

Feb. 12, 1946.

H. G. FISHACK ET AL
COMPUTING AND BILLING DEVICE

2,394,602

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26 Sheets-Sheet 1

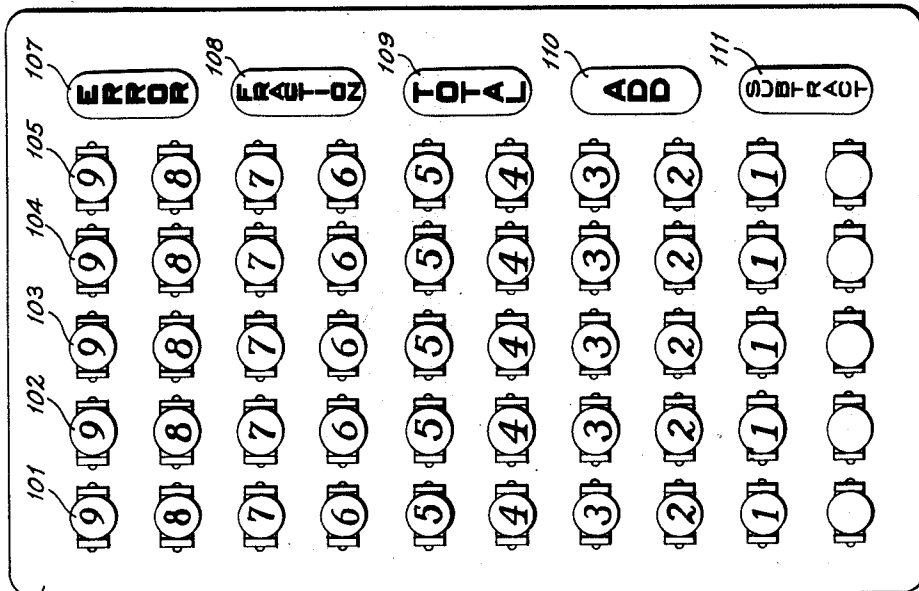


Fig. 1

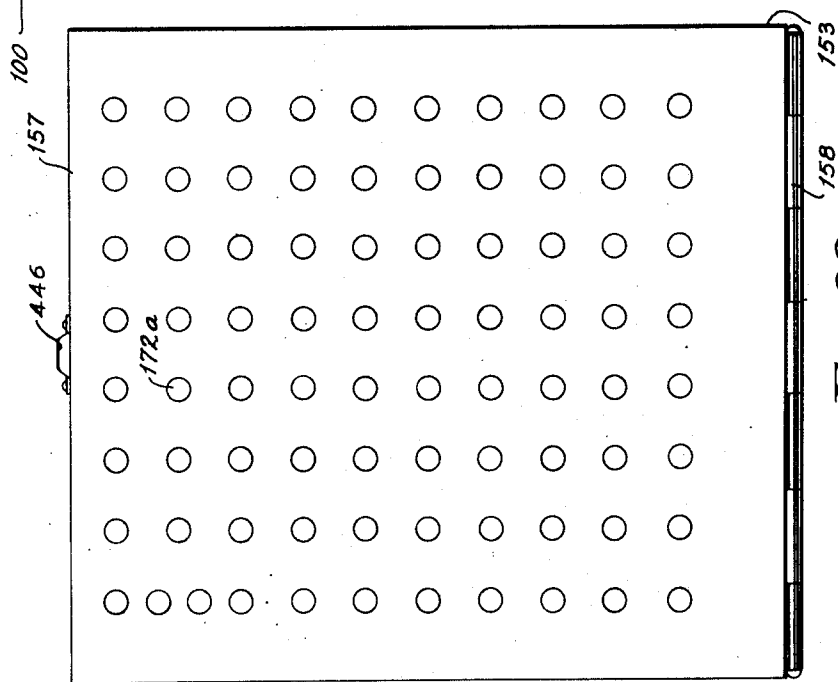


Fig. 32

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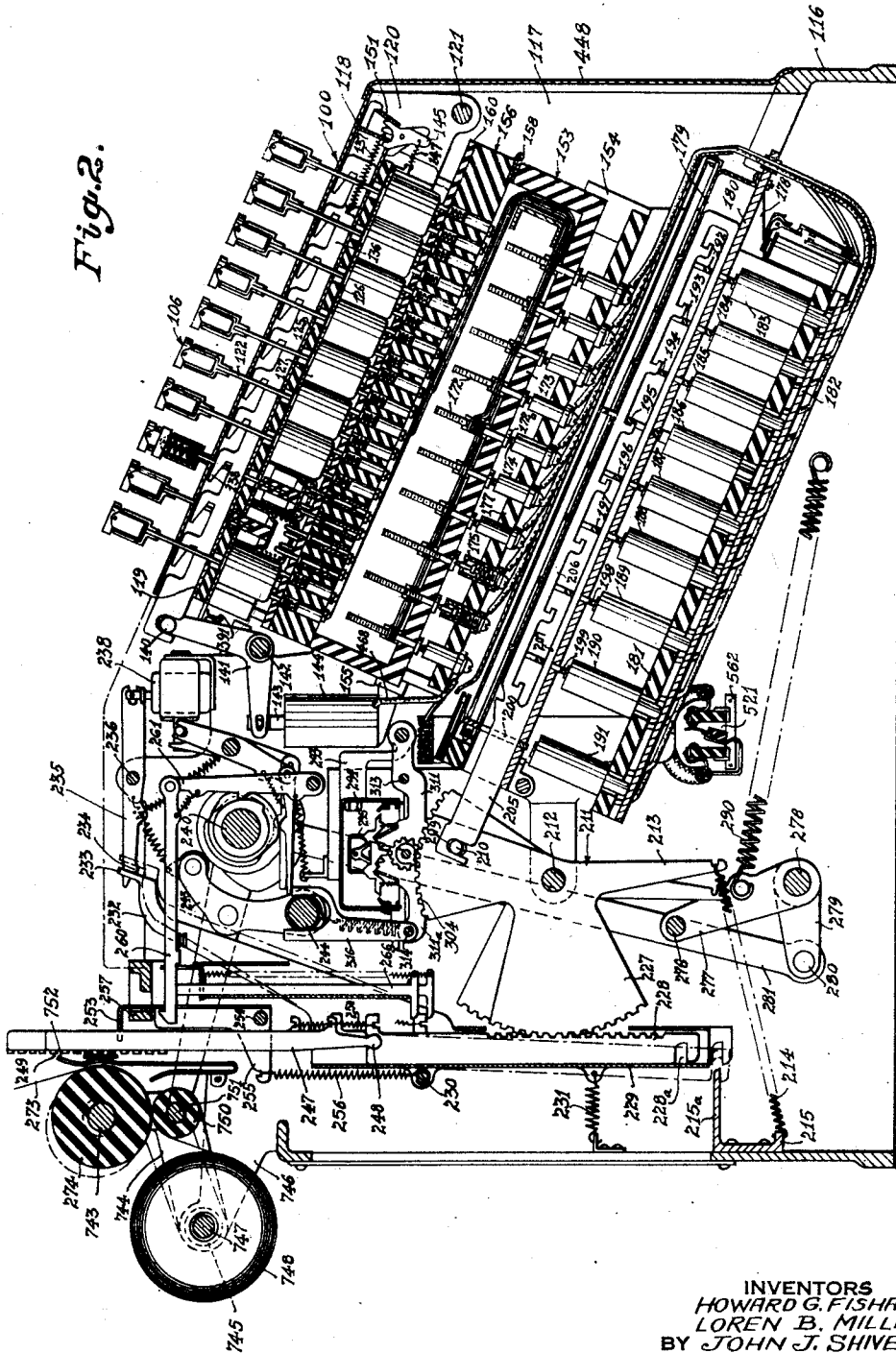
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Fig. 2.



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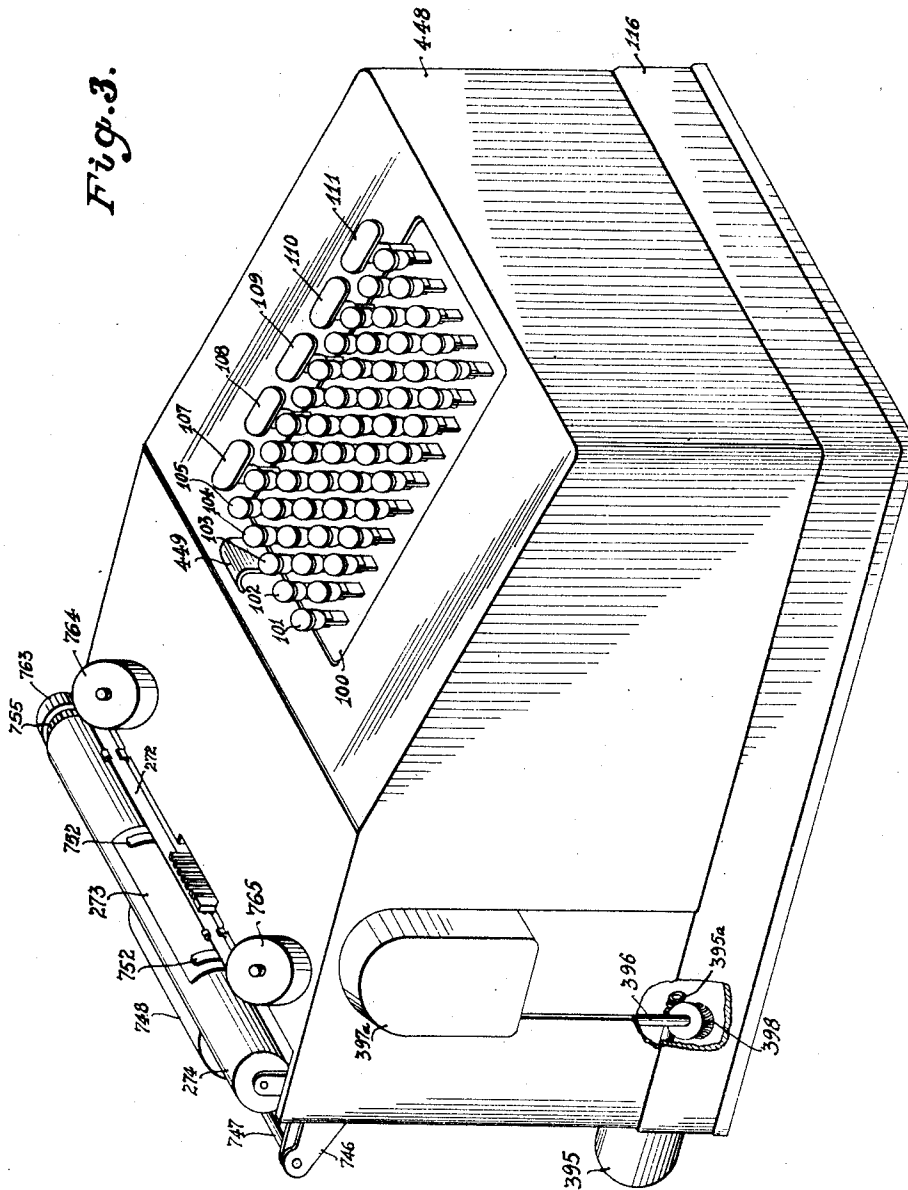
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Fig. 3.



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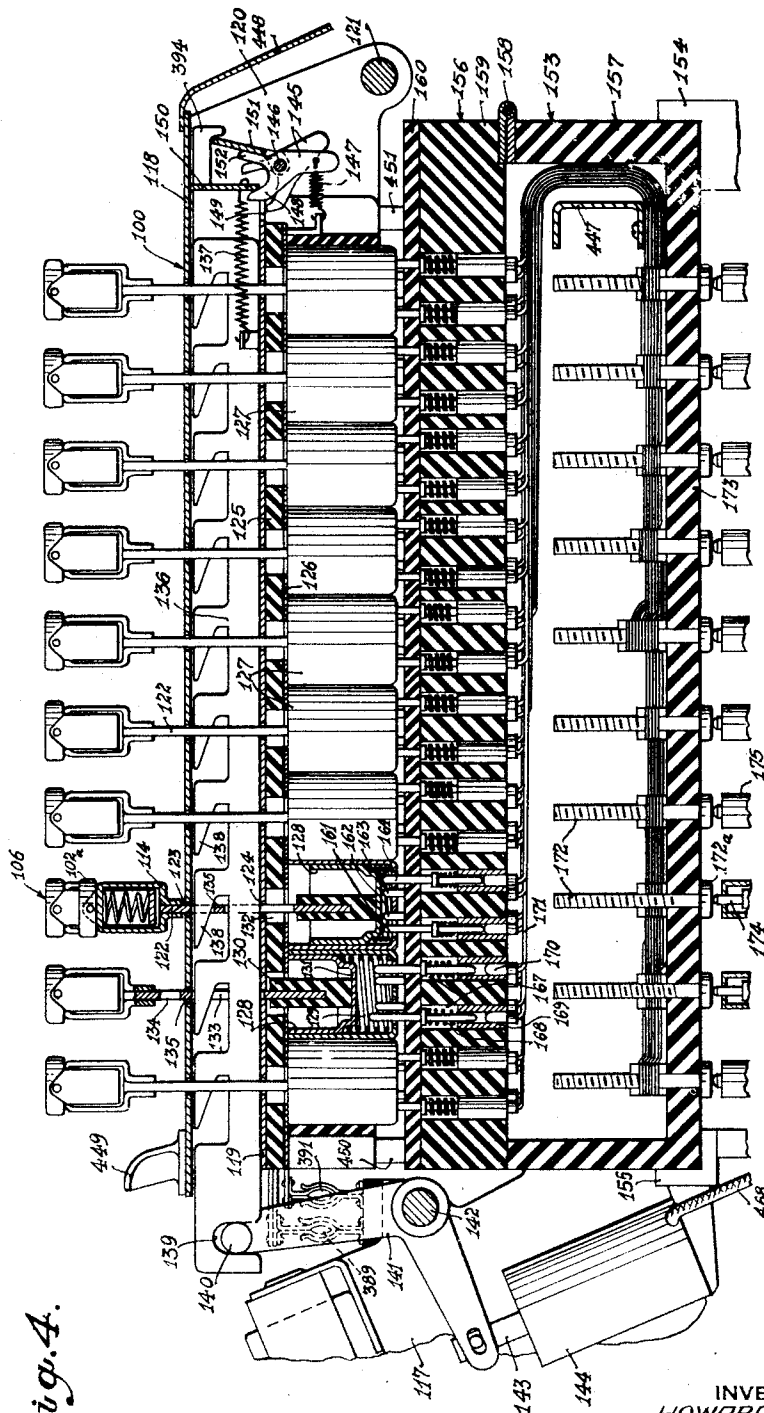
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Fig. 5.

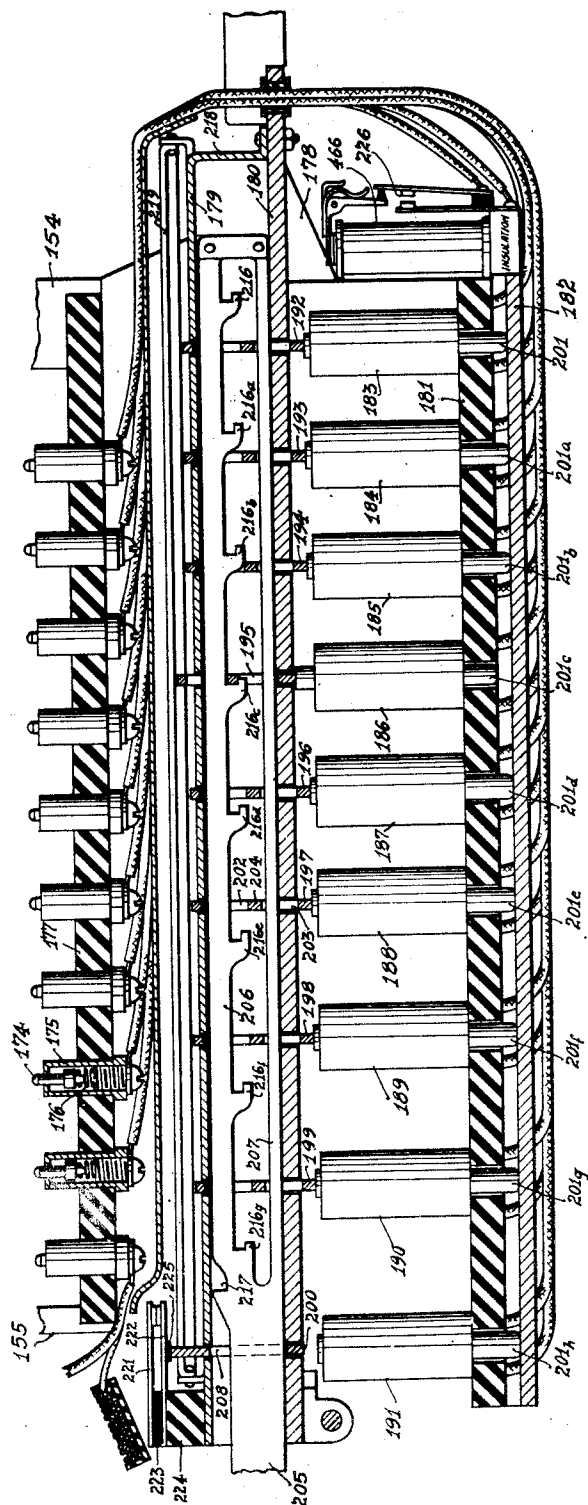


Fig. 7.

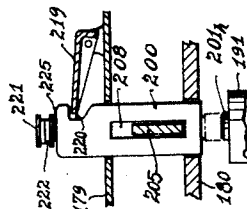


Fig. 6.

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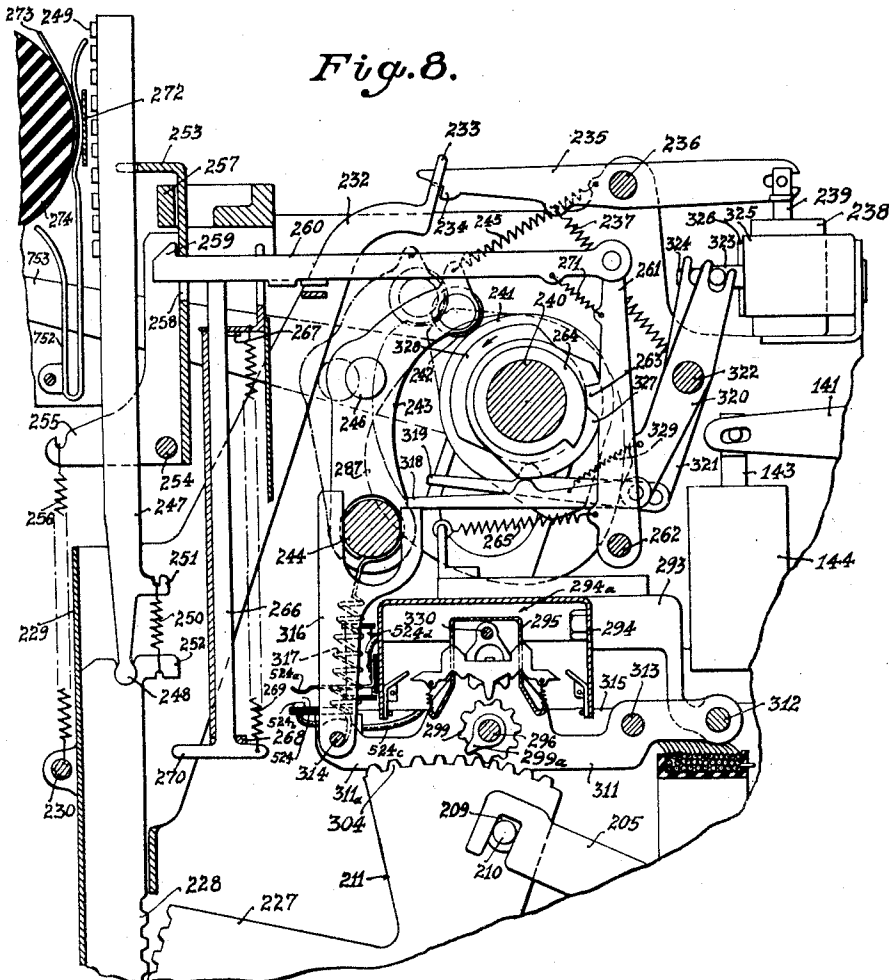
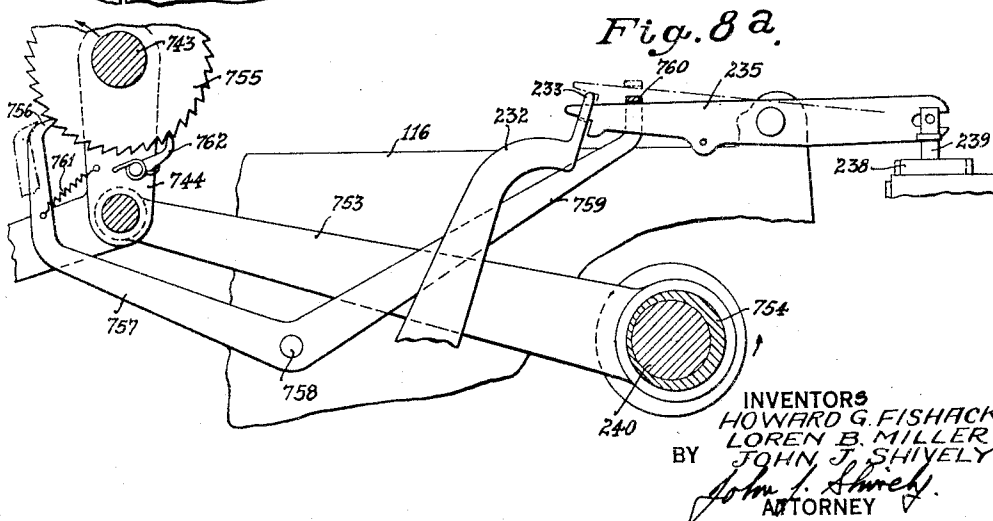
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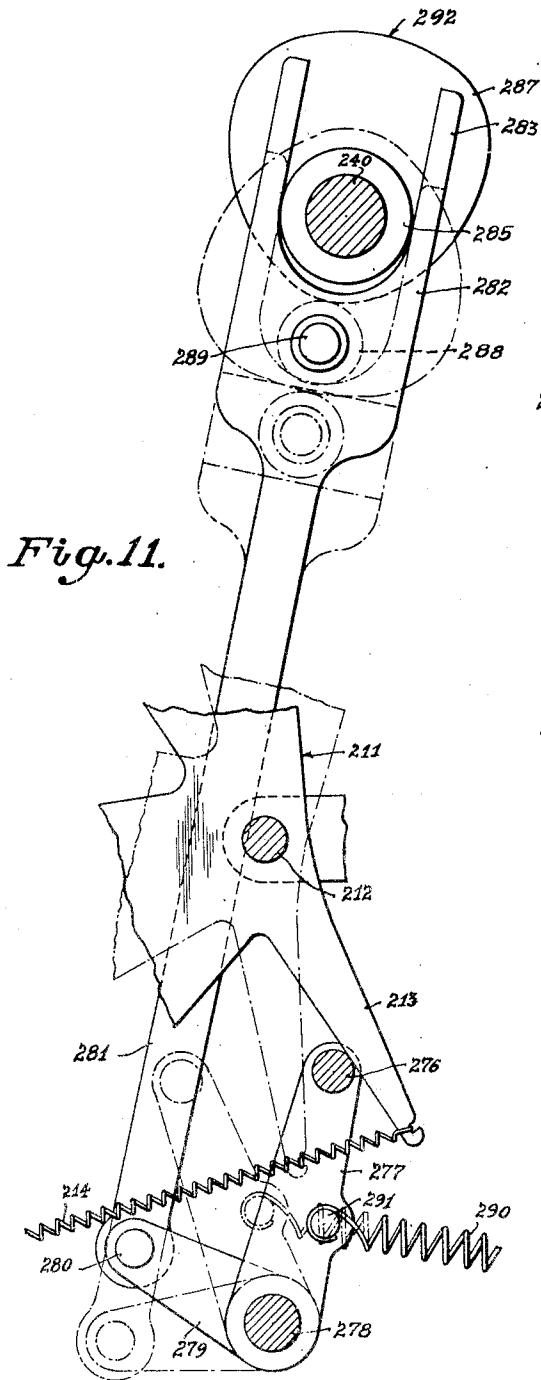
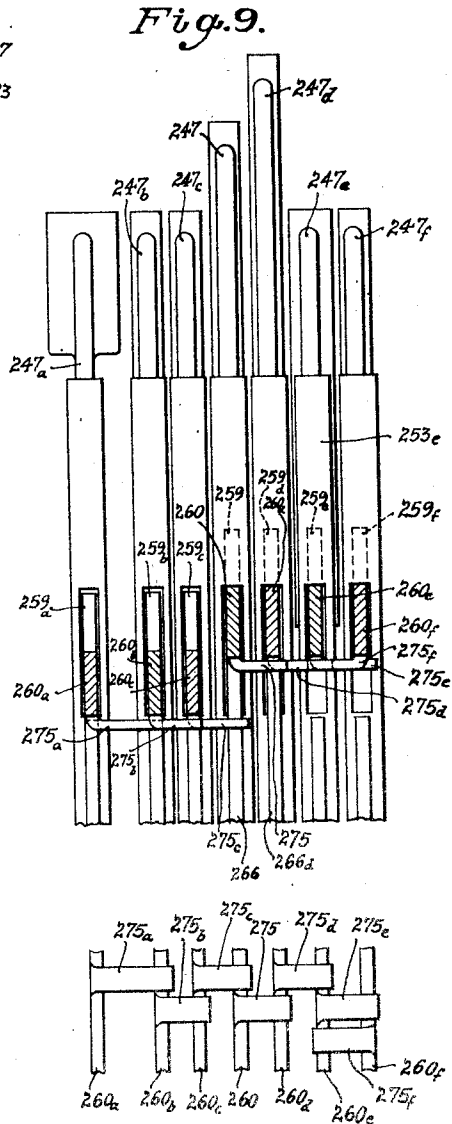
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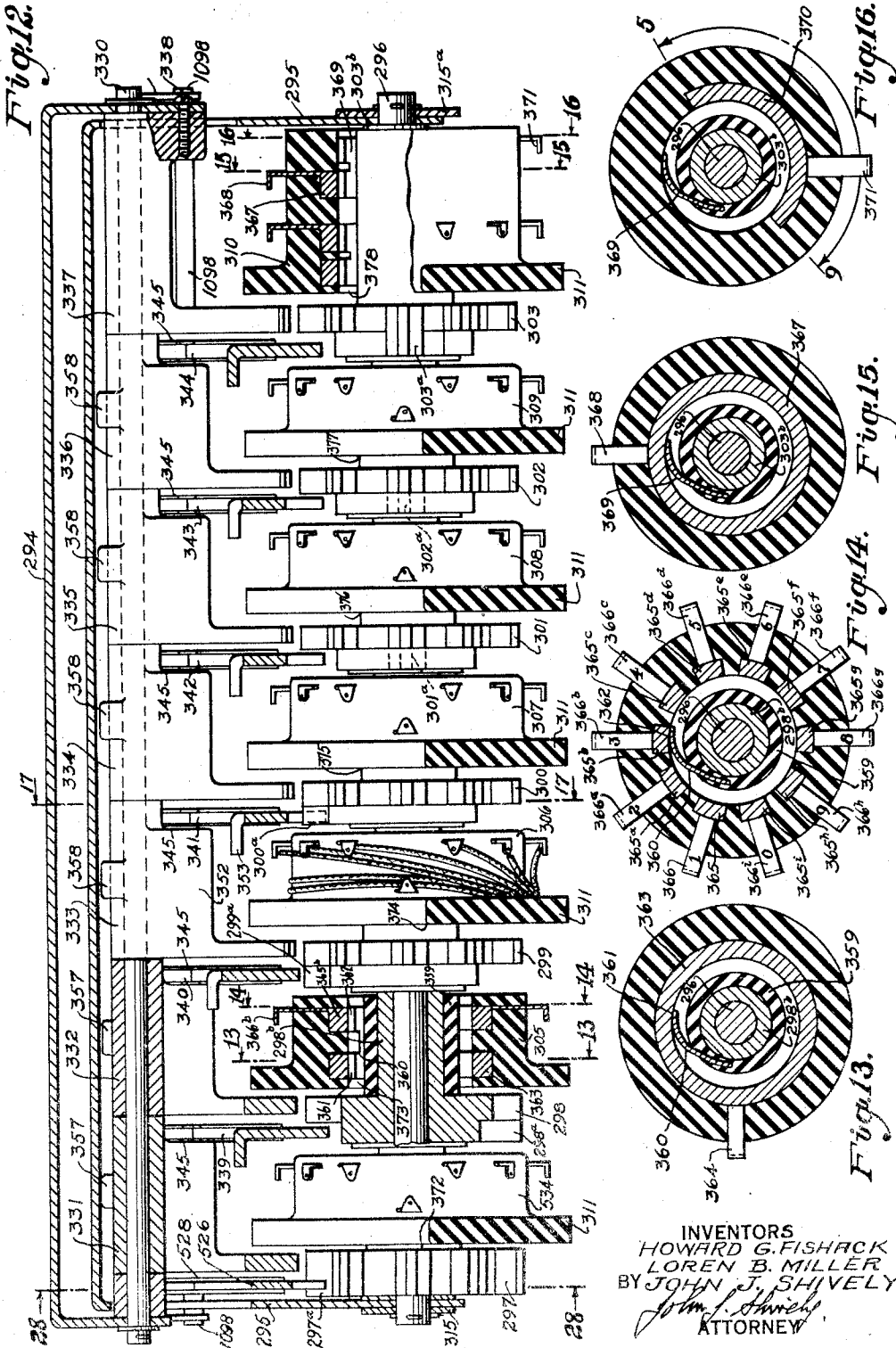
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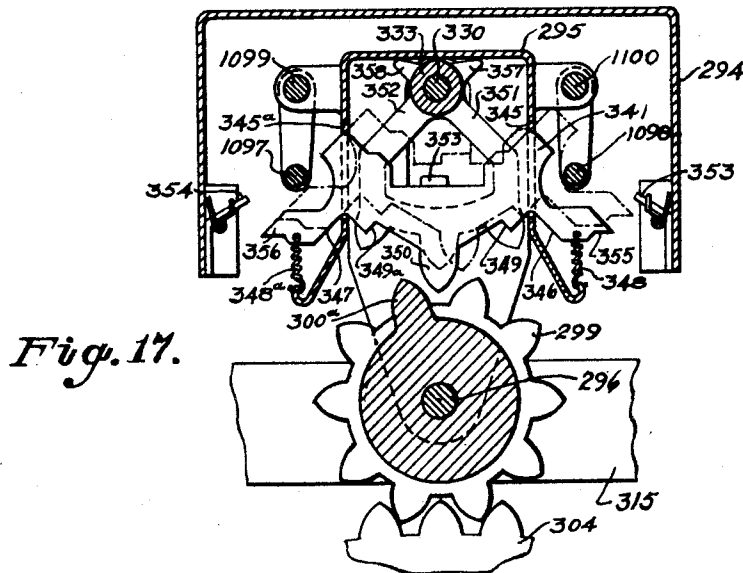
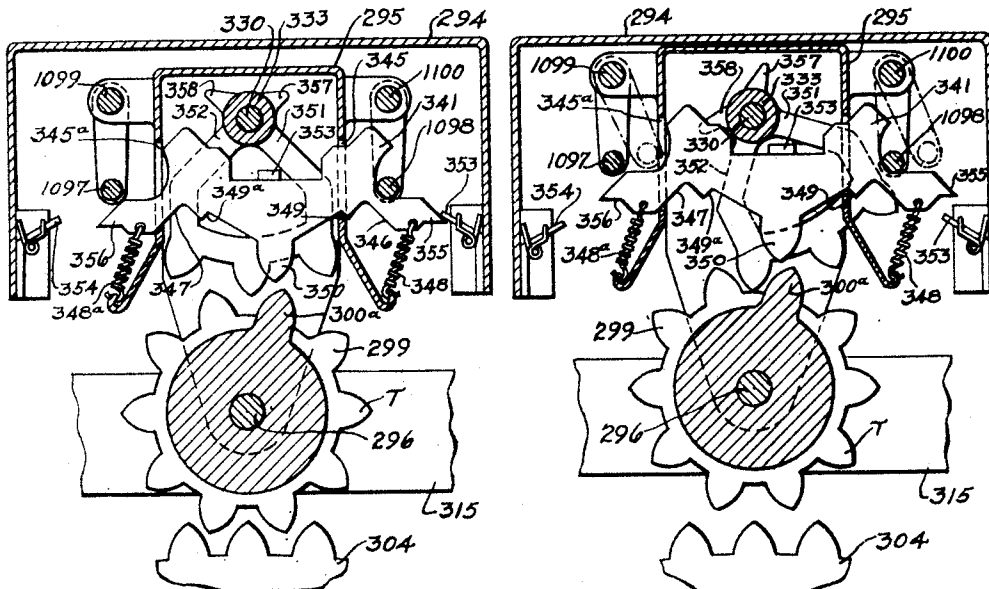


