CHAPTER-1 CLUTCH DT-24/07/2024

CLUTCH AND ITS FUNCTION

(i) clutch is a device used in transmission system of a motor vehicle to engage and disengage the engine to the transmission (gearbox). Thus the clutch is located between the engine and the transmission (gearbox). VVI

(ii) when the clutch is engage, the power flows from the engine to the rear wheels through the transmission system and vehicle moves. (gearbox)

(iii) when the clutch is dis-engaged, the power is not transmitted to the rear wheels and the vehicle stops, while the engine is still running.

(iv) the clutch is disengaged when starting the engine, when shifting the gears, when stoping the vehicle and when idling the engine.

(v) the clutch is engaged only when the vehicle is to move and kept engaged when the vehicle is moving.

(vi) The clutch is also permits the gradual taking up of the load, when properly operated, it prevent (தடுக்கிறது) jerky motion of the vehicle and thus avoides putting undue strain on the Remaining parts of the power transmission (gearbox) system.

PRINCIPLES OF OPERATION

⇒ the clutch work on the principle ~~of~~ of friction

⇒ when two friction surfaces are brought in contact with each other and pressed they are united due to the friction between them.

⇒ If now one is revolved, the other will also revolve.

⇒ The friction between the two surfaces depends upon the area of the surface, pressure applied upon them and co efficient of friction of the surfaces materials.

⇒ The two surface can be separated and brought into contact when required.

→ One surface is considered as driving member and the other as driven member it also starts rotating.

→ when the driven member is separated from the driving member it does not revolve this is the principle on which a clutch operates.

SINGLE PLATE CLUTCH

(1) → It is the most common type of clutch used in motor vehicle, Basically, it consists of only one clutch plate, mounted on the splines of the clutch shaft ~~shown in fig~~.

(2) → the flywheel is mounted on the engine crankshaft and rotates with it.

(3) → the pressure plate is bolted to the flywheel through clutch springs and is free to slide on the clutch shaft when the clutch pedal is operated.

(4) → when the clutch plate is engaged, the clutch plate is gripped between the flywheel and the pressure plate

(5) → the friction lining are both the side of clutch plate.

(6) ⇒ Due to the friction between the flywheel, clutch plate and pressure plate, the clutch plate revolve with the flywheel.

(7) ⇒ As the clutch plate revolves, the clutch shaft also revolves.

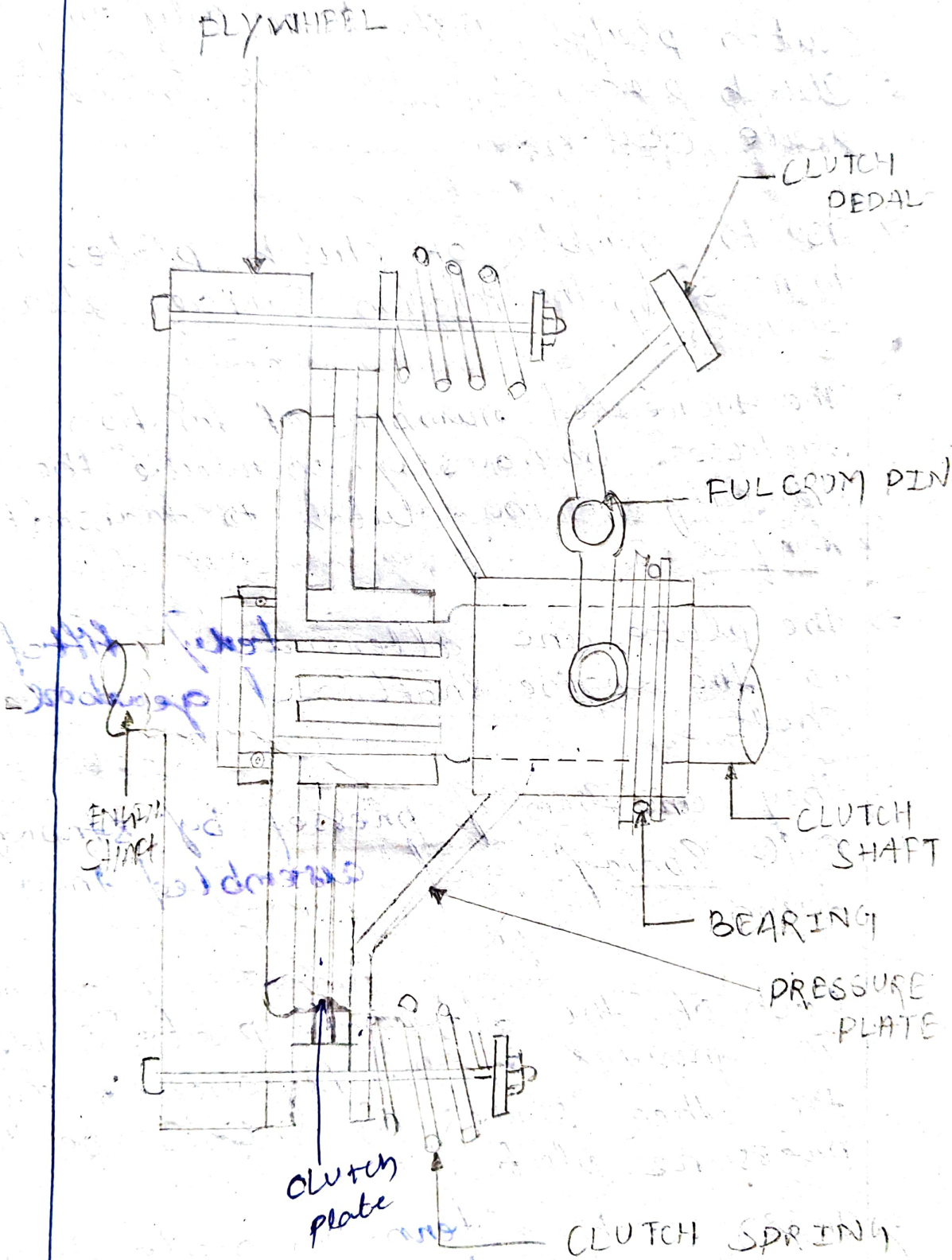
(8) ⇒ Clutch shaft is connected to the transmission thus, the engine power is transmitted from the crankshaft to the clutch shaft.

(9) ⇒ when the clutch pedal is pressed, the pressure plate moves back against the force of the spring, and the clutch plate becomes free between the flywheel and the pressure plate.

(10) ⇒ Thus, the flywheel remains rotating as long as the engine is running and the clutch shaft speed reduce slowely and finally it stops rotating.

⇒ As soon as the clutch pedal is pressed the clutch is said to be disengaged, otherwise it remains engaged due to the spring forces.

engine → pressure
→ clutch



MULTIPLATE CLUTCH

① ⇒ Multiplate Consists of a number of clutch plates, instead of only one clutch plate, as in the case of Single plate clutch.

② ⇒ As the number of clutch plates is increased, the friction surface also increased.

③ ⇒ The increased number of friction surfaces obviously increase the capacity of the clutch to transmit torque.

⇒ the plate are alternately fitted to the engine shaft and gearbox shaft.

⑤ ⇒ they are firmly pressed by strong coil springs and assembled in a drum.

⇒ Each of the alternate plate slides in grooves on the flywheel; and the other slides on splines on the pressure plate.

⇒ Thus, each alternate plate has inner and outer splines.

⇒ The multiplate clutch work in the same way as the single plate clutch, by operating the clutch pedal.

⇒ the multiplate clutch are used in heavy Commercial Vehicles, Racing car and motor cycle for transmitting torque.

⇒ the multiplate clutch may be dry or wet.

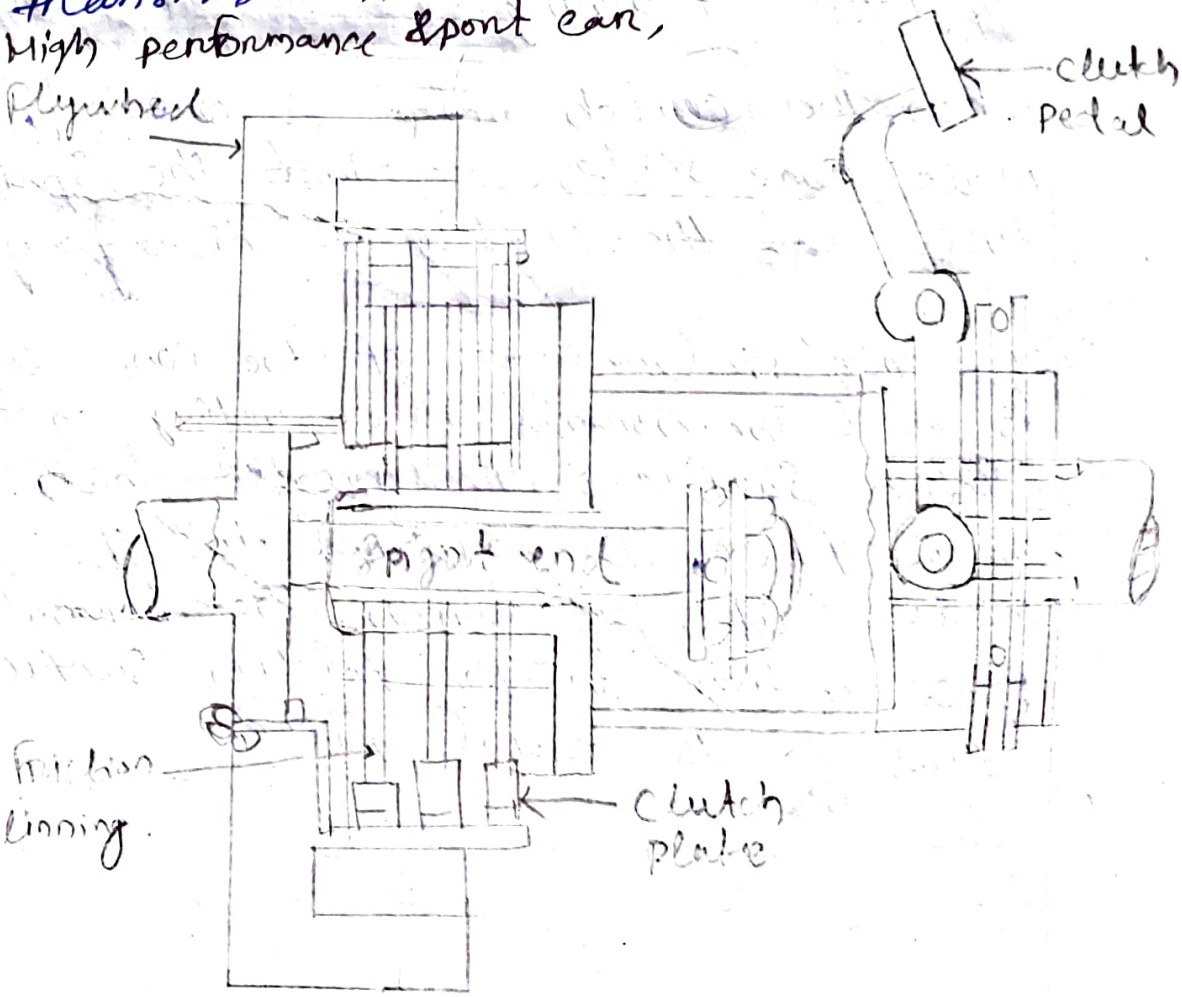
⇒ when the clutches is operated in an oil bath it is called a wet clutch.

⇒ ~~when the clutch is operated in an oil~~

⇒ when the clutch is dry, it is called dry clutch.

⇒ the wet clutch are generally used in conjuction with, or as a part of the automatic transmission.

⇒ High performance sport car,



CONE CLUTCH

⇒ Cone clutch of friction surfaces in the form of cones.

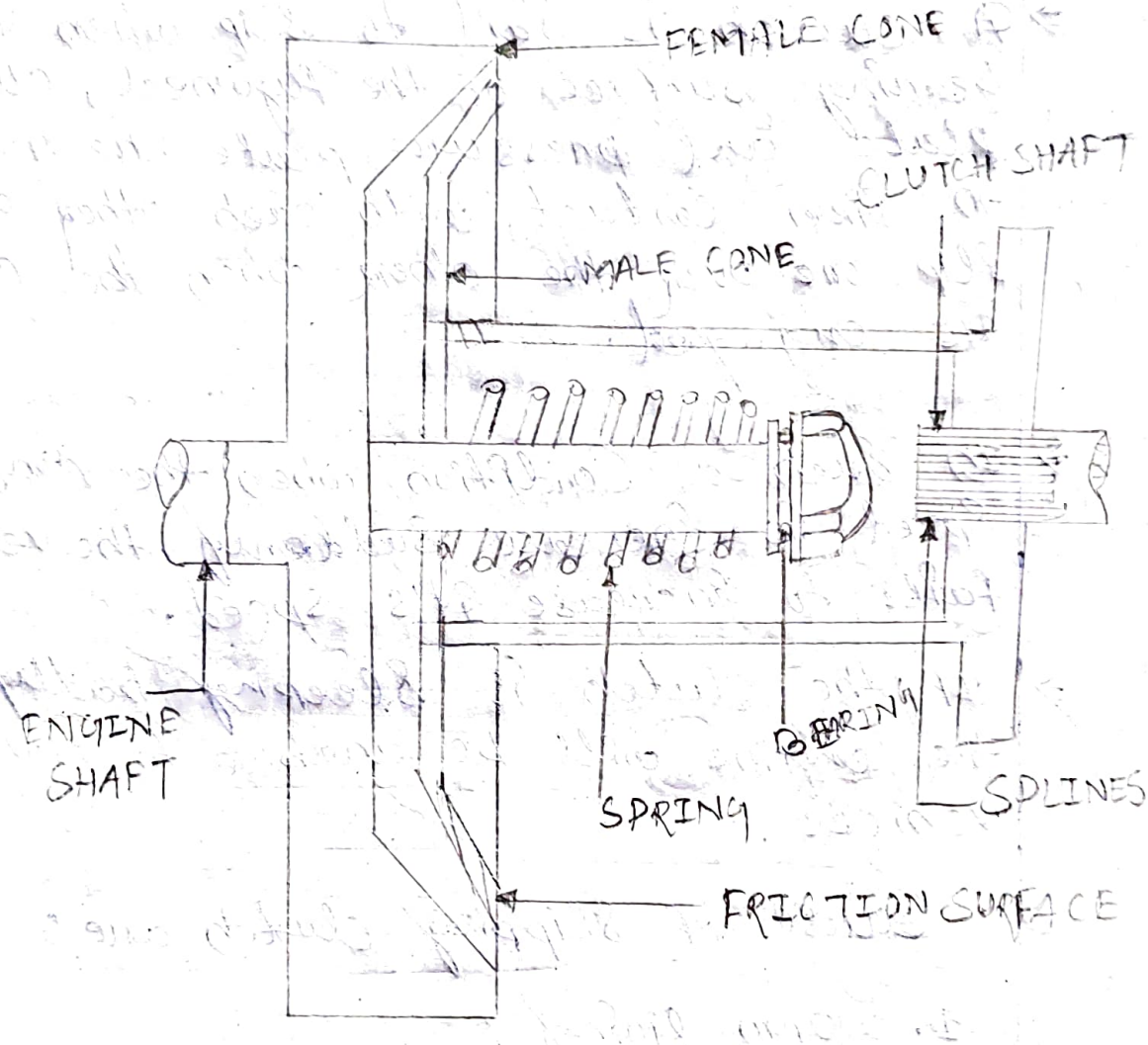
⇒ the engine shaft consists of a female cone. the male cone is mounted on the splined clutch shaft.

