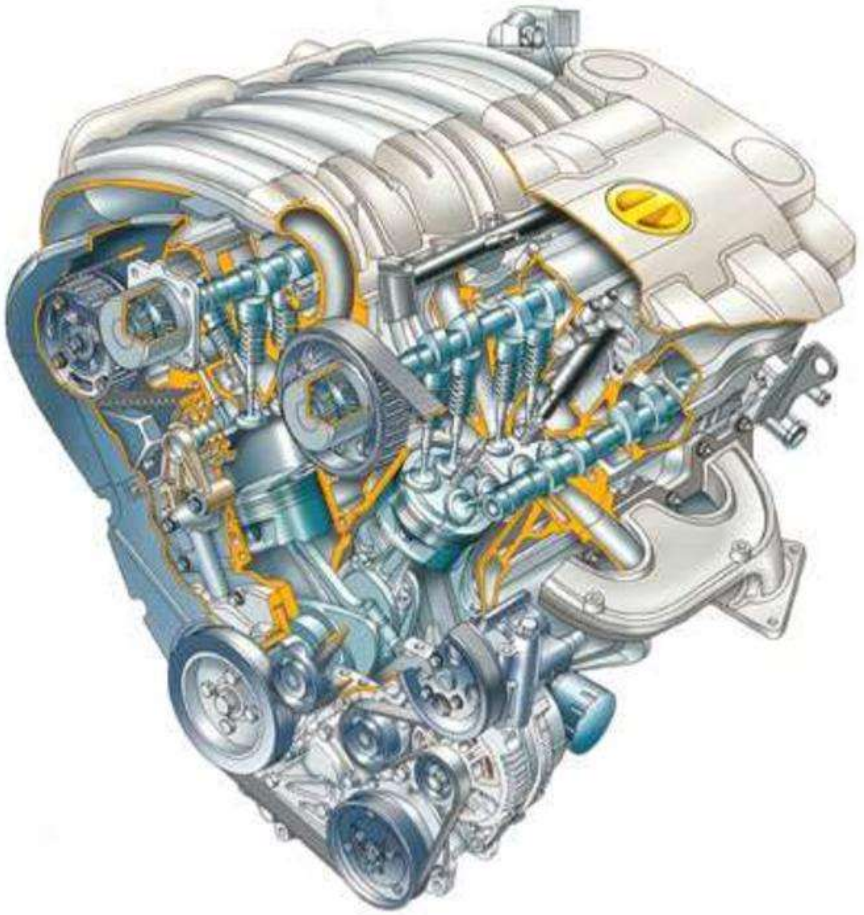
Internal Combustion Engines



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INTRODUCTION

ENGINE

Mechanical device which converts one form of energy into other form of energy

INTRODUCTION

Heat engine :

- It can be defined as any engine that converts thermal energy to mechanical work output.
- Examples of heat engines include: steam engine, diesel engine, and gasoline (petrol) engine.
- On the basis of how thermal energy is being delivered to working fluid of the heat engine, heat engine can be classified as an internal combustion engine and external combustion engine.

