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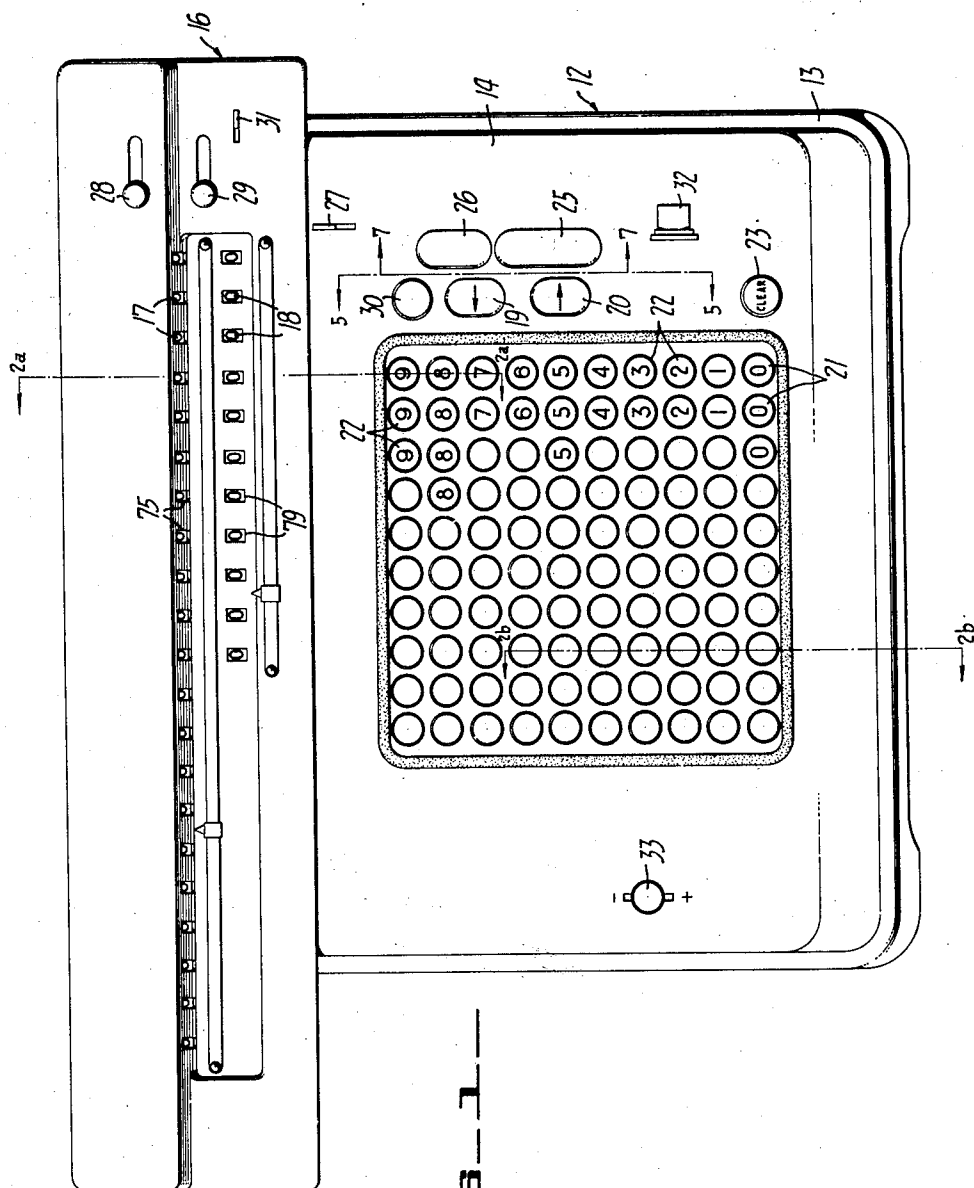
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2,311,354

CALCULATING MACHINE

Filed Jan. 16, 1939

9 Sheets-Sheet 1



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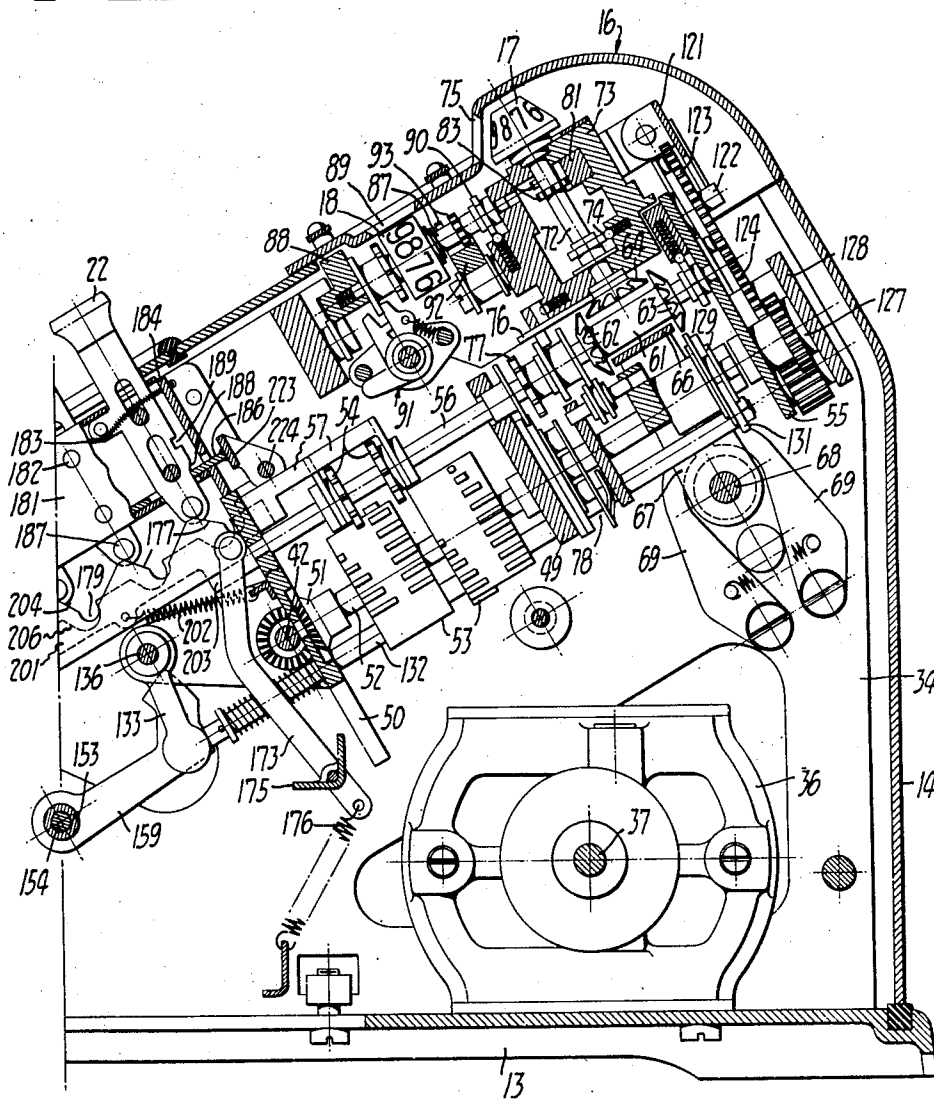
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CALCULATING MACHINE

