GEAR BOX

Necessity and function:

Cars need transmissions because of the physics of the gasoline engine. First, any engine has a maximum rpm value above which the engine cannot run. Second, the engines have narrow rpm ranges where horsepower and torque are at their maximum. For example, an engine might produce its maximum horsepower at 5,500 rpm. The transmission allows the gear ratio between the engine and the drive wheels to change as the vehicle speeds up and slows down. The gears can be shifted so the engine can stay below the limit and near the rpm band of its best performance.

The transmission is connected to the engine through the clutch. The input shaft of the transmission therefore turns at the same rpm as the engine. A five-speed transmission applies one of five different gear ratios to the input shaft to produce a different rpm value at the output shaft. Here are some typical gear ratios:

To start the motor vehicles from rest, the inertia of its whole weight has to be over come. A high percentage of maximum engine power is required for this. Steam engines can develop maximum power at low speeds, whereas the IC engines cannot develop maximum power at low speeds. This makes it difficult to transmit the power from the engine directly to road wheels. IC engines has to work fairly faster to develop maximum power and torque hence the standard vehicles are provided with 4 to 5 speed gear ratios between the engine and road wheels. In low gears the crankshaft revolves at about12 to 18 times without the wheel revolution which permits the engine to operate at fairly high speeds. The torque available at wheels depends upon the tractive resistance (sum of road, gears and gradient resistance). Thus resistance varies with load, sped and gradient and the vehicle for a given vehicle the torque has to be varied as per the requirement of the vehicle. This can be achieved with the help of gear box.

Functions of gear box:

1. To provide variation in speed and torque as per the requirement and thereby providing mechanical advantage.
2. To provide neutral condition for the vehicle to disengage the transmission from gear to remaining parts of transmission.
3. To provide reverse movement of vehicle without changing the direction of rotation of crankshaft.

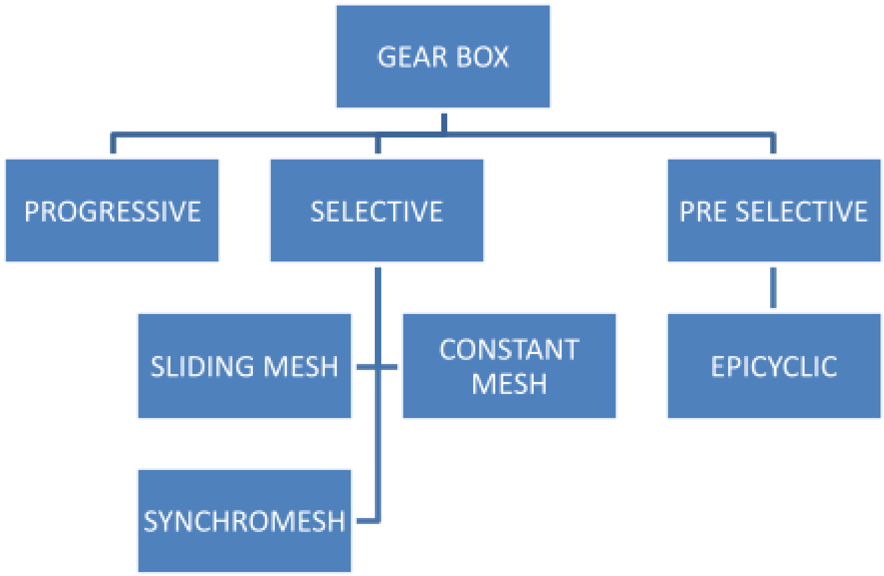
Types of Transmission and Gear Box

Based on the operation of the gear selection transmission can be classified as

1. Manual operated
2. Semi-automatic

3. Fully-automatic transmission

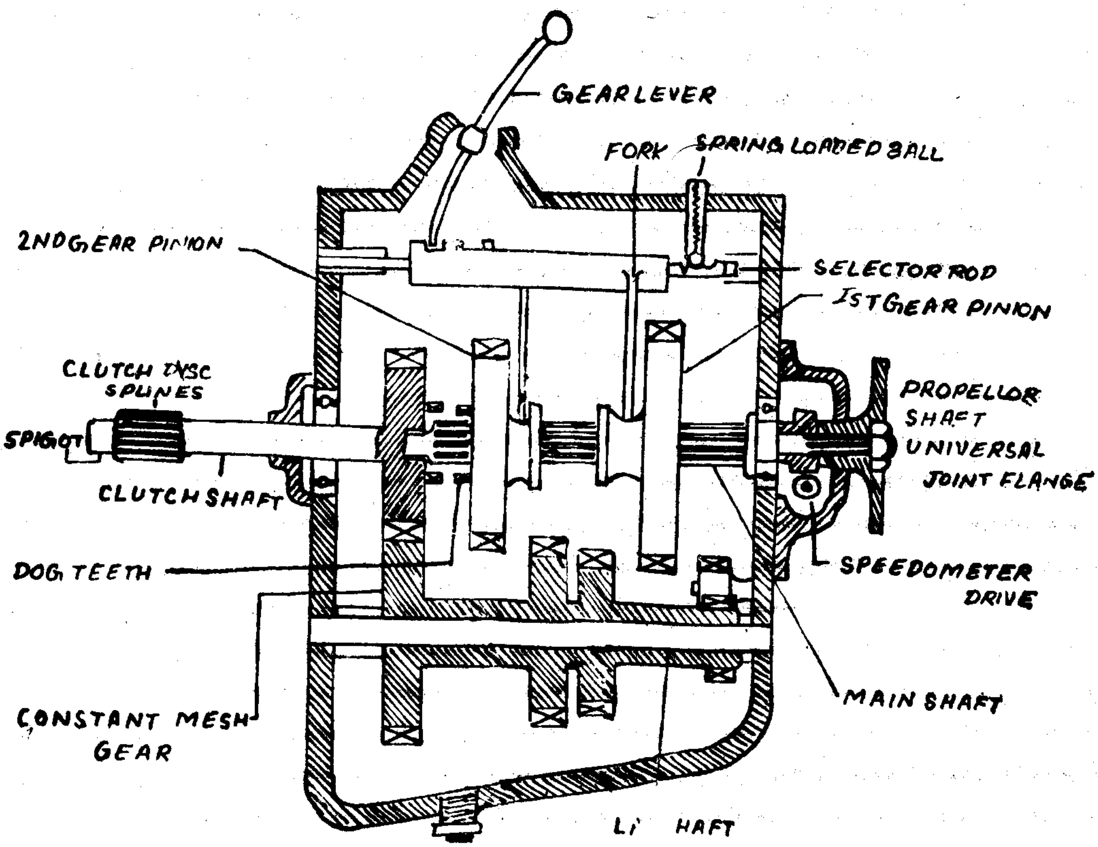
The different types of gear boxes used in automobiles can be classified as follows