Fig. 18.

Fig. 19.

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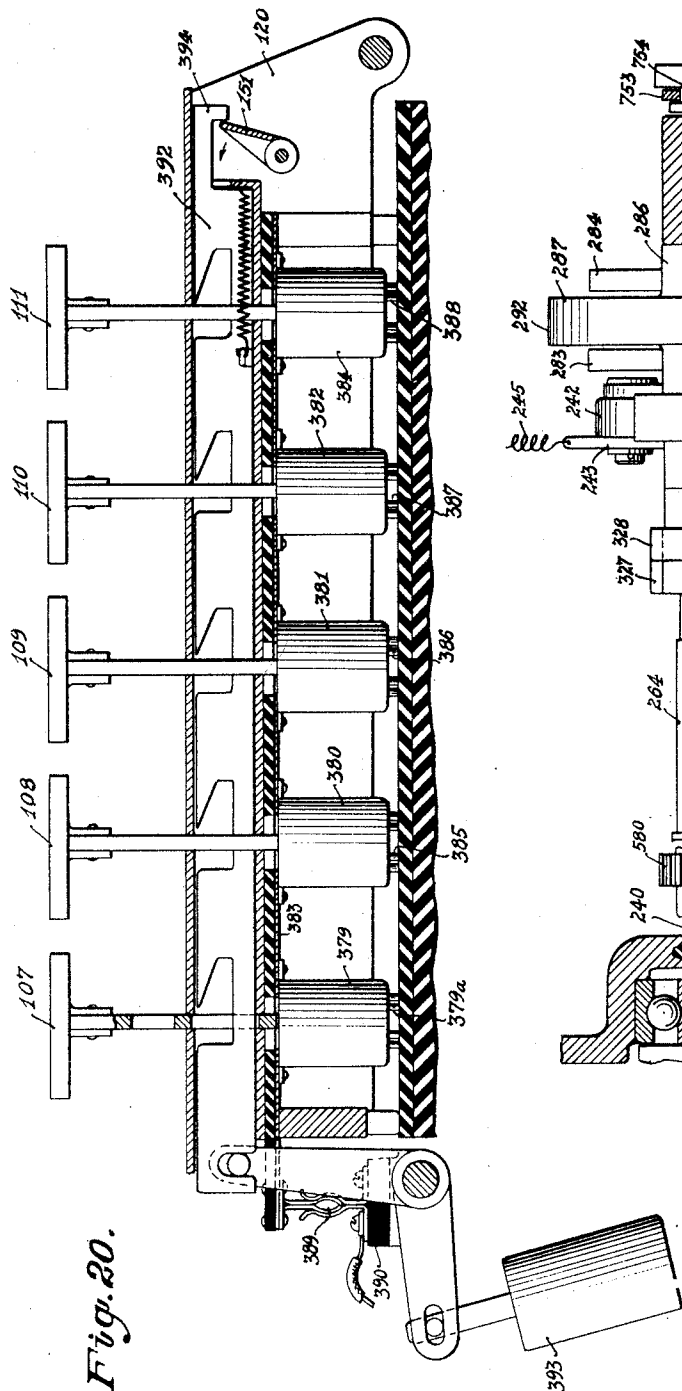
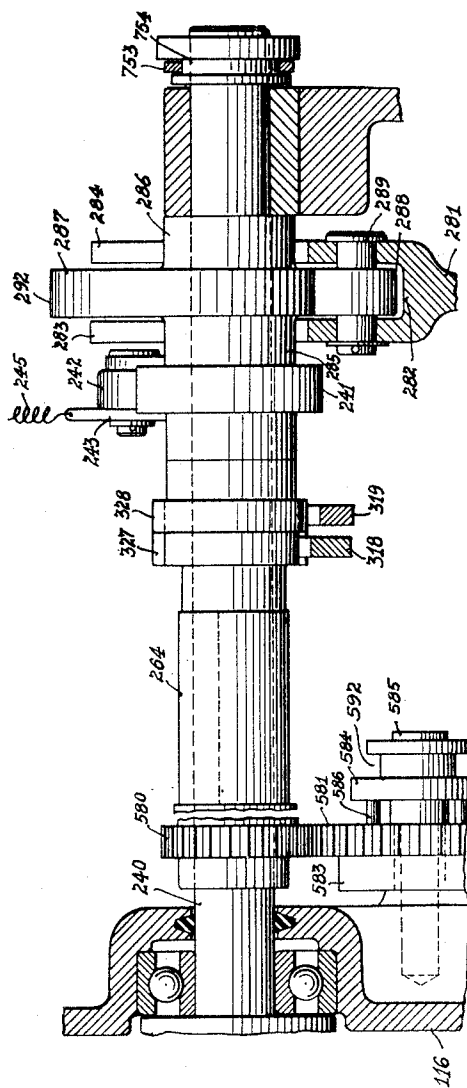
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Fig. 23.

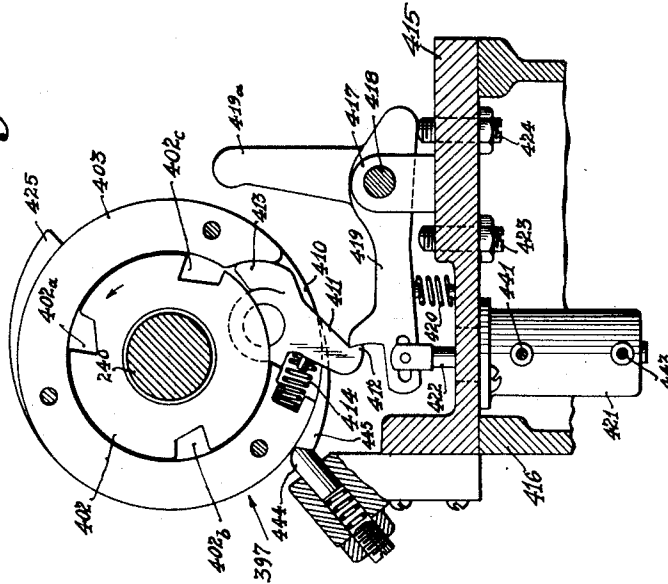
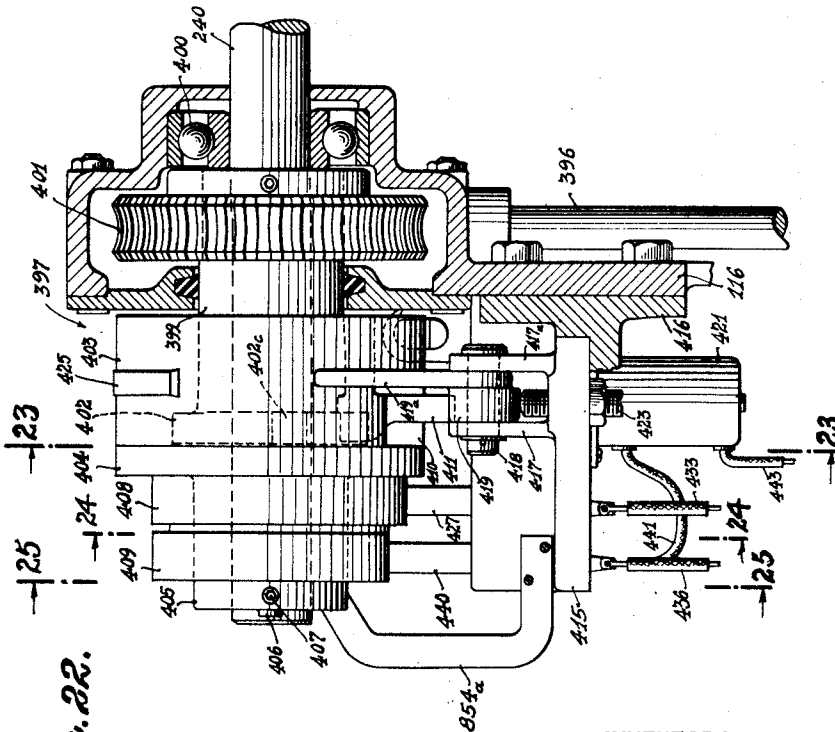


Fig. 22.

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Fig. 24.

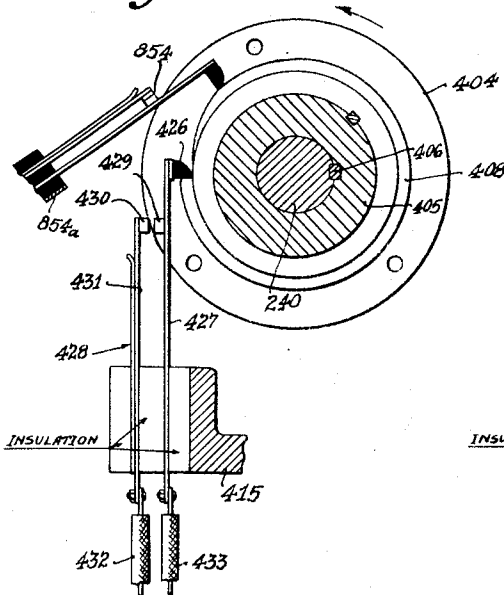


Fig. 25.

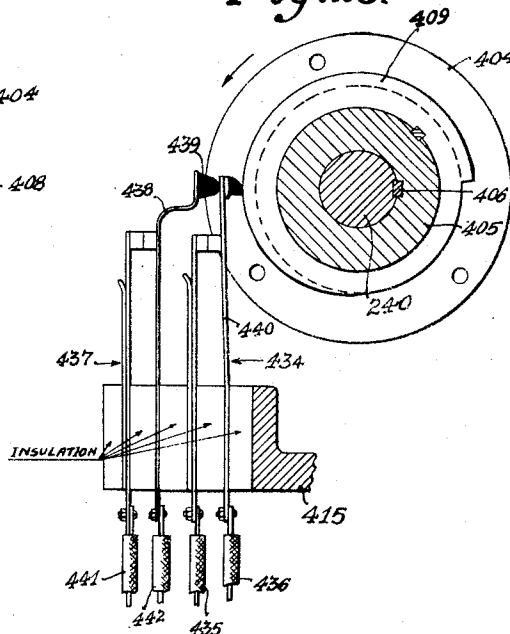
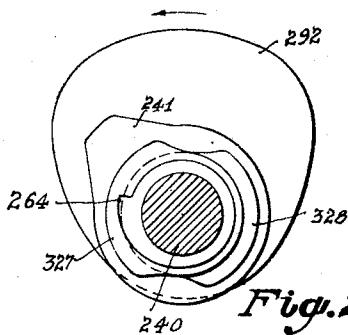


Fig. 26.

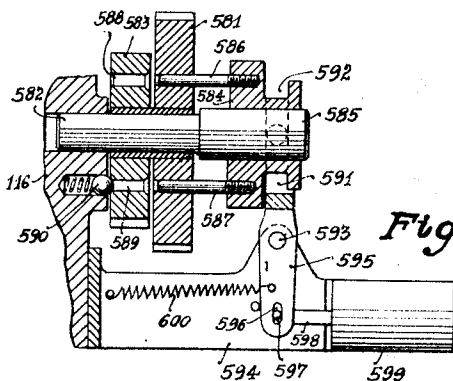
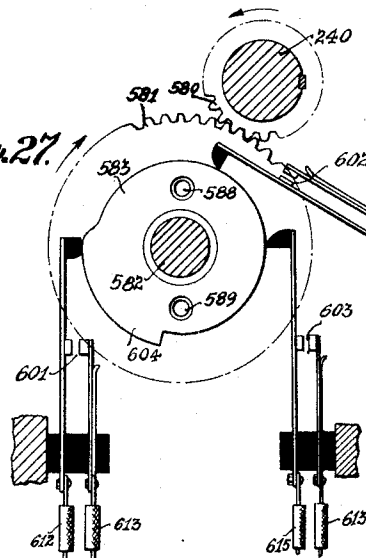


Fig. 27a.

Fig. 27.



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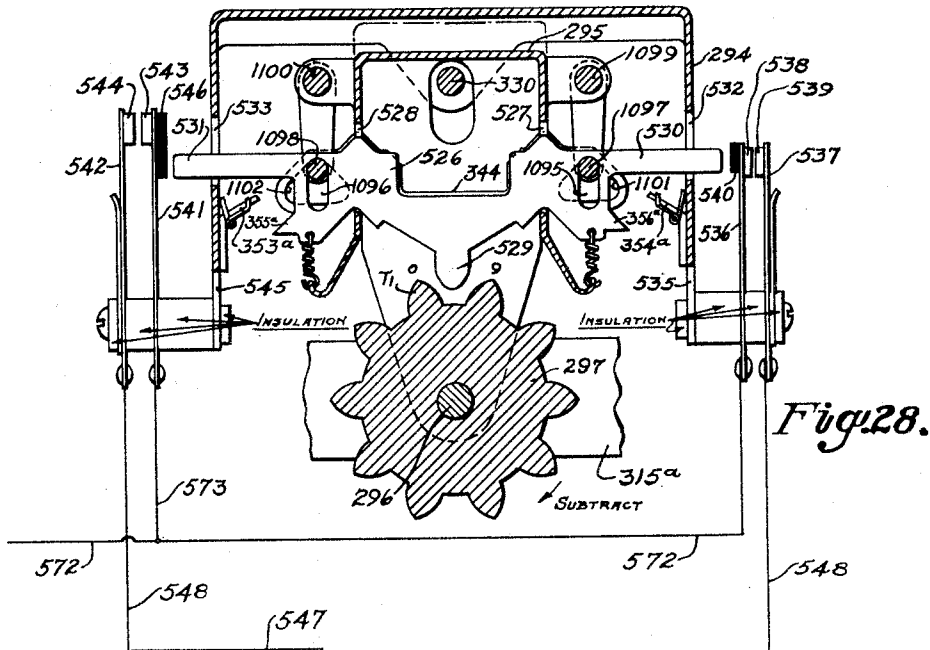


Fig. 28.

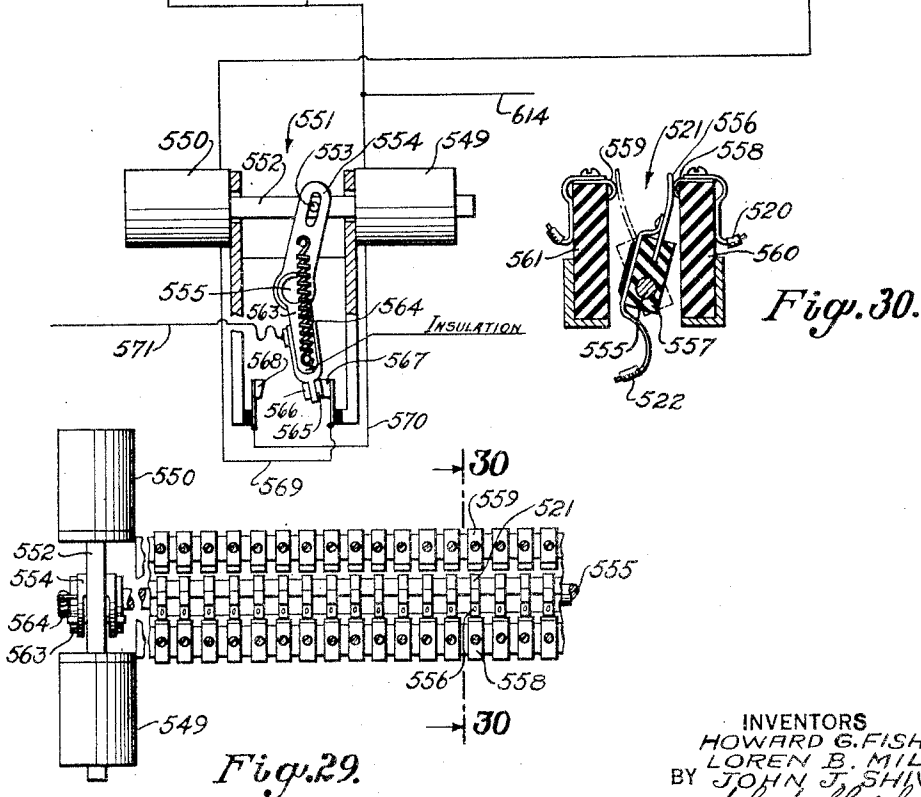


Fig. 29.

Fig. 30.

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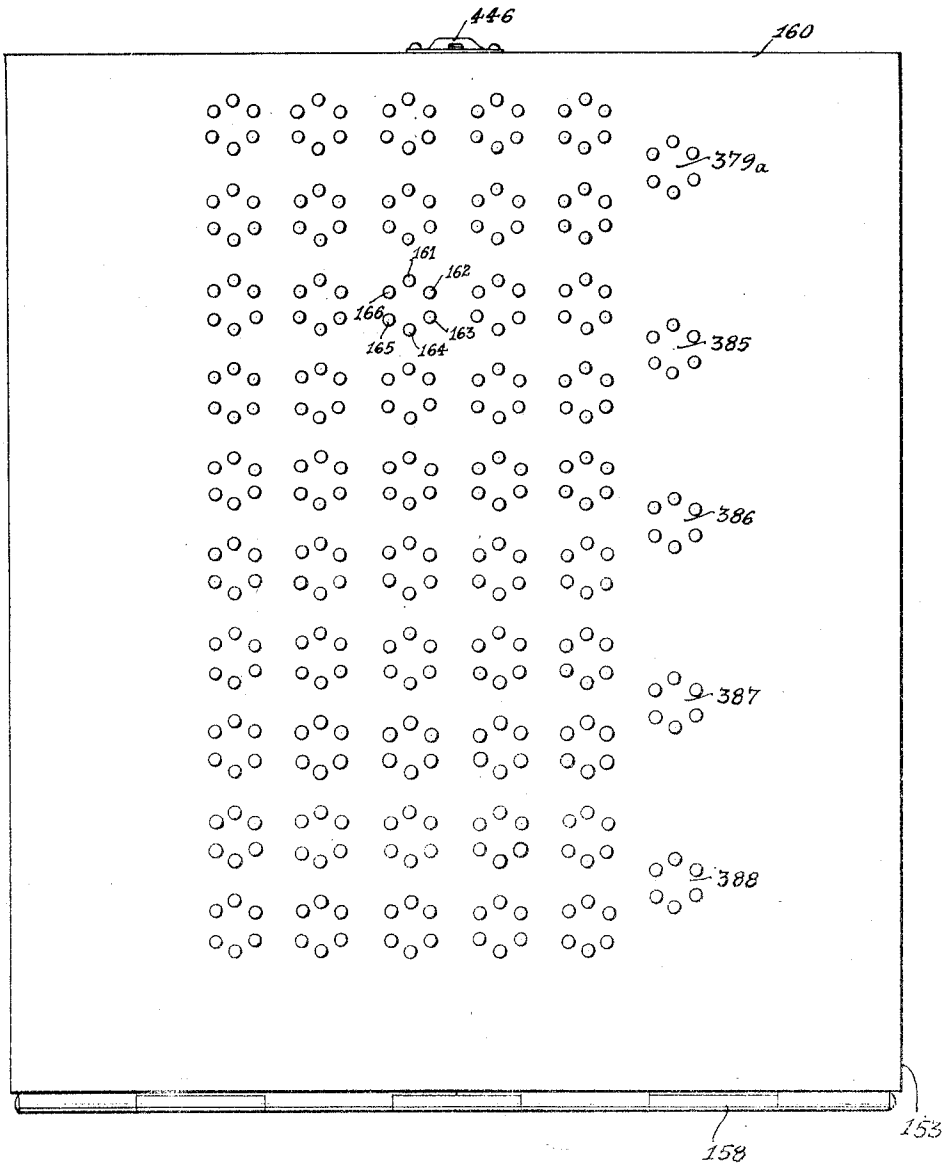


Fig. 31.

