# SRI RANGANATHAR INSTITUTE OF POLYTECHNIC COLLEGE,

## ATHIPALAYAM- 641 110

## DEPARTMENT OF AUTOMOBILE ENGINEERING

## 3rd YEAR / 5th SEMESTER

## N – SCHEME

## NOTES OF LESSON

# 4021520 – POWER UNITS AND TRANSMISSION

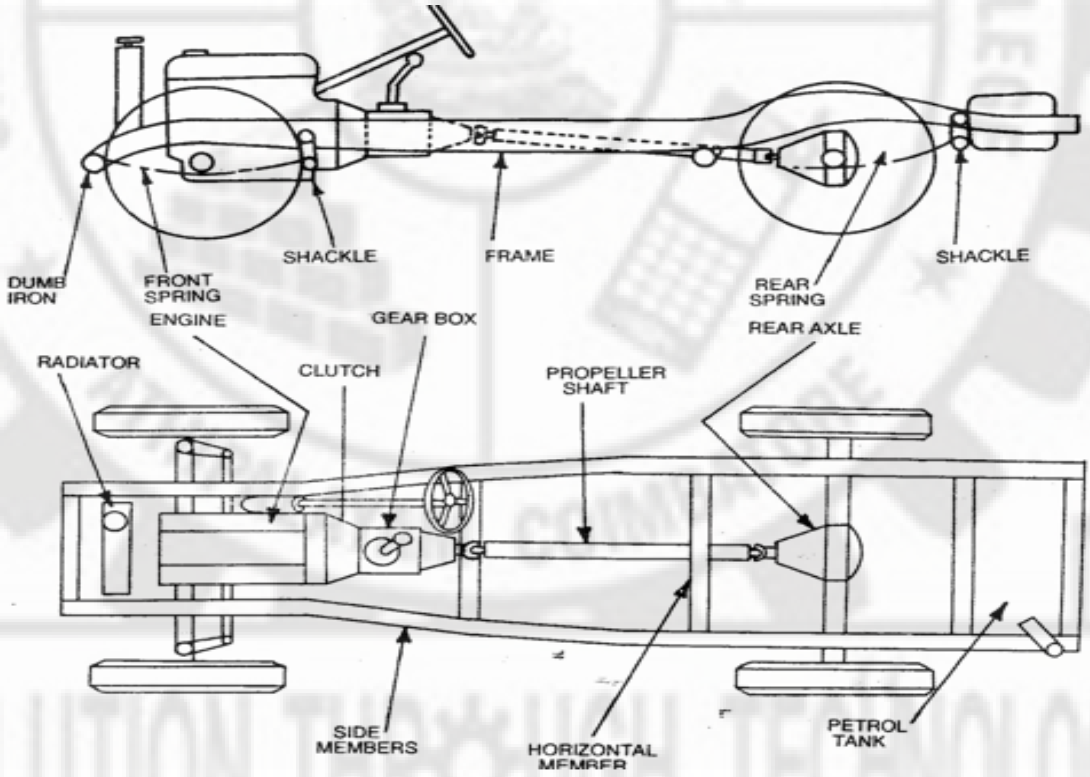
# POWER UNITS AND TRANSMISSION

## UNIT-1

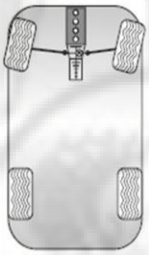
### FRAME AND CHASSIS

Chassis is a French term which is now denotes the whole vehicle except body in case of heavy vehicles. In case of light vehicles of mono construction, it denotes the whole vehicle except additional fittings in the body.

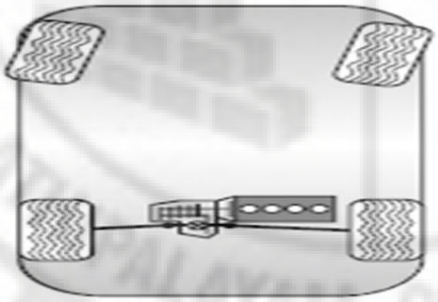
"Chassis consists of engine, power train, brakes, steering system and wheels mounted on a frame".



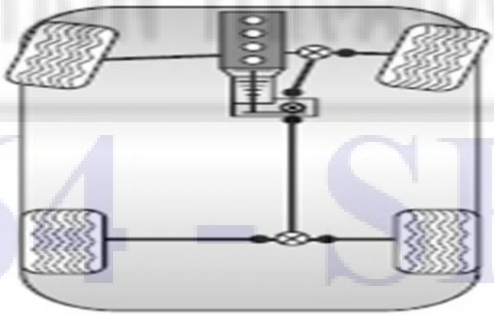
## Front-Engine Front Wheel Drive



## Rear-Engine Rear-Wheel-Drive



## Four Wheel Drive



FRAME

- The frame is the main part of the chassis on which remaining parts of chassis are mounted. The frame should be extremely rigid and strong so that it can withstand shocks, twists, stresses and vibrations to which it is subjected while vehicle is moving on road. It is also called underbody.

The frame is supported on the wheels and tyre assemblies. The frame is narrow in the front for providing short turning radius to front wheels. It widens out at the rear side to provide larger space in the body

# Semi-integral Frame

- In this case the rubber mountings used in conventional frame between frame and suspension are replaced by more stiff mountings. Because of this some of the vehicle load is shared by the frame also. This type of frame is heavier in construction.
- **Example : Popular in European and American car.**

# Integral Frame or Frame-less Construction

- In this type of construction, there is no frame. It is also called unitized frame-body construction. In this case, the body shell and underbody are welded into single unit. The underbody is made of floor plates and channel and box sections welded into single unit. This assembly replaces the frame. This decreases the overall weight compared to conventional separate frame and body construction.

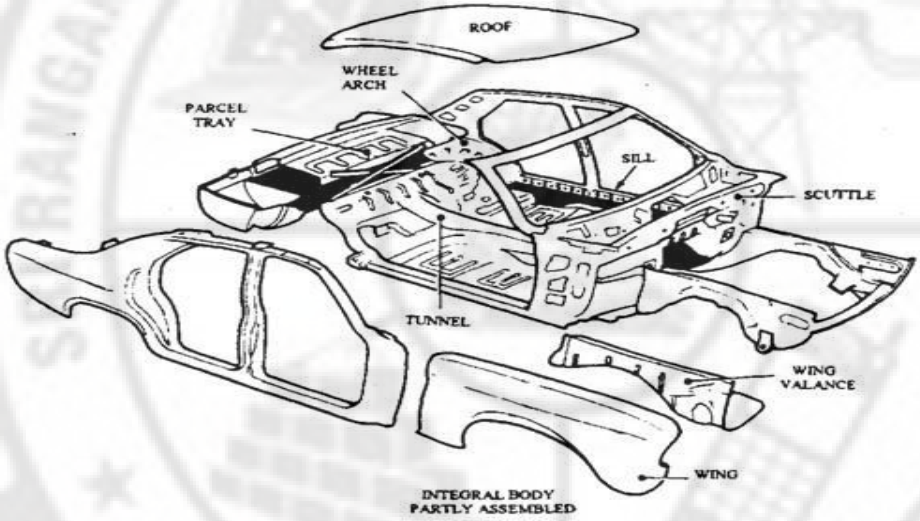
# TYPES OF SECTIONS USED IN FRAMES

- Channel section,
- (b) Tubular section, and
- (c) Box section



- Various loads acting on the frame are
- 1. Short duration Load - While crossing a broken patch.
- 2. Momentary duration Load - While taking a curve.

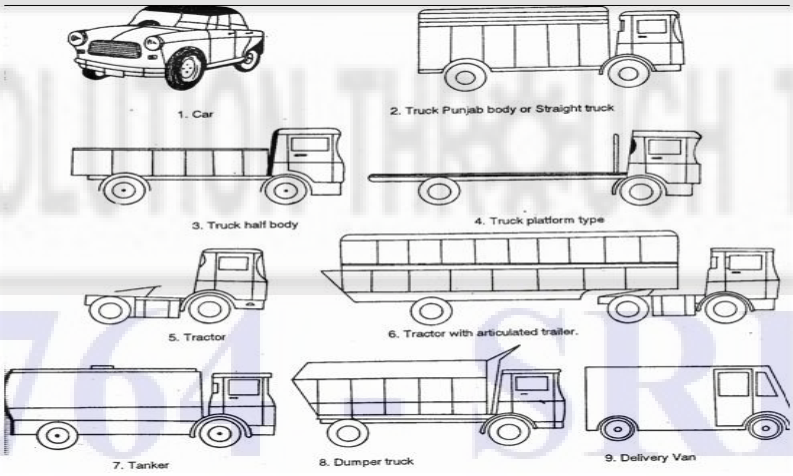
- 3. Impact Loads - Due to the collision of the vehicle.
- 4. Inertia Load - While applying brakes.
- 5. Static Loads - Loads due to chassis parts.
- 6. Over Loads - Beyond Design capacity.

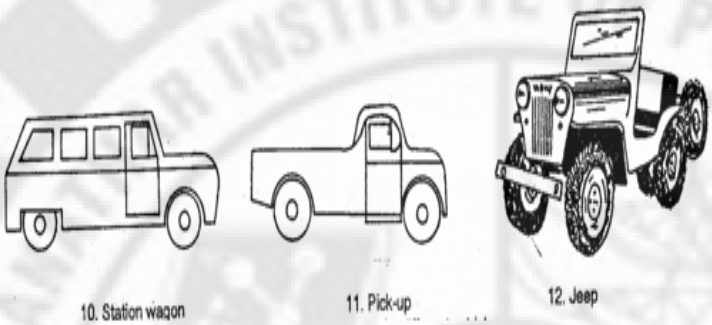



STATE THE DIFFERENT BODIES USED IN AUTOMOBILES

- The Automobile bodies are divided in two groups
- Body

1. Passenger Body 2. Commercial body





10. Station wagon 11. Pick-up 12. Jeep

The Steering System

The steering system consists of the components that allow the driver to turn the front wheels of the vehicle, and for a few vehicles, provides for a limited amount of steering by the rear wheels. The overall function of the steering system has not changed much since the earliest days of the automobile.

Functions of the Steering System. The most basic function of the steering system is to allow the driver to safely and precisely steer the vehicle. Beyond this, the steering system also provides a way to reduce driver effort by making the act of steering the vehicle easier. The components of the steering system also absorb some of the road shock before it gets to the driver. Very little has changed in the operation of the steering system or in some of the components since the earliest automobiles. The things that have changed primarily have to do with increased ease and effectiveness of operation and longer-lasting components that require

less maintenance.

Steering Columns and Shafts. The basic operation and function of the steering column has not changed very much; the column gives the driver the ability to control the direction of the front wheels and provides some leverage to make steering a little easier.

Early steering columns contained the steering shaft, steering wheel, and often had the choke and ignition timing advance controls mounted on them for easy access.

An early model car's steering wheel and column are

Today's columns still perform the same steering functions and still have controls for other systems or components mounted to them for easy access by the driver, as shown in Figure 8-2. New vehicles sold in the United States are also required to have a collapsible steering column to help prevent driver injury in the event of a front-end collision.

Steering shafts transmit the motion of the steering wheel from the column to the steering gear. There is usually at least one coupler or joint between the column and gearbox to allow for changes in angles and to reduce binding when turning the wheel. Figure 8-3 shows how a steering shaft links the steering column and steering gearbox.

Manual Steering Systems. Cars and trucks built

before the 1950s had manual steering systems, meaning that the effort needed to turn the steering wheel and the front wheels was supplied by the driver. Steering wheels were larger in diameter and steering gearbox ratios tended to be higher to help reduce driver effort, but turning the wheels still required a lot of muscle power, and drivers could become quickly fatigued when conditions required them to turn the wheels often.

Hydraulically Assisted Power Steering

Systems. Chrysler offered the first power steering equipped vehicle in 1951, and the other manufacturers soon offered power steering as an option. Today, it would be difficult to find a new car or truck that does not have power steering as standard equipment.

Hydraulic power-assisted steering uses a belt-driven hydraulic pump, called the power steering pump, to supply pressurized fluid to the steering gear. The pressurized fluid then applies force to a piston inside the steering gear. With the addition of the force applied by the fluid, the effort required by the driver to turn the wheels is reduced.

The power steering pump, which is belt-driven from the engine crankshaft, consumes a small amount of engine power to operate, which results in a slight loss in engine power and economy, but most agree that the benefits

are well worth it.

Electrically Assisted Power Steering Systems.

A recent change in power steering is the replacement of the belt-driven hydraulic pump by electric motor assist. There are currently three types of electric assist available: electrically powered hydraulic steering, column drive electric steering, and the electric motor-assisted rack and pinion steering gear.

Each of these systems offers the ability to provide variable amounts of assist based on driving conditions and driver preference. The completely electric types do not use any type of fluid, and so they are more environmentally friendly since no fluid loss can occur.

Basic Principles

Power steering systems use several basic principles to decrease driver effort. These include leverage, hydraulics, and in some systems, electricity.

Mechanical Advantage of the Steering System.

Leverage, or mechanical advantage, is used at the steering wheel and in the gearbox to increase the force supplied by the driver. The gears inside the gearbox act as levers, increasing mechanical advantage and reducing driver effort to turn the wheels.

Leverage is quite visible in the steering system. Think of the steering wheel as a lever, as in Figure 8-4. The

force that you apply to the wheel while turning is applied over the radius of the steering wheel, which allows the steering wheel to act as a lever and to increase the force applied to the steering shaft.

The steering shaft in turn uses the force exerted on it by the steering wheel to act as the input for the steering gearbox. The gearbox uses two gears to further increase the mechanical advantage and decrease driver effort.

The gearbox also converts the rotary motion of the steering wheel and shaft into a linear or back-and-forth motion that moves the wheels. Figure 8-5 shows how a gearbox uses leverage and changes rotary motion into linear motion. Why is the use of leverage important in the steering system? Try this experiment: Ask your instructor to provide you with a lab vehicle. Turn the engine off but leave the steering column unlocked and the vehicle sitting normally on the shop floor. Next, try to push the front wheels side-to-side by yourself. How easy was this to do? Most likely, you were not able to move the wheels much, and the little bit they did move required a lot of effort. Moving the wheels takes effort which is why leverage is important to the steering system.

Manual Recirculating Ball Steering Gearbox

Operation. As discussed before, manual steering systems were standard and power steering was an added expense. While that is no longer true, the basic principles of manual steering are also the basic principles of most power steering systems, and they are important to understand.

Manual steering systems use either a recirculating ball gearbox design or a manual rack and pinion design. The rack and pinion system is discussed later in this chapter.

A recirculating ball gearbox, as shown in Figure 8-6,

has three major components: the worm gear, the sector gear, and the ball nut. The steering shaft connects to the worm gear, usually with a splined and indexed clamp. The worm gear is like a large bolt, with very large and smooth threads. The sector gear forms the top of the sector shaft. The sector shaft is the output shaft and is connected to the steering linkage, which is connected to the tires. The ball nut threads over the worm gear and moves up and down the wormshaft just like a nut on a bolt. The outside of the ball nut has deep teeth cut into it to mesh with the sector gear. As the ball nut moves back and forth on the wormshaft, the rotary motion of the wormshaft is converted to a much smaller linear movement of the sector gear. The ball nut has passages cut into it to allow the ball bearings to travel through the nut and over the threads of the worm gear. The use of the ball bearings greatly reduces the friction between the worm gear and the ball nut, which makes the steering easier for the driver.

Steering Ratio. On the average vehicle, the steering wheel will turn about two and a half to three times completely around, from the right steering lock to the left steering lock, but the front wheels do not turn nearly as much as the steering wheel. This is because the steering gearbox is using gear reduction to gain mechanical advantage. When the gearbox transfers the several turns

of the worm gear into the smaller movement of the sector gear, driver effort is reduced. The number of complete turns of the steering wheel compared to the total amount of wheel and tire movement is called the steering ratio. An illustration is shown in Figure 8-7. The steering ratio, is found by dividing the total number of degrees the steering wheel turns by the total number of degrees of front wheel movement. The ratio determines how much advantage the gearbox will provide and how the steering will feel to the driver.
For example, you may have noticed that very large vehicles, such as school buses and semi trucks, have large-diameter steering wheels and require many turns of the steering wheel to go around a corner. This is because

the steering gearbox has a very high numerical ratio. A high ratio provides easier steering but requires more turns of the steering wheel. A high ratio tends to have less feel or feedback to the driver and is not as responsive to driver input.