Selective transmission is that transmission which any speed ratio can be selected from neutral. In this type neutral position has to be obtained before selection of any forward or reverse positions. It is commonly used in most of the CMV'S and HMV'S. The gearboxes used in such transmission are commonly constant mesh or synchromesh type. In progressive transmission the gears can be shifted from a particular speed to next speed in sequence without selecting neutral. It is most commonly used in two and three wheelers. Usually constant mesh gear boxes are used in such transmission.

Pre-selective mechanisms are used in semi or fully automatic transmission system. In this the gears are selected based on pre-selected program or based on the speed conditions and load conditions.

Sliding Mesh Gear Box:



It is the oldest and simplest form of gear box. In order to mesh gears on the splined main shaft with appropriate gears on the lay shaft for obtaining different speeds, they are moved to the right or left. It derives its name from the fact that the meshing of the gears takes place by sliding of gears on each other.

A three speed sliding mesh gear-box is shown in Figure. Splines are provided on the main shaft. For meshing the pinions with the matching gears on the layshaft, the pinions are slided along the spline. When the main shaft is driven from the layshaft the gear reduction is provided by the first pair of gears which are always in mesh. They are usually known as constant mesh gears. For changing gear the clutch is depressed and the gear lever is moved till the selector pinion on the main shaft engages with its mating gear on the layshaft. The drive from the engine will be again transmitted through the gear-box when the clutch is released. To obtain three forward speeds, reverse and neutral, the relative position of the gears will be as below:

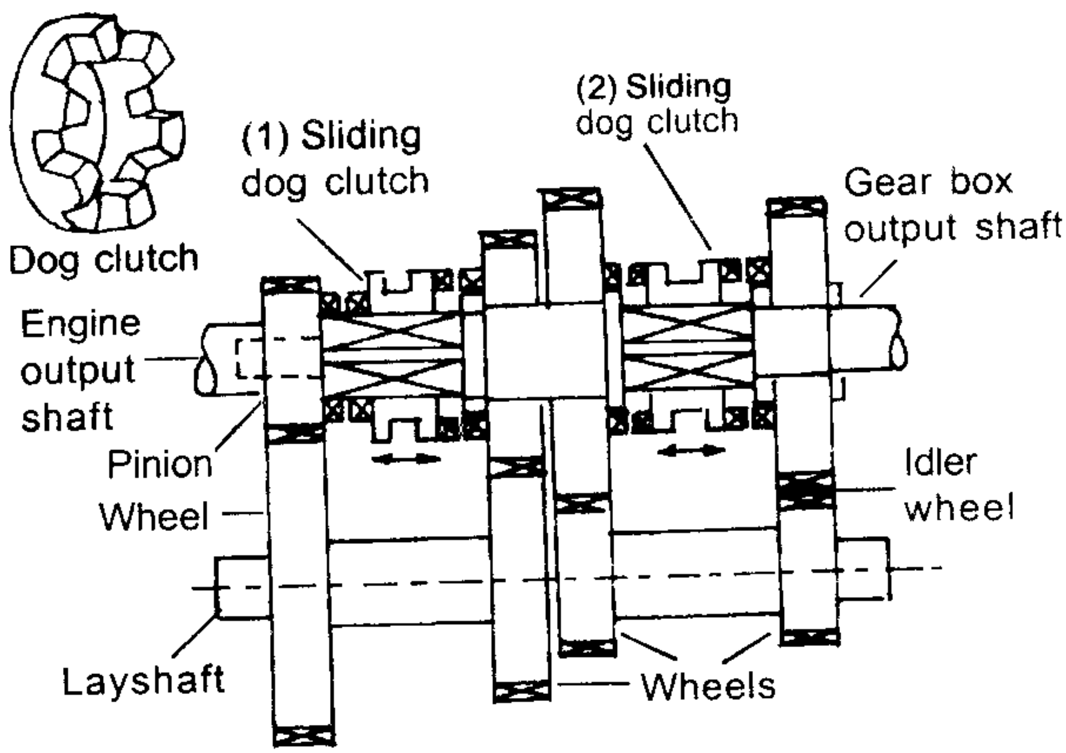
First gear: The largest gear on the main shaft is driven by the smallest gear or pinion on the layshaft. With corresponding increase torque, the speed reduction is quite high. When climbing and moving off steep hill, starting the vehicle from rest this gear is usually used.

Second gear: In this gear, there is less speed reduction and smaller torque increase.

Third or top gear: In order to revolve primary or main shaft at the same speed without any charge in the torque the main shaft is driven through a dog clutch in this gear.

Reverse: In this gear, the peed reduction is usually same as that in the first gear. But the direction of rotation of the main shaft will be reversed by introducing an idler in it. It is due to this change in the direction of rotation of the driving wheels provided by the idler that the motor vehicle moves in reverse direction.

Constant Mesh Gear Box:



In this type all the gears are always in mesh and the engagement between the gears which are freely rotating on the transmission main shaft and the transmission main shaft is effected by moving the dog clutches, as explained below.

