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(19)

(54) SLIDE RULE COMPRISING A STOCK, A SLIDE AND A CURSOR

(71) We, IPROFIL "TEHNOLEMN" — INDUSTRIA PRODUSELOR FINITE DIN LEMN, an Independent Rumanian enterprise incorporated by virtue of Decree 199/1949 of Strada 7 Noembrie No. 3, Timisoara, Romania, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention concerns a slide rule comprising a stock, a slide and a cursor. Slide rules are becoming more and more used for calculations with a limited number of significant figures. The following facts have contributed to this effect; a) improvements in the structure of the rules, in the fineness, the precision and the reading of the scale divisions; b) equipping the rules with an increasing number of scales of wide range of application satisfying wide areas of the technical-engineering field; or else with special scales, providing rules applicable to certain technical fields and specialities, such as electrotechnics, chemistry, tele-communications, reinforced concrete structures, standard times, topography, printing, textiles, navigation, exchange, trade; c) equipping some calculating scales and the slide with an increased set of indices, or fixed marks, and symbols in letters, at small intervals, which facilitate performing certain calculations; and d) manufacture of rules of various sizes, namely, the common size of 250 mm scale length or, for designers, with scale length of 500 and even 1000 mm, these latter possessing increased precision, but being less easy to handle; small rules, designated as pocket rules, usually of a scale length of 125 mm, of lesser precision but more easy to handle. In general, the slide rules are provided with a millimetric scale on one side, frequently on a sloping side face of a trapezoidal section rule, for length measuring purposes.

In recent years, due to the latest improvements in the fineness and the precision of the scale division, pocket slide rule have been produced of only 100 mm scale length, being at the same time narrow and thin so that they can be carried easily. A typical slide rule is provided with a centimetric measuring scale, sub-divided in millimeters, and with eight calculating scales. These are the conventional logarithmic scales C and D, of X, on the slide and the stock respectively; the scales A and B of X^2, on stock and slide respectively; the reciprocal logarithmic red scale CI, of 10/X on the slide; scale S of sexagesimal trigonometric sines $\sphericalangle$ sin 0.01X and 0.1X; the scales L of the decimal logarithms mantissa log X and scales T of sexagesimal trigonometric tangents $\sphericalangle$ tan 0.1X. Another known slide rule, of length 100 mm, very flat, made of plastics, is provided with the same scales, of same location, having above this, on the upper face, the scale of X^3. Thus eqiupped, as far as their reduced dimensions permit it, the known pocket slide rules of 100 mm scale length offer only limited possibilities of calculation, without such calculations of a general character, as required by the whole field of technical engineering knowledge.

The present invention provides a rectilinear slide rule comprising a stock, a slide and a cursor the rule being of 100 mm or 1000 mm scale length and having a linear millimetric scale, logarithmic scales, and a reciprocal logarithmic scale and an exponential double logarithmic scale, in which the logarithmic scales are co-extensive with the linear millimetric scale so as to provide for the following calculations:

(a) with the combined use of a logarithmic scale and the linear millimetric scale — the determination of the mantissa of common logarithms and inversely,

(b) with the combined use of the reciprocal logarithmic scale (when set where its origin coincides with the value 1 of the basic logarithmic scales) and the linear millimetric scale — the determination of the mantissa of commonly co-logarithms and inversely, and

[*Price 25p*]

(c) exponential calculations, heretofore requiring a plurality of exponential scales, using only said exponential double logarithmic scale.

A preferred embodiment of a slide rule according to the invention of 100 mm scale length and of trapezoidal section is described below in connection with figures 1—5 representing:

Fig. 1 — a view of the upper face of the slide rule;

Fig. 2 — a view of the vertical side face of the slide rule.

Fig. 3 —a view of the underside of the slide of the slide rule.

Fig. 4 — a view of the face of the cursor with a semi-cylindrical lens extended to cover the inclined side face.

Fig. 5 — a side view of the cursor.

The slide rule in the example given is composed of stock SA, slide SB and cursor SC. It is of trapezoidal cross section, of pear tree wood radially cut to length, plated on both faces and on the sides with milk-white color celluloid sheets.

