W. J. MEAD.

GEOLOGIST'S CALCULATING DEVICE.

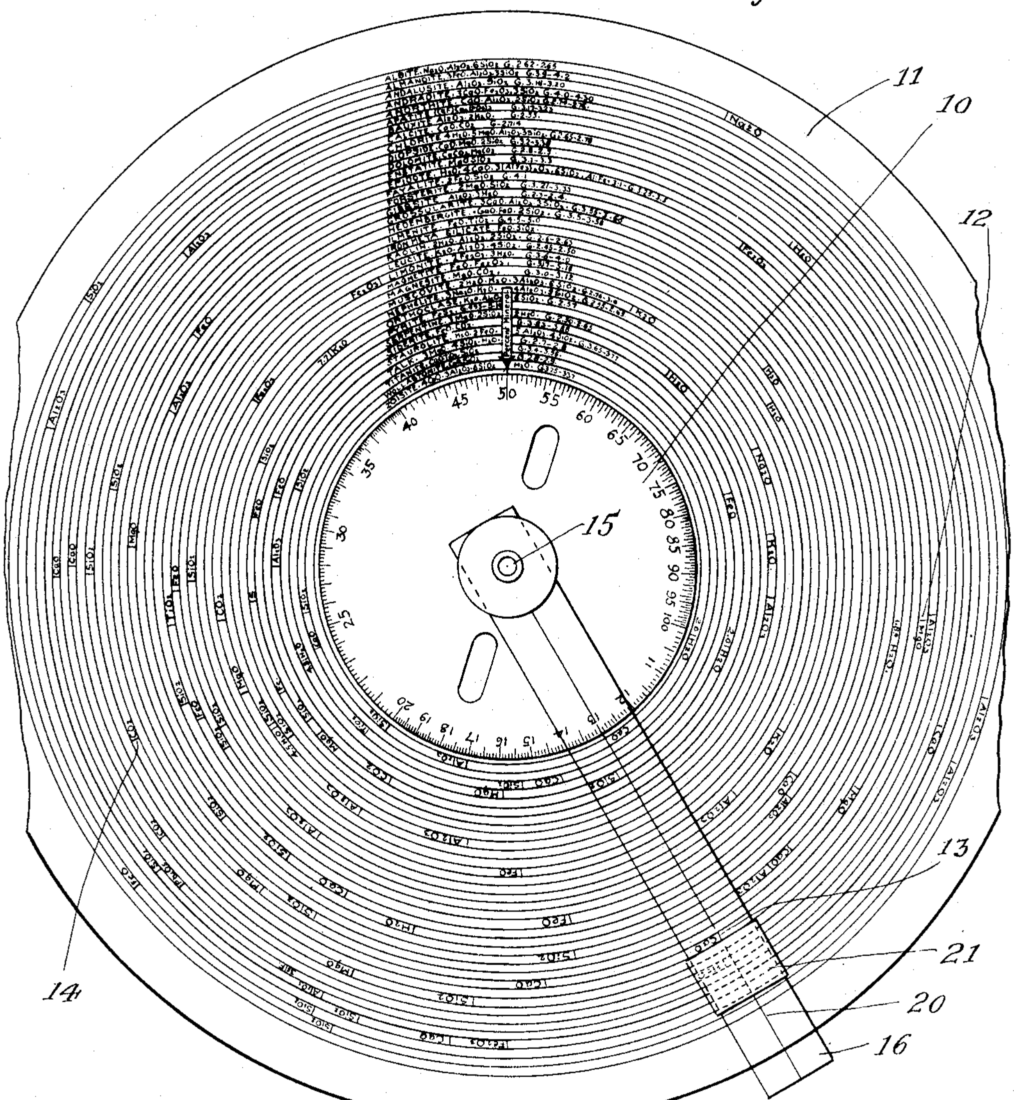
APPLICATION FILED MAR. 19, 1912.

1,171,741.

Patented Feb. 15, 1916.

2 SHEETS—SHEET 1.

Fig. 1.



