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\* **Heat Engine**:- A heat engine is a device in which the chemical energy of a fuel is first converted into heat energy, subsequently this heat energy is converted into mechanical energy.

OR.

An engine is a device which transforms one form of energy into another form. Normally, most of the engines convert thermal energy into useful mechanical work and therefore they are called as heat engine.

\* **Types of Heat Engines**:-

1). External Combustion engines.

2). Internal Combustion (I.C) Engines.

\* Basic Components of engine and its nomenclature:-

1). Cylinder:- It is a cylindrical vessels in which piston reciprocates. It is made up of cast iron or alloy steel. The cylinder is supported in the cylinder block.

2). Cylinder head:- The junction of cylinder head is to seal top end of the cylinder. Space is provided to carry the valve mechanism, spark plug etc.

3). Piston and Piston rings:- The junction of piston is to transmit the gas force to connecting rods, hence to the crank. It slides in the cylinder. Usually, pistons are made of cast steel and aluminium alloy since it requires strength.

Piston rings made of cast steel are provided to prevent the leakage of gas to crank case. Upper rings are called compression rings.

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4). Gudgeon pin or Piston Pin:- It is made of hardened steel in the shape of spindle. It connects the piston to small end of the connecting rod and the bearings fitted in it are called small end bearings.

5). Connecting rod:- Connecting rod transmits the piston load (gas force) to the crank. It converts the reciprocating motion of the piston into rotary motion of the crankshaft.

6). Crank and Crankshaft:- Crank is the integral part of the crankshaft.

Crankshaft is supported in main bearings and carries the balancing weights. It also carries the flywheel to even out the fluctuating torque.

7). Engine bearings:- Crankshaft is supported in main bearings, which are lubricated. Function of bearings is to facilitate smooth motion to crankshaft and reduce friction between them.

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8). **Crankcase:-** Crank, Crankshaft and main bearings are set in the Crank case. The bottom of the engine is closed by means of oil sump which carries lubricating oil.

9). **Flywheel:-** A heavy rotating mass is attached to Crankshaft outside the Crankcase. Called flywheel.

10). **Valve and valve mechanism:-** The engine has two valves, namely, the Suction valve and the exhaust valve. These valves are operated by Cam mounted on Camshaft.

11). **Spark Plug:-** The function of a Spark plug is to provide a high intensity spark for combustion of fuel and air in the cylinder in spark ignition engines.

12). **Carburettor:-** The function of Carburettor is to prepare the mixture of fuel and meter it before sending it to induction system of the engine according to operating conditions of the engine in case of Spark ~~ignition~~ ignition engines.

13). Fuel injection pump; - Function of fuel pump is to inject the atomised fuel to the cylinder under very high pressure in case of compression ignition engines. (5)

### \* Terminology used in I.C. Engine:-

1). Dead Centres:- In case of vertical engines, when the piston is at the top most position, the crank position is called top dead centre (T.D.C). when the piston is at the bottom most position, the crank position is called bottom dead centre (BDC),

2). Clearance volume:- The volume contained in the cylinder above the piston from its top dead centre position is called clearance volume  $V_c$ .

3). Stroke volume:- The travel of piston from T.D.C to BDC is called piston stroke and the volume displaced by the piston is called stroke volume  $V_s$ .

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4). Compression ratio ( $\gamma$ ):- The ratio of cylinder volume to clearance volume is called the compression ratio of the engine.

$$\text{Cylinder volume} = \text{clearance volume } (V_c) + \text{Stroke volume } (V_s)$$

$$\therefore \text{Compression ratio, } \gamma = \frac{\text{Cylinder volume } (V_s + V_c)}{\text{Clearance volume } (V_c)}$$

\* Classification of I.C. Engines:-

1). Based on number of strokes per cycle:-

(a) Four stroke engine:- In which one cycle is completed in four strokes of the piston in two revolutions of the crankshaft.

(b). Two stroke engine:- In which one cycle is completed in two strokes of the piston in one revolution of the crankshaft.

2). Based on thermodynamic cycle used <sup>(7)</sup>

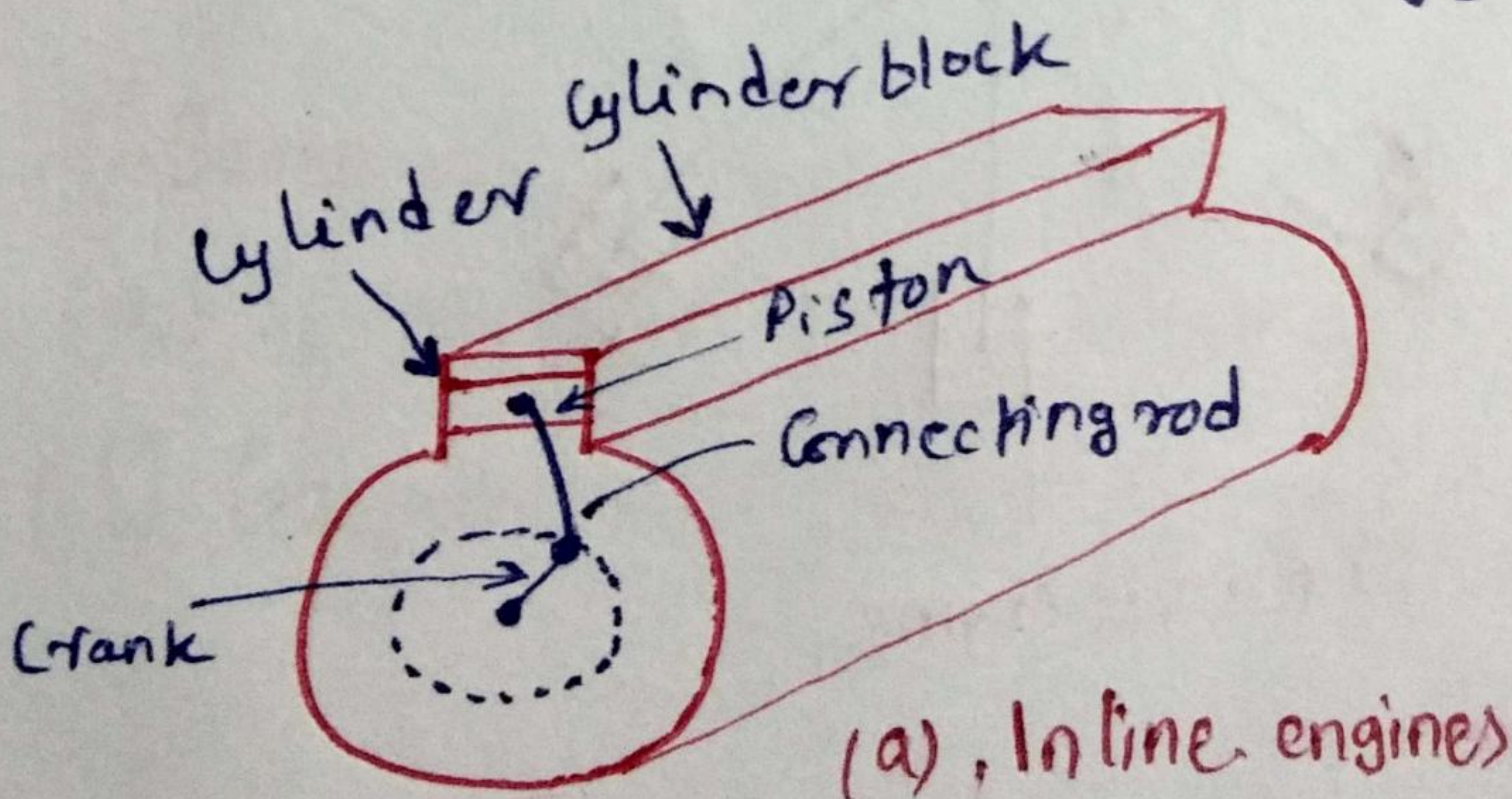
- (a). Constant Volume Combustion cycle or Otto cycle.
- (b). Constant pressure Combustion cycle or Diesel cycle.
- (c). Partly at constant volume, and partly at constant pressure Combustion cycle or Dual Combustion cycle.

