Aug. 31, 1943. C. M. F. FRIDEN 2,327,981

CALCULATING MACHINE

Filed Aug. 10, 1935 5 Sheets-Sheet 1

FIG_2_

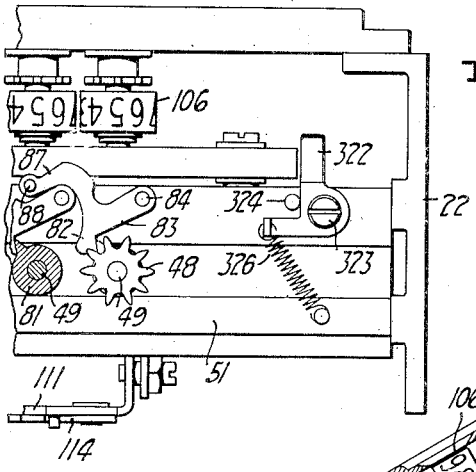
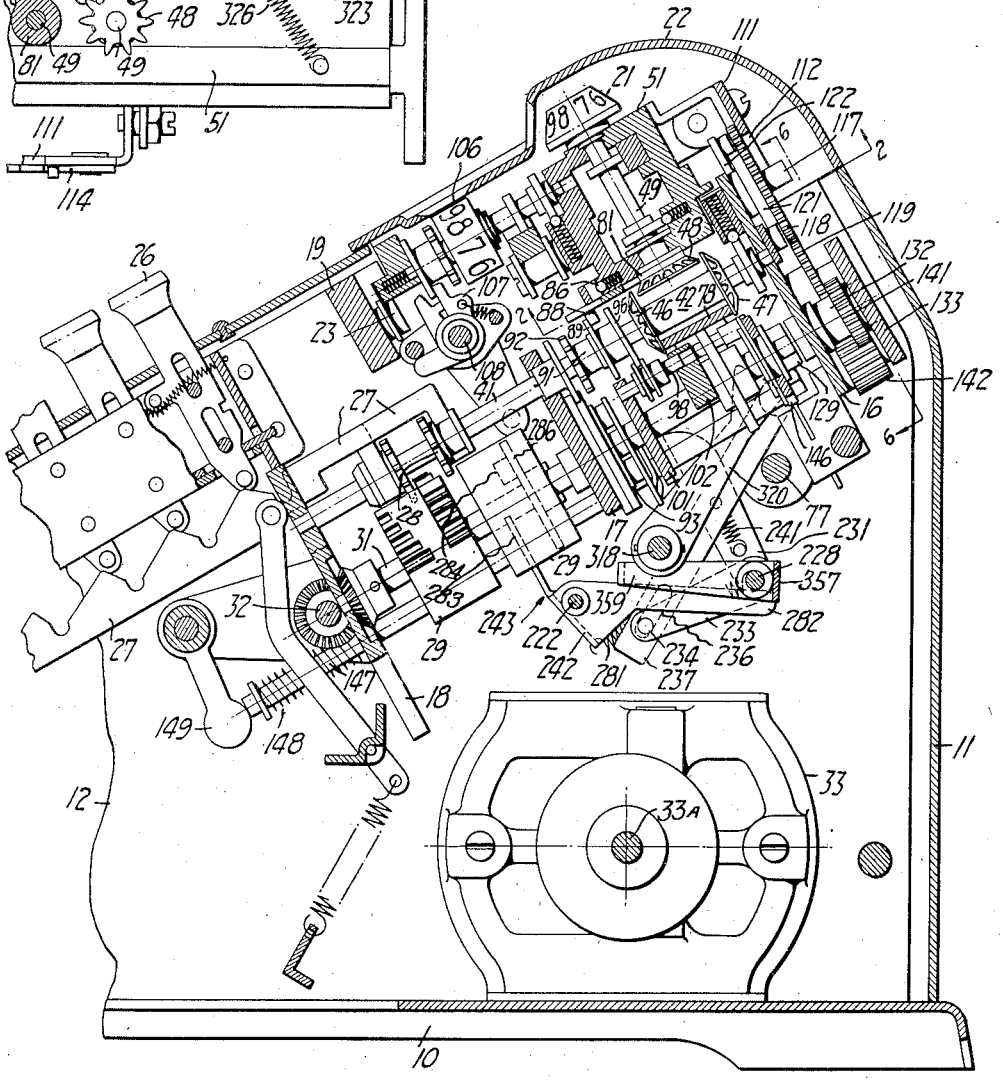


