

May 21, 1968

J. W. BERKMAN ET AL
PLUS AND MINUS ACCUMULATOR

3,384,301

Filed Dec. 23, 1966

7 Sheets-Sheet 1

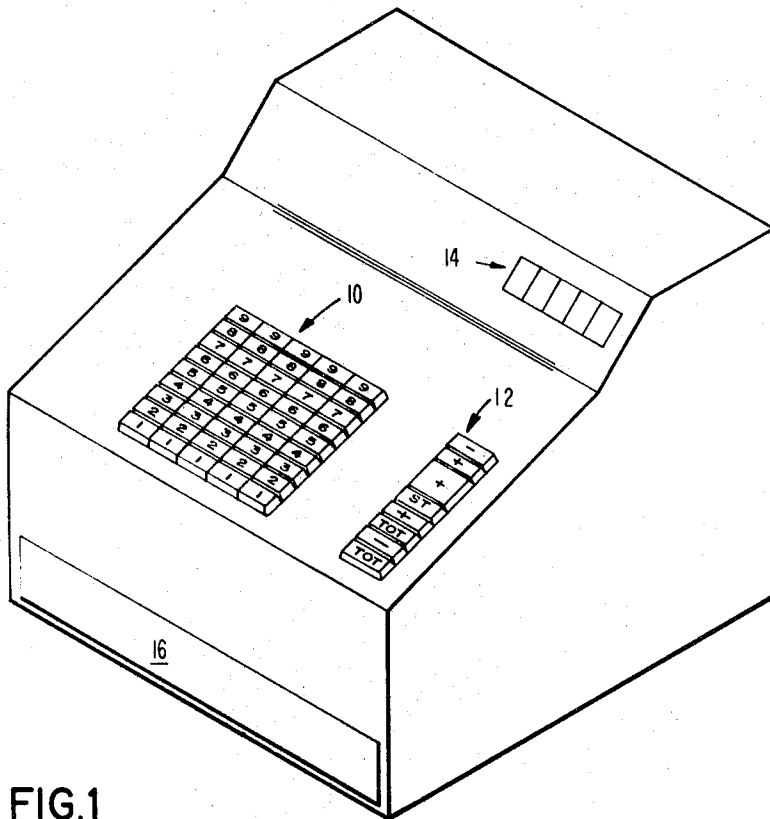


FIG. 1

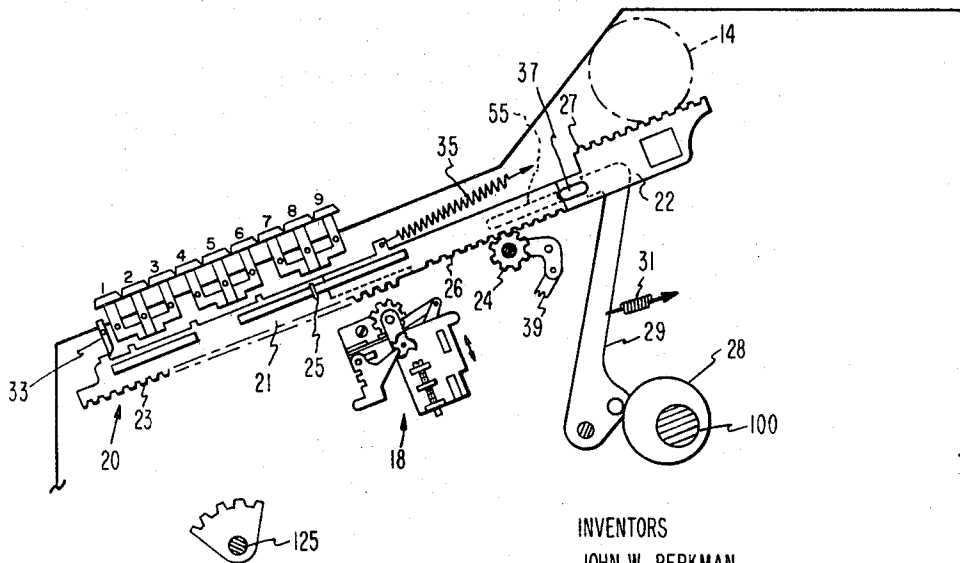


FIG. 2

INVENTORS
JOHN W. BERKMAN
CHARLES G. DE SERRE
THOMAS L. JOHNSON

BY *Richard H. Smith*
ATTORNEY

May 21, 1968

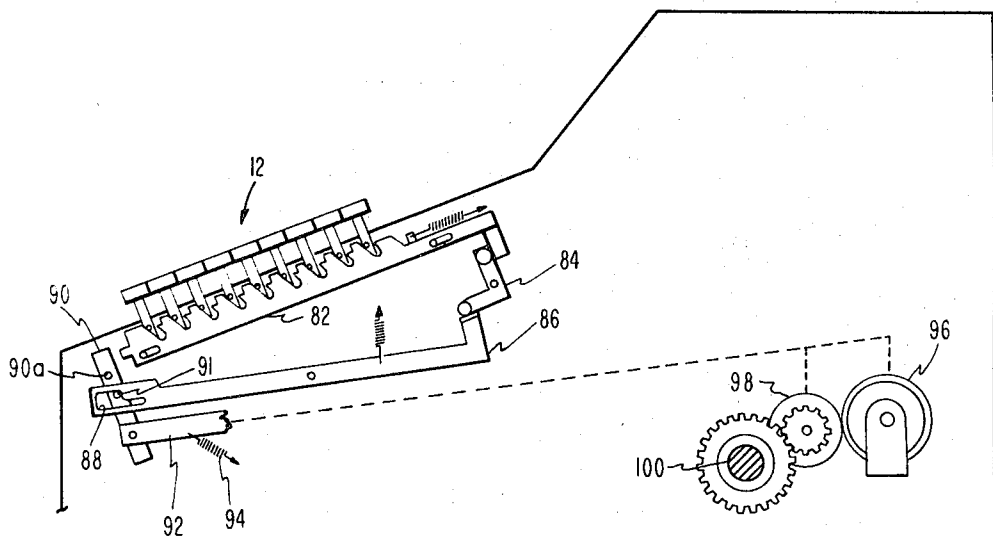
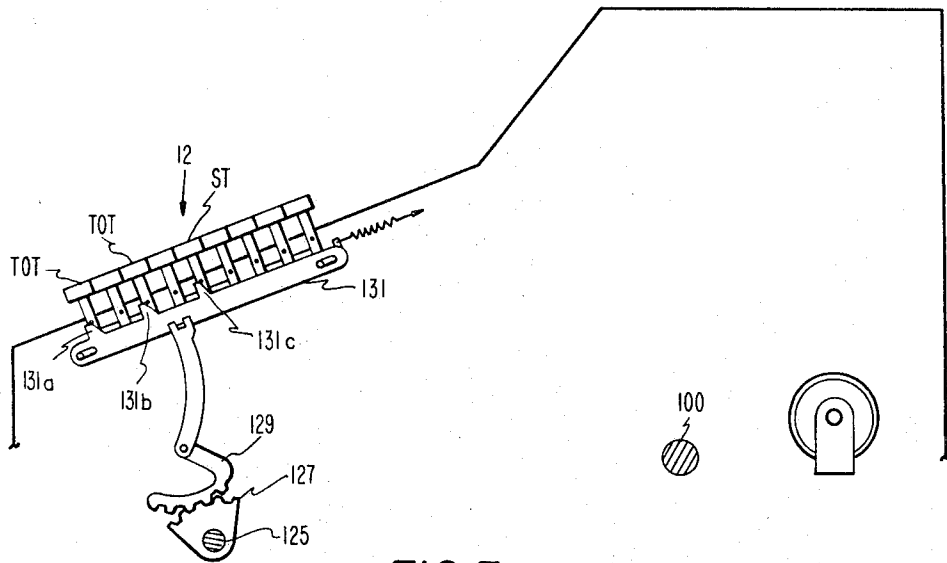
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FIG. 6

