AccessionIndex: TCD-SCSS-U.20121208.046
Accession Date: 8-Dec-2012
Accession By: Dr.Ronald Cox
Object name: Lilly's improved spiral sliderule
Vintage: c.1912
Synopsis: Engineering School, Trinity College Dublin, improved spiral sliderule.

Description:
Oughtred is credited with inventing the linear sliderule c.1622 and the circular rule c.1630. Spiral sliderules are a variation of circular sliderules that are a means to implement a very long sliderule scale. In practise there are three ways this has been achieved: with a single spiral scale (e.g. the Lilly sliderule or the Atlas sliderule), segmenting the scale into multiple concentric partial-scales (e.g. the Fowler sliderule, see elsewhere in this catalog), or a hybrid of these (e.g. the RotaRule sliderule), where all are a form of Gunter scale. This item is an improved example of the first approach, designed by Prof.W.E.Lilly, of the Engineering School, Trinity College Dublin. It was patented in 1912.

According to [1], Lilly's spiral sliderule is constructed on a disc that is 13.4 inches (34 cm) in diameter, with a logarithmic scale spanning ten revolutions of the disc, allowing the scale to be 17.5 feet (5.33 metres) long *[but Mollan says 4.57 metres?]*, and giving a scale that is equivalent to a straight sliderule of about 32 feet (9 metres) long (i.e. the *effective scale length* is about 32 feet) with a minimum resolution of about 0.1%.

Note that for such slidrerules the inner revolution of the scale is shorter than the outer revolution, so the scale resolution increases from the inner to the outer ends of the scale. According to [1] at the inner end of the scale the best resolution is 1001, while at the outer end it is 9999, and the outer revolution has a scale effective length of 9.06 metres.

Interestingly, Prof.Lilly was a Lecturer of Mechanical Engineering in the Engineering School at the time that Prof.J.G.Byrne's father (T.B.Byrne) was an engineering undergraduate (see graduating Class Photograph 1922-23, Fig.6). Prof.Byrne was born in 1933, and it is not known whether as a child he personally was aware of or knew Prof.Lilly.

Many thanks to Ronald Cox for donating this item, which came to this collection from Dr.Cox via Prof.Byrne many years ago.

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Accession Index	Object with Identification
TCD-SCSS-U.20121208.046	Lilly's spiral sliderule, Engineering School, Trinity College Dublin, improved spiral sliderule, c.1912.

References:

1. Edwin J. Chamberlain P.E., *Circular Sliderules very Very Long Scales*, J.Soc.Oughtred, Spring 1999, .see:
   http://osgalleries.org/journal/pdf_files/17.1/V17.1P52.pdf
   Last browsed to 24-Mar-2018.

2. Andrew Nikitin, *Circular slide rule with spiral scale*, online emulator, see:
   http://nsg.upor.net/slide/cratlas.htm
   Last browsed to 24-Mar-2018.

3. Joseph Lipka, *Graphical and Mechanical Computation*, pp.168, Wiley, New York, 1921.

4. G.D.C.Stokes, *The Slide Rule*, Project Euclid, see:
   https://projecteuclid.org/download/pdf_1/euclid.chmm/1428684864
   Last browsed to 25-Feb-2018.

