



I C Engine

LECTURE 1 INTRODUCTION & CLASSIFICATION

INTRODUCTION

What is Engine?

Engine: Device which converts form of energy into Mechanical energy. For eg.

- ▶ Heat Engines: convert chemical energy of fuel into thermal energy which is utilized into useful work. (a)
- ▶ Electric Motor: convert Electrical energy into Mechanical energy. (b)

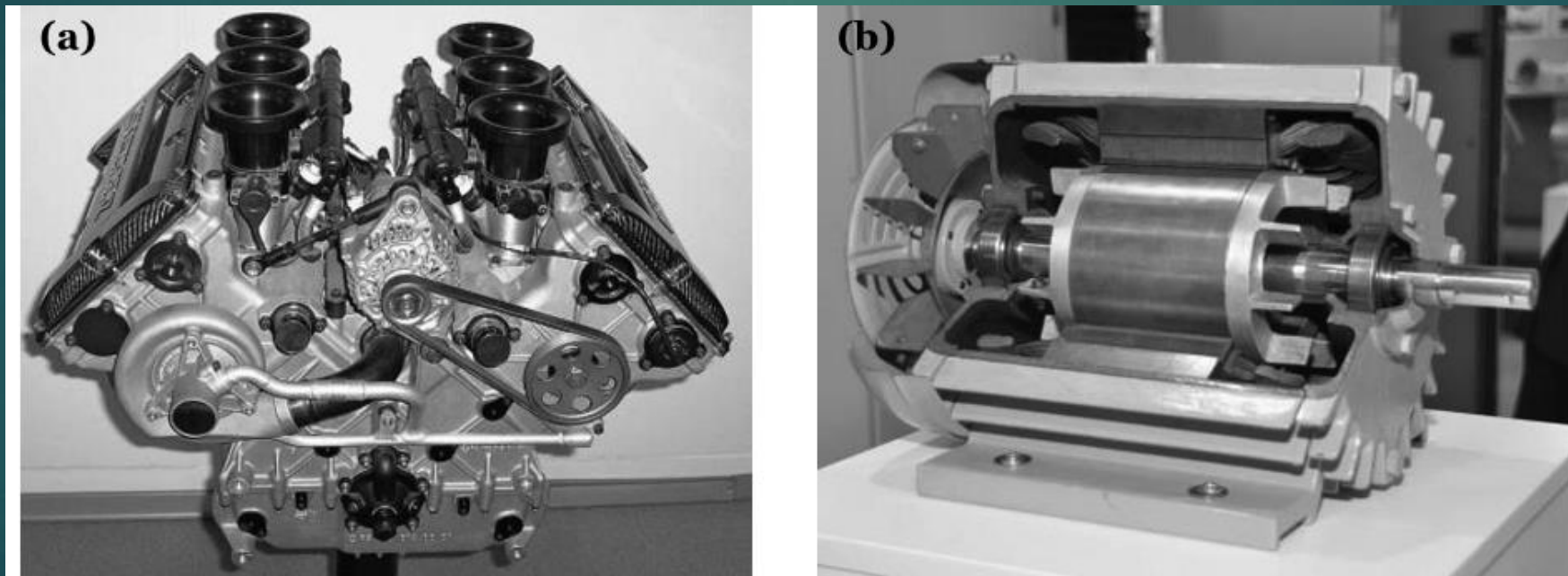


Figure : (a) V6 internal combustion engine from a Mercedes-Benz, (b) Electric motor

Engine: Device which converts one form of energy into Mechanical energy. For e.g. heat engines, electric motors etc.

- ❖ In heat engines, chemical energy of fuel is first converted into heat by combustion.
- ❖ Heat is then converted into mechanical energy with the help of a working fluid.
- ❖ Intense heat produced during combustion increases the pressure and temperature of working fluid.
- ❖ Working fluid then expands resulting in mechanical work.
- ❖ Working fluid can be either liquid or gas.



Ford Ecosport 1.5L three cylinder gasoline engine

Combustion in engines can take place externally as well as internally

External combustion engine

- ❖ Combustion takes place outside the control volume
- ❖ Use of heat exchanger to transfer energy to the working fluid
- ❖ Open or closed cycle
- ❖ Example: steam engine, power plant etc.

Internal combustion engine

- ❖ Combustion occurs within the control volume
- ❖ Open cycle: working fluid is replenished in each cycle
- ❖ Exhaust gas is dumped into the atmosphere
- ❖ Example: Reciprocating engines, gas turbines etc.

