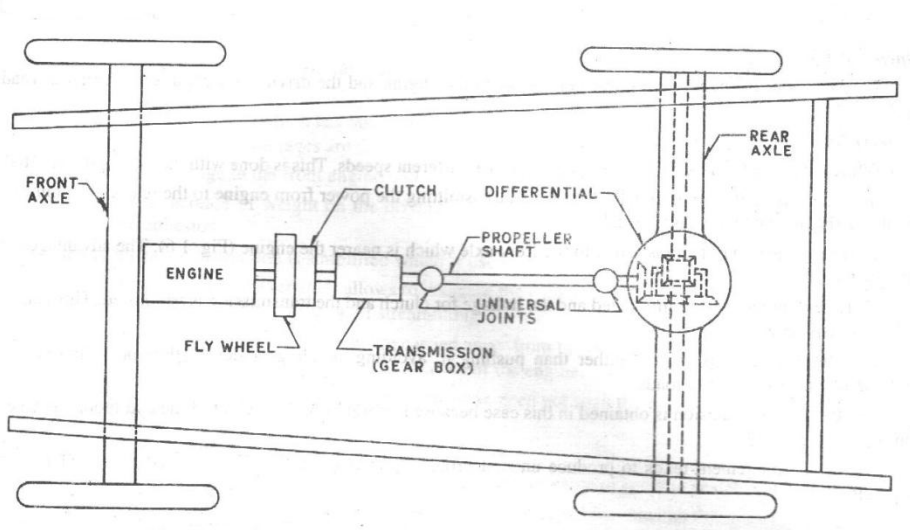
AUTO TRANSMISSION

Transmission system means the whole mechanism that transmits the power from the engine crankshaft to the wheels.

The transmission system consists of a clutch, gear box, propeller shaft, rear axle and differential gear between the driving wheels. The functions of transmission system are

1. To disconnect the engine from the road wheels when decide.
2. Connect the engine to the wheels without shock.
3. To vary the leverage between engine and drive wheels.
4. Reduce the engine speed permanently in a fixed ratio
5. To turn the drive through a right angle.
6. To make provision such that the driving wheels may rotate at different speeds while taking turns.
7. To make provision for the turning of the road springs which causes a relative movement between the engine and driving wheels.



CLUTCH

Clutch is a mechanism which enables the rotary motion of one shaft to be transmitted when decide to a second shaft the axis of which is consistent with that of the first.

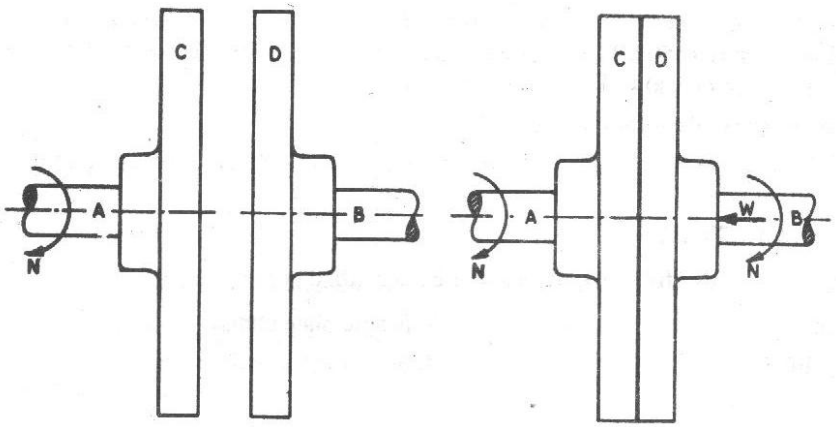
Requirements of clutch

1. Torque transmission
2. Gradual engagement
3. Heat dissipation
4. Dynamic balancing
5. Vibration damping
6. Size
7. Inertia
8. Clutch free pedal play
9. Ease of operation

Classification of clutch

1. Friction clutch
    1. Wet
    2. Dry
        1. Cone clutch
        2. Single plate clutch
        3. Multi plate clutch
        4. Centrifugal clutch
        5. Semi centrifugal clutch
        6. Electromagnetic clutch
2. Fluid flywheel
3. Positive clutch

Principle of friction clutch



The shaft A and disc C are revolving at some speed N rpm. Shaft B and disc D are stationary initially when the clutch is not engaged. Now apply some axial force W to the disc D so that it comes in contact with disc C . As soon as the contact is made, the force of friction between C and D will come into play and consequently the disc D will also start revolving. If W is increased gradually, speed of D will increase correspondingly till the stage comes when the speed of D becomes equal to the C. Then the clutch is said to be fully engaged.

Let W=axial load applied

μ=coefficient of friction

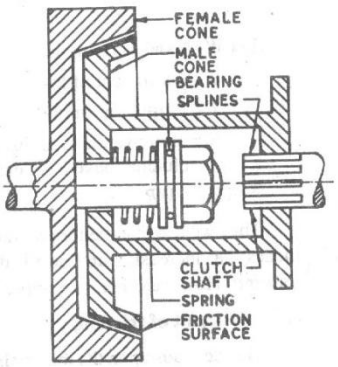
T=torque transmitted

R=effective mean radius of the friction surface

Then,

$$\mathbf{T = \mu w R}$$

Cone Clutch



In this type of clutch, the contact surfaces are in the form of cones. In the engaged position, the male cone is fully inside the female cone so that the friction surfaces are in complete contact. This is done by means of spring which keeps the male cone pressed all the time. For disengaging the clutch, the male cone is pulled out by means of the lever system operated through the clutch pedal, thereby separating the contact surfaces.

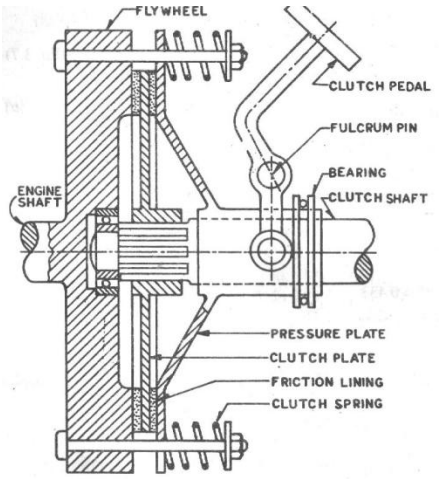
Advantages

1. Simplicity
2. The normal force acting on the contact surface s is always greater than the axial force (W)

Disadvantages

1. If the angle of the cone is made smaller than about 20°, the male cone tends to bind the female cone.
2. A small amount of wear on the cone surface results in a considerable amount of the axial moment of the male cone which is difficult to allow.

Single Plate Clutch



In a single plate clutch, the clutch plate is held between flywheel and pressure plate. There are springs arranged circumferentially which provide axial force to keep the clutch in engaged position. The friction plate is mounted on a hub which is splined from inside and thus it is free to slide over the gear box shaft. Friction facing is attached to the friction plate on both sides to provide two angular friction surfaces for transmission of power. A pedal is provided to pull the pressure plate against the spring force when ever it is required to disengage.

When the clutch pedal is pressed, the pressure plate is moved to the right against the force of the spring. This is achieved by means of a suitable linkage and a throw out bearing. With this movement of the pressure plate, the friction plate is reduced and the clutch is disengaged.

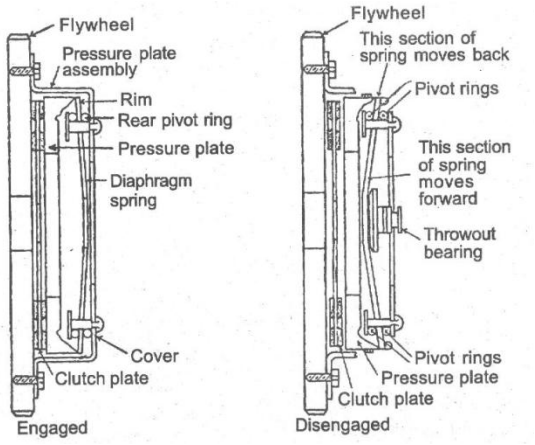
Advantages

1. Gear shifting is easier
2. More reliable

Disadvantages

1. Spring has to be stiffer. So greater force is required to be applied by the driver while disengaging.

<u>Diaphragm Clutch</u>



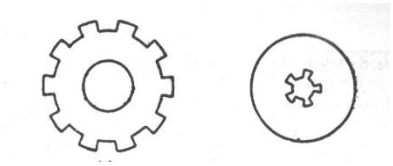
The diaphragm type clutch uses a diaphragm or a conical spring instead of coil spring to produce adequate pressure for engaging the clutch. The clutch cover is secured to the engine flywheel. The pivot rings are held in the clutch cover. The outer rim of the diaphragm spring is in contact with the pressure plate. In engaged position, the diaphragm spring keeps the pressure plate in firm contact with the flywheel.

