Mechanical Power Transmission Fundamentals

An Online Continuing Education Course for Engineers

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Mechanical Power Transmission Fundamentals

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Gear Trains

Gear trains are multiple sets of gears meshing together to deliver power and motion more effectively than can be accomplished by one set of gears. Figure 1 shows the various types of gears that can be used in a gear train. Gears 2 and 3 can be either spur or helical gears and are mounted on parallel shafts. Gears 4 and 5 are bevel gears that mount on shafts that are 90° apart. Gears 6 and 7 comprise a worm gear set and mount on shafts that are at 90°, but are non-intersecting. Worm gears have a high ratio and can be non-reversing.

Figure 2 has a simple gear train at the top and a compound gear train at the bottom. The simple gear train consists of four in-line gears in mesh. The compound gear train consists of the same four gears, except two are located on the same shaft. The overall ratio of the simple gear train is the product of the three individual ratios and is as follows:

$$n_2/n_5 = (N_3/N_2)\,(N_4/N_3)\,(N_5/N_4)$$

n equals the rpm and N equals the number of teeth in the respective gears. When cancelling out like quantities, the equation can be reduced to the following:

$$n_2/n_5 = (N_5/N_2)$$

Suppose gear 5 has 64 teeth and gear 2 has 16 teeth, than the overall gear train ratio would be 4 to 1. If gear 2 is considered the driving member, the gear train in figure 2 is a speed reducing gear train. If the rpm of gear 2 is 400, the rpm of gear 5 is 100. Gears 3 and 4 are called idler gears since they have no effect on the overall gear train ratio.

The equation for the overall ratio of the compound gear train is the product of the two individual ratios and is as follows:

$$n_2/n_5 = (N_4/N_2)\,(N_5/N_3)$$

Assuming that the same four gears are used and that gear 3 has 32 teeth and gear 4 has 48 teeth, the overall ratio for the compound gear train is:

$$n_2/n_5 = (48/16)\,(64/32) = 6$$

The following can be said about using compound gear trains over simple gear trains:

1) More ratio can be obtained.

2) The design is more compact.

3) There is one less shaft.

