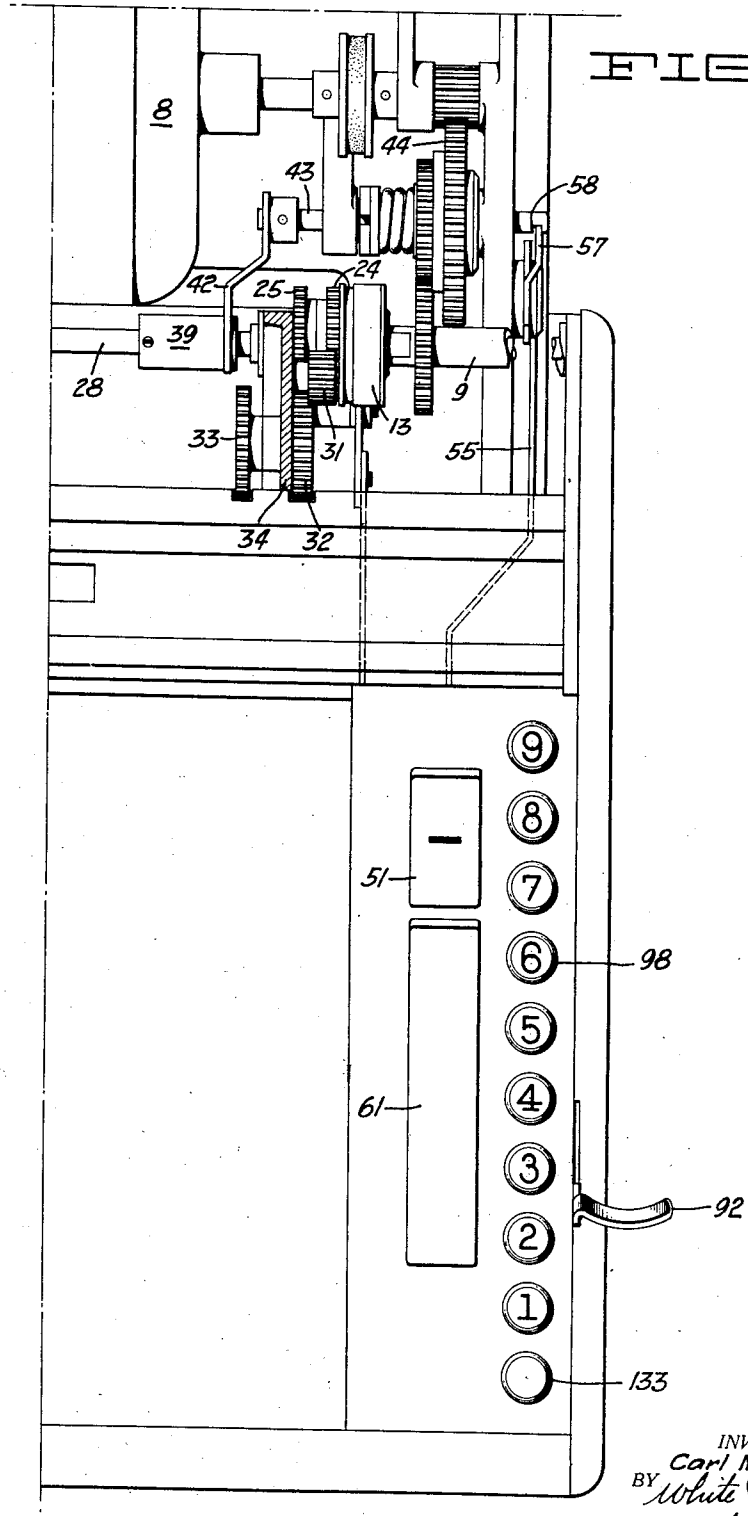
Nov. 20, 1934. C. M. F. FRIDEN 1,981,226

CALCULATING MACHINE

Original Filed Dec. 10, 1923 8 Sheets-Sheet 1

FIG. 1.



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CALCULATING MACHINE

Original Filed Dec. 10, 1923 8 Sheets-Sheet 2

FIG. 3.

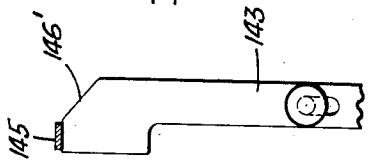

FIG. 2.

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CALCULATING MACHINE

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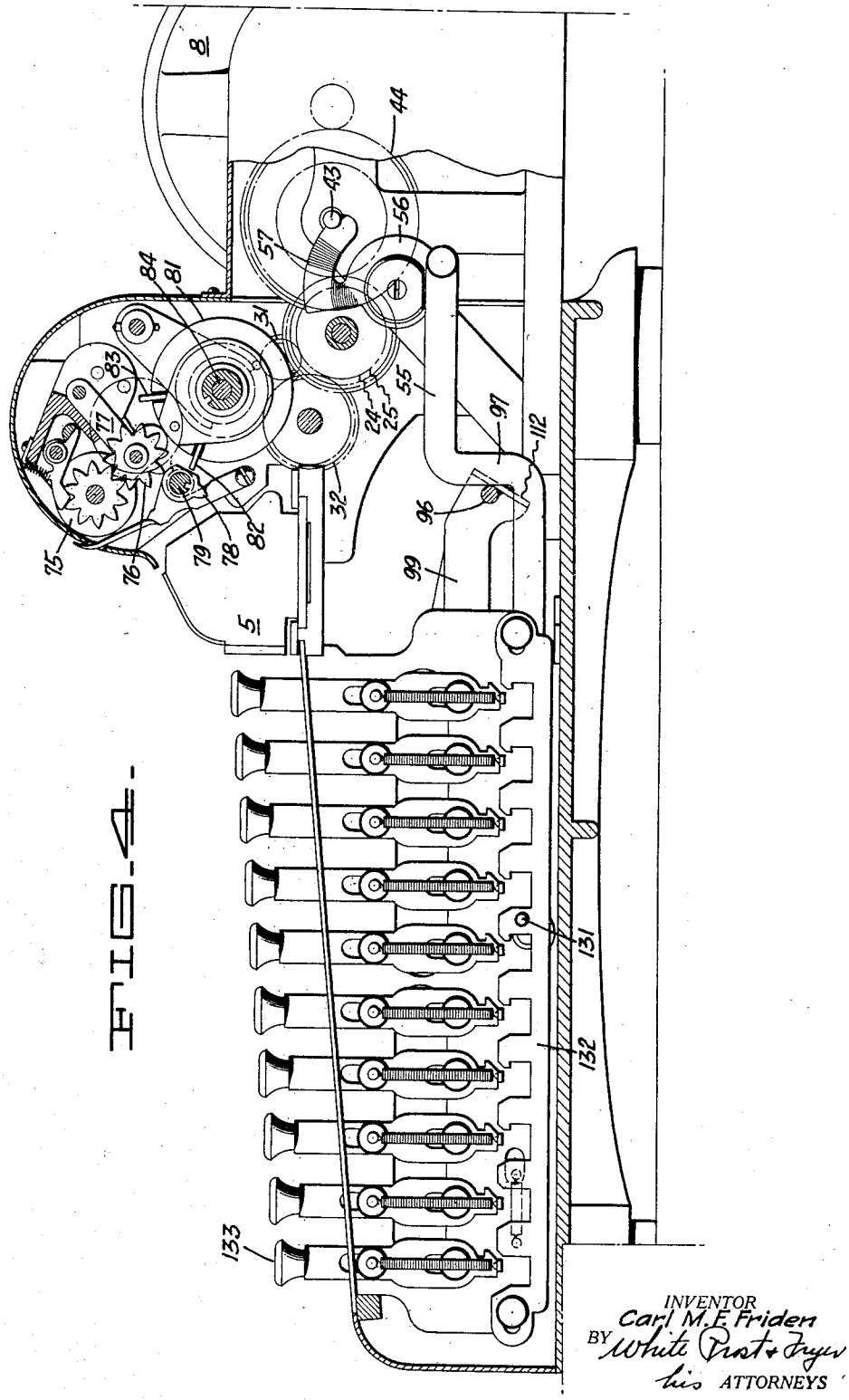