FIG_1_



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CALCULATING MACHINE

Filed Aug. 10, 1935 5 Sheets-Sheet 2

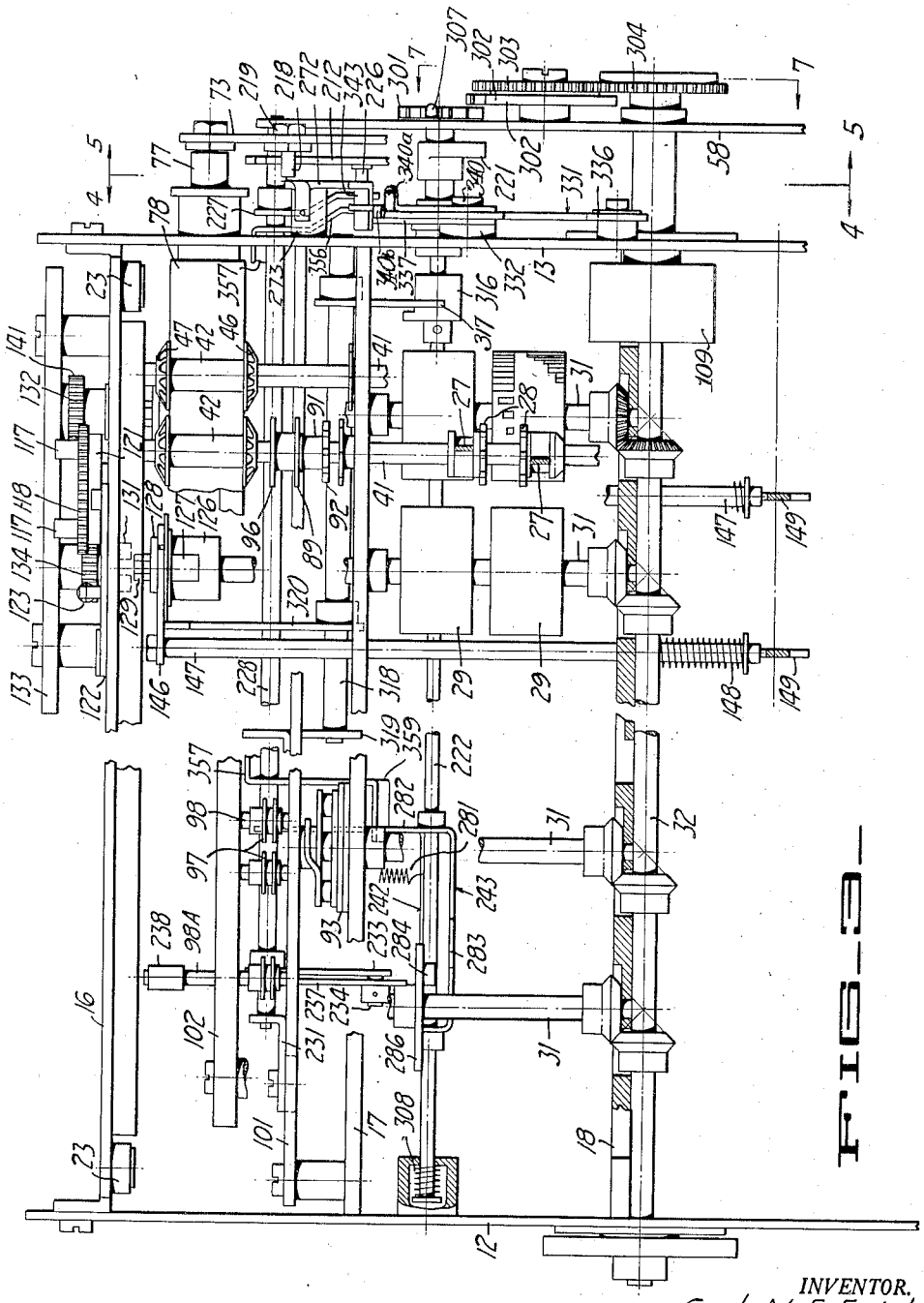

FIG. 3

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CALCULATING MACHINE

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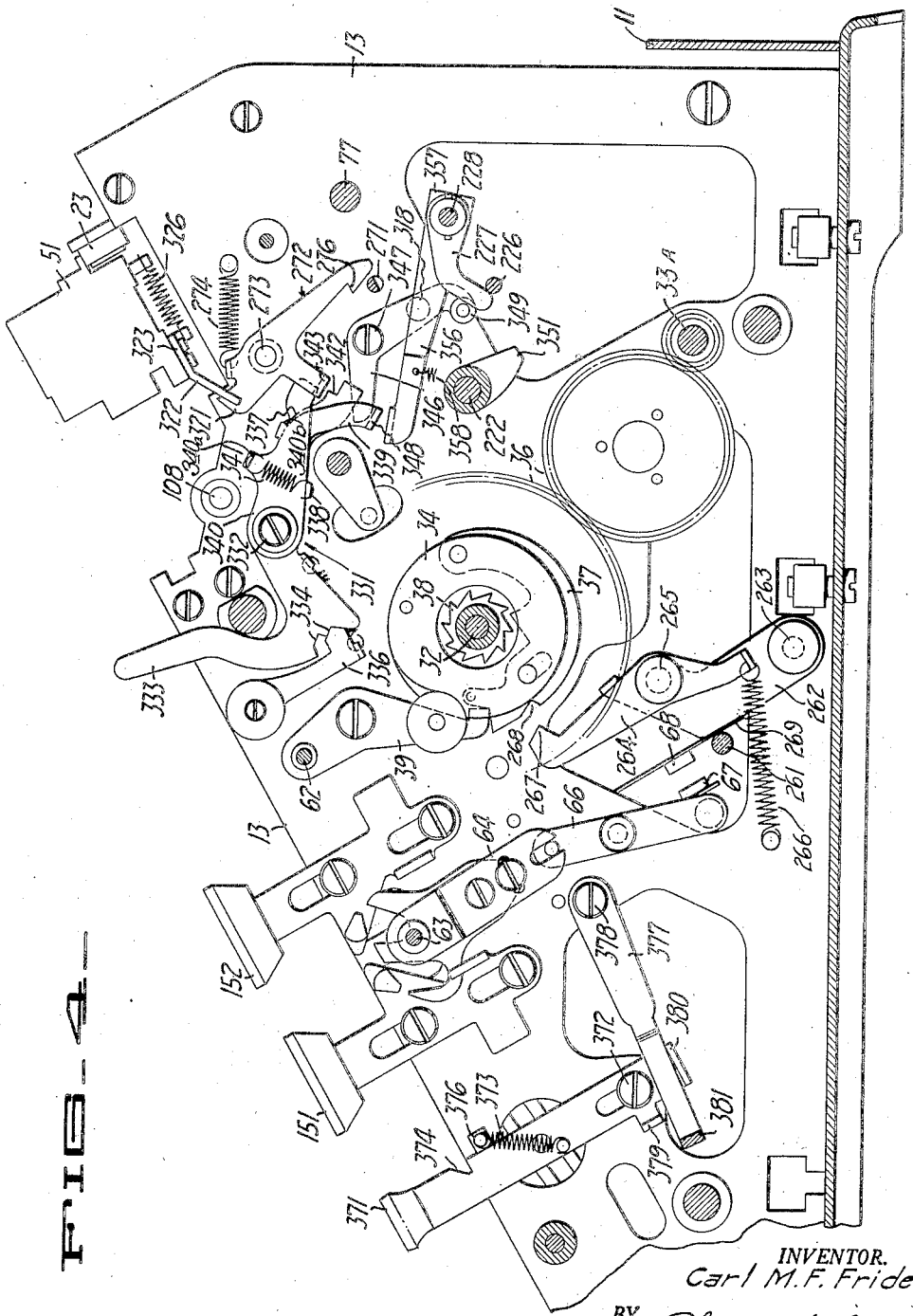

FIG. 4.

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CALCULATING MACHINE

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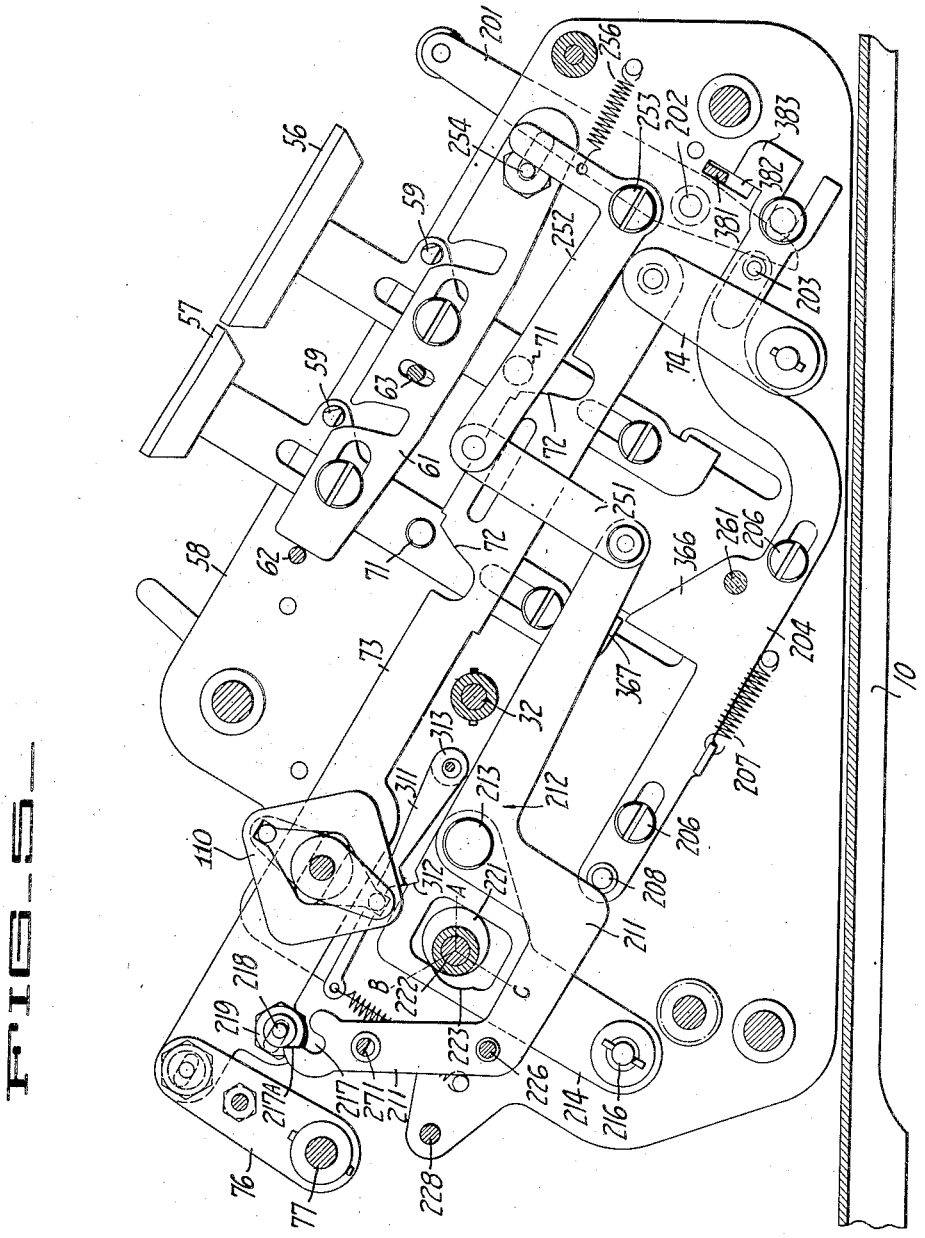

