

## The Oldest German Slide Rule

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### Introduction

The *Astronomisch Physikalische Kabinett in den Staatlichen Museen Kassel* owns a real jewel: It is not only probably the oldest existing slide rule manufactured in Germany, it is also a precious piece made of ivory with silver end plates. It is of special interest because it gives hints about connections with England and—very important—about the ways ideas and inventions had spread. This slide rule is mentioned for the first time in the mathematical inventory of the museum in 1765 as *Ein Helffenbeinem Proportionallineal mit bewegl(ichem) Schieber in der Mitten*: (An Ivory Proportional Rule with movable Slide in the Middle). (Figure 1; Lower line in old German handwriting)

### Description

This double-sided slide rule (Figures 2 & 3) is approximately 286 mm long, about 38 mm wide and 6 mm thick. The slide measures 308 mm. The ivory is slightly bent, but the slide is still easy to move. The ends are unusual:

The unknown instrument maker has used silver, which age has tarnished. In England, the two outer sections of such slide rules usually are held together by small brass plates, but for this slide rule, caps were fabricated that cover also the edges and the front sides (Fig. 4). These silver caps were fixed to the ivory rods by thick rivets of silver. Only for the slide were windows left. Also as a very unusual feature, the scale names were scratched into the left-hand cap (Fig. 4). All the ivory bars have grooves; in the outer ones, forming the body, tongues were inserted to provide good guidance for the slide. There never was a cursor for this slide rule.

The scales were scratched by hand, rather exact and neat. On the other hand numerals were branded with suitable tools. Their location and alignment are not always exact because of the hand manufacture. In some places on the scales, small silver pins were inserted to avoid harming the scales with the sharp steel tips of dividers.

