THE STEEL SQUARE

—AS—

A CALCULATING MACHINE

BEING SIMPLE DIRECTIONS FOR USING THE COMMON STEEL SQUARE FOR THE SOLUTION OF COMPLICATED CALCULATIONS THAT OCCUR IN THE EVERYDAY WORK OF CARPENTERS, BUILDERS, LUMBER DEALERS, PLUMBERS, GAS FITTERS, ENGINEERS, ELECTRICIANS, TINSMITHS, BLACKSMITHS, MASONS, STONE CUTTERS, ETC., ETC.

WITH NUMEROUS ILLUSTRATIONS

By ALBERT FAIR

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PREFACE.

The following pages are not addressed to graduates of technical schools, or even to well-read workmen of experience. They have been prepared for the ordinary workman and for the beginner.

At first sight some may turn up their noses at what is here written and ask: "What is the use of publishing such simple matter as that?"

I thought so myself for some time, until I came into contact with several boss mechanics to whom some of the simplest problems here given were entirely new and wonderfully interesting as well as practically useful. I then came to the conclusion that a little book of this kind cannot be too simple or elementary.

The fact that some of the most simple propositions here set forth are not generally understood is shown by the extraordinary blunders with which some of our popular writers on mechanical subjects have filled their books and magazine articles.

In most cases I have used the common language of the shops instead of the precise terms of the mathematician. The use of these mathematical terms would have made it very much easier writing for the author, but very much harder reading for the reader. I therefore offer no apologies for this peculiarity of the book.

As most of my readers know, almost everything here given has been published over and over again by previous writers, but I am not aware that any of them has put it into quite so simple a shape.

ALBERT FAIR.

New York, August, 1906.

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HINTS AND CAUTIONS.

In the language of a well-known writer on technical subjects, "the day of cutting and trying is past; workmen are now expected to mark out their work to a hair's-breadth and cut to the line. The old-fashioned waste of time and material is no longer tolerated in well-appointed workshops, and if the young mechanic wishes to become anything more than a mere 'hewer of wood and drawer of water' to his more intelligent fellow-craftsmen, he must study the principles according to which all well-designed work is laid out, and learn to put them in practice." *

To the ordinary mechanic who has not had the advantage of a training in one of our technical schools, there is no aid so efficient, so simple and so cheap as the modern steel square. As turned out by our best manufacturers, the workmanship is so accurate and the markings and graduations are so complete that the instrument almost serves the purposes of a pocket-book of rules and tables,

* "How to Become a Good Mechanic." By John Phin. New York: The Industrial Publication Company.

and a sound practical knowledge of the principles which enter into its construction, and of the nature and use of the markings which have been placed upon it, is easily acquired by those who will devote a little time and earnest thought to the work; there is no knowledge of abstruse mathematics required for the study, and an hour or two each evening devoted to practically working out the various problems by means of a few pieces of waste lumber and a few sheets of cheap pasteboard, will soon place the earnest young workman on a level as high as that attained by many of the graduates of our technical schools. It is for the purpose of aiding him in this study that the present book has been written, and such being its object, the author's efforts have been directed to making it as simple as possible, consistent with the giving of sound and systematic information. A mere fragmentary collection of problems will not answer this purpose; the young workman who depends upon instruction of that kind will find himself lost as soon as he departs from a very narrow beaten path, while, if he understands the general principles and their application, he is like the traveler who owns a good compass and who can blaze new paths for himself through what would otherwise be a trackless forest.

Up to the present writing (August, 1906) there is no book within the reach of the American workman which quite meets the requirements demanded for such a course of study. It is true that we have the admirable little "Pocket-book" of Mr. Stoddard, a cheap and handy

volume which every carpenter in the land should own, and we also have the ponderous and pretentious volumes of Mr. Fred. T. Hodgson, as well as two or three others, some of which give really valuable information on special points, but we have no book to which the workman can turn as to a trustworthy text-book, from which he can learn the principles as well as the mere rule of thumb. The recent books of Mr. Hodgson are utterly unreliable, because of the very evident fact that he has no knowledge whatever of geometry, and is obviously unable to perform the simplest mechanical calculation with any degree of accuracy. As his recent productions have been so lavishly praised by his publishers that the uninformed mechanic might be led to have some faith in his writings, it is proper that I should give some easily tested proofs of the justice of such a serious accusation—an accusation which would be absolutely libelous if it were not perfectly true.

It would be easy to give hundreds of instances which would amply support this charge, but the following passages, taken from his latest book on the Steel Square are easily within the comprehension of any boy who has had a common school education, and they are so gross and so glaring that every one whose attention is called to them must be surprised that such stuff should get into print in this day of universal education. They are not printers' mistakes, such as are liable to occur in the books of even the ablest authorities, although these are so very numerous in all Mr. Hodgson's recent publications that

they must prove quite confusing to most readers. Neither are they mere lapses of expression, such as may easily happen in the hurry of preparation for the press; it is evident, that their origin lies deeper than either of these two sources, and they are thoroughly characteristic of all his recent writings. I say *recent* writings because his earlier books, as published by the Industrial Publication Company, were issued under the superintendence of men who knew better than to allow alleged solutions of "squaring the circle" and such like blunders to appear in volumes for which they might be held responsible. Let me give a few examples.

