Branch: Mechanical

Semester: 6th Sem

Subject: Automobile Engineering

Chapter: 1

Topic: Introduction & Transmission System

Faculty: SIBASISH SAHU

INTRODUCTION

Automobile engineering is the one of the stream of mechanical engineering. It deals with the various types of automobiles, their mechanism of transmission systems and its applications. Automobiles are the different types of vehicles used for transportation of passengers, goods, etc. Basically all the types of vehicles works on the principle of internal combustion processes or sometimes the engines are called as internal combustion engines. Different types of fuels are burnt inside the cylinder at higher temperature to get the transmission motion in the vehicles. Most of the automobiles are internal combustion engines vehicles only. Therefore, every mechanical and automobile engineer should have the knowledge of automobile engineering its mechanism and its various applications.

OBJECTIVES

After studying this unit, you should be able to

- Define automobile engineering,
- Classify the vehicles,
- List the various components of automobile, and
- Describes the function of components of automobile

DEFINITION

Automobile engineering is a branch of engineering which deals with everything about automobiles and practices to propel them. Automobile is a vehicle driven by an internal combustion engine and it is used for transportation of passengers and goods on the ground. Automobile can also be defined as a vehicle which can move by itself. Examples : Car, jeep, bus, truck, scooter, etc.

CLASSIFICATION OF VEHICLES

Automobiles or vehicles can be classified on different bases as given below

On the Basis of Load

- Heavy transport vehicle (HTV) or heavy motor vehicle (HMV), e.g. trucks, buses, etc.
- Light transport vehicle (LTV), e.g. pickup, station wagon, etc.
- Light motor vehicle (LMV), e.g. cars, jeeps, etc.

Wheels

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

Fuel Used

- Petrol vehicle, e.g. motorcycle, scooter, cars, etc
- Diesel vehicle, e.g. trucks, buses, etc
- . Electric vehicle which use battery to drive.
- Steam vehicle, e.g. an engine which uses steam engine. These engines are now obsolete.
- Gas vehicle, e.g. LPG and CNG vehicles, where LPG is liquefied petroleum gas and CNG is compressed natural gas.

Body

On the basis of body, the vehicles are classified as :

- Sedan with two doors
- Sedan with four doors
- Station wagon
- Convertible, e.g. jeep, etc
- Van
- Special purpose vehicle, e.g. ambulance, milk van, etc.

Transmission

- Conventional vehicles with manual transmission, e.g. car with 5 gears.
- Semi-automatic
- Automatic : In automatic transmission, gears are not required to be changed manually. It is automatically changes as per speed of the automobile.

Position of Engine

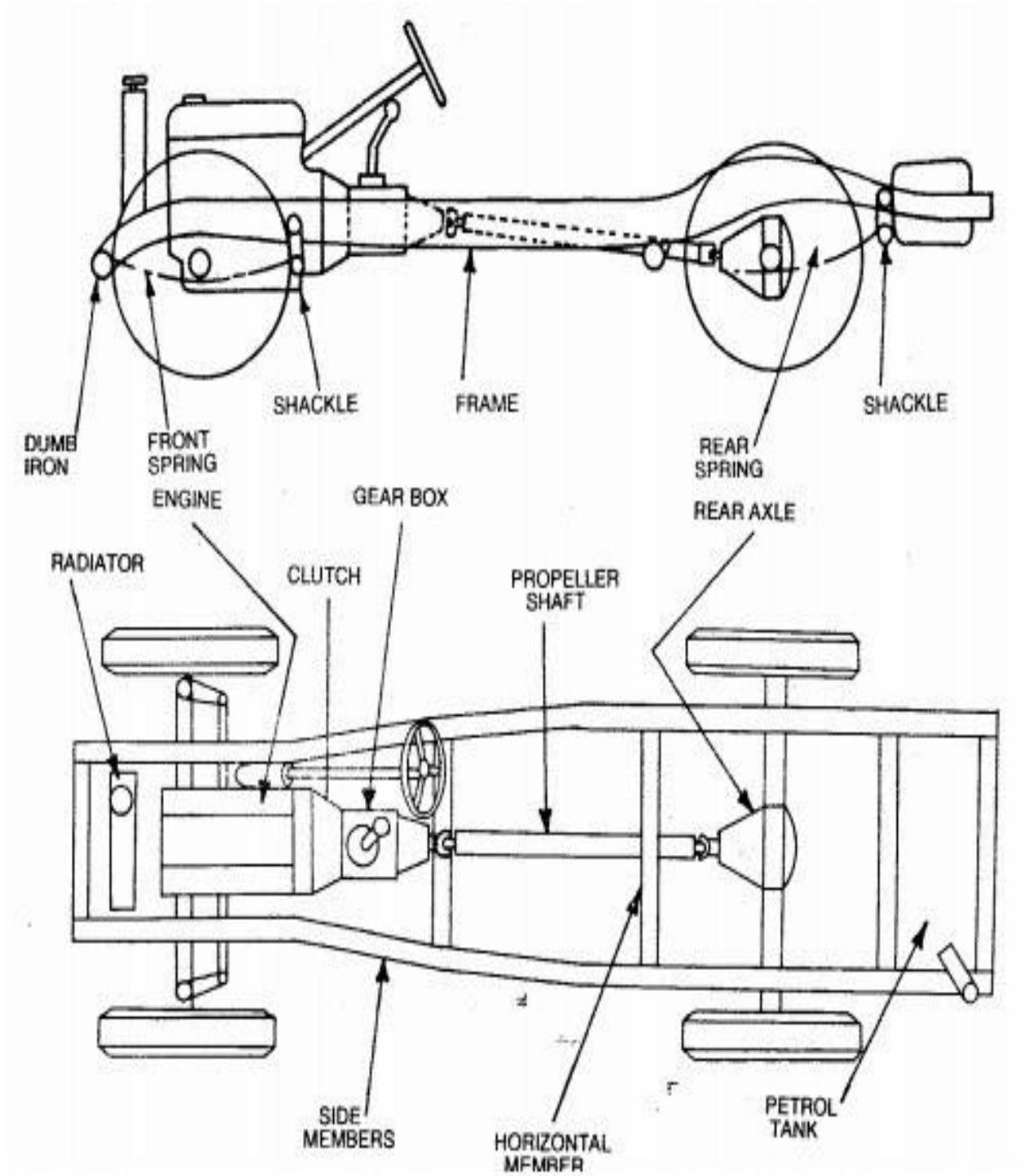
Engine in Front:-Most of the vehicles have engine in the front.

Example: most of the cars, buses, trucks in India.

Engine in the Rear Side:-Very few vehicles have engine located in the rear.

Example: Nano car.

LAYOUT OF AN AUTOMOBILE CHASIS



BASIC CHASSIS

CLUTCH SYSTEM

In clutch one shaft is usually connected to an engine or another power unit (driving member), while the other shaft (driven member) provides output power for the work.

The clutches used in a motor vehicle are almost very similar in construction and operation. There are some differences in the details of the linkage as well as in the pressure plate assemblies.

In addition, some clutches for heavy-duty applications has a two friction plate and an intermediate pressure plate. Some clutches are operated by hydraulic means. The dry single-plate type of friction clutch is almost used in American passenger cars.

The various types of clutches used in the automobile depend upon the type and use of friction.