FIG. 4.

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CALCULATING MACHINE

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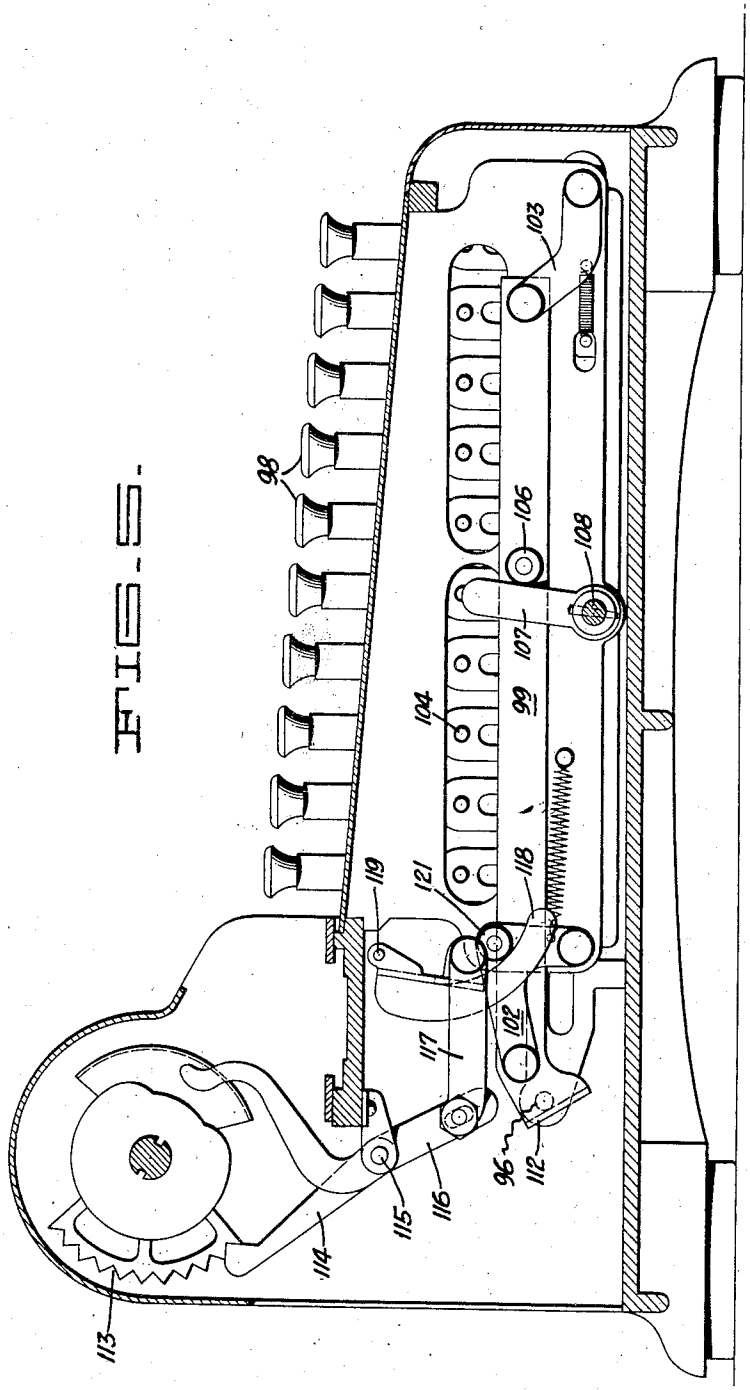
FIG. 5.



