Nov. 28, 1933. C. M. F. FRIDEN 1,936,904

CALCULATING MACHINE

Original Filed Feb. 18, 1924 3 Sheets-Sheet 1

FIG. 1.

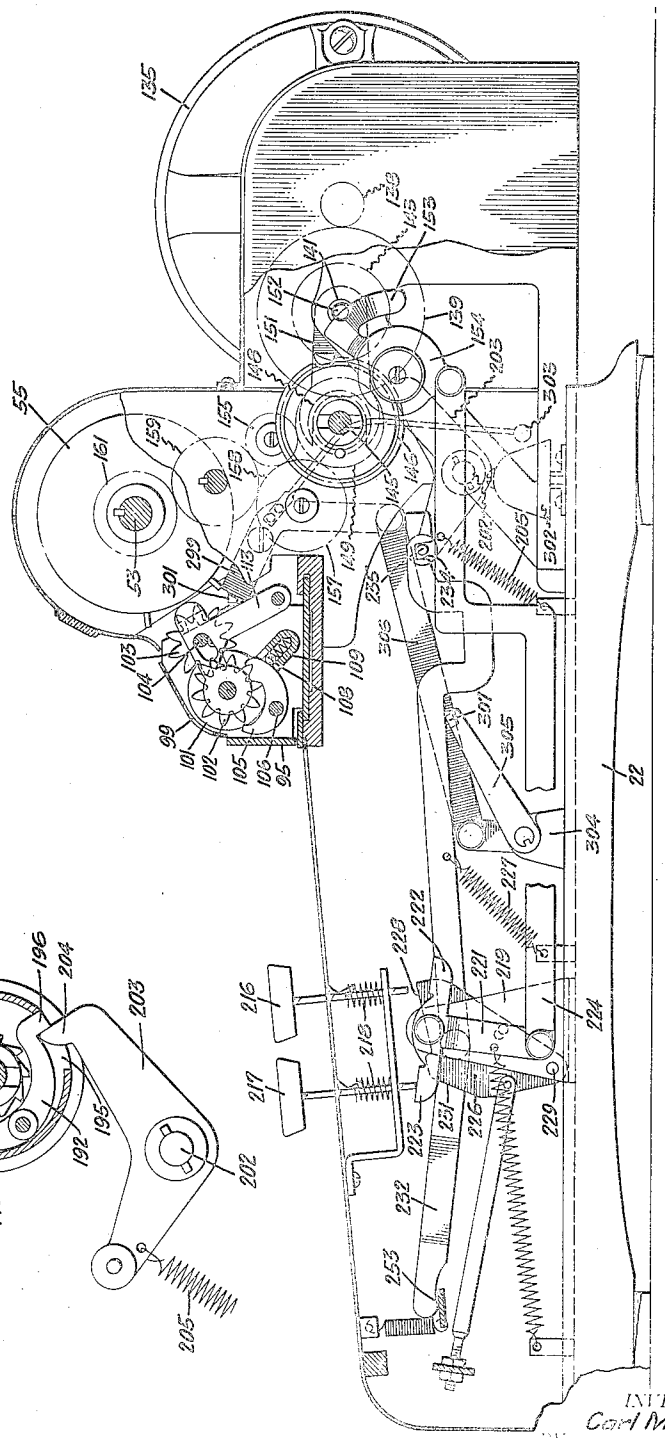

FIG. 2.

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CALCULATING MACHINE

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FIG. 3.

