Chapter 4
Contact Ratio, Interference and Backlash

Contact Ratio

The meshing cycle of a tooth pair begins when the teeth first make contact, and ends when the contact is broken. If one gear is to drive the other in a continuous manner, there must clearly be at least one tooth pair in contact at all times. However, it is found that smooth operation is only possible when the contact at one tooth pair continues until sometime after the contact has begun at a second pair. In other words, there must be parts of the meshing cycle during which two pairs of teeth are in contact simultaneously. In order to measure the amount of overlap, we introduce a quantity called the contact ratio, defined in the following manner. If $\Delta \beta_c$ is the angle through which a gear rotates during one meshing cycle, and $\Delta \theta_p$ is the angle subtended at the gear center by one tooth, the contact ratio $m_c$ is defined as follows,

$$m_c = \frac{\Delta \beta_c}{\Delta \theta_p} \quad (4.1)$$

The angle $\Delta \theta_p$ is known as the angular pitch of the gear, and its value in radians is equal to $2\pi$ divided by the number of teeth,

$$\Delta \theta_p = \frac{2\pi}{N} \quad (4.2)$$

The rotation $\Delta \beta_c$ is called the angle of contact, and in order to find its value, we need to describe the meshing process in some detail. Figure 4.1 shows a pair of meshing gears, and we will assume that gear 1 is driving and is
turning counter-clockwise, so that gear 2 is being driven and is turning clockwise. When the gears rotate, the first contact between a pair of teeth occurs at $T_2$, the point where the tip circle of the driven gear cuts the common tangent to the base circles. This is because the contact point must lie on that line, as we showed in Chapter 3, and the teeth of gear 2 are not long enough to make contact at points on that line below $T_2$. At the initial contact, therefore, the tip of the tooth on the driven gear is in contact with the tooth of the driving gear, at a point on its profile somewhere below the pitch circle.

After the initial contact, the gears continue to rotate, and the contact point in Figure 4.1 moves upwards along the path of contact. On the driving gear, the contact point moves outwards towards the tooth tip, while on the driven gear it moves inwards. Contact ceases when the contact point reaches the tooth tip of the driving gear. The position where this occurs is at point $T_1$, where the tip circle of the driving gear crosses the common tangent to the base circles.

Figure 4.1. The ends of the path of contact.