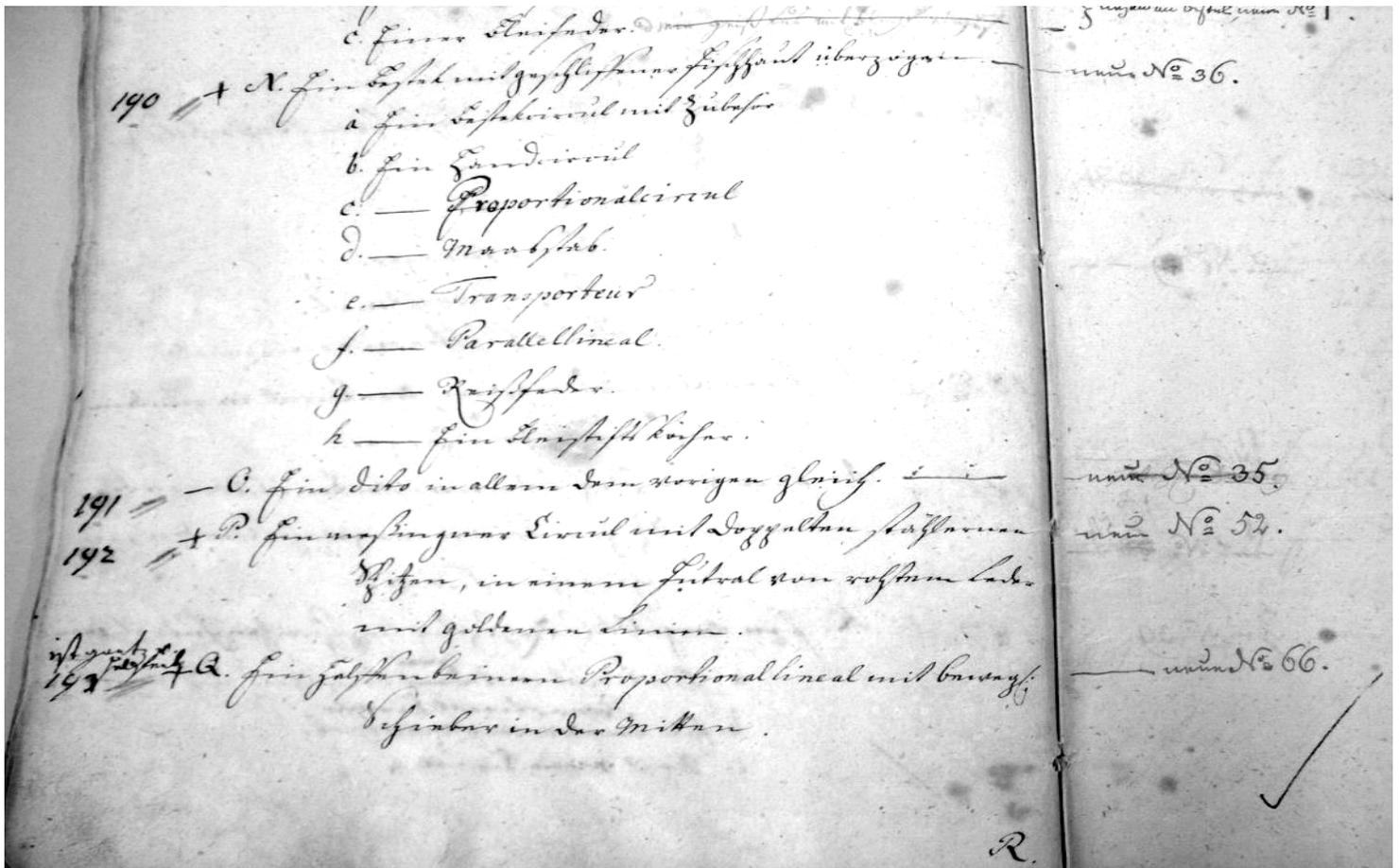


Figure 1. The Inventory

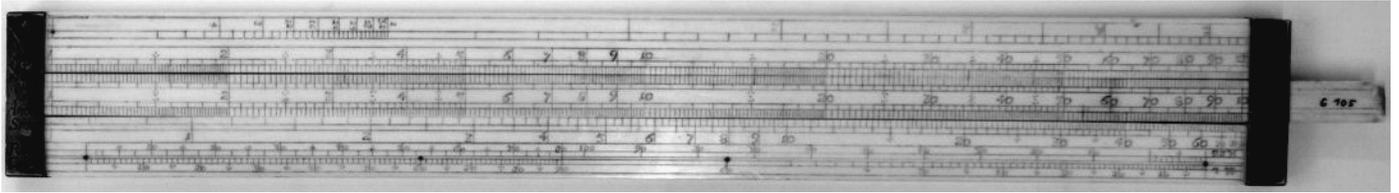


Figure 2a.

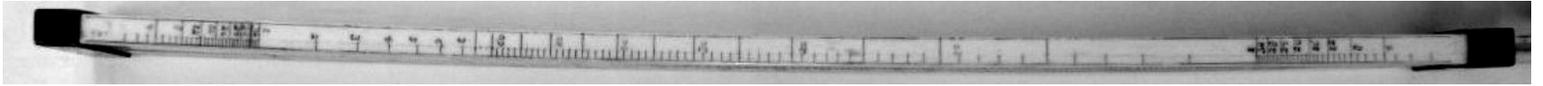


Figure 2b. Front, above, and lower edge of Kassel Slide Rule

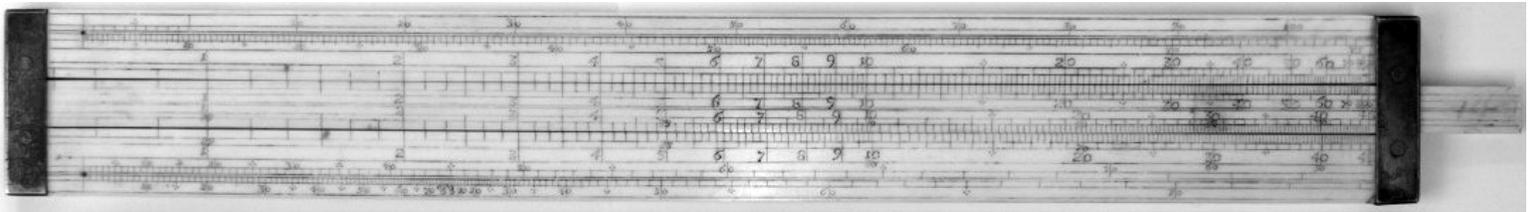


Figure 3a.