Figure 1: Lilly's improved spiral sliderule, front view

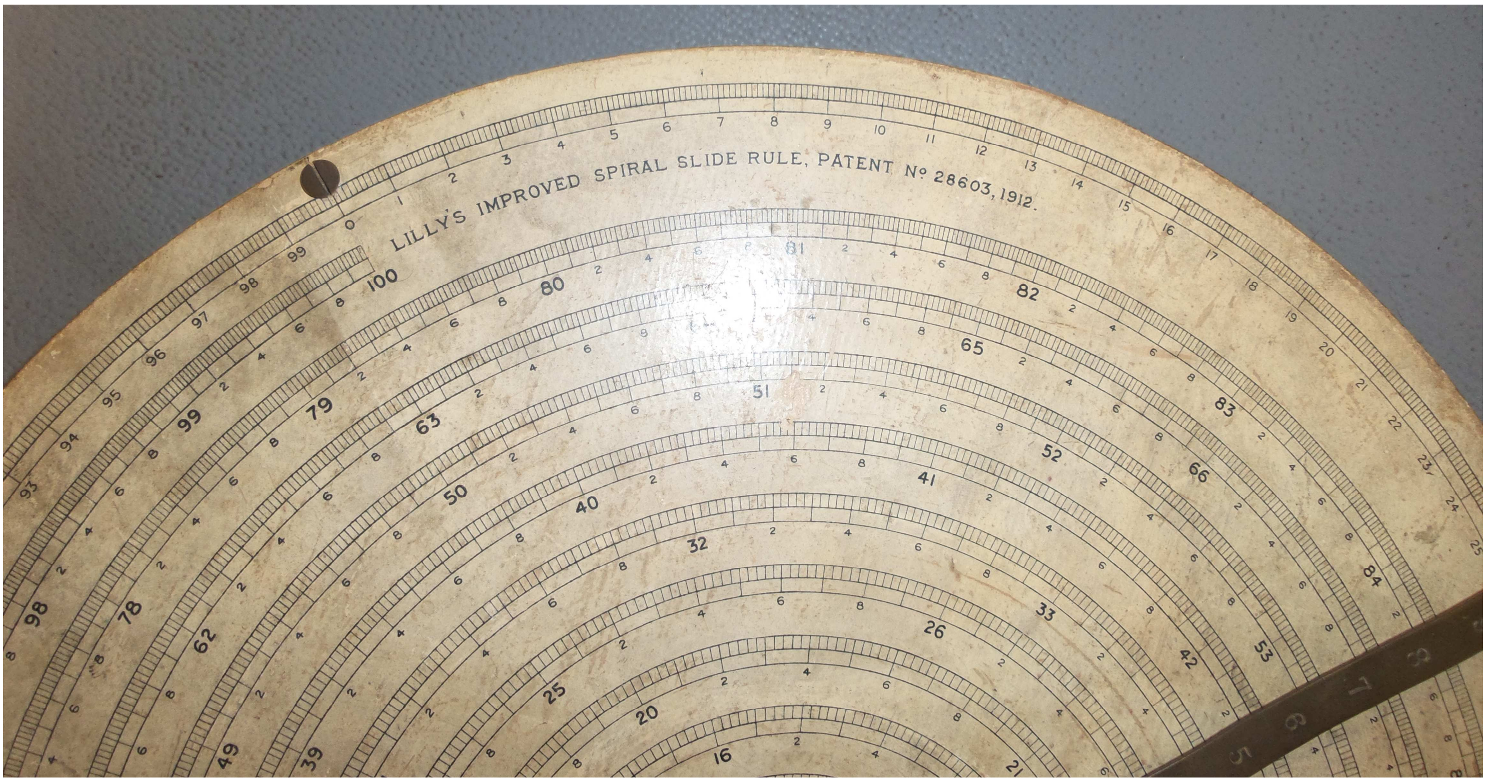


Figure 2: Lilly’s improved spiral sliderule, top front closeup

