

ANIL NAIK TECHNICAL TRAINING CENTER

GEETA MULTIPURPOSE HALL

શ્રી ગાંધી એજ્યુકેશન સોસાયટી, ગાંધીધામ

મહિસાગર

વર્ષ : ૨૦૧૨

**AUTO MECHANIC  
THEORY**





# INTRODUCTION OF ANTTTC



## Introduction

- Introduction about ANTTTC
- Rule's and regulation of the ANTTTC
- Benefit for the society from ANTTTC
- Visit of Display Gallery Class room, Trade Workshop, audio visual room





# INDEX



## Index

Time :912 Hours

Sr. No.	Topics	Hours
1	Introduction of ANTTTC, Training, Visit of Display Gallery & Workshop	02
2	EHS, CRP, Hazard, Risk, 5'S, Accident & Fire safety Training	06
3	Trade Theory	272
4	Trade Practical	576
5	Basic Computer Training & soft skill	56
	(weekly 40 hour x 24 week =960 hour)	
	Total hours	912



**LARSEN & TOUBRO**  
Public Charitable Trust



# THEORY INDEX

Sr. No.	Topics	Hours
1	<b>Automobile Tools &amp; Equipment</b> – Type of spanner, Lifting Equipment	8
2	<b>Automobile Engine-</b> Types of engine,4 stoke , intake system, air filter, Emission system, block, Liner ,Valve Mechanism, piston, camshaft, Crank Shaft , Turbo, EGR, Lubrication System, cooling system	112
3	<b>Fuel System-</b> Feed System, Tank Flushing, Air Bleeding, Injection Pump, Fuel filter	12
4	<b>Transmission System-</b> Principle, Clutch(Single& Double Plate),Hydraulic Clutch, pressure Plate, Type of gear, Manual gearbox , Autotransmission, Propeller shaft, universal joint, Differential, Axle(ded & live),Frame	45
5	<b>Suspension System-</b> Link, Leaf & coil spring, torsion bar, air Stusbar	12
6	<b>Steering system &amp; brake system-</b> Steering Introduction, Rack Pinion, Hydraulic steering, EPS, mechanical, air, Hydraulic Brake ,ABS, Pad, Disc	30





# THEORY INDEX



Sr. No.	Topics	Hours
7	<b>Electrical System</b> -Spark plug, glow plug, ignition system, alternator, starter, power window, airbag, light, sensor	23
8	<b>Air Conditioner system</b> -Blower, Evaporator, compressor, condensing coil, fan motor, thermostat, AC Filter.	6
9	<b>Wheel alignment &amp; Tire puncture</b> –Alignment, balancing, toe in-out, tire rotation, tire wear, tire puncture, wheel bearing,.	10
10	<b>Rule's</b> - Driving rule, traffic rule, sign board, road side caution	4
11	Assist in service, maintenance and repair of the vehicle	6
12	Work Effectively in team	4
	<b>TOTAL</b>	<b>272</b>



# PRACTICAL INDEX



Sr. No.	Topics	Hours
1	Auto Mobile Engine	269
2	Engine fuel system	34
3	Transmission system	53
4	Suspension System	22
5	Steering system & brake system	64
6	Electrical System	70
7	Air Conditioner system	19
8	Wheel alignment & Tire	20
9	Driving Rules	6
10	Vehicle Accessories & damage	14
11	Assist in service, maintenance and repair of the vehicle	5
	<b>Total</b>	<b>576</b>





# SAFETY



Sr .No	Topics	Duration
1	<b><u>Basic Safety Introduction</u></b> 1. What is safety ? 2. Why safety ? 3. Reason to be safe 4. What is Hazard & risk? 5. Basic steps for to be safe	01 hr
2	<b><u>Hazard Identification</u></b> 1. safety signs and its meaning	30 min
3	<b><u>Fire Extinguisher</u></b> 1. Fire Chemistry 2. Type of fire 3. Fire Extinguisher 4. Type of Fire Extinguisher 5. Pass Method 6. Emergency Planning and control	01.15 hrs



Sr .No	Topics	Duration
4	First Aid with CPR	01.15 hr
5	<b>5S</b> 1. Background, 2. Why 5S, 3. Meaning of 5S, 4. Advantage of 5S, 5. Benefit of each, 6. Example & Brief	1 hr
6	<b>Trade Specific safety</b> 1.Basic Hazard, 2. Job related Injury 3.Preventive action, 4. Safety measures in industry 5.Petrol, 6.Lifting tools, 7. Confine area 8.Battery, 9.PPE, 10. Road safety, 11. Toeing of vehicle	01 hr
	<b>Total</b>	<b>06 hr</b>





**AUTO MECHANIC TOOLS & EQUIPMENT**



# AUTO MECHANIC TOOLS & EQUIPMENT

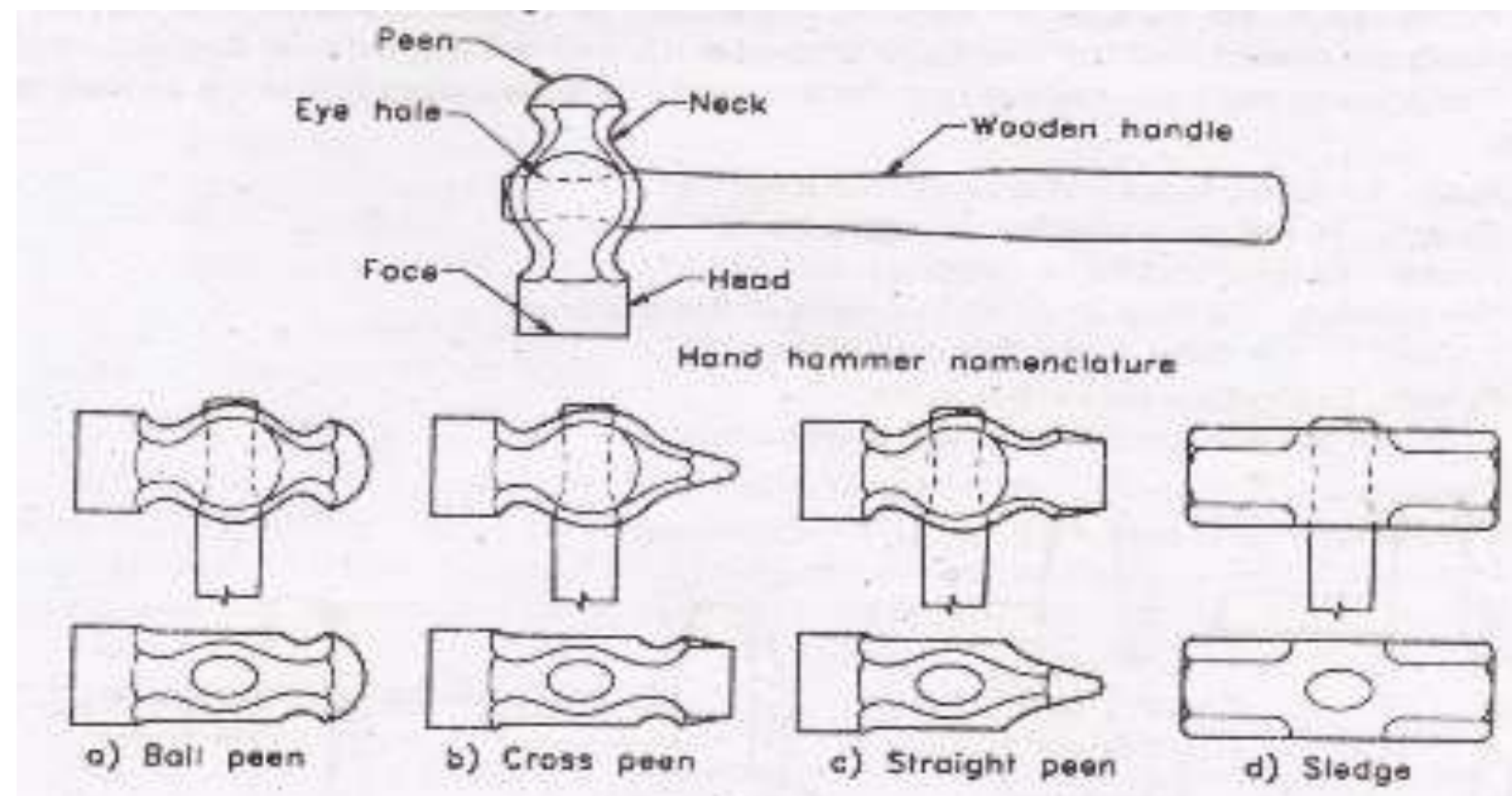


**LARSEN & TOUBRO**  
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A **hammer** is a tool consisting of a weighted "head" fixed to a long handle that is swung to deliver an impact to a small area of an object.

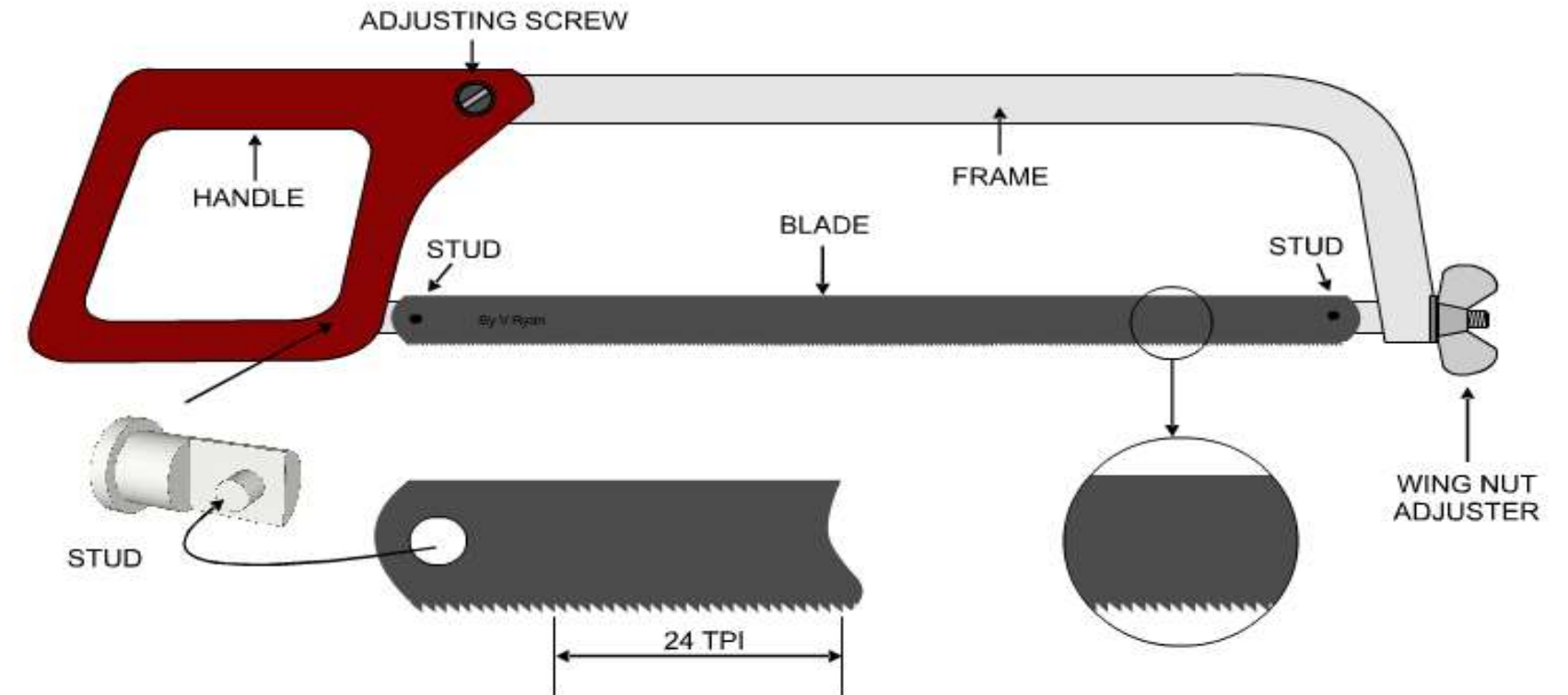
Hammer heads are made of high carbon, heat-treated steel for strength and durability. The heat treatment helps prevent chipping or cracking caused by repeated blows against other metal objects.





Hacksaws, as with most frame saws, the blade can be mounted with the teeth facing toward or away from the handle, resulting in cutting action on either the push or pull stroke. In normal use, cutting vertically downwards with work held in a bench vice, hacksaw blades are set to be facing forwards.

**Frame :** There are two types of Hacksaw Frame, a fixed and an adjustable. Hacksaws are made from Low Tungsten Steel or Carbon Steel thin blade under tension.

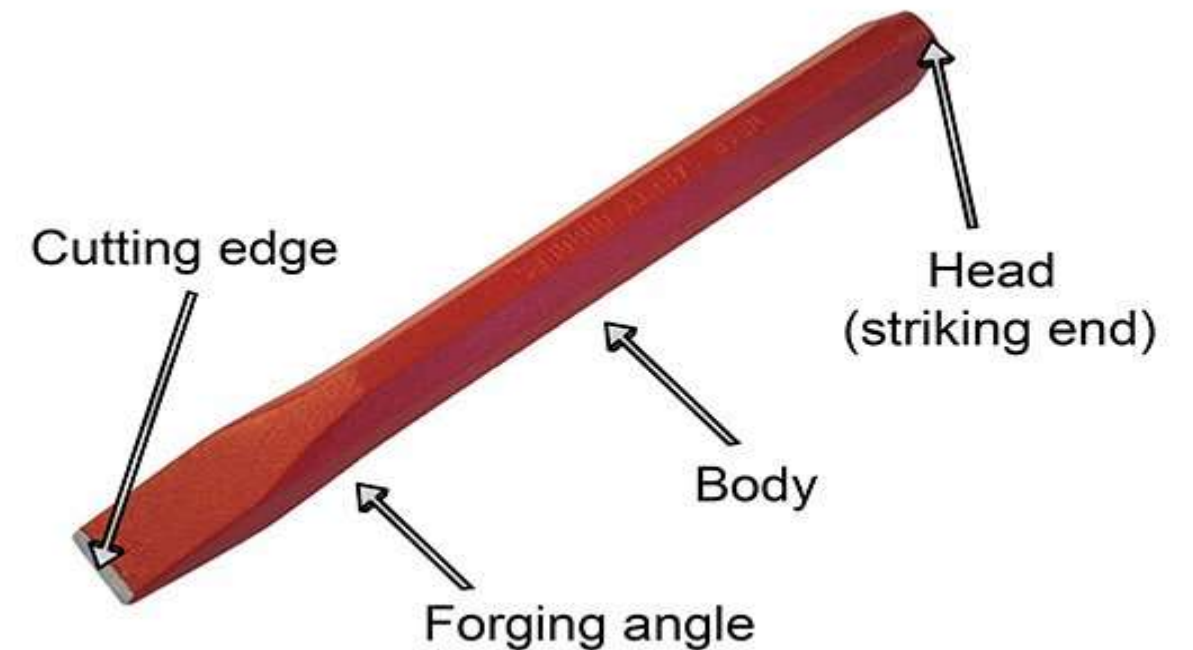


**Blades** Small hacksaw (also known as junior hacksaw). The teeth of the hacksaw blade point forward, away from the handle. Standard hacksaw blade lengths are 10 to 12 in (250 to 300 mm). Blades can be as small as 6 in (150 mm). The Hacksaw is used for cutting materials, and for cutting away waste parts of the work. Most Hacksaws are made from Low Tungsten Steel or Carbon Steel, however the more expensive blades are made from High Speed Steel. There are two types of blades: (1) Flexible type (2) All hard type.

A **chisel** is a tool with a characteristically shaped cutting edge of blade on its end, for carving or cutting a hard material such as wood, stone, or metal by hand, struck with a mallet, or mechanical power.

There are two types of chisel-

- cold chisel
- hot chisel



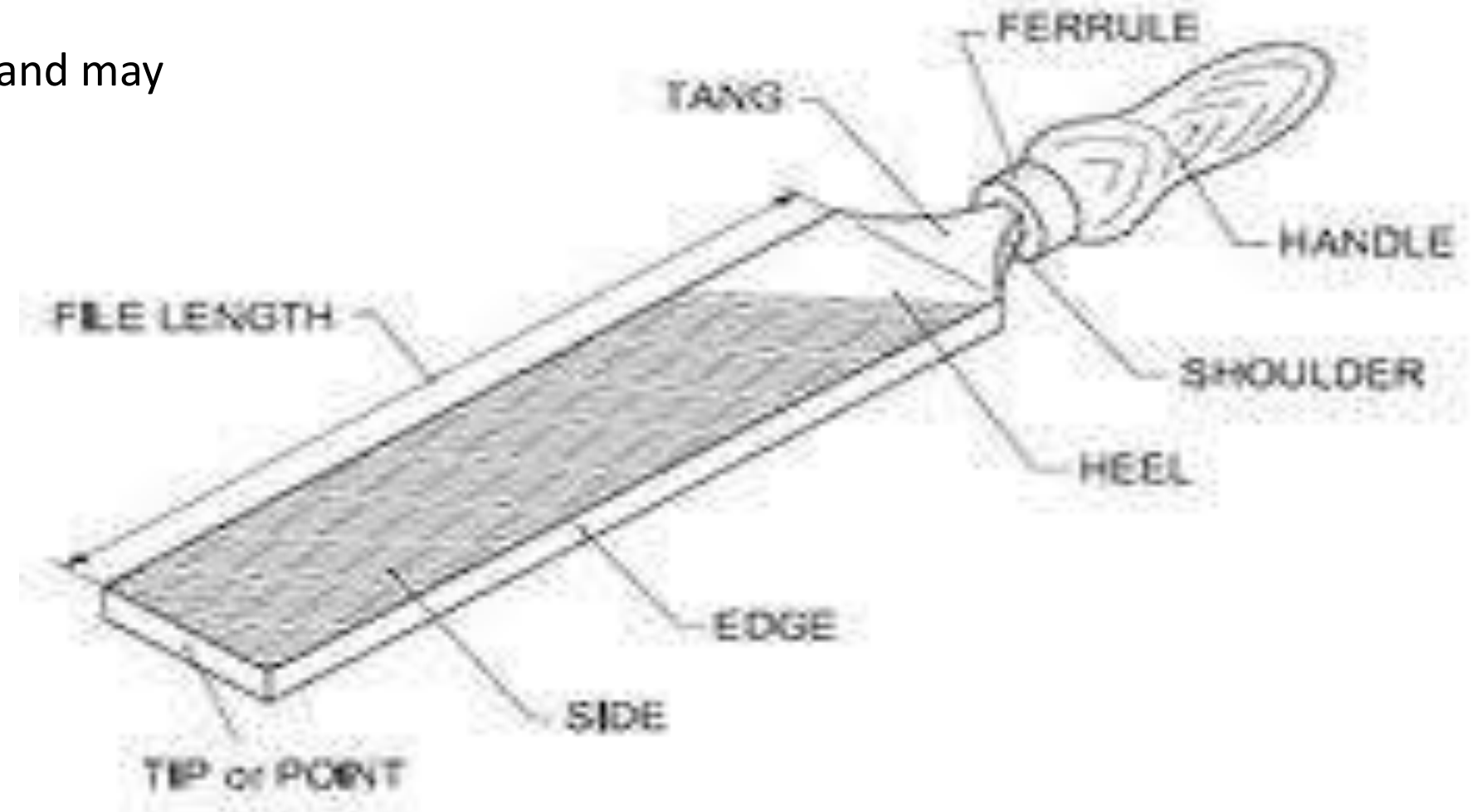


A **file** is a too used to remove fine amounts of material from a work piece. It is common in woodworking, metalworking, and other similar trade and hobby tasks.

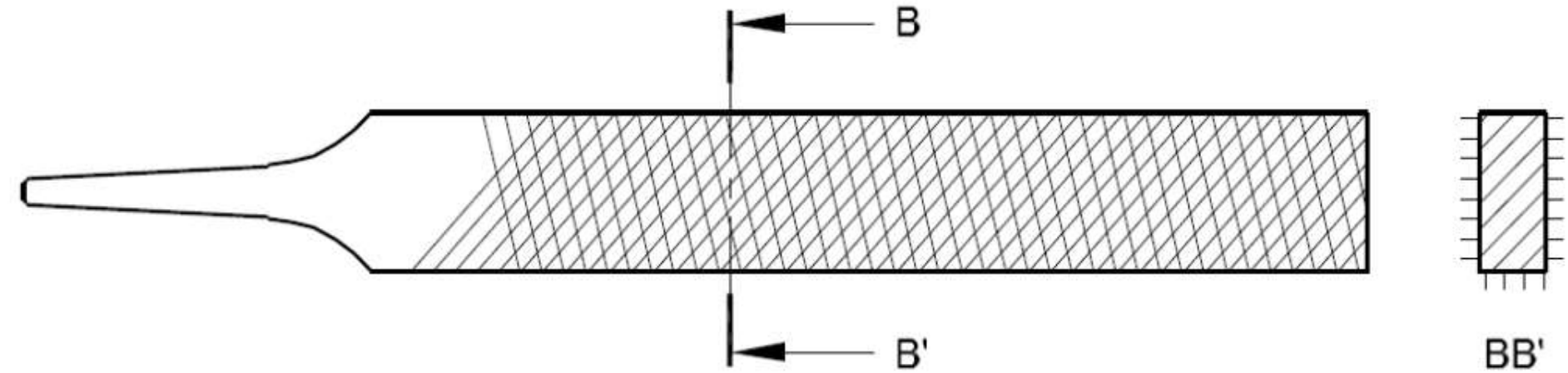
files are made from high **carbon steel** (1.0 to 1.25% **carbon**) and may be through hardened or case hardened.

## Types of File Tool

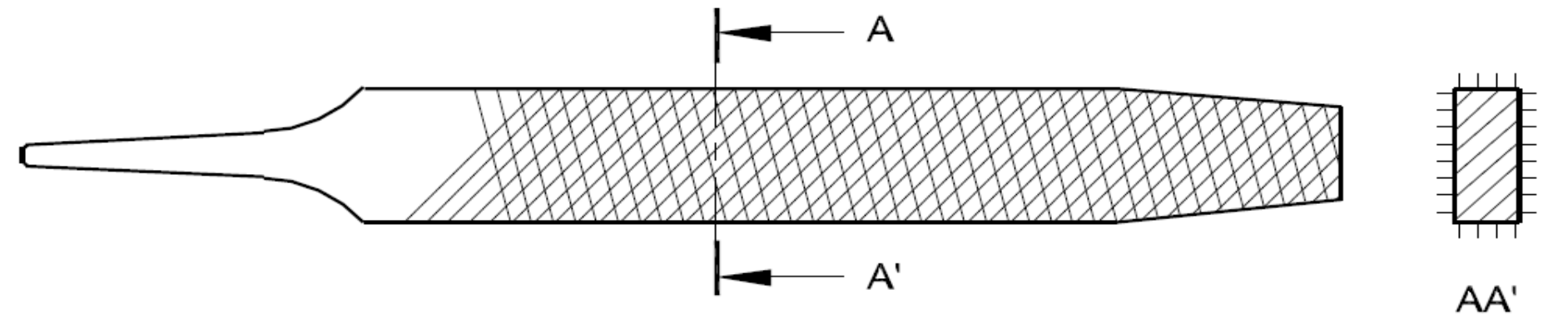
1. Flat file
2. Hand file
3. Square file
4. Round file
5. Half round file
6. Triangular file
7. Knife-edge file



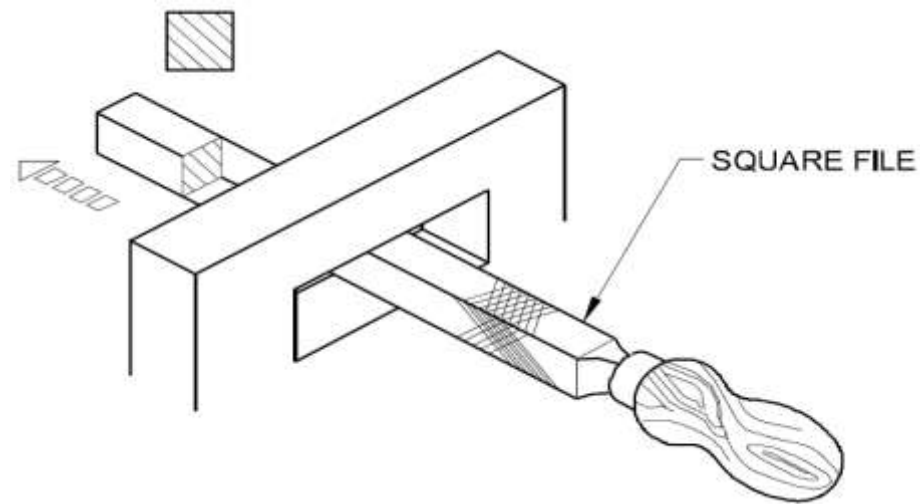
**Flat files** are of a rectangular cross section. The edges along the width of these files are parallel up to two-thirds of the length, and then they taper towards the point. The faces are double cut, and the edges single cut. They are useful for filing and finishing external and internal surfaces.



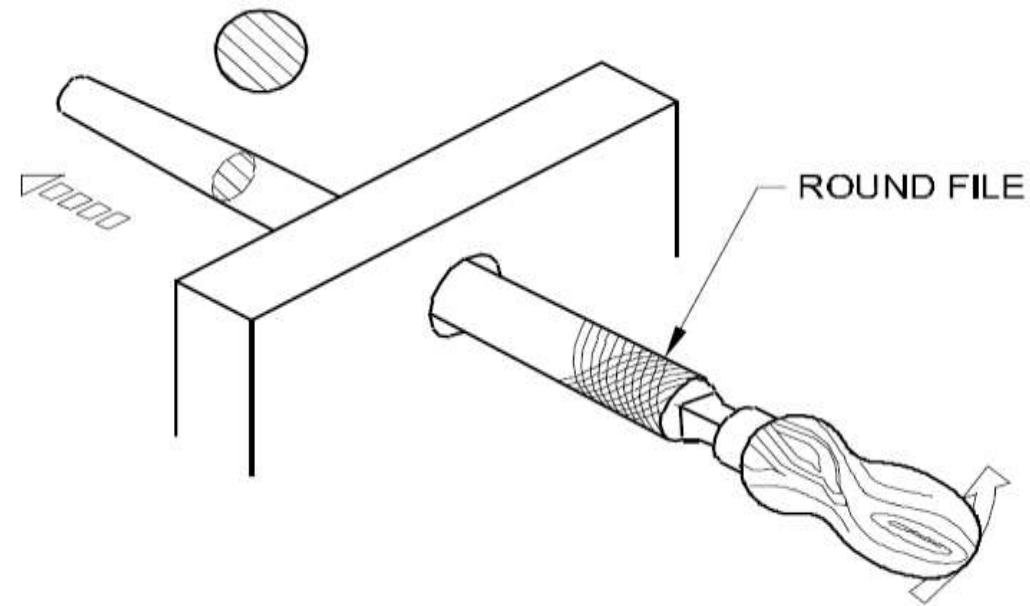
**Hand files** are similar to the flat files in their cross section. The edges along the width are parallel throughout the length. The faces are double cut. One edge is single cut whereas the other is safe edge.



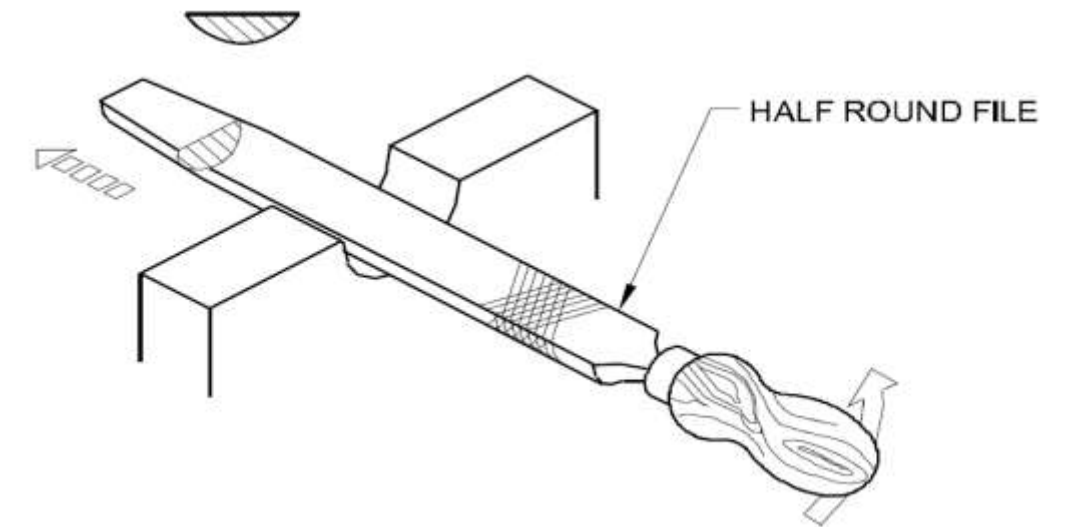
**The square file** is square in its cross section. It is used for filing square holes, internal square corners, rectangular openings, keyways and splines.



**A round file** is circular in its cross section. It is used for enlarging the circular holes and filing profiles with fillets.



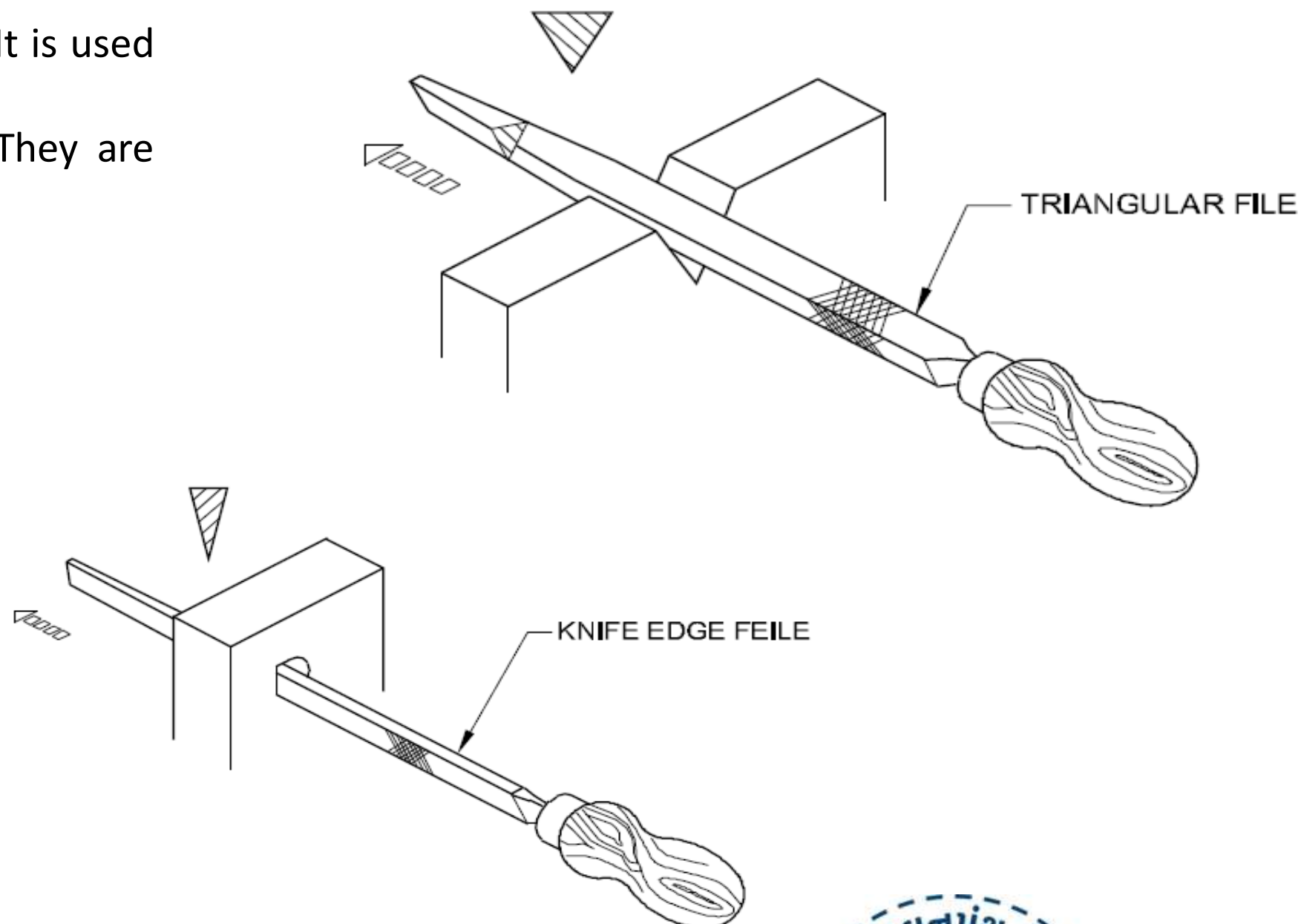
**A half round file** is in the shape of a segment of a circle. It is used for filing internal curved surfaces.





A **knife edge file** has the cross section of a sharp triangles. It is used for filing narrow grooves and angles above 10 degree.

The above files have one third of their lengths tapered. They are available both single and double cuts.



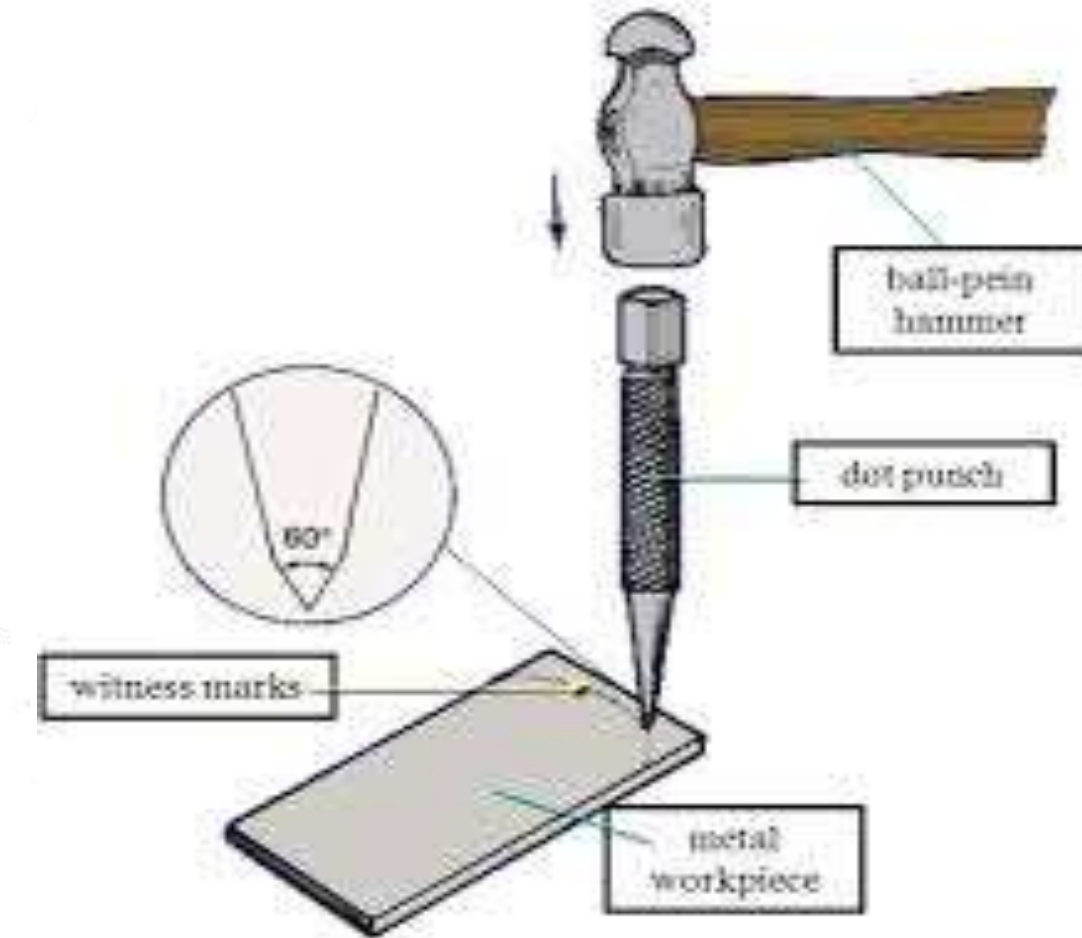
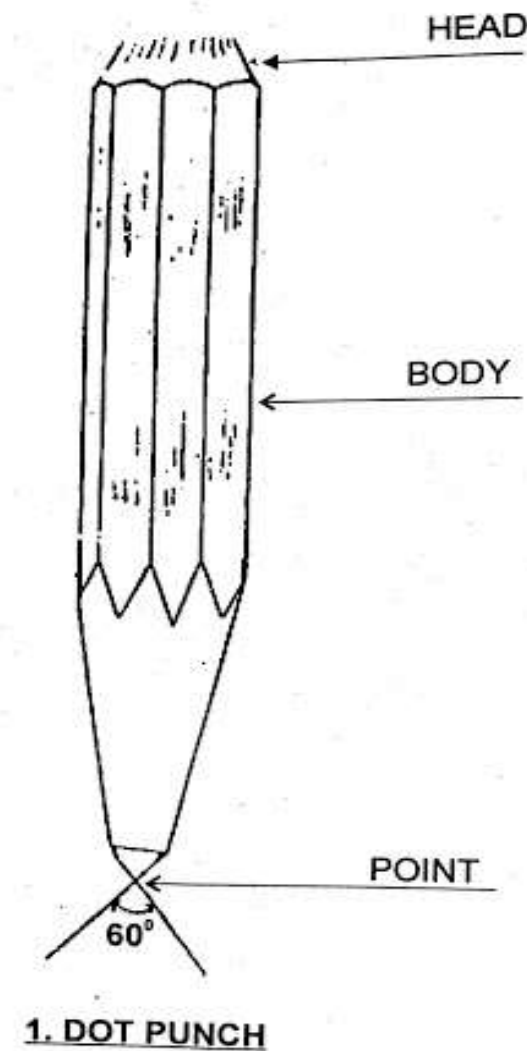
A **triangular file** is of a triangular cross section. It is used for filing corners and angles which are more than 60 degree.

Square, round, half-round and triangular files are available in lengths of 100, 150, 200, 250, 300 and 400mm. These files are made in bastard, second cut and smooth grades.

**Punches** are used in order to make certain dimensional features of the layout permanent. There are two types of punches. They are centre punch and prick punch made of **high carbon steel, hardened** and ground. Punches are used to drive fasteners such as nails and dowels, making a hole, or forming an indentation/impression of the tip on a work piece.

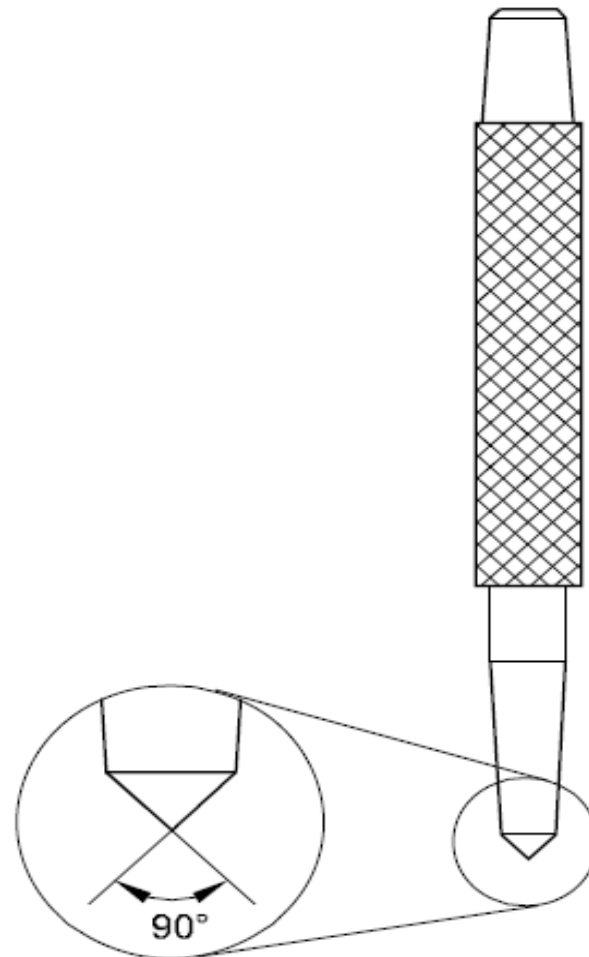
## Types of Punches are as follows

- Centre Punch
- Prick Punch / Dot Punch
- Hollow punch
- Number punch
- Letter punch

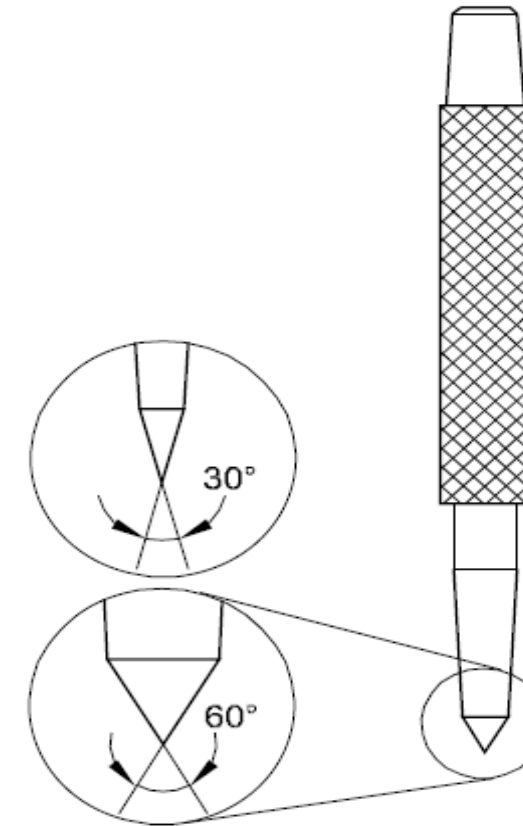


## Centre Punch

The angle of the point is  $90^\circ$  in a centre punch. The punch mark made by this is wide and not very deep. This punch is used for locating centre of the holes. The wide punch mark gives a good seating for starting the drill.



**DOT punch** The angle of the prick punch is  $30^\circ$  or  $60^\circ$ . The  $30^\circ$  point punch is used for making light punch marks needed to position dividers. The divider point will get a proper seating in the punch mark. The  $60^\circ$  punch is used for marking witness marks and called as dot punch.





A *tap* cuts or forms a thread on the inside surface of a hole, creating a female surface that functions like a **nut**. The three taps in the image illustrate the basic types commonly used by most **machinists**:

### Bottoming tap or plug tap

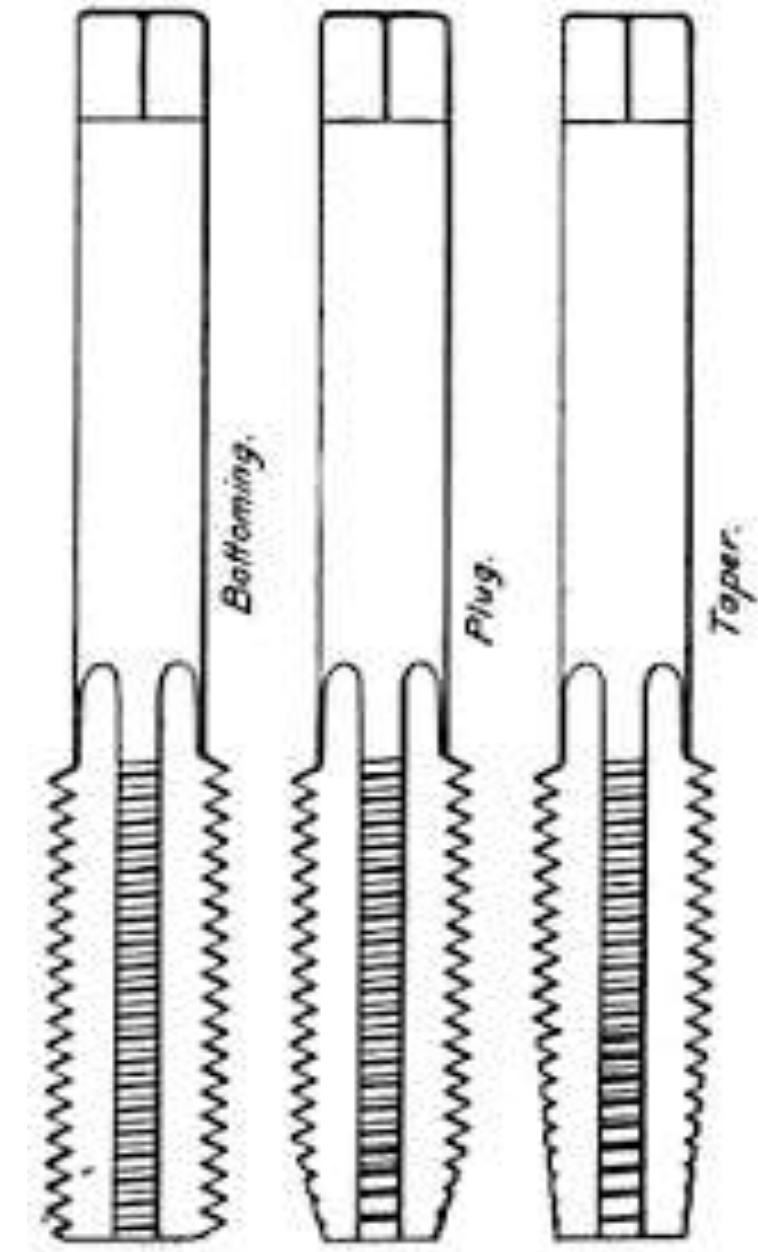
The tap illustrated in the top of the image has a continuous cutting edge with almost no taper — between 1 and 1.5 threads of taper is typical. This feature enables a bottoming tap to cut threads to the bottom of a **blind hole**.

### Intermediate tap, second tap, or plug tap

The tap illustrated in the middle of the image has tapered cutting edges, which assist in aligning and starting the tap into an untapped hole.

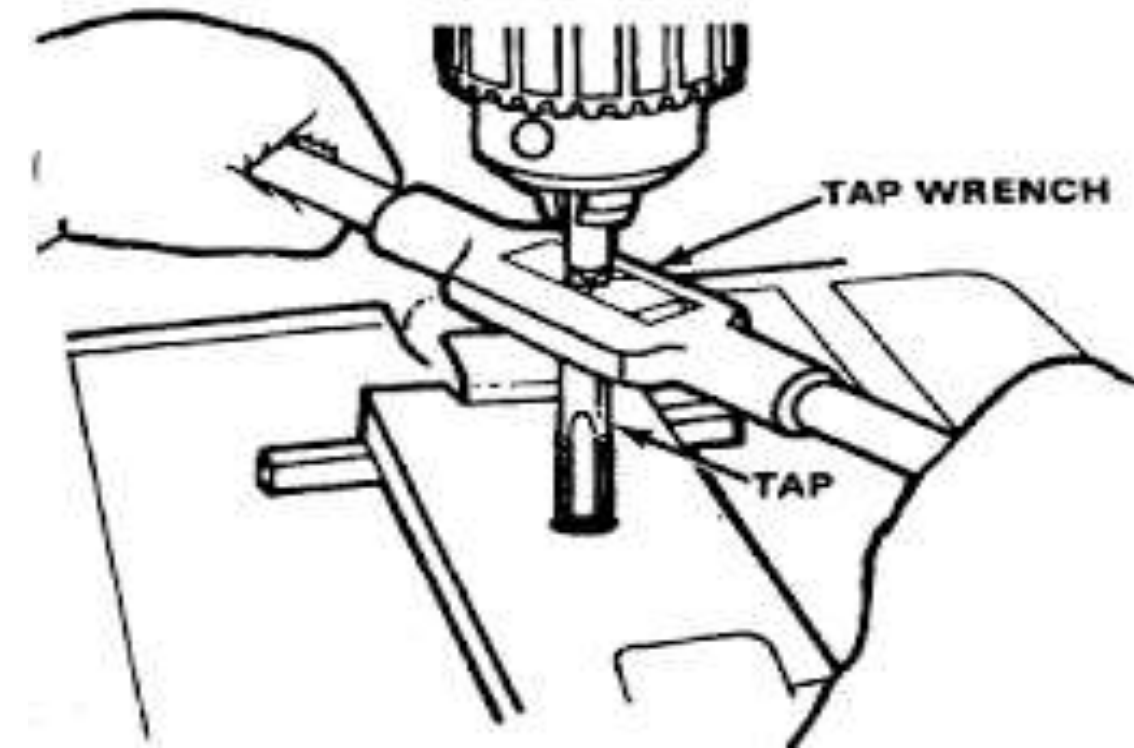
### Taper tap

The small tap illustrated at the bottom of the image is similar to an intermediate tap but has a more pronounced taper to the cutting edges.



## Power taps

The above taps are generally referred to as hand taps, since they are manually operated. During operation, the machinist must periodically reverse a hand tap to break the chip (also known as [swarf](#)) that forms from cutting. This prevents the cut material from *crowding* and breaking the tap.



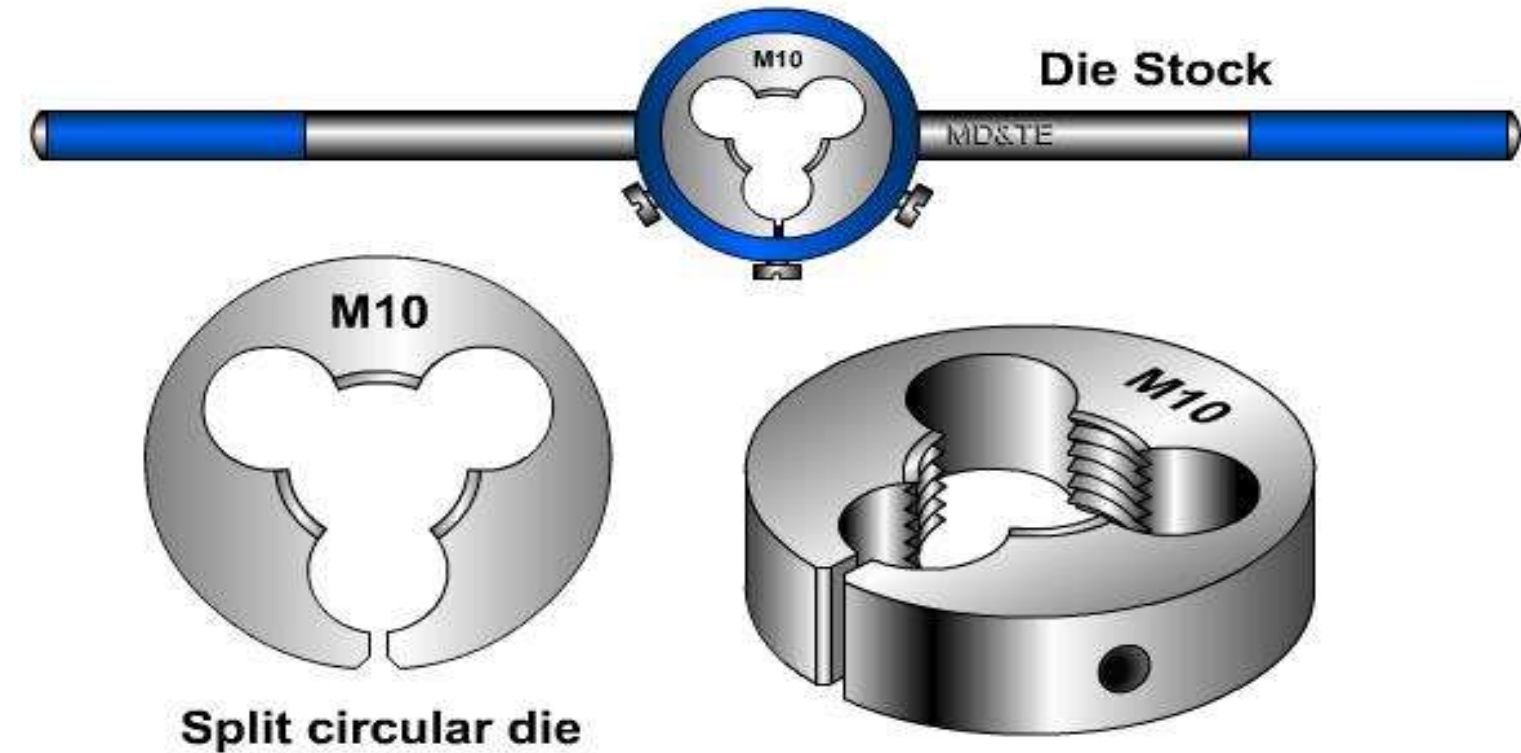
## Tools used for holding Taps

Adjustable Tap Wrench



A **Die** cuts an external thread on cylindrical material, such as a rod, which creates a male threaded piece that functions like a bolt. Dies are generally made in two styles: solid and adjustable. An adjustable die may be adjusted either by an integrated screw or by a set of screws set in to the die holder (termed a "die stock").

Dies without integrated screws are adjusted inside the die stock by radially-arranged screws. Two screws in the stock bear in to indentations on either side of the slit, tending to squeeze the slit closed, whilst a third screw with a tapered tip screws in to the slit forcing it open. Working these three screws against each other adjusts the die.







The dies shown in the image to the right are adjustable:

top left: an older split die, with top adjusting screw

bottom left: a one piece die with top adjusting screw

Center : a one piece die with side adjusting screw (barely visible on the full image)right: two dies without integrated adjusting screws Solid dies cut a nominal thread form and depth, whose accuracy is subject to the precision the die was made with, and the effects of wear.

**screwdriver** is a tool, manual or powered, used for screwing (installing) and unscrewing (removing) screws. A typical simple screwdriver has a handle and a shaft, ending in a tip the user puts into the screw head before turning the handle.

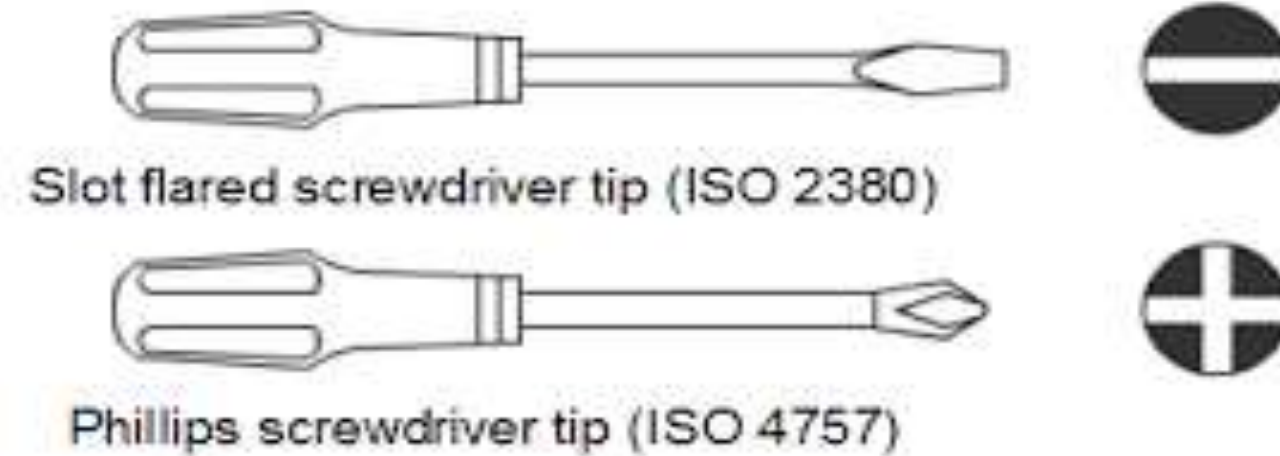
Handles are typically wood, metal, or plastic and usually hexagonal, square, or oval in cross-section to improve grip and prevent the tool from rolling when set down.



## 4 Types of Screwdrivers

Flat/Slotted.  
Phillips.

Hex Key.  
Robertson.



### Slotted

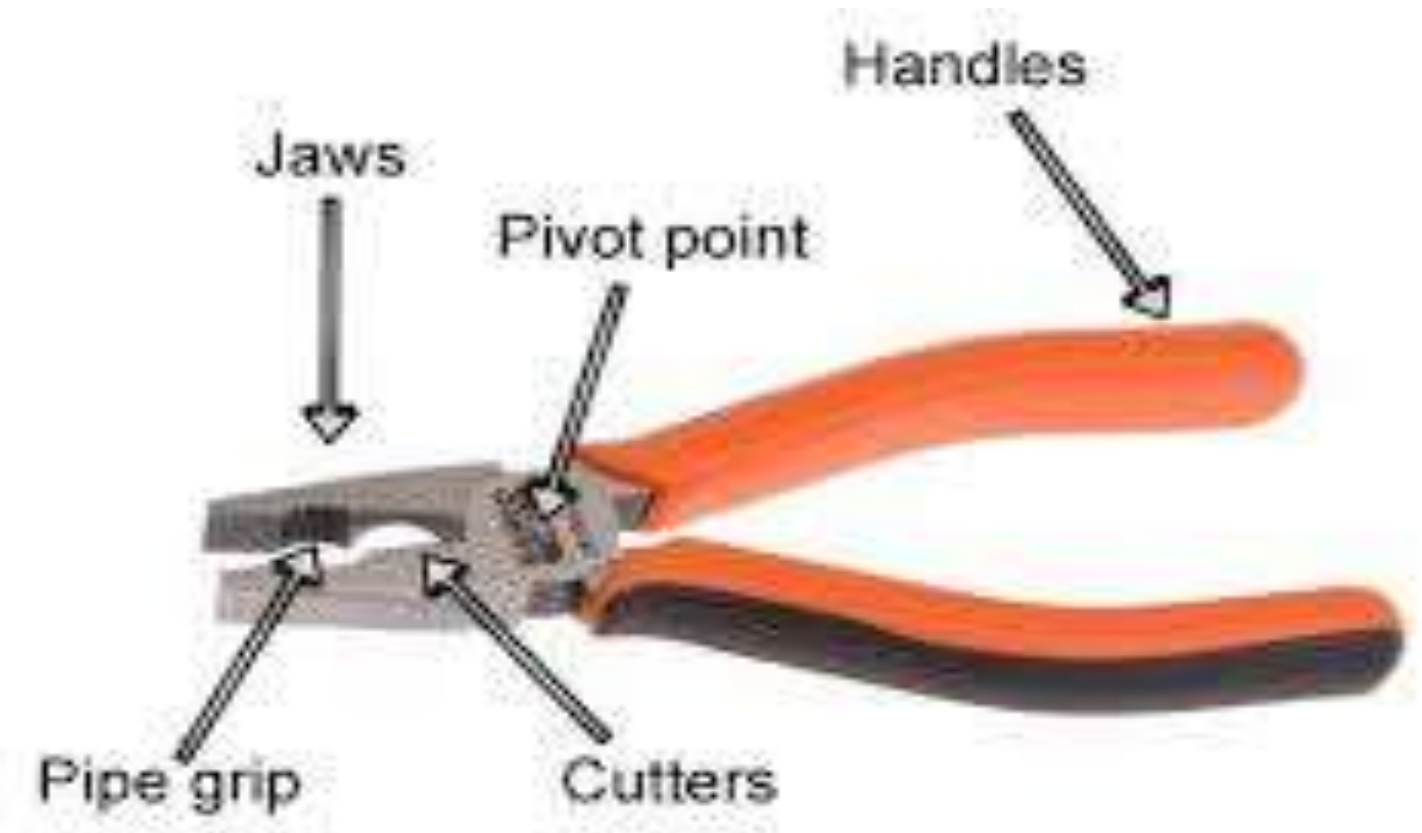
A Torx T25/slot Dual Drive screw, with a  $\frac{3}{16}$ -inch or 4.8-millimeter flat-blade screwdriver on the left, and a T25 screwdriver on the right. Both screwdrivers can drive this screw, by design.

### Phillips

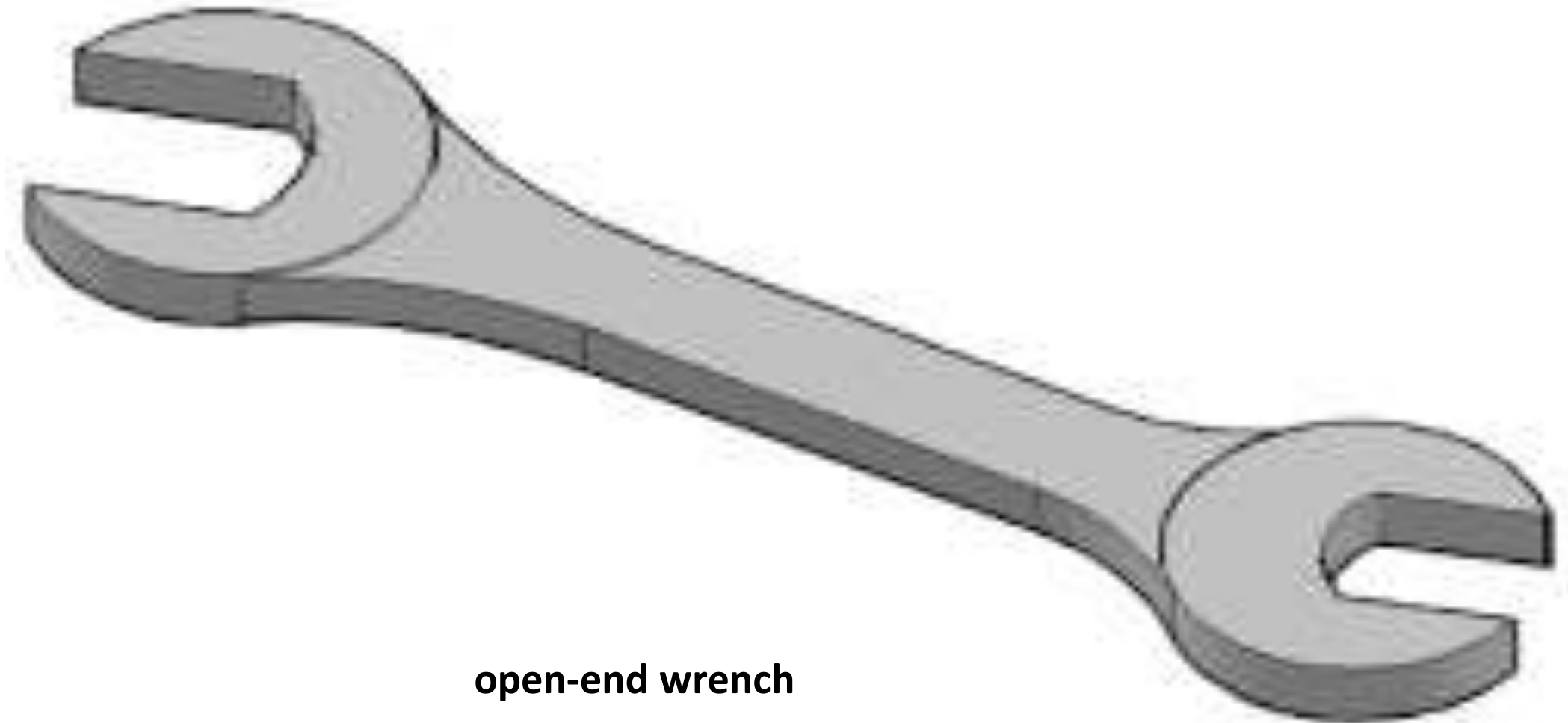
Phillips II recesses are compatible with Phillips drivers, but have a vertical rib in between the cruciform recesses that interacts with horizontal ribs on a Phillips II driver to create a stick-fit, and to provide anti cam-out properties.



- **Pliers** -Generally, pliers consist of a pair of metal first-class levers joined at a fulcrum positioned closer to one end of the levers, creating short *jaws* on one side of the fulcrum, and longer *handles* on the other side.
- Diagonal pliers, also called side cutters, are a similarly-shaped tool for cutting rather than holding, using a pair of stout blades, similar to scissors except that the cutting surfaces meet parallel to each other rather than overlapping.
- Ordinary (holding/squeezing) pliers may incorporate a small pair of such cutting blades.

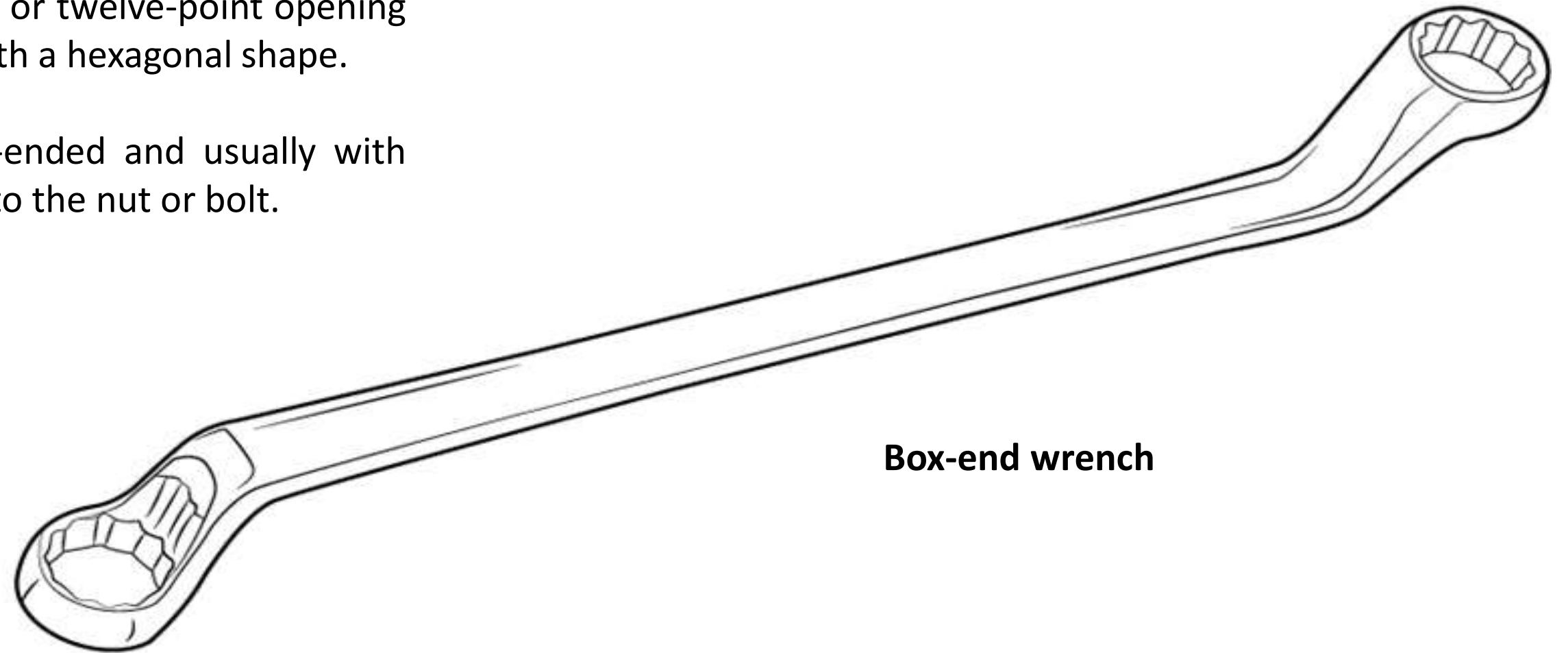


- A one-piece wrench with a U-shaped opening that grips two opposite faces of the bolt or nut.
- This wrench is often double-ended, with a different-sized opening at each end.
- The ends are generally oriented at an angle of around 15 degrees to the longitudinal axis of the handle.



open-end wrench

- A one-piece wrench with an enclosed opening that grips the faces of the bolt or nut.
- The recess is generally a six-point or twelve-point opening for use with nuts or bolt heads with a hexagonal shape.
- Ring spanners are often double-ended and usually with offset handles to improve access to the nut or bolt.



Box-end wrench





A wrench that is used for gripping the nuts on the ends of tubes. It is similar to a box-end wrench but, instead of encircling the nut completely, it has a narrow opening just wide enough to allow the wrench to fit over the tube, and thick jaws to increase the contact area with the nut.

**flare spanner**

**flare nut spanner**

A double-ended tool with one end being like an open-end wrench or open-ended spanner, and the other end being like a box-end wrench or ring spanner. Both ends generally fit the same size of bolt.

**combination spanner**



## Adjustable wrench

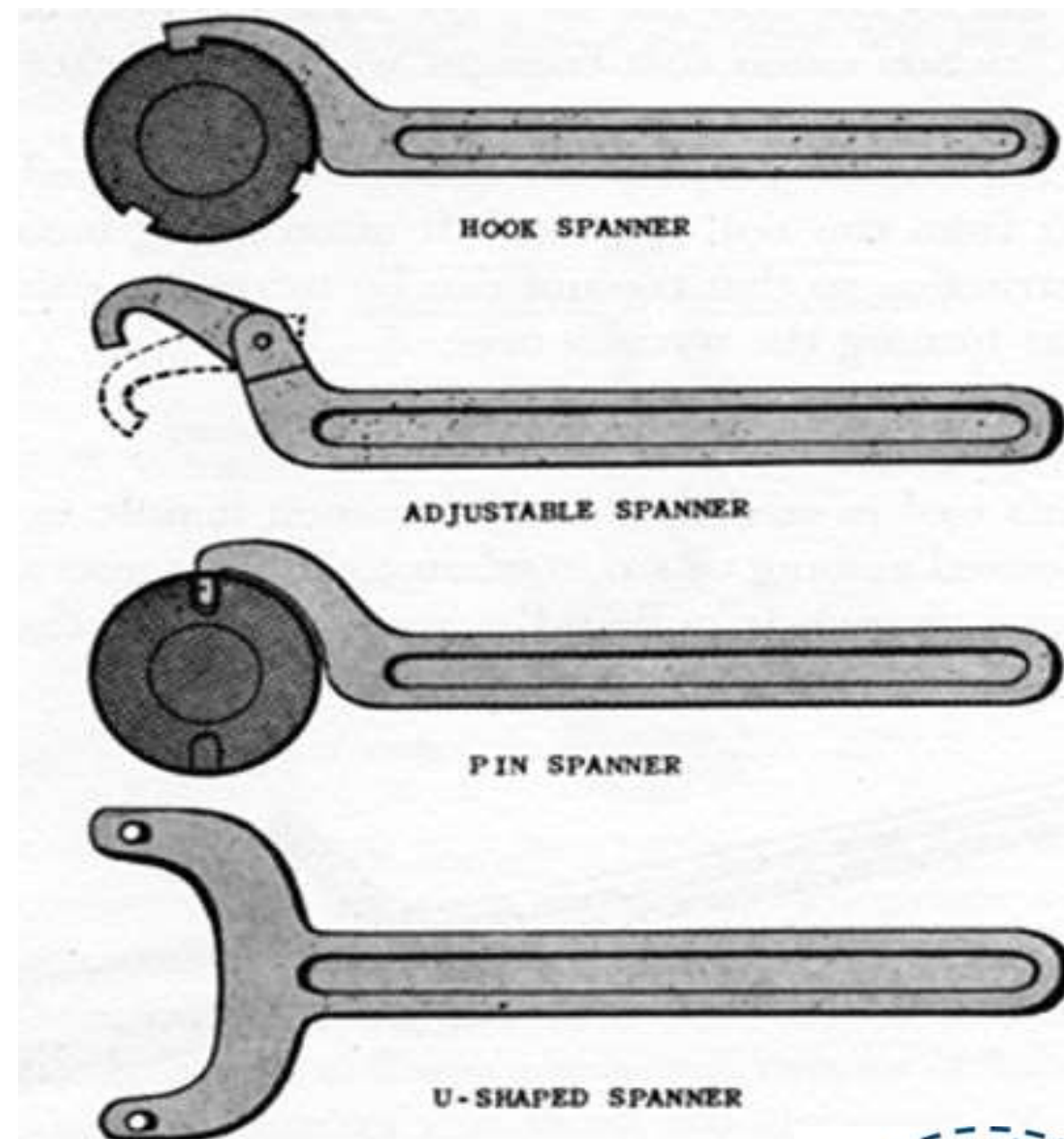
The most common type of adjustable wrench in use today. The adjustable end wrench differs from the monkey wrench in that the gripping faces of the jaws are displaced to a (typically) 15 degree angle relative to the tool's handle, a design feature that facilitates the wrench's use in close quarters.



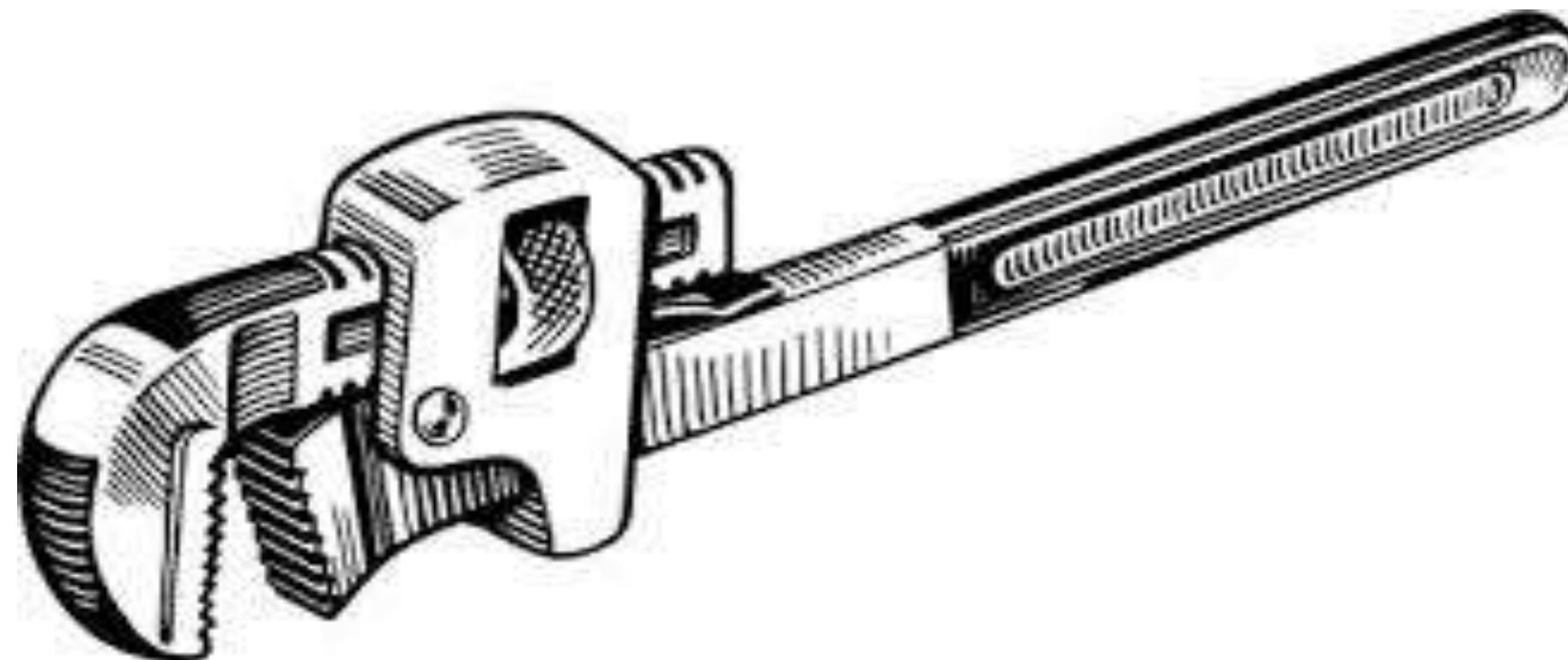


**Pin spanner**  
**Hook spanner**

A wrench with one or several pins or hooks, designed to drive spanner head screws, threaded collars and retainer rings, shafts, and so on.

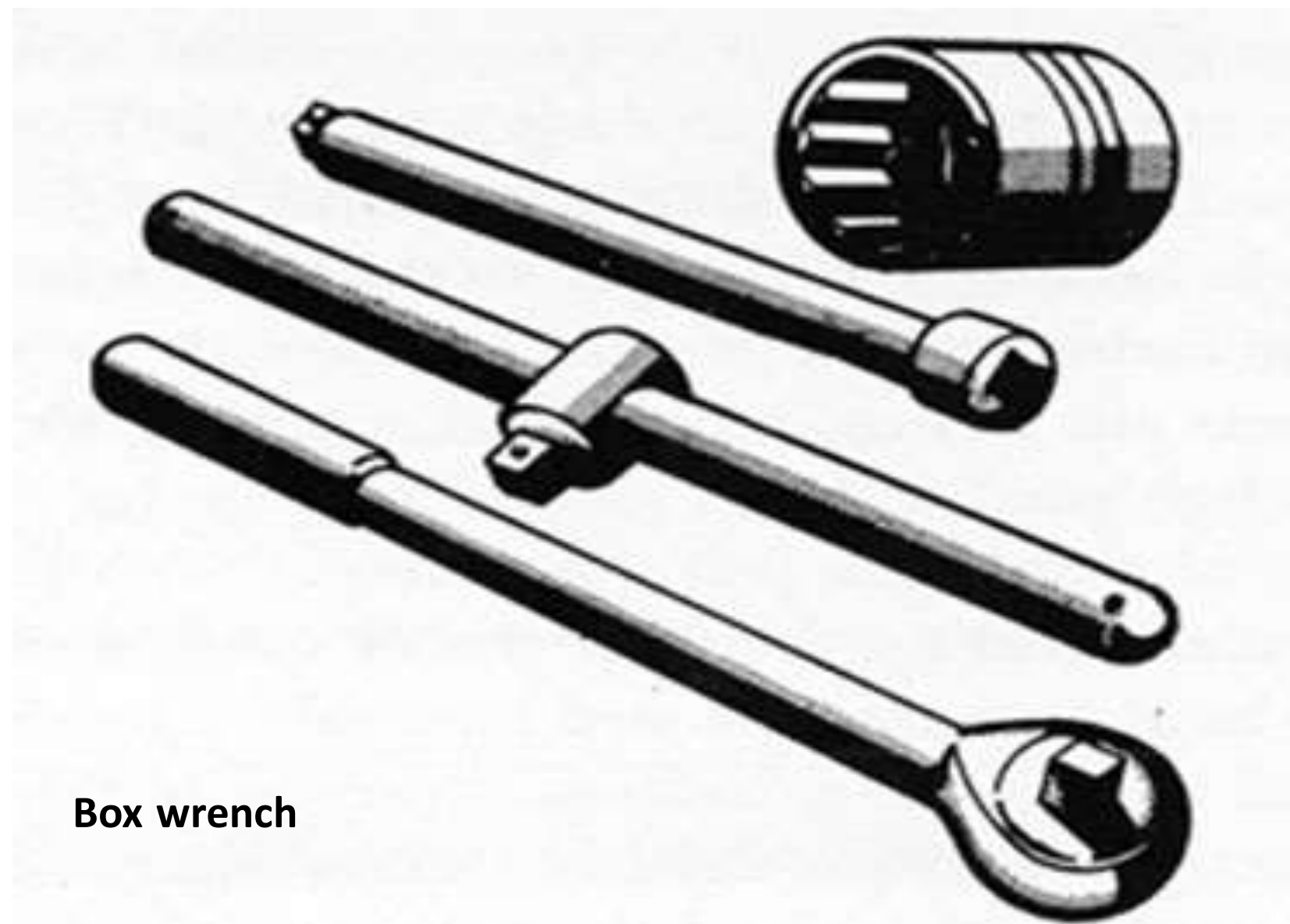


A tool that is similar in design and appearance to a monkey wrench, but with self-tightening properties and hardened, serrated jaws that securely grip soft iron pipe and pipe fittings.



Pipe wrench

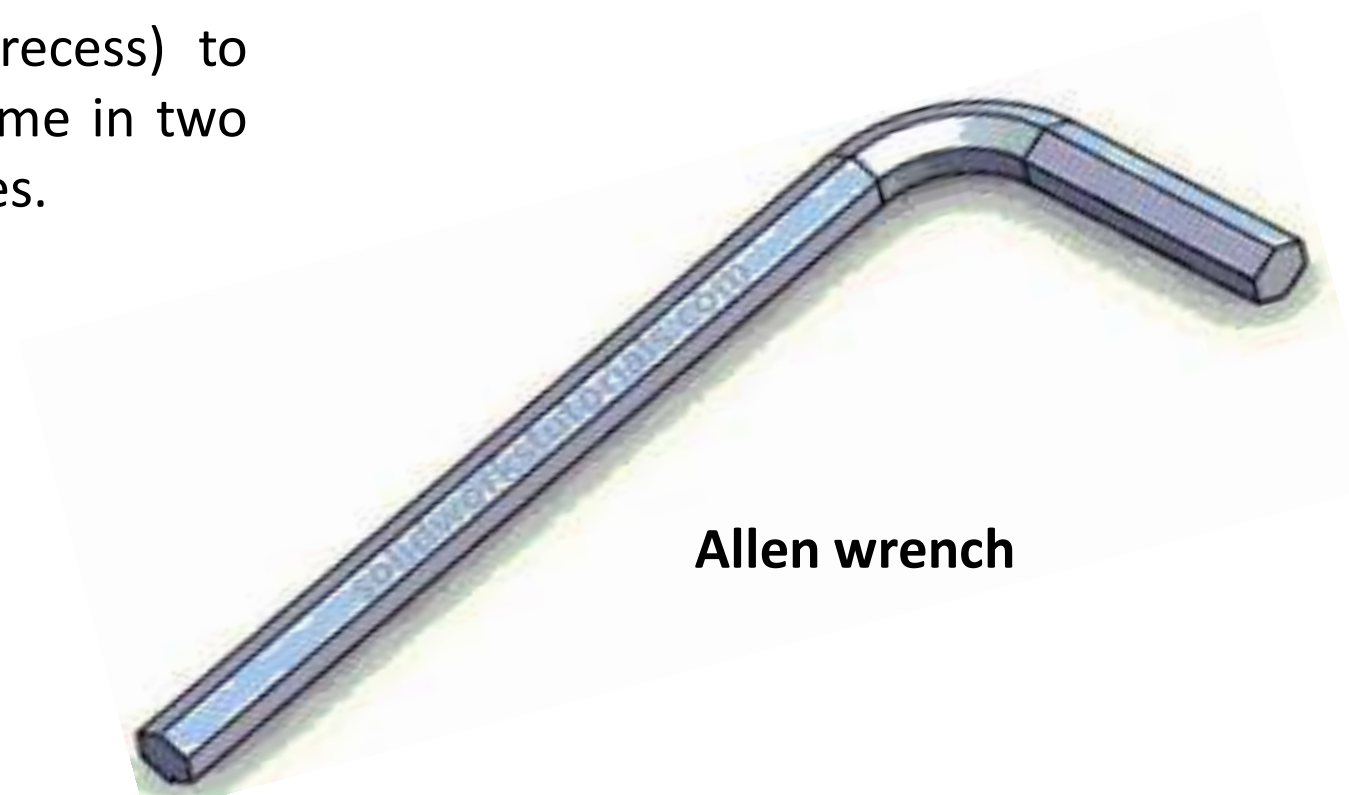
A hollow cylinder that fits over one end of a nut or bolt head. It may include a handle, if it does not then it is often just referred to as a socket and is usually used with various drive tools to make it a wrench or spanner such as a ratchet handle, a tee bar or a knuckle bar.



**Box wrench**



A wrench used to turn screw or bolt heads designed with a hexagonal socket (recess) to receive the wrench. The wrenches come in two common forms: L-shaped and T-handles.



Allen wrench



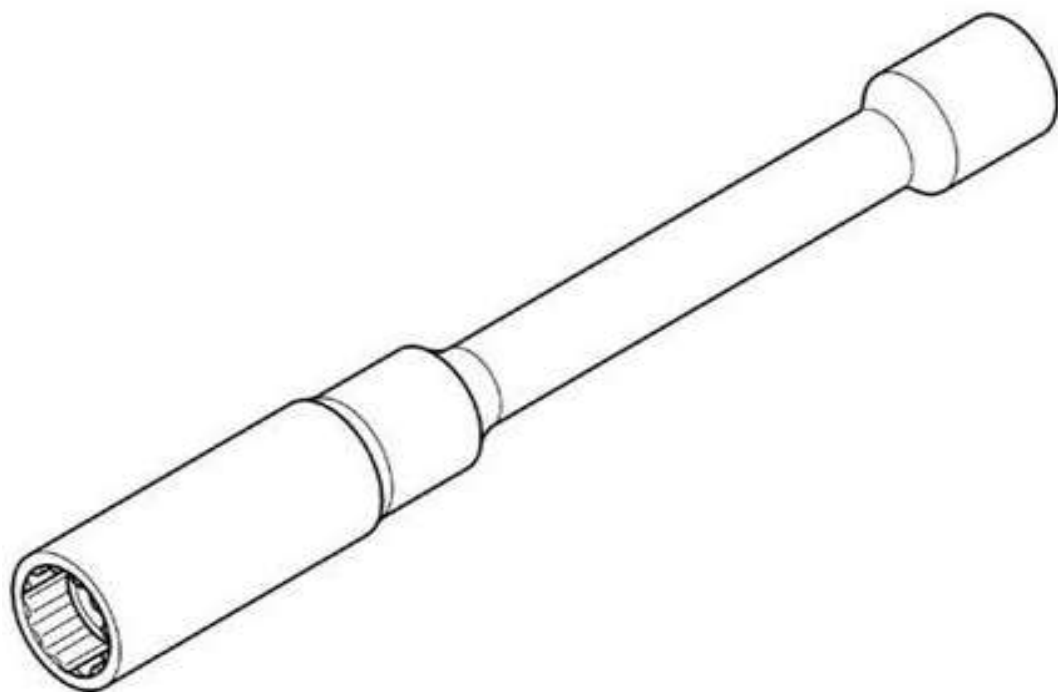


**Torque wrench**

A socket wrench drive tool that is employed to impart a precise amount of torque to a fastener, essential in many cases during the assembly of precision mechanisms.

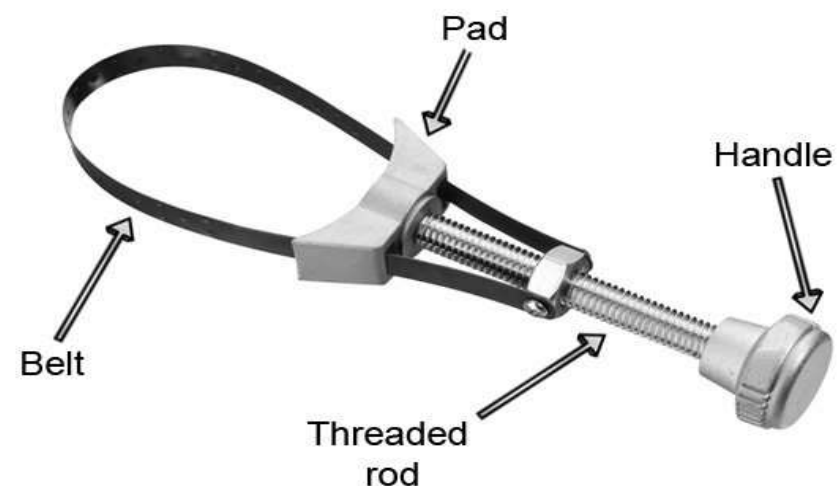
## spark plug wrench

A tube with six-sided sockets on both ends. It is turned with a short length of rod (tommy bar or T bar) inserted through two holes in the middle of the tube.



## oil filter wrench

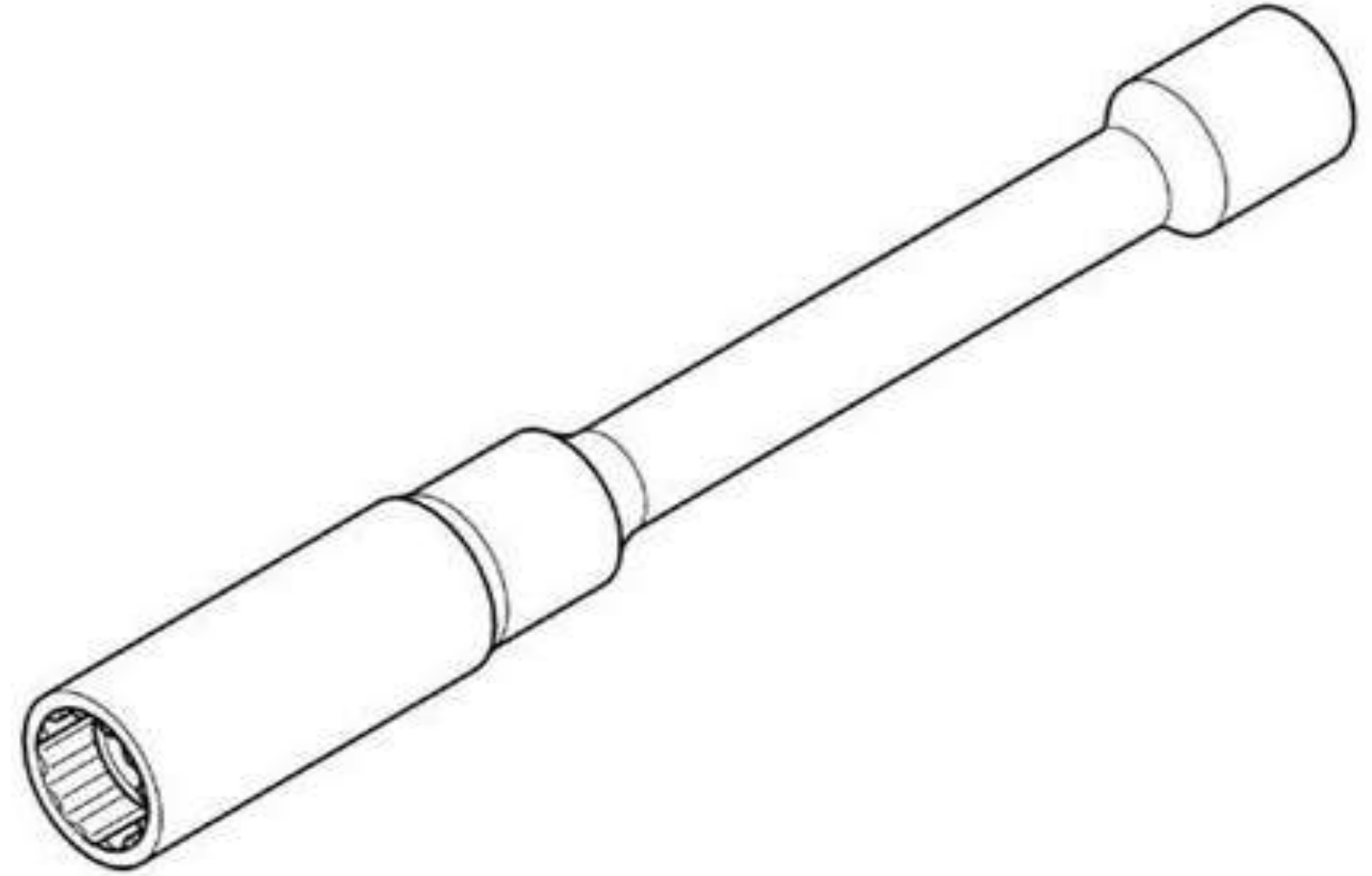
A type of wrench for removing cylindrical oil filters. It may be either a strap-type wrench or a socket.





## spark plug wrench

A tube with six-sided sockets on both ends. It is turned with a short length of rod (tommy bar or T bar) inserted through two holes in the middle of the tube.