Figure 3b. Back, above, and upper edge of Kassel Slide Rule

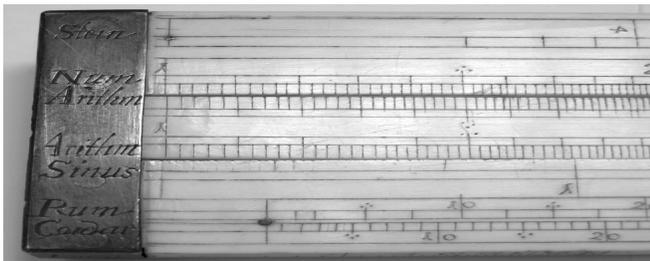


Figure 4a.

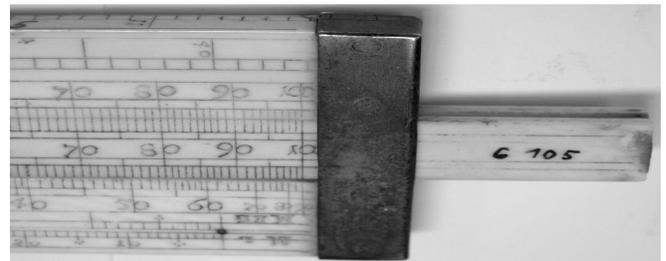


Figure 4b.

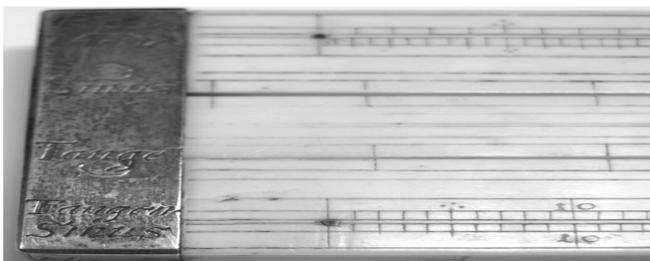


Figure 4c.



Figure 4d.

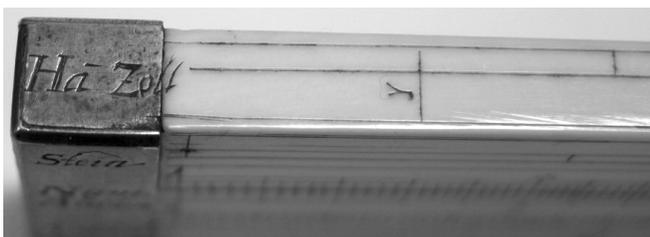


Figure 4e.



Figure 4f.

Figures 4a through 4f: Details of the Kassel Slide Rule

Altogether one has to state that this slide rule obviously was not made for daily use, but more probably was acquired for the *Hochfürstliche Kabinett von Landgraf Karl von Hessen* (1654-1730), i.e., for presentation, or for the *Collegium Carolinum*, founded by Karl for technical students. At that time it was very popular at courts to collect scientific instruments. The *Staatlichen Museen Kassel* today is proud to own many beautiful varieties, for example, the famous celestial globe with clock by Jost Bürgi, who worked in Kassel from 1579 to 1604, and was also buried there. Unfortunately, the slide rule is not signed and dated. However, as explained later, it is possible to date it approximately.

### The Scales

Most of the scale names are scratched onto the silver end caps (Fig. 4). For the following explanation, all scales—including the unnamed—have been numbered, starting on the front side with the logarithms of numbers:

1. *Stein*: (= Stone)
2. *Num*: double radius logarithms
3. *Arithm*: " " "
4. *Arithm*: " " "
5. *Sinus* : Logarithms of Sine 1 to  $90^\circ$
6. *Rum*: (left) and *MEG* (right)
7. *Cordar*: (= Chords, left) and *ML* (right)
8. Edge: *Bley* (Blei= Lead, left), unnamed (center), *Eeyssen* (Eisen = Iron, right)
9. *P EQ*: Equal Parts
10. *Merid*: MER
11. *Sinus*: on Body and Slide (as No. 5)
12. *Tange*: on Body and Slide logarithms of Tangents from 1 to  $45^\circ 13'$ .
13. *Tangen*: Natural Tangents for Radius 3 inches
14. *Sinus*: Natural Sine for Radius 3 inches (left); Secants (not signed, right)
15. Edge: *Ha-Zoll*: Scale of Ha-Inches

