

ZEAL UNIVERSAL MOTOR PVT. LTD

ATV INTERNSHIP

THESIS REPORT

What is ATV?

ATV-ALL TERRAIN VEHICLE is a vehicle that travels on low-pressure tires, with a seat that is straddled by the operator, along with handlebars for steering control.



TYPES OF ATV VEHICLES:

- **SPORT**
- **UTILITY**
- **YOUTH**

SUB-SYSTEMS:

- ✓ **FRAME.**
- ✓ **ENGINE.**
- ✓ **TYRES AND WHEELS.**
- ✓ **SUSPENSION.**
- ✓ **BRAKES.**
- ✓ **STEERING.**

All the above subsystems need a basic outline of a vehicle so that the designing work becomes a less tedious. There are two main basic parameters that provide a clear outline of any vehicle: (i) track width (ii) wheel base

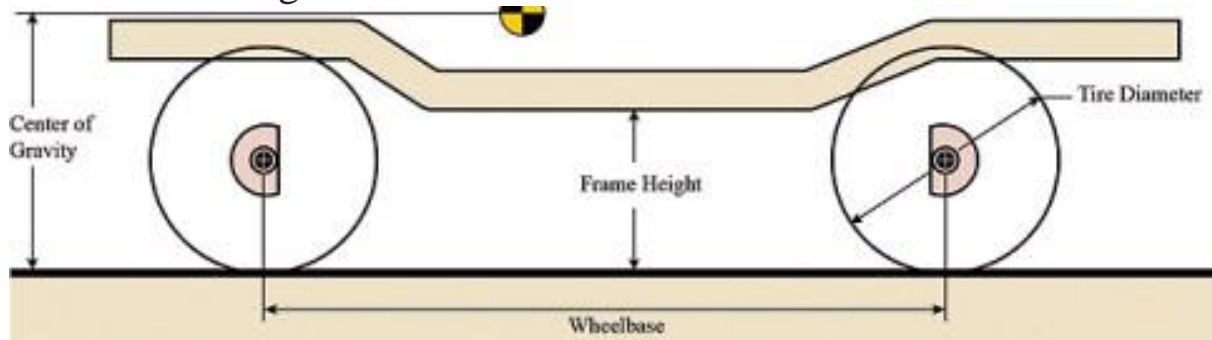
TRACK WIDTH

From the front view the distance between the two centres of planes of both the tyres will give the track width of any vehicle.



WHEEL BASE

From the side view the distance between the centres of the centres of the wheels will give the wheel base of a vehicle.



- It is common that the track width in the front is larger than the rear for an ATV.
- Longer wheel base will ensure good stability and braking of the vehicle but will affect the steering power of the vehicle since the rear end is far away from the driver.
- The **center of gravity** will ensure that the car wouldn't topple to either side during sharp turnings.

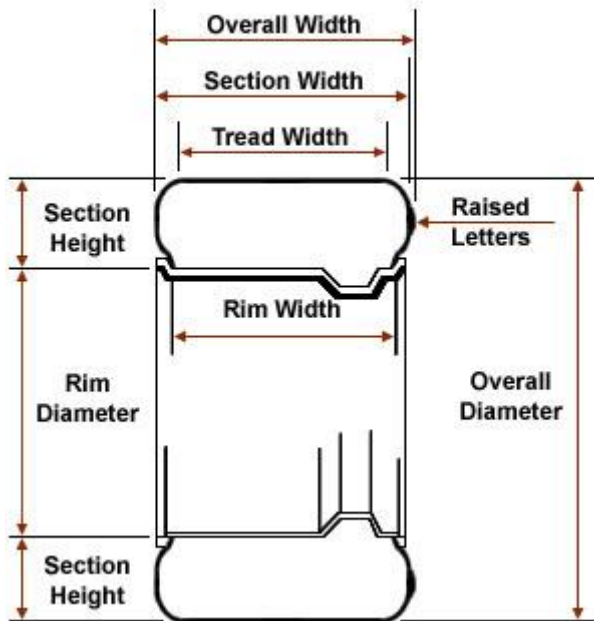
TYRES AND WHEELS

The tyres and wheels are the major elemental factor to be considered while designing a ATV vehicle. In this the weight of the frame rim and the overall mass of the vehicle is to be considered so as to design a top class vehicle.

The wheels are connected with the help of The RIM.

The disc is also attached to the vehicle in order to provide the stability in the brakes to drift the vehicle.

Tire Dimensions & Terminology



- Normally in INDIA, 4" GROUND CLEARANCE is maintained.

- The more the traction in the wheels, the more efficient the vehicle is.

Example: 185/60HR14

Rim Diameter: In this case it is 14

Section Width: In this case it is 185. The first number is the width of the tire in millimeters, measured from sidewall to sidewall. If your dimension is in inches, multiply by 25.4

Aspect Ratio:

In this case it is .60. The second number is the aspect ratio. This is a ratio of section height to section width.

Formula: Diameter in Inches = Rim Diameter Inches +

[(2 x Aspect Ratio x Section Width) / 25.4]

The disc sits on the RIM which is called HUB.

$\text{ASPECT RATIO} = \frac{\text{SECTIONAL WIDTH}}{\text{SECTIONAL LENGTH}}$
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SUSPENSION:

1. **Suspension** is the system of tires, tire air, springs, shock absorbers and linkages that connects a vehicle to its wheels and allows relative motion between the two.
2. Suspension systems serve a dual purpose — contributing to the vehicle's roadholding/handling and braking for good active safety and driving pleasure, and keeping vehicle occupants comfortable and a ride quality reasonably well isolated from road noise, bumps, and vibrations, etc.
3. These goals are generally at odds, so the tuning of suspensions involves finding the right compromise.
4. It is important for the suspension to keep the road wheel in contact with the road surface as much as possible, because all the road or ground forces acting on the vehicle do so through the contact patches of the tires.
5. The suspension also protects the vehicle itself and any cargo or luggage from damage and wear.
6. The design of front and rear suspension of a car may be different.

TYPES:

♦ **DEPENDENT**

1. **RIGID AXLE.**
2. **LEAF SPRING.**

♦ **INDEPENDENT**

1. **DOUBLE WISH BONE.**
2. **MAC PHEARSON STRUT.**
3. **TRAILING ARM.**
4. **MULTI LINK.**

5. PUSH ROD.

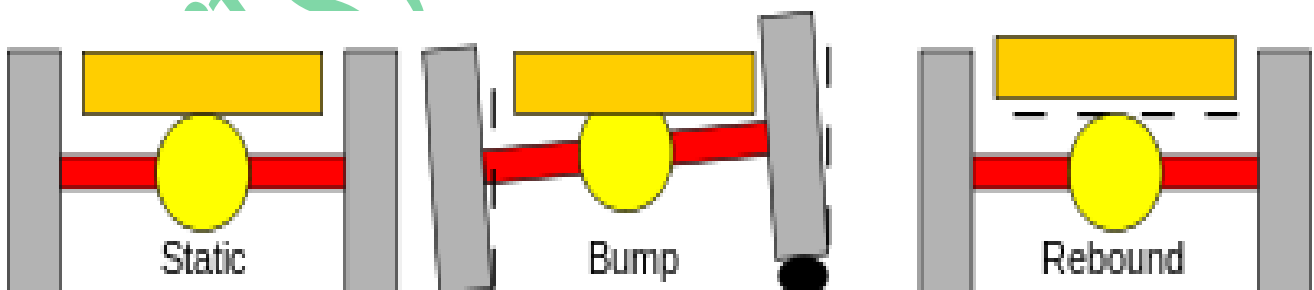
6. PULL ROD.

DEPENDENT:

- ❖ Dependent systems may be differentiated by the system of linkages used to locate them, both longitudinally and transversely.
- ❖ Often both functions are combined in a set of linkages.

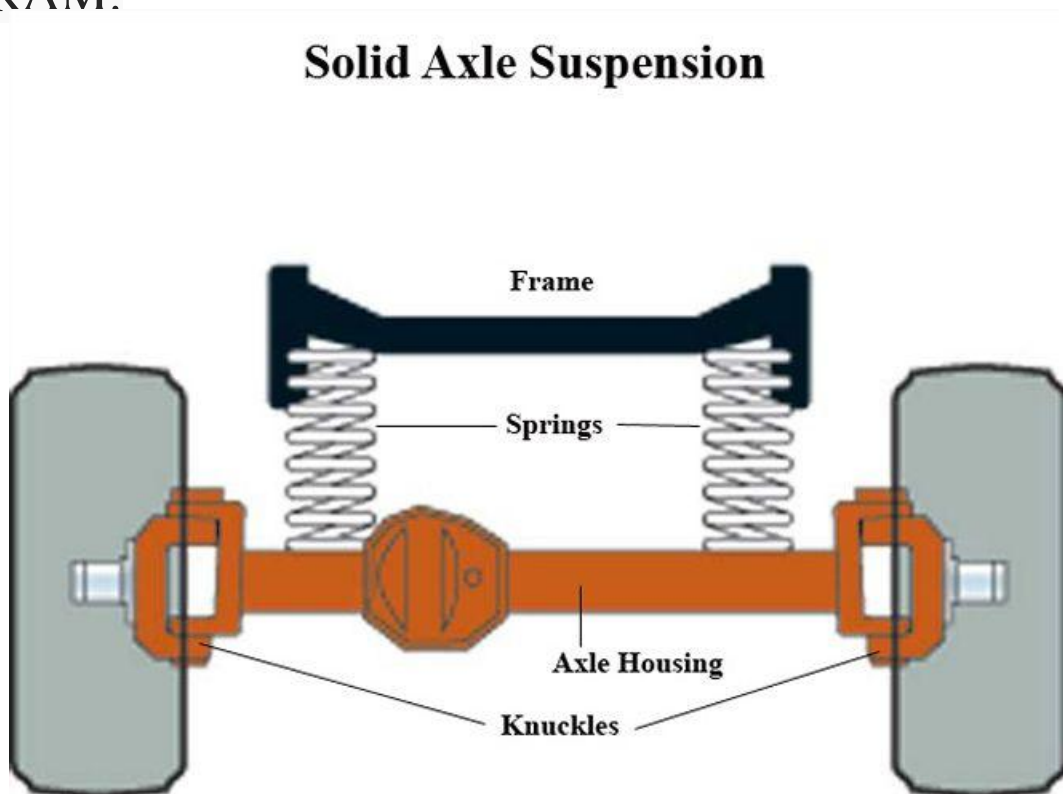
1. RIGID AXLE:

- ✓ A **beam axle**, **rigid axle** or **solid axle** is a dependent suspension design, in which a set of wheels is connected laterally by a single beam or shaft.
- ✓ Beam axles were once commonly used at the rear wheels of a vehicle, but historically they have also been used as front axles in rear-wheel-drive vehicles.
- ✓ In most automobiles, beam axles have been replaced by front and rear independent suspensions.