Heat Engines Classification

External combustion

- ❖ Combustion takes place outside the combustion chamber (Fig.)
- ❖ Use of heat exchanger to transfer energy to the working fluid
- ❖ Open or closed cycle
- ❖ Example: steam engine, power plant

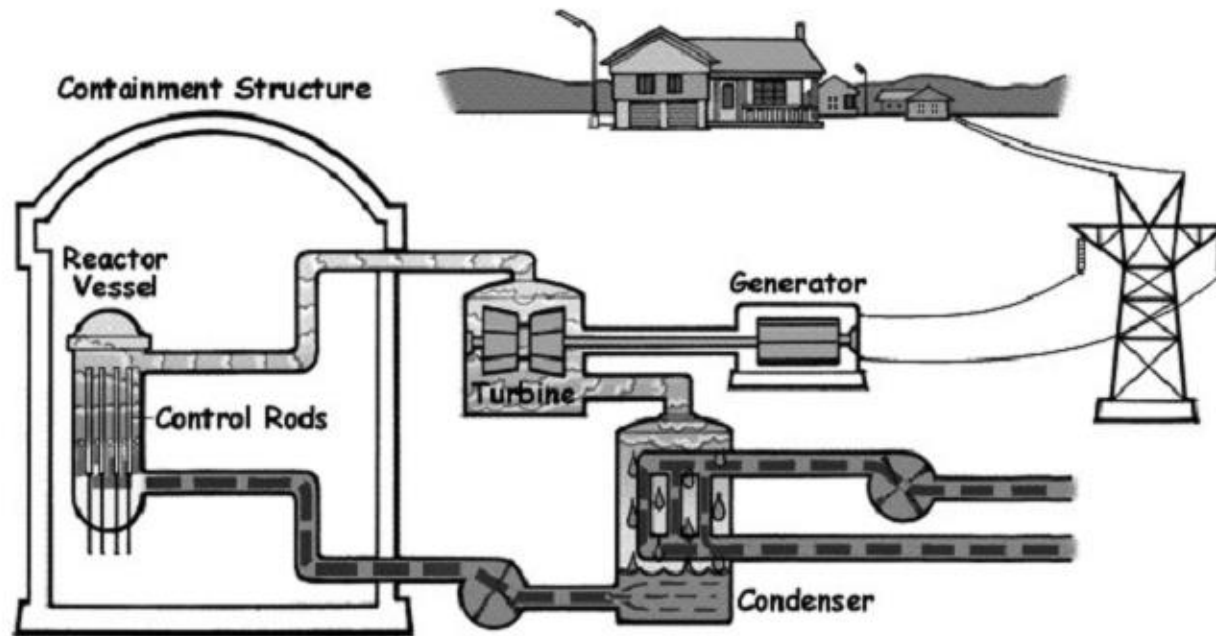


Figure : boiling water reactor of power plant

Heat Engines Classification

External combustion

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- ❖ Open or closed cycle
- ❖ Example: steam engine, power plant