The scales *Num*, *Arithm* (=Num), *Sinus*, *Tange* do not need any explanation. The other trigonometric functions are known from *Gunter Scales* and other nautical slide rules and are defined in Figure 5<sup>1</sup>. Usually these scales are based on radii of 2 or 3 inches. Figure 5 also explains *Rum* (Rhumbs) and *Cordar* (Chords). *Merid* stands for Meridian (MER) and is being used together with scale *P EQ* (Equal Parts) and maps with *Mercator's Projections*. With this projection not only are the East-West distances

extended when going North or South from the Equator, but also the distance between latitudes. This enlarged distance can be read on the *P EQ*-scale.

Scales *Cordar* (Chords) and *ML* (M\*L or LON = Miles of Longitude) belong together, and on this slide rule are related to a radius of 4 inches. On *Gunter Scales* these two lines usually are placed one above the other, but on the slide rule in Kassel they are placed side by side. On the *ML*-scale the length of one degree longitude in sea miles for the respective latitudes (scale *Cordar*) can be read.

Still unknown is the meaning of scale *MEG* (letters turned upside down as well as scale *ML*). Leupold (1674-1727) [1] in his drawing of the *curieusen Rechen=Stab* (curious slide rule) of an unknown inventor had named this scale *LEG*, but unfortunately it is not explained.

Very uncommon are the scales *Stein* (1) = stone, *Bley* (Blei= lead) and *Eeyssen* (Eisen= iron) (8). They indicate the weight of a gun shot made of stone, lead, or iron for a given inside diameter of the gun. The weight comes out in ounces (1/16 of a pound) and can be read off above the logarithmic *Num*-scale; for example, 32 ounces at a gun diameter of  $3\frac{3}{4}$  inches. It must be mentioned that the shot diameter was usually much smaller than the gun diameter; the gap was sealed to avoid allowing too much gas to escape following the ignition of the gunpowder. The guide was: Weight of gunpowder = half the shot weight.

In case of shots of lead or iron, probably the slide rule was held at the gun and the weight was read off directly.

The function of the scale between *Bley* and *Eeyssen* is still unknown.

Now we have one scale left on the second edge. On the end cap we find *Ha-Zoll*. Zoll means inch, and *Ha* is the abbreviation of the city, where the slide rule was made. It can stand for Hamburg, Hanover or Halle. At that time all major cities and regions in Germany and other parts of Europe had their own inch-measure. As the slide rule in Kassel is 286 mm long this would mean it was made in Hamburg. For Hanover we do not have a value. But we should not forget Halle an der Saale. Although belonging to Prussia at this time, it cannot be excluded. Similar to the neighboring town of Leipzig, Halle might have changed their system during the first half of the 18<sup>th</sup> century.

### Who invented the Slide Rule in Kassel?

When searching for early German slide rules, without doubt one will come across Leupold's *Theatrum Arithmetico Geometricum* [1] with the curious slide rule (curieusen Rechen=Stab) of an unknown author. [see: *How well known were Slide Rules in Germany, etc.* in this issue] Fig. 6 shows the *Num* side of this slide rule, which Leupold had made according to his drawing by the *Königlich-Preußischen Paedagogio und Mathematico Experimentalis Georg John* from Halle.

