The Fascinating Tale of the Fowler Magnum Pocket Slide Rule

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The history of the Fowler Calculator line illustrates the connection of collegiate-minded yet practical engineering-skilled types and their pursuit of a unique and special math tool, like the Fowler Magnum (bear in mind, magnum means great). William Henry Fowler (1853-1932) was an Assistant Engineer to the Steam Users' Association after years of engineering training and winning a scholarship to study engineering at Owens College in Manchester. In 1891, he turns from engineering to being the Editor of The Practical Engineer, a weekly Manchester journal publication. In time, by 1898 he establishes the Scientific Publishing Company and publishes *Fowler's Mechanical Engineer's Pocket Book*. In this same year, Fowler's The Mechanical Engineer carries an article about a circular pocket-style calculator (slide rule), which was also sold by the Scientific Publishing Company. This calculator has a rotating face dial and fixed pointers moving over a five scale face, so is very similar to the later models of what becomes the trademark Fowler line of pocket calculators.

Harold Fowler (William's son, born 1879) emulates his father by winning a scholarship to the Manchester School of Technology, then later attends Owens College and studies engineering. Until 1905 he works as an electrical engineer when he works as an editor for *The Mechanical Engineer*.

From 1905 to 1909 W.H. Fowler takes out three patents on the Fowler Calculator. The first is for the double-sided Long Scale version, which is the company's main product for the next 30 years. In this model, a milled nut moves one dial while a knob turns the pointer on this face and moves the opposing dial on the other side. By 1924 father and son take out a patent on a second milled nut that is on the casing edge so that the system's operation can be done with one hand.

The first question, why a circular slide rule? In the Fowler's instruction manual they note that the scales are always kept clean compared to a linear slide rule (as the scales are under glass). There is never a need to switch slides or worry about running over the index (since the index rotates and is continuous). It is small and easier to carry. Like a regular 10 inch linear model, the small circular calculator has 2-3 significant figure capabilities and with long scales, as on the Magnum, up to 4 figures are possible. This classic question of circular versus linear is all a matter of one's interests and goals for the tool.

Through the 1930s and 1940s the company introduces the 12-10 Calculator (1936) made for architects, builders, surveyors, and timber merchants, who not only used the decimal system, but the duodecimal system (12^{ths}). In 1948 the company releases the Jubilee Magnum, which has a 76 inch (193 cm) scale along with a short scale (longer than 10 inches in length) and an L (log) scale.

Despite the patents, new designs, and the classic style of design the company never became very profitable. These calculators, though precise and well made, had a large number of different parts (especially compared with linear slide rules), and had to be assembled by hand (unlike the mass production systems for the other slide rules). Both add considerably to the costs of manufacturing (up to four times); hence, the high sale price.

The supreme design first appears in 1927 (and was manufactured into the 1940s) and is labeled the Fowler's Magnum Long Scale Calculator. It is 4 5/8 inches in diameter, glass-faced, nickel cased, and has the Fowler classic style. Like the newest models in the line, the Magnum uses two screws to control the functions. The screw over the fixed red line cursor rotates the scale while the other screw at 2 o'clock (given the first screw is at noon) rotates the black imprinted cursor line on a plastic strip or a plastic disc, with some variation depending on the model.

FIGURE 1.
Fowler Magnum Long Scale Calculator

Like all other Fowler models, to multiply place the Index under the red datum line and rotate the cursor to the multiplicand. Next rotate the disc with the top screw to the multiplier and then read the product under the rotating cursor. For division, place the numerator underneath the red datum line and rotate the rotating cursor to the denominator. Now rotate

the disc so that the index is beneath the rotating cursor and read the quotient under the red datum line.

