Aug. 22, 1939. C. HAMANN 2,170,406

CALCULATING MACHINE

Filed Dec. 29, 1933 3 Sheets-Sheet 1

Fig. 1

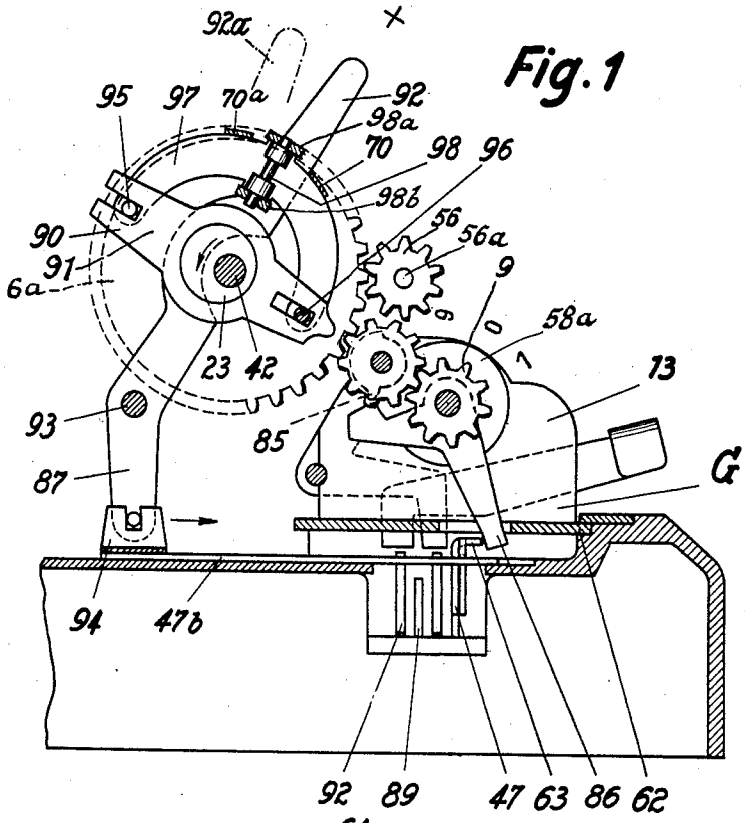


Fig. 3

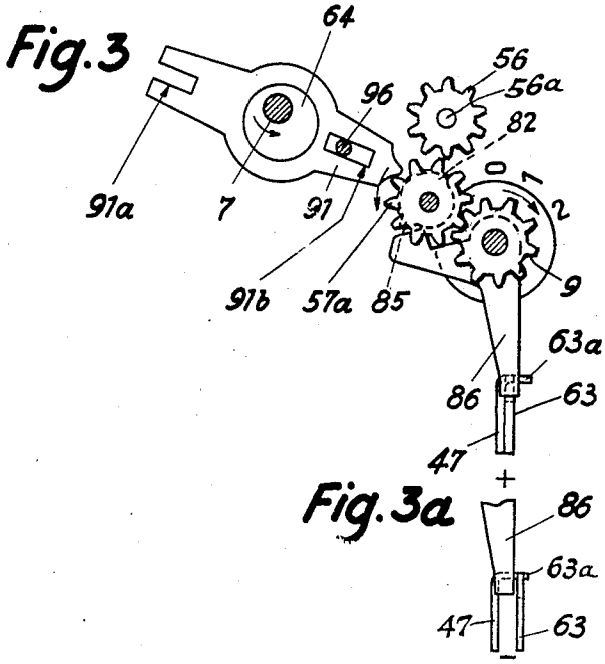


Fig. 3a

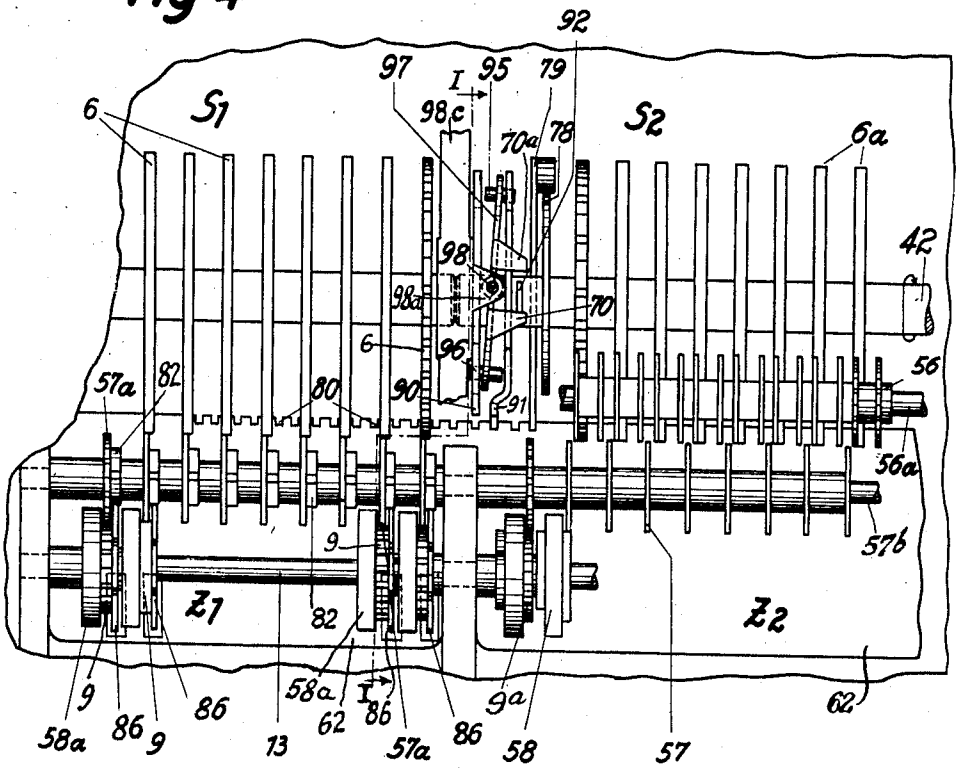
Inventor:
Christel Hamann
by Lorx & Kellenbeck