Solid axle suspension characteristics: Camber change on bumps, none on rebound, large unsprung weight.

DIAGRAM:



2. LEAF SPRINGS:

A **leaf spring** is a simple form of **spring** commonly used for the **suspension** in **wheeled vehicles**. Originally called a *laminated* or *carriage spring*, and sometimes referred to as a **semi-elliptical spring** or **cart spring**, it is one of the oldest forms of springing, dating back to **medieval** times.



Leaf spring on a German locomotive.

A leaf spring takes the form of a slender **arc-shaped** length of **spring steel** of **rectangular** cross-section.

The center of the arc provides location for the **axle**, while **tie holes** are provided at either end for attaching to the vehicle

body.

For very heavy vehicles, a leaf spring can be made from several leaves stacked on top of each other in several layers, often with progressively shorter leaves.

Leaf springs can serve locating and to some extent damping as well as springing functions.

While the interleaf friction provides a damping action, it is not well controlled and results in [stiction](#) in the motion of the suspension.

For this reason some manufacturers have used mono-leaf springs.

A leaf spring can either be attached directly to the [frame](#) at both ends or attached directly at one end, usually the front, with the other end attached through a shackle, a short swinging arm.

The shackle takes up the tendency of the leaf spring to elongate when compressed and thus makes for softer springiness.

Some springs terminated in a concave end, called a *spoon end* (seldom used now), to carry a swivelling member.

❖ INDEPENDENT:

Independent suspension is a broad term for any [automobile suspension](#) system that allows each wheel on the same [axle](#) to move vertically (i.e. reacting to a bump in the road) independently of each other.

This is contrasted with a [beam axle](#) or [deDion axle](#) system in which the wheels are linked – movement on one side affects the wheel on the other side.

Note that "independent" refers to the motion or path of movement of the wheels/suspension.

It is common for the left and right sides of the suspension to be connected with [anti-roll bars](#) or other such mechanisms.

The anti-roll bar ties the left and right suspension spring rates together but does not tie their motion together.

Most modern vehicles have **independent front suspension (IFS)**. Many vehicles also have an **independent rear suspension(IRS)**.

IRS, as the name implies, has the rear wheels independently sprung.

A **fully independent suspension** has an independent suspension on all wheels. Some early independent systems used [swing axles](#), but modern systems use [Chapman](#) or [MacPherson struts](#), [trailing arms](#), [multilink](#), or [wishbones](#).

1. DOUBLE WISHBONE:

- ❖ In automobiles, a **double wishbone** (or **upper and lower A-arm**) **suspension** is an [independent suspension](#) design using two (occasionally parallel) [wishbone](#)-shaped arms to locate the wheel.
- ❖ Each wishbone or arm has two mounting points to the [chassis](#) and one joint at the knuckle.
- ❖ The [shock absorber](#) and [coil spring](#) mount to the wishbones to control vertical movement.
- ❖ Double wishbone designs allow the engineer to carefully control the motion of the wheel throughout suspension travel, controlling such parameters as [camber angle](#), [caster angle](#), [toe](#) pattern, [roll center](#) height, [scrub radius](#), scuff and more.

IMAGE:

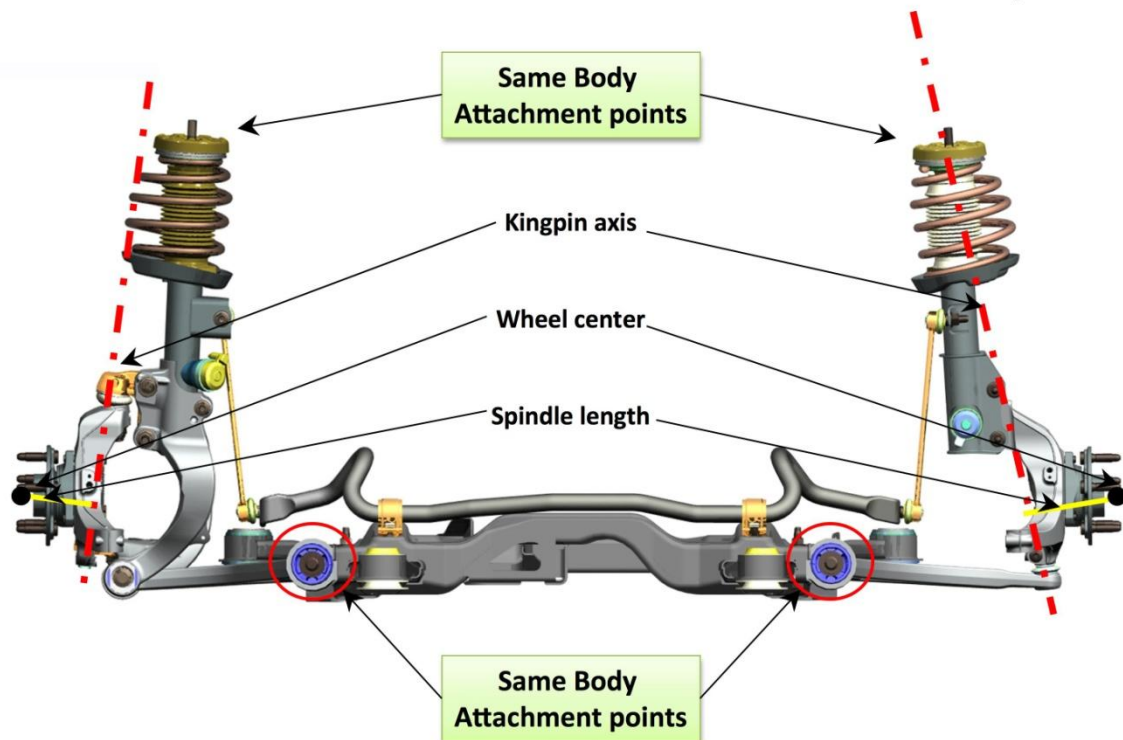


2. MAC PHEARSON STRUT:

- ❖ The **MacPherson strut** is a type of car suspension system which uses the top of a telescopic damper as the upper steering pivot.
- ❖ It is widely used in the front suspension of modern vehicles and is named for Earle S. MacPherson, who developed the design.

IMAGE:

2010 Buick LaCrosse CXS HiPer Strut vs. MacPherson-Strut Front Suspension

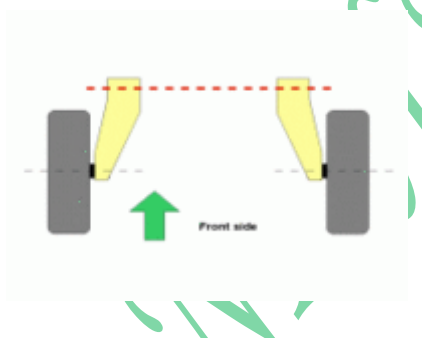


3. TRAILING ARM:

- ❖ A **trailing-arm suspension**, sometimes referred as **trailing-link** is a [vehicle suspension](#) design in which one or more arms (or "links") are connected between (and perpendicular to and forward of) the [axle](#) and a pivot point (located on the [chassis](#) of a motor vehicle).
- ❖ It is typically used on the rear axle of a motor vehicle. A **leading arm**, as used on the [Citroën 2CV](#) and the [M422 Mighty Mite](#), has an arm connected between (and perpendicular to, and to the rear of) the [axle](#) and the [chassis](#). It is used on the front axle.
- ❖ Trailing-arm designs in [live axle](#) setups often use just two or three links and a [Panhard rod](#) to locate the wheel laterally.
- ❖ A trailing arm design can also be used in an [independent suspension](#) arrangement.
- ❖ Each [wheel](#) hub is located only by a large, roughly triangular arm that [pivots](#) at one point, ahead of the wheel.

- ❖ Seen from the side, this arm is roughly parallel to the ground, with the angle changing based on road irregularities.
- ❖ A [twist-beam rear suspension](#) is very similar except that the arms are connected by a beam, used to locate the wheels and which twists and has an anti-roll effect.
- ❖ A **semi-trailing arm suspension** is a simple [independent rear suspension](#) system for [automobiles](#) where each [wheel](#) hub is located only by a large, roughly triangular arm that pivots at two points.
- ❖ Viewed from the top, the line formed by the two pivots is somewhere between [parallel](#) and [perpendicular](#) to the car's longitudinal axis; it is generally parallel to the ground.
- ❖ Trailing-arm and [multilink suspension](#) designs are much more commonly used for the rear wheels of a vehicle where they can allow for a flatter floor and more cargo room.
- ❖ Many small, front-wheel drive vehicles feature a [MacPherson strut](#) front suspension and trailing-arm rear axle.
- ❖ Some aircraft also use trailing arms in their [landing gear](#), with [oleo struts](#) for shock absorption.
- ❖ A trailing arm landing gear results in smoother landings and a better ride when [taxiing](#) compared to other types of landing gear.

