July 29, 1947. E. SEIDMAN 2,424,713

VERNIER FOR SLIDE RULES

Filed May 11, 1946

FIG. 1

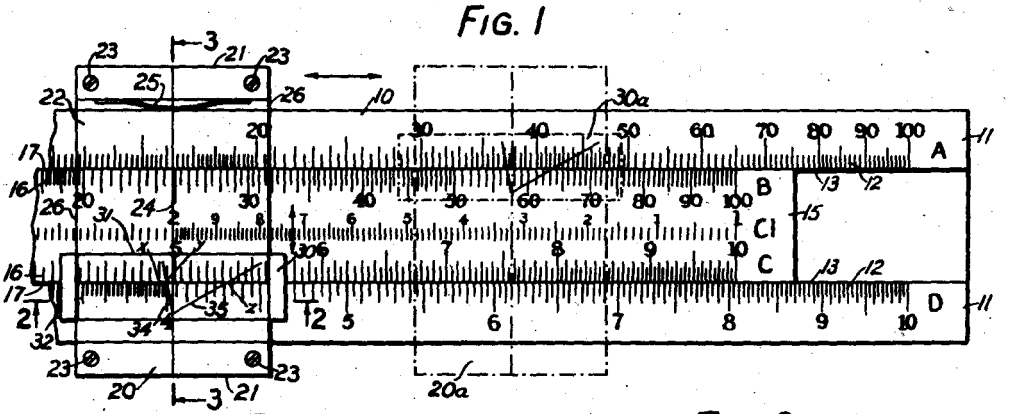


FIG. 2

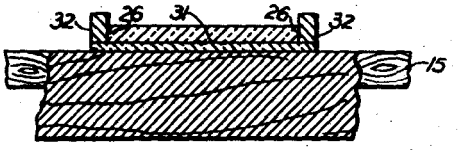


FIG. 3

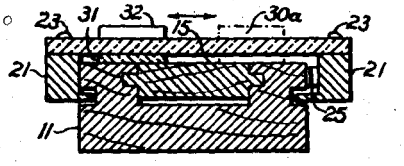


FIG. 4

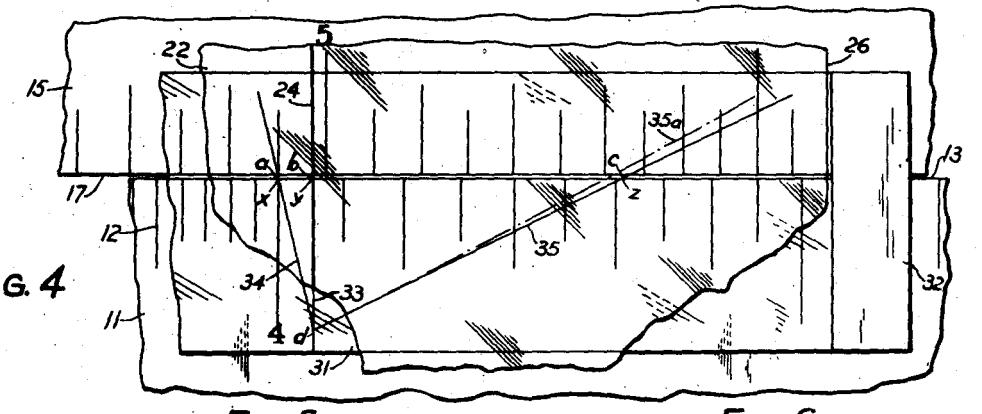


FIG. 5

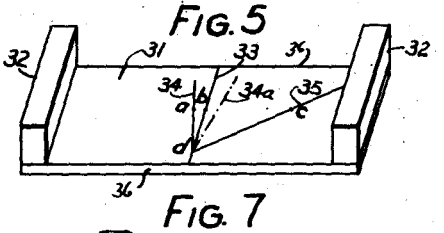


FIG. 6

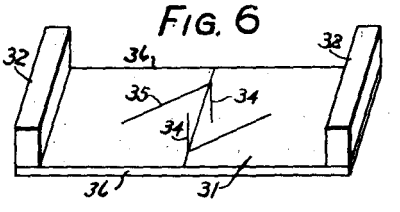
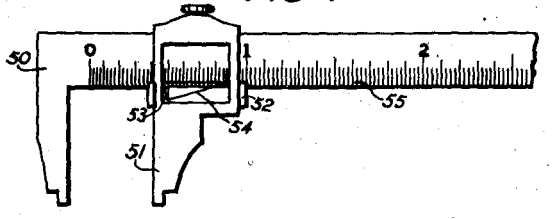


FIG. 7



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VERNIER FOR SLIDE RULES

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9 Claims. (Cl. 235—70)

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This invention relates to verniers and particularly to a slidable accessory adaptable for use on conventional slide rules or similar scaled instruments.

