horse power, neither the power expended in working the air-pumps of condensing engines, the friction of the machinery, nor the force expended in working the valves, has usually been considered, the power in the cylinder being alone expressed by the ordinary formula.

Indicated horse power thus:

$$\frac{\text{Mean eff. pres.} \times \text{diam}^2 \times .7854 \times \text{stroke} \times 2 \times \text{no. rev. per min.}}{33000}$$

Now, this is practically correct, and proves the preceding statement to be incorrect. Since all these items then referred to, are included in the reduction of gross pressure, per inch, on boiler, to Effective pressure, which is two-thirds of the former, one-third being deducted expressly to cover these items of resistance. The above formula is the same as that we have already given, only not so concise, which is:

$$\text{EP} = \text{effective pressure},$$

$$\frac{\text{EP} \times a \times v}{33000} = \text{the actual HP.}$$

It was only in the early days of the steam engine that there was any dispute as to its power, as they could not agree as to the average strength of a horse, one giving 22,916, another 27,500, another 33,000 lbs, raised one foot high, in one minute. There was then show of reason in the attempt to measure by surface of piston. This, however, is quite unnecessary here, since we all agree to the standard of 33,000 lbs. as the actual horse power. It will be observed that the nominal horse power is computed from an "assumed" speed, and an "assumed" pressure. Now, in computing actual horse power, nothing is assumed, the power being computed from the actual conditions laid down. For instance: A new steam engine is required of a certain number of horses power, the boiler not to be pressed above 50 lbs on the square inch, and the piston not to have a velocity beyond 300 feet per minute. These conditions determine the size of the engine. Take another case: A steam engine is required of the same power as the above, but the pressure on the boiler is only to be 30 lbs on the inch, and the piston velocity 250 feet per minute. The conditions, in this instance, will determine that this engine would require to be about twice the size of the former, consequently its cost would be considerably more than that of the former, yet of the same power. A great revolution in the construction of steam engines has taken place since the time when these rules of piston measurement were adopted, "and only partially adopted." The whole field of working steam expansively with increased pressure and speed, and which, with other improvements, the cost for fuel has been reduced in well made engines to a third of what it was at that time, that is, a bushel of coal, with our present well made engines, will raise a weight 3 times heavier, a given height, in a given time, than with the engines of that period—the period of the nominal horse power.

The "mechanical effect" of steam is now better understood and acted upon than at that period. This, however, and the subject of steam boilers, must be deferred until a more appropriate time.

Z.

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