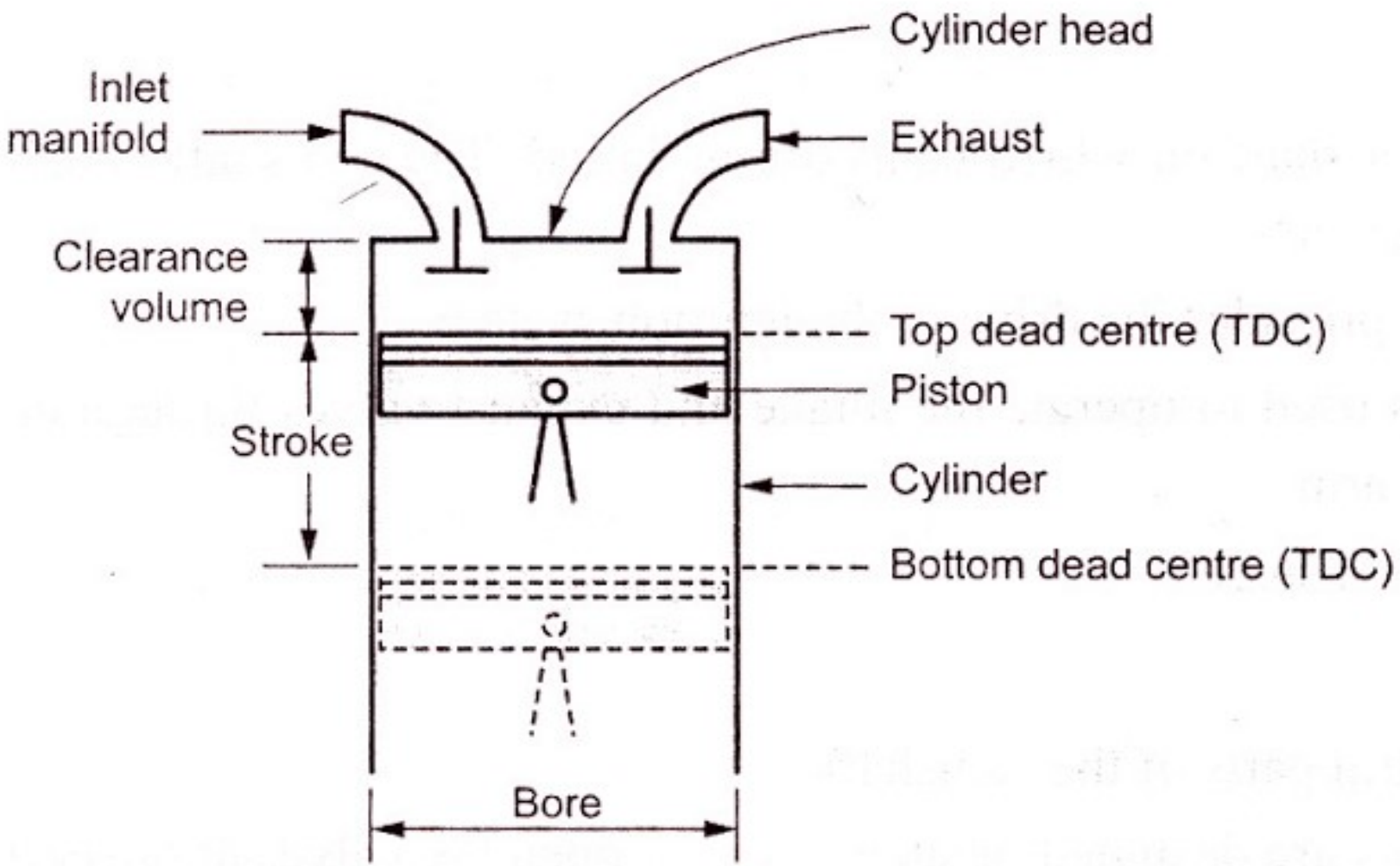
TYPES OF ENGINES

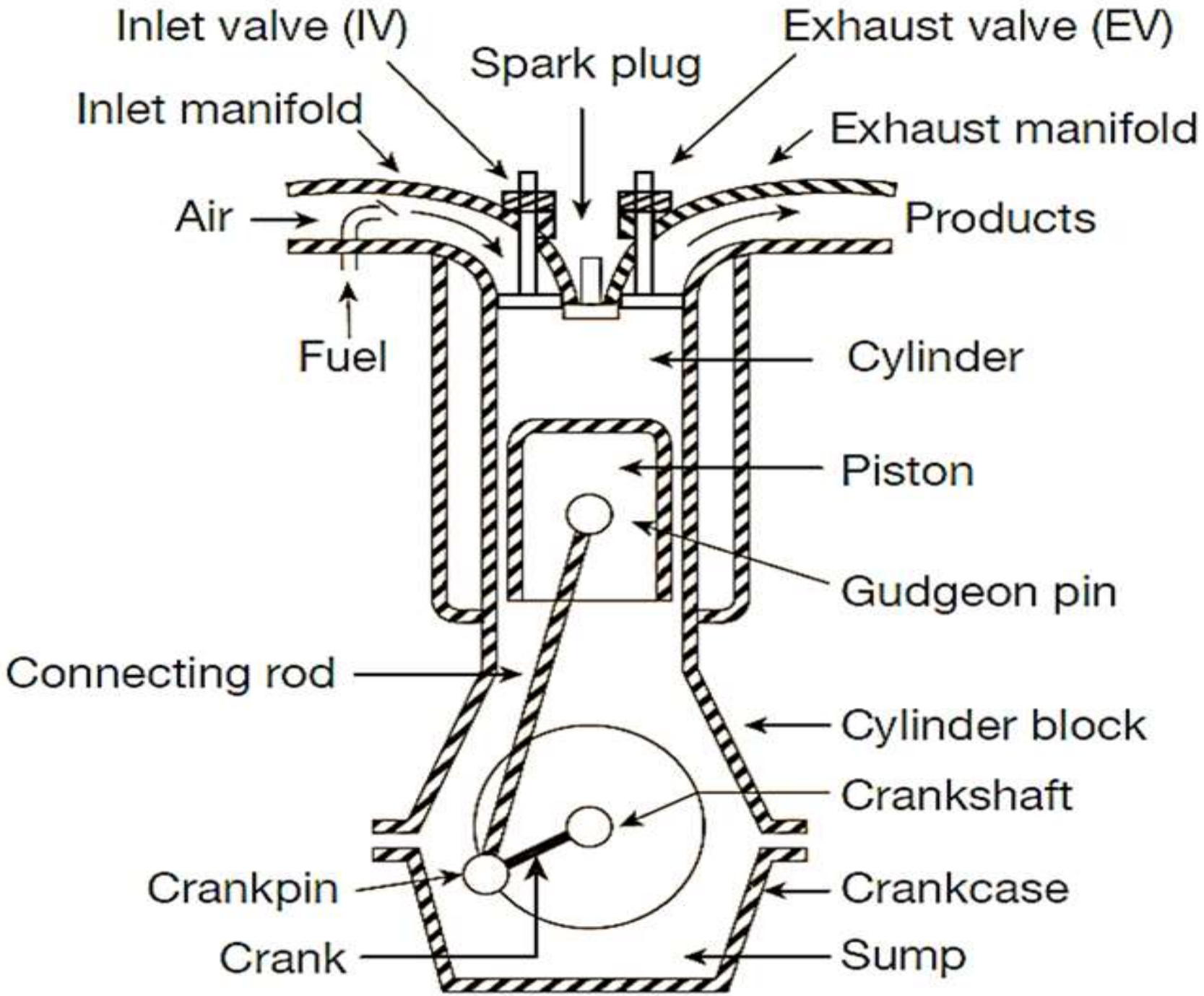
- In an **Internal combustion engine**, combustion takes place inside the engine cylinder
  - Petrol & Diesel engine is an example of internal combustion engine, where the working fluid is a mixture of air and fuel .
- In an **External combustion engine**, combustion takes place outside the engine cylinder
  - Steam engine is an example of external combustion engine, where the working fluid is steam.

Difference Between I C And E C Engine

	Internal Combustion Engine	External Combustion Engine
1	Name it self says that, combustion take place inside the cylinder.	Name it self says that, combustion take place outside the cylinder.
2	Temperature is higher.	Temperature is lower.
3	Pressure is higher.	Pressure is lower.
4	In IC engine, piston and connecting rod is use.	In EC engine, stuffing box is use.
5	Efficiency is higher.	Efficiency is lower.
6	Lighter in weight.	Heavy in weight.
7	IC engine is costly.	EC engine is cheaper compared to IC engine.
8	Less time required to start.	More time required to start.
9	Pressure generated inside the engine is due to combustion of fuel.	Pressure generated inside the engine is due to steam of water.
10	Fuel tank required to store fuel.	Boiler and water storage required to generate steam.