Sports cars usually have very responsive steering that also provides a lot of feedback to the driver. This is due to the gearbox having a lower gear ratio. The trade-off is that steering effort is increased as the gearbox ratio decreases.

Power Steering. As stated before, power steering systems reduce driver effort, and can be either hydraulic or electric. Electric power steering systems are discussed later in this chapter.

Traditional hydraulic power steering systems use a belt-driven power steering pump, power steering fluid, lines and hoses, and a power steering gearbox, shown in Figure 8-8.

Power steering pumps are usually either a meshedgear design or a vane type. In both, the power steering fluid enters the pump and is pressurized before being

requirements, and the correct power steering fluid must be used for the system to function properly.

There are usually two power steering lines from the pump to the gearbox; the high-pressure supply and lowpressure return lines. Most vehicles use a combination of steel lines and rubber hoses to allow for movement of the engine during operation.

The gearbox can be either the recirculating ball or rack and pinion type. With either type, when the engine is running, power steering fluid is pressurized by the power steering pump and directed to the gearbox by the high-pressure supply hose. In the gearbox, the fluid is directed against a piston. The pressurized fluid pushes on the piston, which decreases the amount of effort needed by the driver. The fluid leaves the gearbox via a port and the power steering return or low-pressure hose return line, and returns to the power steering fluid reservoir. Figure 8-9 shows a simplified power steering gearbox.

Rack and Pinion Operation. The traditional recirculating

ball gearbox, which is a heavy piece of cast iron and steel, has been replaced in most vehicles with a rack and pinion gearbox. Even though both types of gearboxes perform the same functions, they do so differently.

A rack and pinion assembly has two main components, the rack gear and the pinion gear, enclosed in an aluminum housing. Figure 8-10 shows a basic manual rack and pinion gearbox. In a rack and pinion, the steering shaft is connected to the top of the pinion gear, which is held in the rack by a set of pinion bearings. The bottom of the pinion shaft has the pinion gear, which is meshed with the rack gear. The rack gear is a gear that has been flattened out with the teeth in a straight line. When the pinion gear turns, it moves the rack gear side-to-side. Just as in the recirculating ball gearbox, the rotary motion from the steering wheel is turned into a linear motion to move the wheels.

Benefits of the rack and pinion gearbox include the reduced weight of the component and the elimination of several pieces of steering linkage. The rack gear attaches to inner tie rods, which in turn connect to outer tie rods. The rack and pinion assembly eliminates the Pitman arm, idler arm, and center link found on parallelogram linkage systems.

## Wheels, Tires, and Wheel Bearings as Part of the Steering System

Since the suspension and steering systems rely on the tires as the only contact point with the ground, it is important to remember that the wheels, tires, and wheel bearings also affect steering performance.

### How Wheels, Tires, and Bearings Affect Steering

Like many systems on the vehicle, the steering system does not work by itself. The steering and suspension

### Steering Columns

The steering column in modern vehicles does more than allow the driver to steer the front wheels. Today's columns contain an airbag and controls for many other components, such as the cruise control, radio, exterior

lighting, and windshield wipers. Most columns provide a tilt function; some have the ability to telescope, and some vehicles have memory columns that move into a preset position based on driver preference.

Basic Operat ion and Construction

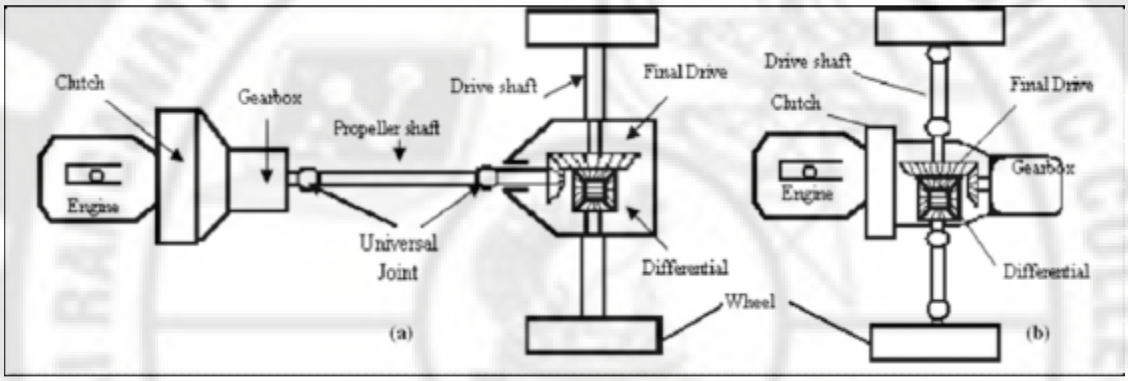
Modern steering columns are made of plastics and metals with a steel steering shaft. The column is bolted to the dash panel on a reinforcement brace that supports the dash. A coupler or joint is usually located where the column passes through the firewall. This joint allows the steering shaft to change angle to reach the steering gearbox.

Plastic covers, as shown in Figure 8-11, cover the switches and other electrical components that are attached to the column. These covers are usually held together by several screws, which are removed to gain access to the column and any attached components.

The steering wheel is secured to the top of the steering shaft with a nut or bolt. The steering wheel and steering shaft are usually aligned by a locating notch or splined groove that can only be installed in one location. This prevents the steering wheel from being installed incorrectly. A few vehicles, mostly older model 4WD trucks, do not have an alignment notch for the steering wheel. This is to center the steering wheel after a wheel alignment is performed.

# UNIT-2

CLUTCH SYSTEM




What is a clutch?

A clutch engages and disengages the transmission system from the engine when a vehicle is being driven away from standstill or when a gear change is required. It lies between the

engine and transmission as shown in pictures above.

The clutch enables to disconnect the engine from the remaining parts of the transmission system at the will of the driver by operation of a foot pedal, thus permitting the engine to run without driving the vehicle. Normally this is designed to handle 125% ~ 150% of the maximum

engine torque to handle the experienced load.

• Why do we need a clutch?

The gradual increase in the transfer of engine torque to the transmission must be smooth. That's why you need a clutch. Once the vehicle is in motion, separation and take-up of the

drive for gear selection must be carried out rapidly without any fierceness, snatch or shock. The clutch cuts off power from the engine when changing gears. When the gear has been

selected, the clutch smoothly connects the engine back to the rest of the transmission to drive the vehicle.

• Functions of a Clutch

The clutch has four functions as below: -

It can be disengaged (clutch pedal down) which allows the engine cranking and permits the engine to run freely without delivering power to the transmission.

While disengaged (clutch pedal down), it permits the driver to shift the transmission into various gears (first, second, third, fourth, fifth, reverse or

neutral) for the operating conditions.
While engaging (clutch pedal up), the clutch slips momentarily. This provides smooth engagement and lessens the shock on the gears, shafts and other drive train components. As the engine develops enough torque to overcome the inertia of the vehicle, the drive wheels turn and the vehicle begins to move.
When engaged (clutch pedal up), the clutch transmits power from engine to the transmission. All slipping has now stopped.
• Key Design Considerations: -
Co-efficient of friction of clutch friction surface should be very high to minimise slippage.
Temperature bearing capacity of clutch friction surface should be high.
Inertia of clutch output member (clutch disc) should be as low as possible. Required to prevent spinning of clutch disc post-disengagement or else this will cause hard gear shifting or crashing of gear teeth.

Centrifugal force of clutch increases at 4-times of engine speed. Hence the clutch should be designed for twice the maximum engine speed or else the clutch parts can fly off (Clutch burst).
• Types of clutches
Clutches can be classified as “Dry” or “Wet”.
The wet clutch is immersed in a cooling, lubricating fluid which keeps the surfaces clean and gives smoother performance and longer life. These clutches however tend to lose some energy to the immersed fluid.
The dry clutch as the name implies, is not immersed in fluid and runs dry.

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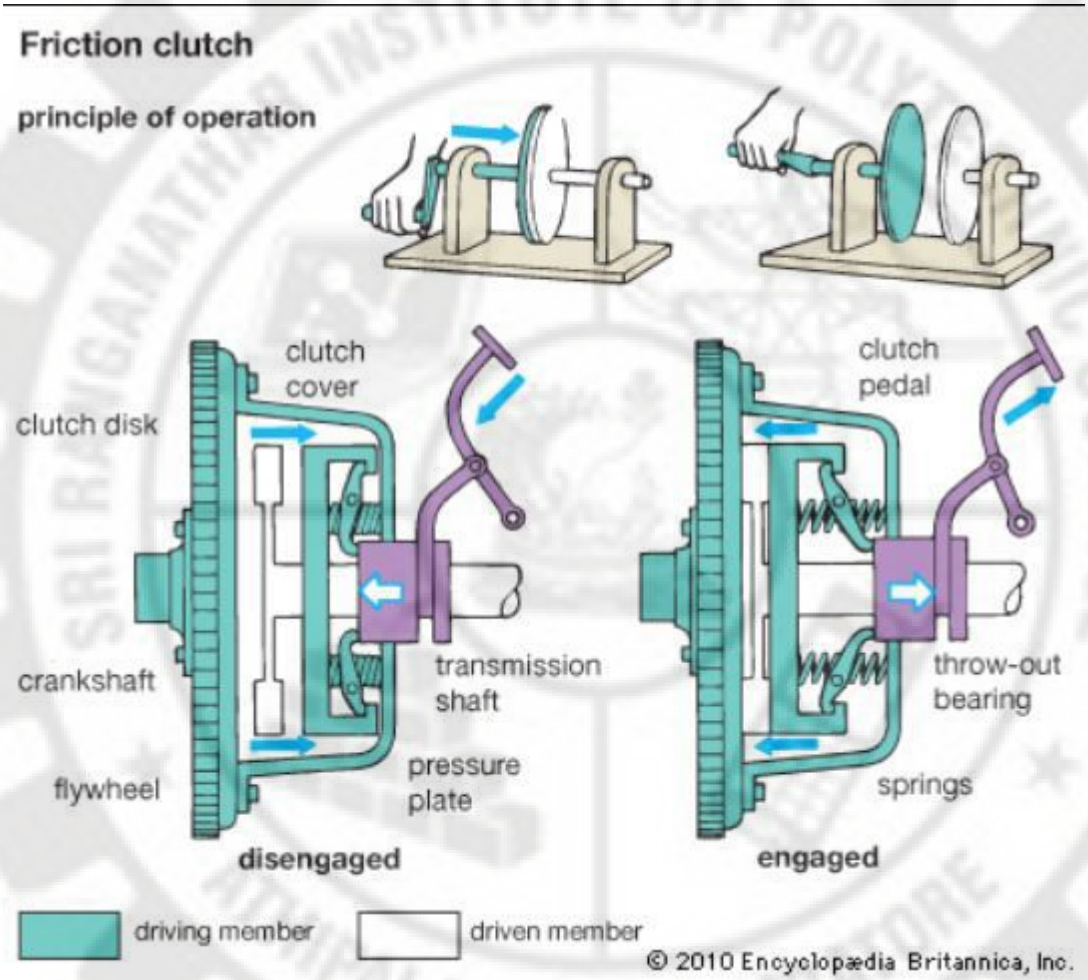
**Types of Clutches**

1. **Friction Clutches:**
   a. Single plate clutch
   b. Multi plate clutch----i)Wet ii)Dry
   c. Cone clutch---i)External ii) Internal
2. **Centrifugal Clutch**
3. **Semi-centrifugal clutch**
4. **Conical spring clutch or diaphragm clutch**
   a. Tapered finger type
   b. Crown spring type
5. **Positive Clutch**—Dog and spline clutch
6. **Hydraulic clutch**
7. **Electro magnetic clutch**
8. **Vaccum clutch**
9. **Over running clutch or free wheel clutch**




The engine shaft consists of a female cone, the male cone can slide on the clutch shaft. When the clutch is engaged the friction surfaces of the male cone is in contact with that of the

female cone due to the force of spring. When the clutch pedal is pressed, the male cone slides against the spring force and the clutch is disengaged.

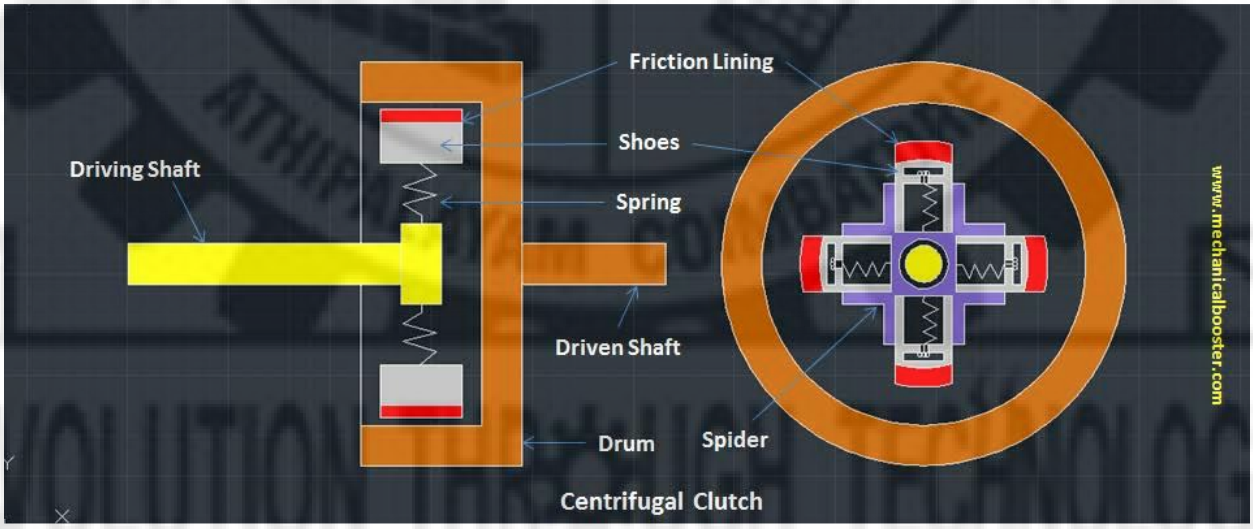
"Uniform wear" principle is used in cone clutches. The only advantage of the cone clutch is that the normal force acting on the friction surfaces is greater that the axial force, as

compared to the single plate clutch in which the normal force acting on the friction surfaces is equal to the axial force.

A contact lever is used to disengage the clutch. The inner cone surface is lined with friction material. Due to wedging action between the conical working surfaces, there is considerable normal pressure and friction force with a small engaging force.

The semi cone angle a is kept greater than a certain value to avoid self-engagement; otherwise disengagement of clutch would be difficult. This is kept around 12.5

Centrifugal Clutch is type of clutch in which centrifugal force is used to connect engine drive shaft with the shaft of transmission. It is placed in between the engine flywheel and transmission system. Its main function is to connect the engine shaft with the transmission shaft. It works more efficiently at higher speeds.
Main parts of a Centrifugal clutch are: -
Shoes: The shoes are of sliding types which slides in the guide ways. It consists of friction lining at the end and this friction lining makes contact with the drum during engagement.
Spring: Spring is used to disengage the clutch when the engine rotates at lower speed Spider or guides: The spiders are mounted on the driver (engine) shaft or motor shaft.
The spiders are equally spaced. Equally spaced means, if they are four guides than each guide is separated from each other by 90 degree. The sliding shoes are kept in between these guides and each guide is holding a spring.




This type of clutch uses lighter pressure plate springs for a given torque carrying capacity, so that the engagement of the clutch in the lower speed range becomes possible. The centrifugal force supplements the necessary extra clamping thrust at higher speeds. Offset bob weights are attached to the release levers at their outer ends, allowing levers to be centrifugally out of balance. The centrifugal force causes the pressure plate to force against the driven plate, adding extra clamping load.

Clutch engagement:

• Clutch springs exerts pressure on pressure plate at low engine speeds.