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9 Sheets-Sheet 2

FIG. 2A



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FIG. 3

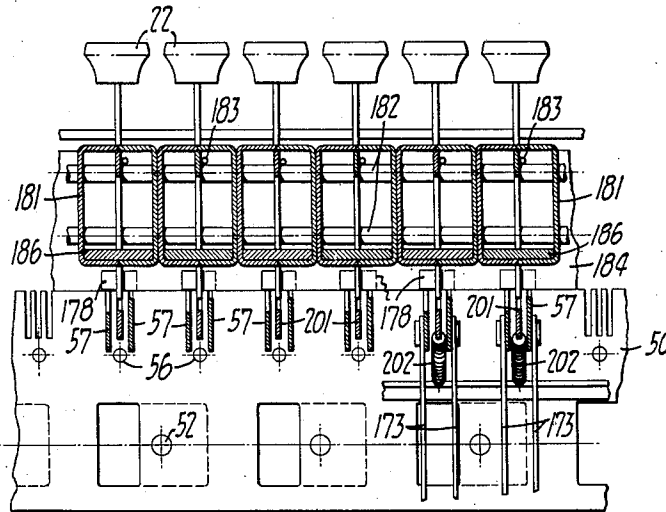
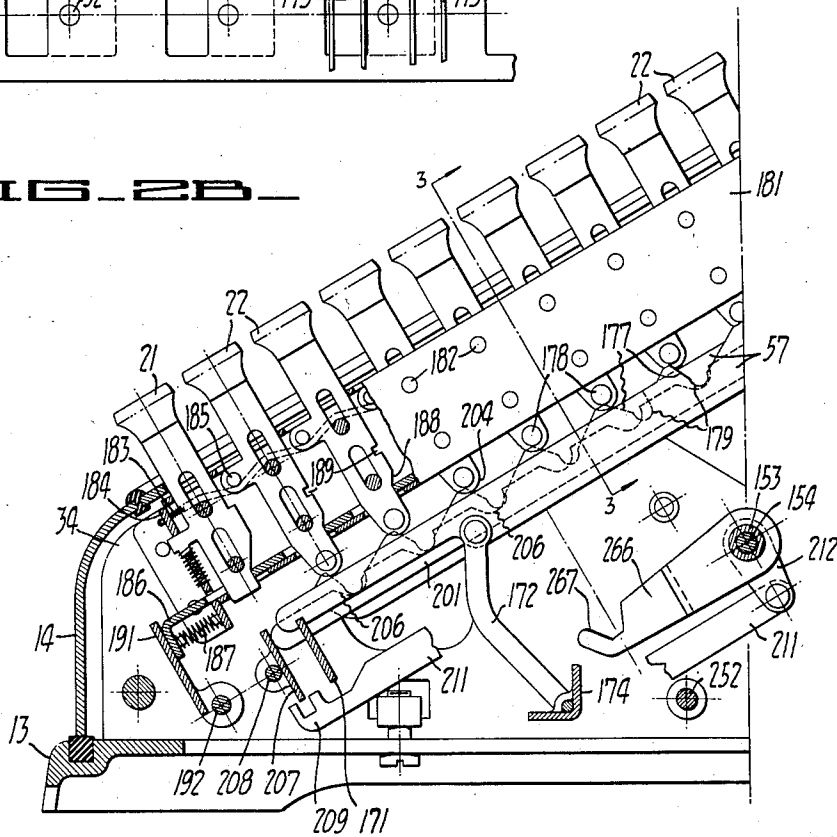


FIG. 2B



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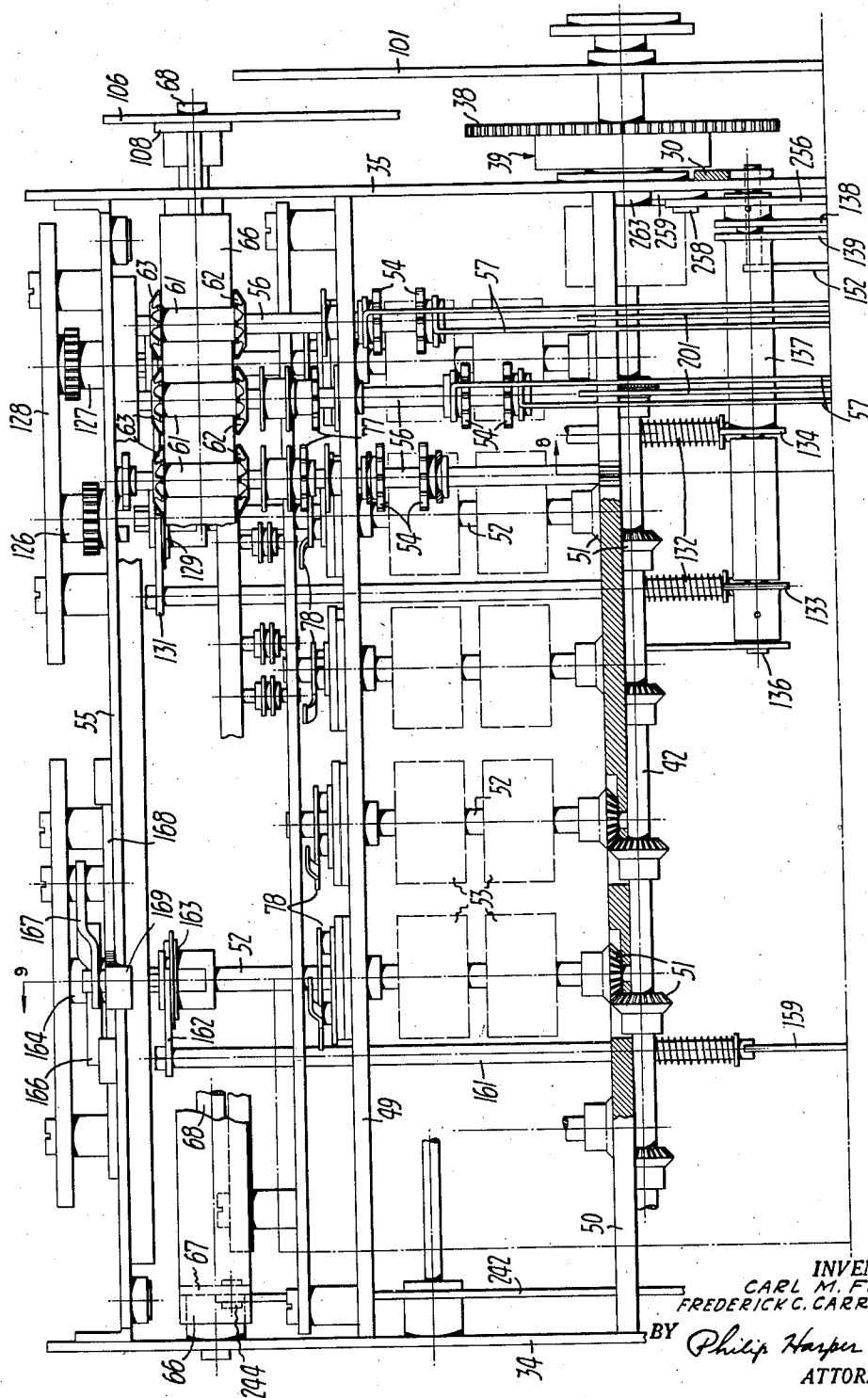


