

ADDENDUM: Other (20) Band- and Tape calculators

(by their Patents)

(Georg Stibitz's invention was surprisingly neither unique nor exclusive!)

The following should be read in conjunction with the main article published in the OS-Journal Volume 21, Number 1 from Spring 2012.

- The authors found a short 1-page account on a “*Film Slide Rule*” by a Dr. George Stibitz published by the American Mathematical Society in the 1947 October edition (Vol. 2 No. 20) of “*Mathematical Tables and Other Aids to Computation*”. The intriguing concept of an analogue “Slide Rule” being related to a computing instrument prompted the authors to find out more. It turned out because of its classified use by the US government the amazing story of the Stibitz slide rule was untold. This eventually led to the groundbreaking article in the JOS.

The authors wish to point out that Detlef Zerfowski provided valuable help in tracking down related "Film Slide Rule" patents included in this Addendum.

| US PAT. NO | YEAR | INVENTOR | TYPE AND DESCRIPTION |
|---|------|------------|---------------------------------|
| 786,102 | 1905 | R.N Cooper | early type of a band calculator |
| " in a calculator endless scale-tapes, wheels around which the tapes pass, means for operating the said wheels, spiders secured to the axis of the wheel, arms mounted to slide on the said axis, friction-bands having one end secured to the spiders and the other ends to the arms, said bands being adapted to engage the inner faces of the wheels, and operating- rods connected with the said sliding arms " | | | |
| | | | |

Fig. 1 detail from patent description R.N. Cooper

The first claim is "A calculator comprising a plurality of endless scale-tapes arranged one alongside the other, and manually controlled means for imparting a travelling motion to the said tapes at the same or different speeds

801,354**1905****F.S. Becket****early Pocket-Tape- calculator**

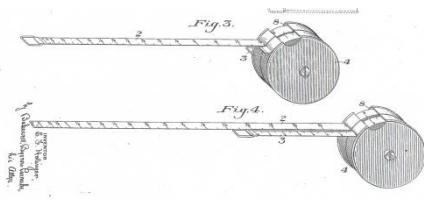
" - relates in improvements in calculating devices and pertains particularly to a chart in the form of a pocket-tape designed for computing, multiplying, dividing, ascertaining the roots and powers of numbers &c.

--provides a simple, compact, handy device for calculating mathematical problems and which may be readily carried in the vest-pocket".

Fig. 2 detail from patent description Becket

(How it works, for example, see fig. 3: Since every decimal has its corresponding equivalent fraction, the notation on scale 6 bears a certain definite relation to that on scale 7, so that if it is desired to find the equivalent fraction of any decimal it is only necessary to find that decimal on scale 6.

Turn over the tape and the fraction on scale 7 directly opposite the decimal just indicated will give the desired result. (F.i. 8125 will be 13/16.)

870,884**1907****Emil F. Holinger****Computing Tape measure**

"a computing measure having at least two independently movable tapes each of which has one free end and having markings thereon arranged to be read in connection with each other in different longitudinal relations of the tapes, and a common carrier for all the tapes, substantially as described".

Fig. 3 detail from patent description Holinger

1,068,982**1913****A. Connio (Buenos Aires)****Calculating machine**

"in a case a pair of spools and a pair of rollers rotatably mounted on each of said standards, the rollers on one standard and adapted to frictionally engage each other, ribbons having coordinated scales, mounted on said spools and rollers, means for driving the rollers on each standard and means for shifting one of the standards whereby it rollers will be brought into engagement with the rollers on the complementary standard".

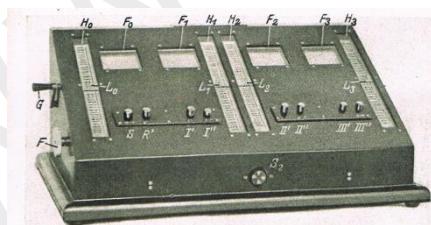
1,777,692**1930****Dr. H. Fuß (Germany)****Calculating machine**

Fig. 4 : „Logarithmische Rechenmaschine von Fuss , Askania-Werke, Berlin, c 1935“

Calculation results are read off fixed markings on the windows. Under the windows logarithmically graduated and perforated continuous steel bands, guided by cogwheels, run back and forth. The total logarithmic scale length (> 1.5 m) of the bands makes it 6 times more accurate than a conventional linear slide rule (25cm scale length).

