Nov. 5, 1935. F. L. FULLER 2,019,900

ACCOUNTING MACHINE

Original Filed Oct. 21, 1930 5 Sheets-Sheet 1

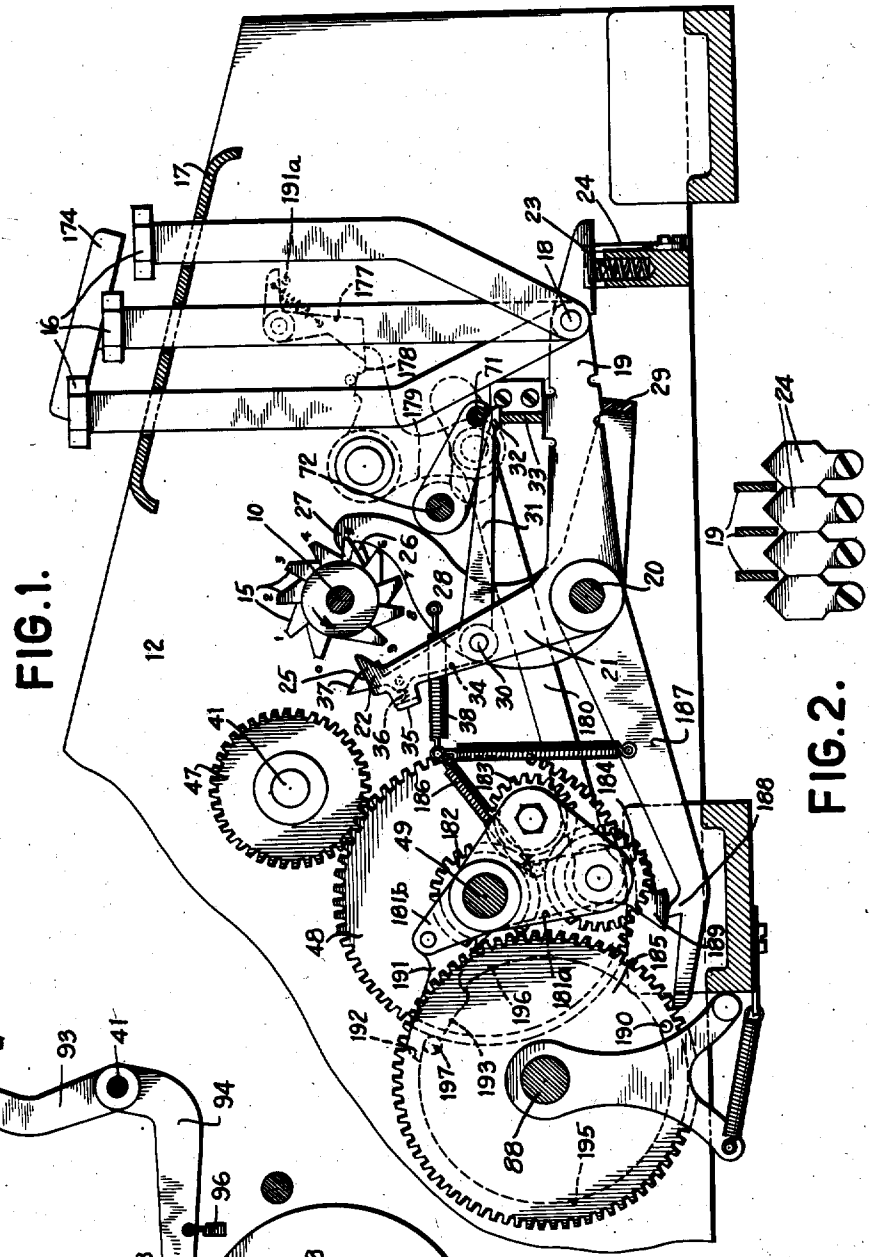

FIG. 1.

FIG. 2.

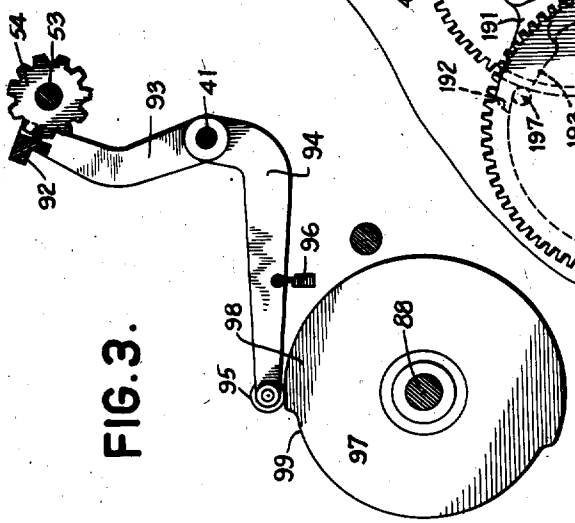

FIG. 3.

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ACCOUNTING MACHINE

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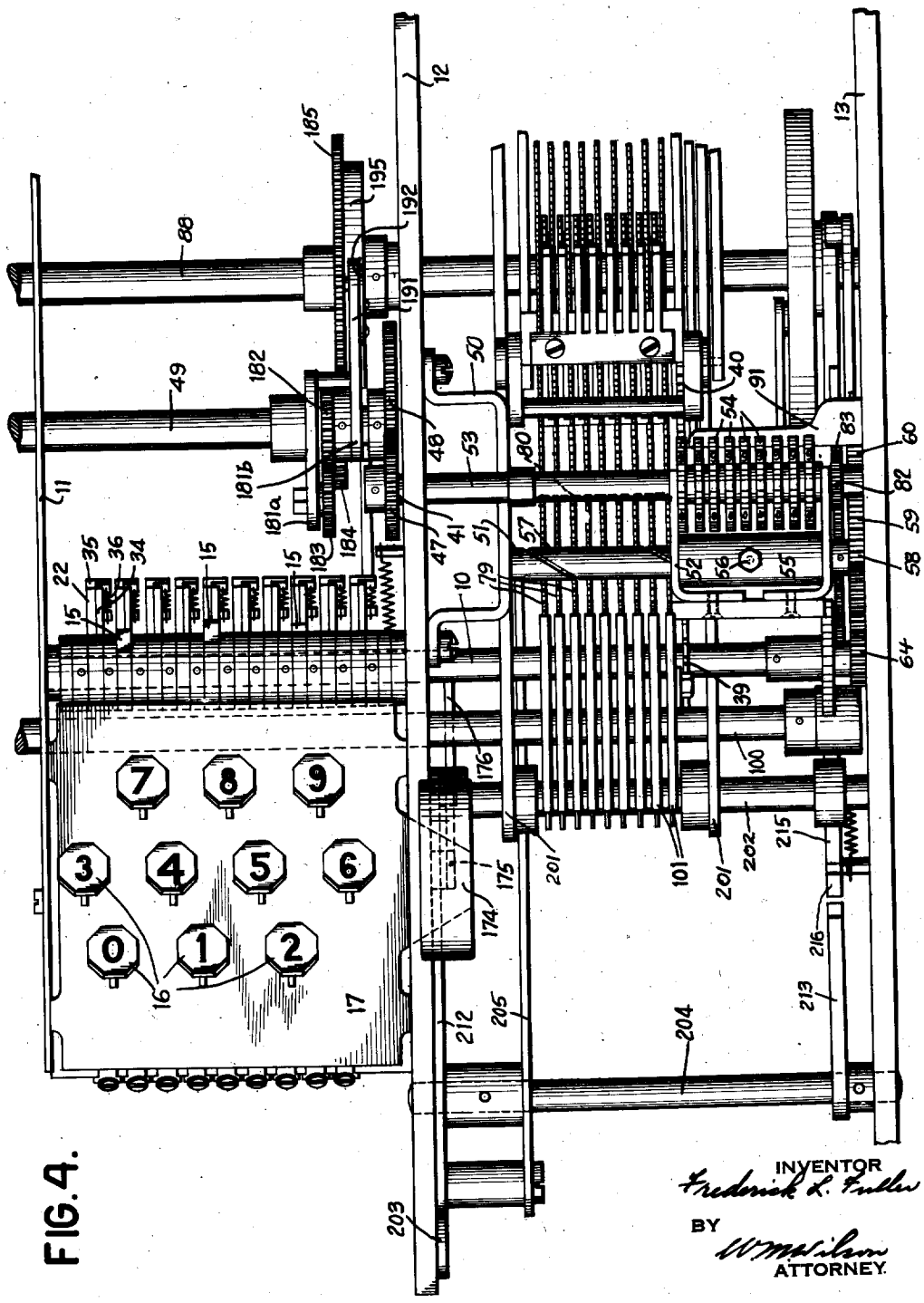

FIG. 4.