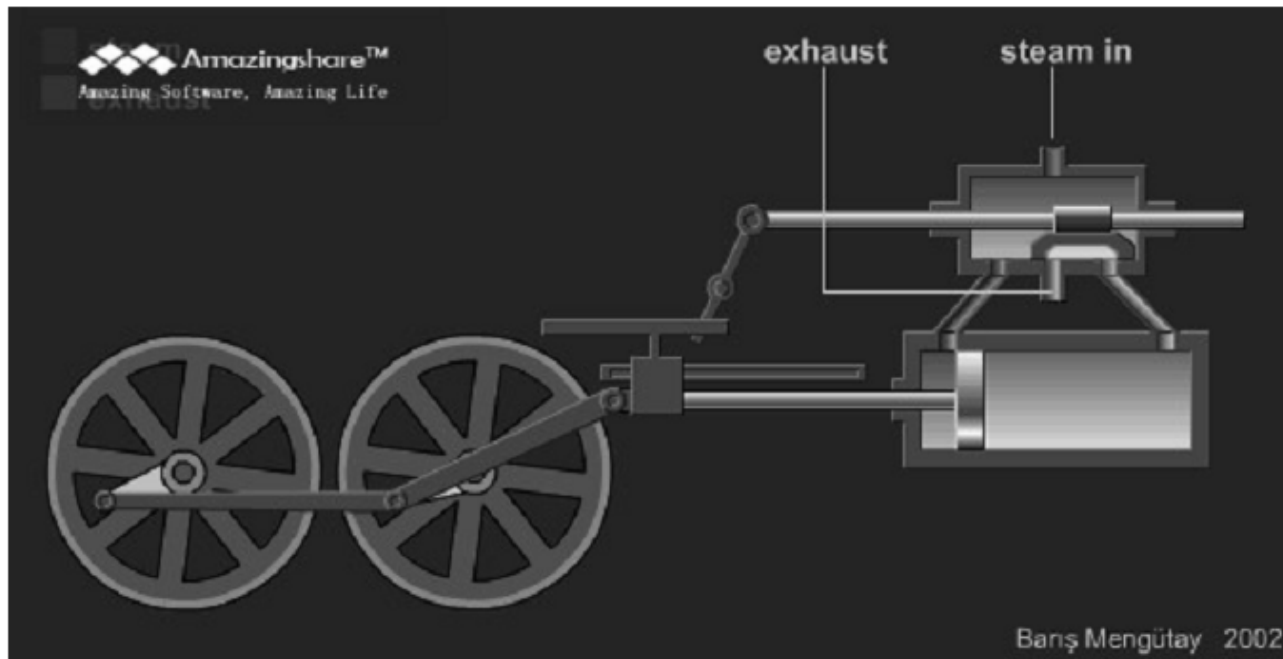


Figure : A steam engine

Heat Engines Classification

Internal combustion

- ❖ Combustion occurs in the working fluid (Fig.)
- ❖ Open cycle – the working fluid is replenished in each cycle
- ❖ Exhaust gas is dumped into the atmosphere

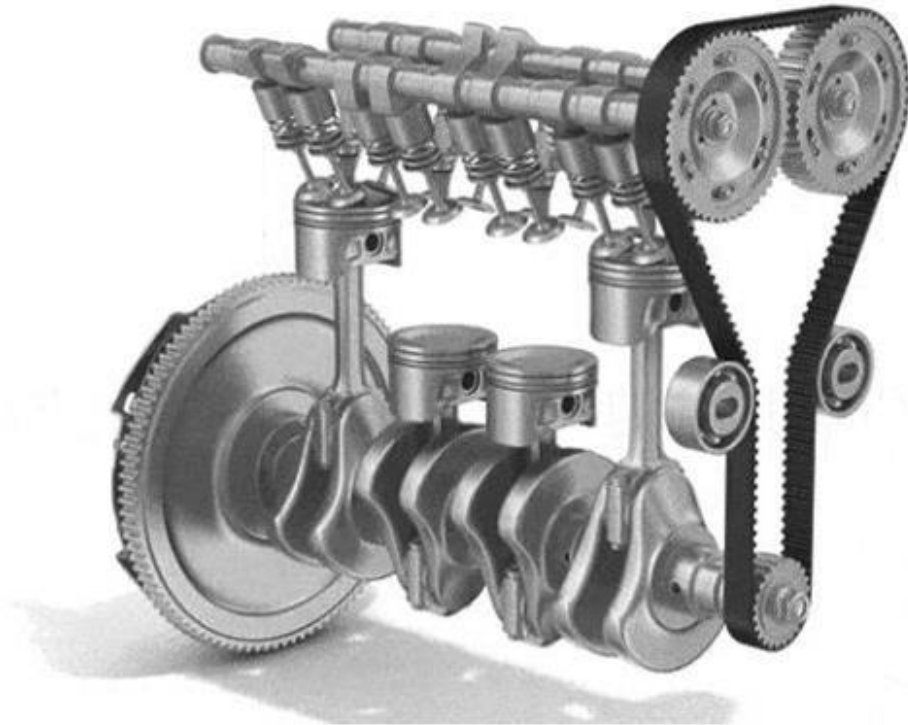
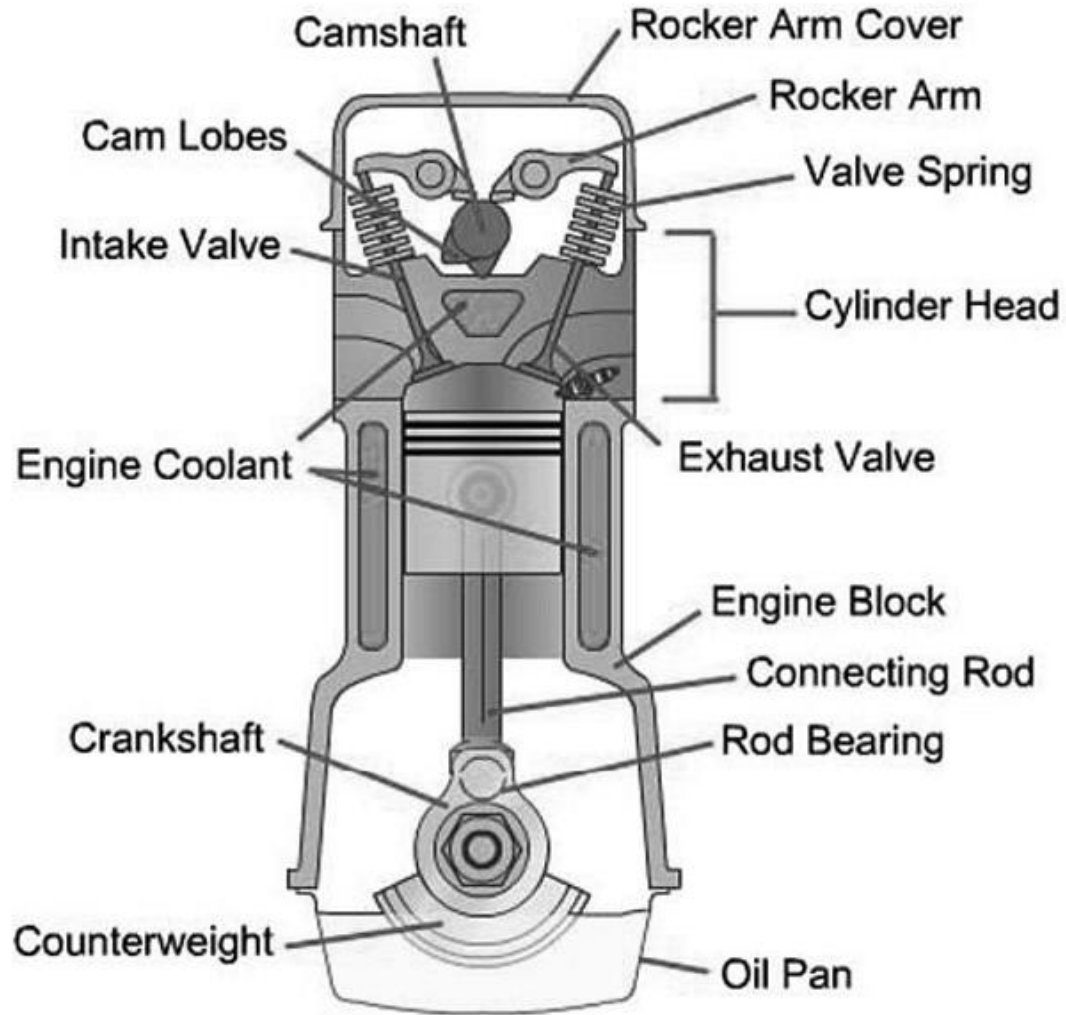