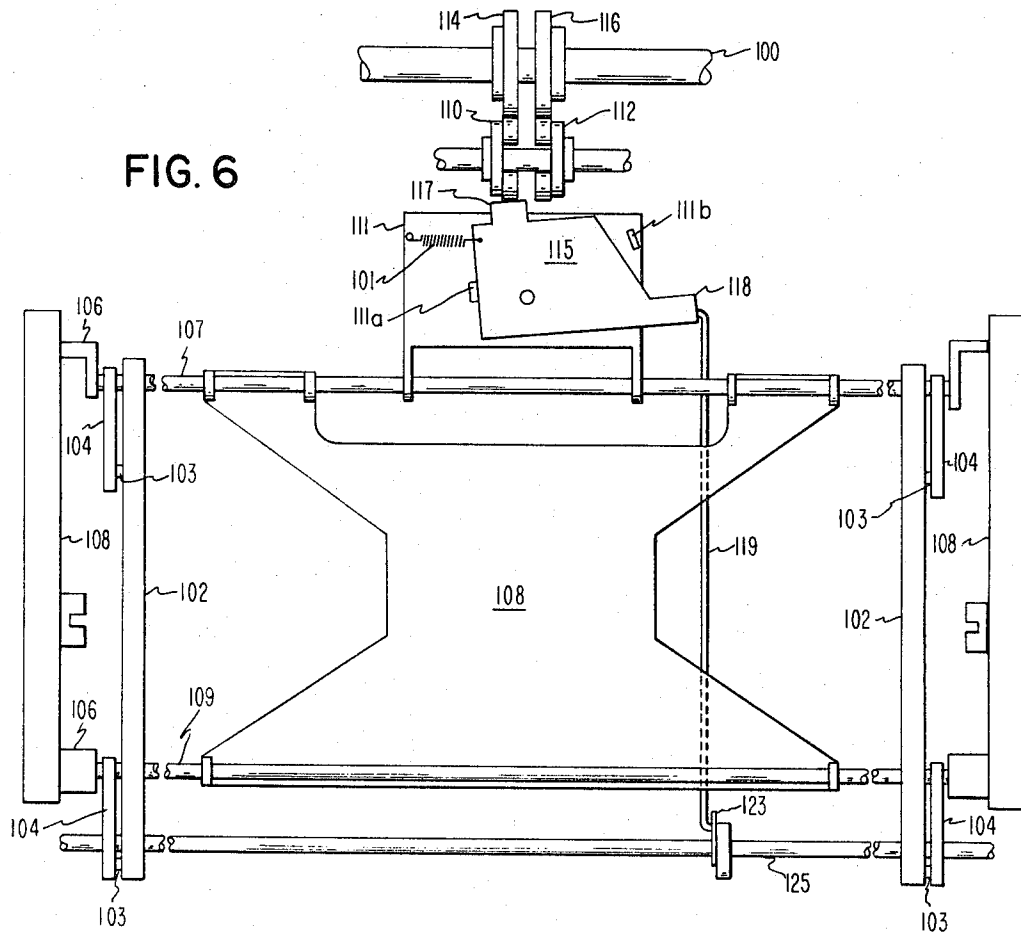
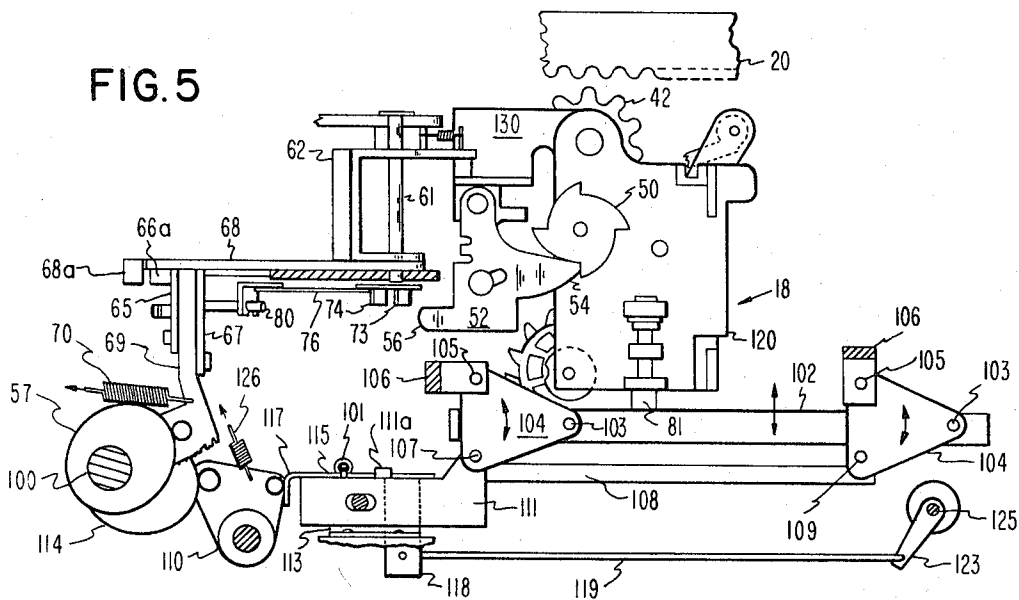


FIG. 5



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FIG. 7

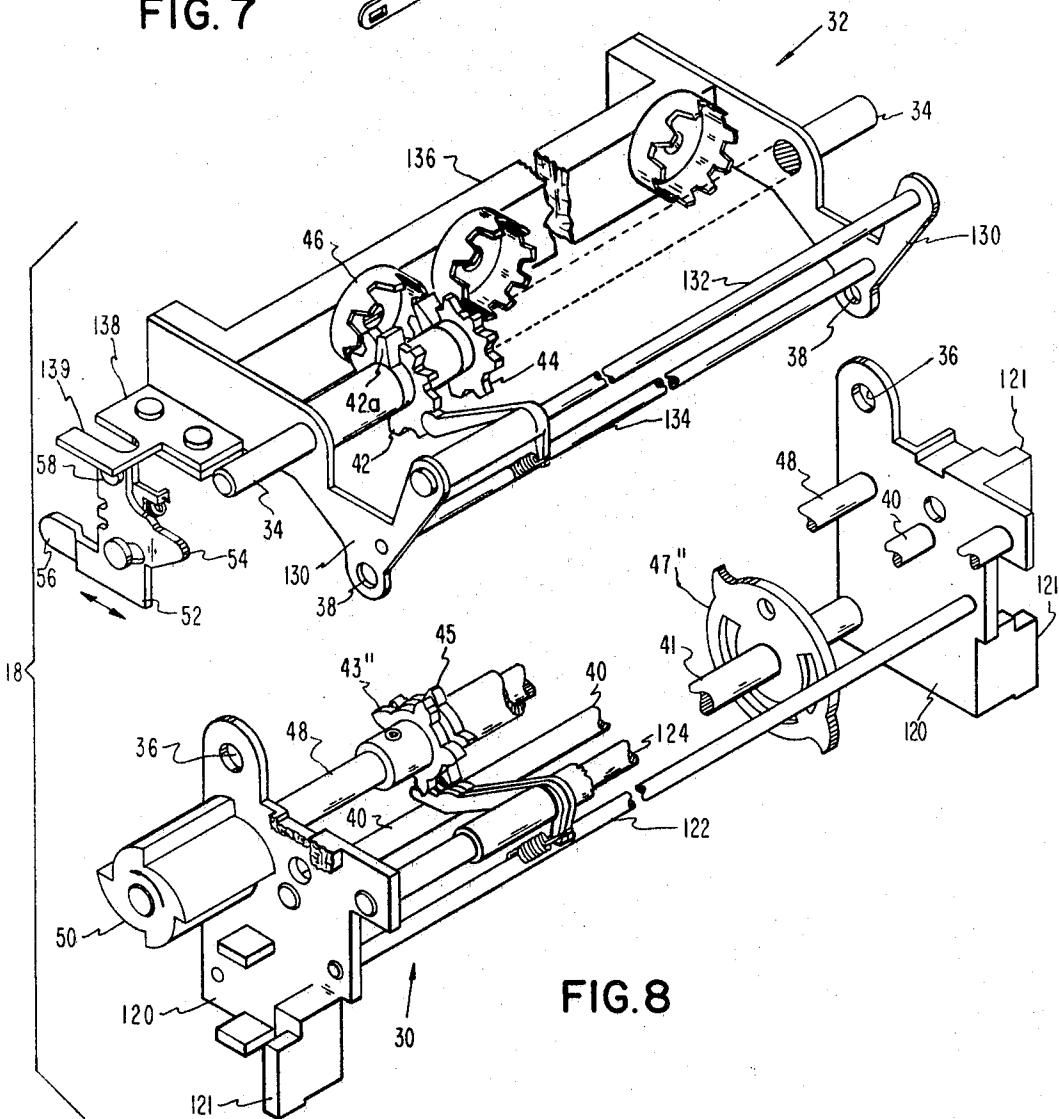
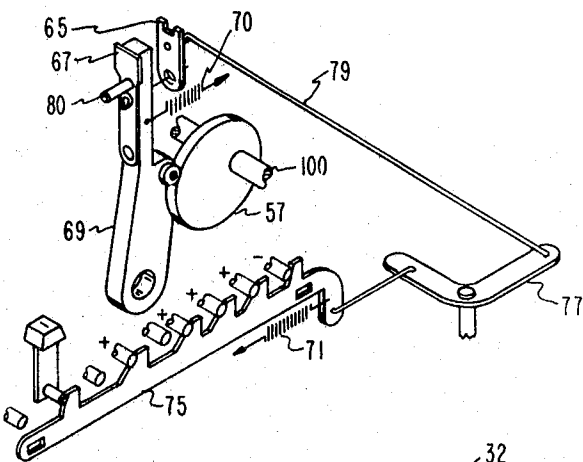


