PATENT SPECIFICATION 650,033

Date of Application and filing Complete Specification: March 31, 1947. No. 8725/47.

Application made in United States of America on March 16, 1946.

Complete Specification Published: Feb. 14, 1951.

Index at Acceptance :—**Class 106**(i), B5(a : f : g19 : g28 : h).

COMPLETE SPECIFICATION.

Navigational and Industrial Computer of the Slide Rule Type.

I, OSCAR EUGENE BATORI, of 527 Lexington Avenue, New York, State of New York, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

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

The intention of this invention is to simplify and expedite computations in general.

One important object of it is to provide new mechanical solutions with slide rules for computations with different terms involved.

Another important object is to provide new and better mechanical solutions for the spherical triangle, with particular regard to simplifying and expediting navigation.

One further object is to simplify and expedite computations for those industries which are using fractional and decimal numerical systems combined.

For the sake of better explanation, brief comparison is made between prior computers of the slide rule type and this invention.

Prior computers of the slide rule type, to perform a simple computation, apply, in general, two coacting scales on two relatively movable members; one, called the base scale on the base member; the other, the slide scale, on the slide member. These two scales are used for the six factors of simple multiplication and division: for the multiplicand, multiplier, and product in case of multiplication, and for dividend, divisor, and quotient in case of division.

In a simple computation one scale has to be used for one factor and the result and the other scale for the other factor. This necessitates knowing certain rules to use the two scales for the three elements in the computation. For users without mathematical background the procedure is complicated and difficult. In most cases beside the base member and the slide member, a third member, the indicator or cursor, is applied to facilitate operation. Slide rules in general are of two types: One with a fixed base, a movable slide and a movable indicator. This type is conventional, mostly used in straight and also in circular slide rules and could be characterized as the standard type slide rule. The other type has two movable parts, the base and the slide and a fixed indicator. This fixed indicator indicates the two arguments in a computation, for instance, in a multiplication, the multiplicand and the multiplier, and the result too. This type of computer is not popular, mainly because the movable members have to be moved singly and also sometimes in unison.

This invention uses two indicators: one hand-operated for the two arguments of the computation, as for instance for the multiplicand and multiplier, and the other one for the result, which is fixed and automatic in operation.

Other objects of the invention and the means for their attainment will be hereinafter more fully described and one embodiment of the invention, by which the invention may be realized, is illustrated in the accompanying drawings.

It is already known to provide computing devices of the circular slide rule type with a fixed permanent indicator (for all factors and the result) at an annular segmental opening.

In the accompanying drawings:

Figure 1 is a plane view showing the face of the computer;

Figure 2 is a sectional view of it;

Figure 3 shows the selected and disposed scales for the solution of spherical triangles;

Figure 4 indicates a spherical triangle, illustrative of the solutions of the spherical triangles by this invention;

Figure 5 shows the selected and disposed scales for the solution of computations with fractional, percentage, and decimal values.

In all figures the scales are indicated with main divisions. The subdivisions, with few exceptions, are not indicated.

