LECTURE NOTE

ON

AUTOMOTIVE TRANSMISSION

DIPLOMA 5TH SEM

DEPARTMENT OF AUTOMOBILE ENGINEERING

PREPARED BY:ER.MANAS KUMAR PARICHHA

GANESH INSTITUTE OF ENGINEERING AND TECHNOLOGY
(POLYTECHNIC)
(Approved by AICTE)
ANDHARUA,BHUBANESWAR

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 real axel.
6. Transmission of power in two-wheelers.

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 &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.

A Tow Rebik - 3

Automatic Tramic

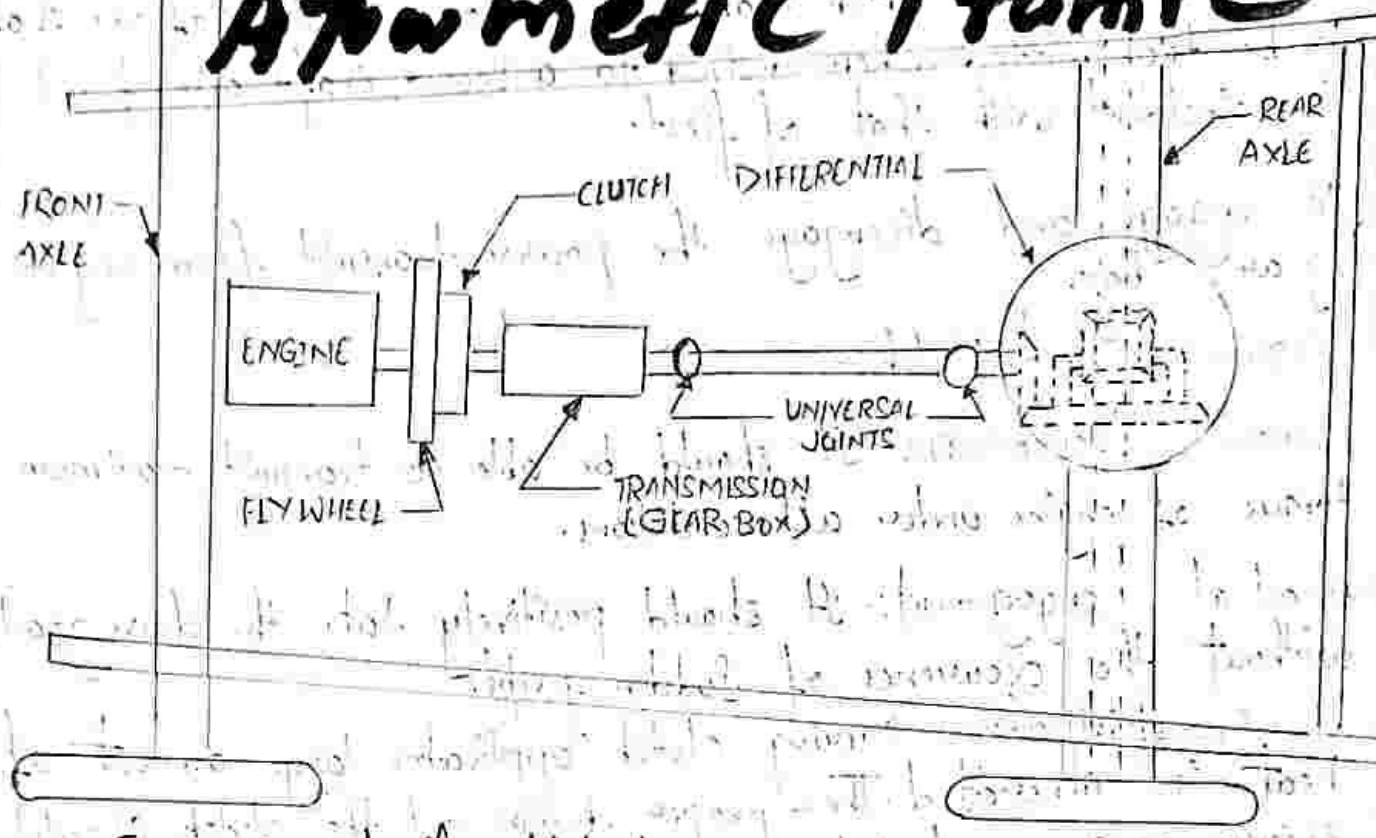


Fig. 3.4. Layout of complete transmission system of an automobile.

TRANSMISSION SYSTEM:-

Transmission System consist of Clutch, gear box, propeller Shaft, U.V Joints. Rear axle, Differential.

Work of Transmit:-

Transmit the power from engine to wheels.

Function of transmit System:-

1. To disconnect the engine from road wheels. When desired.
2. To connect the engine to driving wheels without shock.
3. To vary the leverage between the engine and driving wheels.
4. To reduce the engine speed permanently in a fixed ratio.
5. To turn the drive through a right angle.

CLUTCH :-

It's a mechanism which enables the rotary motion of one shaft to be transmitted when desired to a second shaft axis of which is coincident with that of first.

To engage and disengage the power transmit from engine to gear box.

Requirement of Clutch :-

1) Torque transmission :- It should be able to transmit maximum torque of engine under all conditions.
2) Gradual engagement :- It should positively take the daive gradually without the occurence of sudden jerks.
3) Heat dissipation :- During clutch application large amount of heat is generated. The proper design of the clutch should ensure proper ventialation or cooling for adequate dissipation of heat.
4) Dynamic balancing :- Necessary particularly in high speed clutches.
5) Vibration damping :- To eliminate noise produced in transmission.
6) Ease of operation :- For higher torque transmissions the operation of disengaging the clutch must not be tiresen.

Types of clutch :-

1. Friction clutches
2. Fluid flywheel
3. Friction clutches :-

→ Work on the fact that friction is caused when two rotating discs come into contact with each other.

2. Fluid flywheel :-

→ Work on transfer of energy from one rotor to another by means of fluid.

* Friction Clutches:-

1. Dry type
2. wet type

1. Dry friction clutches:-

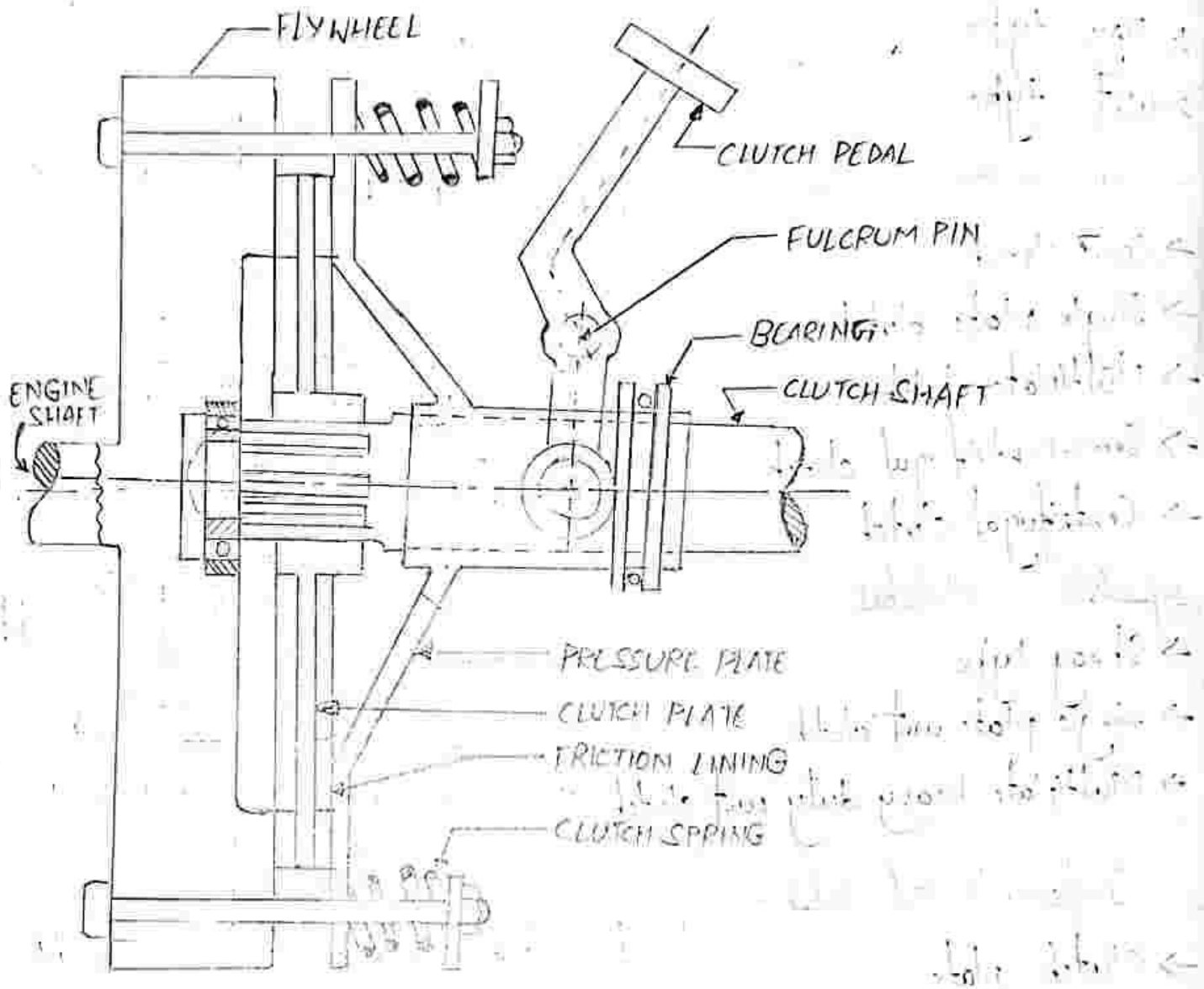
→ Cone clutch
→ Single plate clutch
→ Multiplate clutch
→ Semi-Centrifugal clutch
→ Centrifugal clutch