The engine gear box shaft is integral with a pinion. The pinion meshes with a wheel on the layshaft. The layshaft is therefore driven by the engine shaft. Three more wheels are fixed to the layshaft as in the sliding mesh gearbox. These gears rotate with the layshaft. The transmission main shaft is just above the layshaft and in line with the engine shaft. The three gears (first gear, second gear and reverse gear) on the main shaft are perfectly free to turn on the main shaft. These three gears are in constant mesh with the three wheels on the layshaft. One of these three gears meshes with a wheel on the layshaft through an idler wheel which is mounted and freely rotating on a pin fixed to the gearbox casing. The three main shaft gears are, therefore constantly driven by the engine shaft, but at different speeds. The first gear and the second gear rotate in the same direction as the engine shaft while the reverse gear rotates in the opposite direction to the engine shaft.

If anyone of the gears on/the mainshaft is coupled up to the main shaft, then there will be a driving connection between the main shaft and the engine shaft. The coupling is affected by the dog clutch units. The dog clutch members are carried on splined (or squared) portions of the mainshaft. They are free to slide on those squared portions, but have to revolve with the shaft.

If one of the dog clutch members (l) is slid to the left it will couple the wheel (first gear) to the main shaft giving the first gear. The drive is then through the wheels and this dog clutch member. The other dog clutch is meanwhile in its neutral position.

If, with the above dog clutch member in its neutral position, the other dog clutch member (2) is slid to the right, it will couple the wheel (second gear) to the mainshaft and give second gear. If this dog clutch member is slid to the left, it will couple the mainshaft directly to the pinion fixed to the engine shaft. This will give a direct drive, as in the sliding mesh gear box.

The reverse gear is engaged by sliding the dog clutch member (which gives the first gear) to the right. Then it will couple the wheel (reverse gear) to the mainshaft. The drive is then through the wheels, the idler and the dog clutch member.

In the constant mesh gear box, the gears on the mainshaft must be free to revolve. For this, they are either be bushed or be carried on ball or roller or needle bearings.

The main advantages of the constant mesh gear box over the sliding mesh type are as follows:

1. Helical or double helical gear teeth can be used for the gears instead of spur gears. Then gearing is quieter.
2. Synchronizing devices can be used for smooth engagement.
3. Any damage that results from faulty manipulation occurs to the dog clutch teeth and not to the teeth of the gear wheels.
4. Once the dog clutches are engaged, there is no motion between their teeth. But when gear teeth are engaged, the power is transmitted through the sliding action of the teeth of one wheel on those of the other. The teeth have to be suitably shaped to transmit the motion properly.
5. If the teeth on the wheel are damaged, the motion will be imperfect and noise will result.
6. Damage is less likely to occur to the teeth of the dog clutches, since all the teeth engage at once, whereas in sliding a pair of gears into mesh the engagement is between two or three teeth.

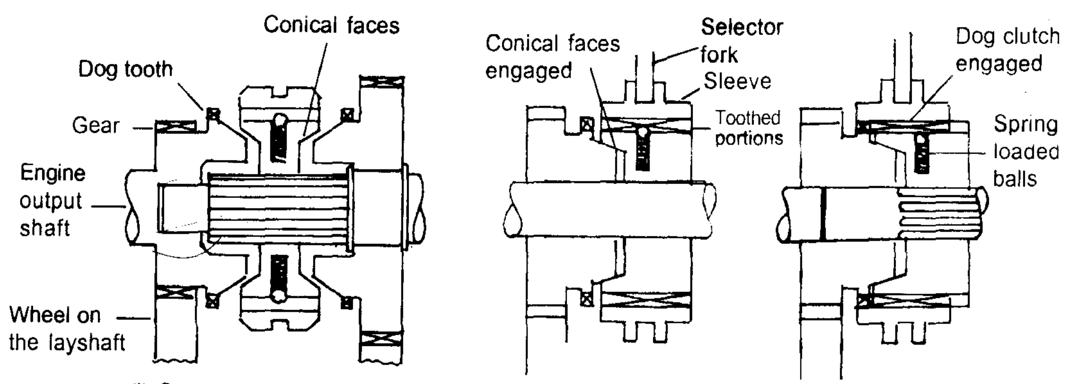
Double Declutching

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

The clutch is disengaged and the gear is brought to neutral. Then the clutch is engaged and accelerator pedal pressed to increase the speed of the main shaft gears. After this the clutch is again disengaged and the gear moved to the required lower gear and the clutch is again engaged. As the clutch is disengaged twice in this process, it is called double declutching.

For changing to higher gear, however, reverse effect is desired i.e., the driver has to wait with the gear in neutral till the main shaft speed is decreased sufficiently for a smooth engagement of the gear.

SYNCHROMESH GEAR BOX:



(i) Synchromesh disengaged (ii) Conical syncromesh faces mate (iii) Teeth of sleeve engaging dog teeth

It is an automatic means for matching the speeds of engaging dogs. It is a device which facilitates the coupling of two shafts rotating at different speeds. This unit is used in most of modern gear boxes. In this type of gear box sliding dog clutches are replaced by synchromesh device. The synchromesh devices are used to simplify the operation of changing gear. This device helps unskilled drivers to change gears without the occurrence of clashes and damages.

By this device, the members which ultimately are to be engaged positively are first brought into frictional contact and then when the friction has equalized their speeds, the positive connection is made.

The basic requirements of synchromesh device are:

(1) A braking device such as cone clutch.

(2) To permit easy meshing means of releasing pressure on the clutch before engagement of gears.

The engine shaft carries a pinion which meshes with a wheel fixed to the layshaft, while the gear on the mainshaft is free to rotate and is permanently meshed with another wheel fixed to the layshaft. Both the pinion and the wheel on the mainshaft have integral dog tooth portions and conical portions. The synchronizing drum is free to slide on splines on the mainshaft. This drum has conical portions to correspond with the conical portions on the gearbox shaft pinion and on the wheel that rotates freely on the mainshaft. The synchronizing drum carries a sliding sleeve. In the neutral position, the sliding sleeve is held in place by the spring loaded balls which rest in the dents in the sliding sleeve (or ring gear). There are usually six of these balls.