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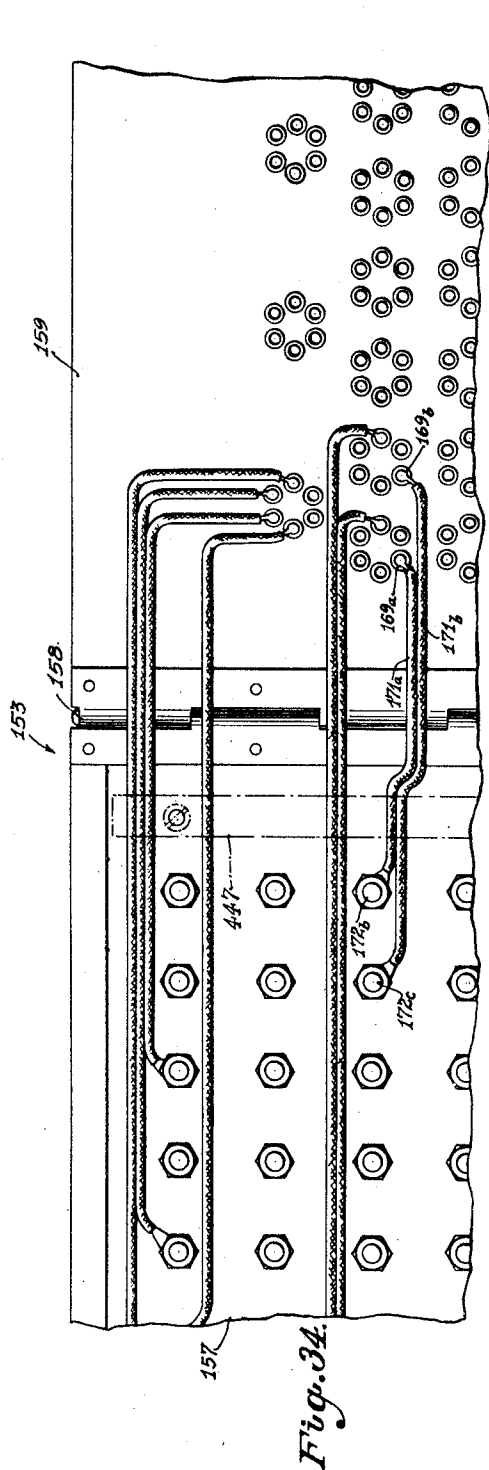
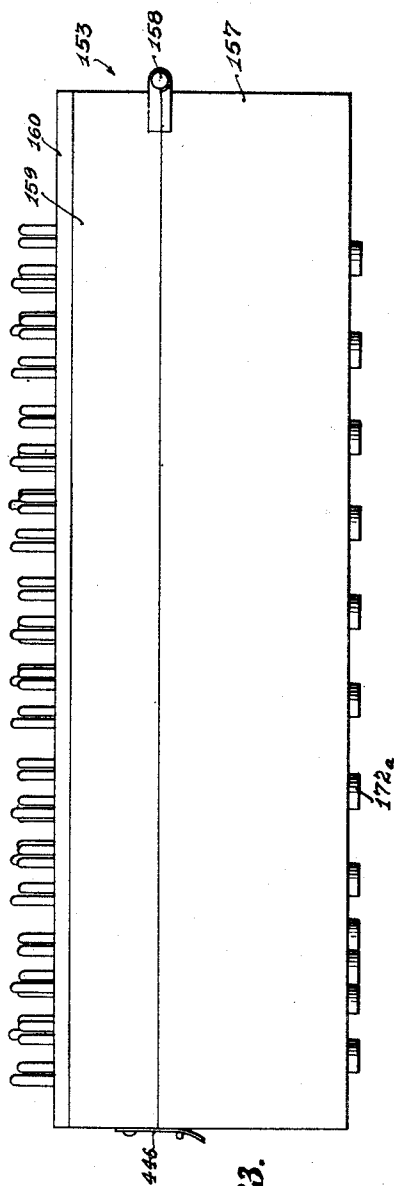
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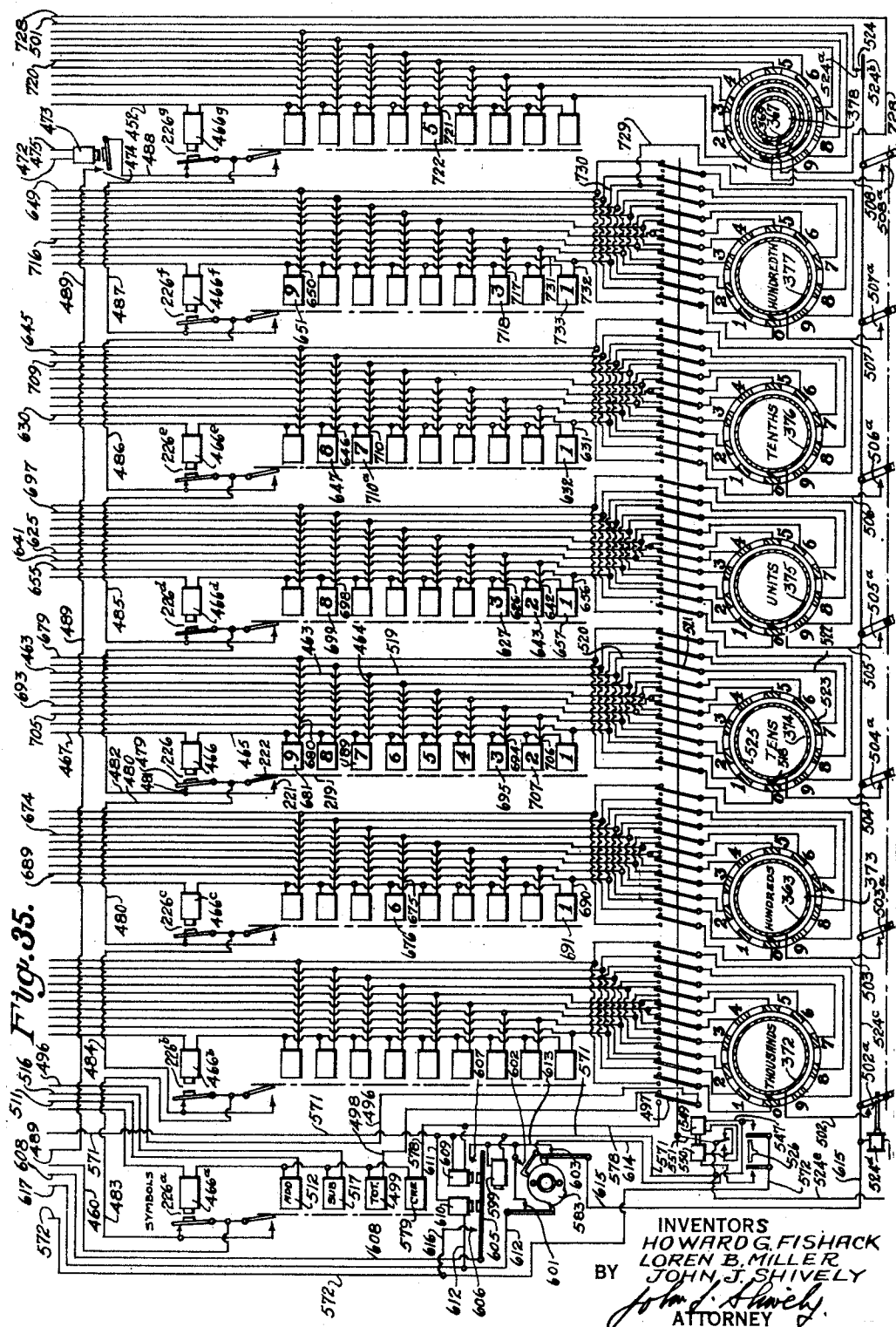
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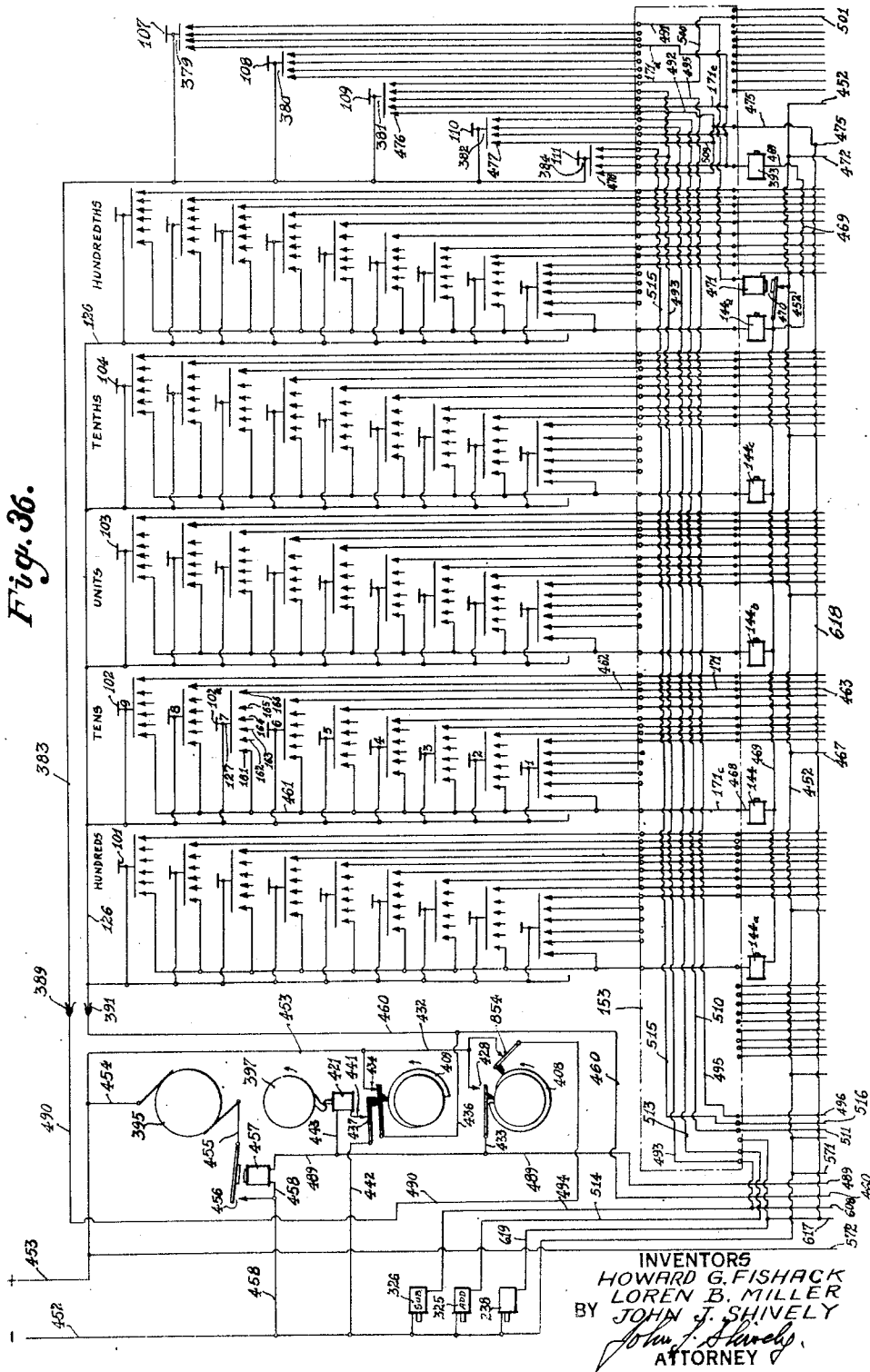
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Fig. 36.



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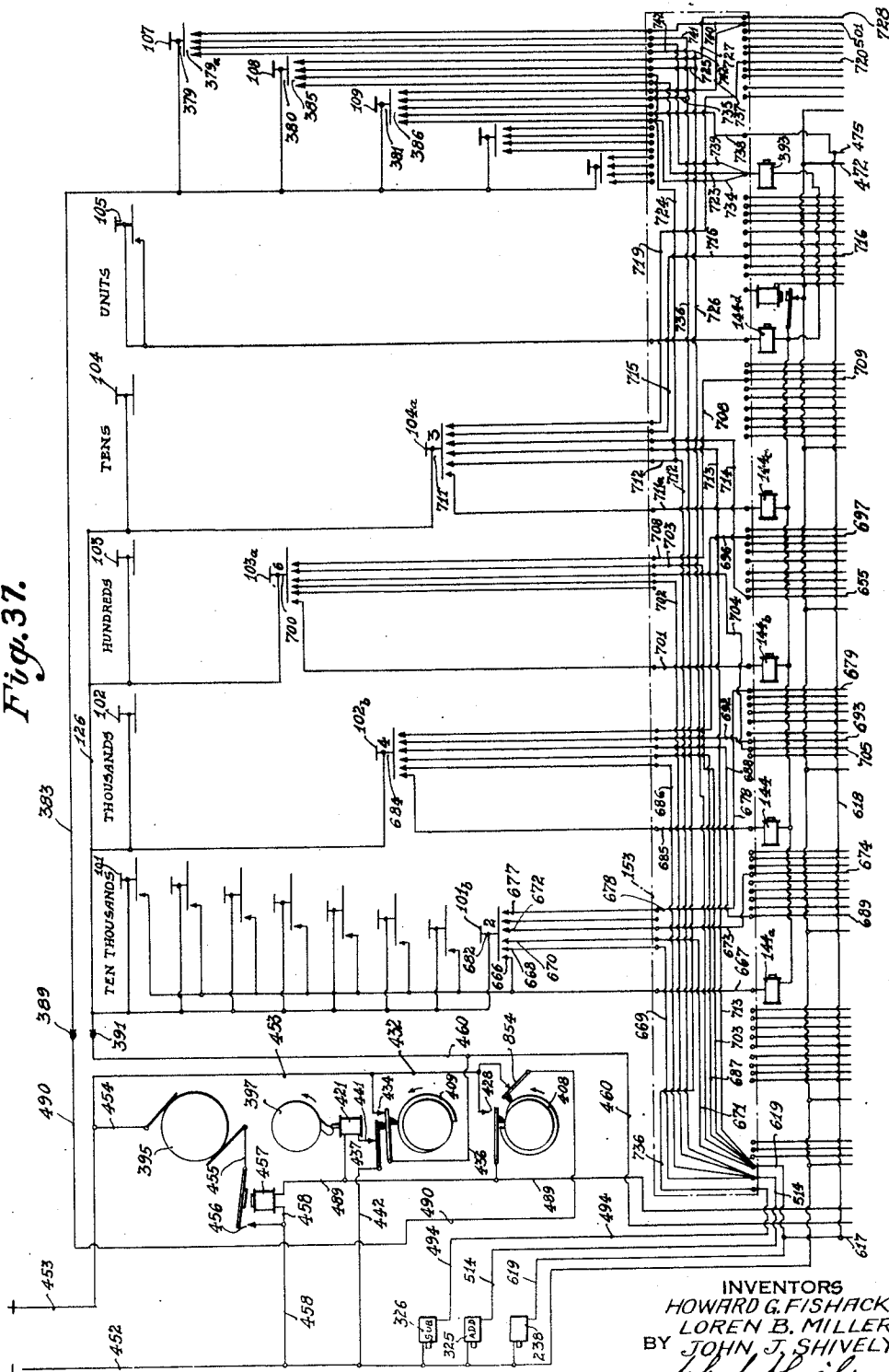
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Fig. 37.



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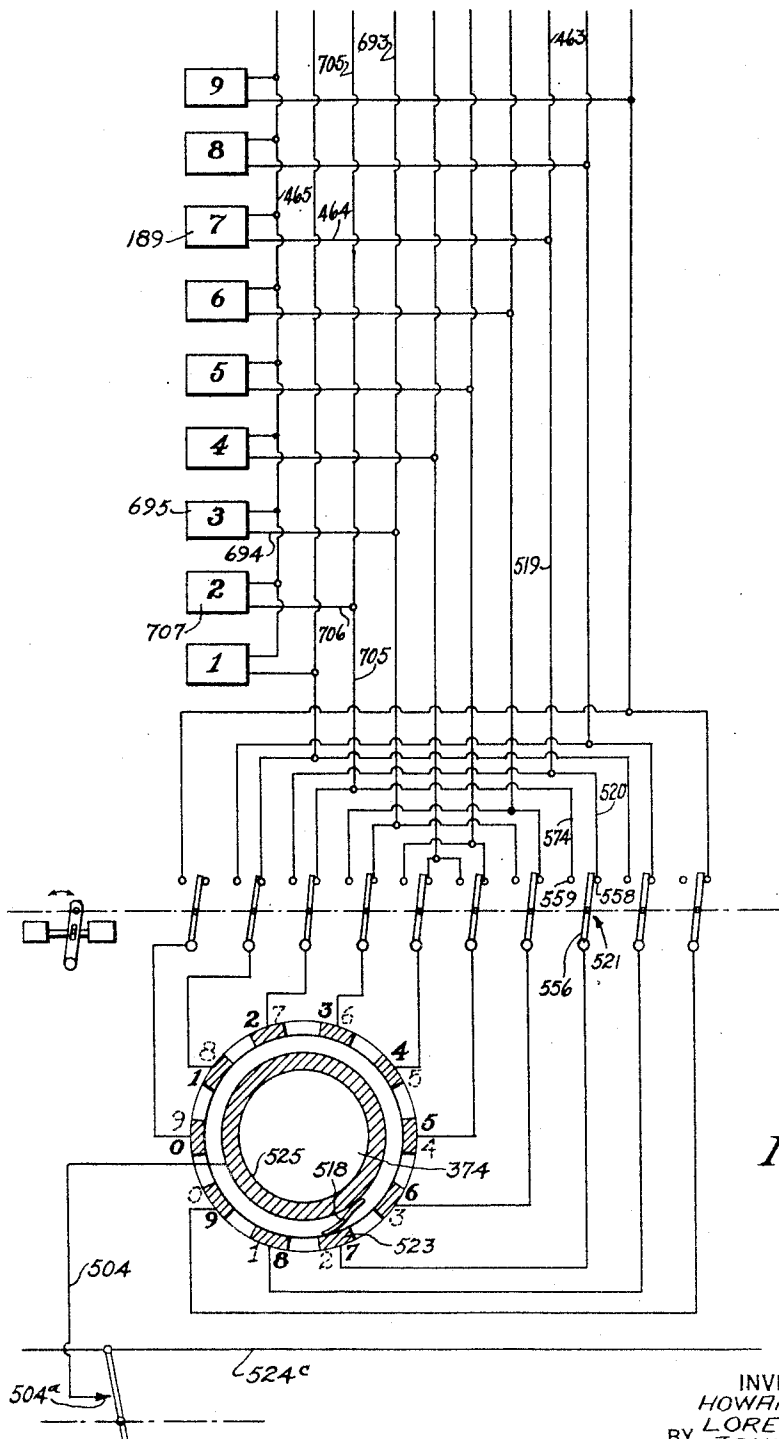


Fig. 38.

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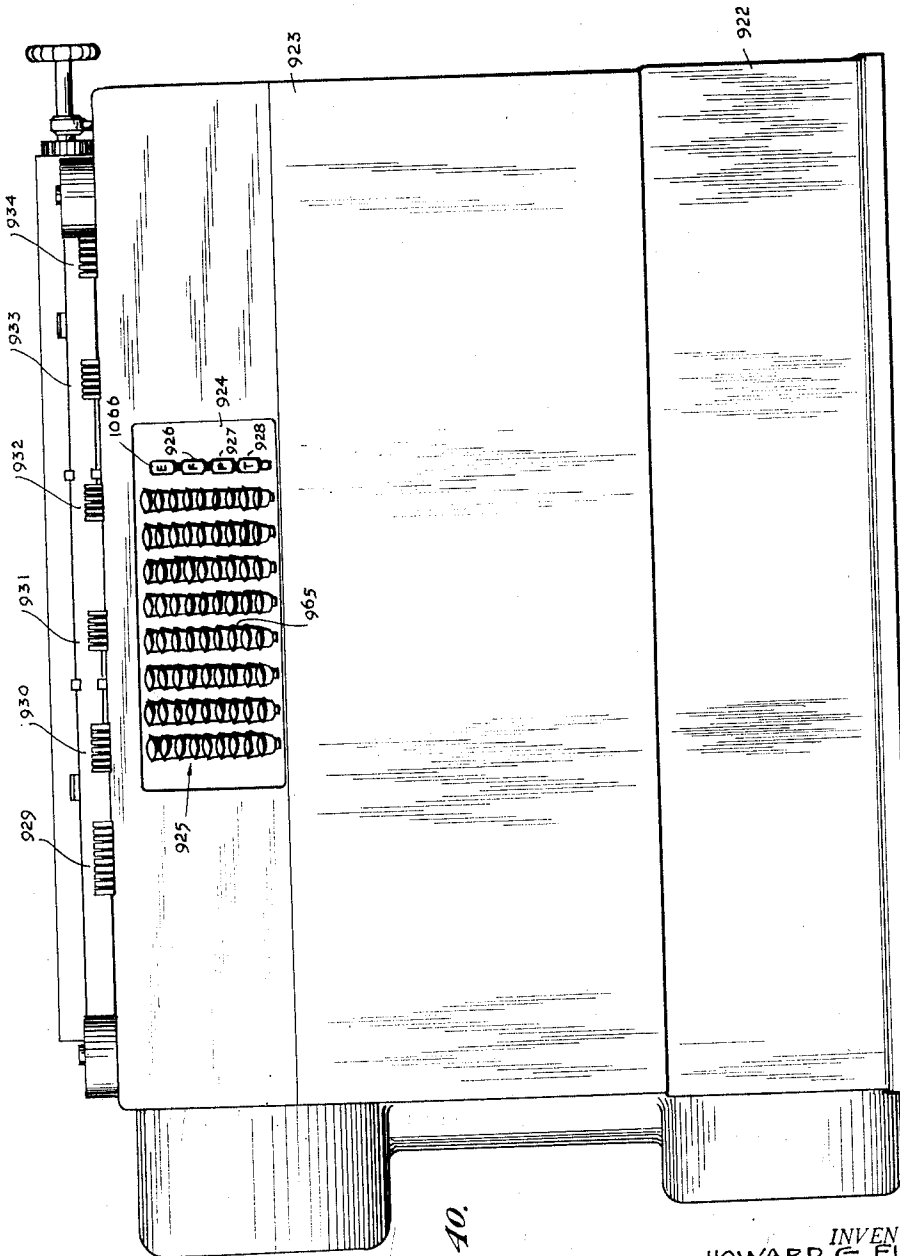


Fig. 40.

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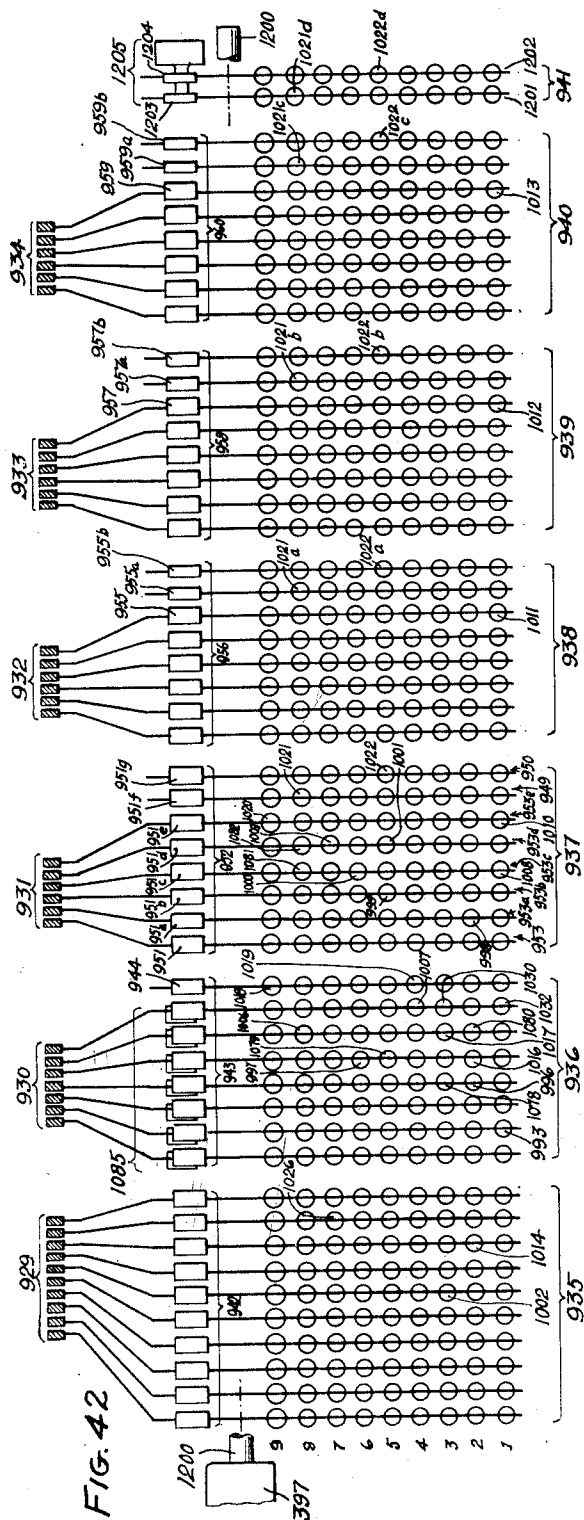
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VALUATION	FULL TAX	FIRST QUARTER	SECOND QUARTER	THIRD QUARTER	FOURTH QUARTER
30,270	1035.23	258.80	258.81	258.81	258.81
919	920				