3). Based on number of cylinders:-

- (a). Single cylinder engine.
- (b). Multicylinder engine.

4). Based on arrangement of cylinders.

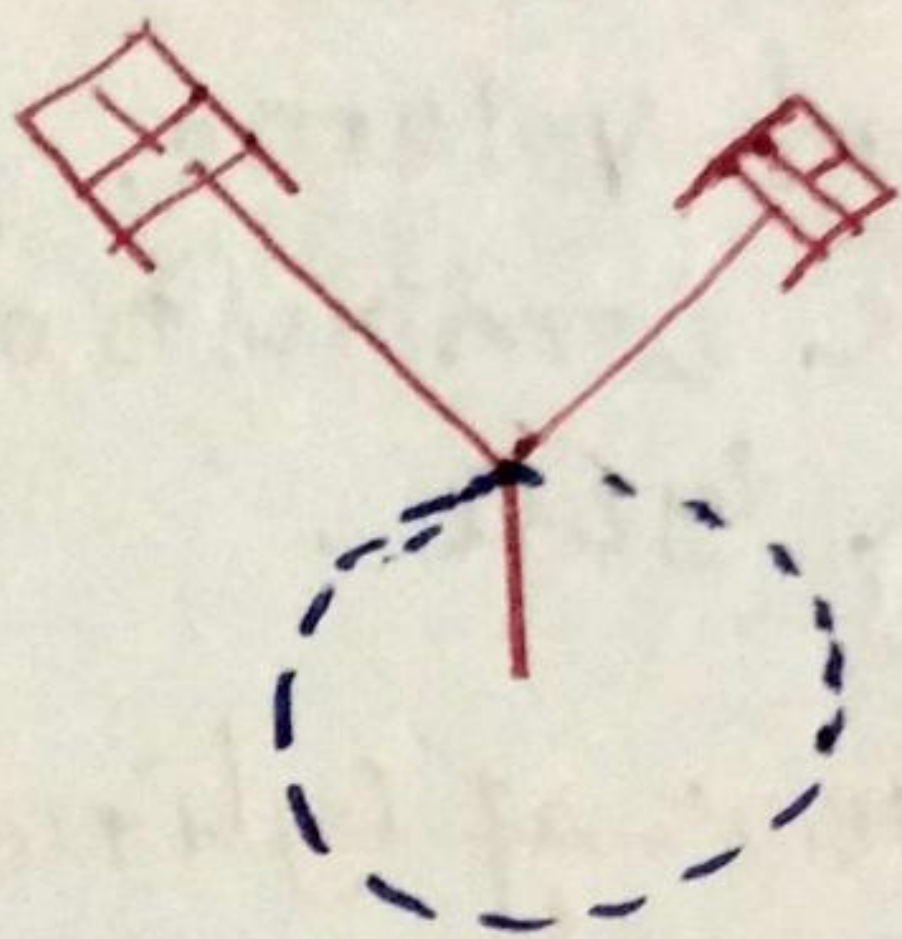
(a) Inline engines;- In this all the cylinders are arranged with their axis parallel and transmit the power to a single crank-shaft.



