
Keuffel & Esser – 1880 to 1899

Bob Otnes

Introduction

This is the first article of a two-part series on the overall subject of the Keuffel & Esser slide rules during the period 1880 to 1913. This first article, as noted in the title, brings the subject up to 1899.

The period from 1880 to 1899 encompasses the first appearance of slide rules in the *K&E Catalogs* (or *Catalogues*, as they were first known) when the rules were imported from a variety of sources, and extends to and includes the point at which K&E began making their own product line of slide rules.

As will be seen, Tavernier-Gravet in France and Denbert & Pape (later Aristo) were early suppliers of slide rules for K&E. It is possible that a few of the early rules might have originated in England or even America itself.

Somewhere in the period 1895 to 1899, K&E began to manufacture slide rules themselves. However, it was not until 1900 that they appear to have taken over the majority of the manufacturing.

The Catalogs

The primary sources of the information employed in this article are the catalogs. In particular, the following Table 1 below lists the catalogs available for this study.

Table 1. K&E Catalogs Examined for this Article.

Year	Edition	G	Type	# Models
1871	6th	0	Pocket sized	0
1876	10th	5	Reprint	0
1880	13th	8	Pocket sized	1
1881	14th	9	Pocket sized	1
1883	17th	12	Full sized	3
1885	18th	13	Full sized	3
1887	20th	14	Photo copy	3
1890	21st		Photo copy	4
1893	24th		Photo copy	5
1894	26th		Photo copy	5
1895	27th		Pocket sized	11
1897	28th		Full sized	15
1899	29th		Pocket sized	18

The “G” numbers were calculated by David C. Garcelon. He believes them to be the “actual” catalog edition numbers as opposed to the system used by K&E. For Garcelon’s explanation of the curious numbering system employed by K&E, please refer to his article

[3]. Basically, Garcelon showed that the edition numbers K&E was using appear to be simply the number of years from their start of operation rather than the numbering of truly different editions. It is possible then that many of editions that *might seem* to have existed from their numbering scheme may not, in fact, have existed.

The “# Models” is the number of different slide rule models in a catalog including the Thacher and some other logarithmic devices. This is emphasized because K&E considered them to be “calculators”, and did not list them as slide rules.

Is the above set of catalogs complete? Perhaps not. However, it is probably close enough to show the trends in what K&E was doing during this formative period.

Definitions

As might be expected when a company takes on a new product line, K&E went through a period of considerable change, both in their products, and how they described them.

The standard slide rules during this time period, other than the duplex, tended to have four logarithmic scales on the front of the rule plus two or three scales on the back of the slide. Though the letters did not always appear, the four scales on the front are usually labeled A, B, C and D. The A scale is on the top of the stock of the rule, while D is on the bottom. B and C are on the slide. A and B always have two-cycle logarithmic scales, and D is always a one-cycle logarithmic scale. It is the C scale that varies.

Engineer’s Rule. This is a rule without a cursor. The B and C scales on the slide are identical two-cycle scales. The basic calculations are done on the A and B scales, with the C and D used in computing squares and square roots. Unfortunately, sometimes this name was used by K&E to include the Mannheim rule. See Figure 3 for an example.

Gunter Rule. Another name for a basic engineer’s rule.

Mannheim Rule. The Mannheim rule has a cursor. The C scale is single cycle, identical to the D scale. In this case, the calculations are usually done on the C and D scales. The cursor is employed to effect square and square root calculations with the A and B scales. See Fig. 4 for an example.

Common Slide Rule. Another name for the simple engineer’s rule, perhaps of a lesser quality.

acteristics in Thacher's recommendation of 1882 [4]:

“Ordinary 12 inch slide rules can be obtained at most hardware stores at a cost of about \$1.25, which will answer every purpose for becoming familiar with the rules and their application to the various classes of examples. They will also be found useful as a check and for approximate calculations. Rules on which the lower line commences at 1 on the left and ends at 10 on the right should be selected.”

It is interesting that Thacher states such rules can be obtained “... at most hardware stores ...”. This would imply that engineer's rules were here in common usage at the time of his article (1882).

The Tavernier-Graves rules shown in Figures 3 and 4 have a camber on their upper edges, while those in the K&E catalogs do not. The camber was an optional, extra expense option that was available from T-G.

The illustration for No. 479-2 is upside down. Furthermore, the *back* of the slide is shown: the sine

scale is visible. While not so identified, the rule is of the Mannheim type. Figure 4 shows a rule made by the French company Tavernier-Gravet that is stamped “KEUFFEL & ESSER Co./NEW YORK & CHICAGO”. It has a notation on the back that the rule received gold medals in 1878 and 1889, and it is an eight-inch (20 cm scale) rule rather than the more common ten-inch (25 cm) configuration. Nevertheless, it is quite similar to No. 479-2 in the catalog, and I conclude that K&E was purchasing rules from France in 1883. It is possible that the No. 479-1 is French, though impossible to prove with such a short description. The French version of the engineer's rule is generally much better made than corresponding English or American models, which might explain the large price differential between 479-1 and 479-5.

