

Automotive Transmission

U5AUA11

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UNIT I

Contents

- **Introduction**
- **Transmission Systems**
 - **Manual**
 - **Automated Manual**
 - **Automatic**
 - **Continuously variable**
 - **Dual Clutch**
- **Propeller Shaft**



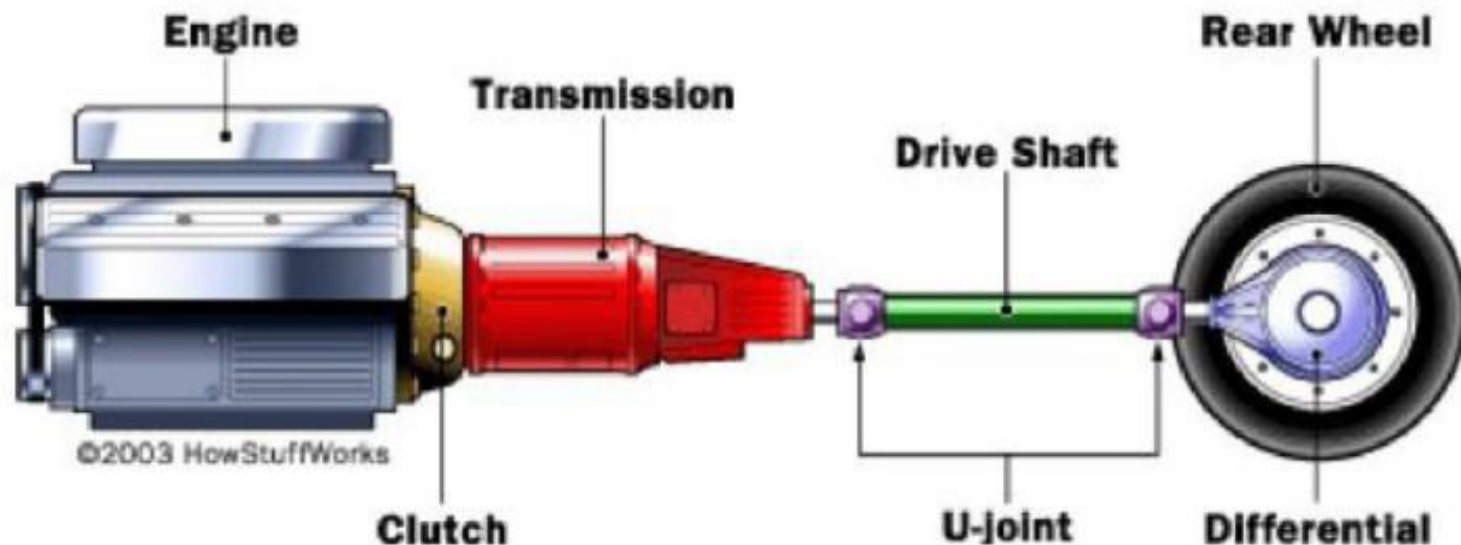
Contents

- **Universal joints**
- **Differential**
- **Requirements of the Transmission Design Process**
 - **Product Life Cycle**
 - **Stages in the Design Process**
 - **Project Set Up**
 - **Concept Design**
 - **Detailed Design**
 - **Engineering Drawings and Tolerancing**



Transmission System

- **Function of transmission:**
 - It is used to transmit engine torque to the driving wheels to drive the vehicle on the road.

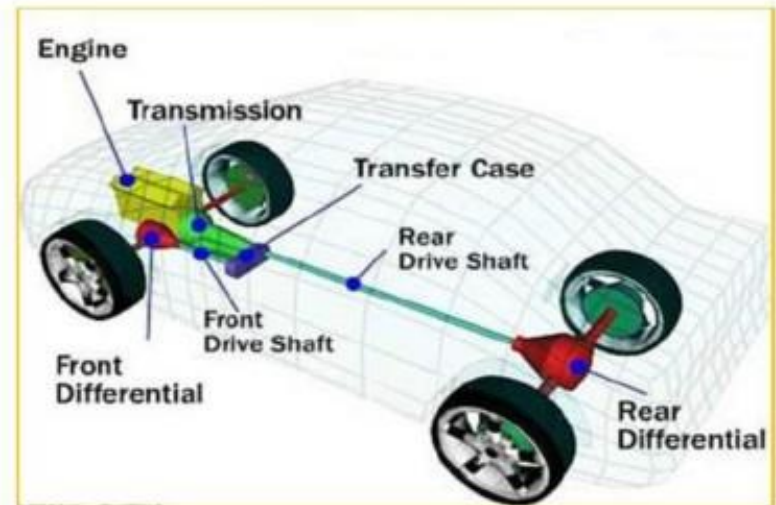
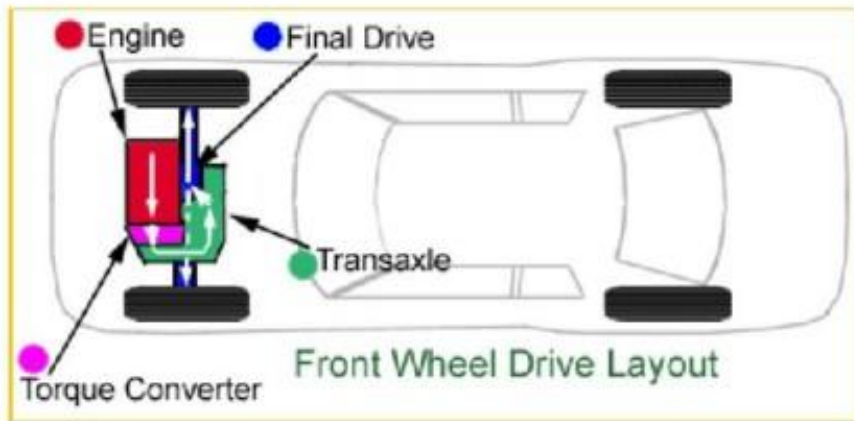
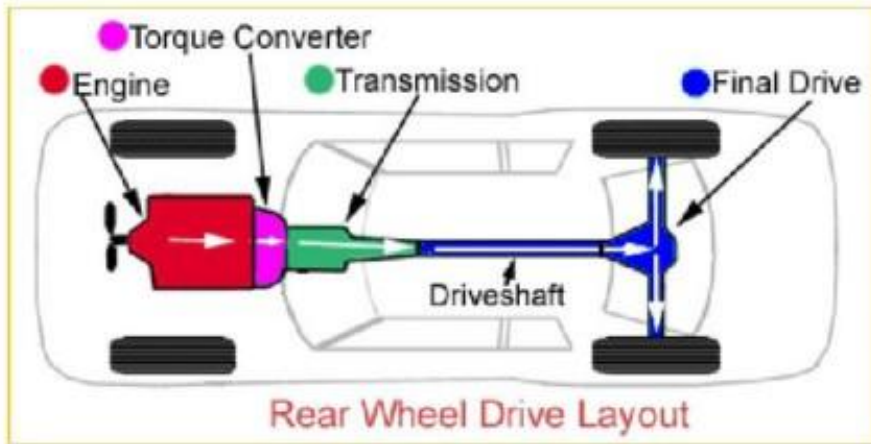


Requirement of Transmission System

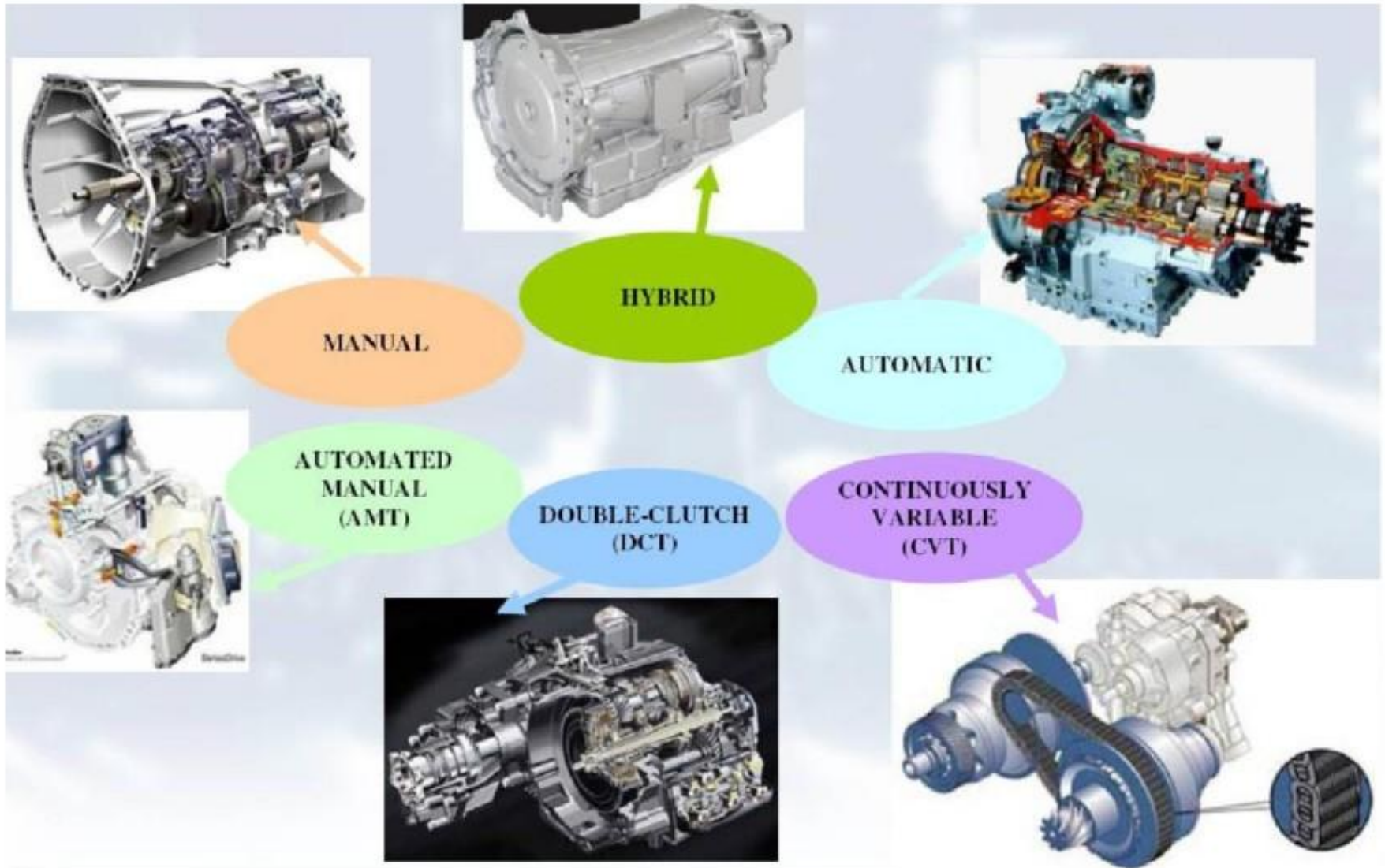
- To provide for disconnecting the engine from the driving wheels
- When engine is running , connect the driving wheels to engine smoothly without shock
- Leverage between engine and driving wheels to be varied
- Enable the driving wheels to rotate at different speeds.
- Provide relative movement between engine and driving wheels



Transmission System - Layout



Transmission Types



Clutch

Function of clutch

- Clutch is used to disengage and engage the engine with rest of the transmission systems.
- To disengage while starting the engine and while changing gear ratio.
- To engage after starting of the engine and gear shift operation.



Clutch

Requirement of Clutch

- Transmit maximum torque of the engine.
- Engage gradually to avoid sudden jerks.
- Dissipate maximum amount of heat.
- Damp the vibrations and noise.
- Dynamically balanced.
- As small as possible.
- Easy to operate.



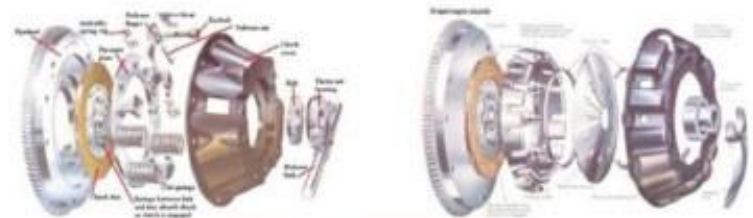
Clutch Unit

- Flywheel also acts as a driving member
- Pressure plate is connected to clutch cover assembly.
- Clutch Cover assembly is bolted to the flywheel.
- Clutch springs placed between Pressure plate & Cover plate, press the Pressure plate against the clutch plate.
- Thus Clutch plate is squeezed between Flywheel & Pressure plate.