Figure : A multi cylinder engine with eternal belt to power peripheral devices

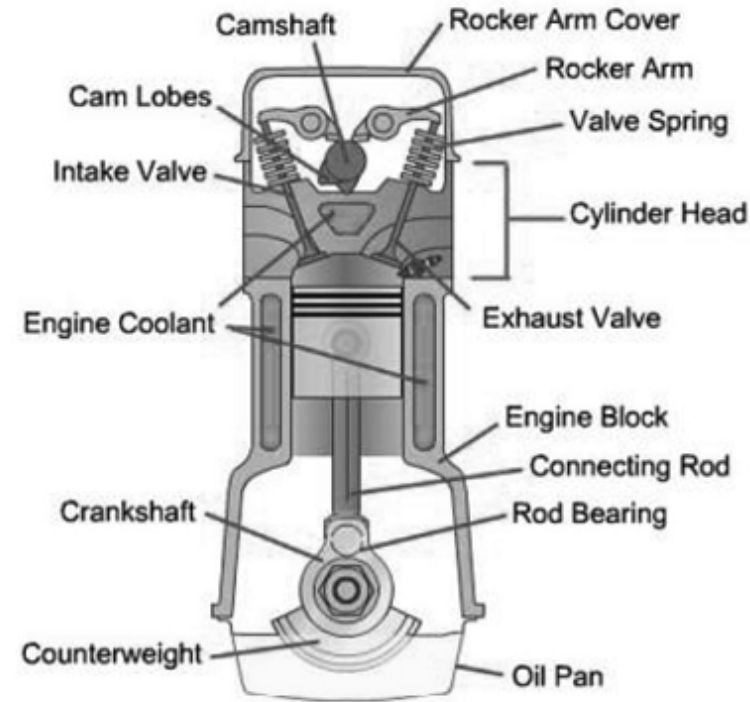
I C Engine Components



Basic components of an IC engine

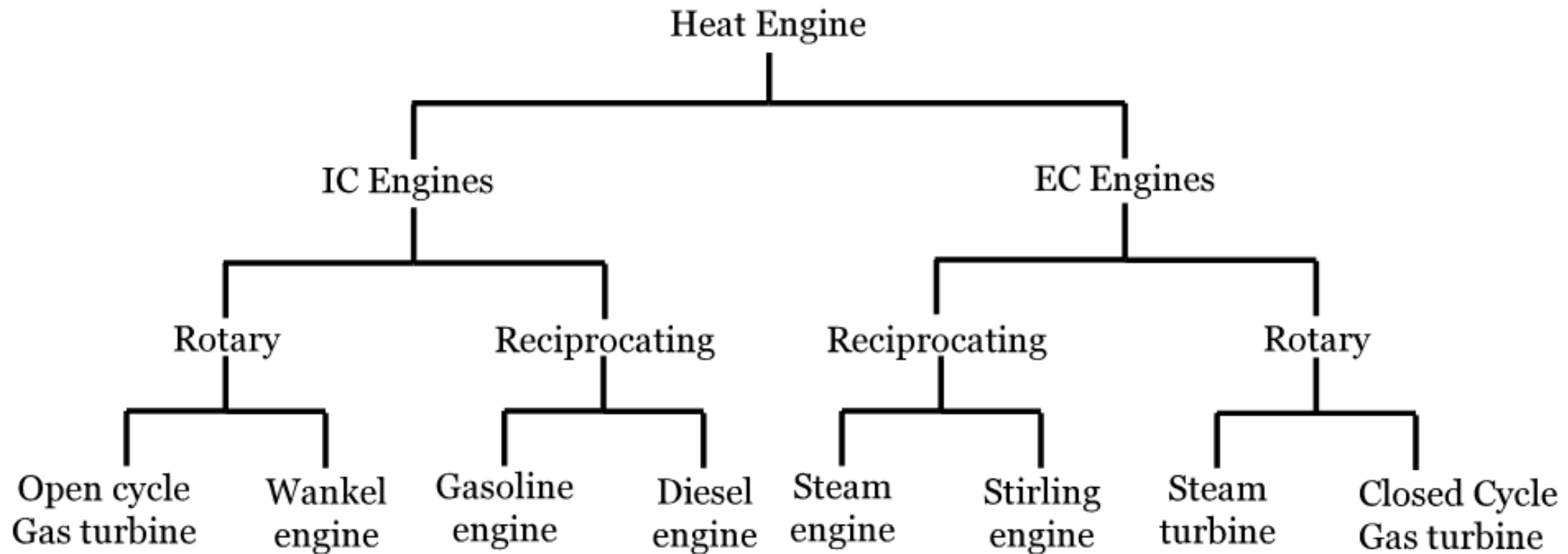
IC engine components

- ❖ **Engine block:** Body of engine
- ❖ **Piston:** Reciprocates inside the cylinder and transfers power to crankshaft through connecting rod
- ❖ **Cylinder:** Volume inside which the combustion takes place
- ❖ **Cylinder head:** Top portion of engine cylinder which holds spark plugs, valves etc.
