

AUTOMOTIVE
TRANSMISSION

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TH-2 AUTOMOTIVE TRANSMISSION

Name of the Course: Diploma in AUTOMOBILE ENGINEERING			
Course code:	Semester	5 th	
Total Period:	60	Examination	3hrs
Lab. periods:	4 P/W	IA	20 marks
Maximum marks:	100	End Semester Examination:	80 Marks

A. RATIONALE:

The power developed by automobile engine is transmitted to the rear axle through many parts & mechanism such as clutch gear Box, propeller shaft and differential. The entire system is called power transmission mechanism in automobile. Knowledge of automobile transmission is of vital importance for an automobile engineer.

B. COURSE OBJECTIVES:

After completion of the course the student shall be able to know

1. Functions, types, requirements & adjustment of clutch.
2. Function, types & operation of gearbox.
3. Functions of propeller shaft & types of joints
4. Functions & types of differentials
5. Types & operation of rear axle.
6. Transmission of power in two-wheelers.

C. TOPIC WISE DISTRIBUTION OF PERIODS

S/No.	Topic	Periods
1.	Clutch	08
2.	Gear Box	08
3.	Propeller Shaft	08
4.	Differential	08
5.	Rear Axle	08
6.	Two Wheeler	08
7.	Performance of automobile	12
		60

COURSE CONTENTS:

1. Clutch

- 1.1 Introduction, requirement of clutch, types of clutch
- 1.2 Clutch operation.
- 1.3 Clutch components, clutch facings.
- 1.4 Clutch problem & adjustment
- 1.5 Fluids fly wheel & coupling.

2. Gear Box

- 2.1 Introduction, functions & types of transmission.
- 2.2 Sliding mesh & constant mesh gearbox.
- 2.3 Epicyclical gear box overdrive.
- 2.4 Free-wheel drive, selector mechanism.
- 2.5 Fluid torque converter.

3. Propeller shaft

- 3.3 Introduction definition & types of propeller shaft.
- 3.2 Universal joints & its types.
- 3.4 Sliding joint.

4. Differential

- 4.1 Function of differential gear box.
- 4.2 Types of differential.
- 4.3 Constructional details of a differential.
- 4.4 Study & inspection of differential.

5. Rear Axle

- 5.1 Definition of rear axle, supporting of rear axle.
- 5.2 Rear axle drives such as Hotchkiss drive, torque tube drive etc.
- 5.3 Types of rear axle.
- 5.4 Rear axle casing.

6. Two wheeler

- 6.1 Power transmission system of moped.
- 6.2 Power transmission system of scooter.
- 6.3 Power transmission system of motorcycle.
- 6.4 Power transmission system of bullet.

7. Performance of Automobile

- 7.1 Power for propulsion resistances for vehicle.
- 7.2 Traction & tractive effort, road performance curves.
- 7.3 Acceleration grad ability & draw-bar pull.
- 7.4 Calculation of equivalent weight.
- 7.5 Calculation of maximum traffic effort.

Syllabus to be covered before IA: Chapter 1,2,3,4

RECOMMENDED BOOKS:

1. Automotive mechanics by Heitner, CBSpublishers.
2. The automobile by Harbans Singh Reyat, S. Chand & Co.
3. Automobile Engineering by G. B. S. Narang, Khannapublishers.
4. Automobile Engineering Volume-1 by Dr. Kipal singh, siddhishier.
5. Automobile Engineering & power Train by W. H. Crouse, Mc GrawHills.
6. Motor manual (Transmission) by A. N. Judge.
7. Motor manual (Car mechanism) by A. N. Judge.

Ch-1

CLUTCH

- 1.1 Introduction, Requirement of clutch, Types of clutch.
- 1.2 Clutch operation
- 1.3 Clutch components, Clutch facing.
- 1.4 Clutch problem and adjustment
- 1.5 Fluid Fly wheel & Clutching

1.1 Introduction, Requirement of clutch, Types of clutch

Introduction :-

When starting internal combustion engines such, as petrol and diesel engine, it is necessary to cut off the load ~~and~~ ~~the~~ on the engines and it is also necessary to cut off load in case of gear changes.

A Clutch is a mechanism which connects or disconnects the transmission of power from one working part to another working part, i.e. the crankshaft and the gear box primary shaft.

* Clutch is installed betⁿ the engine and transmission.

* It connects the smoothly betⁿ the engine and transmission or smoothly engagement and disengagement betⁿ the engine and transmission.

Requirements of a clutch:-

- (i) When the transfer of power needs to be cut, the clutch must instantaneously and completely disconnect engine from the transmission.
- (ii) The clutch should be able to transmit maximum torque of the engine.
- (iii) The clutch should engage gradually to avoid sudden jerk.
- (iv) It should be able to dissipate large amount of heat which is generated during the clutch operation due to friction.
- (v) It should be dynamically balanced specially in case of high speed engine.
- (vi) It should be small in size as possible, that occupies minimum space.
- (vii) It should be easy to operate.
- (viii) It should be light in weight.
- (ix) It should be enable the driving wheels to rotate at different speeds.
- (x) It should be free from slip when engaged.

TYPES OF CLUTCH

These are the basically two types

(i) Positive clutch

(ii) friction clutch

(a) single plate

(b) Multi plate

(1) wet clutch (2) dry clutch

(c) Cone clutch

(d) centrifugal clutch

(e) semi-centrifugal clutch

(iii) Hydraulic clutch

(iv) Electromagnetic clutch

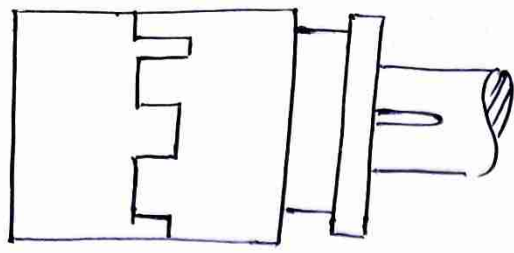
(v) Vacuum clutch

(vi) over-running or free-wheel unit.

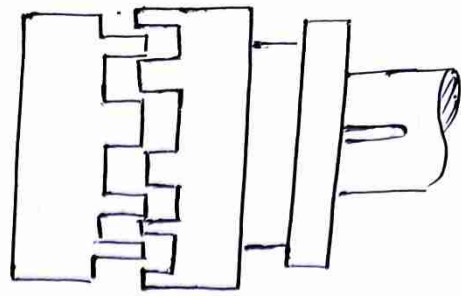
Positive clutch

This type of clutches are 'in' and 'out' type clutches by means of driving shaft may be coupled on (that is that two shafts are rigidly connected) and out (that is shafts are entirely disconnected.) with the driven shaft at will. These clutches are also known as dog clutches and widely used in gear boxes, to lock two shafts together.

In this type clutch uses two members having dogs or notches at their facing. One is fixed with driving shaft and another member is provided on the driven splined shafts.



(in position)



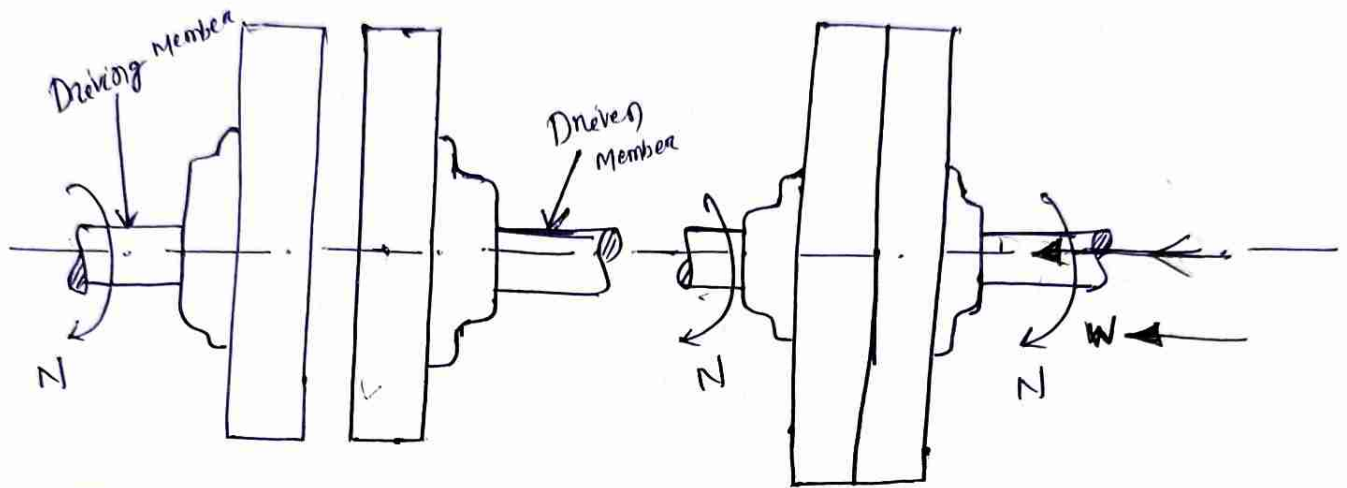
(out position)

} Dog clutches }

Friction clutches

- (i) The friction clutches use the force of friction for their action, which exists betⁿ the two members when they are pressed together.
 - (ii) When the faces of driving member and driven members are brought together in contact by applying some axial forces, starts acting betⁿ them.
 - (iii) Hence resulting in the movement of driven stationary member with the driving member.
 - (iv) At the start, when the force pressing the two members together is small, friction force may not be able to drive the driven member.
 - (v) The speed of driven member depends upon the force of friction present, which is then is proportional to the applied axial force.
- * When the axial force is increased gradually, the force of friction increases. And driven member starts to rotate gradually at same speed of driving member.

* Thus driving member and driven member are moving at the same speed and there is no slip betⁿ them. clutch is considered to be fully engaged.



The engine torque is transmitted to the gear box through the clutch.

W = Axial force

μ = Co-efficient of friction

T = Torque transmitted

R = Mean effective Radius of friction surface

$$T = \mu \times W \times R$$

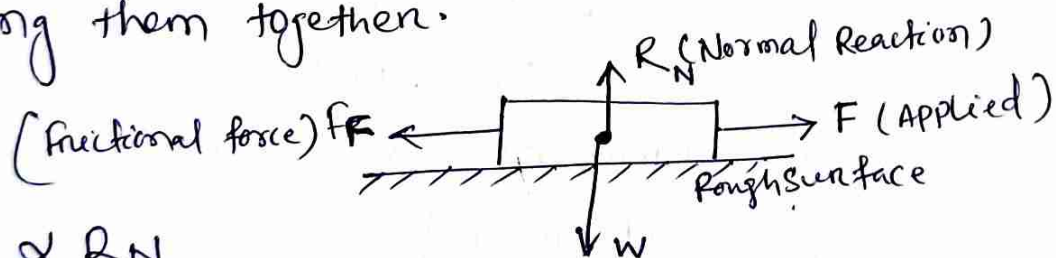
Torque transmit depends upon i.e, μ , W , R as it is increase on all factor the transmit the amount of torque also increase.

Material characteristics for friction surface

- (i) It should have high and uniform co-efficient of friction.
- (ii) It should not be affected by moisture and oil particle
- (iii) It should be able to withstand at high temp^s caused by friction.
- (iv) It should have high conductivity
- (v) It should have high resistance to wear and tear.

Co-efficient of friction for clutch facing materials.

Co-efficient of friction:- It is defined as the ratio of force of friction betⁿ two bodies and the force pressing them together.



$$F_f \propto R_N$$

$$\therefore F_f = \mu R_N$$

where μ = constant of proportionality (Co-efficient of friction)

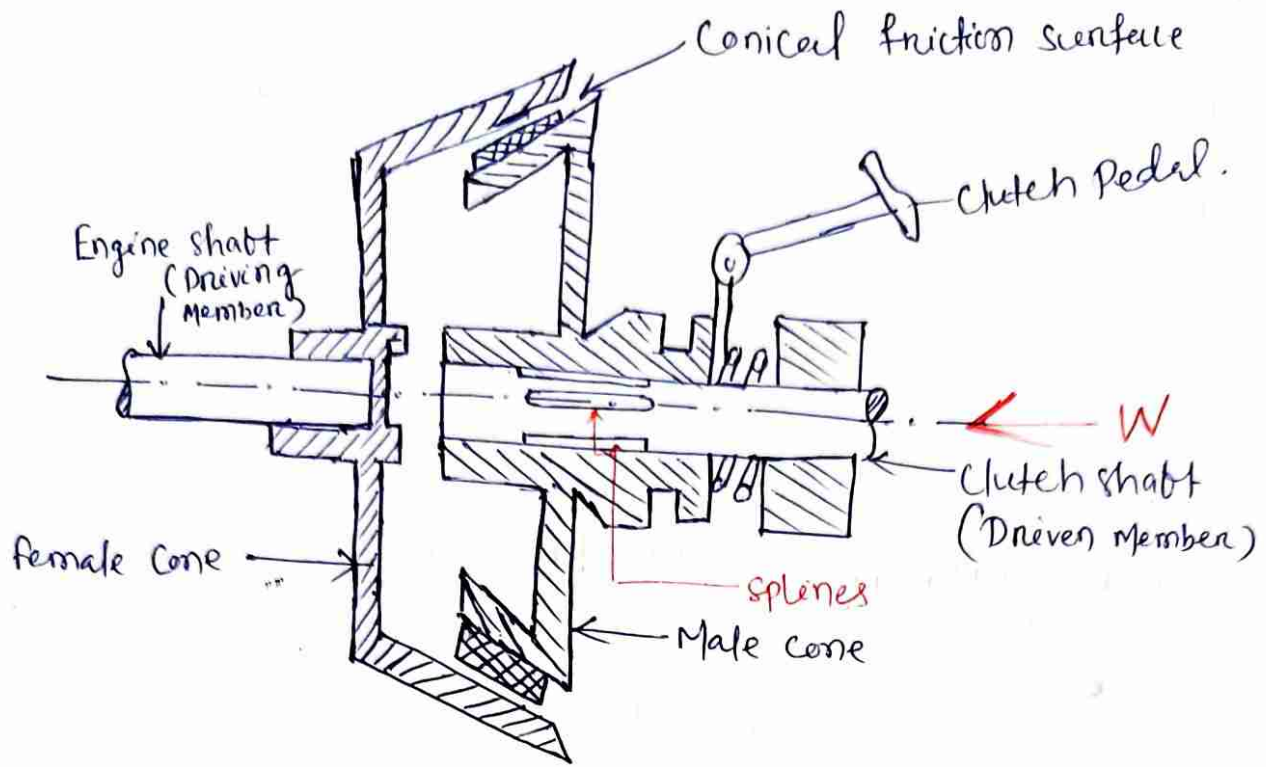
$$\mu = \frac{F_f}{R_N}$$

Material use for friction lining or facing Material

<u>Material</u>	<u>co-efficient of friction</u>
(1) Lather	0.27
(2) Cork	0.37
(3) Cotton fabric	0.4 - 0.5
(4) Asbestos	0.35 - 0.40

CONE CLUTCH CONSTRUCTION

- (i) Cone clutch was extensively used in automobiles, but now days it completely replaced by disc clutch.
 - (ii) It consists of two cone, having pair of friction surface.
 - (iii) These cones are known as male cone and female cone.
 - (iv) Male cone is attached to the engine shaft or Driving shaft.
 - (v) Male cone is attached to the clutch shaft or Driven shaft, which is splined ~~with~~ on clutch shaft.
 - (vi) Female cone which exactly fits into the outside conical surface of the male cone.
- # In the engage position, the male cone is fully in contact with the female cone's frictional surface. This is done by means of spring force.
- # When clutch is in engage position torque is transmitted from engine to gear box shaft.
- # For disengaging the male cone should be pull out by means of lever system. So that clutch pedal separate the contact surface.



Advantages

- (i) The normal force acting on contact surface is greater than the axial force.
- (ii) Higher torque can be transferred than the same size of plate clutch due to large amount of ~~friction~~ frictional force involved.
- (iii) It creates less noise than the plate clutch.
- (iv) Less wear and tear.

Disadvantages

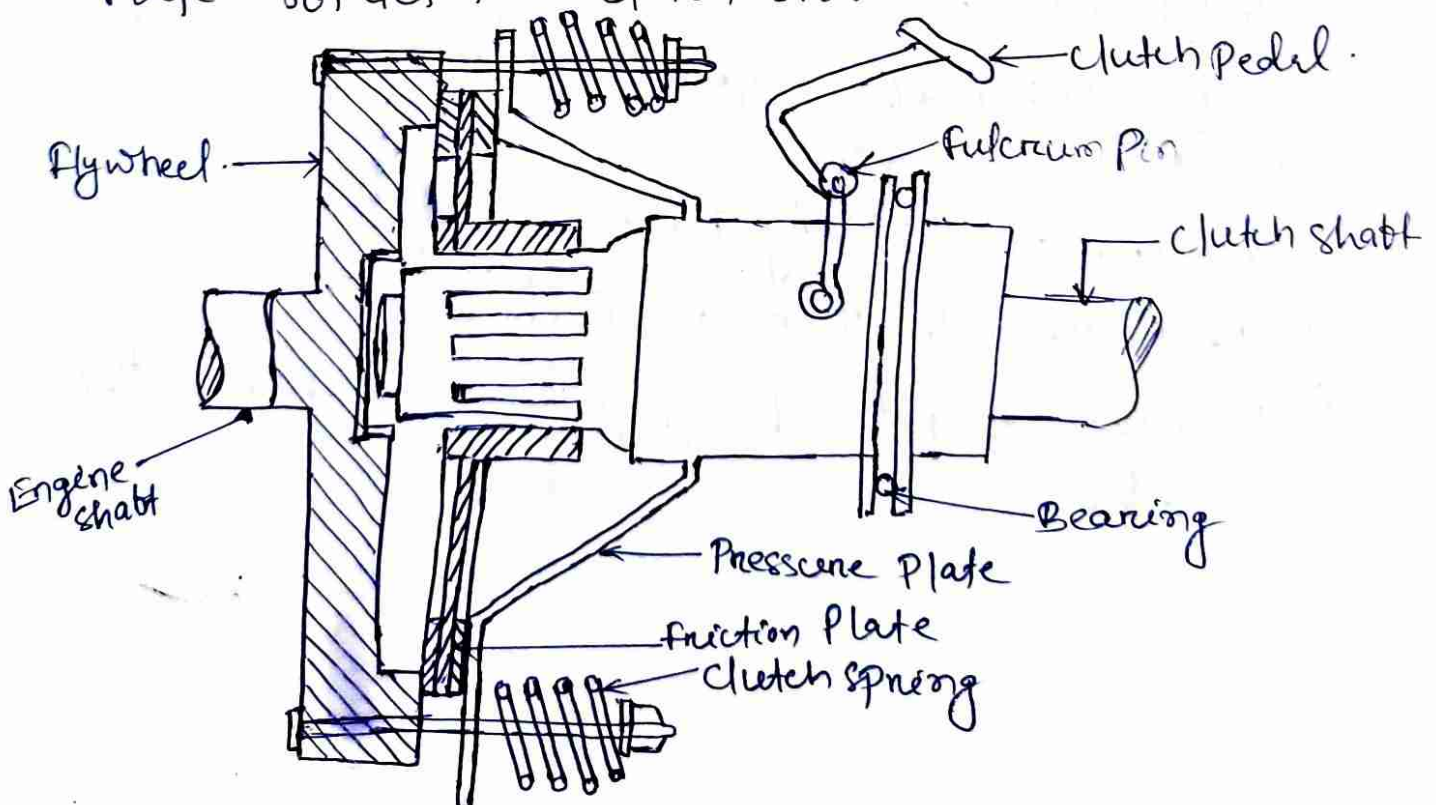
- (i) High maintenance is required
- (ii) It becomes very difficult to disengage

Application

- (i) Cone clutches are used in heavy vehicles
- (ii) It is also used in racing boats.
- (iii) Cone clutch is also used in extreme off-road vehicle.

SINGLE PLATE CLUTCH CONSTRUCTION

- (i) It is the most common type of clutch used in an automobile.
- (ii) This type of a clutch employs a disc or plate whose both sides are fixed with a frictional material.
- (iii) These discs are known as clutch plate or clutch disc.
- (iv) It consists of two driving members, these are flywheel and pressure plate.
- (v) It also consists of a clutch cover, pressure spring, friction plate, release lever, clutch shaft, pedal etc.
- (vi) The cover, pressure plate and springs form one unit that is fixed to the rotating flywheel.
- (vii) The friction plates are the driven member.
- (viii) Splines are provided on its central portion, the friction plate rotates the clutch shaft.



(ix) Fly wheel is connected to the engine crank shaft and the clutch disc is connected to transmission.

Operation :-

* When the clutch pedal is depressed the flywheel and the pressure plate will disengage and the clutch disc will be no longer in contact with the flywheel. frequently no transmission of power will be performed by the the clutch.

* When the clutch pedal is released, the pressure plate will be once again press the clutch disc against the flywheel and disc will be sandwiched betⁿ the flywheel and the pressure plate. Hence the power transmission occurs.

Advantages

- (1) Single plate clutch is smooth in operation i.e engagement and disengagement is smooth.
- (2) very less slip occurs in its operation.
- (3) very less heat is generated as only one clutch plate is used.
- (4) the operation is very fast.
- (5) it is reliable than a cone clutch.
- (6) it makes easy to change gear than a cone type clutch.

Disadvantages :-

- (1) It requires more force to release.
- (2) The space required more as compare to multi-plate clutch.
- (3) The capacity of torque transmission is less.
- (4) The size of the clutch is big even for less torque transmission.
- (5) chance of tearing wear is high in this type.

Application

- (1) This type of clutches are used in BUS, Trucks, Car etc.
- (2) single plate clutch used where large radial space is available.