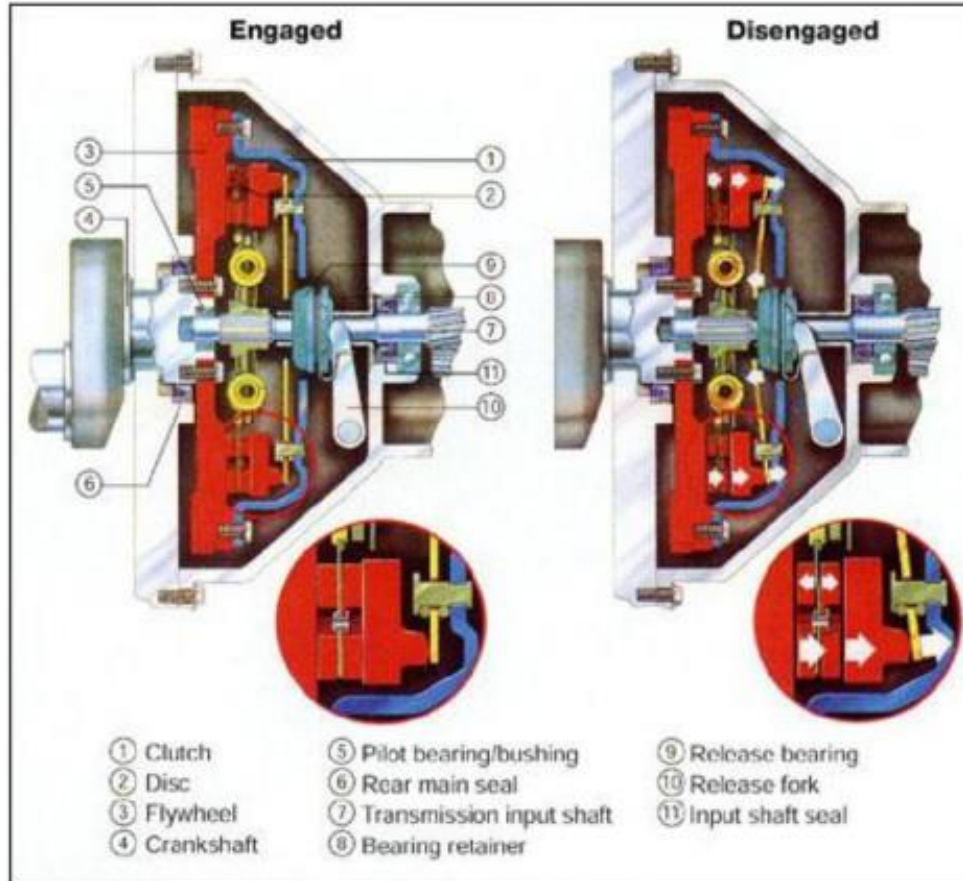


Classification of Clutch

- **Cone clutch**
- **Flat Plate clutch**
 - Dry or Wet type clutch
 - No. of friction plates (Single or Multiple)
 - Actuation mode (Cable or Hydraulic)
 - Actuation spring (Helical or Diaphragm)
- **Centrifugal clutch**



Clutch Engaged & Disengaged



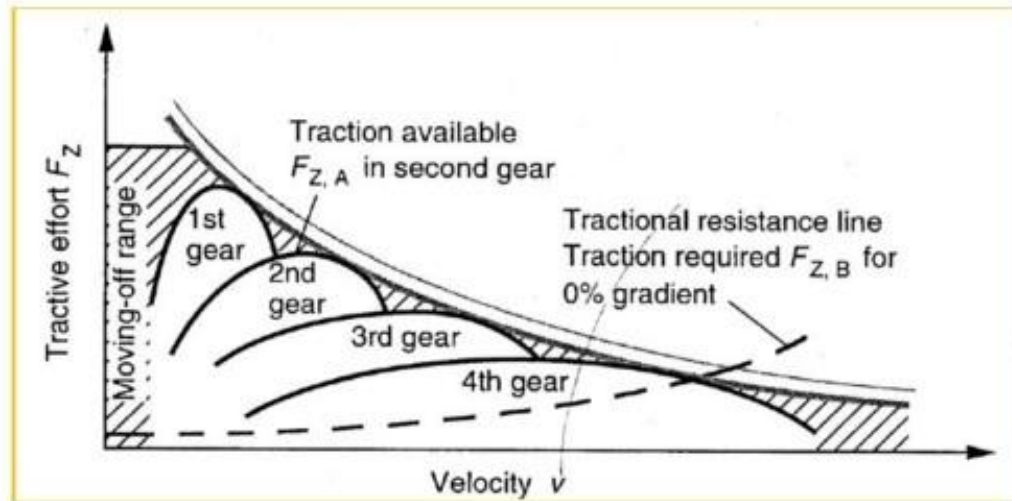
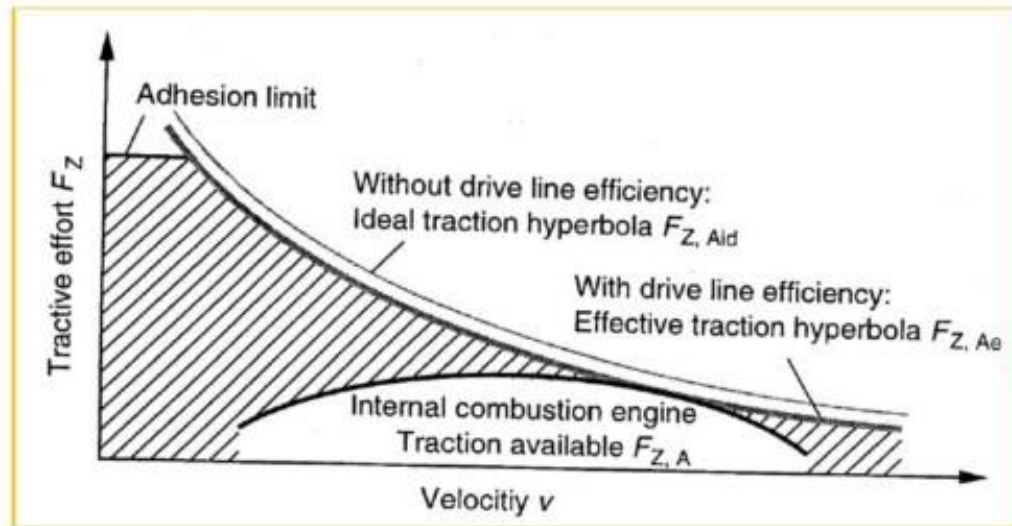
- Clutch is always in engaged state.
- It can be disengaged by pressing of Clutch pedal. Disengagement is effected by non - contact of Clutch plate both with Flywheel face & Pressure plate face.
- Frictional heat is dissipated by openings present in Clutch housing & Cover

Clutch Material

Components	Material	Components	Material
Cover plate	Mild steel	Damper spring	Spring steel
Diaphragm spring	Spring steel	Clutch hub	Mild steel
Coil spring	Spring steel	Bolts to fasten flywheel and cover plate	Steel
Pressure plate	Cast iron	Rivets on cushion spring	Brass
Clutch disc	Mild steel	Retainer spring	Spring steel
Friction facing	Asbestos base	Damper spring retainer plate	Mild steel
Rivets on facing	Aluminum brass	Cushion spring	Mild steel

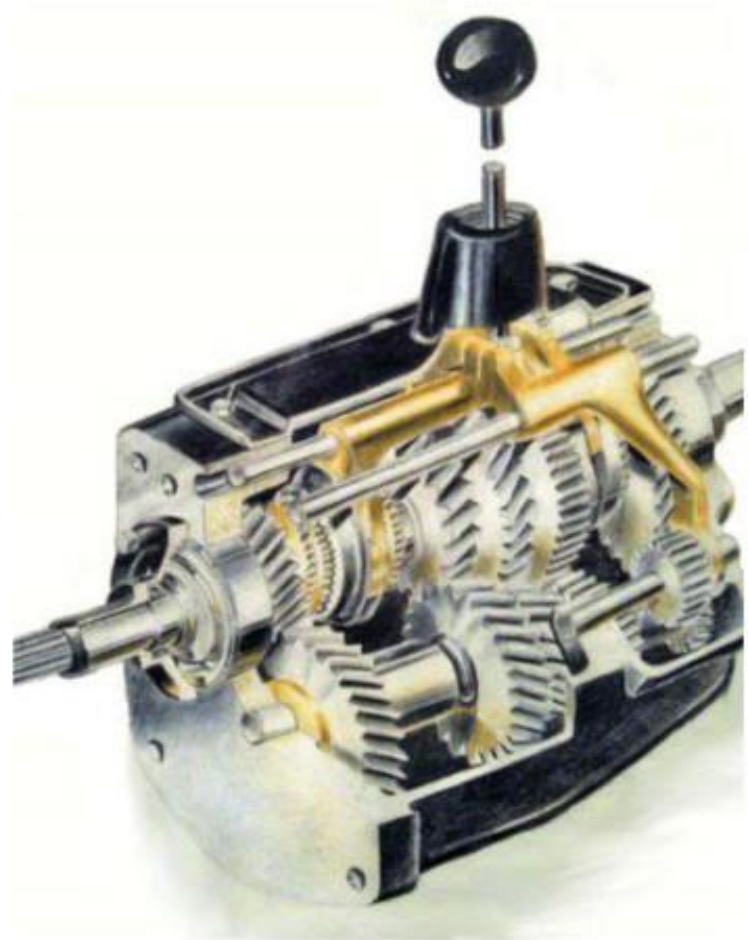


Need of Gear Box

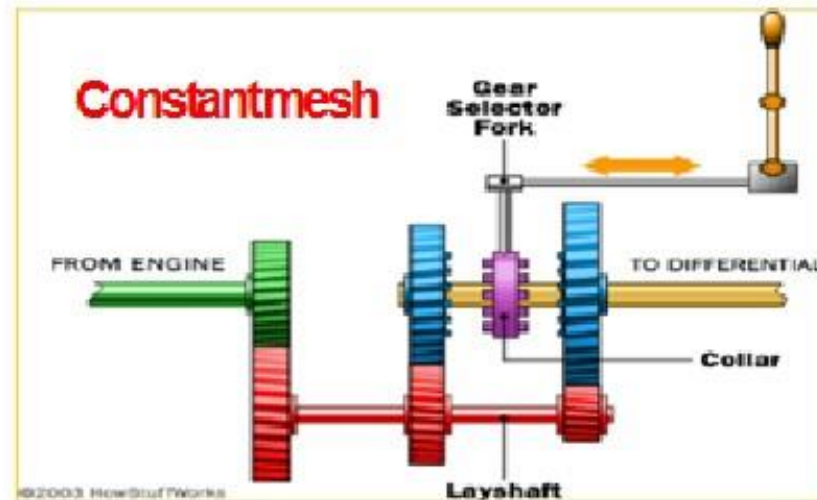
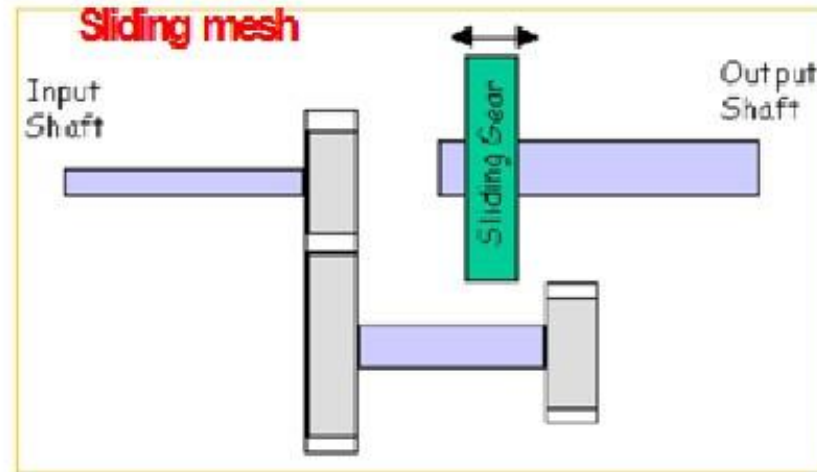


Gear Box

- Gear box varies the leverage (speed ratio & hence torque ratio) between the engine & driving wheels.
- It is located between Clutch & Propeller shaft.
- It is provided with either 4 speed or 5 speed ratios or more depending on design.
- Gear ratio is varied by Gear shift lever.

