points 2) It induces a high voltage in the secondary circuit by causing a more rapid contact break of the primary circuit.

Contact breaker: It makes and breaks the contact in primary ignition circuit.

Distributor: It distributes the high voltage to the respective spark plugs at regular intervals in the sequence of firing order of the engine.

Spark plugs: The spark plug is fitted on the combustion chamber of the engine. It produces spark to ignite the fuel-air mixture. Each cylinder has an individual spark plug..

Working

The rotor of the distributor and contact breaker cam are driven by the engine, there are two circuits in this system.

(a) Primary circuit – It consists of battery, primary coil of the ignition coil, condenser and contact breaker.

(b) Secondary circuit – It consists of secondary coil, distributor and spark plug.

The ignition switch is switched on and the engine crankshaft is turned (cranking is done by a starting motor), the cranking opens and closes the contact breaker points through a cam.

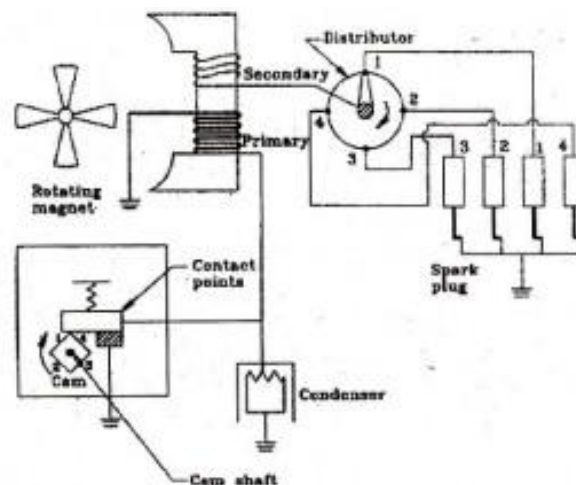
When the contact breaker points are closed

- The current flows from the battery to the contact breaker points through the switch and primary winding and then returns to earth through the battery.
- The current builds up a magnetic field in the primary winding of the ignition coil.
- When the primary current is at the maximum, the contact breaker points are opened by the cam.

When the contact breaker points are opened

- The magnetic field set up in the primary winding is suddenly collapsed.
- A high voltage (20,000 volts) is generated in the secondary winding of the ignition coil.
- This high voltage is directed to the rotor of the distributor.
- The rotor directs the high voltage to the individual spark plugs in the sequence of the firing order of the engine.
- This high voltage tries to cross or jump the spark plug gap (0.45 to 0.6 mm) and the spark is produced. This spark ignites the air-fuel mixture.

9. With a neat circuit, explain the working principle of magneto ignition system.



The magneto ignition system consists of a switch, a magneto, contact breaker, condenser, distributor and spark plugs.

Construction

Magneto: It consists of a rotating magnet assembly and a fixed armature.

Armature: It contains the primary windings and secondary windings. The magnet is located on the outer rim of the flywheel.

Ignition coil (induction coil): It is nothing but a transformer with a primary winding circuit and a secondary winding circuit, in order to step up; the voltage in the ignition system. The primary circuit consists of primary winding, condenser and contact breaker points. The secondary circuit consists of secondary coil, distributor and spark plug-

Working

The ignition switch is switched on and the engine is cranked (crank shaft is turned manually by kicking like in motor cycles or turned with a starting motor as in bigger engines). The engine rotates the magnetic assembly and also opens and closes the contact breaker points.

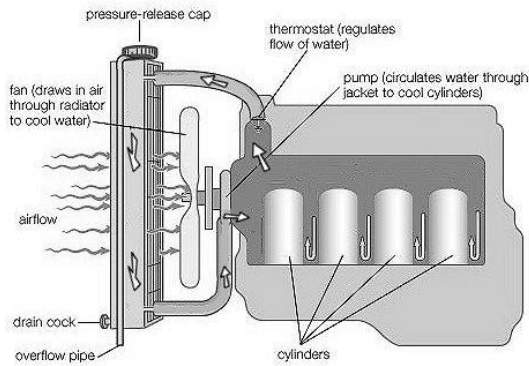
When the contact breaker points are closed

