



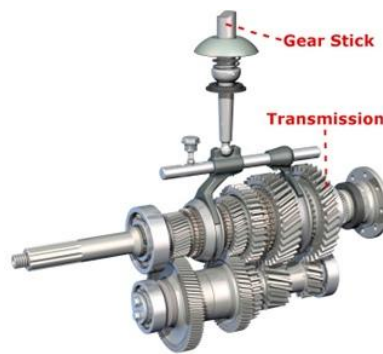
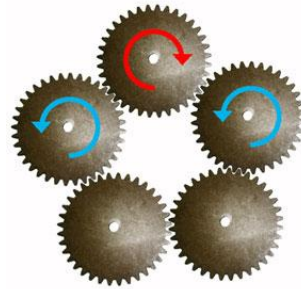
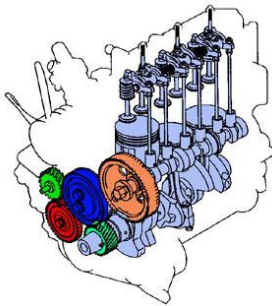
Manufacturing quality transmission products

An Introduction to Gears & Gear Manufacturing

Gear Descriptions and Functions

Gears are mechanical components within machines and mechanical assemblies which transmit power and motion through successive engagement of their peripheral teeth. Gears perform certain key functions with machines and assemblies, including:

- Reversing rotational direction
- Altering angular orientation of rotary motion
- Converting rotary to linear motion and vice-versa
- Altering speed and power transmission ratios



Gear design is based upon an involute curve form which imparts a rolling, rather than sliding action between engaging teeth. This rolling action provides a uniform rotary action that lowers both friction and wear of the gear teeth.



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Gear Types

Gears may have internal or external teeth and are available in forms that typically relate to axis positions, which include:

- Parallel axes, which pertain to two or more tangent pitch shafts using either spur gears-the most common type of gear, or helical gears.
- Intersection axes using straight bevel gears or spiral bevel gears.
- Non-intersecting, non-parallel axes, which refer to worms and worm gears, crossed helical gears and hypoid gears.
- Racks and pinions which are used to convert rotary motion to linear motion are other familiar gear types.



Spur Gears



Helical Gears



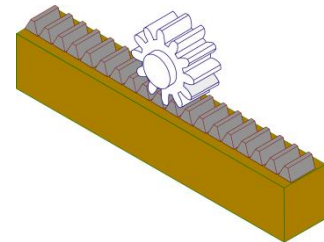
Straight Bevel Gears



Spiral Bevel or Hypoid Gears



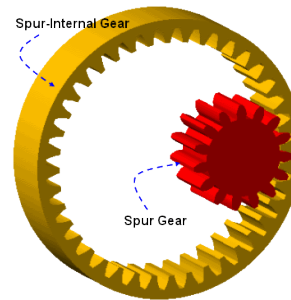
Worm & Worm Gear



Rack & Pinion



Crossed Helical Gears



Internal Gear



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Gear Manufacturing

Materials used to produce gears may include various types of steel, which is the most common material, and various non-ferrous materials including plastics and composites. Manufacturing methods include: machining, forging, casting, stamping, powder metallurgy techniques, and plastic injection moulding. Of these, machining is the most common manufacturing method used.

It can't be stated strongly enough the importance of the turning of the blanks prior to machining the gear teeth, without the correct tolerances being achieved it will not be possible to produce a high standard of gearing. It is not for this paper to discuss the methods and processes involved as this subject is widely covered elsewhere, but it is so vital to gear manufacture.



The Turning Process

Gear machining is classified into two categories:

- Gear Generating
- Gear Form-Cutting

Gear generating involves gear cutting through the relative motion of a rotating cutting tool and the generating, or rotational, motion of the work piece. The two primary generating processes are hobbing and shaping.

Hobbing uses a helically fluted cutting tool called a hob; both the hob and the work piece rotate as the hob is fed axially across the gear blank. Hobbing is limited to producing external gear teeth on spur and helical gears. Hobbing can be performed on a single gear blank, but also allows for stacking of multiple work pieces, increasing production rates.

Shaping produces gears by rotating the work piece in contact with a reciprocating cutting tool.