Figure 3: Lilly's improved spiral sliderule, rear view

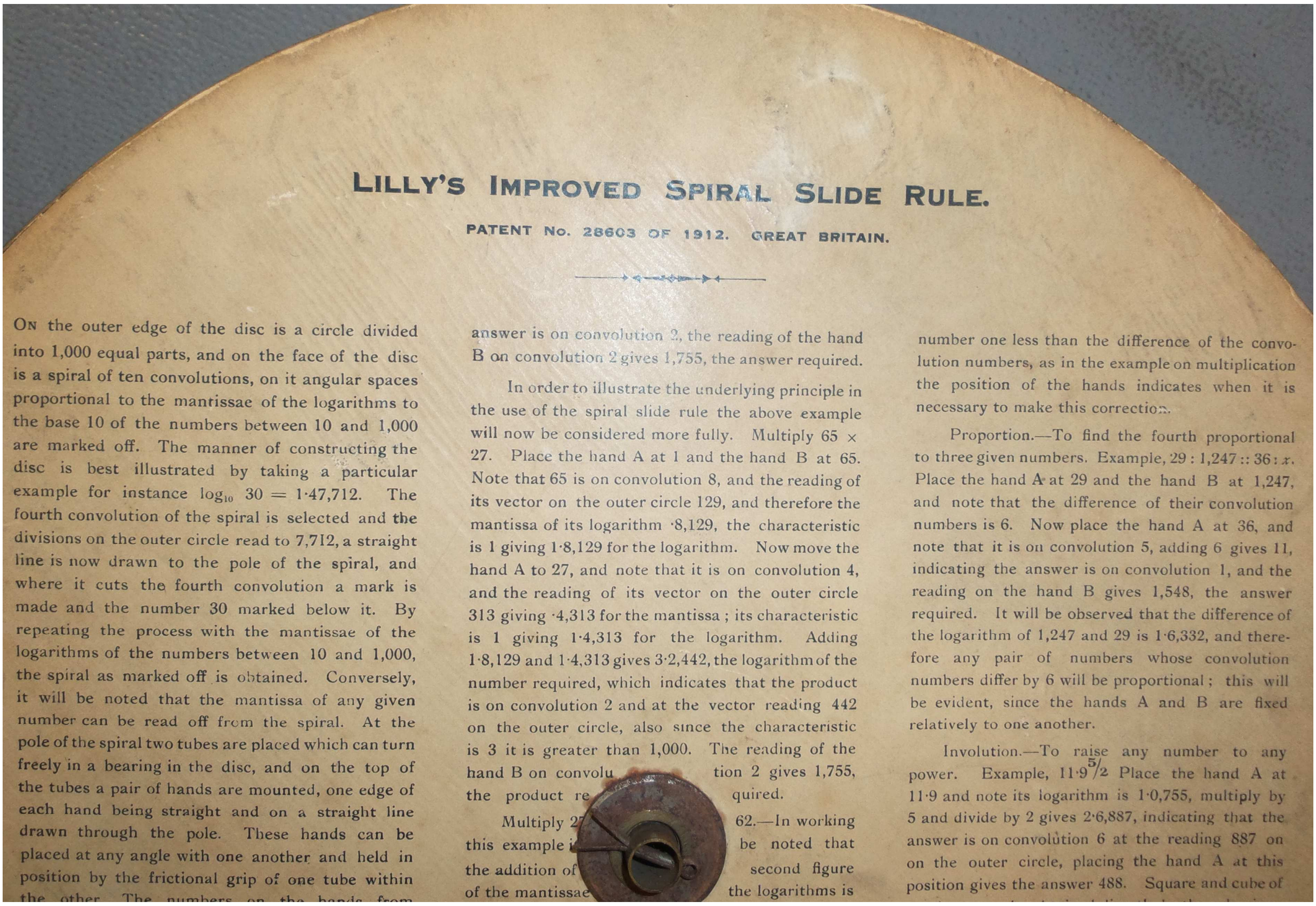
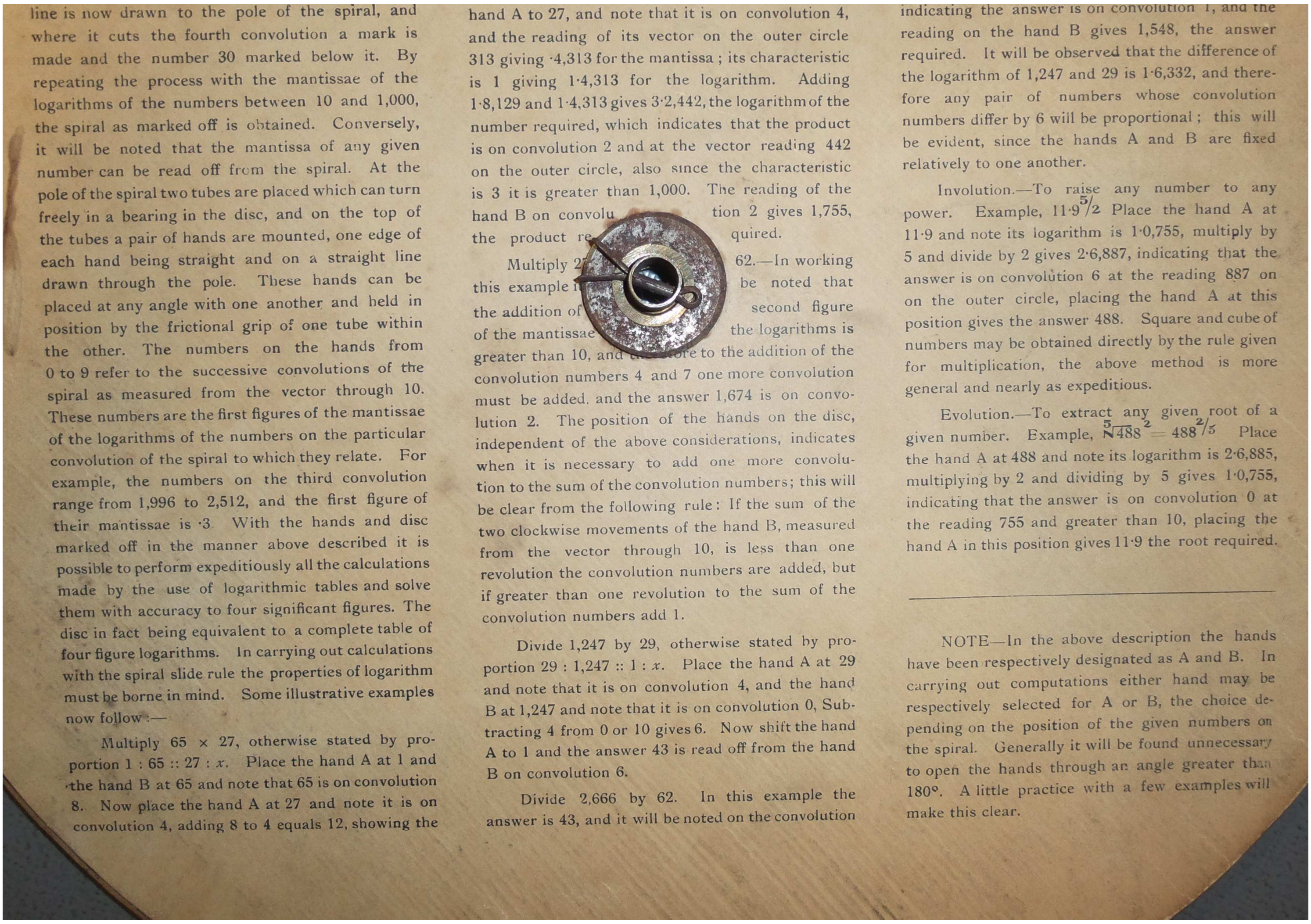