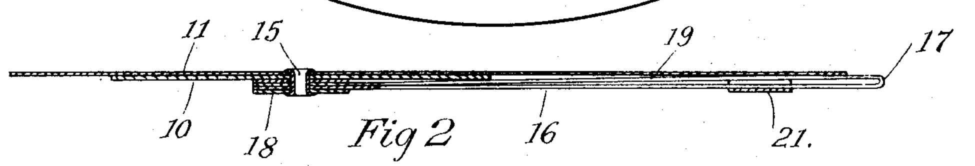


Fig 2

Witnesses:
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Inventor:
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THE COLUMBIA PLANOGRAPH CO., WASHINGTON, D. C.

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2 SHEETS—SHEET 2.

Fig. 3.

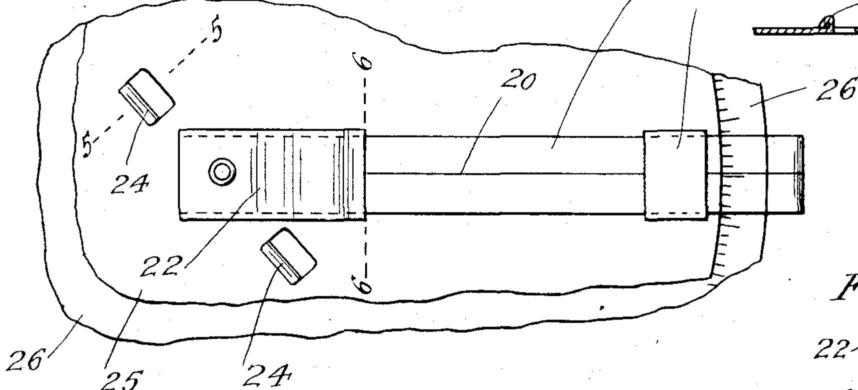


Fig. 5

Fig. 6.

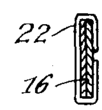


Fig. 4.

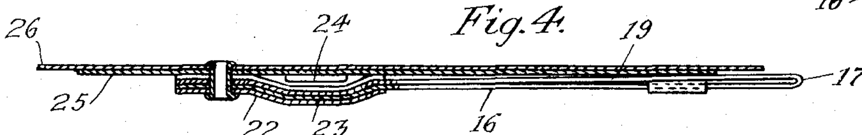


Fig. 8.

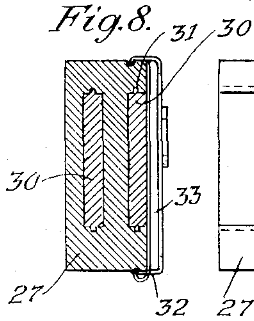
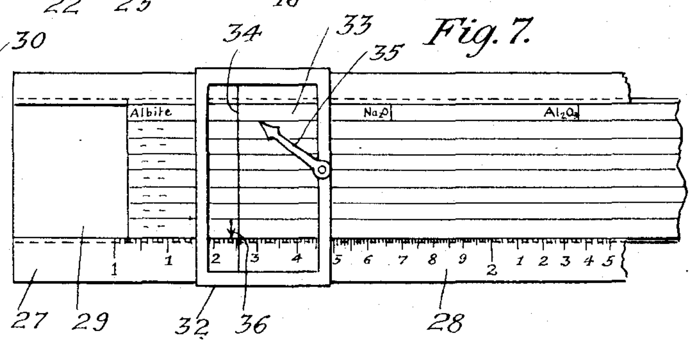


Fig. 7.



MINERAL COMP.		CHEMICAL ANALYSIS.													
Minerals	% Wt.	SiO_2	Al_2O_3	Fe_2O_3	FeO	CaO	MgO	Na_2O	K_2O	H_2O+	TiO_2	P_2O_5	CO_2	SO_3	
		9.15	5.85	77.35						7.65					
Kaolin	14.80	6.90	5.85							2.07					
		2.25	×							5.58					
Quartz	2.25	2.25													
		×													
Limonite	38.40			32.80						5.58					
				44.55						×					
Hematite	44.55			44.55											
				×											
	100.00														

Fig. 9.

Witnesses:
Thos. Lagaard
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THE COLUMBIA PLANOGRAPH CO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

WARREN J. MEAD, OF MADISON, WISCONSIN.

GEOLOGIST'S CALCULATING DEVICE.

1,171,741. Specification of Letters Patent. Patented Feb. 15, 1916.

Application filed March 19, 1912. Serial No. 684,853.