⇒ It has friction surfaces on the conical portion the male cone can slide on the clutch shaft.

⇒ when the clutch is engaged, the friction surface of the male cone are in contact with that of the female cone due to the force of spring.

⇒ when the clutch pedal is pressed, the male cone slides against the spring force and the clutch is disengaged.

⇒ the only Advantage of the cone clutch is that the normal force acting on the friction surfaces is greater than the axial force, As compared to the single plate clutch in which the normal force acting on the friction surfaces is equal to the axial force.



CONE CLUTCH

If α = Semi Cone angle

P = axial force

Q = Normal force.

$$Q = \frac{P}{\cos\alpha}$$

CLUTCH TROUBLES AND THEIR CAUSES

① **Slipping clutch:**

⇒ A clutch is said to slip when the bearing surface of the flywheel, clutch plate and pressure plate are not in firm contact with each other and slip one over the other when the clutch is engaged.

⇒ In such a condition, when the engine speed is increase suddenly, the vehicle fails to increase it's speed.

⇒ If the clutch is sleeping badly, the engine will be unable to move the vehicle.

Cause of slipping clutch are:

1. worn lining
2. Greasy or oil facing
3. Improperly installed lining
4. Bending pedal mechanism
5. Incorrect pedal Adjustment.
6. weak pressure springs.
7. Incorrectly refitted flow board or carpet
8. Scored or warped faces of flywheel and pressure plate

9. Lack of free play in clutch pedal.
10. worn Splines on clutch shaft.

② Grabbing and chattering clutch:

⇒ A clutch is said to be grabbing and chattering when it does not engage smoothly.

⇒ A grabbing clutch during engagement causes the vehicle to move in a series of jerk.

⇒ A chattering clutch causes the vehicle to vibrate during engagement.

Causes of grabbing and chattering clutch are:

1. Grease or oil lining
2. Glazed or hardened lining due to dirt and wear.
3. Bent or tight release shaft.
4. Cracked or damaged pressure plate or flywheel.
5. Badly turned engine.
6. Loose engine support.
7. worn bearing in Rear axle or transmission
8. too much play between gear.
9. Tight Splines on the driven shaft.
10. Misalignment.

③ Dragging clutch:

⇒ A clutch is said to dragging when the pedal is thrown out to disengage the clutch, the driven plate does not stop rotating.

Causes of dragging clutch are:

1. Too much pedal free play.
2. ~~Loose~~ Tight or burned Splines
3. Loose or worn linkage
4. Faulty pilot bearing.
5. warped driven plate
6. Improper Release lever adjustment.
7. Misalignment of clutch housing.

④ Rapid wear of lining:

⇒ the lining of clutch plate may wear out Rapidly.

The cause of Rapid wear of lining are:

1. Badly warped pressure plate
2. Incorrect lining adjustment
3. Insufficient pedal play.
4. weak or broken pressure spring
5. Engagement of clutch slowely to start the vehicle in a second or high speeds.

(5) Clutch Noise:

⇒ A clutch may create noises when engaged and disengaged. the causes of noises arising from an engaged clutch are:

1. poor alignment between the clutch or transmission house and the engine.
2. worn splines on the clutch shaft and the driven plate.

The causes of noises arising from a disengaged clutch are.

1. worn or dry Realease bearing
2. Binding or tight Realease bearing
3. worn ~~out~~ or dry pilot bearing or bushing in the flywheel or crankshaft
4. Loose. Release fork mounting.

SLIDING MESH GEAR BOX

1. It is the simplest type of gear box. the arrangment of gear are shown in fig in neutral position.

2. The gear housing and bearing are not shown. The clutch gear is rigidly fixed to the clutch shaft..

3. It remains always connected to the drive gear of the crankshaft.

4. Three other gears are also rigidly fixed to the countenshaft.

5. They are the second speed gear, first speed gear and reverse speed gear.

6. Two gear are mounted on the splined main shaft which can be slided by the shifter yoke when the shift lever is operated.

7. These geans are the second speed gear and first speed gear and reverse speed gear.

8. They can be connected to the connesponding geers of the countenshaft.

(8) ⇒ A Reverse Idler gear is mounted on another shaft and always remains Connected to the Reverse gear of the Countershaft.

Gears in neutral.

⇒ when the engine is running and clutch is engaged, the clutch shaft gear drives the Countenshaft gear.

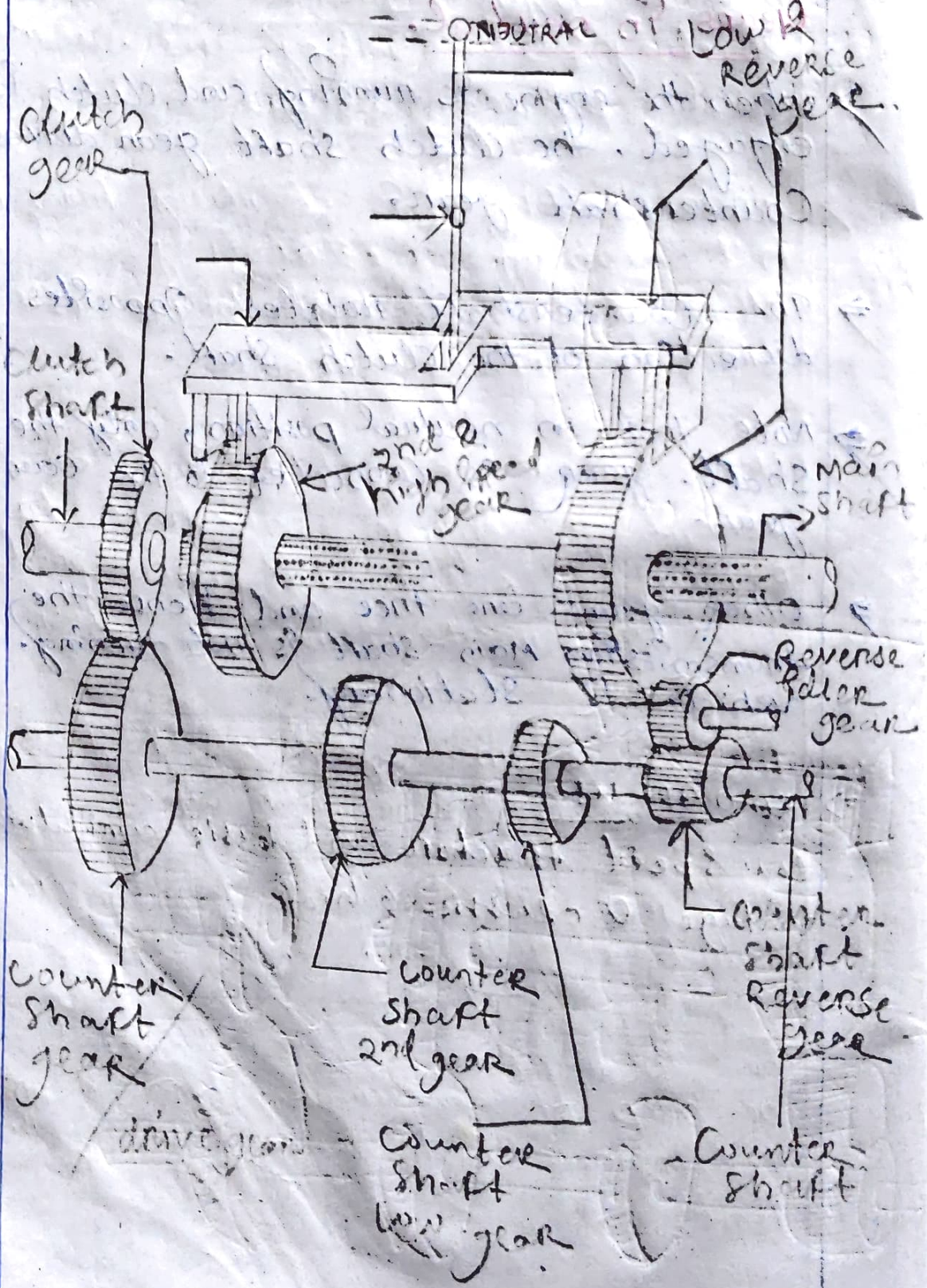
⇒ The Countenshaft rotates Opposites in dierection of the clutch shaft.

⇒ Note that in neutral position, only the clutch shaft gear is Connected to the countenshaft gear.

⇒ Other gears are free and hence the transmission main shaft is not running. the vehicle is stationary.

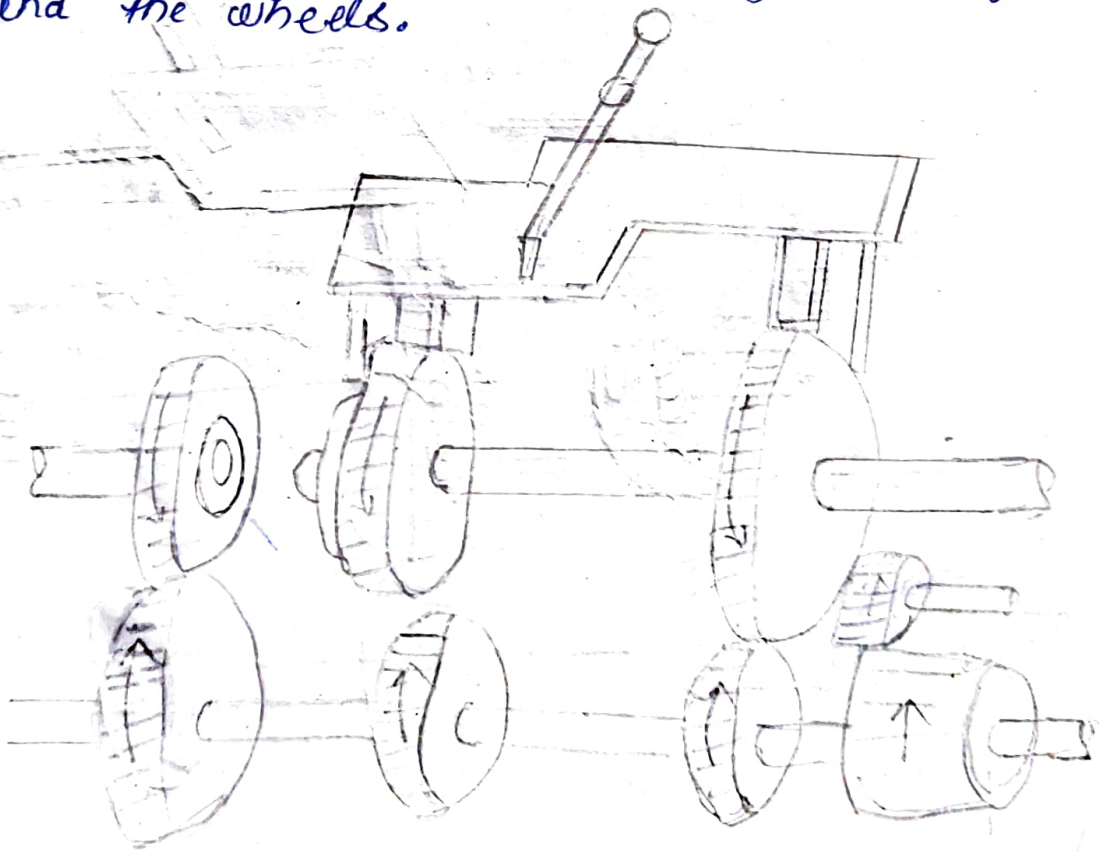
=> ~~two~~ ~~fff~~ uses

- low speed tractor and basic agriculture machine
- vintage & classic vehicle


NEUTRAL
Low & Reverse gear.
Clutch gear
Clutch shaft
2nd & high speed gear
Main shaft
Reverse idler gear
Counter shaft gear
Counter shaft 2nd gear
Counter shaft Reverse gear
drive gear
Counter shaft low gear
Counter shaft

