May 27, 1941. R. E. ANNERÉN ET AL 2,243,075

CALCULATING MACHINE

Filed Dec. 10, 1934 2 Sheets-Sheet 1

FIG. 1.

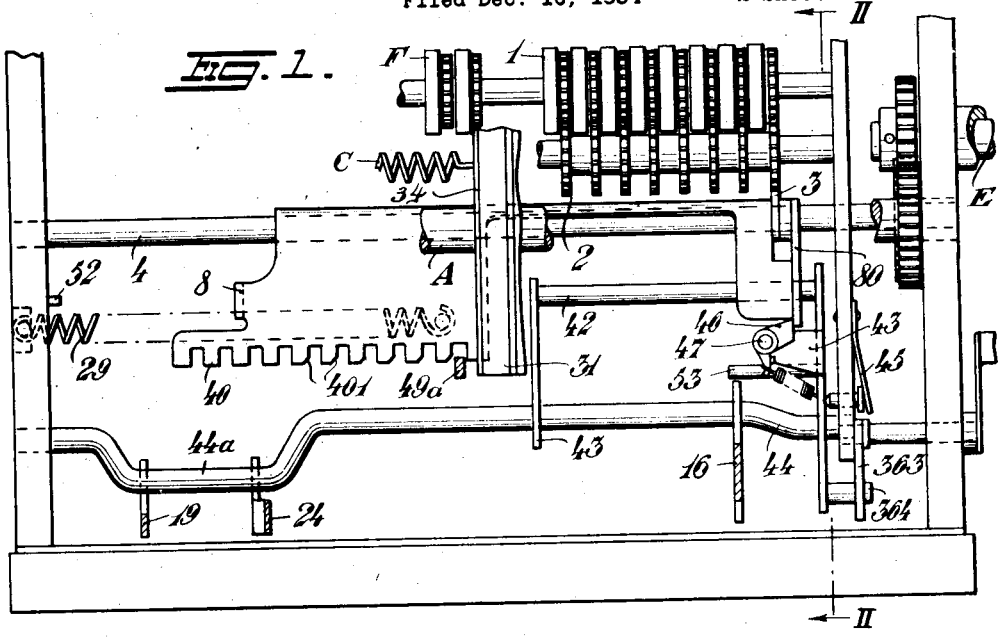

FIG. 3.

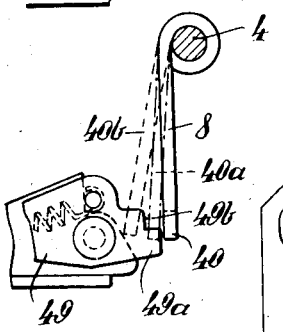

FIG. 2.

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FIG. 5.

