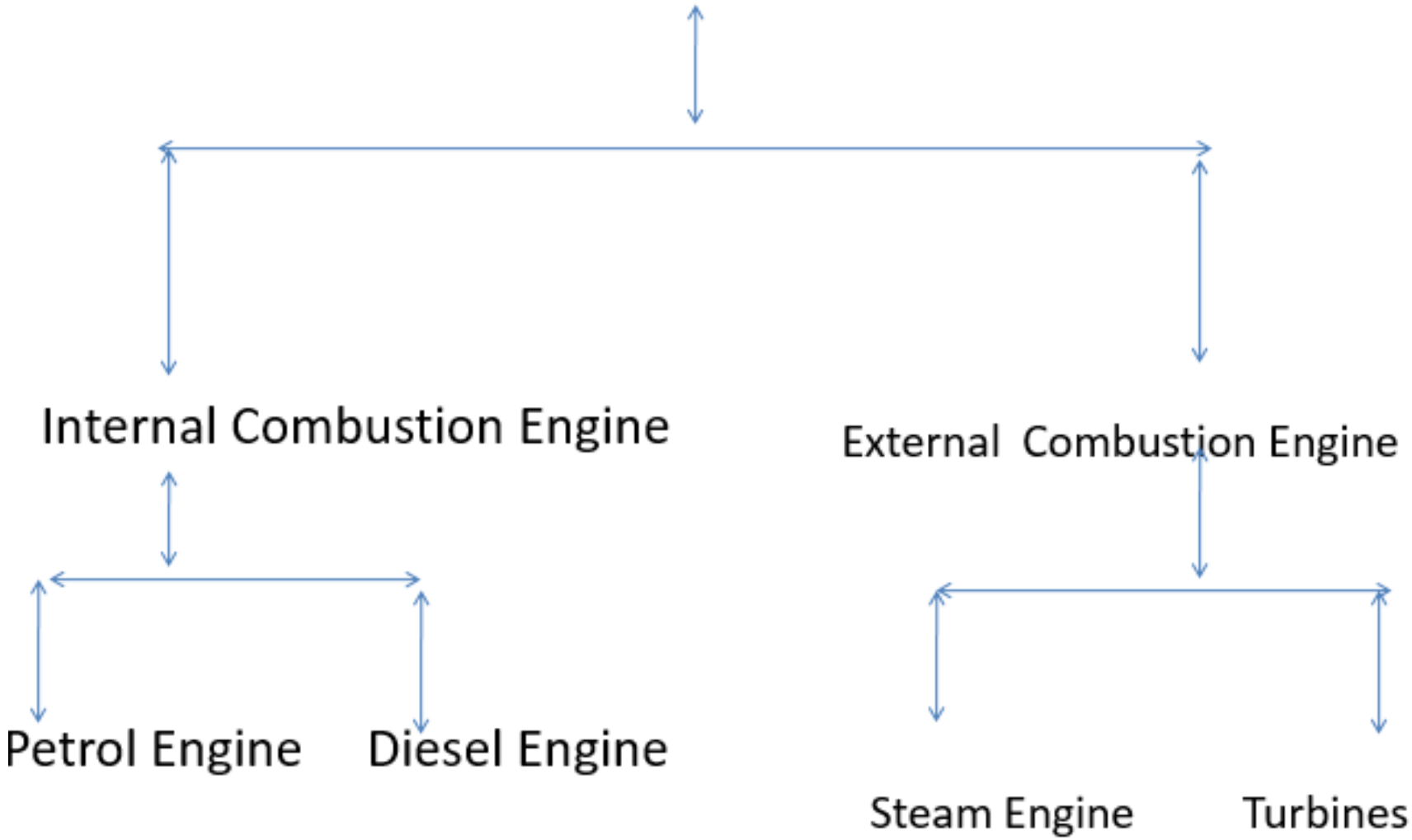
Basic Automobile Technology

Prepared by Eng. Susantha Jayasinghe

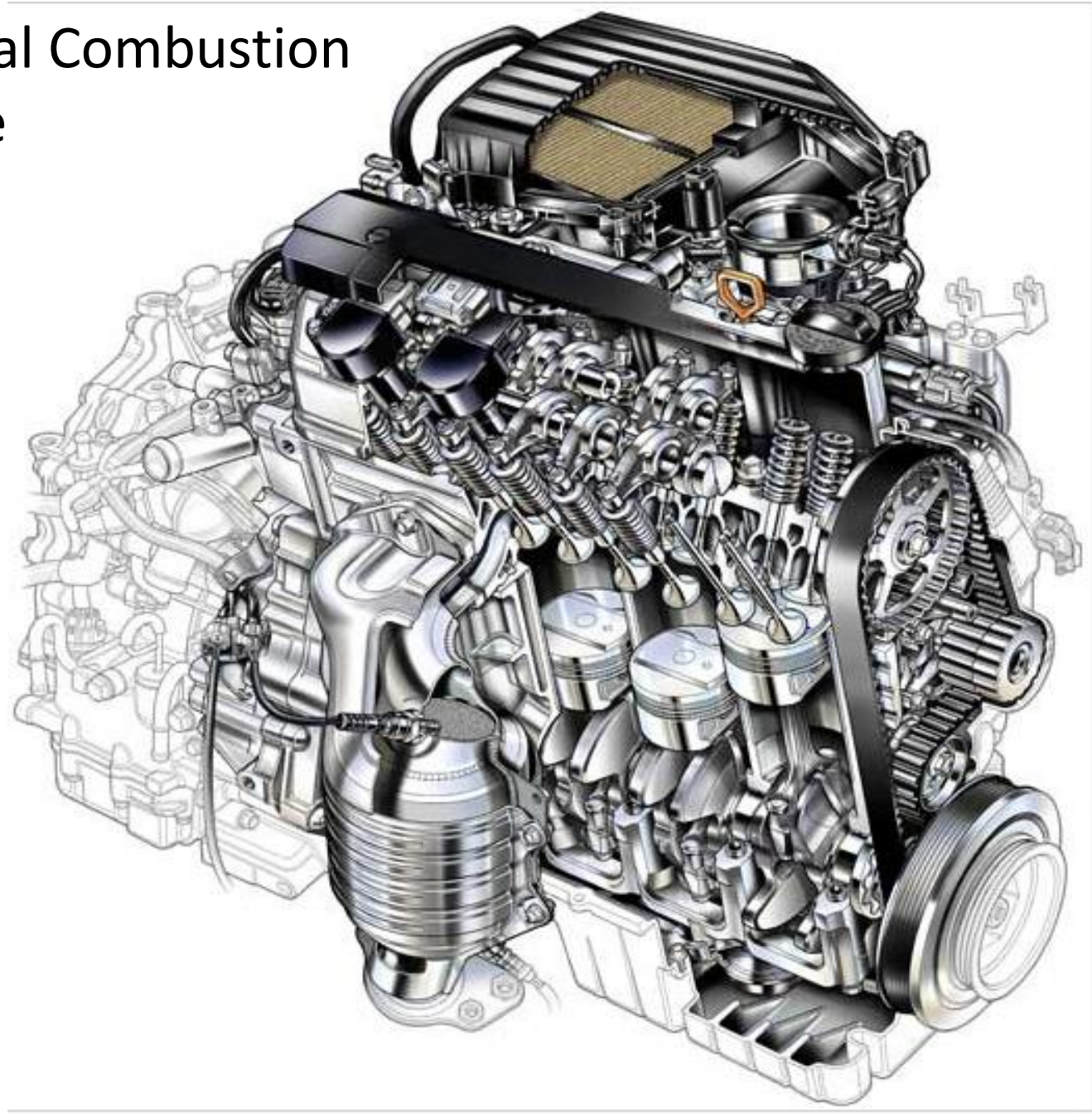
The motor vehicle consist with following systems;

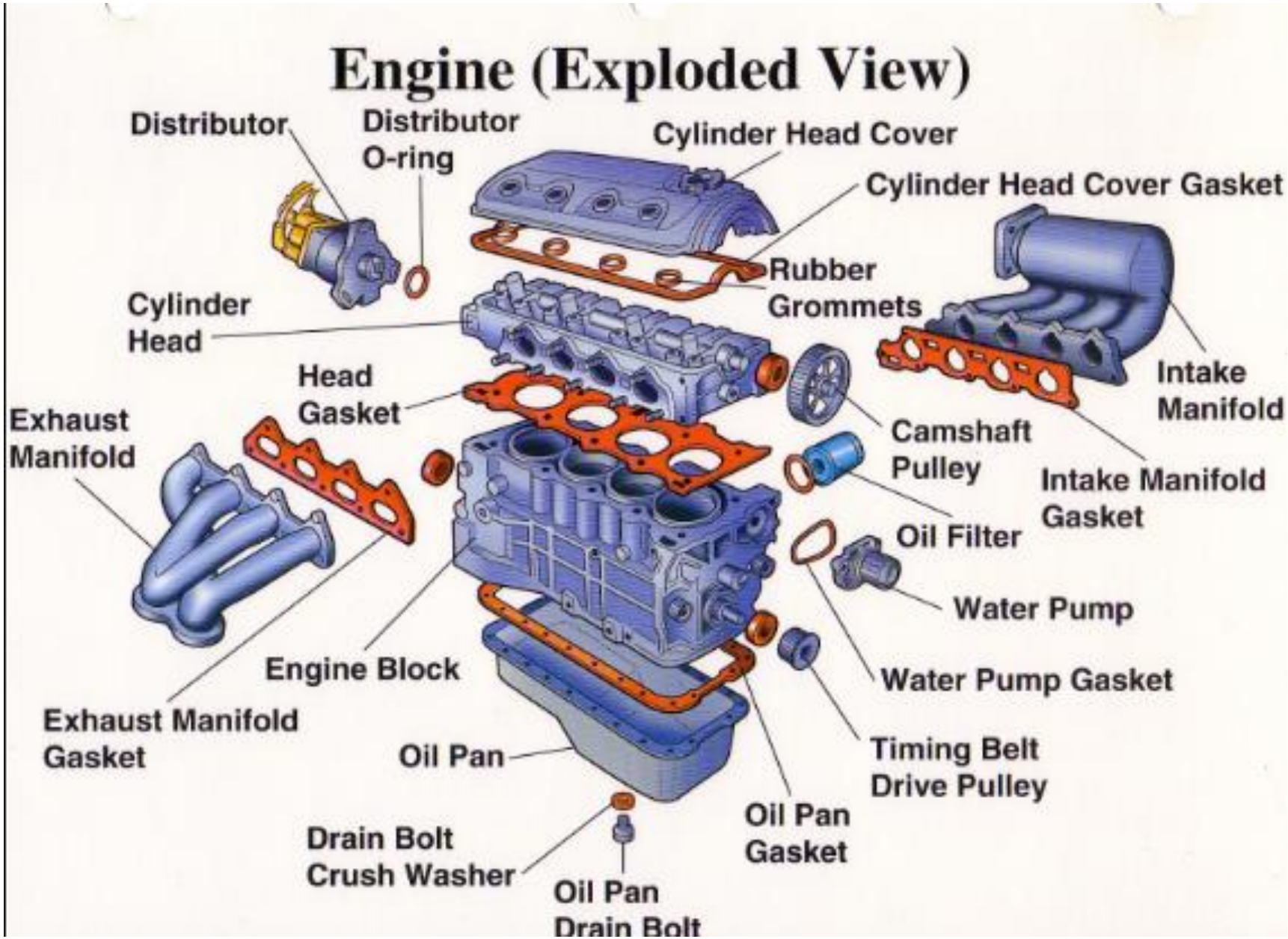
- Engine
- Transmission system
- Steering system
- Brake system
- Suspension system
- Wheels
- Electrical system

Types of Engine



Internal Combustion Engine



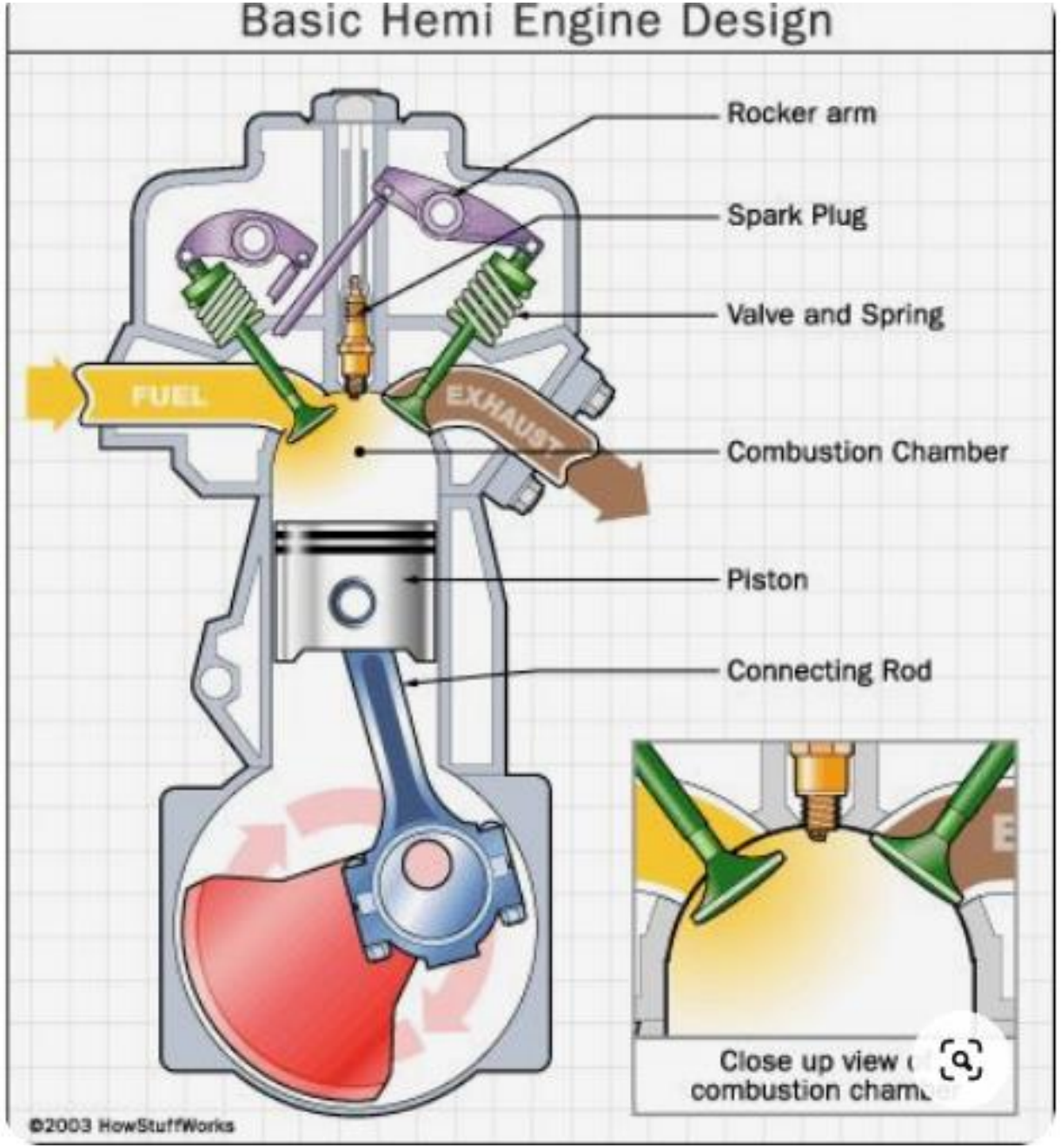

Engine (Exploded View)
Distributor
Distributor O-ring
Cylinder Head Cover
Cylinder Head Cover Gasket
Rubber Grommets
Cylinder Head
Intake Manifold
Head Gasket
Exhaust Manifold
Camshaft Pulley
Intake Manifold Gasket
Oil Filter
Water Pump
Engine Block
Water Pump Gasket
Exhaust Manifold Gasket
Timing Belt Drive Pulley
Oil Pan
Oil Pan Gasket
Drain Bolt Crush Washer
Oil Pan Drain Bolt

Definition of Internal Combustion Engine

In an internal combustion engine the energy supplied by a burning fuel is directly converted into mechanical energy by the controlled burning of the fuel in an enclosed space. The explosive fuel-air mixture may be ignited either by an electric spark or by the resulting compression temperature. In reciprocating engines the explosion causes the rotation of some engine parts by driving the piston in the cylinder. The motion is transmitted to the crankshaft by means of the connecting rod.

We can classify internal combustion reciprocating engines according to the number of strokes of the piston in one complete working cycle. Thus, we can speak of two-stroke engines and four-stroke engines.

There is still another classification according to the process of combustion: explosion or constant-volume combustion engines and constant-pressure combustion or Diesel engines.