To all whom it may concern:

Be it known that I, WARREN J. MEAD, a citizen of the United States, residing at Madison, in the county of Dane and State of Wisconsin, have invented certain new and useful Improvements in Geologists' Calculating Devices, of which the following is a specification.

My invention relates to a logarithmic calculating device for use of geologists.

As is well known, in making chemical analyses of rocks it is impossible to determine directly the mineral constituents of the rocks. Chemical analyses ordinarily give the composition of the rock in terms of oxids; that is, the composition of the rock as determined by chemical analysis is certain percentages of different metallic and nonmetallic oxids, which include the essential constituents of the rock but, of course, do not indicate the minerals entering into the rock, as the same oxids are found in many of the several minerals found in the same rock. To determine the mineral constituents from the chemical analysis requires an extremely extended and laborious numerical computation, involving reduction of the oxids to their molecular ratios, combining these ratios properly and then reconverting the molecular ratios of the mineral combinations to terms of percentage weight.

It is the object of my invention to provide means for making the above calculations without the need of numerical computation, in which, given the analysis of a rock in terms of its oxids, the geologist can readily and with reasonable accuracy, by a process of elimination, obtain the percentages of the mineral constituents of the rock. The reverse operation can, of course, be made with equal facility. That is, if the percentages of minerals entering into a rock are known the true percentages of the oxids in each of said minerals can be read from the calculator and by combining the same the total percentages of all of the oxids in the rock may be obtained. To accomplish these results I provide logarithmic scales, one of which shall be a complete circular scale numbered from 10 to 100 in the usual manner, the other scales each applying to a distinct mineral having pointed thereon lines indicating on the scale logarithmically the true percentage of the different oxids composing the mineral, these lines being designated on the scale by the symbol of the oxid and no figure. There will be in the latter or mineral scales as many of said scales as there are minerals of common or usual occurrence and it is practical and within the scope of my invention to include in a single calculating device practically all of the known distinctive minerals, although for general purposes scales covering those of more common occurrence will be sufficient. The two sets of scales are made relatively movable, that is, the complete numbered scale will be on one disk and all of the mineral scales concentrically positioned on another disk either within or without the numbered scale. Or straight sliding scales may be employed, one moving within the other. The radial line passing through an arrow marking its position on the mineral scales indicates the point of beginning and ending of said scales. The complete numbered scale is made to occupy a position in which the number 100, or its beginning and ending point, will fall in this line and the percentage position of the oxids for each mineral will be indicated on the mineral scale by the radial line passing through the corresponding number on the numbered logarithmic scale. The points for the oxids of the different mineral scales are thus determined from the numbered scale when its beginning and ending point is positioned in the radial line corresponding to the beginning and ending point of the mineral scale and indicated by the aforesaid arrow. If then the scales be relatively rotated or moved until the percentage of a given oxid found in a chemical analysis on the numbered scale comes in the radial line indicating the position of the said oxid on the mineral scale, the aforesaid beginning line or arrow will point to the figure representing the per cent. of the mineral in the substance of which the analysis was made.

In the drawings, representing a form of embodiment of my invention, Figure 1 is a plan view of a calculating device constructed in accordance with the principles of my invention. Fig. 2 is a partial sectional view taken through the radial marker. Fig. 3 is a fragmentary view showing the numbered scale outside of the mineral scales and special means for holding one scale disk for relative rotation with respect to the other. Fig. 4 is a partial section through the marker of the structure shown in Fig. 3. Fig. 5 is a section on line 5—5 of Fig. 3. Fig. 6 is a section on line 6—6 of Fig. 3. Fig. 7 is a plan and Fig. 8 a transverse section of a longitudinally extended right line scale embodying my invention. Fig. 9 is a diagram showing the manner in which, from the percentages of oxids found by chemical analysis of a given rock, the mineral constituents of said rock may be obtained.