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ACCOUNTING MACHINE

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FIG. 6.

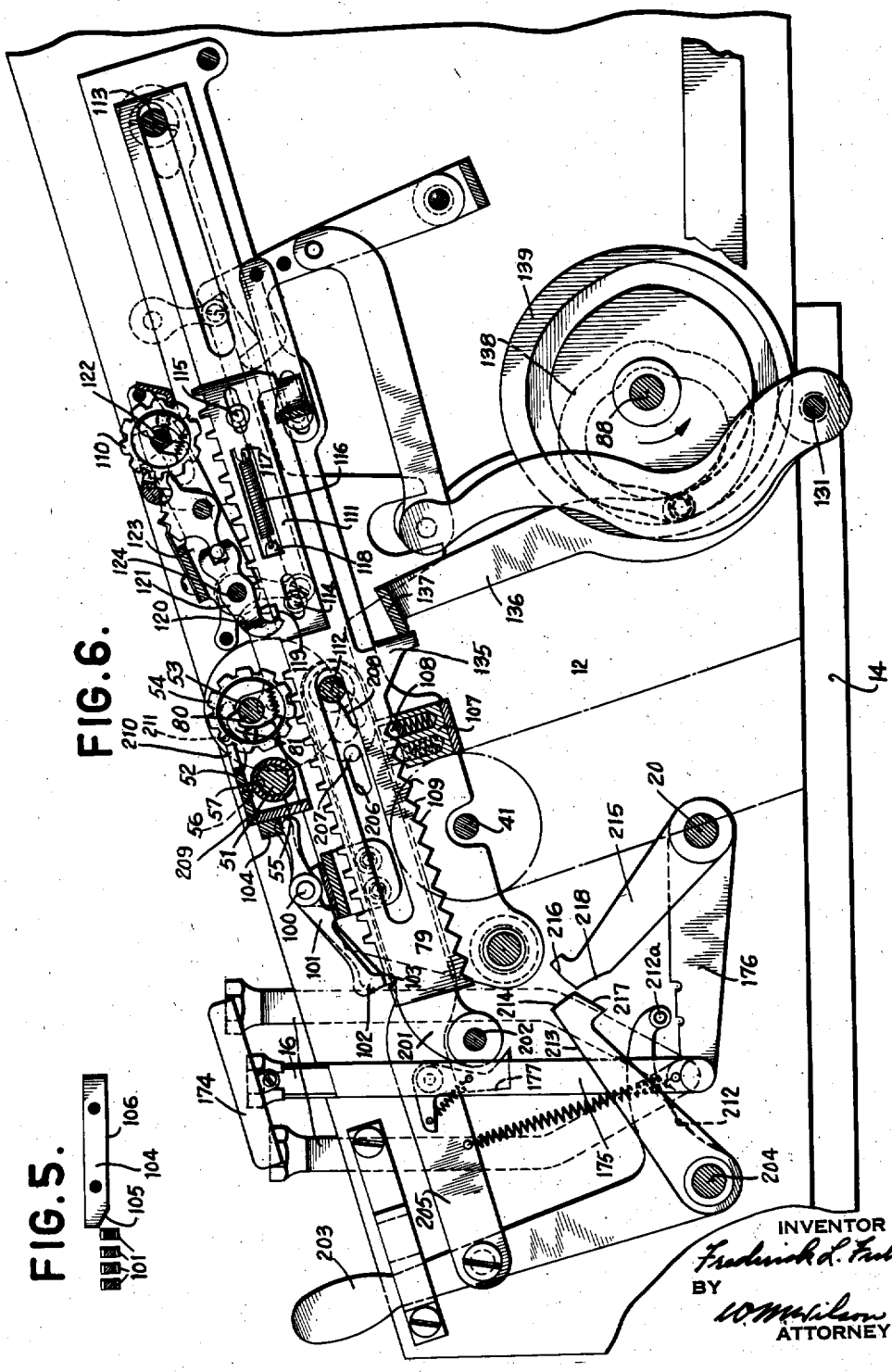

FIG. 5.

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FIG. 7.

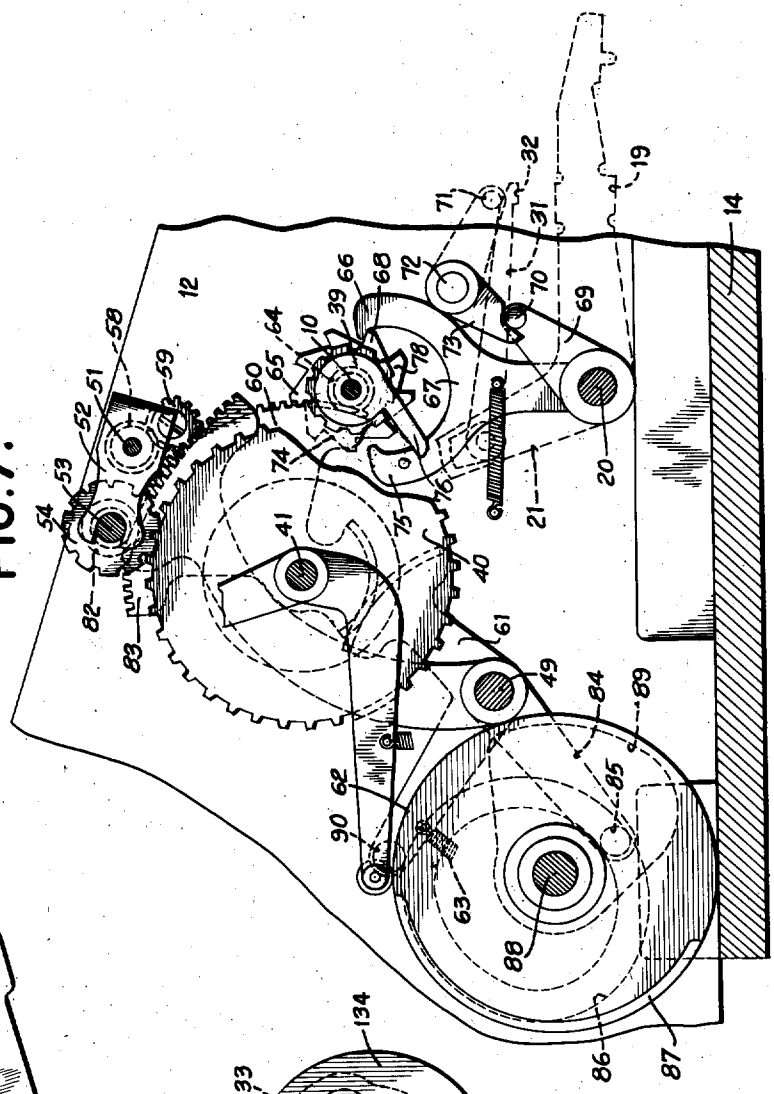
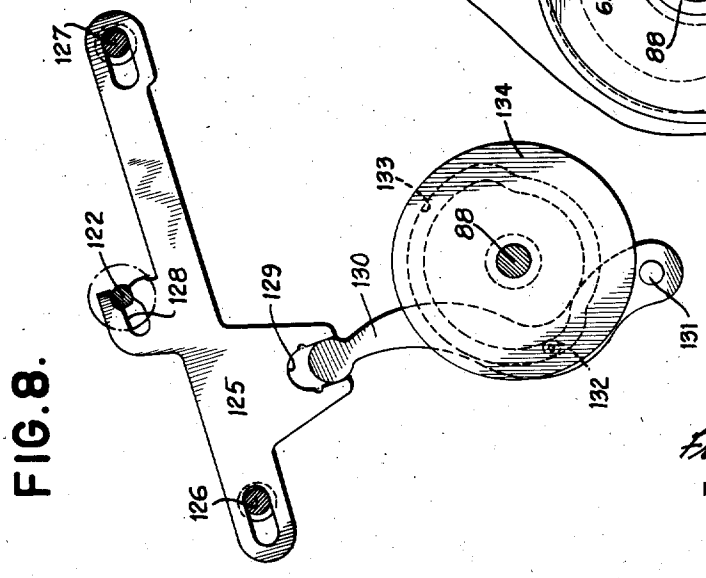


FIG. 8.