Basic Hemi Engine Design
Rocker arm
Spark Plug
Valve and Spring
FUEL
EXHAUST
Combustion Chamber
Piston
Connecting Rod
Close up view
combustion cham
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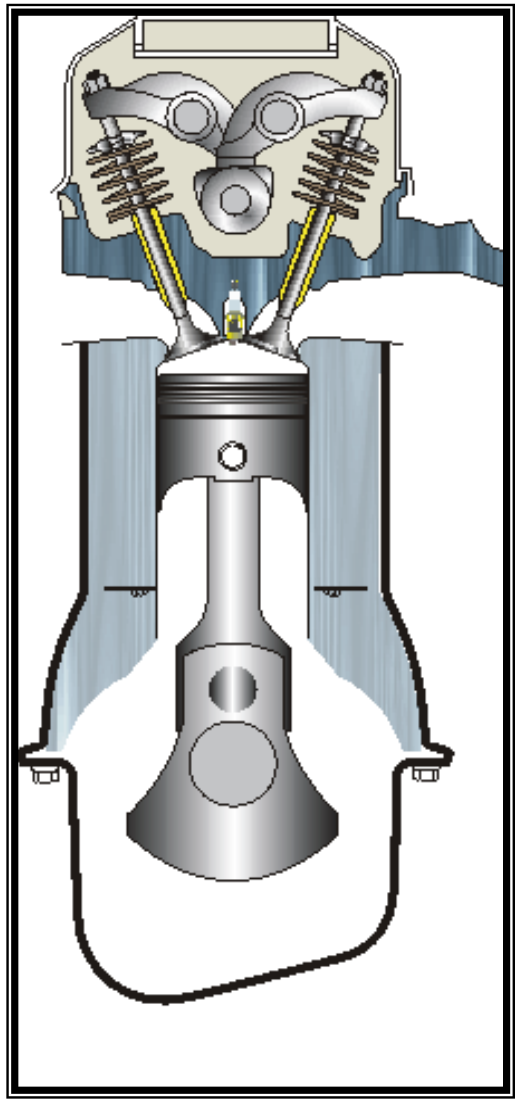
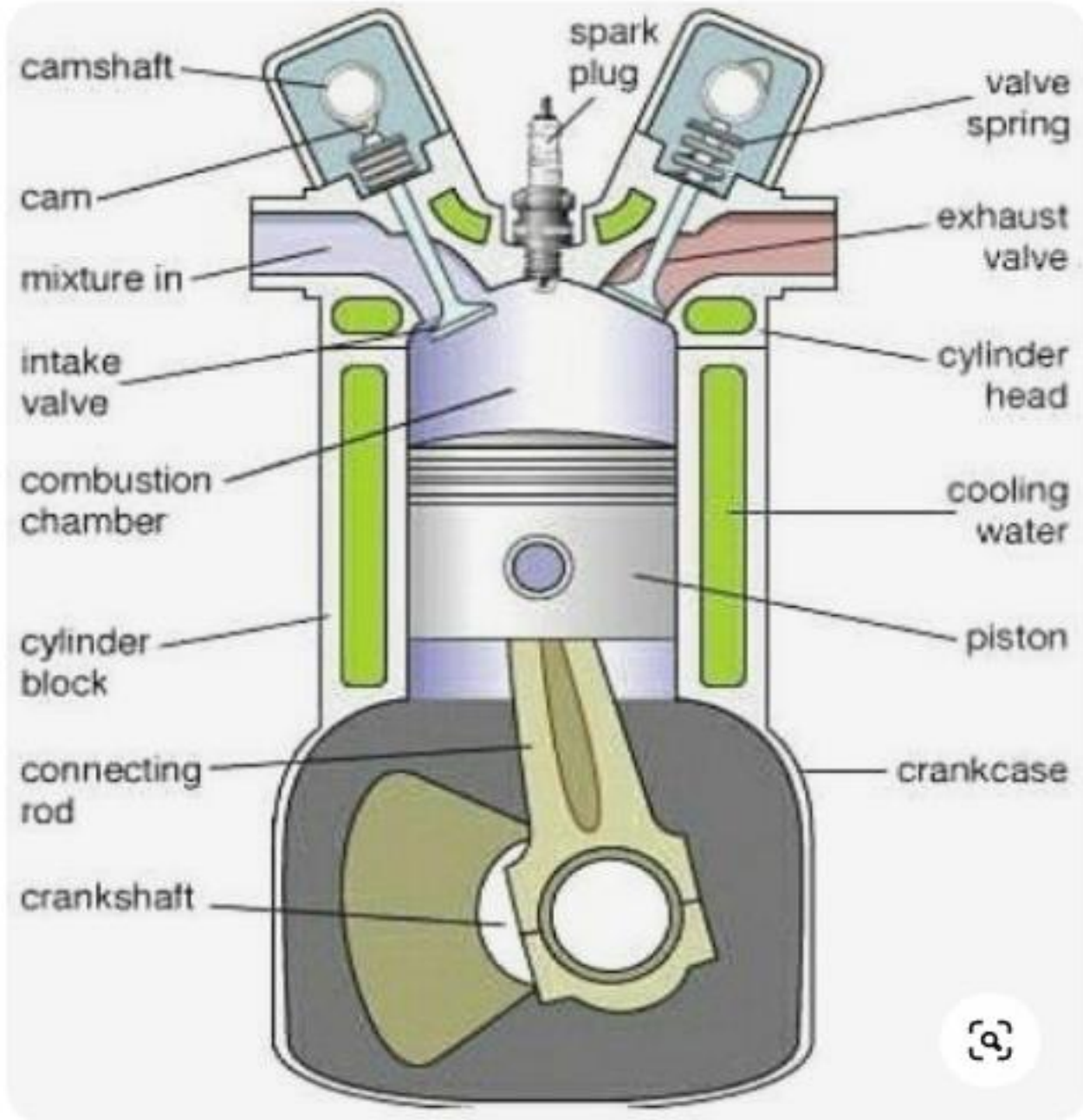
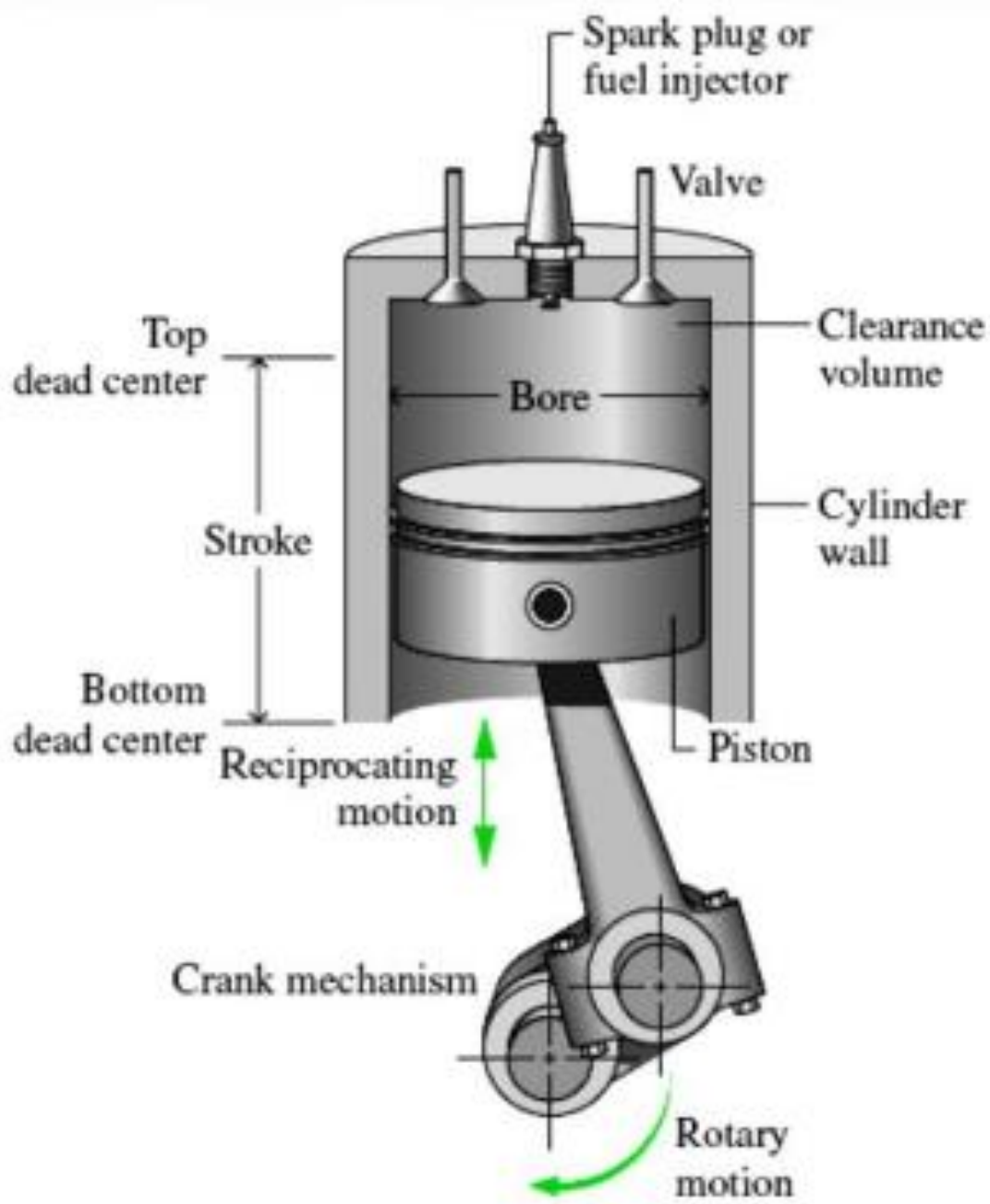
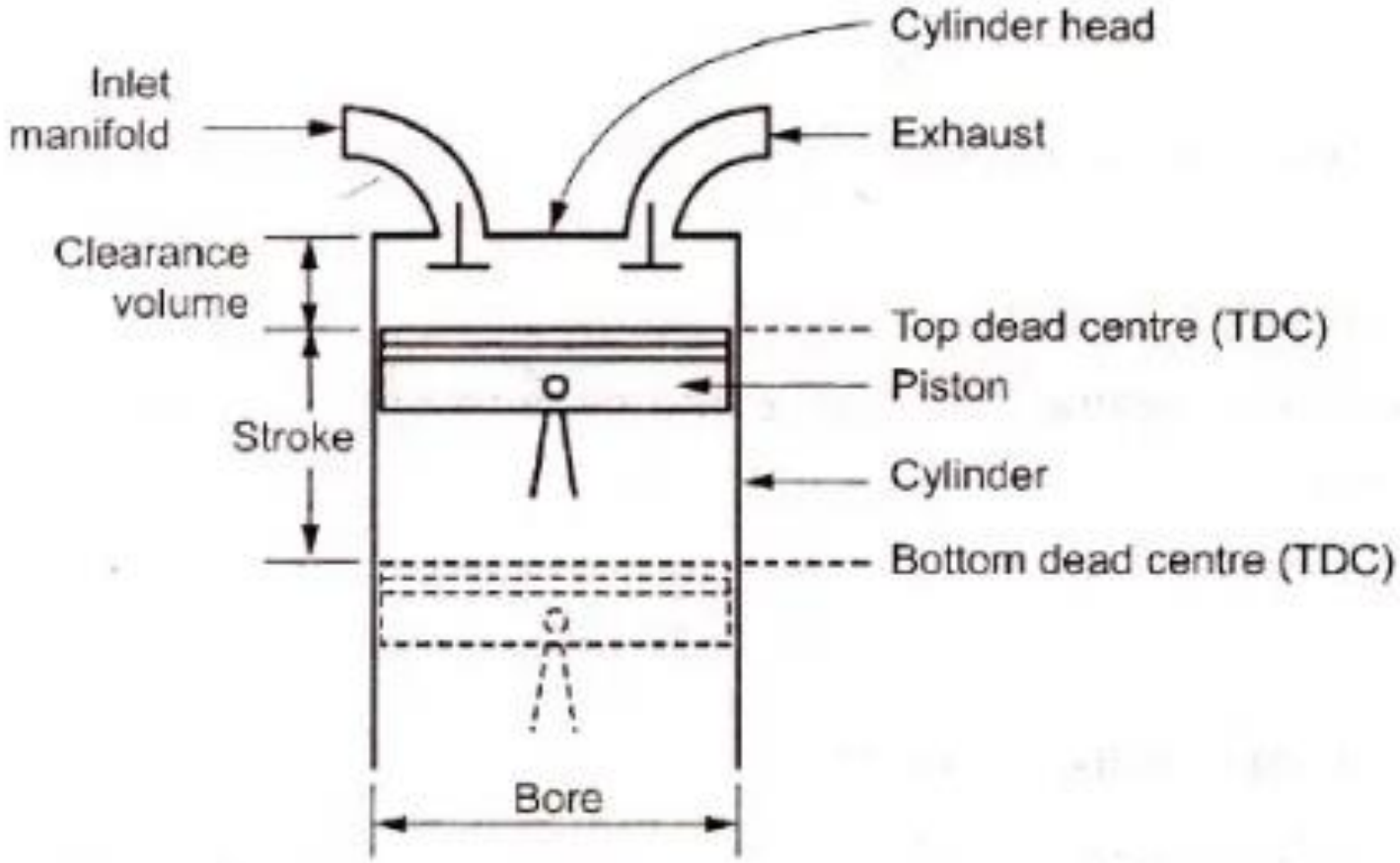



camshaft
cam
mixture in
intake valve
combustion chamber
cylinder block
connecting rod
crankshaft
spark plug
valve spring
exhaust valve
cylinder head
cooling water
piston
crankcase


Spark plug or
fuel injector
Valve
Top
dead center
Clearance
volume
Bore
Cylinder
wall
Stroke
Bottom
dead center
Piston
Reciprocating
motion
Crank mechanism
Rotary
motion

IC Engine Terminology….



1. Bore:

The nominal inside diameter of the engine cylinder is called bore.

2. Top Dead Centre (TDC):

The extreme position of the piston at the top of the cylinder of the vertical engine is called top dead centre (TDC),

Incase of horizontal engines. It is known as inner dead centre (IDC).

3. Bottom Dead Centre (BDC):

The extreme position of the piston at the bottom of the cylinder of the vertical engine called bottom dead centre (BDC).

In case of horizontal engines, it is known as outer dead center (ODC).

4. Stroke:

The distance travelled by the piston from TDC to BDC is called stroke.

In other words, the maximum distance travelled by the piston in the cylinder in one direction is known as stroke.

It is equal to twice the radius of the crank.

5. Clearance Volume (Vc):

The volume contained in the cylinder above the top of the piston, when the piston is at top dead centre is called the clearance volume.

6. Swept Volume (Vs):

The volume swept by the piston during one stroke is called the swept volume or piston displacement.

Swept volume is the volume covered by the piston while moving from TDC to BDC.

Swept volume = Vs = A x L = $\frac{\Pi}{4} D^2 L$

where A = Cross sectional area of the piston in Sq.m,
L = Stroke in m, and
D = Cylinder bore i.e., inner diameter of the cylinder in m.

7. Compression Ratio (rc):

Compression ratio is a ratio of the volume when the piston is at bottom dead centre to the volume when the piston is at top dead centre.

