March 25, 1924. 1,488,190

G. BLOCH

COMPUTING BOARD

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Fig. 1.

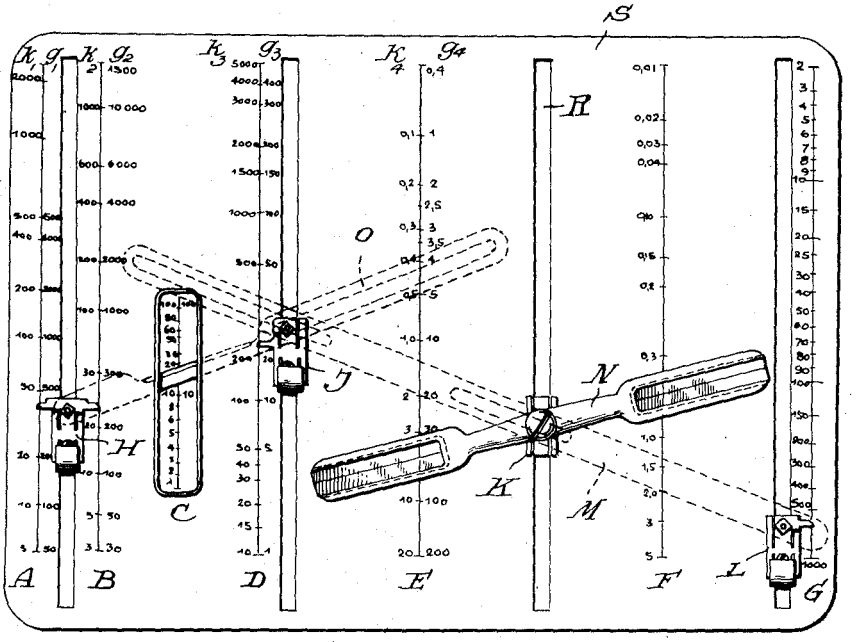

Fig. 2.

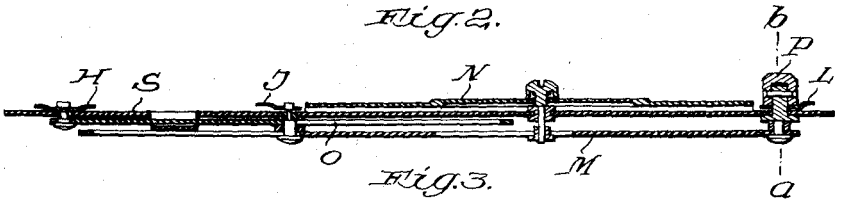

Fig. 3.

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Fig. 4.

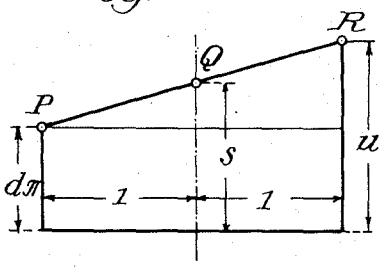


Fig. 5.

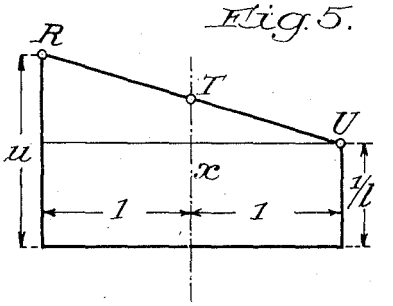


Fig. 6.

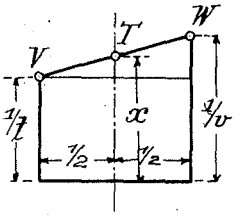
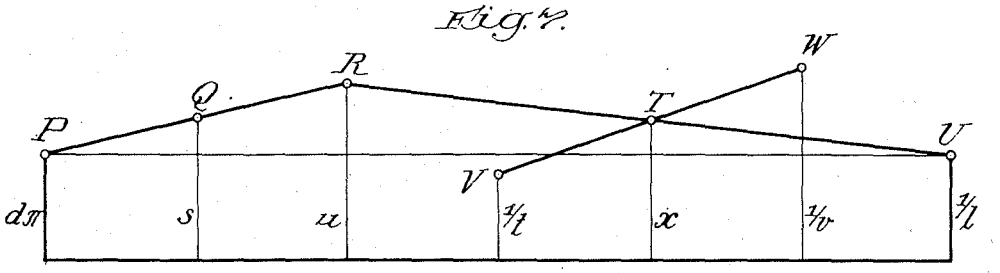


Fig. 7.



