Sept. 9, 1947. C. M. FRIDEN ET AL 2,427,271

MULTIPLIER CORRECTION MECHANISM

Filed Oct. 27, 1941 5 Sheets-Sheet 1

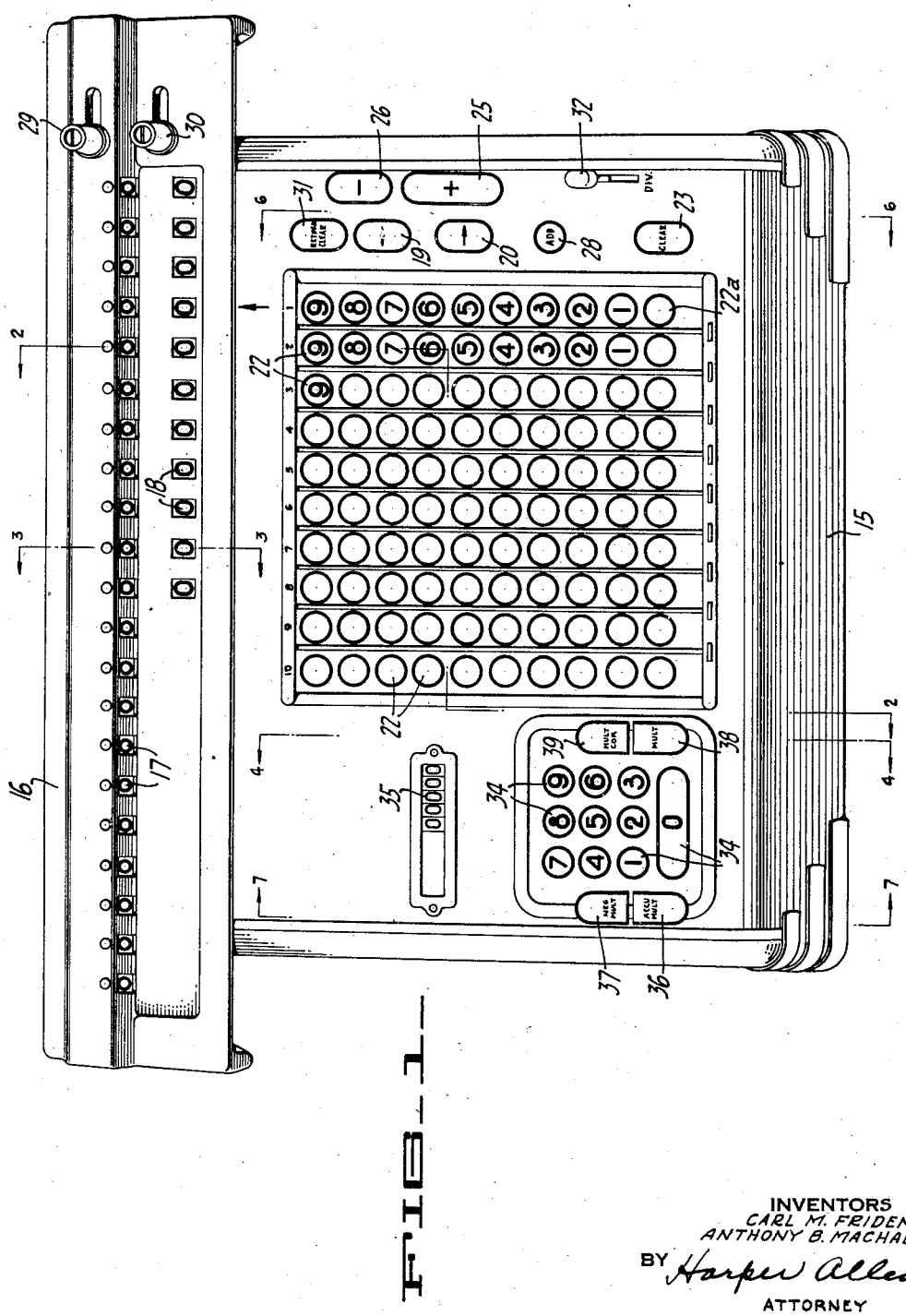

FIG. 1

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MULTIPLIER CORRECTION MECHANISM