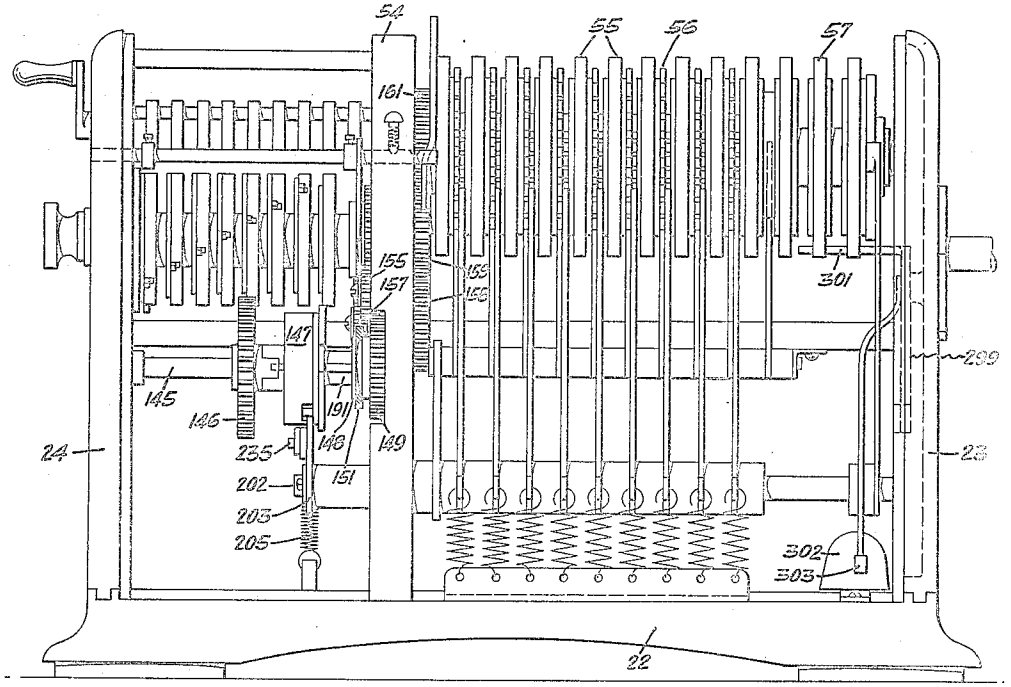


FIG. 4.

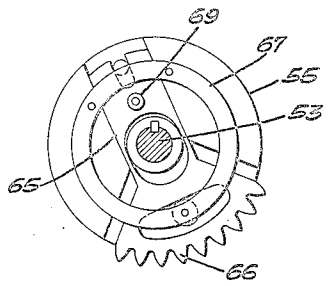
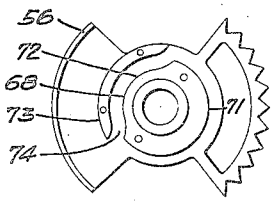


FIG. 5.



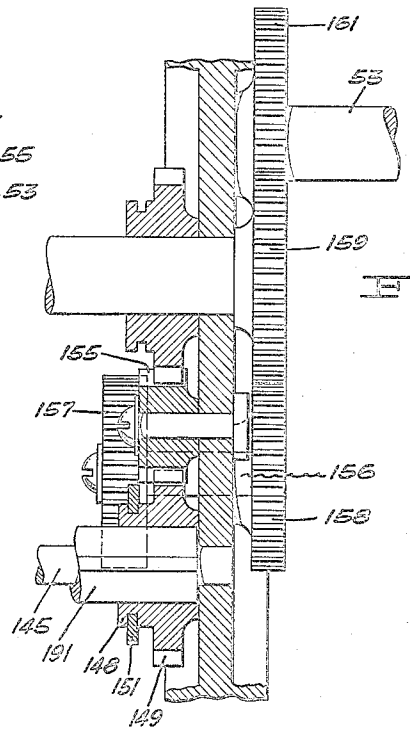


FIG. 6.