FIG. 4A

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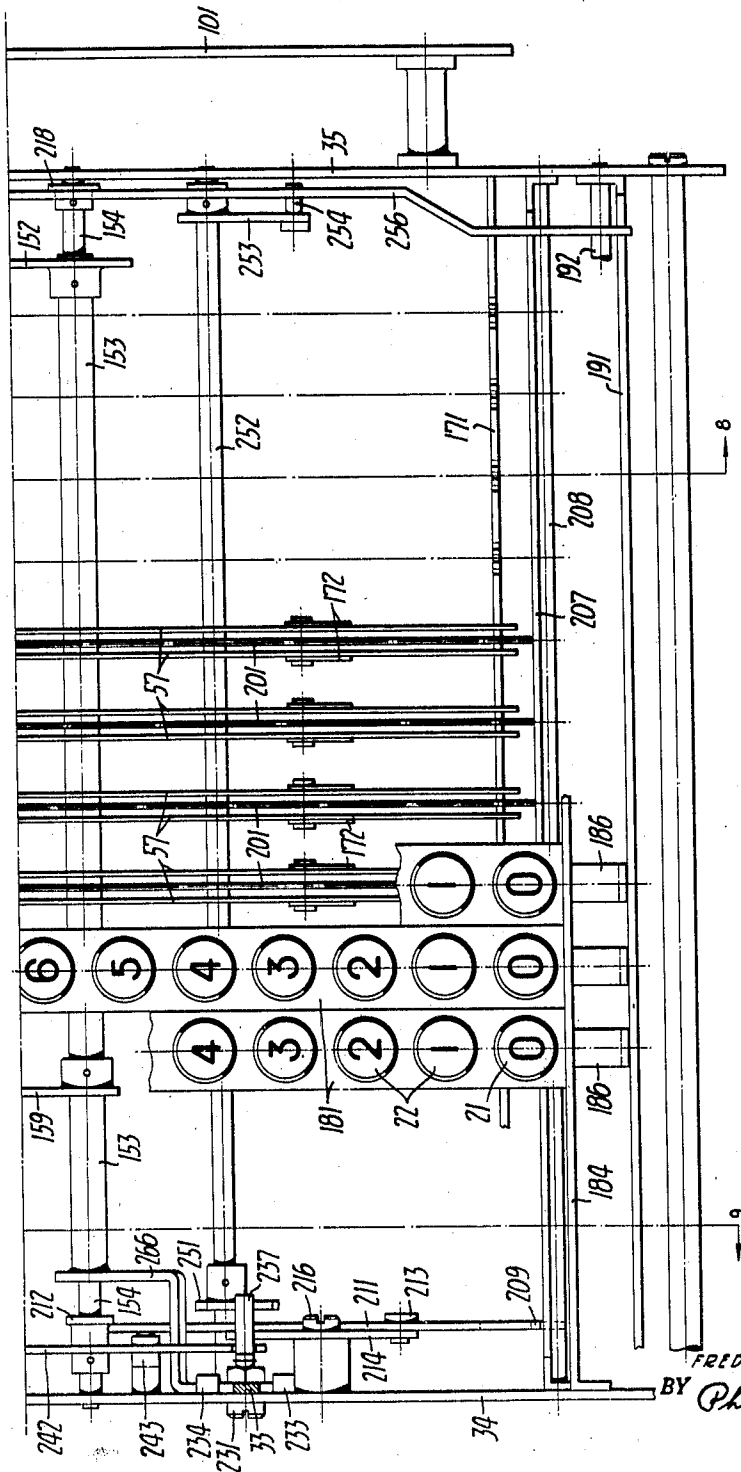
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Filed Jan. 16, 1939

9 Sheets-Sheet 5



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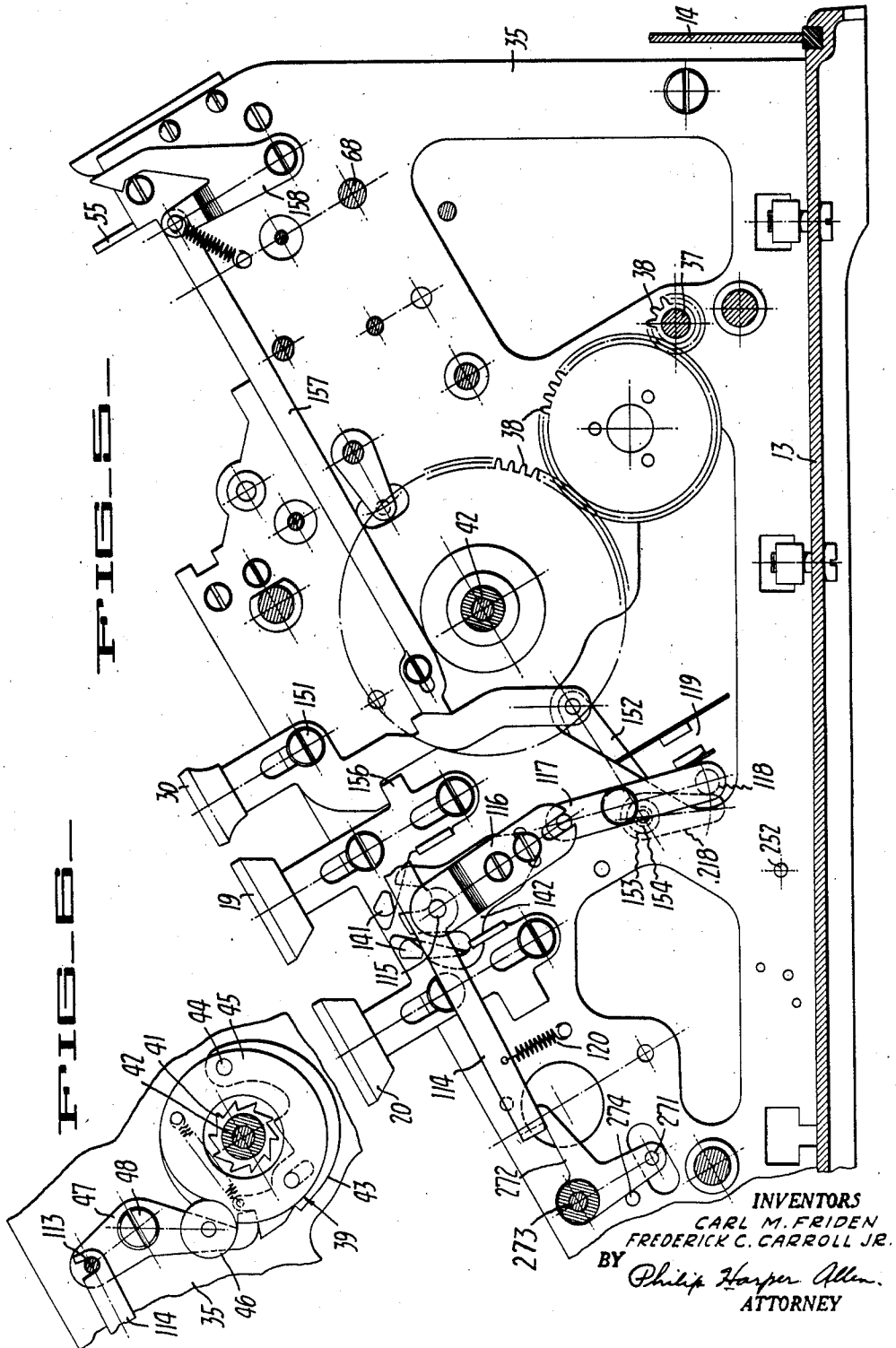
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CALCULATING MACHINE

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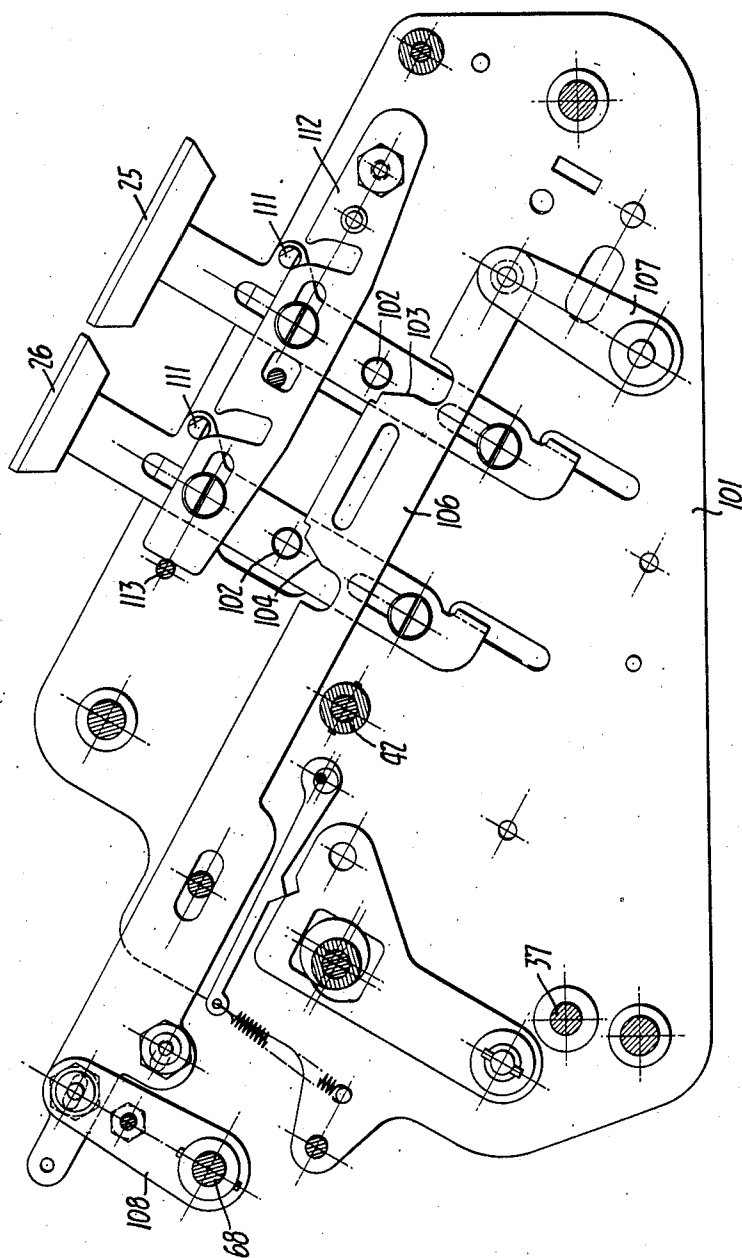
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CALCULATING MACHINE