- ❖ **Crankshaft:** Engine output is obtained
- ❖ **Connecting rod:** Connects piston to crankshaft
- ❖ **Camshaft:** Controls opening and closing of valves
- ❖ **Crankcase:** Lower part of engine surrounding the crankshaft.
- ❖ **Intake valve:** Allows air-fuel mixture to come in through intake manifold
- ❖ **Exhaust valve:** Allows burnt gases discharge through exhaust manifold



Basic components of an IC engine

Classification of Heat Engine



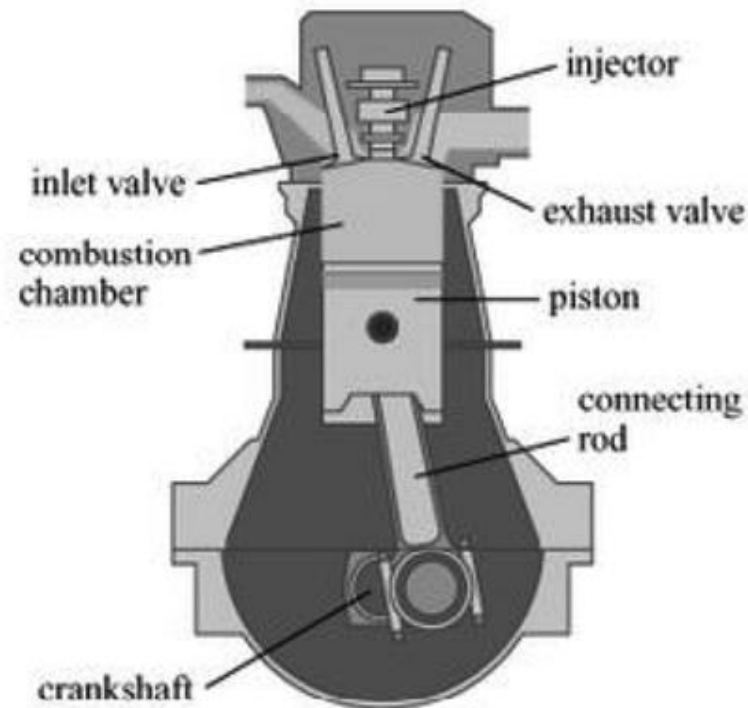
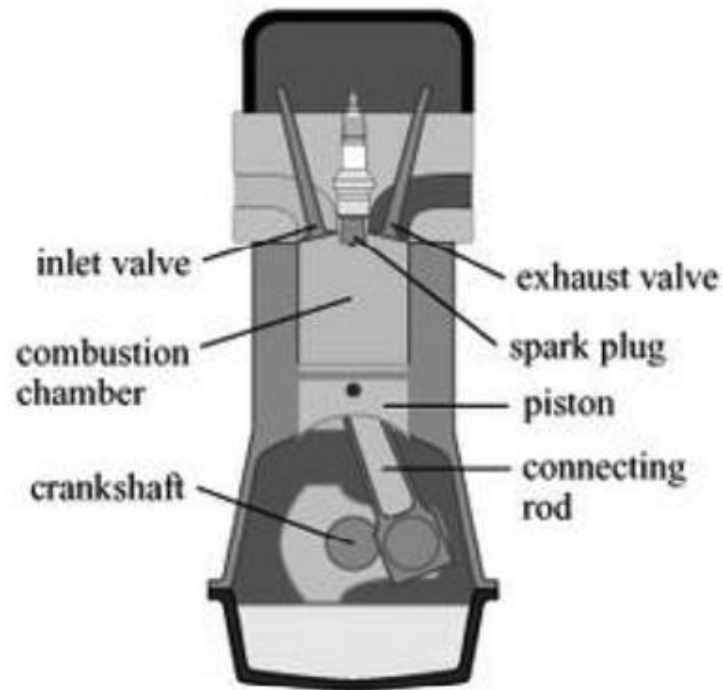
Engine Terminology

