No. 613,395. Patented Nov. 1, 1898.

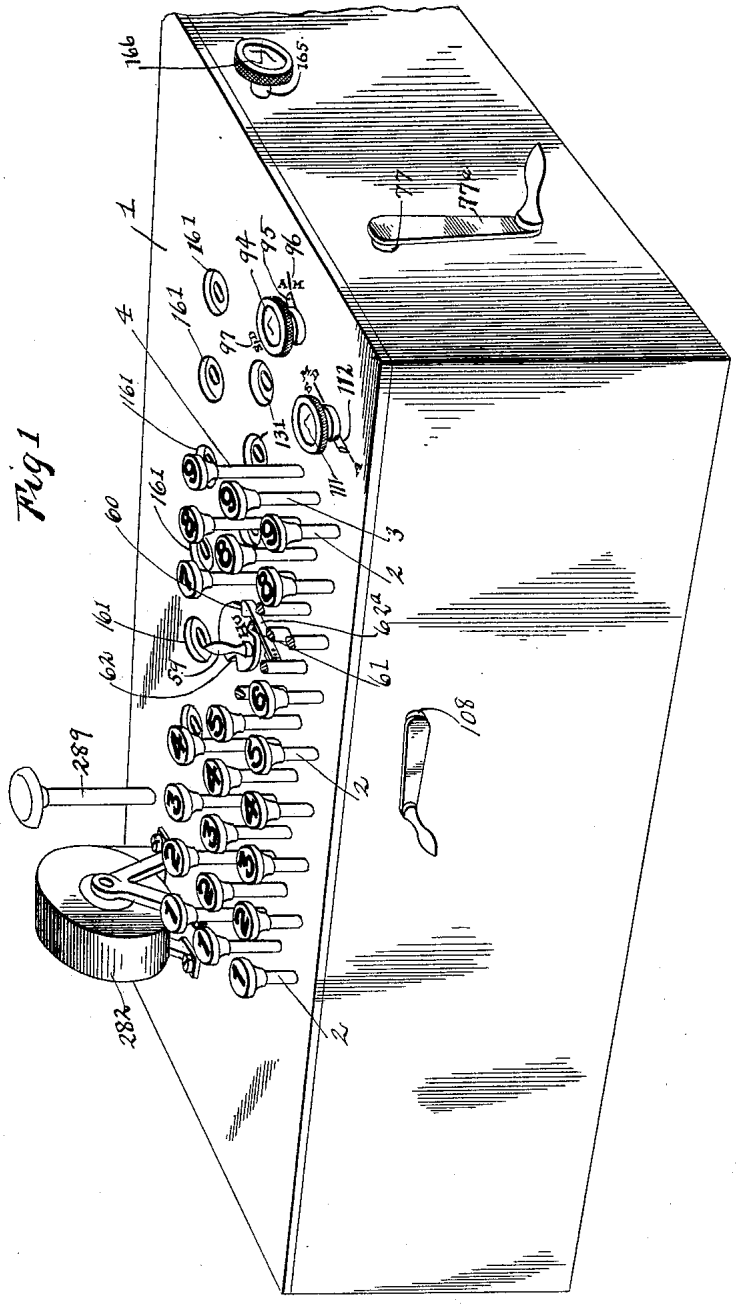
J. PERFLER & A. SCHNEIDER.

COMPUTING MACHINE.

(Application filed Sept. 13, 1897.)

(No Model.) 8 Sheets—Sheet 1.

Fig 1



WITNESSES:

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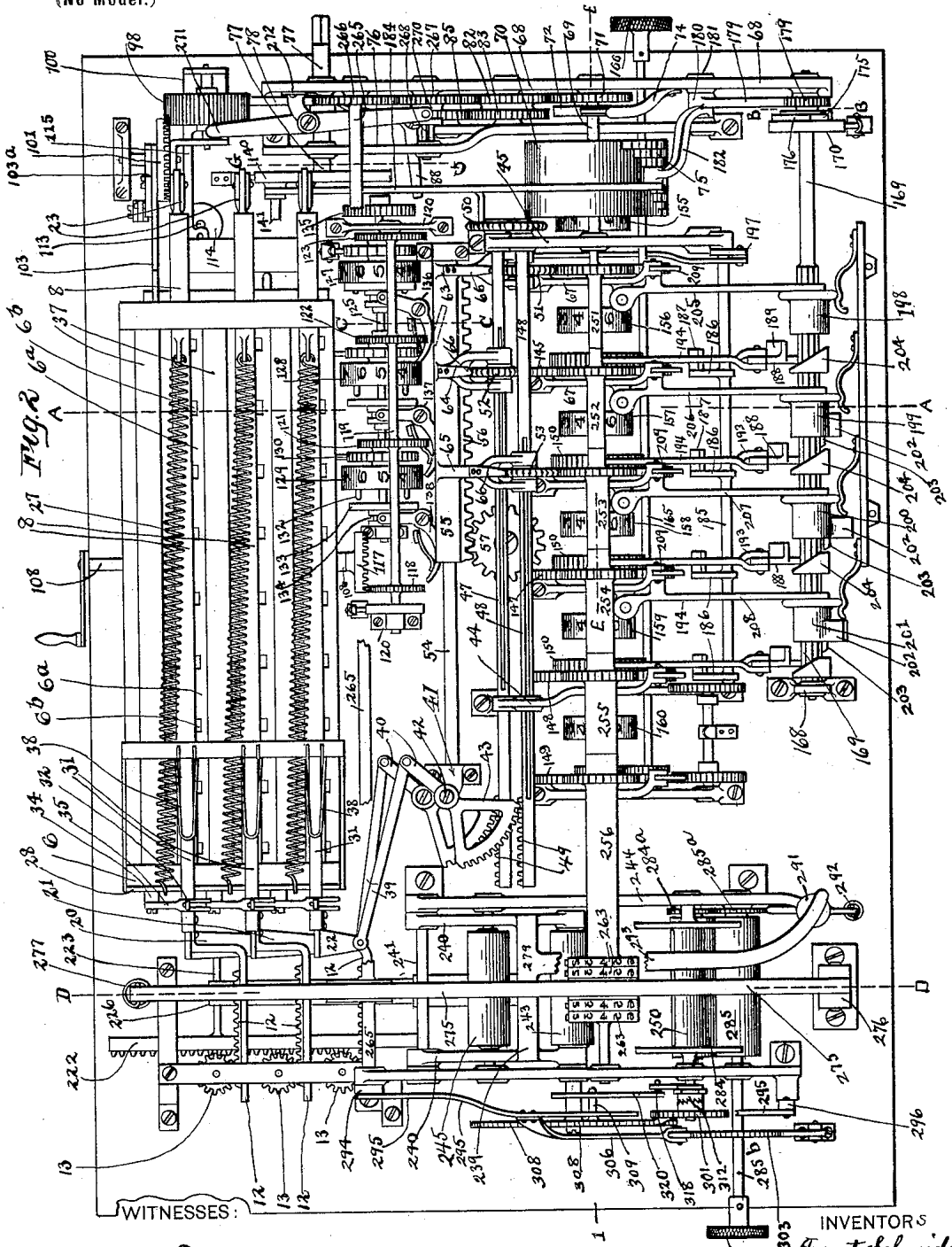
Fig. 2