Attorneys

Aug. 22, 1939. C. HAMANN 2,170,406

CALCULATING MACHINE

Filed Dec. 29, 1933 3 Sheets-Sheet 2

Fig 4



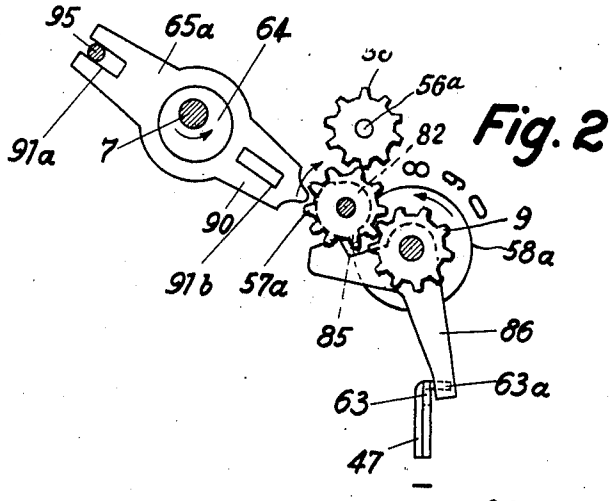


Fig. 2

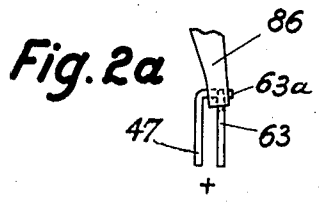


Fig. 2a

Inventor:
Christel Hamann
by
Lowe & Kehlenbeck
Attorneys.

