No. 706,180. Patented Aug. 5, 1902.

I. HULTMAN.

CALCULATING MACHINE.

(Application filed Dec. 16, 1901.)

(No Model.) 3 Sheets—Sheet 1.

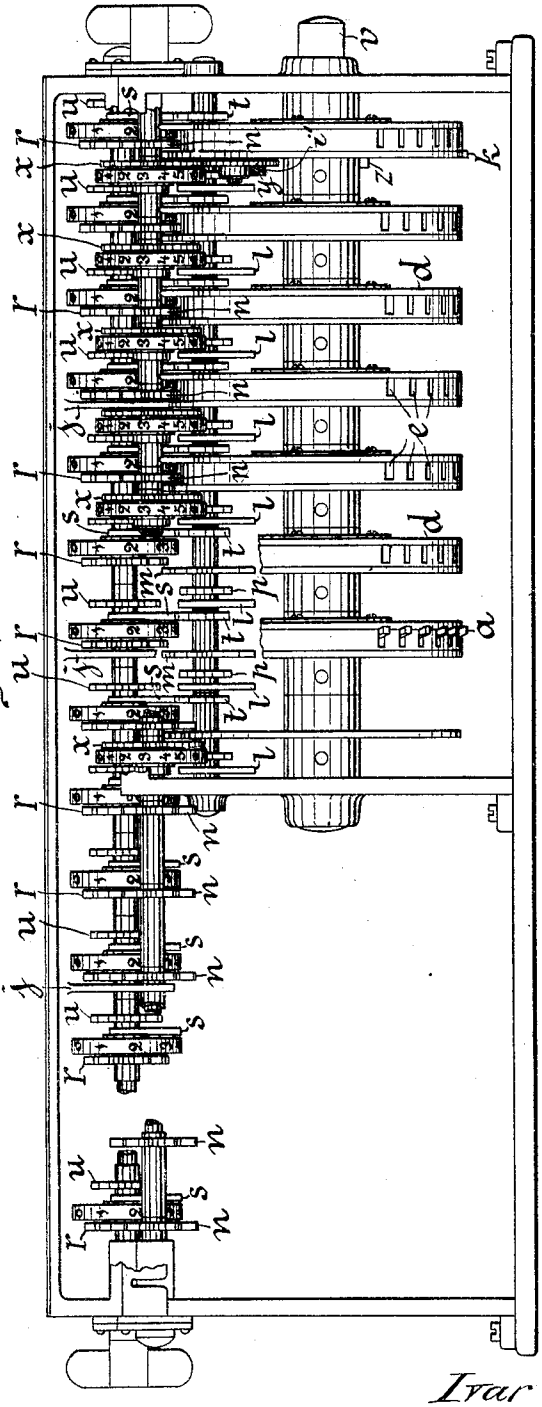

Fig. 1.

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(No Model.) 3 Sheets—Sheet 2.

Fig. 2.

