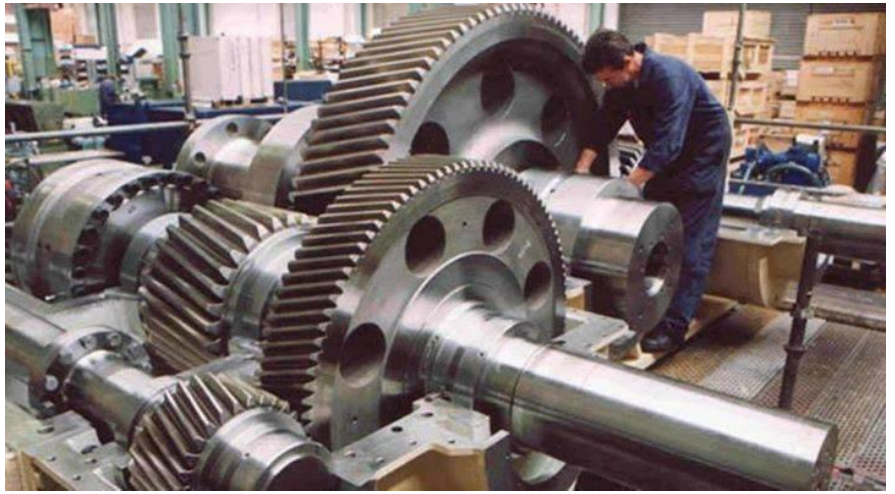
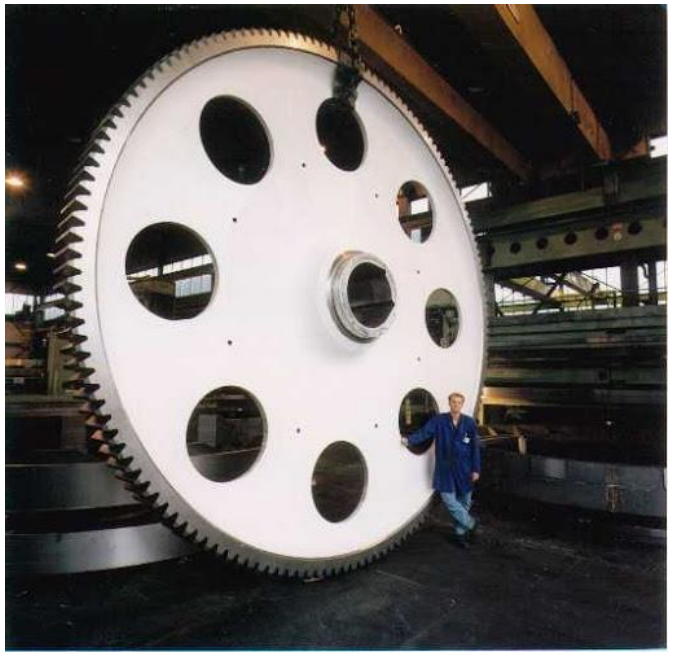
Gears. Introduction

Gears



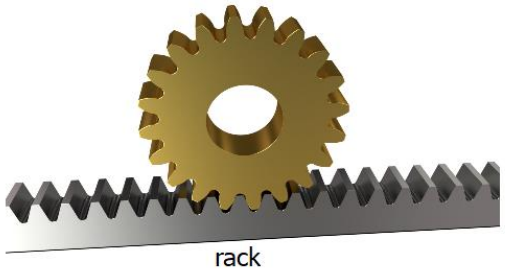
A gear is a wheel with teeth on its outer edge.
The teeth of one gear mesh (or engage) with the teeth of another.

Gears and their mechanical characteristics are widely employed throughout industry to transmit motion and power in a variety of mechanical devices.



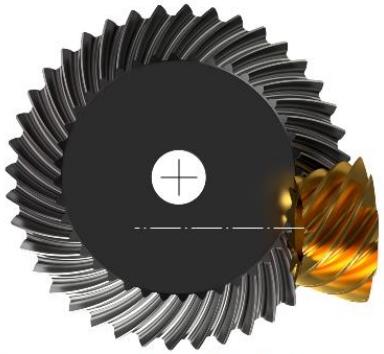
Types of gears


spur gears
(external toothing)

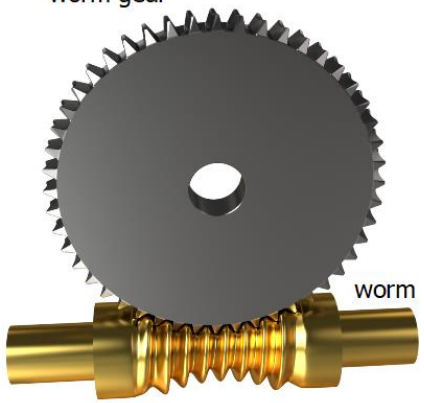

rack

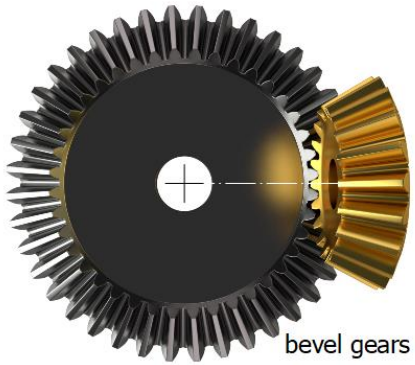

internal toothing


screw gears
(hyperboloid gears)


screw bevel gears
(hypoid gears)

worm gear


worm


bevel gears

Cylindrical gears:

- external toothed gears
- internal toothed gears
- toothed racks
- screw gears (hyperboloid gears)

