Transmission components – 1

Unit II

Parts of an Automatic Transmission

1.Transmission Casing. A transmission casing houses all the parts of the transmission. ...

2. Torque Converter. ...

3. Pump (aka impeller). ...

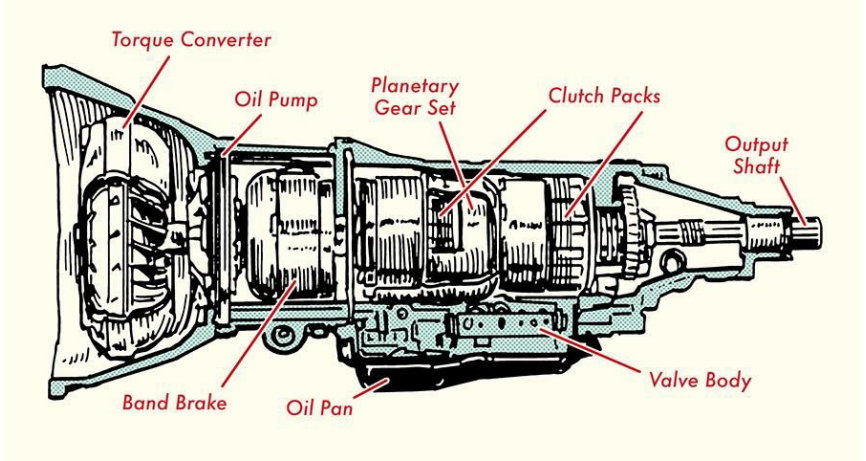
4. Turbine. ...

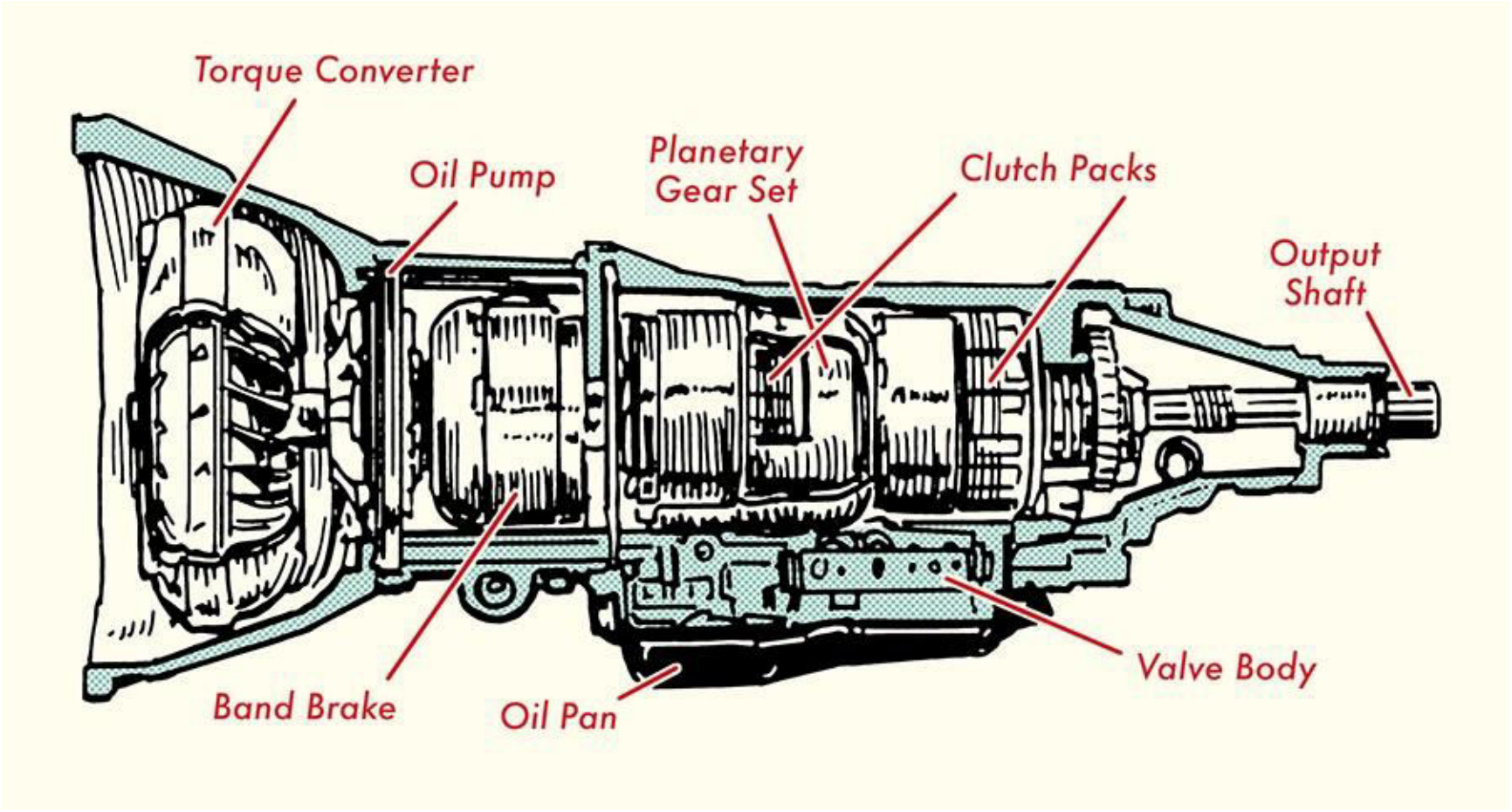
5. Stator (aka Reactor). ...

6. Torque converter clutch. ...

7. Planetary Gears. ...

8. Brake Bands and Clutches.




Torque Converter
Oil Pump
Planetary Gear Set
Clutch Packs
Output Shaft
Band Brake
Oil Pan
Valve Body

Friction plates or clutch plates

- A friction clutch plate is **used in vehicles to allow the transmission input shaft and engine to run at the same speed when rotating**. The friction that is created between the engine and the transmission is what provides the force required to move the vehicle.