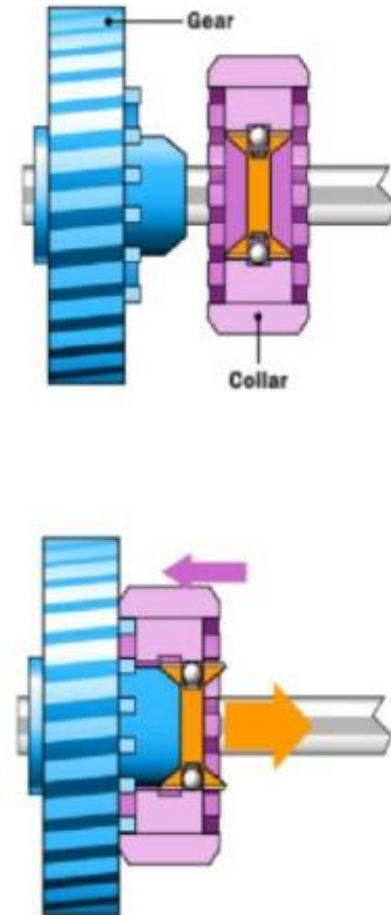


Manual Transmission - Types

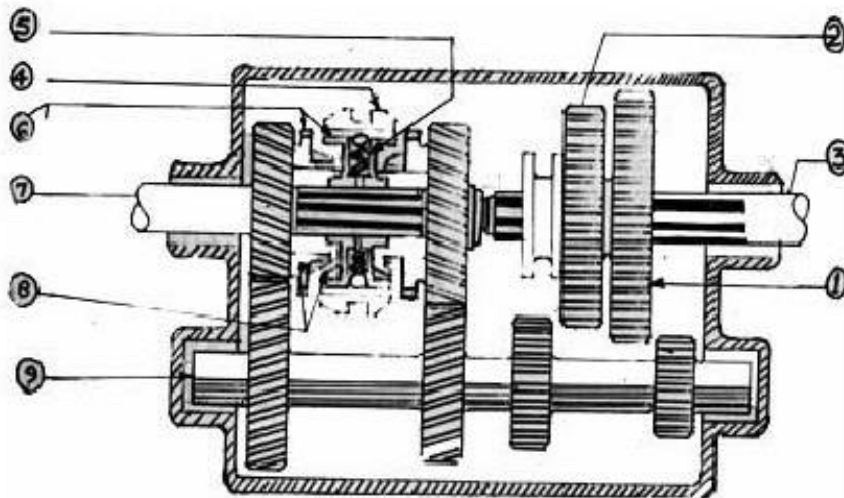
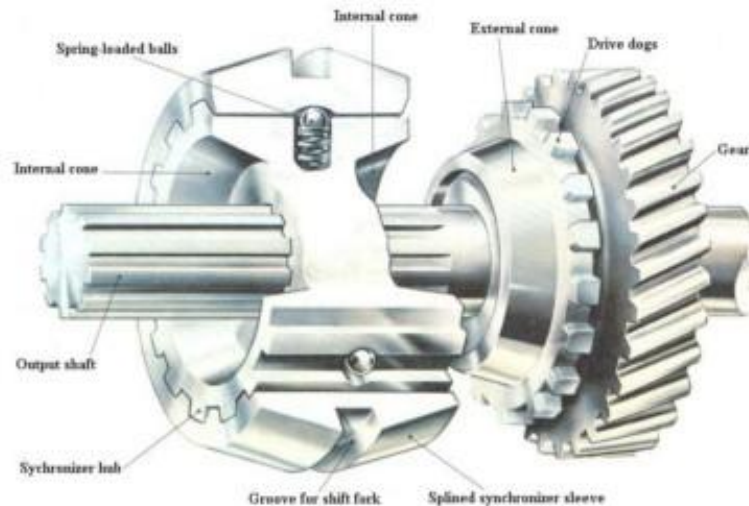


Synchronizers

- A device used to bring two adjacent members to the same speed before allowing the sleeve to engage them.
- The two elements are friction clutch and toothed clutch.
- Lock the positive engagement until speeds are synchronized.
- Establish the positive engagement and power flow.
- Synchronizer is splined on the shaft Cone on the gear (blue) fits into cone-shaped area in the collar.
- Friction between the cone and collar synchronize the collar & gear.
- The outer portion of the collar (sleeve) then slides so that the dogteeth engage the gear.

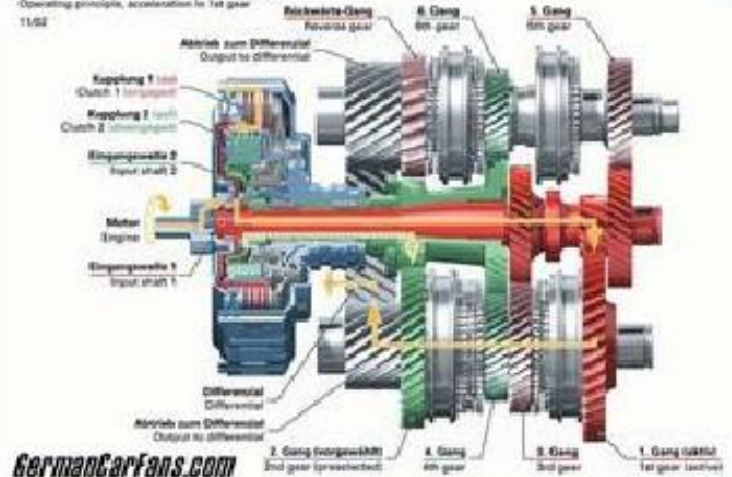


Synchromesh Gearbox



Audi TT 3.2 quattro

mit neuem 6-gang automatischem Sportgetriebe (DSG)
 Funktionsprinzip: Beschleunigung im 5. Gang
 with the new automatic sports transmission (DSG)
 Operating principle: acceleration in 1st gear
 11/02



- 1.I speed gear
- 2.II speed gear
- 3.main shaft
- 4.outer engaging unit
- 5.inner engaging unit
- 6.top gear engaging teeth
- 7.main drive gear
- 8.top gear synchronizing cones
- 9.counter shaft

How Manual Transmission Work?

- **When a driver wants to change from one gear to another in a standard stick-shift car, he first presses down the clutch pedal**
- **This operates a single clutch, which disconnects the engine from the gearbox and interrupts power flow to the transmission**
- **Then the driver uses the stick shift to select a new gear, a process that involves moving a toothed collar from one gear wheel to another gear wheel of a different size**
- **Devices called synchronizers match the gears before they are engaged to prevent grinding**
- **Once the new gear is engaged, the driver releases the clutch pedal, which re-connects the engine to the gearbox and transmits power to the wheels.**



Manual Transmission

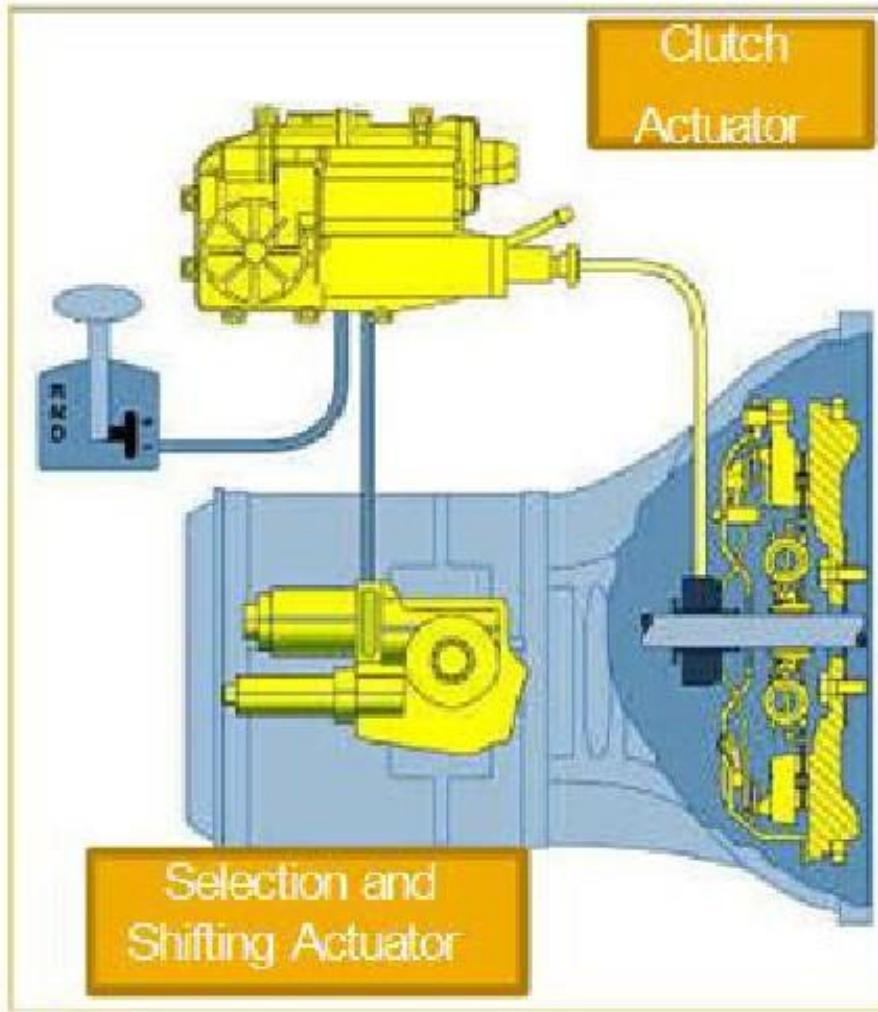
- Cheap to make
- Durable, efficient
- Easy to install
- Established in marketplace and with manufacturing infrastructure
- Gives control to the driver
- But driver comfort an issue with increasing traffic density

Hence automation must be considered



Automated Manual Transmission (AMT)

- Automation of Clutch and Gear shifting operations
- Elimination of Clutch Pedal
- Modification of Gear Shifting lever
- Minimum modifications in manual transmission

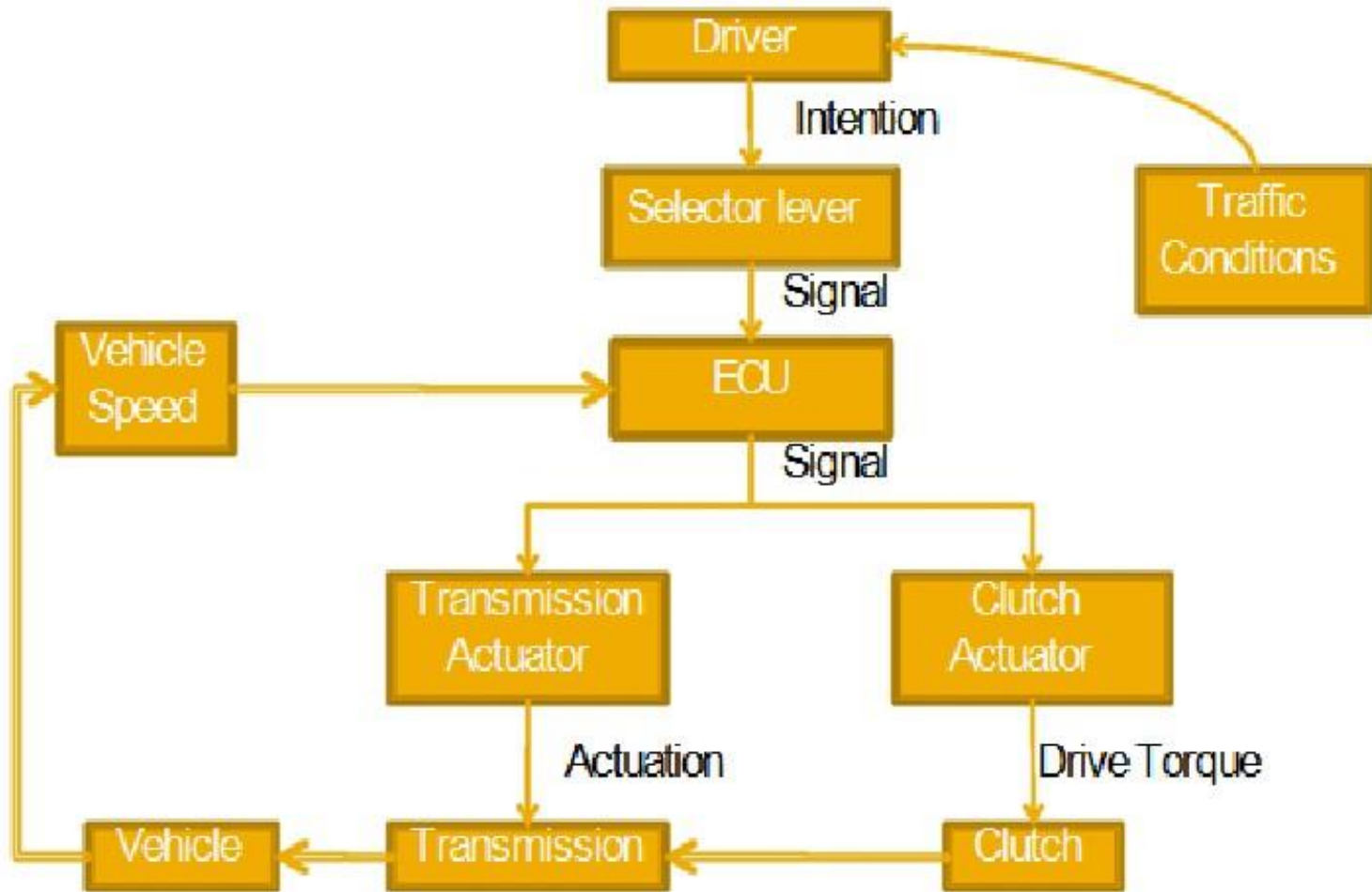


AMT Features

- **Automation of Clutch operation and Gear shifting.**
- **Clutch slip control during starting**
- **Hill start aid system which will assist the driver in hold and move the vehicle in hill slope**
- **Necessary fail safe systems such as sudden shifting from higher gear to lowest gear and vice versa**