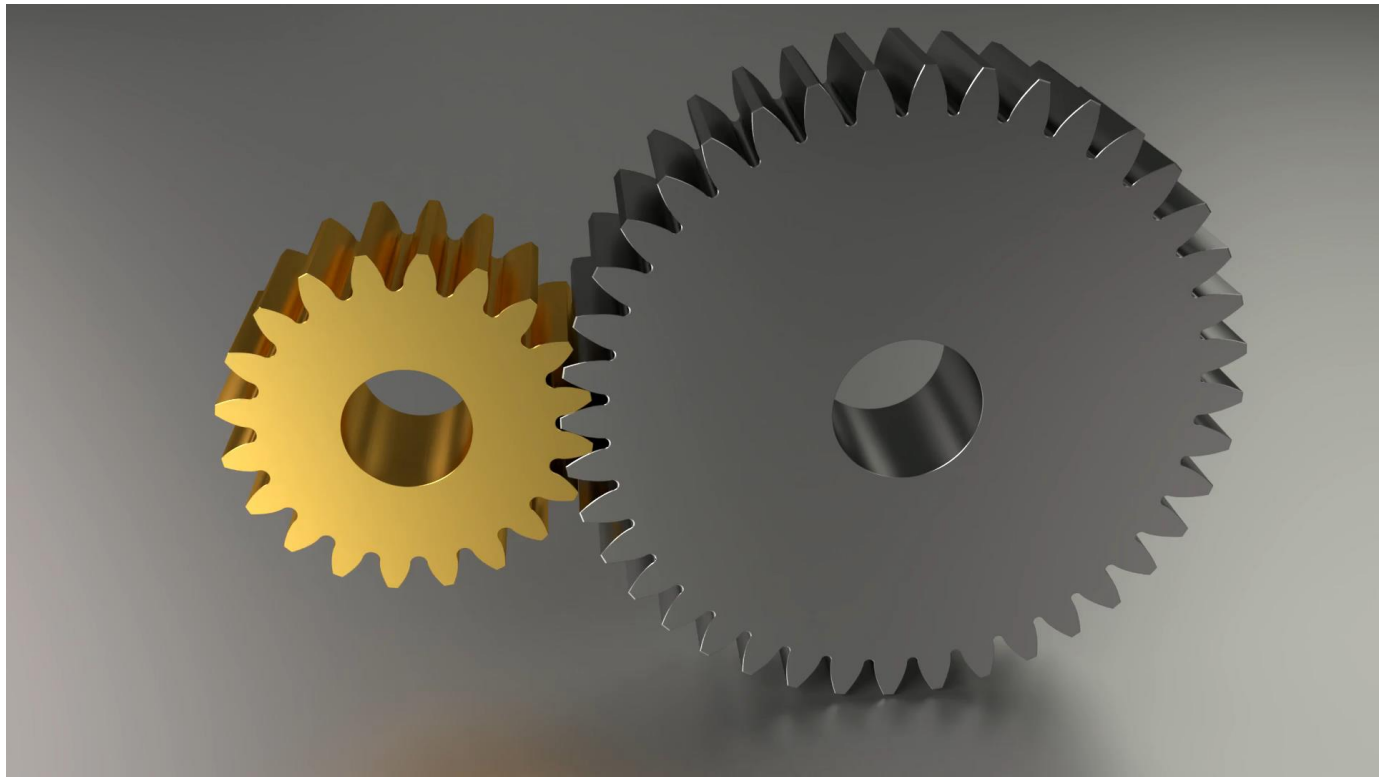
Bevel gears

- “normal” bevel gears
- screw bevel gears (hypoid gears)

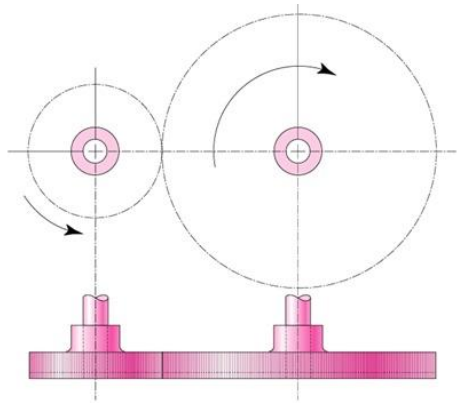
Worm gears

- cylindrical worm and cylindrical worm gear
- globoid worm and globoid worm gear

Cylindrical gears. External toothed gears

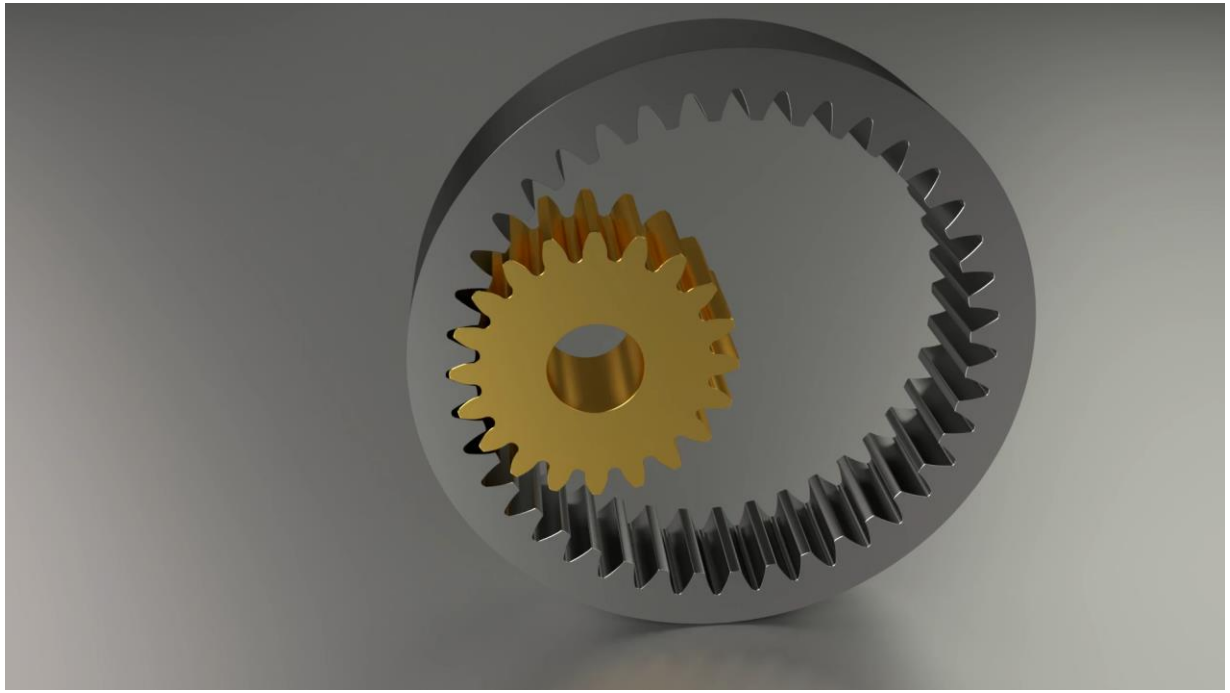


The most common type of gears used in mechanical engineering are cylindrical gears.



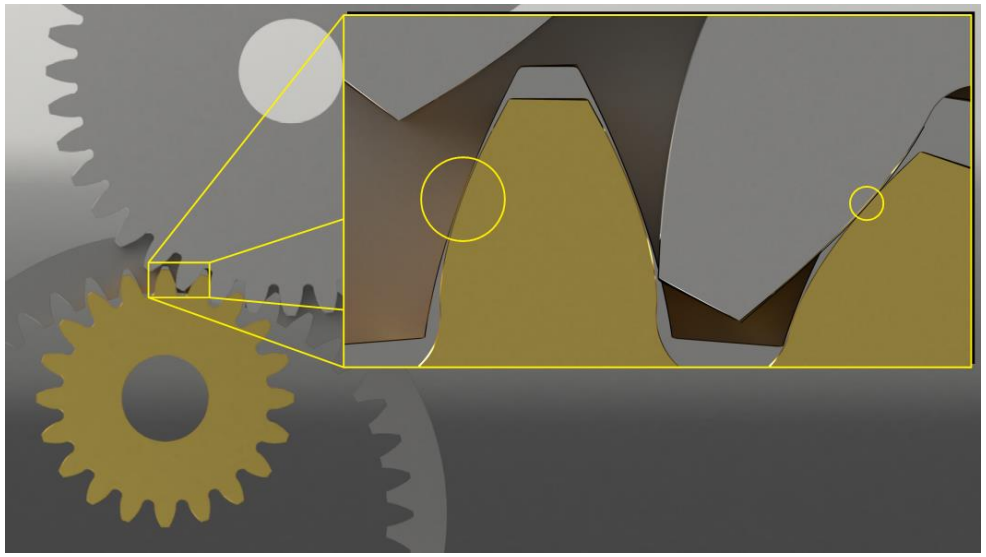
With cylindrical gears, the teeth are arranged on the circumference of a cylinder! The gear axes always run parallel to each other.