Friction or Clutch plates

- The clutch plate (Fig.1) helps to overcome the inertia and start the vehicle moving.
- When the automobile engine develops power that is transmitted via clutch as a twisting force (torque) from the engine crankshaft to driving wheel.
- A smooth and gradual transfer of power and torque is accomplished using a clutch friction unit to engage and disengage the power flow (Fig.2).
- Clutches are useful in devices that have two rotating shafts.

Friction or Clutch plates





(Fig.1) (Fig.2)

In a car, you need a clutch because the engine spins all the time, but the car's wheels do not when at rest.

Wheel can move only by the application of gear.

But without application of clutch if one applies gear to run the wheel, the engine stops because engine is not designed to run the wheel directly when the car is at rest and it is the clutch which gently engages between the driving wheel and the engine crankshaft and initiates motion of driving wheel. https://youtu.be/Tge1ufoS5jY

- https://youtu.be/Or1fCulo9LM Blanking
- https://youtu.be/Tge1ufoS5jY Clutch mfring

Gears

- A gear is a **machine component consisting of a toothed wheel attached to a rotating shaft**. Gears operate in pairs to transmit and modify rotary motion and torque (turning force) without slip.

Types of Gears

Types of Gears

Spur gear

Helical Gear

Bevel gear

Worm gear

Rack & pinion

Gear box in automobile

- A Gear Box is often called a transmission of power.
- Gear boxes simply refer to **a set of gears and their casing**. Since most motor vehicle engines have high operating and idling speeds, transmissions allow the machinery to operate efficiently and even aid in slowing and shutting down machinery.

Use of a gear box in Automobile

- It helps the engine to disconnect from driving wheels.
- It helps the running engine connect to the driving wheel smoothly and without shock.
- It provides the leverage between engine and driving wheels to be varied.
- This helps in reducing the engine speed in the ratio of 4 : 1 in case of passenger cars and in a greater ratio in case of heavy vehicles like trucks and lorries.
- It helps the driving wheels to drive at different speeds.
- It gives the relative movement between engine and driving wheels due to flexing of the road spring.

Gear Ratio

- Gear ratios are geared reduction steps in the gearbox. A gear reduction multiplies the engine torque by gear ratio amount. Torque requirement at the wheel depends on operating conditions.

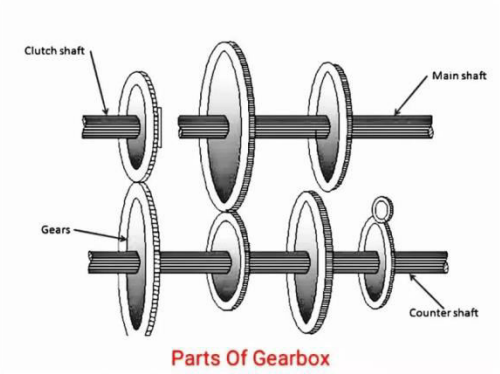
For example :

- Moving a vehicle from a standstill requires much more torque than the peak torque of the engine. Therefore the torque multiplies by the first gear ratio.
- Once starting the vehicle and moving using first gear, it requires less torque at the wheels to keep it moving. Hence it requires no multiplication or very less multiplication.

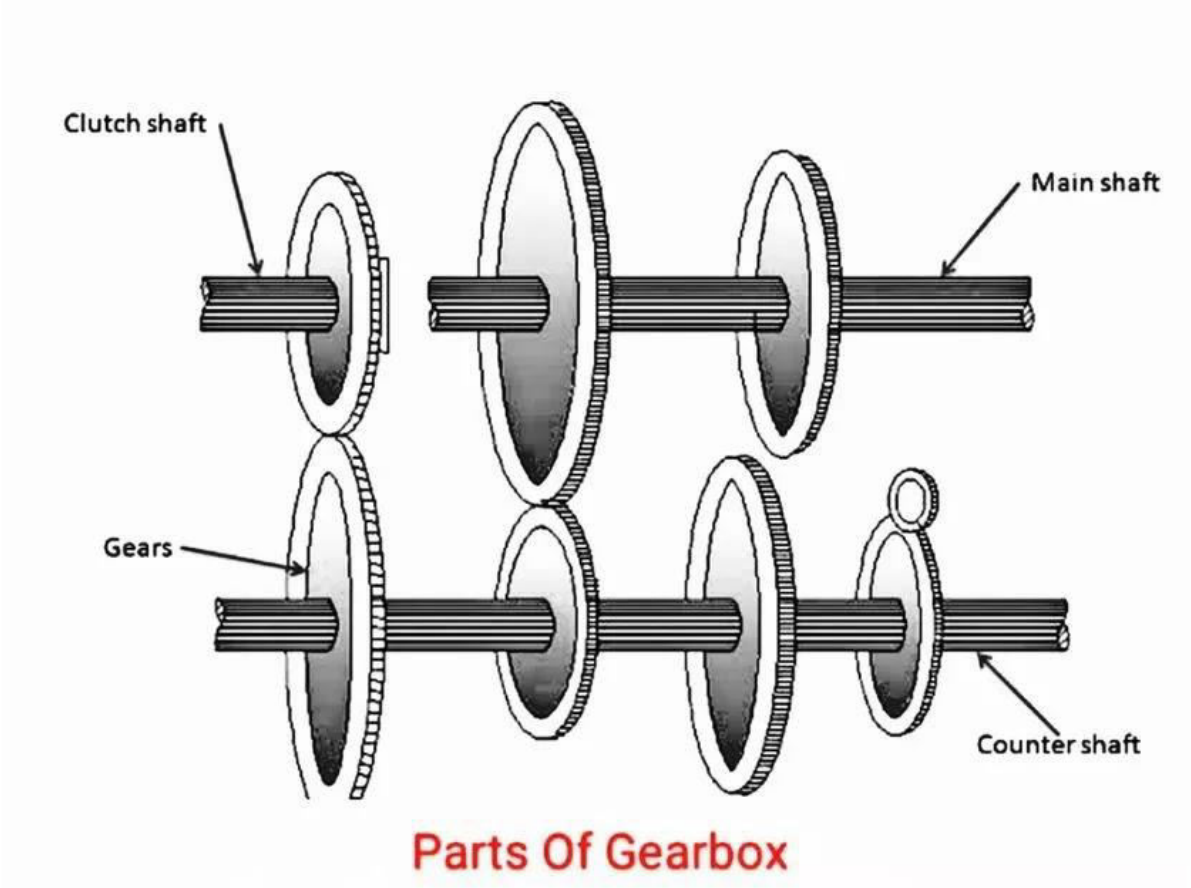
Parts of a gear box

- https://youtu.be/wCu9W9xNwtI

1. Clutch shaft
2. Counter shaft
3. Main shaft/Output shaft
4. Bearings
5. Gears
6. Gear selector fork



Parts of a gear box



Parts of a gear box

1. Clutch Shaft

- The clutch shaft or driving shaft is connected through the clutch and when the clutch is engaged, the driving shaft also rotates.
- Only one gear is fixed on the clutch shaft and this engine rotates with the same speed as the crankshaft. In addition, the driving shaft and main shaft are in the same line.