**HORIZONTAL JACK**



**SCREW JACK**



**VERTICAL JACK**





HYDRAULIC LIFT



HYDRAULIC JACK





**AIR COMPRESSOR**

**AIR GUN**



# AUTOMOBILE ENGINE



Two Wheeler



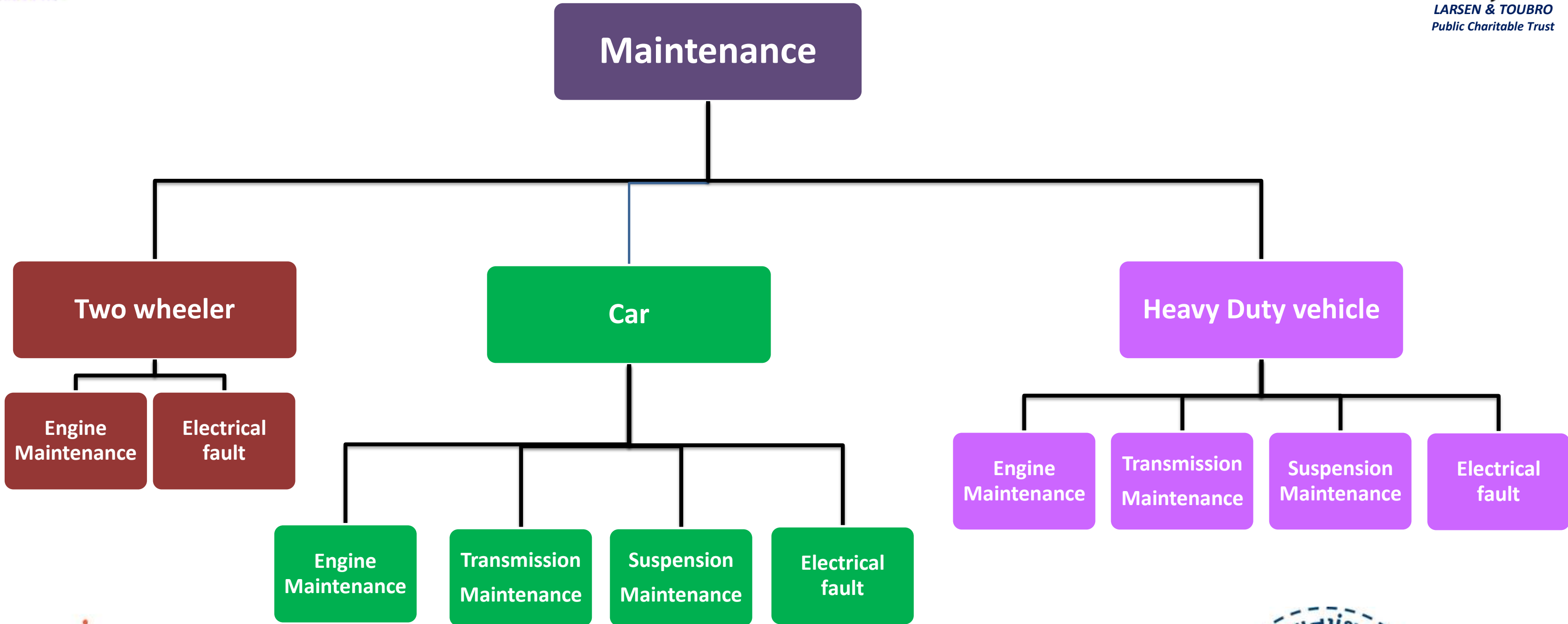
Light Motor Vehicle

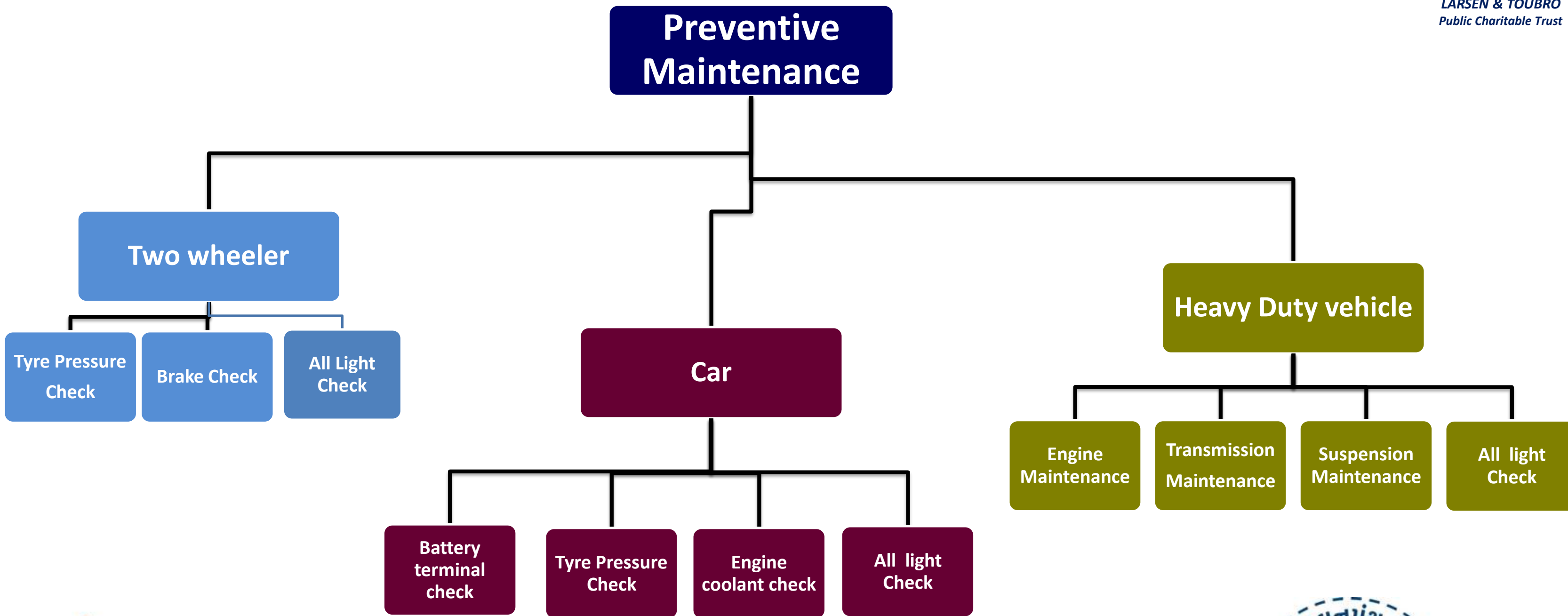


Heavy Duty Vehicle

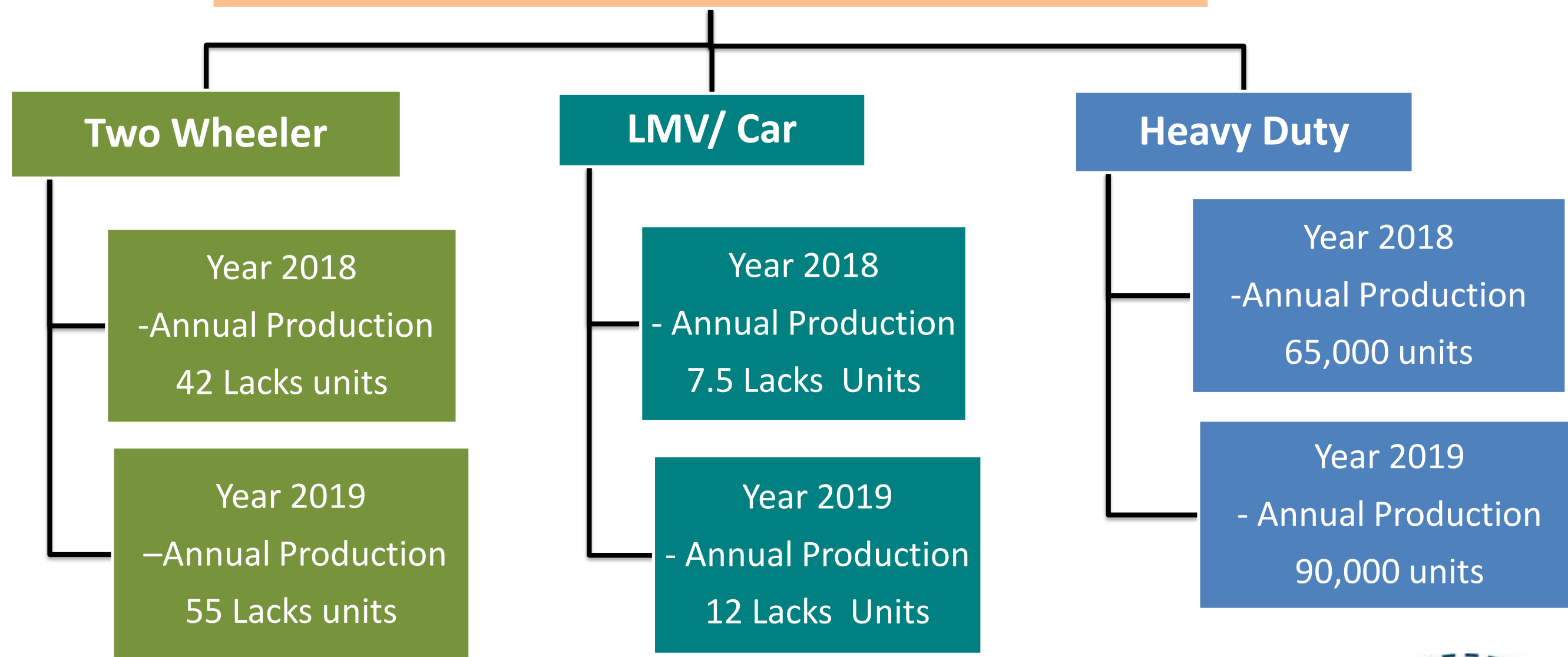




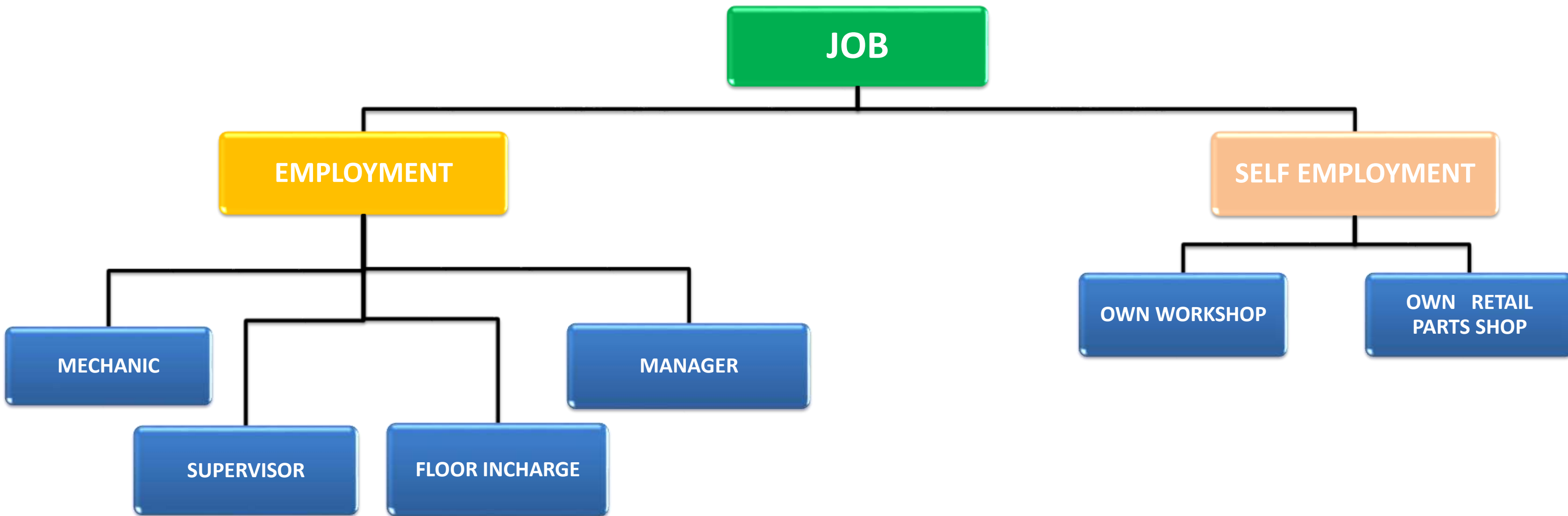


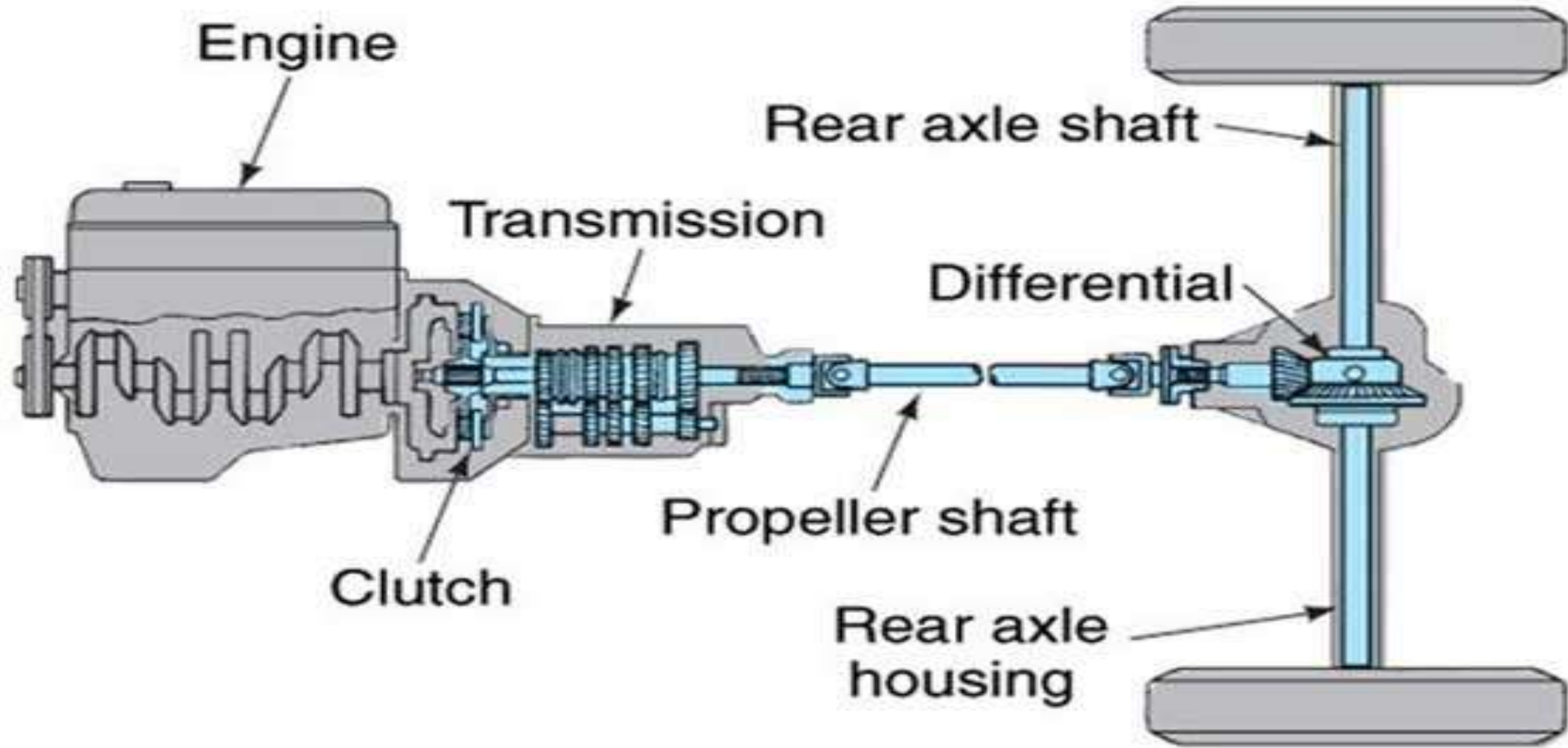


## Employment in Automotive Industries

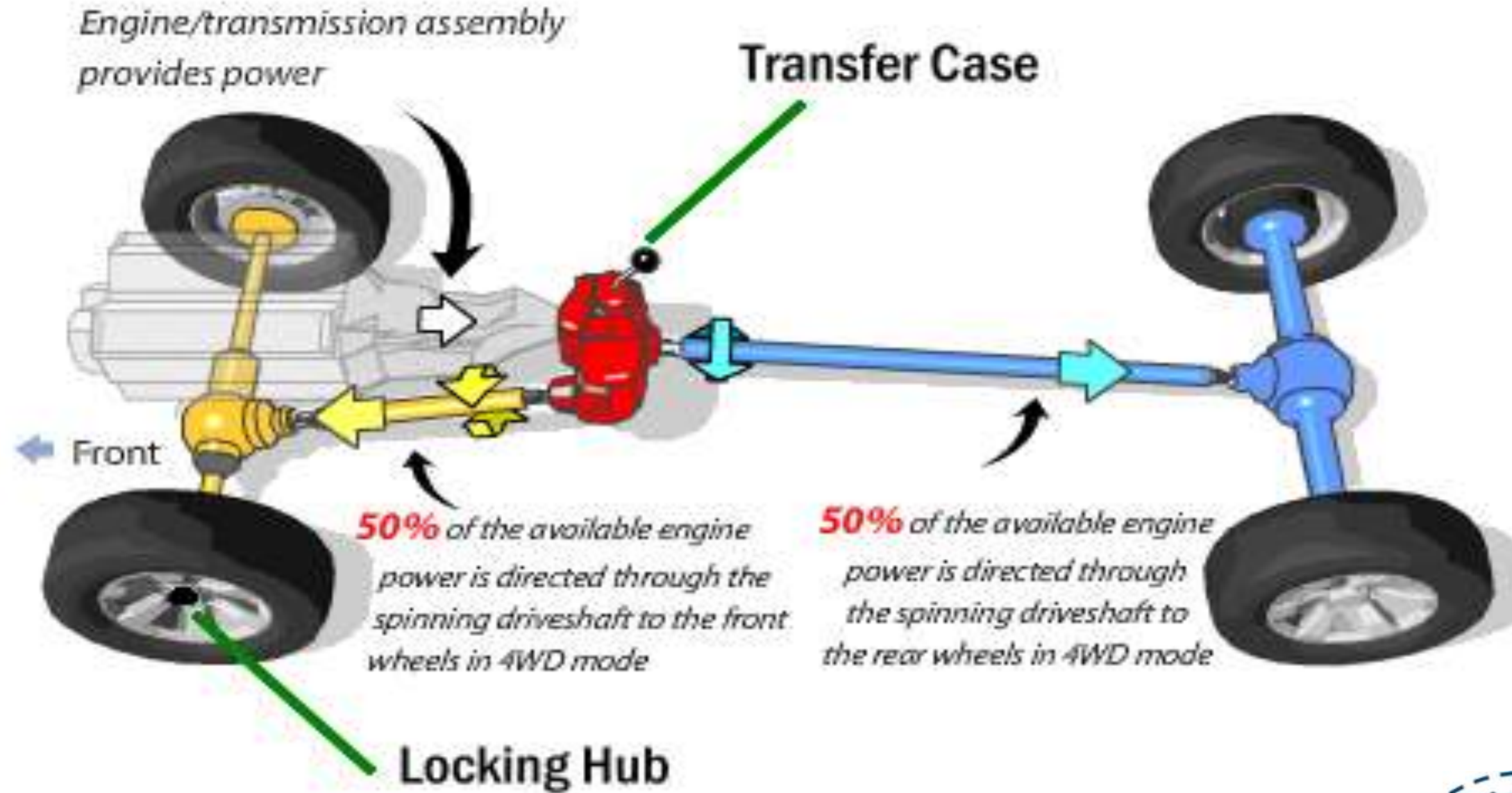






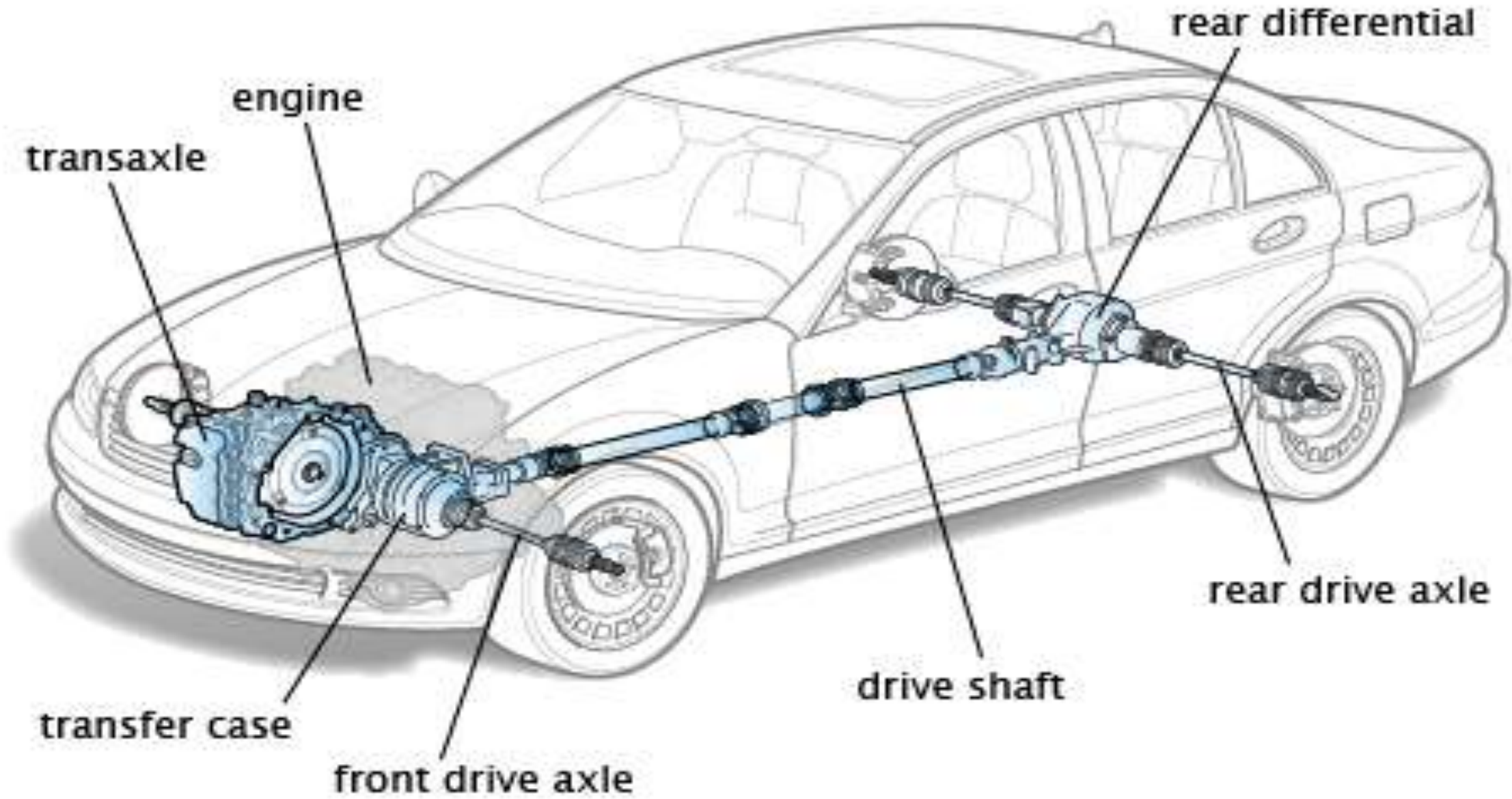


## Standard, Part-Time 4WD Explained



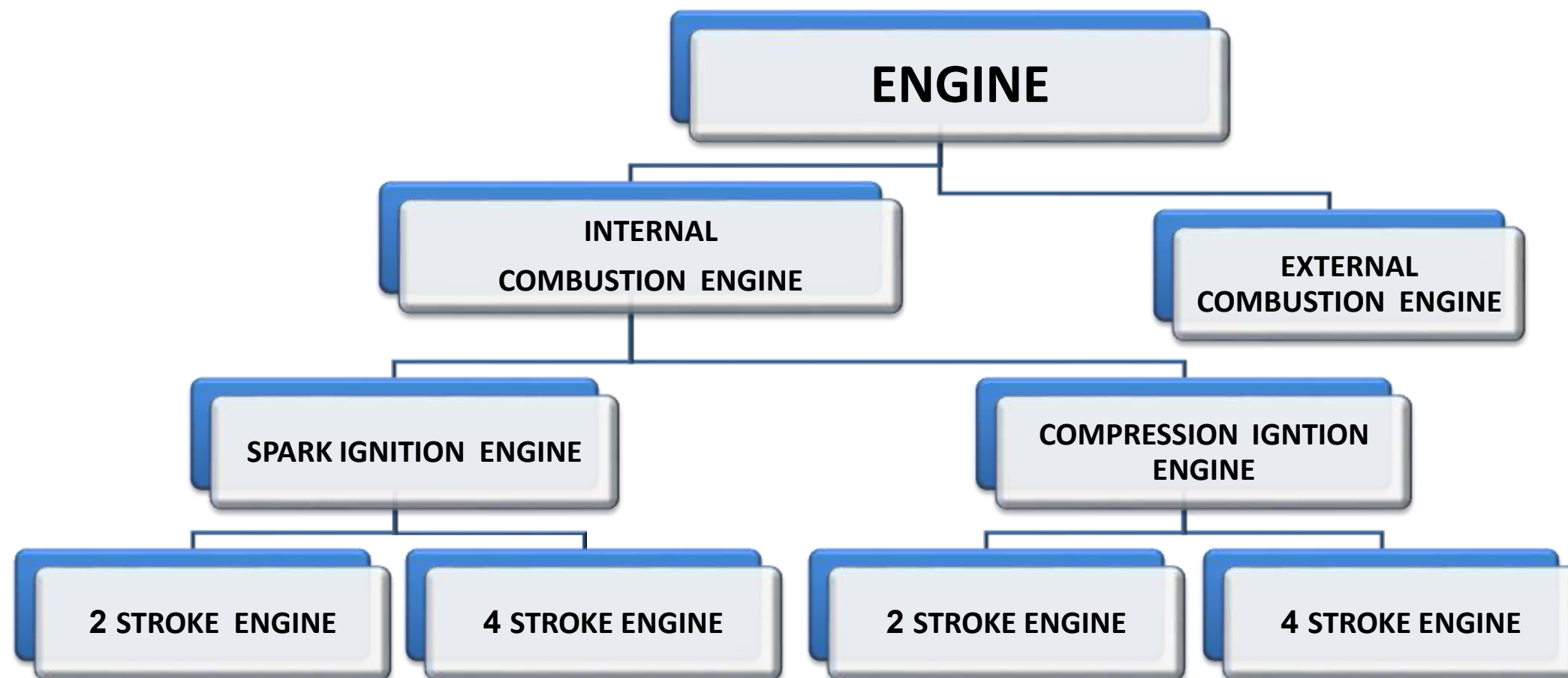


# DRAWING DIAGRAMME OF VEHICLE



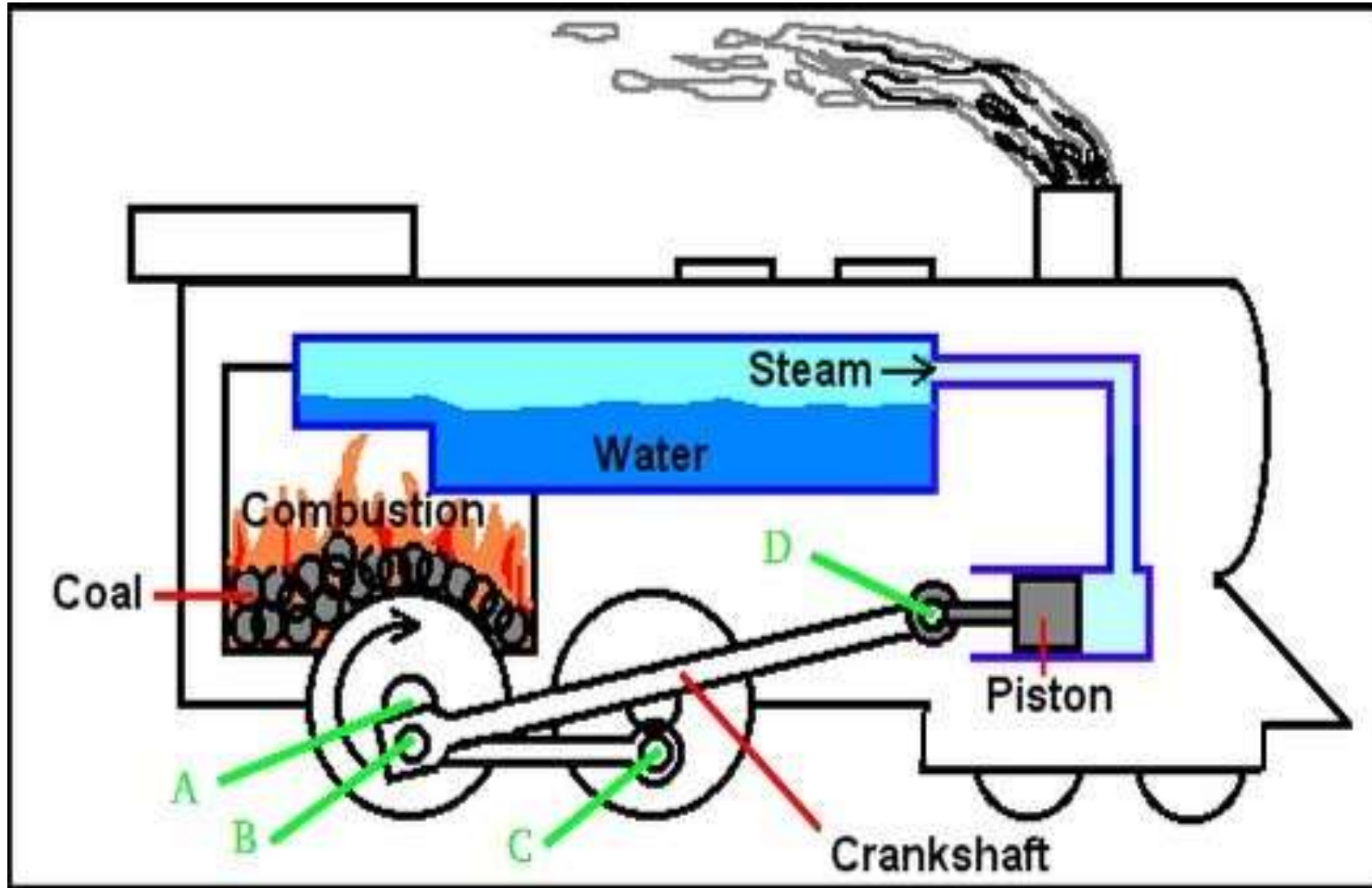
**Engine:** An engine or motor is a machine designed to convert heat energy into mechanical energy.

## Classification of Engine

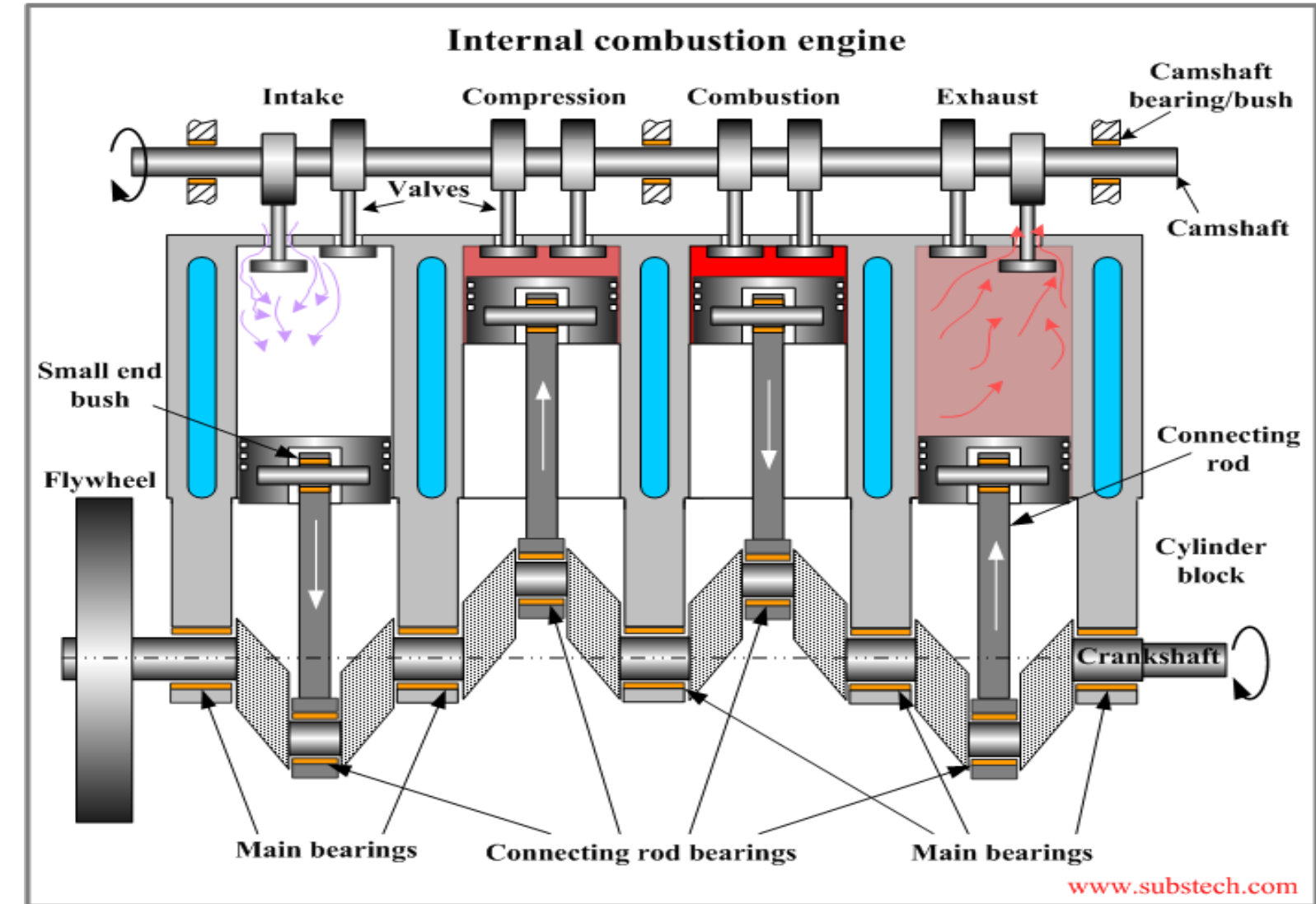




## Type of Engine



External combustion engine



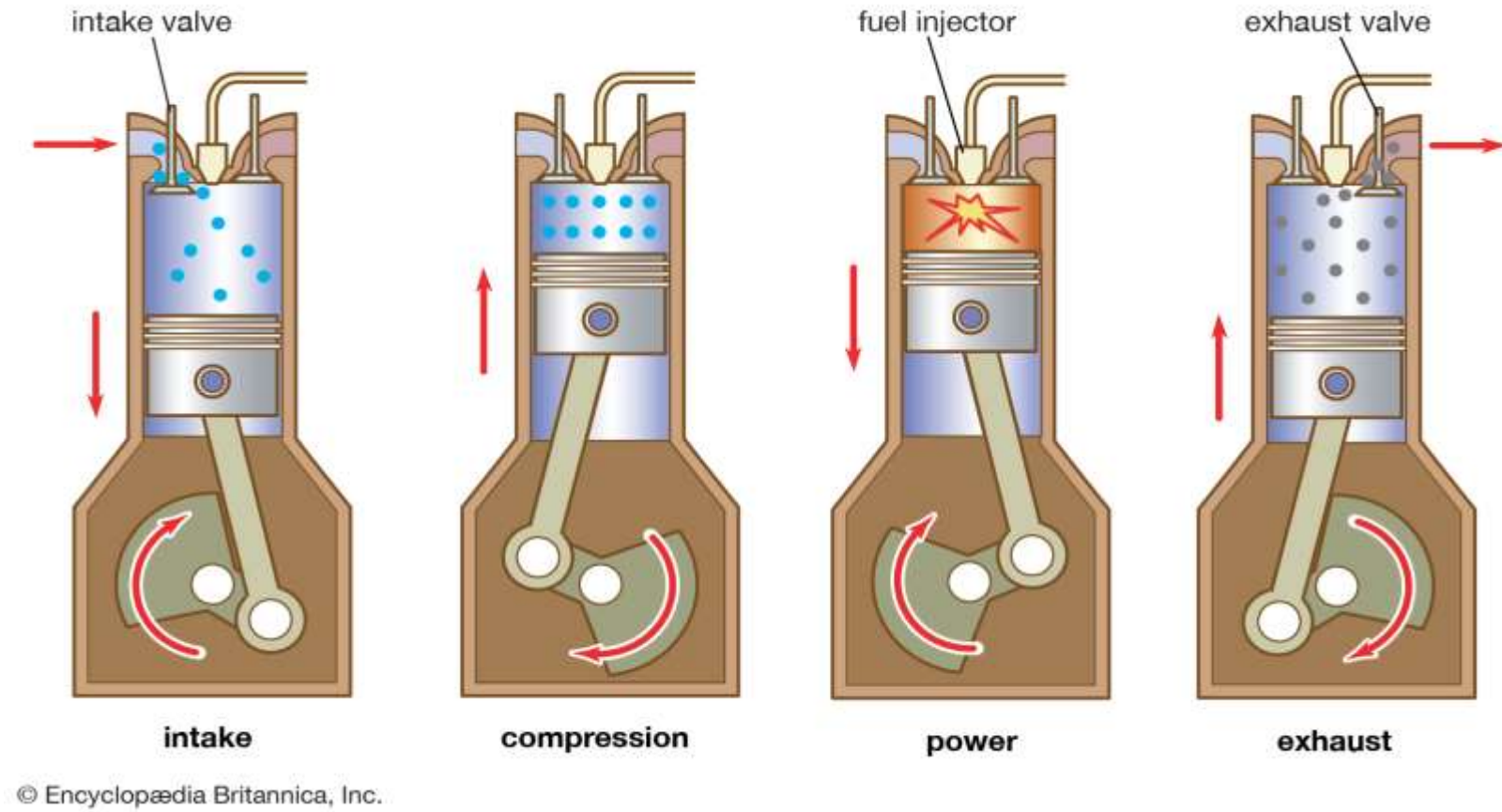
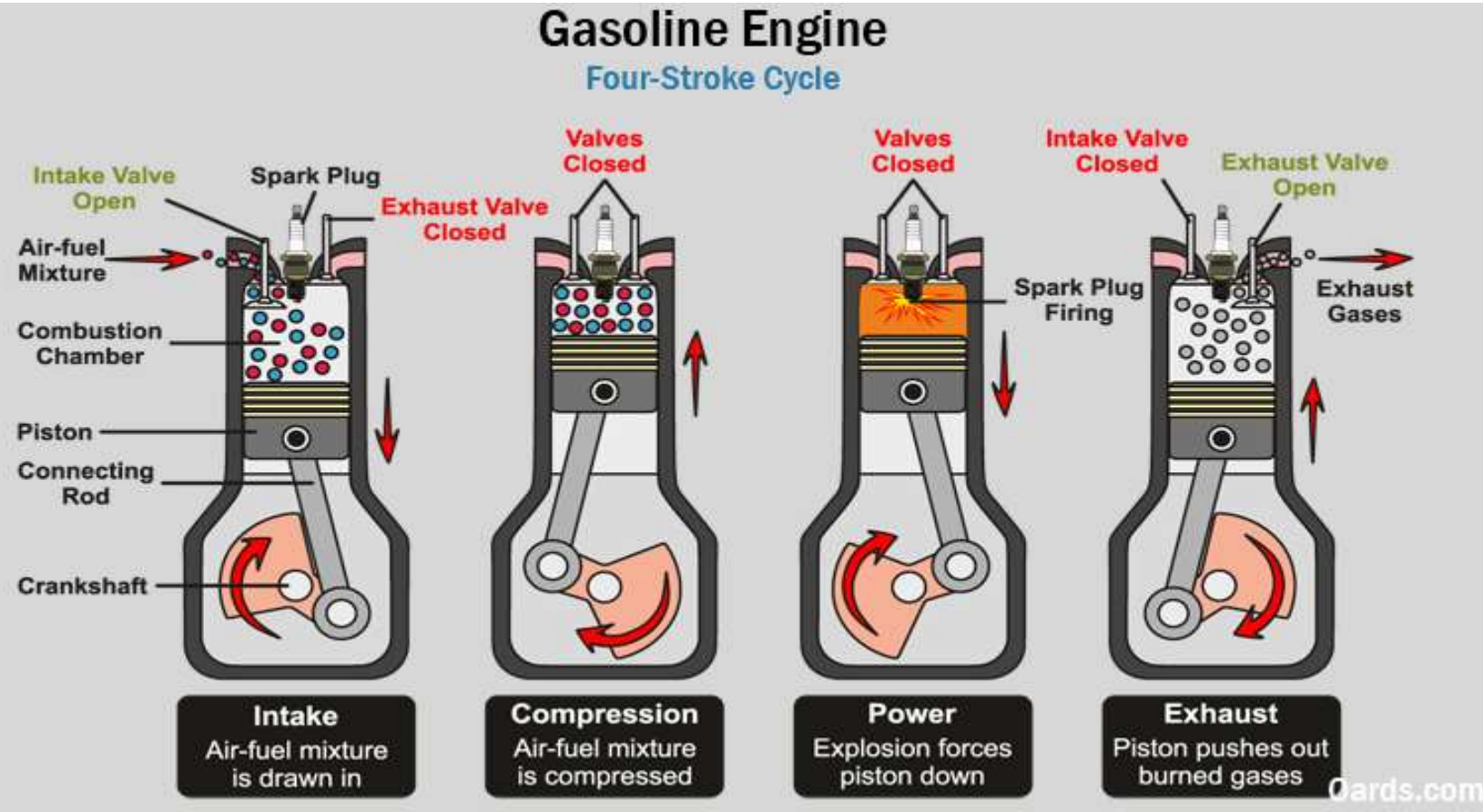
Internal combustion engine



- **Marine (Locomotive) Engine:** An **external combustion engine** (EC engine) is a heat engine where a working fluid, contained internally, is heated by **combustion** in an **external** source, through the **engine** wall or a heat exchanger. The fluid then, by expanding and acting on the mechanism of the **engine**, produces motion and usable work.
  
- **Automotive Engine :**
  - ❖ **Intake :** Also known as induction or suction. This stroke of the piston begins at top dead center (T.D.C.) and ends at bottom dead center (B.D.C.). In this stroke the intake valve must be in the open position while the piston pulls an air-fuel mixture into the cylinder by producing vacuum pressure into the cylinder through its downward motion. The piston is moving down as air is being sucked in by the downward motion against the piston.
  - ❖ **Compression:** This stroke begins at B.D.C, or just at the end of the suction stroke, and ends at T.D.C. In this stroke the piston compresses the air-fuel mixture in preparation for ignition during the power stroke (below). Both the intake and exhaust valves are closed during this stage.
  - ❖ **Combustion:** This is the start of the second revolution of the four stroke cycle. At this point the crankshaft has completed a full 360 degree revolution. While the piston is at T.D.C. (the end of the compression stroke) the compressed air-fuel mixture is ignited by a spark plug (in a gasoline engine) or by heat forcefully returning the piston to B.D.C. This stroke produces mechanical work from the engine to turn the crankshaft.
  - ❖ **Exhaust:** Also known as outlet. During the *exhaust* stroke, the piston, once again, returns from B.D.C. to T.D.C. while the exhaust valve is open. This action expels the spent air-fuel mixture through the exhaust valve.

## FOUR STROKE PETROL ENGINE

## FOUR STROKE DIESEL ENGINE



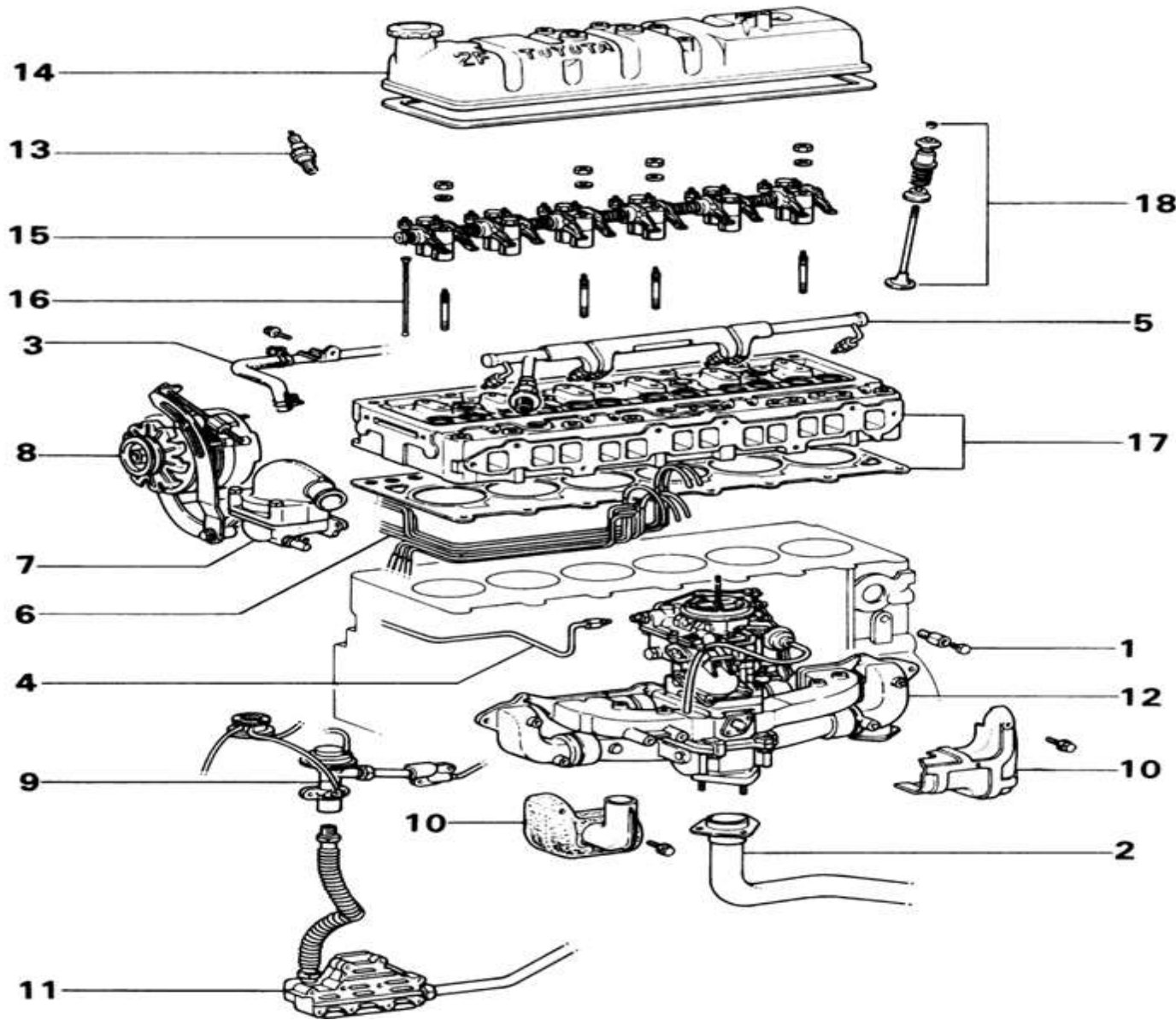
**Cylinder head** is usually located on the top of the engine block.

- It serves as a housing for components such as the intake and exhaust valves, springs and lifters and the combustion chamber.
- This page covers the main function and various designs of cylinder heads, It contains the combustion chambers where the quick burn of fuel and air that moves the pistons occurs.

The intake manifold feeds air into the head through the intake ports, past the intake valves and into the combustion chamber.

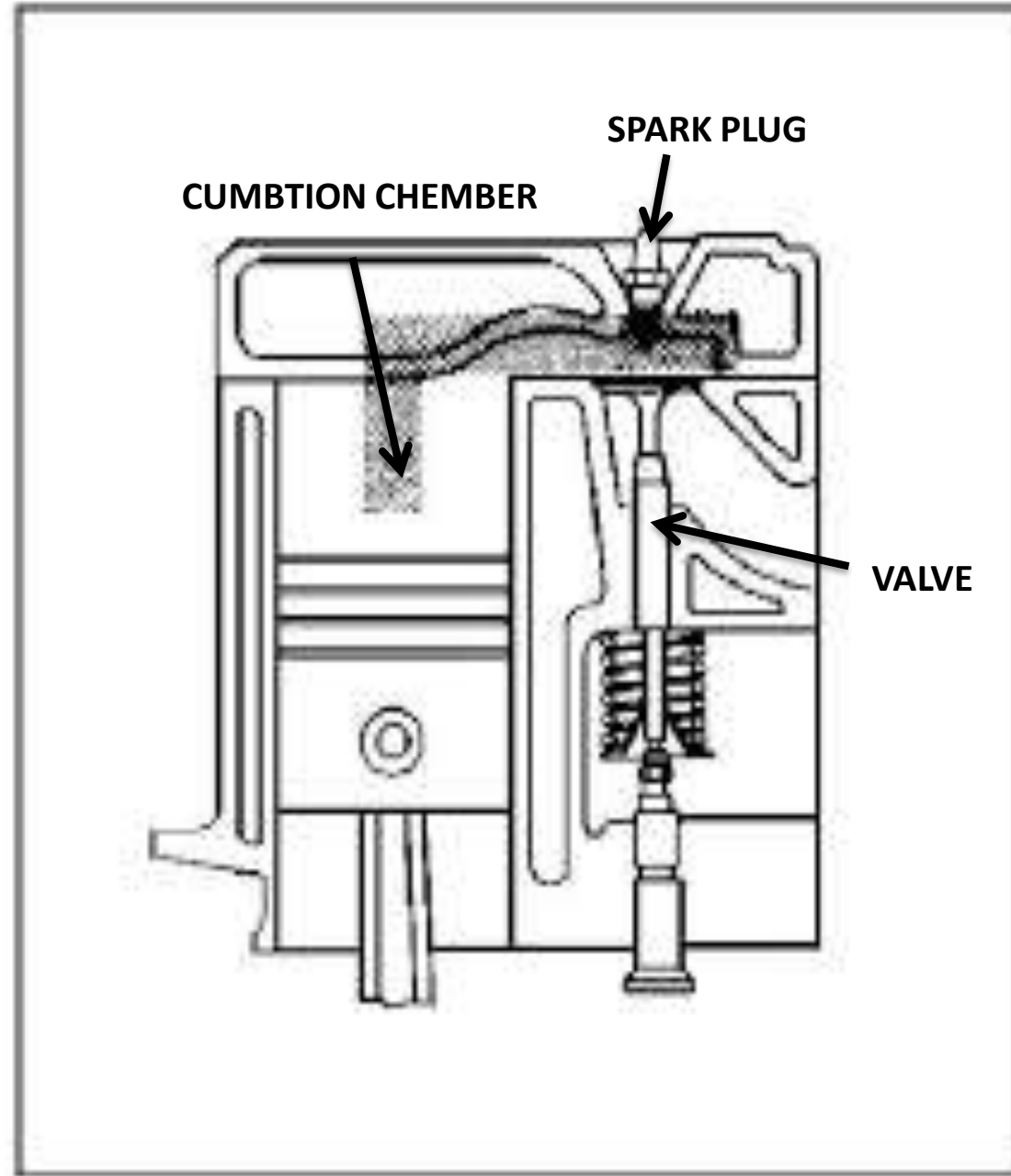
**the cylinder head generally made by aluminium** but even if the engine block is cast iron, the cylinder head is normally made of aluminum as it allows a more rapid extraction of the combustion heat compared to grey iron.



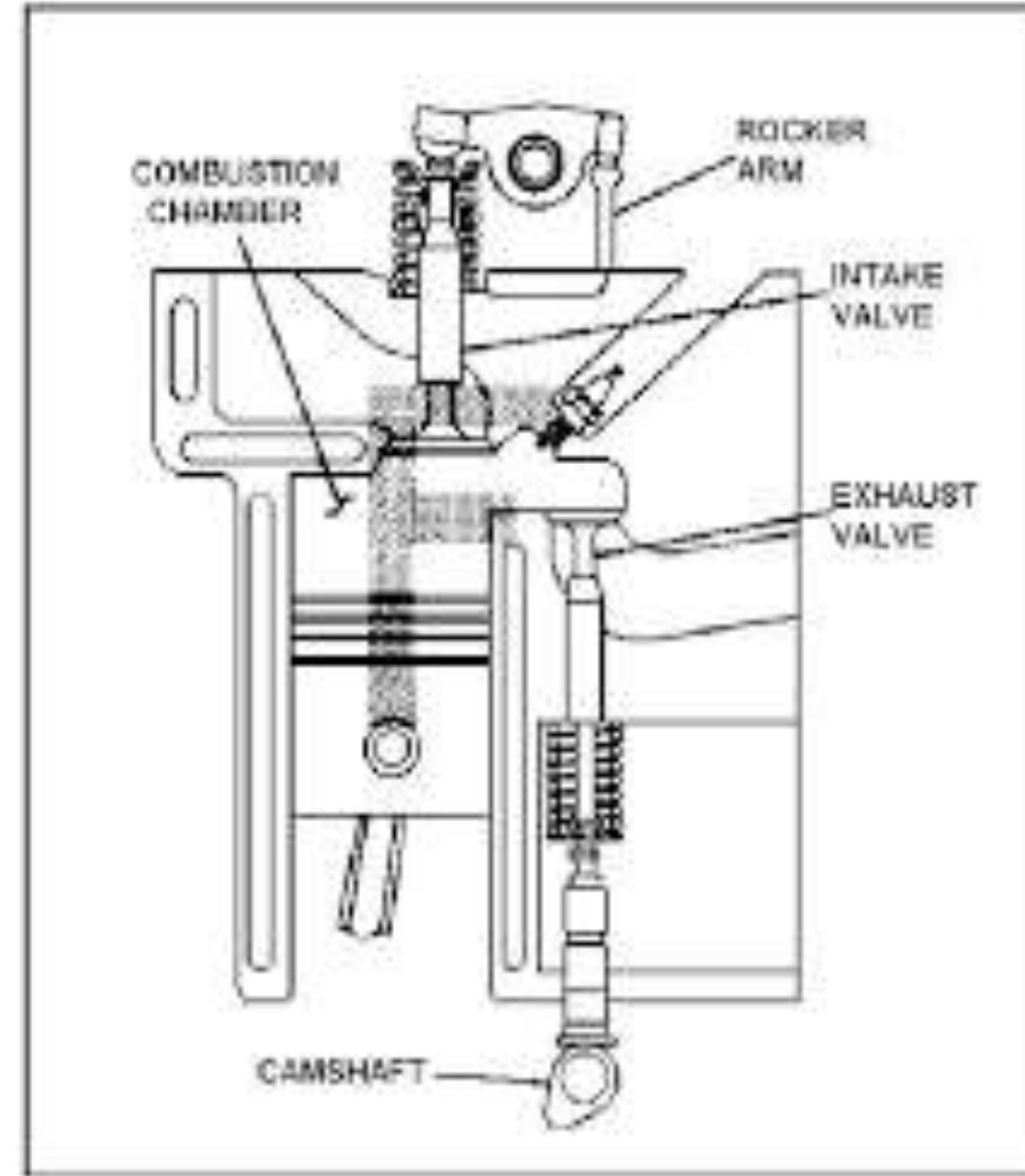


- |    |                        |     |                        |
|----|------------------------|-----|------------------------|
| 1. | Water Drain Plug       | 10. | Insulator              |
| 2. | Exhaust Pipe           | 11. | EGR Cooler             |
| 3. | Oil Cooler Hose        | 12. | Manifold               |
| 4. | Fuel Pipe              | 13. | Spark Plug             |
| 5. | Air Injection Manifold | 14. | Cylinder Head Cover    |
| 6. | Vacuum Pipe            | 15. | Rocker Arm Assembly    |
| 7. | Water Outlet Housing   | 16. | Push Rod               |
| 8. | Alternator             | 17. | Cylinder Head & Gasket |
| 9. | EGR Valve              | 18. | Valve & Spring         |

# TYPES OF CYLINDER HEAD



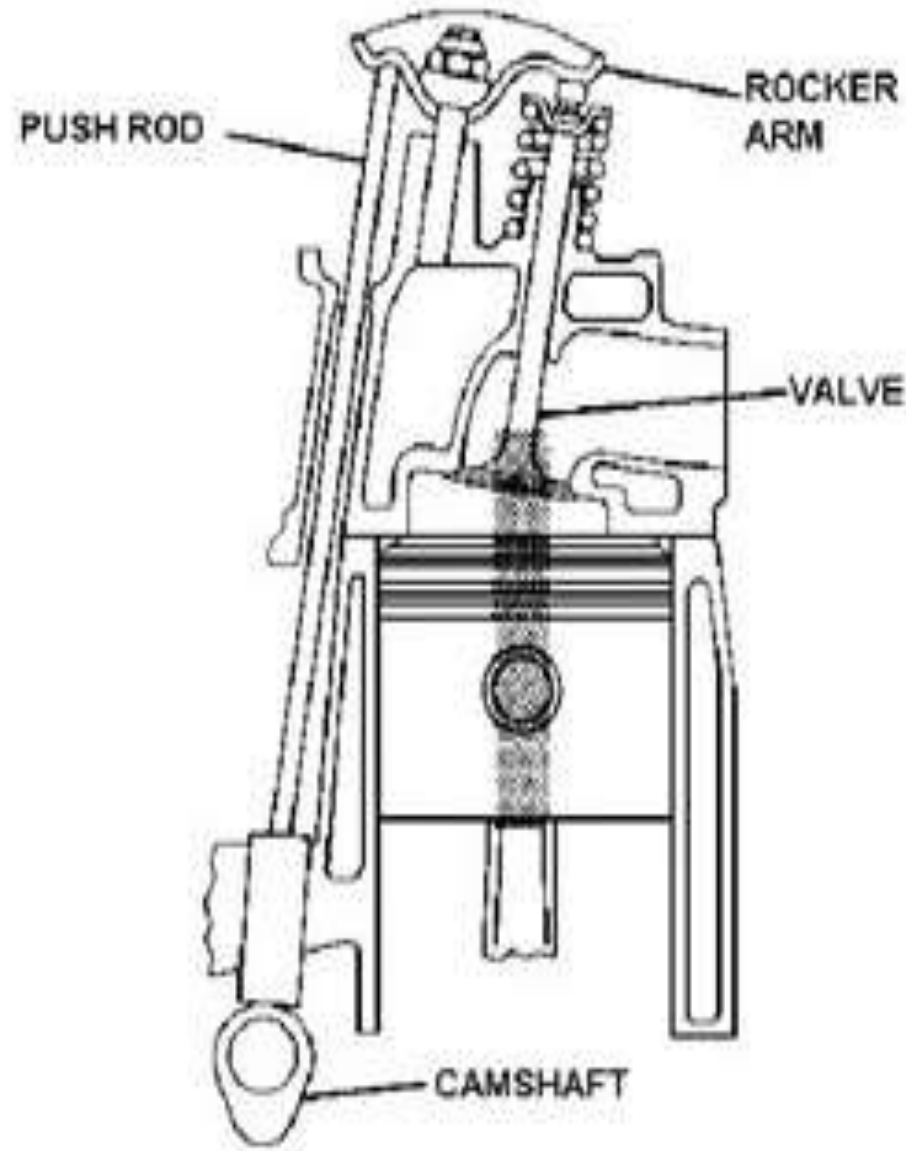
L - HEAD



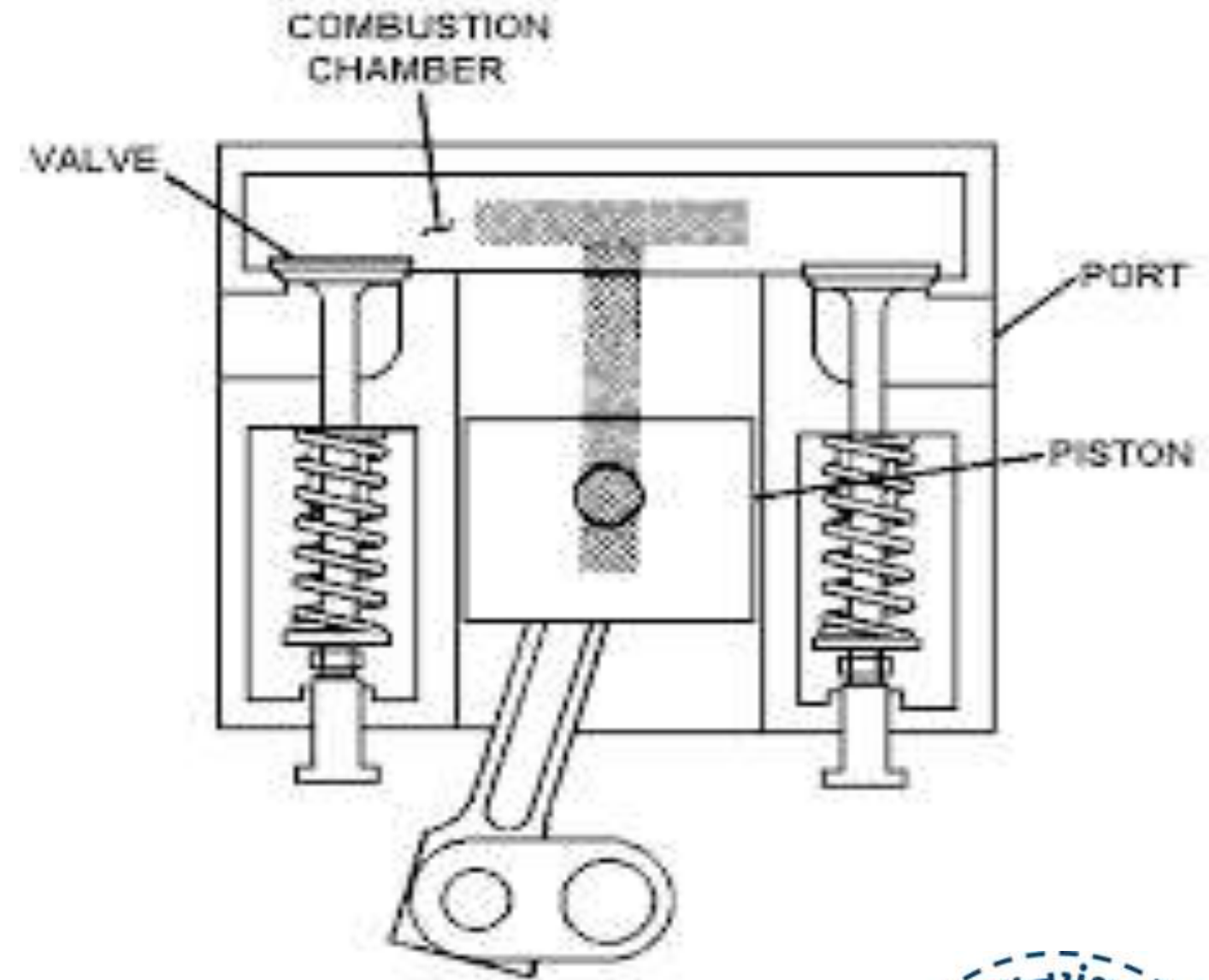
F - HEAD



# TYPES OF CYLINDER HEAD



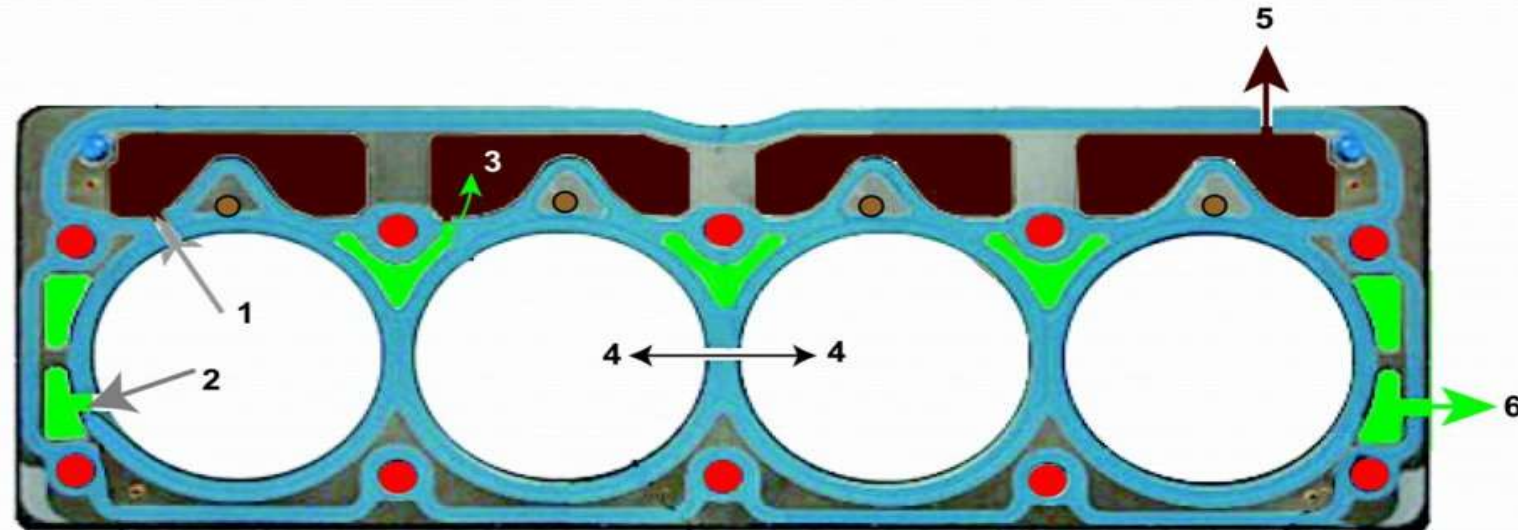
I - HEAD



T - HEAD



**Head Gasket** is compressed between the engine block and the cylinder head. The head gasket seals in the internal combustion process and also keeps coolant and oil from mixing together as the two fluids travel from the engine block to the cylinder head. Simply put, the purpose of a head gasket is the sealing of the cylinders to ensure maximum compression is obtained. **Head Gasket Material** - Multi-Layer Steel (MLS) a solid sheet of copper, and typically requires special machining called 'o-ringing' that places a piece of wire around the circumference of the cylinder to bite into the copper.



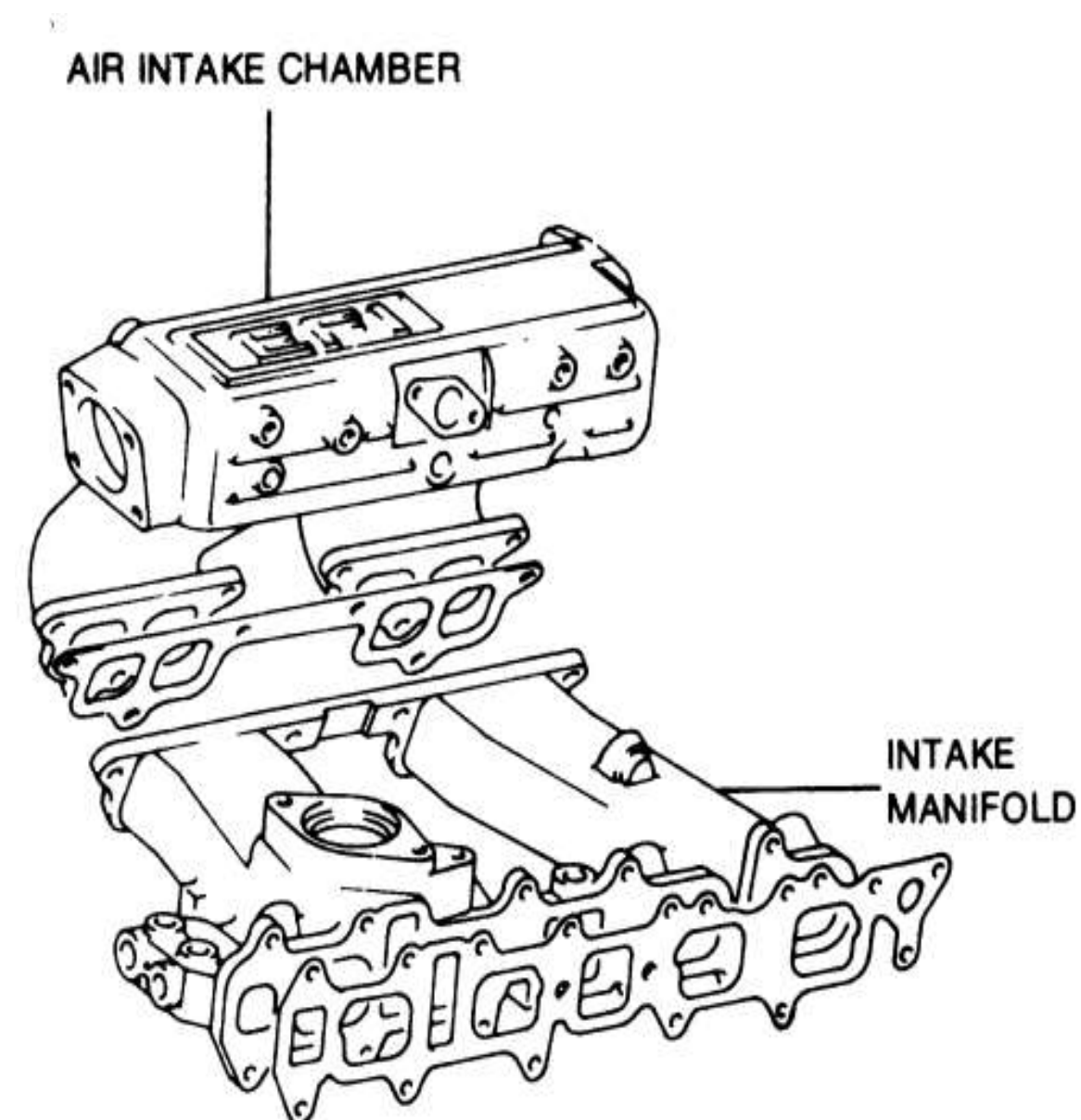
- Head Bolts
- Coolant
- Oil to cam
- Oil return

1. Compression leak to crankcase: smoking and blow-by, low power, misfire
2. Compression leak to cooling jacket: overheating, coolant overflow from radiator or recovery bottle, bubbles in coolant
- 3: Coolant leak to crankcase: coolant in oil pan
- 4: Compression leaks between cylinders: misfire, rough idle
- 5: Oil leak to outside of engine: oil level low
- 6: Coolant leak to outside of engine: coolant always low

**Intake System.** The system that allows air and fuel into the engine is known as the intake system. This system is comprised of the air filter, the intake manifold, and either a carburetor or a throttle body along with pressurized fuel injectors depending on the engine.

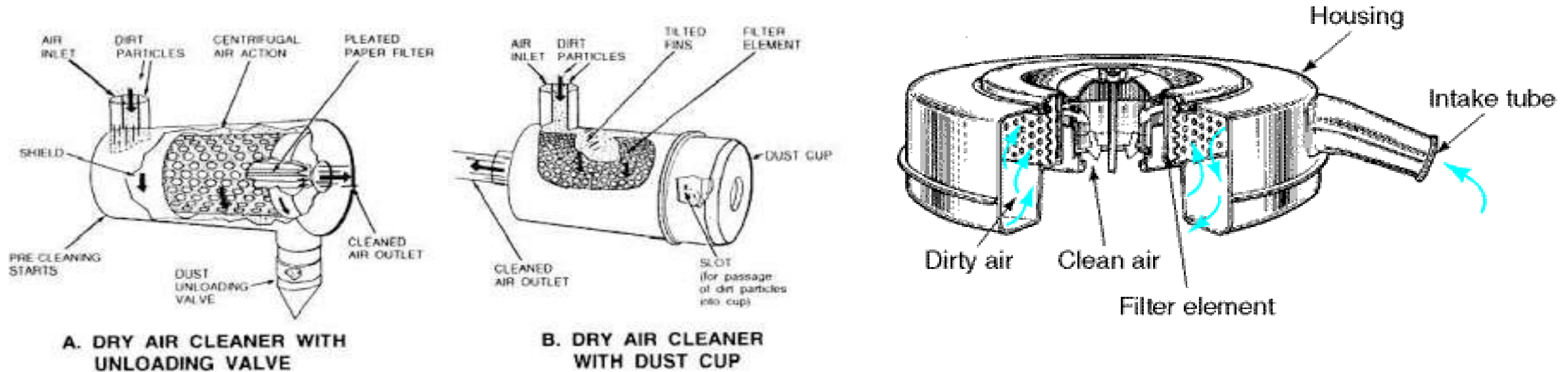
**Located** - directly behind the front grille, the air intake system draws air through a long plastic tube going into the air filter housing, which will be mixed with the car fuel..

An intake hose connects the filter box to the throttle body. Every time the driver steps on the accelerator pedal, a valve in the throttle body opens, allowing the filtered air to flow towards the intake manifold.



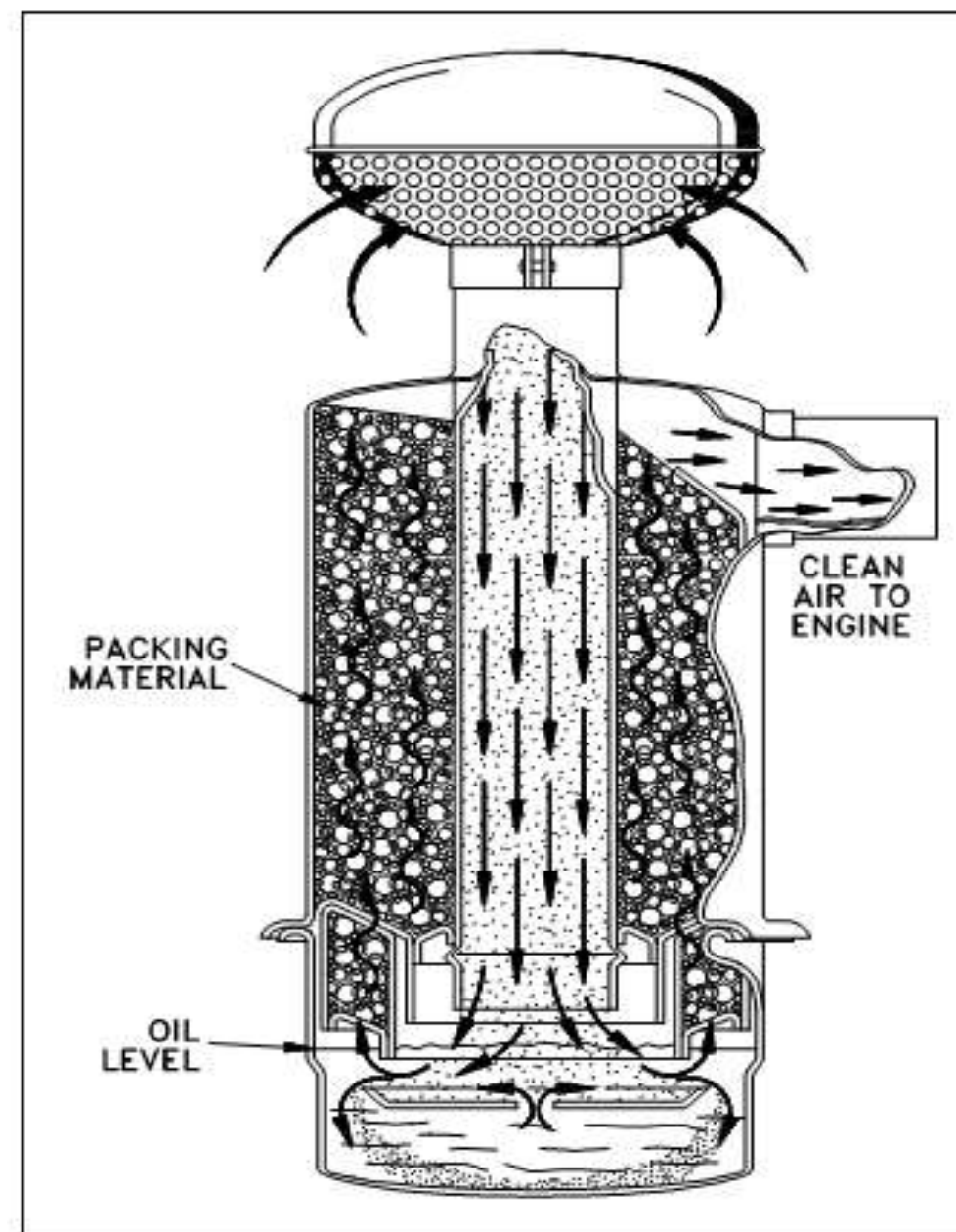


- A particulate **air filter** is a device composed of fibrous or porous materials which removes solid particulates such as dust, pollen, mold and bacteria from the air.
- Filters containing an adsorbent or catalyst such as charcoal (carbon) may also remove odors and gaseous pollutants such as volatile organic compounds or ozone.





An **oil bath air cleaner** consists of a sump containing a pool of oil, and an insert which is filled with fiber, mesh, foam, or another coarse filter media. ... Larger and heavier dust and dirt particles in the air cannot make the turn due to their inertia, so they fall into the oil and settle to the bottom of the base bowl.

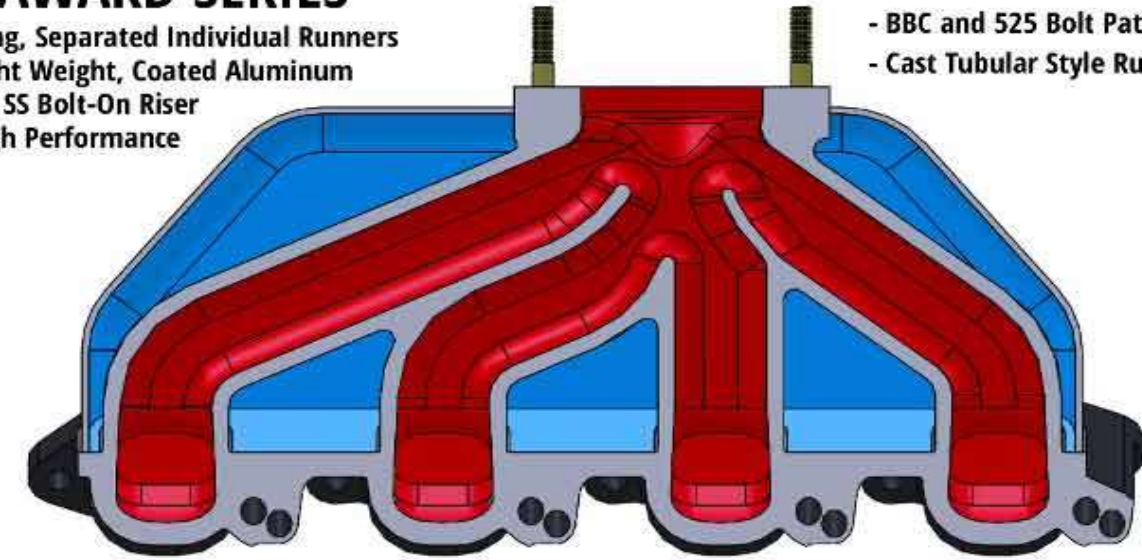


It is connected to your vehicle's engine and collects your engine's emissions. The exhaust manifold receives the air/fuel mixture from the multiple cylinders in your vehicle's engine. Then once they are in one place and completely burnt, the manifold sends the emissions into the rest of the exhaust system.

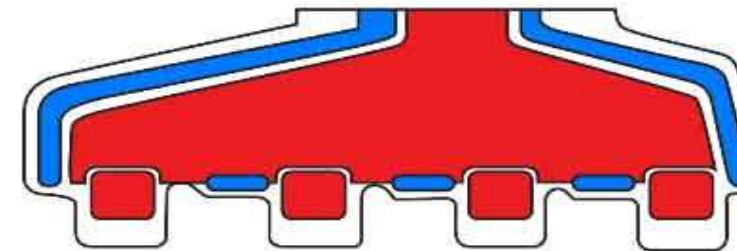
Exhaust manifolds are generally simple cast iron or stainless steel units which collect engine exhaust gas from multiple cylinders and deliver it to the exhaust pipe.

## SEAWARD SERIES

- Long, Separated Individual Runners
- Light Weight, Coated Aluminum
- HD SS Bolt-On Riser
- High Performance



- BBC and 525 Bolt Pattern
- Cast Tubular Style Runners

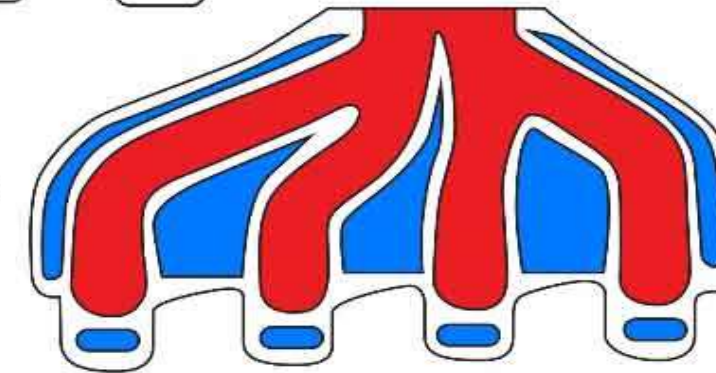


## STOCK / OEM

- Open Exhaust Chamber
- Heavy Cast Iron
- Heavy Cast Iron Bolt-On Riser
- Poor Performance

## AFTERMARKET COMPETITOR

- Short, Inefficient Individual Runners
- Light Weight Aluminum
- Aluminum or SS Bolt-On Riser
- Average Performance
- Made Overseas





## These are six common reasons why a vehicle will fail emissions

- You are past due for an oil change. ...
- You have a rich air/fuel mixture. ...
- You have worn spark plugs. ...
- You have a loose or leaking gas cap. ...
- Your air filter is dirty. ...
- Your “check engine light” is on.

## How to reduce your car's emissions

- Repair the exhaust. Inspect your exhaust and repair any holes that you see. ...
- You don't necessarily need a full service to reduce emissions, but what you should do is get an oil change and change the oil filter too. ...
- Fuel additives. ...
- Use better quality fuel. ...
- Inflate Tyres. ...
- Before the test.

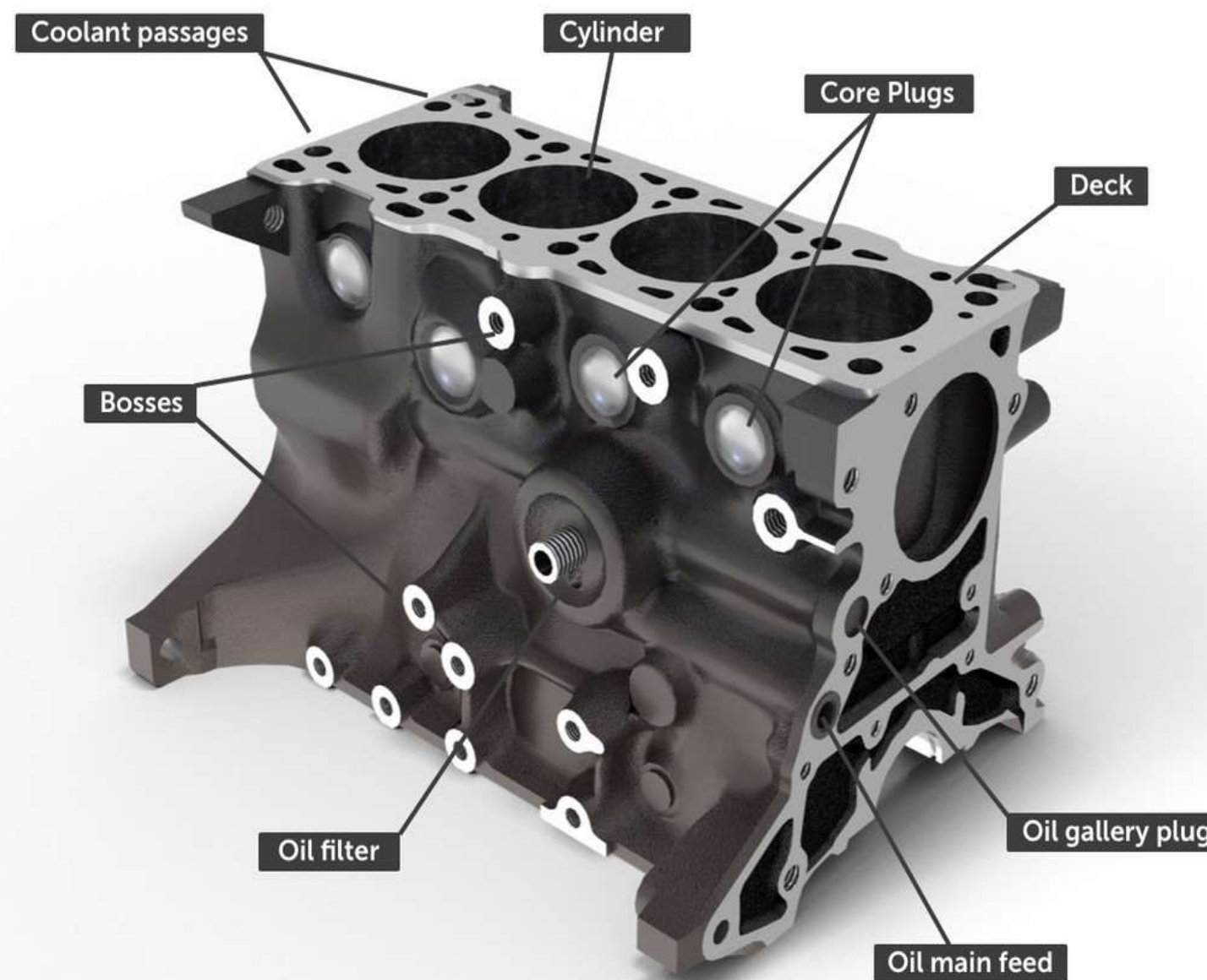




A cylinder block is the structure which contains the cylinder, plus any cylinder sleeves and coolant passages. In the earliest decades of internal combustion engine development, cylinders were usually cast individually, so cylinder blocks were usually produced individually for each cylinder.

The main functions of the cylinder block are: Maintaining the engine's stability and lubrication while withstanding a variety of temperatures and loads. Transferring oil to all parts of the engine, lubricating all the critical components, via a number of oil galleries.

Engine blocks are normally cast from either a cast iron or an aluminum alloy. The aluminum block is much lighter in weight, and has better heat transfer to the coolant.



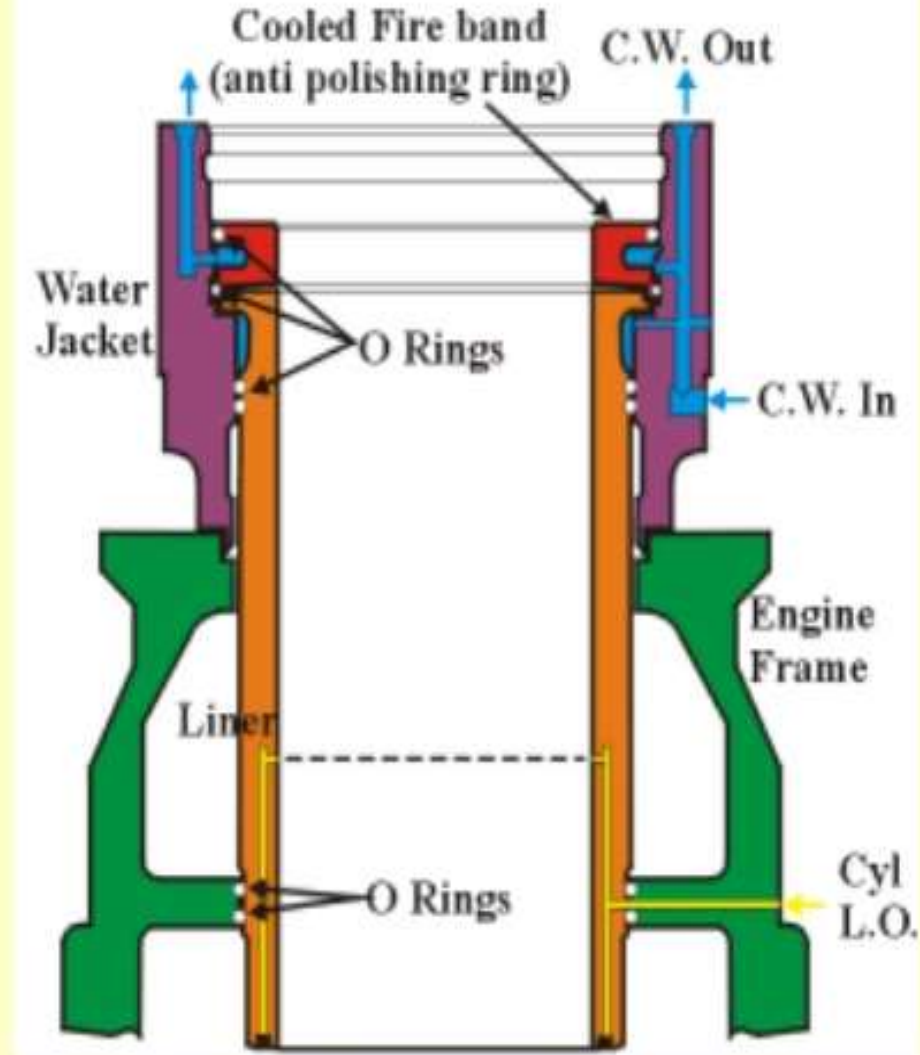
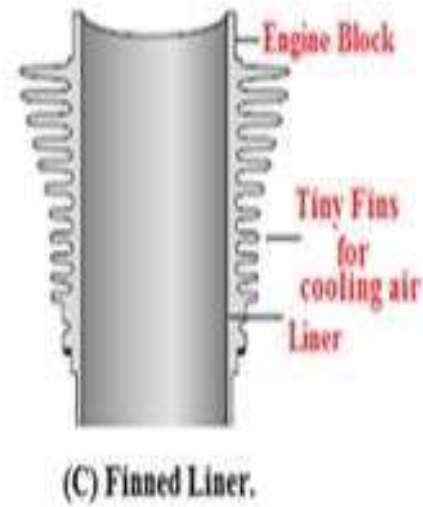
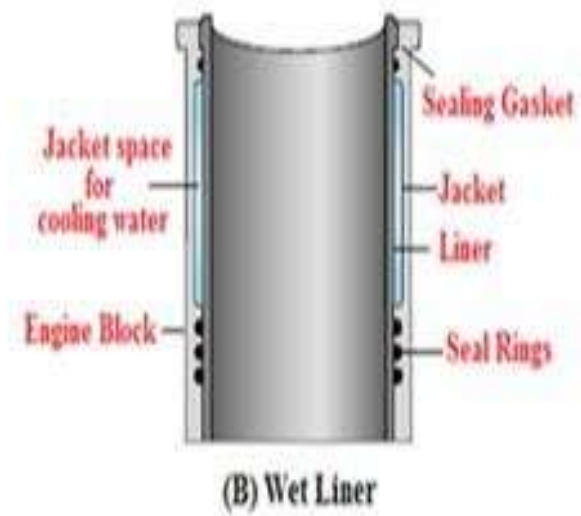
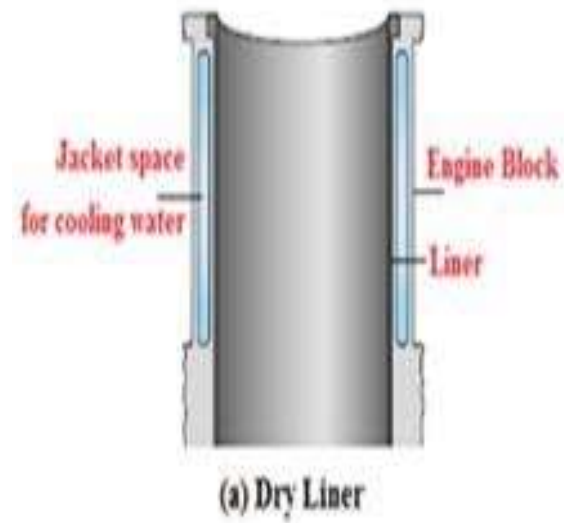


**BORING**



**HORNING**

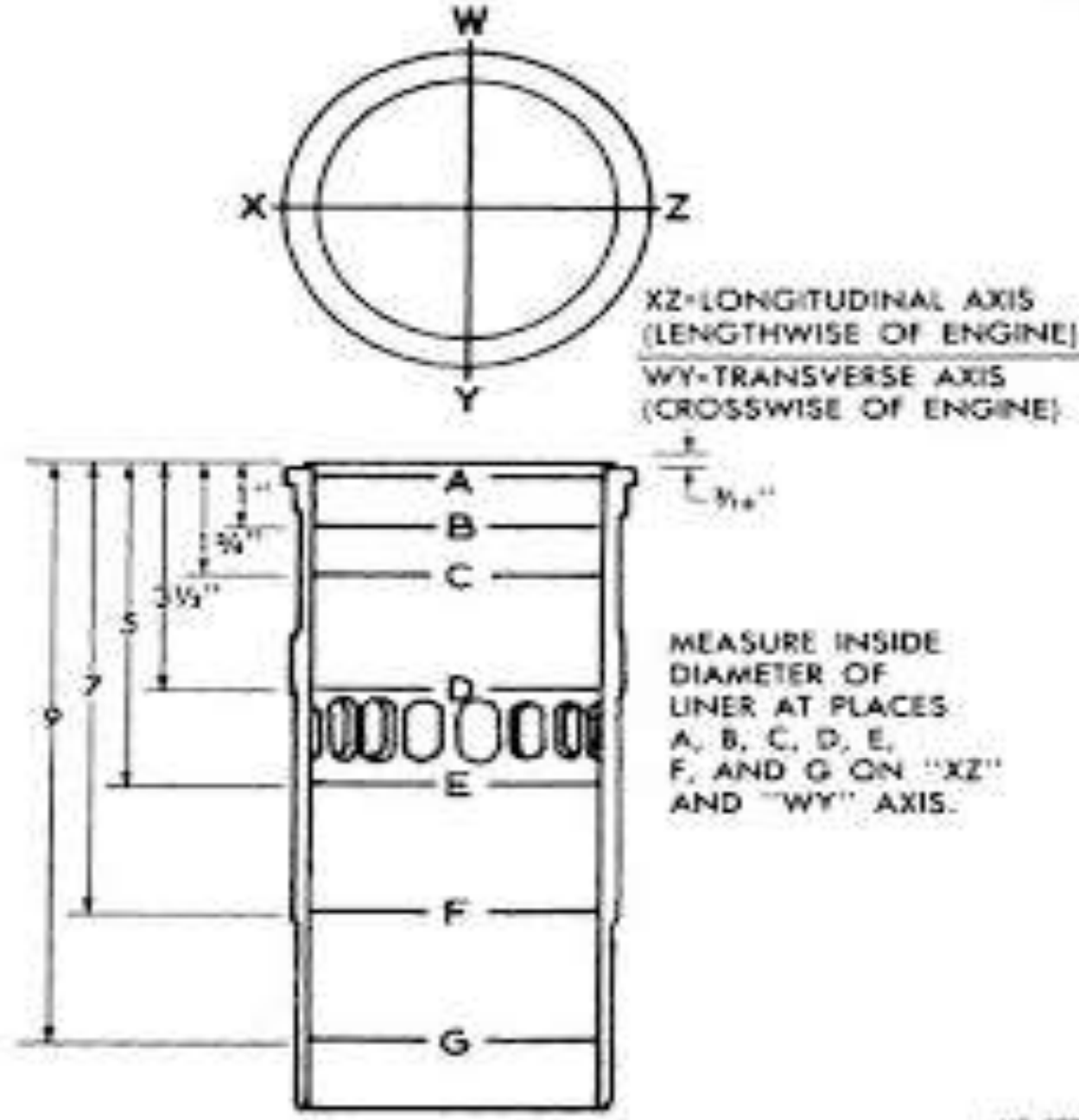




MAN-B&W L58/64 Liner

Tapper

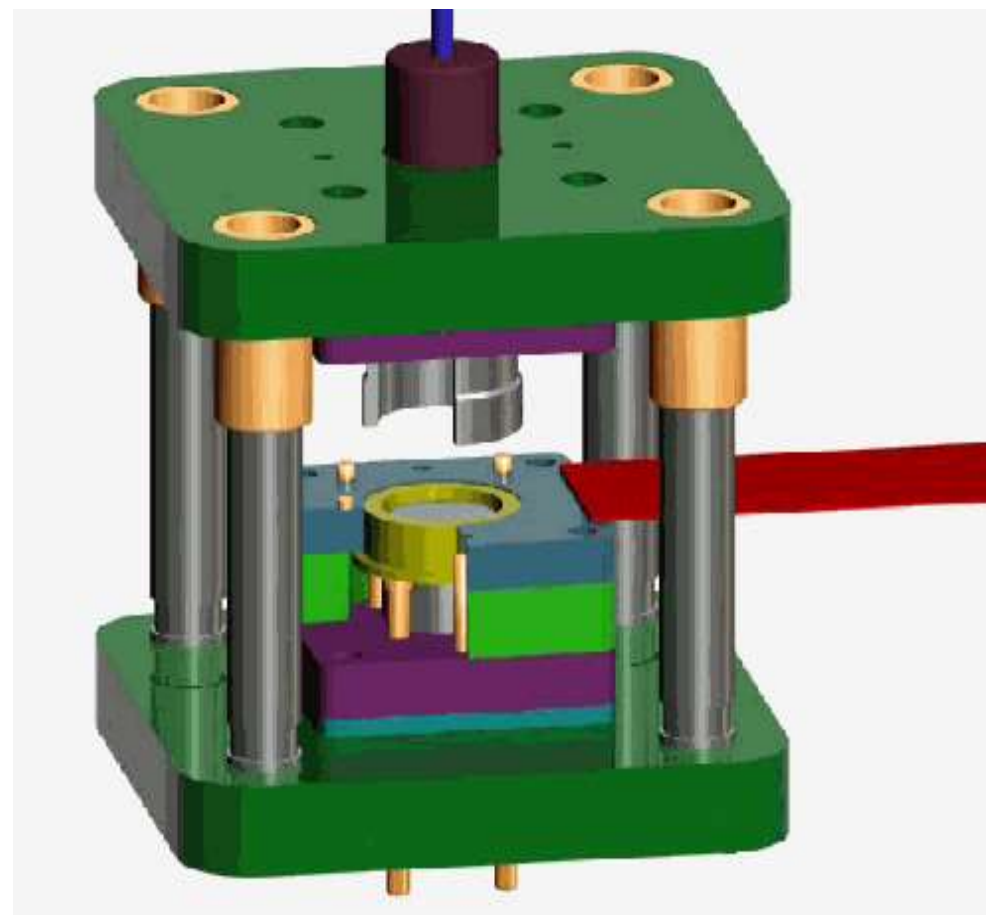




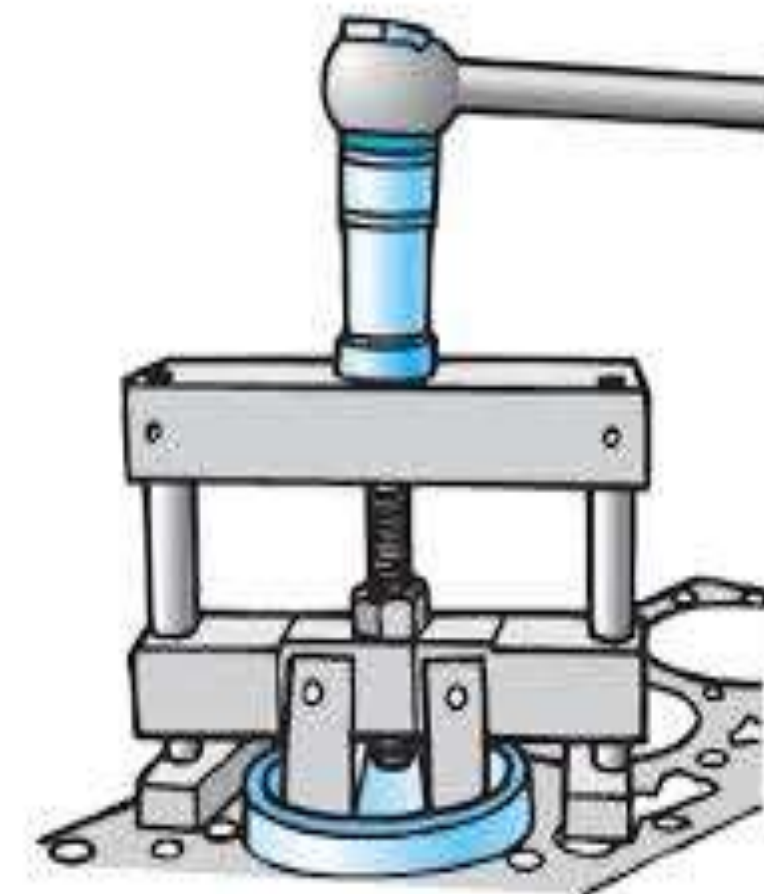
ovality

The cylinder liner, serving as the inner wall of a cylinder, forms a sliding surface for the piston rings while retaining the lubricant within. The most important function of cylinder liners is the excellent characteristic as sliding surface and these four necessary points.

While the cylinder block is made from a grey cast iron, the liner is manufactured from a cast iron alloyed with chromium, vanadium and molybdenum. (cast iron contains graphite, a lubricant. The alloying elements help resist corrosion and improve the wear resistance at high temperatures.)



**Hydraulic Press System**



**Screw tool Press System**

**Valve Mechanism.** Engine valves are used in engines to allow air or air-fuel mixture to enter into the cylinder (through inlet valve) and also to push exhaust gases (through outlet valve) from the cylinder at a specific time during the engine cycle.

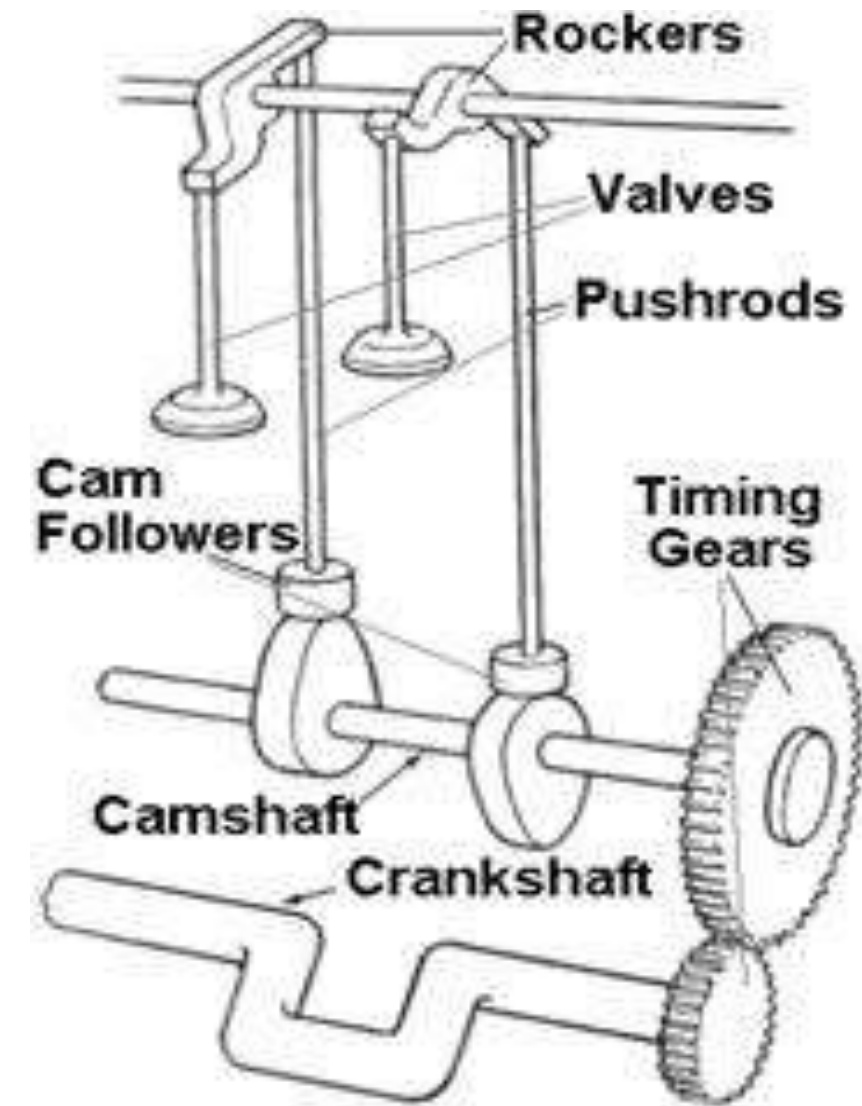
**The valve mechanism consist of:**

- 1 – camshaft
- 2 – pushrod
- 3 – valves (inlet valve and exhaust valve)
- 4 – rocker arm
- 5 – valve springs.

Camshaft driven by a chain, a belt, or a set of gears from the crankshaft.

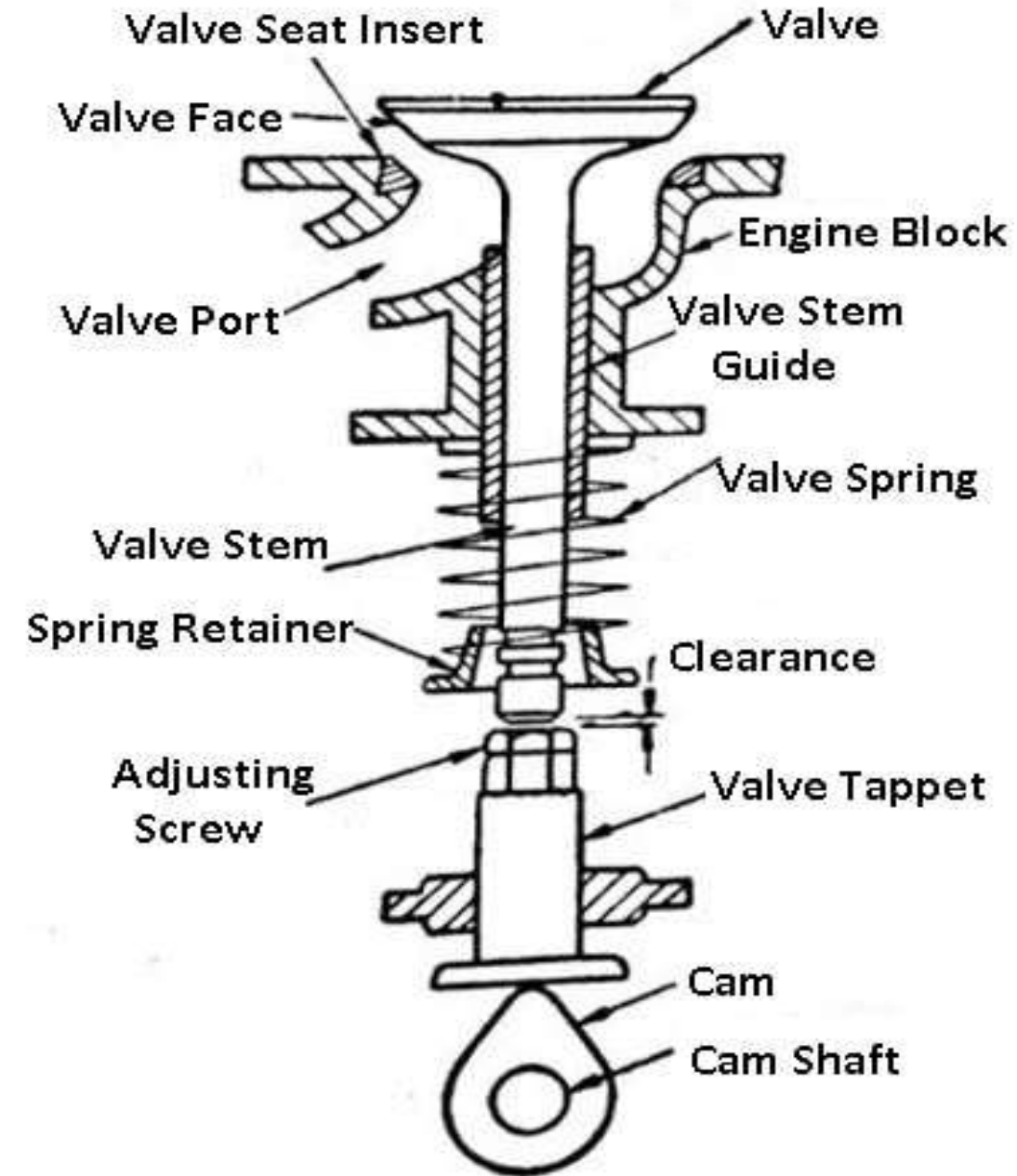
There are two type of valve mechanisam

1. over head valve mechanisam
2. Side valve mechanisam



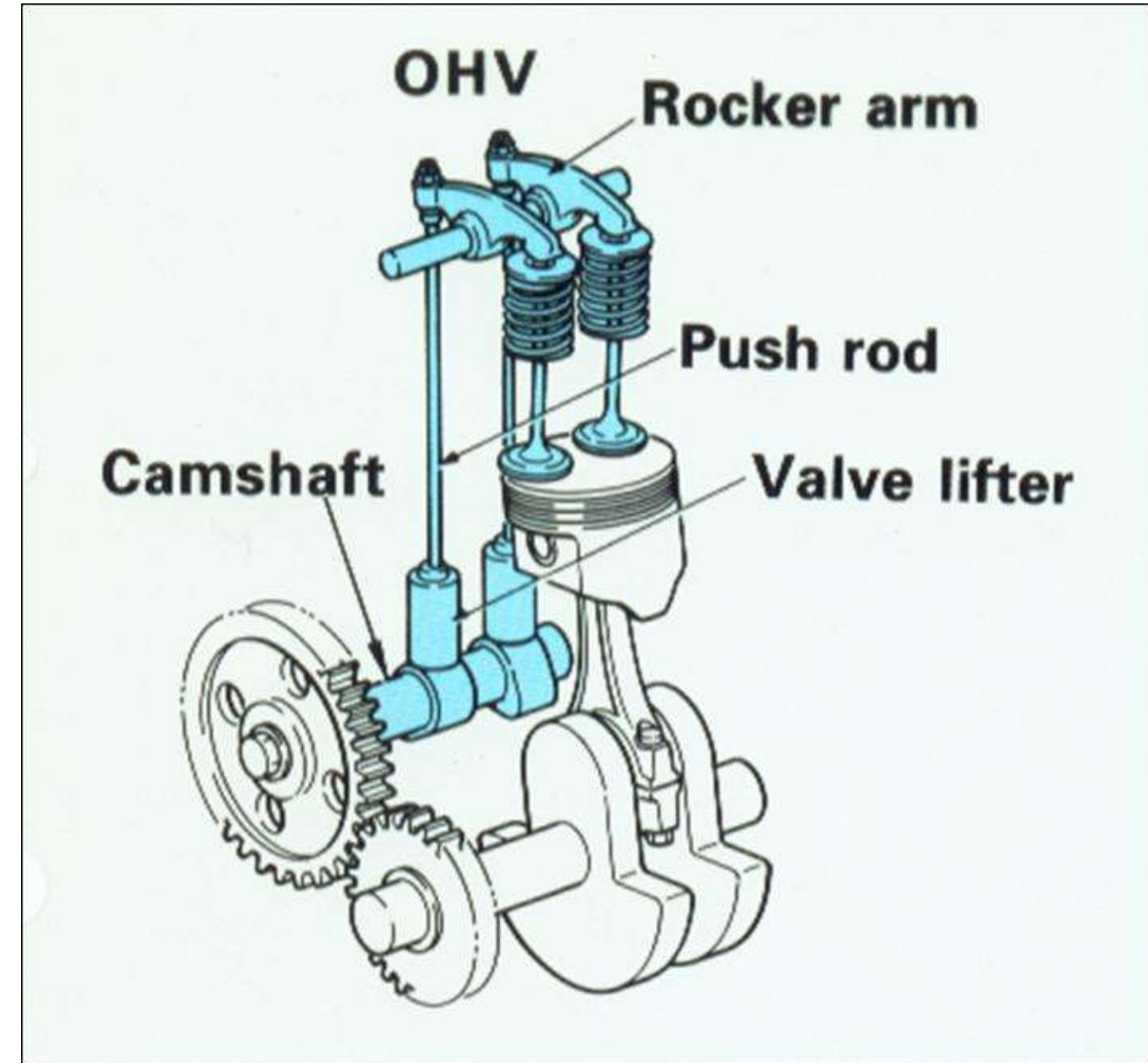


## Side Valve Mechanisam -



An **overhead valve (OHV)** engine, sometimes called a pushrod engine, is a piston engine whose valves are located in the cylinder head above the combustion chamber. This contrasts with earlier flathead engines, where the valves were located below the combustion chamber in the engine block.

In overhead valve (OHV) engines, the valves are positioned above the piston. The camshaft moves the valves through a tappet, pushrods and rocker arms. 4-stroke OHV engines provide more efficient combustion by allowing the air-fuel mixture to spread more evenly throughout the combustion chamber.



There are 3 different types of engine valves as follows:  
Poppet Valve. Sleeve Valve. Rotary Valve.