In the one embodiment of this invention shown in said figures, the computer consists of a base member 1 which has at its outer edge a forwardly direct flange 15. Circular ring 3 is accommodated by base member 1 and within flange 15. It is fixed to the base member by screws 7. Ring 3, it will be understood, is an integral part of the base member 1 and will be referred to as base member, as well as base member 1 itself, which holds ring 3 in place. Ring member 2 is in front of base member 1 and within ring 3, concentric with them. Ring member 2 is held in place by the base members 1 and 3, which also provide for the bearing surface for rotation. Ring member 2 has on its front and outer edge a circular recess, which fits in in the inner circular edge of ring 3. Ring 2 is rotatable around the center of the device. Its inner edge is built up as an internal gear, which matches and coacts with pinion 5. Pinion 5 is firmly secured by screws 13 to driving knob 6. The internal gear on the ring 2, the pinion 5, and knob 6 comprise a driving mechanism for the rotation of ring 2. By rotating knob 6, pinion 5 and ring gear 2 are also rotated. Knob 6 and pinion 5 are carried by result indicator member 4, yet to be described. Result indicator member 4 has a circular hole in it at 14, in which the recessed part of knob 6 fits in. The circular ring surface 14 of this hole serves as bearing surface for rotation of knob 6. Result indicator member 4 is in front of ring member 2 and concentric with it. It is accommodated by base member 1 and secured to it permanently by screws 8. It has a circular offset ring part 12 on its rear face which fits over the circular offset ring part 10 of housing member 1, at 9 and 11. These offset ring parts of housing member 1 and result indicator member 4 are discontinued at 25 and 26 to accommodate pinion 5. Result indicator member 4 has an opening and a transparent window 17 in it, which exposes parts of the scales on ring member 2. Window 17 has in its middle a fine scratched line 24; all results of any kind of computation are indicated at this line 24, which is vertical and permanent in position. It will be understood, that reading the results in the result indicator means to read them at this indicator line 24. The invention has a second indicator 18, called the peripheral indicator, which travels on the periphery or outer part of base member 1 on flange 15 and groove 27, which provide the circular paths for the peripheral indicator. The paths are free from any interference of other parts of the device and are in the full circumference of the device. The peripheral indicator consists of parts 18 and 19, which are clamped together by screws 20 and held in place and in spaced relationship by part 21. Spring 22 acts radially and outwardly and holds the indicator against its path on flange 15 and groove 27. It has a transparent plate 16 fixed to it, which has a fine scratched line 23 in its middle. The peripheral indicator is used to set and read the scales on ring 3 and the exposed outer scale of ring member 2, to be described hereinafter.

Figures 1 and 2 show the selected and disposed scales for simple computations. Scale "A" is a standard logarithmic scale on base member 3, fixed in position. Scales "B," "C" and "D" are standard logarithmic scales, placed on ring member 2 and rotate with it. These latter scales are identical with scale "A," except scale "C," which is inverted with respect to scale "A" and also with respect to scales "B" and "D." All four scales, "A," "B," "C" and "D," are of the same modulus. Scale "B" is exposed in its full length, but scales "C" and "D" are concealed by result indicator member 4, except at the indicator window 17, where they are exposed. By moving ring member 2 and with it the three scales "B," "C" and "D" thereon, their relative position changes with respect to scale "A" on one hand, and to the result indicator 24 on the other hand. The base scale "A," the three slide scales "B," "C" and "D," and the fixed indicator 4, 24, constitute a co-operative system in such a way that the results of any computation are indicated at the permanent result indicato 24. This result indicator shows the results of any computation and their reciprocal values: Scale "C" is for the results, scale "D" for the reciprocals of the same results, both being indicated automatically, simultaneously, in the same permanent result indicator 24.

The procedures for simple divisions, multiplications, and for the respective reciprocal are demonstrated in illustrative examples hereinafter.

In Figure 3 are shown scales "E," "F" and "G," selected for solutions for spherical triangle problems. Scale "E" is on base member 3 and is fixed. It is a logarithmic haversine scale for angles from 1° 10′ to 180°. Haversine, it will be understood, is the name of the expression $\frac{1 - \text{cosine A}}{2}$ for Angle A. This scale will give natural haversines in connection with scale "G," yet to be described, from 0.0001 to 1.0. Scales "F" and "G" are on ring member 2 and are rotatable with the ring member together. Scale "F" is a logarithmic cosine scale for angles from 89° 59′ to 0° and gives natural cosines in connection with scale "G" from 0.0001 to 1.0. Scale "G" is a logarithmic scale for numerical values, for numbers from 0.0001 to 1.0, comprising, in the present embodiment of this invention, a scale of four logarithmic unit lengths. Scales "E," "F" and "G" are of the same modulus; scale "G" is inverted with respect to scales "E" and "F."

Scale "G" is divided by dividing lines into four quadrants, corresponding to its four logarithmic unit lengths. Each unit length is labeled by a numeral, corresponding to the numerical values in the unit: the first quandrant contains numbers from 1.0 to 0.1, and is labeled with the numeral 1; the second quandrant represents numbers from 0.1 to 0.01, and is labeled by the numeral 2; the third has numbers from 0.01 to 0.001, and is labeled by 3; and the fourth has numbers from 0.001 to 0.0001, and is labeled by 4. In all cases the labeling numbers determine and indicate the position of the first figure in the numbers with respect to the decimal point. Thus, in quadrant 1, the first figure has the first place from the decimal point, as in 0.1, in quadrant 2, the second place from the decimal point, as in 0.01, and so on. The labeling of the four logarithmic unit lengths determines thus the absolute values of the respective natural haversines, required in the additional and subtraction involved in the haversine method for the spherical triangles, described hereinafter.