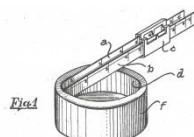
For example, to calculate $a \times b$, one band is moved until factor a appears under the window (F_0). A second band for the factor b is then indexed against 1 in a different window (F_1). Then both bands are coupled up and moved until factor b appears in the second F_1 window. The result of $a \times b$ is now

in window F... - The couplings are electro-magnetic. Herbert Fuß held three foreign patents (SUI, GB, FR) and five German patents for his Calculating machine, the last (516412) was additional to (his first) DRP 471113, the wheels for the log scales were now arranged on one wheel only.

| | | | |
|------------------|-------------|---------------------|---------------------------|
| 1,936,998 | 1932 | J.F. Summers | Calculating device |
| 1,959,990 | 1933 | | |

"a calculating device including a pair of tapes of freely flexible material and arranged with an edge of one tape adjacent to an edge of the other tape....."

| | | | |
|------------------|-------------|---------------------------------|---------------------|
| 2,091,661 | 1937 | H. von Forster, L. Grill | measure band |
|------------------|-------------|---------------------------------|---------------------|



"a calculating device, especially for calculating with logarithmic scales and adapted to be carried in the pocket when not required for use"

Fig. 5 measure band, detail from patent description

| | | | |
|------------------|-------------|---|---------------------------|
| 2,143,892 | 1937 | Fred W. Ludecke and Victor Smith | Calculating device |
|------------------|-------------|---|---------------------------|

"This invention , a calculating device, is an improvement over the conventional slide rule, over which it differs in being constructed with a stationary cursor and movable body and slide, the body and slide being formed of flexible tapes or ribbons which may be made of any desired length according to the degree of accuracy required in the calculation, and the body may be a single ribbon or divided into two ribbons, and the same also applies to the slide ."

| | | | |
|------------------|-------------|------------------|----------------------------|
| 2,285,774 | 1942 | E. Horner | Calculating machine |
|------------------|-------------|------------------|----------------------------|

"relates to calculating machines and more in particular in calculating machines for computing mathematical problems including proportion solved by the so-called rule of three, which problems are frequently met with in the preparation of compounds or mixtures such as the dairy industry, ink-manufacture, etc"

Example: .if the dairyman desires to ascertain how many pounds of 3% butter fat milk are needed to produce 4.5 lbs. of butter fat, he would first and lock dial 1 to read 3% and then turn the knob dial u until the other known quantity 4.5 appears on dial, then the result 150 lbs. on dial 1.

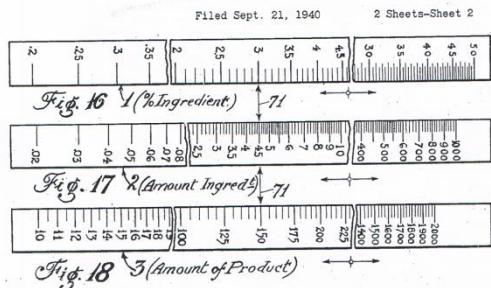


Fig. 6 detail of the Horner patent sheet 2

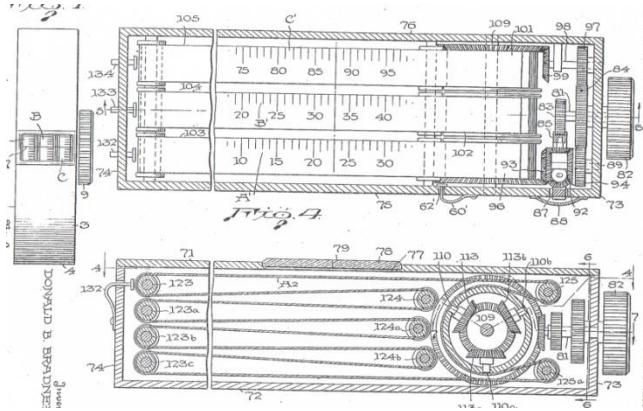
| | | | |
|------------------|-------------|-------------------------|-----------------------------|
| 2,451,987 | 1948 | F. Tellander jr. | Calculator mechanism |
|------------------|-------------|-------------------------|-----------------------------|