The 1885 Catalog

The 1885 catalog is almost identical to the 1883 one, including having the same page number for the slide rules; the placement of the items is slightly different. For this reason illustrations from it are omitted. (*Continued on next page.*)

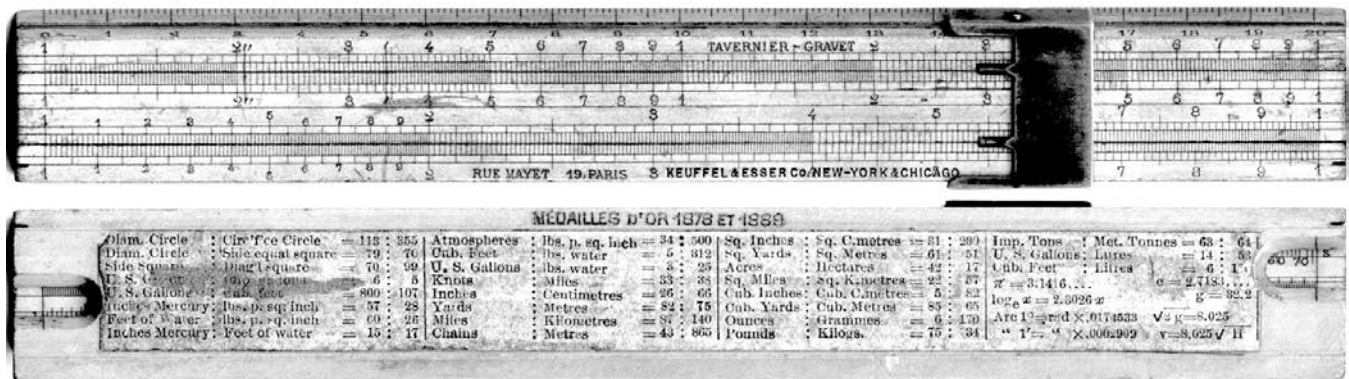


Figure 4. Obverse and Reverse of a Tavernier-Gravet slide rule made in Paris, stamped Keuffel & Esser.

The rule shown in Figure 4 is on the order of 110 years of age. It shows definite signs of use: it has numerous scratches and there is darkening of both the varnish and printed paper on the back. It is also rather plain. In its favor, however, it was very well made. Without having to have any adjustments whatsoever, the rule is tight without binding. While comparison with a steel centimeter ruler indicates that there is a small amount of shrinkage, the scales still match perfectly; it very likely was made from very well aged boxwood. The division lines are some of the sharpest that I have ever seen. This rule, in my opinion, is one of the highest examples of the rule makers art.

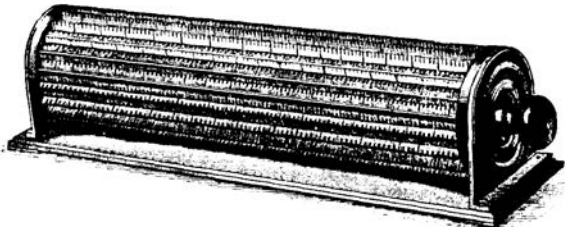
The Oughtred Society plans to have an article on 19th century French slide rules in the next issue of the *Journal*, describing rules by Lenoir, Gravet-Lenoir and Tavernier-Gravet, and also hopefully giving some background on the history of these related companies.

1887

1887

KEUFFEL & ESSER, NEW YORK

**THACHER'S
CALCULATING INSTRUMENT.**



No. 1740.

1740 N Thacher's Calculating Instrument, for performing the greatest variety of Useful Calculations with unexampled Rapidity and Accuracy, in polished mahogany Box . . . each \$ 30 00

The instrument consists of a cylinder 4" in diameter and 18" long working within a framework of triangular bars. The scales, the longest ever made, contain upwards of 33,000 divisions and 17,000 engraved figures, executed upon a dividing machine made expressly for this instrument; they are of such great length viz: 30 and 60 feet each, that results can be obtained to the fourth and usually to the fifth place of figures, sufficient to satisfy nearly every requirement of the professional or business man.

By the use of this instrument the drudgery of calculation is overcome, the mind is greatly relieved, and the results obtained are more reliable than when worked out in the usual way. Examples in multiplication, division, proportion powers or roots, involving not more than three quantities, are solved by one operation, and any number of values of a single variable are found by one setting of the instrument, for example, any of the formula

$$\frac{ax}{b} \cdot \frac{ax^2}{b} \cdot \frac{ax}{b^2} \cdot \frac{ax^3}{b^3} \cdot \sqrt{\frac{ax}{b}} \cdot \sqrt{\frac{a^2x}{b}}$$

in which a and b may have any values and x any number of values are readily solved by one setting. Squares, square roots, cube roots and reciprocals are also readily worked.

The useful applications of the instrument are almost unlimited; among these may be mentioned, finding the stresses and sections in trusses and girders, mensuration, estimates of work and material, solving trigonometrical formula, making and applying tables, problems in the mechanical powers, machinery and hydraulics, problems of simple and compound interest, discount and fellowship, pro-rating, gauging, exchange and the conversion of weights and measures.

It will be found useful to the Engineer, Architect, Actuary, Scientist, Manufacturer, Mechanic, Navigator and Accountant.

A book containing a full description of the instrument, all the necessary rules for operating it, and numerous examples both general and special, will accompany each instrument.

Testimonials will be furnished on application.

Figure 5. K&E 1887, page 128.

The 1887 Catalog

With this issue of their catalog K&E changes the number system from the 479 series to 1700 numbers. This series of numbers would be employed until 1900.

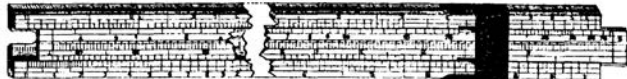
The 1887 K&E catalog carries the first appearance of the Thacher slide rule/calculator in their catalogs that is known to me. It was given the number 1740 N, the "N" no doubt standing for "new".

I have in my possession a pre-1900 Thacher "calculator". It has the number 280 on the right hand knob, and a tiny metal plate on the right end of the base that says "Keuffel & Esser New York" (no mention of Chicago).

The instruction booklet that came with it was published by Van Nostrand in New York with a copyright date of 1884. There is no mention of K&E in this manual. From this I infer that K&E was obtaining the Thacher rules from an external source, possibly Thacher himself,

KEUFFEL & ESSER, NEW YORK

**ENGINEERS SLIDE RULES
or Calculation Rules.**



No. 1746.