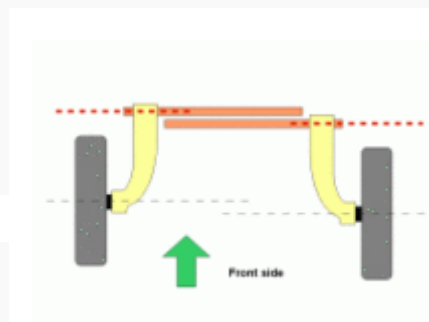
IMAGE:



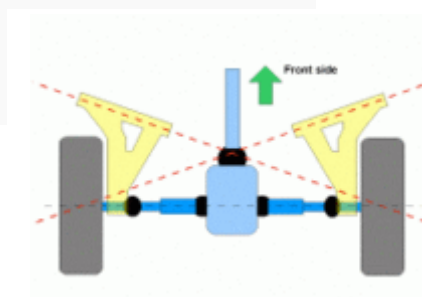
Trailing arm rear suspension of F1 cars



Rear suspension of Renault 4 and Renault 5



Semi-trailing arm suspension



FRAME

INTRODUCTION:

- The objective of the study is to design and develop the roll cage for All - Terrain Vehicle.
- ❖ Material for the roll cage is selected based on strength, cost and availability.
- ❖ The roll cage is designed to incorporate all the automotive sub-systems.
- ❖ A software model is prepared in Solid works software.
- ❖ Later the design is tested against all modes of failure by conducting various simulations and stress analysis with the aid of Ansys Software.
- ❖ Based on the result obtained from these tests the design is modified accordingly.
- ❖ After successfully designing the roll cage, it is ready for fabricated.
- ❖ The vehicle is required to have a combination frame and roll cage consisting of steel members.
- ❖ As weight is critical in a vehicle powered by a small engine, a balance must be found between the strength and weight of the design.
- ❖ To best optimize this balance the use of solid modeling and finite element analysis (FEA) software is extremely useful in addition to conventional analysis. The following paper outlines the design and analysis of the roll cage design.

1. DESIGN & DEVELOPMENT:

- ❖ The design and development process of the roll cage involves various factors; namely material selection, frame design, cross-section determination and finite element analysis.
- ❖ One of the key design decision of our frame that greatly increases the safety, reliability and performance in any automobile design is material selection.

- ❖ To ensure that the optimal material is chosen, extensive research was carried out and compared with materials from multiple categories.
- ❖ The key categories for comparison were strength, weight, and cost. The details of each step are given below.

2. Material Selection:

- ❖ While the rules set many factors of the material's geometry, there are many other limitations.
- ❖ These limitations include the method of fabrication and industry standards for the material.
- ❖ The frame will be built using a bent tube construction and MIG welded joints.
- ❖ MIG welding becomes difficult at wall thicknesses less than 0.035 inches.
- ❖ The tubing bender that will be used for the fabrication can bend a maximum of 1.5 inch diameter tube with a 0.120 inch wall thickness. It also requires that the tube have a minimum wall thickness of 0.055 inches.
- ❖ The geometry is also limited by industry standards. It is important to utilize commonly available tubing sizes and materials.
- ❖ Tubing is available in standard fractional sizes to the 1/8th of an inch: 1, 1.125, 1.25, 1.375, and 1.5.
- ❖ The wall thickness is limited to: 0.035, 0.049, 0.058, 0.065, and 0.083 inches.
- ❖ The most commonly available material for this type of tubing is "ASTM 106 grade B Steel".
- ❖ The ASTM 106 grade B Steel has the same Modulus of Elasticity (E) and density as the mild steel, so using it does not affect the weight or stiffness in members with the same geometry.
- ❖ After a careful study, based on the properties and cost and availability criteria, it was found that the following material with its properties given should be used.

<i>Density (x 1000 kg/m³)</i>	7.7 - 8.03
<i>Poisson's ratio</i>	0.27- 0.30
<i>Elastic Modulus (GPa)</i>	190 - 210
<i>Tensile Strength (MPa)</i>	415
<i>Yield Strength(MPa)</i>	240
<i>Elongation (%)</i>	20
<i>Reduction in Area (%)</i>	48
<i>Hardness (HRB)</i>	100

SPRUNG MASS:

It is the portion of the mass or the weight of the components mounted onto the frame itself. This includes the weight of the frame, body, engine, transmission, clutch assembly, occupants, cargo, etc.

UNSPRUNG MASS:

It is the portion of the mass or the weight of the components which mounted under the frame. This includes suspension, brakes rotors, brake callipers and pads, wheel axles, wheel hubs, wheel bearings, tyres, steering knuckles etc.

FRAME DESIGN:

To begin the initial design of the frame, some design guidelines were required to be set. They included intended transmission, steering and suspension systems and their placement, mounting of seat, design features and manufacturing methods. It is also required to keep a minimum clearance of 3 inches between the driver and the roll cage members. It is also necessary to keep weight of the roll cage as low as possible to achieve better acceleration. It is necessary to keep the center of gravity of the vehicle as low as possible to avoid toppling. Mounting heavier components such as engine, driver seat etc. directly on the chassis is one way of achieving low center of gravity. Also it is imperative to maintain the integrity of the structure. This is done by providing bends instead of welds which in turn reduces the cost. A layout of the chassis within the given geometrical constraints.

FINITE ELEMENT ANALYSIS:

After finalizing the frame along with its material and cross section, it is very essential to test the rigidity and strength of the frame under severe conditions. The frame should be able to withstand the impact, torsion, roll over conditions and provide utmost safety to the driver without undergoing much deformation. Following tests were performed on the roll cage.

- ❖ Front impact
- ❖ Side impact
- ❖ Rear impact

TYPES OF CHASIS FRAMES:

There are three types of frames

1. Conventional frame
2. Integral frame
3. Semi-integral frame

1. Conventional frame:

It has two long side members and 5 to 6 cross members joined together with the help of rivets and bolts. The frame sections are used generally.

- a. Channel Section – Good resistance to bending
- b. Tabular Section – Good resistance to Torsion
- c. Box Section – Good resistance to both bending and Torsion

2. Integral Frame:

This frame is used now a days in most of the cars. There is no frame and all the assembly units are attached to the body. All the functions

of the frame carried out by the body itself. Due to elimination of long frame it is cheaper and due to less weight most economical also. Only disadvantage is repairing is difficult.



3. Semi – Integral Frame:

In some vehicles half frame is fixed in the front end on which engine gear box and front suspension is mounted. It has the advantage when the vehicle is met with accident the front frame can be taken easily to replace the damaged chassis frame. This type of frame is used in some of the European and American cars.



“ ”

IMAGE:



ENGINES

INTRODUCTION:



An **engine**, or motor, is a machine designed to convert one form of energy into mechanical energy. Heat **engines**, including internal combustion **engines** and external combustion **engines** (such as steam **engines**) burn a fuel to create heat, which then creates a force.

Electric motors convert electrical energy into mechanical motion, pneumatic motors use compressed air and others—such as clockwork motors in wind-up toys—use elastic energy. In biological systems, molecular motors, like myosins in muscles, use chemical energy to create forces and eventually motion.

TYPES:

- TWO STROKE ENGINE
- FOUR STROKE ENGINE
- JET ENGINE

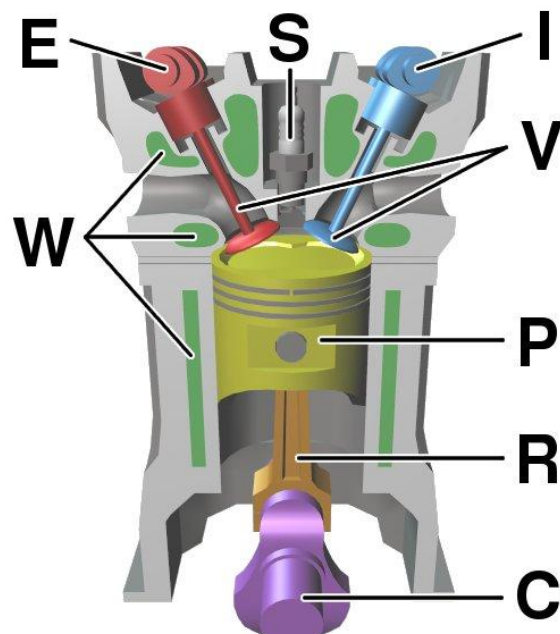
BASIC COMPONENT OF SIMPLE ENGINE **(four stroke)**

I - Inlet camshaft

E - Outlet camshaft

S - Spark Plug

V- Valves



W -Water cooling jackets

P - Piston

R- Connecting Rod

C- Crankshaft

WORKING PRINCIPLE

Engines are built with cylinders having no. of **valves** for inlet fuel and outlet exhaust, inside which the fuel burns along with air. The cylinders are made of super-strong [metal](#) and sealed very tightly, but at one end they open and close as they have tight fitting pistons that can slide up and down inside them. At the top of each cylinder, there are two [valves](#). The inlet valve allows fuel and air to enter the cylinder from a [carburettor](#) or electronic fuel-injector; the outlet valve lets the exhaust gases escape. At the top of the cylinder, there is a spark plug, an electrically controlled device that makes a spark to set fire to the fuel. At the bottom of the cylinder, the piston is attached to a constantly turning axle called a [crankshaft](#). The crankshaft powers the vehicle's driving system, which in turn drives the wheels.

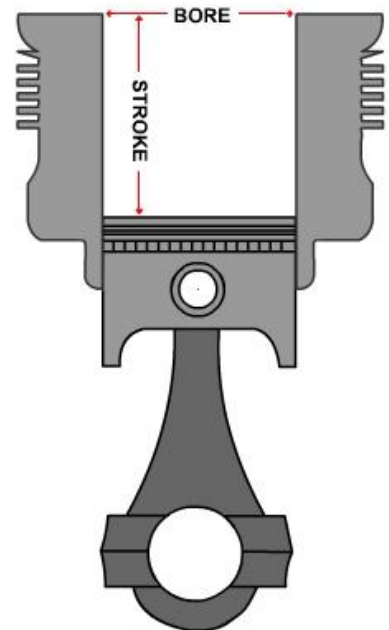
Points to be noted

- The inlet and outlet valves are controlled by a chain system called **timing chain**.
- When both the inlet and outlet valves open simultaneously, it is referred as **valve overlapping**.
- It is always mandatory that the inlet valve is always bigger than the outlet valve.
- Bore is the centre part of the engine where the piston moves vertically.

- The inlet valve must be approximately 45% of the bore diameter and the outlet valve must be approximately 38% of the bore diameter.
- **Sprockets** are circular components which help to drive a chain by locking themselves into the chain.
- The activation of the inlet and outlet valves is done by the **cam lobe**.
- The shape of the piston is neither circular nor oval. It is a specially designed shape called '**ovality**'.