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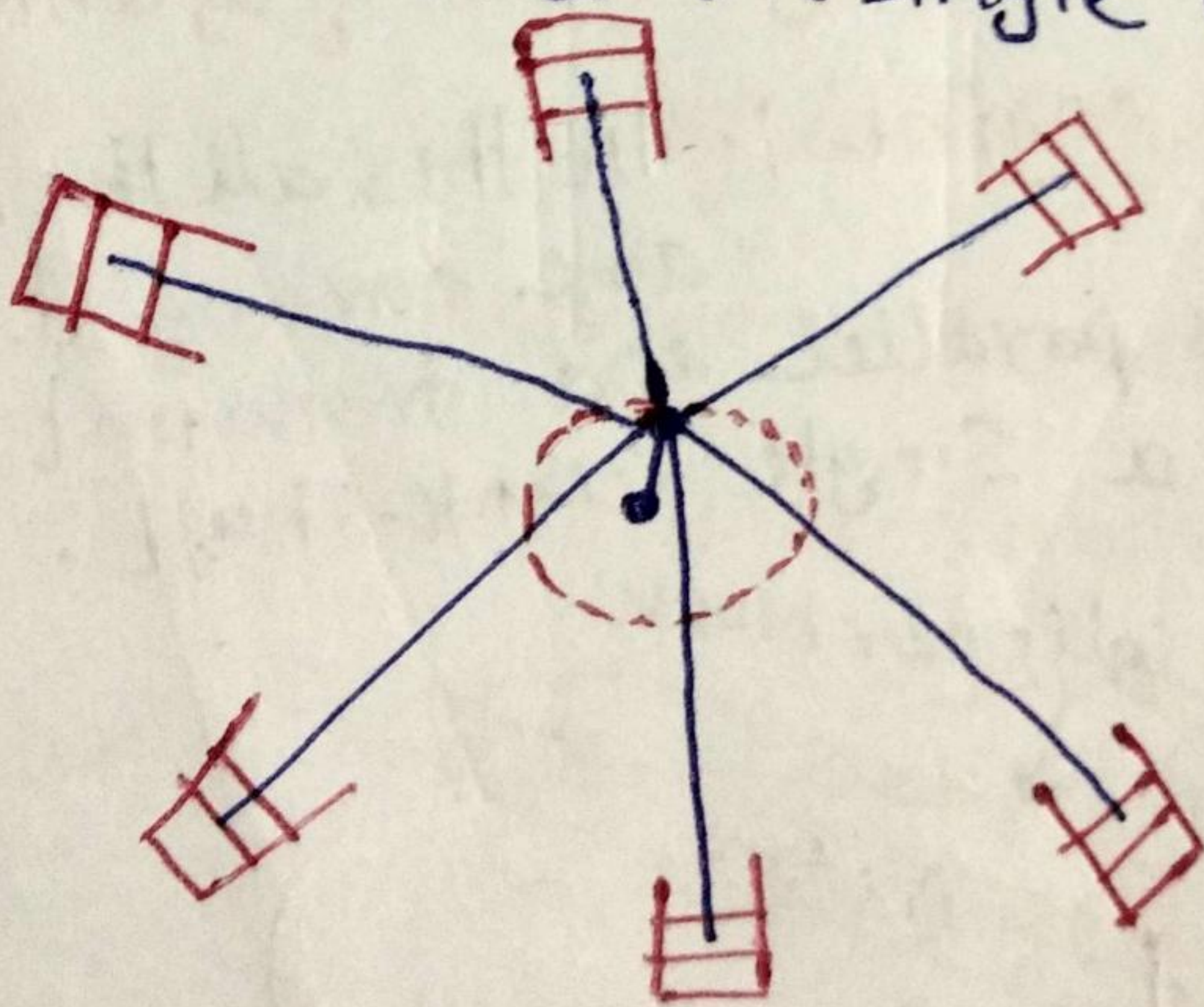
(b). V-engines:- These engines contain two banks of cylinder connected to the same crank and crank-shaft. Their axis are inclined to each other.

~~(a)~~



(b) V-engine

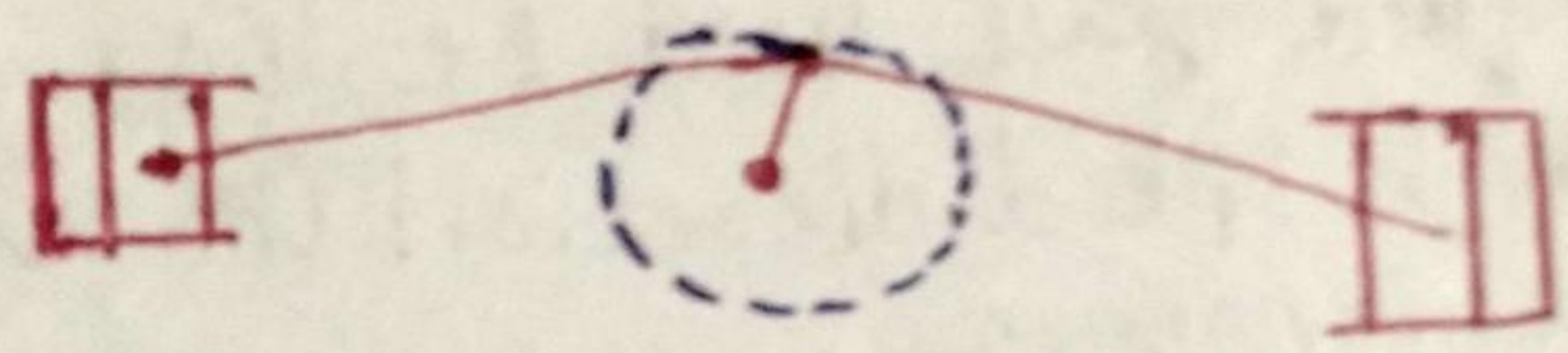
(c). Radial engines:- In this the cylinders are arranged radially and are connected to a single crank-shaft.



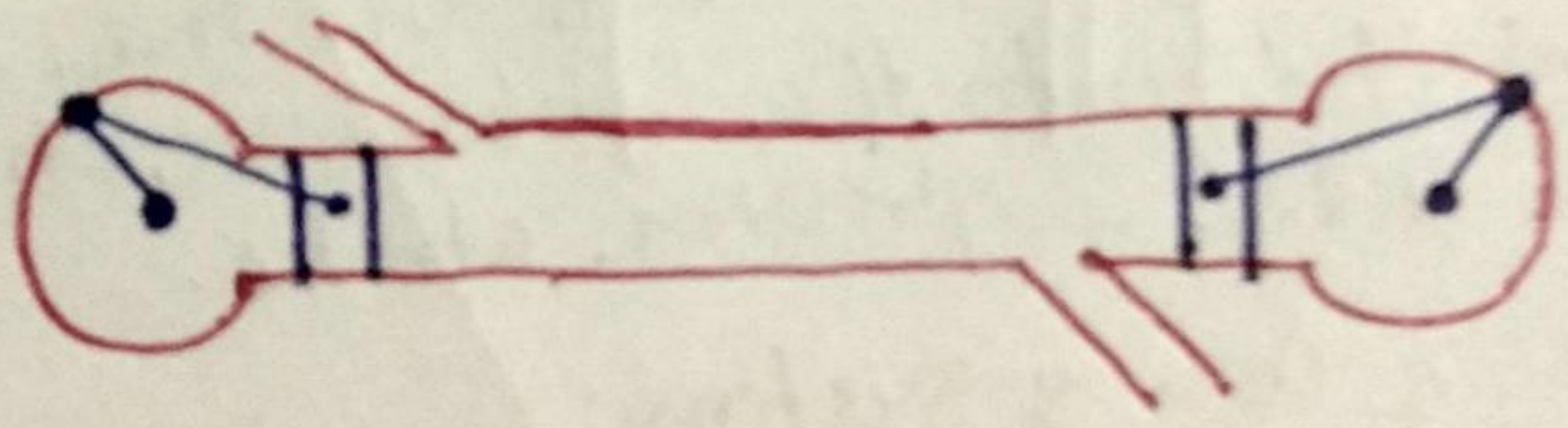
(c) Radial engine.