Most designs of the clutches use a number of coil springs but some use a diaphragm or conical type spring. The type of friction materials also varies in the clutches of different passenger cars

TYPES OF CLUTCHES

Following are the different types of clutches:

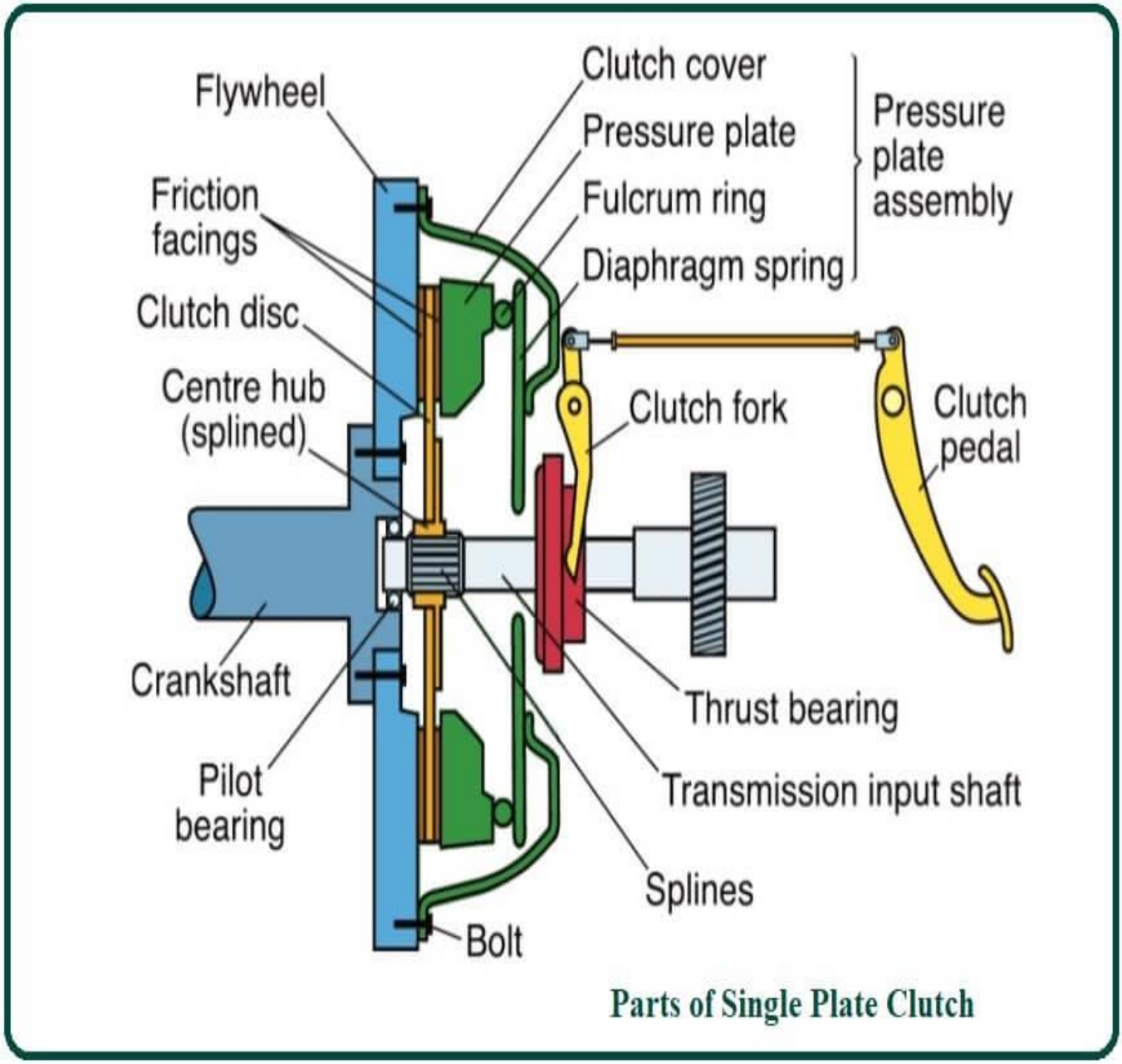
1. Friction clutch
    1. Single plate clutch
    2. Multiplate clutch
        1. Wet
        2. Dry
    3. Cone clutch
        1. External
        2. Internal
2. Centrifugal Clutch
3. Semi-centrifugal clutch
4. Conical spring clutch or Diaphragm clutch
    1. Tapered finger type
    2. Crown spring type
5. Positive clutch
    1. Dog clutch
    2. Spline Clutch
6. Hydraulic clutch
7. Electromagnetic clutch
8. Vacuum clutch
9. Overrunning clutch or freewheel unit

1. SINGLE PLATE CLUTCH

Single plate clutches are one of the most commonly used types of clutches used in most modern light vehicles. The clutch helps to transmit torque from the engine to the transmission input shaft. As the name states it has only one clutch plate.

It consists of a clutch plate, friction plate, pressure plate, flywheel, bearings, clutch spring and nut-bolts arrangement.

The single-plate clutch has only one plate which is attached on splines of the clutch plate. Single plate clutch is one of the main components of the clutch. The clutch plate is simply thin metallic disc which has both side friction surfaces.



Parts of Single Plate Clutch

The flywheel is attached on the engine crankshaft and rotates with it. A pressure plate is bolted to flywheel through clutch spring, which provides the axial force to keep the clutch engaged position, and is free to slide on the clutch shaft when the clutch pedal is operated.

A friction plate which is fixed between the flywheel and pressure plate. The friction lining is provided on both sides of the clutch plate.

Working:

In a vehicle, we operate the clutch by pressing the clutch to peddle for disengagement of gears. Then springs get compressed and the pressure plate moves backwards. Now the clutch plate becomes free between the pressure plate and flywheel. Due to this now the clutch is getting disengaged and able to shift the gear.

This makes flywheel to rotate as long as the engine is running and the clutch shaft speed reduces slowly and then it stops rotating. As long as the clutch peddle is pressed, the clutch is said to be disengaged, otherwise, it remains engaged due to the spring forces. After releasing the clutch pedal the pressure plate comes back to its original position and clutch is again engaged.

Multiplate Clutch

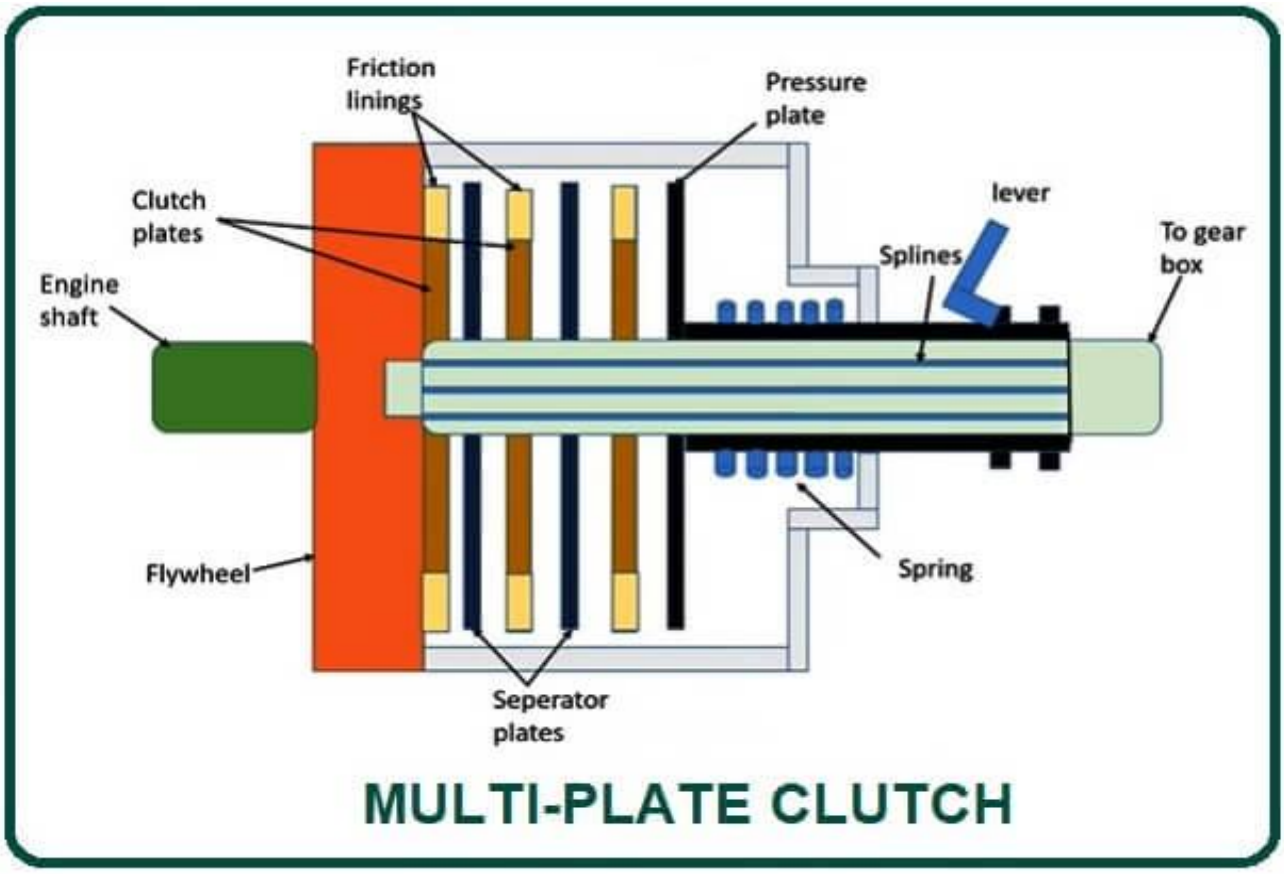
The multi-plate clutch is shown in the figure. These types of clutches use multiple clutches to make frictional contact with a flywheel of the engine. This makes transmit power between the engine shaft and the transmission shaft of a vehicle. The number of clutches means more friction surface.