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ACCOUNTING MACHINE

Original Filed Oct. 21, 1930 5 Sheets-Sheet 5

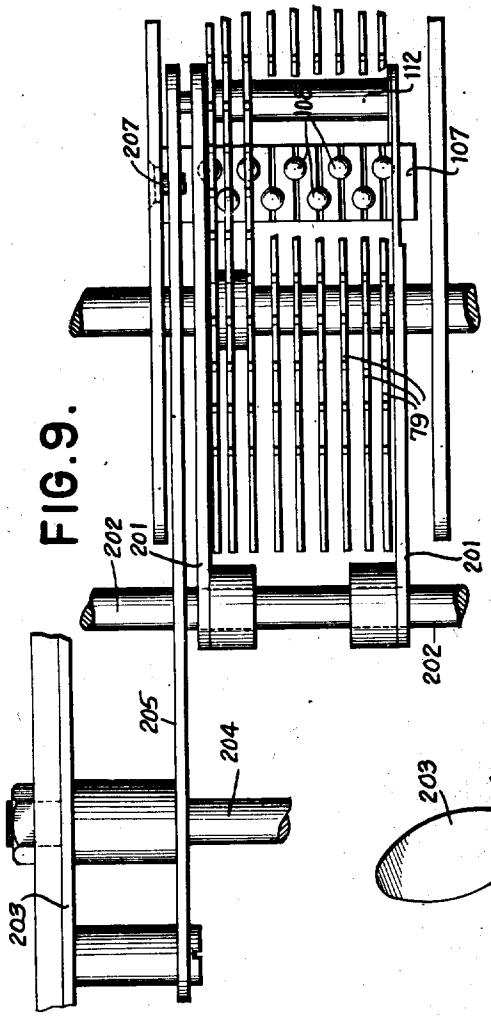

FIG. 9.

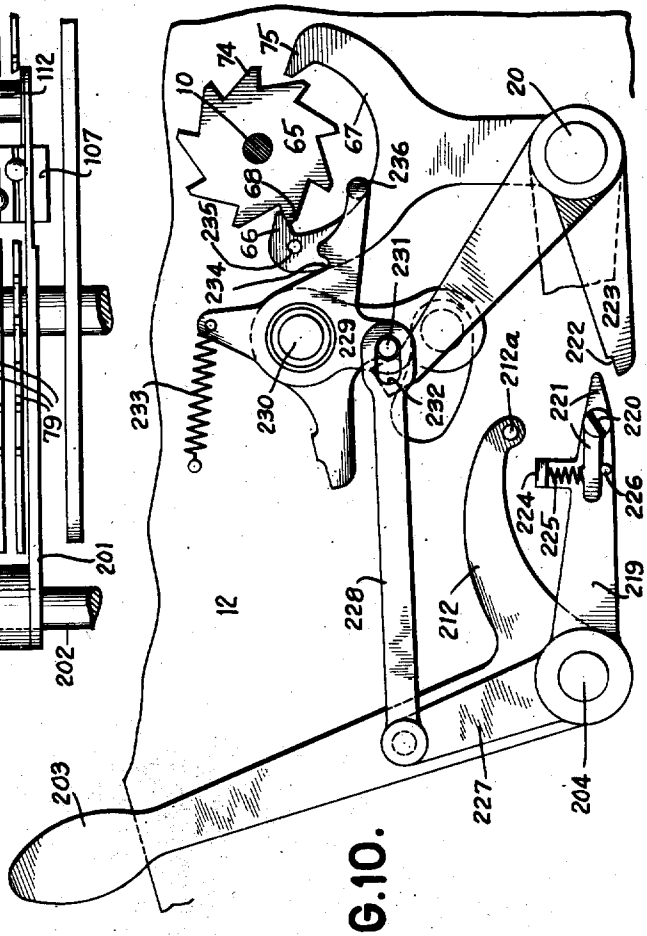

FIG. 10.

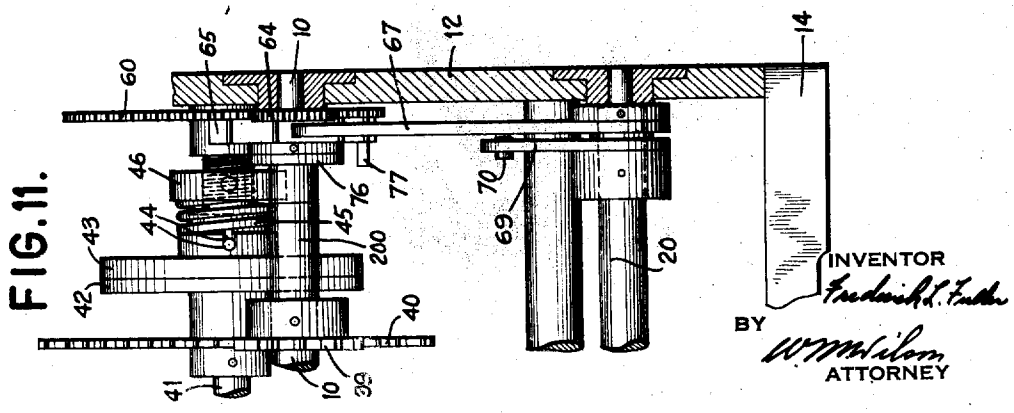

FIG. 11.

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UNITED STATES PATENT OFFICE

2,019,900

ACCOUNTING MACHINE

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Original application October 21, 1930, Serial No. 490,155. Divided and this application February 17, 1934, Serial No. 711,692

18 Claims. (Cl. 235—60)

This application is a division of the co-pending application of Frederick L. Fuller, Serial No. 490,155, filed October 21, 1930.

The present invention relates to calculating machines particularly of the ten-key type.

The main object of the present invention is to improve the differential mechanisms under control of the ten keys so as to simplify such mechanisms and cause the operations to be more positive.

In the present construction a source of power is utilized to rotate a master wheel and the latter as it rotates sets up item representing wheels one after the other, such wheels constituting indicating wheels which may be visually read prior to the entry of the item in the accumulator or item printing devices.

In the event of an error the error mechanism, which is also of an improved type, may come into play to reset the item representing wheels so that the item will not be entered in the accumulator or item printing devices, if employed.

A further object of the invention is to improve the error correcting mechanism so that the operation of resetting the item indicating wheels is effected by power and in such manner that such an operation is the only one effected.

The present invention also includes a modification of the error correcting mechanism which is constructed in a different manner but includes the same improved features.

The invention is illustrated in the drawings in which:—

Fig. 1 is a view in elevation of the ten key keyboard controlling mechanism and also shows the preferred form of the one-revolution clutch mechanism.

Fig. 2 is a view of a conventional key locking mechanism.

Fig. 3 is a view in side elevation of a locking mechanism for the item representing wheels.

Fig. 4 is a plan view of part of the machine.

