THE ELEMENTARY PRINCIPLES OF MACHINE DESIGN, EMBRACING THE PROPORTIONS OF CONNECTING RODS AND PISTONS FOR STEAM ENGINES, COTTER JOINTS, SCREW WRENCHES, ETC., ETC.

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The Elementary Principles of Machine Design, Embracing the Proportions of Connecting Rods and Pistons for Steam Engines, Cotter Joints, Screw Wrenches, Etc., Etc. by J. G. A. Meyer

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J. G. A. MEYER

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THE ELEMENTARY PRINCIPLES

OF

MACHINE DESIGN,

EMBRACING THE PROPORTIONS OF CONNECTING RODS, PISTON RODS AND PISTONS FOR STEAM ENGINES, COTTER JOINTS, SCREW WRENCHES, Etc., Etc.

With Full Instructions for Setting a Plain Slide Valve and Eccentric.

Also Practical and Explanatory Hints for Making all the necessary Calculations and Working Drawings.

By J. G. A. MEYER,

AUTHOR OF "MODERN LOCOMOTIVE CONSTRUCTION," "EASY LESSONS IN MECHANICAL DRAWING AND MACHINE DESIGN," ETC.

HANDSOMELY ILLUSTRATED.

Simplicity and Accuracy are the Characteristics of this Work.

New York:

The Industrial Publication Company.

1897.

PREFACE.

WHILE it is true that there are several very excellent works on machine design before the public, it is also unfortunately the case that we have no simple and cheap work which begins at the beginning and leads the student on by gradual and easy steps to an acquaintance with the more important departments of the subject.

The object of the writer in preparing the present little volume is to supply this want and to furnish a stepping stone, as it were, to the study of more elaborate works.

As the best way to impart a clear knowledge of any practical subject is to work out such easy examples as are likely to occur in every-day practice, the author has begun by giving the rules and directions required for the designing and drawing of one of the most common objects of the workshop—a screw wrench. Having worked out this easily understood example he then passes on to more intricate and difficult problems, and by degrees leads the young mechanic to the study of the slide valve and the eccentric.

Those who desire to carry their studies further in this direction will find ample material in the author's large work entitled, "Easy Lessons in Mechanical Drawing and Machine Design, arranged for Self-Instruction."

The very simplest language has been used throughout the volume, and the methods given are not only the most accurate but the simplest in use.

In the hope that this little book will lead many young mechanics to the successful study of the higher branches of the profession the author submits it to his fellow mechanics.

J. G. A. MEYER.

New York, 1897.

THE ELEMENTARY PRINCIPLES

OF

MACHINE DESIGN.

By Machine Design is generally understood, those calculations and drawings which are required for the production of efficient, economical and attractive-looking tools and machines. This art demands such a combination of knowledge and skill as will insure a proper adjustment of strength to the work to be done, and such a distribution of the material employed and of the form into which it is put, that on the one hand there shall be no superfluous weight and consequent waste, and on the other no deficiency of material where material is needed. The machine designer begins where the inventor leaves off, and without the aid of a good designer most mechanical inventions would either prove failures or they would involve an expense for experimenting that would be ruinous.

It is true that very often we have parts of a machine or tools to design for which it is impossible to determine exactly the magnitude of the forces which act upon them. In such cases we must be satisfied with the results obtained by the application of empirical rules, that is, rules founded upon experiments or experience, and which do not depend on the strict application of the rules of higher mathematics, but on experience or observation alone.

From what just has been stated it will be seen that it is of the utmost importance that the young mechanic should make a thorough study of this branch of his art and the easiest and best way to gain a knowledge of the subject is to commence with some simple tool of every day use in the shop. Such a tool is the wrench, of which we will now give the proportions.

Proportions of a Wrench.

The wrench shown in *Figs. 1b* and *2b* is probably as good, useful and simple a subject as we can take up in these exercises. It will readily be understood that it is impossible to determine exactly the amount of pull which a workman or workmen may exert on the end of the wrench, or to compute the stresses set up in it by the rough usage to which it may be subjected. Hence we employ such empirical rules as will furnish us such proportions as have been found to give good results in practice. Furthermore, we will have the opportuuity of showing the advantage and the great simplicity of the use of symbolic expressions or formulas which are simply shorthand ways of writing a rule, and do not involve any knowledge of algebra, a science which is the great bugbear of mechanics, and is mistakenly considered to be a useless science in practice.

