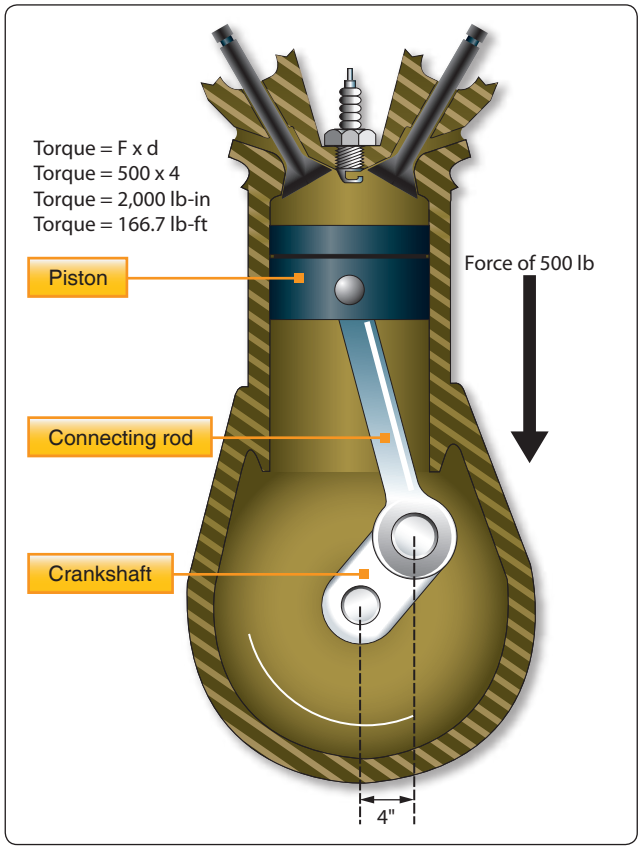

Figure 5-6. *Piston engine and torque.*

product of the force and the offset distance is the torque, in this case 2,000 lb-in.

In a turbine engine, the turbine blades at the back of the engine extract energy from the high velocity exhaust gases. The energy extracted becomes a force in pounds pushing on the turbine blades, which happen to be a certain number of inches from the center of the shaft they are trying to make rotate. The number of inches from the turbine blades to the center of the shaft would be like the length of the wrench discussed earlier.

Mathematically, there is a relationship between the horsepower of an engine and the torque of an engine. The formula that shows this relationship is as follows:

$$\text{Torque} = \text{Horsepower} \times 5{,}252 \div \text{rpm}$$

Example: A Cessna 172R has a Lycoming IO-360 engine that creates 180 horsepower at 2,700 rpm. How many pound-feet of torque is the engine producing?

$$\text{Torque} = 180 \times 5{,}252 \div 2{,}700$$
$$= 350 \text{ lb-ft.}$$

Simple Machines

A machine is any device with which work may be accomplished. For example, machines can be used for any of the following purposes, or combinations of these 5 purposes:

1. Machines are used to transform energy, as in the case of a generator transforming mechanical energy into electrical energy.
2. Machines are used to transfer energy from one place to another, as in the examples of the connecting rods, crankshaft, and reduction gears transferring energy from an aircraft's engine to its propeller.
3. Machines are used to multiply force; for example, a system of pulleys may be used to lift a heavy load. The pulley system enables the load to be raised by exerting a force that is smaller than the weight of the load.
4. Machines can be used to multiply speed. A good example is the bicycle, by which speed can be gained by exerting a greater force.
5. Machines can be used to change the direction of a force. An example of this use is the flag hoist. A downward force on one side of the rope exerts an upward force on the other side, raising the flag toward the top of the pole.

There are only six simple machines. They are the lever, the pulley, the wheel and axle, the inclined plane, the screw, and the gear. Physicists, however, recognize only two basic principles in machines: the lever and the inclined plane. The pulley (block and tackle), the wheel and axle, and gears operate on the machine principle of the lever. The wedge and the screw use the principle of the inclined plane.

An understanding of the principles of simple machines provides a necessary foundation for the study of compound machines, which are combinations of two or more simple machines.

Mechanical Advantage of Machines

As identified in statements 3 and 4 under simple machines, a machine can be used to multiply force or to multiply speed. It cannot, however, multiply force and speed at the same time. In order to gain one force, it must lose the other force. To do otherwise would mean the machine has more power going out than coming in, and that is not possible.

In reference to machines, mechanical advantage is a comparison of the output force to the input force, or the output distance to the input distance. If there is a mechanical advantage in terms of force, there will be a fractional disadvantage in terms of distance. The following formulas can be used to calculate mechanical advantage.