(d). Opposite cylinder engine:- In this engine there are two cylinder banks which are located in the same plane on opposite sides of crankshaft. It can be visualized as two in-line engine arrangements  $180^\circ$  apart.



(e). Opposed piston engine:- In this engine a single cylinder houses two pistons, each of which drives a separate crankshaft.



5). Based on ignition system:-

(a) Spark ignition (S.I) engines:-

(b). Compression Ignition (C.I) engines:-

Compression ignition engines can be further classified as.

- (i) Normal type diesel engines:- These are based on the type of liquid fuel used i.e. light diesel oil (LDO), high speed diesel oil (HSD) and heavy oil diesel engines.
- (ii). Dual-fuel type diesel engines:- In these engines, a gaseous fuel or highly volatile fuel is supplied along with air during suction stroke or initial part of compression stroke through a gas valve in the cylinder head and the liquid fuel is injected into the combustion chamber near the end of compression stroke.

6). Based on cooling system:-

(a) water cooled

(b) Air cooled

7). Based on fuel used

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- (a) Petrol engines, (b) Diesel engines,  
(c) Gas engines.

8). Based on fuel supply system:-

(a) Carburettor engines:- In this the mixture of petrol and air from carburettor is supplied to the engine cylinder.

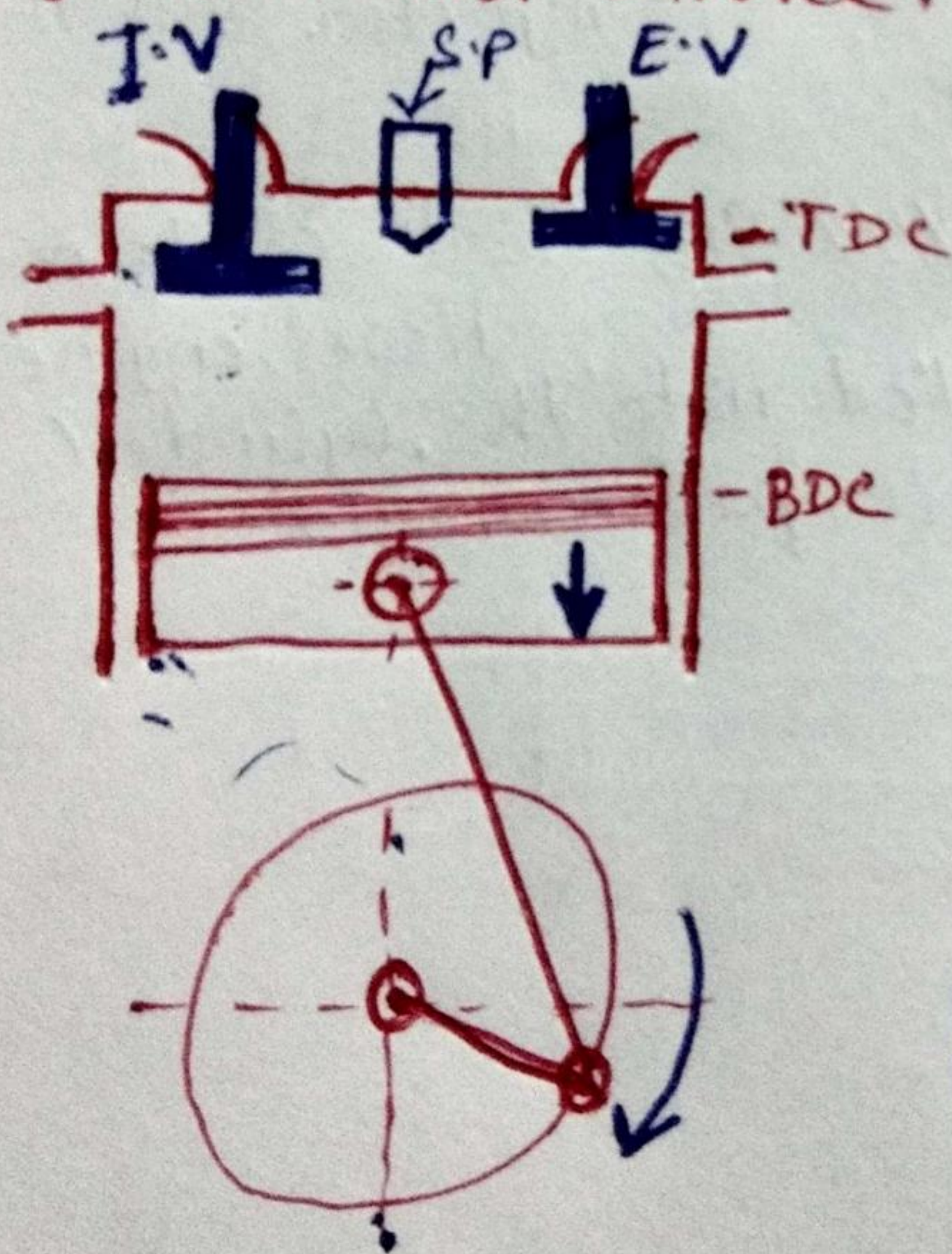
(b) Solid injection engine:- In this the fuel is injected with the help of a fuel pump.

(c) Air injection ~~system~~ engine:- In certain diesel engines the fuel is injected into the cylinder with the help of compressed air.