We may here point out that the advantage of these symbolic expressions is that they are applicable to designing any size of wrench. Thus, in finding the proportions of

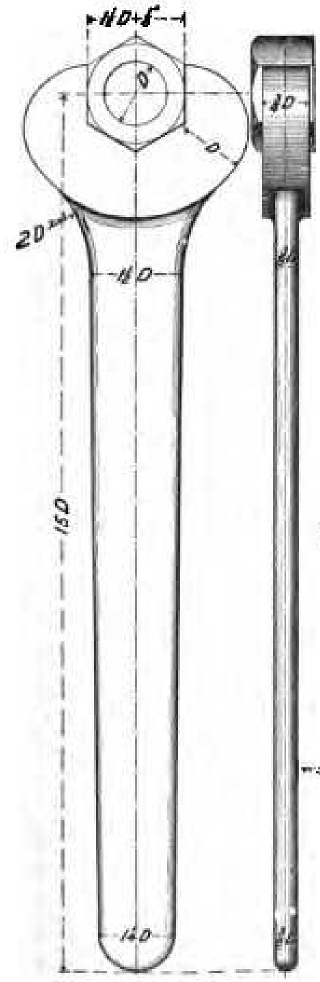

Fig. 1b.

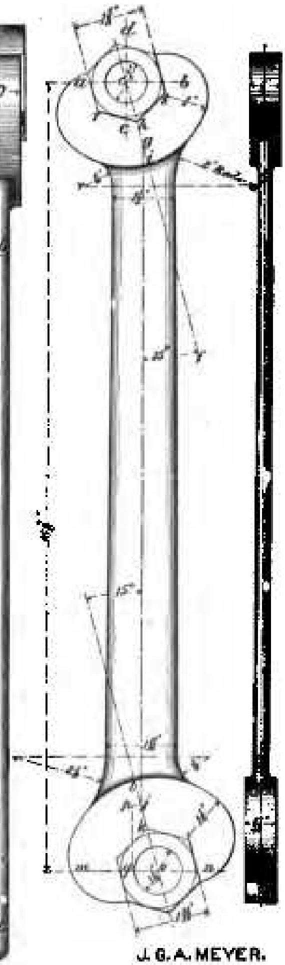

Fig. 2b.

any part of the wrench we use the diameter of the bolt for which the wrench is to be designed, for a unit of measurement, and instead of writing "diameter of bolt" in full we simply write "D," which is the first letter of the word "diameter," and thereby not only save the labor of writing three words, but also add much to the simplicity with which the rule may be stated. If, now, these simple instructions are understood and kept in mind; and if, in addition to this, the student is familiar with the meaning of the ordinary signs used in arithmetic, we may say that he has mastered the whole subject of reading formulas.

Now, it seems to us that the student cannot fail to understand that *Fig. 1b* informs us that the distance between the jaws must be equal to $1\frac{1}{2}$ D + $\frac{1}{8}$", which reads $1\frac{1}{2}$ times the diameter of the bolt plus $\frac{1}{8}$ inch; this dimension is the distance across the flats of the nut made in accordance with the American standard of bolt heads and nuts. The width of the jaw is equal to D; this indicates that the width must be equal to the diameter of the bolt. The width of the shank is marked $1\frac{1}{2}$ D, this indicates that the width must be equal to $1\frac{1}{2}$ times the diameter of the bolt. The radius of the arc joining the edges of the shank and the contour of the head is equal to 2D, or twice the diameter of the bolt; and the length of the wrench from the center of the bolt to the end is equal to 15 times the diameter of the bolt. The thickness of the wrench is plainly indicated in the side view in *Fig. 1b*. We may also point to the fact that in *Fig. 1b* the center line of the head of the wrench coincides with the center line of the shank.

2.—In *Fig. 2b* we show a wrench the head of which is set obliquely to the shank; here the center line of the head makes an angle of 15 degrees with that of the shank. With a wrench of this kind, a nut can be screwed up with the smallest possible angular movement of the wrench. Thus, taking hold of a hexagonal nut we can swing the wrench through an angular movement of 30 degrees, and turn the nut through $\frac{1}{12}$ of a revolution, and then reversing the wrench we can turn the nut through another $\frac{1}{12}$ of a revolution, and by repeating this operation we can turn the nut through any angle we please. If the nut had been a square one, the angle between the center line of the head and that of the shank should have been $22\frac{1}{2}$ degrees. Hence wrenches of this kind are suitable for screwing up nuts in contracted spaces.

3.—In order to explain the mode of procedure of making a drawing of the wrench shown in *Fig. 2b* we will take the following example.

EXAMPLE 1.—**It is required to make a drawing of a wrench for a bolt 1 inch diameter.**

Through any point *c* draw the center line *cf*, making an angle of 15 degrees with a vertical line; around the point *c*, and on the line *cf*, draw a hexagonal nut in accordance with the well-known methods given in all standard works on Mechanical Drawing. A simple and thorougly accurate method will be found in Chapter IV, of the Author's "Easy Lessons in Mechanical Drawing."

According to the proportions given in *Fig. 1b*, the distance across the flats of a hexagonal nut for a 1 inch bolt, and, consequently, the distance between the jaws of the wrench, will be $1\frac{5}{8}$ inches. Now, referring again to *Fig. 1b*, we notice that the outer contour of the jaws consists simply of arcs drawn from centers placed on the inner sides of the jaws; these lines must be produced so that