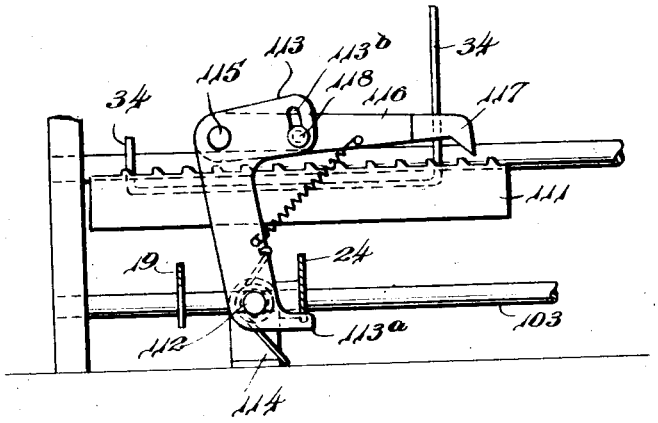
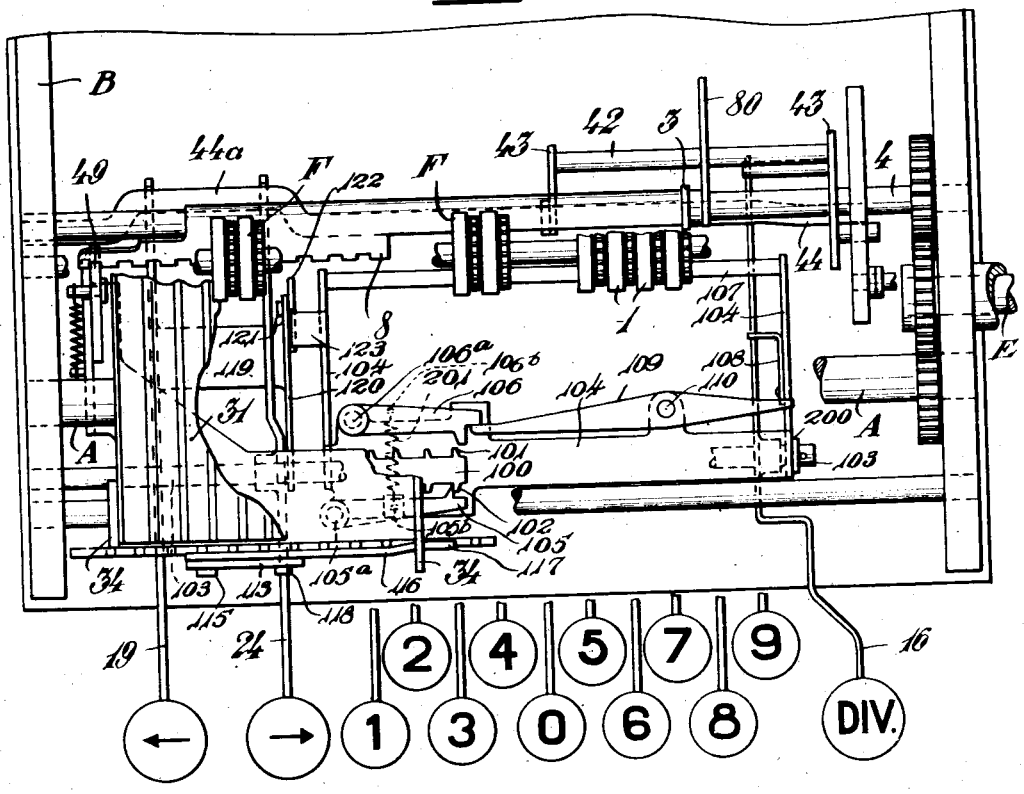


FIG. 4.



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Patented May 27, 1941

2,243,075

UNITED STATES PATENT OFFICE

2,243,075

CALCULATING MACHINE

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Application December 10, 1934, Serial No. 756,823
In Germany January 13, 1934

7 Claims. (Cl. 235—63)

Our invention refers to calculating machines having both a revolutions counter or quotient register and a stationary accumulator, and also having an actuator for the accumulator, the actuator being movable to different decimal positions in relation to the accumulator. Also, the machine comprises an actuating member for the revolutions counter, said actuating member being movable to different decimal positions in relation to the revolutions counter.

The chief object of this invention is to bring the actuator and the revolutions counter actuating means into correct positions in relation to the accumulator and the revolutions counter, respectively, for operations of division, upon depression of a single key.

For this purpose heretofore the actuating members for the revolutions counter were connected with the actuator by means of releasable couplings. A solution of this problem for so called Odhner or pin wheel machines is disclosed in U. S. Patent No. 2,108,596 of February 15, 1938, and a solution for machines of the stop-carriage type in U. S. Patent 1,930,475. Such stop-carriage or selector machines are 10-key adding machines modified for multiplication and have key-operated stops of the co-ordinate type, serving as stops for the levers or the like actuating the numeral wheels. It is an object of this invention to effect an improvement over machines of the above type.