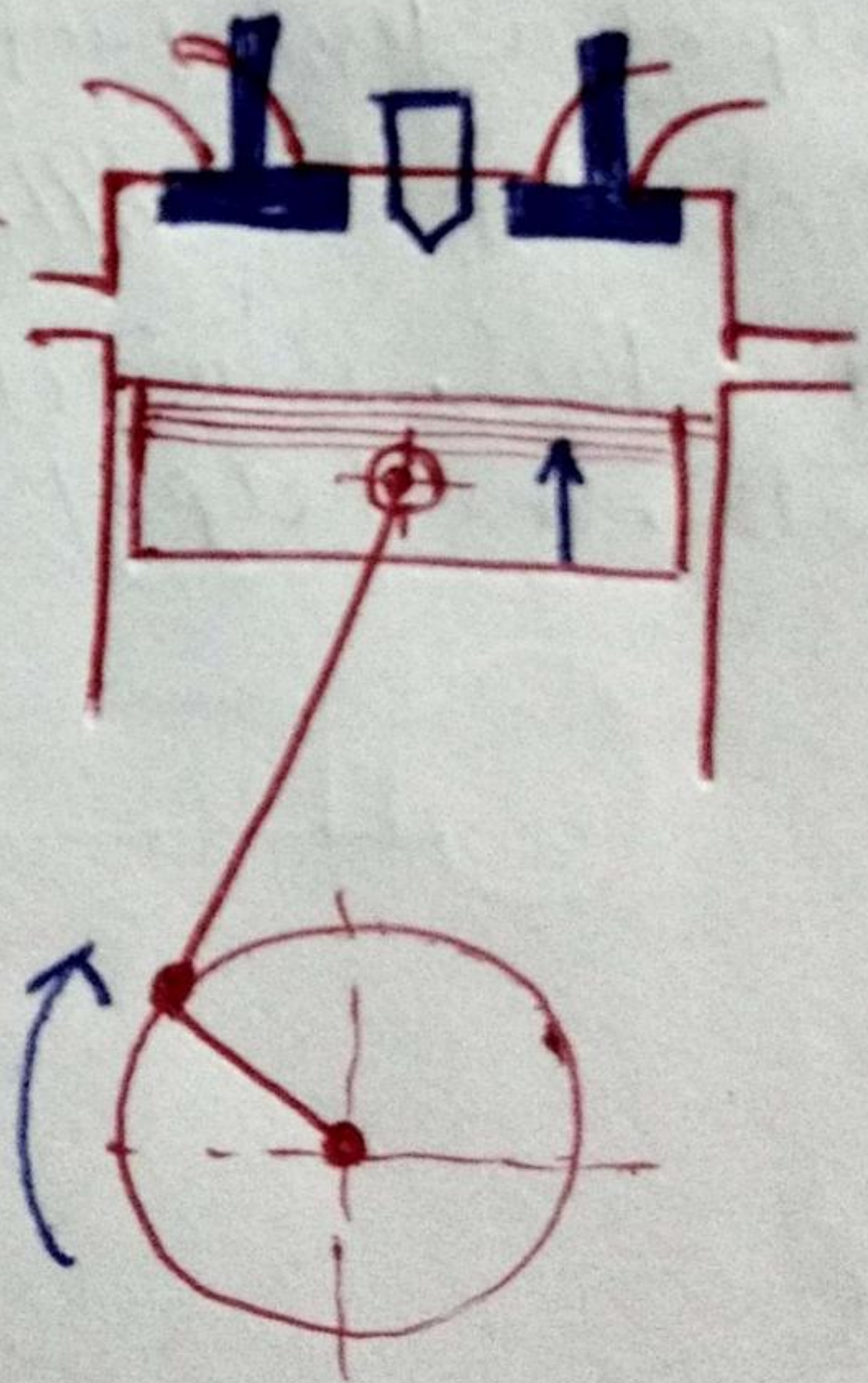
# \* Working Principle of four-stroke cycle S.I engine:-

In a four stroke engine, the cycle of operation is completed in four-stroke of the piston or two revolution of the crankshaft.

