AUTOMOBILE ENGINEERING
(5ME6.2A)

DEPARTMENT

OF

MECHANICAL ENGINEERING

(Jaipur Engineering College and Research Center, Jaipur)

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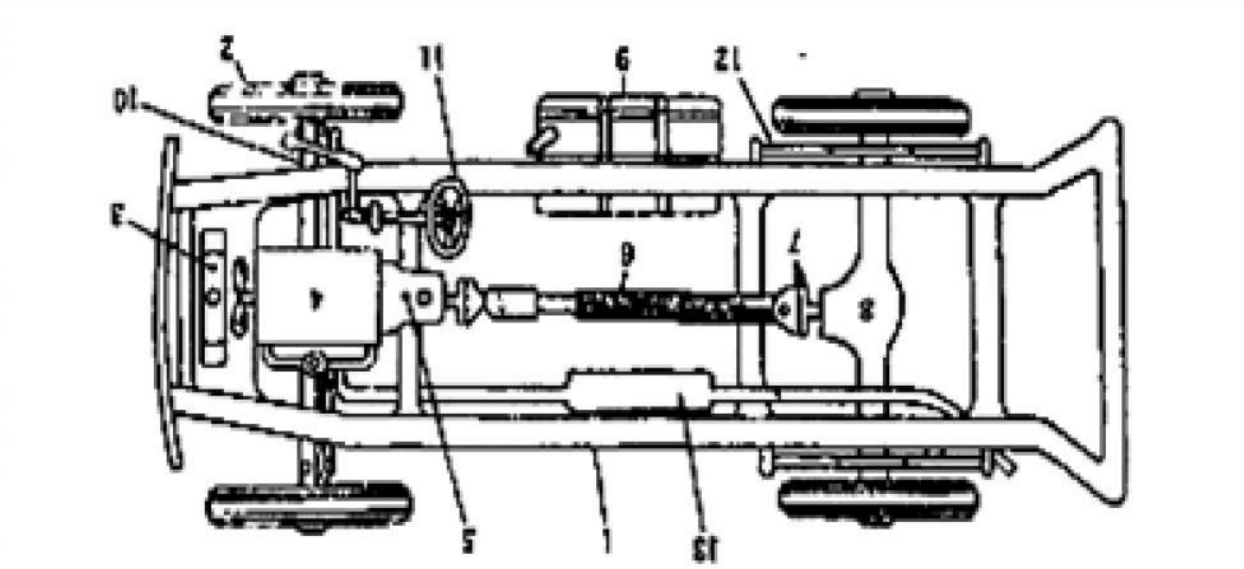
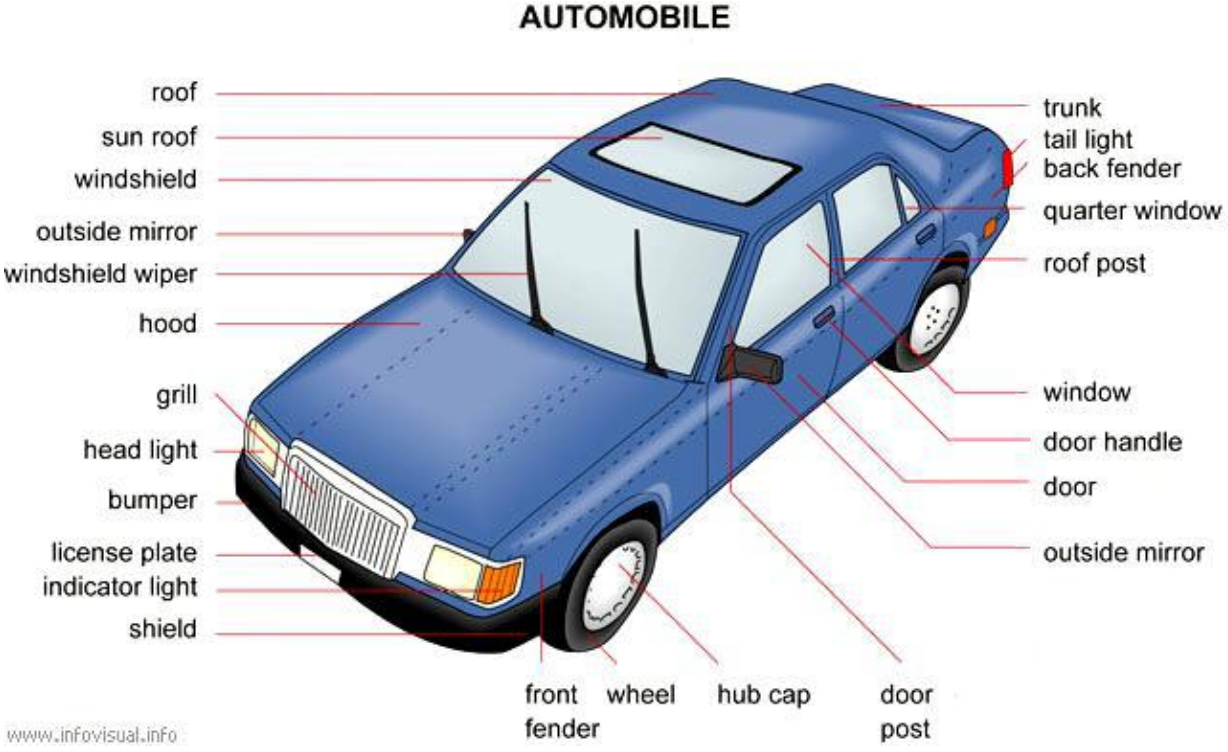
UNIT-1

FRAME AND BODY, CLUTCHES AND BRAKES
INTRODUCTION





Introduction of Automobile or Vehicle:

An Automobile is a self propelled vehicle which contains the power source for its propulsion and is used for carrying passengers and goods on the ground, such as car, bus, trucks, etc.

Types of Automobile:-

The automobiles are classified by the following ways-

1. On the Basis of Load:

- Heavy transport vehicle (HTV) or heavy motor vehicle (HMV)
- Light transport vehicle (LTV), Light motor vehicle (LMV)

2. On the Basis of Wheels :

- Two wheeler vehicle, for example : Scooter, motorcycle, scooty, etc.
- Three wheeler vehicle, for example : Autorickshaw
- Three wheeler scooter for handicaps and tempo, etc.
- Four wheeler vehicle, for example : Car, jeep, trucks, buses, etc.
- Six wheeler vehicle, for example : Big trucks with two gear axles.

3. On the basis of Fuel Used:

- Petrol vehicle, e.g. motorcycle, scooter, cars, etc.
- Diesel vehicle, e.g. trucks, buses, etc.
- Electric vehicle which use battery to drive.
- Steam vehicle, e.g. an engine which uses steam engine.
- Gas vehicle, e.g. LPG and CNG vehicles, where LPG is liquefied

4. On the basis of body style:

- Sedan Hatchback car.
- Coupe car Station wagon Convertible.
- Van Special purpose vehicle, e.g. ambulance, milk van, etc.

5. On the basis of Transmission:

- Conventional vehicles with manual transmission, e.g. car with 5 gears.
- Semi-automatic
- Automatic : In automatic transmission, gears are not required to be changed manually.

6. On the basis of Drive:

- Left hand drive
- Right hand drive

7. On the basis of Driving Axle

- Front wheel drive
- Rear wheel drive
- All wheel drive

8. Position of Engine:

- Engine in Front - Most of the vehicles have engine in the front. Example : most of the cars
- Engine in the Rear Side Very few vehicles have engine located in the rear. Example : Nano car.