Aug. 22, 1939. C. HAMANN 2,170,406

CALCULATING MACHINE

Filed Dec. 29, 1933 3 Sheets-Sheet 3

Fig. 5

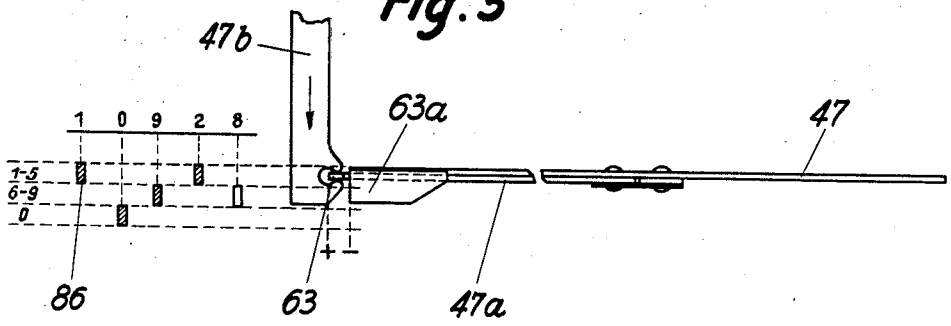


Fig. 6

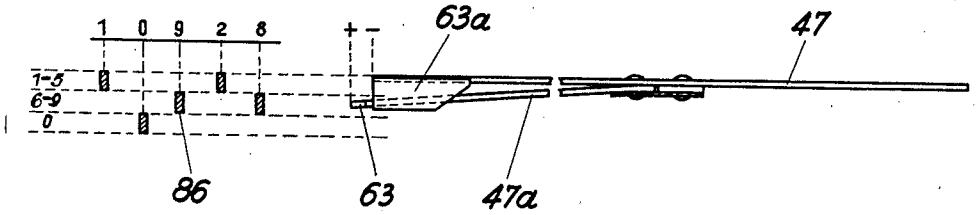
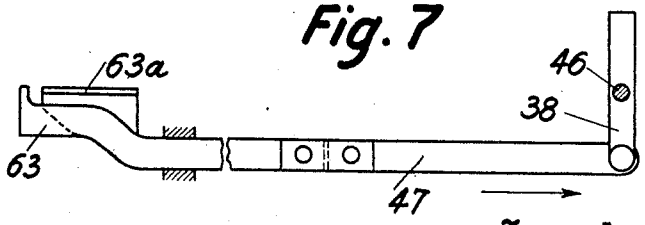


Fig. 7



Inventor:
Christel Hamann
by Lorka & Kehlenbeck
Attorneys

Patented Aug. 22, 1939 2,170,406

UNITED STATES PATENT OFFICE

2,170,406

CALCULATING MACHINE

Christel Hamann, Neu-Babelsberg, near Berlin, Germany, assignor to Deutsche Telephonwerke und Kabelindustrie Aktiengesellschaft, Berlin, Germany, a corporation

Application December 29, 1933, Serial No. 704,376
In Germany October 30, 1933

4 Claims. (Cl. 235—79)

This invention relates to calculating machines for performing automatic multiplication and division comprising an actuator, and a carriage traversable beside it on which are a revolution counter and a totalizer. In particular it relates to machines of this class such as described in Letters Patent of the United States No. 1,968,201 dated July 1, 1934, wherein multiplication is carried out in shortened form by the aid of adjustable stop members associated with the several digit elements of the revolution counter upon the carriage. Said stop members are set in different positions according to the digit set up when the multiplier is transferred to the numeral drums of the revolution counter. During the carriage movement involved in multiplication said stop members co-operate successively with the stepped face of a carriage stop mounted in the frame of the machine to arrest the carriage for each digit either in a positive, or adding, position, or—in case the digit exceeds 5—in a negative, or subtracting, position displaced laterally from the positive position. In the positive position the numeral drums of the totalizer are turned forward to add; in the negative position, owing to the interposition of an idle pinion they are turned backward to subtract. It is by the aid of this backward or subtracting drive that the multiplication is shortened, inasmuch as for digits over 5 the machine in effect multiplies not by the digit but by the difference between 10 and the digit; e. g., instead of multiplying by 6, it multiplies by 4 and subtracts the product instead of adding it, meanwhile adding 1 to the next higher digit.

The shaft of the machine always turns in the same direction, and the numeral drums of the revolution counter are turned backward for ordinary multiplication and forward for division and shortened multiplication. The direction of rotation of the revolution counter is determined by two oscillating counter fingers which move in opposite directions, one or the other of them engaging in the pinion of whichever numeral roll is in register with it.

The present invention is a further development of this construction for the purpose of enabling the machine to make calculations of the form $(a-bc)$ in such a manner that the product bc does not have to be separately calculated nor does it appear on the numeral drums, but during its production is simultaneously subtracted from the number a. To this end the carriage stop mounted in the machine frame, with which the adjustable stop members of the revolution counter co-operate, is made adjustable relatively to said members, so as to cause them to co-operate in different ways with the steps on the face of said carriage stop. Means are also provided for correspondingly shifting the counter fingers, so that the direction of their movements will be reversed. This enables negative multiplications, i. e., those the products of which are to be subtracted from another number, to be carried out in shortened form.