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FIG-7-



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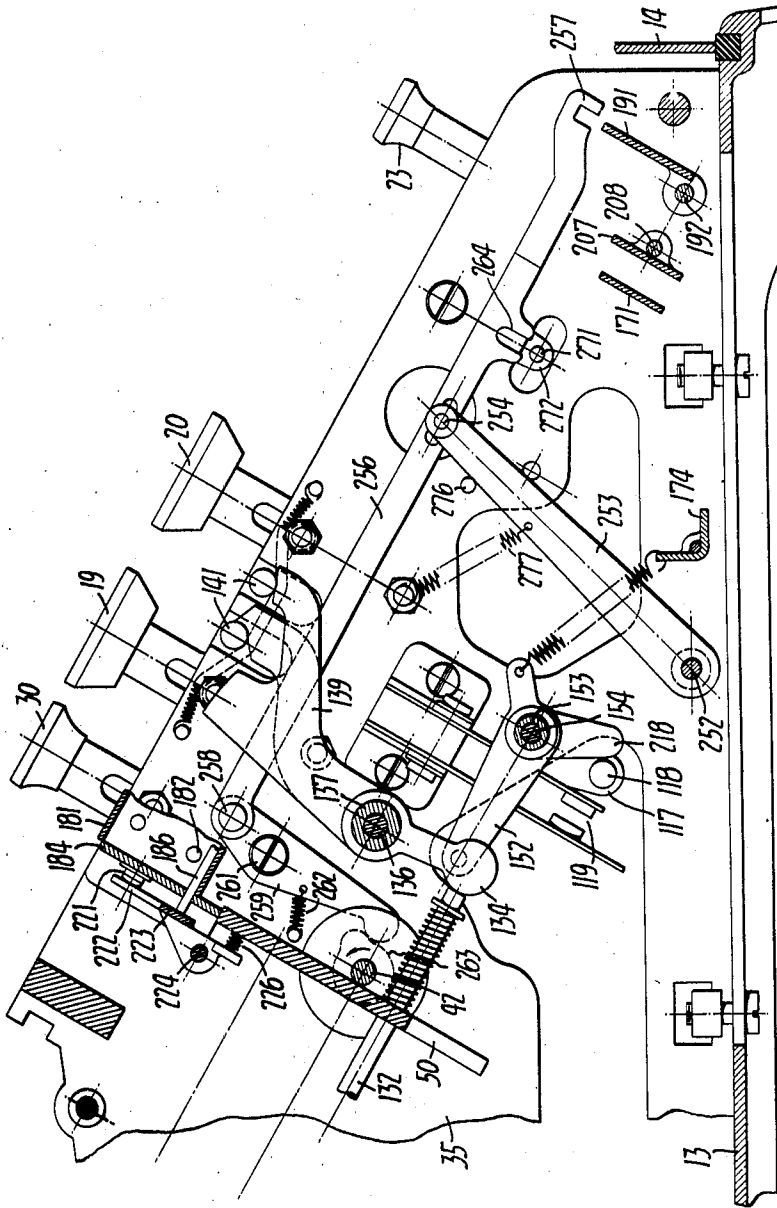
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CALCULATING MACHINE

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FIG. 8

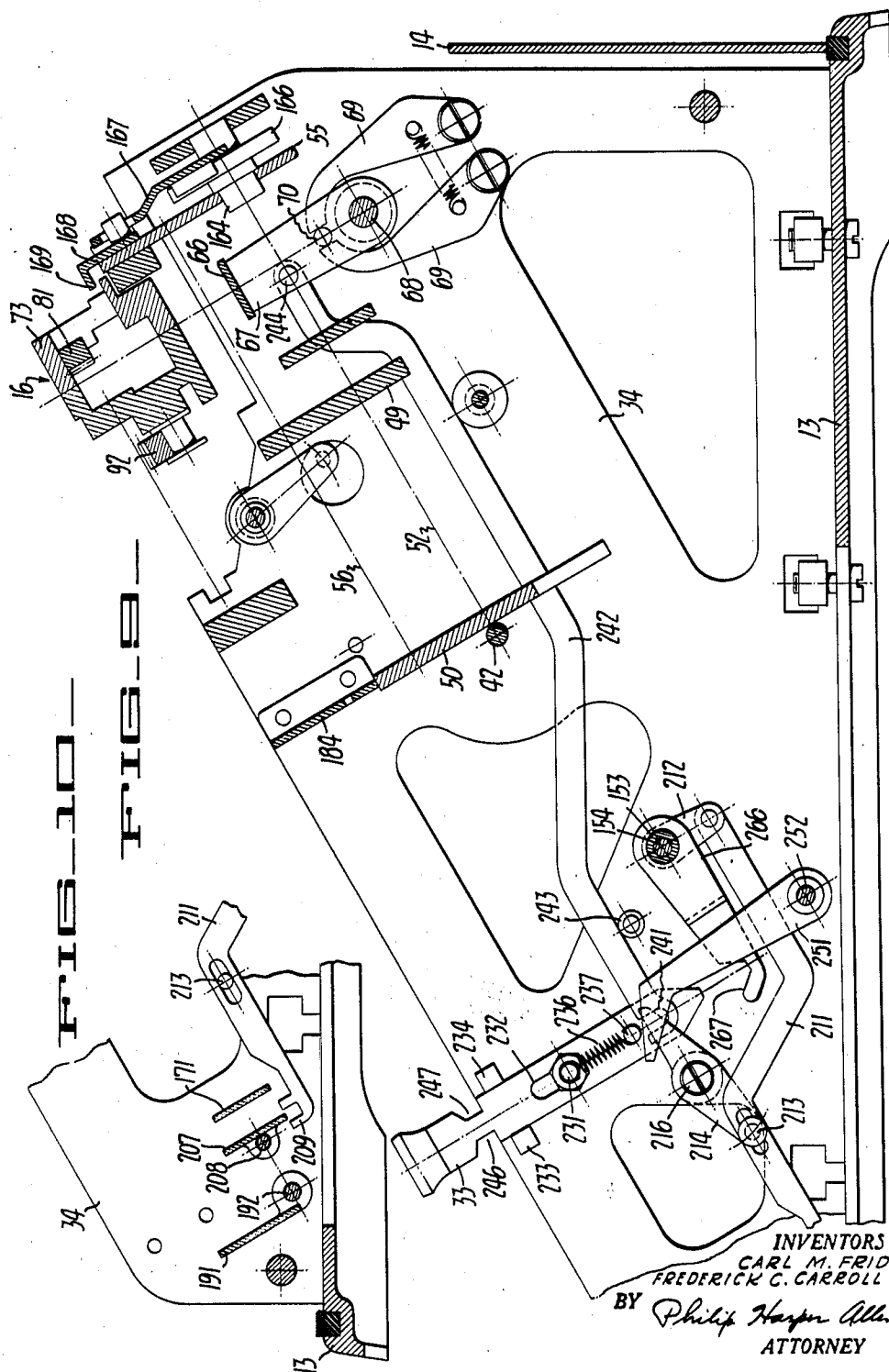


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UNITED STATES PATENT OFFICE

2,311,354

CALCULATING MACHINE

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Application January 16, 1939, Serial No. 251,058

5 Claims. (Cl. 235—82)

This invention relates to calculating machines, and is concerned more particularly with the provision of an improved calculating machine of the type having clutch-driven cyclically operable actuating means which can be operated optionally as a key-set calculator of the usual character in multiplying and dividing operations or as a key-responsive calculator for the addition and subtraction of items.