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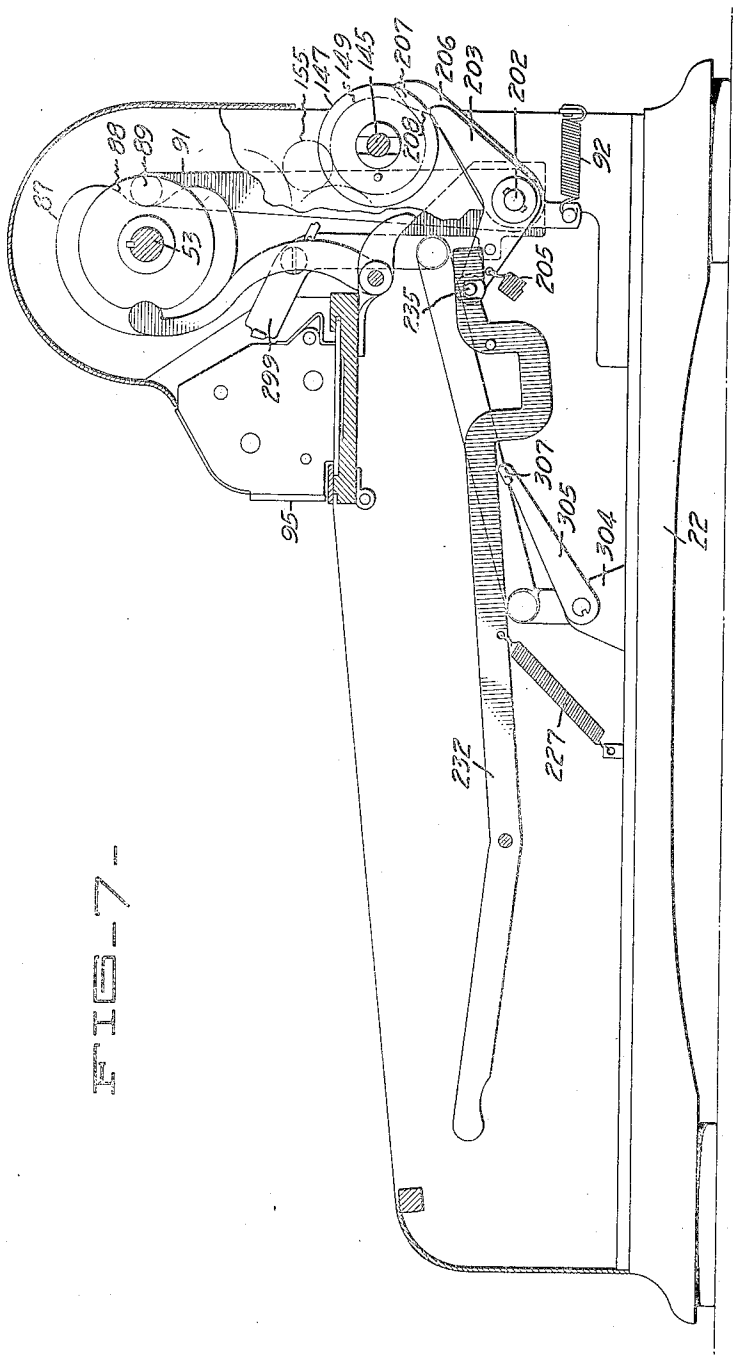
CALCULATING MACHINE

Original Filed Feb. 18, 1924 3 Sheets-Sheet 3



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Patented Nov. 28, 1933 1,936,904

UNITED STATES PATENT OFFICE

1,936,904

CALCULATING MACHINE

Carl M. F. Friden, Oakland, Calif., assignor to Marchant Calculating Machine Company, Emeryville, Calif., a corporation of California

Original application February 18, 1924, Serial No. 693,546. Divided and this application September 20, 1927. Serial No. 220,658

14 Claims. (Cl. 235—32)

This application is a division of my application Serial No. 693,546, filed in the United States Patent Office on February 18, 1924, and issued as Patent No. 1,643,710, September 27, 1927.

The invention relates to calculating machines and particularly to calculating machines adapted to perform the operations of addition, subtraction, multiplication and division.

An object of the invention is to provide a calculating machine in which the multiplication or division of a number by any digit is accomplished by the depression of a key.

Another object of the invention is to provide a calculating machine in which the metal operation involved in the problems of division or multiplication is completed by the introduction of the digit multiplier or divisor into the machine.

Another object of the invention is to provide a calculating machine which is automatic in its operation to compute problems involving division and multiplication.

A further object of the invention is to provide a power driven calculating machine having means operable during the operation of division to stop the operation of the machine when the divisor will not go into the dividend a whole number of times.

A further object of the invention is to provide a power driven calculating machine provided with means for disconnecting the source of power from the machine when the machine has completed the calculating operation.