• At high speeds, the centrifugal force developed by rotation of levers exerts pressure on pressure plate.

• Pressure plate applies pressure on clutch plate.

• Clutch plate firmly rotates in between fly wheel and pressure plate.

• Clutch shaft rotates along with clutch plate.

Disadvantages of Semi centrifugal clutch:

• Springs are designed to transmit the torque at lower engine speeds.

Centrifugal force assists in torque transmission at higher engine speeds.

Advantages of Semi-Centrifugal Clutch:

• Less stiff clutch springs are used as they operate only at low speeds.

• Driver will not get strained in operating the clutch.

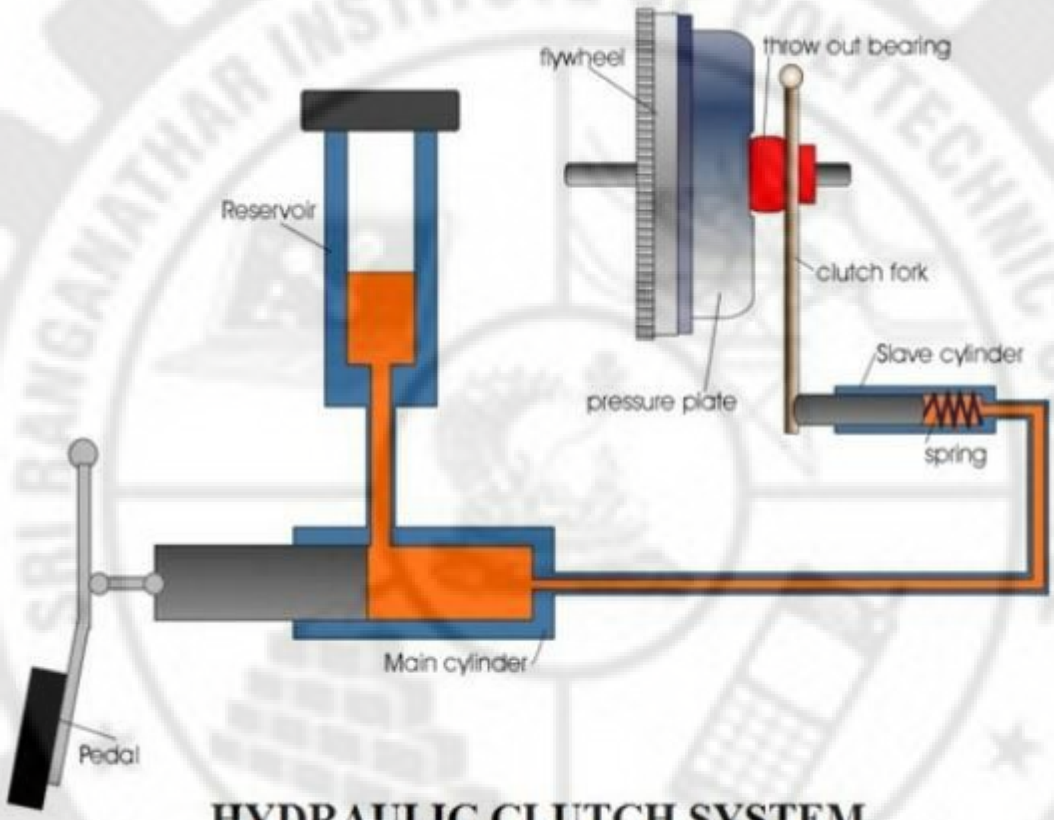
• Principle of Operation of Diaphragm Clutch or Conical Spring Clutch:

A diaphragm clutch is similar to a multi-spring clutch except that uses a single conical dished diaphragm type spring to apply the clamping thrust to the pressure plate.

Principle of Operation of Hydraulic Clutch:

A hydraulic clutch system works using various hydraulic components to actuate the clutch when the pedal is pushed in. The system works similar to how the brakes work on the vehicle. The clutch hydraulics consists of the clutch pedal, connecting push rod, clutch master cylinder, hydraulic metal or plastic piping, and the clutch slave cylinder.

The clutch pedal is a solid lever hooked to a pivot point above the driver's feet area. The pedal lever connects to a rod using a clevis pin. The rod connects directly to the clutch master cylinder. When the pedal is pushed in, it will push the rod out toward the master cylinder. The rod will push in the master cylinder, causing it to push out hydraulic fluid into the fluid line connected directly to it. When the fluid leaves the master cylinder into the piping, it will flow into the clutch slave cylinder. The fluid will cause the slave cylinder to push in the clutch pedal or the clutch pressure plate depending on design.

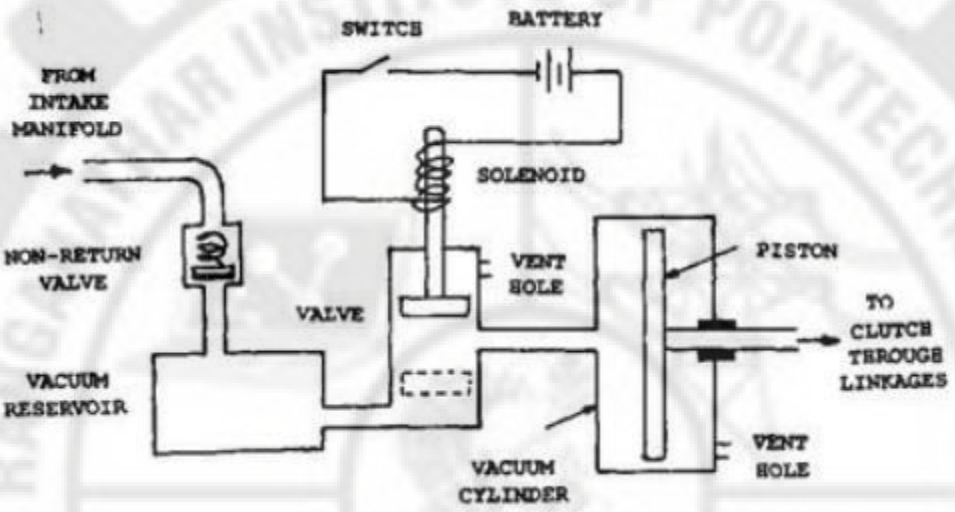



**HYDRAULIC CLUTCH SYSTEM**

Principle of Operation of Vacuum Clutch:

In this type of clutch, engine intake manifold vacuum is used for disengaging the clutch. It uses a vacuum reservoir connected to the intake manifold through a non-return valve. It has a vacuum cylinder and piston; the rod side of the piston is opened to the atmosphere. The solenoid valve is operated from the battery and the circuit incorporates a switch which is placed in the gear lever so that when the gear lever is operated to change the gear, the switch is also closed.

When the throttle is wide open, the pressure in the inlet manifold increases due to which the non-return valve closes thereby isolating the reservoir from the manifold. Thus, a vacuum
exists in the reservoir all the time.




GEAR BOX (TRANSMISSION)

•Purpose of a Gear Box:

To start a motor vehicle from rest, the inertia of the vehicle must be overcome. A high percentage of all the power of the engine must do this. If the automobile engine could develop full power in turning the crank shaft slowly like a steam engine, then it would have been possible to transmit the full power to the driving wheels even in starting. However, the automobile engine does not develop full power when it is running slowly. It has to be working fairly fast before it develops anything like maximum power, maximum torque etc. Even the maximum power and torque do not occur at same engine speed.

Since much power is needed in starting and moving the vehicle from rest, climbing a hill, pulling a load etc. whatever the vehicle speed may be, a means must be provided to permit the engine crank shaft to revolve at relatively high speed (which means output of desired power) while the driving wheel turn at lower speeds. This is accomplished by a set of gears called a "Transmission or Gear Box".

Table below summarizes the operating conditions vis-à-vis engine requirement: -

| Operating conditions | Engine requirement |
|---|---|
| Maximum traction | Maximum engine torque |
| Maximum vehicle speed | Maximum engine power |
| Maximum acceleration | Maximum engine torque |
| Maximum fuel economy | Engine at mid-speed range, under light load with a small throttle opening |

There are three reasons for having a transmission or transaxle (Transmission + Axle) in the automotive power train or drive train. The transmission or transaxle can: -

Provide the torque needed to move the vehicle under a variety of road and load conditions. It does this by changing the gear ratio between the engine crank shaft and the drive wheels of the vehicle i.e. a gear box acts as a torque multiplier.

Provide a "Reversing mechanism" to enable the vehicle to move back ward without changing engine crank shaft rotation whenever required.

Provide a "Neutral gear shifting mode" for starting the engine and running it without turning the drive wheels.

Types of Automobile Gear Boxes:

There are two basic types of gear boxes or transmissions viz. "Manual Transmission" and "Automatic Transmission". In manual transmission, the gears are shifted by hand or manually. In automatic transmission, the gears are shifted automatically with no help from the driver.

A further elaborate classification lists four types of automobile transmissions as below: -

Manual Transmission

Fully Automatic Transmissions

Semi-automatic Transmission

Continuously Variable Transmission (CVT)

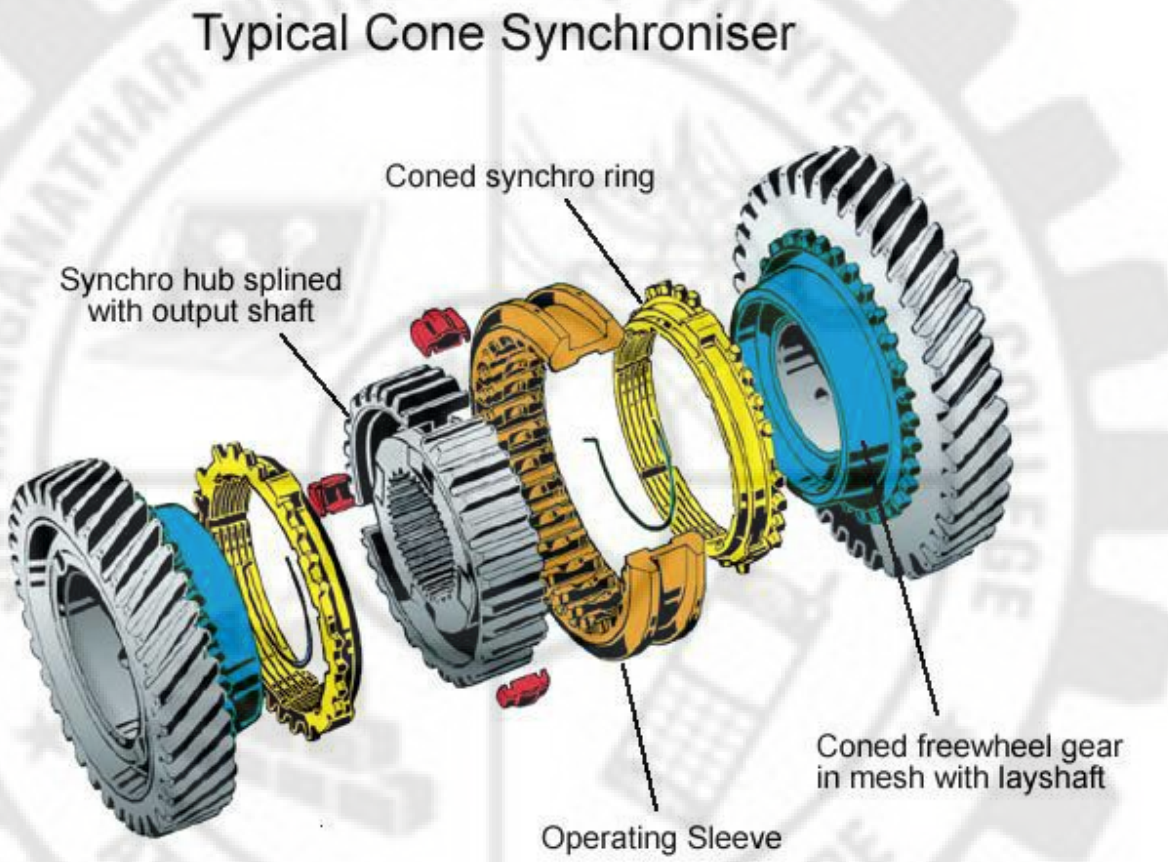
• Brief Explanation of Various Types of Transmissions (Details indicated later): -

Manual Transmission

This gearbox uses a friction clutch modulated by the driver's foot to connect the engine's rotational energy to the transmission's input shaft. From there, a fixed set of gears are engaged using a synchro and gear-selector fork connected to the shifter operated by the driver's right hand (or left, in certain countries).

Fully Automatic Transmission

In an automatic transmission, the hydraulically operated control systems are managed electronically by the vehicle's computer instead of the clutch and gear stick. All the driver has to do is shift the selector from Park (P) or Neutral (N), into Drive (D), and the gear shifting will take place automatically and smoothly, without any additional input from the driver under normal driving conditions.




Various parts of Synchroniser mechanism are given below: -

Speed Gear: This is provided with external conical surface and dog teeth on its face. These gears are in constant mesh with respective gear on lay shaft. Both are provided with helical gear teeth for strength and quiet operation.

Synchroniser Hub: This is provided with internal splines in mesh with external splines on main shaft. This has external gear teeth or splines. The synchroniser hub carries 3- keys on its outer periphery free to slide on their respective key grooves.

Synchroniser Ring: This has internal conical surface which when pushed comes in contact with the external conical surface of the speed gear. The synchroniser ring also has external dog teeth or splines in the periphery.

Synchroniser Sleeve: This fits over the synchroniser hub. The sleeve has internal or teeth or splines that mesh with external teeth or splines of the synchroniser hub. This also has 3-detents which fits on the keys on the synchroniser hub.

Pair of Ring Shaped Synchroniser springs: These springs are fitted on synchroniser hub to apply slight outward force against the keys.

Shifter fork: This fits on the groove over the synchroniser sleeve.

Working of Synchroniser mechanism is explained below: -

Step-I: Synchroniser sleeve is moved towards the gear to be engaged by the gear shifter fork. This causes the synchroniser sleeve to slide on the external splines of the synchroniser hub and also carrying the 3-keys along with it (the pair of springs and the detent in the ring ensures this).

Step-II: The 3-keys carried by the synchroniser sleeve butts against the synchroniser ring which pushes it towards the speed gear. By this action, the internal cone of the synchroniser ring comes in contact with the external conical surface on the face of the speed gear. This generates friction between the two mating conical surfaces thereby the speeds of synchroniser ring and speed gear are brought equal.

Step-III: When speeds of the synchroniser ring and the speed gear are almost equal, the external dog teeth on the face of the speed gear and external dog teeth on the periphery of the synchroniser ring also rotate at nearly equal speed. At this stage, further push on the synchroniser sleeve causes the internal teeth of the sleeve to slide over both the external peripheral teeth of the synchroniser ring and the external facial teeth of the speed gear. This action locks the entire mechanism onto the main shaft and transmits power to the main shaft.

BRAKE

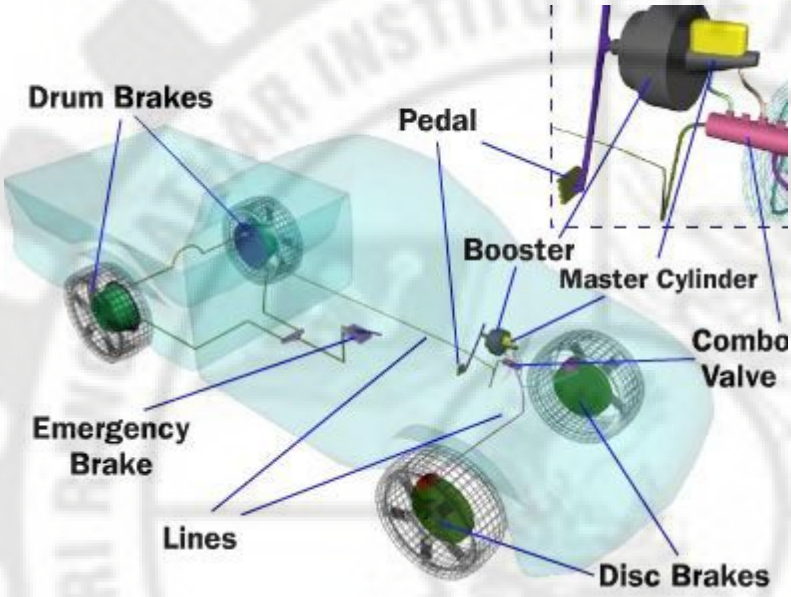
A brake is a mechanical device which inhibits motion.