It is a general object of the invention to provide an improved calculating machine which can be used in both key-set and key-responsive operations as desired.

Another object of the invention is to provide a calculating machine which includes improved mechanism comprising a single key which is manipulatable for converting the machine from key-set multicyclic operation to key-responsive uni-cyclic operation.

Another object of the invention is to provide a calculating machine of the character described including novel and improved mechanism for so controlling the operation of the machine that only one cycle of the actuating means can occur for each item entering operation on the keyboard.

Another object of the invention is to provide a calculating machine of the character described which is automatically restored to key-set operating condition upon manipulation of a control key which initiates a clearing operation of the machine.

Another object of the invention is to provide a calculating machine of the character described having a settable control means which conditions the machine for key-set or key-responsive operation and which also sets the machine for additive or subtractive key-responsive operation.

Another object of the invention is to provide a calculating machine having uni-directionally operable actuating means and bi-directionally operable numeral wheels and which attains the foregoing objects.

The above and other objects of the invention will be apparent from the following description of a preferred embodiment thereof, as shown in the accompanying drawings.

In the drawings:

Fig. 1 is a plan view of a calculating machine embodying the invention.

Fig. 2A is a vertical, longitudinal section of the rear part of the machine and is taken in a plane indicated by line 2a—2a in Fig. 1.

Fig. 2B is a vertical, longitudinal section of the front part of the machine and is taken in a plane indicated by line 2b—2b in Fig. 1.

Fig. 3 is a transverse sectional view thru a part of the keyboard in a plane indicated by line 3—3 in Fig. 2B.

Fig. 4A is a plan view of the rear portion of the machine with the carriage and keyboard removed, and with certain parts partially broken away and others shown in outline to simplify and clarify the view.

Fig. 4B is a plan view of the front portion of the machine with a part of the keyboard and the selection slides controlled thereby omitted.

Fig. 5 is a sectional elevation of the shift keys and the resetting key and the associated drive control mechanism, the view being indicated by line 5—5 in Fig. 1.

Fig. 6 is a fragmentary sectional elevation of the clutch mechanism.

Fig. 7 is a sectional elevation of the plus and minus keys and associated mechanism as indicated by line 7—7 in Fig. 1, the division mechanism being omitted from the view.

Fig. 8 is a sectional elevation of certain control mechanism as indicated by line 8—8 in Figs. 4A and 4B, including the controlling connections for both the shift and driving mechanisms.

Figs. 9 and 10 show a sectional elevation of the control means which sets the machine for key-responsive operation, the view being taken as indicated by line 9—9 in Figs. 4A and 4B.

GENERAL DESCRIPTION

(Fig. 1)

The invention is described in a preferred form as embodied in a Thomas type calculating machine as disclosed, for example, in the co-pending application of Carl M. Friden, Serial No. 724,482, filed May 8, 1934, for Calculating machine. Referring to Fig. 1, the machine includes body 12 comprising base 13 and casing 14 suitably secured thereon, and in which the actuating, selecting, and control mechanisms are mounted. Carriage 16 carries numeral wheels 17 and 18 of the accumulator and revolutions counter, respectively, and can be shifted endwise in either direction by manipulation of respective shift keys 19, 20 through mechanism described hereinafter.

For key-set operation, values are entered into the machine by depression of numeral keys 22 of the keyboard in the various ordinal rows thereof, keys 22 being releasable individually by depression of ordinal clear keys 21, or collectively by depression of keyboard clear key 23. Values introduced into the machine may be reg-

istered additively and subtractively in the accumulator by depression of plus key 25 and minus key 26, respectively, while the number of registrations or its complement can be entered in the revolutions counter by proper setting of control lever 27.

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 28, 29, or by power through depression of return and clear key 30. Depression of key 30 first effects return of carriage 16 to its farthest left position and subsequently effects resetting of numeral wheels 17 alone, or both numeral wheels 17 and numeral wheels 18 as selected by the setting of control lever 31.

The machine may also be equipped to perform automatic plural order division by means of conventional construction including division control lever 32.

The machine is optionally settable for key-responsive operation to add or subtract directly in response to depression of numeral keys 22 as determined by the setting of control key 33 in either direction from the central neutral position thereof shown in Fig. 1, as described more fully hereinafter.

DRIVING AND ACTUATING MECHANISMS

(Figs. 2A, 4A, 5, 6 and 9)

The drive mechanism includes a source of power from which a single path of power leads to provide a cyclic clutch-controlled drive for all power driven parts of the machine. The source of power comprises electric motor 36 (Fig. 2A) whose shaft 37 (Figs. 2A and 5) is connected by gearing 38 with a clutch indicated generally at 39 (Figs. 4A and 6). Clutch 39 comprises driving ratchet 41 journaled on shaft 42 and driven from gearing 38, and a driven element comprising spring-urged pawl 43 pivoted at 44 in disc means 45 carried by transverse shaft 42 journaled in side plates 34 and 35. The cyclic drive for shaft 42 is provided by engagement and disengagement of pawl 43 (Fig. 6) with ratchet 41 under the control of clutch control lever 47 pivoted at 48 on side plate 35. The parts are shown in full-cycle position in Fig. 6 where the nose of lever 47 is engaged with the tail of pawl 43, and roller 46 on lever 47 is engaged with its seat in disc means 45. The clutch mechanism described generally above is of the construction disclosed in the co-pending application of Carl M. Friden, Serial No. 145,979, filed June 2, 1937, but may be of any other suitable construction.

The clutch-driven transverse shaft 42 serves to provide a cyclic uni-directional drive for the actuating means of both the accumulator and the revolutions counter, for the shift mechanism and for the zero resetting mechanism.

Shaft 42 (Figs. 2A and 4A) has bevel gear connections 51 with longitudinally extending accumulator actuating shafts 52 suitably journaled in cross brackets 49 and 50 which extend between side plates 34 and 35. Each shaft 52 carries a pair of toothed actuating cylinders 53 for a pair of adjacent orders of the machine, and for cooperation with the teeth of each cylinder 53, a pair of ten tooth gears 54 are slidably and non-rotatably mounted on square shaft 56 which is suitably journaled in cross brackets 55, 49 and 50. As usual in this type of machine, a shaft 56 is provided for each order of the actuating means. Gears 54 are selectively positioned with respect to the associated stepped teeth of the

actuating cylinder in a conventional manner by means including a pair of differential spring-urged slides 57 (Figs. 2A, 2B, 4A and 4B) associated with each ordinal row of numeral keys 22 in a manner described hereinafter. Intermediate brackets 55 and 49, each shaft 56 is provided with a slidably and non-rotatably mounted spool 51 having opposite bevel gears 62 and 63 for cooperation with numeral wheel gear 64 of the associated order of the accumulator mechanism.