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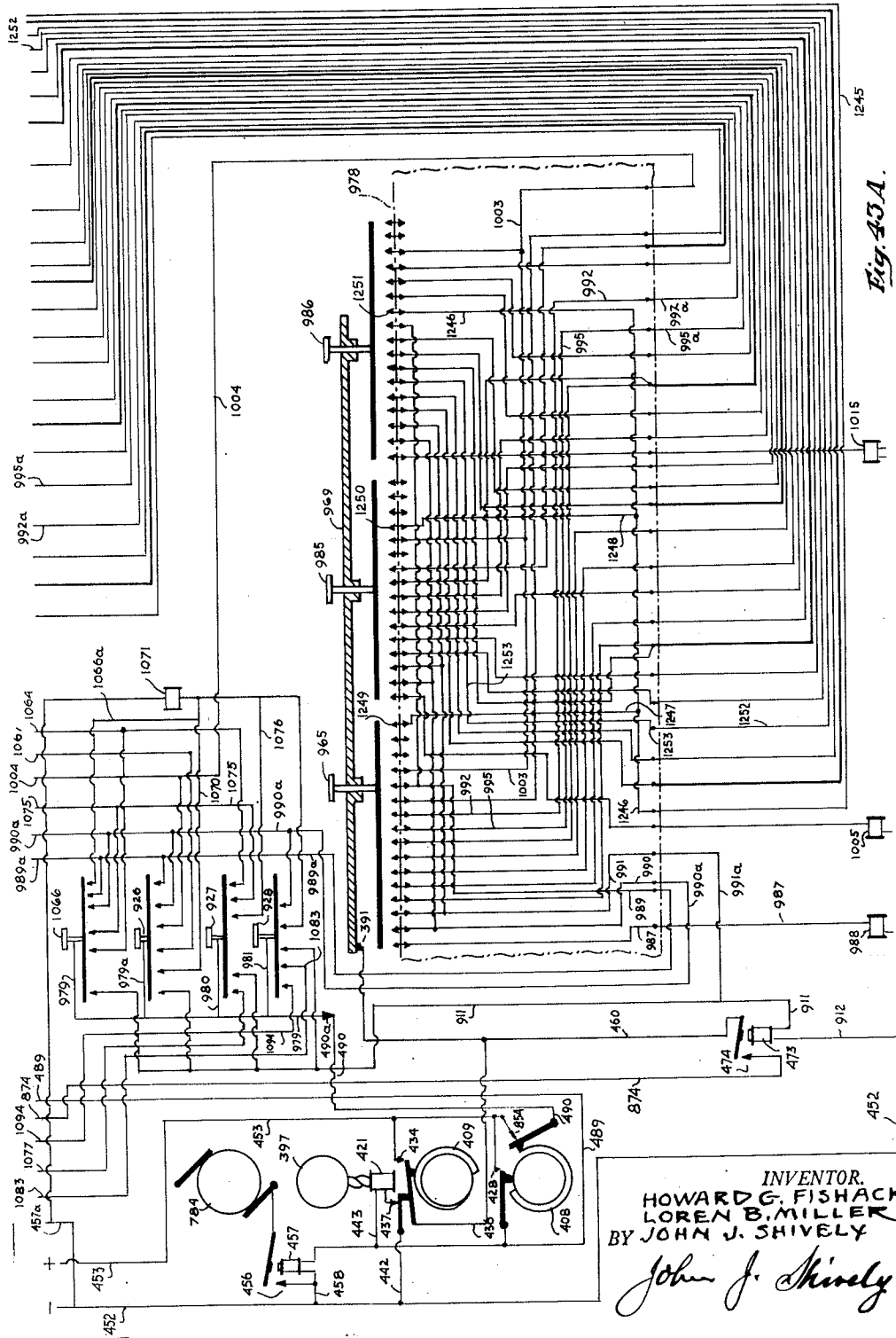
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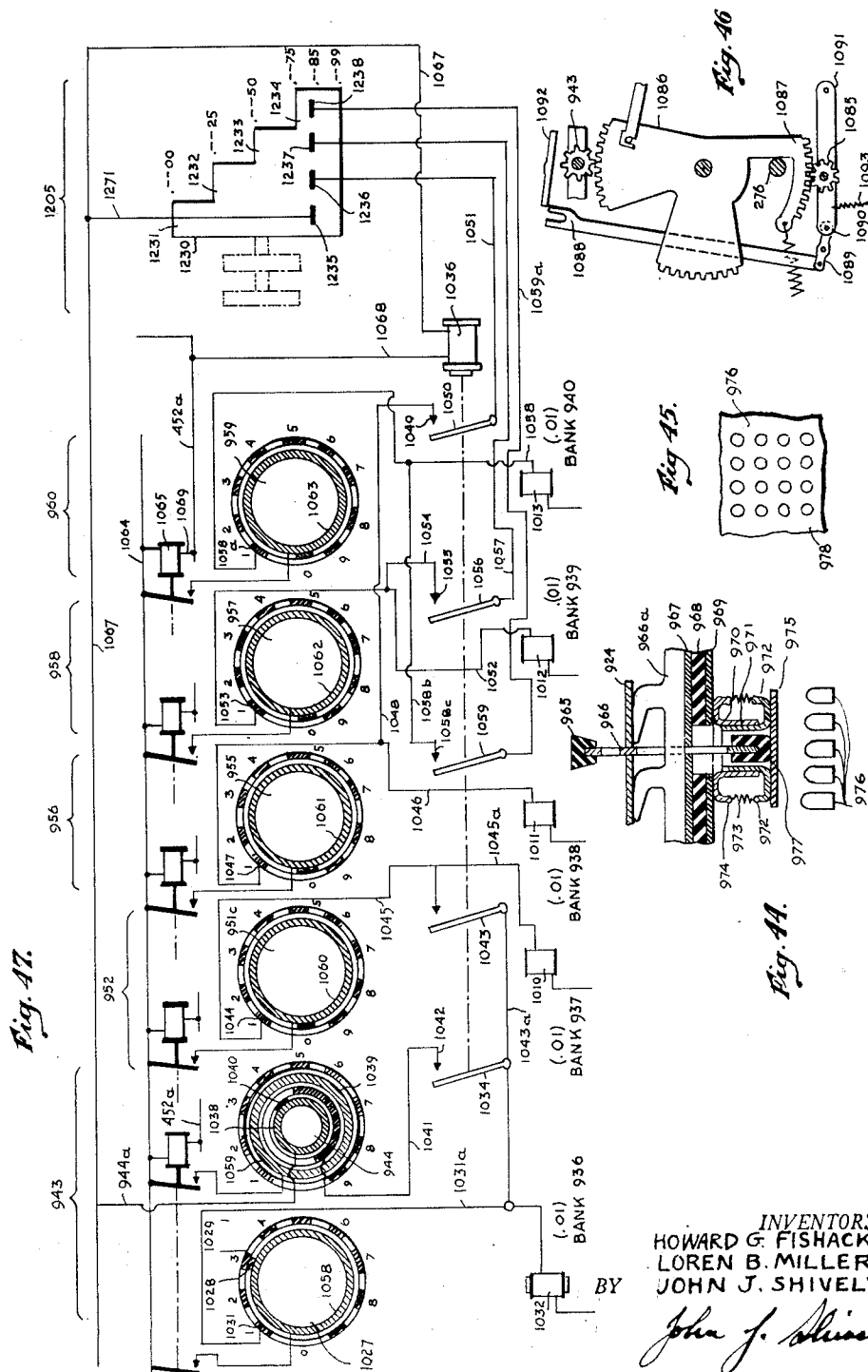
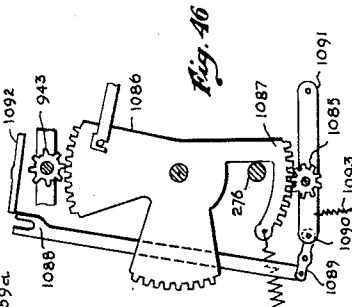
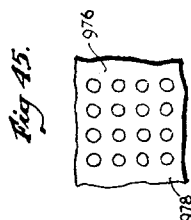
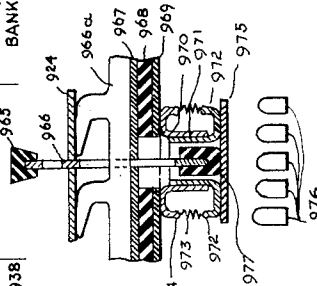
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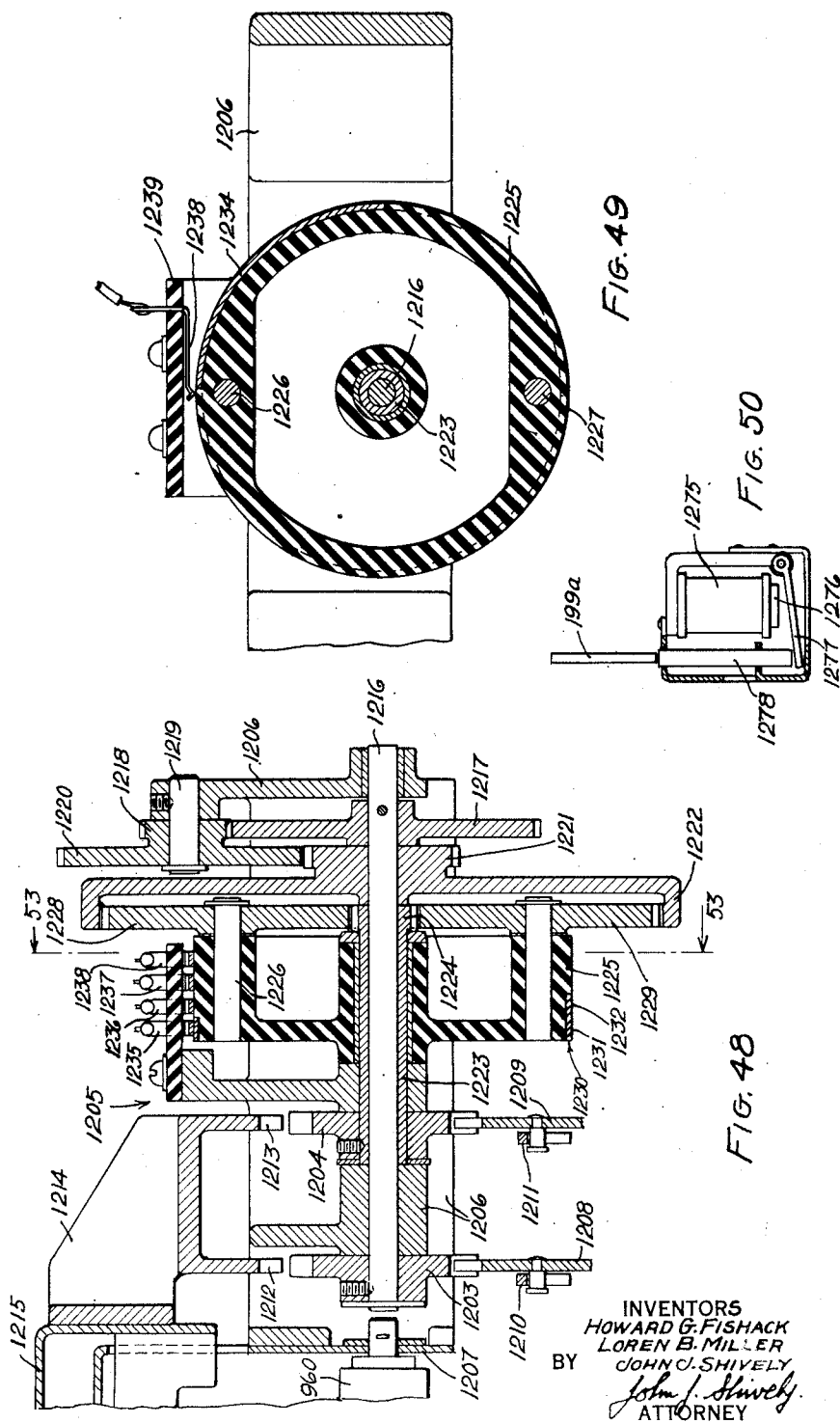
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UNITED STATES PATENT OFFICE

2,394,602

COMPUTING AND BILLING DEVICE

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Application January 21, 1942, Serial No. 427,576

16 Claims. (Cl. 235—60)

This invention relates to improvements in computing and billing devices.

In U. S. Patent No. 2,293,127, issued August 18, 1942, of which the present application is a continuation in part, is described and claimed a device of the above nature having a detachable structural unit interchangeable with any one of a number of other structural units whereby the machine may be made to perform different orders and types of business functions such as adding, subtracting, tax billing, billing insurance premiums, calculating interest, public utility billing and the like.

An object of the present invention is to provide a device of the above general nature having features by which it is particularly adapted to certain classes of the noted functions, especially tax billing, interest calculations, insurance premium billing, exchange calculation, and the like.

Another object is to provide a device of the above type having electrical means to set up and to print quantities entered on keys, together with amounts or results computed from the entered quantities.

A further object is to provide a machine of the above type including means to automatically add or drop fractional decimal amounts in the computed result as, for example, in correcting a bill by adding or dropping a fractional cent in the amount to be printed.

Another object is to provide a device of the above character adapted to automatically compute a full amount to be billed and a plurality of fractional divisions thereof, to correct the full amount by addition or dropping of the fractional cent, to similarly correct the fractional amounts so that their sum may exactly equal the corrected full amount under all conditions, and to print the corrected full and fractional amounts.

Other objects and advantages of the invention will appear in the course of the following description in connection with the accompanying drawings.

Inasmuch as the structures of the various embodiments set forth herein largely follow and are based on those of the universal or general purpose machine first disclosed in the above mentioned patent, a clear exposition of these embodiments may best be made by a description of the structure of the general purpose machine and the manner in which it performs certain of the functions germane to this application, followed by further description of the modifications and additions which produce the special purpose

machine comprising one of the objects of the invention.

Figure 1 is a plan view of a typical keyboard arranged for straight addition, subtraction, or certain computations such as billing;

5 Figure 2 is a cross sectional view of a machine embodying the keyboard shown in Figure 1;

Figure 3 is an exterior perspective view of the same;

10 Figure 4 is an enlarged sectional view of the keyboard, key switches, locking device and permutation panel in the section shown in Figure 2;

Figure 5 is a similarly enlarged view of the electrical set-up and selecting structures;

15 Figure 6 is a detail view of a selector detent and related parts;

Figure 7 is a similar view showing a digit nine detent;

20 Figure 8 is an enlarged sectional view showing the cam-shaft, type controls and adjacent parts;

Figure 8a is an enlarged fragmental view of the platen control means;

Figure 9 is a rear view of the enabling means for printing ciphers;

25 Figure 10 is a bottom detail view of the lifter tabs, Figure 9;

Figure 11 is a detail view of the mechanism for actuating the bail;

30 Figure 12 is an enlarged longitudinal view of the counting and commutating device partly in section;

Figure 13 is a cross-sectional view of the same on the lines 13—13, Figure 12;

35 Figure 14 is a similar view on the lines 14—14, Figure 12;

Figure 15 is a similar view on the lines 15—15, Figure 12;

40 Figure 16 is a similar view on the lines 16—16, Figure 12;

Figure 17 is a sectional view on the lines 17—17, Figure 12, showing the carry-over means about to effect a carry-over;

45 Figure 18 is a similar view showing the carry-over half completed;

Figure 19 is a similar view showing the carry-over operation completed;

50 Figure 20 is a detail view of the error, fraction, total, add and subtract keys, switches and locking mechanism;

Figure 21 is a longitudinal view of the cam shaft;

55 Figure 22 is a side view of the clutch and breaker mechanism;

Figure 23 is a cross-section of the same on the lines 23—23, Figure 22;

Figure 24 is a section on the lines 24—24, Figure 22.

Figure 25 is a similar section on the lines 25—25, Figure 22;

Figure 26 is a view illustrating the angular relation of the bail, type-release, print, add and subtract cams;

Figure 27 is a detail view of the holding switch mechanism for clearing the counters after printing a negative total such as a credit balance;

Figure 27a is a longitudinal detail section of the actuating means for the breaker, Figure 27;

Figure 28 is a detail view showing the actuating means and relay connections for operating the negative total throw-over switch;

Figure 29 is a fragmental top view illustrating the throw-over switches;

Figure 30 is a cross-sectional view on the lines 30—30, Figure 29;

Figure 31 is a top view of a typical permutation panel;

Figure 32 is a bottom view of the same;

Figure 33 is a side elevation of the same;

Figure 34 is a fragmental view of the same opened to illustrate the internal electrical connections;

Figures 35 and 36, taken together, form a circuit diagram of the device using a panel wired for straight addition, subtraction and total taking;

Figure 37 is a similar partial diagram which, when taken with Figure 35, illustrates the circuits when using a panel wired for computation of amounts according to predetermined tables or formulas by single key operation;

Figure 38 is an enlarged view of a portion of the wiring diagram, Figure 36;

Figure 39 is a timing diagram illustrating a complete item entering operation of the embodiment set forth diagrammatically in Figures 35 and 36;

Figure 40 is a front elevation of a form of the invention especially adapted to tax billing and the like;

Figure 41 illustrates a typical tax bill;

Figure 42 is a mechanical diagram showing the arrangement of selector magnets, accumulators and type bars of the machine, Figure 40;

Figures 43 and 43a, taken together, show a typical electrical diagram of the billing machine, Figures 40 and 42;

Figure 44 shows an alternative form of key switch;

Figure 45 is a plan view of the contact pins, Figure 44;

Figure 46 shows a modified arrangement of accumulator mounting applicable to the special billing machine, Figures 40 and 42, illustrating the parts in engaged or operating position;

Figure 47 is an enlarged partial electrical diagram illustrating the operation of the fractional correction means;

Figure 48 is a longitudinal sectional view of the fractional correction control mechanism;

Figure 49 is a cross sectional view of the same on the lines 49—49, Figure 48; and

Figure 50 shows an alternative type of set-up or selector magnet.

Referring to Figure 1, a keyboard 100 is provided with five rows, 101, 102, 103, 104 and 105 of keys 106, each row comprising ten keys. It will be understood that the machine may be constructed to embody any desired number of rows

of keys according to the capacity for which it is designed, the present embodiment being limited to five rows as fully illustrating the construction and operation without unnecessarily complicating the drawings and description.

When the machine is to be used for single digit entries, as in Figure 1, the lower key in each row is a blank, the remaining keys being numbered consecutively from "1" to "9."

At the right side of the keyboard there is provided an error bar 107, a fraction bar 108, a total bar 109, an add bar 110 and a subtract bar 111.

Referring to the general cross-sectional view of the machine shown in Figure 2, a frame or base 116 is provided having upward side extensions 117 at the front end thereof. The keyboard 100 has a top plate 118 and a lower or guide plate 119 secured to side plates 120 which are hinged to extensions 117 by means of a rod 121.

Referring to the enlarged detail drawing, Figure 4, it will be seen that the yokes 114 of keys 106 are secured to flat shanks 122 which are slidably guided in slots 123 and 124 in the plates 118 and 119.

A plate 125 of insulating material is secured to the bottom of the guide plate 119 and a thin conducting plate 126 is in turn secured to the bottom of insulating plate 125. A plurality of switch cylinders 127 are secured to the plate 126 in line with key shanks 122. Hollow conducting pistons 128 are slidably contained in cylinders 127 and are normally urged upward against plate 126 by springs 129. Insulating tips 130 on the lower ends of key shanks 122 bear against the inside of heads 131 of pistons 128. The plates 125 and 126 have openings 132 clearing the shanks 122, so that the latter are insulated from the pistons, cylinders and plate 126.

Each shank 122 has a lower vertical slot 133 and an upper slot 134 separated by a bridge 135. Each row of keys has a common locking bar 136 slidable through the lower slots 133 and normally held to the right by one or more tension springs 137. Upwardly extending longitudinal wedges 138 on the bar 136 are slidable through lower slots 133 of undepressed keys, but are adapted to enter upper slots 134 and engage bridges 135 of depressed keys, as will hereinafter be explained. A vertical slot 139 in the end of bar 136 normally engages a pin 140 in one arm of a bell crank 141 pivoted to base extensions 117 by means of a rod 142, the other arm of said bell crank 141 being connected to the plunger 143 of a stationary solenoid 144.

When a key is depressed, as shown in Figure 4, and the solenoid 144 energized in a manner hereinafter explained in connection with the wiring diagram, the bar 136 is drawn to the left, the lower inclined edge of the wedge 138 engaging the bridge 135. If the key is fully depressed, the wedge holds it depressed as long as the solenoid 144 is energized. If the key is only partially depressed, as a circuit is established through the solenoid, the movement of the wedge forces the key downward to its fully depressed position where it is held as previously noted. When the bar 136 moves, as described, to lock one key in lower position by action of one wedge, the other wedges enter the lower slots 133 of the other key shanks, thus underlying the bridges 135 and preventing the other keys from being depressed.

By the above means it will be noted that depressing one key in a row locks the remaining keys from being depressed.

A row of stop levers 145, one opposite the right or front end of each locking bar 136, is pivotally attached to side plates 120 by means of a rod 146. Each lever 145 is urged clock-wise by a tension spring 147 and has a toe 148 adapted to extend upward through a slot 149 in the guide plate 119 between the right end of bar 136, and a transverse stop plate 150. A flat transverse member 151, also hinged at its ends on the rod 146, is adapted to engage upward extensions 152 of levers 145 to rock the latter counter-clockwise and withdraw the toes 148 through the slots 149 for a purpose hereinafter explained.

Referring again to Figure 4, a permutation panel 153, shown in further detail in Figures 31, 32, 33 and 34, is supported in brackets 154 and 155 formed on or otherwise secured to the base 116. The permutation panel 153 consists of an upper portion 156 and a lower portion 157 preferably hinged together at 158. The upper portion 156 comprises an insulating block 159 covered by an insulating plate 160 which underlies the bottom of the switch pistons 128.

Directly under each piston 128 is a group of pins such as 161, 162, 163, 164, 165, 166, shown in Figures 4 and 31, slidably retained in holes 167 in the block 159 and urged upward by springs 168 backed by sleeves or jacks 169 secured in the bottom of holes 167.

The jacks 169 are individually connected by means of pins 170 and leads 171 with threaded posts 172 disposed in an insulating plate 173 forming the bottom of the lower portion 157 of the permutation panel 153. The connections between the various jacks 169 and posts 172 determine the type of computation which the machine is set up to perform, and the arrangement and manner of making these connections will be hereinafter explained in greater detail.

Referring to Figures 2, 4 and 5, the heads 172a of posts 172 bear against pins 174 slidably in sleeves 175 and urged upwards by springs 176. The sleeves 175 are secured in an insulating plate 177 fastened to the bottom of brackets 154 and 155.

A chassis 178, comprising an upper plate 179, a second plate 180, a solenoid plate 181 and a stop plate 182, is upwardly secured to the base 116 below the insulating plate 177. Selector solenoids are secured to plate 181 in spaced relation, there being nine solenoids per row, corresponding to digits "1" to "9" reading from the right in Figures 2 and 5 and indicated respectively by numbers 183 to 191 inclusive.

Above each solenoid is a selector detent, the nine detents in each row being indicated by numerals 192 to 200 inclusive, in respective correspondence to the solenoids 183 to 191 noted above. The detents are slidably in slots in the plates 179 and 180, and are adapted to be pushed upward by plungers 201, 201a, 201b, 201c, 201d, 201e, 201f, 201g, and 201h, in their respective solenoids.

Taking detent 197 as typical of all detents corresponding to digits "1" to "8," it will be seen in Figure 6 that the detent has therein two aligned vertical slots 202 and 203 separated by a bridge 204. A selector bar 205, slidably between the plates 179 and 180, has an upper rail 206 extending through the slots 202 in detents 192 to 199 and a lower rail 207 running through slots 203.

The number "9" detent 200, as shown in Figure 7, has a single slot 208 through which the bar 205 extends. The rear or left end of bar 205, as

shown in Figure 2, has a vertical slot 209 embracing a pin 210 in a segmental plate 211 rotatably mounted on a stationary rod 212 secured to the base 116. A downward extension 213 of the plate 211 is urged to the left by a tension spring 214 secured by means of an angle 215 to the base 116. The spring 214 thus tends to revolve the plate 211 clockwise and thereby forces the selector bar 205 to the right.

The upper rail 206 of the bar 205, Figure 5, has extending downward therefrom a series of hooks 216, 216a, 216b, 216c, 216d, 216e, 216f, and 216g normally slidable through the upper slots 202 of the selector detents, but adapted to engage and embrace the bridges 204 when the detents are raised. The spacing of the hooks is such that when any detent is raised by its solenoid and the bar 205 moved to the right, a hook engages the bridges 204 of the detent to stop the bar after permitting the latter to travel a distance substantially proportional to the value of the digit corresponding to the raised detent. In other words, if detent 192, corresponding to the digit "1," is raised, the hook 216 will engage detent 192 after allowing the bar to travel a certain distance, while if digit "4," detent 195, is raised the hook 216c encounters the detent 195, as shown in Figure 5, to stop the bar 205 after it has moved to the right a distance substantially four times that permitted by the digit "1" detent.

The bar 205 is provided with an upper notch 217 in which the upper edge of slot 208 of detent 200 normally rests. Thus, when detent 200 is in its lower position, that is, engaging the notch 217, the bar 205 is restrained from moving to the right. If detent 200 is raised by solenoid 191 alone, the bar 205 is allowed to move to the right until stopped by the end 218 of chassis 178, the distance travelled being sufficient to set up the digit "9" in the machine.

It is evident from the foregoing that when any detent corresponding to a digit less than "9" is raised, it is also necessary that detent 200 be raised in order to release the notch 217 and allow the bar 205 to be moved. For this purpose, a rocker 219 is provided, hinged at both ends to chassis 178 and overlying all detents except detent 200, as shown in Figure 8. The rocker 219 engages a notch 220 in detent 200, as shown in Figure 7.

When any detent below the digit "9" is raised it rocks rocker 219 upward and the latter raises detent 200, to disengage it from the notch 217. If detent 200 is raised by solenoid 191, in order to set up the digit "9," rocker 219 is also raised but does not affect the other detents. In other words, when detent 200 is actuated by solenoid 191 it acts alone to allow the digit "9" to be set up, while if any other detent is raised by its solenoid the detent 200 is also actuated as a bar release.

Two cooperative contact members 221 and 222 are secured in insulating blocks 223 and 224 attached to the chassis 178 in such position as to overlie the top of digit "9" detent 200. The contacts normally stand apart, but when the detent 200 rises it engages an insulating pad 225 on the lower contact member 222 to raise the latter into contact with member 221 as shown in Figures 5 and 7. Mounted at the front end of each row of solenoids is a normally closed relay 226 adapted to break quickly when its coil is energized.

The segmental plate 211 has a rearwardly extending segment 227, Figure 2, normally meshing

with a vertical rack 228. The rack 228 is slidable vertically in a guide 229 rockably mounted on a stationary horizontal rod 230. A tension spring 231 urges the guide 229 clockwise, thus tending to draw the rack 228 out of mesh with segment 227. The guide 229 has an upwardly extending arm 232 terminating in a fork 233, shown in enlarged detail in Figure 8, which engages a stop 234 on a release rocker 235, pivoted to the supporting frame of the machine at 236. The rocker 235 is urged into engaged position with fork 233 by a spring 237, while a solenoid 238 has a plunger 239 coupled to the right end of rocker 235 and adapted to rock the stop 234 upward out of engagement with the bottom of fork 233 when the solenoid is energized.

A cam-shaft 240, shown in detail in Figures 21 and 26, carries a cam 241 adapted to engage a roller 242 on the end of a lever 243 pivotally mounted at 244. A spring 245 urges roller 242 against the cam.

When the device is in rest, or starting position, the cam 241 holds the lever 243 to the left as shown in dot and dash lines, Figure 8, causing a pin 246 in lever 243 to engage arm 232 and hold fork 233 slightly free of stop 234 to the left. If solenoid 238 be energized to raise the stop 234 clear of the bottom of fork 233, as the shaft 240 revolves and the lever 243 rocks to the right, Figures 2 and 8, spring 231 causes the arm 232 also to follow to the right. The spring 231 is thus enabled to swing the guide 229 to the left to draw the type rack 228 out of mesh with the segment 227, as shown in dot and dash lines, Figure 2. It is evident from the above that release rocker 235 normally holds the rack in mesh, but if the solenoid 238 be energized, the rack 228 will drop out of mesh as the shaft 240 starts to revolve.

A type bar 247 is pivoted at 248 in the top of rack 228 and carries a column of type 249 adapted to print digits "0" to "9," inclusive, the "0" digit being at the top of the column. A light tension spring 250, disposed between small angular hooks 251 and 252 on rack 228 and bar 247 respectively, normally urges the bar 247 to the right against a forked hammer 253. The hammer 253 is pivoted on a stationary rod 254 and has an arm 255 extending toward the back of the machine. A relatively strong tension spring 256, disposed between arm 255 and rod 230, normally holds the hammer 253 firmly against a stationary stop bar 257 secured to the machine frame 116.

The hammer 253 has therein a slot 258, Figure 8, in which is disposed an upwardly directed hook 259 on the end of a draw link 260. The link 260 is pivoted to the upper end of a lever 261 swung on a stationary rod 262 and having a step 263 urged into engagement with a print cam 264 by means of a spring 265. It will be understood that each type bar is provided with a hammer 253, link 260, and lever 261, all the levers 261 however being pivoted on the single rod 262 and being operable by the single wide-faced cam 264. The relationship of the individual print bars, with their respective links and hammers is further illustrated in Figure 9 as hereinafter set forth.

A lift bar 266, slidable in upper and lower guide combs 267 and 268, is disposed vertically in front of the type bar 247 and with its upper end under the link 260. The bar 266 is urged upward by a spring 269 and has a lower foot 270 underlying the hook 252 on the rack 228. When the rack 228 is drawn down to its lower position, the hook 252 depresses the foot 270, thus lowering the bar 266 and allowing the link 260 to drop so that the

hook 259 may idle in the bottom of slot 258 in the hammer 253 when reciprocated by the print cam 264. A light spring 271, connecting the link 260 and the lever 261, assists gravity in dropping the hook 259 quickly to the bottom of the slot.

When the type rack 228 is raised by the segment 227 to set up the type 249 as shown in Figure 8, the hook 252 on the rack releases the foot 270. The lift bar 266 is moved upward by the spring 269, raising the link 260 so that as the link 260 is retracted to the right, the hook 259 engages the hammer 253 above the upper edge of the slot 258. The hammer 253 is thereby drawn or cocked to the right against the tension of the spring 256, the type bar 247 also being rocked to the right by its spring 250. When the cam 264 over-runs the step 263 on the lever 261, thereby releasing the latter and the link 260, the spring 256 snaps the hammer 253 and the type bar 247 sharply to the left. The hammer 253 is stopped by the bar 257 but the type bar, due to its momentum, continues its movement to the left until stopped by its type encountering an inked ribbon 272 in front of a paper strip, or bill blank 273 backed by a platen 274.

By the action described, the type digit set-up in line with the ribbon prints its figure on the paper, after which the spring 250, together with the rebound of the type, retracts the type bar to vertical position, as shown in Figures 2 and 8.

From the foregoing description it is evident that the lift bar 266 can normally lift the hook 259 to engage the hammer 253 and cause the type bar to print only when the latter has been moved upward from its lowest or "0" position.

