PATENT SPECIFICATION

337,487

Application Date: Aug. 9, 1929. No. 24,344/29.

Complete Left: May 9, 1930.

Complete Accepted: Nov. 6, 1930.

PROVISIONAL SPECIFICATION.

An Improved Logarithmic Calculator of the Cylindrical Type.

I, GODFREY THOMAS GARWOOD, of 7, High Street, Lyndhurst, Hampshire, and of English nationality, do hereby declare the nature of this invention to be as follows:—

My invention consists of a logarithmic calculator or slide rule, designed to carry out substantially the same range of mathematical operations as may be performed on common slide rules of the Mannheim type, & comprising essentially a cylindrical stock, usually about one inch in diameter by about eleven inches long over which is closely fitted a transparent tubular sleeve or slide capable of being moved longitudinally and rotationally in relation to the stock. The slide is approximately one third the length of the stock.

The scales of the calculator are of the sectional or "gridiron" type, the sections of the fixed scales being engraved or otherwise marked along lines parallel to the axis of the cylindrical stock, whilst the sections of the single moveable scale are similarly engraved or marked on longitudinal opaque strips attached to or forming part of the tubular slide. Spaces between the opaque strips referred to enable the scales of the stock to be seen through the tubular slide, and placed in any desired relation to the scales marked thereon. The opaque strips are equally spaced circumferentially.

The arrangement of scales which I employ in my invention is as follows:

The surface of the cylindrical stock is divided by four circumferential lines (which may be continuous or discontinuous) into three divisions of equal length. The middle division is the principal division, and on it is marked a logarithmic scale of one decade divided into six sections arranged each parallel to the axis of the stock and equally spaced circumferentially.

An exactly similar scale of one decade is marked on the opaque strips, hereinbefore referred to, on the tubular slide. These two scales, on the stock & slide respectively, can, by relative movement of the stock & slide, be placed in any desired additive or subtractive relation, and thus enable multiplication, division and allied operations to be carried out by the same process & in essentially the same manner as is employed with common slide rules.

On the left-hand division of the stock there are three scales. The first is a logarithmic scale of one decade divided into three sections, the circumferential spacing of the sections being the same as that of the main logarithmic scale on the middle stock division.

The second is a logarithmic scale of one decade divided into two sections, again with the same circumferential spacing.

By placing the sections of the two scales last above referred to opposite the relevant sections of the scale on the slide, the squares or cubes respectively of the numbers on the slide may be read on the stock; or, by a converse operation, the square roots or cube roots. The third scale on the left hand division of the stock is a uniformly graduated scale in six sections corresponding to the mantissae of the logarithms of the numbers on the slide scale. The sections of this last scale have the same circumferential spacing as is employed in all the scales previously referred to, but in order that they may not be confused with the remaining two scales on the left hand division of the stock, they are displaced circumferentially so as to fall midway between the sections of these two scales. The effect of this arrangement is that, if the scale on the slide is placed alongside the "mantissae" scale on the stock, the opaque strips on the slide obscure the logarithmic scales on the left-hand division of the stock. Similarly, if the scale on the slide is placed alongside either of the two logarithmic scales on the left-hand division of the stock, the "mantissae" scale is in turn hidden by the opaque strips on the slide.

On the right-hand division of the stock there are two scales. The first, or "sine" scale is in six sections, equally spaced circumferentially, the graduations thereof being proportional to the logarithms of the sines of angles running

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from sine $^{-1}0.1$ to sine $^{-1}1.0$. The second, or "tangent" scale, is also in six sections, equally spaced circumferentially, but displaced by a circumferential angle of 30 degrees from the sections of the "sine" scale, & having graduations proportional to the logarithms of the tangents of angles running from tangent $^{-1}0.1$ to tangent $^{-1}1.0$.

By placing the slide scale opposite the "sine" scale, the sines of any of the angles marked thereon may be read directly opposite on the slide scale, the tangent scale being hidden by the opaque strips on the slide. By rotating the slide through an angle of 30 degrees, the sine scale is hidden, & the tangent scale is brought alongside the slide scale, so that the tangent of any angle marked on the tangent scale may be read directly opposite on the slide scale.

It is my intention to incorporate in my invention an important improvement over all existing sectional-scale, logarithmic calculators, whereby the well-known difficulty of reading and interpolating values at or near the extremities of the sections of the scales may be overcome; that is to say, instead of beginning and terminating each scale section at the transverse lines which would normally form the limits of the sections, it is my intention to extend the sections slightly beyond these lines where necessary, thus making redundant those portions of the scales which extend beyond the limits of the transverse lines. The utility of this arrangement is that it completely avoids interrupting the continuity of the scale graduations of the sections at their extremities.

