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(54) **SLIDE RULE**

(54) **REGLE A CALCULER**

(57) **Abstract:**

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This invention relates to calculating devices of the slide rule type.

In the manufacture of paper, the calculation of various physical characteristics of the roll of paper produced or to be produced is a constant requirement and, particularly in mills producing papers of a wide variety of grades and weights, is a tedious and time-consuming operation.

Heretofore, such characteristics have been arrived at (a), and more usually, by estimate, which is rather inaccurate, or (b) by solving the following equation,-

$$\text{Roll weight (lbs.)} = \frac{\pi\, wB\left(\frac{D^2}{4} - \frac{d^2}{4}\right)}{432000\ C}$$

where = 3,1415
w = Roll width (inches)
B = Basis weight (weight in lbs. of 500 sheets size 24" x 36")
D = Roll diameter (inches)
d = Outside core diameter (inches)
C = Caliper (thickness of the paper in inches)

It is an object of this invention to provide a slide rule having two relatively fixed scales and at least three sliding scales and being adapted to calculate quickly and accurately required data.

It is a more specific object to provide means for accurately calculating physical characteristics of paper rolls in a much shorter period of time than has heretofore been possible.

The invention will be described with reference to the accompanying drawing, in which

Figure 1 is a plan view of a portion of a slide rule in accordance with the invention,

Figure 2 is a plan view of the remaining portion of such slide rule, and

Figure 3 is a sectional elevation of the slide rule.

The right and left hand portions of the rule illustrated respectively in Figures 1 and 2 have been separated to permit illustration on a larger scale for the sake of clarity and it will be understood that they constitute portions of a single rule.

In the drawing, the rule comprises relatively fixed parallel side bars 1 and 2 mounted on and preferably integral with the base member 3. Intermediate the side bars are two parallel slides 4 and 5. Slide 4 has a longitudinal groove 6 in one edge to receive a tongue 7 on the adjoining edge of bar 1 and a longitudinal groove 8 on its other edge to receive a tongue 9 on a fixed longitudinally extending center track 10 carried by base 3. Slide 5 has a longitudinal groove 11 in one edge to receive a tongue 12 on the track 10 and a longitudinal groove 13 in its other edge to receive a tongue 14 on the adjoining edge of bar 2. It will be observed that the upper adjacent edge portions overlap the center track 10 to place such portions in substantially meeting relationship. A cursor 15 of usual type and having a cross hair 16 is slidingly mounted on the rule as shown.

The arrangement of scales on the rule will now be described with particular reference to calculation of paper roll characteristics.

Scale A is preferably applied to bar 2 and comprises a logarithmic scale indicative of basis weight. The zero point on the scale has been fixed at "10", i.e., log 10 is presumed to be "zero". There is no maximum limit to the range of the scale but, for practical purposes, the maximum point of "600" has been chosen. Thus, the total scale consists of less than two logarithmic cycles..

A scale B is applied to slide 5 in adjacent relationship to scale A on bar 2 and comprises a logarithmic scale indicative of caliper. The zero point on the scale is indicated at ".1", i.e. log. .1 is presumed to be "zero". The figures shown represent $\frac{1}{1000}$ of an inch, so that .1 represents .0001 inch. Any convenient maximum point may be employed for the scale but, for practical purposes, the point "80" has been chosen. Thus, the total scale consists of less than three logarithmic cycles.

A scale C is also applied to slide 5 on its opposite side adjacent slide 4. Scale C is a logarithmic scale indicative of roll diameter. Its zero point is placed at "1" whereby log 1 = 0. The figures for roll diameters shown on this scale do not correspond to the logarithms, but are obtained from the formula

$$D = 2\sqrt{s+4}$$

where D represents roll diameter in inches, and s represents the numeral belonging to the scaler logarithm. The various points on the scale are therefore obtained as follows:

Zero point - $s = 1$

$D = 2\sqrt{5}$ or 4.472 approximately

$D = 5$ at $s = \frac{D^2}{4} - 4 = 2.25$

$D = 6$ at $= 5.00$

$D = 7$ at $= 8.25$

etc.

The scale may have any convenient maximum point. For practical purposes, in the scale shown a roll diameter of 50 inches has been taken as the maximum which may occur. Thus:

$$D = 50 \text{ at } s = \frac{D^2}{4} - 4 = 621.$$

The scale therefore consists of three logarithmic cycles, as shown.