The increased number of friction surfaces also increases the capacity of the clutch to transmit torque. The clutch plates are fitted to the engine shaft and gearbox shaft.

They are pressed by coil springs and assembled in a drum. Each of the alternate plates slides in grooves on the flywheel and the other slides on splines on the pressure plate. Hence, each different plate has an inner and outer spline.

The working principle of multiple clutches is the same as the working of the single-plate clutch. The clutch is operated by pressing the clutch pedal. The multiple clutches are used in heavy commercial vehicles, racing cars, and motorcycles for transmitting high torque.

The multiple clutches have two characters dry and wet. If the clutch is operated in an oil bath, it is known as a wet clutch. If the clutch is operated dry without oil, it is known as a dry clutch. The wet clutches are commonly used in connection with, or as a part of the automatic transmission.


Friction linings
Pressure plate
Clutch plates
lever
Splines
To gear box
Engine shaft
Flywheel
Spring
Seperator plates
MULTI-PLATE CLUTCH

GEAR BOX

INTRODUCTION

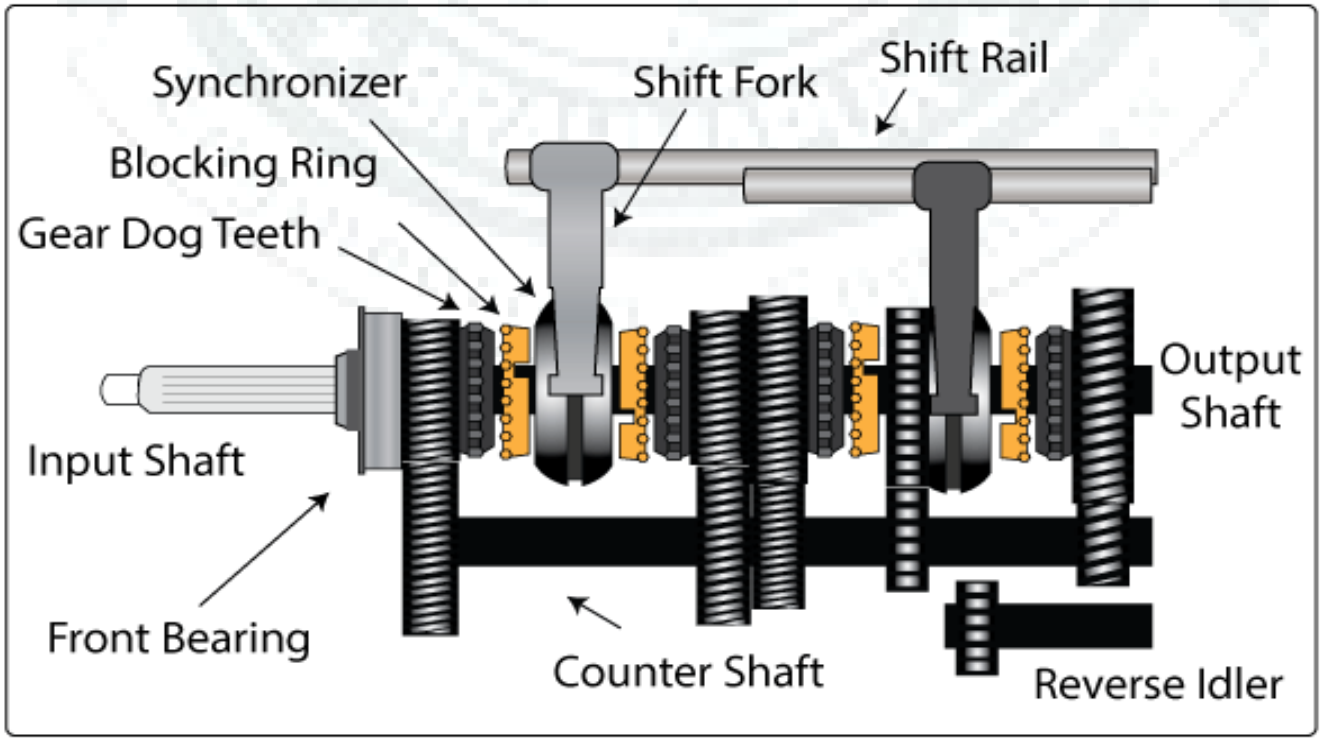
A transmission is a machine in a power transmission system, which provides controlled application of power. Often the term 5-speed transmission refers simply to the gearbox, that uses gears and gear trains to provide speed and torque block conversions from a rotating power source to another device.

High torque is required to start the vehicle from rest, accelerating, hill climbing, pulling a load and facing other resistances. But the IC engine operates over a limited effective speed range which produces a comparatively low torque. In such a situation, the engine is responsible for the stall and the vehicle rests if the speed falls below the limit.

The torque developed by the engine is increasing within limits with the increase of engine speed and reaches a maximum value at some predominant speed. If the engine directly connects to the driving axle, the engine speed may reduce.

Due to the variable nature of the vehicle resistance resulting in load and gradient changes, it require that the engine power should be available over a wide range of road speeds. Hence, for this reason, the engine speed maintain by using a reduction gear resulting in the road wheels rotating at a proper speed suited to the operating conditions of the vehicle.

Therefore, a single torque multiplication in the rear axle must be interposed and a variable multiplication factor in the gearbox is provided for this purpose.



WHAT IS GEARBOX?

The gearbox is a mechanical device used to increase the output torque or to change the speed (RPM) of a motor. The shaft of the motor is connected to one end of the gearbox and through the internal configuration of gears of a gearbox, provides a given output torque and speed determined by the gear ratio.

THE NECESSITY OF GEARBOX

To maintain engine speed on all conditions of load and vehicle speed, the gearbox uses a system to maintain engine speed, while sacrificing the same road speed. To enable the engine to run faster on-road wheels as well as to multiply the torque, a gearbox is required.

PARTS OF GEARBOX

1. CLUTCH SHAFT / DRIVING SHAFT / INPUT SHAFT

A clutch shaft is a shaft that takes power from the engine to supply another shaft. The clutch shaft or driving shaft is connected through the clutch and when the clutch is engaged, the driving shaft also rotates. Only one gear is fixed on the clutch shaft and this engine rotates with the same speed as the crankshaft. In addition, the driving shaft and main shaft are in the same line.

2. COUNTER SHAFT / LAYSHAFT

The counter shaft is a shaft that connects directly to the clutch shaft. It has gear which connects it to the clutch shaft as well as the main shaft. It can be run at engine speed or below engine speed according to gear ratio.

3. MAIN SHAFT / OUTPUT SHAFT

The main shaft or output shaft that rotates at different speeds and also provides the necessary torque to the vehicle. The output shaft is a splined shaft, so that the gear or synchronizer can be moved to engage or disengage.

4. BEARING

The bearings are required to support the rotating part and reduce friction. The gear box has both a counter and main shaft which is supported by the bearing.

5. GEARS

Gears are used to transmitting the power from one shaft to another shaft. The amount of torque transmitted through the gears depends on the number of teeth and the size of the gears. Higher the gear ratio, higher the torque / acceleration and lower the speed. All gears except those on the main shaft are fixed to their respective shafts; They can slide in any of the directions along the shaft.

