PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Improvements in Logarithmic Calculating Apparatus.

I, FRANCESCO FIACCHI, of No. 36, Via XX Settembre, Genoa, Italy, a subject of the King of Italy, 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:—

The present invention relates to a calculating apparatus for making calculations in connection with reinforced concrete ribs and slabs. The apparatus is based on the use of logarithms as in the case of the normal slide rules.

The apparatus according to the present invention is designed to calculate the useful height h_1 and the area Af of sections subjected to bending strains reinforced only in the strained zones and when the neutral axis, for the ribs with slabs strained by compression, falls within the same slab.

The equations solved by the apparatus are as follows:—

$$h_1 = k\sqrt{\frac{M}{b}} \quad \ldots\ldots\ldots\ldots (1)$$

$$A_f = k_1\sqrt{Mb} \quad \ldots\ldots\ldots\ldots (2)$$

in which:

h_1 represents the useful height of the rib or slab, M is the bending moment to which the section is subjected, b is the breadth of the section or portion of the slab considered as solid with the rib, as a compressed zone, and k and k_1 are coefficients which are functions of the unit strain R_c of the concrete and R_f of the iron. Said coefficients, between the limits adopted by the apparatus, can be divided into

$$k = k^1 \times k^{11}$$
$$k_1 = k^1_1 \times k^{11}_1$$

where k^1 and k^1_1 are only functions of R_c, and k^{11} and k^{11}_1 only functions of R_f.

Equation (1) expressed logarithmically becomes:

$\log h_1 = \log k^1 + \log k^{11} + \frac{1}{2}(\log M - \log b)$, and equation (2) becomes

$\log A_f = \log k^1_1 + \log k^{11}_1 + \frac{1}{2}(\log M + \log b)$.

These two equations expressed logarithmically are of the type:

$$X = Y^1 + Y^{11} + \frac{Z}{2} + \frac{W}{2} \quad \ldots\ldots\ldots\ldots (3)$$

and therefore they may be solved by means of reciprocally displaceable scales.

According to the invention the calculating apparatus comprises a cylinder rotatable about its axis, and having one or more graduated scales or groups of graduated scales on its circumference, the spacing of the graduations being proportional to the logarithms of given values, and means on the shaft of the cylinder for imparting to the said cylinder rotary movements proportional to the logarithms of other values.

The cylinder has on it the reading scales which show the final results, the divisions of these scales being proportional to the logarithms of h_1 or of Af. The setting scales are mounted on the shaft of the cylinder for imparting movements thereto in proportion to the divisions on the setting scales. The setting scales are independently rotatable and have divisions whose distances from the origin are proportional to the logarithms of k^1, k^{11}, or k^1_1, k^{11}_1, of M and of b respectively. One pair of setting scales, in order to simplify the adjustment of the apparatus at the beginning of the operation, is rigidly mounted in relation to the reading scales. In this case the beginning of the graduations of such pair of setting scales must coincide with the beginning of the graduations of the reading scales. The other setting scales are frictionally mounted in relation to the reading scales, so that the setting scales when rotated will rotate the reading scales on the cylinder, unless the latter is prevented from rotating. Therefore, as the reading scales perform successive rotary movements together with one or other of the setting scales, the reading scale will have its origin displaced to an extent corresponding to the sum or difference of the lengths corresponding to the rotary displacements of the setting scales, and therefore the algebraic sum or difference indicated by the expression (3) will be indicated under a fixed pointer. The cylinder is also rotatable directly by a knob rigidly connected to it, the said knob also serving to prevent rotation of the cylinder when the frictionally mounted

setting scales are rotated independently of the cylinder.

In order that rotation may always be in the same direction in spite of a subtraction having to be effected the negative or subtractive setting scale is provided with graduations inversely arranged. Finally in order to simplify the operations, the divisions of the scales corresponding to Z and W of the equation (3), are represented in proportions which are half those of the divisions on the other scales.

In the accompanying drawing an example of the invention is illustrated in which

Fig. 1 is a side elevation of the apparatus,

Fig. 2 a longitudinal section of one end and

Fig. 3 shows, on larger scale, a development in plan of the scales.

As shown in the drawing the machine comprises a cylinder 1 mounted on a shaft 2 supported in bearings 2^1 carried by the casing 2^{11}. On the cylinder 1 is fixed a series of scales for reading the results A^1, A^{11}, B^1, B^{11}, C^1, C^{11}, D^1, D^{11} the graduations of which start from a line on the circumference parallel to the axis of the cylinder. At the ends of the shaft 2 are mounted two controlling knobs 3 and two rings 4 carrying setting scales 5 and 5^1 on their circumferences, the beginning of the said scales being in line with the origin of the scales on the cylinder 1.