On page 202, of Volume II. of his book on the Steel Square, occurs the following passage, which would certainly be remarkable if found anywhere else. Speaking of "squaring the circle," he says: "Its solution has been thought an impossibility, and with all due regard to the opinion of others on this point, we think it quite possible to solve this difficult problem by a new and simple method of construction, which is here given." He then goes on to give a so-called geometrical solution of the problem by which he finds "a square, the area of which will be found equal to that of the circle; its diameter being 12 feet, and one side of the square 10 feet 5 inches."

Now, it does not require any great skill in the art of mensuration to find that the square found by Mr. Hodgson's method is too small by nearly 5 square feet! So that his "new and simple method of construction" is

not nearly as accurate as any one of a dozen different methods which have been in common use by mechanics for thousands of years. If Mr. Hodgson's system were applied to the finding of longitude, it would wreck half the ships that sail the ocean, and if a blacksmith's helper were to make such a wild mistake he would be kicked out of the shop. What country wagon-maker would tolerate a blundering apprentice who, in calculating the length of a tire for a wheel 7 feet in diameter, would make it nearly one foot too short?

Such errors in calculation would ruin any contractor.

It would appear that Mr. Hodgson either does not know or does not appreciate the fact that the circle has been "squared" with such an approach to accuracy that nothing further can be required. Give a mathematician the exact diameter or circumference of a circle and, if desired, he will calculate the side of an equal square so accurately that on a circle equal in size to the orbit of the earth round the sun the error would not amount to the millionth part of a square inch! And even in ordinary calculations the error does not exceed the one-thirteen millionth of the quantity in question. It is unnecessary to say that no ordinary measuring instruments, even in the most expert hands, could possibly detect such a trifling error.

An amusing instance of Mr. Hodgson's utter inability to make the simplest mechanical calculation is shown in his copy of O'Connell's very ingenious method of finding the diameter of a circular spout which shall have the

same carrying capacity as another that is square and of which the side is given. The solution given by Mr. Hodgson (page 45, Volume II.), is as follows: "A spout is 20 inches square; what is the diameter of a cylindrical one with the same area of cross-section? Set the bevel to 31 on tongue and 35 on blade; move to 20 on tongue and we obtain 22, the answer, on the blade."

Now this result, as given by Mr. Hodgson, is 20 square inches too small—a rather important error. He evidently was not able to make the calculation and find out the mistake; he simply copied, as he supposed, O'Connell's solution, and he copied errors and all. With Mr. O'Connell, however, it was not originally an error; he gave the required diameter as 22½ (which is very nearly correct), but the ½ got broken off in the electrotype, as is easily seen on close inspection. Mr. O'Connell did not explain the reason for using the numbers 35 and 31, and it is evident that Mr. Hodgson could not do it, so he failed to notice the broken letter. A full explanation of this important problem will be given in its proper place in this book. Meanwhile, we may be allowed to note that Mr. Hodgson claims to have verified all his problems by the actual application of the steel square to the work; the case just cited is one in which he evidently omitted this very essential bit of work, for that he should have made a half inch error in adjusting the bevel to the blade or tongue seems hardly credible.

Again, on page 37 of the same book, we find a table of polygons with remarks, taken without credit, from O'Connell's original work. Here we are told that "in a circle 12 inches in diameter the largest pentagon which may be inscribed is 5.24 inches on a side. Hence for pentagons the bevel is set at 12 inches and 5.24 inches." This blunder was due to a typographical error in Mr. O'Connell's original article, but Mr. Hodgson was unable to detect the mistake and followed it religiously. In reproducing Mr. O'Connell's table and remarks on a subsequent page we have corrected this error.

That Mr. Hodgson does not understand the principles according to which the steel square, or any other square, may be used for making calculations, is shown by the manner in which he couples the steel square with the slide rule. He says: "The principles upon which all slide rules work is that of the square." On a future page we shall show the absurdity of this statement. Mr. Hodgson claims the credit of being the author of a book on the "Slide Rule," but it will be found on examination that he is the real author of very little that is good that has been published over his name.

And here let us note one of the most amusing features of Mr. Hodgson's books, though it is one that is rather annoying to young students. This is his mode of treating any subject which he is unable to understand. Whenever he gets beyond his depth (and this happens quite frequently) he slurs the matter over with the statement that "the subject is too simple to require further explanation" !!