For spherical triangles, this invention applies the haversine method, which is simple, fast and direct. The formula states, with reference to Figure 4, that:

$$\text{Hav } a = \text{Hav A} \times \cos(90^\circ - c) \times \cos(90^\circ - b) + \text{Hav }(c-b);$$

and

$$\text{Hav A} = \frac{\text{Hav } a - \text{Hav }(c-b)}{\text{Cos }(90^\circ - c) \times \cos(90^\circ - b)}$$

The haversine formula implies an addition or subtraction of two numbers involving natural haversines. These numbers may be in the range of 0.1 to 0.01, or 0.01 to 0.001 or 0.001 to 0.0001 or 1.0 to 0.1. With prior slide rules the position of the decimal point or in other words the absolute value of the natural haversine had to be estimated mentally. This invention determines the position of the decimal point automatically by the scales themselves by labeling the scales with numerals 1, 2, 3 and 4, indicative of the decimal point position of the number appearing on the scales so labeled, and thus eliminates the mental estimation of the position of the decimal point. A further advantage of the solution is that the natural haversines are shown in a permanent indicator (24) (not shown in Fig. 3) and in vertical positions.

The scales "E," "F" and "G" and result indicator 24 comprise a co-operative system and create a new method of solving spherical triangles. The procedure is demonstrated in an illustrative example hereinafter.

Figure 5 shows the scales "H," "J," "K" and "L," for computations involving fractional and decimal values of numbers. Scale "H" is for numbers from 1 to 100 and with fractional sub-divisions. It is on base member 3 and fixed in position. Scales "J," "K" and "L" are on rotatable ring member 2 and rotate with it. Scale "J" is identical with scale "H," that is, it is a scale with fractional subdivisions. The fractional subdivisions are partly shown between the numbers 1 and 2, and 10 and 12. Scale "K" is for percentage values between 10 and 1000, and has subdivisions in the decimals of the numbers, as is partly shown between the numbers 100 and 200. Scale "L" is a numerical scale for numbers between 0.1 and 10, with decimal subdivisions and is inverted with respect to the other scales. All beforementioned scales are logarithmic scales, of the same modulus and concentric.

Scales "H," "J," "K" and "L," with the result indicator 4, 24, (not shown in Fig. 5), comprise a co-operative system for computations in which proportions of fractional numbers and their reciprocals are expressed in percentage and in decimal values, with the results indicated at a permanent result indicator.

Illustrative examples are presented hereinafter to demonstrate the new solutions and procedures of this invention. In the examples, the term "index," it will be understood, means the initial point of scales "B," and "F," marked with an arrow in Figures 1 and 3. Set in alignment two graduations on two adjacent scales, means, to bring the respective graduations opposite to each other.

Illustrative Example 1.

Relates to a simple division.

Division: $\frac{4}{2} = 2$ Reciprocal: $\frac{2}{4} = 0.5$

Solution:

Set 4 on scale "A" in alignment with 2 on scale "B,"

Read result in result indicator at 24 = 2 on scale "C," and the reciprocal of the quotient 0.5 on scale "D."

Illustrative Example 2.

Multiplication.

$2 \times 4 = 8$

Solution:

Set index of B to 2 on scale "A,"

Move indicator line 23 to 4 on scale "B,"

Move index of B to indicator line 23,

Read in result indicator at 24 result = 8.

In Examples 1 and 2 the results are indicated in the fixed result indicator, at a permanent location of the indicator and in vertical position.

Illustrative Example 3.

Relates to the solution of a spherical triangle, in which two sides and the included angle are given and the three unknown parts are required. The triangle is shown in Figure 4.

Given: $A=48°$; $b=58°$ $(32°)$;
$c=105°$ $(75°)$, $(15°)$; $c-b=47°$.

Required to find "a," B and C.

The solution is based on the haversine formula, given hereinbefore.

