Nov. 16, 1954 E. E. REYNOLDS 2,694,524

TENS-CARRY MECHANISM FOR CALCULATING MACHINES

Filed Dec. 20, 1952 5 Sheets-Sheet 1

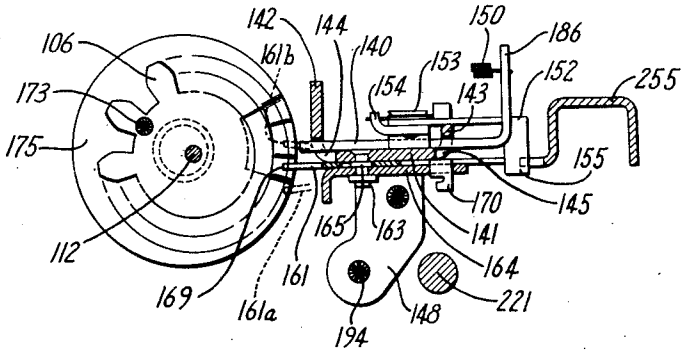


FIG_1_

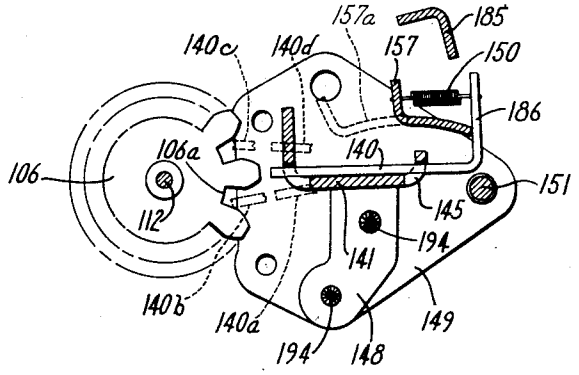


FIG_2_

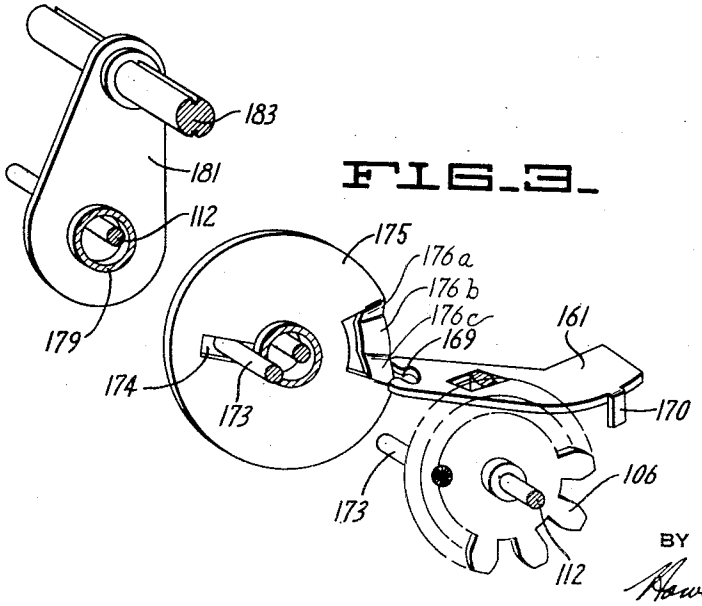


FIG_3_

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TENS-CARRY MECHANISM FOR CALCULATING MACHINES

Filed Dec. 20, 1952 5 Sheets-Sheet 2

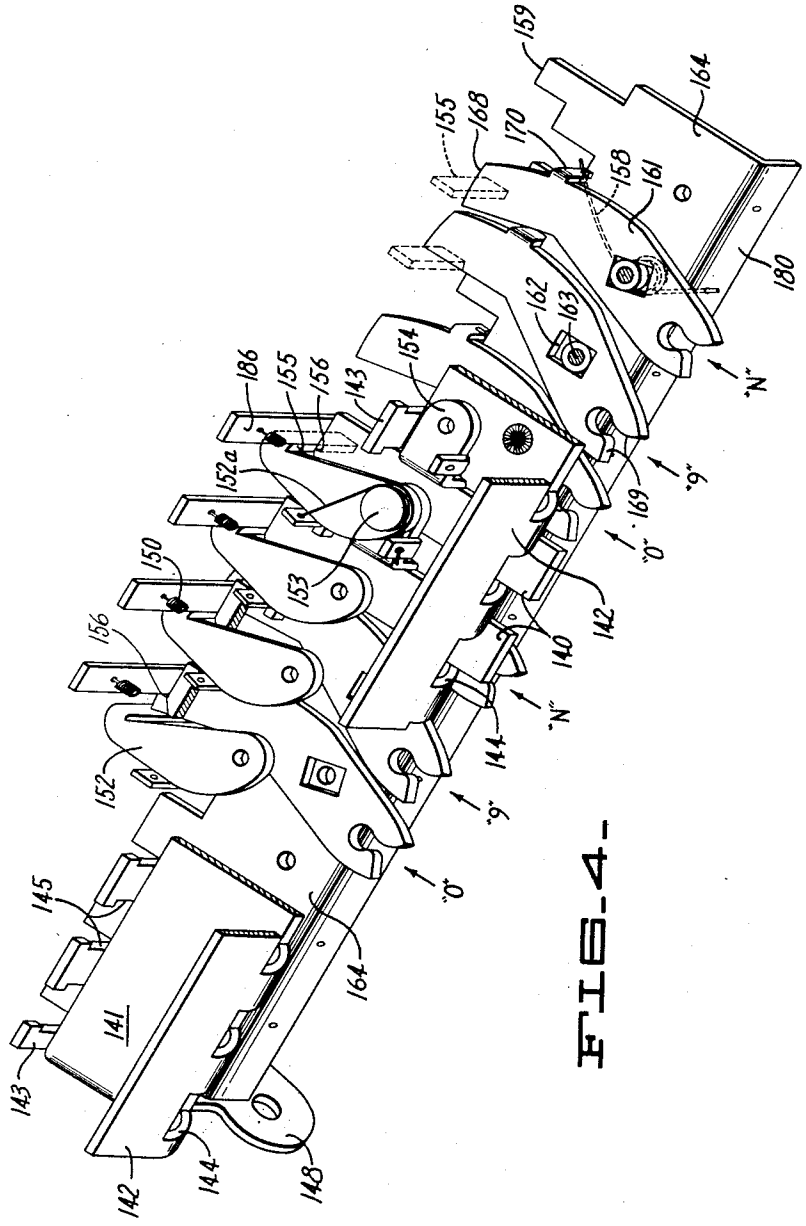


FIG-4-

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TENS-CARRY MECHANISM FOR CALCULATING MACHINES

Filed Dec. 20, 1952 5 Sheets-Sheet 3

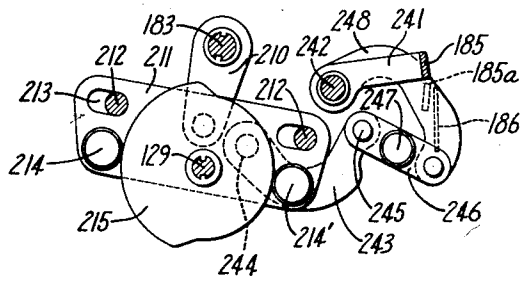


FIG. 5.

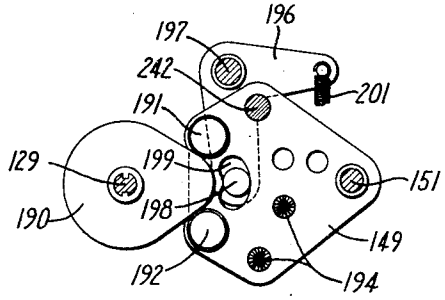


FIG. 6.

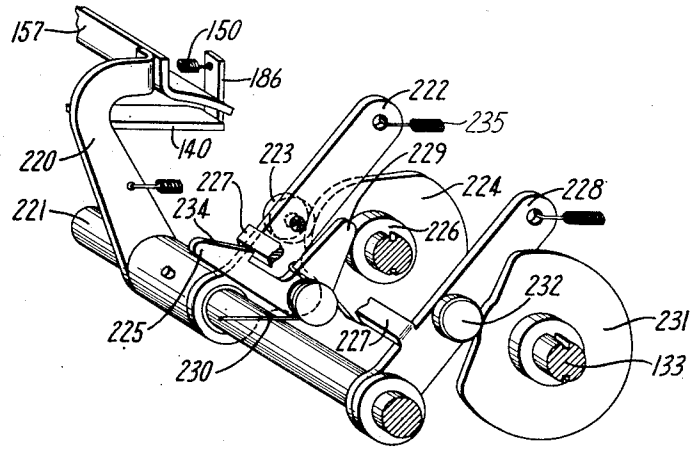


FIG. 7.