Fig. 5 is an end view of the actuating rack locking devices.

Fig. 6 is a longitudinal sectional view of the machine showing particularly the totalizer actuating devices.

Fig. 7 is a view in side elevation of the escapement devices for the item wheel carriage and the master wheel.

Fig. 8 is a view in side elevation of the accumulator engaging devices.

Fig. 9 is a plan view of the preferred form of error correcting mechanism.

Fig. 10 is a modification showing another form of error correcting mechanism.

Fig. 11 is a front view of the friction power drive for rotating the master wheel.

The various features of the machine will now be described in sections, and where possible in a sequential manner so that the operation of the parts involved may be more clearly understood.

Item wheel set-up devices

For the present, the manner in which the preferred structure sets up the numeral or item representing wheels to control the setting of accumulator wheels will now be considered.

Secured to a shaft 10 journalled in the adding machine frames 11, 12 and 13, which are secured to a base 14, are ten spirally arranged stop fingers 15 one for each of ten item entering keys 16. The keys 16 (Fig. 1) are slidably mounted in a guide plate 17 and each at its lower end has a pivot connection 18 to one arm 19 of a bell crank loosely mounted on a shaft 20, the other inclined arm 21 of the bell crank extending upwardly so that when shifted towards shaft 10 by the depression of a key 16 a stop shoulder 22 will be placed in the path of the related stop finger 15.

The keys 16 and related bell cranks 19—21 are suitably spaced apart so that each key is cooperatively related with its associated stop finger 15. The keys are held upward to normal positions by springs 23 (Fig. 1) located beneath extensions of the arms 19.

For the purpose of preventing operation of more than one key at a time pivoted pendants 24 (Fig. 2) of the usual form are provided. The pendants are crowded together by depression of a key, the pendants thus taking up the normal free space therebetween to lock the remaining keys.

The shaft 10, in its normal positions, has its stop fingers 15 spirally located about shaft 10 so that the extent of movement of the shaft in a counterclockwise direction (Fig. 1) is dependent upon which arm 21 is shifted, and in the case of the "9" key the arm 21 will be thrust in the path of the related "0" finger 15 which will, when the shaft 10 is released for rotation, permit a units movement of the shaft 10 as determined by coaction of the "9" finger 15 with a stop shoulder 25 of the arm 21 shifted by the "0" key.

In the case of the "1" key the related stop finger 15 will permit a rotation of two units of shaft 10 in a counterclockwise direction, and similarly the remaining keys control the differential rotation of the shaft 10 which, in the present in-

stance, is always a unit more than the value of the key depressed.

As will be described hereinafter shaft 10 is normally urged for rotation but is normally locked by the provision of a stop finger 26 secured to said shaft (Fig. 1). A hooked part 27 of a member 28 normally engages the stop finger 26 but is drawn out of such engagement by the operation of an integral spring urged bail 29 underlying all of the arms 19 of the ten item keys 16 and operated by the downward movement of any key. Bail 29 is loosely mounted on the shaft 20 and the hooked shaped member 28 is integral with one of the integral side arms of the bail.

Pivoted at 30 (Fig. 1) to each arm 21 is a bell crank comprising, in part, a detent arm 31 having a hooked extension 32 adapted to engage a stationary bar 33 when the related key 16 is initially depressed to thereby hold the key depressed but such action occurs before shaft 10 is released by disengaging the hooked part 27 of member 28 from finger 26. Inserted between the inclined upper arm 34 of the bell crank 31—34 and a lug 35 of the related arm 21 is a compression spring 36. The upper extension of arm 34 has a cam edge 37 and since each finger 15 is of sufficient width (see Fig. 4) to engage both cam edge 37 and the stop shoulder 25 integral with arm 21, it will be observed that when the key is locked in depressed position and shaft 10 rotated the effective finger 15 will contact with the part of the cam edge 37 near the stop shoulder 25 to shift the hook 32 of arm 31 out of engagement with the bar 33 to release the key.

This disengagement occurs just shortly before the time the stop finger 15 coacts with the stop shoulder 25. The cam edge 37 is so proportioned that when engaged by a finger 15 the arm 31 will be freed from bar 33 but, however, spring 23 does not act quickly enough to restore the arm 21 so that, as found in practice, the finger 15 actually coacts with the stop shoulder 25 thus determining the temporarily stopped position of shaft 10. The key is now free to be released either by relieving pressure on the key cap by the removal of operator's finger or subsequently by spring 23 alone, if the operator has previously removed his finger before the shaft 10 is stopped.

The prime purpose of the latch mechanism and associated devices is to insure that the particular arm 21 shifted will be held shifted until engaged by the related stop finger 15 and then automatically released. When the key is released the shaft 10 will again be free to rotate since the related arm 21 has been shifted away from the associated stop finger 15. When the restoration of bail 29 has been effected by a spring 38 during the elevation of the depressed key and the hooked part 27 of arm 28 is again shifted so that it can be caught by the finger 26, shaft 10 will be stopped when the finger 26 again contacts with the hooked part 27 of arm 28. The series of stop fingers 15 is now in normal position (Fig. 1) ready to determine the subsequent differential rotation of shaft 10.

Shaft 10, as will be seen in Fig. 4, extends through frame member 12 and has secured thereto a pinion 39 in mesh with a gear of a master wheel 40 (Figs. 7 and 11) loose on a continually rotating shaft 41 and rotatable with one element 42 of a friction drive, the companion element 43 having a pin and slot connection 44 (Fig. 11) to the continually rotating shaft 41.

The desired amount of friction between elements 42—43 is provided by a spring 45 (Fig. 11) which is regulated by a collar 46, adjustable on shaft 41 by any suitable means such as a screw thread. To the shaft 41 there is secured a pinion 47 (Fig. 1) in mesh with a gear 48 secured to a continually running shaft 49.

It will be observed that the master wheel 40 and the shaft 10 geared thereto are urged to rotate by power but are released for such rotation by depression of any key. The shaft 10 is then stopped in its differential position by the stop devices described and then rotated, as has been described, supplementally to its normal position.

The above described differential rotation of the master wheel 40 under control of the keys is utilized to set up numeral wheels indicating the keys depressed so that upon completion of a series of key operations the numeral wheels will, by their characters, represent the keys previously depressed.

Journalled between side plate 13 and a bracket 50 secured to side plate 12 (Fig. 4) is a shaft 51 carrying a yoke or item wheel carriage 52, the side arms being forked to receive a shaft 53 (see Fig. 7). Between the side arms of the carriage and assembled on the shaft 53 is a series of item wheels 54, each being toothed to mesh with the master wheel 40 and each carrying characters at the extremities of the teeth (see Fig. 4) to indicate the value of the key depressed. A units movement of an item wheel 54 by a depression of the "0" key brings the "0" character into view, and correspondingly, other characters are brought into view by depression of the other keys.

Between the side arms of the item wheel carriage is a sleeve 55 (Fig. 4) mounted on shaft 51 and in which sleeve there is inserted a screw stud 56 having its lower end in engagement with a spiral groove 57 formed in the periphery of shaft 51. By reason of the above arrangement steps of rotation of shaft 51 will cause the item wheel carriage and item wheels to be shifted in increments.

When the machine is at normal, one of the item wheels 54 (see Fig. 7) is in mesh with the master wheel 40 so that this item wheel may be the first to be set up to represent the value of the first key depressed. When this operation has been completed the carriage will then be shifted a step to bring the rotated item wheel out of position of engagement with the master wheel to permit the shaft 10 to then be given its subsequent rotation which occurs during the release of the depressed key.

The worm screw threaded shaft 51 is urged to rotate by suitable spring means now to be described. In mesh with a pinion 58 (Fig. 7) secured to one end of shaft 51 is an idler pinion 59 pivoted to side frame 12 and in mesh with the upper teeth of a double rack segment 60 loose on shaft 41. The lower teeth of said segment are in mesh with a segment 61 loose on the shaft 49 and having an arm 62 normally urged downwardly by a spring 63 to turn worm screw shaft 51 in a clockwise direction (Fig. 7) to shift the item wheel carriage to the left (Fig 4), as the numerals of the keys are read in Fig. 4.