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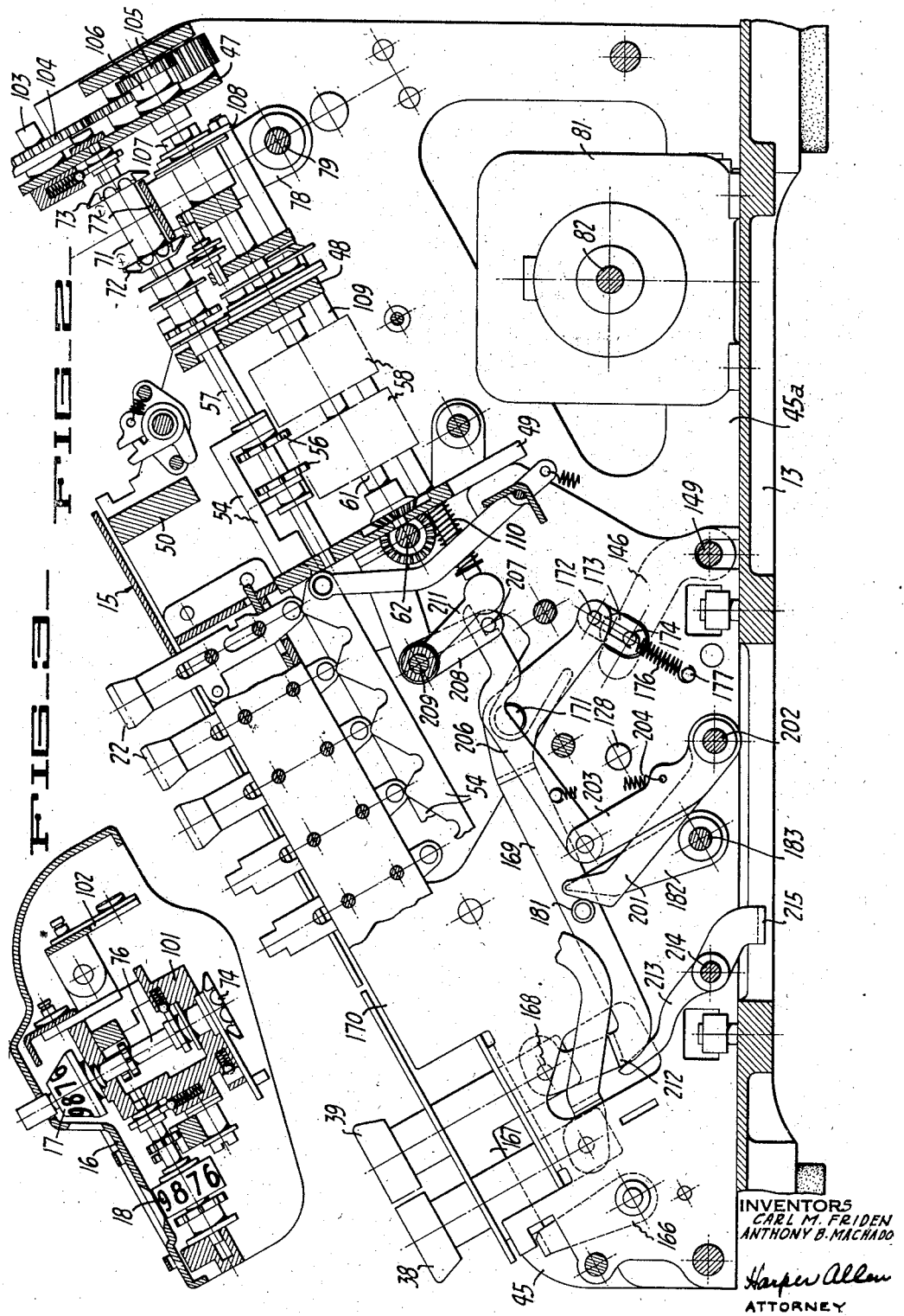
FIG. 2



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MULTIPLIER CORRECTION MECHANISM

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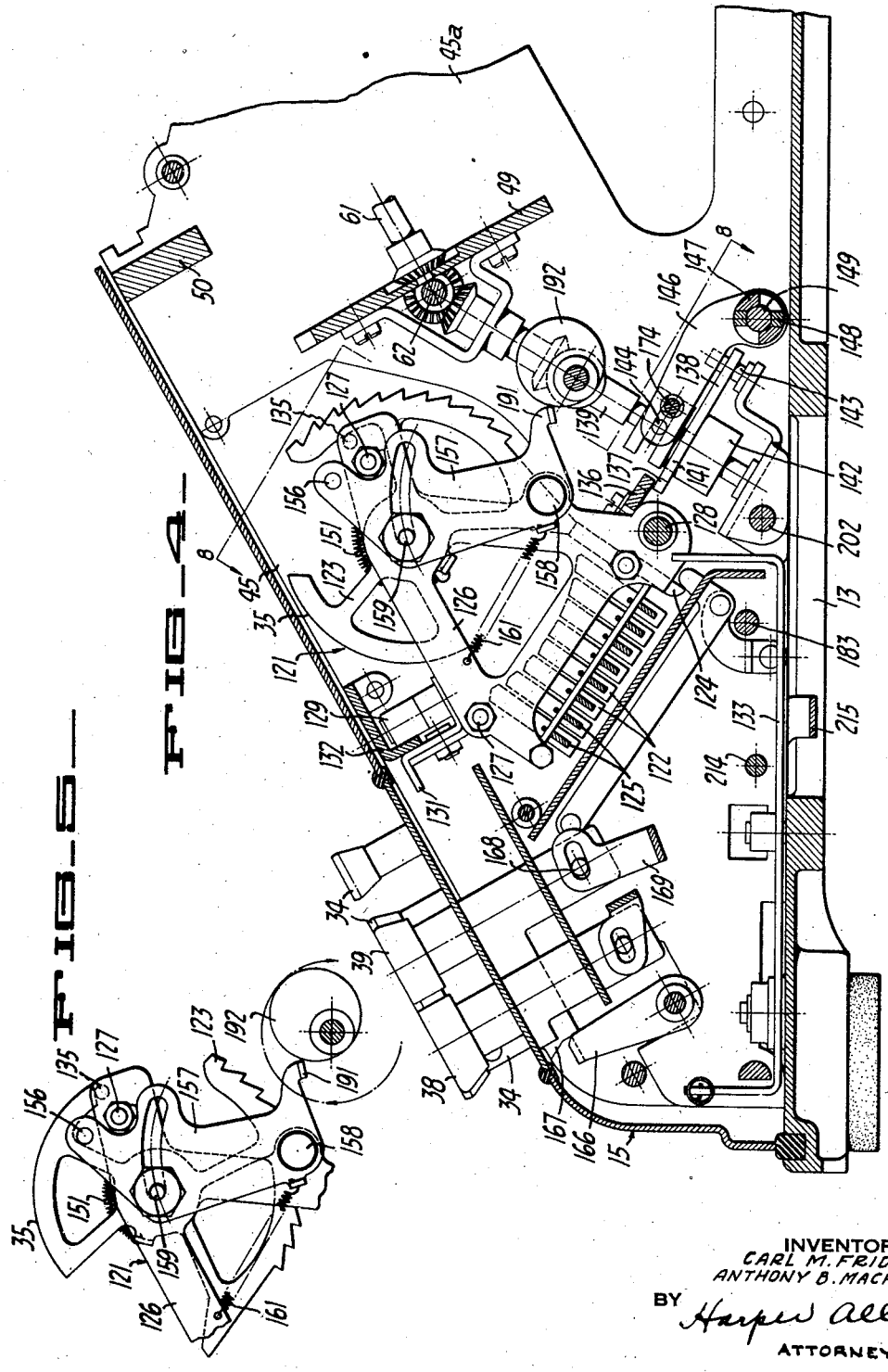