FIG. 5

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CALCULATING MACHINE

Filed Aug. 10, 1935 5 Sheets-Sheet 5

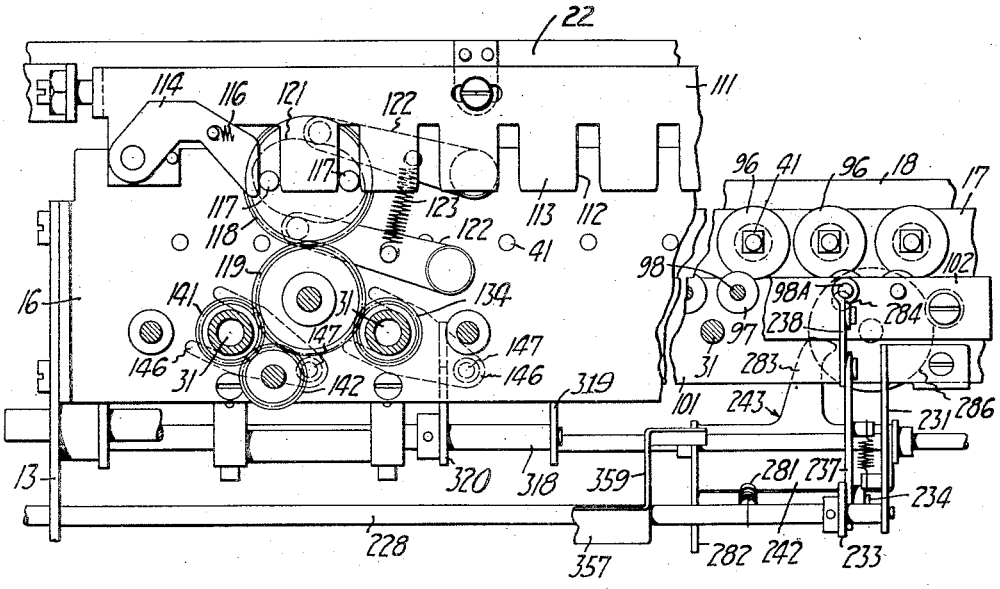

FIG_6_

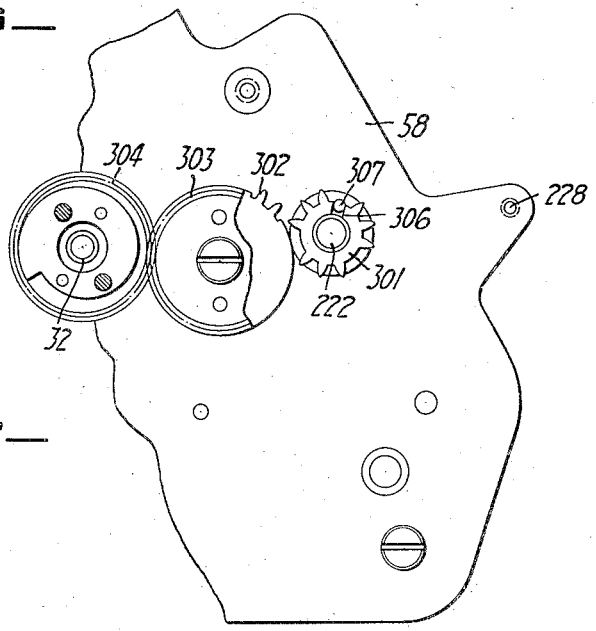

FIG_7_

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Patented Aug. 31, 1943 2,327,981

UNITED STATES PATENT OFFICE

2,327,981

CALCULATING MACHINE

Carl M. F. Friden, Oakland, Calif., assignor to Friden Calculating Machine Co., Inc., a corporation of California

Application August 10, 1935, Serial No. 35,619

32 Claims. (Cl. 235—63)

My invention relates to calculating machines and more particularly to improved mechanism for performing automatic division. The invention is especially useful in connection with the type of machine disclosed in my co-pending application Serial No. 724,482, filed May 8, 1934. This application is a continuation in part of said application, Ser. No. 724,482.

It is an object of my invention to provide in a calculating machine improved automatic division mechanism which will perform division problems rapidly in a minimum number of machine cycles.

Another object of my invention is to provide improved automatic division mechanism in which the drive for the entire division operation is effected by cyclic actuation of the main actuating means.

Another object is to provide automatic division mechanism of an improved type in which a program control device is utilized to control the division operation in a minimum amount of time.

Another object of the invention is to provide a calculating machine having improved means for performing a plural order operation automatically.

Another object of my invention is to provide improved automatic division mechanism in a calculating machine for performing plural order division operations in which the machine can be stopped after any ordinal division is completed.

Another object of my invention is to provide a simple and effective stopping means for the automatic division mechanism of a calculating machine.

Another object of my invention is to provide an improved calculating machine in which an operation can be stopped if the machine is not set up properly for the operation.

Another object of my invention is to provide a calculating machine having automatic division mechanism which, if the machine is adjusted to determine the quotient digit of lowest order, prevents initiation of a division operation.

Another object of my invention is to provide improved automatic division mechanism for a calculating machine in which the operation is blocked if the machine is not properly adjusted for the operation.

Other objects will appear as the description progresses with reference to the following drawings in which

Fig. 1 is a fragmentary, vertical, longitudinal section illustrating the rear portion of the machine.

Fig. 2 is a bottom view of an end of the shiftable register carriage taken in a plane indicated by the line 2—2 in Fig. 1.

Fig. 3 is a plan view of the rear portion of the machine with the shiftable register carriage and the keyboard mechanism removed and certain other parts broken away to better illustrate the construction.

Fig. 4 is a vertical longitudinal section illustrating certain of control means taken in a plane indicated by the line 4—4 in Fig. 3.

Fig. 5 is a vertical longitudinal section illustrating other of the operating controls and is taken in a plane indicated by the line 5—5 in Fig. 3.

Fig. 6 is a fragmentary rear elevational view of a part of the machine in which certain parts are broken away to illustrate the construction more clearly. The view is indicated by the line 6—6 in Fig. 1.

Fig. 7 is a fragmentary elevational view of certain parts of the division control mechanism and is indicated by the line 7—7 in Fig 3.

My invention is illustrated in connection with the type of calculating machine having a unidirectionally operable actuator and reversible or bidirectionally operable numeral wheels, as disclosed in said application. While certain features of my invention are adapted particularly for use in this type of machine, certain of such features and other features of my invention can be used in other types of calculating machines.

Selecting, actuating and accumulating mechanisms

The machine includes base 10 (Fig. 1) which supports casing 11 and has side frame members 12, 13 (Figs. 1 and 4) mounted thereon. Side members 12, 13 are connected by various cross frame members 16, 17, 18 and 19 (Figs. 1 and 3) which serve to mount various mechanisms referred to hereinafter. The accumulator register comprises a series of reversible numeral wheels 21 (Fig. 1) in register carriage 22 which is mounted on frame members 16 and 19 by rollers 23 for endwise shifting movement laterally of the machine in either direction to various ordinal positions. The values to be introduced into numeral wheels 21 are selected by means of a plurality of banks or orders of settable value keys 26, one of which banks is illustrated in part in Fig. 1. Each bank of keys 26 cooperates with selecting mechanism including a pair of spring-urged slides 27 mounted for endwise movement to position the associated pair of gears 28 selec-

tively with respect to the stepped teeth of the associated actuating cylinder 29 in accordance with the value of the depressed key. Cylinders 29 (Figs. 1 and 3) are mounted on actuating shafts 31 having suitable bevel gear connections with transverse shaft 32 which is suitably journalled in side members 12, 13. Each shaft 31 serves for two orders of the machine and has a pair of cylinders 29 mounted therein. Shaft 32 and shafts 31 are driven cyclically from motor 33 (Fig. 1) thru clutch 34 (Fig. 4) which is driven by suitable gearing 36 from motor shaft 33A. As explained in my said co-pending application, clutch 34 is engaged or disengaged by oscillation of spring-urged clutch pawl or dog 37 mounted for rotation with shaft 32 with respect to ratchet 38 journalled on shaft 32 and driven by gearing 36. Clutch control lever 39 pivoted on side member 13 determines engagement or disengagement of the clutch by releasing or engaging clutch dog 37 in the full cycle position thereof.

From the above description, it is seen that the values set in the machine by depression of keys 26 will be introduced into numeral wheels 21 by the cooperation of gears 28 with cylinders 29 during cyclic operation of the clutch. Each pair of gears 28 is slidably mounted on a square shaft 41 (Figs. 1 and 3) supported in cross members 17, 18 and extending rearwardly of the machine thru cross member 17 and having its rear end journalled in cross member 16. Intermediate members 16, 17, a spool 42 is slidably and non-rotatably mounted on each shaft 41 and has opposite bevel gears 46, 47 at its ends positioned for cooperation with numeral wheel gear 48 mounted at the lower end of numeral wheel shaft 49 journalled in frame 51 of carriage 22. Therefore, when one set of gears 46, 47 is engaged with gears 48, numeral wheels 21 will be rotated forwardly or reversely to register a number of increments equal to the value of the depressed keys 26 in the aligned banks of keys.