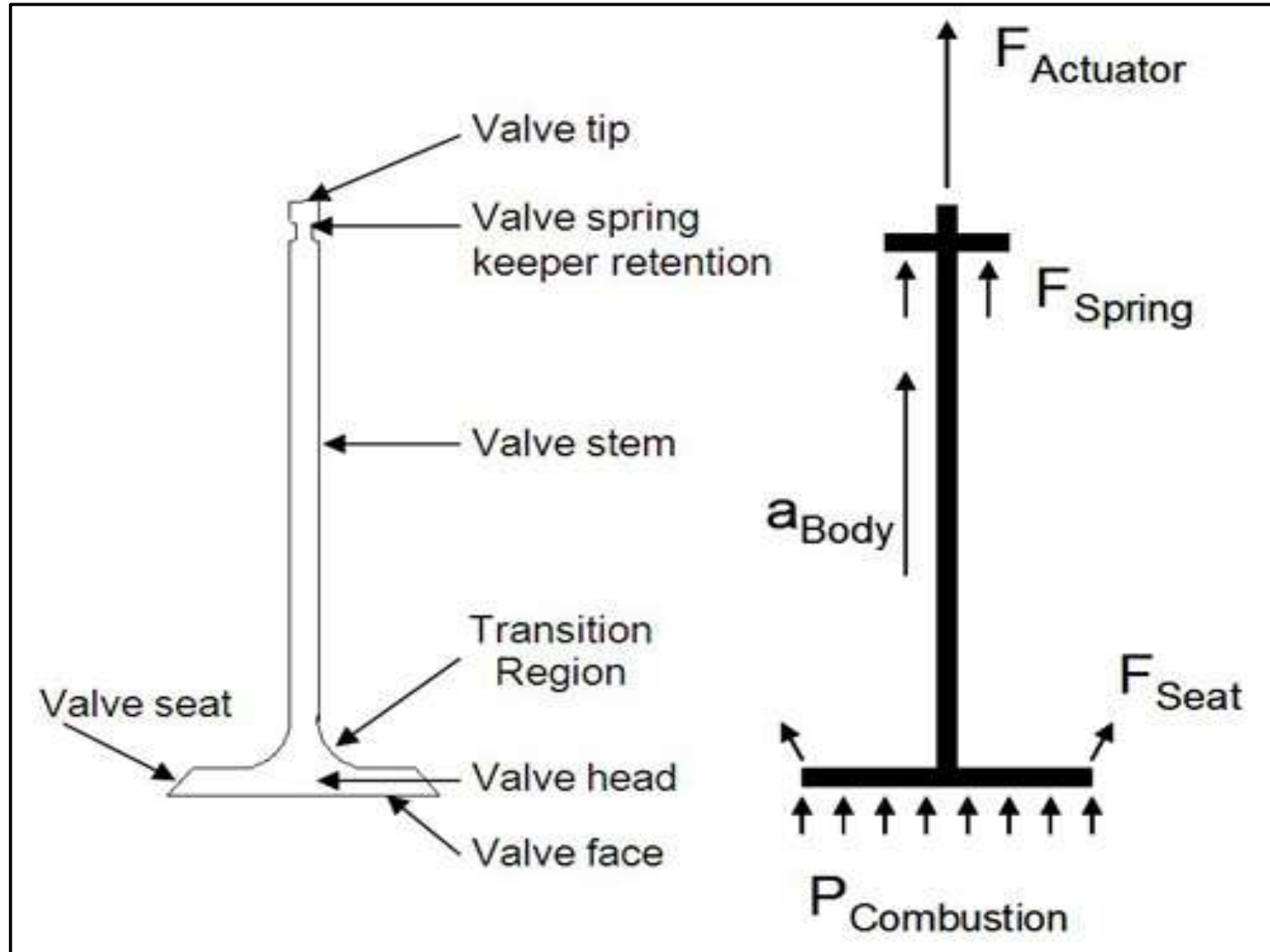
**Material** - Valve bodies are usually metallic or plastic. Brass, bronze, gunmetal, cast iron, steel, alloy steels and stainless steels are very common.

**Valve Guide** - Worn guides can also contribute to valve breakage. The guides support and center the valves as they open and close. A worn guide will allow the valve to wobble slightly as it opens. This will cause it to drift off- center with respect to the seat.

## Top 5 Bad Valve Guide Seals Symptoms

- 1) Too Much Smoke. Once the deterioration of the valve seals has gotten bad enough, the exhaust smoke that comes out of the car after you start the engine will remain there for a while
- 2) Excessive Oil Use
- 3) Off-Throttle Braking. ...
- 4) Idling
- 5) Cold Engine.





Valve



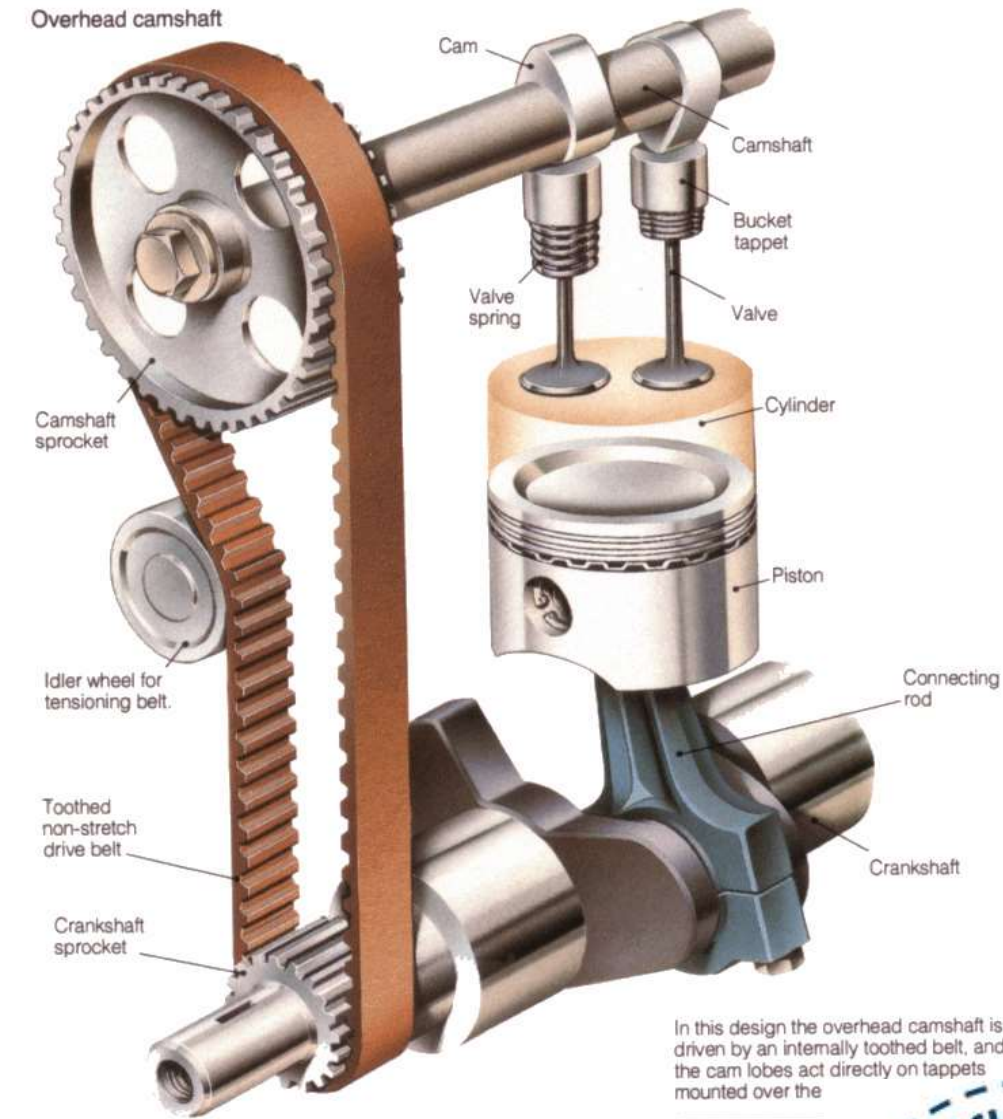
Valve Guide

## Valve Operating Drive

There are three type of Valve Operating Drive (1) Belt drive (2) Gear drive (3) Chain drive

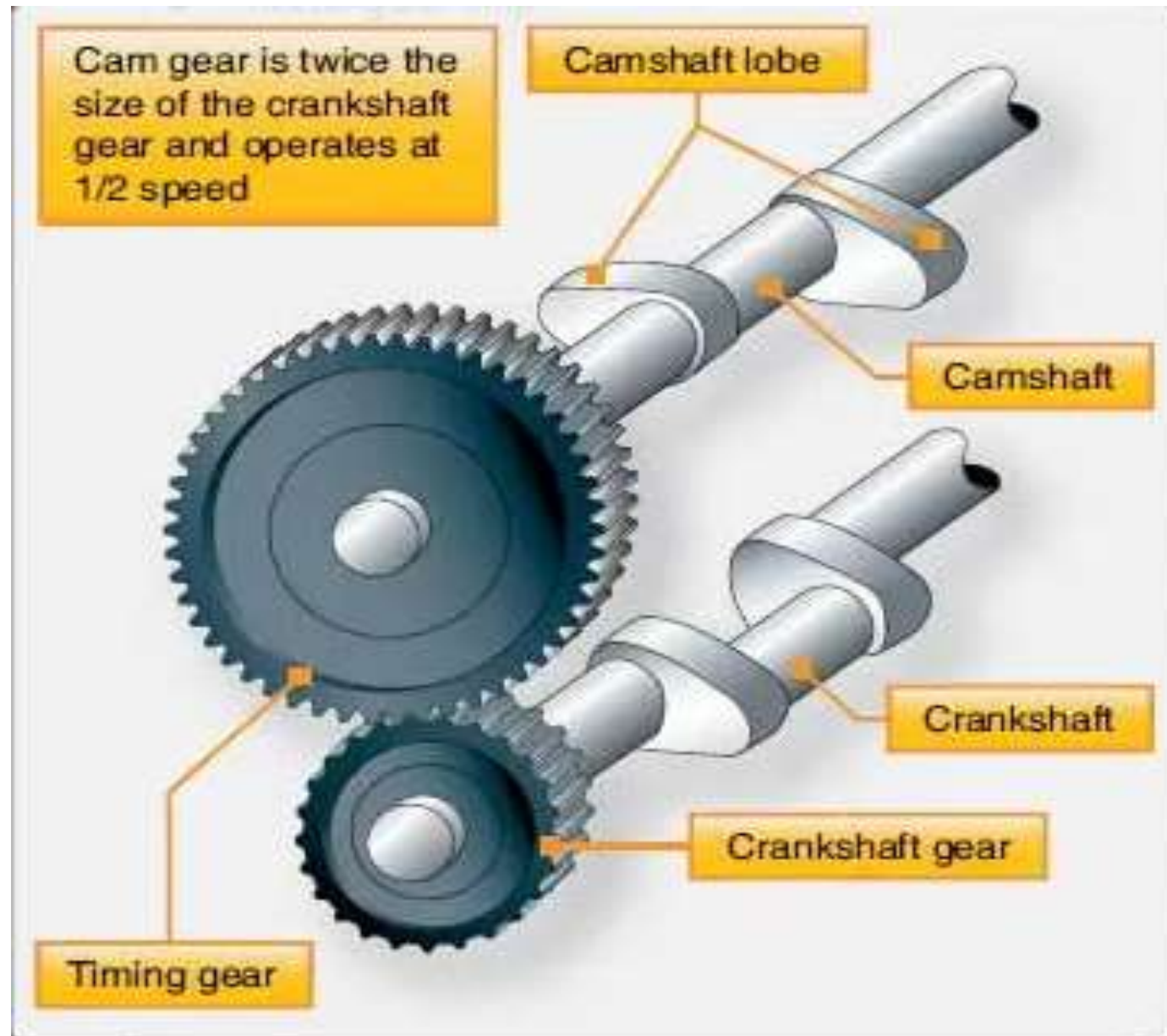
**Drive belts** - use the force of friction to operate. When a **drive** belt is installed, tension is applied. That tension then creates friction between the belt and the pulleys that it's installed around. When the crankshaft turns, friction between the crank pulley and the **drive** belt causes the belt to move

**Drive Gear** The mechanism is operated by planetary gear train to continuously and precisely change the phase angle between camshaft and crank shaft. The internal ring gear has an external worm tooth so it can acts like a worm wheel. It trains with the worm.



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

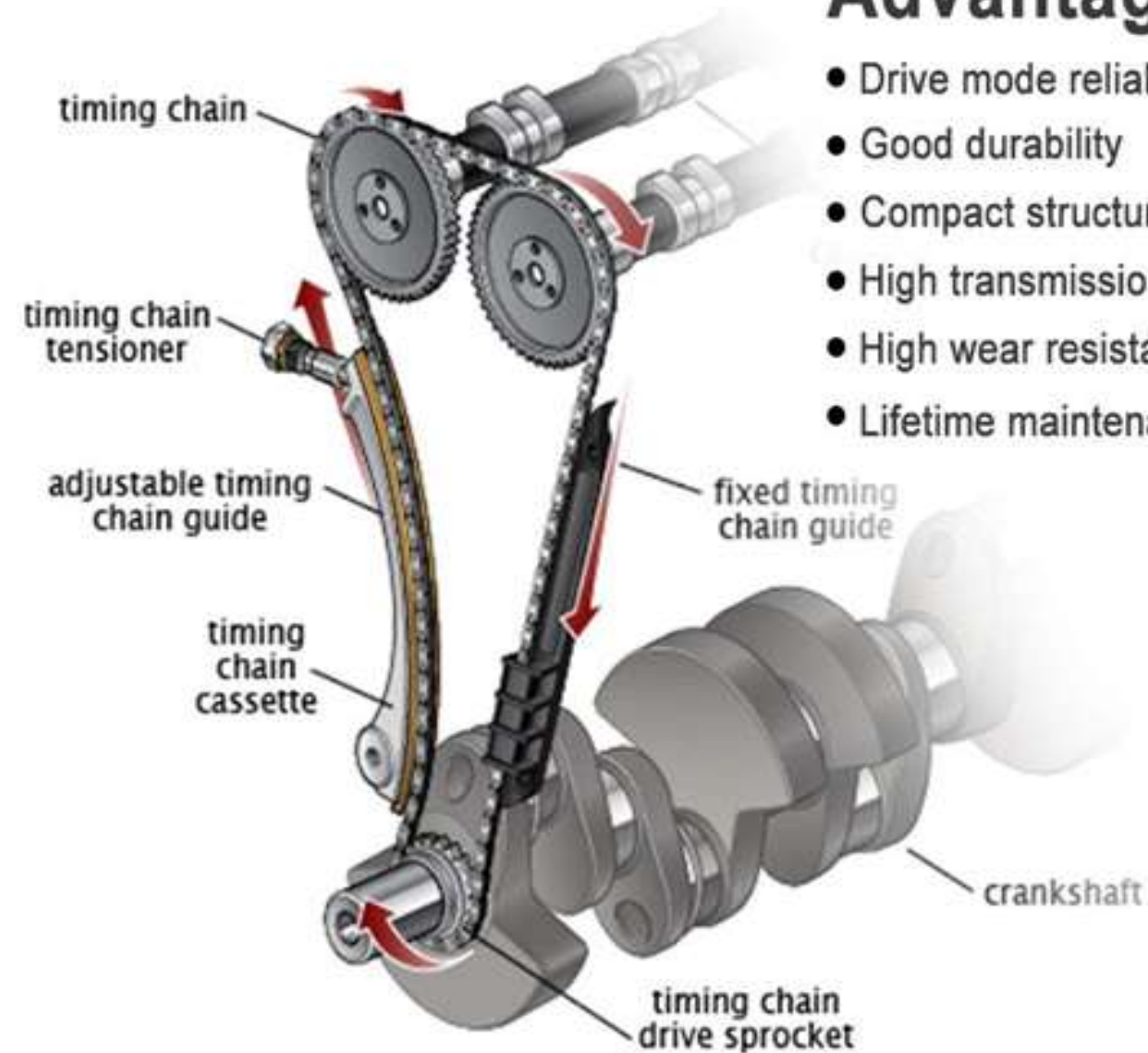




The mechanism is operated by planetary gear train to continuously and precisely change the phase angle between camshaft and gear. The four identically planetary gears are meshing with the ring gear and the sun gear and they are carried by the two arms.



## Timing Chain Kit

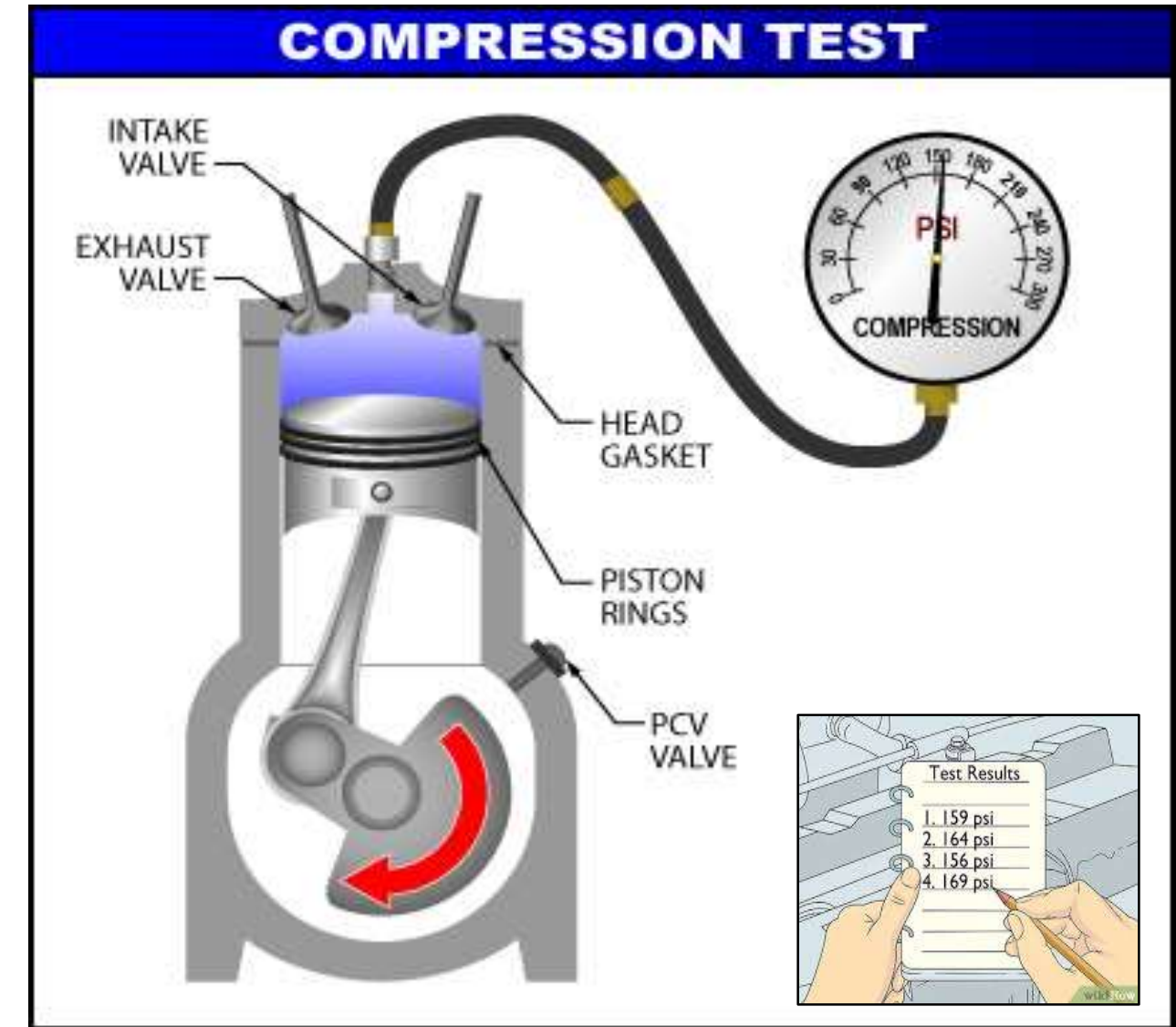


### Advantage:

- Drive mode reliable
- Good durability
- Compact structure
- High transmission power
- High wear resistance
- Lifetime maintenance free

**Drive Chain-** A timing belt, timing chain, or came belt is a part of an internal combustion engine that synchronizes the rotation of the crankshaft and the camshaft(s) so that the engine's valves open and close at the proper times during each cylinder's intake and exhaust strokes.

- A **Compression test** reveals the condition of your engine's valves, its valve seats, and piston rings and whether these parts are wearing evenly.
- Healthy engines should have compression over 100 psi per cylinder, with no more than 10 percent variation between the highest and lowest readings As a general rule a compression of 135 PSI or better is excellent.
- However they are right that it requires the revolution of the crankshaft and thus can damage the valve of an unsynchronized engine.
- Compression pressures that are too high can result in difficult starting and detonation or “pinging” which in turn can cause engine damage.
- If the static compression pressure is too high or too low, the engine will not run as well as it should, and in some cases the resulting problems can be serious.

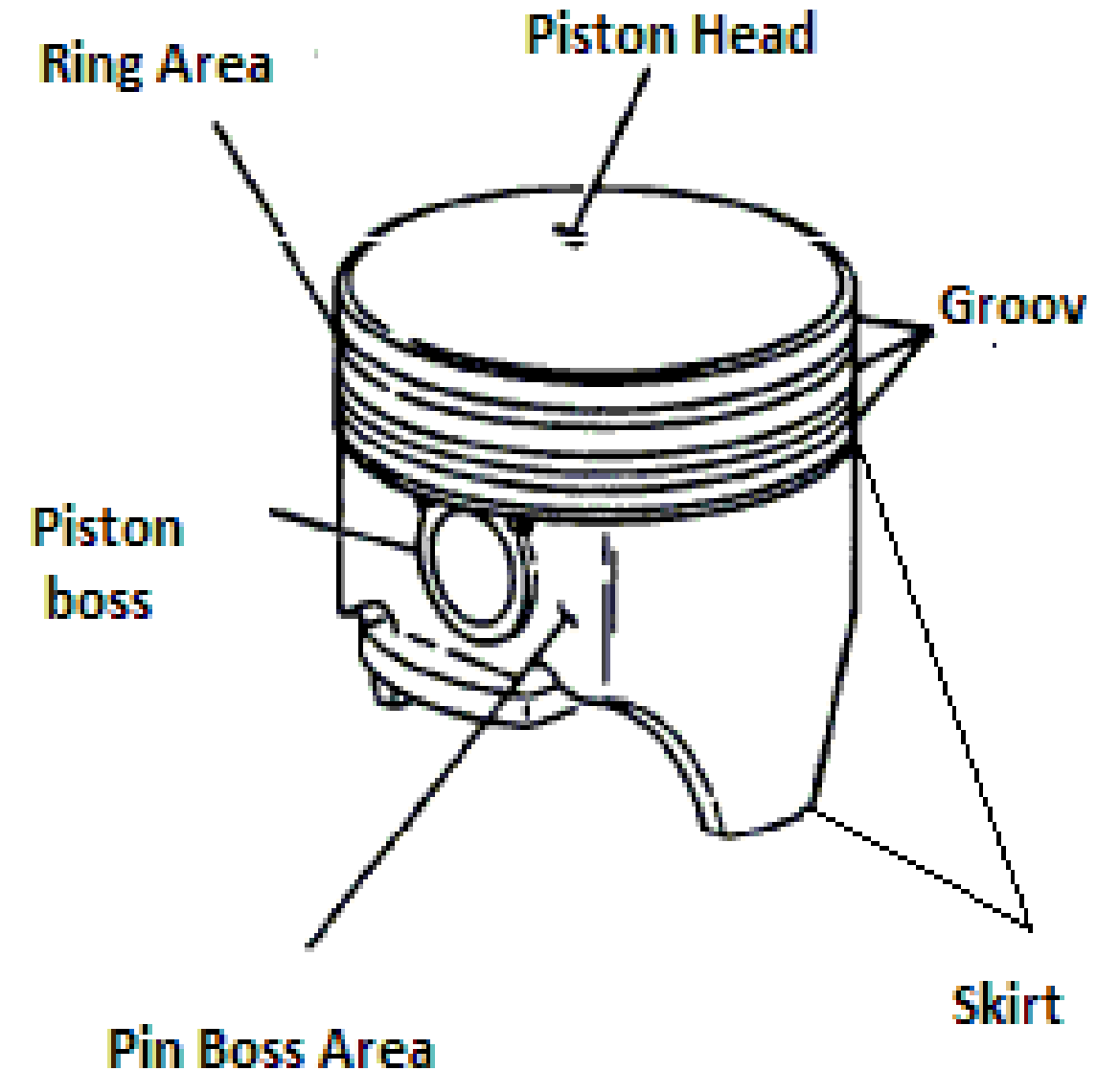


**Principle** - Internal combustion heat engines work on the principle of the ideal gas law: . Raising the temperature of a gas increases the pressure that makes the gas want to expand. An internal combustion engine has a chamber, which has fuel added to it which ignites in order to raise the temperature of the gas.

**Piston construction** - Head  
Groove  
Skirt  
Boss area

**Material** - When a piston is cast, the aluminium alloy is heated until liquid, then poured into a mould to create the basic shape.

There are four type of piston .(1) Flat type (2) Doom Type (3) Concave Type (4) Irregular Type

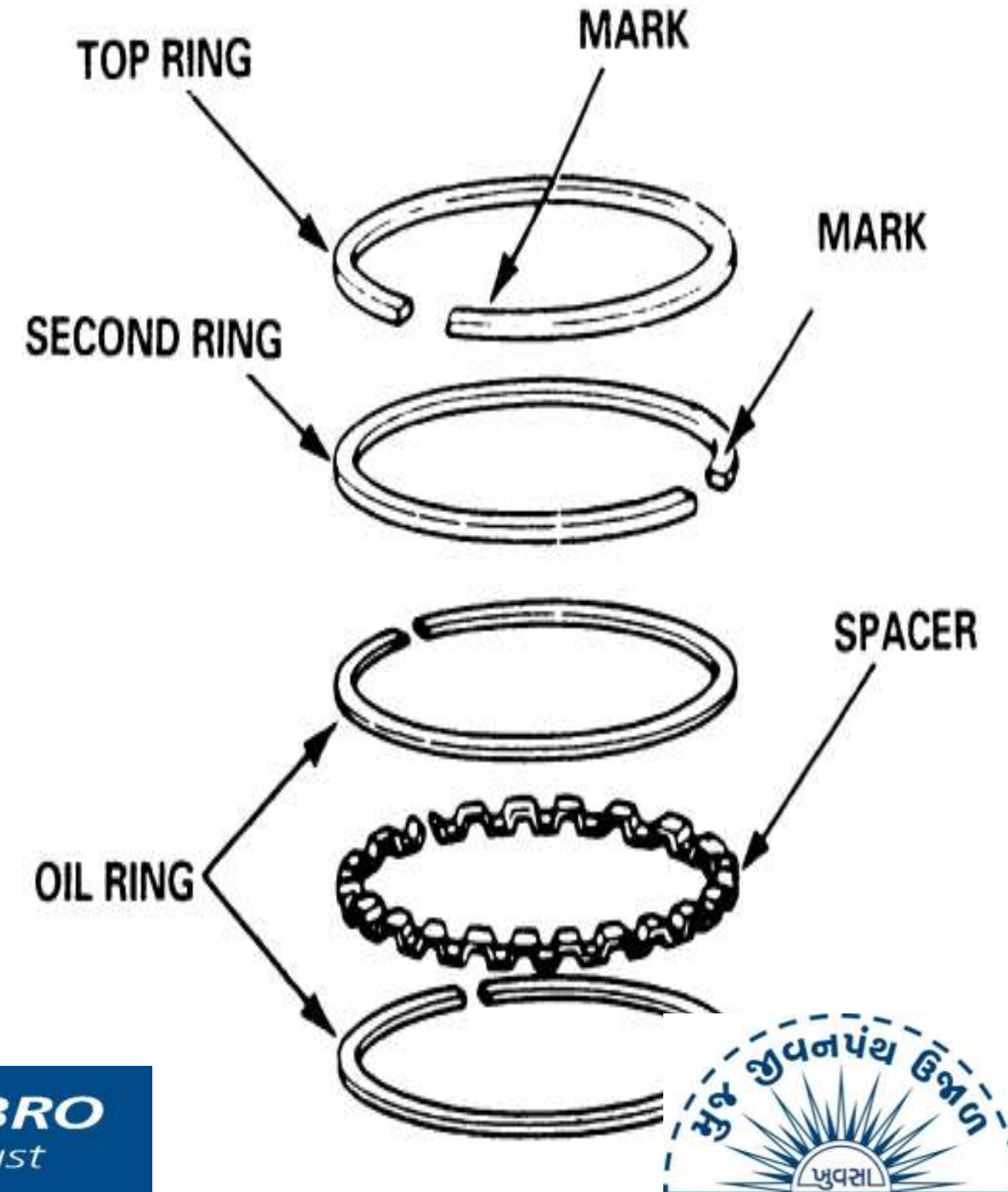




• **Piston Ring** - A piston ring is a metallic split ring that is attached to the outer diameter of a piston in an internal combustion engine or steam engine.

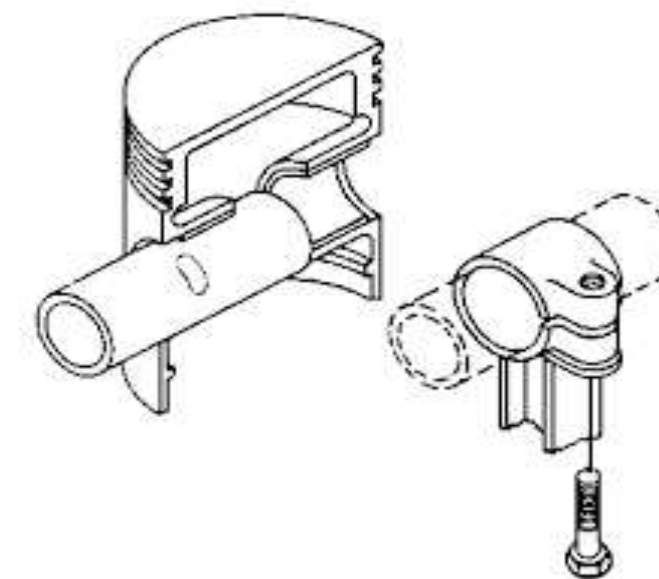
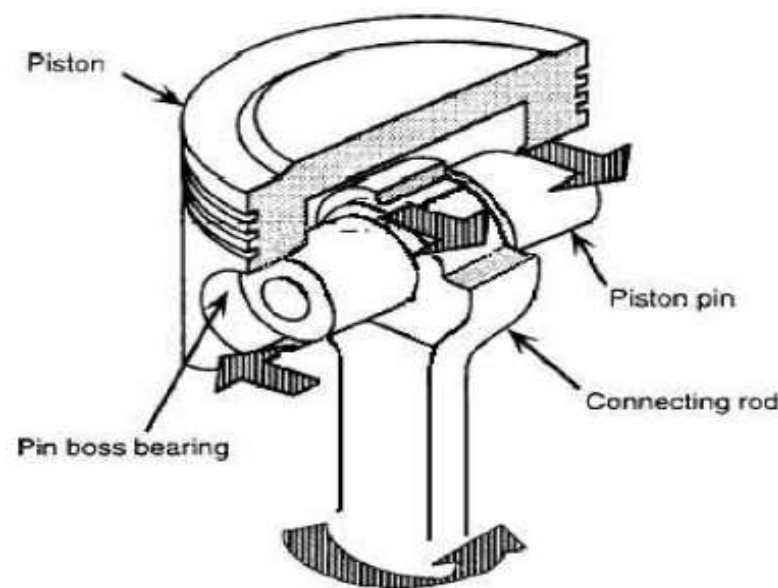
• The main functions of piston rings in engines are: Sealing the combustion chamber so that there is minimal loss of gases to the crank case. A piston ring is an expandable split ring used to provide a seal between the piston and the cylinder wall.

• Piston rings are commonly made from **cast iron**. Cast iron retains the integrity of its original shape under heat, load, and other dynamic forces.



**Piston pin** - In internal combustion engines, the gudgeon pin connects the piston to the connecting rod, and provides a bearing for the connecting rod to pivot upon as the piston moves.

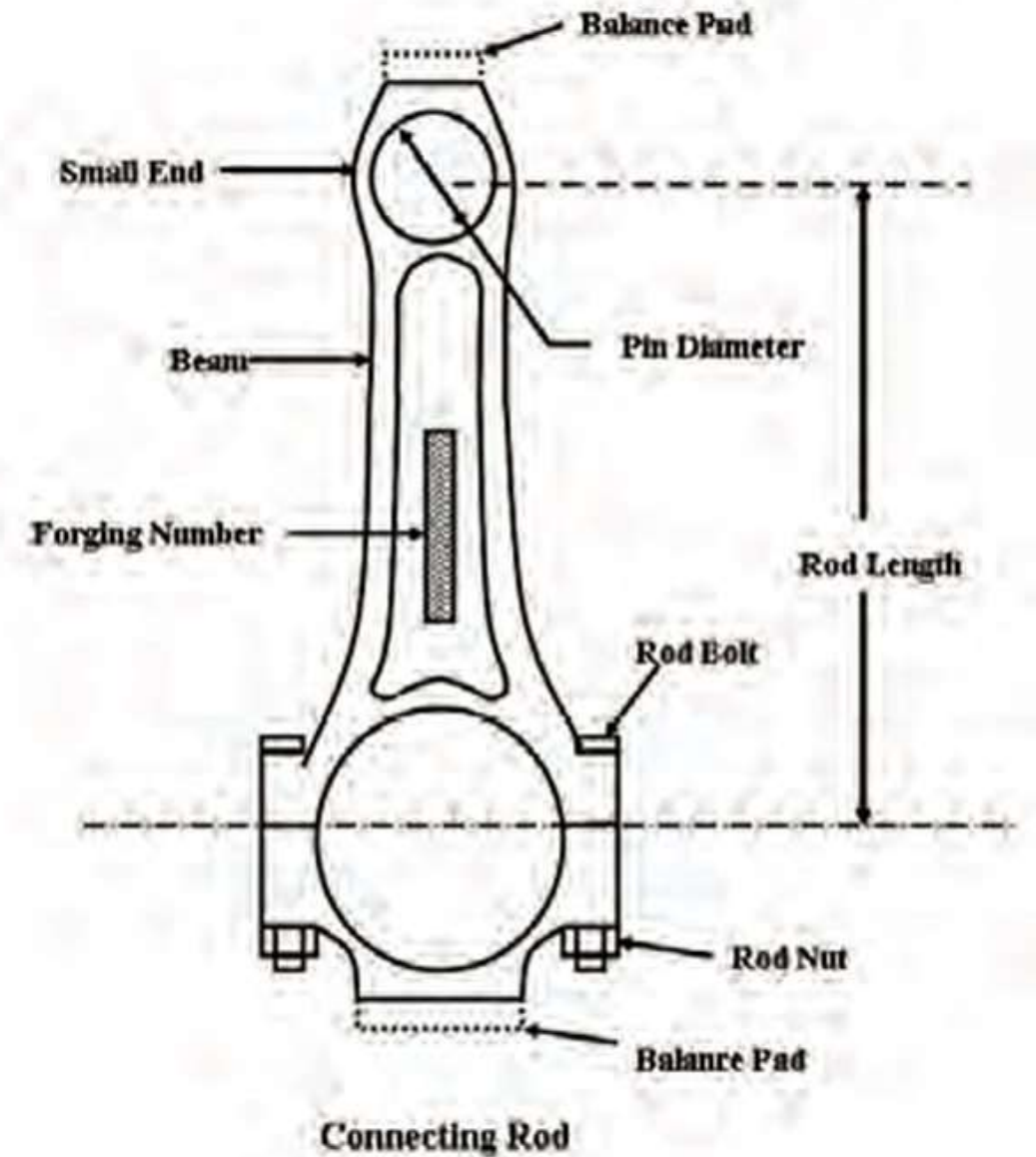
The gudgeon pin is typically a forged short hollow rod made of a steel alloy of high strength and hardness that may be physically separated from both the connecting rod and piston or crosshead.



**connecting rod** - also called a con rod, is the part of a piston engine which connects the piston to the crankshaft. Together with the crank, the connecting rod converts the Reciprocating motion of the piston into the rotation of the crankshaft. The connecting rod is required to transmit the compressive and tensile forces from the piston, and rotate at both ends.

**Connecting rods** are commonly made from cast aluminium alloy.

**Connecting rod bearings** provide rotating motion of the crank pin within the connecting rod, which transmits cycling loads applied to the piston.

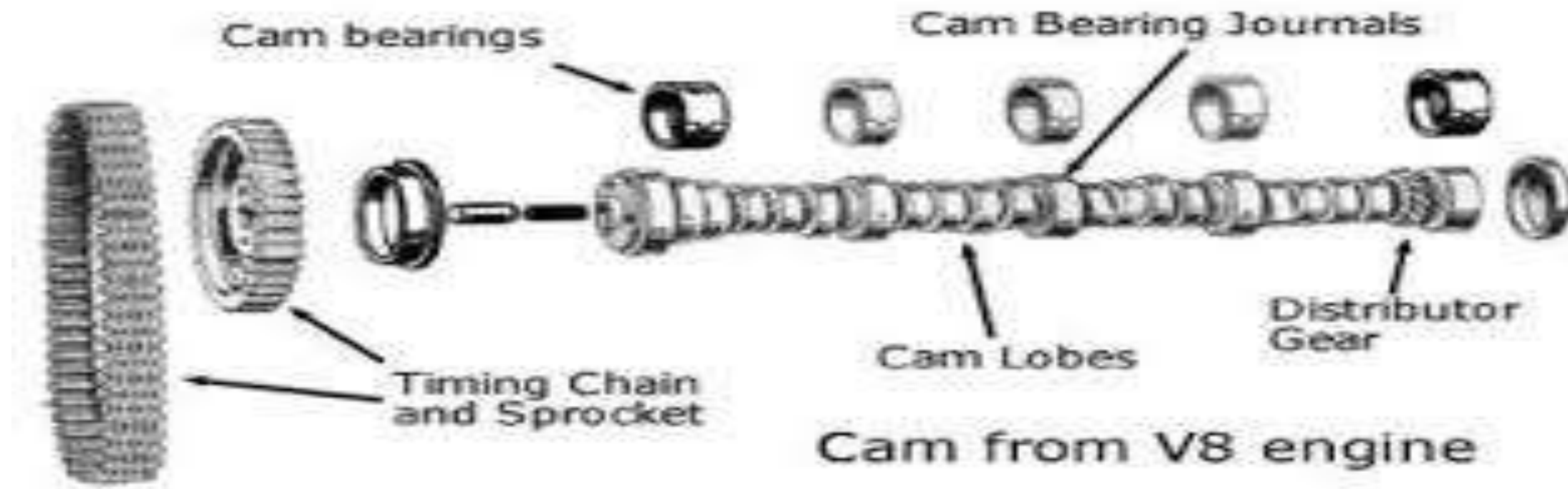




# CAMSHAFT

The key parts of any camshaft are the lobes. As the camshaft spins, the lobes open and close the intake and exhaust valves in time with the motion of the piston

Camshaft made of steel or cast iron? Camshafts are made of steel and cast iron.



A **crankshaft** is a rotating shaft which (in conjunction with the connecting rods) converts reciprocating motion of the pistons into rotational motion. The **crankshaft** rotates within the engine block through use of main bearings, and the crankpins rotate within the connecting rods using rod bearings.

***A crankshaft comprises the following components:***

Main journals. Crank pins. Crank webs. Counter weights.





# CRANKSHAFT



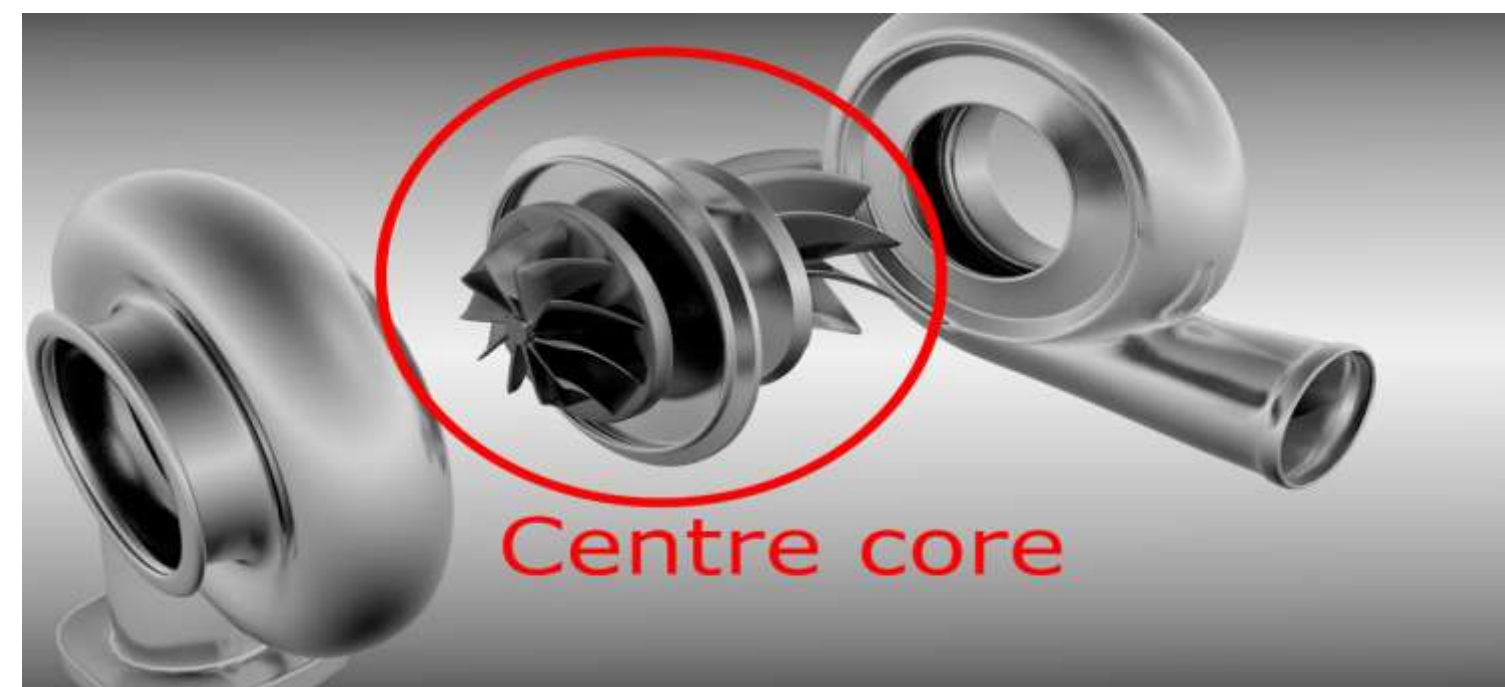
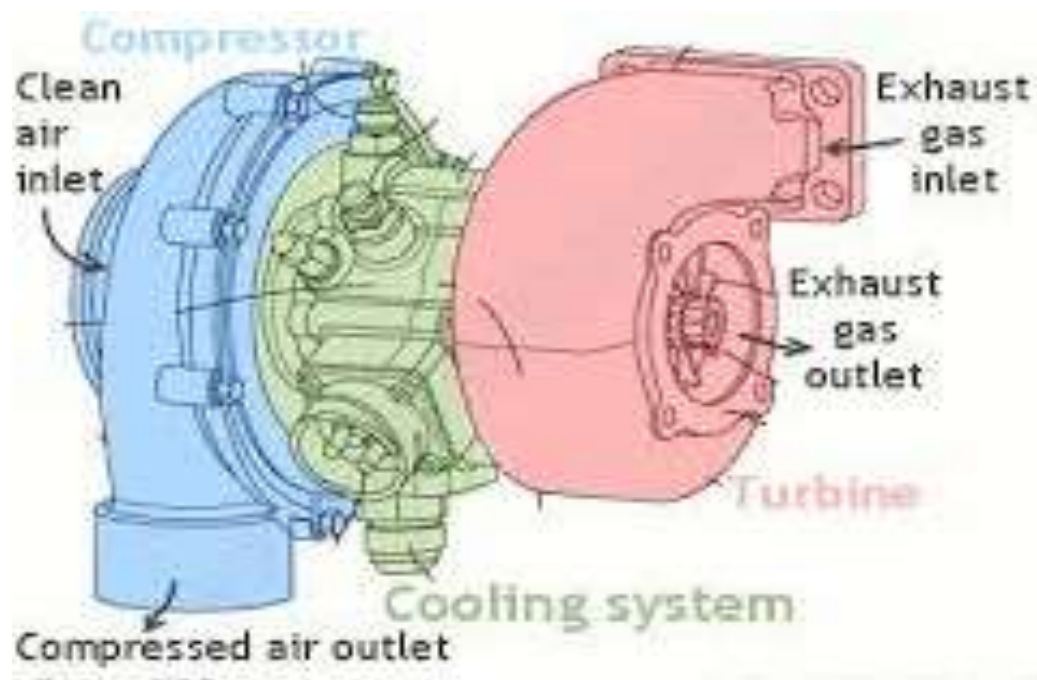
- There are 3 processes to strengthen the crank shaft:
  - Nitriding
  - Carburizing
  - Heat treatment





The turbocharger on a car applies a very similar principle to a piston engine. It uses the exhaust gas to drive a turbine. This spins an air compressor that pushes extra air (and oxygen) into the cylinders. Any improperly designed motor setup, whether it's due to bad ECU programming, not enough fuel delivery or improperly timed spark, will have a negative effect on a vehicle.

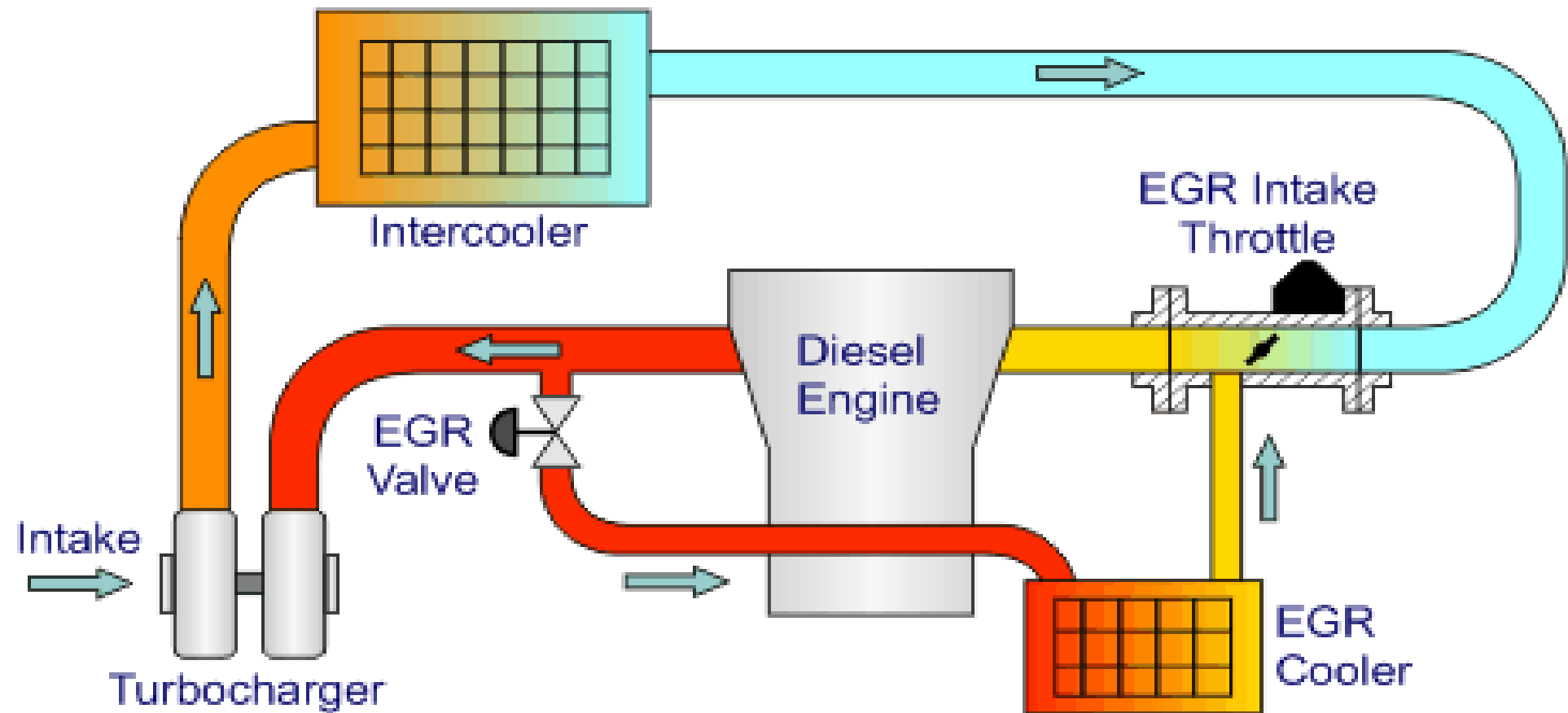
**Turbocharger cleaning** -The cleaning of turbocharger is carried out when the engine is running. If the turbine side cleaning is not carried out then the fouling may lead to back pressure & surging resulting in breakage of turbine blades.



The Exhaust Gas Recirculation or EGR system is one of several vehicle emission control systems. It helps reduce the amount of the nitrogen oxides (NO<sub>x</sub>) in the exhaust gases.

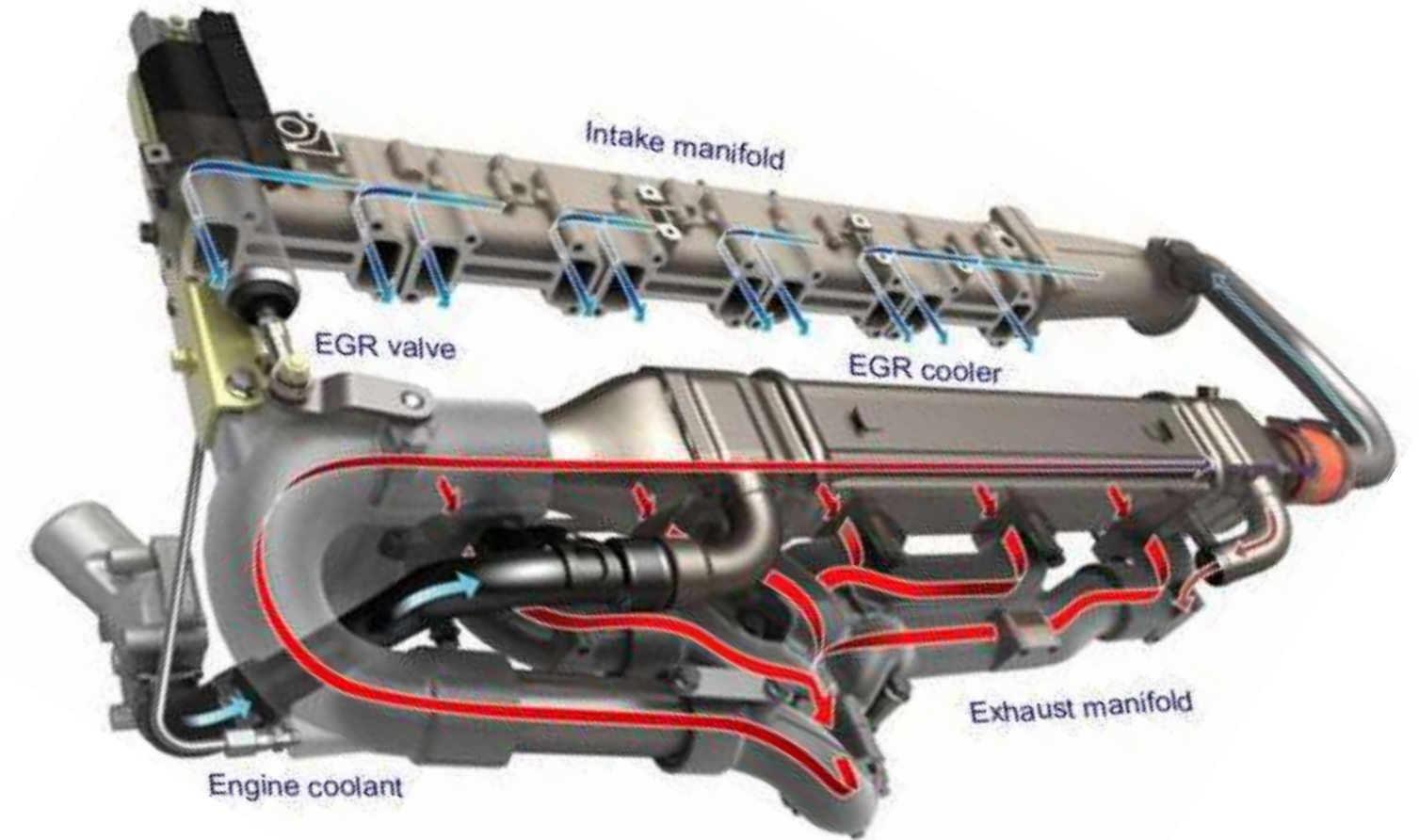
## What are the symptoms of a failing EGR valve?

- Your engine has a rough idle. ...
- Your car has poor performance. ...
- You have increased fuel consumption. ...
- Your car frequently stalls when idling. ...
- You can smell fuel. ...
- Your engine management light stays on. ...
- Your car produces more emissions. ...
- You hear knocking noises coming from the engine.



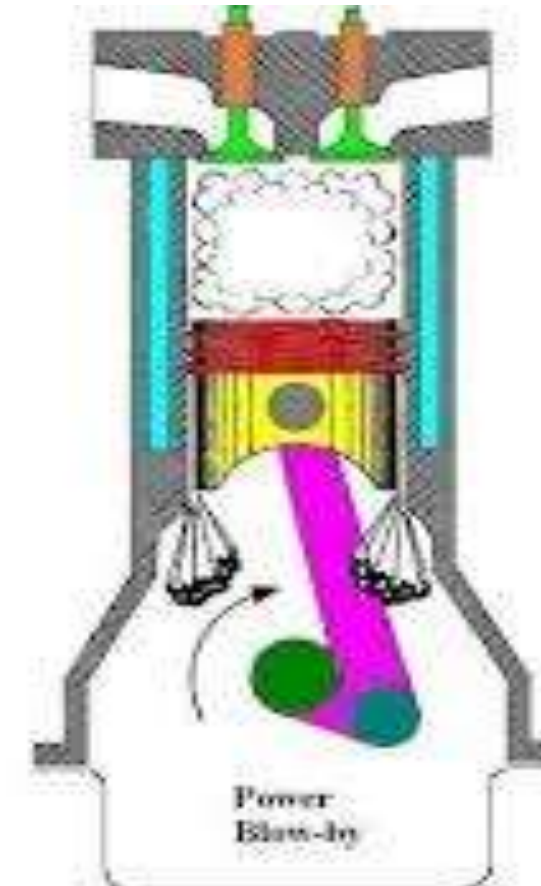
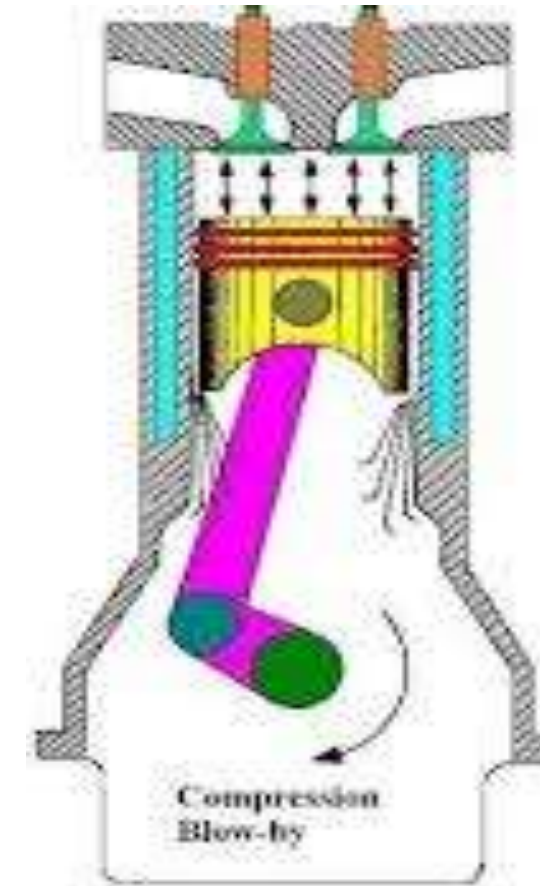
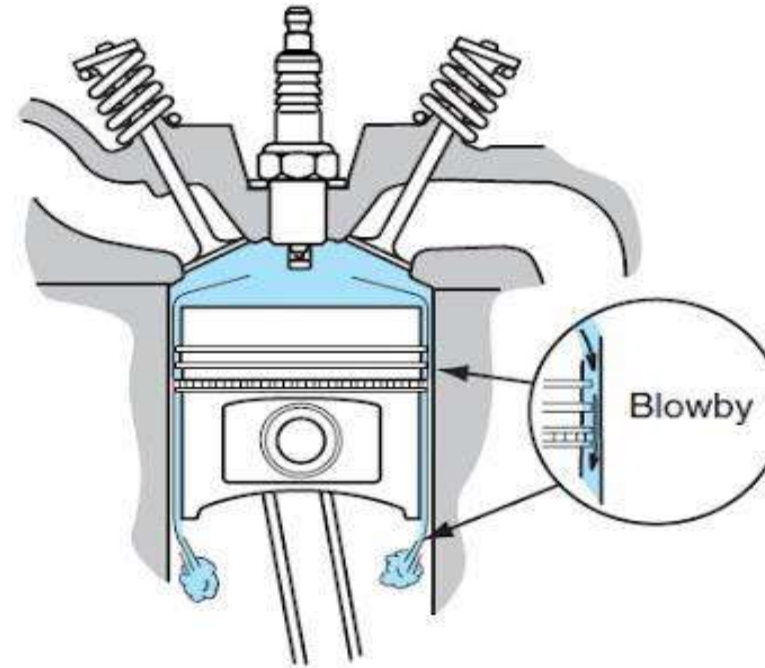


- The main components are: scrubber, cooler, water mist catcher, blower, shut-down valve, change-over valve, water treatment plant (WTP) consisting primarily of the buffer tank, NaOH dosing system and water cleaning unit.
- A control system controls the amount of EGR, the scavenge air pressure, the NaOH dosing, scrubber water circulation and scrubber water discharge.



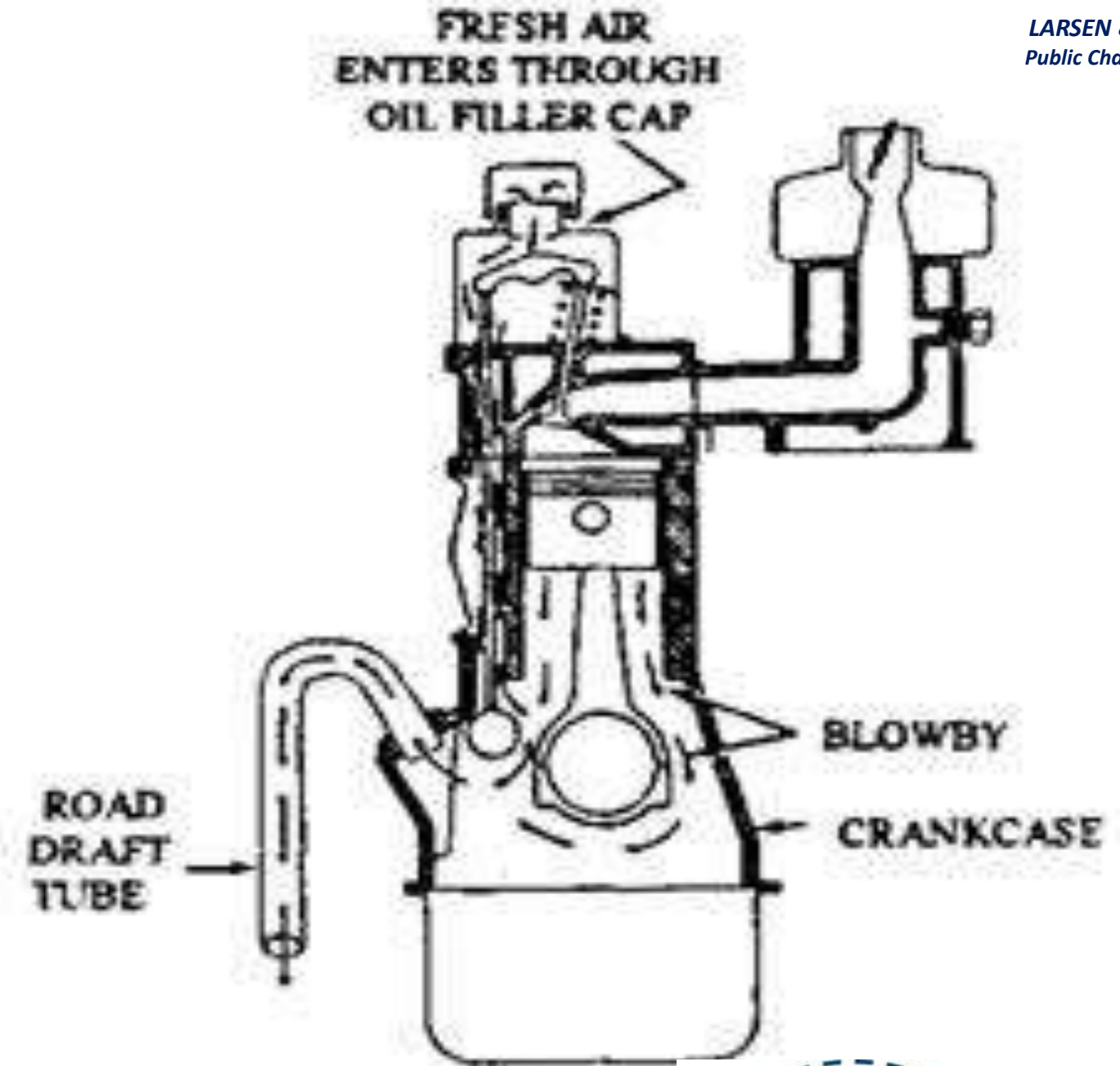


- Blow-by is unwanted leakage of gas under pressure, such as that from a piston or its sealing rings. The blow-by that occurs when too much pressure from the combustion chamber leaks into the crankcase needs to escape somewhere.
- All piston engines experience blow-by of compressed gas past the piston rings.
- During combustion, high pressure on the top side of the piston pushes combustion gasses, as well as droplets of oil and fuel, past the piston rings and into the crankcase. Combustible Fumes.



In an Internal combustion engine a **crankcase ventilation system** removes unwanted gases from the crankcase. The system usually consists of a tube, a one-way valve and a vacuum source (such as the intake manifold).

- The unwanted gases, called "blow-by", are gases from the combustion chamber which have leaked past the piston rings.
- Early engines released these gases to the atmosphere simply by them leaking through the crankcase seals. The first specific crankcase ventilation system was the *road draft tube*, which used a partial vacuum to draw the gases through a tube and release them to the atmosphere.

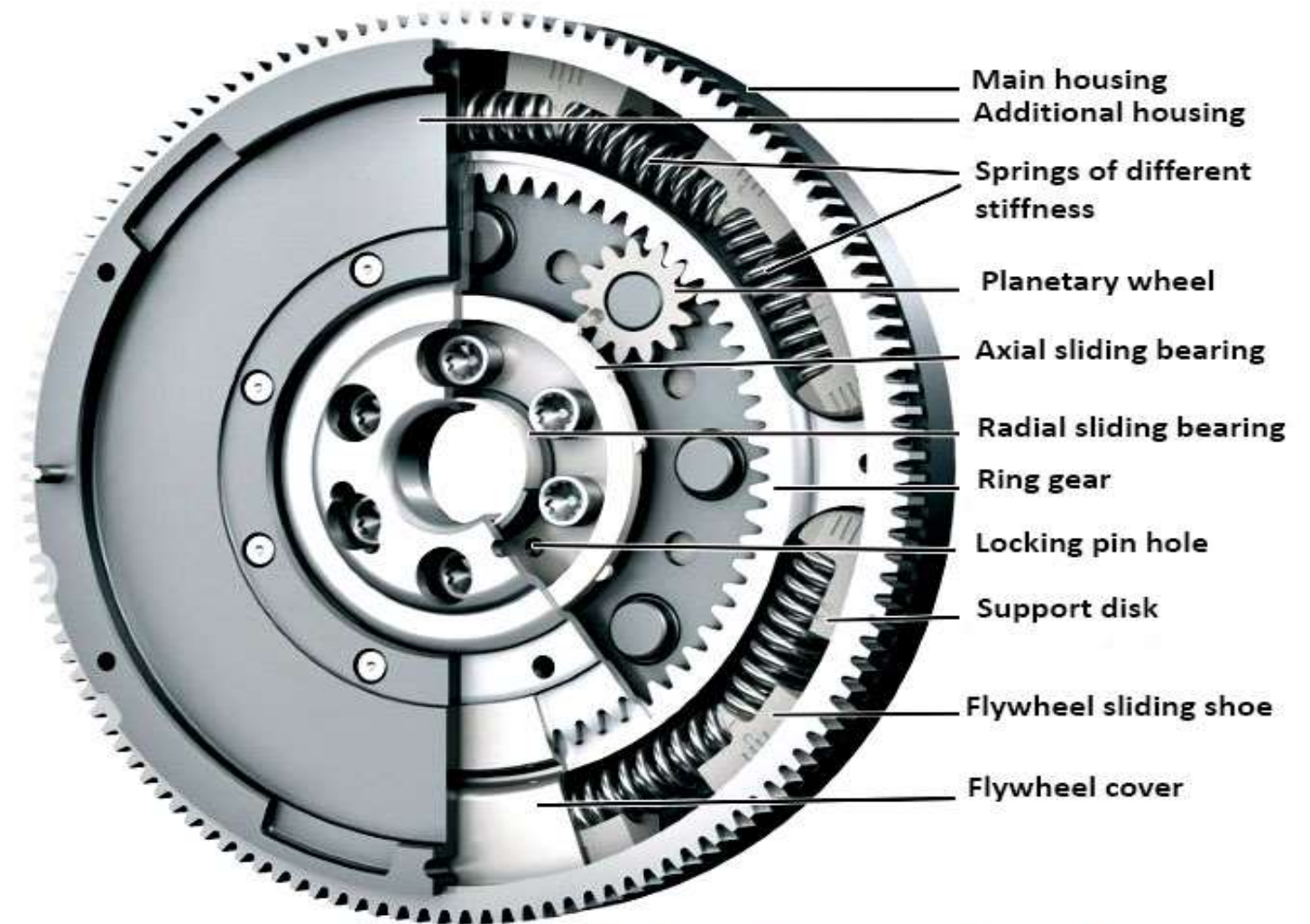




**FLYWHEEL** = Fly + Wheel or basically “A wheel that goes fast”. A flywheel is the main wheel of the motor. A flywheel is essentially a mechanical battery consisting of a mass rotating around an axis.

It stores energy in the form of kinetic energy and works by accelerating a rotor to very high speeds and maintaining the energy in the system as rotational energy. Flywheels are often used to provide continuous power output in systems where the energy source is not continuous.

For example, a flywheel is used to smooth fast angular velocity fluctuations of the crankshaft in a reciprocating engine. Flywheels used in car engines are made of cast or nodular iron, steel or aluminium.



## FLYWHEEL CONSTRUCTION



- Basically, a vibration dampener is usually a visco-elastic substance like Sorbothane, which has the properties of both a solid and a liquid.
- This kind of substance will actually absorb some of the energy from vibration, turning some of it into heat energy and storing some of it until the pressure is off.
- Vibration dampers are widely used to control Aeolian vibration of the conductors and earth wires including Optical Ground Wires (OPGW).



- The **pilot bearing**/bushing supports and centres the transmission input shaft and clutch disc.
- When the clutch is disengaged, the pilot bearing/bushing allows the flywheel to maintain engine RPM while the input shaft is slowing down and stopping
- The pilot bearing has an important job, supporting the input shaft of a manual transmission. If it is worn it can damage the input shaft seal on the transmission, pumping out oil from the transmission and causing clutch failure.
- The noise persists, the release bearing is bad. If the noise is gone, the pilot bearing is bad.
- A bearing noise that occurs when releasing the clutch pedal to engage the clutch while in neutral, but goes away when the pedal is depressed is caused by a bad transmission input shaft bearing.

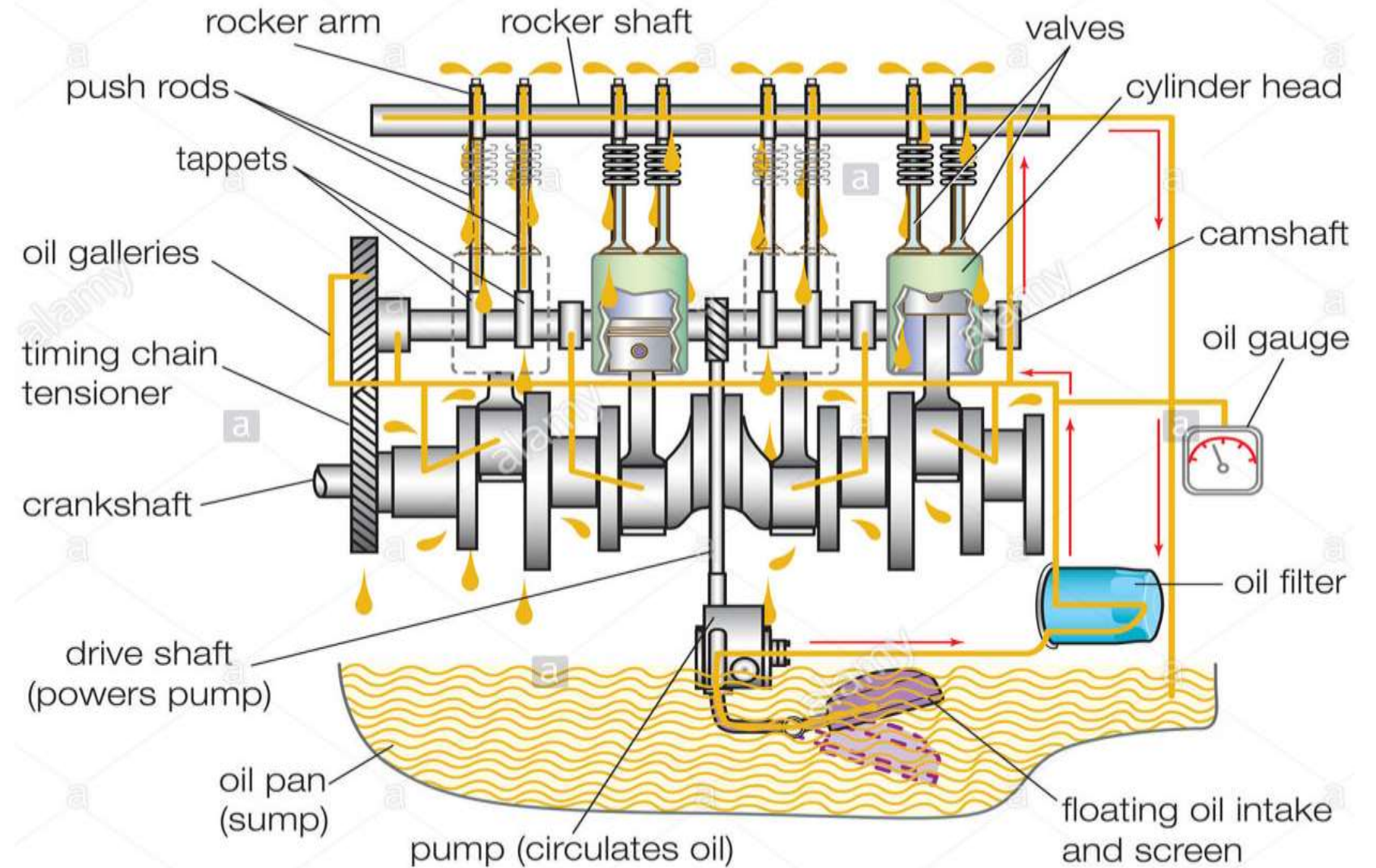


**PILOT BEARING**



## Lubrication Systems

- In order to ensure adequate supplies of oil to the engine parts, a reservoir of oil is provided by the sump which is the lower part of the lubrication system and in automobile engines the sump is the oil pan.
- From the reservoir, oil is distributed throughout the engine either by the splash system or the full pressure system.
- The oil is supplied to the main bearings under pressure due to an oil pump through drilled passages, in the crankcase, called galleries.
- The oil pump also replenishes the troughs. The system is now practically obsolete.





A **lubricant** is a substance, usually organic, introduced to reduce friction between surfaces in mutual contact, which ultimately reduces the heat generated when the surfaces move

- **Properties -**
- A good lubricant generally possesses the following characteristics:
- A high boiling point and low freezing point (in order to stay liquid within a wide range of temperature)
- A high viscosity index
- Thermal stability
- Hydraulic stability
- Demulsibility
- Corrosion prevention
- A high resistance to oxidation





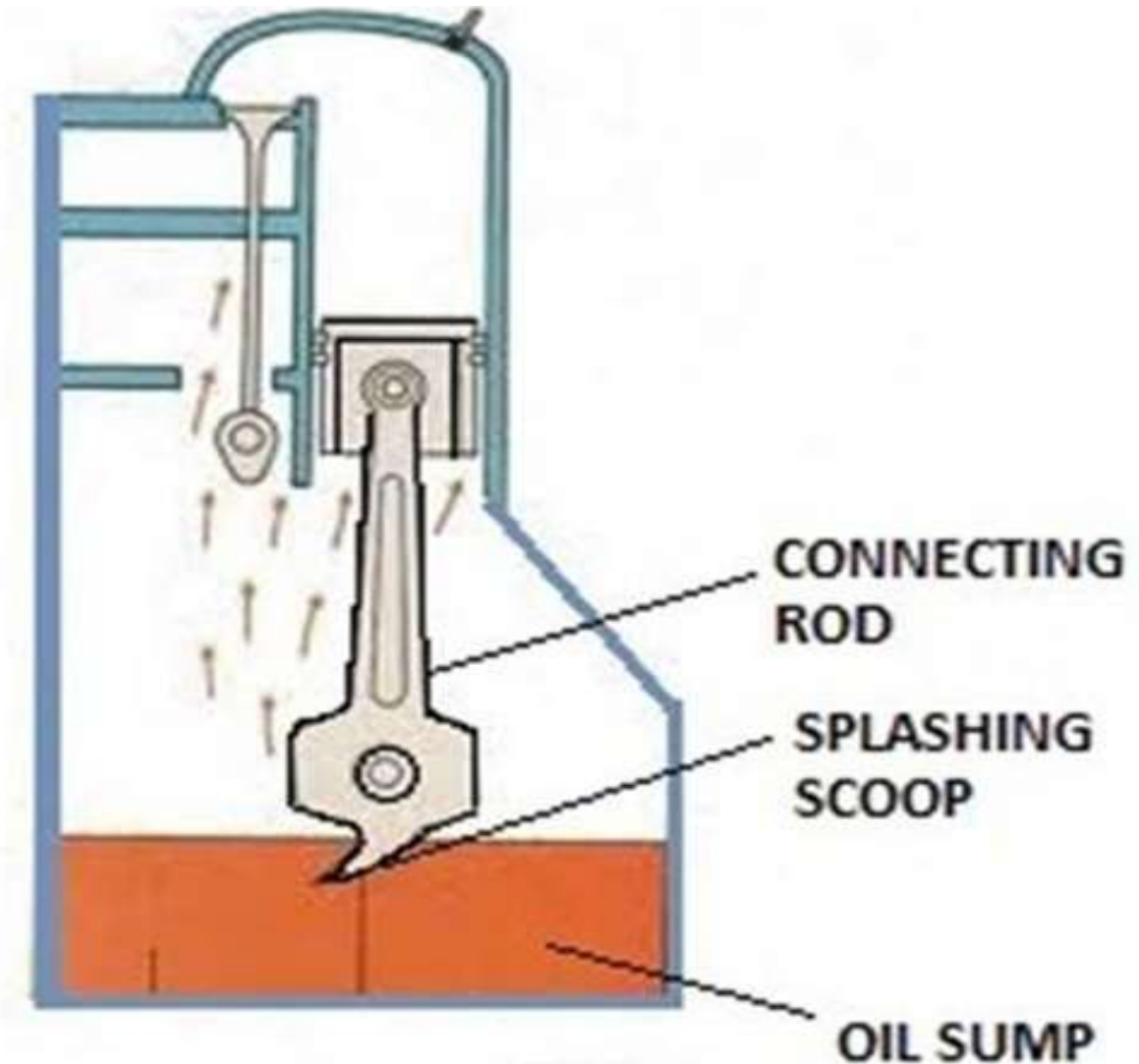
GREASE

GRYNITE



**Splash lubrication** is an antique system whereby scoops on the big-ends of the connecting rods dip into the oil sump and splash the lubricant upwards towards the cylinders, creating an oil mist which settles into droplets.

- (In splash lubrication systems, oil is applied to the cylinders and pistons by rotating dippers on the connecting-rod bearing caps. Each time they rotate, the dippers pass through an oil-filled trough. After running through the oil trough, the dippers splash oil onto the cylinders and pistons to lubricate them.
- Oil splash lubrication is often used for helical, spur, and bevel gearboxes. This method is also referred to as an oil bath, because it uses a reservoir filled with oil. As the gears rotate, they dip into this oil bath and splash the oil onto the other gears and bearings.



## SPLASH SYSTEM LUBRICATION



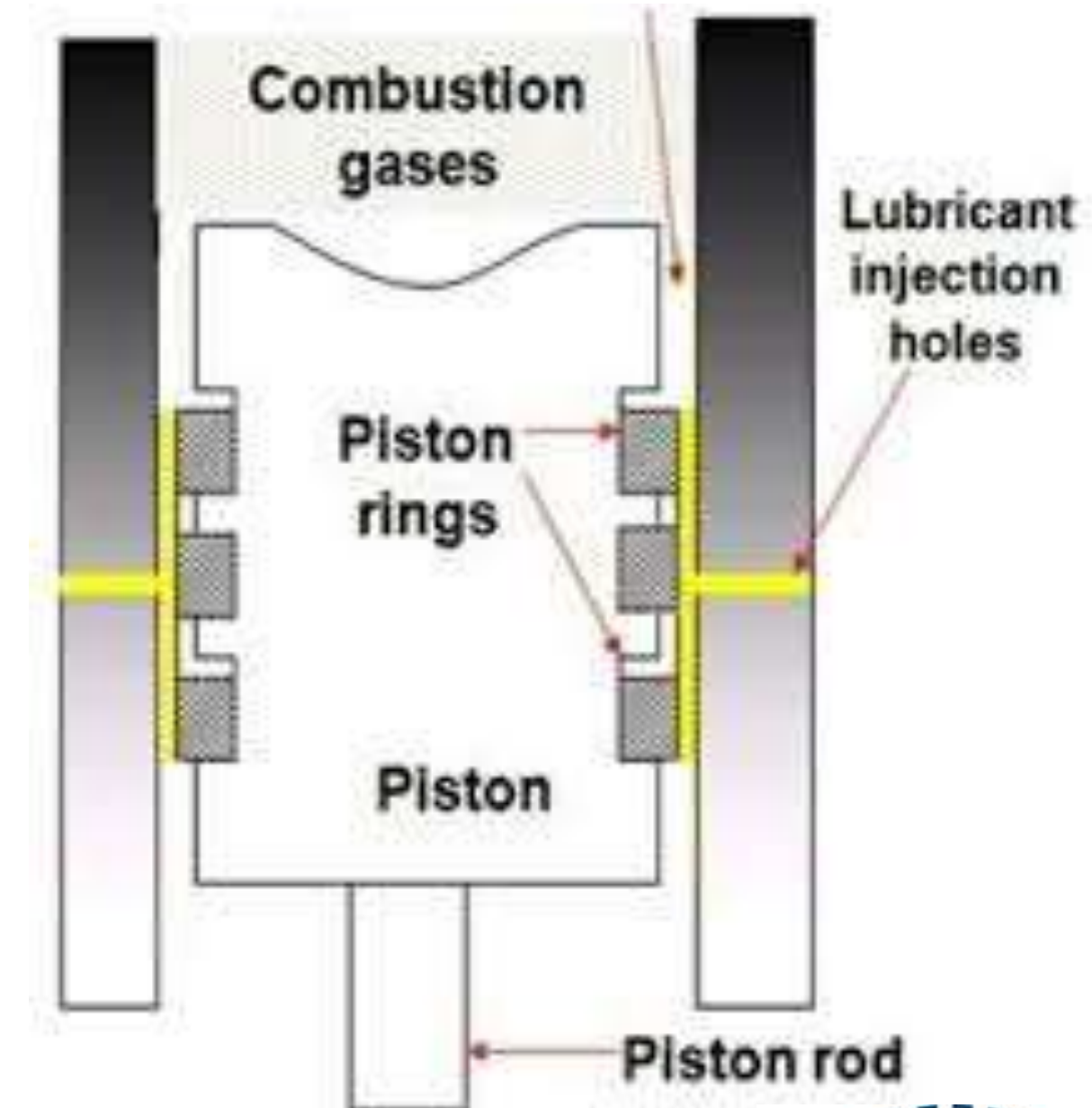


## Cylinder and Piston Lubrication.

Four separate techniques are used for cylinder and piston lubrication.

- (i) Connecting-rod big-end side-clearance oil spray.
- (ii) Connecting-rod big-end radial-hole oil spray.
- (iii) Connecting-rod small-end radial-hole oil spray.
- (iv) Crankcase fixed-jet oil spray.

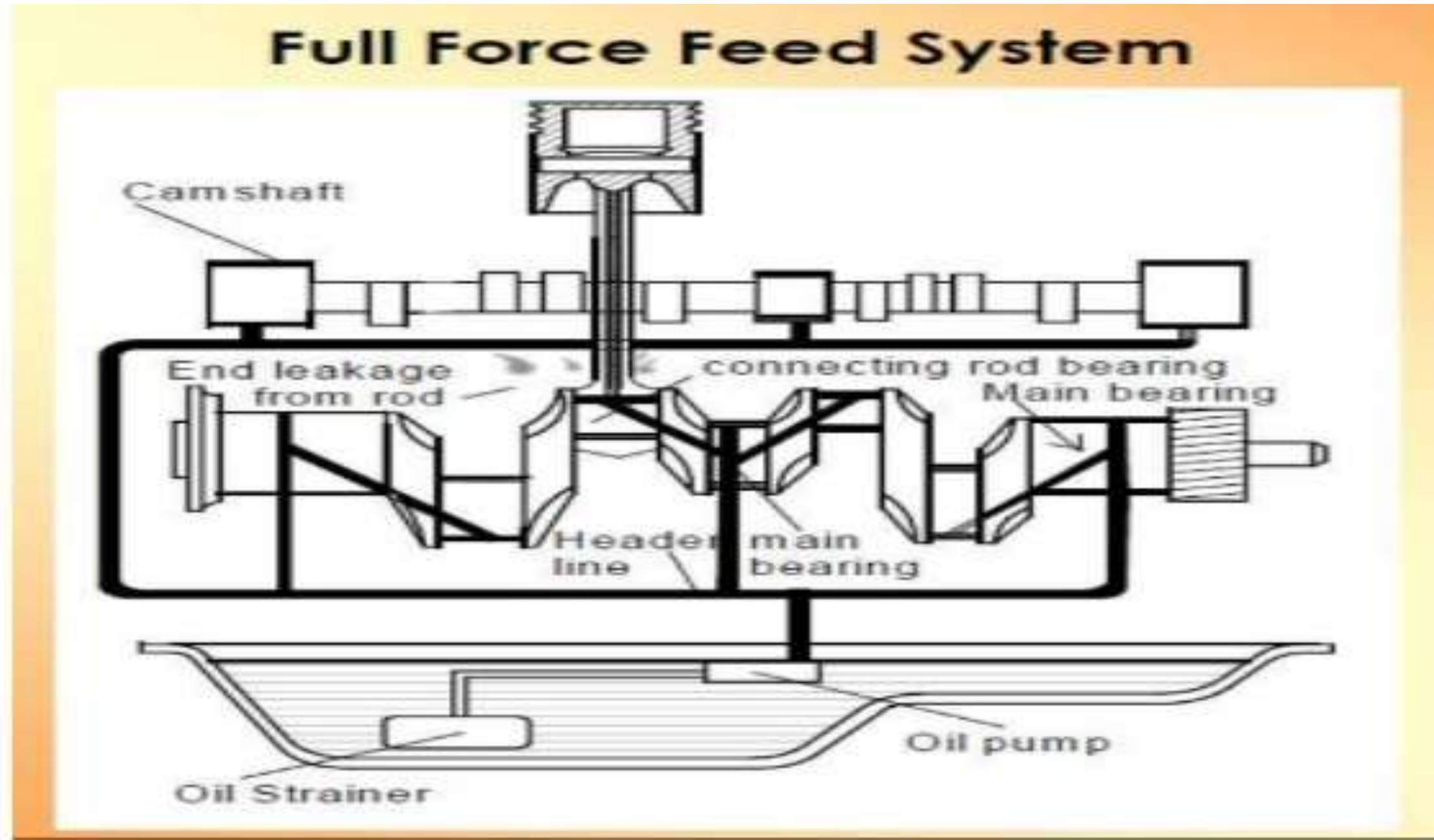
Connecting-rod Big-end Side-clearance Oil Spray. Cylinder and piston lubrication by big-end side-clearance splash



## Force Feed

- A somewhat more complete pressurization of lubrication is achieved in the force-feed lubrication system Oil is forced by the oil pump from the crankcase to the main bearings and the camshaft bearings.
- Oil passages are drilled in the crankshaft to lead oil to the connecting-rod bearings. The passages deliver oil from the main bearing journals to the rod bearing journals.
- In other engines, there are annular grooves in the main bearings through which oil can feed constantly into the hole in the crankshaft.
- The pressurized oil that lubricates the connecting- rod bearings goes on to lubricate the pistons and walls by squirting out through strategically drilled holes.
- This lubrication system is used in virtually all engines that are equipped with semi floating piston pins.





- **Connecting rod Big-end Radial-hole Oil Spray.**

In this case a small radial drilling hole in each connecting-rod big-end directs a squirt of oil to the thrust side of the cylinder bore once in every revolution of the crankshaft. The diameter of the hole and its angular location is critical in this method of lubricating the cylinder.

### Camshaft-lobe Profile Lubrication.

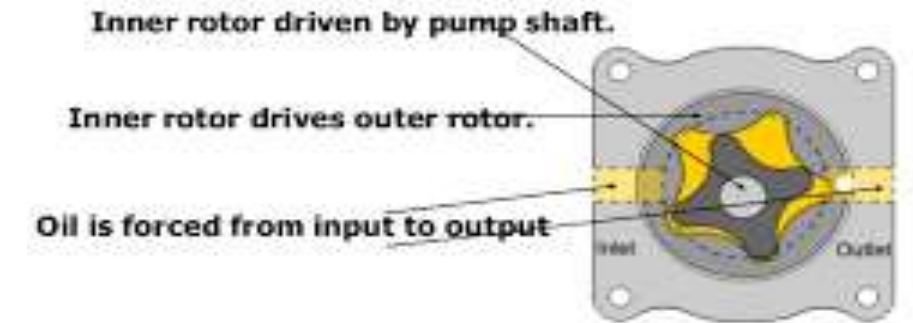
- (a) The big-end side clearance allows oil to be flung out, which splashes the cam lobes each time the crankthrow aligns with the cam shaft, i.e., once every revolution of the crankshaft .
- (b) Draining of oil from the rockers splashes on to the cam profiles .
- (c) Oil mist is created by the rotating crankshaft and the rocker and crankcase ventilation system.

Four basic types of rotary-operating oil-pumps are used in pressure-feed lubrication systems.

- (i) External-spur-gear pump,
- (ii) Internal-gear crescent pump,
- (iii) Eccentric bi-rotor pump
- (iv) Sliding-vane eccentric pump.

- The **oil pump** in an internal combustion engine circulates engine oil under pressure to the rotating bearings, the sliding pistons and the camshaft of the engine.
- This lubricates the bearings, allows the use of higher-capacity fluid bearings and also assists in cooling the engine. Increasingly common recent uses may include the tensioner for a timing belt or variators for variable valve timing systems.
- Increasingly common recent uses may include the tensioner for a timing belt or variators for variable valve timing systems.

## Rotary Oil Pump



May be shaft, gear or chain driven.



## Internal-gear pump

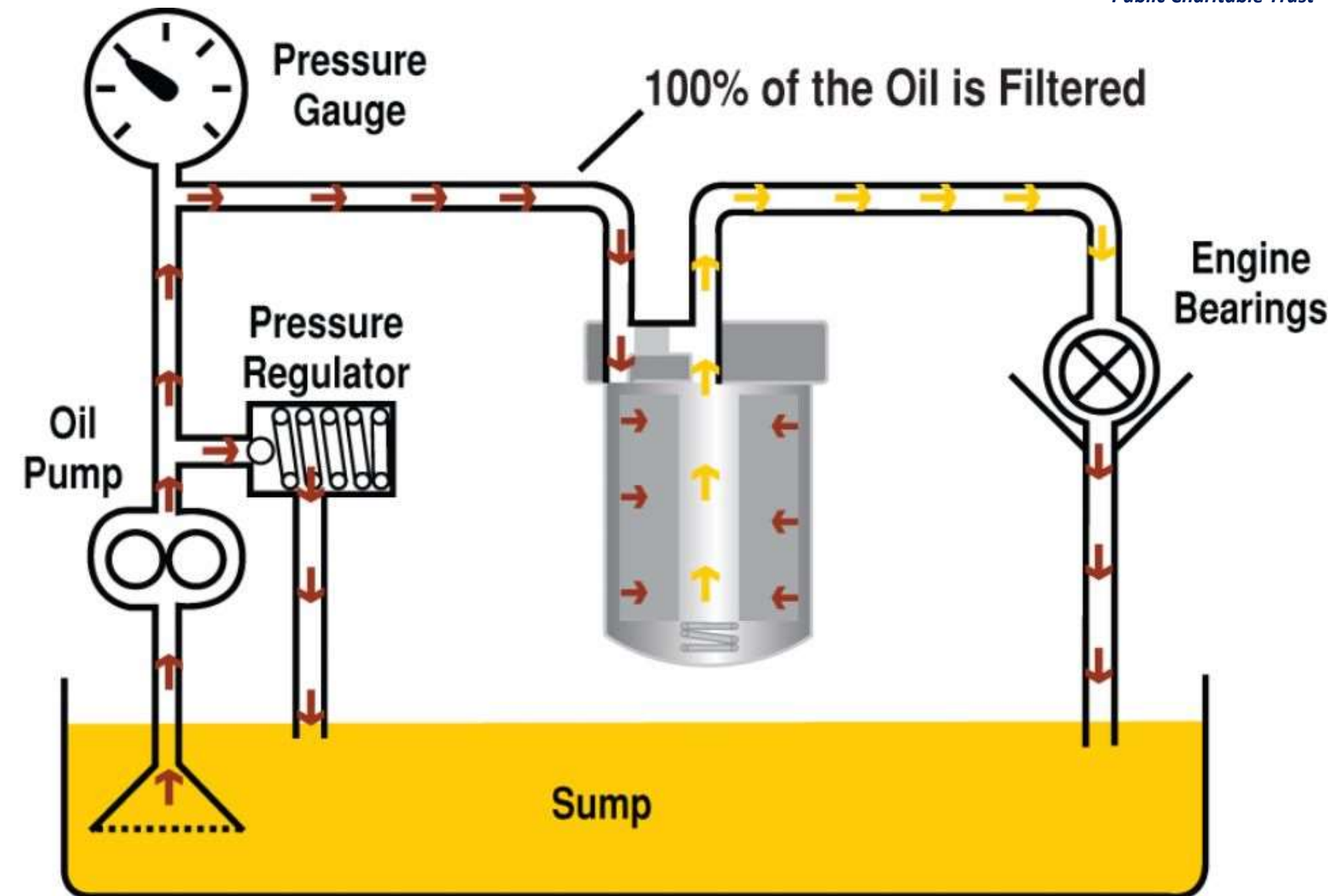
Case

Internal-gear



An **oil filter** is a filter designed to remove contaminants from engine oil, transmission oil, lubricating oil, or hydraulic oil.

- Oil filters are used in many different types of hydraulic machinery.
- A chief use of the oil filter is in internal-combustion engines in on- and off-road motor vehicles, light aircraft, and various naval vessels.
- Other vehicle hydraulic systems, such as those in automatic transmissions and power steering, are often equipped with an oil filter.



Full-Flow



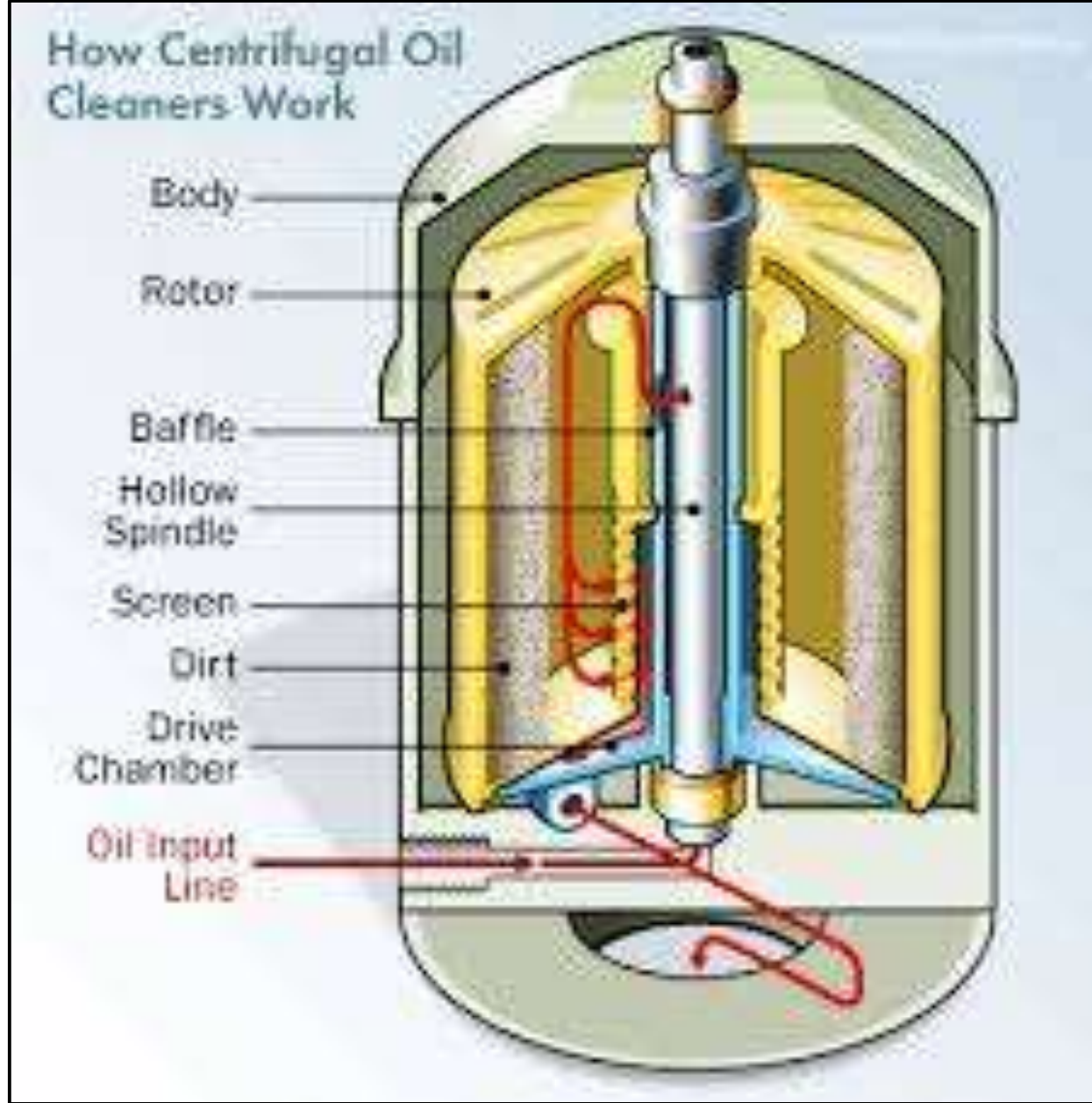
Cartridge and spin-on



Magnetic



# OIL FILTER



Centrifugal

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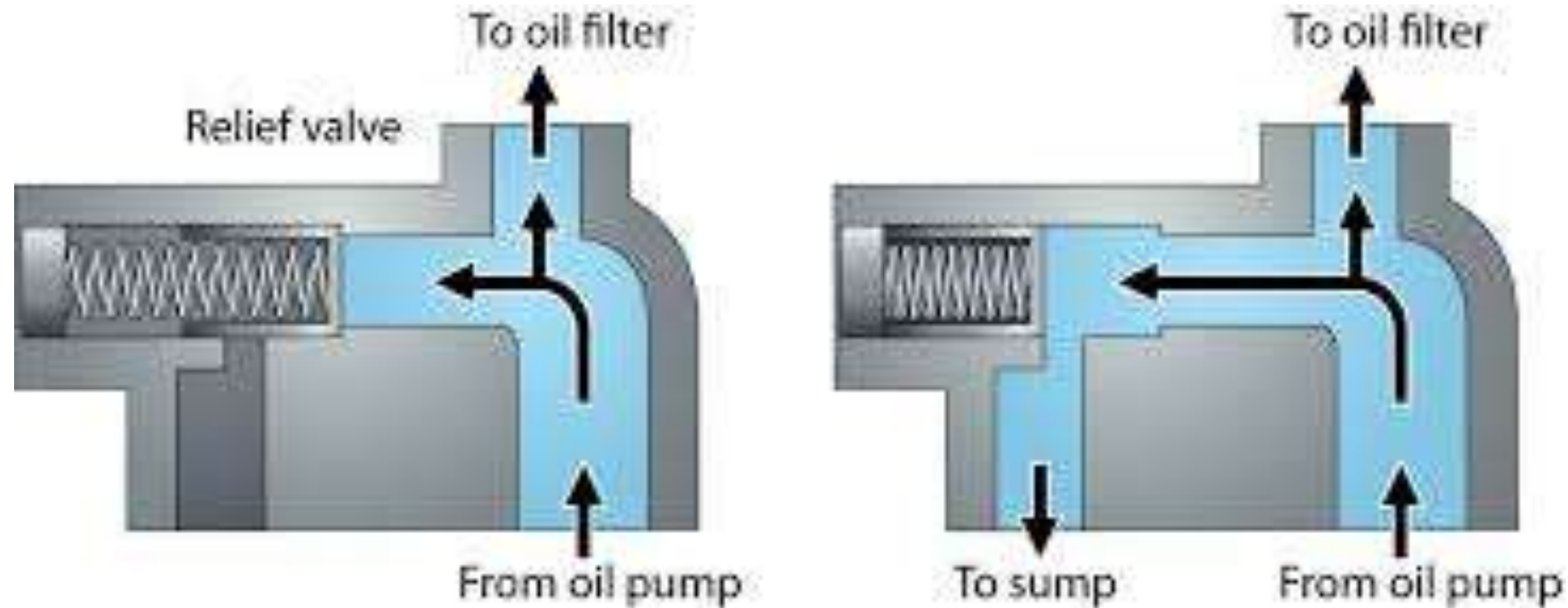
High efficiency (HE)



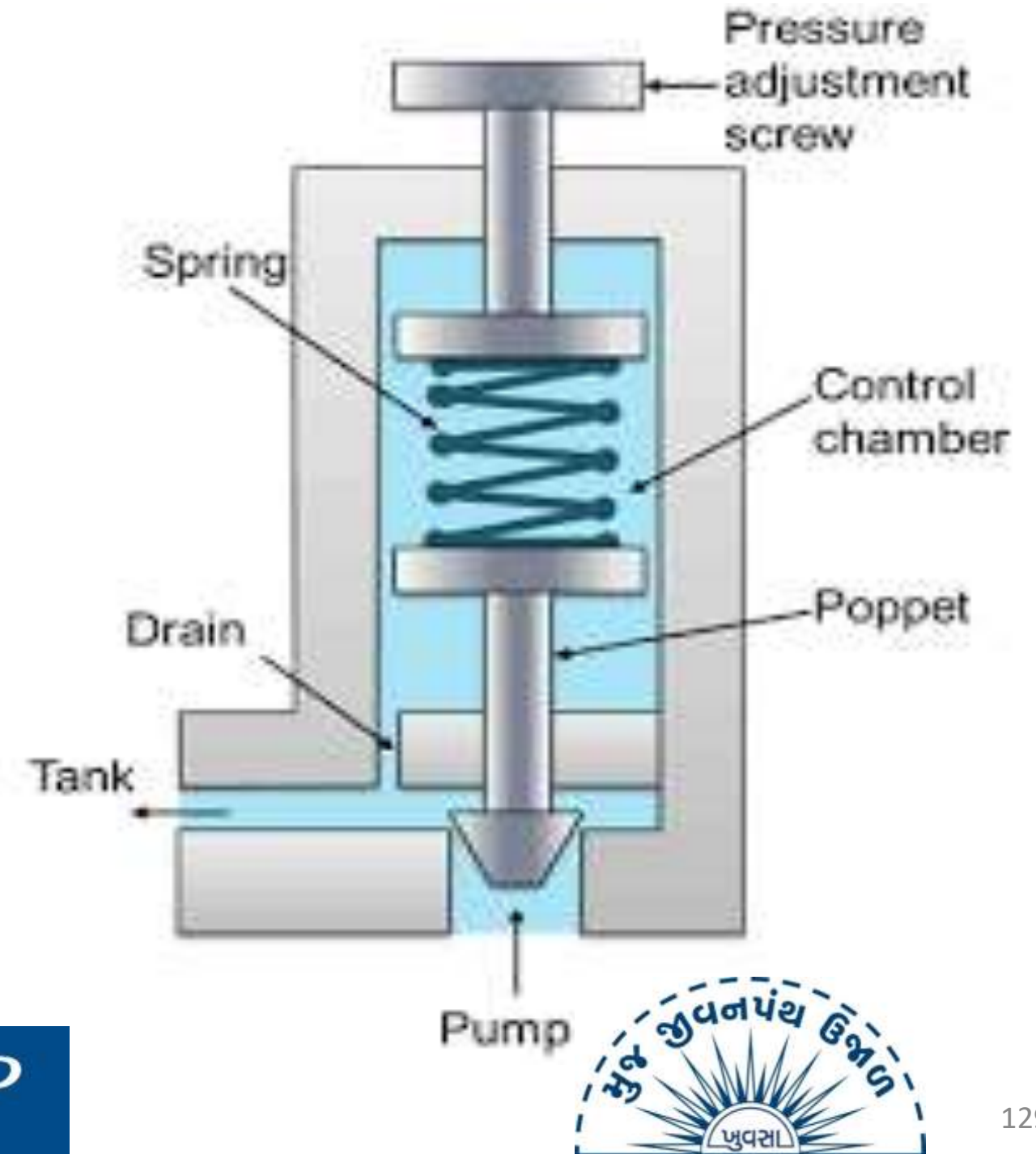


To address this, there's a pressure relief valve located at the oil pump outlet.

- Its purpose is to open when engine oil pressure reaches a certain value. A problem with the pressure relief valve can cause damage to the engine oil filter and to the engine itself.
- Modern vehicles include the pressure relief valve in the oil pump housing which can be found inside the engine behind the timing cover or the oil pan.



Common pressure relief Valve component materials include brass, plastic, and aluminium. Various grades of stainless steel If no date is specified, a pressure relief valve shall be replaced no later than five years following the date of its manufacture.”



