On the whole, P " $1+2+2^2+2^3+\ldots+2^n$, or $2^{n+1}-1$.

And the principle asserts that

$$P \times (2^{n+1}-1) = W \times 1$$

the condition found in § 68.

Inclined plane. Fig. 12.

85. In the inclined plane, the power acting parallel to the plane, (fig. 12), let W be at the bottom of the plane and be drawn up to the top. Then W's vertical displacement is the height of the plane, and P's descent is its length. The principle asserts that

$$P \times \text{length} = W \times \text{height},$$

the condition found in § 72.

Screw. Fig. 13.

86. In the screw, let one complete turn be made. Then the distance moved through by the end of P's arm, estimated always in the direction of P, is the circumference of P; and the space descended by W is the distance between two threads. The principle then asserts that

$P \times$ circumference of $P = W \times$ distance between two threads, the condition found in § 75.

87. Assuming the truth of this principle of *virtual velocities*, it may be conveniently employed to find the mechanical advantage in many machines—as examples, let us take *Roberval's Balance*, *The Differential Axle*, and *Hunter's Screw*,

Roberval's Balance. Fig 17.

88. In *Roberval's Balance* the sides of a parallelogram are connected by free joints with each other and with a vertical axis passing through the middle points of opposite sides; so that the figure is symmetrical about this axis, and the other opposite sides are always vertical. The weights P, W are carried by arms fixed perpendicularly to these latter sides, which arms are therefore always horizontal. If the machine, when at rest, be displaced, one of the weights ascends as much as the other descends, and they are therefore equal.