These known machines suffer, however, from serious drawbacks, particularly in the following respects. In all machines of this type the accumulator has more orders of numeral wheels than the revolutions counter. If only a few orders are set in the actuator, the extreme left, that is, the highest orders of the accumulator may be used for the calculation only if an adequate number of otherwise superfluous zeros are set in the actuator. This inconvenience is particularly noticed in divisional operations. Assume, for instance, that the machine has 13 orders in the accumulator and 8 orders in the revolutions counter, and that, for instance, the number or item "5467" is to be divided by "3." When the item "5467" is set in the actuator, said actuator will immediately upon depression of the tabulating key be coupled to the actuating members for the revolutions counter such as revolutions counter actuating tooth 82 in U. S. Patent No. 2,108,596, or revolutions counter actuating pawls 312, 313 in U. S. Patent No. 1,930,475, and can thus only be tabulated 8—1=7 decimal places to the left, that is, as many steps as said actuating members can be tabulated. In transferring the dividend "5467" from the actuator to the accumulator, the number "5" will thus be transferred to the eleventh order of said accumulator and the two highest orders thereof cannot be used. If then, (after the actuator has been cleared) the number "3" is set in the actuator, said actuator can be tabulated 7 steps or orders only, that is, the number "3" in the actuator can only be tabulated to the eighth order of the accumulator, that is, below the number "7" of the item "5467" previously transferred to said accumulator.

To render it possible to carry out the division just mentioned one of the following three methods must be adopted:

1. The item "5467" is tabulated only so many places to the left that the numeral "5" thereof is at the eighth order of the accumulator. The item "5467" is transferred to the accumulator, the actuator is cleared and the number "3" is set in the actuator. The division will then begin at the eighth order of the accumulator and the five higher orders thereof cannot be used.

2. It is somewhat better to tabulate the item "5467" to the eleventh position or order of the accumulator and to set the item "3000" in the actuator as divisor. In this case the division begins at the eleventh order of the accumulator and only the two highest orders thereof cannot be used.

3. The best method is to set the item "546700" in the actuator and to tabulate it to the thirteenth or highest order of the accumulator and to set the item "300000" as divisor in the actuator. The division may then begin at the highest order of the accumulator. Only in this way the full capacity of the machine can be utilized.

The object of this invention is to remove such difficulties and to cause the machine to work correctly without any necessity of introducing superfluous zeros into the divisor or dividend.

Another object of this invention is to render it possible to utilize the full capacity of the machine without any particular manipulations by the operator.

Another object of the invention is to render it possible to carry out operations of division with a minimum of manipulations and at a maximum speed.

A further object of this invention is to render it possible for both the actuator and the revolutions counter actuating members to move to their extreme left positions at the highest orders of the accumulator and the revolutions counter,

respectively, independently of the number of figures set in the actuator.

A further object of this invention is to lock the revolutions counter actuating members to the actuator, as soon as they are back-spaced, that is, moved to the right.

A further object of this invention is to cause the machine to work correctly under all circumstances.

Further objects will be evident from the following specification and drawings.

Some embodiments of the invention are illustrated in the annexed drawings.

Fig. 1 is a front view of a calculating machine embodying our invention, some parts being broken away;

Fig. 2 is a cross-sectional view taken on the line II—II in Fig. 1;

Fig. 3 shows a detail on a larger scale of the device shown in Figs. 1 and 2;

Fig. 4 is a top view of the machine, some parts being broken away for the sake of clearness; and

Fig. 5 is a front view showing particularly the back-space mechanism.