## failure pressure relief valve

- A blocked oil filter can cause an oil pressure gauge to read high: The mechanic will replace the filter and change the oil in this case.
- A blocked oil gallery can also cause a high reading: If this happens, a mechanic flushes the oil system while changing the oil.
- A broken oil pump may cause a low oil pressure reading the pressure reducing valve ages, it loses it's ability to regulate the water pressure, causing harm to your appliances and plumbing fixtures.
- Moreover, high water pressure can add to the cost of water, energy and waste water bills.



Failure Pressure relief valve



## Advantages of Air Cooled Engines

Air cooled engines have the following advantages:

1. Its design of air-cooled engine is simple.
2. It is lighter in weight than water-cooled engines due to the absence of water jackets, radiator, circulating pump and the weight of the cooling water.
3. It is cheaper to manufacture.
4. It needs less care and maintenance.
5. This system of cooling is particularly advantageous where there are extreme climatic conditions in the arctic or where there is scarcity of water as in deserts.
6. No risk of damage from frost, such as cracking of cylinder jackets or radiator water tubes.

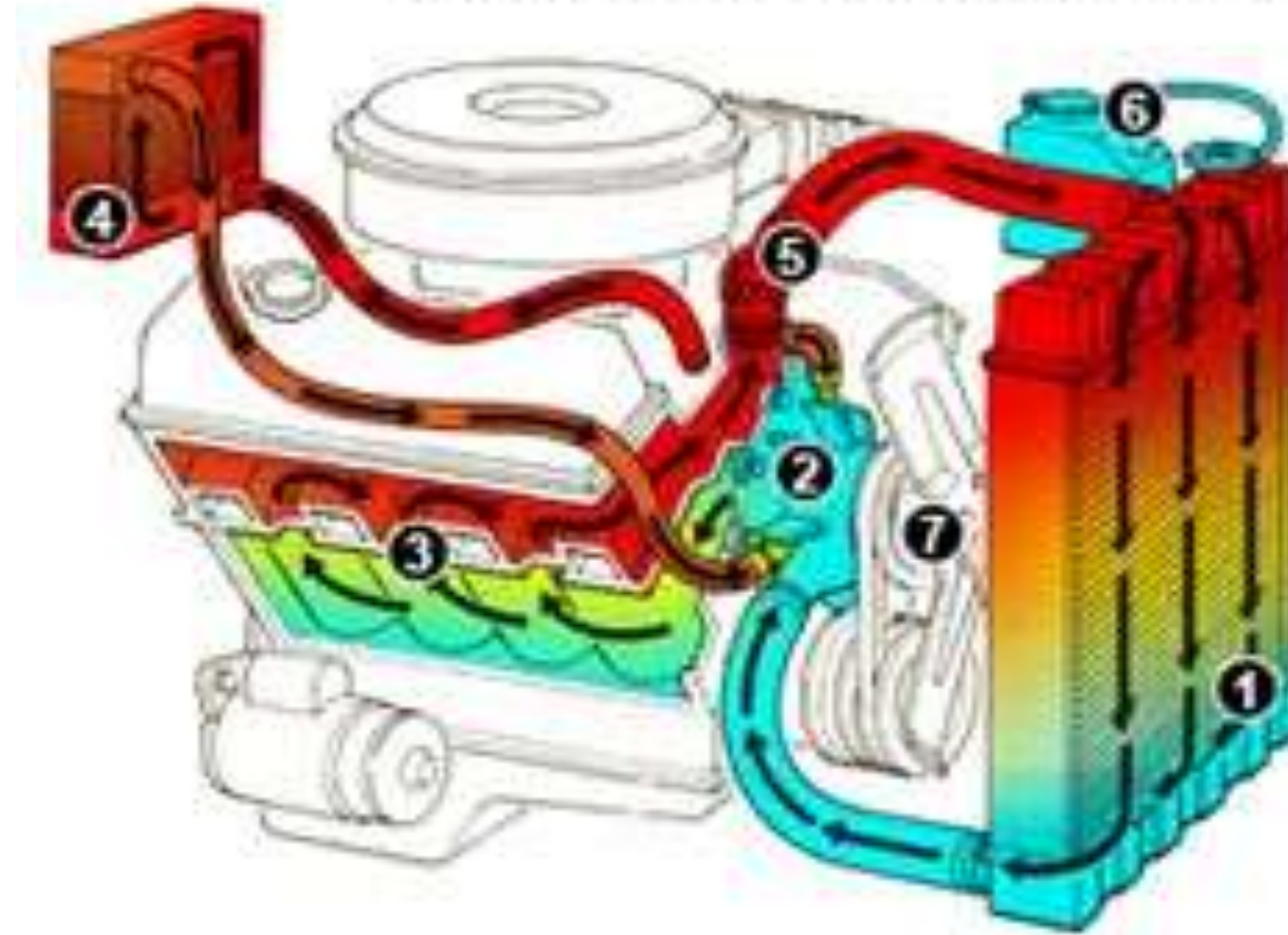


## WATER COOLING SYSTEM

It serves two purposes in the working of an engine:

- a) It takes away the excessive heat generated in the engine and saves it from over heating.
- b) It keeps the engine at working temperature for efficient and economical working.
- c) **This cooling system has four types of systems:**
  - (i) Thermo-Syphone system,
  - (ii) Pump/forced circulation system.

## BASIC COOLING SYSTEM DIAGRAM

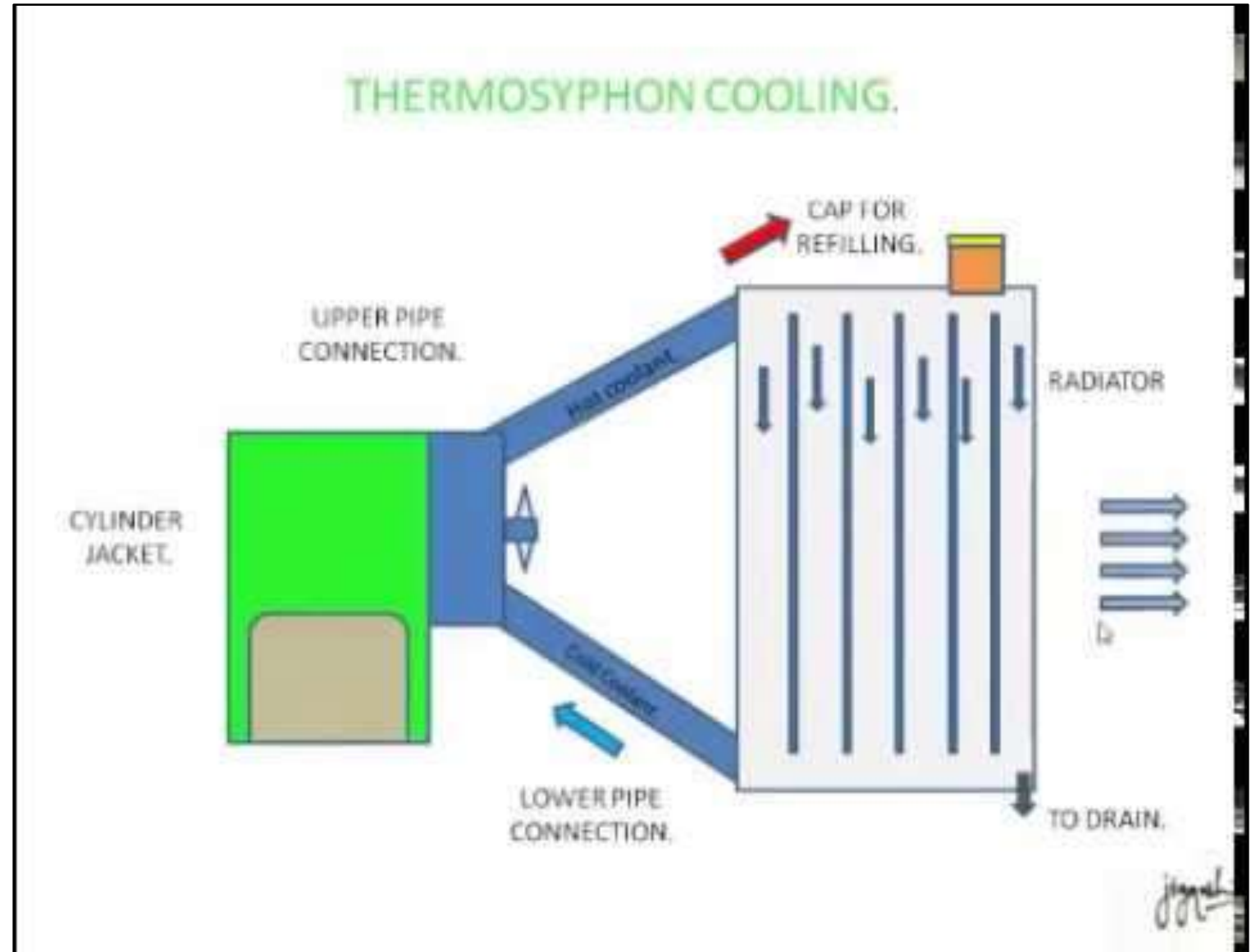


1. Radiator
2. Water Pump
3. Engine Block
4. Heater
5. Thermostat
6. Reservoir
7. Fan



**Thermo-Syphone Water Cooling System** -This system works on the principle that hot water being lighter rises up and the cold water being heavier goes down. In this system the radiator is placed at a higher level than the engine for the easy flow of water towards the engine.

- 1 Rate of circulation is too slow.
2. Circulation commences only when there is a marked difference in temperature.
3. Circulation stops as the level of water falls below the top of the delivery pipe of the radiator. For these reasons this system has become obsolete and is no more in use.





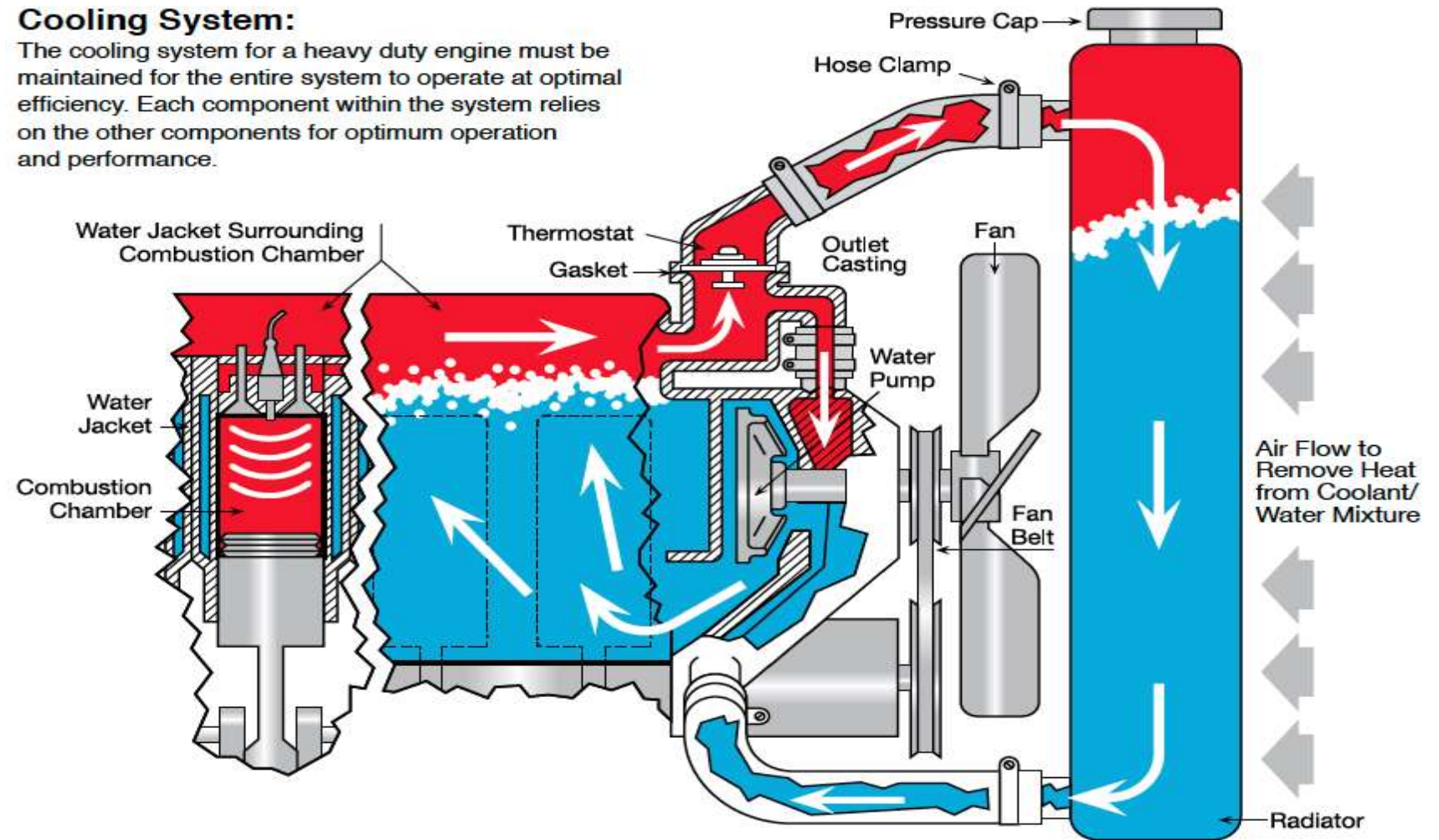
Force Circulation Water Cooling System This system is similar in construction to the thermo-syphone system except that it makes use of a centrifugal pump to circulate the water throughout the water jackets and radiator

## Parts of water Cooling System

- (i) water pump,
- (ii) fan,
- (iii) radiator and pressure cap,
- (iv) fan belt
- (v) water jacket,
- (vi) thermostat valve,
- (vii) temperature gauge and
- (viii) hose pipes.

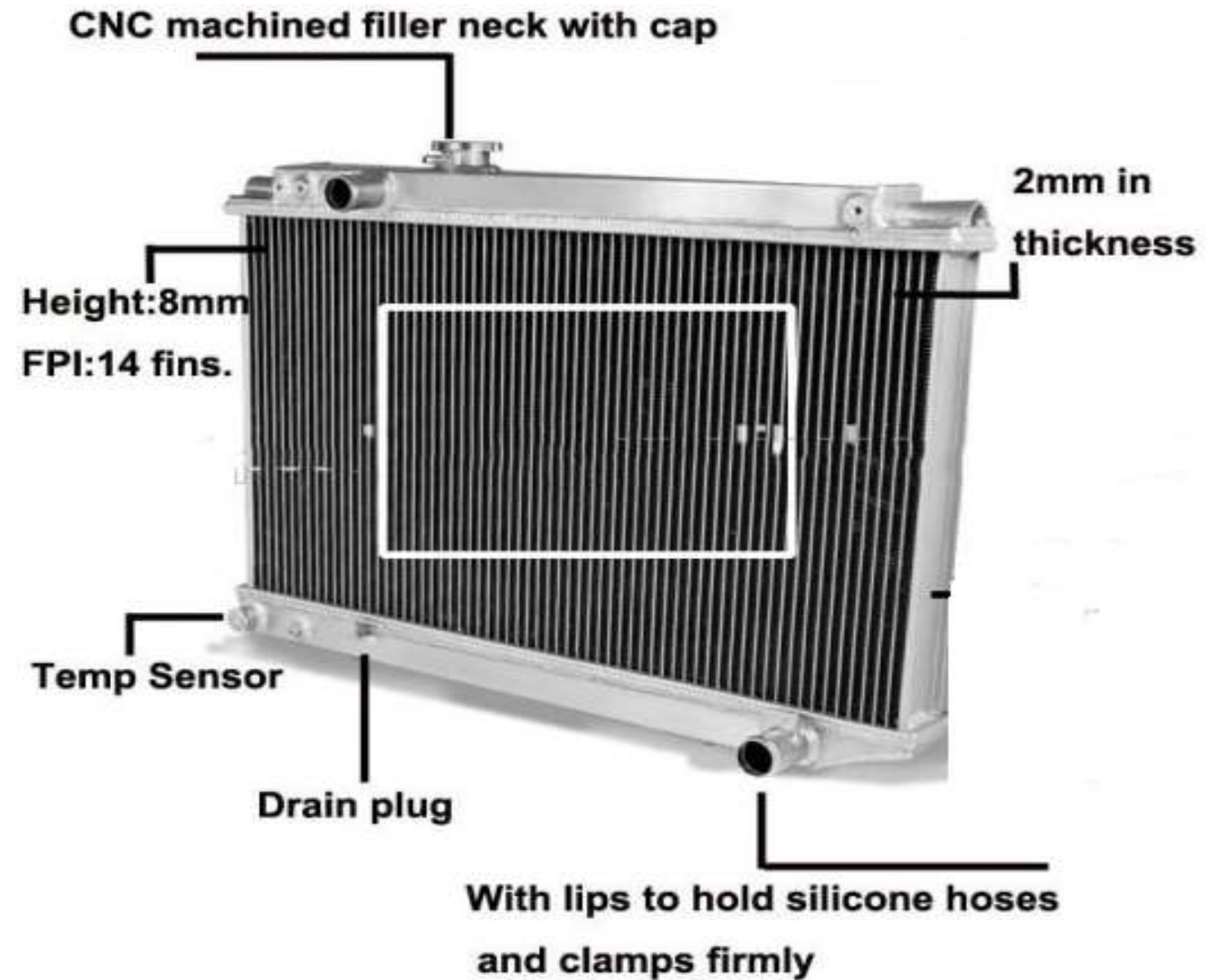
### Cooling System:

The cooling system for a heavy duty engine must be maintained for the entire system to operate at optimal efficiency. Each component within the system relies on the other components for optimum operation and performance.



## Radiator

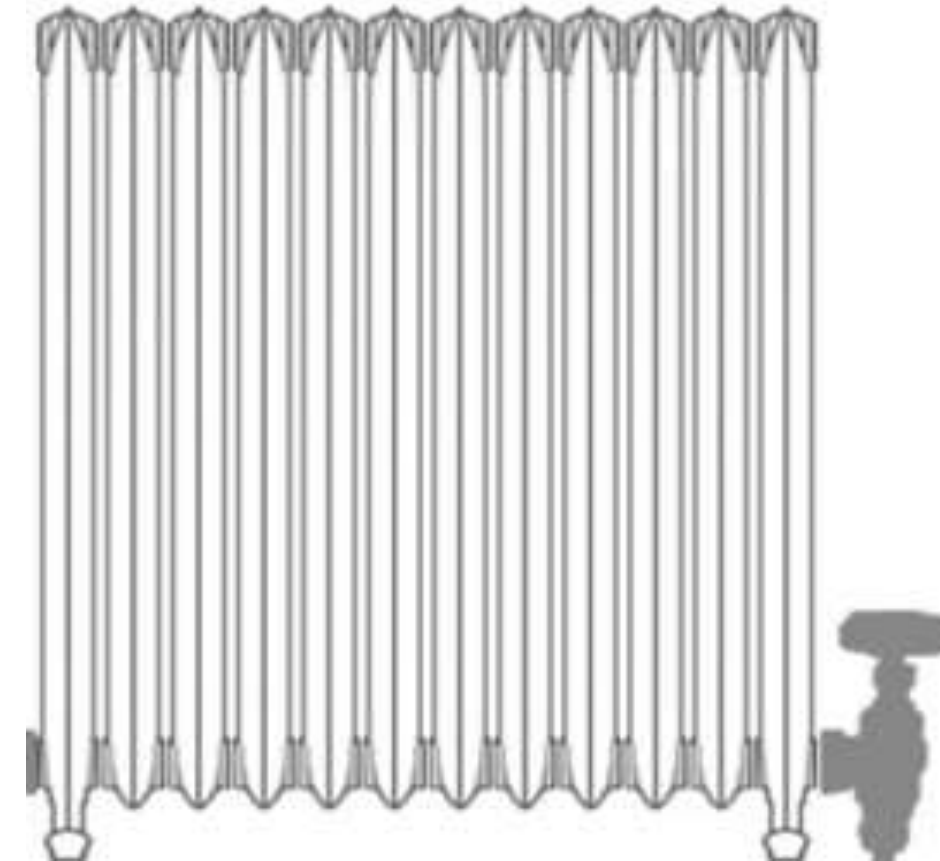
- The radiator is a heat exchanger which transfers heat from the coolant to the air.
- An adequate flow of both coolant and air is required for proper exchange of heat. After the engine has warmed up, all of the additional heat absorbed in the water jackets must be dissipated at the radiator, otherwise coolant temperature increases.
- Evaporation of coolant takes place at a faster rate if the coolant temperature reaches boiling point, so that sufficient quantity of coolant is not available for heat transfer and consequently overheating of engine takes place.





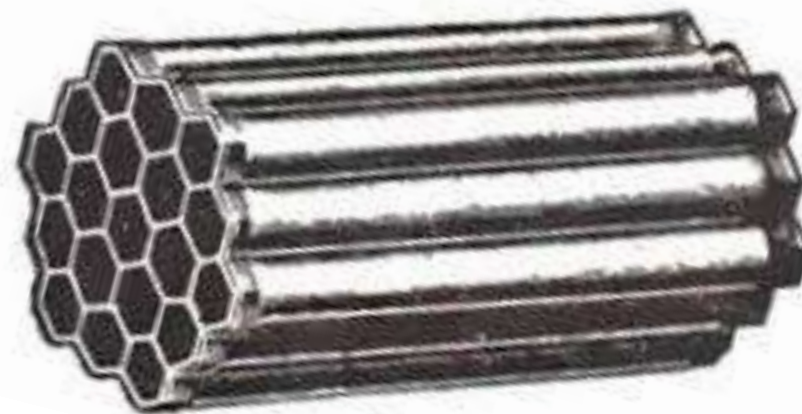
**Tubular radiator:** The only difference between a gilled tubes radiator and a tubular one is that in this case there are no separate fins for individual tubes. The radiator vertical tubes pass through thin fine copper sheets which run horizontally.

**Honey comb or cellular radiator:** The cellular radiator consists of a large number of individual air cells which are surrounded by water. In this, the clogging of any passage affects only a small parts of the cooling surface.



**Tubular Type Radiator**

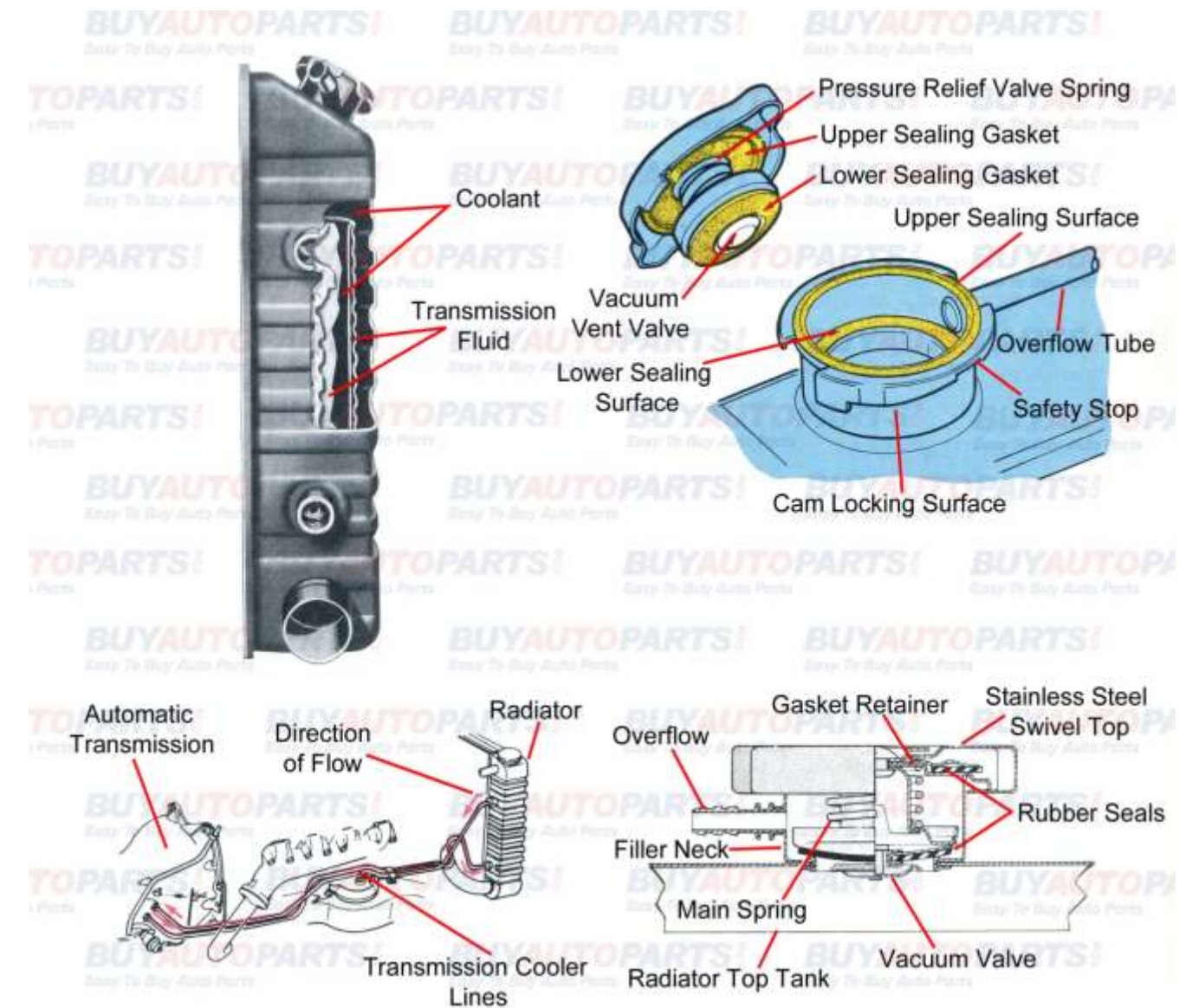
**Honey Comb  
or  
Cellular Radiator**





The hotter the radiator, the better is the heat transfer to the air. With water as the coolant, the highest temperature a radiator could operate at is 373 K, the boiling point of water.

- Addition of ethylene-glycol in a sealed radiator can substantially raise coolant pressure as well as boiling point.
- The filler neck is fitted with a pressure cap to pressurise the cooling system to raise the boiling point of the coolant.
- The pressure cap incorporates a light relief valve with an automatic vacuum break valve. The relief valve is spring loaded to open at a pressure of 20 to 28 kPa above prevailing atmospheric pressure.
- One type of pressure cap is The pressure inside the radiator is communicated through the central port to the pressure disc valve.



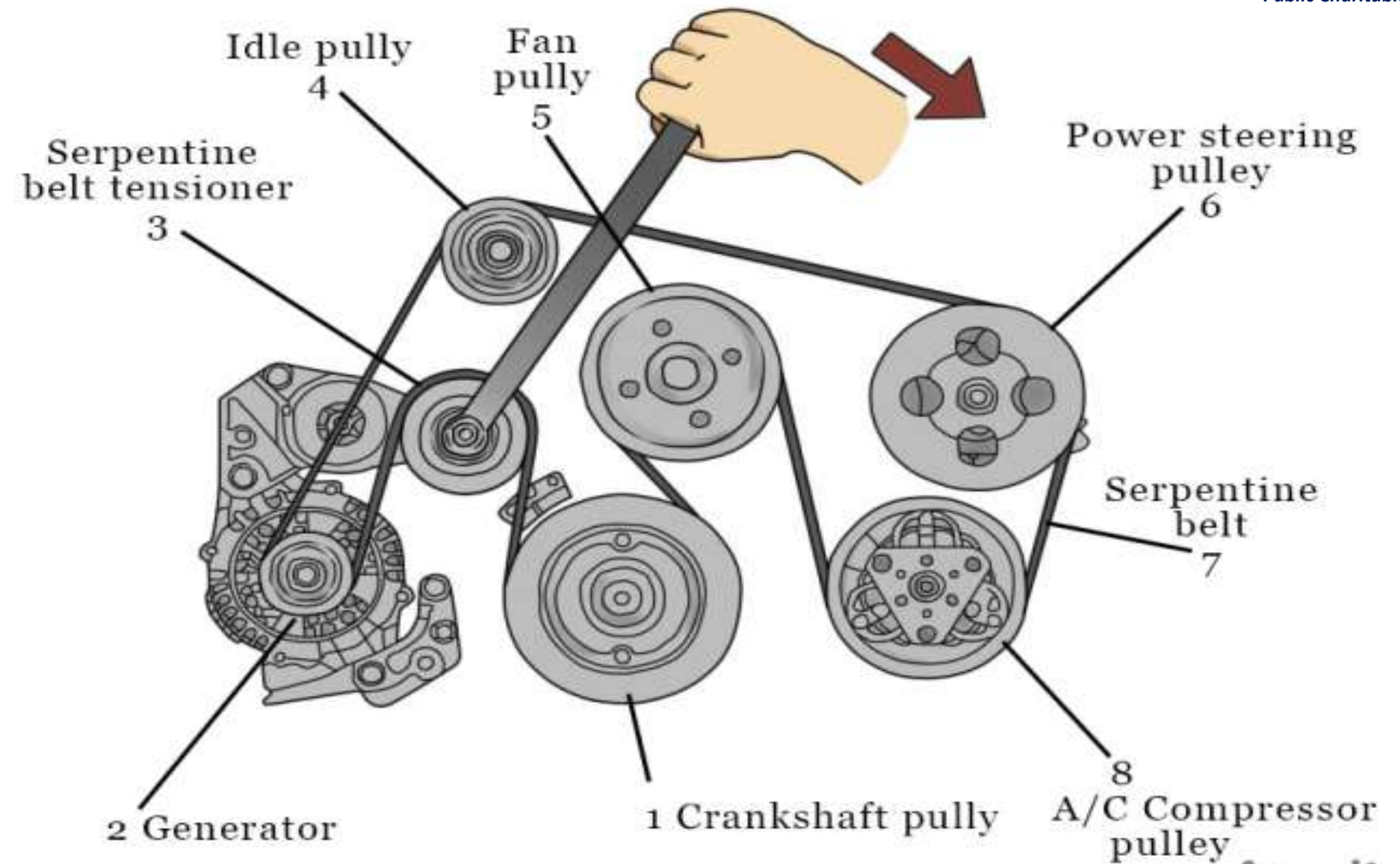
- Get a water hose and put it inside the radiator fill cap to allow water inside vehicle's cooling system.
- 
- Wait until the escaping water is clear and smoothly draining. Through this, you could ensure that your radiator clog has been cleared.
- Shut off the water and allow it to drain completely.
- Most agree that if you have a new car with less than 10,000 miles on it, there should be no need to do a radiator flush for at least a year.
- If there are no other signs that you need to flush out your radiator, you should do it at least every 30,000 miles or according to your owner's manual recommended schedule.



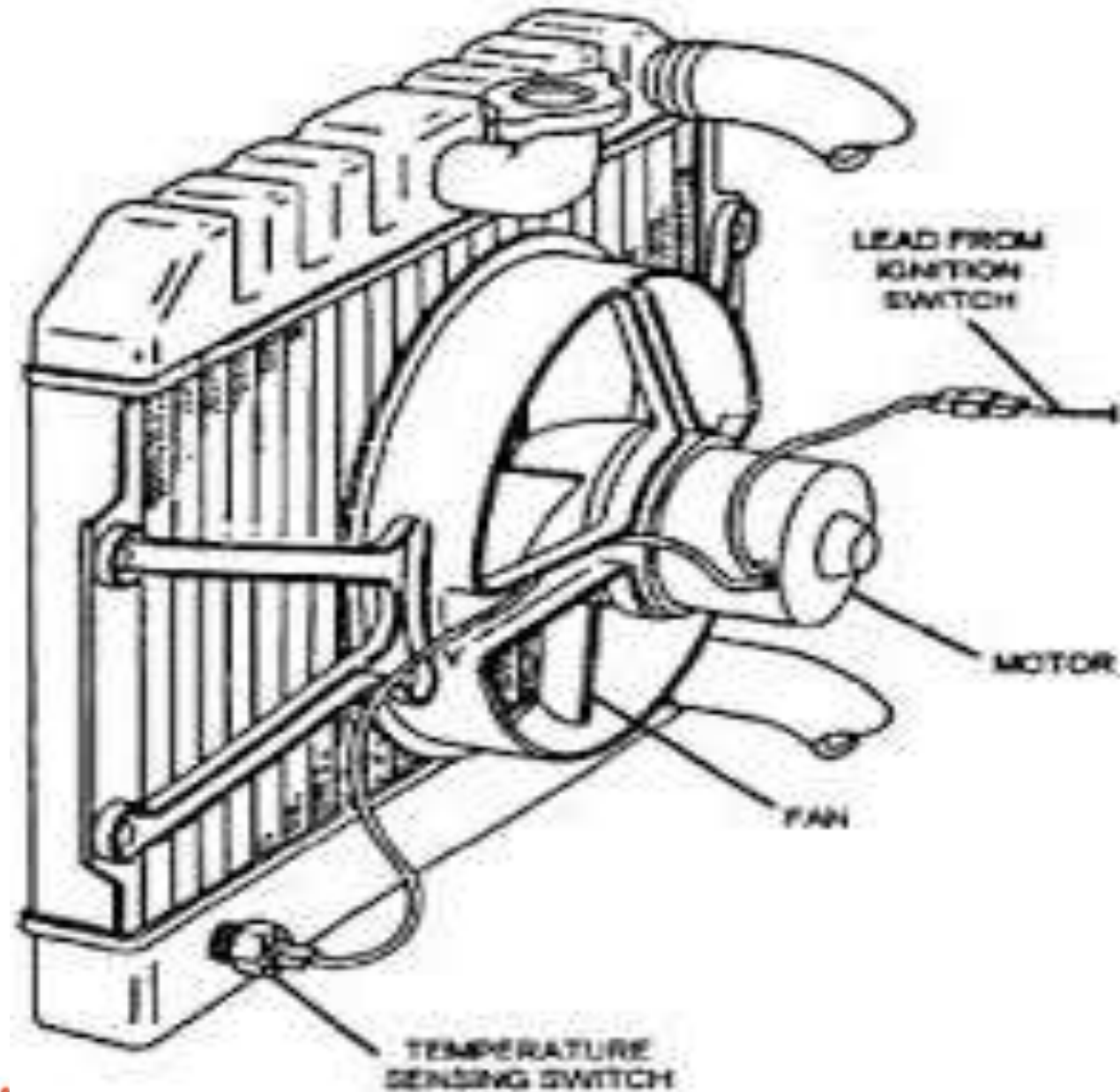


Insert the pry bar above the alternator pulley. Apply gentle pressure upwards so that it adds tension to the drive belt.

Once the drive belt is moved into its desired tension, tighten the adjustment bolt to lock the belt in place. Then, torque the adjustment bolt to the manufacturer's specifications.







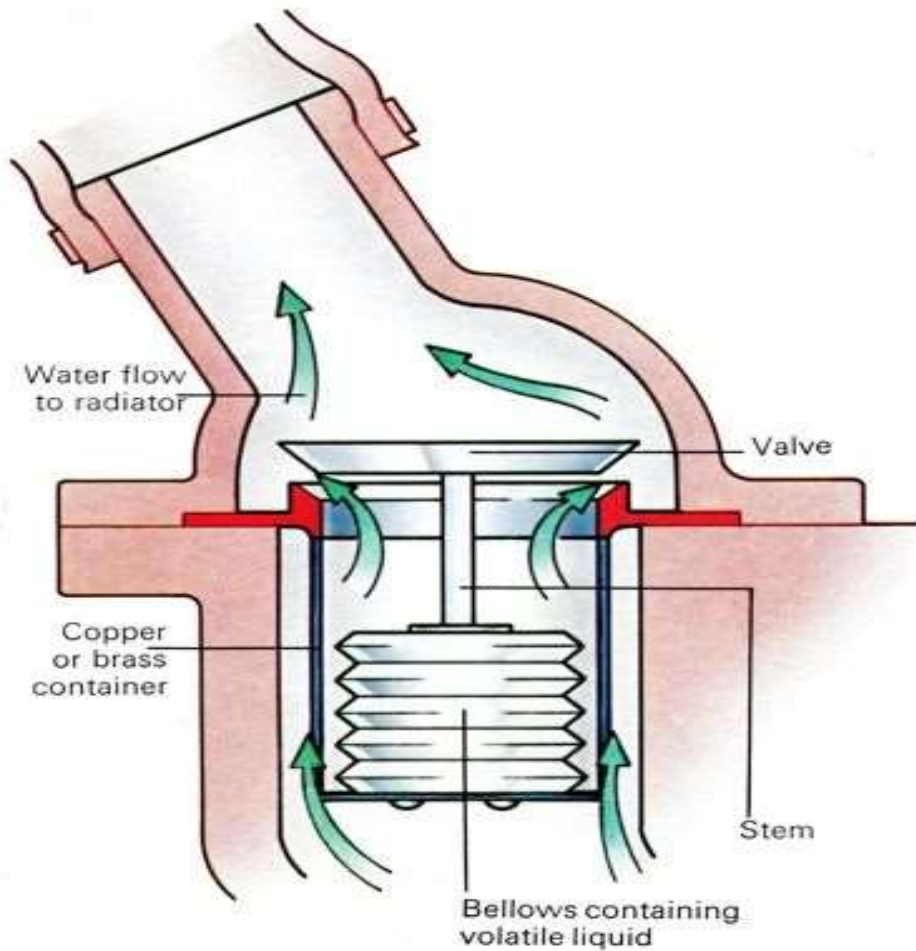
- A mechanical fan is connected to the engine directly by drive pulleys.
- This type of radiator fan is controlled by a thermal fan clutch that senses radiator heat.
- After sensing the heat temperature, the radiator fan turns on when the engine is running at a higher temperature. The radiator fan (or fans) pulls cooling air through the car's radiator.
- Positioned between the radiator and engine, cooling fans are particularly helpful when the car is stationary or moving at speeds too slow to force air through the grille.

- The thermostat is used to control the minimum operating temperature of the engine, so that overcooling is prevented.
- A overcooled engine wastes fuel and wears out at an abnormally fast rate. Also, computerised ignition cars do not run in the normal operating mode until the coolant sensor is at normal operating temperature.

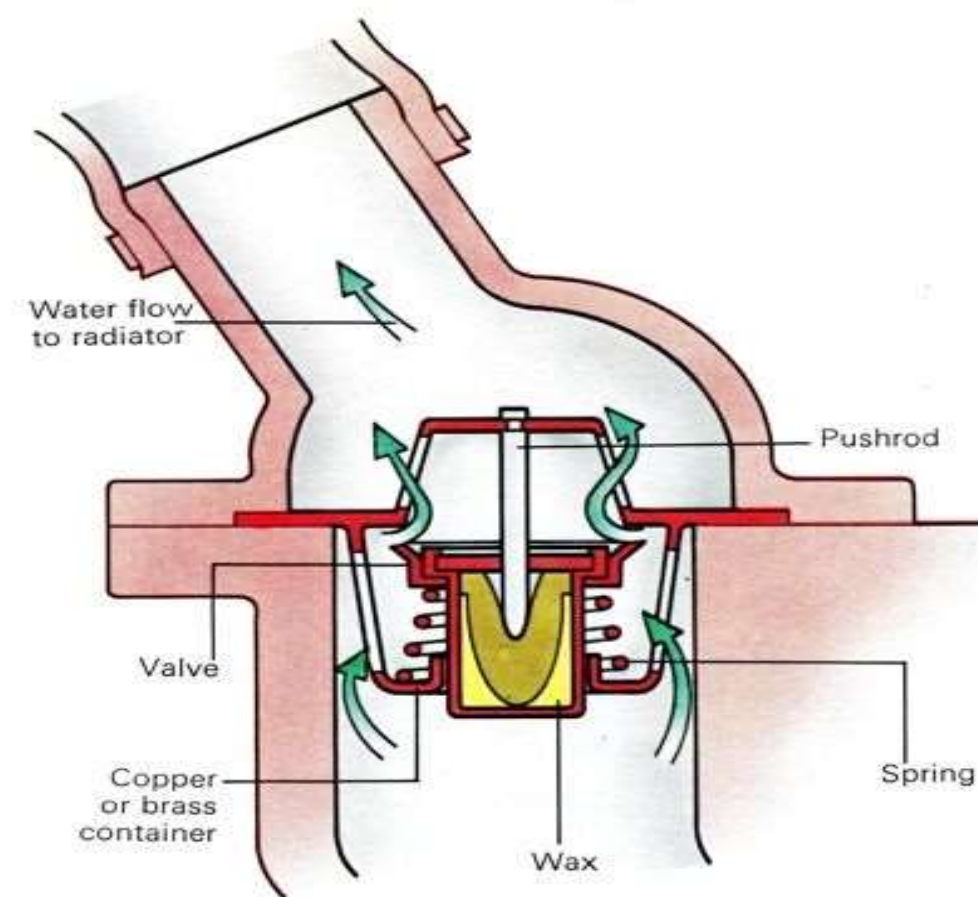
## Wax pellet type

- The most widely used thermostat of the day is the wax-pellet type As the engine warms, heat swells an encapsulated wax-based plastic pellet located on the engine side of the thermostatic valve.
- This opens the thermostat through a mechanical link, which allows a portion of the coolant to flow to the radiator according to the engine cooling requirements needed to maintain normal temperature.
- The remaining portion of the coolant continues to flow through the by-pass. The coolant pump forces the coolant to flow.

**Bellow type thermostat**



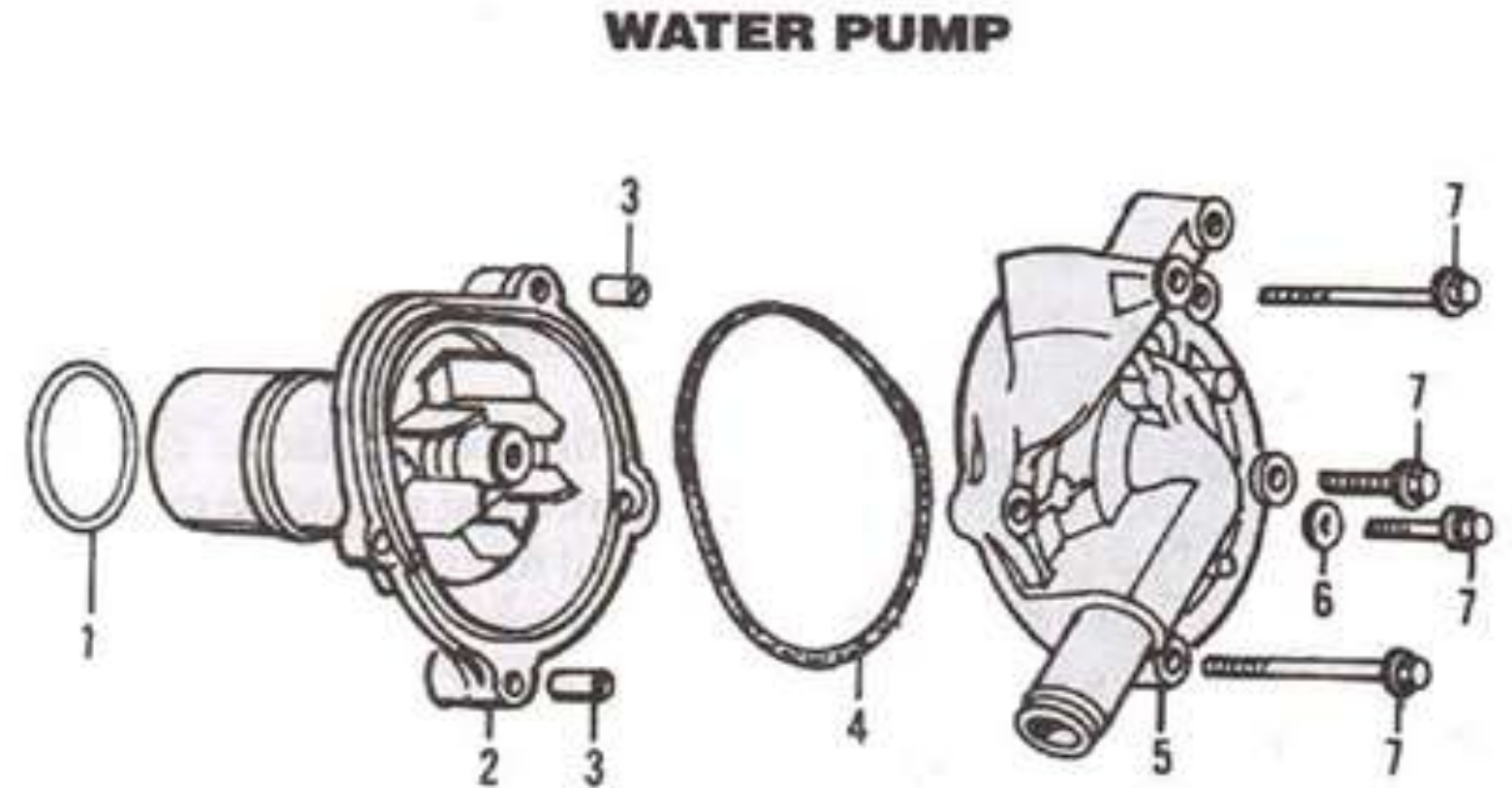
**Wax pallet type thermostat**



- The thermostat restriction causes system pressure to rise, and the pressure lowers as the thermostat gradually opens, there by increasing the coolant flow rate.
- Under extreme heating conditions of the engine like idling in traffic or moving up a long steep grade in hot weather, the thermostat opens wide allowing maximum coolant flow.



- Usually centrifugal pump is used for the circulation of water in the cooling system.
- the construction of a centrifugal pump, which is driven by a fan belt mounted on a common shaft with the fan.
- The centrifugal pump is non-positive in action and does not build up high pressure.
- It simply consists of a casing inside which an impeller containing vanc-s is rotated.
- Water enters the inlet pipe from the bottom of the radiator and is directed by a passage to the centre of the impeller where it is caught by the rotating vanes.



1. O-ring
2. Water pump assembly
3. Locating dowel
4. O-ring

5. Water pump cover
6. Sealing washer
7. Bolt

- **Sectional view of a centrifugal pump.**

The water pump on a V-8 engine at cruising speed pumps about 475 litres per minute of operation.

- Depending on the restriction of the thermostat and radiator, the water pump may create a slight positive pressure at the upper hose.

- The pump insures an adequate flow of coolant through the water jackets and radiator. The pump usually causes a flow of about 0.3 to 0.6 m/s through the radiator tubes

- The water pump impeller shaft is supported by a double set of ball bearings which are permanently lubricated and sealed.

- A carbon seal is used to keep the coolant from leaking along the pump shaft. A weep hole in the housing allows any coolant that seeps past the seal to escape from the pump preventing corrosion or damage to the pump bearings.



# FUEL FEED SYSTEM



# FUEL FEED SYSTEM



**LARSEN & TOUBRO**  
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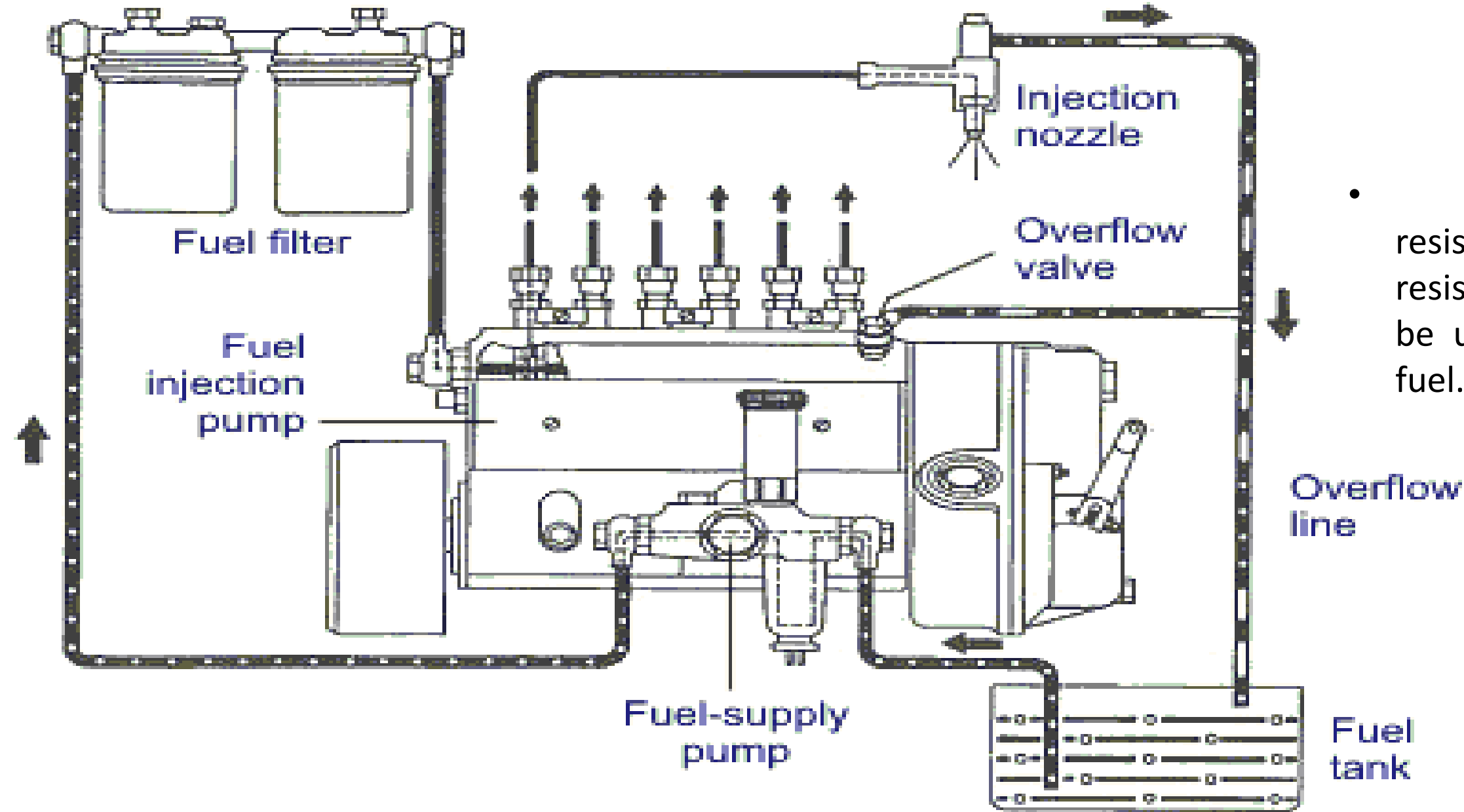




## FUEL LINE

- A **fuel line** is a hose used to bring fuel from one point in a vehicle to another or from a storage tank to a vehicle.
- 
- It is commonly made of reinforced rubber to prevent splitting and kinking.
- This includes all hoses or tubing for the filler neck, for connections between dual fuel tanks, and for connecting a carbon canister to the fuel tank.
- This does not include hoses or tubing for routing crankcase vapour to the engine's intake or any other hoses or tubing that are open to the atmosphere.

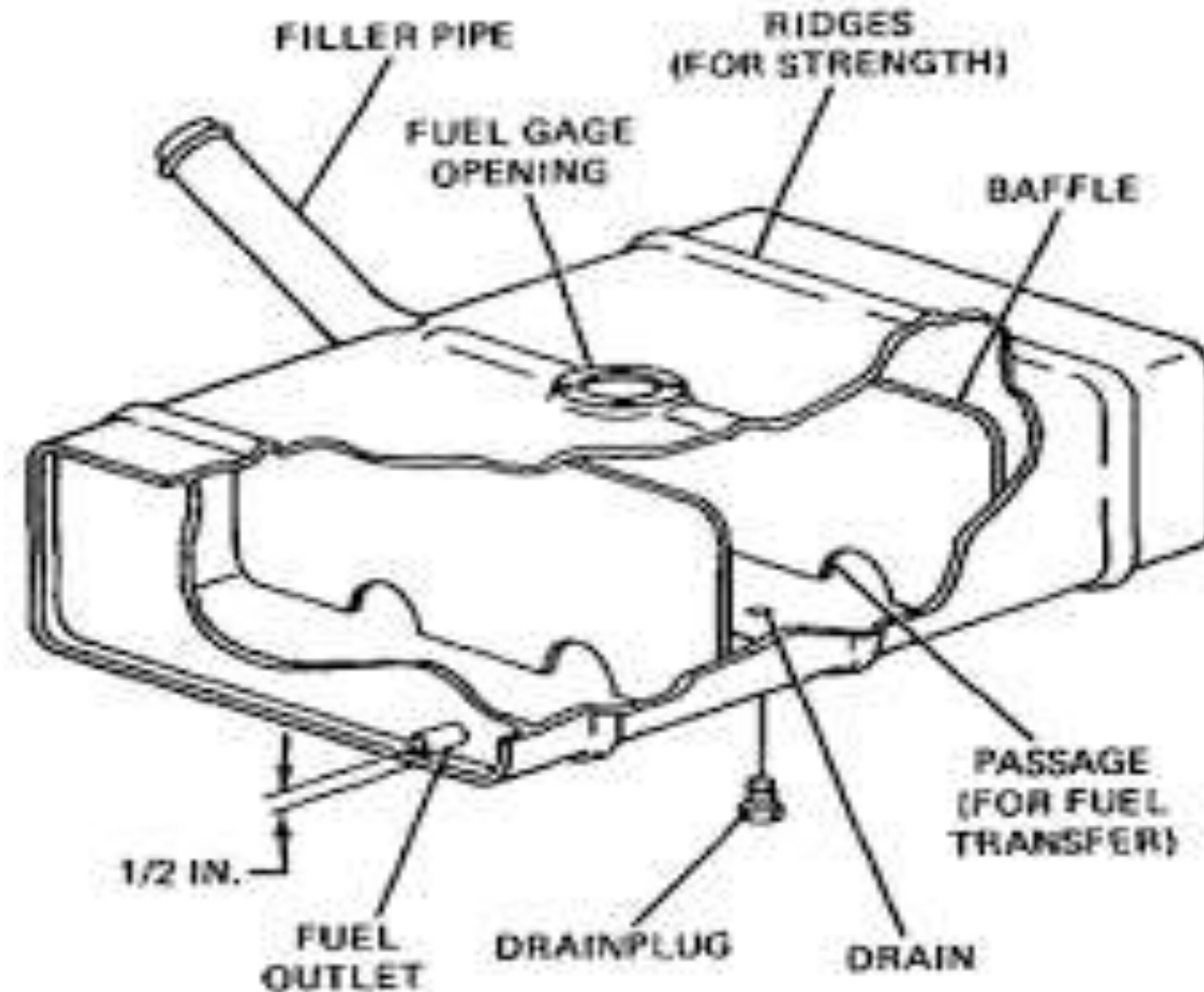
# FUEL FEED SYSTEM



- Fuel line is a petroleum-resistant nitrile tube with a covering that resists weathering, ozone and heat and can be used for ethanol-laced fuels and diesel fuel.

## FUEL TANK CONSTRUCTION

- Fuel tanks are usually made of thin sheet metal or plastic.
- The main body of a metal tank is made by soldering or welding two formed pieces of sheet metal together.
- Other parts (filer neck, fuel tank cap, and baffles) are added to the form to complete the fuel tank assembly.

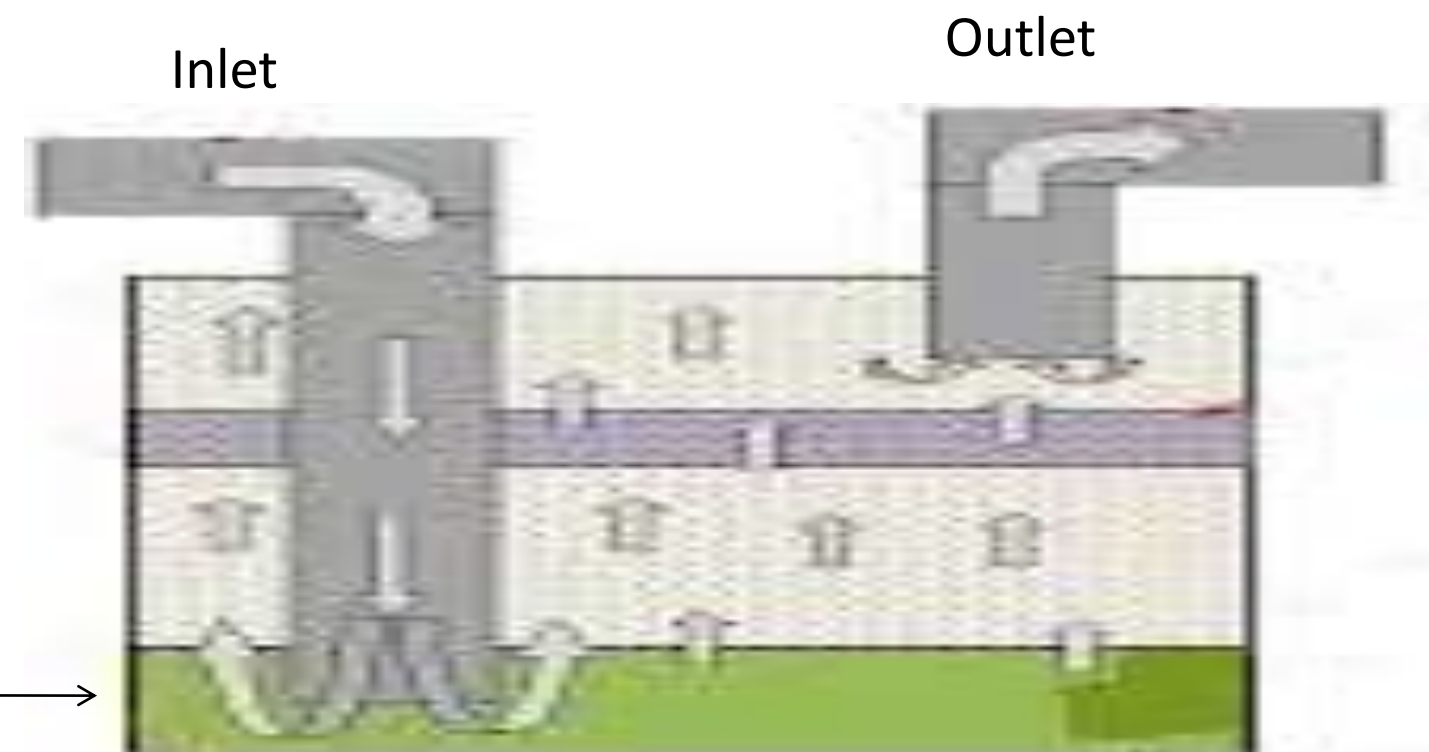
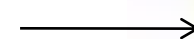




## FUEL TANK FLUSING

- Remove fuel pump from tank (avoid letting residual debris fall into the tank).
- Insert hose into fuel tank and begin pouring a stream of clean, hot water. While water is filling, spray mild detergent in the tank.
- If opening allows, use a brush to loosen debris from the sides of the tank.

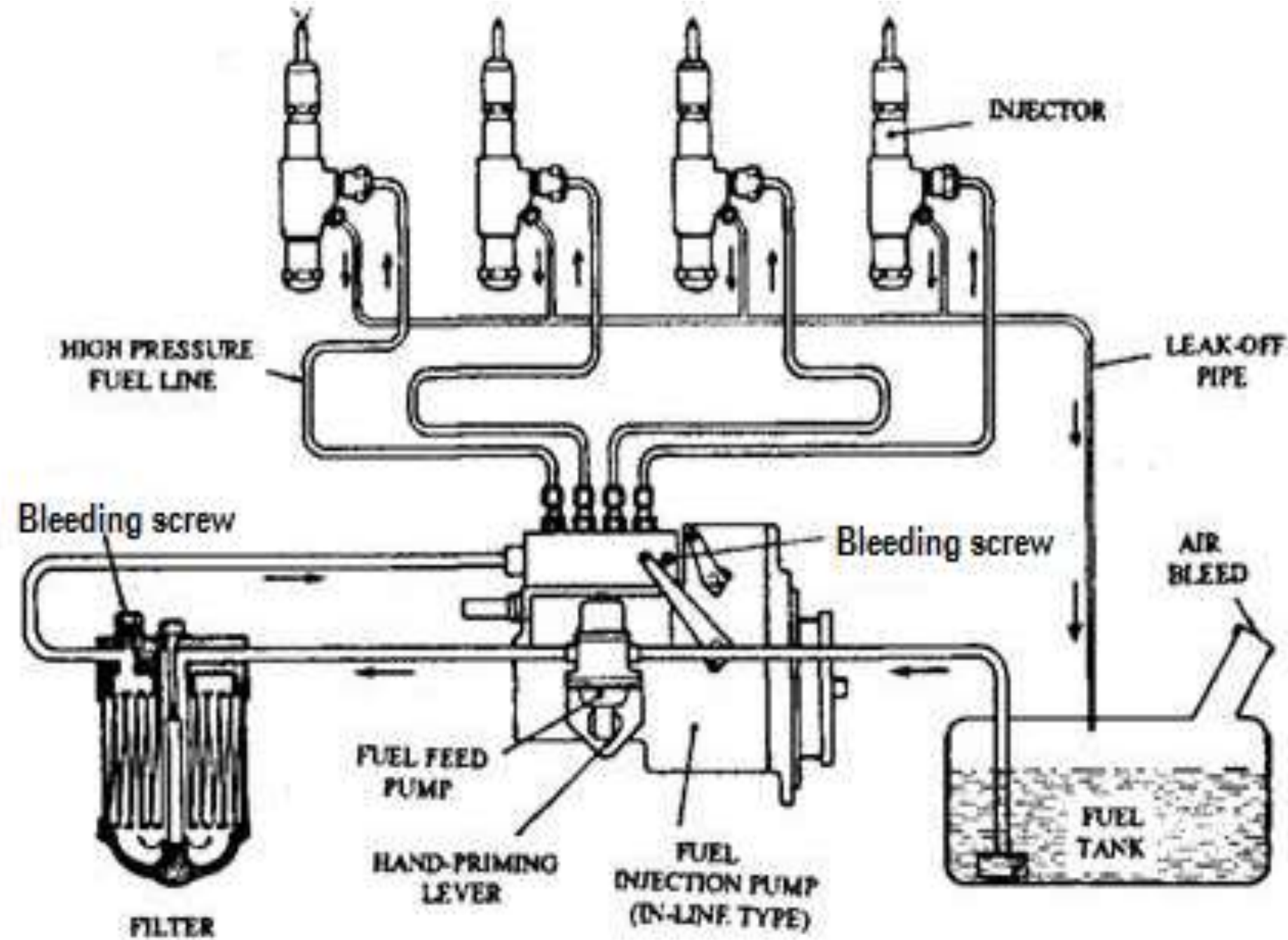
Tank Body



**You can do this by following these step-by-step instructions for proper fuel tank cleaning:**

- ❖ Drain all fuel from the tank with an approved container or a fuel caddy.
- ❖ Drop the tank (see your service manual for further instructions).
- ❖ Clean area where the pump is being removed from with a brush.
- ❖ Remove fuel pump from tank (avoid letting residual debris fall into the tank).
- ❖ Insert hose into fuel tank and begin pouring a stream of clean, hot water.
- ❖ While water is filling, spray mild detergent in the tank.
- ❖ If opening allows, use a brush to loosen debris from the sides of the tank.
- ❖ Stop stream of water.
- ❖ Swish the water around to ensure all debris has been captured.
- ❖ Dump dirty contaminated water out into a pan, being sure to capture any liquids.
- ❖ Further wipe the tank out with a lint-free washcloth.
- ❖ Dry the fuel tank completely with compressed air.
- ❖ Inspect the tank for rust or physical damage; if present, the tank must be repaired or replaced.
- ❖ Add fuel line antifreeze/water remover to help absorb any residual moisture.
- ❖ After the tank has been dried, let it sit for 30 minutes.

# FUEL FEED SYSTEM



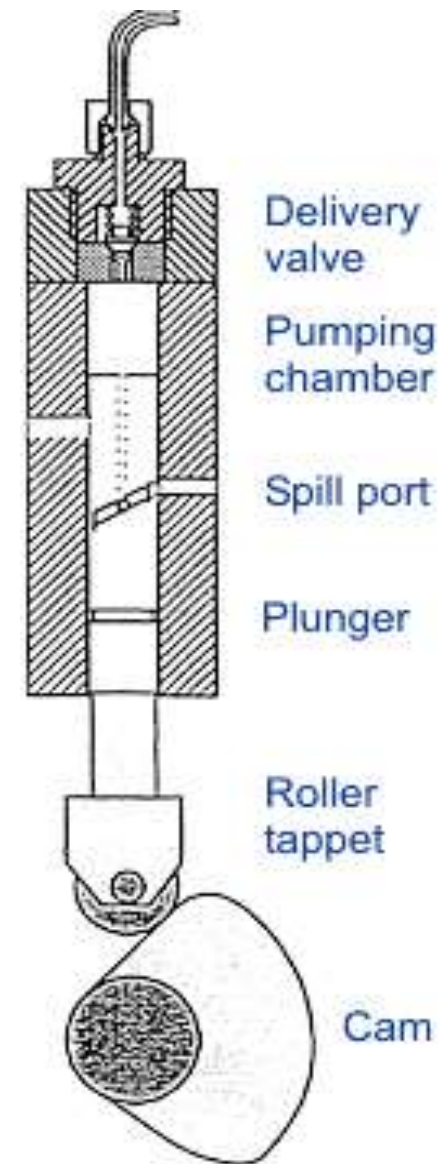


Here are the steps to take in bleeding air from a diesel fuel system:

1. Turn off fuel valve.
2. Clean outside of filter housing.
3. Install new filter element and new gaskets. A little oil on the gasket will aid a tight seal.
4. I'd suggest that you fill a spin-on filter with clean fuel before installation.
5. Open the bleed plug on the filter closest to the fuel tank.
6. Open fuel supply valve so that the fuel is available to the filter and pump.
7. Most all equipment has a hand priming pump lever to pump fuel through the system and replace trapped air. (Check operator's manual.) Pump several times until full flow, without air bubbles, escapes from the bleed plug holes.

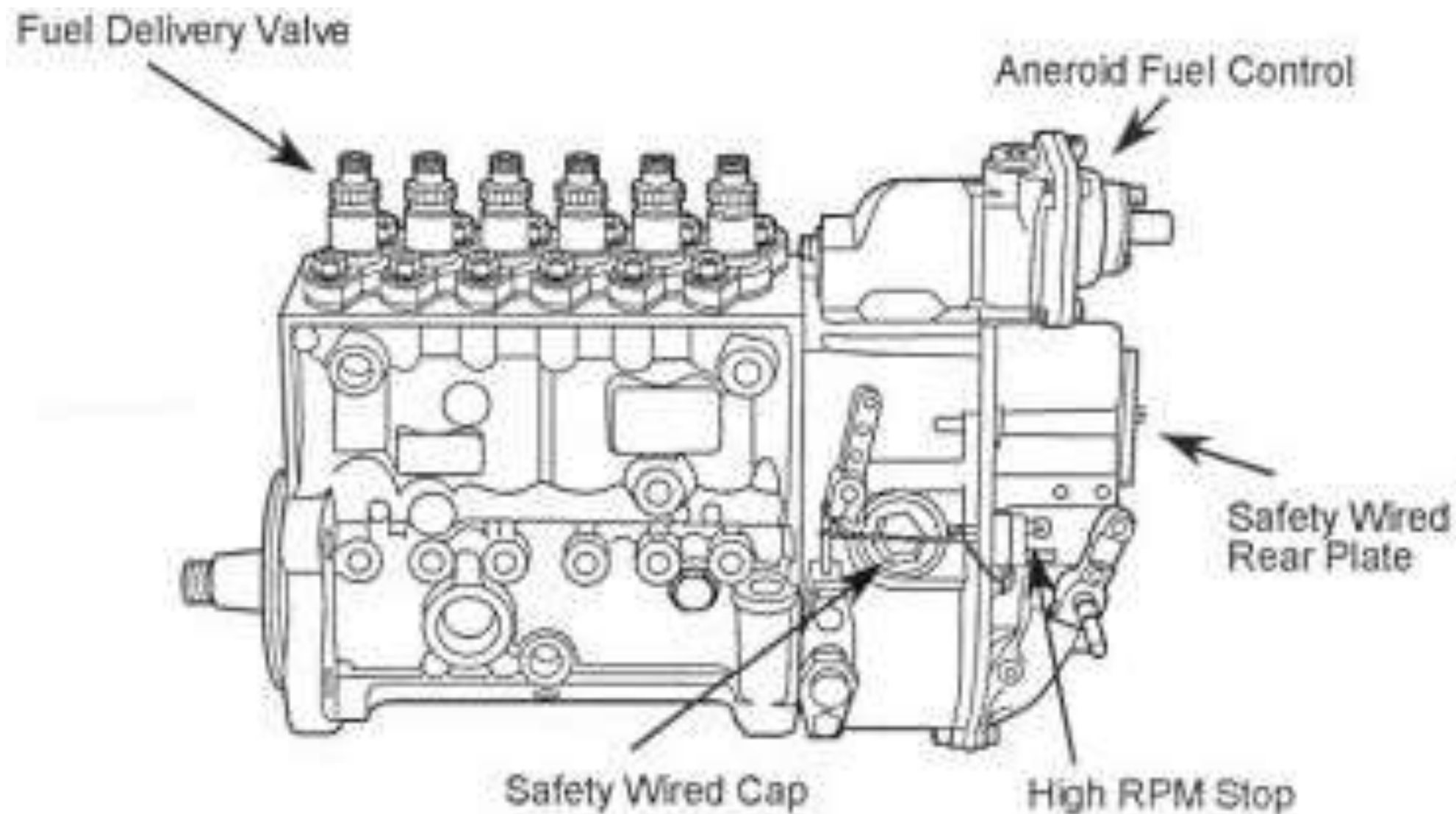
8. You may need to bleed filters, fuel pump and lines to the injectors.
9. Close bleed plugs after all air is removed from the fuel tank, filters, settlement bulb, and fuel pump (only one at a time working through all bleed screws beginning closest to tank and ending at nozzles if necessary).
10. Try the engine; if it doesn't start or runs poorly, you may have to bleed the injection line.
11. Loosen injection lines at the injectors about one turn. The use of two wrenches will prevent the binding or twisting of the steel lines. Usually, it is enough to bleed just half of the lines at a time.
12. Crank the engine until all air is forced out and fuel is present.
13. Engine will start to pop on one or two cylinders.
14. Tighten the injector lock nut one at a time to tell by sound which cylinders are firing properly.
15. Run the engine until it runs smoothly. This will bleed the other injectors.

- An **Injection Pump** is the device that pumps diesel (as the fuel) into the cylinders of a diesel engine.
- It rotates at half crankshaft speed in a conventional four-stroke diesel engine. Its timing is such that the fuel is injected only very slightly before top dead centre of that cylinder's compression stroke.





**Construction** - Earlier diesel pumps used an in-line layout with a series of cam-operated injection cylinders in a line, rather like a miniature inline engine.



## Calibrating fuel injectors

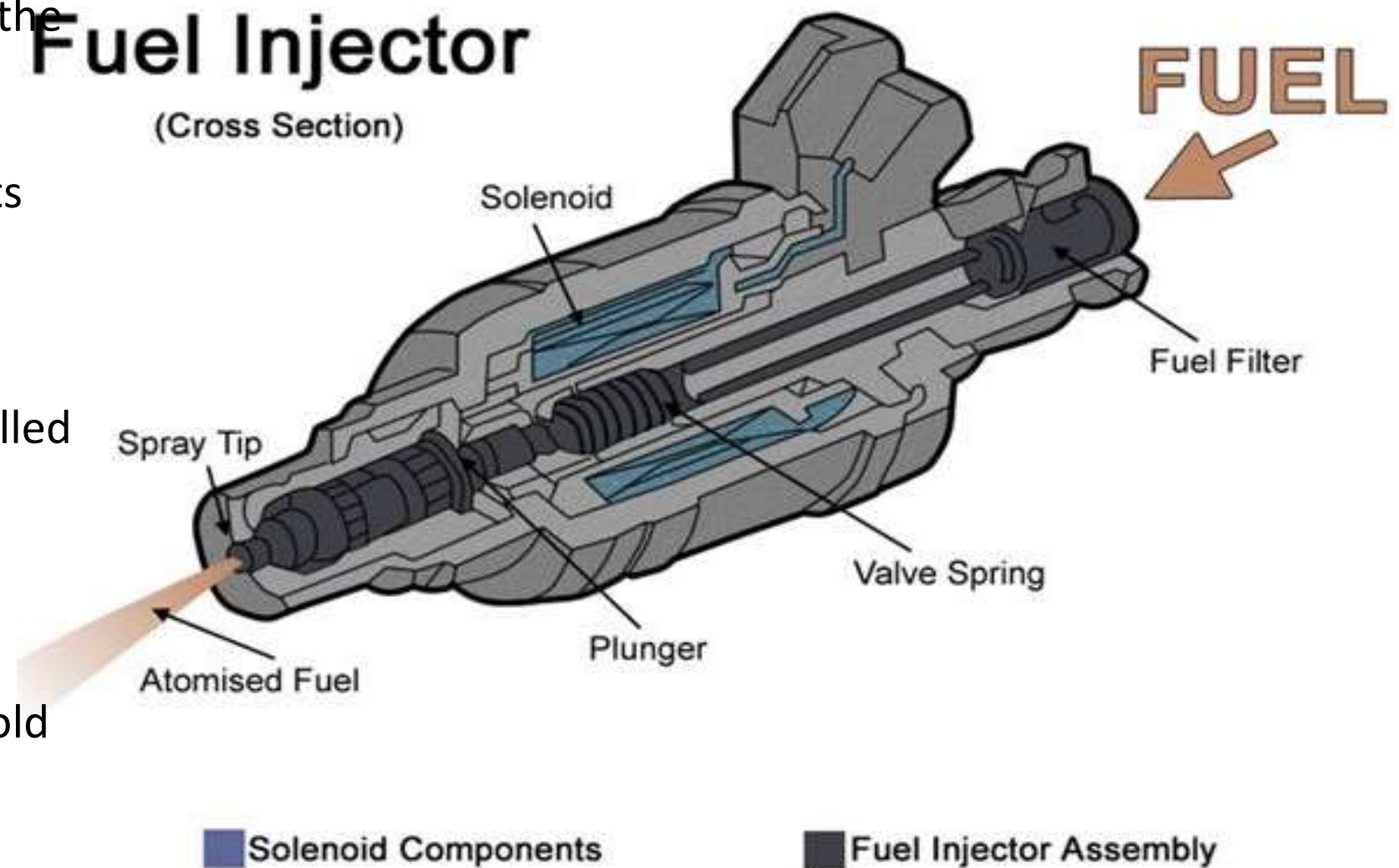
1. Remove the eight cover bolts and withdraw the pump Oil seals, once removed from the pump body, Must be cover from the pump body. Use care not to damage the discarded and replaced with new seals. finished faces of the pump body and cover. Check the pump gear teeth for scoring, chipping or
2. Withdraw the drive shaft, drive gear and gear wear. Check the ball slot in the drive gear for wear. If retaining ball as an assembly from the pump body.
3. Press the drive shaft just far enough to remove the Inspect the drive and driven shafts for scoring or wear. steel locking ball.
4. Then invert the shaft and gear Replace the shafts if necessary.
5. The driven shaft disassembly and press the shaft from the gear. Do not serviced as a gear and shaft assembly only.

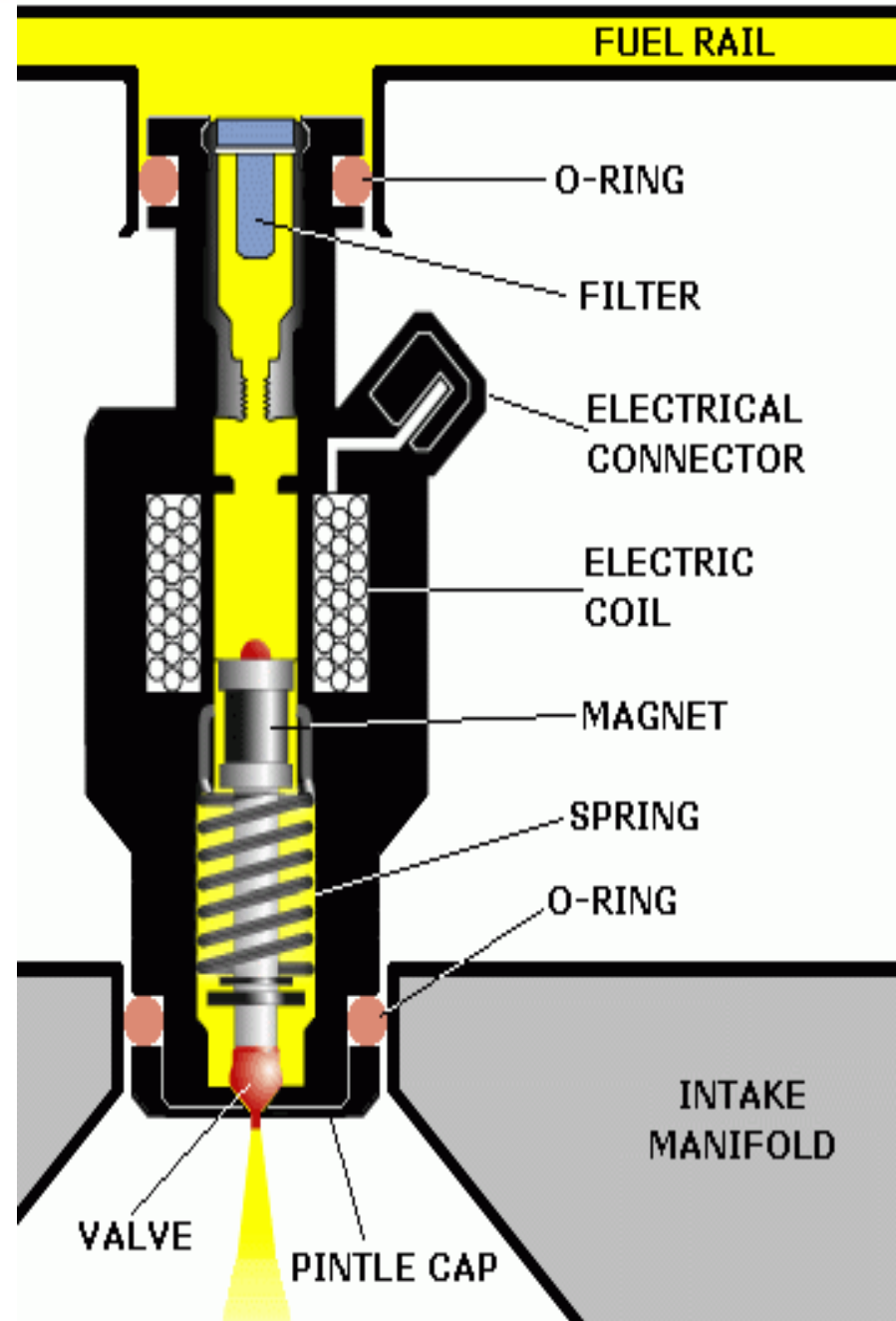
4. Remove the driven shaft and gear as an assembly or wear at areas contacted by the gears and shafts. from the pump body. Do not remove the gear from the Replace the pump cover or body if necessary. shaft. The driven gear and shaft are serviced only as an assembly. The relief valve must be free from score marks and burrs and fit its seat in the pump body.
5. Remove the relief valve plug and copper gasket. scored and cannot be cleaned up with fine emery cloth or crocus cloth, it must be replaced.
6. Remove the valve spring, pin and relief valve from the valve cavity in the pump body.



- The amount of fuel injected is controlled by a flap valve located in the engine's air intake.
- The fuel then squirts out into the inlet port in the cylinder head.
- Each injector contains a spring-loaded valve that is kept closed by its spring pressure.
- The valve only opens when the fuel is squirted in.
- Fuel injectors spray fuel into a car's engine using electronic controlled valves, capable of opening and closing many times a second.
- They have an atomising nozzle that distributes the petrol or diesel evenly, for optimum combustion and efficiency.

Most **fuel injectors** are at the head of the engine, at the intake manifold near the intake valve.

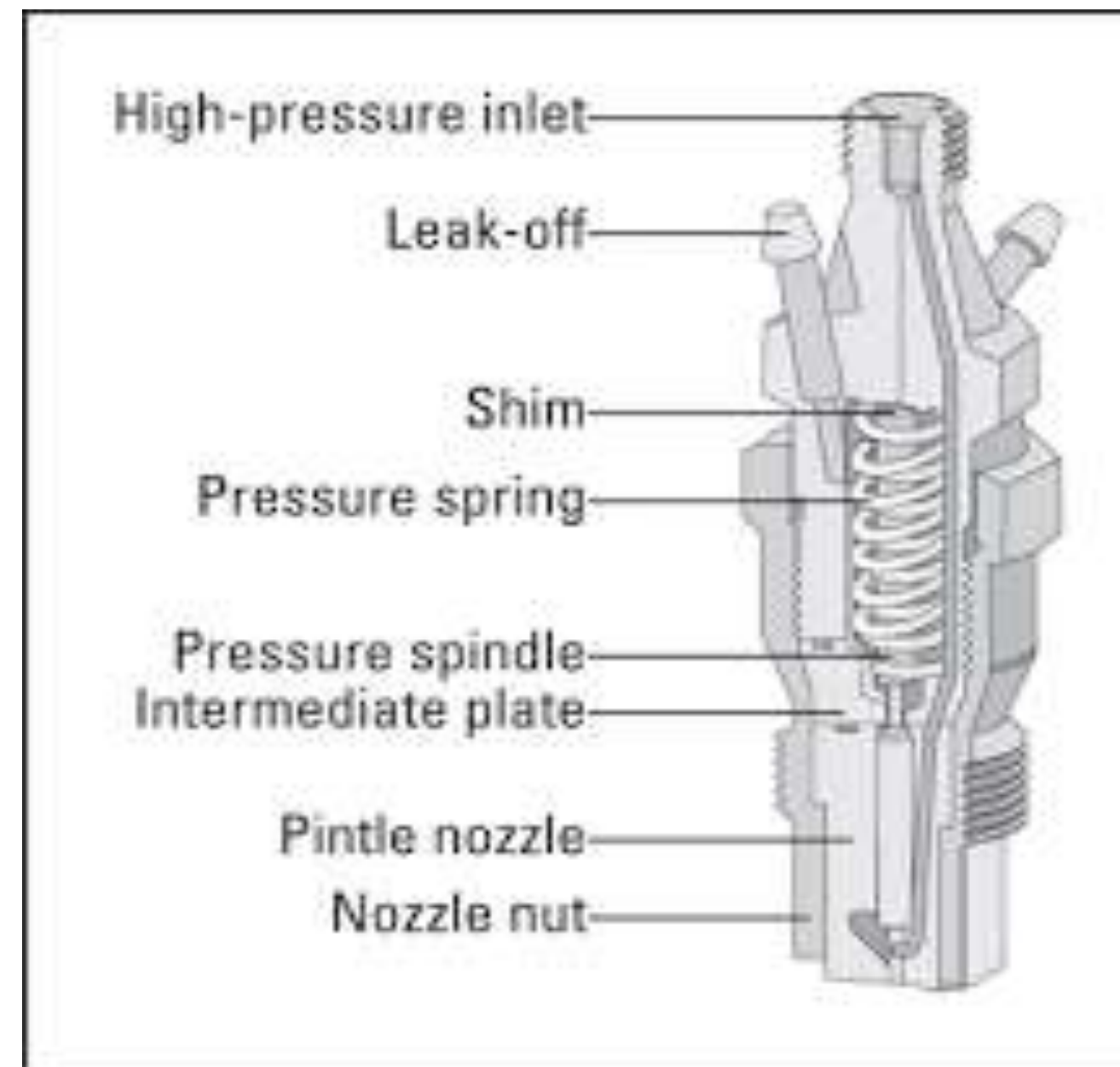




- The fuel injection system lies at the very heart of the diesel engine. By pressurising and injecting the fuel, the system forces it into air that has been compressed to high pressure in the combustion chamber.
- In diesel engines fuel must be in a highly atomized form for proper combustion.
- Usually this is accomplished with a plunger and cylinder arrangement (solid injection), which forces accurately measured amounts of liquid fuel into the combustion chambers through atomizing nozzles.

Here are the 5 most common symptoms of faulty diesel fuel injectors.

- Trouble starting the vehicle or uneven idling. The engine cranks but doesn't start unless you crank it for a long time.
- Misfire. ...
- Smell of **fuel**. ...
- Dirty emissions. ...
- Increased **fuel** consumption and poor miles per gallon.







# FUEL INJECTOR



- Remove the cover off the air cleaner housing (where the air filter lives).
- Ask an assistant to start (or crank the engine, if it doesn't start).
- Check the spray pattern coming out of the injector.

\* Fuel should come out partially atomized in an inverted V pattern. A single, solid spray or irregular pattern means the injector needs cleaning, or that an internal part wore out or broke.

**\* On the other hand, if you don't see fuel coming out, there may be several reasons for this:**

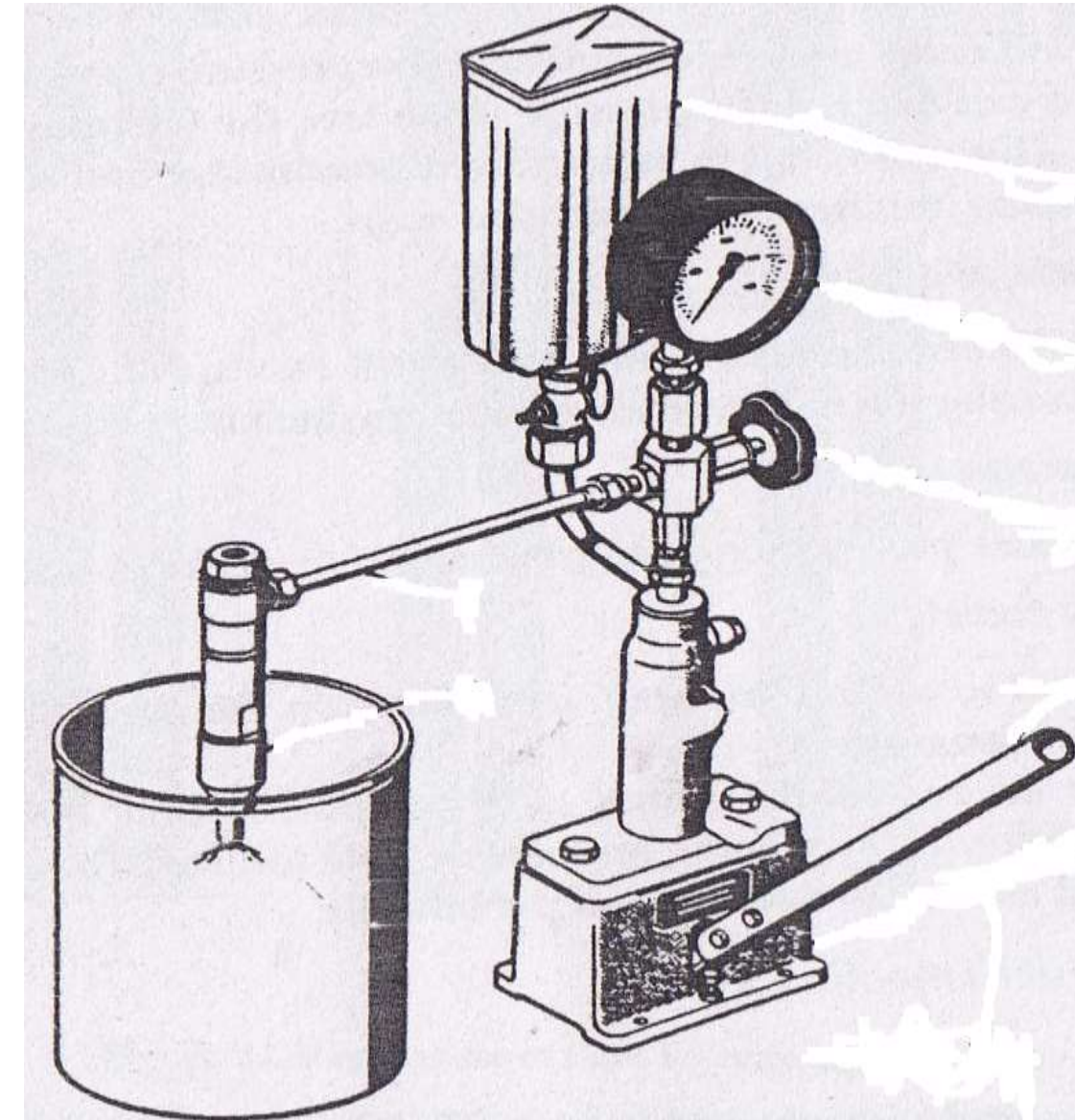
- Blocked fuel injector
- Bad injector
- Injector not receiving power
- Bad fuel pressure regulator
- Fuel filter clogged
- Bad fuel pump



- \* On the other hand, if you don't see fuel coming out, there may be several reasons for this:
- Blocked fuel injector
- Bad injector
- Injector not receiving power
- Bad fuel pressure regulator
- Fuel filter clogged
- Bad fuel pump



- Testing of fuel injector is carried out as follows.
  - Mount the fuel injector in its test rig and connect up the oil supply. Under no circumstances should hands be placed under the injector spray. The high velocity oil jet can penetrate the skin and cause blood poisoning.
  - With the injector priming valve open, operate the hand pump to prime the injector.
  - Once the fuel flows from the priming valve it can be closed. to test for tightness between needle and guide, operate the hand pump to increase pressure until it is just below opening pressure.
  - See how long it takes the pressure to fall off. If the pressure falls quickly the needle and guide should be replaced.

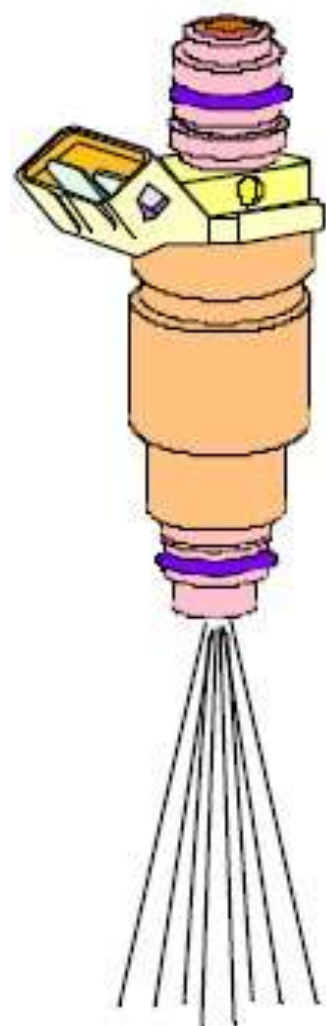




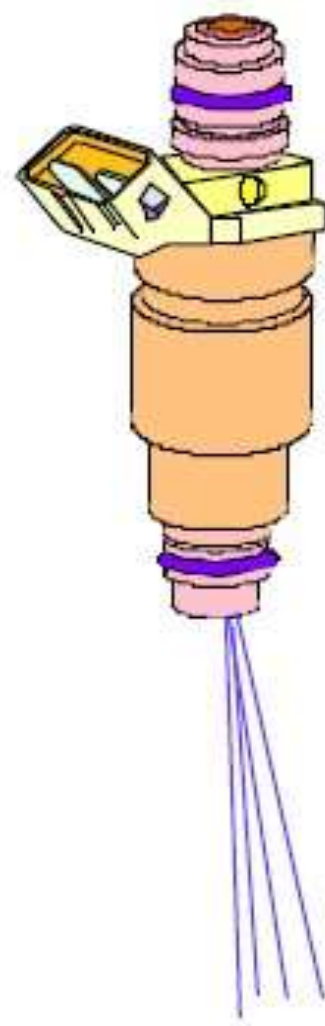
## Checking Fuel Spray

- Remove the cover off the air cleaner housing (where the air filter lives).
- Ask an assistant to start (or crank the engine, if it doesn't start).

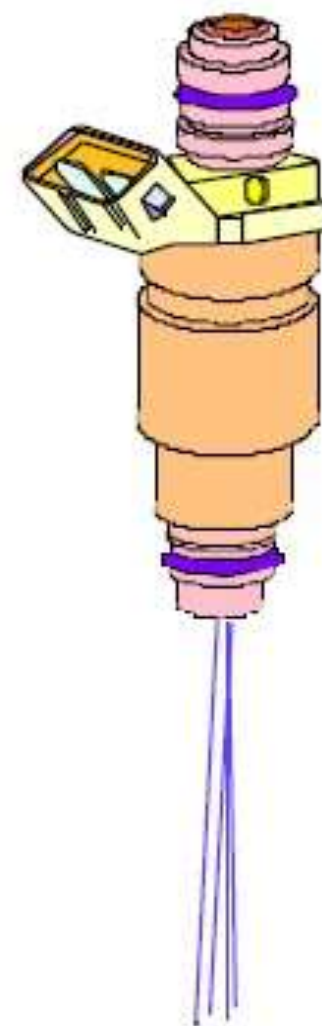
## Injector spray patterns



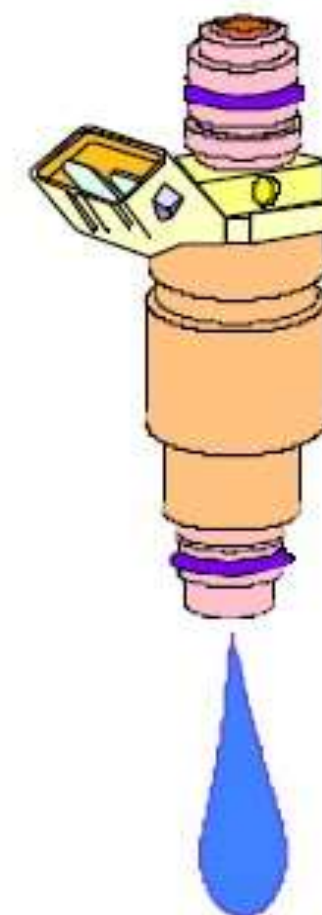
Good even cone



Offset pattern

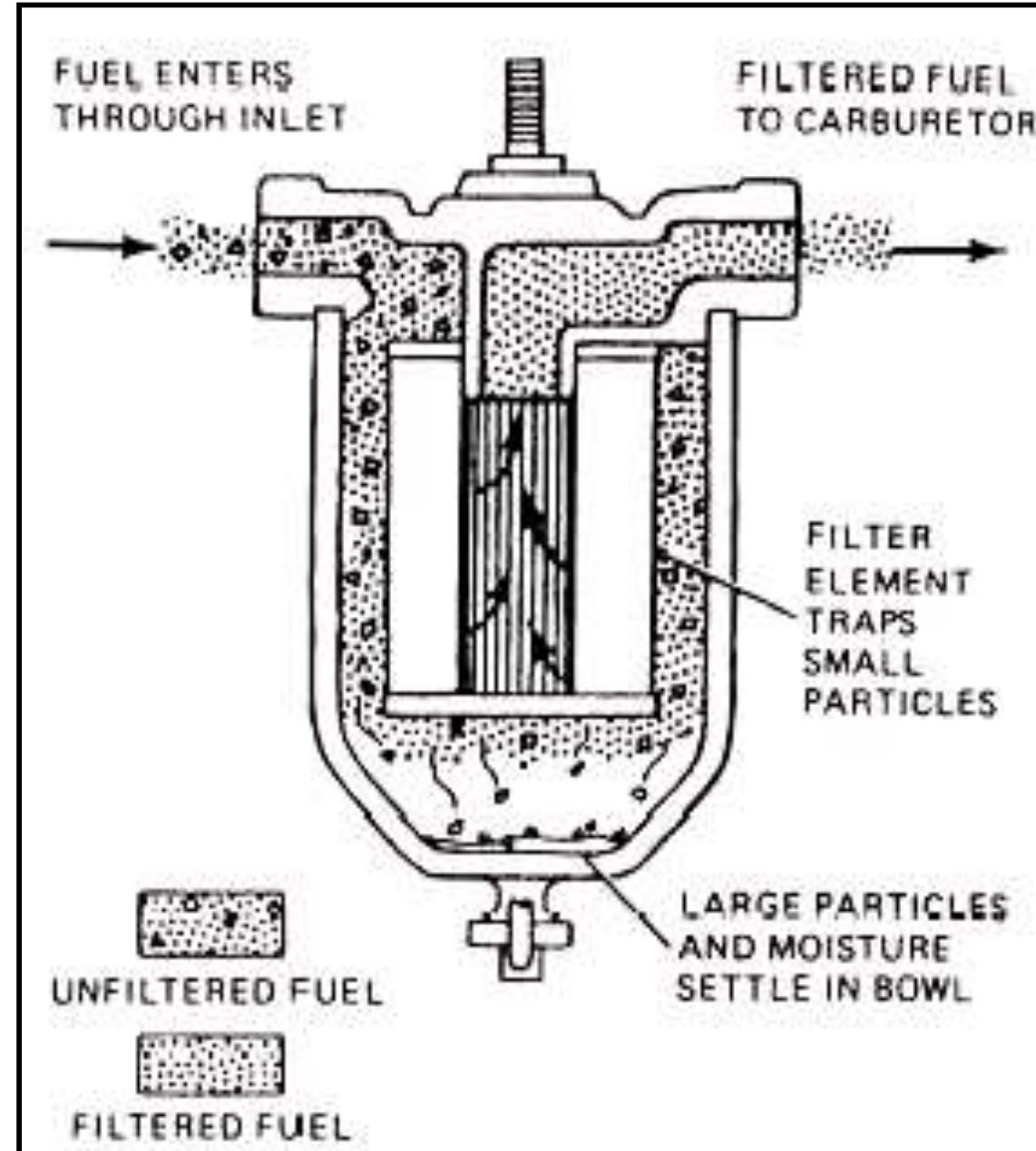


Poor atomisation



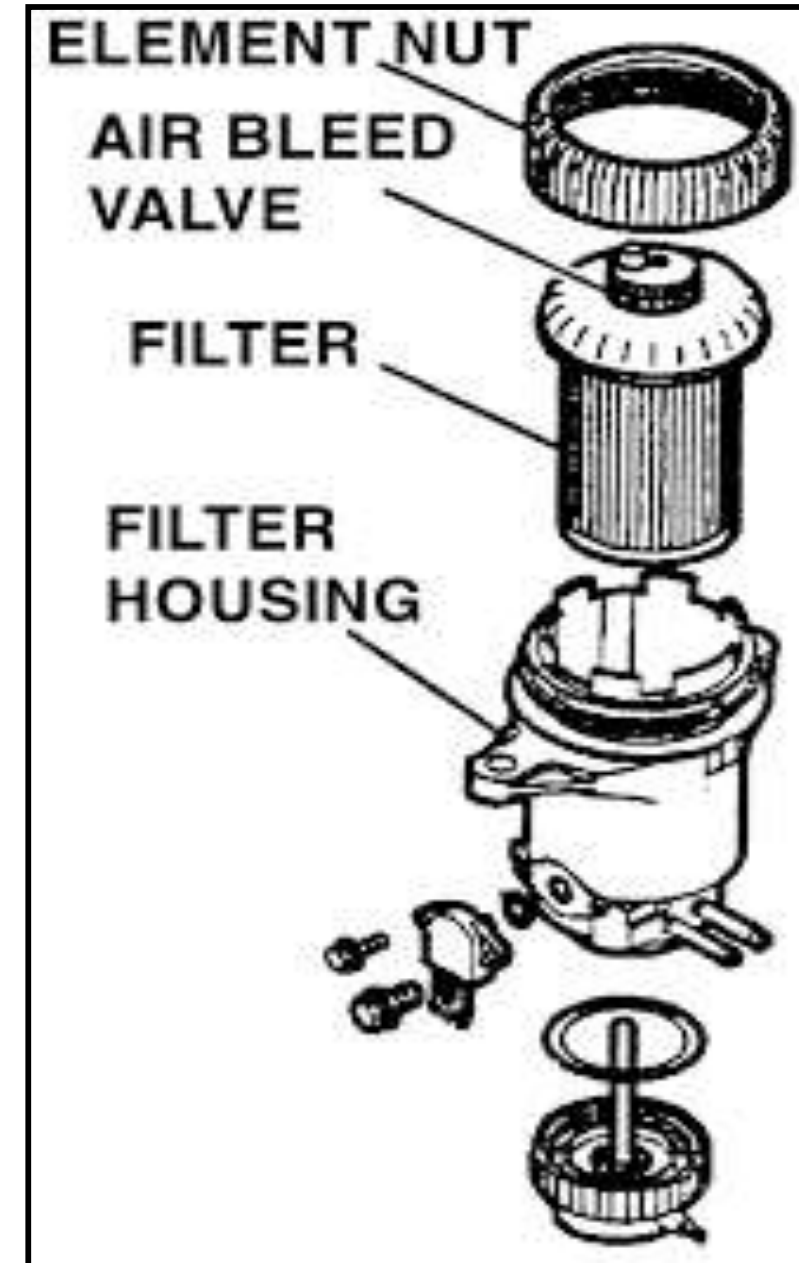
Dribble

- The fuel is sent to the fuel filter mainly by the fuel pump.
- The impurities in the fuel will be cleared through the paper filter element.
- then the fuel can enter the inner cavity of the filter cylinder.
- Through the collection chamber of the filter sea, it leads to the fuel injection pump.



# FUEL FILTER

- A fuel filter is a filter in a fuel line that screens out dirt and rust particles from the fuel, and is normally made into cartridges containing a filter paper.
- They are found in most internal combustion engines. Fuel filters serve a vital function in today's modern, tight-tolerance engine fuel systems.