FIG. 8

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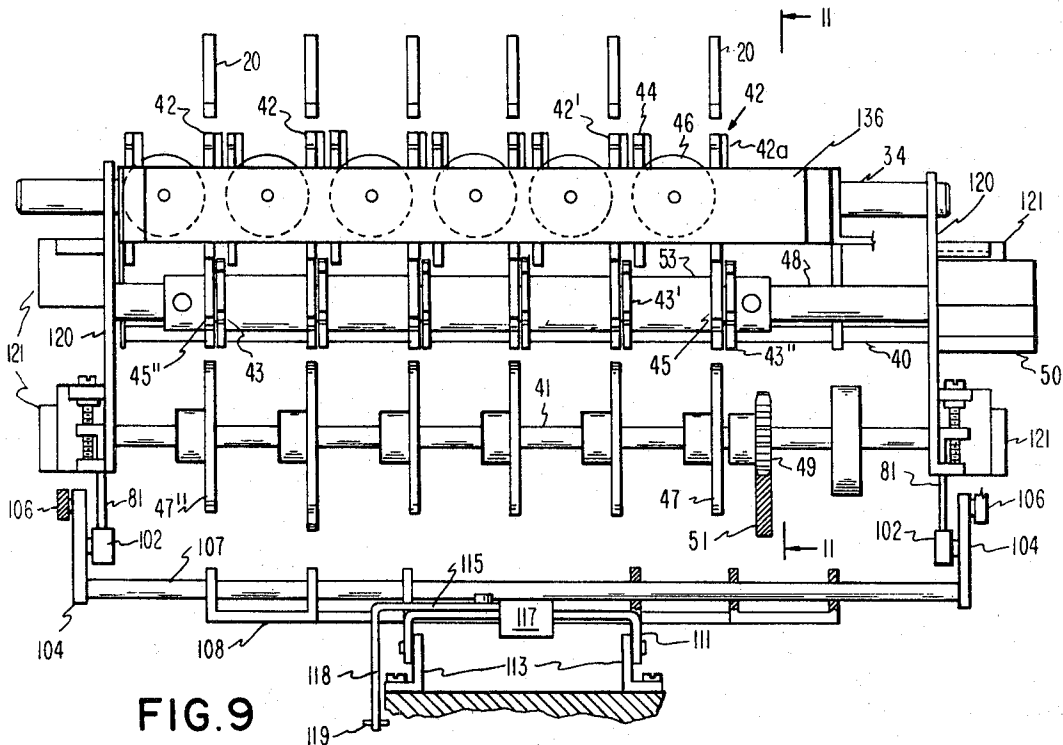


FIG. 9

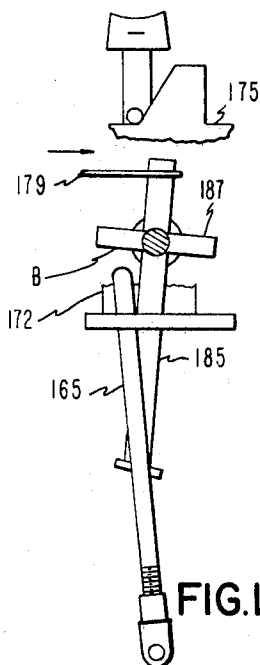


FIG. 13c

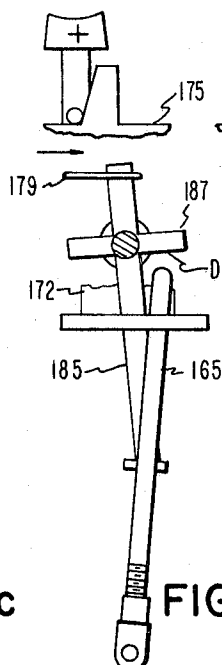


FIG. 13b

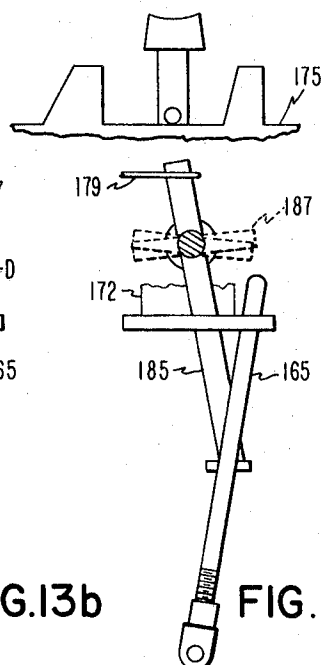


FIG. 13a

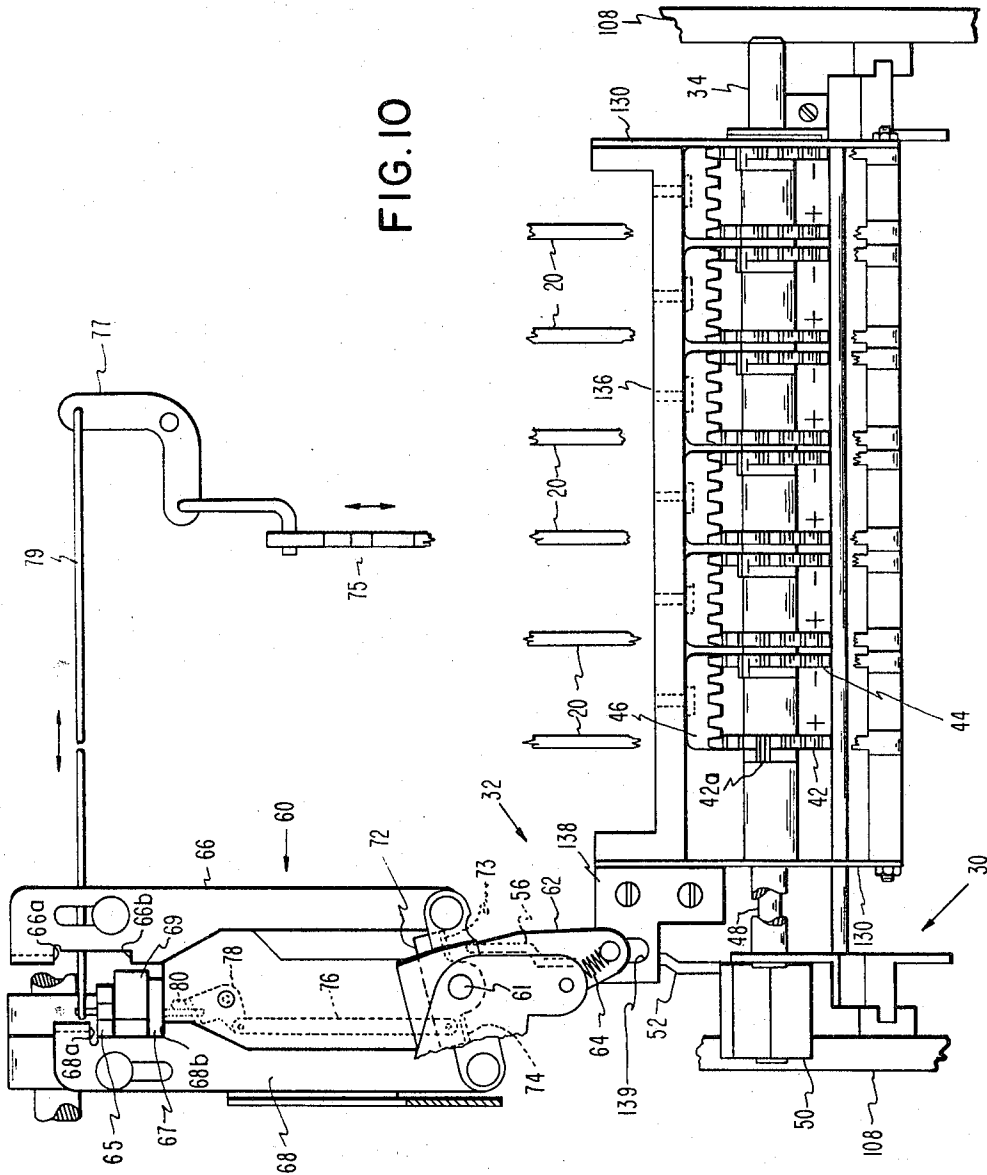
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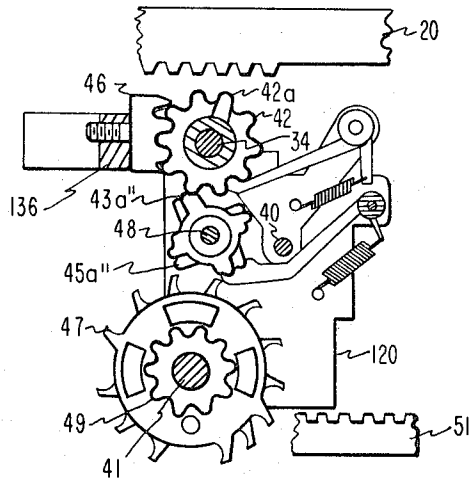