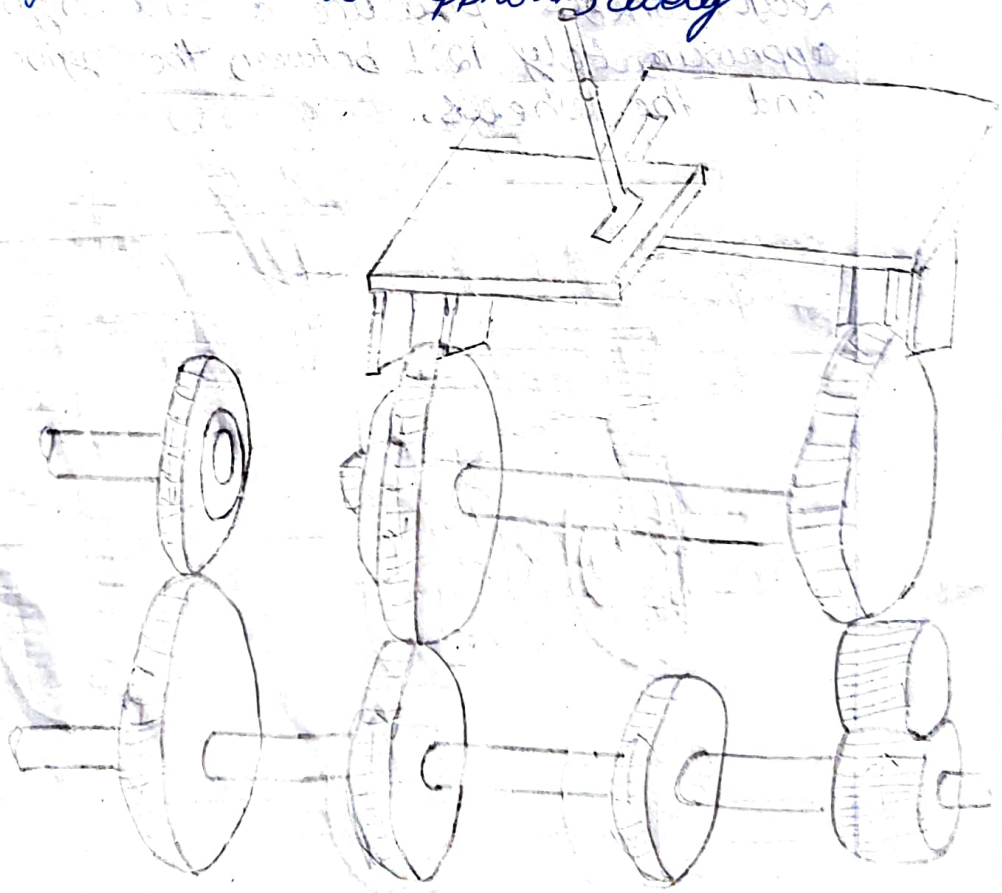
First and low speed gear

- By operating the gear shift lever, the longer gear on the main shaft is move along the shaft to mesh with the first gear of the countershaft.
- The main shaft turns in the same direction as the clutch shaft.
- Since the smaller countershaft gear is engaged with the longer main shaft gear, a gear reduction approximately 3:1 is obtained.
- That is the clutch shaft turns three times for each revolution of the main shaft.
- Further gear reduction in the differential at the rear wheels produce a still higher gear ratio, approximately 12:1 between the engine crankshaft and the wheels.



Second Speed gear

- By Operating the gear shift lever, the larger gear of the main shaft is demeshed from the first gear of the Countenshaft and then the smaller gear of the main shaft is meshed with the second gear of the Countenshaft.
- The main shaft turns in the same direction as the clutch shaft.
- A gear Reduction of approximately 2:1 is obtained.
- The differential gear reduction increases this gear ratio to approximately



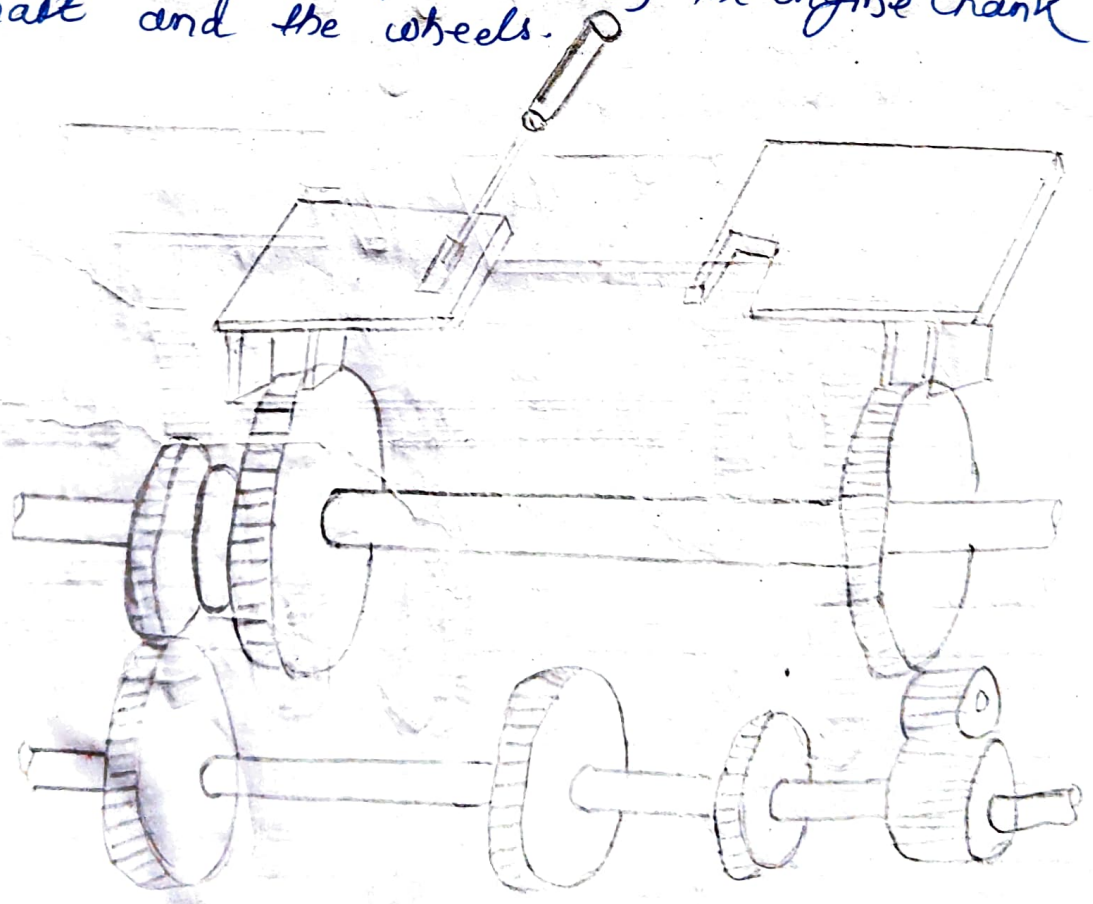
Third, TOP on high Speed gear:

⇒ By Operating the gear shaft lever, the Second gear of the main shaft and Countershaft are demeshed, and then the Second and top gear of the main shaft are Force axially against the clutch shaft gear.

⇒ External teeth on the clutch shaft gear mesh with the Internal teeth in the Second and top gear.

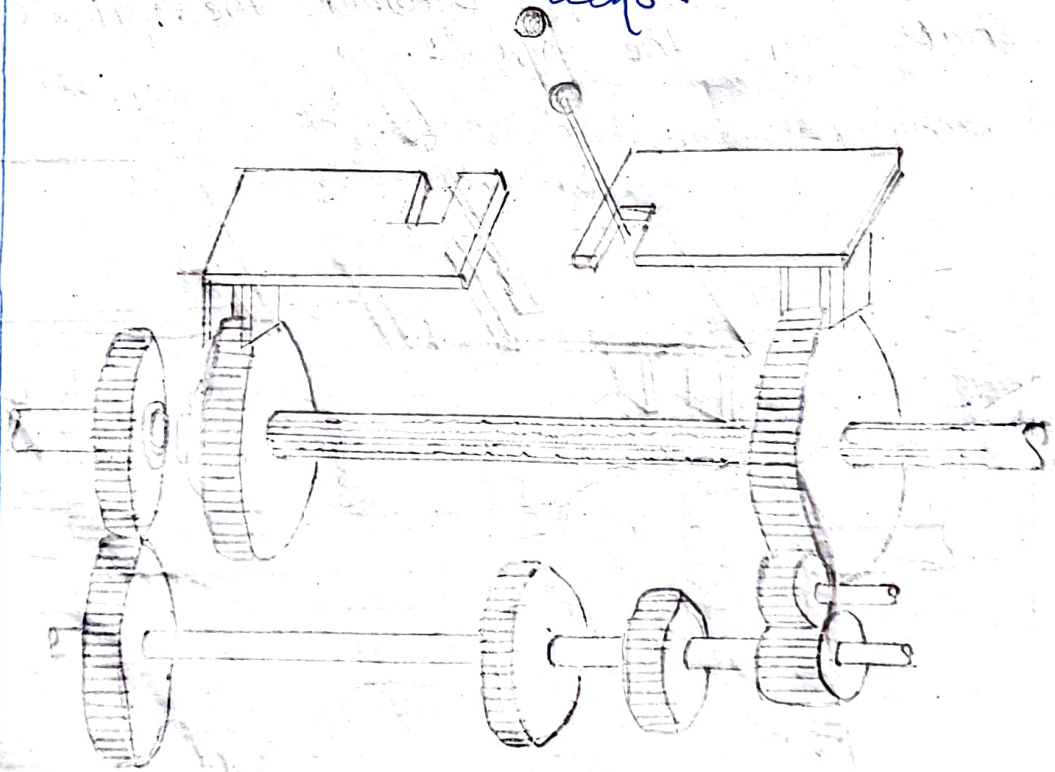
⇒ The main shaft turns with the clutch shaft and a gear ratio of 1:1 is obtained.

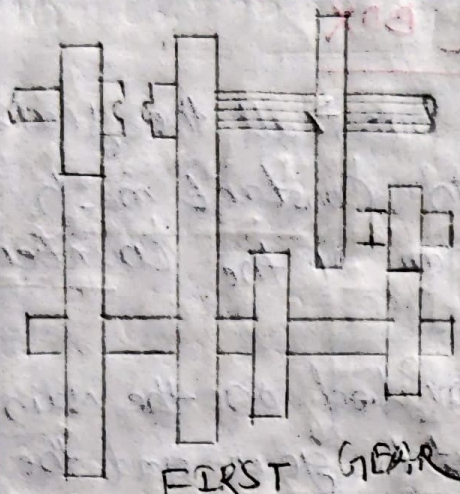
⇒ The differential reduction produces a gear Ratio of about 4:1 between the engine crank shaft and the wheels.



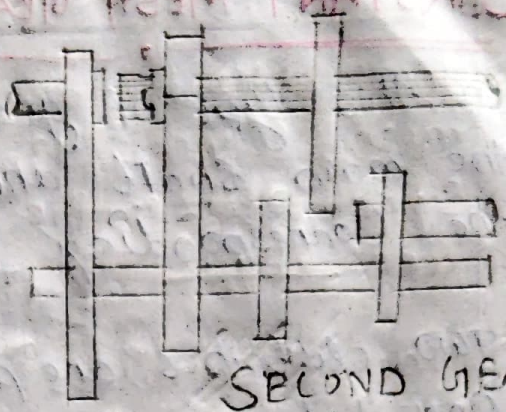
Reverse gear:

- By operating the gear shaft lever, the longer gear of the main shaft is meshed with the reverse idler gear.
- The reverse idler gear is always in mesh with the countershaft reverse gear.
- Interposing the idler gear between the countershaft reverse gear and main shaft bigger, the main shaft turns in the direction opposite to that of the clutch shaft.
- This reverse the rotation of the wheels so that the vehicle backs.

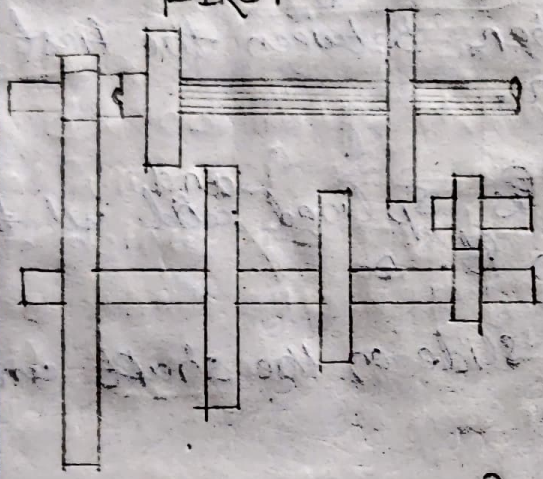




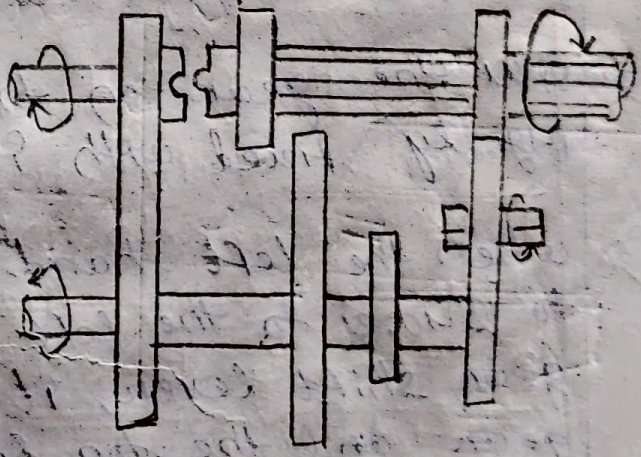
FIRST GEAR



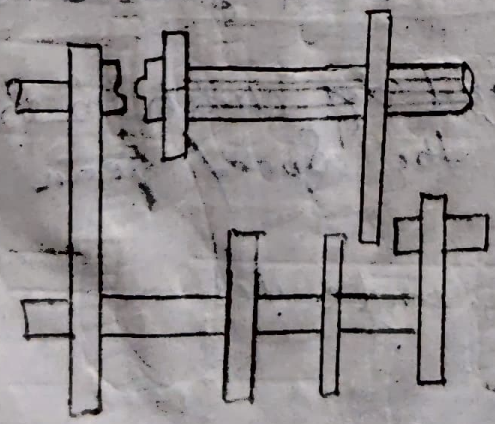
SECOND GEAR



THIRD OR TOP GEAR



REVERSE



NEUTRAL

CONSTANT MESH GEAR BOX

1. In this type of gear box, all the gears of the main shaft are in constant mesh with the corresponding gear of the countershaft.

2. Two clutches are provided on the main shaft: One between the clutch gear and the second gear; and the other between the first gear and reverse gear.