In Figs. 1–5 of the drawings, the revolutions counter 1 is provided with an intermediate or transmission wheel 2 for each order. The wheels 2 are actuated or driven by a revolutions counter actuating tooth 3, which is displaceable axially but will rotate with the shaft 4, a projection or pin 5 in the hub of the tooth 3 permanently engaging a longitudinal slot in the shaft 4. In the calculating operations the shaft 4 is rotated in the usual manner from the operating shaft A of the machine, which may be driven by hand by a crank on shaft E or by a motor (corresponding to U. S. Patent 2,127,102). The lateral displacement of the tooth 3 is effected by a carrier 8 which engages the hub of the tooth 3 on both sides and is provided with a rack 40 and is slidable axially on the rotatable shaft 4. On endplate 80 of the carrier 8 there is a curved cam surface 41 engaged by a pin 42 of a U-shaped member or lever 43 fixed on a shaft 44. The lever 43 may assume three positions as indicated by full lines and by the dash-and-dot lines 43a and 43b. A spring-pressed latch-pin 45 carried by a stationary part of the frame latches the lever 43 in its three positions. When the lever 43 is rocked it will also rock the carrier 8 engaged thereby and the rack 40 to corresponding positions indicated by full lines and by the dash-and-dot lines 40a and 40b in Figs. 2 and 3.

In its normal (full line) position the plate 80 is engaged by a spring pressed ratchet 46 journalled on a pin 47 on the member 43. Normally the carrier 8 is locked in its right end position by said ratchet 46, but when the member 43 is rocked to the position 43a or 43b, said ratchet 46 is disengaged from the plate 80 and the carrier 8 is free to move to the left under the action of the tension spring 29.

The member 43 is secured on the shaft 44 which may be rocked by the key 16 acting on the pin 53 on the member 43 and by step-by-step tabulating key 19 acting on the crank 44a. When depressed, the division tabulating key 16 turns the member 43 to the position 43a and the rack 40 to the position 40a while the step-tabulating key 19, when depressed, turns the member 43 to the position 43b and the rack 40 to the position 40b.

As best seen from Fig. 3 the rack 40 will in the position 40a be engaged by the lower step 49a of the pawl 49 and in the position 40b the higher step 49b will engage said rack 40. The pawl 49 is journalled on a carriage 34, which carries the actuator or setting device 31 (which may be a pin wheel or Odhner rotor, a Thomas-rotor, a stop carriage or selector, etc.). A spring C tends to draw the carriage 34 and the actuator 31 to the left in Fig. 1. The actuator 31 actuates a stationary accumulator F.

A convenient number (or all) of the right-hand teeth of the rack 40 are bevelled on one side, as shown at 401. A stop 52 limits the motion of the carrier 8 to the left.

The tabulating devices for the actuator or drum 31 will now be described.

The means for moving the actuator 31 and its carriage 34 along the shaft A under the action of the keys 16, 19, 24 are as follows:

A double rack 100 having two rows of teeth 101, 102 is secured to carriage 34. A stationary transverse shaft 103 is secured at one end of the machine frame B and at its other end to a lug 200 projecting from the bottom of the machine frame. Rockably, but not slidably, mounted on shaft 103 is a frame 104 which carries a pin 105a on which is pivotally mounted a pawl 105 normally engaging the teeth 102. The shaft 103 is the shaft on which the keys 16, 19, 24 and also the numeral keys are journalled. The frame 104 also carries a pin 106a on which is pivoted a second pawl 106 normally out of engagement with the teeth 101. The back part of key 16 engages a bail 107 of frame 104 from below, and also engages from below one end of a swingable member 108, the other end of which engages one arm of a lever 109 (Figs. 2 and 4). The member 108 is journalled on the pin 108a carried by frame 104. The lever 109 is rotatably journalled on a pin 110 secured to the frame 104 and engages with its other arm the pawl 106, keeping the latter normally disengaged from the teeth 101. Any suitable resilient means may be employed for urging the pawl 105 toward the teeth 102 and the pawl 106 toward the lever 109, such as the spring 201 connected between the two pawls. Pawls 105 and 106 carry pins 105b and 106b, respectively, between which pins is connected a spring 201 which urges the pawls toward each other. The pins 105 and 106b serve as stops acting against the sides of frame 104 for limiting movement of the pawls under the influence of spring 201.

