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(19)

(54) A RECTILINEAR SLIDE RULE FOR CALCULATING πX AND πX^2

(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:—

This invention relates to rectilinear slide rules having a stock, a slide and a cursor, and the invention provides such a slide rule having increased usefulness.

The rectilinear slide according to the invention has a stock, a slide and a cursor with a hair line, a basic logarithmic scale marked X, a square scale marked X^2, having the value 1 permanently aligned with the value 1 on said basic logarithmic scale, and a square scale marked πX^2 having the value of π permanently aligned with the value 1 on the basic logarithmic scale, so that, with the hair line of the cursor set at a number X on the scale marked X^2, the hair line indicates the value of the expression πX on the scale marked πX^2 and so that, with the hair line of the cursor set at a number X on the scale marked X, the hair line indicates the value πX^2 on the scale marked πX^2.

The invention will now be further described with reference to the accompanying drawing in which:—

Fig. 1 is a plan view of a slide rule according to the invention;

Fig. 2 is a front elevation; and

Fig. 3 is an underside view.

The slide rule has a stock SA, a slide SB, and a cursor SC.

The stock has a trapezoidal section and is of known construction. The surfaces of the slide rule are veneered with milk-white celluloid on its faces and borders.

On the face of the rule shown in fig. 1 are placed the scales numbered and marked as follows:

1. A millimeter scale on the sloping side of the stock for linear measurements,
2. a scale P of the Pythagorean values $\sqrt{1-X^2}$ on the stock,
3. a scale K of cubic values X^3 on the stock,
4. a scale A of the square values X^2 on the stock,
5. a scale B of the square values X^2 on the slide,
6. a scale BF marked as πX^2 and having the value π permanently aligned with the origin of the scales of X and X^2. This scale is at the left end of the slide. It starts at π and terminates at the value 36, thus leaving free a space for Scale 7.
7. a double scale IC with the centesimal triginometric indexes on the right end of the slide with a black section sin/cos and a red inverse section tan/cotan,
8. a red inverse reciprocal scale CI for values 10/X on the slide,
9. a basic scale C of values X for the slide,
10. a basic scale D of values X on the stock,
11. an exponential scale LL_3 of values e^X on the stock, with the origin e, the scale starting at 2.5 and terminating at 100 000,
12. an exponential scale LL_2 of values $e^{0.1X}$ on the stock, the scale starting at 1.1 and terminating at 3.2,
13. an exponential scale LL_1 of values $e^{0.01X}$ on the stock, the scale starting at 1.01 and terminating at 1.12.

In the groove of the stock are:

14. a double coloured scale of efficiences, the black left hand end being marked "DINAM" for the efficiency of electric dynamos divided from $\eta=20\%$ to 100% and on the right hand end the red inverse section marked "ELMOT", for the efficiency of electric motors divided from $\eta=100\%$ to 20%,
15. a scale ΔU of voltage drops, divided from 0.5 to 10V.

On the vertical edge of the stock, as shown in Fig. 2, are:

[*Price 25p*]

16. a scale L of the mantissas of the common logarithms of the numbers log X,
17. a scale R for reducing with the ratio 1:2.5.

On the back of the slide, shown in fig. 3 are the following scales:

18. a scale S of the sexagesimal trigonometrical sines/cosines∢sin 0.1X/cos 0.1X for large angles,
19. a scale ST of the sines, tangents and arcs 0.01X for small angles.
20. a scale T of the sexagesimal trigonometrical tangents/cotangents∢tan 0.1X/cotan 0.1X for large angles.