- The current flows in the primary circuit.
- It produces a magnetic field in the primary circuit.
- When the primary current is at the highest peak the contact breaker points are opened by the cam

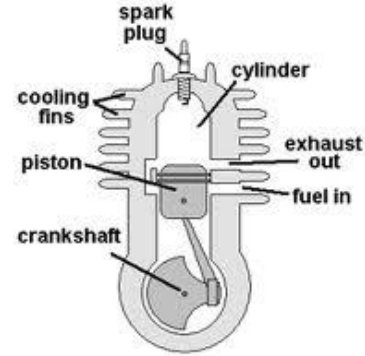
When the contact breaker points are opened

- There is a break in the primary circuit.
- The magnetic field in the primary winding is suddenly collapsed.
- A high voltage (*20,000 volts*) is generated in the secondary winding.
- This high voltage is distributed to the respective spark plugs through the rotor of the distributor.
- The high voltage tries to cross the spark plug gap and a spark is produced in the gap. This spark ignites fuel-air mixture in the engine.

10. Explain with neat sketches the air cooling and water cooling system in IC engines.



Water cooled system



Air cooled system

Water cooling system : This system is generally used in cars, trucks and buses. There are water jackets between the double walls of the cylinder and cylinder heads. Water is circulated through the jackets by a pump driven by crank shaft. When the circulating water becomes hot, it is cooled in the radiator. Water circulated in the radiator should be free from salt and other foreign matters, as it may cause deposits. Anticorrosion elements also shall be added with water. In cold places, antifreeze solution will be added with water. A fan behind the radiator, sucks the atmospheric air which passes through the fins of the radiator, also passes over the tubes. Hence the water inside the tubes gets cooled and it is being recirculated to the water jackets.

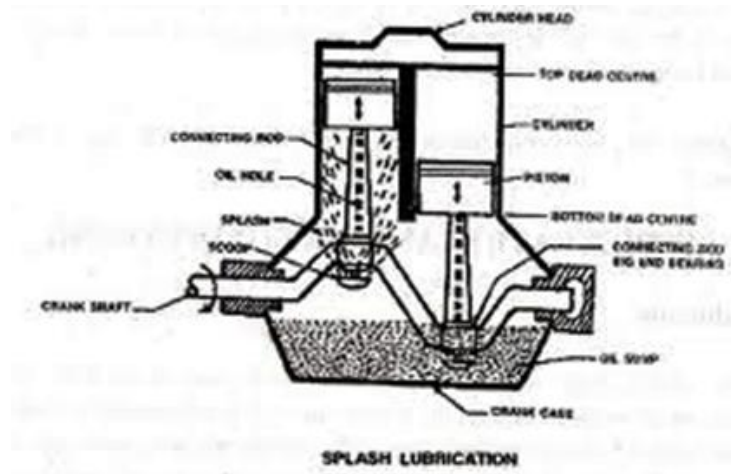
Air cooling system: This system is generally used in motor cycles, scooters and small engines. Cooling fins are provided to the cylinder. When the vehicle is moving forward, the atmospheric air passes through the gaps of the fins and the heat produced by the cylinder is transferred to the atmospheric air. The amount of heat dissipated depends on the area of cooling fins, the amount of air circulated, the velocity of air and the temperature with the surroundings.

11. What are the various types of lubrication? With a neat sketch, briefly explain about splash lubrication system.

The different types of lubrication system are,

- (a) Splash lubrication system
- (b) Pressure lubrication
- (c) Petroil method.

(a) Splash Lubrication system



Construction:

It consists of a flexible spool attached with the bottom part of the crank shaft. The oil is stored in the oil sump and it is properly sealed by the crank case and the screws.

Working :

Lubricating oil is stored in the oil sump. A spool is attached with the bottom of the crank shaft which throws (splashes) the oil to the bottom part of the combustion chamber, due to the fast movement of crank shaft. The oil lubricates the connecting rod and the walls of the combustion chamber. The oil is wiped by the oil rings and brought down to the oil sump.
