JECRC Foundation

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTER

Year & Sem. – I Year & I SEM
Subject –Basic Mechanical Engineering (1FY3-07)
Unit– 2
Presented by – Jitendra Kumar Gupta (Assistant Professor)

VISION AND MISSION OF INSTITUTE

VISION OF INSTITUTE

To became a renowned centre of outcome based learning and work towards academic professional ,cultur al and social enrichment of the lives of individuals and communities .

MISSION OF INSTITUTE

Focus on evaluation of learning ,outcomes and motivate students to research aptitude by project based learning.

•Identify based on informed perception of Indian ,regional and global needs ,the area of focus and prov ide platform to gain knowledge and solutions.

•

•Offer opportunities for interaction between academic and industry .

•Develop human potential to its fullest extent so that intellectually capable and imaginatively gifted lea ders may emerge.

VISION AND MISSION OF DEPARTMENT

Vision

The Mechanical Engineering Department strives to be recognized globally for excellent technical kno wledge and to produce quality human resource, who can manage the advance technologies and contrib ute to society through entrepreneurship and leadership.

Mission

1) To impart highest quality technical knowledge to the learners to make them globally competitive mechanical engineers.

2) To provide the learners ethical guidelines along with excellent academic environment for a long pro ductive career.

3)To promote industry-institute linkage.

Course Outcomes of BME

- To describe the importance of mechanical engineering in any industry and to apply the various concepts in thermal based industry.
- To understand the various machines and power transmission related to it and also the effect of parameters on a job.
- To relate the industrial issues with the environment and to consider key concepts in in engineering materials.
- To come across new practices and researches going in mechanical engineering line CAD, CAM etc.

Contents of UNIT-2

- Introduction of IC Engines.
- Classification of IC Engines.
- Main Components of IC Engines.
- Working of IC Engines and its components.

Introduction

- In 1876 four stroke engine based on Otto cycle was developed by a German engineer Nikolous Otto. Diesel Engine was developed by another German engineer Rudolf Diesel in the year 1892.
- Engine refers as “Heat engine is a device which converts chemical energy of fuel into Heat energy and this Heat energy further convert into mechanical work”.
- Based on where the combustion of fuel take place. Whether outside the working cylinder or inside the working cylinder
- (a) External combustion engines (E.C.ENGINES),
  (b) Internal combustion engines (I.C.ENGINES)

Classification of Heat Engines

- **Internal Combustion Engines (IC Engines)**
- In IC engines, combustion of fuel takes place inside the engine cylinder.
- Examples: Diesel Engines, Petrol Engines, Gas engines.
- **External Combustion Engines (EC Engines)**
- In EC engines, combustion of fuel takes place outside the working cylinder.
- Examples: Steam Engines and Steam turbines

I. C. ENGINES	E. C. ENGINES
Fuel combustion take place inside the cylinder.	Fuel combustion take place outside the cylinder.
Compact in size and more efficient.	Larger in size and less efficient.
Low initial cost.	More initial cost.
Working fluid is mixture of air and fuel.	Working fluid is steam.
Easier and quick starting of these engines.	Starting is difficult and more time is required.
Costly fuels are required like petrol and diesel.	Cheaper fuel may be used like coal.
More suitable for mobile applications.	Less suitable for mobile applications.

Classification of IC Engines

IC Engines are classified into:-

(1) Cycle of operation (No of Strokes per cycle)

- Two Stroke cycle Engines
- Four Stroke Cycle Engines

(2) **Thermodynamic Cycle or Method of Heat addition:**

- Otto Cycle Engines (Combustion at constant volume)
- Diesel Cycle Engines (Combustion at constant Pressure)
- Semi Diesel Engines (Dual Combustion Engines)

(3) Types of Fuel Used : -

- Petrol Engines
- Diesel Engines
- Gas Engines

(4) Ignition Method :-

- Spark Ignition (SI)
- Compression Ignition (CI)

(5) Cooling System:-

- Air cooled Engines
- Water Cooled Engines

(6) Valves Location :

- **L head (Side valve) engine**
- **T Head (Side valve) engine**
- **I head (over head valve) engine**
- **F head (over head inlet and side exhaust) engine**

I.C ENGINE TERMINOLGOGY

- **The standard terms used in I.C Engines are**

1.Bore: Inside diameter of the cylinder is termed as Bore.

2.Top Dead Center (TDC): The extreme position reached by the piston at the top of the cylinder in the vertical engine is called Top Dead center.

3.Bottom Dead Center (BDC): The extreme position reached by the piston at the Bottom of the cylinder in the vertical engine is called Bottom Dead center.

4. Stroke: The nominal distance travelled by the piston in the cylinder between the extreme upper and lower positions of the piston (TDC &BDC) is termed as stroke.

4.

5. **Compression ratio (r): It is the ratio of Maximum cylinder volume to the Clearance volume.**
6. **Cylinder volume (v): It is the sum of swept volume and the Clearance volume.**
   - **V = Vs + Vc**
7. **Swept volume (Vs): It is the volume of space generated by the movement of piston from one dead center to another dead center.**
8. **Clearance Volume(Vc): It is the space in the cylinder, when the piston is at Top Dead Center**

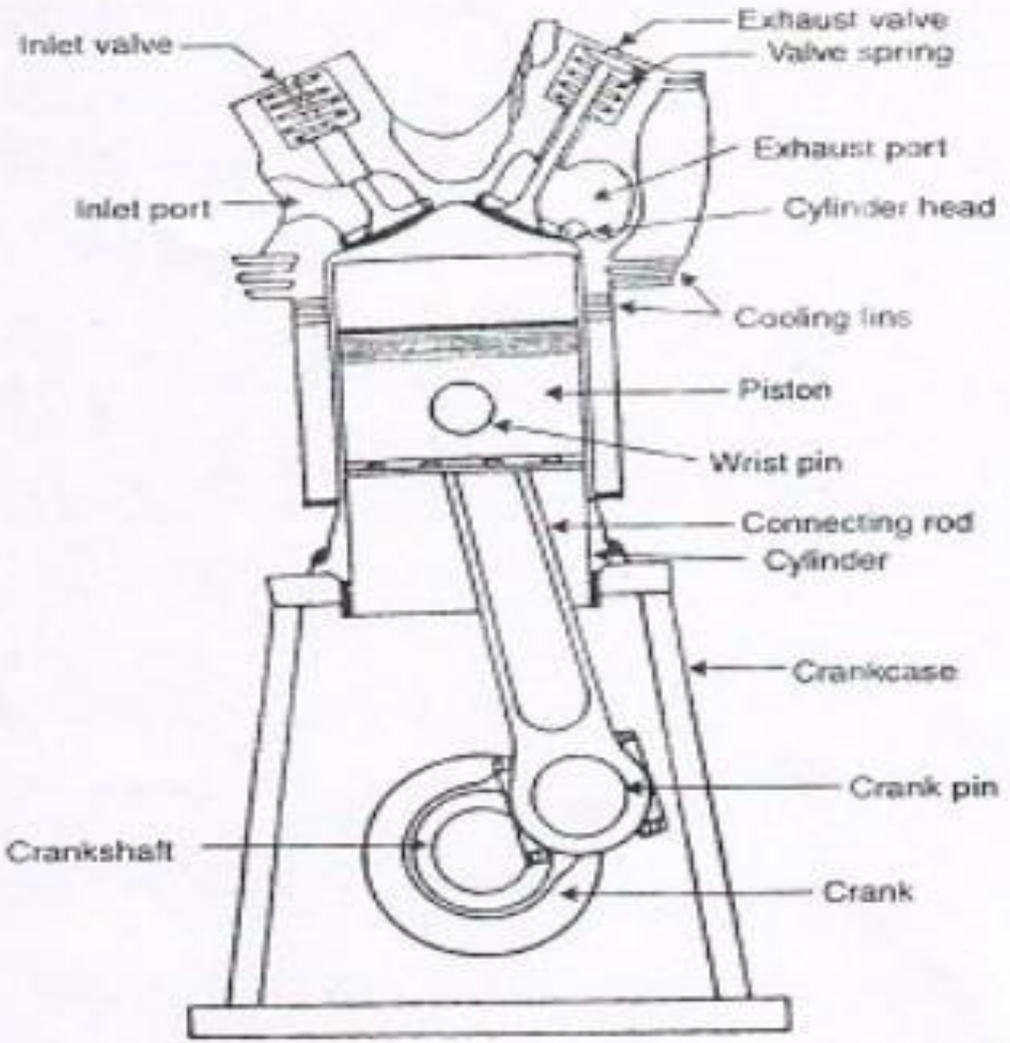


Fig. Air-cooled I.C. engine

Main Components of IC Engines

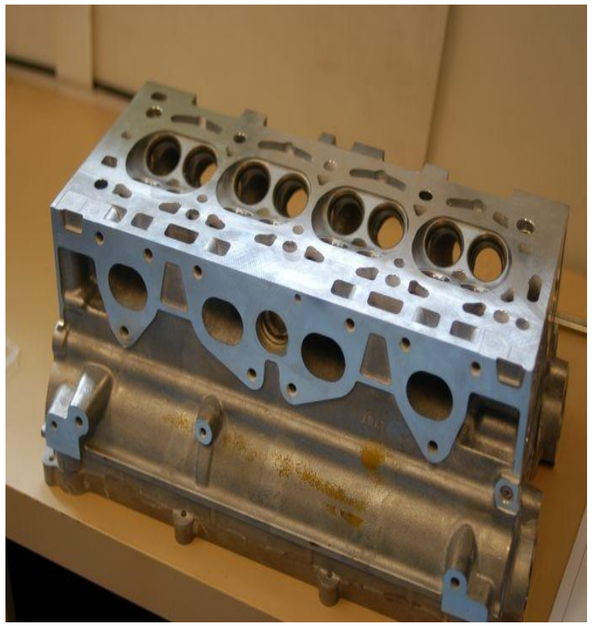
- **Cylinder Block:**
- It is the main block of the engine.
- It contains cylinders accurately finished to accommodate pistons
- The cylinder block houses crank, camshaft, piston and other engine parts.
- In water cooled engines, the cylinder block is provided with water jackets for the circulating cooling water.
- The materials used for cylinder are grey cast iron, aluminium alloys etc.,
- It is usually made of a single casting

Cylinder block of motor cycle

Cylinder block of Car

- **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.
- **Liners are classified into**
- (a) Wet liner (b) Dry liner

- **Cylinder Liners**
- **Wet Liner :** These liners are surrounded or wetted by cooling water.
- It provides wear resisting
- surface for the piston to reciprocate. Also it acts as a seal for the water jacket.

- **Dry Liner :**Dry liners have metal to metal contact with the cylinder block. They are not directly in touch with the cooling water.
- **Liner Materials:**

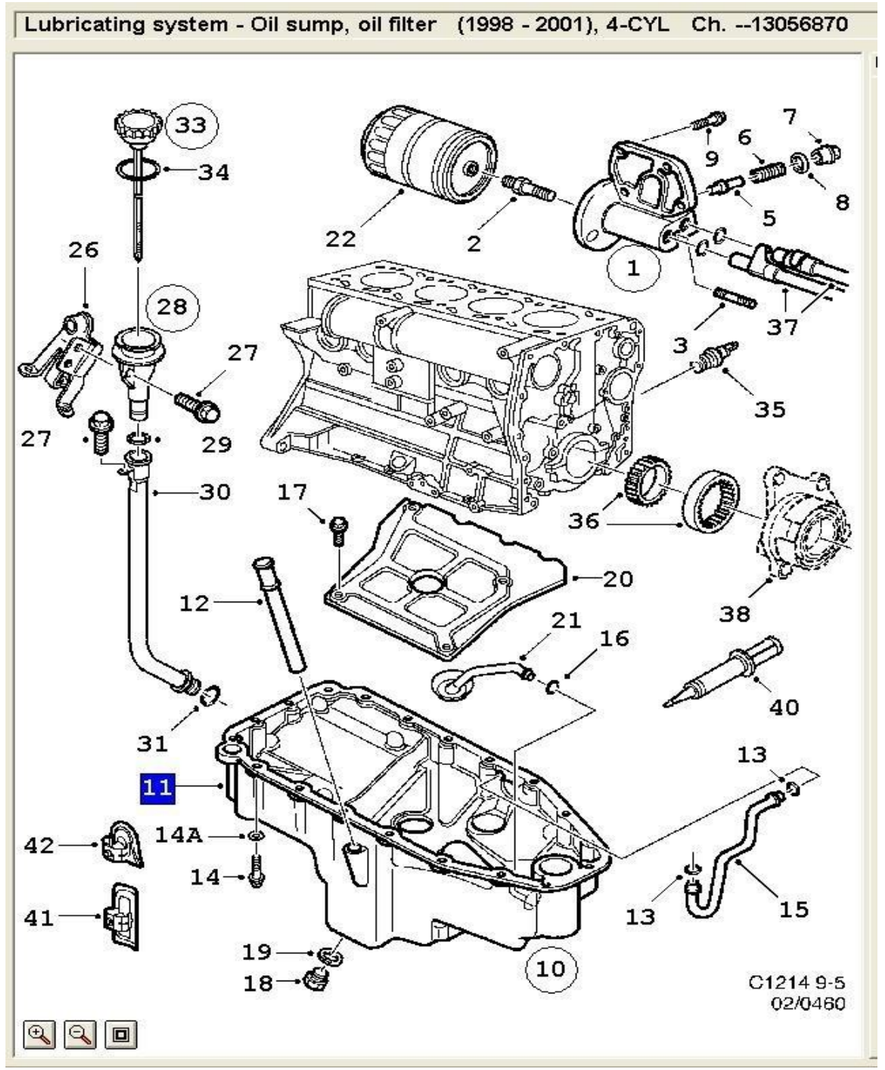
•Liner material should withstand abrasive wear and corrosive.

