Oct. 4, 1960 K. LEICH ET AL 2,954,924

CALCULATING MACHINES

Filed April 19, 1956 7 Sheets-Sheet 1

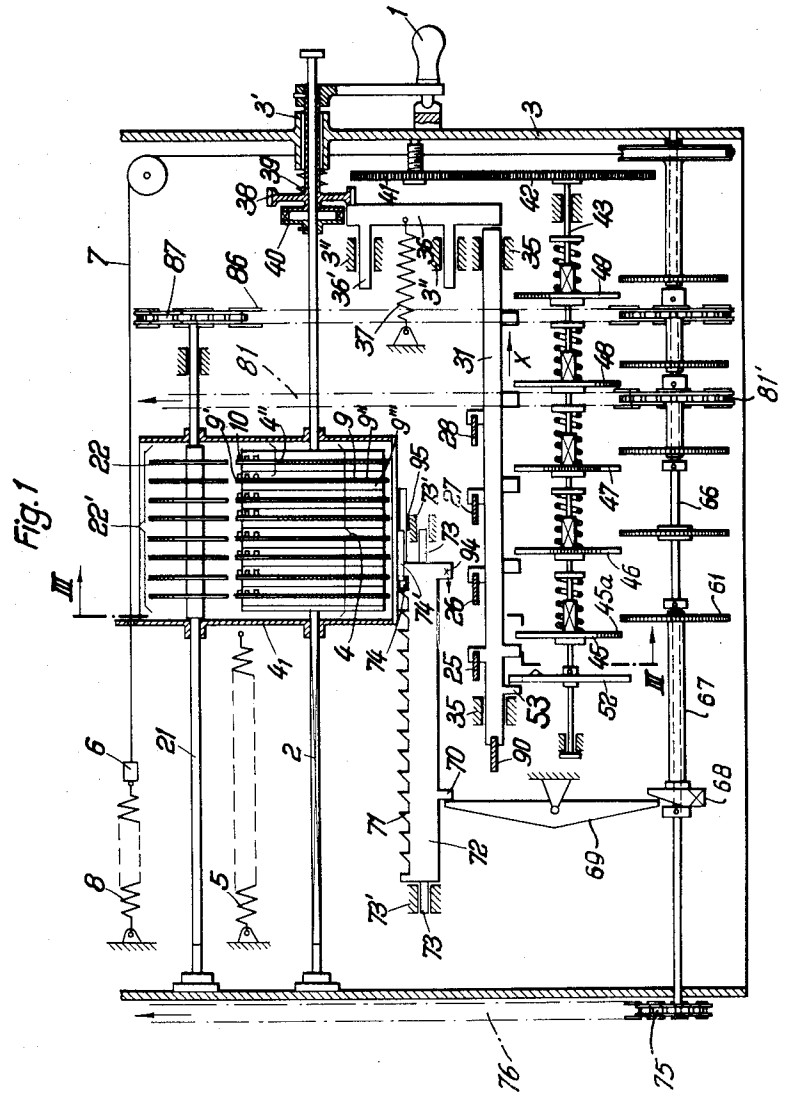

Fig. 1

Inventors
KARL LEICH
EBERHARD MENGE
By Eugene S. Lovette
Attorney

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CALCULATING MACHINES

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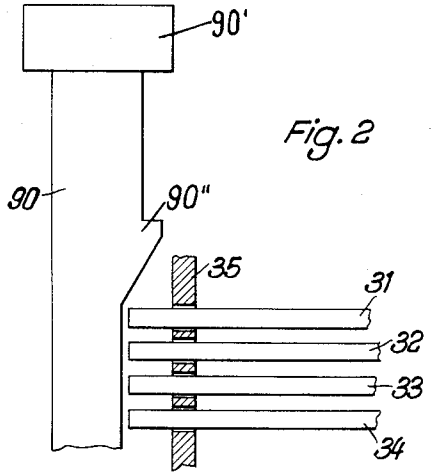

Fig. 2

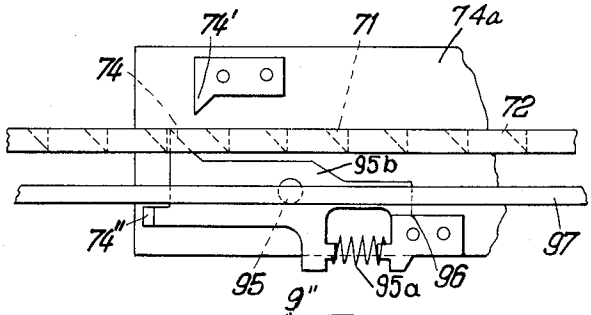

Fig. 5

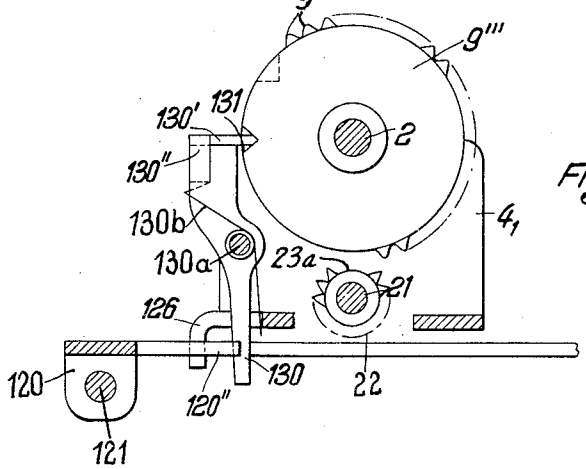

Fig. 6

Inventors
KARL LEICH
EBERHARD MENGE
By Pierce & Jorge
Agents

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CALCULATING MACHINES

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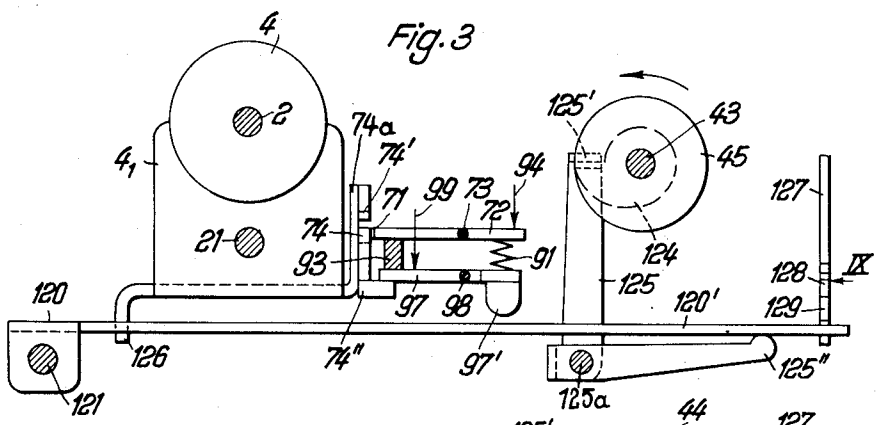
Fig. 3