" contemplated to employ a plurality of calibrated tapes which are so controlled with respect to one another that a point on the tape in cooperation with a hair line always represents a mathematical equation. In a preferred form, three tapes are employed, two of which are movable relative to each other that the third tape displays the answer."

2,454,987

1948 D. Bradner

Calculating machine



„a calculating machine comprising a housing, with three movable logarithmic scales. Movement and controlling of each scale is done by a differential driving mechanism (preferably by a gear). Controlling of one to the other two scales is substantially so constructed and arranged as to maintain the algebraic relationship $M_A + M_C = M_B$, in which M_A , M_C and M_B represent the linear movement of the respective scales in the same direction relative to a fixed point. The movement of the scales is obtained by a

Fig. 7 detail of the Bradner patent

single drive shaft, simplifying the manner of operating, reducing the possibility of error and reducing the time necessary to perform any desired calculation.

2,527,776

1950

John L. Taaffe

Slide Rule

" to obtain solutions to mathematical problems by mechanically moving an inside tape in either direction independently of a pair of flanking outside tapes ; by moving the two outside tapes (having indicia thereon) together in other direction independently of the inside tape (having indicia thereon); and coupling the inside and outside tapes together and moving all three of them in either direction in accordance with the prerogative of the operator"

| DRP(GERMAN PATENT) | YEAR | INVENTOR | TYPE AND DESCRIPTION |
|----------------------------|-------------|-----------------|-----------------------------|
|----------------------------|-------------|-----------------|-----------------------------|

132347

1902

Silvio Masera

Rechenschieber

The Masera slide rule has a logarithmic scale on a revolving continuous band. Calculations are performed by aligning the scale on the band with a second, fixed positioned, logarithmic scale. The continuous band serves the traditional function of the slide.



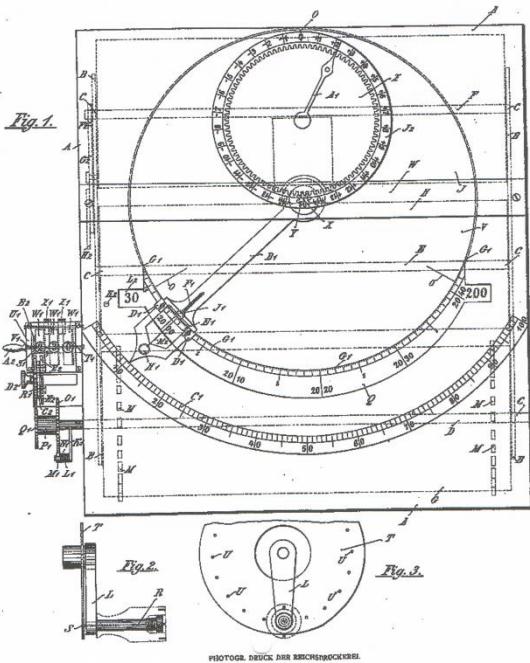
Fig. 8 Masera slide rule (by courtesy of MIT Museum)

199414

1907

E. Leder

Logarithmische Rechenmaschine



„logarithmic calculating machine with a logarithmic scale on an unrolling band. The scale is arranged on a various number of congruent circular arcs (length depending on $\log 10$) , whose midpoints are in the same distance against one and another, and whose vertexes are also on the connecting line of the central points. A turnable pointer is used for setting and reading“

(An interesting idea to build a machine with one unrolling band in circular form.)