•Chromium plated mild steel tubes are used as liners.

- **Crankcase :**

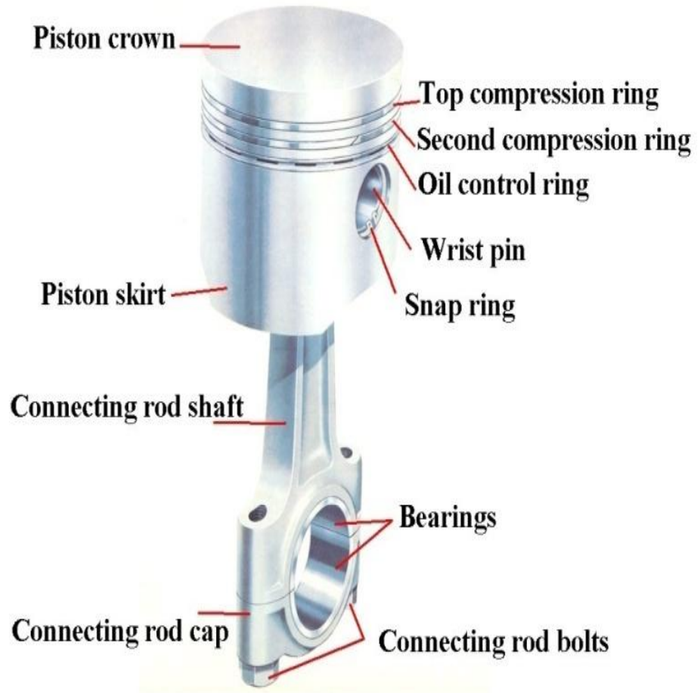
- It may be cast integral with the cylinder block.
- Some times, it is cast separately and then attached to the block.
- *These materials are used for crank case are cast iron, aluminium alloys or alloy steels.*

- **Oil pan or oil sump:** Oil sump is the bottom part of the engine.
- It contains lubricating oil.
- A drain plug is provided the oil sump to drain out the oil.
- *It is made of the pressed sheet.*



- **Piston :**

- *The piston serves the following purposes*
- 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.

1. Compression rings
2. 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 :

- The materials used for piston rings should be wear resistant.
- Normally piston rings are made of alloy steel iron containing silicon, manganese alloy steels etc.,

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.

Camshaft:

- Camshaft contains number of cams.
- It is used to convert rotary motion into linear or straight line motion.
- It has so many cams as the number of valves in an engine. An additional cam is also provided to drive the fuel pump.
- A gear is provided in the cam shaft to drive the distributor or oil pump.
- The opening and closing of the engine valves are controlled by the cams provided on the cam shaft.

Petrol Engines

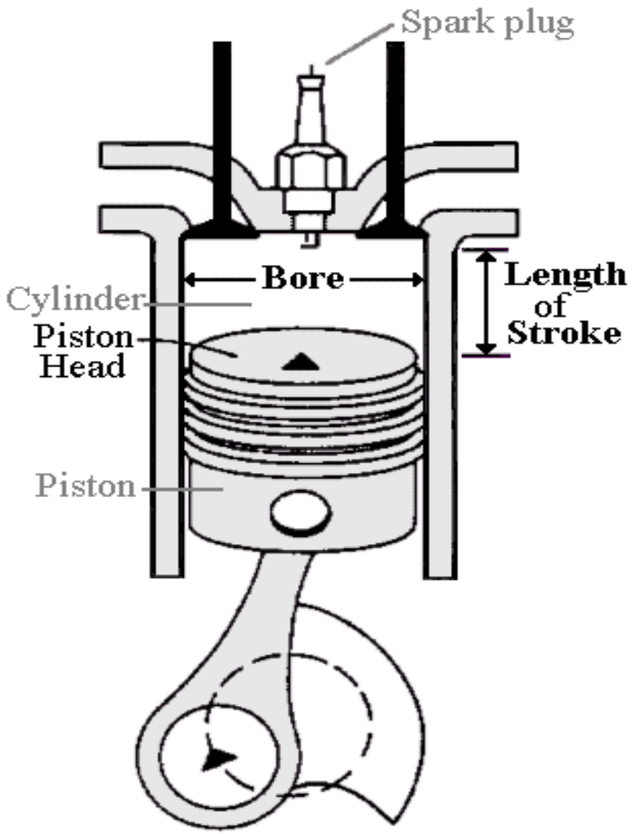
- **Classification of Petrol Engines**

- **Two Stroke cycle Petrol Engines**

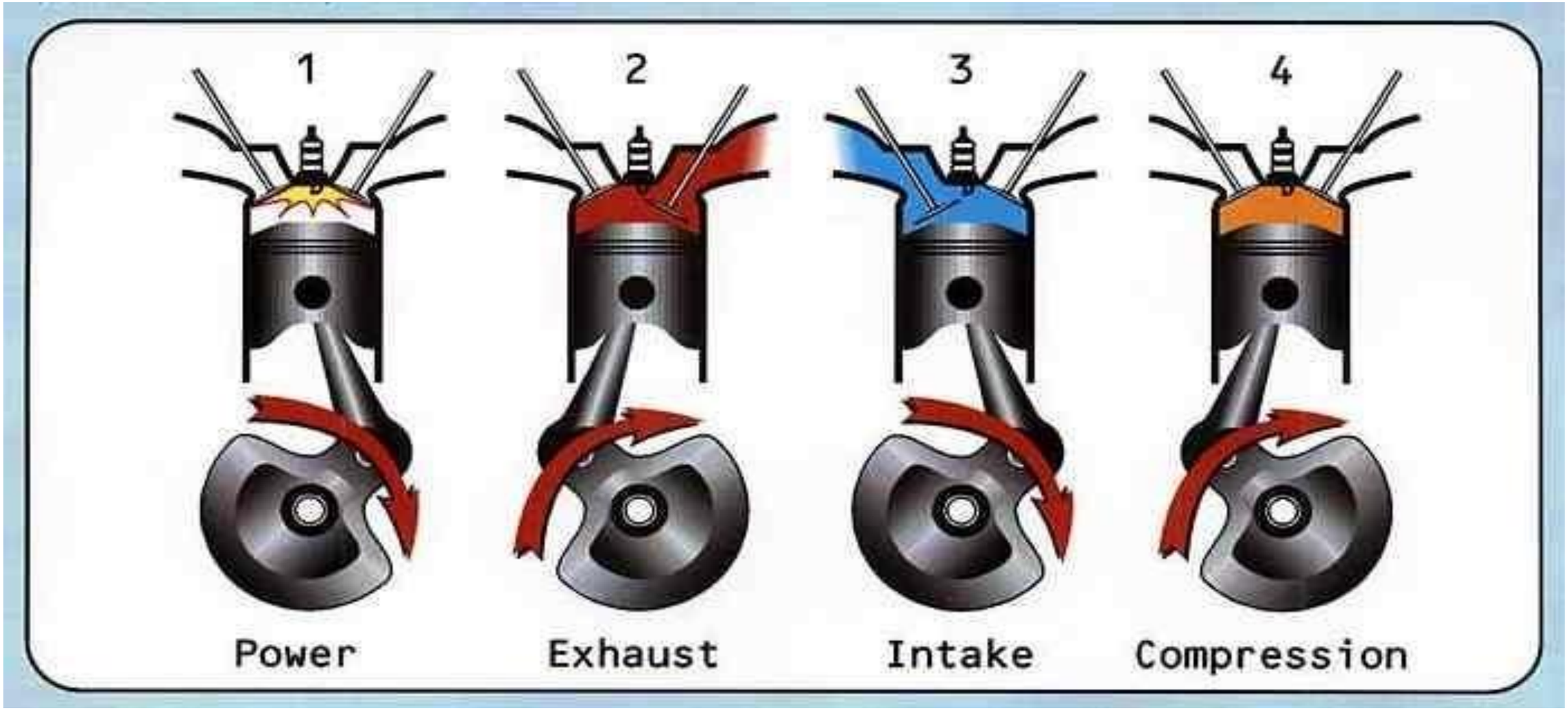
- **Four Stroke cycle petrol Engines**

Four stroke cycle Petrol Engines :-

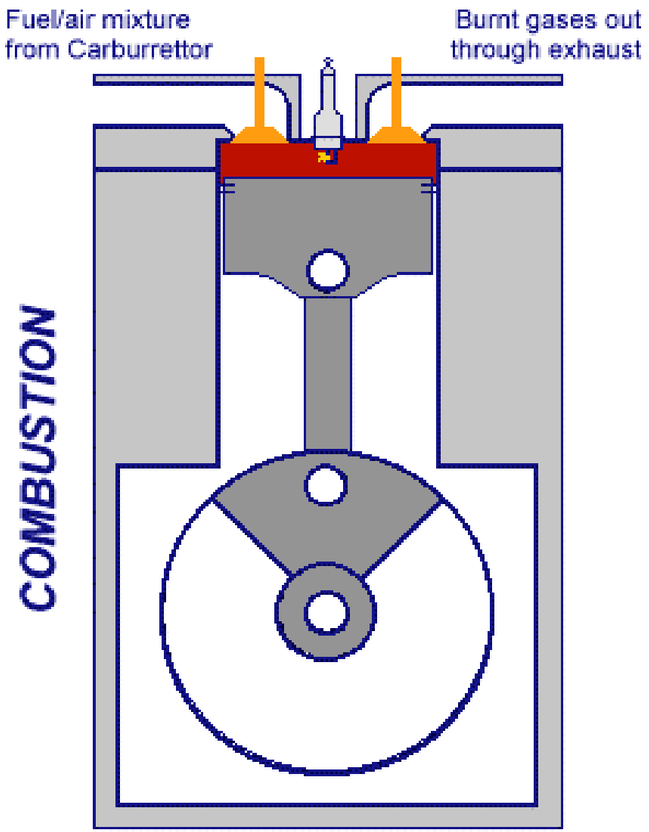
- Construction :
- A piston reciprocates inside the cylinder
- The piston is connected to the crank shaft by means of a connecting rod and crank.
- The inlet and exhaust valves are Mounted on the cylinder head.
- A spark is provided on the cylinder Head.
- The fuel used is petrol



Four Stroke Petrol Engine- Working :-

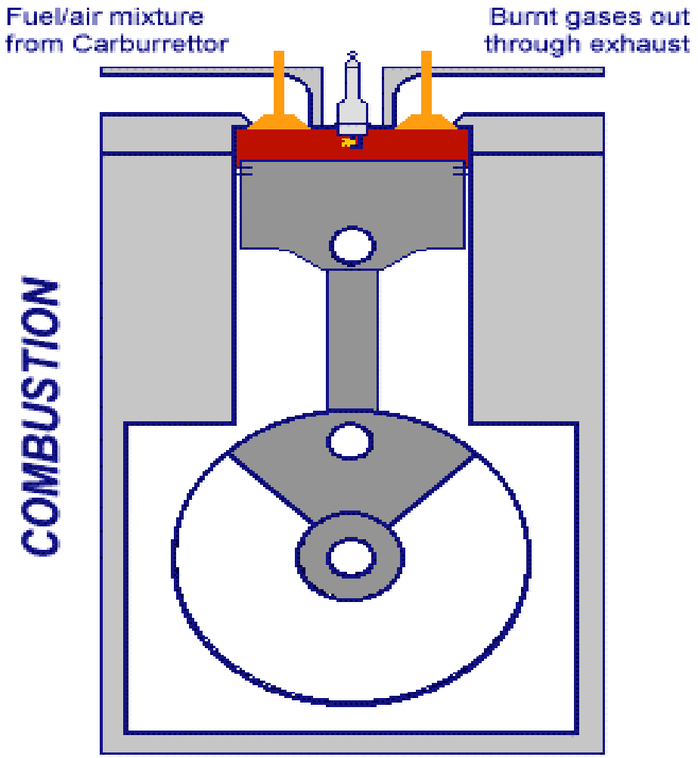


- **(a) Suction Stroke (First Stroke of the Engine)**
- Piston moves down from TDC to BDC
- Inlet valve is opened and the exhaust valve is closed.
- Pressure inside the cylinder is reduced below the atmospheric pressure.
- The mixture of air fuel is sucked into the cylinder through the inlet valve



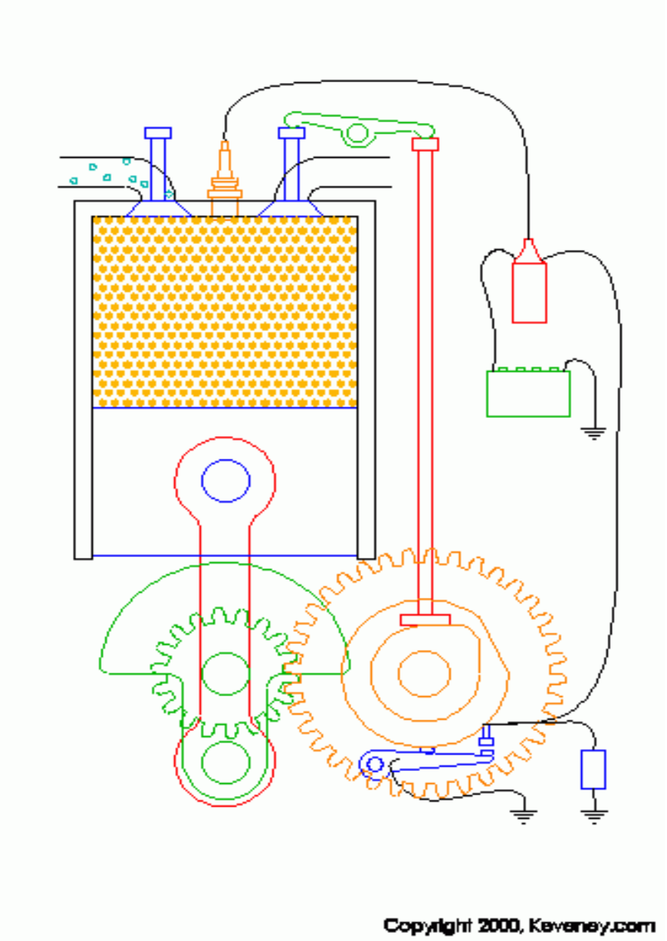
(b) Compression Stroke : (Second Stroke of the piston)

- Piston moves up from BDC to TDC
- Both inlet and exhaust valves are Closed.
- The air fuel mixture in the cylinder is compressed.