FIG. 4

FIG. 5

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MULTIPLIER CORRECTION MECHANISM

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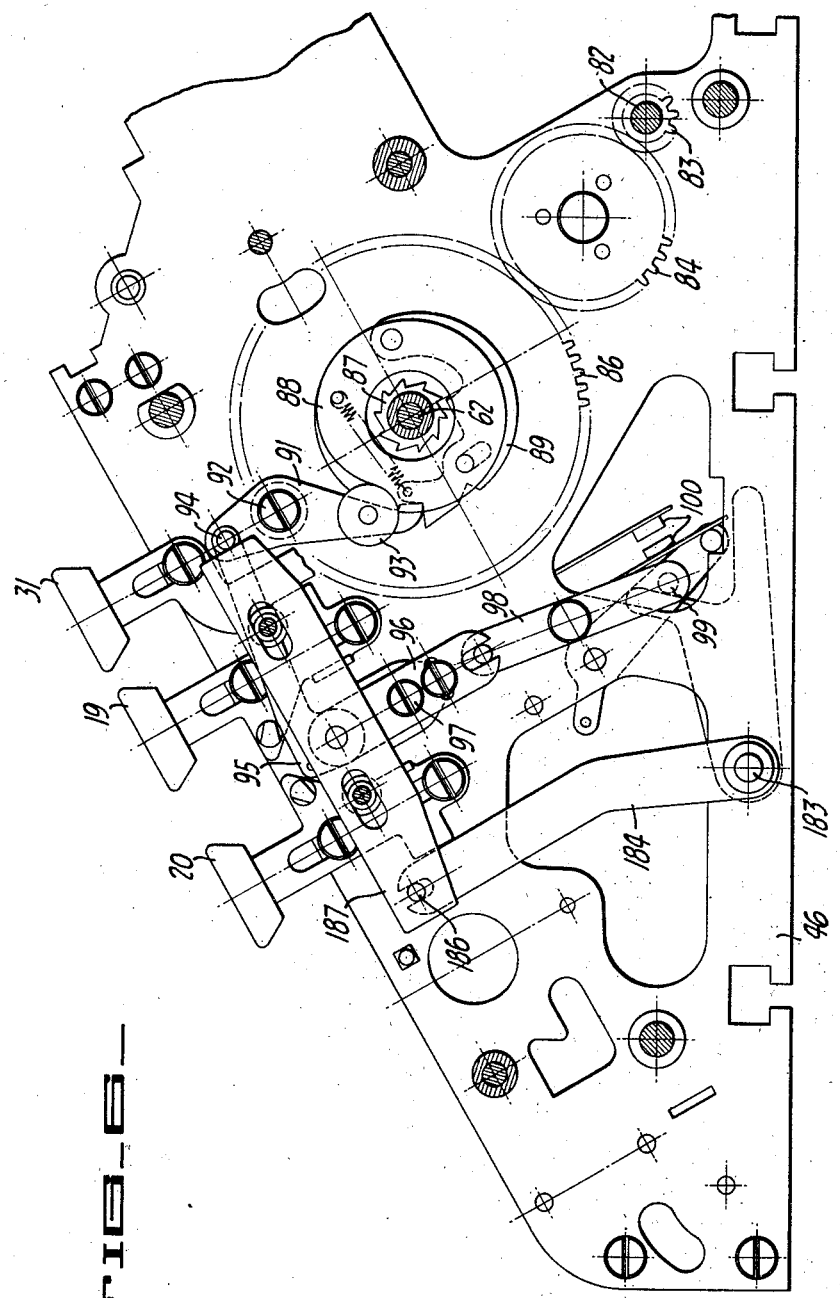

FIG. 6.

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MULTIPLIER CORRECTION MECHANISM