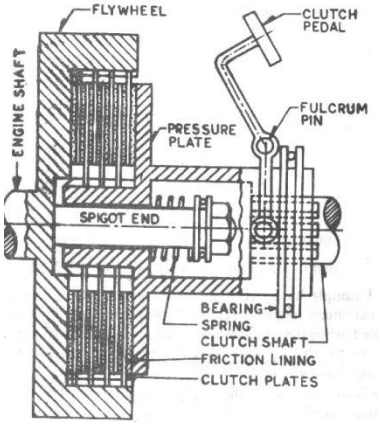
To disengage the clutch, clutch pedal is pressed which causes the linkage to move the throw out bearing forward. This causes the ring of the diaphragm spring move backward, which is away from flywheel. This happens because diaphragm spring is pivoted.

Advantages

1. Does not have any release levers
2. Less effort is required
3. Compact in design

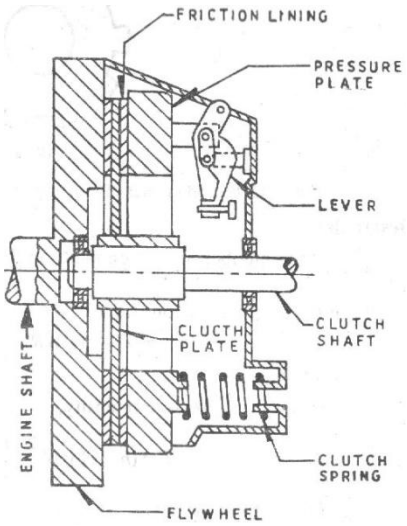
<u>Multi plate Clutch</u>





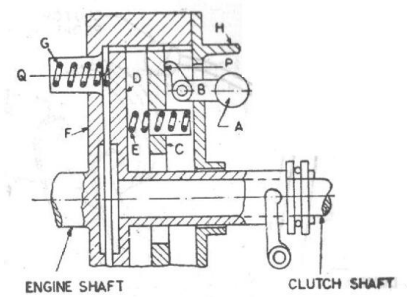
Multi plate clutch has a number of clutch plates as compared to single plate. The increase in number of friction surfaces increase the capacity of the clutch to transmit torque, size remains fixed. During clutch engagement, spring pressure forces the pressure plate towards engine flywheel. This causes the friction plate and the steel driven plates to be held together. Friction locks them together tightly. When the clutch get released, the movement of the pressure plate releases the spring pressure holding the driving and driven plates together.

Semi centrifugal Clutch



In a semi centrifugal clutch, springs are designed to transmit the torque at normal speed, while for higher speed, centrifugal force assists in torque transmission. Three hinged and weighted levers are arranged at equal intervals. At moderate speeds the pressure of the spring is sufficient to transmit the required torque. However at higher speeds, the weight, due to the centrifugal force moves about fulcrum there by pressing the pressure plate. The centrifugal force is proportional to the square of the speed so that enough pressure level is attained.

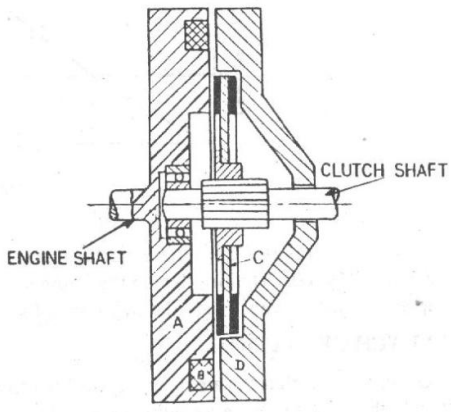
Centrifugal Clutch



In a centrifugal clutch, the springs are eliminated altogether. Only the centrifugal force is used to apply the required pressure to keep the clutch in engaged position. The advantage of centrifugal clutch is that no separate clutch pedal is required that is clutch is operated automatically depending upon engine speed.

As the speed increases, the weight flies there by operating the bell crank lever which presses the pressure plate. This force is transmitted to the clutch disc by means of spring ‘a’. The clutch disc containing friction lining is thus pressed against the flywheel there by engaging the clutch. The spring ’b’ serves to keep the clutch disengaged at low speed. The stopper limits the amount of centrifugal force.

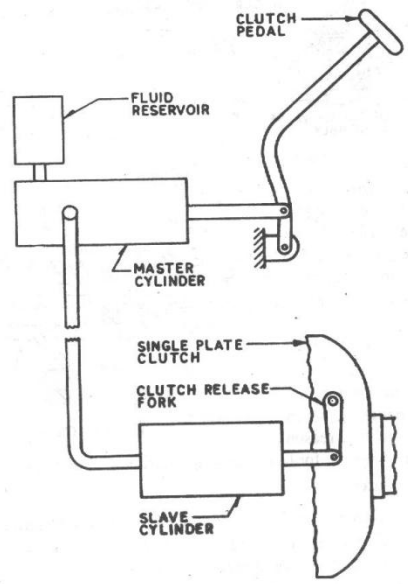
Electro magnetic Clutch



The clutch has a conventional type of friction disc. When battery current is supplied to the magnetic coil, an electromagnet in the flywheel gets energized. Now the armature is pulled by the electromagnet compressing the push off springs. The pressure plate assembly moves towards the flywheel makes the clutch plate contact in between flywheel and pressure plate.

The electromagnetic clutch is best suited where remote operation is desired since no linkages are required to control its engagement.

Hydraulic operation of clutch

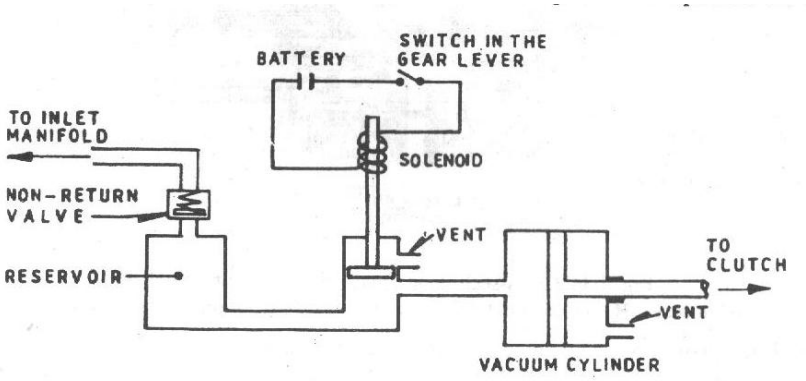


In heavy duty applications the force required to disengage the clutch become excessive. This can be remedied by using hydraulic operation. This type of operation is suitable for vehicles in which the clutch pedal and the clutch have to be located too far away from each other.

In this system, the clutch pedal operates the piston in the clutch master cylinder. The hydraulic pressure thus produced is then transmitted through hydraulic lines to the slave cylinder containing the piston which is connected to the pressure plate. This pressure moves the piston there by releasing the clutch.

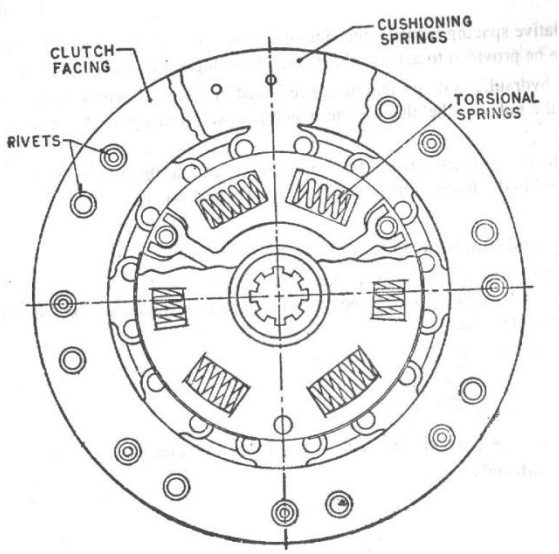
The advantages of the system are complicated clutch linkages, vibration and wear of the linkages are eliminated.

Vacuum Operation



The partial vacuum existing in the engine manifold is put to use to operate the clutch. A reservoir is connected to the engine manifold through a non return valve. The reservoir is further connected to a vacuum cylinder through a solenoid operated valve. The solenoid is operated from the battery through a switch which is operated by a gear lever. Vacuum cylinder contains a piston which is exposed to atmospheric pressure on one side. In the part throttle position, the vacuum in the engine manifold is collected inside the reservoir. During operation the switch in the gear lever remains open and the solenoid operated valve remains in the bottom position. When the driver changes the gear, the solenoid energizes which actuates the piston which further opens the vacuum from the reservoir to the vacuum cylinder. The clutch used is an ordinary friction clutch.

Clutch plate



The clutch plate consists of steel plate with a splined central hub. Annular friction facings are attached to the steel plate by rivets. Special resins are also been used to bind the friction faces. There is a provision of axial cushioning interposed between the clutch plate and friction facings. The curved cushioning spring segments are attached rigidity to the centre plate and friction facings are riveted to the springs to these springs. Apart from the cushioning, clutch plates are also provided with means of absorbing undesirable torsional vibrations. The clutch plate for this purpose has to be made in two parts. That is a central hub subassembly and outer facing ring assembly the two being torsionally flexible with respective each other.