FIG. 11

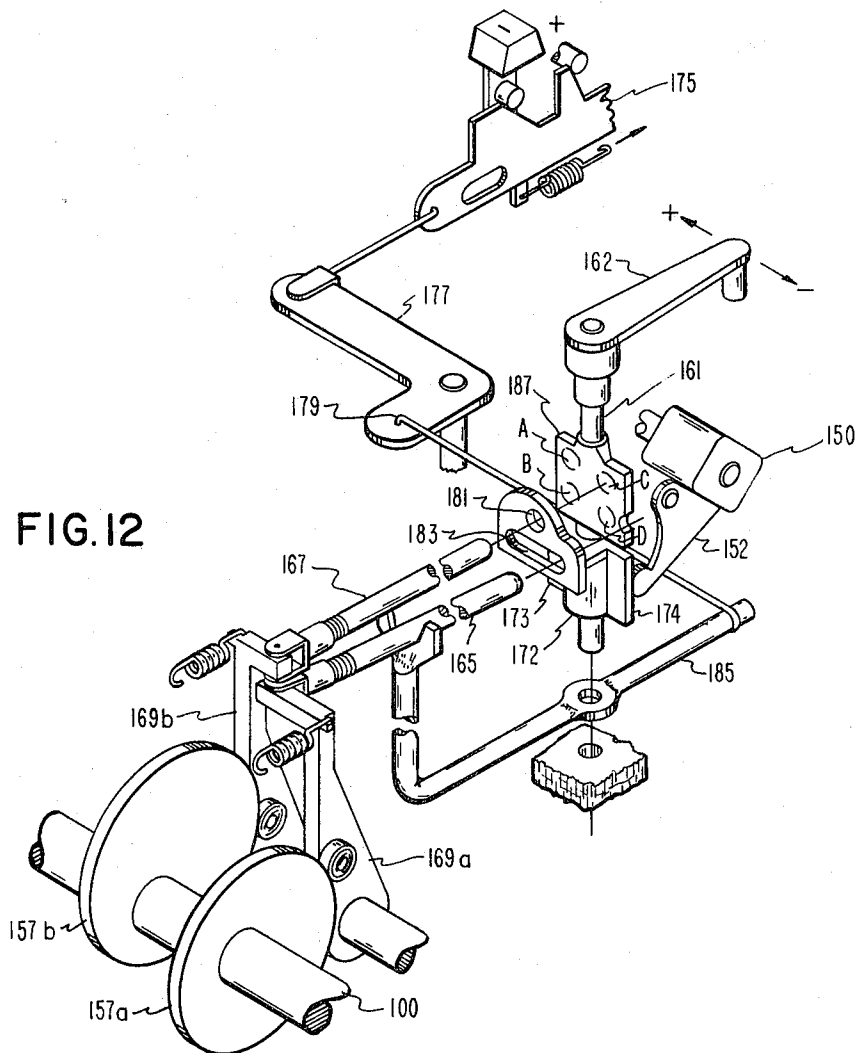


FIG. 12

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PLUS AND MINUS ACCUMULATOR

John W. Berkman, Oronoco, and Charles G. De Serre and Thomas L. Johnson, Rochester, Minn., assignors to Internal Business Machines Corporation, Armonk, N.Y., a corporation of New York

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7 Claims. (Cl. 235—60)

ABSTRACT OF THE DISCLOSURE

A mechanical plus and minus accumulator for a cash register, desk calculator, etc., is described. The accumulator employs a pair of complementarily rotatable digit wheels in each digit position and is laterally shiftable with respect to a common set of differential actuators for the purpose of aligning either the plus or minus set of digit wheels therewith. The mechanism for accomplishing the lateral shift operation includes a portion cooperating with the control keys of the machine to shift the proper set of wheels into alignment with the actuators in accordance with the sign of the number to be added in. Another portion of the shifting mechanism is automatically operable near the end of each add-in machine cycle to shift the accumulator to align with the actuators that set of wheels which corresponds to the sign of the true total stored in the accumulator. Two versions of this shifting mechanism are described. The first employs a single cam and follower and generates the initial shifting movement when the follower is driven in a first direction and generates the final shifting movement when the follower is driven in the reverse direction. The second version employs a pair of cams and cam followers, a first of the cams generating the initial shifting movement and the other cam generating the final shifting movement. Also described in detail are the carry transfer mechanism, the differential actuators and the mechanism for driving the digit wheels of the accumulator into and out of engagement with the differential actuators.

This invention relates to plus and minus accumulators and, more particularly, to plus and minus accumulators of the type employing a pair of complementarily connected digital wheels in each digit position for the purpose of storing positive and negative totals.

In accumulators of the type described, it is the usual practice to employ a common set of differential actuators to enter values into the accumulator and to read totals therefrom. By a common set of actuators it is meant that only a single actuator, generally in the form of a rack, is available for each digit position keyboard column. In entering values into the accumulator, each rack scans a keyboard column and rotates either the corresponding plus accumulator wheel or minus accumulator wheel an amount corresponding to the number set up on the keyboard. Selection of the plus and minus wheels is dependent upon the sign of the input operation.

To read totals out of the accumulator, the amount input keys are not depressed and the racks are manipulated so as to rotate either the plus or minus accumulator wheels back to their home or zero position. Since the racks are connected to drive numerical display wheels and/or print wheels, the total is displayed for readout. Selection of the plus or minus wheels on readout is determined by the sign of the stored total.

It is the simplest and thus most desirable practice to employ a single mechanism for engaging both the plus and minus wheels with the racks rather than to employ duplicate mechanisms for each of the two sets of wheels. This enables use of but a single set of "mode" control

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mechanisms, conserves parts, space, etc. This is generally accomplished by rendering the plus and minus sets of wheels adjustable with respect to the engaging mechanism so that to select between the plus and minus wheels for a given input or output operation, it is necessary only to pre-position the desired set of wheels so that when the engaging mechanism operates it causes the one set and not the other to engage the actuator racks. One way of doing this is to mount both sets of wheels coaxially and to arrange the coaxial line in a frame so as to be selectively shiftable with respect to the differential actuators. To select the plus wheels, the frame is shifted so that that set is in alignment with the actuators and to select the minus wheels the position of the frame is reversed so that the minus wheels are aligned with the actuators. The engaging mechanism operates on the shiftable frame to move the pre-aligned set of wheels into engagement with the actuators.

Prior art mechanisms for performing this prealigning operation are extremely complex and thus tend to be expensive to manufacture and to maintain. A primary cause for the great complexity in prior art systems in that an involved set of mechanisms is provided to enable the total-taking keys to control the shifting of the accumulator line to position the plus or minus wheels in alignment with the actuators during the initial portion of the total cycle. Such control mechanisms, of course, add to the expense of the unit, detract from its reliability and thus tend to be undesirable.

Another shortcoming of some of the prior art systems lies in their dependence upon "finger power" of an operator to perform the actual accumulator line shifting operation. To enable this type of operation to be reliable a complex power train between the control key and the accumulator line must be provided to give a mechanical advantage sufficient to generate the required shifting forces without undue operator strain.

It is therefore an object of the present invention to provide an accumulator having an improved plus and minus selection mechanism.

A further object is to provide an improved accumulator plus-minus selection mechanism that utilizes operator finger power only for setting up control keys and employs machine power for the generation of all operating forces.

Still another object is to provide an accumulator plus-minus selection mechanism that completely eliminates the need for control mechanisms linking the total control keys with the accumulator alignment shifting mechanism.

Still a further object is to provide an accumulator plus-minus selection mechanism that operates entirely automatically without consuming any time at the beginning of a totalizing cycle.

In accordance with the invention, means are provided whereby the machine automatically shifts the accumulator line at the end of each accumulation cycle such that the set of wheels corresponding to the sign of the total stored therein is in position to be engaged with the differential actuator for the purpose of reading out totals. Further, a portion of the same means is employed to enable the machine to shift the accumulator line at the beginning of each cycle of an input operation to condition for engagement that set of digit wheels which corresponds to the sign of the input control key which is depressed.

The primary advantages gained from this scheme are reduced cost, increased reliability of operation and a reduced cycle time on totalizing cycles.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of preferred embodiments

of the invention, as illustrated in the accompanying drawings.

In the drawings:

FIG. 1 is a perspective view of a cash register employing the plus-minus accumulator of the invention. The view illustrates the position of the various control and amount keys included on the keyboard.

FIG. 2 is a schematic sectional view of the cash register of FIG. 1 and illustrates the general spacial relationship between the amount keys of one digit column, the differential actuator racks associated with that column, and the plus-minus actuator assembly.

FIG. 3 is a schematic sectional view showing the control keybank and the control slide associated therewith which operates the total shaft.

FIG. 4 is a schematic sectional view showing the control keybank and the control slide associated therewith which operates the motor and clutch controls to trigger a machine cycle.

FIG. 5 is an elevational view showing the plus-minus accumulator of the invention together with the plus-minus selection and controls and engaging controls associated therewith.

FIG. 6 is a plan view of the engaging controls shown in FIG. 5.

FIG. 7 is a schematic view illustrating the control slide employed in association with the control keybank to operate a portion of the plus-minus selection controls shown in FIG. 5.

FIG. 8 is a perspective, exploded view showing the plus-minus accumulator assembly. As illustrated, the unit is broken apart into its two basic portions, the digit wheel shifting frame on top and the engaging shifting frame on the bottom.

FIG. 9 is a front elevation view of the plus-minus accumulator.

FIG. 10 is a plan view of the plus-minus accumulator together with the plus-minus selection controls.

FIG. 11 is a sectional view taken along the line 11-11 of FIG. 9 and illustrates the digit wheels and carry transfer mechanism associated therewith.

FIG. 12 is a perspective view of a modified form of plus-minus selection mechanism for use with the accumulator of the invention.

FIGS. 13a, 13b, and 13c are schematic diagrams illustrating three different positions in the operation of the mechanism of FIG. 12.