- ❖ **Top dead center (TDC):** Extreme piston position close to cylinder top
- ❖ **Bottom dead center (BDC):** Extreme piston position close to crankcase
- ❖ **Clearance volume, V_c :** Volume of combustion chamber above piston when it is at TDC
- ❖ **Swept volume, V_d :** Volume swept by piston between TDC and BDC
- ❖ **Compression ratio, V_r :** Ratio of maximum to minimum volume. V_r is 8-12 for SI engines and 12-24 for CI engines.
- ❖ **Stroke:** Linear distance travelled by piston between TDC and BDC

Classification of IC Engine

1. Based on Method of Ignition

- ❖ **Spark ignition (SI) engine:** Also called Otto engine or gasoline or petrol engine
- ❖ **Compression ignition (CI) engine:** Also called Diesel engine



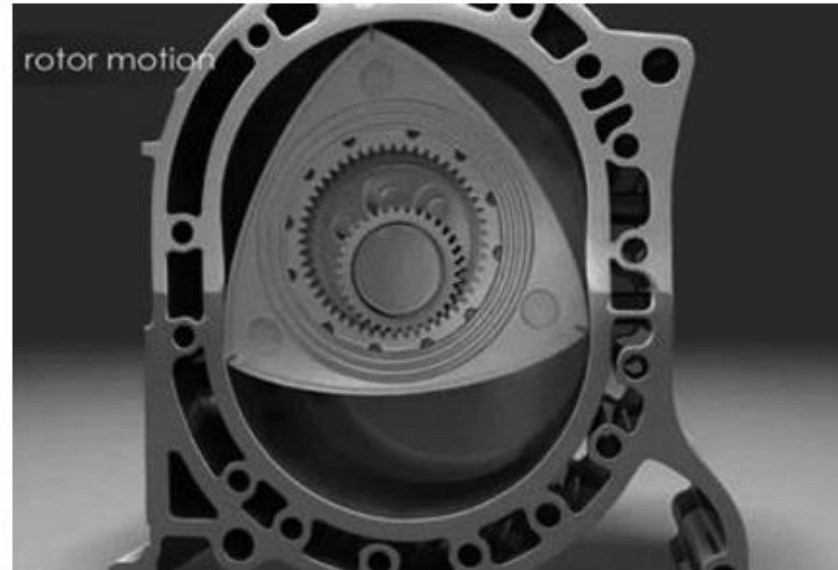
Classification of IC Engine

Based on Design

- ❖ **Reciprocating engine:** Subdivided by arrangement of cylinders: e.g., in-line, V, radial, opposed etc
- ❖ **Rotary engine:** Wankel engine



