

An understanding of gears and gear types

Gear Cutting is one of the specialities of Arrow Engineering, three generations of the Arrowsmith family have been involved in the manufacture of gears. Since inception in 1981, Arrow Engineering have been involved in the design and manufacture of gears for all sorts of industries. Industries include food processing, pharmaceutical, agricultural plant and machinery, marine, mining, textiles, railways and many more.

We are specialists in reverse engineering and can remanufacture a new / replacement component from a broken one. We can also work to original drawings and samples provided. Arrow Engineering are pleased to present a brief understanding of the different of types of gears and their physical characteristics below:

Spur Gears

Spur gears or straight-cut gears are the simplest type of gear. They consist of a circular shape with teeth projecting radially, the edge of each tooth is straight and aligned parallel to the axis of rotation. These gears can be meshed together correctly only if they are fitted to parallel shafts.



Internal and External Gears

As the name suggests internal gears have the teeth cut on the inside of a cone or cylinder. Conversely an external gear has the teeth cut on the outside of the cylinder or cone. Internal Gears possess several advantages when properly applied. One such advantage is reduced sliding action. Corresponding working surfaces of the teeth of an internal gear and pinion are more nearly of the same length than is the case with an external gear and pinion having the same tooth ratio and tooth length.

Therefore, the relative slippage of the teeth is less in the case of the internal. This point presents one of the advantages of using internal Gears. The sliding action of one tooth over another cause's friction; and as a result, causes in tooth wear. So, a reduction in the amount of sliding action is desirable.



Worm Gears

Worm gears resemble screws that usually mesh with an ordinary looking, circular shaped gear, which is called the gear, wheel, or worm wheel. This type of gear sets is a simple and compact way to achieve a high torque, low speed gear ratio. For example, helical gears are normally limited to gear ratios of less than 10:1 while worm-and-gear sets vary from 10:1 to 500:1. A disadvantage is the potential for considerable sliding action, leading to low efficiency.

Worm gears can be considered a species of helical gear, but its helix angle is usually somewhat large (close to 90 degrees). The body is usually fairly long in the axial direction; and it is these attributes which give it its screw like qualities. The distinction between a worm and a helical gear is made when at least one tooth persists for a full rotation around the helix. If this does occur, it is a 'worm'; if not, it is a 'helical gear'. A worm gear may have as few as one tooth. If that tooth persists for several turns around the helix, the worm will appear, superficially. To have more than one tooth, what one in fact sees is the same tooth reappearing at intervals along the length of the worm gear.

The usual screw nomenclature applies: a one-toothed worm gear is called single thread or single start; a worm gear with more than one tooth is called multiple thread or multiple start.



Face Gear

A face gear normally consists of a disc shaped gear grooved on a least one side, in combination with a spur, helical or conical pinion. Face gears have a planar pitch surface and a planar root surface, both of which are perpendicular to the axis of rotation. It can also be referred to as a face wheel, crown gear, crown wheel and contrate gear or contrate wheel.

Bevel Gears

Bevel Gears are used to connect shafts whose axes lie at an angle to each other. Although most applications are at right angle. Bevel gears can be manufactured to suit virtually any angle, making it possible to change the operating angle. By using different numbers of teeth and changing the diameter on each wheel, the ratio of teeth between the drive and the driven wheels can be increased or decreased. As such, the rotational drive, speed and torque can be changed. So, if the speed increases, the torque diminishes.



Splining

Splines are ridges or teeth on a drive shaft that mesh with grooves in a mating piece and transfer torque to it, maintaining the angular correspondence between them. For instance, a gear mounted on a shaft might use a male spline on the shaft that matches the female spline on the gear. The splines on the pictured drive shaft match with the female splines in the centre of the clutch plate, while the smooth tip of the axle is supported in the pilot bearing in the flywheel. An alternative to splines is a keyway and key, though splines provide a longer fatigue life.



Timing Pulleys

Timing pulleys are designed to carry a tensioned belt in a given application. A common application would be in a car where the timing belt runs over a tensioner and the pulley keeps the belt in place. Timing pulleys typically do not have a flange. However, some timing pulleys with timing belts have flanges to keep the timing belt centred. Timing pulleys can be made out of a wide variety of materials including aluminium, steel, brass and plastic.



Double Helical or Herringbone Gears

Double helical gears, or herringbone gear, overcome the problem of axial thrust presented by “single” helical gears by having two sets of teeth that are set in a V shape. Each gear in a double helical gear can be thought of as two standard mirror image helical gears stacked.

This cancels out the thrust since each half of the gear thrusts in the opposite direction. Double helical gears are more difficult to manufacture due to their more complicated shape. We produce all sizes of double helical or herringbone gear in a wide variety of materials.

Elliptical / Quadrant Gears

Two non-circular gears with the same elliptical outline, each pivoting around one focus and positioned at the proper angle, will turn smoothly while maintaining contact at all times. Alternatively, they can be connected by chain or a timing belt, or in the case of a bicycle the main chain-ring main may be elliptical, or an ovoid similar to an ellipse in form.