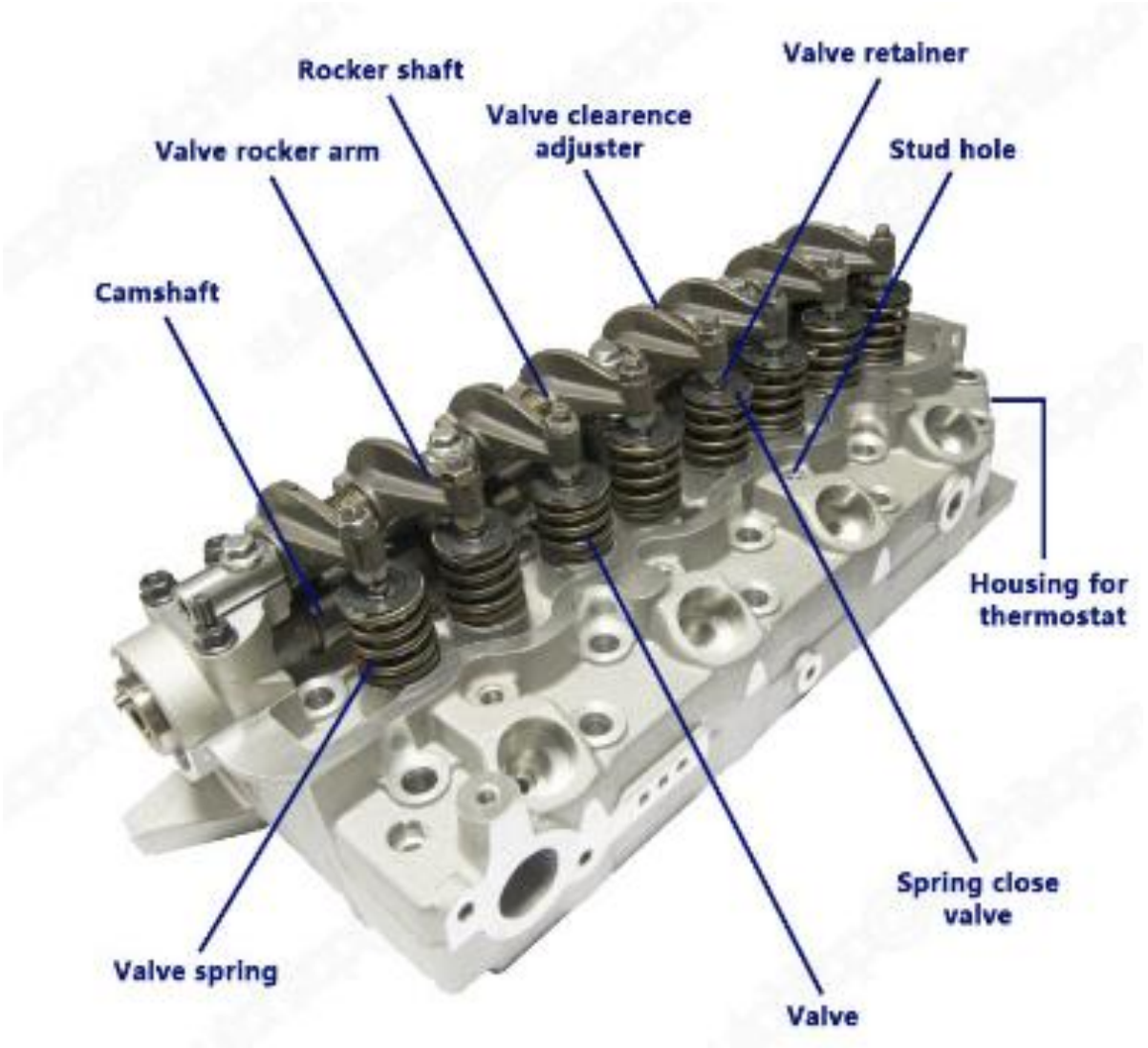
Mathematically,

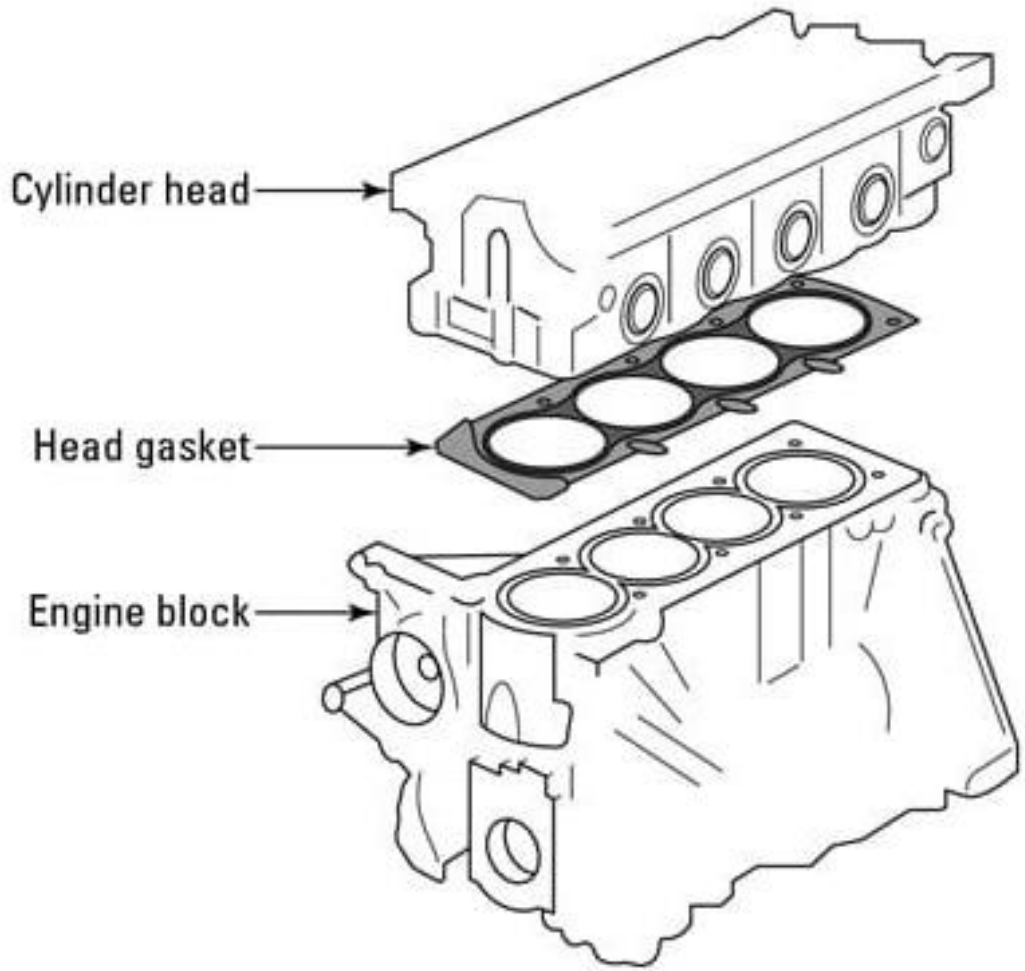
$$\text{Compression ratio} = \frac{Maximum Cylinder Volume}{Minimum Cylinder Volume}$$

$$= \frac{Swept Volume + Clearence Volume}{Clearence Volume}$$

The compression ratio varies from 5 : 1 to 10 : I for petrol engines and from 12:1 to 22 : I for diesel engines.

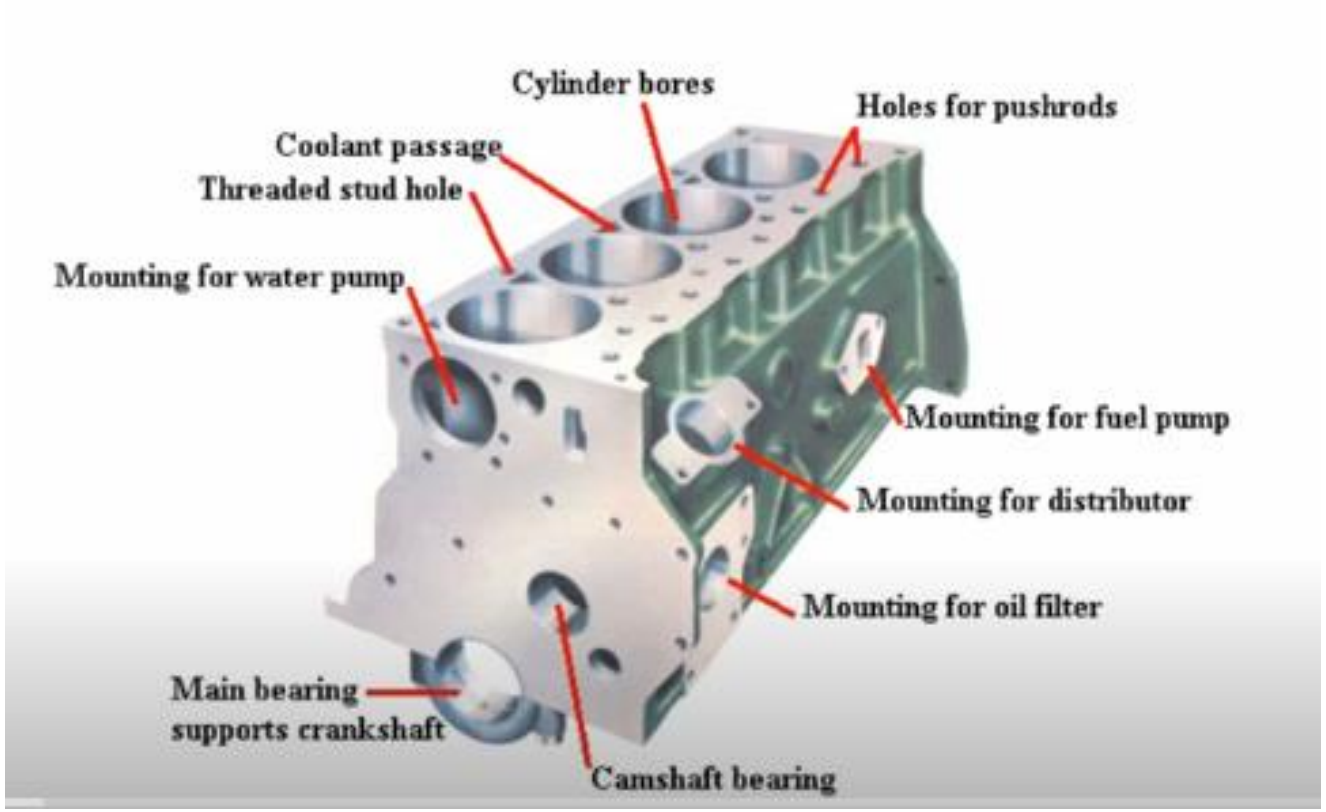
Engine Components – Engine(Cylinder) Head





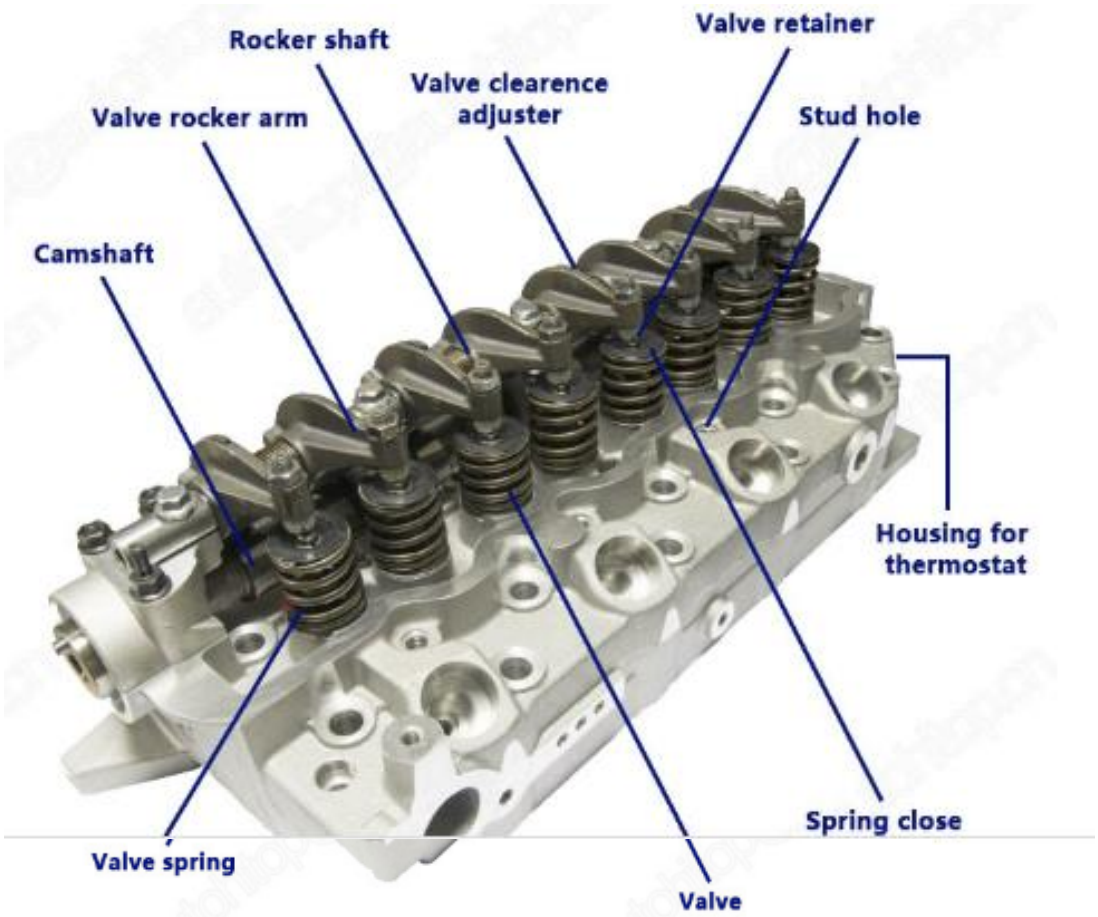
1. Cylinder block

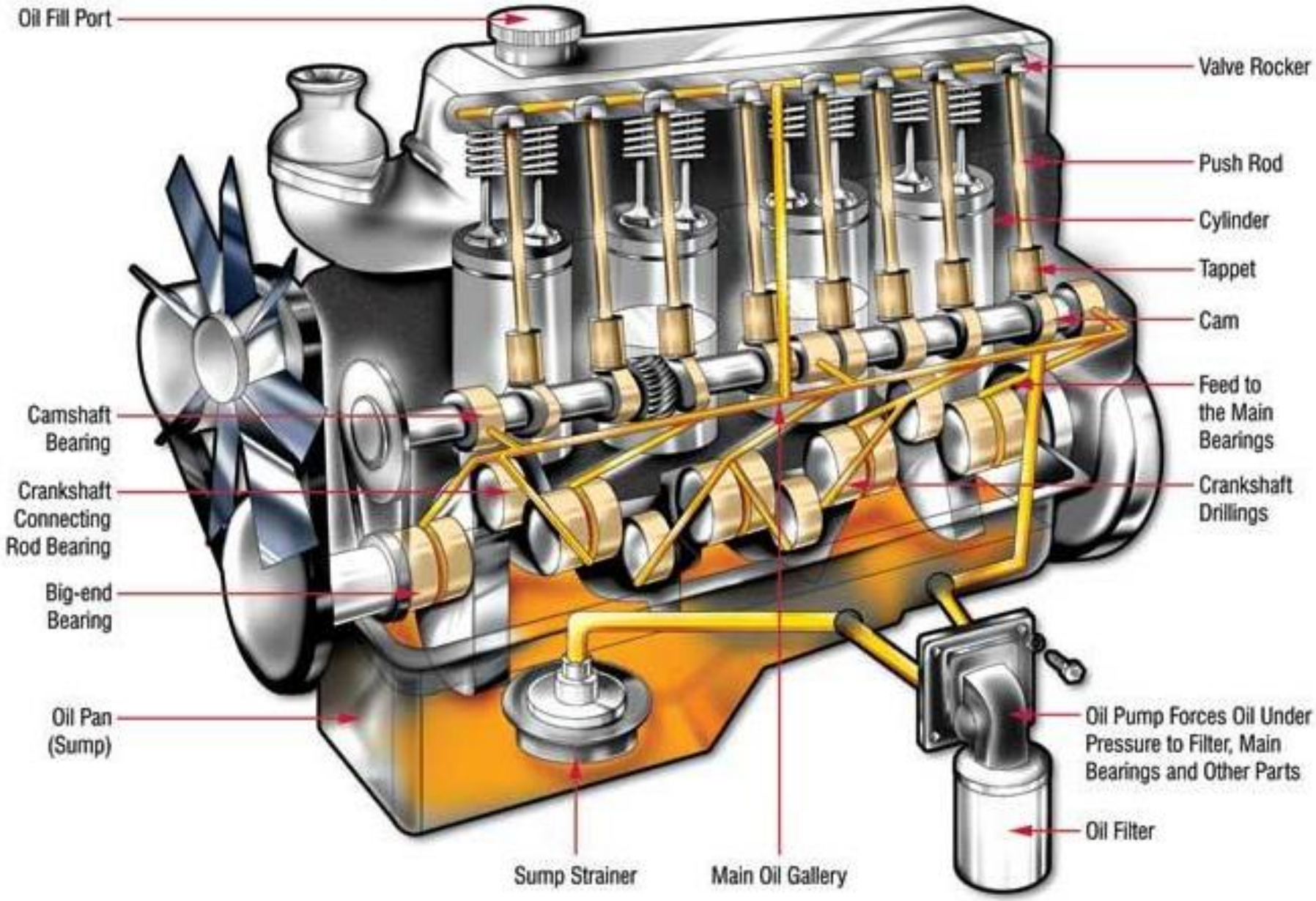
Cylinder is the main body of IC engine. Cylinder is a part in which the intake of fuel, compression of fuel and burning of fuel take place. The main function of cylinder is to guide the piston. It is in direct contact with the products of combustion so it must be cooled. For cooling of cylinder, a water jacket (for liquid cooling used in most of cars) or fin (for air cooling used in most of bikes) are situated at the outer side of cylinder. At the upper end of cylinder, cylinder head and at the bottom end crank case is bolted. The upper side of cylinder is consisting a combustion chamber where fuel burns. To handle all this pressure and temperature generated by combustion of fuel, cylinder material should have high compressive strength. So it is made by high grade cast iron. It is made by casting and usually cast in one piece.



2. Cylinder head

The top end of the engine cylinder is closed by means of removable cylinder head. There are two holes or ports at the cylinder head, one for intake of fuel and other for exhaust. Both the intake and exhaust ports are closed by the two valves known as inlet and exhaust valve. The inlet valve, exhaust valve, spark plug, injector etc. are bolted on the cylinder head. The main function of cylinder head is to seal the cylinder block and not to permit entry and exit of gases on cover head valve engine. Cylinder head is usually made by cast iron or aluminum. It is made by casting or forging and usually in one piece.




Oil Fill Port
Valve Rocker
Push Rod
Cylinder
Tappet
Cam
Feed to the Main Bearings
Crankshaft Drillings
Camshaft Bearing
Crankshaft Connecting Rod Bearing
Big-end Bearing
Oil Pan (Sump)
Oil Pump Forces Oil Under Pressure to Filter, Main Bearings and Other Parts
Oil Filter
Sump Strainer
Main Oil Gallery

3. Piston

A piston is fitted to each cylinder as a face to receive gas pressure and transmit the thrust to the connecting rod. It is a prime mover in the engine. The main function of piston is to give tight seal to the cylinder through bore and slide freely inside the cylinder. Piston should be light and sufficient strong to handle gas pressure generated by combustion of fuel. So the piston is made by aluminum alloy and sometimes it is made by cast iron because light alloy piston expands more than cast iron so thev need more clearances to the bore.