1745 N Engineers Slide Rule, 10 inch long each \$ 3 50
1746 N do. do. 10 " " with brass indicator " 4 50

The Slide Rule is of great value for Mechanical and Civil Engineers, Architects, Machinists, Builders, Contractors and others. In it's present perfected form the following operations are performed with great facility and accuracy:

Multiplication	Extraction of cube root
Division	Extraction of fourth root
Multiplication of a square	Triangulation
Formation of the fourth power of a number	Multiplication of sines and tangents with other figures
Proportions	Division of a number by the sine or tangent of an angle
Division of a square by a number	Logarithms
Division of one square number by another	Weights of prisms, cylinders and spheres
Multiplication of a square quotient	Any calculation the result of which is attained by logarithms.
Division of a number by a square	
Extraction of square root	

We furnish with each Slide Rule a book giving full and plain directions for using the rule.

Book of Instructions (if not furnished with the rule) each \$ 20

Figure 6. K&E 1887, page 129

rather than making the rule in-house. Indeed, it is difficult to conceive that K&E could have been making such an elaborate device 12 years before the first appearance of their published claim to be making their own slide rules (see the comments on the 1899 catalog).

On page 129, they have corrected the orientation of the Tavernier-Gravet Mannheim rule, now No. 1746 N. However, the slide still seems to show the sine scale, etc., rather than the usual B and C scales.

Rule No. 1745 N is not illustrated, but is assumed to be similar to the former 479-1.

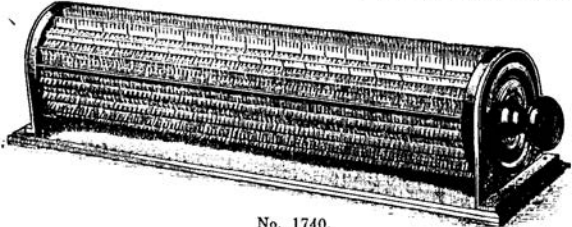
This catalog also marks the first time that instructions for the slide rule are sold separately. There is only one such item, and it is priced at \$0.20. Note that none of these catalogs seems to have decimal points in their prices.

1890

1893

KEUFFEL & ESSER CO. NEW YORK.

THACHER'S CALCULATING INSTRUMENT.



No. 1740.

1740. Thacher's Calculating Instrument, for performing the greatest variety of useful calculations with unexampled rapidity and accuracy, cylinder 18 inch, in polished mahogany Box each \$ 30 00

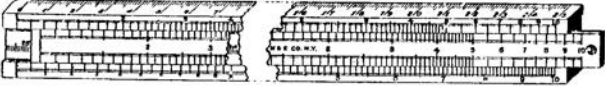
It will be found useful to the Engineer, Architect, Actuary, Scientist, Manufacturer, Mechanic, Navigator and Accountant.

A book containing a full description of the instrument, all the necessary rules for operating it, and numerous examples both general and special, will accompany each instrument, or will be mailed on receipt of 50 c.

Testimonials will be furnished on application.


ENGINEERS SLIDE RULES.

Copyright, 1890, by Keuffel & Esser Co.



No. 1745.

1745. Engineers Slide Rule, 10 inch, boxwood, with directions . each \$ 3 50



No. 1746.

1746. Engineers Slide Rule, 10 inch, divided on celluloid facings, with brass indicator, directions with rule each \$ 4 50

1748. do. do. 20 inch divided on celluloid facings, with brass indicator, directions with rule " 16 50

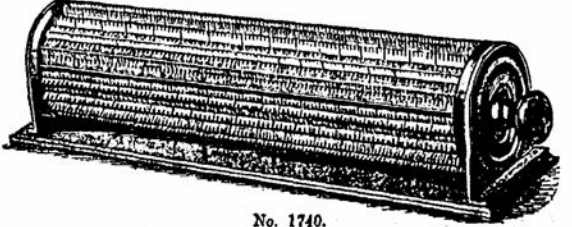
The 20 inch Slide Rules have the great advantage that they admit of finer divisions and consequent closer reading than the 10 inch. Of course the longer rules are more liable to warp, and thereby give rise to complaint, but they are nevertheless preferred on account of the advantages of the finer divisions.

Printed Directions (except when furnished with the rule) each \$ 20

Figure 7. K&E 1890, page 131.

KEUFFEL & ESSER CO. NEW YORK.

THACHER'S CALCULATING INSTRUMENT.



No. 1740.

1740. Thacher's Calculating Instrument, for performing the greatest variety of useful calculations with unexampled rapidity and accuracy, cylinder 18 inch, in polished mahogany Box each \$ 30 00

1741. do. do. do. but with 8 inch reading glass sliding on brass bar, adjustable to any part of the instrument and for focus " 40 00

It will be found useful to the Engineer, Architect, Actuary, Scientist, Manufacturer, Mechanic, Navigator and Accountant.

A book containing a full description of the instrument, all the necessary rules for operating it, and numerous examples both general and special, will accompany each instrument, or will be mailed on receipt of 50 c.

Testimonials will be furnished on application.

SLIDE RULES.

Copyright, 1890, by Keuffel & Esser Co.



No. 1745.

1745. Slide Rule, 10 inch, boxwood each \$ 3 50



No. 1746.

1746. Slide Rule (Mannheim), 10 inch, divided on celluloid facings, with brass indicator, directions with rule . . . each \$ 4 50

1748. do. do. (Mannheim), 20 inch, divided on celluloid facings, with brass indicator, directions with rule . . . " 16 50

The 20 inch Slide Rules have the great advantage that they admit of finer divisions and consequent closer reading than the 10 inch. Of course the longer rules are more liable to warp, and thereby give rise to complaint, but they are nevertheless preferred on account of the advantages of the finer divisions.