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TENS-CARRY MECHANISM FOR CALCULATING MACHINES

Filed Dec. 20, 1952 5 Sheets-Sheet 4

FIG. 8.

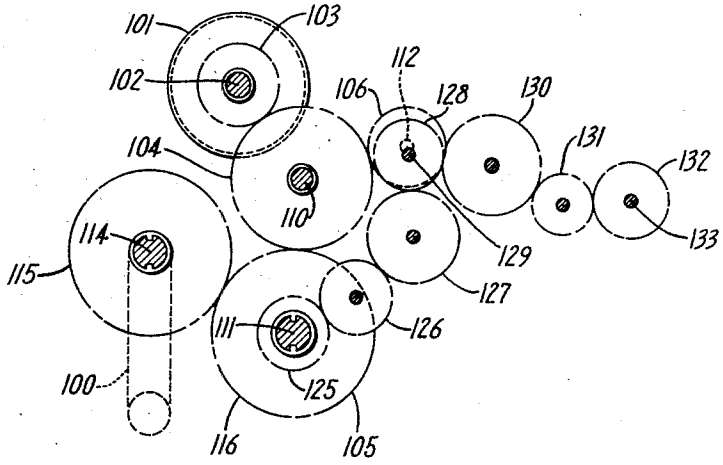
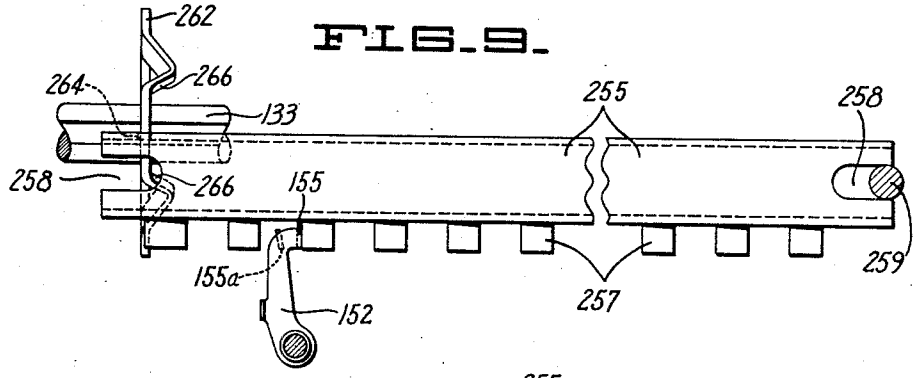


FIG. 9.



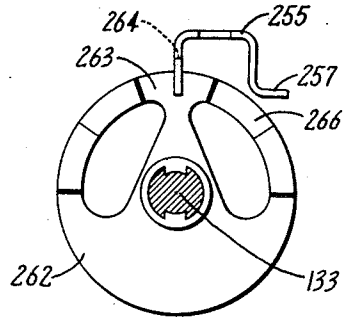


FIG. 10.

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TENS-CARRY MECHANISM FOR CALCULATING MACHINES

Filed Dec. 20, 1952 5 Sheets-Sheet 5

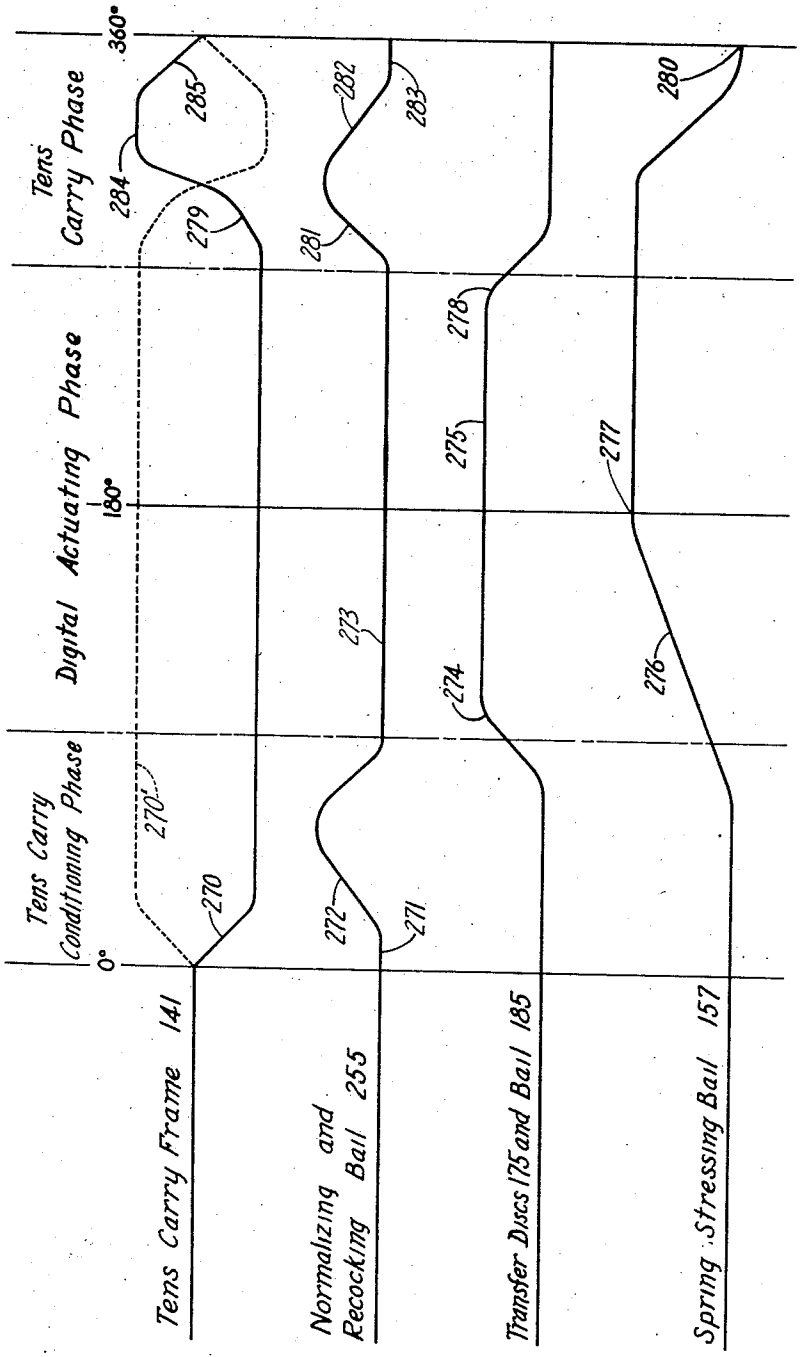


FIG. 11.

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United States Patent Office

2,694,524

Patented Nov. 16, 1954

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TENS-CARRY MECHANISM FOR CALCULATING MACHINES

Eugene E. Reynolds, Richmond, Calif., assignor to Marchant Calculators, Incorporated, a corporation of California

Application December 20, 1952, Serial No. 327,104

10 Claims. (Cl. 235—137)

The present invention relates to tens-carry mechanisms for the registers of calculating machines and particularly concerns means for causing tens-carry operations to occur simultaneously in all orders of an accumulator register.

The present invention is applicable to calculating machines in which the digital actuators and the tens-carry actuators transmit what is generally known as an intermittent drive to the numeral wheels. In such machines the digital actuators drive their aligned numeral wheels by selected amounts, and when a numeral wheel is advanced to or past a registration of zero during additive actuation, or a registration of nine during subtractive actuation, the tens-carry mechanism is conditioned to cause a single digital movement of the adjacent higher order numeral wheel. A tens-carry operation resulting from the passage of a numeral wheel through "0" or "9" as described above is referred to hereinafter as a "primary" carry to distinguish it from a "chain" carry. The latter occurs when a series of adjacent numeral wheels stand at registrations of "9," and "1" is added to the lowest order numeral wheel of the series whereupon the chain of nines are changed to zeros. A chain carry also occurs when a series of adjacent numeral wheels stand at "0" and a "1" is subtracted from the lowest order thereof, thus changing the zeros to nines.

No particular problem exists in causing primary carry operations to occur simultaneously in two or more orders since the carry mechanism in each order where a primary carry is to occur is conditioned for a carry during the digital actuating phase and before the tens-carry operation occurs. The same is not true however, in chain carry operations where the carry through each successive higher order depends upon a carry first occurring in its preceding lower order. It has therefore been generally expedient to provide "staggered" carry elements which cause a sequential carry through a chain of orders.