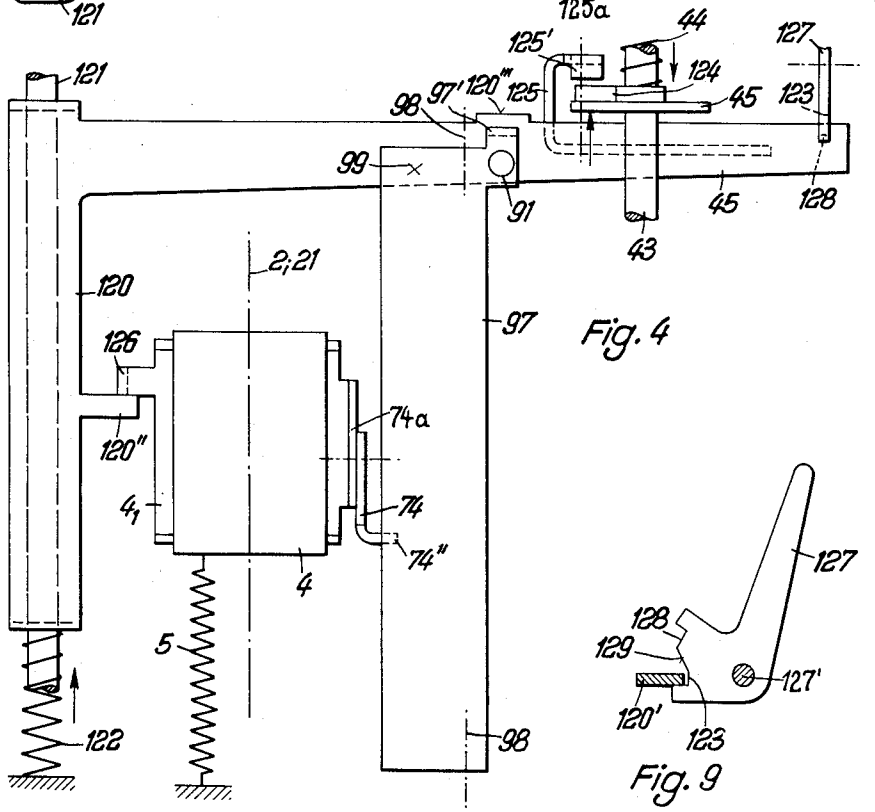


Fig. 4

Fig. 9

Inventors
KARL LEICH
EBERHARD MENGE
By Henry L. Jorge
Agent

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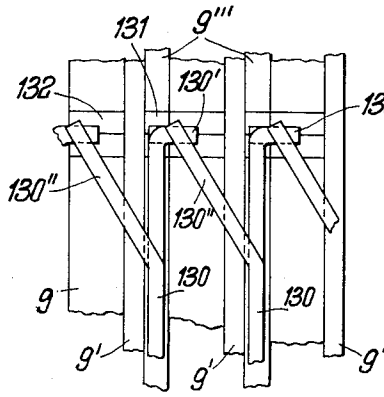

Fig. 7

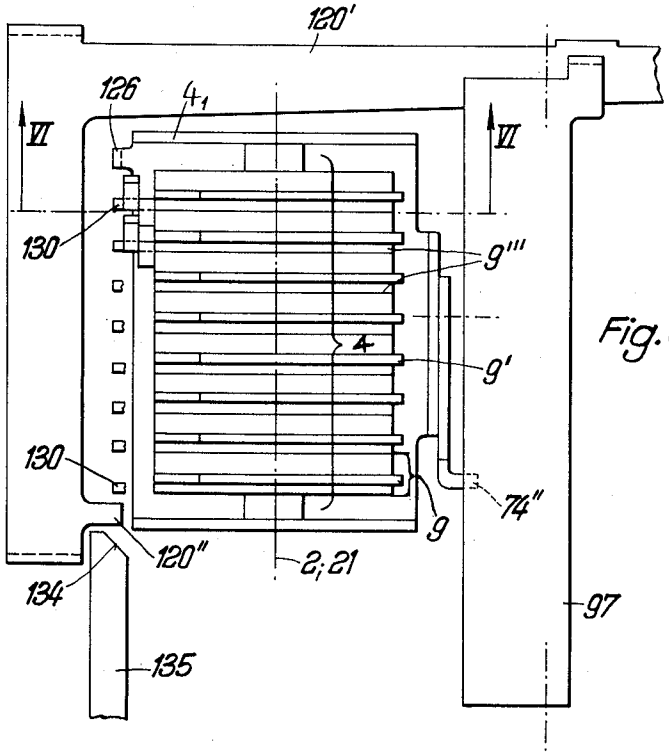

Fig. 8

Inventors
KARL LEICH
EBERHARD MENCE
By Henry B. Jacob
Agent

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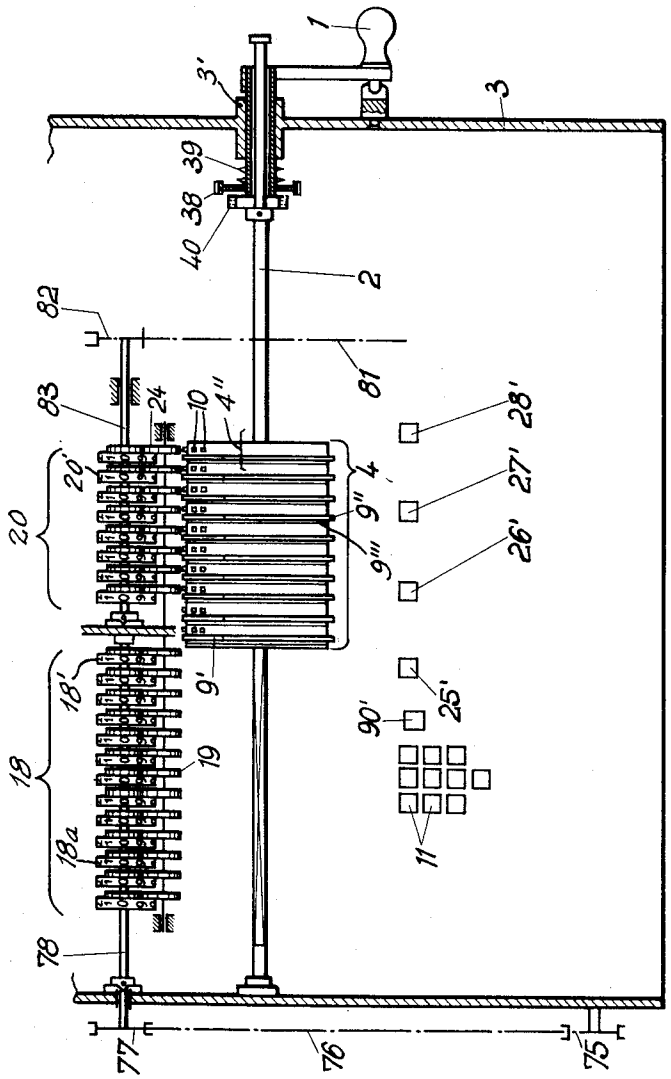