Fig. 9 detail from Leder patent

392432

1923

A. Hengstenberg

Logarithmisches Rechenhilfsmittel

„ simple computing tape calculator with two (or more) flexible tapes of steel or other material, arranged side by side, sliding on rolls which are fixed on both sides of a type of support frame. This frame carries a sliding cursor to set and read on the logarithmic scales“

Abb. I.

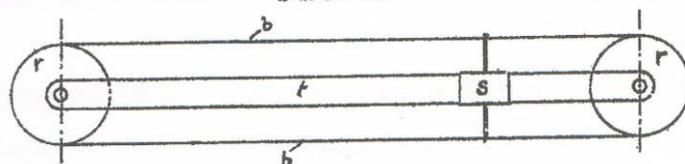


Fig.10 detail from Hengstenberg patent

(French patent) (Brevet d'Invention)

Marie LE SORT

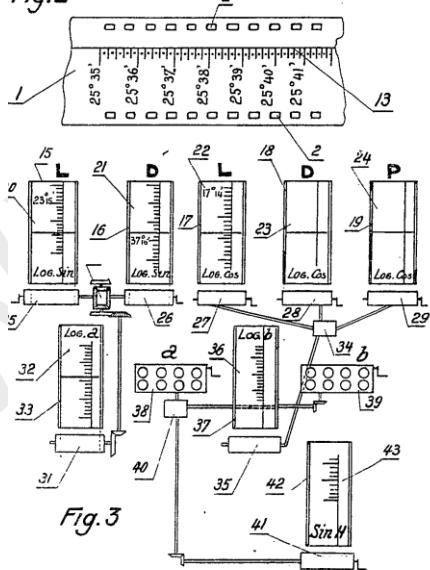
549562

1922

Henri-Thomas-

Instrument de Précision , electricité

Fig.2



(Dispositif de placement ou de contrôle de position d 'un organe mécanique et son application aux machines à calculer, notamment aux machines à résoudre les triangles et à calculer le point à la mer)

"Device (or mechanism) to position, or to verify the position of, a mechanical apparatus; and its application to mechanical calculators, particularly calculators for solving triangles and for taking bearings at sea"

Fig.11 shows the typical tapes or film bands with trig. scales log sin and log cos.

convention Date (Austria: Nov. 2, 1926)

An Improved Apparatus for Calculating and Measuring

Fig.1.

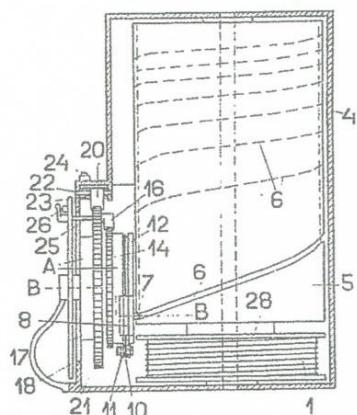


Fig.2.

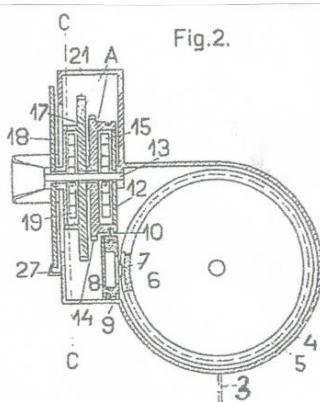
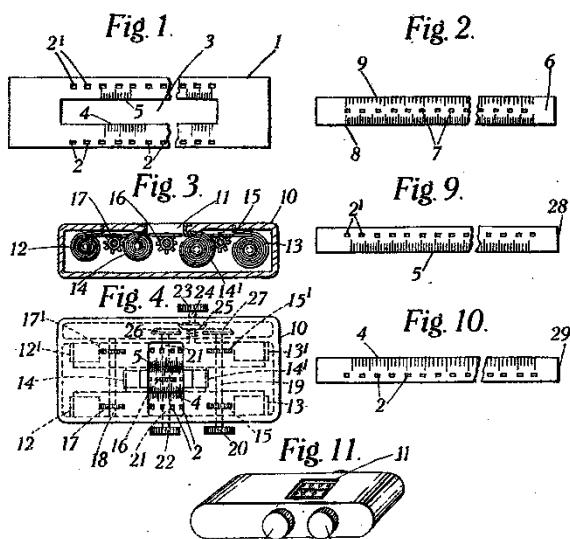