The invention possesses many other advantageous features, some of which, with the foregoing, will be set forth at length in the following description, where I shall outline in full, that form of the invention which I have selected for illustration in the drawings accompanying and forming part of the present specification. In said drawings I have shown one embodiment of my invention, but it is to be understood that I do not limit myself to such form, since the invention as set forth in the claims, may be embodied in a plurality of forms. The invention claimed in this divisional application relates particularly to the means for disconnecting the source of power from the actuator and stopping the actuator in full cycle position during the operation of division, when the divisor will not go into the remaining dividend a full number of times.

All of the features of the calculating machine disclosed in this application, are fully shown and described in my United States Letters Patent Number 1,643,710 of September 27, 1927, which patent resulted from the application of which this application is a division.

Referring to said drawings:

Figure 1 is a side elevation of a calculating machine embodying my invention, parts thereof being broken away and other parts being shown in section to more clearly illustrate the invention.

Figure 2 is a section through the clutch which controls the connection of the motor to the actuator or calculating mechanism.

Figure 3 is a rear elevation of the calculating machine with the motor and the speed reducing gear removed.

Figure 4 is a detail of one of the actuator sections.

Figure 5 is a side elevation of the cam member forming part of an actuator section.

Figure 6 is a detail of the reversing gear mechanism.

Figure 7 is a vertical section through the machine showing the means for stopping the actuator in full cycle position.

The calculating machine shown in the drawings, comprises a suitable base 22 having side plates 23 and 24 and an intermediate plate 54, between which the selecting, counting and controlling mechanism devices are arranged. The counting mechanism comprises a reversible rotary actuator into which values are introduced by the depression of keys and which, upon rotation, transmit the values to the counting mechanism or register, which is mounted in a transversely movable carriage. The actuator comprises nine counting mechanism actuating wheels 55 which are secured to the supporting shaft 53 and nine value selecting elements 56 which are loose on the shaft 53, a wheel 55 and an element 56 being combined together to form an actuating unit. The actuator also comprises additional wheels 57 which, like the wheels 55 are provided with tens carrying pins. The actuator is rotatable in either direction from full cycle position, through a complete revolution back to full cycle position, by a driving motor which is connected to the actuator through gearing which is capable of being reversed, so that for rotation of the motor in one direction, the actuator may be rotated in either direction.

Each actuator unit comprises a counting mechanism actuating wheel and an associated value selecting element. The actuating wheel comprises a disc or wheel carrying a diametrically disposed slide or member 65, seated in the wheel so that it may be moved diametrically thereof. The slide

is provided on one end with an actuating face provided with nine teeth 66, the teeth being arranged on an arc concentric with the wheel and having the same pitch as the teeth of the intermediate wheel of the counting mechanism. The slide is held in the groove in the wheel by a ring 67 secured to the wheel and is normally held in retracted position with the teeth or curved rack 66 lying within the periphery of the wheel. The function of the selecting element is to project and retract the slide, at the proper time during the rotation of the actuator, to bring the selected number of keys into engagement with the counting mechanism. The selecting element 56, which is positioned by the depression of a key, is provided on its side which lies adjacent the associated actuating wheel, with a cam 68 which is engaged by a roller 69 on the slide 65. The cam 68 is provided with a high face 71 and when the roller is in engagement with this face, the slide is held in retracted position, and with a low face 72, and when the roller is in contact with the low face, the slide is in projected position. To insure the positive sliding movement of the slide, a backing cam 73, complementary to the main cam is arranged opposite the low face 72, thus forming a cam groove 74, through which the roller travels as the wheel is rotated, thus insuring the positive sliding motion of the slide at selected times, during the rotation of the wheels, depending upon the setting of the selecting elements. The selecting elements are held stationary during the rotation of the actuator. The slide is thus reciprocated for each rotation of the wheels and the time of its reciprocation with respect to the position of the wheels is determined by the setting of the selecting elements. Each of the nine actuating wheels of the actuator is provided with a slide 65 having a curved rack 66 on its end and in order that all of the projected racks will not engage the intermediate wheel of the counting mechanism at the same time, during the rotation of the actuator, and thus suddenly throw a large load on the driving motor, the slides are spaced apart angularly around the face of the drum.