System Block Diagram



Clutch Actuation Control

- **Engine Start**

- Starter should be operated only when the gear is in neutral position
- When engine is not running and in power on, ECU will disengage clutch
- When engine speed exceeds a specified rpm, ECU engages clutch gradually

- **Vehicle Start**

- On pressing the accelerator pedal, ECU controls the clutch
- actuator travel and clutch engagement



Clutch Actuation Control

- **Gear Change**

- While engaging the clutch after gear shift, the ECU determines clutch actuator travel based on shifted gear position and accelerator pedal stroke

- **Clutch disengagement**

- While gear shifting and when accelerator pedal is released,
- if the vehicle speed is lower than a set speed for select gear position, the ECU disengages clutch



Advantages of AMT

- **Reduced driver effort**
- **Improved Clutch life**
- **Utilization of existing manufacturing facilities for manual transmission**
- **Lower production cost than automatic transmissions**
- **Higher efficiency than automatic transmissions**



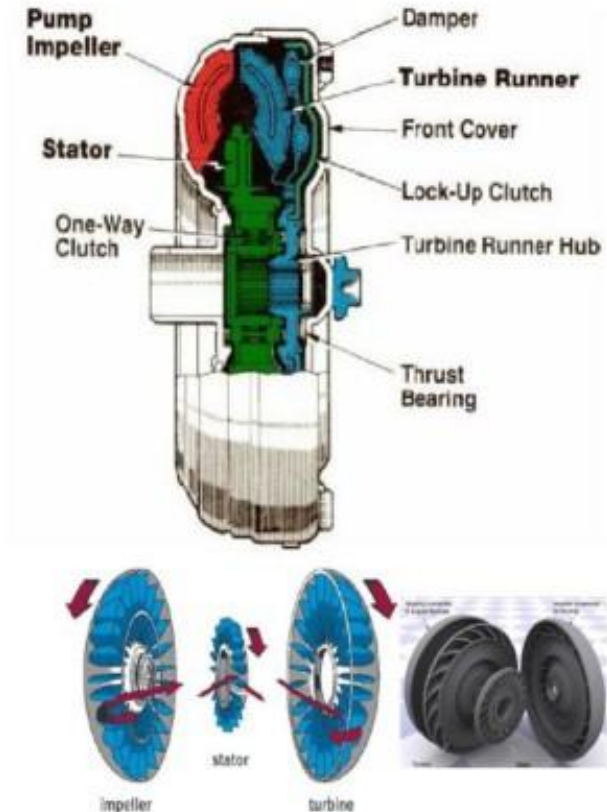
Automatic Transmission (AT)

Conventional Definition

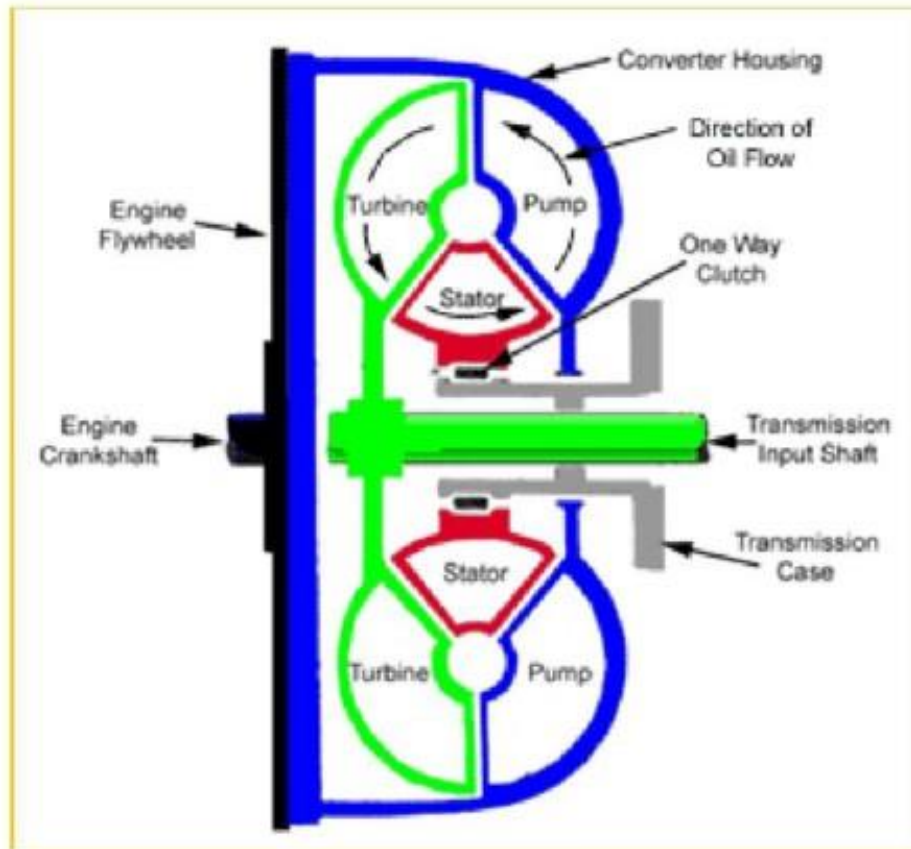
- **Moving away from rest - Torque converter**
- **Achieving ratio change - Planetary gear sets**
- **No power interruption**
- **Mechanism for ratio change**
 - **Wet plate clutches and brakes**
- **Control of ratio change**
 - **Normally automatic timing and actuation**

Torque Converter

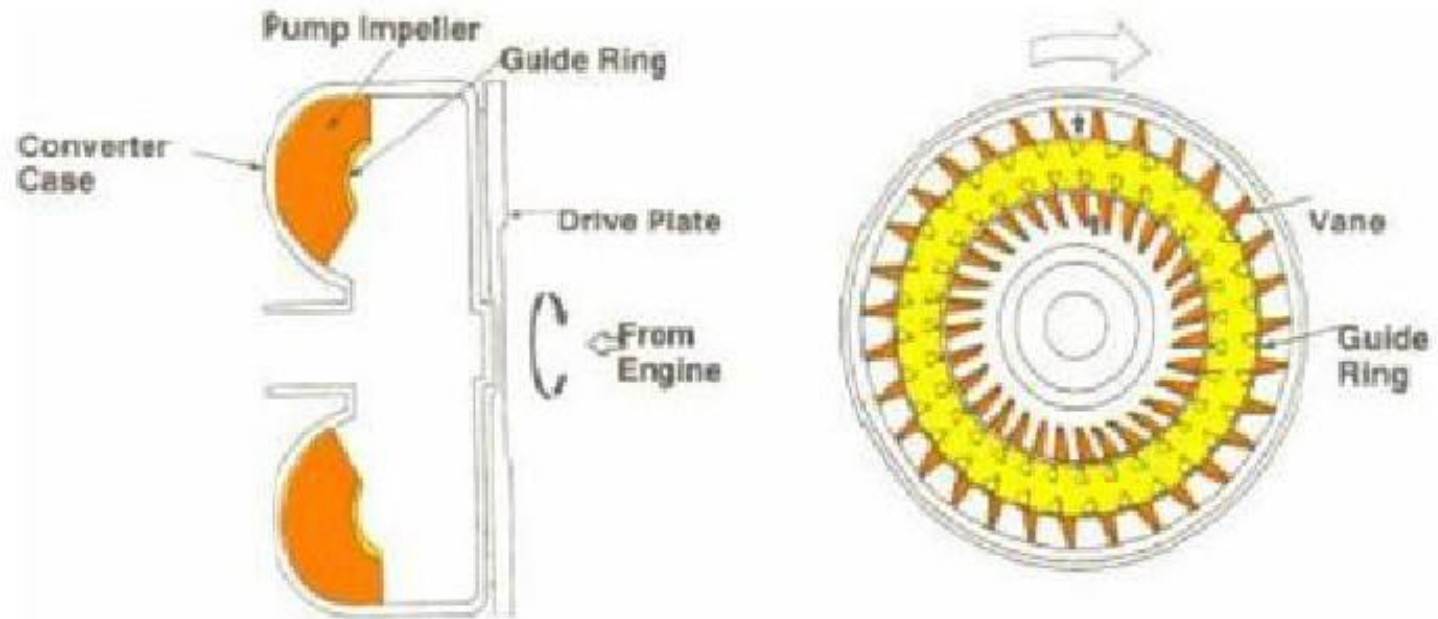
- Serves as automatic clutch which transmits engine torque to the transmission input shaft
- Multiplies torque generated by the engine
- Absorbs torsional vibration of engine
- Acts as a flywheel and smoothes out engine rotation
- Drives oil pump
- A torque converter consists of
 - Impeller
 - Turbine
 - Stator
 - and transmission fluid



