

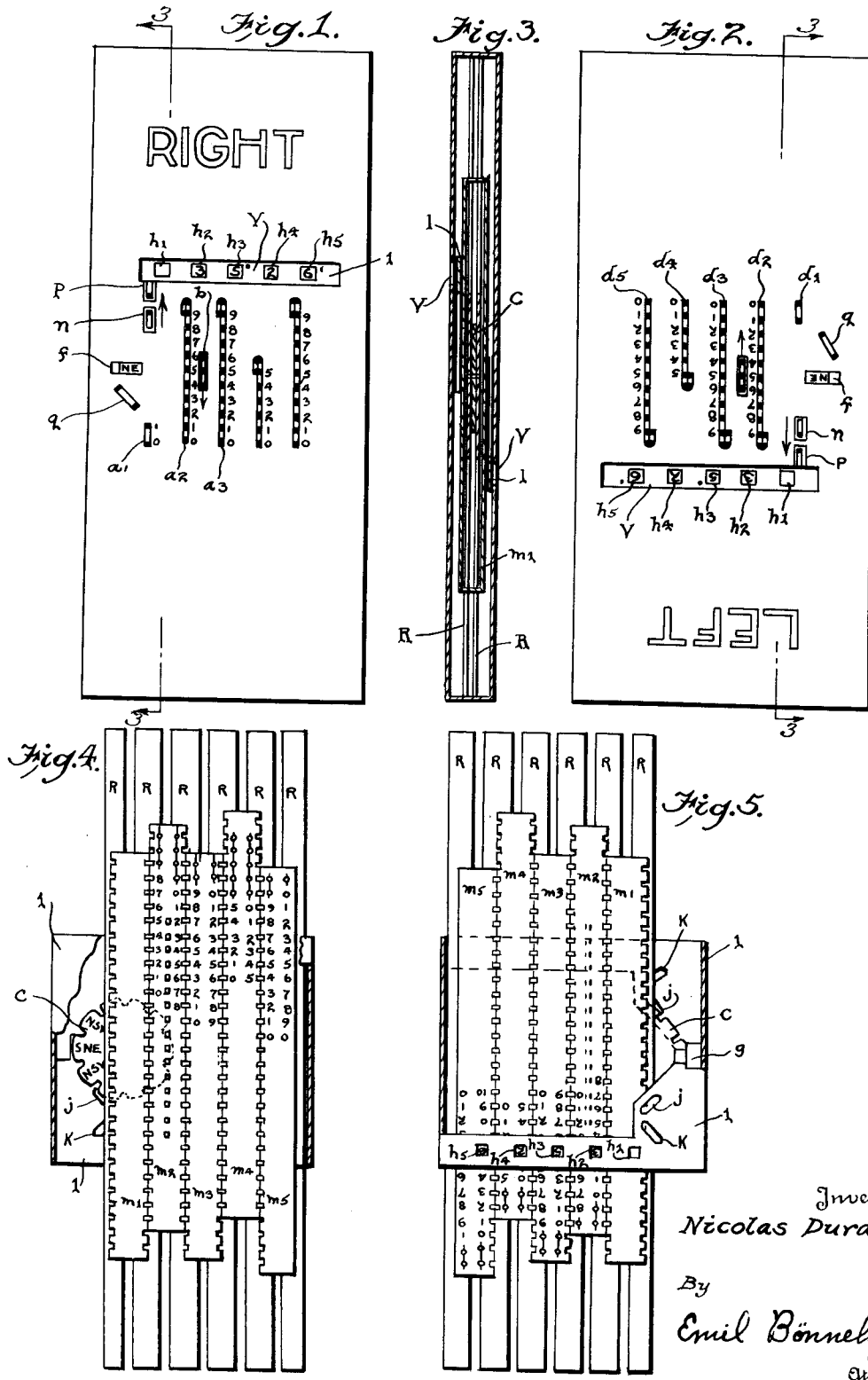
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CALCULATING DEVICE

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CALCULATING DEVICE

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This invention refers to an apparatus which, by some simple operations, will give the calculated bearing of a line, based on the bearing of another line and either the deflection angle corresponding to the two lines or the angle formed between them.