GENERAL DESCRIPTION

FIG. 1 shows one form of machine adapted to utilize the plus-minus accumulator of the invention. The machine schematically shown is a cash register and, for the purposes of the present description, need comprise no more than a set of amount keybanks 10, a control keybank 12 and a set of display wheels 14 for indicating input and output (total) amounts. Of course, a cash drawer 16 may be provided in accordance with the usual cash register practice.

Keybank 12 contains an assortment of plus, minus, sub-total and total control keys for effectuating the four basic cash register operations. Of course, in accordance with conventional practice, the control keys need not be labeled as shown in the drawing but may be labeled in accordance with the specific function assigned. For example, the top control key, rather than being labeled with a minus, may be labeled "error correct" or "returned merchandise," etc. The top plus key would be labeled "tax," etc. Each of the keys 12 is "motorized" meaning that depression of one of the keys not only selects the indicated function but also triggers a machine cycle to perform that function.

The heart of the machine is the plus-minus accumulator mechanism 18 shown in FIG. 2. The accumulator is capable of both addition and subtraction and, in terms of general overall function, it operates in the same manner as any of the plus-minus accumulators well known to the

cash register art. The basic mechanism for adding positive or negative amounts into the accumulator and for reading stored totals out of the accumulator is also shown in FIG. 2. This mechanism comprises, essentially, a compound differential actuator rack 20 positioned to coast with the keystems of one of the keybanks 10 or 12. There is one rack 20 for each keybank. Each actuator consists of a primary section 21 and a relatively slidably secondary section 22. As will be explained in detail subsequently, a zero stop 33 holds each differential actuator in the home position illustrated. During each machine cycle, the stops 33 are withdrawn, the actuators are driven to the right away from home position, are stopped, and then are driven to the left back to home position. The amount of movement undergone by each actuator during an input cycle is proportional to the number keyed in. The amount of movement of each actuator during a total cycle is proportional to the digit stored in the associated digit position of the accumulator. The actuator movement is utilized to set up the display wheels 14.

The accumulator engaging control mechanism (shown in FIGS. 5, 6, and 9) operates to shift the accumulator 18 upwardly to engage the digit wheels thereof with the teeth 23 (FIG. 2) of the differential actuators. During input cycles, this engagement is effectuated only during the time the differential actuators are undergoing their leftward, return-to-home movement. During grand total output cycles, this engagement is effectuated only during the rightward movement of the actuators and during sub-total output cycles it is effectuated during both the rightward and leftward actuator excursion.

The accumulator itself (best illustrated in FIG. 8) comprises a laterally shiftable frame member 32 and a vertically shiftable frame member 30. Frame 32 is supported in the frame 30 and is laterally slidable with respect thereto, shaft 34 being journaled in the holes 36 and shaft 40 running through holes 38 of side plates 130.

The accumulator digit wheels are rotatably supported on shaft 34 and are grouped in complementary pairs 42 and 44. There are six pairs of wheels and, accordingly, the accumulator has a six digit capacity. Each pair of wheel's is geared together by a face gear 46 in a complementary fashion such that when a zero is stored in one wheel, the other wheel is in the nine position. The six wheels 42 constitute the plus accumulator wheels and the six wheels 44 constitute the minus wheels.

The plus-minus selection control mechanism (shown primarily in FIGS. 5, 7 and 10) operates to shift accumulator frame 32 to position either the plus or minus digit wheels in alignment with the differential actuators 20 to enable proper input of positive and negative numbers into the accumulator and to permit proper readout of positive and negative totals from the accumulator. At the beginning of each input cycle, control member 65, positionable by the plus and minus control keys 12, operate under the influence of cam follower 69 to shift frame 32 so that the set of digit wheels corresponding to the sign of the input number is in alignment with the actuators 20. At the end of each input cycle, control member 67 operates under the influence of follower 69 to shift frame 32 so that the set of wheels corresponding to the sign of the total stored in the accumulator is in alignment with the actuators. Of course, if the frame 32 is already in the proper position, no shifting occurs. The frame 32 stays in this lateral position so that a total can be taken on the next cycle without further shifting of frame.

Member 67 is positioned by mechanism which operates in response to an "end-around" carry. An end-around carry signifies that the sign of the stored total has changed and is generated during each input cycle when the high-order digit wheel rotates from nine to zero. This event is indicated during the carry transfer portion of the cycle by rotation of cam 50 through 90°. Cam 50 operates a kicker foot 52 which in turn causes the position of member 67 to be reversed.

Carries are transferred by the mechanism housed in vertical shifting frame 30 (FIGS. 8 and 9). A shaft 48 journaled between side plates 120 rotatably supports a pair of trip and transfer wheels 43 and 45, respectively, for each complementary pair of digit wheels. Each trip wheel 43 is set by the wide tooth of its associated digit wheel when the latter rotates from nine to zero: Each trip wheel is connected to the transfer wheel of the next higher order position and sets a tooth of the transfer wheel into the path of the teeth on a transfer drive wheel 47. During the latter portion of each machine cycle, after the digit wheels are disengaged from the differential actuators, a rack 51 is reciprocated, rotating shaft 41 and the drive wheels 47. This adds the set-up carries into the accumulator. End-around carries are set up by the trip wheel 43' of the high-order digit position (far right in FIG. 9) and are added into the low order position by the transfer wheel 45' and drive wheel 47' associated therewith.

DETAILED DESCRIPTION

Differential actuators

The differential actuators 20 are shown in FIG. 2. There is an actuator for each of the six keybanks in the machine plus a seventh one (used only for read-out purposes) for the high-order digit position of the accumulator. Each actuator comprises a pair of relatively slidable sections 21, the primary section, and 22, the secondary section. The primary section has a pair of lower rack teeth 23 for engaging and rotating a digit wheel of the accumulator. The primary and secondary sections are slidably connected by means of a bent-over tab 25 on the end of the secondary section which engages a slot in the primary section. Both sections have a set of rack teeth 26 whereby a locking pinion 24 can engage both sections and lock them together. The secondary section has a set of upper rack teeth 27 for rotating a pinion (not shown) associated with display wheel 14.

Primary section 21 has four stop lugs on its upper edge. The first (left) of these lugs coacts with zero stop 33 to hold the primary section in the home (zero) position between machine cycles. The other three lugs coact in a conventional manner with the stems of the digit keys 1-9 to allow the primary section to undergo an amount of movement during the initial portion of the machine cycle proportional to the digit keyed in. A tension spring 35 connected to the primary section at one end and to the machine frame at the other end provides the driving power to move the primary section to the right.

A cam 28 on the main cam shaft 100 cooperates with a follower arm 29 and spring 31 to permit the primary and secondary sections to operate in the proper input sequence. A bail 37 extends the full width of the keyboard and passes through a slot 55 in the secondary section of each actuator. Bail 37 is connected to follower 29. During an input cycle the differential actuators operate as follows.

At the very beginning of the machine cycle a cam driven link 39 pivots locking pinion 24 out of engagement with the rack teeth 26. One of the digit keys having been depressed, zero stop 33 has been cammed (by a control slide—not shown) upwardly out of engagement with its stop lug. At the time of key depression, however, no movement of the primary section occurs since its right hand end abuts bail 37 and is thus held stationary. As soon as pinion 24 is pivoted out of the way, cam 28 and spring 31 rock follower 29 to the right whereby bail 37 also moves rightwardly.

The rightward travel of bail 37 drives against the ends of the slots 55 in secondary sections 22 and drives them to the right in a positive manner. This movement resets all display wheels 14 back to zero. Also, rightward movement of bail 37 permits the springs 35 to pull their respective primary sections 21 to the right until a stop lug on each engages the stem of the depressed digit key in the associated keybank. Of course, if no digit key is depressed in

a keybank, the primary section 21 of the associated actuator is held by stop 33 and does not move to the right.

When bail 37 has moved its full rightward distance, there is a period of dwell during which locking pinion 24 is pivoted into engagement with rack teeth 26. Thereafter, follower 29 is rocked to the left driving bail 37 to its home position. During this excursion, the bail engages the end of each primary section and drives each section back to its home position where it is latched up by its zero stop 33. The amount of leftward movement of each actuator thus is proportional to the amount signified by the depressed digit key and each display wheel 14 is likewise rotated by an amount proportional to the digit, enabling display of the input number. As will be explained subsequently, the accumulator 18 is held in an upper position during the leftward movement of the actuators so that primary rack teeth 23 impart the proportional digit movement to each digit wheel of the accumulator.

The mechanism for "motorizing" each control key 12 whereby depression of one of these keys initiates a machine cycle is shown in FIG. 4. Depression of any of the keys 12 causes a spring biased control slide 82 to be cammed to the left. This pivots a bell crank 84 counterclockwise whereby a pivot arm 86 having a slot 88 in one end is pivoted clockwise. A key restore bail 90 pivotable about pin 90a carries a pin 91 engaging the slot 88. When arm 86 rocks clockwise in response to the leftward movement of slide 82, pin 91 enters the elongated portion of slot, permitting bail 90 to be pivoted counterclockwise under the influence of tension spring 94 acting on connecting arm 92. The arm 92, in moving to the right, switches on the machine motor 96 and throws a two-revolution clutch 98 into engagement. The output from clutch 98 drives the main cam shaft 100 through a single revolution, the clutch to cam shaft gear ratio being 1:2. At the end of the single revolution of the cam shaft, a cam thereon drives arm 92 back to the left, switching motor 96 off and rocking key restore bail 90 clockwise whereby the upper portion thereof is rocked against the key hold-down detent slide (not shown) in each keybank to restore the keys.