MULTI PLATE CLUTCH

CONSTRUCTION

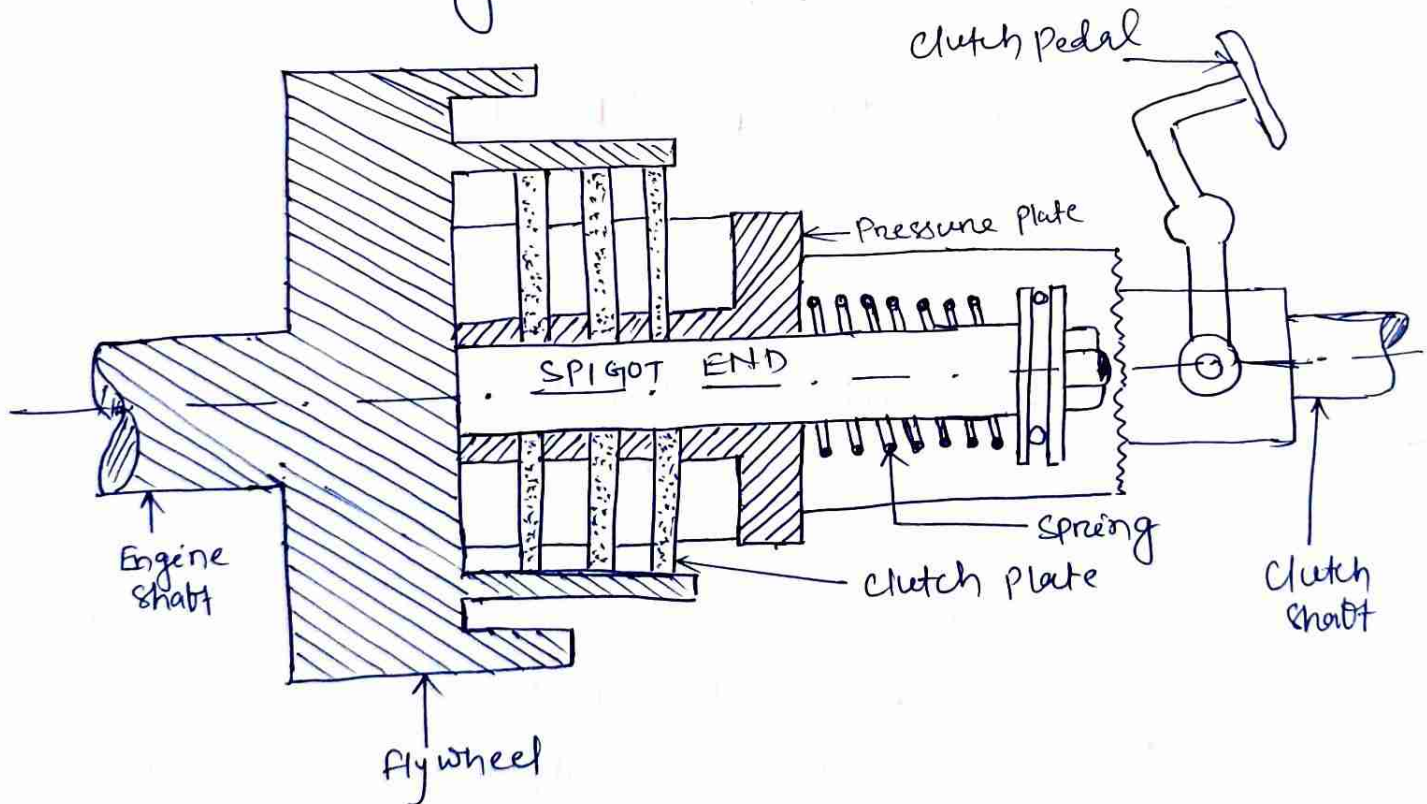
- (i) As per the name a multiplate clutch, consists of more than one clutch plate, it may be two or more.
- (ii) A multiplate clutch is provided with more than one friction plate also.
- (iii) As the number of clutch plate are increased, therefore the friction surface also increased.
- (iv) So that as result in increased capacity of torque transmission in comparison to single plate clutch.
- (v) The plates are alternately fitted to the engine shaft and clutch shaft.

(vi) They are firmly pressed by the strong coil springs and assembled in a drum type casing.

(vii) The each plate of alternate plate slides in grooves on the flywheel and the other slides on splines on the pressure plate.

Operation

While the flywheel is rotating, the pressure plates rotate and press against the friction plate. This causes the friction plate and thus the clutch shaft rotate as well. When the pedal is pressed, the flywheel continues to rotate but the friction plates are released. This happens because they are not fully pressed by the pressure plates. Thus, the clutch shaft also stops rotating.



Q8

Operation/working

When driver release the Pedal:-

- When driver release the pedal, the clutch ~~pedal~~ plate is gripped betⁿ the flywheel and the pressure plate.
- Due to the friction betⁿ the flywheel and pressure plate, the clutch plate revolves with the flywheel.
- So power is transmitted from engine shaft to clutch shaft.

When driver Press the Pedal:-

- When the driver press the pedal, the pressure plate moves back against the force of the clutch spring.
- Hence now the clutch plate free to revolve betⁿ the flywheel and the pressure plate.
- So that there is no power transmitted betⁿ the clutch shaft and engine shaft.

Advantages:-

- (i) It increased torque transmission capacity.
- (ii) It is highly reliable
- (iii) As diameter is reduced, as it has more friction surface which reduces the size of the clutch assembly
- (iv) It is suitable for heavy vehicle
- (v) Decrease the pedal effort to operate the clutch.
- (vi) Required less space.

Disadvantages:-

- (i) complicated design
- (ii) generating more heat as increase of friction surface.
- (iii) Multiplate clutches are too expensive.

Application:-

- (i) used in Two-wheelers, where space is limited
- (ii) used in racing cars.
- (iii) It is used in heavy transport vehicle as well as special purpose vehicle.
- (iv) used in heavy vehicle for high torque.

Wet clutch:-

In this type of clutch, the plates are immersed in bath of oil and also have grooved surfaces for allowing the oil to flow through them. These grooves help to dissipate heat generated during the engage and disengage, while in operation.

Dry clutch

This type of clutch has plates lined with the similar friction material as that used in single plate clutch. There is no any oil is used.

Difference betⁿ the single plate and Multiplate clutch :-

Single plate

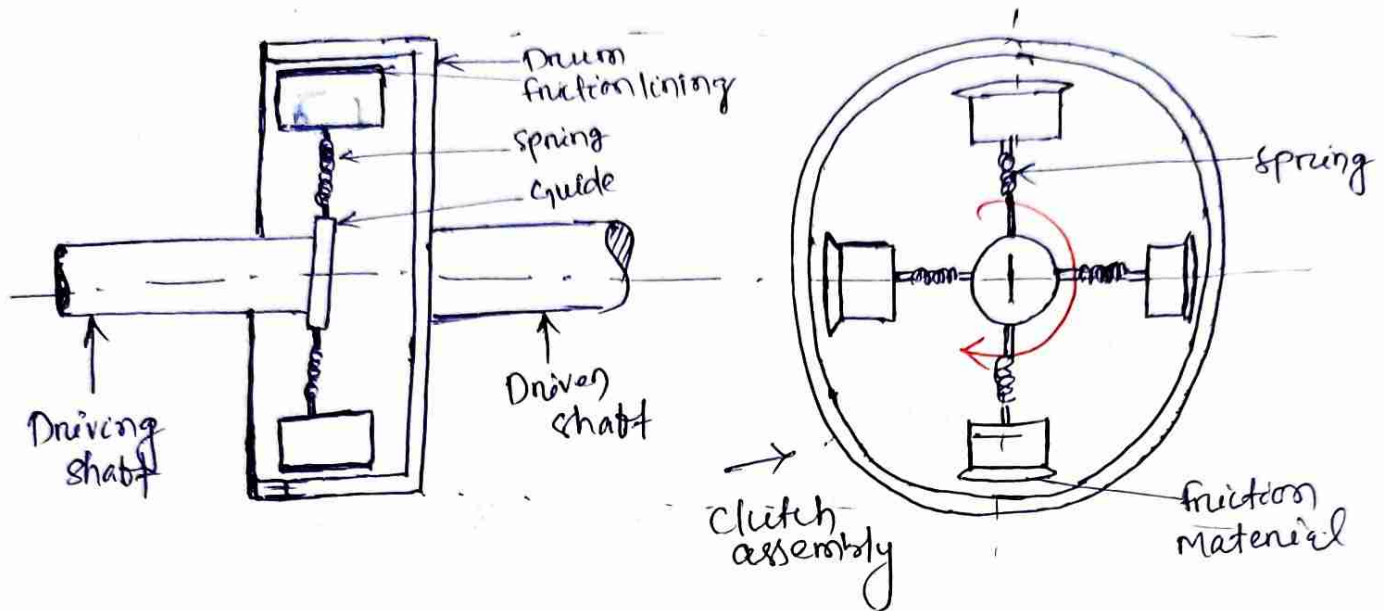
- (i) It consists of only one clutch plate
- (ii) The number of pairs of friction surfaces in contact are two
- (iii) It does not ensure smooth engagement.
- (iv) It requires more space
- (v) For the same power transmission large in size.
- (vi) For same size, torque transmission capacity is less.
- (vii) Frictional power loss is less
- (viii) Used in the Trucks, Jeeps, car etc.

Multiplate

- (i) It consists of two or more number of clutch plate.
- (ii) The number of pairs of friction surfaces in contact are more than two.
- (iii) It ensures a smooth and gradual engagement.
- (iv) It requires less space.
- (v) For the same power transmission, smaller in size.
- (vi) For same size, torque transmission capacity is more.
- (vii) Due to more no. of friction plate, frictional power loss is more.
- (viii) Two-wheelers, racing cars, some heavy duty-vehicle.

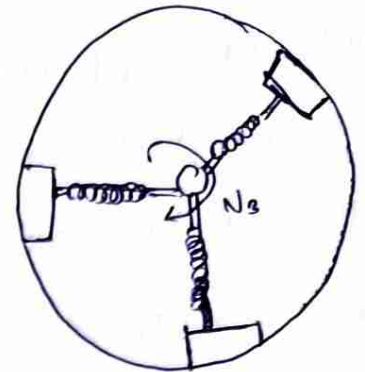
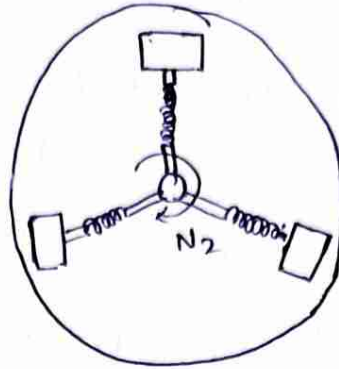
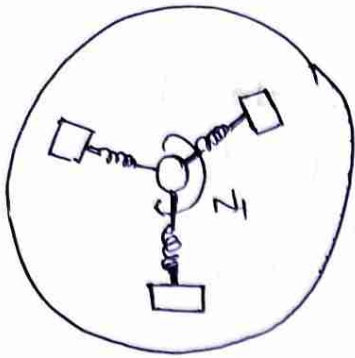
CENTRIFUGAL CLUTCH

Constructional Details and Working Principles



- * In the centrifugal clutch, centrifugal force is used for instead of spring force for keeping the clutch in engaged position.
- * This type of clutch does not require any clutch pedal for operating the clutch.
- * Since there is no clutch pedal is used.
- * Therefore the clutch is operated automatically, which is depending upon the engine speed.
- * So that the vehicle can be stopped in gear without stop or stalling the engine.
- * And also can be started in any gear by pressing the accelerator pedal.

Working:-



$$N_1 < N_2 < N_3$$

In this centrifugal clutch, as the engine speed increases the weight/bush tends to move outwards due to the centrifugal force and make perfect contact with the flywheel unit for the power transmission. The centrifugal force presses the pressure plate through the spring which ultimately presses the driven clutch plate on the flywheel. This makes clutch engage position. As the engine speed decreases the contact between the frictional material and the contact surfaces ^{or inner surface of drum} disengages with each other and it comes back to its original position. And perfect gear changes obtained under varying load and speed condition.

Advantages:-

- (i) No clutch pedal is required for operating clutch.
- (ii) It is operated automatically depending upon the engine speed.
- (iii) Vehicle can be started and stopped in any gear.
- (iv) This clutch is less expensive. ~~can~~ ~~can~~ cause less no. of parts are involved.
- (v) Maintenance cost is low.

Dis Advantages:-

- (i) It can't create high torque.
- (ii) Loss of power is high.
- (iii) The clutch is activated only when an engine reaches at particular speed.
- (iv) It is not suitable for all applications.
- (v) chances of slippage is more.

Application

* used in scooter, go-karts, and mopeds

SEMI-CENTRIFUGAL CLUTCH

A centrifugal clutch uses both centrifugal force and spring force for keeping in engage position. The springs are designed to transmit the torque at moderate speed or normal speed, while the centrifugal force assists in torque at higher speed.

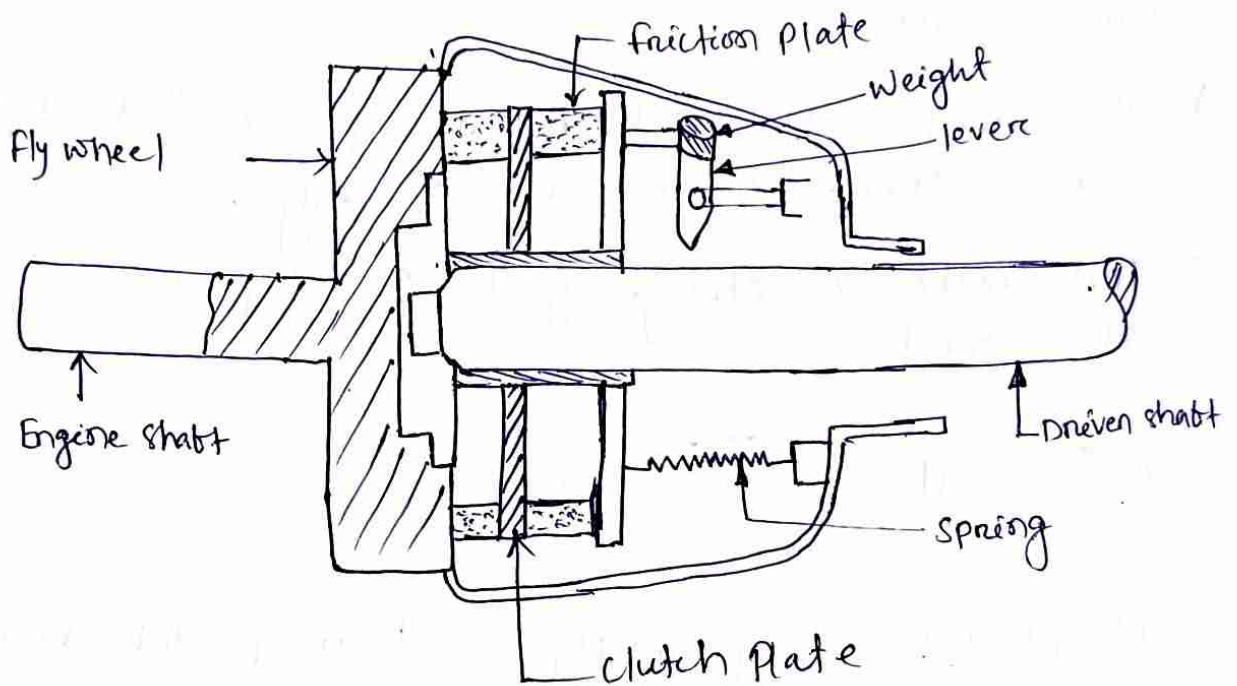
the semi-centrifugal clutch, it consists of three hinged and weighted levers and the clutch springs are arranged at equal space on the pressure plate.

Function:-

- (1) At moderate or normal speed, the pressure of the spring is sufficient to transmit the required torque. In this condition, the weighted levers do not apply any pressure on the pressure plate.

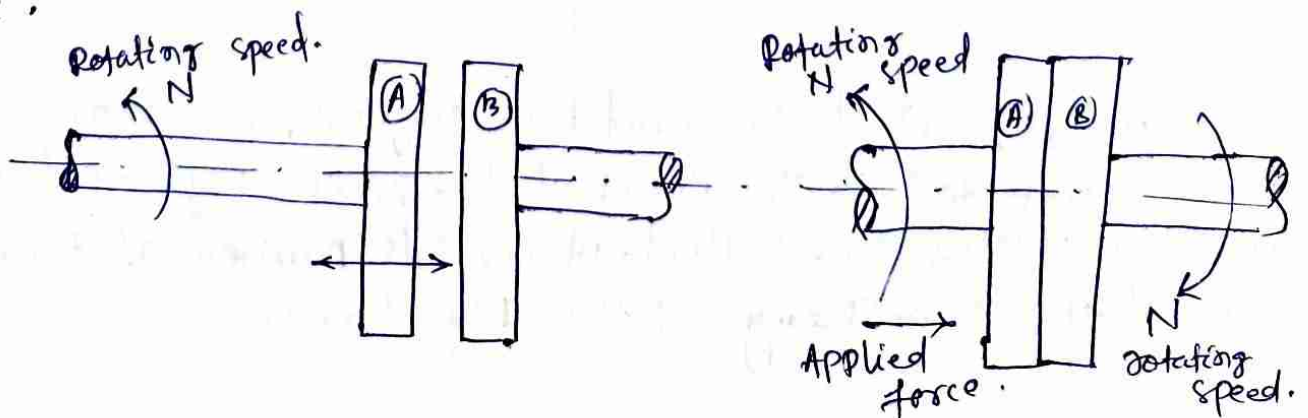
② At higher speeds, the weight attached to the lever moves out due to the centrifugal force about fulcrum, thereby pressing the Pressure Plate. ~~at high~~ centrifugal force proportional to the square of speed, hence adequate pressure is achieved.

③ When the speed decreases, the weights fall and the levers do not exert any pressure on the Pressure Plate. The spring pressure is only exerted on the Pressure Plate which is sufficient to keep the clutch engage.



1.2 Clutch operation

Automobile clutch is a mechanical device, which transmits power from one rotating disc to another disc depending upon the applied force and friction betⁿ two disc.



from the above fig there are two disc A & B both has rough surface. where disc A rotating at N speed and disc B is stationary position. Now the the disc B is made contact with disc A by applying force, then the disc B also start rotating at same speed.

* The clutch is located betⁿ the engine flywheel and the gear box. It transmits the power generated on engine - is the prime mover to the gear box - is the transmission system.

* The function of clutch is to engage and disengage the gear box from the engine smoothly.

* This helps to change gear smoothly while is the vehicle at speed.

1.3 CLUTCH COMPONENTS, CLUTCH FACING

The Basic clutch components are

- (i) clutch body (ii) fly-wheel (iii) clutch disc
- (iv) Pressure plate (v) clutch spring

Clutch body:-

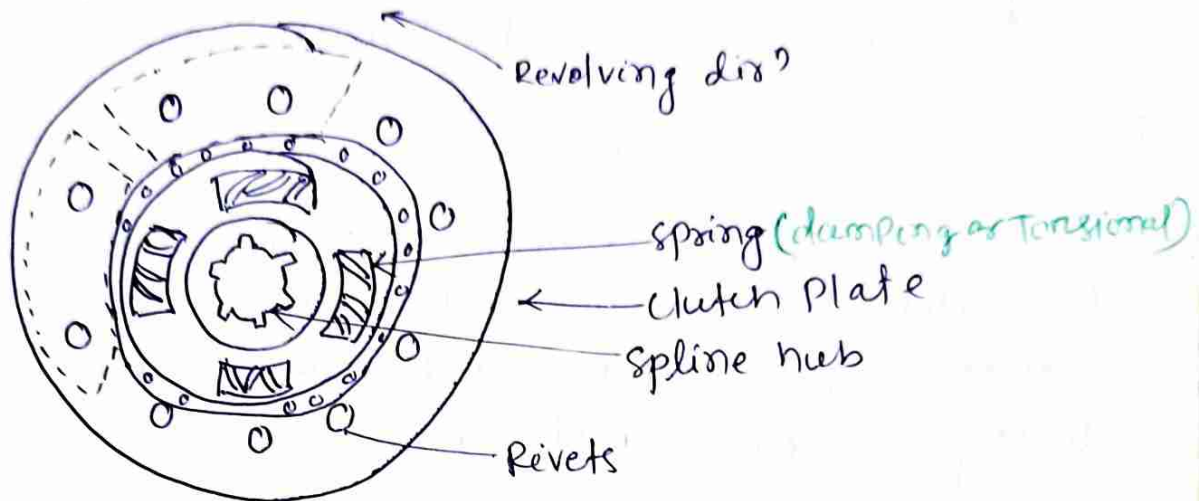
The clutch body or clutch case is a large bell shaped metal casing, betⁿ the engine and transmission. It contains clutch assembly and supports the transmission.

Flywheel:-

It is located behind the engine, the entire mass connected to the crank shaft. on the fly wheel the pressure plates are bolted. It consists number of teeth around the periphery of the flywheel.

Clutch disc :-

The clutch disc is fitted to the transmission main shaft. On the centre of the disc splined so that it can fitted to the main shaft. On the disc friction linings are riveted and it has also coil spring inside the disc for absorb the shocks.



Pressure Plate :-

The Pressure Plates are bolted to the flywheel and consequently these components will rotate as one part. This plate is accurately machined and press the the driven against the flywheel.

Clutch spring :-

These are the members of springs, these springs force the pressure plate on driven plate. so that perfect contact surface can be make ~~and~~ betⁿ them, for the smooth power transmission, from the driven member to the driving member.

CLUTCH FACING

Clutch facing is the portion of clutch on which the the disc (clutch) is gripped betⁿ the flywheel and the Pressure plate. The materials are used for the clutch facing. Clutch facing is provided both side of the disc. for the proper grip and heat dissipation in the clutch plate.

1.4 CLUTCH PROBLEM AND ADJUSTMENT

The clutch problems are generally following types.
(i) clutch slippage (ii) clutch drag (iii) grabbing and chattering clutch (iv) ~~clutch~~ ~~just~~ ~~before~~ Rapid wear of lining (v) clutch noises.