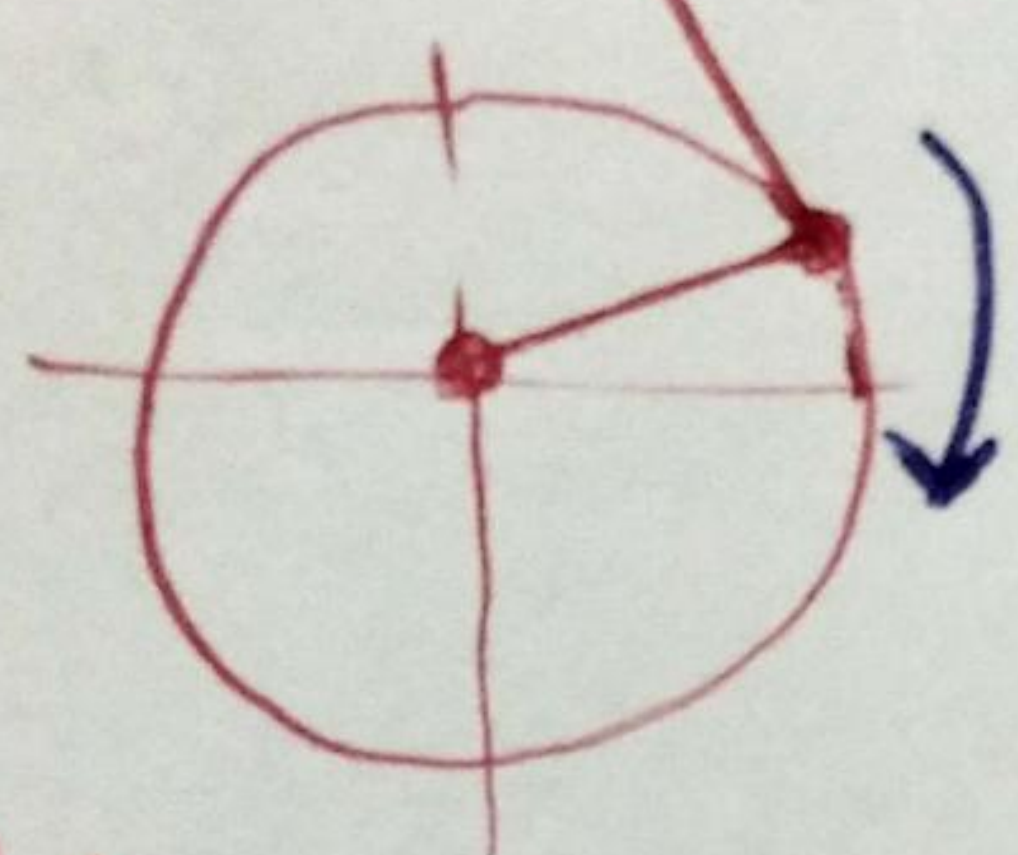
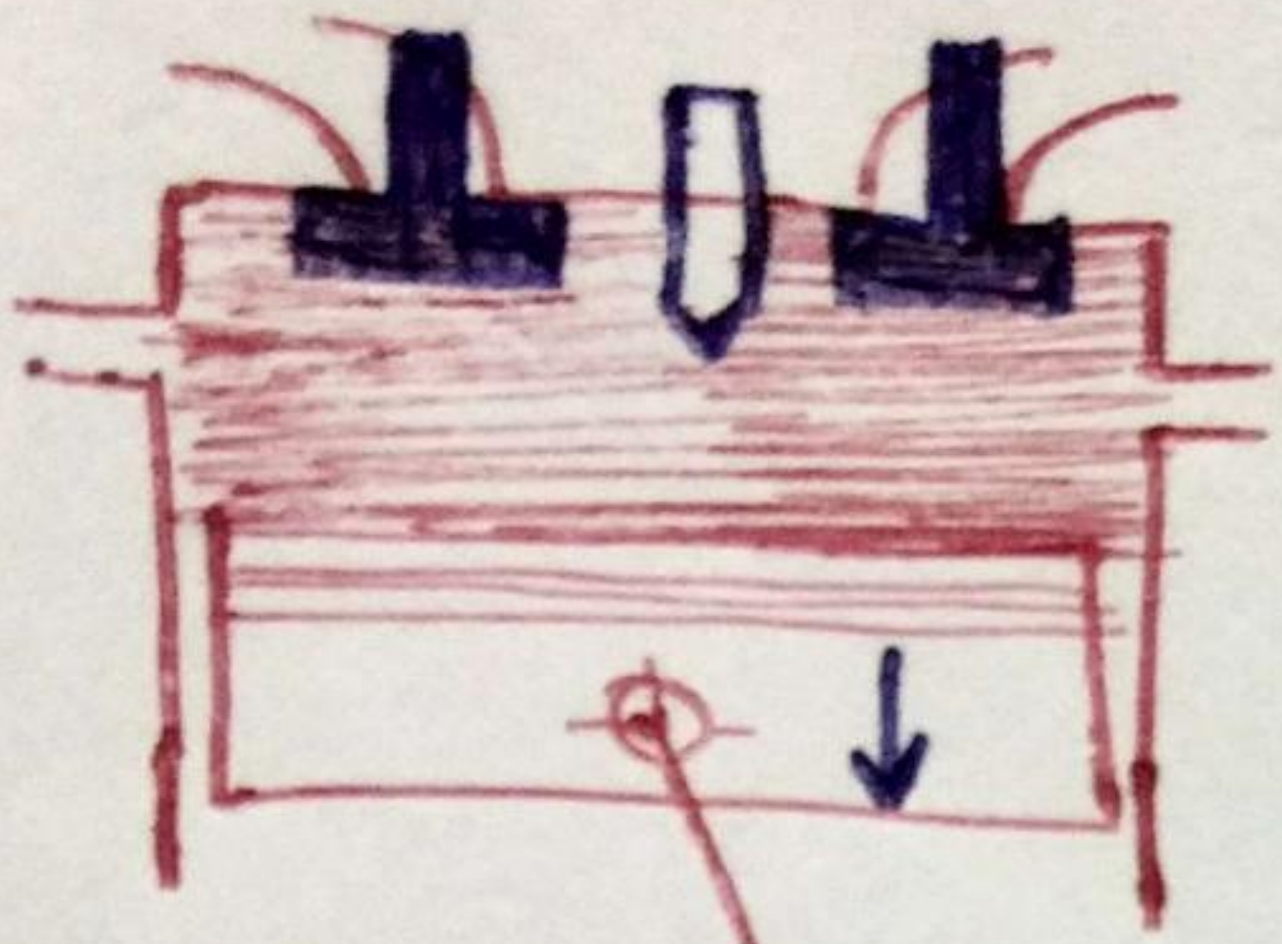
- i) Suction or Intake stroke
- (ii). Compression stroke
- (iii). Expansion stroke or power stroke
- (iv). Exhaust stroke.