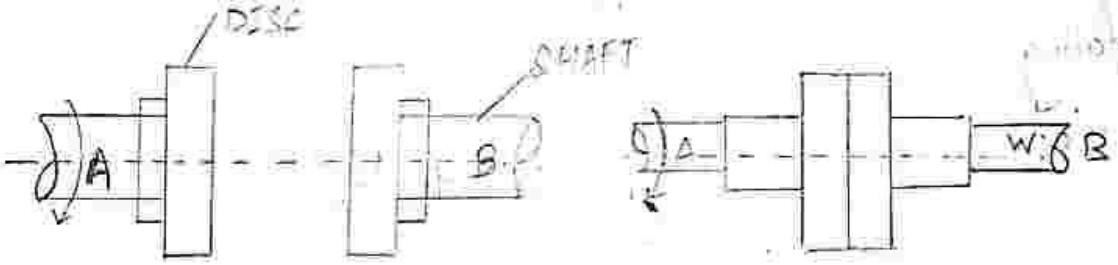
2. Wet clutches:-

→ Spray type
→ Single plate wet clutch
→ Multiplate heavy duty wet clutch

Components of Clutch:-

→ Clutch plate
→ Clutch facing
→ Pressure plate
→ Spring
→ Bearing





Disengages

Engage.

Single plate clutch:-

→ when the clutch pedal is pressed, the pressure plate is moved to the right against the force of the springs. This is achieved by means of suitable linkage and a thrust bearing. With this movement of the pressure plate, the friction plate is released and clutch is disengaged.

Clutch Operation:-

→ when we press the pedal the friction disc which is movable slides on the shaft. This is the disengaged condition in which the friction plate doesn't touch the flywheel. which means that the axial load applied by the pressure plate is zero and hence power/torque transmission is zero.

→ The engine is still running but the vehicle won't move. when the pedal is pressed, the pressure plate moves back against the force of the springs and the plate becomes free between the flywheel and pressure plate.

→ Thus the flywheel remains rotation as long as engine is running and the shaft speed reduces slowly and finally, it stops rotating. As soon as the pedal is pressed the clutch is said to be disengaged. when we completely release the pedal the movable friction disc slides forward on that shaft.

→ This is an engaged condition in which the disc has completely touched the flywheel. which means that the axial load applied by the pressure plate is and the spring force and hence power transmitted is max.

→ The plate is gripped between the pressure plate. Due to friction between the flywheel plate and pressure plate, the clutch plate revolves with the flywheel. As the plate revolve the shaft also revolves. The shaft is connected to the transmission. Thus the engine power is transmitted from the Crankshaft to clutches shaft.

Requirement of clutch facing:-

1. Good wearing properties.
2. Presence of good binder in it.
3. Cheap and easy to manufacture.
4. High co-efficient of friction.

Common clutch facing material are:-

1. Leather
2. Cork
3. Fabric
4. Asbestes
5. Reybestos and Ferodo
6. Non-asbestos (eg Glass Fibre)

Clutch problems and Adjustment:-

1. Clutch slip 2. clutch drag or spin.
3. clutch judder 4. clutch rattle.
5. knock 6. pulsation of clutch pedal.

1. Clutch spin:-

Incorrect linkage adjustment which causes insufficient free pedal.

(a) Adjustment of the linkage will remedy this defect.

(b) Oil or grease on friction facing due to leakage from engine crank case or the gear box or two enassive lubrication of the clutch shaft and its support bearing

(c) This clutches glazing of the friction surfaces leading to sleeping.

Remedy:-

Clean the components and replaced the clutch facing.

Weak or broken clutch springs.

Replace the springs.

Clutch drag or spin:-

Some times when the clutch is to be disengaged it is not disengaged completely and it causes difficulty in changing gear this is known clutch drag or spin.

Reason for defect:-

Excessive free pedal habit.

(b) when be driver is in the habit torque his foot on the clutch pedal well driving this is clutched.

Adjustment:-

* Check the free pedal if found incorrect if should adjusted.
* Oil or greas on friction facings.

Remedy:-

* Clean the facings if a excessively damage then replace them.
* problem pressure plate damaged.

Adjustment:-

Replaced the pressure plate.

Clutch Judder:-

Sometimes as the clutch is engaged a vibration or judder is produced instead of smooth gradual enagagement and the vehicle suddenly jumps forward possible are:-

i.> Loose or worn out clutch facing. It must be replaced.
ii.> Loose rivets. The whole facing should be replaced.
iii.> Distorted clutch plate. It has to be replaced.
iv.> Misalignment of the pressure plate with the flywheel. This has to be corrected.
v.> Flywheel may be loosed on the crankshaft flange. It may by tightning to remove the defect.

Clutch Rattle:-

In the engagement of clutches some peculiar noises may be noticeable when the engine idling. This is known as clutch Rattle. cause are:

i> If the clutch pedal has free movement then it may be due to worn out or loose throw out bearing or it may be that pedal return Spring is disconnected and is loose.
ii> It may be due to damage clutch plate.

i.> Bearing has to be replace spring is also to be replace.
ii> Replace the clutch plate.

Knock:-

This is observed when the engine is idling and the clutch is engaged this may be due to woon out spling of the clutch plate hub or the clutch shaft.

Replace the clutch plate or clutch shaft or both.

The weising out of the spygot bearing in the flywheel may also be the cause of the knock of the clutch.

Bearing will have to be Replace.

pulsation of the clutch pedal:-

Cause due to misalignment of the engine and the transmission the result in rapid weise of clutch part.

Proper Realignment has to be done.