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CALCULATING MACHINE

Original Filed Dec. 10, 1923 8 Sheets-Sheet 5

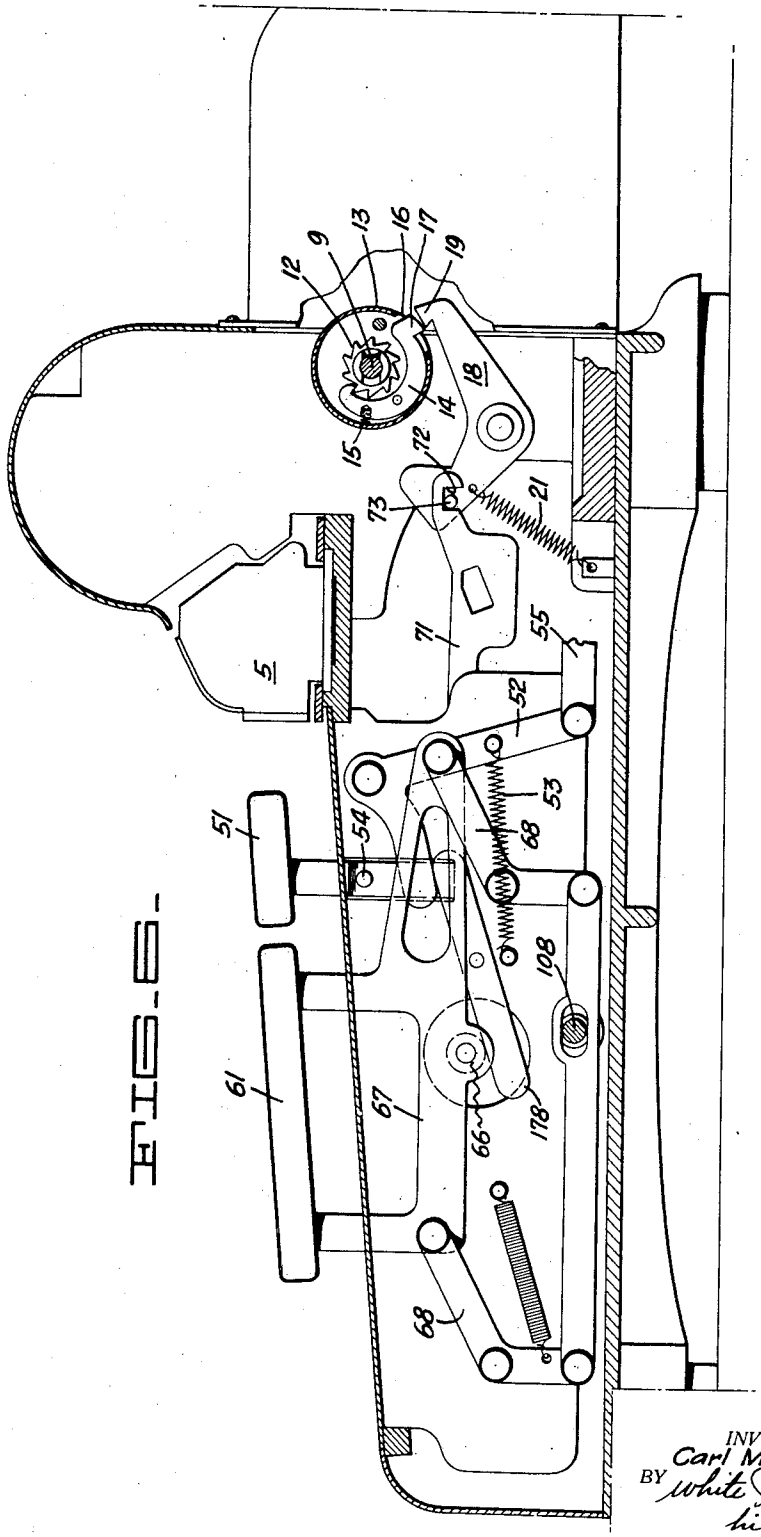

FIG. 5.

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CALCULATING MACHINE

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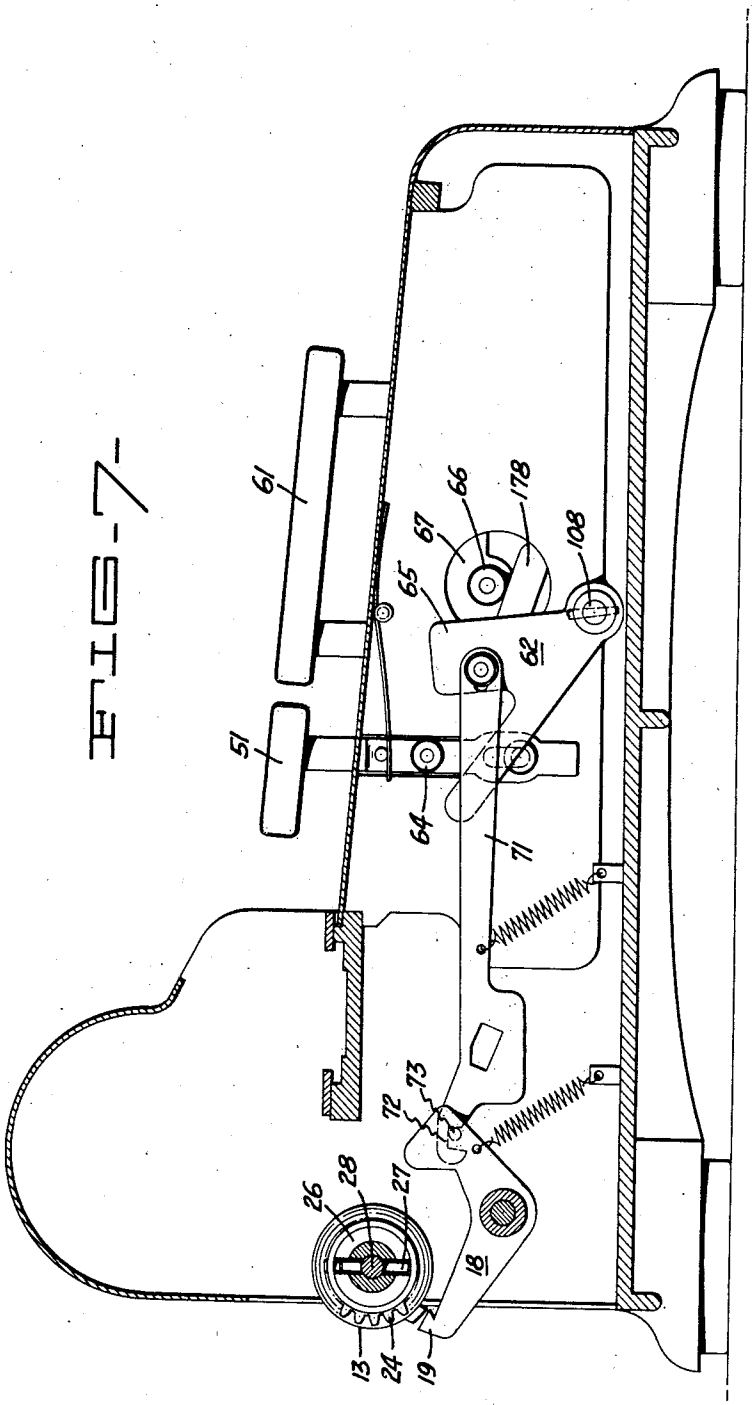
FIG-7-



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CALCULATING MACHINE

Original Filed Dec. 10, 1928 8 Sheets-Sheet 7

FIG. 9.

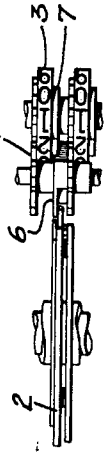


FIG. 10.

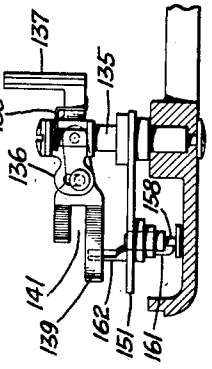
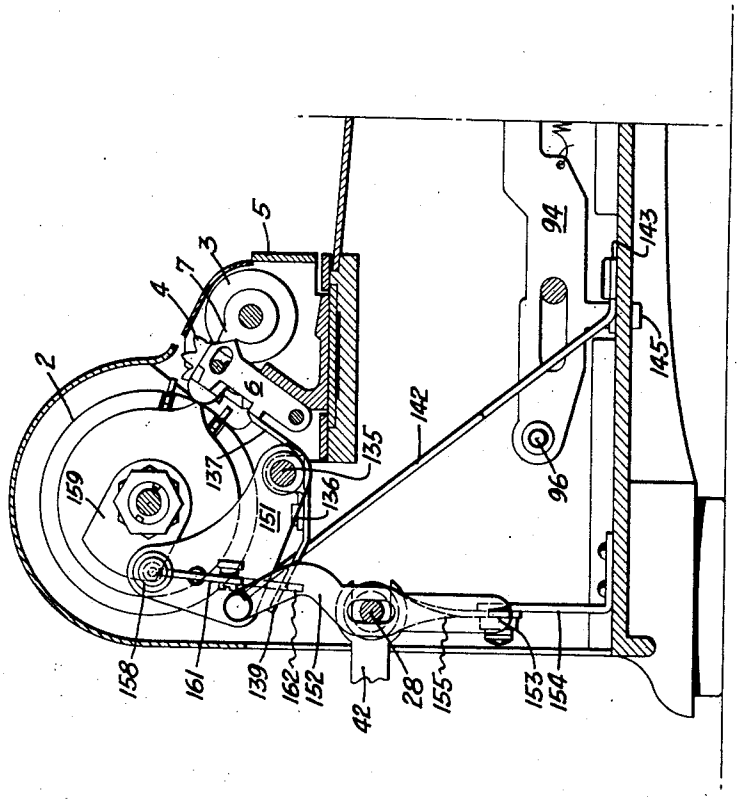


FIG. 8.