3. The main shaft is splined and all the gears are free on it.

4. Dog clutch can slide on the shaft and rotates with it.

5. All the gear on the countershaft are rigidly fixed with it.

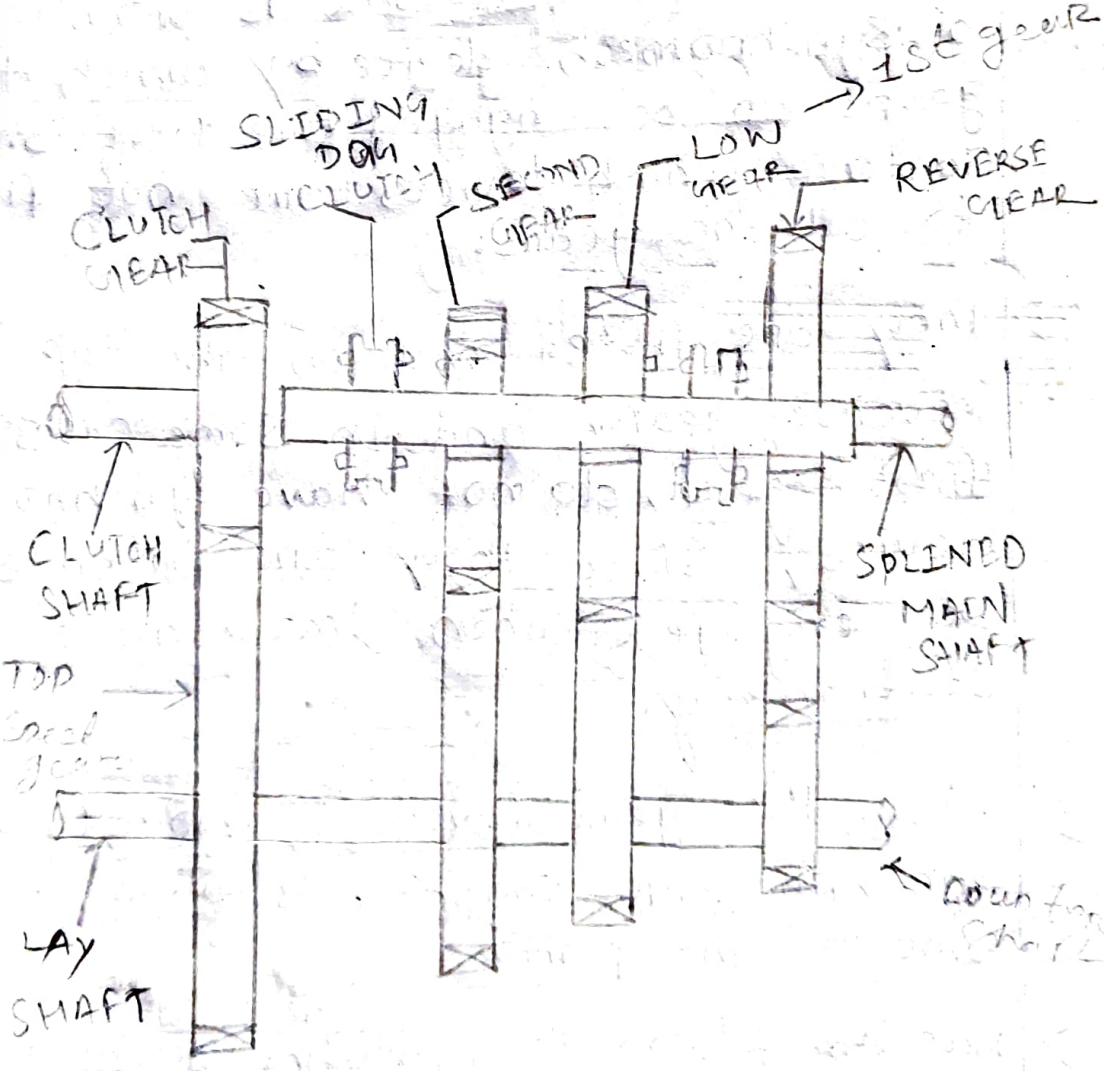
6. When the left hand dog clutch is made to slide to the left by means of the gear shift lever, it meshes with the clutch gear and the top speed gear is obtained.

7. When the left hand dog clutch meshes with the second gear, the 2nd speed gear is obtained.

⇒ Application → Trucks and buses

8 ⇒ Similarly, by sliding the right hand dog clutch to the left and right, the first speed gear and reverse gear are obtained respectively.

9. ⇒ In this type of gear box, because all the gear are in constant mesh, they are safe from being damaged and unpleasant grinding sound does not occur while engaging and disengaging them.



CONSTANT MESH GEAR BOX

SYNCHROMESH GEAR BOX

⇒ The modern car use helical and synchro mesh devices in the gear boxes, that synchronize the rotation of gears that are about to meshed.

⇒ The eliminates clashing of the gears and make gear shifting easier.

⇒ The synchromesh gear box is similar to the constant mesh gear box, but the synchromesh gear box is provided with a synchromesh device by which two gears to be engaged are first brought contact which devices are not fitted to all the gears.

⇒ they are fitted only on the top gears.

⇒ Reverse gear, and in some cases the first gear, do not have synchromesh device, since they are intended to be engaged when the vehicle is stationary.

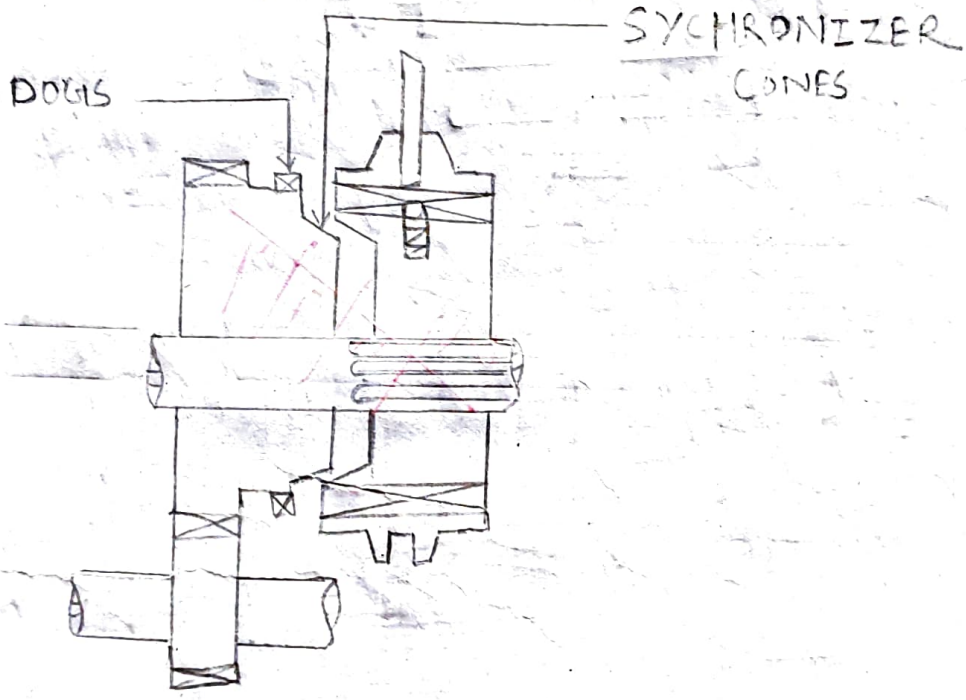
⇒ when the gear lever is moved, the synchronizer cone meets with a similar cone on the pinion.

⇒ Due to friction the rotating pinion is made to Rotate at the same speed as the synchromesh unit.

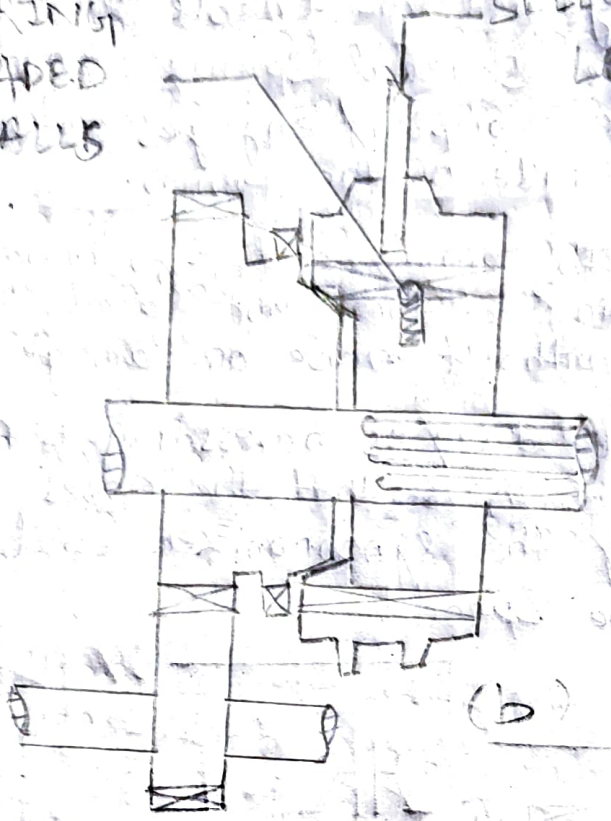
⇒ To give a positive drive - further movement of the gear lever enable the coupling to over-ride several spring loaded balls and the coupling engages with the dogs on the side of the pinion.

⇒ Since both pinion 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.



⇒ uses - Most modern cars, light duty truck



11/4/24

DT-30/07/2027 FLUID COUPLING:

FLUID DRIVE:

⇒ The fluid drive is one name for liquid coupling to transmit turning effort from the engine to the clutch.

⇒ It is located between the crankshaft and the clutch.

⇒ Because the liquid coupling is always a major parts of the engine flywheel assembly, it is something called a fluid flywheel.

⇒ ~~The working principle of a liquid coupling is shown in fig. with the help of two fans.~~

⇒ when one fans is turned on and faced toward the other, the air stream causes the second fan to turn, even though it is not switched on.

⇒ The first fan is the driving member or the impeller and the second fan is the driven member or the runner.

⇒ AIR is the fluid used as the medium of power transmission.

⇒ This is a simple fluid coupling, air serving as the fluid.

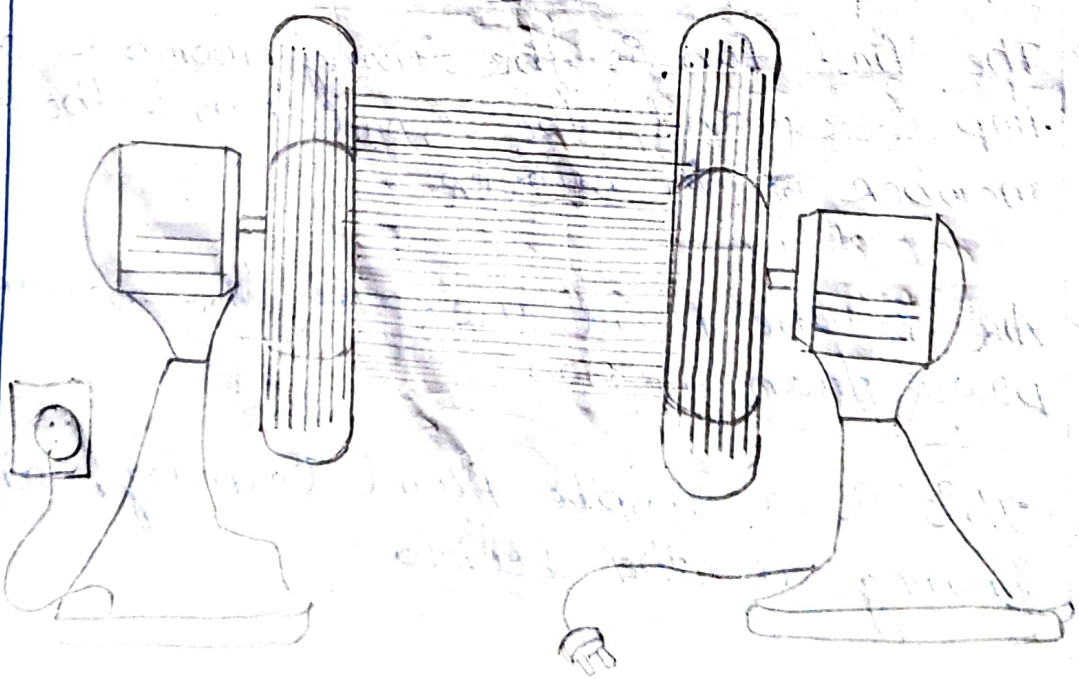
⇒ It consists of, in general, two half-doughnut shaped shells equipped with internal fins that radiates from the hubs.

⇒ One shell is mounted on the crankshaft and is called as Impeller or driving member.

⇒ The other shell is mounted on the driven shaft and is called Runner and driven member.

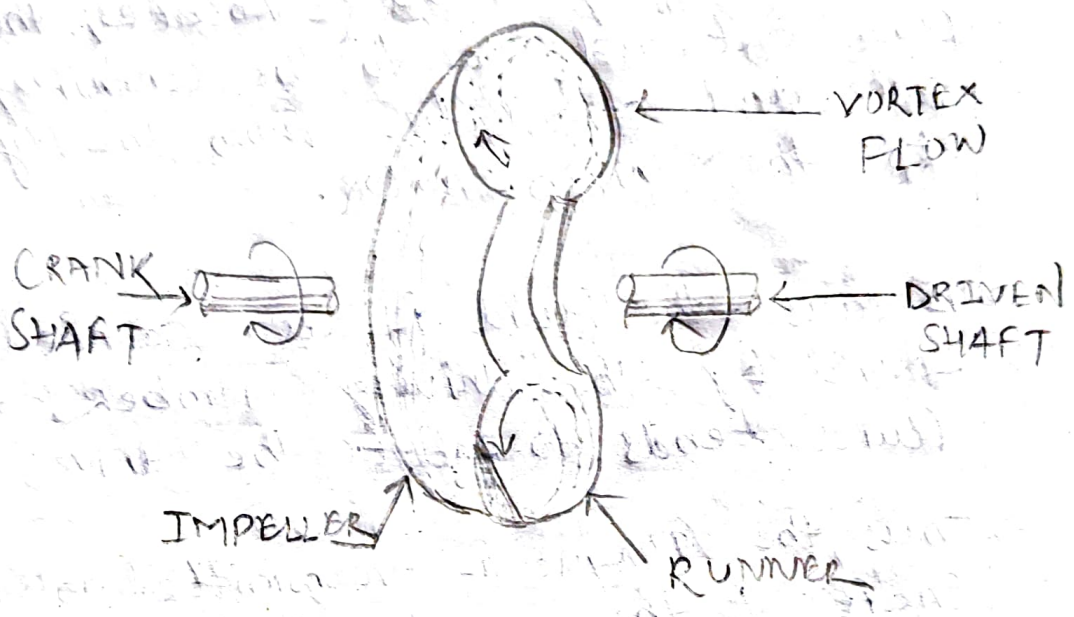
⇒ The two shells are very close with their end facing each other and enclosed in a housing, so that they can be turned without touching each other.