In changing gear, the gear lever is brought to the neutral position in the ordinary way, but is immediately pressed in the direction it has to go to engage the required gear. When a shift starts, the spring loaded balls cause the synchronizing drum and sliding sleeve, as an assembly to move toward the selected gear. The first contact is between the synchronizing cones on the selected gear and the drum. This contact brings the two into synchronization. Both rotate at the same speed. When the speeds of the two have become equal, a slightly greater pressure on the gear lever overcomes the resistance of the balls. Further movement of the shift fork forces the sliding sleeve on toward the selected gear. The internal splines on the sliding sleeve i.e. the dog portion, match the external splines on the selected gear the dog teeth are locked up, or engaged, and thus positive connection is established. The gear shift is completed.

PROGRESSIVE TYPE GEARBOX:

Usually these gear boxes are used in motor cycles. In these gearboxes the gears pass through the intervening speeds while shifting from one speed to another. There is a neutral position between any two positions as shown below in the case of a four speed gearbox:—

4	3	2	NE UT RA L	1

These gearboxes are a combination of sliding and constant mesh gearboxes. The various gear speeds are obtained by sliding the dog clutch or gear to the required position.

SELECTIVE GEAR BOX:

A selective or progressive type gearbox usually contains the following shafts which carry the gears:—

(i) Primary shaft,

(ii) Main shaft,

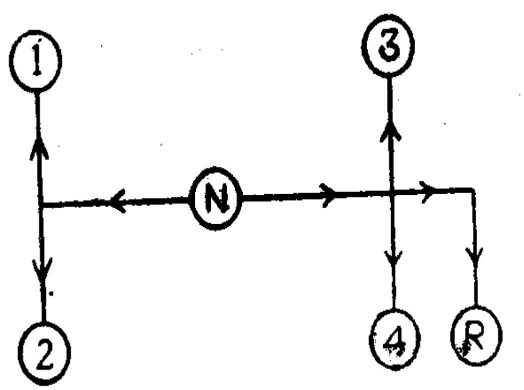
(iii) Lay or counter shaft,

(iv) Idler shaft.

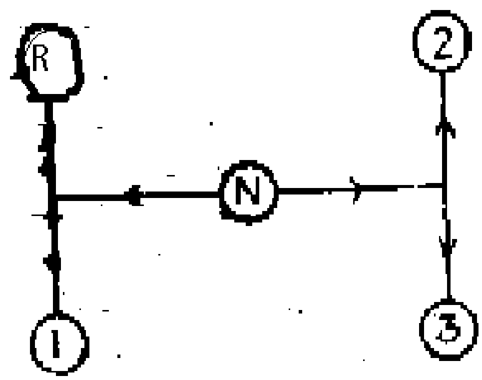
The primary and main shafts are in one line and the lay shaft runs parallel below them. In progressive type gearbox, the primary shaft usually passes through the main shaft. The shafts are supported in the housing through plain, ball and roller bearings. The primary and main shafts are projecting outside the gearbox. The primary shaft is known as clutch shaft and carries clutch plate when the transmission is installed with the engine. The main shaft contains a coupling at its outer end for connection with the propeller shaft.

The idler shaft is placed to one side of layshaft and carries idler gears to obtain reverse speed. The main shaft is splined over which the gears, dog clutch or synchronizing unit slide endwise. In sliding mesh gearboxes, the layshaft is a simple shaft which carries a fixed train of gears having different number of teeth. In progressive type gearbox, the layshaft is usually pegged or splined over which gears or dog move endwise.

The gears used in transmission are spur, helical or herringbone. The spur gears have straight teeth whereas helical gears contain inclined or helical teeth. The teeth on herringbone gears form the shape of V. Spur gears are employed in sliding mesh gearboxes whereas helical and herringbone gears are employed where the gears are to remain in constant mesh. The latter two types of gears are usually used in constant and synchromesh gear- boxes.



Gear change position on a 4 speed gearbox.



GEAR POSITIONS FOR THREE SPEED GEAR BOX

The selective mechanism is employed to obtain various gear speeds. It consists of shafts, forks and balls and springs. The shafts carry the forks to operate or slide gears, dog clutches or synchronizing units. Balls and springs lock the position of forks or shafts as the case may be. In some cases the forks are fixed with the shafts and move as one assembly. In other cases, the shafts are fixed and the forks slide over them.

The selective mechanism is operated through the gear change lever which is either directly mounted at the gearbox or is a remote control by the side of steering column. The path of gear lever travel is usually like the letter H in selective type gearboxes. Reverse speed is obtained by shifting the lever to the right or left on neutral line beyond the legs of H, and then moving it up or down.