Cylindrical gears. Internal toothed gears



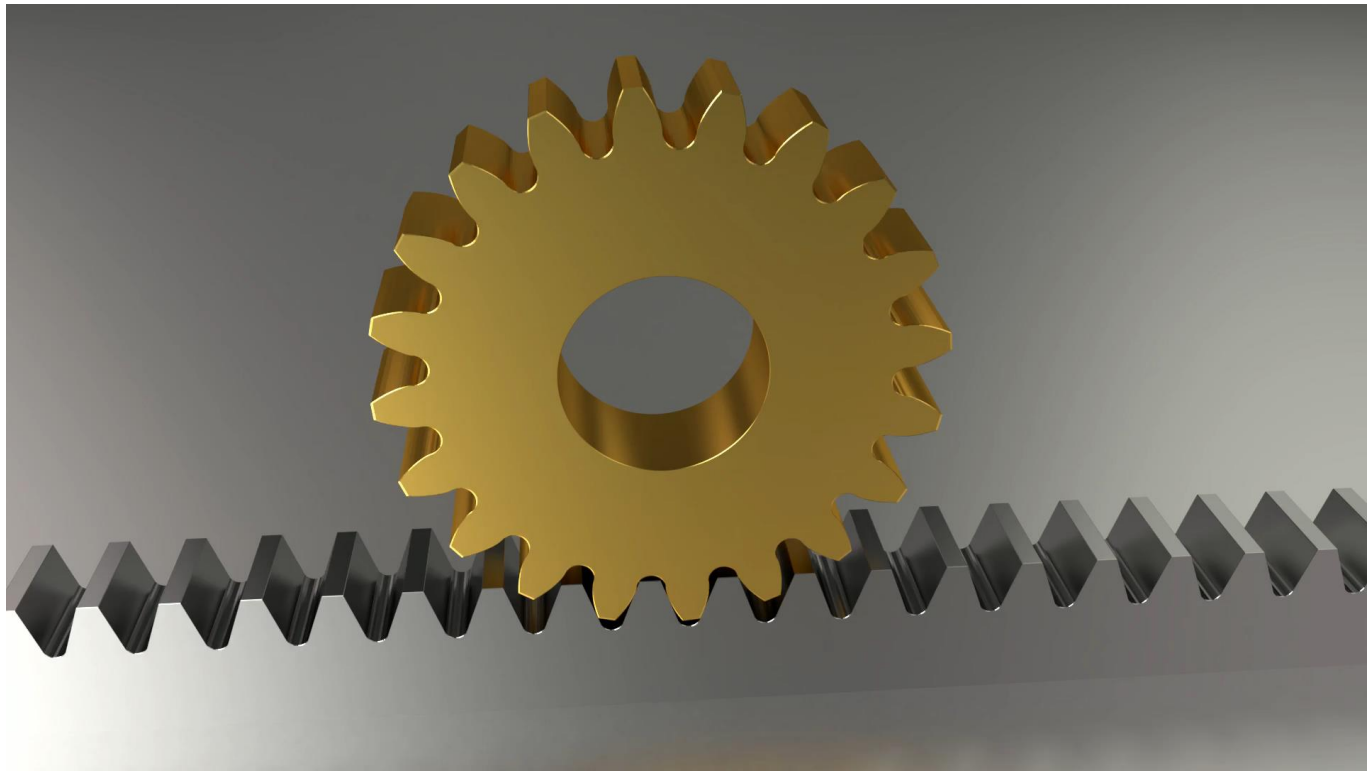
An internal gear wheel is sometimes simply called a ring gear

In addition, the center distance can be shortened by using a ring gear with internal toothing instead of external toothing (with maintaining the transmission ratio). This makes a space-saving gear design possible.



Even though internal gears offer many advantages compared to external gears, internal toothing is limited to a few special cases due to the relatively complex and thus expensive production. Internal gearing is used, for example, in planetary gears (epicyclic gears).

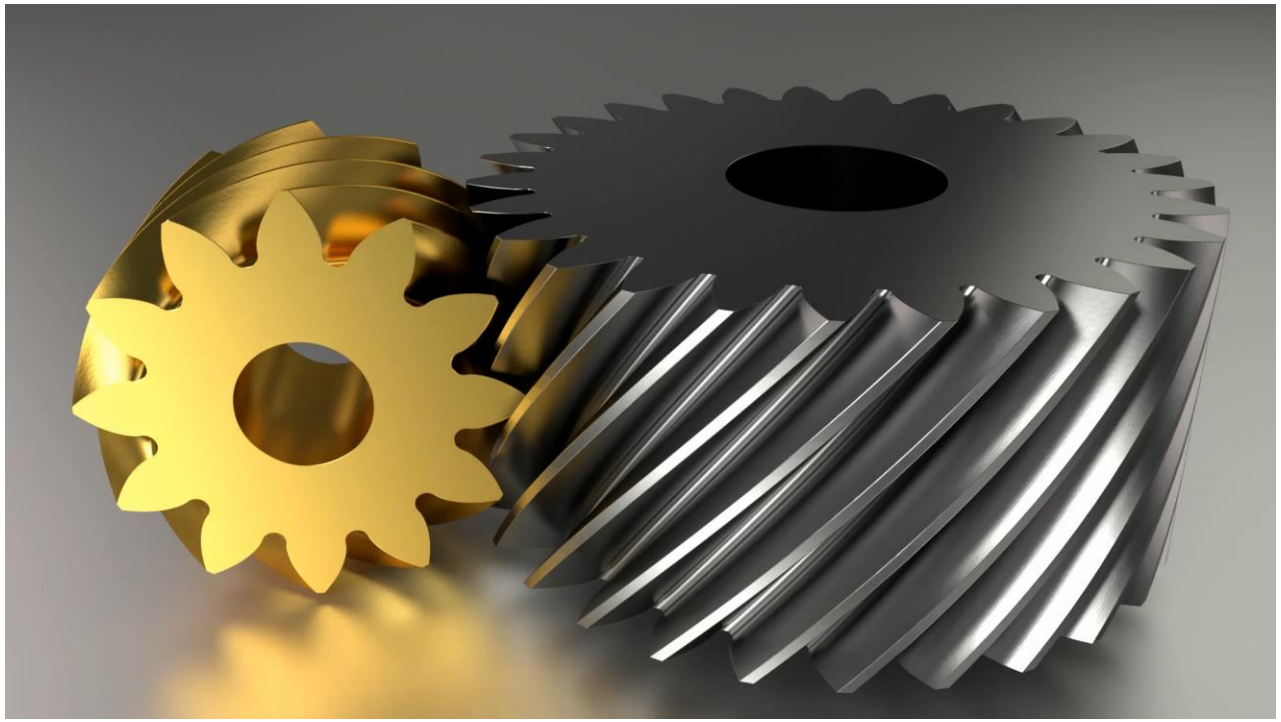
Rack (toothed bar)



A transmission which converts a rotary motion into a linear motion by means of a cylindrical gear (called pinion) and a rack is also called a rack gear.

The rack can be regarded as a cylindrical gear with an infinitely large diameter. In this respect, the rack is only a limiting case of a cylindrical gear.