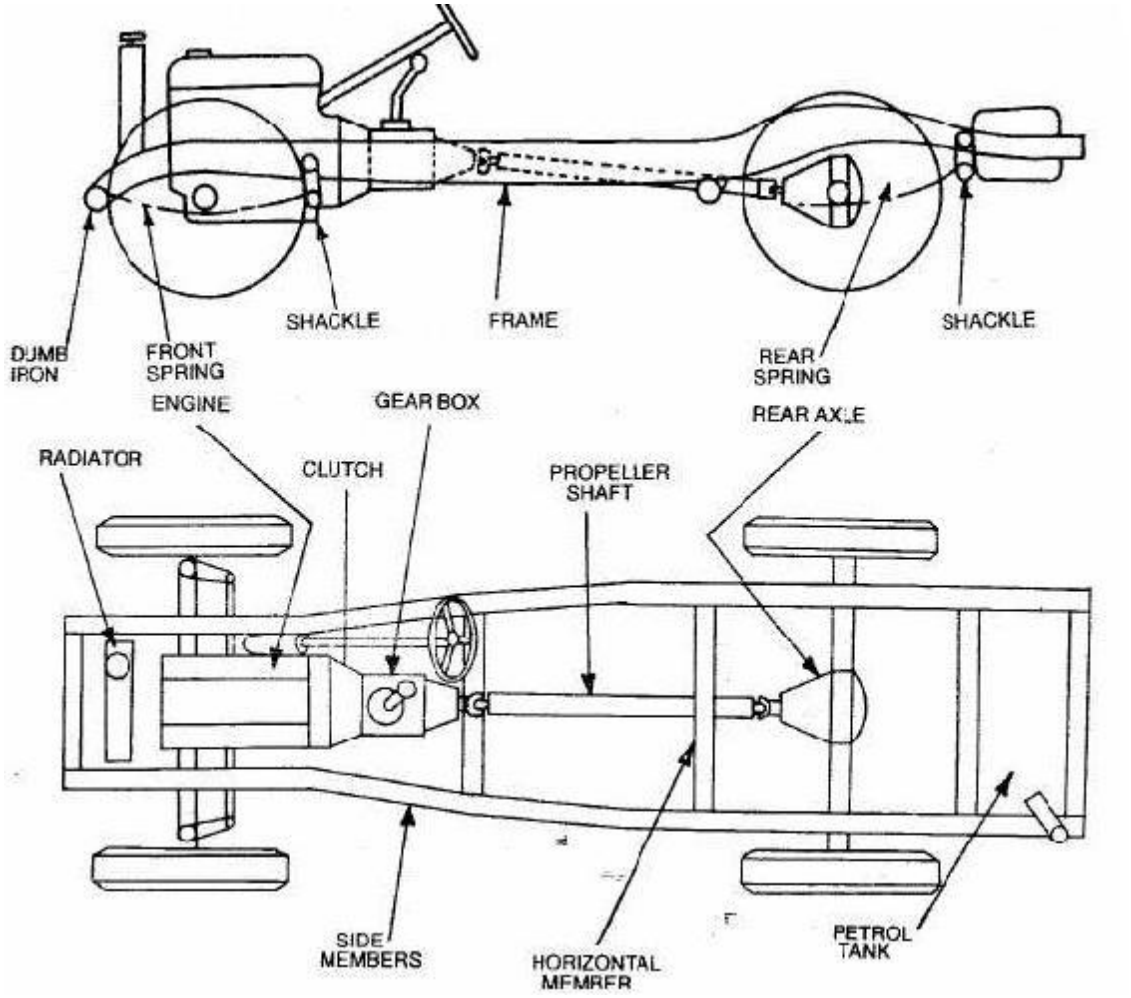
Vehicle construction and Components;

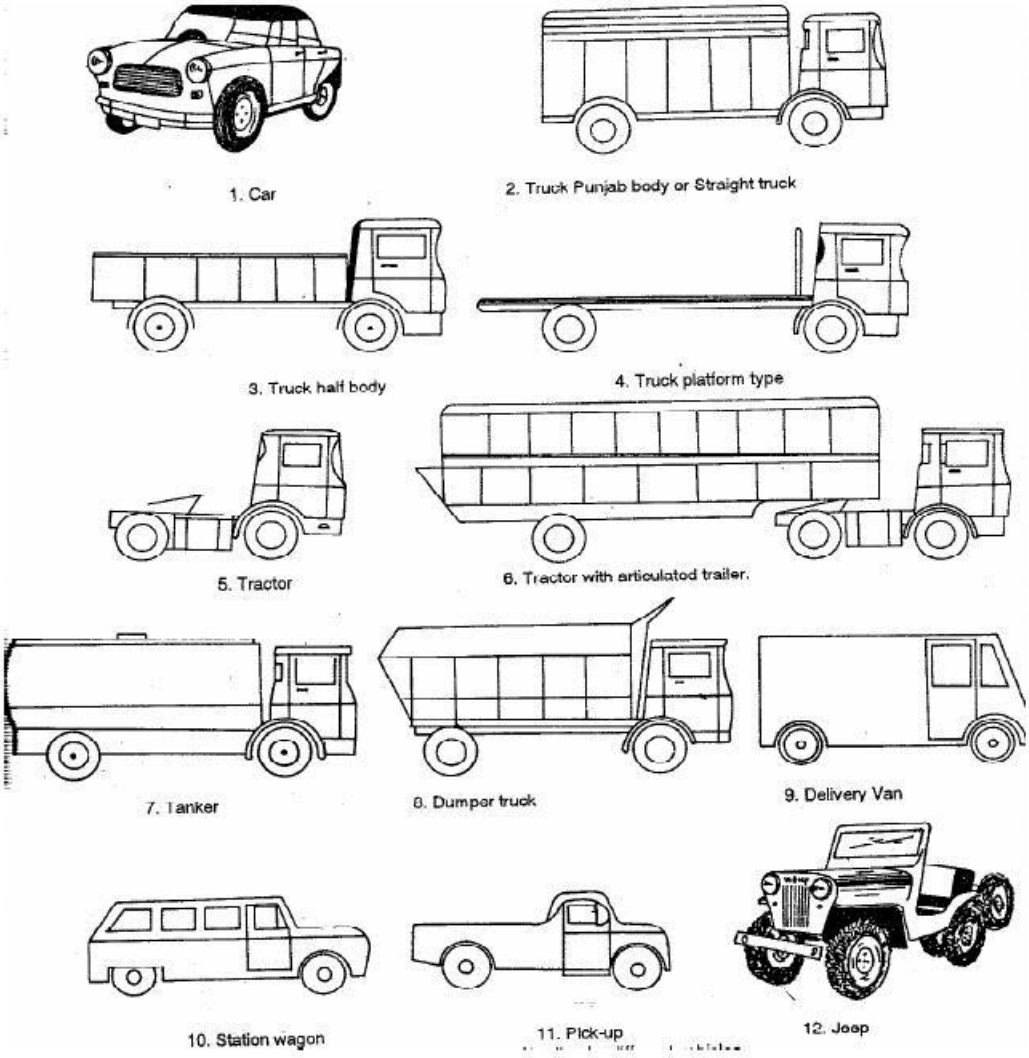
The main components of an automobile refer to the following components;

-□Frame
-□Chassis
-□Body
-□Power unit
-□Transmission system.

An automobile is made up of mainly two units, these are Chassis and Body.

"Frame" + "Base components" = "Chassis"
"Chassis" + "Body" = "Vehicle"





Frame :
The frame is the skeleton of the vehicle. It servers as a main foundation and base for alignment for the chassis.

Types:
-□Conventional frame,
-□Semi integral frame;
-□Integral or untidiest frame.

Chassis:
If the frame contains the base components its called as chassis. The components are like Engine, radiator, clutch, gearbox, silencer, road wheels, fuel tank, wirings, differential units, etc.

Body:
Body is the superstructure of the vehicle and it is bolted to the chasis.

Types:
Car, Truck, Tractor, Delivery van, Jeep, Bus, etc.