Figure 4: Lilly’s improved spiral sliderule, top rear closeup



line is now drawn to the pole of the spiral, and where it cuts the fourth convolution a mark is made and the number 30 marked below it. By repeating the process with the mantissae of the logarithms of the numbers between 10 and 1,000, the spiral as marked off is obtained. Conversely, it will be noted that the mantissa of any given number can be read off from the spiral. At the pole of the spiral two tubes are placed which can turn freely in a bearing in the disc, and on the top of the tubes a pair of hands are mounted, one edge of each hand being straight and on a straight line drawn through the pole. These hands can be placed at any angle with one another and held in position by the frictional grip of one tube within the other. The numbers on the hands from 0 to 9 refer to the successive convolutions of the spiral as measured from the vector through 10. These numbers are the first figures of the mantissae of the logarithms of the numbers on the particular convolution of the spiral to which they relate. For example, the numbers on the third convolution range from 1,996 to 2,512, and the first figure of their mantissae is ·3 With the hands and disc marked off in the manner above described it is possible to perform expeditiously all the calculations made by the use of logarithmic tables and solve them with accuracy to four significant figures. The disc in fact being equivalent to a complete table of four figure logarithms. In carrying out calculations with the spiral slide rule the properties of logarithm must be borne in mind. Some illustrative examples now follow:—