The slide rule is provided with the following indexes, notations and marks: the new indexes W_p and W_z

—an index C, having the mark on the basic scale C of the slide at the value

$$\sqrt{4/\pi}=1.1284,$$

—an index C_1, having the mark on the basic scale C of the slide at the value

$$\sqrt{40/\pi}=3.5683,$$

—respective indexes 0°, 0', 0'', 0^g on the slide scale C with the marks at the radian value of the angle 1, at the values:

$$180/\pi=57.32;$$

$$180\times 60/\pi=3437.7;$$

$$180\times 60\times 60/\pi=206,264.81$$

and

$$200/\pi=63.694;$$

an index W_p on the scale C of the slide, having as basis the relation $W_p=\pi$, $d^3/16=(d/1.72)^3$ with the mark at the value 1.72, serving to fix the diameter of the full sections on the basic scale D, for straight reading of the polar resistance modulus W_p on the scale K of the cubic values against the origin division 1 of the scale B and vice-versa;

—an index W_z on the scale C of the slide, having as a basis the relation

$$W_z-\pi d^3 32=(d/2.17)^3,$$

with the mark at the value 2.17; serving to fix the diameters of full circular sections on the basic scale D, in order to read directly the axial resistance modulus for bending W_z on the scale K of the cubic values at the origin division 1 of the scale B and vice-versa;

—an index L on the scale C of the slider with the mark at the value of 2.303;

—one index π on each of the scales A, B, BF, C, CI and D marked at the value 3.1416;

—an index Cu marked black on the scale A of the body, having as a basis the relation $R=Q_{cu}\times 1/A$ and marked at the value 1.785, for calculating the electrical resistance of copper conductors with full circular section.

—an index cu, marked red on the scale A of the body, having as a basis the relation $G=\gamma_{cu}\times 1\times A$ the mark being at the value 11.22, for calculating the weight of copper conductors with full circular section;

—an index each, marked and noted at the value 736 on the scales A and B, representing the ratio of the power units h.p./kW=0.736;

—an index M on the B scale of the slide, with the mark the value $100/\pi=31.831$;

—an index marked and noted at the value 28.7 on the scale A of the body, representing half of the conductivity of copper;

—a mark at each of the ends of the scales A and B, having as a basis the relation $\pi/4=0.785$, marked at the value 78.5.

—two indexes e at the values 2.7183, marked near the origin of the exponential scale LL_3 and at the end of the exponential scale LL_2;

—an index q on the cursor, with a short hair-line against the scale A on the stock, marked on the left of the major hair line of the cursor at the distance $\sqrt{4/\pi}=1.1284$, corresponding to the scale of the square values;

—two indexes kW on the cursor, the first on the major hair line for fixing on the scale A of the body, the other one on the left of the hair line with a short hair-line for the scale D on the stock;

—two indexes CP on the cursor on the right of the hair line, the first with a short hair-line for the scale A on the stock, and the second for the scale D, both short hair-lines being situated at the distances h.p./0.736—1,35964 corresponding to the respective scales A and D, considered from the indexes kW of the cursor obtained at the same level; further, the hair-line for the index h.p. at the level of the scale D is marked on the right side of the hair line of the cursor at the same linear distance as the mark of the index q on the left side of the hair line of the cursor;

—an index SEXA on the cursor, on the left side of the cursor's hair line, having a short hair-line at the same level of the scale D on the stock, marked at the distance log $10-\log 9=0.04576$ corresponding to the scale D;

—an index CENTE on the hair line of the cursor, reading at the level of the scale D;

—an index d on the hair-line of the cursor, reading at the level of the scale D on the stock.

On the back side of the body, a table SD is pasted bearing data and engineering-technical constants.

With the known scales and marks of the slide-rule given as example, known calculations can be made.

The scale BF and the indexes W_z and W_p afford many new possibilities of calculation as it may be seen in the following examples.

1. In order to find out the perimeter of a circle with the diameter $d=1.4$, the hair-line of the cursor is to be fixed on the division of the scale of squares B of the slide, and at the same hair-line beneath, at the scale BF, the perimeter 4.398 may be read, without any calculations or displacing anew of the cursor or the slide.

2. In order to find out the diameter of a circle with the perimeter $p=6.6$ the hair-line of the cursor is to be fixed on the division 6.6 on the scale BF, and the diameter 2.108 may be read directly at the same hair-line on the scale B of the squares of the slide.

3. In order to find out the value of πd^2, when $d=12$, the hair-line of the cursor is fixed on the basic scale C of the slider at the division 12, and at the same hair-line, on the scale BF the result 452.4 may be read, without any calculation or displacement of the slider.