A scale D is applied to slide 4. It is a logarithmic scale indicative of roll width and having its zero point fixed at "6", i.e., log 6 is presumed to be "zero". The figures shown represent inches. Any desired maximum point may be set but, as shown, a roll of 300" width has been taken as a maximum. There are three logarithmic cycles in the scale as will be observed.

A scale E, indicative of roll weight, is applied to bar 1. This is a logarithmic scale having a "zero" point obtained from the roll weight formula:

$$Wt. = \frac{\pi wB\left(\frac{D^2}{4} - \frac{d^2}{4}\right)}{432000C}$$

The rule is based on the use of a standard core, i.e., one having an outside diameter of 4 inches, and the following zero point is obtained when the rule is closed, that is, when all previously indicated indices are in correspondence:

π = 3.1415

w = roll width = 6

B = basis weight = 10

D = roll diameter = $2\sqrt{5}$

C = caliper = .0001

Solving this equation, there is obtained:

Wt. = 1.388π

= 4.364 lbs.(approximately)

The index is therefore chosen in such manner that log. 4.364 coincides with the index. For practical purposes, a roll weighing 3500 lbs. has been taken as a maximum in the scale shown. There are therefore four logarithmic cycles involved in the scale.

If desired, a supplementary scale F may be provided and, as shown, is conveniently applied to the right hand end portion of slide 4, such portion, in the slide rule shown, being otherwise free of scale markings. Such a scale could be alternatively applied to the reverse side of the slide. Scale F represents calipers in 1/1000 inch and is therefore identical with scale B, except that the three logarithmic cycles have been superimposed. The index is situated at $\frac{\pi}{12}$ = .2618 (approximately), for the indication of the roll length in feet.

The rule, as described, may be employed:

1. To calculate roll weight or roll length when basis weight, caliper, roll diameter and roll width are known.

2. To calculate roll width when basis weight and caliper are known and roll weight (or roll length) and roll diameter are specified.

3. To calculate roll diameter when basis weight and caliper are known and roll weight (or roll length) and roll width are specified.

4. To calculate caliper when basis weight, roll diameter, roll width, roll weight (or roll length) are known.

5. To calculate basis weight when caliper, roll diameter, roll width, roll weight (or roll length) are known.

To illustrate the manner of employing the rule, the following examples are given:

EXAMPLE I

To convert to weight of paper an order for a number of rolls of specified dimensions.

Known characteristics,-

Basis weight - 36 lbs.
Caliper - - 2.9/1000 inch
Roll diameter - 21 inches
Roll width - 82 inches
No. of rolls - 100

Procedure

Opposite 36 (scale A) set 2.9 (scale B)
Opposite 21 (scale C) set index of scale D
Opposite 82 (scale D) read roll weight (scale E) = 788 lbs.
Therefore, 100 x 788 = 78,800 lbs.

EXAMPLE II

To adjust specifications when an order specifies both roll weight and dimensions.

Known characteristics,-

Basis weight - 36 lbs.
Caliper -2.9/1000 inch.
Roll diameter - 21 inches
Roll width - 82 inches
Roll weight - not to exceed 500 lbs.

Procedure

First as above, and it is found that roll weight = 788 lbs. Therefore, in order not to exceed weight limit of 500 lbs. the roll diameter must be lessened.

Opposite 36 (scale A) set 2.9 (scale B)
Opposite 500 (scale E) set 82 (scale D)
Opposite index of scale D read required roll diameter on Scale C = 17 inches

EXAMPLE III

To convert an order given in tons to a number of rolls of specified dimensions.

Known characteristics,-

Basis weight - 45 lbs.
Caliper - 3.75/1000 inch
Roll diameter - 24 inches
Roll width - 72 inches
Total order - 60 tons

Procedure

Opposite 45 (scale A) set 3.75 (scale B)
Opposite 24 (scale C) set index of scale D
Opposite 72 (scale D) read on scale E = 882 lbs.

Number of rolls required =

$$\frac{60 \times 2000}{882} = 136 \text{ rolls}$$

EXAMPLE IV

To rewind machine rolls to different diameters of specified weight,-

Known characteristics,-

Basis weight	- 16 lbs.
Caliper	- 1.5/1000 inch
Roll weight	- 200 lbs.
Roll width	- 36 inches

Procedure

Opposite 16 (scale A) set 1.5 (scale B)
Opposite 200 (scale E) set 36 (scale D)
Opposite index (scale D) read on scale C,
roll diameter = 17.5 inches

As indicated above, the rule as described is based upon use of a core having an outside diameter of 4 inches, since this is the most common diameter of core employed. However, the rule may be employed to ascertain characteristics of rolls having cores of larger diameters. Thus, to obtain the weight of a roll having a core diameter of x inches, the procedure is as follows,-

1. Find the roll weight of a roll with a 4" core.
2. Find the roll weight of a roll of x" diameter with a 4" core.
3. Subtract (2) from (1), and the result will be the required weight.