Directions (except when furnished with the rule) . . . each \$ 25

"The Slide Rule", complete Manual, by W= Cox " 50

Figure 8. K&E 1893, page 131.

The 1890 Catalog



Figure 9. Closeup of a K&E rule made by D&P.

The 1890 catalog for the first time mentions rules "divided on celluloid facings". Dennert & Pape [2] received the German DRP 34583 for "wooden scales with celluloid veneers" in 1886. Figure 9 is a closeup of a Mannheim slide rule with the runner removed. On the bottom stator it is marked "KEUFFEL & ESSER Co. NEW-YORK" and in the gutter "DENNERT & PAPE ALTONA PATENT". Altona is a suburb of Hamburg,

²Recall that the T-G rule shown in Figure 4 has a date of 1889 on it.

Germany. Thus, somewhere around 1890² K&E switched from Tavernier-Gravet to Dennert & Pape as their supplier of Mannheim rules.

It is rare to find a K&E slide rule with the D&P marking. This is because K&E appears to have ground it out on many other examples that have been examined.

No. 1748 is the first appearance of a 20-in. rule.

The 1893 Catalog

The 1893 K&E catalog is similar to that of 1890, except that the illustration for rule No. 1746 has changed. It now shows the rule with a double-sided brass runner, a characteristic of D&P slide rules. Also, the 1741 appears for the first time.

Note that there are now two sets of directions offered: a basic set for \$0.25 (a five-cent increase from 1890) and "The Slide Rule" by William Cox [1]. This is the first of many such manuals that were to bear Cox's name.

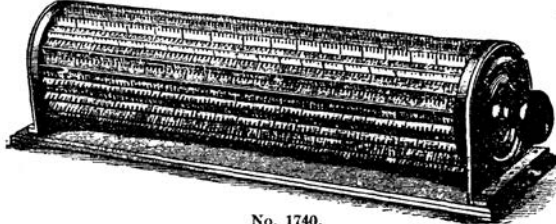
1895

1895

KEUFFEL & ESSER CO. NEW YORK.

SLIDE RULES.

THACHER'S CALCULATING INSTRUMENT.



No. 1740.

1740. Thacher's Calculating Instrument, for performing the greatest variety of useful calculations with unexampled rapidity and great accuracy, cylinder 18 in., in polished Mahogany Box each \$ 35 00

1741. do. do. do. with 3 in. reading glass sliding on brass bar, adjustable to any part of the instrument and for focus \$ 45 00

The Thacher's Calculating Instrument consists of a cylinder 4 inches in diameter and 18 inches long, working within a frame work of triangular bars. The scales, the longest ever made, contain upwards of 33,000 divisions and 17,000 engraved figures, executed upon a dividing machine, made expressly for this instrument; they are of such great length viz.: 30 and 60 feet each, that results can be obtained to the fourth and usually to the fifth place of the figures, sufficient to satisfy nearly every requirement of the professional or business man.

By the use of this instrument the drudgery of calculation is overcome, the mind is greatly relieved, and the results obtained are more reliable than when worked out in the usual way. Examples in multiplication, division, proportion, powers or roots, involving not more than three quantities, are solved by one operation, and any number of values of a single variable are found by one setting of the instrument, for example, any of the formula

$$\frac{ax}{b} \cdot \frac{ax^2}{b} \cdot \frac{ax}{b^2} \cdot \frac{ax^2}{b^2} \cdot \sqrt{\frac{ax}{b}} \cdot \sqrt{\frac{a^2x}{b}}$$

in which *a* and *b* may have any values and *x* any number of values are readily solved by one setting. Squares, square roots, cube roots and reciprocals are also readily worked.

Figure 10. K&E 1895, page 183.

KEUFFEL & ESSER CO. NEW YORK.

The useful applications of the instrument are almost unlimited; among these may be mentioned, finding the stresses and sections in trusses and girders, mensuration, estimates of work and material, solving trigonometrical formula, making and applying tables, problems in the mechanical powers, machinery and hydraulics, problems of simple and compound interest, discount and fellowship, pro-rating, gauging, exchange and the conversion of weights and measures.

It will be found useful to the Engineer, Architect, Actuary, Scientist, Manufacturer, Mechanic, Navigator and Accountant.

A book containing a full description of the instrument, all the necessary rules for operating it, and numerous examples, both general and special, will accompany each instrument.

Testimonials will be furnished on application.

FULLER'S SLIDE RULES.



No. 1742.

1742. Fuller's Spiral Slide Rule, in mahogany box each \$ 28 00

Fuller's Spiral Slide Rule consists of a cylinder which can be moved up or down and turned round a sleeve which is attached to the handle. A single logarithmic scale, 42 feet long, is wound round the cylinder spirally, and ratios are established by means of two pointers or indices, one attached to the handle and the other to an axis which slides in the sleeve.

Figure 11. K&E 1895, page 184.

The 1895 Catalog

The year 1895 saw many changes to the product line in the K&E catalog:

- From one page each for 1890 and 1893 catalogs to five pages for 1895 and eleven rules are now offered.
- Addition of the Fuller's Spiral Slide Rule made by Stanley of London.
- Addition of the Charpentier Calculator, made in France.
- Addition of the the Boucher Calculator, also made in France.

- The first appearance of the Cox Duplex, the most important item in this catalog.
- The first appearance of a stadia rule, No. 1749. Not illustrated, but 20 in. long.
- Now three sets of directions for the slide rule are offered.

It is important to note that K&E apparently was still out-sourcing all of its slide rule line, either overtly in the case of the Fuller³ or covertly in the case of the D&P rules from Germany by grinding out their name.

