(No Model.)

W. COX.

ENGINEER'S SLIDE RULE.

No. 460,930. Patented Oct. 6, 1891.

Fig. 1.

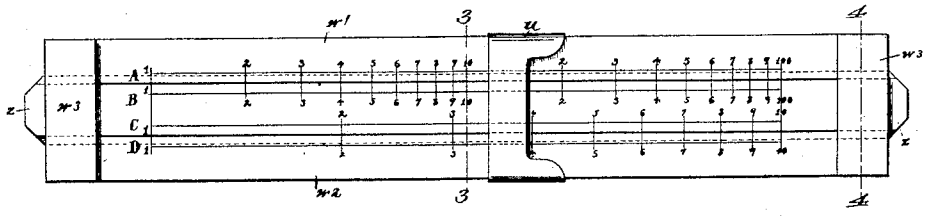


Fig. 2.

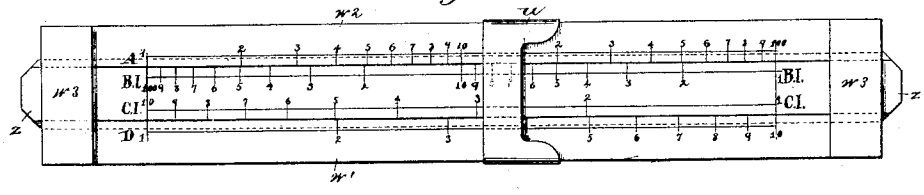


Fig. 3.

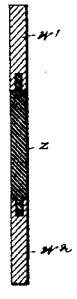
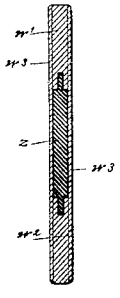


Fig. 4.



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ENGINEER'S SLIDE-RULE.

SPECIFICATION forming part of Letters Patent No. 460,930, dated October 6, 1891.

Application filed June 9, 1891. Serial No. 395,660. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM COX, a subject of the Queen of Great Britain, residing in New York city, in the county and State of New York, have invented a certain new and useful Improvement in Engineers' Slide-Rules, of which the following is a specification.

The rule or body is composed of two parallel bars of adequate depth and moderate thickness, each one having a groove in its edge, which is presented inwardly toward the slide. These bars are held rigidly together by cross-pieces, attached one on each face at each end, and are so distanced from each other that the slide, which is of equal thickness with the bars, may fit nicely between them and be held there in the grooves running from end to end of the inner edges of the bars, but only so held that it may be easily and smoothly drawn out at either end. Each bar is graduated with the proper logarithmic scale in the usual order, progressing from left to right. There is one single scale on the lower bar, running from one to ten and from left to right, while on the upper bar there are two similar scales, but each one being half the length of the lower one, these upper scales also progressing from left to right being commonly known as the "scale of squares." These two lines of scales are graduated not only on one face of the bars, but similarly, and in every respect identically on both faces.

There are in the calculation of many mathematical problems by means of the slide-rule cases in which it is common to reverse, or as it is technically termed, to "invert" the position of the slide, which inversion is rendered practicable by making each edge of the slide with its rabbets, similar and correspondingly preparing the edges of the recess in the body of the rule, and then operating by drawing out the slide its entire length, so as to disconnect it, turning it around end for end, and again sliding it into the body of the rule. When such problems are interwoven with others, in which the slide is used in its usual position, the changes not only involve labor, but render the solution of the problem liable to error and endanger the bending or breaking of the slide and obviously tend to reduce the device to a loosely-fitted instrument, unfit for the nice determination of quantities to several places of integers or decimals, of which, in its best condition, it is capable.

My invention presents on one face of the slide two accurately-graduated scales in the usual or ordinary order, progressing from left to right, corresponding and coinciding with two similar scales on one face of the rule, and on the other face of the slide two accurately-graduated scales in reversed order, progressing from right to left, corresponding with two scales in the usual order on the other face of the rule, (but not coinciding with them,) being eight scales in all, all the indices of which are made to exactly coincide with each other, so that such problems are solved at once by inspection without inverting the slide or making any equivalent change. My rule is therefore double-faced and the slide is equally double-faced, the two combined forming a double-faced slide-rule so constructed as to allow both faces to be used simultaneously.

The slide, as I have said, presents on one face two lines of scales in the usual order, progressing from left to right and corresponding in every respect and coinciding with the lines of scales on the two bars of the rule, while on the other face of the slide are two similar lines of scales, but in reversed order— that is, progressing from right to left—their indices alone coinciding exactly with the indices of the lines of scales on either face of the two bars. The upper scale on each face of the slide is a double one or scale of squares and the lower scale on each face of the slide is a single one or a scale of square roots. These scales in reversed order are therefore equivalent to scales of the ordinary slide inverted, but have, in addition to saving of labor and the avoidance of the risk of injury to the instrument, the advantage of being thus placed contiguous to their corresponding scales on the upper and lower bars of the body and are easier to read, as the figures denoting the values of the gradations stand in their ordi-

nary positions instead of being turned upside down.