Clutch slippage:- It is the condition in which the the engine over speeds but does not provide any power to the rear wheel. slippage occurs when the clutch disc is not gripped properly betⁿ the flywheel & the pressure plate, i.e called slippage of clutch.

Possible causes:-

- (i) incorrect clutch-linkage adjustment.
- (ii) Broken or weak pressure spring
- (iii) Broken engine mount.
- (iv) worn linings
- (v) Greasy or oil facing

Clutch drag:- It is the condition, in which the clutch disc and transmission clutch shaft do not come to a complete stop after the clutch pedal press.

Possible causes:-

- (i) Bending of clutch linkage
- (ii) worn broken or bent components.
- (iii) if there is gear clash.
- (iv) oil or grease on disc facing

Clutch chattering and Grabbing:-

It is the condition, when it does not engage smoothly. Chattering means create vibration during the engagement or causes vehicle to vibrate during the engagement. and grabbing is the condition during engagement (while vehicle in motion) it gives series of jerks.

Causes:-

- (i) Grease or oil on lining
- (ii) Misalignment
- (iii) loose engine support
- (iv) Tight splines on the driven shaft.
- (v) loose friction - disc facing.

Rapid wear of lining:-

This is the condition of lining, which is worn out very fast or rapidly.

Causes:-

- (i) Badly warped Pressure Plate
- (ii) insufficient pedal play
- (iii) unnecessary press of clutch pedal.
- (iv) weak or broken Pressure springs.

Clutch noise

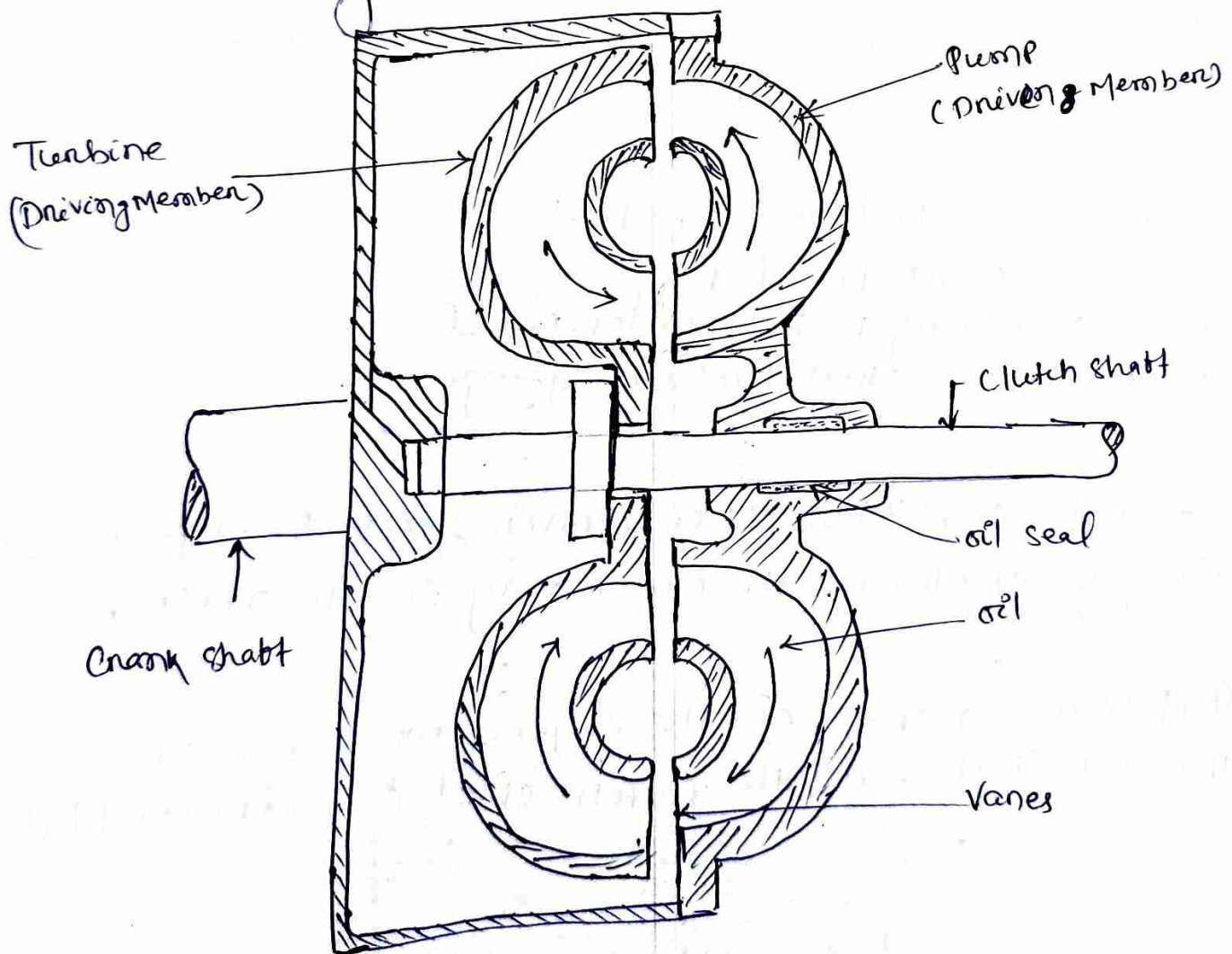
It is the condition, when driven going to engage and disengage of clutch, the clutch may create noise.

Causes:-

- (i) Poor alignment betⁿ the engine and transmission
- (ii) worn splines on the clutch shaft and driven Plate.

1.5 FLUID FLYWHEEL / FLUID COUPLING

Fluid flywheel is a hydraulic unit, that replaces a clutch in semi or fully automatic system, and transmits engine torque to the transmission system. The coupling is the major part of the engine flywheel assembly, so it is called Fluid flywheel. In this device, drive the power flows through a fluid instead of mechanical device. The fluid fly wheel consists of a driving member and driven member both in bowl shaped, and immersed in fluid contained in a casing. These units are mounted very closely with their open ends facing each other, so that they can turn independently with-out touching.



In the fluid flywheel, the unit is a sealed container that filled with the oil that provides the driving force that operates the device when the engine is running. As the driven member rotates, the centrifugal force on the oil in the curved van causes the oil to move to the outer edge of the impeller or pump and start to rotate the driven member.



Ch-2

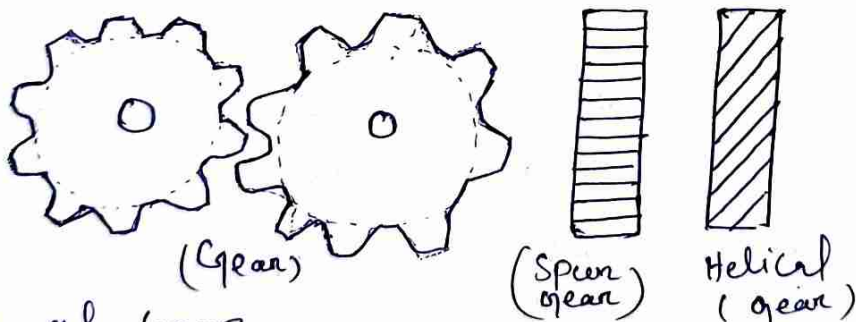
GEAR BOX

- 2.1 Introduction, function, types of Transmission
- 2.2 sliding Mesh and Constant Mesh Gear box
- 2.3 Epicyclic gear box, over drive
- 2.4 free-wheel drive, selector Mechanism
- 2.5 fluid torque Converter

2.1 Introduction, function, types of Transmission

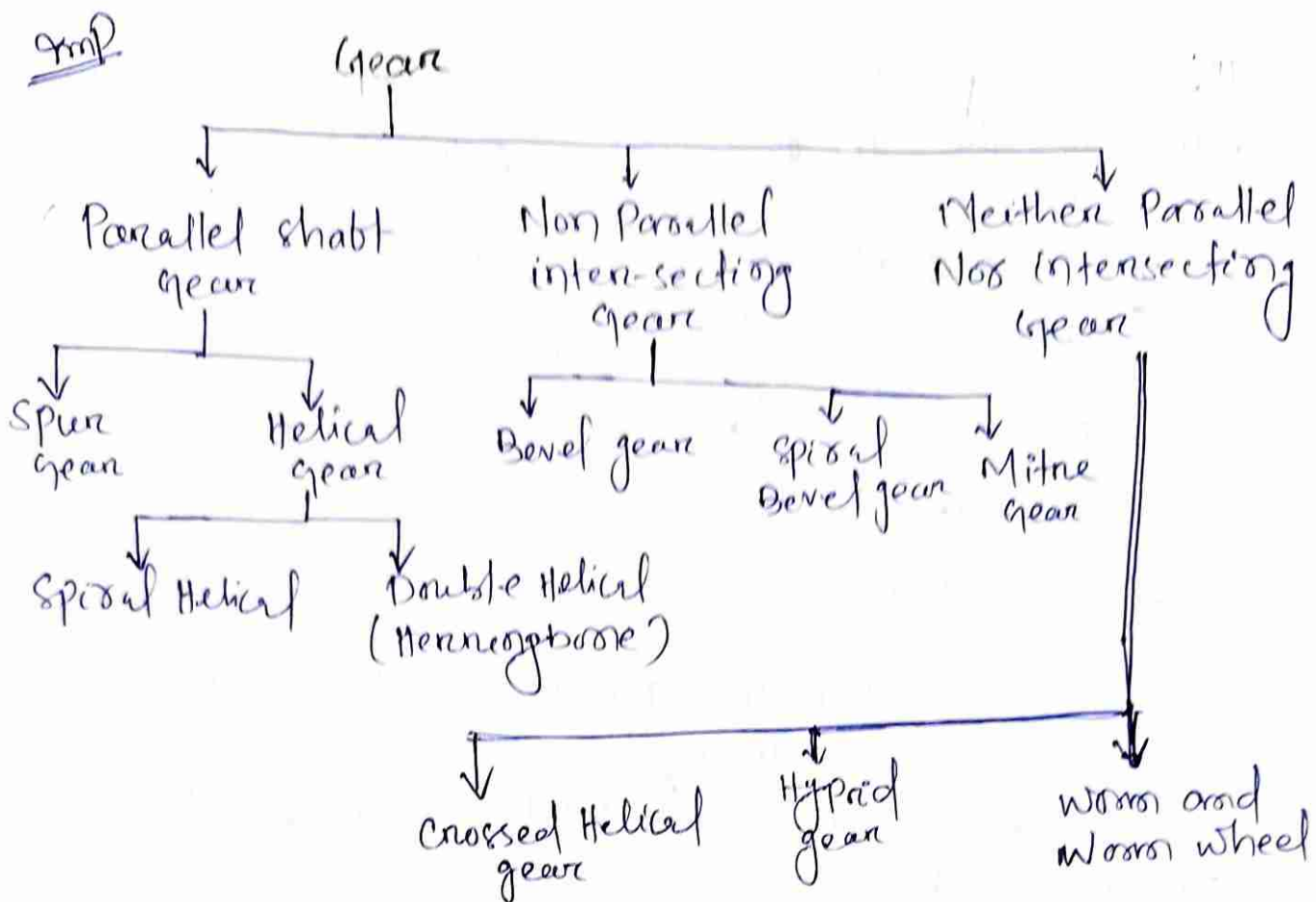
Gear :- A gear is a rotating part of machine, having cut teeth, which mesh with the another toothed part to transmit torque.

→ Gear device can changes the speed, torque and direction of power.



Types of gear

- Spur gear
- Helical gear
- Herringbone gear
- Rack and Pinion
- Bevel gear
- Worm and worm gear.



It is common experience that a high torque is required at the driving wheel, when a vehicle is starting from rest, climbing a hill or accelerating. Due to the variable nature of resistance because of load and gradient changes.

We know that the engine power should be available over a wide range of road speed. For this purpose a device is called transmission or gear set is provided to permit the engine crankshaft to revolve at a relatively high speed while the wheels turn/turns at slower speed.

* The gear set is enclosed in a metal box is called gear box. It is fitted betⁿ the clutch and the rear axle, and helps the road wheels to get the power of the engine in varying ratios.

The driving force or tractive effort used must be equal to the total resistance of the forces opposing the motion of a vehicle and keeping it moving along a road at uniform speed. The moving vehicle has to overcome the following resistance.

(i) Air or wind resistance

(ii) Gradient resistance

(iii) Rolling resistance

Air resistance: is the aerodynamic drag experienced by the vehicle while moving and depends upon the frontal area of the vehicle speed and the speed of the vehicle

$$\text{Air resistance} = \frac{1}{2} \rho C_d A V^2$$

C_d \rightarrow Co-efficient of drag

ρ - Density of Air

A - Area of the frontal part

V - vehicle speed.

Gradient resistance:- Depends upon the weight of the vehicle and steepness or the grade of road. and it is independent of vehicle speed.

Rolling Resistance:- It is the resistance to rolling motion offered by the road over which the vehicle is moving. It is mainly the sum of the losses occurring due to deformation of road and tyre and the losses occurring due to the dissipation of energy on the tyre.

The factors which affects the rolling resistance are mainly inflation pressure of tyre and tyre design. The effects of speed is rather negligible.

Function of Gear Box:-

Basically it transmit power and torque from the engine to driving wheel.

- (i) To enable the connection betⁿ the engine and the driving wheel
- (ii) To disconnect the engine from the driving wheels as and when required
- (iii) To enable a variable leverage between the engine and driving wheels
- (iv) To generate different speeds and different torque ratios.
- (v) To generate reverse motion as and when required.
- (vi) Enable the driving wheels to rotate at different speeds at the time of turning.

Types of Transmission:-

There are two types (i) Manual (ii) Automatic

Manual:- Are those which are shifted by hand manually.

Automatic:- Are those in which driver is not required to change but the gear changes are automatic.

2.2 TYPES OF GEAR BOX

Sliding Mesh Gear box, Constant Mesh Gear box.

Sliding Mesh gear Box :-

The sliding mesh gear box is the oldest and simplest type of gear box. As the meshing of gear takes place by sliding of gear on each other, so it is known as sliding mesh gear box.

→ Driving shaft of the gear box is known as Primary or clutch shaft. The clutch gear rigidly fixed to the clutch shaft and always connected to the driven gear.

Working Principle of 3-Speed Gear box (of Sliding Mesh)

→ 3-speed gear box consists of mainly three shaft. They are clutch shaft (Driving shaft), Counter shaft or lay shaft and main shaft or transmission shaft.

→ The main shaft consists of two gear, one is 1st and reverse gear and other is 2nd gear.

→ Counter shaft consists of reverse gear, 1st gear, 2nd gear.

→ Clutch shaft consists of only one gear. All the gears of each shaft are in a metal box.

→ The gears obtain are as follows

(i) Neutral Position

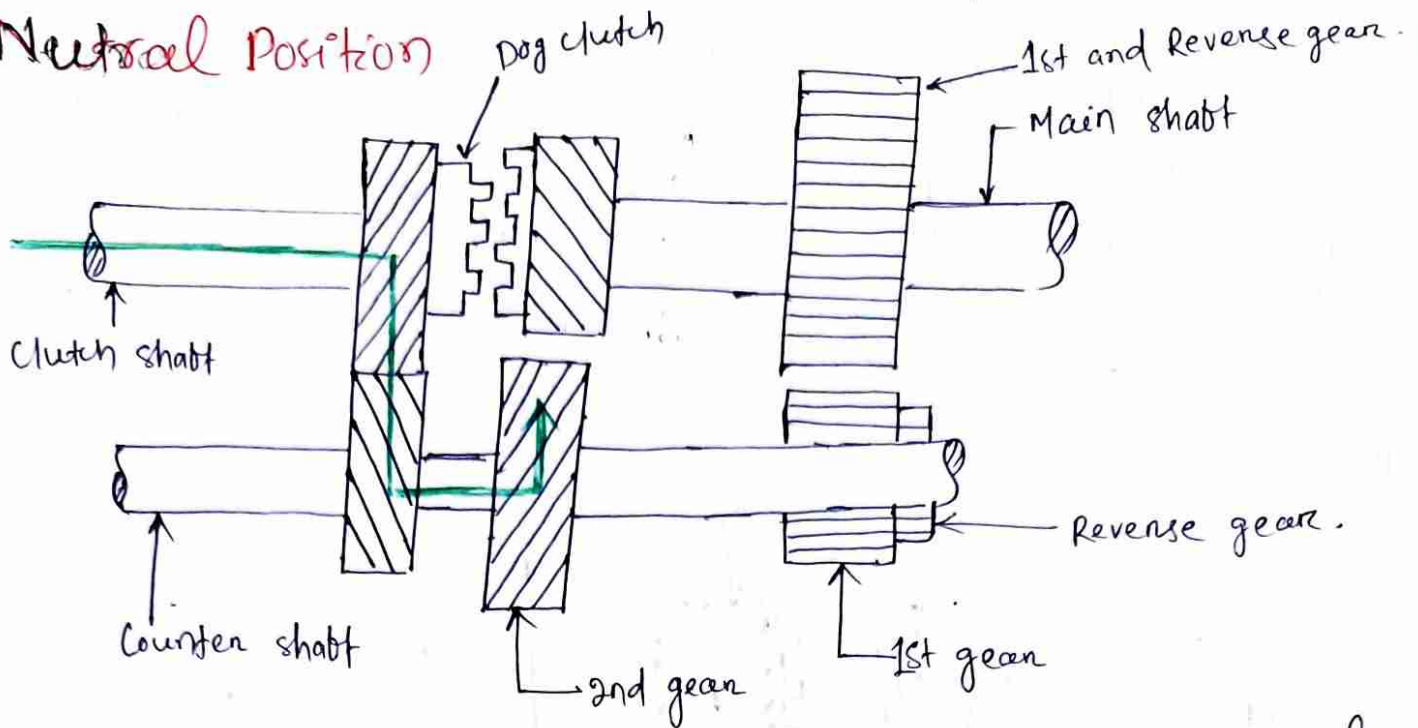
(ii) 1st gear

(iii) 2nd gear

(iv) 3rd gear

(v) Reverse gear

9) Neutral Position



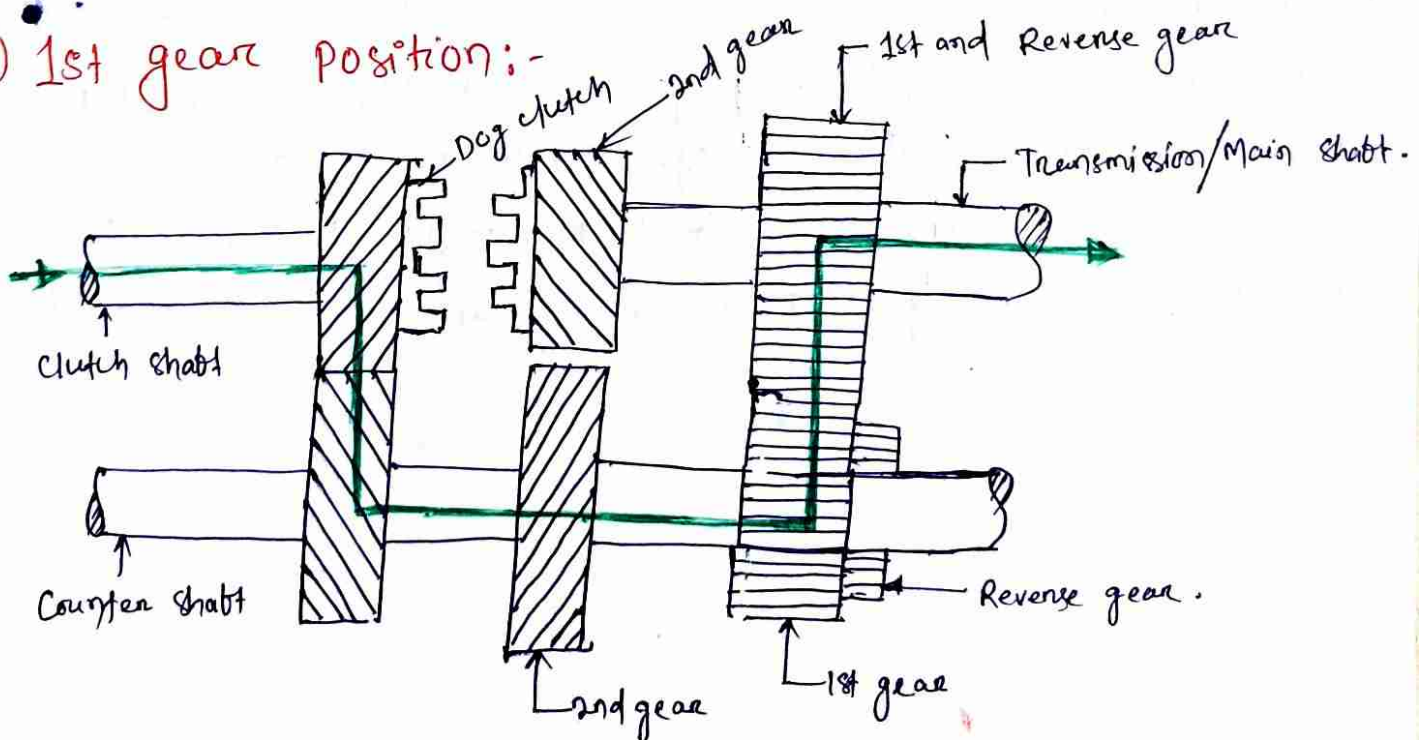
→ This above fig shows the position of gears in neutral position

→ The bold line shows the power transmission in neutral position.

→ As the clutch shaft and counter shaft constantly mesh, when the clutch shaft rotate, counter shaft is also rotate.