The values entered into the actuator, are transferred, upon rotation thereof, to the counting mechanism which is arranged on the longitudinally movable carriage 95, which is movable to permit the action of the actuating element on the counting wheels of different value. Any suitable means are provided for moving the carriage longitudinally either in a step by step movement or continuously to either end of its range of travel. The counting mechanism comprises a plurality of figure discs or numeral wheels 101 arranged in axial alinement in the transversely displaceable carriage. The figure discs are mounted on a shaft and have figures on their faces which are visible through apertures 99 in the carriage casing. Each disc is provided on one side with a toothed wheel 102, secured thereto, and meshing with an intermediate toothed wheel 103 loosely mounted on the shaft 104. On rotation of the actuator, the toothed faces of the actuating elements move into engagement with the intermediate wheel causing rotation thereof and consequent rotation of the figure discs. The figure discs are prevented from overthrowing and are caused to move with a step by step movement by the escapement latches 105 pivoted on the shaft 106. These latches are held in latching engagement with the toothed wheels of the counting discs by spring pressed balls 108, carried by the bar 109. Suitable or well known means may be employed for rotating the figure discs to zero, by the rotation of the shaft on which the discs are mounted or by other suitable means. The counting mechanism is also provided with suitable transfer levers 113 which operate in conjunction with laterally movable tens carrying pins on the actuator, to carry over values from one counting disc to the counting disc of the next higher denominations. The transfer levers cooperate with pins or studs projecting from the side faces of the figure discs and, upon a movement of the figure disc from 9 to zero or zero to nine, the transfer lever is moved backward, moving the rear portion thereof, which is cam shaped, into the path of the tens carrying pins, so that the pins are moved transversely into contact with the intermediate wheel of the counting disc of the next highest order. Therefore, in the event of a transitional carry from one figure disc to the figure disc of next highest order, the transfer lever is moved backward and this backward movement of certain of the transfer levers is utilized in stopping the actuator in full cycle position, as will be set forth hereinafter.

The actuator is driven by an electric motor 135 which is preferably mounted on the base of the machine at the rear portion thereof. Secured to the motor shaft is a pinion 138 which meshes with a gear 139 mounted on the hollow counter shaft 141. Secured to the gear 139 is a gear 143 which meshes with a gear 146 secured to the main driving shaft 145. The shaft 145 is provided, between the gear 146 and the calculating mechanism, with a clutch 147 which controls the duration of operation of the calculating mechanism.

The clutch is normally disengaged, permitting the motor to run continuously without causing rotation of the calculating mechanism. The clutch comprises a ratchet wheel 188 secured to the shaft 145 and a surrounding housing 189 secured to the shaft 191 on which the driving gear 149 is splined.

Pivoted in the housing 189 is a pawl 192 having a tooth 193 adapted to be moved into engagement with the ratchet 188 by the spring 194. The tooth 193 is normally held out of engagement with the ratchet, so that the ratchet is free to rotate without causing rotation of the housing. When the pawl 192 is in engagement with the ratchet 188, the clutch housing rotates synchronously with the shaft 145, thus causing synchronous rotation of the shaft 191, on which the gear 149 is splined.

The gear 149 which drives the calculating mechanism is provided with a collar 148. The gear 149 is movable longitudinally of the shaft 191 to two different positions to accomplish the reversal of direction of rotation of the actuator with respect to the direction of rotation of the motor. In performing problems in division it is essential that the actuator rotate in a reverse direction to that in which it rotates in performing problems in multiplication and a reversing gear is inserted for this purpose and the shifting of the gear 149 accomplishes this reversal. The gear 149 is shifted longitudinally of the shaft 191 by the arm 151 which engages the collar 148. The arm 151 is secured to the rod 152 which extends through the hollow shaft 141. At its end, the rod 152 is provided with a slot in which is disposed the warped or bent arm 153 of the lever 154 and by shifting the lever 154, the rod is moved lengthwise to shift the gear 149.

