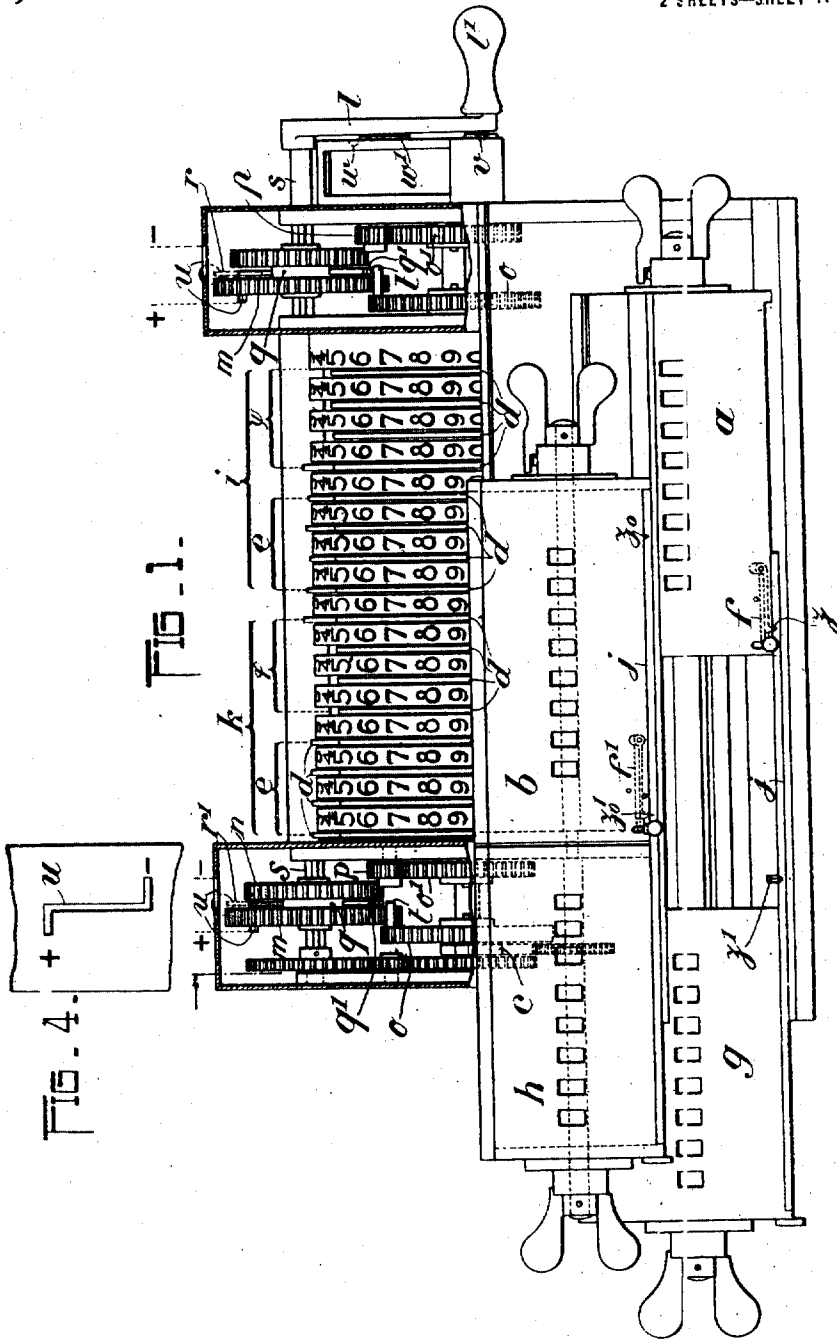


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CALCULATING MACHINE ESPECIALLY DEvised FOR GEODETIC MEASUREMENTS.
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1,221,653.

Patented Apr. 3, 1917.
2 SHEETS—SHEET 1.