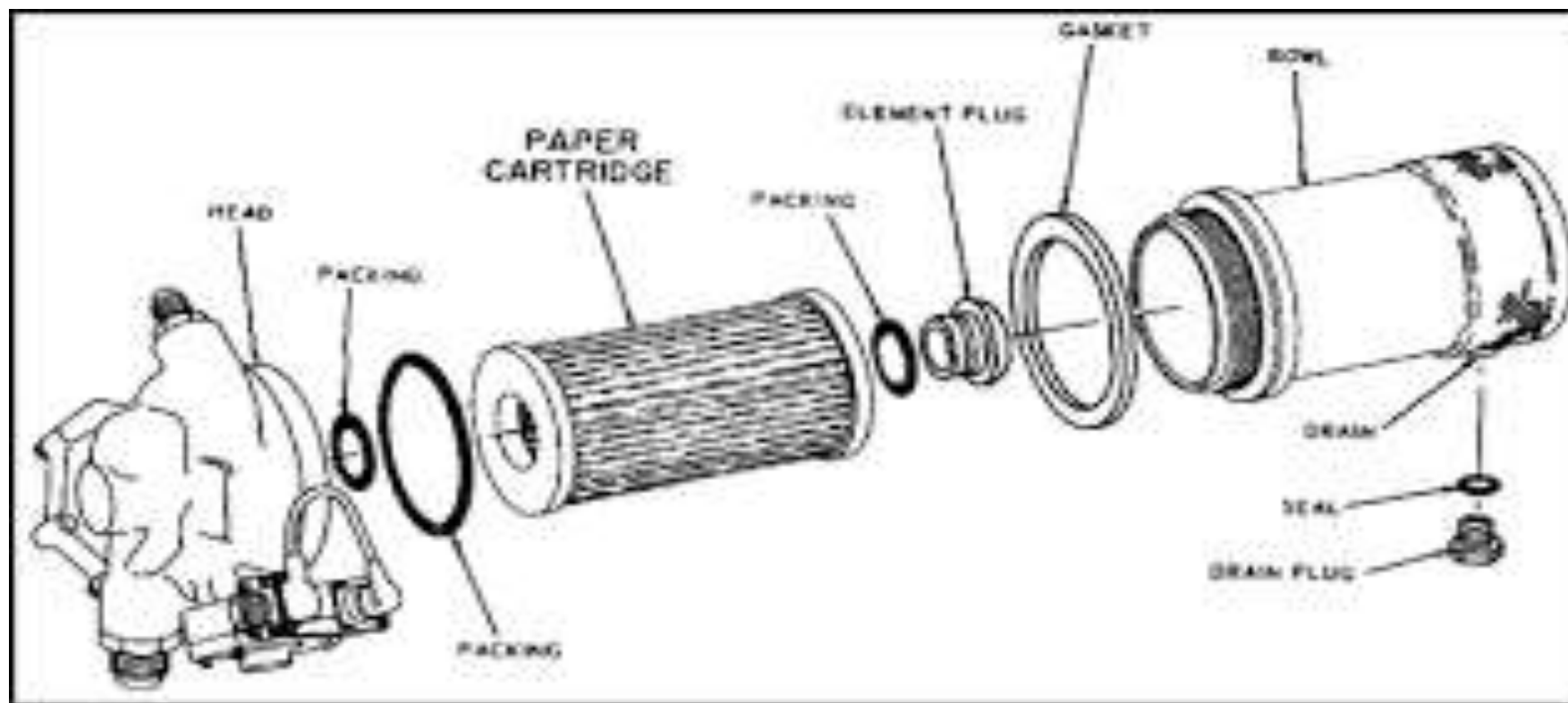






Spin-on type filters

There are two types of fuel filters depending on how they are attached during replacement: **spin-on filters** and **cartridge filters**. The filter medium is contained in a metal case which is threaded on the bottom.

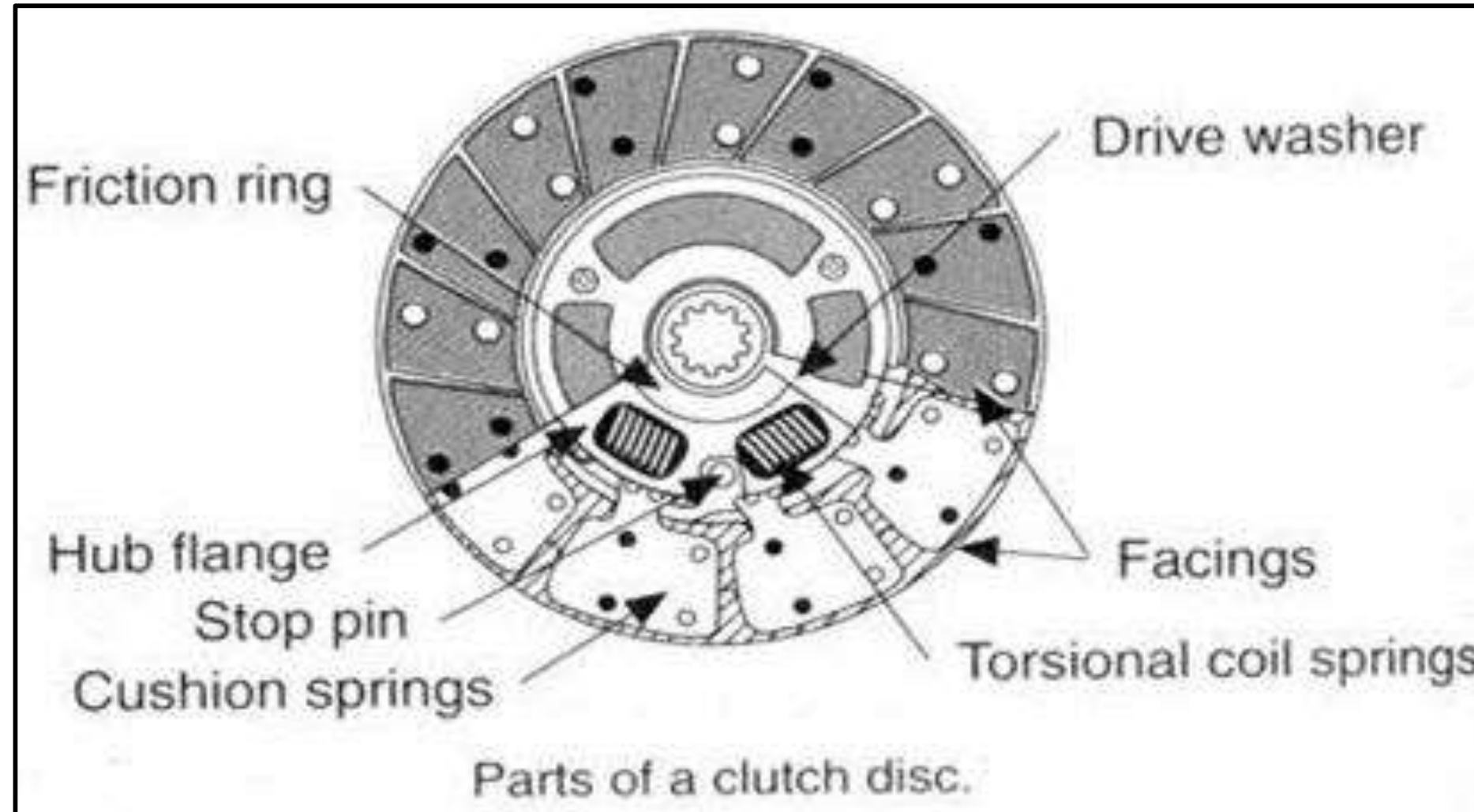


Cartridge type filters.

# TRANSMISSION SYSTEM

## Working Principle of Clutch:

When two revolving friction surfaces are brought into contact and pressed, then they are united and start to revolve at the same speed due to the friction force between them. This is the basic principle of a clutch.





## Function of Clutch –

- It can be disengaged. This allows engine cranking and permits the engine to run without delivering power to the transmission.
- While disengaging, it permits the driver to shift the transmission into various gear according to operating conditions.
- While engaging, the clutch slips momentarily. this provides smooth engagement and lessens the shock on gears, shaft and other parts of an automobile.
- While engaging, the clutch transmits the power to the wheel without slipping, in ideal condition.

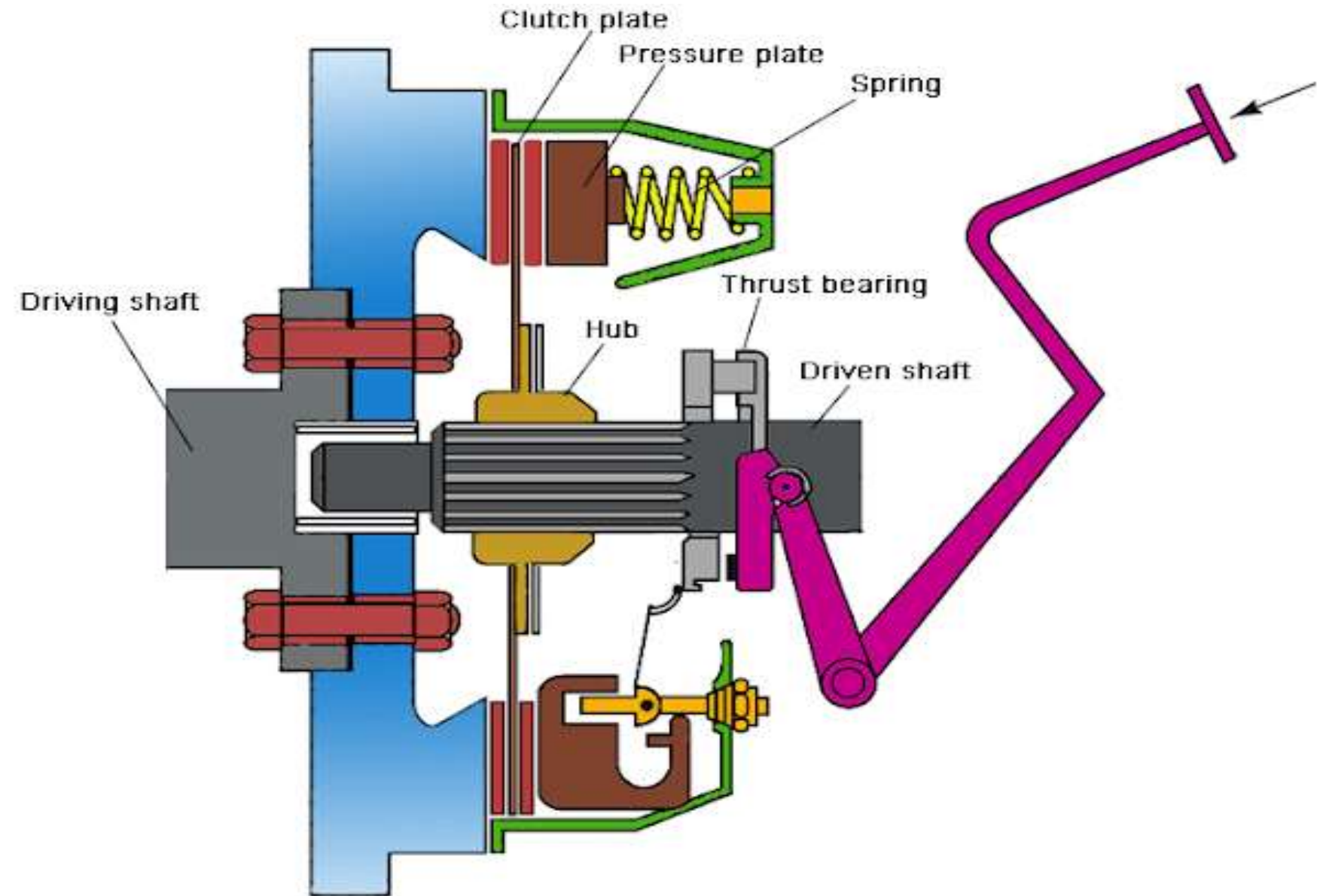
## Types of Clutches:

In mechanical engineering different types of clutches are present.

(1) Friction Clutch (2) Single Plate (3) Clutch Multi Plate (4) Clutch Cone Clutch (5) Centrifugal (6) Clutch Semi-centrifugal Clutch (7) Diaphragm Clutch Dog and Spline (8) Clutch Electromagnetic Clutch (9) Vacuum Clutches (11) Hydraulic clutch (12) Freewheel Clutch

## Single Plate Clutch:

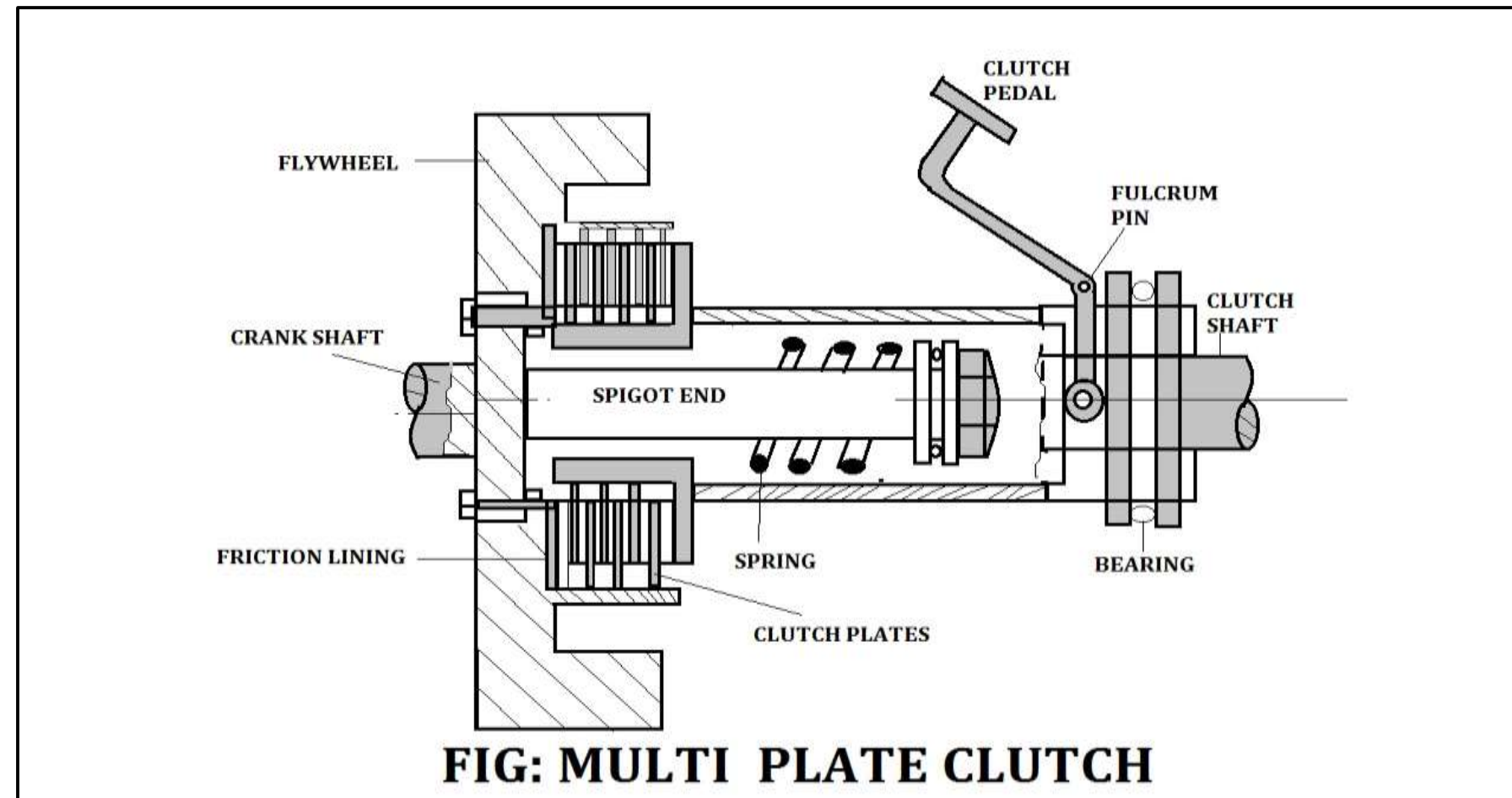
Single plate clutch is mainly used in lightweight vehicles for transmitting torque from an engine to the input shaft. As per the name of this Clutch it just has a single Clutch plate.



## Multiplate Clutch:

This type of clutch has multiple clutch plates that are used to transmit power from the shaft of an engine to the transmission shaft of the same vehicle.

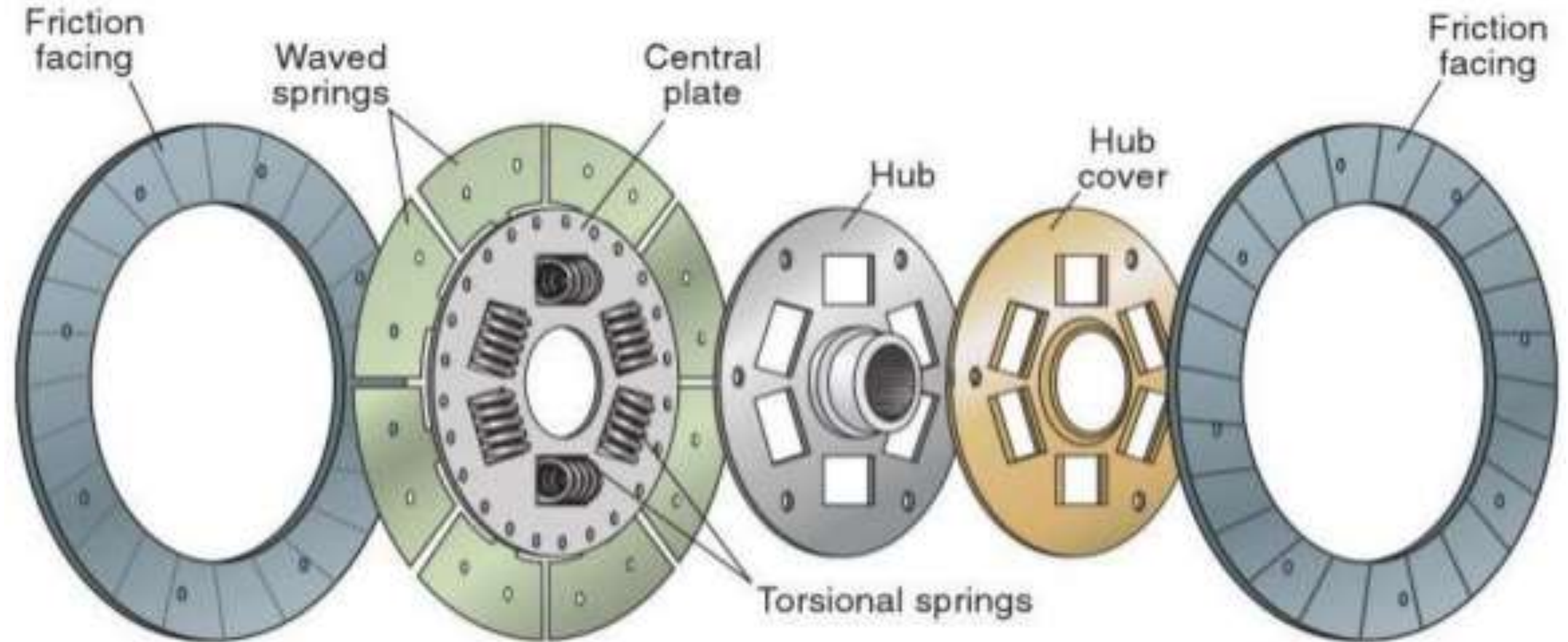
A clutch when operates within an oil bath then it is called a **wet clutch**. On the other hand, a **dry clutch** operates without oil.





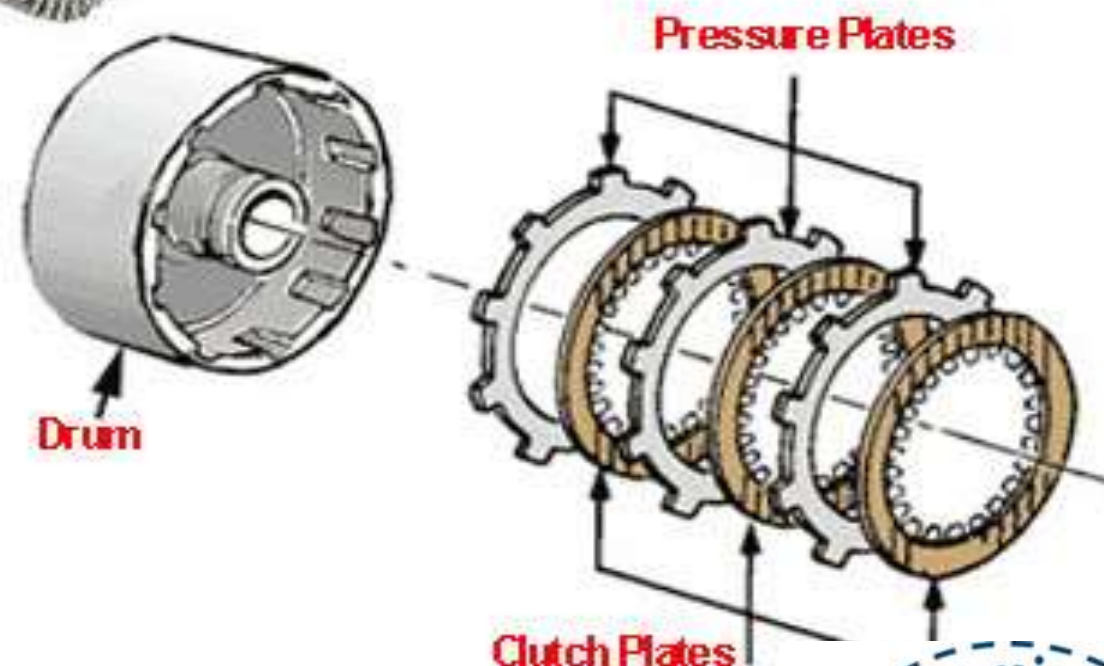
**Dry Clutch-** Avoiding that fluid drag is the single biggest benefit of a dry clutch. Dry clutches, as you might have guessed already, aren't bathed in oil.

That means less drag and more power going to the rear wheel as well as cleaner engine oil, but it also means less cooling for the clutch pack.



**Dry Clutch**

A **wet clutch** transfers power through mechanical and fluid couplings by mating rotating friction plates immersed in lubricant. ... Wet clutches are typically used in a compact and lubricant-rich environment, such as automatic transmission.



Wet Clutch

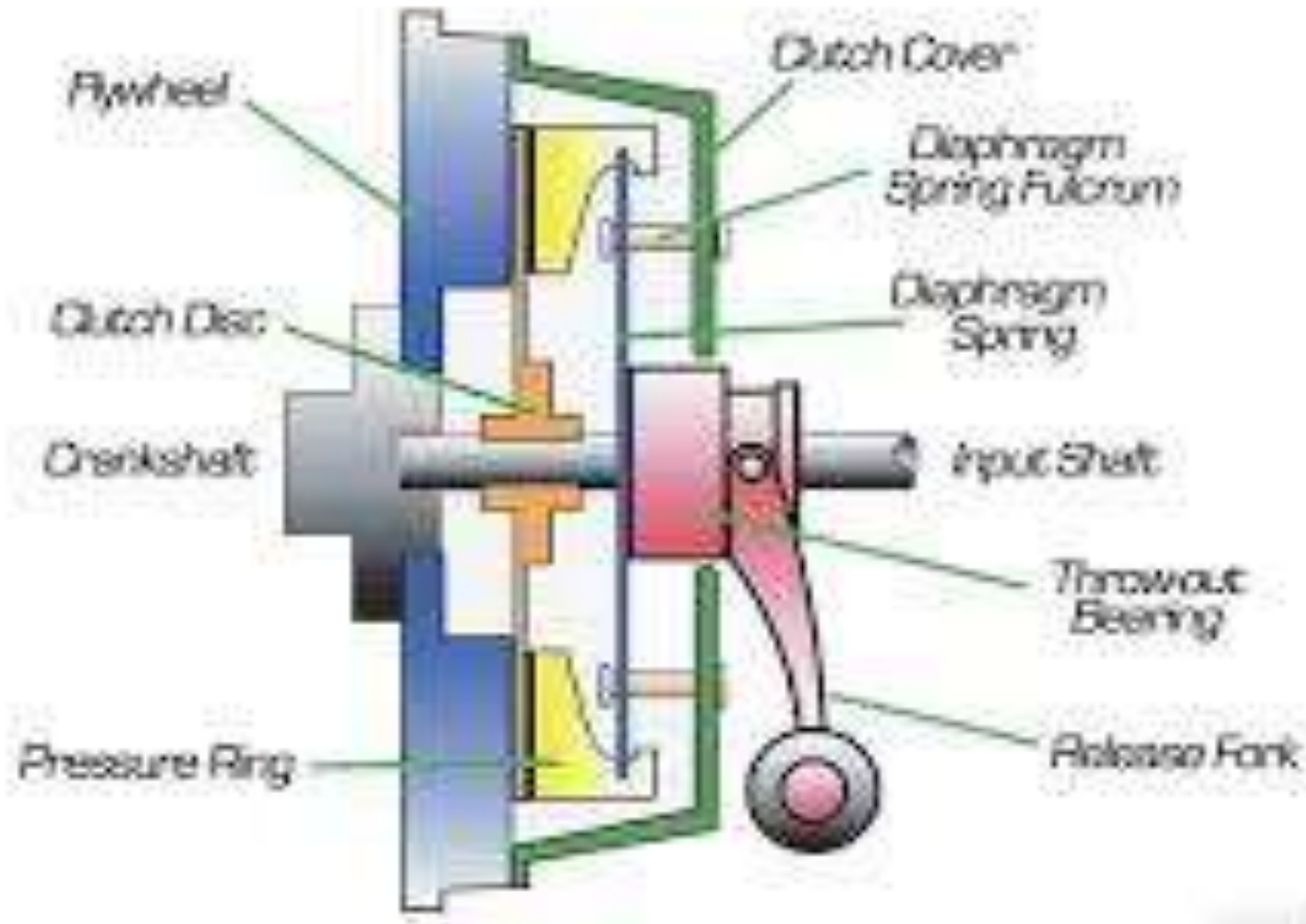


## Working Principle of Diaphragm Clutch:

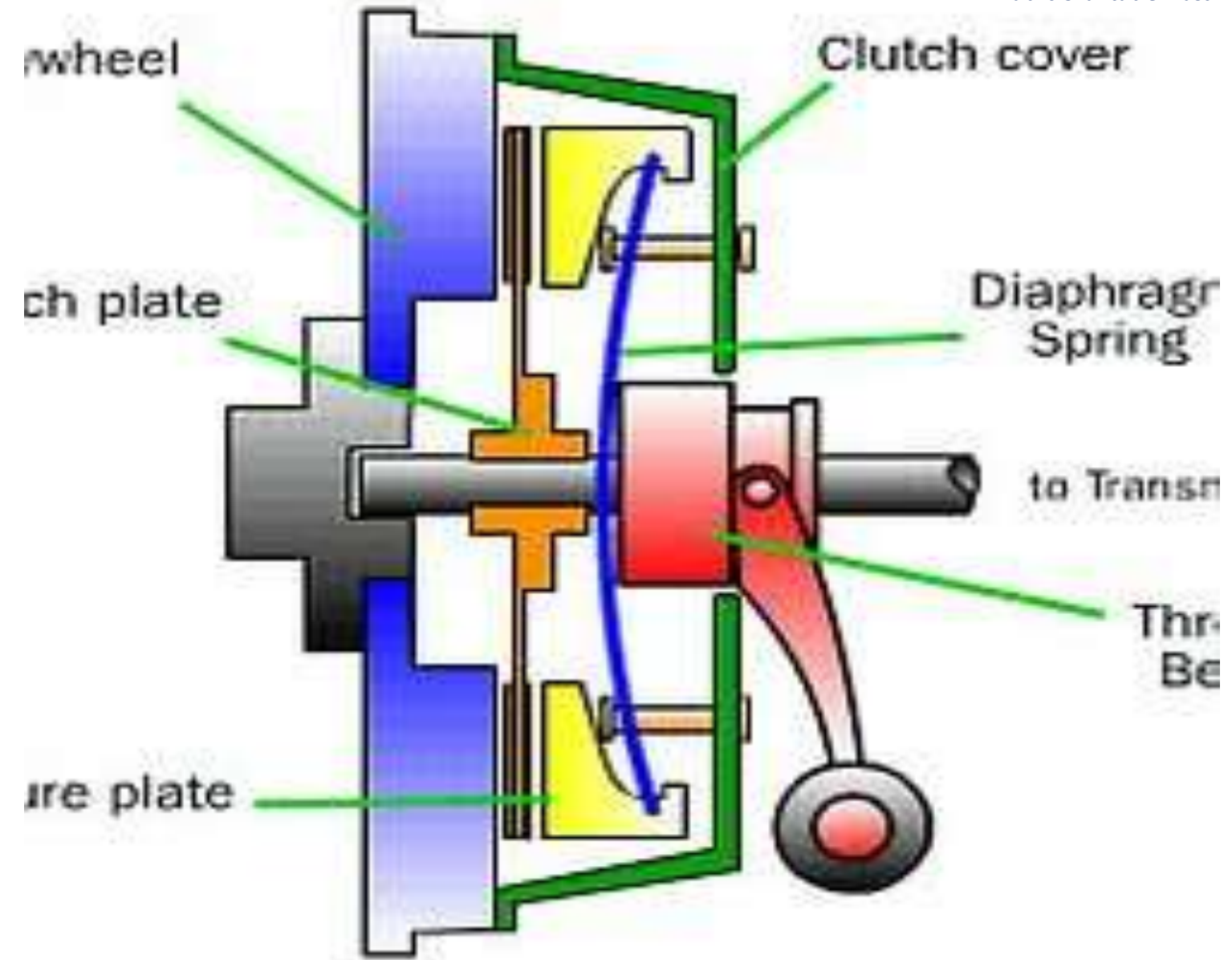
- For the Diaphragm Clutch, engine power is sent to flywheel from the crankshaft.
- Flywheel consists of friction lining, and the clutch is connected with flywheel.
- As the pressure is applied to the pressure plate of the clutch, due to which, the clutch plate is located behind the pressure plate.
- The diaphragm clutch is conical in shape. The outside bearing goes to the flywheel after pressing the clutch pedal of the clutch.
- The outside bearing presses the Diaphragm spring. So that pressure plate is pushed backward by the Diaphragm spring.
- That pressure disengaged the clutch by removing the pressure on the plate.
- The Diaphragm spring and pressure plate came back on the normal state after releasing the pressure from clutch peddles.



## Engaged

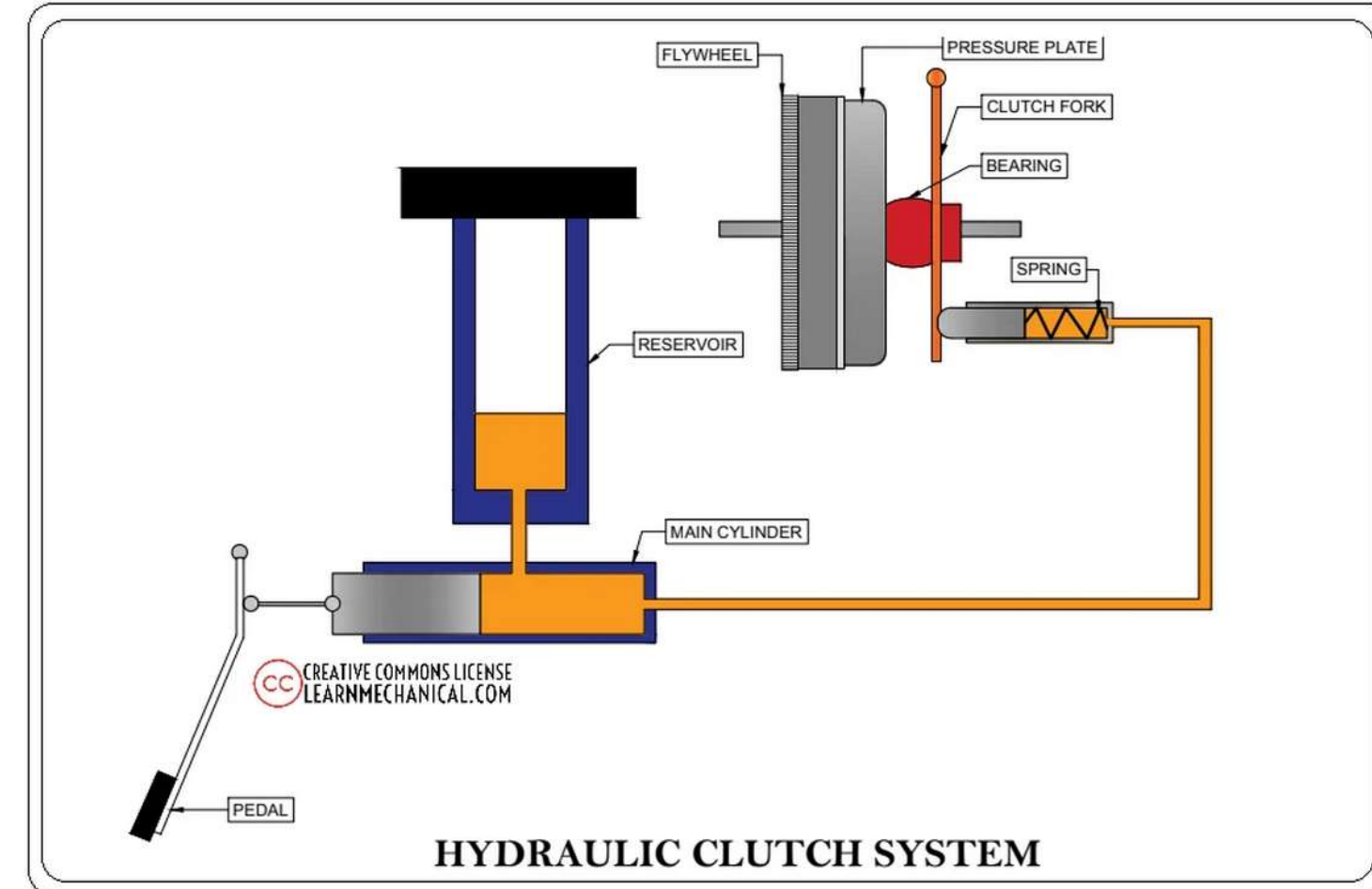


## Disengaged



## Working principle of Hydraulic clutch:

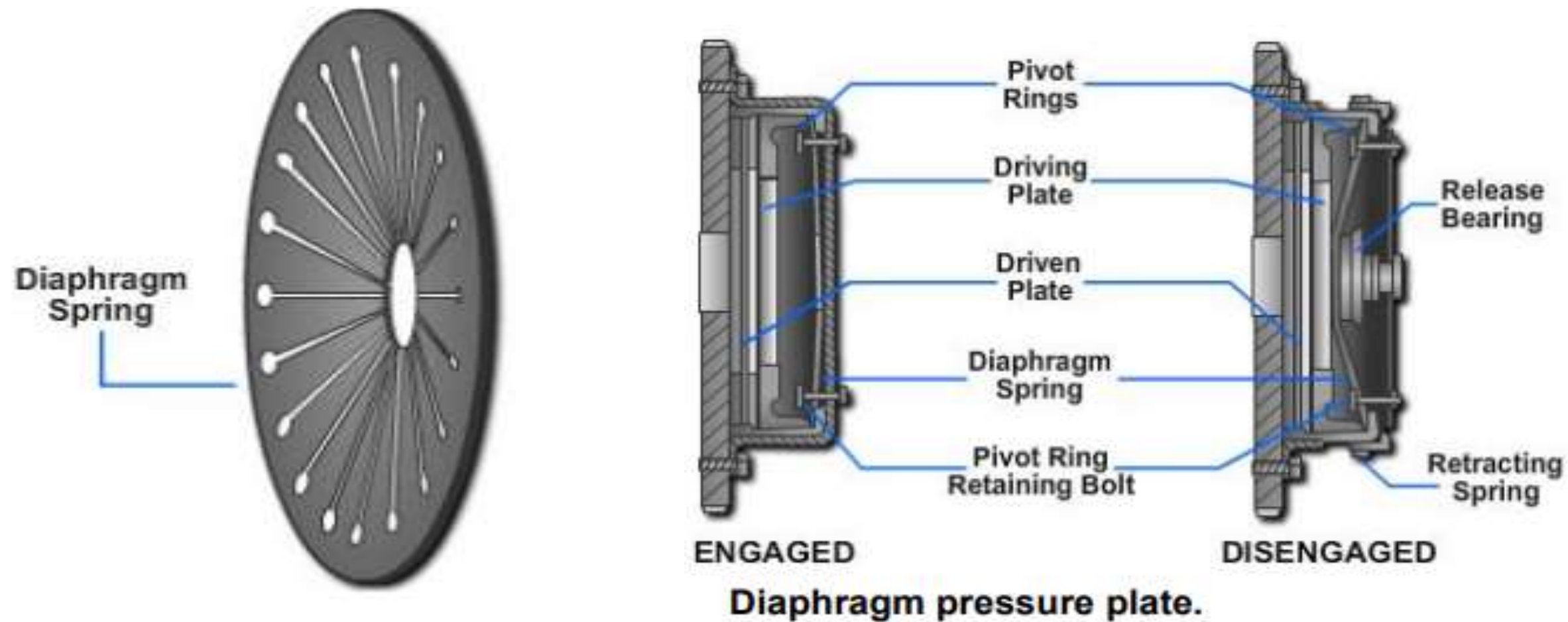
- Oil is pumped to the accumulator from the reservoir through a pump by an engineer.
- The connection between the accumulator and cylinder takes place by a control valve. The engine of the vehicle operates the pump.
- A switch controls the valve. Apart from that, a linkage mechanism is used by engineers to establish the connection between piston and clutch.
- The driver of a vehicle presses the gear lever of the vehicle and opens the switch to the valve to enable the oil flow.
- Due to the pressure of oil, the piston of the vehicle starts moving forward and backward that leads the clutch is engaging and disengaging.





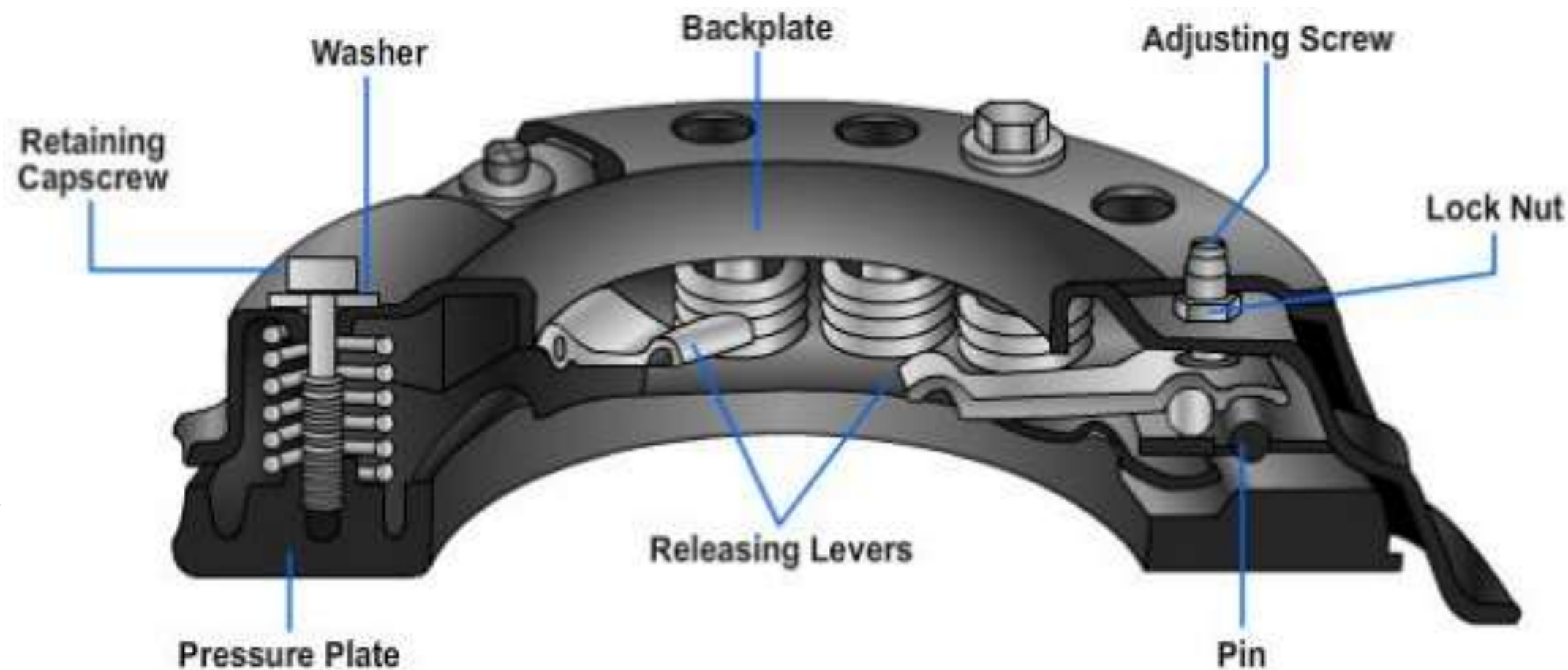
**Diaphragm Pressure Plate** -Diaphragm Pressure Plate The diaphragm pressure plate uses a single diaphragm spring instead of coil springs.

- The diaphragm spring is a large, round disc of spring steel. The spring is bent or dished and has pie-shaped segments running from the outer edge to the center.





- The diaphragm spring is mounted in the pressure plate with the outer edge touching the back of the pressure plate face.
- The outer rim of the diaphragm is secured to the pressure plate and is pivoted on rings approximately 1 inch from the outer edge.

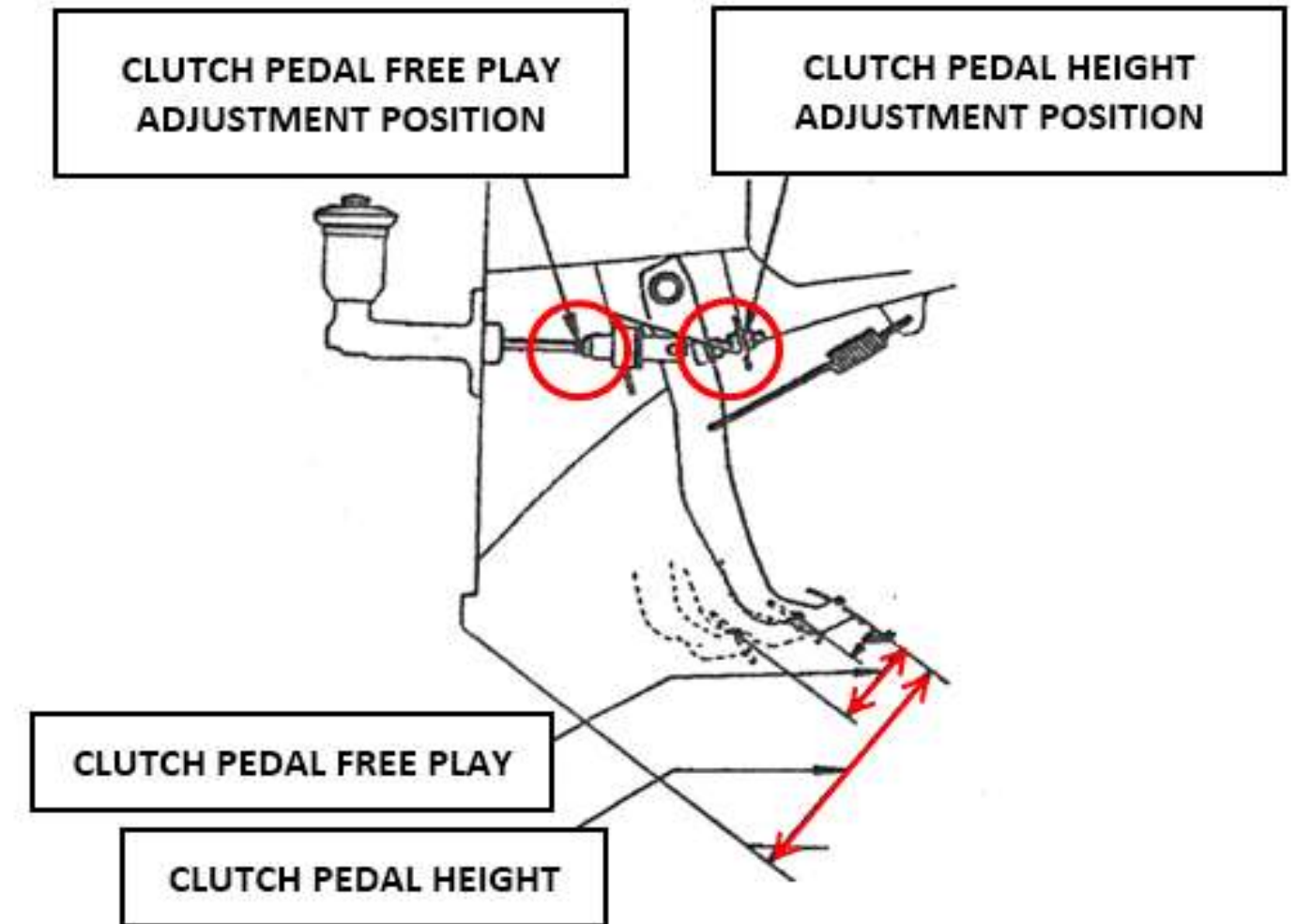


**Coil spring pressure plate.**

When you press the clutch pedal down, does it feel smooth and consistently springy throughout its travel? It should. If your clutch pedal feels soft or 'spongy' at any point as you press it to the floor, it's a sign your clutch fluid is low.

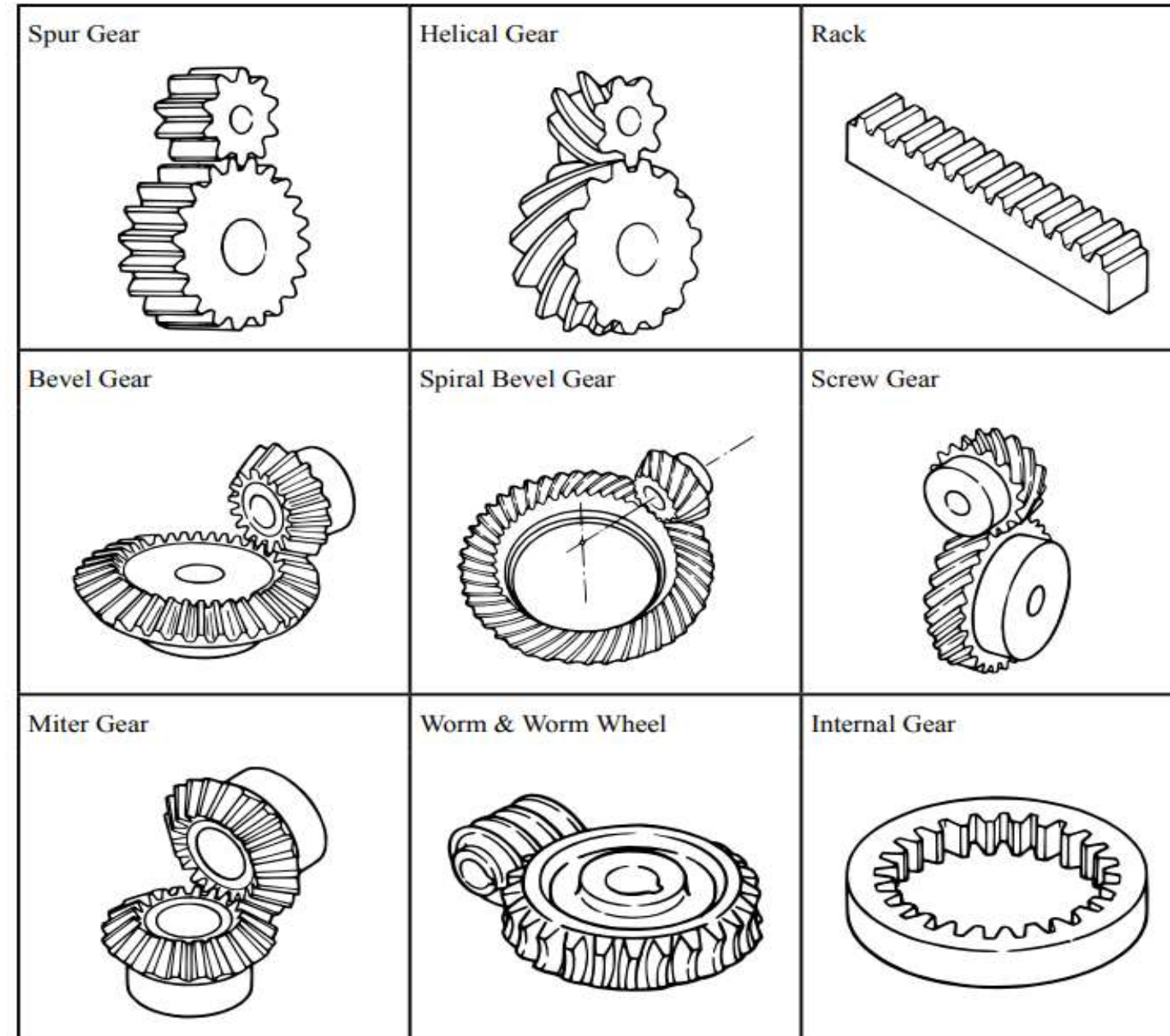
### Symptoms of a Bad or Failing Clutch Cable Adjuster

- Difficulty disengaging the clutch.
- One of the first symptoms commonly associated with a bad or failing clutch cable adjuster is difficulty disengaging the clutch.
- Loose clutch pedal. Another symptom of a problem with the clutch cable adjuster is a loose clutch pedal.
- Excessively tight clutch cable.





- Gears are wheel-like machine elements that have teeth uniformly spaced around the outer surface.
- Gears can be a fraction of an inch in diameter to a hundred feet in diameter. Gears are used in pairs and are a very valuable design tool.
- An automobile transmission is an excellent example of how this principle is put to use to control vehicle motion.



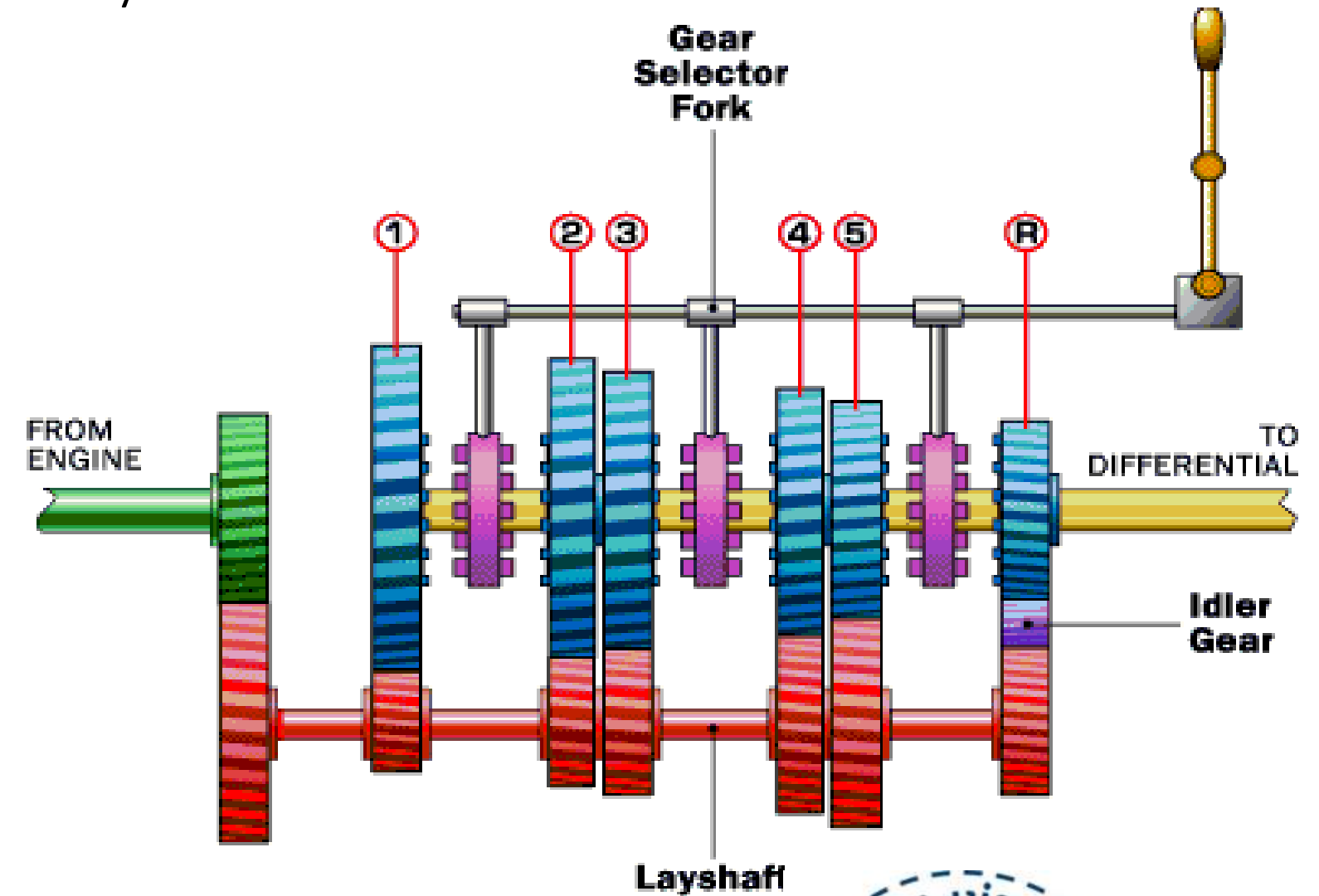


**Material Gears** are made from steel, iron, bronze, and plastic. Steel is the most widely used gear material. Iron is good because of its castability and wear characteristics. Bronze is good for gears where friction is a concern. Plastic gears have good moldability properties but have limited load carrying capability.

**Gear Box Function** - A gearbox uses mechanical advantage to increase output torque and reduce RPM. The motor's shaft is feed into the gearbox and through a series of internal gearing provides the torque and speed conversion.

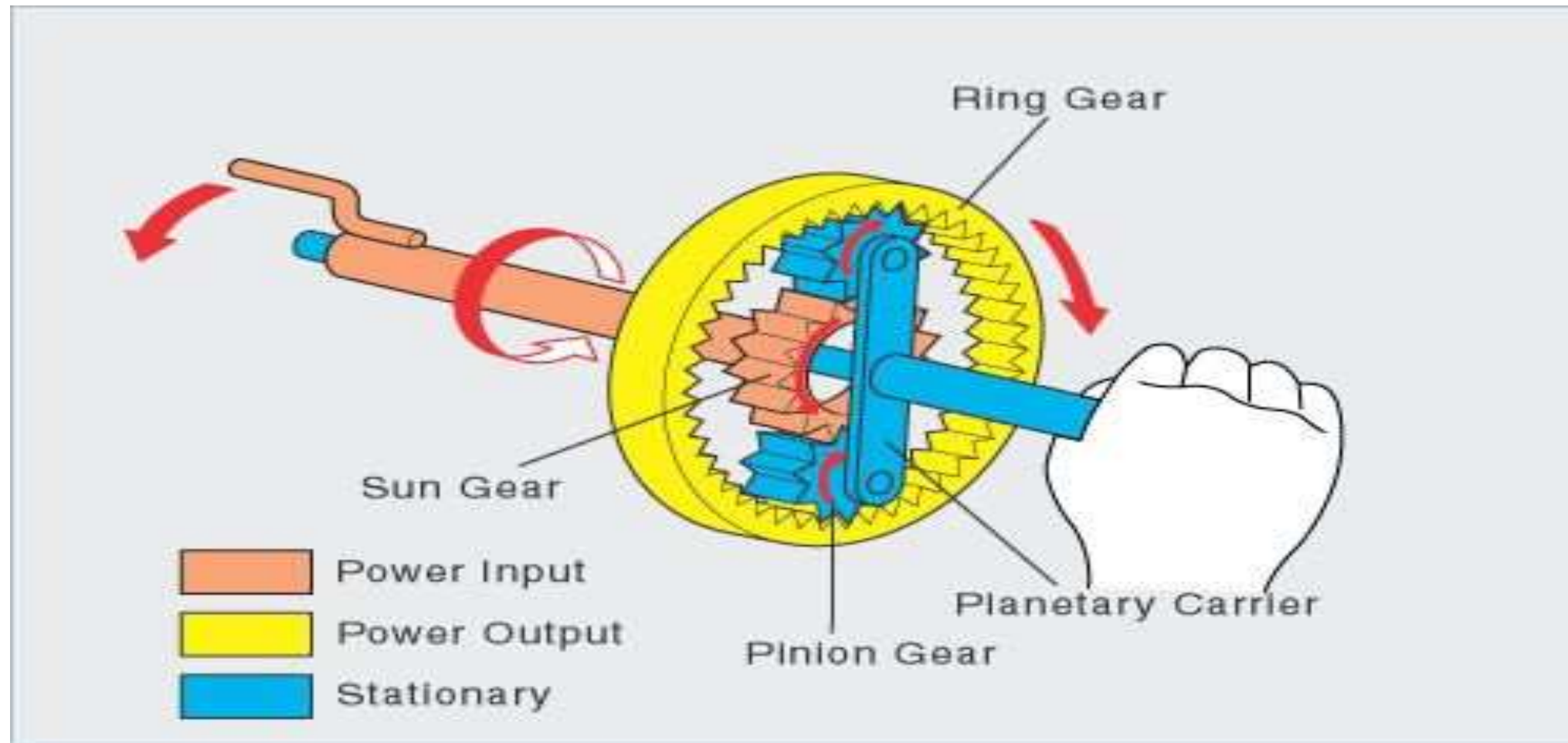
### Here are the different types of Automatic Transmissions

- Traditional Automatic Transmission.
- Manual Transmission. ...
- Continuously Variable Transmission (CVT) ...
- Dual-Clutch Transmission (DCT) ...
- DSG (Direct Shift Gearbox) ...
- Tiptronic Transmission.

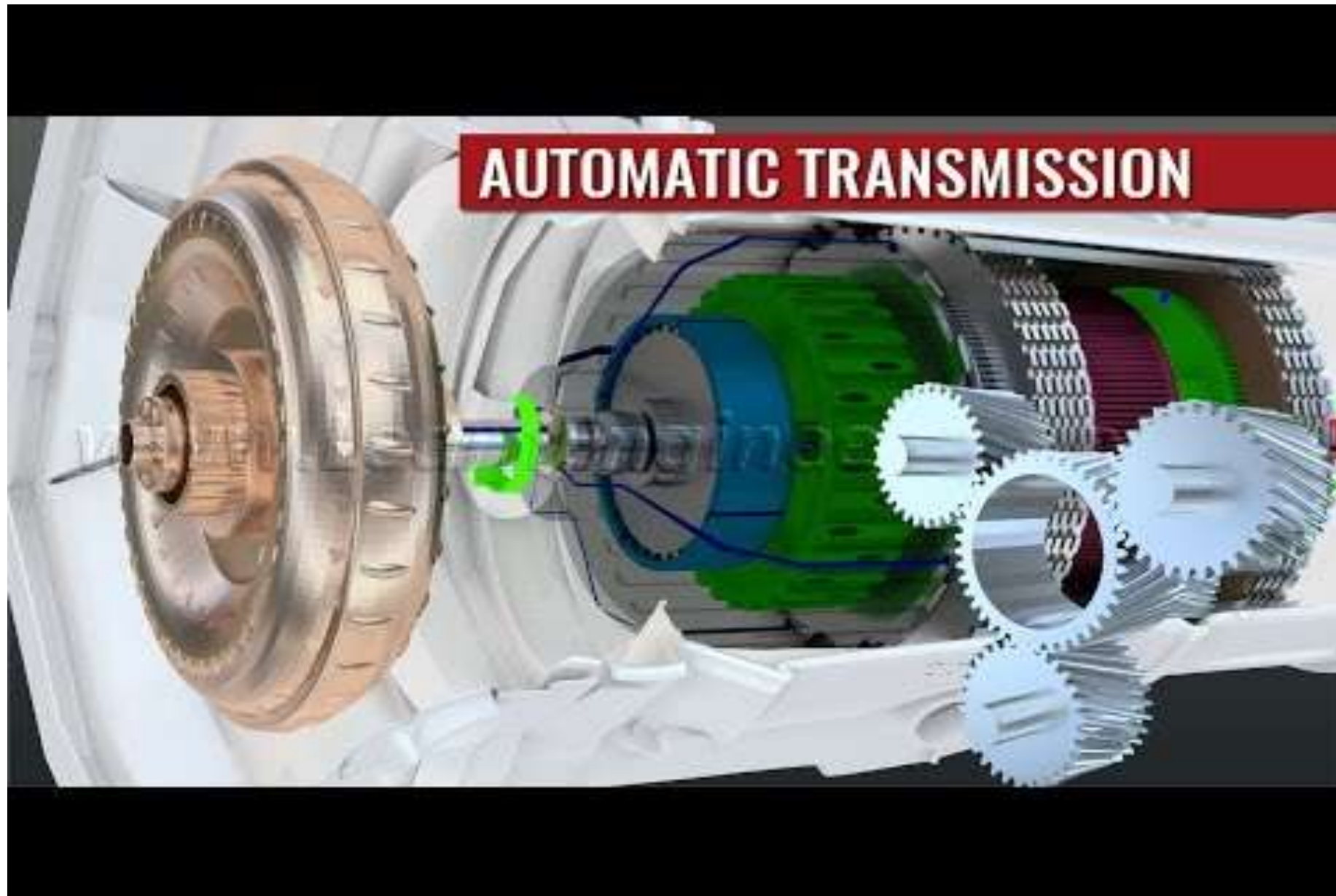


# GEARBOX

An automatic transmission, also called auto, self-shifting transmission,  $n$ -speed Automatic (where  $n$  represents its number of forward gear ratios), or AT, is a type of motor vehicle transmission that automatically changes the gear ratio as the vehicle moves, meaning that the driver does not have to shift the gears manually.



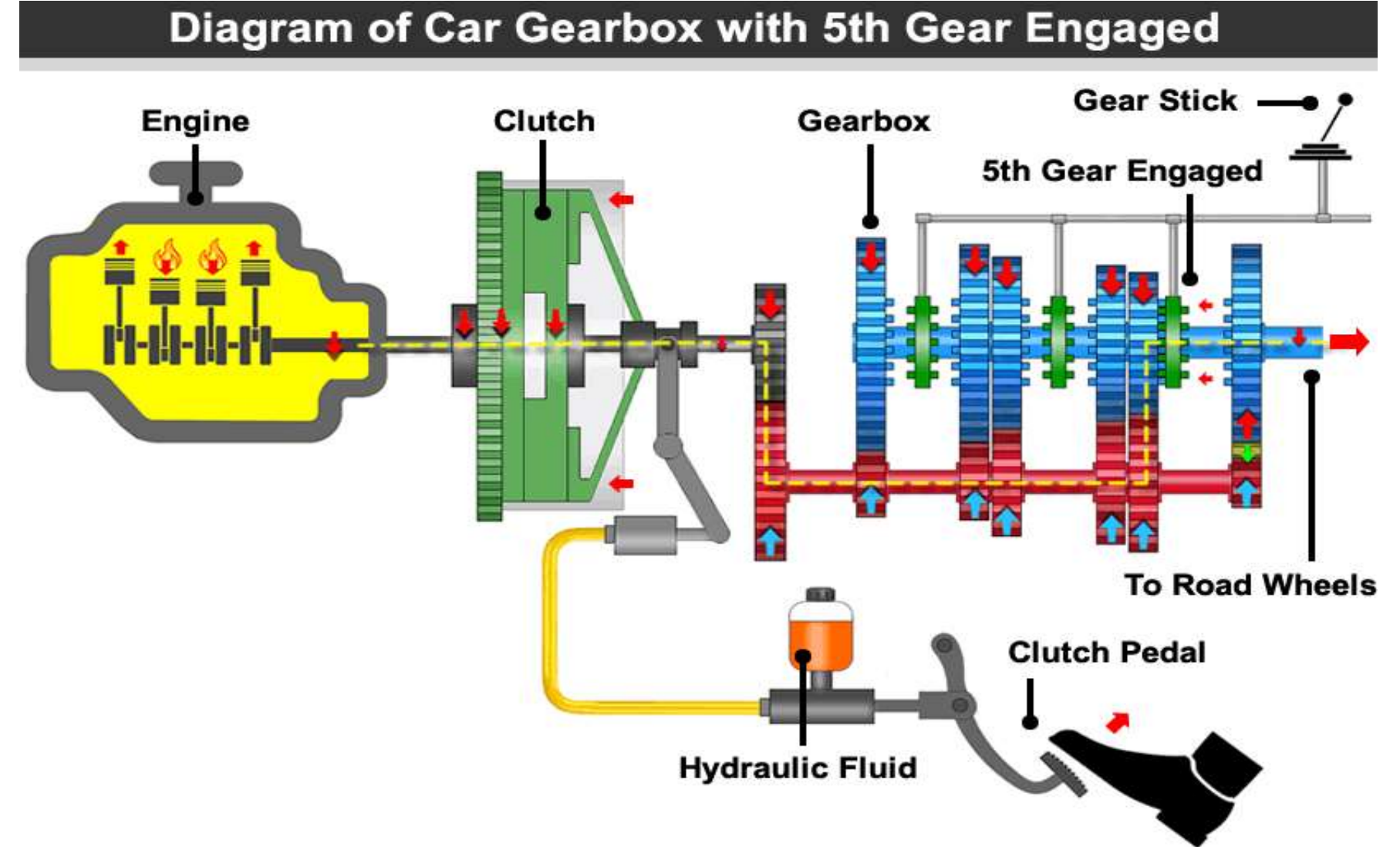




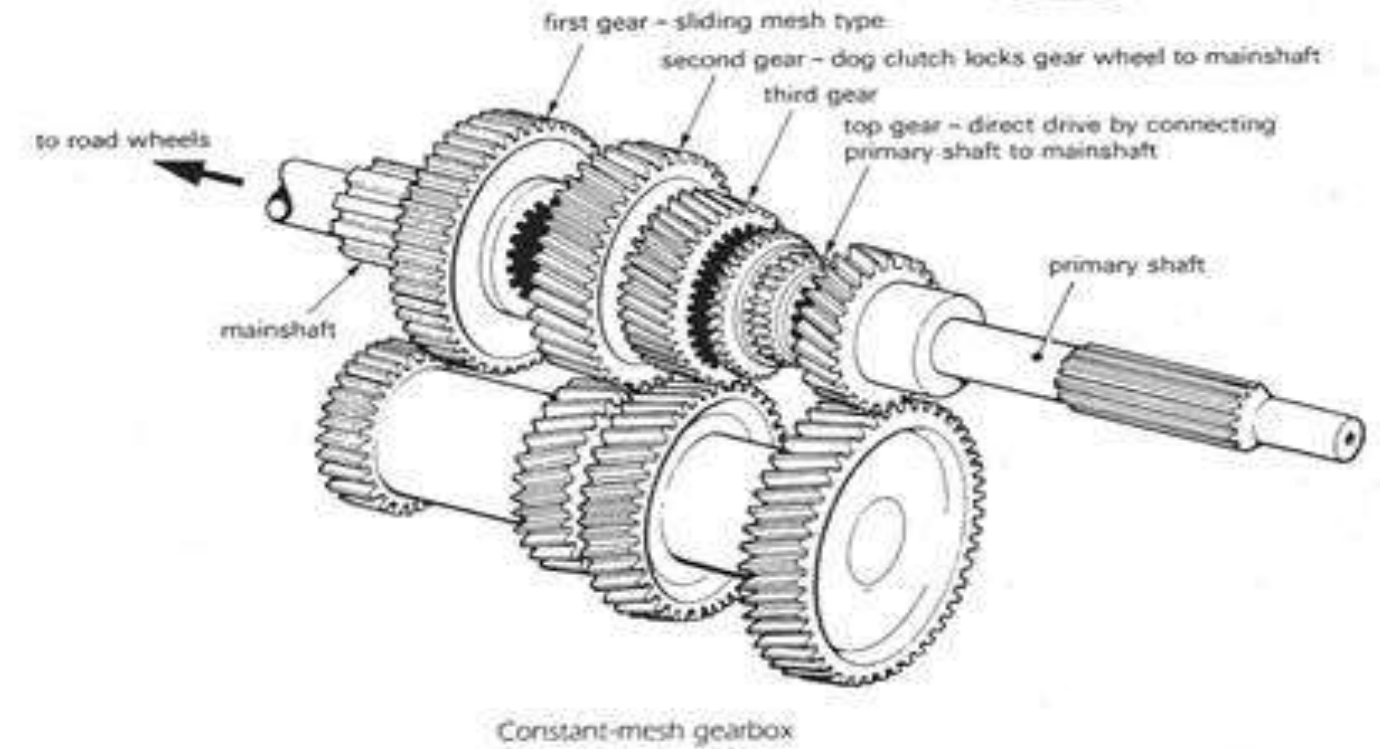
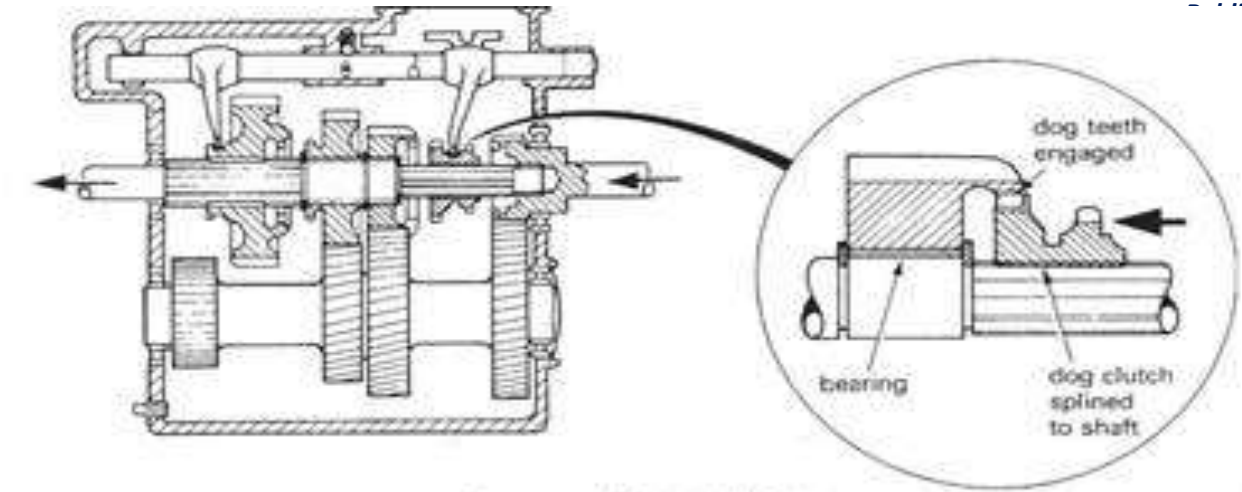
- The most popular form found in automobiles is the hydraulic planetary automatic transmission.
- Similar but larger devices are also used for heavy-duty commercial and industrial vehicles and equipment.
- This system uses a fluid coupling in place of friction clutch, and accomplishes gear changes by hydraulically locking and unlocking a system of planetary gears.
- Auto transmission systems have a defined set of gear ranges, often with a parking pawl that locks the output shaft of the transmission to keep the vehicle from rolling either forward or backward..



- the force apply on clutch pedal
- Master cylinder crate the pressure
- Oil pressure apply force to release bearing
- Release bearing force apply on pressure plate
- Pressure plate press the clutch
- Engine power disconnect to transmission system



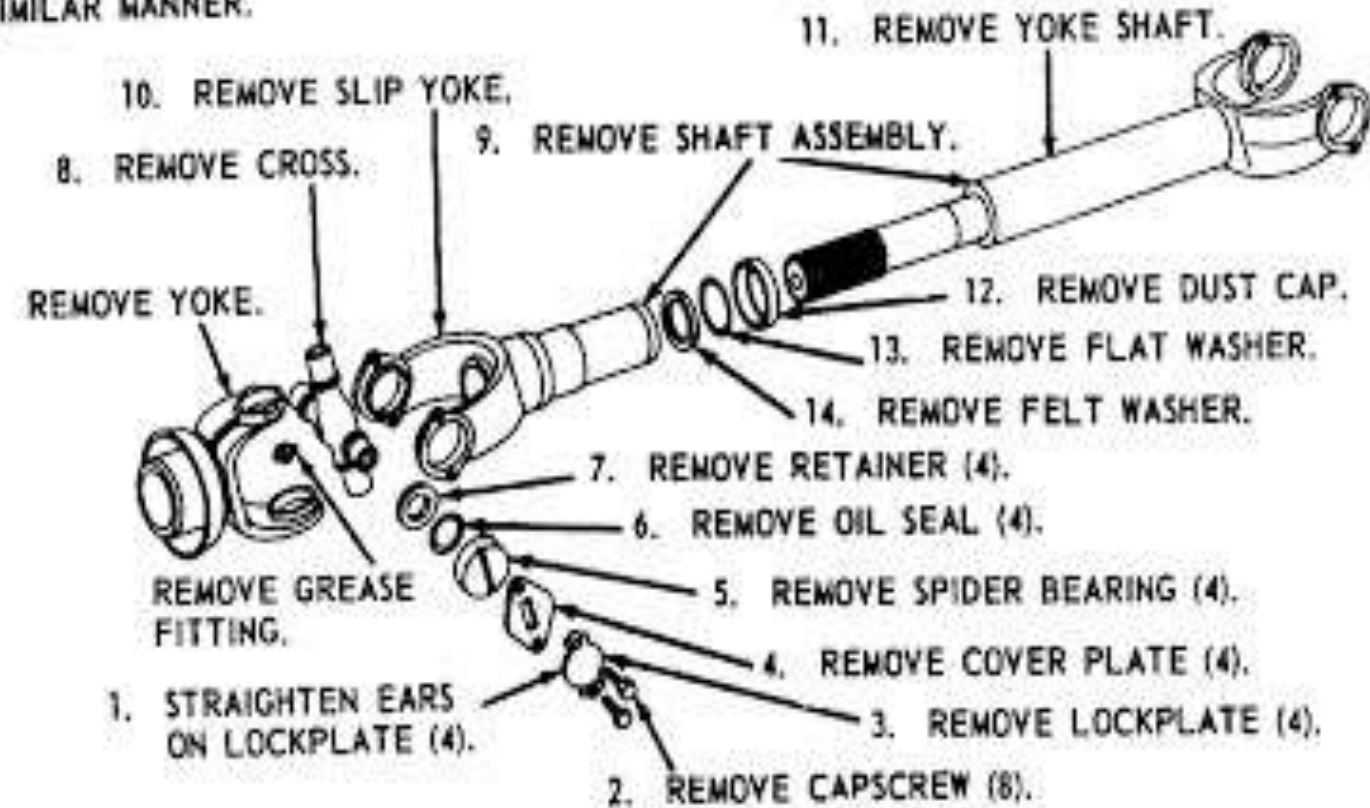
- This gearbox output shaft of a **gearbox** rotates at a slower rate than the input shaft, and this reduction in speed produces a mechanical advantage, increasing torque.
- The purpose of a gearbox is to increase or reduce speed. As a result, torque output will be the inverse of the speed function
- manual transmission consists of three shafts with constantly-intermeshed gears of different sizes. The input shaft connects to the engine, via the clutch.
- There are two type shaft in the gearbox (1) main shaft (2) counter shaft
- Both of shaft are connect with each other gear
- When the vehicle is put into gear the power of the engine goes from the main shaft to the transmission through the counter shaft.





- The propeller shaft transfers the power through the transmission and transfer case to the front/rear axle differential carrier (final reduction gear).
- It is manufactured by a thin rounded steel pipe to have the strong resisting force against the torsion and bending.
- Both ends of propeller shaft are connected to the spider and the center of propeller shaft is connected to the spline to accommodate the changes of the height and length.
- The rubber bushing that covers the intermediate bearing keeps the balance of rear propeller shaft and absorbs its vibration.

NOTE: OPPOSITE END OF SHAFT IS REMOVED IN A SIMILAR MANNER.



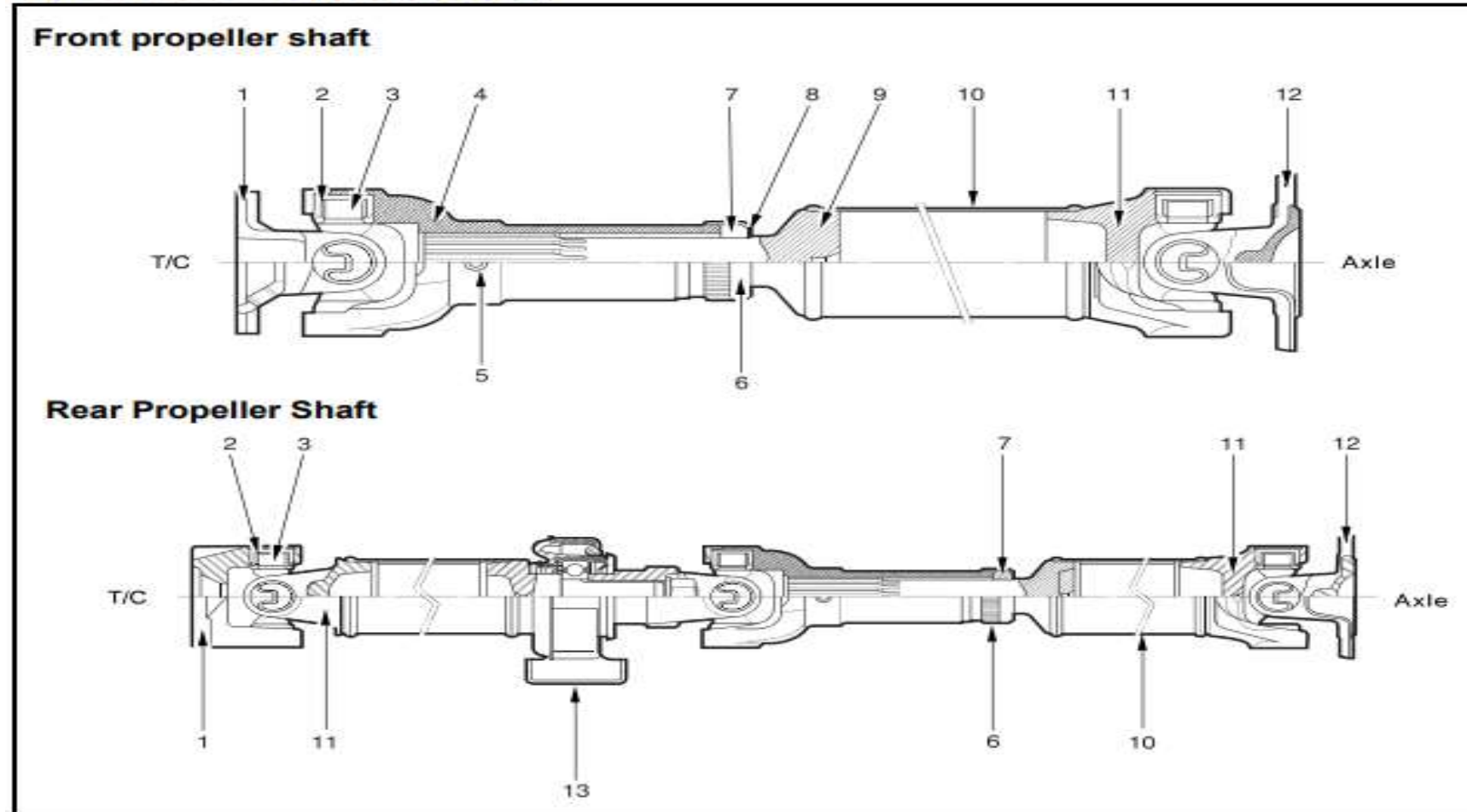
NOTE: THE SLIP YOKE AND YOKE SHAFT ARE MARKED WITH ARROWS FOR ALINEMENT AT REASSEMBLY.

EMC 3810-207-20/189



## 2. COMPONENT LOCATOR

### 1) Cross Sectional View



1. Flange yoke
2. Journal bearing cap
3. Spider journal
4. Slip yoke assembly
5. Grease nipple
6. Dust cap
7. Oil seal

8. Split washer
9. Slip tube shaft
10. Tube
11. Tube yoke
12. Flange yoke
13. Center bearing

### Disassembly propllershaft

- Disassembly Place an alignment mark and remove the propeller shaft. Place an alignment on the spiders before removing.
- Remove the snap ring with snap ring pliers. Tap the yoke shoulder on shaft with copper hammer to remove the roller bearing.

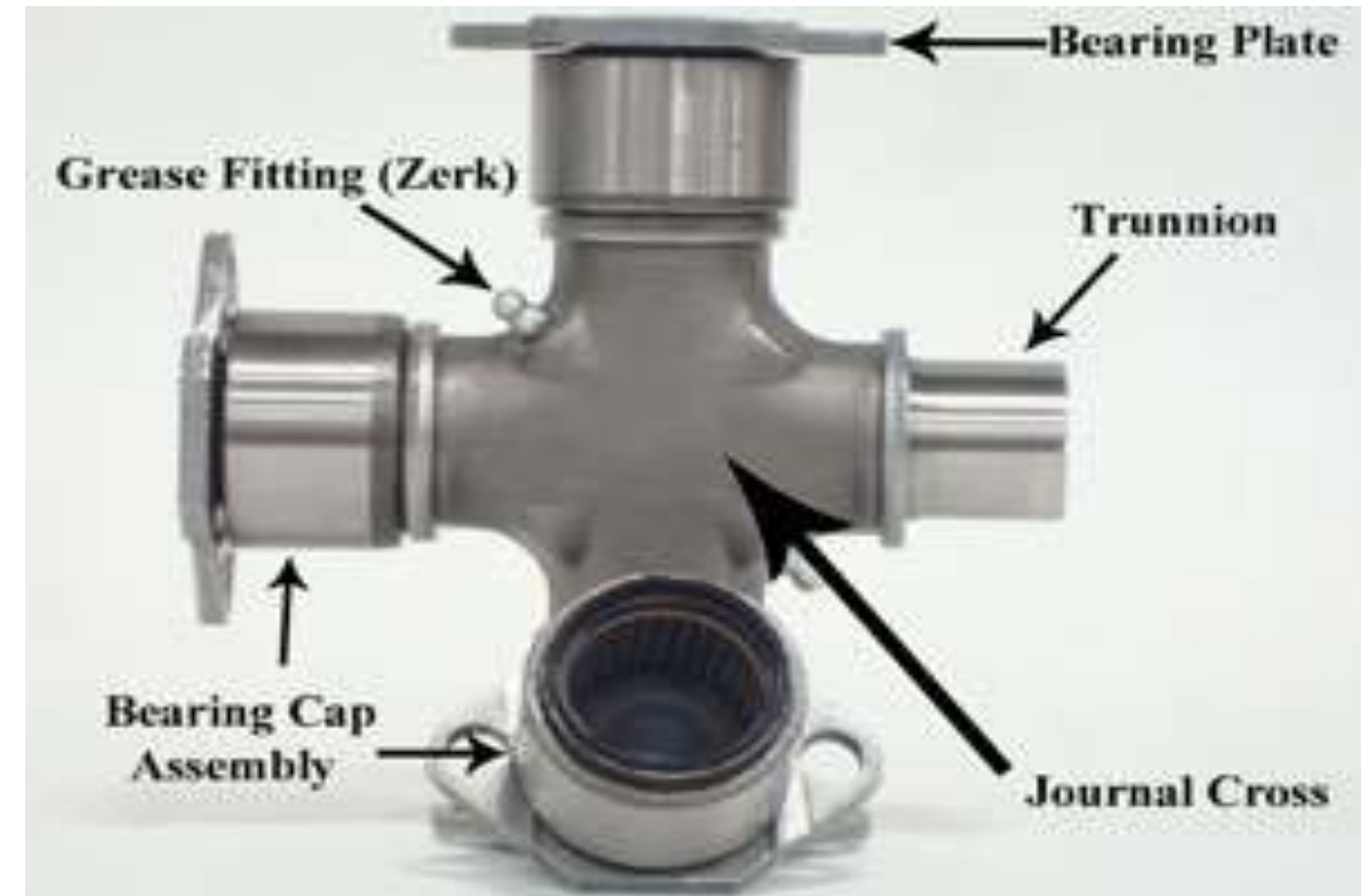
- Remove the other bearings with same manner.
- If it cannot be removed, hold the welding area with vise and remove the needle bearing by using a suitable drift and hammer.
- Disassemble the universal joint. The universal joint compensates the angle changes due to vertical movement of the axle shaft.
- Remove the intermediate bearing bracket and remove the bearing with special tool.

Function of the universal joint- Increase or decrease the length of the propeller shaft when the vehicle falls into the pit

**Material** -Common materials used include stainless steel, steel, naval brass and other similar alloys.

## Universal Joints (Automobile)

- Universal Joints.
- Basic Types of Universal Joints **Cross-type Joint**.
- Speed Variation of a Hooke-type Joint due to Drive and Driven Shaft Inclination.
- Double Hooke's Type CV Joint.
- Tracta Constant Velocity Joint.
- Rzeppa Joint.
- Carl Weiss Constant Velocity Joint.
- Tripode (Tripot) Type CV Joint.

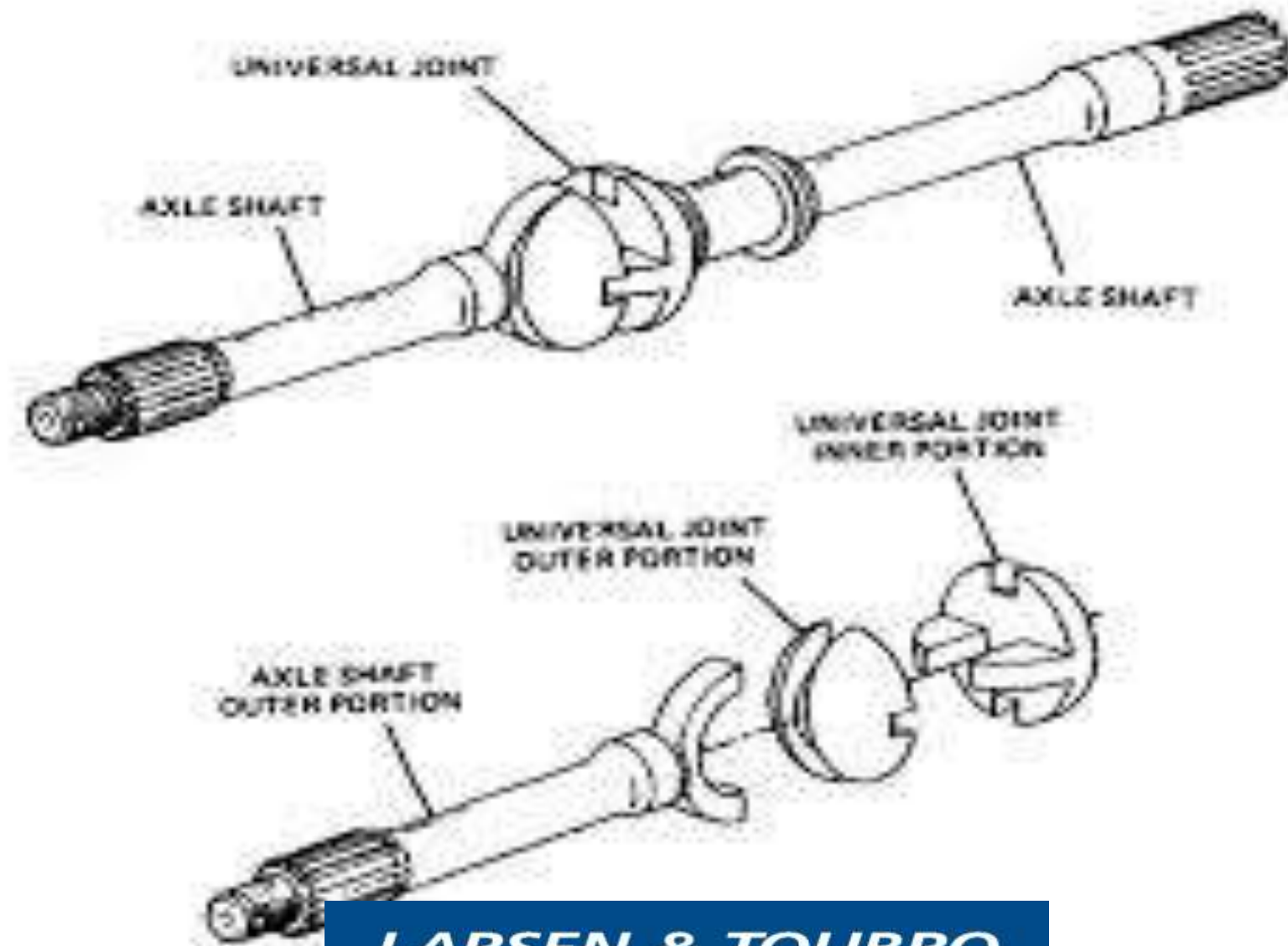




**Basic operation of a CV joint is as follows:**

The outboard CV joint is a fixed joint that transfers rotating power from the axle shaft to the hub assembly.

The inboard CV joint is a sliding joint that functions as a slip joint in a drive shaft for rear-wheel drive vehicles.





# DIFFERENTIAL



- When a car turns a corner, one wheel is on the "inside" of a turning arc, and the other wheel is on the "outside." Consequently, the outside wheel has to turn faster than the inside one in order to cover the greater distance in the same amount of time.

**works:** Assuming the wheels do no slip and spin out of control, the following two examples of car motion describe how the differential works when the car is going forward and when it is turning.

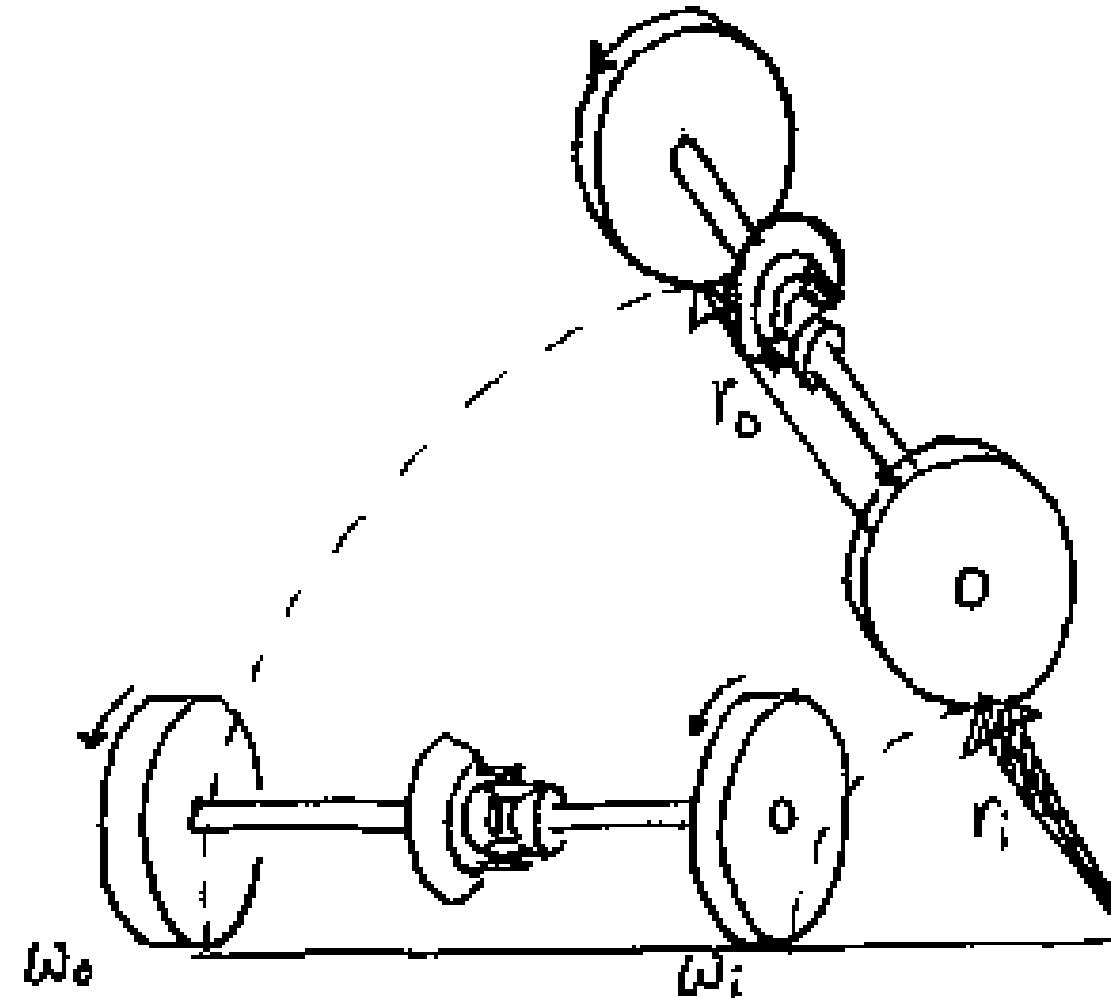


## Differential When Car Turns A Corner (Wheels 2 On Outside of Turn)

When the car is turning, the wheels must move at different speeds. In this situation, the planet pinions spin with respect to the crown wheel as they turn around the sun gears. This allows the speed of the crown gear to be delivered unevenly to the two wheels.

### 4 Different Types of Differentials (and How They Work)

- Open **Differential**.
- Limited-Slip **Differential**.
- Locking **Differential**.
- Torque-Vectoring **Differential**.



$$r_o > r_i \text{ ; } \omega_o > \omega_i$$

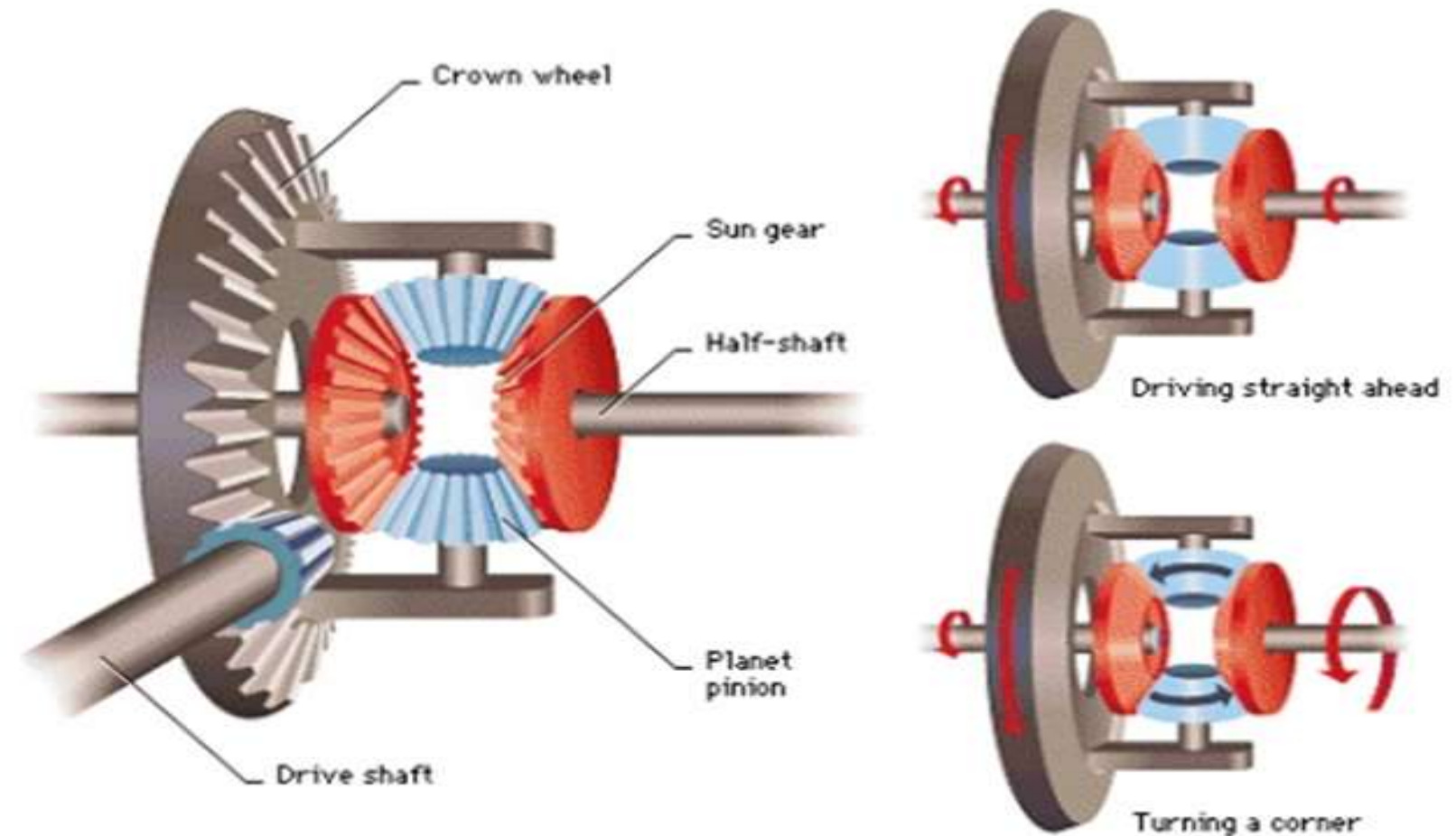


## ➤ Open Differential.

❑ A differential in its most basic form comprises two halves of an axle with a gear on each end, connected together by a third gear making up three sides of a square. This is usually supplemented by a fourth gear for added strength, completing the square.

❑ This basic unit is then further augmented by a ring gear being added to the differential case that holds the basic core gears – and this ring gear allows the wheels to be powered by connecting to the drive shaft via a pinion.

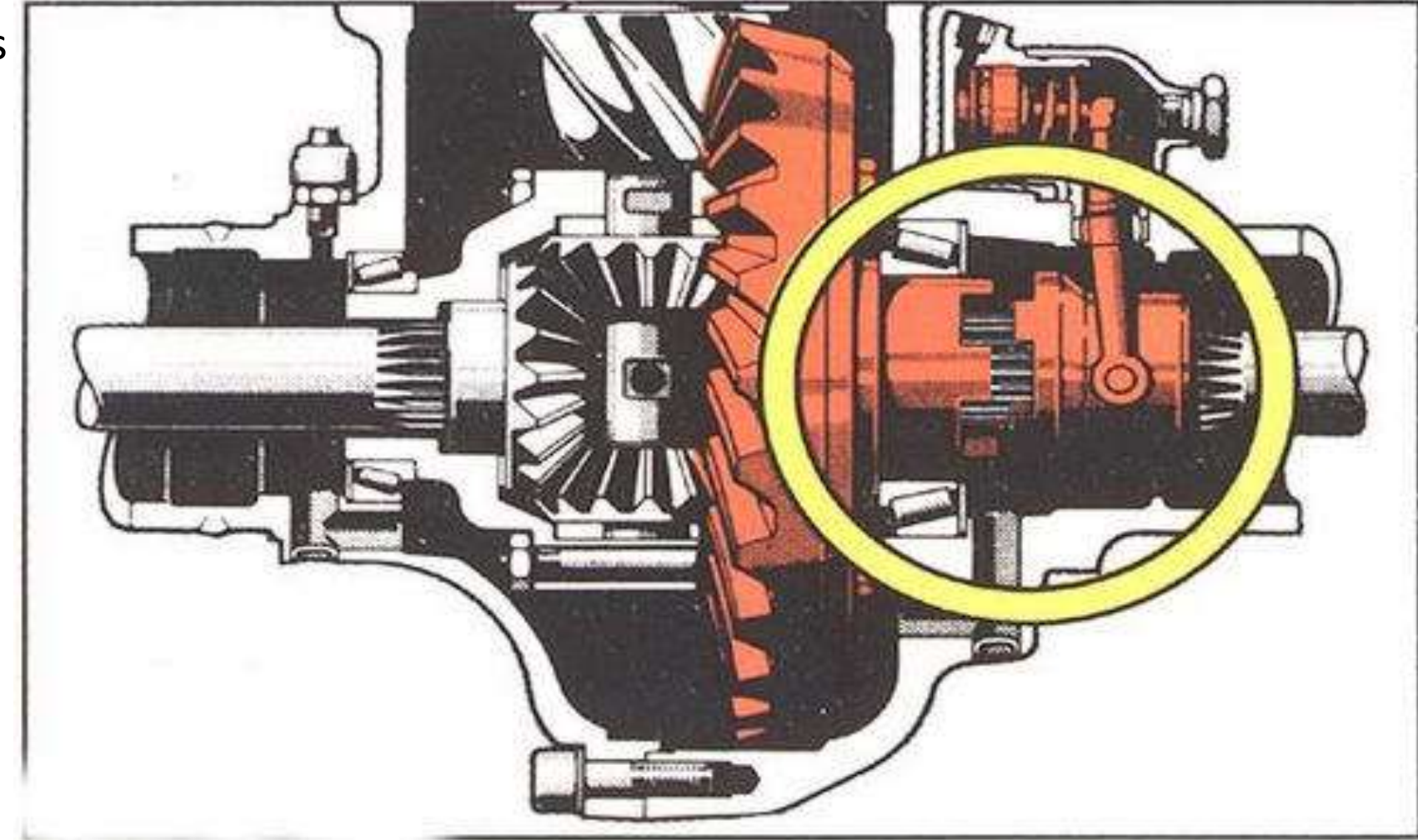
## Differential Action (Open Differential)



- ❑ This gearing arrangement makes up the open type differential, and is the most common type of automotive differential from which more complicated systems are derived.
- ❑ The benefit of this type is mostly limited to the basic function of any differential as previously described, focusing primarily on enabling the axle to corner more effectively by allowing the wheel on the outside of the turn to move at a faster speed than the inside wheel as it covers more ground.
- ❑ The disadvantage of this type is that because the torque is split evenly between both wheels, the amount of power able to be transmitted through the wheels is limited by the wheel with the lowest amount of grip.
- ❑ Once the traction limit of both wheels combined is reached, the wheel with the lowest amount of traction will begin to spin – reducing that limit even further as there is even less resistance from the already spinning wheel.



- Differential is a system that transmits an engine's torque to the wheels. The differential takes the power from the engine and splits it, allowing the wheels to spin at different speeds.
- Engine vertical power translate in to horizontal power
- Turn it around a corner and you'll have no issues, as each wheel is able to turn independently from the other.
- The power goes from gear box to differential
- It has sun gear and a crown wheel
- Live axle attached with sun gear and sun gear attached with crown wheel.