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Patented Mar. 25, 1924. 1,488,190

UNITED STATES PATENT OFFICE.

GEORG BLOCH, OF BOBLINGEN, WURTTEMBERG, GERMANY.

COMPUTING BOARD.

Application filed July 2, 1920. Serial No. 393,767.

To all whom it may concern:

Be it known that I, GEORG BLOCH, a citizen of Germany, residing at Boblingen, Wurttemberg, Germany, have invented certain new and useful Improvements in Computing Boards (for which I have filed application in Germany July 1, 1919), of which the following is a specification.

My invention relates to a computing board.

In ordinary practice it frequently happens that certain values have to be again and again computed according to one and the same formula, for example, when it is a question of determining the cutting periods in the case of machine tools and where the computation would be the following: Say, a steel spindle having a diameter of d=22 mm. and a length b=650 mm. is to be rough-planed at a cutting rate of c=18 m/minute with a feed f of 0.5 mm. per revolution, then the time t required, according to the formula

$$t=\frac{d.\pi l}{c.f}$$

and the number of revolutions r effected by the spindle per minute, will be:

$$r=\frac{c}{d.\pi}$$

Now it has already been attempted to get over the difficulty, which thus presented itself, by employing curve-templets, tables, and scales: however, the use of these instruments meant putting up with very big drawbacks, in particular, as they could not be employed without the aid of a rule and pencil. Besides, these curve-templets, etc., commonly constitute in and for themselves an illegible jumble of lines, particularly where, owing to constant use, they have been worn down so that the obvious want of clearness is still more increased. But, beyond this, this method of computation required closest attention to obtain a result entirely free from error. And, in conclusion, the attempt to ascertain the values required by these means can never be made except at a great loss of time.

For these reasons, use has already been made of computing boards or tables provided with slots in which slides were adapted to move in the longitudinal direction, these slides being mutually acted upon by means of a lever connection of any desired kind. However, tables of this description do not permit of the object above specified to be attained. For in the present instance it is a question of dealing with more than three variable quantities, whereas the previous arrangements, despite the use of four slides, will not admit of computations being made comprising more than three variables. It is true, that by a multiplex arrangement of adjacently disposed systems of this kind, the possibility would be afforded of computing more than three variables, but in that case decidedly unwieldly dimensions would be obtained, and besides it would be necessary to read off the result from a long series of separate slides.

Now by a peculiar combination of means, known per se, such as levers, indices, and slides moving in slots there is secured, by means of my present invention, the possibility of the result being ascertained in a most simple manner even in cases where more than three variable quantities have to be dealt with.

Subject to this invention, the said object is attained by a two-armed index being fixed to rotate on the central of three main slides adapted to move in slots, and of said slides communicating with each other by means of a lever.

However, my invention further renders it possible to compute values in a specially advantageous manner comprising a still greater number of variable quantities, and this by the provision of two additional slots, and of the slide moving in the one auxiliary slot being connected by a special lever, intersecting the other auxiliary slot, by means of a guide arrangement comprising, say, a pivot and link, with the adjacent main slide.

An embodiment of the subject matter of my invention is shown by way of example in the accompanying drawings in which—

Fig. 1 is a top view of the computing board or table.

Fig. 2 a cross sectional view thereof.

Fig. 3 a sectional view of a detail along line a—b in Fig. 2.

Figs. 4 to 7 serve to explain the calculations.