Fig. 10

INVENTORS
KARL LEICH
EBERHARD MENGE

By Harry A. Jaeger
AGENT

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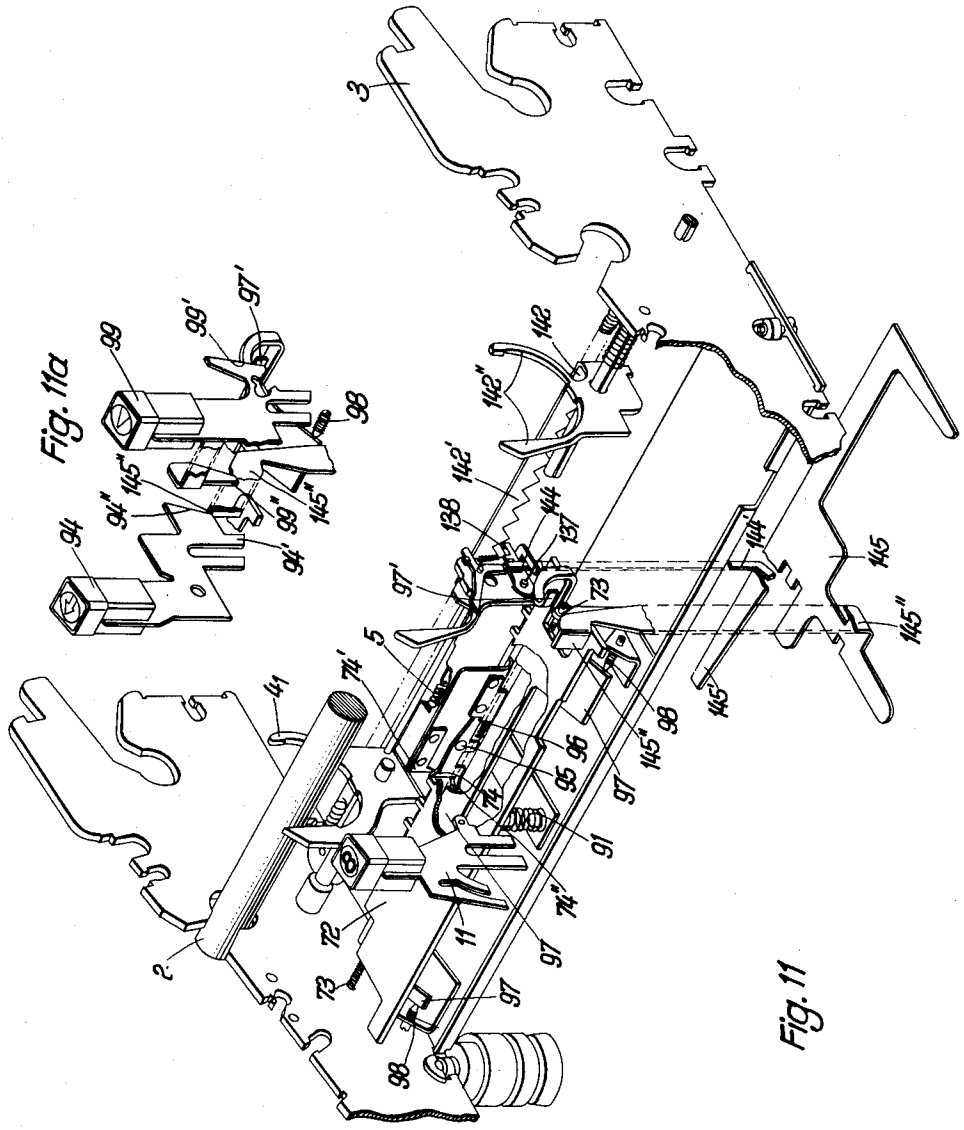

Fig. 11a

Fig. 11

Inventors
KARL LEICH
EBERHARD MENGE
By Eugene N. Loveless
Attorney

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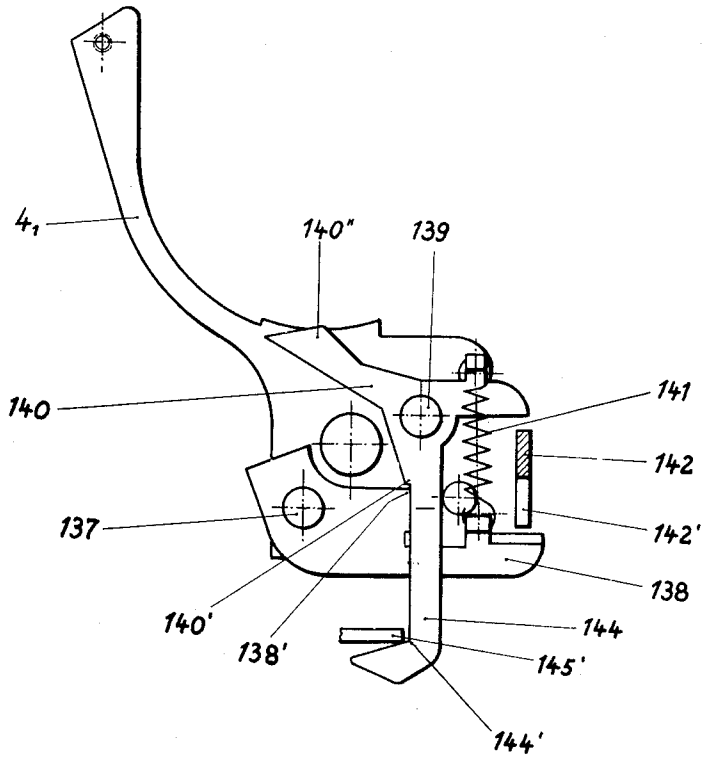
Fig. 12



INVENTORS
KARL LEICH
EBERHARD MENGE

By Hans J. Gundy
AGENT

United States Patent Office 2,954,924 Patented Oct. 4, 1960

2,954,924

CALCULATING MACHINES

Karl Leich, Lebenstedt over Braunschweig, and Eberhard Menge, Braunschweig, Germany, assignors to Brunsviga Maschinenwerke A.G., Braunschweig, Germany

Filed Apr. 19, 1956, Ser. No. 579,293

Claims priority, application Germany Apr. 23, 1955

5 Claims. (Cl. 235—63)

The present invention relates to calculating machines, and more particularly to a ten digit key calculating machine having a rotary differential actuator supported in an ordinally shiftable carriage, a stationary accumulator, and a stationary counter for registering the number of revolutions of the actuator.

Calculating machines of the kind described hereinabove are disclosed in German Patent 907,836, corresponding to U.S. patent application Serial No. 323,411, filed December 1, 1952, in the name of Eberhard Menge, issued as U.S. Patent No. 2,879,938 on March 31, 1959.

It is an object of the present invention to improve the mechanism described in German Patent No. 907,836, corresponding to the above-mentioned U.S. patent.

It is another object of the present invention to provide a retransmitting mechanism including devices for shifting the actuator carriage from its initial rightmost position to a predetermined ordinal position.

It is a further object of the present invention to provide a mechanism allowing a retransmitted item to be transferred into the revolutions counter directly after the retransmission thereof.

It is still another object of the present invention to provide a mechanism allowing a retransmitted item to be transferred into the accumulator.

Further objects and advantages will become apparent from the following description of the invention taken in conjunction with the figures, in which:

Fig. 1 is a plan view of part of the mechanism of a calculating machine according to the present invention;

Fig. 2 is a side elevation, partly in section, on an enlarged scale of one of the keys shown in Fig. 1 and the control slides associated therewith;

Fig. 3 is a side elevation, partly in section, along the line III—III of Fig. 1;

Fig. 4 is a plan view of the mechanism shown in Fig. 3;

Fig. 5 is a detail of Fig. 3 seen at right angles thereto, on an enlarged scale;

Fig. 6 is a side elevation, partly in section, of the left part of Fig. 3, showing some details seen along the line VI—VI of Fig. 8;

Fig. 7 is a partial side elevation of an enlarged scale

of the device shown in Fig. 6, seen at right angles thereto from the rear;

Fig. 8 is a plan view of the device shown in Figs. 6 and 7;

Fig. 9 is an elevation of a detail of Figs. 3 and 4 seen in the direction of the arrow IX in Fig. 3;

Fig. 10 is a schematical top plan view of the main parts of the mechanism shown in Fig. 1 similar to Fig. 1 of U.S. Patent No. 2,879,938;

Fig. 11 is a perspective view of certain details shown in Figs. 6 and 8 and of additional parts;

Fig. 11*a* is a perspective view of a part adapted for cooperation with Fig. 11; and

Fig. 12 is an elevation of a part of Fig. 11.

