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What is a gear engineer?

Skilled engineers design single- and multi-stage gear trains by relying on purpose and application to generate the proper power.

When you are a young person, perhaps 4 or 5 years old, someone might ask, "What would you like to be when you grow up?" Many children answer, "a police officer" or "a firefighter" or perhaps their favorite superhero. They identify with a particular profession that they have seen and wish to emulate. If you ask them if they want to be an engineer, they most likely will respond with, "and drive a train?" Although gear engineers do design gear trains, their designs don't usually help with the daily commute.

Gears cannot work singularly to transmit power. At least two or more gears must be meshed to work. This combination of gears in mesh is called a gear train. Some gear trains are single-stage gear trains and others are multi-stage gear trains.

A pair of meshed gears is the most basic form of a single-stage gear train. In a single-stage gear train, which consists of z_1 and z_2 numbers of teeth on the driver and driven gears, and their respective rotations, n_1 and n_2. The speed ratio is:

$$\text{Speed Ratio } i = \frac{z_2}{z_1} = \frac{n_1}{n_2}$$

Gear trains can be classified by three types, in accordance with the value of the speed ratio i:

$$\begin{array}{ll} \text{Speed ratio } i < 1, & \text{Increasing : } n_1 < n_2 \\ \text{Speed ratio } i = 1, & \text{Equal speeds : } n_1 = n_2 \\ \text{Speed ratio } i > 1, & \text{Reducing : } n_1 > n_2 \end{array}$$

Figure 1 shows the various forms of single-stage gear trains.

The most common forms of single-stage gear trains are the spur gear and the bevel pair meshes. These are detailed in Figures 1 (A) and (B). For these gear trains, the direction of rotation of driver and the direction of rotation of the driven gears are reversed. In the case of an internal gear mesh, as detailed in Figure 1 (C), both gears have the same direction of rotation. In the case of a worm pair mesh, as detailed in Figure 1 (D), the rotation direction of z_2 is determined by the direct of the helix hand.

In addition to these four basic forms, the combination of a rack and pinion can also be considered as a specific type. The displacement of a rack, *l*, for rotation θ of the mating pinion is:

$$\ell = \frac{z_1 \theta}{360} \times \pi m$$
$$\text{Where: } \pi m \text{ is the reference pitch}$$

As detailed in Figure 2.

A two-stage gear train uses two single-stages in series. Figure 3 represents the basic form of an external gear two-stage gear train. In this case, the first gear in the first stage is the driver. This results in the speed ratio of the two-stage gear train being:

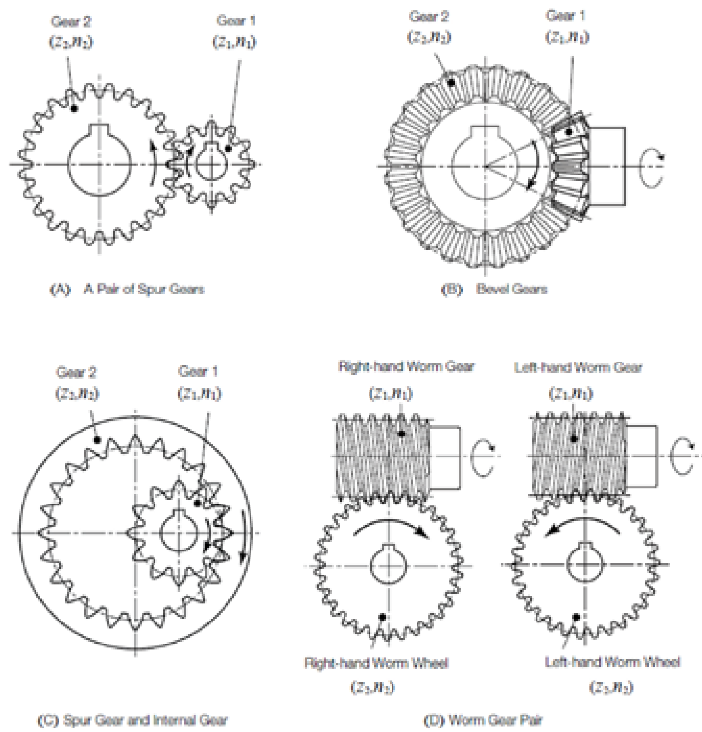

Figure 1: Single-stage gear trains.

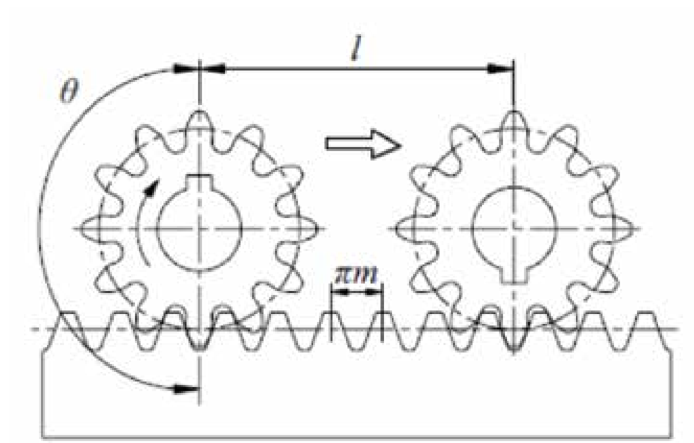

Figure 2: Rack and pinion.

$$\text{Speed ratio } i = \frac{z_2}{z_1} \times \frac{z_4}{z_3} = \frac{n_1}{n_2} \times \frac{n_3}{n_4}$$

In this particular example arrangement, we have set $n_2 = n_3$. Additionally, this two-stage gear train, as detailed in Figure 3, results in Gear 1 rotating in the same direction as Gear 4.