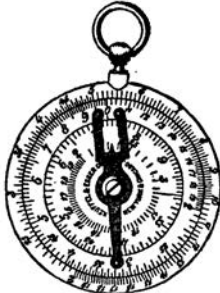
³The illustration on page 184, Figure 11 does show "KEUFFEL & ESSER CO. NEW YORK & CHICAGO" on the Fuller, but it was clear to everyone who made it. Similarly for the Boucher in Figure 12.

1895

1895

KEUFFEL & ESSER CO. NEW YORK.

CHARPENTIER CALCULATOR.




No. 1743.

1743. Charpentier Calculator each \$ 5 00

The Charpentier Calculator is a circular Slide Rule, $\frac{3}{8}$ in. diameter, with a circular slide which is revolved and set by the handle as may be required. This instrument reads scale against scale like the ordinary slide rule, and being made of metal, is but slightly subject to atmospheric variations. Square roots, sines and tangents as well as logarithms may be found with it, and as the circular scale is equivalent to a straight one $\frac{5}{8}$ in. long, results may be read off with a fair degree of accuracy. The small dimensions and light weight of the instrument make it a most useful pocket companion.

BOUCHER CALCULATOR.



No. 1748 $\frac{1}{2}$.

1748 $\frac{1}{2}$. Boucher Calculator each \$ 8 00

The Boucher Calculator resembles an ordinary stem-winding watch, with an open face (glazed) back and front. Ratios are set off by means of pointers or indices. It is $\frac{3}{16}$ in. diameter by $\frac{1}{16}$ thick and very convenient for the pocket.

Figure 12. K&E 1895, page 185.

The 1895 Catalog, Continued

As far as can be told, all of the items in this issue of the catalog were still being out-sourced by K&E. The catalog gives no indication that they were making anything. They were, however, putting their name on the items being sold.

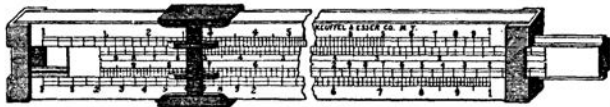
Even the duplex rule was out-sourced. While it was designed by William Cox, an Englishman, during the period he was working as a contractor for K&E⁴, it was actually first made in Germany by D&P.

Cox patented the duplex October 6, 1891, No. 460,930 and assigned it to K&E. The duplex is described elsewhere in this issue of the *JOS*, and in the catalogs themselves.

While previous rules, especially some English spirit rules, look like duplexes, there was, in fact, no clear combined use of a two-sided rule and a cursor prior to Cox.

KEUFFEL & ESSER CO. NEW YORK.

DUPLEX SLIDE RULES.




No. 1744. Patented October 6th. 1891.


1744. Duplex Slide Rule, patented, 10 in., divided on celluloid facings, with brass runner and with Arithmetical Slide, with Directions. in case each \$ 6 50

1744 B. do. do. but with both the Arithmetical and Trigonometrical Slides (interchangeable) 8 00

The "DUPLEX" SLIDE RULE is similar in most respects to an ordinary Mannheim slide rule (No. 1744), its distinguishing feature being that the slide itself is of the same thickness as the rule and has its two faces flush with those of the rule. The rule and slide are fully graduated on both sides, scales A and D being alike on each side of the rule, whereas scales B and C on the slide, are graduated on the upper face in the usual way like A and D, but on the under face in reversed order, the initial indices being on the right hand, and the scales progressing toward the left, as shown in the figures. The indices of the scales of one face coincide with those of the other face, and a metallic runner, encircling the whole rule, enables coinciding points on any scale of either face to be at once found.



Front or Upper Face.



Back or Under Face.

This improvement simplifies considerably the working out of many complex calculations, besides allowing of such computations as

$$a \times b \times c = x, \sqrt{a^2} = x,$$

etc., to be performed with one single setting of the slide. This slide is designated above as the "Arithmetical."

To still further increase the value of the Duplex Slide Rule, an interchangeable "Trigonometrical Slide", having scales of sines, tangents and equal parts on one side, and the ordinary scales B and C on the other side, is also provided when desired, by means of which a great variety of problems, involving the functions of the sides and angles of triangles, may be quickly solved, the trigonometrical formulae being worked out on one side and the arithmetical portion on the other side of the slide rule without inversion or displacement of the slide.

With these modifications the necessity of taking the slide out to invert it, is avoided, besides facilitating the setting of the slide and reading of results, as scales A and B.I, as well as C.I and D lie side by side; all risk of damaging the slide during the operations of inversion is also removed.

Figure 13. K&E 1895, page 186.

So, what was the problem that Cox was trying to solve?

It comes down to this: while the Mannheim rule was viewed as a replacement for the engineer's rule, the engineer's rule has one big advantage: its slide can be reversed so that the two-cycle C scale runs backwards against the two-cycle A scale. This permits the calculation of such expressions as

$$x = a \times b \times c$$

to be computed with a single setting, an advantage to many. It cannot be done on the original Mannheim because the C scale is *one-cycle* rather than two on the engineers rule. This nuance is difficult to comprehend at this distance in time, as the vast majority of what are called Mannheim type rules have an inverted C scale, usually denoted CI, usually on the center of the slide, which solves this problem.

⁴He acted as editor for the K&E house organ, *The Compass Magazine*, which ran to a total of three volumes dating from 1892 to 1894.

1895

KEUFFEL & ESSER CO. NEW YORK.



No. 1745.

1745. Slide Rule, 10 in., boxwood each \$ 3 50

This is the old form of Slide Rule, now generally superseded by improved forms like the Mannheim and the Duplex. The top scale on the rule and the two scales on the slide are double, being graduated from 1 to 100, while the bottom scale on the rule is a single one, graduated from 1 to 10, giving the square roots of the other scales. All ordinary computations have to be effected on the upper scales, so that the same degree of accuracy can not be attained as with the Duplex and the Mannheim.