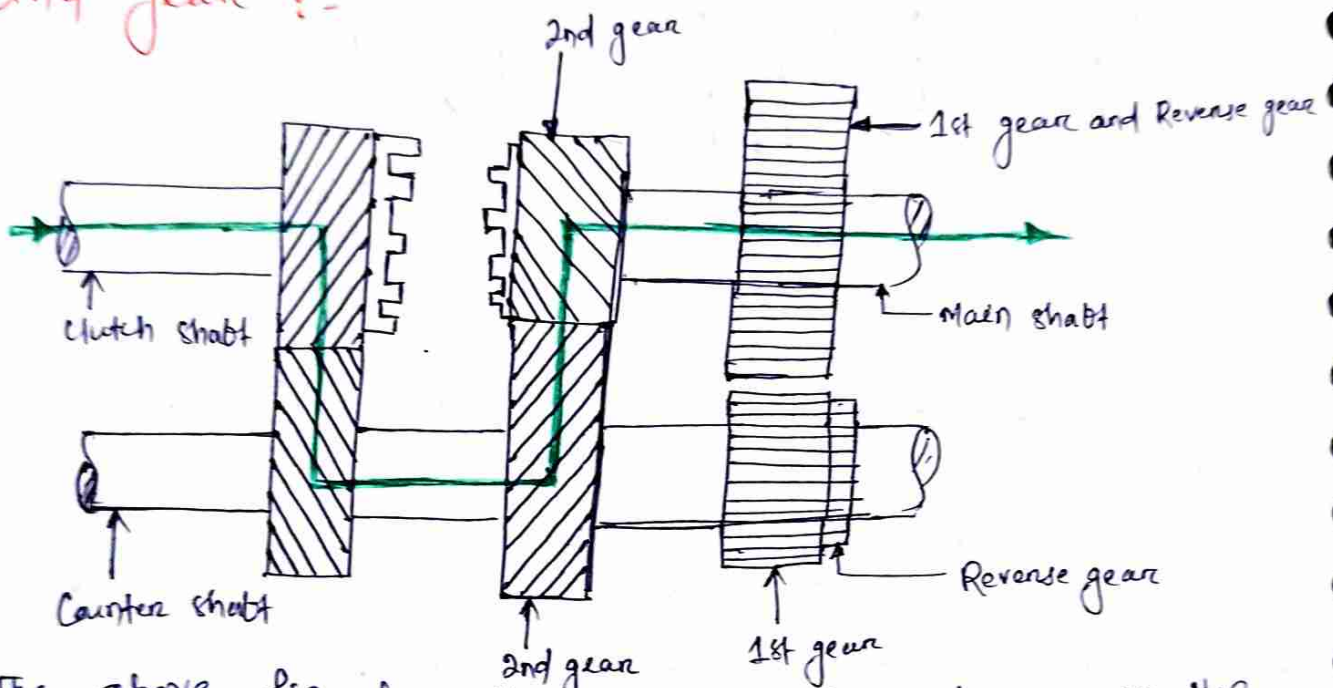
→ As there is no meshing of gears of the transmission shaft with lay shaft, so there is no power transmission to the transmission shaft.

(ii) 1st gear position:-



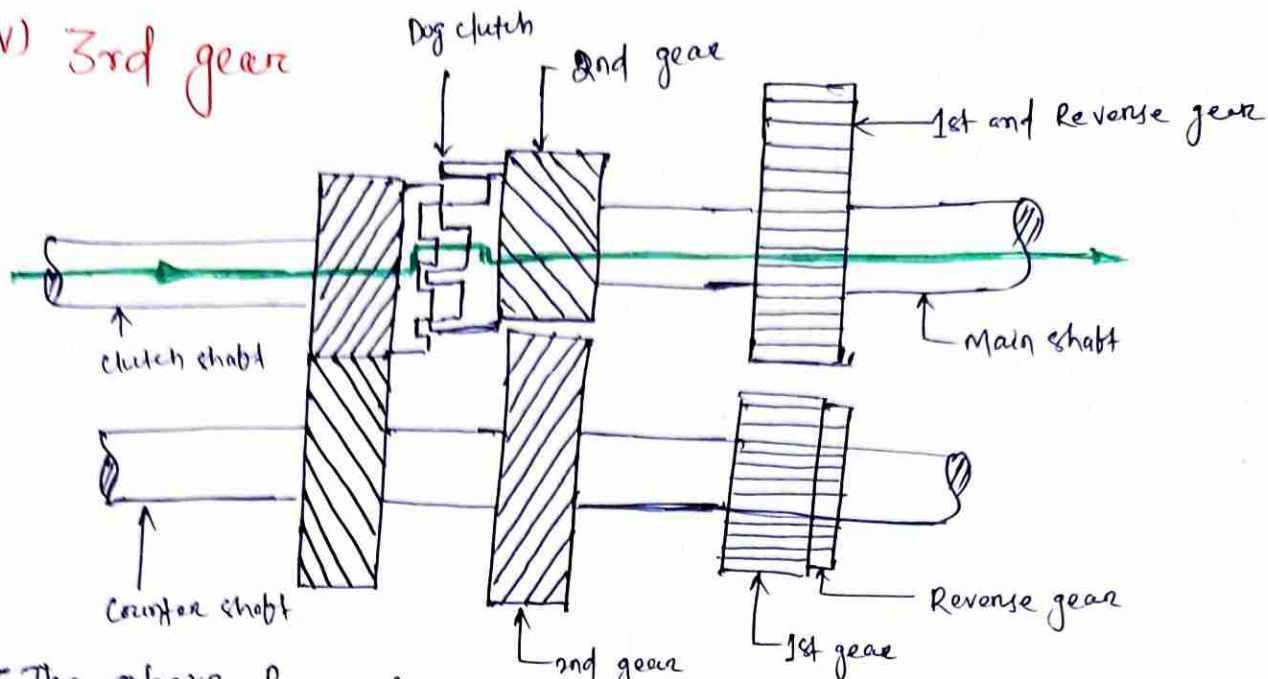
- The above fig shows the position of 1st gear.
- The bold line shows the power transmission in 1st gear.
- The 1st and Reverse gear of the transmission shaft is meshed with the 1st gear of the counter shaft by the help of selector mechanism. The ratio of gears is 1:4, so we get high torque.

(iii) 2nd gear :-



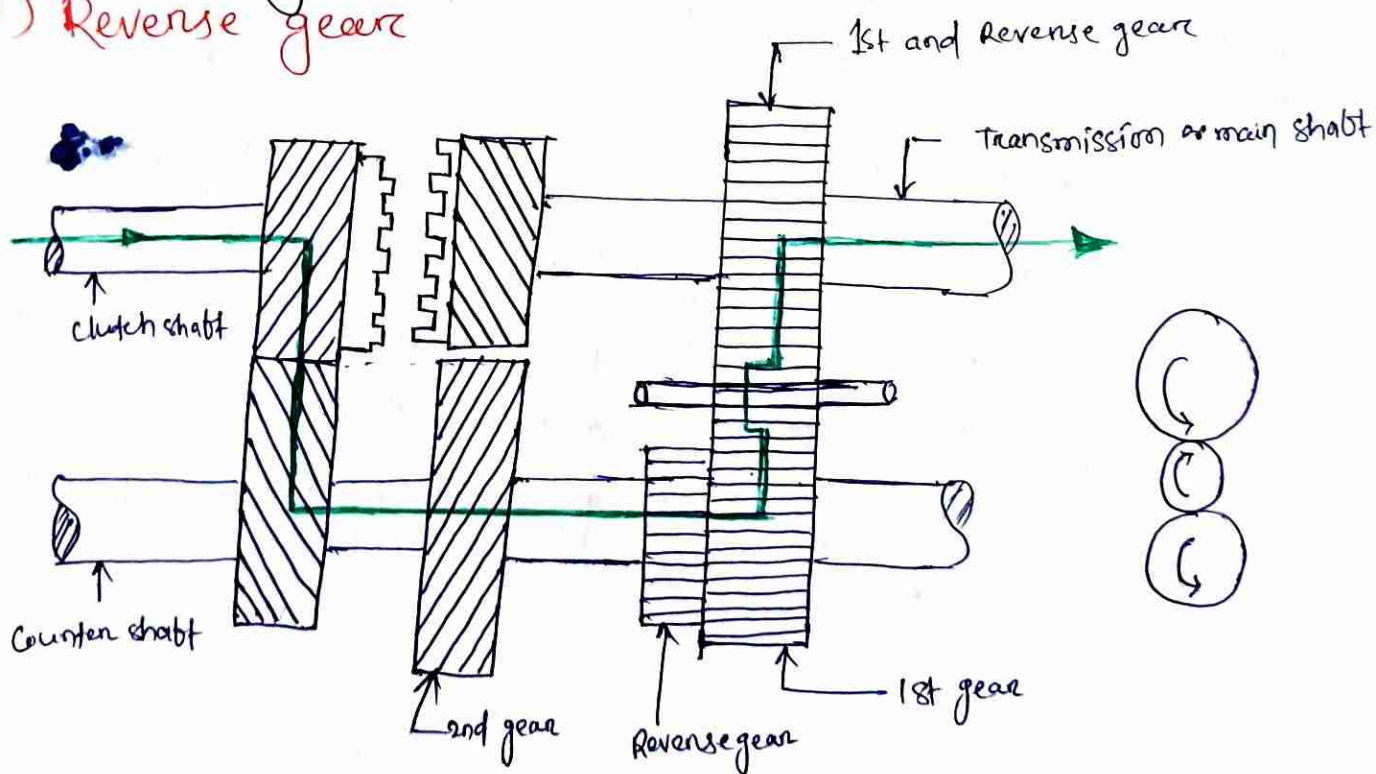
- The above fig shows the position of 2nd gear in the 2nd gear.
- The bold line shows the power transmission in 2nd gear.
- The helical teethed 2nd gear of the main shaft is meshed with the helical teethed 2nd gear of the counter shaft by selector mechanism and the ratio between two gears is 1:2, so we get medium torque at 2nd gear position.

(iv) 3rd gear



- The above fig shows the position of 3rd gear.
- The bold line shows the power transmission in 3rd-gear.
- This position is obtained by shifting of the dog clutch ~~to~~ to the left till the internal teeth with the external teeth of the main driving gear.
- Then the main shaft is locked with the clutch shaft. Thus making a direct drive.

(v) Reverse gear



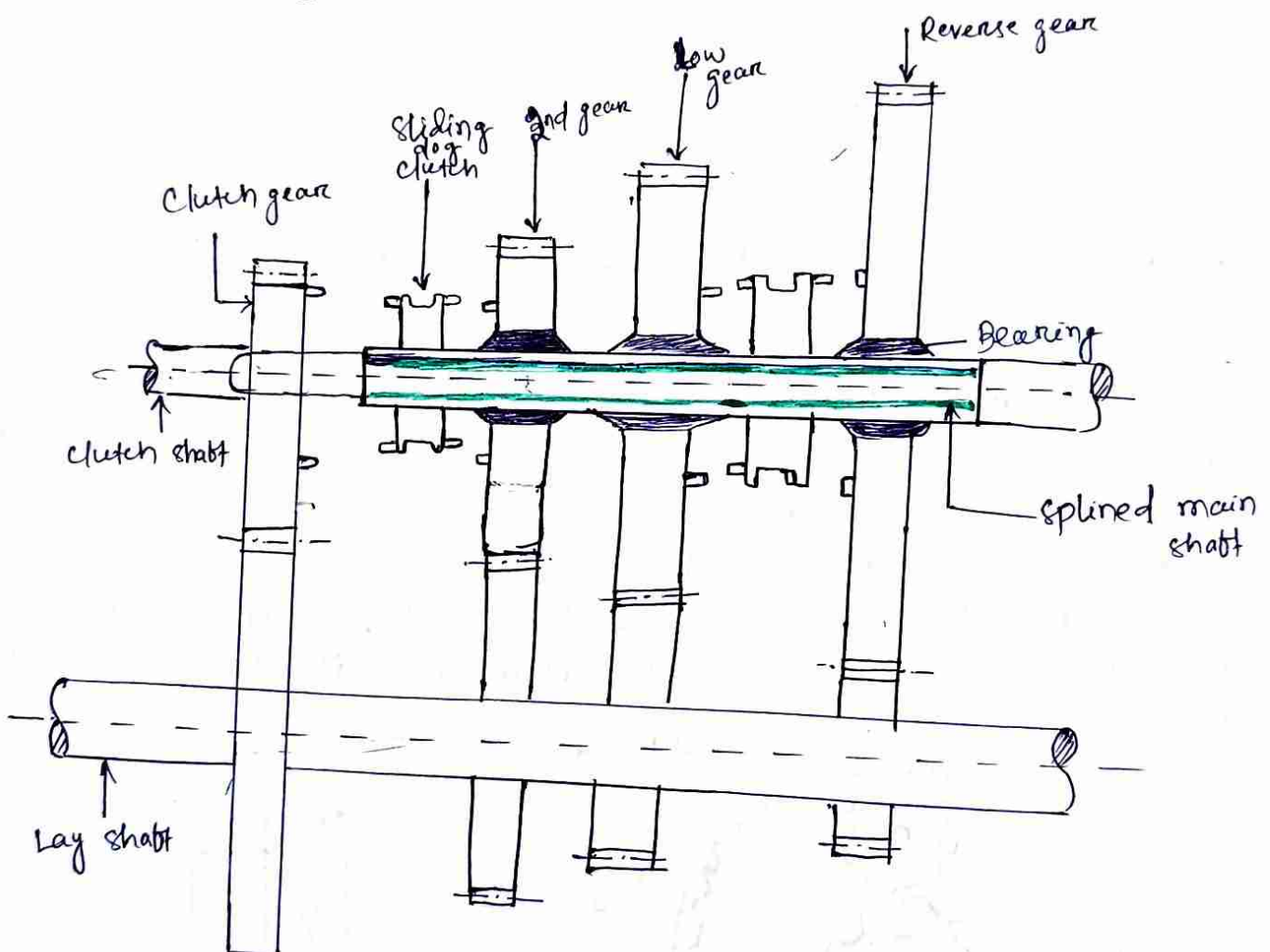
- The above fig shows the position of gears in reverse gear.
- The bold line shows the power transmission in the reverse gear.
- Before obtaining the gear the vehicle is brought into rest and the gear box to its neutral position. After that the 1st and reverse gear is moved to the left till it mesh with the reverse idler.
- Hence we get the reverse direction of the vehicle.

Sliding Mesh Gear Box

- It is the most simplest type of gear box in design, construction and manufacturing.
- In sliding mesh gear box basically there are three shafts used. They are clutch shaft, lay shaft or counter shaft and transmission or main shaft.
- The clutch shaft is rigidly fixed to the clutch gear and always connected to the driver gear of the counter shaft.
- Counter shaft and clutch shaft are constantly meshed.
- For obtaining the other gears, we have to slide the transmission shaft gear to mesh with counter shaft gear by using selector mechanism. Hence the meshing of gear is done by sliding, so this is called sliding mesh gear box.

Constant Mesh Gear Box

- In constant mesh gear box makes use of dog clutch for engagement and disengagement action, instead of sliding the gear, dog clutch slides different gear ratio.
- In this gear box all the gears mesh with each other, all time gives silent and quite quiet operation.
- Hence gear engaging is made easier by employing helical gears.
- The primary shaft which carries the clutch is splined and carries a gear that mesh with the largest layshaft gear.



- In this constant mesh gear box all the gears of the main shaft are in constant mesh with the corresponding gears of the counter shaft or lay shaft.

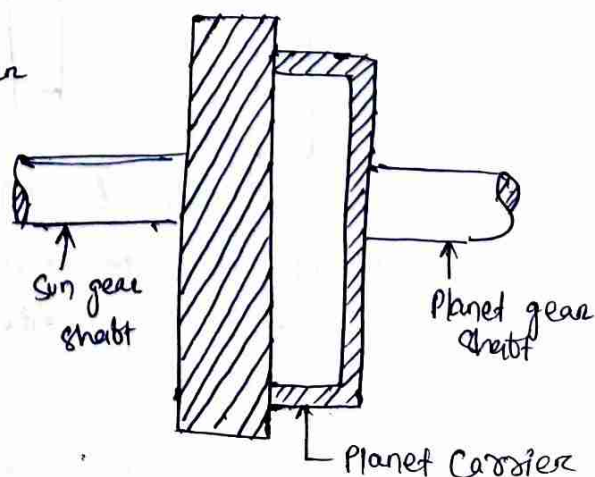
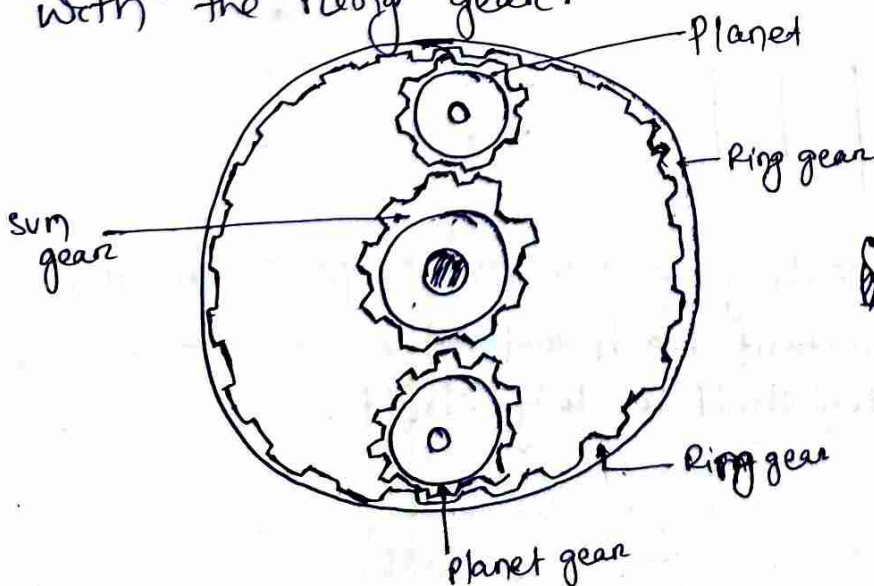
- Because both the shaft are constantly mesh, when one then the power will be transmit to other shaft.
- Always power transmission obtain by using all the gears of both shaft.
- This type of gear box is used where high torque is required (Heavy vehicle), having carrying capacity of 100 tonnes, 120 tonnes etc.)
- constant mesh gear box are helical teethed gear in design.
- In case of constant mesh gear box, skillful handling is necessary on the part of driver.

2.3 Epicyclic Gear Box, Over drive

Epicyclic Gear

An epicyclic gear box consists of two epicyclic or Planetary gear sets. This gear box may even have three or four Planetary gear set.

A simple gear set has sun gear. The planet gears that are supported by a carrier and a shaft, turn around this sun gear. ~~These~~ These gears are also in mesh internally with the ring gear.



Different speed ratios are obtained by making any one of the parts namely the sun gear, the planets and the ring gear stationary. Similarly, by locking two parts with each other, direct gear is obtained. The epicyclic gear box is employed in the overdrive system.

Over Drive :-

→ The over drive is a device, which is fitted in between the transmission and Propeller shaft and is used to provide a gear ratio more than 1:1.

→ This means that the overdrive causes the propeller shaft to turn more faster than the speed of engine crank shaft.

→ Over drive commonly used in high powered vehicles like, sports car, large sedans.

→ It enables a high ~~or~~ cruising speed to be attained with a low engine speed.

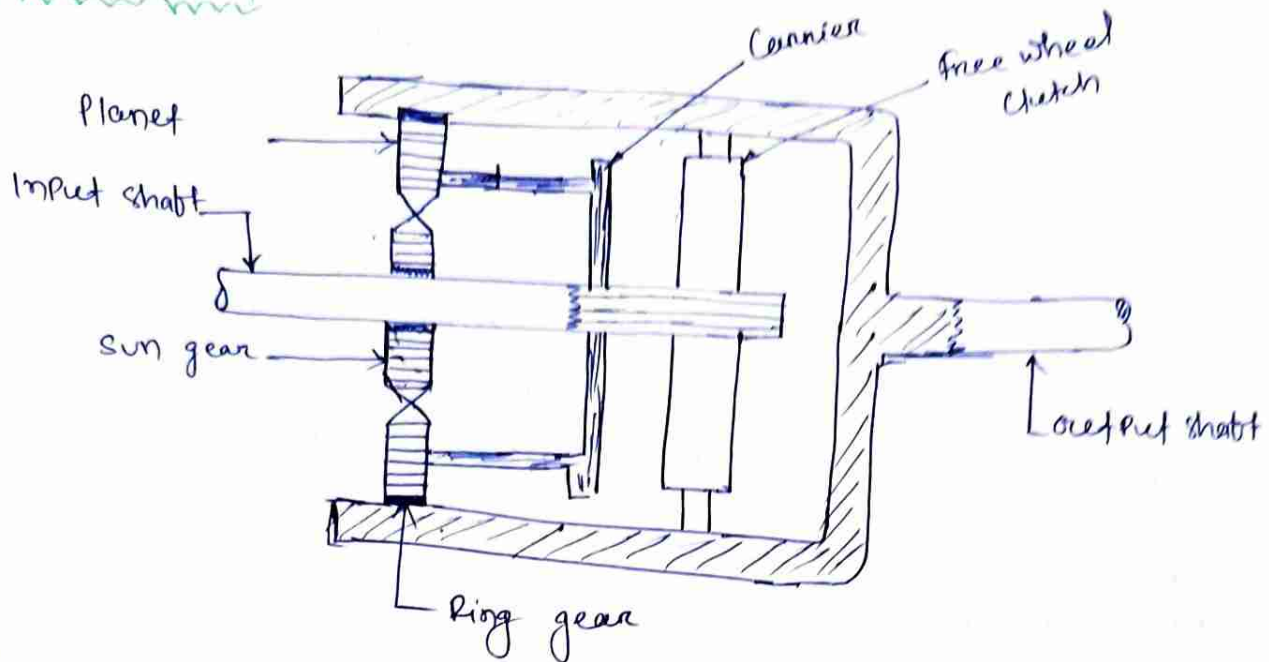
→ Generally overdrive fitted on top gear only.

Advantages

- (i) The engine life is increased since the engine turns lower for any given speed.
- (ii) It decreases vibration and abnormal noises.
- (iii) It improves fuel economy as the friction losses at lower speed are less.