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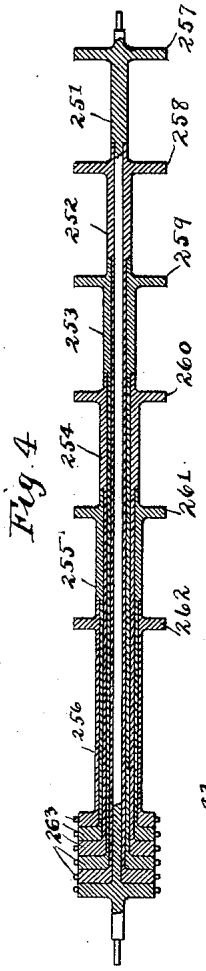

Fig. 4

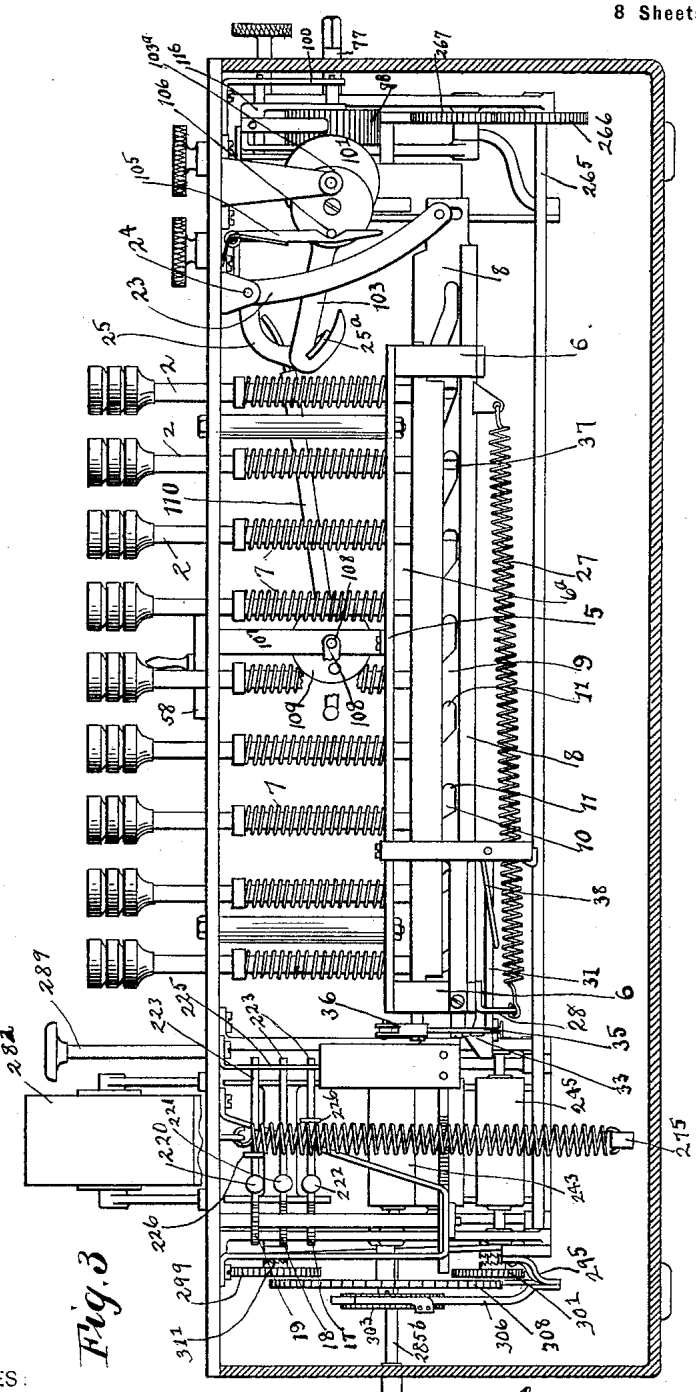

Fig. 3

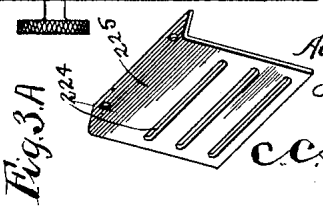

Fig. 3A

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Fig. 5

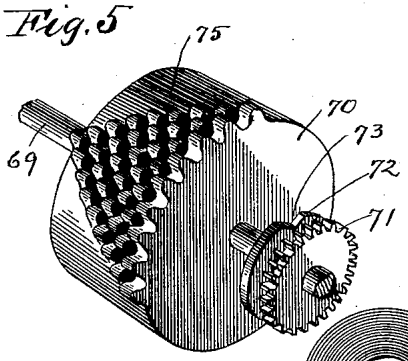

Fig. 6

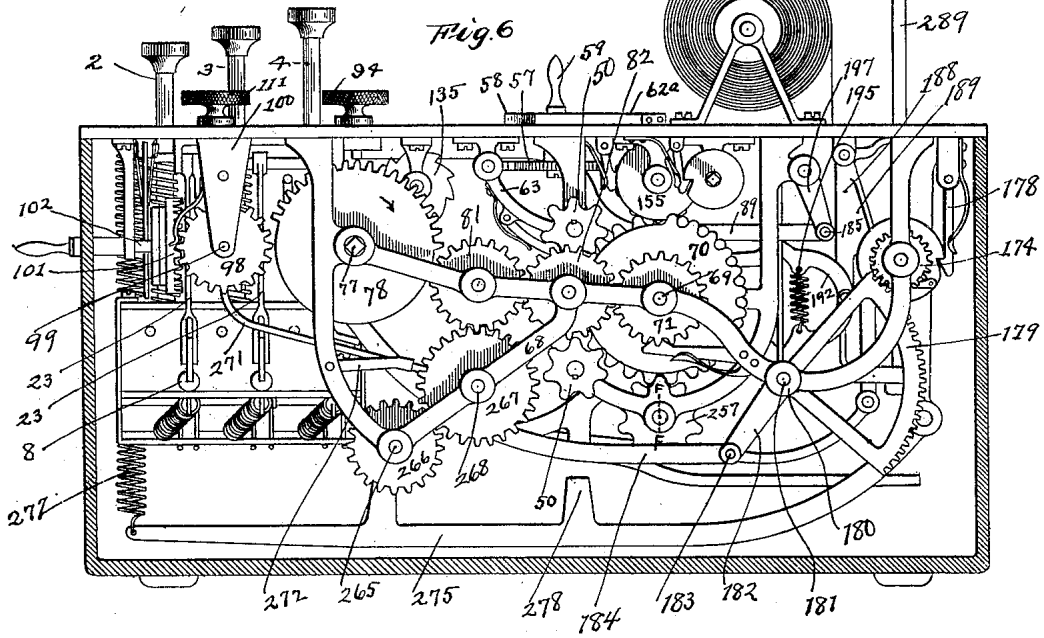

Fig. 7

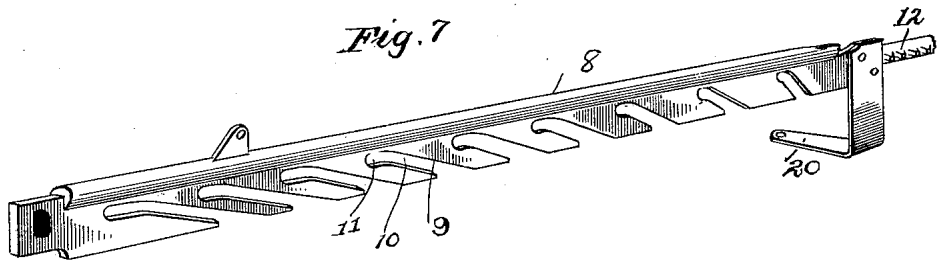

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Fig. 8

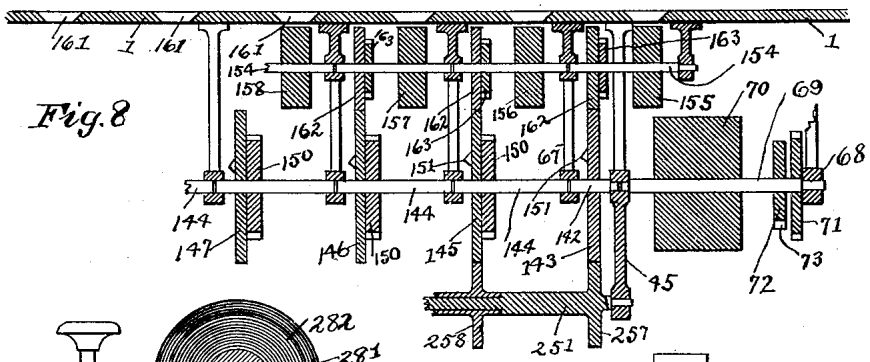

Fig. 9

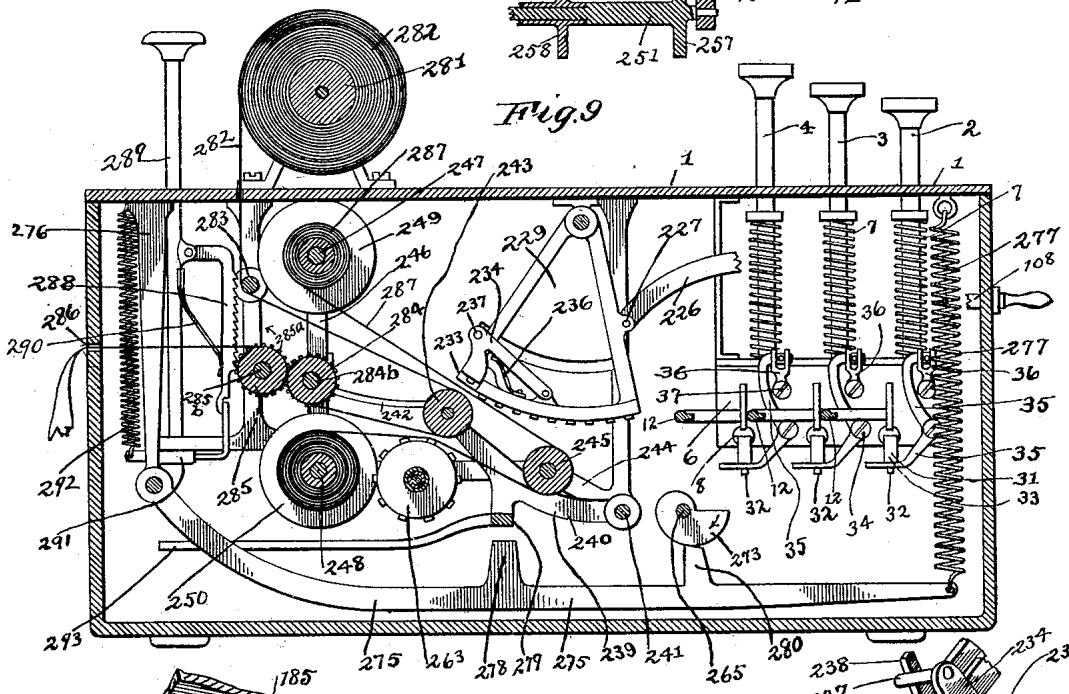

Fig. 10

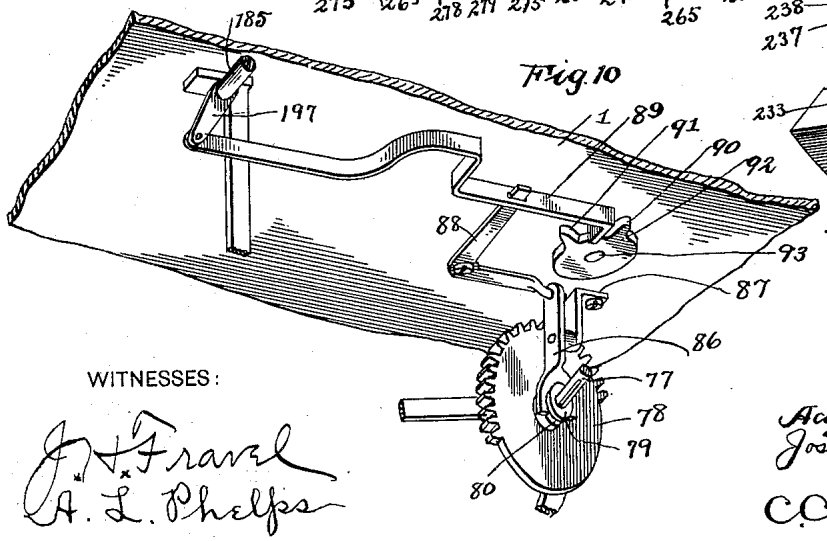

Fig. 11

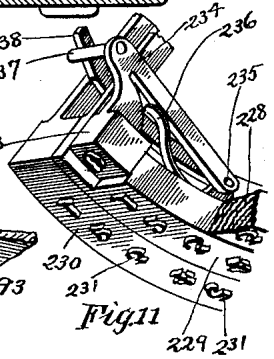

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Fig. 15

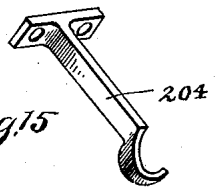

Fig. 13

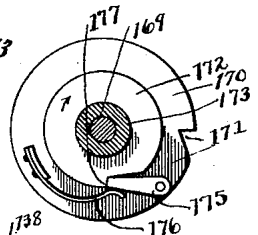

Fig. 14

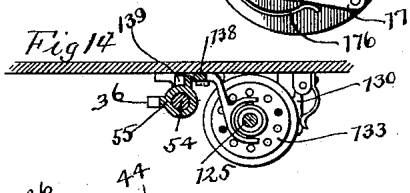

Fig. 12

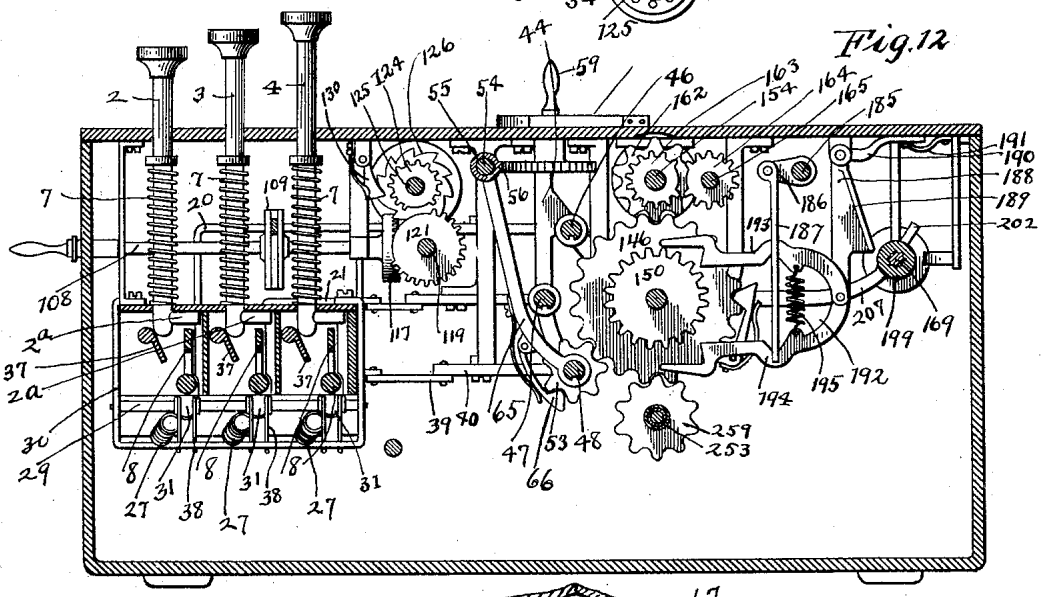

Fig. 16