WORKING OF BRAKES

•A COMMON MISCONCEPTION ABOUT BRAKES IS THAT BRAKES SQUEEZE AGAINST A DRUM OR DISC, AND THE PRESSURE OF THE SQUEEZING ACTION SLOWS THE VEHICLE DOWN. THIS IS IN FACT A PART OF THE REASON FOR SLOWING DOWN A VEHICLE.

•ACTUALLY BRAKES USE FRICTION OF BRAKE SHOES AND DRUMS TO CONVERT KINETIC ENERGY DEVELOPED BY THE VEHICLE INTO HEAT ENERGY.

•WHEN WE APPLY BRAKES, THE PADS OR SHOES THAT PRESS AGAINST THE BRAKE DRUMS OR ROTOR CONVERT KINETIC ENERGY INTO THERMAL ENERGY VIA FRICTION.




HYDRAULIC BRAKES

- Hydraulics is the use of a liquid under pressure to transfer force or motion, or to increase an applied force.

- The pressure on a liquid is called HYRAULIC PRESSURE.

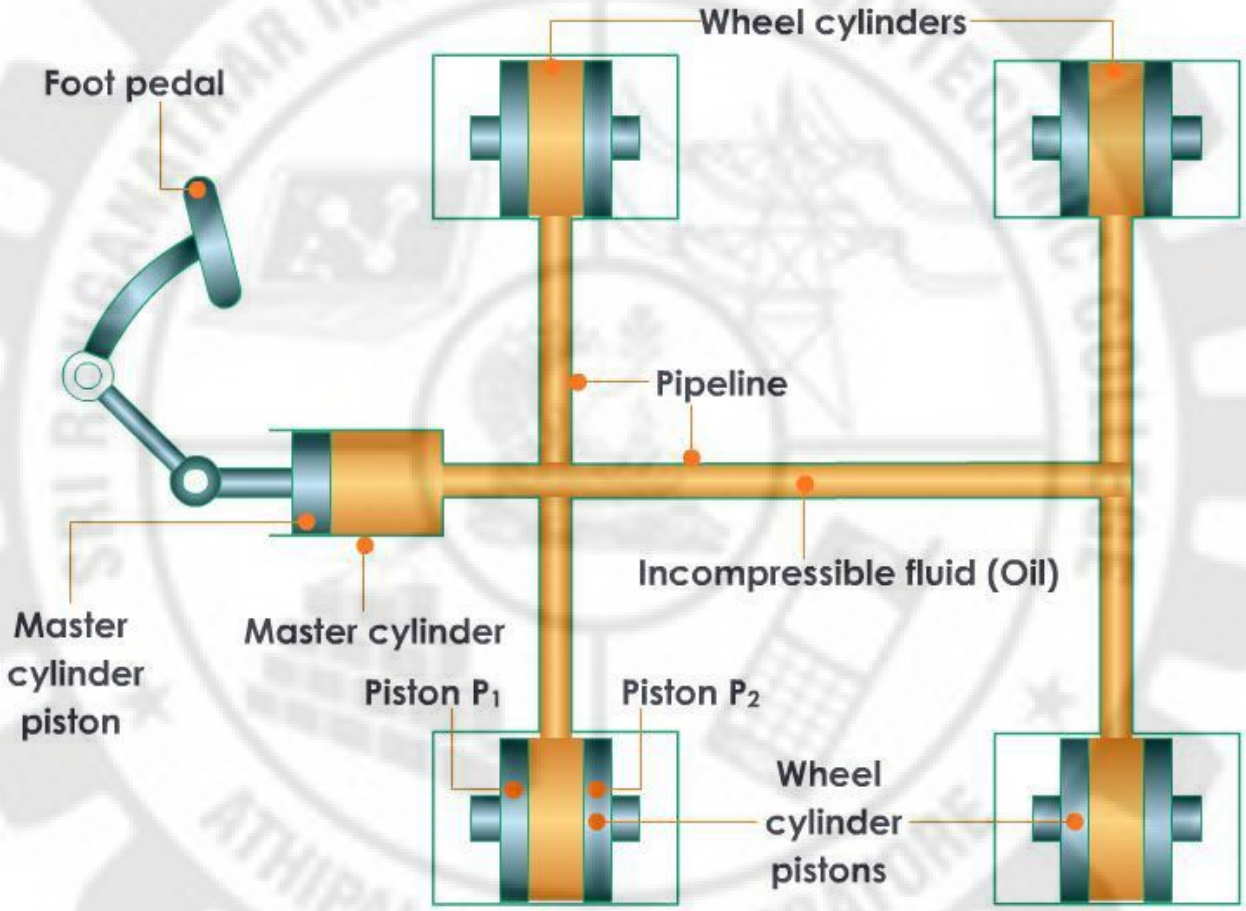
- And the brakes which are operated by means of hydraulic pressure are called HYDRAULIC BRAKES.

- These brakes are based on the principle of Pascal's law.

PASCAL'S LAW

- The pressure exerted anywhere in a mass of confined liquid is transmitted undiminished in all directions throughout the liquid.

- Applied in hydraulic lifts, hydraulic brakes etc.




MASTER CYLINDER IN ACTION

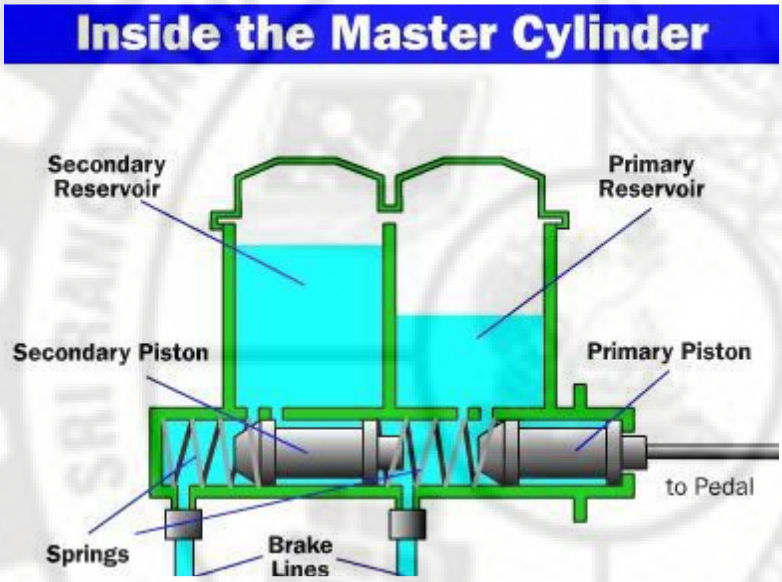
- When we press the brake pedal, it pushes on primary piston through a linkage.

- Pressure is built in the cylinder and the lines as the brake pedal is depressed further.

- The pressure between the primary and secondary piston forces the secondary piston to compress the fluid in its circuit.

- If the brakes are operating properly, the pressure wll be same in both the circuits.

If there is a leak in one of the circuits, that circuit will not be able to maintain pressure.




ADVANTAGES OF HYDRAULIC BRAKES

Equal braking effort to all the four wheels

Less rate of wear (due to absence of joints compared to mechanical brakes)

Force multiplication (or divisions) very easily just by changing the size of one piston and cylinder relative to other.

DISADVANTAGES OF HYDRAULIC BRAKES

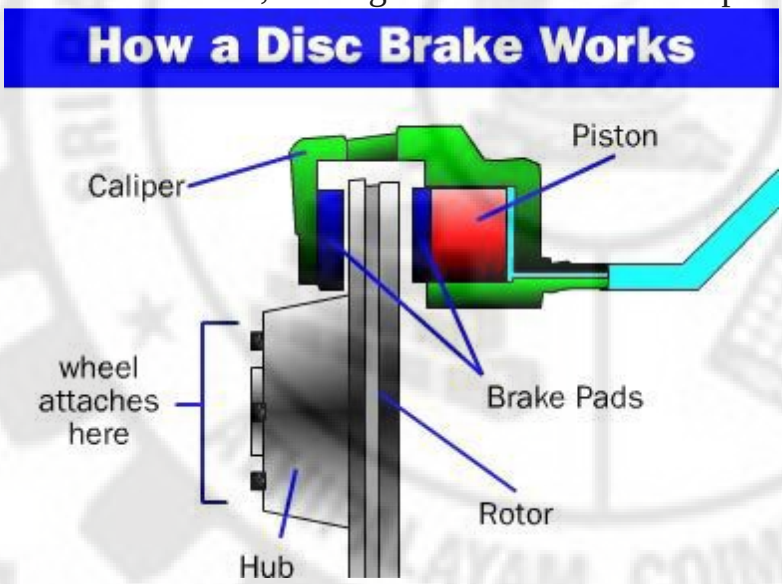
Even slight leakage of air into the breaking system makes it useless.

The brake shoes are liable to get ruined if the brake fluid leaks out.

DISC BRAKES

In a disc brake, the fluid from the master cylinder is forced into a caliper where it presses against a piston.

The piston in turn squeezes two brake pads against the disc (rotor), which is attached to wheel, forcing it to slow down or stop.




DISC BRAKE AND BRAKE OF A BICYCLE

Similar to a bicycle brake where two rubber pads run against the wheel rim creating friction.

But in a disc brake, the brake pads squeeze the rotor instead of the wheel, and the force is transmitted hydraulically instead of through a cable.

DRUM BRAKES

The drum brake has a metal brake drum that encloses the brake assembly at each wheel.

Two curved brake shoes expand outward to slow or stop the drum which rotates with the wheel.

WORKING OF DRUM BRAKES

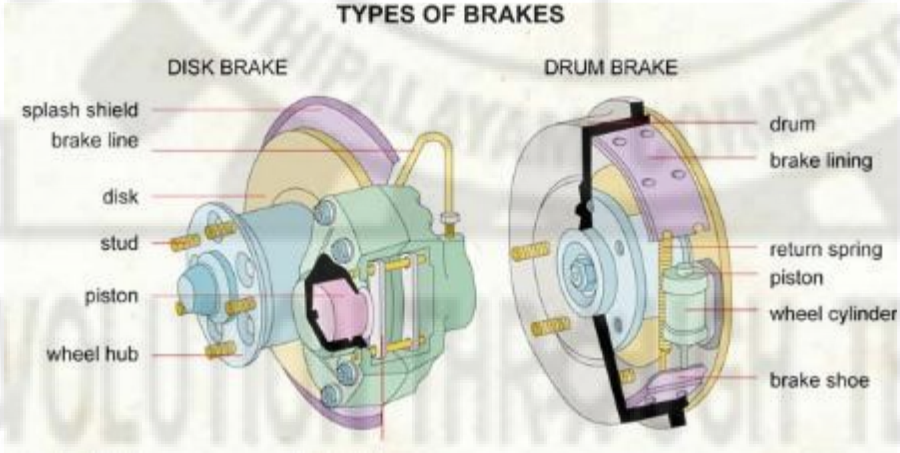
Drum brakes work on the same principle as the disc brakes.

Shoes press against a rotating surface.

In this system that surface is called a drum.

Drum brake also has an adjuster mechanism, an emergency brake mechanism and lots of springs.

The shoes are pulled away from the drum by the springs when the brakes are released.




TYPES OF BRAKE FLUIDS

FLUIDS

GLYCOL BASED (ABSORB WATER) DOT 3 DOT 4

SILICON BASED (DOESN'T ABSORB WATER) DOT 5

PRECAUTIONS

# UNIT-3

## UNIVERSAL JOINT, PROPELLER SHAFT, DIFFERENTIAL

Universal joint is used to make a flexible connection between two rigid shaft.
The purpose of universal joint is to transmit power (torque) even at varied angles without any losses.
Power is transmitted from the gear box to the differential through the propeller shaft.
The gear box is connected to one end of the propeller shaft by means of the universal joint.
The differential is connected to the other end of the propeller shaft by means of another universal joint.
Suppose a car is running on an uneven road. At this time the springs of its rear axle flex.
The differential rises and falls due to which the propeller shaft also changes its angle.
At the same time the propeller shaft rotates.
The universal joint allows the change of angle of the propeller shaft.
Universal joint absorbs some vibrations and gives smooth rotation.
When the differential rises or falls, the distance between the gear box and the differential changes. Correspondingly, the effective length of the propeller shaft also changes.

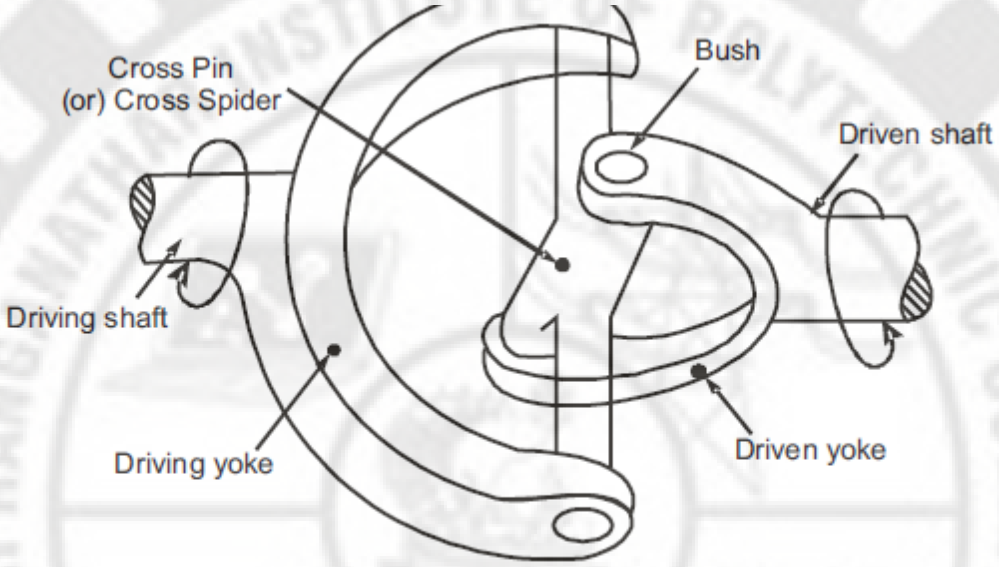



**Fig. 3.1 Cross (or) spider type universal joint**

of Universal Joint

This is permitted by the slip joint external splines on the propeller shaft matches with the internal splines on the universal joint yoke. This allows the propeller shaft to lengthen or shorten according to road condition.

a. Cross (or) spider type (or) Hook's joint
b. Flexible ring type
c. Ball and Trunnion type
d. Pot type

a. Tracta b. Bendiz weiss type center joint
c. Rzeppa joint d. Gerrington joint

It mainly consists of a cross piece or C-type with two yokes as driving and driven members.

These two yokes are connected by means of a crossed spider or cross pin.

The driving member is connected to transmission unit and the driven member is connected to differential through propeller shaft.

When the driving shaft rotates, the driven shaft also rotates.

At the same time the universal joint permits angular motion.

This propeller shaft can rotate at any angle. Thus power is transmitted from the gear box to the propeller shaft at any particular angle.

There are four needle bearings fitted at four ends of spider working on the yokes.

3.3 Types of Universal Joint

(I) Cross (or) Spider Type Universal Joint

(1) Variable Velocity Joint

(2) Constant Velocity Joint

(1) Variable Velocity Joint

The bushes (or) needle bearings in the yokes permit the yokes to swing around the cross member (spider) or trunnion for each revolution.

These are mostly used in luxury vehicles. For the propeller shaft tilt of nearly 200 (small angles) the power is transmitted without any loss or vibration.

Grease is applied on both sides of the spider.

In variable velocity universal joint (cross type) the speed of the driven shaft does not remain constant with respect to the inclination of the shaft.

The variation is small for very small inclinations.

But this variation is to be considered when the inclination is large.

In this case there will be transmission vibration throughout the system.

To overcome fluctuation in speeds when transmitting high torque, constant velocity joints are used.

