June 20, 1933. A. TROCHE 1,915,038

DEVICE FOR ADJUSTING, ALTERING, AND CHANGING SCALES AND GRAPHIC NETS

Filed June 8, 1928

Fig. 1

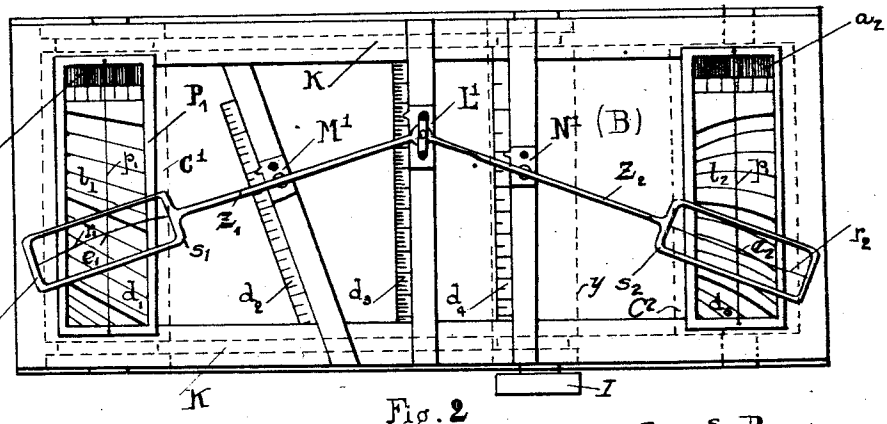


Fig. 2

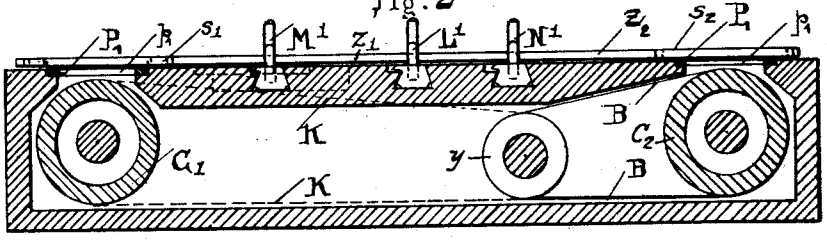
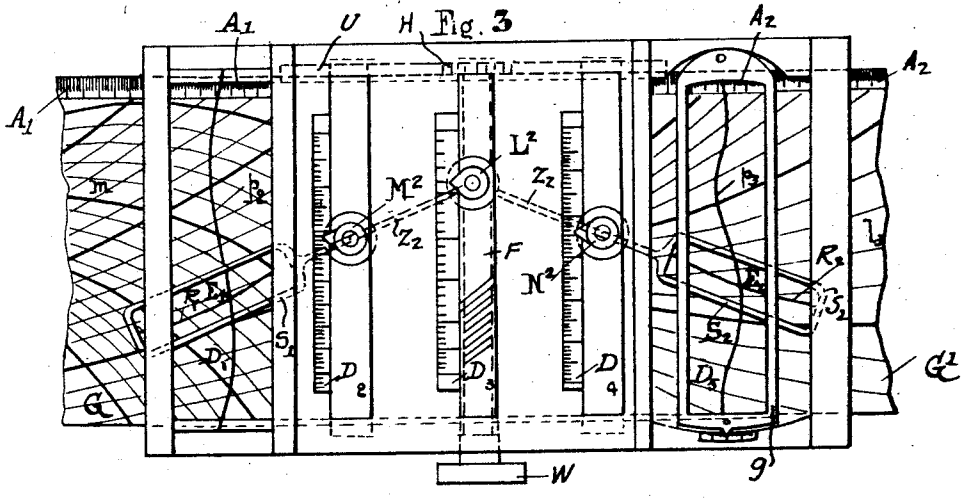


Fig. 3



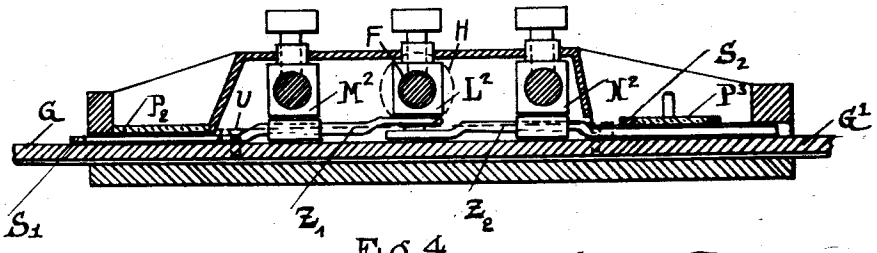


Fig. 4.