2. Counter Shaft / Layshaft

- The counter shaft is a shaft that connects directly to the clutch shaft. It has gear which connects it to the clutch shaft as well as the main shaft. It can be run at engine speed or below engine speed according to gear ratio.

Parts of a gear box

3. Main Shaft / Output Shaft

- The main shaft or output shaft that rotates at different speeds and also provides the necessary torque to the vehicle.
- The output shaft is a splined shaft, so that the gear or synchronizer can be moved to engage or disengage.

Parts of a gear box

4. Bearings

- The bearings are required to support the rotating part and reduce friction. The gear box has both a counter and main shaft which is supported by the bearing.

5. Gears

- Gears are used to transmitting the power from one shaft to another shaft. The amount of torque transmitted through the gears depends on the size of the gears.
- Higher the gear ratio, higher the torque / acceleration and lower the speed. All gears except those on the main shaft are fixed to their respective shafts;

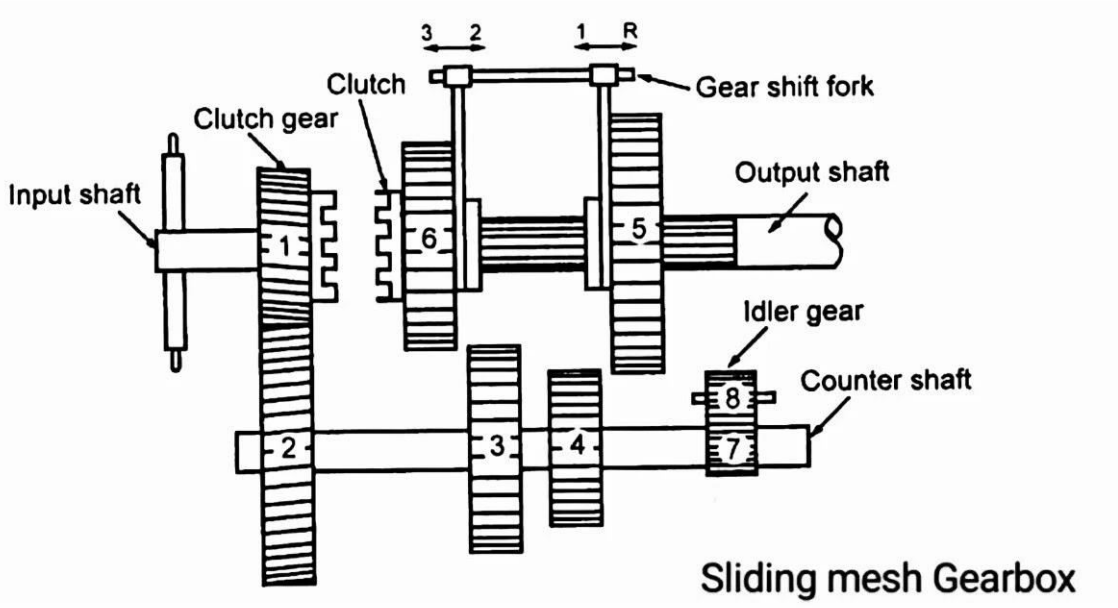
Parts of a gear box

6. Gear Selector Fork

- Gear selectors are simple devices that use a lever that selects gears to engage in disengage mechanisms.
- The motion of the lever slides the engaging part on the shaft. It depends on the type of gearbox whether the lever slides the gear or synchronizer that are already forged along the main shaft.