In order to mark readings on the slide scale, I may equip the slide with a cursor or runner, consisting of a transparent band, engraved with a circumferential line or with one or more pointers, which is capable of being moved longitudinally along the slide.

Dated the 2nd day of August, 1929.

G. T. GARWOOD.

COMPLETE SPECIFICATION.

An Improved Logarithmic Calculator of the Cylindrical Type.

I, Godfrey Thomas Garwood, of 7, High Street, Lyndhurst, Hampshire, and of English nationality, 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:—

My invention relates to that type of logarithmic calculator or slide rule which is constructed in cylindrical form, and is illustrated in the accompanying drawing of which Figure 1 is an elevation of the complete instrument, Figure 2 a developed view of the stock, & Figure 3 a developed view of the slide. The scale graduations in the drawings are only partially shown.

The cylindrical stock *a* is usually about one inch in diameter by about eleven inches long over which is closely fitted a tubular or tube-like sleeve or slide *b* capable of being moved longitudinally & rotationally in relation to the stock. The slide is approximately one-third the length of the stock.

The scales of the calculator are of the sectional or "gridiron" type the sections of the fixed (i.e. stock) scales being marked along lines parallel to the axis of the stock, whilst the sections of the single moveable scale are similarly marked on longitudinal strips *c* attached to or forming part of the slide. Spaces *d* between these longitudinal strips (which are opaque) enable the scales of the stock to be seen through the slide & placed in any desired relation to the scales thereon. The opaque longitudinal strips are equally spaced circumferentially.

The arrangement of the scales employed in my invention is as follows:—

The surface of the cylindrical stock is divided by four circumferential lines *e* (which may be continuous or discontinuous) into three divisions of equal length. The principal of these three divisions is the middle division on which is marked a logarithmic scale *f* of one decade divided into six gridiron sections arranged each parallel to the axis of the stock, & equally spaced circumferentially.

An exactly similar scale of one decade is marked on the opaque strips (six in number) hereinbefore referred to as being attached to or forming part of the slide. These two complete sectional scales, on the stock & slide respectively, can, by moving the slide relatively to the stock, be placed in any desired additive or subtractive relation, & multiplication, division & allied operations may thus be carried out by the same process & in substantially the same manner as is employed in the case of common Mannheim slide rules.

On the left hand division of the stock,

there are three scales, as follows.

The first is a logarithmic scale *g* of one decade, divided into three sections, the circumferential spacing of these sections being the same as that of the sections of the main logarithmic scale on the middle stock division.

The second is a logarithmic scale *h* of one decade divided into two sections, again with the same circumferential spacing.

By placing the sections of the two scales last above referred to opposite the proper sections of the scale on the slide, the squares or cubes respectively of the numbers on the slide may be read on the stock; or, by a converse operation, the square roots or cube roots.

The third is a uniformly graduated scale *i* in six sections corresponding to the mantissae of the logarithms of the numbers on the slide scale. The sections of this last-mentioned scale have the same circumferential spacing as is employed in all the scales previously referred to herein, but in order that the separate scales may not be confused the sections of the mantissae scale are displaced circumferentially from the sections of the remaining scales by an angle of 30 degrees. The effect of this arrangement is that when the scale on the slide is placed alongside the mantissae scale, the " square " & " cube " scales are hidden by the opaque strips of the slide. Similarly, if the " square " or " cube " scales are brought alongside the slide scale, the mantissae scale is in turn hidden.

On the right-hand division of the stock there are two scales. The first, or " sine ", scale *j* is in six sections, equally spaced circumferentially, & graduated in a series of angles, running from sine $^{-1}0.1$ to sine $^{-1}1.0$. The linear distances from the beginning of the sine scale to the marks or graduations corresponding to various angles are proportional to the logarithms of the natural sines of those angles. Hence, by placing the slide scale alongside the sine scale, the sines of any of the angles marked on the latter, may be read directly opposite on the former.

The second of the two scales on the right-hand division of the stock is a " tangent " scale *k*, the graduations of which are spaced from the beginning of the scale at distances respectively proportional to the logarithms of the natural tangents of the angles marked thereon. The tangent scale is in six sections equally spaced circumferentially, & each displaced from the adjoining sections of the sine scale by a circumferential angle of 30 degrees. The range of angles on the tangent scale is from tangent $^{-1}0.1$ to tangent $^{-1}1.0$, & by placing the slide scale alongside the tangent scale, the tangents of any of the angles marked on the latter may be read directly opposite on the former scale.