Torque Converter - Sectional View

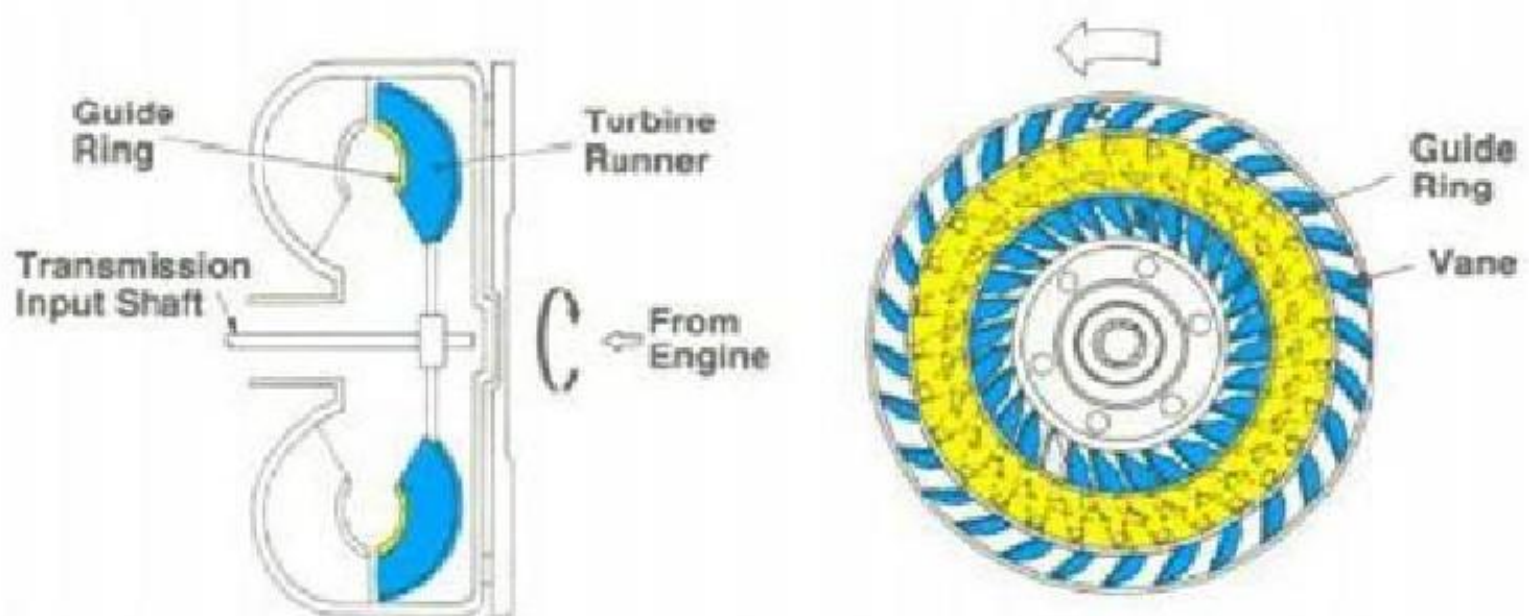


Impeller



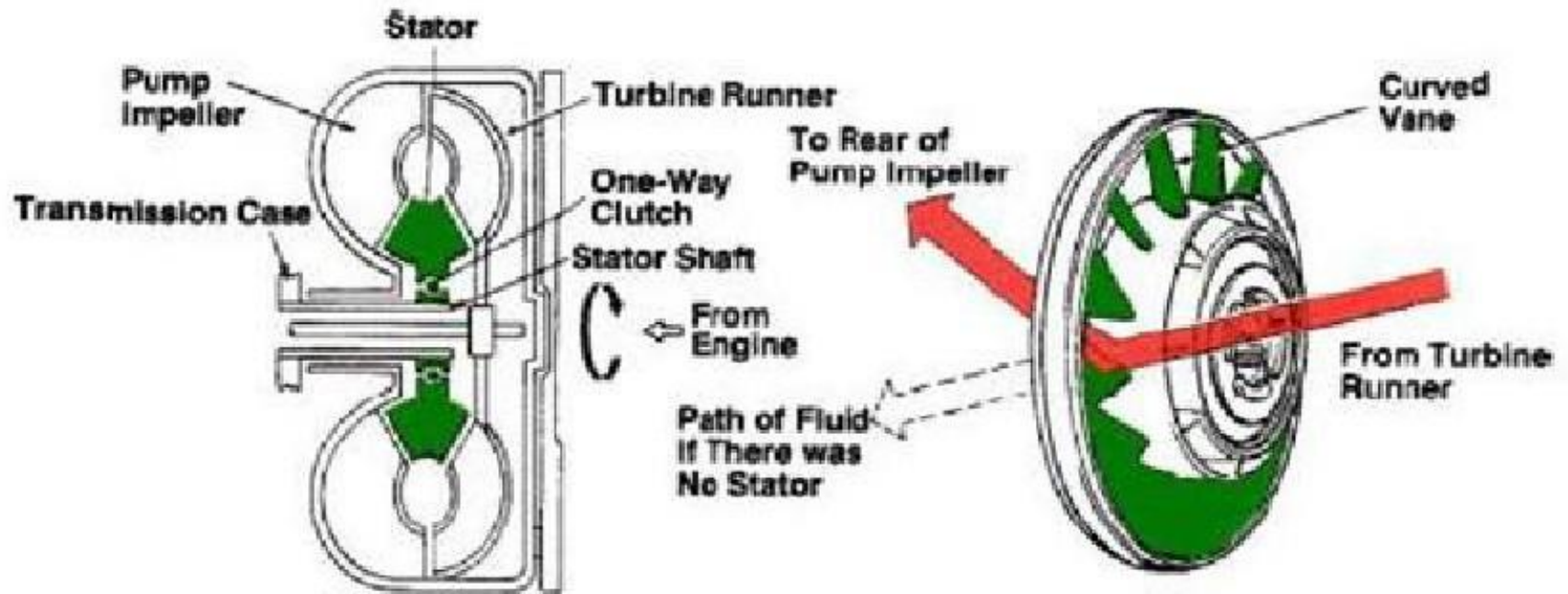
- The **impeller** is connected to the engine and transfers engine power to the transmission fluid.
- When the impeller speed increases, centrifugal force causes fluid flow outward towards the turbine

Turbine



- ❑ It is attached to the transmission input shaft with spline joint
- ❑ The curvature of the vanes is opposite from that of the impeller vanes
- ❑ Fluid caught in the cupped vanes of the turbine and torque is transferred to the transmission input shaft

Stator

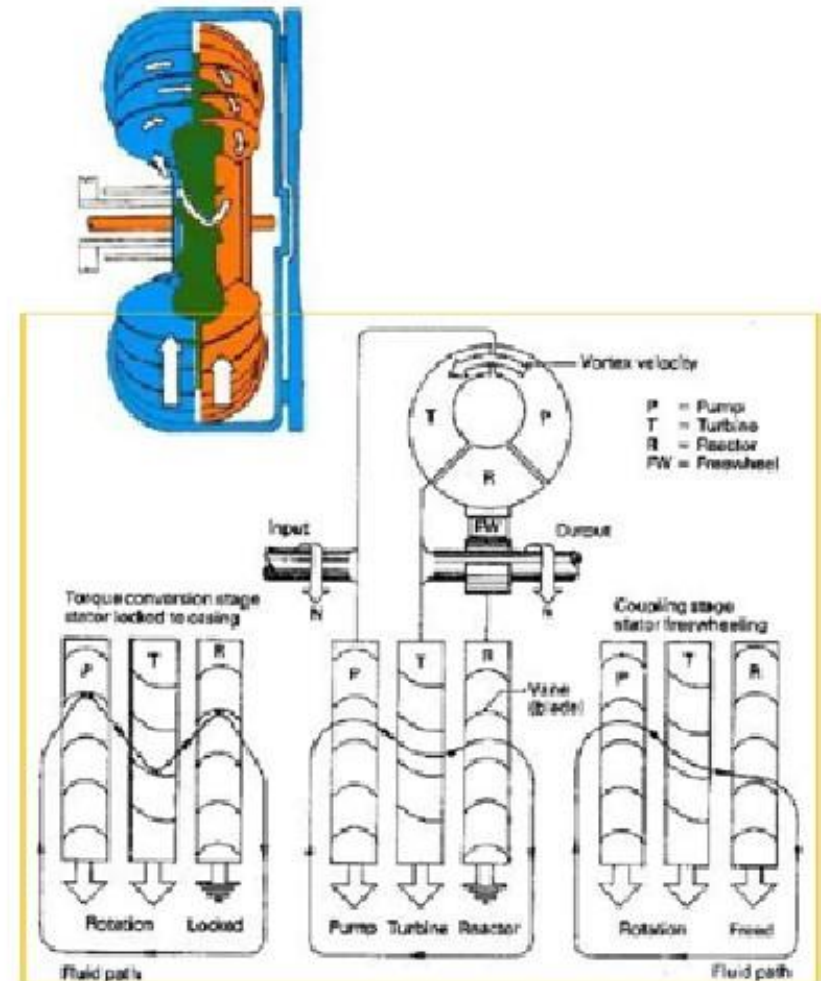


- ❑ The **stator** is used to redirect fluid returning from the turbine before it hits the pump/impeller.
- ❑ Increases the torque to the impeller

Working of Torque Converter

Vehicle accelerates

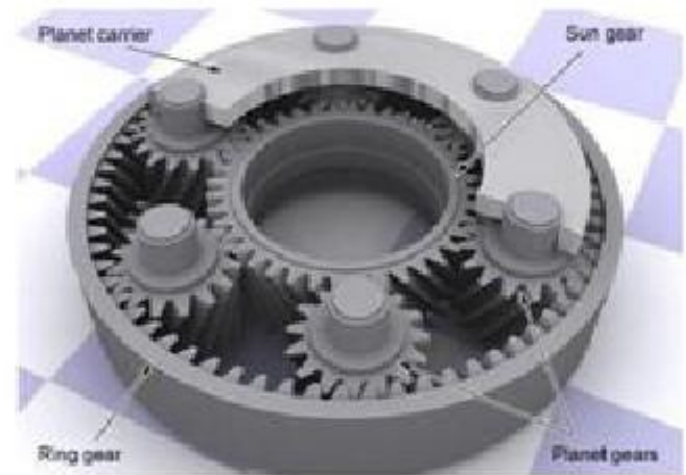
- High vortex flow
 - Speed difference between the impeller and turbine is great when vehicle accelerates
 - Impeller rotates much faster than turbine
 - Fluid leaving the turbine strikes the concave face of the vanes of stator and locks it to rotate in CCW direction
- Fluid leaving from stator strikes the back of the vanes of the impeller to increase the torque



Planetary Gear System

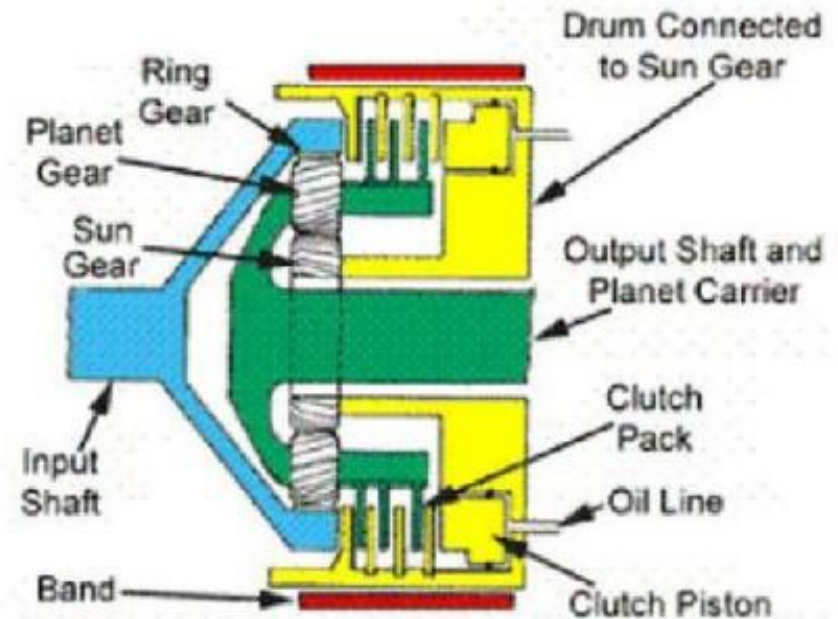
□ Main parts are:

- A Planetary gear set.
- A set of bands to lock parts of a gear set.
- A set of wet-plate clutches to lock other parts of the gear set.
- A hydraulic system to control clutches & bands.
- A pump to move transmission fluid.



Planetary Gear System: Construction

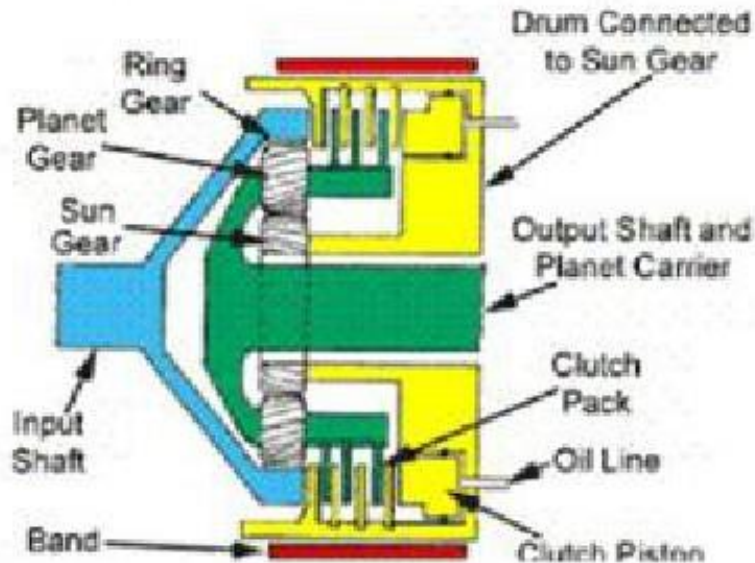
- Input shaft is connected to Ring gear(Blue)
- Output shaft is connected to Plane carrier(Green) which is also connected to Multi-disk clutch
- Sun gear is connected to a Drum(Yellow), which can be locked by brake band (Red). It is also connected to the other half of Clutch



Planetary Gear System: Operation

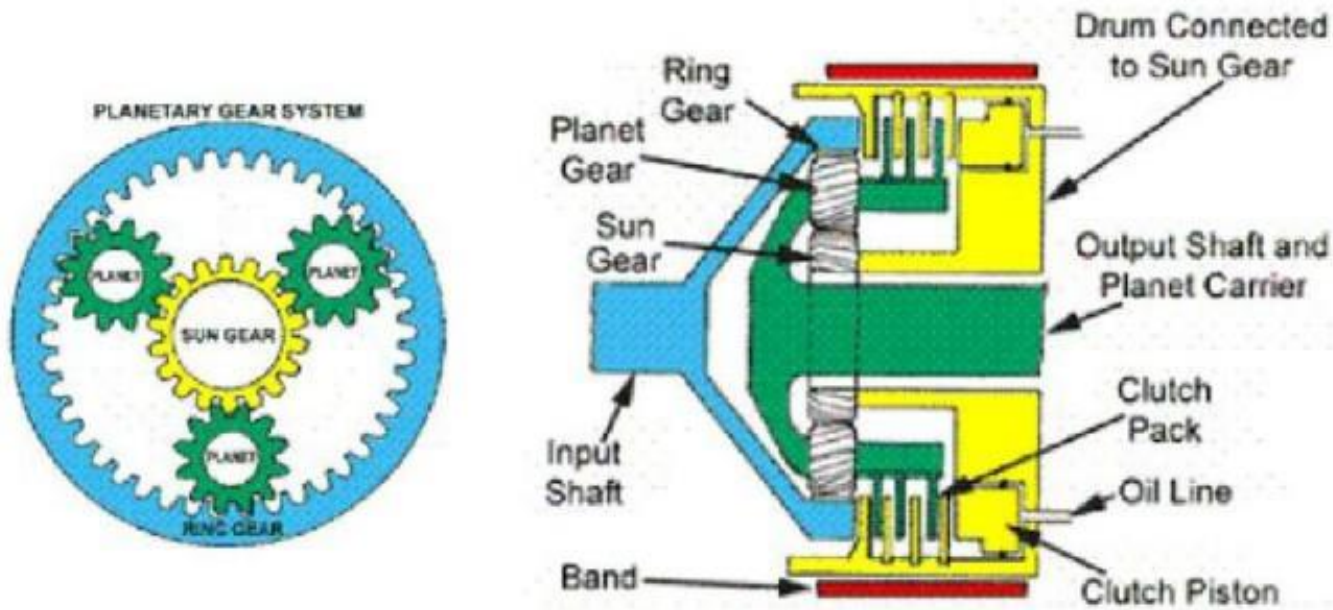
- **In Neutral**

- Both band and clutch sets are released
- Planets assembled to carrier with NRB
- Ring gear only drive planet gear not the planet carrier (Output shaft)
- The planet gears drive the sun gears to spin freely