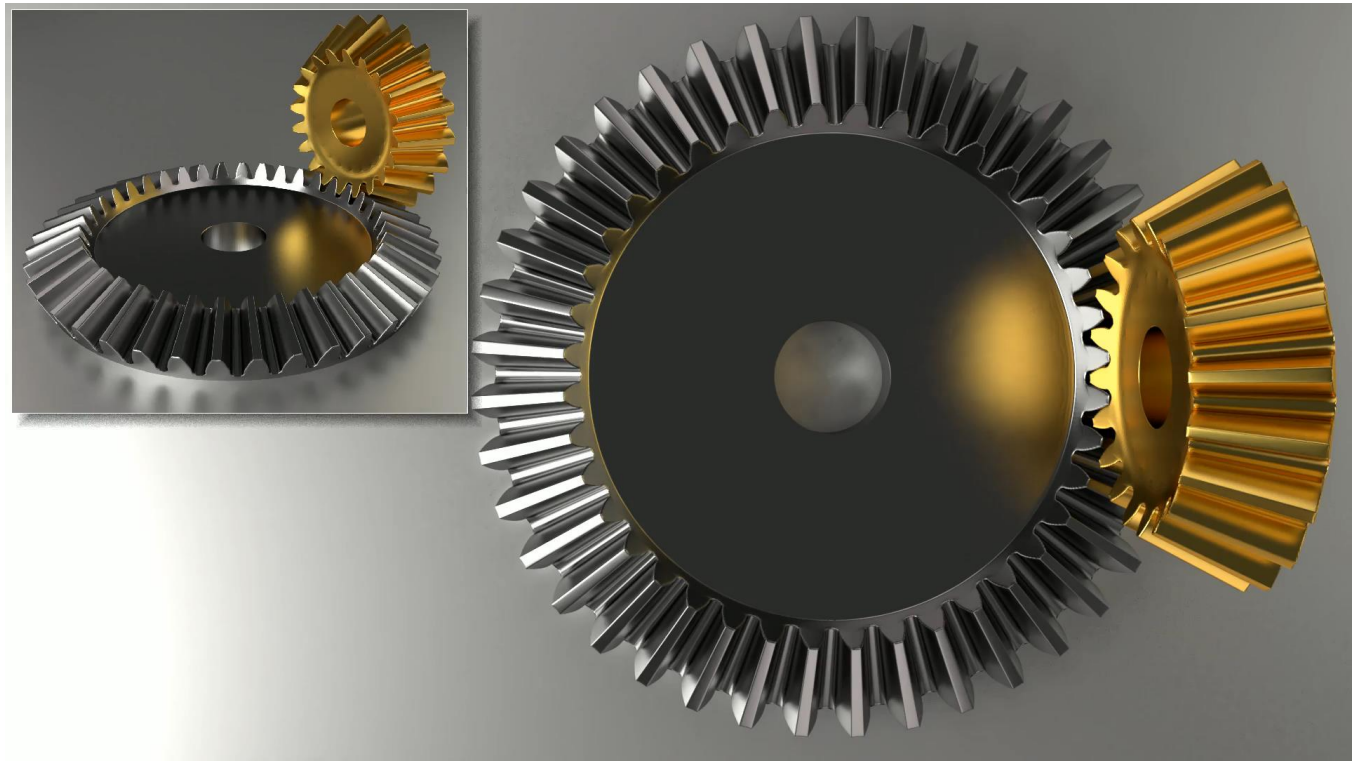
Screw gear



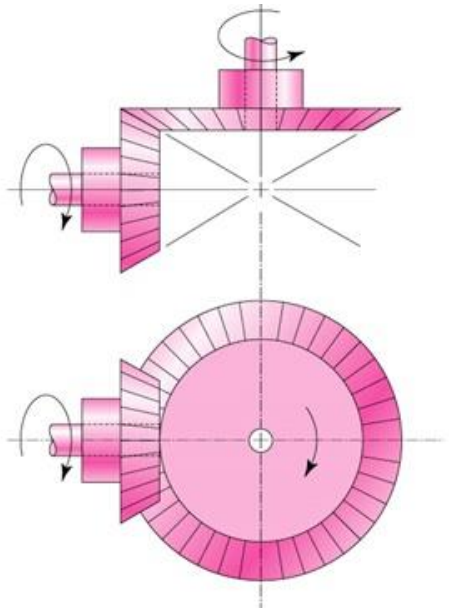
With a special variant of gearing, gears can also be manufactured in such a way that the axes run skew, i.e. they cross each other without intersecting. In such a case one speaks of so-called screw gears or crossed helical gears (hyperboloid gears). Usually the axes of paired screw gears run at an angle of 90° to each other, but in principle any other angle is also possible.

A special case of a screw gear is the so-called worm gear. Compared to the general case of a screw gear, the worm gear offers a line-shaped contact of the flanks and thus allows the transmission of higher torques!