It will be understood that a value corresponding to the value of the depressed key can be entered either positively or negatively in the accumulator by selective positioning of plus-minus gears 62, 63 in the conventional manner under control of transversely extending strap 68 which is carried by a pair of similar arms 67 secured on shaft 68, which is suitably journaled in the frame plates 34 and 35. Strap 66 and the series of plus-minus gears are urged to their central position shown in Fig. 2A by suitable centralizing means comprising opposed spring-urged arms 69 (Figs. 2A and 9) pivoted on plate 34 and engaging opposite sides of pin 70 on one of arms 67. The various control means for positioning the plus-minus gears 62, 63 are described hereinafter.

ACCUMULATOR MECHANISM

(Figs. 1, 2A and 9)

Accumulator.—The accumulator comprises a series of numeral wheels 17 (Figs. 1 and 2A), each of which is carried at the upper end of a numeral wheel shaft 72 suitably journaled in carriage frame 73 and carrying a numeral wheel gear 64. Each shaft 72 has suitable spring-urged ball and gear centering means 74 to insure alignment of the displayed numeral on wheel 17 with sight opening 75 in the carriage cover.

Tens transfer.—Any suitable conventional form of transfer mechanism may be associated with the accumulator and its actuating means. In the form selected for illustration, the mechanism includes a transfer trip lever 76 (Fig. 2A) mounted on carriage frame 73 in each order of the accumulator, a ten-tooth gear 77 on each of shafts 56 (except the lowest order), and a pair of transfer actuators 78 on each shaft 52. The above mechanism is of the type disclosed in said application Serial No. 724,482 and the co-pending application of Carl M. Friden, Serial No. 75,307, filed April 20, 1936.

Resetting means.—Suitable means of conventional construction are provided in carriage 16 for resetting numeral wheels 17 to zero registration which includes rack bar 81 (Figs. 2A and 9) mounted for endwise sliding movement in carriage frame 73 adjacent the upper ends of numeral wheel shafts 72. The teeth of rack bar 81 form a plurality of racks for cooperation with mutilated gears 83 on numeral wheel shafts 72 in a conventional manner, as disclosed, for example, in said application Serial No. 724,482.

For manual operation rack bar 81 is provided with handle 28 (Fig. 1) by means of which the accumulator register can be reset to zero. The power operation of the resetting or zeroizing means is described hereinafter.

REVOLUTIONS COUNTER MECHANISM

(Figs. 1 and 2A)

Counter and counter actuator.—The revolutions counter is also mounted in carriage 16 and comprises numeral wheels 18 (Fig. 2A) on re-

spective shafts 87, which are journaled in carriage frame 73 and bar 88 supported thereon. A numeral wheel 18 is provided for each ordinal position of the carriage, and the displayed numeral of each wheel 18 (Fig. 1) is maintained in alignment with the associated sight opening 89 by ball and gear means 90. The number of actuations of the accumulator are registered in counter numeral wheels 18 (Fig. 2A) by an actuator of conventional construction indicated generally at 91 and driven in a suitable manner from transverse shaft 42.

Resetting means.—The means provided for resetting numeral wheels 18 (Figs. 1 and 2A) of the counter register to zero is similar in construction and operation to that described in connection with accumulator wheels 17, and includes manually operable rack bar 92 suitably mounted in the carriage for cooperation with mutilated gears 93 on shafts 87. Rack bar 92 carries upright handle 29 to provide for manual operation thereof.

The revolutions counter mechanism is of the type shown and described in said application, Serial No. 724,482.

CARRIAGE SHIFT MECHANISM (Figs. 2A, 4A, 5 and 8)

As stated, shift keys 19 and 20 control mechanism for shifting carriage 16 selectively in either direction, and such shifting mechanism may be of conventional construction, as for example of the type disclosed in the copending application of Carl M. Friden, Serial No. 27,338, filed June 19, 1935. Carriage frame 73 (Fig. 2A) carries rack 121 having teeth operatively engaged by a pair of pins 122 on shift gear 123, journaled on bracket 55. Shift gear 123 is selectively driven in either direction thru suitable reversing gearing 124 from one of gear sleeves 126 or 127 (Figs. 2A and 4A) journaled in bracket 55 and plate 128 supported thereon. Gear sleeve 127 is slotted at its front end to receive and be driven by the teeth of shiftable collar 129 having a slidable driving connection with one of actuating shafts 52. Gear sleeve 126 is similarly adapted to be driven from an adjacent shaft 52, and each shiftable collar 129 is controlled by a fork 131 at the rear end of a rod 132 spring-urged forwardly into cooperative relation with depending arms 133, 134 (Figs. 2A, 4A, and 8) on shaft 136 and sleeve 137, respectively. Shaft 136 and sleeve 137 carry respective control arms 138 and 139 (Figs. 4A and 8) operatively related to pins 141 on respective shift keys 19 and 20, so that depression of each shift key will engage one of the drive connections to control shifting of the carriage in a selected direction in accordance with the depressed key.

Pins 141 (Fig. 5) of keys 19 and 20 also overlies cam arm 142 carried by lever 116, so that the clutch is engaged and the motor circuit closed as previously described upon depression of a shift key.

POWER ZERO RESETTNG (Figs. 2A, 4A, 5 and 9)

The means for resetting the accumulator and the revolutions counter is of the type disclosed in the co-pending application of Carl M. Friden, Serial No. 42,268, filed September 26, 1935, and the resetting operation includes shifting or return of the carriage to an end position where the resetting racks are operated. Return and resetting key 30 (Fig. 5) is mounted for substantially

endwise movement on side plate 35 by stud 151 and by its pivotal connection to spring-urged arm 152 (Figs. 5 and 8) on sleeve 153 (Fig. 8) pivoted on shaft 154. Key 30 (Fig. 5) has a shoulder engaging ear 156 on shift key 19 so that the shift key is depressed therewith to initiate a carriage shifting operation. Both keys are latched in depressed position by spring-urged latch slide 157 which may be moved to inactive position at the end of the resetting operation by any suitable means for operating latch releasing bellcrank 158.

To enable the drive for operating resetting racks 81 and 92 at the end of the carriage return, key 30 (Fig. 8) operates thru arm 152 and sleeve 153 (Fig. 2A) to rock cam arm 159 so that rod 161 and fork 162 (Fig. 4A) are moved rearwardly to engage shiftable collar 163 with sleeve 164 carrying cam 166. Cam 166 (Figs. 4A and 9) operates thru a suitable drive connection including arm 167, slide 168 and tooth 169 to reciprocate resetting rack 81 of the accumulator. Resetting rack 92 of the revolutions counter is also actuated if connected for movement with rack 81.

Key 30, which controls the power zero resetting described above is also related to the control means for key-responsive operation as will be described presently.

KEYBOARD

(Figs. 2-4B and 10)

As previously explained, the pair of ten-tooth gears 54 (Figs. 2A and 4A) of an order are positioned by respective differential slides 57 which are guided by vertical slots in brackets 50 adjacent their rear ends and in similarly slotted bracket 171 (Fig. 2B) adjacent their front ends. Each slide 57 is supported for substantially endwise movement by parallel arms 172 and 173 (Figs. 2A and 2B) which are pivotally supported in respective cross rails 174, 175, and each slide 57 is urged rearwardly by spring 176 connected to the associated arm 173. Each slide 57 is provided with cam surfaces 177 of varying inclination for cooperation with pins 178 on keys 22 to effect a differential movement of a slide corresponding to the value of the depressed key, the slide being definitely located when the pin 178 enters the socket 179 at the base of each cam surface 177. One slide 57 of each order cooperates with the "1" to "5" keys 22 thereof, while the other slide 57 of an order cooperates with "6" to "9" keys 22 thereof.