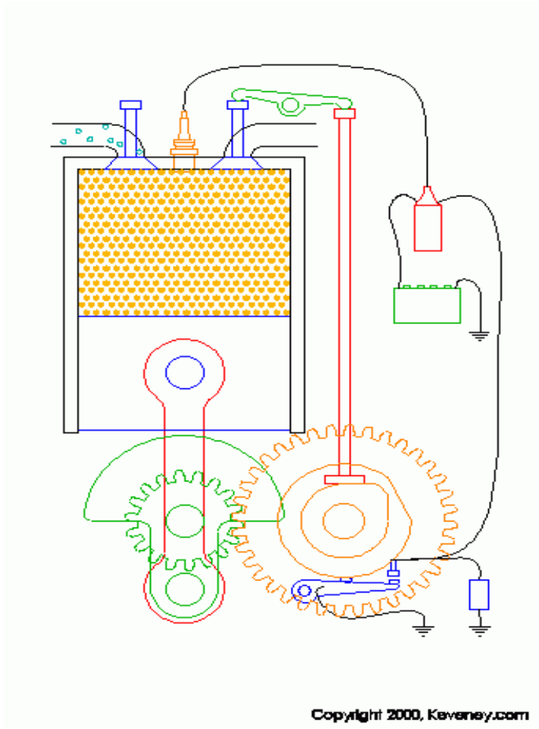
(c) Working or Power or Expansion Stroke: (Third Stroke of the Engine)

- The burning gases expand rapidly. They exert an impulse (thrust or force) on the piston. The piston is pushed from TDC to BDC
- This movement of the piston is converted into rotary motion of the crankshaft through connecting rod.
- Both inlet and exhaust valves are closed.

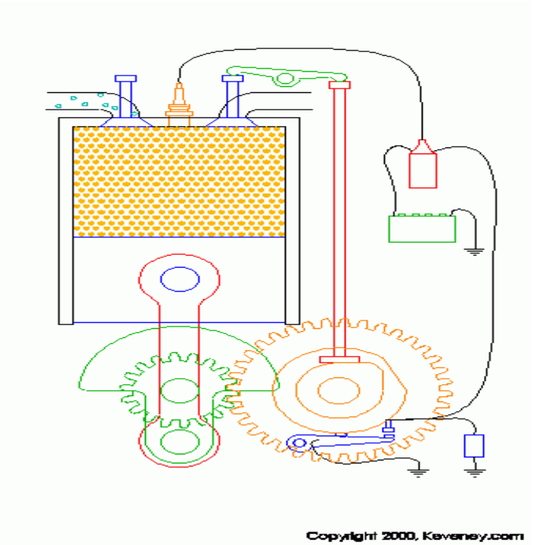


(d) Exhaust Stroke (Fourth stroke of the piston)

- Piston moves upward from BDC
- Exhaust valve is opened and the inlet valve is closed.
- The burnt gases are forced out to the atmosphere through the exhaust valve (Some of the burnt gases stay in the clearance volume of the cylinder)
- The exhaust valve closes shortly after TDC.
- The inlet valve opens slightly before TDC and the cylinder is ready to receive fresh charge to start a new cycle.

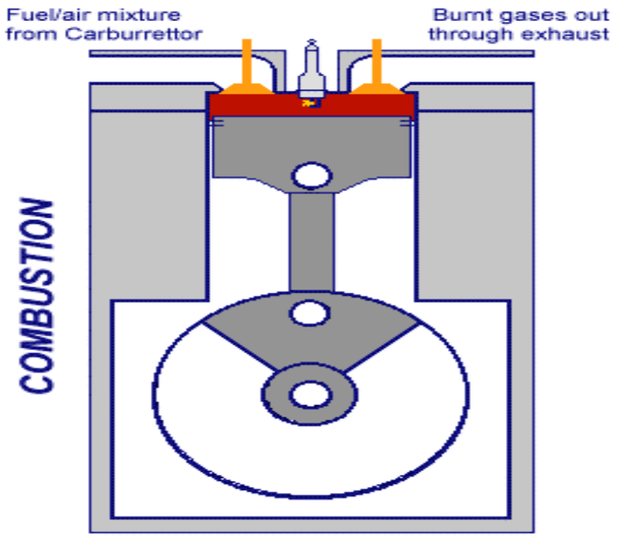


Four Stroke Petrol Engine – Working :-

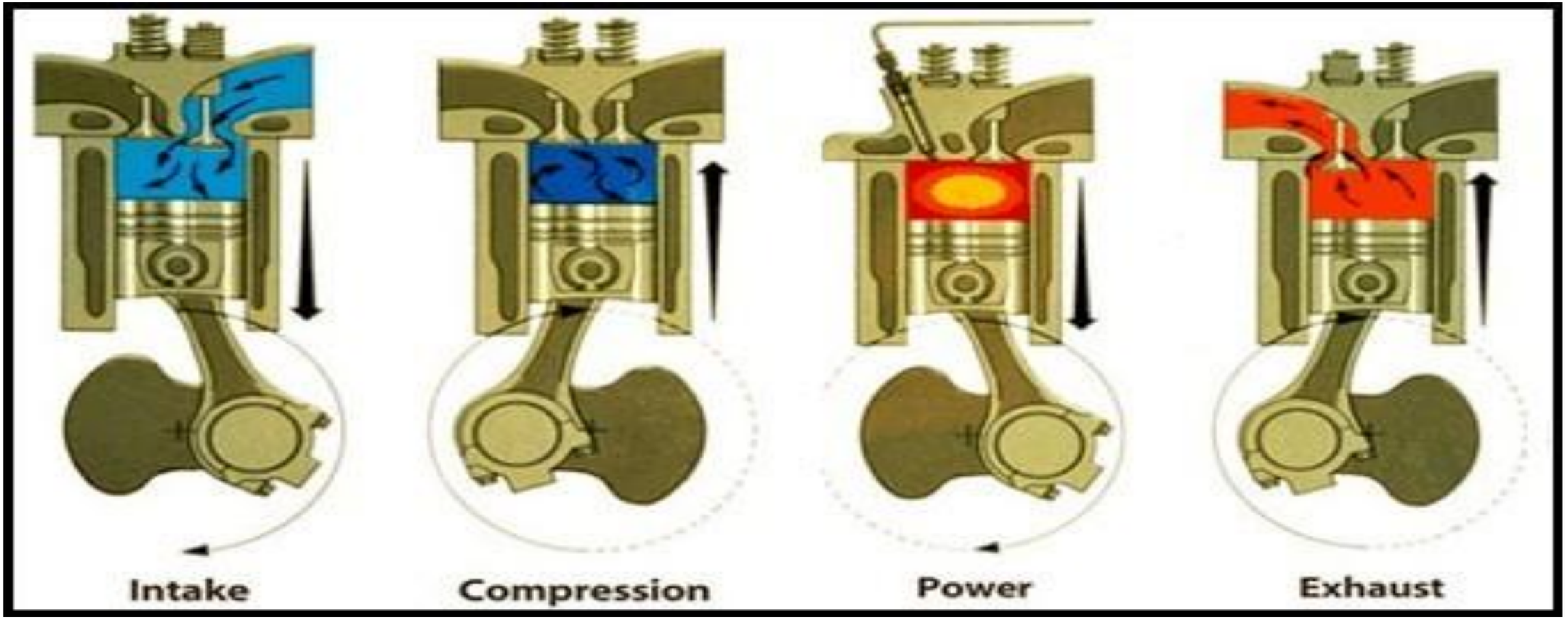


Summary :

- Compression ratio varies from 5 to 8
- The pressure at the end of compression is about 6 to 12 bar.
- The temperature at the end of the compression reaches 250^{o} C to 350^{o} C



Four Stroke Diesel Engine :-



Four Stroke Diesel Engine :-

- **Construction:**

•A piston reciprocates inside the cylinder

- The piston is connected to the crankshaft by means of a connecting rod and crank.
- The inlet and exhaust valves are mounted on the cylinder head.
- A fuel injector is provided on the cylinder head
- The fuel used is diesel.

Four Stroke Diesel Engine Working:-

- **(a) Suction Stroke (First Stroke of the piston)**

- Piston moves from TDC to BDC
- Inlet valve is opened and the exhaust valve is closed.
- The pressure inside the cylinder is reduced below the atmospheric pressure.
- Fresh air from the atmosphere is sucked into the engine cylinder through air cleaner and inlet valve.

Four Stroke Diesel Engine Working:-

- **(b) Compression stroke (Second stroke of the piston)**

- Piston moves from BDC to TDC
- Both inlet and exhaust valves are closed.
- The air is drawn during suction stroke is compressed to a high pressure and temperature

Four Stroke Diesel Engine Working:-

- **(c) Working or power or expansion stroke (Third stroke of the piston)**

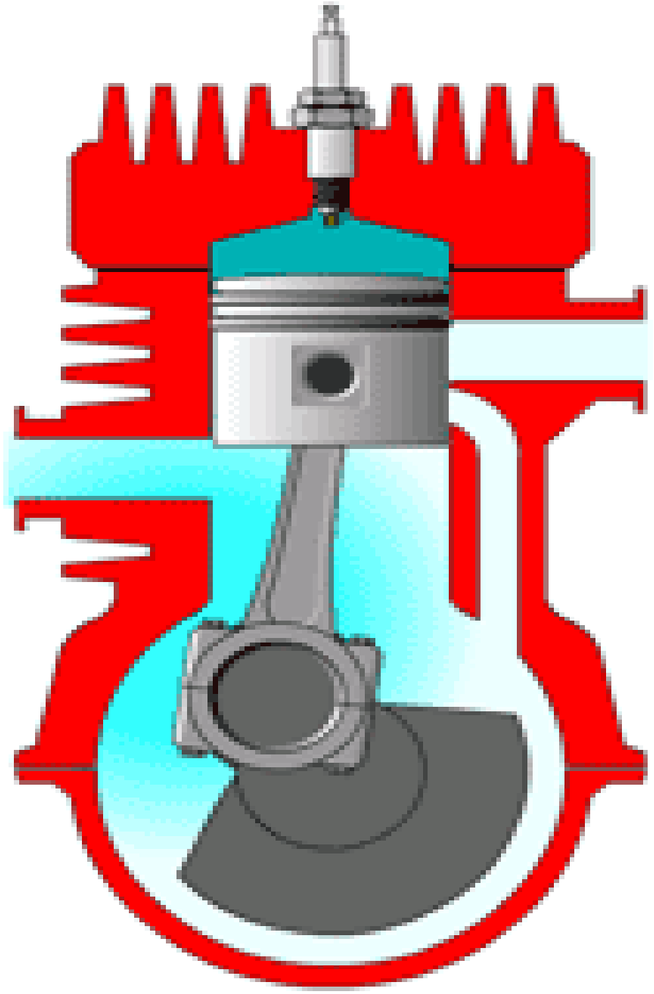
- The burning gases (products of combustion) expand rapidly.
- The burning gases push the piston move downward from TDC to BDC
- This movement of piston is converted into rotary motion of the crank shaft through connecting rod.
- Both inlet and exhaust valves are closed.