Accumulator

The plus-minus accumulator is hereinafter described in detail with reference to FIGS. 5, 8, 9 and 10.

As shown in FIG. 8, the accumulator assembly 18 comprises two main portions, a vertically shiftable frame 30 and a laterally shiftable frame 32 which is supported in the frame 30. The frame 30 comprises a pair of sideplates 120 rigidly spaced apart from one another by support shafts 40, 122 and 124. Journaled for rotation in sideplates 120 are shafts 48 and 41. The former of these shafts carries trip and transfer wheels 43 and 45. Shaft 41 supports a plurality of carry transfer drive wheels 47. These latter wheels cooperate, as described subsequently, with carry transfer wheels 45 during a latter portion of the machine cycle to culminate the carry transfer operation.

Ears 121 extend from sideplates 120 to enable the frame 30 to shift vertically in a pair of slots provided in sidewalls 108 (FIG. 10) fixed to the machine frame. Actually, the shaft direction of frame 30 is at a slight angle (see FIG. 2) to the vertical, but to simplify illustration and description, the detailed drawings herein illustrate the accumulator assembly as though it were normally positioned in a straight up and down fashion.

Lateral shifting frame 32 comprises a pair of sideplates 130 rigidly spaced apart by a bar 136 and a pair of shafts 132 and 134. Frame 32 supports the accumulator digit wheels on a shaft 34 journaled in sideplates 130. Each pair of digit wheels (constituting one digit position) includes two ten-tooth digit wheels, a plus wheel 42 and a minus wheel 44, interconnected by a face gear 46. The wheels 42 and 44 of each digit position are interconnected via gear 46 in a 9's complement fashion, i.e., when one of the wheels is set to store a zero the other wheel stores a 9, etc.

One of the wheels of each digit position is placed into engagement with the teeth 23 of the associated differential actuator when the frame 30 is shifted upwardly by the engaging mechanism, described subsequently, to enable entry and readout of numbers into and out of the accumulator.

Also supported in frame 32, suspended from a plate 138 extending from the left-hand sideplate 130 (FIG. 8), is the end-around carry pivot foot 52. The foot 52 shifts laterally with frame 32 and has a tail 54 which cooperates with the wide cam 50 on shaft 48 of frame 30. As shown in FIGS. 9 and 10, frame 32 has two positions with respect to frame 30, a right position (as referenced to the view of FIG. 10) wherein the plus wheel 42 of each digit position is aligned with the actuators 20 and a left position wherein the minus wheel 44 of each digit position is in alignment with the actuators 20.

Accumulator engaging mechanism

The accumulator engaging mechanism is best shown in FIGS. 5, 6 and 9. This mechanism is positioned below the accumulator 18 and acts against a pair of adjustable lugs 81 connected to the side-plates 120 to shift the accumulator upwardly so that the digit wheels thereof engage the differential actuators. The plan view of FIG. 6 shows the engaging control mechanism by itself. The mechanism comprises a pair of shiftable support rails 102 each pivotally connected by a pair of pins 103 to a pair of hinge plates 104. Each hinge plate is pivotally connected by a pin 105 (FIG. 5) to a stationary support member 106 affixed to a machine sidewall 108. A rod 107 joins the lower corners of the rear hinge plates 104 and a rod 109 joins the lower corners of the forward hinge plates 104. A connecting plate 108 joins the rods 107 and 109.

A slide member 111 is adapted to reciprocate horizontally on a pair of support brackets 113 (FIG. 9). Member 111 is connected to rod 107 and carries a pivotable camming plate 115 which is acted upon by one or the other or both of a pair of cam followers 110 and 112. Followers 110 and 112 are driven by a pair of main cam shaft cams 114 and 116, respectively, and springs 126 (FIG. 5). Whenever slide member 111 is driven to the right (FIG. 5) by one of the cam followers acting on tail 117 of plate 115, the hinge plates 104 pivot counterclockwise about their pins 105, lifting the support rails 102 upwardly. This shifts the accumulator 18 upwardly to engage the digit wheels thereof with the differential actuators 20.

As previously mentioned, there are three different modes of accumulator engaging operation. The first mode is the input mode wherein the digit wheels are engaged with the differential actuators only during the portion of the cycle when the actuators are moving to the left (FIG. 2) back to their home positions. The second mode of operation is the subtotal mode wherein the digit wheels are engaged with the differential actuators during both the rightward and leftward movement thereof. The third mode is the grand total mode wherein the digit wheels are engaged with the differential actuators only during the initial portion of the machine cycle when the actuators are moving to the right. The proper one of these three modes of operation is selected by adjusting the position of camming plate 115 (FIG. 6) under control of the control keys 12 through a series of linkages including a rod 119, bell crank 123 and total shaft 125.

Referring to FIG. 3, the total shaft 125 is operated to one of three selectable angular positions by a sector gear 127 cooperating with an actuator 129 which is controlled by a slide 131 mounted to cooperate with the studs of the total and subtotal keys of control keybank 12. When none of the control keys or a control key other than a subtotal or total key is depressed, slide 131 is spring biased to its far right-hand position and sector 127 and shaft 125 are maintained in a first angular position

corresponding to the input mode of operation of the accumulator engaging mechanism. In this angular position of shaft 125, rod 119 adjusts camming plate 115 (FIG. 6) so that it is held against stop 111a whereby the tail 117 coacts only with cam follower 110. This cam follower is rocked clockwise (FIG. 5) by cam 114 only during the portion of the machine cycle when the differential actuators are being driven to the left back to their home positions. Thus, when the total shaft 125 is in its first angular position the accumulator digit wheels are engaged with the differential actuators in accordance with the input mode of operation, permitting numerical data from the amount keys 10 to be entered into the accumulator.

When the subtotal control key 12 is depressed, its key stud cams against the cam lug 131c of control slide 131 (FIG. 3) and causes the latter to slide one increment in a leftward direction. This positions total shaft 125 in its second angular position whereby camming plate 115 (FIG. 6) is moved by rod 119 to a central position whereby tail 117 coacts with both cam followers 110 and 112. Follower 112 is rocked clockwise by its cam 116 during the initial portion of the machine cycle when the differential actuators are being driven to the right. Thus, during the subtotal mode of operation the followers 110 and 112 drive the accumulator engaging mechanism so that the accumulator digit wheels are engaged with the differential actuators during both directions of movement thereof, enabling readout, on a subtotal basis, of the total stored in the accumulator.

When one of the total control keys 12 is depressed, the key stud thereof coacts with a cam lug 131a or 131b whereby control slide 131 is cammed two increments in a leftward direction (the camming surfaces of lugs 131a and 131b are slightly more inclined than that of lug 131c). This places total shaft 125 in its third angular position whereby (FIG. 6) camming plate 115 is pivoted all the way to the right against stop 111b to permit tail 117 to coact only with follower 112. Thus, the accumulator digit wheels are lifted into engagement with the differential actuators only during the rightward movement of the latter, enabling readout, on a grand total basis, of the stored total.

Plus-minus selection mechanism

As previously described generally, the plus-minus selection mechanism operates in two different instances to laterally shift the accumulator frame 32 to align either the plus or minus digit wheels with the differential actuators. In the first instance this is done under control of the plus and minus keys of control keybank 12 to enable the entry of an amount set up on amount keys 10 into the proper side of the accumulator. In the second instance, the plus-minus selection mechanism operates to shift the frame 32 at the end of every machine cycle to align with differential actuators that set of digit wheels which corresponds to the sign of the total stored in the accumulator.

The plus-minus selection mechanism is best illustrated in FIGS. 5, 7 and 10. As shown in FIG. 10, the basic mechanism for shifting frame 32 to align either the plus or minus wheels with the differential actuator includes a pivot arm 62 pivotable about a pin 61 and positionable by means of a pair of control links 66 and 68 to either a right position, wherein the plus digit wheels are aligned with the actuators 20, or to a left position wherein the minus digit wheels are aligned with the actuators. The mechanism for shifting arm 62 between its right and left positions includes a cam follower arm 69 having a pair of pivotable control arms 65 and 67 mounted on it. Control arm 65 is positioned under control of the keys of control keybank 12 and operates to cause arm 62 to properly position frame 32 at the beginning of each input cycle to align the digit wheels in accordance with the sign of the depressed control key.

The mechanism for accomplishing this control is shown in FIG. 7 and includes a control slide 75 cooperating with the key studs of the plus and minus keys of control keybank 12. Slide 75 has a camming lug for each plus and minus key. No lugs are provided for the total and subtotal keys and thus depression of these keys has no effect on the mechanism. The camming lugs cooperating with plus keys have a greater incline than that of the lugs cooperating with the minus keys. Slide 75 is normally biased to the left in a home position and movement of the slide is communicated to control arm 65 via a bell crank 77 and rod 79.