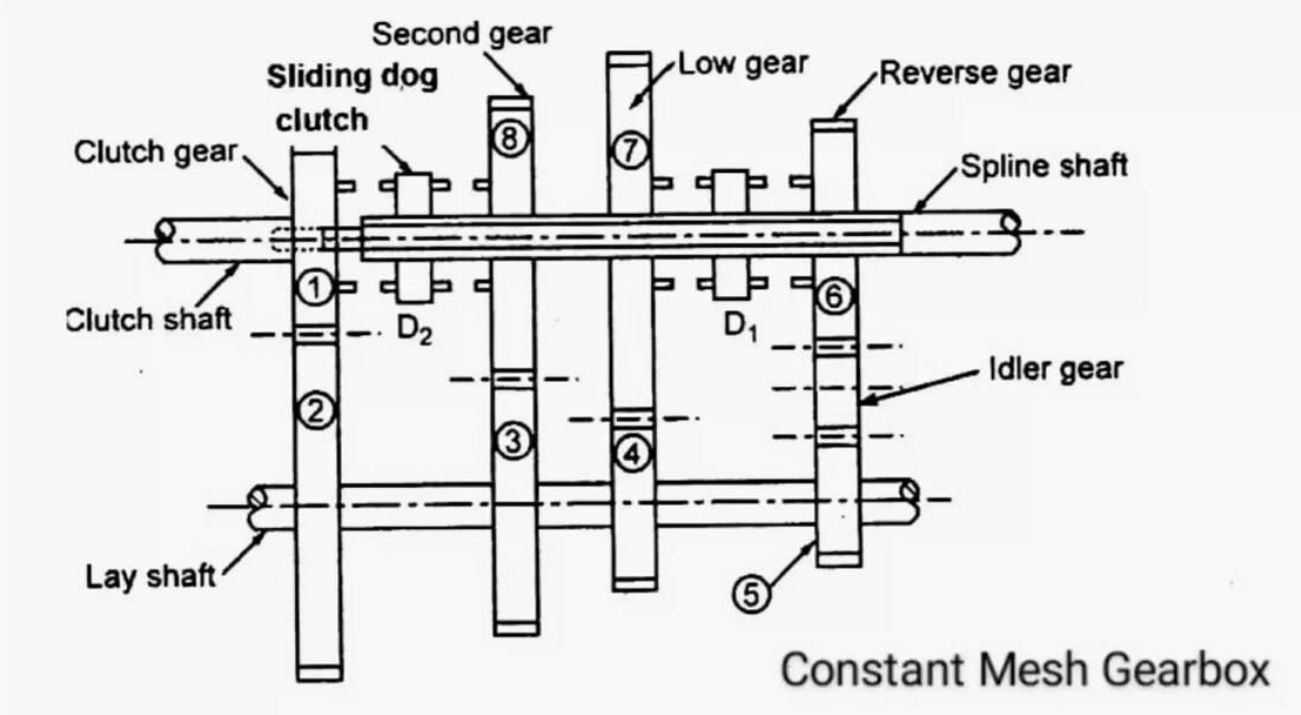
Manual Transmission

1. Sliding mesh Gear box



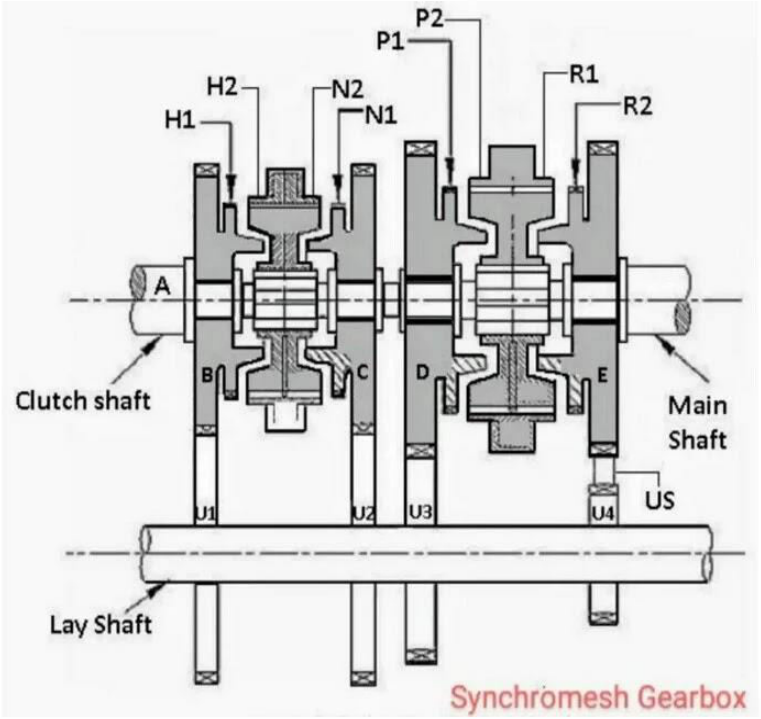
Manual Transmission

1. Constant mesh Gear box



Manual Transmission

1. Synchromesh Gear box



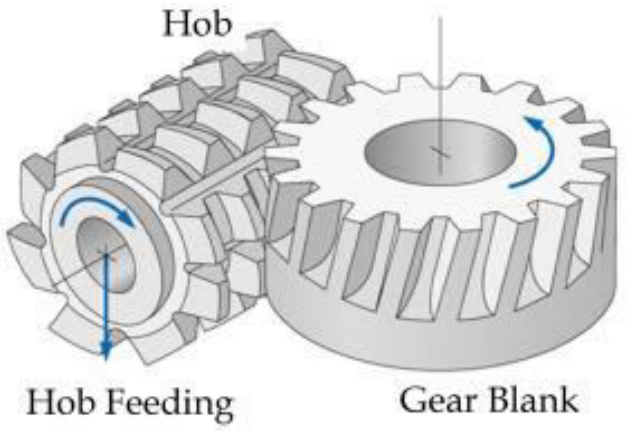
Gear manufacturing

- Gears can be manufactured by a variety of processes, including **casting, forging, gear hobbing, gear broaching, powder metallurgy, and blanking**.
- As a general rule, however, machining is applied to achieve the final dimensions, shape and surface finish in the gear.

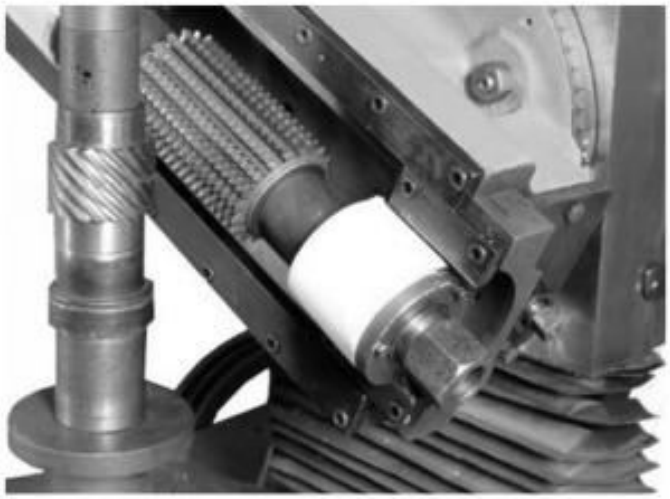
Gear Hobbing

- Gear Hobbing is **the process of generating gear teeth by means of a rotating cutter referred to as a 'hob'**.

A hob resembles a worm gear; it has a number of flutes around its periphery, parallel to the axis, to form cutting edges.