Reciprocating engine

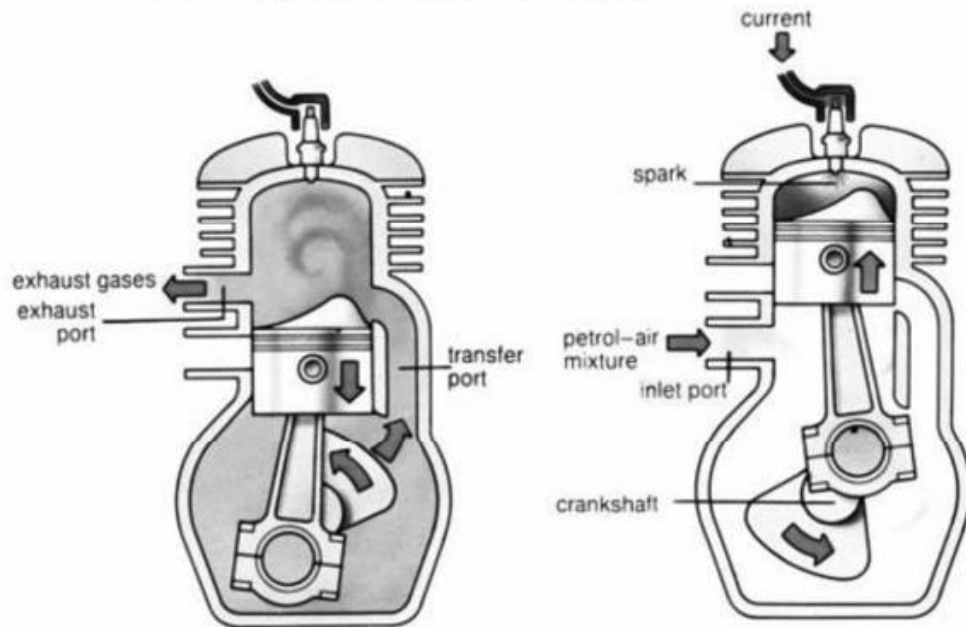


Rotary engine

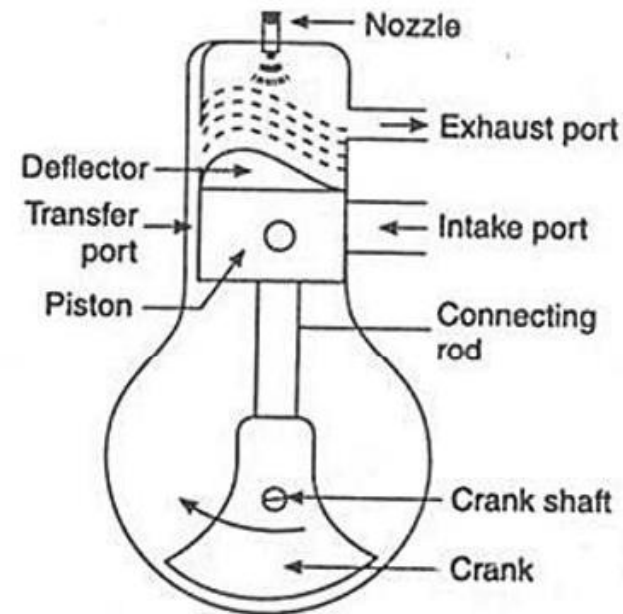
Classification of IC Engine

► Based on working cycle

- ❖ **Four-stroke cycle:** Engine cycle is completed in two rotations of crankshaft.
- ❖ **Two-stroke cycle:** Crankcase scavenged, supercharged, and turbocharged
- ❖ Naturally aspirated (admitting atmospheric air), supercharged (admitting pre-compressed fresh mixture), and turbocharged (admitting fresh mixture compressed in a compressor driven by an exhaust turbine)