Journalled on a shaft mounted in the intermediate wall 54 is a pinion 155 which engages the gear 149 when such gear is in one of its positions. Secured to a shaft 156 journalled in the intermediate wall 54 is a gear 157 which engages the gear 149 when said latter gear is in its other position. The gears 155 and 157 are in mesh with each other so that they always rotate in opposite directions. When the gear 157 is in mesh with the gear 149, such gear 157 rotates in the opposite direction to the gear 149. When the gear 157 is out of mesh with the gear 149 and the gear 155 is in mesh with gear 149, then gear 157 rotates in the same direction as gear 149. Therefore, the direction of rotation of gear 157 is reversed by shifting the gear 149. Secured to the shaft 156 and lying on the opposite side of the intermediate wall is a gear 158 which meshes with a gear 159 journalled on a shaft mounted in the intermediate wall and the gear 159 meshes with the gear 161 which is secured to the actuator shaft. Therefore, by shifting the gear 149, the direction of rotation of the actuator is reversed. The gears 157, 159 and 161 are of the same diameter.

Having described the means employed for accomplishing the reversal of the direction of rotation of the actuator, I shall now describe the means employed for controlling the rotation of the actuator. This rotation is controlled by the clutch and its controlled mechanism. The clutch housing 189 is provided with an aperture 195 through which an ear 196 of the pawl 192 extends. By pressing the ear 196 inward, the tooth 193 is moved from engagement with the ratchet 188 and means are provided for normally holding the ear pressed inward so that the pawl is out of engagement with the ratchet. When the means holding the ear 196 depressed is removed, the pawl drops into engagement with the ratchet and remains in engagement until the ear 196 is again depressed.

Means are provided for permitting the engagement and causing the disengagement of the clutch, for centering the housing in full cycle position at the disengagement of the clutch and for preventing improper operation of the clutch. Pivoted in the casing on the shaft 202 disposed below the clutch, is a lever 203 having a projection 204 on its end which is adapted to engage the ear 196 of the pawl and disengage the pawl from the ratchet. The lever 203 is normally held in position with the projection 204 in contact with the ear 196 by the spring 205 connected to the other end of the lever. The lever 203 not only serves to cause disengagement of the pawl with the ratchet but also serves to stop the clutch housing 189 in full cycle position. Due to the abrupt stopping of the clutch, it may rebound slightly from full cycle position and means are provided for positioning the clutch in full cycle position, comprising a lever 206 secured to the lever 203 and having a cam shaped end 207 adapted to seat in a similarly shaped depression 208 on the face of the housing. The clutch is therefore always stopped in neutral position after disengagement.

Arranged on the keyboard are two actuating keys 216 and 217, the key 216 being designated as the addition key and the key 217 being designated as the subtraction key. Depression of the key 216 causes engagement of the clutch and rotation of the actuator in one direction and depression of the key 217 causes engagement of the clutch and rotation of the actuator in the opposite direction. The keys 216 and 217 are normally held in their raised positions by springs 218 and, preferably, the keys are not provided with means for holding them in the depressed position. Disposed below the keys 216 and 217 is a bracket 219 to which the T shaped lever 221 is pivoted adjacent its upper end. One arm 222 of the T shaped lever lies under the shank of the key 216 and the other arm 223 of the T shaped lever lies under the stem of the key 217. Depression of the key 216 rocks the lever 221 to the position shown in Figure 1 and depression of the key 217 rocks the lever 221 to its opposite position. Connected to the lower end of the lever 221 is a rod or link 224 which is connected at its other end to the lever 154 which operates to shift the shaft 152 which shifts the gear 149.

Means are also provided for causing the depression of either key 216 or 217 to cause engagement of the clutch. Pivoted to the bracket 219 adjacent the bottom thereof, is a plate 226 which is rocked backward by the depression of either key, the plate being normally held in a forward position by the spring 227. The plate is provided, below the shank of the key 216 with a flat surface 228 which is engaged by the shank of the key to cause the plate to rotate about its pivot 229. Below the shank of the key 217 is a plate 226 provided with an inclined face 231 which, when it is engaged by the shank of the keys causes the plate to rock backward. The plate is therefor rocked backward by the depression of either key and the backward movement of the plate operates through suitable instrumentalities to cause engagement of the clutch. Fulcrumed on the plate 226 adjacent its upper end, is a lever 232 which rests at one end on the spring held plate 253 and which is provided at its other end with a notch 234 in which the pin 235 of the lever 203 is normally disposed. Backward movement of the lever 232 will therefore rock the lever 203 about its pivot 202 against the tension of the spring 205 and this movement of the lever 203 withdraws the projection 204 from contact with the ear 196, thereby permitting engagement of the clutch and rotation of the clutch housing.

