The whole weight W (including that of the bar) is the sum of these; therefore,

$$W = P(2^{n+1} - 1) + w_1(2^n - 1) + w_2(2^{n-1} - 1) + \ldots + w_n(2-1).$$

The weight of the pullies therefore increases the advantage of the machine.

Cor. 1. If the weight of each pully be the same (w), then,

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

$$= P(2^{n+1} - 1) + w(2^{n+1} - 2 - n).$$

If we put $P = 0$, we have

$$W = w(2^{n+1} - 2 - n),$$

which is the weight that would be supported by the pullies alone.

Cor. 2. The point of the bar to which the weight should be attached in order that the bar may be horizontal will be the *centre of parallel forces* for the tensions of the strings and the weight of the bar. If we neglect the weight of the pullies and the bar, this point will remain the same in a system, whatever be the power; if, however, the weight of bar and pullies be considered, it will be different for different powers.

69. Taking the same number n of moveable pullies in each system, the respective mechanical advantages are $2n$, 2^n, $2^{n+1} - 1$, and these numbers are in ascending order of magnitude. Hence the mechanical advantage of the third system is greater than that of the second, and of the second than of the first when there is more than one pully. Systems compared.

70. The following combination of pullies may be noticed. It is called the *Spanish Barton*. Spanish Barton. Fig. 10.

The tension of the string to which P is attached is the same throughout and $= P$. That of the other string is also the same throughout and $= 2P$. Therefore $W = 4P$.

If we take the weights of the pullies A, B into account, we have $W + B = 4P + A$.