TRANSMISSION SYSYTEMS

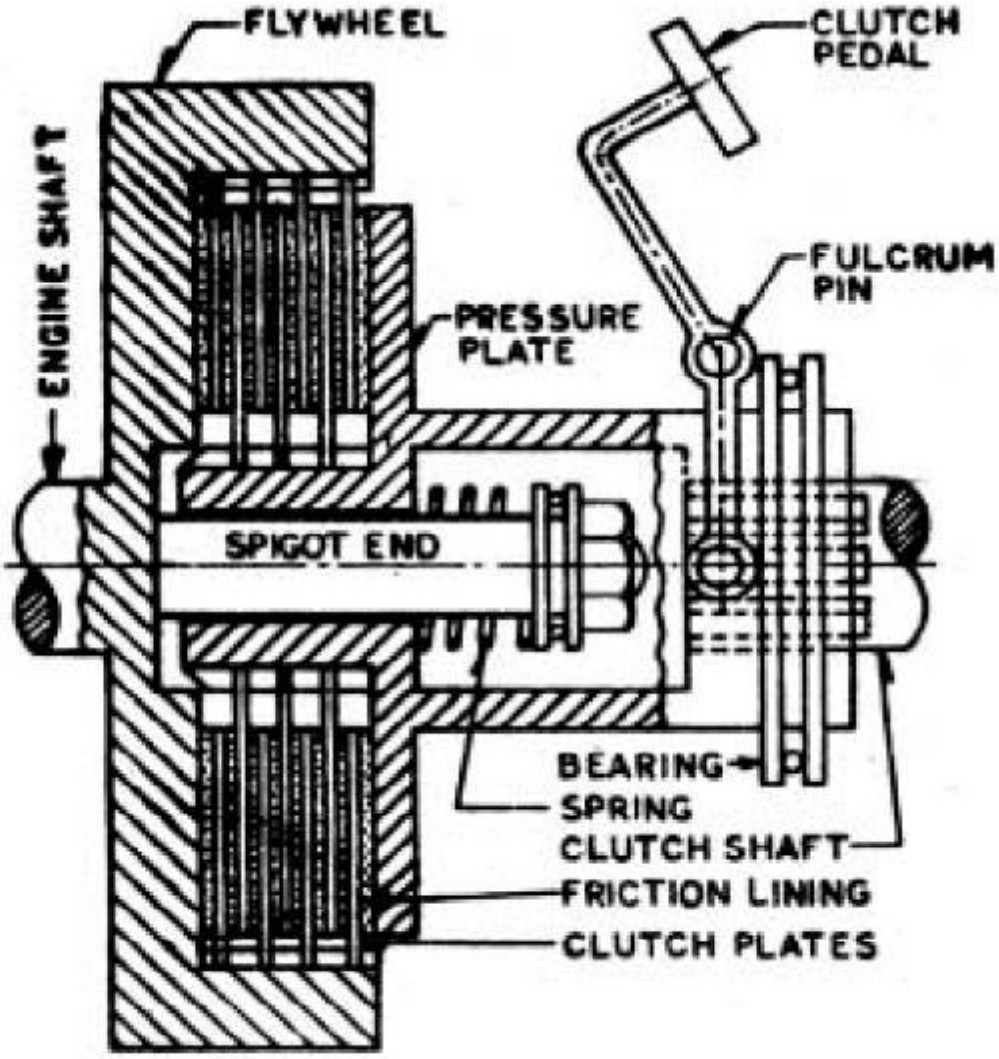
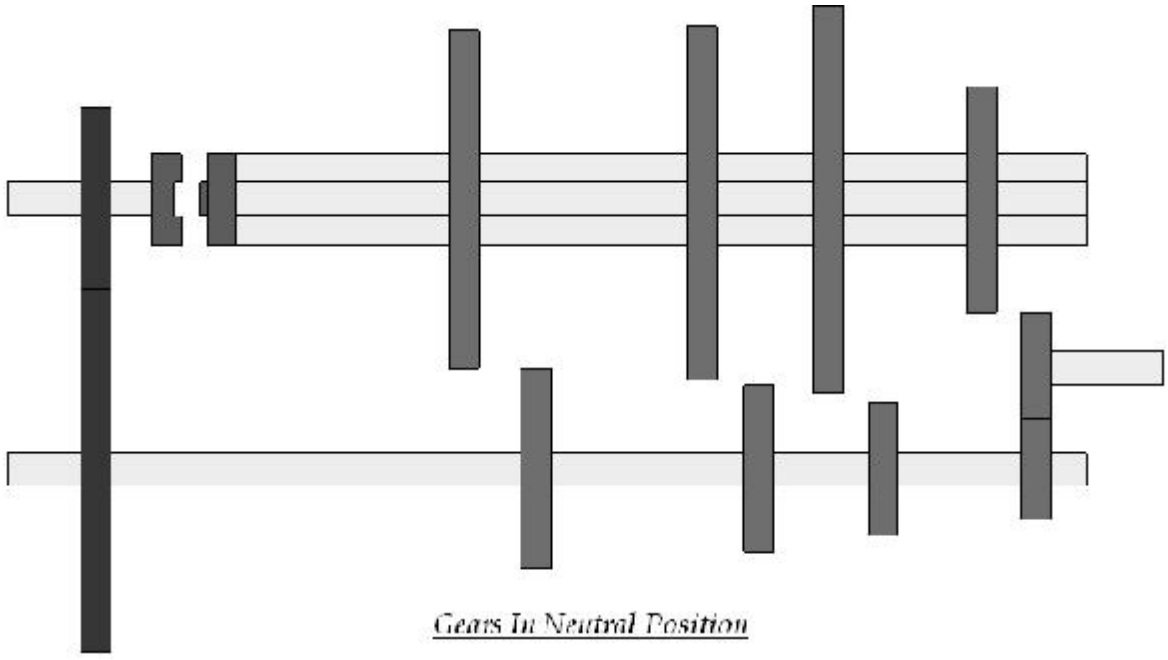


Fig : Multi-Plate Clutch



Gears In Neutral Position

Introduction to the Transmission Systems in Automobile:
The most common transmission systems that have been used for the automotive industry are:
- Manual transmission,
- Automatic transmission,
- Semi-automatic transmission,
- Continuously-variable transmission (C.V.T.).

1. Manual Transmission:
The first transmission invented was the manual transmission system. The driver needs to disengage the clutch to disconnect the power from the engine first, select the target gear, and engage the clutch again to perform the gear change. This will challenge a new driver. It always takes time for a new driver to get used to this skill.

2. Automatic Transmission:
An automatic transmission uses a fluid-coupling torque converter to replace the clutch to avoid engaging/disengaging clutch during gear change. A completed gear set, called planetary gears, is used to perform gear ratio change instead of selecting gear manually. A driver no longer needs to worry about gear selection during driving. It makes driving a car much easier, especially for a disabled or new driver. However, the indirect gear contact of the torque converter causes power loss during power transmission, and the complicated planetary gear structure makes the transmission heavy and easily broken.

3. Semi-Automatic Transmission:
A semi-automatic transmission tries to combine the advantages of the manual and automatic transmission systems, but avoid their disadvantages. However, the complicated design of the semiautomatic transmission is still under development, and the price is not cheap. It is only used for some luxury or sports cars currently.

4.Continuously Variable Transmission (C.V.T.):

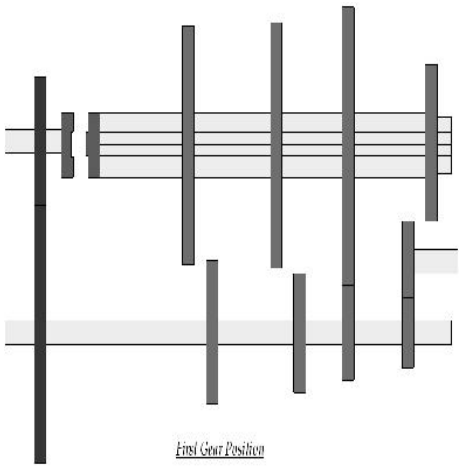
The Continuously Variable Transmission (C.V.T.) is a transmission in which the ratio of the rotational speeds of two shafts, as the input shaft and output shaft of a vehicle or other machine, can be varied continuously within a given range, providing an infinite number of possible ratios. The other mechanical transmissions described above only allow a few different gear ratios to be selected, but this type of transmission essentially has an infinite number of ratios available within a finite range.

It provides even better fuel economy if the engine is constantly made run at a single speed.

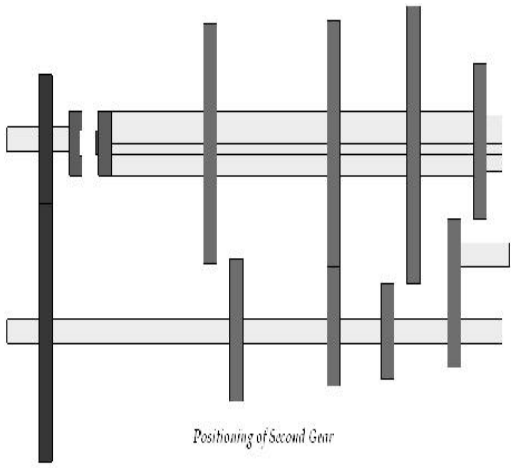
This transmission is capable of a better user experience, without the rise and fall in speed of an engine, and the jerk felt when changing gears.

MANUAL TRANSMISSION SYSTEM

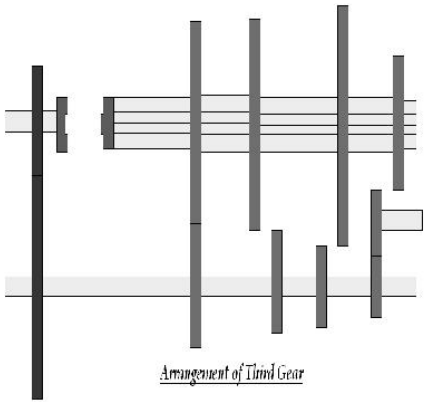
Manual transmissions also referred as stick shift transmission or just ‘stick', 'straight drive', or standard transmission because you need to use the transmission stick every time you change the gears. To perform the gear shift, the transmission system must first be disengaged from the engine. After the target gear is selected, the transmission and engine are engaged with each other again to perform the power transmission. Manual transmissions are characterized by gear ratios that are selectable by locking selected gear pairs to the output shaft inside the transmission.



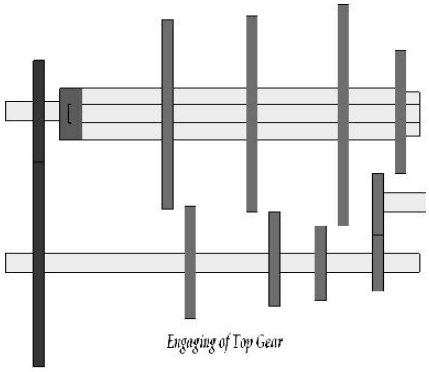
First Gear Position



Positioning of Second Gear



Arrangement of Third Gear

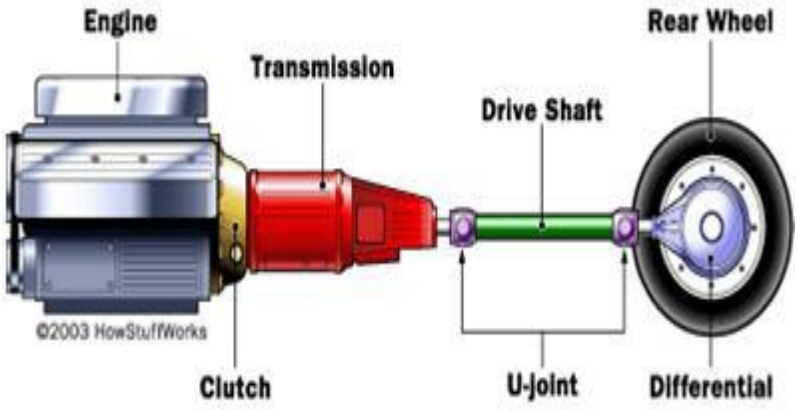


Engaging of Top Gear

The transmission system delivers the engine power to wheels.