Bevel gears

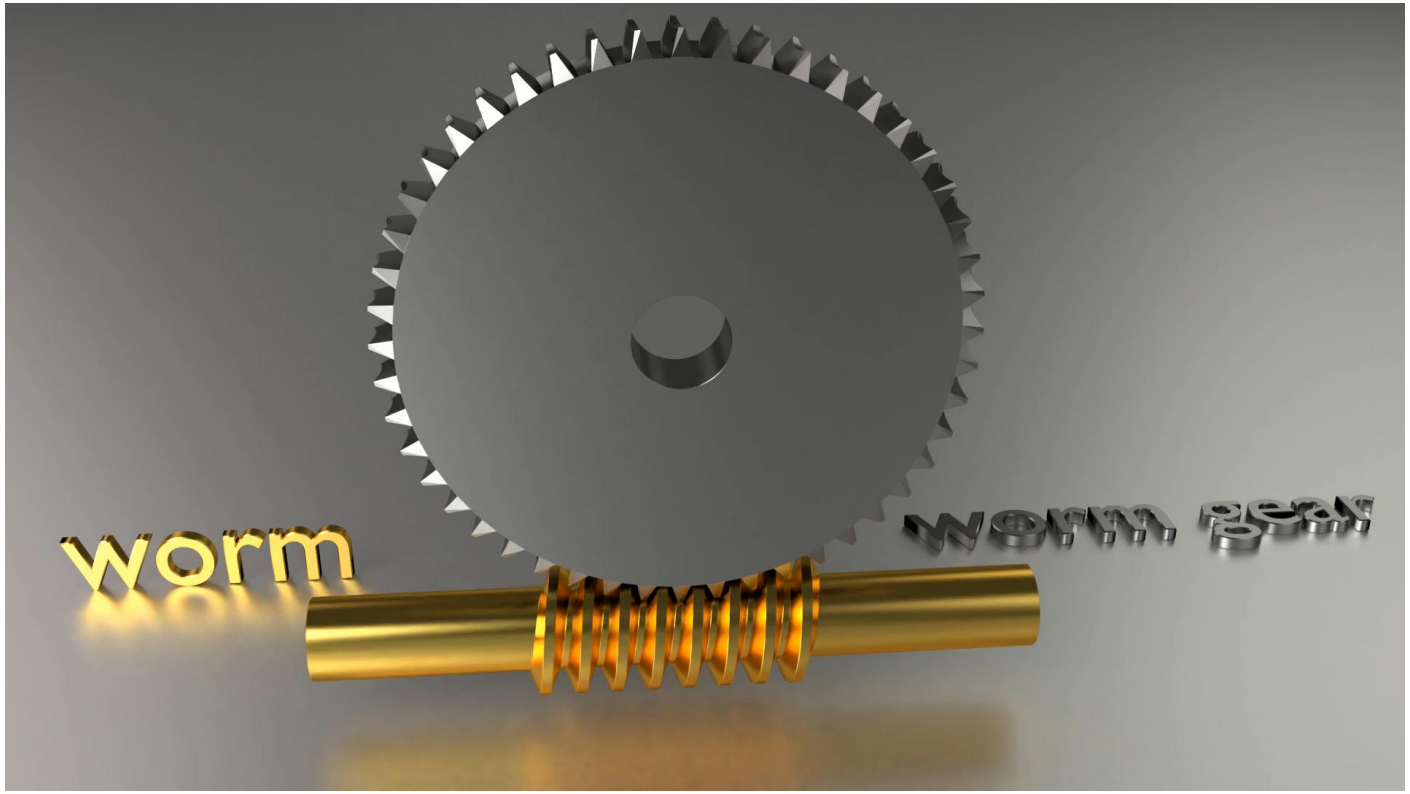


Are used to transmit rotary motion between intersecting shafts

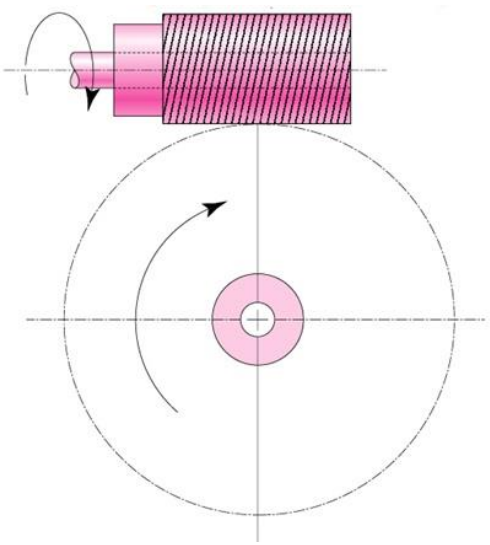


Teeth are formed on conical surfaces, the teeth could be straight or spiral.

Worm gears

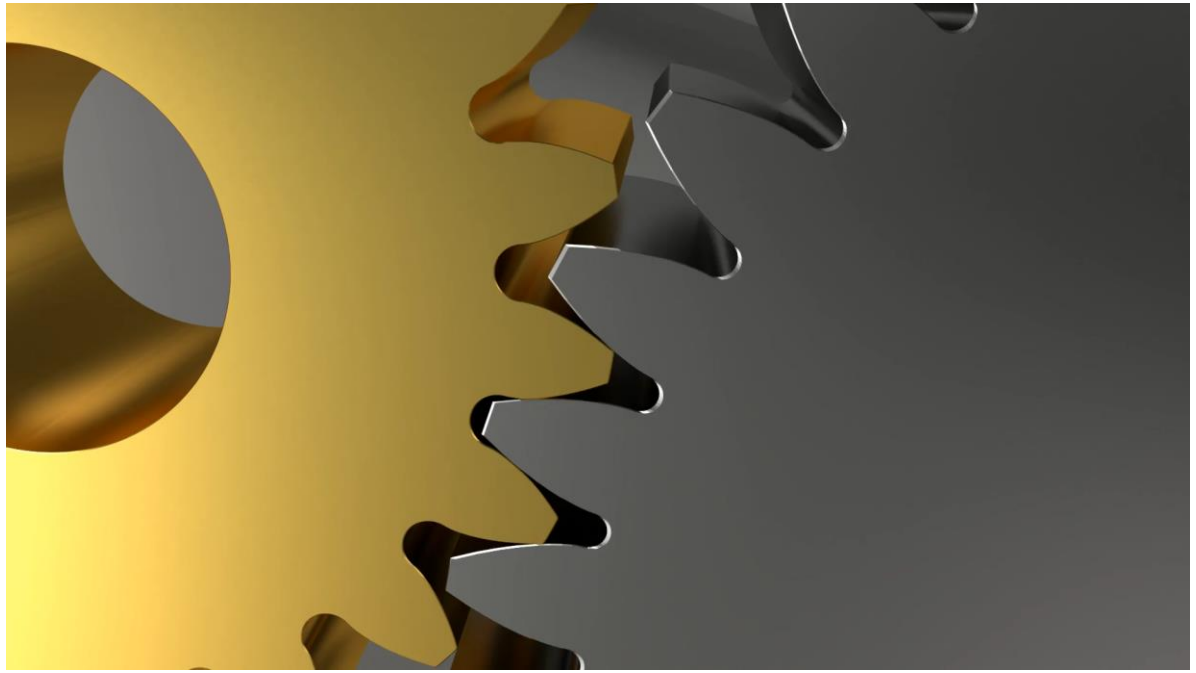


Used to transfer motion between non-parallel and non-intersecting shafts. (criss-crossed shafts)



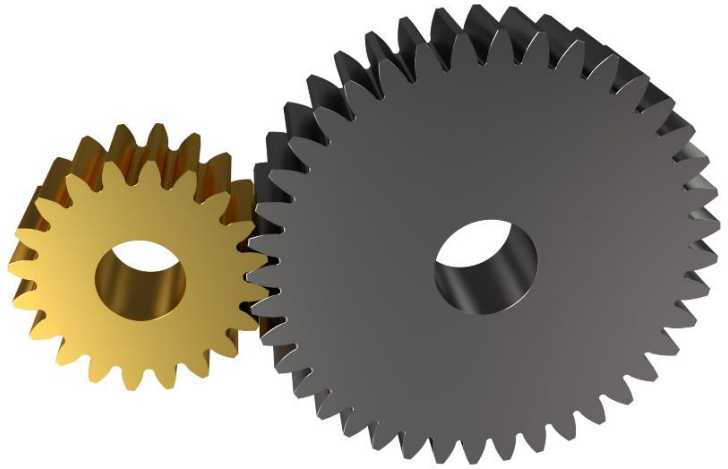
The tooth winds around the worm shaft like the thread of a screw.

Types of toothing. Spur gears



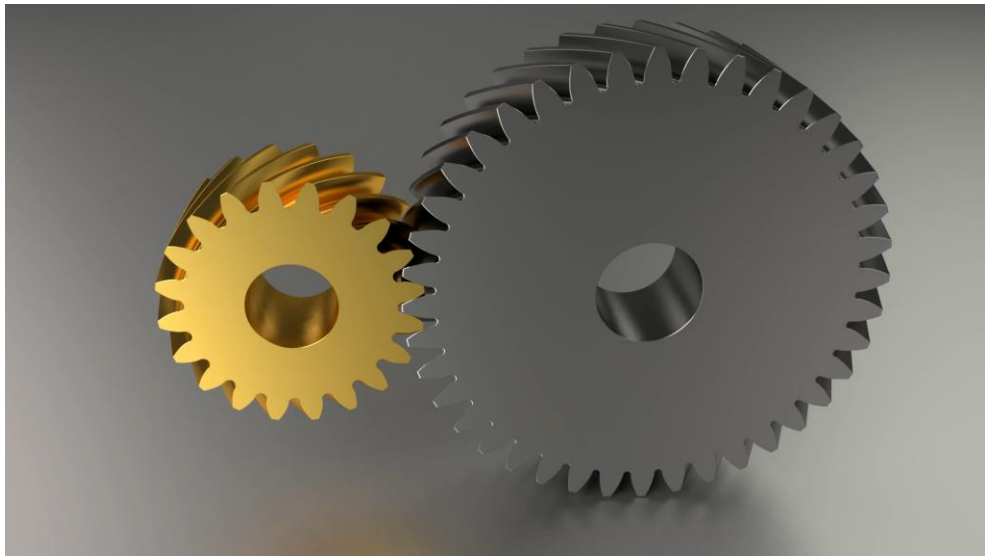
If the teeth of a gearwheel run in a straight line, i.e. in the direction of the rotation axis, it is referred to as a spur gear or a straight-cut gear.

Spur gears are the simplest and therefore most cost-effective type cylindrical gears.



Since with spur gears the entire width of a tooth engages at the beginning of meshing. This leads to relatively high noise levels. Spur gears do not allow the transmission of excessive torques and speeds!