The drawings illustrate one form of construction of the new calculating machine. Fig. 1 is a section through the machine, taken on line I—I of Fig. 4. Figs. 2, 2a, 3 and 3a show different positions of the stop members. Fig. 4 is a plan view of a part of the machine showing the counter fingers, while Figs. 5 to 7 show the adjustable carriage stop which is mounted on the machine frame and co-operates with the stop members. Most parts of the machine not necessary to the understanding of the present invention have been omitted; they may be taken to be like what is described in my above-mentioned Letters Patent.

Upon the shaft 42 (Figs. 1, 2, 3 and 4) which is driven as required by a motor, always in the same direction, are mounted side by side the toothed wheels 6a of the actuating mechanism unit or actuator S2, which in performing a multiplication transfer the digit values of the multiplicand to the accumulator wheels or numeral drums 58 of the totalizer Z2 on the carriage 13, all as in my above-mentioned patent. Transfer from a toothed wheel 6a to that numeral drum 58 of the totalizer which at the particular time is in operative relation to such wheel is effected as disclosed in said prior patent by double pinions 56 (Fig. 4) which are all loose upon a common spindle 56a, there being one double pinion 56 to each gear wheel 6a. The left-hand member of each pinion 56 is permanently in mesh with the respective gear wheel 6a. (The wheels 6 appearing in Fig. 4 are not part of the actuator S2 but of the separate similar actuator S1.) To each numeral drum 58 is fastened a pinion 9a (Fig. 4) which engages with a wheel 57. The latter may either engage with a wheel 6a, or by a lateral movement of the carriage the wheel 57 may be brought into mesh with the right hand part of pinion 56. In the latter position the numeral drum 58 is turned in the opposite direction, and this occurs in subtraction, division, and short cut multiplication, while the former position is that for addition and ordinary multiplication. The wheels 57 are carried loosely on a spindle or axle 57b. This spindle or axle 57b is mounted on the carriage so as

to move therewith laterally, while the spindle 56a is mounted on the frame of the machine and does not move with the carriage.

Thus to change from ordinary to short cut multiplication a lateral shift of the carriage (to the right in Fig. 4) to the extent of the width of the double pinion 56 is required to bring the carriage from the positive or adding position to the negative or subtracting position. This shift is less than the step which the carriage takes from one ordinal position to another. (In multiplication the carriage moves step by step to the right in known manner.)

These lesser and greater steps of carriage movement are determined by the depending stop members 86 (Figs. 1 to 3a) and the cams 82 in the manner described in my said prior patent. There is a stop member 86 extending through an opening in the carriage base plate 62 and a cam 82 associated with each toothed wheel 57a, pinion 9, and numeral drum or counter wheel 58a of the revolution counter Z1 mounted in the carriage, and they therefore travel with the carriage. After being displaced by the cams 82, each of which turns with the corresponding numeral drum 58a of the revolution counter, the stop members 86 are in positions for striking against the portion 63 or 63a of a carriage stop situated in the machine frame, the carriage moving from left to right in front of the actuator S2. As shown in Figs. 5, 6 and 7, the portion 63 projects beyond the portion 63a, and these two portions together constitute abutments or steps forming a stepped face on the carriage stop. For the purpose of the invention the relative position of the faces or steps 63, 63a is made variable in such a manner that a stop member 86 ordinarily striking against the projecting portion or step 63 of the said carriage stop may be made to strike against the shorter portion or step 63a, and vice versa. To this end, the step 63 is carried or formed by the head of a member 47a which is movable, relatively to the bar 47 carrying the other step 63a, by a push rod 47b from the position shown in Fig. 5 to that shown in Fig 6. In Fig. 5 the steps of the carriage stop are in the same relative position as in my said prior patent, as therein described with reference to Fig. 4; that is to say, the longer part or farther projecting step 63 arrests the carriage in its movement to the right in the positive or adding position in which ordinary multiplication by the digits 1 to 5 is effected, and in which the counter finger 90 (Fig. 4, and see the counter finger 25 in Figs. 2 and 5a of my said prior patent) turns the numeral drums of the revolution counter backwards. When a drum is turned back to zero the carriage is released and makes a further step to the right. By way of example Fig. 5 shows the positions of the stop members corresponding to a multiplier 10928 (see Fig. 4 of my said prior patent). At the digit 0 the carriage is not arrested, because the stop member 86 for this digit is displaced by the cam 82 so as to clear both steps 63 and 63a of the carriage stop, as will at once be seen from the drawings. When the movable step 63 is in the position shown in Fig. 5 the shorter step 63a of the carriage stop arrests the carriage in the negative or subtracting position in which short cut multiplication by the numerals 6 to 9 is effected, and in which the counter finger 91 (Fig. 4; see the counter finger 26 in Figs. 2 and 5a of my said prior patent) brings the numeral drum to zero by turning it forward to the extent of the difference between 10 and the numeral set up on it. The lower part of Fig. 3 shows the position of the parts 86, 63 and 63a for positive multiplication. The lower part of Fig. 2 shows these parts in position for positive short cut multiplication. The carriage stop 63, 63a is located at any suitable point of the machine frame, for instance at a point corresponding to the position of the parts 35, 36 in Figs. 5a and 7a of my prior patent above referred to, or at a point corresponding to the position of the left-hand end of the lever 43 in Fig. 3 of Letters Patent of the United States No. 2,081,008, of May 18, 1937.