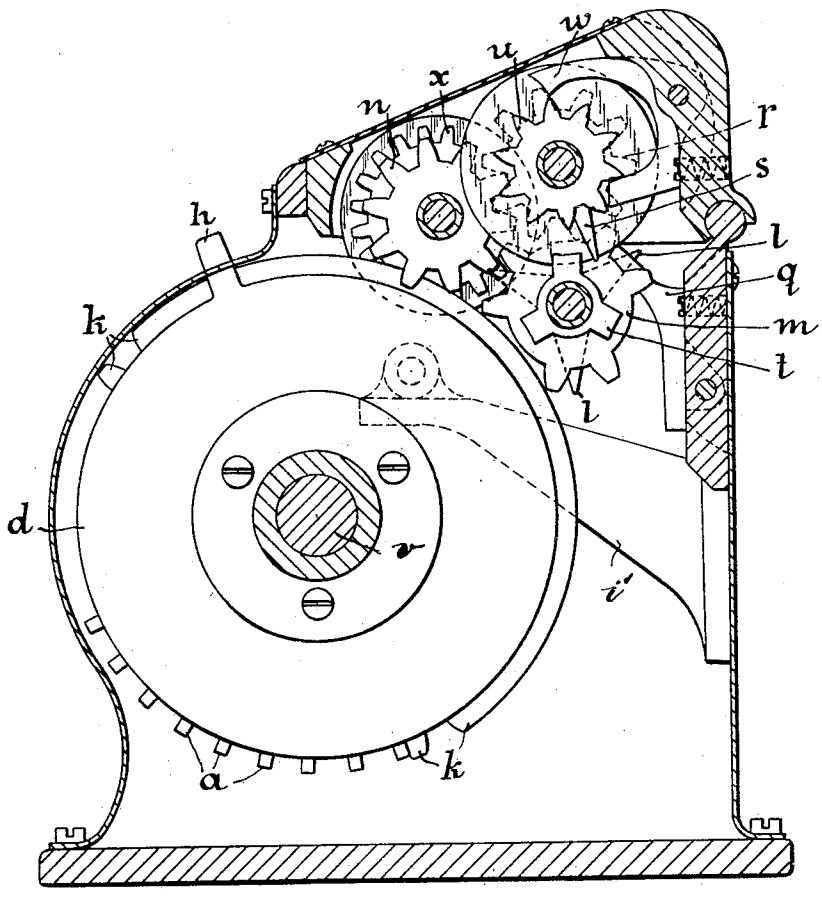

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Fig. 3.

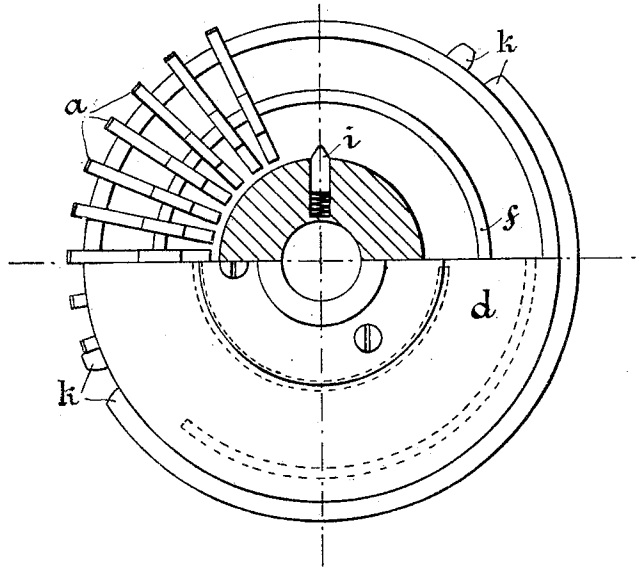


Fig. 4.

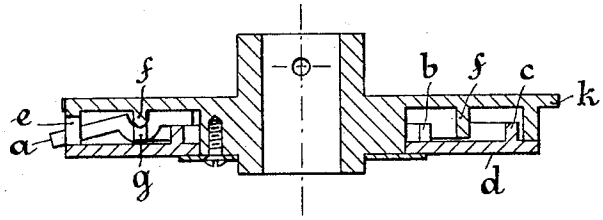
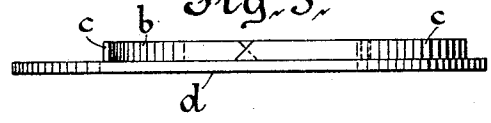


Fig. 5.



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UNITED STATES PATENT OFFICE.

IVAR HULTMAN, OF STOCKHOLM, SWEDEN, ASSIGNOR OF ONE-HALF TO ADOLF MAGNUS JOHANSON, OF STOCKHOLM, SWEDEN.

CALCULATING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 706,180, dated August 5, 1902.

Application filed December 16, 1901. Serial No. 86,102. (No model.)

To all whom it may concern:

Be it known that I, IVAR HULTMAN, a resident of Stockholm, in the Kingdom of Sweden, have invented certain new and useful Improvements in Calculating-Machines, of which the following is a specification.

The invention relates to a calculating-machine for the four rules of arithmetic, and has for its object to avoid certain disadvantages, such as miscalculation and unmanageableness, to which similar machines now in use are often liable.