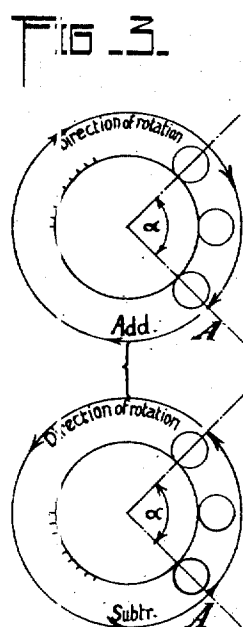
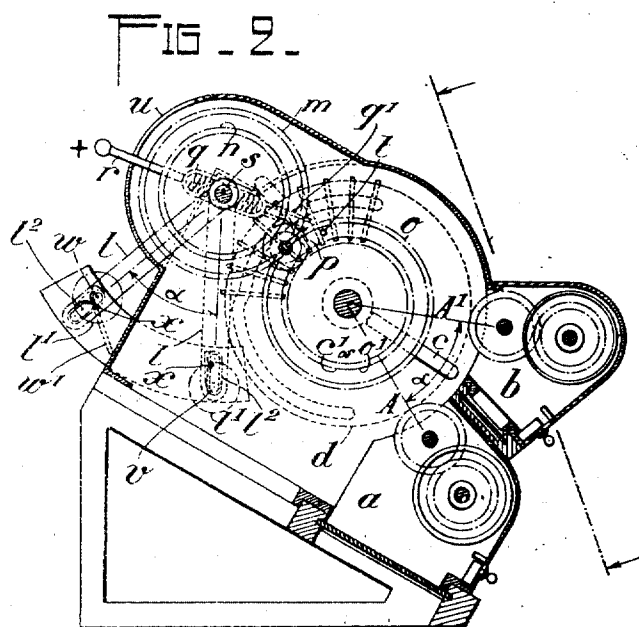


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CALCULATING MACHINE ESPECIALLY DEvised FOR GEODETIC MEASUREMENTS.

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2 SHEETS--SHEET 2.



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UNITED STATES PATENT OFFICE.

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CALCULATING-MACHINE ESPECIALLY DEvised FOR GEODETIC MEASUREMENTS.

1,221,653.

Specification of Letters Patent.

Patented Apr. 3, 1917.

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To all whom it may concern:

Be it known that I, JACOB BALTISSER, a citizen of the Swiss Republic, and resident of Basel, Switzerland, land-surveyor, have invented new and useful Improvements in Calculating-Machines Especially Devised for Geodetic Measurements, of which the following is a full, clear, and exact specification.

The calculation of the limitpoint-coördinates in surveying is based upon the formulæ

$$Y = x \times \sin \alpha + y \times \cos \alpha = \varphi \times x + \psi \times y$$

$$X = x \times \cos \alpha - y \times \sin \alpha = \psi \times x - \varphi \times y.$$

If this calculation be made with the aid of the calculating machine then the $\sin \alpha$ and the $\cos \alpha$ must always be adjusted in alternating series, one time for X , the other time for Y . A further drawback is also that Y and X must be worked out separately. Only the "Duplex" calculating machine, (a machine with two result mechanisms) permits of calculating both Y and X at the same time; this machine requires, however, the adjusting of the $\sin \alpha$ and the $\cos \alpha$ in alternating series.

The regular change of the adjustments of the constant factors $\sin \alpha$ and $\cos \alpha$ requires an increased attention, and it must be regarded as a great relief that the key calculating machines (Millionaire) permit this change of common factors being effected automatically by means of a special additional apparatus. In contrast, however, to the "Duplex" calculating machines these key machines have the drawback that they only have one single result mechanism and therefore one cannot obtain the values Y and X concurrently.

The present invention has for its object to unite in a single machine the advantages of the "Duplex" calculating machine and of the above mentioned key machines. This is attained by the arrangement that two result-calculators in two separate groups of adjustable driving disks or members the adjustment whereof is transmitted to the result-calculators by means of one and the same handle are so arranged adjustable with regard to one another that they can alternately be changed from the operating range of the one group of driving disks to the operative range of the other group of driv-

ing disks. By this construction the possibility is attained after the adjusting of two constant factors in the two groups of driving disks, of engaging the same alternately with the one or with the other result-calculator by simply interchanging the relative position of the two result-calculators with regard to the groups of the driving disks.

The invention will now be described, with reference to the drawing, as applied to an Odhner machine (German Patent No. 64925), in which the driving disks as is well known consist of rotatable adjustable disks provided with finger hooks and with curved slots for the operation of transmitting teeth inserted radially in rotating members which then on their turning act upon the toothed calculating wheels of the result-calculators.

Figure 1 shows a front view of the machine with the casing partly removed and partly sectioned.