In mesh with the upper teeth of segment 60 is a pinion 64, (Fig. 7) secured to which is a toothed escapement wheel 65, both being loosely mounted on a reduced portion of shaft 10. One tooth 66 of a double pallet escapement lever 67 normally engages a tooth 68 of the escapement wheel 65 to prevent rotation of shaft 51 as urged by spring

63. The escapement lever 67 is fixed to the shaft 20 and to said shaft there is fixed an arm 69 having a pin 70. Mounted over the series of arms 31 is a rod 71 of a yoke secured to a rock shaft 72 to which is pinned an arm 73 overlying the pin 70. The action of the parts is such that after the shaft 10, and, therefore, after the first item wheel 54 is differentially rotated by means of the master wheel 40 the arm 31 of the key depressed will elevate rod 71 to depress the outer end of the arm 69. This results in rocking the hooked end 66 of the escapement lever 67 out of engagement with the tooth 68 of escapement wheel 65. The latter then rotates counterclockwise slightly until one of the teeth designated by 74 engages the top of hooked portion 75 of the escapement lever. This permits a step of rotation of shaft 51 sufficient to step the carriage to bring the item wheel 54 just differentially rotated out of engagement with the master wheel 40.

The shaft 10 now being free subsequently rotates supplementally to its normal position and which rotation is effected during the elevation of the key depressed. During this operation an arm 76 (Fig. 7) secured to shaft 10 whips around in a counterclockwise direction and strikes a pin 77 attached to the escapement lever 67 so that the cam end of arm 76 cams the escapement lever to the left.

The escapement wheel will now turn counterclockwise and a second half step of movement of the item wheel carriage is thereby effected since the hooked end 66 has now been shifted to the left (Fig. 7) bringing it in the path of the tooth 78 of the escapement wheel 67 just below the tooth 68 previously engaged.

This second shift of the item wheel carriage causes the wheel 54 just set differentially to mesh with the first of a series of racks 79 (Fig. 6).

In this manner a depression of a key sets up an item wheel, the first one being shifted to mesh with the first rack, the depression of the second key resulting in differentially setting the second item wheel and shifting the first wheel (previously set) into mesh with the second rack, and the wheel just set differentially in mesh with the first rack.

At the end of a setting up operation the item wheels 54 set will represent a number to be printed corresponding to the keys depressed, and verification of the correctness of the amount to be entered is ascertained by reading the figures on the series of wheels 54.

Differential adjustment of racks

The wheels 54 besides indicating to the operator of the machine the values of the keys previously depressed also control the differential positioning of the series of the racks 79. Referring to Figs. 4 and 6, it will be observed that the shaft 53 has a cut in its periphery preferably in the form of a long groove 80 adapted to coact with a series of resetting pawls 81 one of which is secured to the side of each item representing wheel 54 and pivotally mounted within an annular recess of the related wheel.

When a wheel 54 is rotated about shaft 53 and then shifted it is operatively engaged with the groove. The normal relation of an item wheel at home position with the groove 80 is shown in Fig. 6, wherein it will be observed that the end of one of the series of pawls 81 rests upon the circular part of the periphery of the shaft 53. When an item wheel has been rotated by the differential mechanism it will be rotated about shaft 53 in a clockwise direction. When the shaft 53 is then rotated in a counterclockwise direction, it will be apparent that the radial wall of the groove 80 coacting with the end of pawl 81 will pick up the related wheel 54 to restore it backwardly to its normal position and for each wheel such backward restoration will require as many units of movement as a wheel has been previously rotated.

An item wheel restoring operation by shaft 53 is effected by mechanism now to be described. Secured to the end of shaft 53 is a pinion 82 (Figs. 4 and 7) in continuous driving engagement with teeth formed at the upper end of a segment arm 83 loosely mounted upon the shaft 49. Attached to the segment 83 and depending below shaft 49 is an arm 84 provided with a roller 85 engaging the race 86 of a box cam 87 secured to a shaft 88.

As will be described later this shaft 88 is given a single revolution when the item accumulating operations are to be performed during which operation it will be observed that segment 83 will rock drive shaft 53 first in a counterclockwise direction so that the groove 80 therein will return the item wheels 54 to their normal positions.

As stated each item wheel 54 is in the form of a pinion, the teeth of which when the wheels 54 have been shifted are also in mesh with the teeth of the related rack 79. As an item wheel is returned to normal, the rack 79 with which it is in mesh will be shifted to the right an amount dependent upon the value indicated on that particular wheel. After the item wheels are at zero and the racks 79 differentially adjusted the zeroized item wheels are then shifted by mechanism now to be described to the right (Fig. 4) by a movement of the item wheel carriage in the same direction.

During the item wheel setting operations, it will be observed that the spring 63 (Fig. 7) will cause the arm 62 to approach the shaft 88 more or less and to an extent dependent upon the number of item wheels adjusted, or in other words, proportional to the highest denomination of the amount to be entered. A restoration of arm 62 will cause the restoration of the item wheel carriage by a reverse operation of the same mechanism employed to shift the carriage step-by-step when the item wheels are successively adjusted. When the shaft 88 is rotated as an incident to item accumulating operations a profile cam 89 will coact with the roller 90 carried by the arm 62 and elevate the arm 62, this operation being effected after the shaft 53 has been turned to zeroize the item wheels employed to set up a number. The elevation of arm 62 causes the spirally grooved shaft 53 (Fig. 7) to be turned to shift the item wheel carriage to the starting position. During this operation it will be observed that escapement wheel 65 (Fig. 7) will be turned clockwise, the tooth 66 of the escapement lever 67 functioning as a retrograde preventing pawl for the escapement wheel.

When the item wheel carriage is at its normal or starting position (see Fig. 4) the shaft 53 is then rotated in a clockwise direction (Fig. 6) by the box cam 87 so as to be brought to the normal starting position shown in Fig. 4.

The differential adjustment of the racks in the present application is utilized to set up a plurality of accumulator wheels, but before giving a description of the mechanism and the manner of operation by which the mechanism is operated to effect the setting of the accumulator wheels, there will be described certain adjuncts provided to

prevent misoperations of the machine. These mechanisms will now be described in detail.

Alining devices for item wheels

It is desirable that the numeral wheels **54** be alined or locked against movement while the carriage is in its normal position. To carry out the above object there is secured to the side plate **13** a traversely extending bar **91**, Fig. 4, the extremity of which fits within the interdental spaces of a series of item wheels. Such engagement is effected when the wheels **54** are shifted to the right as an incident to the restoration of the item wheel carriage and it will, therefore, be understood that when the item wheels are in their home positions they are locked against rotation by means of the bar **91**. Obviously as the item wheels are successively shifted to engage with the racks **79** they pass out of engagement with the bar **91** but are locked by means of another locking mechanism now to be described.

Supplemental alining devices for item wheels

To this end there is provided an alining bar **92**, Fig. 3. Bar **92** is carried by the upper end of an arm **93** losely pivoted upon shaft **41**.

Secured to the arm **93** is another arm **94** having a roller **95** which is urged by a spring **96** connected to arm **94** to contact with the periphery of a profile cam **97** secured to the shaft **88**. The high portion **98** of the cam **97** normally maintains the locking bar **92** in its locking position, but when the item representing wheels **54** are zeroized to control the movement of racks **79** the cam **97** is rotated so that the roller **95** drops to a lower portion **99** of the cam **97**. Obviously, the movement of the arm **94** is effected by means of the spring **96** and such movement causes the bar **92** to be shifted out of engagement with the item representing wheels **54**. Such relationship is maintained during the time the item wheels are zeroized but immediately thereafter the high part **98** of the cam **97** is again effective to rock the bar **92** into engagement of the item representing wheels **54** keeping them locked during the lateral shifting of the item wheel carriage and until the item wheels pass under control of the fixed locking bar **91**.