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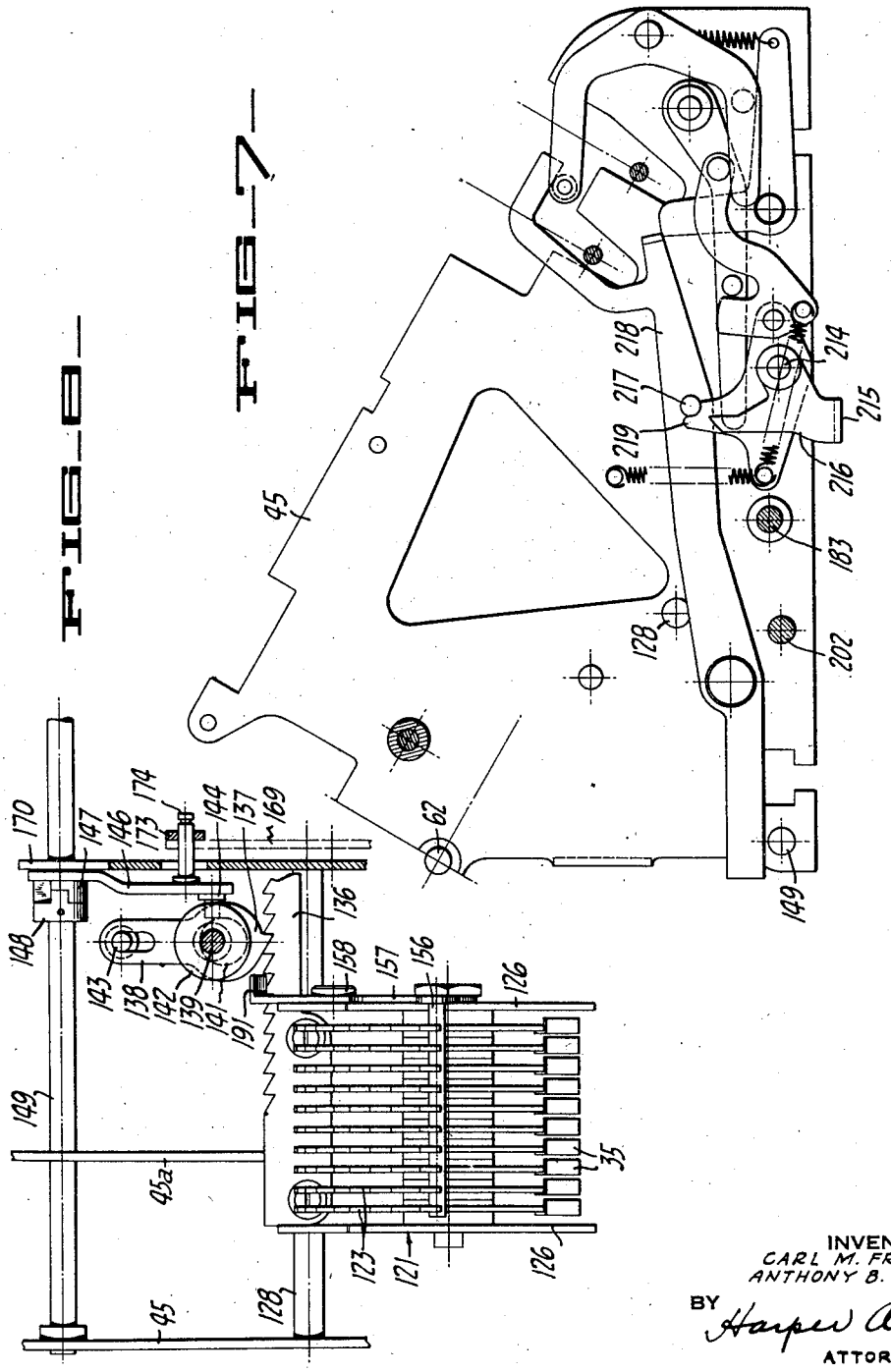
FIG. 8

FIG. 7



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UNITED STATES PATENT OFFICE

2,427,271

MULTIPLIER CORRECTION MECHANISM

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Application October 27, 1941, Serial No. 416,662

6 Claims. (Cl. 235—63)

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This application relates to calculating machines and is concerned more particularly with mechanism for performing plural order multiplication operations.

It is an object of the invention to provide an improved calculating machine of the character referred to in which the multiplier selection mechanism can be restored to zero in an advantageous manner.

Another object of the invention is to provide an improved calculating machine wherein the normalizing of the machine due to an erroneous set-up for plural order multiplifying operations can be effected expeditiously.

Other objects and advantages of the invention will be apparent from the following description of a preferred embodiment thereof, as illustrated in the accompanying drawings, in which:

Figure 1 is a plan view of a calculating machine embodying the invention;

Figure 2 is a longitudinal sectional elevation through the machine taken in planes indicated by the line 2—2 in Figure 1 with the carriage removed;

Figure 3 is a fragmentary sectional view through the carriage, the view being taken as indicated by the line 3—3 in Figure 1. The view is complementary to Figure 2;

Figure 4 is a sectional elevational view through a part of the multiplier mechanism, the view being taken as indicated by the line 4—4 in Figure 1;

Figure 5 is a fragmentary detailed view illustrating a portion of the resetting or correction means for the multiplier selection mechanism;

Figure 6 is a sectional elevational view illustrating a portion of the drive mechanism, the view being taken as indicated by the line 6—6 in Figure 1;

Figure 7 is a fragmentary elevational view of a portion of the multiplier control mechanism;

Figure 8 is a sectional plan view of a portion of the multiplier mechanism, the view being taken as indicated by the line 8—8 in Figure 4.

General description

The invention is described in a preferred form as adapted to a Thomas type calculating machine, as shown for example in the patents to Friden Number 2,229,889, dated January 28, 1941; 2,294,083, dated August 25, 1942; 2,371,752, dated March 20, 1945; and Patent No. 2,399,917, dated May 7, 1946, to Friden and Machado.

Referring to Figure 1, the machine includes a body 15 in which the actuating, selecting, and

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control mechanisms are mounted, and carriage 16 which is mounted for endwise shifting movement transversely of body 15 and which carries numeral wheels 17 and 18 of the accumulator and revolutions counter, respectively. Carriage 16 can be shifted by power in either direction by manipulation of respective shift keys 19, 20.