The primary object of this invention is to provide a vernier of the type stated that is adaptable for use with, and which may be easily mounted on, a conventional slide rule and which will enable the accurate reading of an additional place or digit.

Another object of this invention is to provide a vernier that is movable at right angles to the underlying main scale.

A further object is to provide a transparent vernier plate the indicia of which are visible together with the main scale through the cursor or indicator.

Still another object is to provide a device of the type stated which is easy to read and interpret, and which requires no extraneous apparatus for its operation.

These and other objects of the invention will become apparent from a reading of the following specification and claims, together with the accompanying drawing in which like parts are referred to and indicated by like reference characters and wherein:

Figure 1 is a top plan view of the right portion of a conventional slide rule having the vernier mounted thereon;

Figure 2 is a longitudinal cross-sectional view of the same taken along the line and in the direction of the arrows 2—2 of the Figure 1;

Figure 3 is a transverse cross-sectional view of the same taken along the line and in the direction of the arrows 3—3 of the Figure 1;

Figure 4 is an enlarged view of a portion of the vernier and slide rule as illustrated in the Figure 1;

Figure 5 is a perspective view of the vernier in its preferred form;

Figure 6 is a perspective view of an alternate form of the vernier; and

Figure 7 is a top plan view of the vernier attached to a conventional caliper.

The instant invention consists broadly of the plate 31, having indicia thereon, and the guide pieces 32, which together form the vernier 30 as illustrated in the Figures 5 and 6, and which is shown in Figure 1 as it appears mounted on a conventional logarithmic slide rule 10.

The slide rule consists of two stationary rails 11 having inner edges 13 and a movable rail 15 mounted therebetween having edges 17 which slidably abut the edges 13. Said rail 15 being

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capable of longitudinal sliding movement with reference to the stationary rails 11, by reason of the tongue and groove construction of the slide rule as shown in Figure 3.

The stationary rails 11 have the conventional A and D scales 12 along their edges 13. The movable rail 15 has the conventional B and C scales 16 along its edges 17, and the inverted CI scale in the center, as shown in Figure 1. At 20 there is shown a cursor herein referred to as an indicator, in that it is the common trade term used for such devices.

This indicator is slidable longitudinally of the rails 11 and 15, and consists of a glass plate 22 mounted on the end pieces 21 which have tongues which slidably engage grooves in the outer faces of the rails 11 as shown in Figure 3.

The glass plate 22 has parallel side edges 26, and a central vertical hair-line 24 which is used for the purpose of reading the relative positions of the movable and fixed scales 16 and 12. The screws 23 attach the glass 22 to the end pieces 21, while the flat spring 25 holds the indicator in slight frictional contact with the fixed rails 11, and square with the various scales. The vernier 30 consists of a thin sheet of rigid transparent material such as glass or other transparent material approximately $\frac{3}{8}$'' wide, and long enough to extend the width of the indicator plate 22, and then connect with the guide piece 32.

When attached to a slide rule the vernier is placed so that its plate 31 is under the indicator glass 22 and above the scale faces 12 and 16 with the guides 32 extending vertically from the ends of the plate 31 to hold the vernier in sliding contact with the indicator plate edges 26 as shown in Figures 1, 2 and 3. The guide pieces 32 act as runners which slide along the parallel side edges of the indicator glass 22, and carry the vernier plate up and down the indicator at right angles to the path of travel of the indicator as indicated in Figure 1, where the vernier 30 is shown in an alternate position 30a.

In its preferred form the indicia on the vernier plate 31, as illustrated in Figure 5, consists of a short oblique line 34, and a long oblique line 35, drawn so that their point of intersection d is, and will always remain during movement, on the indicator hair-line 24.

A third line 33 is drawn across the plate 31 thru the point d, and perpendicular to its longitudinal edges 36. This line is added for the sake of convenience in aligning the point d with the hair-line 24, since the point d must lie on the hair-line 24 if the line 33 is made to coincide

with the hair-line **24**. However, this line may be omitted without affecting the operation of the vernier.

The three lines **33**, **34**, and **35** shown in Figure 5 have imaginary points *a*, *b*, and *c* which lie in a straight line perpendicular to hair line **24**.

The lines **33**, **34**, and **35** together with the imaginary line *ac* drawn through the points *a*, *b*, and *c* form two right triangles *abd* and *cbd*, and a third large triangle *adc*.