Components of manual transmission
The main components of manual transmission are:
-□Clutch
-□Gear box
-□U- joint
-□Shafts
-□Differential gear box

Clutch:
Clutch is a device which is used in the transmission system of automobile to engage and disengage the engine to the transmission or gear box. It is located between the transmission and the engine. When the clutch is engaged, the power flows from the engine to the rear wheels in a rearwheel-drive transmission and the vehicle moves. When the clutch is disengaged, the power is not transmitted from the engine to the rear wheels and vehicle stops even if engine is running.It works on the principle of friction. When two friction surfaces are brought in contact with each other and they are united due to the friction between them. If one is revolved the other will also revolve.



The friction depends upon the surface area contact. The friction surfaces are so designed that the driven member initially slips on driving member when initially pressure is applied. As pressure increases the driven member is brought gradually to speed the driving member.

The three main parts of clutch are:
-□Driving member
-□Driven member
-□Operating member
The driving member consists of a flywheel mounted on the engine crank shaft. The flywheel is bolted to cover which carries a pressure plate or driving disc, pressure springs and releasing levers. Thus the entire assembly of flywheel and cover rotates all the times. The clutch housing

and the cover provided with openings dissipate the heat generated by friction during the clutch operation.
The driving member consists of a disc or plate called clutch plate. It is free to slide length wise on the splines of the clutch shaft. It carries friction materials on both of its surfaces when it is gripped between the flywheel and the pressure plate; it rotates the clutch shaft through splines.
The operating members consists of a foot pedal, linkage, release or throw-out bearing, release levers and springs necessary to ensure the proper operation of the clutch.
Now the driving member in an automobile is flywheel mounted on crank shaft, the driven member is the pressure plate mounted on transmission or gear box input shaft. Friction surfaces or clutch plates is placed between two members.

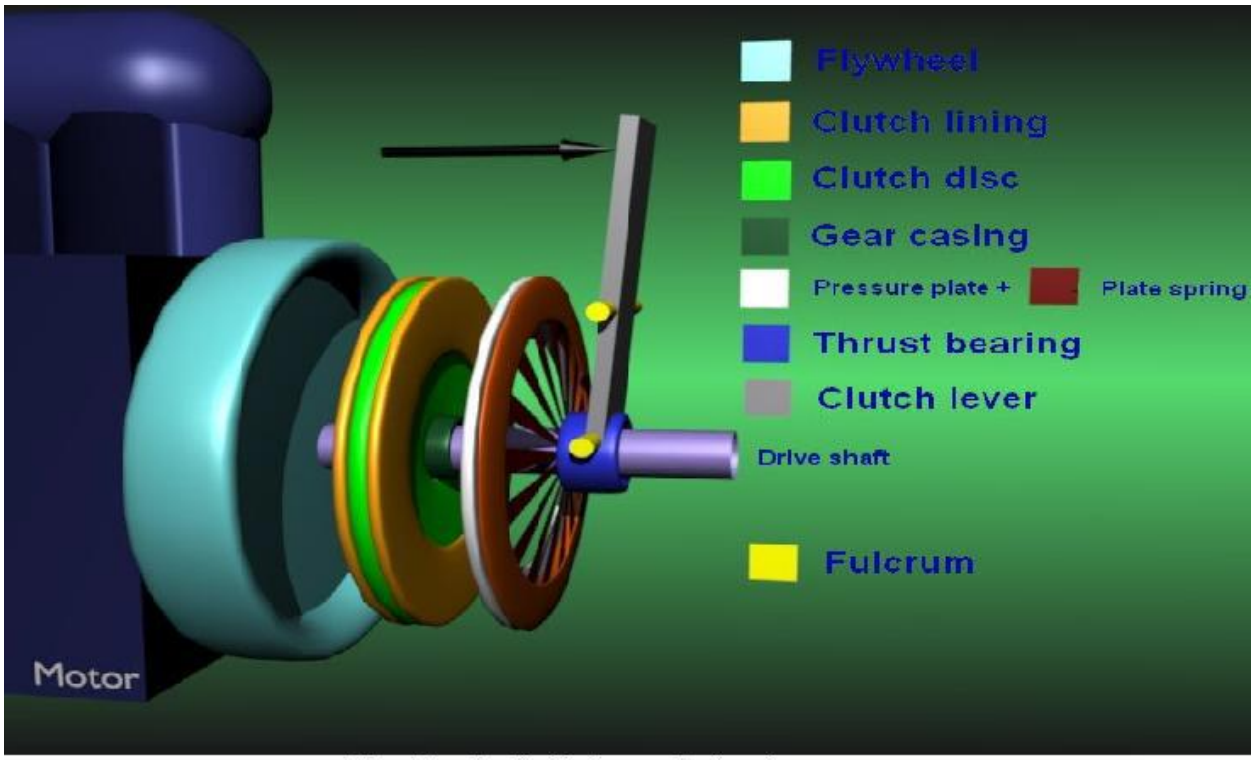


Fig: Exploded view of clutch

Types of Friction Materials:
The friction materials of the clutch plate are generally of 3 types:
- Mill Board Type
- Molded type
- Woven type

Mill Board type friction materials mainly include asbestos material with different types of impregnates.

Molded type friction materials are made from a matrix of asbestos fiber and starch or any other suitable binding materials. They are then heated to a certain temperature for moulding in dies under pressure. They are also made into sheets by rolling, pressing and backs till they are extremely hard and dense. Metallic wires are used sometimes to increase wear properties.

Woven types facing materials are made by impregnating a cloth with certain binders or by weaving threads of copper or brass wires covered with long fiber asbestos and cotton. The woven sheets treated with binding solution are baked and rolled.

TABLE: COEFFICIENTS OF FRICTION FOR CLUTCH FACING MATERIALS

S.No.	Material	Coeffieicent Of Material(μ)
1.	Leather	0.27
2.	Cork	0.37
3.	Cotton fabric	0.4-0.5
4.	Asbestos BaseMaterials	0.35-0.4

Properties Of Good Clutching:

- Good Wearing Properties
- High Resistance to heat
- High coefficient of friction
- Good Binders in it

Operation Of Clutch:

When the clutch pedal is pressed through pedal movement, the clutch release bearing presses on the clutch release lever plate which being connected to clutch release levers, forces these levers forward. This causes the pressure plate to compress pressure springs, thus allowing it to move away from the clutch driven plate. This action releases the pressure on the driven plate and flywheel, the flywheel is now free to turn independently, without turning the transmission.

When the clutch pedal is released, reverse action takes place i.e. the driven plate is again forced against the flywheel by the pressure plate- because of the force exerted by pressure springs. The pressure plate will keep on pressing the facings of driven plate until friction created becomes equal to the resistance of the vehicle. Any further increase in pressure will cause the clutch plate and the transmission shaft to turn along with flywheel, thus achieving vehicle movement.

Single Clutch Plate:

It is the most common type of clutch plate used in motor vehicles. Basically it consists of only one clutch plate, mounted on the splines of the clutch plate. The flywheel is mounted on engine crankshaft and rotates with it. The pressure plate is bolted to the flywheel through clutch springs,and is free to slide on the clutch shaft when the clutch pedal is operated. When the clutch is engaged the clutch plate is gripped between the flywheel and pressure plate. The friction linings are on both the sides of the clutch plate.

Due to the friction between the flywheel, clutch plate and the pressure plate the clutch plate revolves the flywheel. As the clutch plate revolves the clutch shaft also revolves. Clutch shaft is connected to the transmission gear box. Thus the engine power is transmitted to the crankshaft and then to the clutch shaft.

When the clutch pedal is pressed, the pressure plate moves back against the force of the springs, and the clutch plate becomes free between the flywheel and the pressure plate. Thus the flywheel

remains rotating as long as the engine is running and the clutch shaft speed reduces slowly and finally it stops rotating. As soon as the clutch pedal is pressed, the clutch is said to be engaged, otherwise it remains engaged due to the spring forces.

Multi-plate Clutch:
Multi-plate clutch consists of a number of clutch plates instead of only one clutch plate as in case of single plate clutch. As The number of clutch plates are increased, the friction surfaces also increases. The increased number of friction surfaces obliviously increases the capacity of the clutch to transmit torque.

The plates are alternately fitted to engine and gear box shaft. They are firmly pressed by strong coil springs and assembled in a drum. Each of the alternate plate slides on the grooves on the flywheel and the other slides on splines on the pressure plate. Thus, each alternate plate has inner and outer splines.