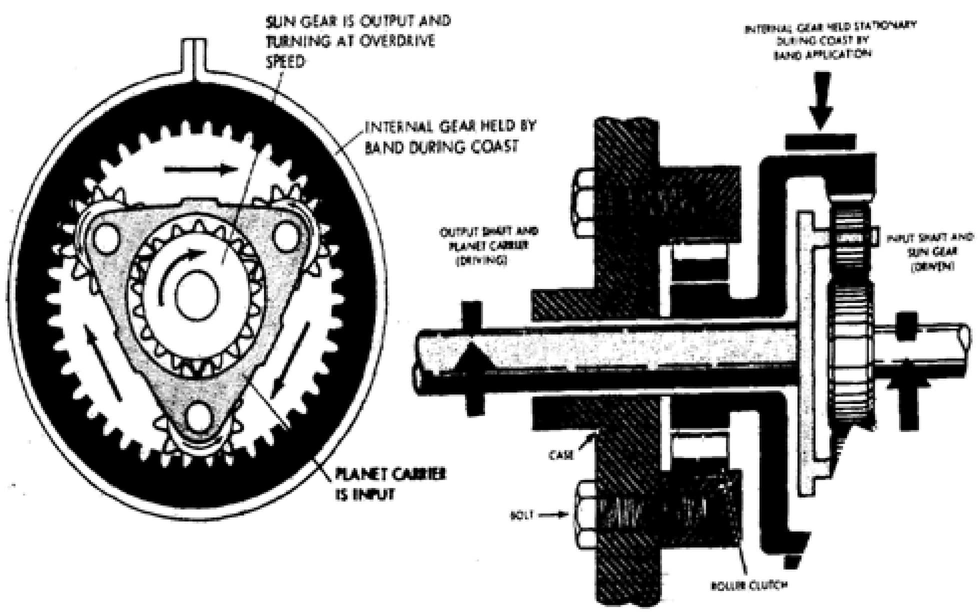
The power flows from the primary shaft to the layshaft and then through the set gear train to the output coupling of main shaft. In direct drive, the main shaft is clutched with the primary shaft and the power flows direct from primary to main shaft. In a three speed gearbox, the power flows through different gear trains during different speeds as shown in the diagrams. A set gear train provides one speed which could be calculated as below

Gear Ratio = Product of No of teeth on driven gears / Product of No. of teeth on driving gears

PLANETARY GEAR ASSEMBLY OR EPICYCLIC GEARBOX AND OPERATION

The heart of the automatic transmission is the planetary gear system. It is essential therefore to review the basic construction of a simple planetary gearset as an introduction to how planetary gears operate. A simple planetary gearset consists of a sun gear or center gear that is surrounded and in constant mesh with the planet pinion gears. The pinion gears are mounted and free to rotate on their support shafts, which are pinned to a planetary pinion carrier. The internal gear also referred to as the ring or annulus gear is in constant mesh with the planetary pinions and surrounds the entire assembly. It should be noted that the sun gear, planet carrier, and internal gear rotate on a common center, while the planet pinion gears rotate on their own independent centers. For clarification, the planet pinion gears are considered to be part of the planet carrier.

SIMPLE PLANETARY GEARSET:



An assembly of gears in constant mesh consisting of a sun gear, several pinion gears mounted in a carrier, and a ring gear. It provides gear ratio and direction changes, in addition to a direct drive and a neutral.

The planetary gearset gets its name from the action of the planet pinion gears. As we will see later, these gears have the ability to turn on their own centers and, at the same time, revolve around the sun gear. This is similar to the earth turning on its axis and rotating around the sun.

LAWS OF PLANETARY GEAR OPERATION

The operation of a planetary gear train is governed by five basic laws that provide the key to understanding the various gearing power flows in all automatic transmissions, regardless of differences in planetary systems: the laws of neutral, reduction, overdrive, direct drive, and reverse. Study them carefully, one at a time. Several rules govern planetary member rotation that will assist you in understanding the power flow in each of the planetary operating modes

• When the internal gear and carrier pinions are free to rotate at the same time, the pinions always follow the same direction as the internal gear.

• The sun gear always rotates opposite carrier pinion gear rotation.

• When the planet carrier is the output, it always follows the direction of the input gear member always follows

• When the planet carrier is the input, the output gear carrier direction.

Law of Neutral

When there is an input but no reaction member, the condition is neutral. The sun gear serves as the driving input member, and the internal gear is free to rotate because it is not grounded to any part of the transmission. The planet carrier is held stationary by the weight of the car on the rear wheels. This causes the planet pinion gears to rotate on their pins, and drive the internal gear opposite the sun gear or input direction.

Reaction member: The stationary planetary member, in. a- planetary gearset, that is grounded to the transmission case through the use of friction and wedging devices known as bands, disc clutches, and one-way clutches.

In many automatic transmissions, neutral-may be achieved-by, another method. In these units, the input shaft is declutched from the gearset. Whether or not another gearset member is held stationary, the result is neutral.

Law of Reduction

When there is a reaction member and the *planet carrier is the output*, the condition is gear reduction. There are two reduction possibilities that meet the requirements of the law of reduction. This is achieved by using a brake or friction band to around a rotating drum and ground it to the transmission case. Either the internal gear or sun gear attached to the drum becomes the stationary or reactionary member. The band is applied by a servo unit that is nothing more than a bore in the case containing an apply piston-and-pin- assembly. Hydraulic force is changed to a mechanical force.

Band: A flexible ring of steel with an inner lining of friction material. When tightened around the outside of a drum, a planetary member is held stationary to the transmission case.

In the first method of reduction the input sun gear driving the pinion gears on their pins opposite the input direction. Because the pinion gears cannot move the stationary internal gear, a reaction force is created between the two gears that cause the pinions to push off the internal gear teeth and walk around the internal gear as they rotate on their centers. This moves the carrier in a forward direction at a reduced speed.

The second reduction method is set up with the sun gear stationary and power input applied to the internal gear. The planet pinions now rotate on their centers, push off the stationary sun gear, and walk around the sun gear to produce another forward reduction effect on the carrier. This planetary gear reduction is widely used for second-gear operation ii many automatic transmissions. When comparing the two reduction possibilities, note that driving the sun gear and holding the internal gear give the deepest reduction.

Law of Overdrive

When there is a reaction member and the *planetary carrier is the input*, the condition is overdrive. Because overdrive gives the opposite effect of gear reduction, the planet carrier serves as the input rather than the output member, with either the sun gear or the internal gear held stationary. It should be noted that even with the planet carrier as the power input, the pinions are still free to rotate on their centers and walk as they push off and react to the fixed planetary member. This time, the turning and walking action moves the output member at an increased speed and reduced torque.

Overdrive produces the opposite effect of a gear reduction. Torque is reduced, and speed is increased by the factor of the gear ratio. Regardless of differences in planetary systems, always

look for the planet carrier as the input to achieve overdrive. The usual setup for automatic overdrive uses the stationary sun gear with the internal gear as the output.