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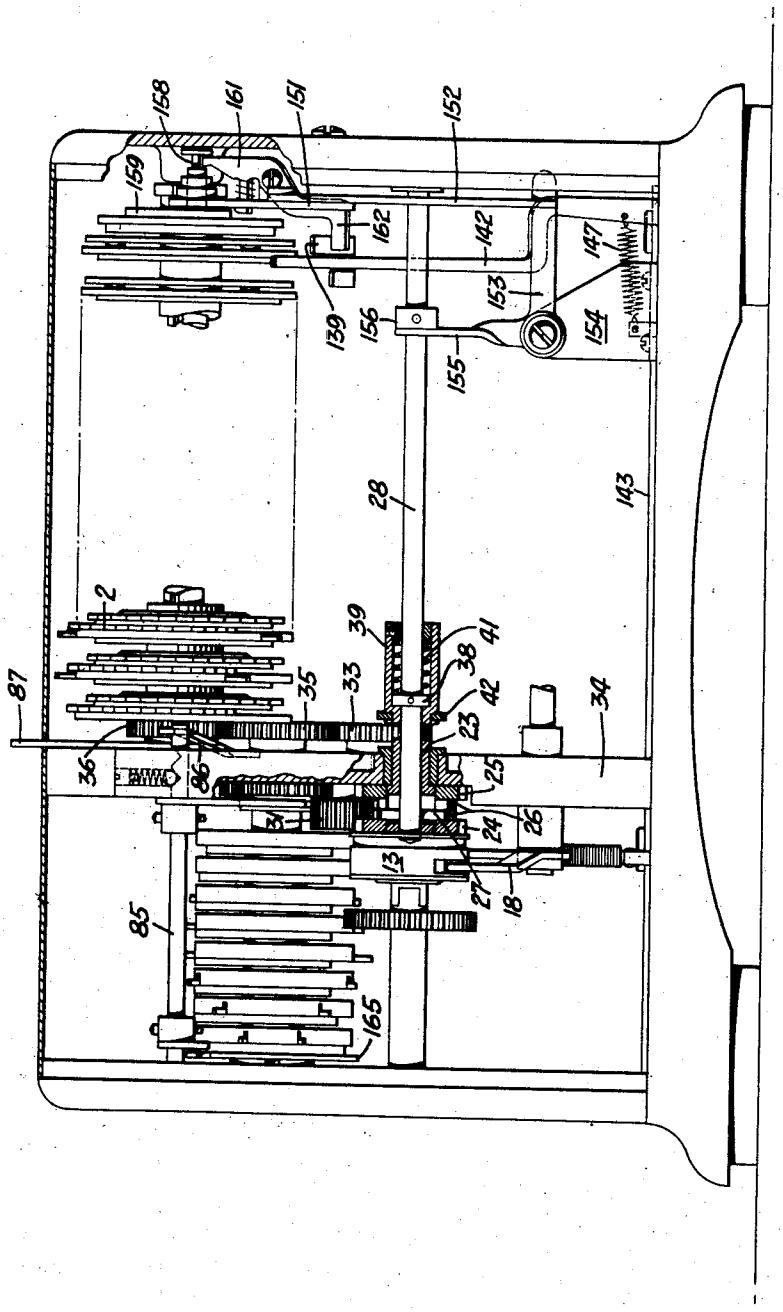
CALCULATING MACHINE

Original Filed Dec. 10, 1923 8 Sheets-Sheet 8

FIG. 11.



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Patented Nov. 20, 1934

1,981,226

UNITED STATES PATENT OFFICE

1,981,226

CALCULATING MACHINE

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

Application December 10, 1928, Serial No. 324,855
Renewed October 13, 1933

8 Claims. (Cl. 235—79)

The invention relates to calculating machines of the motor driven type, and particularly to the means for controlling the actuation of the machine in performing problems in the four rules calculation.

The calculating machine comprises a rotary actuator and a plurality of keys for introducing values into the actuator. The depression of a key introduces a value corresponding to the numeral on the key into the rotatable actuator and rotation of the actuator serves to transfer these values into the counter or register, to effect the calculating operation. The values introduced into the actuator are transmitted, on rotation of the actuator in either direction, to the figure disc of the counting mechanism, which, for the purpose of making direct action of the selected values on the figure discs of highest order possible, is disposed in parallel displaceable relation to the axis of the actuator. The counting mechanism comprises a series of numeral wheels which are mounted on a carriage, which is displaceable transversely of the calculating machine, with respect to the actuator.

The present invention relates particularly to means for controlling the operation of the machine in the performance of problems in division. These means include devices operative to correct an overdraft registration in the register. The overdraft registration correcting means is normally disabled, so that it may not function when the machine is operated to perform problems in subtraction, and is enabled only when the machine is used to perform problems in division.

An object of the invention is to provide a calculating machine, with starting control means, which, when actuated, enables the overdraft control means and initiates divisional movement of the actuator.

Another object of the invention is to provide starting control means for the divisional operation, which means operate to cause continuous movement of the actuator until the actuator is stopped by the overdraft control means.

Another object of the invention is to provide, in a calculating machine, individual starting control means, which, when operated, will invariably cause the calculating machine to operate to solve a problem in division.

The invention possesses 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 my 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 form of mechanism embodying my invention, as it is embodied in a Marchant calculating machine, 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.

Referring to said drawings:

Figure 1 is a top or plan view of a portion of a calculating machine embodying my invention, a portion of the casing being removed to disclose the construction of the driving mechanism.

Fig. 2 is a vertical section through the calculating machine showing the mechanism for controlling the operation of the machine in solving problems in division.

Fig. 3 is a section taken on the line 3—3 (Fig. 2) showing a fragment of the control mechanism.

Fig. 4 is a vertical section through the calculating machine showing the driving mechanism and a portion of the control mechanism.

Fig. 5 is a vertical section through the calculating machine showing the control mechanism and the mechanism for locking the actuator units in adjusted position.

Fig. 6 is a vertical section through the calculating machine showing the mechanism for controlling the transmission of motion from the motor to the actuator.

Fig. 7 is a vertical section through the machine showing the means for controlling the clutch.

Fig. 8 is a vertical section through a portion of the machine showing the overdraft control mechanism, which is operative when the machine is set to perform problems in division.

Fig. 9 is a plan view of a single actuator element, and the associated tens carrying mechanism.

Fig. 10 is a plan view of the overdraft control mechanism.

Fig. 11 is a rear elevation of the machine, parts thereof being shown in section, to more fully disclose the overdraft control mechanism.