The right hand side of this formula consists of two parts:

The first part is:
$\text{Hav } A\times\cos(90°-c)\times\cos(90°-b)=$
$\text{Hav } 48°\times\cos 15°\times\cos 32°.$

The second part is:
$\text{Hav }(c-b)=\text{hav } 47°.$

Solution of the first part:
Set index of scale "F" to 48° on scale "E,"
Indicator 23 to 15° on scale "F,"
Index to indicator 23,
Indicator 23 to 32° on scale "F,"
Index to indicator.
Read result=0.1351, in the first quadrant, in result indicator at 24.

Solution for the second part:
Set index to 47° on scale "E,"
Read result=0.159, in result indicator at 24 in first quadrant.

Third step:
Add the two results:

$$\begin{array}{r} 0.1351 \\ 0.159 \\ \hline 0.2941 \end{array}$$

Set 0.2941 in result indicator at 24, in first quandrant.
Read angle "a"=65° 40′ on scale "E" opposite index.

The procedure for the determination of angles B and C is similar, except that one subtraction of natural haversines is required.

Illustrative Example 4.

Relates to computations with fractional and decimal values. Proportions of fractional numbers are expressed in percentage and their reciprocals in decimal values.

Given:

Proportion in Fractions:	Reciprocal in Fractions:
$\dfrac{1\frac{1}{8}}{1\frac{1}{4}}$	$\dfrac{1\frac{1}{4}}{1\frac{1}{8}}$

Required:

Percentage of Proportion:	Proportion in Decimals:
90	1.112

Solution:
Set in alignment
$1\frac{1}{4}$ on scale "H"
$1\frac{1}{8}$ on scale "J"
Read percentage of proportion=90 in result indicator 24 on scale "K" and reciprocal proportion=1.112 in result indicator at 24 on scale "L."

In this solution the percentage and reciprocal are indicated at the same permanent indicator line 24 and in vertical position.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. A computer comprising a fixed circular base member having thereon a logarithmic scale; a rotatable ring member in front of and within the base member, having one outer and two inner logarithmic scales thereon, one of said last two scales being inverted with respect to the other scales; a result indicator member in front of the ring member, fixed to the base member and of a diameter to conceal an inner marginal part of the ring member and the scales thereof and having an annular segmental opening in alignment with said inner concealed scales of the ring member to expose to view parts thereof: and a movable peripheral indicator, supported by the outer edges and outer cylindrical surface of the base member.

2. A computer comprising a fixed circular base member having thereon a logarithmic haversine scale; a rotatable ring member in front of and within the base member, having an outer logarithmic cosine scale and an inner logarithmic numerical scale thereon, said last scale being inverted with respect to the first said two scales; a result indicator member in front of the ring member, fixed to the base member and of a diameter to conceal an inner marginal part of the ring member and the logarithmic numerical scale thereof and having an annular segmental opening in alignment with said numerical scale to expose to view parts thereof: and a movable peripheral indicator, supported by the outer edges and outer cylindrical surface of the base member.

3. A computer as claimed in Claim 2, in which the logarithmic haversine scale is for angles from 1° 10′ to 180°: the outer logarithmic cosine scale on said rotatable ring member is for angles from 89° 59′ to 0° 0′ and the inner logarithmic numerical scale is divided into four parts of equal length for numbers from 0.0001 to 1.0, each part being marked by limiting lines at its start and end and designated by a numeral indicative of the position of the figure in the number in relation to the decimal point in it.

4. A computer as claimed in Claim 1, in which the logarithmic scale on said base

member has fractional subdivisions, the outer logarithmic scale on said ring member has fractional subdivisions identical with those on said first scale and the two inner logarithmic scales have decimal subdivisions, of which one is of percentage values and the other of numerical values, the last said scale being inverted with respect to the other three scales, whereby the proportions of fractional values are indicated in percentage and their reciprocals in decimal values at the fixed result indicator.