If Gears 2 and 3 have the same number of teeth, then the train is simplified as shown in Figure 4. In this arrangement, Gear 2 is known as an idler, which has no effect on the speed ratio and the resulting speed ratio is:

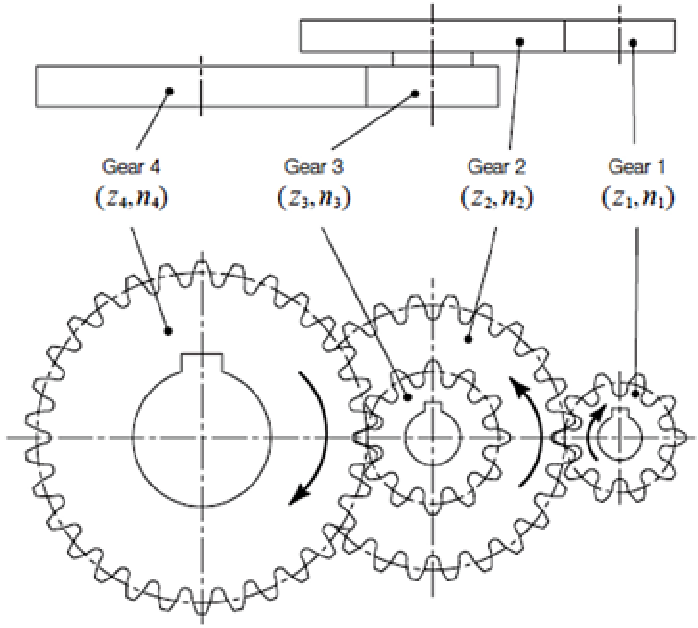

Figure 3: Two-stage gear train.

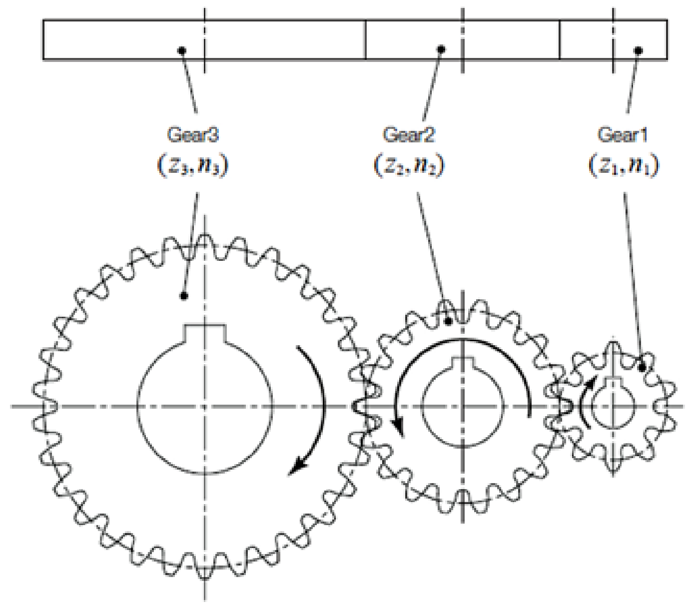

Figure 4: Single-stage gear train with an idler.

$$\text{Speed ratio } i = \frac{z_2}{z_1} \times \frac{z_3}{z_2} = \frac{z_3}{z_1}$$

Table 1 shows the speed ratio calculations for a basic example of the gears shown in Figure 3.

As detailed in the earlier examples, there are many forms of gear trains. Each has a purpose and each application will dictate what style should be selected. However, none will require the use of an air horn when in operation.

No.	Term	Symbols	Formula	Calculation Example	
				Pinion	Gear
1	No. of Teeth (First Gear)	z_1 , z_2	Set Value	10	24
2	No. of Teeth (Second Gear)	z_3 , z_4		12	30
3	RPM (Gear 1)	n_1		1200	–
4	Speed ratio (First Stage)	i_1	$\frac{z_2}{z_1}$	2.4	
5	Speed ratio (Second Stage)	i_2	$\frac{z_4}{z_3}$	2.5	
6	Final speed ratio	i	$i_1 \times i_2$	6	
7	RPM (Gear2 and 3)	n_2	$\frac{n_1}{i_1}$	500	
8	RPM (Gear4)	n_4	$\frac{n_1}{i}$	–	200

RPM: Revolution per Minute
Set value here stands for the values pre-designated by the designer.

Table 1: Speed ratio of two-stage gear trains.

ABOUT THE AUTHOR

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