6. GEAR SELECTOR FORK

Gear selectors are simple devices that use a lever that selects gears to engage in disengage mechanisms. The motion of the lever slides the engaging part on the shaft. It depends on the type of gearbox whether the lever slides the gear or synchronizer that are already forged along the main shaft.

TYPES OF GEARBOX

MANUAL TRANSMISSION

It is the simplest type of gearbox. In this gearbox, spur gears are used. The Figure shows the construction of a sliding mesh type transmission having three forward and one reverse speeds. There are three gears (1, 6 and 5) attached on the main shaft and four gears (2, 3,4 and 7) on the layshaft.

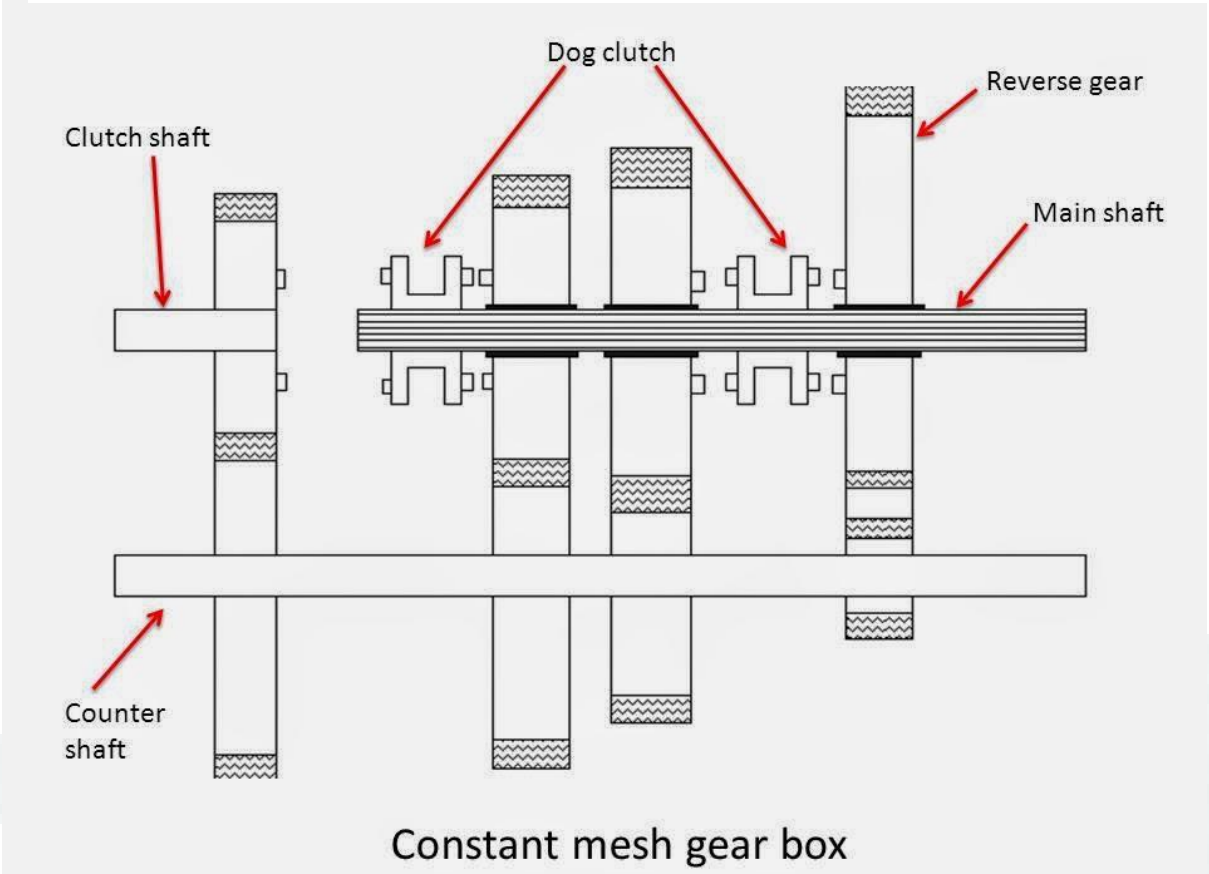
The two gears on the main shaft (6 and 5) can be slided by a shafting yoke and mesh with the gears (3 and 4) on a layshaft. Therefore, it is called a sliding mesh gearbox. A separate idler gear (8) is mounted on the idler shaft.

Figure shows the construction of a constant mesh type gearbox having three forward and one reverse speeds. In this type of gearbox, all gears are constantly in mesh and dog clutches are used for engaging and disengaging the gears. The dog clutches (D) and D2) are mounted on the main shaft. One (D2) is connected between clutch gear and reverse gear whereas the other (D)) is placed between low speed gear and reverse gear. The splines are provided on the main shaft for the linear movement of dogs. Dog clutch can slide on the shaft and rotate along with it. All gears are rigidly fixed on the counter shaft.

All main shaft and layshaft gears and idler gears are engaged by dog clutch to obtain opposite and slow speed. Only reverse gears are spur gear type and all others are helical gears.

As compared with the sliding mesh type, the constant mesh type gearbox meshes more readily with the gears having less danger of damaging during meshing because the gear diameters are smaller with few numbers of teeth. So, this type has more defects

when compared to a synchromesh type. The necessity of double clutching is needed so that it is not used to any large extent.