Two rings 6, 6^1 and 7, 7^1 are frictionally mounted on the shaft 2 between the rings 4, and the cylinder 1 on each side of the cylinder and are secured and registered by means of springs or the like not shown in figure. Each of the rings carries on its circumference an appropriate scale. The frictional mounting of these rings is such that when they are rotated by means of the radial prongs 8, 8^1, 9 or 9^1 the cylinder 1 also rotates, but if the cylinder 1 is prevented from rotating by holding one of the knobs 3, the rings 6, 6^1, 7 and 7^1 are separately rotatable independently of the cylinder 1.

A pointer corresponding to the beginning of the scale is provided on each ring pointing towards the next ring. The casing 10 of the machine, preferably formed of sheet metal has a rectangular opening in which slides the support 11 for four windows 12, 13, 14 and 15, each of which is provided with a wire for reading off the final results. Each window serves two of the scales on the cylinder 1 thus the window 12 serves the scales A^1, A^{11} the window 13 the scales B^1, B^{11} and so on. The four windows may be simultaneously displaced to the right or left by means of a pin 16 so that each window is brought adjacent to the first or second scale which it serves.

When the pin 16 is displaced to the left or right and the cylinder 1 is caused to rotate by the setting of the scales on the left or the right group of rings, the results read off under the wires of the windows on the left-hand scales (A^1, B^1, C^1, D^1) or the right-hand ones (A^{11}, B^{11}, C^{11}, D^{11}) give the values of h_1 or A_f respectively.

The spacing of the graduations on the rings 5, 6, 7, 5^1, 6^1, 7^1 is proportional to $\frac{\log M}{2}, \frac{\log b}{2}, \log k, \frac{\log M}{2}, \frac{\log b}{2}, \log k_1$, respectively.

The graduations of the ring 6 which assist in determining the value h_1 increase in the opposite direction to the other graduations, since in equation (1) the term $\log b$ is negative. Thus rotation of the knob 3 is always in the same direction. It is known that according to the type of construction, the market conditions etc., the unit stresses of the iron to be used may vary. In the example illustrated the four values of σ_f chosen for the iron are 900, 1000, 1100 and 1200. A separate window serves for each of these values.

The following is an example of how to determine the height h_1.

The windows are moved to the left (as shown in Fig. 1) by means of the pin 16. The adjustable ring 6 representing the value b is held against rotation and the ring 5 representing the value M, is rotated by means of the knobs 3, 3^1 until the value of M in kgms. is adjacent to the pointer on the ring 6. Then the ring 7 is held against rotation and the cylinder 1 is turned by means of one of the knobs 3, 3^1 until the given value of b, in cm., read on the ring 6, is adjacent to the pointer on the ring 7. In this manner the machine has been set to the following portion of the equation:—

$$\tfrac{1}{2}(\log M - \log b).$$

Now, if one of the knobs 3, 3^1 is rotated until the value of the unit stress desired in Kg/cm^2 read on the ring 7 is aligned with the fixed pointer on the casing, the machine will have accomplished the operation—

$$\log k + \tfrac{1}{2}(\log M - \log b)$$

i.e. it will have arranged under the wires of the four windows the several dimensions of h_1 according to the above mentioned values of the unit stress in the iron.

In order to use the apparatus for determining A_f, the operation is carried out in a similar manner by moving the pin 16 towards the right and using the rings

5^1, 6^1, 7^1. In this case the graduations of the scale 6^1 increase in the same direction as those of the scales 5^1 and 7^1 since in the second equation the expression log b is positive.

Various changes may be made in my device without departing from the spirit of the invention.

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 logarithmic apparatus for calculating the dimensions of and relating to ribs and slabs in reinforced concrete, characterised by the fact that it comprises a cylinder so mounted that it can rotate about its axis, and having one or more graduated scales or groups of graduated scales on its circumference, the spacing of the graduations being proportional to the logarithms of given values, and further characterised by the fact that means are provided on the shaft of the cylinder for imparting to the said cylinder rotary movements proportional to the logarithms of other values in order to obtain the algebraic sum of these values.

2. An apparatus as claimed in Claim 1, characterised by the fact that the said means are formed of rings, each of which carries on its circumference a setting scale whose spacing is proportional to the logarithms of one of the variables of the equation to be solved.