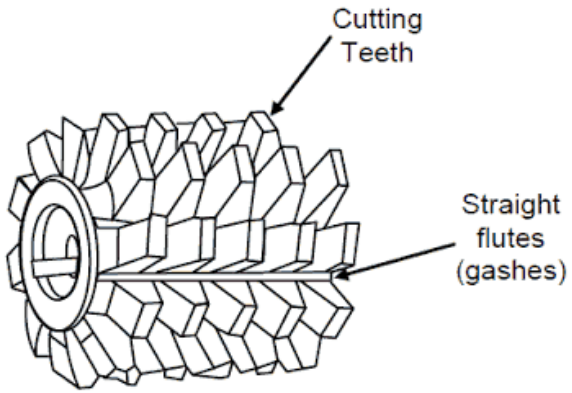
(A)



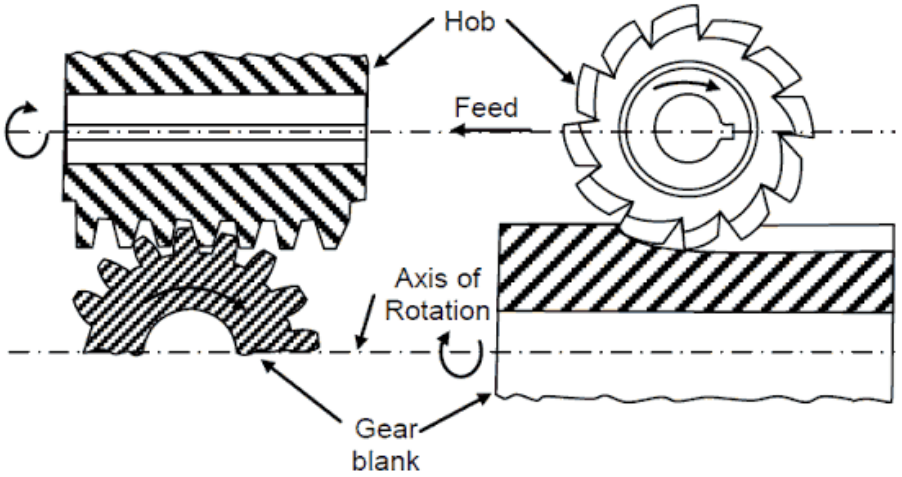
(B)