Construction and operation :-

Construction



There are two shafts in the overdrive, namely the input and the output shaft. The main shaft of the gear box becomes the input shaft of the overdrive. The output shaft of the overdrive is connected to the propeller shaft. There is an epicyclic gear train which sun gear is free to rotate on the input shaft. The carrier moves on splines on the input shaft. A free wheel clutch is also attached on these splines. The ring gear is connected to the output shaft.

operation :-

* When the sun gear is locked with casing, it becomes stationary, now over drive is engaged. Thus increasing the speed of output shaft.

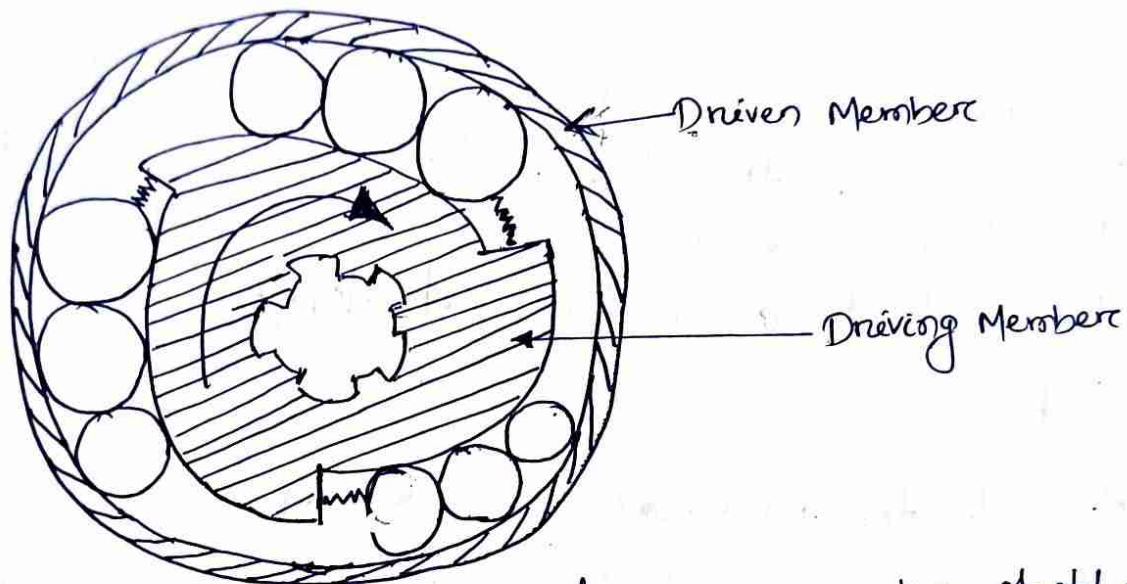
* When the sun gear is locked to the carrier, solid drive through the gear train is achieved. That normal direct drive is obtained.

* The same effect happens, when the sun gear is locked to the sun gear.

2.4 Free wheel Drive, Selector Mechanism

Free wheel Drive

- Free wheel unit also known as running clutch, free clutch or one way clutch.
- It is an essential part of ~~the~~ an overdrive.
- It is fitted at the back of the transmission and in case of overdrive is attached to the transmission.
- It is the part of an overdrive or is attached at its back.



- Inner member is connected to the gear box shaft and the outer one to the propeller shaft.
- The driving member has three steps as in fig.
- On each step there are three spring-mounted rollers of different sizes.
- When the driving member is rotating in the clockwise direction then the driven member also rotate in the same direction.
- But when Driven member becomes driving member, when the vehicle is going downhill with the engine speed or clutch disengaged, the inner member will not rotate along outer one.

→ Thus in this case the transmission and the engine will be isolated from the wheels. This results in fuel economy.

Advantages

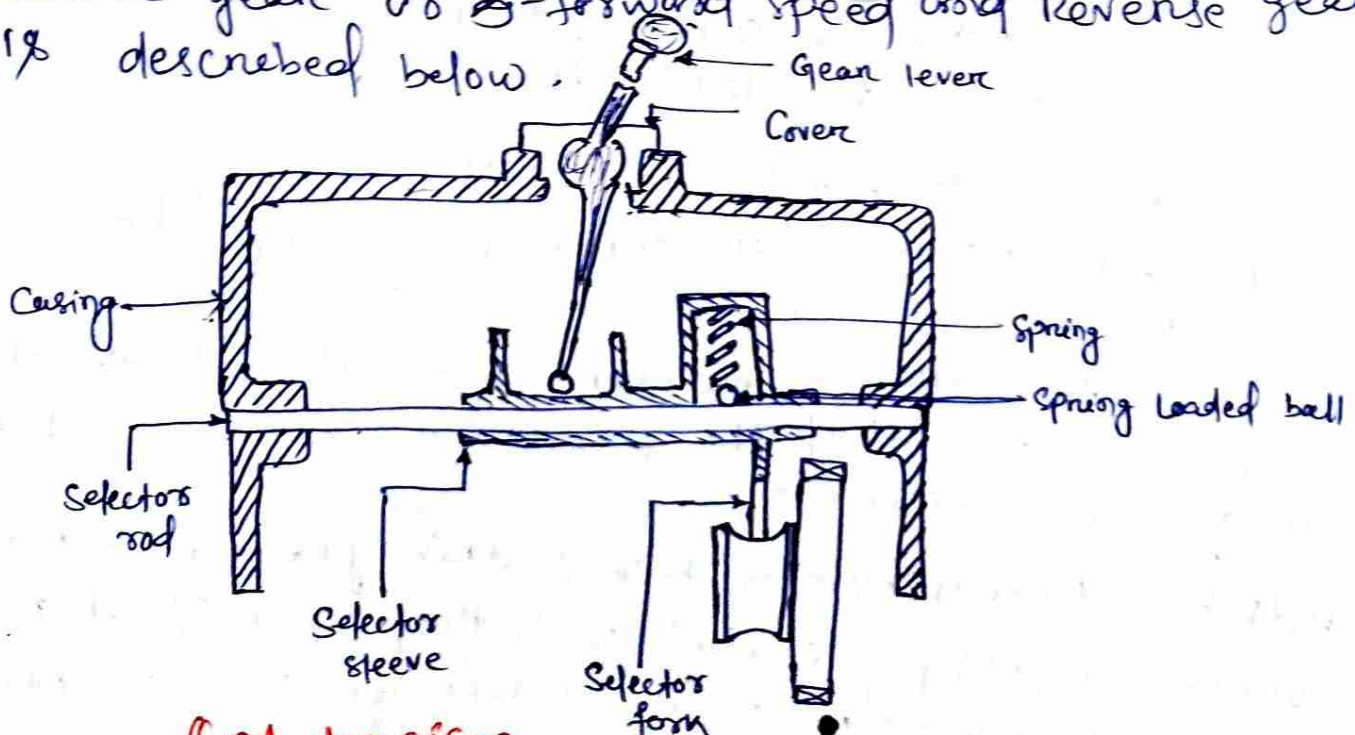
- (i) The gear changing is simplified.
- (ii) The engine can simply idle by closing throttle without bringing the gears neutral.
- (iii) There is less wear of transmission.
- (iv) The fuel saving is appreciable on downwards slope.

Dis Advantages

- (i) There is no resistance due to the engine and transmission friction while free wheeling (ii) hence the brakes must be used more efficiently to stop the vehicle on a downward slope.

Selector Mechanism

A selector mechanism for 4 forward speeds and Reverse gear or 3-forward speed and Reverse gear is described below.



(Mechanism with gear lever on top of gear box)

→ It is used to selecting the desired gear and sliding the same to engage with to corresponding gear on the lay shaft.

→ In selector mechanism it ensures in the design that number of two gears can be engaged simultaneously.

→ This is achieved by using suitable interlocking mechanism which ensure that any gear can be engaged only after neutral has been obtained.

→ A provision is also made to prevent accidental engagement of the reverse gear instead of a forward gear, this is done by means of a shift spring, which has to be overcome by applying external force.

- (i) Mechanism with gear lever on top of gear box
- (ii) Mechanism with gear lever on steering column.

Mechanism with gear lever on top of gear box.

→ The gear lever is ball mounted in the gear box cover. This facilitates any given for movement any dirⁿ.

→ The lower end of the gear lever fits into a slot in the selector sleeve.

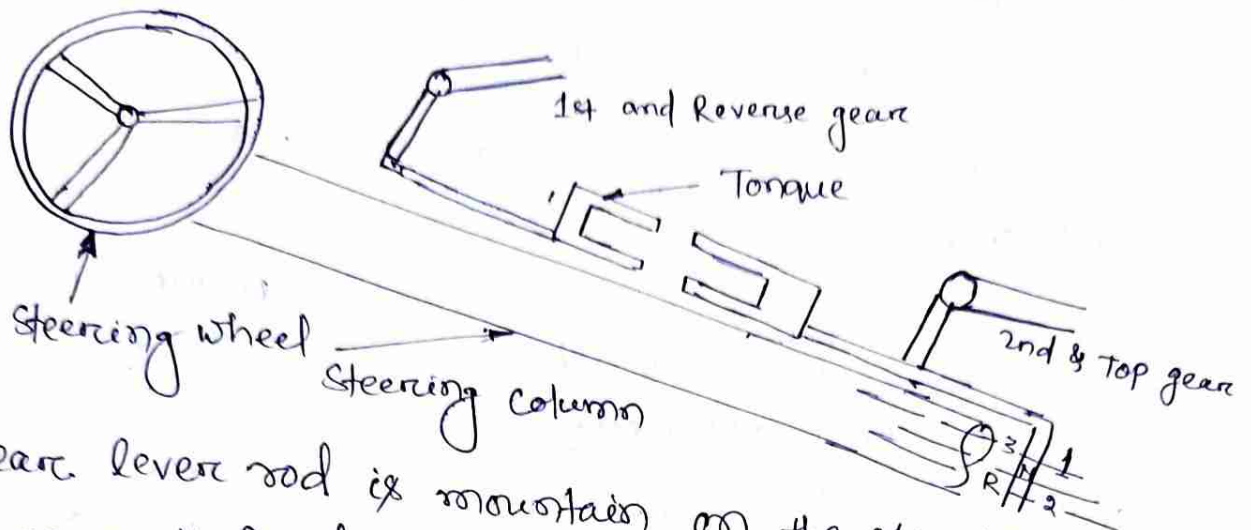
→ Each selector sleeve can slide on its rod but just avoid unwanted engagement of gears, slots are made on the selector rods and sleeves are provided with spring loaded ball.

→ Grooves are provided in the gear where the selector fork can fit it.

→ Various gear positions are marked on the gear lever knob itself.

→ When a particular gear is to be engaged the corresponding selector rod is moved in the desired dirⁿ.

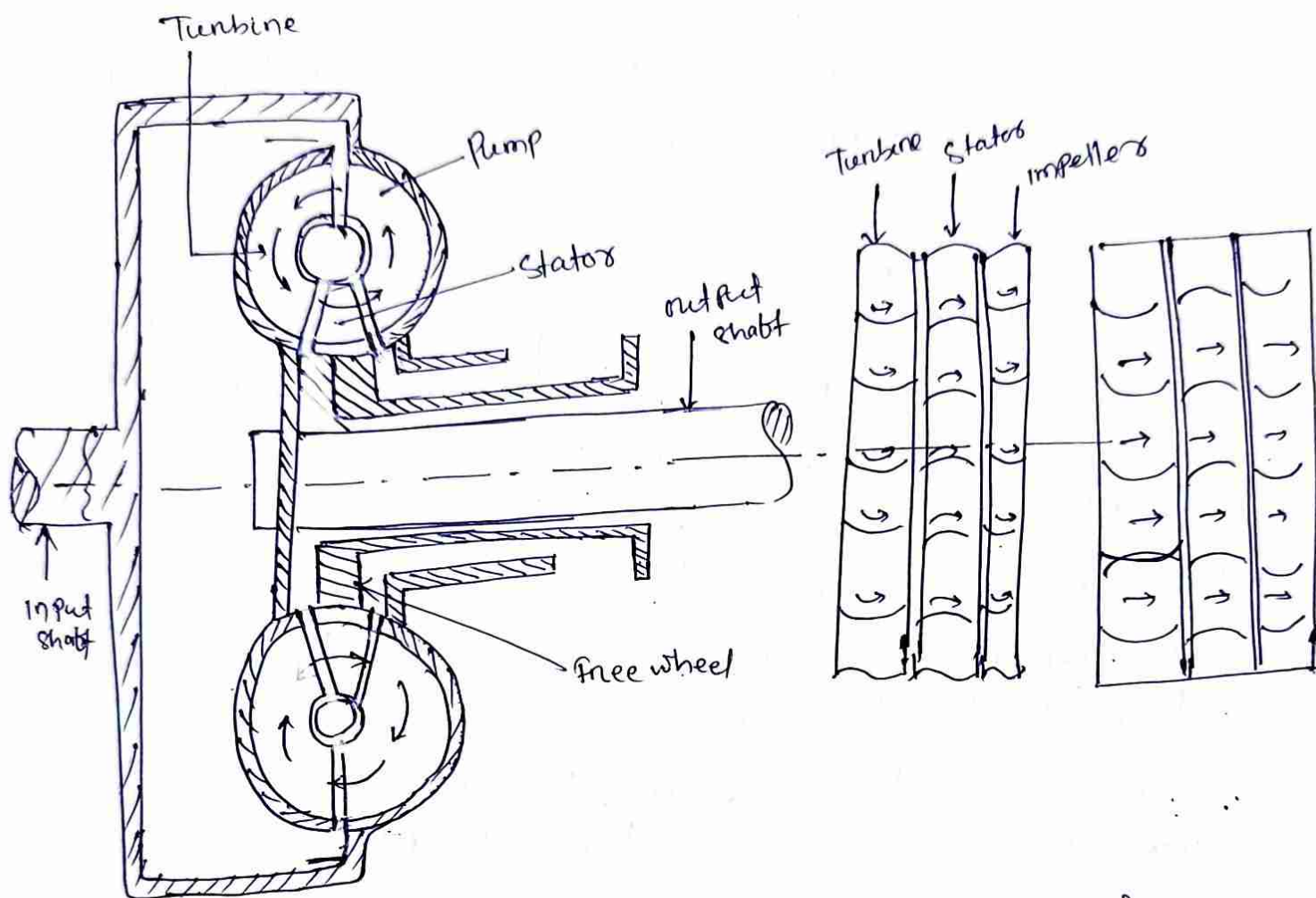
Mechanism with gear lever on steering column.



- The gear lever rod is mounted on the steering column.
- A tongue is fixed on the gear lever which can be engaged to either of the forks by the axial movement of the rod.
- When the fork is operated the angular movement of the gear shift lever slides that the fork in gear box and these by concerned gear to engage the selector gear.
- The one advantage is that it is handy to operate and it saves space, so that one more position can seat on the front seat.
- But now a days this type of selector mechanism are not in use for the poor performance and it take large space inside the gear box to operate.

2.5

Torque Converter



A torque converter is a device which performance is function similar to that of a gear box. that is torque increase the torque while reducing the speed. it is hydraulically operated.

→ It have three principle members

(i) Driving member or impeller or pump which is connected to the engine

(ii) Driven member or rotor or turbine, which is connected to the propellers shaft

(iii) stationary member or reaction member or stator which is fixed to the frame.

→ The stator is mounted on a free wheeling unit, one way clutch so that it can turn only one direction.

- The turbine is driven by the stream of oil, sent to it by pump.
- The entire assembly is connected and linked to the engine flywheel.

Operation:-

- When the engine is running idle, the pump produce a slow circulation of oil as the engine drives it. This slow circulation of oil is not sufficient to move the turbine.
- When the throttle is open wide the engine speed increased and the pump moves faster projecting the oil towards the turbine.
- Still it have less force and the oil return back to the pump with almost less of velocity.
- The increase torque of the turbine (turning force of turbine increased three times of the engine) enables it to rotate and thus drive the input shaft which in turn transmits the power to gear section of the transmission.
- Where as the fluid coupling transmit the same torque as given to it by the engine, the torque converter increase the torque in ratio of about 2:1 to 3:1.

Advantages

- Due to light in weight, absence of clutch it is used in light motor vehicle
- Easy to operate
- Low maintenance cost.

Dis Advantages

- Can't be used in heavy vehicle
- frequently overhauling oil change is needed.

Ch-3

Propeller shaft

- 3.1 Introduction, definition and types of Propeller shaft.
- 3.2 Universal joint and its type
- 3.3 Sliding joint.

3.1 Introduction, definition and types of Propeller shaft

Definition:- The propeller shaft is a driving shaft for connecting the transmission main or output shaft to the differential at the rear axle. The rotary motion of the transmission main shaft is carried out through the Propeller shaft to the differential, thus causing rear wheels to rotate.

Propeller shaft has three parts

- (i) shaft (ii) universal joint (iii) slip joint

shaft:- shaft is a rotating member, usually of circular cross-section, used to transmit power or motion. It provides the axis of rotation, or oscillation, of elements such as gear, pulley, flywheels, cranks, spoked ~~and the bike~~ and ~~controls~~ the geometry of their motion. of the machine. are mounted on the shaft and one used to transmit power from the driving device through a machine.

Universal joint:- One or two universal joints are used depending upon the type of the rear axle drive employed.

Slip joint:- Depending upon the type of the drive, one slip joint may be employed on the shaft. This helps to adjust the length of the Propeller shaft, according to the rear axle movement.

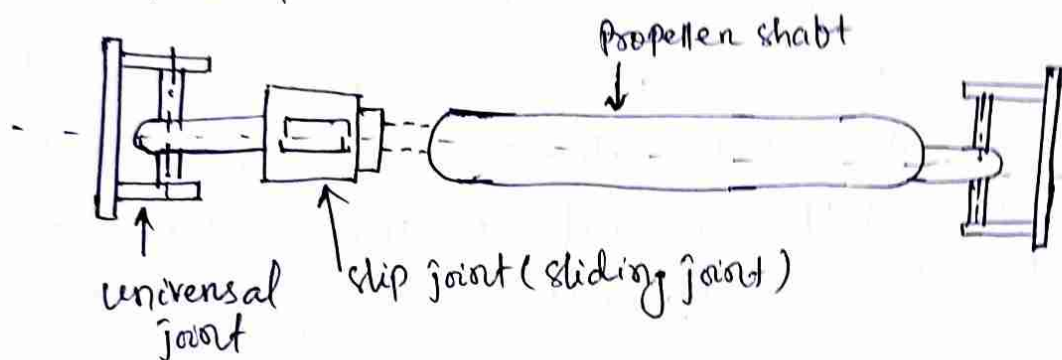
Types of Propeller shaft:-

These are basically two types

- (i) One-piece propeller shaft
- (ii) Two-piece propeller shaft

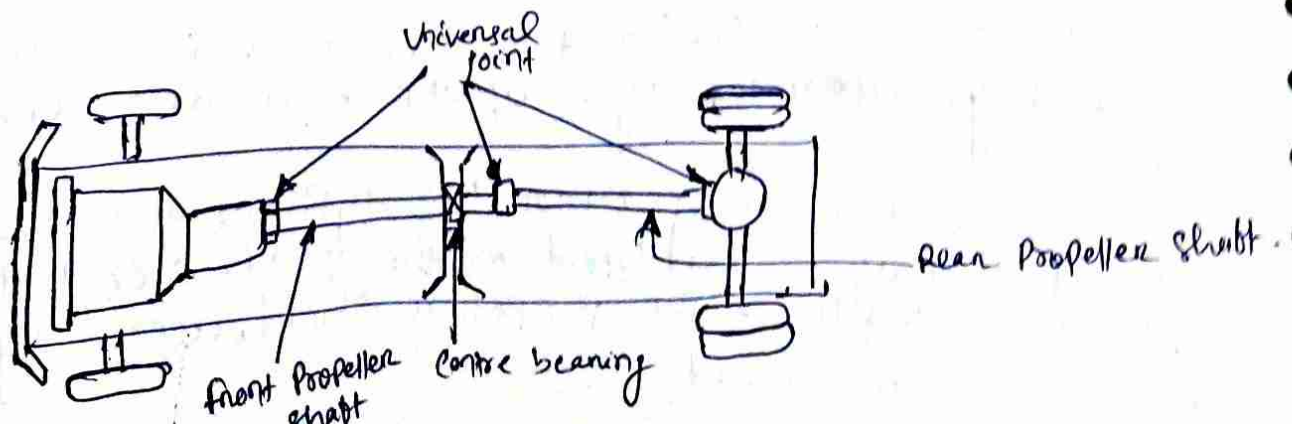
One piece Propeller shaft:-

In this type of drive shaft, the drive is transmitted to the differential of the rear axle by a long piece propeller shaft. This type of propeller shaft has universal joint at each end.



Two-piece Propeller shaft:-

In vehicle having long wheel base such as truck, and buses and the propeller shaft is in two pieces and is supported at the centre to avoid whipping action of long shaft. For fixing of two propeller shaft, at centre a third universal joint and centre bearing to support the middle of the shaft assembly. The rubber rings are used on the centre bearing to take care of the angular movement of shaft and also to absorb vibrations.



3.2 Universal Joint and its type

→ The universal joint is the joint which enables the drive shaft to transmit power at varied angle or An universal joint is used where two shafts are connected at an angle ~~to~~ to transmit torque. In the transmission system of a motor vehicle, the transmission main shaft, propeller shaft and the differential pinion shaft are not in one line; and hence the connection betⁿ them are made by universal joint.

→ One universal joint is ^{used to} connect transmission main shaft and propeller shaft.

→ And other universal joint is ^{used to} connects the propeller shaft and differential pinion shaft.

→ Thus the connection betⁿ the three shafts are flexible and at an angle with each other.

→ Universal joint allow~~s~~ the torque transmission not only angle but also while this angle is changing constantly.