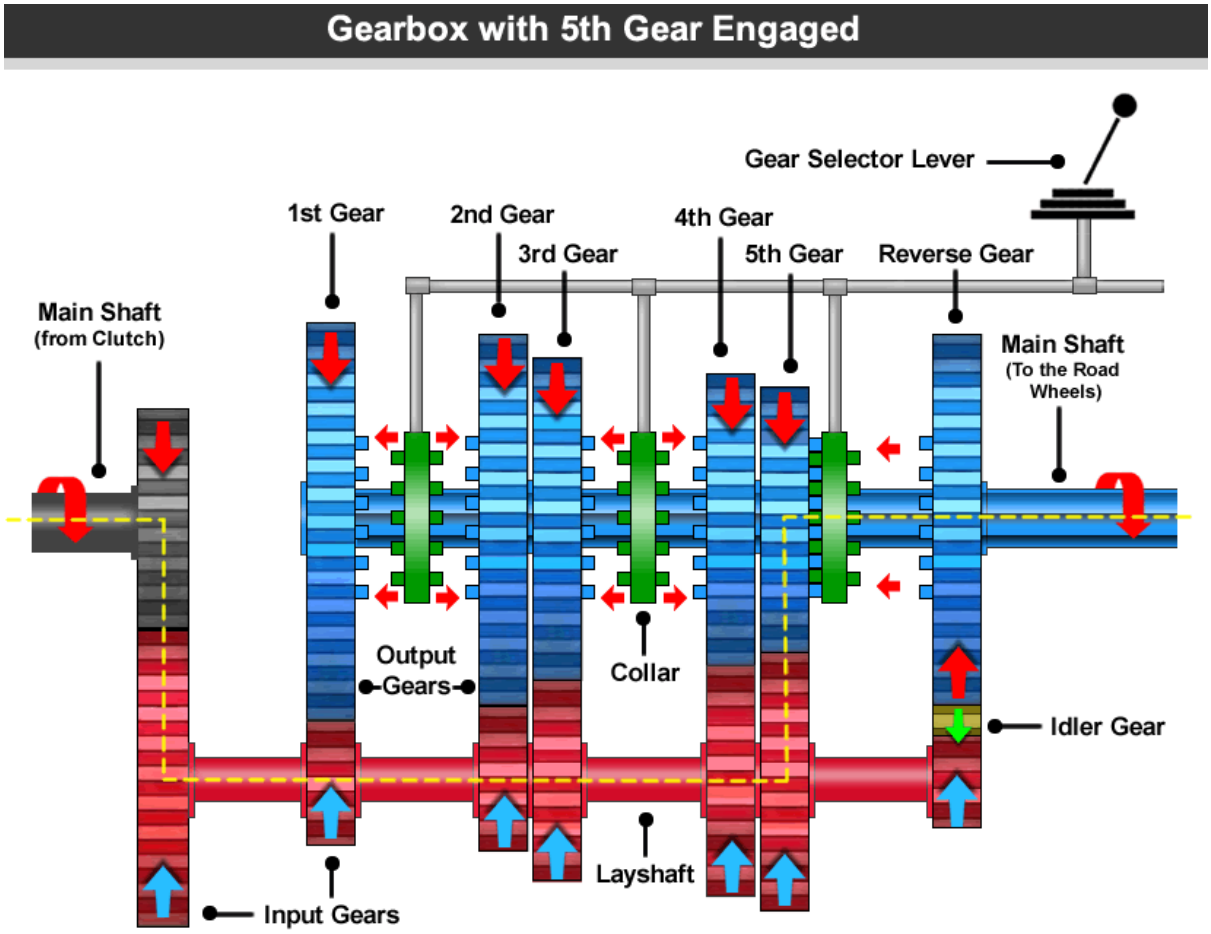
Constant mesh gear box

Synchromesh gearbox uses synchronizer instead of sliding dog clutches to affect the ratio change. The synchromesh gearbox is similar to the constant-mesh gearbox, but the synchromesh gearbox is provided with a synchronizer, the device by which two gears to be engaged are first brought into frictional contact which equalizes their speed, afterward they are engaged smoothly.

To engage, when the gear lever is moved the synchronizer cone meets with a similar cone on the pinion. Due to friction, the rotating pinion is made to rotate at the same

speed as the synchromesh unit. To give a positive drive further, movement of the gear lever enables the coupling to override several spring load balls and the coupling engages with the dogs on the side of the pinion.

Since both pinions and synchromesh units are moving at the same speed, this engagement is done without noise or damage to the dogs. A slight delay is necessary before engaging the dog teeth so that the cones have a chance to bring the synchronizer and pinion to the same speed.



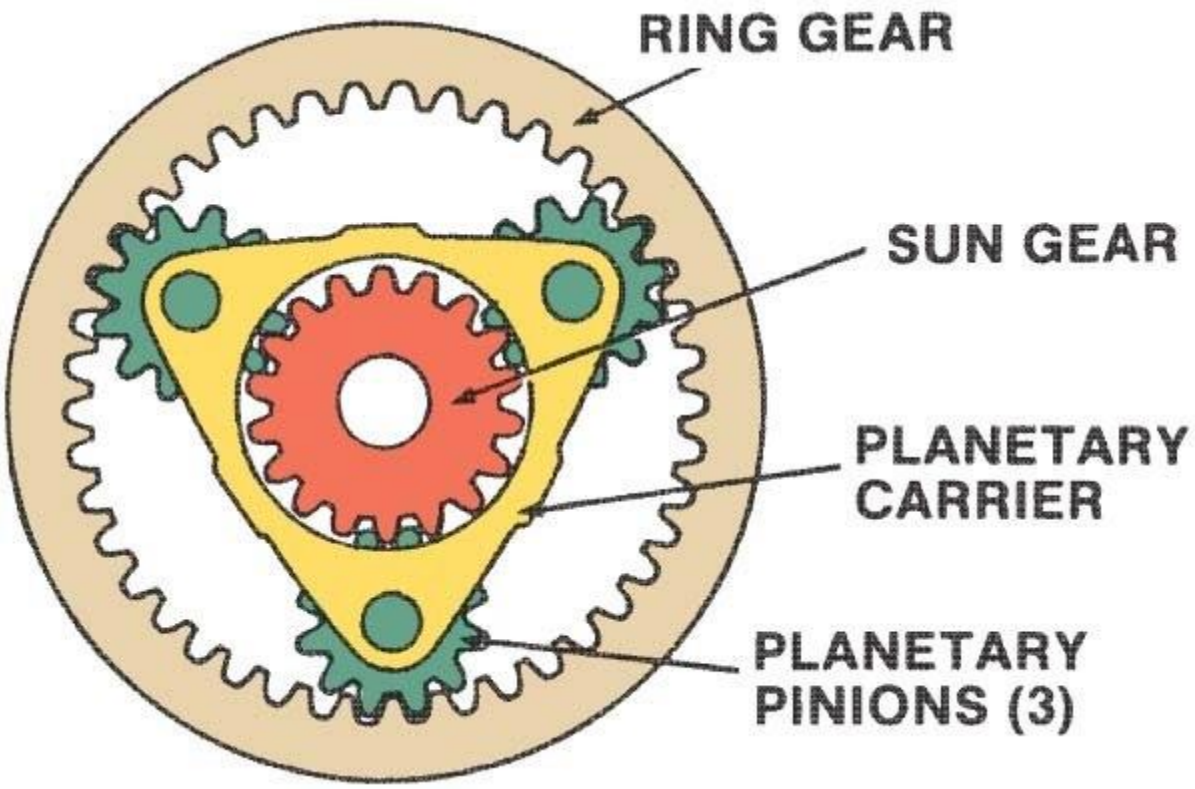
EPICYCLIC GEARBOX

An epicyclic gear train (also known as planetary gear) consists of two gears so that the centre of one gear rotates around the centre of the other. A carrier connects the centers of two gears and rotates to carry one gear, called planet gear or planet pinion, around the other, called sun gear or sun wheel. The rays of the planet and the sun form traps so that their pitch circles are rolled without slip. A point on the pitch circle of the planetary gear traces an epicyclic curve. In this simplified case, the sun gear is fixed and there is planetary gear rolled around the sun gear.

An epicyclic gear train can be assembled so the planetary gear is rolled onto a fixed, external gear ring or inside the pitch circle of the ring gear, sometimes called the annular gear. In this case, the curve detected by a point on the planet pitch circle is a

hypocycloid.

The combination of epicyclic gear trains with a planet engaging both a sun gear and a ring gear is called planetary gear train. In this case, the ring gear is usually fixed and the sun gear is operated.



AUTOMATIC TRANSMISSION

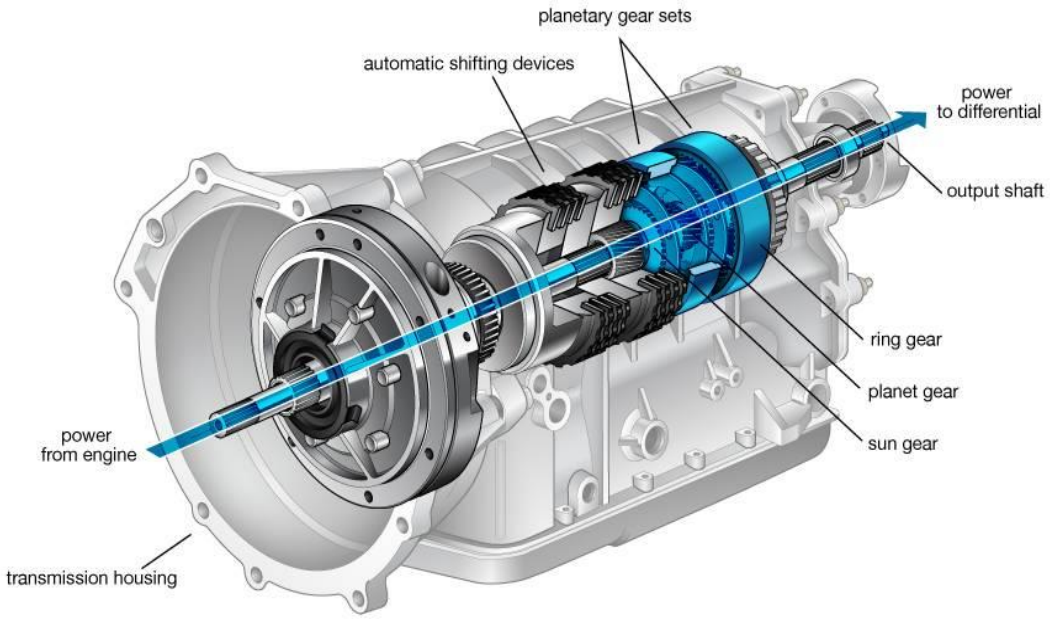
Various speeds are obtained automatically in gearboxes known as automatic gearboxes. Generally, the driver selects the car condition such as neutral, forward or reverse. The gear selection, timing, and engagement of gear for the required gear speed select automatically when the accelerator press or depress.. The Automatic gearbox does not require a gear change lever and a clutch pedal. Since, both clutch and transmission are a combined unit which works automatically. The automatic gearbox operates in two ways namely.