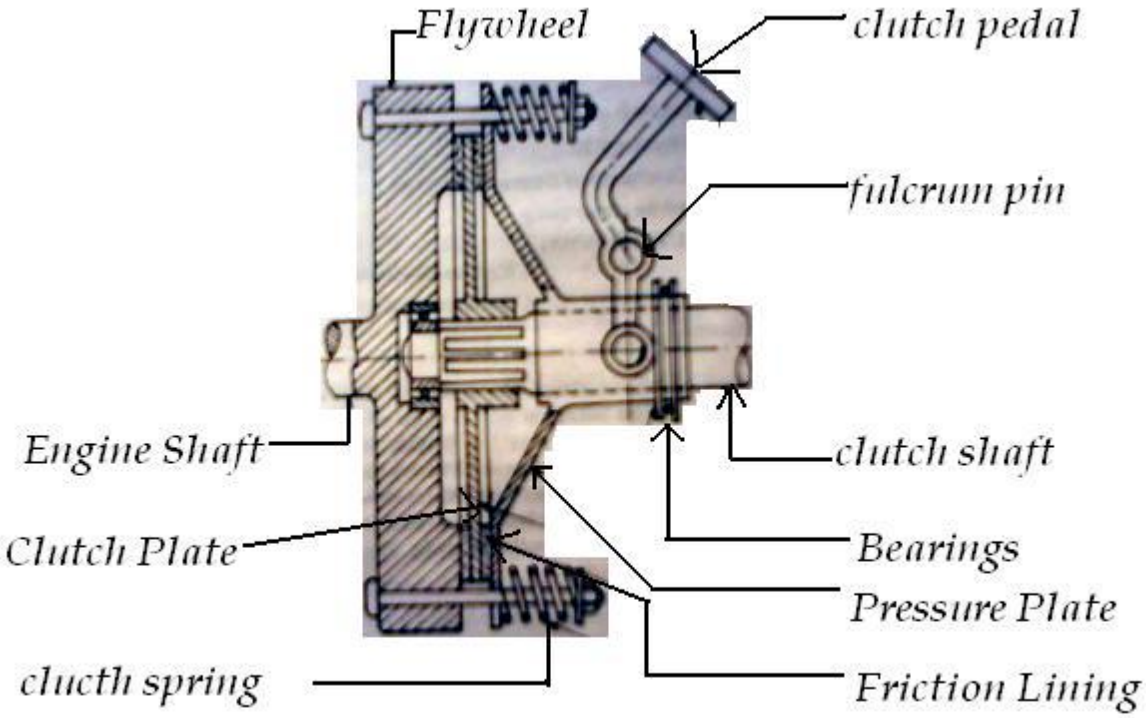


Fig: Single Plate Clutch

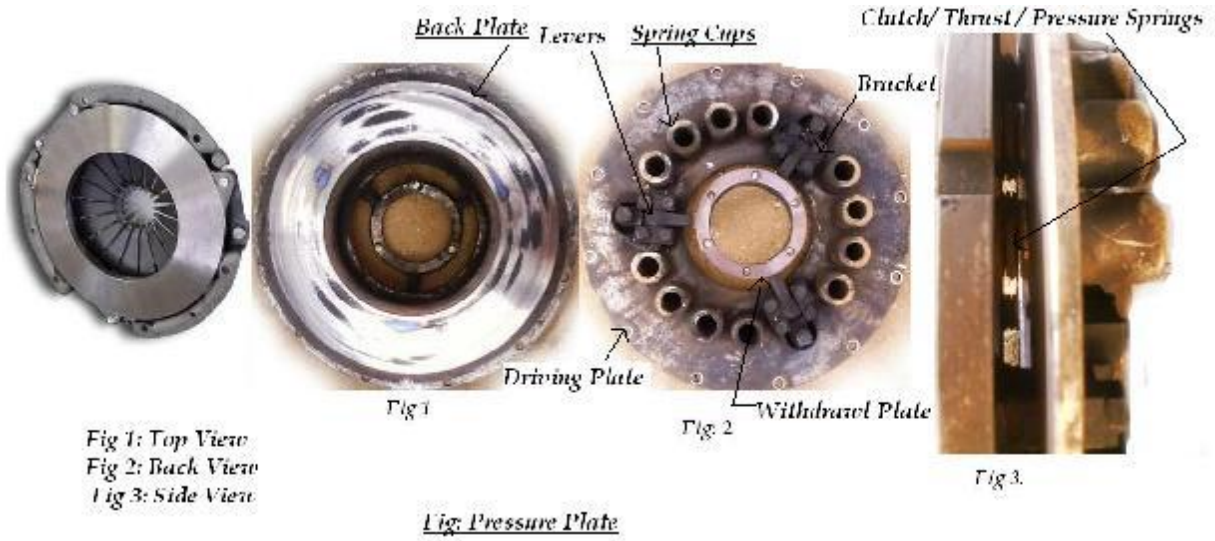


Fig 1: Top View
Fig 2: Back View
Fig 3: Side View

Fig: Pressure Plate

The multi-plate clutch works in the same way as a single plate clutch by operating the clutch pedal. The multi-plate clutches are used in heavy commercial vehicles, racing cars and motor cycles for transmitting high torque. The multi-plate clutch may be dry or wet. When the clutch is operated in an oil bath, it is called a wet clutch. When the clutch is operated dry it is called dry clutch. The wet clutch is used in conjunction with or part of the automatic transmission.

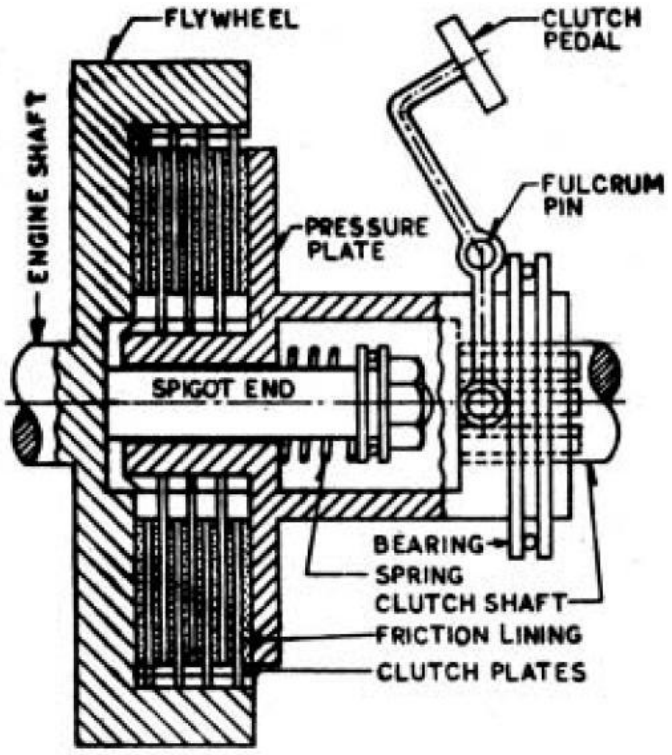


Fig : Multi-Plate Clutch

Fig: Cutway Model Of Multi-Plate Clutch

Fig: Exploded View Of Multi-Plate Clutch

Fig: Multi-Plate Clucth

Cone Clutch:
Cone clutch consists of friction surfaces in the form of cone. The engine shaft consists of female cone. The male cone is mounted on the splined clutch shaft. It has friction surfaces on the conical portion. The male cone can slide on the clutch shaft. Hen the clutch is engaged the friction surfaces of the male cone are in contact with that of the female cone due to force of the spring.

When the clutch pedal is pressed, the male cone slides against the spring force and the clutch is disengaged. The only advantage of the cone clutch is that the normal force acting on the friction surfaces is greater than the axial force, as compare to the single plate clutch in which the normal force acting on the friction surfaces is equal to the axial force. The disadvantage in cone clutch is that if the angle of the cone is made smaller than 200 the male cone tends to bind in the female cone and it becomes difficult to disengage the clutch.

Cone clutches are generally now only used in low peripheral speed applications although they were once common in automobiles and other combustion engine transmissions. They are usually now confined to very specialist transmissions in racing, rallying, or in extreme off-road vehicles, although they are common in power boats. Small cone clutches are used in synchronizer mechanisms in manual transmissions.

Dog & Spline Clutch:
This type of clutch is used to lock two shafts together or to lock a gear to shaft. It consists of a sleeve having two sets of internal splines. It slides on a splined shaft with smallest diameter splines. The bigger diameter splines match with the external dog clutch teeth on driving shaft.

When the sleeve is made to slide on the splined shaft, its teeth match with the dog clutch teeth of the driving shaft. Thus the sleeve turns the splined shaft with the driving shaft. The clutch is said to be engaged. To disengage the clutch, the sleeve is moved back on the splined shaft to have no contact with the driving shaft. This type of clutch has no tendency to slip. The driven shaft

revolves exactly at the same speed of the driving shaft, as soon as the clutch is engaged. This is also known as positive clutch.

Centrifugal Clutch:
The centrifugal clutch uses centrifugal forces, instead of spring force for keeping it in engaged position. Also, it does not require clutch pedal for operating the clutch. The clutch is operated automatically depending on engine speed. The vehicle can be stopped in gear without stalling the engine. Similarly the gear can be started in any gear by pressing the accelerator pedal.

A centrifugal clutch works through centrifugal force. The input of the clutch is connected to the engine crankshaft while the output drives gear box shaft, chain, or belt. As engine R.P.M. increases, weighted arms in the clutch swing outward and force the clutch to engage. The most common types have friction pads or shoes radially mounted that engage the inside of the rim of housing.