Fluid flywheel:-

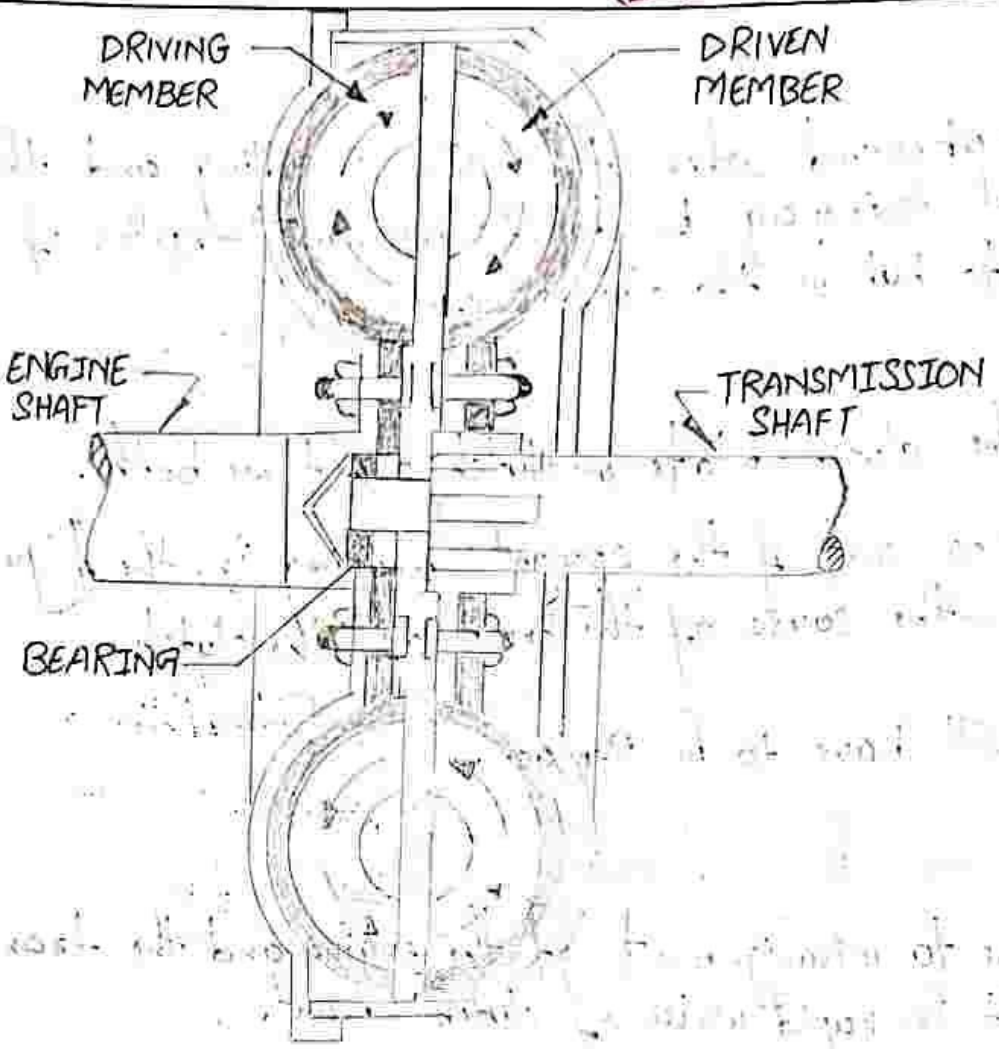
The fluid flywheel or the hydraulic coupling has being used in car employing automatic transmission. It consists of two members..

i) Driving member - attach to engine flywheel.

ii) Driven member - attach to transmission shaft.

Two member do not have any direct contact with each other. Driven member free to slide on the spline of the transmission shaft. The two rotor are always field with fluid of suitable viscosity.

fluid flywheel is also know as hydraulic coupling.



Fluid flywheel:-

→ when the engine is started, the driving member called the impeller starts to move inside the housing containing oil. pockets of moving driving members are completely filled with oil. Due to this the centrifugal force forces the oil outward radially.

→ The pockets are designed in such a way that the splashed oil will strike the pockets or vanes of the driven member. Hence its forced to move in same direction. when the engine speed increases the oil which is coming out from the pocket of the driving members strikes the pockets of the driven member with great force. Thus it tends the driven members to rotate at same speed.

Transmission:-

The word transmission is used for a device that is located between the clutch and the propeller shaft. It may be a gearbox, a torque convert overdrive flywheel drive or hydraulic drive.

Purpose of Transmission:-

To provide high torque at the time of starting hill climbing, accelerating and pulling a load.

Types of transmission:-

1. Manually operated Selective transmission: A type used in cars, buses and trucks. Its also known as standard/Stick shift. Its of 3 types: constant mesh, sliding mesh and Synchromesh.
2. Over drive: A semi automatic type used in conjunction with a selective transmission.
3. Chrysler Semi automatic: An electric and hydraulic controlled type used in conjunction with a fluid drive or torque converter.
4. Automatic transmission

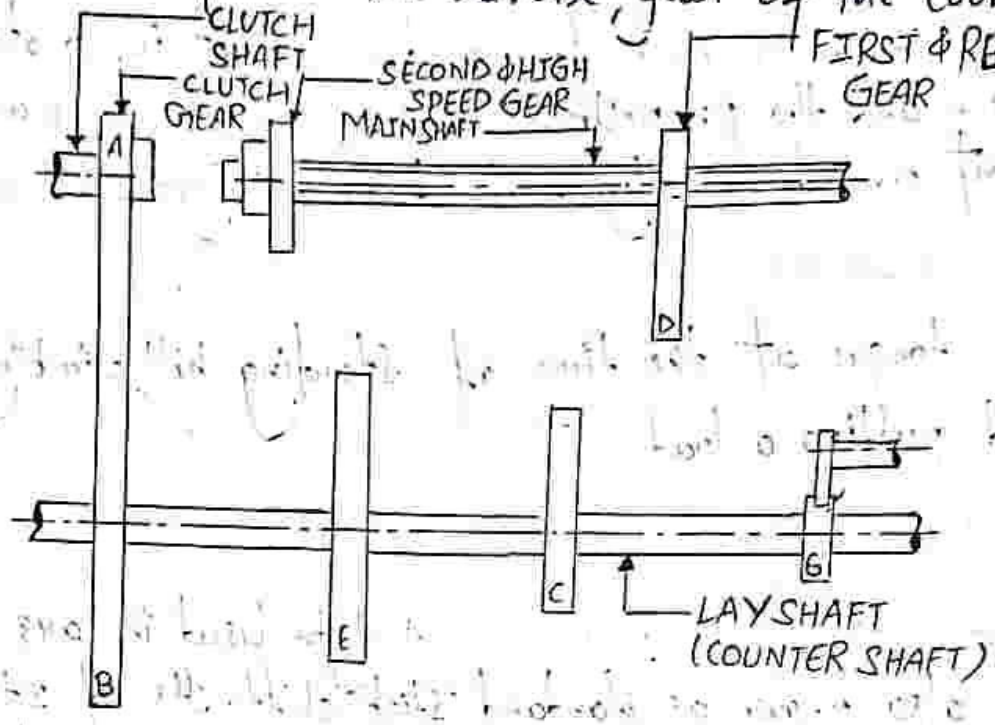
(a) Hydromatic drive.

(b) Torque converter transmission.

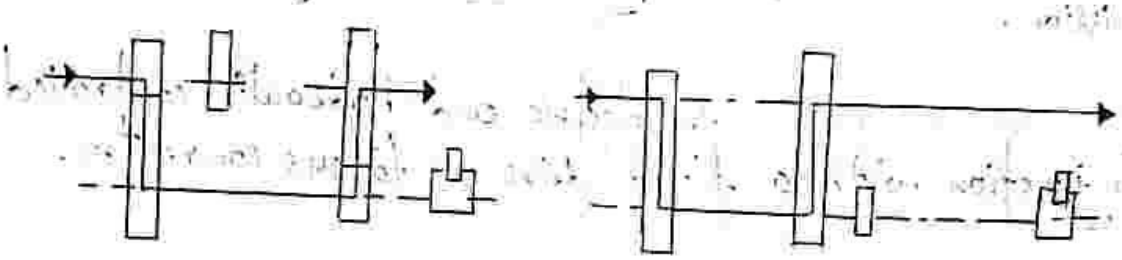
Sliding mesh gearbox:-

Its the simplest type of gearbox. The clutch gear is rigidly fixed to the clutch shaft. It remains always connected to the drive gear of the countershaft. Three other gear are also rigidly fixed to the countershaft clayshaft. They are second speed gear, first speed gear and reverse speed gear. Two gears are mounted on the splined mainshaft which can be slided by the shifter yoke when the shift lever is operated. These gears are the second speed gear and first and reverse speed gear. They can be connected to the corresponding gears of the countershaft.

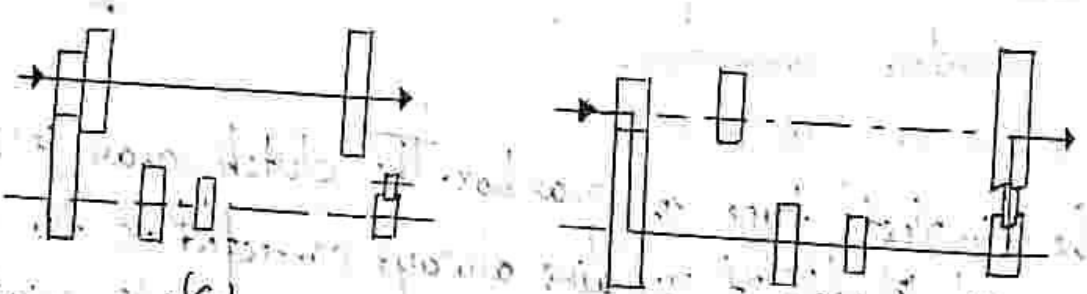
A reverse idler gear is mounted on another shaft and always remains connected to the reverse gear of the countershaft.