The Magnum was produced in 2 models. The better of the two is detailed here. This is an 8-scale design, as follows (from the center out): T, S&T, S, long scale C (6 rings), L, two ring A scale for square roots, C1, short C scale, and finally the outer ring of Gauge Marks. Gauge Marks include: π, $\pi/4$, radian, lbs-kg, km-mile, in-cm, gravitational acceleration (English) and many others. The other version has the L scale inside the 6-ring long scale instead of outside it.

TABLE 1.
Fowler Magnum Long Scale

Ring	Radius (inches)	Circumference (inches)
Outer Ring of Gauge Marks	2.25	14.4
Short C scale	2.125	13.4
C1	2.0	12.6
A (approx 3.1± 1)	1.875	11.8
A (1 – approx 3.1+)	1.75	11.0
L scale	1.6875	10.6
Long C : 6th ring	1.625	10.2
Long C : 5th ring	1.5	9.4
Long C : 4th ring	1.375	8.6
Long C : 3rd ring	1.25	7.9
Long C : 2nd ring	1.125	7.1
Long C : 1st ring	1.0	6.3
Total Length	49.5	
Sine 6^{o} – 75^{o}	0.875	5.5
Sine & Tangent 35' – 5.5^{o}	0.75	4.7
Tangent 6^{o} – 45^{o}	0.6875	3.9

From the chart, the one drawback is the relatively short trig scales where the maximum lengths have the approximate precision of a 6 inch slide rule. Still the lengths are effective enough to obtain 2 significant figures when needed.

The first major strength is the short C scale, which is longer than a conventional 10 inch slide rule scale. There is greater space between marks such as those found between 9 and 1. This allows for a more precise reading of the values when estimating.

For real power in this hand-sized slide rule, the inner long C scale has an effective length of nearly 50 inches (more than double a 20 inch slide rule!). The values between any two secondary values, including 9 to 1, have tenths marked off between them with a good span of distance making 3 significant figures the minimum for all calculations. An added bonus is the fact that one can determine 6th power and 6th roots as needed by reading the short and long C scales for a given value.

The 2-line square root scale helps in finding square roots effectively since it (like all the scales) are read in connection to the outer short C scale. For values 1-10 (and all other odd digit numbers) read the inner ring of the A scale, for values 10-100 (and all other even digit numbers) read the outer A ring.

The L scale has 3 significant figures read very easily so is invaluable as a math tool in determining powers and roots as needed. The L scale outside the long C scale (compared to the other version inside the long C scale) results in a high degree of precision.

The really amazing power is that this tool has all of the capability of a 9-scale slide rule! Looking at the table, one finds the K scale is missing from the classic 9-scale model list of scales. Taking cubes or cube roots would then appear to be a task, since one would have to take the log of the number in question, divide by three, look that back up on the L scale, and find the corresponding answer on the short C scale. Never fear, there is no need.

In order to perform a cube root, look up the number on the A scale and find the cube root on the long C scale. The reverse yields the cube of the value! This is the real genius of the design.

I wonder if there are any other unique slide rules like this where one can have the power of the classic 9-scale model yet with creative forethought and innovation can lead to an incredibly potent, portable, and yet analogous tool that even has a very long scale special addition? This becomes the mathematicians' question – how to maximize the effectiveness of the tool yet minimize its number of requirements. I find this one to be the epitome of pocket-watch style circular slide rule design and consider the Fowler Magnum to be the company's magnum opus (great work). Why is a 9-scale so important? Consider that Einstein and Von Braun used this number of scales for their accomplishments. This range of scales is capable of performing all the functions of a basic scientific calculator and is only limited by one's math skill and imagination.

Could even a classic be improved? The only thing a linear slide rule would calculate that this circular calculator would not do as easily is where a linear rule has a fixed scale and a moving scale so that when a ratio is arranged, all similar ratios are arranged. As the Fowler has no fixed scale (perhaps an outer fixed ring with a C scale would solve this), so to find all similar ratios one must turn the disc once the ratio is arranged. I am looking forward to others to write about the uniqueness of a classic slide rule and associated special attributes.