Clutch Facing

Requirements

1. Good wearing properties

2. Presence of good binder

3. Cheaper

4. High coefficient of friction

5. High resistance to heat

Types

1. Millboard type

2. Moulded type

3. Woven

a. Solid woven variety

b. Laminated woven variety

Common clutch facing material

1. Leather

2. Cork

3. Fabric

4. Asbestos

5. Reybestos

6. Ferodo

7. Non asbestos clutch facing

Other clutch components

1. Pressure plate

2. Release lever

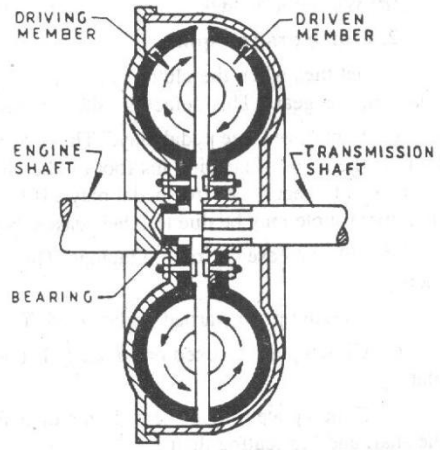
3. Cover

4. Straps

5. Springs

6. Throw out bearings

Fluid Flywheel



The fluid flywheel or hydraulic coupling is normally used in automatic transmissions. It consist of two members the driving and the driven. The driving member is attached to the engine flywheel and the driven member to the transmission shaft. The two members do not have any direct contact. The shell is always filled with fluid of suitable viscosity.

When the flywheel starts rotating the oil in the impeller (pump) starts moving. Due to the force of the rotation the oil impinges on the finds of the turbine and causes it to move. In this way the moving liquid transmits the engine power to any components to which the turbine is attached.

Theoretically the turbine speed becomes almost equal to that of the pump only under the best operating condition when the efficiency of the fluid coupling is highest. But usually turbine speed is less than that of the pump. The lag of the turbine behind the pump is known as slip. For engine speed below about 500rpm percentage of slip is 100 which means the clutch is fully disengage. As the engine speed increases the percentage of slip rapidly falls below 10% beyond which the slip decreases gradually to a small value of about 2%.

Advantages

1. No wear on moving parts

2. No adjustments to be made

3. No maintenance necessary except oil level

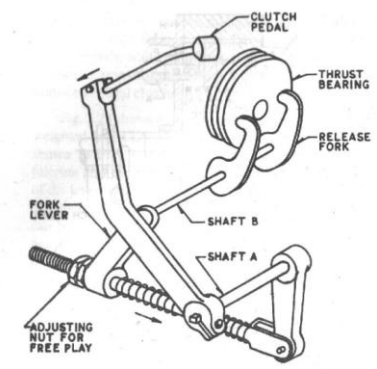
4. Simple design

5. No jerk on transmission in the gear engagement.

6. No skill required for operating

7. Car can stop in gear and moved of

Mechanical operation of clutch mechanism



On pressing the clutch pedal, the shaft A turns, which moves the fork lever and then through shaft B, actuates the release fork to press the thrust bearing. This movement is further conveyed to clutch levers to disengage the clutch.

When the clutch pedal is pressed, the thrust bearing is not pressed immediately. Rather a part of the pedal movement is purposely kept idle. This is done to avoid a rapid wear of the thrust bearing and the clutch plates and is called clutch free pedal play. Usually this is kept about 25mm at the pedal.

GEAR BOX

The main functions of a gear box are

1. To provide a means to vary the leverage or torque ratio between engine and road wheels.

2. To provide a neutral position so that the engine can be disconnected off the road wheels.

3. A means to reverse the direction of rotation of the drive.

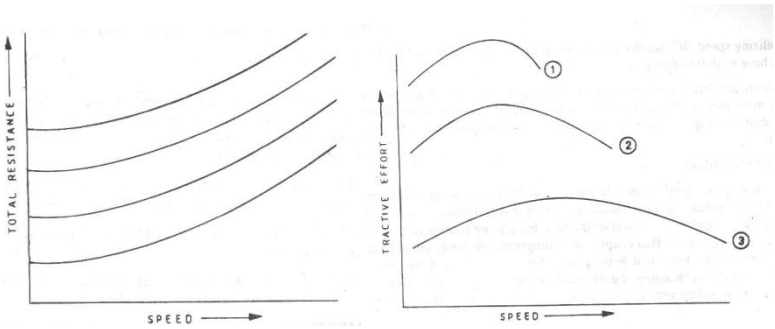
The total resistance to the vehicle motion is commonly

1. Resistance due to wind

2. Resistance due to gradient

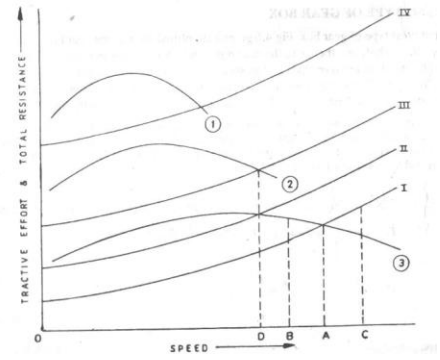
3. Miscellaneous resistance

The total resistance for same type of roads with different gradient may be represented by curves.



The tractive effort of a vehicle at particular gear is minimum at initial point and increases with the speed, peaks at some optimum speed and decreases beyond that. The graph shows the tractive effort in first second and top gears respectively.

Now consider the graph which is obtained by super imposing the above figures.



Here A is the stabilizing speed for gear 3 if a vehicle at gradient. If a vehicle at gradient 1 has a less speed B then the excess tractive effort which accelerates it to speed A. Similarly if the speed at any instant is C then the excess resistance decelerates it to A. If the vehicle has to move through gradient III then it has to be shifted to the next gear, since the stabilizing speed D.

Transmission types

1. Manual

2. Semi automatic

3. Automatic

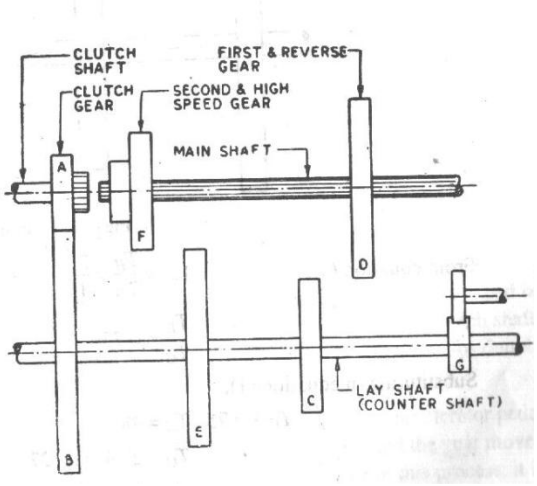
Manual Transmission

1. Sliding mesh gear box

2. Constant mesh gear box

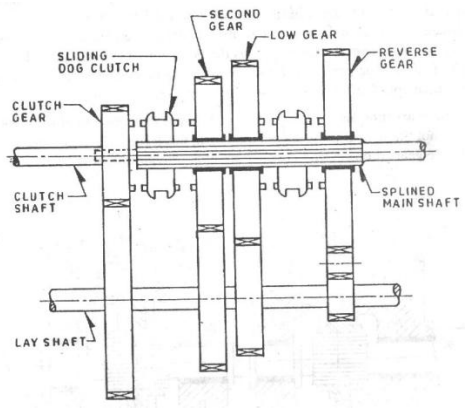
3. Synchromesh gear box

Sliding Mesh Gear box



This is the simplest of gear boxes. It consist of three shafts, a set of gears gear selector mechanism and gear shift lever. The engine is coupled through the clutch to the clutch shaft or input shaft. A lay shaft or counter shaft which is arranged parallel to the main shaft carriers gears of different size which are all fixed. The input shaft gear meshes continuously with the driven gear on the lay shaft. The main shaft is splined and gears can be slide to make it mesh with gears on the lay shaft. The various gear reduction is obtained by sliding the appropriate gear on the main shaft to make it mesh with corresponding gear on the lay shaft. Reverse gear is also provided by the help of idler gear which is provided in between the lay shaft gear and main shaft gear.

Constant Mesh Gear box



In this type of gear box all the gears on the lay shaft are in constant mesh with the corresponding gears on the main shaft. Gears on the main shaft are free to rotate (Bearing). Dog clutches are provided which are free to slide on the main shaft. Gears on the lay shaft to are fixed. When the left dog clutch is slide to the left by means of the selector mechanism, its teeth are engaged with those on the clutch gear and we get the direct gear.The same dog clutch however when slide to right makes contact with the second gear and the second gear is obtained. Similarly movement of the right dog clutch towards left result in low gear and towards the right in reverse gear.