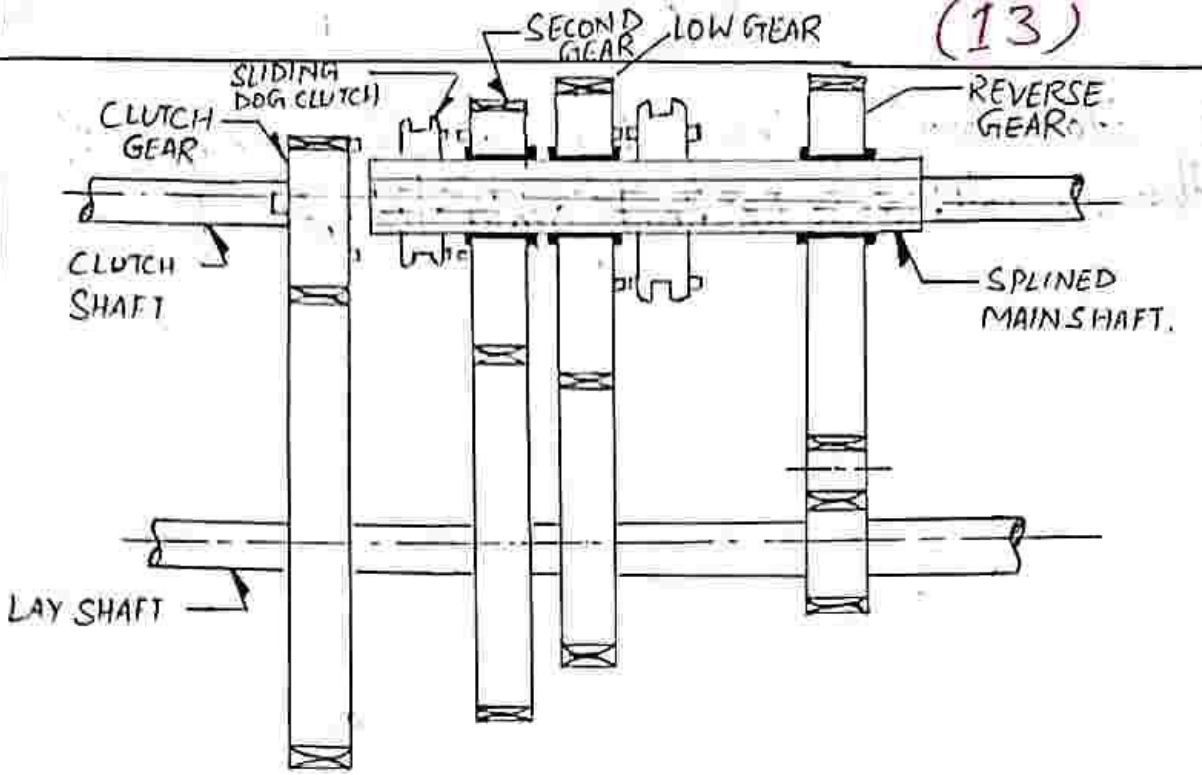
Sliding Mesh Gear Box (Gears in 'neutral').



(a) (b)



(c) (d)



Constant mesh gear box:-

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

Epicyclic gear box:-

An epicyclic gear box consists of two, three or even four epicyclic or planetary gear sets. A simple gear set has a sun gear, about which planets turn round. These planet gears are carried by a carrier and a shaft and are also in mesh internally with a ring gear; which is also called annulus or internal gear. Sometimes. Different torque ratios i.e. speed ratios are obtained by making anyone of the parts. viz. the sun gear, the planets and the

annulus stationary. Similarly by locking two parts with each other, a solid drive i.e direct gears is obtained.

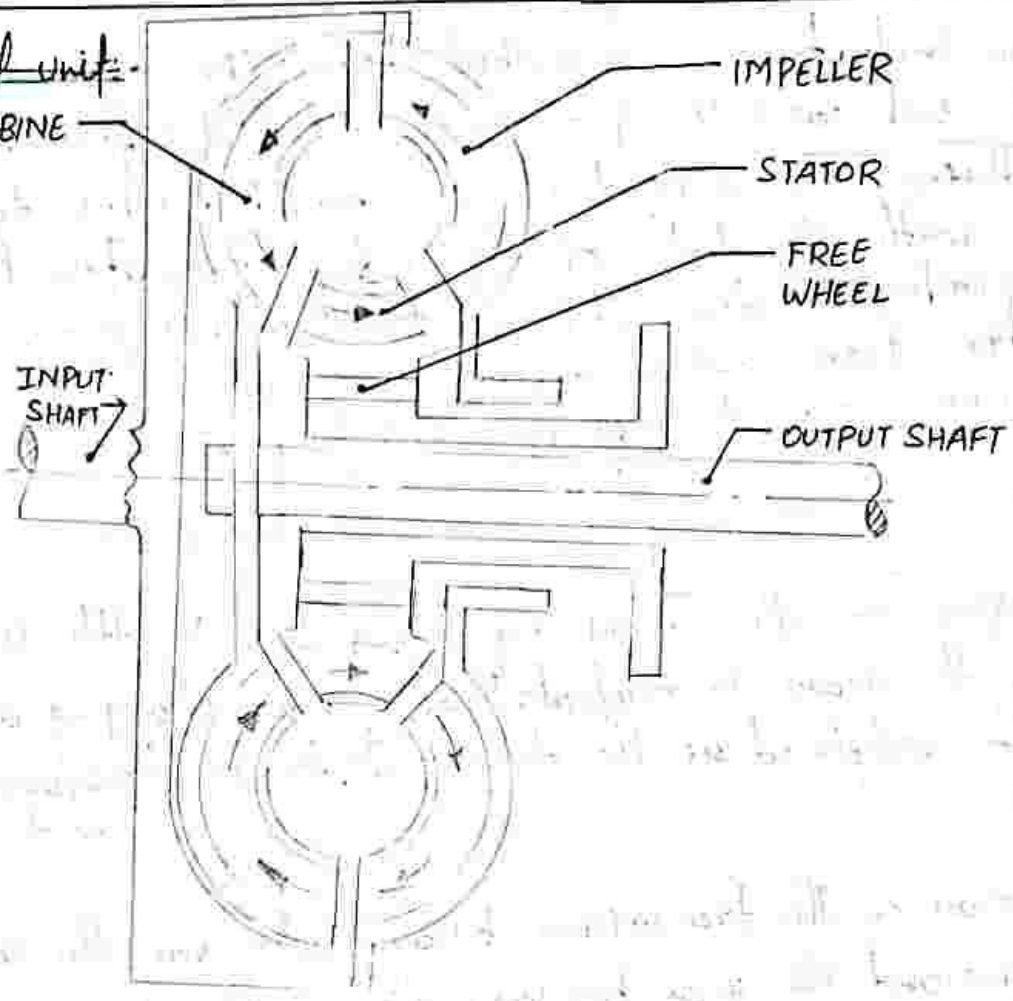
Controls in the epicyclic gear box:-

There are two controls i.e. brake and the clutch. The brake is in the form of a band that surrounds a drum attached to the gear (in case of sun gear) on the outer surface of the gear itself. In case of ring gear). The clutch used is of multiplate type. Both the brake and the clutch are applied by fluid pressure. These are selected by hydraulic shift valves which are usually located in the bottom of the gear box. The details of working principle of such valves will be discussed in Art 5.

Advantage of epicyclic gear box:-

The advantage of epicyclic gearing is thus obvious. All the gears are in constant mesh and to engage any desired gear one simply has to apply the particular brake or the clutch. For this, the drive from the engine need not be disconnected as in case of ordinary crash type gear box. The gear changing operation thus becomes very easy with an epicyclic gear box which makes it suitable for use in automatic transmissions.

free wheel unit:-



In some vehicles a freewheel unit (also called freewheel clutch) is provided just after the gear box. fig 5.7 shows the construction of this unit. It is very much similar in action to the bicycle freewheel. The inner driving member is connected to the gear box shaft and the outer one to the propeller shaft. The driving member has three steps as shown in figure. In each step there are three spring-mounted rollers of different sizes. when the driving member is rotating in the direction shown in the figure. the driven member will also be rotating in the same direction. But when the driven member becomes the driving member e.g. when the car is going down hill with the engine stopped or clutch disengaged, the inner member will not rotate along with the outer one. Thus in this case the transmission and the engine will be isolated from the wheels. This result in fuel economy.

In some instances, the freewheel has to be locked in reverse drive. In such cases the provision of locking the freewheel drive is there. There is a dog clutch provided whose teeth can engage with the teeth on the inside of the outer free-wheel member. The dog clutch is automatically engaged by a connection from the reverse gear selector. There is also a provision for the manual locking of the freewheel.