Referring now to the drawings in detail, and first to Figs. 1 and 10, carriage 4_1 (Fig. 1) is shiftably mounted on a shaft **2** of a calculating machine having a frame **3**, the shaft **2** being arranged in the frame **3** for rotation by a handle or crank. The carriage 4_1 carries a rotary differential actuator **4**, comprising a plurality of denominationally spaced pin wheels **9** which may be adjusted, respectivey, by cam disks **9'** known in the art to project a plurality of pins **10**, displaceable in pin wheels **9**, in a radial direction. A spring **5** urges carriage 4_1 and actuator **4** to the left as seen in Fig. 1, whereas a wire **7** (Fig. 1), loaded by a tension spring **8**, is provided with a stop **6** for engaging and moving the carriage 4_1 to the right into its initial rightmost position, against the action of the spring **5**, during a normalizing operation.

In order to introduce values in the actuator **4** digit keys **11** are sequentially depressed as more fully described in German Patent No. 907,836 and the corresponding U.S. Patent No. 2,879,938 issued to Eberhard Menge on March 31, 1959, reference to which is made. Depression of one of the digit keys **11** causes the associated toothed cam disk **9'** to rotate through an angle corresponding to the digit value represented by the depressed key. Such rotation of the cam disk **9'** causes a cam groove therein to radially project a number of pins **10** (Fig. 10) from the corresponding pin wheel **9**. The cam disks **9'** are rotated by a toothed segment (not shown) operated by the digits keys **11** which engages the teeth of the cam disk **9'** located directly to the right of the unit denomination **18'** of an accumulator **18** having a set of digit wheels **18***a* revolvable about the axle **78** so as to assume any digit position including a zero position.

After completing the value-introducing movement for the highest left denominational order of a number, the actuator carriage **4'** is shifted denominationally to the left so that the value indexing operation described hereinabove may be repeated for the next lower denominational order of the number.

After a desired number has been introduced into the actuator **4**, it is transmitted to the accumulator **18** by intermediate wheels **19** forming part thereof, the wheels **19** being actuated by the pins **10** projecting radially from the pin wheels **9** when actuator **4** rotates.

Simultaneously the number of complete revolutions of the shaft 2 is registered in a revolutions counter 20 (Fig. 10) in a known manner. The revolutions counter 20 is provided with a set of digit wheels 20' and a set of intermediary wheels 24 adapted to be engaged by the pins 10 radially advanced by introducing a number into the actuator 4, if the latter is rotated after being shifted again to the right to a desired position opposite the revolutions counter 20.

The actuator 4 may be moved from any position opposite the accumulator 18 or the revolutions counter 20 by a partial step to the right to a position in which the intermediary wheels 19 or 24 engage the toothed portions 9'' of the cam disks 9' to enable retransmission of either the accumulator 18 setting or the revolutions counter 20 setting into the actuator 4 by a rotation of the shafts 78 or 83 which zeroize the accumulator 18 and the revolutions counter 20, respectively.

The actuator 4 has to be brought into engagement with a zeroizing device 22' (Figs. 1 and 6) which is supported with the actuator 4 by the shiftable carriage 4_1. The zeroizing device 22' comprises a set of partly toothed wheels 22, having an interdental space, shiftably mounted on a shaft 21. The number of wheels 22 equals the number of cam disks 9'. Upon rotation of the shaft 21 by a sprocket wheel 87, driven by a chain 86, more fully disclosed in the Germany Patent No. 907,836 corresponding to the U.S. Patent No. 2,879,938 mentioned hereinabove, the teeth of the wheels 22 engage, respectively, the toothed portions 9'' of the cam disks 9', as more fully described with reference to Fig. 3 of the German Patent No. 907,836 and the corresponding U.S. Patent No. 2,879,938 mentioned hereinabove. Control rings 9''' alternate with the cam disks 9'; their function will be explained in connection with the subject matter of Figs. 6, 7 and 8 under the heading "Zero adjustment of the automatic tabulation of the carriage."

TOTAL RETRANSFER

Four operational keys 25' to 28' are arranged, as shown in Fig. 10, on the keyboard of the calculating machine. The operational key 25' is a retransmitting key; the keys 26', 27' and 28' are, respectively, zeroizing keys for the actuator 4, the accumulator 18 and the revolutions counter 20. In Fig. 1 the stems 25, 26, 27 and 28 of the operational keys 25' to 28' are shown, respectively. Furthermore, a key 90', shown also in Fig. 2, is arranged somewhat out of alignment with the keys 25' to 28' so that the stem 90 of the key 90' is arranged adjacent the ends of slides 31 to 34, shown in Figs. 1 and 2. The slides 31 to 34 are arranged parallel to one another and are slidably supported in guides 35 (Figs. 1 and 2) forming part of the frame 3 of the machine, the slides being arranged in super-position. When the slides 31 to 34 are shifted in the direction of the arrow *x* in Fig. 1, they move a slide member 3'', cooperating with all slides 31 to 34, to the right, the slide member being normally held in its initial position, in which it engages the slides 31 to 34, by a tension spring 37. The slide member 36 is guided by projections 36' sliding between stationary parts 36'' forming part of the frame 3 of the machine.

By laterally shifting the slide member 36, a toothed wheel 38, which rotates with the hand crank 1 and is shiftably mounted on the shaft 2 of the calculating machine, is shifted to the right against the action of a spring 39 inserted between the toothed wheel 38 and a hub 3' forming part of the frame 3. By such movement to the right, a clutch 40, normally connecting crank 1 to shaft 2, is released and toothed wheel 38 is brought into engagement with an intermediary toothed wheel 41 engaging a toothed wheel 42 rigidly connected with a shaft 43. The shaft 43 carries five partially toothed driving wheels 45 to 49, as more fully disclosed in German Patent No. 907,836 and the corresponding U.S. Patent No. 2,879,938 mentioned hereinabove. The common shaft 43, connected to the toothed wheel 42 in gear with the toothed wheel 41, carries a locking disk 52 adapted to engage a locking pin 53 on each of the slides 31 to 34, said parts being more fully described in German Patent No. 907,836 and the corresponding U.S. Patent No. 2,879,938 mentioned hereinabove.

A gear segment 45*a* (Fig. 1) on the driving wheel 45 controls a partial-step ordinal shift of the actuator 4 to a retransmitting position. When the slide 31 is shifted to the right, a projection on the slide 31 moves the gear segment 45*a* into engagement with a driven gear wheel 61, mounted on a hollow shaft 67 which is coaxial with and surrounds a shaft 66. The hollow shaft 67 carries a cam disk 68 which cooperates with one arm of a two-armed rocking lever 69. The other arm of the rocking lever 69 engages a projection 70 of an escapement rack 72. The escapement rack 72 (Figs. 1, 5 and 11) is provided with saw-tooth recesses 71 and has studs 73 which slide in guides 73' forming part of the frame 3 of the calculating machine. The recesses 71 may be engaged by either of two pawls 74 and 74', rigidly or rockably connected to the carriage 4_1 of the actuator 4, the operation of which will be more fully explained hereinafter.