Advantages

1. Helical gears can be used

2. Any damage that result from faulty engagement occurs only to the dog clutch.

3. Less noisy and reliable

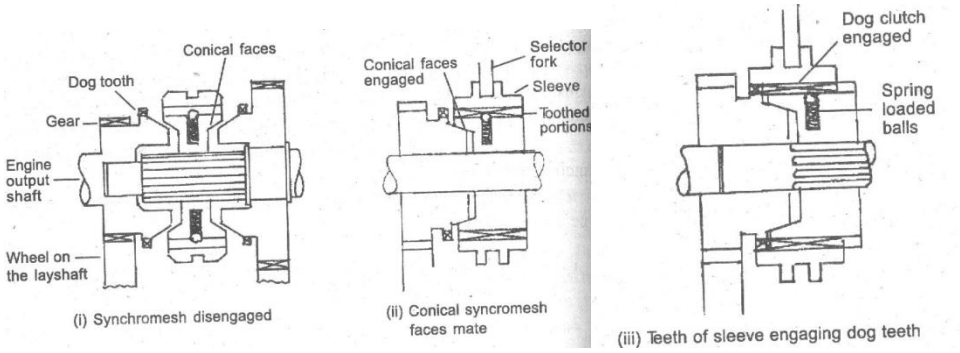
4. All teeth are engaged at once.

Double declutching

In the constant mesh gear box, for the smooth engagement of the dog clutch, it is necessary that the speed of the main shaft gear and the sliding dog must be equal. Therefore to obtain lower gear the speed of the clutch shaft, layshaft, main shaft must be increased. This is done by double declutching.

The clutch is disengaged and the gear is brought to neutral. Then the clutch is engaged and accelerator pedal is pressed to increase the speed of the main shaft gears. After this the clutch is again disengaged and the gear moved to the required lower gear and the clutch is again engaged. As the clutch is disengaged twice in the process this called double declutching. For changing the higher gear however reverse effect is decided; that is the driver has to wait with the gear in neutral till the main shaft speed is decreased sufficiently for a smooth engagement of the gear.

Synchromesh Gear box

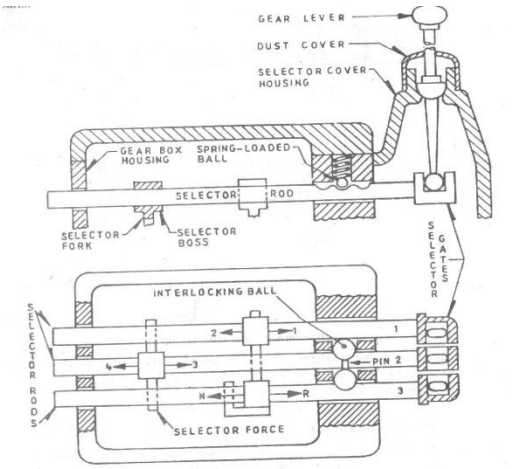


The synchromesh devices are used to simplify the operation of changing gear. This device helps unskilled drivers to change gear without the occurrence of clashes and damages. By this device the members which ultimately are to be engaged are 1st brought into frictional contact and when the friction has equalized their speeds, the positive connection is made. The synchronizer is free to slide on splines. On the main shaft it has conical portions to correspond with the conical portions on the gear box shaft pinion and on the wheel that rotate freely on the main shaft. The synchronizer unit carries a sliding sleeve. In neutral position the sliding sleeve is held in place by the spring loaded ball.

When a shift starts the spring loaded balls cause the synchronizing drum and sliding sleeve as an assembly to move towards the selector gear. The first contact is between the synchronizing cones on the selection gear and the drum. This contact brings both to rotate at the same speed. When the speeds of the two have become equal a slightly greater pressure on the gear over comes the resistance of the balls. Further movement of the shift fork forces the sliding sleeve towards the selector gear. The internal splines on the sliding sleeve match the external splines on the selector gear. Now the dog teeth are locked up or engaged. Thus positive connection is made.

Special modification are made in syneromesh gear boxes to allow sufficient time for smooth operation otherwise a clash will result. Guide bars are provided so that the gear will not be engaged positively before velocity equalization has been made.

Selector Mechanism



There are many mechanism which have been used for selecting the desired gear and sliding the same to engage with the corresponding gear on the layshaft. This can be divided into

1. Shifting mechanism mounted on transmission case

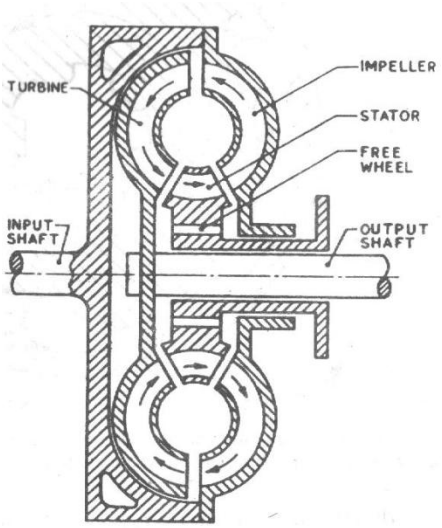
2. Shifting mechanism mounted on steering column

3. Shifting mechanism mounted on floor with remote control linkage.

The lower end of the selector lever fix into slots (Selector gates) in the selector rods. For each selector sleeve separate selector rods are provided. The selector rod can slide but just to avoid unwanted engagement of gears, slots are made on selector rods and are provided with spring loaded balls. An interlocking mechanism which ensures that one gear can be engaged at a time is also used. When particular gear is to be engaged the corresponding selector rod is moved in the desired direction.

Automatic Transmission

Torque Converter



It is the initial component of an automatic transmission. It increases the torque in a ratio of about 2:1 to 3:1. A torque convertor consists of the three main parts.

1. Impeller or the driving member which is connected to the engine.

2. The turbine or the driven member which is connected to the road wheels through the transmission gears

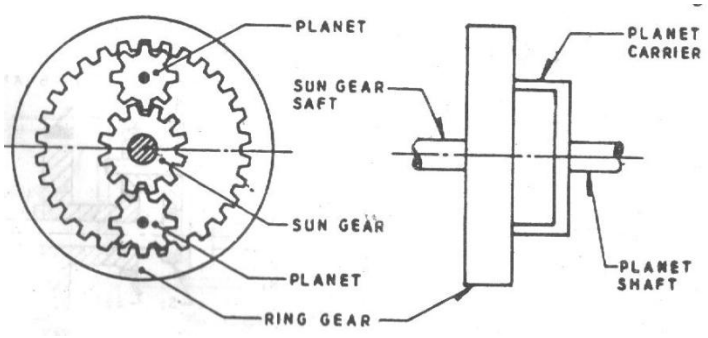
3. Stator fixed to the frame through a free wheel

Oil under pressure is maintained inside the torque converter.

When the engine is started the impeller starts rotating. The oil having taken high kinetic energy from the engine through the impellers hits the outer edge of the turbine. This force increases with the increase of engine speed. The turbine blade angle is such that, when the oil comes out of the turbine, its direction is effectively back ward. It will push the impeller in the opposite direction and will cause a loss of power. To avoid this dragging the fluid is made to strike on stator, which change its direction suitably. The repeated pushing of oil on the turbine blades causes the torque on the turbine to increase, the phenomena is called torque multiplication

When the turbine speed has increased 85% to 90% of impeller speed, the coupling point is reached and the oil leaves the turbine in the forward direction, hitting back the stator blade. To avoids the stator to become a hindrance, It is mounted on a free wheel which allows it to rotate in the direction of turbine or impeller.

Planetary gear unit



An epicyclic gear box consists of two three or even four planetary gear sets. A simple planetary gear unit consist of four main components namely ring gear, pinion or planet gears, carrier, and sun gear. The planets turn around sun gears. These plants gears are carried by a carrier and shaft and are also in mesh internally with ring gear.

Different torque ratios and speed ratios are obtained by making anyone of the parts i.e. the sun gear, carrier or the ring gear stationary. The drive is given to the second member and a varied output is taken from the third.

7 possible speed variations can be obtained from a single planetary gear unit

1. Forward, past output speed, sun gear is stationary - carrier is idle and ring is driven

2. Forward slow output speed sun gear stationary ring gear driving, carrier driven

3. Reverse slow output speed carrier stationary, sun gear driving, ring gear driven

4. Reverse fast output speed carrier stationary, ring gear driving, sun gear driven

5. Forward, very slow output speed, ring gear stationary, sun gear driving, carrier driven

6. Forward, very fast output speed, ring gear stationary carrier driving, sun gear driven

7. Forward, direct drive giving drive to any two members.

Hydraulic Control System

The hydraulic control system of automatic transmission contains the following three main sub systems.

1. Oil pressure producing system- The gear pump.

2. Oil circuit to torque converter and lubrication

3. Gear shift control system

The selection of the particular gear is done hydraulically or done by hydraulic pressure. For shifting to any gear a particular component of the planetary gear unit is locked and drive is given to the second component so that the output is taken from the third one. For locking, brakes are used and for transmitting power clutches are used. The brake is in the form of a band that surrounds the drum attached to the gear. The clutch used is of multiplate clutch. Both the brake and the clutch are applied by fluid pressure. These are selected by hydraulic shift valves.

The selector lever for an AT generally has 5 positions that is P R N D L

Position P is for parking and employs a mechanical pawl system for locking.