Fig. 12 detail from the Jellinek patent

...” by the fact that the motion of an element indicating or measuring linear functions is transmitted to a result scale divided on a logarithmical basis, so that the product of several quantities or a quotient may be directly read from the result scale without a preceding numerical determination of the quantities.” (first claim)

Improvements in or relating to Slide Rules and like Calculating Apparatus

After having described the slide rule “*the utility thereof is very restricted*” –“*the most common is about ten inches long and even then it is frequently necessary for them to be fitted with optical means for magnifying the scale*”, explain the claims this new invention

1. “*A slide rule or like calculating apparatus of the kind referred to in which sprockets or the equivalent for moving the scales are mounted on shafts carrying friction wheels or discs which can be engaged to couple the shafts together so that the scales are moved simultaneously when one of the shafts is rotated.*” Following 8 claims, then the 10th is interesting: “*in which the graduations or markings are produced photographically*”.

Fig. 13 detail from the Dubilier patent

At last two calculators without patent protection, but sold the longest

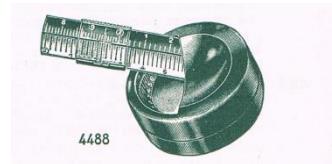
The Paisley Calculator



could be defined as a similar and typical (but simple) "predecessor" of the Film Slide Rule. The Cataloging information at the Smithsonian institution informs: "The slide rule contains two endless celluloid bands mounted in a bakelite case with clear plastic windows on both sides. Both of the bands are printed with identical logarithmic scales, spaced like those on a 20inch slide rule. The tapes revolve around a roller at either end. They are rotated using two knurled knobs, one for each tape. The tapes also can be locked together and rotated in unison. Lines drawn on the plastic windows serve as indicators – however, it is the bands, and not the indicator, that move.

Fig. 14 Paisley calculator

Wichmann Bandmaß (Measure band)



---"for calculation and measuring with two logarithmic scales (50cm scale length) on two steel-bands , with hair-line cursor. with two 70 cm – measuring scales on the reverse sides.

Fig. 15 Wichmann Reflex

Film-Bands or –Tapes, their mechanical realization and accuracy

Most above patents show, that the inventors did (and must) spend a lot of inspiration and experience to solve mechanically the following problems and requests for

- accuracy depending on temperature dilation of the bands velocity,
- to shorten time when winding or rewinding long scales to the right position on the corresponding scale
- avoid extension of film bands at the most often used areas of the scales (no slack)

They constructed paired cog wheels supporting the band in its perforated sides. The short distance of the cog wheel teeth restricted the extension of the film. They also took in consideration to use metal perforated bands.

One Question remains

- Why did so many inventors work out those types of calculating machines?

"The present invention contemplates a calculating machine of the slide rule type which, compared to general similar types heretofore proposed, can be operated faster and more accurately, is smaller in size for equal degrees of precision , and is simpler to operate and read..." (claims Donald B. Bradner in his US patent 2,454,987),

"And it was the use of tapes (films) for making calculations of various kinds, as "multiplication, division, raising a number to a given power, extracting roots, finding the natural sine or tangent of an angle, and also finding the logarithm of a given number" (claims R. Cooper in his US patent 7,86,102),

--- or "to solve proportions by the so called 'rule of three', which problems are frequently met with in the preparation of compounds or mixtures, such as in the dairy industry, ink-manufacture etc "
(claims E. Horner in his US patent 2,285,774),

And , last but not least (OS Journal Vol. 21 no. 1) *the war-secret trajectory calculating of George Stibitz' Film slide rule.*