Drive axle gears - Russell Walsh

This Technical Bulletin follows on from a previous one that discussed drive axles and bearings, it will discuss the common types of gears, their advantages and disadvantages. It will also discuss the basics of calculating how to determine a gear ratio.

There are four common types of gear design:

1. Straight cut gears, also known as spur gears
2. Helical gears
3. Herring bone gears, sometimes called double helical gears
4. Spiral bevel gears

1. Straight cut (spur) gears

These are simple in design and are economic to manufacture.

In a spur gear the teeth are cut in line with the gear's hub as shown below.

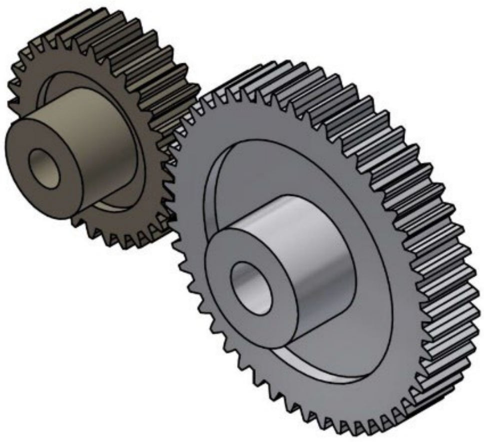

Image retrieved from, https://blog.igus.eu/the-difference-between-helical-gears-and-straight-gears/

Spur gears can be noisy when in use, this is primarily due to the abrupt transfer of torque between gear teeth. The loading is not evenly spread across all gears in mesh at the same time.

Their usual application is one where the one gear can be slid into mesh along a shaft with another. They can be used to transfer the drive to another gear whilst maintaining the same ratio, e.g. 1:1, or can be used to step up or step down a ratio depending on which gear is providing the drive, and which is the driven gear.

Non-synchromesh gearboxes commonly use spur type gears

2. Helical gears.

Helical gears are cut at an angle to the gear hub, this results in more than one tooth being in mesh at the same time, because of this they are more capable of transmitting greater force than spur gears. However, because of the angle of the teeth helical gears produce end thrust which has to be controlled either by arranging two gears arranged back-to-back or by the use of thrust washers.

Helical gears are a lot quieter in their operation than spur gears. This type of gear cannot be slid along a shaft and into mesh with over gears as spur gears can instead, they are usually floating on the gear shaft and locked to the shaft when required by a clutch or hub which engages with the gear. This allows for each gear to be in constant mesh with other gears.

Image retrieved from, https://blog.igus.eu/the-difference-between-helical-gears-and-straight-gears/

3. Herringbone gears (Double helical gears.)

This type of gear is essentially two helical types of gears mounted back-to-back and sharing a common hub. They are very strong and can transmit a lot of torque, they are also very quiet in operation. They produce very little end thrust as the thrust created by one gear is cancelled out the thrust produced by the opposing gear.

This type of gear is particularly valuable for use in heavy duty applications.

Although the two designs (Herring bone and Double helical) have common characteristics there are differences:

The double helical gear has groove between each row of teeth, this groove facilitates manufacture by providing space at the inboard end of each for the tooth cutter when it is cut the tooth, this groove is shown in the following diagram.

Diagram retrieved from, https://cults3d.com/en/3d-model/game/large-herringbone-gear/similar-designs

The herringbone gear has no groove between the opposite teeth, as shown below.

Image retrieved from
https://www.iqsdirectory.com/articles/gear/types-of-gears.html

Neither the double helical nor the herringbone gear can be slid along a shaft to mesh with another similar gear, they must be in constant mesh.

4. Spiral bevel and hypoid gears.

Commonly known as crown wheel and pinion they are used to turn the drive through 90 degrees as in a vehicle's differential.

Image retrieved from, https://vitesse-ltd.co.uk/product/4-12-crown-wheel-pinion-rear longpinion/

These two gear styles are very similar to each other with the main difference being where the pinon meshes with the crown wheel. On a spiral bevel gear set the axis of pinion is in line with the centre line of the crown wheel whereas the pinion in the hypoid set is below the centre line doing this allows for the differential and drive shaft to be set lower than when a spiral bevel set is used.

These gears should be very quiet in operation but must be set up correctly with the meshing of each gear checked to make sure they correctly aligned with each other. They also generate high pressure between the gears because when in mesh they generate both rolling and sliding movement.

Gear clearance and lubrication

All gears operate with a clearance between one gear and the other in any gear set, they also have some bottom clearance. This clearance provides for the expansion of the gears, some distortion and for lubrication. Lubrication is vital to any gear set to prevent premature wearing with some requiring special oils or grease to withstand the high pressures developed when the gears are working.

Calculating the gear ratio

Calculating the ratio of a gear is not hard, but to do this we must understand the functions of gears operating in a gear set. The gear that is providing the drive is the driving gear (the driver) and the other gear, the driven. In a typical crown wheel and pinon set such as the one shown in the above the image of a spiral bevel gear, the pinion is the driver, as it is connected to the power source, the engine, though the drive shaft and gearbox and the crown wheel is the driven gear. The formula for determining gear ratio is: the number of teeth on the driven gear divided by the number of teeth on the driver gear (driven/driver). In the image above there are 33 teeth on the crown wheel and 8 on the pinion, applying the formula this is 33/8, producing a ratio of 4.12:1 meaning the pinion makes 4.12 revolutions to the crown wheel's 1.

When calculating the gear ratio for a complete set of gears, a compound set, in a gearbox each gear set must be calculated as an independent set.