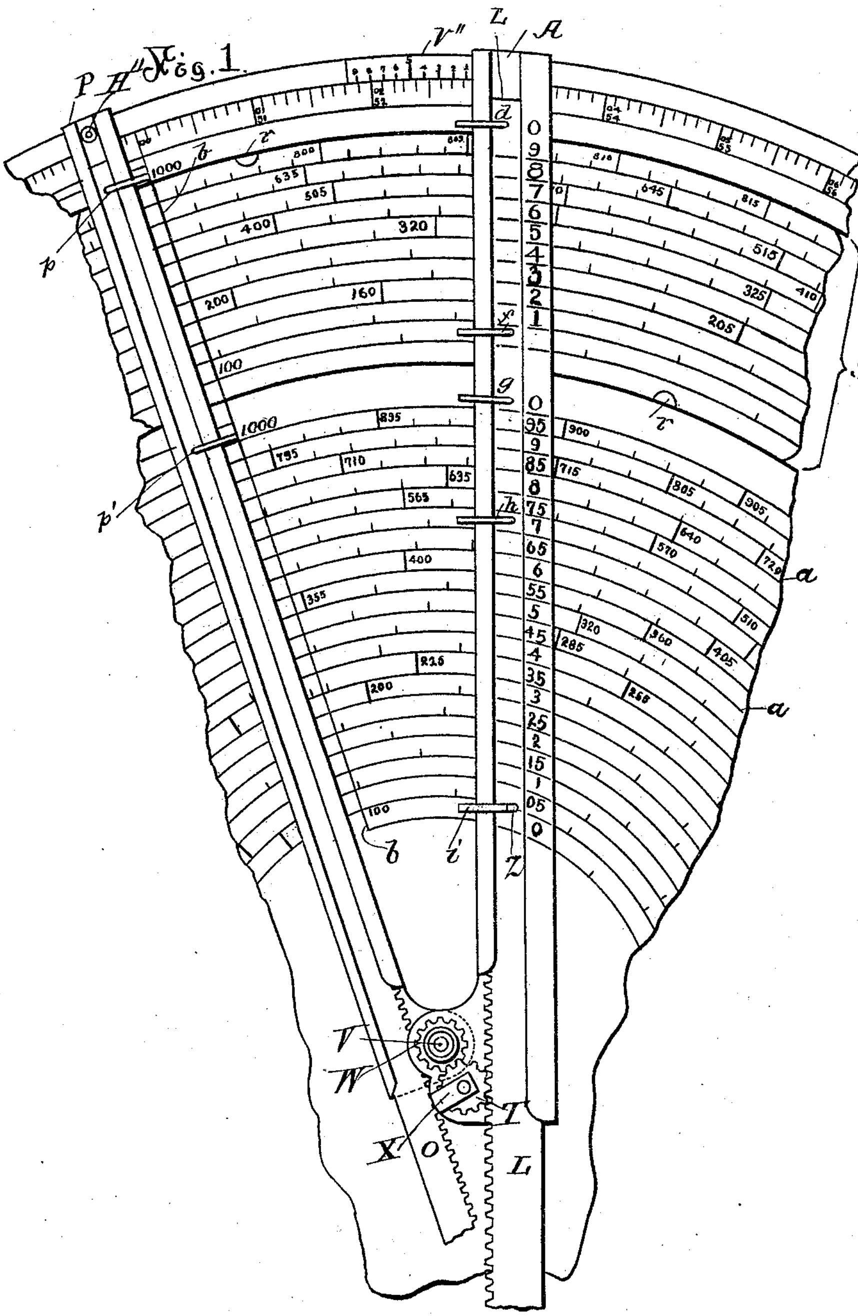
(No Model.) 2 Sheets—Sheet 1.

J. MICHAELSON.

COMPUTING INSTRUMENT.

No. 556,761. Patented Mar. 24, 1896.

Fig. 1



Witnesses:
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M. E. Harrison.

Inventor:
Joseph Michaelson,
by his Attorney,
Wm. L. Pierce.

(No Model.) 2 Sheets—Sheet 2.

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Fig. 2.