Keys 22 (Figs. 2A, 2B, and 3) of each bank or ordinal row are mounted for vertical or endwise movement by opposed U-shaped key frames 181 which are secured together by transverse tie rods 182, which also extend thru slots in the key stems to guide their movement. Key frames 181 are mounted in the machine by respective brackets 184 extending between side plates 34 and 35. The keys are urged to raised position by spring 183 extending under pins 185 thereon and over upper rods 182, and may be latched in depressed position by latching slide 186 mounted for endwise sliding movement in key frames 181 and urged forwardly by spring 187. During depressing movement of a key 22, cam surface 188 thereof moves latching slide 186 rearwardly to release a previously depressed key, and latching slide 186 will subsequently engage in latching notch 189 of the key 22 being depressed. Latching slides 186 are operable individually by ordinal clear keys 21 and collectively by bail 191 (Figs. 2B and 4B) pivoted on transverse rod 192 and operable by

clear key 23, and also automatically as will be described in connection with the live key operation of the machine.

The keyboard as described above is of the conventional type employed in key-set calculating machines.

KEY-SET OPERATION CONTROL

(Figs. 4A-7)

To control addition or subtraction of items in the accumulator during key-set operation, respective plus and minus keys 25 and 26 (Fig. 7) of conventional type are slidably mounted for endwise movement on plate 101 which is secured in spaced relation from side plate 35 (Figs. 4A and 4B). Keys 25 and 26 (Fig. 7) are suitably spring-urged to their upper positions and have respective pins 102 cooperatively related respectively to oppositely inclined cam surfaces 103, 104 of plus-minus slide 106. Slide 106 is pivotally connected to arm 107 pivoted on plate 101 and has an adjustable pivotal connection with arm 108 (Figs. 4A and 7) secured on shaft 68, and is thereby mounted for endwise movement in response to depression of keys 25 and 26 to rock shaft 68 and effect meshing of plus gears 62 or minus gears 63 with numeral wheel gear 64. Upon release of a depressed key, gears 62, 63 and slide 106 are returned to central neutral position by the centralizing arms 69 heretofore described and are free to move relative to the plus and minus keys during key-responsive operation of the machine.

In addition to the setting of the plus-minus gears, depression of keys 25 and 26 simultaneously serves to control engagement of the clutch and closing of the motor circuit. Keys 25 and 26 (Fig. 7) have respective pins 111 overlying suitable cam surfaces of clutch slide 112 mounted for endwise sliding movement on plate 101. At its rearward end, slide 112 abuts pin 113 (Figs. 6 and 7) carried at the upper end of clutch control lever 47. Pin 113 is normally engaged by the hooked end of link 114 (Fig. 6) which is pivoted at 115 to the upper end of lever 116 (Fig. 5) pivoted on side plate 35 and having a pivotal connection at lower end with pivotally mounted lever 117. At its lower end, lever 117 carries laterally extending insulated pin 118 which overlaps one of contacts 119 of the motor circuit. Thus, movement of clutch control lever 47 to and from clutch engaging position also serves to move contacts 119 to and from circuit closing position while link 114 is engaged with pin 113 under the influence of spring 120. From the foregoing description, it is seen that depression of either of keys 25 or 26 will cause one or more registrations in the accumulator of the number set in the keyboard during key-set operation of the machine.

KEY-RESPONSIVE OPERATION CONTROL

(Figs. 2A-6, 8-10)

The machine is settable to operate in addition and subtraction in response to depression of the numeral keys, which can be enabled optionally to control the drive and effect cyclic operation of the clutch. Key 33 (Fig. 9) which controls the condition or state of the machine for key-set and key-responsive operation is mounted for endwise sliding movement to control the state of the machine and in depressed position is movable to control addition and subtraction. Key 33 has slot 232 engaged by stud 231 and extends between latching studs 233, 234 therefor which

prevent any rocking movement of the key until it is fully depressed. The key is urged to raised position by spring 236 tensioned between stud 231 and pin 237 on the key stem. Depression of key 33 serves to condition various parts of the machine for key-responsive operation as will now be described.

Add-subtract control.—Key 33 during its rocking movement in its depressed position serves to connect the actuating means with the accumulator in accordance with the desired character of registration. As key 33 is depressed, pin 237 (Fig. 9) thereof moves into notch 241 at the end of link 242 so that an operative connection is established between key 33 and link 242 which is operatively related to the plus-minus gears and their control means. Link 242 is supported by rollers 243 on plate 34 and at its rearward end is pivotally connected at 244 to one of supporting arms 67 for strap 66 which controls the position of plus-minus gears 62, 63. After depression of key 33, it can be rocked either forwardly or rearwardly of the machine to move link 242 to engage gears 62 and 63 with numeral wheel gears 64 to select positive or negative registration, and the key is latched in adjusted position by the engagement of one of its notches 246 or 247 with one of studs 233, 234.

Drive control.—Associated with each row of numeral keys 22 (Figs. 2A, 2B, 3, 4A, and 4B) is a slide 201 mounted for endwise movement in brackets 50 and 171 between each pair of differential slides 57 in vertical alignment with the keys. Each slide 201 is urged rearwardly to inactive position by spring 202 (Fig. 2A) where slide ear 203 abuts bracket 50, and is moved from this position upon depression of one of keys 22 by the engagement of lower end 204 of the key with the associated cam surface 206 of slide 201. Such forward movement of a slide 201 serves to rock ball 207 (Figs. 2B and 4B) which extends transversely of the machine, and is pivoted on rod 208. The lower edge of ball 207 is adapted for engagement by notched end 209 of link 211 which is pivotally connected at its other end to arm 212 on shaft 154. During key-set operation of the machine, link 211 is in the position shown in Figs. 2B and 10, so that rocking movement of ball 207 is idle. When the machine is conditioned for key-responsive operation by control key 33, link 211 is moved into operative engagement with ball 207. For this purpose, link 211 is slotted intermediate its ends for pivotal and sliding engagement by stud 213 at one end of lever 214 pivoted at 216 on side plate 34, and which is rocked by control key 33 upon depression thereof.

When the operative engagement of ball 207 (Figs. 9 and 10) and link 211 is maintained by latching of key 33 in depressed position, depression of any numeral key 22 will result in rocking of shaft 154 to start the drive after positioning of the associated gear 54 by its selection slide 57. This timing is obtained by the relative spacings of cam surfaces 206 and key stem ends 204 and pins 178 and cam surfaces 177, so that the pin 178 of the depressed key completes the movement of slide 57 and is entering the associated socket 179 at the time stem end 204 starts the movement of the drive controlling slide 201. Shaft 154 extends transversely between side plates 34 and 35, and adjacent plate 34 (Figs. 5 and 8) carries arm 218 which is operatively related to pin 118 on lever 117, so that clockwise movement of shaft 154 and arm 218 as viewed

RELEASE OF KEY-RESPONSIVE CONTROL

(Figs. 8 and 9)

in Fig. 8 will cause a similar movement of lever 117 to close contacts 119 and to engage the clutch through lever 116 (Fig. 5), link 114 (Figs. 5 and 6) and clutch control lever 47.

Thus, the drive for the actuating means is enabled upon depression of one or more of numeral keys 22. Means is provided to insure complete depression of all keys 22 by disabling the drive if any key is incompletely depressed. For this purpose, normally closed contacts 221 (Fig. 8) are provided in the motor circuit in series with contacts 119. One of contacts 221 is carried by one of brackets 184 and the other is carried by upright arm 222 of bail 223 which extends transversely of the machine in operative engagement with the rearward ends of latching slides 186 for the keys 22. Bail 223 is pivotally supported by studs 224 and is spring-urged against slides 186 by spring 226. During depression of a key 22 (Figs. 2A, 2B and 8), the associated latching slide 186 is moved rearwardly and will rock bail 223 to open contacts 221 so that circuit will not be closed until all keys are either entirely raised or entirely depressed.

The drive during key-responsive operation is limited to one cycle for each manipulation of the keyboard, and the numeral keys corresponding to the digits to be entered must be depressed each time an item is entered. The mechanisms for controlling this operation as well as that for preventing latching of the numeral keys in depressed position are enabled by add-subtract control key 33 when moved to active position.