PISTON

A piston is a component of an engine, [pumps](#), [gas compressors](#) and [pneumatic cylinders](#). It is the moving component that is inside a [cylinder](#) and is tightened by [piston rings](#). In an engine, its purpose is to transfer force from expanding gas in the cylinder to the [crankshaft](#) through a [connecting rod](#). In a pump, the function is reversed and force is transferred from the crankshaft to the piston for the purpose of compressing the fuel or ejecting the exhaust from the cylinder.



The piston on the whole consists of three main parts- the piston head, the connecting rod and the crankshaft.

It also consists of **piston rings**. These are split rings that are fitted into grooves on the outer side of the piston. The three main functions of piston rings in engines are

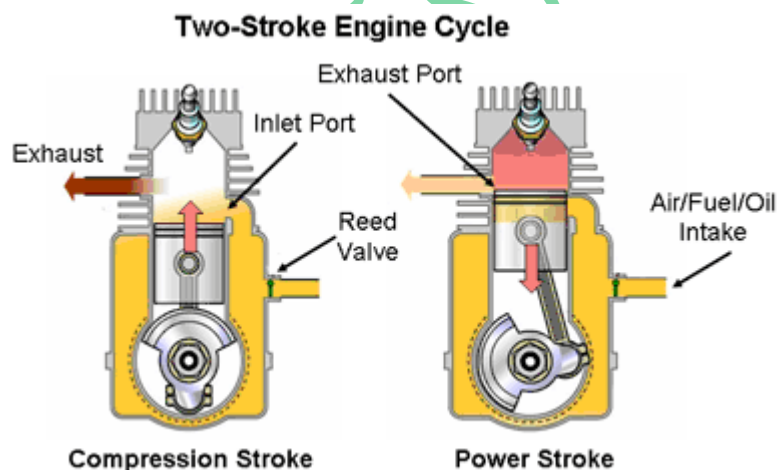


- Sealing the combustion chamber so that there is no transfer of gases from the combustion chamber to the crank.
- Supporting heat transfer from the piston to the [cylinder](#) wall.
- Regulating engine oil consumption

The no. of rings depend upon the type of engine. The upper rings are always the compression rings and groove rings and the lower one is the oil ring.

TWO STROKE ENGINE

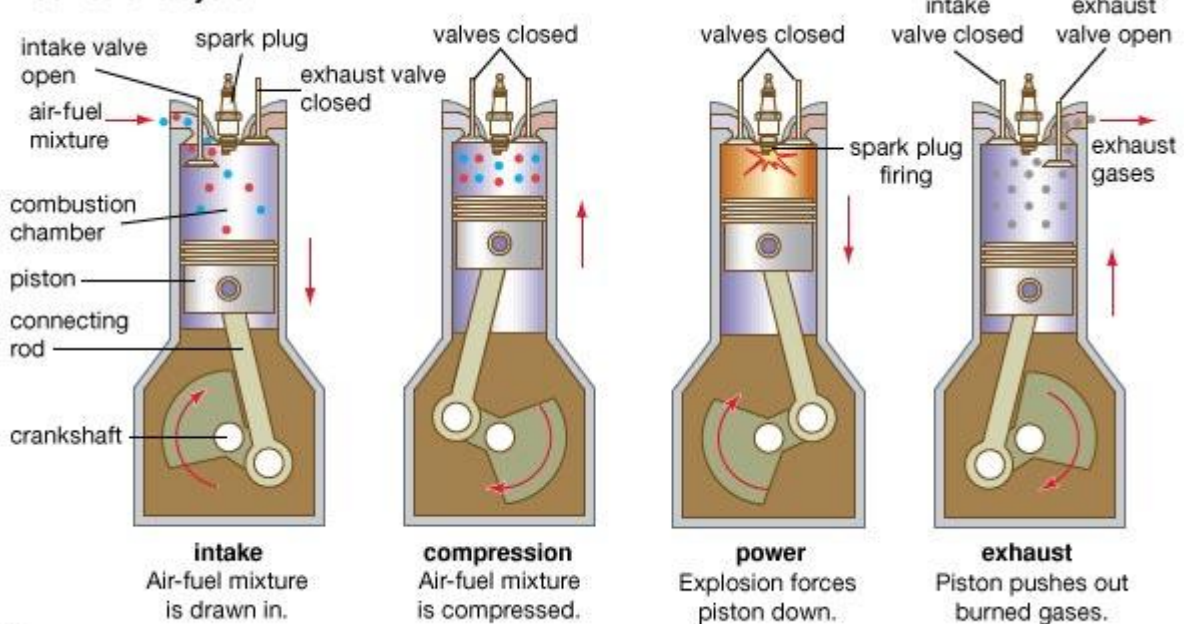
The two stroke engine is a type of internal combustion engine which completes one power stroke in two strokes namely, the **compression** and the **combustion** stroke. The fuel intake and the exhaust happen at the same time. The fuel is taken from the inlet and combustion takes place when the spark plug ignites a spark. The exhaust is now let out and simultaneously the fuel intake for the next cycle is taken aside.



Two stroke engines have high **power-to-torque** ratio than the four stroke engines since they provide a power stroke in two cycles. These have merely less no. of moving parts and they don't have valves and hence they weigh less than the four stroke engines.

FOUR STROKE ENGINE

Four-stroke cycle



A four-stroke engine is an [internal combustion engine](#) in which the [piston](#) completes four separate strokes which constitute a single thermodynamic cycle. A stroke refers to the full travel of the piston along the cylinder, in either direction. The four separate strokes are namely intake stroke, compression stroke, power stroke and exhaust stroke.

- **Intake Stroke:** This stroke of the piston begins at **top dead center (TDC)**. The piston falls from the top of the cylinder to the bottom of the cylinder, increasing the volume of the cylinder. A mixture of fuel and air is forced by atmospheric pressure or by some form of air pump pressure into the cylinder through the intake valve.
- **Compression Stroke:** With both intake and exhaust valves closed, the piston returns to the top of the cylinder compressing the air or fuel-air mixture into the cylinder head.

- **Power Stroke:** This is the start of the second revolution of the cycle. While the piston is close to Top Dead Centre, the compressed air–fuel mixture is ignited, by a [spark plug](#) inside the engine, or which ignites due to the heat generated by compression in a diesel engine. The resulting pressure from the [combustion](#) of the compressed fuel-air mixture forces the piston back down towards the **bottom dead centre (BDC)**.
- **Exhaust Stroke:** During the exhaust stroke, the piston once again returns to top dead centre while the exhaust valve is open. This action expels the burnt fuel-air mixture through the exhaust valve or outlet valve.



AIR FUEL INTAKE

For the combustion to take place inside an engine, air containing oxygen must be present in it. Hence there are certain systems which help to blend air and fuel so that a complete combustion can be achieved easily and no unburnt fuel escapes. There are two main types:

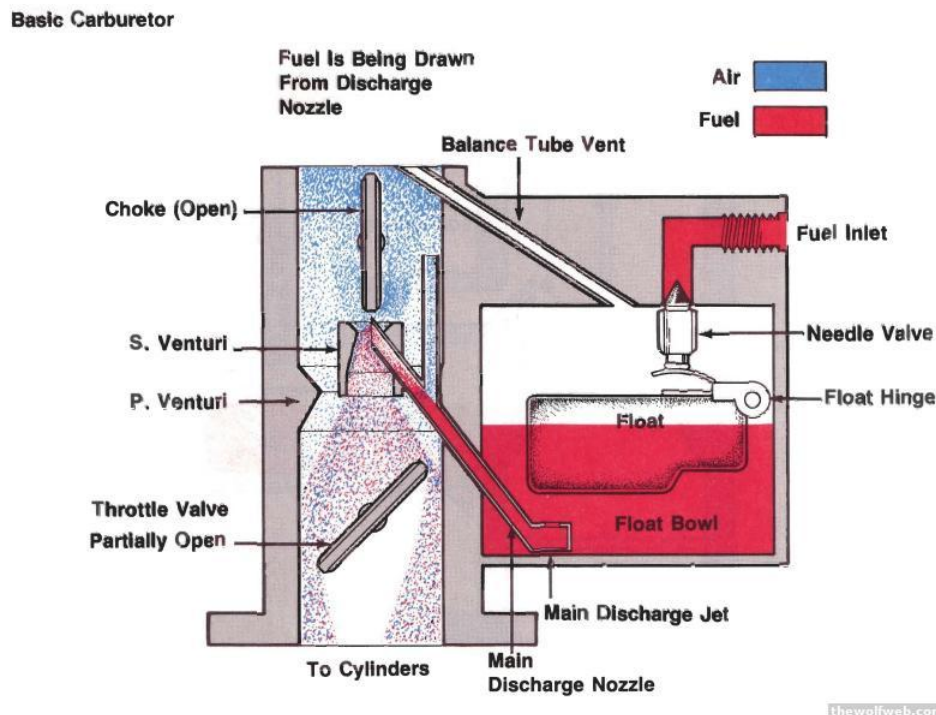
(i) Carburetor (ii) Fuel injection

The value for the mixture of air and fuel is determined using the **stiochiometric ratio**. It gives the ratio of mixture of air to the amount of fuel. The standard ratio is approximately given around **14.7:1**, where ‘14.7’ is the ration of air present to ‘1’ amount of gasoline or any liquid fuel.

CARBURETOR

One of the common types is a carburetor type air-fuel intake. The carburetor works on [Bernoulli's principle](#): the faster air moves, the lower its [static pressure](#), and the higher its [dynamic pressure](#). The [throttle](#) linkage is controlled by a **Throttle Position Sensor(TPS)**

and it does not directly control the flow of liquid fuel. Instead, it actuates the flow of air being pulled into the engine. The speed of this flow, and therefore its pressure, determines the amount of fuel drawn into the airstream.



The carburetor consists of a butterfly valve which opens proportionally to the thrust from the throttle. This valve allows air mixture into the carburetor. Fuel is allowed from a fuel inlet. This inlet is controlled by a **float system**. A **float** is present inside the carburetor vessel which closes the inlet using **jets**. Jets are small needle like structured components which close the vents of the inlet when the required amount of fuel is acquired in the **float bowl**. The air and the fuel are mixed and sent to the cylinders for combustion.

