

DESIGNING VALVE GEARING

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Designing Valve Gearing by Edward J. Cowling Welch

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EDWARD J. COWLING WELCH

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BY

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PREFACE.

IN submitting the following pages to the notice of the engineering profession, I am conscious that I owe some apology for treating of a subject, which has already occupied the attention of so many competent authorities, as Rankine, Zeuner, and others, to whose works I am indebted for much information. For my excuse I must appeal to the fact, with which most engineers are well acquainted, that in "getting out" the details of engine work the question of the valve gearing is frequently the one which presents the greatest difficulty to the designer. To meet this, many of our leading mathematicians have propounded definite formulæ for determining the due proportionment of the various parts; but while these of course ultimately furnish the required results, they necessarily involve such abstruse and complicated mathematical calculations as to be of little or no assistance to the majority of those who most need to use them. To illustrate the truth of this statement, we have but to take the very excellent

treatise on valve gears by Dr. Gustav Zeuner. In this work we find enunciated formulæ for almost every description of valve gear, but a glance at its pages will show that these invariably involve an amount of mathematical knowledge which renders their general adoption impossible. It thus comes to pass that in actual practice we frequently find the "rule of thumb" to be the one exclusively resorted to, with a loss of much time and labour in constructing models and adjusting and readjusting their parts until the dimensions of the various details are approximately obtained, and even then it not unfrequently happens that where several engines of the same class have to be constructed, one is first completed in order that the valve gearing may be tested, and the drawings corrected accordingly, before the others are proceeded with. But there are many engines constructed without any such precautions being taken to secure even tolerable accuracy in their valve arrangements, and it is in the case of these that the best results may be looked for from the proper application of the rules which are discussed in this volume. Nor is the question of the correct design of these details one of trifling importance to the users of steam power, for a defective arrangement, such as, upon inquiry, has been too often found to exist, will in many cases involve a loss of from ten to twenty per cent. in fuel and steam. It will thus be seen that this subject is one

of general interest, and demands more careful attention than has hitherto been paid to it.

My object in preparing the following problems has been to show that, starting with the application of the 31st Proposition of the 3rd Book of Euclid, to the subject of valve gearing, as first suggested by Professor Zeuner, it is possible to obtain certain geometrical constructions which, without involving a single mathematical calculation, or indeed any other operation that can be performed with a rule and compasses, will yet enable us to obtain results practically as accurate as those deduced from mathematical formulæ, but with this further advantage, that whatever errors may chance to occur in the construction must at once make themselves apparent. I have, moreover, endeavoured to show, step by step, how the results are deducible from the recognised principles of geometry, and at the same time given sufficient explanation of the mode of using the figures as to enable foremen and others to apply them in practice without stopping to investigate the means, by which they have been arrived at. In doing this, I have, as far as possible, avoided the use of mathematical language, substituting for it such ordinary terms as are understood in every drawing office and workshop. It will doubtless be observed I have more than once been compelled to state that many of these results are, after all, only approximately, not absolutely correct; but it will also be

easily understood that I have adopted this precaution because in some valve combinations it is almost impossible to obtain either by geometry or mathematical calculation the *exact* movement of all the parts, on which the result depends. In practice, however, *perfect* mathematical accuracy is not required, and the results obtained by the graphic method differ so very slightly from the actual truth as in mechanical construction to be altogether inappreciable.

The problems included in the following pages are applicable to all forms of slide-valve gearing, in which the motion is derived from eccentrics, as now generally adopted; and by a further application of the system, figures for other combinations may be easily obtained.

London, July, 1875.

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