N stands for neutral position. For reverse the lever has to be brought to position R position. L is hold on to a low gear. Position D is for fully automatic operation, up or down.

Electronic Shift Control System

Shift to a particular gear is utilized by an AT controller. AT controller operates solenoid for shifting according to the signals received by it through sensors. The shifting is regulated by two factors.

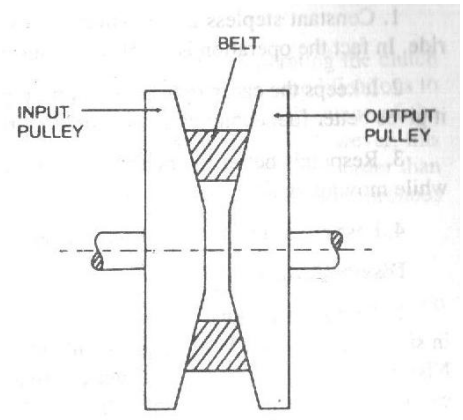
1. Vehicle speed

2. Throttle opening controlled by the driver.

At low speed and high throttle opening the gear is shifted to low gear. Similarly at high speed and low throttle opening the gear is shifted to higher gear. The Vehicle speed is measured using a vehicle speed sensor and the throttle opening is measured by a throttle position sensor. The solenoid operate shift valve so that hydraulic pressure is supplied to the corresponding brake or clutch.

In older version of automatic transmission no AT controller is used. There the vehicle speed is measured by a governor valve and throttle opening is measured by a throttle valve. Fluid pressure is applied at both end of the shift valve from governor valve and throttle valve. When any one of the pressure varies, shift valve moves and shifting takes place accordingly.

Continuously Varying Transmission



CVT is an automatic transmission that can select any desired drive ration within its operating rate unlike a conventional four or five speed transmission.

A single CVT has 3 main components

1. Variable input drive pulley

2. Output pulley

3. Belt

A part from these there are various microprocessors and sensors. Both the driving as well as driven pulleys are of variable diameter type. Each pulley is made of two 200 cones facing each other. The driving pulley is connected to the engine crank shaft while the driven pulley transfers motion to the drive shaft. When the two cones of the pulleys and close together, the belt rides higher in the groove and the pulley dia apparently increases, whereas the belt rides lower in the groove, making the effective diameter decrease, when the two cones of the pulley are far apart. The two cones are moved closer or far apart using hydraulic pressure or centrifugal force or springs tension all through electronic control.

Advantages

1. Constant stepless acceleration

2. Keeps the car in optimum power range under all condition.

3. Response better in changing condition

4. Less emission

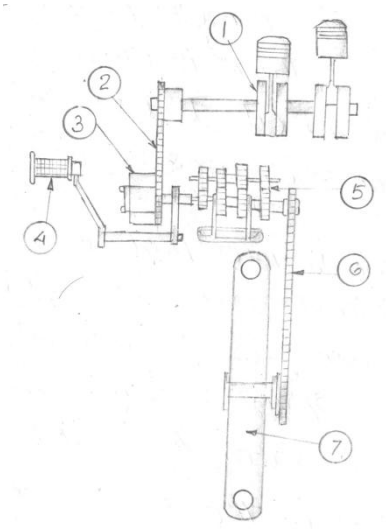
Disadvantages

1. Torque handling capability is limited

2. CVT cannot be used for standard drive line

3. Life of CVT is less compared to AT

Operating Principle of Motor Cycle



1. ENGINE 2. CHAIN 3. CLUTCH 4. KICK STARTER 5. GEAR BOX 6. CHAIN 7. REAR WHEEL

Usually motor cycles are run on the principle of the two stroke engine. On a few occasions they are also run using a four stroke engine. The fuel used is mainly petrol.

Components of power train (With chains)

The drive is transmitted from the engine to the rear wheel with the help of two chain connections one chain is from the engine to the clutch. The other than is from the gear box to the rear axle.

First the kick starter is operated this starts the engine when the engine is running, the drive of crank shaft is transmitted to the clutch by means of chain. The clutch transmits the drive to the grear box. The chain transmit the drive from the gear box to the rear axle. Finally the rear wheel rotates and the motor cycle moves.

(1) Engine (2) Chain (3) Clutch (4) Kick Starter (5) Gear Box (6) Chain (7) Rear Wheel

Multi Plate Clutch

In a motor cycle, a single plate clutch is not able to transmit the power from the engine to the gear box. Therefore, a multi-plate clutch is used. This clutch is always kept immersed in oil. Due to this the surfaces of the plates don't get too heated.

The various parts of multi-plate clutch are four clutch disks, four pressure plates, a clutch hub and springs. When the control lever is operated, the clutch gets engaged then the pressure plates don't press on the clutch disks. Thus there is no transmission from the flywheel to the gear box.

When the clutch lever is not in operation the clutch gets disengaged. The clutch disks carry a clutch lining on both the sides. This develops the adhesive friction required for the operation of the clutch.

Constant Mesh Gear Box

It has a four speed gear box. Four gear of the driving shaft are always in constant mesh with four gear of the driven shaft. Only the movement of the dogs brings the change in speed. Therefore, this gear box is called the constant mesh gear box.

DRIVE LINE

Propeller Shaft

This is the shaft which connects the gear box output shaft to the pinion shaft of differential. The propeller shaft carries the power from the engine clutch and transmission unit to the driving wheels of the vehicle through the final drive. It mainly consist of 3 parts

1. Shaft

2. Universal joints

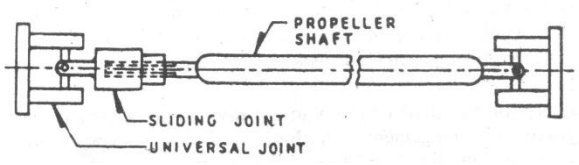
3. Slip joint

Functions of propeller shaft

1. Transmit the power from gear box top final dive.

2. To compensate the change in length.

3. Transmit motion at an angle which is varying frequently

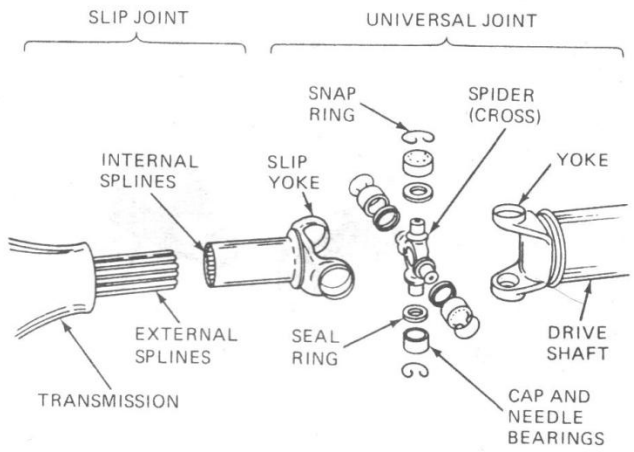


The propeller shaft is manufactured in thin walled steel tubes. Tubular section makes them lighter and stronger than a solid shaft of same size. It is also less expensive. If the distance between transmission shaft and differential is more, one or more intermediate shafts are connected to the gear box main shaft and other end to the main propeller shaft. The intermediate propeller shaft is supported in a bearing unit.

Slip Joint

A splined slip joint is incorporate along the propeller shaft. Slip joint consist of external splines on the end of one shaft and matching internal splines on the other shaft slip joint permits the two shafts to slide back and forth along each other and still transmit power. This joint enable propeller shaft to change its effective length. Slip joint is usually provided in propeller shaft close in the universal joint situated near the gear box.

Universal Joint - Hooks Joint



Universal joints are incorporated at the ends of the propeller shaft. Universal joints take care of the variation in inclination of the propeller shaft. Universal joint consist of two 'Y' shaped yoke and a cross shaped member called spider. The four arms of the spider are assembled into needle bearing housed in the lug of the yokes. The needle bearing consist of steel sleeve and a set of thin needle rollers. Special glands keep the lubricant from flowing out. When the two shaft are an at an angle the bearing in the yoke permit the yoke to swing on the spider with each rotation of the shaft.

The universal joints have one defect, that is the speed of the driven shaft does not remain uniform depending up on the angle of inclination of the shaft. The driven shaft speed under goes cyclic variation. The variation is zero in zero angle of inclination but its magnitude become considerable when the angle is large. In order to limit the fluctuation in speed of the joint angle is limited to 18-20%

The above mentioned speed variations can be overcome by using two separate universal joint connected to the propeller shaft. With this arrangement the velocity variation at the second joint is equal and opposite to that which occurs at the first joint so that both cancels. This will be valid only when angles on the both joints are exactly equal.