<sup>1</sup>Figure 5 has been placed on the last page

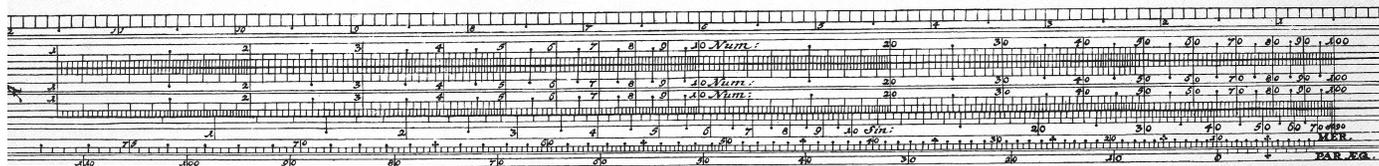


Figure 6. Front of Leupold's Slide Rule after "Unknown Author"

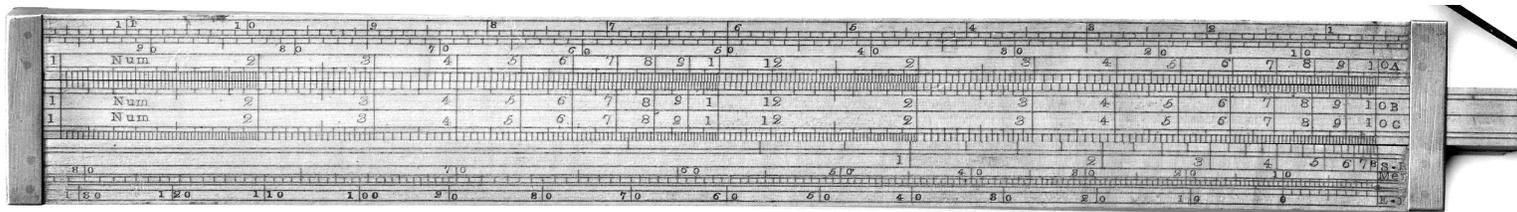


Figure 8. Front of 12-inch Sliding Gunter

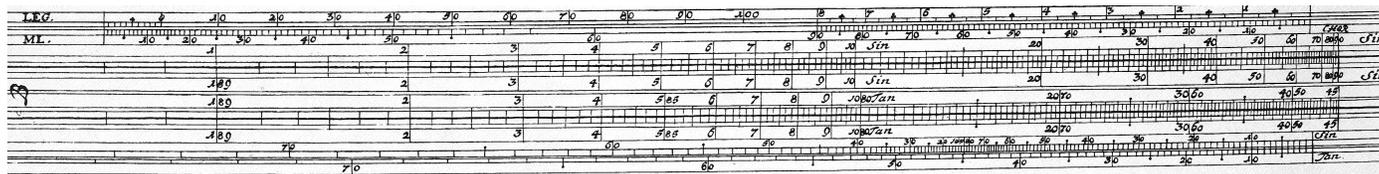


Figure 7. Back of Leupold's Slide Rule after "Unknown Author"

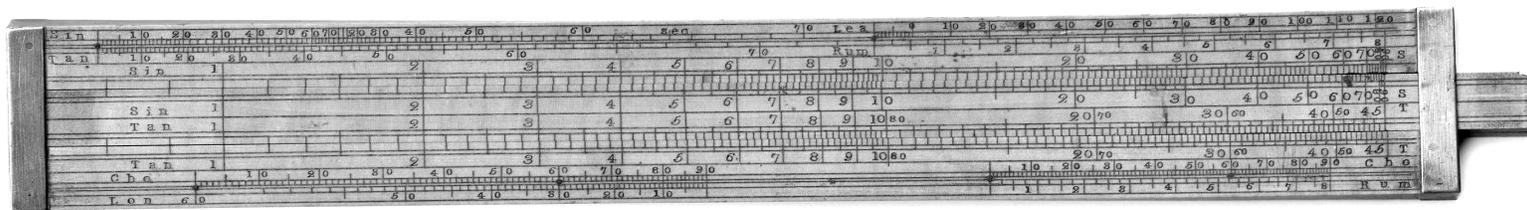


Figure 9. Back of 12-inch Sliding Gunter

Compare Figure 2a and Figure 6. Also compare Figures 7 and 3a. The likeness is surprising! Only a few scales, mostly used together with a pair of dividers were arranged differently. In addition, the Kassel slide rule has the gun-shot scales. Such scales are not common on English slide rules. We know of the *Gun Diamr.* scale on the *Gunter Scale* improved by Benjamin Donn in 1772; i.e., later than the possible date of the Kassel slide rule.

