May 17, 1938. H. GILMORE 2,117,413

DECIMAL POINT INDICATING MECHANISM FOR SLIDE RULE COMPUTATIONS

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Fig. 1.

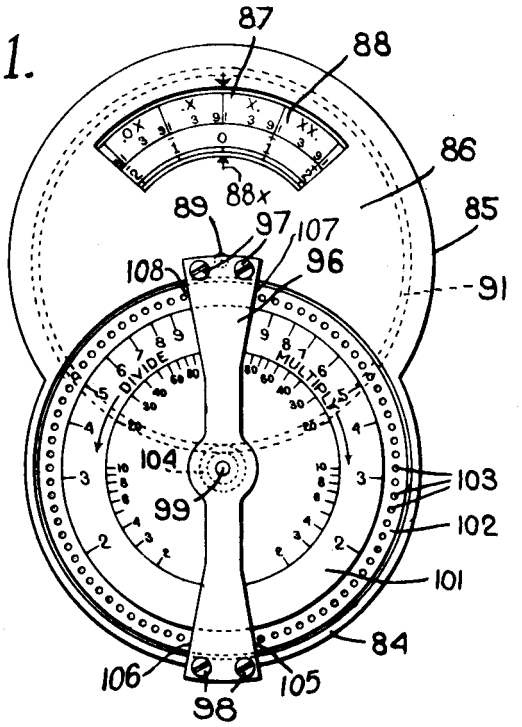
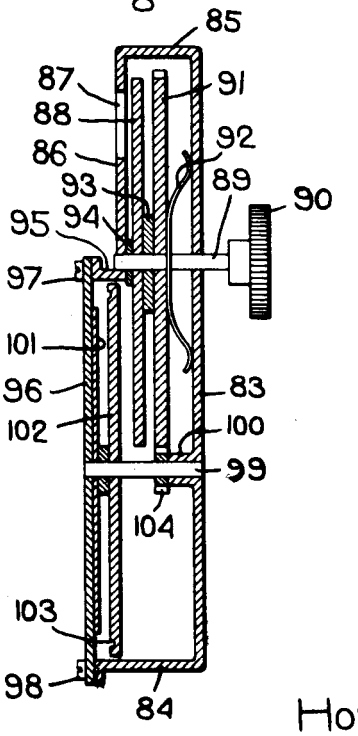


Fig. 2.



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DECIMAL POINT INDICATING MECHANISM FOR SLIDE RULE COMPUTATIONS

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5 Claims. (Cl. 235—84)

This invention relates to methods and apparatus for indicating the position of the decimal point in the numerical result of a problem computed within the working zone of slide rule mechanism.

Usual simple slide rules are of two types, the flat slide rule and the endless slide rule. The flat slide rule comprises relatively movable pairs of juxtaposed scales having similar graduations, each scale being graduated in unequal divsions laid off in lengths which are proportional to the logarithms of the numbers appearing upon the scale and a runner having an indicator, usually in the form of a hair line crossing both scales at right angles to the longitudinal axis, which can be slid along the scale to assist in positioning the scales relatively to each other when multiplying, dividing, or performing any other function within the scope of the slide rule.

The scales of usual flat slide rules in the simple form are graduated from an index 1, usually called the left index, to 10, (often incorrectly marked 1) called the right index, and form a working zone within which computations may be made within the limits of the relative movements of the scale members. The right index is the beginning of the next posterior zone and is the left index of that zone. Since the usual slide rule includes only one zone, (although occasionally it includes two zones) and since no attempt has been made to keep track of the decimal point, it is not necessary for the worker of a slide rule to consider what lies beyond the indices of the rule when the computation is wholly within the working zone.

Now considering the location of the decimal point in the result as obtained from the rule, it becomes necessary to visualize the other zones, since every possible number having the decimal point similarly placed will be found in some zone, either in the working zone, or in some zone not located within the scale of the slide rule.