Four Stroke Diesel Engine Working:-

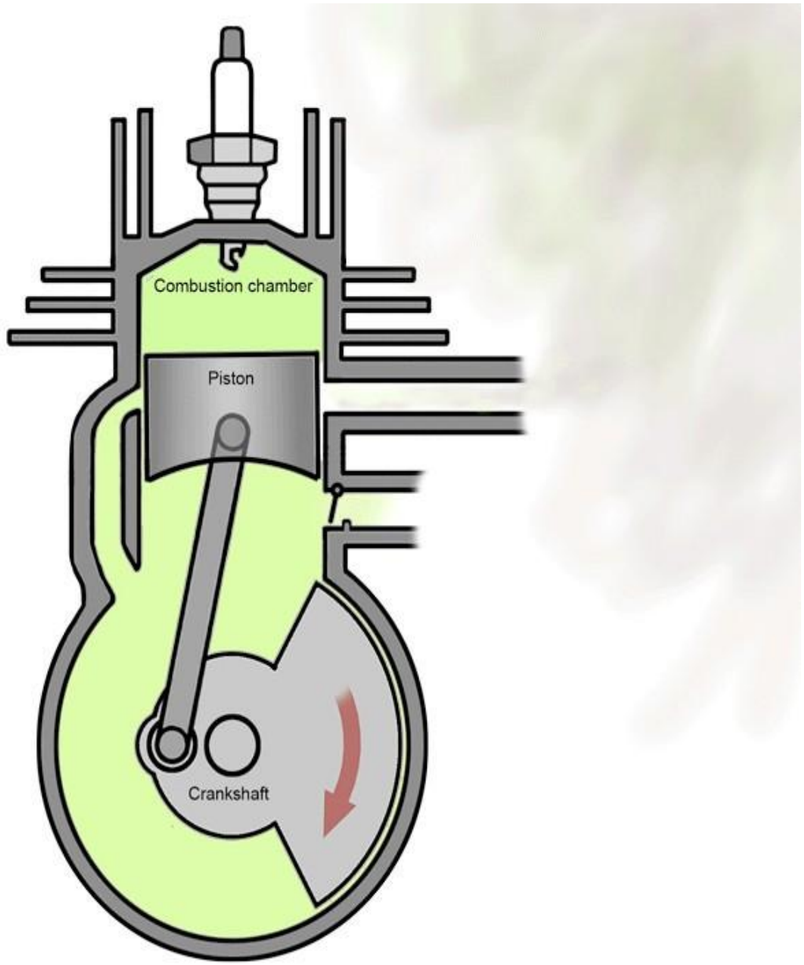
- **(d) Exhaust Stroke (Fourth stroke of the piston)**

- Piston moves from BDC to TDC
- Exhaust valve is opened the inlet valve is closed.
- The burnt gases are forced out to the atmosphere through the exhaust valve. (some of the burnt gases stay in the clearance volume of the cylinder)
- The exhaust valve closes shortly after TDC
- The inlet valve opens slightly before TDC and the cylinder is ready to receive fresh air to start a new cycle.

Two Stroke cycle Petrol Engines :-



Two Stroke cycle Petrol Engines working :-



Two Stroke Cycle Petrol Engine - Construction :-

- **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.

Two stroke cycle Petrol Engines – Working :-

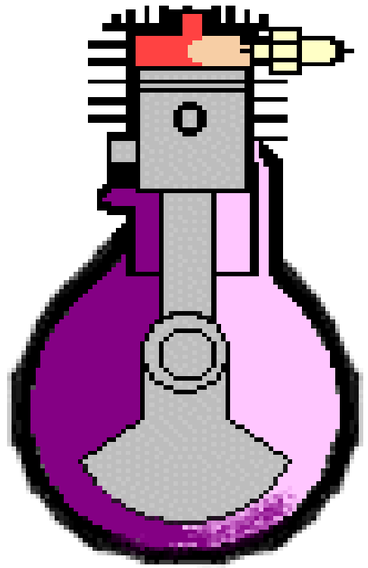
- **First Stroke : (Compression, ignition and inductance) (Upward stroke of piston)**

(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.

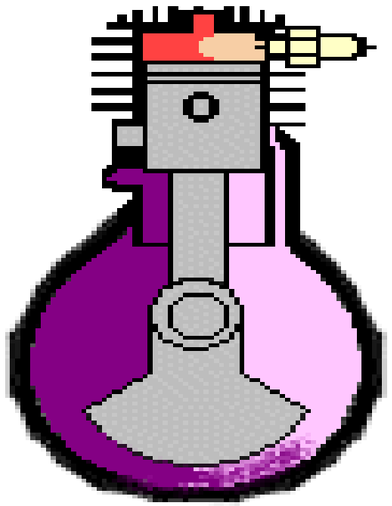


Two stroke cycle Petrol Engines – Working :-

- **First Stroke : (Compression, ignition and inductance) (Upward stroke of piston)**

(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 pois rt uncovered by the plane.
- Fresh air fuel mixture enters the crankcase through the inlet port.



Two stroke cycle Petrol Engines – Working :-

- **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.***

Two stroke cycle Petrol Engines – Working :-

- **Second Stroke: (Downward Stroke of the engine) :**

(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.

Two stroke cycle Diesel Engines- Construction :-

- **Construction :**
- Two stroke cycle diesel engines require air supply
- This air is used to blow out the exhaust gases and to fill the cylinder with clean air
- This air is supplied by a blower or air compressor which is driven by engine itself.
- These engines may be valve or port type.
- A plate is provided in the crank case to admit air into the crank case.
- Transfer and exhaust ports are provided in the cylinder.
- These ports are covered and uncovered by the moving piston.

Two stroke cycle Diesel Engines- Working

- **First Stroke (Upward Stroke of the piston)**
- **(a) Compression and inductance:**

- The piston moves upwards from Bottom Dead Centre (BDC) to Top Dead Centre (TDC).
- Both transfer and exhaust ports are covered.
- Air which is transferred already into the engine cylinder is compressed by moving piston.
- The pressure and temperature of the air increases.
- At the same time, fresh air is admitted into the crankcase through the plate valve (reed valve)

Two stroke cycle Diesel Engines- Working

- **First Stroke (Upward Stroke of the piston)**
  (b) Ignition and inductance.

- Piston almost reaches the top dead centre.
- The fuel is injected into the hot compressed air inside the cylinder. The fuel mixed with hot air and burns.
- The admission of fresh air into the crankcase continues till the piston reaches the top centre.

Two stroke cycle Diesel Engines- Working

- **Second Stroke (Downward Stroke of the piston)**

(c) Expansion and crank case compression:

- The burning gases expand in the cylinder.
- Burning gases force the piston to move down. Thus useful work is obtained.
- At the same time, the air in the crank case is compressed by the movement of the piston.
- All the ports and the plate valve are in closed position

Two stroke cycle Diesel Engines- Working

- **Second Stroke (Downward Stroke of the piston)**

(d) Exhaust and Transfer:

- At the end of expansion, the exhaust port is uncovered.
- The burnt escape to the atmosphere through the exhaust port.
- Transfer port is also uncovered shortly after the exhaust port is opened.
- The partially compressed air from crank case enters the cylinder the transfer port.
- This air is deflected upwards by the deflected shape of the piston.
- Thus the entering air helps in forcing out the combustion products from the cylinder
- The plate valve remains during this period.

Scavenging

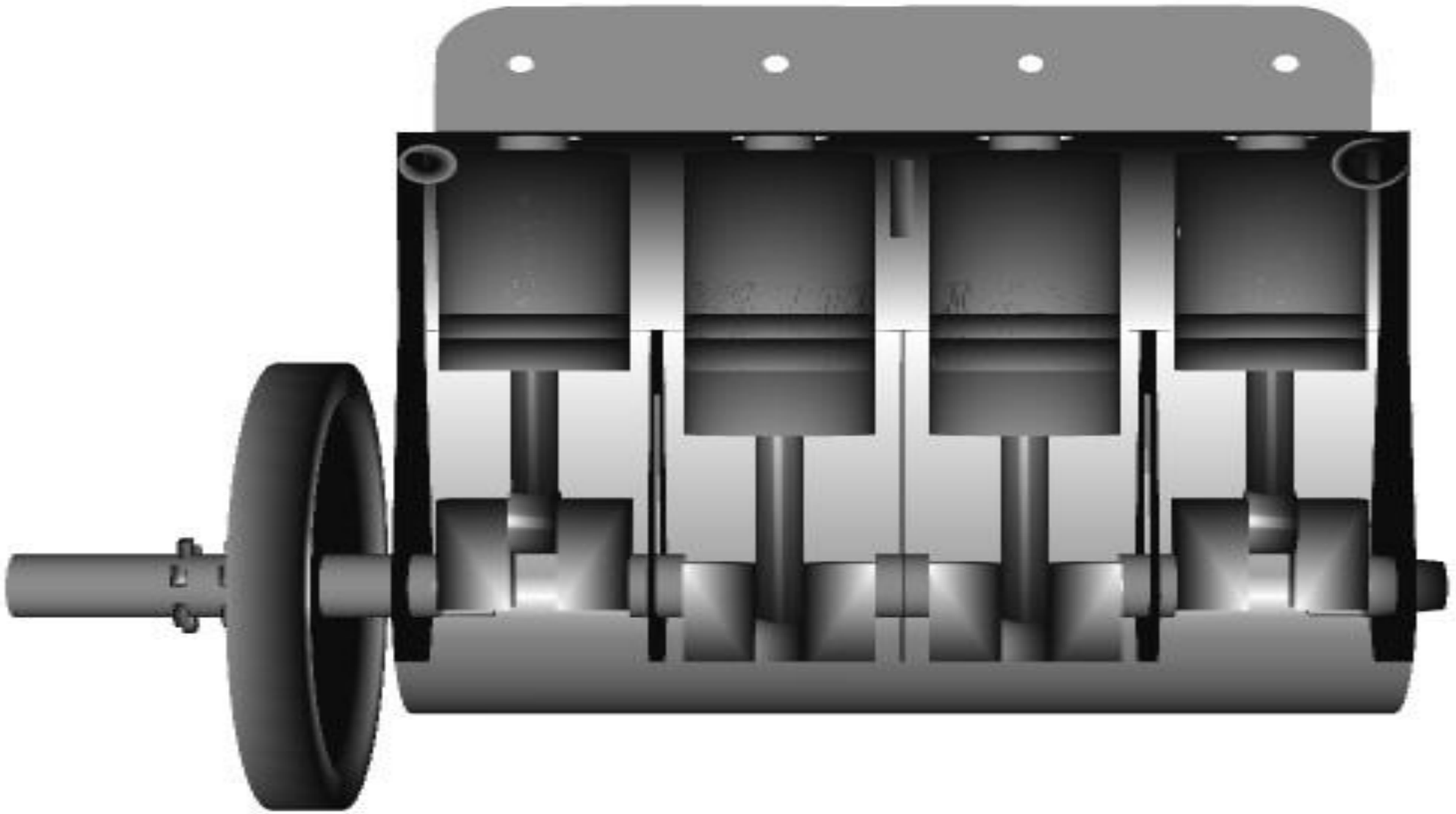
- **Scavenging :**
- It is the process of forcing out the burnt exhaust gases from the cylinder for admitting the fresh charge into the cylinder.
- This action takes place in the two stroke cylinder.

- The charge (air fuel mixture or air) enters the engine cylinder from the crank case at a pressure higher than the exhaust gases.
- This fresh charge forces the exhaust gases to the atmosphere through the exhaust port.
- During the period both the transfer and exhaust ports are kept open for a short period.
- Hence there is a possibility of the fresh charge escaping out with the burnt gases.
- This is over come by designing the piston to have a deflected shape.
- This shape of piston deflects the fresh charge upward in the engine cylinder.
- It also helps out in forcing out the exhaust gases to atmosphere.
- This process is known as **Scavenging.**

Characteristics of Four Stroke Compression Ignition & Spark Ignition Engines

Characteristics	Compression-Ignition Engine	Spark- Ignition Engine
Compression Ratio	14-22 : 1	5-8 : 1
Ignition	Compression	Electric Spark
Thermal Efficiency	30-60%	25-30%
Fuel induction	Injector	Carburettor (Fuel Injection)
Fuel System	Fuel Oil / Diesel	Gasoline (LP gas)
Fire Hazard	Less	Greater
Power Variation	Increase in Fuel	Increase in Air/Fuel Mixture
Air Induction	Constant	Variable
Air-Fuel Ratio	15-100 : 1	10-20 : 1
Relative Fuel Consumption	Lower	Higher
Energy per litre of fuel	Higher	Lower
Manifold Throttle	Absent	Present
Exhaust Gas Temperature	482° C / 900 F	704° C / 1300 F
Starting	Harder	Easier
Lubricants	Heavy duty oils	Regular and Premium Oils
Speed Range	Limited (600-3200 rpm)	Wide range (400-6000 rpm)
Engine Mass per Horsepower	8 kg (17.5 lb)	Average 4 kg (9 lb)
Initial Cost	High	Much Lower
Lugging ability (Torque)	Excellent	Less
Time Before Maintenance	Good	Fair
Continuous Duty	Good	Fair

Animation of Crank shaft , connecting rod and piston



Disassembly of IC Engine :-

- Engine removal
- Disconnect battery cables
- Remove the hood
- Remove air cleaner
- Label all wires and vacuum lines
- Drain coolant and oil
- Remove the radiator
- Remove the distributor and spark plug wiring

Figure 50.1 Remove the air cleaner and hose. Be careful not to crack the hose.