1. Hydramatic transmission, and

2. Torque converter transmission

Nowadays, automatic transmissions are popular with various names prescribe by the manufacturers. They may differ in construction slightly. Somebody employs only fluid coupling with the planetary transmission. But others may include a torque converter with fluid coupling and planetary transmission as per their requirements.

In the case of a dramatic transmission gearbox, the planetary gear sets connect in such a way that power may transmit through them. A centrifugal governor in the transmission chooses the proper gear according to the speed and throttle position.



The gear shifting from one gear to another gear is done through hydraulically operated pistons by actuating springs. These springs control the brake bands on the planetary gear sets and clutches within the planetary unit. The various shifts achieved by the throttle and centrifugal governor.

A torque converter is a type of fluid coupling that transmits rotational power from a prime mover, such as an internal combustion engine, to a rotating driven load. In a vehicle with an automatic transmission, the torque converter connects to the power source to the load. It is usually located between the engine's flexplate and transmission. The manual transmission will have an equal space mechanical clutch.

The main feature of a torque converter is its ability to increase torque when the output rotational speed is so low that it allows the fluid from the winding vanes of the turbine to separate from the stator while it close against its one-way clutch, thus providing the equivalent of a reduction gear.This is a feature beyond simple fluid coupling, which

can match rotational speed, but does not multiply torque, thus reducing power.

Torque converter transmission system employs fluid coupling, torque converter and epicyclic gear arrangement. If all different devices are combines into one unit, they will do their duties jointly without any interruptions.

PURPOSE OF GEARBOX

1. It helps the engine to disconnect from driving wheels.
2. It helps the running engine connect to the driving wheel smoothly and without shock.
3. It provides the leverage between engine and driving wheels to be varied.
4. This helps in reducing the engine speed in the ratio of 4 : 1 in case of passenger cars and in a greater ratio in case of heavy vehicles like trucks and lorries.

5. It helps the driving wheels to drive at different speeds.
6. It gives the relative movement between engine and driving wheels due to flexing of the road spring.

FUNCTION OF GEARBOX

1. Torque ratio between the engine and wheels should be varied for fast acceleration and for climbing gradients.
2. It provides means of reversal of vehicle motion.
3. Transmission can disconnect from the engine by the neutral position of the gearbox.

GEAR RATIO

Gear ratios are geared reduction steps in the gearbox. A gear reduction multiplies the engine torque by gear ratio amount. Torque requirement at the wheel depends on operating conditions.

For example :

Moving a vehicle from a standstill requires much more torque than the peak torque of the engine. Therefore the torque multiplies by the first gear ratio.

Once starting the vehicle and moving using first gear, it requires less torque at the wheels to keep it moving. Hence it requires no multiplication or very less multiplication.

If the vehicle suddenly encounters a gradient , it will require more torque on the wheels to keep the vehicle moving. Hence an intermediate ratio requires.

ADVANTAGES AND DISADVANTAGES OF GEARBOX

ADVANTAGES OF MANUAL TRANSMISSION

- The vehicle is more attractive to the driver.
- The driver has complete control over the gears and when to shift the gears.
- The cost of a manual vehicle is lower than that of an automatic vehicle.
- Transmission cost is less for repair.
- It provides better mileage.

DISADVANTAGES OF MANUAL TRANSMISSION

- Manual transmission can be annoying in heavy traffic.

- There may be some problems in learning the new driver.
- Precise control over hills is necessary to avoid stalling or rolling back.
- Hands and feet can hurt when using gears and clutch.

ADVANTAGES OF AUTOMATIC TRANSMISSION

- It is easy to drive in stop-and-go traffic.
- This transmission is fast and smooth.
- Current automated vehicles offer the same mileage as manual transmission.
- The automatic transmission is very comfortable for the driver when driving.

DISADVANTAGES OF AUTOMATIC TRANSMISSION

- Buying an automatic transmission vehicle is more expensive than a manual transmission vehicle.
- There are more moving parts in the automatic transmission, which increases the cost of repair.
- The gear change takes a little time and the gear shifting detects, and at times a slight shock is also failing.
- You cannot make the automatic gear more or less at your own will, suddenly there is a problem in overtaking the car.

PROPELLER SHAFT

INTRODUCTION

The term drive shaft was used in the mid-19th century for the first time. In 1861 Watkins and Bryson patented the term for a mowing machine where the shaft was used to transmit power from the wheels of the mowing machine to the cutting machine using a gear train.

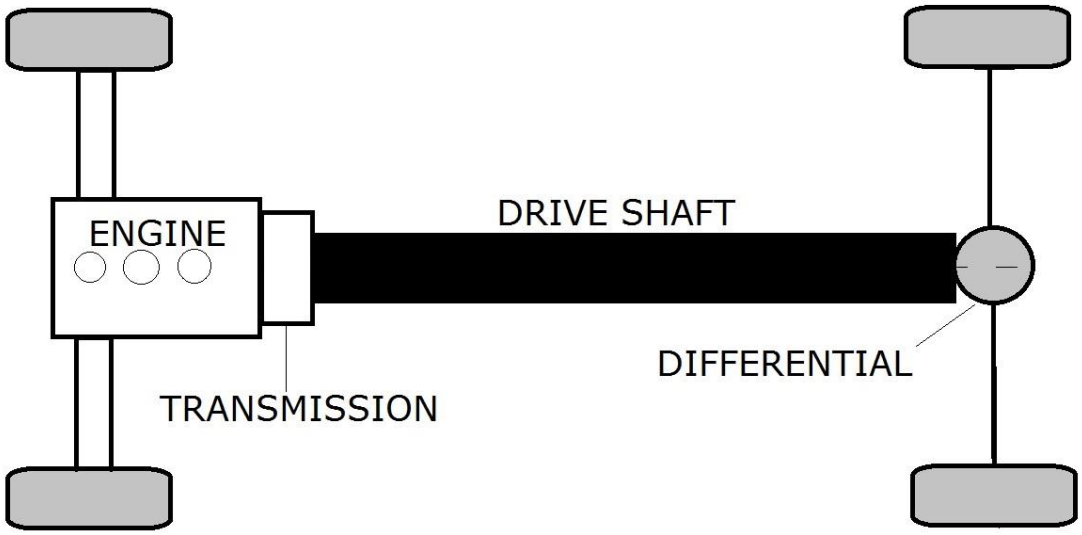
In the 1890s the term drive shaft became quite common. In the year 1899 Bukey used this term for power transmission from wheel to the driven machinery using universal joints.

The first use of drive shaft also known as propeller shaft in the automobile was done in the year 1901 by an automobile company in a gasoline car.

The component which is used to transfer torque from the gearbox to the rear axle or differential is called a propeller shaft. It is not only used in cars but is also used in boats and aeroplanes. It is also known as the Cardan shaft or drive shaft.

The propeller shaft is a hollow tube-like structure with a combination of universal and slips spline joints. In most cars except the modern-day cars, the engine is situated at the front end and it is used to drive the rear wheels.

Hence, The shaft is used to transmit the power from one end of the automobile to the other end. In automobiles where the front wheel is given power, a short shaft is used.



Characteristics of the Propeller Shaft:

The following characteristics are:

- The propeller shaft transmits power from the gearbox's output shaft to the differential.
- There are no or very few power losses, this means there is no change in the RPM when the power is transmitted.
- It can transmit power at a different elevation like if the gearbox output shaft is at 1 meter from the ground and differential is at 0.5 meters from the ground.
- The shaft can adjust itself while the vehicle runs through obstacles such as a speed breaker.

Construction or Parts of Propeller Shaft:

A propeller shaft consists of three main components:

1. Universal joints
2. Split spline joints and
3. Tubular shafts

Let's understand one by one in detail,

Universal joint:

A universal joint is the most important component of a propeller shaft there are two universal joints in a single-piece propeller shaft. The number of universal joints can be up to three or four depending on the type of propeller shaft.