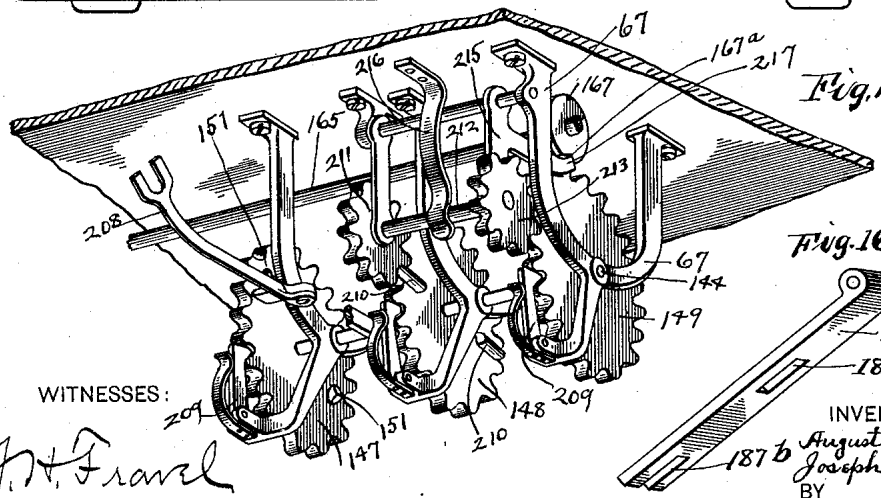

Fig. 16 A

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Fig. 17

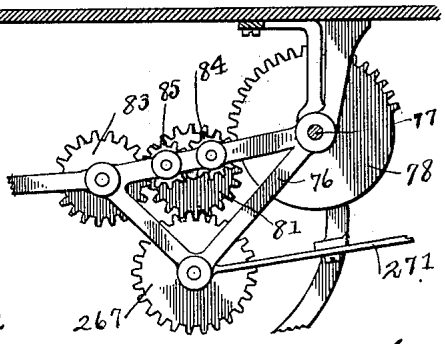

Fig. 18

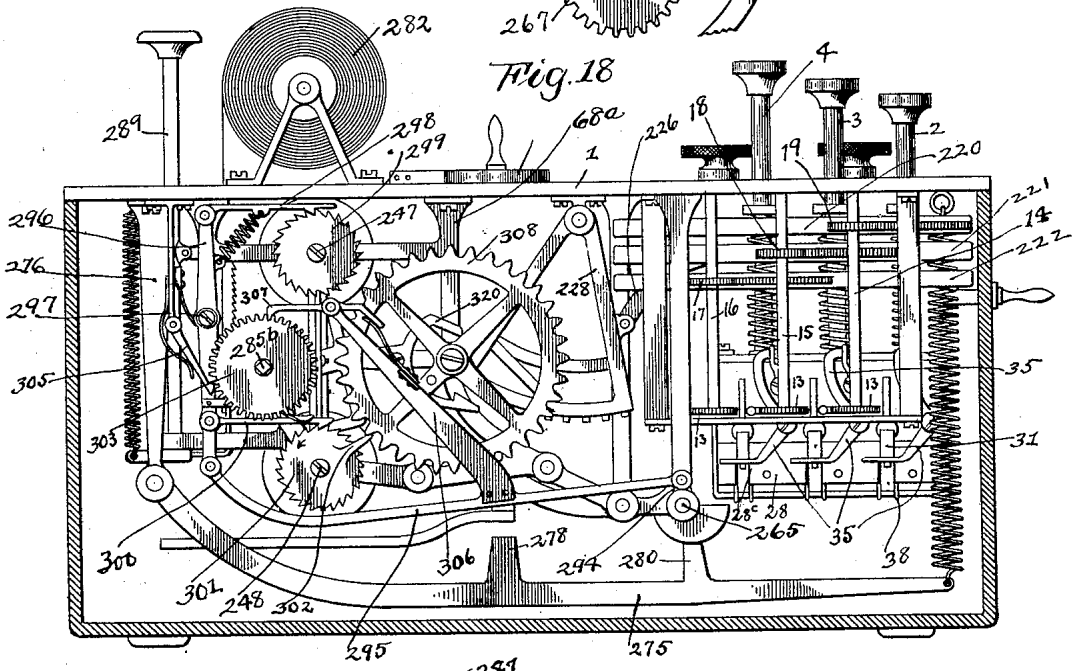

Fig. 19

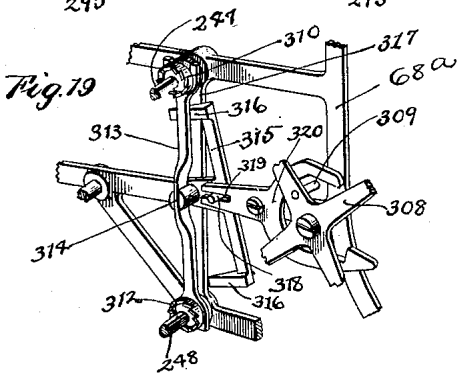

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Fig. 20

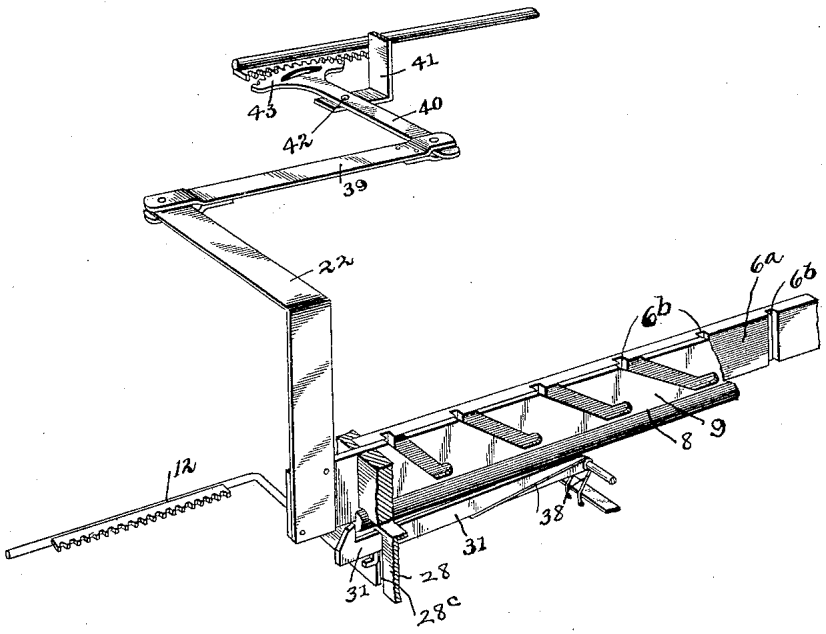
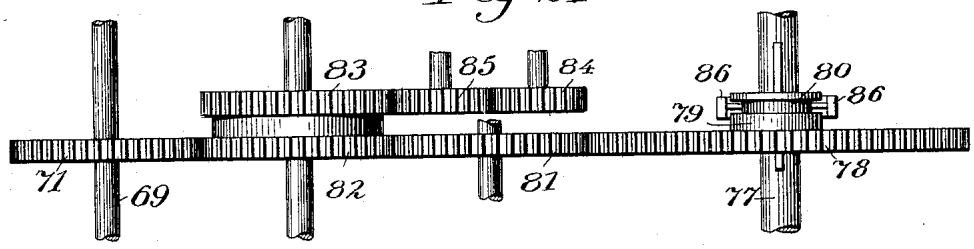


Fig. 21.



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UNITED STATES PATENT OFFICE.

JOSEPH PERFLER AND AUGUST SCHNEIDER, OF COLUMBUS, OHIO, ASSIGNORS OF ONE-THIRD TO LEWIS FINK, OF SAME PLACE.

COMPUTING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 613,395, dated November 1, 1898.

Application filed September 13, 1897. Serial No. 651,407. (No model.)

To all whom it may concern:

Be it known that we, JOSEPH PERFLER and AUGUST SCHNEIDER, citizens of the United States, residing at Columbus, in the county of Franklin and State of Ohio, have invented a certain new and useful Improvement in Computing-Machines, of which the following is a specification.