This result is obtained by means of the device illustrated in the accompanying drawing, in which:

10 Figure 1 is a front view of the apparatus.

Fig. 2 is a rear view of the apparatus.

Fig. 3 is a vertical section of the apparatus taken on lines 3—3 of Figs. 1 and 2.

Fig. 4 is a front view showing the interior details of the front side of the apparatus.

Fig. 5 is a front view showing the interior details of the rear side of the apparatus.

All of these views refer to an apparatus designed to operate with deflections approximate to the sexagesimal minute, which is the most common case in ordinary practice.

Similar reference characters correspond to similar parts in all the figures of the drawing, and as the apparatus is substantially symmetrical with regard to the horizontal axis which passes through its geometric center, whatever is stated in regard to the front side will apply equally to the reverse side, by turning it over its symmetrical axis, unless the contrary is specifically stated.

The apparatus is composed of an adding device, a quadrant indicator and a selector of results.

Any adding device, which would permit the making of additions and subtractions of degrees and their subdivisions, could have been employed, but the system of movable racks has been selected, however, because besides being known by the public, it permits the construction of a compact and light apparatus, which due to its form and dimension being similar to and not larger than those of an ordinary transit book, may conveniently be carried by a worker in the field in his pocket.

The adding device is composed, in front as well as in the reverse side, of five equal flat racks *m1* to *m5*, guided by a support *R* in such a manner that they can move longitudinally only, their edges being provided with a series of similar teeth, equally spaced. Each of the racks on one side is integral with the corresponding rack on the opposite side, and the teeth and notches of one correspond with the teeth and notches of the other.

On each side of the apparatus, the set of racks

is covered by a plate, on whose third central portion five vertical grooves have been made, *a1* to *a5*, of which the first one *a1* is uniform in width through all its length and leaves uncovered a tooth and two notches of the left edge of the rack *m1*. Vertical grooves *a2*, *a3* and *a5* leave uncovered ten teeth and eleven notches of the left edges of racks *m2*, *m3* and *m5*, respectively, but these grooves are uniform in width throughout their length, except that they are shaped at their upper end like curved canes, whose shorter part leaves uncovered a tooth and two notches of the right edge of the rack adjacent to the left so that if between the two racks there is left only the necessary space for their independent movement, the shorter portion of the curved cane will be only an enlargement of the groove. Groove *a4* differs from the three previous ones only in that its length is smaller, leaving uncovered six teeth and seven notches of the left rack-edge of rack *m4*, and through its smaller portion one tooth and two notches of rack *m5*. All of these grooves terminate, at their lower end, at the same horizontal line, and beginning from there up, near the edge of each one of them, the natural series of numerals is set up starting from zero and reading up. The vertical distance between the centers of two consecutive numbers is equal to the space occupied on the edges of the racks by a tooth and a notch, so that when the lower edge of a notch is made to coincide with the lower edge of a groove there will be a hole in front of each one of the numbers just mentioned. Groove *a1* leaves uncovered only one tooth and two notches, for which reason no inscriptions are made on its edges except the figures 0 and 1. On the side of grooves *a2*, *a3* and *a5* figures from 0 to 9 are set up, there being at their upper end a hole in front of which there is no figure. Groove *a4* carries figures 0 to 5, there being also at its upper end a hole in front of which there is no figure.

At a convenient distance above the aforementioned grooves, there is an opening V horizontally elongated, which transversally embraces the five racks, leaving uncovered a strip of each one of them.