The invention relates to motor driven calculating machines, and particularly to the control mechanism for controlling the operation of the actuating means, the machine is provided with positive and negative operation keys, depression of the positive key serving to cause rotation of the actuator in an additive direction, and depression of the negative key serving to cause rotation of the actuator in a subtractive direction. The positive key is used primarily in performing problems in addition and multiplication and the negative key is used primarily in performing problems in subtraction. The machine is provided with a further operation key or lever, which, when manipulated, adjusts the mechanism to produce subtractive rotation of the actuator, adjusts the mechanism which functions to stop the actuator, following an overdraft registration in the register, and initiates rotation of the actuator. The division operation key or lever is associated with means which are effective only when said key or lever is manipulated

for automatically reversing the direction of rotation of the actuator upon an overdraft registration of the numeral wheels, and to stop the actuator at the end of one cycle of such reversed movement, so that the quotient register will show the true quotient figure.

The present machine includes a suitable frame, within which the various instrumentalities of the calculating machine are arranged. Many of these instrumentalities, including the specific construction of the actuator, the connections between the numeral keys and the actuator, the automatic multiplication mechanism, and other features of the machine are fully disclosed in my United States Letters Patent No. 1,643,710, of September 27, 1927, to which reference is hereby made for a complete disclosure of those features of the calculating machine which are not specifically disclosed in this application. The calculating machine includes a reversible rotary actuator 2, comprising a series of units, into which values are introduced by the depression of keys. Each unit is also provided with tens carrying pins for transferring values to the numeral wheels of the counting mechanism of the next highest order. Each unit is provided with two tens carrying pins, and the two series of pins on the actuator are arranged in diverging spirals. One series of pins is effective in carrying tens during an additive or forward rotation of the actuator, and the other series of pins is effective in carrying tens during a subtractive or reverse rotation of the actuator. The values introduced into the actuator by the depression of keys are transferred, upon rotation of the actuator in either direction, to the numeral wheels 3 of the counting mechanism, or counting register as it is generally known, through the intermediate gears 4. The product register, together with its associated intermediate gears and transfer levers, is arranged on a transversely movable carriage 5, which is guided in suitable trackways in the frame, so that the carriage may be moved to establish cooperation between any desired numeral wheel and any desired unit of the actuating means, within the limits of the movement of the carriage. Associated with each counting wheel 3 is a transfer lever 6, which is actuated upon movement of the numeral wheel, forwardly to, or reversely from, zero position, this movement being referred to as a transitional carry. This movement of the transfer lever 6 is effected by an associated toothed member 7, secured to the numeral wheel.

The actuator is driven by the motor 8 and, interposed between the motor of the actuator, is a clutch for connecting and disconnecting the motor to and from the actuator, and a reversing mechanism, whereby the direction of rotation of the actuator may be reversed. The clutch, shown in Figure 6, embodies a driving shaft 9, suitably connected to the motor shaft by means of the speed reduction gearing, as shown in Figure 1, and the driving shaft is provided with a ratchet pinion 12, which rotates continuously with the motor. The motor is provided with a switch, as is shown in my aforesaid application, Serial No. 252,175, which is closed only during the time that the machine is functioning to perform a problem in calculation. Journalled on the driving shaft 9, and enclosing the ratchet pinion 12, is a clutch housing 13, within which is pivoted a dog 14, which is adapted to be moved into and out of engagement with the ratchet pinion 12, to connect and disconnect the pinion and the housing. The dog or pawl 14 is urged toward engagement with the pinion 12 by a spring 15. The clutch housing 13 is provided on its periphery with an aperture 16, through which a foot 17, on the end of the pawl 14, extends when the pawl is in engagement with the pinion. The pawl is disengaged from the pinion by inward movement of the foot 17, and this is accomplished by means of the clutch control lever 18, which is provided on its end with a foot 19, which, when the lever 18 is released of its restraint, is moved into contact with the periphery of the housing 13 by the spring 21, and, as the housing rotates, the foot 19, contacts with the foot 17 and enters the aperture 16, thereby disengaging the clutch and locking the clutch housing. The clutch housing is so positioned, with respect to the actuator, that when the clutch housing is locked, the actuator is locked in full cycle position.

Secured to the clutch housing 13 is a hollow stub shaft 23, which forms part of the reversing gearing. Journalled on the hollow shaft 23 are two gears 24 and 25, either of which may be directly connected to the hollow shaft to rotate therewith. Each of the gears 24 and 25 is provided on its inner periphery with an interrupted flange 26, the two flanges being in contact. The hollow shaft 23 (Fig. 11), is provided with an aperture extending diametrically therethrough and disposed in the aperture is a cross pin 27, which is adapted to seat in the interruption of either of the flanges 26. The pin 27 is of less diameter than the depth of the flange, so that the pin may seat entirely within either flange. The pin is movable transversely in the direction of the axis of the shaft 23, to bring it into engagement with either of the gears 24 or 25, and for this purpose the pin 27 is secured to the rod 28, which extends outward from the end of the hollow shaft 23 and is suitably supported at its other end in the frame of the machine. The interruption in the flanges 26 are somewhat wider than the diameter of the pin 27, to permit the pin to be shifted to reverse the direction of rotation of the actuator, without bringing the actuator to a stop. Meshing with the gear 24 is an idler gear 31, which in turn meshes with a gear 32, which is directly in mesh with the gear 25. Therefore, the gear 32 is driven in one direction when the gear 24 is in engagement with the hollow shaft 23, and in the opposite direction when the gear 25 is in engagement with the hollow shaft 23. Secured to the shaft of the gear 32 is a gear 33, lying on the opposite side of the intermediate wall 34, and the gear 33 is connected to the gear 36 on the actuator shaft by the intermediate gear 35. Therefore, shifting of the pin 27 reverses the direction of rotation of the actuator.

Means are provided for either manually or automatically shifting the pin 27 to reverse the direction of rotation of the actuator. Secured to the shifting rod 28 is a collar 38, which is enclosed by the spring housing 39, between the end of which and the collar 38 there is inserted a compression spring 41 (Fig. 11), which holds the housing tightly against the collar, so that movement of the collar toward the right will effect movement of the rod 28 and permitting movement of the rod 28 to the right without moving the spring housing. In Figure 11, the pin 27 is shown in engagement with the gear 24, thus producing reverse or subtractive drive of the actuator. Movement of the pin 27 to the right and into engagement with the gear 25 will cause forward rotation of the actuator. Engaging in a cir-

cumferential groove in the spring housing 39, is a fork 42, which is attached at its other end to the shifting rod 43 (Fig. 1), which is suitably journalled within the frame of the machine and which extends through the hollow shaft, carrying the transmission gear 44. By movement of the shifting rod 43, which is manually operated, the pin 27 may be moved to cause forward or reverse drive of the actuator. The direction of rotation of the actuator may be reversed manually by moving the fork 42 and is reversible automatically by movement of the rod 28. These two means of accomplishing the reversal of rotation of the actuator will be set forth in full hereafter.