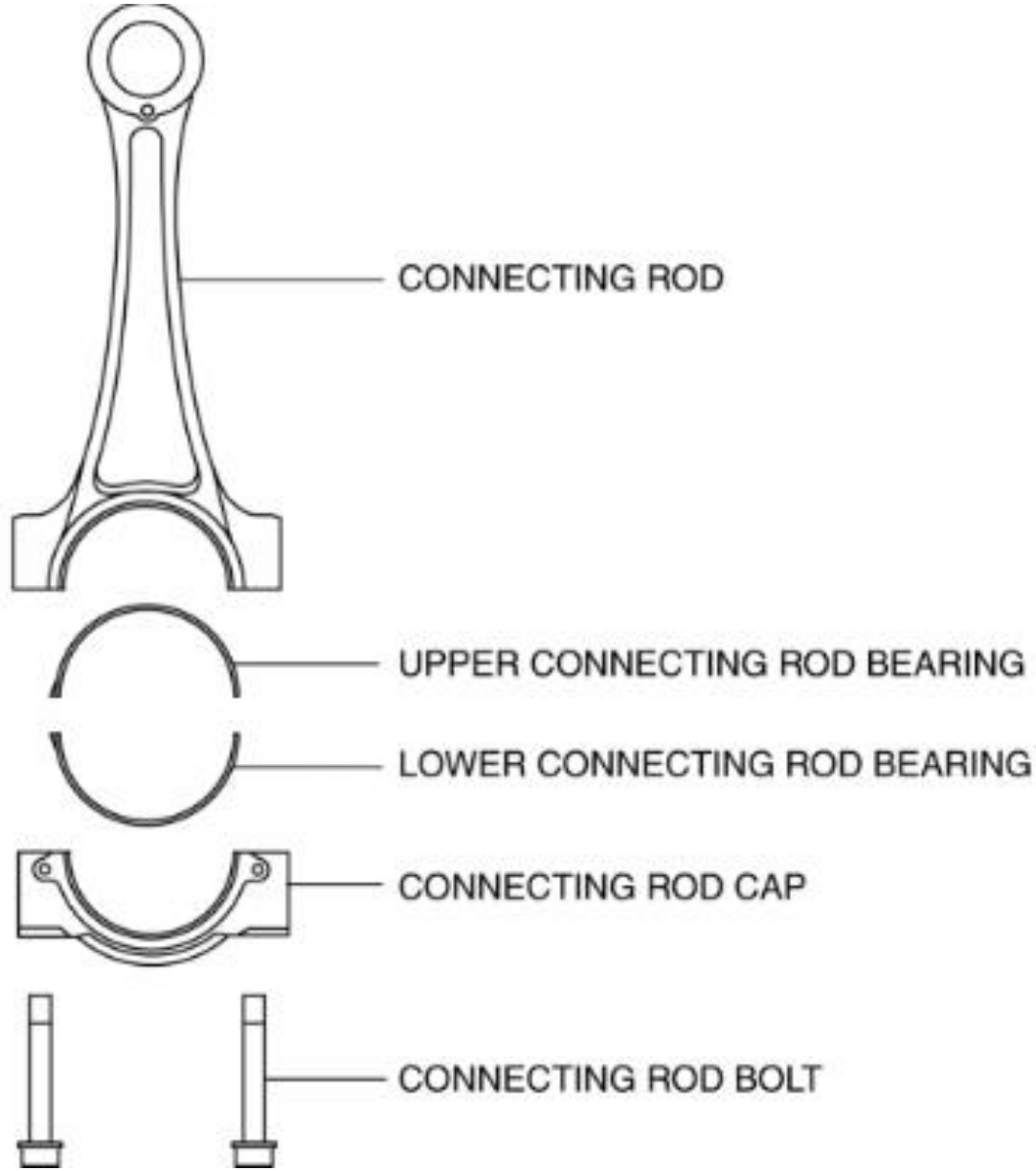
4. Piston rings

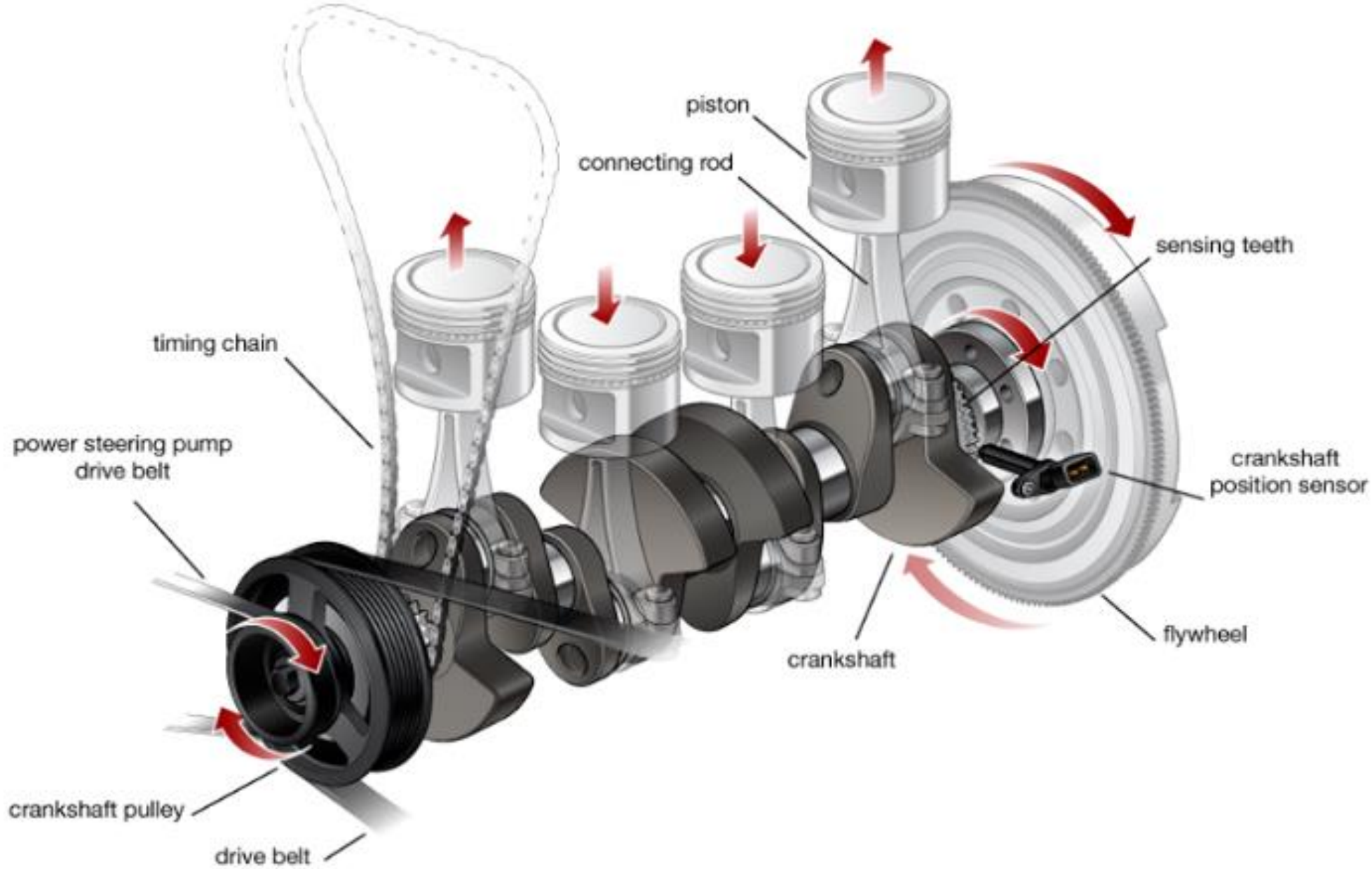
A piston must be a fairly loose fit in the cylinder so it can move freely inside the cylinder. If the piston is too tight fit, it would expand as it got hot and might stick tight in the cylinder and if it is too loose it would leaks the vapor pressure. To provide a good sealing fit and less friction resistance between the piston and cylinder, pistons are equipped with piston rings. These rings are fitted in grooves which have been cut in the piston. They are split at one end so they can expand or slipped over the end of piston. A small two stroke engine has two piston rings to provide good sealing but a four-stroke engine has an extra ring which is known as oil ring. Piston rings are made of cast iron of fine grain and high elastic material which is not affected by the working heat. Sometimes it is made by alloy spring steel.

5. Connecting rod

Connecting rod connects the piston to crankshaft and transmits the motion and thrust of piston to crankshaft. It converts the reciprocating motion of the piston into rotary motion of crankshaft. There are two end of connecting rod; one is known as big end and other as small end. Big end is connected to the crankshaft and the small end is connected to the piston by use of piston pin. The connecting rods are made of nickel, chrome, and chrome vanadium steels. For small engines the material may be aluminum.


BHS


CONNECTING ROD
UPPER CONNECTING ROD BEARING
LOWER CONNECTING ROD BEARING
CONNECTING ROD CAP
CONNECTING ROD BOLT


piston
connecting rod
sensing teeth
timing chain
power steering pump
drive belt
crankshaft
position sensor
crankshaft
flywheel
crankshaft pulley
drive belt

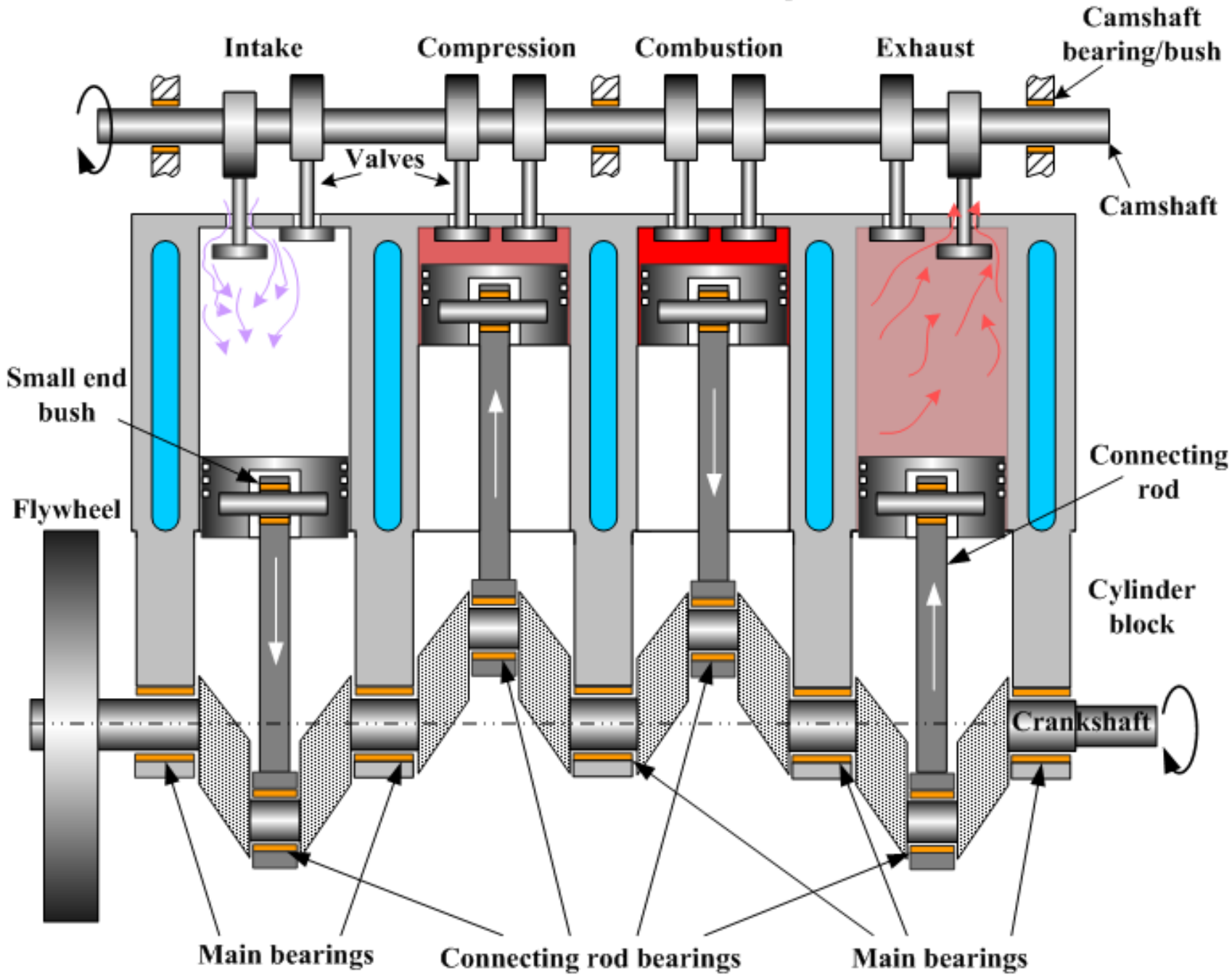
6. Crankshaft

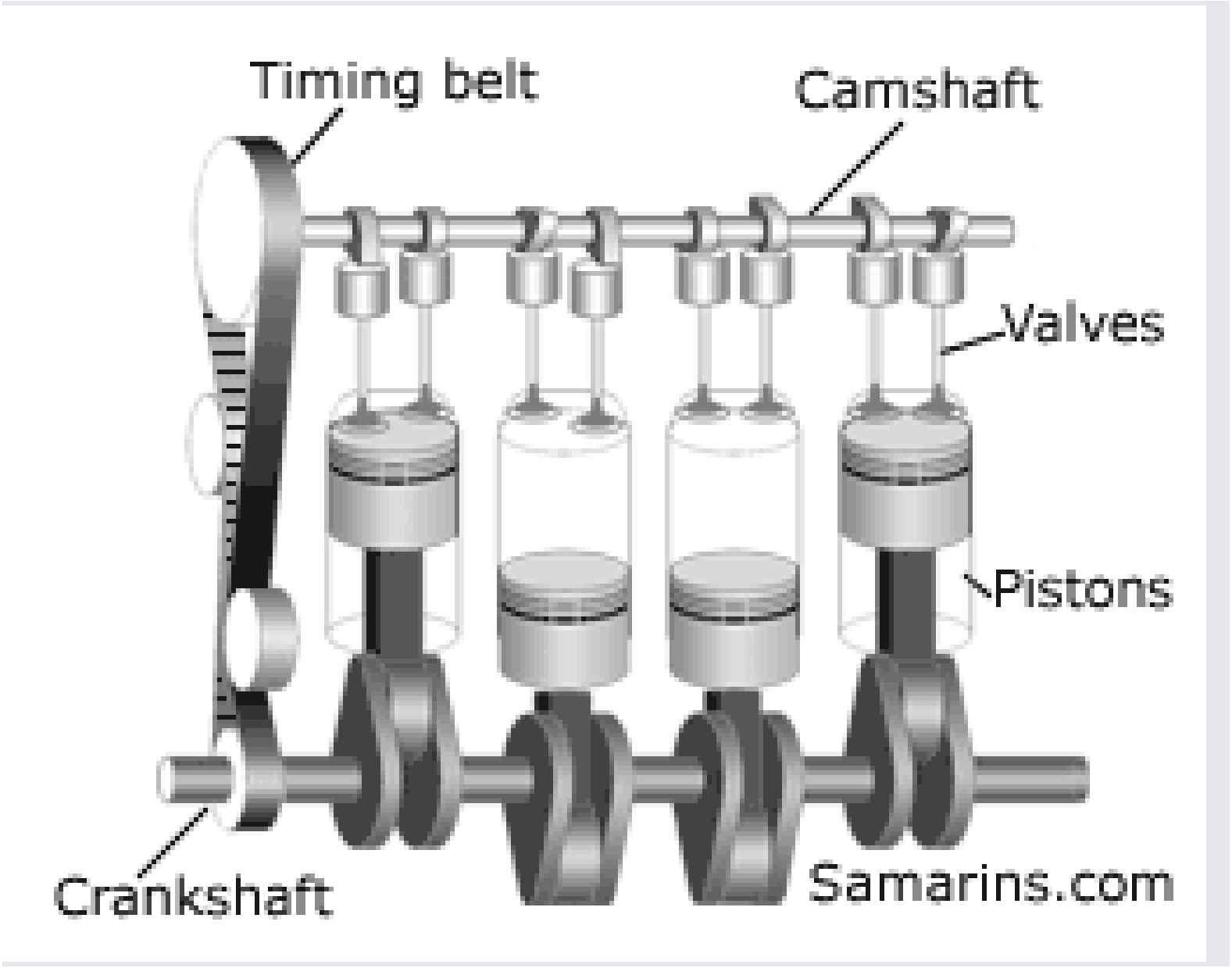
The crankshaft of an internal combustion engine receives the efforts or thrust supplied by piston to the connecting rod and converts the reciprocating motion of piston into rotary motion of crankshaft. The crankshaft mounts in bearing so it can rotate freely. The shape and size of crankshaft depends on the number and arrangement of cylinders. It is usually made by steel forging, but some makers use special types of cast-iron such as spheroidal graphitic or nickel alloy castings which are cheaper to produce and have good service life.