If key 16 is depressed, its back end strikes bail 107 and rocks the frame 104 so that the pawl 105 is rocked downwardly and out of engagement with the teeth 102. Simultaneously the back end of key 16 rocks the member 108, causing it to move the lever 109 (clockwise in Fig. 4), which rocks the pawl 106 to prevent it from engaging the teeth 101. The two pawls 105, 106 are now disengaged from the rack 100 and consequently the carriage 34 with the actuator 31 is free to move to its extreme left position (in Fig. 4) under the action of the spring C. As soon as key 16 is released the pawl 105 again engages the rack 100. It is to be observed that pawl 105, when in operative position, prevents the carriage 34 from being displaced to the left under the action of the spring C, but its point is so bevelled as to permit the rack 100 to move to the right while rocking said pawl 105 yieldingly aside, the teeth of the rack 100 being similarly bevelled on their right sides.

To the front side of said carriage 34 another rack 111 is secured. On a stationary pin 112

(Fig. 2) an arm 113 is rotatably journalled, one offset 113a of which is pressed by a torsional spring 114 to engage the lower side of key 24 (Fig. 5). An arm 116, having a nose or point 117 for cooperation with said rack 111, is swingably mounted on a pin 115 carried by arm 113. A second pin 118 secured to the arm 116 cooperates with a slot 113b in the arm 113 to limit the motion of the arm 116 in relation to the arm 113.

If key 24 is depressed it rocks the offset 113a downwards and consequently also rocks the arm 113, thus moving the arm 116 to the right (in Figs. 4 and 5). The nose 117 of this arm then engages a tooth of the rack 111. Thus, the rack 111 is pushed one step to the right (in Figs. 4 and 5), as the total motion of the key 24, when being depressed, is just sufficient to move the arm 116 one tabulating step to the right. The carriage 34 and the rack 100 rigidly connected with the rack 111 are consequently also tabulated one step to the right. The key 24, when depressed, does not act on the frame 104 and for this reason the pawl 105 remains in engagement with the teeth 102, but it is rocked aside by the latter when the rack 100 is moved one step to the right and then again snaps in to engage the next tooth of the rack 100 for keeping the carriage 34 in its new position. Each time the key 24 is depressed, the carriage 34 is moved one step to the right (in Figs. 4 and 5) and kept in its new position. The key 24, when manipulated will thus cause the carriage 34 to move step-by-step to the right.

The back part of the key 19 carries a bridge 119 integral with an arm 120 journalled on the stationary shaft 103 on which shaft the key 19 is also journalled, said bridge 119 extends so far below the key 24 as not to engage said key when the bridge is moved upwards together with the key 19, when the latter is depressed. On a pin 121 on arm 120 another arm 122 is journalled, which engages from below an offset 123 of the frame 104.

Thus, when the key 19 is depressed, the bridge 119 with the arm 122 is rocked upwards and lifts the frame 104, rocking the same so as to move the pawl 105 downwards and disengage it from the corresponding tooth 102. Because the member 108 is not now rocked by key 16, the lever 109 can swing counterclockwise in Fig. 8 to permit the pawl 106 to engage the teeth 101. As is evident from Fig. 4, the nose of the pawl 106 is displaced so much to the right in relation to the nose of the pawl 105 that the pawl 106, when rocked into engagement with the teeth 101, will engage that tooth thereof which is next to the right of the tooth of the row 102 just engaged by the pawl 105. Consequently, when the frame 104 is rocked by the key 19, as described above, the pawl 105 is rocked out of engagement with one of the teeth 102, while simultaneously the pawl 106 is rocked in between the opposite tooth of the row 101 and that tooth of the row 101 which is next to the right of said opposite tooth.