A two-stroke SI engine

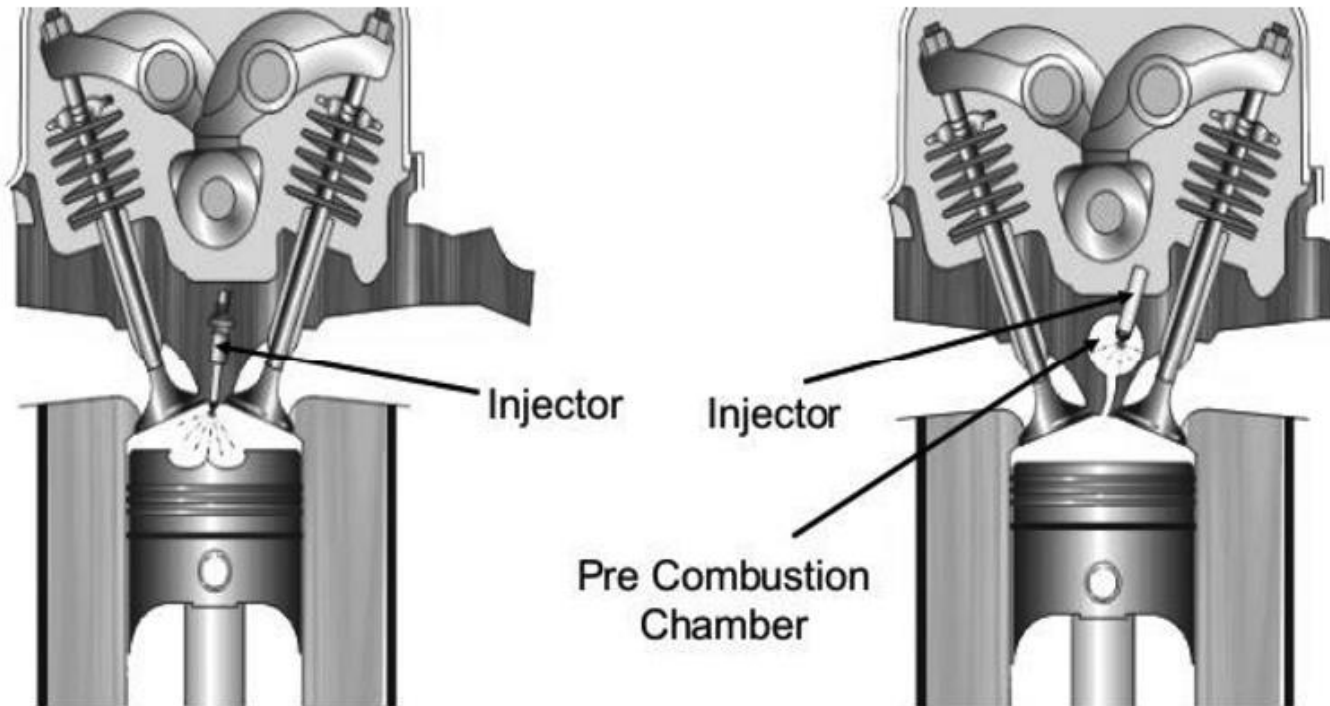


A two-stroke CI engine

Classification of IC Engine

► Based on combustion chamber design

- ❖ **Open Chamber:** Many designs: e.g., disc, wedge, hemisphere, bowl-in-piston
- ❖ **Divided Chamber:** Small and large auxiliary chambers; many designs: e.g., swirl chambers, pre-chambers



Classification of IC Engine

Based on Method of Cooling

- ❖ **Water Cooled:** Water is used for cooling the engine.
- ❖ **Air Cooled:** Air is used for cooling the engine.

Based on Valve or Port Design and Location

- ❖ Overhead (or I-head) Valves
- ❖ Underhead (or L-head) Valves
- ❖ Rotary Valves
- ❖ Cross-Scavenged Porting: Inlet and exhaust ports on opposite sides of cylinder.
- ❖ Loop-Scavenged Porting: Inlet and exhaust ports on same side of cylinder.
- ❖ Through or uniflow scavenged: Inlet and exhaust ports at different ends of cylinder.

Classification of IC Engine

Based on fuel

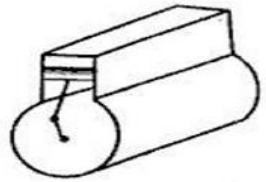
- ❖ Petrol
- ❖ Diesel
- ❖ Natural gas
- ❖ Liquid petroleum gas
- ❖ Alcohols (methanol, ethanol)
- ❖ Hydrogen
- ❖ Dual fuel

Based on method of load control

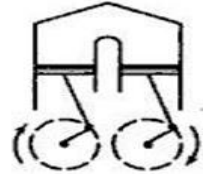
- ❖ Throttling of fuel and air flow together
- ❖ Control of fuel flow alone
- ❖ A combination of these two

Classification of IC Engine

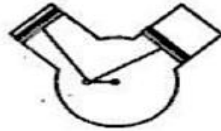
- Based on cylinder arrangement



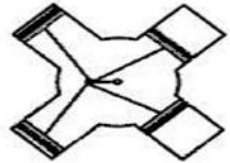
In-line



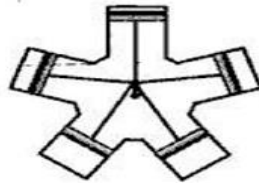
U-cylinder



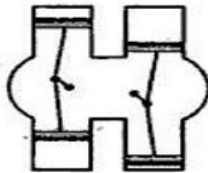
V-type



X-type



Radial



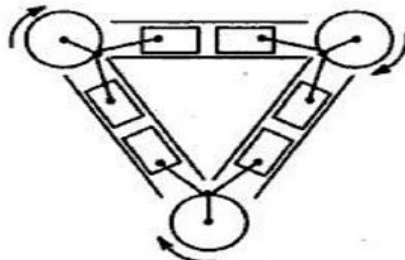
H-type



Opposed cylinder



Opposed piston



Delta type

Classification of IC Engine

► On the basis of ignition

Spark-ignition engines require an external source of energy for the initiation of spark and thereby the combustion process. A high voltage spark is made to jump across the spark plug electrodes. In order to produce the required high voltage there are two types of ignition systems which are normally used. They are :

- (i) battery ignition system
- (ii) magneto ignition system.