Previous attempts to accomplish simultaneous primary and chain carry are exemplified by the following three patents: Patent No. 809,075 issued to Alexander Rechnitzer on June 29, 1901, Patent No. 2,008,355, issued to Gustaf Hellgren on July 16, 1935, and Patent No. 2,376,481, issued to W. S. Gubelmann on May 22, 1945. In both the Rechnitzer and Gubelmann mechanisms the power for causing the chain carry originates in a respective lower order and is transmitted from this lower order through successive higher orders. In such case the inventors were faced with the problems of an inherent lag between the various parts of the chain carry mechanism, and furthermore, were required to overcome loads due to friction, which loads increase exponentially in accordance with the number of orders through which the chain carry must be transmitted.

Hellgren obviated these problems by providing a separate source of power for driving each ordinal tens-carry actuating member, but in so doing created another problem by providing a tens-carry conditioning mechanism which operates sequentially from order to order. Therefore, the time required for the sequential operation of the conditioning mechanism is lost just as if the chain carry mechanism itself operated sequentially.

Another objection to these three above mentioned tens-carry mechanisms is that they are not adaptable for use in connection with high speed rotary actuating mechanisms. Rechnitzer employs an assisted odometer type of tens-carry mechanism which operates sequentially from order to order after the tens-carry phase is completed and

which is inherently slow in operation because the time required for affecting the odometer assisting operation is lost just as though the tens-carry mechanism were of the staggered type. In the case of Gubelmann and Hellgren the tens-carry mechanism is of the type wherein the tens-carry actuator is of the reciprocating rack type which is inherently slow in operation, and with particular reference to Gubelmann, is incapable of effecting subtractive carry movement except by the addition of complements.

The present invention therefore provides a simultaneous tens-carry mechanism by means of which the simultaneous tens-carry movement to the numeral wheels is transmitted individually and directly by each separate ordinal tens-carry actuating mechanism, without the necessity of assisting devices to insure the proper action of the tens-carry mechanism.

A main object of the invention is to provide an improved simultaneous tens-carry mechanism.

Another object is to drive each numeral wheel which partakes of a chain carry movement by means of a power transmitting train individual to that numeral wheel.

Another object is to adjust the tens-carry actuators for positive or negative simultaneous chain carry by a unitary means responsive to the direction of rotation of the digital actuators.

Another object is to achieve each of the foregoing objects in connection with a carculating machine having a reversible drive to the numeral wheels.

Still another object is to store power from the drive means previous to the tens-carry phase, and utilizing this power during the tens-carry phase to independently move each tens-carry actuator into engagement with its respective numeral wheel gear.

Other objects and advantages will become apparent from the following detailed description of the invention in which:

Fig. 1 is an enlarged right side view partly in section, of the tens-carry mechanism.

Fig. 2 is an enlarged right side view showing the various positions a tens-carry slide assumes during a carry operation.

Fig. 3 is an enlarged isometric projection of a tens-carry control disc and associated mechanisms as seen from the right front of the machine.

Fig. 4 is an enlarged isometric projection as seen from the right front of the machine showing the tens-carry conditioning mechanism in various positions assumed previous to a primary carry.

Figs. 5 and 6 are enlarged right side views of respective tens-carry operating cams and related mechanisms.

Fig. 7 is an enlarged isometric projection of the mechanism which stores power for urging the tens-carry slides to active position.

Fig. 8 is a right side view of the digitation and tens-carry drive gearing to the numeral wheels.

Fig. 9 is an enlarged front view of the normalizing mechanism for the tens-carry latches.

Fig. 10 is an enlarged left side view of part of the mechanism shown in Fig. 9.

Fig. 11 is a timing chart showing the sequence of operation of the various tens-carry control mechanisms.

General description

The tens-carry mechanism comprises a series of ordinal tens-carry slides each of which is permanently associated with a respective numeral wheel. The slides are mounted on a common supporting member, and are normally locked in a retracted position on the member, in which position they are ineffective to cause a tens-carry operation.

Early in the operating cycle of the machine the supporting member is rocked about a shaft from an initial central position to a first extreme position and remains in this position throughout the digital actuating phase. During this phase, a carry conditioning mechanism controlled by the rotation of the numeral wheels conditions the slides for operation in those orders in which a tens-carry is called for. Then at the end of this phase the tens-carry actuating slides so conditioned are released and upon such release each slide moves into engagement with a drive receiving gear of an associated numeral wheel gear train. The supporting member for the tens-carry slides

is then rocked from the first extreme position to a second extreme position during which the released slides advance the gears and their related numeral wheels one digit. After the carry operation is completed, the slides which were released for the tens-carry operation are retracted to their initial positions on the member, and the latter is then rocked back to its initial central position, thus completing the current operating cycle of the machine.

The mechanism for holding each tens-carry slide in its normally retracted position on the rocking support member includes an interlocking mechanism between adjacent slides so that the locking of the lowest ordinal slide in its retracted position also locks all of the higher order slides in retracted position. A tens-carry conditioning element is associated with each slide and is controlled by the next lower order numeral wheel, to disconnect any tens-carry slide from its adjacent lower order slide, and thereby permit the disconnected slide to move to tens-carry operating position. The disconnection of a slide may, under certain conditions, also permit the adjacent higher order slides to move to tens-carry position and to thereby cause a "chain" carry, as is explained hereinafter.

Accumulator register

The accumulator register comprises a plurality of ordinally arranged numeral wheels **101** (Fig. 8), freely mounted on a transverse shaft **102** and each numeral wheel carries a drive receiving gear **103**. The latter meshes with an idler gear **104**, freely mounted on shaft **110**, and which gear is driven alternatively by a digitation gear **105** or a tens transfer gear **106**, freely mounted on a transverse shaft **112**. The shafts **102**, **110**, and **112** are fixed in the side frames (not shown) of the machine, and the accumulator register is therefore fixed within the framework of the machine. It should be noted, however, that the present invention is not limited to this type of construction but is equaly applicable to a calculating machine having an accumulator register which is shiftable relative to the main body or frame of the machine as will appear hereinafter.

Main drive train

The main drive train comprises a shaft **114** (Fig. 8) which is rotated by a handcrank **100** or by motor power one complete turn in a clockwise direction for a positive digital actuation, or one complete turn in a counterclockwise direction for a subtractive actuation. A gear **115** is carried by the drive shaft **114** and meshes with a gear **116** fixed on a shaft **111** which is the digital actuator drive shaft. A plurality of ordinal digitation drive gears **105**, coaxial with gear **116**, are connected and disconnected from the drive shaft **111** (by clutching means not shown) at selected times in the machine cycle to cause advance of their respective numeral wheels in accordance with selected values. Since the specific form of the digital actuating mechanism plays no part in the present invention, the above description is believed adequate, it being sufficient to point out that the ordinal actuator drive gears **105** are each advanced by selected amounts and each transmits a digital drive through the idler gear **104** to an associated numeral wheel gear **103**.

The main drive mechanism also includes means for rotating various control cams which are associated with the tens-carry mechanism. These cams will be described later, but it may be noted at this point, that shafts **129** and **133** (Fig. 8) upon which the cams are mounted, are driven by the hand crank and shaft **111** as follows: A gear **125** is fixed to the actuator drive shaft **111** and drives through the idler gears **126**, **127** to rotate a gear **128** fixed on a tens-carry drive transmitting shaft **129**. Gear **128** also meshes with an idler gear **130**, which, through an idler **131**, drives a gear **132** fixed to a tens-carry control shaft **133**.

Tens-carry mechanism

The tens-carry mechanism comprises the previously mentioned tens-carry slides which are released in those orders where a tens-carry is to occur and also includes the rocking member, for the slides, referred to hereinafter as a rocking frame. This frame is oscillated once during each machine cycle and is operable with the following mechanism to cause the released slides to advance their respective numeral wheels.

The slides **140** (Figs. 1 and 4) are mounted for sliding movement upon the rocking frame **141** having upturned flanges **142** and **143** which are slotted as at **144** and **145**, respectively, to receive the slides and guide them during their movement relative to the frame. A downwardly projecting ear **148** (Figs. 1 and 2) is formed at either end of the frame, and each ear is fixed to a respective plate **149** (Fig. 2) which is pivotally mounted at **151** to a side plate of the machine for rocking movement of the frame **141** about the pivot **151**.