Figure 1

Various Gear Types in a Train

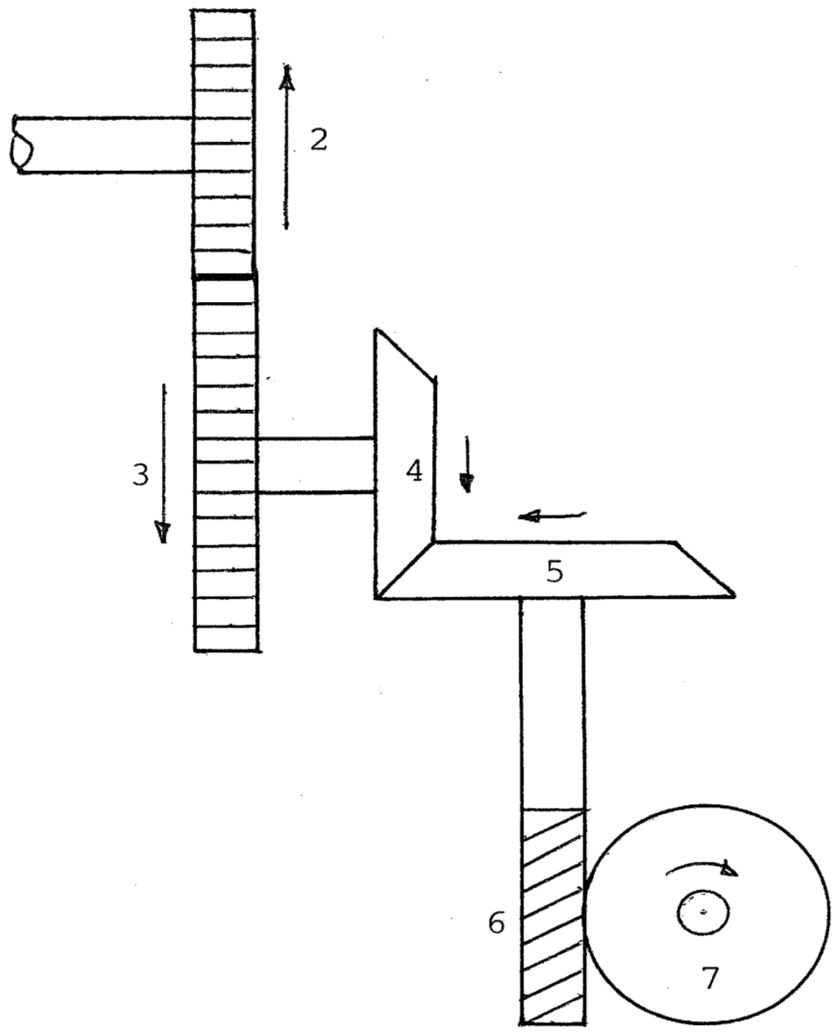
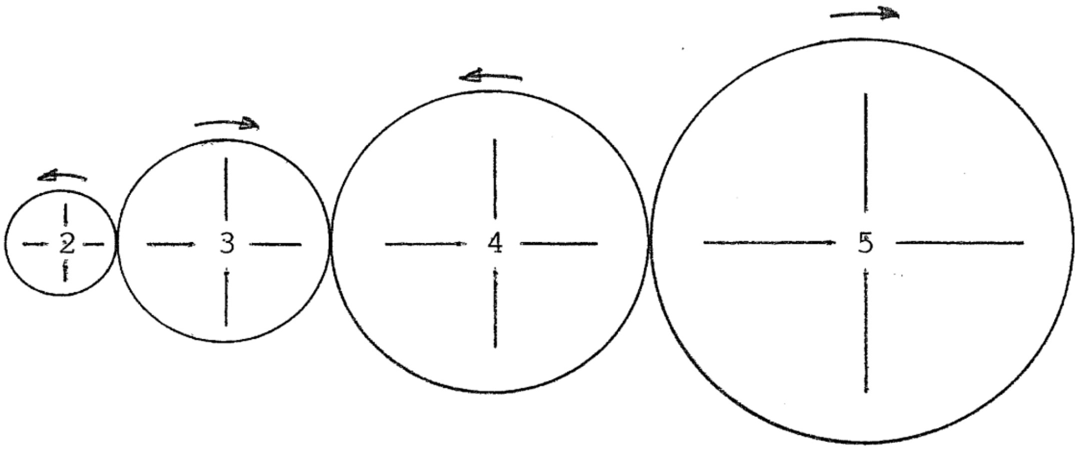
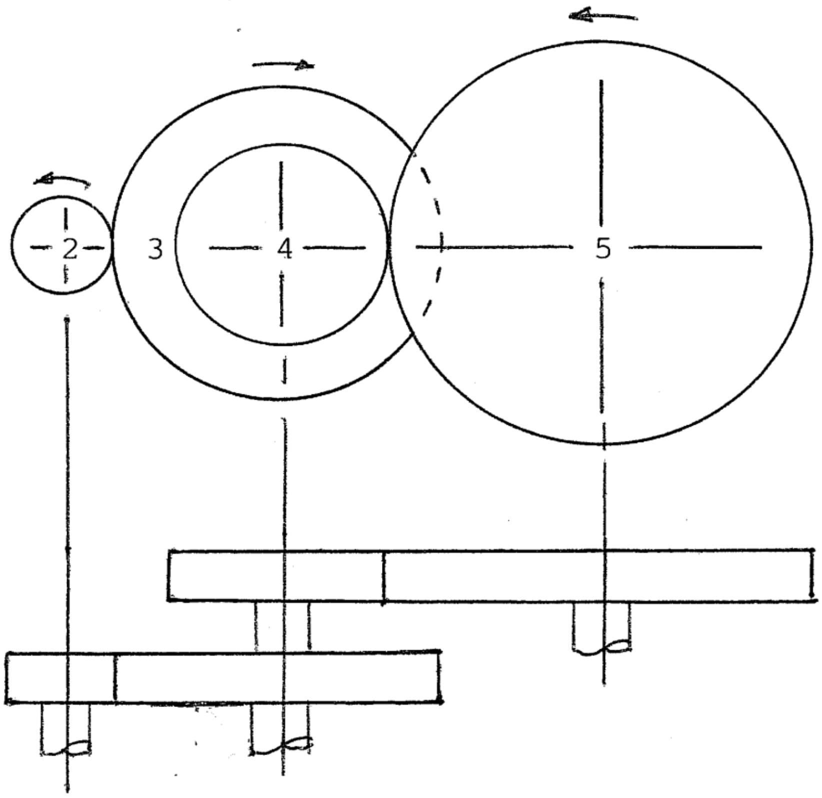