The arithmetical table S is provided with graduations or scales, which in size and partly also by their position are developed to represent scales of function according to the vanishing line system. In the case under notice scale A represents the length

of the cutting action in mm., B the diameter of the turning tool, milling cutter, or drill, according to whether the compution is to be based on a turning, milling, or drilling operation. C denotes the cutting speed in meters per minute, or in the case of planers and slotters, the mean speed at which the machine works. D represents the revolution of the turning tool, milling cutter, or drill, etc., the double working strokes being indicated in minutes. E is the work time in minutes; F the feed per revolution, per cutting operation in mm., and G the length of the work-piece, the depth of the hole, or the width of the planing action.

The computing table is further provided with slides H, T, K, and L, interconnected by means of levers O and M. The lever O, which is adapted to move across the slot containing scale C, and by means of which lever the values of the cutting speed indicated on said scale may be read off on an indicating knife edge, secured thereon, is pivoted to the slide H and provided at its unsupported end with a slot in which slide T is adapted to engage by means of a pivot. The lever M is pivoted to the slide L and likewise connected with slides K and T by means of a link arrangement.

The slides are adapted to move resiliently within their guides and may, after having been set, be locked in position by means of an eccentric reversible lever P (Fig. 3). The slides H, T and L are provided with indices, the points whereof are at a level with the centre of the pivot, and which serve to set the slides to certain determined values of the respective function scale. In contradistinction to the other scales, scale C is disposed beneath the table.

A two-armed lever N is arranged on the slide K above the table, said lever being provided at each of its arms with an opening in which a sheet of celluloid, having a central line of graduation, is inserted. These lines of graduation are disposed along a straight line in consonance with the point of rotation of slide K.

The scales A, B, D and E are each provided with two columns of figures k and g and suitable indices, the value of the one column of figures in each case representing ten times the corresponding value of the other column of figures. If, when the scales are set, the k values are employed, then obviously the result must be read off on the k column, and vice versa. This double arrangement of the scales is specially important for the purpose of enabling the scope of the computation to be increased, without increasing the size of the table.

This improved arithmetical table may be employed for all formulæ, it will, however, prove to be most useful in cases where a complicated formula has to be applied, and according to which computations have to be repeatedly carried out. For such cases, the use of this improved table will prove a great convenience and will mean a saving of time.

As stated in the introduction, the following equations are to be solved by means of the novel device, viz:

$$u=\frac{s\pi}{d} \quad \text{(Equation 1)}$$

$$t=\frac{d\pi l}{sv} \quad \text{(Equation 2)}$$

For solving the equations, scales of different graduation are disposed in parallel to the slots, and the figures to be used in the calculation are marked thereon. The relation of these scales to the lines in the drawing is as follows:

Scale A Fig. 1 corresponds to line d in Figs. 4 and 7.

Scale B Fig. 1, corresponds to line s in Figs. 4 and 7.

Scale D Fig. 1 corresponds to line u in Figs. 4, 5 and 7.

Scale E Fig. 1 corresponds to line l/t in Figs. 1, 6 and 7.

Scale F Fig. 1 corresponds to line l/v in Figs. 1, 6 and 7.

Scale G Fig. 1 corresponds to line l/l in Figs. 5 and 7.

The distance between two correlated scales may be as desired but should always be the same. (Figs. 4, 5, 6).

The graduation of the scales is equal to half the usual graduation in the central one of each three correlated scales. The scale is logarithmic and marked L′.

For the solution of equation 1, provided that the points P, Q, R are disposed on a straight line, the following relation may be derived from Fig. 4 according to the laws of proportionality:

$$\frac{L'u-L'd\pi}{\frac{L's}{2}L'd}=2/1 \text{ or}$$

$$L'u=L's-L'd\pi \quad \text{(Equation 3)}$$

As the graduation is logarithmic, we may substitute:

$$\text{Log } u=\log s-\log d\pi$$

When the corresponding angles are substituted for the logarithms, we find:

$$u=\frac{s}{d}\pi \quad \text{(Equation 1)}$$

As the several points of the graduations are connected by a rigid, straight-line system of levers, the above condition, that P, Q and R must be disposed on a straight line,

is fulfilled and it is therefore possible to make the calculation according to equation 1.

The second equation to be solved by means of the novel device, viz:

$$t=\frac{d\pi l}{sv} \quad \text{(Equation 2)}$$

contains 5 variables, t, d, l, s and v.