Gear Hobbing

- Gear hobbing



Gear Hob



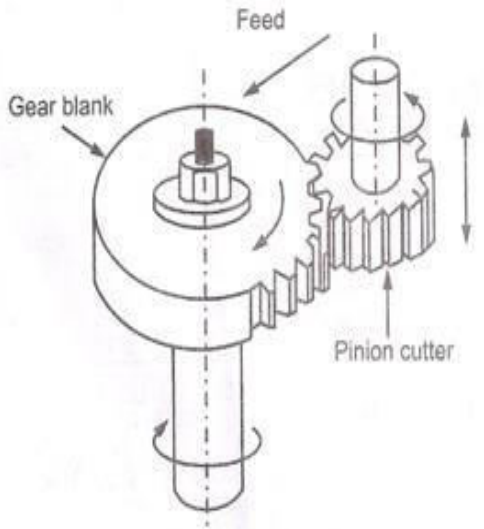
Process of Gear Hobbing

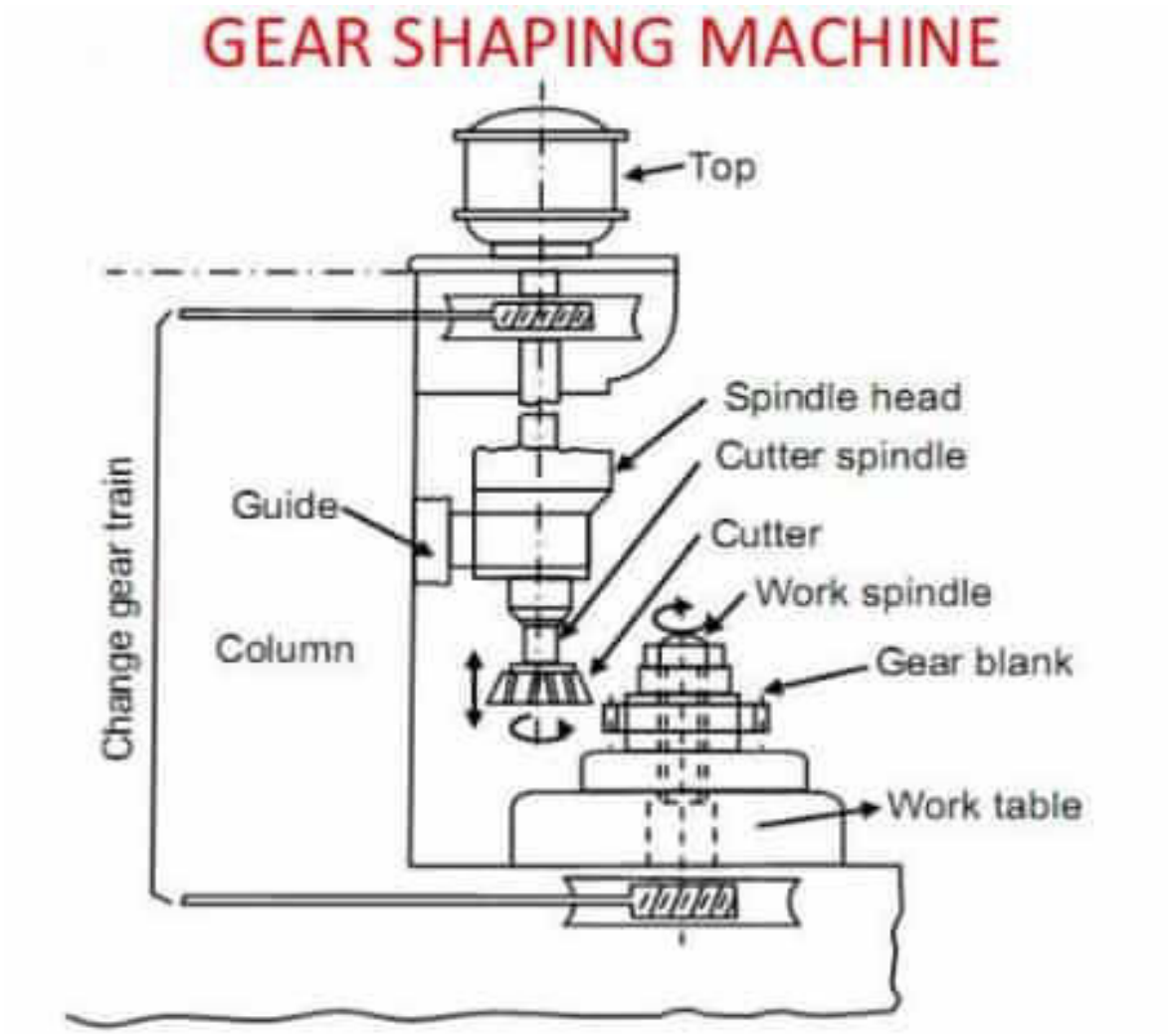
Gear Shaping

- Shaping is a milling process. This process helps form the gear teeth with the help of a rotating cutter tool, wherein its axis is parallel to that of the gear.
- The rotating speed and velocity of the cutter must match with the gear blank for teeth formation.
- A train of gears helps achieve the relative motion between the cutter shaft and the gear blank. Here the cutting may happen either at a downward or upward stroke.
- This is a widely used process for making internal and external gears. High dimensional accuracy is one of the major benefits of the shaping process apart from its cost-effective tools. A
- After this process, surface finishing may be required depending upon the application.

Gear Shaping

- Gear Shaping





Gear Hobbing

- Gear Hobbing is a machining process for gear cutting, cutting splines, in a milling machine.
- The teeth or splines of the gear are progressively cut into the material (a flat, cylindrical piece of metal) by a series of cuts made by a cutting tool called a hob.
- The hob is basically a worm cut across it to produce the tooth face cutting edges.
- All motions in hobbing are rotary, and the hob and gear blank rotate continuously as in two gears meshing until all teeth are cut.
- Hobbing is one of the most fundamental processes in gear manufacturing.

Gear Hobbing

Gear Hobbing

Gear Shaping

- Gear shaping is a process for generating gear teeth by a rotating and reciprocating a pinion-shaped cutter. The cutter axis is parallel to the gear axis.
- The cutter rotates slowly in timed relationship with the gear blank at the same pitch-cycle velocity, with an axial primary reciprocating motion; to produce the gear teeth.
- A train of gears provides the required relative motion between the cutter shaft and the gear-blank shaft. Cutting may take place either at the down stroke or upstroke of the machine.
- Gear shaping is one of the most versatile of all gear cutting operations used to produce internal gears, external gears, and integral gear-pinion arrangements.
- **Advantages** of gear shaping with pinion-shaped cutter are the high dimensional accuracy achieved and the less expensive tools. The process is applied for finishing operation in all types of production rates.

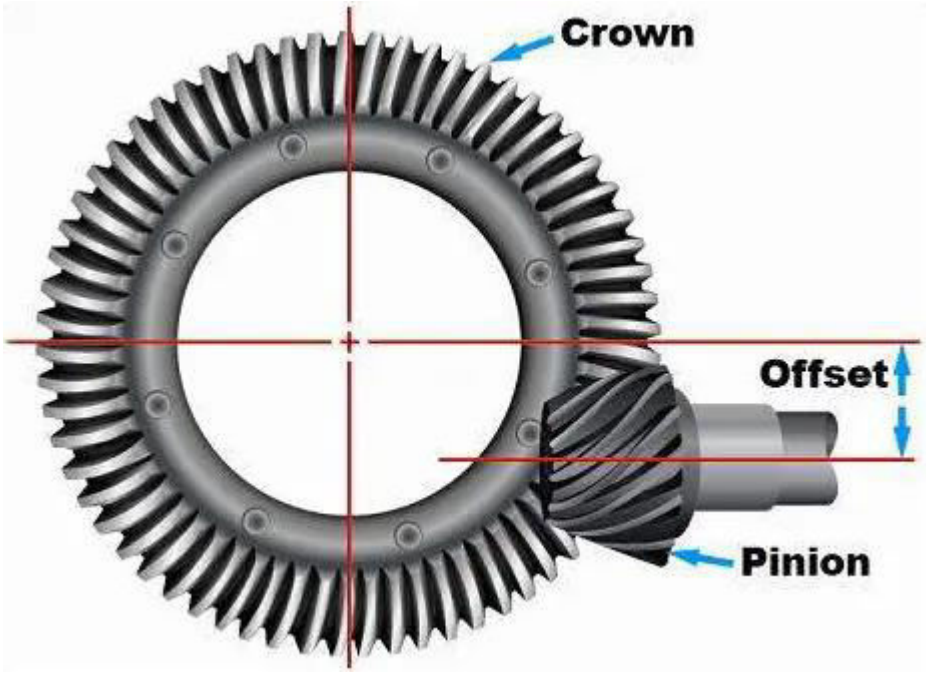
Hypoid Gears

- Hypoid gears are a type of spiral bevel gearbox, with the difference that hypoid gears have axes that are non-intersecting and not parallel.
- In other words, the axes of hypoid gears are offset from one another. The basic geometry of the hypoid gear is hyperbolic, rather than having the conical geometry of a spiral bevel gear.

Hypoid Gears

- In a hypoid gearbox, the spiral angle of the pinion is larger than the spiral angle of the gear, so the pinion diameter can be larger than that of a bevel gear pinion.
- This provides more contact area and better tooth strength, which allows more torque to be transmitted and high gear ratios (up to 200:1) to be used.
- Since the shafts of hypoid gears don’t intersect, bearings can be used on both sides of the gear to provide extra rigidity.

Hypoid Gears



The difference in spiral angles between the pinion and the crown (larger gear) causes some sliding along the teeth, but the sliding is uniform, both in the direction of the tooth profile and longitudinally. This gives hypoid gearboxes very smooth running properties and quiet operation.
https://youtu.be/O-JTo0_Detw

Heat treatment of gears

- **Induction hardening** is commonly used in the heat treatment of gears. Induction heating is a process which uses alternating current to heat the surface of a gear tooth. The area is then quenched resulting in an increase in hardness in the heated area. It is typically accomplished in a relatively short period of time

Heat treatment of gears

- Heat treatments improve physical properties such as **surface hardness**, which imparts wear resistance to prevent tooth and bearing surfaces from simply wearing out

Heat treatment of gears

- Common types of heat treating methods include
- **Annealing,**
- **Normalising,**
- **Quenching,**
- **Stress relieving** or Tempering

Gear Finishing Process

- For effective and noiseless operation at high speed , it is important that profile of teeth is accurate, smooth without irregularities
- In machining the gear blank is composed of tiny flats on its surface.
- Finishing operation intend to perform

1. Eliminate after effect of heat treatment.
2. Correct error of profile & pitch.
3. Ensure proper concentricity of Pitch circle & Centre hole.