The advantage of using a freewheel unit are:-

1. The engine can idle simply by closing the throttle is without bringing the gears in neutral. Thus gear changing at low speed is much simplified as the clutch need to be disengaged for this purpose.
2. Lesses wear on the transmission because whenever the car free wheels, the engine and the gear box are disconnect from the propeller shaft.
3. On long downward slopes, an appreciable amount of fuel is saved. The saving may be up to 20 percent.

Torque Converter:-

Role:-

1. Multiples torque generated by engine.
2. Serves as an automatic clutch which transmits engine torques to the transmission.
3. Asorbs torsional vibration of the engine and drive train.
4. Smoothes out engine rotation.
5. Drives the oil pump of the hydraulic control System.
6. Its filled with automatic transmission fluid and transmits the engine torque to the transmission.
7. It can either multiply the torque generated by the engine or function as a fluid coupling.

Components:- 3 major over: pump impeller, turbine runner and the stator.

1. pump impeller:- The impeller is integrated with the torque converter case and many curved vanes that are radially mounted inside. A guide ring is installed on the inner edges of the vanes to provide a path for smooth fluid flow. When the impeller is driven by the engine crankshaft, the fluid in the impeller rotates with it. When the impeller speed increase, centrifugal force causes the fluid to flow outward toward the turbine.
2. Turbine Runner:- The turbine is located inside the converter case but is not connected it. The input shaft of the transmission is attached by splines to the turbine hub when the converter is mounted to the transmission. Many cupped vanes are attached to the turbine. The curvature of vanes is opposite from that of the impeller vanes. Therefore when the fluid is thrust from the impeller its caught in the cupped vanes of the turbine and torque is transferred to the transmission input shaft, turning it in the same direction as engine crankshaft.

3. Stator:- Its located betn impeller and turbine. Its mounted on the stator reaction shaft which is fixed to the transmission case. The vanes of the stator catch the fluid as it leaves the turbine runner and redirects it so that of strikes the back of the vanes of impeller giving the impeller and added boost or torque.

Working operation:- when impeller is driven by engine crankshaft, the fluid in the impeller rotates in same direction. when the impeller speed increases centrifugal forces causes the fluid to flow outward from the ~~et~~ center of the impeller and flows along the vane surfaces of the impeller. As the impeller speed rises further, the fluid is forced out away from the impeller toward the turbine. The fluid strikes the vanes of the turbine causing the turbine to begin rotating on the same direction as impeller. After the fluid dissipates it energy against the vanes of then turbine its flows onward along the vanes of turbine. when it reaches the interior of turbine, the turbine curved inner surface direct the fluid at the vanes of the stator and the cycle begines again

Selector Mechanism:-

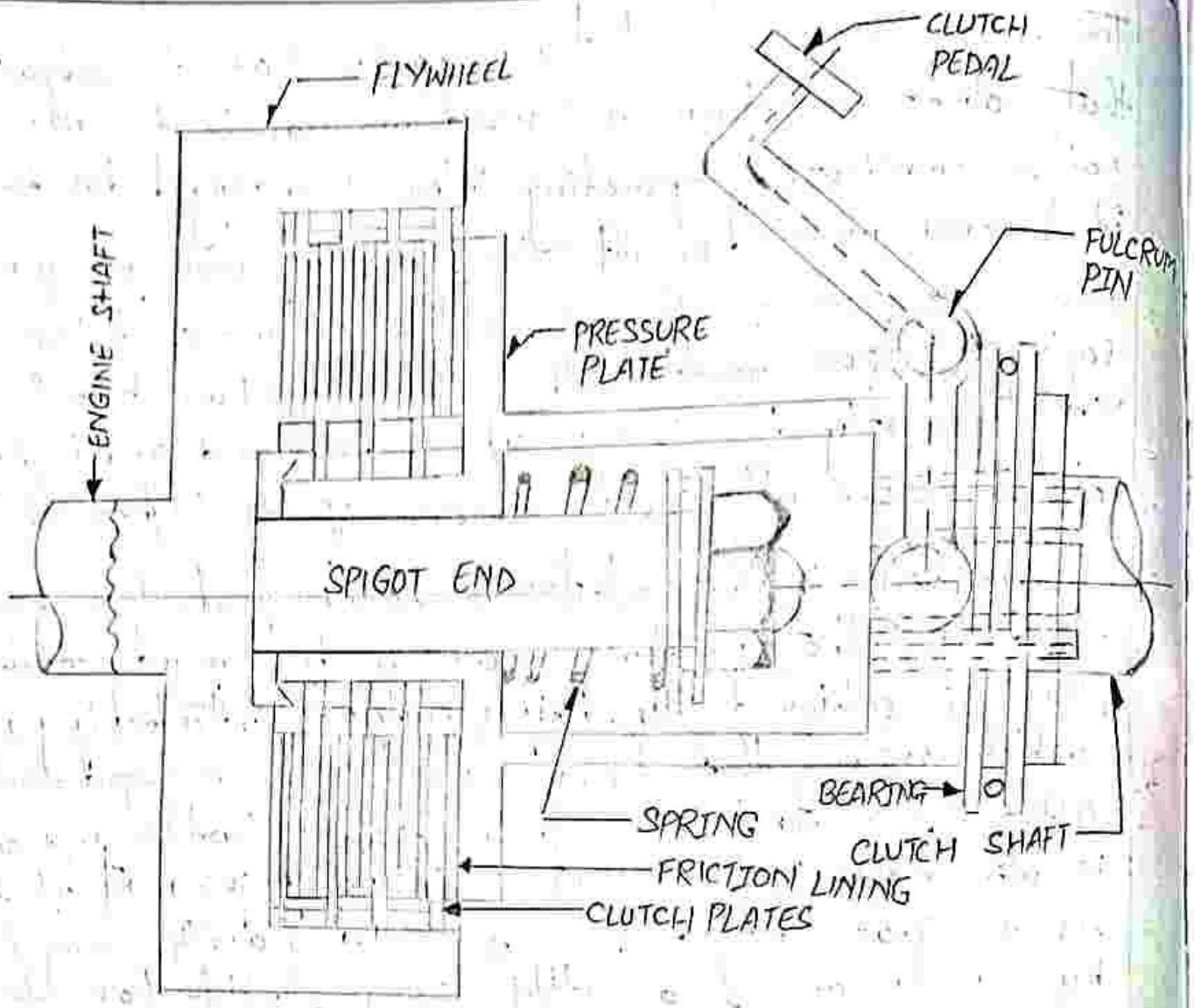
There are many mechanisms which have been used for selecting the desired gear and sliding the same to engage with the corresponding gear on the layshaft. Broadly speaking these can be divided into two categories viz. the mechanisms where the gear shift lever is mounted on the top of transmission case and the ones where the gear shift lever is mounted on the steering column. However in these two types most of the mechanism is similar and only the external linkage is different.

The former type of selector mechanism has the advantage that almost no linkage is involved whereas in the later type rather complicated operating linkage is employed due to which it becomes more difficult to feel the gear engagement. However, in case of the steering column-mounted lever, a saving of space results. Both these types have been in use. Yet currently the former type is preferred and is being almost universally used because of its higher efficiency.

Whichever is the selector mechanism used, it is ensured in the design that no two gears can be engaged simultaneously. This is achieved by using suitable interlocking mechanism which ensures that any gear can be engaged only after the neutral has been obtained. Further a provision is also made to prevent accidental engagement of the reverse gear instead of a forward gear. This may be done by means of a stiff spring which has to be overcome by applying extra force.

Mechanism with gear lever on top of transmission case.

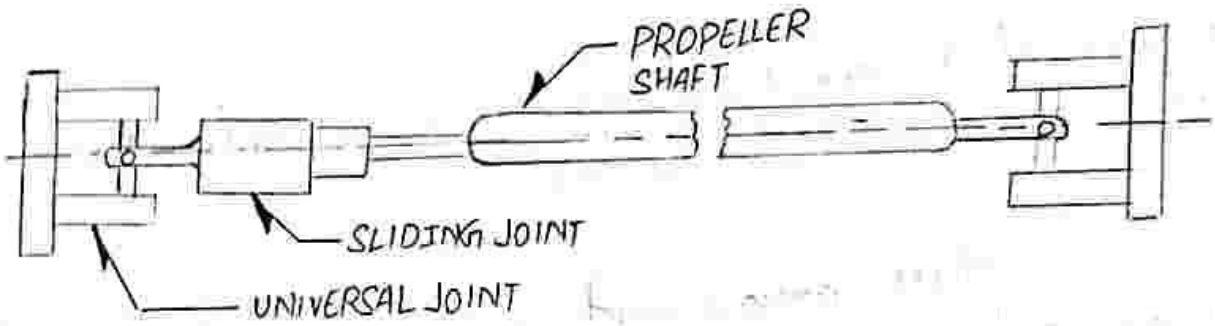
A typical mechanism for a 4-forward speeds and reverse gear box is described here. The gear lever is ball mounted in the gear box cover. This facilitates its movement in any direction. The lower end of the gear lever fits into a slot in the selector sleeve. There are forks mounted on the sleeves on three separate selector rods which are supported in the gear box casing. Each selector sleeve can slide on its rod, but just to avoid unwanted engagement of gears, slots are made on the selector rods and the sleeves are provided with spring loaded balls. These balls resist the movement of the forks until some force is applied to the gear lever to overcome their resistance. In some cases the forks are fixed on the selector rods by means of pins and the assembly can slide;



Multiplate clutch:-

The multiplate clutch is an extension of single plate type where the number of frictional and the metal plate is increased. The increase in the number of friction surface obviously increases capacity of the clutch to transmit torque, the size remaining fixed. Alternatively the overall diameter of the clutch is reduced for the same torque transmission as a single plate clutch.