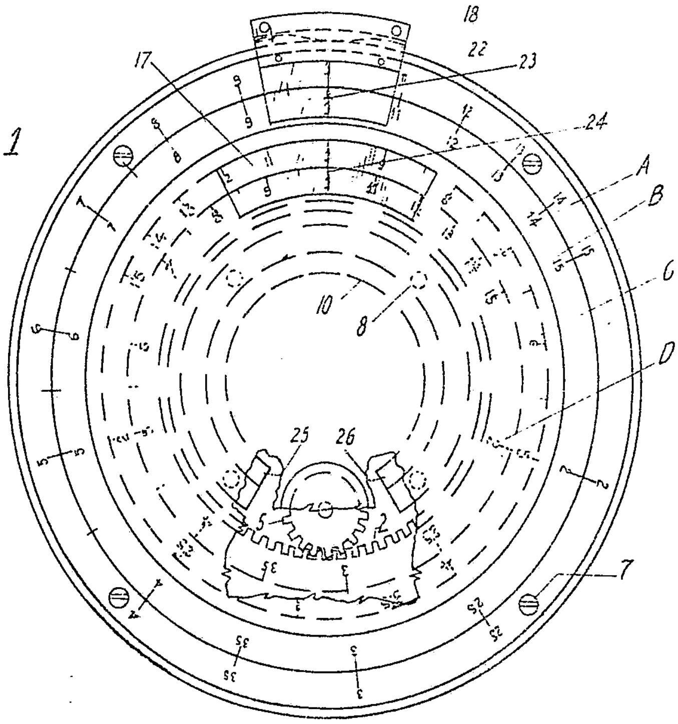
5. A computer as claimed in Claim 1, in which the rotatable ring member is peripherally supported, said ring member is built as an internal spur gear, and said result indicator member accommodates on its face a driving knob which in turn holds a driving pinion placed at the rear face of the result member, said pinion being in contact with the internal gear of the ring member.

Dated the 31st day of March, 1947.

HASELTINE, LAKE & CO.,
28, Southampton Buildings,
London, England,
and
19/25 West 44th Street, New York, U.S.A.,
Agents for the Applicant.

Abingdon : Printed for His Majesty's Stationery Office, by Burgess & Son (Abingdon), Ltd.—1951.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which
ies, price 2s. per copy ; by post 2s. 1d. may be obtained.