I reserve the right to interchange the positions of any of the stock scales hereinbefore described.

It is my intention to incorporate as an essential feature of my invention an important improvement whereby the well-known difficulty experienced in existing sectional scale calculators of reading or interpolating values at or near the extremities of the scale sections is avoided; that is to say, instead of terminating each scale section at the circumferential lines, which otherwise would constitute the limits of the sections, it is my intention to prolong the scale sections beyond these circumferential boundary lines to an extent sufficient in each case to complete the otherwise interrupted division, thus making redundant those portions of the scales thus extended. In order that the scales on the three stock divisions may not by this arrangement run into & confuse one another, the scales belonging to any particular stock division are bodily displaced circumferentially (as shown in Figure 2) from those of the neighbouring division.

I may incorporate in my invention a cursor or runner *l* consisting of a tubular or substantially tubular sleeve or band embracing the slide & capable of longitudinal & rotational movement in respect thereto, & equipped with one or more pointers or markers; or, if the cursor is transparent, with a circumferential line.

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

A logarithmic calculator, consisting of a cylindrical stock divided into three divisions, a moveable slide of tubular or tube-like form & equipped if desired with a cursor or runner, the stock & slide being engraved or marked with sectional logarithmic scales having redundant section endings, the whole being substantially as & for the purpose hereinbefore described. & as shown in Figures 1, 2 & 3 of the accompanying drawing.

Dated the 8th day of May, 1930.