On the center shaft there are an assorted amount of extension springs, which connect to a clutch shoe. When the center shaft spins fast enough, the springs extend causing the clutch shoes to engage the friction face. It can be compared to a drum brake in reverse. The weighted arms force these disks together and engage the clutch.

When the engine reaches a certain RPM, the clutch activates, working almost like a continuously variable transmission. As the load increases the R.P.M. drops thereby disengaging the clutch and letting the rpm rise again and reengaging the clutch. If tuned properly, the clutch will tend to keep the engine at or near the torque peak of the engine.

These results in a fair bit of waste heat, but over a broad range of speeds it is much more useful then a direct drive in many applications. Weaker spring/heavier shoes will cause the clutch to engage at a lower R.P.M. while a stronger spring/lighter shoes will cause the clutch to engage at a higher R.P.M.

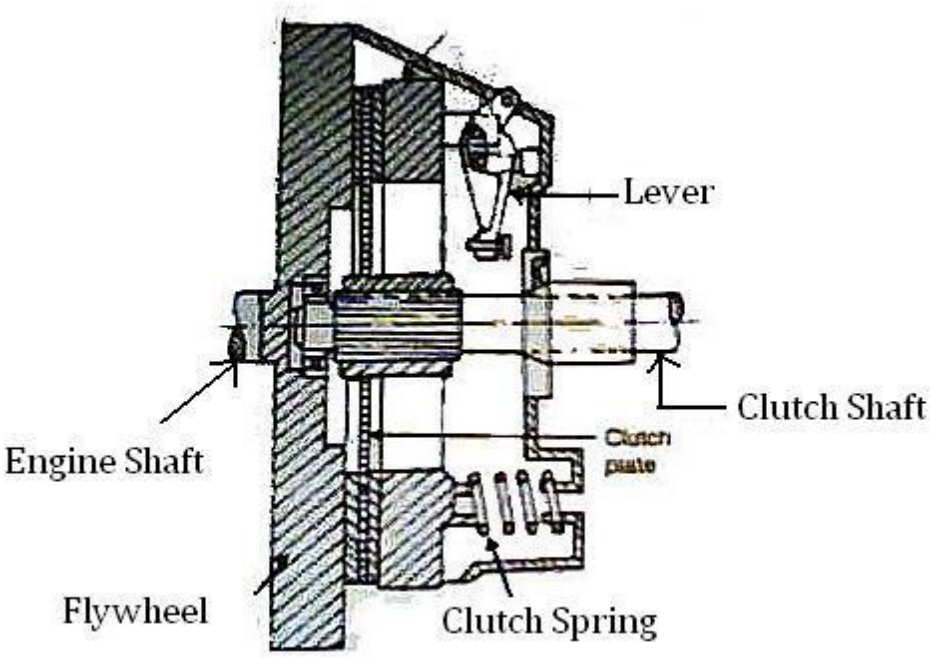


Fig: Semicentrifugal Clutch

Electromagnetic Clutch:

An electromagnetic clutch is a clutch (a mechanism for transmitting rotation) that is engaged and disengaged by an electromagnetic actuator. In this type of clutch, the flywheel consists of winding. The current is supplied to the winding from battery or dynamo.

When the current passes through the winding it produces an electromagnetic field which attracts the pressure plate, thereby engaging the clutch. When supply is cutoff, the clutch is disengaged. The gear lever consists of a clutch release switch. When then the driver holds the gear lever to change the gear the witch is operated cutting off the current to the winding which causes the clutch disengaged. At low speeds when the dynamo output is low, the clutch is not firmly engaged.

Therefore three springs are also provided on the pressure plate which helps the clutch engaged firmly at low speed also. Cycling is achieved by turning the voltage/current to the electromagnet on and off. Slippage normally occurs only during acceleration. When the clutch is fully engaged, there is no relative slip, assuming the clutch is sized properly, and thus torque transfer is 100% efficient.

The electromagnetic clutch is most suitable for remote operation since no linkages are required to control its engagement. It has fast, smooth operation. However, because energy dissipates as heat in the electromagnetic actuator every time the clutch is engaged, there is a risk of overheating. Consequently the maximum operating temperature of the clutch is limited by the temperature rating of the insulation of the electromagnet. This is a major limitation. Another disadvantage is higher initial cost.

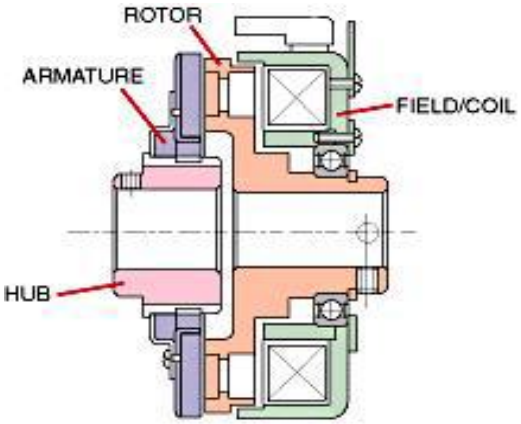


Fig: Electromagnetic Clutch

Braking System;

A brake is a mechanical device which inhibits motion, slowing or stopping a moving object or preventing its motion. The rest of this article is dedicated to various types of vehicular brakes. Most commonly brakes use friction between two surfaces pressed together to convert the kinetic energy of the moving object into heat, though other methods of energy conversion may be employed. For example regenerative braking converts much of the energy to electrical energy, which may be stored for later use. Other methods convert kinetic energy into potential energy in such stored forms as pressurized air or pressurized oil. Eddy current brakes use magnetic fields to convert kinetic energy into electric current in the brake disc, fin, or rail, which is converted into heat.

Still other braking methods even transform kinetic energy into different forms, for example by transferring the energy to a rotating flywheel.

Brakes are generally applied to rotating axles or wheels, but may also take other forms such as the surface of a moving fluid (flaps deployed into water or air). Some vehicles use a combination of braking mechanisms, such as drag racing cars with both wheel brakes and a parachute, or airplanes with both wheel brakes and drag flaps raised into the air during landing.

Since kinetic energy increases quadratically with velocity ( ), an object moving at 10 m/s has 100 times as much energy as one of the same mass moving at 1 m/s, and consequently the theoretical braking distance, when braking at the traction limit, is 100 times as long. In practice, fast vehicles usually have significant air drag, and energy lost to air drag rises quickly with speed. Almost all wheeled vehicles have a brake of some sort. Even baggage carts and shopping carts may have them for use on a moving ramp. Most fixed-wing aircraft are fitted with wheel brakes on the undercarriage. Some aircraft also feature air brakes designed to reduce their speed in flight.

Notable examples include gliders and some World War II-era aircraft, primarily some fighter aircraft and many dive bombers of the era. These allow the aircraft to maintain a safe speed in a

steep descent. The Saab B 17 dive bomber and Vought F4U Corsair fighter used the deployed undercarriage as an air brake. Friction brakes on automobiles store braking heat in the drum brake or disc brake while braking then conduct it to the air gradually. When traveling downhill some vehicles can use their engines to brake.

When the brake pedal of a modern vehicle with hydraulic brakes is pushed, ultimately a piston pushes the brake pad against the brake disc which slows the wheel down. On the brake drum it is similar as the cylinder pushes the brake shoes against the drum which also slows the wheel down. Brakes may be broadly described as using friction, pumping, or electromagnetic. One brake may use several principles: for example, a pump may pass fluid through an orifice to create friction.

Frictional brakes are most common and can be divided broadly into "shoe" or "pad" brakes, using an explicit wear surface, and hydrodynamic brakes, such as parachutes, which use friction in a working fluid and do not explicitly wear. Typically the term "friction brake" is used to mean pad/shoe brakes and excludes hydrodynamic brakes, even though hydrodynamic brakes use friction.

Friction (pad/shoe) brakes are often rotating devices with a stationary pad and a rotating wear surface. Common configurations include shoes that contract to rub on the outside of a rotating drum, such as a band brake; a rotating drum with shoes that expand to rub the inside of a drum,commonly called a "drum brake", although other drum configurations are possible; and pads that pinch a rotating disc, commonly called a "disc brake".

Other brake configurations are used, but less often. For example, PCC trolley brakes include a flat shoe which is clamped to the rail with an electromagnet; the Murphy brake pinches a rotating drum, and the Ausco Lambert disc brake uses a hollow disc (two parallel discs with a structural bridge) with shoes that sit between the disc surfaces and expand laterally. Pumping brakes are often used where a pump is already part of the machinery. For example, an internal-combustion piston motor can have the fuel supply stopped, and then internal pumping losses of the engine create some braking.

Some engines use a valve override called a Jake brake to greatly increase pumping losses. Pumping brakes can dump energy as heat, or can be regenerative brakes that recharge a pressure reservoir called a hydraulic accumulator.

Electromagnetic brakes are likewise often used where an electric motor is already part of the machinery. For example, many hybrid gasoline/electric vehicles use the electric motor as a generator to charge electric batteries and also as a regenerative brake. Some diesel/electric railroad locomotives use the electric motors to generate electricity which is then sent to a resistor bank and dumped as heat.