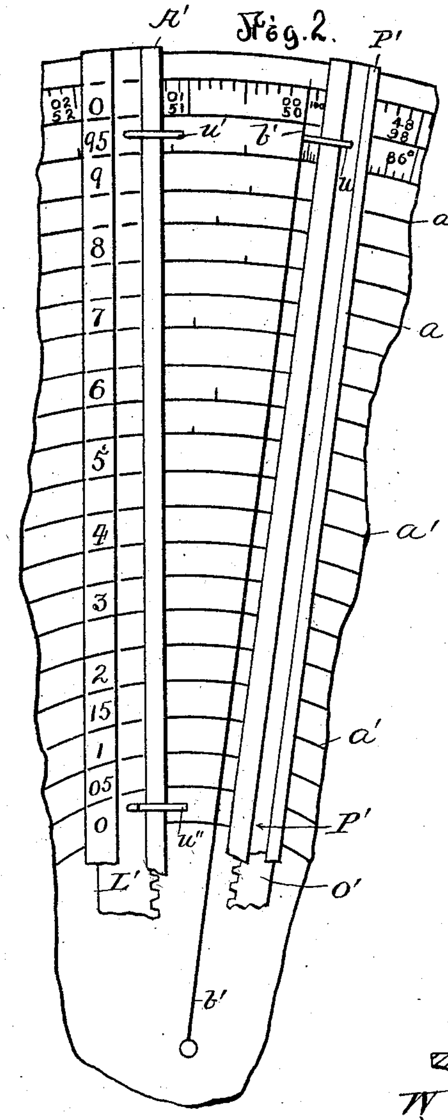
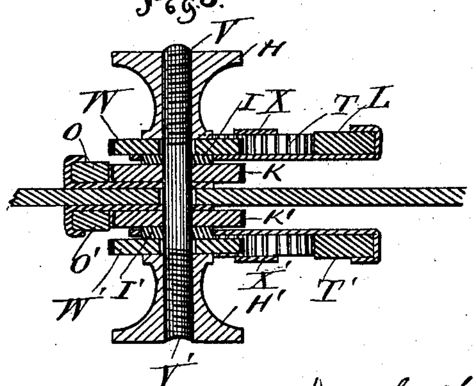


Fig. 3.



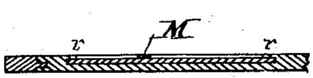


Fig. 4.

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UNITED STATES PATENT OFFICE.

JOSEPH MICHAELSON, OF NEW BRIGHTON, PENNSYLVANIA.

COMPUTING-INSTRUMENT.

SPECIFICATION forming part of Letters Patent No. 556,761, dated March 24, 1896.

Application filed May 2, 1894. Serial No. 509,760. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH MICHAELSON, a citizen of the United States, residing at New Brighton, in the county of Beaver and State of Pennsylvania, have invented or discovered new and useful Improvements in Computing-Instruments, of which the following is a specification.

In the accompanying drawings, which make part of this specification, Figure 1 is a plan view of a portion of my scale, the two arms, the sliding racks in said arms, and the gear for manipulating the latter. Fig. 2 is a view of the reverse side of the same, omitting the figuring. Fig. 3 is a vertical section through the shaft of the operative parts; and Fig. 4 is a vertical cross-section throughout the outer rim of Fig. 1, illustrating the mechanical construction of the rotating annulus dovetailed into the scale.

My invention, generally stated, relates to a mechanical logarithmic computer whereby multiplication, division, involution and evolution of numbers may be performed. Likewise the logarithm of any number may be determined and the antilogarithm of any logarithm, or any operation performed in which logarithms may be used advantageously. Further, multiplication, division, involution and evolution of any trigonometric function may be mechanically done. The natural trigonometrical function may also be determined.

The main difficulty with prior computers of this type lies in the fact that the number of antilogarithms increases for a constant increase in the logarithms. Prior scales have not been able to accommodate this increase without reducing the size of the subdivisions until finally they become practically imperceptible.

In the present application I show how a computer composed of a series of spirals or approximate spirals may be used to obviate the difficulty just recited. I also show certain novel details of construction in connection with the arms, slides and operative mechanism. I further show a scale consisting of either spirals or circles in two groups, the value of a complete rotation of the pointer in one group being a factor of the value of a complete rotation of the pointer of the other group. I overcome the disadvantages of slide-rules by using spirals or approximate spirals with increase of length corresponding approximately to the increase of the antilogarithms. Therefore my subdivisions of the scale in the higher numbers are virtually as large and as easily read as in the lower numbers. On the other hand, all slide-rules are practically limited in the number of their subdivisions. Likewise prior computers require double the number of scales which I use for accomplishing the same computation.

In the present application I further show a simple and rapid mechanical method of computing squares or any other desired power or root.

I will first describe the construction illustrated in Figs. 1, 2 and 3.

In the practice of my invention I take a sheet of suitable substance and mark upon the same a series of spirals or approximate spirals *a a* of any desired number, but preferably with a regular rate of increase. I then assume arbitrarily an initial line *b b*, running from center to circumference.

All numbers are on spirals which are designated by the leading figures, one or more, of the mantissas of the logarithms. Here the first spiral contains all divisions for logarithms between 0 and 05; but obviously this may be indefinitely varied. I next subdivide each of the spirals, so that the angular distance between the initial line and a line passing through the center and the number at that subdivision shall be proportional to the excess of the mantissas of the logarithm of the number above the number ascribed to the spiral on which the number falls. The first group of spirals I have shown as consisting of twenty. Outside of these I have likewise an annulus S of spirals, here shown as ten, similarly subdivided. Instead of spirals concentric circles may be employed for each group, and the inner group may be the power while the outer is the root. If desired, the annulus may be on one side of the scale, and the other group, of which it is a factor in relative value of revolutions, may be on the reverse side of the scale. In these outer groups, however, the value of a revolution is double the value of a revolution on one of the inner groups.