G. T. GARWOOD.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1930

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

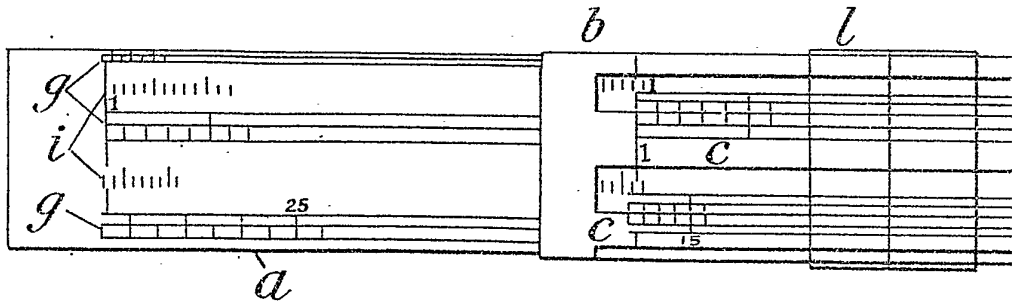

Fig. 1

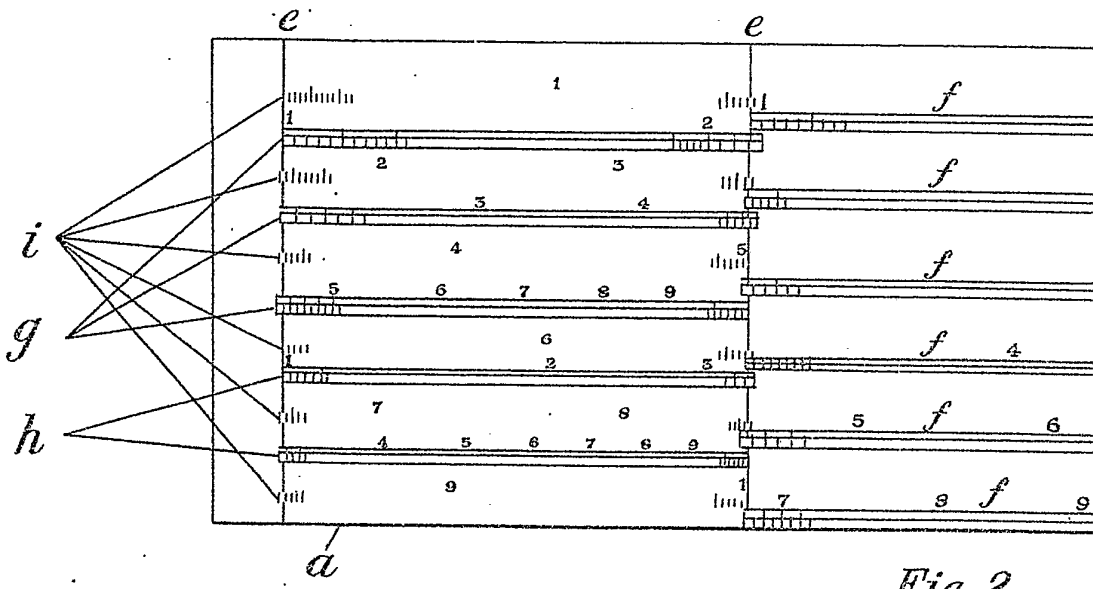

Fig. 2

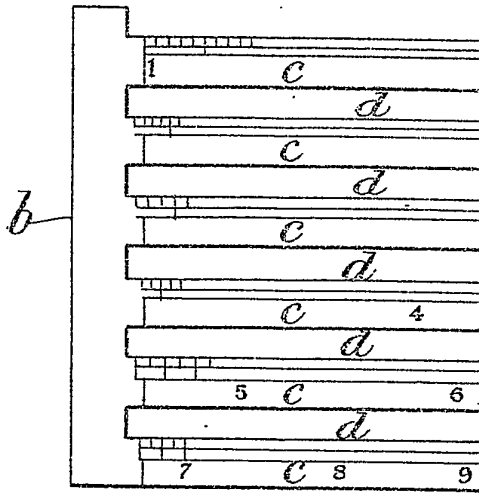

Fig. 3

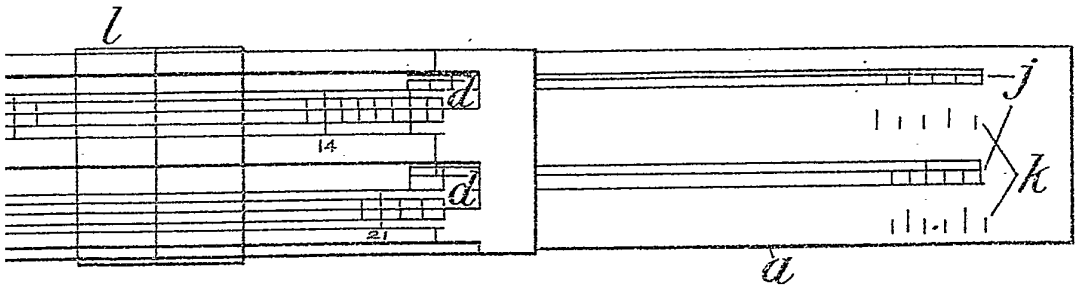

Fig. 1