When the step 63 is in the position shown in Fig. 6 the co-operation is reversed, that is to say, the longer step 63 is operative for the numerals 6–9 and the shorter step 63a for the numerals 1–5. The relative positions of the parts 86, 63, and 63a for negative multiplication are shown in Fig. 3a and for negative short cut multiplication in Fig. 2a. With the parts 86, 63, 63a in this position, the totalizer on the carriage performs subtractions (and not additions) in the case of the digits 1 to 5, while in the case of the digits 6 to 9 the totalizer will under said conditions perform additions (and not subtractions). Or one may say the totalizer "adds a negative product" corresponding to the expression $(a+(-bc))$, the mulitplier c being less than 6. The result is $(a-bc)$ as desired. Ordinary positive multiplication corresponds with the expression $(a+(+bc))$, c again being <6. Short cut multiplication by the numerals 6–9 corresponds to the expression $(a+10b)-b(10-c)$, where $c>5$; and so short cut negative multiplication is expressed by $(a+(-10b))+b(10-c)$, which gives the desired result $(a-bc)$.

When the step 63 is shifted the drive of the numeral drums of the revolution counter must be reversed. The invention provides for this purpose a lever 92 (Figs. 1 and 4) which turns about the pivot 93. A pin in its tail 37 engages a slotted shoe 94 upon the push rod 47b which shifts the step 63 of the carriage stop. The alternative position of the lever 92 is indicated in dotted lines in Fig. 1, the neighboring signs + and − corresponding with the two positions of the step 63. In Fig. 7, I have shown the bar 47 as pivotally connected wtih a lever 38 fulcrumed at 46, this lever being part of a mechanism which need not be described here; a full description thereof is found in the above-mentioned Patent No. 2,081,008, particularly in connection with Fig. 9. The parts 76 and 79 shown in Fig. 4 of the instant case correspond to the parts 49 and 50, 51 respectively shown in Figs. 2 and 9 of Patent 1,968,201 hereinbefore referred to and described in said patent on page 2, lines 116 to 128. That is to say, in the present application, after each step the carriage 13 is held automatically, in the position reached, by means of the lever 79 suitably fulcrumed on the frame of the machine and adapted to engage the notches 80 in the base plate 62 of the carriage 13. A spring (not shown in the drawings of the instant case, but illustrated in Fig. 9 of Patent 1,968,201) presses a roller carried by said lever, against the cam 78 mounted on the shaft 42, and thus causes the lever to be rocked into holding engagement with the carriage while the shaft rotates, as described in the aforesaid patent.

The means by which the movements of the counter fingers are reversed appears in Figs. 1 and 4. Upon the shaft 42 of the machine there is fastened an eccentric 23 which carries both counter fingers 90, 91, which in Fig. 1 are one

behind the other. Each counter finger has slots 91*a*, 91*b* respectively running lengthwise of it, and in these slots pins 95, 96 can enter laterally. When the pin 96 engages the slot 91*b* located between the eccentric 23 and the nose of one finger, the pin 95 enters the slot 91*a* of the other finger. The consequence of this is that the noses of the two counter fingers rock in opposite directions as the eccentric 23 rotates, so that if the one is acting upon a numeral drum 58*a* of the revolution counter Z1 (through the respective wheels 57*a* and 9) it will turn the drum forward, while if the other finger actuates the drum it will turn the drum backward. The two pins 95, 96 are fastened in an arcuate member 97, which is mounted between the two counter fingers upon a pivot 98 journaled in supports 98*a*, 98*b* projecting from the frame 98*c* of the machine. Ears 70, 70*a* projecting laterally from the arcuate member 97 embrace the lever 92, so that when the lever is shifted from the full line position to the dotted line position of Fig. 1 the engagement of the pins with the counter fingers is reversed, and therefore the direction in which the fingers rock is reversed as required for short cut negative multiplication.