In accordance with the mechanism so far described, the clutch will remain in engagement as long as either of the keys 216 or 217 is held depressed and as soon as pressure is released from the keys, the spring 227 will pull the lever 232 backward and cause the projection 204 on the lever 203 to disengage the clutch and stop the clutch housing in full cycle position. Due to back-lash in the gear train between the clutch and the actuator, the actuator travels slightly beyond neutral or full cycle position, when the clutch is stopped and locked in full cycle position and the lever 91 operating on the cam 87 serves to return the actuator to full cycle position. The actuator has an idle phase on either side of full cycle position and the overthrow of the actuator due to the back-lash is not sufficient to carry the actuator beyond the idle phase. Secured to the drum shaft is a cam 87 having a deep depression 88, which is engaged by a roller 89 on the end of the lever 91. The lever is suitably pivoted within the machine and the roller is pressed against the cam by the spring 92, the slope of the cam and the tension of the spring being sufficient to cause the lever to center the actuator in neutral position at the end of a calculating operation.

In carrying out problems in division, the actuator is rotated in a reverse direction a number

of times equal to the number of times that the divisor will go into the dividend as a whole number. On the next rotation of the drum, the counting wheels in the counting mechanism carried by the carriage, are operated to expose a series of nines to the left of the dividend, thus indicating that the drum has rotated one time more than the whole number by which the dividend is divisible by the divisor. It is then necessary to rotate the drum once in the opposite direction to counteract the extra rotation of the drum which throws the nines into the counter. Means are provided for sounding an alarm and stopping the operation of the actuator when the nines are thrown into the counting mechanism or register, so that the machine may then be operated for one revolution in the reverse direction, thereby showing the proper number in the divisor. The throwing of the nines into the register is accompanied by a movement of the transfer levers 113 to the left of the number appearing in the register and means are provided for causing the throwing of these levers to stop the actuator. Mounted in the frame of the machine and extending into the carriage at the left hand side of the machine so as to be positioned adjacent the transfer levers 113 which will comprise the furthest left active transfer lever is a lever 299 which is provided on its end with an ear 301 which is engaged by the transfer lever when the series of nines is thrown. The movement of the transfer lever at left causes movement of the lever 299 about its pivot and movement of this lever is employed to sound the alarm and to raise the rear end of the lever 232 to cause disconnection of the clutch. Arranged within the casing and supported on the base thereof, is a bell 302 adjacent to which there is disposed the clapper 303 which is attached to the lever 299. When the lever 299 is rocked on its pivot by the movement of the transfer lever 113, the clapper strikes the bell 302 and sounds a warning. Arranged in the machine below the lever 232 and pivoted on the bracket 304 is a bell crank lever 305, one arm of which is connected to the lever 299 by the link 306 and the other arm of which is provided with an ear 307 which is disposed below the rear portion of the lever 232. As the lever 299 is rocked by the transfer lever 113 at the left of the series of active numeral wheels, the bell crank lever 305 is rocked to lift the rear portion of the lever 232, raising the notch 234 from engagement with the pin 235 on the clutch control lever 203 thus freeing the clutch control lever and permitting it to be moved by its spring, to cause disengagement of the clutch and the locking of the clutch housing in full cycle position. When this occurs, the actuator has rotated one revolution too many and the addition key 216 is then depressed causing a single rotation of the actuator in the opposite direction, so that the true quotient figure is shown.

Other features of the machine including the quotient register and its carrying mechanism are fully described in my said application Serial Number 693,546, of which this application is a division.