MANNHEIM SLIDE RULES.



No. 1746.

1746 Slide Rule (Mannheim), 10 in., divided on celluloid facings, with brass indicator, with Directions each \$ 4 50

1748. do. (Mannheim) 20 in., divided on celluloid facings, with brass indicator, with Directions 16 50

The 20 in. Slide Rules have the great advantage that they admit of finer divisions and consequent closer reading than the 10 in. Of course the longer rules are more liable to warp, and thereby give rise to complaint, but they are nevertheless preferred on account of the advantages of the finer divisions.

STADIA SLIDE RULE.

1749. Stadia Slide Rule, 20 in. celluloid faced each \$ 13 50

The Stadia Slide Rule is especially designed to solve the two equations generally used in stadia measurements, viz.:

$$\text{Height} = \frac{\text{Stadia Distance}}{2} \times \sin 2\alpha$$

and

$$\text{Distance} = \text{Stadia Distance} \times \cos 2\alpha.$$

It is 20 inches long, with fine graduations on celluloid, and will be found to be of great use to the Topographer, as it enables him to compute quickly the results of his labors in the field.


Directions (except when furnished with the rule) each \$ 25
 "The Slide Rule," complete Manual, by Wm. Cox " 50
 Manuals of the Duplex and Mannheim Slide Rules, bound together " 75

Figure 14. K&E 1895, page 187.

1897

KEUFFEL & ESSER CO. NEW YORK.

DUPLEX SLIDE RULES.




No. 1744. Patented October 6th. 1891.

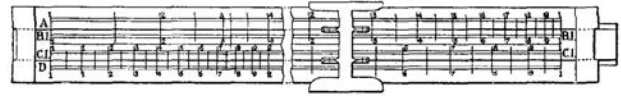
1744. Duplex Slide Rule, patented, 10 in., divided on celluloid facings, with brass runner and with Arithmetical Slide, with Directions, in case each \$ 6 50

1744 B. do. do. but with both the Arithmetical and Trigonometrical Slides (interchangeable) 8 00

The "DUPLEX" SLIDE RULE is similar in most respects to an ordinary Mannheim slide rule (No. 1746), its distinguishing feature being that the slide itself is of the same thickness as the rule and has its two faces flush with those of the rule. The rule and slide are fully graduated on both sides, scales A and D being alike on each side of the rule, whereas scales B and C on the slide, are graduated on the upper face in the usual way like A and D, but on the under face in reversed order, the initial indices being on the right hand, and the scales progressing toward the left, as shown in the figures. The indices of the scales of one face coincide with those of the other face, and a metallic runner, encircling the whole rule, enables coinciding points on any scale of either face to be at once found.



Front or Upper Face.



Back or Under Face.

This improvement simplifies considerably the working out of many complex calculations, besides allowing of such computations as

$$a \times b \times c = x, \sqrt{a^b} = x,$$

etc., to be performed with one single setting of the slide. This slide is designated above as the "Arithmetical".

To still further increase the value of the Duplex Slide Rule, an interchangeable "Trigonometrical Slide", having scales of sines, tangents and equal parts on one side, and the ordinary scales B and C on the other side, is also provided when desired, by means of which a great variety of problems, involving the functions of the sides and angles of triangles, may be quickly solved, the trigonometrical formula being worked out on one side and the arithmetical portion on the other side of the slide rule without inversion or displacement of the slide.

With these modifications the necessity of taking the slide out to invert it, is avoided, besides facilitating the setting of the slide and reading of results, as scales A and B, I, as well as C, I and D lie side by side; all risk of damaging the slide during the operations of inversion is also removed.

Figure 15. K&E 1897, page 192.

The 1897 Catalog

Pages 189, 190 and 191 of the 1897 catalog are omitted. Except for the change in page numbers, they are the same as pages 183, 184 and 185 of the 1895 issue.

- There are now 15 slide rule models and 4 sets of directions.
- A second version of the duplex, 1744 B, is now offered with an additional slide having trigonometric functions.


- The No. 1746 $\frac{1}{2}$ is the 1746 with a framed glass cursor. Similarly, the model 1748 $\frac{1}{2}$ is the 1748 20-in. rule with a framed glass cursor.
- A student's rule, No. 1749-1, has been added.
- Two huge rules by Colby have been added, a sewer rule (1749-2) and a stadia rule (1749-3), in addition to the previously mentioned 1749 stadia rule. The Colby Stadia Rule in its case is 51 in. long, and one of the crudest slide rules that I have ever seen. It is difficult to imagine taking this monster out to the field for surveying. Even using it on a desk would be a challenge.

1897

1897

KEUFFEL & ESSER CO. NEW YORK.

GUNTER SLIDE RULE.




No. 1745.

1745. Slide Rule, 10 in. boxwood, polished each \$ 3 50


This is the old form of Slide Rule, now generally superseded by improved forms like the Mannheim and the Duplex. The top scale on the rule and the two scales on the slide are double, being graduated from 1 to 100, while the bottom scale on the rule is a single one, graduated from 1 to 10, giving the square roots of the other scales. All ordinary computations have to be effected on the upper scales, so that the same degree of accuracy can not be attained as with the Duplex and the Mannheim.

MANNHEIM SLIDE RULES.



No. 1746.

1746 Slide Rule (Mannheim), 10 in., divided on celluloid facings, with brass indicator, in case, with Directions . . . each \$ 4 50



No. 1746 1/2.