Figure 2



Simple Gear Train

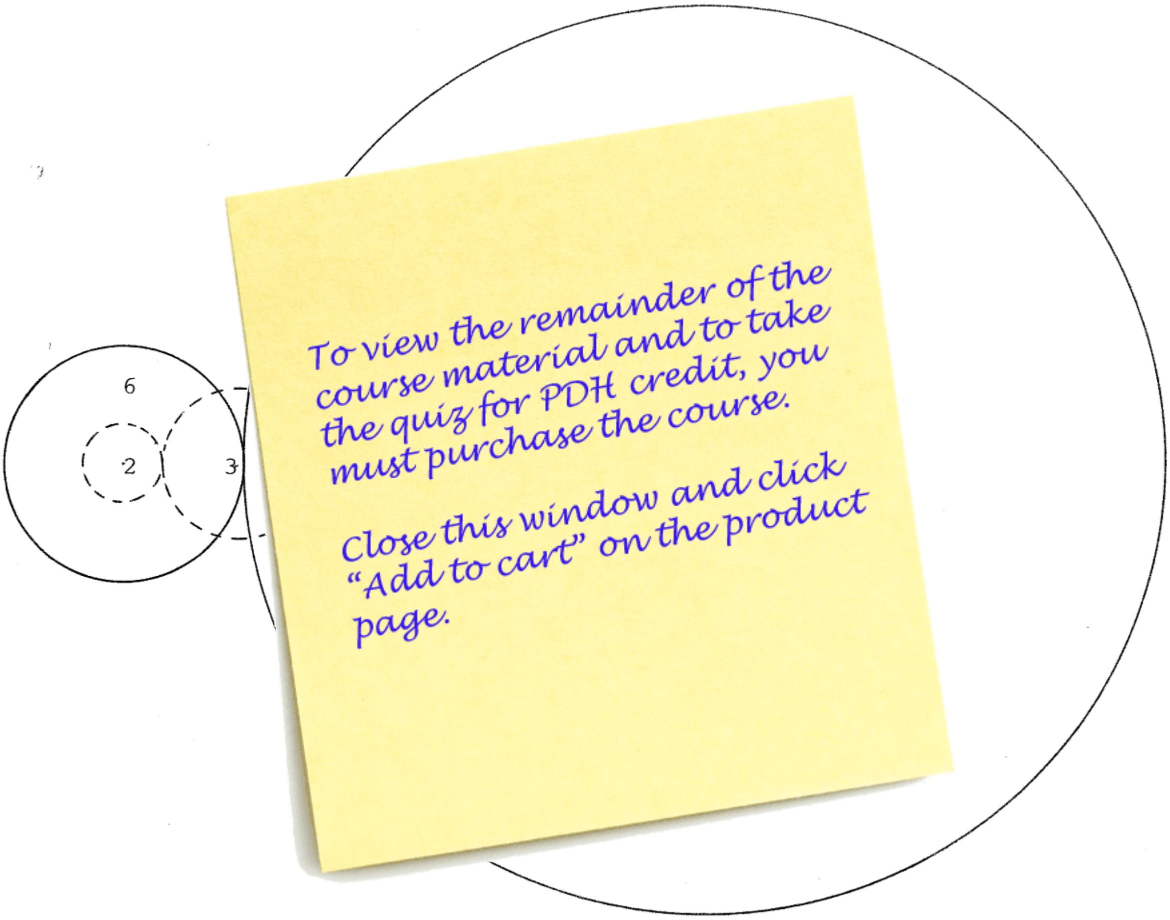


Compound Gear Train

1. More ratio can be obtained.
2. The design is more compact.
3. There is one less shaft.

Figure 3 shows that very large gears 6 and 7 are needed if a simple gear train is not used. The effect is even greater for a compound gear train.

Figure 3



Gears 6 and 7 needed if gear train is not used.