Perhaps the most striking illustration of utter ignor-

ance of the most elementary principles of geometry is to be found in figures 60 and 81, on pages 106 and 137, of Volume I., of the book from which we have already quoted. These two engravings are substantially the same; the problems which both illustrate are the same, and why Mr. Hodgson should have given the same problem and the same solution twice within 32 pages, except to pad out his volumes and make a big book out of little available matter must be a puzzle to every intelligent reader. But setting this aside, it turns out that in both cases the solution given by Mr. Hodgson is wrong. The problem, according to him, is how "to determine the dimensions of the largest timber, other than square, that could be cut from a given log," and the figures and the solutions that he gives in both cases, are those given by the old astronomer and mathematician, Galileo, nearly three hundred years ago; but the problem, as presented to Galileo, was not how to cut the *largest* timber out of a log, but how to cut the *strongest* beam. The problem and the figure are well known, and will be found in various mechanical and mathematical books.

But the dimensions thus found are not those of "the largest timber, other than square," that can be cut from a log; an octagon, which, in some cases, is a legitimate form for timber, is much larger—larger than even the square. Neither does the given method determine the "largest rectangular beam, other than square," that can be cut from a log; the square log is the largest, and the nearer the log approaches to square the larger it will be,

so that a thousand rectangles, each larger than the one given by Mr. Hodgson (and yet not square), might be drawn on the end of any round log.

As we have already said, the problem as propounded to Galileo, and solved by him, was not to determine the dimensions of the *largest* beam, but of the *strongest* one that could be cut from a round log, and the richest part of the joke is that in both the figures given by Mr. Hodgson, the beam is laid flatwise, whereas the same beam placed on edge would be twice as strong. To make this quite clear to our readers we here reproduce the original figure by Galileo, and the figure given by Mr. Hodgson.

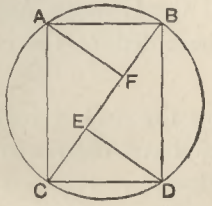

FIG. 1.

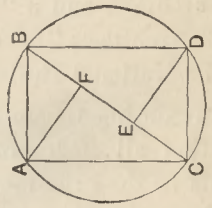

FIG. 2.

The method given by Galileo for finding the strongest beam is as follows: Let the circle ABDC, Fig. 1, represent the end of a round log and let BC be the diameter. Divide this diameter into three parts at the points E and F, as shown in the engraving and from F square out to the circle by the line FA and from E square out by the line ED. Join AB, BD, DC and CA, and the rectangle thus formed will be the cross-section of the strongest beam that can be cut from the log.

In Fig. 1 is shown the figure which accompanies the solution given by Galileo and followed by all reputable authorities; Fig. 2 is the same engraving turned one-quarter round as Mr. Hodgson has it in both places in his book, but in Mr. Hodgson's book the lettering is right side up, although the beam is wrong. This shows that the error was in his drawing, and that the mistake was not due to the printer. Any mechanic of the least intelligence must see that the beam A, B, C, D, when in the position shown in Fig. 1, will support a much greater weight than it can when in the position shown in Fig. 2. And yet Mr. Hodgson advertises himself as a professional architect and a "Member of the Ontario Association of Architects." He is also heralded as the editor of "The National Builder."

In presenting the following pages the author feels assured that all such gross blunders have been avoided, and this he does the more confidently from the fact that throughout the preparation of the work he has had the advice and assistance of Mr. John Phin and Mr. Charles G. Peker—both well known as sound and trustworthy writers upon technical subjects.

A FEW SIMPLE EXPLANATIONS.

As this book is intended for those who have had little or no technical education, it may be well to explain a few terms and elementary principles which are no doubt familiar to expert mechanics, but which may not be so

well understood by beginners. And first as to the names of the different parts of the square:

The steel square, as shown in Fig. 3, consists, as is well known, of two arms at right angles to each other, or in the common language of the shops—square with each other. One of these, AB, is usually longer and wider

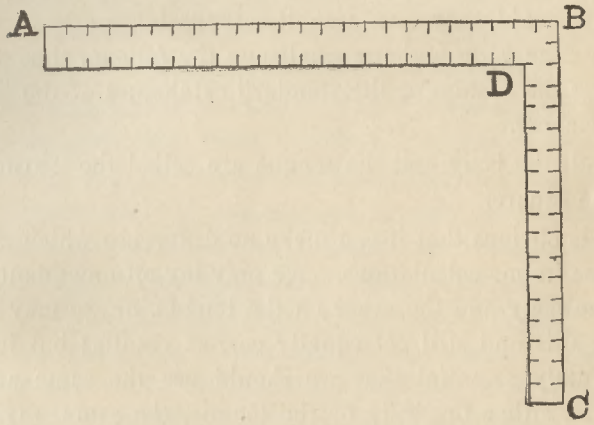

FIG. 3.

than the other and is called indifferently the body, stock or blade. In the standard catalogues of manufacturers such as Sargent & Co., it is always called the body, but the name often given to it by many writers on the subject is "blade." This term, however, is somewhat confusing. What these writers call the "tongue" really corresponds to the blade of the old drafting square and the wooden