Devices for unlocking operating racks

Referring to Figs. 4, 5 and 6, loosely mounted on a rod **100**, is a series of locking pawls **101**. The left ends of the pawls **101** are so weighted that gravity urges integral locking portions **102** thereof to normally fit in recesses **103** formed in the upper edges of the left ends of the series of racks **79**. The portions **102** prevent accidental movement of the racks, but when the item wheel carriage is shifted the pawls are successively operated to unlock the racks which are utilized in the item accumulating operations.

To this end a bar **104** secured to the cross plate of the item wheel carriage has a beveled portion **105** (see Fig. 5) which passes over the rearward ends of the pawls **101** to shift them so that by the disengagement of the locking portion **102** and the recess **103** the related rack **79** is unlocked. As a pawl **101** is operated it is held in shifted position by a straight edge **106** forming the lower straight edge of the bar **104**.

In this manner if four item wheels **54**, for example, are set to represent a number the corresponding racks **79** are unlocked for operation.

Alining devices for racks 79

For the purpose of alining the racks **79** in the different positions of adjustment there is inserted in holes in a stationary bar **107** a series of resiliently urged balls **108** (see also Fig. 9). There is provided a ball **108** for each rack **79** and each coacts with the related series of wedge-shaped notches **109** formed at the lower edge of the associated racks **79**. It is obvious that by the above construction the racks **79** are resiliently held in different positions of adjustment.

Accumulating devices

The accumulating devices in the present machine comprise a series of accumulating wheels **110**, each of which is in operative alignment with the related operating rack **111** which is slidably mounted upon the associated rack **79**.

In view of the fact that it is necessary that the accumulating wheel **110** be turned an amount commensurate with the number indicated on the related item wheel **54**, a lost motion connection is provided between the short rack **111** and the related rack **79** on which the former is slidably mounted.

This lost motion connection consists of a unit of movement of the rack **79** which extra unit of movement is derived in setting up the item wheel **54** since it will be recalled that the item wheel is turned one step greater than the amount represented by the controlling key. This extra step of movement, as more fully shown and described in the parent application, is utilized to adjust printing wheels to the proper positions. The printing wheels have blank portions thereof presented to the printing line the extra step being utilized to adjust the printing wheel to present a "zero" to the printing line. As the printing mechanism is not involved in the present application no further description of its operation will be given.

As best shown in Fig. 6 each rack **79** is slidably mounted upon a rod **112** and a rod **113**, each of which fits in suitable elongated slots formed in the racks **79**. Each rack **111** is slidably mounted upon the associated rack **79** by means of pins **114**, **115** carried by the rack **79** and fitting in elongated slots formed in the rack **111**. A spring **116**, one end of which is connected to an ear **117** integral with the rack **111** and its other end connected to an ear **118** integral with the rack **79**, tends to shift the rack **111** to the left, Fig. 6, independent of the rack **79** and such action is normally prevented by means of a lug **119** integral with the rack **111** which lug normally engages a hook **120** of a transfer controlling arm **121**. The normal relationship of the lug **119** and hook **120** at the beginning of an item entering operation is shown in Fig. 6 and it will be, therefore, obvious that when the rack **79** is shifted to the right a differential amount, the rack **79** will move one step independent of the movement of the rack **111**.

At the termination of this first step of movement of the rack **79** the pins **114** and **115** will coact with the right end of the related slots formed in the rack **111** and the latter will then be given a differential movement commensurate with the value of the numeral key depressed and corresponding to the amount exhibited by related item wheel **54**. As has been premised, hereinbefore, the racks **79** are first given differential movements and then restored to normal and during this restoration the accumulator wheels **110** are en-

gaged with their operating racks 111 so as to be differentially actuated.

The accumulator wheels 110 are loosely mounted upon a shaft 122 which is carried by a frame 123 loosely pivoted on a rod 124. The accumulator wheel carrying frame 123 is adapted to be rocked about the pivot 124 so as to intermesh the accumulator wheels 110 and the operating racks 111 and such relationship is effected by mechanism best shown in Fig. 8. A slide 125 is slidably mounted by means of a pair of stationary studs 126 and 127 and said slide is provided with a cam slot 128 in engagement with the shaft 122 which, it will be recalled, is carried by the accumulator wheel supporting frame 123. A downward extension of the slide is provided with an open notch 129 in which fits the upper extremity of an arm 130, the latter being pivoted on a rod 131 and provided with a roller 132 engaging the cam race 133 of a box cam 134 secured to the shaft 88. When the racks have been differentially adjusted the cam race 133 rocks the arm 130 so as to shift the slide 125 to the right, as viewed in Fig. 8. The cam slot 128 will depress the shaft 122, thus rocking the accumulator frame 123 about its pivotal point 124 so as to intermesh the accumulator wheels 110 and the operating racks 111. Thereafter the operating racks are restored to normal by mechanism now to be described.

Each rack 79 has a downward projecting portion 135 (Fig. 6). Loosely mounted upon the rod 131 is a yoke shaped frame comprising arms 136 and a cross bar 137, one of the arms 136 having a roller in operative engagement with the cam race 138 formed in the box cam 139 which is secured to shaft 88. The cam race 138 is so designed that when the racks 79 are shifted to the right a differential amount the cross bar 137 will be simultaneously shifted so as not to interfere with the differential setting of the racks 79. After the racks have been differentially set, the cam race 138 is then active to restore the cross bar 137 to normal, but prior to such restoration the accumulator wheels 110 are engaged with the racks 111. The bar 137 will thereupon engage the downward projecting portions 135 of the racks 79 which have been shifted from normal. It will first encounter the rack or racks 79 which have received the greater extent of movement and thereafter, in order, restore to normal those racks which have been moved lesser amounts. In this manner the racks 79 are positively restored to normal positions and the accumulator wheels actuated differential extents so as to indicate the amount represented upon the item representing wheels 54.

Transfer mechanism

The transfer mechanism provided in the machine is fully shown and described in the parent application, and as it forms no part of the present invention, it will not be described herein.

Motor bar control

The performance of the operations just described and others are under control of a motor bar 174 (Figs. 1 and 6) depressible by the operator to effect the clutching of the constantly running shaft 41 (Figs. 1 and 6) with the shaft 88 which causes the operations incidental to the item accumulating operations. The preferred form of clutch mechanisms will now be described in detail.

The motor bar 174 is operable externally of the machine (see Figs. 4 and 6) and is carried by a stem 175 slidably guided at its upper end and pivoted at its lower end by an arm 176. The stem carries a pawl 177 (Fig. 1) the lower end of which is adapted to engage one arm 178 of a bell crank, the vertical arm 179 being pivoted to a link 180 which is secured to the lower end of a pinion carrying frame comprising parallel plates 181*a* and 181*b* both loosely mounted on shaft 49 (see Figs. 1 and 4). Secured to the constantly running shaft 49 is a pinion 182 in mesh with an idler pinion 183 pivotally mounted on the frame plate 181*a*. Pinion 183 is in constant mesh with a broader pinion 184 also pivotally mounted on plate 181*a*. The pinion 184 when rocked into mesh is sufficiently broad to mesh with and drive a pinion 185 secured to the cam carrying shaft 88.

A spring 186 (Fig. 1) connected to the frame 181*a*—181*b* retracts the latter so that a normal disengagement is effected between pinions 184 and 185. When the motor bar is depressed pawl 177 rocks bell crank 178—179 to shift the link 180 so that when the pinion carrying frame is rocked sufficiently to effect a driving engagement between pinions 184—185 a lug 188 of a spring urged latch arm 187 will spring behind a projection 189 of frame plate 181*b*. Shaft 88 will now be driven to effect the various functions described. Towards the end of a complete revolution a pin 190 secured to gear 185 will coact with a tail of the latch arm 187 to rock the latter permitting spring 186 to restore the frame 181*a*—181*b* to effect a disengagement between pinion 184 and gear 185.