Our invention relates to the improvement of computing-machines; and the objects of our invention are to provide improved mechanical means for accomplishing the operations of addition, subtraction, multiplication, and division; to combine therewith improved means for printing the results of the additions; to so construct said machine as to insure a positive operation of the parts and accurate results, and to produce other improvements in details of construction and arrangement of parts, which will be more fully pointed out hereinafter. These objects we accomplish in the manner illustrated in the accompanying drawings, in which—

Figure 1 is a perspective view of our machine as it appears when incased. Fig. 2 is a view of the under side of the machine with the casing removed. Fig. 3 is a sectional view of the casing, showing a side view of the mechanism contained therein. Fig. 3^{A} is a detail view in perspective of a guide-frame which we employ in the manner hereinafter set forth. Fig. 4 is a central longitudinal section of one of the sectional shafts which we employ, said section being taken on line F F of Fig. 6. Fig. 5 is a detail view in perspective of the amount-regulating wheel. Fig. 6 is an end view of the mechanism. Fig. 7 is a detail view in perspective of one of the regulating and operating bars, showing said bars inverted. Fig. 8 is a sectional view on dotted line E E of Fig. 2. Fig. 9 is a sectional view on dotted line D D of Fig. 2. Fig. 10 is a detail view in perspective of the reversing mechanism. Fig. 11 is a detail view in perspective of a portion of the printing-segments. Fig. 12 is a sectional view on line A A of Fig. 2. Fig. 13 is an enlarged sectional view on line B B of Fig. 2. Fig. 14 is a sectional view on line C C of Fig 2. Fig. 15 is a detail view in perspective of a sleeve-throwing cam-finger which we employ in the manner hereinafter specified. Fig. 16 is a detail view in perspective of a portion of the transfer mechanism. Fig. 16^{A} is a detail view in perspective of one of the bars which we hereinafter employ in the reversing mechanism. Fig. 17 is a transverse section on line G G of Fig. 2. Fig. 18 is a view in elevation of the opposite end of the machine from that indicated in Fig. 6. Fig. 19 is a detail view in perspective of the ribbon-reversing mechanism. Fig. 20 is a detail view in perspective, showing one of the guide-bars and key-bars and means for transmitting motion to the amount-wheel-operating shafts; and Fig. 21 is an under side view of the gear connections between the operating-wheel, hereinafter numbered 78, and the amount-wheel.

Similar numerals refer to similar parts throughout the several views.