The constant velocity joint is normally used at the front wheel drive (eg., Maruti 800, Zen, Uno) and rear wheel drive with independent springs suspensions as in military trucks.

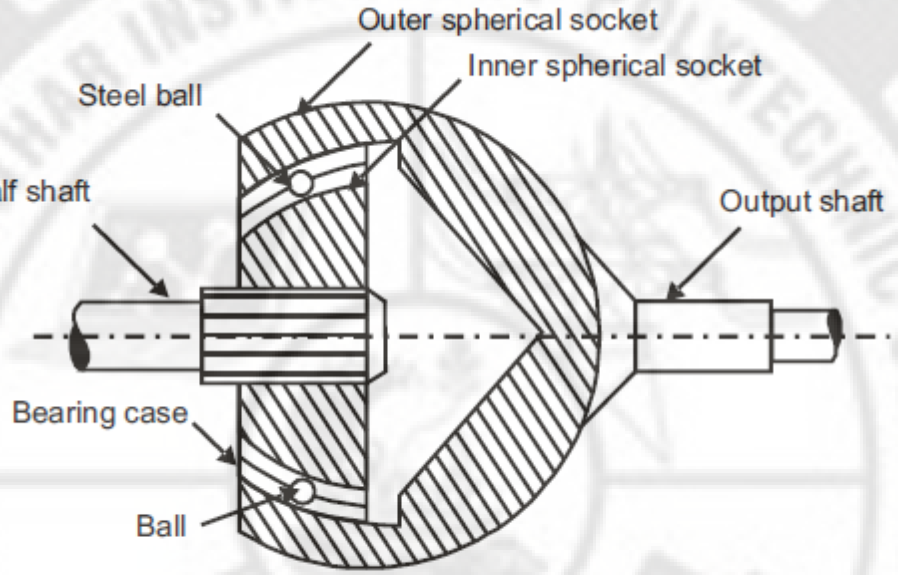



**Fig. 3.2 Constant velocity joint**

(2) Constant Velocity Universal Joint

Transaxle wheel is connected with half shaft through constant velocity joint.

When the vehicle moves up and down the half shaft tilts (300 to 400) and transmits power without any loss.

It is mostly used in front engine front wheel drive vehicles.

This joint has the input of a half shaft.

The shaft is splined at one end on which the inner spherical socket sits.

The inner spherical socket and the outer spherical socket have grooves in which balls move.

The outer spherical socket is connected to the output shaft.

This arrangement provides equal speeds to input shaft and output shaft, irrespective of the angle between them.

In order to prevent vibration and wear on the bearings, constant velocity universal joint is used.

In this type uniform motion is obtained.

It consists of spherical inner and outer ball races having grooves cut parallel to the shafts.

Steel balls are placed in the grooves on the spherical recess as shown in figure.

The torque transmission is done from one race to another by the balls.

The circular pattern of balls causes both shafts to turn at the same velocity.
Bendix weiss joint is shown in figure.
In this type of joint five steel balls are placed in the receives with the help of ball cage made in the yokes.
Out of these 5 balls 4 are placed at four ends whereas one is held in the centre.
The contact between the two havels of the coupling remains in a plane which bisects the angle between the two shafts and the speed is constant at any angle.

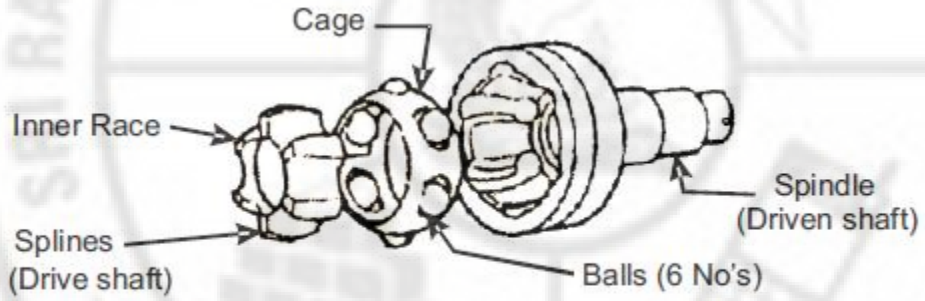



**Fig. 3.3 Rzeppa constant velocity joint**

Four yokes are used in this joint in which two are fastened to the shafts and other two are floating at the centre of the joint.
The mating parts of the yokes are made into segments of a circle.
Both the circular segments and the floating action of the two yokes give in a constant velocity joint.
This joint differs from the above two joints.
This type of joints are widely used in military purpose vehicles.
As the frictional contact is more, the rate of wear is more.

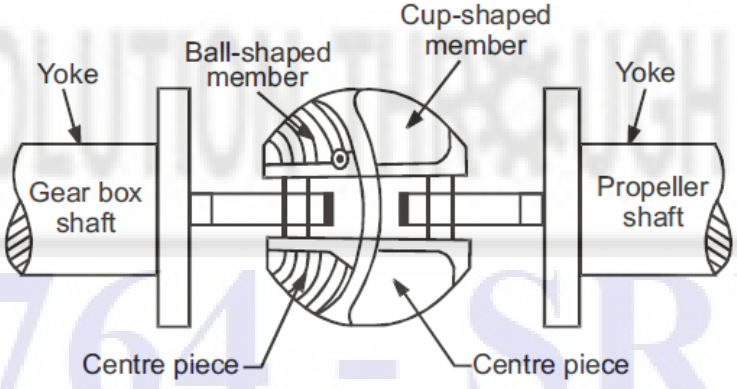



**Fig. 3.4 Bendix weiss joint**

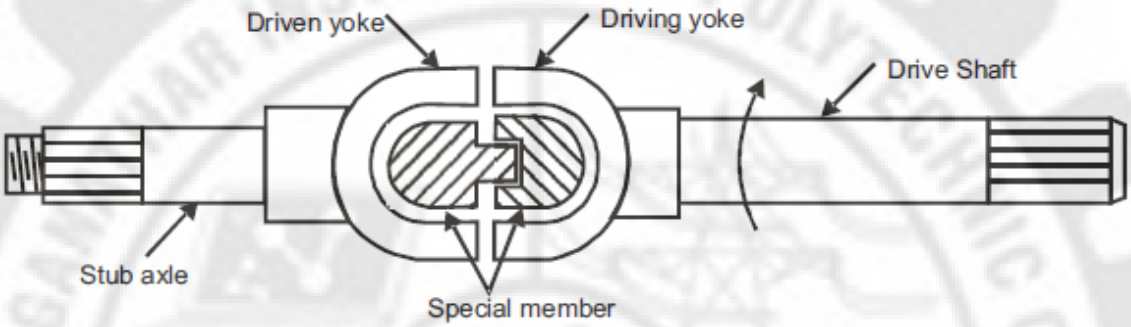



**Fig.Tracta Joint**

Propeller shaft is an important shaft in the transmission system. It is also called drive shaft. It is connected between the gearbox and the differential with universal joint at each end. The rotary motion of the transmission main shaft is carried out through the propeller shaft to the differential, thus causing the rear wheel to rotate.
By this means the power from transmission is transmitted to the driven axle at varied lengths varied angles. In heavy vehicles two or three piece propeller shafts are used. It consists of three parts namely shaft, universal joint and slip joint.
It has to withstand mainly torsional loads.
Therefore, it is usually made of tubular cross section.
At high speeds, whirling should be avoided.
For this reason, this shaft has to be well balanced.
So it is made of strong steel tube.

PROPELL

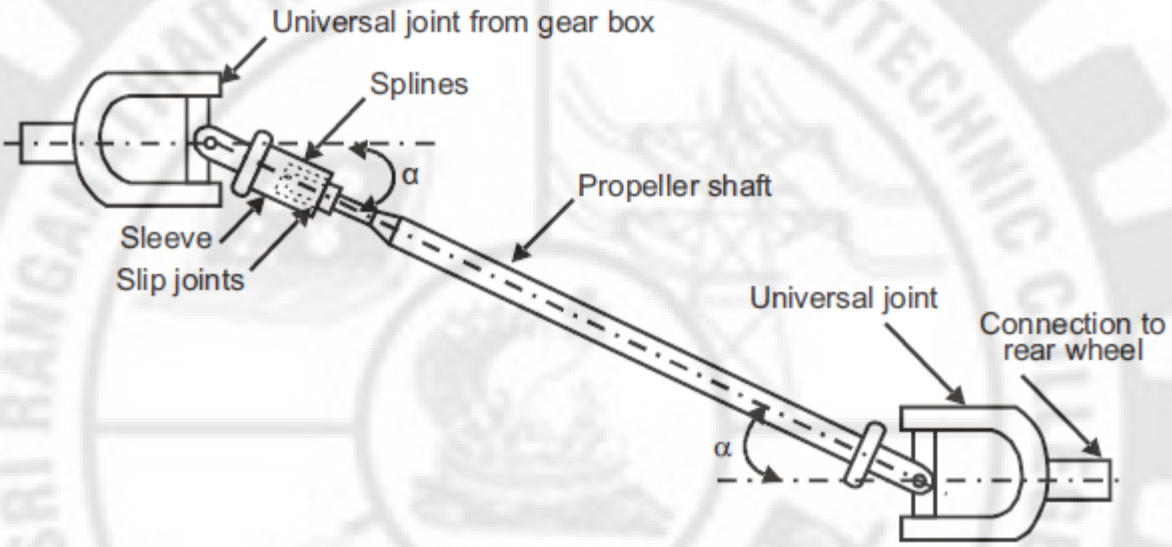



**Fig. 3.5 Propeller shaft connection**

ER SHAFT

3.4 Introduction

FTo accommodate the change in length, slip joints are used.

FIf there is no slip joint, the propeller shaft would break.

FIt transmits rotary motion and power to differential

FTransmits motion at varying angles which is at varying frequency.

FAccommodates change in length.

FPower is completely transmitted to the differential without any loss.

FAbsorbs shocks and vibrations coming on the transmission system when the vehicle starts from rest.

The vehicles having long wheel base use two propeller shafts.

A centre bearing is used between these two propeller shafts.

It is made of spring steel and it is made as hollow shaft.

To transmit power at varied angles, one or two universal joints are used depending upon the type of the rear axle drive employed.

Depending upon the type of the drive, one slip joint may be employed in the shaft.

This helps to adjust the length of the propeller shaft, according to the rear axle movements.

(ii) Universal Joints

(iii) Slip Joints

3.5 Functions of Slip Joint

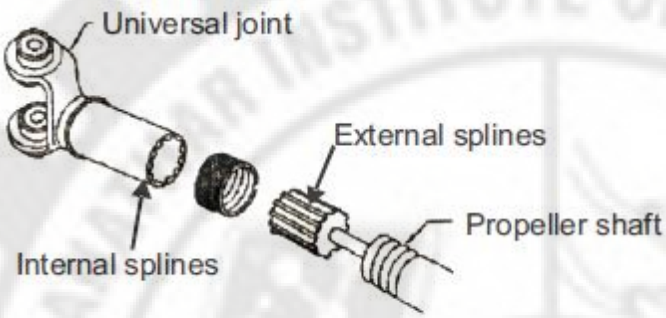
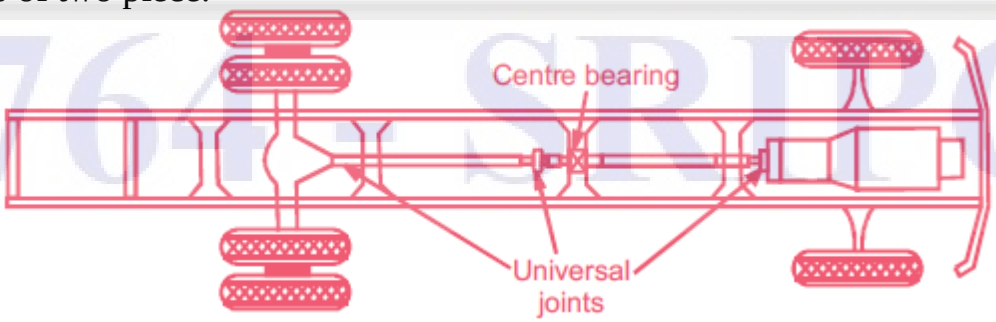



**Fig. 3.6 Slip joints**

FMost of the vehicles use the open type of the propeller shaft.
FIt is tubular in cross section and is not closed.
FOne of the universal joints is connected to the transmission output shaft and the other to the driving axle pinion shaft.
FIn order to provide a telescopic action, the front universal joint is splined to the propeller shaft.
FSome drive lines have two piece propeller shafts with a third universal joint between each section.
FThis third universal joint includes a central bearing and support assembly, which supports the centre of the drive line.
FThis propeller shaft is of solid cross section.
FIt is usually enclosed in a tubular structure called the torque tube.
FOne end of the torque tube is rigidly connected to the gear box casing by a ball joint and the other end to rear axle casing.
FWhile applying brakes, the torque and twisting motion of rear axle casing are resisted by this torque tube.
FThe propeller shaft design and construction takes care of the variation of the angles and the length, during vehicle movement.
FThe propeller shaft may be hollow or solid as per the design.
FIt may be protected by an outer cover or may be exposed.
FIn cars and vans the propeller shaft is single piece, but in buses and trucks with long wheel base.
FIt is of two piece.



3.6 Types of Prshaft two piece construction

FThere are single piece propeller shafts having two universal joints and two piece propeller shafts having three universal joints and two slip or sliding joints.

FThe propeller shaft is an alloy steel tube which transmits full engine power from the gear box to the differential.

FThree piece propellers have four universal joints and three slip or sliding joints.

The propeller shaft are subjected to driving and braking torques. When a front engine rear drive car starts from rest or is suddenly braked to slow down, the shock to the transmission is cushioned by the long propeller shaft which twists slightly and then untwists. These forces are taken care of by the following three types of construction of propeller shaft.

1. Hotchkiss type propeller shaft.
2. Torque tube type propeller shaft.
3. Torque arm type propeller shaft.

The Hotchkiss type propeller shaft is the most simple and widely used system.

In this arrangement, the springs besides taking weight of the body, also take the torque reaction, driving thrust and side force.op

The Hotchkisss type propeller shaft consist of an open propeller shaft secured to the transmission output shaft and differential pinion gear shaft.

The propeller shaft is provided with two universal joints and a sliding joint as shown in figure.

The springs are bolted to the axle casing.

The front end of the spring is rigidly fixed to the frame, while the rear end is connected to the frame by swinging links or shackle.

The front half of the sprinwill transmit the driving thrust to the frame.

It is seen that, the axle casing cannot turn under the torque reaction without causing the springs to flex which is shown in the figure.

The springs offer considerable resistance to this deformation, to overcome the torque reaction.

He springs deflect as they experience torque reaction and the bevel pinion shaft changes it's position.

Under the above condition the axis of bevel pinion shaft will not pass through the centre of the front universal joint.

Therefore, if there is no universal joint at the rear end, the propeller shaft will bend.
To overcome this effect, two universal joints, one at the front and other at the rear end are used.

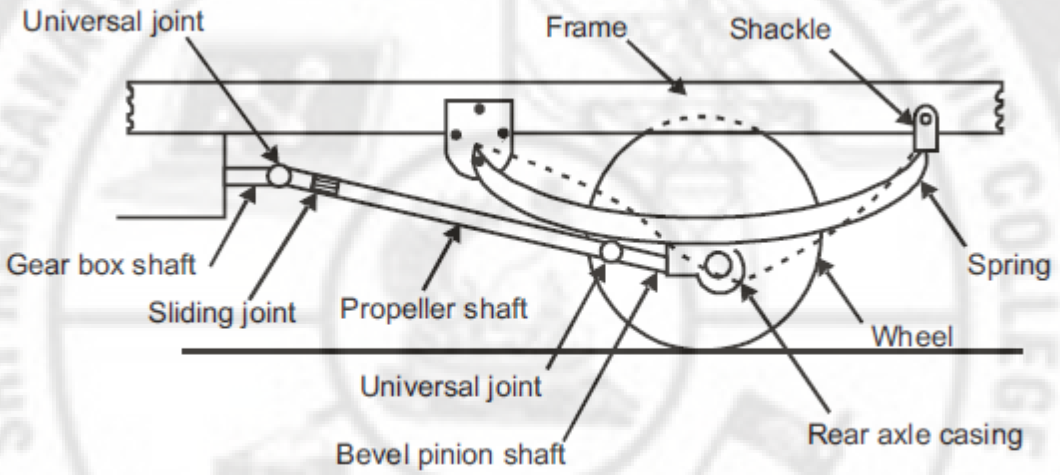



**Fig. 3.8 Hotchkiss drive**

(ii)

Torque Tube type Propeller Shaft
In this type, the springs take the body weight and side thrust only.
The torque reaction and driving thrust are taken by another member called Torque tube.
These torque tubes are made tubular to surround the propeller shaft.
One end of torque tube is attached to the axle casing while the other end which is spherical in shape fits in the cup fixed to the frame as shown in the figure. (3.9)
As torque tube takes torque reaction, the axis of bevel pinion shaft will not change and always pass through the centre of spherical cup.
If the universal joint connecting propeller shaft and transmission shaft is located exactly at the centre of spherical cup.
Hence only one universal joint is used at the front end.