Overdrive planetary outputs for automatic transmissions were avoided and deemed not cost effective or necessary at one time, but unpredictable fuel costs and government mileage and emission standards influenced the introduction of a wide variety of four-speed overdrives in the late 1970s and early 1980s, for both rear-wheel and front-wheel drive systems, by domestic and import car manufacturers. It is common to find a three- speed automatic transmission integrated with an overdrive planetary to achieve fourth gear. The overdrive planetary is either at the input or output end of the three-speed system.

Law of Direct Drive

Direct drive is obtained by clutching or *locking any two members* of the gearset together. Driving any two members at the same relative speed and in the same direction gives the same effect.

Direct drive: The gear ratio is 1:1, with no change occurring in the torque and speed input/output relationship. The usual practice in direct drive is to use multiple-disc clutches to lock two members of a planetary gearset to the input shaft. Apply and releases of the clutches are controlled by the transmission valve body.

Law of Reverse

When the *planet carrier is held* against rotation with either the sun gear or internal gear driving, the result is reverse. The sun gear input gives a reverse reduction, while an internal gear input gives a reverse overdrive. With the planet carrier held by a band application, the sun gear input rotation is reversed by the carrier pinion gears acting as reverse idlers. The counterclockwise pinion rotation drives the internal gear and output shaft at a reverse reduction. In place of a band, the transmission design can incorporate a multiple- disc clutch to ground the carrier to the transmission case. Since the carrier is stationary, the pinion gears act as reverse idlers only and have no effect on the gear ratio.

Advantages of planetary gear box

1. All members of the planetary gearset share a common axis, which results in a structure of compact size.

2. Planetary gears are always in fill and constant-mesh, eliminating the possibility of gear tooth damage from gear clash or partial engagement. The full and constant mesh feature also permits automatic and quick gear ratio changes without power flow interruption.

3. Planetary gears are strong and sturdy and can handle larger torque loads, for their compact size, in comparison to other gear combinations in manual transmissions. This is be cause the

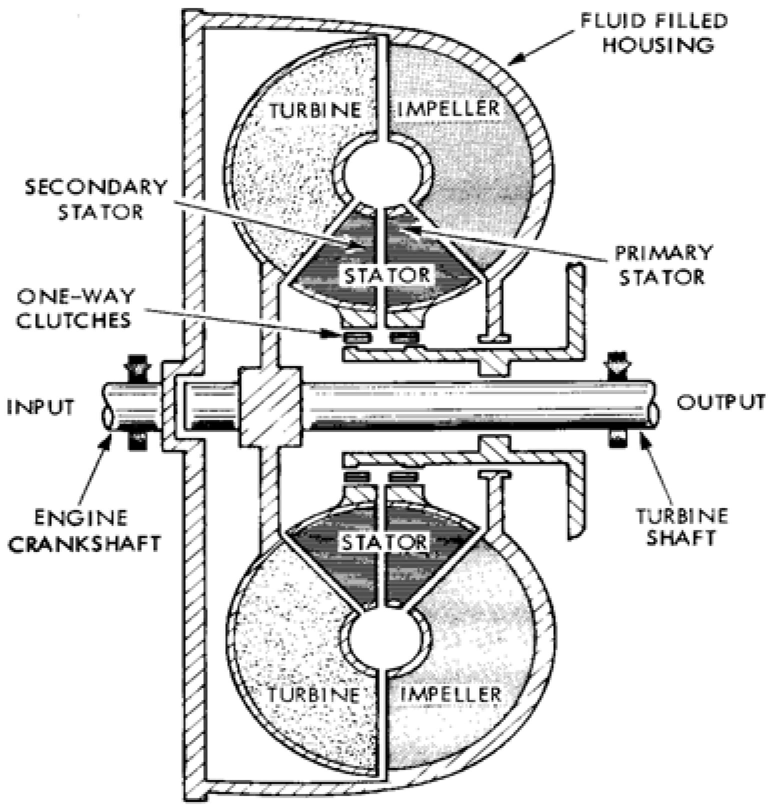
torque load as it passes through the planetary set is distributed over the several planet pinion gears, which in effect allows more tooth contact area to handle the power transmission.

4. The location of the planetary members makes it relatively easy to hold the members or lock them together for ratio changes.

TOROHE CONVERTER

Function and construction

The torque converter is modified form of fluid flywheel. Fluid flywheel is used for the transmission of power, whereas torque converters are used to transmit the power with varied torque as per the requirement. In addition the driving member (impeller / pump) and driven member (turbine), it consists of a reaction member also (stator). In its simplest form it consists of an impeller connected to the crankshaft, turbine connected to output shaft and stator mounted on overrunning clutch on stationary component impeller is normally an integral part of the converter housing. (It is generally welded to the cover half during the manufacturing). Turbine and stator are enclosed within the welded housing. The stator incorporates a one-way clutch and mounts on a stationary support shaft that is grounded to the transmission case directly or indirectly through the transmission pump assembly. The impeller and turbine blades are designed with special features. The curved shape of the impeller blades in a backward direction gives added acceleration and energy to the oil as it leaves the impeller. The curved shape of the turbine vanes is designed to absorb as much energy as possible from the moving oil as it passes through the turbine. The vane curvature has two functions that give the turbine excellent torque absorbing capacity. It reduces shock losses due to the sudden change in oil direction between the impeller and turbine. It also takes advantage of the hydraulic principle that the more the direction of a moving fluid is diverted, the greater the fore that fluid exerts on the diverting surface. The fluid impact is absorbed along the full length of the vane surface as the fluid reverses itself. The stator is the third bladed member of the converter. During the torque phase, its function is to redirect the fluid flow as it leaves the turbine and reenters the impeller. This assists the impeller rotation and gives a thrust boost to the fluid discharge.