1746 1/2. Like No. 1746, but indicator with glass face each \$ 5 00

1748. Slide Rule (Mannheim) 20 in., divided on celluloid facings, with brass indicator, in case, with Directions 16 50

1748 1/2. Like No. 1748, but indicator with glass face 17 00

The 20 in. Slide Rules have the great advantage that they admit of finer divisions and consequent closer reading than the 10 in. The longer rules are naturally more liable to warp and may give rise to complaint, but they are nevertheless often preferred on account of the advantages of the finer divisions.

K. & E. STUDENT'S SLIDE RULE.



No. 1749-1.

The Student's Slide Rule is intended for the use of students, to enable them to become familiar with the slide rule without incurring the relatively heavy expense of obtaining the regular rule intended for professional use.

It is in general like our Mannheim Slide Rule, of the same size and with the same graduations, except that the vertical edge is not divided. The body of the rule and the slide are of thoroughly seasoned hardwood, and are backed by stout binder's board. The graduations are on a special strong and tough white paper facing and have a protective coating. The brass indicator or runner holds a piece of thin transparent celluloid marked with a hair-line. The index mark for the under side of the slide is also a hair-line on celluloid. On the under side of the rule there is a table of the most frequently occurring proportions and formulas. With each rule we furnish plain directions, prepared by Prof. J. B. Johnson.

1749-1. Student's Slide Rule, 10 in., with Indicator and Directions, each \$ 1 00

Figure 16. K&E 1897, page 193.

KEUFFEL & ESSER CO. NEW YORK.

STADIA SLIDE RULE.

1749. Stadia Slide Rule, 20 in. celluloid faced, in case, with Directions each \$ 13 50

The Stadia Slide Rule is especially designed to solve the two equations generally used in stadia measurements, viz.:

$$\text{Height} = \frac{\text{Stadia Distance}}{2} \times \sin 2\alpha$$

and

$$\text{Distance} = \frac{\text{Stadia Distance}}{2} \times \cos 2\alpha.$$

It is 20 inches long, with fine graduations on celluloid, and will be found of great use to the Topographer, as it enables him to compute quickly the results of his labors in the field.

BOOKS ON THE SLIDE RULE.

Directions for Mannheim Rule, (the same as furnished with the rule) each \$ 25

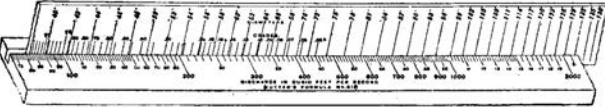
"The Slide Rule," complete Manual, by Wm. Cox " 50

Directions for Duplex Slide Rule, by Wm. Cox " 25

Manual of the Duplex and Mannheim Slide Rules, bound together " 75

COLBY'S SEWER COMPUTER.

No. 1749-2.




This is a slide rule graduated after Kutler's formula and the values obtained by it are the same as given by that formula, the value of the coefficient "N" being taken at .013. It gives the relations between discharge, diameter and grade for round sewers from 6 inches to 20 feet in diameter and for egg-shaped sewers from 12 x 18 inches to 12 x 18 feet, and the grades for either from .30 to 20 per cent. The rule is 20 inches long. The few directions required, are furnished with the rule.

1749-2. Colby's Sewer Computer, hardwood, in case each \$ 10 00

COLBY'S SLIDE RULE


No. 1749-3. **FOR STADIA REDUCTIONS.** Patented July 30th, 1896.



This rule gives differences of elevations between two points when Stadia-Reading and vertical angle are known.

1749-3. Colby's Stadia Slide Rule, 50 in., in case, with Directions, each \$ 20 00

IVORY AND BOXWOOD SECTORS.



No. 1749-7.

1749-7. Boxwood Sector, 12 in. brass joint, hand divided . . . each \$ 1 00

1749-8. Ivory Sector, 12 in., German silver joint, hand divided . . . 2 25

Figure 17. K&E 1897, page 194

The 1897 Catalog, Continued

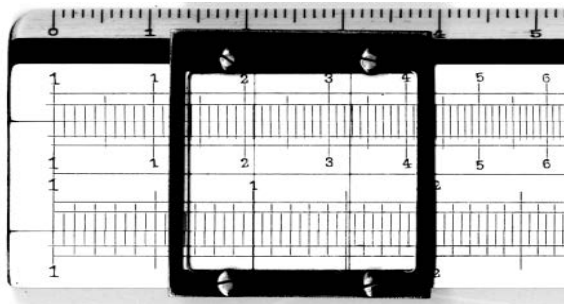


Figure 18. Detail of the first framed cursor.

The cursor shown in Figure 18 is on a model 1748 1/2

20-in. rule. Note that it has *two* hairlines rather than the usual one. The principal reason for having two hairlines is that there is only 0.5 cm. of space at each end of the rule, probably not enough to support the cursor when using it at the very end without having it tip. It has four screws to hold the glass in from the front. I only know of this single example of a cursor of this type.

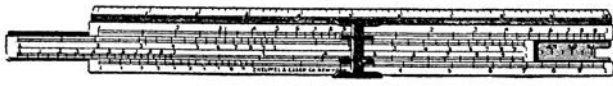
The rule itself appears to have been made by D&P: while it is prominently marked "K&E" on the stock, there is a ground-out area in the gutter where, very likely, there originally was a D&P logo of some sort. Assuming that it is a D&P-made rule, then it is fair to assume that the cursor was also made by them.

1899

1899

KEUFFEL & ESSER CO. NEW YORK.

K. & E. MANNHEIM SLIDE RULES.




No. 1746.

1746. Slide Rule (Mannheim), engine divided, 10 in., divisions on celluloid facings, with brass indicator, in case, with Directions each \$ 4 50

1747. do. do. like No. 1746, but 5 in., in sewed leather case, with Directions " 4 50

This rule is divided as closely as the 10-inch rule, notwithstanding its small size.