This type of clutch is, therefore, used in some heavy transport vehicle and racing cars where high torque is to be transmitted. Besides, this find application in case of scooters and motor cycles, where space available is limited.



(a) Shafts:- As this has to withstand mainly torsional loads, it is usually made of tubular cross-section id also has to be well balanced to avoid whirling at high speeds. Shafts are made of steel, aluminium or composite materials.

(b) One or two universal joints:- depending upon the type of rear axle drive used. The universal joints account for the up and daon movements of the rear axle when the vehicle is running modern vehicle use, however, cardan joints or high-speed constant velocity joints, cardon joint rubber couplings with options for intermediate bearings, limited slip devices and crash features absorb energy.

(c) Slip joints:- Depending upon the type of drive, one slip joint may be there in shaft. This adjust the length of the propeller shaft when demanded by the rear axle movements a propeller shaft, with two universal joint at the ends and a slip or sliding.

Propeller shaft/Drive shaft:-

→ Drive shaft also known as propeller shaft is a component of the drive train in a vehicle, with the purpose of delivering torque from the transmission to the differential, which then transmit the torque to wheels in order to move the vehicle.

→ Drive shaft are used differently in different vehicle varying greatly in cars with distinct configuration for front wheel drive, four wheel drive and front engine rear wheel drive.

→ Other vehicle also used drive shaft like motor cycle locomotive and Marine vessels.

→ propeller shaft, sometimes called cardan shaft transmit power from the gearbox to the rear axle.

→ The two pieces arrangement is supported at the midpoint by an elastic mounted bearing.

→ Short drive shaft are incoperated for the transmission of power from the last drive assembly to the road wheels in both front and rear wheel drive layout.

Types of propeller shaft:-

1. Single pieces type:-

→ Used in vehicle with a short distance between engine and axle and best four wheel drive vehicle the friction welding adopted at the junction contribute to an improvement in the strength quality and durability of the junction.

2. Two pieces / Three pieces type:-

→ Utilized as a part of vehicle with a long distance between a engine and axle and front engine front drive base four wheel drive vehicle.

→ The division of the propeller shaft into two or three part allow the critical number of revolution to lower preventing vibration issues from occuring, when the overall length of the shaft increased.

Component of propeller Shaft:-

→ The propeller shaft transfers engine torque to the rear axle through one or more universal joints. The splines on the ends of the propeller shaft fit perfectly into the splines on the sleeve. This permits a length variation between the driving and driven unit to vary slightly without damaging and ~~it~~ input bearings.

→ The main bearing support and guide the propeller shaft.

→ The flange associate the propeller shaft to the gearbox.

Requirements of propeller Shaft:-

For achieving efficient functions the following are expected on a propeller shaft.

* High torsional Strength:- Therefore they are made of solid or hollow circular cross sectional.
* Toughened and hardened:- Therefore they are made of superior quality steel and induction hardened.
* Efficiently jointed:- Therefore they are generally welded by submerged arc Co^2 welding process.
* Dynamically balanced:- Since the phenomenum of whirling may be critical at higher Speed, therefore propeller shaft are tested on electronic balancing machine.
* Reduced thrust loads:- Since resonance is dangerous for then life of shaft. It also transmits excessive dynamic force to the shaft and support and so its occurence should be avoided.

Universal joint:-

→ It is used where two shaft are connected at an angle to transmit torque.

→ One universal joint is used to connect the transmission main shaft and the propeller shaft, other universal joint is used to connect the other end of the propeller shaft and the differential pinion shaft.

→ The universal joint permits the torque transmission not only at angle but also while this angle is changing constantly.

→ A simple U.V Joints consist of two yokes, On driving shaft and the other on the driven shaft, and a cross piece called the Spider. The four arm of spider known as trunnions are assembled into bearing in the end of two shaft yokes. The driving and the driven shaft at an angle to each other, the bearing in the yokes permit the yokes to swing around on the trunnions with each revolution.

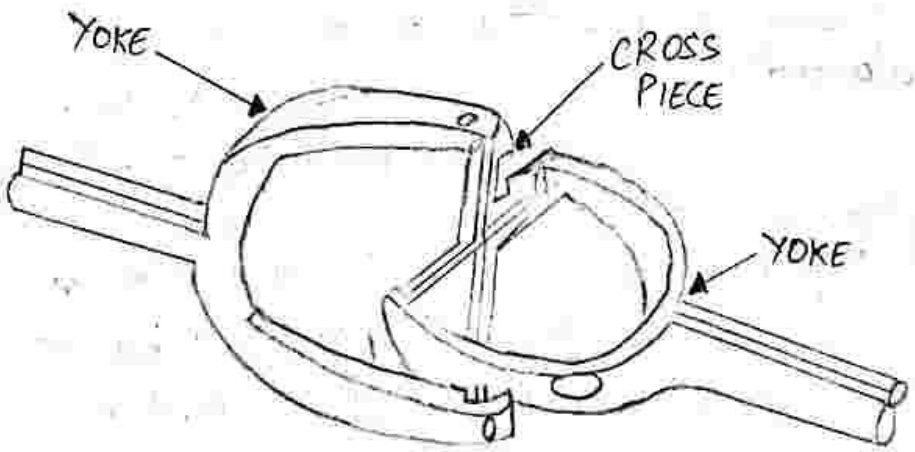


Fig:- A simple universal joint. (Cross type)

Types of universal joint:-

i) Cross type
ii) Ball and trunnion type
iii) Constant velocity

i) Cross type

→ The cross type universal joint consist of a cross piece or spider and two yokes, therefore it is known as cross type of spider and two yoke type universal joint. There are four needle bearing one for each trunnion of the spider. The bearing are held implace by rings heat droop into undercut in a yoke bearing wholes. One commerical design of the cross type U.V joints incoperates a slip joint. One yoke is integral with hub that holds the female end of the slip joint. when the joint is used between the propeller shaft and Rear axle gear shaft the slip joint is ommited. So that a direct connection is made the two joint unit.

ii) Ball and trunnion type:-

→ The ball and trunnion type U.V joints consists of a ball head fastened to the end of the propeller shaft. Through which pin is pressed to steel ball fit over the end of the pin the ball retain the roller bearing between them and U-shaped channel in the body.

The centring bottoms and the bottom spring help to keep the pin propedly centred. The universal joints and propeller shaft assembly is bolted to a companion flange with the gasket and grease cover between them. The companion flange is splined to the other shaft. The rotary motion is carried out through the pin and balls.

iii) Constant velocity:-

→ The constant velocity universal joint consist of two individual joints linked by a ball and socket. The ball and socket splits the end of the two propeller shafts between the two universal joints. The type of joint permits uniform motion. Because the two joints are operating at the same angles, the acceleration resulting at any instant from the action of one universal joint is cancelled out by the deceleration of the other and vice versa.

Differential:-

→ When the car is taking turn the outer wheels will have to travel greater distance as compared to the inner wheels in the same time. In order to reduce the speed of the inner wheels and increase the speed of the outer wheels when taking turns differential serves the function.

* It helps to avoid wheel.
* Skidding - It should at the same time keep the speed of wheels same when going straight.
* It helps in distribution of power from the propeller shaft to the wheel.