The lines **34** and **35** are drawn at such an angle to the line **33** that the length of the base *ab* of the triangle *abd* will bear a predetermined ratio to the length of the base *ac* of the triangle *adc*.

When used with a logarithmic slide rule the most convenient ratio has been found to be 1:10 since this will give readings in tenths of the smallest scale division. However, any ratio found to be most convenient for the use intended may be employed.

The ratio illustrated here may be stated as follows

$$\frac{ab}{ac}=\frac{1}{10}$$

If a second line should be drawn to intersect lines **33**, **34**, and **35** parallel to the line *abc*, the new triangles formed will have angles equal to the angles of the original triangles, and therefore the new triangles will be similar to the original triangles, and the lengths of their base sides will bear the same ratio to each other as those of the original triangles, namely, 1:10.

In other words, irrespective of the location of the lines drawn to intersect the lines **33**, **34**, and **35** parallel to the original line *abc*, the ratio of the lengths of the new bases *a'b'* to *a'c'* will always be 1:10, or a constant.

By placing the vernier on the slide rule indicator in such a manner that the edge **13** of one of the scales **12** becomes the line *abc*, we can put this knowledge to practical use in accurately determining the location of the indicator hair-line when it lies between two scale divisions as illustrated in Figure 4.

When using a conventional slide rule as illustrated in Figure 1 we read four figures of a result on one part of the scale, and three figures on the remaining part. These figures can be accurately read on the scale division lines only. If the reading, as represented by the hair-line **24**, falls between scale divisions the number has to be estimated as being a certain percentage of the distance from the next preceding scale division to the next following scale division. However, the location of the hair-line can be accurately determined by the use of this vernier in the following manner.

The Figure 1 shows a slide rule with a reading indicated somewhere between 4.00 and 4.05 which is shown for greater convenience in enlarged form in Figure 4.

The indicator hair-line **24** is shown intersecting the scale **12** at a point *y* on its edge **13**. The point *y* is somewhere between the reading 4.00 and 4.05. The problem is to find out where. The vernier **30** is moved along the indicator at right angles to the scale edge **13**, with the vernier hair-line **33** coinciding with the indicator hair-line **24** until the line **34** intersects the scale division next preceding the position of the hair-line **24**, at the point *x* on the scale edge **13**. The line **35** will then intersect the scale edge **13** at a point *z*.

We now have a set up for our vernier which uses the edge **13** to form a line which runs through point *x* on the scale, which we will call point *a* on the line **34**; point *y* on the scale, which we will call point *b* on line **33**; and point *z* on the scale, which we will call point *c* on line **35**.

From our previous discussion we know that

$$\frac{ab}{ac}=\frac{1}{10}$$

By looking at Figure 4, we can see that the distance from *a* to *c* is six scale divisions, therefore, by substitution in the above equation we have

$$\frac{ab}{6}=\frac{1}{10}$$

$ab=0.6$.

Since *ab* on the vernier is the same as *xy* on the scale edge **13**, we now know that the point *y* on the scale edge **13** represents 0.6 of the distance between the point *x*, or the scale division marked 4.00, and the next following scale division marked 4.05. Since $0.6\times0.05=0.03$, and the hair-line **24** is beyond the scale division 4.00, the correct reading must be 4.00 plus 0.03 or 4.03.

Another and quicker way of arriving at the same answer is to take the scale reading at *a* and subtract it from the reading at *c*, then multiply the difference by the constant, which in this case is

$$\frac{1}{10}$$

and add the product to the reading at *a*

$$(4.30 \text{ minus } 4.00)\times\frac{1}{10}=0.03$$

4.00 plus 0.03=4.03 which is the exact reading indicated by the hair-line **24** in Figure 4.

When used with scales having equally spaced division marks the lines **34** and **35** are straight lines, but with scales having unequally spaced division marks, such as a logarithmic scale, the true path of the line **35** is a curve as shown at **35***a*. However, this curve deviates so little from a straight line when used with a conventional ten inch slide rule, that it can be very closely approximated by a straight line.

If we wish to get a still closer approximation, we may modify the indicia on the plate **31** by using two pair of oblique lines as shown in Figure 6. One of the pair will be used as before, but only for the first half of the distance between scale divisions such as the distance between 4.00 and 4.025, if we use the same hair-line position as illustrated in Figure 4; and the inverted pair to be used for reading the second half of the distance, or the distance between 4.025 and 4.05.

In using the inverted pair the short inverted oblique line of the vernier is made to intersect the next scale division following the hair-line **24**, which would be 4.05 in this case, and then subtracting the value found which would be 0.02 from 4.05 to give the answer 4.03.