Values are entered into the machine by depression of numeral keys 22 of the usual keyboard in the various ordinal rows thereof, keys 22 being releasable individually by depression of ordinal clear keys 22*a*, or collectively by depression of keyboard clear key 23. Values introduced into the machine may be registered additively or subtractively on accumulator numeral wheels 17 by depression of plus key 25 or minus key 26, respectively. If desired, add key 28 may be depressed to cause clearing of the keyboard in the usual manner after a single registration in the accumulator.

Values registered in numeral wheels 17 and 18 can be erased, i. e., the registers can be zeroized, by manipulation of respective manually operable resetting handles 29, 30 or by power through depression of return and clear key 31.

The machine is adapted to perform automatic plural order division by means of conventional construction including division starting control lever 32. Automatic predetermined multiplication can also be performed by depression of multiplier selection keys 34 to set up the desired multiplier figures as indicated on dials 35, and by depression of one of multiplication keys 36, 37 or 38 to start the multiplying operation. By depression of multiplier correction key 39 values entered into the dials 35 can be removed and the multiplier selection mechanism normalized.

Selecting and actuating mechanism

Within casing 15, the frame includes left side plates 45 and 45*a* (Figure 4) and right side plate 46 (Figure 6) which are suitably mounted on base 13 and are interconnected by various cross frame members including transverse brackets 47, 48, 49 and 50 for supporting various mechanisms including the selecting and actuating mechanism.

The values to be introduced into accumulator numeral wheels 17 are selected by means of a plurality of similar orders of selecting mechanism associated with numeral keys 22. For this purpose, each bank or order of keys 22 (Figure 2) cooperates with a pair of similar parallel spring-urged value selecting slides 54 mounted for endwise movement by a suitable supporting linkage

and extending through suitable slots in cross frame plate 49.

Each selecting slide 54 (Figure 2) is connected at its rear end with a ten-tooth gear 56 slidably and non-rotatably mounted on longitudinal square shaft 57, whereby movement of slide 54 serves to position the associated gear 56 on shaft 57 with respect to stepped teeth of the associated actuating cylinder 58 in accordance with the value of the depressed numeral key 22. A pair of actuating cylinders 58 for adjacent orders of the machine are mounted on each longitudinal actuating shaft 61, which is suitably journalled in cross plates 48 and 49 and has a suitable bevel gear connection with transverse shaft 62. Shaft 62 is operable cyclically in a single direction from clutch controlled driving means as described hereinafter to provide the only path of power flow from the motor.

Each shaft 57 (Figure 2) is suitably journalled in cross plates 47, 48 and 49, and between plates 47 and 48 has associated therewith selectively settable plus-minus gears for driving an aligned numeral wheel 17. The plus-minus gears of each order of the machine include a spool 71 slidably and non-rotatably mounted on shaft 57 and having opposed ten-tooth bevel gears 72, 73 arranged for selective engagement with gear 74 (Figure 3) on numeral wheel shaft 76. The engagement of gear 72 and 73 with gear 74 is controlled by strap 77 (Figure 2) which extends transversely of the machine between each set of plus-minus gears 72, 73 and is mounted by similar spaced arms 78 on transverse shaft 79, which is suitably journalled in side plates 45a and 46. Shaft 79 is controlled in a manner hereinafter described to determine positive registration by meshing gears 72 with gears 74, and negative registration by meshing gears 73 with gears 74. In the central neutral position shown in Figure 2, in which gears 72 and 73 may be held normally by suitable spring-urged centralizing means associated with strap 77, carriage shifting can be effected.

During additive and subtractive registration of values in numeral wheels 17, suitable transfer mechanism of conventional construction may be operative to effect the tens transfer as disclosed, for example, in said Patent 2,229,889.

Drive mechanism

As stated above, the actuating means is operable cyclically to effect registration in the accumulator of the values set into the machine by depression of the numeral keys. For this purpose a clutch-controlled drive is provided for the actuating mechanism which preferably forms the sole drive means for all power driven parts of the machine. This source of power of the drive means comprises electric motor 81 (Figure 2) provided with drive shaft 82 carrying drive gear 83 (Figure 6) which is connected by idler gear 84 with gear 86 journalled on transverse shaft 62 and carrying driving clutch element or ratchet 87 on its hub. Driven clutch element 88 is secured on shaft 62 and has pivoted thereon spring-urged clutch pawl 89 having a tooth for engagement with the teeth of ratchet 87 to establish the drive connection. Pawl 89 is spring-urged to operative position but is restrained in the neutral or full cycle position of the parts by clutch control lever 91 pivoted at 92 on side plate 46. Lever 91 carries roller 93, which seats in a depression on clutch element 88 in the full cycle position thereof, and in other positions thereof maintains lever 91 in its clutch engaging position for a purpose later referred to.

It is seen, therefore, that one or more cycles of operation of the actuating mechanism can be determined by oscillation of clutch control lever 91.

Simultaneously with movement of control lever 91, the circuit for motor 81 is established, and for this purpose pin 94 (Figure 6) on the upper arm of clutch control lever 91 is connected by link 95 with lever 96 pivoted at 97 on side plate 46 and connected at its lower end with lever 98 also pivoted on plate 46. Lever 98 has a suitable insulated pin 99 in overlapping relation with spring mounted contact 100 normally spaced from similar contact 100. Thus, clockwise movement of clutch control lever 91 serves through link 95 and lever 96 to oscillate lever 98 in a counter-clockwise direction whereby contacts 100 are engaged to establish the circuit for the motor. It will be noted that roller 93 in maintaining control lever 91 in clutch engaging position when the actuating means is out of full cycle position also serves to maintain contacts 100 closed, so that the motor circuit can be interrupted only in the full cycle position of the parts.