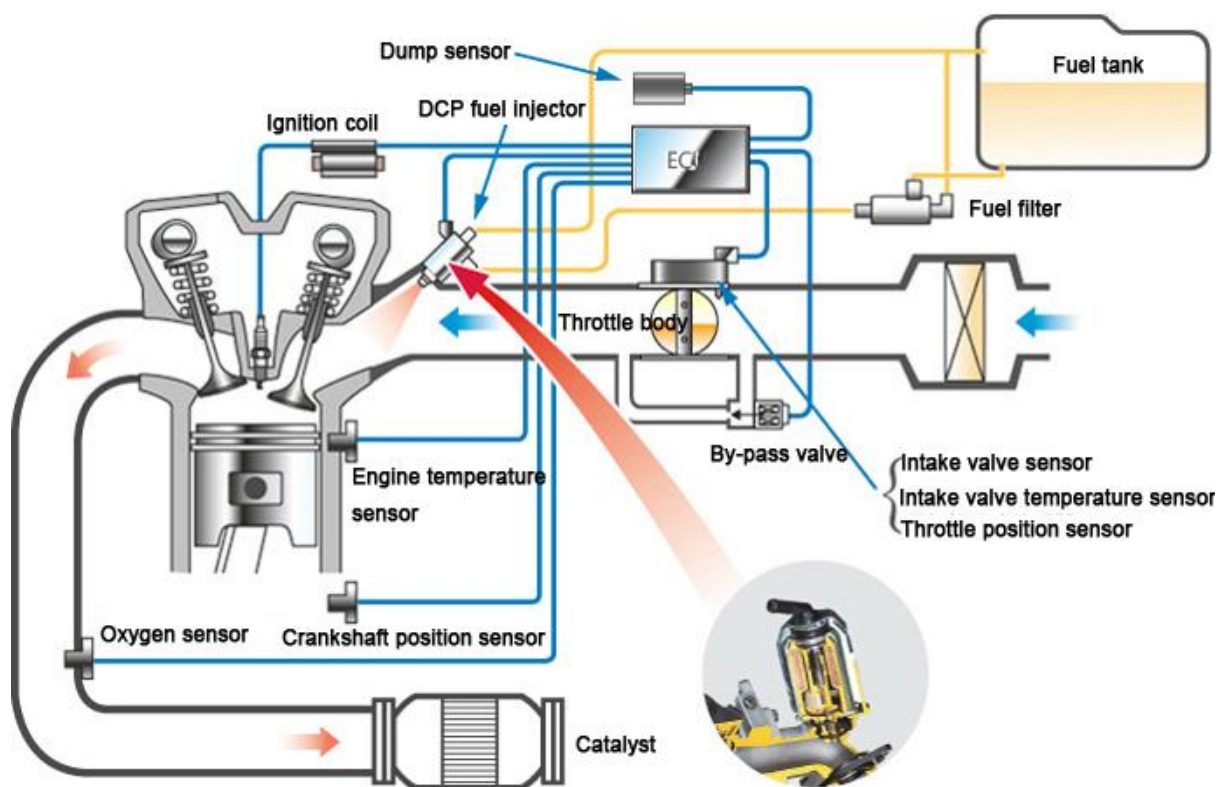


FUEL INJECTION

It is a latest method used in automobiles for air-fuel mixture intake, which have replaced the conventional carburetors from the late 20th century. In this method fuel is injected or sprayed into the air mixture

which provides a complete blend of air and fuel for the combustion to take place.

The fuel injector is electronically controlled unlike carburetor which is mechanically controlled. The fuel injector is controlled by an **Electronic Control Unit(ECU)**. The ECU instructs the injector about the amount of fuel to be injected, the speed of injection and the throttle response. The temperature of the piston and bore is monitored and controlled by a **Temperature Sensor** device.



Some of the benefits of fuel injection include more smoother and more consistent throttle response, such as during quick [throttle](#) transitions, easier cold starting, more accurate adjustment to varying temperatures and changes in air pressure, less maintenance, and better fuel efficiency.

Points to be noted

- Compression ratio is given by v/v_c , where $v = v_s + v_c$

V_c = clearance volume

V_s = swept volume

V = total volume

- When there is a complete exhaust inside the engine after the power stroke it is known as **scavenging**.
- A stroke engine can deliver more torque and power than a four stroke engine; it weighs less than a four stroke engine, but emits more smoke along with unburnt fuel at times.
- '**hp**' refers to **horse power** which is the power produced by the piston head due to the power stroke.
- '**bhp**' refers to **break horse power** which is obtained by neglecting the **frictional power** from the horse power.

CLUTCH ASSEMBLY

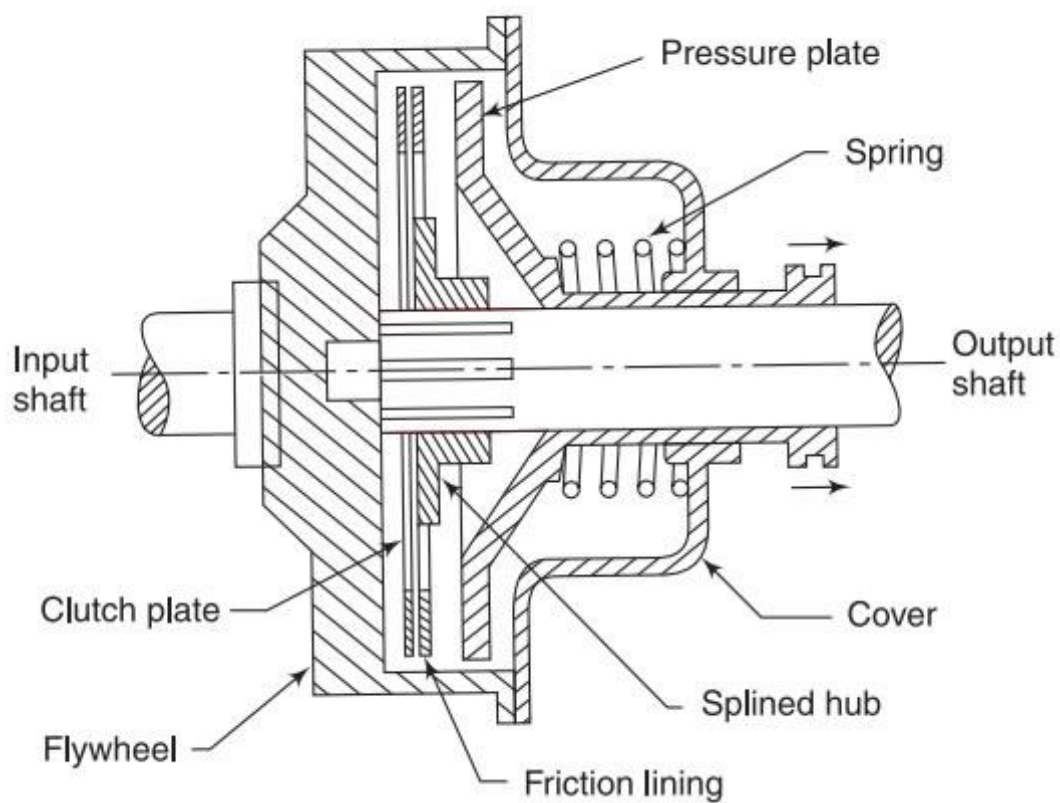
A clutch is a mechanical device that is used to engage and disengage the power [transmission](#), especially from [driving shaft](#) to driven shaft. The clutch assembly consists of a clutch plate, friction plates, pressure plates, springs, central hub, clutch lever or pedal etc. The whole clutch system is assembled entirely with frictional contact.

When the driver applies the clutch, the pressure plate loses friction and they tend to extend outwards which disengages the clutch plate from the flywheel as the frictional contact is lost and the acceleration to the wheels is stopped and the wheel starts to decelerate and stops at one point. Hence the speed of the vehicle can be controlled using the clutch system. There are some common types:

- (i) single plate
- (ii) multi plate
- (iii) centrifugal
- (iv) Diaphragm

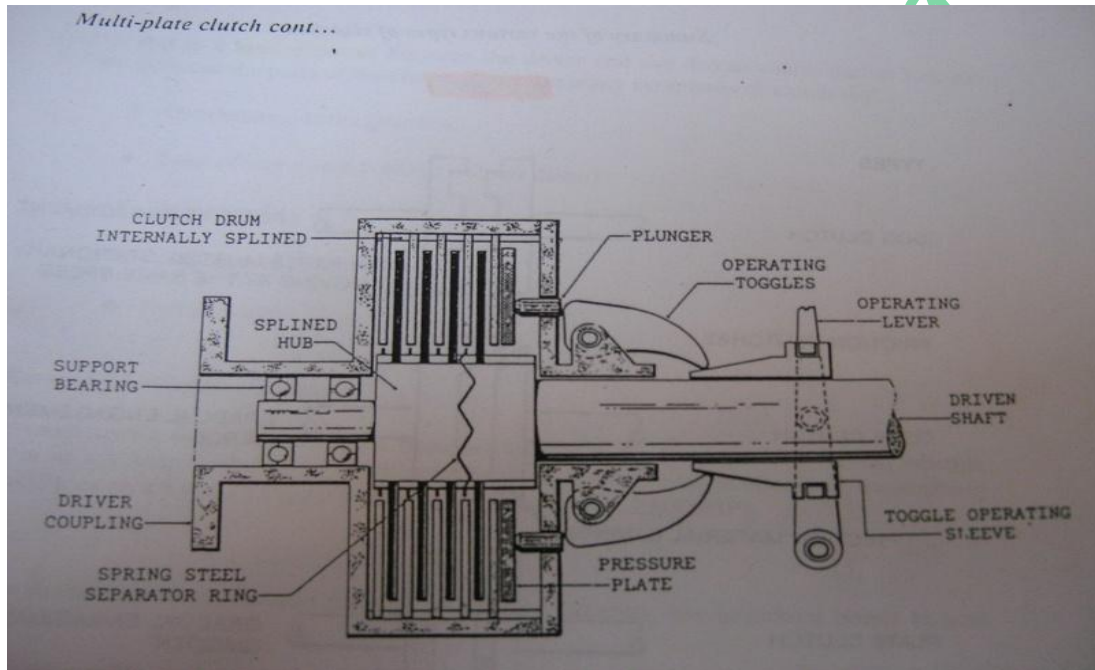
SINGLE PLATE CLUTCH

Most vehicles especially two-wheelers use single plate clutch to transmit torque from the flywheel to the main shaft. The flywheel is the clutch driving member. The clutch unit is mounted on the flywheel's machined rear face, so that the unit rotates with the flywheel.