Now the spring C draws the carriage 34 to the left, until said carriage is stopped by the engagement of the pawl 106 with said tooth next to the right. When thereafter the frame 104 is restored to its normal position, the pawl 106 is rocked out of engagement with the teeth 101, but before that the pawl 105 again has been rocked to engage the next tooth 102, that is, that tooth of row 102 which is next to the right of the tooth from which the pawl 105 was just disengaged. When the pawl 106 is rocked out of engagement with the teeth 101, the spring C draws the carriage 34 a little more to the left, until it is checked by the said engagement of pawl 105 with the next tooth 101. Thus, the key 19 has caused the carriage to be moved one step to the left. The repeated manipulation of the key 19 will thus cause the carriage 34 to be moved step-by-step to the left in Fig. 4.

Normally the parts have the positions indicated by full lines in Figs. 1–5. If the division tabulating key 16 is actuated, lever 43 is rocked to the position 43a and the pawl 46 thereon is rocked out of engagement with the plate 80 and the spring 29 draws the carrier 8 to its extreme left position at the stop 52. Movement of the lever 43 causes pin 42, which engages cam surface 41 on end plate 80, to rock this plate and the carrier 8 and hence rack 40 to position 40a. In this position the rack engages the step 49a of the pawl 49, so that the revolutions counter-actuating tooth 3 connected with carrier 8 is coupled to the carriage 34, on which pawl 49 is pivoted, for the actuator 31. Simultaneously a spring C draws the carriage 34 to the left in well-known manner because the carriage 34 was also released at the depression of the tabulating key 16 as is explained hereinafter. In case of an accumulator register F having thirteen orders and a revolutions counter I having eight orders, as assumed above, the carrier 8 can be moved only seven steps or orders to the left. If now less than 13—7=6 orders have been set in the actuator 31 (for instance, if the actuator has been moved less than six steps in the setting operation preceding the tabulation), the carrier 8 will be stopped (by stop 52) in its extreme left position before the actuator 31 has reached its extreme left position. The strong spring C of the actuator 31 will, however, draw said actuator farther to the left, causing the stepped point 49a of the pawl 49 to be pushed aside (pressed down) by the bevelled edges 401. Thus, the actuator will not stop, until it has also reached its extreme left position.

Upon depression of the key 19 the rear end of the key is raised and strikes the crank 44a, thus rotating the shaft 44 and the plate 43 mounted thereon through a sufficient angle so that the pin 42 on the plate, cooperating with the cam surface 41, rocks the end plate 80 of the carriage 8 to bring the rack 40 to the position 40b (Fig. 3), where the teeth of the rack engage the step 49b of the pawl 49. This step engages the unbevelled bottom portion of the teeth of rack 40 and for this reason it cannot (be pressed down by) the oblique edges 401 and the carrier 8 is consequently rigidly coupled to the carriage 34, until at the next clearing operation the parts are restored to their original positions. For clearing, the member 43 is moved to its position shown in full lines. A part 363 of the clearing mechanism strikes the pin 364 to restore member 43 to the normal position shown in full lines in Fig. 2.

At all tabulations to the right—upon depression of backspace key 24—the steps 49a or 49b will immediately engage the corresponding tooth of the rack 40, as has been described, and couple carrier 8 rigidly to carriage 34. For all tabulations to the right, that is, backspacing, whether the key 16 has been previously used or not, the actuator 31 and the tooth 3 are consequently united to an aggregate and move in unison. It is preferred to cause the key 24, when actuated,

to rock the member 43 to the position 43b. For this purpose the key 24 may, for instance, also act on the crank 44a.

In order to show the mode of action of the machine more clearly, it is now described how "5467" is divided by "3," when it is assumed that the results register has thirteen orders or register wheels and the quotient register has eight orders or register wheels.

