CHAPTER 5

The Energy of the Swing

Sources of Energy

In the early days of golf, the golf swing could not have possibly been considered in terms of the concepts used in this chapter. The concepts of work and energy, as used in mechanics, did not exist in the 15th century when golf was being played in Scotland. The words “energy” and “work” first appeared in the present context in 1807 and 1826, but the ideas behind these words developed earlier. It took about 100 years from the first glimmer of these ideas before we find the statement of the principle of conservation of energy in 1847. This principle as applied to all forms of energy is one of the fundamental ideas of physics. The ancients knew that hands rubbed together became warm, but this effect was one of the mysteries.

In the development of our understanding of the dynamics of the swing of a golf club we have used the concepts of force, torque, and linear and angular motion. We may further this understanding if we look at the swing of a club using the concepts of work and energy.

In the golf stroke some of the energy supplied by the muscles of the golfer and the energy coming from the fall of the arms and club in the gravitational field is transferred to the golf ball at impact. Since the transfer of energy from the clubhead to the ball during the collision between them is determined by the physical properties of the clubhead and the ball and by the laws of physics, there is nothing the golfer can do during the collision to influence this transfer in any way. We may therefore focus our attention on how the club acquires its energy during the downswing.

In our two-rod model of the downswing, the energy put into the moving system comes from three sources. The major source is the work done by the golfer when the torque $T_S$ acting on the arms moves them through the angle of the downswing. A second source of energy is the potential energy of the arms and club at the top of the backswing; this potential energy changes into kinetic energy as the arms and club fall during the swing. The third source of energy is the work done by the golfer during the shift of the axis of the swing.
The Calculation of Energies

A computer was programmed to give, for the standard swing, the total kinetic energy of the arms and club and that of each of them separately. These energies are plotted in Fig. 5.1 in Curves A, B, and C as functions of the downswing angle.

Let us first consider Curve D in Fig. 5.1. This curve shows the work done by the golfer as a function of the downswing angle as he applies the torque $T_s$ on his arms. Since the work he does is the product of the constant torque $T_s$ and the downswing angle $\alpha$, it is then directly proportional to the downswing angle measured from the beginning of the downswing. This curve is therefore a straight line. This curve also represents the contribution to the kinetic energy of the arms and club from this work done by the golfer. If we add to this curve the work done by the golfer in his shift toward the target and the kinetic energy coming from the decrease in potential energy previously mentioned, we arrive at the total kinetic energy of the arms and club shown in Curve A. This curve is not a straight line, since the contribution to the total kinetic energy of the system by the decrease in the potential energy is not directly proportional to the downswing angle.

![Figure 5.1](image_url)  
**Figure 5.1.** How energies of the system vary with the angle $\alpha$ into the downswing. Curve D, a straight line, shows the work done by the golfer as he applies the torque by his arms to the system. Curve B shows how the kinetic energy of the arms varies throughout the downswing. Curve C shows how the kinetic energy of the club alone varies into the downswing. Curve A shows the total kinetic energy of the system as it develops throughout the downswing.