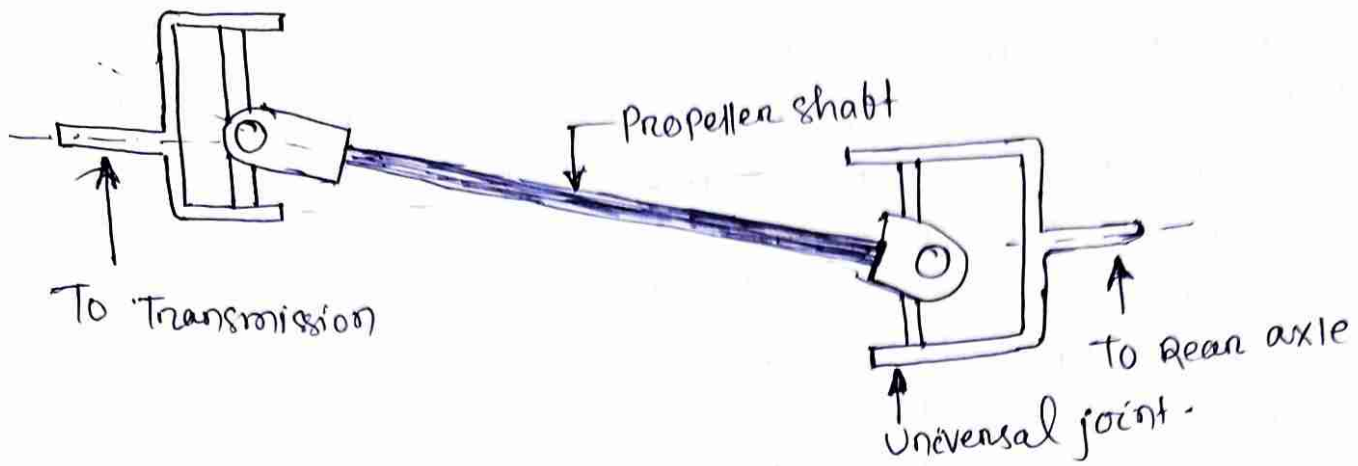
Types of Universal joint

The universal joints are classified as follows

① Cross-type or spider and two yokes type or Hookes joint

② Ball and Trunnion type

③ Constant velocity universal joint.



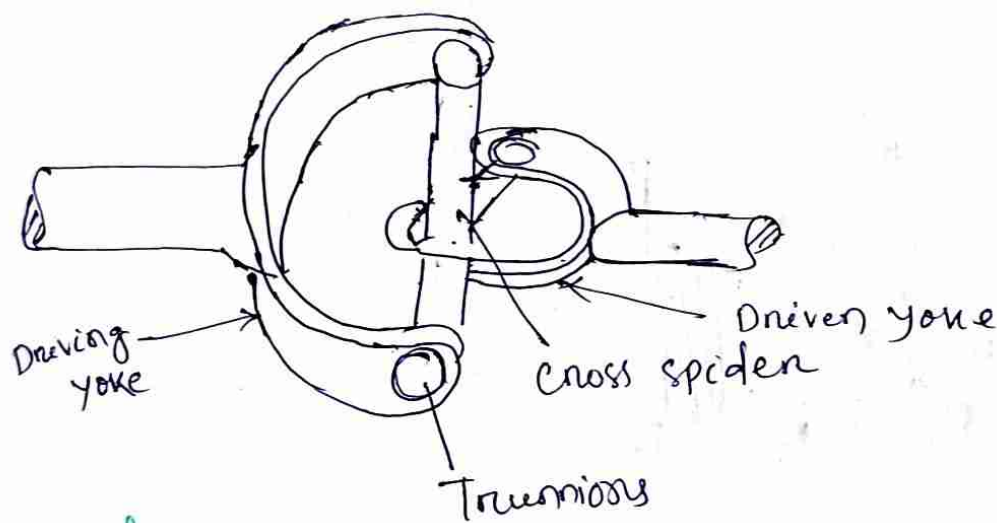
Variable velocity joint :-

- (i) In variable velocity joints, the driving and driven member do not turn at the same speed.
- (ii) Even each part of revolution of driving and driven members, they turn at the same rpm.
- (iii) The driven and driving shaft should, therefore, be in straight line so that they may turn at same speed through each part of revolution.
- (iv) But in a automobile, it is not feasible as the drive shaft inclined.
- (v) When there is an angle betⁿ the driving and driven shafts, the driven shafts turn slower than the driving shaft through half revolution.
- (vi) Thus the average speed of the driven shaft is equal to the driving shaft.
- (vii) The speed of variation in the driven shaft increase when the flex angle of the universal joint is increased.
- (viii) It is owing to this fact that variable velocity joints are usually used when the flex angle small.

Cross or spider type :-

It is also commonly known as Hook's joint, it is most common type of universal joint used in Automobiles and is widely used because of the fact that it is simple in construction and reasonably efficient at small angles (generally upto 20°) of Propeller shaft movement up and down.

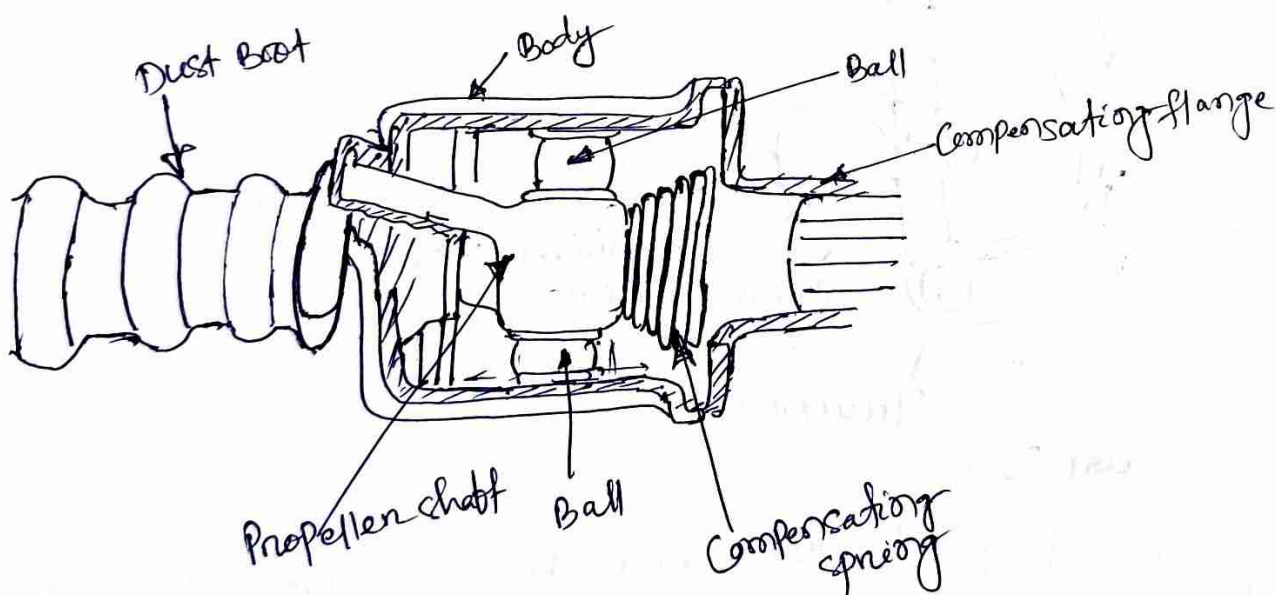
It consists of two y-shaped yokes connected at right angles to each other by means of a cross or spider. The arms of the cross are called as trunnions. The needle type bearings are employed betⁿ the yokes and cross ends.



Ball and Trunnion

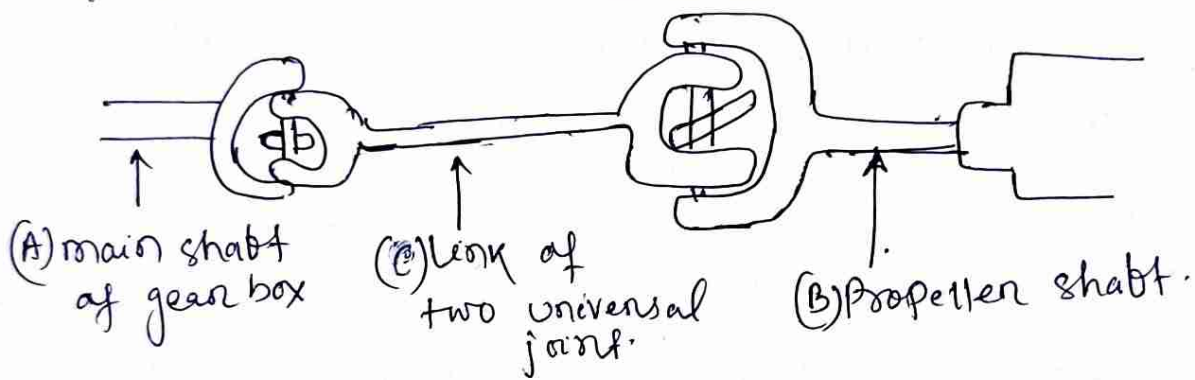
- This type of joint combines both universal and slip joint in one assembly.
- The ball and trunnion universal joint is a T-shaped shaft that is enclosed in the body of the joint.
- The trunnion end carries a ball mounted on needle bearings.
- The balls fits into the grooves of the trunnion which is attached to the other shaft.

- The complete assembly is free to slide in grooves machined in the outer body of the joint, in effect creating slip joint.
- The compensating springs at each end of the drive shaft hold it in a centered position.
- The variation of length is permitted by the longitudinal movement of the ball on the body grooves.
- The angular displacement is allowed by outward movement of the balls on the turnion pins.
- This type of universal joints is usually protected from dust, dirt, and water by a rubber boot.



Constant velocity joint/(CV) joint

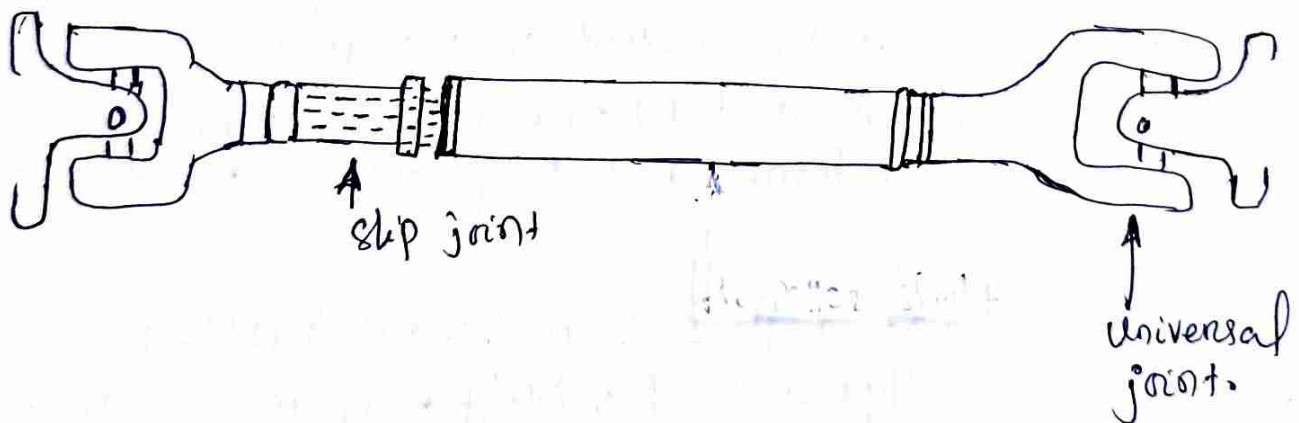
- In constant velocity joint there are two universal joints and two shafts.
- One is the main shaft of the gear box and other is propeller shaft connects to the differential unit.
- Both these shafts are parallel at the same time, but only the connecting link is inclined.
- It prevents the situation occurring while acceleration and deceleration fashion during the revolution of shaft, which are operational noise, vibration.



- * When (A) main shaft rotates (C) connecting link also rotate.
- * This rotation is transmitted to the propeller shaft. But since shaft (A) and (B) are parallel their rates of rotation are uniform and they rotate at the same velocity.
- * Thus by using a pair of universal joints, this arrangement develops constant velocity. In this manner the vibrations are minimized.

3.3 Sliding joint./ Slip joint

- The Propeller shaft is connected betⁿ the transmission main shaft and the differential pinion shaft.
- The front yoke of the universal joint is known as slip joint and splined to the external splines of the transmission output shaft.
- The spline of the slip joint fits perfectly to the transmission output shaft and is free to move in and out.
- It increase and decrease the length of propeller shaft when vehicle goes over bump or irregular surface.
- It has outside splines on the shaft and matching internal splines in mating hollow shaft as yoke.
- when assembled the splines causes the shafts to rotate together while they can move back and forth. This changes the length of the propeller shaft.



Ch-4

Differential

4.1 Function of differential gear box

4.2 Types of differential

4.3 Constructional details of differential

4.4 Study and inspection of differential.

4.1 function of differential gear box

Differential

A differential is a device, which is capable of transmitting torque and rotation through three shaft, almost always used in one of two ways. In one way, it receives one input and provides two outputs; this is found in most automobiles. In other way it combines two inputs to create an output that is the sum, difference or average of the inputs.

Def Differential is a mechanical device, which is mechanical addition and subtraction assembly. By splitting the engine torque to the drive wheels, when the vehicle is turning a corner.

Def Differential is a mechanical device, which differentiates the engine torque, among the the rear wheels.

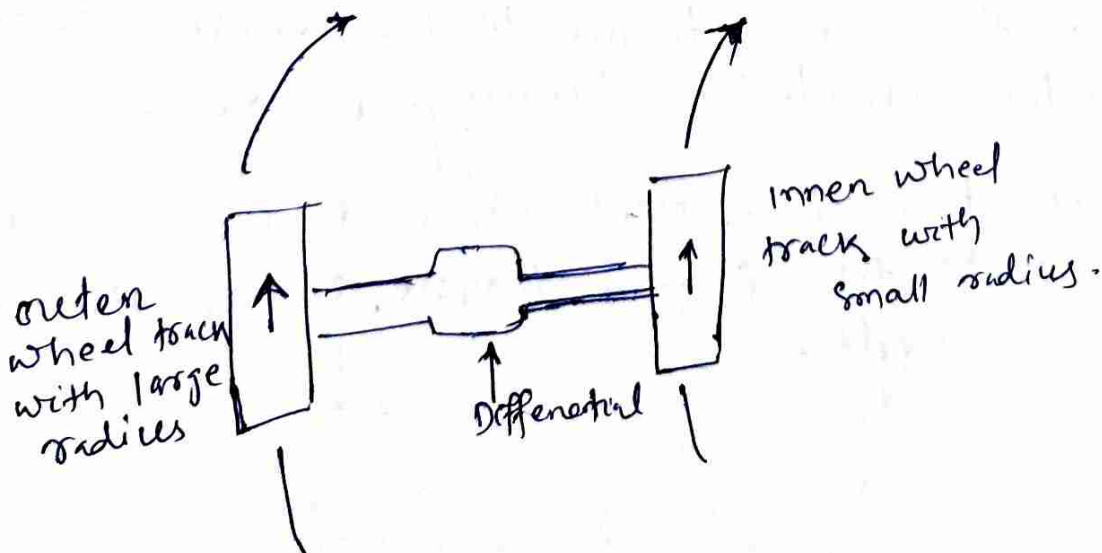
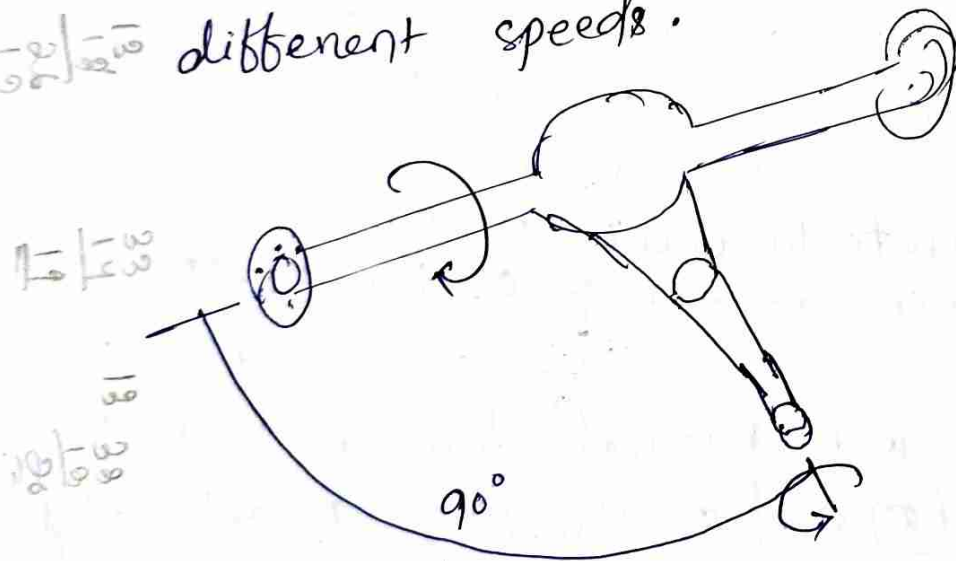
Function of Differential Gear Box:-

→ The differential ~~box~~ allows engine torque to be applied to both drive axle, which rotate at varying speed during cornering and while travelling over bumps and dips in the road. The differential ~~speed~~ also changes the direction of engine torque 90° from the rotation of the drive shaft length-wise with the vehicle.

Basic function of differential

(i) To change the direction of Engine torque

(ii) To allow the drive wheels to rotate at different speeds.



- (iii) Transfer power from drive shaft to the wheel
- (iv) Provide final gear reduction
- (v) split amount of torque going to each wheel
- (vi) Allow the wheels to rotate at same speed while ^{moving} in straight condition.

4.2 Types of Differential

These are basically

- (i) Conventional Differential
- (ii) Limited slip Differential (LSD)
 - (a) Mechanical LSD
 - (b) Viscous coupling LSD
 - (c) Electronic LSD

Conventional Differential

The conventional differential consists of a case which contains differential gears. The differential gear consists of two side gear or sun gear and two or four pinion gears. All gears are bevel gear type. The pinions are fitted on pin if there are two numbers and on a spider, if there are four in numbers. The pinions are free to move around the axis. The pin or spider is held in bet[?] the two parts of the case which encloses the differential gear.

Limited slip Differential (LSD)

The purpose of differential is to make easier for vehicle to corner turn correctly. This component however the opposite effect of about to happen, vehicle operation in each following situation.

(1) when driving on bumpy roads: - It is very common for a vehicle, ~~when~~ ^{if} one wheel to lose contact with the surface when that surface bumpy in nature. When this occurs, a much higher degree of drive torque will be directed to that wheel. When this wheel subsequently comes back into contact with road surface, it will be turning much faster than the corresponding wheel on opposite side of the vehicle.

→ The left/right speed difference generated in such a situation has a harm effect on the vehicle's straight stability.

(2) When one tyre encounters a slippery section of road: -

A wheel will start to 'free-wheel' when it loses traction (Grip is the pulling power of engine) on mud, on ice or on other kind of slippery surfaces. The design of the differential is such that, in this kind of situation, a higher ~~gog~~ degree of drive torque will be delivered to the slipping wheel. Similarly other wheel on the drive shaft will receive a small amount of torque, insufficient for propelling the vehicle forward.

③ When cornering at high speed:-

The inner driven wheel often lifts off the road surface corner is negotiated at high speed. While the wheel will then be harder by the differential, while the outer wheel, still in contact with the road surface, will receive less torque.

* The limited speed differential (LSD) was developed to take care of these types of the problems. When there large difference betⁿ the speed of the left and right side gear, the LSD restricts the operation of the differential, so that a sufficient amount of drive torque will still be delivered to the slower, driving wheel.

There are basically three types of limited speed differential:-

(1) Mechanical:-

A mechanical LSD has two clutches inside the differential. Whenever a wheel starts to slip, it activates the clutch, so that shaft leading to that wheel cuts the power to that wheel thereby sending the power to the other wheel.

(2) Viscous coupling:-

In viscous coupling, there is a thick liquid inside LSD. The liquid spins in the direction of the wheels and if one wheel starts to spin considerably faster than the other, the viscosity of the spinning liquid forces the other wheel to spin as well. This action is similar to a locking differential as power is not actually removed from the slipping wheel.

③ Electronic

An electronic LSD may also have two clutches inside the Differential and uses ECU to determine when one of the clutches should restrict the power to a wheel thereby sending the power to the other wheel. An electronic LSD may operate by itself with its own ECU or may use the systems that operate the traction control and also the LSD.