In order to facilitate the understanding of the calculations, a re-arrangement or disintegration will be necessary. In equation 2 the expression

$$\frac{s}{d}\pi$$

is substituted by u (see equation 1), and equation 2 is now transformed into:

$$t=\frac{l}{uv} \quad \text{(Equation 4)}$$

As there are still 4 variables, l, u, v and t, in equation 4, an auxiliary graduation x is employed. This graduation is not shown in Fig. 1 as it is not needed when using the device, but it is shown in Figs. 5 and 6 in order to explain the calculations.

It having been shown from Fig. 4 that

$$u=\frac{s}{d}\pi,$$

we find for Fig. 5:

$$u=xl \text{ or } x=u/l \quad \text{(Equation 5)}$$

It further follows from Fig. 6 according to the same rules of proportionality that:

$$l/v=tx \text{ or } x=\frac{l}{v}\,\frac{l}{t} \quad \text{(Equation 6)}$$

The derivations from Figs. 5 and 6 apply under the same condition which was laid down for Fig. 4 that is, that the points R, T, U or V, T, W must be disposed on a straight line. This condition is fulfilled by the rigid system of levers. When the values from equations 5 and 6 are equalled, we find:

$$u/l=\frac{l}{v}\,\frac{l}{t} \text{ or } t=\frac{l}{uv},$$

or after reintroducing the expression

$$\frac{s}{d}\pi$$

for u, (see equation 1):

$$t=\frac{d\pi l}{sv}$$

as had to be proved.

For the graduations E, F and G in Fig. 1, it follows from Figs. 4, 5, 6 and 7 that instead of t, v and l their reciprocals must be employed.

Fig. 7 shows the manner in which the several calculating operations illustrated in Figs. 4, 5 and 6 are combined into the total operation.

The particular meaning attached to the numerical values indicated on the scales is, of course, of no importance whatsoever for the nature of the invention. This rather resides, as may be added for its better understanding, in the knowledge of the fact that, given the relation $xv=yz$ by the introduction of an auxiliary u, there may be effected a division into the formulæ $u=xv$ and $u=yz$. With this to rely upon, one comes to the result that the auxiliary u will be represented by the position of the slide K in an auxiliary slot R, while the products xv and yz will result from the numerical values symmetrically disposed thereto, and which are indicated by the index N and the slides L and T.

The example mentioned at the beginning might be computed by aid of this improved table in the following manner:

The index is set to point to 22 on the function scale BK_2, and the slide, T moved for such a distance upward till the edge of the lever on scale C will cross 18; then the index of scale L is set to point to 650 on scale G, and the right hand line of graduation of lever N caused to intersect the notation 0,5 on scale F. The result obtained is hereupon read off from the scale DK_3; namely the left-hand line of graduation of lever N will point to 5 min. and the index T to 260 revolutions. Since all the indices retain their positions until the result has been read off, full security is provided for enabling the process of calculation to be checked or proved.

The particular manner of determining the graduations of the scales which are preferably logarithmic is immaterial. As regards the formula cited and preferably employed in the calculation of the scales employed with the invention, reference is made for instance to Paul Luckey, Einführung in die Nomographie (Introduction to Nomography) second part, volume 37 "die Zeichnung als Rechenmaschine" (the drawing as a calculating machine) Mathemat.-Physic. Bibliothek, published by B. G. Teubner, Leipzig 1920.

When it is desired to solve for instance the equation

$$t=\frac{l}{rv}$$

by means of the apparatus in which l is for instance=650, r=260 and v=0,5, the slides are adjusted to these values, and the left arm of the rotatable indicator N is pointed to 5. By now drawing up scale 1 by means of the Brigg-logarithms the value of 650 is found to correspond to 2, 81291. This

latter value is then marked off in inches so as to be indicated by the pointer, and as appears from the scale should be marked off negative. The scales for u, t, and v are marked off in the same manner.