The number 5467 is set up in the actuator in the usual manner, the actuator carriage being stepped one place (step) to the left as each numeral is set up therein, in the manner usual with ten-key machines (see U. S. Patent No. 2,108,596). The dividend 5467 is now in alignment with the four register wheels at the right end of the results register. In order to make use of the entire capacity of the machine, it is desirable that this number should be recorded on the four register wheels at the left hand of the results register. To accomplish this, the division tabulating key 16 is actuated, which releases both the carrier 8 and the actuator 31 so that the springs 29 and C, respectively, are able to move both of these members to their respective extreme left hand positions. Upon the depression of key 16, the carrier 8 moves seven steps to the left, while the actuator 31 moves primarily seven steps to the left and then two additional steps at which the pawl 49 (Figs. 5–8) is pushed aside by the bevelled edges 401. The extreme left hand position for the actuator is with the digit 5 of the number 5467 in alignment with the last or thirteenth register wheel of the accumulator. The extreme left position for the carrier 8 is such that tooth 3 is in alignment with the last, or eighth, wheel in the quotient register. Shaft A is now turned one revolution in order to transfer the number 5467 into the results register, where it will appear on the last four wheels (thirteenth to tenth orders). Revolution of shaft A will also cause tooth 3 to actuate the last wheel in the revolutions counter so that this wheel will register 1, but this is not important inasmuch as both the actuator and the revolutions counter are cleared before further operation of the machine.

When the actuator and revolutions counter have been cleared and the former moved back to its starting position, the divisor "3" is set up in the actuator. The division key 16 is again actuated, causing the actuator 31 to be moved again to its extreme left position and the carriage 8 to be moved to its extreme left position. The divisor "3" is consequently in alignment with the thirteenth place in the results register and hence in alignment with the digit 5 recorded therein. The tooth 3 is in alignment with the last (eighth) wheel in the quotient register.

The shaft A is now caused to rotate one revolution in reverse direction. This, in effect subtracts 3000 from the dividend number 5467, leaving the number 2467 in the accumulator. The one revolution of shaft A causes tooth 3 to register the number 1 in the last (eighth) wheel of the revolutions counter. Inasmuch as the number 2467 is less than 3000, the latter can not be subtracted therefrom and the actuator 31 is stepped to the right one space by the actuation of key 24. As is explained above, the actuation of key 24 also steps tooth 3 to the right one step and hence aligns it with the seventh wheel in the revolutions counter. Shaft A is now rotated in the reverse direction as many times as 300 can be subtracted from 2467, which is eight times. This causes the number in the accumulator to be reduced to 67 and the eight revolutions causes tooth 3 to record the number 8 in the seventh wheel of the revolutions counter.

This process is repeated until the division is completed. In the example taken, the revolutions counter will show 18223333 if the division is carried out to the capacity of the machine, leaving in the accumulator the number "1" in the sixth digit.

Thus, $5467 \div 3 = 1,822.3333$, leaving a remainder of 0.0001.

In the embodiment shown the revolutions counter actuating tooth is rotated in well-known manner by the rotation of the shaft 4. The actuating member for the revolutions counter may, however, be of other construction, for instance, that shown in the U. S. Patent No. 1,930,475 referred to above.

The tabulating means proper may be of any well-known or suitable construction.

What we claim is:

1. In a calculating machine of the ten-key type, the combination of a stationary accumulator, a stationary revolutions counter, a laterally shiftable carriage, an actuator on said carriage for actuating said accumulator, a laterally shiftable carrier, revolutions counter actuating means on said carrier, and a rack-and-pawl connection for coupling said carrier to said carriage for lateral shifting movement therewith, the rack of said rack-and-pawl connection having teeth bevelled on one side only for rendering said connection yielding in one direction and unyielding in the other direction.

2. In a calculating machine of the ten-key type, the combination of a stationary accumulator, a stationary revolutions counter, a laterally shiftable carriage, an actuator on said carriage for actuating said accumulator, a laterally shiftable carrier, and revolutions counter actuating means on said carrier, a rack-and-pawl coupling including a rockable element between said carrier and said carriage for lateral shifting movement, one of the elements of said coupling being carried by said carrier and the other by said carriage, the rack of said rack-and-pawl connection having teeth beveled partially on one side, to form both a beveled edge and an unbeveled edge on said side, and a straight edge on the other side, said beveling on one side of the teeth rendering said coupling yielding in one direction and said straight edge on the other side of the teeth rendering the coupling unyielding in the other direction, and means for rocking one element of said coupling in relation to another element of said coupling to cause said pawl to selectively engage either the beveled or the unbeveled edge on said one side of said teeth.