There is one tens-carry slide **140** for each numeral wheel except the numeral wheel of the lowest order since no tens-carry increments are transmitted to this order, and each slide is permanently associated with its respective numeral wheel. Springs **150** are connected to the slides and to a common bail **157** (Fig. 7) which is rocked counterclockwise to stress the springs before the tens-carry operation is begun, as explained hereinafter, and urge the slides forwardly of the machine; however, the slides normally are each held in the rearwardly retracted position shown by means of a lever **152** (Figs. 1 and 4), referred to hereinafter as a "chain latch." Each latch is freely mounted on a stud **153** carried by an upright extension terminating in a lateral projection **154** of the slide **140**. A downwardly turned ear **155** is formed on each latch and lies behind a shoulder **156** (Fig. 4) of the adjacent lower order slide. A torsion spring **152***a* urges the chain latch in a clockwise direction with the ear **155** being blocked in the position shown by the upturned extension **186** of the adjacent slide **140**. Since there is no slide associated with the "units" order numeral wheel to hold the "tens" order slide in its retracted position, a lug **159** (Fig. 4) is provided on the right rearward end of a plate **164** integral with frame **141**, as explained hereinafter, and which lug lies in front of the ear **155** of the "tens" order chain latch **152** and normally holds the "tens" order slide in retracted position. From the foregoing description it will appear that the slides **140** tend to move to a forward position on frame **141** but normally are held in a retracted position due to the overlapping arrangement provided by the ears **155** of the chain latches and the shoulders **156** of their adjacent lower order slides.

If the chain latches were all that were provided to maintain the tens-carry slides in retracted position, then the release of any slide from its adjacent lower order slide would permit not only that released slide, but also all higher order slides, to move forwardly on the frame. Therefore, a second means is provided which prevents the succeeding adjacent higher order slides **140** from following a released and forwardly moving slide, except during chain carry operations as explained hereinafter. For this purpose a plurality of ordinally spaced levers **161** (Figs. 1 and 4) hereinafter known as blocking members are mounted beneath the frame **141** for limited rocking movement on the enlarged portion **165** (Fig. 1) of rivets **163** which connect a plate **164** to the tens-carry frame **141**. The enlarged portion **165** holds the plate **164** in spaced relationship to frame **141** and provides sufficient clearance to permit each blocking member to rock about its pivot for a purpose explained below. In the initial position of the blocking levers, illustrated by the rightmost lever **161** indicated at "N" in Fig. 4, the rearward end **168** of the blocking lever stands in front of the ear **155** of the adjacent higher slide **140** and prevents forward movement of the same. From the above description it is seen that each tens-carry slide **140** is prevented from moving forward under the urgency of its spring **150** because the ear **155** of its chain latch **152** is blocked from such movement by: (1) the shoulder **156** of the adjacent lower order slide **140** and, (2) the end of blocking lever **161**.

It will be observed that if a blocking lever is rocked clockwise about its pivot **165** from the position indicated at "N" in Fig. 4 to the position indicated at "9" the rearward end **168** of the blocking lever is removed from behind the depending ear **155** on the chain latch **152**. At such time a torsion spring **168**, having one end anchored to a flange **180** of plate **164** and the other end lying within a notch cut in a depending ear **170** of blocking lever **161**, moves the blocking lever rearwardly to the position indicated at "9," this movement being permitted by the pin and slot connection **162—165**. In this position the left rearward side of the blocking lever lies adjacent the next higher order ear **155**, and if the blocking lever is now rocked counterclockwise to the position indicated at "0," the blocking lever, through impingement on ear **155** moves the chain latch **152** counterclockwise about its pivot **153**. In this manner the ear **155** is moved out of engagement with the shoulder **156** of the next lower order tens-carry

slide, thus releasing the higher order slide for forward movement. The succeeding adjacent higher order slide is not released, however, because the blocking lever **161** associated therewith stands in front of the ear **155** of that slide and prevents such movement.

The mechanism for rocking a blocking lever **161** to permit release of a slide as described above includes a transfer disc **175** (Figs. 1 and 3) one each associated with the respective numeral wheels and driven by gear **106** of the numeral wheel gear train by means including a pin **173** fixed to the gear and projecting into a slot **174** in the transfer disc **175**. The latter is fixed on a hub **179** journalled in an ordinal supporting arm **181**, and the inner diameter of hub **179** is larger than the diameter of the supporting shaft **112** for gear **106**, so as to permit relative movement between the hub **179** and the shaft **112**. The hub normally lies in a leftmost position adjacent the shaft **112**, as shown, and in which position the disk **175** lies clear of a bifurcated tip **169** of the blocking lever **161**. Early in each operating cycle, in a tens-carry conditioning phase which precedes the digital actuating phase, the transfer disks **175** are moved toward the right from the position shown in Figs. 1 and 3 to the extent that the disk lies within the bifurcated tip **169**. This condition is maintained throughout the digital actuating phase, and in those cases where a numeral wheel is rotated to a registration of "0" or "9," during plus or minus actuation respectively, the cam surfaces **176***a* and **176***c* deflect the blocking lever **161** and condition the tens-carry mechanism for a subsequent carry. Then, at the end of the digital actuating phase, and before the tens-carry operation is begun, the transfer disks **175** are withdrawn from the bifurcated tips **169** and returned to their initial positions shown, so that relative movement between a disk **175** and the blocking lever **161** during the tens-carry operation will not cause further and improper tripping of the blocking lever **161**.

The movement of the disks **175** relative to the shaft **112** to engage the disks with the tips **169** is controlled as follows. A plurality of ordinally arranged supporting arms **181** (Fig. 3) for the hubs **179** are fixed to a transverse shaft **183** and this shaft is rocked counterclockwise by the main drive mechanism during the tens-carry conditioning phase, referred to above, thereby moving the hubs **179** to a position in which they are concentric with shaft **112**, and bringing disks **175** into engagement with the tips **169**. The pin and slot arrangement **173—174** permits such movement while maintaining a driving connection between the gears **106** and the disks **175**.

The bifurcated tip **169** of the blocking lever **161**, in the initial position shown, straddles the periphery of the disk **175**; however, from an inspection of Fig. 3 it will be noted that the tip **169** has a flared-out opening, and therefore rightward movement of the disk relative to the tip is required before the disk enters the narrowed portion of the bifurcation. Each disk **175** has offset cam surfaces **176***a* and **176***c* with a connecting portion **176***b* between the camming surfaces, and when the numeral wheel stands at "0" the cam surface **176***c* lies opposite the bifurcated tip **169**. When the disks **175** are moved to the right toward their respective bifurcated tips **169** of the blocking levers **161** the camming surface **176***c* would tend to engage the tips; however, at the same time, the tens-carry frame **141** (Fig. 1) is rocked counterclockwise about shaft **151** (during plus operation), and the blocking members **161** move to the dotted line position **161***a*; therefore the rightward movement of the disk with the coincident rocking of the frame **141** brings the bifurcated tip **169** below the cam surface **176***c* without imparting any tripping movement to the blocking lever **161**. This is the condition that prevails at the beginning of a positive digital actuating phase.

When the tens-carry frame **141** is rocked counterclockwise as mentioned above, the tens-carry slides **140** move counterclockwise from the full line position shown in Fig. 2 to the dotted line position **140***a* where each slide lies opposite the tooth space **106***a* on gear **106**. Now, assuming that during the digital actuating phase the numeral wheel **101** (Fig. 8) is rotated in a counterclockwise (plus) direction to its "9" position, the disc **175** (Fig. 3) is correspondingly rotated nine tenths of a revolution in a counterclockwise direction and the leading cam surface **176***a* passes through the bifurcated tip after which the disc comes to rest with the offset connecting portion **176***b* lying in engagement with the bifurcated tip **169** (Fig. 3). This rocks the blocking member **161** from its normal

"N" position (Fig. 4) to the position indicated at "9," at which time the rearward blocking surface **168** of member **161** is moved clockwise about stud **163** from behind the ear **155** on the chain latch, thus releasing the blocking member **161** and permitting the torsion spring **158** to move the blocking member rearwardly from the forward position indicated at "N" to a position indicated at "9" with the left side of the blocking lever lying adjacent the ear **155**. The removal of the blocking lever **161** from behind the ear **155**, however, does not release the adjacent higher order chain latch and its slide **140** for forward movement since the ear **155** on the chain latch **152** is still blocked through its overlapping engagement with the lower order slide **140**. This condition prevails until the above mentioned numeral wheel is rotated from its "9" position to its "0" position whereupon the disc **175** (Fig. 3) is rotated counterclockwise one digital increment to the initial position shown and the trailing cam surface **176***c* moves past the blocking lever **161**, thus permitting the torsion spring **158** (Fig. 4) to move the blocking lever **161** counterclockwise to the "0" position shown in this figure. This movement causes the rearward end of the blocking lever to engage the right side of ear **155** and rock the ear counterclockwise off the shoulder **156** of the adjacent lower order slide **140** at which time the higher order slide is released from restraint of the latch ear **155** and is conditioned for subsequent movement to operative position.