The operation of the partial-step ordinal shift of the actuator 4 to a retransmitting position will now be explained. When rotated, the gear segment 45*a*, meshing with the gear wheel 61, causes one complete revolution of the cam disk 68. At the beginning of this revolution, the cam swings the two-armed lever 69 on its pivot. The pin 70 of the escapement rack 72 is thereby shifted in an ordinal direction together with the pawl 74 engaging the escapement rack 72 and secured to the actuator carriage 4_1. This shift involves a partial-step ordinal shift and moves the actuator 4 to a retransmitting position in which the intermediate wheels 19 or 24 (Fig. 10) engage the teeth 9'' of the cam disks 9'. This enables retransmission of either the accumulator 18 setting or the revolutions counter 20 setting into the actuator 4 by a rotation of the respective shafts 78 or 83, which zeroizes the accumulator 18 or the revolutions counter 20, respectively.

The shaft 78 carries a sprocket 77 connected to a sprocket 75 by a chain 76. The sprocket 75 (Figs. 1 and 10) is rigid with a shaft 66 driven by the gear wheel associated with partially toothed gear 46. Hence, rotation of the partially toothed gear 46 will zeroize the accumulator 18.

The shaft 83 carries a sprocket wheel 82 driven by a chain 81 also engaging a sprocket wheel 81'. The sprocket wheel 81' is rotatable with the driven gear associated with the partially toothed gear 47. Hence, rotation of the partially toothed gear will zeroize the revolutions counter 20.

In addition to the operational keys 25' to 28' shown in Fig. 10, a further operational key 90', shown in Fig. 2, is provided; the key 90' has a stem 90 and a projection 90''. Upon depression of the operational key 90', the projection 90'' displaces all four slides 31 to 34 into their right-hand positions. Thus, the slide member 36 is actuated and, by opening the clutch 40 and coupling the toothed wheels 38 and 41, switches the drive of the crank 1 from the shaft 2 to the control shaft 43.

Since all four slides 31 to 34 have moved to their right-hand positions, the projections thereon have shifted the respective partially toothed driving gear wheels 45 to 49 into engagement with the driven gear wheels aligned on shaft 66. Hence, when the crank 1 is driven, all five operations are carried out one after the other by the shiftable, partially toothed driving gear wheels 45 to 49 in the sequence determined by the angular arrangement of the partial toothing thereon. A more detailed disclosure is available in U.S. Patent No. 2,879,938.

The following table contains a summary of the control operations according to the above mentioned German Patent No. 907,836 corresponding to U.S. Patent

No. 2,879,938 in lines 1 to 6, whereas line 7 lists the additional operation according to the present invention:

Table

No.	Keys	Key-operated control action	Designation of control slide for operational step				
			Actuator zeroizing	Carriage shift to retransmission position	Revolutions counter zeroizing	Accumulator zeroizing	Carriage return to right position
(1)	26′	Actuator zeroizing	32				32
(2)	27′	Accumulator zeroizing				33	
(3)	28′	Revolutions counter zeroizing			34		
(4)	26′, 27′, 28′	Total zeroizing	32		34	33	32
(5)	25′, 27′	Retransfer from accumulator to actuator.	31	31		33	
(6)	25′, 28′	Retransfer from revol. counter to actuator.	31	31	34		
(7)	90′	Total transfer with carriage return	31, 32	31	34	33	32

AUTOMATIC TABULATION OF THE CARRIAGE TO THE LEFT

After a total retransmission effected by key **90′**, the carriage 4_1 is in a position all the way to the right in Fig. 1, the actuator **4** being adjusted to the value received from the denominational places of the revolutions counter **20** opposite which it was arranged before the beginning of the total retransmission procedure.

In this initial right-most position, the value may be retransmitted into the revolutions counter **20** by means of a rotation of the crank **1** which, as more fully explained in the German Patent No. 907,836 and the corresponding U.S. Patent No. 2,879,938, after the end of the operation is automatically coupled by the clutch **40** to the driving shaft **2** of the actuator **4**. It should be noted that, as a rule, the accumulator **18** is spaced apart by several denominational orders from the counter **20** for accommodating the bearings arranged between the shafts **78** and **83**. Although this expedient is not absolutely required, it avoids confusion of the numbers printed by the accumulator **18** and the revolutions counter **20**. Since in the right-most position of actuator **4**, the two left-most orders thereof are aligned with the space between the accumulator and counter, as shown in Fig. 10, these two left-most orders of actuator **4** can not be used for a retransmission into the revolutions counter **20**.

For transferring retransmitted values into the accumulator **18**, the carriage 4_1 of the actuator **4** must be shifted to the left so as to align its right-most significant denominational order with the right-most denominational order **18′** of the accumulator **18**. A single tooth slide, more fully described in U.S. Patent No. 2,108,596, issued on February 15, 1938 to K. V. Rudin for "Calculating Machine," and particularly described on page 4, left column, line 66, to page 5, right column, line 31 and shown in Figs. 30 and 31 thereof, remains opposite the first place of the revolutions counter **20**.

As shown in Figs. 1, 3 and 5, the escapement rack **72**, provided with sawtooth recesses **71**, is rockable about the bearings or guides **73** and under the pressure of a compression spring **91**, is urged against a stop member **93**. A key **94** (Figs. 1, 3 and 11*a*) controls denominational escapement of the carriage 4_1 along the escapement rack **72**. Pressure on the key **94** results in a small rotation of the escapement rack **72** about the pivots **73** in a clockwise direction as seen in Fig. 3. Upon release of the key **94**, a single step escapement towards the left is effected by this rotation of the escapement rack **72**, the saw-tooth recesses **71** of the escapement rack **72** engaging first a gripping pawl **74′** and then a locking pawl **74** which are both arranged on a projection **74***a* (Figs. 3 and 4) of the carriage 4_1.

The locking pawl **74** is arranged on a member **95***b* (Fig. 5), loaded by a spring **95***a*, which is rotatable about the axle **95** and intercepted by the part **96**. When the carriage 4_1 is shifted towards the right (Fig. 1), the locking pawl **74** is depressed by and passes over the saw-teeth **71** of the escapement rack **72**. In order to release the carriage 4_1 for a motion to the left, Fig. 1, the locking pawl **74** must be depressed and freed from the saw-tooth recesses **71**. To this end, the member **95***b* is provided with a laterally projecting lug **74″** which engages an elongated rocking member **97** (Figs. 3, 4, 5, 8 and 11) during the entire traverse of the carriage 4_1 towards the left. The rocking member **97**, referred to hereinafter as the "left-shift rocker," is effective during a shift toward the left. It is supported by pivots **98** and urged against the stop member **93** by the lower end of the spring **91** (Fig. 3). At the point marked by the arrow **99** in Figs. 3 and 4, a key **99** (Fig. 11*a*) causes an anti-clockwise rocking motion in Fig. 3 of the left-shift rocker **97** which depresses the locking pawl **74** and releases the saw-tooth recesses **71** of the escapement rack **72**. Now the carriage 4_1, urged by the tension of its spring **5**, moves leftward until it reaches its extreme left position, unless it is stopped in this path for instance by a premature engagement of the saw-tooth recesses **71** by the locking pawl **74**.