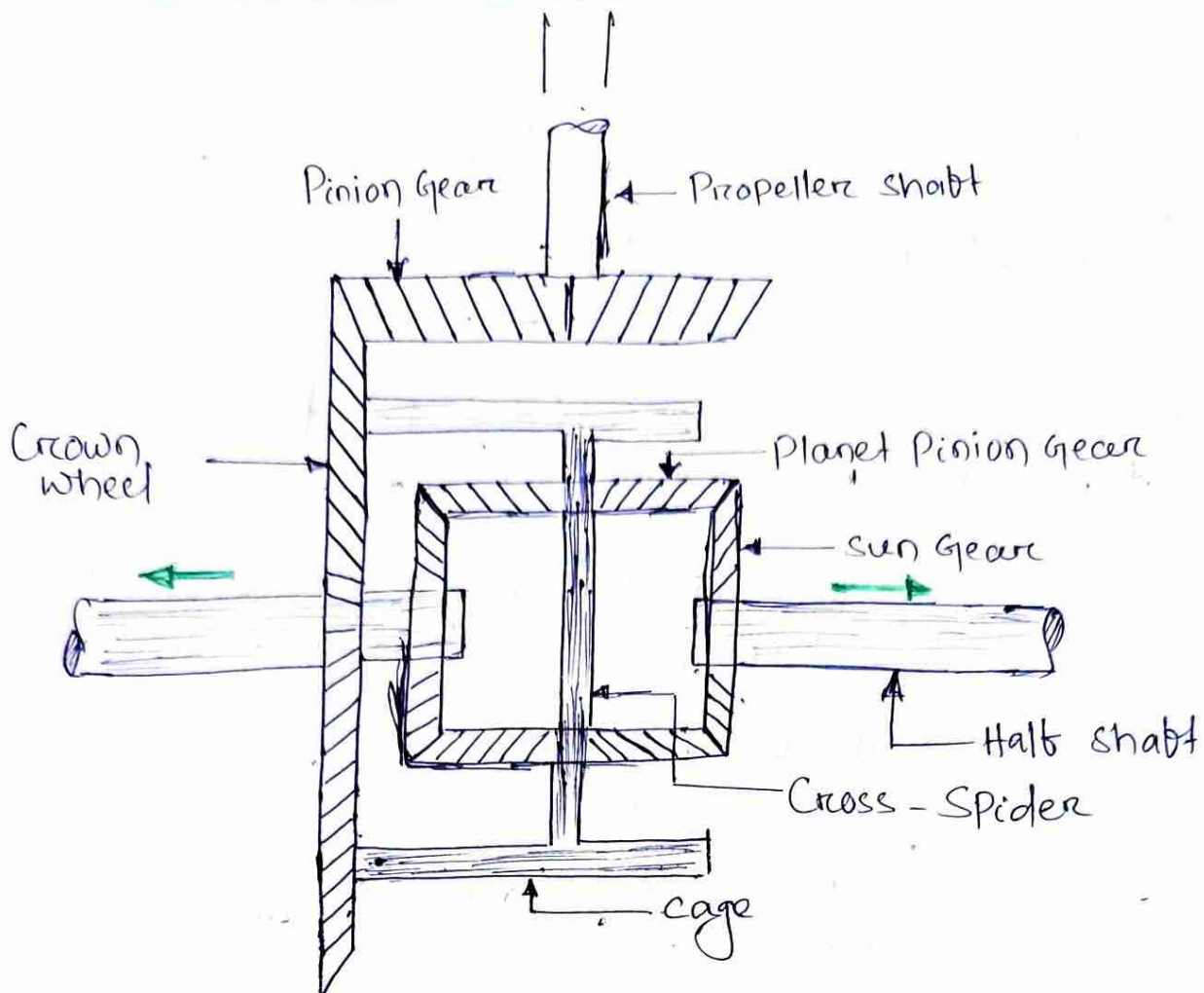
4.3 Constructional Details of the Differential

The differential receives the power from the drive shaft. The differential does the following works

- (1) It splits the power that is received and send the same through two half axle shafts to the driving wheels.
- (2) It allows the two driving wheels to turn by same amount, when the vehicle goes on a straight path.
- (3) It allows the driving wheels to turn by different amounts, when the vehicle goes around a curve and at the same time delivers power to the ~~two~~ both wheels.

The Basic Parts of the differential are

- (i) Pinion drive gear
- (ii) Ring gear
- (iii) Spider gear
- (iv) Differential Case assembly
- (v) Rear drive axle.



Pinion drive gear :- Transfer the power from the drive shaft to the ring gear.

Ring gear :- It will transfer power to the differential case assembly

Side/spider gear :- This is the lies at the heart of the differential and special mention should be made about its rotation. And help both wheels to turn independently when turning.

Differential case assembly/cage assembly :- Hold the gear and drive the axle.

Rear drive axle :- It transfer the torque from differential to the drive wheels.

4.4 Study and Inspection of Differential :-

Problem

Probable Cause

Remedy

- (1) Breaking bearing (case, gear etc)
- (i) Insufficient or wrong kind of gear oil
 - (ii) Improperly shimmed side bearing or pinion bearing
 - (iii) Improper mesh of drive pinion with ring gear
 - (iv) Distorted rear axle
 - (v) Loose bolts securing gear
- (2) Gear noise
- (i) Maladjustment backlash betⁿ drive pinion and ring gear
 - (ii) Damage gear teeth or improper mesh of drive pinion and ring gear
 - (iii) Improper tooth contact on the mesh betⁿ drive pinion and ring gear
 - (iv) Insufficient or wrong kind of gear oil.
- (3) Bearing noise
- (i) (Constant noise) Insufficient or wrong kind of gear oil
 - (ii) (Constant noise) Damage or worn bearing or worn parts

(i) Replace or change

(ii) Adjust or replace.

(iii) Adjust or replace.

(iv) Replace

(v) Replace.

(i) Adjust.

(ii) Replace or Adjust.

(iii) Adjust.

(iv) Replace or change.

(i) Replace or change.

(ii) Replace.

Ch-5

Rear Axle

5.1 Definition of Rear axle, supporting of Rear axle

5.2 Rear axle drives such as Hotchkiss drive, torque tube drive, etc.

5.3 Types of Rear axle

5.4 Rear axle casing

5.1 Definition of Rear axle, supporting of Rear axle:-

In most of the vehicle has at front end engine is situated, the power which is developed by the engine is transmitted to the wheels through the transmission system such as clutch, gear box, universal joint, propeller shaft, slip joint and the differential at last differential to the axle and to the driving wheels.

- * Axles are the last of the links in power transmission.
- * Axles are supports the weight of the rear of the vehicle

Basically in Automobile axles are two types

(i) Live axle (ii) Dead axle

Axle:- An axle is a type of shaft used for rotating a gear or a wheel. The axle may be fixed to the vehicle with the wheels rotating around it, or may be fixed to the wheel such that both the axle and wheels rotate together.

Live axle: - The axle which rotates itself and transmits the power from the differential to the driving wheel is called live axle.

Dead axle: - That axle which is not rotates itself and not transmit the power from the, any transmission system to driving wheel is called dead axle.

Rear Axle: - Rear axle are basically fitted at the rear of the vehicle, to transmit power and support the rear ~~wt~~ weight of the vehicle, these axles are may be live axle or dead axle.

Functions of Rear axle:-

- (i) It acts as a beam to support the weight of the vehicle.
- (ii) It acts as an axis for the wheel.
- (iii) It transmits the power to the wheel.
- (iv) It acts as a housing and support for the final drive, differential and axle shaft (or half shaft)

5.2 Rear axle drives such as Hotchkiss Drive and Torque tube drive etc.

In the case of rear axle drive (live axle), the Propeller shafts are subjected to driving and braking torque. When a front engine rear wheel drive vehicle starts from rest or suddenly brake is applied to slow down, the shock to the transmission is cushioned by Propeller shaft which twist slightly. The two most commonly used rear axle drives are

(i) Hotchkiss drive (ii) Torque tube drive

(i) Hotchkiss drive :-

This type of drives is the simplest type rear axle drive. It is mostly used in cars and trucks, buses.

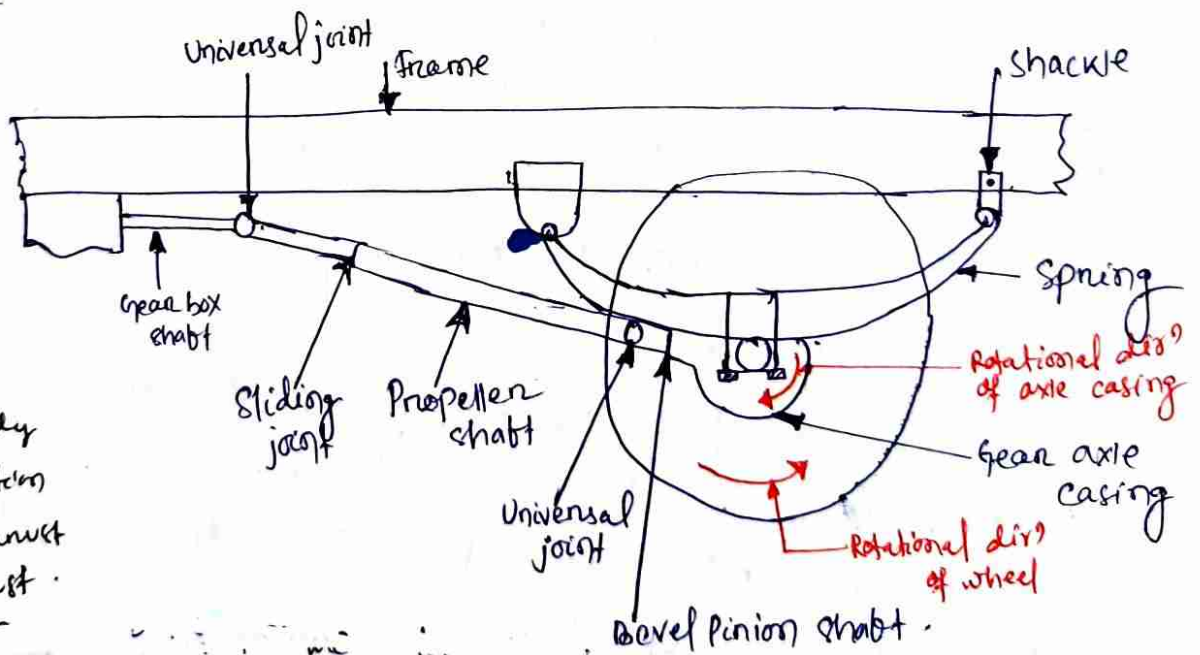
→ In this drive an open propeller shaft with two universal joints and a slip joint is used.

→ The universal joint allows it to operate at different angles and changes in drive length are achieved with a slip joint.

→ In this type drive the propeller shaft is not enclosed in a tube.

→ In this type drive the spring is fixed rigidly in the middle to the rear axle.

→ The front end spring is rigidly fixed on the frame, and rear end of the spring is attached to or supported to the shackle.



- weight of body
- torque reaction
- driving thrust
- side thrust.

→ The rear-end torque is absorbed by the rear end spring.

* When the car is moving forward, (in this arrangement the wheel is rotating anticlockwise direction), as a result the axle casing tends to move in the clockwise direction.

* This follows from the law that every action has equal and opposite reaction.

* The shackle helps in expansion and shortening of the leaf spring, which depends upon various conditions.

* The arrangement of the shackle where it can move to and fro by a slight amount is called shakness-arrangement. A

* And this type of arrangement drive is called notch-kick drive.

* This prevents the to and fro movement of the rear axle casing but only allows it to move up and down:

(ii) Torque tube drive

→ This type of drive is the oldest method, in which a solid propeller shaft is completely enclosed in a large diameter hollow tube is called torque tube.

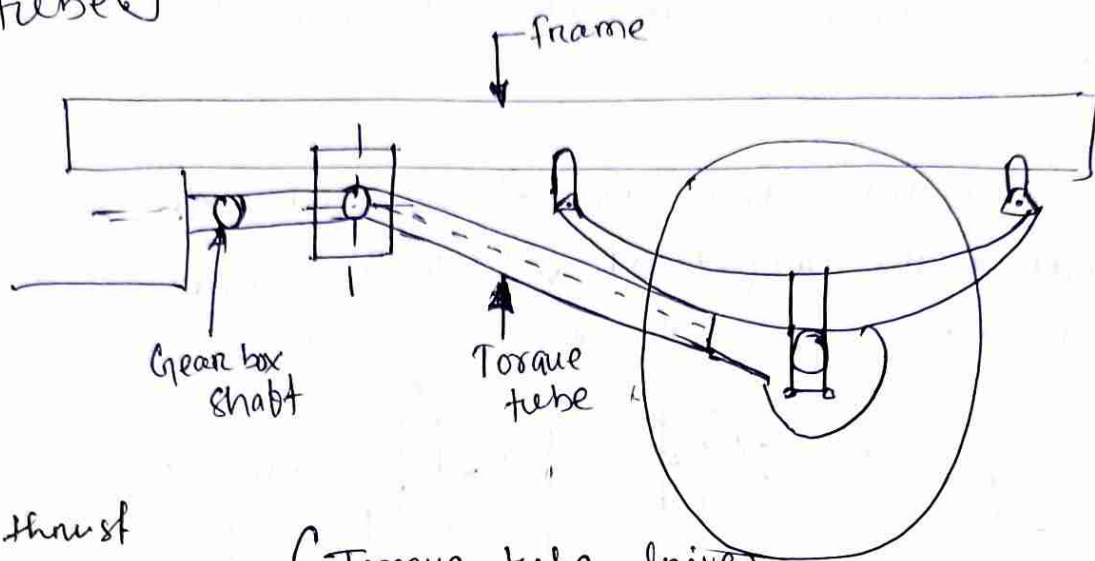
→ The torque tube is securely fastened to the rear axle housing.

→ A universal joint is fitted at the transmission at end of the propeller shaft.

→ which allows to move the complete assembly (up & down) to the length.

→ the changes in length are achieved by slip joint

→ In normal engine power transmission takes place through the propeller shaft, the braking and acceleration causing sudden torque are borne by the torque tube.



- Side thrust
- Body weight.

(Torque tube drive)

5.3 Types of Rear Axle

These are depending upon the methods of supporting the rear axles and mounting the rear wheels, these are three types

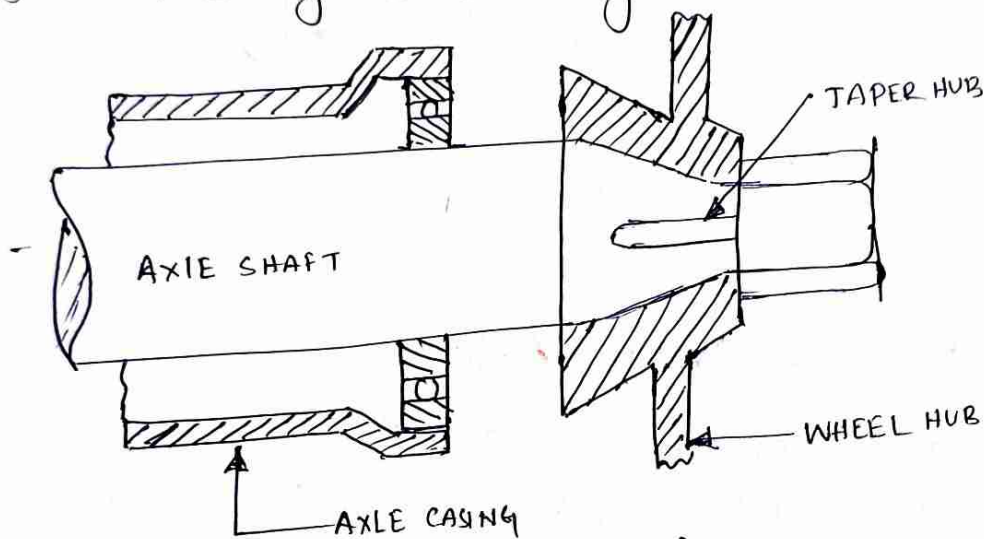
- (i) Semi-floating axle
- (ii) Full floating axle
- (iii) Three quarter floating axle.

(i) Semi-floating Rear axle :-

In this type of Rear axle, the complete load of the vehicle is taken care by the axle shaft. In this axle, the bearings of the wheel hub are fitted on the half shafts inside the axle tube.

The wheels are fitted at the two ends of the axle by means of a key and lock nut. The whole load of the vehicle is first transmitted to the suspension springs then to axle tube, rear axle, wheel and then to ground.

* There are two functions of the rear axle (i) one is to carry the weight of vehicle (ii) Transmit the power from the engine to the ground.



Advantages and Dis Advantages

- (i) Very simple in structure
- (ii) Its cost is very cheap as compared to others.
- (iii) Dis-Advantages the axle shaft has to bear the driving torque
- (iv) The axle shaft has to take the vehicle load.
- (v) The axle shaft has to take the cornering load when the vehicle turning
- (vi) In case of braking, the axle shaft of the vehicle will fall to one side of the ground.

(ii) Full floating axle:-

→ In this type of rear axle, the wheel hub is fixed on the axle tube or case with the help of two roller bearings.

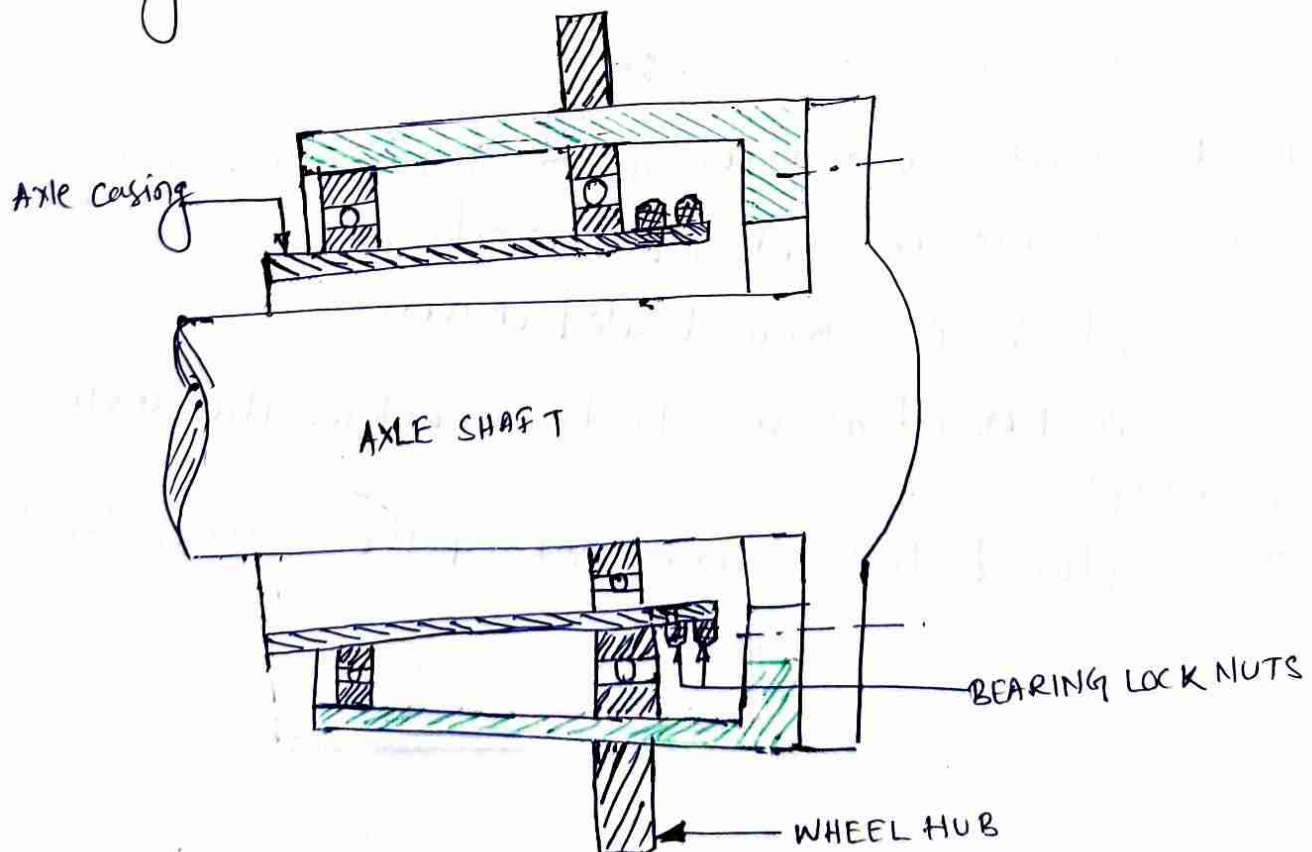
→ The axle shaft is introduced inside the axle tube and the end of the axle shaft is bolted to the wheel hub.

→ In this type of axle, the complete load of the vehicle as well as other loads are taken care by the axle tube.

→ The tube has only to transmit the driving torque and for the reason it is called fully floating type rear axle.

→ The axle shaft can be removed by removing the bolts without removing the hub.

→ This type of axle is very strong and used for the heavy vehicle and commercial vehicle.



(iii) Three quarter floating Rear axle:-

- In this type of rear axle, the load of the vehicle is partly supported by the axle tube and partly by the axle itself.
- The axle is fitted inside the axle tube.
- In this type of axle, one bearing of the wheel hub is fitted on the axle, whereas the other is on the axle tube.
- The axle is fitted with the wheel by means of key and lock nut.
- The axle takes care of driving and cornering torque.
- This type of Rear axle is used in the small and medium vehicles.

Reasons for Axle failure:-

- ① The lubricant is not as specified (i.e. incorrect grade)
- ② The lubricant is not maintained at required level.
- ③ The vehicle is over-loaded driven
- ④ The dust or abrasive particles enter the axle assembly
- ⑤ The replaced parts are not of the correct specification.

5.4 Rear Axle casing :-

Rear axle casing are following types

- (i) Split type
- (ii) Banjo or separate carrier type
- (iii) Salsbury or Integral carrier type

Split type :- In this type of axle casing is made in two halves and then bolted together for assembly. This type has a major disadvantage that in case of any fault, the whole of the rear axle has to be removed and as a unit and then disassembled. This type is obsolete now.

Banjo or separate type :-

This type of axle of one-piece type, shaped like a banjo. The complete differential unit is carried in a separate carrier which is ~~assembled~~ bolted to the axle casing. The two half shafts are put from sides. Therefore in case of any need for repairs, the half shaft can be taken out directly from the sides and the differential assembly removed by opening bolts only.

Salsbury or Integral carrier type :-

This is very similar construction to the banjo type except that in this the carrier, i.e. the differential housing, has permanent tubes pressed and welded in its sides. According to S.A.E, nomenclature it is called the unitized carrier housing. This type of housing is mostly used in recent days in the case of rear ~~code~~ drive cars.