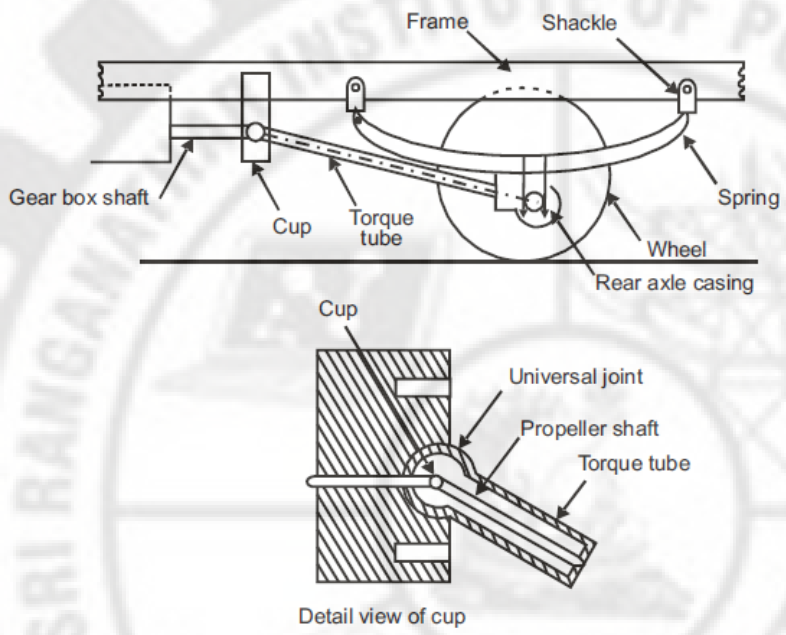



**Fig. 3.9 Torque tube drive**

Also both the pinion shaft and propeller shaft will move about the same centre i.e., about the centre of spherical cup. Hence no sliding joint is required in this case.

In both drives leaf springs take the side thrust.

When coil springs are used, they are notable to take side loads and therefore a separate member is used which is called "Panhard rod".

The panhard rod is in the form of transverse radius rod fixed parallel to wheel axis with one end attached to axle casing and the other end to the chassis frame.

The torque arm type propeller shaft consists of a tubular arm connected between the rear axle housing and the frame with a rigid connection at the axle housing and a ball and socket joint at the frame.

The propeller shaft unlike torque tube drive remains open.

Apart from this the working principle is exactly same as the torque tube drive.

## 3.8 Final Drive

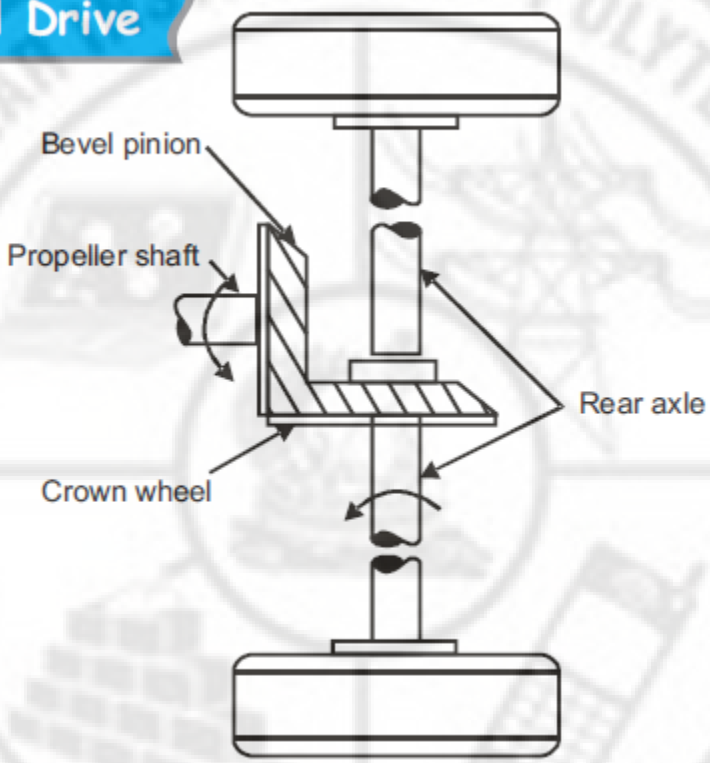



**Fig. 3.10 Final Drive**

The final drive for a four wheeler is a shaft drive.
The final drive consists of a bevel pinion and crown wheel.
The bevel pinion is mounted on a shaft which is connected to the propeller shaft.
It meshes with the crown shaft of the differential unit.
This unit which transmits the engine power to the axle shaft is called final drive.
It gets the power from the gear box through propeller shaft and reduces the speed and transmits it to the wheel at an angle of 90 degrees.
If gear reduction takes place, the speed gets reduced and it increases the torque or pulling power.
The gear reduction for passenger cars is of the order of 3:5:1 to 6:1 and for commercial vehicles it is 10:1 to 12:1.
It transmits the drive at right angle to the rear axles.
It provides a permanent speed reduction.
It provides a great leverage and mechanical advantage
It transmits the torque to both real axle shaft. Torque on the driving wheels gets increased.
Crown wheel have teeth 3 to 4 times as many teeth on the bevel

pinion.
(i) Straight bevel gear (ii) Spiral bevel gear
(iii) Hypoid bevel gear (iv) Worm and Worm wheel
This is the arrangement made in the older models.
In this the teeth of the crown wheel and bevel pinion are straight.
The pinion is fitted in the centre line of crown wheel.
Final Drive Ratio =
Number of teeth in crown wheel
Number of teeth in pinion wheel
Functions

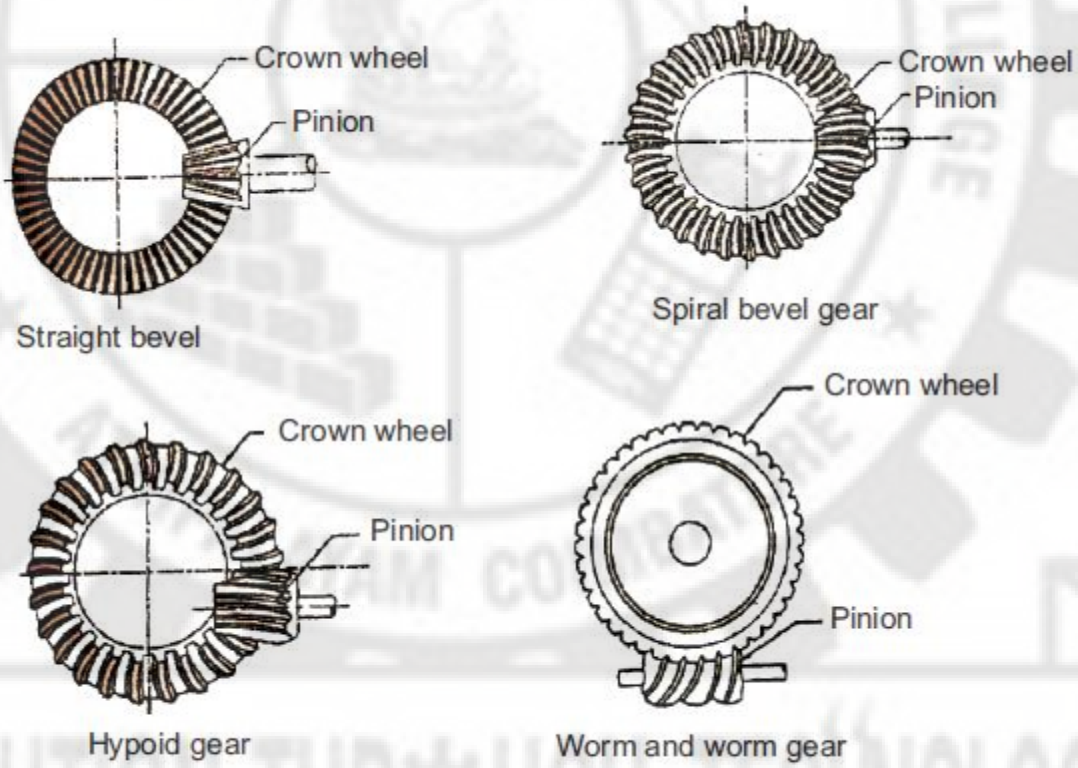



**Fig. 3.11 Types of bevel gears**

3
of Final Drive Gears
(i) Straight bevel gear
The parts get worn out uniformly on both the crown wheel and pinion. It has more service life.
This is a form of bevel pinion and crown wheel drive.
The axis of the pinion shaft is below the centre of the crown wheel.
They consume more power to revolve and make more noise and suffer from high wear.
It is cheapest, used in low price vehicles.

In this type, the crown wheels are in the form of a spiral gear.
The pinion of the propeller shaft also has teeth in the same form.
In this system the pinion is fitted in the centre line of crown wheel.
The teeth on both crown wheel and pinion are spiral which result in more contact area with each other.
No sound is developed when these teeth mesh and the meshing is also very smooth.
This permits a lower position of the propeller shaft thus allowing a low chassis height.
In this arrangement too the running is noiseless.
Another advantage is that a lower propeller shaft can be placed without any difficulty.
More heat is generated and for that reason extreme pressure lubricating oil is used.
These are used in heavy vehicles.
It is frequently used instead of bevel pinion and crown wheel.
In this type of final drive gear, large speed reductions can be obtained without using large gears.
The worm gear is mounted on either above or below the worm wheel depending upon the design and the space available.
When the worm gear is mounted on the top, it provides greater ground clearance for the vehicle.
It is particularly useful in heavier vehicles.
This gives a quiet efficient and very strong drive.
Worm is usually made of nickel steel and case hardened steel where as worm wheel is made of phosphor bronze.
These gears are expensive and yield a higher mechanical efficiency.
Cost is high
More weight
Lubrication of teeth becomes difficult

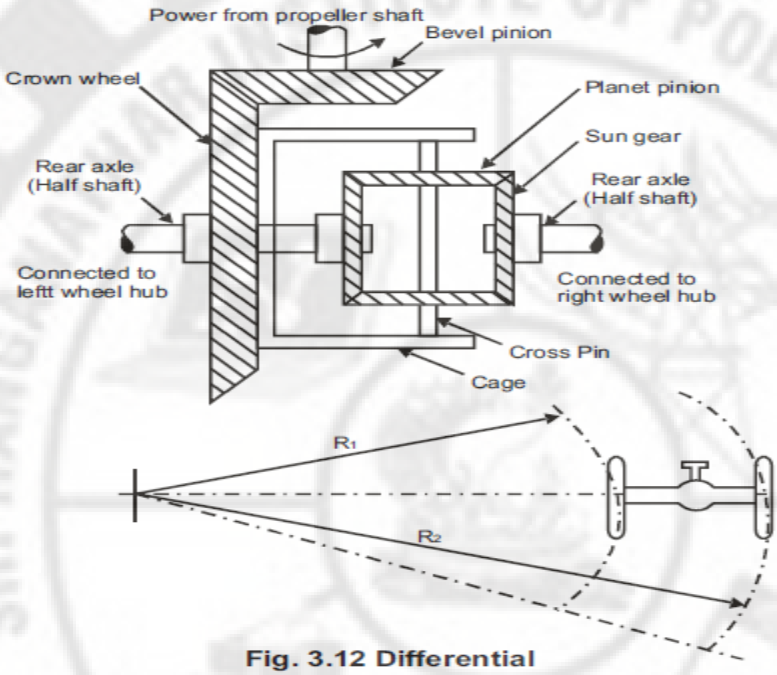



**Fig. 3.12 Differential**

DIFFERENTAL

3.1O Introduction - Differential

The differential unit was developed by a Frenchman, Mr. Bequer in 1827. When the vehicle travels on a straight level road, the two rear wheels turn on the road exactly at the same speed.

There is no relative movement between the two rear wheels. But when the vehicle takes a turn, the outer wheel turns faster than the inner wheel. Thus, there is a relative movement between the two rear wheels.

Differential is mainly used to prevent skidding of the vehicle. When it turns in a curved path.

If the two rear wheels are rigidly fixed to a rear axle the inner wheel will slip which will cause rapid tyre wear leading to steering difficulties and poor road holding.

Therefore, there must be some device to provide relative movement to the two rear wheels when the vehicle is taking a turn. Such a device which serves the above function is called differential.

It splits the power that is received and sends the same through the two half axle shafts to the driving wheels.

When the vehicle goes on a straight path, it allows the two driving wheels to steer to the same magnitude.

When the vehicle takes a turn, it allows the inner rear wheel to revolve slowly and the outer wheel to revolve faster.

It is of the following types :;
1. Conventional 2. Non-slip (or) power lock
3. Double reduction type

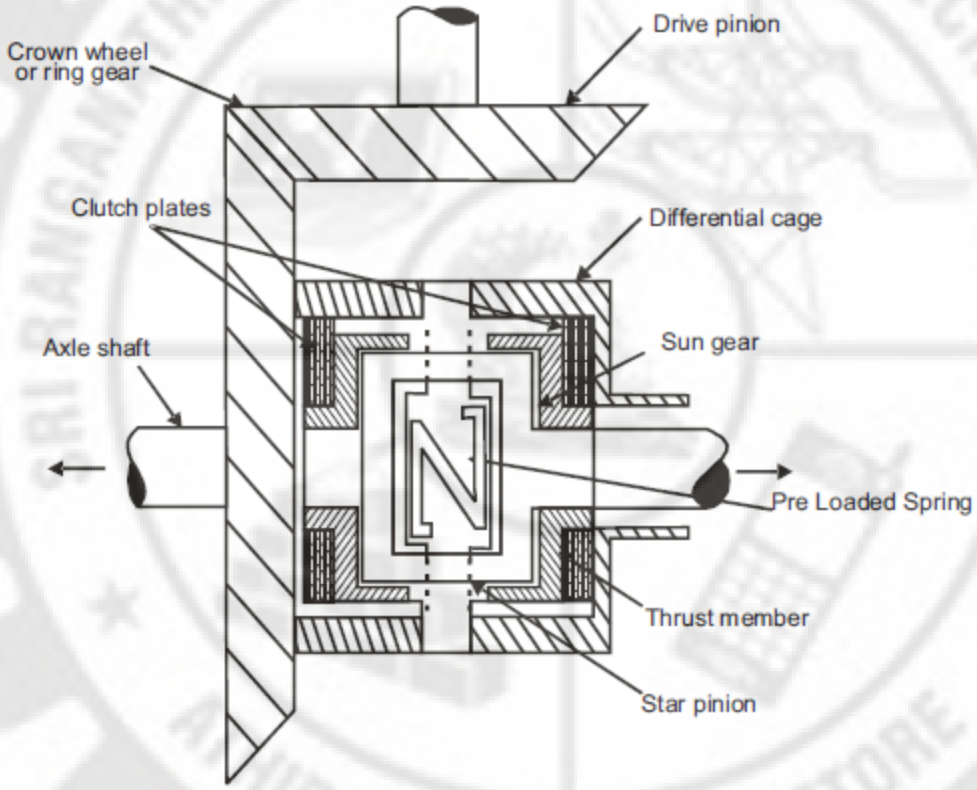



**Fig. 3.13 Non-Slip differential**

Differential
Purpose
Types
the crown wheel of
the final drive.
The crown wheel is driven by the bevel pinion gear, which is turned by the propeller shaft.
It consists of a cage which contains differential gears. The differential gear consist of two sun gears and two or four planet pinions, all of bevel gear type.
The planet pinions, are fitted on a pin or spider.