Alfred Troche
by: D. Siegel, Atty.

Patented June 20, 1933 1,915,038

UNITED STATES PATENT OFFICE

ALFRED TROCHE, OF DARMSTADT, GERMANY

DEVICE FOR ADJUSTING, ALTERING, AND CHANGING SCALES AND GRAPHIC NETS

Application filed June 8, 1928, Serial No. 283,954, and in Germany August 2, 1926.

This invention is an improved calculating device for employing variable scales and utilizing them in a new way, and includes as the main feature a scale which is variable by itself, as hereinafter described and claimed, and which is especially adapted for use for calculating cross sections of reinforced concrete.

In the accompanying drawing

Figure 1 is a plan of apparatus constructed in accordance with one form of my invention.

Figure 2 is a vertical, longitudinal, sectional view of the same.

Figure 3 is a plan of a modified form of the invention.

Figure 4 is a vertical, longitudinal, sectional view of the same.

In Figures 1 and 2 the curves l_1 of the scale d_1 are drawn on a cylinder C_1. The curves l_2 of the scale d_5 are drawn on an endless web B. The cylinder C_1 and the web B are connected together by a chain K so that any movement of the web B must induce positively a rotary movement of the cylinder C_1. Here, therefore, the movements of the elements of different scales d_1 and d_5 are positively connected together.

Similarly in Figs. 3 and 4 the movable runners L^2, M^2, N^2 and hence also the pointers Z^1, Z^2 and their reading lines R^1, R^2 may be connected by means of gears, racks and similar auxilary devices, belts, chains etc., with the plate G, so that any movement of the runner L^2 must induce positively a sliding movement of the plate G. The movements of the scale elements and indicator elements l_3, m, L_2, Z_1, Z_2, R_1, R_2 are coupled together, that is, they are positively connected. In Figs. 3 and 4 the connection is effected by means of the spindle F, the toothed wheel H, the rack U and the hand wheel W.

In the form of the invention shown in Figs. 3 and 4, plates P^2 and P^3 made of transparent material as glass, celluloid or the like, carry lines p^2, p^3 respectively scratched or etched thereon. These plates carrying these lines are mounted on frames, either rigidly as shown in Fig. 3 at the left hand side, or movably as shown in Fig. 3 at the right hand side (T). A group of curves l_3 or a net work of curves m is drawn on another plate G made of any desired material. This second plate G is slidable in the frame underneath the transparent plates P^2 and P^3. Each curve of the group l_3 has a certain number, as for example 1, 2, 3, 4 etc. The eye of the observer who bends down over this apparatus then projects the line p_3 upon the group of curves l_3 owing to the transparency of the plate P^3. The line p_3 then appears to him as being located within the group of curves l_3 and intersecting this group. The apparent points of intersection of this group l_3 with the line p_3 subdivide this line in accordance with a certain scale so that the numbering of the curves will then apply to the value of the scale. This scale D_5 then comprises two cooperating scale elements which are locally separated from each other but are optically in coincidence. These two elements are the line p_3 and the group of curves l_3. This scale has no actual points but only apparent optical points.

If now the plate G with the group of curves l_3 thereon is shifted laterally towards the right or towards the left, the location of the apparent points of the scale also is varied for the curves l_3 converge. The scale D_5 then shows another division. This scale D_5 has thus been changed in itself.

Taken theoretically the optical cooperation of the line p_3 with the group of curves l_3 permits an absolutely indefinite number of scale devices or variations of the scale D_5.

The representation of the line p_3 may be effected obviously without the aid of transparent plates. This line will be represented by a thread or wire as shown in Figure 1 at the left hand but only if the line p_1 is rectilinear. It may also be represented by a very thin rod which may be utilized either as a straight rod or in any variable desired shape, for instance in the shape of an S as being then similar to the line p_2 of scale D_1 in Figure 3. All of these various embodiments have that deceptive feature in common that the scales are composed of separate individual elements p_1 and l_1 (or p_2 and m, or p_3 and l_3). They are optically associated

and the scale device or graduation is variable as desired.

The reading points e_1 and e_2 of optical scales d_1 and d_5 are marked by lines r_1 and r_2, which are constructed in the same or a similar manner as the lines p_1, p_2, p_3 and are borne by the elements z_1, z_2. These elements z_1 and z_2 rotate round the points L^1, M^1 and N^1 and also slide upon M^1 and N^1.