As shown in fig. 1, the following scales are provided:

— a millimetric scale, divided in millimeters and half-millimeters on the inclined side of the rule. The origin of the scale is colinear with the origin of the other calculation scales. The millimetric scale is provided for measuring lengths and as a calculating scale for logarithms of X and cologarithms of X (that is, logarithms of 1/X) "X" being set on the D or CI scales in a manner described below (see "examples"),

— a scale A of X^2 of the numbers X set on a basic scale D on the stock,

— a scale B of X^2 of the numbers X set on a scale C of the slide,

— a scale CI on the slide of 10/X in red, of the number X set on the scale C of the slide,

— a scale C of X on the slide,

— a scale D of X on the stock,

—on the vertical side face (see fig. 2) a Pythagorean P scale $\sqrt{1-X^2}$

The underside of the slide (see fig. 3,) bears:

— a scale S of sexagesimal trigonometric sines ∢ sin 0.1 X, providing as well the values for cosines;

— an exponential double logarithmic LL3 scale of e^x, (as referred to in claim 1), the origin being at e, divided from 2.718 and up to 22,000;

— a scale T of sexagesimal trigonometric tangents ∢ tan 0.1 X providing as well the values for contangents.

The rule is provided with the following indices:

π, as 3.14; C as $\sqrt{4/\pi}=1.128$ on scale C, and e as 2.718 at the origin of scale LL_3.

The cursor of the rule, which can be a known cursor as shown in Fig. 1, but is preferably as shown in Figs. 4 and 5, consists of a plate 1, of a transparent thermo-plastics, on which a hair line SD is traced. The lower edge of the plate is twice folded at right angles, to achieve a link *a* which will glide inside the lower groove of the stock SA while the upper edge of the plate is twice folded, once to provide a surface corresponding to the surface of the millimetric scale and once to provide a surface extending away from the rule thus constituting a narrow prolongation strip *b* on which the hair line SD is continued, thus permitting reading the mantissae of X as set on the millimetric scale divisions.

Inside the cursor, at its upper part, a double bow metal spring 2, of steel strip, has its middle fixed to the cursor by means of a rivet 3. The spring has dimensions adequate for gliding within the upper groove in the stock SA. The cursor may also be provided with a semi-cylindrical magnifying lens 4 and/or a separate magnifying lens 5 on the prolongation strip *b*.

With the help of the known scales and indices of the rule mentioned in the above example, usual calculations may be carried out.

The rule equally allows for numerous further calculations to be performed, as shown in the examples which follow:

Examples

1) To find the mantissa of log 235, the cursor hair line marks the division 235 on the basic scale D, and the same hair line indicates on the upper millimetric scale, the figure 371; thus log 235=2.371.

2) Inversely, to find the number X corresponding to the decimal logarithm $\bar{4}.512$, the mantissa 512 is marked by the cursor hair line on the millimetric scale, while on the basic scale D, the same hair line marks 325; consequently X=0.000325.

3) To find the mantissa of colog 235, the slide is brought to the position, where its origin coincides with that of the rule; the cursor hair line then marks the division 235 on the CI scale and the same hair line indicates the maintissa on the upper millimetric scale: 629; thus, colog. 235 is $\bar{3}.629$. Inversely, marking the cologarithm mantissa on the millimetric scale, one may find directly the corresponding number on the reciprocal basic scale CI.

4) To raise to a higher power a number inferior to e=2.718, by means of scale LL_3, the procedure is as follows: Let us calculate, for instance, $1.45^{2.82}$. As the figure 1.45 does not appear on the exponential scale LL_3 the given number X will be multiplied and divided by an integer *n*, raised to the respective power, and chosen, so as n>2.718. To simplify, let us take for this case, n=10. We may then write:

$$1.45^{2.82}=\frac{(10\times1.45)^{2.82}}{10^{2.82}}=\frac{14.5^{2.82}}{10^{2.82}}=\frac{1875}{658}=2.85$$

the numerator and the denominator being calculated by means of the exponential scale LL_3 and the basic scales C and D of the slide and the rule.

For the numerator: the slide is pushed in, turned so as to have the exponential scale LL_3 on the rule face, and the origin division 1 of the basic scale D is marked by means of the cursor hair line. The slide is then shifted left, so that the figure 14.5 on the scale LL_3 should be at the level of the origin division 1 of the basic scale D. The cursor is shifted right, marking with the hair line, the number 2.82 on the basic scale D, and the figure corresponding to the denominator 1875, is read at the cursor hair line on the exponential scale LL_3.

The division 1875: 658 is then performed by means of the basic scales C and D, the final result being 2.85.

Instead of multiplying by 10 at the given power, any convenient integer may be chosen. For the case $1.15^{2.35}$ we may choose, for instance, "3" and write:

$$1.15^{2.35}=\frac{(3\times1.15)^{2.35}}{3^{2.35}}=\frac{3.45^{2.35}}{3^{2.35}}=\frac{18.35}{13.2}=1.39$$

Acting as above, and using the exponential scale LL_3 and the basic scale D, we find 18.35 : 13.2, which with the help of the basic scales C and D gives the result 1.39.