3. An apparatus as claimed in Claim 2, characterised by the fact that one of said means is fixed to the cylinder shaft.

4. An apparatus as claimed in Claims 2 and 3 characterised by the fact that the spacing of the divisions on the setting scales are arranged so as to include the numerical coefficients of the variables and their signs.

5. An apparatus as claimed in Claims 1 to 4 characterised by the fact that it is provided with one or more windows on which there is a reading wire, the graduations on the cylinder being disposed beneath the windows.

6. An apparatus as claimed in Claim 4, characterised by the fact that it is provided with one or more windows each having a reading wire and being displaceable for bringing the window or windows over one or another of the scales on the cylinder.

7. An apparatus as claimed in any of the preceding claims substantially as described and illustrated.

Dated this 11th day of August, 1927.

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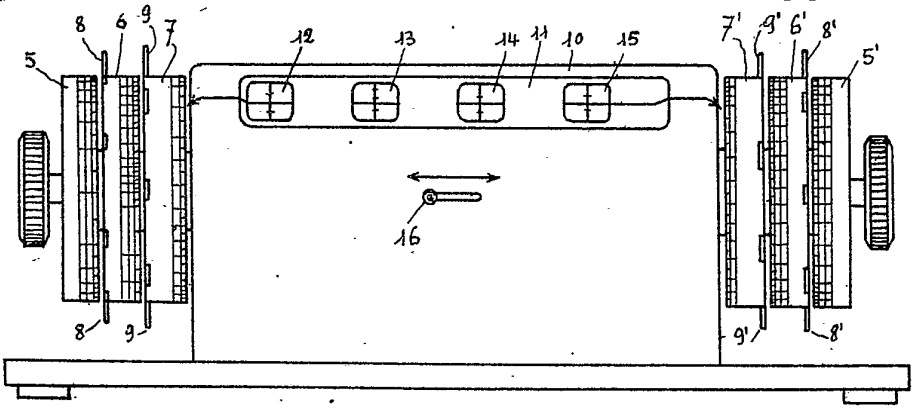

Fig. 1.

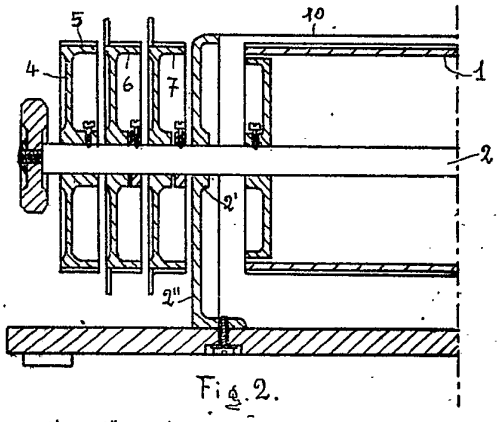

Fig. 2.

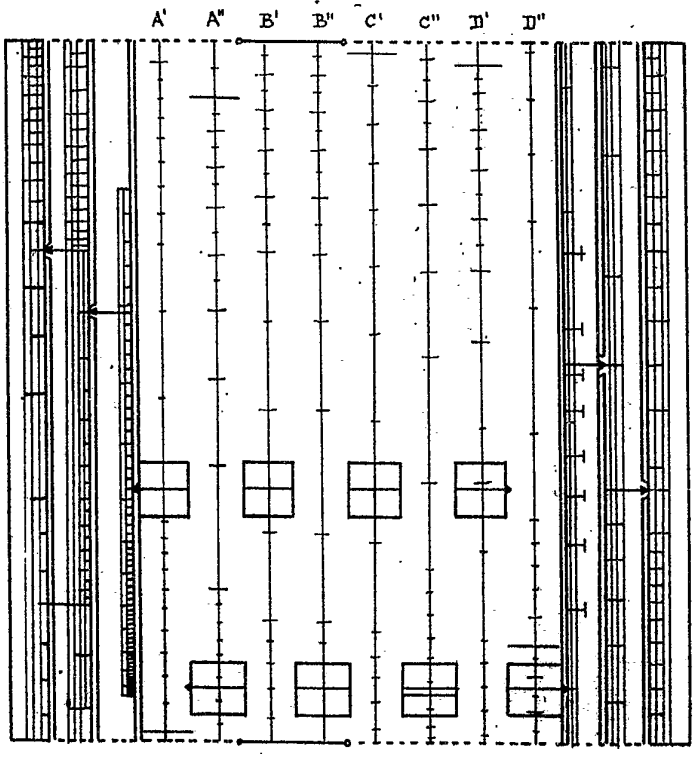

Fig. 3.

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