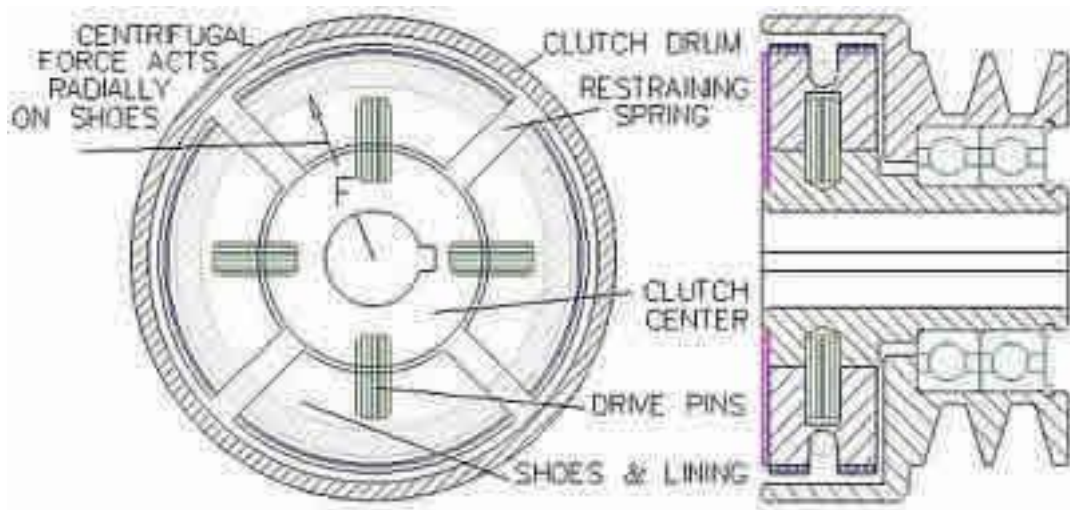
MULTI PLATE CLUTCH

A multi plate clutch assembly is similar to a single plate clutch assembly except that it has more no. of clutch plates and friction plates than the latter. More no. of plates will ensure more torque is transmitted to the driven shaft, and friction capacity increases and proportionally torque is increased.



CENTRIFUGAL CLUTCH

The centrifugal clutch is used in the case of automatic transmission vehicles. It is based on the principle of centrifugal force. As engine revolutions per minute increase, weighted arms in the clutch swing outward and force the clutch to engage. The most common types have friction pads or shoes mounted, that engage the inside of the rim of the linings. On the center shaft there are an assorted number of extension springs, which connect to a clutch shoe. Hence at high speeds the clutch engages as the weight of the arms increase which forces the clutch disks to engage.

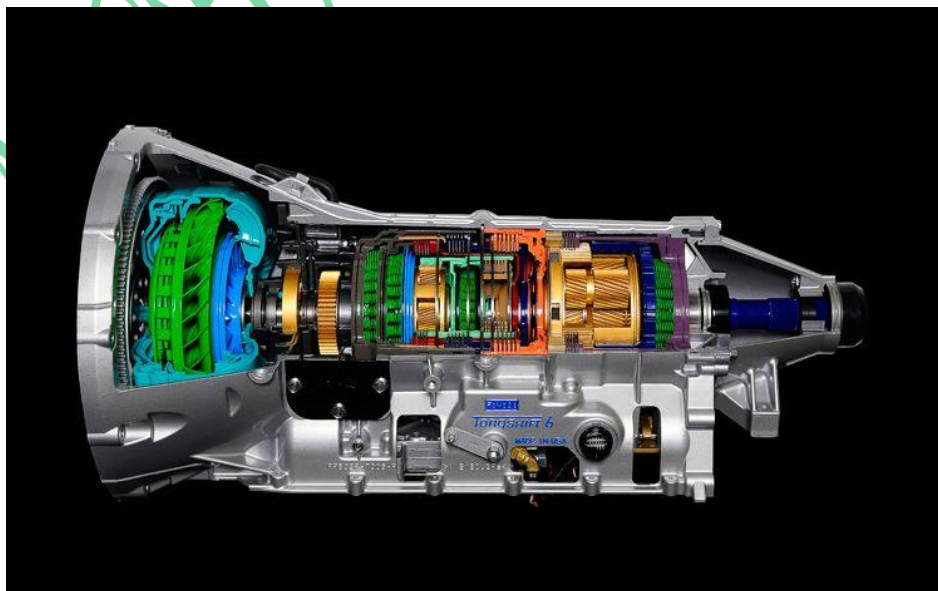


TRANSMISSION

Transmission is the assembly of parts which consists of **gears, shafts, sprockets** etc. Which help is transmitting the power from an input to an output. In automobiles, the shaft is driven by internal combustion which is transmitted as mechanical energy in order to drive the wheels by means of a **gearbox transmission** system. The main types of gearbox transmissions are:

- (i) **sliding mesh**
- (ii) **constant mesh**
- (iii) **synchronmesh**

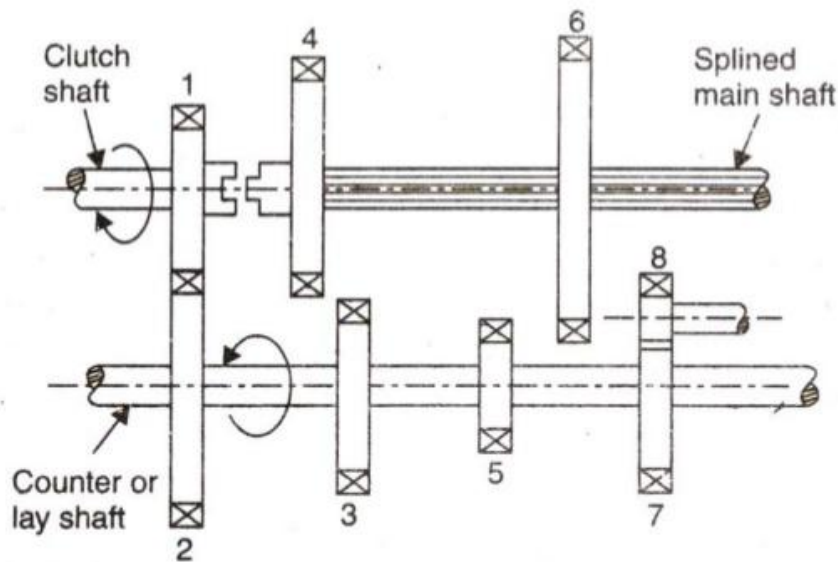
When the vehicle is in rest, it needs a very high torque to move from static to dynamic motion. Hence the first gear needs a very high torque to move the vehicle and the remaining gears get changed during the movement of the vehicle and help in reducing the stress for the engine's driving shaft



SLIDING MESH

In this type of transmission, the **lay shaft** remains stationary whereas the **main shaft** slides accordingly to the gear change response. When the first gear is shifted, the main shaft moves and the gears responsible get locked and therefore they transmit the torque to the main shaft via lay shaft.

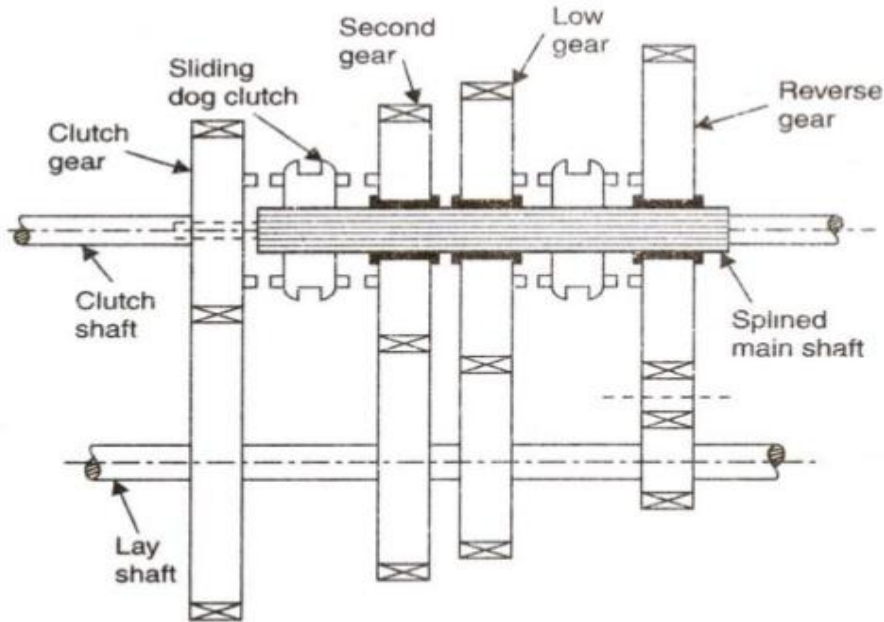
Sliding Mesh Gearbox



CONSTANT MESH

Unlike sliding mesh gearbox the main shaft doesn't move in this. Both the lay shaft and the main shaft are stationary. The special type of component used in this type gearbox is a **dog clutch**. The movement of the dog clutch is controlled by the gear lever. When the gear is shifted, the dog clutch moves accordingly. This dog clutch has inner walls made in the shape of sprockets so that they can easily engage with the respective gear. By this way the dog clutches move and they help in gear shifting.