In order to find out the value of the same relation when the diameter is greater than 3.16; 31.6; 316 etc. for example when d=3.5, the slide is displaced to the right, bringing the origin division 1 of the scale B of the slider upon the division 10 of the scale A of the body; then, with the hair-line of the cursor the diameter 3.5 is fixed on the basic scale D of the body and the result 38.48 is to be read directly on the scale BF without any calculation.

4. Many values for quantities expressed in units in the composition of which are the time-second, the sexagesimal degree-second, the day approximated as the 360th part of a year can be converted in a simple way into values in such units as hours, sexagesimal degree, years and vice-versa. The same counts for other conversions, in which the ratio 1:36 or its inverse appears, which are frequent in physics and technical subjects. For such transformations the slider is to be moved to the left, bringing the end division 36 of the BF scale against the division 10 of the scale A of the squares on the stock; the given values and the looked for ones are face-to-face on these scales. In this way, the results are obtained without any calculations, only by moving the cursor.

Some examples are given:

In order to transform 0.25 kWh into Joules, the hair line of the cursor is fixed on the scale A of the squares at the division 25, and below it on the scale BF, at the same hair-line the division 9 is directly read; the result is 900,000 Joule.

To transform 5.2° into sexagesimal seconds, the hair-line of the cursor is fixed on the scale A on the stock at the division 5.2, and beneath, on the scale BF of the slide, at the same hair-line, the division 1872 is directly read; the result is 18,720″.

To express 1.5 hours in seconds, the air-line of the cursor is to be fixed on the scale A on the stock at the division 1.5 and beneath, on the scale BF of the slider at the same hair-line, the division 5.4 is directly read; the result is 5400 seconds.

In order to express 21 days in years, the hair-line of the cursor is to be fixed on the scale BF of the slider at the division 21, and above, on the scale A on the stock, at the same hair-line, 583 is to be directly read, the result being 0.0583 year.

5. In order to find out how many ohms is the inductive reactance of an electric alternating current circuit with the frequency of 50 Hz and an inductance of 16 mH, the hair-line of the cursor is fixed on the scale B at the division 1.6 and beneath, on the scale BF, with the same hair-line the result 5Ω is read, without any caluculation, arranging or moving of the slide.

6. To find out how many ohms is the capacitive reactance of an alternating current with a frequency of 50 Hz, having a capacitance of 1.15μF, the hair-line of the cursor is fixed on the basic inverse red scale CI of the slide at the division 1.15 and beneath, on the basic scale C of the slide, an intermediate value 8.7 is read; moving the cursor to the left, the division 8.7 is to be fixed with the hair-line on the scale BF, and directly above, at the hair-line on the scale B of the squares of the slide the value 277 is read; the result is 0.0000277.

7. A way to resolve the former example 6 in the particular case when the frequency is different from the usual one of 50 cycles per second is as follows: In order to find out how many ohms is the capacitive reactance of an alternating current with the frequency 60 Hz having a capacitance of 1.15μF, the hair-line of the cursor is to be fixed on the basic red inverse scale C1 of the slide at the division 1.15; beneath, on the basic scale C of the slide, an intermediate value 8.7 is read at the hair-line; moving the cursor to the left, on the scale A on the stock the division 120 is fixed, representing the double frequency in Hz; the slide is then pushed to the left, bringing the division 8.7 of the scale BF to the hair-line, and at the beginning of the division, 1, of the squares-scale A, on the scale B of the slide, the value 231 is read; the result being 0.0000231.

8. In order to find out the resonant frequency of an alternating electric current circuit containing an inductance of 200 mH and a capacitance of 380μF, the proceeding is as follows:

On the scale A on the stock is fixed, at the division 380 representing the value of the capacitance, the origin division 1 of the scale of squares B of the slide, then, the hair-line of the slide is fixed on the division 200 representing the value of the inductance of the scale B; then, moving the slide to the left, the division 2 of the basic red inverse scale CI is brought to the hair-line of the cursor. At the origin division 1 of the basic scale C of the slide the intermediate value 174 is read on the basic scale D on the stock, which is being fixed with the hair-line of the cursor; moving the slide to the left, that intermediate value 174 on the BF scale is brought to the hair-line, and in line with the origin division 1 of the scale A, on the scale of the squares B of the slide the final result of 18.25 cycles per second is read, which is the resonant frequency looked for.