When stem 175 is depressed pawl 177 will rock the bell crank and by the coaction of a tail of the pawl with a fixed stud 191*a* the pawl will be rocked in its downward movement and will pass by the arm 178 after the pinion carrying frame is rocked to be latched by pawl 187. The engaging end of pawl 177 now being below the arm 178 it will be observed that repeated operations of the shaft 88 cannot be effected by holding the motor bar depressed. The provision of the above "non-repeat" device requires restoration of the motor bar and a subsequent depression for each operation of the drive shaft 88.

Secured to an extension 191 of plate 181*b* is a plate 192 the lower concentric edge 193 being adapted to be engaged by a pin 197 secured to the gear 185 rotatable with shaft 88. The passage of the pin 197 beneath the concentric edge also retains initially the desired clutching engagement of the drive and driven pinions and this is maintained after the pin has cleared the edge 193 by the concentric edge 196 of disk 195 coacting with the lower edge 193.

Error key mechanism (Figs. 6 and 9)

In the event that any of the keys 16 are depressed in error it is desirable that the item representing elements 54 be restored to normal without transmitting the value represented on them to the accumulator.

It will be remembered that it was previously stated that the rod 112 was the supporting means for the racks 79 at their forward ends, as will be best seen in Fig. 6. This rod is carried by a pair of arms 201 (Fig. 9) fixed to a cross rod 202 supported in the machine side frames 12 and 13. The error key lever 203 is pivoted upon a rod 204 and the handle portion thereof projects through a slot in the cover plate of the machine so as to be externally operable by the operator of the machine.

Articulated to the mid-portion of the error key

lever is a plate 205 (Fig. 6) having an elongated slot 206 receiving a stationary pin 207. The plate 205 is also provided with a cam slot 208 receiving a reduced end of the rack supporting rod 112. When the parts are as shown in Fig. 6, it will be observed that the teeth formed at the upper forward ends of the racks 79 are in mesh with the pinion teeth of the item representing elements 54 which have been shifted laterally. If at the termination of such an operation the operator observes that the amount represented is incorrect, for rectification, it is only necessary to shift the lever 203 rearwardly. During such operation, it will be seen that the action of the cam slot 208 upon the supporting rod 112 is such that the rod 112 will be lowered thereby effecting a disengagement between the teeth of the racks 79 and the teeth of the laterally shifted item representing wheels 54.

During the subsequent machine operation it will be observed that the restoring shaft 53 will be rocked to pick up and restore the previously set item wheels 54 but during such operation, it will be noted that no movement will be transmitted to the racks 79 and that they will merely remain in their normal position of adjustment. By the provision of such means, it will be observed that the machine goes through an idle cycle of operation and the only effective work that is accomplished is the restoration of the item wheels 54 and the restoration of the item wheel carriage.

For the purpose of defining the normal or zero position of the item representing wheels when they are restored during the resetting operations there is secured to the item wheel carriage a plate 209 (Fig. 6) having a plurality of stop fingers 210 against which pins 211 secured to the side faces of the wheels 54 abut at their zero positions.

For the purpose of automatically setting the machine into operation by shifting of the error key 203 when employed, the error key lever 203 has a curved extension 212 (Fig. 6) carrying a stud 212a in the plane of the arm 176 and adapted to depress this arm and therefore, motor bar 174 when the lever 203 is shifted to the rear.

While the lever 203 may be held in shifted position at the end of the machine cycle no second operation of the machine will ensue for the reasons explained in connection with the motor bar 174 described in the section designated —Motor bar control—.

Interlock

For the proper performance of the machine it is desirable that an interlock be provided between the adding keys 16 and the error key lever 203.

The error key lever 203, as stated, is secured to the shaft 204, and also secured to the shaft 204 is a rearwardly extending arm 213 (Fig. 6) having its extreme edge 214 concentric with respect to the shaft 204.

As previously stated the shaft 20 is reciprocated during the operation of the adding keys and secured to this shaft is an arm 215 having an edge 216 adapted to pass beneath an edge 217 of the arm 213 to lock the error key lever 203 when an adding key is depressed. This mechanism prevents shifting of the error key 203 during the operation of an adding key 16.

Shifting of the error key lever 203 causes the edge 214 of arm 213 to pass in front of a concentric edge 218 of arm 215 to lock the shaft 20 and therefore the adding keys while the error key lever 203 is away from its normal position.

Modification of error key mechanism

As has been stated hereinbefore, restoration of the differentially set item wheels without an entry to the accumulator was performed by preliminarily lowering the racks 79 and holding them in their lowered position during the time the item wheels are zeroized and the item wheel carriage is returned.

Another construction by which errors made in setting up of the wheels 54 may be rectified is as follows, referring to Fig. 10.

In this arrangement the shaft 112 (Fig. 6) supporting the left ends of the racks 79 is fixed. The new device which may be employed comprises a bell crank secured to shaft 204. The arm 219 of said bell crank has pivotally mounted at its extremity by pivot pin 220 a by-pass pawl 221, the rearward extremity of which coacts with a shoulder 222 of an arm 223 which is integral with the escapement lever 67. Between the left end of pawl 221 and a lug 224 integral with arm 219 is a spring 225.

It should be explained at this point that if an item has been set up a certain number of the item wheels 54 will be shifted laterally into mesh with the racks 79. If an error is detected the error key lever 203 is shifted to the rear as previously explained. In so doing the pawl 221 will strike the shoulder 222 and by the coaction of a pin 226 carried by arm 219 with the left end of pawl 221 the latter will be prevented from turning so that the free end of arm 223 of escapement lever 67 will be depressed. This will cause the hook 66 to be disengaged from the tooth 68 of escapement wheel 65 but will bring the hook 75 under the tooth 74 of the escapement wheel 65, permitting the escapement wheel to rotate slightly, as previously described. This causes a step of movement of the item wheel carriage to bring the item wheels 54 that have been set out of mesh with the racks 79 and in between them.

The other arm 227 of the bell crank secured to shaft 204 has a link connection 228 to an irregular shaped member 229 pivotally mounted on a stud 230. The link 228 is conected to the member 229 by means of a pin 231 fitting in an elongated slot 232 in the extreme end of the link 228. Under action of a spring 233 attached to the member 229 it will be observed that when the link 228 is shifted to the right by a corresponding movement of the error lever 203 a hook 234 will catch over a pin 235 secured to the escapement lever 67 thereby holding the latter in its shifted position and which was previously caused by the rocking of the arm 223.

After the initial step of rotation of the escapement wheel 65 has been effected the arm 212 which is integral with the error key lever 203 will cause the depression of the motor bar 174, as previously explained so that during such operation the item wheels 54 will be zeroized and the item wheel carriage shifted to normal.

During the restoration of the item wheel carriage it will be recalled that the escapement wheel 65 is turned in a counterclockwise direction. For the purpose of unlatching the escapement lever so as to permit rotation of the escapement wheel in this direction the member 229 is provided with a pin 236 which, when member 229 is in the position to latch the escapement lever 67, is in the path of one of the teeth of the escapement wheel and by its engagement with the in-

clined wall of one of the teeth the escapement wheel **65** in its rotation will cam the plate **229** in a clockwise direction against the action of the spring **223**. Since at this time pin **231** still occupies the right end of the slot **232** it will be observed that the slot **232** permits this movement of member **229**. Therefore, an uninterrupted rotation of the ratchet wheel **65** in a counterclockwise direction will ensue.

Since the error key **203** is still in the shifted position it will be observed that the extremity of pawl **221** is considerably below the left extremity of arm **223**. By means of the by-pass pawl **221** the error key lever **203** may be shifted to its normal position without affecting the position of the arm **223**.