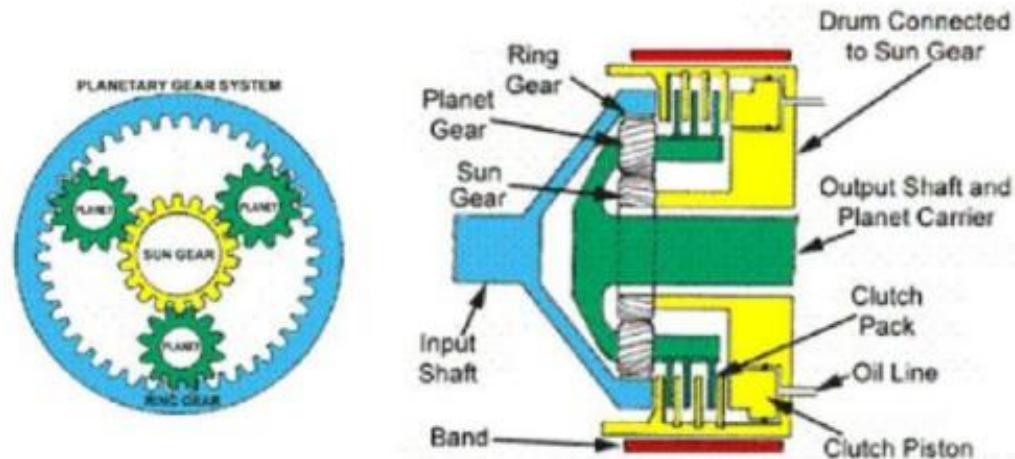
Planetary Gear System: Operation

- In Low Gear (forward reduction)
 - Band locks the *sun gear* by locking the drum
 - Planets walk around the sun gear
 - Planet carrier to spin in same direction as ring gear
 - Gear ratio = $\frac{\text{sun \& ring teeth}}{\text{no of teeth of ring gear}}$



Planetary Gear System: Operation

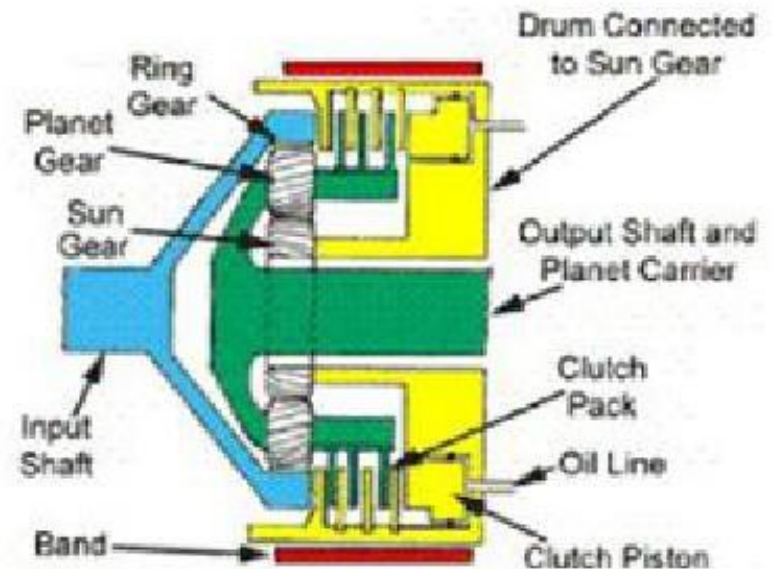
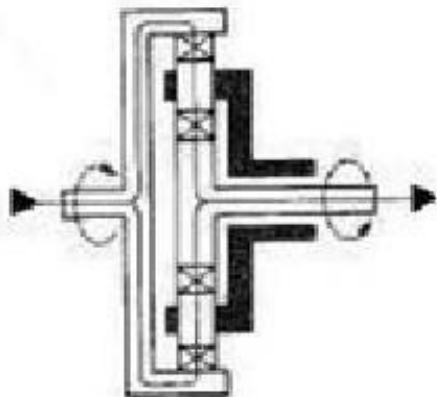
- **In High Gear (Direct drive)**
 - Band is released.
 - Lock any two members
 - Clutch is engaged so that the sun gear and planet carrier is locked to act as a rigid member
 - Planets has to walk around the ring gear,
 - Ring Gear (Input shaft) will spin at the same speed as the Planet Carrier (Output shaft)



Planetary Gear System: Operation

- **Reverse Gear**

- Planet carrier is locked
- Ring gear (Input shaft) will cause the sun gear (Output Shaft) to turn in the opposite direction



UNIT IV

Automatic Transmission (AT)

Advantages

The only option for comfortable automatic shifting

Cost issue mitigated by high volume manufacturing

Disadvantages

Cost for development and manufacturing

Fuel economy due to torque converter

Lack of control by the driver

Modern improvements

Better control algorithms

Torque converter lock up

Most useable transmissions based on a couple of standard arrangements

Ravigneaux

Lepelletier



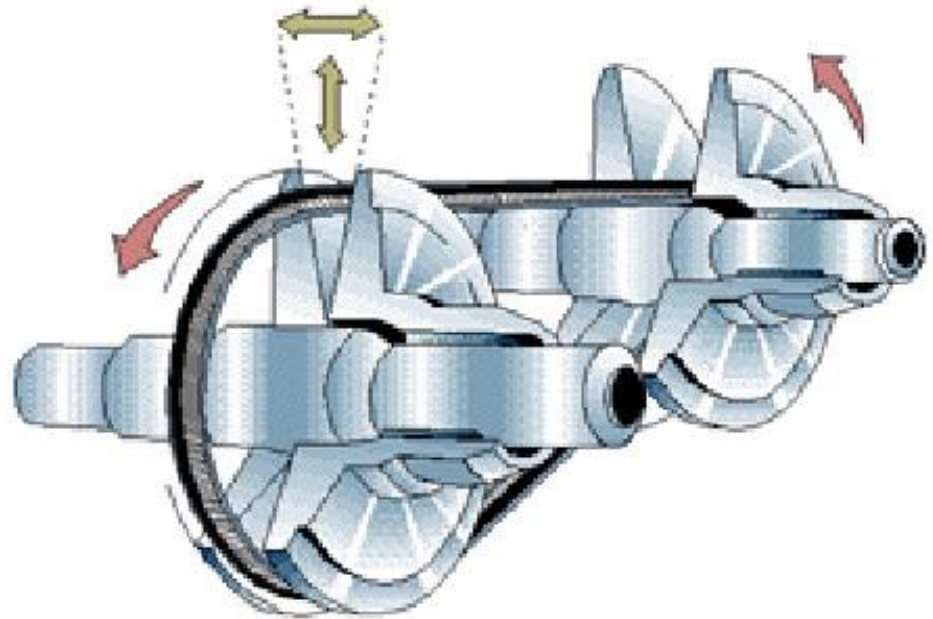
Continuously Variable Transmission (CVT)

- CVT provides infinite number of gear ratios (between a minimum & a maximum).
- Shifts automatically with an infinite number of ratios
- Seamless power delivery, no torque interruption & power loss



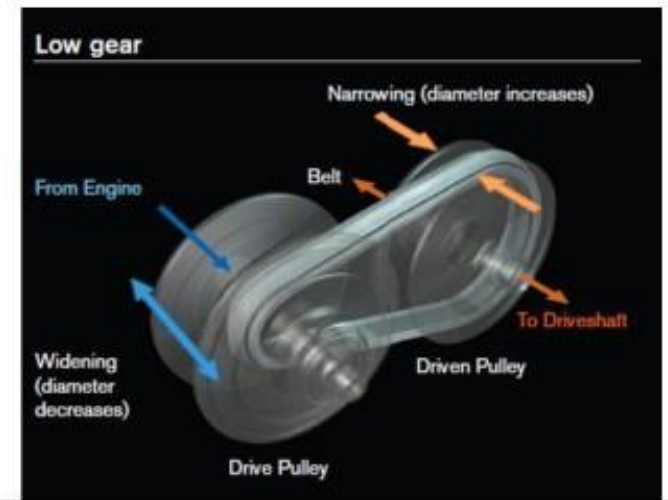
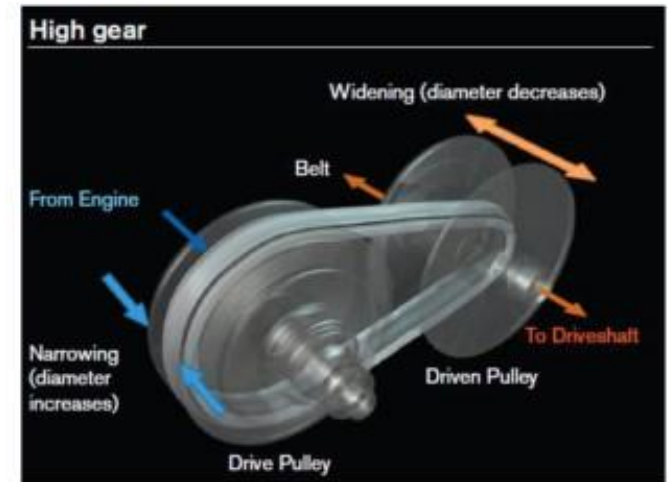
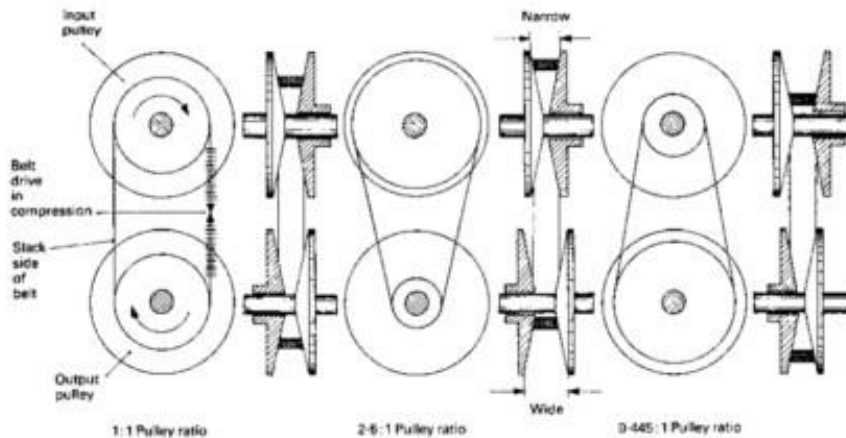
CVT: Construction

- Uses a pair of axially adjustable sets of pulley halves (Variators)
- Both pulleys have one fixed and one adjustable pulley half
- A “belt” is used to transfer the engine's power from one shaft to another



CVT: Functioning

- The transmission ratio is varied by adjusting the spacing between the pulleys in line with the circumference of the tapered pulley halves.
- The variators are adjusted hydraulically.
- When one pulley is varied, the other pulley must adapt itself inversely since the length of the belt is fixed.



Propeller Shaft

- **Single piece**
- **Two piece**
 - Front engine rear wheel drive
 - Reduction in car height (lowering of body)
- **Crash energy management**
- **Material**
 - Aluminum
 - steel
 - Composite (75% carbon, 25% glass-fibre with bonded steel end fittings- Renault)
- **Cold rolled and seam welded**



Jaguar X-Type

Propshaft with Front Aluminium Tube and Crash Energy Management Feature

Propeller Shaft



- It propels the vehicle forward, so called propeller shaft
- A Propeller Shaft connects a gearbox to a Differential.
- It is used to transmit the drive force generated by the engine to the axles.
- It is strong enough to handle maximum low gear torque
- It is provided with two U-joints to maintain constant velocity and positioning of differential at different plane.
- It is provided with a slip joint to take care of the change in length.
- Shaft diameter and its thickness decides the torque carrying capacity and angle of operation.