With the exception of rack *m1*, all of them carry on their faces, in the space left free by the teeth, and in vertical strips at each side of the middle line, a series of numbers which correspond, in horizontal lines, forming pairs on each rack. Vertically, these pairs are regularly

spaced, the vertical distance from center to center of two consecutive pairs being equal to the space occupied on the edge of the racks by one tooth and one notch, and being also disposed in such a manner that when a notch on the edge of a rack coincides with the lower end of the corresponding groove, one of the pairs of figures of such occupies the axis of the opening. The racks, of course, are of a length somewhat greater than is strictly necessary, in order that, in their movement, all of the pairs of numerals contained by them may successively come to occupy the axis of the opening.

On the front side, the pair of numerals, as they appear beginning from below up, are as follows, attention being directed to the fact the indicium which on the rack appears to the left is cited first, and that some indicia have been suppressed while others have been substituted by a conventional sign, which on the drawing is a cross, the former are herein represented by a point mark and the latter by the sign #. Once this explanation is made, one will find on rack *m2*: 8—, 0—7, 1—6, 2—5, 3—4, 5—2, 6—1, 7—0, 8—#; on rack *m3* there is found: 0—9, 1—8, 2—7, 3—6, 4—5, 5—4, 6—3, 7—2, 8—1, 9—0; on rack *m4* there is found: 0—5, 1—4, 2—3, 3—2, 4—1, 5—0; and on rack *m5* there is found: 0—10, 1—9, 2—8, 3—7, 4—6, 5—5, 6—4, 7—3, 8—2, 9—1, #—0. On each rack, above the highest pair of numerals, there are at least two pairs of conventional signs, like these: #—#, #—#.

On the reverse side, the pairs of numerals are as follows: on rack *m2*: 8—, 7—0, 6—1, 5—2, 4—3, 3—4, 2—5, 1—6, 0—7, #—8; on rack *m3*: 9—0, 8—1, 7—2, 6—3, 5—4, 4—5, 3—6, 2—7, 1—8, 0—9; on rack *m4*: 5—0, 4—1, 3—2, 2—3, 1—4, 0—5, and on rack *m5*: 10—0, 9—1, 8—2, 7—3, 6—4, 5—5, 4—6, 3—7, 2—8, 1—9, 0—#. Here also there are at least two pairs of conventional signs #—#, #—# above the last pair of numerals on each rack.

The set is so disposed that when any one pair of indicia on any rack occupies the axis of the opening on the front side, the same pair of indicia on the same rack will occupy the axle of the opening on the reverse side.

There is no indicium set up on rack *m1*. When this rack occupies its normal position, which is the middle position, the space left uncovered by the opening is in blank, but immediately above the left half or the rack has been painted in color, red for instance, in front and blue on the reverse side, and the right half blue and red respectively.

I may state that the sum of each pair of indicia is unalterable on each rack, it being for instance 7 for rack *m2*, 9 for rack *m3*, 5 for rack *m4* and 10 for rack *m5*; if these figures are placed in the order in which they have been obtained, one after the other, and they are given, in the same order, the valuations of tens of degrees, degrees, tens of minutes and minutes, it will be found 79° 5(10)', seventy nine degrees, fifty and 10 minutes, that is, eighty degrees.

In fact, the pairs of indicia corresponding to rack *m1*—and which are 0—1 and 1—0—have been substituted by colors. If the unalterable sum of these pairs, which is 1, is placed in the space for the corresponding tens of degrees, the result will be one hundred and eighty degrees, or in other words, any combination of pairs which may appear through the opening will be characterized by the fact that the number of degrees and minutes formed by the indicia on the left

of each pair will be always supplementary to that formed by the indicia on the right.