Provision is made for the positive coupling of the movements of a plurality of scale elements. In Figures 3 and 4, for instance, one scale element of scale D^5, namely the group of curves l_3 and another scale element of the scale D_1 namely the net m are drawn on the same plate G. Now if this plate G is shifted, the two elements m and l_3 are both shifted simultaneously and the scale devices or graduations of both scales D_1 and D_5 become variable in accordance with a very definite rule or law. The movements of the scales D_1 and D_5 or the movements of their elements, therefore, are coupled together here in the most simple way. They are positively or rigidly interconnected.

The origin and production of an optically variable scale or of an optically variable scale element, namely the group of curves l_1, l_2, l_3 out of a large number of individual scales of the known type is discussed as follows.

If one draws all or only a few scales of a group of scales as close together as necessary on a base, joins together the points of similar notation by curved lines 0, 1, 2, 3, 4 in the groups l_1, l_2, l_3 and then again removes the original scale carriers (the reference lines to which the scale points leading to the curves were drawn), to short end pieces, which merely serve for indicating the scale carriers which were originally there, then from the former groups of scales there exist series of curves l^1, l^2, l^3 while the remaining end pieces of the previous scale carriers form reference scales a^1, a^2, A^1, A^2 transversely of the series of curves l^1, l^2, l^3. If now one places an optical axis p, for example a line p^3 on a transparent plate P^3 or a wire p^1 stretched in a frame P^1 or thin line-like rods of suitable form over the series of curves, it appears to the eye as if these lines p^1, p^2, p^3 were divided like a scale by the curves l^1, l^2, l^3 crossing it (optical scales d_1, D_1, d_5, D_3). Line p^1, p^2 or p^3 therefore replaces the scale carrier previously concerned; p^1, p^2 or p^3 and l^1, l^2 or l^3 are thus two individual but optically coacting scale elements, which form new scales upon the smallest movement relative to one another.

In the operation just described the elements l^1, l^2, l^3, or the bases with the curves l^1, l^2, l^3 drawn thereon remain at rest, and the lines p^1, p^2, p^3 are moved thereover. The reverse would naturally be possible, the elements l^1, l^2, l^3 being drawn on movable bases, for example on rollers C, endless bands B, movable slides G, leaves and so forth, and movable or rotatable beneath the stationary elements p^1, p^2, p^3 or both elements p^1 (or p^2 or p^3) and l^1 (or l^2 or l^3) or their carriers might be simultaneously movable.

Also the movement of the elements can be effected by deforming, for example bending, same. In all cases they form optically coacting scales of unlimited variability.

Instead of simple curves l^1, l^2, l^3 and single lines p^1, p^2, p^3, so called nets m may be provided, consisting of series of curves crossing one another. They can be arranged in one plane, for example on the same base, C^1 or G or P^1 or P^2 or S' or s^1, or like; the scales above described may be arranged in different planes above one another (for example on C^1 and several plates P^1 or a plurality of frames s^1 above one another). The nets m formed are then associated, optically connected nets with more than two elements.

For indicating the reading positions e^1, e^2, E^1, E^2 on the scales and nets so formed in this invention, optical axes (lines and curves) r^1, r^2, R^1, R^2 are again employed, these being arranged to be movable (that is, in position or form) transversely above (or below or between) the elements l^1, l^2, l^3, m and p^1, p^2, p^3, for example upon frames s^1, s^2, S^1, S^2, these again being carried upon holders z^1, z^2, Z^1, Z^2 which are pivotally mounted on movable fulcrum points L^1, M^1, N^1 and L^2, M^2, N^2, respectively. Each movement of the latter for example alters the position of the reading position e^1 *or* E^1 in a desired manner.

In the following, two examples will be described illustrating the utilization of the apparatus shown in Figures 1 and 2.

First example.—In this example the two runners M^1, N^1 are first clamped on the known points of the scales d^2 and d^4. It may be assumed that that point is known on which the endless web B may be set on the scale a^2. Hence owing to the connection of the chain K with the cylinder C^1 the point on the scale a^1 to which the cylinder C^1 is to be set is absolutely determined. It may now be desired to find the pertaining values of the scales d^1, d^5. This means that we have to find the correct position of the pointers z^1, z^2 and this correct position of these pointers will be that position in which underneath both reading points e^1, e^2 of scale d^1 and scale d^5 there is a curve of the group l^1, l^2 which in both scales d^1 and d^5 have the same numerical indication, pointed out on the scale d^3 by the runner L^1.