In carrying out our invention we inclose the greater portion of the mechanism thereof in a suitable casing or box, of which 1 represents the top plate. Passing through and projecting above the upper side of the casing are three horizontal rows or banks of keys, these rows or banks being indicated, respectively, at 2, 3, and 4, and being further designated, respectively, as units, tens, and hundreds keys. The outer ends or push-buttons of the keys of each bank are numbered consecutively from "1" to "9." Supported from the under side of the casing top plate is a key-frame, which consists of a horizontal frame-plate 5, having downturned ends 6. As indicated in the drawings, the stems of the keys 2, 3, and 4 pass downwardly through the frame-plate 5, each of said key-stems being normally retained in its upper or elevated position by a coiled spring 7 thereon. The lower end portion of each of the key-stems has projecting at right angles therewith a short pin 2^{a}, these pins being shown in Fig. 12.

8 represents parallel regulating and operating bars, of which there is one for each bank of keys. The bars 8 are adapted to extend through and have a sliding bearing in the key-frame end faces 6. Each of said bars is provided throughout its length with an upwardly-extending blade portion 9, in which

are formed successively-inclined recesses or ways 10, each of the latter terminating at its lower end in a rounded shoulder or horizontal extension 11, this construction being shown more clearly in Fig. 7 of the drawings. Extending between the frame ends 6 and adjacent to each of the blades 9 is a vertical guide-plate 6^a, these guide-plates being provided at intervals on those sides which are next to the blades 9 with vertical guideways 6^b, into which the ends of the key-pins 2^a are adapted to project. Each of the sliding bars 8 has extending from what we will term its "outer end" a rack-bar 12, the side teeth of which gear with pinions 13, which are mounted on the lower end portions of vertically-journaled shafts 14, 15, and 16, said shafts carrying on their upper end portions, for reasons hereinafter stated, pinions 17, 18, and 19, the latter being supported at different heights on said shafts, as shown more clearly in Fig. 18 of the drawings. With each of said outer bar ends is also secured a forwardly-extending arm, said arms being numbered, respectively, at 20, 21, and 22. As shown more clearly in Fig. 20 of the drawings, each of the rack-bars 12 is of an angular form or provided with a crank-bend.

With what we will term the "inner end" of each of the bars 8 is jointedly connected the upper end of a downwardly and outwardly inclined bar 23, the upper ends of the latter being fulcrumed below the top plate on a short transverse shaft 24, this construction being shown in Figs. 3 and 2. 25 represents a rocking frame which also is fulcrumed to the shaft 24 and normally leans toward the key-banks.

Each of the bars 8 has connected therewith one end of a coiled spring 27, the remaining end of which is secured to a downwardly-extending end extension 28 of the key-frame, said springs operating to exert an outward tension on said bars. As indicated in Figs. 12, 9, 2, and 3, we fulcrum on a cross-shaft 29 of a frame 30, which bridges the bars 8, the inner end portions of outwardly-extending latch-bars 31, the outer end portions of the latter working loosely in slotted openings 28^c of the frame 28. On the outer side of this frame 28 each of said latch-bars is provided with a T-lug 32 on its upper side and is formed with a catch shoulder or head, which is indicated at 33 in Fig. 3, these catch-shoulders being adapted to be detachably engaged with the outer ends of the bars 8. As shown more clearly in Figs. 3, 9, and 2, we fulcrum at 34 to the outer side of the outer end frame 6 a substantially bell-crank-shaped lever 35. The lower arm of each of these levers 35 is bifurcated and made to embrace the stem of one of the T-heads, while the rearwardly-turned upper arm thereof has a jointed connection with the upper end of a short arm 36, one of which depends from the outer projecting end of each of three journaled trip-bars 37, which extend between the end frame pieces 6 and adjacent to the rear side of each of the bar-blades 9, said trips being shown in Figs. 3, 12, and 2. As indicated, each of the latch-bars 31 is normally pressed upward by a spring 38, which serves to retain the shoulder or head 33 in engagement with the outer end of the bar 8 and prevents the latter being forced outward by its spring 27. To each of the forwardly-turned arms 20, 21, and 22 is fulcrumed one end of a lever-bar, these lever-bars being indicated at 39. These arms 39, which are inclined inwardly and forwardly, are, as shown more clearly in Fig. 2 of the drawings, fulcrumed at their remaining ends to the outer ends of segmental rack-stems 40, the latter being fulcrumed to a frame-stand 41 at points indicated at 42, each of said stems carrying beyond its fulcrum-point a rack-segment 43. As indicated more clearly in Figs. 2 and 12, we provide at points in front of the key-frame downwardly-extending frame-hangers 44 and 45, between which are journaled, one above the other and in the arc of a circle, horizontal shafts 46, 47, and 48, which shafts will hereinafter be referred to as units, tens, and hundreds shafts. With the outer end portion of each of these shafts is formed a short horizontal rack 49, with the teeth of which are adapted to engage, respectively, the teeth of the rack-segments 43. On the outer end of each of the shafts 46, 47, and 48 is carried a small gear-wheel 50, the upper and lower ones of these gear-wheels being shown in Fig. 6 and the lower and a portion of the middle gear-wheel being shown in Fig. 2. For reasons hereinafter set forth we provide each of the shafts with a small gear-wheel, which is keyed to slide thereon, said gear-wheels being indicated, respectively, at 51, 52, and 53, and each of said gear-wheels having a corresponding number of teeth with the wheels 50, this construction being shown in Fig. 2 and partially in Fig. 12 of the drawings. Journaled adjacent to the under side of the top plate 1 of the casing, in rear of the shafts 46 47 48, is a horizontal shaft 54, which, as shown in Figs. 2 and 12, is surrounded by a sliding sleeve 55. Carried on the forward side of this sleeve is a horizontal rack 56, the teeth of which are adapted to gear with the teeth of a gear-wheel 57, which is mounted on the lower end of a short vertical shaft which passes through the casing-top and carries on the outer side of said casing-top a disk 58. This disk is provided with an eccentrically-projecting handle 59 and has formed on one side of its periphery adjacent notches 60 and 61 (see Fig. 1) and on the opposite side a notch 62, the notches 60 and 61 being lettered, respectively, "U" and "H" to designate the words "units" and "hundreds" and the notch 62 being known as "tens-notch."