Fig. 2 shows a cross section of Fig. 1;

Fig. 3 shows a motion diagram;

Fig. 4 shows a detail.

The machine as shown in Figs. 1 and 2 possesses two angularly displaced result-calculators a, b with the usual counting mechanisms g, h and two groups i, k of adjustable driving disks d for the determination of two constant factors (Fig. 1), for example the values ψ and φ of the above equation. The result-calculators a, b are adjustable both with regard to one another and with regard to the groups of the adjusting or driving disks. As shown in Fig. 1 the result-calculator a is under the control of the driving disk group i from which assuming that the constant factor ψ only possesses four places of figures there will be only effective the four adjusting disks which lie to the right, whereas the four adjusting or driving disks of the same group which lie to the left, that is those within the space c will permanently run idle or be adjusted to zero and thereby act as separators between the groups of driving disks; the result-calculator b on the other hand is under the control of the group of driving disks k of which likewise only the four disks which lie to the right serve for the adjustment of the factor φ assumed to be of four places of figures.

The two groups of adjusting disks are ar-

5 ranged with their transmitting teeth revolving members upon two separate axles, which, however, can be turned by means of suitable switching gears (hereinafter described) by means of the same actuating handle l . The positions of the result-calculators a , b in their final places are insured by means of the springs f , f' which engage in notches z , z_0 or z^1 , z_0^1 upon the rails j connected with the counting mechanisms g , h . For the movement of the result-calculator a to the left the spring f is removed from the notch z , and at the end of its motion it springs back into the notch z^1 ; on the displacing of the result-calculator b to the right, the spring f' is released from the notch z_0^1 and finally allowed to engage in the notch z_0 . The releasing of the springs f , f' therefore takes place only upon the change over the result-calculators a and b .

20 The counting mechanisms g , h are arranged at the same height as the corresponding result-calculators a , b and stand in the well known manner under the control of a catch or single tooth c which is fixed upon a wheel c^1 which is once rotated at each rotation of the actuating handle l and consequently moves on the adjusted wheel of the counting mechanisms by one tooth or one numeral. The counting mechanism h is shown in Fig. 1 displaced two places to the right; the hundreds counting disk is brought into working position with regard to the catch c ; likewise the result-calculator b connected with the counting mechanism h engages over the space c , but is not hereby influenced. The counting mechanism g occupies the normal position.

40 As the two transmitting or driving disk groups i , k must be movable independently of one another for addition or subtraction, that is forward or backward, these motions, however, in each case are to be effected by means of a single handle l , it is necessary to provide a switch gearing for each group of adjusting or driving disks. These gearings consist in each case of a pair of wheels m , n , displaceable longitudinally along the axle s of the handle l by means of a groove and feather, of which wheels the wheel m is capable of engaging directly with the driving wheel o of the respective adjusting disk group for the addition or multiplication, while the wheel n by the interposition of an intermediate wheel p revolving upon a fixed axle can be engaged with the driving wheel o^1 of the adjusting disk group. In consequence of the interposition of the wheel p the adjusting disk group receives in the latter case by turning the handle l in the same direction a rotary motion opposed to the preceding one and thus either subtraction or division can be carried out. It is to be assumed that the figures of the result-calculators decrease in the clockwise direction.

In order to calculate by means of the above described machine and according to the formulæ:

$$X = x \times \psi - y \times \varphi$$

and

$$Y = x \times \varphi + y \times \psi$$

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upon the result-calculator a the values of X and upon the result-calculator b the values of Y , the driving disk group i is first brought into connection with the result-calculator a and the driving disk group k is brought into connection with the result-calculator b . After adjustment of the ψ value in the group i and of the φ value in the group k , then to obtain the products $\psi \times x$ and $\varphi \times x$ the handle l is turned right about until in the counting mechanisms g and h there appears the factor x . After the extinction of x in the mechanism h and the release of the spring f , the result-calculator a in Fig. 1 is displaced to the left, and the result-calculator b after release of the spring f' is shifted over to the right, whereupon the handle l is again turned right about until the factor y appears in the mechanism h , whereby this factor in the result-calculator a appears multiplied with the value φ and in the result-calculator b appears multiplied with the value ψ . The driving disk groups i , k are hereby adjusted according to the indications or signs of ψ and φ to addition or subtraction. Under the assumption that the values x and y are positive ones, the turning of the handle to the right according to the above described process gives the result of the formulæ in the result-calculators a , b . If, however, the values x and y are negative ones, then the handle l instead of being turned to the right must be turned around to the left. This turning of the handle to the left requires certain further improvements in the machine.