In the foregoing description of primary carry operations the blocking levers **161** were described as standing in the dotted line position **161***a* (Fig. 1) during positive digital actuation of the numeral wheels, and in which position the deflecting cam surfaces **176***a*, and **176***c* on disk **175** were so related to the blocking levers as to condition for a carry when an associated numeral wheel passed from "9" to "0." In performing subtractive digital actuation, however, the blocking levers are moved to the dotted line position **161***b* during the tens-carry conditioning phase and which position is spaced from position **161***a* by an amount equal to approximately one tooth increment of gear **106**. In this condition the bifurcated tip **169** stands opposite surface **176***b* on the deflection disk, and when the disk is moved into engagement with the bifurcated tip the surface **176***b* deflects the blocking lever **161** (Fig. 4) in a clockwise direction about stud **163**. Upon subtractive rotation of a numeral wheel its associated disk **175** is rotated in a clockwise direction (Fig. 3) and during the first movement of the disk corresponding to one subtractive digital increment, the cam surface **175***a* rocks the blocking member in a return counterclockwise direction to condition the next higher order tens-carry mechanism for a "borrow." Thus the conditions for a "borrow" are the reverse of those described for a positive tens-carry, i. e., when the numeral wheel stands at a registration of "0" and the machine is conditioned for minus actuation of the numeral wheels, the surface **176***b* rocks the blocking lever clockwise to the same position it occupied upon a registration of "9" during positive actuation; also when the numeral wheel is rotated in a subtractive clockwise direction from "0" to "9" the deflection cam **175***a* rocks the blocking lever counterclockwise in the same manner as it did when the numeral wheel was advanced from "9" to "0" during positive actuation. The mechanism for causing plus or minus carry operations is described in the next section entitled Tens-Carry Drive.

The foregoing description mentioned that the movement of a blocking lever **161** (Fig. 3) first, in a clockwise direction, and then in a counterclockwise direction under the control of its deflection cam **175** caused release of an associated tens-carry slide **141** to condition the tens-carry mechanism for a positive or negative transfer. Upon such release of a slide **140**, it tends to move forward to engage between the teeth of gear **106**. Such movement is delayed, however, until after digital actuation is completed so as to prevent interference between each slide and its gear **106** during the digital actuation.

The means for delaying the forward movement of any released tens-carry slide comprises a transverse bail **185** (Fig. 2) which stands in the dotted line position **185***a* (Fig. 5) throughout the digital actuating phase, thus blocking the upstanding fingers **186** of the slides **140** from forward movement. Bail **185** is moved to the full line position out of the path of fingers **186** at the end of digital actuation, as explained hereinafter, whereupon any tens-carry slide **140** which was released for a positive carry, for example, moves from the dotted line position **140***a* (Fig. 2) forwardly to the position indicated

at 140*b* into engagement with its associated gear 106. The tens-carry operation is then affected by rocking the frame 141 and its supporting plate 149 clockwise about the pivot 151 to move slide 140 to position 140*c* and advance the gear 106 by one gear tooth, thus advancing its associated numeral wheel one digit. At the end of the tens-carry phase the released slides are retracted from position 140*c* to 140*d* where they are disengaged from their respective gears 106 and are locked in their initial positions by means described hereinafter. Shortly thereafter the frame 141 is rocked counterclockwise and returned to the initial position shown.

The above sequence is reversed during subtractive actuation. During the tens-carry conditioning phase the tens-carry frame 141 is rocked clockwise from its initial central position shown in Fig. 2 to the extent that the tens-carry slide 140 moves to the dotted line position 140*d*. If this slide is released for a "borrow" during digital actuation then during the tens-carry phase it moves to the dotted line position 140*c* and engages the gear 106. Then the tens-carry frame 141 is rocked counterclockwise and moves the tens-carry slide to position 140*b*, thus rotating the gear 106 one digital increment in a subtractive direction. Shortly thereafter the tens-carry slide is moved to position 140*a* where it stands clear of gear 106 and then the rocking frame 141 is rocked clockwise to return the frame and all of the tens-carry slides to their initial position.

The foregoing description has been concerned with a primary carry operation whereas the following description is concerned with chain carry operations. Assume, for purposes of illustration that a series of adjacent numeral wheels stand at a registration of "9's" and the lowest order numeral wheel of the series of "9's" is rotated in a plus direction to a registration of "0." In those orders where the numeral wheels stand at "9," the transfer discs 175 (Fig. 3) hold their blocking levers 161 (Fig. 4) in clockwise "9" positions, with the left rearward side of each lever lying adjacent the ear 155 of its associated chain latch 152. With this condition of the parts each tens-carry slide 140 is held in its retracted position only through the overlapping of the ear 155 with the adjacent lower order slide. Then, when the lowest order numeral wheel is moved to or past a "0" registration during digital actuation, the tens-carry slide 140 for the adjacent higher order is released for a primary carry. Since the adjacent higher order slides 140 wherein the numeral wheels stand at "9's" are each held in retracted position only by the overlapping of the ear 155 with its adjacent lower order slide, the release and forward movement of the lowest order slide of the series permits all of the higher order slides of the series standing at "9's" to simultaneously move forward in response to the urgency of their respective springs 150, to the extent permitted by the bail 185, as previously described. Then when the bail 185 releases the tens-carry slides and the tens-carry frame 141 is rocked from its first extreme position to its second extreme position, the released tens-carry slides simultaneously advance their respective numeral wheels and cause the chain-carry operation.

Tens-carry driving mechanism

The tens-carry driving mechanism includes various cams fixed on the previously mentioned drive shafts 129 and 133 (Fig. 8) and which cams perform different conditioning and control functions. Similar cams 190, one of which is shown in Fig. 6, are fixed on the right and left ends of shaft 129 and rotate once for each turn of the handcrank. Cams 190 and associated mechanisms rock the tens-carry frame 141 (Figs. 1 and 2) from an initial central position to its first rocked position, then to its second rocked position, and then back to its central position to thereby cause the released tens-carry slides 140 to advance their respective gears 106. As previously mentioned, the depending ears 148 of the tens-carry frame 141 are each fixed at their right and left ends to a respective rocking plate 149 by means of rivets 194 and which plates 149 are pivotally mounted on coaxial studs 151 carried by the framework of the machine. Two rollers 191, 192 (Fig. 6) are mounted on plate 149, and in the initial position of the parts shown, the two rollers embrace opposite sides of the cam 190. If shaft 129 and cam 190 are rotated in a clockwise direction, which occurs during positive actuation of the numeral wheels, then cam 190 rocks plate 149 counterclockwise about pivot 151.

When the high point of cam 190 (Fig. 6) is first rotated past roller 192, the other roller 191 tends to float away from contact with the cam, therefore, a detent pin 198, carried by a lever 196, is provided to maintain plate 149 in either extreme adjusted position thereof. Lever 196 is pivotally mounted at 197 and urged by spring 201 in a clockwise direction. Pin 198 projects through a slot 199 in the rocking plate 149 and upon movement of the plate in either direction from its initial central position, the pin 198 exerts a toggle action upon the plate and holds it in its rocked position. In the present case where positive actuation is being performed, the plate 149 is rocked and is held in its counterclockwise position until the end of the digital actuating phase.

Then, during the tens-carry phase, the rise of cam 190 moves beneath roller 191 and rocks the plate 149 and the tens-carry frame 141 to the second extreme (clockwise) position to cause the tens-carry slides 140 to rotate their respective gears 106 one tooth increment and advance their associated numeral wheels by one digit as previously mentioned.

During subtractive actuation the cam 190 is rotated in a counterclockwise direction thus rocking the plate 149 and the tens-carry frame 141 first in a clockwise direction where it remains until the end of digital actuation. Then the frame 141 is rocked to its extreme counterclockwise position and returned to its initial central position. These movements are the opposite of those transmitted during positive actuation and obviously cause the released tens-carry slides 140 to rotate their associated gears 106 one digit in a subtractive direction.

Referring now to the mechanism for rocking the previously mentioned discs 175 (Fig. 3) into engagement with the bifurcated tips 169 of the blocking members 161, it will be recalled that the hubs 179 of discs 175 are journalled in depending arms 181 fixed on shaft 183. The left end of the shaft (Fig. 5) carries a second arm 210, and a sliding plate 211 is freely pivoted to the lower extremity of arm 210. Plate 211 is supported for limited endwise motion by means of similar pins 212 fixed to the framework of the machine and projecting through slots 213 in the plate. A pair of rollers 214 and 214', mounted on plate 211, embrace a cam 215 fixed on the previously mentioned shaft 129. In the initial position of the parts the left roller 214 rides on the high periphery of the cam while the right roller 214' rides on the low periphery of the cam. It will be seen that regardless of the direction of rotation of the hand crank and of shaft 129, the cam 215 first moves through an idle period corresponding to the tens-carry conditioning phase and then when the low periphery of the cam passes under roller 214 and the high periphery of the cam passes under roller 214', plate 211 is moved endwise toward the right. This rocks arm 210, shaft 183 and arm 181 (Fig. 3) in a counterclockwise direction to engage the discs 175 with the blocking members 161 as previously mentioned. This relationship of the parts is maintained throughout the digital actuating phase so that each numeral wheel that passes through a registration of 9 to 0 (during positive actuation) or through a registration of 0 to 9 (during subtractive actuation) will cause its associated disc 175 to rock its respective blocking lever 161 back and forth in the manner previously described to condition the tens-carry slides for a tens-carry operation. At the end of the digital actuating phase and at the beginning of the tens-carry phase, the cam 215 (Fig. 5) returns the plate 211 to its initial position thus disengaging the discs 175 from their respective blocking members so as to prevent interference between the parts during the tens-carry operation.