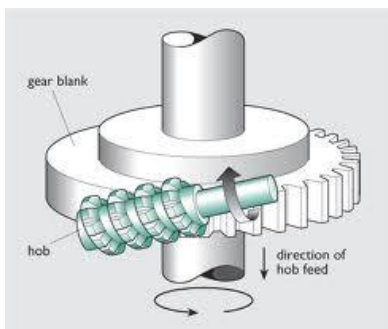


Diagram of Gear Hobbing Process

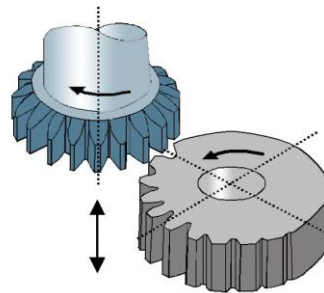


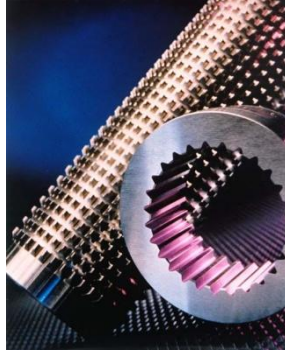
Diagram of Gear Shaping Process



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Gear form-cutting uses formed cutting tools that have the actual shape, or profile, desired in the finished gear. The two primary form-cutting methods are broaching and milling. Broaching is the fastest method of machining gears and is performed using a multi-tooth cutting tool called a broach. Each tooth on the broach is generally higher than the preceding tooth. As a result, the depth of cut increases with each tooth as the broaching operation progresses. Broaching is typically used to produce internal gear teeth.



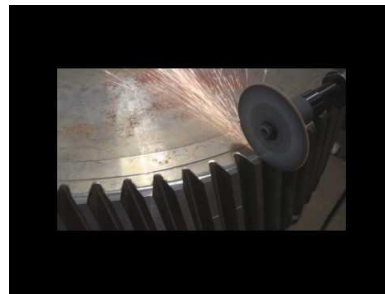
Broaching tool and Part Produced

Gear Deburring

The above discussed methods of gear manufacture have an unfortunate side effect of producing machining burrs around the gear tooth profile. It is vital that these burrs are removed so that nothing obstructs the working profile of the gear or potentially cause deposits within the gear box housing lubrication system which may lead to abrasive wear failure. There are many methods employed in the deburring process from manual fettling to dedicated machines.



Gear before any Deburring



Gear being Deburred



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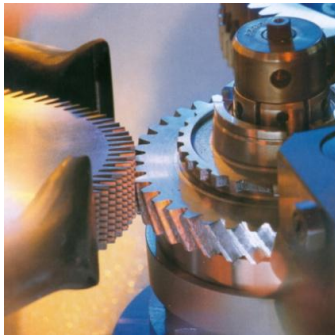
Gear Finishing

After manufacturing, gears require a number of finishing operations. Finishing operations include heat treatment and final dimensional and surface finishing. This can be accomplished using:

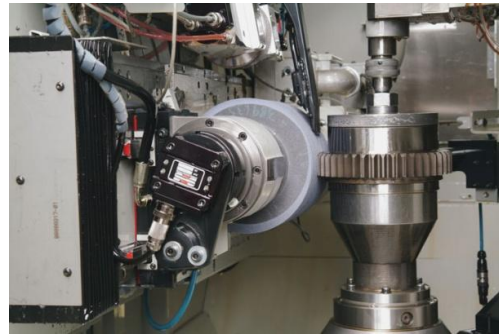
- Shaving
- Grinding

Shaving is performed with a cutter having the exact shape of the finished gear tooth. Only small amounts of material are removed by a rolling and reciprocating action. The process is fast but generally expensive due to the cost of machinery and tooling. Shaving is typically performed prior to heat treating.

Grinding sometimes serves as an initial gear production process, but is most often employed for gear finishing. Grinding is classified as either form grinding or involute-generation grinding. Form grinding uses wheels having the exact shape of the tooth spacing. The grinding wheels are either vitrified-bond wheels, which require periodic redressing, or Cubic Boron Nitride (CBN) wheels, which can last hundreds of times longer than vitrified wheels without dressing. Involute-generation grinding refers to a grinding wheel or wheels used to finish the gear tooth by axially rotating the work piece while it is reciprocated in an angular direction, which in turn is determined by the type of gear being finished. This type of grinding is performed either intermittently or continuously. Intermittent grinding uses tooth profiles dressed on cup wheels, or on one or two single-rib wheels. Each tooth is ground individually and indexed to the wheel. Continuous grinding uses grinding wheels with the rack profile dressed helically on the outside diameter, both the grinding wheel and the work turn in timed relationship for continuous finishing.



Gear Shaving



Gear Grinding using Rack Profile type Grinding Wheel



Gear Grinding using a Single Rib Wheel



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