Types of Braking system in Automobile:

- By applications –

1. Foot Brake,
2. Hand brake.

-□By Method of power –
1. Mechanical brake,
2. Hydraulic brake.
3. Vacuum brake,
4. Electrical brake and
5. Air brake.
-□By method of operations –
1. Manual brake,
2. Servo brake.
3. Power operation.
-□By construction –
1. Drum type brake,
2. Disc type brake.

Anti-lock braking system (ABS)

Anti-lock braking system (ABS) is an automobile safety system that allows the wheels on a motor vehicle to maintain tractive contact with the road surface according to driver inputs while braking, preventing the wheels from locking up (ceasing rotation) and avoiding uncontrolled skidding. It is an automated system that uses the principles of threshold braking and cadence braking which were practiced by skillful drivers with previous generation braking systems. It does this at a much faster rate and with better control than a driver could manage.

ABS generally offers improved vehicle control and decreases stopping distances on dry and slippery surfaces for many drivers; however, on loose surfaces like gravel or snow-covered pavement, ABS can significantly increase braking distance, although still improving vehicle control.

Since initial widespread use in production cars, anti-lock braking systems have evolved considerably. Recent versions not only prevent wheel lock under braking, but also electronically control the front-to-rear brake bias. This function, depending on its specific capabilities and implementation, is known as electronic brake force distribution (EBD), traction control system, emergency brake assist, or electronic stability control (ESC).

Operation

The anti-lock brake controller is also known as the CAB (Controller Anti-lock Brake). Typically ABS includes a central electronic control unit (ECU), four wheel speed sensors, and at least two hydraulic valves within the brake hydraulics. The ECU constantly monitors the rotational speed of each wheel; if it detects a wheel rotating significantly slower than the others, a condition indicative of impending wheel lock, it actuates the valves to reduce hydraulic pressure to the brake at the affected wheel, thus reducing the braking force on that wheel; the wheel then turns faster.

Conversely, if the ECU detects a wheel turning significantly faster than the others, brake hydraulic pressure to the wheel is increased so the braking force is reapplied, slowing down the wheel. This process is repeated continuously and can be detected by the driver via brake pedal pulsation. Some anti-lock systems can apply or release braking pressure 15 times per second.

Because of this, the wheels of cars equipped with ABS are practically impossible to lock even during panic braking in extreme conditions.

The ECU is programmed to disregard differences in wheel rotative speed below a critical threshold, because when the car is turning, the two wheels towards the center of the curve turn slower than the outer two. For this same reason, a differential is used in virtually all roadgoing vehicles. If a fault develops in any part of the ABS, a warning light will usually be illuminated on the vehicle instrument panel, and the ABS will be disabled until the fault is rectified.

Modern ABS applies individual brake pressure to all four wheels through a control system of hub-mounted sensors and a dedicated micro-controller. ABS is offered or comes standard on most road vehicles produced today and is the foundation for electronic stability control systems, which are rapidly increasing in popularity due to the vast reduction in price of vehicle electronics over the years.

Modern electronic stability control systems are an evolution of the ABS concept. Here, a minimum of two additional sensors are added to help the system work: these are a steering wheel angle sensor, and a gyroscopic sensor. The theory of operation is simple: when the gyroscopic sensor detects that the direction taken by the car does not coincide with what the steering wheel sensor reports, the ESC software will brake the necessary individual wheel(s) (up to three with the most sophisticated systems), so that the vehicle goes the way the driver intends. The steering wheel sensor also helps in the operation of Cornering Brake Control (CBC), since this will tell the ABSthat wheels on the inside of the curve should brake more than wheels on the outside, and by how much.

ABS equipment may also be used to implement a traction control system (TCS) on acceleration of the vehicle. If, when accelerating, the tire loses traction, the ABS controller can detect the situation and take suitable action so that traction is regained. More sophisticated versions of this can also control throttle levels and brakes simultaneously.

Components of ABS

There are four main components of ABS:

- Speed sensors,
- Valves,
- Pump, and
- Controller.

Speed sensors

A speed sensor is used to determine the acceleration or deceleration of the wheel. These sensors use a magnet and a coil of wire to generate a signal. The rotation of the wheel or differential induces a magnetic field around the sensor. The fluctuations of this magnetic field generate a voltage in the sensor. Since the voltage induced in the sensor is a result of the rotating wheel, this sensor can become inaccurate at slow speeds. The slower rotation of the wheel can cause inaccurate fluctuations in the magnetic field and thus cause inaccurate readings to the controller.

Valves
There is a valve in the brake line of each brake controlled by the ABS. On some systems, the valve has three positions:
In position one, the valve is open; pressure from the master cylinder is passed right through to the brake.
In position two, the valve blocks the line, isolating that brake from the master cylinder. This prevents the pressure from rising further should the driver push the brake pedal harder. In position three, the valve releases some of the pressure from the brake.
The majority of problems with the valve system occur due to clogged valves. When a valve is clogged it is unable to open, close, or change position. An inoperable valve will prevent the system from modulating the valves and controlling pressure supplied to the brakes.

Pump
The pump in the ABS is used to restore the pressure to the hydraulic brakes after the valves have released it. A signal from the controller will release the valve at the detection of wheel slip. After a valve release the pressure supplied from the user, the pump is used to restore a desired amount of pressure to the braking system. The controller will modulate the pumps status in order to provide the desired amount of pressure and reduce slipping.

Controller
The controller is an ECU type unit in the car which receives information from each individual wheel speed sensor, in turn if a wheel loses traction the signal is sent to the controller, the controller will then limit the brake force (EBD) and activate the ABS modulator which actuates the braking valves on and off.

Use
There are many different variations and control algorithms for use in ABS. One of the simpler systems works as follows.
The controller monitors the speed sensors at all times. It is looking for decelerations in the wheel that are out of the ordinary. Right before wheel locks up, it will experience a rapid deceleration.
If left unchecked, the wheel would stop much more quickly than any car could. It might take a car five seconds to stop from 60 mph (96.6 km/h) under ideal conditions, but a wheel that locks up could stop spinning in less than a second.

The ABS controller knows that such a rapid deceleration is impossible, so it reduces the pressure to that brake until it sees an acceleration, then it increases the pressure until it sees the deceleration again. It can do this very quickly, before the tire can actually significantly change speed. The result is that the tire slows down at the same rate as the car, with the brakes keeping the tires very near the point at which they will start to lock up. This gives the system maximum braking power.
This replaces the need to manually pump the brakes while driving on a slippery or a low traction surface, allowing steering even in the most emergency braking conditions. When the ABS is in operation the driver will feel a pulsing in the brake pedal; this comes from the rapid opening and closing of the valves. This pulsing also tells the driver that the ABS has been triggered. Some ABS systems can cycle up to 16 times per second.

Hydraulic braking system

The disc brake or disk brake is a device for slowing or stopping the rotation of a wheel while it is in motion. A brake disc (or rotor in U.S. English) is usually made of cast iron, but may in some cases be made of composites such as reinforced carbon-carbon or ceramic-matrix composites. This is connected to the wheel and/or the axle. To stop the wheel, friction material in the form of brake pads (mounted on a device called a brake caliper) is forced mechanically, hydraulically, pneumatically or electromagnetically against both sides of the disc. Friction causes the disc and attached wheel to slow or stop. Brakes (both disc and drum) convert motion to heat, but if the brakes get too hot, they will become less effective because they cannot dissipate enough heat. This condition of failure is known as brake fade.

Construction of Braking system;

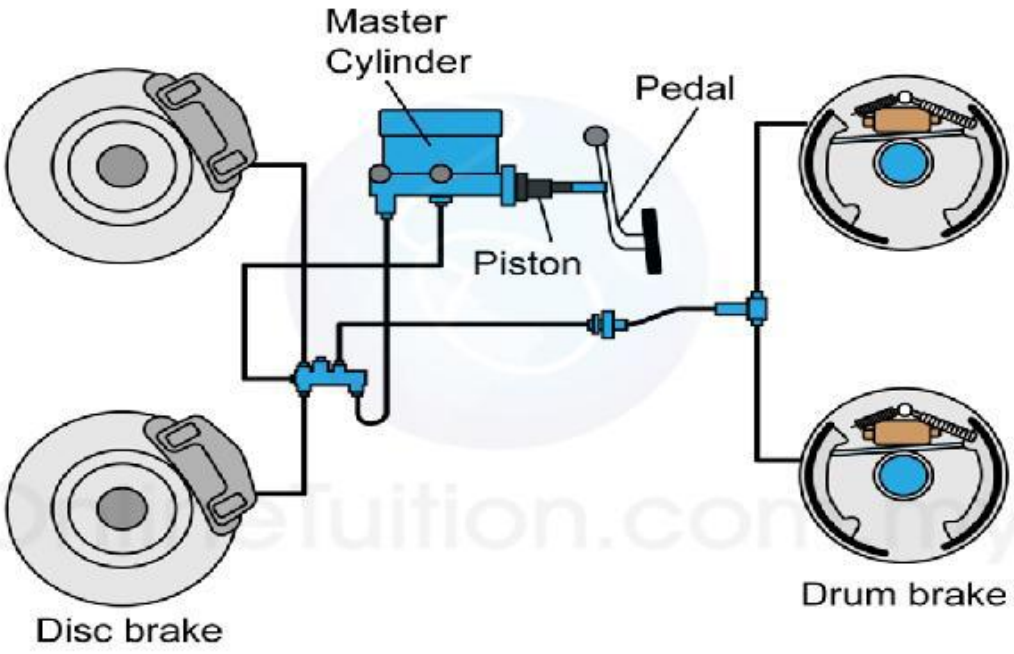
The most common arrangement of hydraulic brakes for passenger vehicles, motorcycles, scooters, and mopeds, consists of the following:

- Brake pedal or lever
- A pushrod (also called an actuating rod)
- A master cylinder assembly containing a piston assembly
- Reinforced hydraulic lines

Brake caliper assembly usually consisting of one or two hollow aluminum or chrome-plated steel pistons (called caliper pistons), a set of thermally conductive brake pads and a rotor (also calleda brake disc) or drum attached to an axle.The system is usually filled with a glycol-ether based brake fluid (other fluids may also be used).