It will be recalled that a bail 185 (Figs. 2 and 5) is rocked to the dotted line position 185*a* to intercept any released slides and hold them out of engagement with their respective gears until digital actuation is completed. The bail 185 is then moved out of restraining engagement with the slides, whereupon the latter engage with their respective gears 106 in preparation for the tens-carry advance of the respective numeral wheels.

The means whereby bail 185 is rocked to the dotted line position 185*a* and then back to the full line position includes the following mechanism. Bail 185 extends transversely of the machine and is supported at opposite ends by a pair of arms 241 (Fig. 5) each fixed to a stub shaft 242. Each of the stub shafts is journalled in a respective plate 149 (Fig. 6), and in the initial position of

the parts, arms **241** and bail **185** (Fig. 5) are held in the full line position shown by means of a connecting linkage between plate **211** and one of the arms **241**. A link **243** is pivotally mounted at **244** on the sliding plate **211**, and at its opposite end is pivotally connected at **245** to a double armed lever **246**. The latter is pivoted on a stud **247** fixed in the framework of the machine, and at its right end the lever **246** is pivotally connected to arm **248** fixed on one of the supporting stub shafts **242** for the bail **185**. Since the plates **149** (Fig. 6) serve to support the stub shafts **242** and also the tens-carry frame **141** (Fig. 2), it will be seen that the relationship between the bail **185** and tens-carry frame is maintained constant during the rocking of the tens-carry frame from its centrally located position to the previously mentioned extreme counter-clockwise and clockwise positions. For this reason the relationship between the bail **185** and the extensions **186** on the slides **140** is also maintained constant during the rocking movement of the tens-carry frame.

It will be recalled that plate **211** (Fig. 5) is shifted to the right just before digital actuation occurs and is held in this position until the active tens-carry phase begins. Therefore, the linkage comprising link **243**, lever **246** and arm **248** rocks the bail **185** clockwise to the dotted line position **185***a* where the bail lies in front of the extensions **186** of the tens-carry slides **140**. Thus, when the slides **140** are released during the digital actuating phase they do not move forwardly far enough to engage their respective gears **106** but only move a slight distance forwardly where they are blocked by the bail **185**. This condition prevails until the end of the digital actuating phase whereupon the cam **215** slides the plate **211** back to the left, and bail **185** is rocked counterclockwise away from the extensions **186**. Then the released slides **140** which are to partake of a tens-carry movement, simultaneously move forward into engagement with their respective gears **106**. Bail **185** remains in its counterclockwise position through the remainder of the calculating cycle.

Referring now to the tens-carry slides **140** (Fig. 2) and the means for stressing the springs **150** which urge the slides to the tens-carry position, a transverse bail **157** is fixed at its ends to a pair of arms such as the arm **220** shown in Fig. 7, and the springs **150** are each connected at one end to the bail and at their other end to an upstanding ear **186** of one of the respective slides. The arms **220** and bail **157** are rocked counterclockwise by the following described mechanism to stress the springs and thus provide power for moving each slide individually to tens-carry position. This stressing occurs during each tens-carry conditioning phase.

Cams **224** and **231** (Fig. 7), fixed to the previously mentioned drive shaft **133**, comprise the means for rocking and locking the arm **220** in a counterclockwise position to stress the springs **150**. Cam **224** and associated devices, described below, stresses the springs during 180° of rotation of the cam in either direction, whereas cam **231** and associated mechanism become effective at approximately 180° of rotation of the cams to supersede cam **224** and hold the arm **220** in spring stressing condition until the tens-carry movement of slides **140** is completed. For this purpose an arm **222** is fixed on shaft **221** and a lever **228** is freely mounted thereon, the arm and the lever carrying respective rollers **223** and **232** for cooperation with cams **224** and **231**. A latching pawl **225** is freely mounted on a lower rightward extension of arm **222** and is adapted to cooperate with a bent ear **227** on lever **228**; however, in the initial position of the parts shown, an extension **229** of the pawl abuts the hub **226** of cam **224** and is rocked counterclockwise against the tension of a torsion spring **230** thus rocking the pawl **225** out of engagement with ear **227**.

Upon rotation of shaft **133** in either an additive or a subtractive direction, cam **231** almost immediately rocks lever **228** and its ear **227** in a counterclockwise direction and holds it there throughout the digital actuating phase and most of the tens-carry phase. The rise of cam **224**, on the other hand, is more gradual so as to slowly rock the integral arms **222** and **220** in a counterclockwise direction and slowly stress the springs **150**. This causes arm **222** to lag behind lever **228**. As shown as arm **222** begins to rock counterclockwise, the extension **229** of latch pawl **225** moves away from hub **226**, and the latch pawl **225** rocks clockwise to the extent permitted by the contact of surface **234** on the pawl with the underside of ear **227**. As the cam **224** continues to rotate, arm **222** moves farther counterclockwise and it will be noted that the total rise of cam **224** is sufficient to cause the arm **222** to carry the hook of pawl **225** past the ear **227** at which time the pawl snaps up under the ear and locks the arm **222** to the ear **227** and lever **223**. Since cam **224** has the same rate and amount of rise for 180° of rotation thereof, in either direction, it will be clear that cam **224** rocks arm **222** counterclockwise and stresses the springs **150** during such 180° of rotation of the cam in either direction thereof, whereas the rotation of cam **231** in either direction is effective through lever **228**, the ear **227** and latch pawl **225**, after 180° of rotation of cam **231**, to hold the arm **222** in counterclockwise position and maintain the springs **150** stressed until after the tens-carry slides have completed the advance of their respective numeral wheels. Arm **228** then drops to the low of cam **231**, thus permitting arms **228** and **222** to return to the initial position shown. At this time the spring **235** on arm **222** returns the arm **220** to the clockwise position shown and the rearward end of bail **157** pushes the slides **140**, which were previously released for tens-carry operations, back to their initial positions where they are locked by the chain latches as described hereinafter.

During chain carry operations the tens-carry slides **140** (Fig. 2) are interconnected by the chain latches and move forwardly as a unit as previously explained. Therefore any slack between the interconnecting parts, due to manufacturing tolerances, tends to permit the springs **150** to move the released higher order slides **140** forwardly a slight amount ahead of the lower order slides, thus creating what is termed a "stagger" of the slides. It will be noted, however, that this "stagger" of the parts does not affect the tens-carry actuating operation since the extreme forward movement of the released slides **140** is limited in each order through abutment of the extension **186** of the slides with the bail **157**, which stands in the dotted line position **157***a* at the time the slides advance their respective numeral wheel gears. Each slide is therefore held spaced in the same relationship to its respective numeral wheel gear **106** as the other slides. In this manner the present invention overcomes an objectionable inherent defect which is present in previous interconnected chain carry mechanisms, it being noted that the effects of stagger are overcome without having to allow extra time in the calculating cycle to effect such remedy.

When the slides **140** (Fig. 4) are returned to their initial rearward positions they are locked in this position by the re-engagement of each chain latch **152** with the rearward shoulder of its respective lower order slide **140**, the torsion springs **152***a* urging the chain latches **152** in a clockwise direction to insure such re-engagement. Since the lowest order slide of the series is locked by the re-engagement of its chain latch **152** with the fixed projection **159** on frame **164**, all of the slides are therefore held in retracted position on the frame. Furthermore, the depending portion **155** of each chain latch **152** reengages the rearward edge of its blocking lever **161** thus returning all of the parts to their initial "N" positions.

The springs **152***a* normally carry out the function of returning the chain latches to their initial position; however friction or momentum of the parts may prevent a spring **152***a* from returning its chain latch to initial position and therefore the following means including a centralizing bail **255** (Fig. 9) are provided to insure such return.

Bail **255** (Figs. 9 and 10) is a channel shaped member extending transversely of the machine and has ordinally arranged teeth **257** for cooperation with the respective chain latches **152**, one of which is shown in Fig. 9. The bail is slidably mounted for endwise movement by means of opposite end slots **258** which embrace the reduced shanks of screws **259** threaded into brackets (not shown) fixed in the framework of the machine. The endwise movement of bail **255** is controlled by a cam **262** fixed on the previously mentioned shaft **133**. The periphery of the cam engages a notch **264** cut within a downwardly depending flange of the bail **255** and, in the position of the parts at rest, holds the bail in its leftmost position.