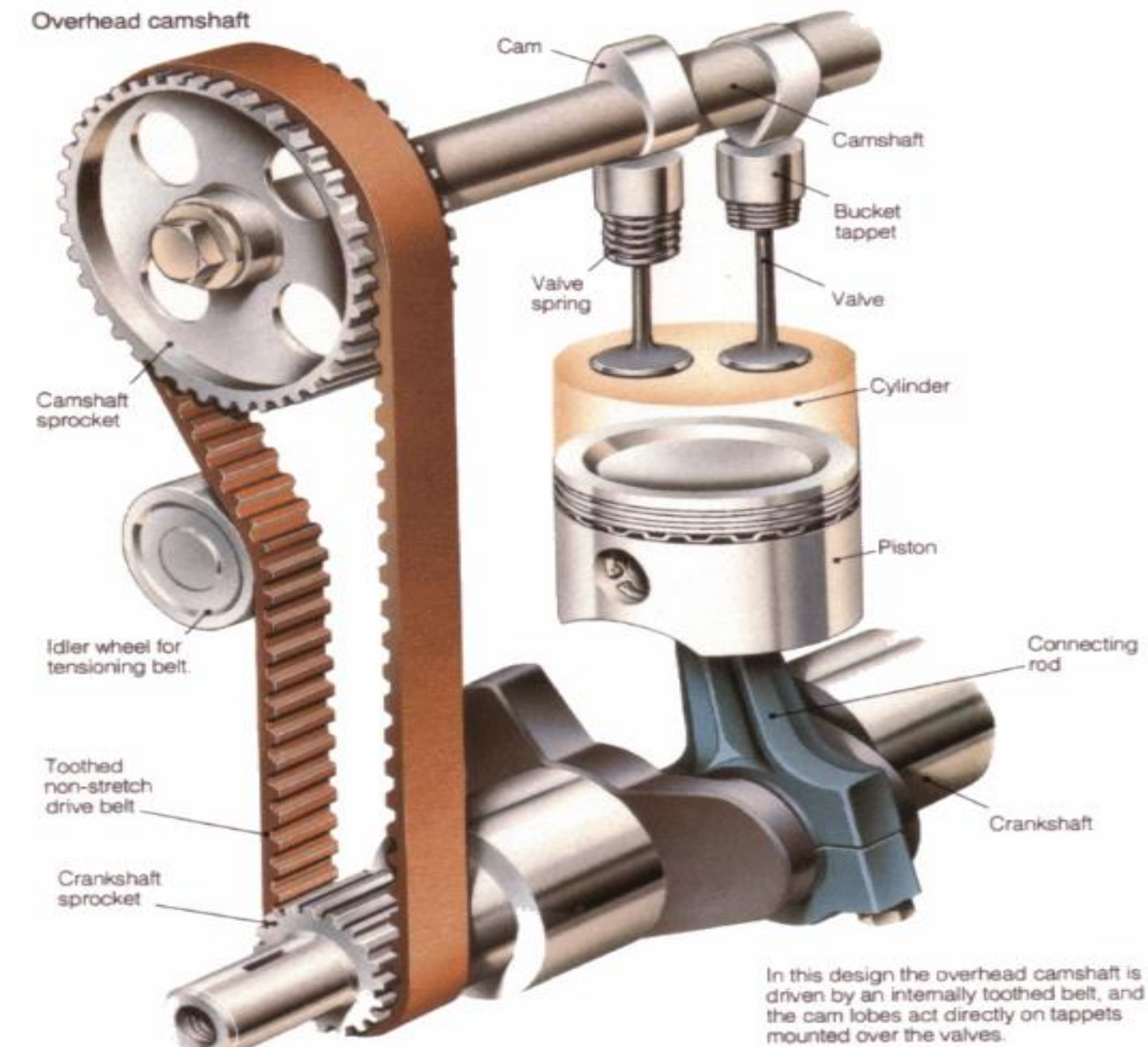
16. Flywheel

A flywheel is secured on the crankshaft. The main function of flywheel is to rotate the shaft during preparatory stroke. It also makes crankshaft rotation more uniform.

Internal combustion engine

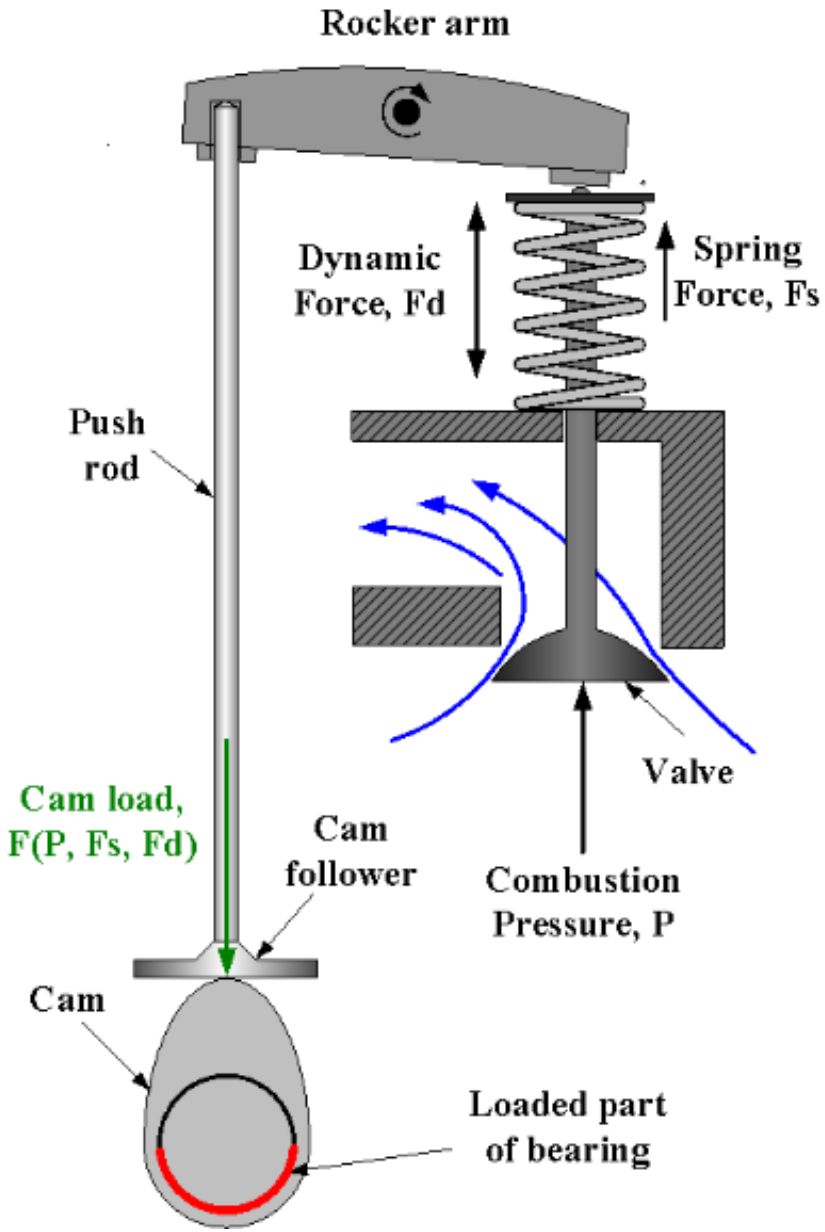


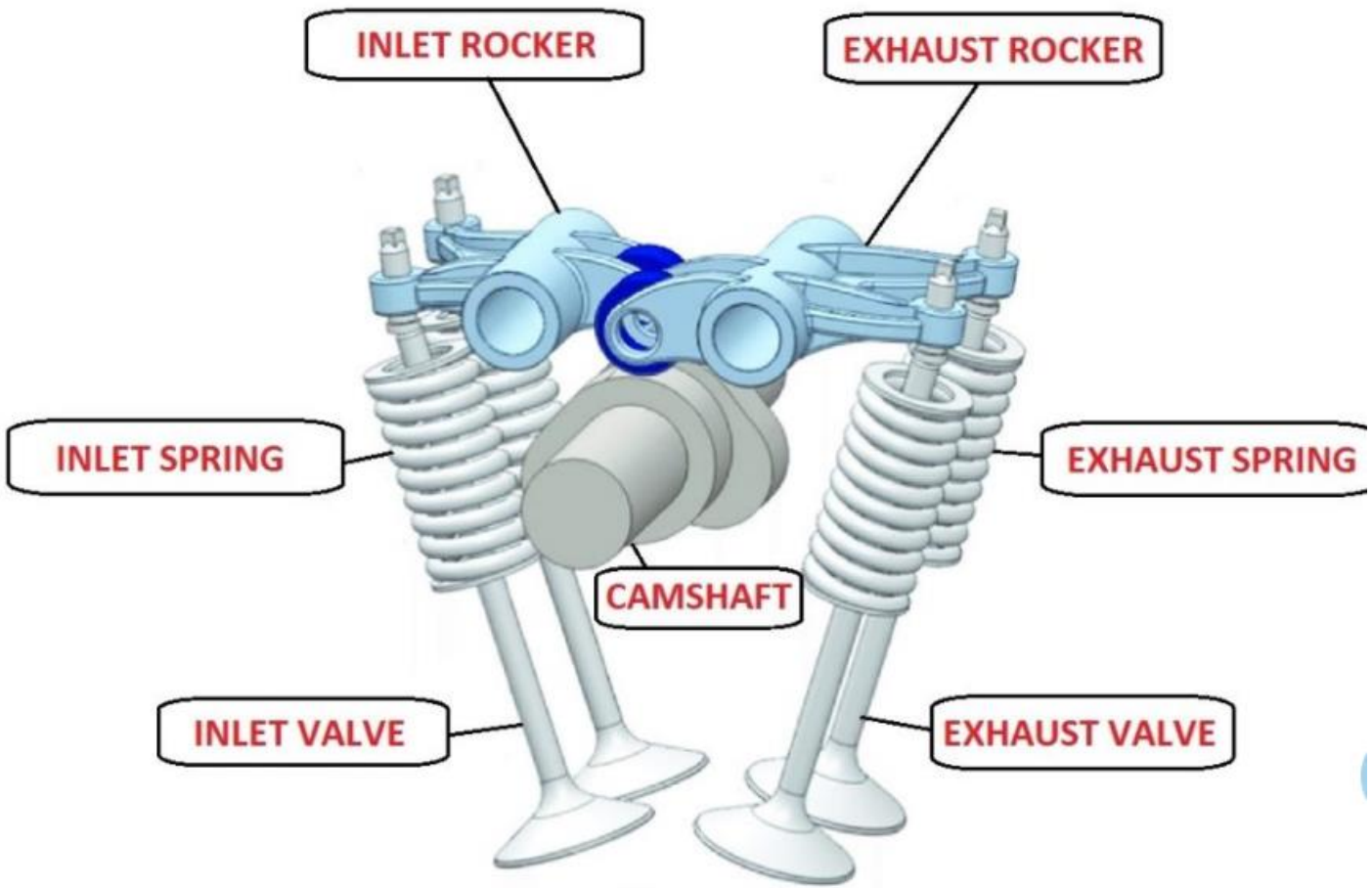

Timing belt
Camshaft
Valves
Pistons
Crankshaft
Samarins.com



In this design the overhead camshaft is driven by an internally toothed belt, and the cam lobes act directly on tappets mounted over the valves.

Overhead valve (OHV) design



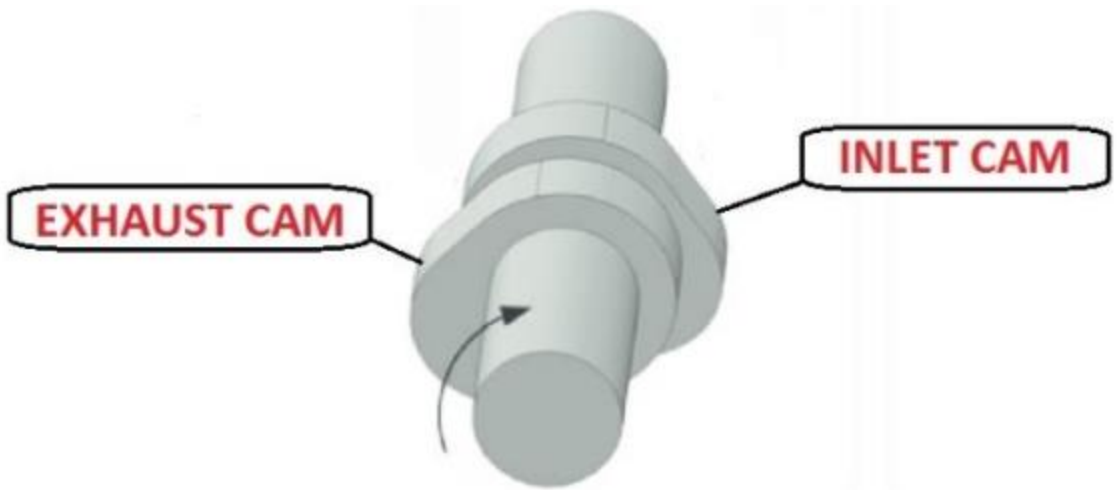


13. Camshaft

Camshaft is used in IC engine to control the opening and closing of valves at proper timing. For proper engine output inlet valve should open at the end of exhaust stroke and closed at the end of intake stroke. So to regulate its timing, a cam is use which is oval in shape and it exerts a pressure on the valve to open and release to close. It is drive by the timing belt which drives by crankshaft. It is placed at the top or at the bottom of cylinder.

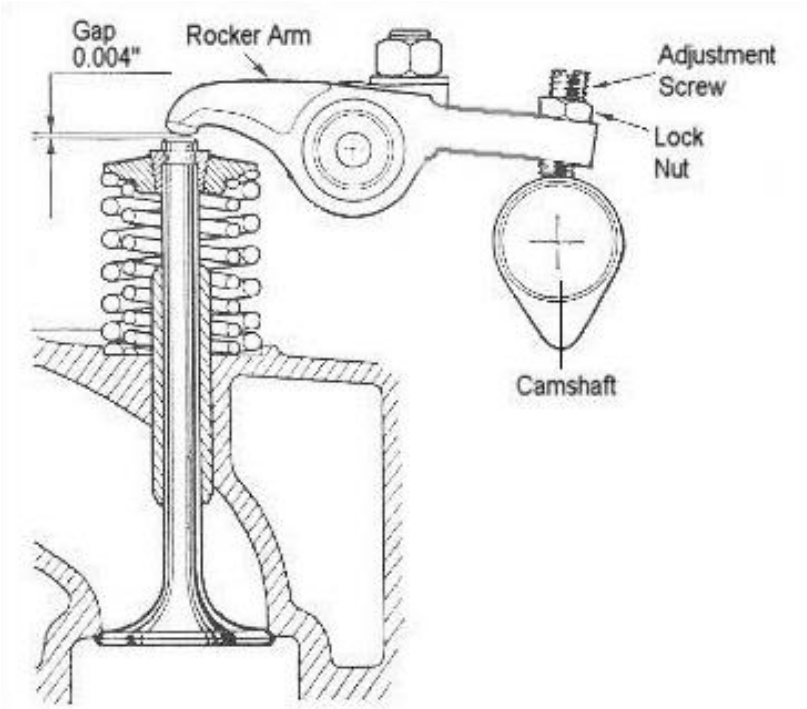
9. Valves

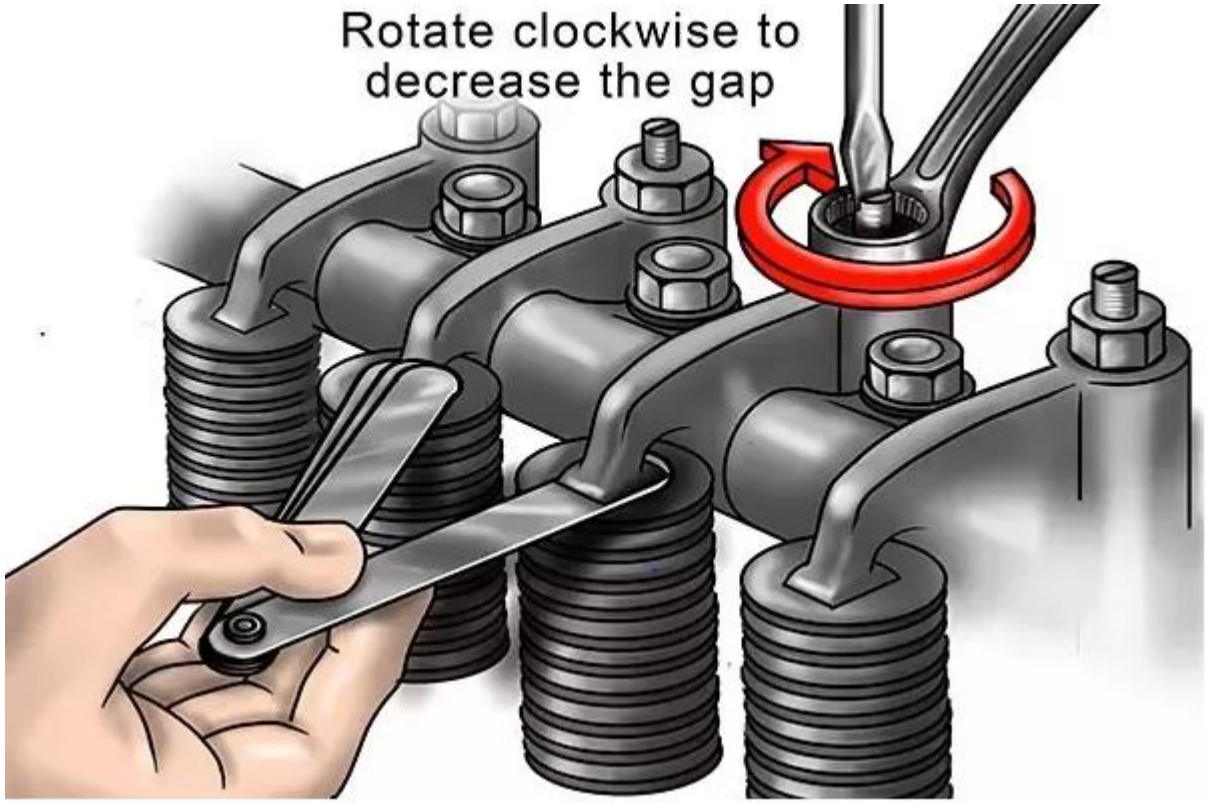
To control the inlet and exhaust of internal combustion engine, valves are used. The number of valves in an engine depends on the number of cylinders. Two valves are used for each cylinder one for inlet of air-fuel mixture inside the cylinder and other for exhaust of combustion gases. The valves are fitted in the port at the cylinder head by use of strong spring. This spring keep them closed. Both valves usually open inwards.