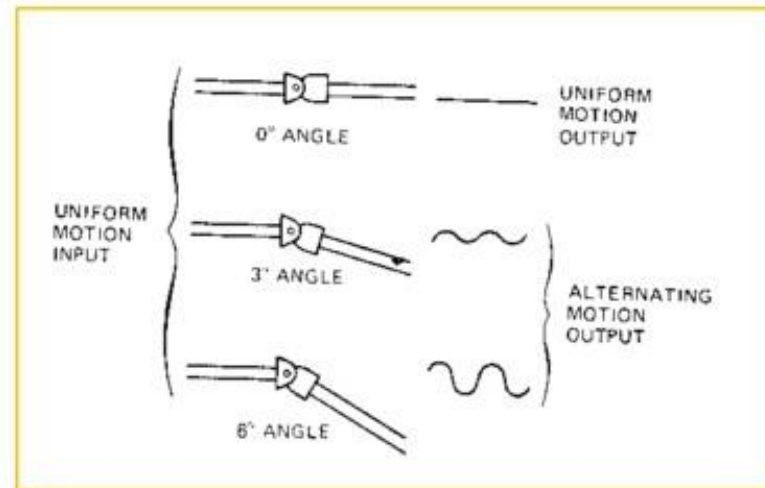
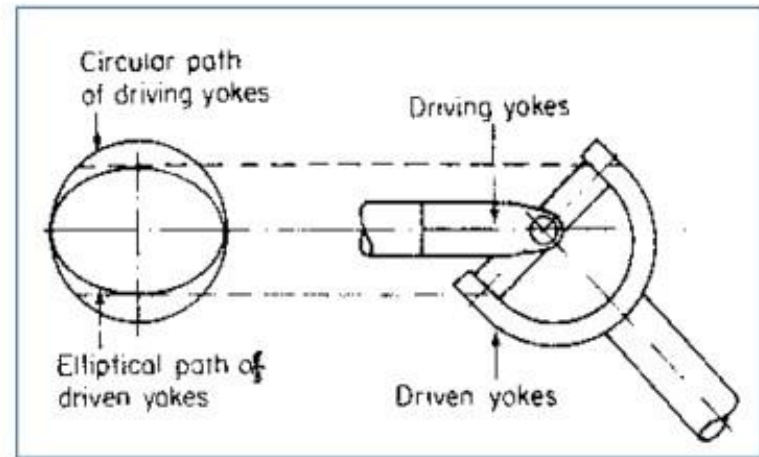
Propeller Shaft

- **Design requirements**
 - Critical speed is at least 15% above top speed
 - Torque carrying capacity requirements
 - Plunge requirements (suspension travel)
 - Assembly requirements



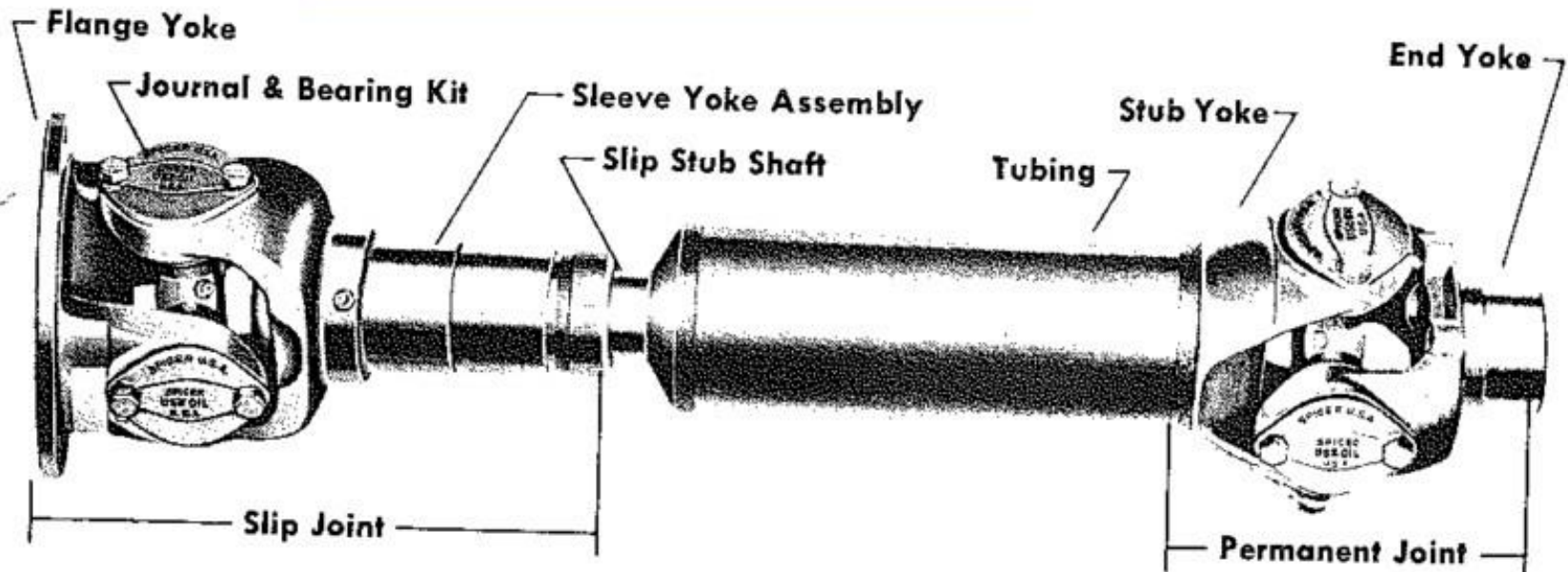
Universal joints

- Designed to eliminate torque and speed fluctuations (constant velocity joints)
- If only one universal joint is used, speed fluctuations will not be neutralized.
- To maintain uniform motion, two universal joints are used with yoke lugs in phase.

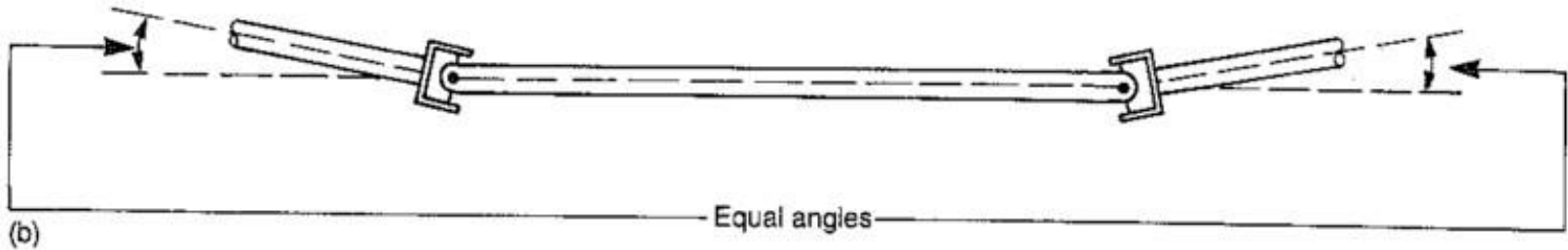
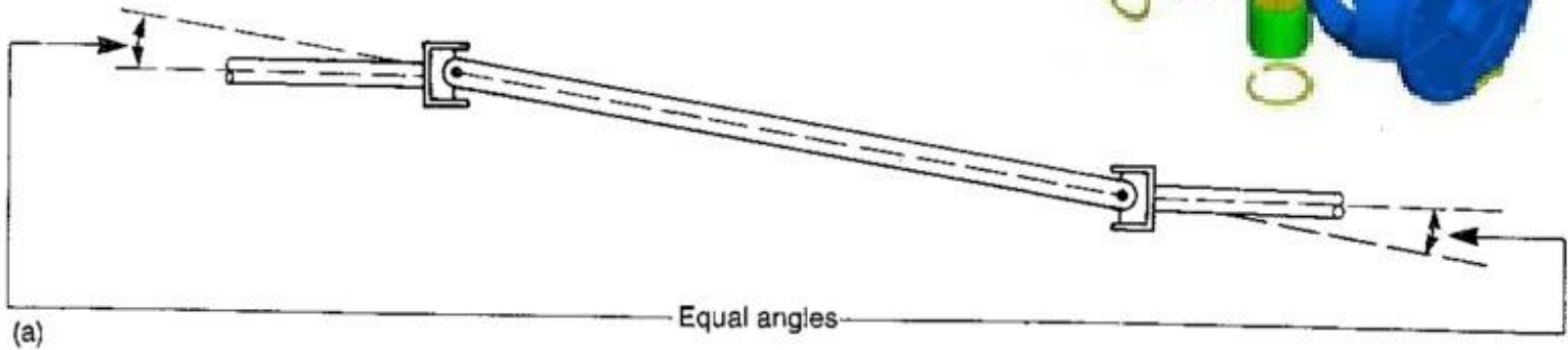
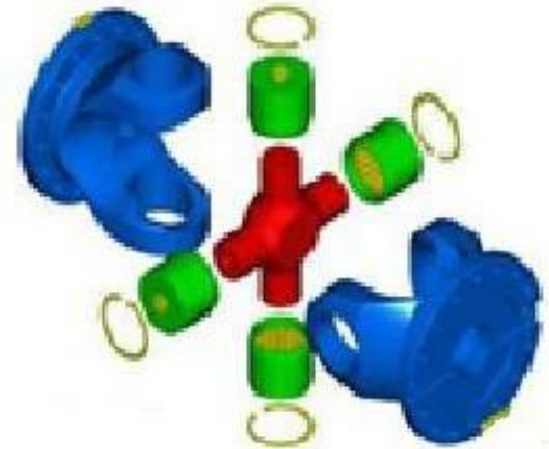


Universal joints

Drive-shaft RPM		Maximum Normal Operating Angle	
5000	3 degrees	15 minutes	
4500	3 "	40 "	
4000	4 "	15 "	
3500	5 "	0 "	
3000	5 "	50 "	
2500	7 "	0 "	
2000	8 "	40 "	
1500	11 "	30 "	



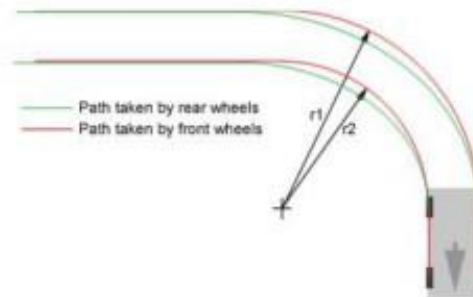
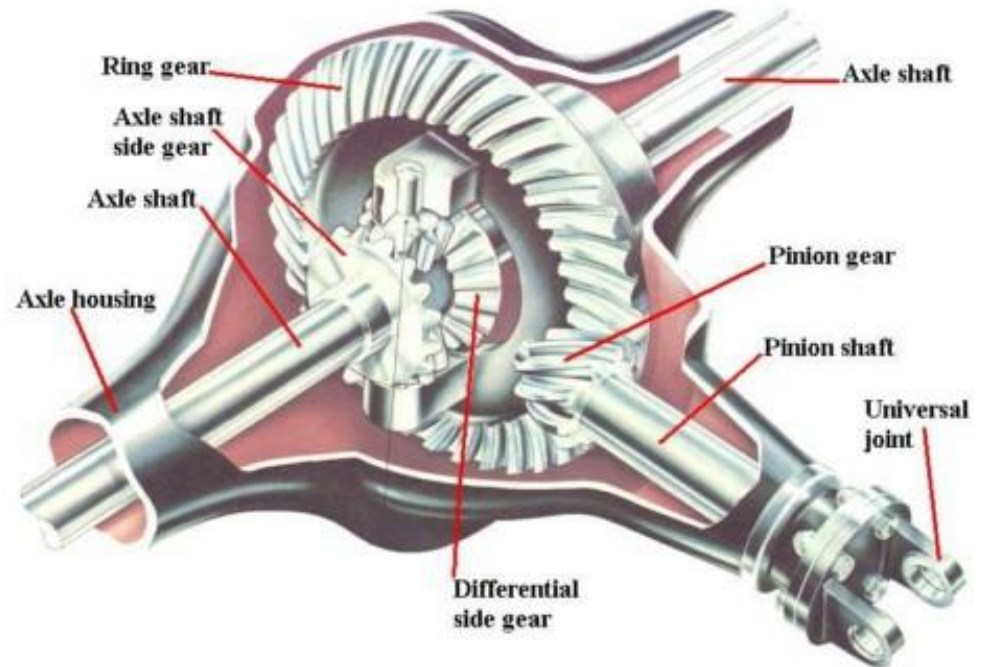
Hooke's Joint