Another modified form of indicia has the short oblique lines **34***a*, on the same side of the hair-line **33** as the long oblique line **35**, as shown in Figure 5. The point *a* now falls to the right of *b* since the line **34***a* is to the right of the line **33**.

The line **34***a* is made to intersect the next scale division following the location of the hair-line **24** and the same equation is used:

$$\frac{ab}{ac}=\frac{1}{10}$$

However, the result is subtracted from the reading at point *a* since that is a reading of a scale division beyond the location of the hair-line **24**.

The vernier may be used to read the hair-line position in combination wtih other scales on the slide rule, as indicated by the other position of the vernier on the indicator, as shown at **30***a* in Figure 1.

This type of vernier may be used with any instrument employing a scale, and is not to be thought of as being confined to use with slide rules. A modified form of this vernier is shown in Figure 7, attached to a conventional caliper **50**, having a scale **55** and a sliding jaw **51**. The vernier **52** has the characteristic short oblique line **53**, and the long oblique line **54**, and is capable of being moved at right angles to the scale **55** in order to take a reading.

It will now be clear that there is provided a device which accomplishes the objectives heretofore set forth. While the invention has been disclosed in its preferred form, it is to be understood that the specific embodiment thereof as described and illustrated herein is not to be considered in a limited sense as there may be other forms or modifications of the invention which should also be construed to come within the scope of the appended claims.

I claim:

1. In combination with a slide rule of the type having a set of opposed linear graduations and a cursor thereon, a plate slidably engageable with the aforesaid cursor, the said plate having indicia thereon, the said indicia consisting of a pair of lines intersecting on a line on the cursor and intercepting a segment of the opposed linear graduations.

2. In combination with a slide rule of the type having a set of opposed linear graduations at abutting edges thereof and including a movable indicator having a hair-line thereon, a plate slidably engageable with the aforesaid indicator, the said plate having a pair of oblique lines thereon capable of forming together with the aforesaid abutting edges and the hair-line two right triangles.

3. In combination with a slide rule of the type having a set of opposed linear graduations at abutting edges thereof and including a movable indicator having a hair-line thereon, a plate slidably engageable with the aforesaid indicator, the said plate having a pair of oblique lines thereon capable of forming together with the aforesaid abutting edges and the hair-line two right triangles, and guide means on the said plate engageable with the indicator.

4. In combination with a slide rule of the type having a set of opposed linear graduations and a cursor thereon, a plate slidably engageable with the aforesaid cursor, the said plate having indicia thereon, the said indicia consisting of a pair of lines intersecting on a line on the cursor and intercepting a segment of the opposed linear graduations, and guide means on the said plate engageable with the cursor.

5. In combination with a slide rule of the type having two or more sets of opposed linear graduations and a transparent indicator, having a hair-line engraved thereon, slidably engaged therewith and capable of longitudinal motion with reference to the said linear graduations, a vernier comprising, a movable plate slidably engaged with the aforesaid indicator, said plate having indicia inscribed thereon consisting of two intersecting lines capable of intercepting a segment of the said linear graduations and intersecting at a point lying on the aforesaid indicator line.

6. In combination with a slide rule of the type having two or more sets of opposed linear graduations and a transparent indicator, having a hair-line engraved thereon, slidably engaged therewith and capable of longitudinal motion with reference to the said linear graduations, a vernier comprising, a movable plate slidably engaged with the aforesaid indicator, said plate having indicia inscribed thereon consisting of two intersecting lines capable of intercepting a segment of the said linear graduations and intersecting at a point lying on the aforesaid indicator line, said indicia lines making unequal angles with the said indicator line.

7. In combination with a slide rule of the type having two or more sets of opposed linear graduations and a transparent indicator, having a hair-line engraved thereon, slidably engaged therewith and capable of longitudinal motion with reference to the said linear graduations, a vernier, comprising in combination, a transparent plate member slidably mounted on said indicator and movable at right angles to the movement of the indicator, said plate having indicia inscribed thereon consisting of two intersecting lines capable of intercepting a segment of the said linear graduations and intersecting at a point lying on the aforesaid indicator line, and guide members attached to and integral with said plate member and capable of holding said plate member in fixed slidable relation with the aforesaid indicator hair-line.

8. A vernier of the type defined in claim 7 and further characterized by the transparent plate having a third line inscribed thereon drawn from the point of intersection of the first two lines, perpendicular to the segment of the linear graduations intercepted by the said lines.

9. A vernier of the type defined in claim 7 and further characterized by the length of the segment of the linear graduations intercepted by the two intersecting lines having a definite known ratio to the length of the segment intercepted by one of the said lines and the aforesaid indicator line.

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