Helical gears

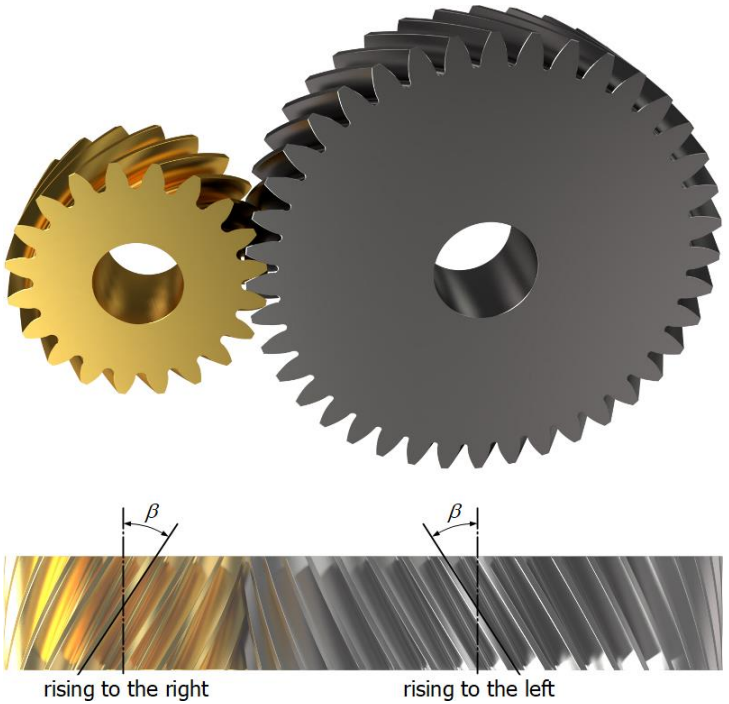


With helical toothing, the force for a pair of mating gears does not suddenly apply over the entire tooth width but is point-shaped. At the end of the meshing, the force transmission does not drop abruptly, but the tooth gradually slips out, so to speak.

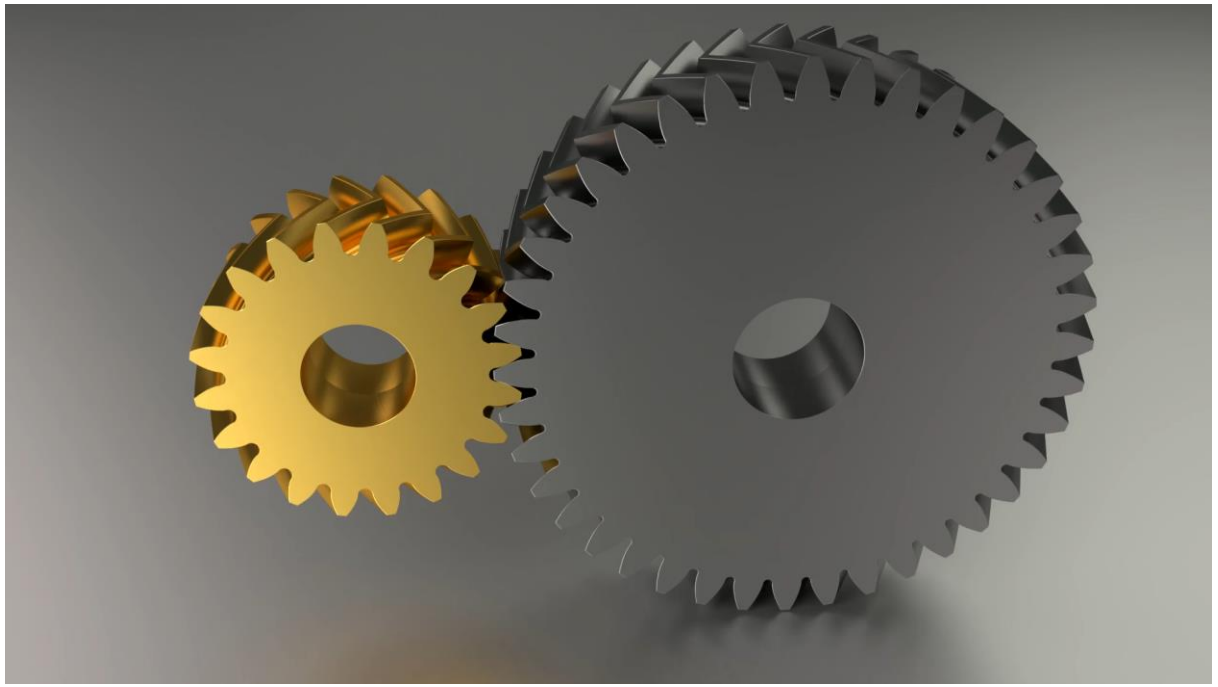
The teeth no longer run as a straight line in the axial direction, but at a certain angle (depending on the application between 8° and 20°).

To reduce noises and transmit high torques, helical gears are often used!

Helical gears cause axial forces which must be absorbed by bearings!