Control arm 67 is positioned by a "memory" unit comprising a slotted pivot member 78 (FIG. 10) which is connected to a bistable pivot member 72 by connecting link 76. Member 72 is pivotable about pin 61 independently of arm 62 and has a pair of ears 73 and 74 which cooperate with end-around carry kicker foot 52. Each time the kicker foot operates it contacts one of the ears 73 or 74 and reverses the position of control arm 67.

Cam follower 69 begins each machine cycle in the position shown in FIG. 10. As shown in FIG. 7, a cam 57 on main cam shaft 100 operates during the machine cycle to cause follower 69 to rock first clockwise under the influence of spring 70 at the very beginning of the cycle and then counterclockwise back to its initial position at the very end of the cycle.

Referring to FIG. 10, operation of the plus-minus selection mechanism is as follows. Assume that the accumulator is storing a plus total. When a plus control key is depressed to initiate a machine cycle, control slide 75 is cammed upwardly (in the sense of FIG. 10) through a long increment, pivoting bell crank 77 clockwise and pivoting control arm 65 to its right-most position. Next, cam follower 69 begins its excursion in an upward direction and drives arm 65 against shoulder 66a of link 66 whereby pivot arm 62 is shifted into its right position (if it is not already in that position) and the plus wheels of the accumulator are aligned with the differential actuators.

After the number has been added into the accumulator by the actuators and the machine cycle is nearing its termination, follower 69 is driven back to its home position and (assuming the true total stored in the accumulator is still positive) control arm 67, being in its left position, does not contact shoulder 66b and thus pivot arm 62 does not shift and the accumulator remains in the plus position.

When a minus control key is depressed to initiate a machine cycle, control slide 75 moves through a short increment, pivoting bell crank 77 through a small clockwise angle to move control arm 65 from its home (far-left) position to the position shown in FIG. 10. When follower 69 begins its upward excursion, the left edge of arm 65 engages shoulder 68a on link 68 and pivot arm 62 is driven to its left position whereby the minus digit wheels are aligned with the differential actuators. At the end of the machine cycle, if the sign of the total stored in the accumulator has not changed and is thus still positive, followed 69, in moving back to its home position, drives arm 67 against shoulder 68b and thus pivots arm 62 back to its right position whereby the accumulator frame 32 is shifted back to the plus position. The accumulator remains in this position until the next machine cycle requiring entry of a negative amount.

If, however, during a negative input operation, the sign of the total stored in the accumulator changes from plus to minus, an end-around carry is generated and the toe 56 of kicker foot 52 engages ear 74 on bistable member 72, pivoting that member and member 78 clockwise. This shifts arm 67 to its right position. Thus, when follower 69 moves back to its home position at the end of the machine cycle, arm 67 does not engage shoulder 68b and thus accumulator frame 32 is allowed to remain in the negative position. Arm 67 stays in its right position

until the next end-around carry is generated. Until that happens, the accumulator is shifted back to its minus position at the end of each machine cycle regardless of the position to which it was moved during the initial portion of the cycle. When the next end-around carry occurs, arm 67 is pivoted back to its left position and therefore frame 32 is driven to the plus side at the end of each machine cycle.

When any total or subtotal key is depressed to initiate a machine cycle, control slide 75 remains in its home position under the bias of spring 71 (FIG. 7) and thus control member 65 remains in its far left position. In this position, the central slot in member 65 is aligned with the downwardly turned shoulder 68a on link 68 (FIG. 10) and thus when follower 69 undergoes its regular excursion, member 65 contacts neither shoulder 68a nor shoulder 66a and frame 32 is not shifted. Of course no shifting is required of the frame 32 at this time since the accumulator is already positioned, as per the operation just described, to the correct side for readout out of the true total.

Carry transfer mechanism

The carry transfer mechanism of the accumulator is best illustrated in FIGS. 9 and 11. As shown in FIG. 9, shaft 48 supported between sideplates 120 of vertical shifting frame 30 supports a plurality of pairs of four-tooth trip and transfer wheels 43 and 45. There is one pair of trip and transfer wheels associated with each digit wheel which is aligned with a differential actuator 20. The trip wheel 43 of each set is positioned to cooperate only with the wide tooth of the associated digit wheel. Each transfer wheel 45 is positioned so that its teeth coast with the regular teeth of the associated digit wheel.

Each trip wheel 43 is rigidly connected to rotate with the transfer wheel associated with the next higher order digit position. For example, the trip wheel 43' associated with plus digit wheel 42' is connected by a sleeve 53 to rotate with the transfer wheel 45 associated with the adjacent higher order digit wheel. The assembly consisting of trip wheel 43', sleeve 53 and transfer wheel 45 is freely rotatable about shaft 48. The same is true of the four other similar assemblies. The trip wheel 43'' associated with the highest order digit is pinned to shaft 48 as is the transfer wheel 45'' associated with the low order digit wheel. This is the means by which end-around carries are transferred out of the high order digit position and into the low order digit position.

Shaft 41, journaled in sideplates 120 below the shaft 48, supports a plurality of transfer drive wheels 47. There is one wheel 47 aligned with each transfer wheel 45. The teeth on the wheels 47 are spaced so as to transfer carries serially. A pinion 49 on shaft 41 cooperates with a vertically fixed, horizontally reciprocable rack 51 when the frame 30 is in its down position. Rack 51 is cam driven at an appropriate time near the end of the machine cycle to drive the wheels 47 through one revolution in a clockwise direction (FIG. 11) to transfer the carries which were set up during the preceding portion of the machine cycle. After the carry transfer operation has been completed, rack 51 rotates the wheels 47 in a reverse direction back to their home positions.

Referring to FIG. 11, operation of the end-around carry transfer mechanism is as follows. During the add-in portion of an input cycle, the digit wheels 42 are in engagement with the teeth on the differential actuators. The actuators are traveling to the right, as previously described, to impart an amount of clockwise rotation to the digit wheels 42 which is proportional to the keyed-in digits. When the wide tooth 42a is rotated past the tooth 43a'' of the associated trip wheel 43'', it causes the trip wheel to rotate approximately twelve degrees counterclockwise. This indicates that the digit wheel 42 has rotated from the 9 position to the 0 position during the input operation and sets up an end-around carry.

Since trip wheel 43" is pinned to shaft 48 as is the transfer wheel 45" associated with the low order digit wheel, the transfer wheel 45" is also rotated 10 degrees counterclockwise and the tooth 45a" thereof is interjected into the path of the teeth of the transfer drive wheel 47" (FIG. 9). When the drive wheel 47" is rotated clockwise during the later portion of the machine cycle when the transfer drive rack 51 is actuated, transfer wheel 45" is driven 78 degrees counterclockwise and a tooth thereon imparts a single tooth increment of clockwise rotation to the low-order digit wheel, adding the carry digit thereinto.

It should be understood that a carry can also be set up during the carry transfer operation when the addition of a carry into a digit wheel causes that wheel to rotate from 9 to 0. This is the reason for the serial transfer operation.

The operation just described is for an end-around carry. It is to be understood that intermediate carries are transferred in the same manner. The only difference is that each trip wheel 43 rotates the adjacent transfer wheel 45 through a connecting sleeve 53, rather than through the shaft 48. On readout cycles, the tops of the teeth on trip wheels 43 serve as stops to arrest the reverse rotation of the digit wheels in the zero position.

Operation

Since the above description has set forth the operation of each of the individual subassemblies of the machine, only a brief summary of four exemplary machine cycles is hereinafter provided to tie together the operational descriptions given above. To enter a positive number into the accumulator the operator sets up the number on amount keys 10 and then depresses one of the plus control keys 12 to trigger a positive input machine cycle. This turns on motor 96 (FIG. 4), engages clutch 98 and initiates rotation of the main cam shaft 100. It also causes control slide 75 (FIG. 10) to pivot control arm 65 to its far right position whereby the initial movement of follower 69 positions accumulator frame 32 to the right, aligning the plus digit wheels with the differential actuators 20.

Thereafter, locking pinion 24 (FIG. 2) is pivoted downwardly and cam follower arm 29 begins its clockwise movement, drawing bail 37 to the right to cause the secondary actuator sections 22 to reset display wheels 14 and to cause the primary actuator sections 21 to scan their respective keybanks to detect the position of the amount key therein which has been depressed. When the rightward excursion of follower 29 stops, slide member 111 of the engaging mechanism (FIG. 5) is cammed to the right whereby the accumulator is shifted upwardly to engage the plus digit wheels with the differential actuators. Also at this time, locking pinion 24 (FIG. 2) is pivoted into engagement with the teeth 26 on the primary and secondary actuator sections.

Next, follower 29 pivots to the left, driving bail 37 against the ends of the primary sections 21 whereby the differential actuators, the primary and secondary sections thereof being integrally connected by the locking pinion 24, are driven back to their home positions. This sets up the display wheels to display the input number and adds the number into the accumulator. After the actuators reach home, slide 111 (FIG. 5) moves to the left, disengaging the digit wheels from the actuators and engaging carry drive pinion 49 with transfer drive rack 51. Thereafter, the rack 51 operates to transfer any carries which may have been set up. Following this, cam follower 69 (FIG. 10) returns home and positions the accumulator to the side reflecting the sign of the stored total. Finally, link 92 (FIG. 4) is driven to the left, disengaging clutch 98, turning motor 96 off and pivoting bail 90 to restore the keyboard.