As shown in Fig. 2, the nine transmitting teeth of the driving disks or members do not occupy the full periphery of the driving disks, but a portion of the periphery thereof during the rotation remains without operative action of the transmitting teeth. This idle wheel part is of importance for the present improvements. At A (Fig. 2) is shown the result-calculator a in engagement; each figure will in this middle position of the result-calculator be added to or subtracted from on each complete revolution of the handle. Besides the result-calculator a there is, however, within the peripheric part without teeth action the result-calculator b also in position of engagement, so that on the addition of a figure the same will be transmitted on a complete revolution of the handle with the initial position thereof in A to both the result-calculators a , b ; the complete rotation of the handle effects for b as well as for a consequently the transmission of the figure.

If, however, with the shown angular displacement between the result-calculators a , b , on the position of the result-calculator b to the right of the result-calculator a the figure is subtracted, then on a full rotation of the handle from its initial position in A the transmitting means for the tens of the result-calculator b will first be moved back into the position of rest, if the handle for the full rotation be farther moved back from A to A' (Fig. 2), consequently farther over the extent of the indicated angle α . Therefore, while the addition on the position of the result-calculator b to the right of a only involves one revolution of the handle, in the case of subtraction it is necessary that the handle be rotated a complete revolution plus the angle α .

If the result-calculator b would be in Fig. 2 at the angle α to the left of A , then the subtraction in contrast to the position of the result-calculator b to the right of a would be effected for both result-calculators by a revolution of the handle, the addition, however, would require further the turning of the handle by the amount of the angle α and this not from A to A' , but in the opposite direction from A by the amount of the angle α , to the left.

In other words, if a complete rotation of the handle for two or more result-mechanisms is to give the correct addition or subtraction, then that mechanism which is last influenced by the rotating teeth of the adjusting mechanism must be operated by a full rotation of the handle. The interchange of the direction of the rotation of the handle involves therefore the alteration of the original position of the rotating mechanism by the angle α . Fig. 3 shows diagrammatically the above described procedure.

This angular displacement of the driving disks by the amount of the angle α can be effected in two ways:

1. Switching means comprise two shifting levers r, r' pivotally arranged upon the axle s , which can each be engaged with a side projection t of a wheel o of the switching means, so that by rocking of these levers the wheels o and consequently the respective driving disk groups are displaced by the amount of the angle α . The levers r, r' are coupled with the wheel pairs m, n and of the respective switching means and are guided in Z-shaped slots u in the casing (Fig. 4), whereby they are to be shifted on the transfer from the positive to the negative position from one end of the slots u to the other, consequently first shifted from the side into a middle position, then rocked in a peripheric direction and finally again pushed to the side, thus affording the said angular displacement of the driving disks as well as also the switching of the gears.

Therefore the adjustment of the levers r, r' for addition or subtraction determines the indications or signs of ψ and φ . In order that the shifting levers r, r' may not hinder in their end positions the turning of the wheels o , but for the aforesaid angular displacement can be brought to engagement upon the projections t , they are made displaceable in the manner shown in Fig. 2 by means of a slotted part q provided upon them. By pressing upon the shifting levers in the direction of their length, the same can be pushed back out of their middle position assured by means of two opposing springs in the direction toward the projections t by a small amount, until a fork q' provided thereon engages with the above mentioned projections t , whereby this pressure is maintained upon the shifting levers until the displacement of the driving disks has taken place to the extent of the angle α , or the way of the lever r , or r' is traversed in the slot u from the plus to the minus position, whereupon the pressure ceases and the shifting levers again take their normal middle position in consequence of the spring action. The fork q' of the levers r and r' has the purpose of preventing an overturning of the wheels o so long as the levers r and r' move in the middle peripheric part of the slots u ; but when the levers r, r' move in the one or other of the side limbs of the slots u then there is not possible any faulty turning of the wheels o , the wheels m or n meshing already with the wheels o or p . If the transmitting teeth come into cooperation with the calculating wheels, then consequently the new position of the driving disks differing from the previous one by the amount of the angle α cannot be disturbed.