In order to prevent the rack 228 from being drawn upward by the spring 269 and lift bar 266, Figure 11, when the rack is disengaged from the segment 227, a notch 228a is provided in the back of the rack near its lower end, as shown in Figure 2. When the rack 228 is swung clear of segment 227, as shown in dot-and-dash lines, Figure 2, the notch 228a engages an extension 215a of the angle member 215 which restrains the rack from upward movement until it has been returned into mesh with the segment 227.

Since it is normally desired to print all zero figures to the right of any greater printed figure, the following provision is made to enable the print bars to print in "0" positions.

Figure 9 is a rear detail view of the upper parts of the various print bars and related parts in which the numeral 247a denotes the extreme left type bar carrying multiple type rows adapted to print, for instance, "Add," "Sub" (denoting subtract), "Tot" (signifying total), and "Cre" (signifying negative total or credit balance). The second type bar 247b carries digits of thousands denomination, 247c the hundreds denomination, 247d carries digits in the tens denomination and 247e the units denomination. Bar 247f carries the decimal point and tenths digits, while 247g carries the hundredths digits. The hammers, hooks, lift bars, etc., relating to the various type bars are denoted by the numerals assigned these parts in the description relating to the type bar 247 with the addition of the respective alphabetical symbols assigned to various type bars noted above.

The links 260a, 260b, 260c, 260d and 260e have formed thereon tabs 275a, 275b, 275c, 275d and 275e extending horizontally to underlie in each case the next link to the right, adjacent tabs being staggered as shown in Figure 10. The hundredths link 260f carries a similar tab 275f

extending to the left to underlie the tenths link 263e.

When any type bar, for instance bar 247, is raised above its "0" position, as shown in Figures 2, 8 and 9, the link 260 is raised by the lift bar 266 as already described. The tab 275 raises the link 260d to enable the hammer 253d. Similarly, the tab 275d raises the link 260e and tab 275e raises the link 260f. Thus, when on any type bar any digit is set up and no digit is set up in a type bar to the right thereof, all type bars to the right thereof are enabled to print zeros.

When a digit is set up only in the hundredths column, that is on bar 247f, it is desirable that the decimal point and tenths zero also be printed. In this case, when the link 260f is raised, its tab 275f raises the link 260e to allow the hook 259e to cock the hammer 253e in the manner previously described.

A bail 276 on arms 277, Figures 2 and 11, secured to a longitudinal bail shaft 278, is disposed behind and spanning the downward extensions 213 on the segmental plates 211. The bail shaft 278 is rockably journaled in the base 116 and carries a lever 279 to which is pivoted at 280 a push rod 281. The upper end of push rod 281, shown in Figures 11 and 21, terminates in a fork 282 having slotted side plates 283 and 284 respectively guided on the hubs 285 and 286 of a bail cam 287 secured on the cam shaft 240. A roller 288 is rotatably mounted on a pin 289 in the bottom of the fork 282.

A strong tension spring 290, Figures 2 and 11, attached at one end to a pin 291 on one of the arms 277 and at the other end to the base 116, urges the bail assembly clockwise and holds the roller 288 in engagement with the periphery of the bail cam 287. In normal or initial position, as illustrated in Figure 14, the bail 276 holds the segmental plates 211 in their extreme counterclockwise position. When the shaft 240 is revolved, the lobe of the cam 287 acting through the roller 288, forces the push rod 281 downward to swing the bail counterclockwise against the tension of the spring 290. If any selector bar 205 has meanwhile been released by the raising of the detent 200 in the manner previously described and shown in Figure 6, the spring 214 causes the extension 213 to follow the bail to the left, allowing the plate 211 to swing clockwise, normally raising the type bar 247. This movement continues until one of the hooks, such as 216c, Figure 5, engages its detent 195 which stops the bar 205 to hold the connected parts in position wherein the type digit corresponding to detent 195 is set up in line with the platen 274. This position is maintained until the descent of roller 288 from the lobe of cam 287 allows the strong spring 290 to return the bail 276 to the right. As the bail moves to the right it re-engages the extension 213 to return the selector bar and type bar to initial or "0" position.

From the above, it will be understood that the movement of the bail allows all released selector bars to move into positions determined by their respective detents, allows the parts to remain in this position while the outer circumferential surface 292 of the lobe of cam 287 traverses the roller 288, then picks up and returns all the selectors and attached parts to initial position, the strong spring 290 overcoming all the weaker springs 214.

A stationary bracket 293, Figures 2 and 8, has secured thereto the casing 294 of an accumulator assembly generally denoted by the numeral 294a and further shown in enlarged detail in Figures

12, 13, 14, 15, 16, 17, 18, 19 and 28. A movable frame 295 is positioned inside the casing 294 and supports a longitudinal shaft 296 on which are rotatably mounted accumulator gear wheels 297, 298, 299, 300, 301, 302 and 303, disposed above and adapted to mesh with gear segments 304 on the plates 211, Figures 2 and 8. The wheels each have 10 teeth and the wheel 297 is of double width for a purpose hereinafter described. The remaining wheels 298, 299, etc., have formed thereon cams 298a, 299a, 300a, 301a, 302a and 303a respectively, Figure 15, the cams preferably being in the form of widened single teeth of the wheels. The wheels have extended hubs as shown at 298b, Figures 12, 13 and 14, and at 303b, Figures 12, 15 and 16. The hubs of the various wheels extend respectively into hollow shells 534, 305, 306, 307, 308, 309 and 310, made of non-conducting material such as Bakelite and having laterally extending arms 311 and 311a, the arms 311 being rockable on a rod 312 secured to the bracket 293, Figures 2 and 8. Bolts 313 and 314 through the arms 311, 311a and through cross strips 315 and 315a welded or formed on the frame 295, secure these parts together in a unit, the assembly being rockable on the rod 312 to move the gear wheels into or out of mesh with the gear segments 304.

A vertical fork 316, pivotally mounted on the bolt 314 spans the shaft 244 and is slidably guided thereby. A tension spring 317 attached to the bolt 314 and shaft 244, urges the counter assembly and fork 315 upward.

A pair of tappet levers 318 and 319, Figure 8, are pivoted to the lower end of rocker arms 320 and 321 fulcrumed on a stationary rod 322. The upper ends of arms 320 and 321 are attached to the plungers 323 and 324 of horizontal solenoids 325 and 326, hereinafter referred to as Add and Subtract cam solenoids respectively.

A pair of cams 327 and 328 on the shaft 240, hereinafter referred to as the Add and Subtract cams respectively, engage the tappet levers 318 and 319 respectively, the lobes of the cams being set at 180 degrees from each other so that during a complete revolution of the shaft 240 the cams rock the tappets downward alternately.

With the shaft 240 starting counterclockwise from normal rest position, shown in Figure 26, the add cam 327 first rocks the tappet 318 downward against the tension of a small spring 329, holds the tappet down throughout the greater part of 180 degrees of revolutions, then allows it to return to upper position at the half-way mark. During the second half of the revolution the subtract cam 328 actuates the tappet 319 in the same manner.

If the solenoid 325 is energized previously to the starting of the shaft 240, the retraction of plunger 323 thrusts the tappet 318 forward so that its end overlies the upper part of the fork 316. When the shaft 240 then revolves to rock the tappet 318, the latter engages the fork 316 to rock the accumulator assembly downward against the tension of the spring 317, thus placing the accumulator gear wheels in mesh with the segments 304 during the first half revolution of the shaft. As the bail 276 makes its counter-clockwise motion during the first half of the above revolution, as previously explained, it will be seen that any clockwise motion of the plates in setting up numbers causes a counter-clockwise rotation of the counter gears, by which means the numbers are "stored" in the accumulators, the pitch radius of the segments 304 being such that the angular movement thereof in setting up each digit moves the corresponding accumulator wheel the number

of tenths of a revolution corresponding to the digit's denomination.

If solenoid 326 is energized, the accumulator wheels are similarly placed in mesh with segments 304 during the second half-revolution, that is, while the plates 211 are returned to their initial position, the accumulator gears being thereby revolved clockwise. The latter operation takes place during subtraction or in clearing the accumulators as hereinafter described.

In either addition or subtraction it is necessary that a carry-over be provided between adjacent accumulator units. To perform this function, the following provision is made:

A rod 330 in the casing 294, Figures 12 and 17, carries a series of segmental rockers 331, 332, 333, 334, 335, and 336 overlying the accumulator gear wheels 297, 298, 299, 300, 301 and 302 respectively and adapted to mesh with them when the accumulator assembly is moved upward in the casing 294 by the spring 317 as previously described. A segmental member 337 overlies the gear 303 and is secured by a screw 338 to the casing 294, since this gear is the lowest in the series of counters and therefore is never shifted by a carry-over.

Trip plates 339, 340, 341, 342, 343 and 344, slidable in slots 345 and 345a in the sides of frame 295, overlie the cam 298a, 299a, 300a, 301a, 302a and 303a respectively. As the operation of all the carry-over devices is identical, it will be described herein by example, the carry-over or transfer taking place from the gear 300 to the gear 299. In Figure 17, the cam 300a of gear 300 is shown in section with the gear 299 behind it according to section lines 17—17, Figure 12. It will be understood that the intervening shell 306 and various other parts are omitted from Figures 17, 18 and 19 in order to clarify the showing of the carry-over mechanism.

Referring to Figures 17, 18 and 19, the trip plate 341 has two tapering recesses 346 and 347. Tension springs 348 and 348a urge the plate 341 downward so that the apices of the recesses normally rest on the bottom of the slots 345 and 345a respectively. Notches 349 and 349a are disposed adjacent the inward extremities of the recesses 346 and 347. A tooth 350 on the plate 341 normally projects downward into the rotary path of the cam 300a as shown in Figure 17. The segmental rocker 333 has sloping wings 351 and 352 adapted to be engaged by a finger 353, Figures 12 and 17, formed on the plate 341.

Assuming the cam 300a to be initially in the digit "9" position, as shown in full lines in Figure 17, a rotation of cam 300a by its gear 300 in addition direction, that is clockwise in the above figure, carries the cam into the zero position. In the movement described, the cam encounters the tooth 350, moving the plate 341 to the right and upwardly. As the cam 300a overrides the tooth 350 the notch 349 engages the bottom of the slot 345. The plate 341 is thereby held in the position shown in dotted-and-dashed lines, Figure 17, the finger 353 underlying the wing 351 of the rocker 333 but spaced a short distance below it.

As the spring 317, Figure 8, raises the accumulator assembly, as previously noted, the gear wheel 299 is drawn out of mesh with the segment 304 and starts into mesh with the segmental rocker 333. Figure 18 shows the position of the parts when the frame 295 has moved upward approximately half its total distance, in which position the teeth of the wheel 299 are nearly out of mesh with 304 and are entering mesh with the teeth of rocker 333, and in which the finger 353

engages the sloping wing 351 of 333. As the upward movement of the frame 295 and attached parts continues, the wheel 299 moves entirely out of mesh with segment 304 and into mesh with rocker 333, while at the same time the finger 353 swings the rocker 333 to the right. This movement of 333 carries with it the wheel 299 until the parts come to rest at the top of the upward movement in the position shown in Figure 19, the wheel 299 having been revolved the angular distance of one tooth "T" from Figure 18 to Figure 19.

From the foregoing it will be seen that the passage of the cam 300a from "9" to "0" position cocks the plate 341 to the right, and that the following upward movement of the accumulator assembly causes the plate to advance the next higher accumulator wheel in the series by one digit. In case of a double carry-over, that is, in case the passage of the cam 300a is caused by a carry-over to it from the lower unit 301, Figure 12, the action is as follows:

In this case the accumulator gear wheel 299 is already partly in mesh with rocker 333 before the cam 300a starts its clockwise motion, since this motion is now caused by carry-over from a lower unit. The plate 341 is in mid-position in the frame 295 as in Figure 17, but as the frame 295 itself has already been moved upward, the finger 353 is closely adjacent the sloping wings 351 and midway between them. As the cam 300a moves from "9" to "0" position it cocks the plate 341 to the right as already described, the finger 353 engaging the wing 351 to swing the parts into the same position shown in Figure 19 and thus revolving the wheel 299 one digit in the manner previously noted. By the means described, the device is adapted to carry-over throughout the entire series when necessary.

In order to return the trip plate 341 to normal position, upwardly rockable spring latches 354 and 354a are provided on the casing 294 opposite the ends of the trip plate 341. Tapered extensions 355 and 356 on the plate 341 are adapted to snap past the latches as the plate moves upward in cocked position as shown in Figure 18. As the accumulator assembly is again moved downward to mesh the gear wheel 299 with the segment 304, the tapered extension 355 encounters the latch 354 which restrains its downward motion, lifting the notch 349 clear of the bottom of slot 345 and allowing the springs 348 and 348a to snap the plate 341 into central position as shown in Figure 17.

The rocker 351 has on its top a pair of outwardly extending ears 357 and 358. As the frame 295 nears its lower position its upper part engages the ear 357, swinging the rocker 351 into central position as also shown in Figure 17.

The foregoing series of operations has been described in connection with an addition carry-over, but as the two sides of the apparatus are identical in structure, it is obvious that the device operates in the same manner when the cam 300a moves counter-clockwise from "0" position to "9" position to effect a carry-over in subtraction. Due to the fact that all the transfer parts are returned to neutral position as the gears mesh with the segments 304, the device is always conditioned to effect a carry-over in either direction irrespective of whether an addition or subtraction has been made in the previous cycle.

Referring to Figures 12, 13 and 14, the hub 290b of the accumulator gear 298 has secured thereon an insulating sleeve 359, preferably of Bakelite,

which carries a resilient brush 360 having two contact shoes 361 and 362. The shoe 361 slidably engages a conducting slip ring 363 secured in the shell 305 and provided with an exterior terminal 364. The second shoe 362 of brush 360 is adapted, when rotated, to successively engage a set of commutator segments 365, 365a, 365b, 365c, 365d, 365e, 365f, 365g and 365h, corresponding to counter positions of digits "1" to "9" and having exterior terminals 366, 366a, 366b, 366c, 366d, 366e, 366f, 366g and 366h, Figure 14. The zero position, as shown in Figure 14, also has a segment 365i provided with a terminal 366i. It will be seen that the brush 360 is adapted to establish an electrical connection between the slip ring 363 and any commutator segment with which the shoe 362 is in contact.

All the shells 334, 305, 306, 307, 308, 309 and 310 are provided with slip rings and commutators as described, except that the zero segment may be omitted from shell 310, but shell 310 also contains a second slip ring 367 provided with a terminal 368 and adapted to be connected by a forked brush 369 with a single commutator segment 370 extending around the interior of the shell 310 from the digit "5" to the digit "9" position inclusive, as shown in Figure 16. Segment 370 has a terminal 371.

To avoid confusion and complication on the wiring diagram, the various complete commutating units are represented in Figure 35 with their slip rings and segments arranged concentrically instead of side by side, and the complete units are denoted in Figures 15, 38 and 42 by the numerals 372, 373, 374, 375, 376, 377 and 378, the unit 378 being hereinafter referred to as the fractional cent commutator.

Referring to Figure 20, the error key 107, fraction key 108, total key 109, add key 110 and subtract key 111 are equipped with piston switches 379, 380, 381, 382 and 384 respectively, all secured on a conducting plate 383 separate from the plate 126 shown in Figure 4 and adapted to engage groups 379a, 385, 386, 387 and 388 of pins in the top of the permutation panel 153, Figure 31. The plate 383 is adapted to be connected electrically to one side of a source of current through a snap connector 389 on an insulating block 390 secured to the stationary frame of the machine.

The connector 389 and a similar connector 391, which latter supplies current to the numerical piston switches through the plate 126, Figure 4, also serve the purpose of latches to hold the frame 120 and key switch assembly firmly in place above the permutation panel 153.

The keys 107, 108, 109 and 111, Figure 20, are provided with a locking bar 392 operable by a solenoid 393 in the manner previously described in connection with Figure 4. A hook 394 on the right end of the bar 392 is adapted to rock the transverse member 151 counter-clockwise when the bar is moved to the left for a purpose hereinafter explained.

The various mechanical functions of the machine, as previously set forth, are brought about by rotation of the cam shaft 240. A motor 395, Figure 3, is adapted to drive a vertical shaft 396 through a worm 395a and worm gear 398. The vertical shaft 396 in turn is adapted to drive the cam shaft 240 through a clutch enclosed in a housing 397a, Figure 3, the clutch 397 being shown in detail in Figures 22 and 23.

A sleeve 399, Figure 22, is rotatably mounted

on the shaft 240 adjacent a ball bearing 400 supported in the casing 116. Secured on the sleeve 399 is a worm gear 401 meshing in the usual manner with a worm (not shown) on the upper end of the vertical shaft 396. The left, or outer, end of the sleeve 399 has formed thereon a flange 402, hereinafter referred to as the driving member and provided with a series of circumferential notches 402a, 402b, and 402c, Figure 23. A cylindrical member 403, hereinafter referred to as the driven member, encircles the sleeve 399 and driving member 402 which are normally rotatable therein. A flange 404 is secured to the driven member 403 and has a hub secured on the camshaft 240 by means of a key 406 and set screw 407. Two cam rings 408 and 409 are secured on the outside of the hub 405 as shown in Figures 22, 24 and 25.

The driven member 403 has therein a recess 410 in which is rockably mounted a lever 411 which extends outwardly and terminates in an angular lip 412. A dog 413 extending laterally from the lever 411 so as to normally overhang the circumference of the driving member 402 is adapted to engage any one of the notches 402a, 402b or 402c when the lever 411 is rocked counter-clockwise by a compression spring 414, Figure 23. A bracket 415 secured to a support 416 on the frame 116 has a pair of upwardly projecting lugs 417 and 417a carrying a horizontal pin 418. A trip latch 419, rotatably mounted on the pin 418, is urged upward by a spring 420 so as to normally engage the lip 412 of the clutch lever 411. A solenoid 421 is provided with a plunger 422 connected to the latch 419 and adapted to pull the latch 419 out of engagement with the lever 411 when the solenoid is energized.

Adjustable stop screws 423 and 424 are provided to limit the motion of the latch 419. An upwardly extending finger 419a on the latch 419 is adapted to be engaged by a cam 425 on the periphery of the driven member 403 to ensure positive relatching of the clutch.

The cam 408, as shown in Figure 24, engages an insulated shoe 426 on the inner arm 427 of a breaker 428 insulatedly secured to the bracket 415. When the cam 408 revolves it presses a contact point 429 on the arm 427 against a similar point 430 on the outer arm 431, thus establishing a connection between leads 432 and 433 attached to the arms. When the cam 408 completes its revolution to normal position, the shoe 426 overrides the sharp edge of the cam lobe, allowing the breaker to snap open, as shown in Figure 24.

A second breaker 854, of construction similar to breaker 428, is mounted on an arm 854a, secured to the bracket 415, Figures 24 and 22. Breaker 854 is arranged to be normally held closed by cam 408, and is allowed to snap open as approximately seven-eighths of the latter's revolution is passed, being then reclosed as the revolution is completed.

The cam 409, as shown in Figure 25, is adapted to operate a third breaker 434. The operation is the same as described except that in normal position the cam 409 holds the third breaker 434 closed, the break occurring at substantially the half-way point in the cam's revolution. Breaker 434 is provided with leads 435 and 436. A fourth similar breaker 437, superimposed on the second breaker 434, has on its inner arm 438 an insulating shoe 439 bearing against the rear of the inner arm 440 of breaker 434. The fourth

breaker 437 is thus operable by the cam 409 simultaneously with the third breaker 434. Breaker 437 has leads 442 and 441, the latter of which is connected to the solenoid 421, as shown in Figure 22, the second lead of the solenoid being denoted by the numeral 443.

The operation of the clutch is as follows:

Assuming the motor 395 to have been started by means hereinafter set forth, the sleeve 399 is driven thereby through the vertical shaft 396 and worm gearing previously described, the driving member 402 idling inside the driven member 403 which latter is held stationary by the latch 419 engaging the lever 411, as shown in Figure 23. When the solenoid 421 is energized, the plunger 422 is drawn downward, releasing the lip 412 of lever 411. The spring 414 forces the lever 411 counter-clockwise, causing the dog 413 to snap into the first of notches 402a, 402b or 402c, which registers with it, thereby clutching the driven member 403 to the driving member 402. The member 403 is thereby rotated, carrying with it the attached flange 404, hub 405, and cam shaft 240. As the cam 409 on hub 405 revolves past the half-revolution, the breakers 434 and 437 open, as previously described. The breaker 437 being in series with the solenoid 421 through the lead 441, the opening of 437 breaks the circuit through the solenoid, allowing the latch 419 to be snapped upward by the spring 420.

As the driven member 403, cam shaft 240, and attached parts approach the end of one revolution, the latch 419 intercepts the lever 411, swinging the latter clockwise in the driven member to withdraw the dog 413 from the notch in the driving member and bring the driven member 403 again to a stop in the position shown in Figure 23. A spring-pressed wedging pawl 444 is adapted to snap into place behind a ratchet cam 445 on the driven member, thus preventing rebound of the latter and holding the cam shaft accurately in stop position.

The purpose of the finger 419a is to ensure return of the latch to stopping position irrespective of the strength of spring 420. In case the latch 419 has not been returned to upper position by the spring before the cam 425 encounters the finger 419a, the cam swings the finger outward, thus positively returning the latch 419 to latching position, as shown in Figure 23.

This provision allows the spring 420 to be relatively light, reducing the necessary size and current consumption of the solenoid 421 while at the same time making impossible any accidental failure of the clutch to disengage at the end of one revolution. In this manner accidental "repeating" or double operation of the machine by the camshaft is prevented.

Referring to the wiring diagram, Figure 36, the permutation panel 153 comprises all the connections enclosed in the dotted and dashed rectangle. While in order to avoid undue multiplication of lines in the diagram certain leads are shown joined within the interior of the panel rectangle, it will be understood that in practice all connections are made between internal terminals in the panel itself as illustrated in Figure 34. For instance, from typical jacks 169a and 169b, constituting the incoming terminals, Figure 34, connections are made by individual leads 171a and 171b to the posts 172b and 172c which constitute the outgoing terminals. Obviously only one lead may be plugged into each jack, but a

number of leads may be required connecting different jacks to one post, especially in panels wired for billing computations as illustrated in Figure 37. For this reason the posts 172 are made relatively long, as shown in Figure 4, in order to accommodate as many lead eyes or clips as may be required.

In order to conveniently wire a permutation panel 153, a spring latch 446, Figures 31, 32 and 33, is released and the panel laid open, the hinge 158 allowing the upper and lower portions to be spread apart after the manner of an open book, to expose all the internal connecting means.

All connections are then made between jacks and posts, as illustrated in Figure 34, all the leads overlying the hinge 158. A binding strip 447, preferably a channel of insulating material, is then secured over the bunched leads, as shown in Figure 4. The panel is then closed, the latch 446 snapping into engagement to hold the parts firmly together.

A closure casing or cover 448, Figures 2, 3 and 4, having been removed from the machine, the keyboard with its attached switches 127, is swung upward by means of a finger grip 449, the entire key and piston-switch assembly swinging on the rod 121. The panel 153 is then dropped into place on the brackets 154 and 155, Figure 4, and the keyboard assembly closed above it, the snap or latch connectors 389 and 391 holding the keyboard assembly firmly in position while downward projections 450 and 451 thereon press against the top plate 160 of the permutation panel. All parts are thereby located in operative relation as shown in Figures 2 and 4, after which the closure casing 448 is replaced on the main casing or base 116 and the machine is ready for operation as hereinafter described.

In connection with the following description, it will be noted that the wiring in Figures 36 and 37 is identical except those connections which are within the permutation panels. This illustrates the fact that in order to change the machine from one type of function to another it is only necessary to replace the panel wired for the first type of function with a panel wired for the second type. No wiring connections are made between the panel and the remainder of the machine. Panels may therefore be wired for any desired function by experts at the factory or service station, from which they may be shipped to users of the machines. The user has only to place the panel in the machine as previously described, in order to condition it to perform the desired function, the necessity on his part of any wiring skill or ability to set up plugboard connections being entirely eliminated.

Referring again to the circuit diagram, Figure 36, main lines 452 and 453 are normally connected to a source of current. From the line 453 a branch lead 454 is connected to the motor 395. The second lead 455 of the motor is connected to a normally open breaker 456 controllable by a relay magnet 457, from which breaker a wire 458 is connected to the main line 452, the wire 458 also being connected to one terminal of the magnet 457.

The line 453 is normally connected through the breaker 434, leads 436 and 460 and the latch connector 391 to the conducting plate 126, which carries and supplies current to the key switches 127, shown in Figure 4, and which is diagrammatically represented as lead line and its branches leading to the various key switches in order to clarify the diagram, the same diagram-

matic procedure being followed throughout the figures wherever the attempt to represent conducting parts pictorially would greatly increase the complication and necessary size of the diagram.

From each key switch, for example, the switch 127 of the digit seven key 102a in the tens column, the contact pins 161, 162, 163, 164, 165 and 166 lead into the permutation panel 153 as illustrated by the lines 461 and 462 representing continuation of the pins 161 and 166 respectively. From the pin 166 the internal lead 171 in the panel completes a connection through a wire 483 and a branch lead 464 to the number "7" set up solenoid 189 in the tens row, Figure 35. From the solenoid 189 as well as all the other solenoids in the tens row, a common line 465 leads to the magnet 466 of the quick-acting breaker 226, previously shown in Figure 5. The other terminal of the magnet 466 is connected through a lead 467 to the main supply line 452, Figure 36.

The pin 161 and its continuation 461 are connected through an internal lead 171c of the panel 153 and a lead 468 to the locking bar solenoid 144, Figures 2 and 4. From the solenoid 144 and the similar locking solenoids 144a, 144b, 144c and 144d of the various numerical key rows a common lead line 469 leads through a magnetic breaker 470 to the main supply line 452, the breaker 470 being controllable by an electro-magnet 471.

From the supply line 452 a lead 472 runs to the controlling magnet 473 of a normally open relay 474, Figure 35, hereinafter referred to as the cut-in relay. From the magnet 473 a conductor 475 leads to the panel 153 through which a connection is made in the manner previously described, via lead 492 to a contact pin 476 of the total key 109, a pin 477 of the add key 110, and a pin 478 of the subtract key 111, Figure 36.

Referring to Figure 35, it will be seen that one contact point 479 of the breaker 226 and the contact member 222, shown in detail in Figure 5, are connected to a common conductor 480. Similarly, the other point 481 of breaker 226 and the contact member 221 are connected to a second common lead 482. The breaker 226, as previously noted, is normally closed, while the contact members 221 and 222 are normally out of engagement. If a current is directed through any set up solenoid such as 189 in the tens row, the breaker magnet 466 being in series with all solenoids in that row is also energized to quickly break the connection between conductors 480 and 482.

As soon as the set up solenoid 189 acts to set up its detent, the rocker 219 is moved as described in connection with Figure 5 to bring the contact members 221 and 222 into engagement, thus re-establishing the contact between leads 480 and 482. The two sets of contacts just described together with their actuating means thus constitute a break-and-make combination which breaks the connection between leads 480 and 482 as any set up solenoid in the tens row is energized to start a set up and restores the connection as the set up is completed.

By reference to the diagram, Figure 35, it may be seen that a break-and-make combination as just described is provided for each row of set up solenoids, and that all the contact combinations are connected in series from conductor 460 at the left of the diagram by means of leads 483, 484, 480, 482, 485, 486, 487, and 488 to one contact of the normally open relay 474, the other contact of relay 474 being connected to a conductor 489

leading to the motor relay magnet 457, Figure 36.