Plus and minus keys

Means are provided for selectively determining positive or negative registration on the numeral wheels in the form of plug key 56 (Fig. 5) and minus key 57 which are slidably mounted on control plate 58. Depression of either of keys 56, 57 serves to engage the clutch, close the motor circuit and select the sign character of the registration. To enable the drive, keys 56, 57 have respective pins 59 in operative relation with suitable cam surfaces on clutch actuating slide 61 mounted for endwise movement on plate 58. To effect control of the clutch by such movement, pin 62 on the upper arm of clutch control lever 39 (Figs. 4 and 5) abuts the rear end of slide 61, so that rearward movement of slide 61 oscillates lever 39 in a clockwise direction as viewed in Fig. 4 to release clutch dog 37 for engagement with ratchet 38 on shaft 32. To close the motor circuit, slide 61 is connected by pin 63 (Figs. 4 and 5) with lever 64 (Fig. 4) pivoted on side member 13 and connected at its lower end with lever 66 also pivoted on member 13. Lever 66 has a suitable insulated pin in overlapping relation with spring mounted contact 67 normally spaced from similar contact 68. To determine the sign character of the registration, plus and minus keys 56, 57 (Fig. 5) have respective rollers 71, disposed in operative relation with opposed cam surfaces 72 on plus-minus slide 73. Slide 73 is mounted for endwise movement at its front end by link 74 and at its rear end by arm 76 on shaft 77 (Figs. 3 and 5) which is suitably journalled in side members 12, 13. Shaft 77 carries transversely extending strap 78 (Figs. 1 and 3) which is positioned between gears 46, 47 so that rocking movement of shaft 77 under control of plus-minus slide 73, serves to determine engagement of gears 46 or 47 with numeral wheel gears 48 (Fig. 1) or to determine the disengagement thereof as in the position shown. Thus, depression of plus key 56 by meshing gears 46, 48 and enabling the drive determines one or more positive registrations of the value set in the keyboard on numeral wheels 21. Similarly, depression of key 57 determines one or more negative registrations of such values by meshing gears 47, 48.

Accumulator transfer mechanism

Means are provided for carrying from order to order in the accumulator register when the registration of a numeral wheel changes from zero to nine or vice versa. For this purpose, each numeral wheel shaft 49 (Figs. 1 and 2) carries single tooth gear 81 immediately beneath frame 51 in operative relation with nose 82 of transfer lever 83 pivoted at 84 on frame 51. Lever 83 is mounted in frame 51 (Fig. 1) by spring-pressed ball 86 engaging a suitable notch in pivot 84. Each lever 83 has an arm 87 (Figs. 1 and 2) extending into the next higher order of the machine and carrying pin 88 extending downwardly in operative relation with flange 89 (Figs. 1 and 3) on collar 91. Gear 92 on collar 91 is normally disposed out of the path of single tooth actuator 93 on shaft 31. When numeral wheel 21 of one order passes from nine to zero or vice versa, single tooth gear 81 rocks lever 83, which thru pin 88, moves collar 91 to position gear 92 of the next higher order in the path of the associated transfer actuator 93. Thus, the transferred increment is introduced through either gear 46 or 47 of next higher order depending upon setting of the machine for addition or subtraction. Transfer gear 92 is maintained resiliently in either adjusted position thereof by the engagement of flange 96 of collar 91 between spaced flanges 97 on stub shaft 98 slidably mounted in cross members 101, 102 and engaged by a suitable spring-pressed ball (not shown). Suitable restoring means is provided for the shiftable transfer mechanism in association with transfer actuator 93 as fully disclosed in my said co-pending application.

Revolutions counter

A revolutions counter is also provided to register positively or negatively the number of actuations of accumulator numeral wheels 21. Revolutions counter numeral wheels 106 (Fig. 1) are suitably journalled in carriage 22 and are actuated by actuator 107 on shaft 108 to register the number of positive and negative registrations on numeral wheels 21 as fully disclosed in said application. A part of the driving means for revolutions counter actuator 107 as disclosed in said application is indicated schematically at 109 in Fig. 3, while a portion of the control means therefor is shown at 110 in Fig. 5.

Carriage shift mechanism

Means are provided for shifting the carriage in either direction from one ordinal position to another by power driven means controlled by manually operable keys,. The power driven means includes a part of the actuating means for enter-

ing values into the accumulator register. Carriage 22 (Figs. 1 and 6) has plate 111 suitably mounted along the rear side thereof and provided with vertical slots 112 formed by teeth 113. End slots 112 are formed in part by similar yieldable pawls 114, only one of which is shown, and which are connected by spring 116. Slots 112 are adapted for engagement by opposite shift pins 117 on shift gear 118 suitably journalled on cross frame member 16. Shift gear 118 is rotated selectively in either direction thru idler gear 119 to shift the carriage thru any desired number of ordinal spaces by the cooperation of pins 117 and teeth 113. Shift gear 118 (Fig. 6) is centralized by means of cam 121 and centralizing arms 122 having spring 123 connected therebetween.

In order to rotate shift gear 118 selectively in either direction the two right hand actuating shafts 31 (Fig. 3) are extended and are provided with similar controllable drive connections with gear 118. Each connection includes a collar 126 fixed on the associated shaft 31 adjacent the end thereof and having opposite slots slidably engaged by corresponding teeth 127 of shiftable collar 128, which is mounted for sliding movement at the end of said shaft 31. Collar 128 has smaller teeth 129 in operative relation with corresponding slots in gear sleeve 131. Gear sleeve 131 is suitably journalled in cross member 16 and plate 133 and carries gear 134 (Figs. 3 and 6) meshing with idler gear 119. Similar gear sleeve 132 has gear 141 which meshes with wide gear 142 (Figs. 1 and 6) also in operative relation with idler gear 119. Thus, by selective shifting of collars 128 to establish a drive connection, rotation of actuating shafts 31 determines rotation of shift gear 118 in either direction and correspondingly shifting of the carriage 22 in either direction. Similar mechanisms are provided to control shifting of collars 128. Each mechanism includes a fork 146 (Figs. 3 and 6) at the rear end of rod 147 and engaging the associated collar 128. Rod 147 is slidably mounted in cross members 17, 18 and is spring-urged to the position shown by spring 148. Rods 147 (Figs. 1 and 3) have associated therewith respective arms 149 which are oscillated to shift rods 147 by means including shift keys 151, 152 (Fig. 4) mounted for endwise movement on side member 13 and also suitably connected to engage clutch 34 and close the motor circuit. Thus, carriage 22 carrying numeral wheels 21 can be shifted selectively in either direction by depression of keys 151, 152.

Division control mechanism

The above described mechanisms cooperate with mechanism about to be described in performance of plural order machine operations in solving problems in division. The conventional method of division is used which comprises repeated subtraction until an overdraft, correction of the overdraft, and shifting of the divident register to the next lower order where the process is repeated. The number of subtractions in each order is registered in the revolutions counter as the quotient. The mechanism disclosed herein for performing division by the above method provides programmed operation of the machine under control of a program control device which, upon each overdraft in the dividend register, initiates a predetermined sequence of operations during uninterrupted cyclic operation of the actuating means. As will be more apparent later, the structure provided herein provides for a minimum time consumed by a given division operation, as the drive for the actuating means is not stopped even momentarily from the beginning until the end of the operation, and as a minimum number of cycles of the actuating means is utilized during functioning of the program control device. The division operation is initiated by manipulation of a division starting control lever which enables the program control device with respect to the plus-minus control of the machine and with respect to the overdraft mechanism. For convenience in description, the setting of the machine for division will be described first.

The division starting control is operative first to connect the program control device to the plus-minus control of the machine and to the overdraft mechanism as well as to condition the clutch for engagement. Subsequent manipulation of the control (return to its normal position) engages the clutch and closes the motor circuit to start the operation. Division control lever 201 (Fig. 5) is pivoted at 202 on control plate 58 and has its lower end in operative relation with roller 203 on division setting slide 204. Slide 204 is mounted for endwise movement by slots formed therein and engaged by studs 206 on plate 58. Spring 207 tensioned between slide 204 and plate 58 urges slide 204 to its forward position illustrated in Fig. 5. At its rear end, slide 204 carries roller 208 in abutting relation with a depending part of arm 211 of connecting lever 212. Lever 212 is pivoted at 213 on arm 214 which is supported pivotally at 216 on plate 58. Arm 214, as later described, forms a part of the program control device and is oscillated in controlling machine operation. From the foregoing description, it is seen that rearward movement of division setting slide 204 serves thru roller 208 to rock lever 212 in clockwise direction about its pivot 213. Such clockwise movement serves to connect the program control device with plus-minus slide 73. For this purpose the rearward end 211 of lever 212 is provided with notch 217 adapted to engage pin 218 which is adjustably mounted on plus-minus slide 73 by means of nut 219 and a suitable slot formed in slide 73. The movement of bell crank 212 to engage notch 217 with pin 218 serves to move slide 73 forwardly by virtue of inclined edge 217A adjacent notch 217, thereby rocking shaft 77 and meshing gears 47, 48 so that the machine is set for subtraction. This action occurs because of the position of pivot 213 for connecting lever 212 as determined by control cam 221 on shaft 222 of the program control device. Cam 221 engages aperture 223 in arm 214 and is rotated in a manner described later to adjust the machine for addition or subtraction.