9. In order to find out the axial modulus of resistance to bending W_z of a driving shaft with full circular section having a diameter of $d=5$ cm, the index W_z of the basic scale C is placed on the division 5 of the basic scale D of the body; then the cursor is brought with its hair-line on the origin division 1 of the slide, the above, on the scale of the cubes K the result 12.27 cm^3 is read at the hair-line.

10. In order to find out the necessary diameter of the circular full section corresponding to the known axial modulus of resistance to bending $W_z=12.27$ cm^3, the hair-line of the cursor is fixed on the scale of the cubes K at the division 1227, after what the origin division 1 of the slide is brought to the hair-line, and, on the basic scale D of the body, at the index W_z the looked for result $d=5$ cm is read.

11. In order to find out the polar resistance modulus W_p of a shaft with a full circular section having a diameter of $d=3$ cm, the division 3 of the basic scale C of the slide; then the hair-line of the cursor is brought on the origin division 1 of the slide, and above, on the scale K of the cubes, the result 5.3 cm^3 is read on the hair-line.

12. In order to find out the necessary diameter for the circular full section corresponding to the known polar resistance modulus $W_p=5.3$ cm^3, the division 5.3 is to be fixed on the scale K of the cubes, with the hair-line of the cursor; then the origin divisional of the slide is brought to the hair-line, and on the basic scale D on the stock, at the index W_p the looked for result $d=3$ cm is read.

The slide rule for general purposes, provided with the new scale BF and with the new indexes W_p and W_z, offers the following advantages of increased efficiency of utilization:

—The scale BF complete, or limited to the value of 36, simplifies in a substantial way the calculations involving π, a constant outstandingly frequent in physics, mechanics, machine construction and electrotechnology. The scale allows one to find out easily the perimeter of the circle for a known diameter and vice-versa; simplifies the resolving of relations of the form πd^2; equally the calculation of the inductive and capacitive reactance, calculation of the resonant frequency of alternating electric circuits, as well as a great number of transformations and conversions frequent in science and technology.

—The indexes W_z and W_p on the basic scale of the slide are useful for calculations of the resistance of materials, obtaining directly and easily the axial and the polar resistance moduli of the full, circular sections for any given diameter and vice-versa. The indexes are also useful to obtain the diameter when one of these moduli is given. These new indexes are also useful for calculating sizes when designing many kinds of machines or reinforced concrete with round sections, as well as to check design calculations in these fields.

The slide-rule described above brings also a number of other advantages. Thus, placing the exponential scales for e^x, $e^{0.1x}$ and $e^{0.01x}$ upon the upper face of the slide rule, precise locating and reading are obtained, by means of the semicylindrical magnifying glass of the cursor. This allows easy extraction of roots of superior, entire, digital or fractional order, respectively raising to a power entire, digital or fractional order either positive or negative, by simple direct and precise reading of the result. Also, many intricate calculations can be made using the exponential scales combined with the rest of the scales of the slide rule, placed on the upper face, in order to reduce the great volume of calculations frequent in the field of electrotechnology, chemistry and nuclear physics. The indexes CENTE and SEXA on the cursor allow direct reading in centesimal degrees of any angle shown in sexagesimal degrees and vice-versa without calculations.

WHAT WE CLAIM IS:—

1. A rectilinear slide rule having a stock, a slide, a cursor with a hair line, a basic logarithmic scale marked X, a square scale marked X^2, having the value 1 permanently aligned with the value 1 on said basic logarithmic scale, and a square scale marked πX^2 having the value of π permanently aligned with the value 1 on the basic logarithmic scale so that, with the hair line of the cursor set at a number X on the scale marked X^2, the hair line indicates the value of the expression πX on the scale marked πX^2 and so that, with the hair line of the cursor set at a number X on the scale marked X, the hair line indicates the value πX^2 on the scale marked πX^2.