<u>Operation</u>:

Converter starts operating when the impeller starts rotating, with the engine providing the required input. The impeller creates a centrifugal pumping head or vortex flow. At the same time, the fluid must follow the rotational inertia or the effort of the impeller. These two fluid forces combine to produce a resultant force in the form of an accelerated jet stream against the turbine vanes. The impeller and turbine attempts to act as an effective fluid coupling by featuring curved impeller and turbine vanes rather than a straight radial design. The turbine vanes reverse the fluid direction. The curved turbine vanes provide efficient energy transfer, but the reentry of the remaining fluid thrust back to the impeller, works against the impeller and crankshaft direction. Hence, it is necessary to introduce the stator element to make the converter work. The stator is employed between the turbine, outflow and impeller inflow to reverse the direction of the fluid and make it flow in the same direction as that of the impeller. Instead of the fluid opposing the impeller, the fluid energy now assists the impeller and crankshaft rotation. This results in boosting the rpm of' the impeller. This allows the impeller to accelerate more and recycle the fluid with a greater thrust against the turbine vanes. The purpose of using the remaining fluid energy to drive the impeller is referred as regeneration gain. The stator is mounted on a one-way clutch. During the torque phase, the stator remains locked and at coupling speed it overruns.

The torque multiplication occurs when the turbine is turning at a slower speed than the impeller and the stator is stationary / reactionary. This is called torque phase, slip phase or stall phase. This sequence generates a boost in output torque. Recycling of the fluid permits more of the impeller input to be used in increasing the jet stream velocity and turning effort of the turbine. By helping the impeller to accelerate the fluid thrust against the turbine, the stator provides the basis for torque multiplication The curved turbine blades absorb the energy from the impeller discharge until the force of fluid is great enough to overcome the turbine resistance to motion. The converter torque is equal to the product of effective fluid force and working radius of the turbine (torque= force x lever arm radius). It is similar to the torque multiplication by gear reduction. The maximum throttle occurs with the engine at wide open throttle (WOT) and zero turbine speed. This is commonly referred as torque rating or stall torque of the converter. For best efficiency, engineering design of the three-element converter keeps the maximum torque ratings within a range of 2:1 to 2 5:1.

During the torque phase, vortex flow is the predominant force in the fluid. Therefore the fluid cycles like a continuous chain from the impeller to the turbine and back to the impeller through the locked stator. This action is continuous until the turbine speed is at nine-tenths of the impeller speed, at which the converter has achieved a speed ratio more than 90%. After a moment at stall the turbine and vehicle starts moving. Once the turbine starts, it becomes easier and easier for the fluid force to drive the turbine and vehicle. The turbine rpm actually starts to gain and approach impeller speed. As the turbine gains the speed, the turbine lever arm absorbs less and less of the fluid force and converter torque output gradually drops. The fluid thrust under vortex influence is trying to hit a moving target that is moving away from it faster and faster. Finally when the converter has reached a speed ratio of more than 90%, the converter enters the coupling phase of the operation. The stator is no longer needed and must freewheel with the rotary flow. The vortex effect on the fluid has dropped significantly and the rotary flow is now the main force. The rotating inertia of the fluid mass, impeller and the turbine form a hydraulic lock or bond. The converter is now in coupling phase and the torque ratio is 1:1. When the speed difference between the impeller and turbine is at its minimum, it is referred as coupling phase. It occurs when the torque converter is operating at its greatest hydraulic efficiency. At this point the stator freewheels and there is no torque multiplication.

Operating Characteristics

In operation on the road, the converter provides effortless driving characteristics.

1. At engine idle, the converter acts as an automatic clutch and permits the engine to run and the car to stand still.

2. The converter automatically adjusts its torque output to drive shaft torque requirements within its design limits. It acts as a fluid coupling for level-road, constant-speed conditions, but when

performance is needed for acceleration or hill climbing, it responds with the necessary extra torque dictated by the slowdown of the turbine from in creased drive shaft torque.

3. As the converter is a fluid unit, it acts as a natural shock absorber during gear ratio changes and adds to shift smoothness. The fluid also absorbs the torsional vibrations from the engine crankshaft.

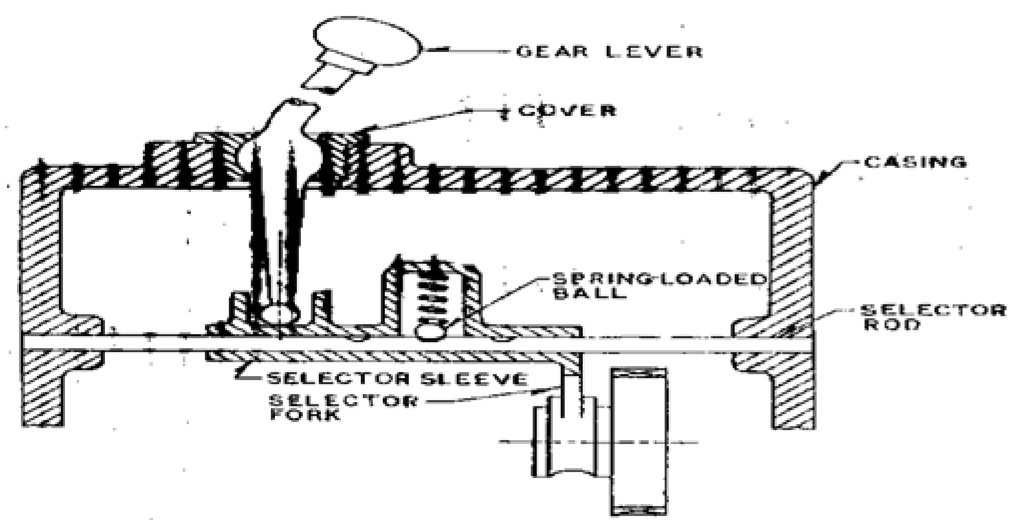
4. The converter permits continuous shock-free acceleration, extending the life of drive train components—which is especially important for stop-and-go driving.