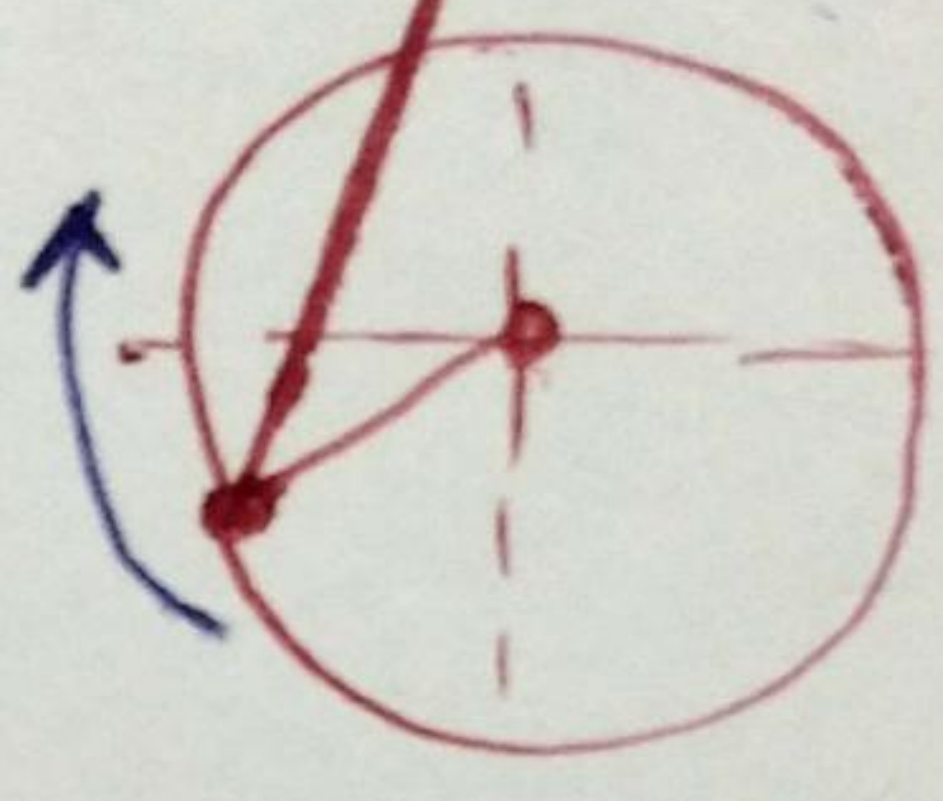
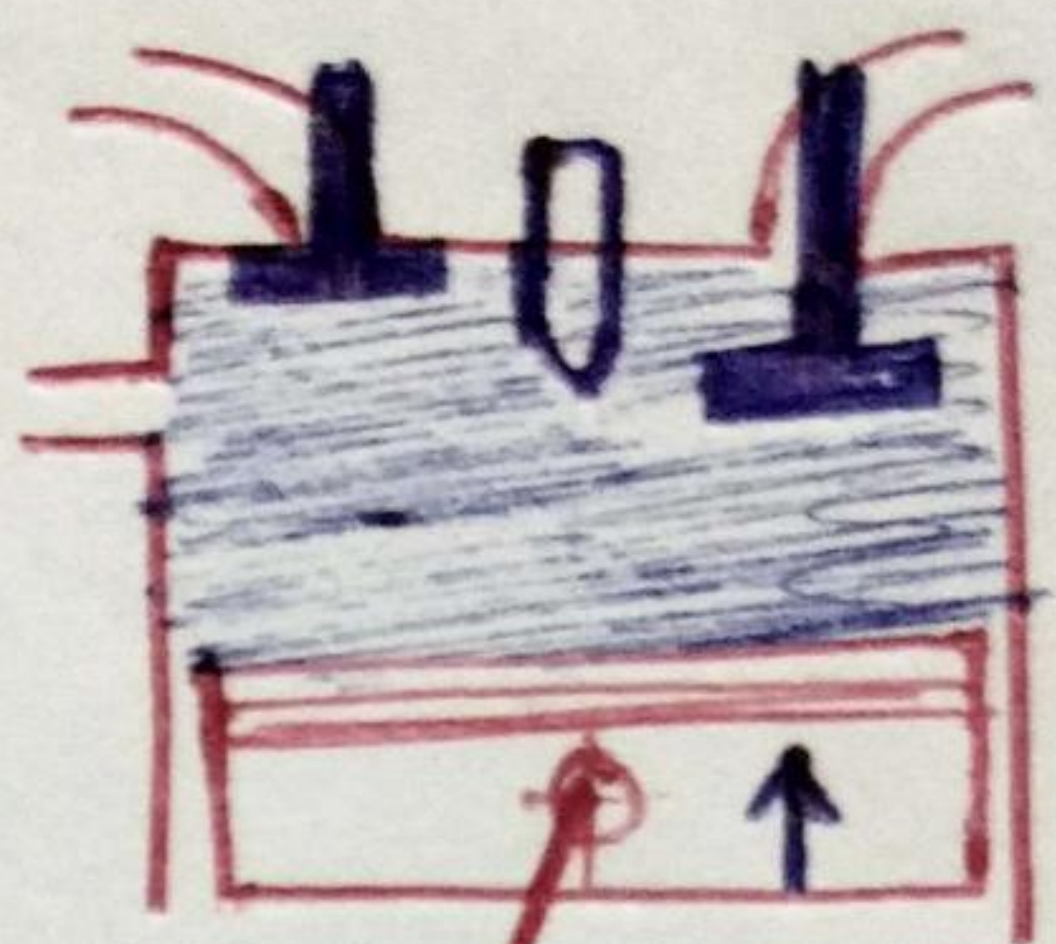
(a) Suction



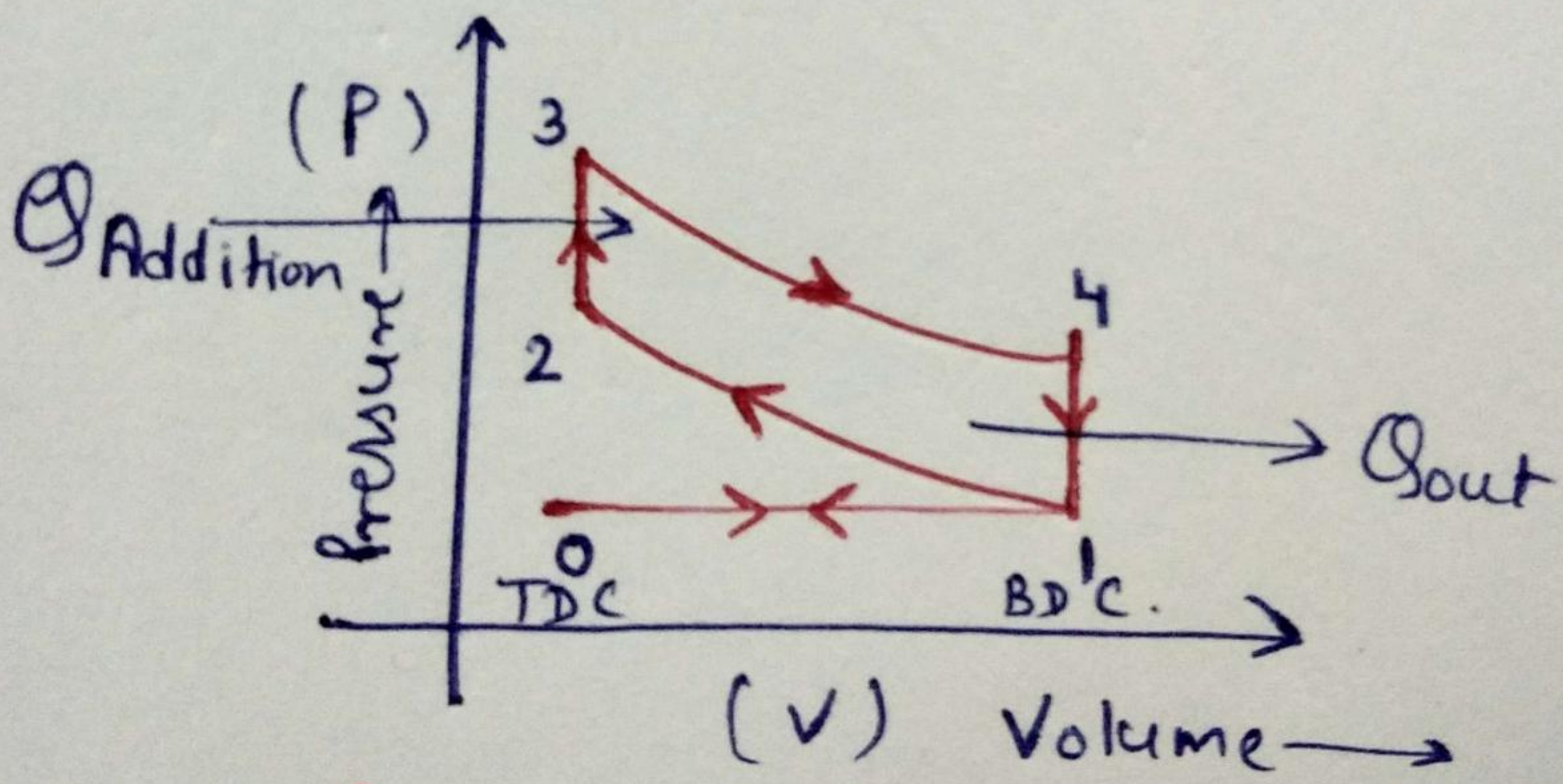
(b) Compression.