From the conductor 489 the lead 443 is connected to the clutch trip solenoid 421, shown in Figures 22 and 23, and from solenoid 421 a connection is made through the lead 441, breaker 437 and lead 442 to the main line 452. The breaker 428, previously shown in Figure 24, is connected between the conductor 489 and main line 453 by means of leads 433 and 432.

The lead 432 is normally connected through breaker 354 with a conductor 490 which leads through the snap connector 389 to the conducting plate 383 which supplies current to the error, fraction, total, add and subtract key switches 379, 380, 381, 382 and 384.

Two contact pins of the error key switch 379 are respectively connected through the panel 153 by means of internal leads 171d and 491 with the locking solenoid 393 and the magnet 471 which latter magnet is also connected to the main line 452.

The fraction key switch 380 has no connections in the panel 153, as this switch has no function in ordinary addition, subtraction and total taking for which the machine is arranged by the panel illustrated in Figure 36.

The total key switch 381 has five connections through the panel 153 as follows:

1. To the cut-in relay magnet 473, Figure 35, via panel lead 492 and the lead 475 as previously noted;

2. To the locking bar solenoid 393 through lead 171e, shown as joining 171d to avoid multiplicity of lines;

3. To the subtract cam solenoid 326 through panel lead 493 and external lead 494, the solenoid 326 being connected on the other side to main line 452;

4. Through a panel lead 495, an external lead 496, a throwover switch 497 hereinafter described, and a conductor 498 to the total symbol set up solenoid 499, Figure 35; and

5. Through a panel lead 500, Figure 36, a wire 501, the breaker 524, Figure 8, to conductor 524c. From conductor 524c, normally open switches 502a, 503a, 504a, 505a, 506a, 507a and 508a are adapted when closed to form connections through leads 502, 503, 504, 505, 506, 507 and 508 to the slip rings of accumulator commutators 372, 373, 374, 375, 376, 377 and 378 respectively.

It will be understood that the above indicated switches 502a, 503a, 504a, 505a, 506a, 507a and 508a constitute the parallel contactors of a multi-contact relay operable by a single solenoid or electro-magnet 524d secured on the side of the accumulator casing 294, Figure 8. One side of magnet 524d is connected to conductor 524c, while its other side is connected through a lead 524e to a conductor 571 which in turn is connected to the main line 452. The magnet 524d acts to close its various switches noted above whenever the conductor 524c is energized, but normally allows the switches to stand open. The purpose of this arrangement is to prevent possible flow-back of current to the conductor 524c through any commutator during the set up of selector solenoids by depression of the digit keys.

The add key switch 382 has four connections through the panel 153 as follows:

1. Via panel lead 509 to the conductor 475 leading to the cut-in relay magnet 473, Figure 35;

2. To the locking bar solenoid 393;

3. Via a panel lead 510 and external lead 511

to the add symbol set up solenoid 512, Figure 35; and

4. Via a panel lead 513 and external lead 514 to the add cam solenoid 325, the other side of solenoid 325 being connected to the main line 452.

The subtract key switch 384 has the following connections through the panel 153:

1. To the conductor 475 leading to the cut-in relay magnet 473 in the same manner as described for the total and add key switches;

2. To the locking bar solenoid 393;

3. Through a panel lead 515 and external lead 516 to the subtract symbol set up solenoid 517, Figure 35; and

4. Via a panel lead shown for purposes of simplification as the lead 493 and a branch thereof to the external lead 494, thence to the subtract cam solenoid 326.

The operation of the device, as arranged for addition, subtraction and total taking, is as follows, the operation of key 102a being taken as typical of that of all numerical keys:

As the operator depresses key to enter digit seven in the tens column, the piston 128 (Figure 4) of the key-switch 127 encounters the elongated pin 161. The switch 127 being connected through the plate 126 and other conductors previously described with one main supply line 453, current flows from the switch through the pin 161, lead 461, panel lead 171c, locking bar solenoid 144, conductor 469 and breaker 470 to the other main supply line 452. The solenoid 144 is thereby energized, throwing the switch into firm contact with its remaining pins and locking the other key switches in the tens row as previously described. Current flows from the pin 166 through lead 462, the panel lead 171 and leads 463 and 454 to the digit seven solenoid 189, Figure 38, thence through conductor 465, breaker magnet 466 and return line 467 to the main supply line 452. Solenoid 189 and magnet 466 are thereby energized, the magnet acting as previously described to break the connection between leads 480 and 482 while the solenoid raises or sets up its selector detent and restores the above connection by moving the bar 219 as the set up is completed.

As keys in other rows are depressed to complete the digit entry, the same sequence of events takes place in the manner described, the depressed keys being held down by their locking solenoids to maintain the circuits through the set up solenoids which thereby maintain their respective detents in set up position, as illustrated in Figure 5.

If it is desired to add the digit entry, the add key 110 is depressed, causing its locking solenoid 393 to act as previously described, closing circuits through the add cam solenoid 325, the add symbol set up solenoid 512, Figure 35, and the cut in magnet 473. The symbol solenoid operates in the same manner as described for the digital set up solenoids, to set up its selector detent and re-establish a connection between conductors 483 and 460. Meanwhile the cut-in relay 474 is closed, completing a circuit from the main line 453 through the breaker 434, the line 436, the line 460, the various break-and-make combinations in series, as previously described, the relay 474 and line 489 to the motor relay magnet 457 thence via lead 458 to the main line 452.

The motor relay 456 is thereby closed, directing current from line 453 through the motor 395, lead 455, relay 456 and lead 458 to the line

452 and starting the motor. Current from the conductor 489 also passes through the clutch trip solenoid 421 and breaker 437 via 442 to the line 452, causing the clutch to engage and revolve the camshaft 240 through one revolution, as previously described, to set up the type bars and print the digit entry.

The add cam solenoid 325 being energized, as previously noted, causes its cam and cooperative parts to throw the accumulator wheels into mesh with the segments 304 during the first half revolution as illustrated in Figure 8, revolving the wheels and with them their commutator brushes, previously described and illustrated in Figures 12, 13 and 14, an angular fraction of a revolution corresponding to the value of the respective digits set up and printed. For example, starting from zero position, Figure 35, the brush 418 of commutator 374 is revolved through seven-tenths of a revolution, coming to rest in contact with the number "7" segment of the commutator as the machine sets up and prints the digit "7" in the tens column. Similarly, the other commutator brushes form connections between their slip rings and the commutator segments corresponding to the numbers set up by their selector mechanisms. As the cam shaft approaches the half-revolution point, the add cam allows the accumulators to be raised out of mesh, leaving the entered amount stored therein.

As the camshaft reaches the half-revolution point, the cam 409 allows the breakers 434 and 437 to spring open. The opening of 437 deenergizes the clutch trip solenoid 421 to allow the latch 419, Figure 23, to return to stop position and disengage the clutch at the completion of the revolution. The opening of breaker 434 breaks the circuit from the line 453 to the plate 126, deenergizing the locking bar solenoids and the selector solenoids. The numerical keys thereby are allowed to return to normal position.

Previous to the opening of the breaker 434, the cam 408 closes the breaker 428, thus providing a direct connection from the line 453 to the conductor 489 to keep the motor in operation.

At approximately the seven-eighths point in the revolution the cam 408 allows the breaker 854 to open, cutting off the current supply to the add key switch through plate 383; the locking solenoid 393 being thereby deenergized, the add key is released and rises to normal position, breaking all pin connections from its switch.

The motor continues to run until the revolution of the camshaft is completed, when the cam 408 allows the breaker 428 to open. The conductor 489 is thereby deenergized, releasing the motor breaker 456. The motor stops, returning all the parts to normal condition except that the digit entry has been stored in the commutating accumulators as previously described.

As additional entries are made in the machine and printed thereby, the above sequence of operations is repeated, except that in each case the accumulator wheels start from their position determined by the previous operation so that the final positions of the brushes with respect to the commutator segments correspond to the total accumulated.

When it is desired to subtract an entry, the procedure and operation are the same as above, except that the depression of the subtract key 111 throws the subtract symbol selector solenoid 517 and the subtract cam solenoid 326 into action, printing the subtract symbol and bringing the accumulator wheels into mesh during the

second half revolution of the camshaft 240. As the segment 304, Figure 8, returns to normal position, the gear wheels are revolved in the reverse direction, resulting in a direct subtraction of the entry from the quantity previously stored in the accumulators.

It will be noted in Figure 35, and the enlarged detail wiring diagram, Figure 38, that the digit "7" solenoid 189 is connected through the lead 464, a conductor 519 forming a continuation of lead 463, a short lead 520, a double-throw or throw-over switch 521, and a lead 522 to the number "7" segment 523 of the commutator 374. Similarly all the other solenoids in the tens row are connected to corresponding segments of the commutator 374 while the solenoids of the other denominational rows are connected in the same manner to corresponding segments of their respective commutators, with the exception that in the case of the thousandths or fractional cent commutator 378 no throwover switches are interposed, as shown in Figure 35. The function of the throw-over switches, namely for negative total taking, is fully set forth in the previously mentioned Patent No. 2,293,127. Therefore, as negative total taking is not a part of the present invention, no description of the throw-over switch operation is included herein, these switches remaining throughout in their normal position as shown in Figures 38 and 35 to form in effect solid connectors.

Assuming a positive total to have been accumulated in the commutators, as previously described, the total may be printed as follows:

The total key 109 is depressed, energizing the locking bar solenoid 393, as noted above, to positively close the connection of the total key switch 381 with all its contact pins. Current flows through the panel lead 500, the wire 501 and breaker 524 to the conductor 524c, through the relay magnet 524d, thence via conductors 524e and 571 to the line 452, Figure 36. The relay magnet 524d is energized closing switches 502a, 503a, 504a, 505a, 506a, 507a and 508a, allowing current to flow from conductor 524c to the various commutator slip rings, thence through the brushes and segments in contact therewith and the leads and throw-over switches, described above, to the various set up solenoids corresponding to the stored total.

For example, if the brush 518 in total position provides a connection between slip ring 525 and segment 523 of the commutator 374, as shown in Figure 38, current flows from the switch 504a and lead 504 through slip ring 525, brush 518, segment 523, lead 522, switch 521, short lead 520, and conductors 519 and 464 to the solenoid 189, which is energized in the same manner as though its key 102a has been depressed. In other words, all set up solenoids corresponding to the accumulated total are set up as though their respective keys had been depressed simultaneously.

Meanwhile, current also flows from the total key-switch 381 via connections previously described, to the total symbol set up solenoid 499, Figure 38, to the cut-in relay magnet 473, Figure 35, and the subtract cam solenoid 326, Figure 36. The motor is started upon completion of a circuit to conductor 489, as previously described, and the machine goes through a cycle, the set up total being printed. During the second half of the cycle the action of subtract cam 328, Figure 8, depresses the accumulator gears into mesh, as previously described, causing the total just printed to be subtracted in the accumulators. By

this means the accumulators are cleared or returned to zero position. The downward motion of the accumulator assembly in moving into mesh separates the contacts 524a and 524b of the breaker 524, thus cutting off the current through the commutators before they are revolved in clearing. The solenoids 183-191 are thereby de-energized, but the locking hooks 216, 216a, etc., prevent the set stops 192, 193, etc., from dropping out of engagement until the bars 205 are retracted by the action of the bail 276 through the member 211, as previously described. From the above description it will be noted that the positive total is printed and the accumulators cleared in a single revolution of the cam-shaft 240.

The cooperative action of the relay 226 and contacts 221 and 222 in breaking a connection in the line to the motor relay 457 at the instant any selector solenoid in the tens row is energized and restoring it as the solenoid completes the set up of its detent, has been previously described in connection with addition, it also having been pointed out that each row of selector solenoids is provided with a similar break-and-make combination. The principal purpose of these combinations is carried out in the total taking operation just described, in which a number of selector solenoids are energized at the same time.

By the provision of the above combination, the motor relay connection is broken at each row of selector solenoids containing a solenoid energized through the commutators, the break occurring substantially at the instant the current is applied, and the connection at each row is not restored until the set up in that row is completed. As the various make-and-break combinations are disposed in series in the motor relay line, it is obvious that no current can pass through that line until the slowest selector solenoid has acted. It is therefor impossible for the motor to start until all detents of any multiple set up have been raised to selecting position, thus assuring proper operation at all times.

Tax billing and the like

Figure 37, as previously stated, represents, in combination with Figure 35, a set of typical circuits of the machine including the permutation panel 153 wired for a service such as tax billing, wherein the printed amounts represent the product of the entered quantities and a predetermined multiplier such as a given tax rate.

The tax rate chosen for illustration is \$3.45 tax per \$100.00 of assessed value, and an assessed valuation of \$24,630.00 has been chosen for the present example.

As tax assessments are not made in amounts that are fractional dollars the entire keyboard may be utilized for dollars, the right hand row of keys 105 representing units, row 104 tens, 103 hundreds, 102 thousands and 101 ten thousands, this arrangement being made possible by the fact that no direct connection exists between any key and any particular type row or digit, their relation being determined at any time entirely by the wiring of the particular permutation panel in place in the machine.

In the present case the switch 682 of digit "2" key 101b of the ten thousands row has the following connections;

1. Through the pin 666 and panel lead 667 to the locking solenoid 144a;

2. Through pin 668, panel lead 669 and exterior lead 514 to the add cam solenoid 325;
 3. Through pin 670, panel lead 671, and exterior lead 619 to the type bar cutout solenoid 238, also from 619 through 617, 618 and 475 to cut-in relay magnet 473, Figure 35;

4. Through pin 672, panel lead 673, and exterior wires 674 and 675, Figure 35, to the digit "6" selector solenoid 676 in the hundreds row; and

5. Through pin 677, panel lead 678, and exterior leads 679 and 680, Figure 35, with the digit "9" selector solenoid 681 in the tens row.

When the switch 682 is closed by depression of the key 101b the locking solenoid 144a, the add cam solenoid 325, the type bar cutout solenoid 238 and the selector solenoids 676 and 681 are energized through their connections described above. The cut-in relay 474 being closed due to current feeding to its magnet through conductors 618 and 617 from the energized conductor 619 leading to the type cutout solenoid 238, the completion of the selector set up closes the circuits through the conductor 489 and the motor relay magnet 457 and clutch trip solenoid 421. The machine performs a cycle, storing the amount 690.00 in the accumulators, but due to the action of cutout solenoid 238 the print bars are allowed to drop out of mesh.

The amount stored, 690.00, is a partial product, being the result of multiplying the 20,000.00 by the tax rate of 3.45 per hundred (100.00) or \$.0345 per unit.

The switch 684 of digit "4" key 102b has the following pin connections:

1. Through panel lead 685 to the locking solenoid 144;

2. Through panel lead 686 and exterior lead 514 to the add cam solenoid 325;

3. Through the panel lead 687 and exterior lead 619 to the type cutout solenoid, and through 617, 618 and 475 to the cut-in relay magnet 473, Figure 35;

4. Through panel lead 688 and exterior leads 689 and 690, Figure 35, to the digit "1" selector solenoid 691 in the hundreds row;

5. Through a panel lead 692 and exterior leads 693 and 694, Figure 36, to the digit "3" selector, solenoid 695 in tens row; and

6. Through panel lead 696 and exterior leads 697 and 698, Figure 35, to the digit eight selector solenoid 699 in the units row.

When the key 102b is depressed the quantity 138.00 is stored in the accumulators in the manner previously described. This partial product, representing the result of multiplying 4,000 by .0345, the tax rate per unit, is added to the partial product 690.00 already stored by depression of the key 101b.

The switch 700 of digit "6" key 103a has a pin connection as follows:

1. Through panel lead 701 to the locking solenoid 144b;

2. Through panel lead 702 and exterior lead 514 to the add cam solenoid 325;

3. Through panel lead 703 and exterior lead 619 to the type cutout solenoid 238, also through 617, 618 and 475, to the cut-in relay magnet 473, Figure 35;

4. Through panel lead 704 and exterior leads 705 and 706, Figure 35, to the digit "2" selector solenoid 707 in the tens row; and

5. Through panel lead 708 and exterior leads 709 and 710, Figure 35, with the digit "7" selector solenoid 710a in the tens row.

When key 103a is depressed, the ensuing cycle of the machine adds the partial product 20.70 to the partial products already stored in the accumulators, this partial product being the result of multiplying the quantity 600.00 by the rate factor .0345.

The switch 711 of the digit three key 104a has the following pin connections:

1. Through panel lead 711a to the locking solenoid 144c;

2. Through panel lead 712 and exterior conductor 514 to the add cam solenoid 325;

3. Through panel lead 713 and exterior lead 619 to the type cutout solenoid 238, and through 617, 618 and 475 to the cut-in relay magnet 473, Figure 35;

4. Through panel lead 714 and exterior leads 655 and 656, Figure 35, to the digit "1" selector solenoid 657 in the units row;

5. Through the panel lead 715 and exterior leads 716 and 717, Figure 35, to the digit "3" selector solenoid 718 in the hundreds row; and

6. Through panel lead 719 and exterior leads 720 and 721, Figure 35, to the digit "5" selector solenoid 722 in the thousands row.

Depression of key 104a operates through the connections described to initiate a cycle which stores the amount 1.035 in the accumulators in addition to the partial products already stored therein.

The foregoing operations may be summarized by the following table:

Partial quantities entered	Rate	Partial products
20,000	0.0345	= 690.00
4,000	.0345	= 138.00
600	.0345	= 20.70
30	.0345	= 1.035
Total quantity 24,630	Total product .0345	849.735
24,630		849.735

From the above table it is evident that the total accumulated equals the product of the total entered quantity multiplied by the rate factor, the total product including the third fractional decimal. In billing it is not practical to include fractional cents, the custom being to add one cent if the fractional cent is equal to or greater than one-half cent and to drop the fraction if it is less than one-half cent. In terms of dollars the third decimal in the above example is .005 or one-half cent. Accordingly one cent should be added to the total accumulated product making the amount to be billed 849.74. In order to perform this function, the following provision is made:

The switch 380 of fraction key 108 has the following pin connections from its pin group 385:

1. Through panel lead 723 to the locking solenoid 393;

2. Through panel lead 724, the panel lead 712 representing a continuation of 724, and the external lead 514 to the add cam solenoid 325;

3. Through panel lead 725, an extension 726 thereof and exterior lead 619 to the cutout solenoid 238, and through 617, 618 and 475 to the cut-in relay magnet 473;

4. Through panel lead 727 and an external lead 728, Figures 37 and 35, to the second slip ring 367 of the fractional cent commutator 378, previously described in connection with Figure 19. The segment 370, which, as previously described, extends from the digit "5" to the digit "9" positions inclusive, in the commutator 378, is connected through conductors 729, 730, 731

and 732 with the digit "1" selector solenoid 733 in the hundredths row.

When the fraction key 108 is depressed, current flows through the connections described to the add cam solenoid 325, the type cutout solenoid 238, the cut-in relay magnet 473, and the locking solenoid 393. Current also flows through panel lead 727 and external lead 728 to the second slip ring 367. As the digit "5" has previously been entered in the fractional cent commutator, the brush 369 connects slip ring 367 with the segment 370 allowing current to flow through the conductors described above to the digit "1" selector solenoid 733 which is thereby energized, initiating a cycle of the machine which adds the quantity .01 to the sum already stored in the accumulators. The total stored in the present example is therefore 849.745. As the thousandths or third fractional decimal place set up mechanism is not provided with a type bar, it is obvious that if the above total be taken the third decimal digit will be dropped in printing, leaving the printed amount 849.74.

The switch 381 of the total key 109 has the following connections from its pin group 386:

1. Through panel lead 734 to the locking solenoid 393;
2. Through panel lead 735, a continuation 736 of 735, and exterior lead 494 to the subtract cam solenoid 326;
3. Through panel lead 737, the exterior lead 501, breaker 524, lead 524c and its branch switches to the accumulator commutators; and
4. Through panel lead 738 and exterior lead 475 to the cut-in relay magnet 473, Figure 38.

When the total key 109 is depressed, the ensuing cycle of the machine prints the accumulated total in the manner previously described except that the fractional cent remaining in the third decimal accumulator 378 is omitted from the printed total. The total printed in the present instance is 849.74, the proper tax billing for the assessed valuation of \$24,630 figured at the tax rate of \$3.45 per \$100.00.

During the second half of the cycle the amount standing in all the accumulators is subtracted in the manner previously described, thus clearing the accumulators.

The foregoing description has shown by a specific example how the use in the machine of a permutation panel wired to extend entered quantities directly to their products by a predetermined factor may be used in tax billing, it being understood that the panel is pre-wired throughout to connect each digit key throughout the banks with the selector solenoids representing the product corresponding to the quantity entered by depression of that key. For purposes of simplicity, the key switches have been shown as comprising six contact pin connections each, but it will be understood that these switches may be provided with any desired number of pins within practical limits, the minimum of six shown throughout the foregoing description being entirely illustrative. When it is desired to construct the machine and panels with a comparatively large number of pins per switch one alternative structure may be used as shown in Figures 44 and 45 and hereinafter explained in connection with the description of a machine especially designed throughout for tax billing and the like.

In case the first accumulated total of partial products includes a third decimal fraction less

than .005, that is, less than one-half cent, the brush 369 of the fractional cent commutator 378, Figure 35, does not make contact with the segment 370. Consequently, when the fraction key 108 is pressed no selector solenoids are energized, the machine performing an idle cycle.

When the total is then taken by depression of the key 109 the amount printed is the original accumulated amount with the fractional cent omitted.

If it is ascertained that a wrong digit has been entered at any time previous to printing the total or billed amount, the entered quantity may be removed for correction as follows:

The switch 379 of error key 107 has the following connections from its pin group 379a, Figure 37:

1. Through panel lead 739 to the locking solenoid 393;
2. Through panel lead 740, exterior lead 501, breaker 524, Figure 35, conductor 524c and its branch switches to the accumulator commutators;
3. Through a panel lead 741, the extension 736 representing a continuation thereof, and the exterior lead 494 to the subtract cam solenoid 326; and
4. Through panel lead 742, the extension 726 representing a continuation thereof, and the exterior lead 619 to the type cutout solenoid 238, also from 619 through 617, 618 and 475 to the cut-in relay magnet 473, Figure 35.

When the error key is depressed, the above connections cause the machine to go through a normal total-taking cycle, except that, due to the action of cutout solenoid 238, no printing occurs and the effect is simply to subtract in the accumulators any amount stored therein at the beginning of the cycle. The accumulators are thus cleared, allowing the desired quantity to be entered correctly.

In the entering of multi-digit quantities for tax billing and the like, it has been seen that the machine performs a storing cycle at each depression of a digit key, in consequence of which the locking magnet releases the key during the process of the cycle. In entering such quantities, however, it is desired that the keys operated remain slightly depressed until the entire entry is completed, in order to prevent confusion and double digit entries on the part of the operator. For this purpose the following provision is made, referring to Figure 4:

When a locking bar 136 is drawn to the left by solenoid 144 following the depression of a key in its row, the small lever 145 is swung clockwise by its spring 147, interposing the toe 148 between the stop plate 150 and the end of bar 136. When the bar 136 is returned to the right by spring 137 after deenergization of the solenoid 144, the bar encounters the toe 148 which prevents its complete return to normal position. The wedge 138 thereby is prevented from entirely releasing the bridge 135 of the key shank 122, so that the key is held depressed sufficiently to indicate its previous operation but not sufficiently to hold the switch piston 128 in contact with any of its contact pins. The key remains in this partly depressed position until the operation of the total key 109 or any other key served by the locking bar 392, Figure 20. When any of the latter keys is depressed, causing the locking bar 392 to be drawn to the left, the hook 394 on bar 392 rocks the hinged transverse member 151 to the left, engaging the upward extension 152, of lever 145. Levers 145 are thereby rocked counter-clockwise,

withdrawing the interposed toes 148 and allowing the locking bars, such as 136, to complete their return to the right to release the partly depressed keys.

In the use of the machine for straight addition or subtraction, the levers 145 function in the same manner to retain digit keys partially depressed until the entry is completed by depression of the add or subtract key.

In the printing of added or subtracted amounts, it is customary to employ a continuous roll of paper, while bills may normally be printed on individual forms. Referring to Figure 2, it will be seen that shaft 743 of the platen 274 is rotatably mounted on angular end levers 744 rockable on hollow pivots 745 secured in brackets 746 formed on the rear of the base or frame 116. A rod 747, through the pivots 745 is adapted to carry a roll 748 of paper 273. A pressure roller 750 in compressive contact with the platen 274, has an axial shaft 751 also rotatably mounted in the end levers 744. Elongated U-shaped members 752, secured to the frame 116, are disposed in front of the platen 274 to act as supports in which a bill form may rest and also to serve as guides for the paper 273 which is fed from the roll 748 between the platen and the pressure roller 750.

A connecting rod 753, pivoted to the end levers 744 at the angle thereof, engages an eccentric 754 on the cam-shaft 240, as shown in detail in Figures 8a and 21.

In Figures 8a and 2, the eccentric is shown at approximately right hand dead center, corresponding to the forward position of the platen 274, in Figures 2 and 8, in which position printing is about to occur. After printing is completed and the cam-shaft 240 revolves, the eccentric 754 to the left, the connecting rod 753 rocks the levers 744 upward and to the left on the pivots 745, as shown in dot and dash lines, Figure 2. By this motion the platen 274 is withdrawn from printing position and raised at the same time, bringing the printed portion of the bill or paper above the level of the ribbon 272 and the type bars 247, so that the figures just printed are visible to the operator. The platen remains normally in its elevated and withdrawn position while the machine is stopped, thus allowing bills to be readily withdrawn from or placed in the supporting members 752, and during the first half of a cycle the eccentric 754 draws the platen, together with the paper or bill, into operative position in line with the type bars and ribbon 272, as shown in Figures 2 and 8.

Figure 8a also shows a means of advancing the paper 273, the parts thereof having been omitted from Figures 2 and 8 to avoid confusion by avoiding the showing of an undue multiplicity of superimposed structures. The platen shaft 743 has secured thereto a ratchet wheel 755 adapted to engage the tooth 756 of a pawl lever 757 pivoted to the frame 116 at 758.

An upwardly inclined arm 759 of the lever 757 has on the end thereof a hook or tab 760 overlying the forward portion of the type bar release rocker 235. A tension spring 761 attached to the lever 757 and the platen supporting lever 744 normally holds the tooth 756 in engagement with the ratchet wheel 755. A spring pressed pawl 762, mounted on the supporting lever 744, is provided to limit the rotation of the ratchet 755 to the counter-clockwise direction.

When the supporting levers 744 are rocked upward and to the left by the operation of the eccentric 754, as previously described, the shaft

743 swings in an arc indicated by the curved arrow, Figure 8a. The engagement of the tooth 756 with the ratchet restrains the latter's movement at the point of contact, causing the ratchet to revolve counter clockwise through an arc sufficient to cause the platen 274, Figure 2, to advance the paper 273 upward a distance equal to the normal vertical line spacing between print rows.

The above operation takes place during the second half of each print cycle of the machine. During cycles in which no printing occurs, for instance when partial products are being accumulated as previously described, the advance of the paper is prevented as follows:

As type bar release or cutout rocker 235 rocks upward, as indicated in dot-and-dash lines in Figure 8a, to release the lever 236, it engages the tab 760 and moves the latter upward. The pawl lever 757 is thereby rocked counter-clockwise, disengaging the tooth 756 from the ratchet 755 and holding it clear thereof during the upward and leftward movement of the platen. By this means the advance of the paper is prevented except after printing has occurred.