Such elliptical gears may be used in mechanical equipment to produce variable angular speed or torque from a constant rotation of the driving axle. In the case of a bicycle to allow a varying crank rotation speed with inversely varying mechanical advantage. Elliptical bicycle gears make it easier for the chain to slide off the cog when changing gears. An example gear application would be a device that winds thread onto a conical bobbin on a spinning machine. The bobbin would need to wind faster when the thread is near the apex than when it is near the base.

Helical Gear

Helical gears offer a refinement over spur gears. The leading edges of the teeth are not parallel to the axis of rotation, but are set at an angle. Since the gear is curved, this angling causes the tooth shape to be a segment of a helix. Helical gears can be meshed in a parallel or crossed orientations. The former refers to when the shafts are parallel to each other; this is the most common orientation. In the latter, the shafts are non-parallel, and in this configuration are sometimes known as “skew gears”.

The angled teeth engage more gradually than do spur gear teeth causing them to run more smoothly and quietly. With parallel helical gears, each pair of teeth first make contact at a single point at one side of the gear wheel. The moving curve of contact then grows gradually across the tooth face to a maximum then recedes until the teeth break contact at a single point on the opposite side. In spur gears teeth suddenly meet at a line contact across their entire width causing stress and noise.



Broaching

Broaching is a process that uses a toothed tool, called a broach, to remove material. There are two main types of broaching: linear and rotary. In linear broaching, which is the more common process, the broach is run linearly against a surface of the workpiece to affect the cut. Linear broaches are used in a broaching machine, which is also sometimes shortened to broach.

In rotary broaching, the broach is rotated and pressed into the workpiece to cut an axis symmetric shape. Broaching is used when precision machining is required, especially for odd shapes. Commonly machined surfaces include circular and non-circular holes, splines, keyways, and flat surfaces. Typical workpieces include small to medium sized castings, forgings, screw machine parts, and stampings

Sprockets and Pulleys

A sprocket is a toothed wheel that meshes with roller chain of the same pitch (pitch is the measurement from roller pin centre to centre of the next roller pin of the chain). The standard range is mainly imperial pitch (1/4" up to 3" pitch) there are also a few metric pitch chains and sprockets available (i.e. 6mm and 8mm pitch). They can also be single (simplex), double (duplex), triple (triplex) and even 4 row (quadruplex) drives.

With a variety of teeth numbers, drives can be designed to change the ratio and speed of driven equipment e.g. by increasing the drive sprocket you can increase the speed of the drive or vice versa. Sprockets are used in bicycles, motorcycles, cars, tracked vehicles, and other machinery. Either to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a track, tape etc.



Chain Coupling

Sprockets can be used as a high strength coupling, by meshing two, same number of teeth simplex sprockets together with a duplex chain.

A Chain Coupling is pound for pound much stronger than a rubber insert type coupling (size for size) because of being all steel, this also can be used to transmit much higher torques in compact / tight spaces.



Heat Treatment

Heat treatment involves the use of heating or chilling, normally to extreme temperatures, to achieve a desired result such as hardening or softening of a material. We use various methods of heat treatment to suit different applications including Nitriding, Cyaniding, Induction and Flame Hardening.

Nitriding

Nitriding is used for the hardening the surface of medium carbon alloy steels. It is a process of hardening which uses Nitrogen gas, and is used to harden the top surface of the skin of metal. In conjunction with the use of Ammonia, a Nitrogen atom is deposited, which makes the material hard. Nitriding is done in an electric furnace where temperatures range between 450oC and 510oC.

The finished / machined part is placed in an airtight container that has outlet and inlet tubes, which ammonia gas is circulated. During this process, Nitrogen gas is released from ammonia in the form of atomic Nitrogen, which reacts with the surface of the part and forms iron nitrate. The depth of the surface hardness depends on the length of time spent at the Nitriding temperature. The finish is a dull black colour.

Carbonising / Case Hardening

This process is used to provide a hardened external surface, whilst keeping the inner core soft. It is a process of carbonising by saturating the surface layer with a layer of steel carbon. The purpose of case hardening is to provide a tough hard exterior with a soft interior which helps to absorb shock.

Induction Hardening and Flame Hardening

Induction Hardening and Flame Hardening are hardened by heating with an Oxy-acetylene flame



Procedure for Hardening

Steel is heated above its critical temperature range; it is held at that temperature for a definite period of time. The steel is then rapidly cooled by quenching. The quenching method is selected according to the degree of hardness required. Air, Water, brine, oils and molten salts are used as quenching mediums. When steel is hardened the process is called hardening, it becomes brittle and has a high residual stress.

Tempering modifies the properties of the hardened steel by quenching and in doing so, increases its usefulness. There are three categories of tempering; low temperature, medium temperature and high temperature. Depending on the type of hardening required.

Tempering can be used to relieve stresses, reduce brittleness, improve ductile strength and to increase wear resistance.