If racks *m2* to *m5* are placed in such a manner that in the axis of the opening there will appear all the zeros on the left, that is pairs: 0—7, 0—9, 0—5, 0—10, and if we mark, in any convenient manner, for instance with points over the respective teeth, as has been done in the drawing, the holes which remain above those appearing in front of Figure 3 in groove *a2*, of Fig. 9 in groove *a3*, of Fig. 5 in groove *a4*, and of Fig. 9 in groove *a5*, we will have the complete adding mechanism. In order to set up therein a deflection, indicia are operated one after the other, attributing to each groove a special order for units, according to their positions, that is the hundreds of degrees will be inscribed in groove *a1*, the tens of degrees in groove *a2*, the unities in groove *a3*, the tens of minutes in groove *a4* and the unities of minutes in groove *a5*; the setting up of an indicia is made by introducing the point of a suitable driver in the hole which, in the corresponding groove, is situated in front of the cipher which it is desired to set up and by pushing the driver downward, when the hole is one of those not marked, until the lower end of the groove has been reached; if the hole should be one of those marked, the driver is pushed upward and the curve formed at that end is followed in order to terminate the movement at the lower end of the shorter portion of the curved cane. The front face is reserved to set up therein deflections to the right, and the reverse side for deflections to the left; in order to avoid confusion, the front side shows very plainly the word "Right" and the reverse side the word "Left".

I will now proceed to describe the quadrant indicator.

Rack *m2* carries along its middle line a series of perforations which permit the point of the driver to pass through, and which correspond horizontally to the notches on the edges. On the plate forming the face of the apparatus, and between grooves *a2* and *a3*, there is a vertical groove *b*, which is symmetrical with regard to the horizontal middle line of said face, and whose total length is equivalent to the space occupied on the edges of the racks by two teeth and three notches. This groove is situated exactly over the middle line of rack *m2*, so that through the same the point of the driver may be introduced in the perforations of the rack which have just been described. As an indication to facilitate the work said groove is bordered by a line of the same color selected for the right strip on the reverse side of the rack *m1* and carries an arrow pointing downwards.

In the free space which remains between the racks on one side and those corresponding on the opposite side, there is mounted a thin disc *c*, which may rotate on its axle, which is situated exactly over the symmetrical line of the apparatus. The edge of this disc passes through the middle line of rack *m2* and carries an even number of radial cuts, similar and equally spaced. The cuts are so disposed that when one of them coincides with the one of the ends of groove *b*, the adjacent one will coincide with the other end of the latter, so that if the point of the driver is introduced close to the upper end of groove *b*, and through one of the perforations of rack *m2*, until one of the cuts on the disc is reached, and the driver is pushed downwards until it reaches the opposite end of the groove, rack *m2* will have

moved down a space equivalent to that occupied on its edge by two teeth and two notches. At the same time the disc will have rotated such an angle that each cut thereon will have come to occupy the place previously occupied by the preceding cut in the direction of the movement. In the sectors formed by connecting with straight lines the opposite cuts, and outside of the circle which is constantly covered by rack *m1*, there are alternatively inscribed the groups of initials: S N E, N S W, S N E, N S W, etc. which groups are repeated in the same sectors on the reverse side. One of these groups, that which is in the symmetric line and on the left of rack *m1*, is visible from the exterior through opening *f*, made on each side symmetrically to the horizontal middle line of said side. The meaning of these initials, as usual, is: N—North, S—South, E—East and W—West.

The selector of results mechanism is composed of a plate or shutter 1 which on each side covers completely the corresponding opening *V*, and which in turn carries five small openings *h1* to *h5*, and which may be displaced horizontally. Each one of said five openings corresponds to one of the racks and they are so disposed that when the shutter occupies its extreme left position, they will leave uncovered only one of the indicia or signs set up on the left half of each one of the racks, while when the shutter occupies its extreme right position, they will leave uncovered only one of the indicia or signs set up on the right half of each rack. The shutter of the front side is integral to that of the reverse side, and the piece which serves to connect them carries for each side, a tongue *g*, so disposed that, depending on the extreme position which may be occupied by the shutter, it will conceal one or the other of the first two initials of the group appearing through opening *f*. Consequently, when the shutter occupies its extreme left position, leaving uncovered the indicia or signs on the left half of the racks, tongue *g* will conceal the first one of said initials, so that, according to the position of the disc, there will be seen only NE or SW, which indicate respectively quadrants North-East and South-West; on the other hand, when the shutter occupies its extreme right position, leaving uncovered the indicia or signs corresponding to the right half of the racks, the tongue will conceal the second one of the initials, leaving visible, according to the position of the disc, only SE or NW, which correspond to quadrants South-East and North-West.