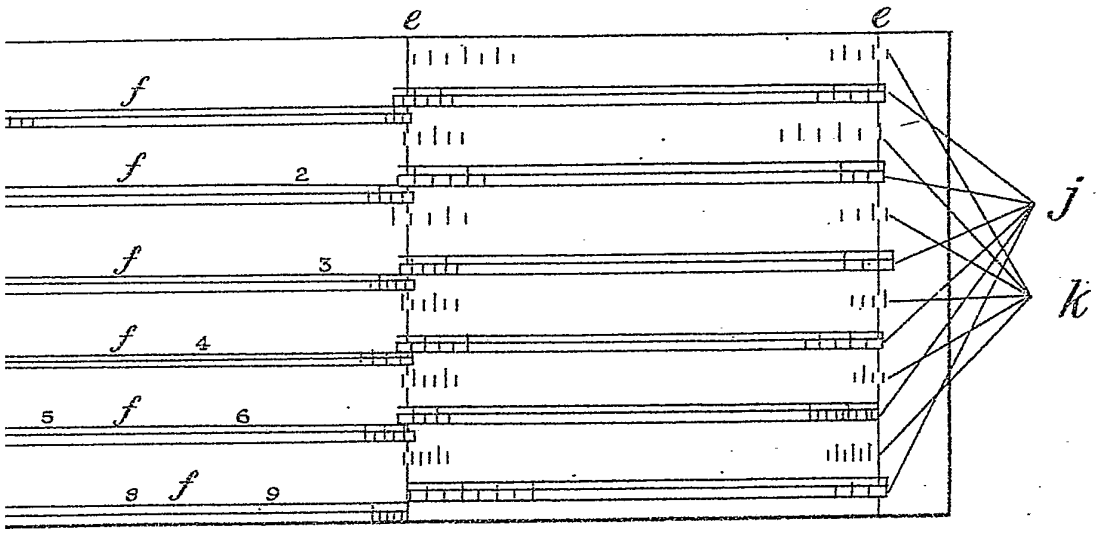

Fig. 2

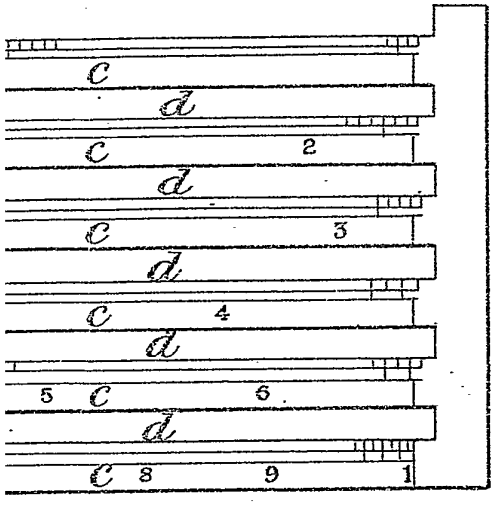

Fig. 3

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

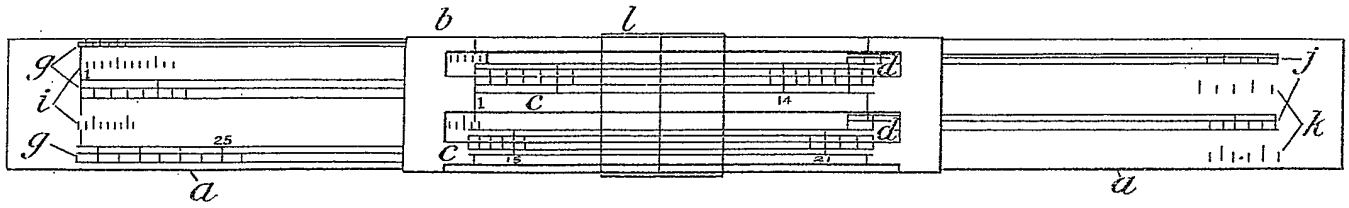

Fig. 1

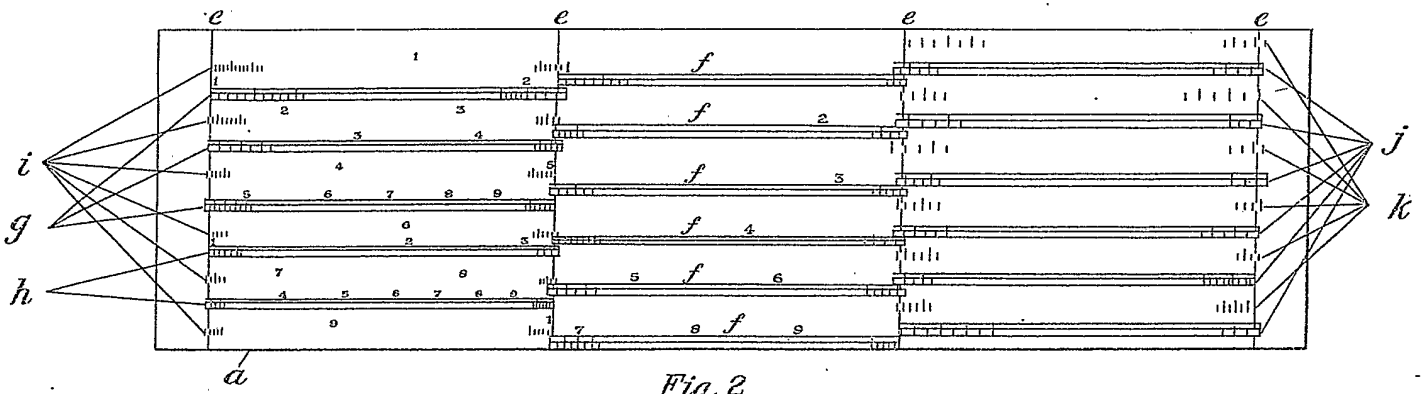

Fig. 2

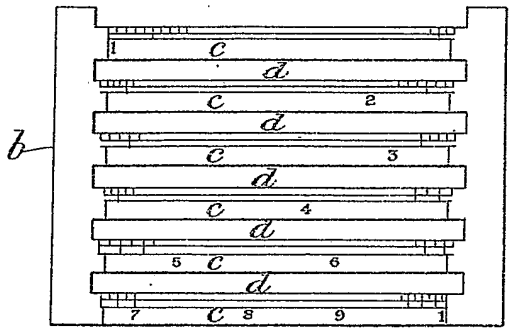

Fig. 3

Charles & Read Ltd. Photo Litho.