It should be mentioned that the princes of Kassel also collected other instruments for guns, such as optical sights.

As the slide rule in the *Staatlichen Museen* of Kassel is neither signed nor dated, other evidence must be taken into account:

Leupold had completed his *Theatrum Arithmetico Geometricum* certainly several years before his death and had his slide rule made even earlier. It can be assumed that the slide rule in Kassel was made according to Leupold's drawing, especially as we know that Landgraf Karl bought several instruments from Leupold in Leipzig. Perhaps it was even made by *Georg John* in Halle near Leipzig, the maker of Leupold's slide rule.

- Landgraf Karl (1677-1730) was a great lover of exact science and promoter of technical innovations [2],

who extended the collection in many aspects. In 1709 he founded the *Collegium Carolinum* for young people studying physics, mathematics, astronomy, mechanics, optics, etc.

- This slide rule was already listed in the museum's inventory of 1765.

With some certainty therefore, we can say that this (probably) oldest preserved German slide rule was made in the first quarter of the 18<sup>th</sup> century, and most likely in Halle an der Saale (see above).

### Partridge's Double Scale of Proportion = Sliding Gunter

If we compare the copper prints from Leupold's book (Figures 6 and 7), the slide rule in Kassel (Figures 2 and 3) and the two sides of a one-foot-long Sliding Gunter (Figures 8 and 9), we notice that all main scales are identical and are exactly as described by Seth Partridge in his *Double Scale of Proportion* [3]. The first issue dates from 1661, followed by reprints in 1671, 1685, and 1692. The unknown author cited by Leupold had just translated Partridge's book into German.<sup>2</sup> Both Partridge and Leupold had recommended adding other scales.

<sup>2</sup>see: *How well known...*, in this issue

Actually the slide rule in Kassel and also the *Sliding Gunter* have scales added, especially those popular with seamen used to the *Gunter Scale*.

The question is: Why is the double-sided slide rule, invented by Partridge, not associated with his name? Cajori [4] of course mentioned Partridge's invention, but he did not say that it was Partridge's idea which later became famous as the *Sliding Gunter*. According to Cajori, Edmund Stone in 1723 used this name for the first time. Later, other inventors, for example John Robertson in 1775, also claimed to have improved the *Gunter Scale* by converting it to a slide rule. The name *Sliding Gunter*

certainly was created by seamen who were accustomed to the *Gunter Scale* for a long time.

#### Acknowledgements

I have to thank the *Astronomisch Physikalischem Kabinett der Staatlichen Museen Kassel*, especially Dr. Karsten Gaulke, for the opportunity to study in detail this oldest preserved slide rule manufactured in Germany, and for the photographs and the permission to publish them.

I also thank Otto van Poelje for his very valuable remarks regarding Gunter scales.