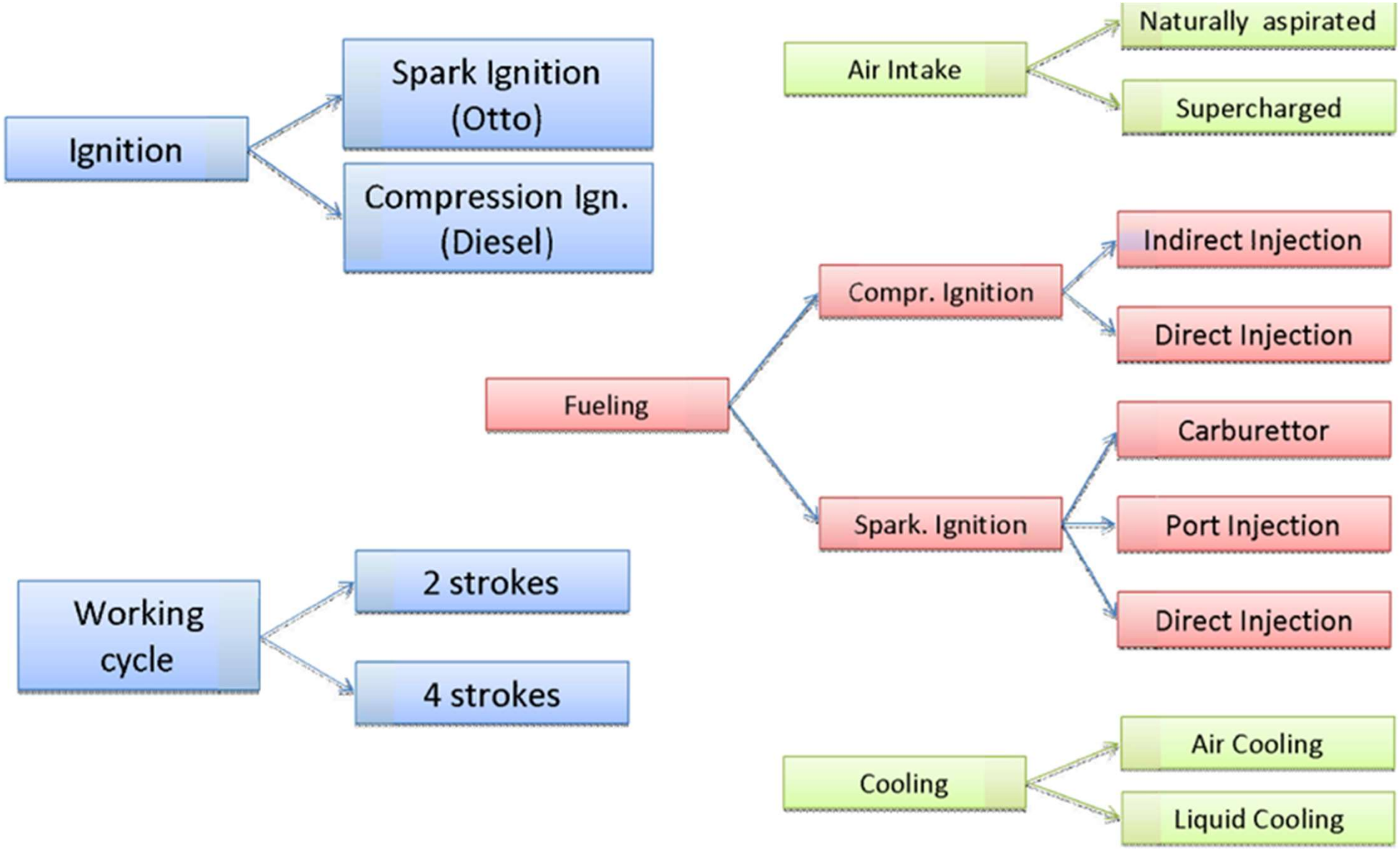
Terms for I C Engine



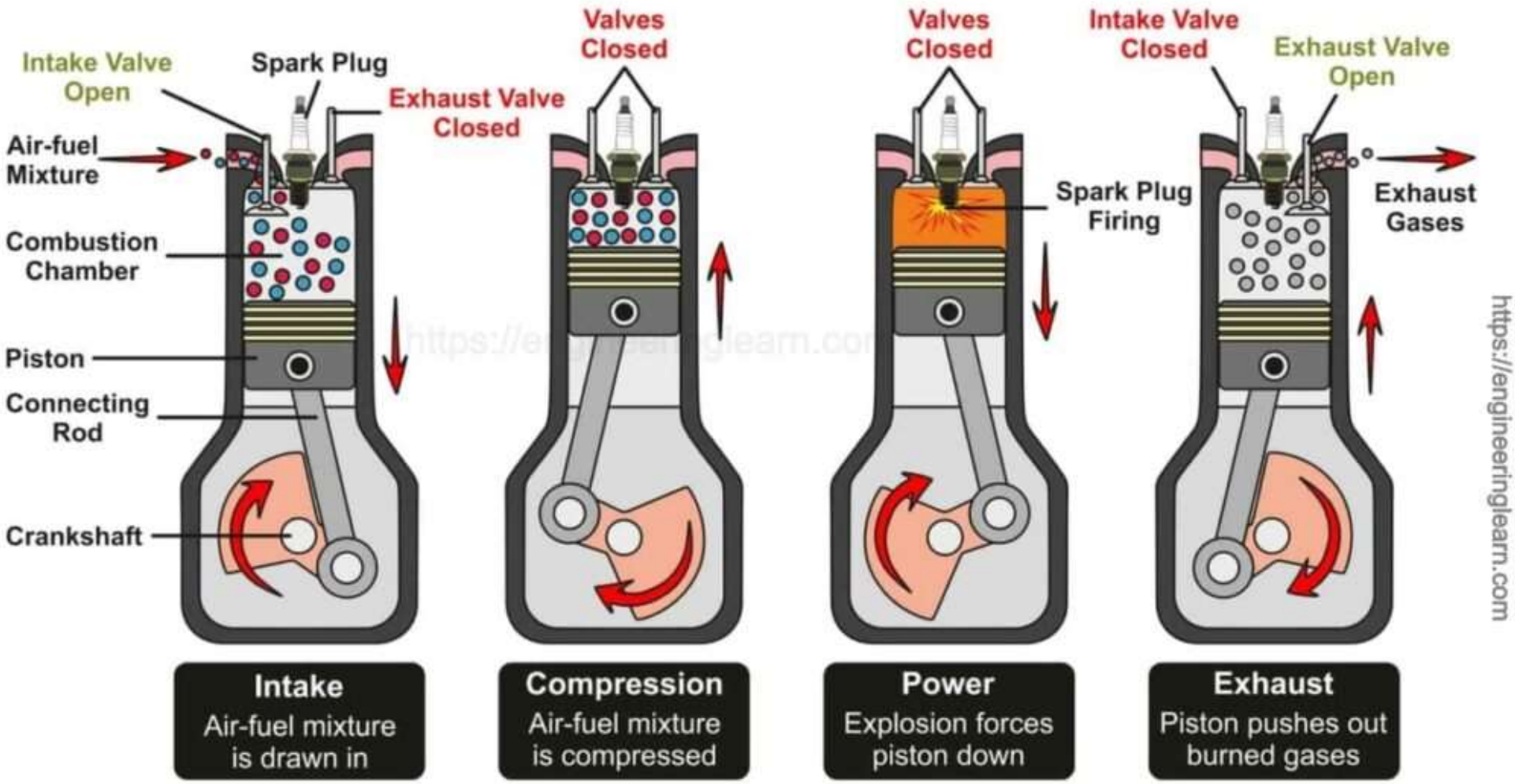


What is IC Engine?