Manual operation of the reversing gear is effected by the depression and release of the negative operation key 51, which is preferably arranged on the keyboard of the machine. Pivoted within the machine is a bell crank lever 52 (Fig. 6) which is normally held in restrained position by the spring 53, and when the lever 52 is in such restrained position, the reversing mechanism is in position to cause forward or additive rotation of the actuator. One leg of the bell crank lever 52 underlies a pin 54 on the stem of the negative operation key 51, so that when they key 51 is depressed, the lever 52 is moved against the restraint of the spring 53. The lever 52 is connected by means of the link 55, with a lever 56, having a sector shaped cam 57 (Fig. 4), which engages in a slot 58 (Fig. 1) in the projecting end of the rod 43. Depression of the negative operation key 51, therefore, shifts the rod 28 to cause reverse rotation of the actuator.

The above described operation occurs when the machine is employed in problems of subtraction. Means are provided for setting the machine into operation to perform problems in division, and this means is associated with the link 55, so that when the division operation means is operated, the link 55 is shifted, shifting the rod 43 to cause reverse rotation of the actuator. Mechanism for accomplishing this will be hereinafter described.

The machine is also provided with a positive operation key 61, depression of which causes additive rotation of the actuator. The connection between the motor and the actuator is controlled by the clutch, and the action of the clutch is controlled by the lever 18, which is normally held in clutch disengaging position by the spring 21. Means are provided whereby the depression of either key 51 or key 61 will rock the lever 18 to move it out of engagement with the clutch housing 13, to permit engagement of the clutch. Pivoted within the machine is a bell crank lever 62 (Fig. 7) underlying a roller 64 on the stem of the negative operation key 51, and having a substantially vertical arm 65, lying in back of a roller 66, carried by the frame 67 of the positive operation key 61. The frame 67 is mounted on levers 68 in such manner that depression of the positive operation key 61 causes backward movement of the roller 66 against the upright portion 65 of the bell crank lever, thereby rocking said lever. In Figure 7, the bell crank lever 62 is shown in its rocked position, that is, the position to which it is moved by the depression of either of the keys 51 or 61, although in the drawings these keys are shown in their elevated positions. Pivoted to the arm 65 of the lever 62 is a bar 71, which is connected to the clutch control lever 18, in the present instance, the bar being provided at its rear end with a notch 72, in which a pin 73 on the forward end of the clutch control lever 18 is disposed. Therefore, rearward movement of the bar 71 rocks the lever 18 upon its pivot to move it out of engagement with the clutch housing. When the clutch is engaged by depression of either key 51 or 61, the release of either of the depressed keys will cause the clutch lever 18 to again move into engagement with the clutch housing. Other means are provided for controlling the movement of the clutch control lever 18, when the machine is employed in solving problems in division, as will be set forth hereinafter.

The calculating machine is also provided with a register or counting mechanism, usually known as the multiplier register or quotient register, for indicating directly the proper and correct multiplier or quotient. This register comprises a series of numeral wheels 75 (Fig. 4), each numeral wheel being provided with an intermediate gear 76, and a transfer lever 77. Means are provided for causing a single operation of a selected numeral wheel for each rotation of the actuator in either direction, and tens carrying means are provided so that the register will always show the correct figure. The numeral wheels 75 are actuated in time with the rotation of the actuator by the rotatable single toothed member 78, which is splined to the shaft 79, which is rotatable in time with the actuator.

The tens carrying device in the particular embodiment shown, comprises a drum 81, having two series of tens carrying pins 82 and 83 thereon, the pins in the two series being arranged in diverging spirals so that they are reversibly operated upon reverse rotation of the drum. The drum is secured to a shaft 84, journalled in the frame of the machine, and the tens carrying pins 82 and 83 cooperate with the transfer levers 77 to transfer values to the numeral wheels of the next highest order. Means are provided for reversing the direction of rotation of the actuator 78 and the drum 81. The drum is provided with a reversing gear, such as is shown in my aforesaid Patent No. 1,643,710, and comprising a shifting rod 85, which is provided on its end with a slot, which is engaged by the bent or warped end 86 of the lever 87, which projects through an aperture in the casing, so that by moving the lever 87 the direction of rotation of the drum may be reversed. In performing problems in division, it is essential that the tens carrying drum 81 rotates in a direction to show increasing values on the register 75, whereas, the main actuator, comprising the actuator units 2, must rotate in a reverse or subtractive direction. Means are provided, therefore, so that the tens carrying drum and the actuating finger 78 may be rotated in the same or the opposite direction to the actuator 2, depending upon the position of the lever 87. The actuating member 78 is adjustable longitudinally of the shaft 79, into cooperative relation with the numeral wheel 75 of the desired numerical order. The mechanism for shifting the actuator 78 laterally in time with and in opposition to the movement of the carriage 5 is fully disclosed in my aforesaid patent above referred to.

The machine is provided with means, which when actuated initiate operation of the machine to perform problems in division. Before manipulating this member, the lever 87 is placed in "division" position. The manipulation of this member shifts the reversing gear to cause subtractive rotation of the actuator 2, causes engagement of the clutch 12—14 and enables the over-

draft control mechanism. Arranged at the side of the machine is a lever 91, having a finger piece 92, which, when drawn forward, initiates the division operation.

I shall first describe the mechanism for shifting the rod 28 to cause subtractive rotation of the actuator. Pivoted to the lower end of the lever 91 is a bar 94, which is normally held in forward position by the spring 95. At its rear end, the bar 94 is provided with a laterally extending pin 96, which, as shown in Figure 4, lies in front of the upstanding portion 97 of the link 55. Consequently, when the finger piece 92 is moved forward, the pin 96 is moved backward, moving the link 55 backward, and thereby moving the cam 57 to shift the rod 43 and consequently the rod 28.

Forward movement of the finger piece 92 also rocks the clutch control lever 18 to free the clutch housing 13 and cause engagement of the clutch. In the present instance, this mechanism is associated with the starting control mechanism which is operated by depression of one of the automatic multiplier keys 98. Associated with the automatic multiplier keys is a bar 99 (Fig. 5), which is mounted on the links 102, 103, and which is disposed below the pin 104, projecting laterally from the stem of the keys 98, the mounting of the bar 99 being such that on depression of a key 98, the bar is moved downwardly and backwardly. Mounted on the bar 99 is a roller 106, which is positioned immediately in front of the lever 107, which is secured to the shaft 108, so that backward movement of the bar 99 will cause a counter-clockwise movement of the shaft 108. The bell crank lever 62 (Fig. 7) is also secured to the shaft 108, so that, upon counter-clockwise movement of the shaft 108, the lever 62 is rocked backward, operating through the bar 71 to rock the clutch control lever 18 in a counter-clockwise direction, releasing the clutch housing and permitting engagement of the clutch. In the present construction, the bar 99 is provided at its rear end with a transversely extending lip 112, which lies directly behind the pin 96 and which is disposed substantially at right angles to the path of movement of the pin 96. Consequently, when the link 94 is moved backward, the pin 96 engages the lip 112 and causes a backward movement of the bar 99, which backward movement causes counter-clockwise movement of the shaft 108 and consequently moves the clutch control lever 18 to cause engagement of the clutch.