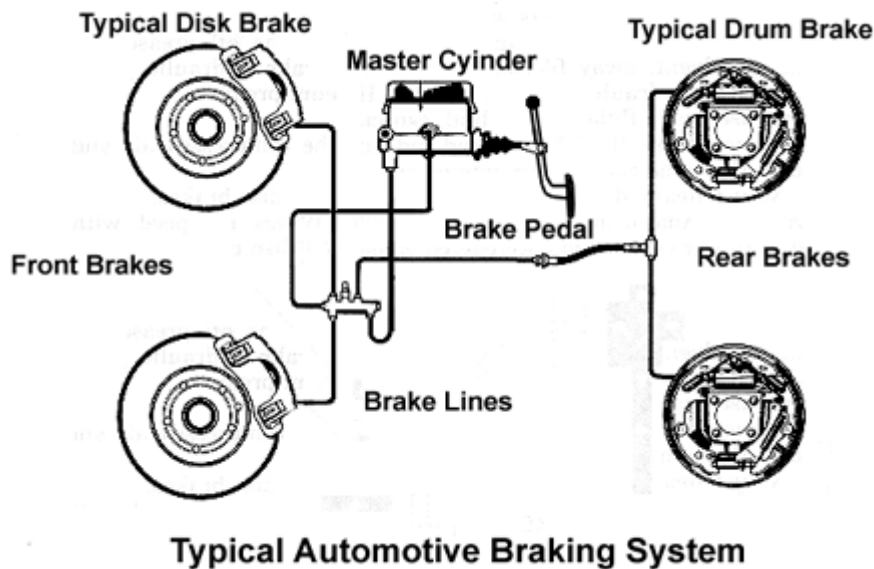
Constant Mesh Gearbox



BRAKES

Brakes are mechanical devices which slow down, stop, and decelerate the motion of a moving object which is in dynamic motion. Brakes use the principle of **friction** which **converts kinetic energy into heat**. In commercial vehicles brakes are fitted to the wheels of the vehicle, in order to stop its motion. There are two main types:

- (i) **drum brakes**
- (ii) **disk brakes**

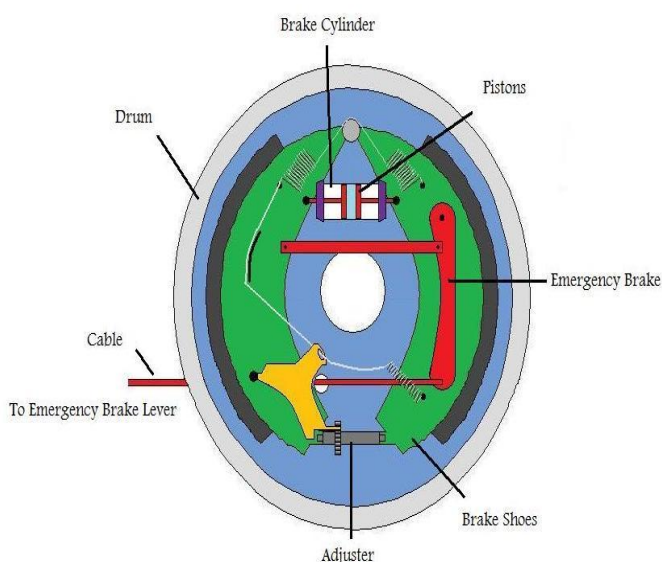


The main components of a brake system are master cylinder, callipers, rotor/disc, pads, pedal/ lever, hose line/ pressure line, etc. The **master cylinder** consists of a **piston** which exerts pressure on applying the brakes. Commonly, the master cylinder and the brake pedal are pivoted to a joint called **fulcrum** on the chassis of the vehicle.

When the brakes are applied, two processes take place one after the other. First a **mechanical process** followed by a **hydraulic process**. A pressure is applied on the master cylinder which pushes the piston inside by which the **pressurised fluid** leaves the cylinder. This fluid with high pressure reaches the rotor to which the pads of the brake are attached. This fluid pushes the pads accordingly so as to stop the rotation of the rotor.

DRUM BRAKES

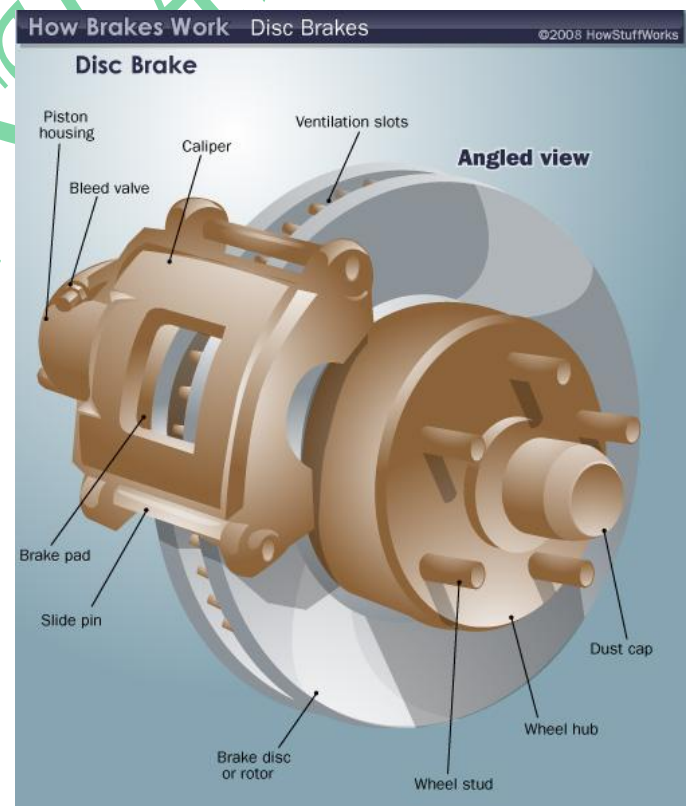
A [brake](#) that uses [friction](#) caused by a set of [pads](#) that press against a rotating rotor to stop the motion is called a brake drum. The term drum brake usually means a brake in which shoes press on the [inner surface](#) of the drum. When shoes press on the outside of the drum, it is usually called a [clasp brake](#). Where the drum is pinched between two shoes, similar to a conventional [disc brake](#), it is sometimes called a **pinch drum brake**. Drum brakes are one of the most widely used brakes for automobiles. Mostly these types of brakes use high tension springs to control the braking action. An emergency braking mode is enabled when the hand brakes are applied.



Disc brakes

A disc brake is a type of [brake](#) that uses [callipers](#) to push a pair of [pads](#) against the rotating [disc](#) in order to create [friction](#) that retards the rotation of the wheel of the vehicle, either to reduce its rotational speed or to hold it stationary. The energy of motion is converted into [waste heat](#) which must be dissipated. After a certain no. of times of frictional action the pads tend to get worn out.

Compared to [drum brakes](#), disc brakes offer better braking performance as the disc is more readily cooled as the vehicle keeps moving. As a consequence discs are less prone to the brake failure caused when brake components overheat. Holes or vents are present on the discs in order to dissipate the heat that is produced.

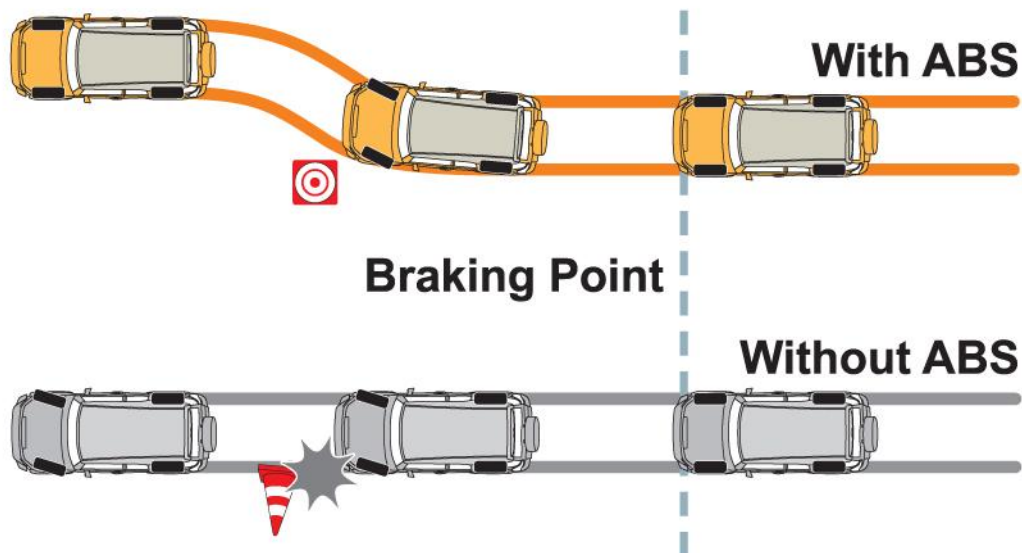


ABS

The most advanced development made in the braking mechanism is probably the Anti-lock Braking System (ABS). It is used predominantly in the disc brakes. In the pads of the callipers hit the disc and return and hit again, thus repeating this until the disc stops rotating. The speed of the pads in the ABS is calculated to be around **15 times per second**.

The ABS braking proves to be very much efficient than the other brakes, especially in the corners. It tends to move the vehicle as the driver wishes to, without any topple or slip off the road.

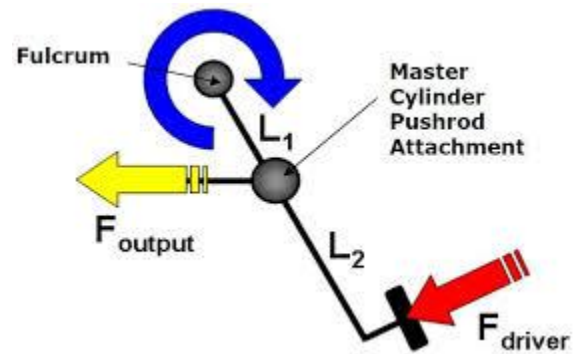
But it is mandatory that the vehicle must be at high speed to enable the ABS, (i.e.) the ABS is effective only at high speeds.



Points to be noted

- Selection of a good material for the disc plate is very essential. The material must possess high **strength-to-weight** ratio, and high **heat dissipation** property.
- The pads of the callipers/drum are made of **asbestos** due to its good thermal conductivity.