The clockwise oscillation of connecting lever 212 also serves to enable the overdraft mechanism with respect to the program control device. Pin 226 (Fig. 5) on rear arm 211 of lever 212 is disposed beneath arm 227 (Figs. 3 and 4) on the right hand end of shaft 228 journalled in control plate 58, side member 13 and bracket 231 on cross piece 101. Adjacent bracket 231 (Figs. 1 and 3), shaft 228 has arm 233 secured thereon having pin 234 disposed in slot 236 (Fig. 1) in link 237. Link 237 (Figs. 3 and 6) is pivotally supported at its upper end in bracket 238 secured on the extended end of transfer stub shaft 98A of next to highest order of the machine. Link 237 is urged to the inoperative position thereof shown in Fig. 1 by spring 241 which normally maintains the free end of link 237 below depending plate portion 242 of lever member 243 rotatably and

non-slidably mounted on shaft 222 of the program control device. Upon clockwise oscillation of lever 212, pin 226 rocks arm 227, shaft 228 and arm 233 to lift link 237 into operative position with respect to plate portion 242 of lever member 243.

The clockwise movement of lever 212 also serves to condition the clutch for engaging and the motor circuit for closing. At its front end lever 212 is pivotally connected with link 251 having its upper end pivotally connected to the rearward horizontal arm of bell crank 252 which is pivotally mounted at 253 on plate 58. The vertical arm of bell crank 252 is in abutting relation with pin 254 adjustably mounted on clutch actuating slide 61. Spring 256 tensioned between bell crank 252 and plate 58 maintains bell crank 252, link 251 and connecting lever 212 in the positions shown when division setting slide 204 is also in its idle position. Thus, clutch actuating slide 61 is free to be moved under the influence of the other operating controls. From the describing linkage it is seen that clockwise motion of lever 212 serves thru link 251 and bell crank 252 to move clutch actuating slide 61 rearwardly to rock control lever 39 (Fig. 4) to clutch engaging position as previously described. However, the clutch is not engaged because of the action of special mechanism brought into play by division setting slide 204. Pin 261 on slide 204 lies in front of arm 262 (Fig. 4) pivoted at 263 on side member 13. Pawl or lever 264 pivoted at 265 on arm 262 has its upper arm held against a suitable lateral extension of arm 262 by spring 266. Spring 266 also serves to hold arm 262 and pawl 264 in the position shown with nose 267 of pawl 264 spaced from its cooperating notch 268 in clutch dog 37. Rearward movement of slide 204 through pin 261 serves to rock arm 262 and pawl 264 to engage nose 267 with notch 268 so that clutch dog 37 is maintained in clutch disengaging position irrespective of the release thereof by control lever 39. Subsequently, the return movement of slide 204 forwardly, permits engagement of the clutch. Thus, the clutch is not engaged prematurely so that if the motor should be coasting from a previous operation no harm is done. It will be recalled also that the rearward movement of slide 61 serves thru levers 64, 66 (Fig. 4) to move contact 67 to circuit closing position. However, the circuit is not closed but merely conditioned for closing by virtue of insulated pin 261 (Figs. 4 and 5) mounted on division setting slide 204 and engaging extended end 269 of contact 68. When slide 204 moves rearwardly pin 261 moves contact 68 out of circuit closing position and the circuit is merely conditioned for energization. Subsequent restoration of control lever 201 and division setting slide 204 allows contact 68 to return to normal position and engage contact 67 to start the division operation.

However, before the division operation begins, i. e. before return of lever 201 to its normal position, latch means becomes effective to latch the settable parts in their above described adjusted positions for the division. Preferably the latch means is associated with connecting lever 212 to maintain said lever in its adjusted active position until the end of the division operation, or until such operation is interrupted by the operator. Adjacent its rear end, lever 212 (Figs. 4 and 5) has flat bottomed pin 271 projecting therefrom in operative relation with latch lever or member 272 (Fig. 4) pivoted at 273 on side member 13 and urged in a clockwise direction as viewed in Fig. 4 by spring 274. When lever 212 is moved by setting slide 204, pin 271 moves upwardly rocking latch member 272 until pin 271 rises above latching face 276 on member 272. Spring 274 then becomes effective to move face 276 beneath pin 271 whereby lever 212 and the parts adjusted thereby are maintained in operative relation. Thus, arm 214 of the program control device, connecting lever 212, plus-minus slide 73 and latch member 272 are latched together for movement as a unit, slide 73 having been adjusted to its minus or subtracting position. Also overdraft control link 237 (Fig. 1) has been moved into operative relation with member 243 of the program control device.

The above described conditioning is effected entirely during rearward movement of setting slide 204. Thereafter, when the operator releases lever 201, slide 204 and lever 201 are returned to normal position under the influence of spring 207 so that the clutch is engaged and the circuit is closed as described above to start the division operation.

When the machine starts operation, the divisor set in the keyboard is subtracted repeatedly from the dividend entered in the accumulator or dividend register with the carriage positioned in the usual manner to obtain the highest order digit of the quotient. When the divisor is subtracted once too often, the resulting overdraft causes forward movement of the stub shaft 98A (Fig. 3) of the next to highest order after approximately 200° of the overdraft cycle. Such movement of shaft 98A is utilized through the overdraft control means to condition the machine for initiation of operation of the program control device, the actual initiation thereof, however, being effected by an element of the actuating means. Upon an overdraft, shaft 98A and link 237 (Fig. 1) move forwardly, and, as link 237 has been moved into line with plate portion 242 of member 243, member 243 is rocked in a clockwise direction as viewed in Fig. 1 against the influence of spring 281 which normally maintains tail 282 of member 243 against shaft 228. Such clockwise movement of member 243 moves upwardly extending cam arm 283 (Figs. 1, 3 and 6) of member 243 into the path of roller or pin 284 on disk 286, which is secured on actuating shaft 31 of highest order. Thus, the overdraft control means conditions the program control device for operation, such conditioning taking place after approximately 300° of the overdraft cycle.

Immediately after cam arm 283 is moved into the path of roller 284, it is engaged thereby to shift member 243 and shaft 222 to the right as viewed in Fig. 3 to start operation of the program control device. Thereafter, the program control device determines a predetermined sequence of operations including correction of the overdraft, shifting of the register carriage to the next lower order, and resetting of the machine for subtraction.

The program control device, which, in the typical example shown, may comprise the shaft 222 and cams 221 and 316 thereon, exercises its control by virtue of intermittent rotation of certain parts thereof including shaft 222 during the overdraft cycle of the machine and the two succeeding cycles of the machine, after which the device is automatically disabled. To produce the intermittent movement of shaft 222, gear 301 (Figs. 3 and 7) is mounted on the end of shaft 222 which projects beyond the right hand side of control plate 58. Gear 301 is normally in the in-

operative position shown in Fig. 3 out of the path of cooperating mutilated gear **302** which is driven cyclically through gears **303**, **304** from shaft **32**. Such inoperative position is determined by notch **306** of gear **301** engaging over pin **307** on plate **58** under the urgency of spring **308** (Fig. 3) at the left end of shaft **222**. As seen in Fig. 7, gear **301** has three equally spaced sets of three teeth each for cooperation with the single set of three teeth provided on gear **302**. Also, as gear **302** rotates in a counterclockwise direction as viewed in Fig. 7, its teeth are positioned to engage a set of teeth of gear **301** immediately before the end of a cycle. The arrangement is such, therefore, that when gear **301** is projected into the path of gear **302** during a cycle of operation, gear **301** is rotated one-third revolution at the end of that cycle and also one-third rotation at the end of each of the two next succeeding cycles, being maintained in projected position by the engagement of pin **307** with the inner face of gear **301**.

It will be recalled that, upon overdraft, cam arm **283** (Figs. 1 and 3) is moved into the path of roller **284** so that shaft **222** is moved to the right (Fig. 3) and gear **301** is placed in operative relation with gear **302**. Thus, the first one-third rotation of shaft **222** occurs just before the end of the overdraft cycle. This first one-third rotation of shaft **222** is utilized to change the setting of the machine from subtraction to addition so that the next cycle of the actuating means will cause a correction of the overdraft. As described previously, eccentric cam **221** (Fig. 5) is normally positioned to set the machine for subtraction by moving plus-minus slide **73** forwardly of the machine when the machine is set for division by operation of lever **201**, setting slide **204** and connecting lever **212**. This position of cam **221** is indicated at A in Fig. 5. The one-third rotation of shaft **222** at the end of the overdraft cycle moves cam **221** from position A in a counterclockwise direction to position B, and such movement results in rearward movement of arm **214**, connecting lever **212** and plus-minus slide **73** to set the machine for addition by meshing gears **46**, **48** (Fig. 1). The machine drive is maintained during such movement of arm **214** (Fig. 5) and connecting lever **212** as link **251** merely oscillates about its pivotal connection with bell crank **252** without changing the adjustment of bell crank **252**.