The accompanying drawings form a part of this specification and represent what I consider the best means of carrying out my invention.

Figure 1 is a face view of one face, the finest graduations being omitted, but enough being shown to indicate the character of the whole. Fig. 2 is a view of the opposite face correspondingly presented. Fig. 3 is a cross-section on the line 3 3 in Fig. 1. Fig. 4 is a cross-section on the line 4 4 in Fig. 1.

The same letters of reference indicate the same or like parts in all the figures.

The slide-rule has the usual Arabic figures to mark its peculiar diminishing graduations. Certain capital letters A B C D have long been used to designate the different lines of graduations on the slide and on the rule. I will not therefore use any of these letters as reference-marks to designate parts of the mechanical construction, but will use therefor lower-case letters in the latter part of the alphabet.

The upper part of the body is marked w', the lower part of the body w^2, and the rigid connecting-pieces at the ends w^3. The slide is marked z. The several graduated lines on the one face of my slide-rule are marked by their usual designations A, B, C, and D, A and D being on the two bars and B and C on the slide. The two lines of graduations on the other faces of the two bars of the rule are similarly marked A and D, while the two lines of graduations on the corresponding face of the slide are designated by the proper letters B and C, with a capital I appended, indicating that they are inverted or reversed. One face of my slide-rule presents the ordinary standard—four lines of graduations—A B C D. The opposite side of my slide-rule has its upper and lower lines of graduations identical in all respects and coinciding with the lines A and D, and they are similarly marked; but the intermediate scales—those carried on the slide on this side—are inverted and are marked B I and C I, meaning, respectively, B inverted and C reversed, the scale B reversed being next to the scale A, and the scale C reversed next to the scale D of the rule.

My scales A and B are alike, short radii. My scales C and D are alike, long radii. My scale B I is short radii reversed, and my scale C I is long radius reversed.

A runner or metallic band encircles the whole rule and slides freely along its whole length, enabling corresponding points on either face and on any scale to be noted and complex problems to be solved without the necessity of reading off any of the intermediate results.

When in the use of my duplex slide-rule it is required to determine a problem in which the ratios are in the reverse proportion, as, for example, if it is required to know if six men can build a wall in four days, how long it will take eight to build it, this becomes—

8 : 6 : : 4 : 3.

With my slide-rule I hold it so as to present to the eye the face of the instrument which shows the graduations in a reversed order, B I C I, and I set 6 on scale C I against 4 on scale D and under 8 on scale C I, I find 3 on scale D, which is the answer required.

My improved rule is of value in performing two consecutive multiplications or divisions with one single setting of the slide. Thus, $2\times3\times4=24$. This I demonstrate thus:

Scale C I	Set 2	Then on Scale C under 4
Scale D	To 3	Find 24

That is to say, I set 2 on scale C I=C inverted against 3 on scale D, and then turning the rule over I find under 4 on scale C (not inverted) the product 24 of the three factors 2, 3, and 4. On the ordinary slide-rule this requires two separate operations, the first to obtain the product of $2\times3=6$, and the second operation, with a second setting of the slide, to obtain the product of $6\times4=24$. It will therefore be seen that it is not necessary with my duplex slide-rule, as with the ordinary slide-rule, to entirely remove the slide from the body and invert it and return it to place, and then adjust it longitudinally to perform the problem, because the two faces of my slide being both visible, and having the two faces of the body both graduated alike and the slide graduated on one face to correspond with the body and on the other face with similar graduations in the reversed order, it is only necessary to turn the entire instrument over and read from the other face on the slide the graduations in the reversed order.

For further uses of my slide-rule see *The Slide-Rule*, by William Cox, published by the Keuffel & Esser Company, New York, 1891.

I claim as my invention—

1. In a slide-rule, in combination with a suitable graduated slide, the body described, composed of a lower bar grooved on its upper edge and logarithmically and identically graduated on each face, an upper bar grooved on its lower edge and logarithmically and identically graduated on each face, the two bars being rigidly connected together by cross-pieces arranged to hold the lower and upper bars firmly in their relative positions, as herein specified.

2. A double-faced slide-rule having a slide with lines of logarithmic graduations on each face, in combination with a body composed of parallel rigidly-connected bars engaged with the edges, respectively, and graduated logarithmically on each face, and with the runner u, enabling corresponding points on either face and on any scale on either side to be indicated, as herein set forth.

3. The double-faced slide-rule described,

having lines of logarithmic graduations on each face of the body and slide, with some of the lines of graduations in direct and others in reversed order, adapted to overcome the necessity of inverting the slide, as herein specified.

In testimony that I claim the invention above set forth I affix my signature in presence of two witnesses.

WM. COX.

Witnesses:
CHARLES R. SEARLE,
M. F. BOYLE.