(c) Compression



(d) Exhaust



Pressure volume diagram.

- 0-1 = Intake stroke
- 1-2 = Adiabatic compression
- 2-3 = Const volume (Heat addition)

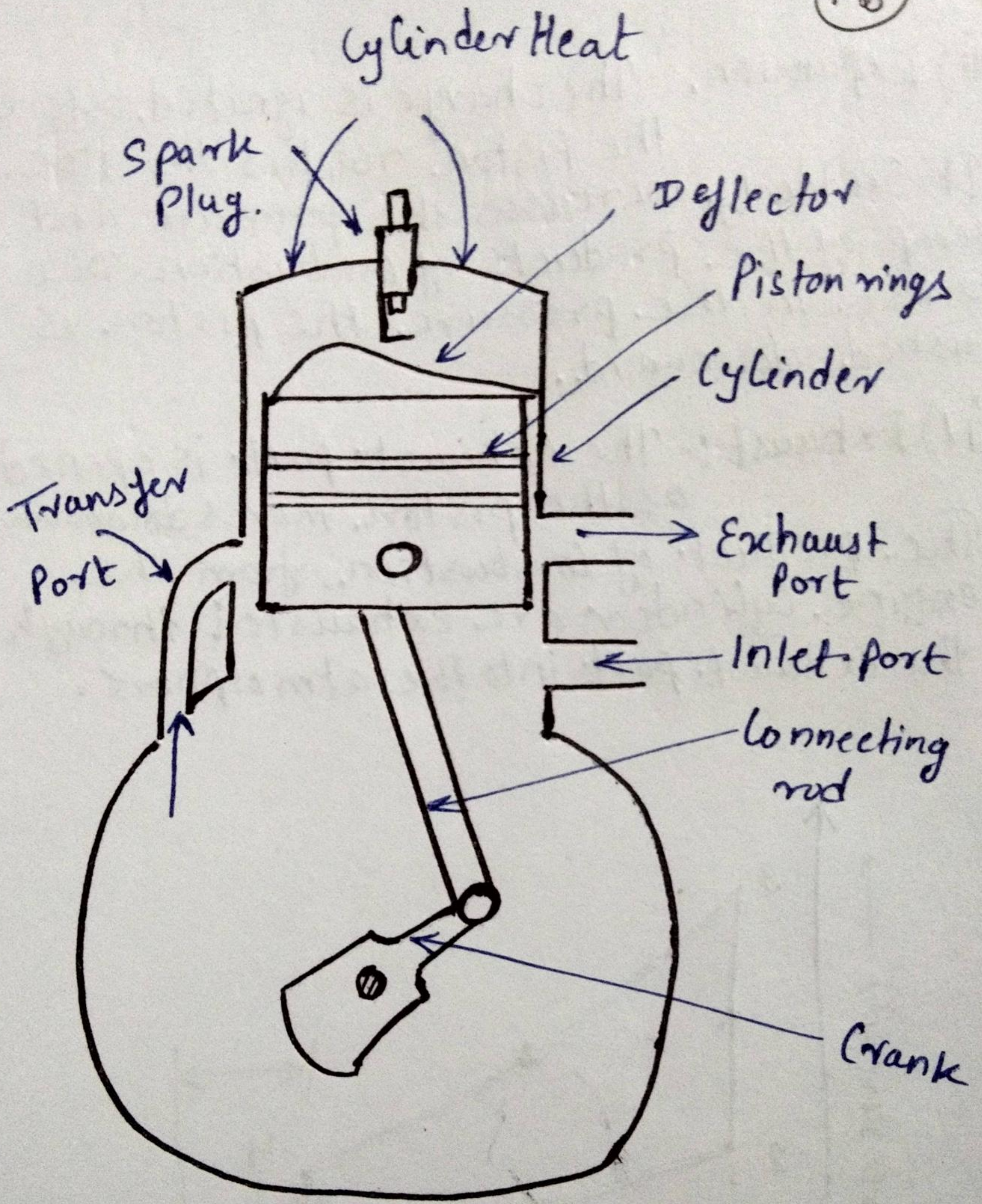
- 3-4 = Adiabatic expansion
- 4-1 = Heat rejection
- 1-0 = Exhaust stroke.

\* Working of Two-Stroke S.I (Petrol) engine:- In this type of Engine, the valves of the four stroke engine are replaced by ports which are three in numbers, namely, transfer port, inlet or induction port and exhaust port.

A two stroke engine is a type of internal combustion engine that completes a power cycle with two strokes of the piston during only one crankshaft revolution.

(i) Suction ~~stroke~~:- Piston moves towards BDC and while moving downward both the transfer port and exhaust port get opened. The air fuel mixture flows into the cylinder from the crankcase.

(ii), Compression:- In this stage, the piston moving upwards, it first covers the transfer port and then exhaust port. After the fuel is compressed as the piston moves upwards.



Two stroke S.I. engine.

(iii) Expansion :- The charge is ignited before the piston reaches the TDC. It suddenly increases the pressure and temp of the products of combustion. Due to rise in the pressure, the piston is pushed downward.

(iv) Exhaust :- The exhaust port is opened as the piston moves downwards. The product of combustion, from the engine cylinder are exhausted through the exhaust port into the atmosphere.