- When air bubbles enter into the pressure line of the brakes, **air bleeding** is done. Air bleeding is the process of taking out the air that is mixed with the brake oil inside the pressure line.
- The master cylinder is manufactured in two types:
 1. Single piston
 2. Tandem master



Pedal ratio is given by the total length from the brake pedal to the fulcrum ($L_1 + L_2$) divided by the length from the fulcrum to the master cylinder (L_1).

STEERING

The basic mechanism of a vehicle which allows the driver to select the desired direction of travel. It consists of a steering wheel, steering wheel shaft, gear systems, stabilisers, etc. The most conventional steering system arrangement is to turn the front wheels using a steering wheel which is positioned right in front of the driver. The basic aim of a steering is to ensure that the wheels are pointing in the desired directions. This is typically achieved by a series of linkages, rods, pivots and gears which move accordingly to the response from the steering wheel given by the driver.

There are two common types of steering mechanisms:

- (i) rack and pinion type
- (ii) worm type

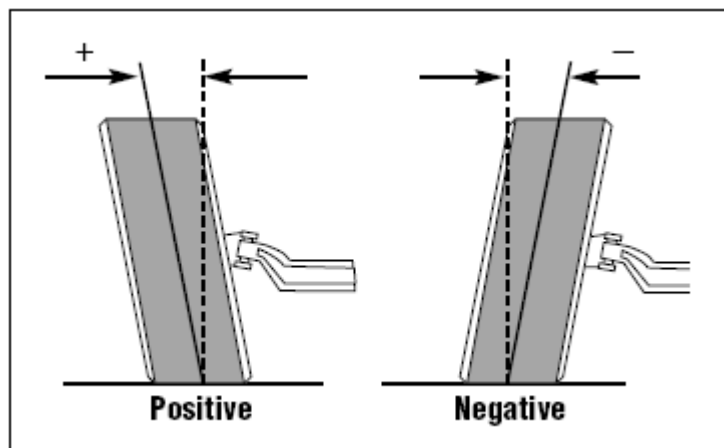
BUMP STEER

Bump steer or roll steer is the term for the tendency of the wheel of a car to steer as it moves upwards. It is typically measured in degrees of steer per metre of upwards motion or degrees per foot.

On modern cars the front of the tire moves outwards as the suspension is raised, a process known as the front wheels **toeing out**. This gives roll [under steer](#). The rear suspension is usually set up to minimize bump steer, where possible.

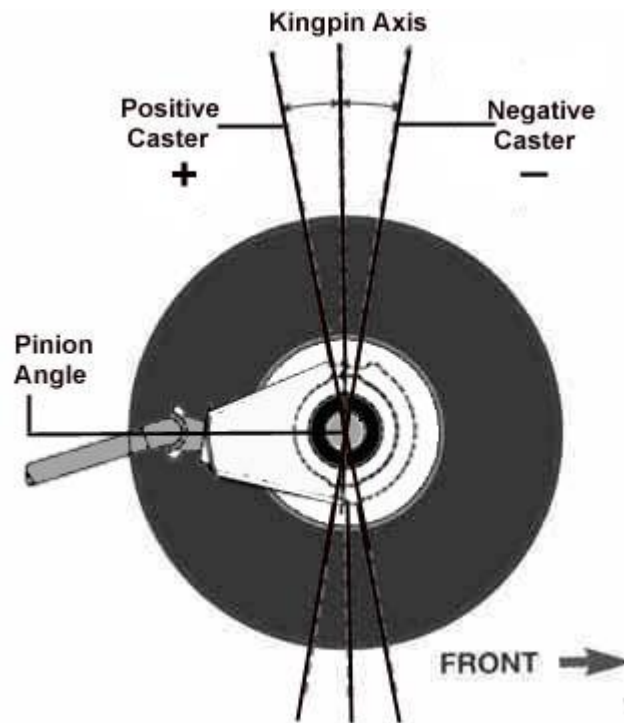
CAMBER ANGLE

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 from the front view. It is used in the design of [steering](#) and [suspension](#). If the top of the wheel is farther out than the bottom, it is called **positive camber**; if the bottom of the wheel is farther out than the top, it is called **negative camber**.



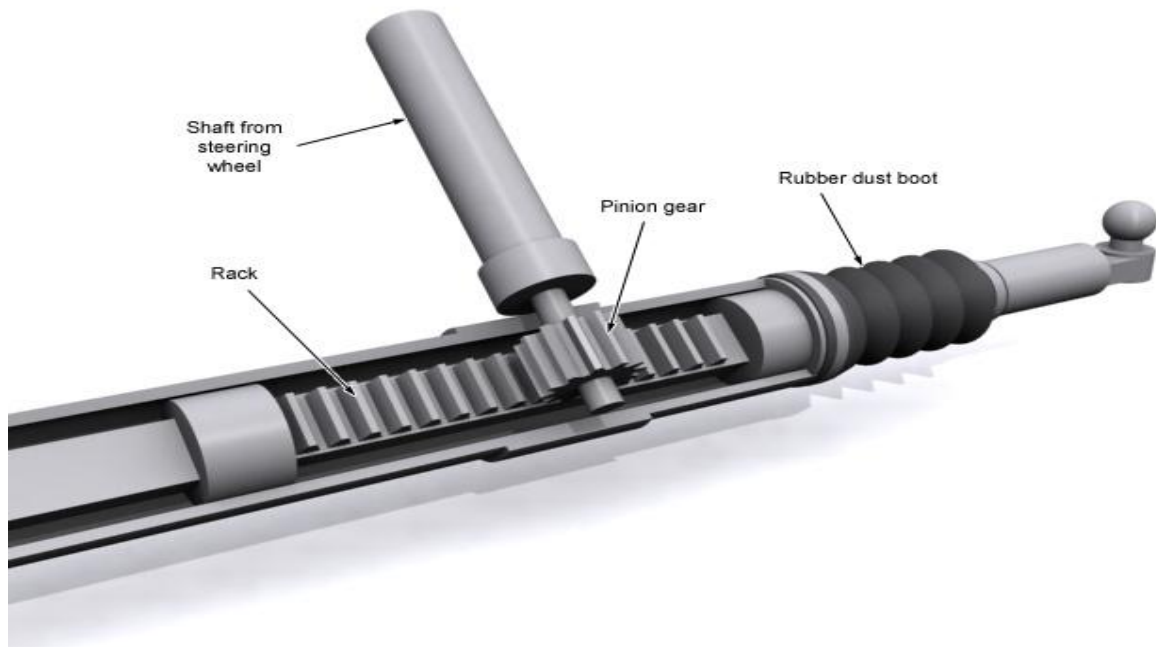
CASTOR ANGLE

The castor angle is the angle between the pivot line or the **king pin** axis and the positive castor or negative castor. The king pin is the main pin in a steering mechanism and responsible for steering action.



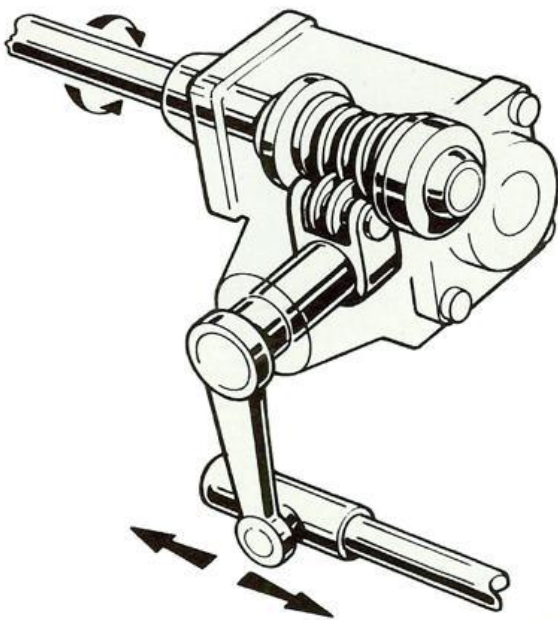
RACK AND PINION STEERING

A rack and pinion is a type of mechanism which comprises of a pair of gears which convert rotational motion into linear motion. A circular gear called the pinion engages teeth on a linear **gear** bar called the **rack**; rotational motion applied to the pinion causes the rack to move relative to the pinion, thereby translating the rotational motion of the pinion into linear motion.



WORM STEERING

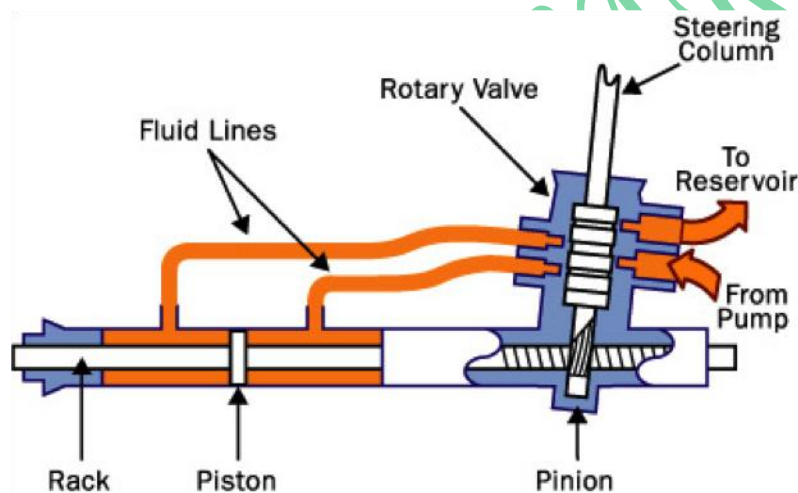
A worm type steering is a [gear arrangement](#) in which a **worm** (a [screw](#)) rotates with a **worm gear** (a [spur gear](#)). The two [elements](#) are also called the worm screw and worm wheel. Like other gear arrangements, a worm drive can reduce [rotational speed](#) or allow higher [torque](#) to be transmitted.



POWER STEERING

One of the modern improvements in steering mechanisms is power steering. It uses the principle of **hydraulics** to achieve precise and accurate steering control on the vehicle. A standard power steering system consists of a fluid for control, rotary valves to control the flow of liquid, fluid hose or lines, a reservoir, and a piston.

When there is a response from the driver on the steering, the fluid moves the piston to the instructed direction which tends to move the vehicle to the chosen direction.



SUBMITTED BY

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