Ch- 6

TWO WHEELER

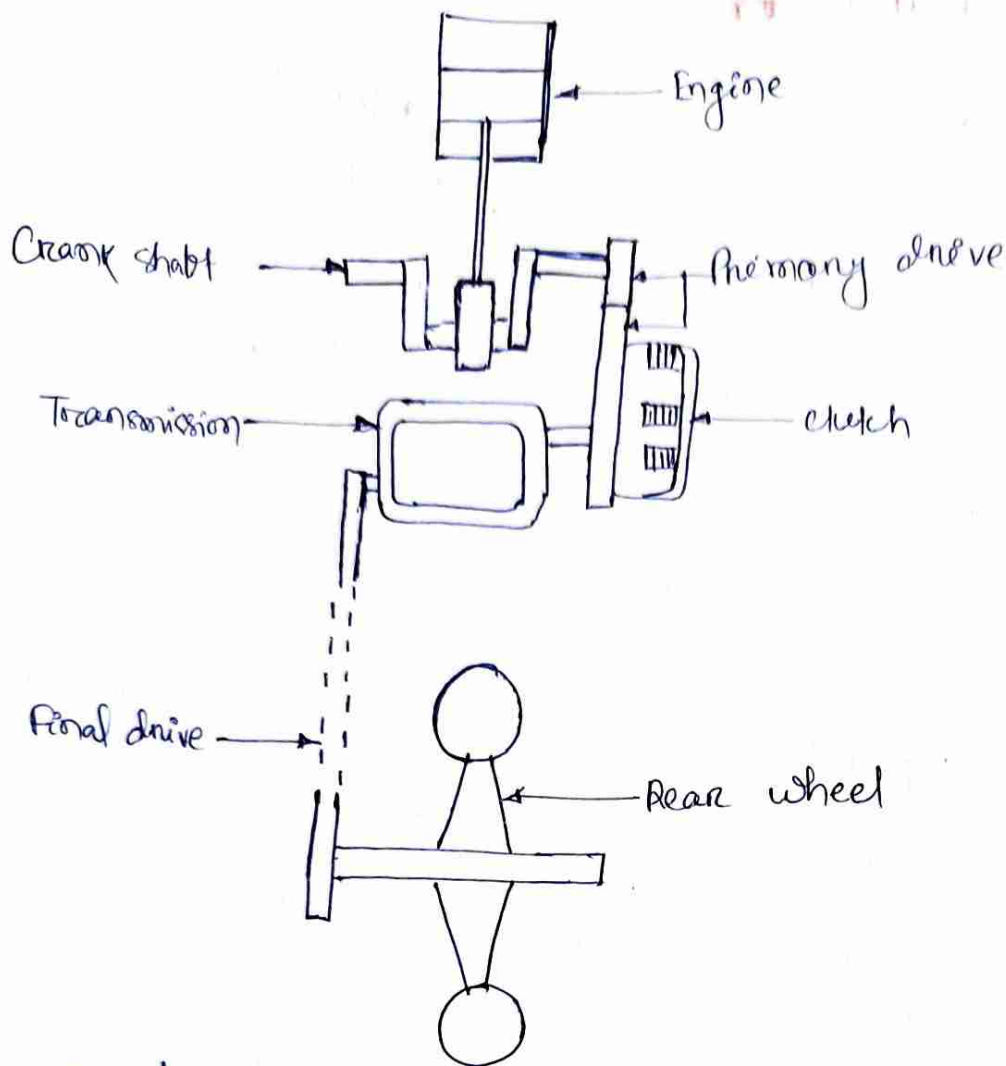
- 6.1 Power transmission system of moped
- 6.2 Power transmission system of scooter
- 6.3 Power transmission system of motor cycle
- 6.4 Power transmission system of bullet.

6.3 Power Transmission system of moped

The transmission system transmits the power from engine crankshaft to driving wheel. There are various components are working in organized manner to form a power train. The main function of transmission system

- * To vary the torque ratio betⁿ the engine and driving wheel.
- * Transmission system helps to reduce high speed of engine to optimum speed at which the vehicle can run safely
- * It also provide neutral position so that the engine can be disconnected from the driving wheels even with clutch in the engaged position.
- * The transmission system provides flexible link to transmit torque and power to the rear driving wheel even under condition of fluctuation.

Lay-out of Moped transmission system



→ The transmission of power train of any two wheelers basically includes primary drive, clutch, gear box and final drive.

→ The engine crank shaft is connected to the clutch through primary drive.

→ Primary drive helps to initial speed reduction.

→ Primary drives are belt drive, chain drive, or gear drive.

The main parts of moped transmission system

(i) Clutch → Clutch is used to smooth disengagement & engagement ~~more bet~~ the engine and gear box. Clutches are basically used in mopeds multiplate clutch and is centrifugal clutch.

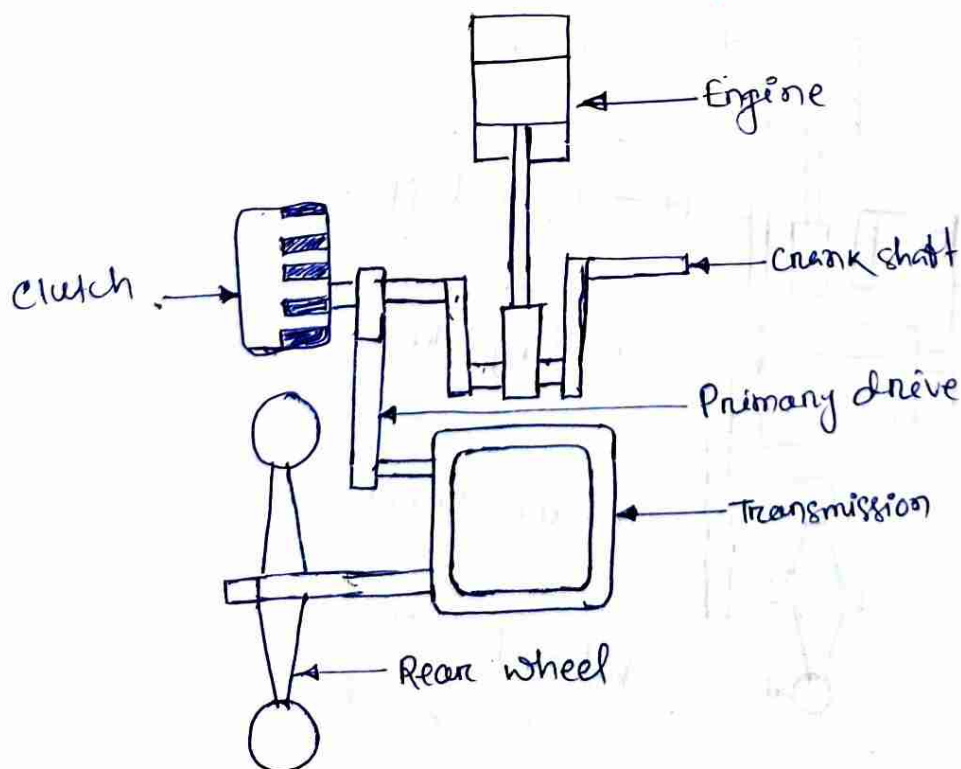
Transmission :- It is also known as gear box, encloses set of four or five pairs to provide correct torque ratio as per requirement.

Chain drive :- These are used as an alternative to belt drive for primary reduction. The chain drive includes driving sprocket and driven sprocket, the chain, and chain tensioner. The drive sprocket splined to the crank shaft and can accommodate single, dual or even triple roller chain.

Driving sprocket :- Driving sprocket is attached with the output shaft gear box which is smaller in size. which provides the drive to the driven sprocket.

Driven sprocket :- Driven sprocket is mounted at the rear side with the rear wheel, which is bigger in size.

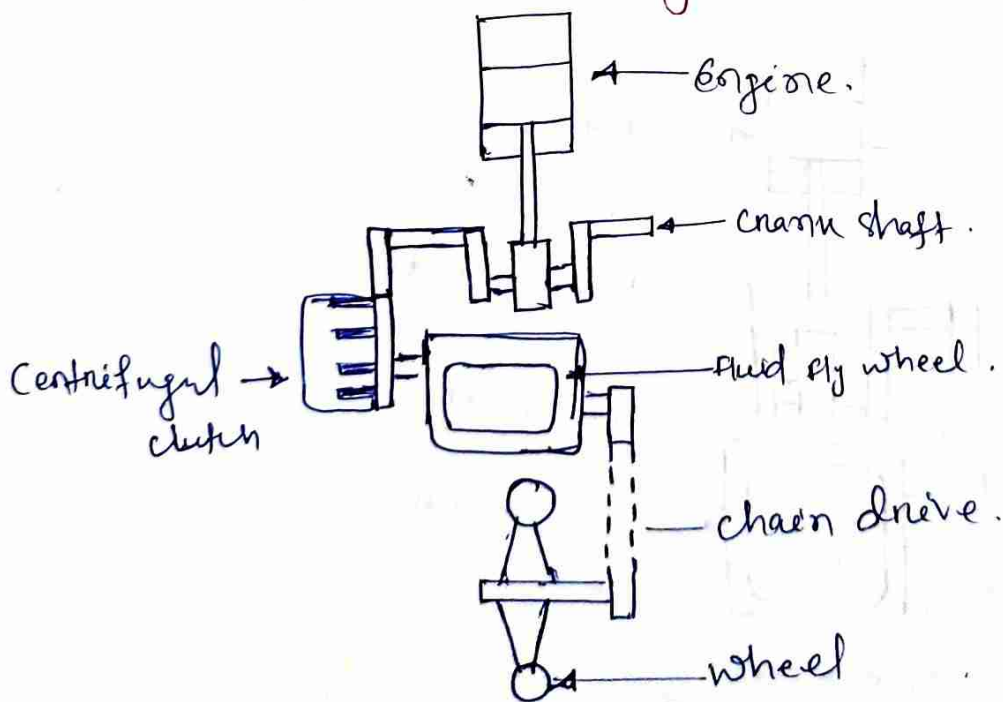
6.2 Power transmission system of Scooter



The fig shows the layout of scooter with transmission in which final drive is eliminated and the output shaft of gear box is directly connected with rear driving wheel. The power to primary drive is transmitted through the clutch. therefore, primary drive is also disconnected from the engine whenever the clutch is disengaged. All the scooters with these constant mesh gear box. Elimination of final drive makes the unit compact and becomes easy to accommodate within available space.

Primary drive:- It is provided in betⁿ the engine and clutch. because two-wheeler engine operates much faster than the car engine to meet power and torque requirements. so its necessary to reduce the speed before the power flow reaches to the gear box. therefore speed reduction is needed in the two wheeler.

6.1 Power transmission system of moped.



The fig shows the layout of transmission system of moped in which final drive is eliminated and the output shaft of gear box is directly connected with rear driving wheel. The power to primary drive is transmitted through the clutch. Therefore primary drive is also disconnected from the engine whenever the clutch is disconnected from the engine disengaged. All the scooters uses constant mesh gear box. Elimination of final drive makes the unit compact and becomes easy to accommodate within available space.

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Driving sprocket :- Driving sprocket is attached with o/p shaft gear box, which is smaller in size. which provides the drive to driven sprocket.

Ch-1

Performance of Automobile

- 7.1 Power Propulsion, resistance for vehicle.
- 7.2 Traction and Tractive effort, road performance curves.
- 7.3 Acceleration grade ability & draw-bar pull.
- 7.4 Calculation of equivalent weight.
- 7.5 Calculation of maximum traffic effort.

7.1 Power for Propulsion.

The motion of vehicle moving on a road is resisted by aerodynamic forces, known as wind or air resistance, and road resistance which is generally termed as rolling resistance. In addition to these two types of resistances, the vehicle has to overcome grade resistance when it moves up on a gradient, because the weight of vehicle is to be lifted through a vertical distance. Hence the power required to propel a vehicle is proportional to the total resistance to its motion and the speed.

Let

P_v = Power required by the vehicle, kW

P_R = engine power required, kW

V = speed of the vehicle km/hr

η_H = Transmission & drive line efficiency

R = total resistance, N

R_a = air resistance, N

R_g = grade resistance, N

Then the power required to propel a vehicle

$$P_v = \frac{R \times V}{1000} \times \frac{1000}{60 \times 60} = \frac{R V}{3600}, \text{ kW}$$

$R = (R_a + R_r)$ when vehicle moves along a level road.

$= (R_a + R_r + R_g)$ when vehicle moves up a gradient.

The calculation of engine power takes into account the losses in transmission. Hence required engine

power

$$P_R = \frac{P_v}{\eta_H} = \frac{R V}{3600 \eta_H}, \text{ kW}$$

Resistance for a vehicle

This is the resistance offered by air to the movement of a vehicle. The air resistance has an influence on the performance, ride, and stability of the vehicle and depends upon the size and shape of the body of the vehicle, its speed and the wind velocity.

$$\text{Air resistance} = \frac{1}{2} \rho C_d A v^2$$

C_d = Co-efficient of drag

ρ = density of Air

A = Area of the frontal part

v = vehicle speed.

Rolling Resistance

It is the resistance to rolling motion offered by the road over which the vehicle is moving. It is mainly the sum of the losses occurring due to deformation of road and tyre and the losses occurring due to the dissipation of energy in the tyre.

Magnitude of rolling resistance depends mainly

(a) the nature of road surface

(b) types of tyre

(c) weight of the vehicle

(d) Speed of the vehicle.

where w = Total weight of vehicle, N
 K = constant of rolling resistance

road surface and types of tyres = 0.0059

for good roads = 0.18

loose sand roads = 0.015

v = speed of the vehicle km/hr.

$$R_{rr} = (a + bv)w$$

mean value of a, b are 0.015, 0.00016 respectively

Grade Resistance

The component of the weight of the vehicle parallel to the gradient as the slope on which it moves is termed as grade resistance. Thus it depends upon the steepness of the grade.

7.2 Traction

Traction or tractive force is the force used to generate motion betⁿ a body and tangential surface, through the use of dry friction, through the use of shear force of the surface.

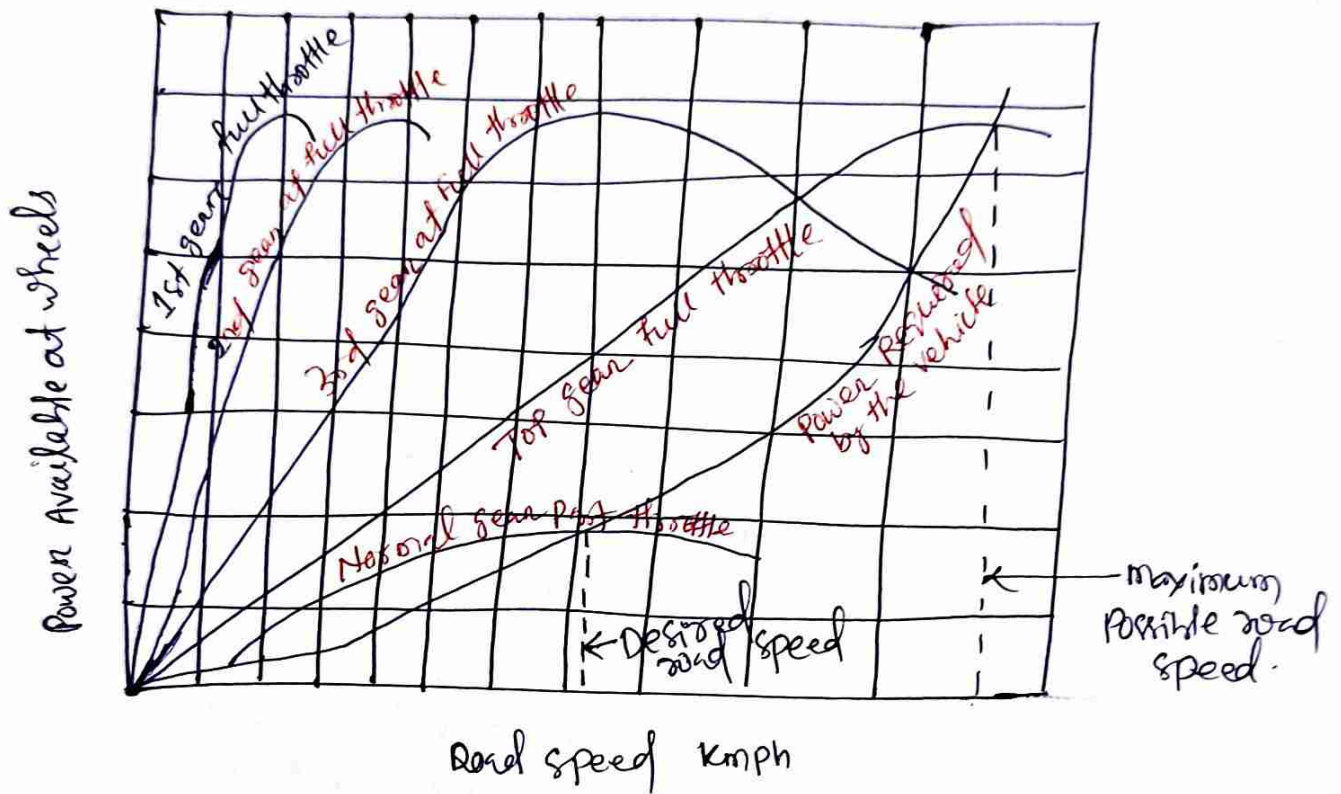
Tractive effort

Tractive effort is defined as the force at the rims or the outer edges of the driving wheels of moving trains. In other words, it is the sum of the tractive force and rolling effect on the road surface, it is caused by the locomotive.

Road performance curves

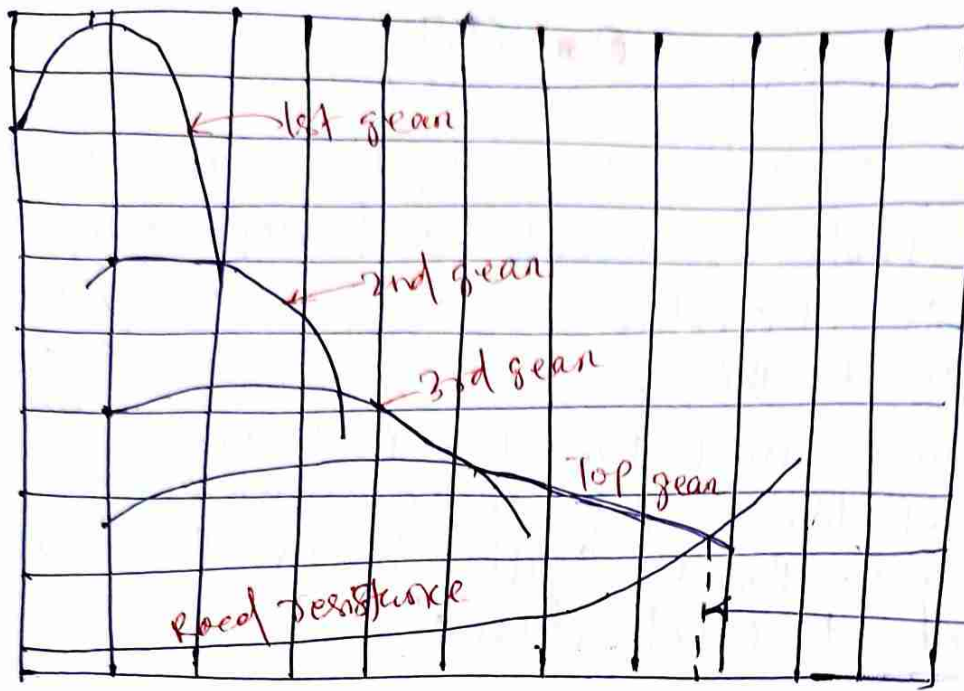
Passenger car performance is based on acceleration, ability to go up a slope, top speed, fuel economy, noise level and durability. Transmission gearing is designed to provide maximum acceleration at low speed by holding the driving wheel torque output at the point of corresponding wheel spin. As wheel spin occurs, the acceleration decreases from the maximum. Also the gear is designed for maximum fuel economy when the engine is developing 80% of its maximum torque as the automobile is moving at a constant speed. This gives 20% additional speed torque for acceleration. The power required to drive an automobile increases as the cube of the speed i.e. it takes eight times the power to double speed. When the power required to push the vehicle, the speed becomes constant. Excess power is required for acceleration and hill climbing. Maximum speed is reached when there is no excess power remaining. Here the curve is showing the power required by vehicle at various road speed is also presented.

At any speed, the difference of ordinates of power available and power required by the vehicle gives the surplus power, which can be utilized either for acceleration or for drawbar pull or for hill climbing. or else the surplus power may be shared by all the three items as when required.



The above fig indicates the Power available, that can be converted into tractive effort. Hence the tractive effort performance curves for four gear ratio can be plotted against the road speed. And road resistance curve is also presented. The difference betⁿ the coordinates of tractive effort and road resistance at any road speed gives the surplus tractive effort which is utilized for acceleration, drawbar pull and hill climbing.

TRACTIVE EFFORT N



ROAD SPEED, kmph.

Maximum possible road speed.

7.3 Acceleration, gradability and draw-bar pull.

Acceleration: - when the vehicle is accelerated, its rotating parts also accelerated depending upon their moments of inertia and the gear ratio in the drive line. Due to this, weight of the vehicle is increased, from w to w_e . This is increased weight, w_e is the effective weight of the vehicle. when surplus power that is surplus to active effort is fully utilized to acceleration.

Gradability: - The maximum percentage grade which a vehicle can negotiate with full rated condition is known as gradability.

Draw bar Pull: - when the excess power is fully utilized for pulling extra load attached to vehicle then, maximum drawbar pull = tractive effort - Road resistance

$$= (F - R)$$

Road resistance in this section is made up of rolling resistance and Air resistance.

7.4 Calculation of Equivalent weight.

Q11 The engine of a car develops 121 N-m torque at 3500 rpm. The car is driven in the 2nd gear having gear ratio of 4:1. If the transmission efficiency is 80% what is the torque and speed of drive shaft?

Given data

$$T_E = 121 \text{ N-m}, N = 3500 \text{ rpm}, G = 4:1, \eta_T = 80\% = 0.8$$

Torque of the drive shaft

We know that torque of drive shaft is torque at driving wheel

$$T_W = G \times \eta_T \times T_E = 4 \times 0.8 \times 121 \\ = 387.2 \text{ N-m}$$

Speed of the drive shaft

N_D = speed of drive shaft

We know that speed of drive shaft is reduced by gear reduction, therefore

$$N_D = N/G = 3500/4 = 875 \text{ rpm out.}$$