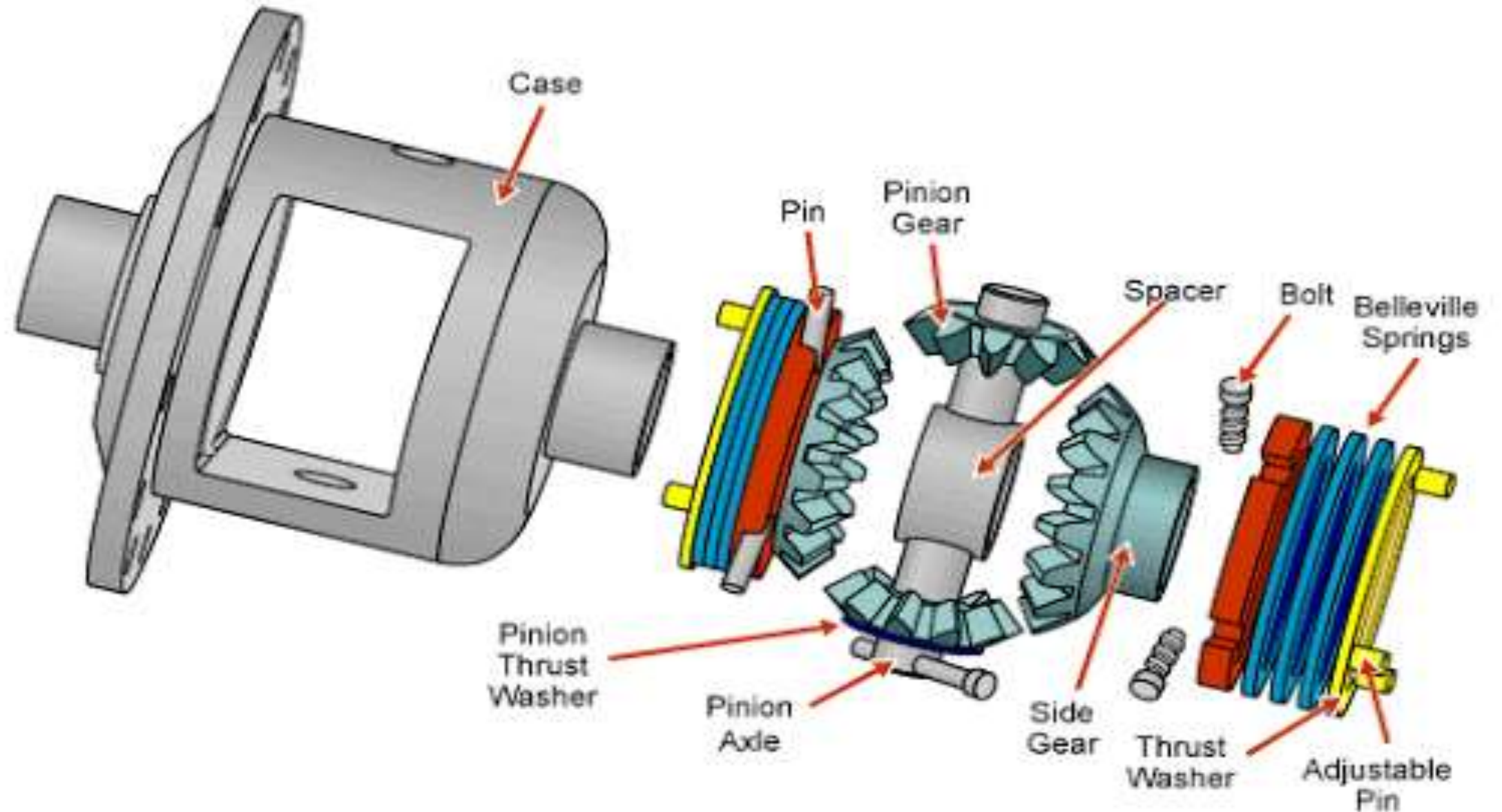




➤ **LIMITED SLIP DIFFERENTIAL:**

LSD's work to combine the benefits of Open and Locked differentials through a more complicated system.

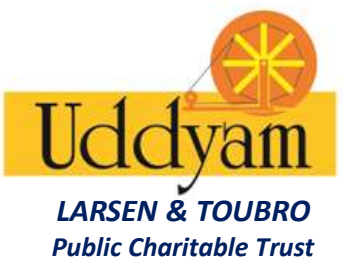
There are two categories which use different forms of resistance to achieve the same effect.



- ❑ In a **one-way LSD**, the pressure is only exerted under acceleration. This means that when cornering and off the power the diff behaves as an open type, allowing them to turn independently – but under acceleration the forced rotation of the differential creates friction in the clutch plates, locking them in place in order to gain more traction.
- ❑ A **Two way LSD** takes it a step further and exerts pressure on the clutch plates under deceleration too, in an effort to improve stability under braking on variable road surfaces.
- ❑ The **one and half way** again tries to combine the best of both subtypes, by exerting a greater amount of pressure under acceleration and lesser amount under deceleration.



# DIFFERENTIAL



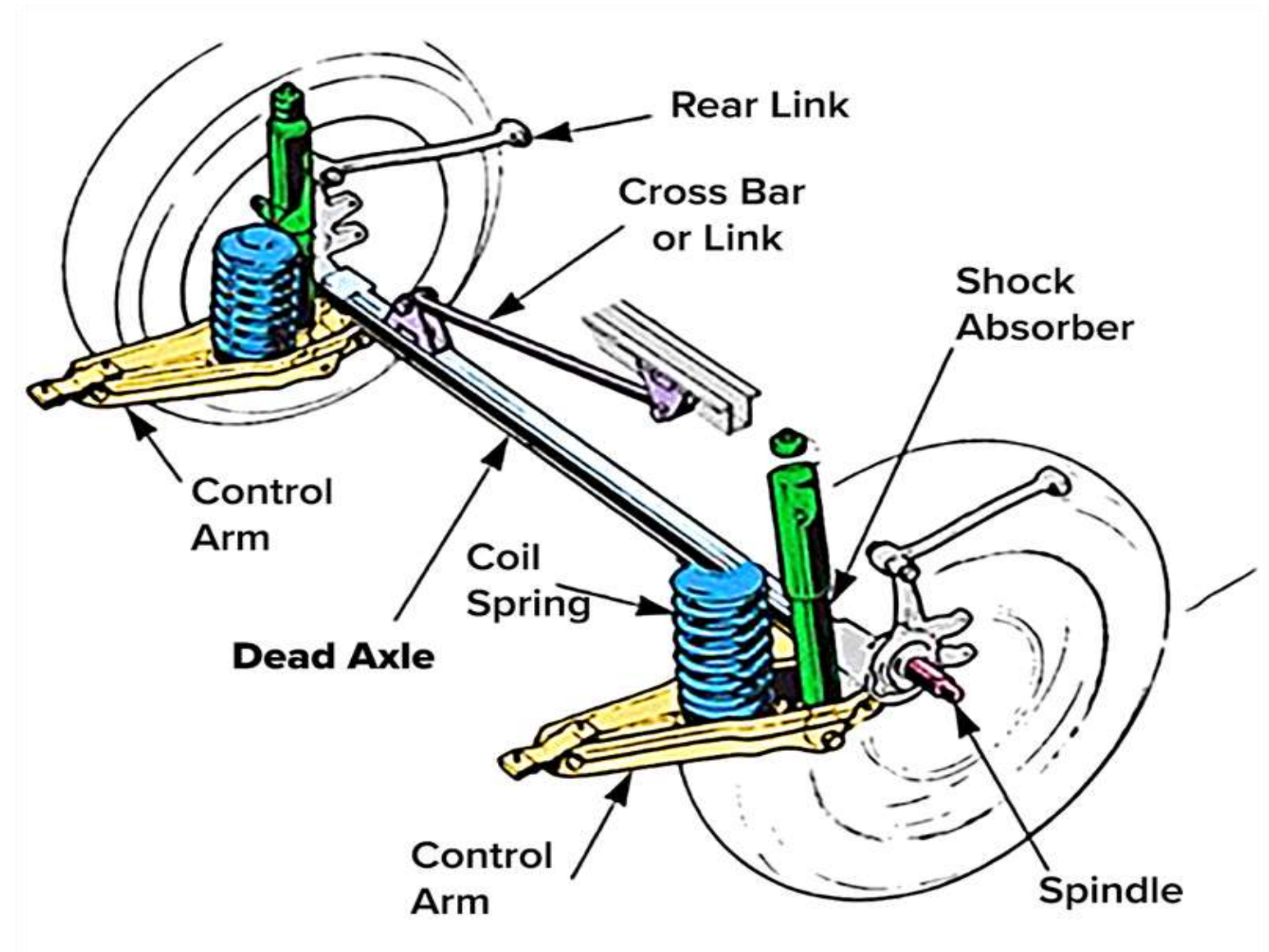
## How do differentials fail, exactly?

- Excessive mechanical wear of gears and bearings caused by poor, inadequate, contaminated, or unsuitable lubrication/lubricants
- Excessive backlash (clearance) between the pinion and ring gears
- Inadequate backlash (clearance) between the pinion and ring gears
- The above points cover a lot of ground, and while it is not always easy to distinguish between cause and effect when it comes to diagnosing differential issues, you can remove a lot of guesswork from the equation if you know and understand some of the basic terms that pertain to differential repair. Below are some-

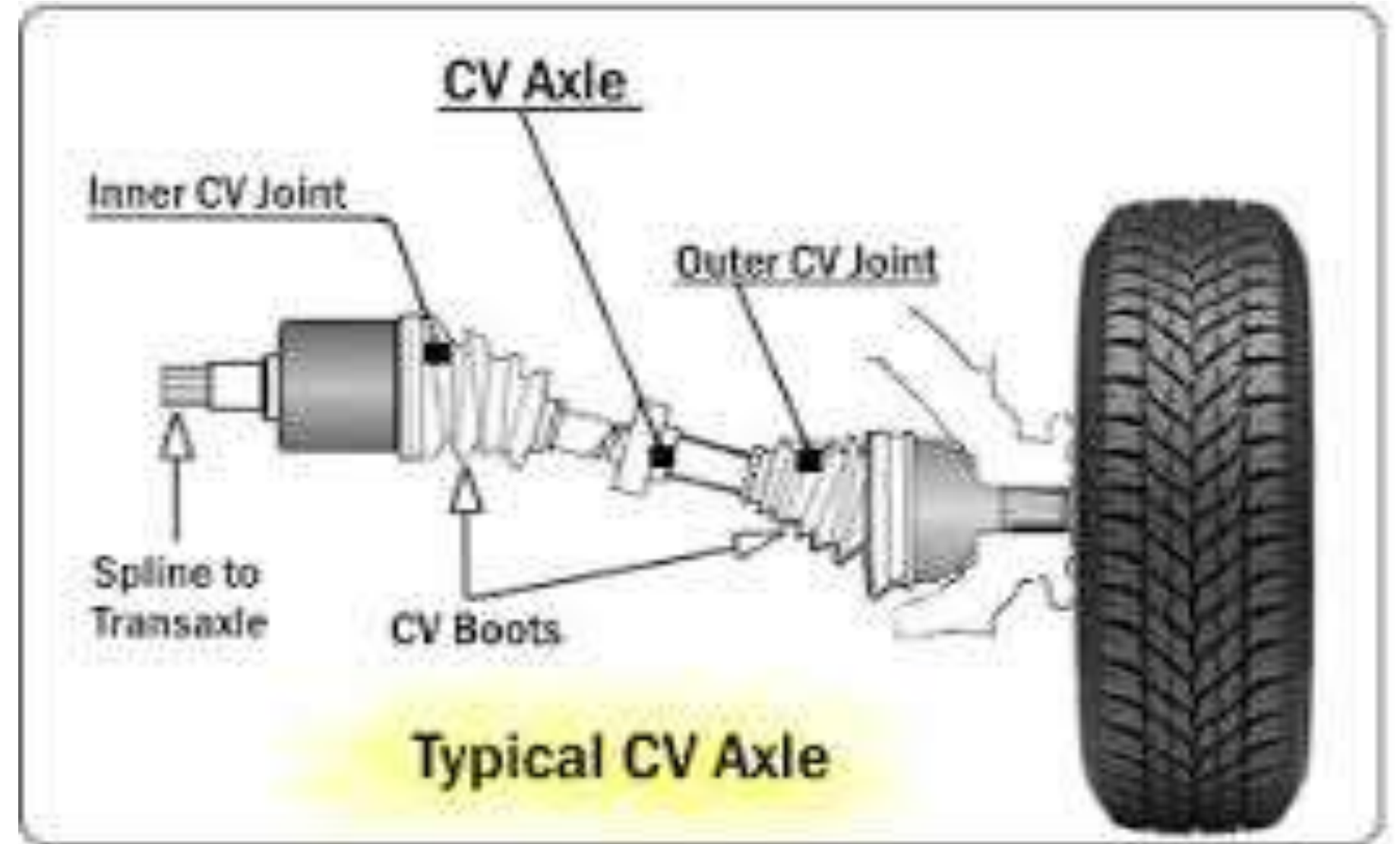


There are two types of axle: (1) Dead Axle (2) Live Axle

- **Dead axle** - Dead axle is the axle which only supports the wheels.
- It does not transfer power or torque to the wheels whatsoever. In case of a front wheel drive, the rear axle is the dead axle, and in case of rear wheel drive, the front axle is the dead axle.
- Dead axles support the weight of the vehicle only while allowing the wheels to rotate freely on the axle.
- The wheels on dead axles are not considered drive wheels since they support the vehicle's weight.
- A dead axle located immediately in front of a drive axle is called a *pusher axle*. A tag axle is a dead axle situated behind a drive axle.



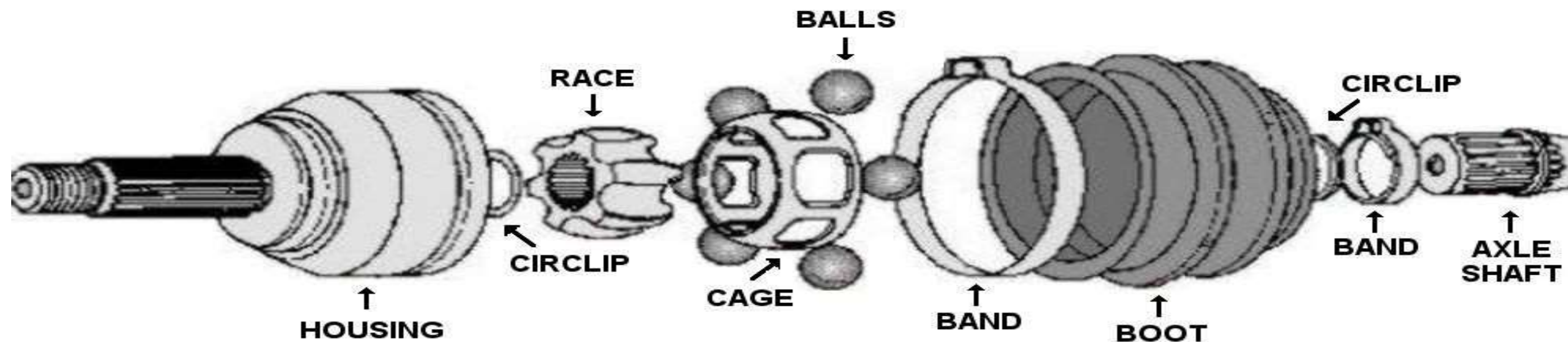
- **Live Axle** - An axle that is driven by the engine or prime mover is called a *drive axle*.
- Modern front-wheel drive cars typically combine the transmission(gearbox and differential) and front axle into a single unit called a *transaxle*.





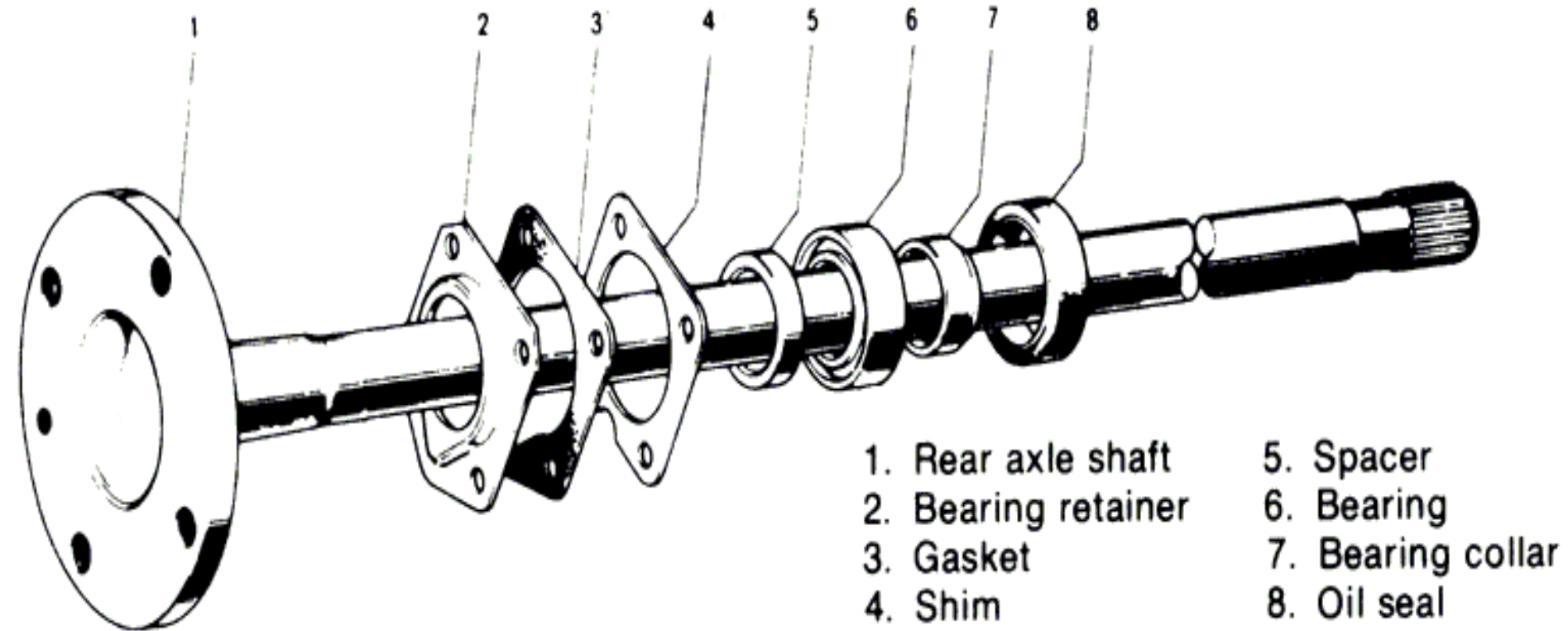
- In rear-wheel drive cars and trucks, the engine turns a driveshaft (also called a *propeller shaft* or *tail shaft*) which transmits rotational force to a drive axle at the rear of the vehicle.
- The drive axle may be a live axle, but modern rear wheel drive automobiles generally use a split axle with a differential.

## CV JOINT COMPONENTS



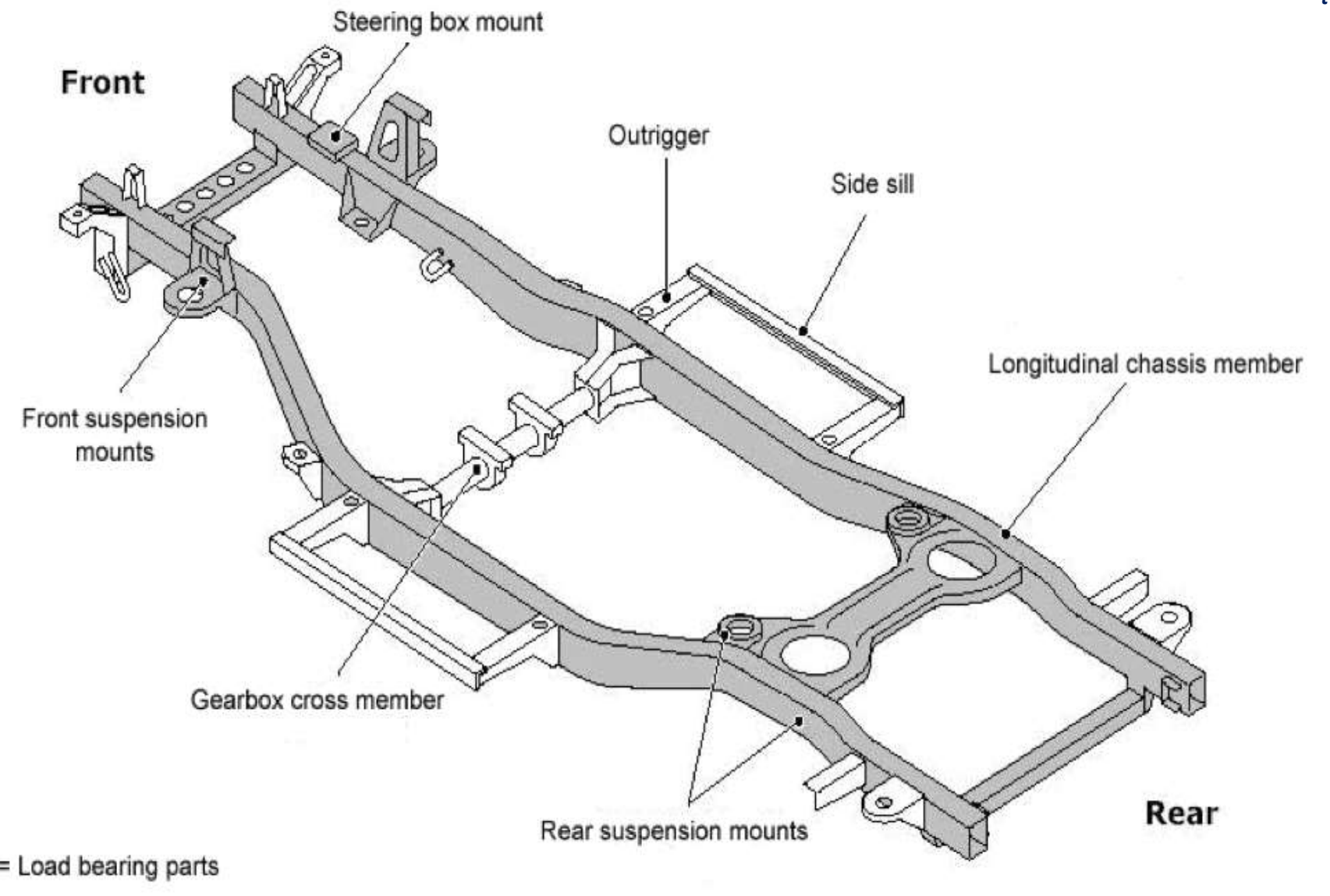


## Live Axle



## Rear drive live Axle

- A **chassis** is the **load-bearing framework** of an artificial object, which structurally supports the object in its construction and function.
- An example of a chassis is a **vehicle frame**, the underpart of a **moto vehicle**, on which the body is mounted
- if the **running gear** such as wheels and transmission, and sometimes even the driver's seat, are included, then the assembly is described

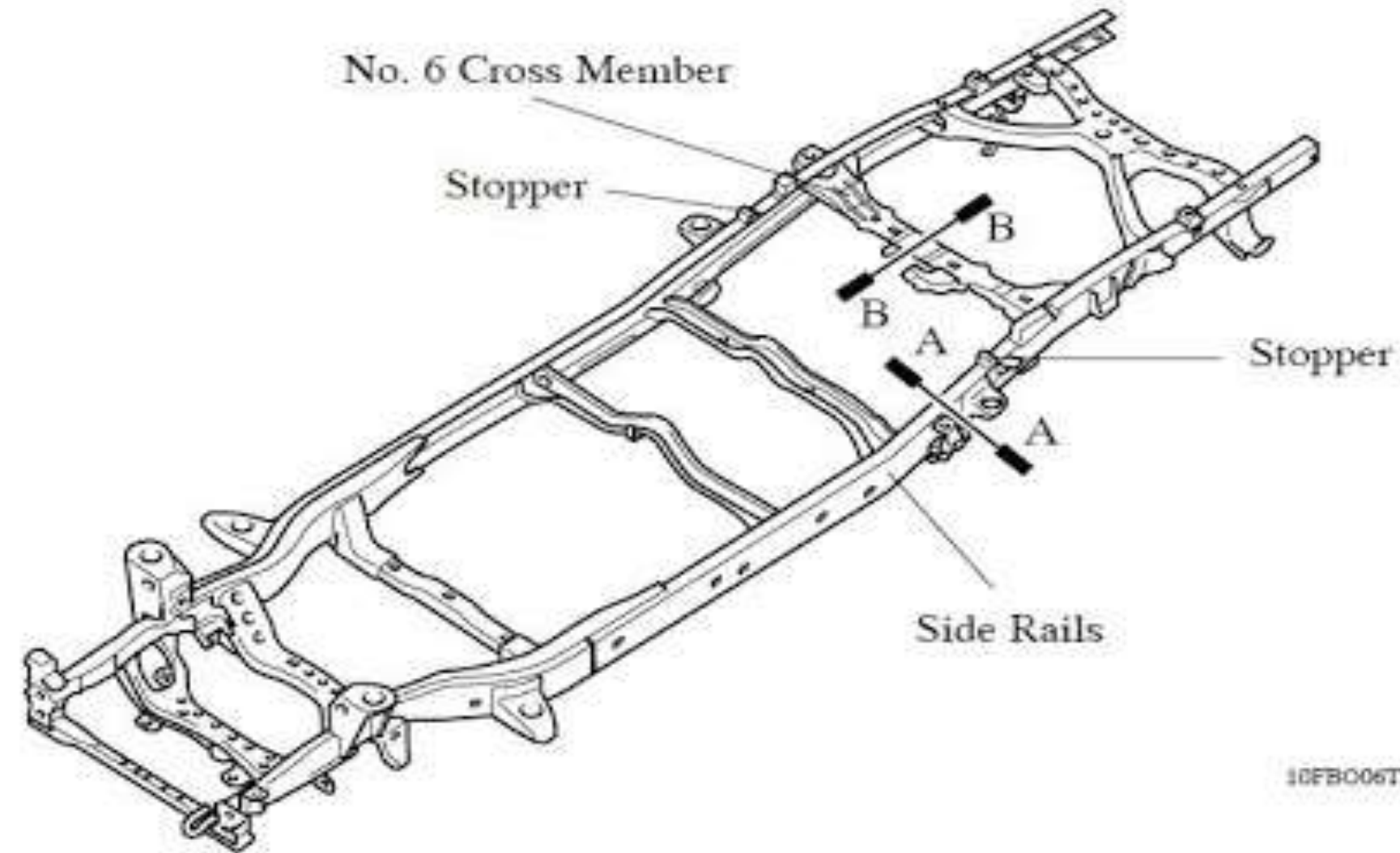


- **Ladder frame** is one of the best that uses the two large longitudinal beams, which is name as long members.
- These are the best solution for the stiffest frames could be carbon fibre or chassis that has welded with a roll cage.
- A tubular frame helps to attach and carry the body and the suspension assembly.
- A tubular frame helps to attach and carry the body and the suspension assembly.
- However, this chassis is heavier at the same time than a single body. The chassis does not provide any protection against any side impacts.



## Types of frame

- ❖ Ladder frame.
- ❖ Unibody.
- ❖ Backbone tube.
- ❖ X-frame.
- ❖ Perimeter frame.
- ❖ Platform frame.
- ❖ Space frame.
- ❖ Sub frame.



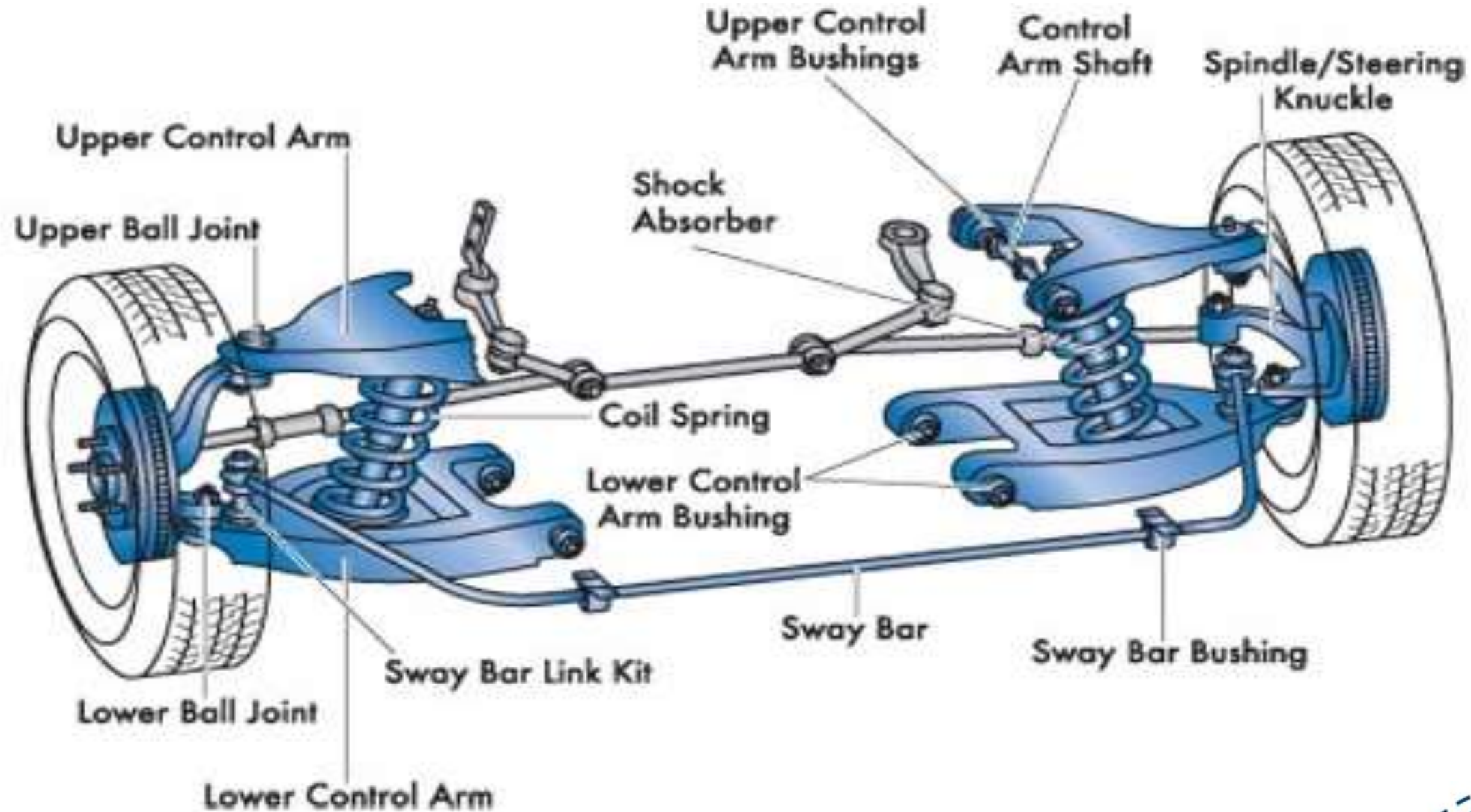
Long Wheelbase Frame for Double Cab



# VEHICLE SUSPENSION SYSTEM

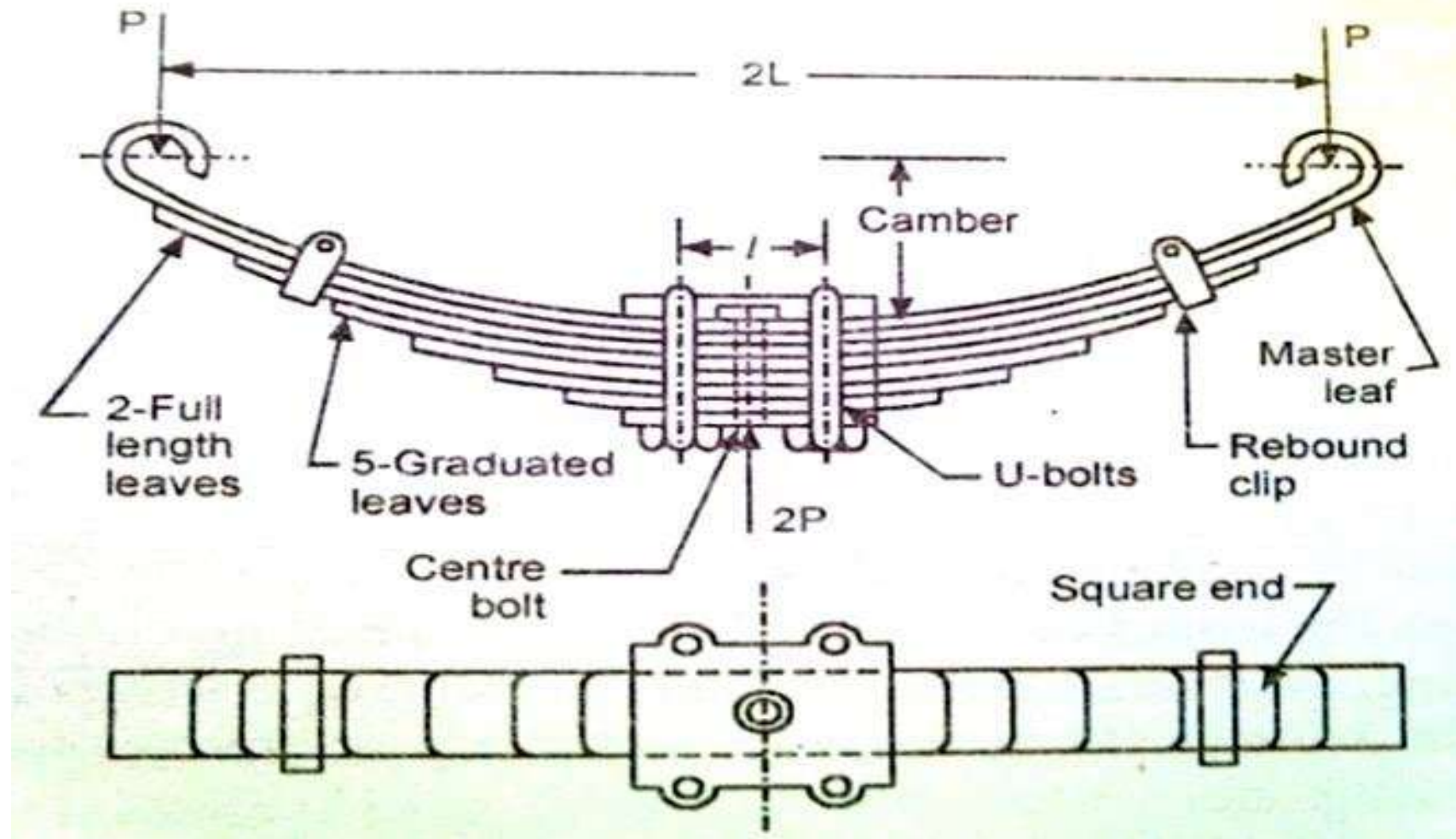
# SUSPENSION SYSTEM

The suspension of a car is actually part of the chassis, which comprises all of the important systems located beneath the car's body. These systems include:





- The **frame** - structural, load-carrying component that supports the car's engine and body, which are in turn supported by the suspension
  - The **suspension system** - setup that supports weight, absorbs and dampens shock and helps maintain tire contact
  - The **steering system** - mechanism that enables the driver to guide and direct the vehicle
  - The **tires and wheels** - components that make vehicle motion possible by way of grip and/or friction with the road
- So the suspension is just one of the major systems in any vehicle.



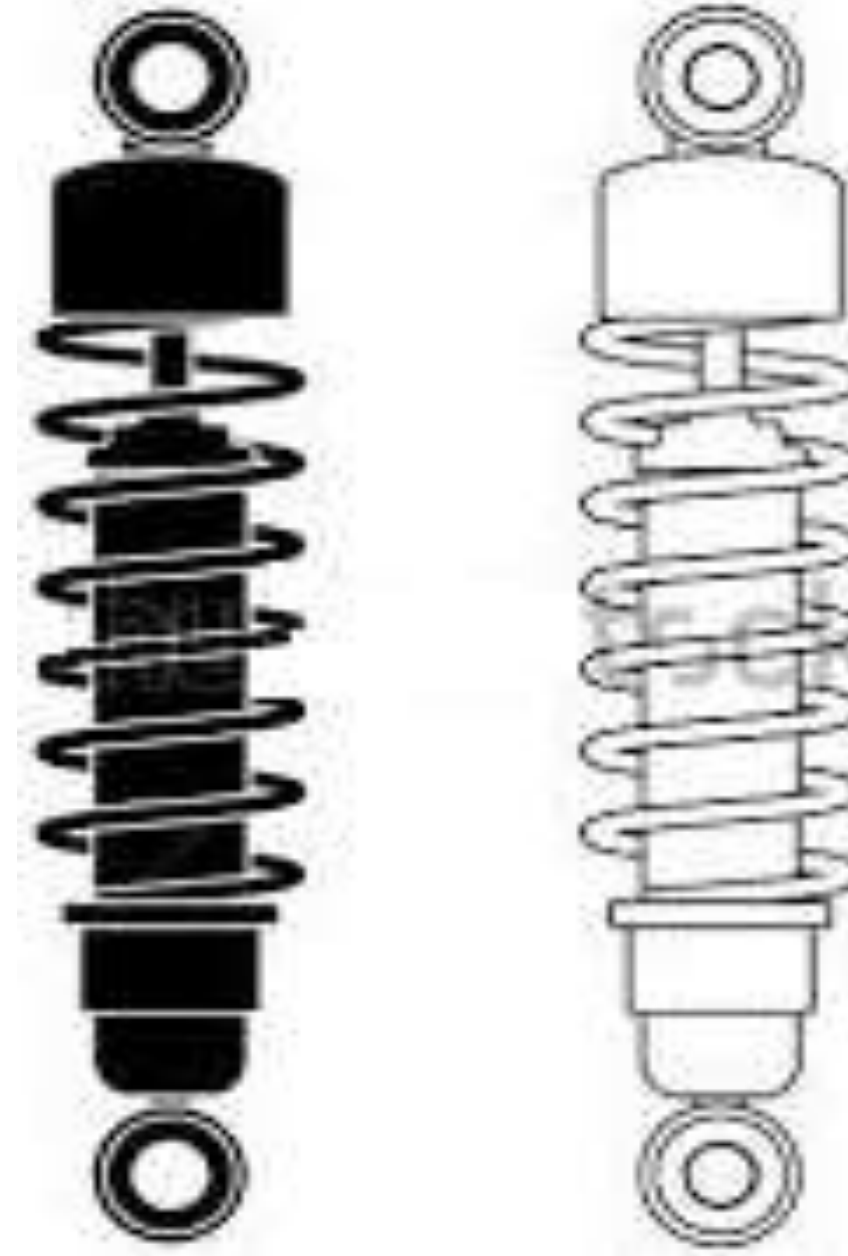
**Leaf springs**

**Leaf springs** consist of several layers of metal (called "leaves") bound together to act as a single unit. Leaf springs were first used on horse-drawn carriages and were found on most American automobiles until 1985. They are still used today on most trucks and heavy-duty vehicles.

Today's springing systems are based on one of four basic designs:

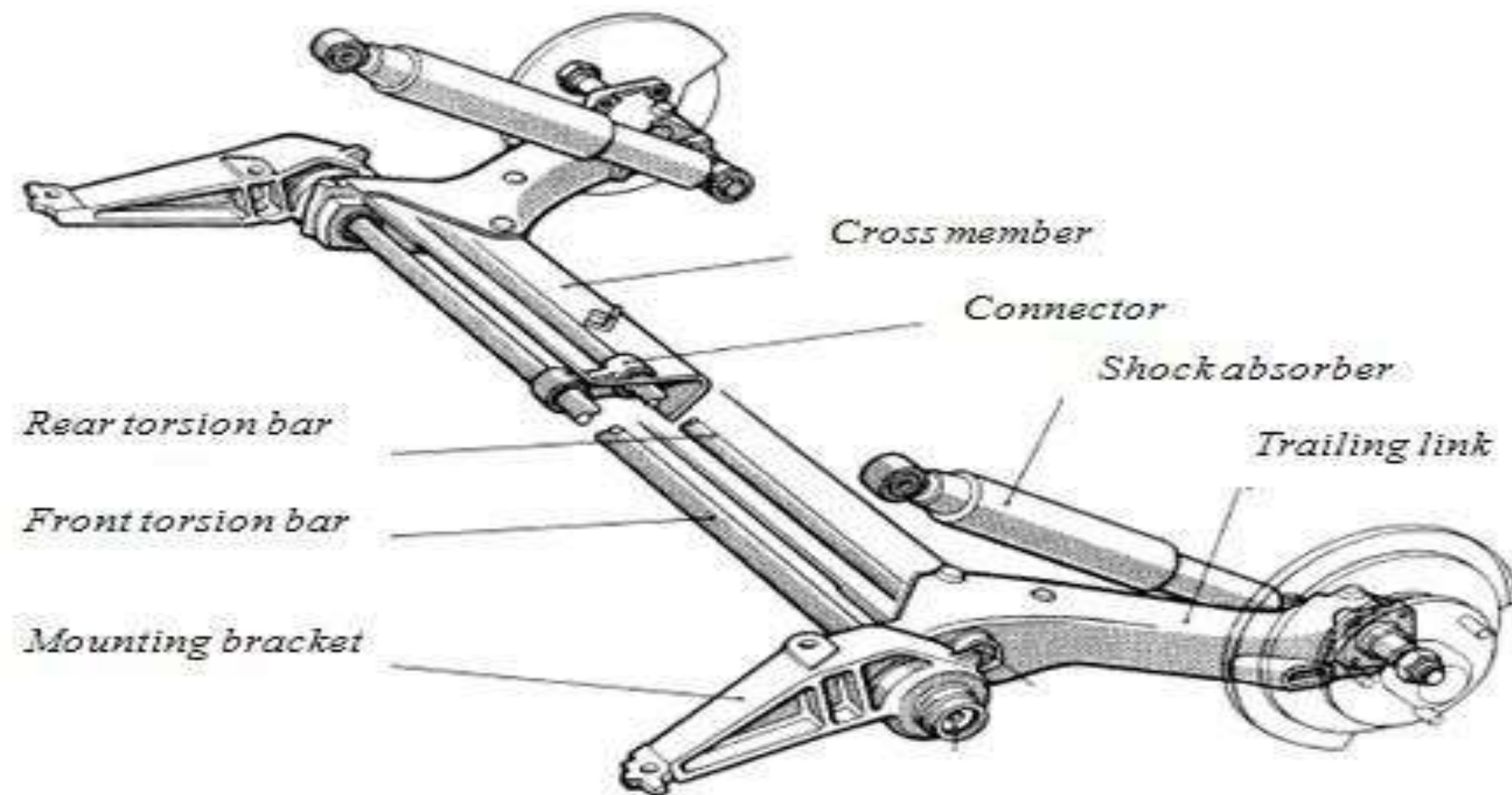
**Coil springs** - This is the most common type of spring and is, in essence, a heavy-duty torsion bar coiled around an axis. Coil springs compress and expand to absorb the motion of the wheels.

Coil springs

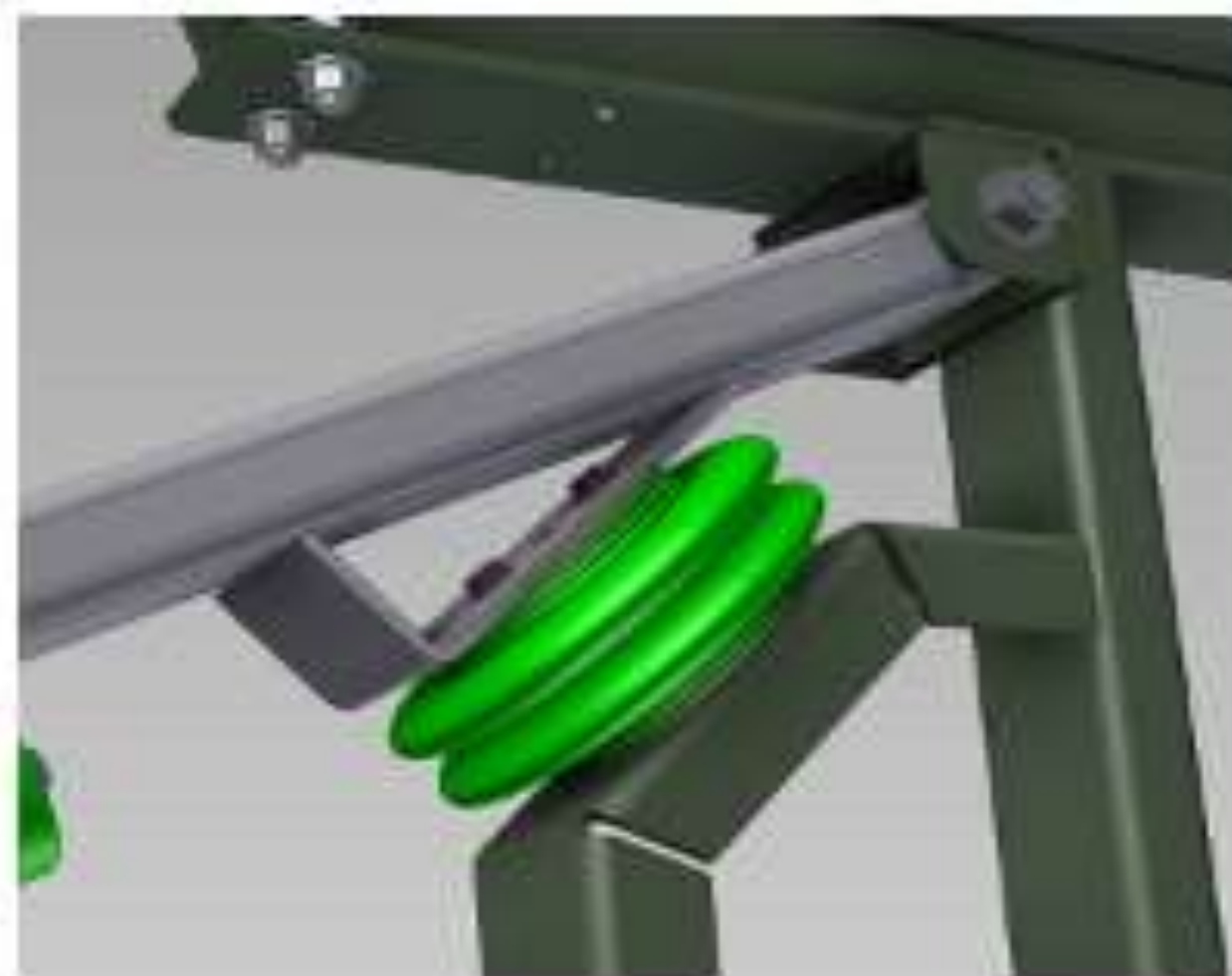




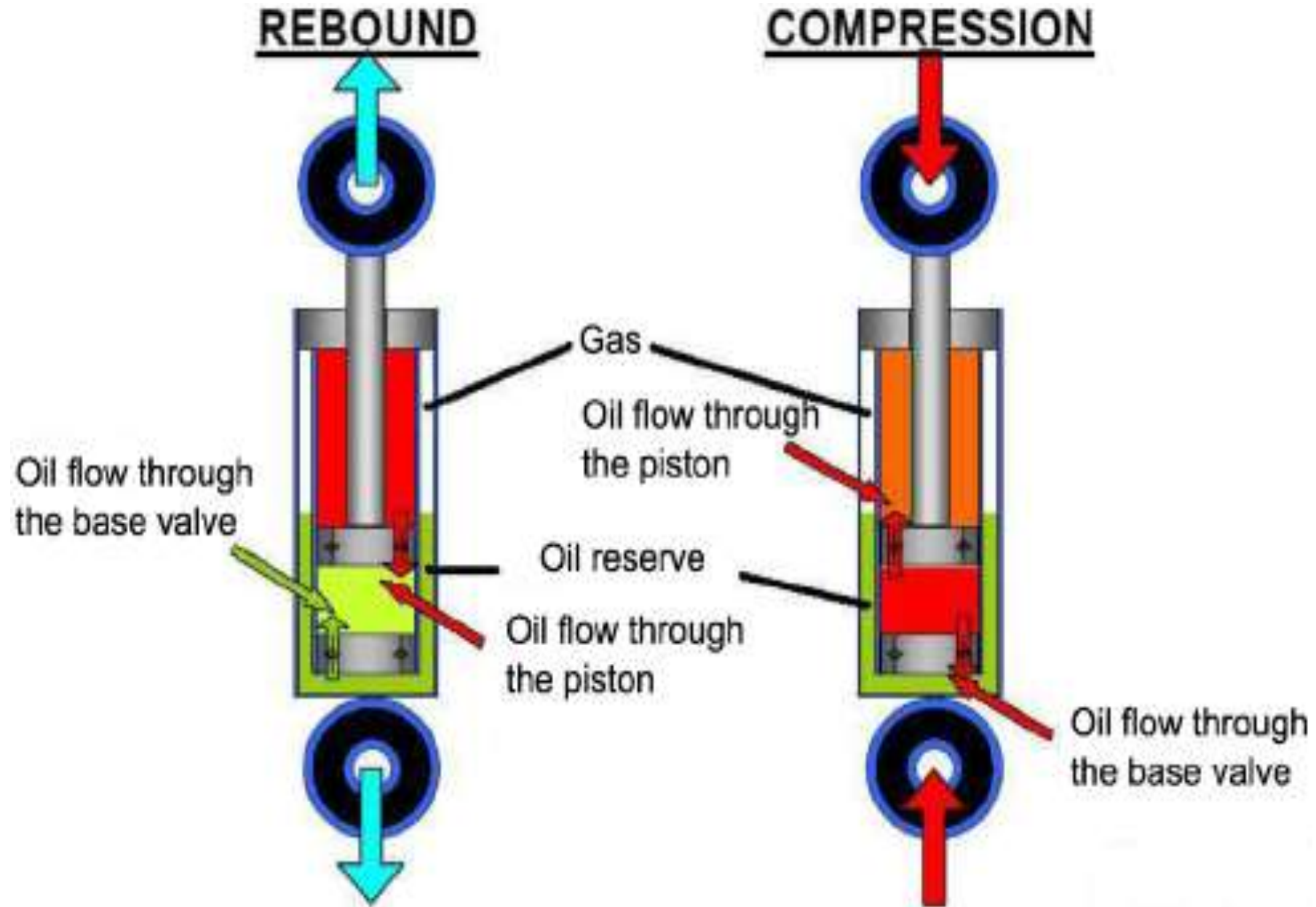
**Torsion bars** use the twisting properties of a steel bar to provide coil-spring-like performance. This is how they work: One end of a bar is anchored to the vehicle frame. The other end is attached to a wishbone, which acts like a lever that moves perpendicular to the torsion bar.



**Air springs** consist of a cylindrical chamber of air positioned between the wheel and the car's body, use the compressive qualities of air to absorb wheel vibrations. The concept is actually more than a century old and could be found on horse-drawn buggies.



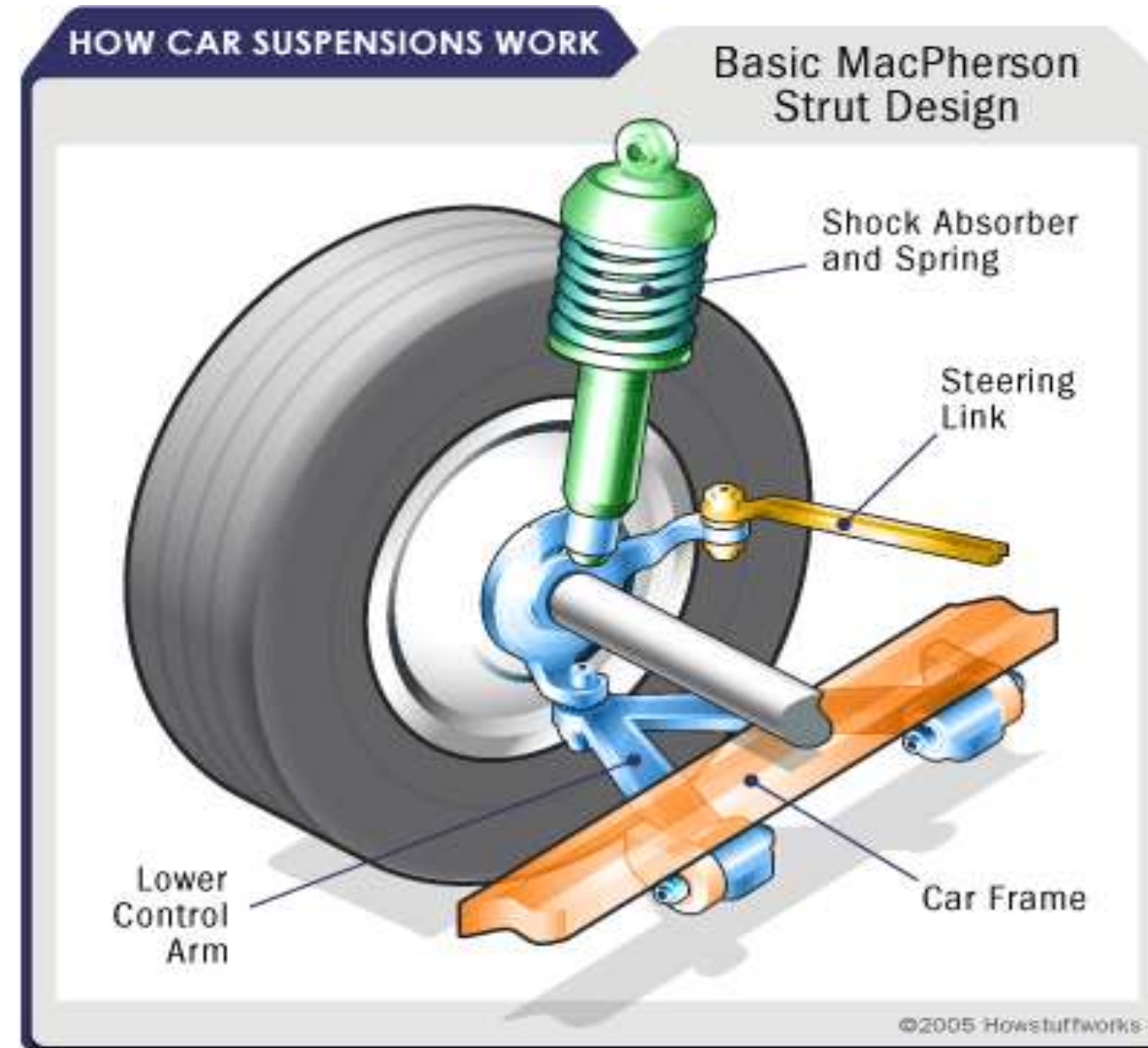
# SUSPENSION SYSTEM





**Strut bar** -Another common dampening structure is the strut — basically a shock absorber mounted inside a coil spring.

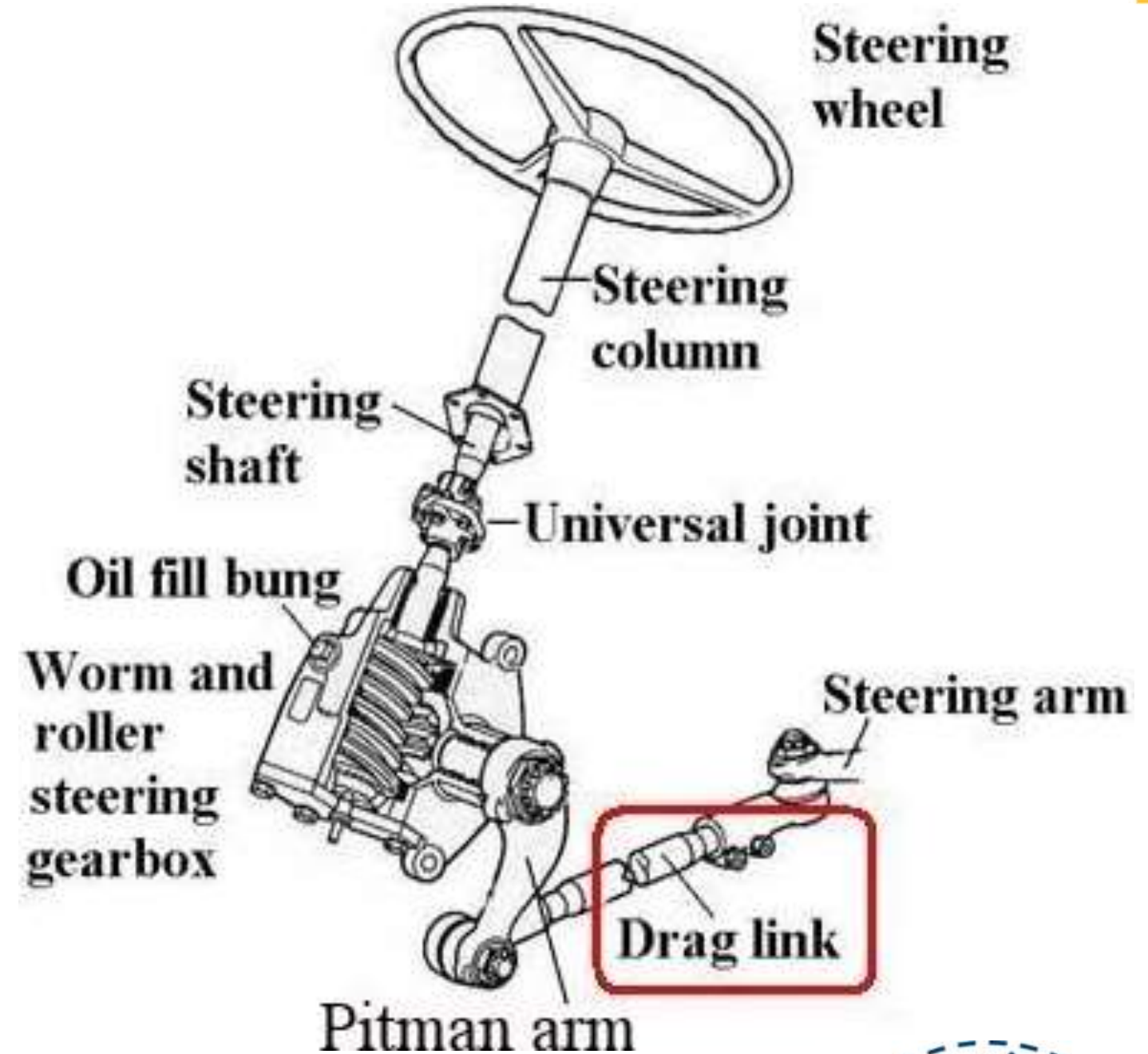
- Struts perform two jobs: They provide a dampening function like shock absorbers, and they provide structural support for the vehicle suspension.
- That means struts deliver a bit more than shock absorbers, which don't support vehicle weight — they only control the speed at which weight is transferred in a car, not the weight itself.



# STEERING & BRAKE SYSTEM

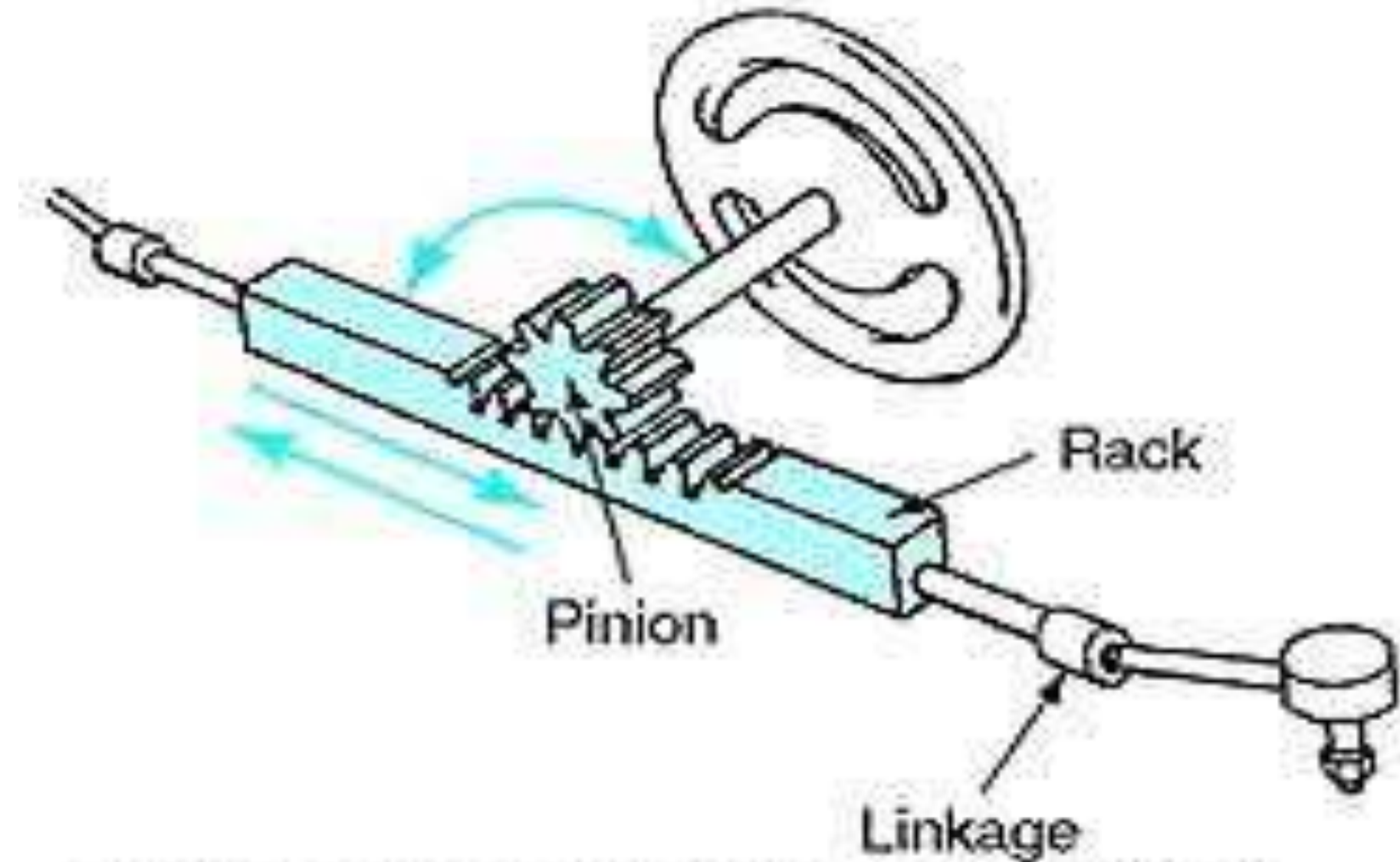
**Introduction of Steering** is a system of components, linkages, etc. which allows any vehicle (car, motorcycle, bicycle) to follow the desired course.

- An exception is the case of rail transport by which rail tracks combined together with railroad switches
- provide the steering function. The primary purpose of the steering system is to allow the driver to guide the vehicle.



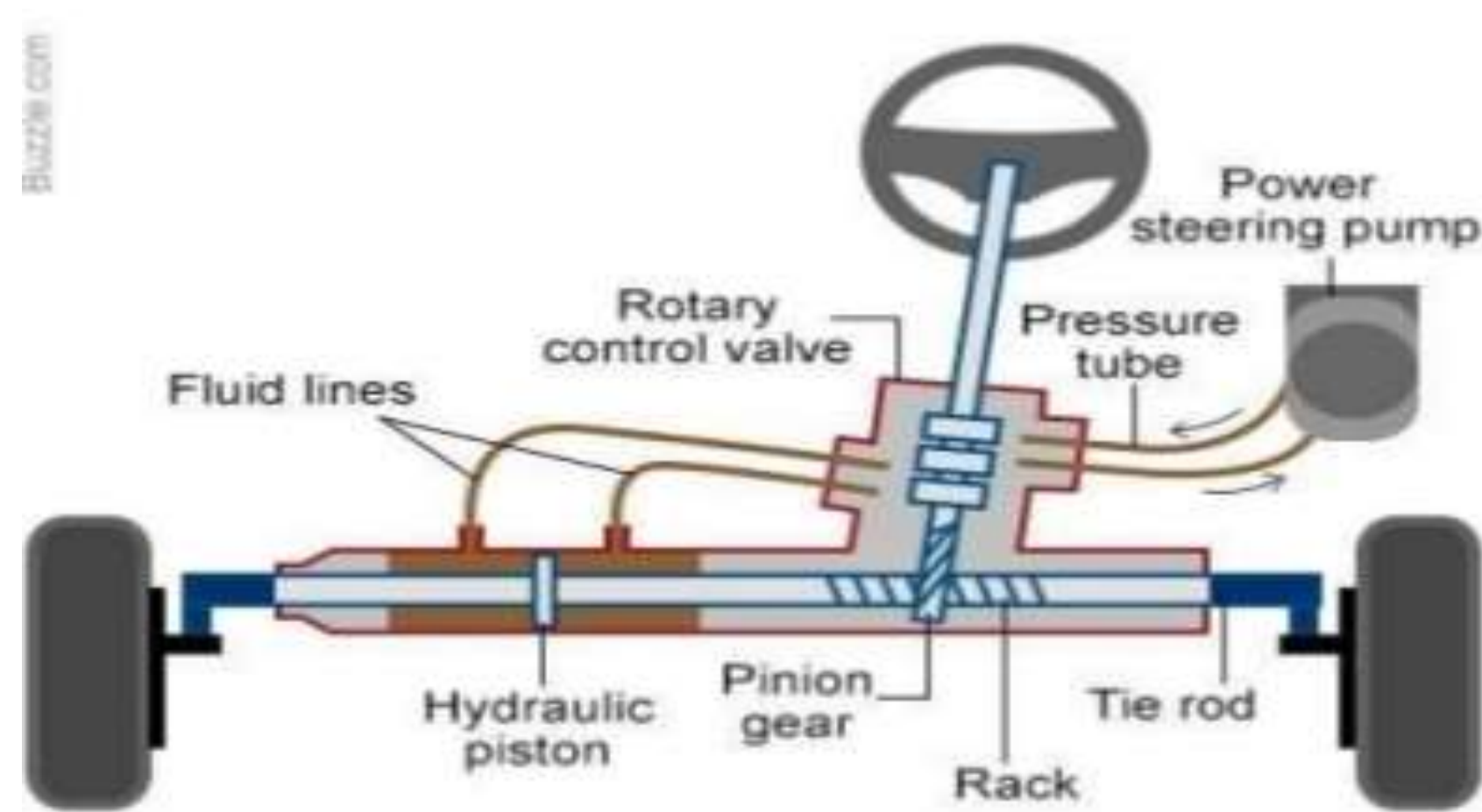


Many modern cars use rack and pinion steering mechanisms, where the steering wheel turns the pinion gear; the pinion moves the rack, which is a linear gear that meshes with the pinion, converting circular motion into linear motion along the transverse axis of the car (side to side motion). This motion applies steering torque to the swivel pin ball joints that replaced previously used kingpins of the stub axle of the steered wheels via tie rods and a short lever arm called the steering arm.



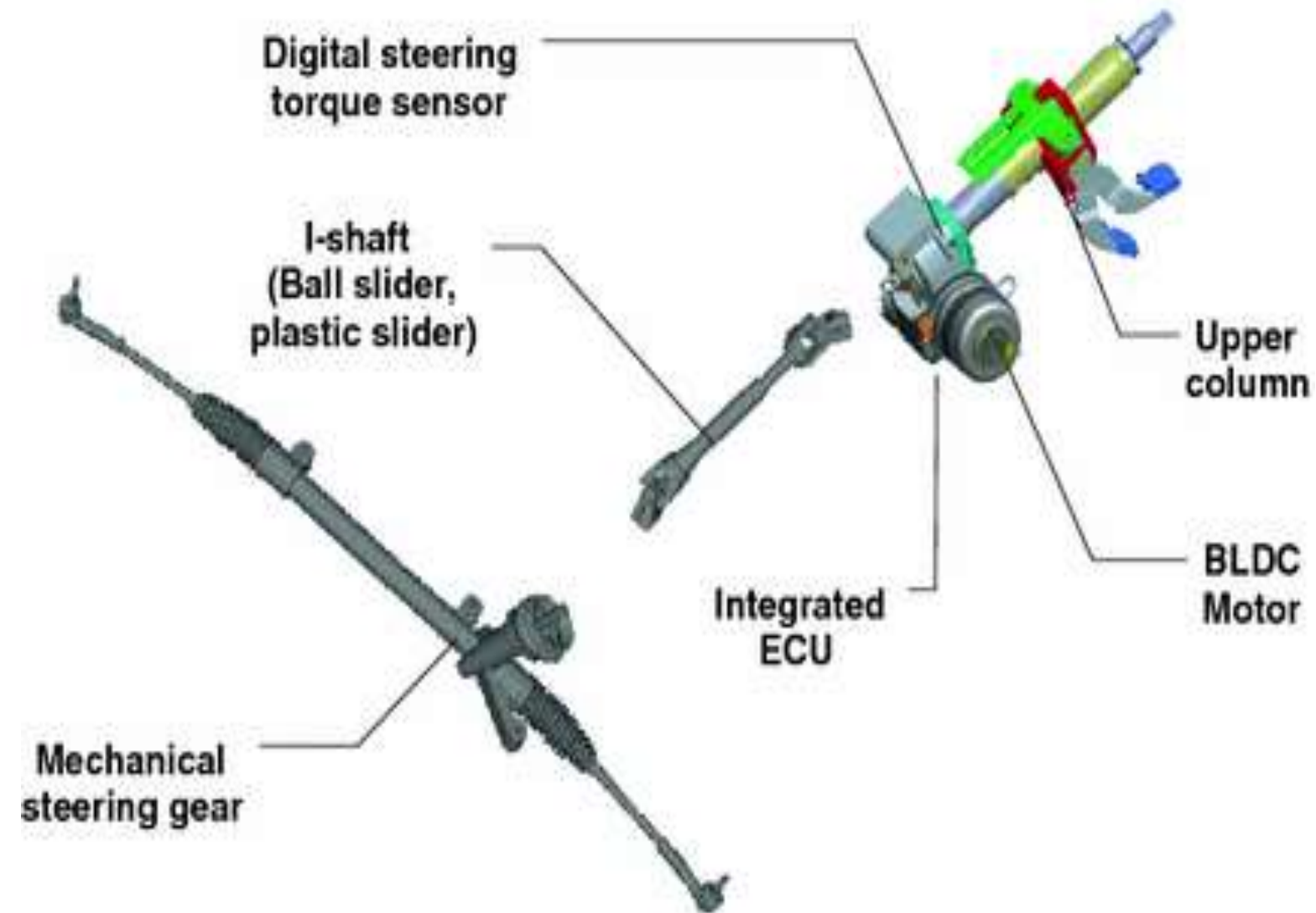
**Basic rack and pinion components**

The hydraulic power steering system is a closed loop system that uses pressurized hydraulic fluids for changing the wheel angle of front wheels based on steering angle. It contains a hydraulic pump driven by a belt, valves, cylinder, reservoir and a driver control mechanism



When the high-pressure fluid is fed to any of the openings, the piston will move towards the opposite direction along with the rack. This will generate a smooth and precise linear motion of the front wheels.

**Electric power steering (EPS)** is more efficient than hydraulic power steering, since the electric power steering motor only needs to provide assistance when the steering wheel is turned, whereas the hydraulic pump must run constantly.



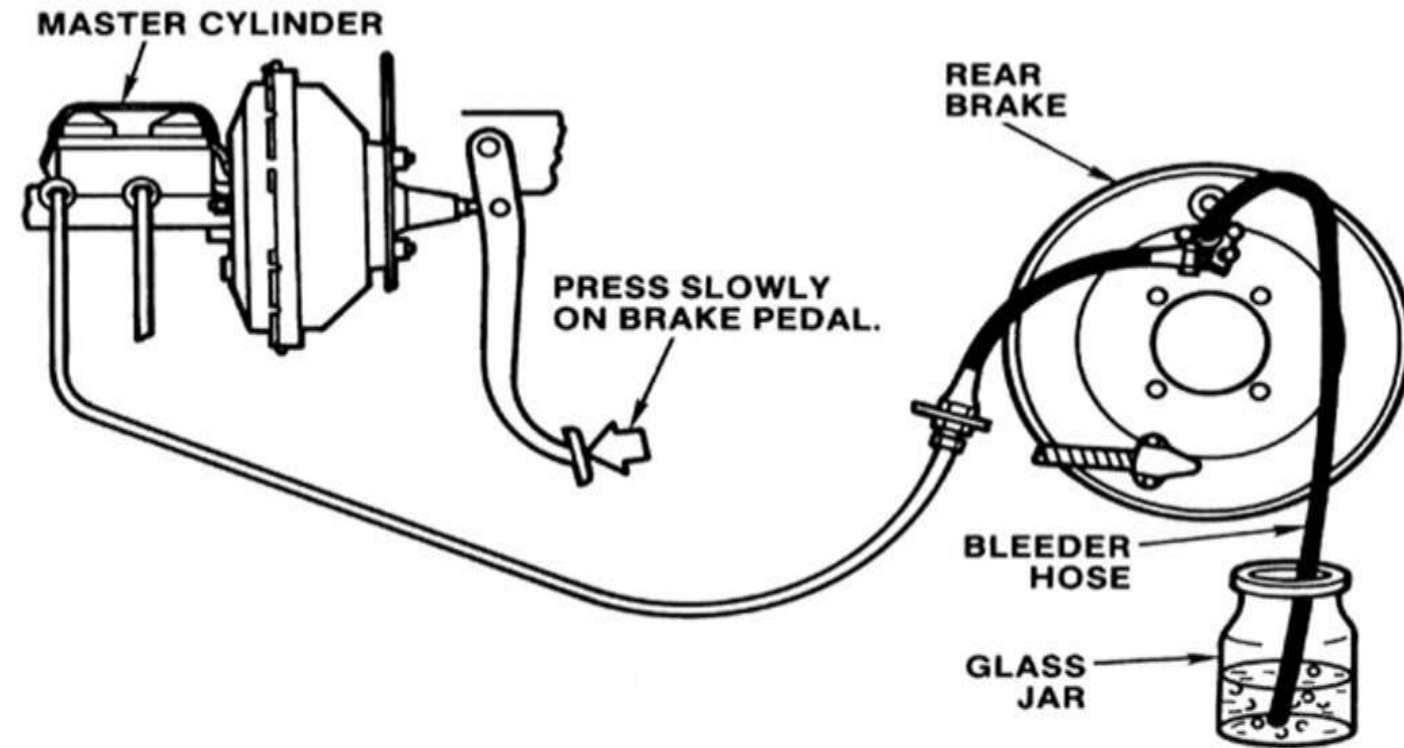


**Brake bleeding** is the procedure performed on hydraulic brake systems whereby the brake lines (the pipes and hoses containing the brake fluid) are purged of any air bubbles.

This is necessary because, while the brake fluid is an incompressible liquid, air bubbles are compressible gas and their presence in the brake system greatly reduces the hydraulic pressure that can be developed within the system. The same methods used for bleeding are also used for brake flushing or purging, where the old fluid is replaced with new fluid, which is necessary maintenance

Bennett/Norman, Heavy Duty Truck Systems, 4e

## Manual Bleeding Technique



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**Brake linings** are the consumable surfaces in brake systems, such as drum brakes and disc brakes used in transport vehicles.

**Brake pads** are a component of disc brakes used in automotive and other applications. Brake pads are composed of steel backing plates with friction material bound to the surface that faces the disc brake rotor.

## Material

Constituent	Steel fibres
Whiting (Chalk)	Rubber particles
Bronze powder	"Friction Dust"
Graphite	Sand
Vermiculite	Aramid fibres
Phenolic resin	



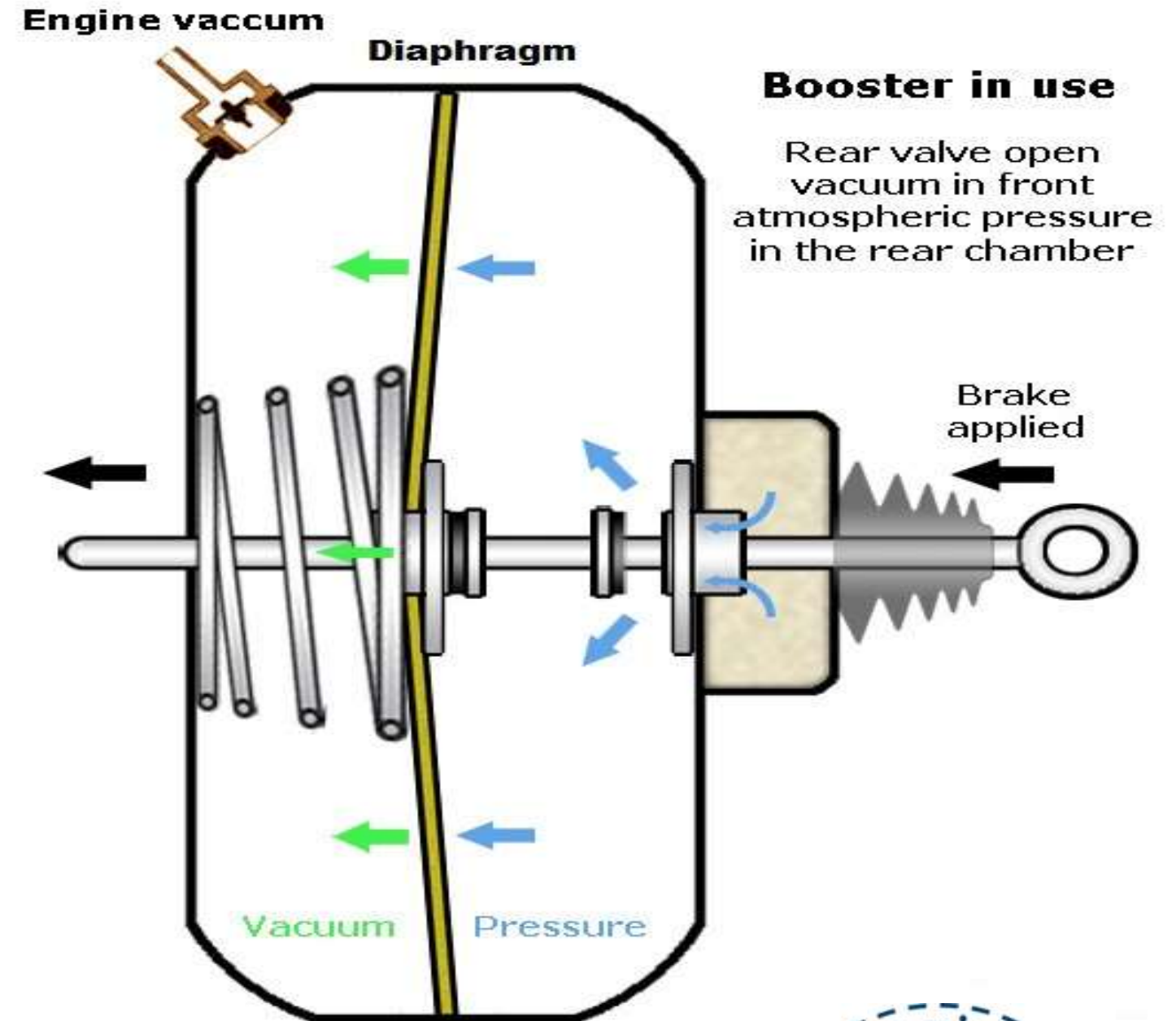
**PAD**



**LINER**



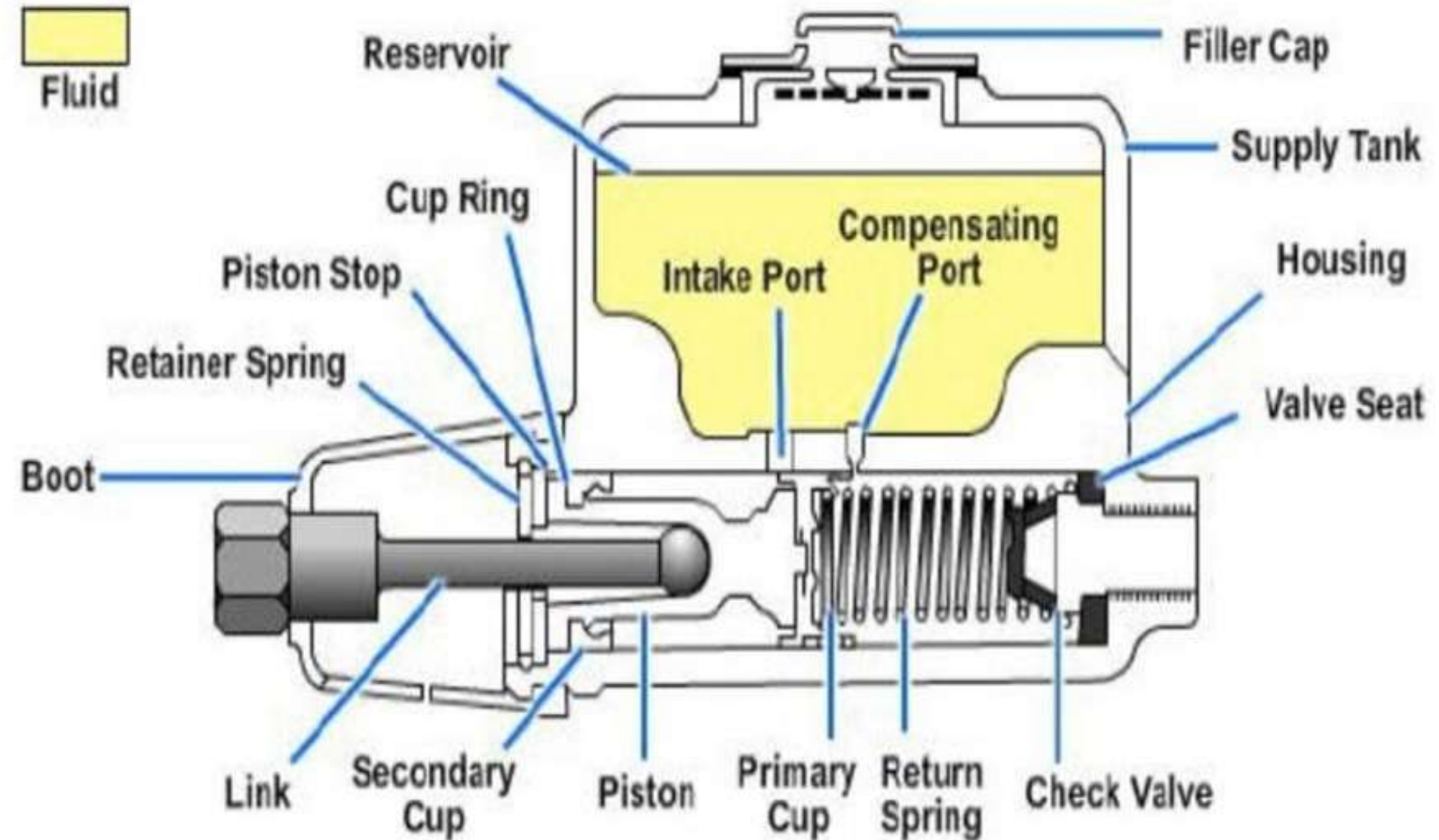
- **Brake booster** - Brake booster from a Geo Storm .
- Most modern passenger vehicles, and light vans, use a vacuum assisted brake system that greatly increases the force applied to the vehicle's brakes by its operator.
- This additional force is supplied by the manifold vacuum generated by air flow being obstructed by the throttle on a running engine.
- This force is greatly reduced when the engine is running at fully open throttle, as the difference between ambient air pressure and manifold (absolute) air pressure is reduced, and therefore available vacuum is diminished. However, brakes are rarely applied at full throttle; the driver takes the right foot off the gas pedal and moves it to the brake pedal - unless left-foot braking is used.





In automotive engineering, the **master cylinder** is a control device that converts force (commonly from a driver's foot) into hydraulic pressure. This device controls slave cylinders located at the other end of the hydraulic system.

As piston(s) move along the bore of the master cylinder, this movement is transferred through the hydraulic fluid, to result in a movement of the slave cylinder.



## Maintenance

Brake pads should be checked at least every 5,000 km for excessive or uneven wear. Although brake pad wear is unique to each vehicle, it is generally recommended that brake pads be replaced every 40,000 km.

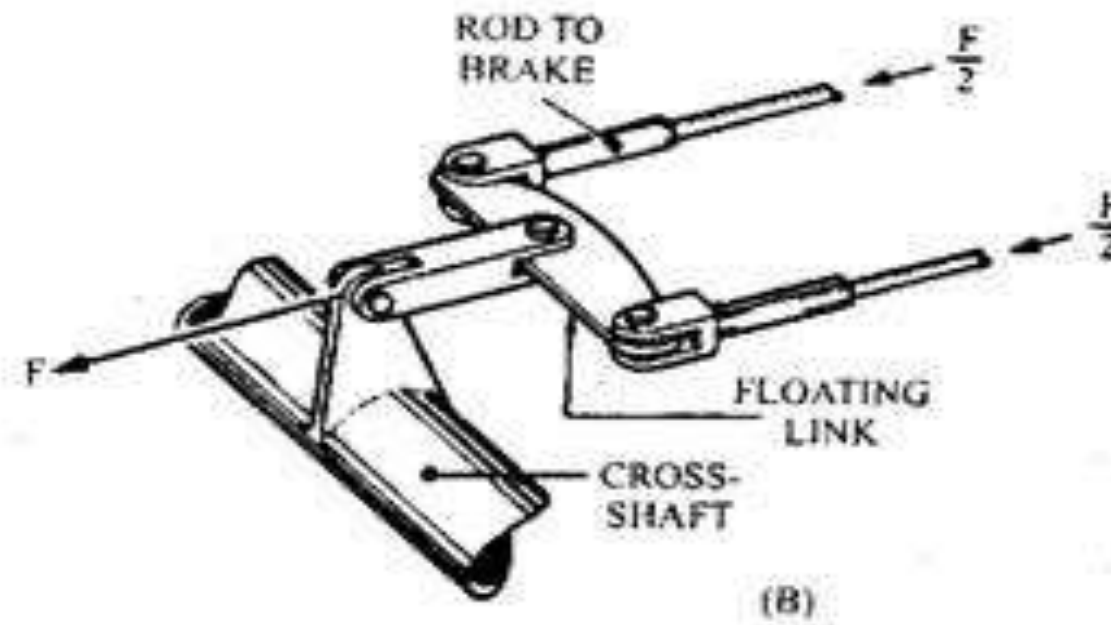
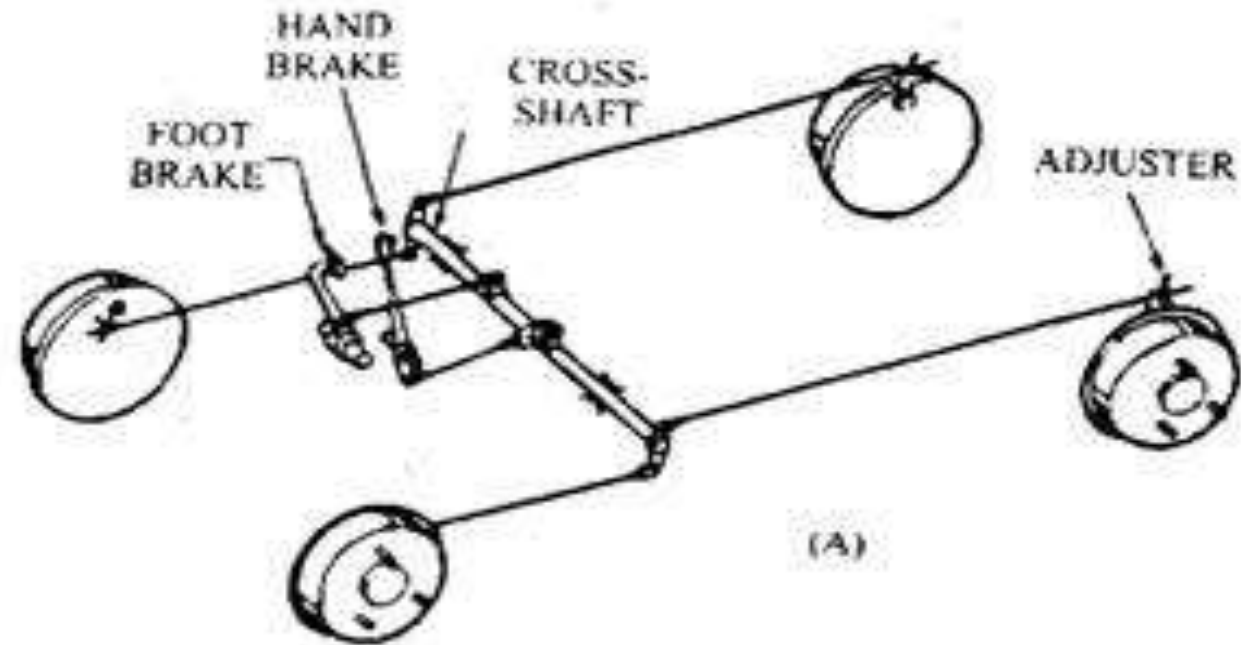
Issue	Possible Cause
Braking requires an abnormal amount of force on brake pedal	Worn brake pads, contaminated brake fluid, faulty master cylinder, loss of vacuum
Car pulls to one side when braking	Brake pad lining(s) contaminated with oil or brake fluid, brake pads not replaced in pairs, brake pad not fitted correctly
Poor braking performance	Brake pad lining(s) soaked with water, oil, or brake fluid; Overheated brake pad linings, worn brake pads
Sensitive braking	Incorrect brake pad linings; Greasy brake pad linings
Noisy braking (grinding or screeching sounds when braking)	Extremely worn brake pads, brake pad(s) not fitted correctly
Vibration under braking	Contaminated rotors or pads, rotors scabbed

## Types of Brake Systems

- Mechanical Brake Systems
- Hydraulic Brake Systems
- Parking Brake Systems
- Vacuum Brake System
- Servo Brake System
- Air Brake system

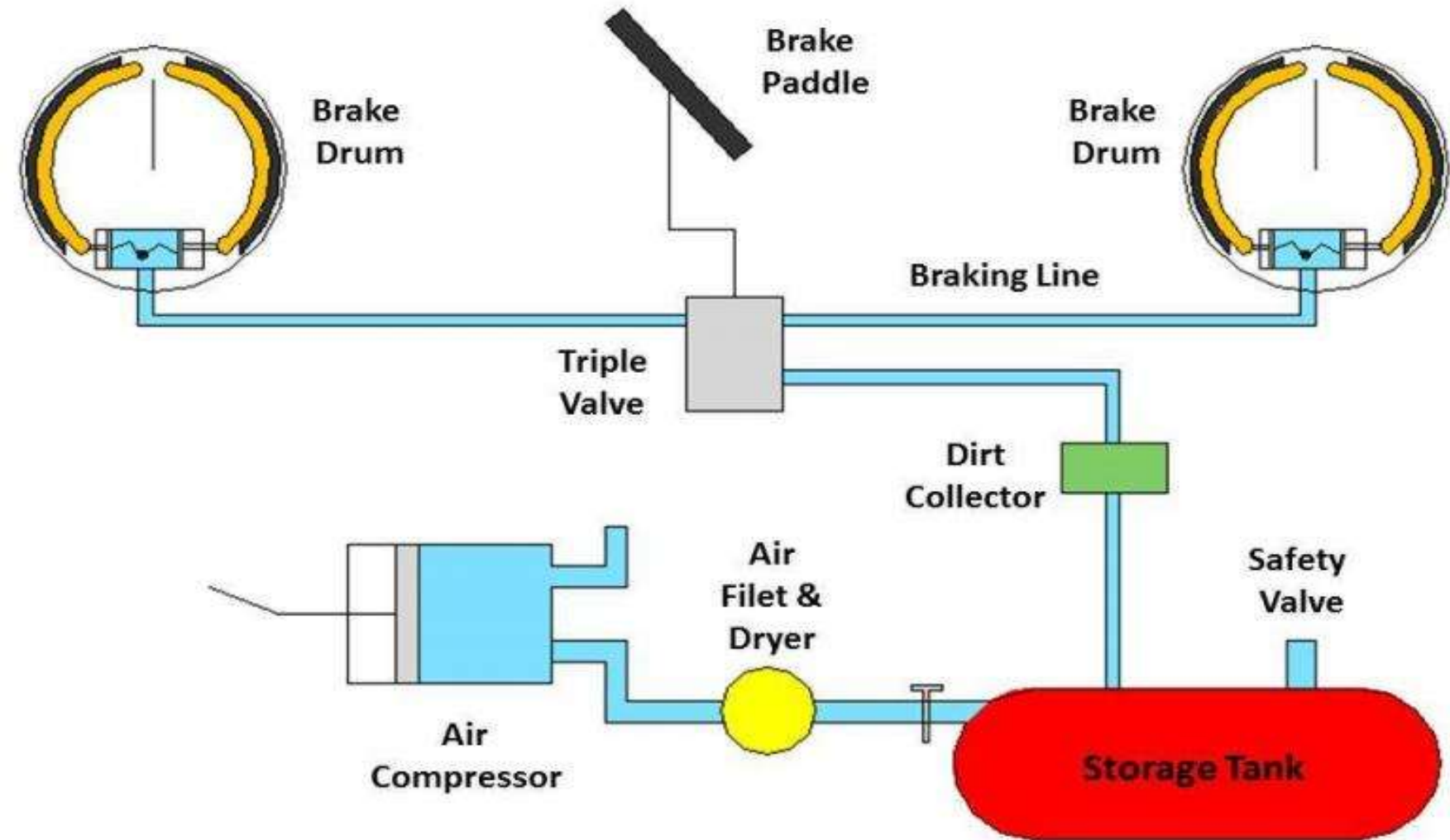
## Mechanical Brake Systems

Mechanical brakes all act by generating frictional forces as two surfaces rub against each other. The stopping power or capacity of a brake depends largely on the surface area of frictional surfaces as well as on the actuation force applied.



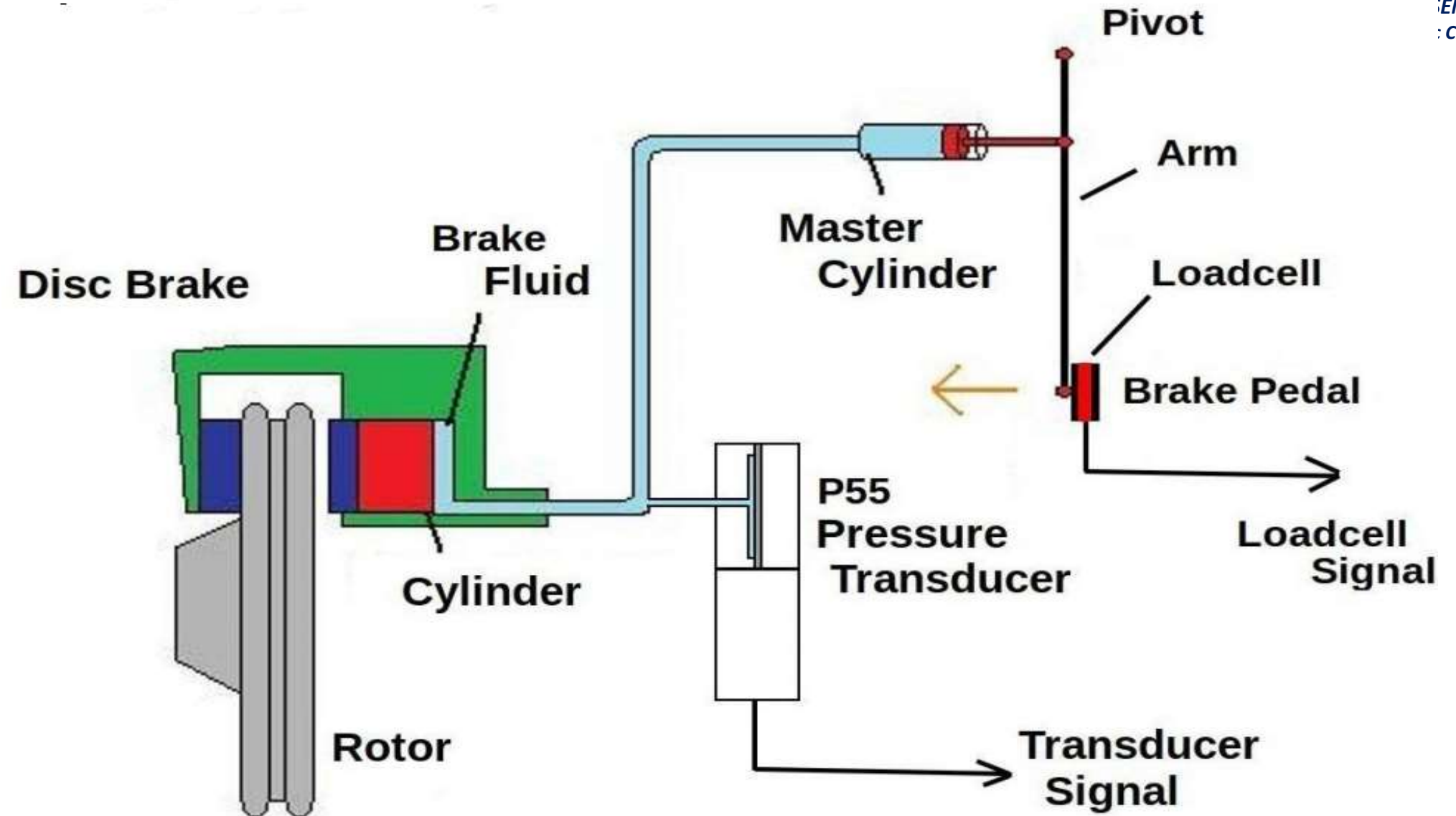


- An **air brake** or, more formally, a **compressed air brake system**, is a type of friction brake for vehicles in which compressed air pressing on a piston is used to apply the pressure to the brake pad needed to stop the vehicle.
- The air compressor is driven by the engine either by crankshaft pulley via a belt or directly from the engine timing gears. It is lubricated and cooled by the engine lubrication and cooling systems.
- Compressed air is first routed through a cooling coil and into an air dryer which removes moisture and oil impurities and also may include a pressure regulator, safety valve and smaller purge reservoir.



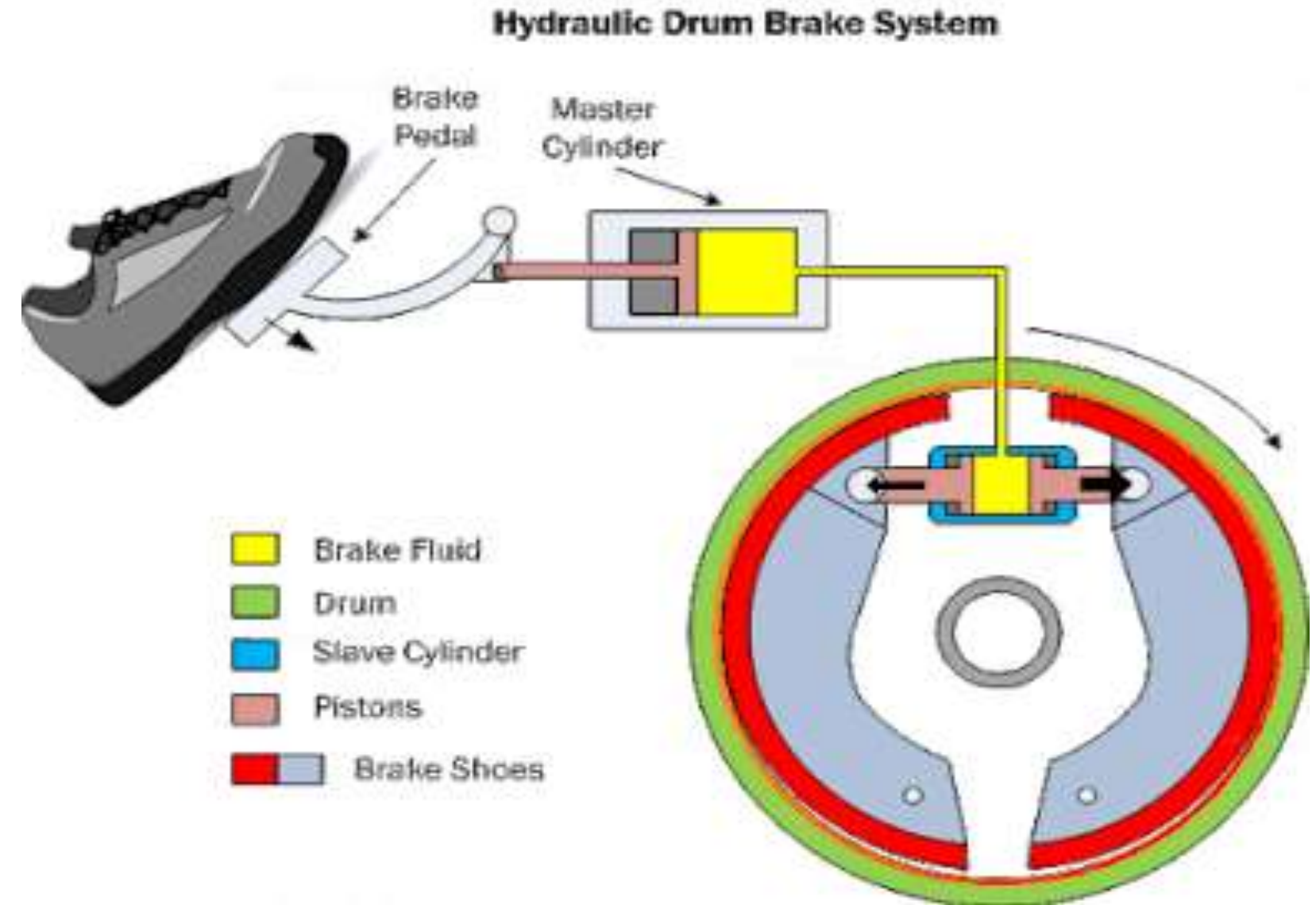
**Air Brake System**

- Press the brake Pedal
- Boosters power given to master cylinder
- Master cylinder create to the hydraulic pressure
- Pressurised liquid go to in the calliper



DISC BRAKE

- The pad in the caliper will push across and press the disc(front wheel)
- The liner will stick to the drum as the arm of the piston in the drum comes out.





- Press the brake Pedal ? **(ABS)**
- Boosters power given to master cylinder
- Master cylinder create to the hydraulic pressure
- ECU signal given to brake module
- Pressurised liquid go to in the calliper
- The pad in the caliper will push across and press the disc(front wheel) but The brakes will be applied and released
- The vehicle will stop at a short distance & controlled
- The liner will stick to the drum as the arm of the piston in the drum comes out.