⇒ It is a complete assembly of a liquid coupling, the liquid is filled in the housing.



⇒ when the crankshaft turns, the oil trapped in the impeller fins impinges on the runner fins and causes it to move.

⇒ In this way the liquid transmit engine force to the clutch plate without any metal contact.



⇒ The liquid coupling is always major part of the engine flywheel assembly and hence it is also known as fluid flywheel.

⇒ Another design of the fluid flywheel is shown in fig.

⇒ It consists of a split housing which is rotated by the engine crankshaft.

⇒ Inside the housing is a driven rotor which is connected by a shaft to the gear box.

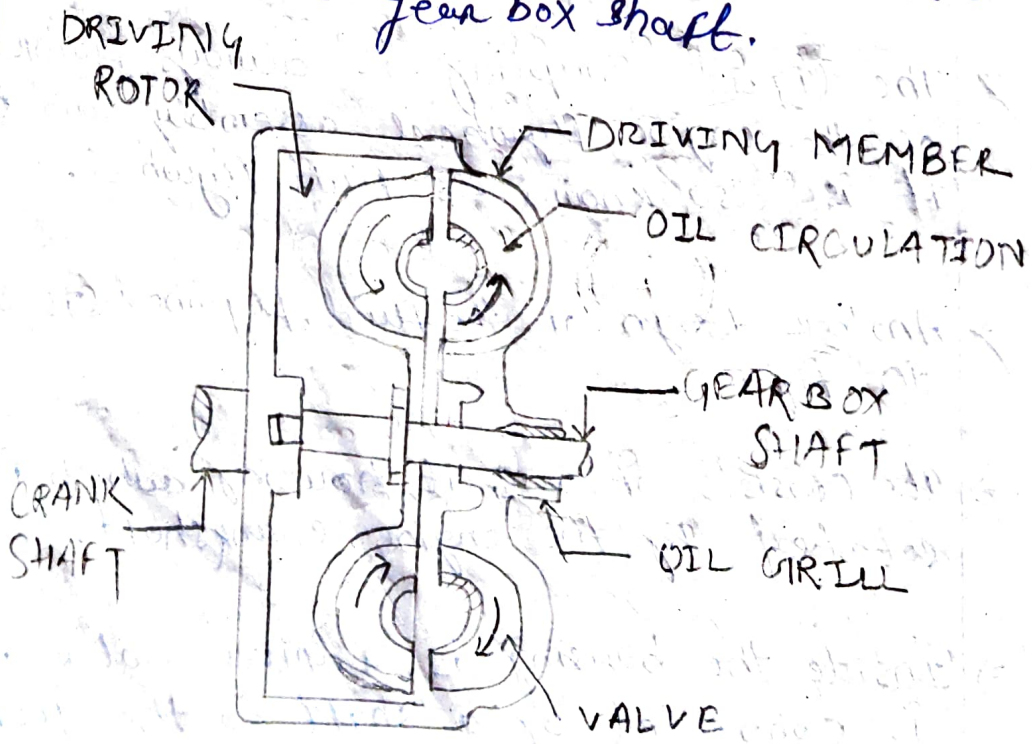
⇒ The flywheel housing is divided into a number of cells by means of Radial vanes.

⇒ these cells correspond to similar opening in the driven rotor.

⇒ As the driving member rotates, the fluid flow outward due to the centrifugal force and circulates from the flywheel to the driven rotor.

⇒ Because the fluid is also carried out round by the driving member, the fluid tends to rotate the driven rotor.

⇒ Thus, the Torque is transmitted to the crank shaft to the gear box shaft.



ADVANTAGE OF A LIQUID COUPLING

a. A liquid coupling, when used with a conventional clutch and transmission enables the driver to use the clutch and gears with less skill and fatigue than with an all mechanical linkage.

b. If the driver fails to de-clutch or shift to neutral before coming to a stop, the coupling will slip sufficiently to prevent stalling the engine.

c. Unskilled clutch engagement or selection of improper gear will not produce the chattering and bucking.

d. Any sudden load is cushioned and absorbed by the coupling, so that the dynamic stresses on the gear teeth of the transmission and rear axle are greatly reduced.

e. The vehicle may be started in high gear when equipped with a liquid coupling, because the coupling slips sufficiently to enable the engine to speed up.

f. Liquid coupling at low speeds is not as efficient a mechanical ones. It reduces engine braking when slowing down and requires high speed to start the vehicle.

Dt-31/07/2024 TORQUE CONVETER

TORQUE CONVETER

⇒ A Torque Converter is a device which performs a function similar to that of a gear box, that is, to increase the torque while Reducing the Speed.

⇒ But where as gear box provides only a small number of fix ratio, the torque converter provides a continous variation of Ratio from the lowest to the highest.

CONSTRUCTION

⇒ The Construction of Torque Converter is similar to that of a fluid coupling, the only difference being that it has an additional stationary member called the Reaction member.

⇒ Thus a torque converter consists of three principle member instead of two, these are;

1. Driving member or Impeller or pump, which is connected to the engine.
2. Driven member or Rotor or turbine, which is not connected to the propeller shaft.

3. Stationary member OR Reaction member OR stator, which is fixed to the frame. It is the member which makes it possible to obtain a change of torque between input and output shaft.

4. The fluid coupling does not have this member and cannot produce any change of torque.

5. The stator is mounted on a free wheeling one way clutch so that it can turn in only one direction.

6. A stationary shaft, called the reaction shaft, extends from the geared transmission in back of the converter through the pump to support the stator.

TORQUE CONVERTER AS A FLUID COUPLING

⇒ A torque converter is a type of fluid coupling that uses a fluid to transmit Torque from one shaft to another.

⇒ Because a torque converter has a stator, which is not in the fluid coupling, it increase the torque ratio.

⇒ However, at higher speed, the torque converter work as a fluid coupling, giving the gear ratio 1:1.

⇒ when the engine is running idle, the pump produce a slow circulation of oil, as the engine drive it.

⇒ This slow circulation of oil is not sufficient to move the turbine.

⇒ when the throttle is open wide, the engine speed increases and the pump moves faster projecting the oil toward the turbine.

⇒ But the oil is still having less force which is insufficient to turn the turbine.

⇒ therefore, the oil Return back to the pump with almost no loss of velocity, expect that due to friction.

⇒ The net effect of the Redirection of flow is to increase the pump output.

⇒ The pump output under these condition is the output velocity that it is creating because of the engine torque, plus the input velocity of the Redirected oil.

⇒ A built-up output velocity of two to three times the output ~~of the turbine~~ velocity due to the engine alone is achived when the turbine is stationary.

⇒ this makes the turning force of the turbine to three times of that of engine.

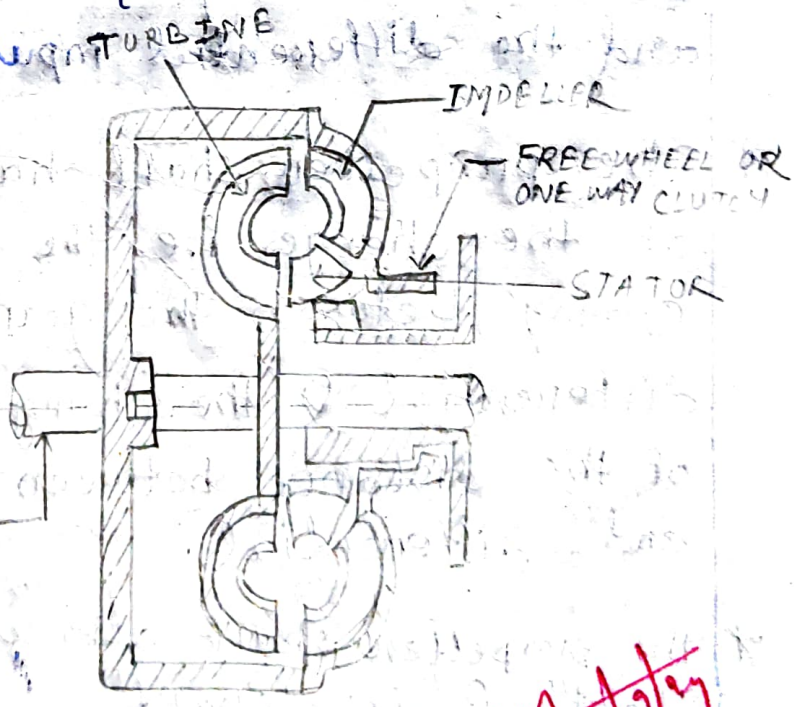
⇒ The increased Torque of the turbine enable it to Rotate and thus drives the input shaft, which in turn transmit the power to geared section of the transmission.

⇒ whereas 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.

⇒ Thus, it serves the same purpose as that of a gear box but in a better way.

⇒ In a gear box the torque variation is only in a finite number of steps, but in a torque converter, the torque variation is continous.

⇒ However the efficiency of a torque converter is high only within narrow limit of speed.



PROPELLER SHAFT Dt - 03/09/2024

⇒ The propeller shaft is driving shaft that connects the transmission main (or output) shaft of the gear box to the differential of the rear axle.

⇒ It transmit the power from gear box to rear axle with the help of universal joints.

It performs the following two functions:

(i) To receive the power from the gear box output shaft and without any change in speed transmit it to the input pinion of the differential for onward transmission to the rear axle and rear wheels.

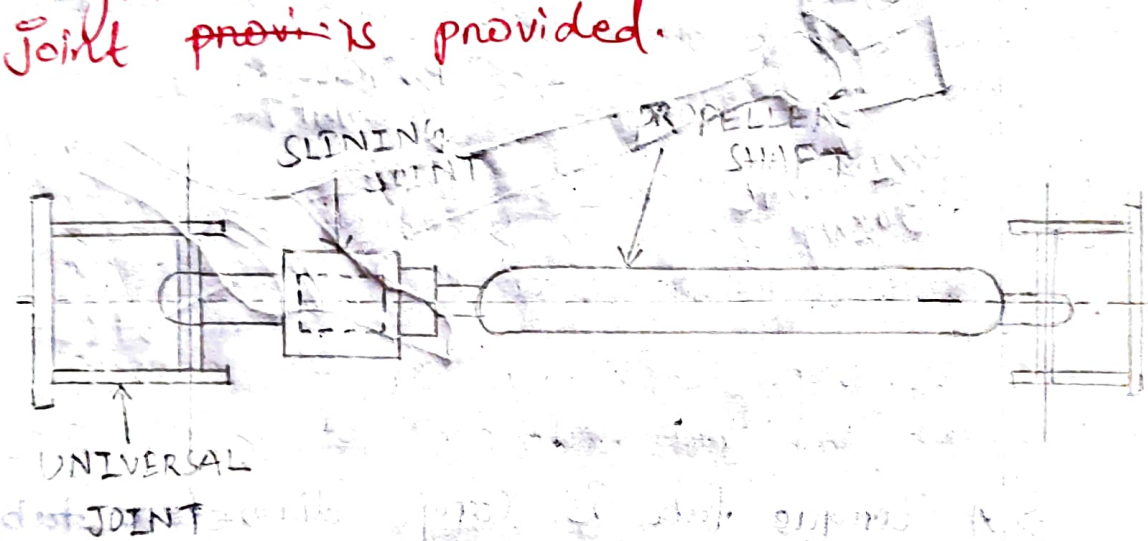
(ii) To cope (→ match) with the difference in line with the level of the gear box output shaft and the differential input pinion shaft.

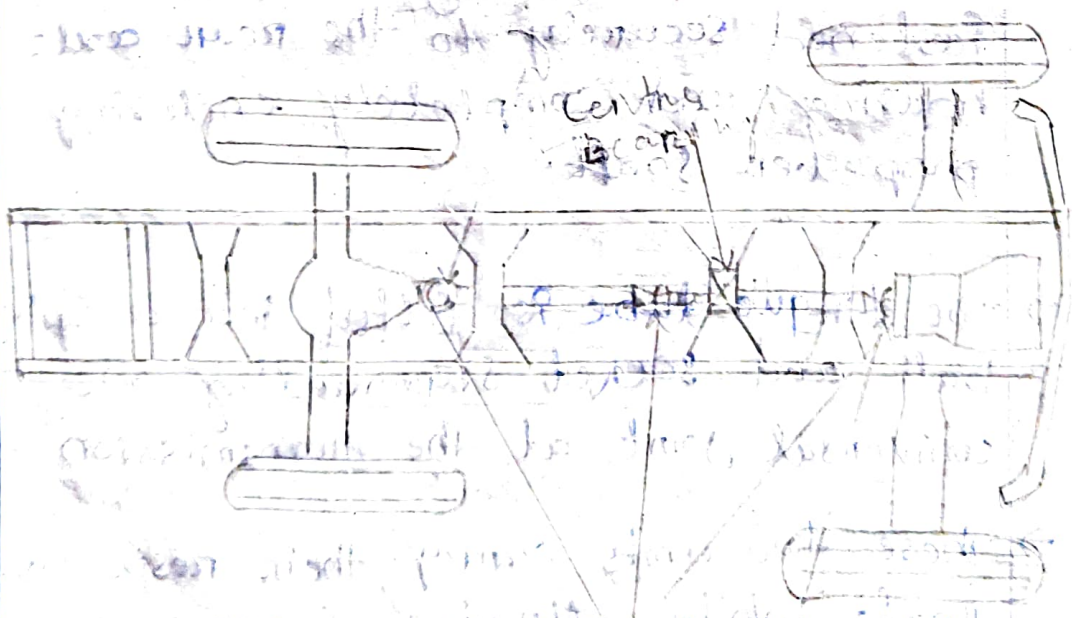
* The propeller shaft has to meet both of the changes i.e, the angular change coming between the gearbox and differential & the change in length of the distance between the gear box and differential.