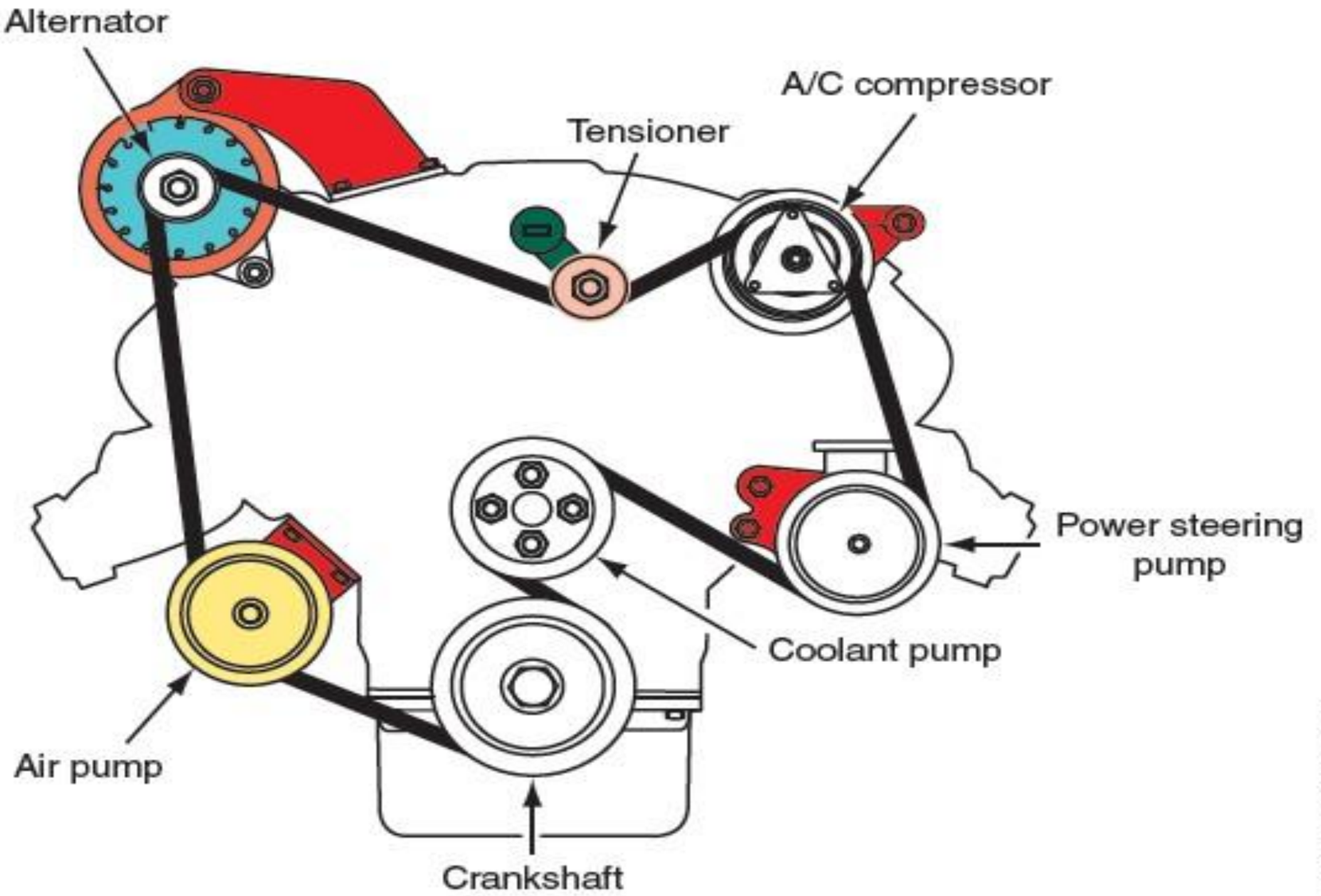


Figure 50.5 Remove the alternator and air pump.

Engine Disassembly :-

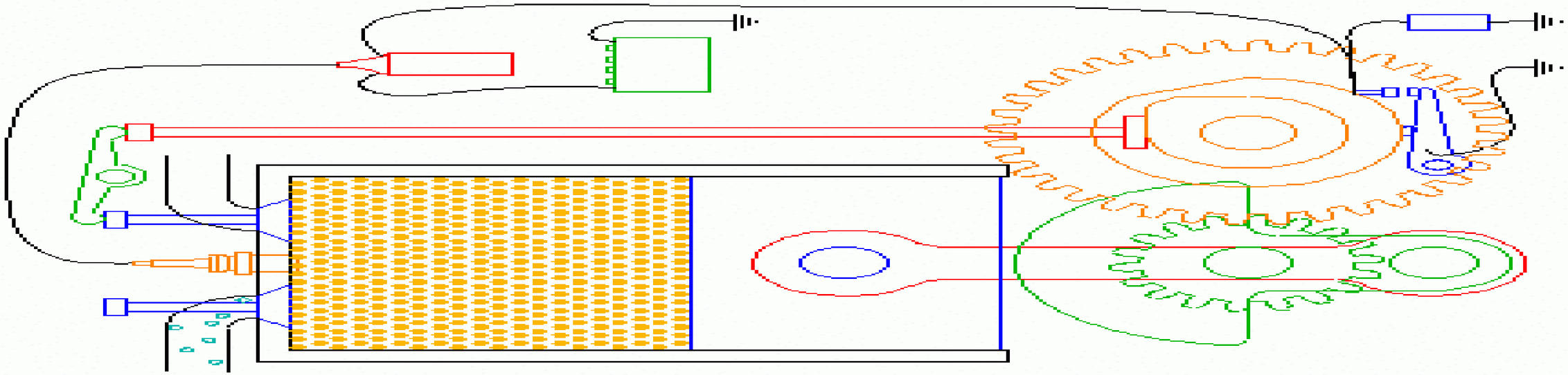
- Important steps
  - –Remove clutch parts
  - –Remove hybrid armature (puller required)
  - –Mount engine to a stand
  - –Remove coolant pump
  - –Remove oil pan
  - –Remove valve covers

OTTO CYCLE

- The Otto cycle is very similar to that of the Diesel cycle in that both of these are closed cycles
- commonly used to model internal combustion engines.
- The difference between these two is that the Otto cycle is a spark-ignition cycle while the Diesel cycle consists of a compression-ignition cycle.
- A spark-ignition cycle is designed to use fuels that require a spark to begin combustion.
- When discussing engines, we must consider both the mechanical operation of the machine as well as the thermodynamic processes that enable the machine to produce useful work.

OTTO ENGINE

- The Otto engine consists of many parts and each part is essential for the four-stroke cycle to occur.
- The main parts of a four-stroke cycle engine are the intake valve, the exhaust valve, the piston, the piston rings, the combustion chamber, the connection rod, the crankshaft, and the spark plug. These parts play an important role in the operation of this engine.



OPERATION OTTO CYCLE

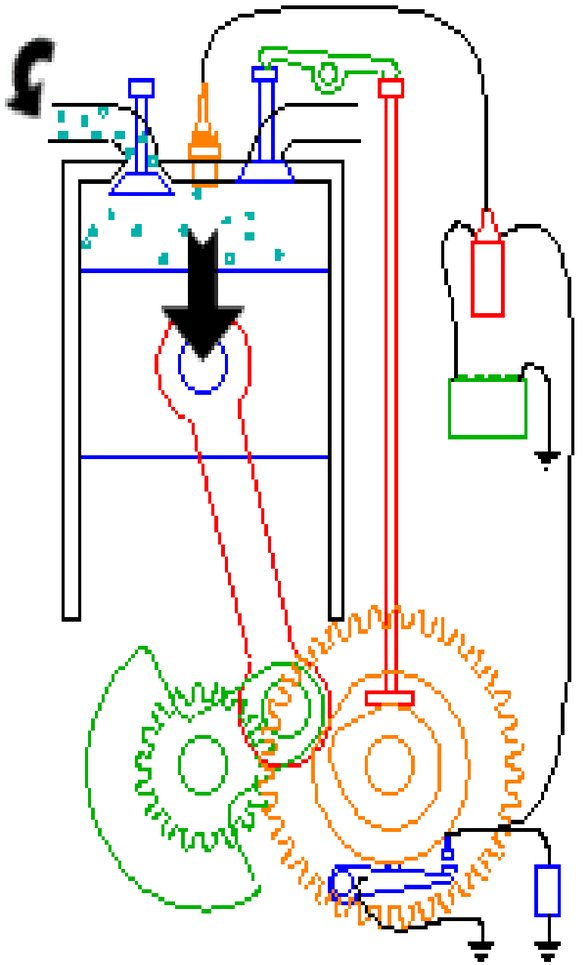
- **INTAKE STROKE:**

 # Intake valve starts opening

 # Air-fuel mixture is sucked in the cylinder through the opened intake valve by the piston moving towards the crank shaft

