

The Efficiency of Gas and Oil Engines*

A New Method of Stating the Power of Gas and Oil Engines, Claimed by the Writer to be more Convenient and Practical, and Also to form a Better Basis for the Comparison of the Thermo-dynamic Performance of Engines of Different Types. Power of Engine Expressed in Total Work Done by the Working Substance, called Thermo-dynamic Horse Power

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For a whole century the indicated h.p. of the steam engine has been accepted as the most satisfactory measure of the work done in the cylinder of that engine. When the gas engine came into use it was but natural that the same measure of its power should be used. So long as the whole cycle took place in one cylinder there was but little doubt as to what was meant by the indicated h.p. of the engine; but when auxiliary air and gas pumps

and certain resistance. Consequently it does not permit a comparison to be made between the actual amounts of work done by the working substances in the cylinders of engines of different types.

So far as the steam engine is concerned, the indicated h.p. is certainly the most convenient and probably the most practical method of stating the amount of work that is done in the engine; but for gas and oil engines, it is possible to use another method of stating the power of the engine; a method which is not only more convenient and practical but which also gives more information as to the real actions taking place, and forms a better basis for the comparison of thermodynamic performance of engines of different types.

DEFINITION OF INDICATED HORSE POWER.

The indicated h.p. of a steam engine is really the algebraic sum of two quantities; these are (a) the total work done by the steam inside the cylinder and (b) the negative work done in overcoming the frictional and inertia resistances of the steam during the exhaust period. Thus, in Fig. 1, if $a b$ represents the pressure in the space into which the steam is exhausted, the total work done by the steam in the cylinder is $a c d f b$, and of this amount $f e a b$ is used up in overcoming the resistances to the escape of the steam, leaving the area $e c d f$ as the indicated work, or the total work done on the piston.

The work done in the cylinder is not however the total work done by the steam, since the steam has to do work in order to overcome the resistances to its admission. In Fig. 1, if $g h$ represents the boiler pressure, the area $g h d c$ is the work that the steam has to do in order to flow from the boiler to the cylinder. The total work

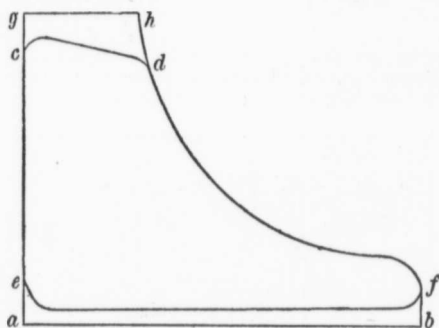


FIG. 1—Indicator Card of Steam Engine

were used, the indicated h.p. acquired special definition. A committee of this society reported in 1902 a code of rules which contained this special definition, and which has given a consistent meaning to the indicated h.p. of steam engines and of gas and oil engines of all types.

The definition referred to is not, however, universally accepted. The pages of the *Zeitschrift des Vereins deutscher Ingenieure* for 1905 contain a long and most animated discussion by many of the ablest German engineers on the meaning of indicated h.p. and mechanical efficiency in two-cycle engines, and they show very marked differences of opinion as to the correct method of calculating those quantities. Within the past few months the definition of the indicated h.p. of a four-cycle engine has been the subject of debate by the British Institution of Mechanical Engineers, and a strong tendency manifested itself to take as the measure of the indicated work of a four-cycle engine only that area which is included in the positive loop of the indicator card.

DIFFERENT METHOD OF STATING POWER OF ENGINE.

In all cases it has been assumed that the indicated h.p. is the best measure of the work done in the engine, but the differences of opinion as to the methods of its measurement are really indications of the fact that the indicated h.p. of an engine, and the quantities deduced from it, do not give that information which engineers have been trying to extract from them. The fundamental trouble with the indicated h.p. as the unit of power is that it does not represent the actual work done by the working substance, but the difference between that quantity

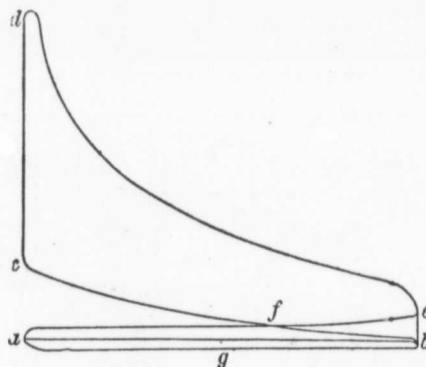


FIG. 2—Indicator Card of Four-cycle Gas Engine

done by the steam is consequently the area $g h b a$; and the area $c d f e$ (i. e., the indicated work) is the difference between the total work done by the steam and the work necessary to get the steam into and out of the cylinder. The total work done by the steam in a steam engine is not shown directly on the indicator card, but has to be

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