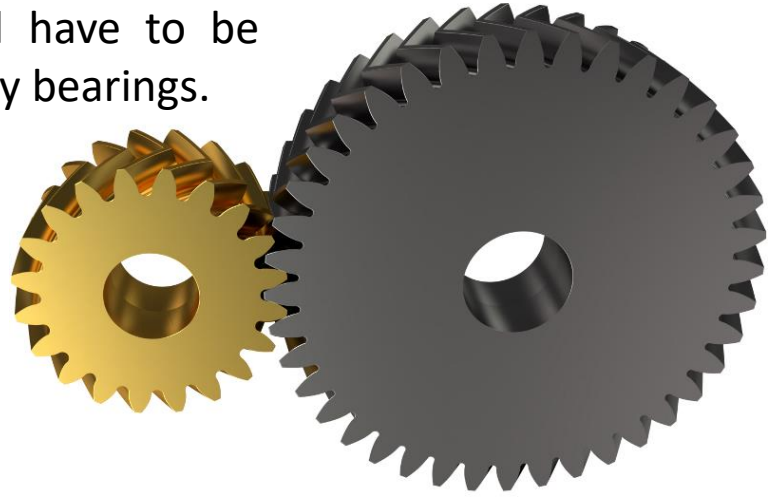


Herringbone gears



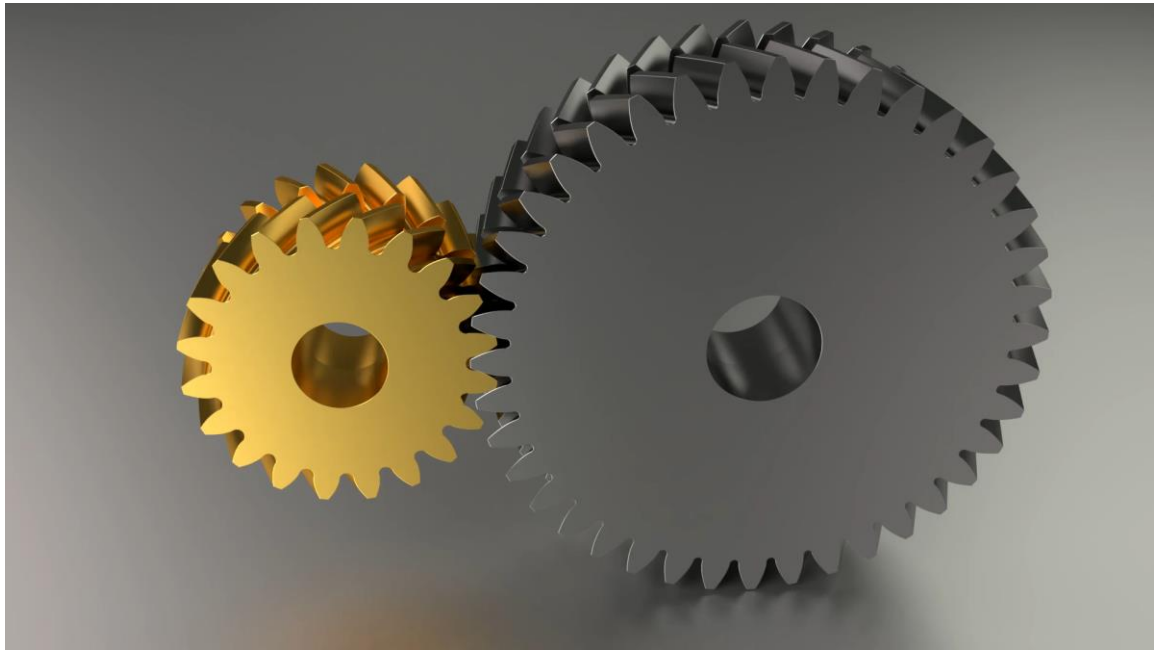
Due to the reciprocal arrangement of the helixes, each side generates an opposing axial force, which cancel each other out. This prevents axial thrusts that would have to be absorbed by bearings.

In order to combine the advantage of helical gears (higher load capacity and lower noise emission) with the advantage of spur gears (no axial forces and lower wear), so-called herringbone gears are used in special cases.

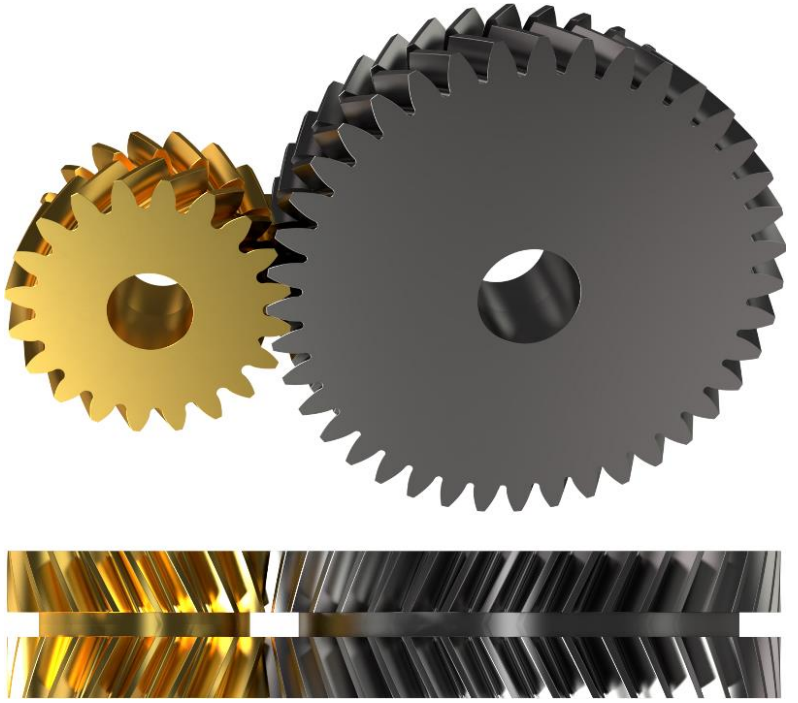


The production of such a gearing is very complex and therefore expensive!

Double helical gears



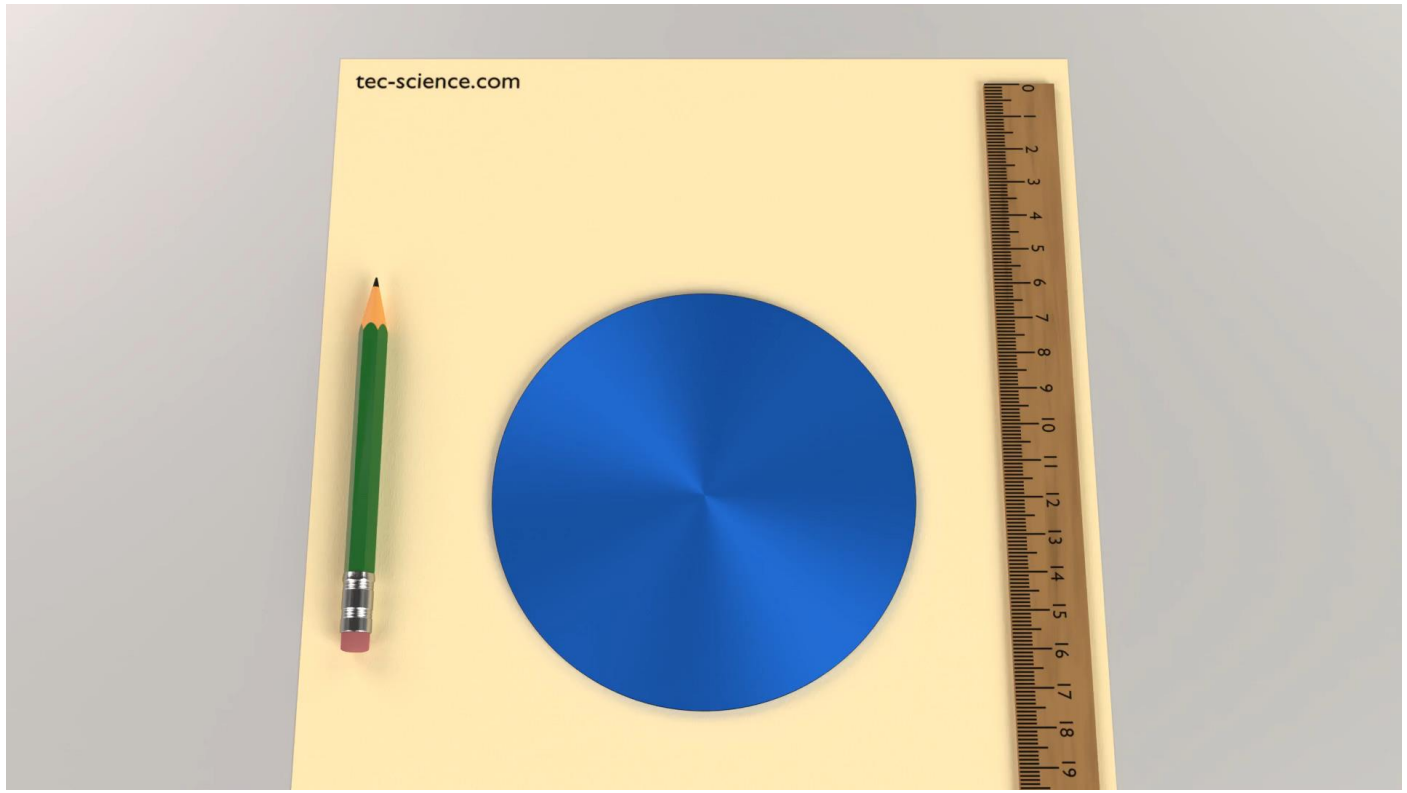
Double helical gears consists of the mirror-image production of two helical gearing, with a groove in the middle between the helix halves.



The production of a double helical gear is cheaper than the production of a herringbone gear!