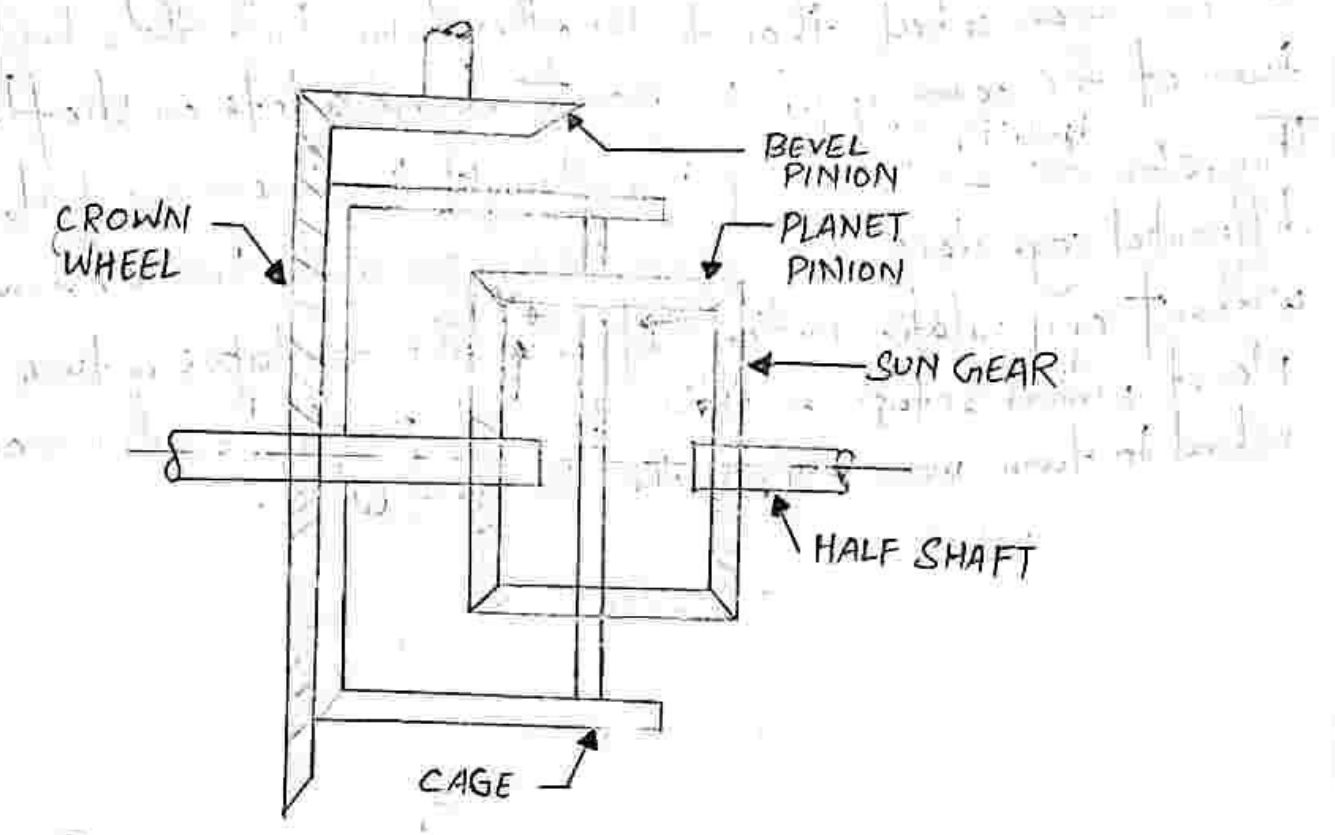
There are four types of differential?

1. Open differential:- It splits the engine torque into two outputs and allows the wheels to rotate at different speeds. In its working when one to loses tractor, the opposing will also lose power.

2. Locking differential:- In this type, connected wheels rotate at the same speed, which make turning very difficult for any vehicle. It is often seen on jeep wrangler and most full size trucks.

3. Limited slip differential:- Combines both open and locking differentials. Used on sport vehicle. It usually act as the open differential but locks automatically while slipping occurs.

4. Torque vectoring differential: It uses an additional gear train. It fine tunes the torque delivered to each drive wheel. Slowing down or quickens the cars rotation around a corner can be easier.



The sun gears are mounted on the inner end of each rear axle (called the half shaft). A differential cage is assembled on the left axle. A ring gear is attached to the case, so that the cage rotates with the crown gear. The crown gear is driven by the bevel pinion. Both the crown wheel and cage are free on the left rear axle. The cage supports two planet pinion (called the differential pinion gears) on a shaft which mesh with the

two sun gears. Thus, when the differential cage is rotated, both the sun gear rotate and thus both wheels turn which are attached to the outer end of the rear axles. Now let us suppose that one wheel is held stationary. Then when the differential cage is rotated, the planet gears will also rotate as they run around on the stationary axle sun gear. While rotating in this manner, the planet pinions carry rotary motion to the other axle sun gear, causing it, and the wheel too, to rotate. Therefore, when one rear wheel turns more rapidly than the other, while the car is taking a turn, the planet gear's pin on its shaft transmitting more rotary motion to one rear wheel than to the other. When both the wheels turn at the same speed the planet do not rotate on shaft. Thus, when the car is running in a straight line, the crown wheel, differential cage, planet pinions and the sun gears all turn as a unit without any relative motion. But when the car takes a turn, the planet pinions rotate on their shaft to permit the outer rear wheel to turn more rapidly than the inner wheel.

Rear Axle:-

→ It is used to transmit power from the differential to driving wheels.

→ Almost all rear axle on modern passenger car a live axle. That is they revolve with the wheel. Dead axle simply remain stationary, do not move with the wheel.

Types of Rear Axle:

Depending upon the method of supporting the rear axle and mounting the rear wheel.

The rear axle are three types:

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

Semi-floating axle:-

→ An axle in which the shaft has to take all the loads is called Semi or Non-floating axle

Full-floating axle:-

→ The one in which only driving toque is taken by the axle shaft is called full-floating axle.

→ It is a comparmise between the more robust full-floating type and the simplest semi-floating type.

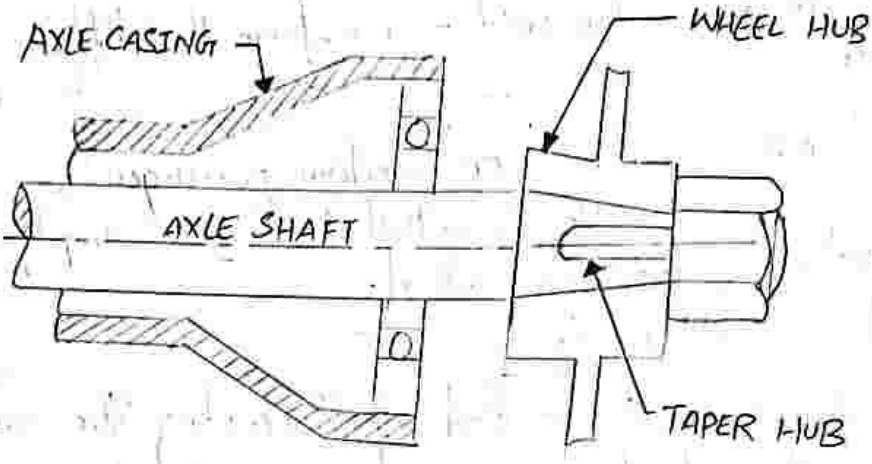


Fig- Semi-floating axle

→ 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, whereas outer end is supported by a single bearing inside the axle casing. In this all the loads are taken by the axle shaft (Shearing forces due to vehicle weight, Driving torque, Bending movement caused by the end thrust and its reaction offer by the tyres on the ground, end thrust caused by the side forces on account of cornering side wind etc. The vehicle load is transmitted to each of the half shaft through the casing and bearing. This causes a bending load and tendency to shear at a point Besides the sides forces also caused end thrust and bending moment in the axle shaft, which have to take driving torque also. It is simplest and cheapest of all type. Because of which it is widely used on cars. Since the axle shaft have to support all load they have to be of larger diameter For the same torque transmitted compact to other type of supporting.