Cam **262** has a pair of identical cam surfaces **266** for moving bail **255** toward the right and back at the beginning of each calculating cycle regardless of whether plus or minus calculations are begin performed, this move-

ment of the bail being provided to move, or "recock" any displaced depending ear **155** from the dotted line tens-carry position **155***a* to the full line position **155**. Since two cam surfaces **266** are provided, it will be obvious that, in either direction of operation of cam **262**, one surface **266** is effective to reciprocate rack **255** at the beginning of each calculating cycle while the other is effective to reciprocate the rack near the end of the cycle. The arrangement and timing of operation of the parts is such, however, that only the first reciprocation of the rack **255** causes recocking of the chain latches **152**; the second reciprocation of the rack occurs while the tens-carry slides, which have been released for a tens-carry operation, are still in their forward positions with the ears **155** of their levers out of the path of the teeth **257** on the rack. In those cases where the tens-carry slides **140** are not released for a tens-carry operation, the chain latches **152** remain in their initial rearward positions and the recocking movement of rack **255** near the end of the calculating cycle is merely an idle operation with respect to those latches.

From the above description of the cam **262** and associated mechanisms, it is seen that recocking of the tens-carry latches by cam surfaces **266** occurs during the tens-carry conditioning phase without increasing the length of the overall operating time of the machine.

Operation

The performance of the machine in carrying out a typical cycle of calculation is now briefly reviewed including references to the timing chart shown in Fig. 11. Either a positive or a negative cycle of actuation would suffice, and for convenience a positive cycle of operation is described.

Upon rotation of the hand crank in a plus direction the cam **190** (Fig. 6) rocks plate **149** and the tens-carry frame **141** (Fig. 2) from its initial centrally located position to an extreme counterclockwise position as indicated at **270** on line 1 of the chart (Fig. 11), thus moving the tens-carry slides **140** (Fig. 2) to the dotted line position **140***a*. The tens-carry frame **141** is held in this position throughout the remainder of the tens-carry conditioning phase, throughout the digital actuating phase, and until slightly after the active tens-carry phase is begun as is indicated at **279** in Fig. 11.

Referring now to the recocking of the chain latches **152** (Fig. 9), cam **262** holds the bail in its leftmost position when the cam stands in its initial position as is indicated at **271** (line 2, Fig. 11). This holding of bail **255** in its leftmost position is a continuation from the end of the previous calculating cycle as is indicated at **283** and explained more fully hereinafter in connection with the latter part of the present calculating cycle. The rotation of cam **262** (Fig. 9) in either direction causes a respective one of the cams **266** to move bail **255** toward the right, as is indicated at **272** (line 2, Fig. 11) to recock the chain latches **152** (Figs. 4 and 9) by moving the ears **155** of the latches on to the shoulders **156** (Fig. 4) of their respective lower order slides in case they have not been moved there by their torsion springs **152***a*. Then when the cam surface **266** (Fig. 9) moves past the bail **255**, the bail is returned to its initial position as indicated at **273** (line 2, Fig. 11) and is maintained in this position until slightly after the tens-carry phase is begun.

Meanwhile, the cam **215** (Fig. 5) rocks shaft **183** counterclockwise and shaft **242** clockwise, shaft **183** moving the transfer discs **175** (Fig. 3) into engagement with their respective blocking levers **161** while shaft **242** (Fig. 5) rocks the transverse ball **185** to the dotted line position **185***a*, all of which is indicated at **274** (line 3, Fig. 11), in the dotted line position of bail **185** (Fig. 5), the transfer slides **140**, which are released during the subsequent digital actuating phase, contact the bail and, as is indicated by the straight line **275** (line 3, Fig. 11), are prevented from engaging their respective gears **106** (Fig. 2) until after the tens-carry phase is begun.

Bail **185** (Fig. 5) is moved to the dotted line position **185***a* before the digital actuating phase is begun, and then the springs **150** (Figs. 2 and 7) are stressed to provide the power for moving any subsequently released tens-carry slides **140** to their forward positions. For this purpose bail **157** (Fig. 7) is rocked counterclockwise and held in spring stressing position by cams **224** and **231**. Cam **224** stresses the springs **150** as is indicated at **276** (line 4, Fig. 11), and at approximately 180° of the calculating cycle, the cam **231** and its associated mechanisms lock the bail **157** in spring stressing position as indicated at **277**. This condition prevails throughout the remainder of the digital actuating phase and through a portion of the tens-carry phase, as is indicated by the straight line portion **277** of line 4 in Fig. 11.

Assume now that digitation occurs with one or more numeral wheels being advanced sufficiently to cause a primary or chain carry. In such a case the respective tens-carry slides **140** which are to partake of a carry movement are released from their chain latches, but move forwardly only to the extent permitted by bail **185** (Fig. 5). Then, near the end of the digital actuating phase, the transfer discs **175** (Fig. 3) are withdrawn from engagement with their respective blocking members **161** as is indicated at **278** on line 3 (Fig. 11), and simultaneously with this movement, the bail **185** (Fig. 5) is rocked counterclockwise from the dotted line position **185***a* to the full line position thus permitting the released tens-carry slides **140** (Fig. 2) to move forwardly to the dotted line position **140***b* and enter between the teeth of their respective gears **106**. This occurs before the tens-carry frame **141** rocks to its extreme clockwise position as is indicated at **284** (line 1) on the chart, and during such clockwise movement the tens-carry slides **140** are moved from the dotted line position **140***b* (Fig.2) to the dotted line position **140***c*. This advances their respective gears **106** one gear tooth and in turn rotates the associated numeral wheels each by one digit. The extreme clockwise position of frame **141** is momentarily held as indicated at **284** (Fig. 11, line 1) to positively arrest the advance of the numeral wheels and prevent overthrow thereof.

At the end of the tens-carry (clockwise) movement of the frame **141** (Fig. 2) the bail **157** (Fig. 7) is returned to and held in its initial clockwise position as is indicated at **280** (line 4) of the timing chart. This movement of bail **157** returns the tens-carry slides **140** to their initial rearward positions where they are locked by the chain latches **152**. The withdrawal of the tens-carry slides from engagement with their respective gears **106** permits the tens-carry frame **141** to be returned in a counterclockwise direction to its initial central position, such return begin indicated at **285** (line 1) on the chart.

Meanwhile, one of the cam surfaces **266** (Fig. 9) moves the centralizing bail **255** to the right and back through an idle recocking motion as indicated at **281—282** (line 2) of the chart. The reference numeral **283**, line 2, indicates the return of the recocking bail **255** to its initial position which is the same as indicated at **271** on the same line.

This completes the current cycle of operation of the machine at which time the handcrank may continue to be rotated through one or more cycles if multicyclic operations are being performed, or the machine may come to rest if single additions or subtractions are being performed. In either event the tens-carry mechanism stands in a normalized condition and ready for the next cycle of operation.

The timing chart (Fig. 11) is also correct with respect to the machine in performing subtraction, with the exception that the tens-carry frame **141** reverse its direction of carry operations, all as has been previously described, and which is indicated in Fig. 11 by the dotted line **270'**. The remainder of the mechanism charted on lines 2, 3, 4 follow the same course in additive and subtractive directions of operation.

From the foregoing description, it is seen that the tens-carry operations occur simultaneously in all orders and that in both primary and chain carry operations the movement of the tens-carry slides to effective tens-carry positions occurs under power individual to each order. Furthermore, the power for causing the movement of the slides to tens-carry position is stored previous to the tens-carry phase, namely during the tens-carry conditioning phase and the digital actuating phase, thus permitting the tens-carry operations to be carried out immediately after the digital actuating phase without sudden increase in resistance to the handcrank and without delay for the operation of any auxiliary mechanisms.

I claim:

1. In a calculating machine having a register comprising a plurality of numeral wheels and digital actuators therefor, and a plurality of tens-carry actuators mounted for in-and-out movement relative to their respective numeral wheels for engagement and disengagement therewith; the combination of means for yieldably urging each tens-carry actuator from a normally retracted position to

a position of engagement with its respective numeral wheel, a latch member carried by each tens-carry actuator normally locking the actuator to its adjacent lower order actuator, means to lock the lowest order tens-carry actuator in said retracted position thereby holding all of said tens-carry actuators in retracted position, with means associated with each numeral wheel and operable upon movement of the numeral wheel to a given registration to unlock the next higher order tens-carry actuator from its adjacent lower order tens-carry actuator, restraining means common to said tens-carry actuators operable throughout the digital actuation of the numeral wheels to restrain an unlocked tens-carry actuator and prevent the latter from engaging its respective numeral wheel, and mechanism operable at substantially the end of the operation of the digital actuators to release the tens-carry actuators from restraint of said means and permit the yieldable means to move the released tens-carry actuators into engagement with their respective numeral wheels.