Thus, the operation cycle after an overdraft cycle, serves to correct the overdraft. At the end of the corrective cycle, the second one-third rotation of cam **221** and shaft **222** occurs and determines a carriage shift cycle of the machine. This is effected by setting plus-minus slide **73** to its neutral position where both gears **46**, **47** are out of mesh with gears **48** as illustrated in Fig. 1 and by engaging the drive connection to determine a one step shift of the carriage to the left. The second one-third rotation of shaft **222** (Fig. 5) moves cam **221** counterclockwise from position B to position C where a slight clearance is provided so that arm **214**, lever **212**, plus-minus slide **73** and gears **46**, **47** can be centralized quickly in neutral position by the engagement of spring-urged latching pawl **311** with notch **312** in arm **214**. Pivot **313** for pawl **311** is mounted eccentrically on plate **58** to provide for easy and accurate adjustment of pawl **311** with respect to notch **312**. Means are provided for engaging left-hand collar **128** (Fig. 3) with gear sleeve **131** during said second one-third rotation of shaft **222**. Cam **316** fixed on shaft **222** adjacent right hand side member **13** is positioned normally out of alignment with arm **317** on shaft **318**. Shaft **318** is pivoted in side member **13** and bracket **319** on cross piece **101** and carries arm **320** which extends upwardly and rearwardly so that its end abuts left hand shift fork **146**. When the program control device is enabled by shifting of shaft **222**, cam **316** is moved into alignment with arm **317**. Cam **316** is so positioned angularly on shaft **222** that it is effective to rock arm **317**, shaft **318**, and arm **320** to engage collar **128** with gear sleeve **131** during said second one-third rotation of shaft **222**. Such engagement is maintained for one cycle of operation of the machine and effects one ordinal spacing of the carriage.

At the end of the shift cycle, shaft **222** receives its third one-third rotation to restore the program control device to its original condition, cam **221** (Fig. 5) being rotated from position C to position A to reset the machine for subtraction, and shaft **222** (Fig. 3) being moved to the left by spring **308**, notch **306** in gear **301** engaging over pin **307**. As a result, subtraction begins in the new position of the carriage until an overdraft, when the program control device is again placed in operation as described above.

The division control mechanism in the typical example shown may be summarized as including the starting control comprising lever **201** and slide **204**, the program control device comprising shaft **222** and cams **221** and **316** thereon, and the overdraft control comprising member **243** and control link **237** therefor, as well as certain cooperating mechanisms including the connecting lever **212** and latch lever **272** therefor which maintain the program control device and the overdraft control means active, and the automatic division stop means including live pawl **322** described hereinafter.

Division stop means—Automatic control

The described sequence of operations continues until the carriage is shifted into its lowest order position when division stop means become effective to terminate the operation automatically after completion of the quotient figure of lowest order. To effect this control, the second one-third rotation of shaft **222** of the program control device after overdraft in the lowest order is utilized. Latch lever **272** (Fig. 4) is provided with upwardly extending arm **321** which lies in the path of "live" pawl **322** (Figs. 2 and 4) pivoted at **323** on the bottom side of carriage frame **51** and held against stop pin **324** by springs **326**. As the carriage is shifted into the lowest order position, pawl **322** strikes arm **321** and is turned about its pivot **323**, the subtracting operation then ensues and pawl **322** is maintained out of the normal position thereof shown in Fig. 4 when the machine is set for subtraction. After the overdraft cycle, the machine is set for addition which causes counter-clockwise movement of latch lever **272** and forward movement of arm **321** thereof a sufficient amount to permit pawl **322** to move, under the influence of spring **326**, into longitudinal blocking alignment with arm **321** so that further movement of latch lever **272** is prevented while the carriage is in its lowest order position. Therefore, when the second one-third rotation of shaft **222** and cam **221** occurs at the end of the additive overdraft correction cycle and plus-minus slide **73**, lever **212**, and pin **271** move forwardly of the machine, pin **271** moves off of latching face **276** to disable the division control mechanism. How-

ever, this action is not completed until the clutch has begun the shift cycle. This cycle is ineffective to shift the carriage because of yielding of pawl **114** (Fig. 6) and merely serves to complete the operation of the program control device and restore its parts to normal condition.

It will be noted that a subsequent division operation cannot be initiated with the carriage in its lowest order position as latch lever **272** (Fig. 4) is maintained out of operative relation with pin **271** on connecting lever **212** by pawl **322**.

Division stop mechanism—Manual control

Manually operable control means are provided for optionally terminating the division operation of any time or after the completion of any selected ordinal division. Thus, the machine can be stopped at once if the set up is erroneous or after any desired number of quotient figures are obtained without completing a full plural order division operation through the lowest order quotient digit. To accomplish the latter result, the manual control means operates in a manner similar to the action of pawl **322** in stopping the division operation in the lowest order position of the carriage. Optional stop control lever **331** (Figs. 3 and 4) is pivoted by stud **332** on side frame member **13**. Upper bent arm **333** (Fig. 4) of lever **331** extends upwardly to form a handle, and is provided with a pair of notches **334** for cooperation with spring-urged latching pawl **336**. Lever **331** is shown in inoperative position. Pivoted coaxially with lever **331** on the inner or left hand side thereof, is "live" pawl **337** having offset lug **338** extending beneath lower arm **339** and "live" pawl **340** pivoted coaxially with lever **331** on the outer or right hand side thereof. Lug **338** is connected by spring **341** with a suitable lug **340***a* on pawl **340** having a suitable bent lug **340***b* overlying arm **339** of lever **331** only. The function of pawl **340** is described hereinafter. By means of this connection, pawl **337** yieldably follows counter clockwise movement of lever **331** and is positively carried therewith in a clockwise direction. At its end, pawl **337** has notch or seat **342** which is positioned below laterally extending lug **343** on division latch lever **272**. Upon forward movement of arm **333** of stop control lever **331** to determine stopping of the division operation, arm **339** and pawl **337** are moved upwardly, pawl **337** being stopped before completing its movement by lug **343**. Lever **331** is latched resiliently in its operative stopping position by the engagement of pawl **336** in upper notch **334**. When lever **331** is in operative position, pawl **337** is positioned to unlatch the division control mechanism, and lower arm **339** of lever **331** enables means for restoring lever **331** to normal inoperative position. Such restoring means comprises lever **346** pivoted at **347** on side member **13** and having its upper end in operative relation with lateral extension **348** at the end of arm **339**. The lower arm of lever **346** carries roller **349** which is normally out of the path of cam **351** on shaft **222** of the program control device. Movement of lever **331** rocks lever **346** to move roller **349** into the path of cam **351**. With the parts conditioned as described above, the following operation occurs after an overdraft and during operation of the program control device. When lever **272** is rocked in a counter clockwise direction as an incident to setting the machine for the additive overdraft correction cycle, pawl **339** moves up to engage notch **342** with lug **343** so that subsequent clockwise movement of latch lever **272** is blocked. Consequently, during the second one-third rotation of shaft **222**, pin **271** is moved off of latching face **276** as previously described to terminate the division operation. Subsequently, during the last one-third rotation of shaft **222** at the end of the shift cycle, cam **351** strikes roller **349** to rock lever **346** which restores lever **331** and pawl **337** to inoperative position, releasing latch lever **272**. Thus, a division operation can be stopped after any selected ordinal division.

To effect stopping of a division operation at any time when the machine is set improperly, as for example, when the divisor is set incorrectly or the operator forgets to set the divisor on the keyboard, stop control lever **331** is oscillated in a clockwise direction and held until the machine stops. Such clockwise oscillation enables the program control device in the same manner as when an overdraft occurs and also conditions means for disabling the division control mechanism at the end of the first shift cycle. The means for enabling the program control device by movement of stop control lever **331** includes arm **356** (Figs. 3 and 4) formed at the right end of bail **357** which is pivotally mounted on shaft **228** and spring urged in a clockwise direction by spring **358** (Fig. 4). At its left end, bail **357** has arm **359** (Figs. 1 and 4) having a lateral extension engaging tail **282** of member **243** of the program control device. Clockwise oscillation of stop control lever **331**, therefore, causes counterclockwise oscillation of arm **356**, bail **357** and arm **359**, which through tail **282** rocks member **243** to place cam arm **283** thereof in the path of roller **284** on disk **286**. From the previous description of such mechanism it will be recalled that this conditioning thereof initiates operation of the program control device near the end of the cycle of operation then in progress so that shaft **222** will rotate intermittently as described.

At the same time that operation of the program control device is determined by clockwise movement of lever **331**, pawl **340** (Fig. 4) is conditioned to disable division latch lever **272**. Clockwise movement of pawl **340** with lever **331** is interrupted before completion thereof by the engagement of pawl **340** with lug **343** of lever **272**. When lever **272** is rocked in a counterclockwise direction in setting the machine for addition, pawl **340** completes its clockwise movement under the influence of spring **341** and moves into blocking relation with lug **343** on lever **272**. Subsequently the operation is terminated in the manner described in connection with pawl **337**. After release of lever **331** it is restored to its normal inoperative position by latching pawl **336** which remains in operative relation with the lower extended side of lower notch **334**. Thus, a division operation can be terminated at any time by operation of stop control lever **331**.