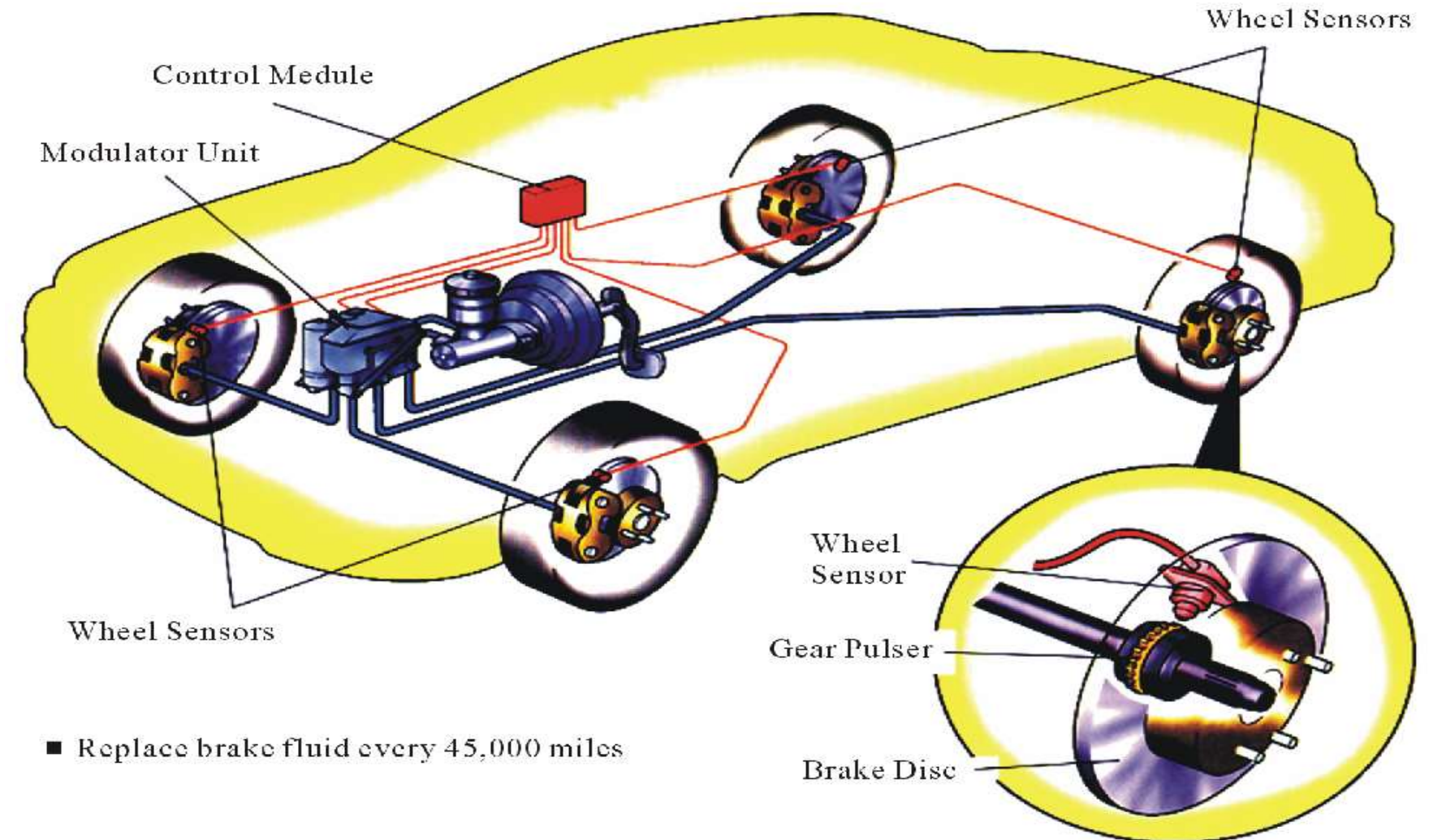
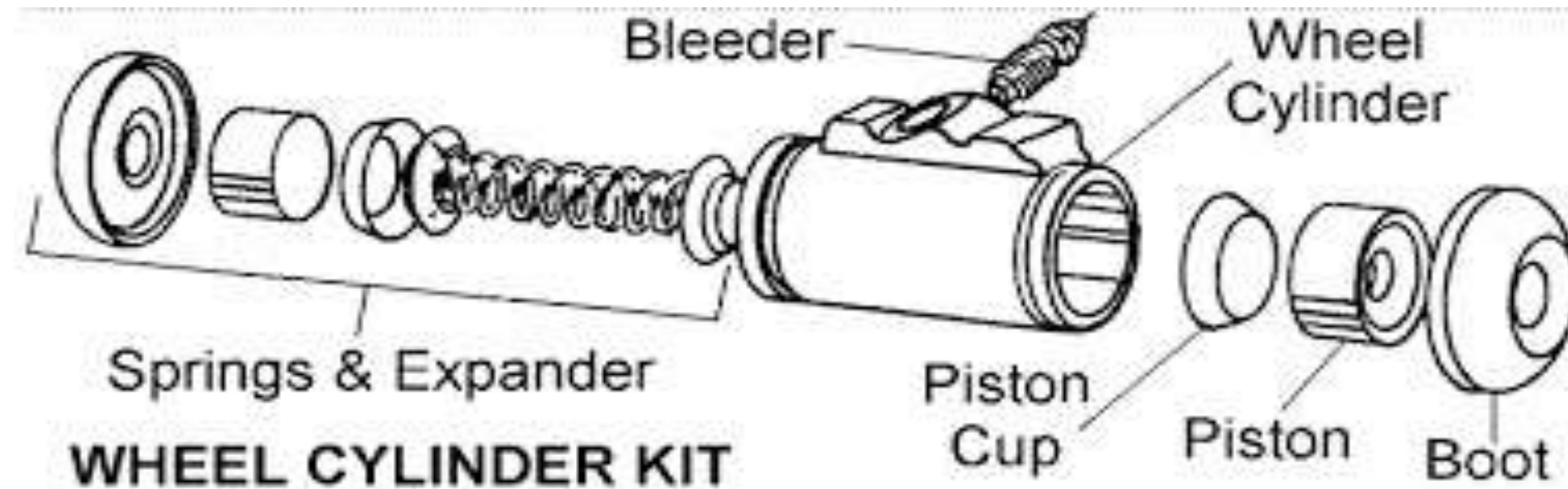


Figure 1. Typical ABS components [4]

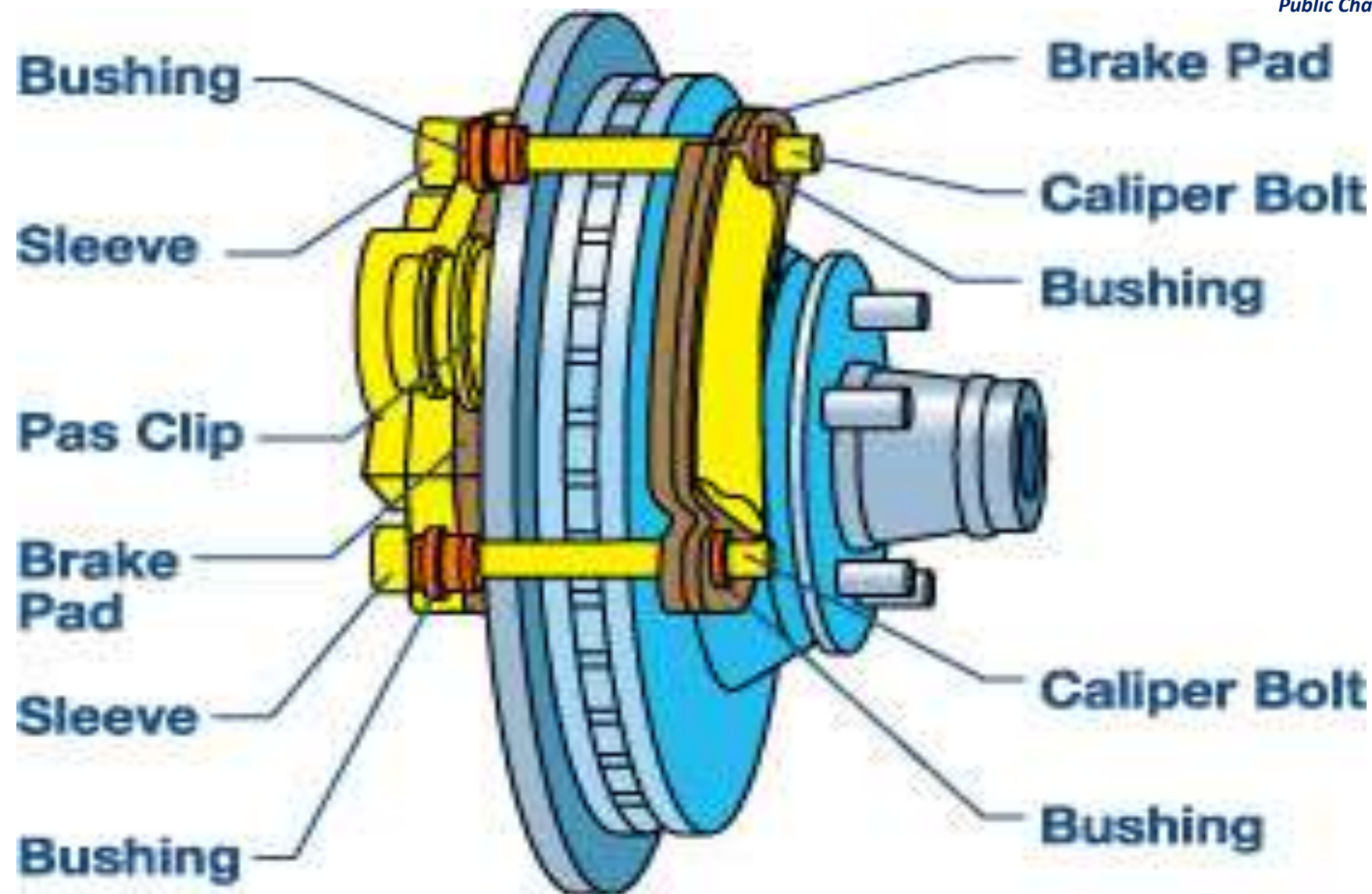
## Wheel cylinder

- Cut-away section of a wheel cylinder. One wheel cylinder operates the brake on each wheel.
- Two pistons operate the shoes, one at each end of the wheel cylinder. The leading shoe (closest to the front of the vehicle) is known as the primary shoe.
- The trailing shoe is known as the secondary shoe. Hydraulic pressure from the master cylinder acts on the piston cup, pushing the pistons toward the shoes, forcing them against the drum.



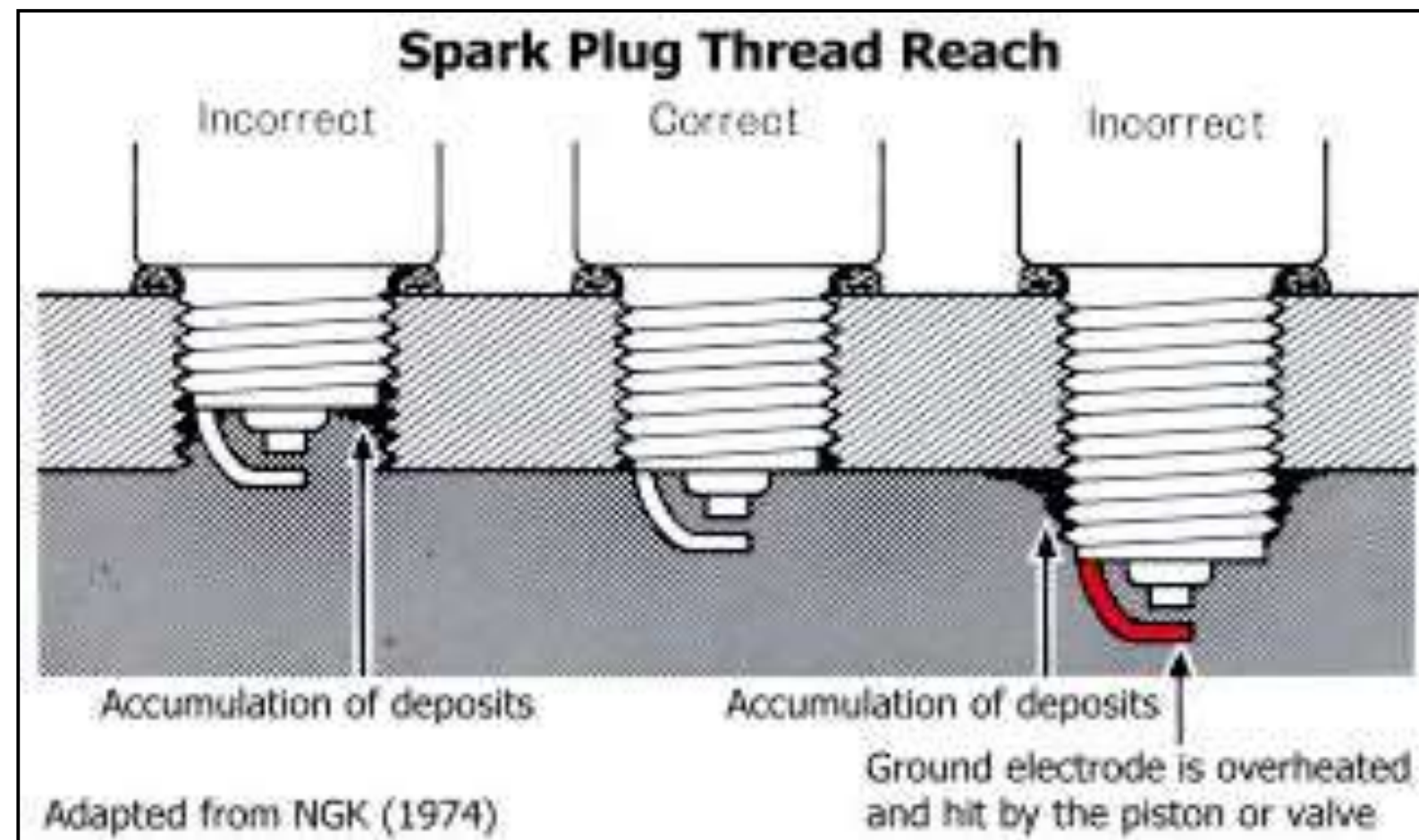
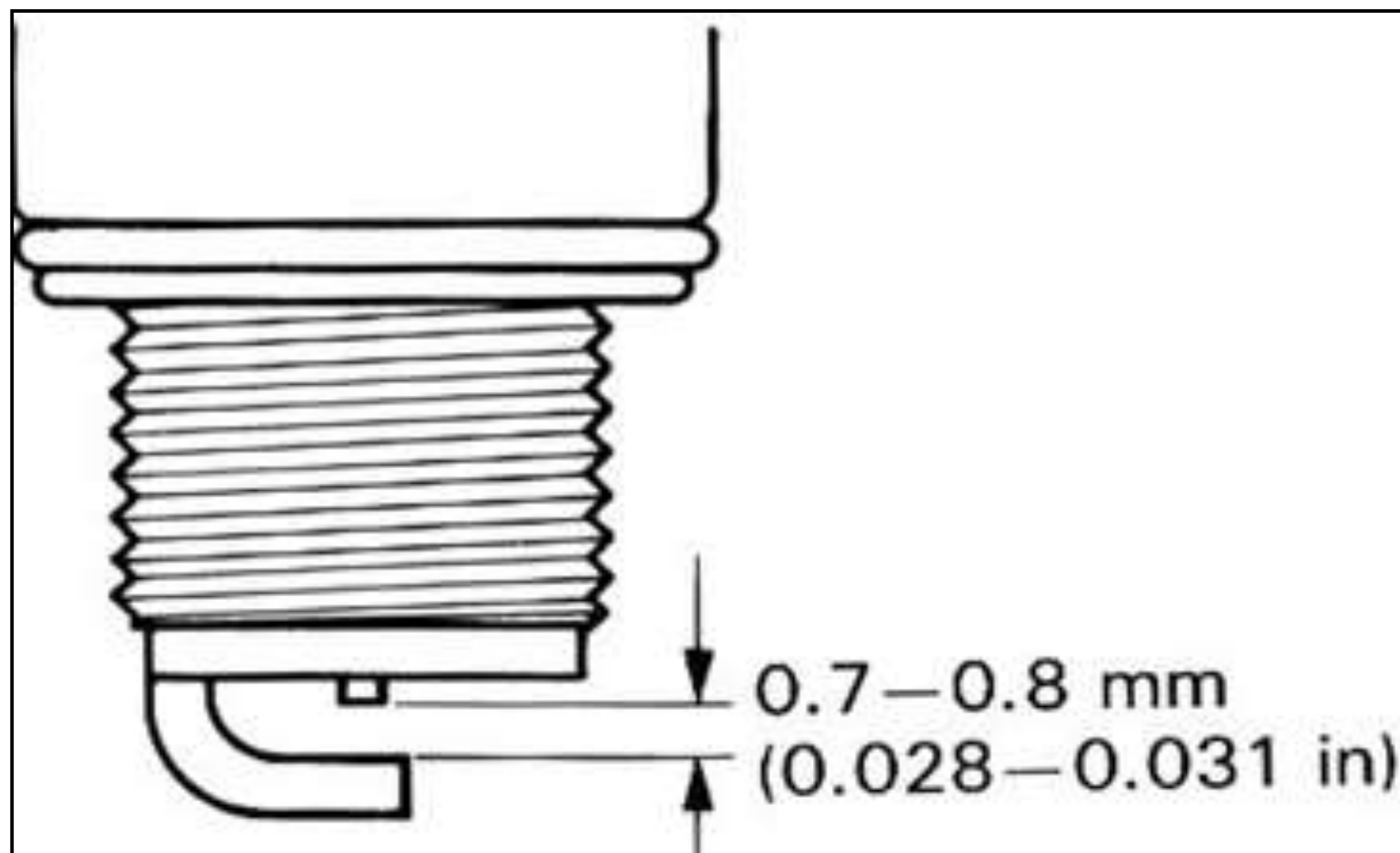


- A **disc brake** is a type of brake that uses the callipers to squeeze pairs of pads against a disc or "rotor" to create friction.
- This action slows the rotation of a shaft, such as a vehicle axle, either to reduce its rotational speed or to hold it stationary. The energy of motion is converted into waste heat which must be dispersed.
- Hydraulically actuated disc brakes are the most commonly used form of brake for motor vehicles, but the principles of a disc brake are applicable to almost any rotating shaft.





Electrical energy is transmitted through the **spark plug**, jumping the gap in the **plugs** firing end if the voltage supplied to the **plug** is high enough. This electrical **spark** ignites the gasoline/air mixture in the combustion chamber.





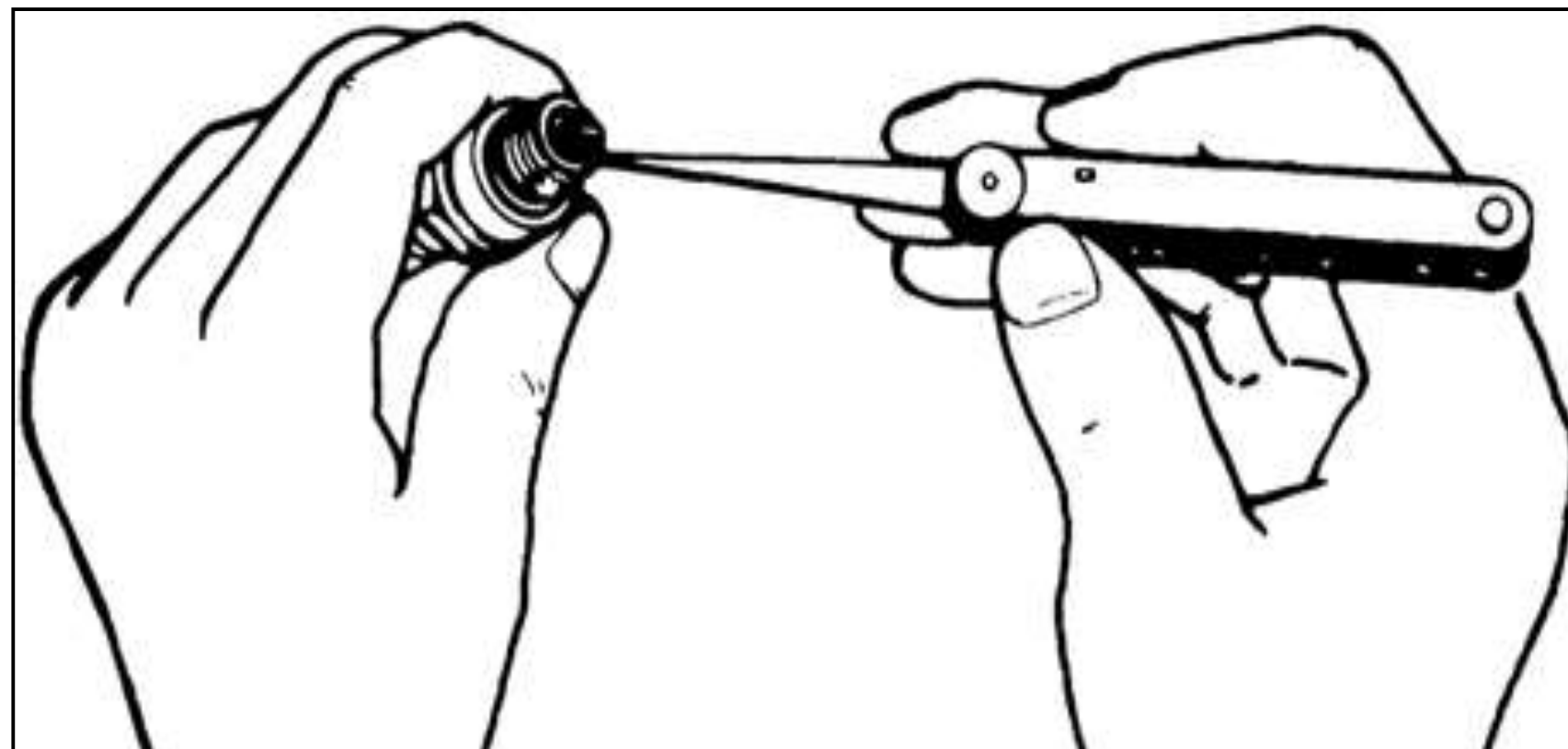
# ELECTRICAL SYSTEM

## Checking Small Engine Spark Plugs

- The electrodes on a spark plug must be clean and sharp to produce the powerful spark required for ignition.

## When To Check & Replace Spark Plugs

For standard lawn mower and small engine maintenance, you **should check and/or replace spark plugs:** once a season, every 25 hours of use, if your lawn mower or outdoor power equipment won't start

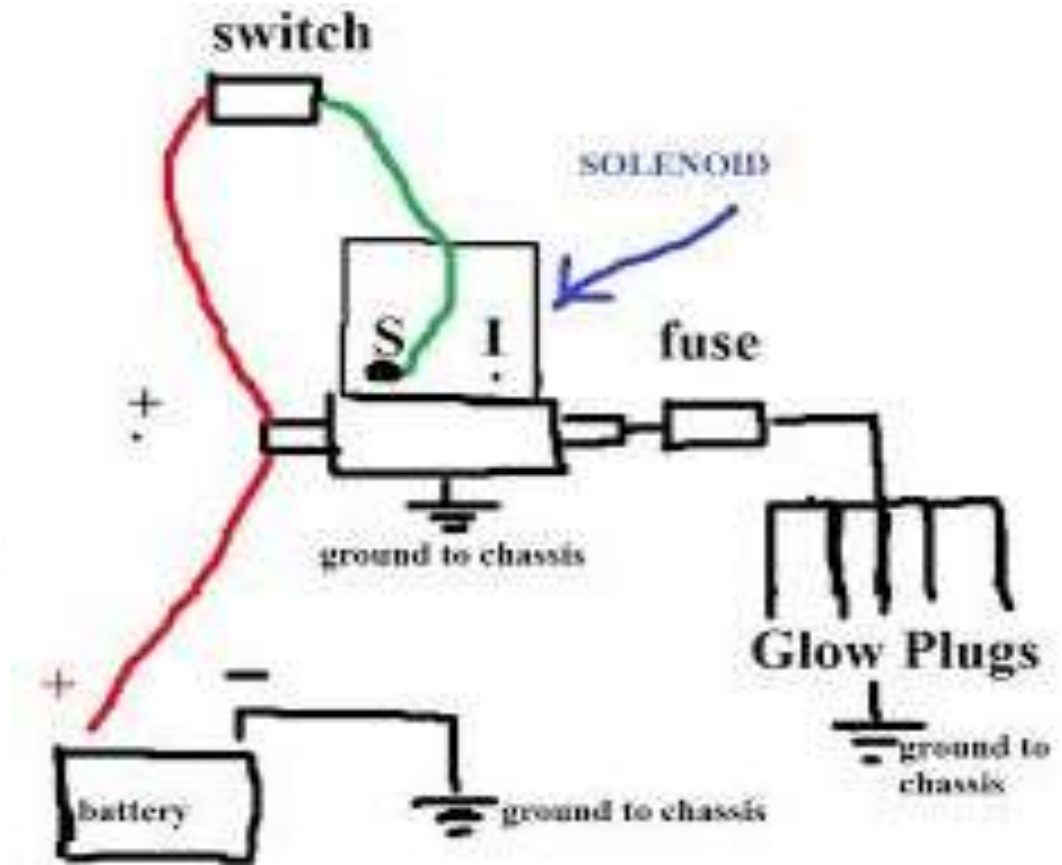
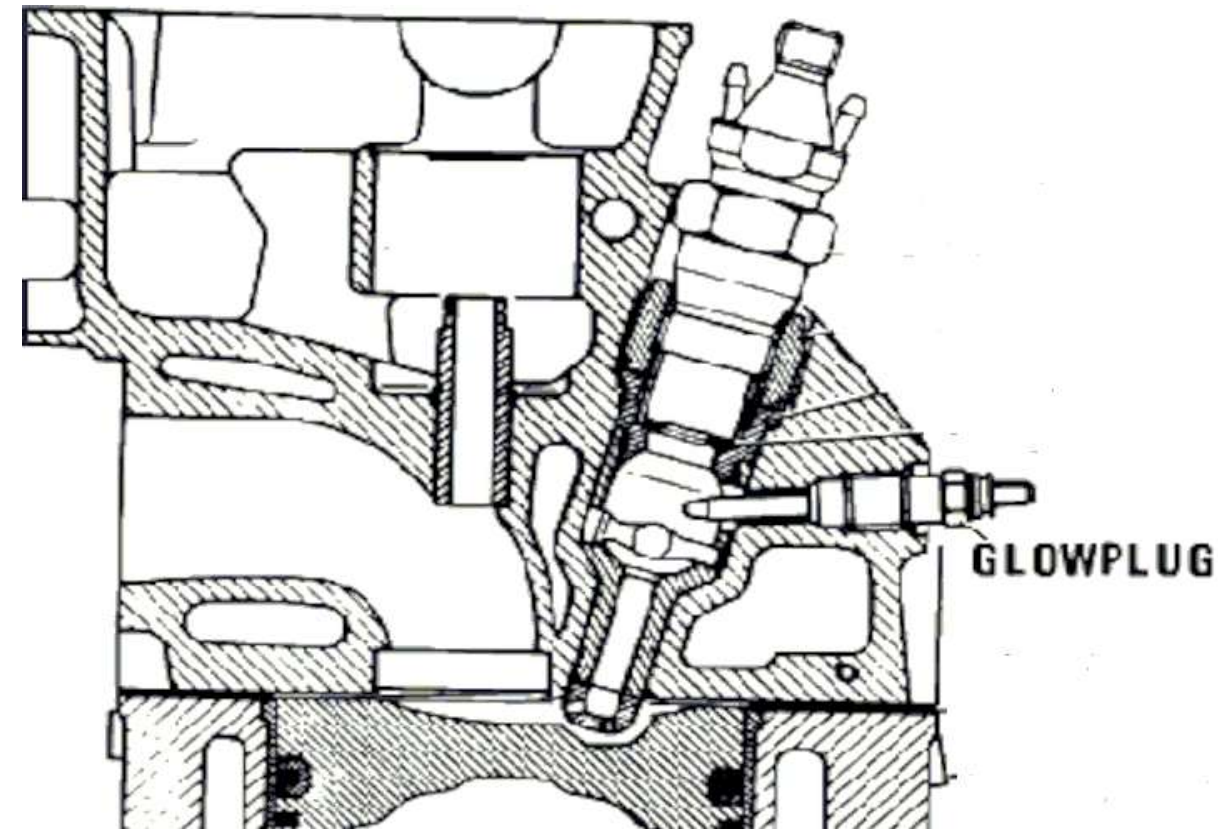


Spark Plug Cleaning

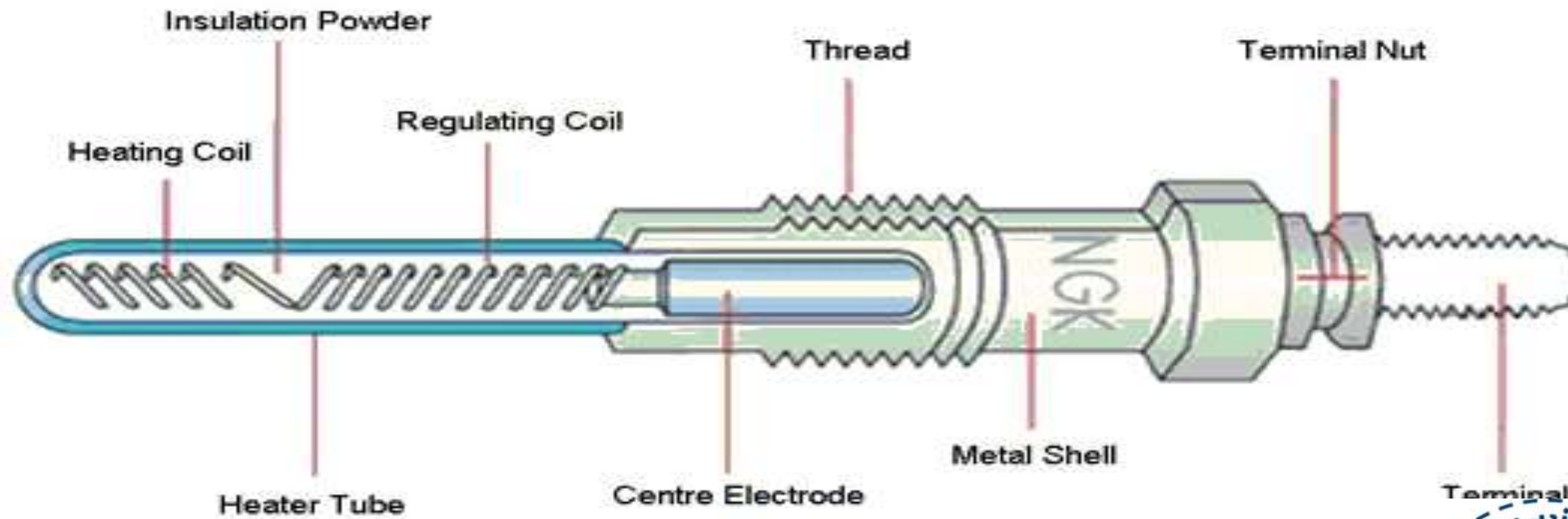


# GLOW PLUG

A **glowplug** (alternatively spelled as **glow plug** or **glow-plug**) is a heating device used to aid starting diesel engines. In cold weather, high speed diesel engines can be difficult to start because the mass of the cylinder block and cylinder head absorb the heat of compression, preventing ignition. Pre-chambered engines use small glowplug inside the pre-chambers.

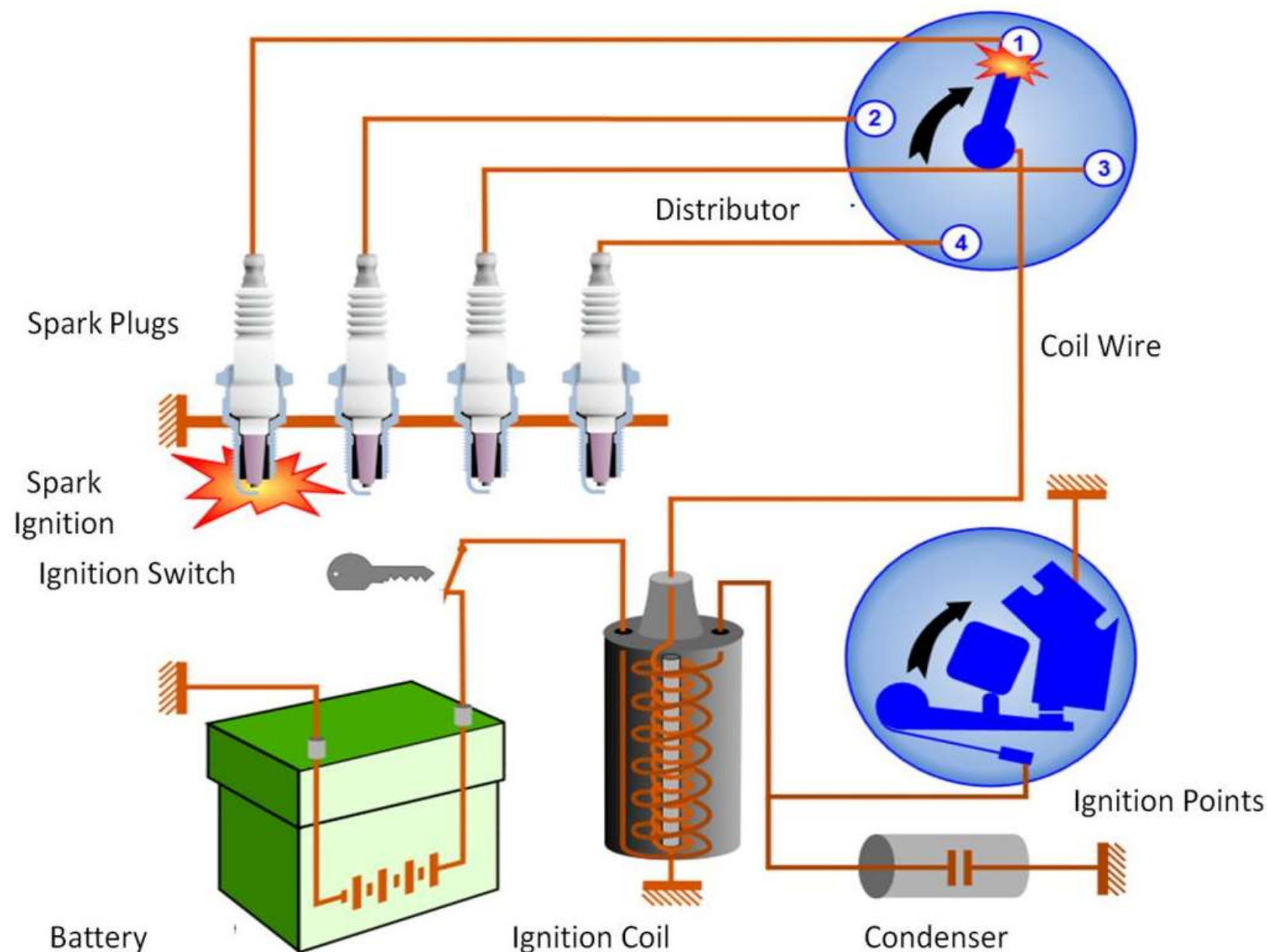


Direct-injected engines have these glow plug in the combustion chamber. The glow plug is a pencil-shaped piece of metal with a heating element at the tip.



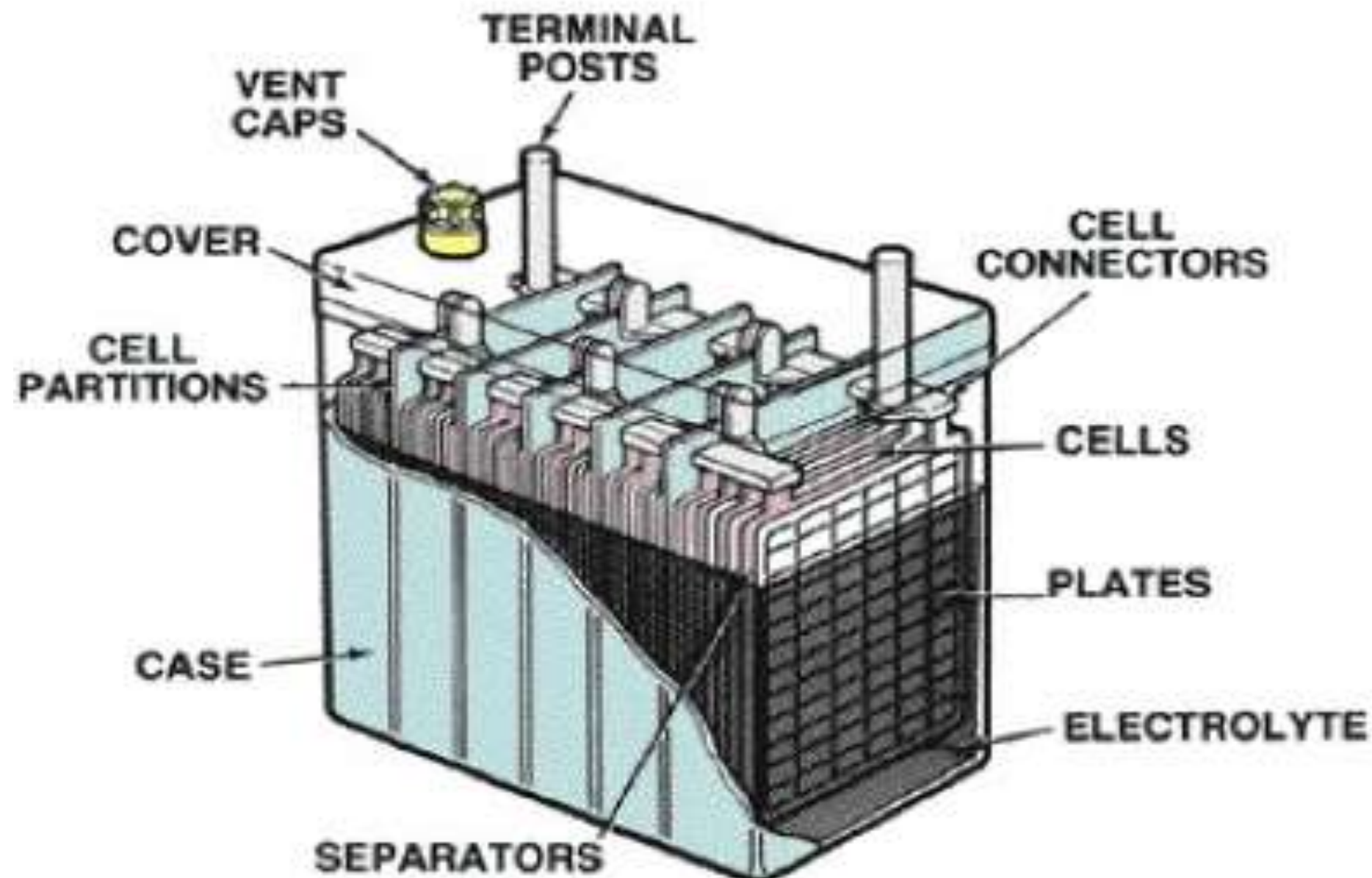


- The 12 volt current of the battery goes into the ignition key
- The current goes from the ignition key to the coil
- The current steps up in the coil
- Step up current goes to distributor
- Distributor distributes current to each spark plug
- Spark plug ignites spark





- An **automotive battery** is a rechargeable battery that supplies electrical current to a motor vehicle.
- Its main purpose is to feed the starter, which starts the engine. Once the engine is running, power for the car's electrical systems is still supplied by the battery with the alternator charging as demands increase or decrease.



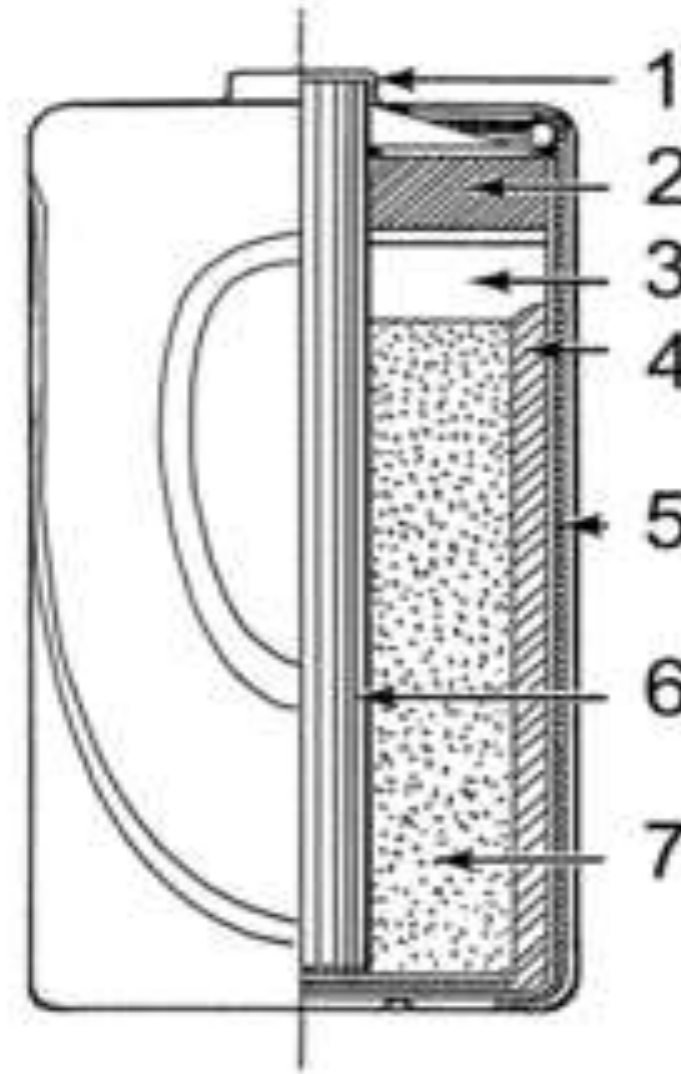
## Type of battery

Dry cell battery

Wet cell battery

A common dry cell is the zinc-carbon cell, sometimes called the dry Leclanché cell, with a nominal voltage of 1.5 volts, the same as the alkaline cell (since both use the same zinc–manganese dioxide combination).

A standard dry cell comprises a zinc anode, usually in the form of a cylindrical pot, with a carbon cathode in the form of a central rod. The electrolyte is ammonium chloride in the form of a paste next to the zinc anode. The remaining space between the electrolyte and carbon cathode is taken up by a second paste consisting of ammonium chloride and manganese dioxide, the latter acting as a depolarizer.



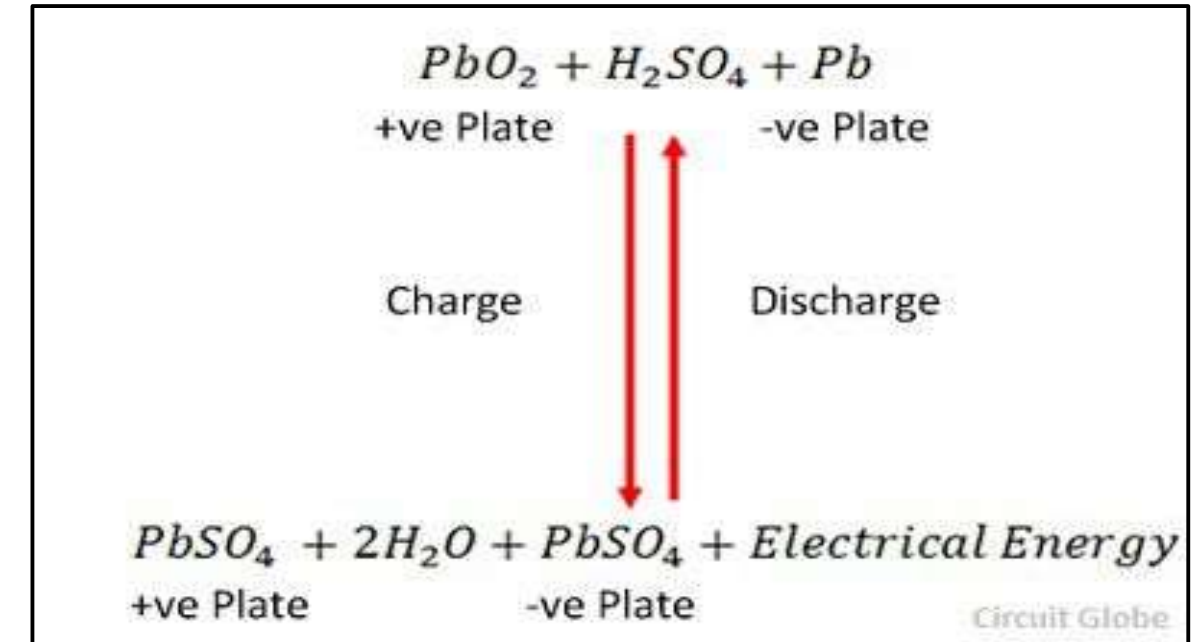
1. brass cap, 2. plastic seal, 3. expansion space, 4. porous cardboard, 5. zinc can, 6. carbon rod, 7. chemical mixture.



## Specific Gravity:

The most accurate and direct way to test the state of charge of a battery cell is to determine the specific gravity of the battery electrolyte. The higher the specific gravity of the electrolyte the higher the state of charge. The best way to truly monitor your system over its life is to regularly take and record specific gravity readings. Unfortunately, hydrometers are not easy to use. Testing can be time-consuming, there are possibilities for error and safety must be considered. For these reasons, we present this table .

Battery State-of-Charge (SoC) @ 80°F			
Open Circuit Voltage	Approximate State-of-Charge at 80° F (26.7°	Hydrometer Average Cell	Electrolyte Freeze Point
12.65	100%	1.265	-77°F(-67°C)
12.45	75%	1.225	-35°F (-37°C)
12.24	50%	1.190	-10°F(-23°C)
12.06	25%	1.155	15°F(-9°C)
11.89 or less	DISCHARGED	1.120 or less	20°F(-7°C)





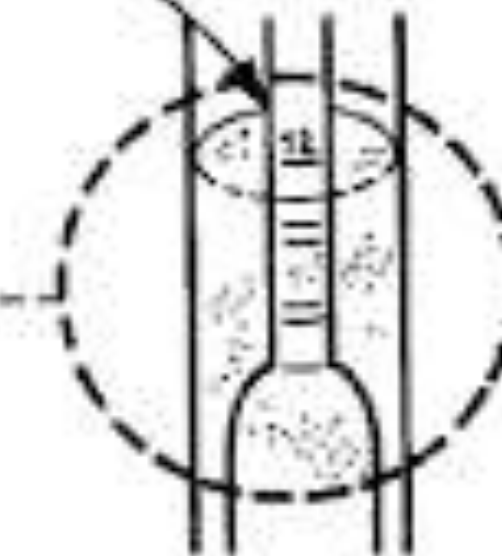
## Hydrometer

Hydrometers come in many sizes and shapes. We recommend a hydrometer with a float, contained in a glass vessel with a rubber bulb to draw the acid into the tube. Stay away from floating colored balls as the extra inaccuracy results in very subjective testing. The hydrometer should give you a numeric reading directly from the instrument. A good hydrometer is accurate to +/- 0.005 points so 1.265 could read from 1.260-1.270. The instrument accuracy should be known.

HOLD HYDROMETER VERTICAL

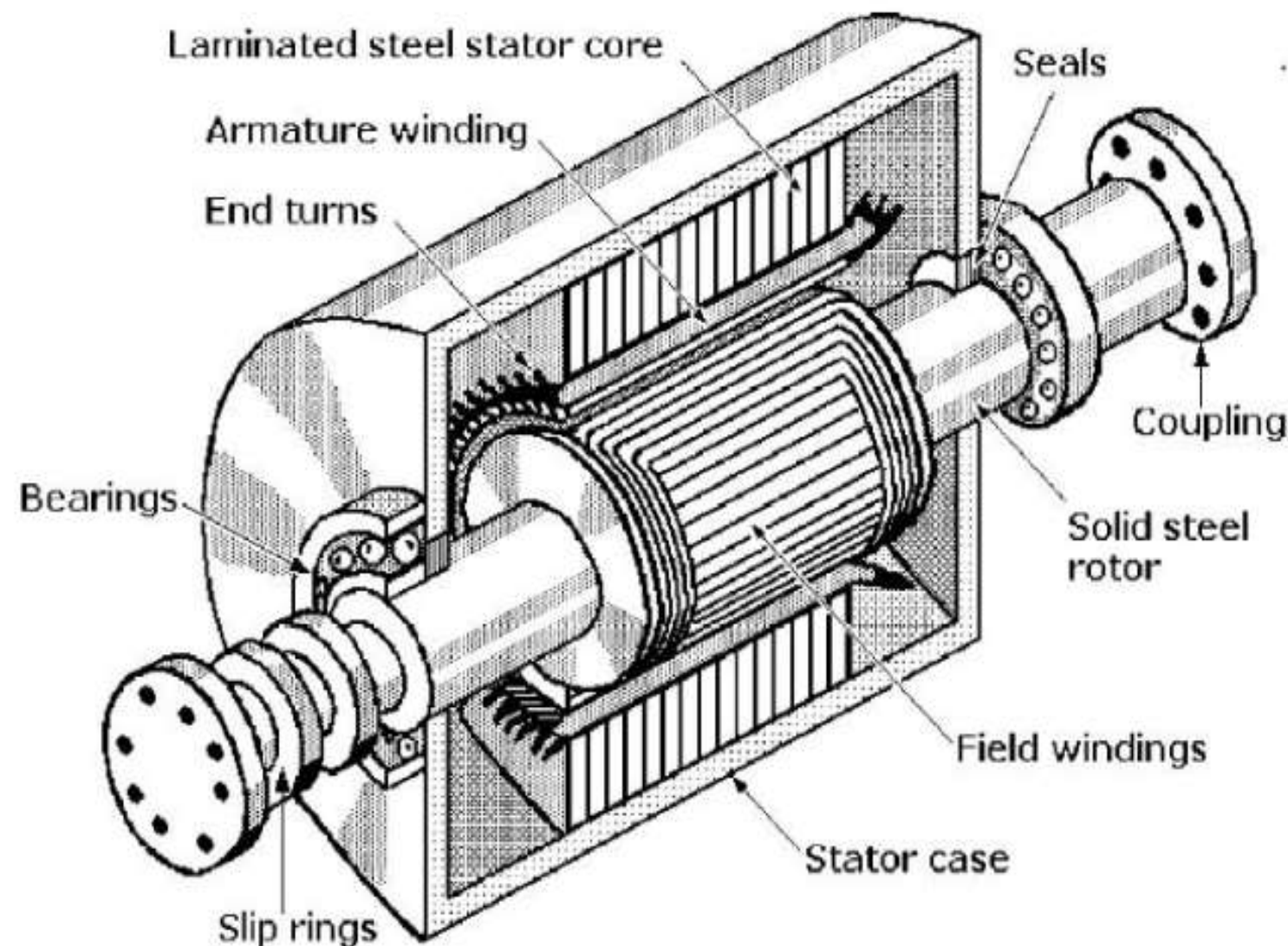


TAKE READING AT EYE LEVEL



## The advantages of an alternator

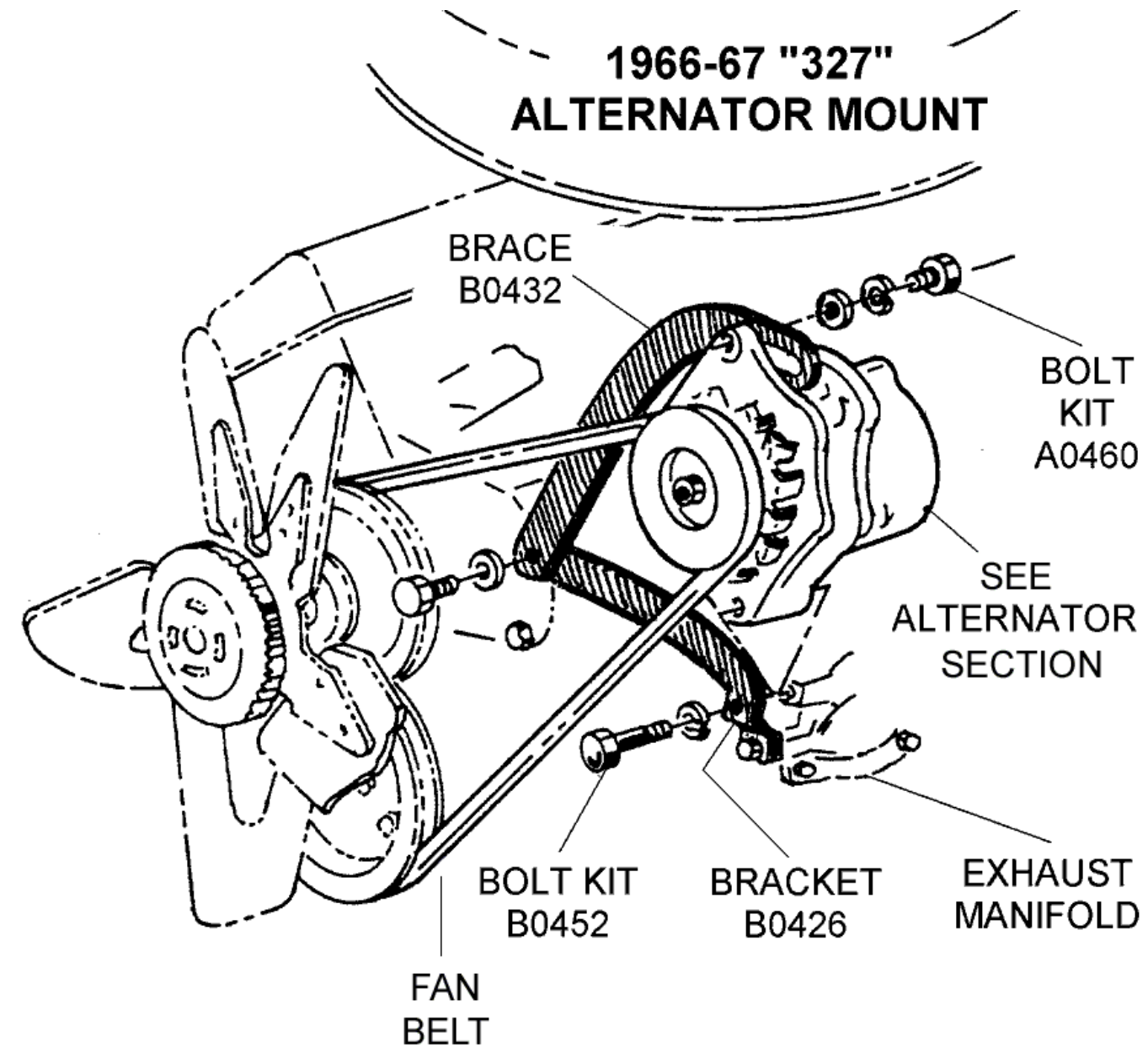
- Lighter, cheaper, and more rugged.
- Can provide useful charge at idle speed.
- Use slip rings, having greatly extended brush life over a commutator.
- by the engine. This is not a problem because the alternating current is rectified to direct current.



Cutaway view of a synchronous AC generator with a solid cylindrical rotor capable of high-speed rotation.

## Symptoms of a Failing Alternator

- The indicator **light**
- Headlights are dim or **flickering**. ...
- Other electrical failures. ...
- Strange **noises**. ...
- Car stalls or has difficulty starting. ...
- Battery dies.





A starter (also self-starter, cranking motor, or starter motor) is a device used to rotate (crank) an internal-combustion engine so as to initiate the engine's operation under its own power

## Types of Motor Starters

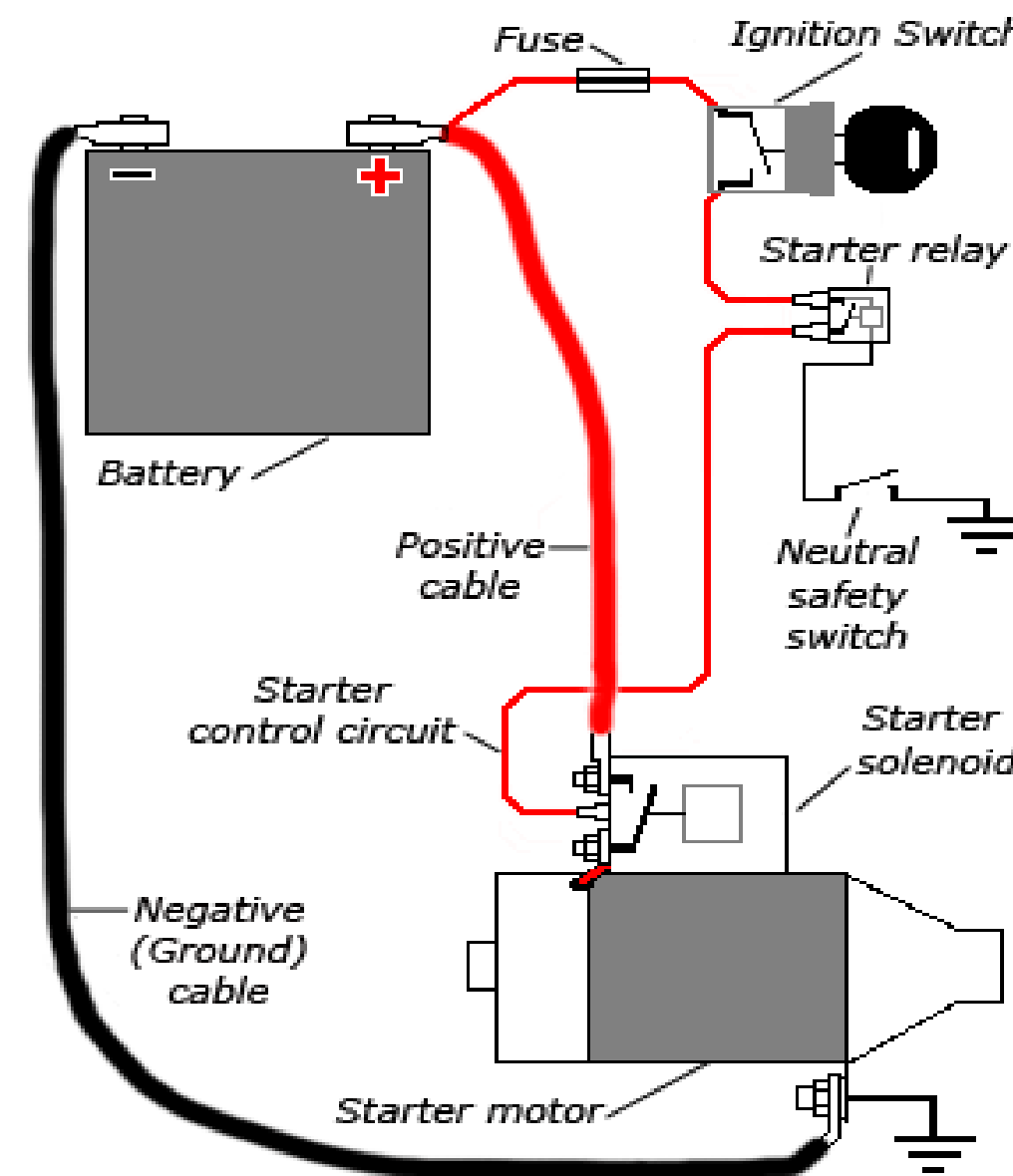
- Inertia Drive
- Over running clutch.

### Inertia Drive

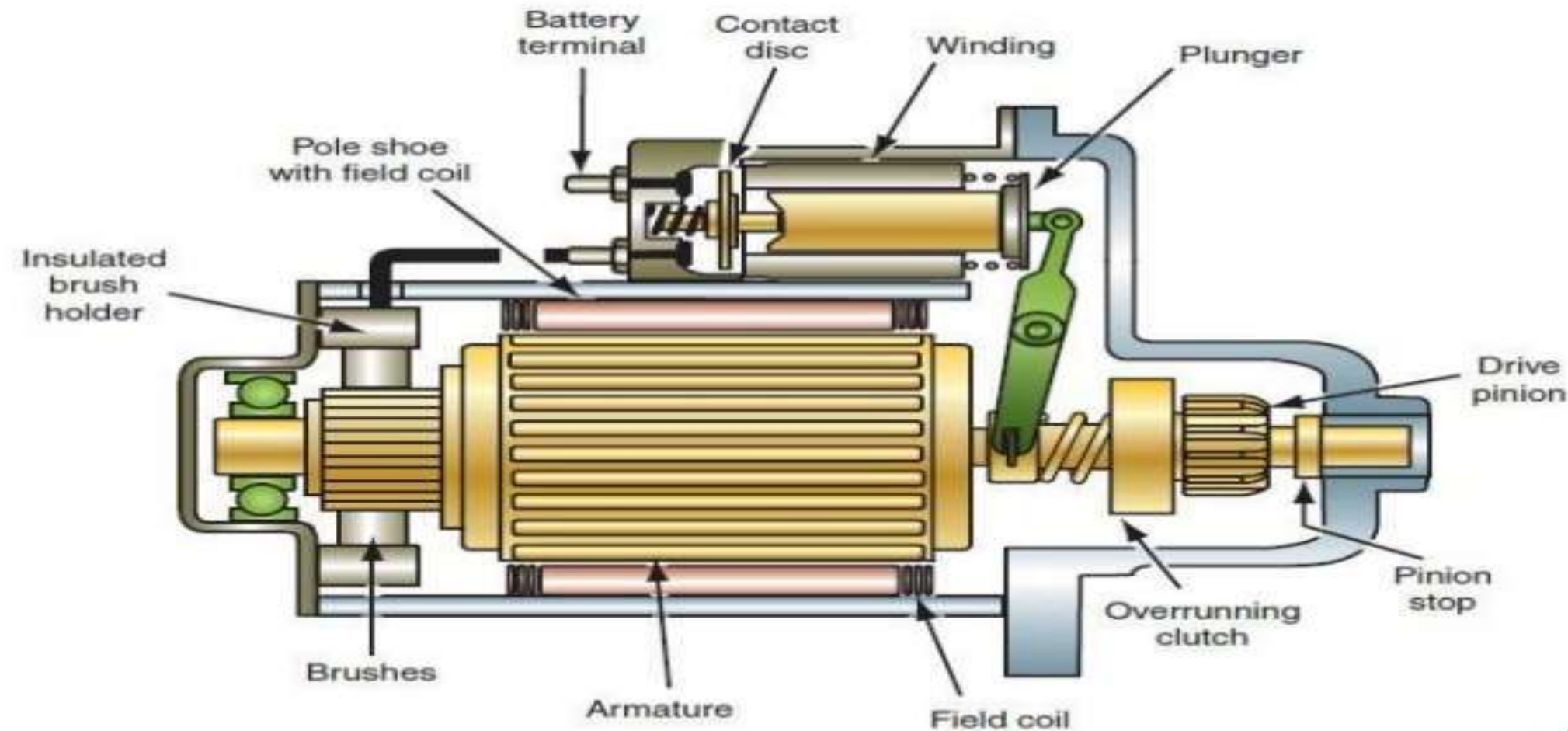
**Inertia starters** work by rotating a pinion and moving it forward through centrifugal force towards the ring-gear. As it continues to spin, the teeth of the pinion lock into the ring-gear and crank the engine. A key advantage of **inertia** starter in is that they automatically disengage once the engine has started.

### Inertia Drive

- Bendix Drive
- Folo-thru Drive



**Bendix Drive** is a type of engagement mechanism used in starter motors of internal combustion engines. The device allows the pinion gear of the starter motor to engage or disengage the ring gear (which is attached to the flywheel or flex plate of the engine) automatically when the starter is powered or when the engine fires, respectively. It is named after its inventor, Vincent Hugo Bendix.



## Head light

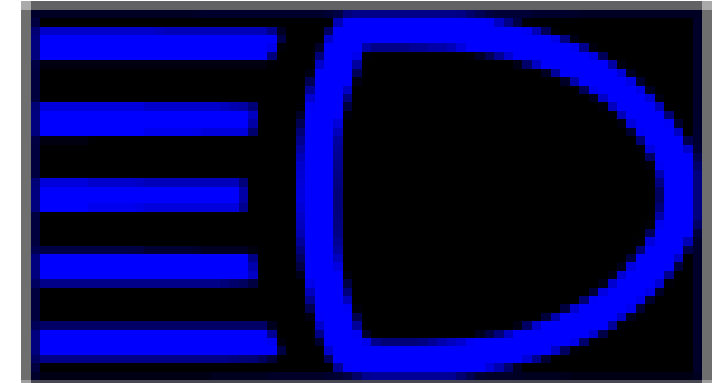
### ***Dipped beam (low beam, passing beam, meeting beam)***

Dipped-beam (also called low, passing, or meeting beam) headlamps provide a light distribution to give adequate forward and lateral illumination without dazzling other road users with excessive glare



### ***Main beam (high beam, driving beam, full beam)***

Main-beam (also called high, driving, or full beam) headlamps provide an intense, centre-weighted distribution of light with no particular control of glare.





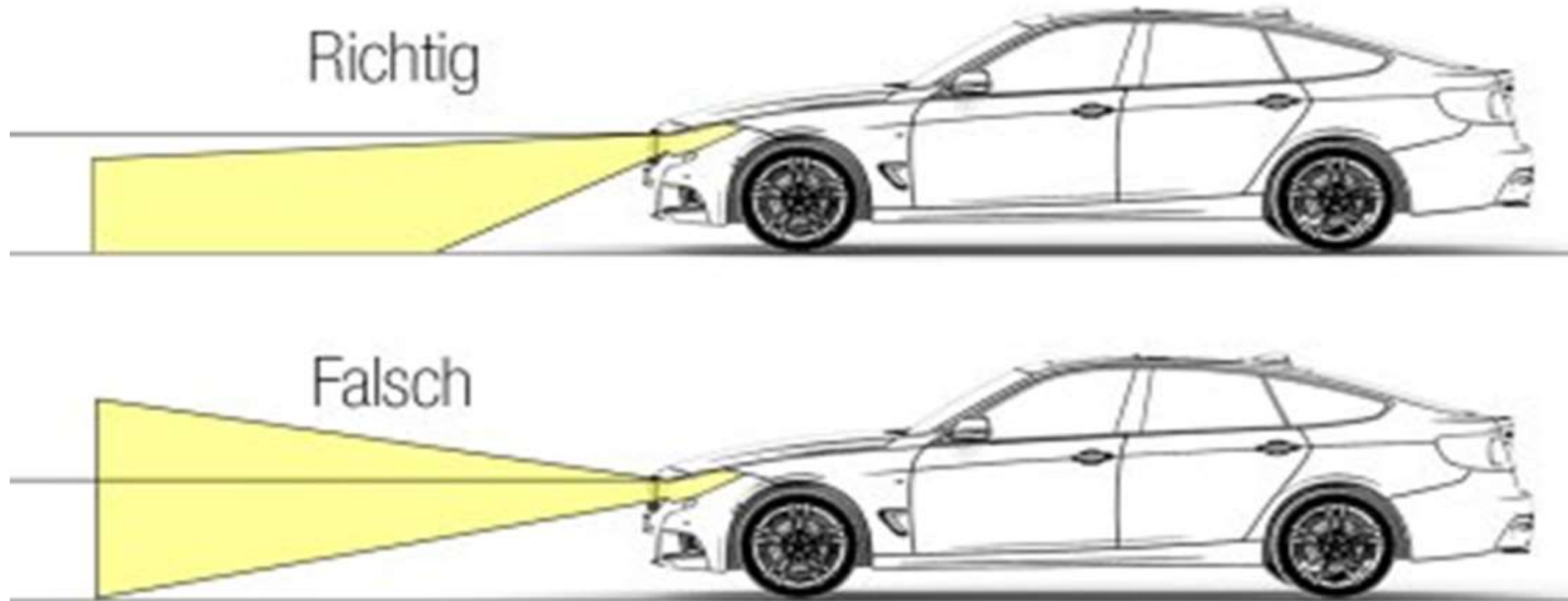
## ADJUSTMENT OF HEADLAMP SYSTEMS:

- Headlamps were first aimed at the so-called "10-meter wall". That means a vehicle is driven to a distance of 10 m in front of a light-coloured wall which has certain markings on it. The headlamps are then checked or adjusted on the basis of these markings.
- This has remained the statutory test method until today. It is still used particularly for checking agricultural or special vehicles. One of the disadvantages of this method is that a relatively large, light-coloured and free wall needs a corresponding amount of space. Both were, and are, not exactly often present in workshops.



ADJUSTMENT OF HEADLAMP SWITCH

These circumstances were also ultimately among the factors responsible for the development of beam setters. Such devices enable quicker and more flexible checking of light distribution.



There are three different types of headlight bulbs: **halogen** (which is based on the technology that has been around for decades), **xenon** (which uses newer technology to create longer-lasting, brighter light) and **LED**, which is the newest, most energy-efficient type of automotive light.

**Turn Light** - Direction-indicator lamps or turn signals, informally known as "directional signals", "directional", "blinkers", or "indicators", are blinking lamps mounted near the left and right front and rear corners of a vehicle, and sometimes on the sides or on the side mirrors of a vehicle, activated by the driver on one side of the vehicle at a time to advertise intent to turn or change lanes towards that side.



## Reversing (backup) lamps

When we run car back side then we can use reverse light



## Warning Light

### Brake Warning Light

Indicator light turns on when the handbrake is on. If it lit continuously, it means that hydraulic pressure has been lost in one side of the brake system or that the fluid level in the master cylinder is dangerously low (due to a leak somewhere in the brake system).



### Oil Pressure Warning Light

Indicator light means loss of oil pressure, meaning lubrication is low or lost completely. Immediately check the oil level and pressure.



## Warning Light

### Engine Temperature Warning Light

Indicator light means the engine temperature has exceeded normal limits. Check coolant level, fan operation, radiator cap, coolant leaks.



### Battery Charge Warning Light

Indicator light means that the car's charging system is short of power or is not charging properly. It normally indicates a problem with the battery itself or the alternator.



## Safety Symbols

Your vehicle's dashboard light plays an important role. These lights indicate an issue with your car that needs either an immediate action or checking.

### Transmission Temperature

Indicator light means the engine temperature has exceeded normal limits. Check coolant level, fan operation, radiator cap, coolant [leaks](#).



### Tire Pressure Warning Light

Indicator light means the pressure is low in one of your [tires](#).



### Traction Control Off

Indicator light means that the vehicle's TCS (traction control system) has been deactivated.





## Trailer Tow Hitch Warning

Indicator lights mean that the tow hitch is unlocked or that there's an issue with the lighting system.



## Steering Wheel Lock

Indicator light means your steering wheel is locked and can not be moved. To turn off the steering lock, insert the key into the ignition and turn it to at least the first position while turning the steering wheel in either direction.



## Traction Control Light

Indicator light turns on when the vehicle TCS (traction control system) is activated.



## Reduced Power Warning

Indicator light means that the Engine Computer has limited engine power output.



## Seat Belt Indicator

Indicator light means that a seat belt has not been secured for a passenger in the vehicle.



## Parking Brake

Indicator light means park brake is on.



## Automatic Gearbox Warning

Indicator light means there's a gearbox/transmission malfunction.



## Anti-lock Braking System (ABS)

Indicator light means there may be a malfunction in the ABS system.





## Door Ajar

Indicator light turns on when one or more doors of the car are not shut properly.



## Recirculated Cabin Air

Indicator light means that the vehicle's ventilation system is recirculating air from within the vehicle, suitable when particularly cold outside.



## Glow Plug Indicator

Indicator light means that the engine's glow plugs are warming up and the engine should not be started until the light goes out. If it flashes, an issue has been detected, such as a worn out glow plug.



## Fuel Filter Warning

Indicator light means that the diesel fuel filter is full, and needs to be emptied to avoid engine damage.



## Mass Air Flow Sensor

The MAF or Mass airflow sensor is one of the essential sensor used in automobiles. This sensor is used in an engine of the car. This sensor can be controlled by a computer and can calculate the air density in the engine.



Mass Air Flow Sensor

## Engine Speed Sensor

The engine speed sensor in the automobile can be connected to the crankshaft. The main purpose of this sensor is to monitor the crankshaft's rotating speed.



Engine Speed Se



## Oxygen Sensor

Located in the exhaust stream, usually near the exhaust manifold and after the catalytic converter, the oxygen sensor (or O<sub>2</sub> sensor) monitors the content of exhaust gases for the proportion of oxygen.



Oxygen Sensor

## Spark Knock Sensor

The spark knock sensor is used to ensure whether the fuel is burning smoothly, otherwise, it will cause an unexpected ignition.



Spark Knock



## Coolant Sensor

The coolant sensor is the most significant sensor used in automobiles. Because the computer depends on the sensor inputs to control all the functions.



Coolant Sensor

## Manifold Absolute Pressure Sensor

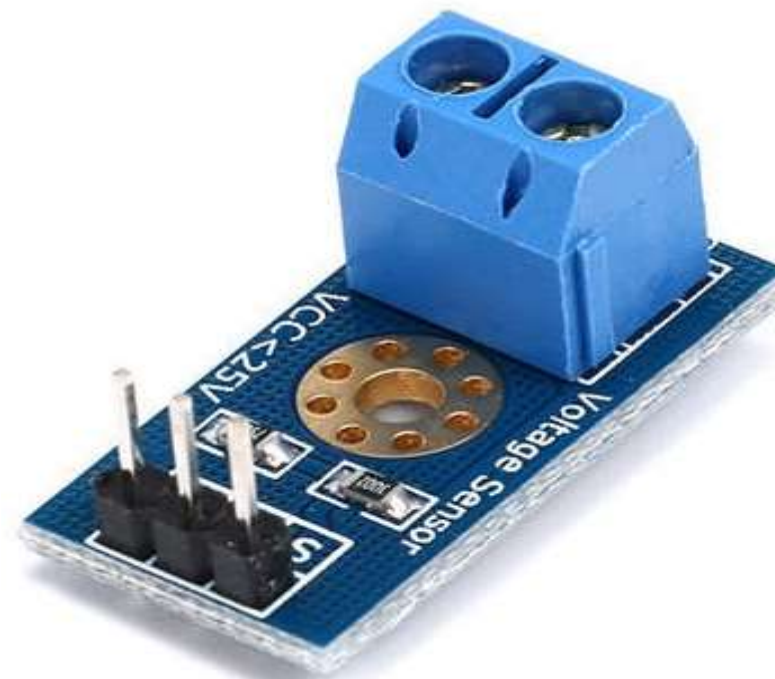
The short term of the manifold absolute pressure is MAP. The main function of this sensor in an automobile is to monitor the load of an engine



Manifold Absolute Pressure Sensor

## Vehicle Speed Sensor

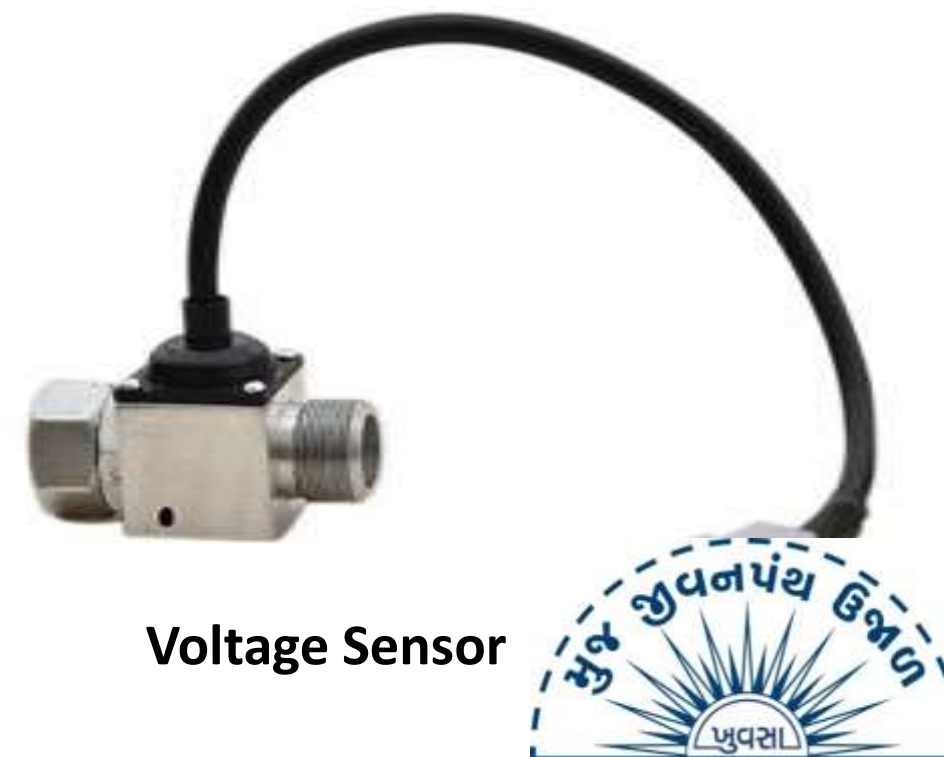
As the name suggests, this VSS sensor has the capability to verify the speed of [the car](#) wheels. It is a type of tachometer.



Vehicle Speed Sensor

## Voltage Sensor

Voltage Sensor is one type of sensor used in automobiles. The main function of this sensor is to manage the car speed and to make sure the speed of is increased (or) decreased as required. So it is essential to have in your car.



Voltage Sensor



## Throttle Position Sensor

The throttle position sensor in automobile mainly uses feedback carburetion & electronic fuel injection (EFI).



Throttle Position Sensor

## Fuel Temperature Sensor

The fuel sensor is used to check the temperature of the fuel continually whether the fuel utilization is optimum or not

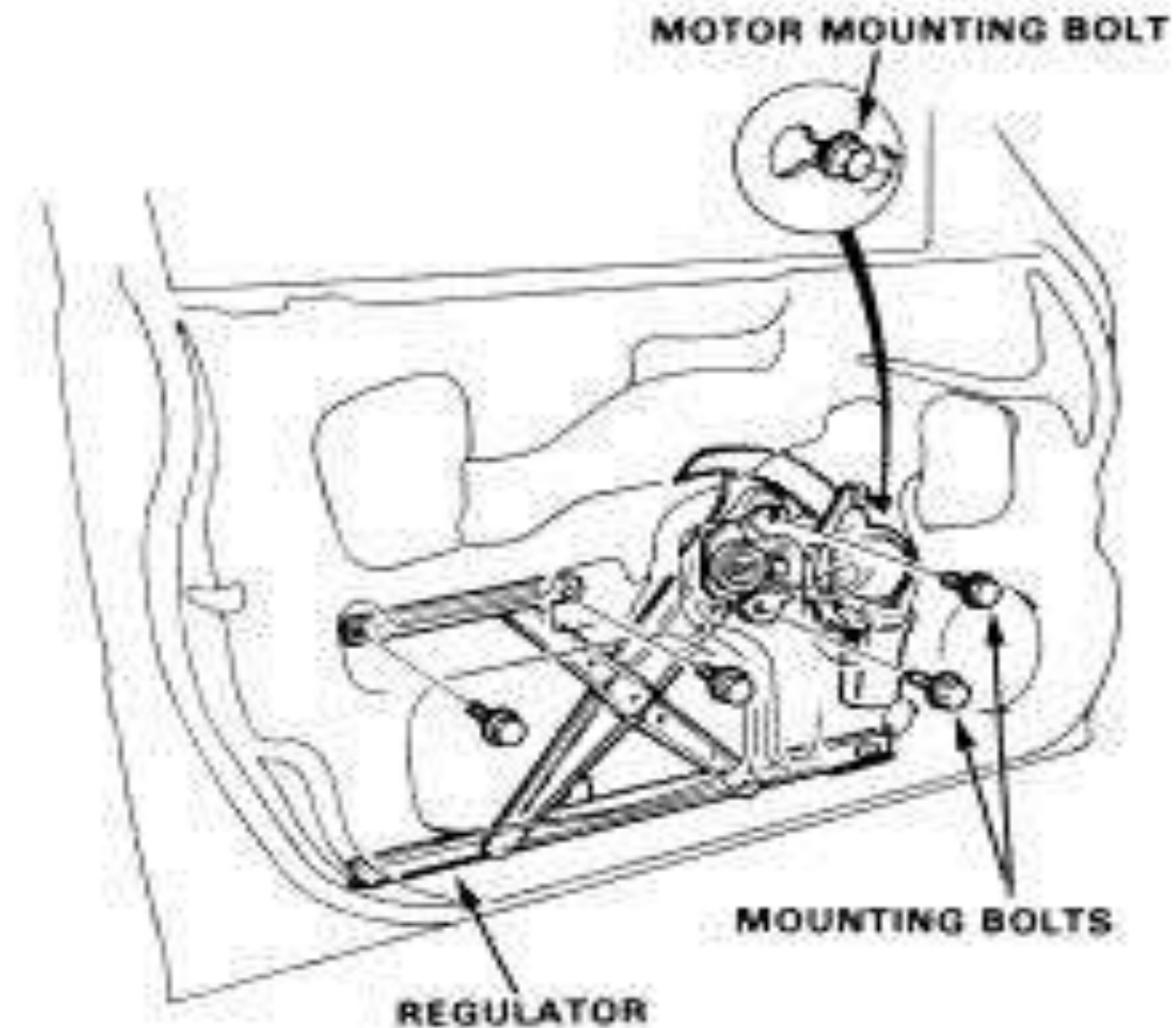


Fuel Temperature Sensor

There are two type of window

- Electric Power oprating windows
- Manual oprating window

Electric Power oprating

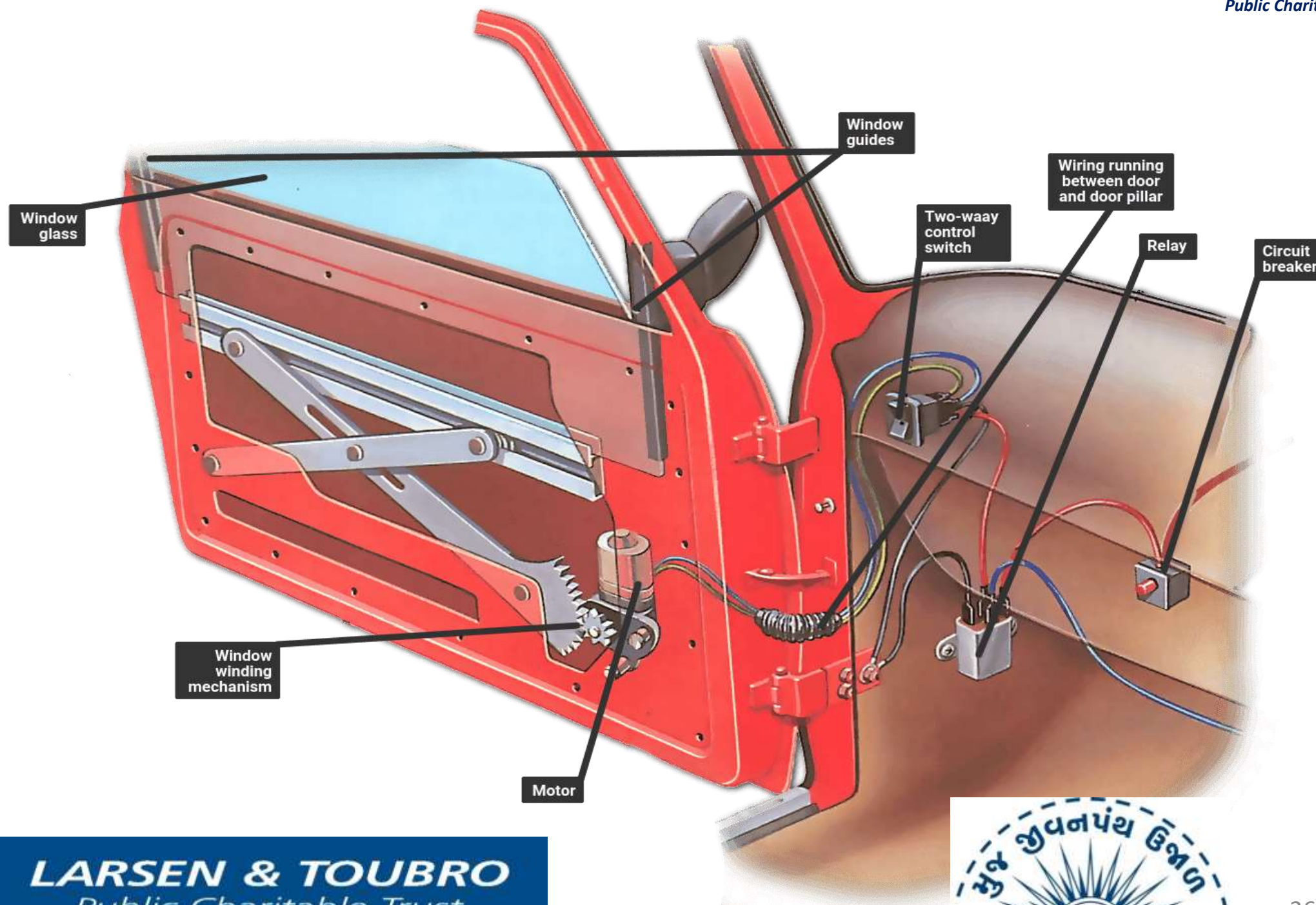




Open the car door

Remove the car door matt

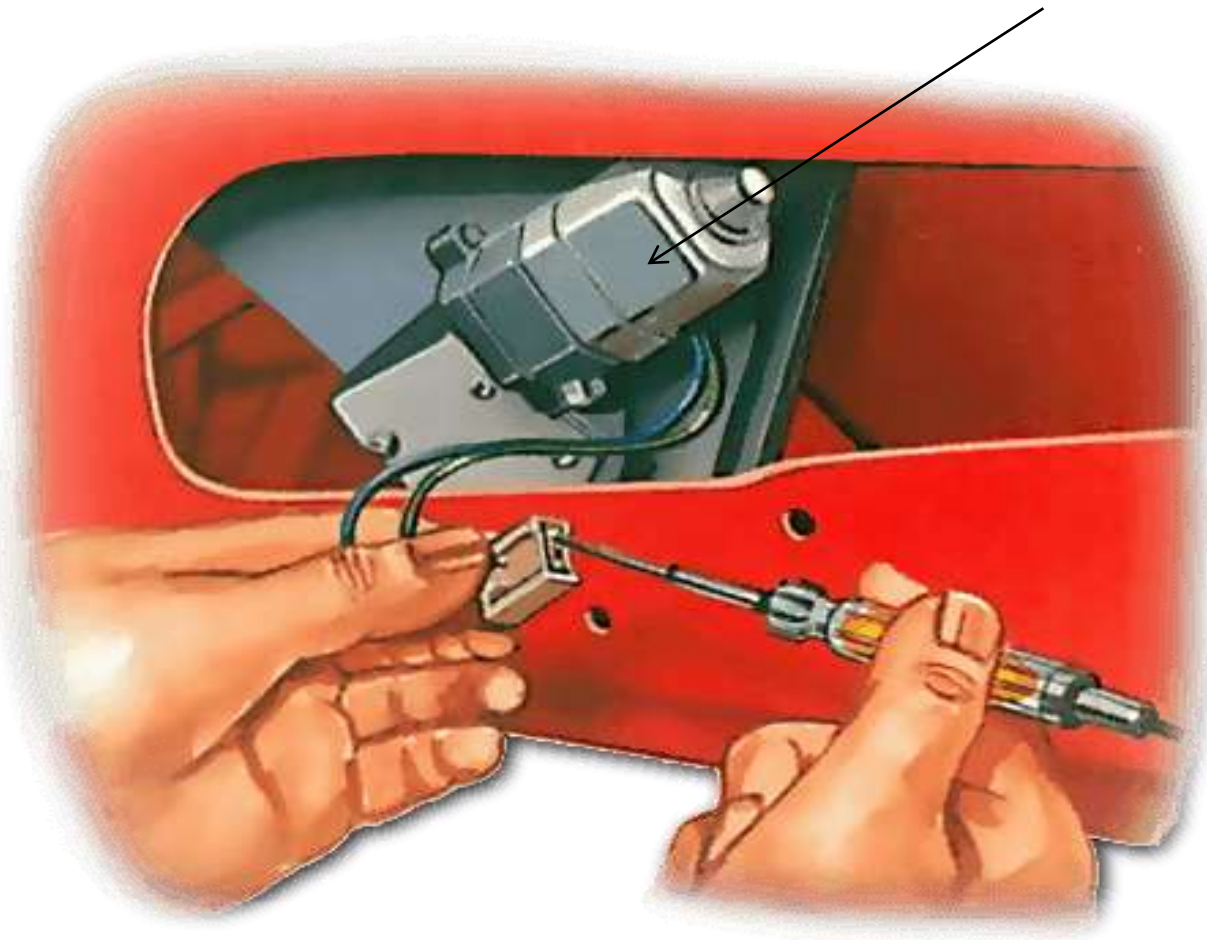
- Check the all electrical coupler
- Check the wire
- If the wire is broken, replace it
- Check the earthling
- Make sure the wire is not stretched





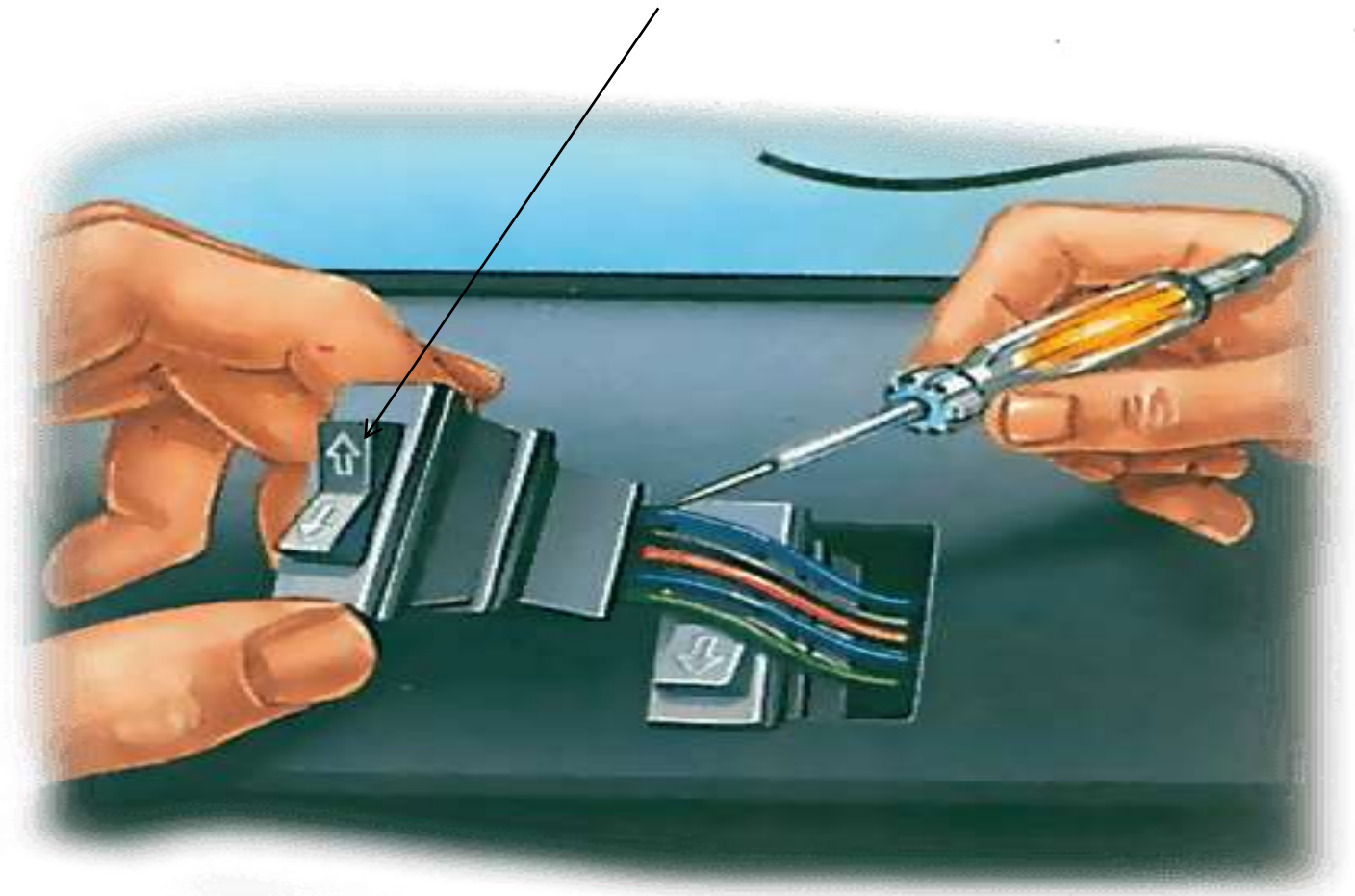
Check the electric motor

Electric motor

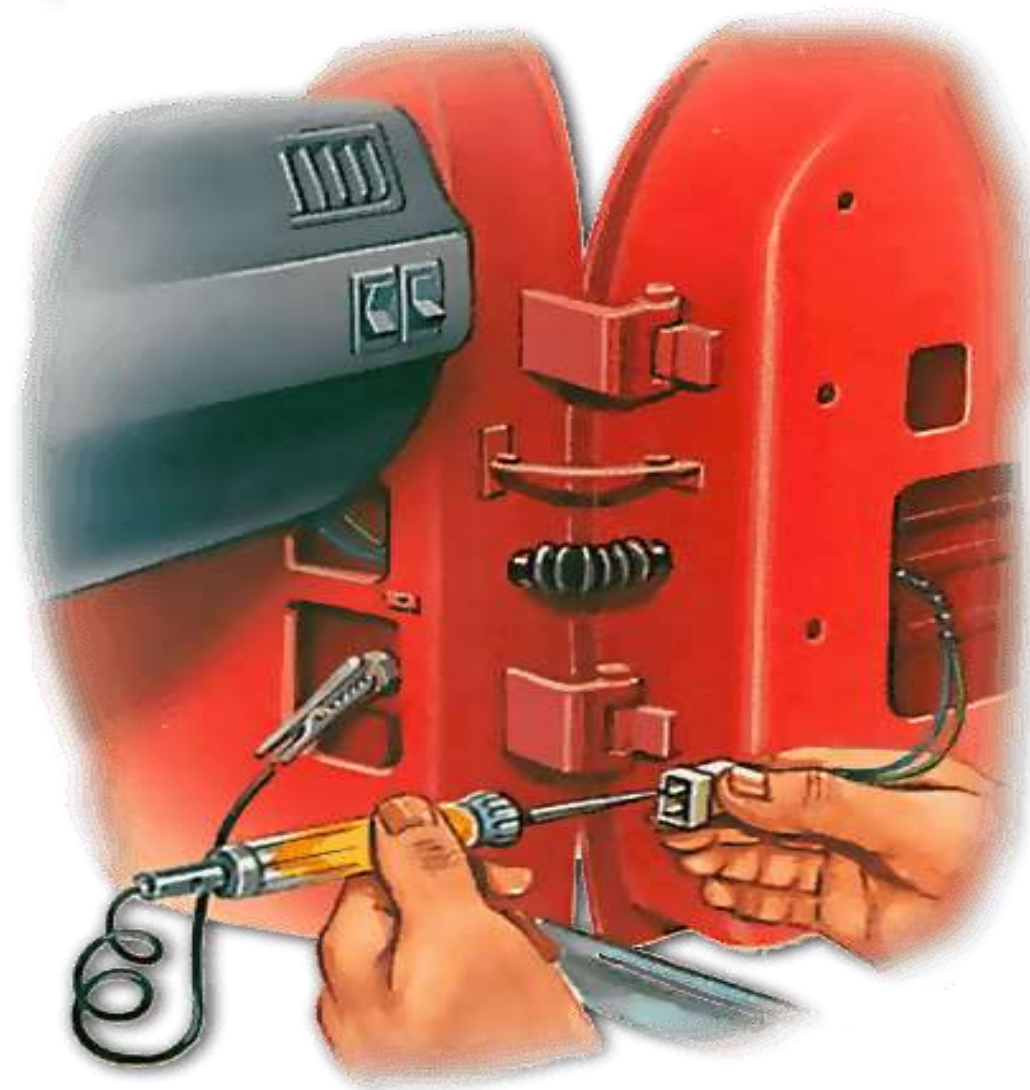


check the electrical switch

Switch



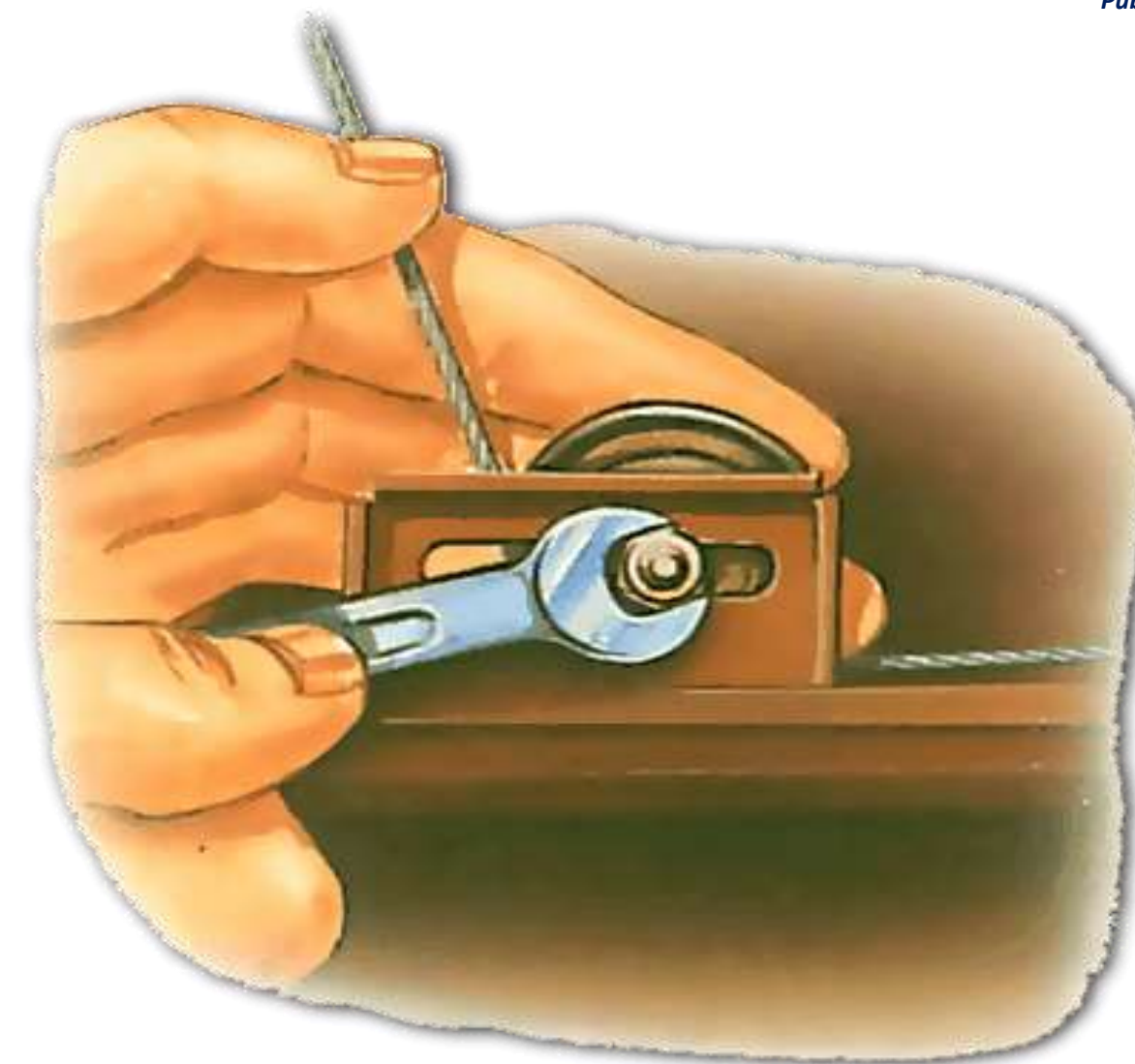
- Check the all electrical coupler
- Check the wire
- If the wire is broken, replace it
- Check the earthling
- Make sure the wire is not stretched





## Check the mechanism

- Sticking and jerky operation is often due to troubles with the window mechanism.
- To check it start by removing the door trim. Look over the mechanism to see if there is any obvious damage and make sure there is nothing that might make it jam - loose wires in the door cavity are a particular risk.



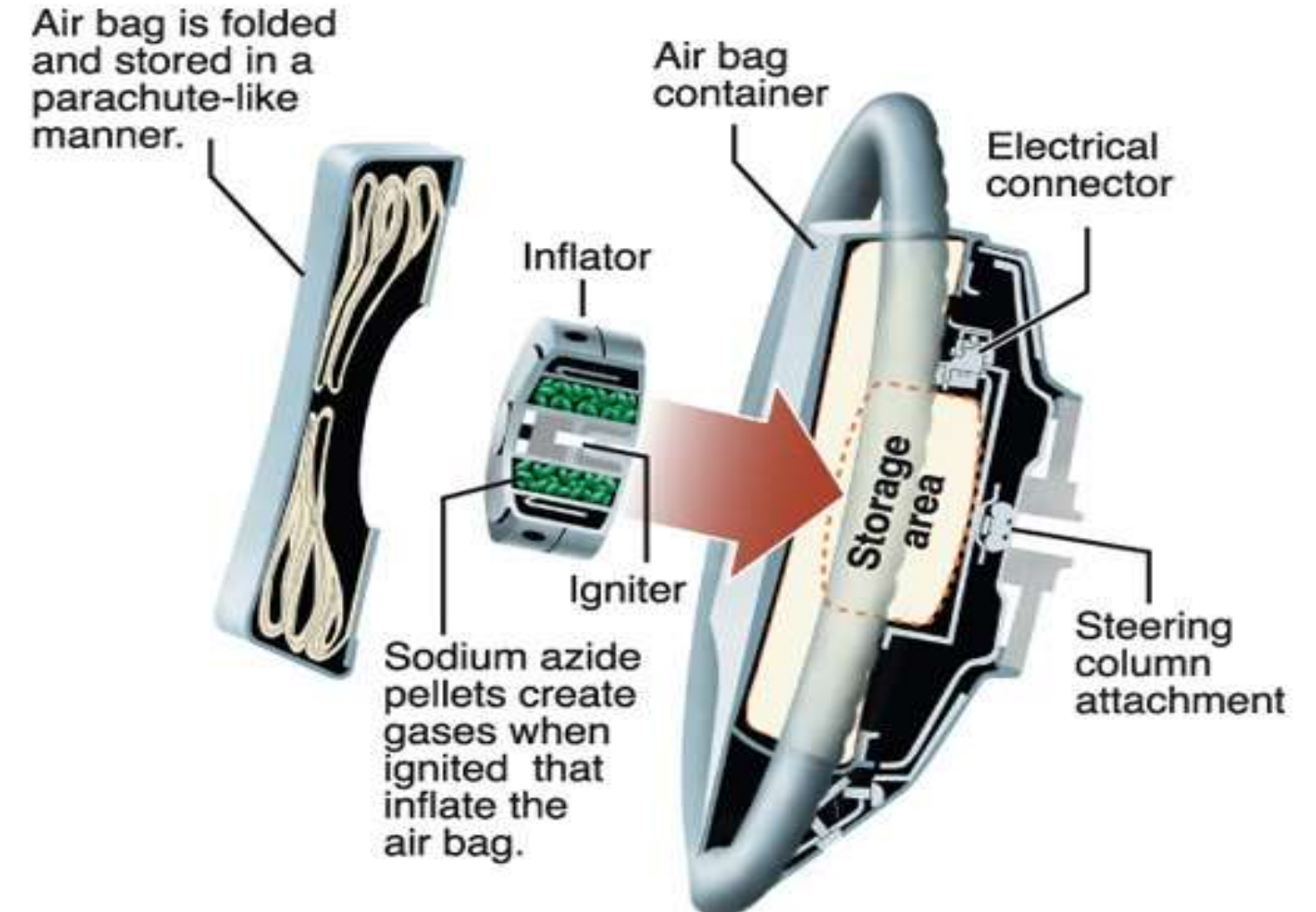


Should the action remain sluggish the problem may lie in the motor so remove it to check. If the motor appears to be running (you may be able to hear it or feel the vibrations) but there is no movement the gear drive between motor and mechanism has probably failed so remove the motor to check it.