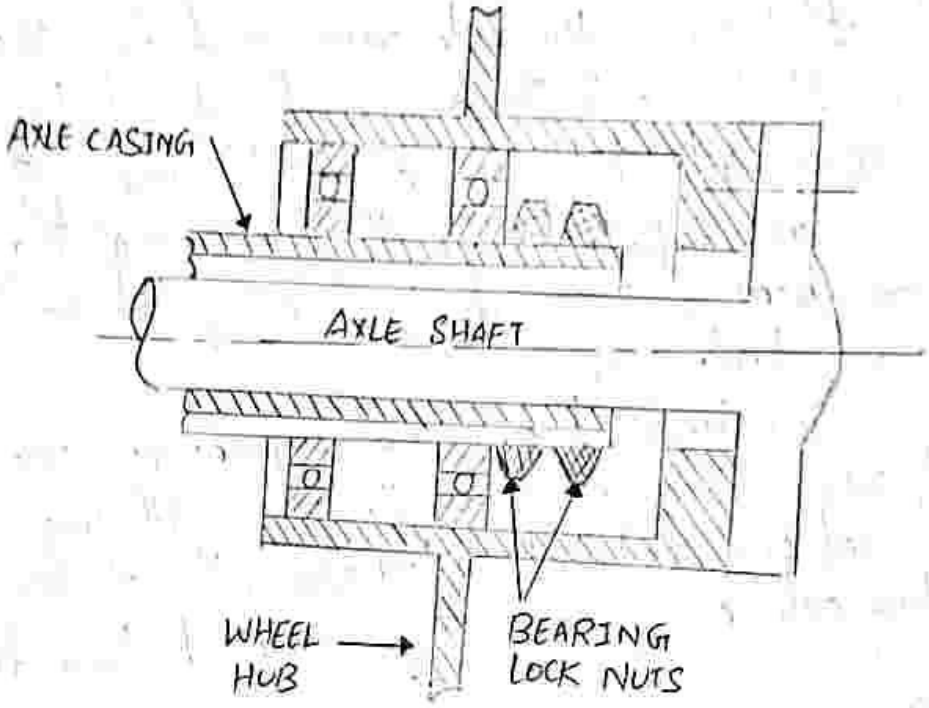
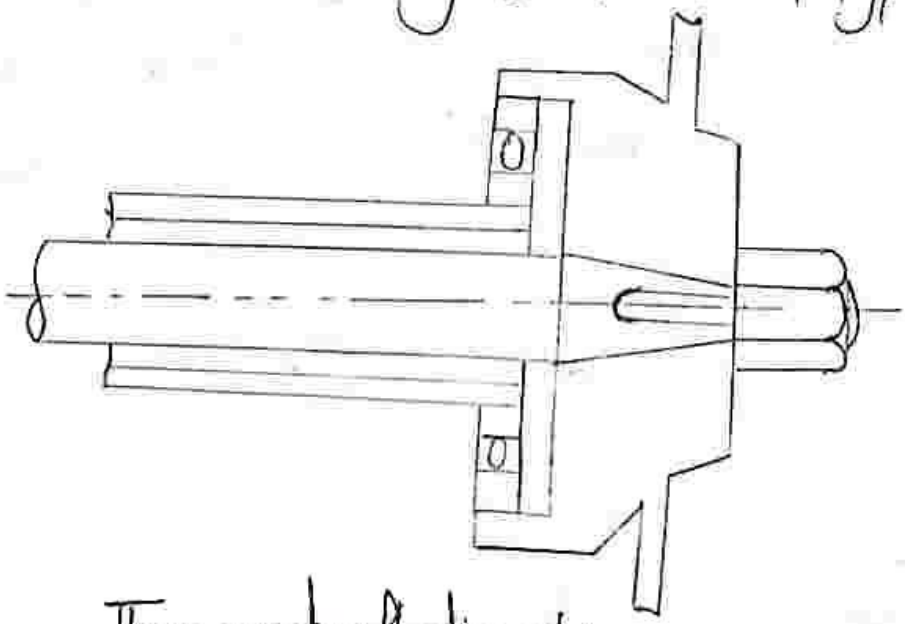


Fig - Full floating axle:-

→ This type is robust one end is used for heavy vehicle. The axle shaft have flange at the outer ends, which are connected to the flange sleeve by means of bolts there are two taper roller bearing supporting the axle casing in the hub which take up any side load thus in this the axle shaft carry only the driving torque. The weight of the vehicle at the end thrust are not carried by them, the weight being completely supported by the wheel and the axle casing. It is costliest type.



Three quarter floating axle:-

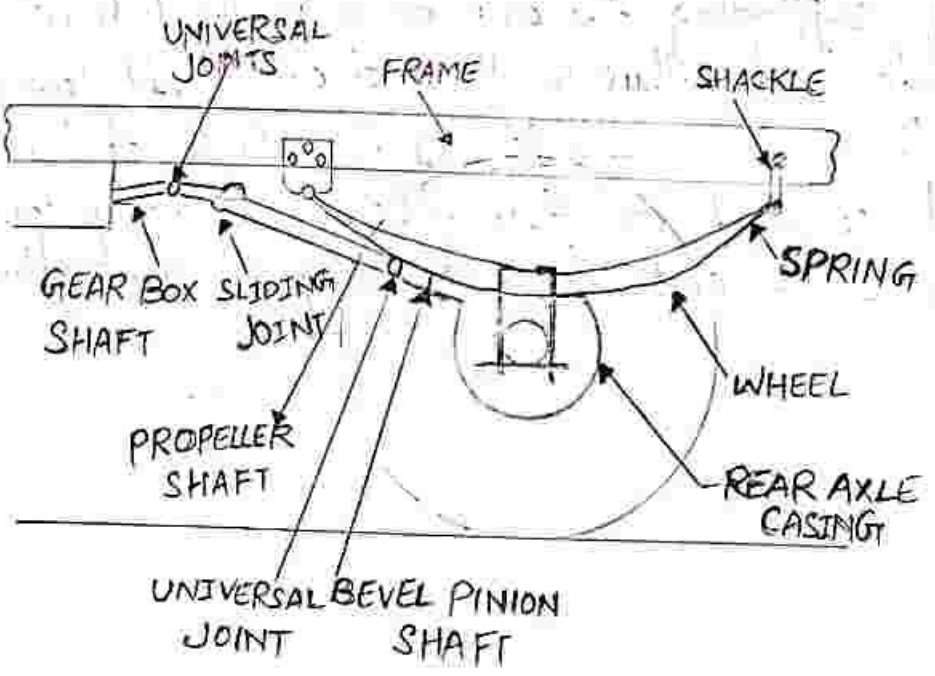
In this bearing is located between the axle casing and the hub instead of between the axle casing and the shaft as in case of semi-floating axle. The axle shaft do not have to with stand any shearing and bending action due to weight of the vehicle which are taken up by the axle casing through the hub and the bearing, provided the bearing lies in the plane of the roadwheel.

This type of axle was popular for car and light commercial vehicles at one time however with improvement in design material and fabrication technique, the cheaper and simple semi-floating axle are again being preffered these days.

Rear Axle Drive:-

→ In all the drive employed for the rear axle the spring take the weight of the body Two important drive are:-

i) Hotch kiss drive
ii) Torque tube drive



i) Hotchkiss drives-

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

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

→ The propeller shaft is provided with two U.V joint and Sliding joint.

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

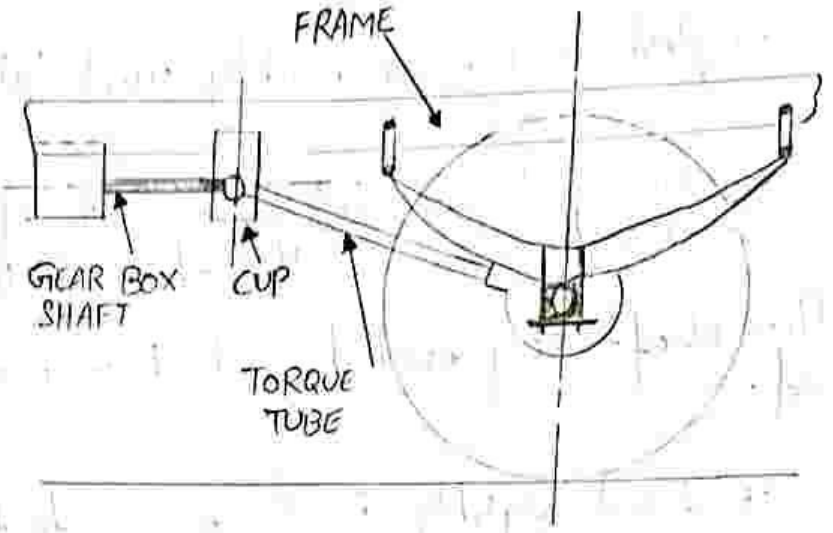
→ The front end of the spring is fixed rigidly on the frame while the rear end is supported in a shackle.

→ The driving thrust is transmitted to the frame by the front half of the spring.

→ The torque reaction is taken up by the spring.

Thus torque reaction is taken up by the spring. To take up breaking torque the spring would deflect in opposite direction. when the spring deflect the driven pinion shaft also changes it position. Therefore if there is only one U.V joints at the front end of the propeller shaft it will bend under this condition.

→ To avoid this another U.V Joints at the rear end of the propeller shaft.



iii) Torque Tube drive:-

→ In this type of drive the spring takes only the side thrust beside supporting the body weight.

→ The torque reaction, breaking torque and the driving thrust are taken by another member called the torque ~~to~~ tube.

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