* the propeller shaft also known as "driveline shaft" & "drive shaft"

☆ The propeller shaft is also not on the same line as the gear box output shaft but it runs to the rear axle at an angle because the level of the rear axle is lower than the gear box.

☆ TO adjust "angular motion", universal joints are provided to adjust for the change in length of the propeller shaft, a slip joint ~~provi~~ is provided.



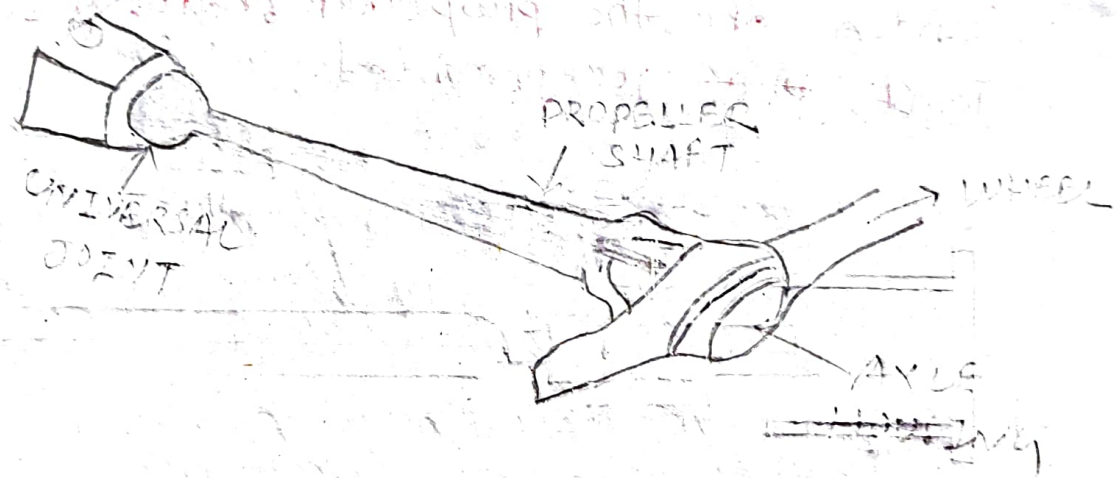


Construction of propeller shaft.

It is two types:

1. Torque tube type propeller shaft
2. Hotch kiss type propeller shaft.

TORque tube type propeller shaft



⇒ A torque tube is large diameter tube fastened securely to the rear axle housing and completely enclosing the propeller shaft.

⇒ The torque tube is fitted into a spherical ball and socket surrounding one universal joint at the transmission end.

⇒ these two units carry their respective loads while allowing suspension flexibility.

⇒ Thus, while normal engine power transmission take place through the propeller shaft, the braking and acceleration causing sudden torque are borne by the torque tube.

Hotchkiss type propeller shaft:

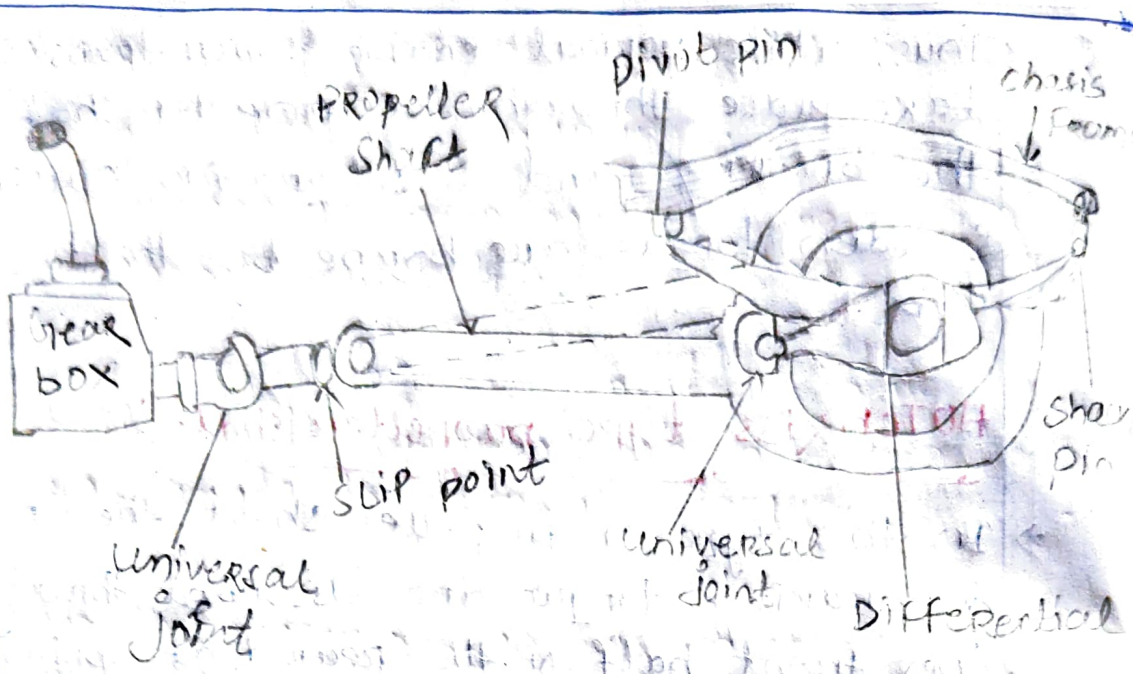
⇒ In this type of propeller shaft the driving & braking torque are absorbed through the front half of the rear leaf spring.

⇒ Hotchkiss drive are mostly used in all these cars & trucks now day.

⇒ It's cheaper & give satisfactory result.

⇒ The hotchkiss drive consists of a leaf spring and a propeller shaft with two universal joint and one sliding joint.

⇒ the front end of the leaf spring is pivoted in pin of bracket which bolted to the vehicle frame while rear end of the leaf spring is supported in swinging shackle with antifriction bush material.



Troubleshooting of propeller shaft:

Propeller shaft shakes:

(i) propeller shaft and splined yoke coupling are not properly connected.

Remedy: Assemble the splined yoke so that yoke on rear end of the shaft and propeller shaft are in the same plane.

(ii) Bent propeller shaft:

- In case the shaft is badly bent, it should be Replaced with new one.

(iii) worn out needle bearing of universal joint

- In case of slightly worn out needle beering Replace the needle bearing which comes duly assembled in cap.

NOISY Running of propeller shaft:

(i) slip joint splines worn out.
- Replace the splined shaft and splined yoke. (universal joint)

(ii) universal joint being worn out.
- Replace universal joint assembly

(iii) Loose flanged yoke.
- Tighten it fully.

(iv) ~~centre~~ centre bearing loose or worn out.
- replace worn out part

(v) centre bearing housing misaligned
- Align the centre bearing housing, tighten it holding down bolts.

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UNIVERSAL JOINT

⇒ A universal joint is considered the oldest of all flexible couplings.

⇒ It commonly known for its application in automobile and trucks

⇒ A universal joint is located where two shaft of the ~~gearbox~~ are to be joined at an angle to transmit torque.

⇒ In this transmission system of a vehicle, the output shaft of the gearbox.

⇒ The propeller shaft and the differential pinion shaft are not in one line, and hence the connection between them is made by a universal joint

⇒ Thus, the universal joint permits the torque transmission at an angle, and also while the angle is changing Constantly while the vehicle is moving on the road.

⇒ It is also known as Cardon joint or Hook joint.

Parts of universal joint

following are the parts of a universal joint

① Driving yoke and driven yoke.

② Spider.

① Driving yoke and Driven yoke

⇒ The universal or cardan joint is consists of two yokes, one is a driving yoke and another is driven yoke, to form the unit.

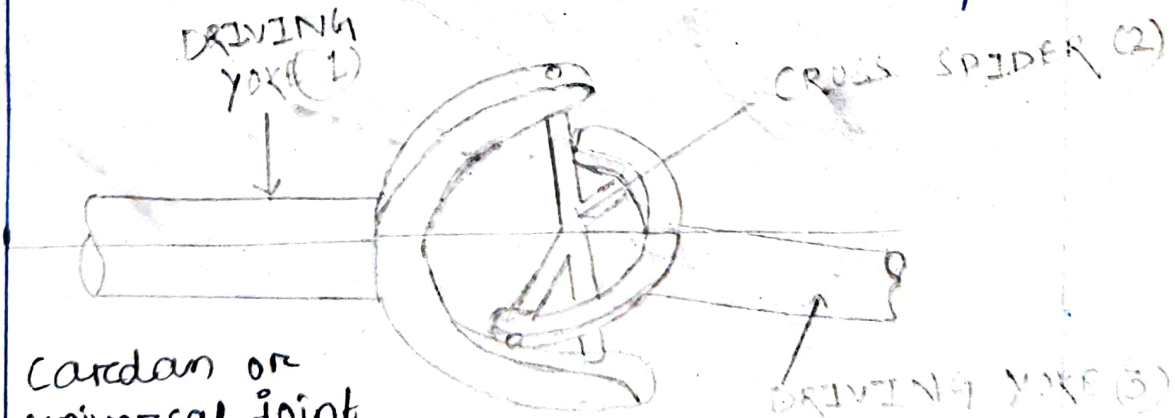
② Spider

⇒ These yokes are connected by means of a cross-shaped intermediate member called the spider.

⇒ In this, a shaft can be rotated at many angles.

⇒ If the shaft is connected straight, the output shaft.

⇒ It is obvious that both the input and out put shaft will rotate at the same speed.



Cardan or universal joint

WORKing of universal joint

⇒ It consists of driving yoke on one side.

⇒ this is connected to the main shaft of the gear box, and there is driven yoke. is connected to the propeller shaft.

⇒ These two yokes are connected by means of a crossed spider.

⇒ the four arms of the spider are known as trunnions.

⇒ when the driving shaft is rotating the driven shaft also rotates, at the same time, the universal joint allows angular motion.

⇒ Hence the power is transmitted from the gearbox to the propeller shaft at an angle

Function of universal joint

- the important functions of the universal joint are as follows.

(1) It is used to connect two shafts, whose axles intersect.

(2) It permits the rotation of one shaft about it axis by another shaft which rotates about their own axis.

(3) the permit the transmission of power not only at an angle, but also while this angle is being changing constantly.

Types of universal joint

- Mainly there are 3 types of universal joint as follows:

(1) Cross type or spider and two-yoke type joint
(2) Ball and trunnion type joint.
(3) Constant velocity type joint.

Cross-type universal joint

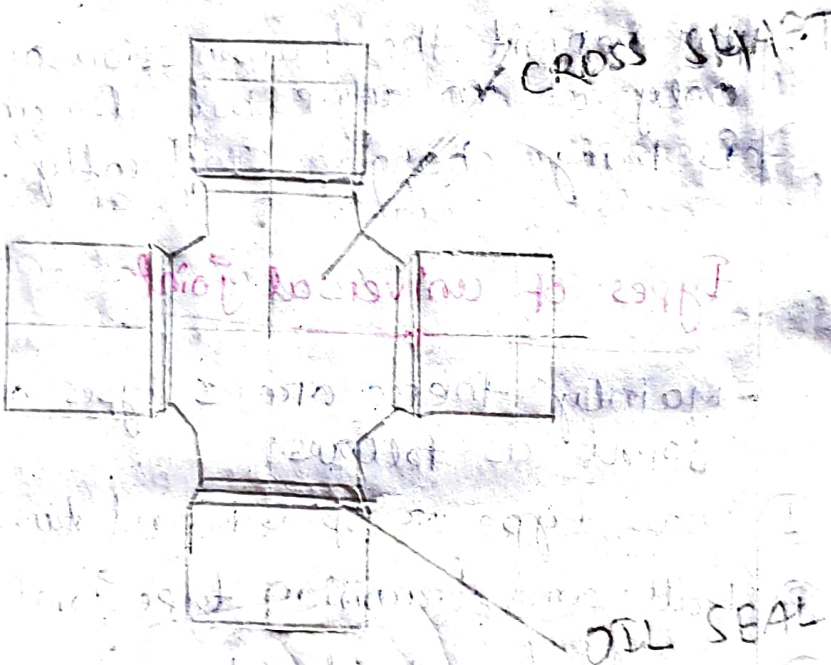
⇒ It is type of universal joint that has two 'Y' shaped yokes and a crosspiece (also known as a spider).

⇒ one yoke is attached to the driving shaft and another one is attached to the driven shaft.

⇒ The cross piece consists of four-arms (trunnion) that are connected to both ends of the yokes.