I claim:

1. In a calculating and computing device in combination, a plurality of at least three parallel guideways, indicators movable in said guideways, indicating bars intersecting each other at one of the intermediate indicators and axially slidably engageable with said indicator, and respectively pivotally secured to the indicators of the outer guideways, scales along said guide ways, and means on said indicators pointing on said scales.

2. In a calculating and computing device in combination, a pluralty of at least three parallel guideways, indicators movable in said guideways, graduations along said guide ways, and means on said indicators pointing on said scales, bars intersectingly slidably engaging an intermediate indicator, and respectively pivotally secured to the indicators of the outer guideways, and additional intermediate scales crossed by said bars, the points of intersection of said scales with said bars and with said pointing means corresponding to the different values of the variables represented by said scales.

3. In a calculating and computing device in combination, a plurality of at least three parallel guideways, and scales along said guideways, indicating variable quantities, indicators movable along said guideways, and pointing means on said indicators cooperating with said scales, bars intersectingly slidably engaging an intermediate indicator, and respectively secured to the indicators of the outer guideways, additional intermediate scales and guideways parallelly spaced from the other scales and guideways and crossed by said bars, thereby determining the values of additional variable quantities, a two armed indicating lever slidably fulcrumed in one of said additional guideways, intermediate two of said additional scales, and engageable with said scales and operatively connected to one of said intersecting bars.

4. In a calculating and computing device in combination, three parallel guideways equally spaced from each other, graduated scales on the outer guideways and graduated scales next to the central guideway, such scales indicating different variable inter-related quantities, slides in said guideways, indicating means on the outer guideways engageable with the adjacent scale graduations, a two-armed indicator pivoted to the slide of the central guideway, and adapted for engagement with the graduated scales next to its sides, a connecting bar, pivoted to the slide of one of the outer guideways, and means on said bar for sliding engagement thereof with the slides of the other guideways, additional guideways and scales in parallel spaced relation to the first mentioned guideways and beyond thereof, an additional bar intersectingly and slidably connected to the other bar and to the slide of the outer guideway engageable therewith, and a sliding indicator in one of said additional guideways pivotally connected to said additional bar, and means on said last bar, engageable with the additional scales, thereby determining the value of the corresponding variable quantities.

5. In a calculating and computing device, in combination, a substantially plane support comprising three guide slots in parallel spaced relation with each other, graduations parallel to said slots indicating variable quantities, slides movable in said slots, a connecting bar on one side of the support pivoted to the slide of one of the outer guide slots and movably guided in the other slides, a two armed pointer on the opposite side of the support, pivoted to the slide of the central guide slot and cooperating with the scales at the sides thereof, additional parallel slotted portions on said support beyond the first mentioned guide slots, graduated scales along said additional slotted portions, a slide in one of the additional slots, and an indicating bar pivoted to the last mentioned slide slidably and intersectingly connected to the adjacent slide and to the other bar, and crossingly engaging the additional scale graduations, and means on said indicators pointing on the scales adjacent thereto, and indicating thereon the values of the respective variable inter-related quantities represented by said scales, and means to lock said indicators in position.

6. In a device of the kind described in combination a substantially plane support, slotted portions in said support comprising three guide slots, a slide in each of said slots, a straight bar pivoted to one of the slides and slidably engaging the other slides, graduated scales parallel to and adjacent said slots, a two-armed indicator pivoted intermediate its ends to the slide of the central slot and engageable with the scales adjacent thereof, and additional slotted portions on said support, an additional slide for said additional slotted portions, a connecting bar pivoted to said additional slide and slidably connected to the adjacent slide, and intersecting the first mentioned bar, additional scales engageable with said additional bar, and indicating means on said slides engageable with the scales and indicating the value of the respective variable quantity thereon.

7. In a computing device, a plane support, a parallelly slotted portion on said support comprising two lateral parallel slots and a central slot parallel thereto, scales next to said slots and between the same, indicating slides in said slots, a two armed pointer substantially centrally pivoted in the slide of the central slot, and a connecting bar pivoted to one of the lateral slides and slidably engaged with the slide of the central slot, and means on said lateral slides engageable with said scales.

In testimony whereof I affix my signature.

GEORG BLOCH.