The carriage is stopped in the position illustrated in Fig. 4 by devices such as shown at 10 and 19*a* in Figs. 1 and 2 of Patent 2,081,008 mentioned above.

I claim:

1. In a calculating machine having an actuating mechanism, a driving shaft therefor, an eccentric upon said shaft, counter-actuating fingers embracing said eccentric and projecting on either side of it, and a carriage movable along said mechanism and provided with accumulator wheels and counter-wheels adapted to be brought into co-operative relation to said mechanism and to said fingers respectively; that improvement which comprises two pivot pins movable to engage and pivotally mount said fingers, means carrying said pins on opposite sides of said eccentric and adjustable to engage one pin with a finger and the other pin with the other finger so that rotation of said eccentric will cause said fingers to oscillate in opposite directions, and means shiftable to one position for adjusting said carrying means to engage each pin with its finger and shiftable to a second position to engage each pin with the other finger.

2. In a calculating machine having an actuating mechanism, a carriage movable along said mechanism, a revolution counter mounted on said carriage and having denominationally ordered counter wheels, and also provided with stop members, one for each of said counter wheels, a carriage stop having steps adapted to co-operate with said stop members to arrest the carriage, for each denominational order, in one or the other of two positions, a totalizer likewise mounted on said carriage and having denominationally ordered accumulator wheels, means, operated by said actuating mechanism, for driving said totalizer in one direction when the carriage is in one of its said positions, and in the opposite direction when the carriage is in the other of its said positions, and means, operatively connected with said actuating mechanism, for turning the counter wheels to zero position in one direction or the other; that improvement according to which one of the said steps of the carriage stop is movable relatively to the other so as to reverse the manner in which they co-operate with the stop members of the revolution counter, means for effecting such relative movement, and means for reversing the movement of the means for turning the counter wheels to zero position.

3. In a calculating machine having an actuating mechanism, a carriage movable along said mechanism, a revolution counter mounted on said carriage and having denominationally ordered counter wheels, and also provided with stop members, one for each of said counter wheels, a carriage stop having steps adapted to co-operate with said stop members to arrest the carriage, for each denominational order, in one or the other of two positions, a totalizer likewise mounted on said carriage and having denominationally ordered accumulator wheels, means, operated by said actuating mechanism, for driving said totalizer in one direction when the carriage is in one of its said positions, and in the opposite direction when the carriage is in the other of its said positions, and means, operatively connected with said actuating mechanism, for turning the counter wheels to zero position in one direction or the other; that improvement according to which one of the said steps of the carriage stop is movable relatively to the other so as to reverse the manner in which they co-operate with the stop members of the revolution counter, means for effecting such relative movement, and means, operatively connected with the means for effecting said relative movement, for simultaneously conditioning for reverse movement, the means for turning the counter wheels to zero position.

4. In a calculating machine having an actuating mechanism, a carriage movable along said mechanism, a revolution counter mounted on said carriage and having denominationally ordered counter wheels, and also provided with stop members, one for each of said counter wheels, a carriage stop having steps adapted to co-operate with said stop members to arrest the carriage, for each denominational order, in one or the other of two positions, a totalizer likewise mounted on said carriage and having denominationally ordered accumulator wheels, means, operated by said actuating mechanism, for driving said totalizer in one direction when the carriage is in one of its said positions, and in the opposite direction when the carriage is in the other of its said positions, and means, operatively connected with said actuating mechanism, for turning the counter wheels to zero position in one direction or the other; that improvement according to which one of the said steps of the carriage stop is shiftable relatively to its neighboring step transversely of the carriage path so as to reverse the manner in which said steps co-operate with the stop members of the revolution counter, means for effecting such relative shift of said stop member, and means for reversing the movement of the means for turning the counter wheels to zero position.

CHRISTEL HAMANN.