No. 1746 1/2.

1746 1/2. Slide Rule (Mannheim) 10 in., like No. 1746, but indicator with glass face each \$ 5 00

1748. do. do. 20 in., engine divided, divisions on celluloid facings, with brass indicator, in case, with Directions " 16 50

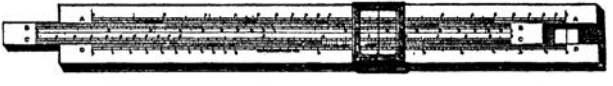
1748 1/2. do. do. like No. 1748, but indicator with glass face " 17 00

The 20 in. Slide Rules have the great advantage that they admit of finer divisions and consequent closer reading than the 10 in. The longer rules are naturally more liable to warp but they are nevertheless often preferred on account of the advantages of the finer divisions.

1748-3. Favorite (Mannheim) Slide Rule, 10 in., divided on celluloid facings, indicator with glass face, with Directions each \$ 3 00

The Favorite Slide Rule is of the same pattern as the Mannheim rule, No. 1746-1/2 and has the same graduations. It has but one hair-line on the glass face of the runner and an inch and metric comparing scale on the under surface, instead of the table of settings of our regular Mannheim rules. As the divisions are produced by a lithographic process, they are not quite as sharp as those of the engine-divided rules, although correct, and they are not as permanent as the latter, so that the Favorite rules are less durable. We offer this rule in place of similar imported rules, over which it has the advantage of being seasoned here, so that it is very much less liable to warp or shrink.

K. & E. STUDENT'S SLIDE RULE.



1749-1. Student's Slide Rule, (Mannheim), 10 in., with Indicator and Directions each \$ 1 00

The Student's Slide Rule is intended only for the use of students, to enable them to become familiar with the slide rule without incurring the relatively great expense of obtaining the regular rule.

It is similar to our Mannheim Slide Rule, and the graduations are on white paper facing and have a protective coating. With such rule we furnish plain directions, prepared by Prof. J. B. Johnson.

For books on the Slide Rule, see page 193.

Figure 21. K&E 1899, page 194.

The 1899 Catalog, Continued

Conclusions

During the 20-year period from 1880 to 1899 K&E moved from carrying a single item to a fairly extensive line of slide rules. Originally they probably imported everything in this line that they sold. By 1899 they were starting to design and make their own products.

K&E probably did not originally make the Thacher Calculator. When they took over the manufacturing themselves is not clear, but it certainly happened by 1900.

As will be seen in the second article on this subject, K&E rapidly changed and broadened their line of slide rules. There were some false steps, but by 1909, their rules would begin to take the form for which they were

KEUFFEL & ESSER CO. NEW YORK.

STADIA SLIDE RULE.

1749. Stadia Slide Rule, engine divided, 20 in., divisions on celluloid facings, in case, with Directions each \$ 13 50

The Stadia Slide Rule is especially designed to solve the two equations generally used in stadia measurements, viz.:

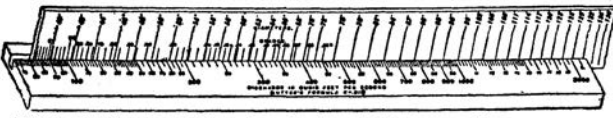
$$\text{Height} = \frac{\text{Stadia Distance}}{2} \times \sin 2\alpha$$

and

$$\text{Distance} = \text{Stadia Distance} \times \cos^2 \alpha.$$

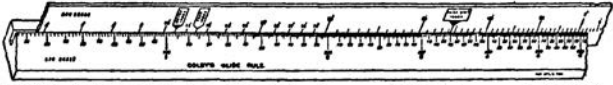
These two equations can be read off on the face of the rule with one setting. It is 20 inches long, with fine graduations and will be found of great use to the Topographer, as it enables him to compute quickly the results of his labors in the field.

COLBY'S COMPUTERS.



1749-2. Colby's Sewer Computers, hardwood, in case, with Directions each \$ 10 00

This is a slide rule graduated after Kutter's formula and the values obtained by it are the same as given by that formula, the value of the co-efficient "N" being taken at .013. It gives the relations between discharge, diameter and grade for round sewers from 6 inches to 20 feet in diameter and for egg-shaped sewers from 12 x 18 inches to 12 x 18 feet, and the grades for either from .05 to 20 per cent. The rule is 20 inches long. The two directions required, are furnished with the rule.

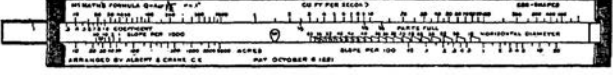


1749-3. Colby's Stadia Slide Rule, 50 in., in case, with Directions, each \$ 20 00

Colby's Stadia Slide rule, pat. July 30th, 1885, gives differences of elevation between two points when stadia-reading and vertical angle are known.

CRANE'S SEWER SLIDE RULE.


Patented Oct. 6, 1891.



1749-4. Crane's Sewer Slide Rule, 10 in., paper facings, with Directions each \$ 2 00

Crane's Sewer Slide Rule, is based on McMath's formula for amount of storm water and Kutter's formula for capacities, for circular sewers from 6 to 180 in. diam. and egg-shaped sewers from 18 to 60 in. horizontal diameters, ratio of radii 1: 2: 6.

IVORY AND BOXWOOD SECTORS.



No. 1749-7.

1749-7. Boxwood Sector, 12 in., brass joint, hand divided . . . each \$ 1 00

1749-8. Ivory Sector, 12 in., German silver joint, hand divided . . . " 2 25

Figure 22. K&E 1899, page 195.

known for over 60 more years.

Acknowledgements

I should like to thank Robert De Cesaris and Conrad Schure for their help in preparing this article.

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