2. A slide rule as claimed in claim 1 wherein said scales of X, X^2 and πX^2 are provided on the slide.

3. A slide rule as claimed in claim 1 wherein the scale marked as πX^2 is confined in length to commence at π and terminate at a value above but close to 31.4, such as 36.

4. A slide rule as claimed in claim 3 having a further scale co-linear with the scale marked as πX^2.

5. A slide rule as claimed in claim 4 in which said further scale is the scale of centesimal trigonometrical indexes.

6. A slide rule as claimed in claim 1 having an index (Wz) marked on the basic logarithmic scale of X at the value X=2.17 to set the diameters of full circular sections of beams for direct reading, on a scale of X^3, the axial resistance modulus for bending of the beams.

7. A slide rule as claimed in claim 1 having an index (Wp) marked on the basic scale of X at the value X=1.72 to set the diameters of full circular sections of beams for direct reading, on a scale of X^3, the polar resistance modulus for the beams.

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

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1326655 COMPLETE SPECIFICATION

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

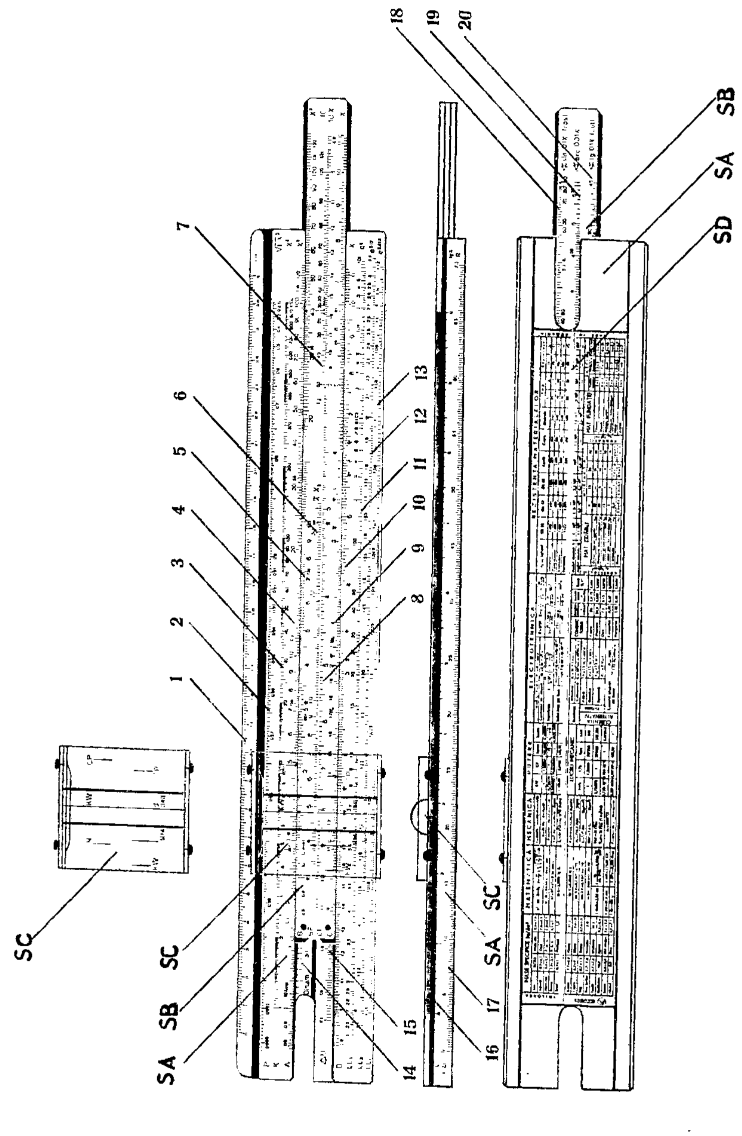

Fig.1

Fig.2

Fig.3