COUPLING OF THE SINGLE TOOTH SLIDE WITH THE CARRIAGE OF THE ACTUATOR

A pawl **138** is supported by a pivot **137** at the right of the carriage 4_1 (Figs. 11 and 12) and is held by a shoulder **138′** on the lower end **140′** of a second pawl **140** on a shaft **139**. The pawls **138** and **140** are held in the position shown in Fig. 12 by a tension spring **141** attached to off-set flanges thereof. The pawl **140** has an arm **140″** with a double slope cooperating with a cam or pin (not shown) which revolves with the actuator **4**. During each revolution of the actuator **4**, the arm **140″** and thus the pawl **140** are rotated about the pivot **139** so that its end **140′** slides off the shoulder **138′** and releases the pawl **138** which is rotated by the spring **141** about its pivot **137**. The right or posterior end of the pawl **138** upon release engages between teeth **142′** of a bar **142** of a counting tooth slide, whereas before the pawl **138** was free to slide over the teeth **142′** without being influenced. The bar **142**, supported in the machine frame, outflanks with fork-shaped arms **142″** the counting tooth slide (not shown) which is shiftably arranged on the main driving shaft and advances in a manner known per se in the art by one tooth the oppositely arranged wheel of the revolutions counter **20** or the intermediary wheel thereof at each revolution of the actuator **4**.

It will be realized that the pawl **138** does not engage teeth **142′** during the adjustment shifts of the actuator

involving a shift but no rotation of the actuator, so that the bar **142** which guides the counting tooth slide (not shown) and the latter remain at rest during these steps. However, when a transmitting revolution is carried out with the actuator **4** set to a certain value, the pawl **140** releases the pawl **138**. The pawl **138** is now freed to engage the teeth **142'**, whereby the guide bar **142** couples the counting tooth slide (not shown) to the carriage 4_1 for a common step-by-step motion.

The operation relative to the transfer of a dividend will now be discussed. When the counting tooth slide (not shown) reaches its extreme left-hand position and the carriage 4_1 of the actuator is further shifted to the left, the pawl **138** slides along the inclined sides of the teeth **142'** into the respective next tooth gaps. The shoulder **138'** of the pawl **138** is not displaced sufficiently to allow the end **140'** of the pawl **140** to pass beyond the shoulder **138'** so that the pawl **138** remains in engagement with the teeth **142'**, and the counting pawl slide (not shown) remains coupled to the carriage 4_1 of the actuator **4**.

When the carriage 4_1 of the actuator **4** is moved by the wire **7** towards its extreme right-hand position, the guide bar **142** of the counting tooth slide (not shown) reaches its right-hand position and comes to a stop. During a further movement of the carriage 4_1, the pawl **138** slides towards the right along the inclined tooth flanks into the respective adjacent gaps of teeth **142'**. When the carriage 4_1 reaches its extreme right-hand position, the outer or rear end of the pawl **138** engages an inclined face (not shown) and is lifted thereby so that the end **140'** comes to lie against the shoulder **138'**. Thereafter, when the carriage 4_1 is tabulated to the left for setting a new value in the actuator **4**, the pawl **138** remains in its initial setting, shown in Fig. 12, in which the pawl **138** is out of contact with the teeth **142'** until a revolution of the actuator is effected and the pawl **140**, by engagement of the above-mentioned cam or pin (not shown) with one of the arms **140''**, releases the pawl **138** so that the latter may engage the teeth **142'**.

If a value-setting operation of the actuator **4** is followed by ordinal escapement of the carriage 4_1 or by tabulation thereof to the left-end position, the counting tooth slide (not shown) has to participate in these movements to the left. To this end the pawl **140** has to be disengaged not only by revolution of the actuator **4**, but also by the two left-shift keys **94** and **99**. In order to accomplish this, an arm **144** (Figs. 11 and 12) is connected with the pawl **140** and has an extension **144'** arranged in front of an edge **145'** of a control slide **145**. The arm **144** may be rocked from the front to the rear in the machine to rock the pawl **140** in the same direction as the cams or pins (not shown) of the carriage 4_1 engaging the inclined ends **140''**. The slidably mounted control slide **145** is moved by means of a lug **145''** thereon which is engaged by inclined faces **94''** and **99''** on the keys **94** and **99**, respectively, when either of these keys is depressed so as to force the lug **145''** to the rear.

It will be realized by those skilled in the art that the operation of the described coupling of the counting tooth with the carriage 4_1 of the actuator **4** corresponds to the coupling shown in Figs. 31 and 32 of U.S. Patent No. 2,108,596 issued on February 15, 1938, to K. V. Rudin for a "Calculating Machine."

AUTOMATIC RELEASE OF THE TABULATION OF THE CARRIAGE

In order to automatically control the leftward tabulation of the actuator carriage 4_1 to align the rightmost denominational order of the actuator **4** with the rightmost denominational order of the accumulator **18** in the total retransfer operation according to the invention, the mechanism described hereinafter with reference to Figs. 3, 4, and 9 is provided.

At a suitable place in the machine, preferably at the right end of the left-shift rocker **97**, there is arranged an automatic tabulation control slide **120** having a forwardly extending arm **120'**. The control slide **120** is rockable about an axle **121** on which it is supported so as to be axially displaceable. A weak spring **122** urges the slide **120** and the arm **120'** thereof against a stop **123** fixed in the machine and formed, for instance, by a face of an adjustable lever **127** supported by the shaft **127'** which is fixedly connected with the frame of the machine. The operation of the lever **127** will be explained in more detail hereinafter.

A cam **124** is arranged on one of the toothed driving wheels **45—49** which are axially displaceable, for instance, on the wheel **45**, which effects a partial step ordinal shift of the actuator carriage 4_1 for the retransfer operation. When axially displaced, the cam **124** engages a projection **125'** of a bellcrank lever **125** supported by the axle **125***a*, or of a swinging rocker (not shown) and rotates the same in counterclockwise direction upon a rotation of the control shaft **43**. The other arm **125''** of the lever **125** engages the arm **120'** of the slide **120** from below and lifts the same during the last phase of the rotation of the control shaft **43**, that is during the return travel of the carriage 4_1 toward the right.

When the arm **120'** is lifted, it lifts the lug **97'** of the member **97**, rocking the member **97** in counterclockwise direction (Fig. 3) to disengage the pawl **74** in the same manner as when the left-shift key **99** is depressed in the direction of the arrow (Fig. 3), the carriage 4_1 being released to move toward the left by the spring **5**. During this motion, a stop **126** of the carriage 4_1 engages a forwardly extending lug **120''** of the slide **120** so as to move the same along toward the left until the arm **120'** is withdrawn from below the lug **97'** which slides off the edge **120'''** of the arm **120** (Fig. 4); locking pawl **74** is now released. This takes place when the locking pawl **74** is positioned to engage the tooth of the saw-tooth recesses **71** that corresponds to the desired denominational position of the carriage 4_1, i.e., with the rightmost denominational order of the actuator **4** aligned with the rightmost denominational order of the accumulator **18**.