The zone represented on the slide rule may be called the "Working zone" or the "Neutral zone", or the "0 zone", whichever designation conveys the most correct understanding at the moment. Within this zone all numbers have the decimal point at the right of the first digit. It is called the neutral zone since it is the only zone used in the calculations where numbers may be employed without correction. It is the "0" zone for the same reason and also because the logarithm of the lowest number in this zone is 0, and it is obvious that it is called the working zone because the numerical computations are made within it. In the first posterior zone all numbers have two digits before the decimal point, that is one more than does the neutral zone to the left and one less digit before the decimal point than does the next posterior zone to the right. Conversely, the first zone to the left of the working zone is the —1 zone or first anterior zone and the decimal point of all numbers located in this zone have all the digits located immediately after the decimal point. The same general description applies to other posterior and anterior zones which extend in opposite directions from the working zone, figuratively into space and to distances limited only by the imagination.

In order completely to visualize the zones, it is necessary to recall that in no instance does the right hand index point belong to the zone; for example, 9.999 belongs to the neutral zone, but 10 belongs in the first posterior zone.

There is no connection between the insignia or zone numbers used to designate the decimal zones and the logarithm of any number in the zones, but it is convenient to have the insignia of the zone the same as is the logarithm of the lowest number in that zone, and when in the description or in the claims we speaks of adding zone numbers we mean adding numbers which correctly represent the logarithm of the lowest number in the zone represented by such zone number. The main advantage of so selecting the insignia will be apparent in the description of the so-called "short-cut" method of placing the decimal point in accordance with the invention herein described.

Suitable insignia are used to facilitate the location of the decimal point. Thus, X, XX, etc. are employed to indicate integral decimal zones, and .X, .0X, etc. to indicate fractional zones. For example:

X. is any number in 0 zone and the log. of lowest number (1) is 0
XX. is any number in 1+ zone and the log. of lowest number (10) is 1
XXX. is any number in 2+ zone and the log. of lowest number (100) is 2
.X is any number in —1 zone and the log. of lowest number (.1) is —1
.0X is any number in —2 zone and the log. of lowest number (.01) is —2

In order to aid in explaining the present invention reference may be made to the use of logarithmic tables by means of which the operations of multiplication and division are replaced by those

of addition and subtraction. The integral part of a logarithm is called the "characteristic" and the fractional part the "mantissa". As the base of the logarithmic tables is 10 the logarithms of all numbers in which the digits are the same, no matter where the decimal point may be, have the same mantissa. A change in the position of the decimal point amounts to multiplication or division by some power of 10, and this corresponds to the addition or subtraction of some integer in the case of a logarithm, the mantissa therefore remaining intact. In tables of logarithms of numbers to the base 10 the mantissa only is in general tabulated as the characteristic of the logarithm of the number can always be written down, the rule being that if the number is greater than unity the characteristic is less by unity than the number of digits in the integral portion of it, and that if the number is less than unity the characteristic is negative and is greater by unity than the number of ciphers between the decimal point and the first significant figure. Thus the characteristic of any number from 1 to 9.99+ is 0. The characteristic of any number from 10 to 99.99+ is 1. The characteristic of any number from 100 to 999.99 is 2, etc., the mantissa being the same in all cases.

In the use of a slide rule the computations within the neutral or working zone of a slide rule is comparable to the addition or subtraction of the mantissa of the logarithmic tables with the characteristic 0. The insignia employed herein in computations made by the logarithmic lengths on the scales of slide rules may be said to indicate the respective decimal zones wherein the problem wanders.

The usual method of working any slide rule is essentially the same and makes no attempt to visualize the wandering of the problem among the decimal zones and it is only in the very simplest problems that the location of the decimal point is apparent, it being usually necessary to make an additional rough arithmetical calculation to establish its location and such calculation does not give the same confidence in the location of the decimal point as does the working of the slide rule give confidence in the correctness of the digits obtained, as a result of the calculation. By the present method these so-called wanderings are kept track of, and if desirable the worker may know at any moment in just what decimal zone the problem so far worked is located, or if such close track is not necessary the method may be simplified by short-cut means which will correctly indicate the decimal point upon completion of the computation. Broadly speaking this method has for its object to keep track of the wanderings of the problem among the various decimal zones, and may be defined as a method of positioning the decimal point in the numerical result of a problem computed within the working zone of a slide rule mechanism which comprises providing insignia to represent zone values of the several equal length decimal zones, that is the working or neutral zone, the posterior and anterior zones respectively, positive and negative to, and located on opposite sides of the working zone, successively adding the whole zone values of the numbers used in the computation to the part zone values of the digits as located in the working zone of the slide rule, and placing the decimal point in the result in accordance with the insignia thus obtained, or alternatively in a short-cut method by adding the whole zone values of the numbers used in the computation and to the same adding the sum of the part values of the same digits as located in the working zone of the slide rule, and placing the decimal point in the result in accordance with the insignia thus obtained. Another short method comprises adding the part zone values of the digits of the numbers used in the computation as located in the working zone of the slide rule, placing the decimal point in the result in accordance with the insignia thus obtained, adding the whole zone values of the numbers used in the computation, and changing the location of the decimal point thereafter in accordance with the insignia last obtained.

