Principles and Use of Gears, Shafts, and Bearings

An Online Continuing Education Course for Engineers

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Introduction

Gears, shafts, and bearings are the backbone of equipment used in the field of Mechanical Power Transmission. They are the primary components in such things as transmissions, drive trains, and gear boxes. Transmissions and drive trains deliver power from engines to the wheels of a variety of vehicles ranging from automobiles to earth moving equipment. Gear boxes of a variety of sizes and types power the many machines and equipment that are found in our factories and in our homes.

This course takes the reader through the various steps needed to better understand the function and use of gears, shafts, and bearings and how they work together in the field of Mechanical Power Transmission. The steps include description/design, material/manufacture, load/stress analysis, sample problems, and application in various pieces of industrial equipment with expert analysis. It is written in an easy step-by-step style with as many images as there are pages of text in an effort to be as informative and educational as possible.

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Gears

Description: Gears are one of the most important elements in the field of *Mechanical Power Transmission.* They are round wheel-like shaped components that have teeth equally spaced around the outer periphery. They are used in pairs and are a very valuable design tool. They are mounted on rotatable shafts with the teeth on one gear meshing (engaging) with the teeth on another gear. They are used to transmit rotary motion (rpm) and force (torque) from one part of a machine to another. They have been in existence for thousands of years and are used in everything from watches to wind turbines. Much scientific study, research, and development has been completed on gears. Formulas have been developed and standards established to make gear design and application as easy an endeavor as possible. The gear tooth has been so successfully perfected that, when two gears mesh, almost perfect rolling takes place. Most gears operate in the high 90% range similar to anti-friction bearings where virtual pure rolling does take place. By changing the diameter of one gear with respect to another, they can be designed to regulate rpm and torque. A gear that is driven by a smaller gear 3/4 its own size will rotate at 3/4 the speed of the smaller gear and deliver 4/3 the torque as seen on Figure 1 between the drive and idler gears. The idler gear, having the same number of teeth as the driven gear, serves only to change the direction of rotation between the drive gear and the driven gear. Precaution has to be taken when using idler gears because the teeth undergo reverse bending which shortens their lives compared to the drive and driven gears where only single direction bending takes place. The advantageous use of gears is exhibited in the transmission of an automobile where they are used to power the vehicle in a very smooth and efficient manner.

Terminology: The gear is one component of mechanical power transmission systems that does not lack for descriptive terminology: (See Figure 2.)

- *Pinion* is the smaller of two gears in mesh. The larger is called the *gear* regardless of which one is doing the driving.
- *Ratio* is the number of teeth on the gear divided by the number of teeth on the pinion.
- *Pitch Diameter* is the basic diameter of the pinion and the gear when divided by each other equals the ratio.