Multiply 65 × 27, otherwise stated by proportion 1 : 65 :: 27 : x. Place the hand A at 1 and the hand B at 65 and note that 65 is on convolution 8. Now place the hand A at 27 and note it is on convolution 4, adding 8 to 4 equals 12, showing the hand A to 27, and note that it is on convolution 4, and the reading of its vector on the outer circle 313 giving ·4,313 for the mantissa; its characteristic is 1 giving 1·4,313 for the logarithm. Adding 1·8,129 and 1·4,313 gives 3·2,442, the logarithm of the number required, which indicates that the product is on convolution 2 and at the vector reading 442 on the outer circle, also since the characteristic is 3 it is greater than 1,000. The reading of the hand B on convolu[illegible]tion 2 gives 1,755, the product re[illegible]quired.

Multiply 2[illegible] 62.—In working this example i[illegible] be noted that the addition of [illegible] second figure of the mantissae [illegible] the logarithms is greater than 10, and [illegible]re to the addition of the convolution numbers 4 and 7 one more convolution must be added. and the answer 1,674 is on convolution 2. The position of the hands on the disc, independent of the above considerations, indicates when it is necessary to add one more convolution to the sum of the convolution numbers; this will be clear from the following rule: If the sum of the two clockwise movements of the hand B, measured from the vector through 10, is less than one revolution the convolution numbers are added, but if greater than one revolution to the sum of the convolution numbers add 1.

Divide 1,247 by 29, otherwise stated by proportion 29 : 1,247 :: 1 : x. Place the hand A at 29 and note that it is on convolution 4, and the hand B at 1,247 and note that it is on convolution 0, Subtracting 4 from 0 or 10 gives 6. Now shift the hand A to 1 and the answer 43 is read off from the hand B on convolution 6.

Divide 2,666 by 62. In this example the answer is 43, and it will be noted on the convolution indicating the answer is on convolution 1, and the reading on the hand B gives 1,548, the answer required. It will be observed that the difference of the logarithm of 1,247 and 29 is 1·6,332, and therefore any pair of numbers whose convolution numbers differ by 6 will be proportional; this will be evident, since the hands A and B are fixed relatively to one another.

Involution.—To raise any number to any power. Example, $11{\cdot}9^{5/2}$ Place the hand A at 11·9 and note its logarithm is 1·0,755, multiply by 5 and divide by 2 gives 2·6,887, indicating that the answer is on convolution 6 at the reading 887 on on the outer circle, placing the hand A at this position gives the answer 488. Square and cube of numbers may be obtained directly by the rule given for multiplication, the above method is more general and nearly as expeditious.

Evolution.—To extract any given root of a given number. Example, $\sqrt[5]{488^2} = 488^{2/5}$ Place the hand A at 488 and note its logarithm is 2·6,885, multiplying by 2 and dividing by 5 gives 1·0,755, indicating that the answer is on convolution 0 at the reading 755 and greater than 10, placing the hand A in this position gives 11·9 the root required.

NOTE—In the above description the hands have been respectively designated as A and B. In carrying out computations either hand may be respectively selected for A or B, the choice depending on the position of the given numbers on the spiral. Generally it will be found unnecessary to open the hands through an angle greater than 180°. A little practice with a few examples will make this clear.

Figure 5: Lilly's improved spiral sliderule, bottom rear closeup

Figure 6: Class Photograph, TCD Engineering School BAI Class of 1922-1923
Photograph courtesy Dan McCarthy
See elsewhere in this catalog for more detail

Prof.W.E.Lilly is third from the right in the front row
Prof.J.G.Byrne's father, T.B.Byrne, is fourth from the right in the second row