To enter a negative amount into the accumulator, the operator sets the amount into the amount keys 10 and depresses a minus control key 12 to initiate the machine

cycle. This time control slide 75 (FIG. 10) moves control member 65 from its far left home position to the position shown, whereby follower 69, in its initial excursion, shifts frame 32 so that the minus digit wheels are aligned with the differential actuators. The rest of the cycle is the same as described above for a positive input.

To read out the stored total on a subtotal basis, the operator simply depresses the subtotal control key 12. This rotates total shaft 125 (FIG. 6) so that camming plate 115 is pivoted to its central position. Slide 111 (FIG. 5) is thereafter immediately driven to the right to engage the digit wheels with the differential actuators. Also at this time locking pinion 24 is disengaged. The actuators then begin their rightward (as viewed in FIG. 2) movement and the digit wheels rotate in the reverse direction (counterclockwise as viewed in FIG. 11) until the wide tooth on each wheel engages the top of a tooth on the associated trip wheel. This arrests rotation of the respective digit wheels in the zero position and stops the primary section of each differential actuator in a position representing the digit which is stored in the associated digit position of the accumulator. The rightward movement of the actuators also resets the display wheels to zero, as in the input cycle.

After the rightward movement of the actuators stops, locking pinion 24 is pivoted into engagement with the teeth 26 and the subsequent leftward movement of the actuators sets up the stored total on the display wheels 14 and also reads the total back into the digit wheels since the engaging mechanism maintains the accumulator in its upward position due to the action of cam follower 110 on slide 111 (FIG. 6). When the leftward movement of the actuators has terminated, the accumulator is shifted downwardly out of engagement with the actuators and the remaining portion of the cycle is the same as described above.

To read out on a grand total basis, the operator depresses one of the total control keys 12 to initiate the machine cycle. The cycle is exactly the same as described above for subtotal operation except that the engaging mechanism disengages the accumulator wheels from the differential actuators after the rightward (FIG. 2) movement of thereof has terminated. Thus, the accumulator digit wheels remain in their zero positions after readout and the accumulator is reset.

Modified plus-minus selection mechanism

A modified form of plus-minus selection mechanism is shown in FIG. 12. A pivot arm 162 is analogous in function to pivot arm 62 of the previously described embodiment. Movement of arm 162 to the left shifts the accumulator frame 32 to position the plus digit wheels in alignment with the differential actuators and movement of arm 162 to the right aligns the minus wheels with the actuators. Arm 162 is connected to pivot shaft 161 as is paddle member 187. A pivot member 172, analogous in function to pivot member 72 of the previous embodiment, is pivotable about shaft 161 as is pivot arm 185. The latter arm is positionable to any of three different positions by a control slide 175 which cooperates with the plus and minus keys of the control keybank. Control slide 175 is the same as slide 75 of the previous embodiment except that the camming lugs cooperating with the minus keys have a more inclined camming surface than the lugs cooperating with the plus keys.

A drive pin 167 passes through a hole 181 in pivot member 172 and is positioned by that member to engage either point C or point A on paddle 187 when cam 157b drives follower 169b and pin 167 to the right at the end of each machine cycle. A pin 165 passes through slot 183 in member 172 and is positioned by pivot arm 185. Pin 165 is driven to the right by a cam 157a operating through follower 169a at the end of each machine cycle and engages paddle 187 at either point B or point D.

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When one of the plus or minus control keys is depressed, the spring bias acting on control slide 175 pivots arm 185 so that pin 165 is positioned all the way to the right (FIG. 13a) whereby actuation of pin 165 by cam 157a causes the pin to miss paddle 187. When a plus control key is depressed (FIG. 13b), control slide 175 is moved through a short increment whereby arm 185 pivots clockwise to position pin 165 so that when the pin is actuated by cam 157a it engages the right-hand side of paddle 187 at point D. When a minus control key is depressed (FIG. 13c), control slide 175 is moved through a long increment and arm 185 pivots pin 165 all the way to the left so that it is in position to contact the left-hand side of paddle 187 at point B when actuated by the cam.

Operation of modified mechanism

The modified plus-minus selection mechanism operates as follows. At the beginning of the machine cycle, cam 157a rocks follower 169a clockwise to drive pin 165 forward. If no plus or minus control key has been depressed, pin 165 misses paddle 187 and pivot arm 162 remains where it is and the position of accumulator frame 32 is not changed. If a plus control key has been depressed, pin 165 is driven against point B and pivots arm 162 to the right to align the minus wheels of the accumulator with the differential actuators. Pin 165 thus performs the function of control arm 65 of the previous embodiment.

At the end of the machine cycle, follower 169a is rocked back counterclockwise and cam 157b rocks cam follower 169b clockwise to drive pin 167 forward. Since end-around carry cam 150 and kicker foot 152 operate to position pivot member 172 in exactly the same manner that cam 50 and kicker foot 52 position member 72 of the previous embodiment, pin 167 is driven against paddle 187 at either point C or point A, in accordance with the sign of the total stored in the accumulator. This pivots arm 162 accordingly to position the proper set of accumulator wheels in alignment with the differential actuators. Pin 167 is thus analogous in function to arm 67 of the previous embodiment.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

We claim:

1. In an accumulator of the type employing complementary sets of plus and minus digit wheels for storing positive or negative totals, said wheels being mounted in a shiftable frame to enable a common engaging mechanism to move either said plus set or said minus set of wheels into engagement with a common set of differential actuators, the combination comprising:
 - motor driven means for driving said actuators through an accumulation cycle; and
 - shifting means operated by said driving means at the termination of said cycle for shifting said frame to a position enabling said common engaging mechanism to move the set of wheels corresponding to the sign of the total stored therein into engagement with said actuators.
2. The accumulator set forth in claim 1 wherein said shifting means comprises:
 - means operable during said cycle for indicating a change in the polarity of the total stored in said digit wheels;
 - a bistable mechanism selectively positionable to either of two positions, said mechanism, when in a first of said positions, causing said driving means to shift said frame at the termination of said cycle to enable said engaging mechanism to move said plus digit wheels into engagement with said actuators, and when in the second of said positions, causing said driving means to shift said frame at the termination

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of said cycle to enable said engaging mechanism to move said minus digit wheels into engagement with said actuators; and

means operable in response to said change of polarity indication for reversing the position of said bistable mechanism.

3. In an accumulator of the type employing complementary sets of plus and minus digit wheels for storing positive or negative totals, said two sets of wheels being selectively alignable with a common set of differential actuators, the combination comprising:

motor driven means for driving said actuators through an accumulation cycle; and

shifting means operated by said driving means at the termination of said cycle for shifting into alignment with said actuators the set of said wheels corresponding to the sign of the total stored therein.

4. The accumulator set forth in claim 3 wherein said shifting means comprises:

means operable during said cycle for indicating a change in the polarity of the total stored in said digit means;

a bistable mechanism selectively positionable to either of two positions, said mechanism, when in a first of said positions, causing said driving means to align said plus digit wheels with said actuators at the termination of said cycle and, when in the second of said positions, causing said driving means to align said minus digit wheels with said actuators at the termination of said cycle; and

means operable in response to said change of polarity indication for reversing the position of said bistable mechanism.

5. The accumulator set forth in claim 4 wherein:

said change of polarity indicating means comprises a camming element movable in response to the transfer of a carry out of the high-order digit wheels; and said means for reversing the position of said bistable mechanism comprises a pivot foot operated by said camming element, said pivot foot being shiftable with said digit wheels such that said foot generates either a first or a second control movement, depending on which set of digit wheels are aligned with said actuators at the time of said high-order carry transfer.

6. The accumulator set forth in claim 5 wherein:

said driving means comprises a plurality of cams mounted on a common drive shaft;

said shifting means further comprises a pivotable operator pivotable in a first direction to align a first set of said digit wheels with said actuators and pivotable in a second direction to align said second set of digit wheels with said actuators; and

said bistable mechanism comprises a first follower arm operated on by a first one of said cams for movement at the termination of said cycle, a first lever arm mounted on said first follower arm and detentably positionable to either of two positions for operation on said pivotable operator in response to said first follower arm movement, and a first control link pivotable in a first direction in response to said first control movement of said pivot foot to locate said first lever arm in said first position and pivotable in a second direction in response to said second control movement of said pivot foot to locate said first lever arm in said second position, whereby said first follower arm movement causes rotation of said pivotable operator in either its first or second direction.

7. The accumulator set forth in claim 6, further comprising:

a manually depressible plus key and a manually depressible minus key, each of said keys being adapted upon depression to trigger operation of said driving means;

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a second follower arm operated by a second one of said
cams for movement during the beginning of said
cycle;
a second lever arm mounted on said second follower
arm and positionable to either of two positions for
operation on said pivotable operator in response to
said second follower arm movement, said second le-
ver arm, when in the first of said two positions, caus-
ing rotation of said pivotable operator in its first di-
rection and when in said second of said positions
causing rotation of said pivotable operator in said
second direction; and
second control linkage means operated by said plus key
when the latter is depressed to position said second
lever arm in said first position and operated by said

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minus key when it is depressed to position said sec-
ond lever arm in said second position.

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STEPHEN J. TOMSKY, *Primary Examiner.*