The present invention comprises mechanism which can be operated to indicate directly the position of the decimal point of any computation made within the working or neutral zone of the slide rule, suitable indicia being used to facilitate the location of the decimal point. The mechanism comprises means for actuating a dial having a zone indicator by movements correlated to distances proportional to the logarithms of the numbers used in the computation, suitable oppositely disposed multiplication and division scales being employed to measure the distance of the movement corresponding to the number employed in the computation.

A preferred embodiment of the invention is illustrated in the accompanying drawing, in which—

Fig. 1 is a front elevation of a device adapted to be manually operated in conjunction with computations made upon a slide rule of any type, and,

Fig. 2 is a vertical central sectional view of the construction illustrated in Fig. 1.

The device for determining and indicating the position of the decimal point in the result of a problem which is independently computed on a slide rule comprises a casing having a flat back 83 having upper and lower intersecting cylindrical sections with continuous peripheral walls 84 and 85, the upper wall being provided with a preferably integral front plate 86 having therein an arcuate window 87 through which a zone indicating scale or dial 88 may be observed, with an index 88x at the center of the window which when the zone on the dial is opposite it will designate the position of the decimal point. The dial is divided into equal radial divisions corresponding respectively to the working or neutral zones and the posterior and anterior zones, and these zones are provided for convenience with an inner scale having a zero point and numerals +1, +2, etc., and −1, −2, etc. indicating the beginning of the respective posterior and anterior zones. The dial is also provided with an outer scale having the insignia X for the neutral zone, XX for the first posterior zone, and .X and .0X respectively for the first and second anterior zones, etc. The outer scale is also conveniently provided with numbers 1, 3, and 9, to designate the initial, middle and terminal numbers of each zone.

The zone indicating dial 88 is fixedly secured to a shaft 89 which is journaled in the front and rear walls of the casing and is provided with a knurled knob 90 by which the dial may be rotatably positioned. A gear 91 is rotatably mounted upon the shaft 89 and is pressed toward the dial by a spring 92. Desirably a friction disk or washer 93, of leather, or other suitable material, is interposed between the gear 91 and the rear face of the dial 88, and preferably also a smaller metal disk or washer 94 is interposed between the dial 88 and the front wall of the casing. The gear 91 and dial 88 are thus normally connected

together, but may be disconnected and the dial initially set by drawing the knob outwardly to disengage the friction elements and rotating it in the proper direction. The lower cylindrical portion of the casing is somewhat wider than the upper cylindrical wall 85 and the lower edge of the front plate 88 is provided with a flanged offset 95 to which is secured a narrow plate or bridge 96 which extends vertically and diametrically across the lower cylindrical portion of the casing. The plate 96 is secured to the flanged offset 95 by suitable screws 97 and the opposite end of the plate is secured to the casing by screws 98. A shaft 99 is rotatably mounted in a boss 100 extending inwardly from the rear wall of the casing and in the central portion of the plate 96. A circular scale member 101, concentric with the axis of the shaft 99, is fixedly secured relatively to the plate 96, and is provided with multiplication and division scales which are graduated in unequal divisions laid off in lengths which are proportional to the logarithms of the numbers appearing upon the scale and extend upwardly in opposite directions from index points at the respective lower edges of the plate 96.