Roll weights when employing cores below four inches diameter cannot be found with the procedure outlined above; however, it will be appreciated that the additional paper obtained by winding on a 3-inch core instead of on a 4-inch core may be disregarded as having negligible influence on the final result.

EXAMPLE V

To find the roll weight for a roll having a core with an outside diameter of 7".

Known characteristics,-

Basis weight	- 160 lbs.
Caliper	- 15/1000 inch
Roll diameter	- 22 inches
Core diameter	- 7 inches
Roll width	- 80 inches

Procedure

Opposite 160 (scale A) set 15 (scale B)
Opposite 22 (scale C) set index scale D
Opposite 80 (scale D) read weight on scale E = 727 lbs.

Now, leaving the initial setting (A-B):

Opposite 7 (scale C) set index scale D
Opposite 80 (scale D) read weight on scale E = 50.5 lbs.
Subtracting 50.5 from 727, there is obtained 676.5 lbs. as the required roll weight.

Scale F is employed when it is desired to find the length of paper wound on a roll. The procedure is as follows,-

Opposite roll diameter (scale C) set caliper (scale F)
Opposite index of scale F read figure on scale B (caliper scale)
Multiply this figure:
- by 10,000 if the original caliper lies between .1 and 1
- by 1,000 if the original caliper lies between 1 and 10
- by 100 if the original caliper lies between 10 and 100.

For calipers having a value of exactly 1 or 10, it does not matter whether they be chosen as lying at the end of one scale or at the beginning of the one above, as long as the figure found opposite the index is multiplied by the appropriate factor belonging to the scale.

EXAMPLE VI

To find the length of paper of caliper 2.3 wound on a roll having a diameter of 32".

Opposite 32 (scale C) set 2.3 (scale F)
Opposite index (scale F) read 28.8 on scale B
Multiply 28.8 by 1000 (caliper between 1 and 10) thus obtaining 28,800 feet as the length of paper wound on the roll.

EXAMPLE VII

To find the length of paper of caliper 1.0 wound on a roll having a diameter of 12".

Opposite 12 (scale C) set 1.0 (scale F, bottom scale)
Opposite index (scale F) read .845 on scale B
Multiply .845 by 10,000 (caliper between .1 and 1), thus obtaining 8450 feet.

If the caliper 1.0 had been chosen on the center scale of scale F, the reading (on scale B) opposite the index on scale F would have been 8.45 which multiplied by 1000 (caliper between 1 and 10) yields the same result as before, namely, 8.450 feet.

The slide rule described makes possible the accurate calculation of data in a very much shorter time than was heretofore possible. For instance, the average time taken for solving the roll weight equation set forth above is 12 minutes for a clerk of average ability; the same clerk would take between 20 and 30 seconds to work out the same problem by aid of the rule. The saving in time can, therefore, be estimated as 11.5/12.0, i.e. 96% approximately. In other words, where approximately 200 such problems per week occur, the savings effected would be 2300 minutes per week, or about 38 hours, i.e., approximately one clerk's entire working time.

While the device has been described as applied to the calculation of characteristics of rolls of paper, it will be understood that it may be employed for calculating the characteristics of rolls of any flexible sheet material, such as metal foils, plastic sheeting and the like.

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THE embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A slide rule comprising a pair of relatively stationary members, a cursor mounted on said members, a pair of slides movable relatively to said members and to each other, a logarithmic scale on one of said members indicative of a range of weights of a specified number of sheets of paper of specified size, a logarithmic scale on one of said slides indicative of a range of thickness of paper sheets, a second logarithmic scale on said one slide indicative of a range of diameters of paper rolls, a logarithmic scale on said other slide indicative of a range of widths of paper rolls, and a logarithmic scale on said other member indicative of a range of weights of paper rolls.

2. A slide rule as defined in Claim 1, including an additional logarithmic scale on one of said slides indicative of a range of sheet thicknesses.