The backward movement of the bar 99 also serves to lock the adjustable element of the actuator in adjusted position. Each actuator unit includes a selecting unit, which is movable to adjusted position, usually by the depression of a key in the keyboard. Each selector unit is provided with an arcuate serrated member 113, which is engaged by locking means when the actuation of the machine is initiated. This locking means constitutes a pawl 114 pivoted at 115, there being one pawl for each actuator unit, and all of the pawls being secured to the shaft 115. Also secured to the shaft 115 is a lever 116, which is connected by means of the link 117, to the curved lever 118, which lever is pivoted at 119. Carried by the link 102 is a roller 121, which is in engagement with the top face of the lever 118. When the bar 99 is moved backward, the roller 121 is moved backward, causing the lever 118 to rock backward and thereby moving the locking pawls 114 into engagement with the arcuate toothed members 113, thereby locking the selecting element in adjusted position.

Means are provided for latching the lever 91 in its forward position and for holding it in such position until it is released by manual manipulation, in the event that an error has been accidentally introduced into the machine, or automatically, by the operation of the overdraft control mechanism. The bar 94 (Fig. 2) is provided with a notch 123, which, when the lever 91 is pulled forward, is engaged by the spring pressed pawl 124, which is pivoted at 125. The pawl is provided with a nose 126, under which is disposed one end of a bell crank lever 127, fulcrumed on the screw 128. At its other end, the lever 127 is provided with a shoe, 129, which lies directly behind the pin 131, which is secured to the slide 132 (Fig. 4), which forms a part of the automatic multiplier mechanism. Depression of the zero or clearance key 133 of the bank of automatic multiplier keys moves the slide 132 backward, thereby rocking the lever 127 in a clockwise direction and raising the latch 124 from engagement with the bar 94, thereby permitting the lever 91 to spring forward, resulting in the stopping of the machine. This manual stopping means is used to stop the machine when it is observed that the human element has caused the introduction of an error into the machine. The means for automatically releasing the lever 91 and stopping the machine, by the operation of the overdraft control mechanism, will be hereinafter described.

In machines of this character, when used in the performance of problems in division, the numeral wheels of the product register to the left of the wheels being operated upon by the actuator, change sign when an endeavor is made to divide the divisor into the dividend a greater whole number of times than is possible. Under such circumstances, the numeral wheel registration changes from a positive to a negative registration or from a negative to a positive registration, and this change or overdraft registration has heretofore been utilized to throw into operation mechanism for stopping the machine. Division is accomplished by a subtractive rotation of the actuator, and, when a condition of overdraft registration existed, and the machine had been brought to a stop, the positive operation key was then depressed to cause rotation of the actuator in an additive direction, for one revolution, to correct the overdraft registration. This correction of the overdraft registration by operation of the positive operation key produced the proper number in the product register and the proper indication in the quotient register. In the present construction, the overdraft registration is utilized to effect the automatic reversal of the direction of rotation of the actuator, without stopping the actuator, so that the actuator is given a forward or additive rotation and is then brought to a stop at the end of the first cycle of forward rotation. This means, however, is disabled when the machine is set for performing problems in addition, multiplication and subtraction, and is brought into operation only when the machine is set for performing problems in division. Therefore, this automatic reversal and stopping means does not function in the event of an overdraft registration during multiplication, which, if not observed, would result in the introduction of errors into the calculation. The pulling forward of the actuating lever 91 also serves to enable the automatically operating means for reversing the direction of rotation of the actuator in the event of an overdraft registra-

tion and to stop the actuator at the end of its first cycle of forward rotation. Therefore, in performing problems in division, the operator merely pulls forward on the lever 91 and this lever remains in its forward position, and the machine remains in operation until an overdraft registration has occurred, and until the overdraft is corrected by one forward rotation of the actuator. The lever 91 is then released and the mechanism brought to a stop.

The overdraft registration is usually indicated by a change of sign of the numeral wheel of the next to the highest order within the range of the actuator. This change of sign in a division operation is from zero to nine. On this change of sign, the toothed element 7 (Fig. 8) moves the transfer lever 6 backward. Pivoted on a stud 135 (Figs. 8 and 10) is a lever 136, having a transversely extending arm 137, which lies behind and in contact with the rear face of the transfer lever 6 at the left of the series being operated on. The arm 137 is held in engagement with the transfer lever by the spring 138, so that when the transfer lever 6 is rocked backwardly at the time of an overdraft registration or transitional carry, the lever 136 is rocked on its pivot. Secured to the lever 136 is a laterally shiftable arm 139, which is preferably provided with a slot 141 for receiving a laterally shifting member. This member is shifted to position to enable the overdraft control mechanism, by forward movement of the lever 91.

The arm 139 is shifted sidewise into and out of operative engagement with the reversing and stopping mechanism by means of the bar 142, the upper end of which is disposed in the slot 141. At its lower end, the bar 142 is secured to the transversely movable slide 143, and means are provided for causing transverse movement of this slide to swing the arm 139 into operative position, upon forward movement of the lever 91. The bar 94, which is pivoted to the lever 91, is provided with an ear or projection 145, which moves in a slot 146 in the base plate. The ear 145 engages the cam shaped or bevelled edge 146' of the slide 143, so that as the lever 91 is rocked the slide 143 is moved transversely. The slide 143 is normally held in retracted position by the spring 147, connected to the bar 142, this spring serving to normally hold the arm 139 in inoperative position and serving to hold the slide 143 with the lip 145 in engagement with the cam face 146, so that forward movement of the lever 91 will cause movement of the slide 143 and consequently of the bar 142, in a direction to enable the arm 139.

I shall now describe the overdraft control mechanism. Pivoted to the stud 135 (Fig. 10) is a lever 151 (Fig. 8), to which is pivoted the substantially vertical link 152, which at its lower end, bears against the arm of the bell crank lever 153 (Fig. 11). The bell crank lever is pivoted on the bracket 154, and the vertical arm 155 of the lever is forked and engages the collar 156, secured to the rod 28. The horizontal arm 153 of the bell crank lever is thus held elevated by the spring 41, associated with the rod 28. The lever 151, to which the bell crank lever is connected by means of the link 152, is therefore normally held in its elevated position.

Means are provided for quickly depressing the lever 151 at the proper time in the operation of the machine, to shift the rod 28 to shift the pin 27, and thus cause the reversal of rotation of the actuator. Mounted in the upper end of the lever 151 is a spring restrained pin 158, which is normally in extended position. This pin lies adjacent a cam 159 (Fig. 8), secured to the actuator shaft, and when the pin is moved inward, the pin lies in the path of the cam and is struck by the cam just before the actuator reaches full cycle position. When the cam strikes the projected pin, the lever 151 is rocked in a counter-clockwise direction, depressing the link 152 and thus moving the rod 28 to the right (Fig. 11) to shift the reversing gear. During the operation of division, the actuator rotates in a reverse or counter-clockwise direction, and the cam 159 is so positioned that it operates to shift the rod 28 when the actuator is in full cycle position, thereby permitting the shifting of the pin 27 from engagement with the gear 24 into engagement with the gear 25 without stopping the operation of the machine.