A universal joint is that component that allows rotation of the propeller shaft on various axis. It is a flexible joint that compensates for the elevation difference between the gearbox output shaft and the differential.

Slip spline joint:

A slip spline joint is generally used at the output side of the propeller shaft. It helps in torque transmission at various lengths of the propeller shaft. It comes in action during the obstacles faced by the automobile.

For example, when a car approaches a speed breaker the rear wheels will be pushed up this results in compression of the propeller shaft as soon as the car passes the breaker the dampers push back the rear wheel which results in the normal length of the shaft.

To transmit power during such conditions a slip spline joint is used. It also protects the shaft from compressive and tensile stresses.

Tubular shaft:

The tubular shafts are used to compensate for the distance factor between the gearbox and the rear axle. There can be two or more tubular shafts depending on the type of propeller shaft.

The tubular shafts can be short as well as long depending on the distance from the gearbox to the axle. In the case of a rear-wheel drive, long tubular shafts are used and in the case of a front-wheel drive, short tubular shafts are used.

The tubular cross-section provides better strength and flexibility and is lightweight when compared to a filled cross-section.

Flange yoke:

Flange yoke is the first connecting member which connects the whole drive shaft assembly with the gearbox.

Bearings:

There are present at many rotational joints in the shaft. The function of bearings is to reduce friction and reduce heat generation.

Types of Propeller Shafts:

There are two basic types of propeller shaft:

1. Single piece or one-piece type and
2. Two-piece type propeller shaft.

Single piece type propeller shaft:

In this type, there are two universal joints, one slip spline joint, and one tubular shaft. It is used for short-distance transmission.

Such as cars and is also used widely for front and four-wheel drive. It provides better strength to the arrangement. It is more durable than a two-piece type propeller shaft this is due to the friction welding at the junctions.

Two-piece type propeller shaft:

There are three universal joints, one slip joint and two tubular shafts in the arrangement of two-piece type. It is used for long-distance transmission. Such as busses and trucks.

The strength factor is less due to the increased number of joints. It is less durable as friction welding is not done. The torque transmission is less than that of a single piece.

Materials used for making Propeller Shafts:

The following material can be used for making Propeller shaft are SM45C steel, Epoxy composite material Alloys of aluminium and stainless steel, SAE1045 steel, and Kevlar epoxy

SM45C steel:

SM45C is a low-carbon high-quality structural steel. The wear resistance of this material is high which is a requirement for the propeller shafts. It is a quenched and tempered form of steel. The tensile strength of SM45C is greater than 600MPa.

Epoxy composite material:

Propeller shafts are also made of epoxy composite materials mainly carbon epoxy composites. These have a high tensile strength varying from 800-1300 MPa. These materials are ideal for making high-precision tubes.

Alloys of aluminium and stainless steel:

Different alloys of aluminium and stainless steel are used for making propeller shafts as they are strong and can sustain the torsional vibrations. The tensile strength of aluminium alloys is also high.

SAE1045 steel:

SAE1045 is high-quality steel with a tensile strength varying from 570-700MPa. It has good machinability and weld ability. It is widely used for making propeller shafts in various automobiles.

Kevlar epoxy:

Kevlar epoxy is another material that can be used for making propeller shafts. it is an uncommon material for propeller shafts as studies are still in progress on this material. Although a simulation-based study says that Kevlar epoxy serves as a better material than the conventional materials used for making propeller shafts as it is lighter and stronger.

Requirement of a Propeller shaft:

The following requirement is:

- Lightweight: it must be lightweight to ensure the proper weight of the vehicle.
- Thermal resistance: the material used must not show high variations in physical properties under increased temperature.
- High torsional strength: the propeller shaft must have high torsional strength to survive under high torque conditions.
- Damping quality: there are many variations that a propeller shaft has to face hence it is important to have a damping quality to absorb vibrations.

Advantages of Propeller shafts:

Following advantages of Propeller shaft:

- Low or no power losses.
- The weight of the shaft is less due to the tubular structure.
- Construction is not very complex.
- Ensures safe power transmission.
- Low noise at high torques.
- It is durable.

Disadvantages of Propeller shaft:

Following disadvantages of Propeller shaft:

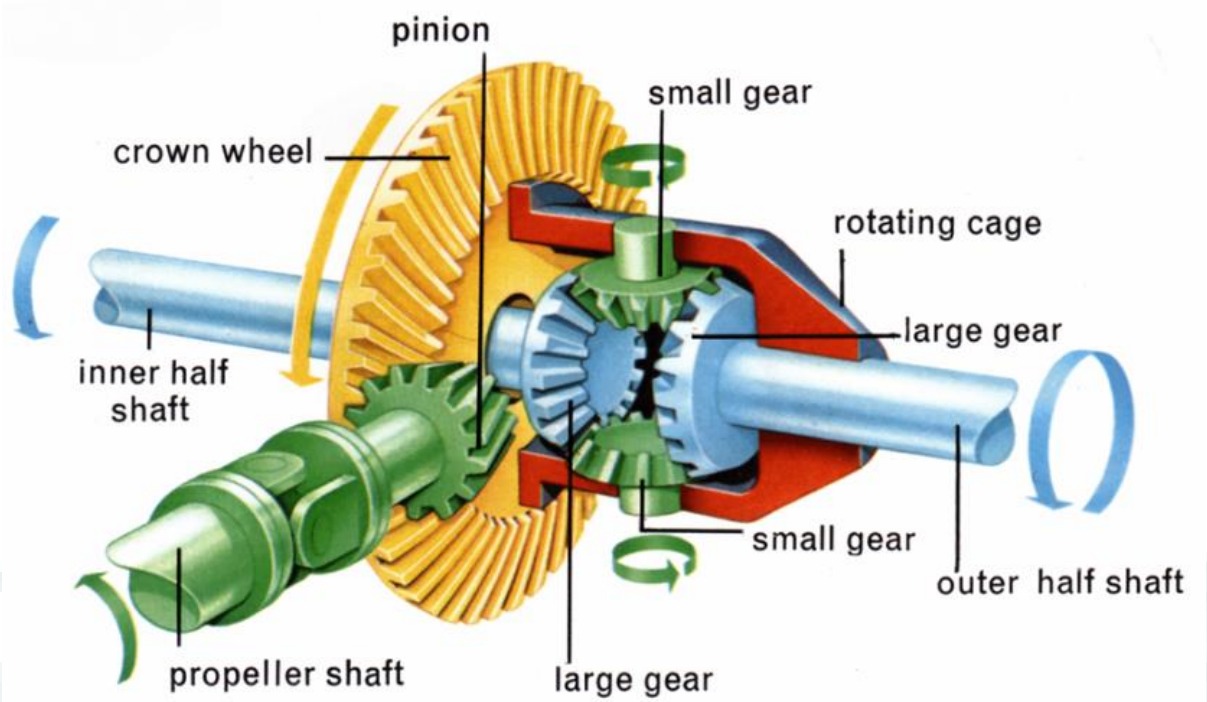
- May damage if the RPM is too high.
- Hollow propeller shafts are costly.
- They are not very strong
- Not suitable to counter bending forces.
- There may be an oil leakage problem at the spline.

Applications of Propeller shafts:

Following application of Propeller shaft:

- Propeller shafts are used in constructional motor vehicles.
- They are also used in various heavy-duty machines.
- Propeller shafts are widely used in commercial automobiles.
- It is also used in ships for providing power to the propeller.
- It was also used in old airplanes.

DIFFERENTIAL: FUNCTIONS, WORKING PRINCIPLES, AND CLASSIFICATION



The differential is a very important part in a vehicle, as a component transfer, the engine power is transmitted to the wheels. Engine power is transferred by a rear propeller shaft to the wheel first changed direction by differential rotation are then referred to rear axle shafts after that to the rear wheels.

Differential functions to reduce the speed received by the propeller shaft to produce a great moment and to change the direction of rotation of the propeller shaft 900 is transmitted to wheel next round through the rear axle shaft rear separately. However, if the differential is not working then it will result in the vehicle which cannot be run A.

HOW IT WORKS?

At the time of straight road.