The operation of the arrangement described hereinabove is as follows:

Upon depression of the key **90'**, the control shaft **43** is connected to crank **1** for operation thereby and all five independent operations, namely zeroizing of the actuator **4**, displacement of the actuator **4** into a denominationally intermediate retransfer position, zeroizing of the accumulator **18**, zeroizing of the revolutions counter **20** and return of the actuator carriage 4_1 to the right are effected in the sequence just named. During the last-mentioned phase, the cam **124** imparts a swinging motion to the bellcrank lever **125** so that its arm **125''** imparts a swinging motion to the arm **120'** of the slide **120** which in turn acts upon the member **97** through the lug or projection **97'** so that the locking pawl **74** is withdrawn from the saw-tooth recesses **71** of the escapement rack **72**. In consequence thereof, the carriage 4_1 moves toward the left and, before reaching the position in which the rightmost denominational order of the actuator **4** is aligned with the rightmost denominational order of the accumulator **18**, the carriage 4_1 starts to displace the slide **120** toward the left. For this purpose, the stop **126** abuts against the stop **120''** to release the member **97** when the projection **97'** slides off the edge **120'''**. The locking pawl **74** thereupon engages the saw-tooth recesses of the escapement rack **72** and stops the carriage 4_1 in the denominational position mentioned above. Thus, the carriage 4_1 and also the counting tooth slide (not shown), and more fully disclosed in U.S. Patent No. 2,108,596 mentioned above, which has been arrested at the first denominational order of the revolutions counter **20** (Fig. 10) are ready for a multiplication involving the retransferred amount.

Since the slide **120** has to operate only in the position of the carriage specified hereinabove, the slide **120** may

be carried along by the carriage 4_1 during further steps or shifts to the left until the carriage 4_1 has reached its end position.

SUPPRESSION OF THE AUTOMATIC TABULATION OF THE CARRIAGE

In order to suppress the automatic tabulation of the carriage 4_1 to the left, if desired, the adjusting lever **127**, shown in Fig. 9 is provided. A stop face **123** and **128** are connected by an intermediary face **129**. The position of the lever **127** shown in Fig. 9 corresponds to a setting for controlling tabulation to the left. However, upon counterclockwise angular displacement from the shown position, the arm **120'** of the slide **120** is shifted toward the left by the stop face **128** so that the overlap of the arm **120'** with the arm **125''** or the lug **97'** or both is discontinued. Therefore, the cam **124** has no effect on the member **97** and the carriage 4_1 remains in its right-hand end position when the handle or crank is actuated after a depression of the combined operations key **90'**.

ZERO ADJUSTMENT OF THE AUTOMATIC TABULATION OF THE CARRIAGE

The carriage 4_1 is stopped during a tabulation to the left in a position in which all denominational orders of the actuator **4** are arranged opposite the right-hand denominational orders of the accumulator **18**. If zeros are adjusted in the right-hand orders of the actuator **4**, the corresponding orders of the accumulator **18** cannot be used for calculating purposes. For this reason, the stop **126** of the carriage 4_1 has to be advanced by so many orders to the left as there are zeros in the rightmost orders of the actuator **4**, if these zeros are not to be aligned with the operating orders of the accumulator **18**. In order to accomplish this for each denominational order, a series of controllable stop members **130** (Figs. 6, 7 and 8) is arranged to the left of the stop **126**. The first of the stop members **130** is spaced from the stop **126** by a distance equal to one denominational order. Each of the following stop members **130** is spaced from the preceding one by the same distance, as shown in Fig. 8. The stop members **130** are controlled by the control rings **9'''**, rigidly connected with the cam disks **9'**. The control rings **9'''** have circumferential recesses or grooves **131** (Figs. 6 and 7) which in the zero position are aligned with similar recesses or grooves **132** of the cam disks **9'** of the actuator **4**. In the rest position of the actuator **4**, an arm **130'** of the controllable stop member **130** engages the recess **132**. This arm **130'** is displaced as soon as the associated cam disk **9'** is adjusted to a position differing from the zero position, i.e., to a significant digit. The stop member **130** is thereby rocked in counterclockwise direction (Fig. 6) about the pivot **130*a*** against the force exerted by a spring **130*b*** and is removed from the path of the stop **120''** of the slide **120** so that the latter is caught by the next stop member **130** arranged to the right, as viewed in Figs. 1 and 10. Thus, as soon as the left cam disks **9'** are adjusted to any position corresponding to a value, for instance, by a retransfer operation according to the present invention, the associated stop members **130** are rocked about their pivots on shafts **130*a***. Thus the locking pawl **74** of the carriage 4_1 engages the saw-tooth recesses **71** of the escapement rack **72** in that denominational position in which the lowest adjusted denominational order of the actuator is aligned with the rightmost denominational order of the accumulator **18**. For the case that zeros are adjusted in the actuator to the left (as viewed in Figs. 1 and 10) of orders having significant digits set therein, or intermediate those orders having significant digits set therein, follower extensions **130''** of the stop members **130** overlap adjacent lower order followers **130** to the left and form, as it were, a "living bridge," to lift those stop members **130** from the grooves **131, 132** which are in denominational orders set at zero to the left (as viewed in Figs. 1 and 10) of any order having an adjusted value other than zero therein. Thus the stop members **130** remain in effective position only in the denominational orders set at zero and on the right of an adjusted value. Hence, according to the invention, the carriage 4_1 of the actuator **4** is stopped by the stop **126** or by stop members **130** during tabulation to the left according to the denominational position of the rightmost significant digit entered into the actuator during the retransfer operation.

In the arrangement just described, in case of a tabulation of the carriage to the left or of a tabulation followed by subsequent escapement of the carriage, and if a value has been adjusted in the leftmost orders of the actuator, the slide **120** will be engaged and taken along by one of the stop members **130** correspondingly far to the left so that under certain circumstances the space available for movement of the slide **120** to the left may be exceeded. Since the slide **120** has to operate only in its initial position to the right, the stop members **130** which are in normal, zero, position may be rotated by an inclined edge **134** (Fig. 8) of a member, such as a rail **135**, secured to the frame of the machine, into an ineffective position with respect to the stop lug **120''**, the rail **135** holding the members **130** in this position. This has the simultaneous advantage, that the members **130**, after a corresponding displacement of the carriage 4_1 to the left, remain out of engagement with the recesses or grooves **131, 132** in those orders to the left of incline **134** during rotation of the actuator **4**.

Thus, it is seen that the simultaneous zeroizing of the accumulator **18** and of the revolutions counter **20** renders the selective retransfer either from the accumulator **18** or from the revolutions counter **20** possible by previously shifting the carriage 4_1 of the actuator **4** into the correctly aligned position in which the denominational orders of the actuator are arranged opposite the orders of the accumulator or revolutions counter mechanism, whereas the remaining orders, for instance of the other mechanism, are cancelled without further effects. Thus, also serial multiplication may be carried out quickly, since after a retransfer, the accumulator and the revolutions counter are available for another multiplication involving the retransferred value. However, if it is required to retransfer a value from the accumulator or the revolutions counter without cancelling the value stored in the other mechanism, the procedure disclosed in German Patent No. 907,836 and the corresponding U.S. Patent No. 2,879,938 mentioned hereinabove applies, namely pressing the normal retransfer key **25'** in connection with the zero key for the transmission of definite values, whereupon the drive is actuated, the values stored in either the accumulator or the revolutions counter are not cancelled, and the actuator **4** remains in its initial denominational position.