Depression of key 33 enables the means for determining uni-cyclic operation, and also enables automatic key release means operable during each cycle of the machine. For this purpose pin 237 (Fig. 9) on key 33 is operatively related to arm 251 on shaft 252 which extends across the machine and at its other end carries arm 253 (Fig. 8) having pin 254 engaging a slot in link 256. Link 256 is reciprocated once during each cycle of the machine, and for this purpose has its rear end pivotally connected at 258 to the upper end of lever 259 pivoted at 261 on side plate 35. The lower end of lever 259 is urged by spring 262 to engage cam 263 on shaft 42. The cyclic reciprocation of link 256 is made ineffective in the position of the parts shown in Fig. 8 by arm 253 which maintains notched end 257 of link 256 above key release bail 191, and notch 264 thereof above pin 271 on clutch disengaging bellcrank 272 (Fig. 5) pivoted at 273 on side plate 35 and gravity-urged against stop 274. Bellcrank 272 has an arm underlying the bent end of clutch control link 114 so that counter-clockwise movement thereof serves to move link 114 in a clockwise direction to effect disengagement thereof from pin 113 on clutch control lever 47 and thereby permit the lever to move to clutch disengaging position.

As described above, arm 253 is urged to the position shown in Fig. 8 in engagement with stop 276 by spring 277 and serves to hold link 256 inactive during key-set operations. However, upon movement of key 33 to active position, arm 253 is actuated to lower link 256 and engage notches 264 and 257 with pin 271 and bail 191, respectively. Thus, during key-responsive operation, the clutch is engaged for only a single cycle by depression of a numeral key 22, and the depressed numeral keys are released near the end of each cycle of operation.

Means is provided for effecting automatic restoring of the settable control key 33 upon operation of a control key used in normalizing operation of the machine. As previously described, return and clear key 30 when depressed oscillates sleeve 153 (Figs. 8 and 9) which carries bent arm 266 (Fig. 9) having V-shaped cam notch 267 underlying the beveled end of key 33. If key 33 is in depressed position when key 30 is operated one of its beveled end surfaces of key 33 will be engaged with a wall of cam notch 267, the clearance between the beveled end of key 33 and cam notch 267 as well as the loose fit of pin 231 in slot 232 being such as to provide for the downward and rocking movement of key 33 without binding against arm 266. Upward rocking movement of arm 266 upon depression of key 30 serves through the cam notch 267 to centralize key 33 so that spring 236 can restore key 33 to raised position. Depression of key 30 will restore key 33 to raised position.

OPERATION

(Figs. 1-2B, 4B-6, 8-10)

Key-set.—The machine is conditioned for key-set operation as illustrated in the drawings, key 33 (Figs. 1 and 9) being located in its raised or inoperative position. The key-set operation of the machine is conventional and detailed description thereof is believed unnecessary.

Key-responsive.—The machine is conditioned for key-responsive uni-cyclic operation by depressing key 33 (Figs. 1 and 9) and by moving the key rearwardly to set the machine for subtraction and by moving the key forwardly to set the machine for addition. As described, the depression of key 33 renders operative various means whereby simultaneous depression of selected numeral keys 22 will effect entry of the corresponding values either additively or subtractively in the accumulator. Repeated additions or subtractions can be made by repeatedly depressing the selected numeral keys.

Depression of key 33 (Figs. 9 and 10) operates through lever 214 to raise link 211 and engage notched end 209 thereof with bail 207 to enable the drive control from numeral keys 22, and through arm 251 (Fig. 9), shaft 252 (Fig. 4B) and arm 253 (Figs. 4B and 8) to lower link 256 and engage notched portions 257 and 264 thereof with bail 191 and pin 271, respectively, to enable the key release and uni-cycle clutch control of numeral keys 22. After depression of key 33 (Fig. 9) when pin 237 is engaged with notched end 241 of link 242, the key is moved rearwardly or forwardly to operate link 242 and thereby rock strap 66 (Figs. 2A and 9) and thereby mesh minus gears 63 or plus gears 62 with numeral wheel gears 64.

With the machine conditioned as described above, the selected numeral keys 22 (Figs. 2A and 2B), and the corresponding selecting slides 57 are operated simultaneously to position gears 54 with respect to the teeth of actuating cylinders 53. In depressing the keys, the operator depresses only the desired keys representing the value to be entered, and no other keys should be depressed until after the entry is completed. Toward the end of the stroke of the depressed keys 22, the lower ends thereof move the associated slides 201 and thereby rock bail 207 and operate link 211. The resulting rearward move-

ment of link 211 (Fig. 9) operates through arm 212, shaft 154, and arm 218 (Figs. 4B and 8) to close contacts 119 (Figs. 5 and 8) and move clutch control lever 47 (Fig. 6) to clutch engaging position. The drive cannot begin however if any key 22 is only partially depressed, because any displaced key latching slide 186 (Fig. 8) will hold contacts 221 open. When all the displaced key slides 186 have entered the latch notches 189 (Fig. 2B) of the depressed keys, contacts 221 will close and the drive will begin. Toward the end of the cycle, cam 263 (Fig. 8) oscillates lever 259 to pull link 256 rearwardly and thereby operate key releasing bail 191, and also operate bellcrank 272 (Figs. 5 and 8) to rock link 114 (Figs. 5 and 6) to release clutch control lever 47 in sufficient time to disengage the clutch after one cycle of operation. While the operation of key-releasing bail 191 operates through slides 186 during the latter part of a cycle to open contacts 221, 222 of the motor circuit, the momentum of the parts is sufficient to carry the parts to home position and complete the cycle of operation.

While we have shown and described a preferred form of the invention, it is to be understood that the invention is capable of both variation and modification from the form shown, so that its scope is to be limited only by the scope of the claims appended hereto.

We, therefore, claim as our invention:

1. In an optional key-set and key-responsive calculating machine, a register, actuating means for said register, drive means for said actuating means, settable means for determining positive and negative registration on said register, selecting mechanism for controlling the entry of values in said register, ordinal keys for controlling said selecting mechanism, a key-responsive operation control key, a controlling connection from said control key to said settable means and a controlling connection between said ordinal keys and said drive means for conditioning the machine for key-responsive operation, said control key being movable in one direction to condition the connection between the ordinal keys and the drive means for key responsive operation and being selectively movable in either of two other directions to operate the connection between said control key and said settable means to condition said settable means for positive or negative registration on said register respectively.

2. In an optional key-set and key-responsive calculating machine having a register, actuating means for said register, driving means for said actuating means, and keyboard mechanism for selecting the values for registration on said register; settable control means for controlling the

state of said machine for key-set and key-responsive operation, a control key operatively related to said driving means to initiate operation thereof, and means controlled by said control key upon depression thereof for moving said settable control means to key-set position if displaced therefrom.

3. In an optional key-set and key-responsive calculating machine having a register, actuating means for said register, and keyboard mechanism for selecting the values for registration on said register; settable control means for controlling the state of said machine for key-set and key-responsive operation, a control key for initiating a clearing operation of said machine, and means controlled by said control key upon depression thereof for moving said settable control means to key-set position if displaced therefrom.

4. In an optional key-set and key-responsive calculating machine having a register, actuating means for said register, means for shifting said register relative to said actuating means, settable means for establishing a drive connection from said actuating means to said register, a keyboard mechanism for selecting the values for registration on said register; settable control means for controlling the state of said machine for key-set and key-responsive operation including means for setting said drive-connection establishing means, a control key associated with said shifting means for initiating a machine operation involving shifting of said register, and means controlled by said control key upon depression thereof for moving said settable control means to key-set position if displaced therefrom.

5. In an optional key-set and key-responsive calculating machine, a series of numeral wheels having gears thereon, actuating means for said numeral wheels, plus-minus gears movable from a central inactive position in either direction to mesh with said numeral wheel gears to control additive and subtractive registration in accordance with the direction of movement from said central position, means including a key movable from an inactive position to either of two active positions to set the machine for key-responsive operation, and means controlled by said key upon movement to one of said active positions to effect meshing of said plus-minus gears with said numeral wheel gears for additive registration, and upon movement of said key to the other active position thereof to effect meshing of said gears for negative registration.

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