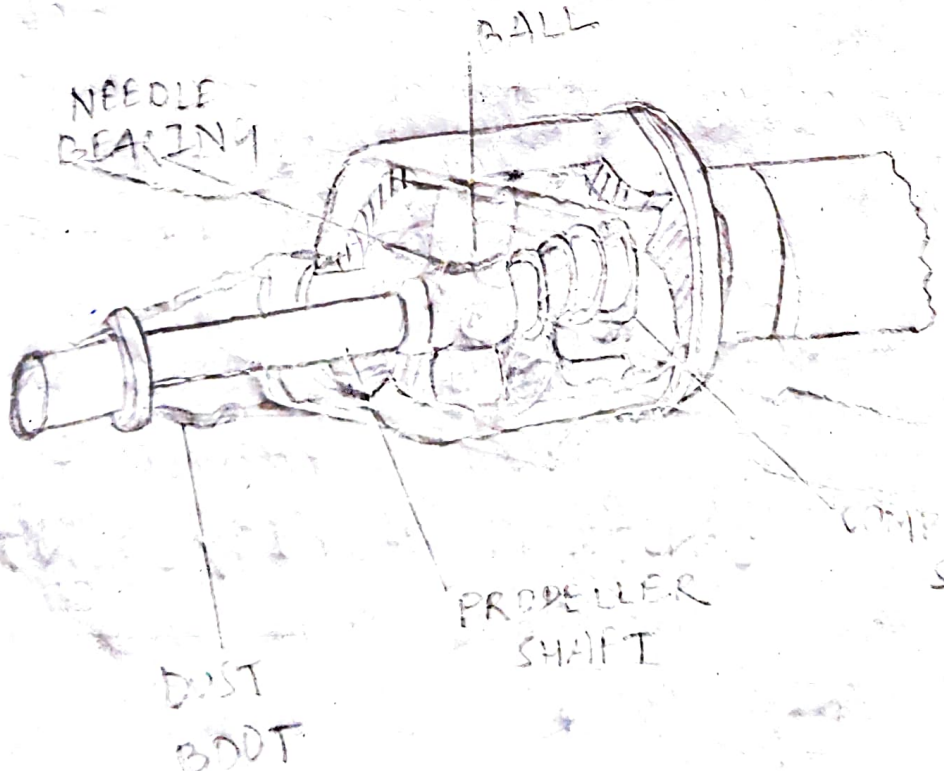
⇒ four needed bearing were also provided for each arms of the cross-piece.

⇒ these bearing allow the yoke to move arround the trunnion while simultaneously moving the driving and driven shafts at an angle



Ball trunnion type universal joint

1. => It is a combination of both universal and slip joints in one assembly.
2. => the ball trunnion universal joints is consists of a ball-type head that are fastened to one end of the propeller shaft or drive shaft.
3. => A pin or cross shaft is pressed through this end of the shaft forming a "T" shape.
4. => In this pin, two balls are fitted firmly.
5. => the joint helps in the rotational motion through the ball and the pin.
6. => the balls can also move axially in direction.
7. => Ball and trunnion joints are also variable velocity joints.



BALL AND TRUNNION TYPE

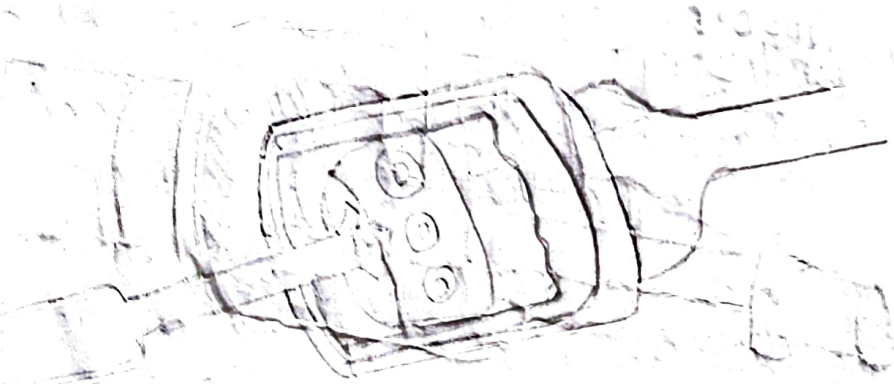
constant velocity type universal joint

⇒ It is type of universal joint, which allows both driving and driven shaft to move at a constant velocity.

⇒ Because, in this case, the two joints acts on the same angle.

⇒ these joints are typically used when the vehicle is in a front-wheel (axle) drive.

⇒ Because the speed variation between the driving and driven shaft will present difficulty in the steering system and result in excessive tire wear.



CONSTANT VELOCITY JOINT

Advantage of universal joint

- following are the advantage of universal joint

(1) universal or caridan joints have more elastic properties than knuckle joints.

(2) these joints help in torque transmission between shaft that have an angular misalignment.

(3) they are cheaper in cost and are simple to be assembled and dismantled.

(4) the universal joint can be provided high torque transmission efficiency.

(5) these joint allow angular displacement compared to other type.

Disadvantage of universal joint

- following are the disadvantages of universal joint:

(1) If the joint is not lubricated properly, it may wear out.

(2) It requires frequent maintenance to avoid wear.

(3) universal joint can cause unstable motion.

(4) they cannot support conial misalignment.

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Differential:

⇒ when the car is taking a turn, the outer wheels will have to travel greater distance as compared to the inner wheels in the same time.

⇒ If therefore, the car has a solid rear axle only and no other device, there will be tendency for the wheels to skid.

⇒ Hence the wheel skidding is to be avoided, some mechanism must be incorporated in the inner wheels and increase the speed of the outer wheels when taking turns.

⇒ It should at the same time keep the speeds of all the wheels same when going straight ahead.

⇒ Such a device which serves the above function is called a differential.

⇒ To understand the principle on which differential works consider the simplest differential called an open differential.

⇒ To the crown wheel of the final drive is attached a cage, which carries a 'cross-pin' (In case two planet pinions are employed)

⇒ Two sun gears mesh with the two or four planet pinions.

⇒ Axle half-shafts are splined to each of these sun gears.

⇒ the crown wheel is free to rotate on the half-shaft as s

⇒ when the vehicle is going straight the cage and the inner gears rotate as a single unit and the two half shafts revolve at the same speed.

⇒ In this situation, there is no relative movement among the various differential gears

⇒ To understand what happens when the vehicle is taking a turn, assume that the cage is stationary

⇒ then turning one sun gear will cause the other to rotate in the opposite direction.

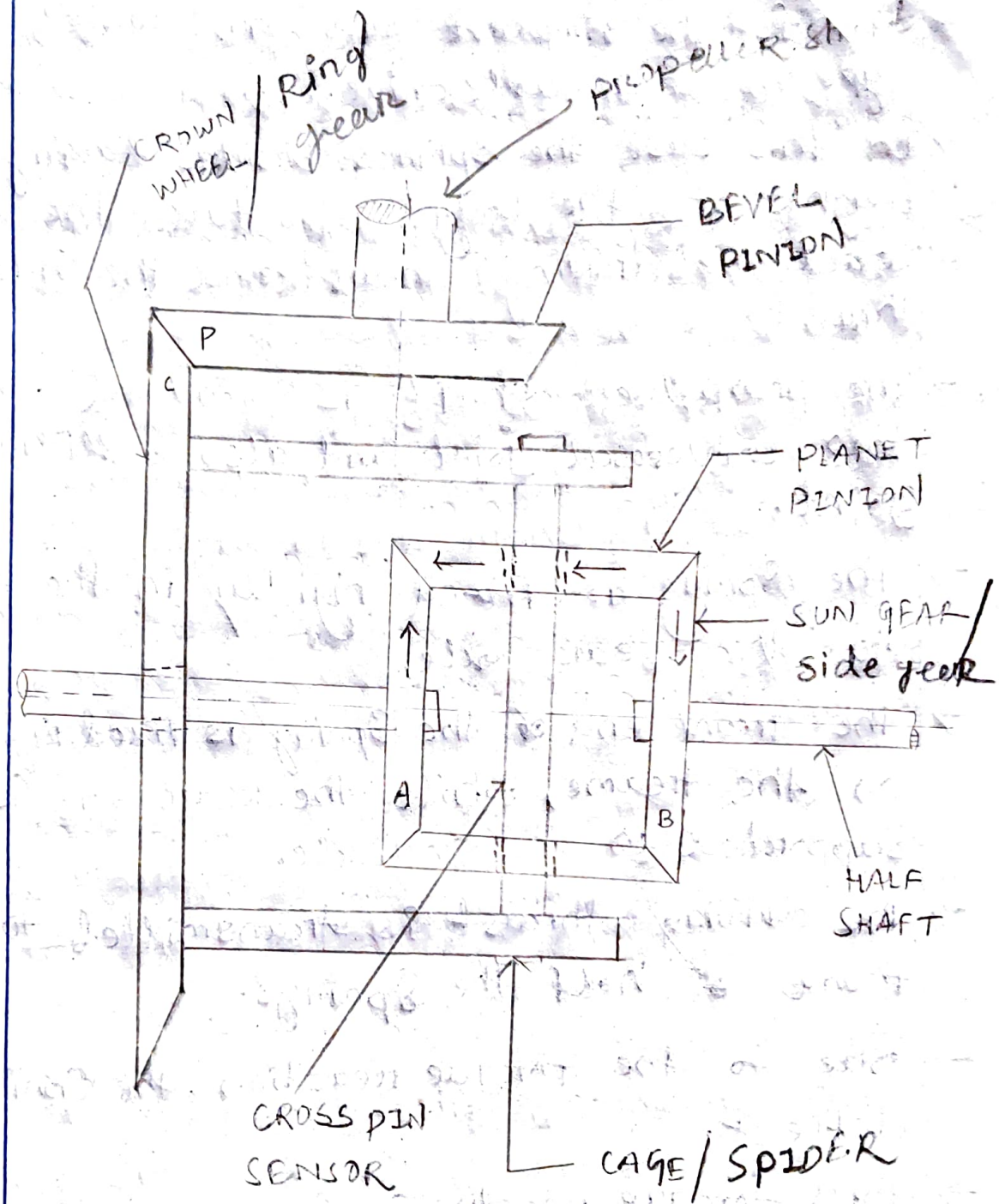
⇒ that means that if left sun gear rotate 'n' times in a particular time, the right sun gear will also rotate 'n' times in the same period but, of course, in the opposite direction.

⇒ The rotation is super-imposed on the normal wheel speed when the vehicle is taking a turn.

⇒ Thus, for example, consider a vehicle with wheel speed when ~~the vehicle is taking a turn~~ speed N rpm. going straight, when it takes a turn toward right.

⇒ At this time there will be a resistance to the motion of the right wheel and as a result of differential action if the right wheel rotates back at 'n' r.p.m then the left wheel will rotate forward at 'n' rpm.

⇒ this will give the resultant speed of the left wheel (N+n) and that of the right wheel as (N-n) rp.m.



PRINCIPLE OF DIFFERENTIAL.

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REAR AXLE DRIVES

Hotchkiss Drive

→ this is the simplest and most widely used type of rear axle drive.

→ In this case the springs besides taking weight of the body, also take the torque reaction, driving thrust and the side thrust.

→ The propeller shaft is provided with two universal joint and also a sliding joint.

→ The spring is fixed rigidly in the middle to the rear axle.

→ The front end of the spring is fixed rigidly on the frame, while the rear end is supported in a shackle.

→ the driving thrust is transmitted to the front ~~of~~ half the springs.

→ Due to the torque reaction, the spring deflect.

→ thus torque reaction is taken up by the spring.

→ Similarly, to take up the breaking torque the spring would deflect in the opposite direction.

→ when the Spring deflect in the manner, the bevel pinion shaft also changes position.

→ Therefore if there is only one universal joint at the front end of the propeller shaft, it will bend under this condition.

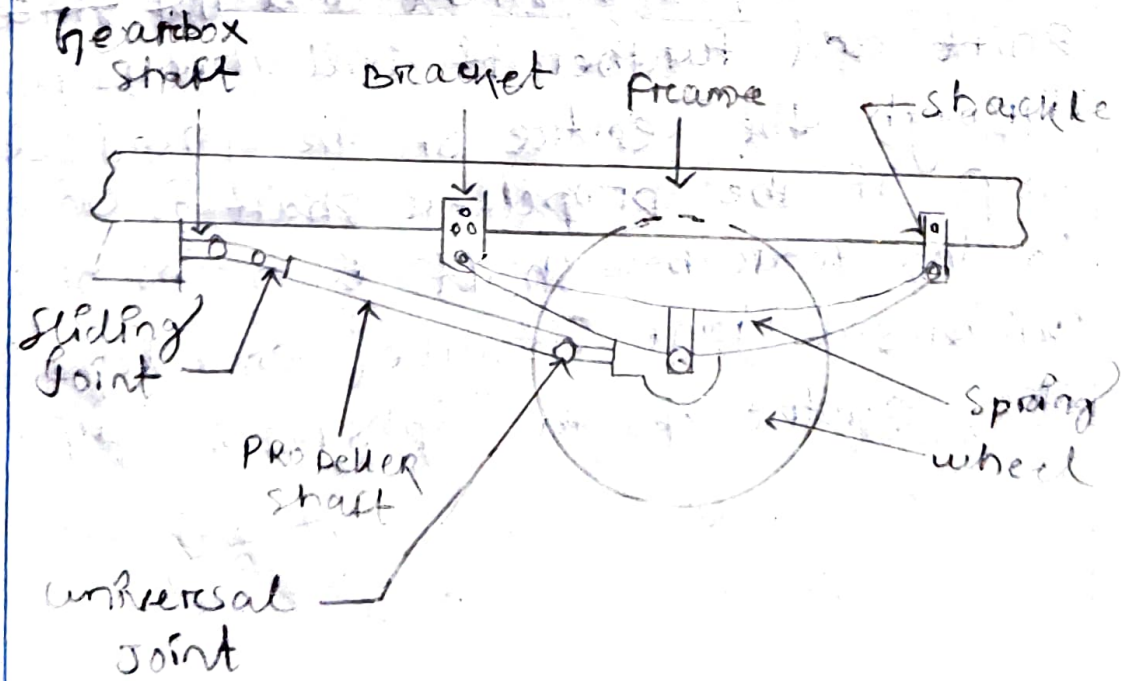
→ to avoid this, another universal joint at the rear end of the propeller shaft is used.

→ Again when the rear axle moves up and down, it has to move in a circle with the front Spring at the frame as centre.

→ But for the propeller shaft motion, the centre is at the front universal joint.

→ this mean that during this movement of rear axle, the length of the propeller shaft has to very.

→ this is provided for by means of a sliding joint in the propeller shaft.



HOTCHKISS DRIVE

★ Torque tube Drive

→ In this type of drive, the springs take only the side thrust besides supporting the body weight.

→ The torque reaction, braking torque and the driving thrust are taken by another member which is called the torque tube.

→ one end of torque tube is attached to the axle casing, while the other end which is spherical in shape fits in the cup fixed to the frame.