Carriage shift mechanism

Conventional means are provided to shift the carriage in either direction under control of the shift keys 19 and 20 such as disclosed in Friden Patent No. 2,294,083. Carriage 16 (Figure 3) includes a frame 101 having a toothed shift rack 102 extending along the rear side thereof. The rack 102 is adapted for engagement by shift pins 103 (Figure 2) on a shift gear 104 suitably journalled upon cross bracket 47. Shift gear 104 can be rotated selectively in either direction through suitable gear connections 105 to a pair of similar gear sleeves 106, one of which is seen in Figure 2. Gear sleeves 106 are axially aligned with two adjacent actuating shafts 61, and have similar engageable drive connections therewith. These drive connections are made by means of a clutch element or collar 107 having a slidable drive connection with one of the actuating shafts 61 and shiftable by means of a fork 108 carried by a shift rod 109. Rod 109 is slidably mounted in cross brackets 48 and 49 and is spring urged by a spring 110 to the inactive position shown in Figure 2. There are two shiftable rods 109 which are selectively moved to active position by a suitable means from the respective shift keys 19 and 20.

Multiplier mechanism

The multiplier mechanism comprises a ten key keyboard including keys 34 (Figures 1 and 4) and a pin carriage 121 (Figure 4) associated therewith, having ten ordinal rows of settable stop pins 122 and ten ordinal differentially adjustable elements 123 (Figures 4 and 8). Adjustable elements 123 are in the form of spring-urged racks into which the digits of the multiplier may be set successively for subsequent control of the multiplying operation. Each rack 123 is normally held inactive by a latch lever 124. In order to set up the multiplier digits, each pin row includes eight pins corresponding to the "1" to "8" keys and a fixed stop 135 corresponding to the "9" key so that a depressed multiplier key operates through a conventional lever system as disclosed in Patent 2,371,752 to set the corresponding pin of an aligned ordinal row to active or raised position. At the same time that a pin

of the pin carriage is moved to active position, the aligned rack is released from its latch 124 to move into engagement with the active pin 122 and thereby be set differentially in accordance with the values of the depressed multiplier key. The depressed multiplier key also operates a conventional form of escapement mechanism to move the pin carriage one ordinal step with respect to the multiplier selection mechanism. As shown in Figure 1, the carriage 121 has been moved five steps from its normal position by depression of the zero key 34. This mechanism is of the type disclosed in said Patent 2,371,752.

The differentially adjusted positions of each rack 123 is utilized in a well known manner to control the number of registrations in a corresponding ordinal position of the accumulator, to shift the accumulator from left to right following multiplication by each multiplier digit, to enable correct registration of the next ordinal product, as well as to shift the pin carriage one step so that the next higher order rack 123 comes into controlling position with respect to the operation of the machine. To enable exercise of the above control, a conventional pawl drive (not shown) is provided for returning each adjusted rack step by step to its initial position, this operation being successive from the adjusted rack of lowest order with the shifting of the accumulator and the multiplier pin carriage following the last step of movement of each rack to condition the machine for operation in the next higher order. As the pin carriage is returned step-by-step toward the right as viewed in Figure 1, pin restoring fingers 125 of conventional construction which engage the slotted lower ends of pins 122 act to restore the active pins of the respective rows to inactive position successively.

As explained in said Patent 2,399,917, when one of the keys 36, 37 or 38 is depressed and latched into depressed position, the multiplying operation is performed by first returning the carriage to its end position (with resetting of the register if the key 38 is depressed). After the carriage is in its end position, the multiplying operation proceeds in the usual fashion under control of the adjusted racks of the multiplier carriage 121.

As seen in Figures 4 and 8, the multiplier carriage 121 comprises end plates 126 which may be connected by suitable tie rods 127. Adjacent its lower portion, the carriage 121 is slidably engaged and supported by a transverse rod 128, while at its upper end the carriage has a roller 129 and a rack 131 engaging a guide 132 on the frame of the machine. The escapement mechanism for determining step-by-step shifting movement of the multiplier carriage to the left as viewed in Figure 8 during the setting of the values into the multiplier unit is of conventional construction and includes the rack 131 and the spring-urged lever 133 (Figure 4) having an upstanding portion engaging an end plate 126 of the carriage.

The power return of the carriage in step-by-step fashion is provided for by means of rack 136 (Figures 4 and 8) which is adapted for engagement by the tooth 137 of shift pawl 138 which is normally positioned below the rack 136 as seen in Figure 4. The pawl 138 is journalled about a suitable eccentric 141 carried by collar 142 which is slidable on shaft 139. Shaft 139 has a suitable drive connection with the transverse shaft 62. Pawl 138 is also slotted to engage a stationary guide pin 143. Collar 142 is provided with a groove engaged by pin 144 carried by an adjustable control arm 146 having clutch teeth 147 associated with similar teeth 148 on the control shaft 149. The clutch connection 147, 148 provides for rocking adjustment of control arm 146 by clockwise movement of the shaft 149 or independently of shaft 149. During the multiplying operation the shift pawl 138 is raised at the end of each ordinal multiplying operation by rocking of shaft 149 to cause a one step shift of the multiplier carriage so that the racks 123 are successively restored to zero.