By this mode of calculation, the exponential e^x scale LL_3 replaces efficiently the scale of cubes X^3 as well as the exponential scales LL_2, LL_1 and LL_0, the function of $e^{0.1x}$ assuming values ranging from 1.1 to 3; $e^{0.01x}$ ranging from 1.01 to 1.11 and $e^{0.0001x}$ ranging from 1.001 to 1.01.

Moreover, the exponential scale LL_3 permits, in the same manner, to raise a number to a negative power. Thus, in order to perform the operation

$$3^{-2.35}=\frac{1}{3^{2.35}};$$

we may write directly, according to what we said above

$$\frac{1}{13.2},$$

and get by division result 0.757.

Similarly

$$1.15^{-2.35}=\frac{3^{2.35}}{3.45^{2.35}}=\frac{13.2}{18.35}=0.720$$

The scale LL_3 may thus equally replace the scales LL_{03}, LL_{02}, LL_{01} and LL_{00}, exponential e^{-x}: $e^{-0.1x}$: $e^{-0.0x}$: and $e^{-0.001x}$: of the known slide rules.

With the calculating possibilities described by way of example above, a pocket slide rule of only 100 mm divided length permits a wide range of operations.

A slide rule illustrated in the figures shows the advantage that it provides additional possibilities of calculation, even with scale lengths as short as 100 mm, the slide rule being able to perform the following operations: multiplication, division, squaring, extraction of square root, obtaining the reciprocal values of the numbers and of their squares, of decimal logarithms and cologarithms and reversely, of the Pythagorean value $\sqrt{1-X^2}$, of the trigonometric functions sin (cos), tan (cotan), as well as of the sexagesimal and centisimal arcs of circle, direct solution of triangles, solution of equations of the 2nd degree, natural logarithms of numbers and reverse, raising a number to an arbitrary power and extraction of the root of an arbitrary degree, forming of exponential proportions; thus, it can solve a range of operations, comparable to that of known slide rules of larger lengths and provided with more scales.

WHAT WE CLAIM IS:—

1. A rectilinear slide rule comprising a stock, a slide and a cursor, the rule being of 100 mm or 1000 mm scale length and having a linear millimetric scale, logarithmic scales, and a reciprocal logarithmic scale and an exponential double logarithmic scale, in which the logarithmic scales are co-extensive with the linear millimetric scale so as to provided for the following calculations:

(a) with the combined use of a logarithmic scale and the linear millimetric scale — the determination of the mantissa of common logarithms and inversely,

(b) with the combined use of the reciprocal logarithmic scale (when set where its origin coincides with the value 1 of the basic logarithmic scales) and the linear millimetric scale — the determination of the mantissa of common co-logarithms and inversely, and

(c) exponential calculations, heretofore requiring a plurality of exponential scales, using only said exponential double logarithmic scale.

2. A slide rule according to claim 1 characterised in that the millimetric scale is subdivided in half millimetres.

3. A slide rule according to claim 1 or 2 characterised in that, in order to increase the reading precision, the cursor is provided with a semi-cylindrical magnifying lens for the hair line and the hair line is prolonged down to the small divisions of the millimetric scale.

4. A slide rule according to claim 3, characterised in that it is of trapezoid section and, with the millimetric scale on the inclined side of the trapezoid for the purpose of simplifying and increasing the precision of cursor hair line tracing, it has the cursor made of a single plate of transparent thermoplastic material, a first edge of the plate being folded twice in order to engage one groove in the stock, remote from the side with the millimetre scale, and a second edge being also folded twice, once to provide a surface corresponding to the surface of the millimetric scale and once to provide a surface extending away from the rule, the guiding of the cursor at the second edge being ensured by a double spring fixed by its middle to the cursor, the spring moving to and fro in a second groove in the stock.

5. A slide rule substantially as hereinbefore described with reference to the accompanying drawings.

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1311574 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

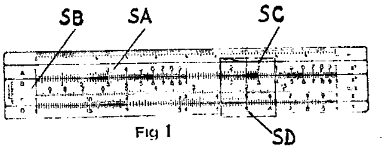

Fig 1

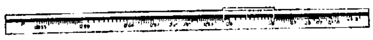

Fig. 2

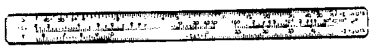

Fig 3

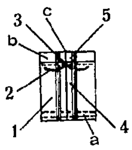

Fig. 4

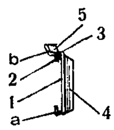

Fig. 5