The shaft 99 has fixedly secured to it a disk 102 which is provided adjacent its periphery with narrowly spaced indentations or apertures 103 adapted to receive the end of a pencil, stylus, or other device, by means of which the disk may be polled downwardly until the stylus is arrested by the edge of the bridge plate 96 which is located at the index point of the scale, to position the decimal indicating dial. The shaft 99 also has fixedly secured to it a pinion 104 which meshes with the teeth of the gear 91. Desirably the ratio of the gear 91 to those of the pinion 104 is 8 to 1, as with the gear ratio of 8 to 1 the logarithmic scales may be conveniently made of a length $\frac{1}{8}$ of the circumference of the circular scale member 101. This allows sufficient space so that the indexes 1 of the respective oppositely graduated multiplication and division scales may be placed at the lower edges 105 and 106 of the plate 96 and the complementary indexes 1 or 10 at the opposite end of the respective scales at the edges 107 and 109 of the upper portion of the plate 96, the plate in such instance acting as stops to limit the movement of the disk 102 when rotated by polling.

If then the dial is divided into 18 equal divisions, each division corresponds to one complete zone as polled on the disk 102. If, for example, the disk 102 is polled twice at approximately 3.16, (which corresponds to the logarithm of .5), it is in effect multiplying 3.16×3.16, which makes approximately 10 for a complete zone, and the dial 88 will be advanced one division. If this device were made with exceeding accuracy with the divisions accurately engraved and on a sufficiently large diameter, it would serve as a complete slide rule with the decimal point indicated and for all substantial purposes would be the same as the construction shown in Fig. 1. However, it is purposely made less accurate as it is intended for a rough calculator to be used in conjunction with a more accurate slide rule of any type which does not have an automatic decimal indicator.

In the operation of the device the proper zone space on the dial must first be set opposite its indicator to correspond to the assumptions made as to the decimal value of the numbers used in the computations. The dial 89 is set in the manner above described in reference to the setting of the drum in the construction shown in Fig. 1. That is to say, all digits over and in excess of 1 are counted as +1, etc. The decimal point and each 0 in a decimal is counted as −1, whether numerator or denominator, and the sum of said digits transferred from the denominator to the numerator. After the dial is set to represent the zone number thus computed, each of the numbers of the problem is then polled by inserting the end of the pencil in a depression in proximity to the value of the number, and the pencil or stylus then pushed downwardly until it engages the edge of the plate 96, the rotation of numbers, or digits, to be multiplied being made upon the right half of the disk, and those to be divided upon the left half of the disk. Inasmuch as the computation thus made upon the device corresponds to the computation of the numbers on the slide rule, the actuation of the indicator will accurately position the indicator scale so that the zone on the indicator scale which is opposite the index 88x will indicate the position of the decimal point in the result of the problem in the manner above described.

The circular scale member 101 may be provided with any number of scales. The outer scale illustrated is the one most used, that is the scale to be used in ordinary problems of multiplication and division. In the drawing, a scale for square roots is also shown, this being exactly similar to the outer scale, only that it is one-half as long. The lower half and upper half have similar graduations. The digits, however, are marked differently. A point in the upper half, corresponding to 2 in the lower half, is marked 28, and each other location in the upper half is ten times that of similar markings in the lower half. These markings do not need further description since one skilled in the art of using a slide rule is familiar with them. A cube root scale, a reciprocal scale, or any of several other scales, may be added, the use of which are evident, and a description thereof is unnecessary to the understanding of the device.

It will be understood that the particular embodiment which is shown and described herein is of an illustrative character and not restrictive, and that other devices may be employed to perform the method herein described within the meaning and scope of the following claims.

Having thus described the invention, what is claimed as new, and desired to be secured by Letters Patent, is:

1. A device for determining and indicating the position of the decimal point in the result of a problem which is independently computed on a slide rule which comprises a stationary index and a relatively movable dial graduated in equal zone divisions representing the normal zone of computation of the slide rule and successive zones respectively anterior to and posterior to said normal zone, each division being provided with indicia representing the position of the decimal point characteristic of such zone, means for actuating said decimal point indicator comprising stationary multiplication and division scales extending in opposite directions from properly positioned index points and having graduations proportional to the logarithms of the numbers on said scales and an associated movable actuator member, means for transmitting the movements of said actuator member to said dial in amounts proportional to the movements of said actuator and means on said movable actuator adapted to be engaged by a polling device at a point corre-

sponding to the number used in the computation and movable by said polling device to the index position of its scale, whereby successive movements of said actuator will so rotate said dial as to position a decimal zone on the dial opposite the stationary index which cooperates with said dial which will show directly where the decimal point should be placed in the numerical result computed on the slide rule.