3. In a calculating machine of the ten-key type, the combination of a stationary accumulator, a stationary revolutions counter, a laterally shiftable carriage, an actuator on said carriage for actuating said accumulator, a laterally shiftable carrier, revolutions counter actuating means on said carrier, a pawl-and-rack coupling including a rockable element between said carriage and said carrier, one of the elements of said coupling being carried by said carrier and the other by said carriage, at least some of the teeth of said rack being bevelled on one side only and to a part of their height, said pawl having two stepped noses, and means for rocking at least one of the elements of said coupling, to cause said rack to selectively engage said

noses of said pawl with the bevelled or unbevelled portions of said teeth.

4. In a calculating machine of the ten-key type, the combination of a stationary accumulator, an actuator for said accumulator, a carriage for said actuator, a division tabulating key, a forward step-by-step tabulating key, a backward step-by-step tabulating key, said carriage being laterally shiftable under the control of said division tabulating key and of said forward step-by-step tabulating key and of said backward step-by-step tabulating key, to bring said actuator into operative relation with the different orders of said accumulator, a stationary revolutions counter, actuating means for said revolutions counter, a carrier for said revolutions counter actuating means, said carrier being laterally shiftable to bring said revolutions counter actuating means into operative relation with the different orders of said revolutions counter, a pawl-and-rack coupling between said carriage and said carrier, one of the elements of said coupling being carried by said carrier and the other by said carriage, at least some of the teeth of said rack having bevelled portions on one side only, said pawl having two stepped noses, and a shaft for carrying said rack, said rack being rockable on said shaft by said division tabulating key and said forward step-by-step tabulating key, and said backward step-by-step tabulating key to selectively engage either the bevelled or the unbevelled portions of said teeth.

5. In a calculating machine of the ten-key type, the combination of a stationary accumulator, a stationary revolutions counter, a laterally shiftable carriage, an actuator on said carriage for actuating said accumulator, a laterally shiftable carrier, revolutions counter actuating means on said carrier, a coupling between said carrier and said carriage, said coupling having a rack element and a pawl element having engaging surfaces, one of the elements of said coupling being carried by said carrier and the other by said carriage, and one of the elements of said coupling being beveled on one face of the engaging surfaces and straight on the opposite face for rendering said coupling yieldable in one direction and unyieldable in the opposite direction.

6. In a calculating machine of the type described, the combination of a stationary accumulator, a stationary revolutions counter, a laterally shiftable carriage, an actuator on said carriage for actuating said accumulator, a laterally shiftable carrier, revolutions counter actuating means on said carrier, and a rack-and-pawl uni-directional coupling between said carriage and said carrier, said coupling being yieldable to permit motion of said carriage to the left, while said carrier remains stationary.

7. In a calculating machine of the ten-key type, the combination of an accumulator, an actuator for said accumulator, said accumulator and said actuator being shiftable in relation to each other, means holding said actuator in its normal position, a revolutions counter, actuating means for said revolutions counter, said revolutions counter and said actuating means being shiftable in relation to each other, a locking mechanism for preventing the shifting of said revolutions counter and its actuating means in relation to each other, a division tabulating key, means operable upon depression of said division tabulating key to shift said accumulator and its actuator in relation to each other and to concurrently shift said revolutions counter and its actuating means in relation to each other, a coupling between said actuator and said actuating means settable to be yieldable in one direction, stops for limiting the movement of said actuator and said actuating means in said one direction, and means operable upon depression of said division tabulating key for setting said coupling to yieldable position and for releasing said holding means and said locking mechanism, whereby said actuator and said actuating means are moved by said shift means into positions defined by said stops.

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