VALVE CONSTRUCTION

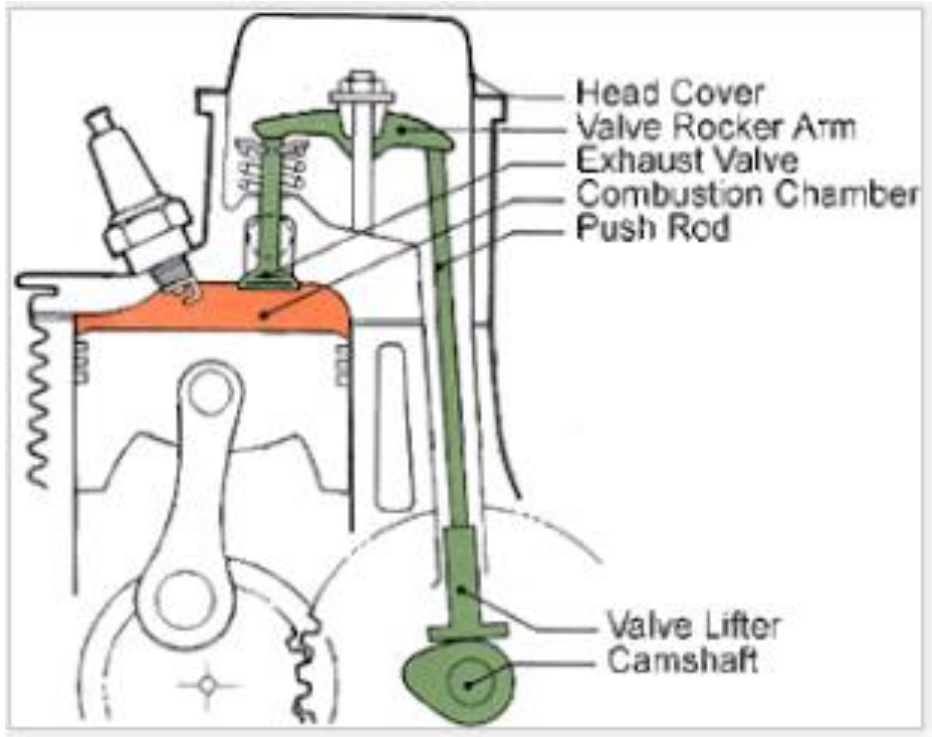
Valve Tappet Clearance





Tappet clearance is a space between the top of the stem of the valve and the rocker arm when the valves are closed position & the engine is at the cooled condition at the compression stroke.

Its purpose is to allow some mechanical expansion and lengthening of the valve stem and push rods when the engine warms up.


Head Cover
Valve Rocker Arm
Exhaust Valve
Combustion Chamber
Push Rod
Valve Lifter
Camshaft

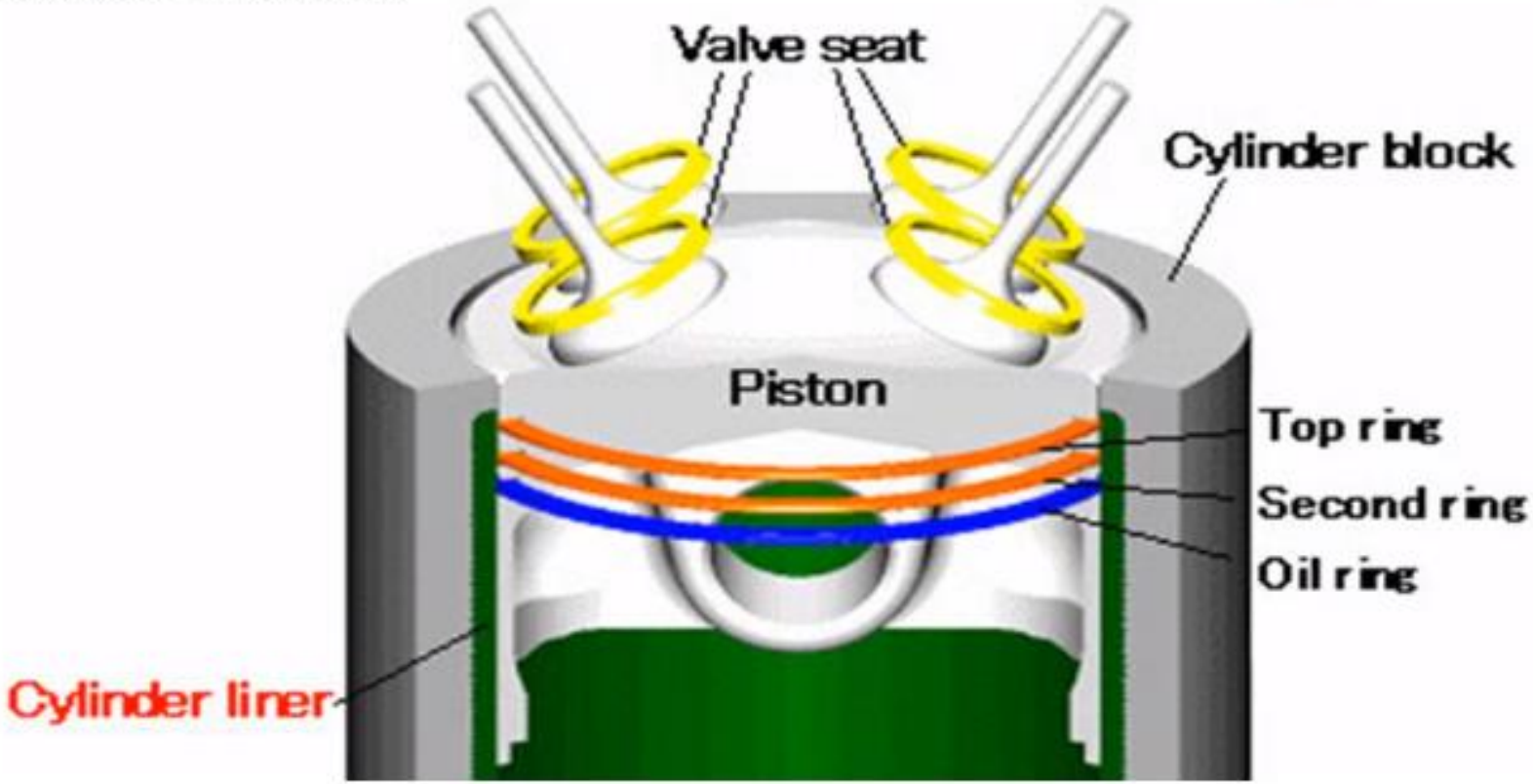
10. Spark plug

It is used in spark ignition engine. The main function of a spark plug is to conduct a high potential from the ignition system into the combustion chamber to ignite the compressed air fuel mixture. It is fitted on cylinder head. The spark plug consists of a metal shell having two electrodes which are insulated from each other with an air gap. When high potential current supply to spark plug it jumping from the supply electrode and produces the necessary spark.

11. Injector

Injector is usually used in compression ignition engine. It sprays the fuel into combustion chamber at the end of compression stroke. It is fitted on cylinder head.

Cylinder Liners



- Liners are cylindrical components that fit inside the cylinder bore.

Purpose of liners:

- Liners are provided in order to increase the service life of the engine i.e., wear resistant surface for bore
- It simplifies the production of cast iron engines

Material used:

- Liners are made of cast iron and special alloys of iron containing silicon, manganese, nickel and chromium.

There are two types of liners Dry liner and Wet liner

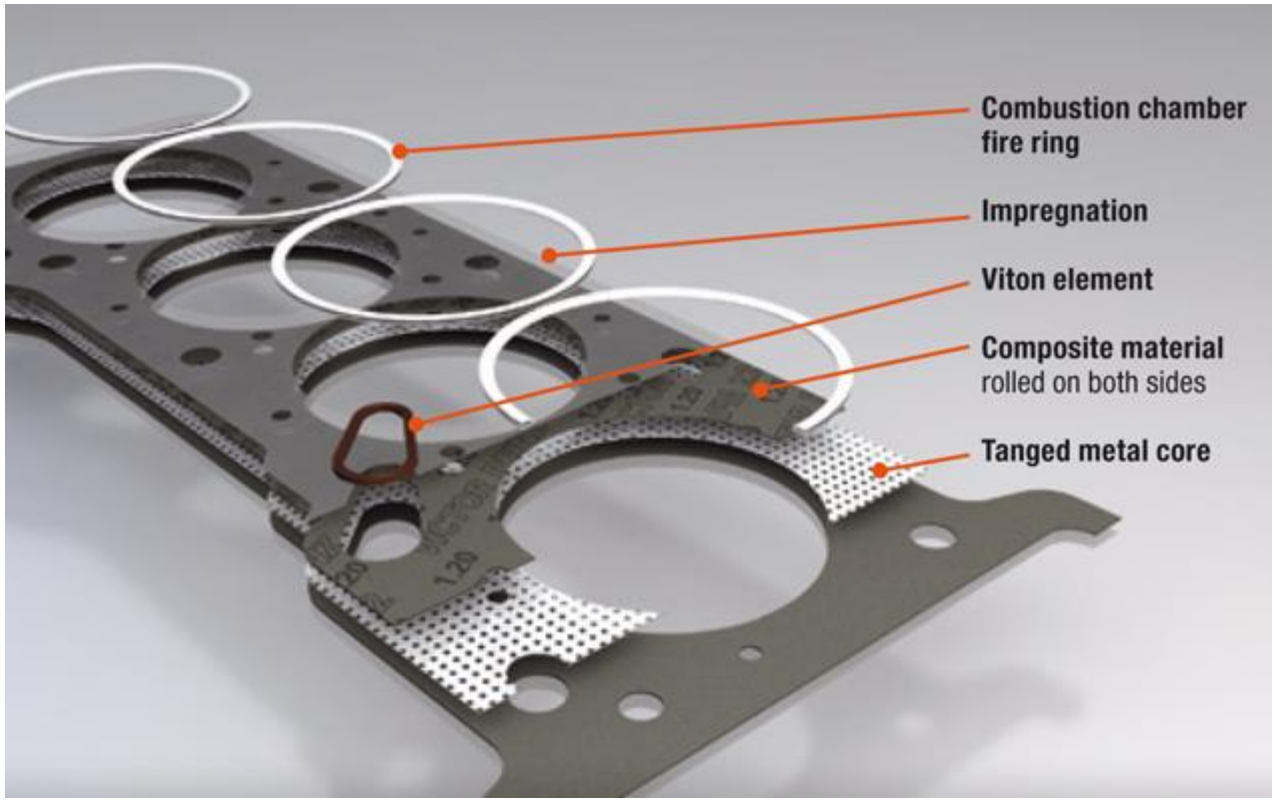
Dry liner

- It is in the form of a barrel having flange at the top which fits in the grooves of block.
- It is not directly in contact with water. Hence it is called dry liner. It is machined from both the sides.

Wet liner

- It is in the form of barrel shape provided with flange at top which fits into the grooves of the cylinder block.
- Grooves are provided to cylinder or liner. Rubber packings are inserted into the bottom grooves.
- These are having direct contact with water. Hence called as wet liners.
- Machining from both the sides are not required because it does not bear against the cylinder block.

Head Gasket



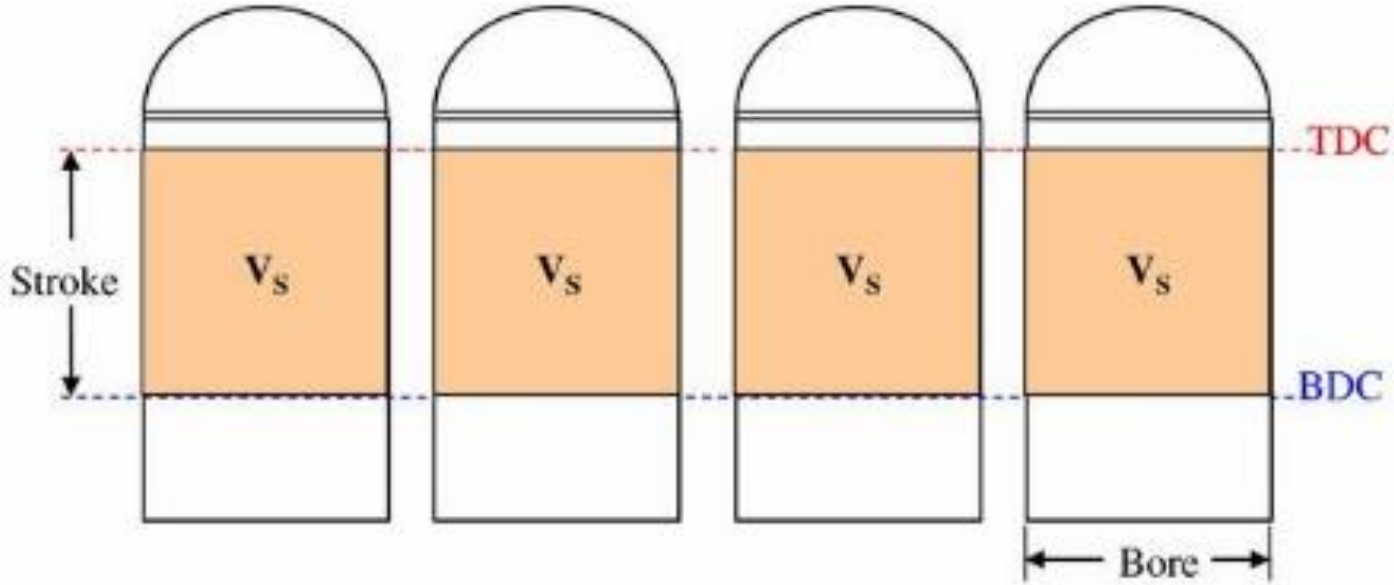
Within a water-cooled internal combustion engine, there are three fluids which travel between the engine block and the cylinder head:

1. Combustion gases (unburned air/fuel mixture and exhaust gases) in each cylinder
2. Water-based coolant in the coolant passages
3. Lubricating oil in the oil galleries

Correct operation of the engine requires that each of these circuits do not leak or lose pressure at the junction of the engine block and the cylinder head. The head gasket is the seal that prevents these leaks and pressure losses.

Volume or Engine Capacity (CC)

The term “cc” stands for Cubic Centimeters or simply cm^3 which is a metric unit to measure the Engine's Capacity or its volume. It is the unit of measuring the volume of a cube having a size of 1cm X 1cm X 1cm. CC is also known as ‘Engine Displacement’. It means the displacement of the piston inside the cylinder from the Top Dead Centre (TDC) to the Bottom Dead Centre (BDC) in the engine's one complete cycle. The Engine Volume is also measured in Liters corresponding to Cubic Centimeters.



- $Ve = V_S\ n$
- $Ve = (\pi/4)\ D2\ L\ \ n$

Where:

V_e = engine capacity, V_s = cylinder swept volume

n = number of cylinders, L = stroke, D = bore diameter

SL.	Engine Capacity	Fuel Mileage (Petrol)	Overall (Max.) Range*	Power Output*	Ideal Usage
1	Up to 110cc	Best	Above 80 Km/L	Up to 10 BHP	Best for Low Fuel-budget, Frequent city travel
2	110cc to 150cc	Better	80 to 60Km/L	10 to 15 BHP	Daily Commuting mainly within city
3	150cc to 200cc	Moderate	60 to 40 Km/L	15 to 20 BHP	Mix of City & Highway travel
4	200 to 500cc	Low	40 to 25 Km/L	20 to 30 BHP	Better for highway travel, Occasional within city travel
5	above 500cc	Least	Up to 25 Km/L	Above 30 BHP	Performance, Off-roading, Leisure travel

Typical data ranges of Petrol Four Wheelers with naturally aspirated engines under Indian driving conditions:

SL.	Engine Capacity	Fuel Mileage (Petrol)	Overall (Max.) Range*	Power Output*	Applicable vehicle segments
1	Up to 1000cc	Best	Above 20 Km/L	Up to 70 BHP	Small Cars, Hatchbacks
2	1000cc to 1500cc	Better	20 to 17 Km/L	70 to 110 BHP	Family Cars, Entry level saloons, Sub-4 meter vehicles
3	1500cc to 1800cc	Moderate	16 to 13 Km/L	110 to 170 BHP	Mid-Size Cars, Small Wagons,
4	1800cc to 2500cc	Lower	12 to 9 Km/L	170 to 230 BHP	Semi-Luxury Cars, Wagons, MPVs, SUVs
5	Above 2500cc	Least	Up to 9 Km/L	above 230 BHP	SUVs, Sports Cars, High End Luxury Cars

TYPES OF IC ENGINES

According to number of Strokes…

1. Two stroke engine

In a two stroke engine a piston moves one time up and down inside the cylinder and complete one crankshaft revolution during single time of fuel injection. This type of engine has high torque compare to four stroke engine. These are generally used in scooters, pumping sets etc.

2. Four stroke engine

In a four stroke engine piston moves two times up and down inside the cylinder and complete two crankshaft revolutions during single time of fuel burn. This type of engines has high average compare to two stroke engine. These are generally used in bikes, cars, truck etc.

According to Method of Ignition.....

1. Compression ignition engine

In these types of engines, there is no extra equipment to ignite the fuel. In these engines burning of fuel starts due to temperature rise during compression of air. So it is known as compression ignition engine.

2. Spark ignition engine

In these types of engines, ignition of fuel start by a spark, generated inside the cylinder by some extra equipment (Spark Plug). So it is known as spark ignition engine.

According to Arrangement of Cylinders….

1. In-line engine

In this type of engines, cylinders are positioned in a straight line one behind the other along the length of the crankshaft.