From the foregoing description it is seen that division stop control lever and associated parts provide selectively operable means for stopping a division operation before completion either with correct quotient figures or with incorrect quotient figures.

Interlocks

Certain safety devices are also provided to in-

sure correct setting of the machine before a division operation can be begun. For this purpose, means are provided for preventing setting of the machine for division if the minus key is depressed. Division setting slide 204 (Fig. 5) has vertical projection 366 having its rearward flat face positioned below and immediately forward of stem 367 of minus key 57. If key 57 is depressed, stem 367 is in the path of projection 366 and blocks movement of slide 204 and lever 201.

Means are also provided for preventing setting of the machine for division if the "add" key is depressed to determine release of any depressed keys of the keyboard. Add key 371 (Fig. 4) is mounted for sliding and pivotal movement on stud 372 secured on side member 13, and can be depressed against the tension of spring 373 to engage notch 374 formed therein with pin 376 on member 13. The means for determining automatic release of any depressed keys 26 when key 371 is depressed may be of any conventional construction, for example, that shown in my said co-pending application. Associated with key 371 is lever 377 pivoted at 378 on side member 13 and extending between spaced lugs 379, 380 on key 371. At its forward end, lever 377 has lateral extension 381 which is guided for vertical movement by slot 382 (Fig. 5) in control plate 58. Extension 381 in the raised position thereof lies immediately above and rearward of vertical projection 383 at the front end of division setting slide 204. Depression of add key 371 moves extension 381 behind projection 383 to block movement of slide 204 and key 201.

Thus, a division operation cannot be started if the machine is improperly conditioned.

I, therefore, claim as my invention:

1. In a calculating machine, a register, actuating means therefor, division control mechanism for automatically enforcing a predetermined sequence of machine operations after each overdraft of said register in a division operation, said mechanism including a program control device, and control means for stopping operation of the machine before completion of a division operation including means for enabling said device irrespective of an overdraft on said register.

2. In a calculating machine, a register, actuating means therefor, division control mechanism for automatically enforcing a predetermined sequence of machine operations after each overdraft of said register in a division operation, said mechanism including a program control device, and control means for stopping operation of the machine before completion of a division operation including means for enabling said device irrespective of an overdraft on said register, and means for disabling said division control mechanism after the sequence of operations determined by enabling of said device.

3. In a calculating machine having relatively shiftable numeral wheels and actuating means therefor, mechanism for controlling a plural order division operation comprising control means for initiating said operation, and means for terminating said operation upon completion of the lowest order quotient digit, said operation terminating means being positioned relative to said control means when said numeral wheels and actuating means are relatively positioned for determination of said lowest order digit to prevent initiation of a division operation by operation of said control means.

4. In a calculating machine for performing division operations, a clutch including a drive-engaging element, a control member for said element, control means for initiating a division operation and operable to move said member to enable engagement of said clutch, and means movable by said control means to block the drive-engaging movement of said element enabled by movement of said member and to release said element subsequently to establish the drive.

5. In a caluculating machine, a register, actuating means therefor, division control mechanism for automatically enforcing a predetermined sequence of machine operations during a division operation; said control mechanism having a program control device including a member operable in time with said actuating means, a normally disabled drive connection between said device and said actuating means, means responsive to an overdraft in said register for enabling said drive connection, and control means for enabling said device with respect to said register and said actuating means; an optionally operable control associated with said division control mechanism for stopping said machine during a division operation, said control being manually movable from an inactive position to an active position to initiate the stopping operation, and means for releasably latching said control in said active position.

6. In a calculating machine, a register, actuating means therefor, division control mechanism for automatically enforcing a predetermined sequence of machine operations during a division operation; said control mechanism having a program control device including a member operable in time with said actuating means, a normally disabled drive connection between said device and said actuating means, means responsive to an overdraft in said register for enabling said drive connection, and control means for enabling said device with respect to said register and said actuating means; and an optionally operable control associated with said division control mechanism for stopping said machine during a division operation by operating said drive connection enabling means.

7. In a calculating machine, a register, cyclically operable actuating means therefor, drive means for said actuating means including a clutch, means for controlling a plural order division operation by continuous and uninterrupted cyclic operation of said actuating means including means for maintaining said clutch engaged throughout a division operation, and a control member associated with said division operation controlling means for stopping operation of the machine after completion of a selected ordinal division.

8. In a calculating machine, a register, cyclically operable actuating means therefor, drive means for said actuating means including a clutch, means for controlling a plural order division operation by continuous and uninterrupted cyclic operation of said actuating means including means for maintaining said clutch engaged throughout a division operation and a program control device for automatically enforcing a predetermined sequence of machine operations during a division operation, and a control member associated with said division operation controlling means optionally operable to stop operation of the machine after completion of a selected ordinal division.

9. In a calculating machine, a shiftable carriage, a register in said carriage, actuating

means therefor, means including a clutch for driving said actuating means, means for shifting said register carriage relative to said actuating means, a series of reversing gears interposed between said register and said actuating means, a slide for moving said gears in either direction from a central inactive position thereof to determine additive and subtractive registration on said register, a cam for periodically effecting a back and forth movement of said slide during a division operation, means including a connecting lever for operatively connecting said cam with said slide during a division operation, said connection also controlling engagement of said clutch, spring means urging said connecting lever to inoperative position, a latch associated with said connecting lever for maintaining said lever operatively associated with said slide during a division operation and movable back and forth with said slide, and a member selectively settable into the path of movement of said latch for disabling said latch with respect to said connecting lever to permit movement thereof to inactive position and thereby terminate the division operation.

10. In a calculating machine having a register, actuating means for said register, and driving means for said actuating means; a cyclically operable clutch including a drive member connected to said driving means, a driven member connected to said actuating means, and a control element mounted on said driven member for movement into and out of drive establishing engagement with said driving member; means for controlling said movement of said control element to determine cyclic operation of said actuating means by said driving means; a manually operable control member for said movement controlling means; normally disabled blocking means for preventing movement of said control element into drive establishing position; and means controlled by said manually operable control member for first enabling and then disabling said blocking means, whereby to delay engagement of said clutch.

11. In a calculating machine having a register, actuating means for said register, and driving means for said actuating means; a cyclically operable clutch including a drive member connected to said driving means, a driven member connected to said actuating means, and a pawl mounted on said driven member and spring-urged into drive establishing engagement with said driven member; a lever for holding said clutch pawl in inoperative position and movable to and from the holding position to control cyclic operation of said actuating means; manually operable means for controlling movement of said holding lever; a normally inactive blocking pawl for preventing movement of said clutch pawl to drive establishing position; and means movable by said manually operable means upon operation thereof to move said lever out of engagement with said clutch pawl, for moving said blocking pawl first into and then out of engagement with said clutch pawl, whereby to delay engagement of said clutch.

12. In a calculating machine, a shiftable carriage, a register in said carriage, actuating means therefor, means for controlling positive and negative registrations on said register, means for shifting said register carriage relative to said actuating means, normally disabled program control means associated with said controlling means and said shifting means for controlling operation thereof during a division operation, means for enabling said program control means, a normally disabled drive connection for said program control means for effecting cyclic operation thereof with said actuating means, means controlled by said register upon an overdraft registration for enabling said drive connection to initiate the sequence of operations determined by said program control means at the end of each ordinal division operation, manually operable means for enabling said drive connection, and means controlled by said manually operable means for disabling said program control means.

13. In a calculating machine, a shiftable carriage, a register in said carriage, actuating means therefor, means for controlling positive and negative registrations on said register, means for shifting said register carriage relative to said actuating means, normally disabled program control means associated with said controlling means and said shifting means for controlling operation thereof during a division operation, means for enabling said program control means, a normally disabled drive connection for said program control means for effecting cyclic operation thereof with said actuating means, means controlled by said register upon an overdraft registration for enabling said drive connection to initiate the sequence of operations determined by said program control means at the end of each ordinal division operation, and normally inactive means cooperatively related to said program control means and movable to active position relative thereto to disable said control means at the end of the sequence of operations next initiated thereby.

14. In a calculating machine having a register and actuating mechanism therefor, automatic division control mechanism including a member movable to a plurality of positions in accordance with setting of the machine for different operations, latching means for said member, and means automatically controlled by said member during movement thereof for disabling said latching means after completion of the division operation.