At one time, passenger vehicles commonly employed drum brakes on all four wheels. Later, disc brakes were used for the front and drum brakes for the rear. However disc brakes have shown better heat dissipation and greater resistance to 'fading' and are therefore generally safer than drum brakes. So four-wheel disc brakes have become increasingly popular, replacing drums on all but themost basic vehicles. Many two-wheel vehicle designs, however, continue to employ a drum brake for the rear wheel.

In a hydraulic brake system, when the brake pedal is pressed, a pushrod exerts force on the piston(s) in the master cylinder, causing fluid from the brake fluid reservoir to flow into a pressure chamber through a compensating port. This results in an increase in the pressure of the entire hydraulic system, forcing fluid through the hydraulic lines toward one or more calipers where it acts upon one or two caliper pistons sealed by one or more seated O-rings (which prevent leakage of the fluid).



The brake caliper pistons then apply force to the brake pads, pushing them against the spinning rotor, and the friction between the pads and the rotor causes a brakingtorque to be generated, slowing the vehicle. Heat generated by this friction is either dissipated through vents and channels in the rotor or is conducted through the pads, which are made of specialized heat-tolerant materials such as kevlar orsintered glass.

Subsequent release of the brake pedal/lever allows the spring(s) in my master cylinder assembly to return the master piston(s) back into position. This action first relieves the hydraulic pressure on the caliper, then applies suction to the brake piston in the caliper assembly, moving it back into its housing and allowing the brake pads to release the rotor.

The hydraulic braking system is designed as a closed system: unless there is a leak in the system, none of the brake fluid enters or leaves it, nor does the fluid get consumed through use.

Pneumatic braking system

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.

Air brakes are used in large heavy vehicles, particularly those having multiple trailers which must be linked into the brake system, such as trucks, buses, trailers, and semi-trailers in addition to their use in railroad trains.

George Westinghouse first developed air brakes for use in railway service. He patented a safer air brake on March 5, 1872. Westinghouse made numerous alterations to improve his air pressured brake invention, which led to various forms of the automatic brake. In the early 20th century, after its advantages were proven in railway use, it was adopted by manufacturers of trucks and heavy road vehicles.

Construction of Braking system;

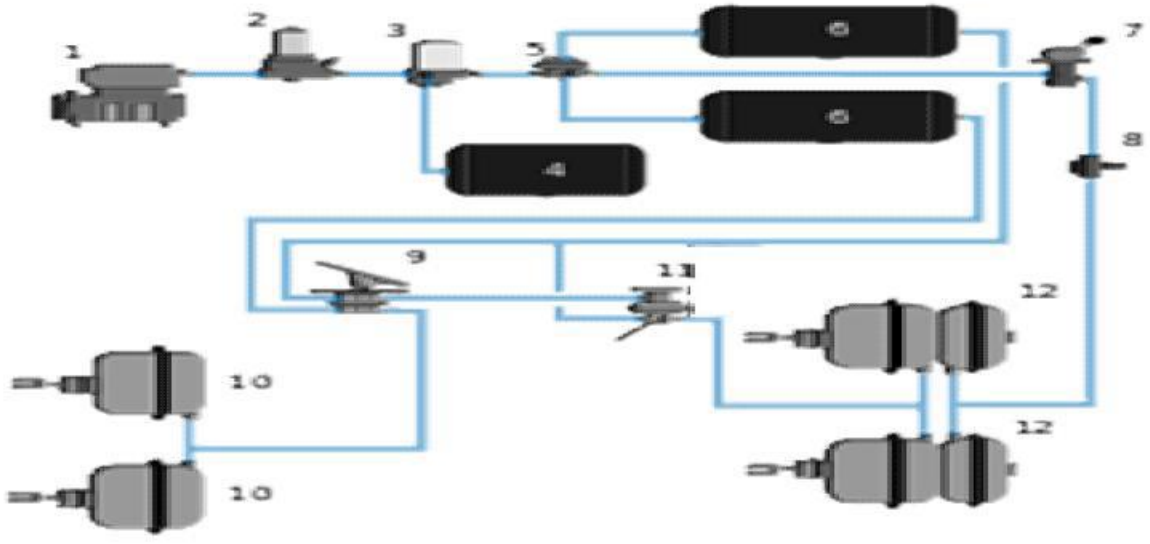
Air brake systems are typically used on heavy trucks and buses. The system consists of service brakes, parking brakes, a control pedal, and an air storage tank. For the parking brake, there is a disc or drum brake arrangement which is designed to be held in the 'applied' position by spring pressure.

Air pressure must be produced to release these "spring brake" parking brakes. For the service brakes (the ones used while driving for slowing or stopping) to be applied, the brake pedal is pushed,routing the air under pressure (approx 100–120 psi or 690–830 kPa) to the brake chamber, causing the brake to be engaged. Most types of truck air brakes are drum brakes, though there is an increasing trend towards the use of disc brakes in this application. The air compressor draws filtered air from the atmosphere and forces it into high-pressure reservoirs at around 120 psi (830 kPa).

Most heavy vehicles have a gauge within the driver's view, indicating the availability of air pressure for safe vehicle operation, often including warning tones or lights. Setting of the parking/emergency brake releases the pressurized air in the lines between the compressed air storage tank and the brakes, thus allowing the spring actuated parking brake to engage. A sudden loss of air pressure would result in full spring brake pressure immediately.

A compressed air brake system is divided into a supply system and a control system. The supply system compresses, stores and supplies high-pressure air to the control system as well as to additional air operated auxiliary truck systems (gearbox shift control, clutch pedal air assistance servo, etc.).

Highly simplified air brake diagram on a commercial road vehicle (does not show all air reservoirs and all applicable air valves). The air compressor is driven by the engine either by crankshaft pulley via a beltor 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. As an alternative to the air dryer, the supply system can be equipped with an

anti-freeze device and oil separator. The compressed air is then stored in a reservoir (also called a wet tank) from which it is then distributed via a four way protection valve into the front and rear brake circuitair reservoir, a parking brake reservoir and an auxiliary air supply distribution point. The system also includes various check, pressure limiting, drain and safety valves.Air brake systems may include a wig wag device which deploys to warn the driver if the system air pressure drops too low.

Control system

The control system is further divided into two service brake circuits: the parking brake circuit and the trailer brake circuit. This dual brake circuit is further split into front and rear wheel circuits which receive compressed air from their individual reservoirs for added safety in case of an air leak. The service brakes are applied by means of a brake pedal air valve which regulates bothcircuits.

The parking brake is the air operated spring brake type where its applied by spring force in the spring brake cylinder and released by compressed air via hand control valve. The trailer brake consists of a direct two line system: the supply line (marked red) and the separate control or service line (marked blue). The supply line receives air from the prime mover park brake air tank via a park brake relay valve and the control line is regulated via the trailer brake relay valve.

The operating signals for the relay are provided by the prime mover brake pedal air valve, trailer service brake hand control (subject to a country's relevant heavy vehicle legislation) and the prime mover park brake hand control.

Advantages of Air Brakes;

Air brakes are used as an alternative to hydraulic brakes which are used on lighter vehicles such as automobiles. Hydraulic brakes use a liquid (hydraulic fluid) to transfer pressure from the brake pedal to the brake shoe to stop the vehicle. Air brakes have several advantages for large multitrailer vehicles:

- The supply of air is unlimited, so the brake system can never run out of its operating fluid, as hydraulic brakes can. Minor leaks do not result in brake failures.
- Air line couplings are easier to attach and detach than hydraulic lines; there is no danger of letting air into hydraulic fluid. So air brake circuits of trailers can be attached and removed easily by operators with little training.
- Air not only serves as a fluid for transmission of force, but also stores potential energy. So it can serve to control the force applied. Air brake systems include an air tank that stores sufficient energy to stop the vehicle if the compressor fails.
- Air brakes are effective even with considerable leakage, so an air brake system can be designed with sufficient "fail-safe" capacity to stop the vehicle safely even when leaking.