What is claimed as new is as follows:—

1. In a computing machine the combination with a series of numeral keys, of a plurality of item wheels for representing the values corresponding to the keys depressed, a master wheel for differentially operating the wheels seriatim, a power driven shaft, a shaft for controlling the master wheel carrying a plurality of stops arranged spirally about the shaft, a friction drive between said power driven shaft and said controlling shaft, means controlled by said keys for releasing said controlling shaft to permit the master wheel to be driven by said power driven shaft to set an item wheel, means individual to each key for arresting said controlling shaft by said stops, means for thereafter causing said power driven shaft to give a supplemental rotation to the shaft carrying said stops, resilient means effective before the operation of the last named means to effect a relative displacement between said master wheel and the item wheel set, and means for causing the power driven shaft to store up power in said resilient means.

2. In a computing machine, the combination with a series of numeral keys, of a plurality of item wheels, a master wheel, means for effecting successively an operative relationship between the item wheels and said master wheel for setting up said item wheels seriatim, means for differentially controlling the operation of said master wheel comprising a differentially rotatable shaft carrying a series of stops spirally arranged about said shaft, means for causing rotation of said shaft whereby said keys coact with said stops to control the differential positioning of the item wheels, and means for causing the last named means to effect a supplemental rotation of said shaft after the differential rotation of the latter.

3. In a computing machine, the combination with a series of numeral keys, of a plurality of item wheels, a master wheel for setting up the item wheels seriatim, a power drive for said master wheel, a shaft having a permanent driving mechanical connection to said master wheel and comprising a plurality of stops spirally arranged about said shaft for controlling by rotation from normal the differential operation of said master wheel, means common to the keys for releasing the shaft and master wheel for operation by said power drive, means individual with each key coacting with said stops, and means for causing a relative displacement between the item wheel which has been set up and said master wheel to allow the shaft to resume its normal position.

4. In a computing machine, the combination with a series of numeral keys, of a plurality of item wheels, a master wheel, means for effecting successively an operative relationship between said item wheels and said master wheel, for setting up the item wheels seriatim, a shaft carrying a plurality of stops spirally arranged about the shaft and coacting with said keys to determine the differential rotation of the shaft, a power drive for said shaft, means common to said keys for releasing the shaft for differential rotation by said power drive, and means for causing the power drive to rotate the shaft supplementally in the same direction as its differential rotation.

5. In a computing machine, the combination with a series of numeral keys, of a series of item wheels, a master wheel for setting up the wheels seriatim, a master wheel control device comprising a unidirectionally rotatable shaft geared to the master wheel and having a plurality of fingers spirally arranged about said shaft coacting with said keys and differentially controlled thereby, and means for causing a rotation of said shaft in the same direction after each key causes its differential rotation.

6. In a computing machine, a series of keys, a series of item wheels, a master wheel driven unidirectionally for setting the item wheels, means comprising a shaft carrying a series of fingers spirally arranged about a shaft and coacting with the numeral keys for differentially controlling by a differential rotation thereof the uni-directional rotation of the master wheel, and means under control of the keys for causing a relative movement between the item wheel and master wheel when an item wheel is differentially set, and for causing concomitantly a supplemental rotation of the shaft in the same direction as its differential rotation.

7. In a computing machine, a series of item wheels, a series of keys, a master wheel for separately setting the item wheels, means under control of said keys for differentially controlling the extent of operation of the master wheel and a single item wheel, and means whereby each of said means and the master wheel are controlled to receive a supplemental operation of a complemental extent after having been differentially set.

8. In a computing machine, a series of keys, a series of item wheels, a master wheel for setting the item wheels seriatim, means controlling the differential setting of the master wheel comprising a differentially rotatable shaft carrying a set of fingers spirally arranged about the shaft and coacting with the keys, and means whereby said shaft is restored to normal by a rotation in the same direction as its differential rotation after differentially setting the master wheel.

9. In a computing machine, a totalizer, a series of item wheels, a series of keys, power driven means, means operated by said power driven means and including a master wheel under control of said keys for differentially setting each of the item wheels separately by successive operative engagement with each of the series of item wheels, a plurality of racks, means for positively restoring the item wheels to differentially set the racks, and means for causing said power driven means to move said racks to operate the totalizer to register thereon the amount represented on the item wheels.

10. In a computing machine, a totalizer, a series of item wheels, a series of keys, a power driven means, means operated by the power driven means and including a master wheel under control of said keys for differentially setting the item wheels, a plurality of racks, means operated by the power driven means for positively restoring the differentially set item wheels to differentially set the racks, and means operated by the power

driven means, for positively restoring the racks when differentially set to actuate the totalizer.

11. In a computing machine, a series of item wheels, a totalizer, power driven means, a series of keys, a uni-directionally rotatable master wheel means under control of said keys and operated by the power driven means for differentially setting the item wheels by said master wheel, a plurality of racks, means operated by said power driven means for positively restoring the differentially set item wheels to differentially set the racks, and means operated by the power driven means for causing said racks to be positively restored to operate the totalizer to register thereon the amount represented on the item wheels.

12. In a machine of the class described, the combination of a series of keys, a series of item wheels set by said keys, operating devices differentially set by said item wheels after the latter are shifted into engagement with the operating devices and restored, and an error key having provision of means whereby said item wheels are shifted to a position intermediate said operating devices whereby the item wheels are restored without setting the operating devices.

13. In a computing machine, a series of keys, a series of toothed item wheels, a series of totalizer racks, a rotatable master gear, power means for rotating the master gear uni-directionally, means under control of said keys for causing the differential rotation of said master gear to cause a single item wheel to be separately set and then causing the master gear to be supplementally rotated when disengaged from the item wheel set, and means for gearing the item wheel set with one of the totalizer racks before another item wheel is set by said master gear.

14. In a machine of the class described, in combination, a series of keys, item wheels, means for causing the differential positioning of said item wheels under control of said keys, a series of actuating devices differentially positioned upon restoration of said item wheels, an escapement mechanism controlling engagement of the item whcels with said devices, and means for causing said escapement mechanism to position the differentially positioned item wheels intermediate said actuating devices for restoration of the item wheels independently of actuating said devices.

15. In a machine of the class described, in combination, a series of keys, a series of item wheels, a power drive, means including a single master wheel operated by said power drive and under control of said keys for successively differentially positioning said item wheels, a series of operating devices, means operated by said power drive to differentially position said operating devices under control of said item wheels, and means operated by said power drive to restore said operating devices from their differential positions.

16. In a machine of the class described, in combination, a series of operating devices, a series of keys, a series of item wheels, a power drive, a master wheel, means operated by said power drive and under control of said keys for differentially rotating said master wheel to successively set up the item wheels, mechanical means comprising a friction drive between said power drive and said master wheel, means operated by said power drive to reset the item wheels to differentially position said operating devices, and means operated by the power drive to restore the operating devices from their differential positions.

17. In a machine of the class described, in combination, a series of operating devices, a series of keys, a power drive, a series of item wheels, means operated by said power drive and under control of said keys for setting said item wheels differentially, escapement means for causing an item wheel set to be disengaged from the setting means and engaged with one of said operating devices before another item wheel is set, means operated by said power drive for causing said operating devices to be moved differentially under control of the item wheels set, and means operated by the power drive to restore the operating devices from their differential positions.

18. In a computing machine, the combination with a series of keys, of a series of item wheels, a power drive, a master wheel for setting up said item wheels seriatim, a master wheel control device comprising a shaft with a plurality of fingers spirally arranged about said shaft and adapted to coact with said keys, a friction drive comprising one element rotatable with said power drive and a normally contacting companion element which is rotatable with said shaft, locking means for normally preventing the rotation of said shaft and of the element rotatable therewith, common means under control of said keys for causing said locking means to be ineffective whereby said friction drive is then effective to turn said master wheel and said shaft, and means individual to each key and cooperating with said fingers to first determine a differential rotation of said shaft corresponding to the key depressed, and subsequently to allow a further complemental rotation of said shaft.

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