It is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In a calculator having a frame the combination comprising, an axle supported in the frame, a counter mounted on said axle and having a denominational series of rotatable digit wheels; a second axle supported in said frame coaxial with said first axle, an accumulator having a denominational series of rotatable digit wheels mounted on said second axle; a third axle extending parallel to said first two axles and secured to the frame, a denominationally shiftable carriage mounted on said third axle for denominational displacement thereon and normally urged to the left from an initial right-hand position, a cyclically operable rotary differential actuator having a denominational series of number wheel elements supported in said carriage, said number wheel elements each including means settable to operate said accumulator or said counter wheels upon cyclic rotation of said actuator and means engageable by said accumulator

wheels or said counter wheels to set said settable means upon zeroizing said accumulator or said counter, said settable means of said actuator number wheel elements being adapted to cooperate with any plurality of said digit wheels ordinally aligned therewith upon shifting said carriage; a first device, said first device being adapted to zeroize the actuator and to shift said carriage by a partial step to align said engageable means of said number wheel elements of said actuator with a selected denominationally aligned plurality of adjacent digit wheels; a second device, said second device being adapted to zeroize said actuator and to shift said carriage to its initial right-hand position; a third device adapted to zeroize said accumulator; a fourth device adapted to zeroize said counter; cyclically operable drive means for said four devices, means for enabling said drive means in response to the enabling of at least one of said devices; said drive means operating said four devices in predetermined sequence during said cycle; an escapement rack supported on said frame, a spring-loaded pawl rockably mounted on said actuator carriage and having a rack-release and a rack-engaging position, said spring forcing said pawl into the rack-engaging position; said rack and pawl being shaped to enable shifting of said actuator carriage to the right and for holding of said actuator carriage against shifting to the left in the rack-engaging position of said pawl; a pawl-rocking member engaging said pawl in all shifted positions of said carriage and movable from a normal inoperative position to an operative position to rock said pawl to its rack-releasing position; an axially shiftable control device urged to a normal axial position operably engaging said rocking member and being operable by said first device to move said pawl-rocking member into its operative position, said control device being engageable by said actuator carriage upon movement to a selected denominational position to shift said control device out of operative engagement with said pawl-rocking member, thereby enabling said pawl-rocking member to restore to its inoperative position at a predetermined location of the actuator carriage when the actuator is in ordinal alignment with the predetermined plurality of digit wheels; and a manually operable control lever engaging said control device and effective upon adjustment from normal position to axially shift said control device out of operative engagement with said pawl-rocking member.

2. In a calculator having a frame, an accumulator and a revolutions counter each having a denominational series of digit wheels supported in axial alignment in said frame, a denominationally shiftable carriage supported by said frame for movement parallel to said accumulator and said revolutions counter and normally urged to the left from an initial right-hand position, a cyclically operable rotary differential actuator including an ordinal series of settable differential actuator elements supported in said carriage on an axis parallel to said accumulator and revolutions counter axis, said actuator elements being adapted to operate the digit wheels of said accumulator or said revolutions counter upon cyclic rotation thereof and being adapted to be set by the digit wheels of said accumulator or said revolutions counter upon zeroizing the latter, an automatic tabulation control device to shift the actuator carriage to the left from its initial right-hand position into ordinal alignment with a predetermined plurality of digit wheels, said tabulation control device comprising an escapement rack supported on said frame, a spring-loaded pawl rockably mounted on said actuator carriage and having a rack-release and a rack-engaging position, said spring forcing said pawl into the rack-engaging position; said rack and pawl being shaped to enable shifting of said actuator carriage to the right and for holding of said actuator carriage against shifting to the left in the rack-engaging position of said pawl; a pawl-rocking member engaging said pawl in all shifted positions of said carriage and movable from a normal inoperative position to an operative position to rock said pawl to the rack-releasing position; an axially shiftable control device urged to a normal axial position operably engaging said rocking member and being operable by said first device to move said pawl-rocking member into its operative position, said control device being engageable by said actuator carriage upon movement to a selected denominational position to shift said control device out of operative engagement with said pawl-rocking member, thereby enabling said pawl-rocking member to restore to its inoperative position at a predetermined location of the actuator carriage when the actuator is in ordinal alignment with the predetermined plurality of digit wheels, and means to actuate said control device.

3. In a calculator having a frame, the combination comprising, an axle supported in the frame, a counter mounted on said axle and having a denominational series of rotatable digit wheels; a second axle supported in said frame coaxial with said first axle, an accumulator having a denominational series of rotatable digit wheels mounted on said second axle; a third axle extending parallel to said first two axles and secured to the frame, a denominationally shiftable carriage mounted on said third axle for denominational displacement thereon and normally urged to the left from an initial right-hand position, a cyclically operable rotary differential actuator having a denominational series of number wheel elements supported in said carriage, said number wheel elements each including means settable to operate said accumulator or said counter wheels upon cyclic rotation of said acuator and means engageable by said accumulator wheels or said counter wheels to set said settable means upon zeroizing said accumulator or said counter, said settable means of said actuator number wheel elements being adapted to cooperate with any plurality of said digit wheels ordinally aligned therewith upon shifting said carriage; a first device, said first device being adapted to zeroize the actuator and to shift said carriage by a partial step to align said engageable means of said numbers wheel elements of said actuator with a selected denominationally aligned plurality of adjacent digit wheels; a second device, said second device being adapted to zeroize said actuator and to shift said carriage to its initial right-hand position; a third device adapted to zeroize said accumulator; a fourth device adapted to zeroize said counter; cyclically operable drive means for said four devices, means for enabling said drive means in response to the enabling of at least one of said devices; said drive means operating said four devices in predetermined sequence during said cycle; an escapement rack supported on said frame, a spring-loaded pawl rockably mounted on said actuator carriage and having a rack-release and a rack-engaging position, said spring forcing said pawl into the rack-engaging position; said rack and pawl being shaped to enable shifting of said actuator carriage to the right and for holding of said actuator carriage against shifting to the left in the rack-engaging position of said pawl; a pawl-rocking member engaging said pawl in all shifted positions of said carriage and movable from a normal inoperative position to an operative position to rock said pawl to its rack-releasing position; a slide, said slide being rockably mounted in said frame, said slide being slidable along a path of motion parallel to said axles, a cam driven by said drive means, said slide being urged to a normal axial position operably engaging said pawl-rocking member and being operable by said cam to move said pawl-rocking member into its operative position, and a stop rigidly connected to said actuator carriage, said stop axially sliding said slide out of operative engagement with said pawl-rocking member upon movement of said actuator carriage to a selected denominational position, thereby enabling said pawl-rocking member to restore to its inoperative position at a predetermined location of the actuator carriage when

the actuator is in ordinal alignment with the predetermined plurality of digit wheels.

4. In a calculator, the combination as claimed in claim 3, further comprising, a plurality of additional stops supported by said carriage and denominationally spaced from one another, said additional stops being positioned to the left of said rigidly connected stop and denominationally spaced therefrom, each of said additional stops being associated with one of said number wheel elements, said additional stops being displaceable out of the path of said slide, a stop-adjusting member for each of said additional stops, each stop-adjusting member being actuated by the setting of said associated number wheel element to a significant digit other than zero to displace said associated stop out of the path of said slide, and means responsive to a stop positioned outside the path of said slide to remove from the path all stops of highest denominational order to the left of the removed stop.

5. In a calculator, the combination as claimed in claim

4, further comprising, a stop return member, said stop return member being supported at a predetermined location in the frame adjacent the path of said carriage and denominationally spaced beyond the position at which said stop or said additional stops engage said slide, said return member being adapted to sequentially move any of said additional stops from the path of said slide as said additional stops respectively are shifted with the carriage past said stop return member.

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