The scale comprises primarily a disk 10 on which the completely numbered logarithmic scale appears and a disk 11 on which a series of concentric mineral scales are indicated. The disk 10, as shown in Fig. 1, is centered at the centers of the scales on disk 11 and the scale on the disk 10 runs to the circular edge thereof and is positioned inside of the inner scale on disk 11. The arrow marked "Per cent. mineral" on the disk having the mineral scales falls in the radial line corresponding to the beginning and ending of such scales. Each mineral scale is marked with the name and symbol of its oxid constituents and also with figures representing the specific gravity of that mineral, as albite,

$$Na_2O_3.Al_2O_3.6SiO_2., G. 2.62–2.65,$$

almandite, etc. The mineral scales have markings only for the oxid constituents thereof and these markings are found in the following manner: The numbered scale is positioned with the point 100 at the arrow. The percentages of oxids in the mineral are then read on the numbered scale and radial lines protracted from such number across the space bounded by two concentric circles comprising the particular mineral scale, each of said lines being designated by the symbol of the oxid for which it stands. Thus, take the mineral dolomite composed of calcium and magnesium carbonates, the pure mineral contains 21.7 per cent. of magnesium oxid, 30.4 per cent. of calcium oxid and 47.9 per cent. of carbon dioxid. With the numbered scale having the point 100 at the arrow, the radial line passing through the mark indicated by 21.7 on the numbered scale is protracted across the annular space between the two circles forming the dolomite scale and marked MgO, as indicated at 12, the radial line extending through the point on the numbered scale marked 30.4 is similarly protracted and marked CaO, as indicated at 13, and the radial line passing through the point 47.9 on the numbered scale is marked CO_2 on the dolomite scale as indicated at 14. By the same procedure each of the named mineral scales is produced, which thus provide markings indicating positions on the scale corresponding to the percentage composition of the oxids forming the mineral if read radially to the numbered logarithmic scale when the same is positioned with the mark 100 at the arrow representing the beginning and ending of the mineral scales.

Upon the centrally pivoted member 15 by means of which disks 10 and 11 are secured together, is pivoted a marker arm 16, which in practice may be composed of a single strip of celluloid or other transparent material doubled upon itself as indicated at 17 and having the free ends secured between washers to the pivot post 15, as plainly shown at 18 in Fig. 2. Upon the inside member 19 of the marker arm a radial line 20 is marked. The marker arm is freely rotatable independently of either of the disks and can be positioned so that the radial line 20 thereon will fall upon any of the short radial indications of the oxids on the various mineral scales. In order to carry the marker arm accurately around so as to indicate for any particular mineral scale, I secure to the outer arm 16 a slide 21 of aluminum or any other opaque material, said slide being adapted to be positioned on the line marking the outside circular boundary of any mineral scale, in which position as the arm 16 is carried over the disk 11 the markings on the particular mineral scale employed for a given calculation will be accurately indicated just inside of the inner edge of slide 21.

In Figs. 3 to 6, inclusive, in place of the washers shown at 18 in Fig. 2 a special clamping member 22 is employed which may be of a single piece of metal bent as indicated in Fig. 6, or a pair of such pieces united at the edges, but which comprises an arched portion 23 carrying the inner face of said member away from the plane of the adjacent disk to allow for clearance of thumb pieces 24 formed, as is clearly indicated in Figs. 3 and 5, by striking up and turning over a portion of the metal of the top disk. The transparent marker arm 16 will have its ends positioned in the holder 22, as clearly shown in Fig. 4, and by means of said holder the operative portion of the arm or that portion including the radial line 20 will be held in the plane of the scales while the thumb pieces 24 can be used to rotate one disk on the other or hold the disks so provided stationary while the other disk is relatively rotated.

In the construction shown in Figs. 3 and 4 the mineral scales are formed on the up-per disk 25, the numbered scale being on a disk 26 of sufficiently larger diameter than disk 25 so that said numbered scale may be positioned with the markings extending radially inward to a circle falling outside of the outermost mineral scale. In practice this form of my invention will be the preferred form as it will enable the mineral scales to be drawn in closer to the center and will give sufficient extent to the numbered scale so that the divisions may be made comparatively small.

It will be noted that in forming the mineral scales, in certain instances the true percentage of an oxid constituent will be less than 10, as, for example, in epidote the true percentage of H_2O is 1.89. As there are no figures on the logarithmic scale between zero and 10 it is necessary, in order to read from the scale, to find a position on the mineral scale for the particular oxid opposite to the number on the complete scale corresponding to the true percentage with the decimal point advanced one, or, in the case cited, to the mark numbered 18.9. In order to indicate on the scale that the decimal point has been advanced one so that in reading percentages the operator may be apprised of that fact and point back properly for obtaining the true reading, I have in such cases inserted before the mark indicating the oxid the true percentage (less than 10) of the given oxid.