Fig.1


18
22
23
17
24
A
B
C
D
10
8
25
26
7

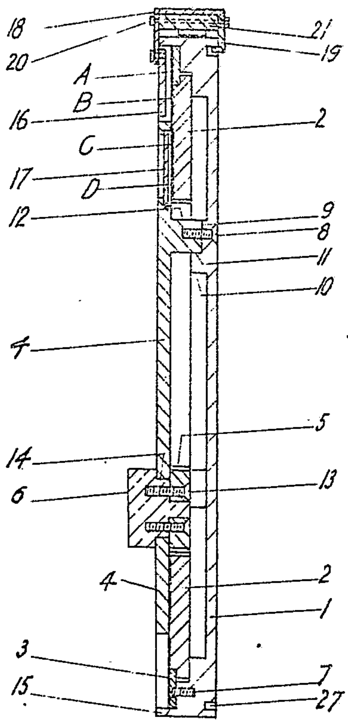

18
21
20
19
A
B
16
2
C
17
D
12
9
8
11
10
4
5
14
13
6
2
4
1
3
7
15
27

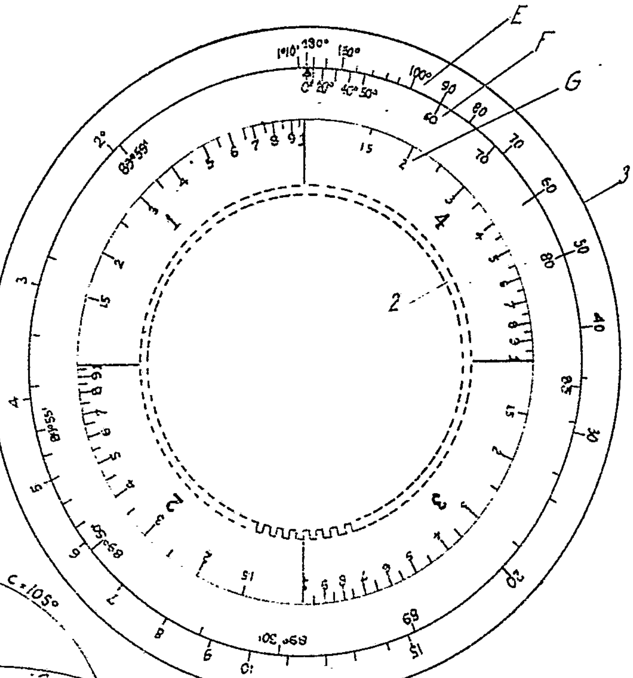
Fig.2

2 SHEETS

SHEET 2

SHEET 1

Fig. 3



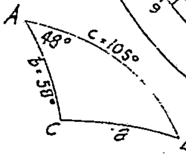


Fig. 4

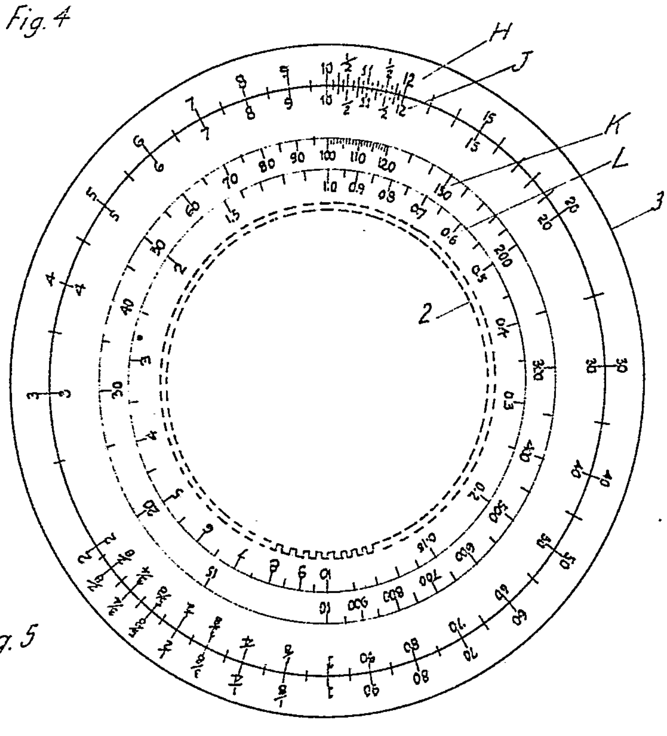
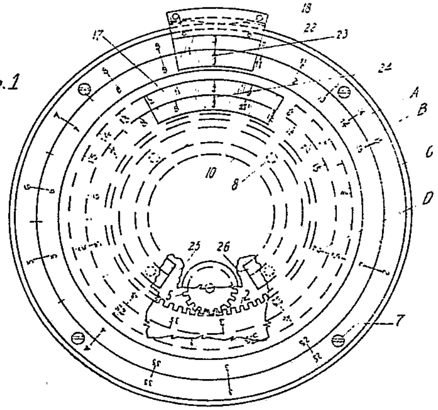


Fig. 5

SHEET 1

Fig. 1



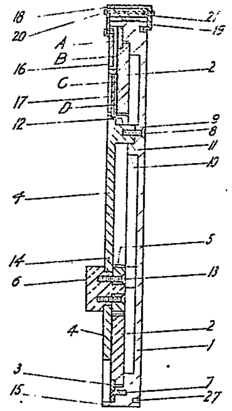


Fig. 2

SHEET 2

Fig. 3

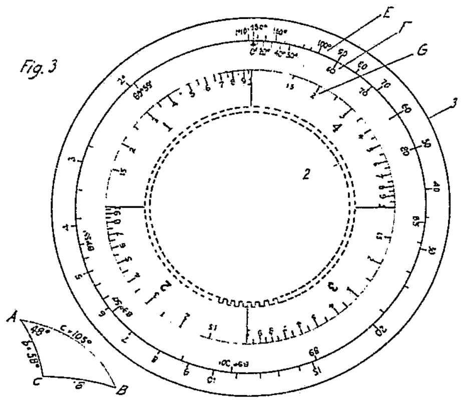


Fig. 4

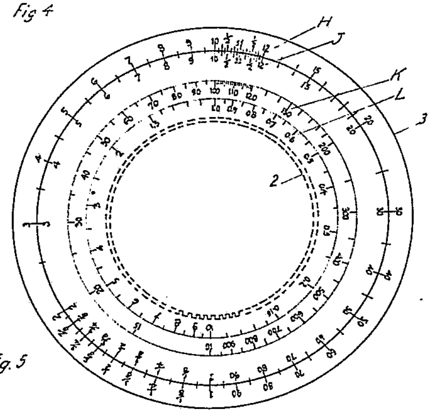


Fig. 5

[This Drawing is a reproduction of the Original on a reduced scale.]