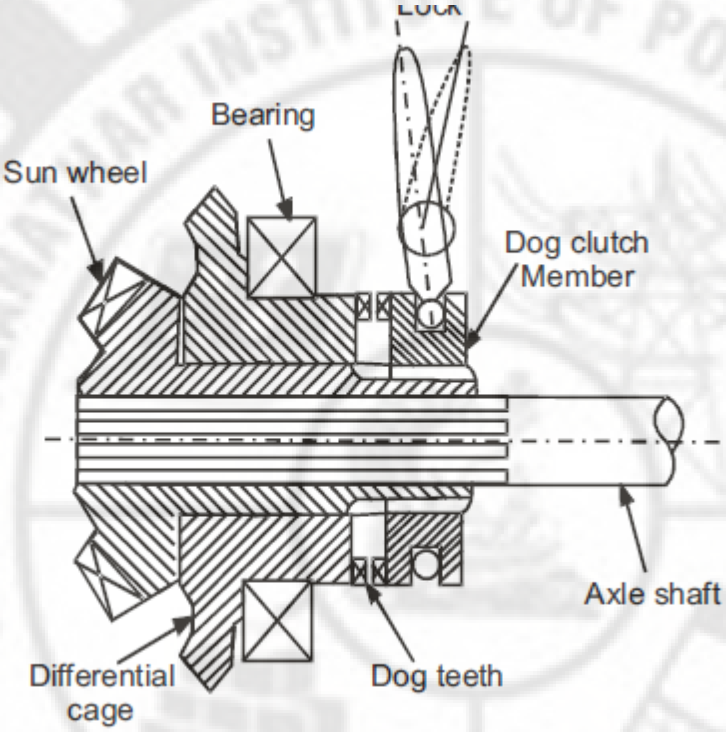



**Fig. 3.14 Locking differential**

## 3.11 Conventional Type Differential

provided on both sides of the cage.

When installed in the drive axle, the whole assembly moves around the bearings.

The resistance offered by both the driving wheels is the same and there is no relative movement between the two rear wheels.

The whole arrangement mesh together moves as one unit and both the half shaft in the driving wheels rotate at the same speed.

The pinions are free to move around their axis.

The pin or spider is held in between the two parts of the cage which encloses the differential gears.

The sun gears and planet pinions are always in mesh with each other.

The sun gears are free to move inside the cage. Axle half shaft is splined to each of these sun gears.

The differential assembly is supported on taper roller bearings

Now the differential splits the torque equally to both the wheels. In this condition the planet, sun gears rotates freely and do not vary because the both wheel gets equal resistance.

The differential transmits equal torque to both the wheels at an angle of 90 degrees.

When the vehicle is taking a turn, the inner wheel is subjected to a higher resistance than the outer wheel and hence its rotation is slowed down.
Hence to achieve stability with speed variations avoiding the slips, the left wheel need to rotate at a speed less than the right wheel.
The difference in speed between the left and the right wheels is given by the driving planet pinion to the sun gear.
Thus, the reduced speed in the inner wheel is transmitted to the outer wheel increasing the speed of the outer wheel.
Working
Limited Slip Differential (LSD is also known as Non slip differential or power lock.
The conventional differential delivers the same amount of torque to each wheel on the drive axle.
If one wheel slips on a slippery road, mud or ice, the wheel becomes stationary, all the power flows to the slipping wheel. This results in no movement to the vehicle.
In order to overcome this drawback, the vehicle is now provided with a non-slip or self-locking differential.
Non-slip differential is very much similar in construction to conventional type except that it has two sets of clutch plates in addition.
In non-slip differential, the ends of pinion shafts lay loosely in notches, in the two halves of the differential cage.
A pre loaded spring is fixed between the sun gear.
It provides close contact to the clutch plate and pre pressure plates.
When taking a turn, the non-slip differential functions in the conventional way to tend the outer wheel to run faster than the inner wheel and thus to cover more distance within the same time period.
This action is permitted by the slipping of clutch plates.
When the vehicle moves in a straight path. It transmits the same torque to both the rear axle.
Thus the LSD acts as a conventional. Differential in a straight road.
When one wheel gets struck in the mud then the wheel moves freely without any resistance and the vehicle stops.
In LSD as the clutch plates and pressure plates are in close contact using the pre loaded spring the rear axle is locked to the

differential casing.
Thus the power in transmitted to both the rear axle and the vehicle moves forward easily using LSD.
Figure shows the arrangement of differential lock used on motor vehicle.
It is used to prevent differential action by locking together, any two individual members of a differential.
It consists of a sliding dog clutch member splined to a differential sun gear.
The cage of the differential has dog teeth.
It is engaged with sliding dog teeth by means of a fork on the outside of the axle.
Normally the sliding dog teeth is not engaged with dog teeth on cage.
When one wheel on slipping surface, the vehicle does not move due to the spinning action of slipping wheel.
In order to avoid this spinning action, slippery wheel as well as sun gear is locked by sliding dog teeth members to cage.
It ensures that other sun gear will rotate with slippery wheel speed.
As a result, the vehicle tends to move on the road.

Trouble: Humming Noise

1. Incorrect adjustment with out Adju st the pinion gear proper clearance between gears
2. Crown wheel, pinion teeth broken Replace
3. Insufficient clearance between gears Adjust the pinion gear
4. Improper adjustment of final drive Adjusting back lash
5. Worn out sun gear, star gear and bearings Replace
6. Differential cage bolt s and axle shafts loose Tighten properly
7. Wrong lubricant for differential and un- lubricated bearings Use correct oil and lu bricate properly
8. Worn out thrust washers on differential pinions Replace
9. Sudden acceleration Open the throttle

valve slowly to allow
the differential to do
its job properly
10. Unlubricated bearings Lubricate properlyof final drive - Rear Axle
Trouble: Humming Noise
1. Due to worn out bearings Replace the worn out
bearings
2. Due to worn out gears Replace the worn out
gear
3. In some case, this noise may Back lash and use shim
be due to only the excessive method of adjusting back
clearance between the pinion lash, to adjust the
and the crown wheel clearance
Trouble: Knock
1. Worn out splines of the axle Replace the defective
shaft may cause knocking or shaft
clicking sound
2. Chipped teeth of some gear in Replace the gear with
the rear axle may cause the chipped teeth
knocking sound
Trouble: drive may not be transmitted
1. Out of two half shafts, any Replace the broken
one may be broken shafts
2. There may be stripped splines on Replace the axle shaft
the axle shafts
3. The teeth of some gear in there ar Gear with such
axle drive may be stripped defect may be replaced
4. There may be fractured taper Replace the fractured
key in the hub taper key

**UNIT-4**

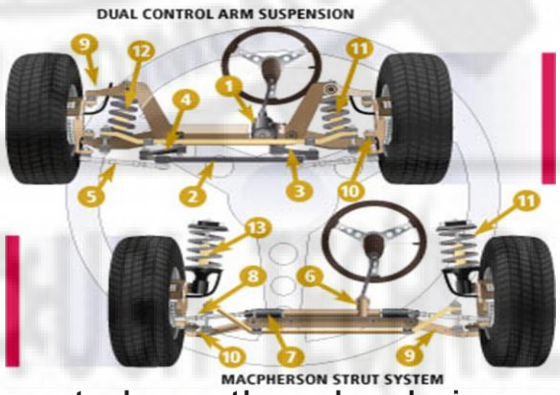
# SUSPENSION SYSTEM

## What is suspension system?

- Suspension is the term given to the system of springs, shock absorbers and linkages that connects a vehicle to its wheels
- Serve a dual purpose – contributing to the car's handling and braking.
- Protects the vehicle itself and any cargo or luggage from damage and wear

## PURPOSE OF SUSPENSION SYSTEM

- Supports the weight.
- Provides a smooth ride.
- Allows rapid cornering without extreme body roll.
- Keeps tires in firm contact with the road.
- Allows front wheels to turn side-to-side for steering.



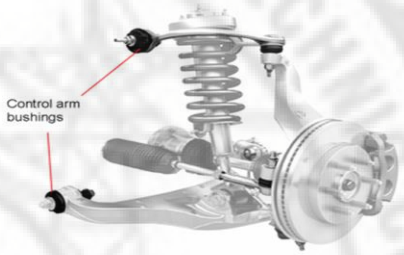

- Works with the steering system to keep the wheels in correct alignment.
- Isolate passenger and cargo from vibration and shock

Causes Remedies

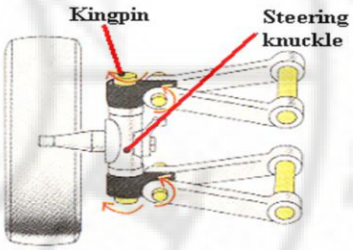
# Suspension System

## Basic Parts:

Control Arm:- movable lever that fastens
the steering knuckle to the vehicle's
body or frame.



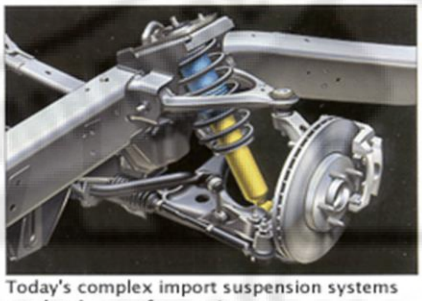

Steering Knuckle:– provides a spindle or bearing support for the wheel hub, bearings
and wheel assembly.



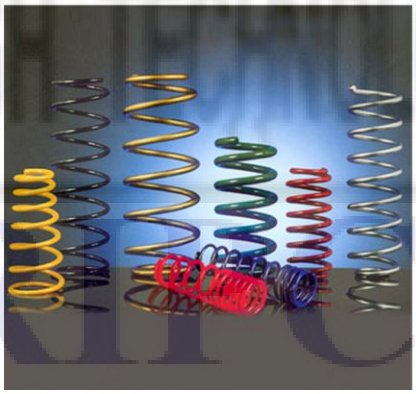

# Suspension System

## Basic Parts:

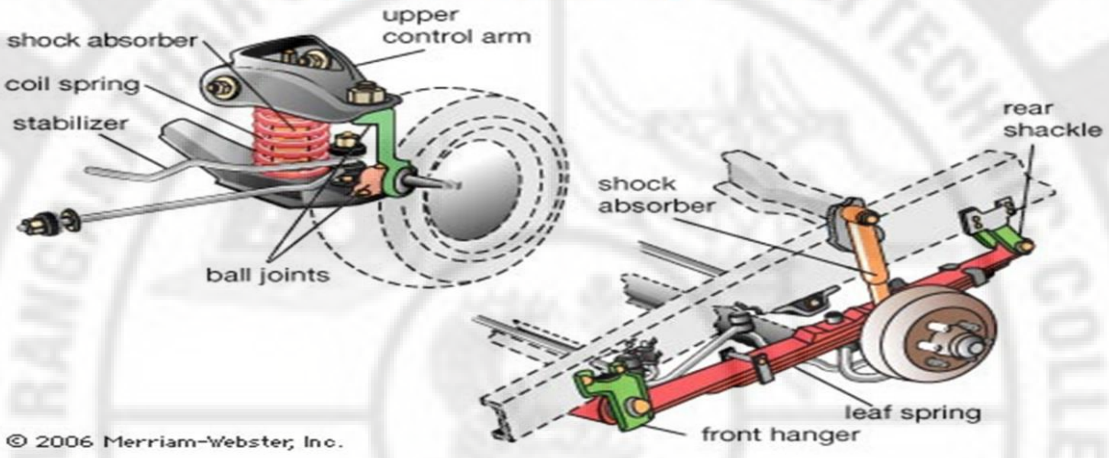
Ball Joints:– swivel joints that allow control arm and steering knuckle to move up and down and side to side.


Today's complex import suspension systems aren't tolerant of excessive wear.

Springs:– supports the weight of the vehicle; permits the control arm and Wheel to move up and down.



# Suspension System




## COIL SPRING AND LEAF SPRING

### LEAF SPRING

- Used in many early applications
- Internal friction provides damping
- Provide Lateral location for the axle
- Heavy
- Prone to weaken over time
- Leaf springs are now limited to the rear of some cars

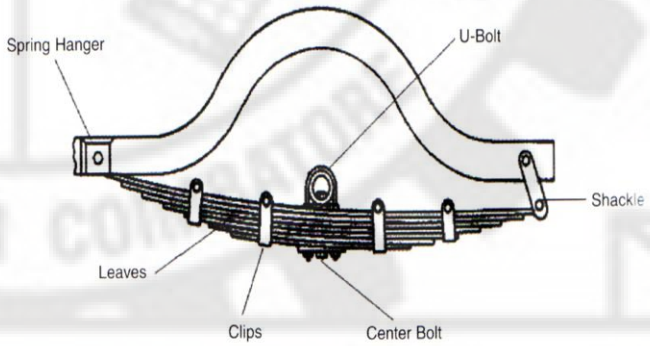



**Figure 8.17.** *A multi-leaf spring. Adapted from TM 9-8000 (1985).*

# COIL SPRING

- Little to no internal damping
- Low cost
- Compact Size
- Used in many Suspension types
- Coil spring is the most common type of spring found on modern vehicles

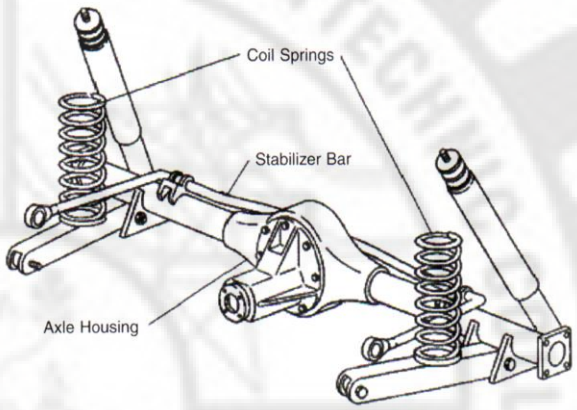
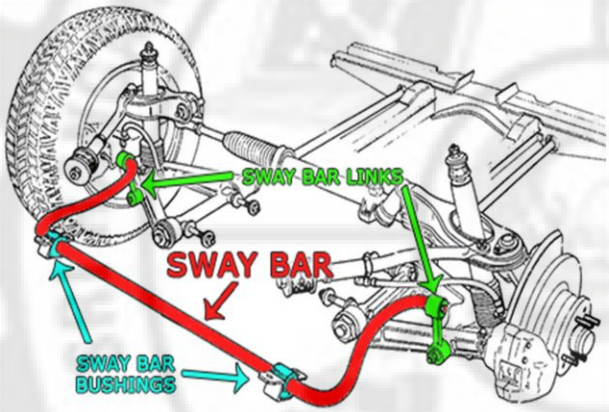



**Figure 8.19.** *A coil spring suspension. Adapted from TM 9-8000 (1985).*

## Torsion bar *(large spring rod)*

- One end is attached to the frame and the other to the end of a wheel arm.
- Up and down of the suspension system twists the torsion bar
- When the wheel strikes a bump, it begin to vibrate up and down.