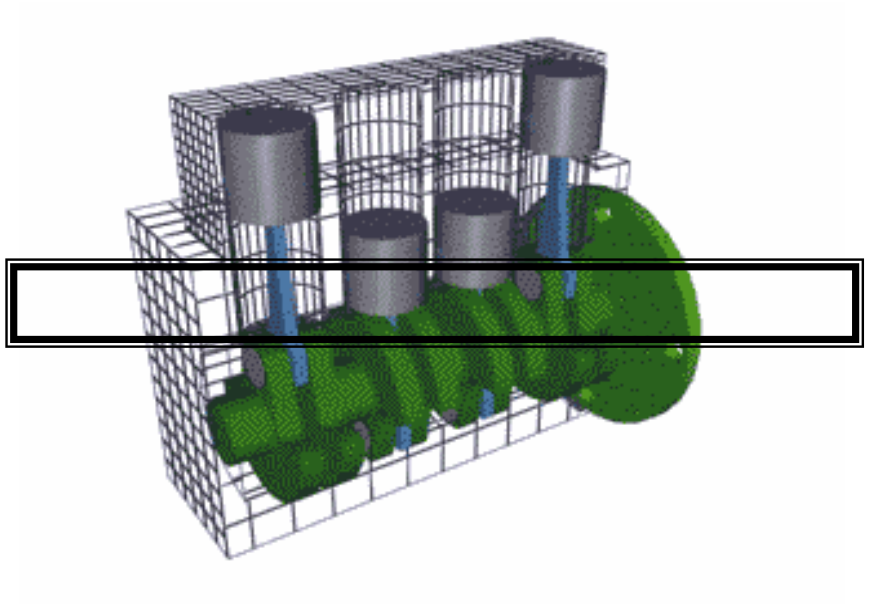
2. V-type engine

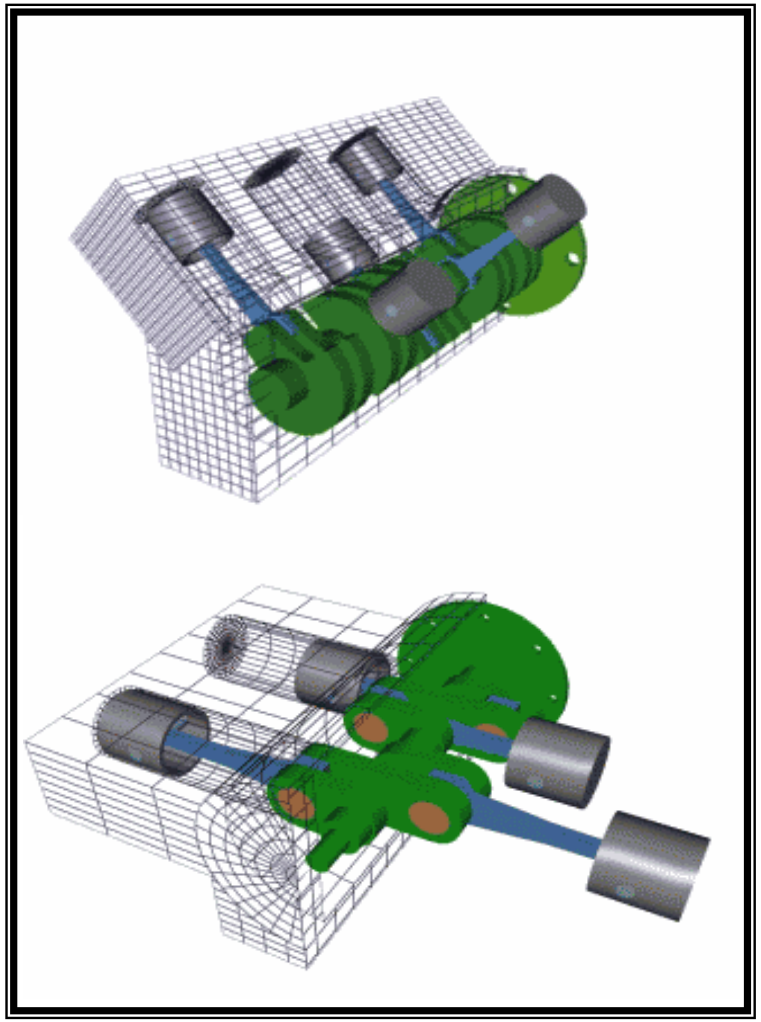
An engine with two cylinder banks inclined at an angle to each other and with one crankshaft known as V-type engine.

3. Opposed cylinder engine

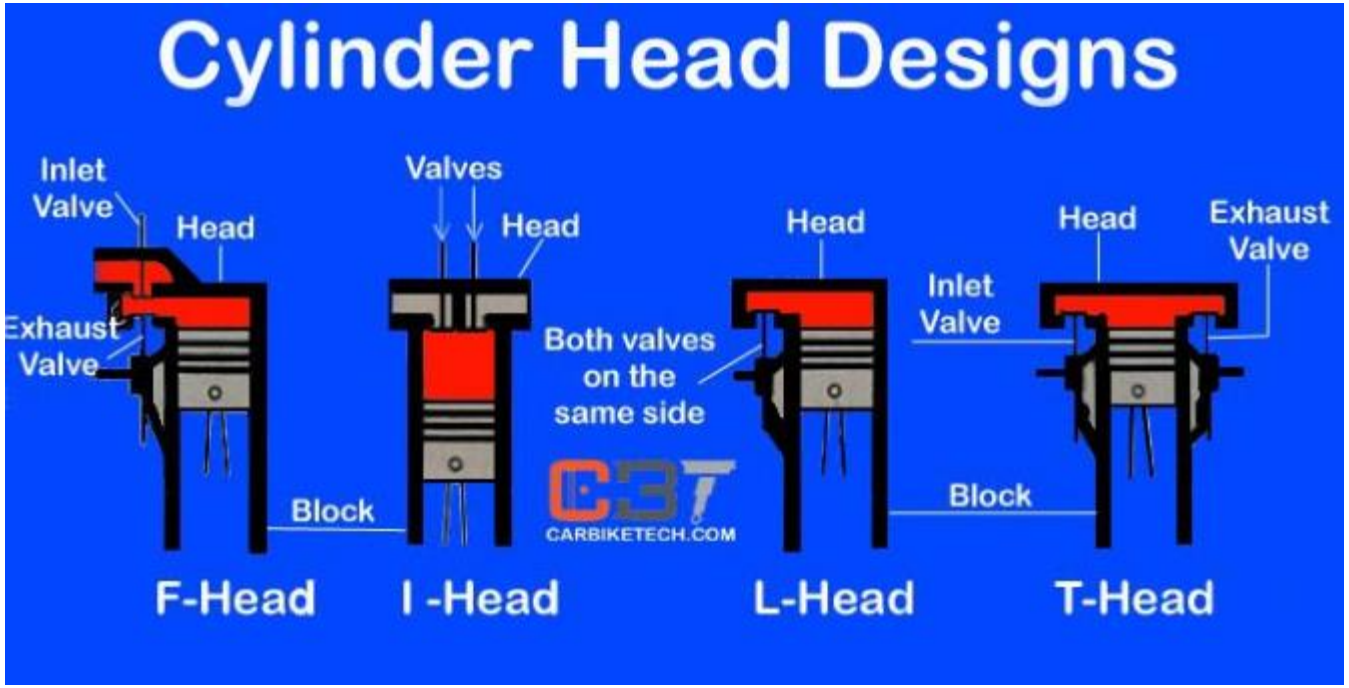
An engine with two cylinders banks opposite to each other on a single crankshaft (V-type engine with 180o angle between banks).

Cylinder Arrangement





According to Valve Arrangement….



~~However~~, the "I" head engines have the valves in the head which operate through push-rods and rocker arms. The "T" head engines have the inlet valves on one side and the exhaust valves on the other side which requires two camshafts. The "F" types have the inlet valve in the head and exhaust valve in the cylinder block and employ one camshaft.

According to Air Intake Process.....

1. Naturally aspirated

In this types of engine intake of air into cylinder occur by the atmospheric pressure.

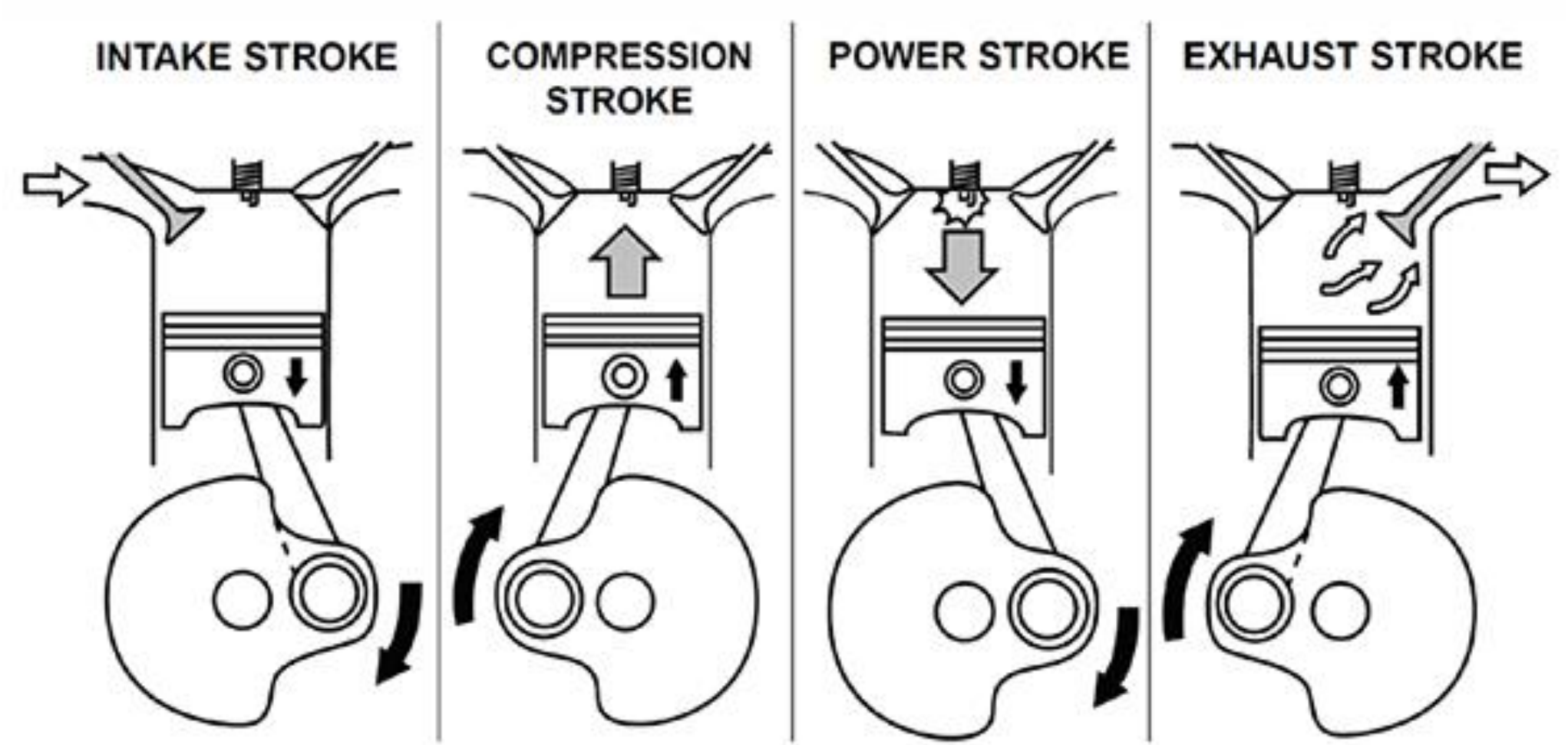
2. Supercharged engine

In this type of engine air intake pressure is increased by the compressor driven by the engine crankshaft.

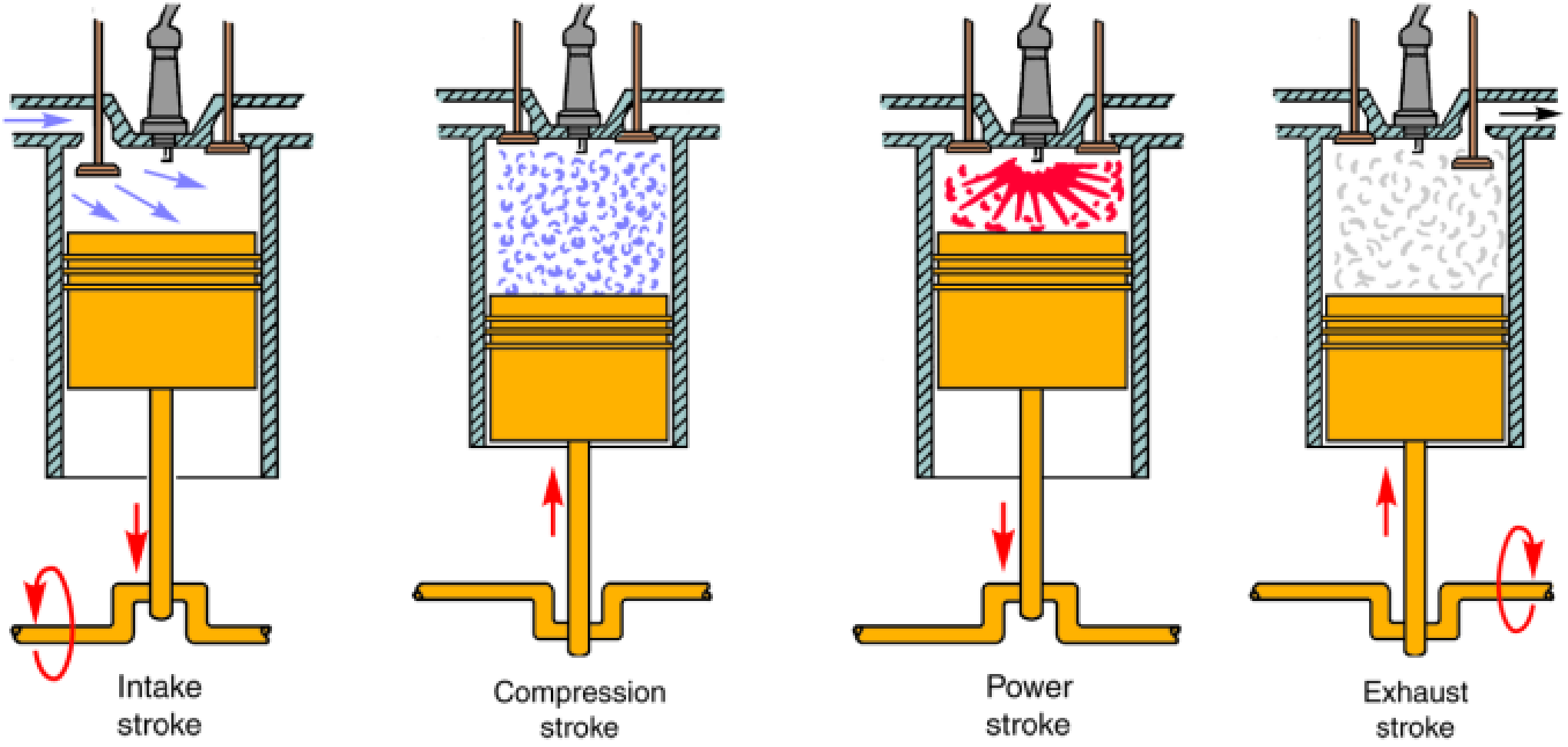
3. Turbocharged engine

In this type of engine intake air pressure is increase by use of a turbine compressor driven by the exhaust gases of burning fuel.

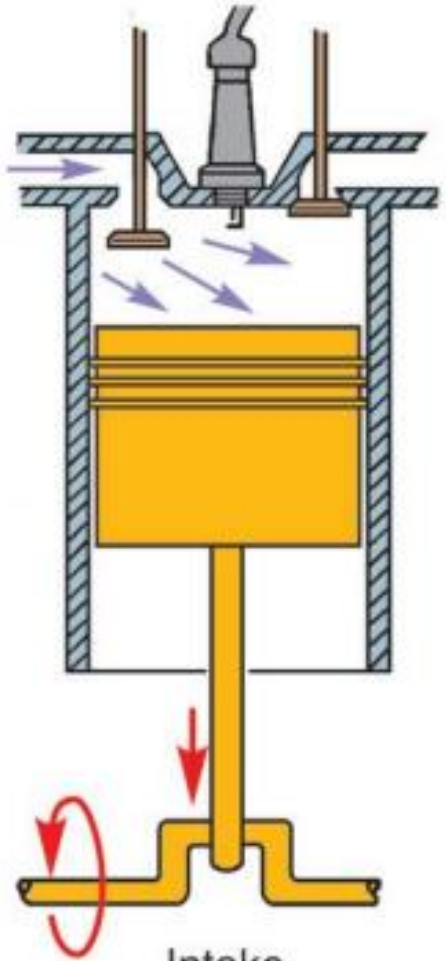
Four Stroke Cycle in Petrol Engine



Four-Stroke Engine



Intake Stroke



- Piston travels downward
- Volume of space above piston increases
  - Creates partial vacuum
- Intake valve open and exhaust valve closed

Intake Stroke

- Atmospheric pressure forces air through carburetor, through intake valve port, and into cylinder
- Intake valve must open and close at the correct time
  - Incoming air-fuel mixture cools valve during engine operation

Intake stroke

- Piston moves down the cylinder bore from top dead center (TDC) to bottom dead center (BDC)
- Intake valve is open, the exhaust valve is closed
- Downward piston motion creates a vacuum (negative air pressure) that draws that air/fuel mixture into the engine via the open intake valve

Compression stroke

- Piston moves up the cylinder bore from bottom dead center to top dead center
- Both the intake and exhaust valves are closed
- Upward piston motion compresses air/fuel mixture in the combustion chamber