 # Exhaust valve remains closed

 # No ignition is given by the spark plug



OPERATION OTTO CYCLE

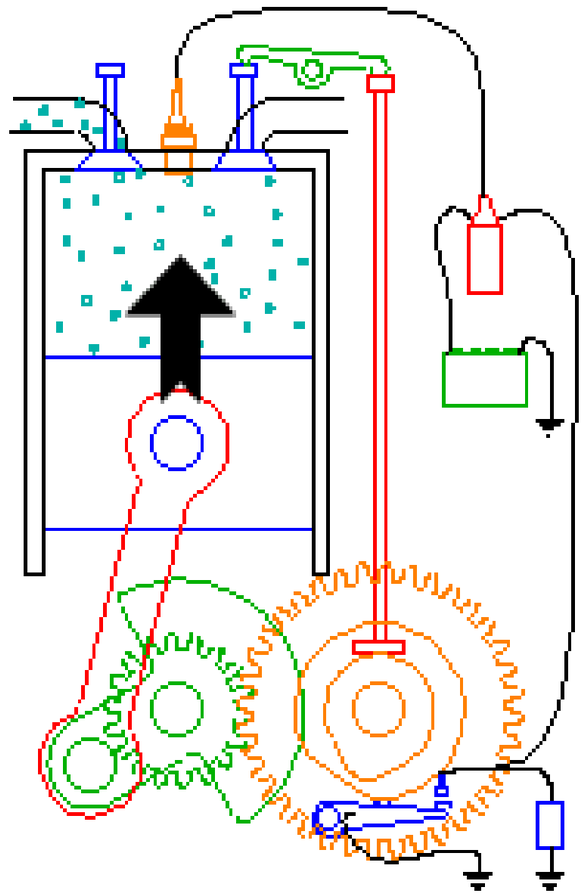
- **COMPRESSION STROKE:**

 # intake valve closes

 # air-fuel mixture is compressed in the cylinder by the piston sliding away from the crank shaft

 # Exhaust valve remains closed

 # No ignition is given by the spark plug till the piston reaches TDC.



OPERATION OTTO CYCLE

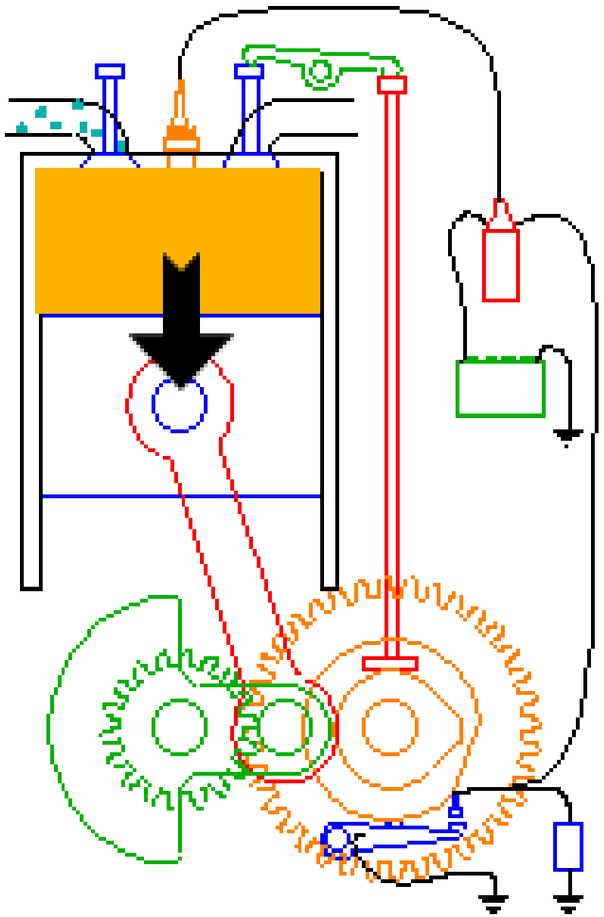
- **IGNITION/POWER STROKE:**

 # Intake valve and exhaust valve remain closed

 # Ignition is given by the spark plug when the piston reaches TDC

 # Compressed air-fuel mixture ignited by the spark starts burning

 # The gas expands in the cylinder pushing the piston towards the crankshaft generating rotary power at the crankshaft



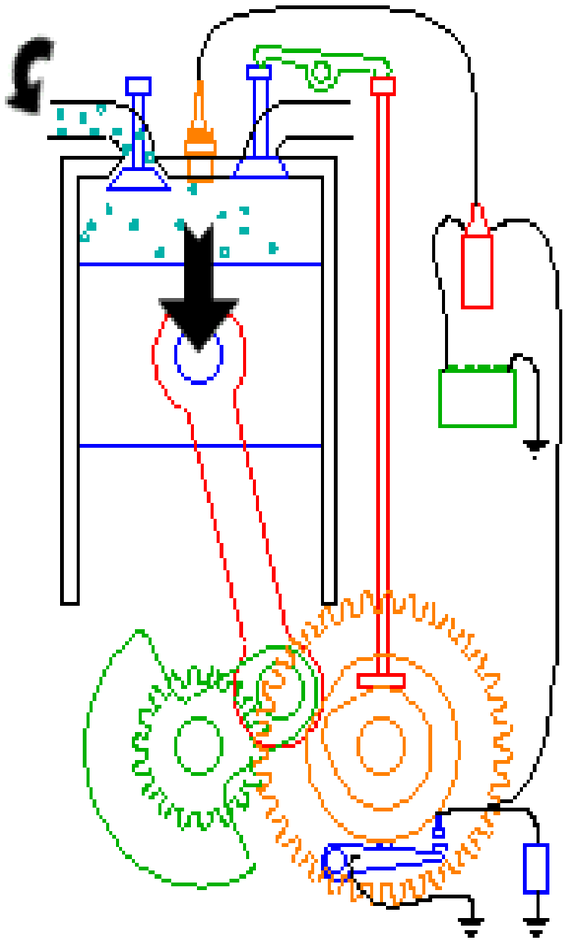
OPERATION OTTO CYCLE

- **EXHAUST STROKE:**

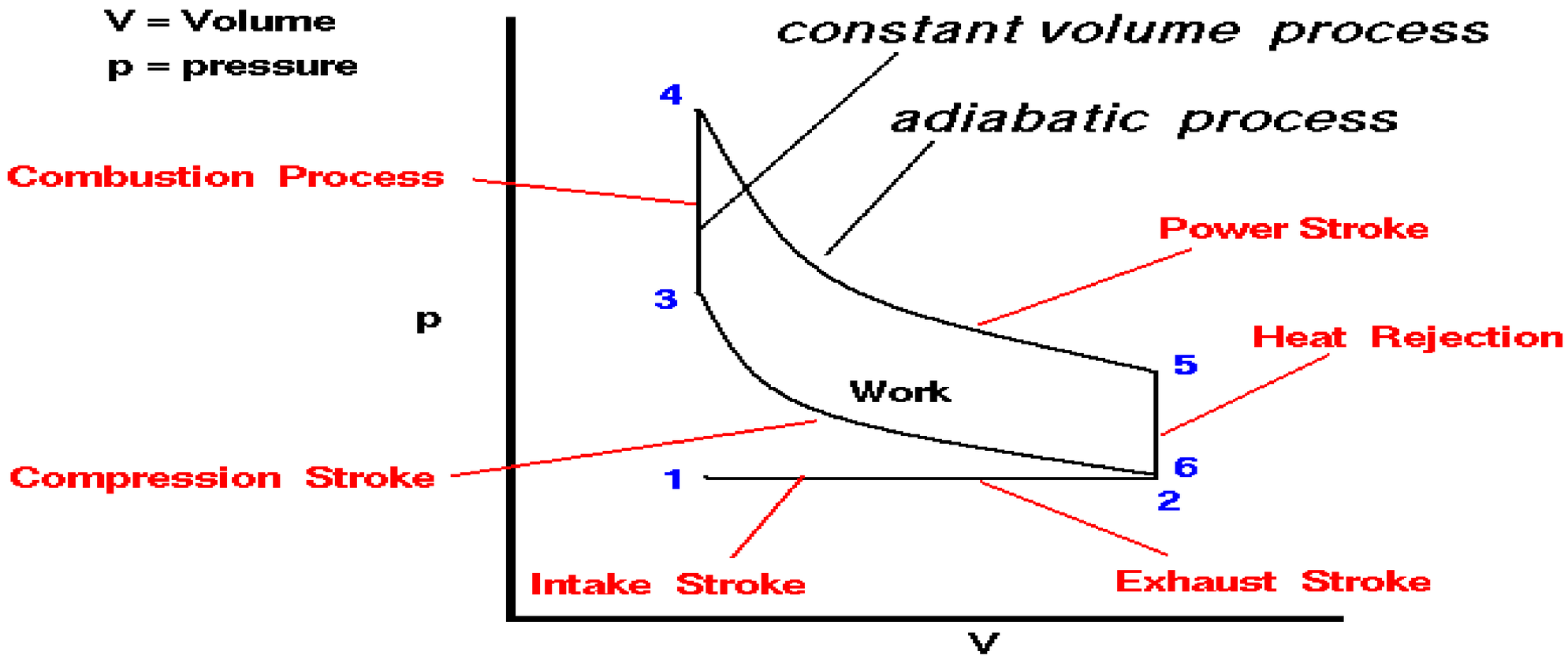
 # Exhaust valve starts opening

 # Burnt gas is pushed out of the cylinder through the opened exhaust valve by the piston moving away from the crankshaft

 # Intake valve remains closed till the piston reaches TDC



THERMODYNAMIC PROCESSES OTTO CYCLE (p-v DIAGRAM)



OPERATION OTTO CYCLE

- **Stage 1** It is the beginning of the **INTAKE STROKE** of the engine. The pressure is near atmospheric pressure and the gas volume is at a minimum. Between Stage 1 and Stage 2 the piston is pulled out of the cylinder with the intake valve open. The pressure remains constant, and the gas volume increases as fuel/ air mixture is drawn into the cylinder through the intake valve.

- **Stage 2** Begins the **COMPRESSION STROKE** of the engine with the closing of the intake valve. Between Stage 2 and Stage 3, the piston moves back into the cylinder, the gas volume decreases, and the pressure increases because **WORK IS DONE** on the gas by the piston.

- **Stage 3** is the beginning of the **COMBUSTION** of the fuel/air mixture. The combustion occurs very quickly and the volume remains constant. **HEAT** is released during combustion which increases both the **TEMPERATURE** and the pressure, according to the **EQUATION OF STATE**.

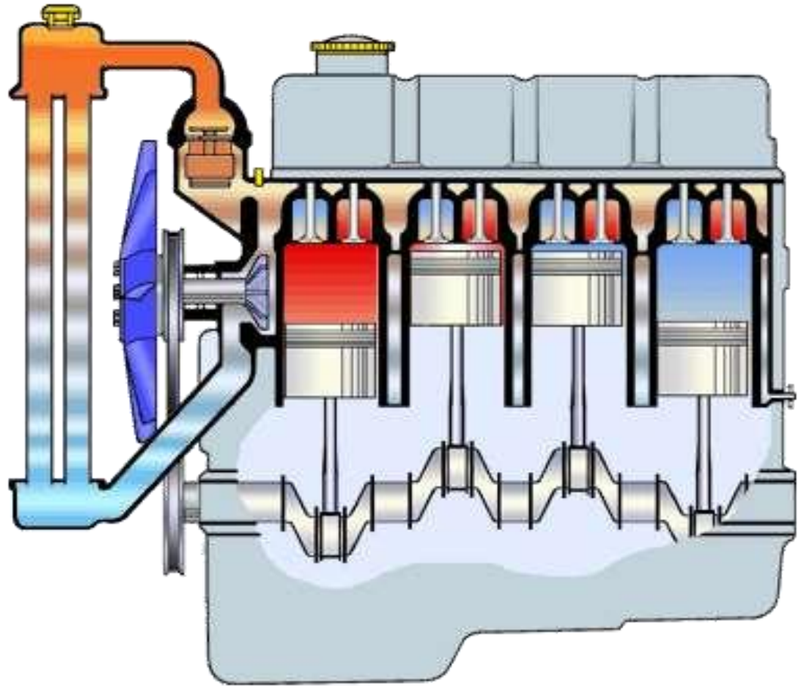
OPERATION OTTO CYCLE

- Stage 4 Here begins the POWERSTROKE of the engine. Between Stage 4 and Stage 5, the piston
- is driven towards the crankshaft, the volume in increased, and the pressure falls as WORK IS DONE by the gas on the piston.

- Stage 5 Now the exhaust valve is opened and the residual heat in the gas is EXCHANGED with the surroundings. The volume remains constant and the pressure adjusts back to atmospheric conditions.

Cooling System of IC Engine

- An automobile's cooling system is the collection of parts and substances (coolants) that work together to maintain the engine's temperature at optimal levels. Comprising many different components such as water pump, coolant,
- a thermostat etc. the system enables smooth and efficient functioning of the engine at the same time protecting it from damage



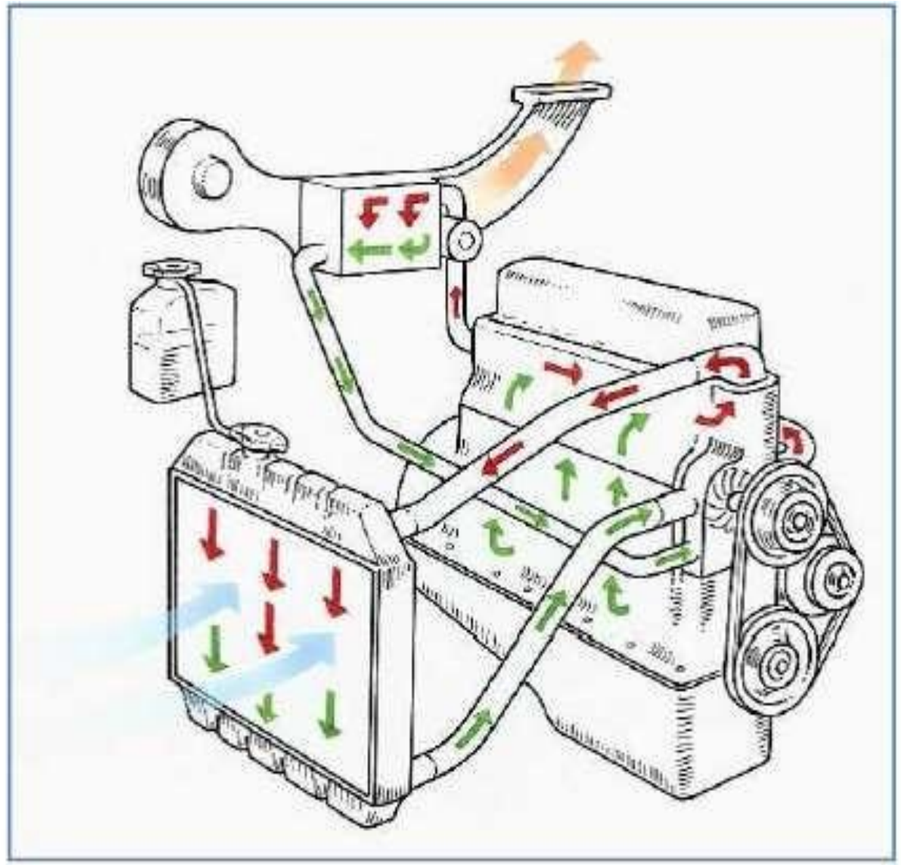
Types of cooling system

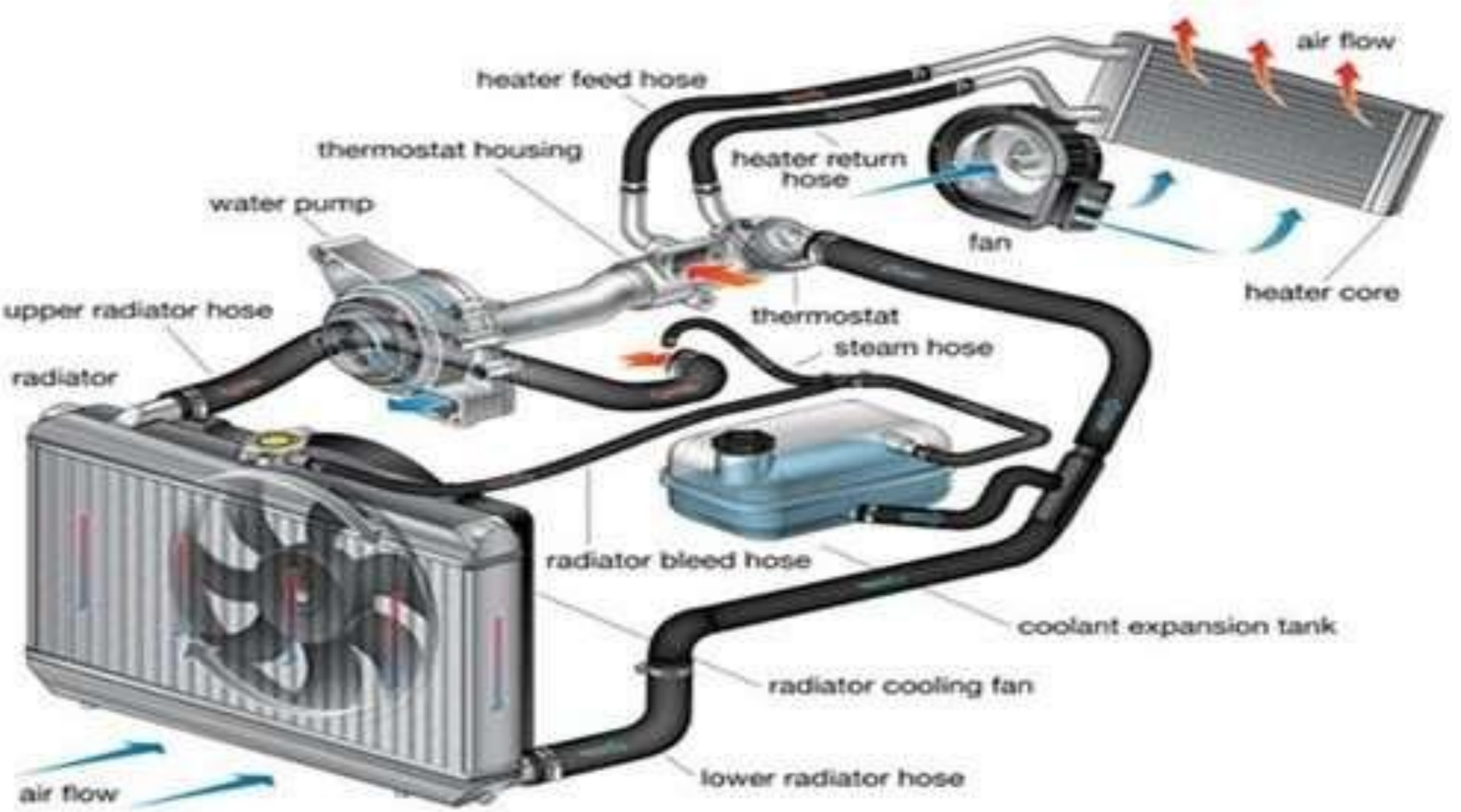
- In order to cool the engine a cooling medium is required. On the basis of medium ,in general use for cooling I.C. engine ,types of cooling system are

1) liquid or indirect cooling system.
2) air or direct cooling system.