The improved machine has four horizontal axles. In the following the one of them is designed as driving or crank axle and the three others as controlling-axle, intermediate axle, and carrying-axle, respectively. The wheels on driving-axle (driving-wheels) are fixed to the axle and will thus partake in the movement when the axle is rotated by means of a crank. The other wheels (called "controlling," "intermediate," and "carrying" wheels) are loose on their axles and can thus be rotated independently. The controlling-axle and intermediate axle are, as usually, mounted in a carriage, which can be shifted in a direction parallel to the axles and eventually also turned on a separate axle parallel to the other axles. The driving-wheels are provided with nine movable cogs or teeth, which can be locked in suitable (working or resting) position. Said wheels bear also two series of fixed cogs or teeth, the one series being used for addition and multiplication, the other for subtraction and division. The movable teeth or levers *a* (shown in Fig. 1)—*i. e.*, those of them being in working position—act upon the controlling-wheels when the driving-wheels are rotated, and said controlling-wheels always mesh with the intermediate wheels. The latter bear one or more arms or tappets, which act upon the corresponding carrying-wheels or upon arms or tappets fixed to the latter. The carrying-wheels are also turned directly by the fixed teeth of driving-wheels; but engagement with said driving-wheels cannot take place unless the carrying-wheel is previously turned a little through the corresponding intermediate wheel by means of said arms or tappets. For this purpose the teeth of each carrying-wheel are preferably disposed in groups or series separated by spaces of greater width than the usual spaces, and one of these wide spaces faces toward the driving-axle when the crank is in its starting position. Besides, the parts are so disposed that the fixed teeth of the driving-wheels do not reach the carrying-wheels before the movable teeth have already passed the controlling-wheels. The number of fixed teeth in each series on the driving-wheels is not less than the number of teeth in each group on the carrying-wheels in order that the latter when engaged with the driving-wheels may always be turned a whole group or a distance between two wide spaces by a full turn of the crank, so that a wide space will again stop opposite the crank-axle, and thus further turning of the carrying-wheel directly by means of the driving-wheels will be impossible unless said carrying-wheel is previously brought into working position by help of the corresponding intermediate wheel and the tappets stated above. Other arms or tappets fixed to the carrying-wheels act upon the next controlling-wheel or intermediate wheel to the left or upon a wheel fixed to either of them and perform the carrying when the carrying-wheels are turned directly by means of the driving-wheels. The figure-disks showing the sum, rest, and product may be mounted on the controlling-axle or upon the intermediate axle and may be fixed to the corresponding controlling-wheels or intermediate wheels or to separate wheels meshing with them, the result appearing, as usually, in suitable apertures in the casing. The quotient is shown by separate figure-disks mounted on the controlling-axle or the intermediate axle or a separate axle having bearings in the carriage, said disks showing the number of turns made by the crank-axle.

Figure 1 is a front elevation of a calculating-machine constructed according to this invention, the front part of the casing being taken away, so as to show the mechanism uncovered. For the sake of clearness also the controlling-axle and intermediate axle and two driving-wheels are partly broken away. The movable teeth are shown on one driving-wheel only, and the figures are drawn

only on some of the figure-disks. Of the braking device only the wheels are shown. Fig. 2 is a vertical cross-section seen from the right. Figs. 3, 4, and 5 show means for bringing the movable teeth into and out of working position.

The last-named mechanism consists therein that the movable teeth are constructed as radial levers *a*, turnable in axial planes and acted upon by concentric ribs *b c* or such like formed on the inside of a lid *d*, which is turnable upon the driving-axle *v* and serves as cover on a cylindric box, within which the levers are loosely mounted, said box forming the body of the driving-wheel. The levers are guided in slots *e* in the cylindric side wall of the box and in notches *g* in a rib *f*, formed on the inside of the bottom of said box between and parallel with the ribs *b c* of the lid. The bottom of said rib *f* enters a transverse groove or incurvation on the levers, whereby radial displacement of the latter is prevented. The one end of each rib *b c* forms an inclined plane, and these ends lie at the same radius, as shown in Fig. 5, so that the one rib will engage with the levers when the other rib releases said levers. The lids *d* are turned by pointers or handles *h*, projecting through slots formed in the front portion of the casing of the machine, and are locked in any given position relatively—the corresponding driving-wheel, for instance—by means of a spring-bolt *i*, loosely placed in a radial socket in the central part or hub of the wheel and engaging with a series of notches or teeth provided on the turnable lid. Fig. 3 is a side view of a driving-wheel, the upper half being shown in section for uncovering the levers *a*. Fig. 4 is a cross-section of a driving-wheel. Fig. 5 is a lid *d*, seen from the edge.

The fixed teeth *k*, which may be formed on the periphery of the box of driving-wheel or on a separate disk or wheel fixed to the latter, lie in the same vertical plane as the corresponding carrying-wheel *m*. In the illustrated example the carrying-wheels have two teeth in each group and the driving-wheels two teeth in each series. The last tooth in each series is enlarged in peripherical direction and may be common to both series, as shown. The object of this enlarged tooth is to stop the rotation of the carrying-wheel in the right moment, and thus absolutely prevent it from being thrown over into working position after it has reached free position. The corresponding series of fixed teeth on the different driving-wheels are not situated right opposite each other, but are a little displaced, so that first the units-driving wheel, then the tens-wheel, then the hundreds-wheel, and so on will engage with the corresponding carrying-wheel in order to avoid two or more simultaneous carryings, which would increase the resistance and render the handling of the machine more difficult.