3. A slide rule for calculating physical characteristics of a roll of paper comprising an elongated base member having a pair of relatively stationary side bars fixed thereto, a cursor carried by said side bars, and a pair of adjoining slides mounted on the base member and being slidable relatively to each other and to said side bars, one of said side bars having thereon a first logarithmic scale of a range of weights of a specified number of sheets of paper of specified size, one of said slides having thereon a second logarithmic scale of a range of thicknesses of paper sheets for co-relation of paper sheet thickness with paper sheet weight on said first scale, said one slide also having thereon a third logarithmic scale of a range of diameters of paper rolls, said other slide having thereon a fourth logarithmic scale of a range of roll widths for co-relation of roll width with roll diameter on said third scale, and said other side bar having thereon a fifth logarithmic

B

scale of a range of roll weights for co-relation of roll weight with roll width on said fourth scale.

4. A slide rule for calculating physical characteristics of a roll of paper comprising an elongated base member having a pair of relatively stationary side bars fixed thereto, a cursor carried by said side bars, and a pair of adjoining slides mounted on the base member and being slidable relatively to each other and to said side bars, one of said side bars having an edge in juxtaposed relation to an edge of one of said slides and having along said edge a first logarithmic scale of a range of weights of a specified number of sheets of paper of specified size, said one slide having along its said edge a second logarithmic scale of a range of thicknesses of paper sheets for co-relation of paper sheet thickness with paper sheet weight on said first scale, said one slide having along its other edge a third logarithmic scale of a range of diameters of paper rolls, said other slide being in juxtaposed relation to the other of said side bars and having thereon a fourth logarithmic scale of a range of roll widths for co-relation of roll width with roll diameter on said third scale, and said other side bar having along its said edge a fifth logarithmic scale of a range of roll weights for co-relation of roll weight with roll width on said fourth scale.

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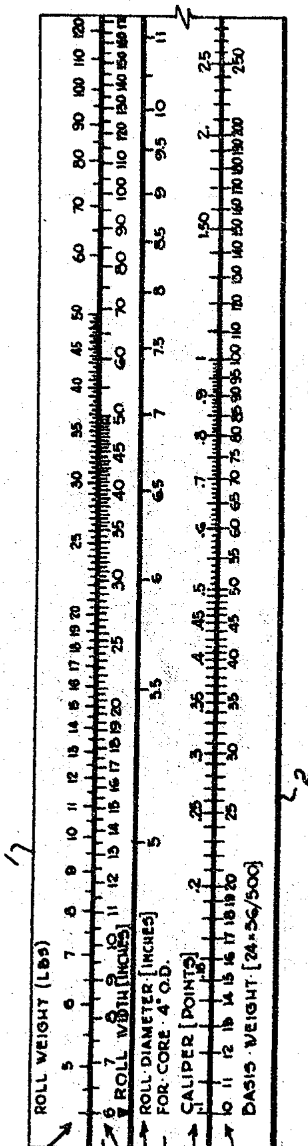

Fig. 1

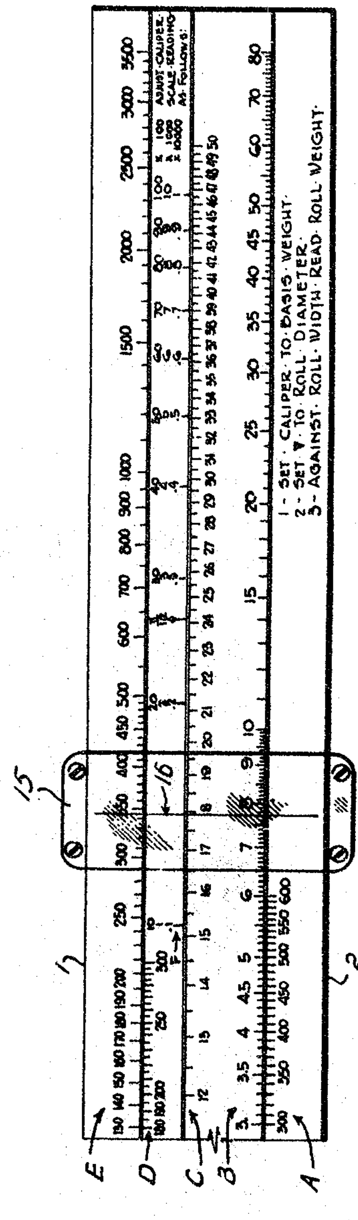

Fig. 2

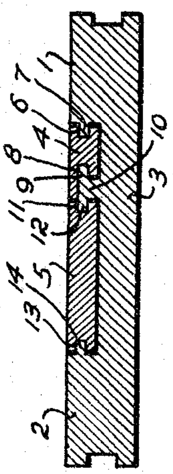

Fig. 3

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