In the form of my invention shown in Figs. 7 and 8 I use right line scales instead of circular scales, as in the other forms. For this purpose I provide a straight block 27 having a numbered logarithmic scale 28 of usual form along one margin thereof and extending to the edge of a cavity 29 provided in the face of the block 27. The mineral scales are formed upon slides 30 formed with central tongues 31 for registry in corresponding grooves in the side walls of the cavity 29. The slides 30 have mineral scales upon each side thereof, there being in the example given eight of said scales on each face of the slide. The sets of scales on the different faces of the slides are interchangeable so that where two such slides are employed, as indicated in Fig. 8, the one not in use being positioned in a pocket in block 27, thirty-two mineral scales are available. Mounted to slide upon the top of block 27 and scale slide 30 positioned therein is a member 32 provided with a transparent face 33 having a right line 34 marked thereon and extending at right angles to the edge of the scale 28. A pointer arrow 35 is pivoted to the member 32 so as to be capable of swinging and indicating whichever one of the mineral scales is being used. An arrow 36 falling in the line which is at the beginning of the mineral scales points toward the logarithmic scale. It is obvious that the principle of operation of the right line calculating device above described is similar to that of the circular scale, except that the circular arrangement permits a larger number of minerals to be grouped in a readily accessible form, is more compact and somewhat more convenient in use.

In operation, take for example the showing in Fig. 1, suppose a certain analysis to show 13 per cent. of calcium oxid present in connection with the mineral dolomite. By setting the slide 21 on the outer circle and the line 20 of the arm 16 on the radial line for CaO of the dolomite scale, and then relatively rotating the numbered scale so as to bring the mark numbered 13 beneath the line 20, it will be seen that the arrow "Per cent. mineral" points to the number on the scale corresponding to 42.7, which indicates that in the particular rock analyzed 42.7 per cent. of the rock is composed of the mineral dolomite. On the other hand, if the percentage of dolomite in a given rock or compound were known to be 42.7, by setting the numbered scale so that the arrow would point to the mark 42.7 and then rotating the arm 16 so as to bring the radial line over the mark indicating CaO, the number 13 will be read, when over the mark MgO the number 92.3 will be read, or having in mind the proper position of the decimal point and pointing back one, the number 9.2, while by carrying the line 20 over the CO_2 mark the number 20.5 will be read, thus showing that a compound having 42.7 per cent. of dolomite has of the oxid constituents of dolomite 9.2 per cent., of MgO, 13 per cent. of CaO and 20.5 per cent. of CO_2.