Liquid Cooled System

- A liquid is circulated around th e cylinders and absorb heat from the cylinder walls and cylinder h ead.
- Coolant absorbs heat as it passes t hrough the engine and also lubric ates the water pump.
- Hot coolant enters the radiator in which the heat is passed on to air that is flowing through the radiat or.




air flow
heater feed hose
thermostat housing
heater return hose
water pump
fan
heater core
upper radiator hose
thermostat
steam hose
radiator
radiator bleed hose
coolant expansion tank
radiator cooling fan
lower radiator hose
air flow

Advantages of liquid Cooling System

- Uniform cooling of cylinder, cylinder head and valves.
- Specific fuel consumption of engine improves by using water cooling system.
- If we employ water cooling system, then engine need not be provided at the front end of moving vehicle.
- Engine is less noisy as compared with air cooled engines, as it has water for damping noise.

Disadvantage of liquid Cooling System

- It depends upon the supply of water.
- The water pump which circulates water absorbs considerable power.
- If the water cooling system fails then it will result in severe damage of engine.
- The water cooling system is costlier as it has more number of parts. Also it requires more maintenance and care for its parts.

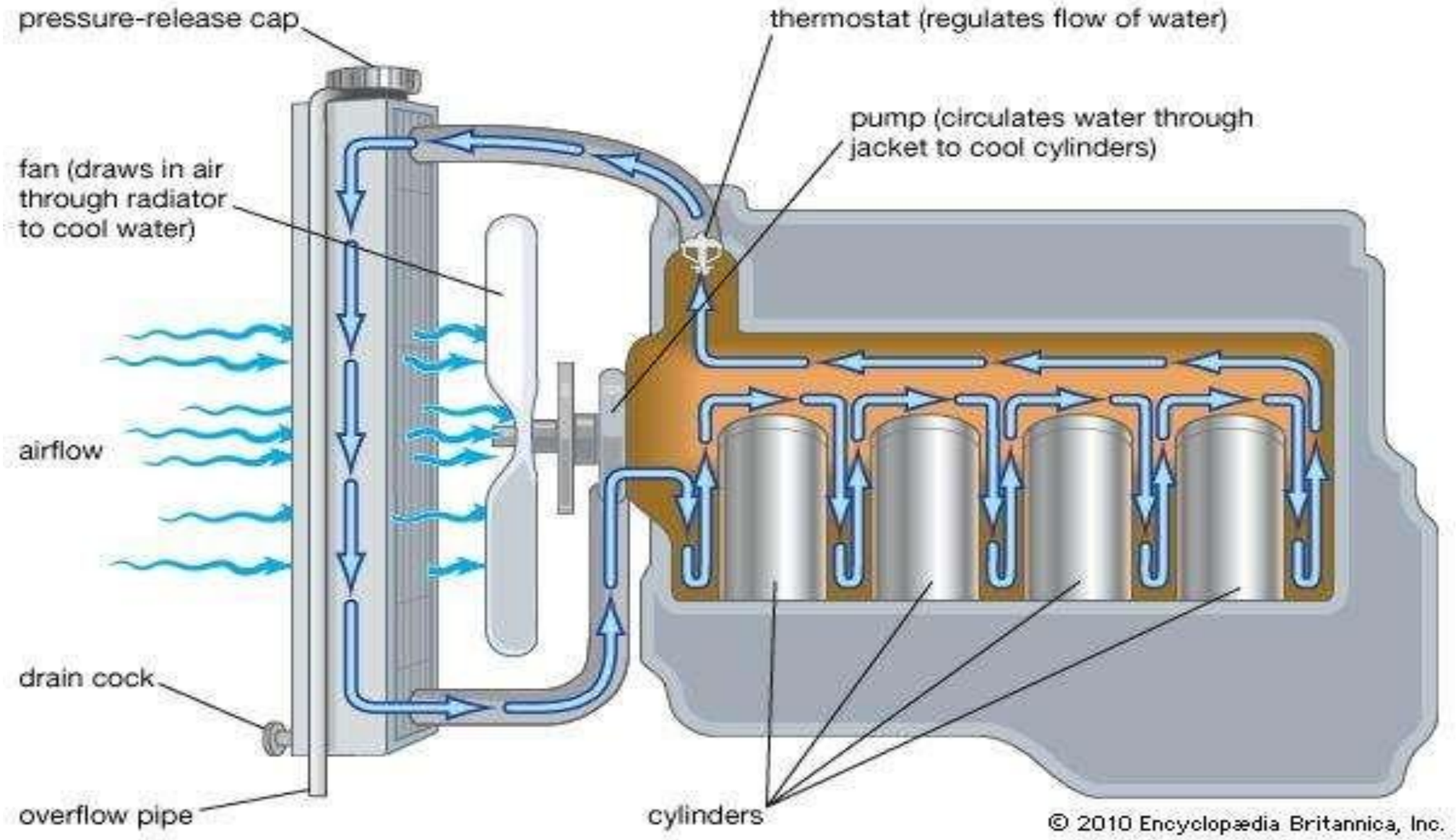
Air Cooled System

- In air cooled system a current of air made to flow past the outside of the cylinder barrel ,outer surface area which has been considerably increased by providing cooling fins.
- The amount of heat dissipated to air depends upon :

  (a)Amount of air flowing through the fins.

  (b)Fin surface area.

  (c)Thermal conductivity of metal used for fins.


pressure-release cap
thermostat (regulates flow of water)
pump (circulates water through jacket to cool cylinders)
fan (draws in air through radiator to cool water)
airflow
drain cock
overflow pipe
cylinders
© 2010 Encyclopædia Britannica, Inc.

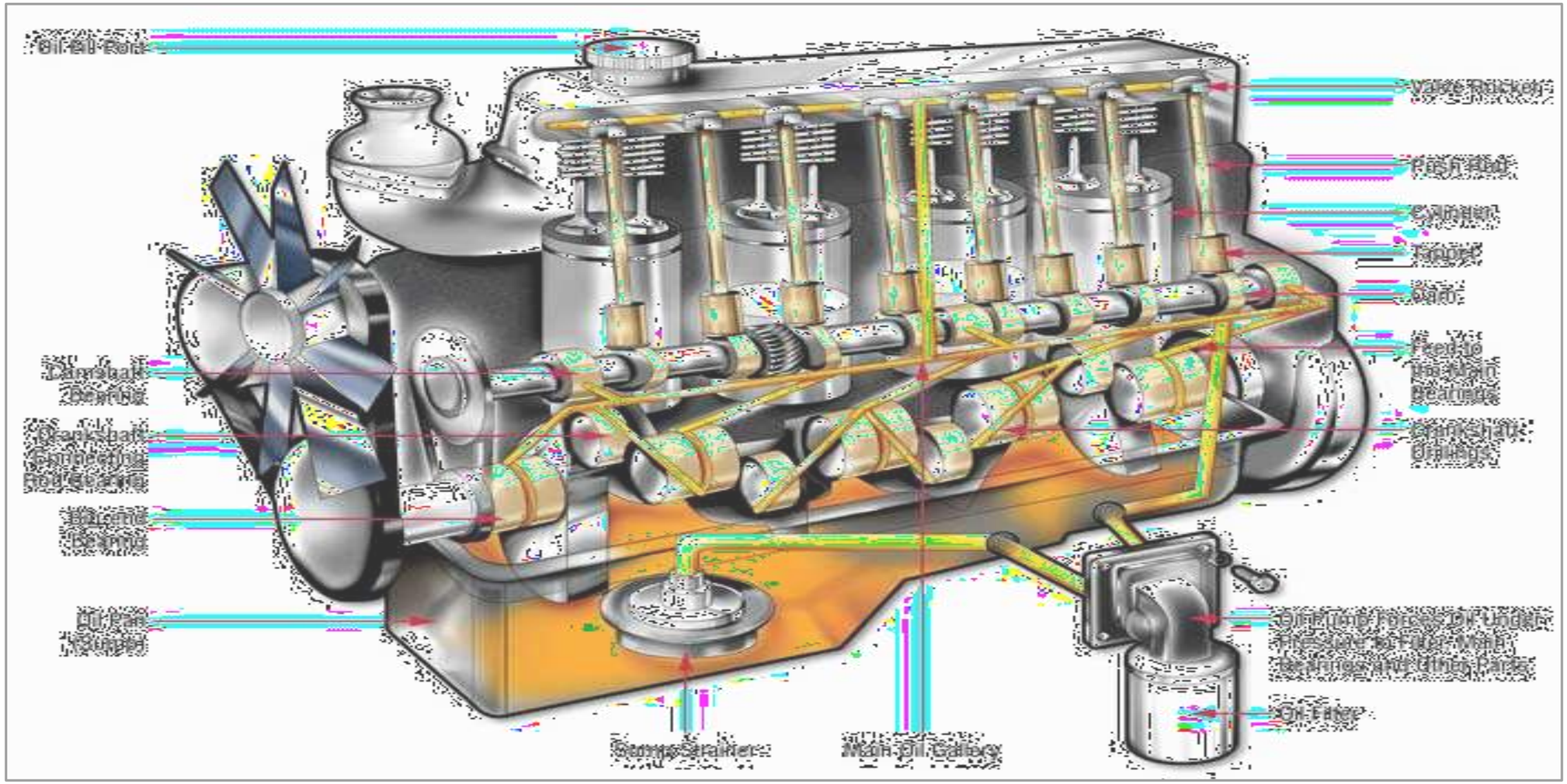
Advantages of air Cooling System

- Radiator/pump is absent hence the system is light.
- In case of water cooling system there are leakages, but in this case here are no leakages.
- Coolant and antifreeze solutions are not required.
- This system can be used in cold climates, where if water is used it may freeze.

Disadvantages of air Cooling System

- Comparatively it is less efficient.
- It is used in aero planes and motorcycle engines where the engines are exposed to air directly.

LUBRICATION SYSTEM IN IC ENGINES



Definition of lubrication

- Lubrication is the action of applying a substance such as oil or grease to an engine or component so as to minimize friction and allow smooth movement.

- Lubrication System

- Lubricating system is a mechanical system of lubricating internal combustion engines in which a pump forces oil into the engine bearings.

PURPOSE OF LUBRICATION

- To reduce the friction between moving parts
- To increase the efficiency
- To minimize the vibrations
- To reduce the corrosion and carbon deposits
- To reduce the heat of moving parts
- To minimize power loss due to friction
- To reduce the noise created by moving parts
- To provide cooling to the engine

TYPES OF LUBRICANTS

- SOLID LUBRICANTS
  - e.g. graphite ,molybdenum ,mica

- SEMI-SOLID LUBRICANTS
  - e.g. heavy greases

- LIQUID LUBRICANTS
  - e.g. mineral oil obtained by refining petroleum oil,vegetable oils obtained from olive,linseed,caster and animal oil

PROPERTIES OF LUBRICANTS

- **Viscosity**
  - It is a measure of the resistance to flow of an oil
  - It is measured in saybolt uniuniversal seconds (SUS)
  - It is expressed in centistokes ,centipoises and redwood seconds

- **Viscosity Index**
  - viscosity of oil decreases with increase in temperature

- **Cloud point**
  - If an oil is cooled , it will start solidifying at some time .
  - Temperature at which oil starts solidifying , is called cloud point

PROPERTIES OF LUBRICANTS

- **Pour point**
  - It is temperature just above which the oil sample will not flow under certain prescribed conditions
  - this property is important for operation of engines and substances at low temperature conditions
- **Flash point and Fire point**
  - The temperature at which vapour of an oil flash when subjected to a naked flame is called flash point
  - Fire point is the temperature at which the oil ,it once lit with flame ,will burnt steadily at least
    - for 5 seconds
- **Specific Gravity**
  - It varies between 0.85 to 0.96

PROPERTIES OF LUBRICANTS

➢ **Acidity**

❑ Oil must have low acidity

➢ **Carbon residue**

❑ It is quantity of carbaneous residues which remains after evaporation of a sample

- oil under specific conditions

➢ **Oiliness**

❑ It is property of oil to cling to the metal surface by molecular action and then to provide a very thin film under lubrication conditions

❑ This property affects start of engines

ADDITIVES

➢ Additives are the compound added to the oils to provide and improve their desired properties ,some of additives are :