I claim:

1. In a motor driven calculating machine, a counting mechanism comprising a series of counting wheels in axial alinement, tens carrying levers associated with said wheels, a rotary actuator for actuating the counting mechanism, a clutch interposed between the motor and the actuator, means for causing the motor to rotate the actuator in either direction, and means operative by the movement of the last numeral wheel at the left of the series between its 9 and 0 positions for disengaging and locking the clutch.

2. In a motor driven calculating machine, a counting mechanism comprising a series of counting wheels in axial alinement, a rotary device for actuating the counting mechanism, a clutch interposed between the motor and the device, and means operative by the movement of the last counting wheel at the left of the series from 0 to 9 position to lock the clutch in full cycle position.

3. In a motor driven calculating machine, reversible numeral wheels, actuating mechanism therefor having a reversible cycle of operation, and automatic means for disconnecting the mechanism from the motor and stopping the mechanism in neutral position, including a member rotatable in the same direction throughout a forward or reverse cycle of movement, an element spring-urged into locking engagement with said rotatable member, means for holding said element from engagement with the rotatable member and means controlled by a selected numeral wheel for tripping said holding means.

4. In a calculating machine, numeral wheels, a reversible rotary actuator therefor having a full-cycle position, and means controlled by a selected numeral wheel to lock said actuator in full-cycle position against both forward and retrograde movement.

5. In a calculating machine, numeral wheels, a reversible rotary actuator therefor having full-cycle position, and means controlled by a selected numeral wheel in positive operation of said actuator to lock said actuator in full-cycle position against both forward and retrograde movement.

6. In a calculating machine, numeral wheels, a reversible rotary actuator therefor, an operation control element for starting the machine to perform a division calculation, means including a rockable member for locking the actuator in full-cycle position, means operable by the movement of said element to starting position for moving said rockable member to inoperative position to permit the actuator to rotate, and means controlled by a selected numeral wheel for restoring said member to operative position to lock said actuator against both forward and retrograde movement.

7. In a motor driven calculating machine, numeral wheels, a reversible rotary actuator therefor having full-cycle position, means controlled by a selected numeral wheel to disconnect said motor from said actuator and to lock said actuator in full-cycle position against both forward and retrograde movement.

8. In a calculating machine, numeral wheels, a reversible rotary actuator therefor having a full-cycle position, means for automatically determining the number of negative rotations of said actuator, in combination with means controlled thereby for locking said actuator in full-cycle position against both forward and retrograde movement.

9. In a calculating machine, numeral wheels, a reversible rotary actuator therefor having full-cycle position, means controlled by a selected numeral wheel in negative operation of said actuator to lock said actuator in full-cycle position against both forward and retrograde movement.

10. In a calculating machine, numeral wheels, a reversible rotary actuator therefor having full-cycle position, a motor for driving said actuator, means controlled by a selected numeral wheel in

the performance of a division calculation to disconnect said motor from said actuator and to lock said actuator in full-cycle position against both forward and retrograde movement when the divisor has been over-subtracted from the dividend.

11. In a calculating machine, numeral wheels, a reversible rotary actuator therefor having full-cycle position, a motor for driving said actuator, means controlled by a selected numeral wheel in the performance of a division calculation to disconnect said motor from said actuator, and to lock said actuator in full-cycle position against both forward and retrograde movement when an over-subtraction error has been corrected.

12. In a calculating machine, numeral wheels, a reversible rotary actuator therefor, means controlled by a selected numeral wheel in the performance of a division calculation for positively locking said actuator against both forward and retrograde movement when the quotient has been determined.

13. In a calculating machine, numeral wheels, a reversible rotary actuator therefor having full-cycle position, means operable in the performance of problems in division for automatically determining the number of positive rotations of said actuator, in combination with means controlled thereby for locking said actuator in full-cycle position against both forward and retrograde movement.

14. In a calculating machine, numeral wheels, a reversible rotary actuator therefor having full-cycle position, an operation control element for starting the machine to perform a division calculation, means including a rockable member for locking said actuator in full-cycle position, means operable by the movement of said element to starting position for moving said rockable member to inoperative position, including means for retaining said member in said inoperative position, and means controlled by a selected numeral wheel for withdrawing said retaining means to permit said member to rock into operative position to lock said actuator.

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