As seen in Figure 4, each rack 123 is urged in a clockwise direction by a spring 151. Figure 5 shows the position of the rack 123 when set to the value of "9." In the "9" position of a rack 123 a portion of the rack engages a cross rod 156 carried by a lever member 157 which is pivoted at 158 on the carriage 121 and is slotted to engage pivot rod 159 of the racks 123. The engagement of one end of the slot with the rod 159 under the influence of spring 161 provides a normal position of the arm 157 and the rod 156. As will be later described, the rod 156 provides means for restoring any adjusted rack 123 to zero position after the shifting of the pin carriage to its inactive position.

In order to correct the multiplier setting, the correction key 39 is depressed. The depression of this key serves to enable the power shift for returning the multiplier or pin carriage and also to enable the shift for the accumulator carriage to return it to its end position. Key 39 (Figures 2 and 4) is spring-urged to the raised position shown and is adapted to be latched in depressed position by engagement of spring-urged latch arm 166 with an extension 167 of the key. Adjacent its lower end key 39 has a pivotal pin and slot connection at 168 (Figure 2) with a lever 169 pivoted on an auxiliary frame plate 170 at 171. The lower arm of lever 169 carries a pin 172 engaged in a slotted link 173 which also engages a pin 174 on arm 146. Spring 176 is connected between pin 174 and a suitable stud 177 on the frame of the machine to urge the parts to the position shown in Figure 2. Spring 176 also serves through arm 146 to maintain pawl 138 below rack 136 as shown in Fig. 4. Upon depression of key 39, lever 169 (Figure 2) is rocked in a counterclockwise direction to rock arm 146 in a clockwise direction, and to raise the actuating pawl 138 (Figure 4) for the pin carriage return shift. The pin carriage will therefore be returned one step with each cycle of the machine and will be restored to its initial position, which is one cycle more than the number of set multiplier racks 123. Depression of key 39 (Figure 2) also operates through roller 181 on lever 169 to oscillate an arm 182 carried by transverse shaft 183 which also (Figure 6) carries an upstanding arm 184 with its upper forked end embracing a pin 186 carried by slide 187 mounted for endwise sliding movement on the frame of the machine. The end of slide 187 abuts pin 94 carried by clutch control lever 91, so that movement of slide 187 to the right, as viewed in Figure 6, not only engages the clutch, but also operates through the link 95 and levers 96 and 98 to close the contacts 100.

During the last cycle of shifting movement, the lever 157 (Figure 4) has its arm 191 moved into operative relation with cam 192 to be oscillated thereby in a counterclockwise direction during such last cycle so that rod 156 will restore racks 123 to their zero positions. Cam 192 is suitably driven in cyclic fashion from the shaft 62.

Preferably also the key **39** engages the carriage shift to return the accumulator carriage to its leftmost position to facilitate the multiplying operation. Such a multiplying operation starts with a return of the carriage to its leftmost position and is shortened if the return is effected simultaneously with the multiplier correction operation. For this purpose roller **181** (Figure 2) is operatively engaged with an arm **201** secured on a shaft **202** which also carries an upstanding arm **203**. At its upper end, arm **203** carries a pusher arm **206** operatively related with a pin **207**, carried by depending arm **208** on a shaft **209**. Arms **203** and **206** are connected by spring **204**. Shaft **209** also carries depending arm **211** which is operatively engaged with the end of shift rod **109** which controls shifting to the left. Spring **110** for shift rod **109** is stronger than spring **204** so the parts are normally positioned as shown in Figure 2.

As explained in said Patent No. 2,399,917, when the accumulator carriage shift mechanism reaches an end position, it overdrives one cycle, and this cycle is ordinarily utilized in a multiplying operation to trip the multiplying mechanism for operation, and when the carriage shift is enabled by depression of key **39**, this trip for the multiplying operation must be disabled. As seen in Figure 2, the lever **169** has an offset portion **212** operatively related to an upstanding finger **213** pivoted on shaft **214**. Finger **213** is connected by cross piece **215** (Figures 2 and 7) to a locking finger **216** (Figure 7). Upon depression of key **39**, finger **216** is moved beneath pin **217** of a multiplier control arm **218**. Arm **218** is normally held inactive by latch **219** which is tripped during the overthrow cycle of the shift to start the multiplying operation. However, with the correction key **39** depressed, locking nose **216** moves beneath pin **217** to hold the arm **218** inactive and thereby prevent the initiation of a multiplying operation.

Operation

In operation, when an erroneous multiplier figure is set into the dials **35**, the operator depresses the correction key **39**. Key **39** (Figure 2) through lever **169**, arm **182**, shaft **183** and arm **184** (Figure 6) operates to engage the clutch and enable the motor circuit, and, through lever **169** (Figure 2) link **173** and arm **146** enables shift pawl **137** (Figure 4) to effect step-by-step return of the pin carriage **121**. As each rack **123** is withdrawn from view its active stop pin **122** is withdrawn by the associated finger **125** and the rack moves to its "nine" position against pin **156** as seen in Figure 5. During the overthrow step of carriage **121** when finger **191** is moved into alignment with cam **192**, cam **192** becomes operative to restore all displaced racks **123** to their zero position where they are held by latch levers **124**. Also during this overstroke cycle, lever **133** operates in a manner disclosed in the above-mentioned Patent Number 2,371,752, to move latch arm **166** to inactive position so that key **39** is restored to raised position by the spring associated therewith.

During the time key **39** is depressed, the accumulator carriage **16** is also moved step-by-step toward its left end position.