Pivoted on the lever 151 is a pin operating lever 161 (Fig. 11), which rocks in a plane at right angles to the plane of movement of the lever 151. The lever 161, at its upper end, engages in a groove in the pin 158, and at its lower end is provided with a foot 162, which lies below the plane of the rear end of the arm 139. When the machine is set for performing problems in addition, subtraction and multiplication, the arm 139 is rocked to one side, so that it does not overlie the foot 162, but when the lever 91 is operated to cause operation of the machine to perform problems in division, the arm 139 is moved to the position shown in Figure 11, where it overlies the foot 162. Consequently, upon the occasion of an overdraft registration or transitional carriage, the lever 136 is rocked, depressing the arm 139, consequently rocking the lever 161 to project the pin 158 into the path of the cam 159. At full cycle position, the cam 159 strikes the pin 158, rocks the lever 151 and shifts the pin 27 of the reverse gear to reverse the direction of rotation of the actuator. This is accomplished without disengaging the clutch.

Means are also provided for disengaging the clutch and stopping the actuator at the end of the first cycle of reverse or additive rotation. Secured to the shaft 84 of the tens carrying drum of the multiplier or quotient register, is a disc 165, which, when the machine is set to perform problems in division, rotates in a clockwise direction, when the actuator is rotating in a subtractive direction, and rotates in a counter-clockwise direction when the actuator is rotating in an additive direction. Projecting laterally from the disc 165 is a pin 166, which, on counter-clockwise rotation of the disc 165, serves to operate mechanism which results in stopping the machine, when the machine has been thrown into operation by pulling forward on the lever 91.

The means for stopping the machine comprises a pivoted slide 167, which is slidable on and pivoted on the stud 168. The movement of the pivoted slide is controlled by the spring 169, and the guide pin 172. The pivoted slide is free to rock or slide with respect to the stud 168, against the tension of the spring 169. At its rear end, the slide 167 is provided with a bevelled foot 173, which, when the machine is set to perform problems in division, lies in the path of the pin 166. The slide 167, however, is normally held in position so that the foot 173 is out of the path of the pin 166, so that the slide 167 cannot function except when the machine is operated in problems of division. Normally, the lower end of the slide 167 is in contact with the shelf 174, formed on

the end of the slide 175, which is pivoted to the lever 91. When the lever 91 is in its backward position, the slide 175 and the shelf 174 are in their forward positions, with the lower end of the slide 167 resting on the shelf 174. In this position, the slide 167 is rocked about its pivot so that the foot 173 is disposed out of the path 166. It is evident, therefore, that, unless and until, the lever 91 is pulled forward, the slide 167 is held in inoperative position. When the lever 91 is pulled forward, the slide 175 is moved to the position shown in Figure 2, permitting movement of the slide 167, to bring the foot 173 into the path of the pin 166. Upon clockwise rotation of the disc 165, the pin 166 strikes the bevelled surface of the foot 173, causing the slide 167 to move about its pivot; this rocking movement of the slide 167 performs no function. As a consequence of the overdraft registration, the direction of rotation of the disc 165 is reversed, causing the pin 166 to strike the flat end of the head 173 and thus move the slide downward, and forward, and this movement of the slide serves to release the lever 91 and stop the machine.

The latch lever 124 which holds the lever 91 in forward position is provided with a rearwardly extending arm 174, which underlies a roller 175 on the slide 167, and when this slide is moved forwardly and downwardly by the pin 166, the roller 175 strikes the arm 174 and rocks the lever 124 to release the bar 94 and consequently the lever 91. On release of the lever 91, the parts associated therewith and moved thereby return to inoperative position. The return movement of the bar 99, which is permitted by retraction of the pin 96, secured to the bar 94, permits the lever 107 and consequently the lever 62 to return to normal position. The return of the lever 62 to normal position permits the clutch control lever 18 to rock to engage and lock the clutch housing 13 and disengage the clutch. It is seen, therefore, that as a result of the overdraft registration the direction of rotation of the actuator is reversed, without causing disengagement of the clutch, and that the rotation of the actuator is stopped at the end of the first cycle of corrective rotation. This single cycle of corrective or additive rotation corrects the error in the quotient register and in the product register caused by the over registration which resulted in the transitional carriage. During the time that the machine is in operation, caused by pulling forward the lever 91, the negative operation key 51 is ineffective and the positive operation key 61 is locked against operation by the inter-locking lever 178.

The present machine also embodies a switch in the electric circuit, which is closed to energize the motor, when the clutch control lever 18 is rocked to release the clutch housing and cause engagement of the clutch, as shown in my copending application, Serial No. 252,175, filed February 6, 1928, but such switch mechanism is not disclosed herein, since the present invention is applicable to machines operated by a continuously rotating motor or a motor which is energized only by the manipulation of one of the control keys.

I claim:

1. In a motor driven calculating machine, numeral wheels, a uniaxial actuator therefor, means for connecting the motor to the actuator, normally disabled overdraft control means controlled by said numeral wheels and operable by said actuator and a manually operable member movable to operative position to actuate the connecting means to initiate subtractive rotation of the actuator and enable the overdraft control means.

2. In a motor driven calculating machine, numeral wheels, a reversible rotary actuator therefor, normally disabled overdraft control means controlled by said numeral wheels and operable by a member carried by said actuator, means for connecting the motor to the actuator, and means operable to enable the overdraft control means and connect the motor to the actuator.

3. In a motor driven calculating machine, numeral wheels, a uniaxial actuator therefor, clutching and reversing mechanism between the motor and the actuator, normally disabled overdraft control means and a manually operable member movable to operative position to enable the said overdraft control means and actuate the clutching and reversing mechanism to initiate subtractive rotation of the actuator.

4. In a motor driven calculating machine, numeral wheels, a uniaxial actuator therefor, clutching and reversing mechanism between the motor and the actuator, normally disabled overdraft control means, control means for the clutching and reversing mechanism, means for moving the overdraft control means to operative position and a common member to which said overdraft control moving means and said clutching and reversing control means are operatively connected.

5. In a motor driven calculating machine, numeral wheels, a uniaxial actuator therefor, reversing gearing between the motor and the actuator, an operating member movable to operative position, means for holding said member in operative position, normally disabled overdraft control means, means operated by movement of said member to operative position to enable said overdraft control means and means controlled by the overdraft control means for reversing the direction of rotation of the actuator while said operating member is held in operative position.

6. In a motor driven calculating machine, numeral wheels, a reversible rotary actuator therefor, means for connecting said actuator to the motor drive and means for dividing an amount registered upon said numeral wheels by an amount set up in said actuator, including normally disabled means for stopping the actuator to determine the instant quotient figure and means for simultaneously initiating divisional rotation of the actuator and enabling the said stopping means.

7. A motor driven calculating machine comprising a drive controlling clutch, reversing mechanism, means operated by the driven mechanism for causing a series of operations of said reversing mechanism without operating said clutch, and a single means for conditioning said means and operating said clutch.

8. In a motor driven calculating machine uniaxial actuating mechanism, a clutch for connecting the motor to said actuating mechanism, reversing mechanism, and means operated by said actuating mechanism for causing an uninterrupted series of operations of said reversing mechanism while said clutch remains engaged.

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