Constant Velocity Joints

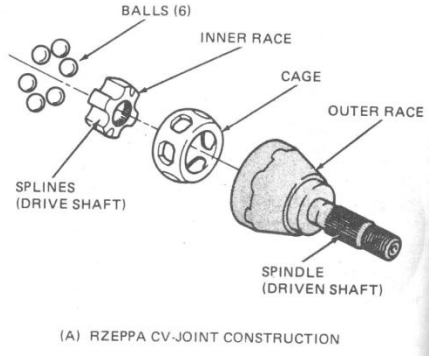
1. Rzeppa joint

2. Tripod joint

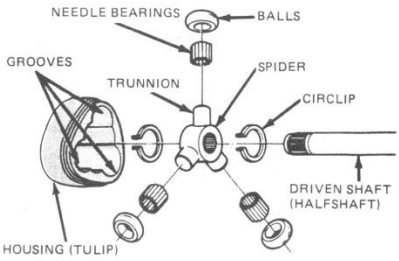
3. Rzeppa plunging CV joint

4. Closed tulip plunging CV joint

5. Open tulip plunging CV joint



(A) RZEPPA CV-JOINT CONSTRUCTION



(A) TRIPOD CV-JOINT CONSTRUCTION

Constant velocity joints are used where the front axle are being driven, regulation of rotation and transmission of torque at large indication are vital. In these vehicles the inclination between the shafts may assume a large varying (40^0). The speed of shaft connected by these joints are absolutely equal. Types of CV joints are given above.

The first CV joint is the Rzeppa joint. In this 6 sperical ball are held in a precise geometrical position midway between 2 shaft. Another CV joint is tripod joint which are 3 roller bearing attached to arms at the end of the driving shaft further modified with plunging capability. This permits driving and driven shaft move towards away from each other.

Rear axle

Various forces and torques experienced by rear axle can be identified as follows.

1. Weight of the body

The rear axle may be considered a beam supported at ends loaded. This weight causes shear force and bending movement in the axle shaft.

2. Driving Thrust

The driving torque produced in the engine causes the thrust to be produced in the road wheels which has to be transmitted from the axle casing to chassis frame and the body of the vehicle.

3. Torque reaction

If the road wheels are prevented from rotation from the propeller shaft rotating, it is seen that bevel pinion with tends to roll down to crown wheel. This tendency is also present when the vehicle is running. Thus there is a force on axle casing to rotate. This called torque reaction.

4. Side Thrust

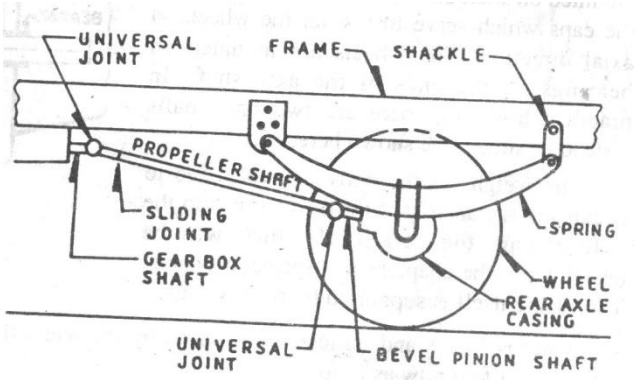
Often the rear axle experiment side thrust or pulls due to any side load on the wheel.

The commonly used rear axle drives are

1. Hotch kiss drive

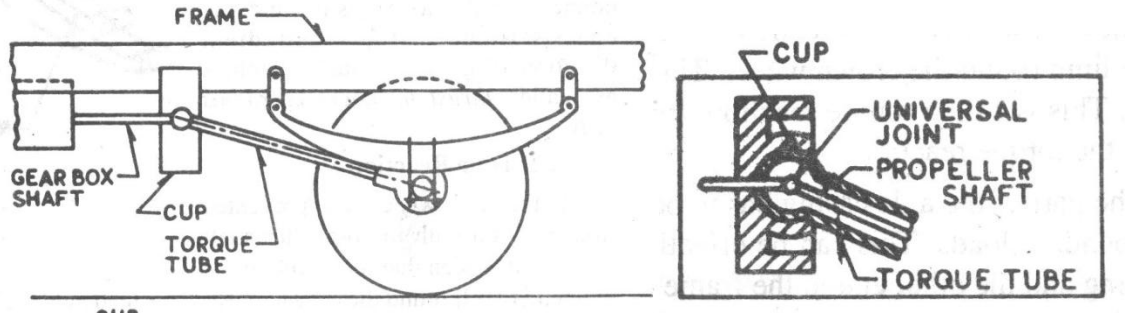
2. Torque tube drive

1. Hotch kiss drive



This is the simplest and most widely used type of rear axle drive. In this case the springs besides taking weight of the body also takes the torque reaction, driving thrust and side thrust. The propeller shaft is provided with two universal joints also a sliding joint. The springs is fixed rigidly in the middle to the rear axle. The front end of the spring is fixed rigidly on the frame while the rear end is supported in the shackle.

2. Torque tube dive



In this type of drive the spring takes only the side thrust besides supporting the body weight. The torque reaction and driving thrust are taken by another member which is called torque tube. One end of the torque tube is attached to the axle casing, another end which is in spherical shape fixed in the cup fixed to the frame. The torque tube encloses the propeller shaft since the torque tube takes the torque reaction the centre line of the bevel pinion shaft will not shift. So that no sliding joint is required and one universal joint is enough.

Rear axle shift supporting

Load on Rear live axle half shaft

1. Shaft force due to vehicle weight

2. Bending moment on accountant of the offset of vehicle load applied through spring seats and road wheels.

3. End thrust carried by side forces

4. Bending moment caused by end thrust and its reaction offered by tyres

5. Driving torque

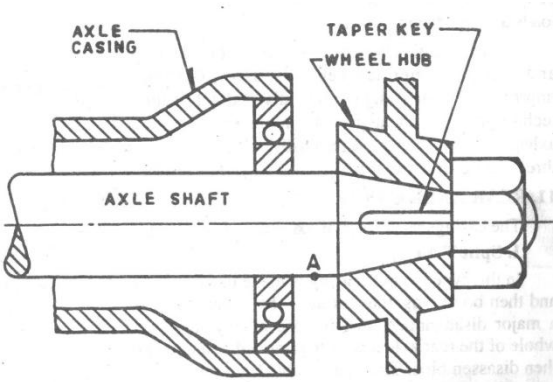
Three common types of rear axle support are

1. Semi floating

2. Fully floating

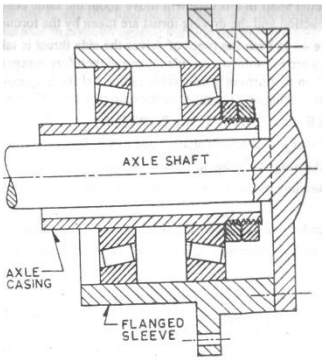
3. Three quarter floating

1. Semi floating



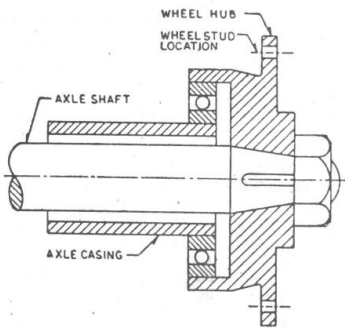
An axle in which the shaft has to take the entire load is called semi or non floating axle. In this wheel hub is directly connected to the axle.The inner end of the axle shaft is splined and is supported by the final drive unit where as outer end is supported by a single bearing inside the axle casing. In this type all the loads are taken by the axle shaft. The whole load acts on the shaft and shaft has a tendency to shear at the point A. The semi floating axle is the simplest and cheapest but for a given torque they have to be of larger dia. for the same torque transmitted compared to the other type of rear axle supports.

2. Fully floating



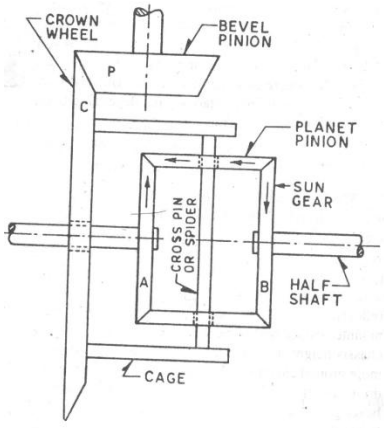
This type is very robust and is used for heavy vehicle. The axle shafts have flanges at the outer end which are connected to the flanged sleeve by means of bolts. There are two tapper roller bearing supporting axle casing in the hub which take up any side load. Thus the axle shaft carry only the driving torque. So their failure or removal does not affect the wheels.

3. Three quarter floating



This type of axle is a combination of full and semi floating bearing. In this bearing is locating between the axle casing and hub axle shaft do not have to withstand any shearing or bending action due to the weight of the vehicle, which are taken up by the axle casing through the hub and bearing. However it has to take the end loads and driving torque.

Differential



When a car is taking a turn the outer wheels has to travel greater distance as compared to the inner wheels at the same time. So some mechanism must be incorporated in the rear axle which would reduce the speed of the inner wheels and increase the speed of the outer wheel when taking turns. The device which serves the function is called a differential. The crown wheel of the final drive is attached to a cage which carry a cross pin (spider), two sun gears mesh with the two planet gears. Axle half shafts are splined to each of these sun gears. The crown wheel is free to rotate on half shaft. When the vehicle is going straight the cage and the inner gears rotate as a single unit then the

two half shafts revolve at the same speed. In this situation there is no relative movement among the various differential gears.