2. In a calculating machine having a register including numeral wheels, and digital actuators therefor; the combination of, tens-carry actuators for the numeral wheels slidably mounted on a carrier common to said tens-carry actuators, resilient means for moving each tens-carry actuator on said carrier into engagement with its numeral wheel, a releasable connection between each tens-carry actuator and its adjacent lower order tens-carry actuator, a device to hold the lowest order tens-carry actuator out of engagement with its respective numeral wheel, with mechanism operable by each numeral wheel in response to movement thereof to a predetermined registration to release said connection to thereby condition the next adjacent higher order tens-carry actuator for movement by its resilient means, restraining means common to the tens-carry actuators for preventing movement of the conditioned actuator into engagement with its numeral wheel, means operable to disable said restraining means and permit the conditioned tens-carry actuator to engage its numeral wheel, and mechanism for rocking said carrier to cause the conditioned actuators to advance their respective numeral wheels.

3. In a calculating machine having a register including a plurality of numeral wheels, digital actuators for the numeral wheels and a reversible drive means for the actuators; the combination of, tens-carry actuators for the numeral wheels mounted on a carrier common to said tens-carry actuators, a releasable connection between adjacent tens-carry actuators for locking the actuators out of said engagement with their numeral wheels, means responsive to movement of each numeral wheel to a predetermined registration to release said connection, resilient means for urging each released tens-carry actuator into engagement with its numeral wheel, restraining means common to the tens-carry actuators for preventing any released actuator from engaging with its respective numeral wheel, means controlled by said reversible drive means in either direction of operation thereof to disable said restraining means at substantially the conclusion of a digital actuating operation, and mechanism selectively operable in response to the direction of operation of the drive means to rock said carrier in one or the other direction to cause the released tens-carry actuators to advance their numeral wheels one digit corresponding in sign to the sign of the digital actuating operation.

4. In a calculating machine having a register including a plurality of numeral wheels, a plural order digital actuating mechanism for the numeral wheels, drive means for the actuating mechanism, tens-carry actuators for the respective numeral wheels each actuator being mounted for movement from an initial rearward position on a carrier common to the actuators to a forward position on the carrier wherein the actuator engages its respective numeral wheel, means including resilient means individual to the actuators for moving the actuators forwardly into engagement with their numeral wheels, a releasable connection between adjacent actuators for normally preventing said forward movement of the actuators, means responsive to movement of each respective numeral wheel to a predetermined registration to release its adjacent higher order tens-carry actuator and permit the same to move into engagement with its respective numeral wheel, mechanism operable to rock said carrier to cause the released actuator to advance its numeral wheel one digit, and mechanism controlled by a part of said digital actuator drive means for returning said released actuator to its initial rearward position.

5. In a calculating machine having a register including a plurality of ordinally arranged numeral wheels, and digital actuating means for the numeral wheels; a tens-carry mechanism for the numeral wheels comprising respective tens-carry actuators mounted upon a common carrier and each actuator adapted for movement in one plane relative to the carrier, resilient means for moving each actuator from a first position on said carrier to a second position on said carrier and into engagement with its respective numeral wheel, two restraining means comprising a blocking device and a releasable connection in each order normally operable to prevent numeral wheel engaging movement of a respective actuator, said blocking means normally effective to prevent the forward movement of the actuator to said second position and adjustable to a disabled position, said releasable connection including a member carried by each tens-carry actuator and normally enabled to connect the actuator to its next adjacent lower order actuator, means to retain the lowest order actuator in its rearward position on the carrier thus restraining all of the actuators in said first position, in combination with mechanism responsive to the rotation of a numeral wheel to a position indicative of a first value to disable the blocking device associated with the adjacent higher order actuator, mechanism responsive to the movement of the numeral wheel to a position indicative of a second value to release said adjacent higher order tens-carry actuator from said connection and permit forward movement of the actuator to engage its numeral wheel, and mechanism for moving said carrier in a plane perpendicular to said first mentioned plane to cause said engaged actuator to advance its numeral wheel one digital increment.

6. In a calculating machine having a register including numeral wheels, digital actuating means for the numeral wheels, and tens-carry mechanism for the numeral wheels comprising a tens-carry actuator, in each order resilient means for urging the actuator to a position of engagement with a respective numeral wheel, a releasable connecting member between each tens-carry actuator and its adjacent lower order actuator, two devices associated with the connecting member to prevent movement of the actuator to engage its numeral wheel, the first device comprising a blocking means normally standing in blocking relationship with said member, and said second device comprising a portion of the adjacent lower order tens-carry actuator normally standing in locking relationship with said member, means responsive to the movement of a numeral wheel to one value indicating position to move the first device out of blocking relationship with the connecting member, and means responsive to the movement of the numeral wheel to a second value indicating position to move the connecting member out of locked relationship with the lower order actuator.

7. In a cyclically operable calculating machine having a register including numeral wheels, digital actuators and tens-carry mechanism for the numeral wheels, said tens-carry mechanism comprising a tens-carry actuating member for each numeral wheel, resilient means for moving each member in one plane from an inactive position to an active tens-carry position, means associated with all of said members to move the same in a second plane to thereby enable those members which stand in an active position to advance their respective numeral wheels one digital increment, a first control means having two phases of operation and effective in either phase to stress said resilient means, a second control means also having two phases of operation and effective at approximately one half of the calculating cycle to supersede the first control means and maintain the resilient means in said stressed position throughout the movement of the tens-carry members in said second plane.

8. In a cyclically operable calculating machine having a register including numeral wheels, digital actuators and tens-carry mechanism for the numeral wheels, said tens-carry mechanism comprising a tens-carry actuating member, for each numeral wheel, resilient means for moving each member in one plane from an inactive position to an active tens-carry position, means associated with all of said members to move the same in a second plane to thereby enable those members which stand in an active position to advance their respective numeral wheels one digital increment, means comprising a first cam and a follower therefor operable in either direction of rotation of the cam and through not more than one

half of the calculating cycle to stress said resilient means, a second cam having a cam follower and associated mechanism effective at approximately one half of the calculating cycle and in either direction of rotation of the second cam to engage said first cam follower and thereafter maintain the same in said stressing position throughout the movement of the tens-carry members in said second plane.

9. In a calculating machine having a register including a series of numeral wheels, means for rotating the numeral wheels in accordance with selected digital values, a tens-carry actuator for each numeral wheel, a drive means associated with each numeral wheel and adapted to receive a tens-carry increment of advance from a respective actuator, an actuator carrier mounted for rocking movement relative to the numeral wheel drive means, ordinal members mounted on said carrier and normally enabled to prevent movement of the actuators into engagement with their respective numeral wheel drive means, a releasable connecting means carried by each tens-carry actuator normally connecting the actuator to its adjacent lower order actuator to further prevent the engaging movement of the actuator, means controlled by each numeral wheel upon rotation thereof to a registration of nine during positive digital actuation or to a registration of zero during subtractive digital actuation to disable the associated ordinal member, and means controlled by each numeral wheel upon rotation thereof to a registration of zero or nine during positive or negative digital actuation, respectively, to disconnect said connecting means of the next higher order actuator and permit the disconnected actuator and all consecutive higher order actuators, whose members have been disabled, to simultaneously move to engaging position, and mechanism for rocking said actuator carrier to cause the engaging actuators to advance their respective numeral wheels one digital increment.

10. A register comprising a plurality of ordinally arranged numeral wheels, digital actuators and tens-carry actuators therefor, ordinally arranged resilient means to urge each of the tens-carry actuators into engagement with a respective numeral wheel, a restraining member for each tens-carry actuator normally standing in a first position in which it prevents said engagement of its tens-carry actuator and adjustable to a second position in which it enables such engagement, a mechanism in each order responsive to the movement of a respective numeral wheel to a position indicative of a first value to adjust the restraining member of the next adjacent higher order to said second position, normally effective means in each order to prevent each enabled actuator from engaging its respective numeral wheel, means in each order responsive to the movement of its respective numeral wheel to a position indicative of a second value to disable the preventing means associated with the adjacent higher order tens-carry actuator and thereby release the same for movement in a first plane into engagement with its respective numeral wheel and to simultaneously release all successive higher order enabled actuators for engaging movement relative to their respective numeral wheels, and mechanism operable at substantially the end of digital actuation to move the released tens-carry actuators in a second plane to thereby move their respective numeral wheels one digital increment.

No references cited.