

Practically, *efficiency* is always lost, owing to the various resistances due to the parts of the machine.

93. Among engineers the standard of *efficiency* in the comparison of machines has usually been taken to be a *horse power*, which is represented by 33000, a lb. and foot being the units employed, and the power being exerted for one minute of time. Thus a horse in one minute is supposed to lift 33000 lbs. through 1 foot, or 3300 lbs. through 10 feet, or 330 lbs. through 100 feet, and so on. A machine is then said to be of so many horse-powers, whence the *work done* by it in any time can be calculated.

FRICTION.

Hitherto the surfaces of bodies in contact have been considered *smooth*, and exerting on each other no pressure except in a normal direction. In nature, however, all surfaces are more or less rough, and when one surface is pressing or moving upon another a force is called into play which acts in a direction contrary to that of the motion, or to that in which motion would occur if the surfaces were smooth. This force is called *Friction*.

In machines, when a power is supporting a given weight, the magnitude of the power, determined on the supposition of the smoothness of the machine, may be increased beyond this value without disturbing the equilibrium, until it is great enough to overcome the friction together with the weight; and on the other hand, may be diminished till it is so small as with the aid of friction just to prevent the weight overcoming it. So also, with a given power, the weight may be increased or diminished within certain limits without disturbing the equilibrium. Generally, when the power is on the point of raising the weight, friction acts to the disadvantage of the power; but, when the power is just preventing the weight from descending, friction acts advantageously. When the equilibrium of a system depends on position, this position may with the aid of friction be varied within certain limits of the position determined on the supposition of smoothness, and the equilibrium be still maintained.