The plate forming the shutter has a downward projection which covers several of the teeth on the left edge of rack *m1*, and carries two inclined grooves *j*, *k*, each of which forms the hypotenuse of a triangle whose vertical cathetus is of a length equal to the space occupied on the edge of the rack by a tooth and two notches and whose horizontal cathetus is of a length equal to the space between the indicia forming pairs on each rack. Besides, they are so disposed that when the shutter occupies its extreme left position, the lower end of groove *k* will coincide with one notch of rack *m1*, this latter being in its normal position, and when the shutter is on its extreme right position, the lower end of groove *j* will coincide with another notch on rack *m1*. On the two sides of the apparatus and on the upward extension of groove *a1*, there are two other grooves *n*, *p*, the length of each of which is equal to the space occupied by a tooth and two

notches. These grooves are so disposed that their lower ends will coincide with the same notches on rack *m1* which coincide with the lower ends of inclined grooves *j*, *k*, as just explained above, so that if—when the shutter is on its extreme left position—the point of the driver is introduced close to the lower end of the groove *p* and is pushed upward until the other end of the groove has been reached, the rack *m1* will go up for a space equal to that occupied by a tooth and a notch, while the shutter will pass from its extreme left position to its extreme right position; likewise if—when the shutter is on this latter position—the driver is introduced close to the lower end of groove *n*, and it is pushed upwards, as before, rack *m1* will go up for a space equal to that occupied by a tooth and a notch, while the shutter will move from the position it had to its extreme right position. In order to facilitate handling, grooves *p* and *n* are bordered with lines of equal color, respectively, as that of the right and left halves of rack *m1* on the side in consideration, and an arrow pointing upwards shows the direction in which the movement should be made.

Inclined groove *q* embraces the space comprised between two cuts on the disc for the quadrants, so that by introducing the driver close to one of its ends and by pushing it until the other end is reached, the group of initials visible through opening *f* will be changed without disturbing any other part of the mechanism.

The manner in which this device is to be used is as follows: It is first necessary to make appear in the openings the bearing to be started from, and to this end I begin by ascertaining if the quadrant is to the East or to the West. Let it be supposed that I am dealing with quadrant to the East. It will then be observed that through opening *f* there appears one of these quadrants. If such be the case there will remain nothing to be done in that direction, but if instead of one of the quadrants to the East there should be one to the West, I would introduce the driver close to either one of the ends of the groove *q* and would push until the other end of the groove is reached, and thereby the desired result would be obtained.

I would then proceed to ascertain if the quadrant needed is to the North or to the South—let it be assumed that it is one to the North—and to see if the one appearing through opening *f* is the one desired or not. If it is not, it is necessary to introduce the driver close to the lower end of one of the grooves *j* or *k*—which is possible in one of them only—and to push it upwards until the opposite end is reached, whereby there will appear through opening *f* the desired quadrant NE, but immediately after this operation, it will be necessary to set up one hundred degrees in groove *a1*—as already explained—in order that no color will appear through opening *h1*. Then by moving the different racks with the driver and through the corresponding grooves, it is easy to make appear in openings *h2*, *h3*, *h4* and *h5* the numerals representing the tens and units of degrees and the tens and units of minutes, respectively, which form the direction to start from; the position of the racks is rectified and the device will then be ready for work.