We claim:

1. In a calculating machine having a multiplier selection mechanism including a carriage provided with a plurality of orders of differentially settable elements spring-urged toward the "nine" position, a latch for each of said elements normally holding the element in "zero" position, eight selectively settable pins for each element operable to stop the element in the "one" to "eight" positions when said latch is released, a means common to all said elements to stop each element in the "nine" position, said carriage being displaceable step-by-step from an initial position during successive setting of said elements, means for returning said carriage beyond said initial position to a restoring position, means for withdrawing stop pins which have been set upon movement of said carriage to said restoring position thereby permitting the associated elements to move to the "nine" position determined by said common stop means, means operable upon arrival of said carriage in said restoring position for moving said common stop means to restore all elements in the "nine" position to the "zero" position for latching by said latches, and means operable after the setting operation to initiate operation of said carriage returning means and said common stop moving means.

2. In a calculating machine adapted to perform multiplication calculations, a multiplier selection mechanism including a carriage provided with a plurality of orders of differentially settable elements, a keyboard comprising ten keys for entering the multiplier value in said selection mechanism, selective depression of one of said keys causing differential setting of one of said elements followed by movement of said carriage into the next ordinal position, said carriage being moved step-by-step from its initial position as the multiplier value is entered into said selection mechanism, means for normalizing said selection mechanism including a manually operable control key, means for shifting said multiplier carriage to its initial position, a cyclically-operable power drive means for actuating said shifting means, means responsive to operation of said control key for causing said drive means to actuate said shifting means to return said carriage to initial position step-by-step during successive cycles of said drive means, means for restoring said differentially-settable elements to zero position, and means driven by said cyclically-operable drive means operative upon arrival of said carriage in initial position to actuate said restoring means.

3. In a calculating machine having a frame, a selection mechanism including a carriage having a series of pivotally mounted axially aligned differentially settable elements, said carriage being displaceable relative to said frame step-by-step from an initial setting position during successive differential setting of said elements, mechanism for restoring said selection mechanism comprising a restoring member mounted on said carriage for movement therewith and operable to restore any of said elements from a common setting to zero setting, a cyclically operable cam rotatably mounted in said frame, means for returning said carriage beyond said initial setting position to a restoring position, means operable during return of said carriage for positioning differentially set elements in said common position, said cam operating said restoring member upon arrival of said carriage in the restoring position, and means operable after the differential setting of said elements for initiating operation of said carriage returning means and said cam.

4. In a calculating machine adapted to perform multiplication calculations, a multiplier

selection mechanism including a carriage provided with a plurality of orders of differentially-settable elements, a keyboard comprising ten keys for entering the multiplier value in said selection mechanism, selective depression of one of said keys causing differential setting of one of said elements followed by movement of said carriage into the next ordinal position, said carriage being moved step-by-step from its initial position as the multiplier value is entered into said selection mechanism, cyclically operable means for shifting said multiplier carriage step-by-step, toward its initial position, adjustable control means for rendering said shifting means effective, a cyclically-operable power drive means for actuating said shifting means, an operation key, means actuated by depression of said operation key for initiating operation of said drive means and for adjusting said control means to thereby effect substantially uniform cyclic operation of said shifting means simultaneously with operation of said power drive means to return said carriage one step for each successive cycle of said drive means while said key actuated means is in actuated position.

5. In a calculating machine adapted to perform multiplication calculations, a multiplier selection mechanism including a carriage provided with a plurality of orders of differentially-settable elements, a keyboard comprising ten keys for entering the multiplier value in said selection mechanism, selective depression of one of said keys causing differential setting of one of said elements followed by movement of said carriage into the next ordinal position, said carriage being moved step-by-step from its initial position as the multiplier value is entered into said selection mechanism, means for returning said carriage toward said initial position comprising a rack on said carriage and a cyclic shifting element engageable therewith, a power drive means for said element including a cyclic clutch for controlling operation thereof, said element being normally disposed in a position where it is inoperative upon said rack, control means for moving said element into operative position with respect to said rack, an operation key, means actuated by said operation key upon depression thereof for engaging said clutch, and operating connections between said key and said control means responsive to depression of said key for moving said element into said operative position to maintain said carriage returning means cyclically operable in time with cyclic operation of said clutch, to thereby effect returning of said carriage one step for each cycle of said carriage returning means and said clutch.

6. In a calculating machine adapted to perform multiplication calculations, a multiplier selection mechanism including a carriage provided with a plurality of orders of differentially-settable elements, a keyboard comprising ten keys for entering the multiplier value in said selection mechanism, selective depression of one of said keys causing differential setting of one of said elements followed by movement of said carriage into the next ordinal position, said carriage being moved step-by-step from its initial position as the multiplier value is entered into said selection mechanism, an accumulator for registering a product mounted in a shiftable carriage, means for shifting said accumulator carriage toward its left end position preparatory to registering of a product in said accumulator, means for shifting said multiplier carriage to its initial position, a cyclically-operable power drive means for actuating both said shifting means, correction means responsive to shifting of said multiplier carriage to its initial position for effecting restoration of previously set differentially-settable elements to normal positions, an operation key, means actuated by depression of said key for effecting operation of said multiplier carriage shifting means by said power drive means to shift said multiplier carriage to its initial position, and means also actuated by depression of said key for effecting operation of said accumulator carriage shifting means by said power drive means to shift said accumulator carriage toward the left, whereby while said multiplier carriage is being shifted toward its initial position preparatory to the entering of a new value in said selection mechanism, said accumulator carriage will be shifted toward its left end position preparatory to registering of a product in said accumulator.

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