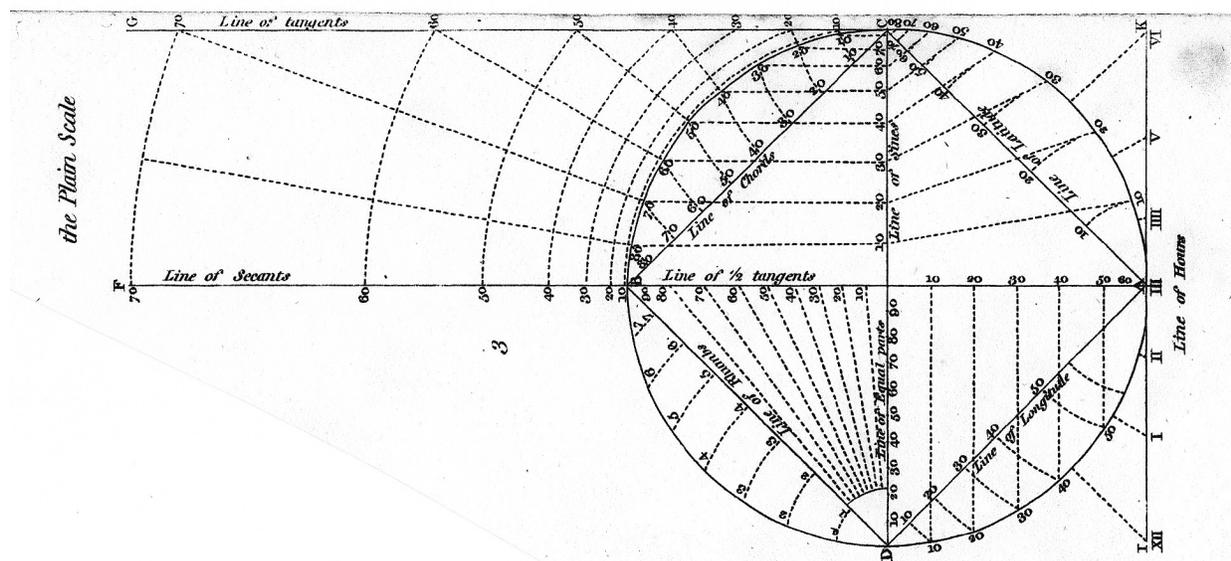


Figure 5

#### References

1. Leupold, J., *Theatrum Arithmetico Geometricum*, Das ist Schau=Platz der Rechen=und Meß=kunst Leipzig, 1727, Reprint of 1982.
2. Mackensen, L. von, *Die Naturwissenschaftlich—Technische Sammlung die Geschichte, Bedeutung und Ausstellung in der Kasseler Orangerie*, Kassel, 1991.
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4. Cajori, F., *A History of the Logarithmic Slide Rule*, New York, 1910, reprinted by The Astragal Press, 1994.
5. Poelje, O.E. van, "The Navigation Scale, Improved by B. Donn," *Journal of the Oughtred Society*, 14:2, 2005.
6. Jerrmann, L. (Capitän), *Die Gunterscale*, Hamburg, 1888.
7. Binning, Thomas, *A Light to the Art of Gunnery*, London, 1676.

#### Addendum

1. Otto van Poelje has identified the linear divided scale *MEG* (letters upside down) as *LEA*, known from English Gunter Scales. *LEA* stands for *League*: one league is three nautical miles, or 1/20 of one degree longitude at the equator. In Germany a similar unit was known at that time: one "Old German Mile" was 1/25 of one degree of longitude, i.e., 4457.5 m. It may be assumed that Leupold had read *LEG* instead of *LEA* and that the maker of the Kassel slide rule had used an *M* for Meilen (Miles).

2. Recently, I have been able to provide a better explanation for the uncommon scales *Bley*, *Stein* and *Eeyssen*. They were called *Visier* scales and can be described as Gun scales. They are constructed in the same way, but of unequal length due to the different specific weights. Given are weights of a shot in *Loth* = 1/32 *Pfund* resp. in *Preußischen Pfunden* = 468.3 grams.

The scale for *Eeyssen* (Iron) extends to 60 *Pfund*, for *Bley* (lead) only to 7 *Pfund*. Lead obviously was too rare and too expensive for heavier shots. The stone-scale (*Stein*) extends to 40 *Pfund*. With the slide rule one had actually measured the diameter of the gun in *Ha-Zoll*, but one read the weight of a shot, which diameter was approximately 5% smaller than the gun diameter. With this weight the required quantity of gunpowder could be determined.

As a guide one chose gunpowder equal to half the weight of a shot. However, this number could vary according to experience, shot distance, quality of gunpowder, etc.

The gap between shot and gun was sealed to avoid allowing too much gas to escape.

It ought to be mentioned that for *Bley* and *Eeyssen* the slide rule could be held directly to the gun mouth. In case of stone shots (*Stein*) one had to use a pair of dividers to measure the gun diameter and then read the shot weight on scale *Stein* starting at the inserted silver pin.

3. There is one difference between the main scales on the Kassel slide rule and a *Sliding Gunter*. The *NUM* side of the Kassel slide rule shows a *Sine* scale, whereas a *Sliding Gunter* usually has a scale *Sine Rhumbs*.