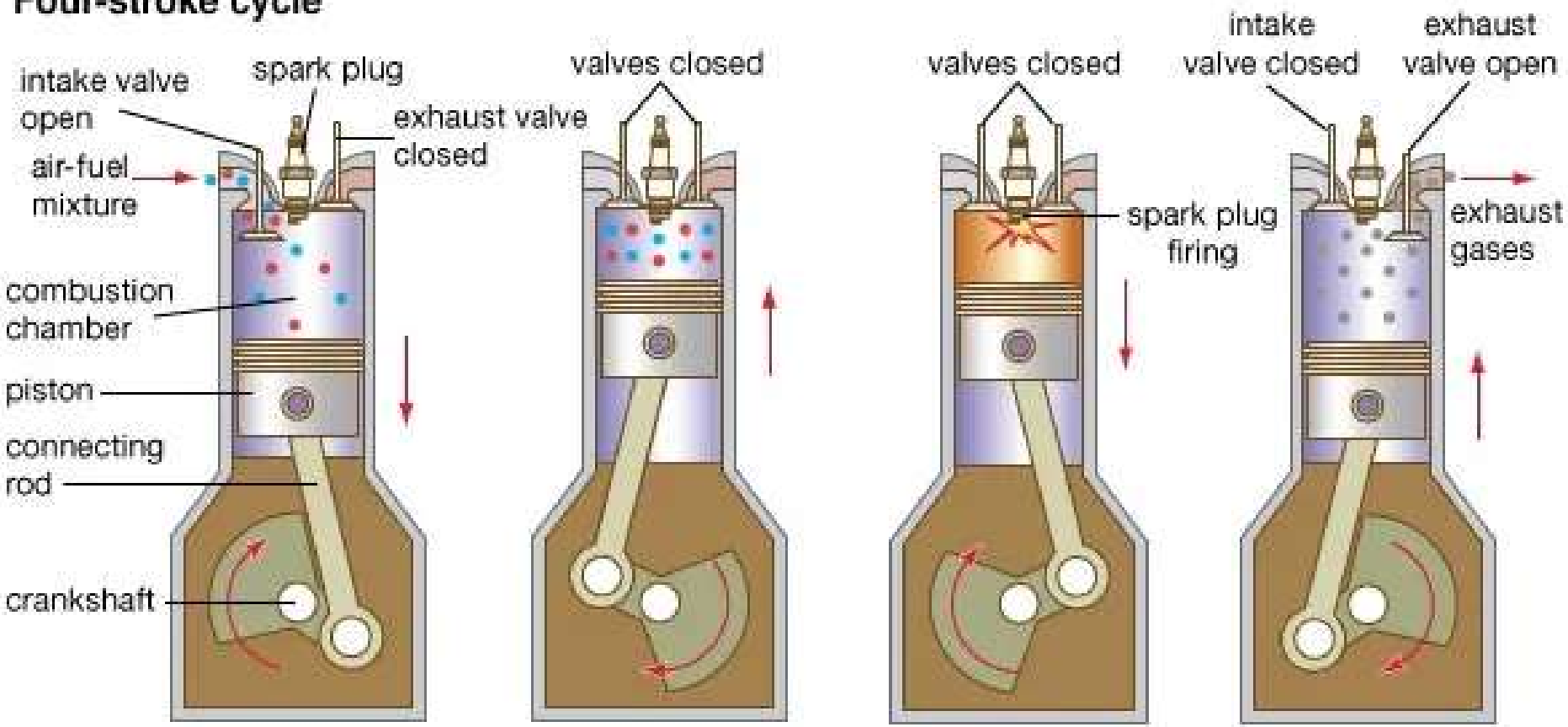
Classification of I C Engine



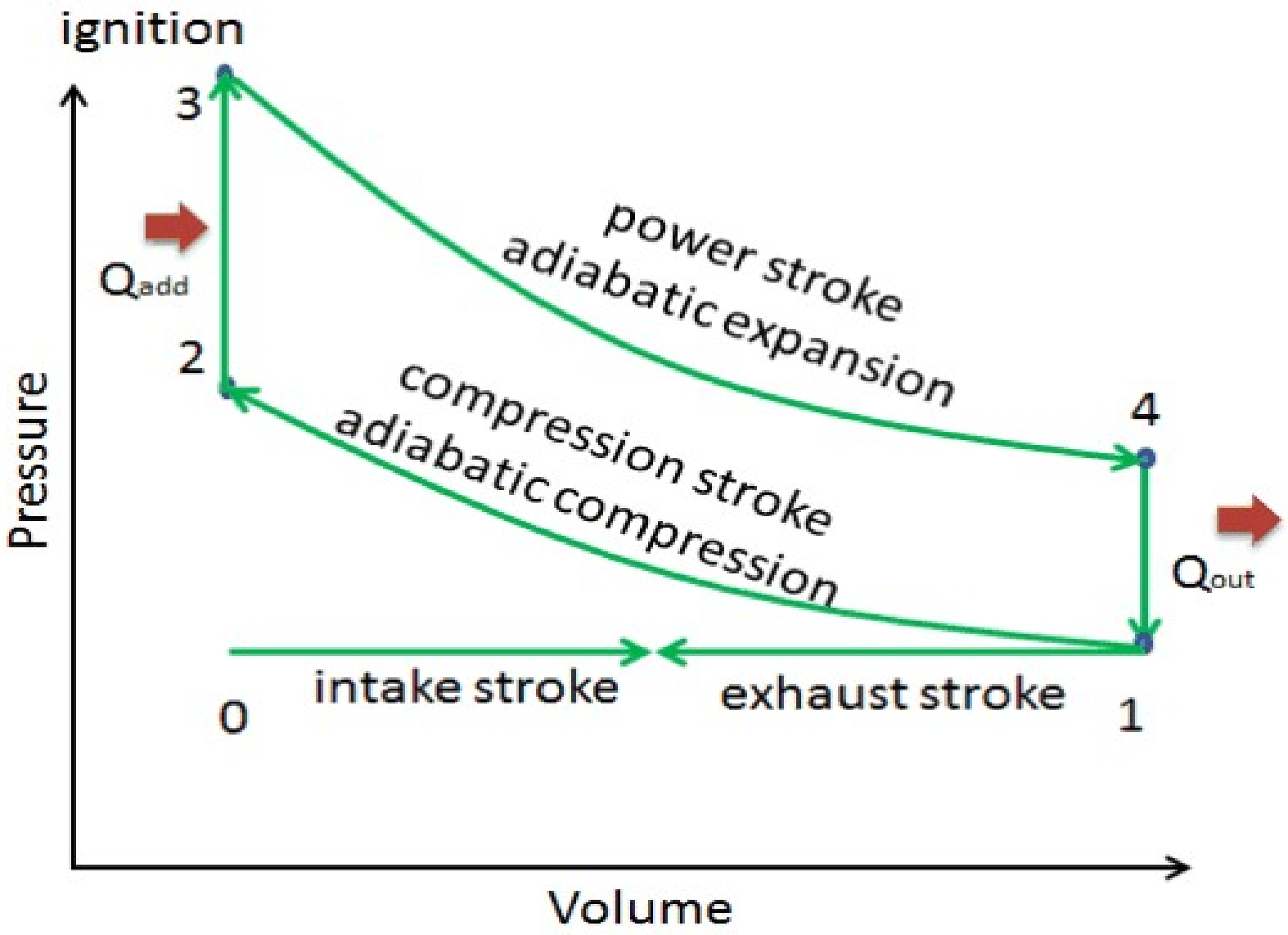
Four Stroke Engine



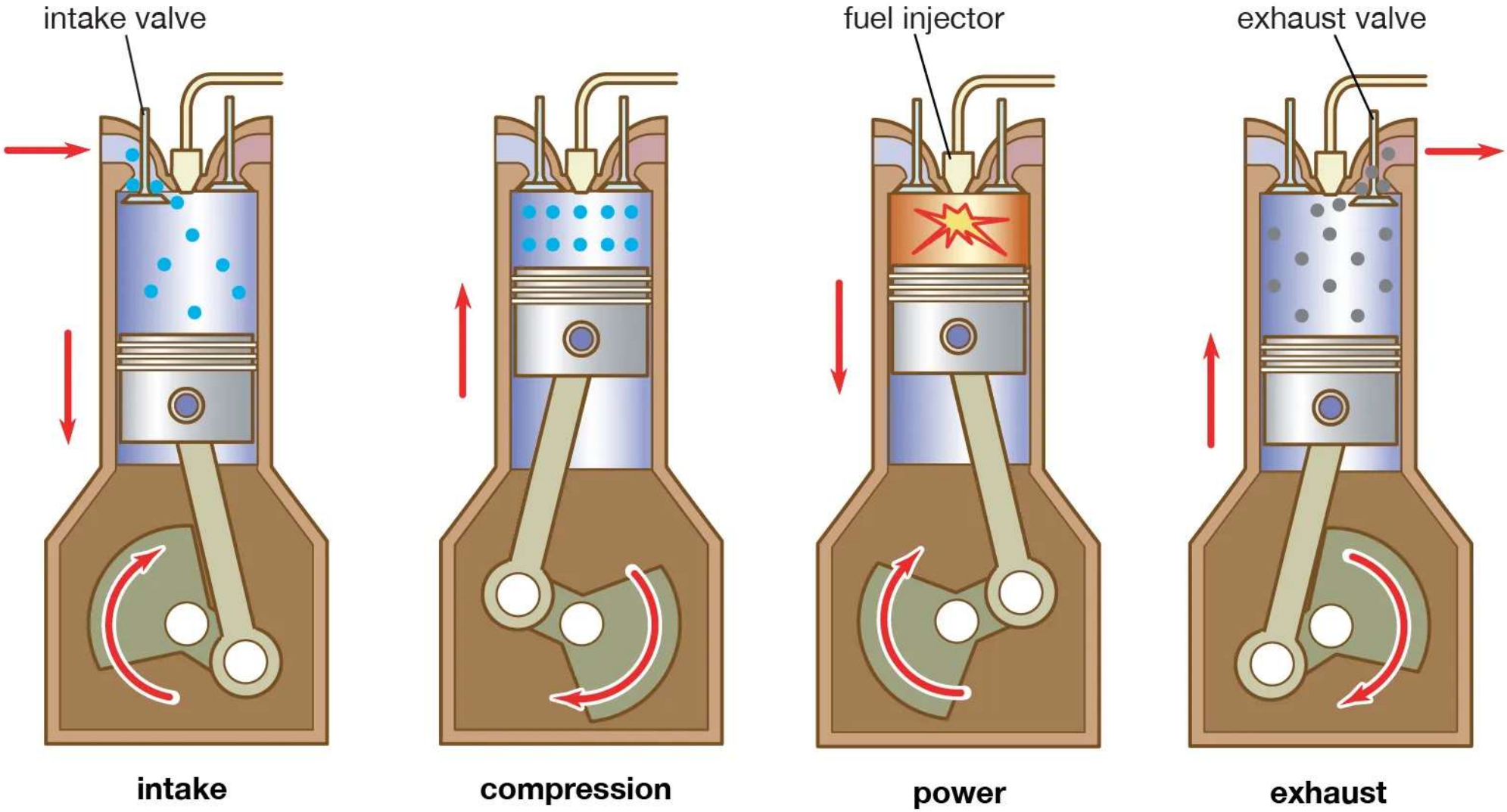
Four-stroke cycle



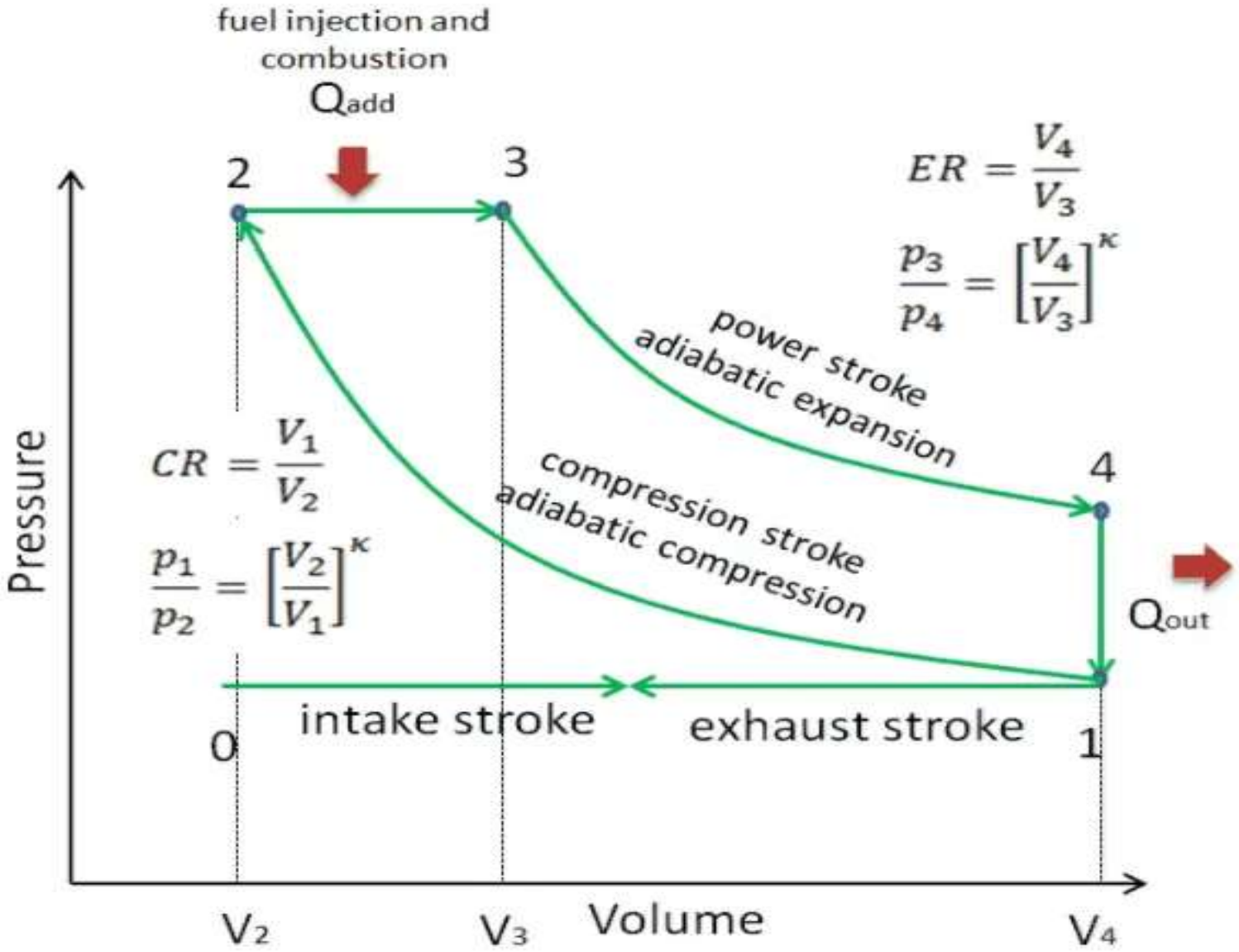
Petrol Engine – Otto cycle



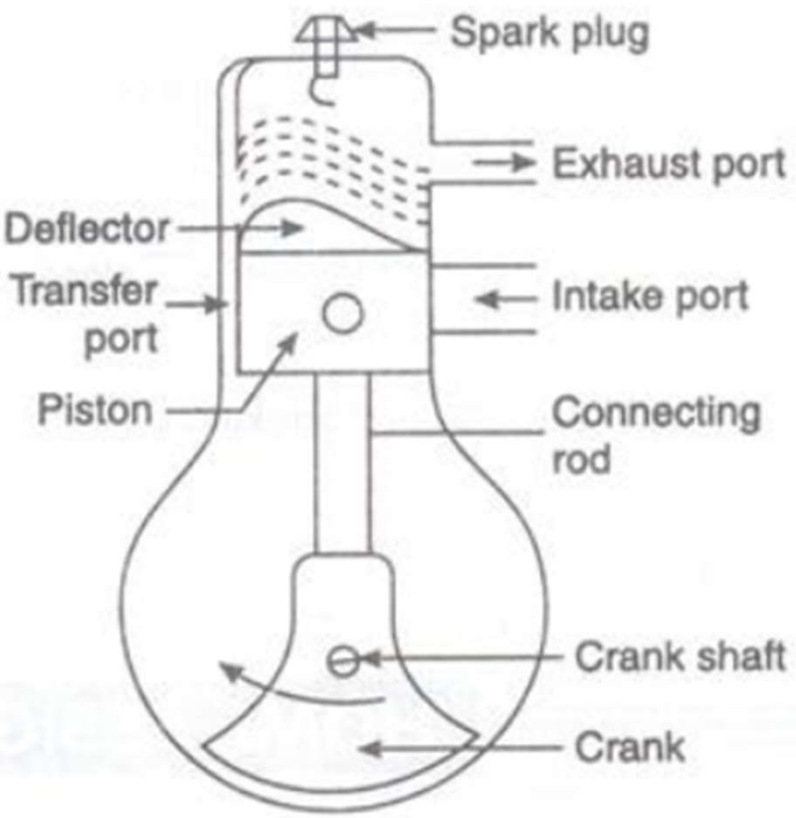
Diesel Engine

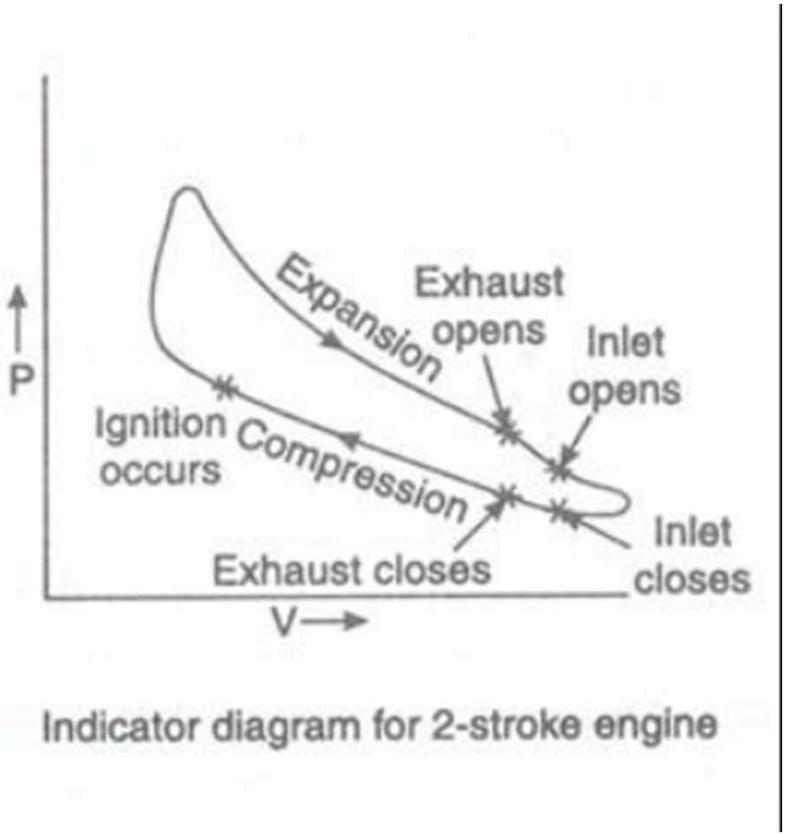


Diesel Engine

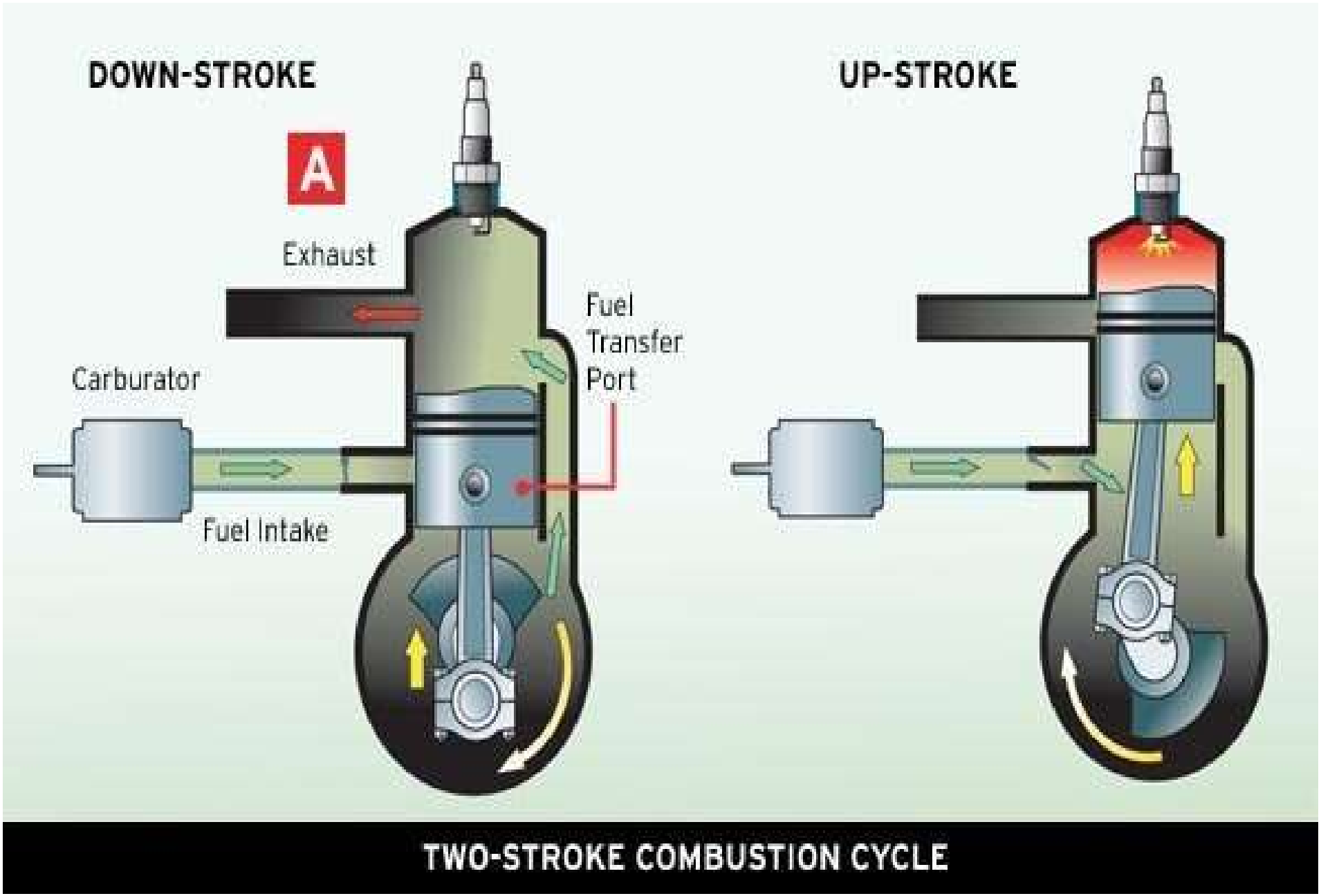


Two Stroke Engine

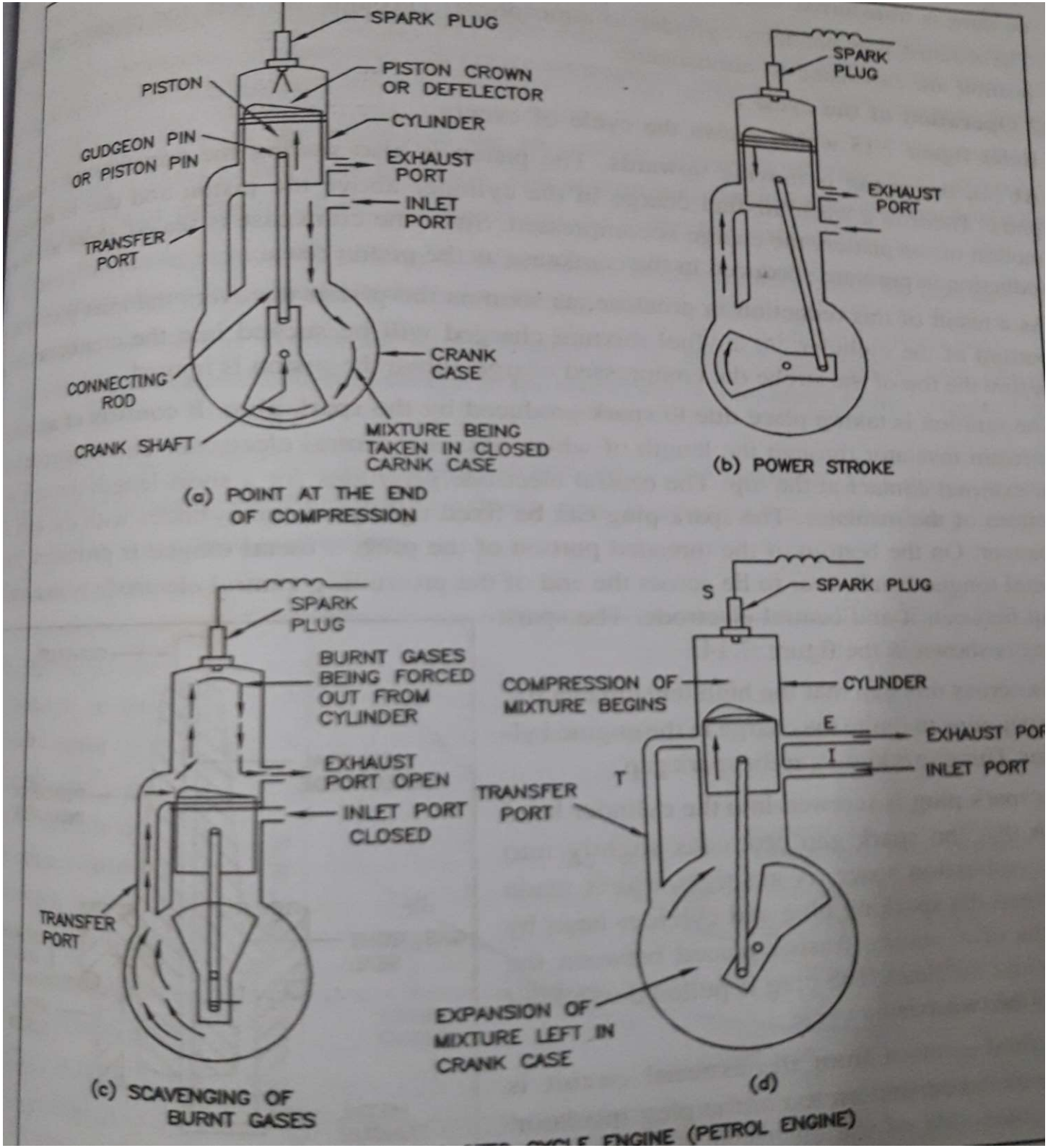




Indicator diagram for 2-stroke engine



TWO-STROKE COMBUSTION CYCLE



ENGINE (PETROL ENGINE)

Comparison between Two Stroke and Four stroke Engine

COMPARISON BETWEEN FOUR STROKE CYCLE AND TWO STROKE CYCLE ENGINE (MERITS AND DEMERITS):

S.No.	Two Stroke Cycle Engine	Four Stroke Cycle Engine
1	**Merits:** One power stroke in one revolution of the crankshaft	**Demerits:** One power stroke in two revolutions of the crank shaft