The number of teeth on the controlling-wheels *n* and on the intermediate wheels *r*, meshing with the same, may be ten or a multiple of ten. When the number is ten, as shown in the drawings, each intermediate wheel should have only one arm or tappet *s*, which once for each full turn of said wheel engages with a tappet *t* on the corresponding carrying-wheel. As the latter has three groups of teeth, the tappet *t* is three-armed. Each carrying-wheel is provided also with another three-armed tappet *l*, which may act upon the next controlling-wheel or intermediate wheel, although in the form shown on the drawings it is disposed so as to act upon an extra wheel *u*, fixed to the intermediate wheel.

The braking device for stopping the controlling and intermediate wheels in right positions may be of every suitable construction and does not form any part of this invention. In the example illustrated it consists of angular levers *w*, (not shown in Fig. 1,) acted upon by springs and engaging with the teeth of said wheels *r*. For stopping the movement of the carrying-wheels there may be used similar or other devices—for instance, wheels *p*, (not shown in Fig. 2,) fixed to the same and engaging with spring-levers *q*. (Not shown in Fig. 1.)

The controlling and intermediate axles have bearings in the ends of the carriage and are, besides, supported by intermediate bearings *j*, so as to evitate bending or swaging of the same.

In the illustrated form of the machine the figure-disks showing the sum, rest, and product are fixed to the intermediate wheels, while the numeral-disks showing the quotient and the number of turns (up to nine) made by the crank are mounted on the controlling-axle. The latter disks are fastened each to a gear *x*, and one by one of said gears (shown in Fig. 1) may by shifting the carriage be brought into engagement with a gear *y*, mounted on a separate short axle which is secured to a separate support *i'* on the stationary frame and acted upon by a stud *z* on the driving-shaft *v*. The number of teeth on these gears is preferably so proportioned that the figure-disk will rotate one-eighteenth turn for every full turn of the driving-axle. After nine turns of the crank thus the figure-disk has made only a half-turn. The periphery of said disks on the controlling-axle is provided with the figure series "0 1 2 3 4 5 6 7 8 9 8 7 6 5 4 3 2 1," so that the number of turns of the crank in either direction will be indicated. The figures on the disks on the other axle should correspond in number to the teeth on the wheels *n* or *r*. Thus if the latter are ten-teethed the disks should bear the figure series "0 1 2 3 4 5 6 7 8 9."

Before the beginning of an operation the figure-disks should be brought to their original position, so that only the figure "0" will appear in the apertures of the casing. This turning of the disks may be effected by any suitable means—for instance, by small tap-

pets fastened on the axle and engaging with the disks or their wheels when the axle is displaced a little in its longitudinal direction, so that the disks will partake in the turning of the displaced axle, but are free to rotate on the axle when the latter is not displaced.

By addition and multiplication the crank should be turned forward, but by subtraction and division backward.

The adding of, say, twenty-seven to forty-three may be performed as follows: At first the one addendum—for instance, twenty-seven—is set up by moving the pointer *h* of the lid *d* of the units-driving wheel to the figure "7" and the tens-pointer to the figure "2" of the usual figure series provided on the casing along the slots through which the pointers project, so that seven levers *a* of the units-wheel and two levers or teeth of the tens-wheel are brought into working position. Then the crank is moved a full turn, so that the corresponding wheels *n* and *r* are moved seven-tenths and two-tenths turn, respectively, thus causing the figure-disks on the intermediate axle to show the addendum "27" in the apertures. Now the other addendum is set up by moving the units-pointer to "3" and the tens-pointer to "4," and the crank is moved forward a full turn again, so that the sum "70" appears in the apertures. By this second turn of the crank the units-carrying wheel *m* is brought into working position and is thus caused to make one-third turn by engagement with the driving-wheel, so that one arm of the tappet *l* is caused to move the tens-figure disk one-tenth turn corresponding the carrying, the three-tenths turn of the units-disk and the four-tenths turn of the tens-disk being performed by means of the levers *a* previous to said carrying.

It makes no difference if you begin with the addendum forty-three instead of twenty-four. It is also equal if the tens-pointer is moved before the units-pointer, or vice versa.

By subtraction it should be proceeded in the same manner, except that after setting up the subtrahend the crank should be turned backward instead of forward.