- 1] **VISCOSITY INDEX IMPROVERS**

❑ They are additives which improves the viscosity to work over wide range of temperatures

- 2] **ANTIOXIDANTS**

❑ They reduce oxidation of lubricating oil

- 3] **ANTIWEAR AND DETERGENT**

❑ Both serves to cleanse and prevent sticking of piston rings

ENGINE PARTS THAT REQUIRE FREQUENT LUBRICATION

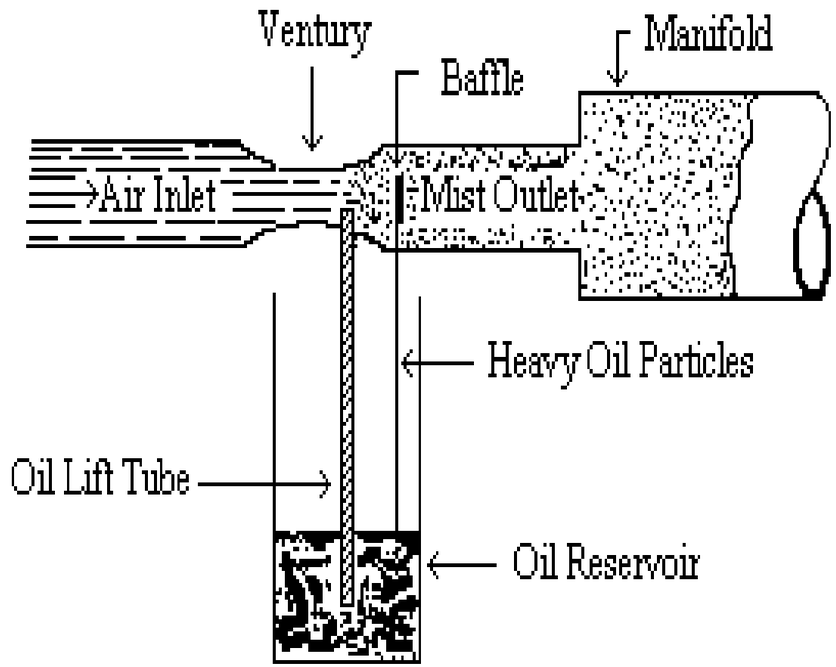
- CYLINDER PISTON AND PISTON RINGS
- MAIN BEARING
- CRANKSHAFT
- CRANK PIN AND PISTON PIN
- BIG END AND SMALL END CONNECTING ROD
- CAMSHAFT
- VALVES
- TIMING GEARS

TYPES OF LUBRICATION SYSTEM

- MIST LUBRICATION SYSTEM
- WET SUMP LUBRICATION SYSTEM
- DRY LUBRICATION SYSTEM

MIST OR PETROIL |PETROL PLUS OIL| LUBRICATION SYSTEM

- This system is used in 2 stroke cycle engines
- The lubrication oil (2% to 3%) is mixed with the petrol in the fuel tank
- The oil and the fuel mixture is inducted through carburetor.
- The optimum fuel oil ratio used is 50:1
- Petrol gets evaporated and the oil lubricate s the main parts of cylinder.
- Fuel oil ratio used is important for the go od performance of engine.



ADVANTAGES of mist lubrication

- separate lubricating system is not required.
- No maintenance cost for lubrication system
- Weight of engine is reduced by avoiding separate lubri cating system

DISADVANTAGES of mist lubrication system

- If oil is less then there is chance of seizure of the engine
- More oil makes excess air in the exhaust

WET SUMP LUBRICATION SYSTEM

- In this system a big oil sump is provided at the base of crank case.
- From the sump oil is pumped to different parts of the engine
- The main types of Wet sump lubrication system are:
  - splash lubrication system
  - pressure lubrication system
  - Splash and pressure lubrication system

SPLASH LUBRICATION SYSTEM

- The lubricating oil is filled in the sump
- Scoop are attached to the end of co nnecting rod
- When system moves to Bottom De ad Centre (BDC) scoop splashes lu bricating oil to the piston ,cylinder , big end of connecting rod ,main be aring and cam shaft bearing
- The splashed oil settles on engine p arts and then to sump again

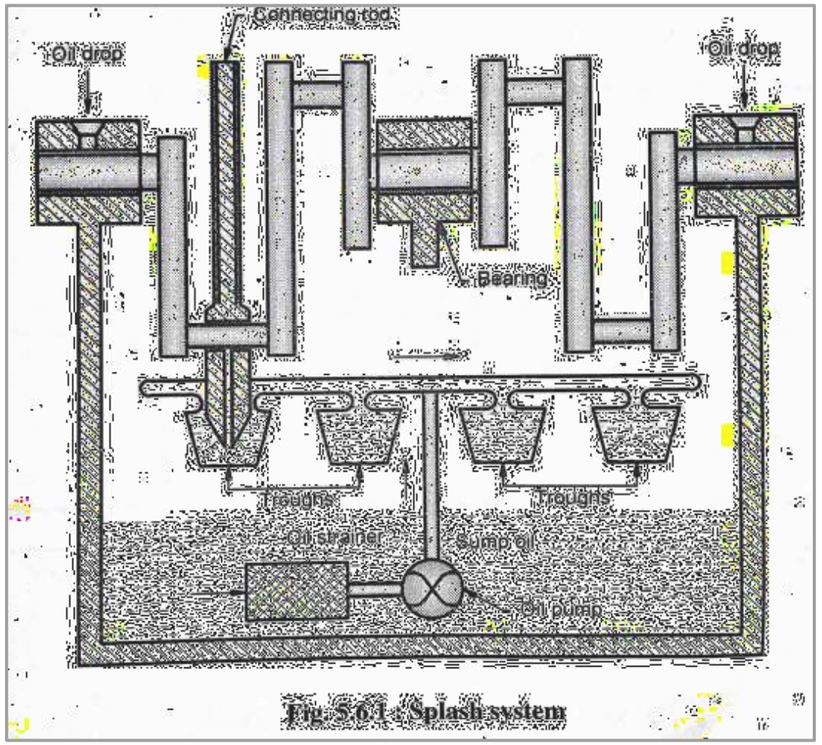
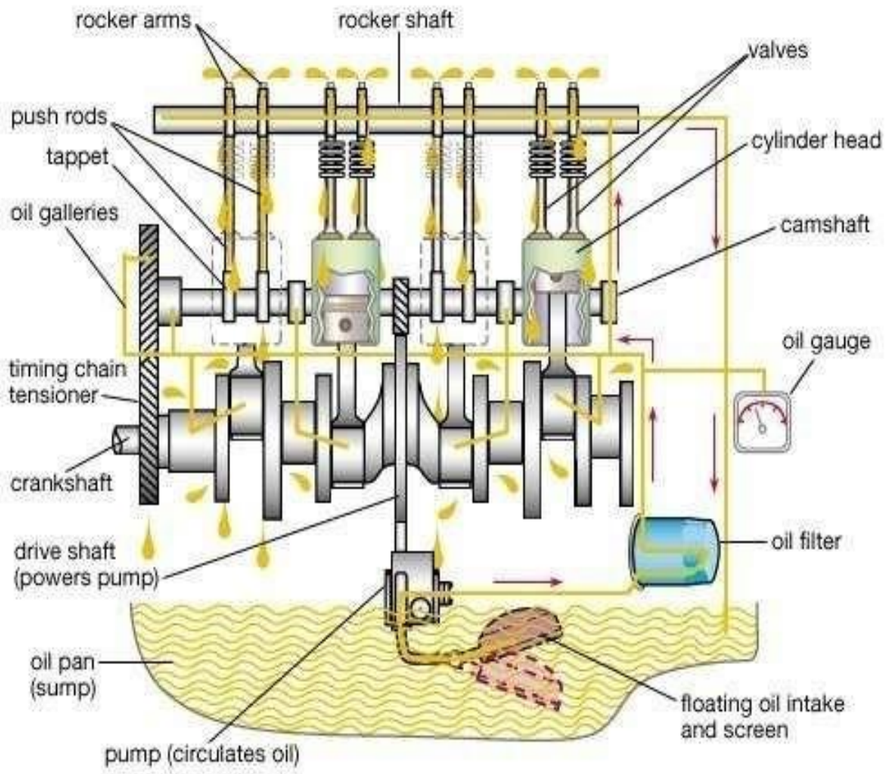


Fig. 5.61 : Splash system

PRESSURE LUBRICATION SYSTEM

- In this system , lubrication is done with the help of pressure pump which is submerged in the su mp
- With the help of pressure pump after filtration, oil is forced under pressure to different parts of the engine through oil tubes
- From the bearing oil floats to connecting rod through oil holes between connecting rod and cam shaft
- Then this oil flows to piston pin through oil holes and sprayed over piston ,piston rings , cylinder valves and other parts



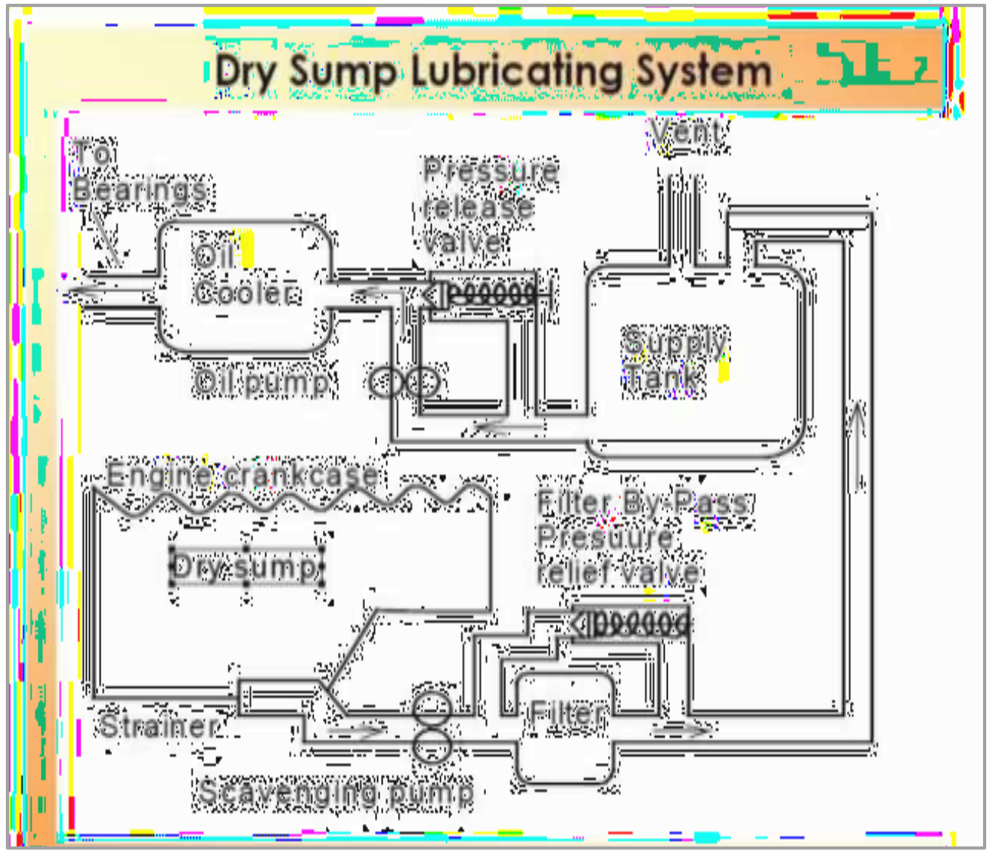
PRESSURE TYPE LUBRICATION

SPLASH AND PRESSURE LUBRICATION SYSTEM

- Splash system is not sufficient when bearing Aare higher hence lubricating oil under pressure is supplied by oil pump to main a nd crankshaft bearings
- Oil pump also supplies oil under pressure to pipes which directs a stream of oil against the dippers (scoop) on the connecting rod bearing cups
- Other parts are lubricated by splash of oil by scoop.

DRY SUMP LUBRICATION SYSTEM

- In dry sump , extra oil is stored in a tank outside the engine rather than oil pan
- In this system ,the lubrication oil is passe d through the pipes using scavenging pu mps
- After lubrication ,the oil is again collecte d by special connecting sections and pas sed to heat exchanger for cooling
- Scavenging pump has greater capacity th an oil feed pump and it is placed extern ally to sump



ADVANTAGES OF DRY SUMP LUBRICATION SYSTEM

- Improvements to vehicle handling and stability. The vehicle's center of gravity can be lowered by mounting the engine lower in the chassis due to a shallow sump profile. A vehicle's overall weight distribution c an be modified by locating the external oil reservoir away from the engine
- Improved engine reliability due to consistent oil pressure. This is the reason why dry-sumps were invented
- Increased oil capacity, by using a larger external reservoir than would be practical in a wet-sump system
- Having the pumps external to the engine makes them easier to maintain or replace.

DISADVANTAGES OF DRY SUMP LUBRICATION SYSTEM

- Dry-sump systems add cost, complexity, and weight.
- The extra pumps and lines in dry-sump engines require additional oil and maintenance.
- The large external reservoir and pumps can be tricky to position around the engine and within the engine bay due to their size.
- Inadequate upper valvetrain lubrication can also become an is sue if too much oil vapor is being pulled out from the area, especially with multi-staged pumps.

JECRC Foundation

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

Thank you!

STAY HOME, STAY SAFE