By the term "value of a revolution" I mean the algebraic or arithmetical value which is represented graphically by a complete revolution of the arms A A' P P', hereinafter described. This outer group may be on the scale integral with the inner group or on an annulus S, moved by thumb-piece M in a depression in the scale. (Seen in Fig 4.) The annulus is held from rising by guides *r r*. The outermost division of all is the vernier-circle, which is here shown as subdivided into fifty principal subdivisions and each of these into ten minor subdivisions, as seen clearly at periphery of Figs. 1 and 2. The vernier-circle has at each major division preferably two sets of figures, here differing from each other by fifty; but one set only may be employed. The vernier V'' is on a circle of its own and is connected rigidly to vernier-arm A and moves therewith. This is an arm revoluble around the center of the chart. On said arm A are short arcs corresponding to the spirals and numbered with the spiral-numbers. Within said arm A moves slide L, bearing five pointers *d*, *f*, *g*, *h* and *i*. The lower pointer, *i*, is hinged or pivoted at *z*, so as to swing back when passing the gear-wheels. A line through the outer ends of these pointers would pass through center of the scale. Slide L has upon its inner edge rack-teeth meshing with loose gear-wheel T, supported in bracket X and meshing with loose gear-wheel W upon shaft V. H is a threaded thumb-screw. I is a collar above a gear-wheel K fast on shaft V, meshing into the rack-teeth of a slide O in arm P. Upon the under side of the scale the same operative parts are repeated for the angle-scale—viz., T', X', W', V', H', I' and K'.

Slide O has two pointers *p p'* and clamping thumb-screw H''. H'' clamps arm P to the outer rim containing the vernier, which is fixed to arm A, thus keeping the arms A and P at any desired angle. On the reverse side of the sheet or on an independent sheet may be laid out in like manner a number of spirals *a' a'* with preferably constant increase, as seen in Fig. 2. These spirals in like manner are subdivided for angular distances from the initial line *b' b'*, corresponding to logarithmic sines or any other trigonometric function. The vernier-circle is similarly subdivided to the one described on the first sheet. This scale has also arms A' P', P' having a single pointer *u* and arm A' having two pointers *u'* and *u''*. The arms A' P' are marked with arcs of circles corresponding to spirals and numbered with the numbers of spirals. Arms A' P' have like racks L' O'.

The figuring and numbering are omitted on the reverse scale, being the same in principle as on the sheet first described.

The arms on the reverse sheet may be independent of the arms on the first sheet or may have a common rotation with them through any suitable connection, as shown in Fig. 3. They may also have a rotation independent of each other or a common rotation when clamped.

The operation of the scale will be understood from a series of examples, taking, first, the inner group of Fig. 1. For instance, to multiply 225 by 4, first set inner pointer, *p'*, on P at 1; second, bring pointer *i* on arm A to 225; third, clamp center and outer thumb-screws H H''; fourth, swing both arms and bring inner pointer, *p'*, down to 4; fifth, then the answer will be read at pointer *g* at 9.

To illustrate the use of the combination of the inner group of spirals with the spirals in the annulus S, take the problem of $2^2 \times 4$. Set pointer *i* on arm A at 200 on inner group of spirals, clamp both thumb-screws, swing both arms and move pointer *d* on A to 4. Then pointer *f* will be on answer.

The rule for determining the position of the decimal point when working with scale of Fig. 1 is that when pointer *g* stands at the answer the characteristic is one less than the sum of the digits before the decimal point; but when pointer *i* is at answer the characteristic is equal to the sum of the digits of both factors. By "characteristic" I mean, of course, the number of digits preceding the decimal point.

Computations may be made by adding or subtracting revolutions noted on pointers and reading result desired, which is either sum or difference, according as we are multiplying or dividing.

Division is performed by just inverse process.

Involution may be performed either as a continued product or by means of logarithms—viz., by reading logarithms and multiplying by power required, then reading antilogarithms.

Evolution is performed by reverse process.

To illustrate method of determining logarithm of any given number, find logarithm of 320. Any pointer on arm A is brought in line with 320. The mantissa of 320 is .50515, which is read as follows: The initial 5 is read on the arm at 320. The next two figures, 05, are read at the nearest large subdivision of vernier-circle just passed by arm A. The next figure, 1, is the minor subdivision following major subdivision of outer circle. The final 5 is read on vernier by reading, as usual, line on vernier coinciding with line on scale.

The antilogarithm is obtained by just the reverse operation.

On the reverse side, where the scale of the sines, &c., appears, the logarithmic functions are read the same as logarithms of numbers.

Multiplication, division, involution and evolution of logarithmic functions are performed in analogous manner to similar operations with numbers.

I claim—

In logarithmic computers, a scale subdivided into parts, two radial rotating arms pivoted to said scale, a slide upon each arm and clamp connections between said slides whereby when clamped a radial movement of one slide produces a radial movement of the other.

In testimony whereof I have hereunto set my hand this 19th day of April, A. D. 1894.

JOSEPH MICHAELSON.

Witnesses:

WM. L. PIERCE,

FLORA MCK. PIERCE.