Gear finishing methods

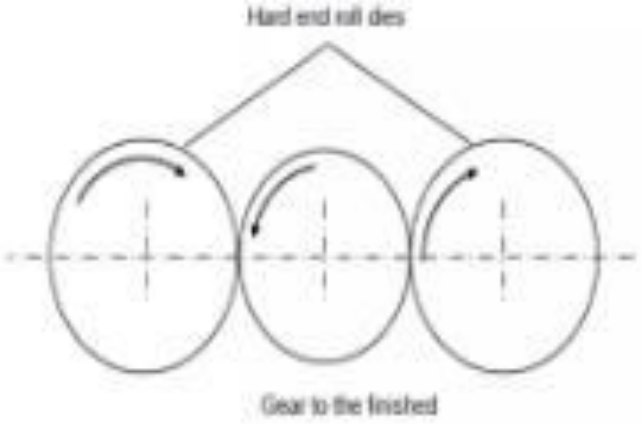
- Gear Shaving
- Gear Rolling
- Gear Grinding
- Gear Honing
- Gear Lapping
- Blast finishing
- Shot Peening
- Phosphate coating

Gear Shaving

- Process of finishing of gear tooth by running it at very high rpm in mesh with a gear shaving tool.
- A gear shaving tool is of a type of rack or pinion having hardened teeth provided with serrations.
- These serrations serve as cutting edges which do a scrapping operation on the mating faces of gear to be finished. Both gears in mesh are pressed to make proper mating contact.
- The gear shaving operation is composed by the simultaneous rotation of workpiece and cutter as a pair of gears with crossed axes. The crossed axes generate a reciprocal sliding action between the flank gear tooth and the cutter teeth.
- Soft materials like aluminium alloy, brass, bronze, cast iron etc. and unhardened steels are mostly finished by shaving process.

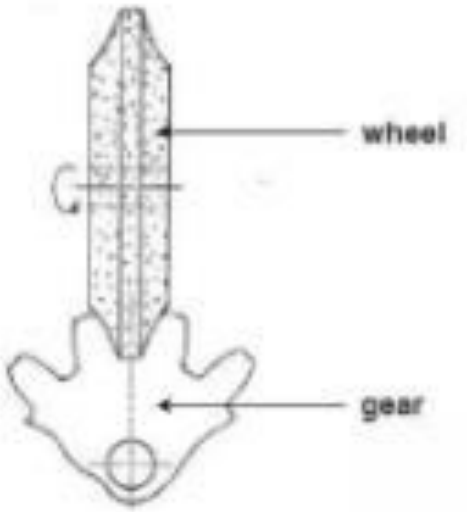
Gear Rolling/Roll Finishing/Gear Burnishing

- This process involves use of two hardened rolling dies containing very accurate tooth profile of the gear to be finished.
- The gear to be finished is set in between the two dies as and all three are revolved about their axis.
- Pressure is exerted by both the rolling dies over the gear to be finished.
- The surface irregularity of gear teeth is squeezed by hard die through plastic deformation of high spots and burrs on the profile of gear tooth resulting to smooth surface
- The resulting cold Working of the tooth surfaces improves the surface finish,
- also induces compressive residual stresses thus improving their fatigue life.
- Process improves only surface finish of teeth and does not correct the tooth profile or pitch of teeth.
- This process is suitable only for gears which do not require high accuracy.



Gear Grinding

- Abrasive grinding wheel of a particular shape and geometry are used for finishing of gear teeth.
- The two basic methods for gear grinding are form grinding (non-generating) and generation grinding.