Condition for Constant velocity drive with two Hooke's joint

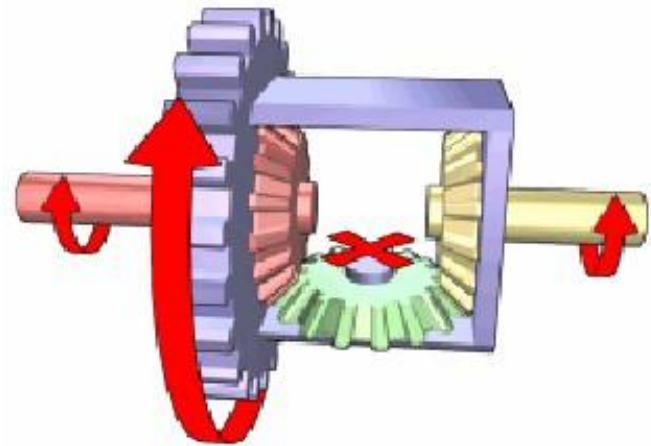
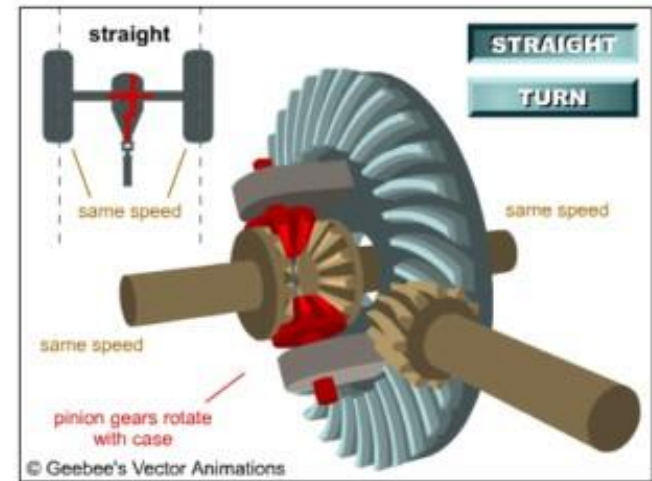
Differential

- To transfer the engine power to the wheels
- To act as the final gear reduction in the vehicle
- To make the wheels to rotate at different speeds while negotiating a turn.



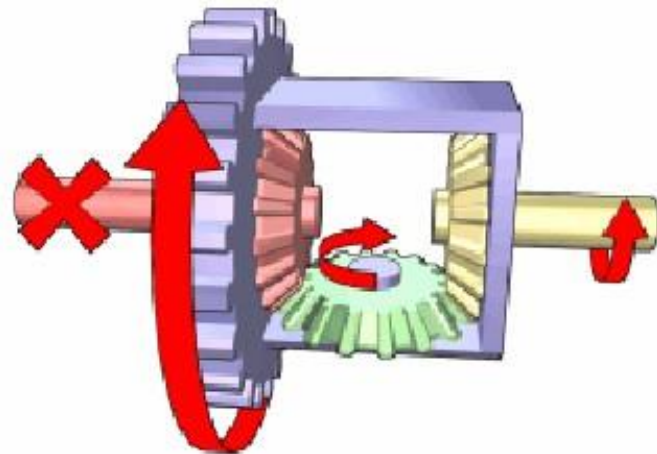
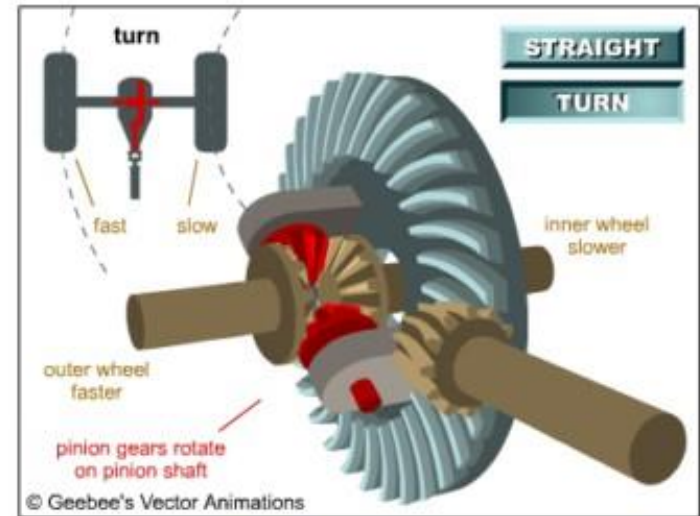
Differential: In Straight Ahead Motion

- Input torque is applied to the ring gear, which turns the entire carrier, providing torque to both side gears, which in turn may drive the left and right wheels.
- If the resistance at both wheels is equal, the pinion gear does not rotate, and both wheels turn at the same rate.



Differential: In a Turn

- If the left side gear (red) encounters resistance, the pinion gear (green) rotates about the left side gear, in turn applying extra rotation to the right side gear (yellow).



Axle

- Transmits rotary motion and torque from the engine-transmission-driveshaft to the wheels
- Changes torsional direction from longitudinal to transverse
- Provides speed reduction and torque multiplication
- Provides a differential action to permit vehicle cornering
- Provides mounting points for suspension and brakes



Transmission Troubleshooting

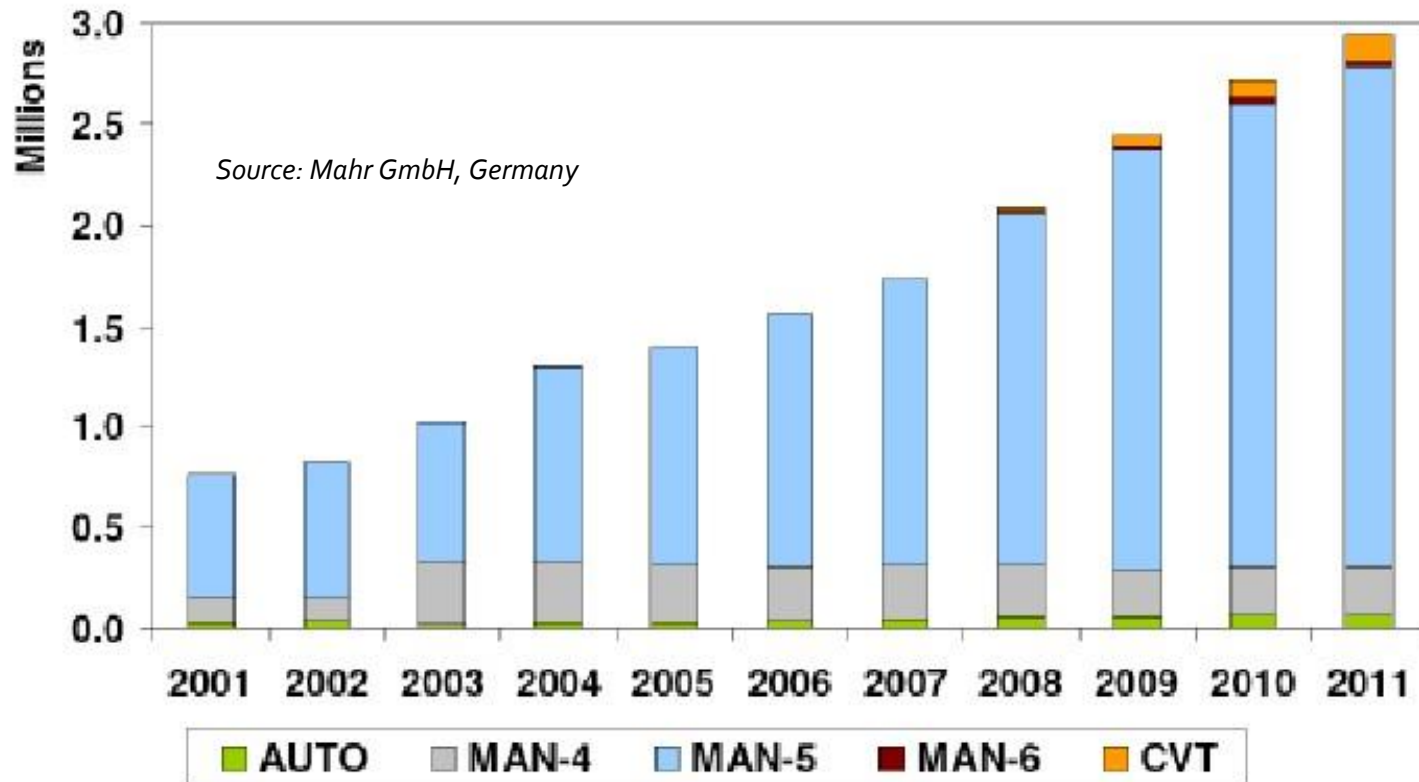
- **Leaking Transmission Fluid**
- **Slipping of Transmission**
- **Damaged Transmission Fluid**
- **Surging of Transmission**
- **Gear Problems**
- **Fluid Leaking**
- **Spilling out of Fluid**
- **Erratic Gear Shifting**
- **Overheating of Transmission**



Transmission Trend

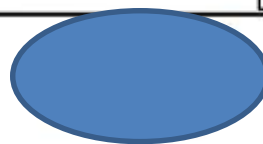
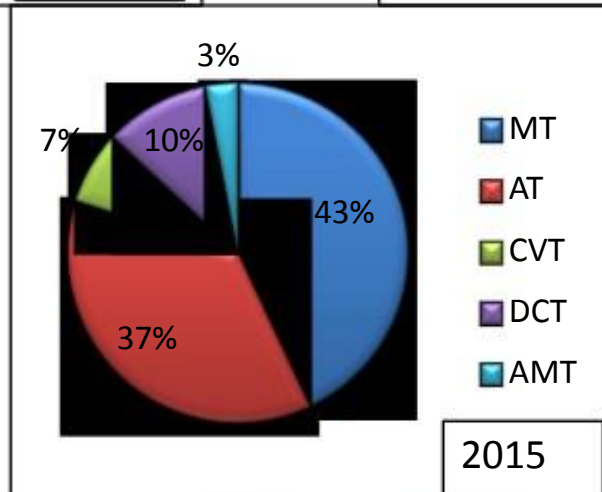
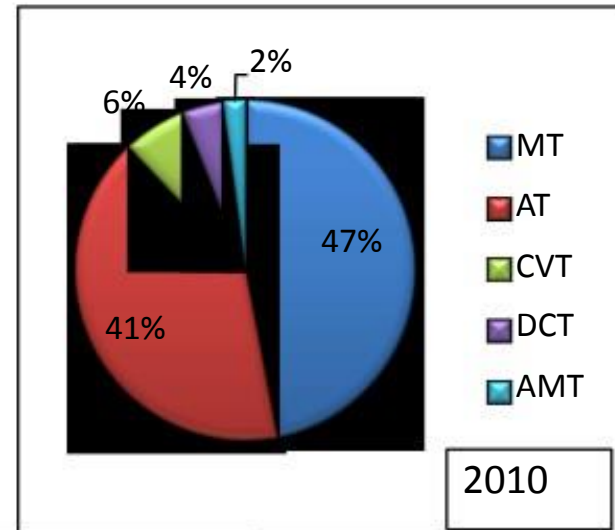
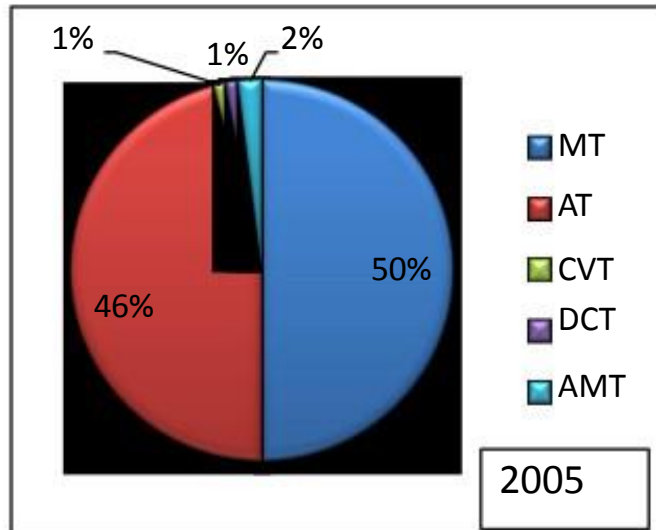
Passenger Car Transmission in India

- Manual transmission is more dominant in India as compared to other types of transmissions.
- Majority of the MT are using 5speed GB as compared to 6 speed GB.
- But many of the luxurious car manufactures are now using AMT or T's.



Global Transmission Trend

Estimated global market share (%) for passenger car transmission types



THANK YOU