2. A device for determining and indicating the position of the decimal point in the result of a problem which is independently computed on a slide rule which comprises a stationary index and a relatively rotatable dial graduated in equal decimal zone divisions representing the normal zone of computation of the slide rule and successive zones respectively anterior to and posterior to said normal zone, each division being provided with indicia representing the position of the decimal point characteristic of such zone, stationary circular multiplication and division scales extending in opposite directions from properly positioned index points and having graduations proportional to the logarithms of the numbers on said scales, an associated rotatable actuator having means located in proximity to said scales adapted to be engaged by a polling device at a point corresponding to the number used in the computation and movable by said polling device to the normal index position of its scale, and means for transmitting the movements of said rotatable actuator to said dial in amounts proportional to the movements of said rotatable actuator, whereby successive rotative movements of said actuator will so rotate said dial as to position a decimal zone on the dial opposite the stationary index which cooperates with said dial which will show directly where the decimal point should be placed in the numerical result computed on the slide rule.

3. A device for determining and indicating the position of the decimal point in the result of a problem which is independently computed on a slide rule which comprises a stationary index and a relatively rotatable dial graduated in equal zone divisions representing the normal zone of computation of the slide rule and successive zones respectively anterior to and posterior to said normal zone, each division being provided with indicia representing the position of the decimal point characteristic of such zone, means for initially setting said dial in accordance with the algebraic sum of the assumed decimal values of the numbers used in the computation, circular multiplication and division scales extending in opposite directions from properly positioned index points and having graduations proportional to the logarithms of the numbers on said scales, an actuator disk concentric with said scales having means in proximity to said scales adapted to be engaged by a polling device at a point corresponding to the number used in the computation, stops for arresting said polling device at the index of the respective scales, and means for transmitting the movements of said rotatable disk to said dial proportional to the movements of said rotatable disk, whereby successive actuations of said rotatable disk in accordance with successive computing numbers will so rotate said dial as to position a decimal zone thereof opposite the stationary index which cooperates with said dial which will show directly where the decimal point should be placed in the numerical result computed on the slide rule.

4. A device for determining and indicating the position of the decimal point in the result of a problem which is independently computed on a slide rule, comprising a casing, a dial shaft mounted in said casing having a dial fixedly secured thereto graduated in equal divisions provided with indicia representing the position of the decimal point, a gear rotatably mounted on said shaft, means for connecting said gear to said dial, an actuator shaft mounted in said casing having an actuator disk secured thereto provided with means to be engaged by a suitable polling device, stationary circular multiplication and division scales located in proximity to the path of said polling device and extending in opposite directions from properly located index points and having graduations proportional to the logarithms of the numbers on said scale, stops for said polling device at the index points of the respective scales, and a pinion on said actuator shaft engaging the gear on said dial shaft and having a suitable ratio relatively thereto for so rotating said dial that by polling said actuator disk in accordance with successive computing numbers on said scale a decimal zone on said dial will be positioned opposite the index which cooperates with said dial which will show directly where the decimal point should be placed in the numerical result computed on the slide rule.

5. A device for determining and indicating the position of the decimal point in the result of a problem comprising a casing, a dial shaft mounted in said casing having a dial fixedly secured thereto graduated in equal divisions provided with indicia representing the position of the decimal point, a gear rotatably mounted on said shaft, means for connecting said gear to said dial, an actuator shaft mounted in said casing having an actuator disk secured thereto provided with means to be engaged by a suitable polling device, stationary circular multiplication and division scales located in proximity to the path of said polling device and extending in opposite directions from properly located index points seven-sixteenths of a complete circle and having graduations proportional to the logarithms of the numbers on said scale, stops for said polling device at the index points of the respective scales, and a pinion on said actuator shaft engaging the gear on said dial shaft and having a ratio of 1 to 8 relatively thereto.

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