2. To the side of the casing of the machine are provided two notches v, w for the arresting of the actuating handle l . If the handle l is turned away from the notch v to the right (that is forward), and the shifting levers r, r' are adjusted for addition, then both result-calculators a, b effect the calculation of addition. If, however, the levers r, r' are adjusted to subtraction, then by the moving of the levers r, r' from the positive to the negative position and the engagement thereof with the projections t the respective driving disk groups will be displaced by the amount of the angle α from A to A' , and also the switching wheel pairs m, n will be shifted and there will then take place on the same turning of the handle in the result-calculators a, b , subtraction. If, however, the handle l is turned backward (that is to the left) and if the levers r, r' are adjusted to addition, then with the motion of the handle l from the notch v to the notch w there takes place an angular adjustment of the driving disk groups from A

to A^1 , while at the same time the spring
acted handle part L^1 slidably arranged in a
longitudinal slot L^2 of the handle L is com-
pulsorily raised in the slot L^2 by means of
the sloping cam surface w^1 and finally en-
gages behind the catch spring x so as to be
held fast in this new position. The end of
each full revolution of the handle L is there-
fore determined on the turning backward
rotation by means of the notch w and the
handle stroke is thus displaced with regard
to the previous one by the amount of the
angle α : for both result-calculators a, b
there takes place simultaneously subtraction.
Finally if the levers r, r^1 are adjusted
to subtraction, then they again lead the
driving disks from A to A^1 ; this motion is,
however, compensated on the turning back
of the handle L through its turning from the
notch v to the notch w . By this means ad-
dition takes place in the result-mechanisms
 a, b .

If for the forward motion of the handle
 L there be taken the plus sign and for the
backward motion the minus sign, and if the
two end positions of the levers r, r^1 have
given them the sign plus and minus, then
the machine gives with the same designa-
tions for the direction of rotation of the
handle L and the position of the levers r, r^1 ,
addition and, with opposite designations it
gives subtraction of the products.

The equations for Y and X can there-
fore be solved in the simplest manner; for ϕ
and φ the designations are determined by
the position of the shifting levers r and r^1 ,
for y and x by the forward or backward
motion of the actuating handle. This ad-
vantage of the new machine which removes
all need of thinking for the interchange of
the designations of all the factors, is how-
ever not purchased by a more difficult oper-
ating or any increase in the sources of error.

What I claim is:

1. In calculating machines, a plurality of
groups of adjustable driving members for
the adjustment of calculation figures, a cor-
responding number of result-calculators,
angularly displaced with regard one to an-
other relatively to said groups and arranged
to be operated by the said groups of driving
members having been adjusted, a common
actuating device to move said groups of
driving members for the transmission of

their adjustment upon the result-calcula-
tors and means to allow of relative displace-
ment between the said groups of driving
members and result-calculators for the pur-
pose of interchanging relative coöperation
between them, substantially as described.

2. In calculating machines, a plurality of
groups of adjustable driving members for
the adjustment of calculation figures, a cor-
responding number of result-calculators,
angularly displaced with regard one to an-
other relatively to said groups and ar-
ranged to be operated by said groups of
driving members having been adjusted, a
common actuating device to move said
groups of driving members for the trans-
mission of their adjustment upon the result-
calculators, switching means between said
actuating device and said groups of driving
members for allowing the latter to be moved
in opposite directions, and interconnecting
means between said switching means and
groups of driving members to produce on
switching simultaneous angular displace-
ment of said groups corresponding to the
angle of displacement of the result-calcula-
tors, substantially as described.

3. In calculating machines, a plurality of
groups of adjustable driving members for
the adjustment of calculation figures, a cor-
responding number of result-calculators ar-
ranged to be operated by said groups of
driving members having been adjusted, a
corresponding number of counting mecha-
nisms associated with said result-calcula-
tors, a common actuating device to move
said groups of driving members for the
transmission of their adjustment upon the
result-calculators and to also move said
counting mechanisms, and means to allow
of relative displacement between the said
groups of driving members and result-cal-
culators for the purpose of interchanging
relative coöperation between them, sub-
stantially as described.

In witness whereof I have hereunto
signed my name this 23rd day of January
1917, in the presence of two subscribing
witnesses.

JACOB BALTISSER.

Witnesses:

CARL O. SPAMER,
ARNAND BRAUN.