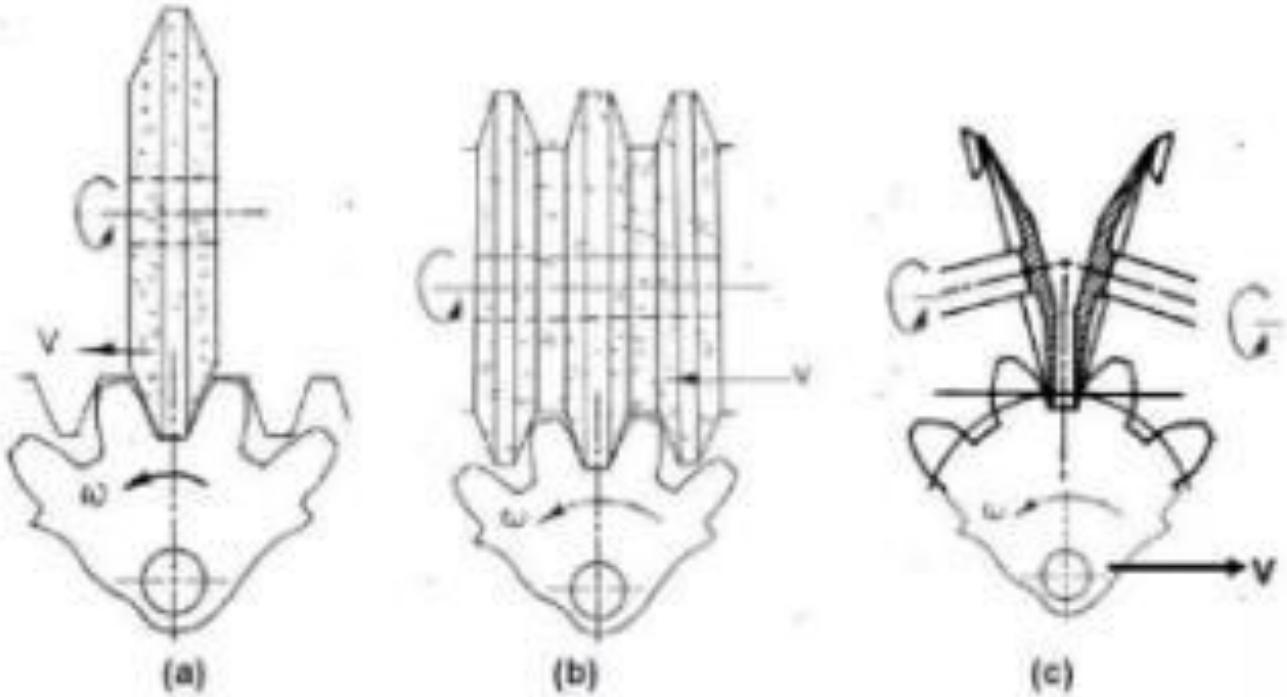


Form Grinding

- This is very similar to machining gear teeth by a single disc type form milling cutter where the grinding wheel is dressed to the form that is exactly required on the gear.
- Gear to be finished is mounted and reciprocated under the grinding wheel.
- The teeth are finished one by one and after one tooth finished, the blank is indexed to the next tooth space as in the form milling operation.
- Need of indexing makes the process slow and less accurate.
- The wheel or dressing has to be changed with change in module, pressure angle and even number of teeth.
- Form grinding may be used for finishing straight or single helical spur gears, straight toothed bevel gears as well as worm and worm wheels.

Gear Grinding

The simplest and most widely used method is very similar to spur gear teeth generation by one or multi-toothed rack cutter. The single or multi-ribbed rotating grinding wheel is reciprocated along the gear teeth as shown. Other tool – work motions remain same as in gear teeth generation by rack type cutter. For finishing large gear teeth a pair of thin dish type grinding wheels are used. Whatsoever, the contacting surfaces of the wheels are made to behave as the two flanks of the virtual rack tooth.



(a) (b) (c)

Gear Honing

- Honing is suitable for finishing of heat treated gears.
- It is carried out with steel tools having abrasive or cemented carbide particles embedded in their surface.I
- t is used for super finishing of the generated gear teeth. Honing machines are generally used for this operation. The hones are rubbed against the profile generated on the gear tooth.
- Gears that have been honed instead of ground offer excellent wear characteristics and are extremely quiet.
- it is mostly used in automotive, aerospace, truck, and heavy equipment industries.
- This method is suitable for any application where quiet, robust, and reliable gearing is required.
- **Benefits of gear honing gear honing:**
- Corrects dimensional errors
- Corrects distortions caused by heat treatment
- Removes nicks caused by handling
- Improves surface finishing

Gear Lapping

- Lapping is done on generally gears having hardness more than 45 RC to remove burrs, abrasions from the surface and to remove small errors caused by heat treatment.
- In this process the gear to be lapped is run under load in mesh with a gear shaped lapping tool or another mating gear of cast iron.
- Abrasive paste is introduced between the teeth under pressure. It is mixed with oil and made to flow through the teeth.
- Lapping typically improves the wear properties of gear teeth, and corrects the minute errors in involute profile, helix angle, tooth spacing and concentricity created in the forming, cutting or in the heat treatment of the gears.
- Therefore, gear lapping is most often applied to sets of hardened gears that must run silently in service.

Blast Finishing

- Blast finishing uses the high-velocity impact of particulate media to clean and finish a surface.
- The most well known of these methods is sand blasting, which uses grits of sand (SiO_2) as the blasting media.
- Various other media are also used in blast finishing, including hard abrasives such as aluminum oxide (Al_2O_3) and silicon carbide (SiC), and soft media such as nylon beads and crushed nut shells.
- The media is propelled at the target surface by pressurized air or centrifugal force.
- In some applications, the process is performed wet, in which fine particles in a water slurry are directed under hydraulic pressure at the surface.

Blast Finishing

- for cleaning, smoothening and roughening of metal casts and forged parts-Paint removal, Rust removal, Etching for shiny surface

- Cleaning operations using abrasive blasting can present risks for worker's health and safety.
- large amount of dust created through abrasive blasting is hazardous Noise pollution & safety issues

Shot Peening

- In shot peening, a high-velocity stream of small cast steel pellets (called shot) is directed at a metallic surface with the effect of cold working and inducing compressive stresses into the surface layers.
- Used primarily to improve fatigue strength of metal parts.
- Cleaning is accomplished as a by-product of the operation.
- Shots (round metallic, glass, or ceramic particles) produce force sufficient to create plastic deformation
- it operates by the mechanism of plasticity rather than abrasion: each particle functions as a ball-peen hammer. In practice, this means that less material is removed by the process, and less dust created

Shot Peening

- Peening a surface spreads it plastically, causing changes in the mechanical properties of the surface.
- Its main application is to avoid the propagation of microcracks from a surface. Such cracks do not propagate in a material that is under a compressive stress
- Shot peening is often called for in aircraft repairs to relieve tensile stresses built up in the grinding process and replace them with beneficial compressive stresses.
- Depending on the part geometry, part material, shot material, shot quality, shot intensity, and shot coverage, shot peening can increase fatigue life up to 1000%.
- Plastic deformation induces a residual compressive stress in a peened surface, along with tensile stress in the interior. Surface compressive stresses confer resistance to metal fatigue and to some forms of stress corrosion. The tensile stresses deep in the part are not as problematic as tensile stresses on the surface because cracks are less likely to start in the interior.

Phosphate Coating

- **Phosphate coatings** are used on steel parts for corrosion resistance, better adherence of lubrication, lubricity, or as a foundation for subsequent coatings or painting.
- It serves as a conversion coating in which a dilute solution of phosphoric acid and phosphate salts is applied via spraying or immersion and chemically reacts with the surface of the part being coated to form a layer of insoluble, crystalline phosphates.
- Phosphate conversion coatings can also be used on aluminum, zinc, cadmium, silver and tin.
- The main types of phosphate coatings are manganese, iron and zinc. Manganese phosphates are used both for corrosion resistance and lubricity and are applied only by immersion.
- Iron phosphates are typically used as a base for further coatings or painting and are applied by immersion or by spraying.
- Zinc phosphates are used for corrosion resistance (phosphate and oil), a lubricant base layer, and as a paint/coating base and can also be applied by immersion or spraying

Thank You

- Blast Finishing
- Blast finishing uses the high-velocity impact of particulate media to
- clean and finish a surface.
- The ...

- Gear Lapping
- Lapping is done on generally gears having hardness more than 45 RC to
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