

THURSDAY, NOVEMBER 11, 1909.

*THE INTERNAL COMBUSTION ENGINE.*

*The Gas, Petrol, and Oil Engine.* By Dugald Clerk, F.R.S. Vol. i. New and revised edition. Pp. ix+380. (London: Longmans and Co., 1909.) Price 12s. 6d. net.

MR. DUGALD CLERK originally published this book under the title of "The Gas Engine" in 1886. Ten years later it reappeared in enlarged form as the "Gas and Oil Engine." It has now been found necessary, the author tells us, to re-write practically the whole of it, and in doing so the further change of dividing it into two volumes has been made. This is in itself evidence of the development of science and practice that has taken place during the last twenty-three years. The two new volumes are to be called "The Thermodynamics of the Gas, Petrol, and Oil Engine," and "The Gas, Petrol, and Oil Engine in Practice." It is the first of these volumes which is now issued. It is ostensibly a book on the thermodynamics of the gas engine, and it is as such, therefore, that it must be examined and discussed. We may say at once that it is quite unlike any other book on thermodynamics that we remember to have read. Its appeal must be to the comparatively small number of engineers and physicists who are familiar alike with modern practice in gas-engine work and with some of the most recent results in physics. To the experimenter in this important field of work, it will be invaluable as containing in compact form a record of the latest experiments as well as an occasional commentary upon them from the author's standpoint.

It interested us to compare the present volume with Mr. Dugald Clerk's book on the gas engine issued in 1896. We were the more interested in such a comparison because of the change that has come to the point of view of so many workers on account of later knowledge of the physical properties of the gases concerned in the gas-engine cycle. Mr. Clerk's point of view has also changed materially. The author remarks on p. 200:—

"Some things, however, have been definitely settled. Holborn and Austin's investigations have placed it beyond doubt that the specific heat of steam and carbonic acid increases considerably with increase of temperature, and that a small increase occurs with oxygen and nitrogen. Nernst's investigations have proved that the dissociation of steam and carbonic acid at about 2000° C. is unexpectedly small."

When the 1896 edition was published, and until a much later date, Mr. Dugald Clerk was disinclined to accept the contention of the French physicists that specific heat increased with temperature, and the thermodynamic part of that volume, which is, we notice, reproduced with but little change in the first 118 pages of the present one, was based on the constancy of specific heat. After reproducing this earlier work, Mr. Dugald Clerk now adds:—

"Throughout the present chapter the working fluid has been assumed to be dry air obeying perfectly the laws of Charles and Boyle; its specific heat has also

been assumed to be constant throughout the temperature range. . . . It is now known that the specific heat of air is not quite constant between 0° and 1400° C. . . . The mean  $K_p$  between 100° C. and 1400° C. is about 8 per cent. higher than that between 100° and 200° C. . . . But it must be remembered that the efficiencies and mean pressures determined by these calculations for ideal air are not the efficiencies and mean pressures which would be proper to the actual working fluid. . . . Meantime, however, it may be taken that the reasoning and conclusions reached in this chapter are valuable when properly used."

From p. 119 onwards the author takes into account the variability of specific heat with temperature. Indeed, in virtue of its importance, the greater part of the book is devoted to the consideration of this matter and of the associated problems.

Practically all recent work is described at more or less length, and particular stress is laid on the important work carried out on gaseous explosions at the Royal College of Science, on the initiation of Prof. Perry. Mr. Dugald Clerk is able to reproduce a great deal of this experimental work which had not previously been published, and he analyses the results obtained with great skill and infinite patience. It seems a pity that the record of these experiments has not previously been published, and we can only surmise that their importance was not realised adequately, perhaps because the experimenters, Messrs. Bairstow and Alexander, did not bring out their points with the emphasis at Mr. Dugald Clerk's command. How far the accuracy of these experimenters will stand the test of time remains to be seen; the virtue that led Mr. Dugald Clerk to refer to them at such length is that they are the only experiments so far known from which can be obtained a series of cooling curves under various conditions of pressure and temperature. We anticipate that practical results of real use will be obtained from this work.

At the end of the volume the author reproduces the very valuable 1908 report of the Gaseous Explosions Committee of the British Association. It includes a description of Mr. Dugald Clerk's "zig-zag" experiments. It also criticises them, and gives reason for thinking that they may contain an error of as much as 10 per cent. The committee remarks, "If there be systematic error in Mr. Clerk's work it seems most likely that it lies in the estimate of heat loss," and proceeds to indicate a way in which this error can be corrected. It is very curious to read this report at the end of Mr. Dugald Clerk's book, when, on turning to his own account of these very experiments, he omits to discuss any correction of the kind. We think that it would have been better if some notice had been taken of the committee's remarks, although it may well be that to have done so would have led to such a mass of extra work that any author might shrink from it.

We are so grateful to Mr. Dugald Clerk for this interesting volume that we do not wish to press too hard the main criticism to which it is liable, viz. that it is insufficiently edited, that a tight enough grip is not held upon the subject, and that the style is not such as to make it easily readable.