Comparison of torque converter with fluid flywheel

Sl. No.	**FLUID COUPLING**	**TORQUE CONVERTER**
1	It has two main components: impeller and runner	It has three main components: pump, stator and turbine.
2	It is simply a means to connect driving and driven members	It connects the driving and driven members as well as multiplies torque.
3	Impeller and runner are locked up and movement of oil stops during engagement. (When the centrifugal force is approximately same on both members)	It never locks up and flow of oil never stops.
4	Its blades are merely fins.	The turbine blades are inclined having pitch

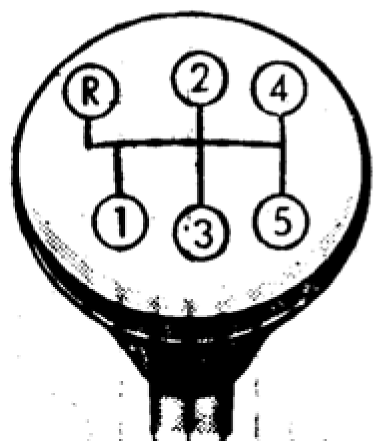
5	It serves the purpose of an automatic clutch	It acts as an automatic clutch and serves the purpose of automatic gear box to increase the torque.
6	It is efficient at high speeds.	It is not as efficient as fluid coupling at higher speeds, but is more efficient under load
7	It is not assisted by friction clutch	It is usually used in conjunction with friction or fluid clutches to eliminate the loss of efficiency at high speeds.

<u>Mechanical gear lever on top of transmission case</u>

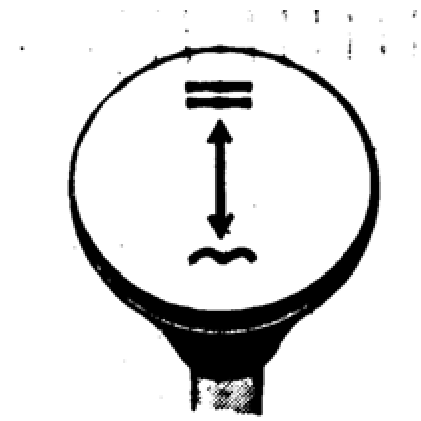


A typical mechanism for a 4-forward speeds and reverse gear box is shown in the figure. The gear lever is ball mounted in the gear box cover. This facilitates its movement in any direction. The lower end of the gear lever fits into a slot in the selector sleeve. There are forks mounted on the sleeves 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. This ball resists the movement of the forks until some force is applied to overcome their resistance. In some cases the forks are fixed on the selector rods by means of pins and the assembly can slide.

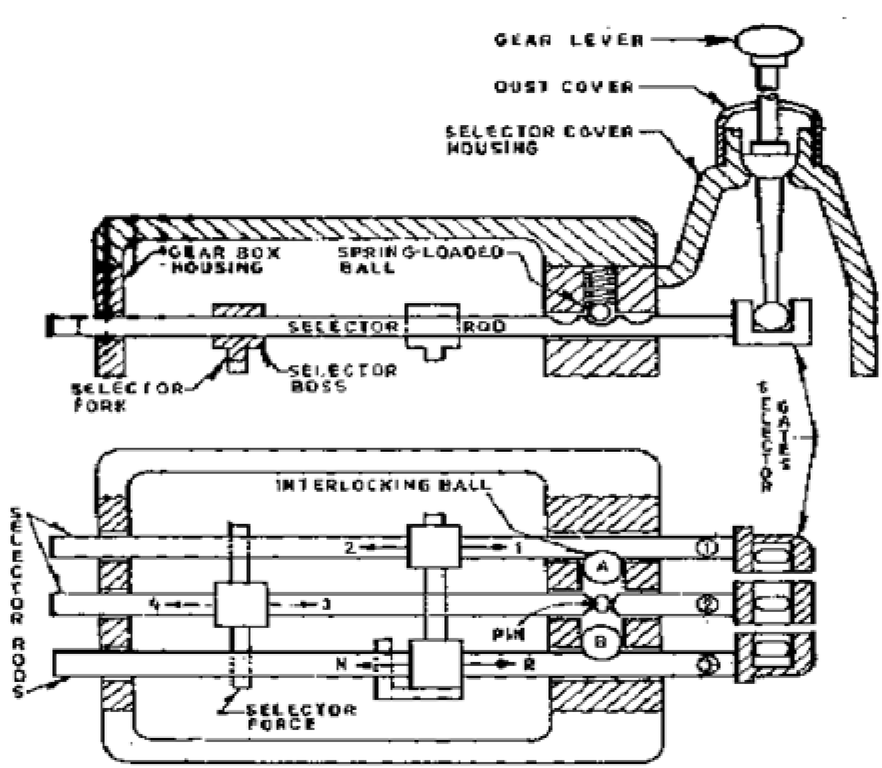
Grooves are provided on the gear bosses where the selector forks can fit in. Transverse motion of the gear lever selects the fork which is to be engaged and the longitudinal movement then slides the fork and its gear to engage the selected gear. Various gear positions are marked on the gear lever knob itself as shown the figure below



Gear lever know for a five speed gearbox



Gear lever knob for transfer case



An interlocking mechanism which ensures that only one gear can be engaged at a time is shown in Figure above. The middle selector rod (2) has a radial hole chamfered on both sides. An interconnecting pin ‘C is fitted inside this hole. On the other two selector rods there are single grooves cut facing the central rod. There are holes in the gear box casing as shown which hold two interlocking balls A and B. In some cases, spherical-ended plungers are used instead of balls.

When a particular gear is to be engaged, the corresponding selector rod is moved in the desired direction. For example if rod (2) is moved towards left, the contacting interlocking balls A and B are pushed outwards and away from the rod so that the balls now contact the straight rides of the rod. This movement of the balls pushes them onto the grooves in other rods, locking them in the neutral position. In the sane way f the selector rods (1) or (3) are to be moved, rods (2), (3) and (1), (2) will be locked in neutral position. Thus the mechanism allows only one rod to be operated at a time.