During the vehicle runs straight, the wheels of the rear axle will be screened by the drive pinion through the ring gear differential case, wheel-wheel differential gear pinion shaft, wheel-pinion differential gears, side gear teeth is not spinning, remain to be drawn into the ring gear rotation. Thus the spin on the wheel left and right alike.

At the time of turning.

At the time of vehicle turning left prisoners left wheel is bigger than the right wheel. If the differential case with the ring gear rotates the pinion will rotate on its axis and also the movement around the left side gear, so round the right hand side gear increases, the side where the number of revolutions of the gear which is 2 times round the ring gear. It can be said that the average second round gear is comparable with the rotary ring gear. as it should.

WORKING PRINCIPLE OF DIFFERENTIAL

The basic principle of the differential gear unit can be understood by using equipment that consists of two gears pinion and rack. Both rack can be moved in the vertical direction as far as the weight rack and slip resistance will be lifted simultaneously. Placed between the tooth pinion rack and pinion gear connected to the braces and can be moved by these braces. When the same load "W" placed on each rack then braces (Shackle) is pulled up the second rack would be lifted at the same distance, this will prevent the pinion gear does not rotate. But if a greater burden placed on the left rack and pinion buffer will then be drawn up along the gear rack rotates the load gets heavier, which is attributed to differences in prisoners who are given the pinion gear, so the smaller the burden will be lifted. The raised rack spacing is proportional to the number of turns pinion gear. In other words that rack gets custody larger still and while prisoners who received a smaller load will move. This principle is used in the planning of differential gears.

FUNCTIONS OF DIFFERENTIAL

1. Further reduces the rotations coming from the gear box before the same are passed on to the rear axles.
2. Changes the direction of axis of rotation of the power by 90o i.e. from being longitudinal to transverse direction.

. To distribute power equally to both the rear driving axles when the tractor is moving in straight ahead direction.

4. To distribute the power as per requirement to the driving axles during turning i.e. more rotations are required by the outer wheel as compared to the inner wheel – during turns.

THE MAIN COMPONENTS OF THE DIFFERENTIAL

1. Input pinion gear
2. Crown wheel gear
3. Differential cage
4. Differential star
5. Differential axle (sun) gear

TYPES OF DIFFERENTIALS

1. Open Differential
2. Locked Differential
3. Viscous Limited Slip Differential
4. Mechanical Clutch-Type LSD (Including eLSD)
5. Torsen & Helical Differential
6. Torque Vectoring Differential

1. Open Differential

Open differentials are the most basic form of a differential. The purpose is to allow for different speeds between the two wheels, while torque split is held constant at 50/50. A common misconception with open differentials is that when one wheel is lifted, 100 per cent of the torque is sent to it. This is not true, however the amount of torque sent to the wheel with traction is very low because the amount of torque required to spin a wheel is also low. Remember, both wheels always receive equal torque, but if one has no resistance (eg. if it's in the air), the amount of torque sent to the drive axle as a result is very low.

- Splits the engine torque into two outputs
- Allows the wheels to rotate at different speeds
- When one tire loses traction, the opposing tire will also lose power
- Found in family sedans and economy cars

Advantages:

1.Allows for completely different wheel speeds on the same axle, meaning no wheel slip will occur while going around a corner, as the outside tyre will travel further.

2.From an efficiency standpoint, less energy will be lost through the differential versus alternative options.

3. Cost.

Disadvantages:

- When one wheel has poor traction, this drastically limits the amount of power the vehicle can put down. Because the torque distribution is always 50/50, if one wheel cannot put down much power, the other will receive an equally low amount of torque.

2. Locked Differential (Including Locking And Welded Diffs)

Locked differentials are on the opposite side of the spectrum versus open diffs. The purpose is for wheel speed to remain constant between the two wheels, and the major benefit here is that torque will go to the wheel with traction, up to 100 per cent at a single wheel. For off-road use, it is common for the differential to have a locking feature, so that it is open when driving on pavement.

- Connected wheels always spin at the same speed

• Turning the vehicle can be very difficult
• Found in Jeep Wranglers and most full-size trucks

Advantages:

• Allows for torque to go to the wheel with the most traction. For all differential styles, this will allow for the most torque to reach the ground on any surface condition.
• For off-road use where tyre wear is not an issue, this is about as good as it gets. Robust, simple, and very effective.
• In situations where it's desirable to keep wheel speed constant on an axle (ex: drifting), this is an easy solution (a welded differential works exactly the same).

Disadvantages:

• A locked differential will not allow for wheel speed differences between the right and left wheels. This means additional tyre wear, as well as binding within the drivetrain as a result.

3. Viscous Limited-Slip Differential (VLSD)

VLSD are fairly simple as far as operation, however they have some drawbacks in comparison to other forms of LSDs.
• Combination of open and locking differentials
• Usually acts as an open differential
• Automatically locks when slipping occurs
• Found in sports vehicles like Nissan 370Z and the Mazda MX-5 Miata

Advantages:

• Allows for different wheel speeds on an axle, thus reducing tyre wear versus a locked differential (the same applies for all forms of LSD, but this style is particularly good for it).
• Allows for torque to be sent to the wheel which has more traction.
• Very smooth operating, typically won't have the low speed clunkiness associated with other LSD types navigating in a tight radius (eg. parking lots).

Disadvantages:

• Cannot fully lock up, the system requires a speed differential between the two sides in order to transfer torque.
• As the internal gear fluid heats up (in cases where it's being used too frequently), the effect of the LSD will be reduced.

4. Mechanical Clutch-Type LSD (Including eLSD)

Clutch type LSDs come in a wide variety. one-way, 1.5-way, two-way, and even electronic. In principle, they all operate very similarly, with a clutch pack that attempts to lock up the differential, allowing for torque to be sent to the wheel with the most grip.

Advantages:

• Applies lock when throttle is applied. Unlike a VSLD, this means that torque split can occur before one wheel reaches a different speed (similar to a locked differential).
• For one-way LSDs, the differential acts like an open diff when not on the gas, thus easily allowing for different wheel speeds while cornering.
• For two-way LSDs, the differential applies locking force while decelerating, which in some cases can help with braking stability.
• Works well even if one wheel is off the ground or has limited traction.
• Electronic LSDs allow for the clutch engagement to be controlled by the onboard computers, optimising lock based on the driving conditions.

Disadvantages:

• Often requires regular oil changes, and the clutches may wear out eventually requiring replacement.
• Electronic LSDs will add cost and complexity.

5. Torsen & Helical Differentials

Torsen and helical differentials work in a fairly similar fashion, using clever gearing to apply locking force to transfer torque to the wheel with more grip. They're great for street use and even light track use, though they do have a disadvantage.

Advantages:

• These differentials begin to send more torque to the slower-rotating wheel the instant there is a speed differential between them. Essentially, it reacts far quicker than a VLSD.
• These are purely mechanical systems, with no routine maintenance required as the differential action is dependent upon friction throughout the gears.

Disadvantages:

• When one wheel is in the air, a Torsen diff acts very similarly to an open differential, and very little torque is sent to the drive axle. For street use this is completely acceptable, but it may be an issue for more purpose built vehicles on the track.

6. Torque Vectoring Differential (TVD)

Without a doubt the most complex of the differentials, this option allows for the greatest amount of control by the developers, meaning unique programming to react to any situation, as well as the ability to help induce yaw.

• Uses additional gear trains

• Fine tunes the torque delivered to each drive wheel

• Can slow down or quicken the car's rotation around a corner

• Heavy, complex and low-performing for fuel economy

• Found in the BMW X5 M or the Lexus RC F

Advantages:

• Allows for more torque to be sent to the outside wheel while cornering. In general, LSDs will send torque to the wheel which is rotating at a slower speed. This is because a greater wheel speed is perceived as slip, so the LSD locks up to send more torque to the slower wheel and prevent wheel slip. When accelerating out of a corner, a TVD sends more torque to the outside wheel, helping to induce yaw and rotate the vehicle.

• Allows for complete control by the designer, the system can choose in what situations the vehicle will send more torque to either wheel, rather than being reactive.

• Can send up to 100 per cent of available torque to a single wheel.

Disadvantages:

• Cost and complexity