The method of using my calculating device in calculating mineral constituents of rocks from chemical analyses showing the total content of oxids is illustrated in the diagram in Fig. 9. Supposing an analysis of an iron bearing rock to show 77.35 per cent. of ferric oxid (Fe_2O_3), 5.85 per cent. aluminum oxid (Al_2O_3), 9.15 per cent. silica (SiO_2), and 17.65 per cent. water (H_2O), the geologist knowing that kaolin is the only mineral which in such a group of oxids could contain the aluminum oxid places the slide 21 on the arm 16 so as to come opposite to the kaolin scale circle and carries the arm about until the radial line thereon falls above the short line marked Al_2O_3, then rotates the mineral scale until the mark corresponding to 58.5, that is, 5.85, falls beneath the radial line, then reading from the arrow marked "Per cent. mineral" the number 14.85 is read from the numbered scale which is the amount of the mineral kaolin present in the particular rock analyzed. The word "Kaolin" followed by the percentage of the mineral 14.85 is written at the right of the diagram, as indicated in Fig. 7. Since kaolin also contains silica and water the radial line is carried over the mark designated SiO_2 in the kaolin scale and, with the numbered scale still set so that the arrow indicates 14.85 as the per cent. mineral, 6.9 is read therefrom, which indicates the amount of silica present in the kaolin. In the same way, reading from the scale, 2.08 is found to be the percentage of water in the kaolin. These figures are entered below the original figures in the columns designated SiO_2 and H_2O, respectively, and subtracted therefrom leaving 2.25 per cent. of silica, 5.57 per cent. of water. Since the Fe_2O_3 has not been applied its percentage of 77.35 may be brought into the same horizontal line with the remainders of silica and water. Of the remaining oxids silica does not occur in any mineral compound in which the other oxids of the analysis are found, so it follows that the remaining 2.25 per cent. of silica must exist in the rock as quartz, which accordingly is set down in the column at the left. There is now left 77.35 per cent. of Fe_2O_3 and 5.57 per cent. of water. Limonite is the only compound containing ferric oxid and water. Hence, 5.57 per cent. of water must have existed in the mineral limonite. By setting the slide 21 above the mineral scale of limonite and carrying the same around until the radial line falls over the mark designated H_2O then rotating the numbered scale until the mark indicated by 55.7, or 5.57, comes under the radial line, it will be noted that the arrow indicating the per cent. mineral points to the mark on the numbered scale corresponding to 38.25, which is the amount of the mineral limonite present in the rock. The word limonite together with the percentage 38.25 is written in the column at the left of the diagram. By the use of the pointer with reference to the limonite scale it is shown that 38.25 per cent. of limonite contains 32.5 per cent. of Fe_2O_3, which leaves a total of 44.85 per cent. of the ferric oxid. As this is an oxid with nothing else to combine therewith, it must be in the form of the mineral hematite, so that the particular rock analyzed is found to have contained 14.75 per cent. of kaolin, 2.25 per cent. of quartz, 38.25 per cent. of limonite and 44.85 per cent. of hematite. By using the rule in the above manner the geologist who has some familiarity with the probable minerals existing in any given rock can from the chemical analysis of the rock obtain the percentages of the minerals to be found therein.

I claim:

1. A geologist's calculating device comprising two relatively movable members, one formed with a completely numbered logarithmic scale, the other comprising an extended plane surface adjacent said scale line, said surface being ruled with a multiplicity of parallel lines, the spaces between each adjacent pair of parallel lines having therein the designation of a definite mineral compound, said extended surface having marked thereon an indicator at the beginning of all of said parallel spaces and extending perpendicularly across the same and pointing perpendicularly to the scale edge, each of said spaces being ruled across with lines perpendicular to said scale edge and so positioned relative to said indicator and the scale as to indicate the logarithmic percentage positions with reference to the scale of the different oxid constituents of said minerals and being designated in said spaces by the chemical symbols of said oxids, and a member movable uniformly along said scale and said spaces having an indicating line extending transversely across the same.

2. A geologist's calculating device comprising two concentric disks pivotally connected for relative movement, one having marked thereon a complete circular logarithmic scale, the other comprising an extended plane surface limited in one direction by the line of said scale, said surface being ruled with a multiplicity of concentric circles, the spaces between each adjacent pair of circles having therein the designation of a definite mineral compound, said extended surface having marked thereon an indicator representing the beginning of all said concentric spaces and extending radially across the same and pointing radially to the scale edge, each of said concentric spaces being ruled across with radial lines so positioned relative to said indicator and the scale as to indicate the logarithmic percentage positions with reference to the scale of the different oxid constituents of said minerals and being designated in said spaces by the chemical symbols of said oxids, and an arm mounted for independent rotation about the common center of and having a radial line extending across said scale and said concentric spaces.

3. A geologist's calculating device comprising two concentric disks pivotally connected for relative movement, one having marked thereon a complete circular logarithmic scale, the other comprising an extended plane surface limited in one direction by the line of said scale, said surface being ruled with a multiplicity of concentric circles, the spaces between each adjacent pair of circles having therein the designation of a definite mineral compound, said extended surface having marked thereon an indicator representing the beginning of all said concentric spaces and extending radially across the same and pointing radially to the scale edge, each of said concentric spaces being ruled across with radial lines so positioned relative to said indicator and the scale as to indicate the logarithmic percentage posi-

tions with reference to the scale of the different oxid constituents of said minerals and being designated in said spaces by the chemical symbols of said oxids, an arm mounted for independent rotation about the common center of and having a radial line extending across said scale and said concentric spaces, and a marker slidable along said arm to be positioned at the margin of any selected concentric space.

In testimony whereof I affix my signature in presence of two witnesses.

WARREN J. MEAD.

Witnesses:
F. E. WILLIAMS,
V. C. FINCH.