2	Power developed for the same engine speed theoretically twice that of a four stroke engine	Power developed for the same engine speed is theoretically half that of two stroke engine.
3	Simple design and lighter in construction for the same power	For the same power complicated design and heavier in construction
4	**Merits:** Uniform torque is obtained. Hence a lighter fly wheel can be used	**Demerits:** Non uniform torque on the crankshaft. Hence a heavier flywheel is required for balancing.
5	Design of ports is simpler. Hence initial cost is less	Design valve mechanism is difficult. Hence initial cost is more.
6	Mechanical efficiency is high. No moving parts like cam, follower, rocker arm valves etc.,	Mechanical efficiency is less. Power is lost due to friction caused by valve mechanism
7	**Merits:** Starting is easy	**Demerits:** Starting is not so easy
8	These engines are generally air cooled	These engines are generally water cooled.

Difference between Petrol and Diesel Engine

Petrol Engines	Diesel Engines
Follows Otto cycle	Follows diesel cycle
Air and petrol are mixed into the carburetor before they enter into the cylinder	Fuel is mixed with air inside the cylinder
Ignition is done by an electric spark	Ignition is done by heat of compression
Lower compression ratio	Higher compression ratio
Less power output	More power output
Contains spark plug	Contains fuel injector
Burns highly volatile fuel	Burns less volatile fuel
Used in light vehicles	Used in heavy vehicles
More fuel consumption	Less fuel consumption
Lighter	Heavier
Frequent maintenance is required	Less frequently maintained
Lower maintenance cost	Higher maintenance cost
Less initial cost	More initial cost
Thermal efficiency is about 26%	Thermal efficiency is about 40%
The starting of petrol engine is easy due to low compression ratio	The starting of the diesel engine is slightly difficult due to higher compression ratio compared to a petrol engine
High speed engines	Low speed engines

1. Power and mechanical efficiency:

(i) Indicated power.

The total power developed by combustion of fuel in the combustion chamber is called indicated power.