The usual hand wheel 763, Figure 3, is provided on the end of shaft 743 to permit advance of the paper 273 by hand. If desired in billing, the paper 273 may be carbon jacketed and the bill forms inserted in the supports 752 in front of it. By this means, a strip record may be kept of the amounts billed on the forms. The ribbon 272, provided with the usual magazine 764 and 765, Figure 3, may be moved by suitable means, and as such means are well known in the art their description herein is unnecessary.

The foregoing description has set forth the manner in which one form of the invention may be made to perform two different types of functions; namely

1. Direct addition, direct subtraction, and positive total taking;
2. Tax computation and billing.

The change from one type of functional operation to another is accomplished by inserting in the machine permutation panels identical in main structure and differing only in their pre-wiring. All of the structure hitherto described appears in applicants' previously mentioned Patent No. 2,293,127. The following description sets forth the manner in which substantially the same structures are incorporated in a typical special purpose machine together with further structures to form the combination embodied in the present invention.

Tax billing machine

Figure 41 shows a typical tax bill 917 having a main portion 918 carrying spaces 919 and 920 for printing the assessed valuation and the full or yearly tax respectively. Four stubs, 921, 921a, 921b and 921c are provided upon which the quarterly tax may be printed.

Figure 40 shows a form of the machine especially adapted to tax billing and the like, the machine having a base or frame 922 equipped with a removable cover 923. The cover 923 is apertured to expose an inclined keyboard 924 having a key bank 925 comprising eight rows of digit keys, an error key 1066, a fraction key 926, a print key 927, and a total key 928. It will be understood that the machine may be constructed with any desired number of rows of digit keys, the number eight being chosen as typical. Each row of keys carries digit figures

from "1" to "9" inclusive in the manner shown in Figure 1.

The machine is provided with six type groups 929, 930, 931, 932, 933 and 934. Each type group is provided with substantially the same operational and control devices shown in Figure 2 and the various other figures associated therewith, all operative from a common cam-shaft 1200, shown diagrammatically in 42. The individual operation of these parts has already been described in great detail, and in order to avoid undue repetition further detail description thereof will be given only in regard to their arrangement and functions in connection with the mechanical and electrical diagrammatic illustrations, Figures 42, 43, 43a, and 47.

Referring to Figure 42, it will be seen that the machine contains seven groups of selector solenoids, comprising an assessed valuation group 935 having ten rows of nine solenoids each, a full tax group 936 of eight rows, four quarterly tax groups, 937, 938, 939, and 940, of eight rows each, and a group 941 of two rows for use in controlling fractional correction in the quarterly bills as hereinafter explained.

The solenoid group 935 directly controls the type bars of type group 929 and also controls an accumulator assembly 942. Solenoid group 936 directly controls the bars of group 930, also an accumulator assembly 943 including a third fractional decimal order or fractional cent accumulator unit 944 not provided with a type bar. Solenoid group 936 also controls a total yearly tax accumulator assembly 1085. For this purpose the structure illustrated in Figure 46 may be used, in which the accumulator assembly 1085, similar in construction to those already described, is inverted below the segmental plates 1086 which control the units of the yearly tax accumulator assembly 943, the plates 1086 being provided with downwardly projecting toothed segments 1087 adapted to actuate the accumulators of assembly 1085. The forked member 1088, functionally similar to forked member 316, Fig. 8, is elongated and is pivoted to one end of a centrally pivoted lever 1089, the other end of which has a pin 1090 engaging a slot in the movable frame 1091 of assembly 1085. When the forked member 1088 is thrust downward by an add or subtract cam tappet lever, for example, the lever 1092, similar to the lever 318, Fig. 8, and controllable by subtract cam solenoid 983, Fig. 43, in the manner previously described in connection with Figures 2 and 8, the reversing action of the lever 1089 causes the assembly 1085 to be raised into mesh with segments 1087 against the tension of a retracting spring 1093, as shown in Figure 46. When the forked member 1088 is released by the tappet lever 1092, the spring 1093 retracts the assembly 1085 downward to de-meshed or normal position. Figure 46 shows the parts in engaged position, it being understood that in normal position the spring 1093 holds the assembly 1083 below and out of engagement with the segments 1087. The operation of assembly 1085 is thus the same as that of the previously described assemblies except that it operates from below the segmental plates 1086, thereby allowing its incorporation without further increase in width of the machine. Obviously similar totalizing means may be provided for any or all of the other printing stations, if desired, their structures and operation being identical with that just described, which latter therefore serves as an illustration for as many such totalizers as may be required.

The solenoid group 937, with the exception of the lowest two denominational rows 949 and 950, directly controls the type bars of group 931, also units 951, 951a, 951b, 951c, 951d, and 951e of an accumulator assembly 952.

The third and fourth fractional decimal solenoid rows 949 and 950 directly control accumulator units 951f and 951g of assembly 952, these two units not being provided with type bars as illustrated in Figure 42.

The solenoids of groups 938, 939 and 940 respectively, control the type bar groups 932, 933 and 944, also respectively control corresponding accumulator groups 956, 958 and 960, no type bars being provided for the lowest two decimal units in each of these sub-combinations as also shown in Figure 42.

The solenoid rows 1201 and 1202 of group 941 respectively control gears or entry-receiving wheels 1203 and 1204 of a fractional control head 1205 shown in detail in Figures 48 and 49. The head 1205 has a main frame 1206 secured to the movable frame 1207 of the accumulator group 960, so that when the group 960 is rocked downward for addition or subtraction in the manner previously explained, the frame 1206 rocks downward as a unit therewith. This downward motion causes the gears or wheels 1203 and 1204 to mesh with segmental plates 1208 and 1209, the latter being operable by selector bars 1210 and 1211 under control of the solenoid rows 1201 and 1202 in the manner fully shown and set forth in connection with Figure 2.

The wheels 1203 and 1204 are the same in structure as those shown in Figures 17 and 12, except that no provision is made for carry-over between wheel 1204 and 1203, and these latter wheels are not equipped with individual commutators. As no carry-over is required, the wheels in upper position mesh with stationary holding lobes 1212 and 1213 on a bracket 1214 secured to the stationary frame 1215 of accumulator group 960.

The wheel 1203 is secured to the left end of a shaft 1216 journaled in the frame 1206 and carrying near its right end a spur gear 1217. The gear 1217 meshes with a pinion 1218 rotatably mounted on a pin 1219, which is secured in the frame 1206. Formed integrally with the pinion 1218 is a gear 1220, which in turn meshes with a smaller gear 1221, rotatably mounted on the shaft 1216. A comparatively large internal gear 1222 is secured to or formed integrally with the gear 1221.

The second entry receiving wheel 1204 is secured to the left end of a sleeve 1223 which is rotatably mounted on the shaft 1216 and terminates in a small pinion 1224.

A drum 1225 of insulating material is rotatable on the sleeve 1223. Pins 1226 and 1227, secured in the drum 1225, carry planet gears 1228 and 1229, both meshing with the sleeve pinion 1224 and the internal gear 1222. The drum 1225 thus comprises a planetary carrier rotatable by pinion 1224, internal gear 1222, or both of them. In the latter case, it will be evident to those skilled in the art that the drum 1225 is driven differentially by the pinion 1224 and internal gear 1222, and if both these driving gear members are rotated in the same direction the rotation of the drum 1225 is the additive resultant of motions due to both drivers, each acting as a reaction member for the other's driving force. Furthermore, since the pinion 1224 is directly connected via the

sleeve 1223 with the wheel 1204, and the wheel 1203 is back-gearred to the internal gear 1222 via the shaft 1216 and gears 1217, 1218, 1220 and 1221, it will also be evident that rotation of the two entry-receiving wheels causes a resultant composite rotation of the drum 1225, the total resultant angular rotation of the drum being dependent on the proportion of the described differential and back-gearing.

In the present case the gearing is so proportioned that rotation of wheel 1203 drives the drum 1225 at one-to-one ratio; while rotation of wheel 1204 drives the drum at ten-to-one ratio. As a consequence the composite rotation of the drum 1225, taken in hundredths of a complete revolution thereof, represents the equivalent of the combined entries in wheels 1203 and 1204 in proper decimal arrangement, since each entry-receiving wheel has the usual ten digital positions. For example, an entry of 5 in wheel 1203, and an entry of 3 in wheel 1204 cause the drum 1225 to be revolved through fifty-three one-hundredths of a revolution, its final rotative position representing 53, the combined digital entry standing in the two wheels. Similarly, any combination of entries, either single or successive, causes the drum 1225 to take a final position corresponding in hundredths of a revolution to the final two-digit number finally represented by the entry-receiving wheel positions. The two wheels 1203 and 1204 in combination with the differential apparatus thus comprise an accumulator operable under the control of the auxiliary solenoid group 941. The differential arrangement described obviously eliminates the necessity for any direct carry-over mechanism in the control-head entry-receiving wheels 1203 and 1204.

The insulating drum 1225 has in its circumferential surface a conducting ring 1230. The ring 1230 is of stepped construction as shown in diagrammatic development in Figure 47, comprising a completely circumferential portion 1231, a segmental portion 1232 extending throughout three-quarters of the circumference, a segmental portion 1233 extending throughout one-half the circumference, and a segmental portion 1234 extending throughout one-quarter of the circumference. Four narrow parallel brushes, 1235, 1236, 1237, and 1238, mounted in an insulating member 1239, secured to the frame 1206, bear on the periphery of the drum 1225 in circumferential alignment respectively with conducting ring portions 1231, 1232, 1233 and 1234.

In zero position of the drum 1225, that is, when both entry-receiving wheels 1203 and 1204 stand in cleared or zero position, the brush 1235 of course is in engagement with its conductor portion 1231, but the other brushes are not engaged by their respective conductor portions. When entries in the wheels revolve the drum 1225 through .25 revolution, the segment 1232 engages the brush 1236. At .50 revolution the segment 1233 engages the brush 1237, while at .75 revolution the segment 1234 engages the brush 1238. As the drum finally turns from .99 revolution to full revolution or zero position, segments 1232, 1233 and 1234 simultaneously disengage their respective brushes.

The purpose and functioning of the described control head will be fully explained hereafter in connection with fractional cent correction.

The digit keys of bank 925 are each provided with a modified form of switch of the construction shown in Figures 44 and 45. Referring to Figure 44, it will be seen that a typical key 965

is attached to a shank 966 slidable through the keyboard top plate 924 and the second plate 967, the shank being slotted as previously described, to cooperate with a locking bar 966a.

An insulating plate 968 is attached to the second plate 967 and carries on its lower face a conducting plate 969 through which current may be supplied to the various key switches. A conducting guide socket 970, attached to conducting plate 969, has slidable therein a switch member 971 having upturned lugs 972. Tension springs 973 connect the lugs 972 with similar downwardly turned lugs 974 on the socket 970 and urge the movable member 971 upward. A contact plate 975, preferably square shape, is secured to the member 971 and is adapted to make contact with a group of contact pins 976 when pressed downward by an insulating shoe 977 on the lower end of shank 966. The pins 976 are disposed in a rectangular group in the top of the permutation panel 978 as shown in Figure 45 and are backed by springs and jacks in the manner shown in Figure 7. The rectangular grouping of the pins permits a large number of contacts to be disposed in a relatively small area.

Figures 43 and 43a illustrate the electrical connections of the device by which a typical billing operation may be carried out, the permutation panel 978 being wired throughout in accordance with a tax rate of 3.42 per hundred dollars of assessed valuation, or \$.0342 per dollar.

In the case of the keys and selector solenoids, sufficient of such units are shown to permit the tracing of a typical series of circuits throughout a complete operation of the machine, the remaining units being omitted in order to avoid undue complication and duplication.

It has been previously explained in connection with Figure 35, that each row of selector solenoids is provided with a break-and-make combination typified by the quick acting magnetic breaker 226 and the contacts 221 and 222 with their connections, whereby the motor relay line is broken as a selector set up is begun, and reclosed as the set up is completed. Each row of solenoids in the form of the invention shown diagrammatically in Figures 43 and 43a is provided with a similar break-and-make combination, and as these combinations are identical in structure and function with those shown in Figure 35, they are not shown in detail in Figure 43 but are generally represented by small dotted rectangles marked with the letter X, a typical combination being indicated by the numeral 852. It will be understood that in Figure 43 the vertical lines from the set-up solenoids and from the line 452b to the dotted rectangles are the leads to and from the magnets 466 (Fig. 5), and the horizontal lines are the leads for the break-and-make circuit itself, that is, the leads for the circuit including switch 226 and switch members 221 and 222. Such parts as the motor relay 456, the various cam-operated breakers, and their connecting leads are identical in Figure 43a with those previously set forth and shown in Figure 35, and are therefore indicated by the same numerals.

Referring to Figure 43a, it will be seen that the motor clutch control and cam-controlled switches are included in the same interrelation as previously explained and shown in connection with the general purpose machine circuit, Figures 35 and 37. Since for the purpose of tax billing and the like no negative totals are normally involved, the provisions previously described for this purpose may be omitted from the present

embodiment. Thus the holding switch mechanism, Figures 27 and 27a, for clearing accumulators after taking negative totals as set forth in Patent No. 2,293,127, and the throw-over switch 521, together with their connections, are not included in the present embodiment, the normal connections between commutator segments and their corresponding solenoids being made by simple direct conductors, as shown in Figures 43 and 47. For example, the digit "1," segment 1044 of accumulator unit 951e, Figure 47, is connected directly via wire 1045 with the corresponding digit "1" solenoid 1010, no throw-over switch being interposed. The conductor 460 (Figure 43a) is normally connected to the line 453 through the breaker 434, and is adapted to furnish current to the conducting plate 969 through the snap latch connector 391 and to one side of the cut-in relay 474. Similarly, the conductor 490 is normally connected to line 453 through the breaker 854 and is adapted to supply current through a snap latch connector 490a to a plate in turn supplying current to the switches of error key 1066, fraction key 926, print key 927, and total key 928, the plate being represented in Figure 43a by a conductor 25 979 and its branches 979a, 980 and 981.

Referring to Figure 43, the accumulator assembly 1085 is provided with add and subtract cam solenoids 982 and 983 of the type illustrated in Figure 8. Similarly, add and subtract cam solenoids 982a and 983a are provided for accumulator assembly 942; 982b and 983b for assembly 943; 982c and 983c for assembly 952; 982d and 983d for assembly 956; 982e and 983e for assembly 958; and 982f and 983f for assembly 960. Type disconnecter solenoids 984, 984a, 984b, 984c, 984d and 984e are provided for the type groups 929, 930, 931, 932, 933 and 934 respectively.

It will be seen on Figures 43 and 43a that while the solenoids of groups 935, 936 and 937 are connected with the various key switches through the panel 978 by suitable individual leads, no such connections directly to the key switches are provided for solenoid groups 938, 939, 940 and 941. To supply proper energizing current to the latter groups, the following provision is made:

All the corresponding solenoids or magnets of the two lowest decimal order rows in groups 937, 938, 939, 940 and 941, are connected respectively in parallel. For example, referring to Figure 43, a common conductor 1240 from the digit "5" solenoid 1022 in the fourth fractional decimal or ten-thousandths order of group 937, has connections to the corresponding solenoids 1022a, 1022b, 1022c and 1022d of groups 938, 939, 940 and 941. Therefore when set-up current is supplied to solenoid 1022, the above noted corresponding solenoids in groups 938, 939, 940 and 941, are also energized, all set-up solenoids having connections to main line 452 via branch lines 452b and 452a.

Similarly a common supply connection via a conductor 1241 is provided from the digit "8," solenoid 1021, of the third fractional decimal or thousandths row 949 of group 937 to the corresponding "8" solenoids 1021a, 1021b, 1021c and 1021d of groups 938, 939, 940 and 941. It will be understood that the other solenoids of the two lowest order rows are correspondingly connected in the same manner illustrated by the examples given, further showing thereof being omitted from the drawings to avoid undue multiplicity of lines and numerals.

The corresponding solenoids of the remaining higher orders in the banks 937, 938, 939 and 940 are also adapted to be connected respectively in

parallel, but a normally open multiple contact relay 1242 is interposed in all the connections between banks 937 and 938, a second similar relay 1243 between banks 938 and 939, and a third similar relay 1244 between banks 939 and 940, Figure 43. The three relays 1242, 1243 and 1244 are all connected on one side to the branch line 452b leading via a second branch 452a to the line conductor 452, Figure 43a. On the other side the relays are connected to a common conductor 1245 leading to the permutation panel 978, Figure 43a, and within the panel via leads such as 1246, 1247 and 1248 with contact points of all key switches, as exemplified by contact points 1249, 1250 and 1251 of key switches 965, 985 and 986 respectively. Whenever any key switch is closed, therefore, the three relays 1242, 1243 and 1244 are energized to close all their contacts.

To show a typical connection effected through the three transfer relays, assume that the digit "9" solenoid 1020 of the hundredths order in bank 937 receives a set-up current via lead 1252 and panel wire 1253 from the key switch 986. As the closure of the key switch has caused closure of the transfer relays 1242, 1243 and 1244, as explained above, a current connection also exists from lead 1252 via a lead 1254, closed contactor 1255 of relay 1242, and a second lead 1256 to corresponding solenoid 1023 of bank 938; also thence via a lead 1257, closed contactor 1258 of relay 1243 and a lead 1259 with corresponding solenoid 1024 of bank 939; and finally via lead 1260, closed contactor 1261 of relay 1244, and lead 1262, to the corresponding solenoid 1025 of bank 940. From all selector solenoids, as previously noted, current connections are completed to main line 452 through the branches 452b and 452a.

Similarly, all the other respective corresponding solenoids of the four banks 937, 938, 939 and 940 are provided with parallel connections through the three described transfer relays 1242, 1243 and 1244, in all orders except the third and fourth fractional decimal orders, the solenoids of these latter orders being permanently connected without the interposition of the transfer relays, as previously explained. As the means of connecting all the corresponding solenoids are identical with the above examples, Figure 43 shows only such further samples of these means as are essential to examples of the device's operation herein-after described.

The effect of the arrangements described above may be briefly summarized as follows:

Any key controlled set-up in the solenoid group or bank 937 is duplicated throughout in banks 938, 939 and 940. Also, the third and fourth decimal fractional portion of the set-up is duplicated in auxiliary bank 941. However, in any set-up not effected by the key switches the relays 1242, 1243 and 1244 are open, so that except in the directly connected lowest two orders the solenoids of banks 937, 938, 939 and 940 are controllable independently through their respective accumulator commutators.

The reason for the described difference in set-up connections between the higher and lowest two orders is that while all key-controlled entries are duplicated in all the banks 937 to 940 at all times, in later operations, the orders above the third decimal fraction may require different set-ups in these four banks for fractional cent corrections and printing, as hereinafter set forth.

Assuming, for purposes of illustration, an assessed valuation of \$30,270, to be taxed at the assumed rate of \$3.42 per hundred, the entering

of the above amount in the machine calls for depression of digit "3" key 965 in the ten thousands row of bank 925, the digit "2" key 985 of the hundreds row, and digit "7" key 986 of the tens row.

Referring to Figure 43a, the depression of key 965 is adapted to close the following connections from plate 969:

1. Through panel lead 987 and exterior lead 987a to locking solenoid 988, thence to main line 452;

2. Through panel lead 989 and exterior lead 989a to the type disconnecter solenoid 984a of type group 930, Figure 43, thence through a branch 452a to line 452, Figure 47a;

3. Through panel lead 990 and exterior lead 990a to the type disconnecter solenoids 984, 984b, 984c, 984d and 984e, thence through branch 452a to the line 452;

4. Through panel lead 991 and exterior leads 991a and 991 to the magnet 473 of cut-in relay 474, thence through lead 912 to line 452;

5. Via point 1249, panel leads 1247 and 1246, and exterior lead 1245 to transfer relays 1242, 1243 and 1244, thence via branches 452b and 452a to line 452;

6. Through panel lead 992 and exterior lead 992a to the digit "1" selector solenoid 993 in the thousands row of bank 936, thence through the break-and-make magnet 994 and branches 452b and 452a to the line 452; and

7. Through a panel lead 995 and exterior lead 995a to the digit "2" selector solenoid 996 of the tens row, bank 936, thence to line 452 through connections obviously similar to those traced for solenoid 993 and therefore not further described in order to avoid undue multiplicity of numbers.

As all connections shown from the keys through the permutation panel 978 to the various selector solenoids are made in the manner already thoroughly described, further detail description of these connections is hereinafter omitted in order to simplify and shorten the description. Continuing the listing of connections, depression of key 965 also closes connections as follows:

8. To digit "6" solenoid 997 of the units row, bank 936;

9. To digit "2" solenoid 998 in the hundreds row, bank 937, and via contacts of relays 1242, 1243 and 1244, to corresponding digit "2" solenoids in banks 938, 939 and 940;

10. To digit "5" solenoid 999 of the tens row, bank 937, and via contacts of relays 1242, 1243 and 1244, to corresponding digit "5" solenoids in banks 938, 939 and 940;

11. To digit "6" solenoid 1000 of the units row, bank 937, and via contacts of relays 1242, 1243 and 1244, to corresponding digit "6" solenoids in banks 938, 939 and 940;

12. To digit "5" solenoid 1001 of the tenths row, bank 937, and via contacts of relays 1242, 1243 and 1244 to corresponding digit "5" solenoids in banks 938, 939 and 940;

13. To the digit "3" solenoid 1002 of the ten-thousands row of bank 935; and

14. Through a panel lead 1003 and exterior conductors 1004 and 1004a to the add cam solenoids 982a, 982b, 982c, 982d, 982e and 982f, thence via branch 452a to line 452.

Depression of key 985 is adapted to close the following connections:

1. To locking solenoid 1005;

2. To type disconnecter solenoid 984a;

3. To type disconnecter solenoids 984, 984b, 984c, 984d, and 984e;

4. To cut-in relay magnet 473;

5. To the digit "6" selector solenoid 997, Figure 43, in the units row of bank 936;

6. To the digit "8" solenoid 1006 in the tenths row, bank 936;

7. To the digit "4" solenoid 1007 in the hundredths row, bank 936;

8. To digit "1" solenoid 1008 in the units row, bank 937, and corresponding digit "1" solenoids in banks 938, 939 and 940;

9. To digit "7" solenoid 1009 in the tenths row, bank 937, and corresponding digit "1" solenoids in banks 938, 939 and 940;

10. To digit "1" solenoid 1010 in the hundredths row, bank 937, and corresponding digit "1" solenoids 1011, 1012 and 1013 in banks 938, 939 and 940;

11. To digit "2" solenoid 1014 of the hundreds row, bank 935; and

12. Through conductor 1004 to add cam solenoids 982a, 982b, 982c, 982d, 982e, and 982f.

Depression of key 986 closes the following connections:

1. To locking solenoid 1015;

2. To type disconnecter solenoid 984a;

3. To type disconnecter solenoids 984, 984b, 984c, 984d, and 984e;

4. To cut-in relay magnet 473;

5. To digit "2" selector solenoid 1016 in the units row, bank 936;

6. To the digit "3" solenoid 1017 in the tenths row, bank 936;

7. To the digit "9" solenoid 1018 in the hundredths row, bank 936;

8. To digit "4" solenoid 1019 in the thousandths row, bank 936;

9. To digit "5" solenoid 1001 in the tenths row, bank 937, and to corresponding digit "5" solenoids in banks 938, 939 and 940;

10. To digit "9" solenoid 1020 in the hundredths row, bank 937, and via relay contactors 1255, 1258 and 1261, and branches 1254, 1256, 1257, 1259, 1260 and 1262, to corresponding digit "9" solenoids 1023, 1024 and 1025 in banks 938, 939 and 940;

11. To digit "8" solenoid 1021 in the thousandths row, bank 937, and via conductor 1241 to corresponding digit "8" solenoids 1021a, 1021b, 1021c and 1021d of banks 938, 939, 940 and 941;

12. To digit "5" solenoid 1022 in the ten-thousandths (fourth fractional decimal) row, bank 937, and via conductor 1240 to corresponding digit "5" solenoids 1022a, 1022b, 1022c and 1022d of banks 938, 939, 940 and 941;

13. To digit "7" solenoid 1026 in the tens row, bank 935; and

14. To the add cam solenoids 982a, 982b, 982c, 982d, 982e and 982f.

In operation, depression of key 965 acts through the described connections to send the machine through a cycle in which the following actions occur:

1. The partial quantity 30,000 is entered in accumulator assembly 942;

2. The partial amount 1026.00 is entered in accumulator assembly 943; and

3. The partial amount 256.50 is entered in each of accumulator assemblies 952, 956, 958 and 960.

Due to the action of the type disconnecter solenoids 984, 984a, 984b, 984c, 984d and 984e, no printing occurs.

When key 985 is depressed, the machine performs a cycle in which:

1. The partial quantity 200. is entered in accumulator assembly 942;

2. The partial amount 6.84 is entered in assembly 943;

3. The partial amount 1.71 is entered in assemblies 952, 956, 958 and 960.

Depression of key 986 results in the entry of the following:

1. The partial quantity 70. in accumulator assembly 942;

2. The partial amount 2.394 in assembly 943;

3. The partial amount .5985 in assemblies 952, 956, 958 and 960;

4. The partial amount .0085 in the control head accumulator wheels 1203 and 1204, Figures 43 and 48.

By depression of the above three digit keys, the partial quantities and partial amounts entered in the accumulators and the quantities and amounts accumulated thereby stand as represented in the following table:

Table 2

942	943	952	956	958	960	1205
30,000	1,026.00	256.50	256.50	256.50	256.50	.0000
200	6.84	1.71	1.71	1.71	1.71	.0000
70	2.394	.5985	.5985	.5985	.5985	.0085
30,270	1,035.234	258.8085	258.8085	258.8085	258.8085	.0085

If the above accumulated amounts were printed through the second decimal fraction, the full entered quantity printed by the type group 929 would be \$30,270., the correct assessed valuation.

The full tax printed by group 930 would be \$1,035.23, also the correct amount, since the dropped fraction is less than one half cent. Groups 931, 932, 933 and 934 would each print the quarterly amount \$258.80. The sum of the four printed quarterly amounts would be four times \$258.80 or \$1035.20, or three cents less than the full tax, due to dropping the fractions in the quarterly amounts. In order to correct the quarterly amounts so that, as printed, their sum is always equal to the printed full tax, the following provision is made:

Fractional correction

Figure 47 illustrates in enlarged diagrammatic form the commutator structures of the following accumulator units:

1. The hundredths unit 1027 and thousandths (first fractional cent) unit 944 of full tax group 943;

2. The hundredths unit 951e of assembly 952;

3. The hundredths unit 955 of assembly 956;

4. The hundredths unit 957 of assembly 958;

5. The hundredths unit 959 of assembly 960;

and

6. The stepped circumferential conductor ring 1230 of the control head 1205, Figures 48 and 49.

Unit 1027 comprises a commutator of the construction previously shown in Figures 13 and 14, its segments being connected to corresponding selector solenoids in the hundredths row of bank 936. For instance, digit "3" segment 1028, Figure 47, is connected by means of lead 1029, Figure 43, to its digit "3" solenoid 1030. The digit "1" segment 1031 of unit 1027 is normally connected to its digit "1" solenoid 1032, via a wire 1031a, the latter solenoid also being connected to one pole 1034 of a normally open five-pole switch controlled by a relay 1036.