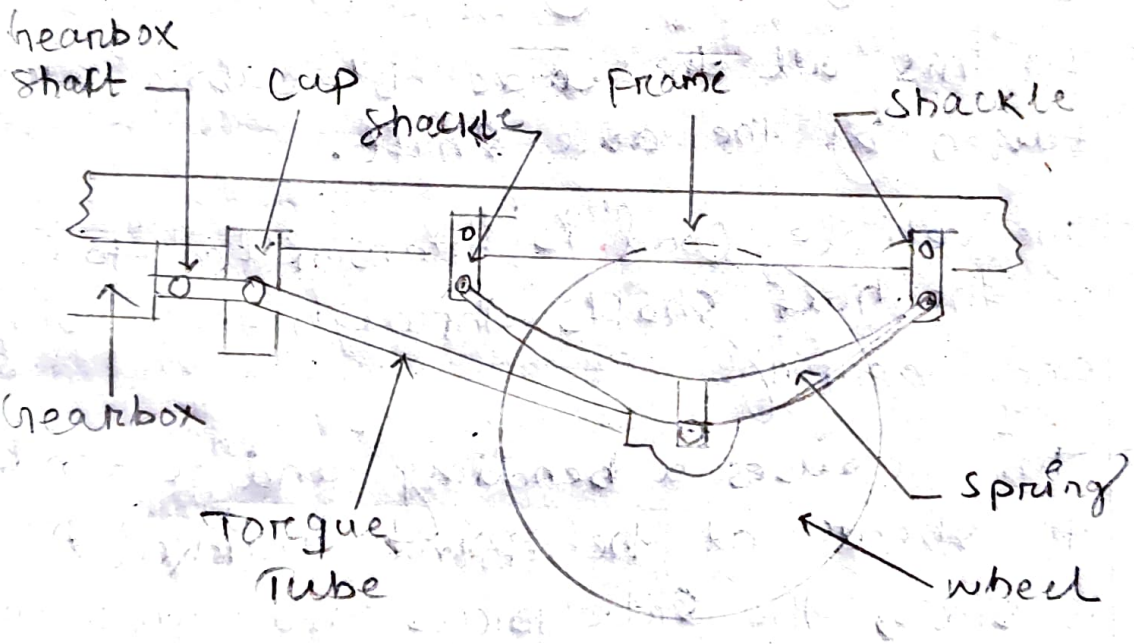
→ the torque tube encloses the propeller shaft.

→ Since in this case the torque tube takes the torque reaction, the centre line of the bevel pinion shaft will not ~~since~~ shift and further it will always pass through the centre of the spherical cup if the propeller shaft is connected to the gear box shaft by means of a universal joint situated exactly at the centre of the spherical cup.

→ In such a situation, no universal joint is needed at the rear end of the propeller shaft.

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

→ Clearly torque reaction and the driving thrust are taken by the torque tube.



Torque Tube Drive

REAR AXLE SHAFT SUPPORTING

* Semi-floating axle:

⇒ the wheel hub is directly connected to the axle shaft or is an extension of the same.

⇒ The inner end of the axle shaft is splined and is supported by the final drive unit, where as the outer end is supported by a single bearing inside the axle casing.

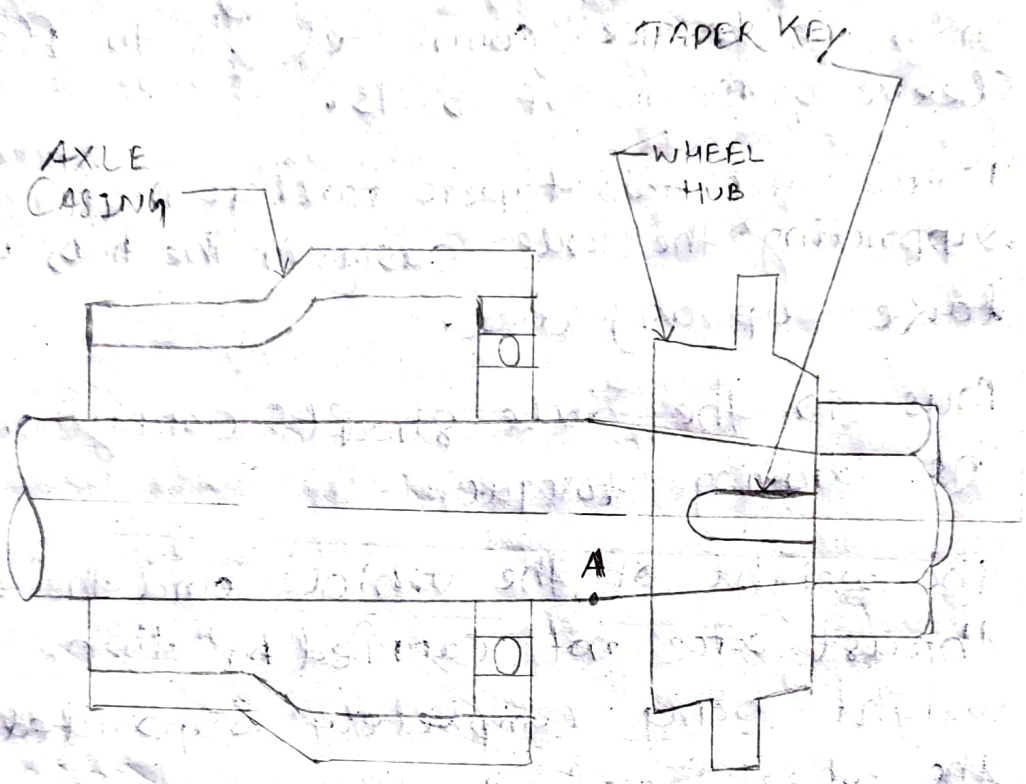
⇒ In this all the loads listed above are taken by the axle shaft.

⇒ the vehicle load is transmitted to each of the half shafts through the casing and bearing.

⇒ this causes a bending and a tendency to shear at the point marked 'A' Besides, the side forces also cause and thrust and bending moment in the axle shafts, which have to take driving torque also.

⇒ The Semi-floating axle is the simplest and the cheapest of all types, because of which it is widely use on cars.

⇒ However, since the axle shafts have to support all loads, they have to be of largere diameter for the same torque transmitted compared to the other types of axle supporting.



SEMI-FLOATING AXLE.

⇒ It cannot carry high load.
⇒ It uses on car & light vehicle
⇒

★ Full-floating axle:

⇒ This type is very robust one and is used for heavy vehicles.

⇒ The axle shafts have flanges at the outer ends, which are connected to the flanged sleeve by means of bolts.

⇒ There are two taper roller bearings supporting the axle casing in the hub, which take up any load.

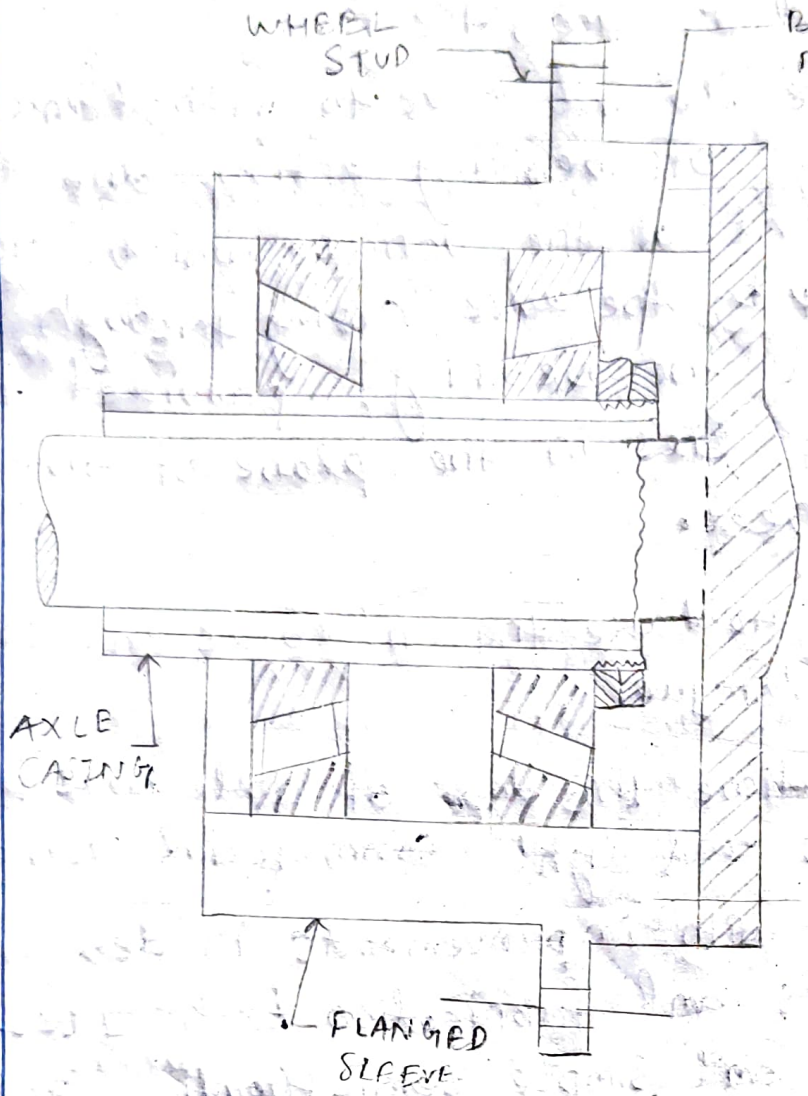
⇒ Thus in the axle shafts carry only the driving torque.

⇒ The weight of the vehicle and the end thrust are not carried by them, the weight being completely supported by the wheel and the axle casing.

⇒ As the axle shafts carry only the driving torque, their failure or removal does not affect the wheels.

⇒ Thus the axle shafts can be taken out or replaced without jacking up the vehicle.

⇒ For the same reason the vehicle can be towed even with a broken half-shaft



THREE QUARTER FLOATING AXLE

⇒ This is compromise between the more robust full floating type and the simplest semi-floating type.

⇒ In this bearing is located between the axle casing and the hub instead of between the axle casing and the shaft as in case of semi-floating axle.

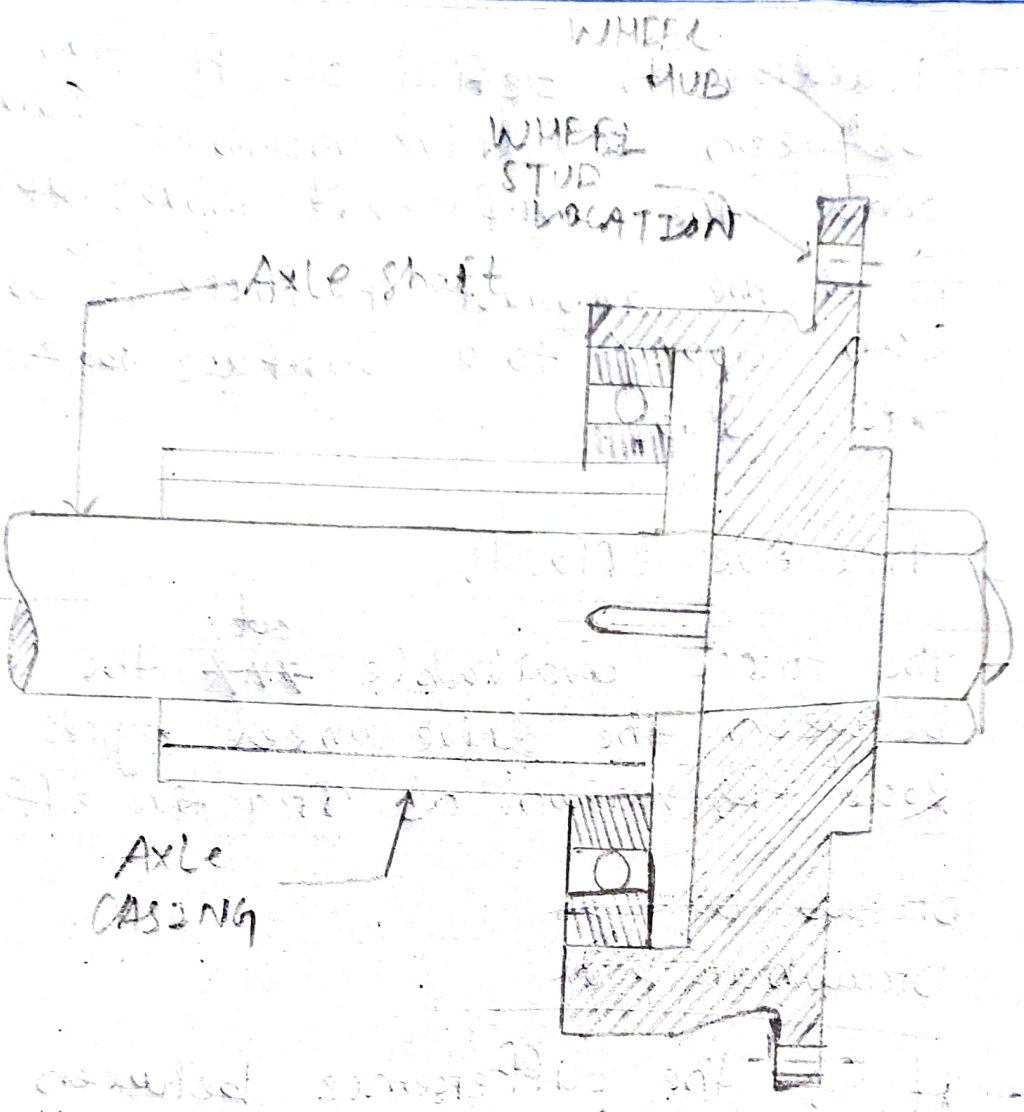
⇒ ~~As is clear from the f~~

⇒ the axle do not have to withstand any shearing or bending actions due to the weight of the vehicle, which are taken up by the axle casing through the hub and the bearing, provided the Bearing lies in the plane of the road wheel.

⇒ It has to take the end loads and the driving torque.

⇒ At one time this type of axle was popular for cars and light commercial vehicles.

⇒ However with improvements in design, materials and fabrication techniques the cheaper and simple semi-floating axles are again being preferred these days over the three-quarter floating type.



THREE - QUARTER FLOATING AXLE