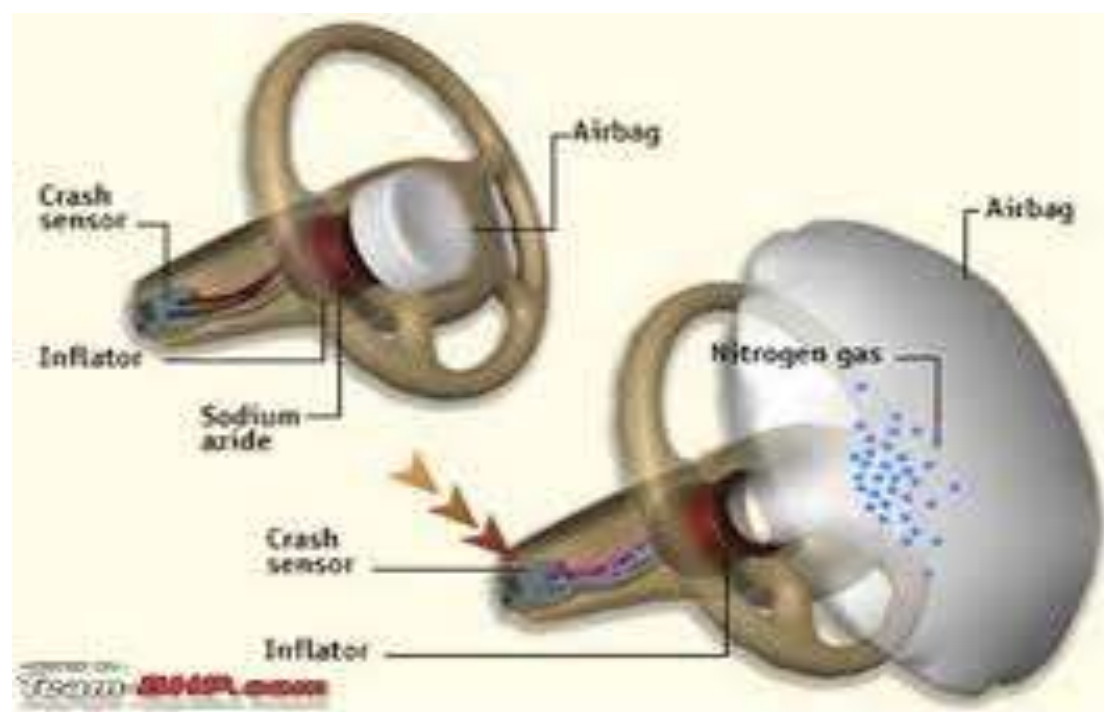
- **Supplementary Restraint System (SRS) or “Air-Bag”**
- An **airbag** is a vehicle occupant-restraint system using a bag designed to inflate extremely quickly, then quickly deflate during a collision.
- The purpose of the airbag is to provide a vehicle occupant with a soft cushioning and restraint during a crash event. It can reduce injuries between the flailing occupant and the interior of the vehicle.
- The bag itself and its inflation mechanism is concealed within the steering wheel boss (for the driver), or the dashboard (for the front passenger), behind plastic flaps or doors which are designed to tear open under the force of the bag inflating.

## How an airbag works





- Within about 40 milliseconds of impact, all these components react in three separate reactions that produce nitrogen gas.
- The reactions, in order, Frontal crash **sensors** may be **located** in the front of the vehicle near the engine, in the passenger compartment, or sometimes in the electronic control unit (ECU). Side-impact crash **sensors** may be **located** in the ECU, the door, the doorsill, or between the front and rear doors.



Airbag Sensor





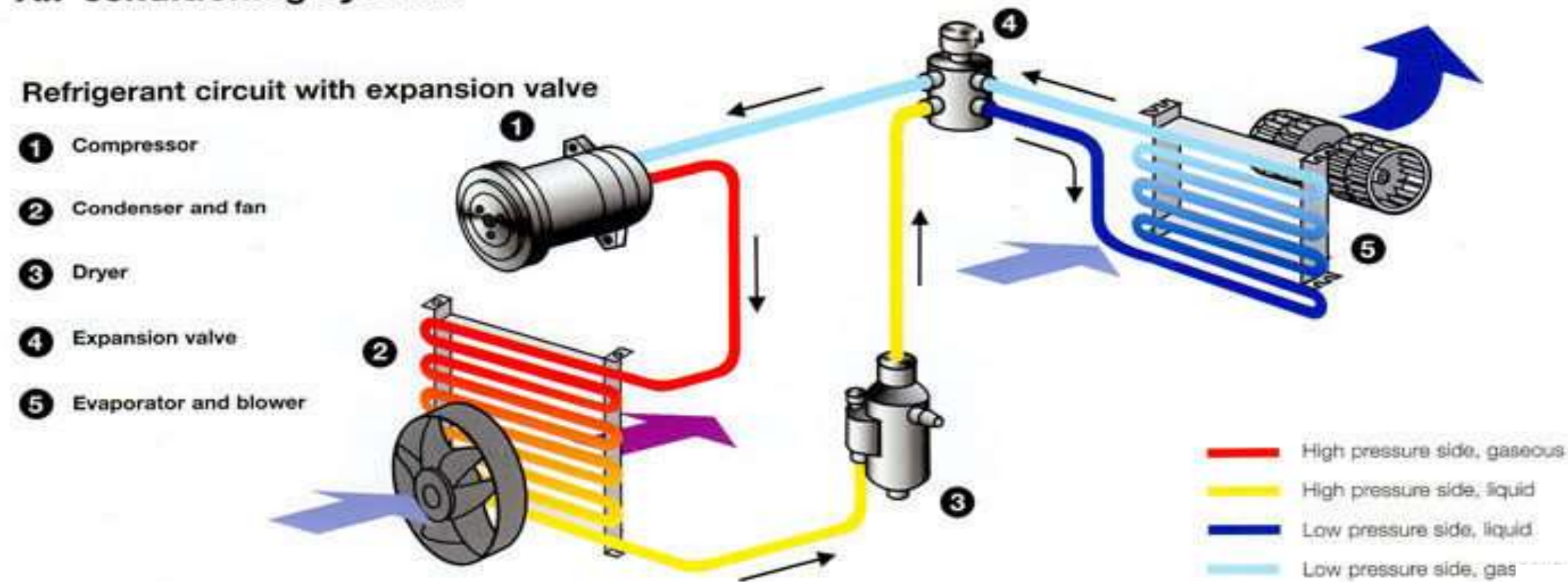


# AIR CONDITIONER SYSTEM

**Operating principles-**In the refrigeration cycle, heat is transported from the passenger compartment to the environment. A refrigerator is an example of such a system, as it transports the heat out of the interior and into the ambient environment.

Circulating refrigerant gas vapor (which also carries the compressor lubricant oil across the system along with it) from the evaporator enters the gas compressor in the engine bay, usually an axial piston pump compressor, and is compressed to a higher pressure, resulting in a higher temperature as well.

## Air conditioning system.



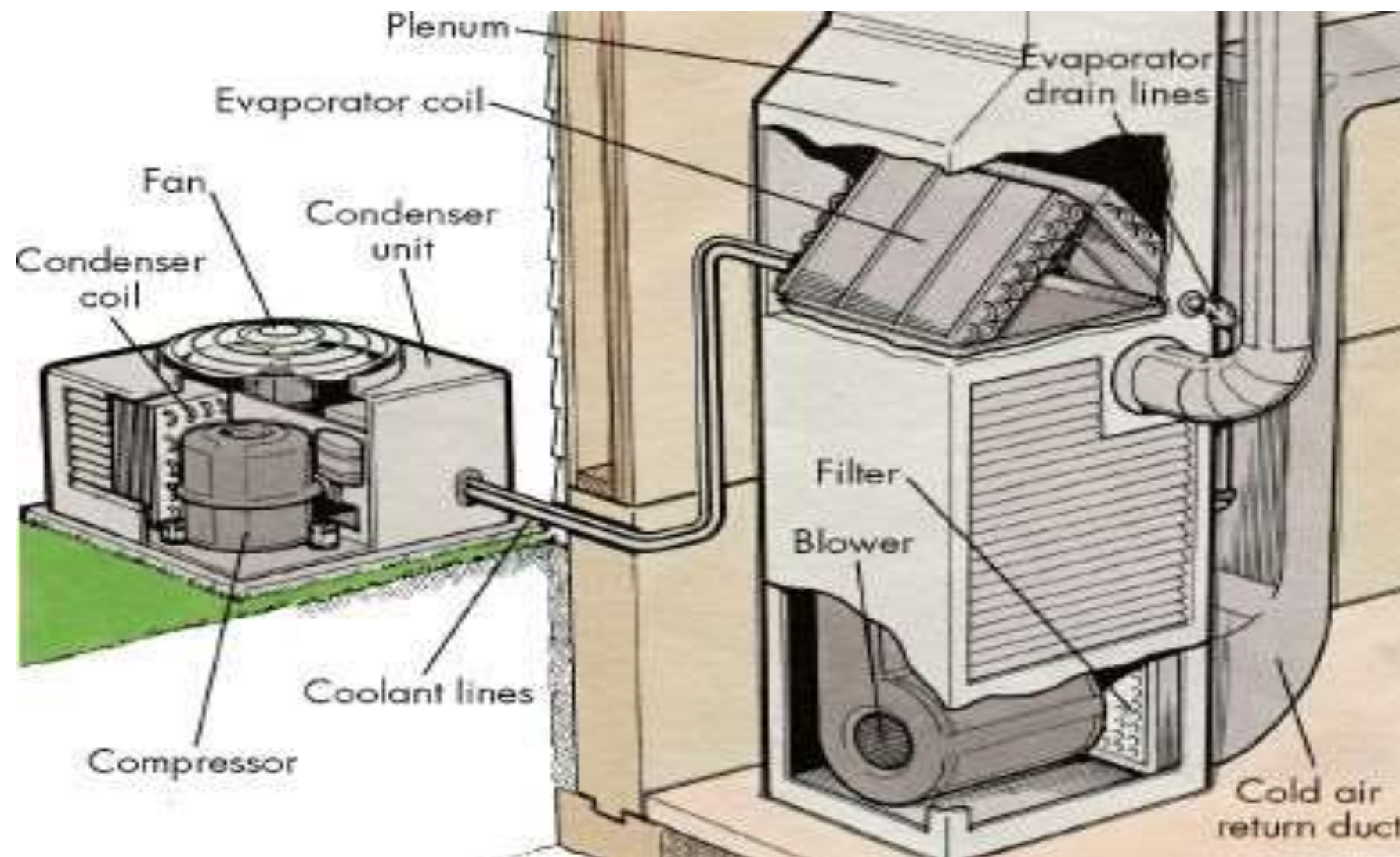
## AIR CONDITIONER PARTS & FUNCTIONS

**Blower:** Air flowing from supply registers is the work of the blower. This component, which also works with your furnace, circulates cooled air into your home and pulls room-temperature air back for re-cooling.

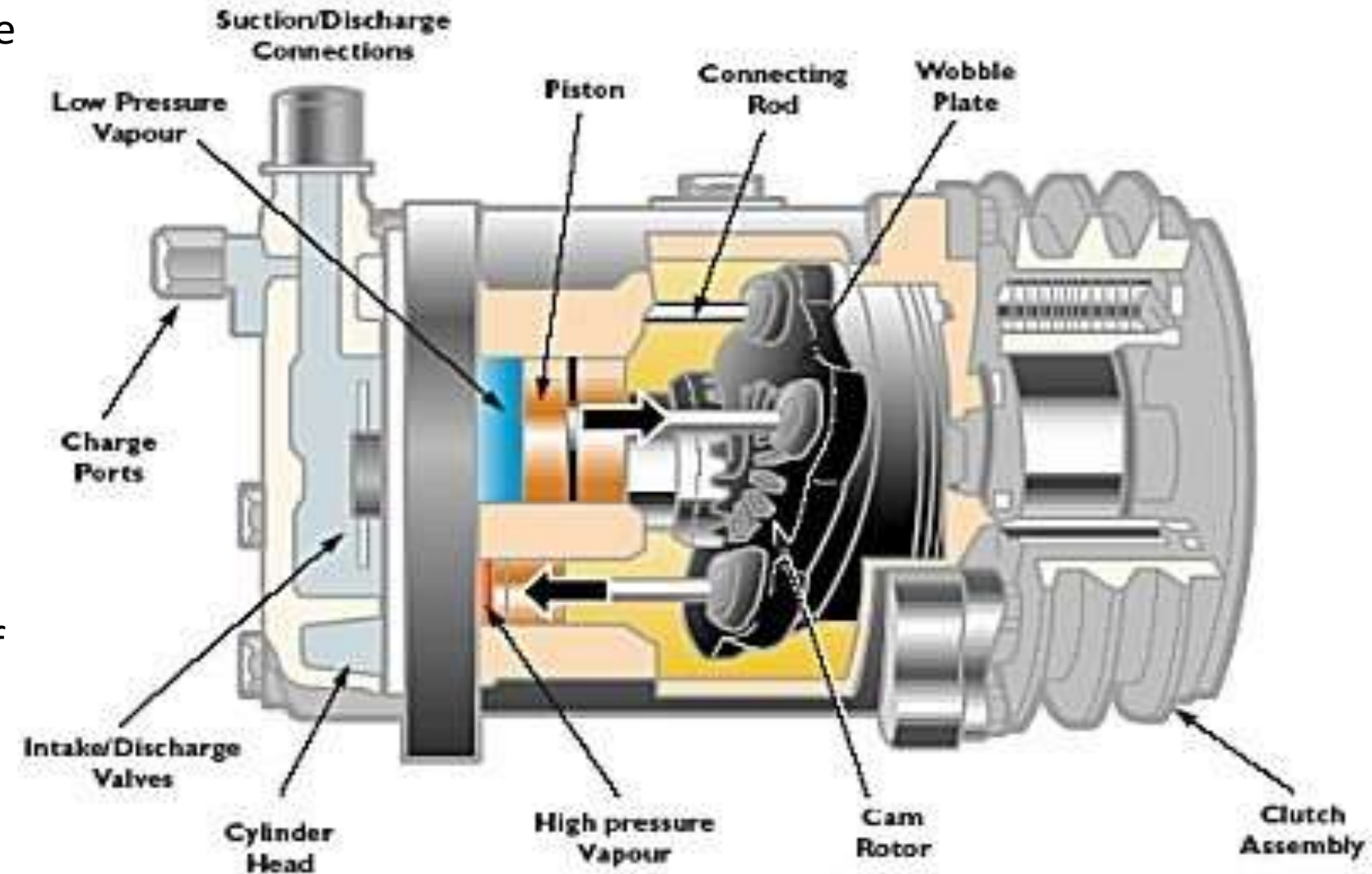




**Evaporator coil:** This indoor component, located near the blower, is responsible for extracting heat and humidity from the air. This is possible thanks to the refrigerant running through the coil.



- **Compressor:** Once it has absorbed heat, the refrigerant is in a gaseous state. It passes through the compressor, where the gas is pressurized and heated even more.
- the compressor pumps, or forces, the liquid from the evaporator into a condenser and expansion valve, and then back to the evaporator.
- The engine drives the compressor with a belt.
- Its main job is to compress and transfer refrigerant gas through the car's A/C system. Because there is more than one way to compress gas, different types of compressors can be used within an A/C system. The most commonly used types of compressors include rotary piston, scroll and variable displacement.

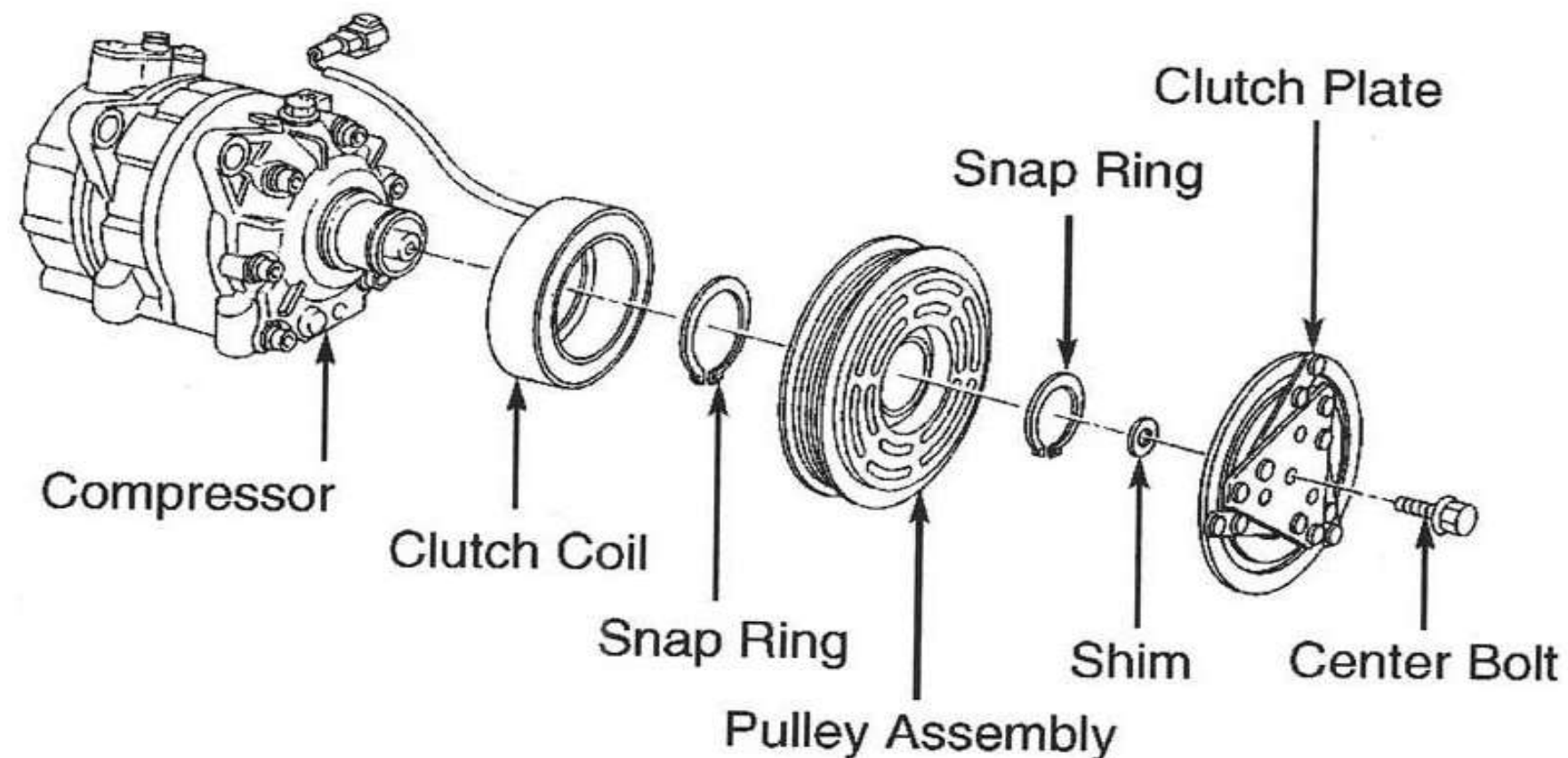




## Symptoms of a Bad or Failing AC Compressor

- Cabin temperatures higher than normal. One of the first signs that a compressor may be having trouble is the AC no
- longer blowing as cold as it once did. ...
- Loud noises when the compressor is running. ...

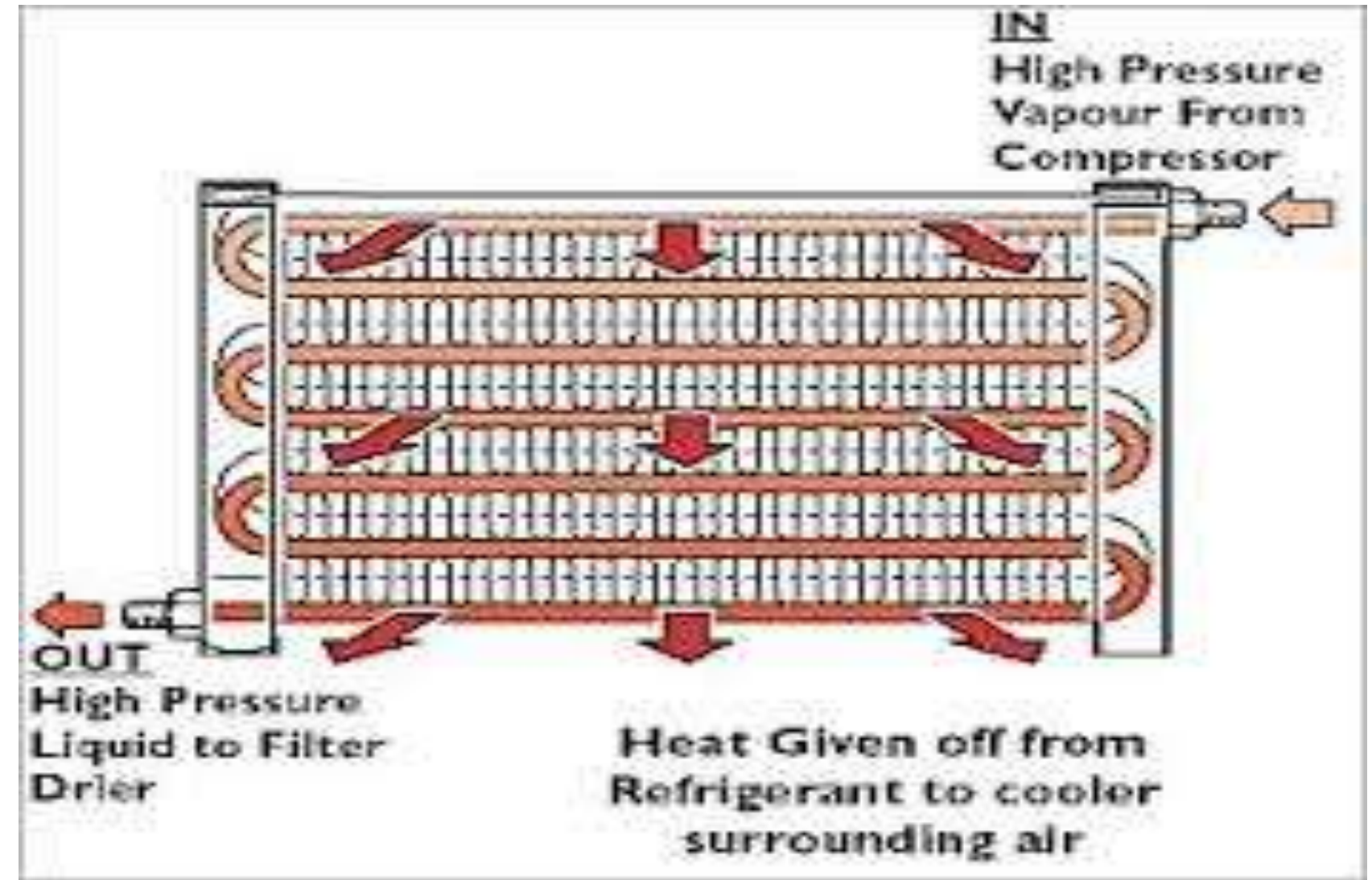
most cases it is more cost effective to replace the compressor instead of trying to order parts and repair one. Other problems that AC compressors have is bad Ac seal which will leak AC oil or refrigerant. There is no way to replace seals on an AC compressor, so replacement is necessary if this is the problem.





**Condensing coil:** This is the outdoor equivalent to the evaporator coil. As refrigerant travels from the compressor to the condenser, it expels the heat collected from indoors to the outside.

Once the refrigerant is cooled to a liquid, it circulates back inside to collect more heat in the evaporator coil.



**Fan:** The outdoor condensing unit becomes very hot with all that overheated refrigerant running through it.

A fan and fins that act as heat syncs draw the heat away so the unit doesn't overheat.

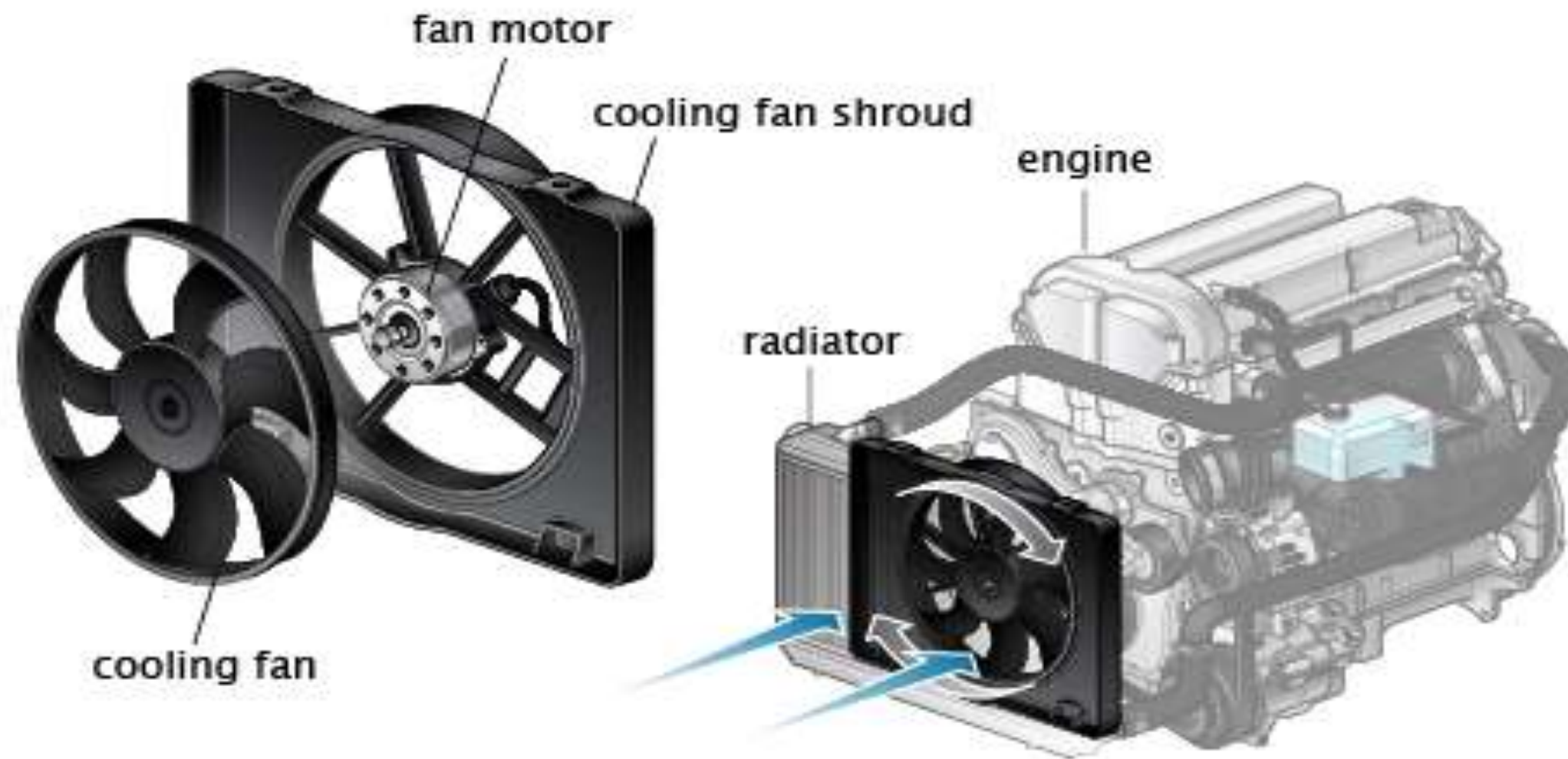
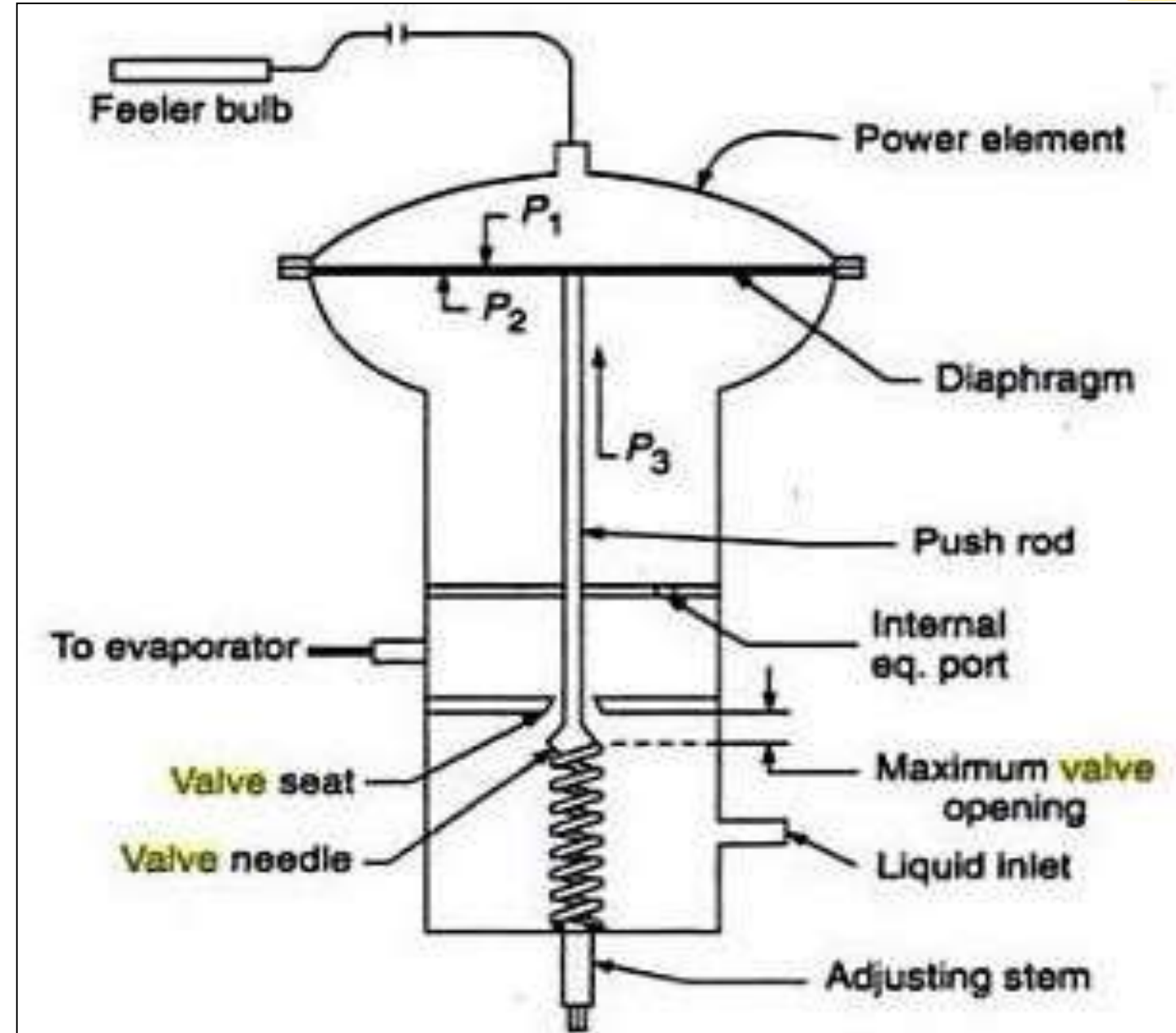


Image courtesy of ClearMechanic.com

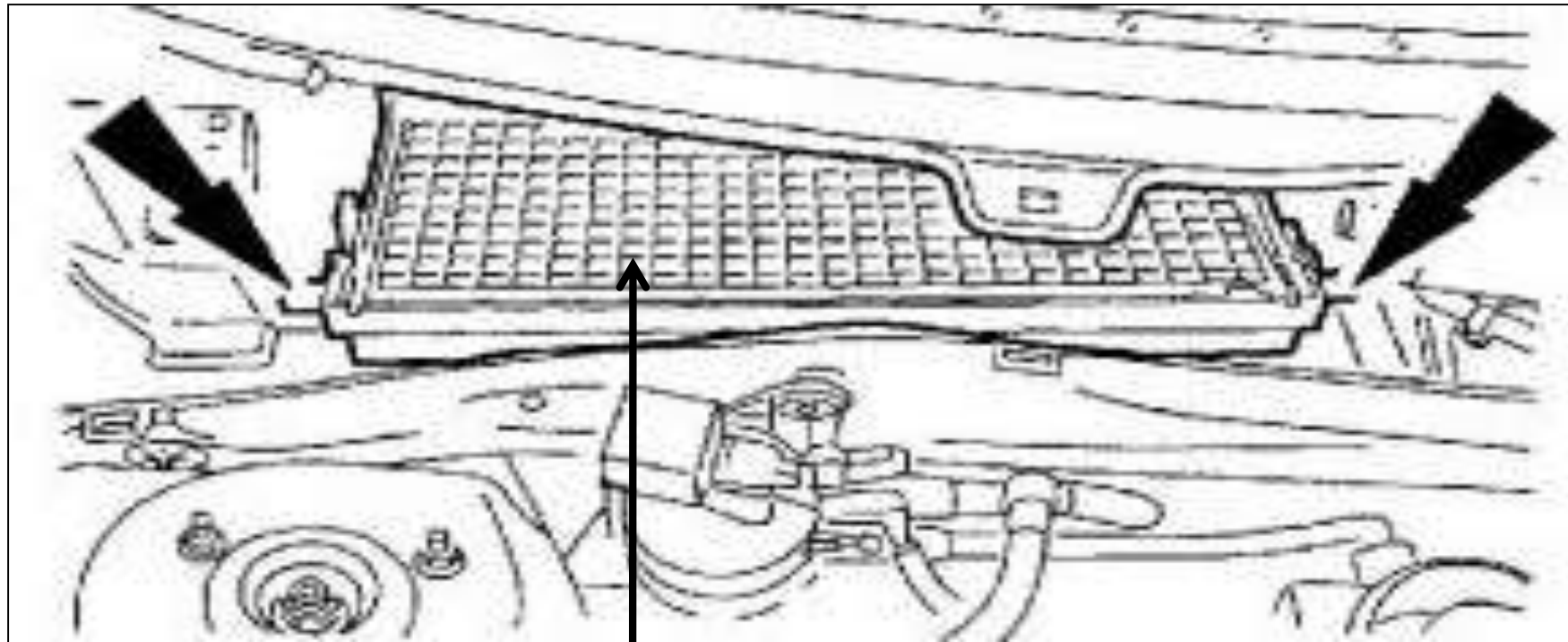


**Thermostat:** This is the control center of the entire air conditioning process, reading the indoor temperature and telling the air conditioner when to turn on and off. You change temperature settings here based on your needs. The higher you set the thermostat, the lower your cooling bills will be.





**AC Air filter:** While an air conditioner can function without the air filter, dust and dirt in the air would quickly collect on A/C components and possibly damage them without the filter in place. Install an efficient enough filter and you can even improve indoor air quality while the air conditioner operates.



A C Filter



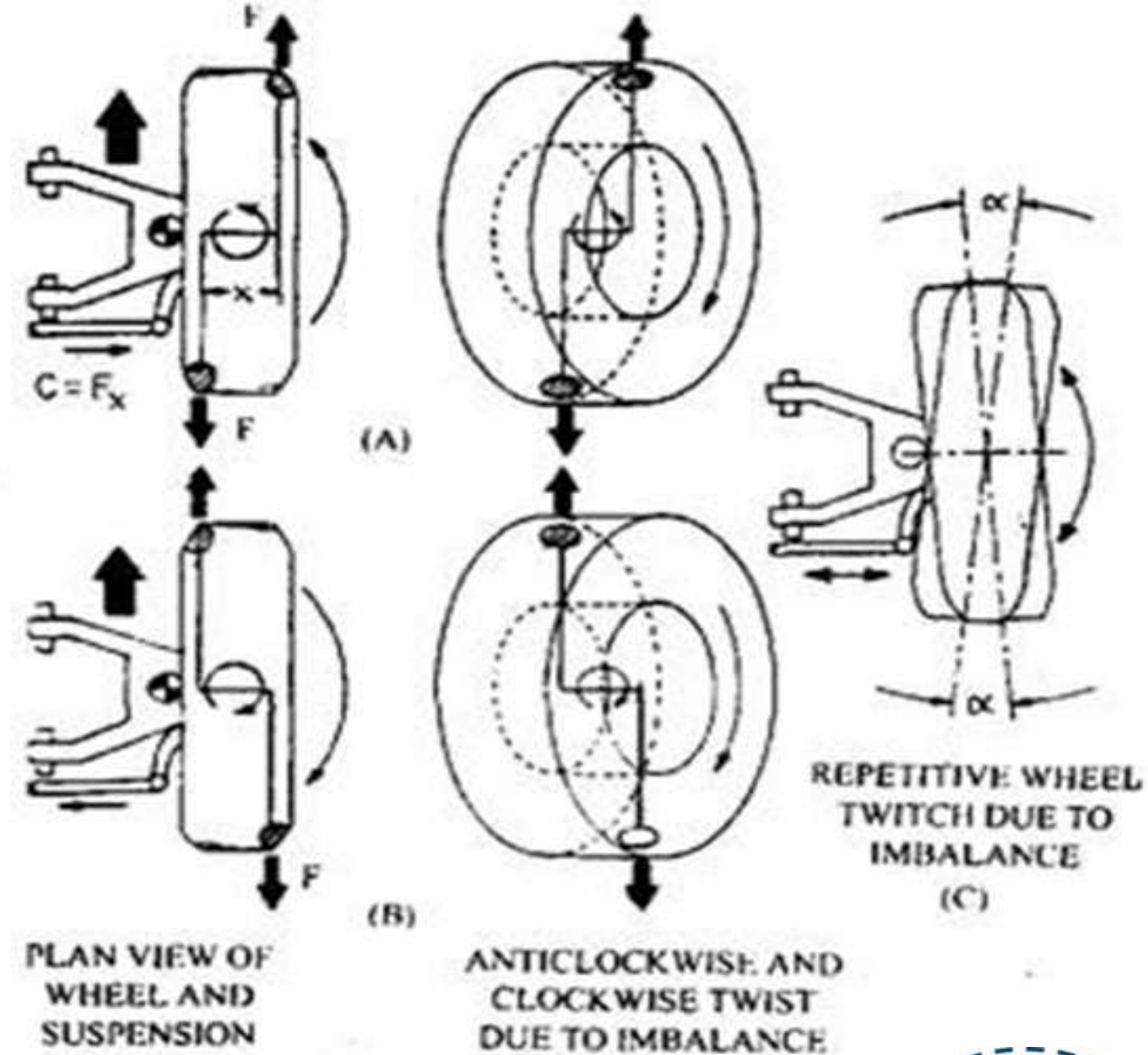
A C Filter



# WHEEL ALIGNMENT & TIRE



- **Wheel Balancing** is about rotational balancing. The Metal wheel, and the rubber tire are not perfectly balanced for each other.
- **Wheel balancing** is important because **wheels** lose their **balance** over time. Factors concerning the weight distribution of your vehicle, road conditions and tread wear can cause an unevenness in the tires, which can then lead to further uneven tread wear.





**wheel alignment**, can help your tires perform properly and help them last longer. It can also improve handling and keep your vehicle from pulling in one direction or vibrating strangely on the road.

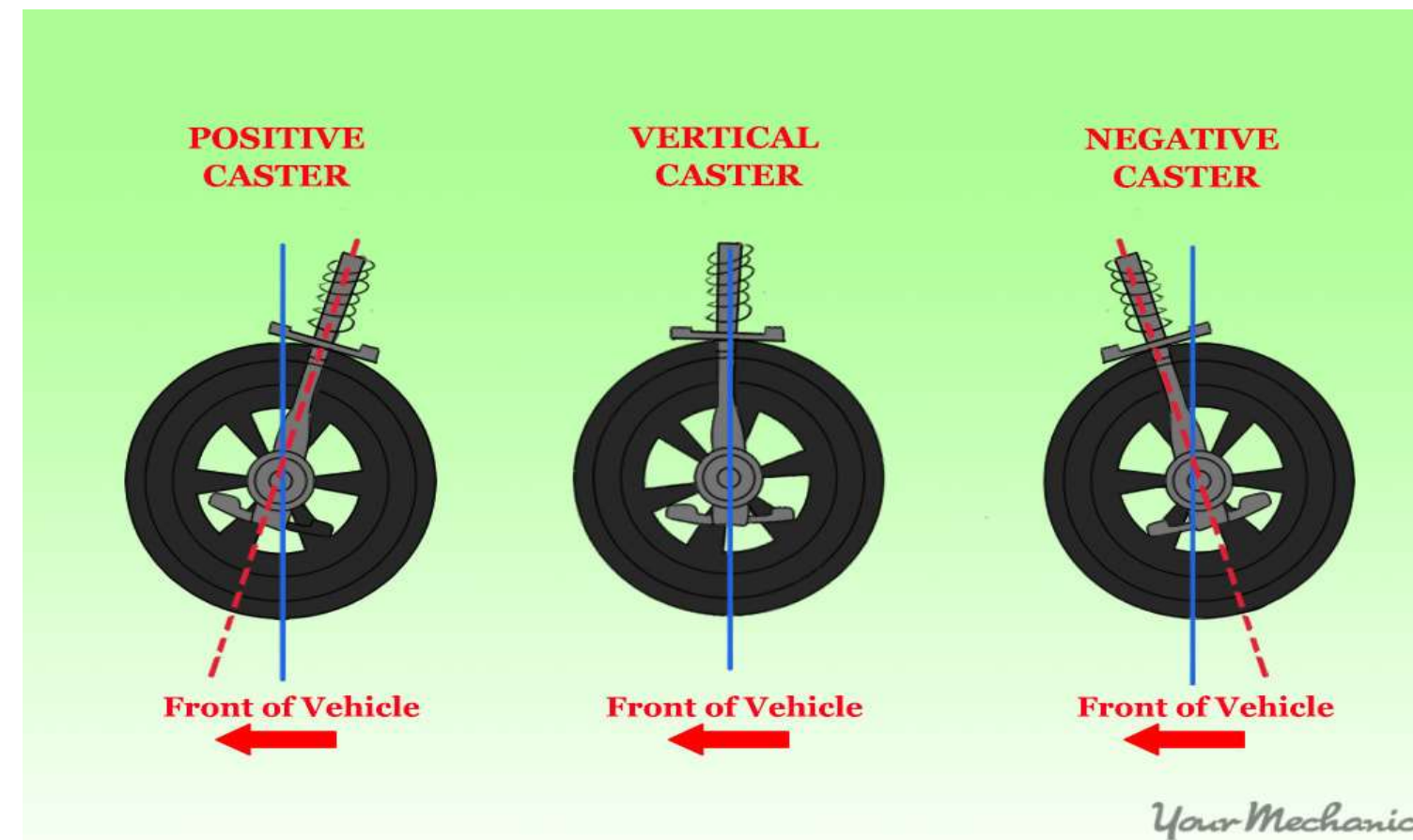


- Most manufacturers recommend having the wheel alignment checked every 10,000 miles.
- Wheel alignment has to do with how the wheels align with the frame, the road, and each other. It can affect steering, tire wear, and yes, even fuel mileage.
- Wheel balancing, on the other hand, has to do with how smoothly each individual wheel spins. If it is out of balance, it will cause vibration and possibly excessive wear.

The **caster angle** is the angular displacement of the steering axis from the vertical axis of a steered wheel in a car, motorcycle, bicycle, other vehicle or a vessel, measured in the longitudinal direction.

**Purpose-** the wheel casters around in order to trail behind the axis of steering.

- **Caster** is said to be **positive** if the line slopes towards the rear of the vehicle at the top, and **negative** if the line slopes towards the front.
- **Positive caster** also increases tire lean when cornering (almost like having more **negative camber**) as the steering angle is increased.

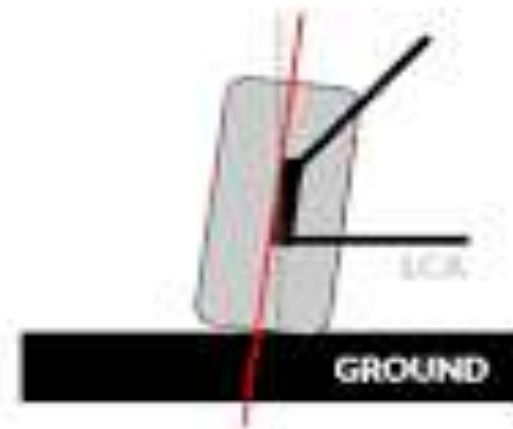




**Camber angle** is the angle made by the wheels of a vehicle; specifically, it is the angle between the vertical axis of the wheels used for steering and the vertical axis of the vehicle when viewed from the front or rear.

- The general consensus is that a **positive camber** is good for keeping a recreational vehicle stable.
- while a **negative camber** is better for allowing high-performance vehicles to turn corners faster and more accurately.

NEGATIVE  
CAMBER



NEUTRAL  
CAMBER



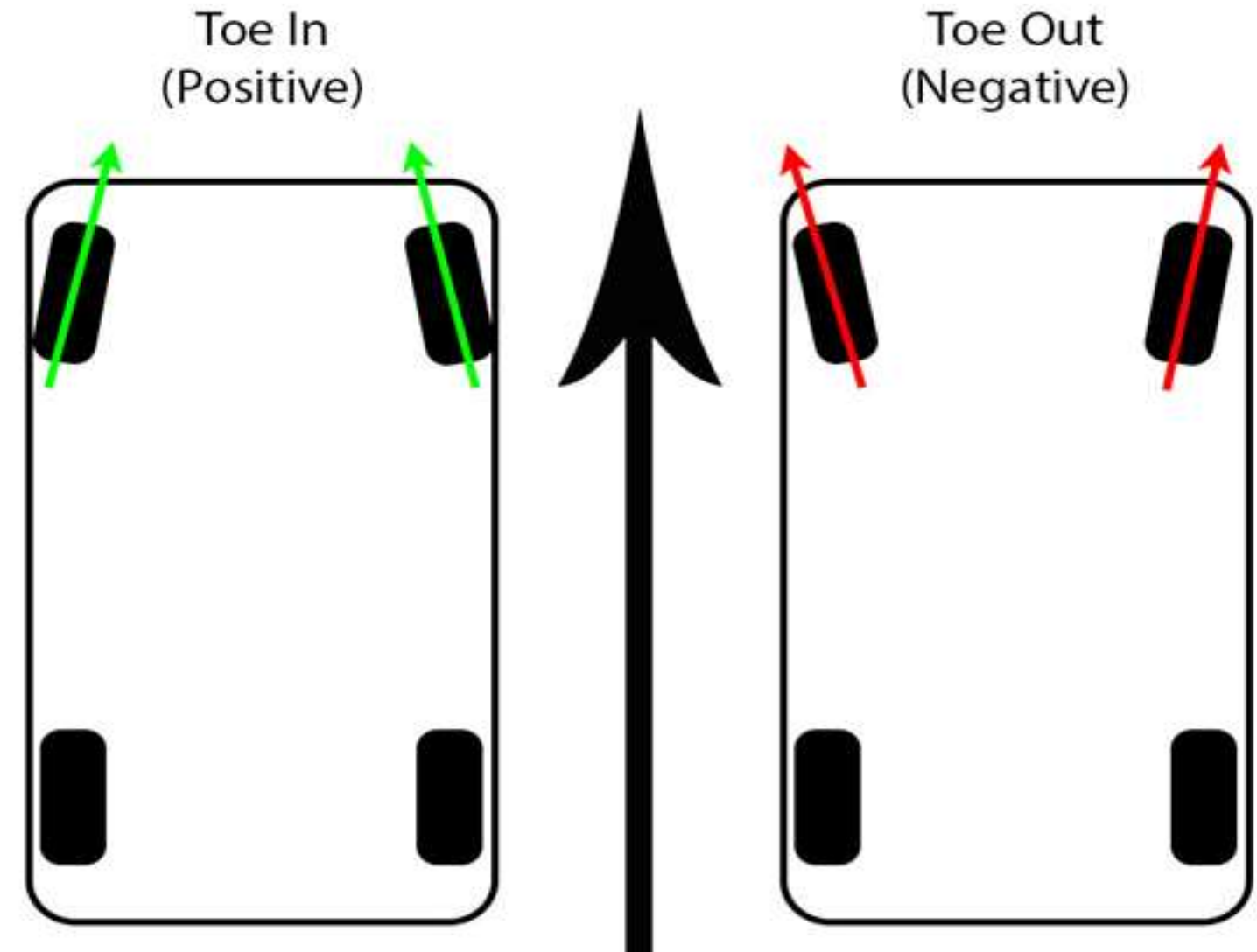
POSITIVE  
CAMBER



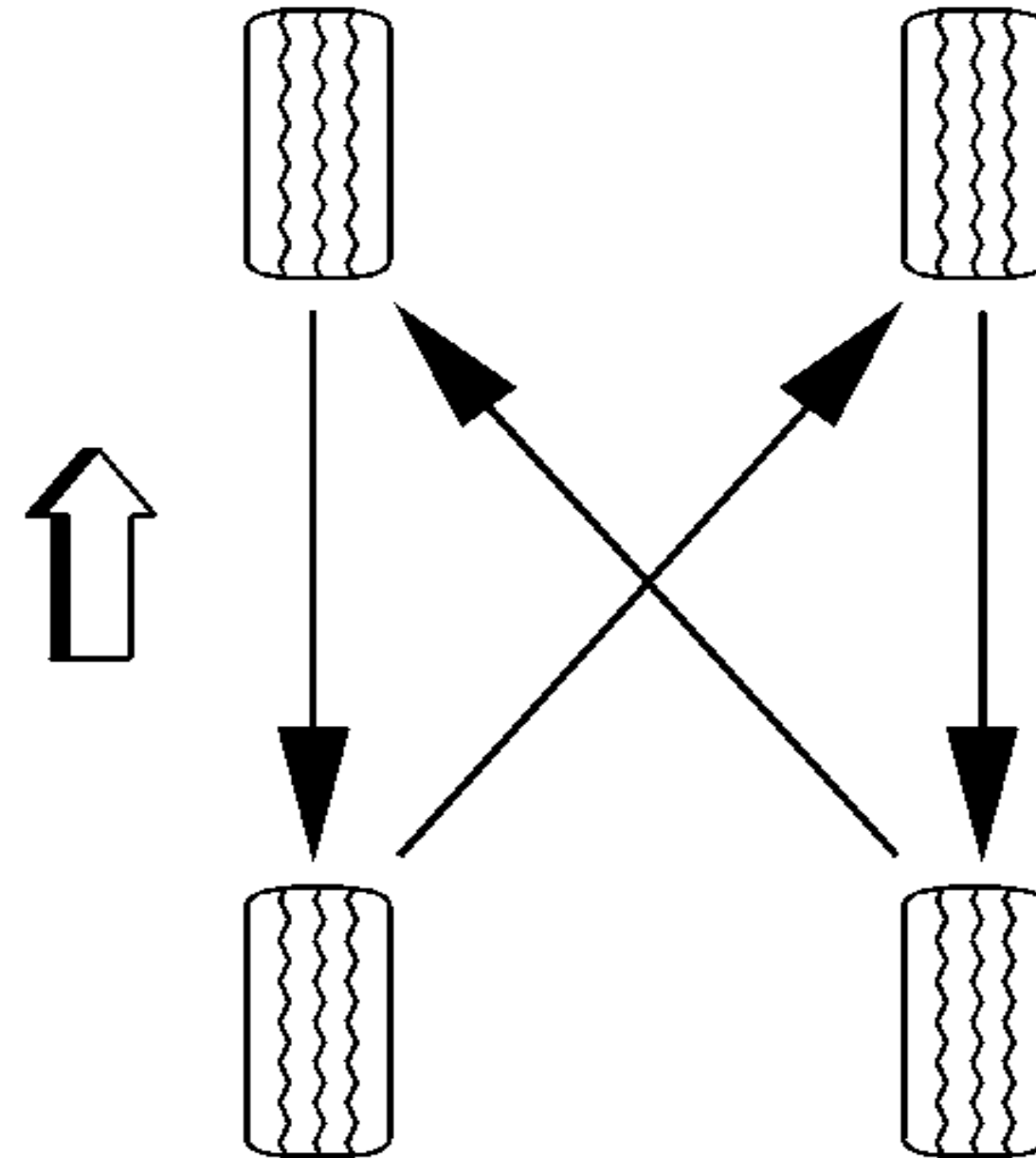
## Toe Angle

**TOE IN & TOE OUT** -In automotive engineering, **toe**, also known as **tracking**, is the symmetric angle that each wheel makes with the longitudinal axis of the vehicle, as a function of static geometry, and kinematic and compliant effects.

The basics: **Toe in/toe out** is related to tire or wheel geometry and tells you how much the wheels are turned around the vertical axis, when pointed straight-on (so as they are in the rear and with the steering wheel in the middle in front)



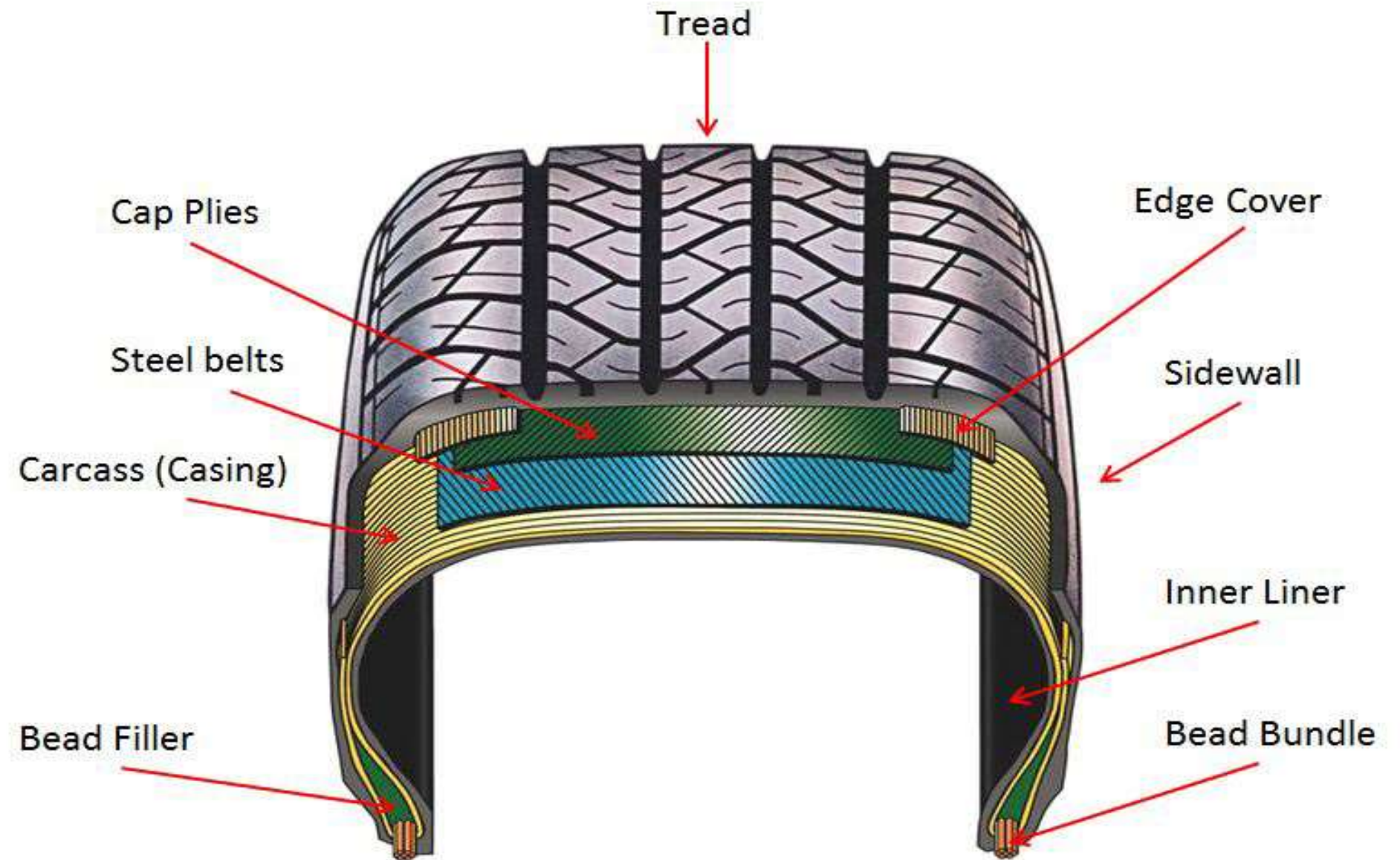
- **Tire rotation** means periodically changing the position of each of the tires on your vehicle. You should rotate your tires as recommended by the vehicle manufacturer, or every 5,000 miles. For many of you, that will mean when you get your vehicle's oil changed.
- Regularly rotating your tires also gives you a good opportunity to visually inspect them for damage, check their air pressure, have them rebalanced if you're noticing any vibration, and check their tread depth.



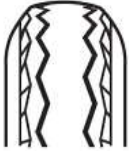





Tire Rotation Pattern



- A tyre is made from rubberized fabric piles over a rubber liner and the edges of the piles are wrapped around a wire bead, which holds the tyre to the wheel rim.
- In radials tyres the ply or ply cords are aligned at 90 degrees to the circumference.
- While radials improve performance the fact is that they are not very good for bad roads and overloading.

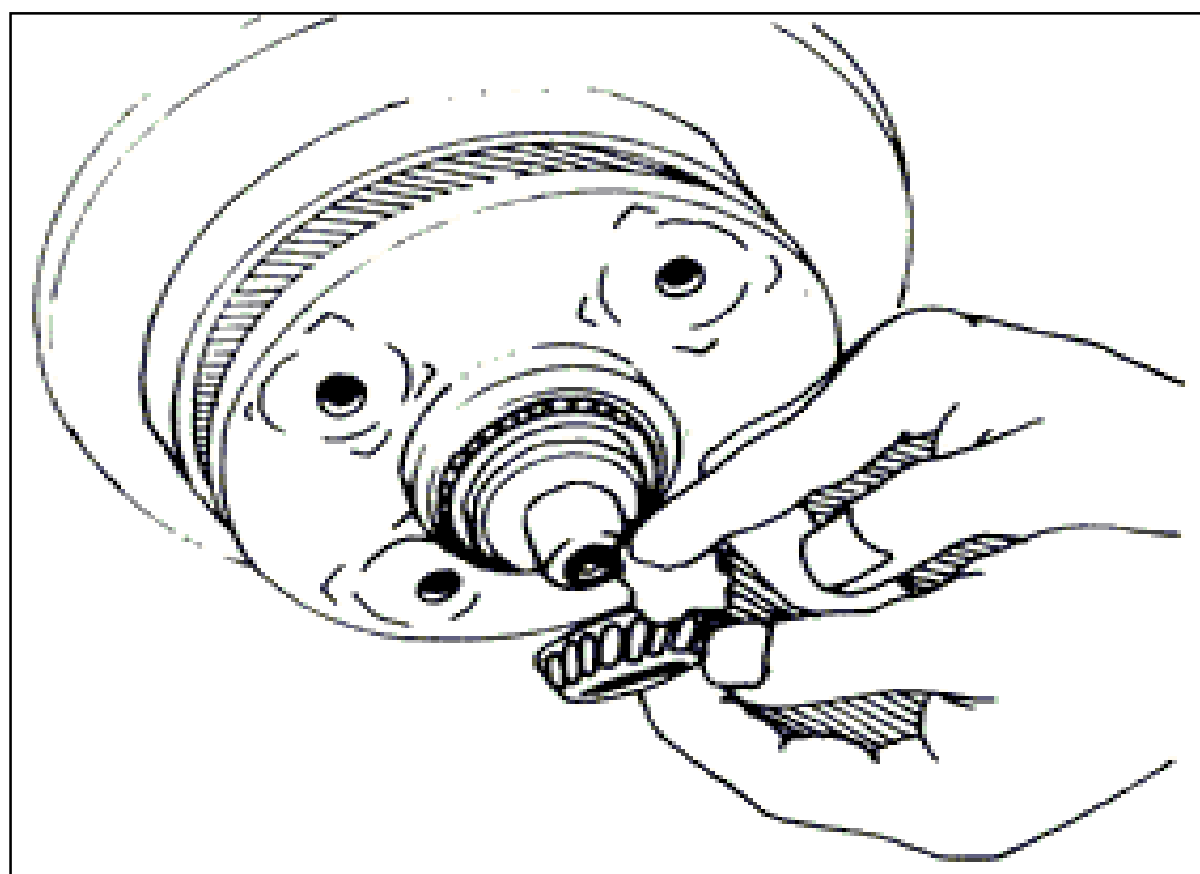


# TIRE

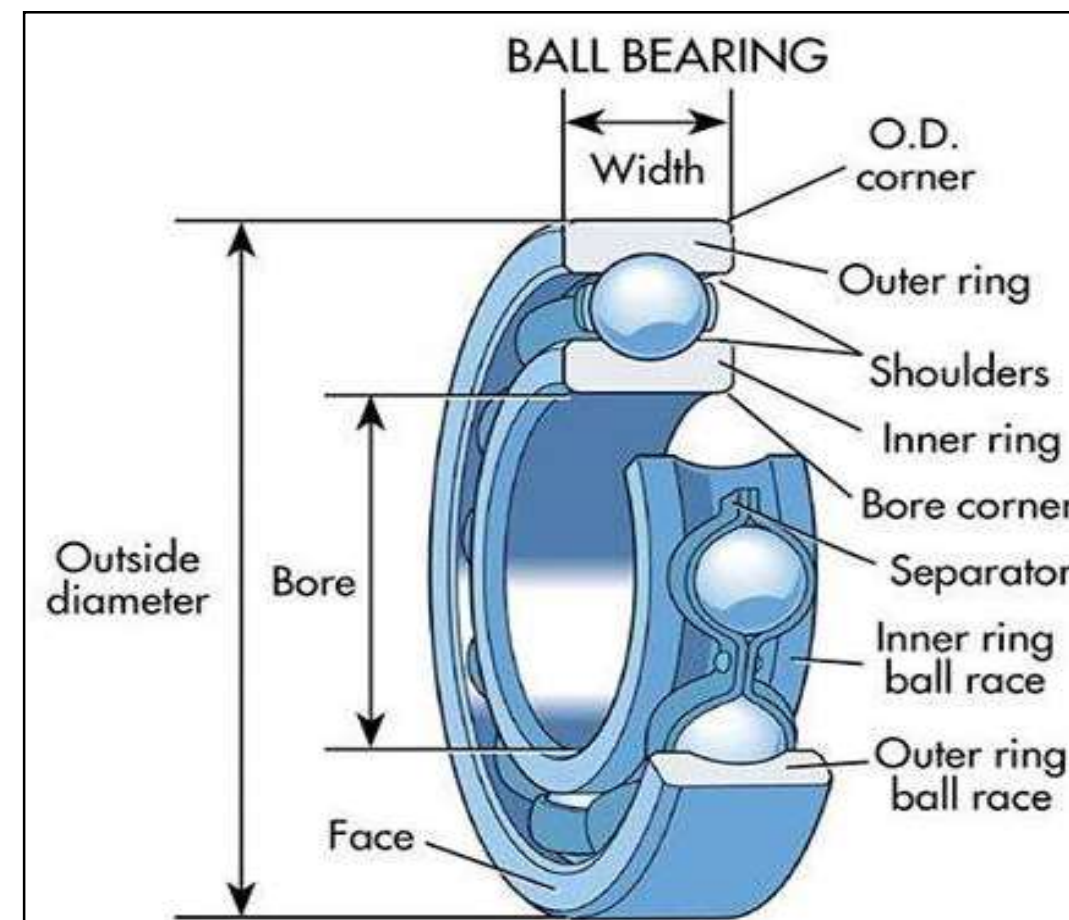
Wear Pattern	Cause	Action
	<b>Center Wear</b> Over Inflation	Adjust pressure to particular load per tire catalog
	<b>Edge Wear</b> Under Inflation	Adjust pressure to particular load per tire catalog
	<b>Side Wear</b> Loss of camber or overloading	Make sure load doesn't exceed axle rating. Align at alignment shop
	<b>Toe Wear</b> Incorrect toe-in	Align at alignment shop
	<b>Cupping</b> Out-of-balance	Check bearing adjustment and balance tires
	<b>Flat Spots</b> Wheel lockup & tire skidding	Avoid sudden stops when possible and adjust brakes



- Wheel bearings are essential in the operation of your vehicle.
- The wheel bearing allows friction-free movement and rotation of the hub assembly, and thereby provides smooth tire and wheel rotation.
- The bearings won't allow the wheel to turn freely, which exacerbates the problem

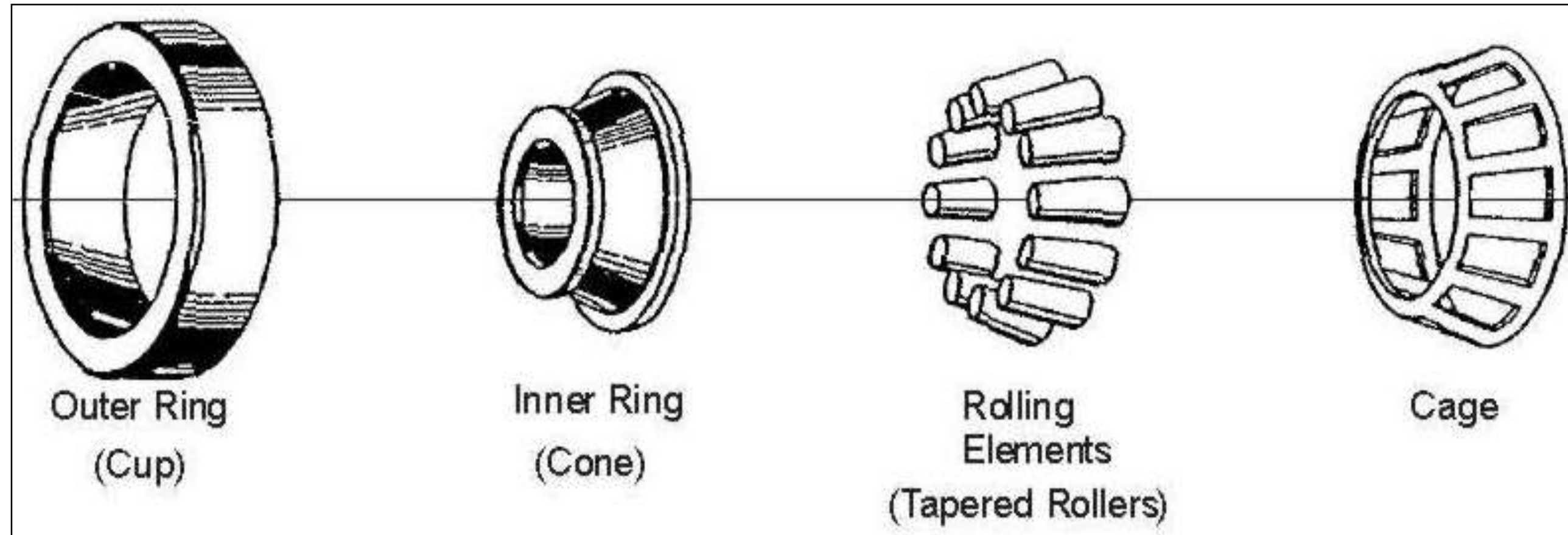


Greece apply on Wheel bearing





- Wheel bearings have an average lifespan of 136,000 to 160,000 km (approximately 85,000 to 100,000 miles).
- This is only a rule of thumb though, the actual lifespan of a wheel bearing depends on the quality of the wheel bearing and the operating conditions.



- Vehicle stand on the jack
- Remove the tyre
- To Take related spanner to open the tires
- To take tube in the tire
- Fill the air in tube and check out air leakage
- Stick the pill on tube
- Refill again air in tube and check out
- Insert the tube into the tire
- Fill The air in tire
- Tire install to vehicle





## Tube tyres

Fixing a puncture can be a tedious and time-consuming task for someone not used to handling such repairs. While finding a puncture repair shop is the most obvious choice, learning to fix a flat can come in handy on a bad day.

**Tools:** A wheel nut spanner, tyre iron, pliers, chalk, file, rubber patch, Fevikiwik or any other adhesive, a few bricks, foot pump and spare tube.

### Step 1:

First check if the rubber has been pierced. If you fail to find a cut or puncture on the tyre, check the tube, as a worn out tube itself may have led to a cut or tear and developed a puncture.

## Method of operation



1 Check tire scratches



2 Clean up debris



3 Apply a proper amount of glue



4 Press for a few minutes and leave for 24 h



**Step 2:**

Remove the wheel. Use a spanner to unscrew the wheel nut, hit the threaded side of the bolt to remove the bolt and with it the wheel.

**Step 3:**

To remove the tube, remove one side of the tyre from the rim. Use the tyre iron to remove it the tyre from the rim. Slot in the tool at the intersection of the rim and the rubber and gently push the lever and allow the tyre to gradually slide out across the circumference of the rim.

**Step 4:**

Unbolt the valve and remove the tube from the tyre. Inflate the tube and immerse it in water. Air bubbles will rise from the puncture area.

**Step 5:**

Rub the punctured area with the file to ensure that the adhesive allows the rubber patch to stick properly and the patch doesn't bulge out of the tube. Use adhesive to stick the rubber patch over the punctured area.

**Step 6:**

Check if the puncture is sealed by submerging in water. Put the tube back into the tyre. Push the air valve through the hole of the rim and gently push the tube into the tyre. Use the tyre iron to put the tyre back into the rim and put the wheel back. Tighten the wheel nut.

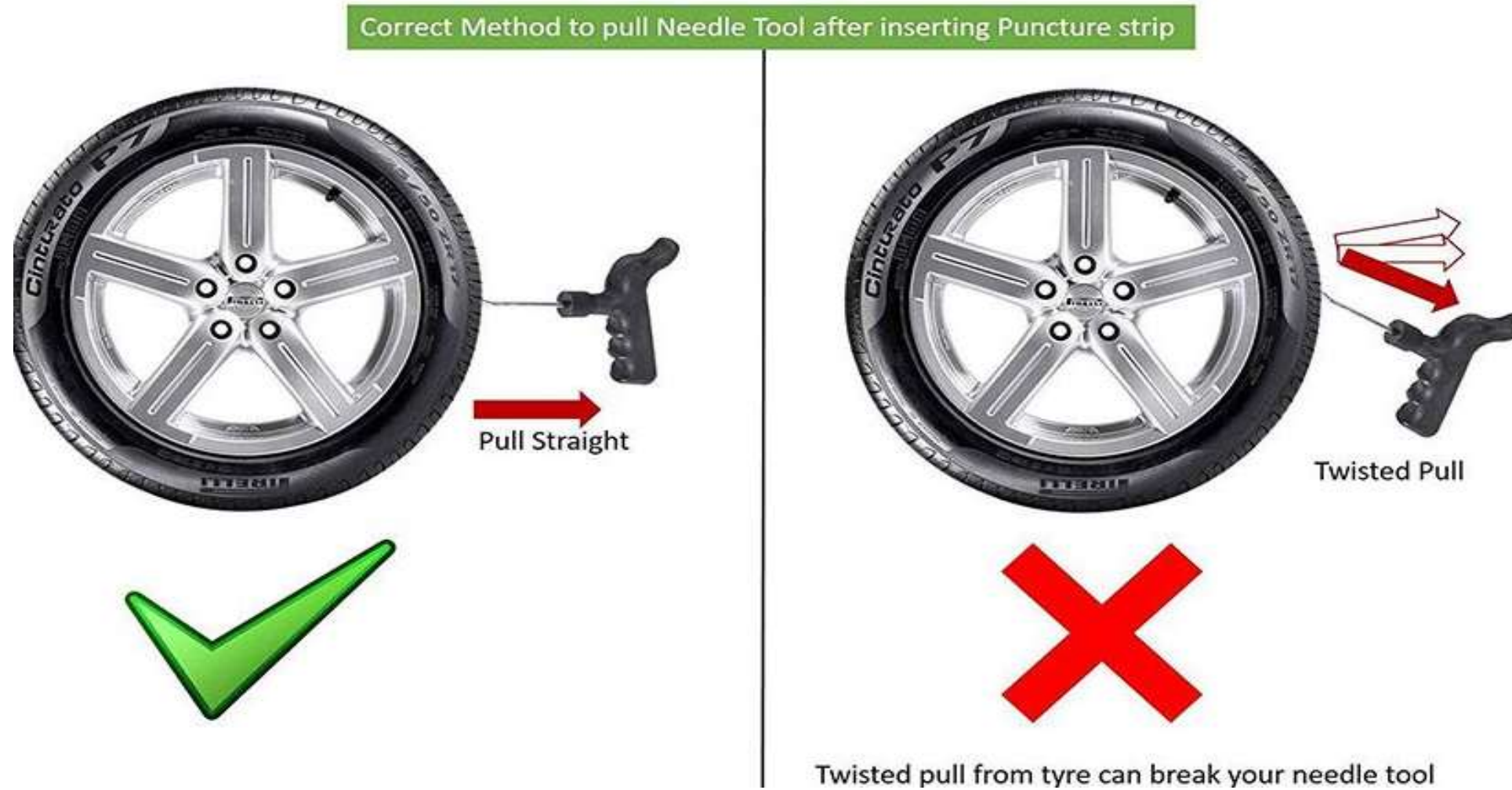
## Tubeless tyres

Most manufacturers provide tubeless tyres on their motorcycles today as they are easy to mend. Though they can be ridden for a considerable distance when punctured, it is necessary to fix the puncture to prevent further damage.

Fixing a puncture on a tubeless tyre is easy as the tyre need not be removed. Here's how you do it.



**Tools you need:** To fix a puncture on a tubeless tyre you need a special kit that includes pliers, a smoothing tool, puncture repair strips, puncture strip insertion tool and a knife/blade.





**Step 1:**

First identify the location of the puncture. Check the tyre for a nail, screw or sharp stone that has pierced the rubber.

**Step 2:**

Remove the object that has ruptured the tyre with the pliers.

**Step 3:**

Insert the smoothening tool into the puncture hole to ensure that it is large enough to insert the puncture repair strip into. Leave the tool inside the punctured area.

**Step 4:**

Insert the puncture repair strip halfway into the puncture strip insertion tool like threading a needle.

**Step 5:**

Use the puncture repair insertion tool to push the puncture strip inside. Use the smoothening tool as well. Gradually pull out the smoothening tool as you insert the puncture strip till about a millimetre of it is above the tyre.

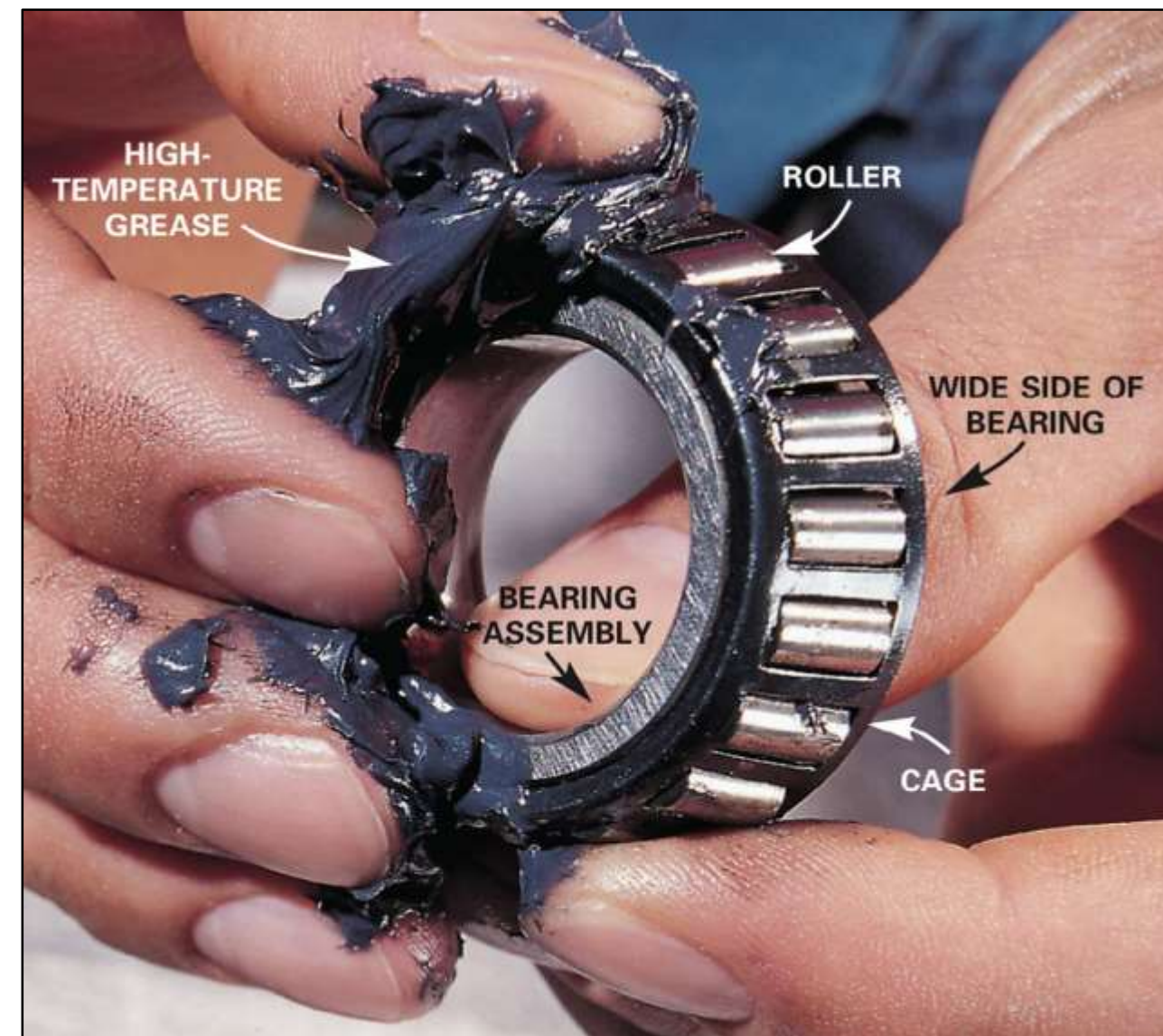
**Step 6:**

If the strip is protruding too much, trim it with a knife. The puncture is fixed.

## Bearings Made of **Chrome Steel** - SAE 52100

The most common material used to produce the load carrying components in **precision ball bearings**, roller bearings, and tapered roller bearings is 52100 **chrome steel**. These components are the bearings inner and outer rings, balls and rollers.

Bearings in some applications use oil, but grease is the lubricant of choice for 80 to 90% of bearings. Grease consists of about 85% mineral or synthetic oil with thickeners rounding out the rest of the grease volume.



**Grease apply on Wheel bearing**



# DRIVING RULES & TRAFFIC



## 1. Keep Left

Drive adjacent to the left side of the road and let other vehicles in the opposite direction to pass on the right hand side.

## 2. Turning Left

If you want to turn left, stay close to the left side and then, turn left. After turning, continue to stay to the left side of the road.

## 3. Turning Right

When you want to turn right, you should first come to the centre of the road carefully and then, turn right keeping your vehicle close to the left side of the road.

## 4. Passing

Always remember to pass or overtake the vehicle in front of yours from its right side.

## 5. Passing Prohibited

- Overtaking or passing a vehicle and progress in the same direction is prohibited in the following cases:
- *If overtaking or passing causes trouble to any other vehicle moving in any direction*
- *Overtaking is prohibited in a curve as you may not have a clear view of the road ahead and sometimes, it may lead to serious accidents*

## 6. When another Vehicle Overtakes your Vehicle

You should not try to increase your speed or do anything that prevents the other vehicle from passing or overtaking.

## 7. Intersections

You should be extra cautious while approaching a junction, intersections or a crossing. Make sure that your vehicle does not cause any inconvenience to other vehicles or pedestrians.

## 8. Right of Way

While approaching an intersection, always give a right of way to vehicles already progressing on that particular road. In other cases, you should proceed only after giving way to vehicles approaching from the right side of the road..

## 9. Emergency Vehicles

As a road user, it is your responsibility to give way to fire service vehicles and ambulances.

## 10. Pedestrians

Pedestrians have the right of way at pedestrian crossings or zebra crossings.

## 11. “U” Turns

U turns can only be taken when

- *there is no warning sign nearby*
- *you give a proper indication to other vehicle drivers that you are going to take a U turn either by hand signals or vehicle indicators*

## 12. Required Signals

If your vehicle indicators get damaged without any warning, what will you do? At this juncture, hand signals can be really helpful and hence, it is essential for you to learn them. Here are certain situations where hand signs can be used when your vehicle indicator or brakes are not in proper working condition:

- *When your vehicle is slowing down*
- *When your vehicle is preparing to stop*
- *When you are planning to turn right or overtake a vehicle from the right side*
- *When you plan to turn left*
- *When you give permission to the vehicle behind you to overtake your vehicle*

## 13. Indicators

By using mechanical devices or electronic devices, you can simplify the signals for indication.

## 14. Parking

When you park the vehicle, make sure that it does not cause any hurdle or disturbance to any other road users.

## 15. Registration

No goods or loads should be kept in a way that hinders the visibility of other vehicles, the headlamps, tail lamps or the vehicle's registration number. If the vehicle's registration number is some way tampered, it should be replaced immediately with a duplicate one.



## 16. One way Roads

In the case of one way roads, try to drive only in the direction indicated on the road signs. Never park your vehicle in reverse on a one way street.

## 17. Stop Lines

When there are stop lines on the road, ensure that you stop the vehicle behind those lines.

## 18. Towing

No vehicles should be towed closer to other vehicles on the road. Some of the exceptions are:

- *Vehicles that are mechanically disabled*
- *Partially assembled vehicles*
- *Registered trailers and sidecars*

## 19. Noise

Drivers should not:

- *Use the horn needlessly*
- *Use the horn in prohibited areas like hospital zones, school zones, etc.*
- *Use horns that are blaring, irritating, or loud*
- *Use vehicles that cause a lot of noise when in motion*
- *Drive vehicles without proper silencers*

## 20. Traffic Lights and Signs

Always obey traffic signs, the instructions given by traffic officials or any other authorized person.

*You May Also Like:*

[10 Important Road Safety Rules to Teach Your Children](#)

## 21. Following Distance

It is better to keep a safe distance from the vehicle in front of you since there is a chance for the vehicle to stop suddenly. When you keep sufficient distance, you will be able to avoid unnecessary hazards.

## 22. Right of way on Steep Roads

When the width of the road decreases, it will be difficult for each vehicle to pass at the same time. In such cases, it is always better to stop your vehicle aside and let the other vehicle pass.

## 23. Obstruction of Control

You should not allow anything that obstructs the view of the road. No one should be permitted to settle, stand, or place anything that hinders his control on the vehicle.

## 24. Passing Pedestrians

Do not drive your vehicle at a speed of more than 25 km/hr, especially when you pass a procession, meeting, strike, or a march.

## 25. Tractor and Goods Carriages

It is not allowed to carry passengers on a tractor. Also, drivers of good carriages should not allow more passengers than register

## 26. Loading

It is dangerous to overload vehicle with materials. There should not be anything in the loads that extend towards the front, back or rear side of the vehicle that cause inconvenience to other road users. Also, it should follow the height restrictions decided by the authorities.

## 27. Dangerous Materials

It is better for a public transport service to not carry explosive, inflammable, or harmful substances as it can be dangerous to them as well as other road users.

## 28. Driving in Reverse

When you take reverse, you should ensure that it does not cause annoyance to any other people on the road.

## 29. Essential Documents

A driver should possess the following documents while driving a vehicle: –

- a. Driving license
- b. Registration certificate of the vehicle
- c. Taxation certificate
- d. Insurance certificate
- e. Fitness certificate



## 30. Additional Regulations

In addition to the rules mentioned above, the drivers should be aware about their duties, speed limits, weight limits, signals, etc. Also, they should have an idea about the consequences of driving vehicles without relevant documents, drunken driving etc.

The above mentioned rules can be very much valuable for people of all ages. These rules can make the people safe and secure on the roads. Every year, the number of vehicles on road goes on increasing; so does the importance of road safety. Hence, knowing essential road safety rules can help you and your friends from road related crisis.

## TRAFFIC

### Types of traffic signs

There are numerous traffic signs and each has its own purpose. The various traffic safety signs have been divided into three categories. They are:

 <p>Stop</p>	 <p>Give Way</p>	 <p>One Way</p>	 <p>No Entry</p>	 <p>One Way</p>	 <p>One Way Both Direction</p>	 <p>Compulsory Keep Left</p>
 <p>Right Turn Prohibited</p>	 <p>Left Turn Prohibited</p>	 <p>One Way</p>	 <p>U-Turn Prohibited</p>	 <p>Over Taking Prohibited</p>	 <p>Horns Prohibited</p>	 <p>Compulsory Sound Horn</p>
 <p>Speed Limit</p>	 <p>Compulsory Turn Left</p>	 <p>Compulsory Ahead Only</p>	 <p>Compulsory Turn Right Ahead</p>	 <p>Compulsory Ahead Or Turn Right</p>	 <p>Compulsory Ahead Or Turn Left</p>	

**Traffic signs that provide information:** Informatory traffic signs provide information to the driver via the boards. The information maybe about:

- The distance left to cover to reach a specific destination.
- Alternative routes to the specific destination, if any.
- Locations on the cautionary traffic signs are also displayed such as schools, colleges, workplaces, clubs, public places and restaurants.
- It is mandatory for the driver to slow down at all inter junctions, pedestrian crossings, intersections and road crossings.
- If the driver is driving the vehicle on a main road that has does not have traffic regulation, he or she has to allow the vehicles to overtake from the right side.



 <p>Right Hand Curve</p>	 <p>Left Hand Curve</p>	 <p>Right Hair Pin bend</p>	 <p>Left Hand Pin Bend</p>	 <p>Right Reverse Bend</p>	 <p>Left Reverse Bend</p>
 <p>Steep Ascent</p>	 <p>Steep Descent</p>	 <p>Narrow Road Ahead</p>	 <p>Road Widens Ahead</p>	 <p>Narrow Bridge</p>	 <p>Slippery Road</p>
 <p>Lose Gravel</p>	 <p>Cycle Crossing</p>	 <p>Pedestrian Crossing</p>	 <p>School Ahead</p>	 <p>Men At Work</p>	 <p>Cattle</p>
	 <p>Falling Rocks</p>	 <p>Ferry</p>			

**Traffic signs that are mandatory:** As the name suggests, the first category of traffic signs is mandatory signs which perform the function of ensuring the smooth operation of the traffic on the road.

These traffic signs also make sure that the drivers on the road follow the instructions on it. Violation of any mandatory traffic sign is an offence punishable by law as per the Roadways and Transport department. The traffic signs images are displayed in next sheet.



# VEHICLE ASSESORIES



Here all assessories are protect ane decorative to your vehicle

- Tyre Inflators.
- Vacuum Cleaner.
- Car Lightings.
- Door and Bumper Guard.
- Perfumes and Freshener.
- Dashboard Accessories.
- Seat Covers Seat Cover
- Roof mating



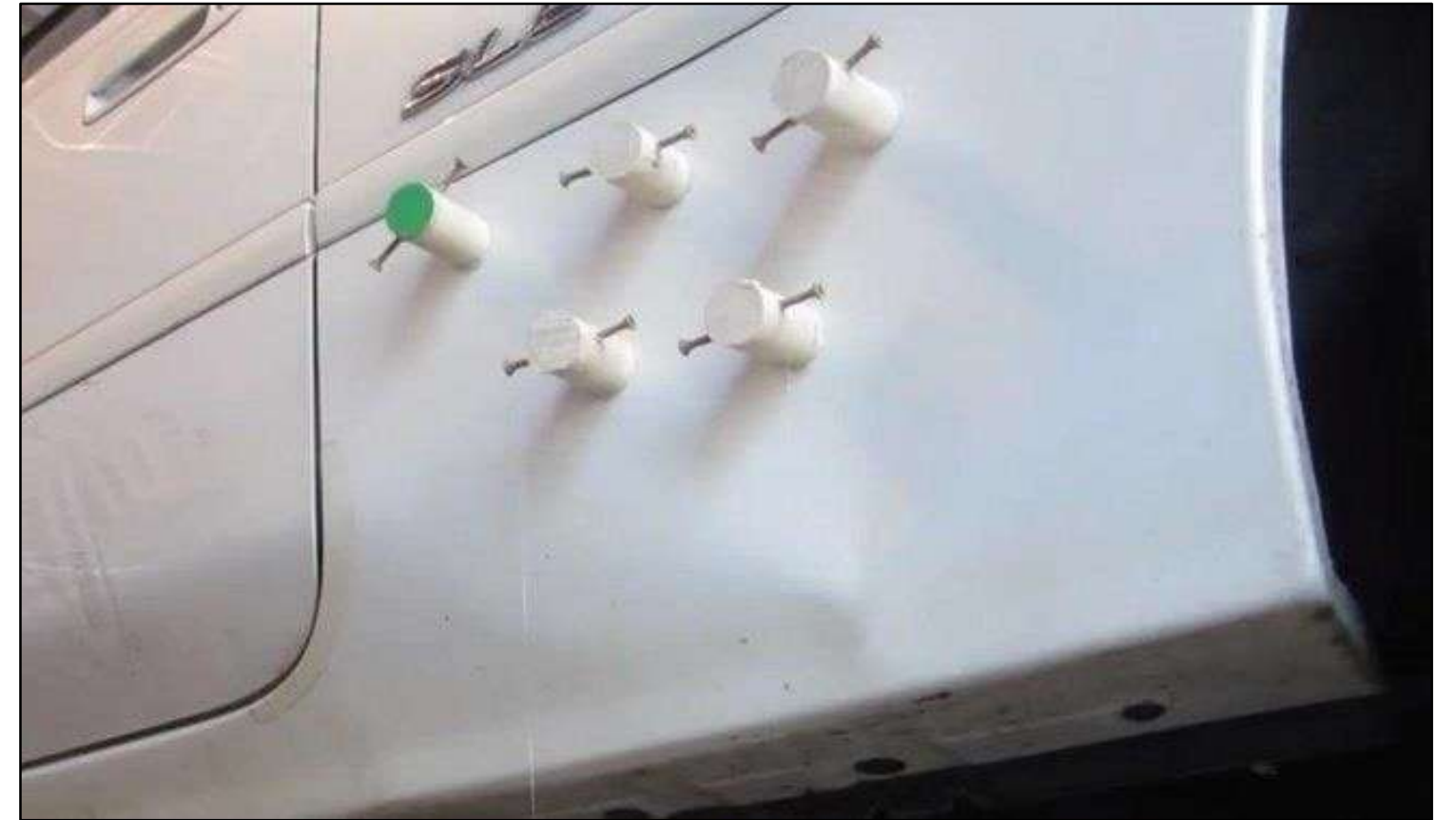


## Use Boiling Water

- Reversing into an object is one of the easiest ways to get a dent.
- So for plastic bumpers, even if you attempt to take off the bumper, it might still be difficult to push out the dent because of how stiff the plastic is. Solve this issue by boiling some water in a pot and throwing it on the dent.

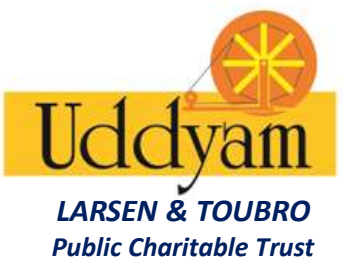
As soon as you've poured the water, reach behind the bumper and try to pop the dent back in. Thanks to the heat of the water, the plastic should be a bit more flexible, making it easier to put back into place.

Use Hot Glue, Wooden Dowels, & Screws





# VEHICLE DENT REMOVE



- **Paint less dent repair (PDR)**, also known as **paint less dent removal**, describes a method of removing minor dents from the body of a motor vehicle.
- Paint less dent repair may be used on both aluminum and steel panels.
- Glue and specially designed tabs may be used to pull out the dents from the outside of the panel. Fine tuning the repair often involves tapping down the repair to remove small high spots.
  
- **Automotive paint** is paint used on automobiles for both protection and decoration purposes.
- Water-based acrylic polyurethane enamel paint is currently the most widely used paint for reasons including reducing paint's environmental impact.
  
- A basecoat is applied after the primer paint is applied. Following this, a clear coat of paint may be applied that forms a glossy and transparent coating. The clear coat layer must be able to withstand UV light.





These are some of the items which will be checked by our expert workshop

- ❖ Braking systems
- ❖ Engine oil level and quality
- ❖ Brake fluid level and quality
- ❖ Coolant level
- ❖ Battery water
- ❖ Battery testing
- ❖ Auto electrical and wiring
- ❖ Automotive belts tightness
- ❖ Clutch Systems

- ❖ Tyre and rim
- ❖ Filter (air, oil, fuel and cabin filter)
- ❖ Air conditioning
- ❖ Wiper blades
- ❖ Horns
- ❖ Head lights
- ❖ Tail lights
- ❖ Brake lights
- ❖ Indicator lights
- ❖ Suspension and steering
- ❖ Braking system testing
- ❖ Air-conditioning checks
- ❖ Filter replacement (air filter, oil filter and fuel filter)
- ❖ Oil & fluid replacement and top-up (oil, coolant, brake fluid etc)
- ❖ Battery checks
- ❖ Electrical checks (Horns, lighting, starter motor and alternator)
- ❖ Transmission checks
- ❖ Wiper blade replacement
- ❖ Tyre check (balancing, alignment, pressure checks etc)

- Collect and safely handover personal belonging of customer like phone ,pen, document etc.
- Assist in placing the vehicle on a suitable platform, before the servicing/repair actually start.
- Assist in organizing the secure parking area and moving vehicles around as directed
- Lift raw materials, finished products, and packed items, manually or using hoists.
- Understand the auto component manufacturer specifications related to the various components/ aggregates in the vehicle
- Ensure that service maintenance and repair activities and carried out on the vehicle without causing damage to any other aggregate/component.
- Assist in performing service or repair of vehicle under supervision of senior such as.
  1. Carry out minor minor component repair or replacement.
  2. Carry out oil change and lubrication
  3. Washing vehicle as par prescribed standard process
  4. Fetching correct materials or tool, gauges





ASSIST IN SERVICE, MAINTENANCE AND REPAIR OF VEHICLE



# MAINTENANCE OF VEHICLE



**LARSEN & TOUBRO**  
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- Assist in maintaining and managing the work shop tools, equipment and machinery in required condition by
  1. Cleaning and lubricating equipment
  2. Raising object, tool and equipment
  3. Placing them on drying racks
  4. Using cloth, squeegees or air compressors to dry surface
  5. Cleaning and organizing the workshop
  6. Placing tools at their place after use
- Ensure any malfunctions observed in tools and equipment are reported to the concerned persons
- Assist in fitting and balancing the replaced and refitted parts



# WORK EFFECTIVELY IN TEAM



# TEAM WORK



**LARSEN & TOUBRO**  
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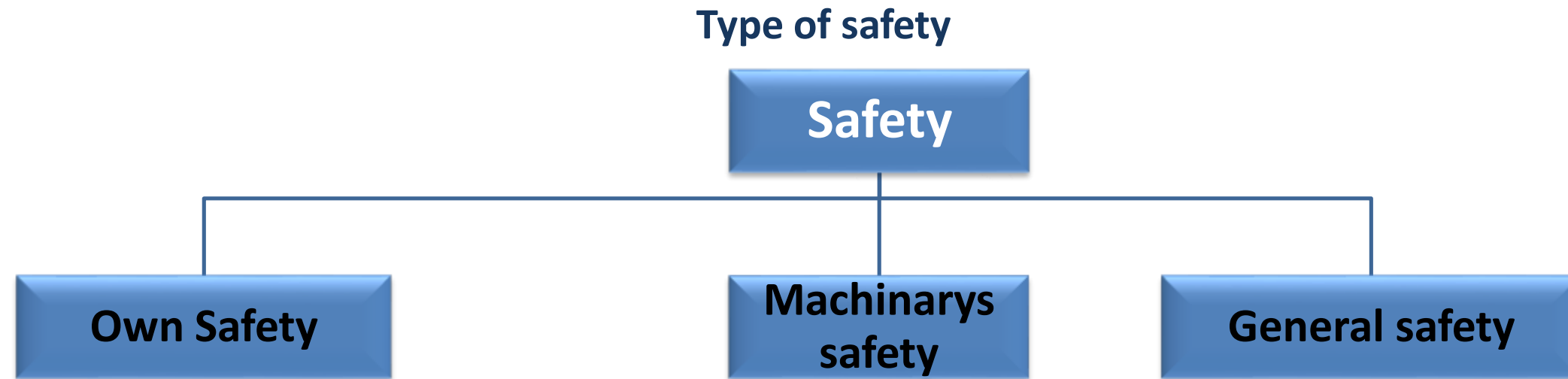




After completing this module, the participants will be able to .

- Maintain clear communication with colleagues
- Work with colleagues to integrate work
- Pass on information to colleagues in line with organizational requirement both through verbal as well nonverbal means
- work in ways that show respect for colleagues
- Carry out commitments made to colleagues
- Identify problem in working with colleagues and the take the initiative solve these problems

**Definition of safety** :- Safety is the state of being "safe", the condition of being protected from harm or other non-desirable outcomes. Safety can also refer to the control of recognized hazards in order to achieve an acceptable level of risk.



**Type of accidents** :- There are three tpye for an accident which are as follows

- Idustrial accident
- Road side accident
- Accidents involving Animals.

**Causes of accidents** :- There are many reasons for an accident which are as follows

- Aversion to work (Dislike work)
- Hurry to work
- Helth is not wealth
- Ignorance
- Over confidance
- Overtime
- Condition of machine





- (1) **EHS** stands for “environment, health, and safety,” and for many companies, a crucial part of their **processes** is **EHS** management, meaning the codification and practice of procedures aimed at ensuring the safety of workers and their surroundings.
- (2) **CPR** is an [emergency procedure](#) that combines chest compressions often with [artificial ventilation](#) in an effort to manually preserve intact brain function until further measures are taken to restore spontaneous blood circulation and breathing in a person who is in [cardiac arrest](#). CPR involves chest compressions for adults between 5 cm (2.0 in) and 6 cm (2.4 in) deep and at a rate of at least 100 to 120 per minute
- (3) **HAZARD** : A **hazard** is something that can cause harm, e.g. electricity, chemicals, working up a ladder, noise, a keyboard, a bully at work, stress, etc. A **risk** is the chance, high or low, that any **hazard** will actually cause somebody harm. For example, working alone away from your office can be a **hazard**.
- (4) **RISK** : **Risk** is the potential for uncontrolled loss of something of value. ... **Risk** can also be defined as the intentional interaction with uncertainty. Uncertainty is a potential, unpredictable, and uncontrollable outcome; **risk** is an aspect of action taken in spite of uncertainty.
- (4) **5's** : 5S, sometimes referred to as 5s or Five S, refers to five Japanese terms used to describe the steps of the 5S system of visual management. Each term starts with an S. In Japanese, the five S's are *Seiri, Seiton, Seiso, Seiketsu, and Shitsuke*. In English, the five S's are translated as Sort, Set in Order, Shine, Standardize, and Sustain.

**Fire safety** is the set of practices intended to reduce the destruction caused by fire. Fire safety measures include those that are intended to prevent ignition of an uncontrolled fire, and those that are used to limit the development and effects of a fire after it starts.

**There are four classes of fires:**

**Class A:** Ordinary solid combustibles such as paper, wood, cloth and some plastics.

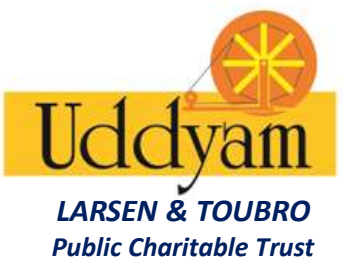
**Class B:** Flammable liquids such as alcohol, ether, oil, gasoline and grease, which are best extinguished by smothering.

**Class C:** Electrical equipment, appliances and wiring in which the use of a nonconductive extinguishing agent prevents injury from electrical shock. Don't use water.

**Class D:** Certain flammable metallic substances such as sodium and potassium.



# FIRE EXTINGUISHER



- ❖ The **Water** and Foam **extinguisher** eliminates a **fire** by allowing **water** to take away the heat component of a **fire** while foam separates oxygen from the **fire**. A **water extinguisher** should only be **used** on Class A **fires** (Combustibles such as wood, paper, cloth, trash, and plastics)
- ❖ **Dry chemical** :- A **dry** free-flowing **chemical fire extinguishing composition** in the form of a finely divided mixture of particles and consisting essentially of about 79.35% monoammonium phosphate, about 5% of tricalcium phosphate, about 12% of barium sulfate, about 2.50% of ammonium tartrate, about 0.45% of silica and about 0.70% of ammonium
- ❖ **Co2 Type** :-CO2 fire extinguishers contain pure **carbon** dioxide which is a clean extinguisher, leaving no residue. Suitable for class B flammable liquid fires (petrol, oil, solvents), and recommended for use on live **electrical** equipment. Our extinguishers are BAFE approved, fully charged and supplied with a wall bracket.
- ❖ **Wet chemical** :- (potassium acetate, potassium carbonate, or potassium citrate) extinguishes the **fire** by forming an air-excluding soapy foam blanket over the burning oil through the **chemical** process of saponification



## Using The Correct Fire Extinguisher

Water	Dry Powder	Foam	CO2	Wet Chemical
<p><b>For use on</b></p> <ul style="list-style-type: none"> <li>CLASS A Wood, Paper, Textiles etc</li> </ul> <p><b>Do not use on</b></p> <ul style="list-style-type: none"> <li>CLASS B Flammable liquid</li> <li>Live electrical equipment</li> </ul>	<p><b>For use on</b></p> <ul style="list-style-type: none"> <li>CLASS A Wood, Paper, Textiles etc</li> <li>CLASS B Flammable liquids</li> <li>CLASS C Gaseous fires</li> </ul> <p><b>Do not use on</b></p> <ul style="list-style-type: none"> <li>Live electrical equipment</li> </ul>	<p><b>For use on</b></p> <ul style="list-style-type: none"> <li>CLASS A Wood, Paper, Textiles etc</li> <li>CLASS B Flammable liquids</li> </ul> <p><b>Do not use on</b></p> <ul style="list-style-type: none"> <li>Live electrical equipment</li> </ul>	<p><b>For use on</b></p> <ul style="list-style-type: none"> <li>CLASS B Flammable liquids</li> <li>Live electrical equipment</li> </ul> <p><b>Do not use on</b></p> <ul style="list-style-type: none"> <li>CLASS A Wood, paper and textiles</li> <li>CLASS D Flammable metal fires</li> </ul> <p>Do not use in a confined space</p>	<p><b>For use on</b></p> <ul style="list-style-type: none"> <li>CLASS F Cooking oil fires</li> <li>CLASS A Wood, Paper, Textiles etc.</li> </ul> <p>Discharge entire contents on to fire from at least 1 metre distance</p>

### Fire Extinguisher Chart

Extinguisher	Color	Type	Type of Fire			
			Solids (paper)	Flammable Liquids	Flammable Gas	Electrical Equipment
	Red	WATER	✓ Yes	✗ No	✗ No	✗ No
	Yellow	FOAM	✓ Yes	✓ Yes	✗ No	✗ No
	Blue	Dry Powder	✓ Yes	✓ Yes	✓ Yes	✓ Yes
	Black	Carbon Dioxide (CO <sub>2</sub> )	✗ No	✓ Yes	✗ No	✓ Yes

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