While taking a turn the inner wheel meets the higher resistance than the outer wheel and its rotation is solved down the resistance at the inner wheel is more. This causes the planet gear to turn on their spindles this inturn causes the planet gear to roll around the side gear (sun gear) on the inner shaft. The above action causes more turning effort to the outer sun gear and thereby it accelerates so that the outer turns a greater distance than the inner wheel while the input torque supplied to the differential is balanced between the two half axles.

Due to this reason if one wheel is in a slippery surface, no tractive force could be obtained from the other wheel. This equality of torque is true only if there is no friction in the differential system but this is not always happened.

The larger the amount of friction inside differential, the larger is the inequality of torques. Hence if one wheel is on a slippery surface the grip of the other wheel can be utilized. This is possible only when friction is present. For this reason some times friction is introduced in differentials intentionally by employing clutch friction plates between the sun gear and cage. These plates are loaded by means of springs which are so mounted that loading increases directly as the torque is varied. Such differential is called limited slip differential.

Another alternative to overcome this problem is to provide a differential lock. When the lock is applied the differential action is stopped and the whole is applied to the wheel which retains the grip on the ground.

WHEELS AND TYRES

Functions

1. The wheel along with tyre has to take the vehicle load provide cushioning effect and cope with steering control.

2. It should be balanced statically and dynamically

3. It should be light so that unsprung weight is less

4. It should be possible to remove or deteriorate with weathering and age.

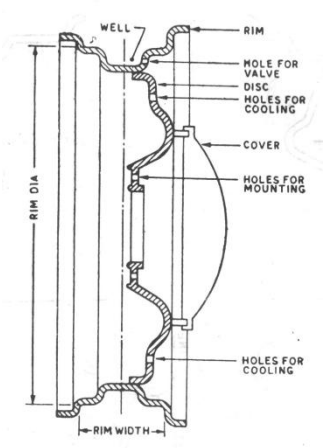
Type of wheels

1. Pressed steel disc wheel

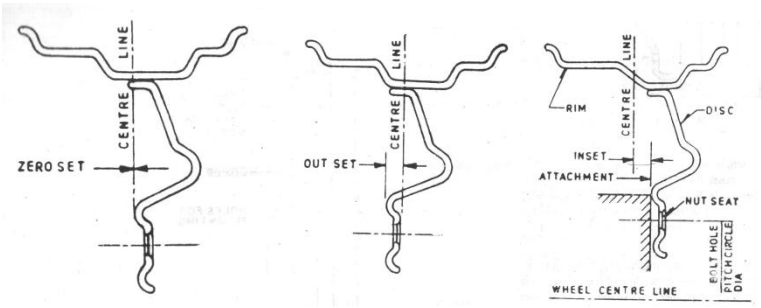
2. Wired wheel

3. Alloy wheel

Disc Wheel



This type of wheels consists of two parts, a steel rim which is generally well based to receive the tyre and pressed steel disc. The rim and disc may be integral permanently attach or attachable. The seat of the rim where the tyre rests usually has a 5-15° taper. The wheel is fitted on the axle by the bolt in to a flange attached. Slots are provided on wheel disc to allow the air to pass.



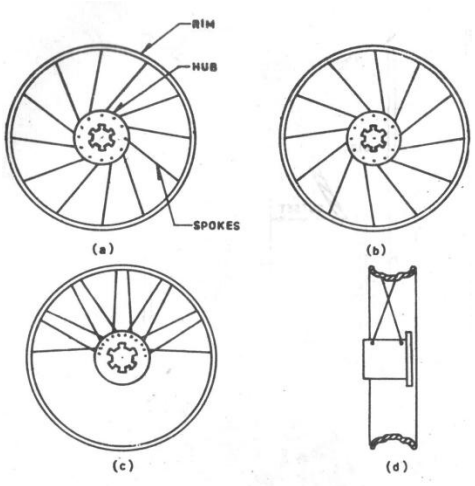
A wheels may inset, outset or zeroset depending upon the position of the rim in relation to attainment face of the disc. In the inset wheel the centre line of the rim is located inboard of the attachment face of the disc. A zero set wheel is the one in which the rim centre line coincides with the attachment face of the disc.

In the outset wheel, the centre line of the rim is located out board of the attachment face of the disc.

A wheel whose disc can be mounted on either face provide inset or outset does decreasing or increasing of wheel track is called reversible wheel.

A wheel constructed in two parts which when securely faster together combined to form a rim having two fixed flanges is called a divided wheel. For have in vehicles the large tyres are used which are bulkier in the bead region for such types flat rims are used may be 2, 3, 4 or 5 piece construction.

Wire Wheels



Taking stresses by spokes due to :
(*a*) driving torque (*b*) braking torque
(*c*) vehicle weight (*d*) side force.

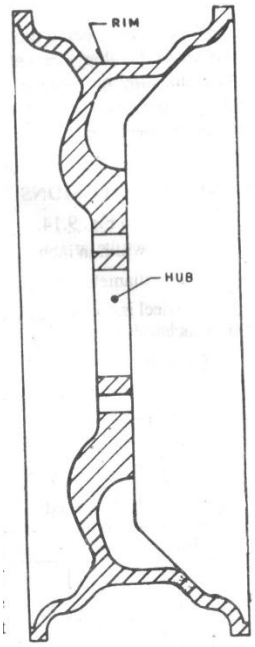
The wire wheel has a separated hub which it attached to the rim through a number of wires hooked at one end of the hub while the other end is pushed through the hole in the wheel rim. where a tapered nut called nipple is creed down pulling the spoke tight. The spoke carry weight, transmit the driving and braking torques and width stand the side forces while cornering in tension. The spokes are mounted a complicated criss cross fashion in all the three planes. The initial tension of the spoke can be adjusted by means of screw nipple which also serve secure the spoke of the rim. The hub is provided with internal splines to correspond to the splines provided on the axle shaft.

The advantages are

Light weight

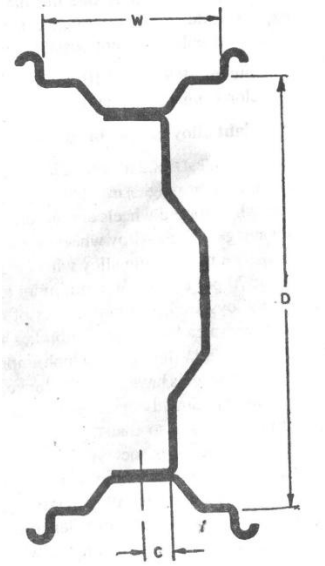
High strength and greater cooling of brake drum.

High Alloy Wheels



Alloy wheels are made from Aluminum or Magnesium alloys. Cast vehicles are used for cars while forged wheels are preferred for heavier vehicles. The main advantage of alloy wheels is their reduced weight which reduces unsprung weight. More over they are better conductors of heat. Further wider rims are possible in this case which improves stability on cornering. Magnesium alloys have high impact and fatigue strength while Aluminum alloy wheels are less prone to corrosion. Aluminum alloy wheels are generally used for commercial applications where as in sports and racing cars Magnesium alloys are used, higher cost is their only disadvantage

Wheel dimension



W-Width in inches (or mm)

D-Diameter in inches (ormm)

C-Offset

The wheels denoted by a code no. which contains the following in sequence

1. Width

2. A letter identify the rim profile

3. Diameter

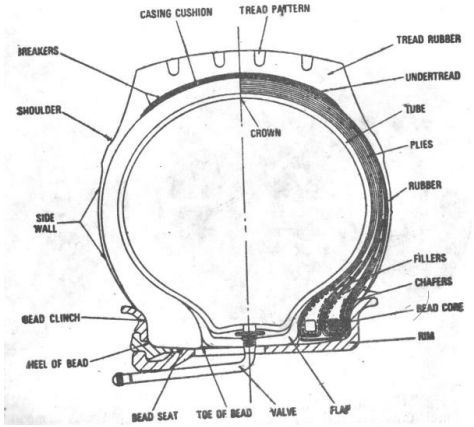
For eg. The code 5.50B-13 shows

The width is 5.5 inches, the rim type as B and 13 inches diameter.

Wheel of the same dimension W and D may have different offsets, C.

Wheels of identical offset must be fitted to a vehicle

Tyre



Tyre is a cushion provided with an automobile wheel. It consists of the tyre proper and the tube inside. The tyre tube assembly is mounted over the wheel rim it is the air inside the tube that carries the entire load and provides the cushion.