In practice, it is almost not possible to assemble two separate helical gears in order to obtain a “double helical gear” due to the very precise arrangement with the mating gear!

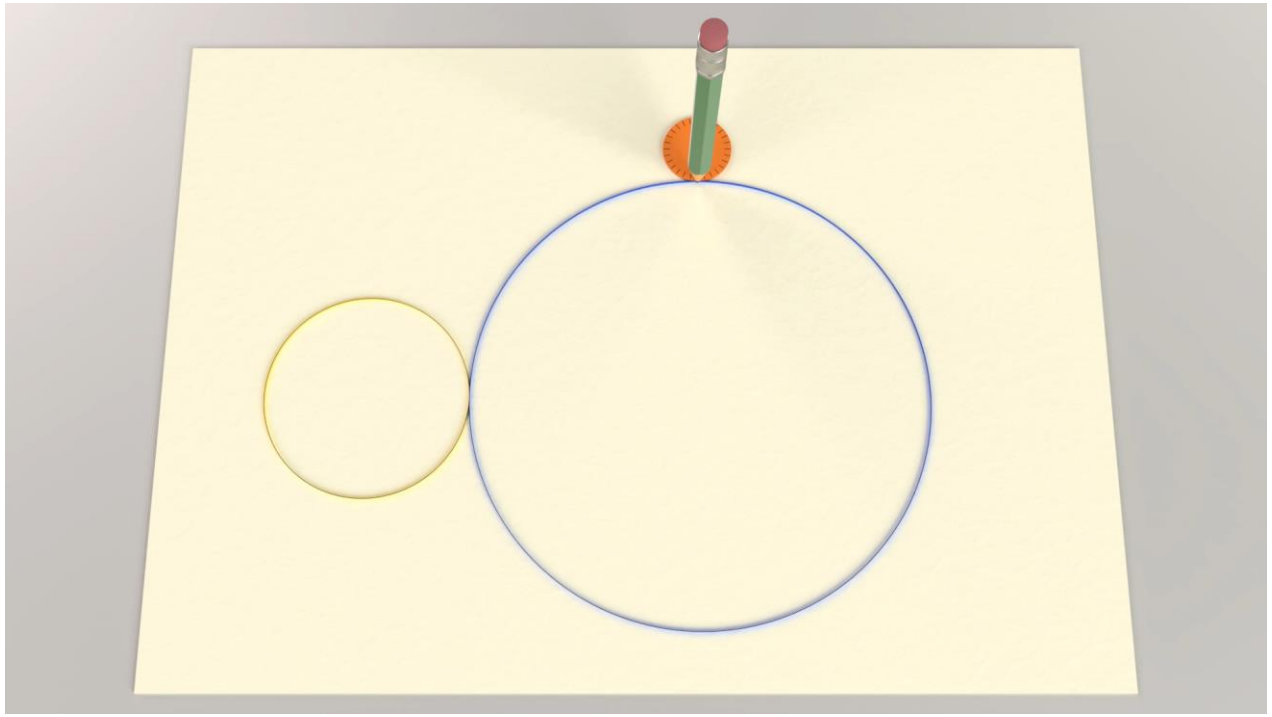
Gears profiles. Involute gear.



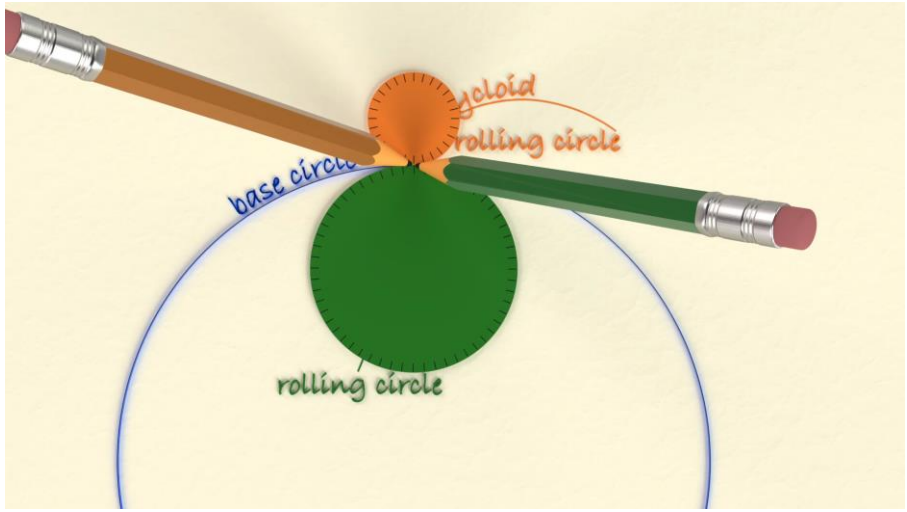
In the case of involute toothing, the shape of the tooth flanks consists of two involutes of circles (called involutes for short). An involute is constructed by rolling a so-called rolling line around a base circle. The resulting trajectory curve describes the shape of the involute. Two mirror-inverted involutes then form the basic shape of a tooth.

Involute toothing is often used in mechanical engineering for gears, as it offers favourable meshing and is easy to produce!

Cycloidal gear



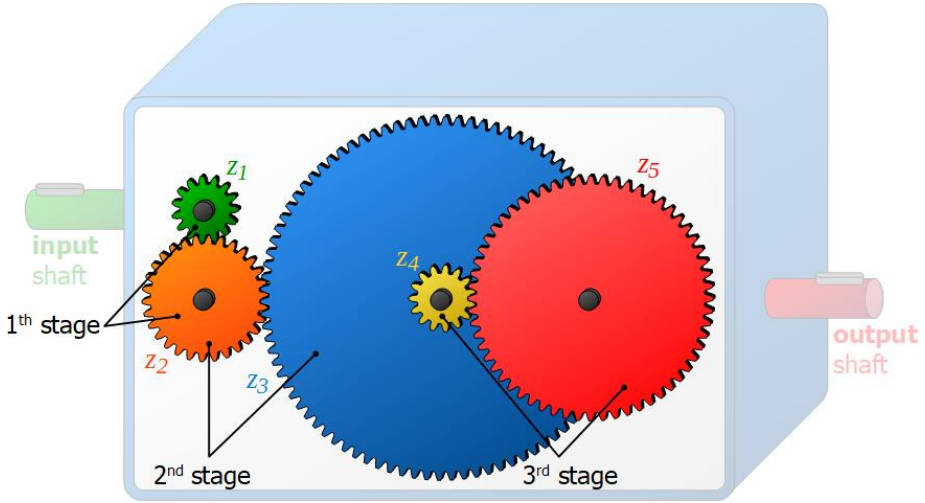
A cycloid is constructed by rolling a circle on a base circle. A fixed point on the rolling circle describes the cycloid as a trajectory curve. A distinction can also be made between an epicycloid and a hypocycloid. An epicycloid is obtained when the rolling circle is rolled on the outside of the base circle. If, on the other hand, the rolling circle is rolled on the inside of the base circle, this is referred to as a hypocycloid.



Cycloidal gears must always be specially matched to each other and can generally not be exchanged at will!

The lower friction and the low number of minimum teeth are the main reasons why cycloidal gears are/were often found in clocks.

Gear stage. Gearbox.



A transmission usually consists not only of one pair of gears but of several, each mounted on different shafts. Each pair of gears that meshes with each other represents a so-called gear stage.

Multi-stage gearboxes offer the advantage of dividing the desired transmission ratio into several smaller gear stages, thus keeping the overall dimensions of the gearbox small.