Solution of this problem.—The web B and hence also the cylinder C^1 are set in the proper position so that the line p^1 of scale d^5 passes through the assumed point of the scale a^2. The two runners M^1, N^1 are then clamped on the known points of the scales d^2, d^4. Then the runner L^1 is slowly shifted along the scale d^3. During this shifting movement of the

runner L^1 the two pointers z^1, z^2 will turn about their pivotal supports on the runners M^1, N^1 because these pointers are mounted on these runners M^1, N^1 not only that they can rotate but also can slide thereon. Owing to the rotation of the pointers the reading lines r^1, r^2 now slide over both optical scales so that the apparent intersections e^1, e^2 of the lines p^1, r^1, r^2 travel along the optical scales. In general the point e^1 on the left hand scale d^1 will first be on a curve l^1 having a numerical value different from that of curve l^2 with which the point e^2 on the right hand scale d^5 coincides. But the location of the two points e^1, e^2 will be shifted simultaneously and during this shifting movement it will happen once only that point e^1 of the pointer z^1 is on a curve l^1 having the same numerical indicator as the curve l^2 below the point e^2 of the pointer z^2. At this instant the movement of the pointers is stopped because the desired position of the pointers has now been found. The result may then be read. This result is: (1) The value of the scale d^3 for the runner L^1 and (2) the numerical indication of the curves below the points e^1, e^2, which numerical indicator in both scales d^1, d^5 is now of the same numerical value.

Second example.—It may be assumed that the setting points of the three scales d^2, d^3, d^4 are known. It is desired to find the pertaining reading points on the scales d^1, d^5 and a^1, a^2 again dependent on the same condition, namely that e^1 to the left and e^2 to the right must be located about curves l^1, l^2 of the same numerical indicator value.

Solution.—The three runners L^1, M^1, N^1 are set to the assumed points of the scales d^2, d^3, d^4, and the two pointers z^1, z^2 are in fixed positions. A slow movement is now imparted to the web B by means of an auxiliary roll or cylinder y which is located below the scale d^4. Owing to the action of the chain K in the form of the invention shown in Figures 1 and 2, the cylinder C^1 also is rotated so that the two scales a^1, a^2 slowly pass below the lines p^1. The two scales a^1, a^2 passing underneath the lines p^1 indicate the evenness of this rotary movement to the optical scale value. During this movement of the web B and the cylinder C^1 there are also continually displaced the curves l^1, l^2 below the two reading points e^1, e^2. In this operation, therefore, just as in the first example, there will occur an instance and one instance only where again curves l^1, l^2 are below the two points e^1, e^2 which have the same identical numerical indicator. It is, therefore, this numerical indicator of the two curves l^1, l^2 which had to be determined. The other value to be determined is the value of the scale a^1 which at this very instant is located below the line p^1 and can be read.

From these two practical examples it will be apparent that the apparatus as shown in Figures 1 and 2 as well as the apparatus shown in Figures 3 and 4, serve for solving equations with two unknowns. Figures 1 to 4 show diagrammatically two embodiments of a calculating machine for calculating cross-sections of reinforced concrete. The scales a^1 and a^2 and A^1 and A^2 respectively show the strains which occur in the cross-section to be calculated if this cross-section is put under strain by a pressure force and an external bending moment. The value of the pressure force can be set on the scale d^4 or D^4 respectively. The bending moment can be set on the scale d^2, D^2 respectively. The curves l^1 or l^2 or l^3 or m respectively show then the reinforcement necessary for the cross-section. The scales d^3 and D^3 respectively show the strength of the cross-section. Hence, the case assumed in the first example is the following: The known values are the permissible marginal strains, and the forces coming into play, that is, the pressure force and the moment. It is desired to find the strength of the steel reinforcement to be used and the cross-sectional area to be employed. In the case of the second example, conditions given above the outer forces are known and the area of the cross-section. What is to be found are the marginal strains and the strength of the reinforcement required.

The use of this optically variable scale is not limited to these two forms of the embodiment illustrated, as further modifications may be made therein within the scope of the appended claims.

I claim:

Calculating apparatus of the class described, comprising a plurality of movable scale elements arranged in spaced relation, and each having an optical scale formed of curved lines, and also having a scale for determining its position, means for simultaneously moving the said scale elements, means presenting an optical axis line across each optical scale; a pointer for each scale element and having a line extending across the optical axis line thereof, a pivot by which said pointers are pivotally connected together, means for moving the said pivot, and hence the connected ends of the pointers simultaneously in a path substantially parallel with the optical axis lines, a scale for determining the position of the said pivot, means for independently moving the said pointers, and scales, each associated with one of the pointers, for determining the positions thereof.

In testimony whereof I have hereunto set my hand this 28th day of March 1928.

ALFRED TROCHE.