Unit 944 is of the construction shown in Figures 15 and 16, having a second slip ring 1038 and a single commutating segment 1039 extending through digit "5" to "9" positions of the rotative

brush 1040. A lead 1041 connects the segment 1039 with the normally disengaged contact 1042 of the relay controlled switch pole 1034. It will be seen that if the relay 1036 is closed the segment 1039 is thereby connected to the digit "1" (.01) solenoid 1032. The second pole or movable contact member 1043 of the relay 1036 is connected via a jumper 1043a to the pole 1034. The normally disengaged contact 1271 of pole 1043 has connections via conductors 1045 and 1045a respectively to the digit "1" segment 1044 of accumulator unit 951e and to the latter's digit "1" (.01) solenoid 1010 of bank 937. When the relay 1036 is closed, and segment 1039 is energized, as hereinafter set forth, it is evident from the above connections that current may flow from segment 1039 to both selector solenoids 1032 and 1010. However, when relay 1036 is open as shown, solenoids 1032 and 1010 may be energized independently through their own commutator segments 1031 and 1044 respectively.

Digit "1" (.01) solenoid 1011 of bank 938 (Figure 42) is connected via lead 1046 with its digit "1" commutator segment 1047 of accumulator unit 955. From lead 1046 a branch 1048 is connected to the normally disengaged contact 1049 of switch pole 1050. From pole 1050 a wire 1051 is connected to the brush 1236 adapted to engage the segmental portion 1232 of stepped conducting ring 1230.

Similarly, the digit "1" (.01) solenoid 1012 of bank 939 is connected via lead 1052 with its digit "1" commutator segment 1053 of accumulator unit 957. A branch 1054 connects lead 1052 with normally disengaged contact point 1055 of switch pole 1056, from which latter pole a lead 1057 connects to brush 1237 adapted to engage segmental portion 1233 of conducting ring 1230. Digit "1" (.01) solenoid 1013 is similarly connected via lead 1058 to its commutator segment 1058a of accumulator unit 959, also via branch 1058b to normally disengaged contact 1058c of switch pole 1059, the latter pole being connected via a wire 1059a to the brush 1238 adapted to engage segment 1234 of the ring 1230.

The main slip rings 1058, 1059, 1060, 1061, 1062, and 1063 of units 1027, 944, 951e, 955, 957 and 959 respectively are all adapted to receive current from a line 1064 through multiple contact relays such as 1065, Figure 47, operable by current from line 1064 when the latter is energized from conductor 979, Figure 43a, by depression of the error key 1066 or the print key 927. The purpose of the above relays, which are provided for all multi-segment commutators in the various assemblies, as shown in Figure 43, is to normally keep the various commutators disconnected from each other and from the conductor 1064 in order to prevent possible flow-back of current through any unit in case its brush is in contact with a segment connected to an energized solenoid during operation of an entry key.

The control head conducting ring 1030 is connected at all times via brush 1035 and a branch 1271 to a common conductor 1067 adapted to be energized from plate 979, Figure 43a, by depression of the fraction key 926. Auxiliary slip ring 1038 of commutator 944 is also connected to conductor 1067 via a branch 944a. The relay magnet 1036, Figure 47, is also connected to conductor 1067 on one side and on the other through a lead 1068 and branch 452a to line 452, Figures 43 and 43a. The return connections from relays 1065, etc., are also made via short leads 1069 to branch 452a.

The fraction key 926, in addition to the connection through conductor 1067 to the fractional correction commutator slip ring 1038, stepped ring 1230, and relay 1036, as noted above, is adapted, upon depression, to close the following connections from normally charged plate 979:

1. To cut-in relay magnet 473 through lead 911, Figure 43a;
2. Through lead 1070 to the locking solenoid 1071;
3. Through lead 1004 to the add cam solenoids 982a, 982b, 982c, 982d, 982e and 982f, Figure 43;
4. Through lead 990a to the type disconnecter solenoids 984, 984b, 984c, 984d and 984e, Figure 43; and
5. Through lead 989a to type disconnecter solenoid 984a, Figure 43.

In operation, after the entry of a succession of partial quarterly amounts in accumulator assemblies 952, 956, 958 and 960, the accumulated quarterly amounts standing in these four assemblies are identical, since the entries were made identically under control of the key switches as previously explained. Furthermore, the auxiliary accumulator entry-receiving wheels 1203 and 1204 stand in a position representing the third and fourth fractional decimal accumulation of the quarterly amounts, since they have received partial entries in these orders identical with those of the above four accumulator assemblies also through the parallel solenoid connections previously described. As a consequence, the drum 1225 and ring 1230 have been rotated forward an angular amount corresponding in hundredths of a revolution to the third and fourth decimal accumulation. If this angular amount is less than .25 revolution, none of the three brushes 1236, 1237 or 1238 is in contact with its respective segment of ring 1230. If the amount is from .25 to .49 revolution inclusive, segment 1232 is in contact with brush 1236. If the amount is from .50 to .74 revolution inclusive, segment 1233 is also in contact with its brush 1237. If the amount is from .75 to .99 revolution inclusive, the third segment 1234 is also in contact with brush 1238.

When conductor 1067 is energized by depression of the fraction key 926, the relay 1036 is energized, closing all movable pole members 1034, 1043, 1059, 1056 and 1050, on their respective contact points. At the same time ring 1230 is charged via brush 1235 and lead 1271, Figure 47. If none of the brushes 1236, 1237 or 1238 engages its respective segment of charged ring 1230, no current connection exists therefrom to switch poles 1050, 1056 and 1059. If brush 1236 engages segment 1232, current flows therefrom via wire 1051, switch pole 1050, point 1049, branch 1048 and lead 1046 to digit "1" solenoid 1011, thence through branches 452b and 452a (Figure 43) to the line 452, causing an additional digit "1" to be entered in accumulator unit 955, that is, an additional ".01" entry in accumulator group 956 as the operative cycle is completed. If brush 1237 also engages its segment 1233, solenoid 1012 is similarly energized via switch pole 1056 and its described connection, causing an additional entry of digit "1" in unit 957, that is, an additional ".01" in accumulator group 958.

Similarly, if brush 1238 engages segment 1234, solenoid 1013 is energized via switch pole 1059 and its described connections, causing an additional entry of digit "1" in unit 959, that is, an addition of .01 in accumulator assembly 960.

Summary of fractional correction

Summarizing the above description as applied to tax billing, if the fractional cent accumulation in the quarterly tax entry accumulation is less than one-quarter cent or .0025 in the accumulator groups, no additional cents are added in accumulator assemblies 956, 958 or 960. If the fractional cent accumulation is from .0025 to .0049 inclusive, one cent is added in accumulator assembly 956. If the accumulation is from .0050 to .0074 inclusive, one cent is added in each assembly 956 and 958. If the accumulation is from .0075 to .0099 inclusive, one cent is added in each assembly 956, 958 and 960.

Under any of the four above described conditions, if the accumulated amount in the third decimal fractional unit 944 of the full tax accumulator assembly 943 is greater than or equal to 5, that is, if the fractional cent in the full-tax accumulation is one-half or more, the brush 1040 is in contact with segment 1039, and since relay poles 1034 and 1043 are closed as noted above, current is directed to solenoids 1032 and 1010, causing an additional digit "1" to be entered in units 1027 and 951e. If, on the other hand, the fractional cent is less than one-half in the full tax accumulation, brush 1040 is out of contact with segment 1039 and no circuit is established to solenoids 1032 and 1010 so that no additional cents are entered in units 1027 and 951e.

The above fractional correction may be summarized briefly in the following table in which:

- A represents the full tax initially entered in accumulator assembly 943;
- A₁ is the third fractional decimal digit of A;
- B is the quarterly tax initially entered in accumulator assemblies 952, 956, 958 and 960;
- B₁ is the third and fourth fractional decimal entry of B;
- C, D, and E are the quarterly accumulations entered in assemblies 956, 958 and 960, their third decimal fractional digits being the same as B₁.

The figures below, A₁ and B₁ represent the various conditions of these quantities, while the figures below, A, B, C, D, and E, show additions thereto under the various corresponding conditions.

Table 3

A ₁	A	B	B ₁	C	D	E
>4	+0.01	+0.01	75 to 99	+0.01	+0.01	+0.01
>4	+0.01	+0.01	50 to 74	+0.01	+0.01	-----
>4	+0.01	+0.01	25 to 49	+0.01	-----	-----
>4	+0.01	+0.01	0 to 24	-----	-----	-----
<5	-----	-----	75 to 99	+0.01	+0.01	+0.01
<5	-----	-----	50 to 74	+0.01	+0.01	-----
<5	-----	-----	25 to 49	+0.01	-----	-----
<5	-----	-----	0 to 24	-----	-----	-----

From the above table it is evident that any one of eight different sets of conditions may exist at the completion of the entry of the assessed valuation in the machine and prior to the fractional correction. By the provision of the means described, the machine is adapted to drop or add the fractional cent in the full tax and to correct the quarterly accumulations so that the full tax to be printed is always exactly equalled by the sum of the four quarterly amounts to be printed. The automatic correction under the eight different sets of conditions may be illustrated as follows:

Table 4

Full tax entries	Quarterly tax entries		Printed
99.99	24.99	27.73 +0.01	27.74
9.999	2.499	27.73 +.01	27.74
.999	.2499	27.73 +.01	27.74
110.955	5>4 27.7389	27.73 +.01	27.74
+ .01	89	Sum	110.96
110.96	Printed		110.96
99.99	24.9975	27.74 +0.01	27.75
9.999	2.4997	27.74 +.01	27.75
.999	.2499	27.74 +.01	27.75
110.988	8>4 27.7471	27.74	27.74
+ .01	71	Sum	110.99
110.99	Printed		110.99
14.32	3.58	3.97 +0.01	3.98
1.432	.358	3.97 +.01	3.98
.143	.0358	3.97	3.97
15.895	5>4 3.9738	3.97	3.97
+ .01	38	Sum	15.90
15.90	Printed		15.90
99.90	24.975	27.72 +0.01	27.73
9.990	2.4975	27.72	27.72
.999	.2497	27.72	27.72
110.889	9>4 27.7222	27.72	27.72
+ .01	22	Sum	110.89
110.89	Printed		110.89
1028.00	258.50	258.80	258.80
6.84	1.71	258.80 +0.01	258.81
2.394	.5685	258.80 +.01	258.81
1035.234	4<5 258.8085	258.80 +.01	258.81
.00	85	Sum	1035.23
1035.23	Printed		1035.23
99.48	24.87	27.60	27.60
9.948	2.487	27.60 +0.01	27.61
.994	.2487	27.60 +.01	27.61
110.422	2<5 27.6057	27.60	27.60
.00	57	Sum	110.42
110.42	Printed		110.42
13.31	3.3275	3.60	3.60
1.331	.3327	3.60 +0.01	3.70
.133	.0332	3.60	3.60
14.774	4<5 3.6034	3.60	3.60
.00	34	Sum	14.77
14.77	Printed		14.77
99.46	24.865	27.60	27.60
9.946	2.4865	27.60	27.60
.994	.2486	27.60	27.60
110.400	0<5 27.6001	27.60	27.60
.00	01	Sum	110.40
110.40	Printed		110.40

The foregoing examples illustrate the fact that the automatic correction is exact under any set of conditions which may arise. The lowest two order accumulator units of assemblies 956, 958 and 960, Figures 42 and 43, need not be equipped with commutators, being used only for accumulation and carry-over of fourth decimal fractions by means of mechanical structures shown in Figures 17, 18 and 19. No commutators are necessary, since the solenoids of these orders are directly controllable in parallel with those of group 952 via the permanent wiring conditions such as 1240 and 1241, Figure 43. For the same reason no individual commutators are required on the control-head entry-receiving wheels 1203 and 1204, Figure 48, as previously noted.

It will be noted that the example illustrating the fifth set of conditions in Table 4, involves the entered full tax and quarterly tax amounts given in Table 2 and figured on the assessed valuation of \$30,270. at the assumed yearly rate of \$3.42 per hundred dollars. In other words, the quantity 30,270 having been entered by depression of the digit keys as described, the fraction key is depressed, causing the machine to perform a cycle in which the quarterly amounts in the accumulators are corrected in the second decimal

fraction, one cent being added to three of the quarterly amounts.

The print key 927 when depressed closes the following connections from the normally charged plate 978;

1. Through a lead 1075 to subtract cam solenoids 983a, 983b, 983c, 983d, 983e and 983f, Figure 43;
2. Through conductor 911 to the cut-in relay magnet 473;
3. Through lead 1064, Figures 43a and 43, and the switches controlled by relays such as relay 1065, Figure 47, to the read-out or commutating devices of accumulator assemblies 942, 943, 952, 956, 958 and 960;
4. Through a lead 1076 to the locking solenoid 1071;
5. Through a conductor 1077 to the add cam solenoid 982 of total accumulator assembly 945, Figure 43.

Depression of print key 927, therefore causes the machine to perform a cycle in which:

1. The assessed valuation of \$30,270 previously stored in accumulator assembly 942 is set up under control of the read-out devices thereof by means of selector solenoids 1002, 1014, and 1026, bank 935 and printed by the type bars of group 929 in the space 919 of the bill 917, Figure 41;
2. The amount accumulated in full tax accumulator assembly 943 is set up under the control of the accumulator read-out devices by means of solenoids 993, 1078, 1079, 1080 and 1030, bank 936, and the full tax amount \$1035.23 is printed by the type bars of group 930 in space 920 of the bill 917;
3. The quarterly tax accumulation in assembly 952 is set up under control of the accumulator read-out devices, by means of solenoids 998, 999, 1081, 1082, 1021 and 1022, bank 937, set-ups corresponding to the third and fourth decimal fractional order quarterly tax set-ups also being caused in solenoid banks 938, 939, 940 and 941, by parallel connections controlled from accumulator units 951f and 951g. At the same time, the set-ups above the two lowest orders having been completed in solenoid banks 938, 939 and 940 under control of accumulator groups 956, 958 and 960, the corrected quarterly tax amounts of \$258.80, \$258.81, \$258.81 and \$258.81, are printed on stubs 921, 921a, 921b and 921c respectively of bill 917; and
4. The corrected full tax of \$1035.23 is stored in the total accumulator assembly 1085 due to the action of the latter's add cam solenoid 982; during the second half of the cycle the accumulator assemblies 942, 943, 952, 956, 958, 960, and the control head 1205, are cleared due to the action of their subtract cam solenoids as previously described.

Depression of the total key 928 completes the following connections:

1. To the cut-in relay magnet 473;
2. Through lead 1094 to the total accumulator assembly 1085;
3. Through lead 990a to the type disconnecter solenoids 984, 984b, 984c, 984d and 984e;
4. Through lead 1083 to subtract cam solenoid 983 of the total accumulator assembly 945; and
5. Through a lead 928a to the locking solenoid 1071, Figure 43a.

Accumulator assembly 1085 being adapted to control solenoid bank 936 through leads such as 1084, Figure 43, the total accumulated in assembly 1085 is set up in bank 936. The machine performs a cycle in which the total of the full tax

bill is printed by the type group 938 either on a bill such as 917 or on any desired type of blank such as the paper strip 273 shown in Figure 3. During the second half of the cycle, the accumulators of assembly 1085 are cleared by direct subtraction, as previously set forth.

If at any time previous to the printing of a bill, an error in entry is discovered, the error key 1066 may be depressed. This action closes connections to the cut-in relay magnet 473, to all accumulators and their subtract cam solenoids except those of the total accumulator assembly, to the locking solenoid 1071, and to the type disconnecter solenoids. The machine performs a cycle in which all accumulators except the total accumulators are cleared by direct subtraction. The erroneous entries are thus cleared and the machine returned to normal without disturbing previously accumulated totals, after which the assessed valuation may be re-entered correctly.

It is obvious that the use of the fractional correction control head may be extended to divisions of a full amount other than quarters by providing the ring 1230 with the proper number of segmental steps and corresponding brushes for controlling the desired number of set-up magnet banks, and that the ability of the invention to automatically correct divisional amounts to bring the sum of their printed divisional amounts into exact agreement with the corrected full amount renders the present invention particularly applicable to computations in banking and the like wherein no discrepancy is permissible. In the case of machines adapted to computations from loan principal amount entries and the like, including fractional dollars, the full yearly tax or interest accumulator bank 943 may be provided with a fourth decimal fractional order unit and solenoid row.

Throughout the description the set-up selector magnets have been described as solenoids, but it will be understood that magnets of the core and armature type may be used in the same manner, particularly in machines of the nature just described in which the multiplicity of simultaneous set-up operations may make the use of the latter type magnets desirable in order to minimize current consumption. Figure 50 illustrates a suitable magnetic selector of the core and armature type, in which energization of the coil 1275 causes the core pole 1276 to attract the armature 1277, raising a rod 1278 which in turn elevates the detent 199a.

From the foregoing description, illustrating the application of the invention to certain typical computational functions, it will readily be evident to those skilled in the art that it is applicable to a wide variety of computational uses such as calculating and billing insurance charges, calculating and recording interest, dividends, commissions, installment payments, discounts and payments based on piece work rates; translating and recording foreign exchange rates and the like.

While the invention has been described in preferred form, it is not limited to the exact structures illustrated, as various modifications may be made without departing from the scope of the appended claims.

What is claimed is:

1. In a computing device, in combination, a full amount accumulator including units of three fractional decimal orders, a plurality of divisional amount accumulators each including units of four fractional decimal orders, a control ac-

cumulator including two ordinal entry-receiving units, means to enter a primary full amount in said first accumulator and primary divisional amounts in said divisional amount accumulators and said control accumulator, the entries in said divisional amount accumulators being each equal to said full amount entry divided by the number of said divisional amount accumulators within the decimal limits of said accumulators and the entry in said control accumulator comprising the third and fourth decimal fractional order portions of said entered divisional amounts, means controllable by said third fractional decimal order unit of said full amount accumulator to condition said entering means to cause entry of an additional digit "1" in the second fractional decimal order unit of said full amount accumulator and an additional digit "1" in the second decimal fractional order unit of one of said divisional amount accumulators to produce final entries in said two accumulators when said primary third order decimal fractional entry in said full amount accumulator is greater than "4," and means selectively controllable by said control accumulator in accordance with the magnitude of said primary entry therein to condition said entering means to cause increase of the entry in one or more of said other divisional amount accumulators whereby the sum of the final entries in all said divisional amount accumulators through the second decimal fractional orders therein may equal said final full amount entry through the second decimal fractional order thereof.

2. In a computing device, in combination, a full amount accumulator including units of at least three fractional decimal orders, four divisional amount accumulators each including units of at least four fractional decimal orders, an auxiliary accumulator having two decimal ordinal entry-receiving units, means to enter a primary full amount in said first accumulator and to enter primary divisional amounts in said four divisional amount accumulators and an auxiliary entry in said auxiliary accumulator, the primary entries in said four divisional amount accumulators each being one-fourth of said primary full amount to the fractional limits of said accumulators and said auxiliary entry being identical with the third and fourth fractional decimal entries in said divisional amount accumulators, means controllable by the third fractional decimal order unit of said full amount accumulators when the primary entry in said unit is digit "5" or greater to condition said entering means to increase by "1" the digital entries in the second fractional decimal order units of said full amount accumulator and one of said divisional amount accumulators to produce final amount settings therein, and means controllable by said auxiliary accumulator in accordance with the magnitude of said auxiliary entry therein to selectively cause said entering means to increase by digit "1" the second decimal fractional primary entry in one of said other three divisional amount accumulators when said auxiliary entry is from "25" to "49" inclusive, in two of said other three divisional amount accumulators when said auxiliary entry is from "50" to "74" inclusive, and in all said other three divisional amount accumulators when said auxiliary entry is from "75" to "99" inclusive.

3. In a billing machine, in combination, a full amount accumulator including at least one fractional cent ordinal accumulator unit, a plurality of divisional amount accumulators each includ-

ing at least two fractional cent ordinal accumulator units, an auxiliary accumulator including two ordinal entry-receiving units, manually controllable means to enter a primary full amount in said full amount accumulator and to simultaneously enter divisional amounts in said divisional amount accumulators and to effect an auxiliary entry in said auxiliary accumulator, said divisional amount entries being each equal to said primary quantity divided by the number of said divisional quantity accumulators and said auxiliary entry being identical with the first and second fractional cent portions of said divisional amount entries, means selectively conditioned by said full amount accumulator to control said entering means to effect an additional cent entry in said full amount accumulator and in one of said divisional amount accumulators when the primary fractional cent entry in said full amount accumulator is one-half cent or greater, and means adapted to be selectively conditioned by said auxiliary accumulator to control said entering means to effect an additional cent entry in one or more of said other divisional amount accumulators whereby the sum of all the final divisional entries through the full cents order may equal the final full amount entry through the full cents order.

4. In a device of the character described, in combination, two accumulators each including a plurality of digital units in successive denominational orders, control means including auxiliary entry-receiving units in successive decimal orders, means including actuator bars to effect original entries in said accumulators and in said auxiliary units, a plurality of digital selector detents operable to stop said bars from determining the values of said entries, individual electrical means to operate said detents, said bars, detents and individual electrical means being associated in groups, one group for each of said accumulators and said control means, means including a power circuit to cause said entry effecting means to effect said entries, commutating control means operatively connected to said auxiliary entry-receiving units and settable conjointly therethrough by said original entries therein, and means selectively controllable through said commutating means to energize one or more of said individual electrical means to condition the same to determine an additional entry by said entry-effecting means in one or both of said accumulators.

5. In a business machine, including main accumulators and means to effect entries therein, said means including a plurality of electrically operable selector means for determining the values of said entries, and means to selectively establish primary operating circuits from a source of current through said selector means, in combination, an auxiliary accumulator including ordinal units in two successive decimal orders, said units being adapted to receive primary entries by said entering means under control of some of said selector means, said selector means being associated in groups, one group for each of said accumulators including said auxiliary accumulator, said auxiliary accumulator including control means operatively connected to both said auxiliary ordinal units and adapted to be positioned conjointly therethrough by said primary entries in said units, said control means including commutating means adapted to selectively direct current to one or more of said other selector means in one or more of said groups associated with said main accumulators in accordance with the combined magni-

tude of said primary entries in said auxiliary units and the consequent positioning of said control means, and means to establish an operative circuit or circuits from said source of current through said commutating means and said one or more of said other selector means.

6. The combination claimed in claim 5, wherein said control means includes a carrier differentially geared to both said auxiliary ordinal units, the gear ratio between said carrier and one of said units being ten times the gear ratio between said carrier and said other unit.

7. The combination claimed in claim 5, wherein said control means includes a carrier differentially geared to both said auxiliary ordinal units and wherein said commutating means includes a stepped conducting member carried by said carrier and a plurality of stationary brushes adapted to be successively engaged by said stepped conducting member when said carrier is driven in a forward direction through said gearing.

8. In a business machine, in combination, a plurality of similarly arranged groups of selector magnets, circuit means to connect corresponding magnets of said groups in parallel, said circuit means being normally open, switching means to close said circuit means, a source of current, manipulative means to actuate said switching means and to concurrently and selectively direct current through said parallel connections to said corresponding magnets in said groups, control means adapted to selectively establish individual connections to predetermined magnets in said groups independently of said switching means and said actuating means, and variably settable means to direct current from said source through said individual connections to said magnets independently of said first current-directing means.

9. The invention according to claim 8 wherein certain corresponding magnets in said groups are permanently connected in parallel, whereby current may be directed thereto in parallel either by said manipulative current-directing means or by said variably settable current-directing means through said control means.

10. The invention according to claim 8 wherein said switch-closing means includes magnets adapted to receive current from said source through said manipulative current-directing means.

11. In a billing machine, in combination, a plurality of groups of entry-receiving devices, manually controllable means to simultaneously effect an entry in the first of said groups to at least three fractional decimal orders, and to effect a divisional entry in each of said other groups, each of said divisional entries being equal to said first entry divided by the number of said divisional entries to at least four fractional decimal orders; and auxiliary control means adapted to be selectively pre-conditioned, in accordance with the third and fourth fractional digit entries made in the divisional groups by said entry-effecting means, during said entries, to control said entering means for causing alteration of one or more of said original divisional amount entries, and manipulative means to cause operation of said auxiliary control means, whereby the final sum of said divisional entries through the second fractional decimal order will equal said first entry through the second fractional decimal order.

12. The combination claimed in claim 11 wherein said first group of entry-receiving devices includes control means adapted to control said entering means to cause increase of said first entry

and of one of said divisional entries by "1" in the second fractional decimal order when the third fractional decimal order of said first entry is digit "5" or greater, said last control means being rendered effective upon operation of said manipulative means.

13. In a device of the character described, in combination, an accumulator assembly comprising a plurality of digital units in successive decimal orders, means to enter an initial full amount in said assembly, a plurality of divisional amount accumulator assemblies each comprising a plurality of digital units in successive decimal orders, auxiliary entry-receiving means, means controllable concurrently with said first entering means to enter initial divisional amounts in said divisional amount assemblies, and to effect an auxiliary entry in said auxiliary entry-receiving means, each of said initial divisional amounts being equal to said full amount divided by the number of said divisional amount assemblies within the fractional limits of said accumulators, means controllable by one of said digital units at said first accumulator assembly to condition said first entering means to alter the initial amounts entered in said first assembly and in one of said divisional amount assemblies whereby a final full amount may be accumulated in said first assembly and a final divisional amount may be accumulated in said one of said divisional amount assemblies, means controllable by said auxiliary entry receiving means to condition said second entering means to selectively alter the initial amounts entered in said other divisional amount accumulator assemblies to accumulate final divisional amounts therein, whereby the sum of said final divisional amounts in and above a pre-determined decimal order may exactly equal said final full amount in and above said pre-determined decimal order, and means to actuate said conditioned first and second entering means.

14. In a device of the character described, including a plurality of electrically operable selectors, in combination, a controller having two entry-receiving units in successive decimal orders, means to effect entries in said units under control of some of said selectors, a carrier differentially geared to said two units, the gear ratio from said higher decimal order entry-receiving unit to said

carrier being ten times higher than the gear ratio from said lower decimal order entry-receiving unit to said carrier, commutating means operable by said carrier and adapted to direct current to one or more of said other electrically operable selectors selectively and in accordance with the magnitude of said entries, devices associated with said other selectors and controllable thereby, and means to establish an operative circuit or circuits through said commutating means and one or more of said other electrically operable selectors to condition the same to control said devices selectively and in accordance with the magnitude of said entries.

15. The combination claimed in claim 14, wherein said carrier is rotary, and wherein said gear ratio from said higher decimal order unit to said carrier is ten to one and said gear ratio from said lower decimal order unit to said carrier is one to one, whereby the rotative movement of said carrier due to entries in said units may equal in hundredths of a complete revolution the total two digit entry in said controller.

16. In a tax billing machine, in combination, plural entry-receiving means, means to effect entries of a primary full tax amount through at least three fractional decimal orders in one of said entry receiving means and of primary divisional tax amounts comprising fractions of said full tax amount in the others, means settable by said entry-effecting means in effecting said primary full tax amount entry to control elements of said entry-effecting means to effect a one-cent addition to said primary full tax amount receiving means and to one of said primary divisional tax amount receiving means when the lowest fractional cent entry of said primary full tax amount is one half-cent or greater, and means settable by said entering means in effecting said primary divisional tax amount entries to control elements of said entering means to selectively effect additions to one or more of said divisional tax amount entry receiving means whereby the sum of said final divisional tax amount entries exclusive of fractional cents may exactly equal said final full tax amount entry exclusive of fractional cents.

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