Functions of tyre

1. To support vehicle load

2. To provide cushion against shocks

3. To transmit driving and breaking forces to road.

4. To provide concerning power for smooth steering

Tyre properties

1. Non skidding

2. Uniform wear

3. Load carrying

4. Cushioning

5. Power consumption

6. Tyre noise

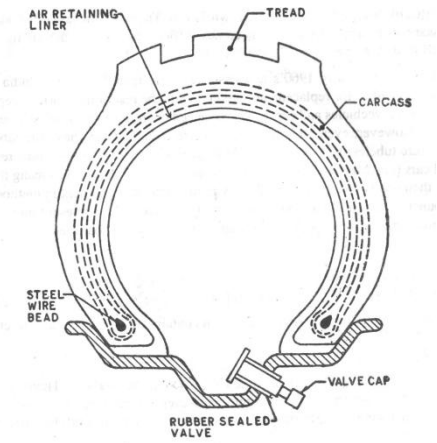
7. Balancing

The tyre consist of two parts the carcass and the thread. The carcass is the basic structure taking mainly the various loads and consist of a number of piles wound in a fashion from the coats of rayon or any other suitable material. Each cord in each ply is covered with rubber and insulated against each other inorder to prevent the tyre from being thrown out of the rim. The plies are attached to two rings of high tension steel wire called beads.

The thread is the part of the tyre which contacts the road surface when the wheel rolls. The thread design depends on various tyre properties, the grip noise, and wear. The thread is moulded into a series of grooves and ribs, the ribs provided the traction edges required for gripping the roads surface while the grooves provided passage for quick escape of any foreign matter such as water Sipes are provided on the ribs.

Between the bead and the thread, outer rubber covering of the carcass is called side wall. Inside the tyre there is a tube which contains the air at pressure.

Tubeless tyre



This type of tyre does not need a separate tube, instead the air under pressure is filled in the tyre itself. The inner construction is similar to that of a tubed tyre except that it is lined on inside with a special air retaining liner made up of halogenated butyl rubber. The bead area of the tyre sits more tightly within the flange of the rim to ensure stability along with the correct tyre pressure for which there is an extra wrapping over the bead area.

Advantages

1. Lesser unsprung weight

2. Better cooling

3. Slower leakage of air

4. Simpler assembly

5. Improved safety

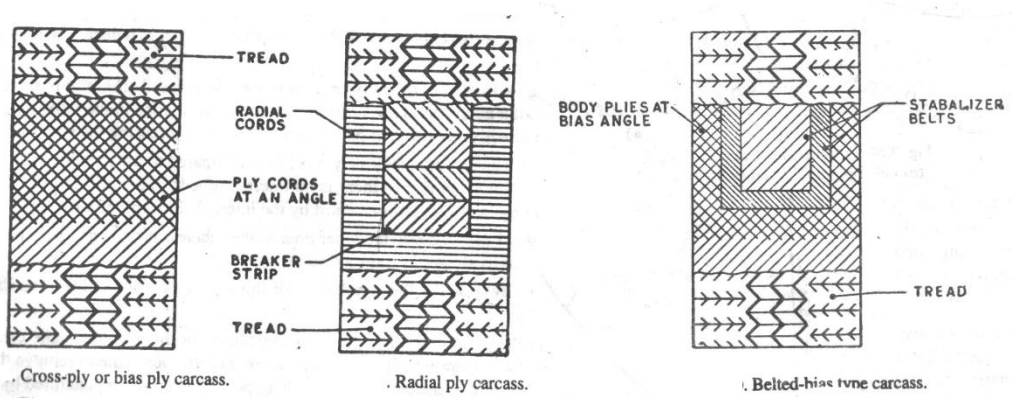
Carscass types

Carcass or skeleton of a tyre is of three types

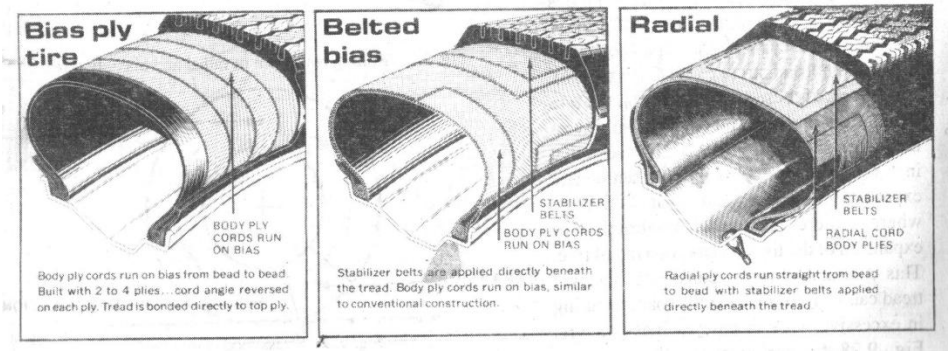
1. Cross ply or bias ply

2. Radial ply

3. Belted Bias Type



. Cross-ply or bias ply carcass. . Radial ply carcass. . Belted-bias type carcass.



Cross ply

In this type the ply cords are woven at an angle (30-40°) to the tyre axis. There are two layers which run in opposite direction. However the cords are not woven like wrap and weft because that would lead to rubbing of the two layers and thus produce heat which would damage the tyre material.

Radial Ply

In this the ply cords run in the radial direction, ie in the direction of the tyre axis. Over this basic structure run a number of breaker strips in the circumferential direction. The material for the brake strip must be flexible but inextensible so that no change of circumference takes place which change in the amount of inflation. Without the brakes strips the radial ply gives soft drive but does not have any lateral stability.

Belted bias type

This is combination of cross ply and radial ply type. The basic construction is the bias ply over which run a number of breaker belts. The belts improve the characteristics with the bias ply to larger extent. The stress in the carcass is restricted and the thread area is stabilized due to belts. It increases tyre life. The breaker belts hold the tyre flatter against the road surface, thus causing increase in traction and safety.

Comparison of radial and Bias ply type

1. The side walls of redial ply tyres can bend radially.

Their shock absorbing deflection is about 25% more than cross ply tyres.

2. The breaker strips of the radial tyres act independently of the wall plays unlike in cross ply tyre where there is no breaker strips and the thread is supported only by the higher walls plys. Thus there is a continuous flat contact patch area with the road surface for the radial tyres.

3. Lower rolling resistance and hysteresis loss which ultimately means reduced fuel consumption.

4. Longer thread life.

5. On account of greater side wall flexibility and thread region stiffness, water removal efficiency and hence the braking efficiency on wets roads is better in case of radial ply tyres.

6. Smaller slip angles and higher cornering power which result in better steering characteristics

7. Less tendency to skid while cornering

8. Larger resistance to punctures, cuts and impacts in the thread area on account of the breaker belts.

Disadvantages of radial tyres

1. Heavier steering at low speeds

2. Uncomfortable hash ride at low speech

3. The cost is initially higher

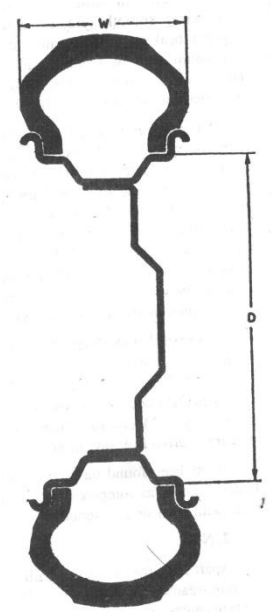
Tyre materials

Rubber used in tyres is a blend of natural and synthetic rubber to which various chemicals are added to obtain desired properties like wear resistance, less internal friction, reduced hysterisis etc. eg. carbon black is added to tread rubber to improve resistance wear. For beads bronze plated high tensile steel wire is used, a special rubber insulation is squeezed around and between the separated stands.

Staple cotton, was first use as tyre carcass material it was replaced by rayon. Subsequently nylon was introduced which is stronger and more elastic. Terylene was also used.

For cords of stabilizer welts the materials used are rayon, terylene, glass fiber or steel

Tyre Section



The ratio tyre section height / tyre section width is called aspect ratio and is expressed in percentage. At first the aspect ratio used was 100 and in advancement of technology types with lower aspect ratio became popular. Now a days aspect ratios as low as 50% are used. Rather in racing cars it is down to 27%.

Tyre Designation

A tyre is represented by a code no: which contains a following in sequence

1. Width

2. Speed rating

3. Type of tyre

4. Diameter in inches R sincerities the type is of radial

For eg. 145 SR-13

Signifies that tyre has speed rating up to 170 km/hour is of radial tyre, has w=145mm, D=13 inches.

Factors affecting tyre life

1. Inflation

2. Vehicle maintenance

3. Manner of driving

4. Miscellaneous factors

1. Inflation

The tyre must be inflated according to the specified pressure. Both under inflation and over inflation are detrimental to tyre life. The main effects of over inflation are rapid wear of tyre thread in centre, increase tendency for concussion brakes, hash ride, decrease resistance to skidding

The effects of under inflation are excessive flexing of tyre carscass which causes damage to itself, more thread wear on the sides than the centre, rimbruise.

2. Vehicle maintenances

1. Wheel alignment

2. Camber

3. Castor

4. Brake adjustment

5. Matching and spacing of dual tyres

3. Manner of driving

The manner in which the vehicle is driven effects the tyre life. Excessive speed in quick starts and sudden stops all causes faster thread wear. Careless parking may lead to kerbing, when the side wall grazes the pavement and gets damaged.

4. Miscellaneous Factors

1. Heat

2. Position in which tyre is fitted

3. Road condition

4. Seasons.