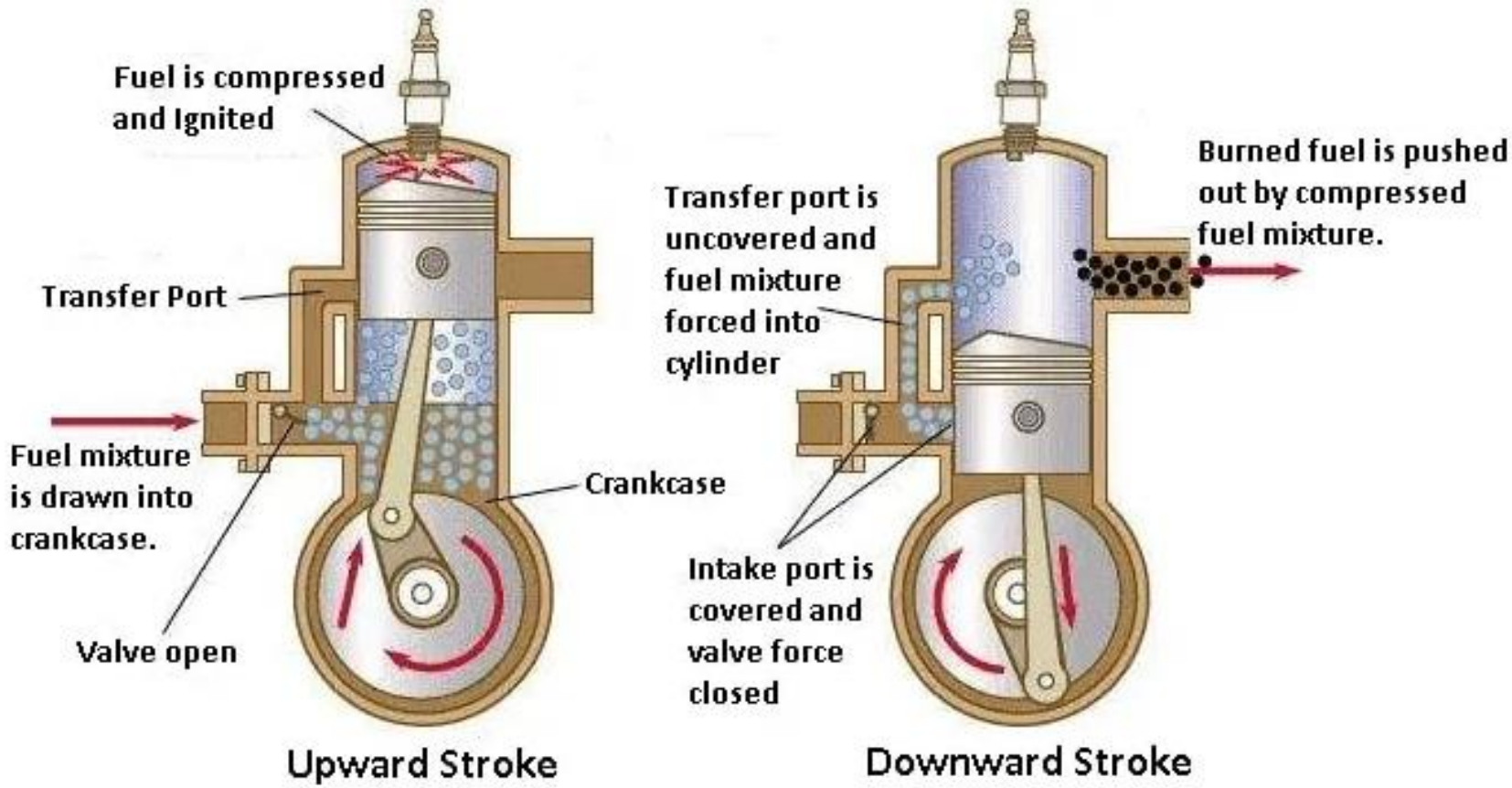
Power stroke

- At the end of the compression (previous) stroke, the spark plug fires and ignites the compressed air/fuel mixture. This ignition/explosion forces the piston back down the cylinder bore and rotates the crankshaft, propelling the vehicle forward.
- Piston moves down the cylinder bore from top dead center to bottom dead center
- Both the intake and exhaust valve are closed

Exhaust stroke

- Piston moves up the cylinder bore from bottom dead center to top dead center. The momentum caused by the power stroke is what continues the crankshaft movement and the other 3 strokes consecutively.
- Intake valve is closed, the exhaust valve is open
- This final stroke forces the spent gasses/exhaust out of the cylinder. The cycle in now complete and the piston is ready to begin the intake stroke.

Two Stroke Petrol Engine



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

The two-stroke engine employs for small powers required in autocycles, scooters, motorcycles. In **two-stroke engines**, there is no suction and exhaust strokes. There are only two remaining strokes the compression stroke and power stroke. These are usually **called the upward stroke and downward stroke**. Also, instead of valves, there are inlet and exhaust ports in two-stroke engines.

The principle of two stroke spark ignition engine is shown in the figure. Its two strokes are as follows:

1. Upward Stroke
2. Downward Stroke

Upward Stroke

During upward stroke, the piston moves upward from the bottom dead centre to top dead centre. By compressing the charge air petrol mixture in the combustion chamber of the cylinder. Due to upward movement of the piston, a partial vacuum is created in the crankcase.

And a new charge is drawn into the crankcase through the uncovered inlet port. The exhaust port and transfer port are covered when the piston is at the top dead centre position. The compressed charge is ignited in the combustion chamber by a spark given by the spark plug.

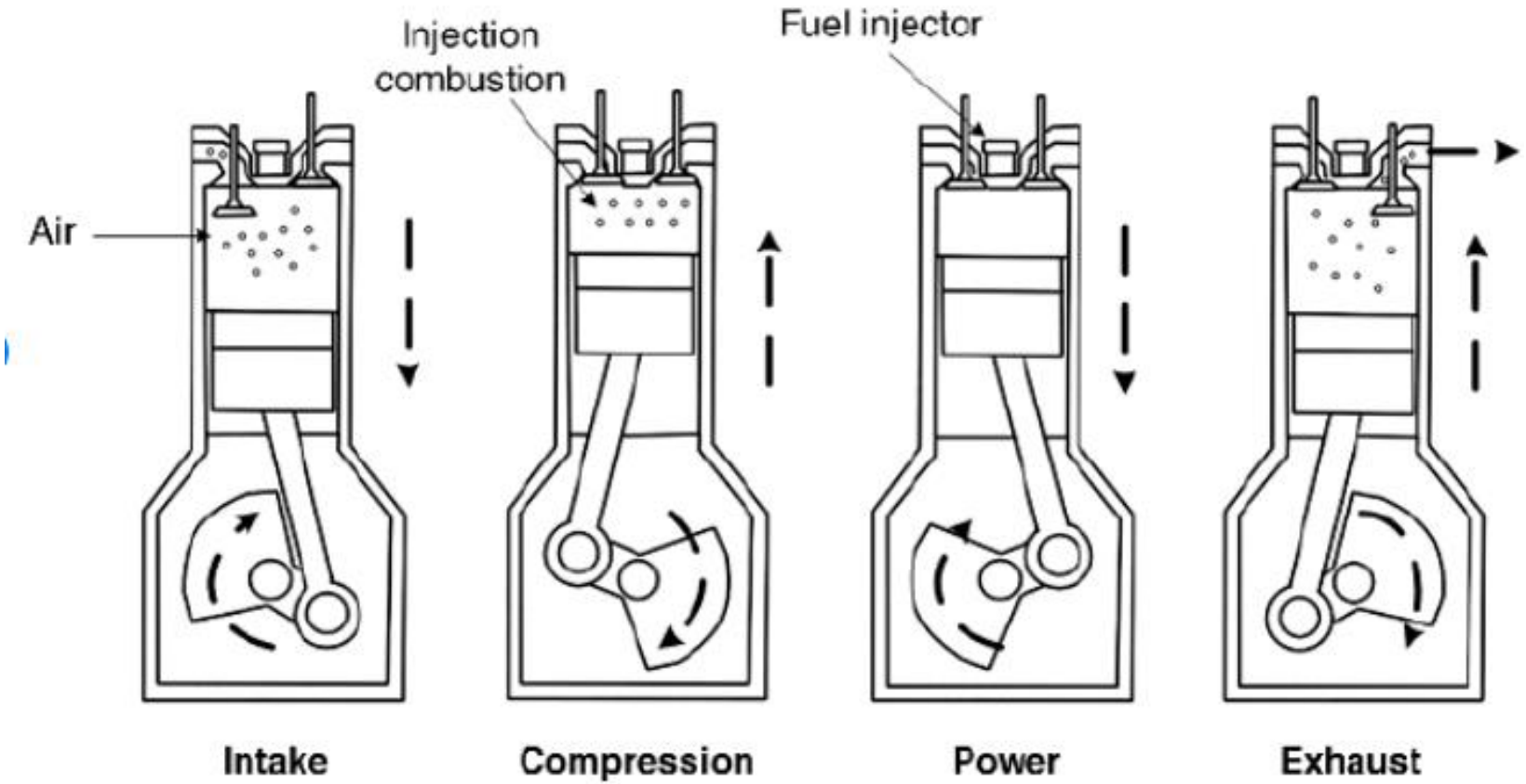
Downward Stroke

As soon as the charge is ignited the hot gases compress the piston which moves downward, rotating the crankshaft thus doing the useful work. During this stroke, the inlet port is covered by the piston and the new charge is compressed in the crankcase. Further downward movement of the piston uncovers first the exhaust port and then the transfer port. and hence the exhaust starts through the exhaust port.

As soon as transfer port is open, the charge through it is forced into the cylinder. The charge strikes the deflector on the piston crown, rises to the top of the cylinder and pushes out most of the exhaust gases. The piston is now at the bottom dead centre position.

The cylinder is completely filled with a fresh charge, although it is somewhat with the exhaust gases. The cycle of events is then repeated, the piston making two strokes for each revolution of the crankshaft.

Diesel 4 – Stroke Engine



A conventional internal combustion diesel engine works on 'Diesel Cycle'. In the simple diesel engines, an injector injects diesel into the combustion chamber above the piston directly. The 'Compression-Ignition engine' is also another name for the Diesel engine. This is mainly because it burns the diesel with hot and compressed air. The temperature of the air inside the combustion chamber rises to above 400°c to 800°c. This, in turn, ignites the diesel injected into the combustion chamber. Thus, the 'Diesel Cycle' **does not use** an external mechanism such as a spark-plug to ignite the air-fuel mixture.

The Four-Stroke diesel engine works on the following cycle:

1. Suction Stroke – With pistons moving downwards and the opening of the inlet valve creates the suction of clean air into the cylinders.

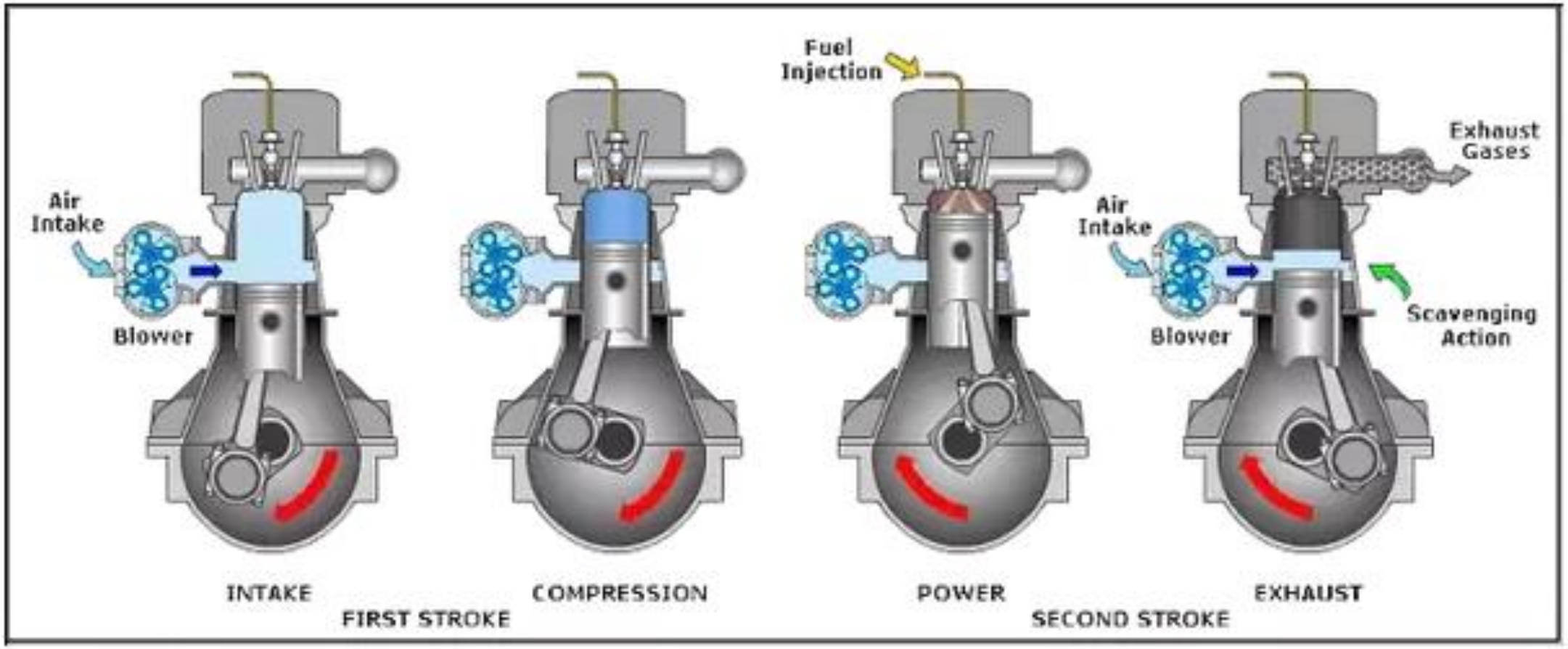
2. Compression – With the closing of Inlet valve the area above the piston gets closed. The piston moves up resulting in compression of the air in a confined space under higher compression-ratio.

Combustion Process - At this stage, the injector sprays the diesel into the combustion chamber. The rise in temperature of the air caused by its compression; results in instantaneous burning of diesel with an explosion. This causes heat to release which generates expanding forces known as power.

3. Power Stroke – Furthermore, these forces again push the pistons downwards resulting in their reciprocating motion.

4. Exhaust Stroke – On their way up, the pistons push the exhaust gases above them thru' the exhaust valve which opens during the exhaust stroke.

Two Stroke Diesel Engine



1. Upward stroke

The upward stroke is a step that piston move upward from BDC (bottom dead center) to TDC (top dead center). In this stroke there are two steps, the intake step and compression step.
The intake step is the process of entering air into the engine cylinder, while the compression step is the process of compressing air into a denser form so that the air pressure and temperature increases.

It start when piston on the BDC, in this condition the air will enter through the air hose around the cylinder wall. This air can be pushed in because the intake channel has a blower or turbo that pushes the air towards the engine.

Then the piston will move up, this movement will make the air hole covered by the piston wall. As a result, when the new piston moves ¼ upward the compressed air will begin.

When the piston reaches TDC, the air has been successfully compressed so the pressure and temperature rises and is ready for combustion.

2. Downward stroke

The downward stroke is a step that piston moving down from TDC to BDC. In this stroke there are 2 steps, combustion step and exhaust step.

The combustion step is the burning process of the compressed air and fuel, while the exhaust step is the process of removing combustion residual gas from the engine to the exhaust.

The combustion step will occur when the piston reaches TDC at the end of the compression step, at this time the injector will atomize some of the diesel fuel into the high pressure air. The result is the diesel fuel will burn by itself.

Petrol Engine	Diesel Engine
This engine works on the base of the otto cycle.	It works on the base of a diesel engine.
In this engine, the ignition process occurs due to the spark provided by a spark plug.	In this engine, ignition occurs due to high compression of the air-fuel mixture.
It uses petrol or gasoline as a working fluid.	It uses diesel.
This engine is less efficient.	It is most efficient.
It has a low compression ratio.	This engine has a high compression ratio.
It uses less amount of fuel.	It uses a low amount of fuel.
These engines are mostly used in small applications like bikes, motorcycles, and generators, etc.	These engines are mostly used for heavy-duty applications like buses, trucks, and vans, etc.

Comparison between 4-Stroke & 2-Stroke Engine.

Two Strokes	Four Strokes
It has one revolution of the crankshaft during one power stroke.	It has two revolutions of the crankshaft during one power stroke.
It generates high torque.	It generates less torque.
It uses a port for the fuel's outlet and inlet.	It uses valves for the fuel's outlet and inlet.
Its engines result in lesser thermal efficiency.	Its engines result in higher thermal efficiency.
It has a larger ratio in terms of power to weight.	It has a lesser ratio in terms of power to weight.
It generates more smoke and shows less efficiency.	It generates less smoke and shows more efficiency.
Requires more lubricating oil as some oil burns with the fuel.	Requires less lubricating oil.
Due to poor lubrication, more wear and tear occurs.	Less wear and tear occurs.
Engines are cheaper and are simple to manufacture.	Engines are expensive due to lubrication and valves and are tough to manufacture.
Engines are basically lighter and noisier.	Engines are basically heavier because their flywheel is heavy and less noisy.

Valve Timing Diagram

In Four-stroke engines, the Thermodynamic cycle will be completed in the two revolutions of the crankshaft. Four Stroke Engine uses valves rather than the ports.

- Port: Fluid can be operated inward and outward.
- Valve: The fluid can be operated in one direction only.

The closing and the opening of the valves will be operated by a camshaft. The cycle of operation of a 4 Stroke Engine consists of the following processes:

1. Suction or intake stroke,
2. Compression stroke,
3. Expansion or power stroke,
4. Exhaust stroke.

The above processes will be operated with the sequence of operations of the valves in the Four-stroke engine. This relation between the valve opening timings to the piston moves from the Top Dead Centre (TDC) to the Bottom Dead Centre (BDC) can be represented on a circle. This is called the Valve Timing Diagram.

The following theoretical Valve Timing diagram will illustrate how the events such as the Inlet valve and Exhaust Valve are open and closes in an ideal cycle. See the below Theoretical Valve Timing Diagram for the Four-stroke Engine.

Valve Timing Diagram of Four Stroke SI Engine – Low Speed and High-Speed Operation