

XX.—*Note relating to a Newly-Discovered Absolute Limit to Economical Expansion in Steam-Engines.*

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NOTE.—This paper was prepared in the latter part of April, 1882, and sent to the Academy for presentation. But an accidental non-delivery prevented its reaching the Committee on Papers and Publication, until too late for reading before the meetings were suspended for the summer. It was, therefore, presented at the first meeting of the autumn; but its actual date of reading is really several months later than it should properly have been.

D. S. M.

A paper "On the Behavior of Steam in the Steam Engine, and on Curves of Efficiency,"* was read by the writer before the New York Academy of Sciences, February 13th, 1882.

In that paper it was shown that, if a "Curve of Efficiency" were constructed for any steam engine, such that its ordinates should be proportional to the work done by quantities of steam laid down in arithmetical progression as abscissas,—the quantity used at full stroke, *i. e.*, without expansion, being taken as unity,—that such curve would depart from the curve given by the ideal perfect engine, in character, form and location, and that it could not pass through the origin, as does that of the ideal engine, unless by passing through a point of inflection.

It was shown that, such a curve being constructed, ratios of expansion at maximum efficiency could be determined by drawing tangents to the curve from the junction of the back-pressure line with the ordinate passing through the origin. It was shown that the ratio so determined is larger as the ratio of initial to back pressure increases. It is the object of this note to call attention to the fact that, for the real engine, there exists an absolute limit to economical expansion for every such engine, which cannot be exceeded, however high the pressure of steam may be carried.

* Trans. N. Y. Acad. Sci., February, 1882; Journal Franklin Institute, Feb., 1882.

For : when the steam-pressure (p^1) becomes infinite, the ratio ($r = \frac{p^b}{p^1}$) becomes zero, and the tangents to the curve of efficiency are drawn from the origin (O , Fig. 1).

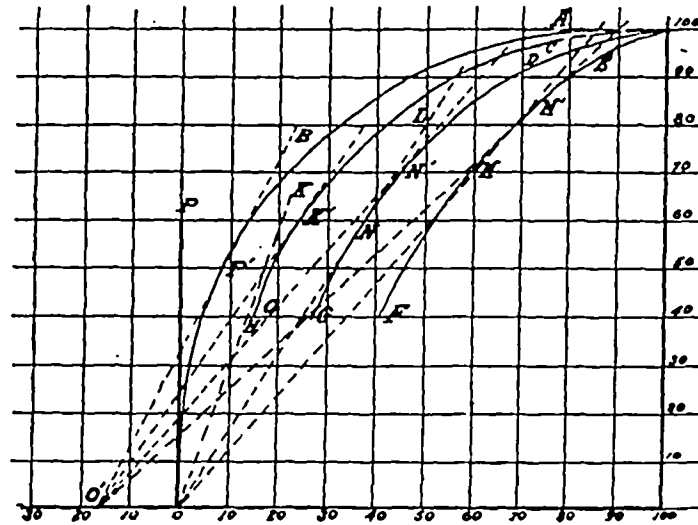


FIG. 1, CURVES OF EFFICIENCY.

The point of tangency, which, for the ideal case, $A B O$ is found at the origin O , where $r = \infty$, is for the real case, $C D H$ found at H , a point corresponding to some finite value of r . This point thus constitutes a limit to economical expansion such as is here considered, and which is now, so far as the writer is aware, first discovered.

It was shown, in a paper read before the Society of Mechanical Engineers, April, 1882,* that, by making the distance $O O'$, measured toward the left from the origin, proportional to the costs of engine, apart from the costs of supplying steam, and drawing tangents from O' , ratios of expansion at maximum commercial efficiency could be determined. It is now seen that such a limit as is above described is found not only for the real but also for the ideal engine, when commercial efficiency is studied, their limit being determined by the points of tangency B or H , given by the lines $O' B$, $O' K'$.

* Trans. Am. Soc. Mech. Engrs., 1882. Jour. Franklin Inst., May, June and September, 1882.