In multiplication the multiplicand is set up by moving the pointers *h* to the corresponding figures. Then the crank is turned so many times as the units-figure of the multiplier indicates, this number of times being automatically controlled by the corresponding figure-disk on the controlling-axle. Then the carriage is moved a step to the right, and the crank is turned so many times as the tens-figure of the multiplier designates. The carriage is then moved a further step to the right and the crank turned, as indicated by the hundreds-figure of the multiplier, and so on for every figure of the multiplier. The product will be seen in the usual apertures.

In division, first the dividend is set up and caused to appear in the usual apertures. This is accomplished by any suitable means, which I do not consider of such importance to show, in order to evitate the appearance of figure "1" in the quotient-apertures. Then the pointers *h* are moved to the figures indicated by the divisor, and the carriage is moved so that the first figure of the dividend comes right opposite the first figure of the divisor. If the part of the dividend thus lying opposite the divisor is smaller than the latter, the carriage must be moved a step to the left. Then the crank is turned backward until the rest of the part of the dividend thus diminished is less than the divisor. Now the carriage is moved a step to the left and the crank is turned again until the new rest is smaller than the divisor, and so on until the rest of the whole dividend is smaller than the divisor. If after any of these movements of the carriage the part of the dividend being opposite the divisor is from beginning less than the latter, then the crank should not be turned in this position of the carriage, but the carriage should be moved a new step until said part of the dividend is not smaller than the divisor.

When setting up the dividend by means of turnable knobs, as stated above, the carriage should be lifted or displaced a little in order that the carrying-wheels may not be acted upon.

In subtraction and division it often happens that the operator from inadvertency moves the crank forward instead of backward, and in multiplication it often occurs that the operator moves the crank, for instance, seven and one-half turns instead of seven turns, so that the crank must be moved in the opposite direction for compensating such fault. If such backward movement of the crank begins ere the crank has reached the starting-point, the result often will be wrong when using machines of hitherto-known construction. In operating on such machines it therefore will be necessary to first complete the wrong turn ere the crank is moved in the opposite direction. This enervating attentiveness is not necessary when using the new machine, as a wrong turn may be stopped at any point and the crank drawn back without incurring the risk of wrong result.

Although the described means for bringing the movable cogs in and out of working position is very suitable, I do not wish to limit myself to this construction, as any other means accomplishing the same effect may also be used.

I claim—

1. A calculating-machine, the combination of a series of driving-wheels fixed to a crank-axle, a series of controlling-wheels loosely mounted on another axle parallel to the crank-axle and adapted to engage with movable teeth on the driving-wheels, a series of intermediate wheels loosely mounted on a third parallel axle and meshing with the controlling-wheels, and a series of carrying-wheels loosely mounted on a fourth parallel axle and adapted to engage with fixed teeth on the

driving-wheels after having been turned a little by means of the intermediate wheels, said carrying-wheels acting upon the next controlling-wheel substantially as set forth.

2. A calculating-machine having four series of wheels (viz. driving, controlling, intermediate and carrying wheels) on four parallel axles, two of which (viz. controlling and intermediate) are mounted in a movable carriage, the carrying-wheels having teeth disposed in groups separated by wide spaces, so that said wheels cannot be turned directly by the driving-wheels unless first acted upon indirectly by means of the intermediate wheels and thereby brought into working position.

3. A calculating-machine having four parallel series of wheels (called driving, controlling, intermediate and carrying wheels), the driving-wheels having two series of fixed teeth adapted to engage with the carrying-wheels, the last tooth in each series being enlarged in peripherical direction and preferably common to both series, substantially as and for the purpose set forth.

4. A calculating-machine consisting of driving-wheels with two series of fixed teeth and one series of movable teeth, controlling-wheels adapted to engage with said movable teeth when these are brought into working position, intermediate wheels meshing with said controlling-wheels, and carrying-wheels having teeth disposed in groups and provided with two tappets each having an arm for each group of teeth, the one tappet being acted upon by a tappet fixed to the corresponding intermediate wheel for bringing the carrying-wheel in working position, so that it may be acted upon by the fixed teeth of the corresponding driving-wheel and thus turned a distance corresponding to a group of teeth, whereby the other tappet is caused to act upon the next intermediate wheel or upon a wheel fixed to the same for performing the "carrying," said machine having means for stopping the movement of the wheels and for showing the result of the operation, substantially as and for the purpose specified.

5. A calculating-machine having driving-wheels provided with fixed teeth and movable teeth, the latter consisting of levers turnable in axial planes and acted upon by concentric ribs for bringing the same into or out of working position.

In testimony whereof I have hereunto set my name in the presence of two subscribing witnesses.

IVAR HULTMAN.

Witnesses:
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J. A. G. WEDELIN.