$$I.P. = \frac{kP_{mi}LAn}{60000}\ kW$$

Where,

k = Number of cylinders,

P_{mi} = Indicated mean effective pressure in Pa or N/m^2,

L = Length of stroke in m,

A = Area of piston, m^2, and

n = number of explosions per minute

= N/2 for 4-stroke engine,

= N for 2-stroke engine,

N = speed of the engine on rpm.

(ii) Brake power (B.P.).

The power developed by an engine at the output shaft is called the brake power.

$$B.P. = \frac{2\pi NT}{60000}\ kW$$

Where,

T = torque in N-m.

The difference between I.P. and B.P. is called **frictional power F.P.**

$$F.P. = I.P. - B.P.$$

The ratio of B.P. to I.P. is called **mechanical efficiency**

i.e. mechanical efficiency, $\eta_{mech} = \frac{B.P.}{I.P.} X\ 100\ \%$

FRICTION POWER & MECHANICAL EFFICIENCY

- The difference between the *ip* and *bp* is the friction power, *fp*.
- It is defined as the power required to overcome the frictional resistance of the engine parts.

$$fp = ip - bp$$

- The mechanical efficiency is defined as $\eta_m = \frac{bp}{ip}$
- The value lies between 80 to 90%.

Indicated Thermal Efficiency (η_{ith}):

It may be defined as the ratio of heat converted into indicated work to the heat energy supplied by the fuel, during a specified period of time.

So, Indicated thermal efficiency ,

$$(\eta_{ith}) = \frac{Heat\ equivalent\ to\ ip\ per\ minute}{Heat\ energy\ supplied\ by\ fuel\ per\ minute}$$

$$= \frac{ip\ X\ 60}{M_f\ X\ CV}$$

Where, M_f = Mass of fuel supplied to the engine per minute.

CV = Lower calorific value of the fuel.

Brake Thermal Efficiency (η_{bth}):

It may be defined as the ratio of heat equivalent to brake power (bp) to the heat energy supplied by the fuel during a specific period of time.

So, Brake thermal efficiency ,

$$(\eta_{bth}) = \frac{Heat\ equivalent\ to\ bp\ per\ minute}{Heat\ energy\ supplied\ by\ fuel\ per\ minute}$$

$$= \frac{bp\ X\ 60}{M_f\ X\ CV}$$

Where, M_f = Mass of fuel supplied to the engine per minute.

CV = Lower calorific value of the fuel.