Let it be assumed that the initial bearing was 35 degrees, 26' NE, and that I have a deflection to the right of 12 degrees 16' I will set up this deflection on the face marked "Right"—as already explained—after which I will be able to read the

new direction, ascertaining first that no color has appeared through opening *h*1, and this will mean that the reading of 47 degrees 42' to the NE, which appears through the opening, is correct. It should be noted here that if—when any reading is being made—I find that a cross has appeared, instead of an indicium, through one of the openings, it is necessary to make the former disappear and to accomplish this it is only necessary to introduce the driver in front of the zero on the corresponding rack, and to push the driver upwards until the movement is terminated, following the curve thereon, at the shorter portion or the curved cane. If I would now have a new deflection, for instance of 82 degrees 54' to the right, I would proceed to set up the same in the same manner and on the same side, but when intending to make a reading I would find that in opening *h*1 there has appeared the red color, which would indicate that an additional operation is needed, consisting in introducing the driver close to the lower end of the groove bordered with red color on that side, and pushing the driver upwards until the other end of the groove is reached. After this operation has been terminated, I will find that the red color has disappeared, which would be an indication that the reading now to be made—49 degrees 24' to the SE—is correct. If I would now have a deflection of 12 degrees 18' to the left, I would turn the apparatus over a horizontal axis, and on the other side marked "Left" would set up the last named deflection and read the result obtained, as usual, finding the bearing 61 degrees 42' to the SE.

Let it now be assumed that I have a deflection of 102 degrees 13' to the right. I will set up this deflection on the side marked "Right" as usual, but when trying to make a reading I will find that the blue color has appeared in opening *h*1, which will indicate that it is necessary to introduce the driver, successively, in the two grooves bordered with blue color, it making no difference in which order this is done, and, following the indication marked on each one of them, to carry out the respective movement, going through the same from one end to the other in the direction of the respective arrows, after which—the blue color having disappeared from opening *h*1—I will make the correct reading of the 40 degrees 31' SW.

More examples could be given indefinitely, but as this would be of no interest, I will limit myself to observe that if—when a complementary operation is made to make disappear a color from the opening *h*1—instead of securing the desired result, another color is found, it will be necessary

to execute the operation indicated by said new color, whereby the latter will be made to disappear and it will be possible to make the correct reading. This case is not common.

The device described is intended to operate with deflection angles, but there is nothing to prevent making grooves *a*1 of a length equal to three teeth and four notches, whereby directions may be calculated, in an obvious manner, if interior angles should be had.

Likewise, it would be easy, through a similar enlargement of the mechanism, to construct a device which would operate with angles approximate to the second.

I claim as my invention:

1. A calculating device comprising a plurality of flat racks arranged adjacent each other and having equally-spaced teeth along their edges, a support for guiding said racks so that they may be moved longitudinally, a plate on each side of the racks have vertically-arranged grooves therein adapted to cooperate with the teeth and spaces between the racks, and a shutter arranged around the racks and plate.

2. A calculating device consisting of an adding device, a quadrant indicator, and a selector of results, said adding device comprising a support, a plurality of flat racks guided by said support, and a plate provided on each side of the racks, said quadrant indicator comprising a disc rotatably mounted between the racks and adapted to cooperate with a plurality of perforations in one of the racks and having a plurality of radial cuts equidistantly spaced from each other, and said selector of results comprising a shutter arranged around the racks and cooperating therewith.

3. A calculating device according to claim 2, in which the racks are provided with equally-spaced teeth along their edges and are arranged adjacent each other.

4. A calculating device according to claim 2, in which the part connecting both sides of the shutter is provided with a tongue adapted to cooperate with the disc.

5. A calculating device according to claim 2, in which the shutter is partly open on both sides and has small openings therein to show the numbers provided on the racks corresponding to the teeth on said racks.

6. A calculating device according to claim 2, in which the shutter is provided with a plurality of short perforations adapted to cooperate with the teeth on one of the racks.

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