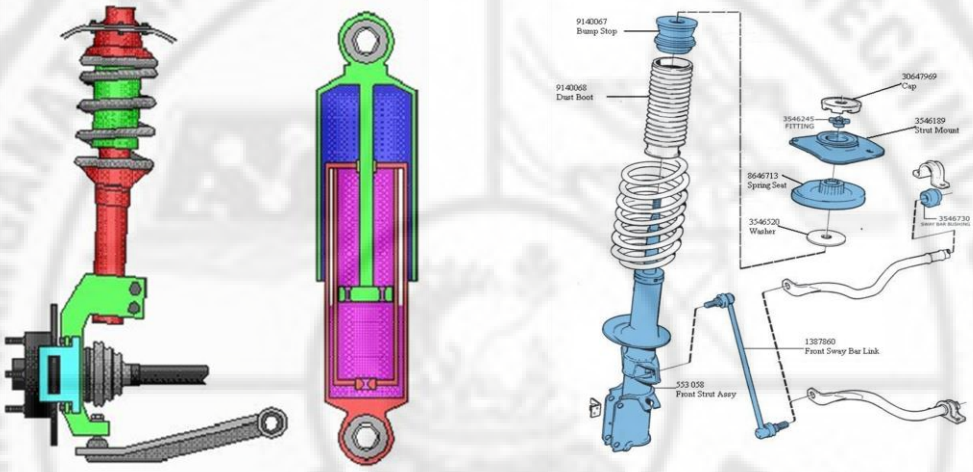
# Anti-sway bars or Anti-roll bars




## Shock absorbers

- A shock absorber is a mechanical device designed to smooth out or damp shock impulse, and dissipate kinetic energy.
- Limits spring compression-extension movements to smooth the vehicle's ride.
- Without shock absorbers, the vehicle would continue to bounce up and down long after striking dip or hump in the road.

**Strut assembly** *(MacPherson struts)*




# Strut Assembly

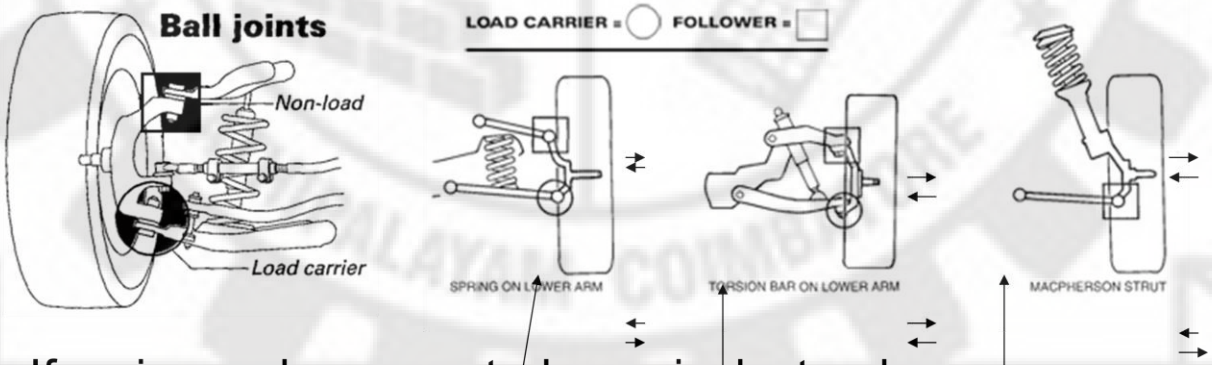
- Its is a independent suspension system
- Consists of a shock absorber, a coil spring, and an upper damper unit.
- Strut assembly often replaces the upper control arm.
- The steering gear is either connected directly to the lower shock absorber housing, or to an arm from the front or back of the spindle.
- When you steer, it physically twists the strut and shock absorber housing (and consequently the spring) to turn the wheel.

## Air Suspension

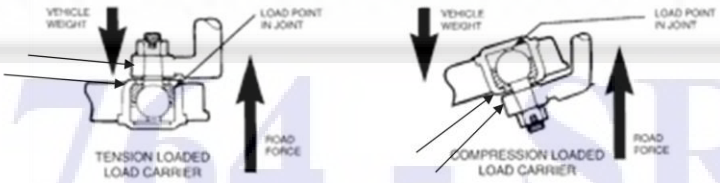
**Air suspension:-** Air Suspension is a type of vehicle suspension powered by an electric or engine driven air pump or compressor. This compressor pumps the air into a flexible bellows, usually made from textile-reinforced rubber. This in turn inflates the bellows, and raises the chassis from the axle.

Pneumatic Spring On Semitrailer

## Checking Ball Joints




- If spring on lower control arm, jack stand goes under the control arm.
- If spring on upper control arm, jack stand goes under frame.




If any play found, replace it.

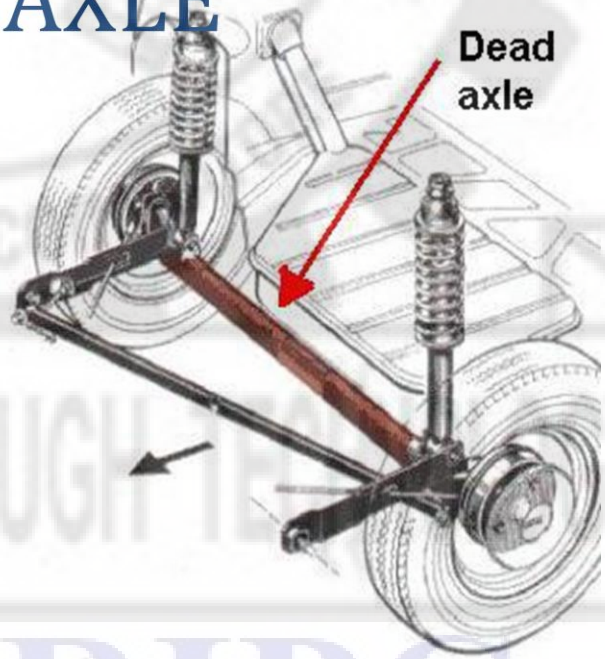
# FRONT AXLES

Front wheels of the vehicle are mounted on front axles .

- It supports the weight of front part of the vehicle.
- It facilitates steering.
- It absorbs shocks which are transmitted due to road surface irregularities.
- It absorbs torque applied on it due to braking of vehicle.

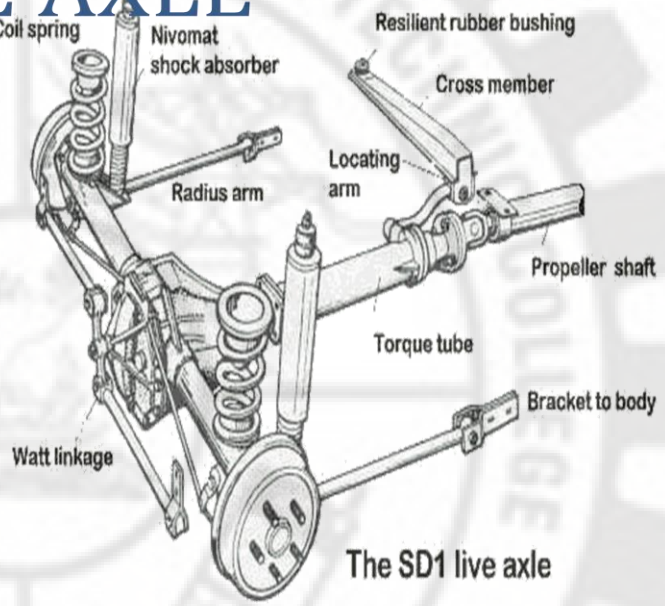
# DEAD AXLE

- Dead axles are those axles, which do not rotate.
- These axles have sufficient rigidity and strength to take the weight.
- The ends of front axle are suitably designed to accommodate stub axles.



# LIVE AXLE

- Live axles are used to transmit power from gear box to front wheels.
- Live front axles although, resemble rear axles but they are different at the ends where wheels are mounted. Maruti-800 has line front axle.



The SD1 live axle

## *TYPES OF STUB AXLES*

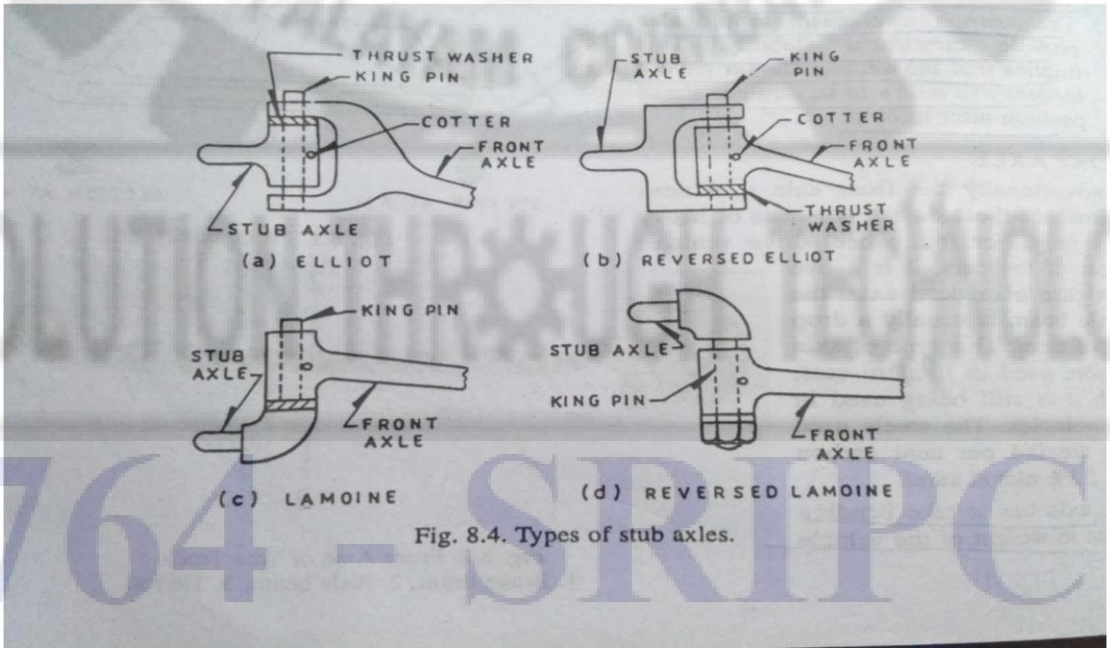


Fig. 8.4. Types of stub axles.

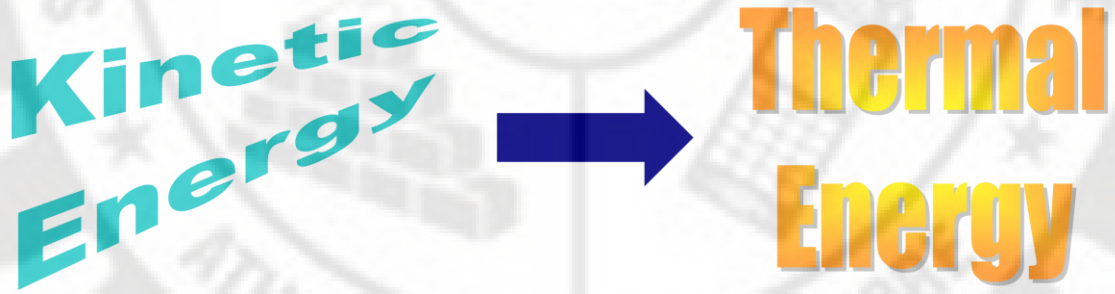
**UNIT-5**

# Brakes – What do they do ?

Simple Answer : They slow you down

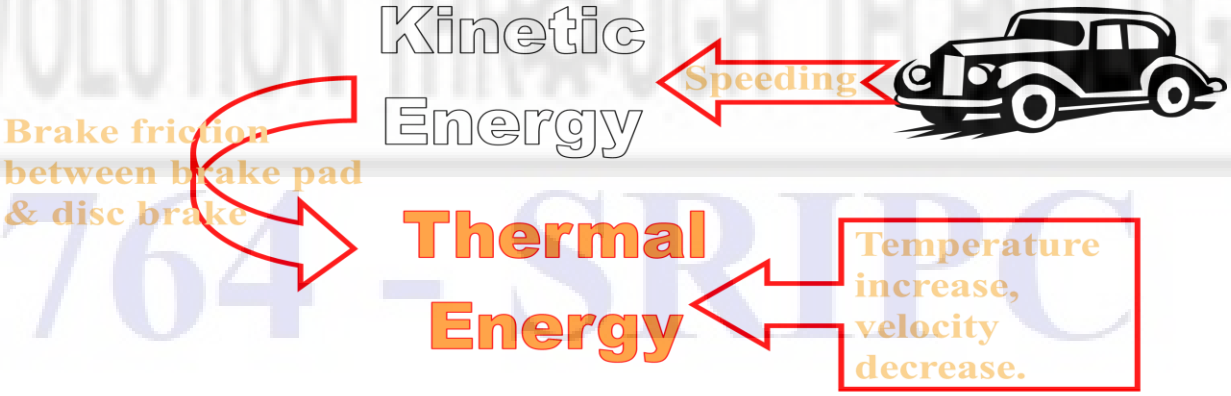
Complex Answer :

It is converted from kinetic energy to thermal energy

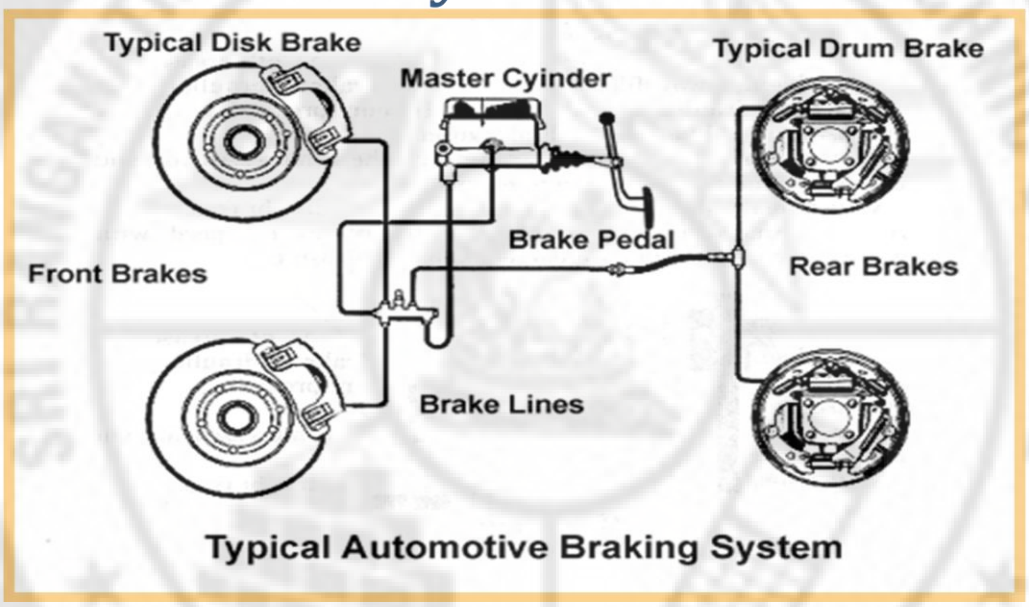



## How It's Work ?

- Fact : 1st Law of Thermodynamics – Energy cannot be created or destroyed, it can only be converted from one form to another.

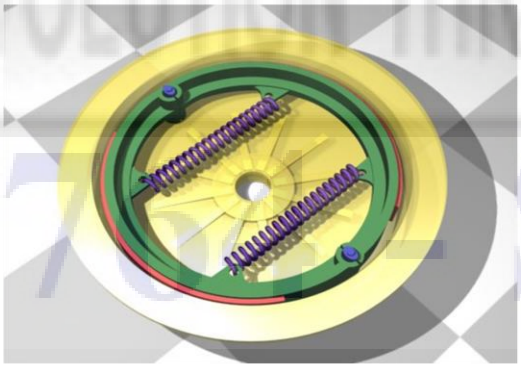


# Basic Automotive Braking System

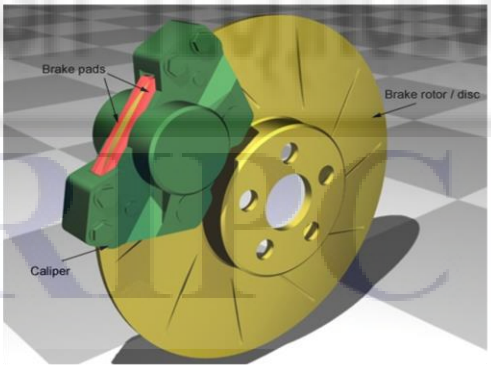



# Type of Brake


Bicycle Wheel Brake



Drum Brake




Disc Brake

# General Automotive Brake Allocation