15. In a calculating machine having a shiftable carriage, a register in said carriage, and actuating means therefor, a member settable to a plurality of positions to control registration and the sign character thereof by said actuating means on said register, means for controlling setting of said member during a division operation, means for latching said controlling means and said member for movement together as a unit, and means shiftable with said register carriage and conditioned as an incident to final movement of said carriage upon completion of a division operation for disabling said latching means.

16. In a calculating machine having a register and actuating means therefor, a member settable to a plurality of positions to control registration and the sign character thereof by said actuating means on said register, means for controlling setting of said member during a division operation, means for latching said controlling means and said member together, said controlling means and said latching means being movable with said member as a unit, and means for terminating a division operation comprising means for disabling said latching means by blocking movement thereof with said member.

17. In a calculating machine having a register

and actuating means therefor, a member settable to a plurality of positions to control registration and the sign character thereof by said actuating means on said register, means for controlling setting of said member during a division operation, means for latching said control means and said member for movement together as a unit, and means for terminating a division operation comprising means for disabling said latching means as an incident to movement of said member from one position thereof to another position thereof.

18. In a calculating machine having relatively shiftable numeral wheels and actuating means therefor, settable control means for initiating a division operation, a latch for holding said settable means in active position, and means for disabling said latch to prevent initiation of a division operation when said numeral wheels and said actuating means are relatively positioned to determine the lowest order quotient figure.

19. In a calculating machine, a frame, a carriage shiftable with respect to said frame, a register in said carriage, actuating means for said register, control means for initiating operation of said actuating means on said register, and a spring-urged pawl mounted on said carriage to block operation of said control means in one position of said carriage.

20. In a calculating machine having a register, actuating means for said register, and means for controlling registration on said register by said actuating means; means including a clutch for driving said actuating means, settable means for causing engagement and disengagement of said clutch, operation starting control means operatively related to said settable means to control setting thereof and also having a controlling connection with said registration controlling means, and means controlled by said starting control means for blocking engagement of said clutch; said starting control means having a movement to operate said settable means, said registration controlling means, and said blocking means to condition the machine for operation before initiating the operation and having a second movement to disable said blocking means to initiate the operation.

21. In a calculating machine having a register, actuating means for said register, and means for controlling registration on said register by said actuating means; means including a clutch for driving said actuating means, settable means for causing engagement and disengagement of said clutch, operation starting control means operatively related to said settable means to control setting thereof and also having a controlling connection with said registration controlling means, and means controlled by said starting control means for blocking engagement of said clutch; operation of said starting control means serving first to operate said settable means, said registration controlling means and said blocking means, and thereafter to release said blocking means, whereby to delay engagement of said clutch until the machine is fully conditioned for operation.

22. In a calculating machine, a register, actuating means therefor, means for shifting said register, division control mechanism for automatically enforcing a predetermined sequence of machine operations during division, said control mechanism including a program control device for controlling the sign character of the registration on said register and for controlling shifting of said register after each ordinal division, and control means for enabling said device with respect to said register and said actuating means, and other control means operatively related to a portion of said control mechanism for selectively disabling said device with respect to said register and said actuating means to provide an optionally operable division operation stopping control.

23. In a calculating machine, a register, cyclically operable actuating means therefor, means for controlling a plural order division operation including means for causing cyclic operation of said actuating means, and selective control means cooperatively related to said division controlling means and operable to stop a division operation irrespective of the completion of an ordinal division and operable to stop a division operation after completion of a selected ordinal division, said control means including a manually operable member selectively movable in either of two directions, said member being movable in one direction to cause stopping with completion of an ordinal division and in another direction to cause stopping irrespective of completion of an ordinal division.

24. In a calculating machine, a register, cyclically operable actuating means therefor, means for controlling a plural order division operation including means for causing cyclic operation of said actuating means and a manually operable key for initiating the division operation, a settable control member, and means associated with said cyclic operation causing means and moved to active position by setting of said control member for stopping operation of the machine after completion of a selected ordinal division, said last-named means remaining in said active position until said stopping operation is effected.

25. In a calculating machine, a register, cyclically operable actuating means therefor, means for controlling a plural order division operation including means for causing cyclic operation of said actuating means and a manually operable key for initiating the division operation, a settable control member, means for releasably latching said member in active position, means associated with said cyclic operation causing means and controlled by said member when set in active position for stopping a division operation after completion of a selected ordinal division, and means operated by said actuating means for restoring said member to inactive position.

26. In a calculating machine, a register, actuating means therefor, division control mechanism for automatically enforcing a predetermined sequence of machine operations during a division operation, said control mechanism having a program control device including a member operable in time with said actuating means, and having control means for enabling said device with respect to said register and said actuating means, and other control means associated with said division control mechanism for optionally stopping the machine during a division operation, said last-named means including a manually operable member movable in either of two directions from a central position to initiate the stopping operation.

27. In a calculating machine, having numeral wheels, an actuating mechanism for said numeral wheels, and settable means movable in either direction from a central neutral position for determining additive and subtractive registration on said numeral wheels by said actuating mechanism; automatic division control mechanism in-

cluding a cam having three operative positions, corresponding to the three operative positions of said settable means, said cam being normally positioned to determine subtractive registration, normally inoperative connecting means between said settable means and said cam, a division control key movable from its normal position and then back to its normal position to initiate a division operation, and means controlled by said division control key during its movement away from its normal position for enabling said connecting means.

28. In a calculating machine, having numeral wheels, an actuating mechanism for said numeral wheels, and settable means movable in either direction from a central neutral position for determining additive and subtractive registration on said numeral wheels by said actuating mechanism; automatic division control mechanism including a cam having three operative positions corresponding to the three operative positions of said settable means, said cam being normally positioned to determine subtractive registration, normally inoperative connecting means between said settable means and said cam, a division control key movable from its normal position and then back to its normal position to initiate a division operation, and means controlled by said division control key during its movement away from its normal position for enabling said connecting means, and latch means for engaging said connecting means to maintain it in operative position with said key returned to its normal position.

29. In a calculating machine having a frame, unidirectionally operable actuating means having cyclic operation, a bi-directionally rotatable register, opposed series of settable plus-minus gears for selectively connecting said actuating means to drive said register additively or subtractively, means for shifting said register with respect to said actuating means, and control mechanism for causing the performance of a plural order division operation; said last-named mechanism including a control shaft mounted on said frame for endwise shifting movement to and from operative position, overdraft control means for causing shifting of said shaft to its operative position, a gear on said shaft having a face cooperatively related to a face of said frame, an aperture in one of said faces, a pin mounted on the other of said faces and normally engaging said aperture, and a mutilated gear driven cyclically by said actuating means and meshing with said shaft gear in the operative position of said shaft, said pin engaging with said apertured face to maintain the projected position of said gear in operative relation with said mutilated gear; the driving of said control shaft by said gears operating through said cam to determine correction of an overdraft, shifting of the register with said plus-minus gears inactive, and resetting of said plus-minus gears to subtractive position.

30. In a calculating machine having a register, actuating means therefor, means for controlling both positive and negative registrations on said register by said actuating means, means for shifting said register relative to said actuating means, a source of power, a clutch for driving said actuating means in a single direction from said source of power, and control means for said clutch; division control mechanism including a normally locked program control device comprising a shaft mounted for endwise shifting movement and cam means on said shaft for controlling said shifting means and said registration controlling means to effect a predetermined sequence of operations thereof, said shaft having a normally disconnected intermittent drive connection with said clutch, and overdraft control means associated with said register for causing endwise shifting of said shaft to unlock said program control device and to enable said drive connection.

31. In a calculating machine having a register, actuating means therefor, means for controlling both positive and negative registration on said register by said actuating means, means for shifting said register relative to said actuating means, a source of power, a clutch for driving said actuating means in a single direction from said source of power, and control means for said clutch; division control mechanism including normally disabled means for latching said clutch control means in clutch-engaging position to provide a continuous and uninterrupted drive from said source of power through said clutch to said actuating means, a normally inactive program control device comprising a shaft and a plurality of cams on said shaft for controlling said shifting means and said registration controlling means to effect a predetermined sequence of operations therof, normally disabled overdraft control means associated with said register for enabling said program control device by causing endwise shifting movement of said shaft, and means including a control key for enabling said clutch control means, said latching means, and said overdraft control means.

32. In a calculating machine having a register, actuating means therefor, means for controlling both positive and negative registration on said register by said actuating means, means for shifting said register relative to said actuating means, a source of power, a clutch for driving said actuating means in a single direction from said source of power, and control means for said clutch; division control mechanism including a normally locked program control device comprising interconnected cam means for controlling said shifting means and said registration controlling means to effect a predetermined sequence of operations thereof, a connecting member between said program control dvice and said positive and negative registration controlling means, said member being normally in inactive position, a division control key for moving said member to active position, and a spring-urged latch positioned for engagement with said connecting member upon movement thereof to active position.

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