62^a represents a spring-pawl the tooth of which is adapted to engage with the desired one of the notches 60, 61, or 62.

As shown in Figs. 12, 2, and 6, the sleeve 55 has connected therewith downwardly-ex-

tending arms 63, 64, and 65, which have their lower ends engaging, respectively, with the shafts 46, 47, and 48, and said arms also have bifurcations embracing, respectively, the wheels 51, 52, and 53. Each of the sliding wheels 51, 52, and 53 has engaging with the rounded teeth thereof a spring-pressed friction-pawl 66. Between the frame-hangers 45 and 44 we provide a number of downwardly-extending separated frame-hangers 67, the construction of these hangers being shown more clearly in Fig. 16 of the drawings. Journaled between the outer hanger or frame-piece 45 and a frame-arm 68 at the inner side of the machine is a horizontal shaft 69, this construction being shown in Figs. 5, 8, and 2 of the drawings. Upon this shaft 69 is carried an amount-regulating wheel or drum 70, and on the outer end of the shaft 69 is carried a gear-wheel 71, and on the inner side of said gear-wheel said shaft carries a friction-disk 72, the latter being provided with a peripheral notch 73. In this notch 73 is adapted to rest the tooth of a spring-actuated pawl 74. The regulating-wheel 70 has formed on its periphery nine rows of teeth or projections 75, said rows extending in the direction of the circumference of the wheel and being graduated with respect to the number of teeth in the rows from nine to one, the longest row of said teeth being on the outer side of the wheel-face.

Journaled between the frame 68 and an inner side parallel frame 76 is an operating-shaft 77, the latter projecting through the side or end of the casing and being adapted to receive an operating-crank 77^a. This shaft has keyed thereon a segmental or partially-toothed gear-wheel 78, said gear-wheel being provided on its inner face with a projecting hub 79, the latter having a peripheral clutch-way 80 therein, this construction being shown more clearly in Fig. 10 of the drawings. In rear of the wheel 78 is journaled a gear-wheel 81, which on its rear side gears with the outer one of two connected gear-wheels 82 and 83. (See Figs. 2, 6, and 17.) The gear-wheel 82 gears with the wheel 71, which is carried on the shaft 69, as heretofore described. On the inner side of the gear-wheel 81 are loosely journaled two engaging pinion-wheels 84 and 85, the teeth of the pinion 85 engaging with the teeth of the inner gear-wheel 83.

In the manner hereinafter described the gear-wheel 78 is adapted to be made to engage with the teeth of the gear-wheel 81, as shown in Fig. 21, or with the pinion 84.

As shown more clearly in Fig. 10 of the drawings, the peripheral groove 80 of the wheel-hub 79 is embraced by the forks of a clutch-arm 86, which, extending upwardly, is fulcrumed to a depending frame-arm 87 and has jointedly connected with its outer end one arm of a pivoted bell-crank 88, the remaining arm of which engages with a slotted opening in a rearwardly-extending connecting-bar 89. The forward and outturned end of this bar 89 extends between two radially-arranged teeth or projections 90 and 91, which are formed on a disk 92, the latter being mounted on the lower end of a short vertical shaft 93, which passes upward through the top plate 1 and carries thereon a thumb nut or button 94. The shank of this button carries on the outer side of the casing a short pointer or indicator-hand 95. The upper surface of the top plate 1 has printed, engraved, or otherwise produced thereon at points adjacent to the button 94 letter groups 96 and 97, the group 96 consisting of the separated letters "A" and "M" and the group 97 consisting of the separated letters "S" and "D."

In front of the wheel 78 is journaled a comparatively broad gear-wheel 98, the latter being keyed to slide on its shaft 99, which is supported in the lower end of downwardly-extending frame-arms 100. In addition to being adapted to gear with the teeth of the segmental gear-wheel 78 the teeth of said wheel 98 engage with the laterally-projecting teeth of a wheel 101, the shaft 102 of which is journaled at right angles with the shaft 99. The shaft 102 has eccentrically fulcrumed thereon on the outer side of the wheel 101 the rounded head or disk-shaped end of an outwardly-extending hook-arm 103, the hook-shaped outer termination of which embraces loosely the rearwardly-projecting end 25^a of the rocking frame 25, this construction being shown more clearly in Fig. 3 of the drawings. 105 represents a spring-actuated friction-pawl the notched side of which is adapted to engage a pin projection 106 of the disk-shaped head 103^a of the hook-arm 103. Journaled in suitable downwardly-extending frame-pieces 107 and extending transversely beneath the key-frame plate 5 is, as shown in Figs. 3 and 2, a shaft 108. Above the key-frame the shaft 108 carries a disk 109, with which is eccentrically connected a resetting-arm 110, the outer end of which is adapted to engage with the rocking frame 25.

111 represents a thumb nut or button which is located at a point in front of the button 94 on the outer side of the machine, said button carrying a pointer or indicating-hand 112, the latter being adapted to indicate a point "A" or to be so turned as to indicate a point "S M D," the letters indicating these points being printed, engraved, or otherwise made to appear on the face of the case-top on opposite sides of said thumb-nut. The downwardly-extending shaft 113 of the button or nut 111 carries on its lower end a disk 114, which has eccentrically connected with its under side an outwardly-extending shifting-arm 115, said shifting-arm terminating, as indicated more clearly in Fig. 3 of the drawings, in a downwardly-projecting shifting-frame 116, the fingers of which embrace opposite sides of the wheel 98.

On the rear end of the shaft 108, as indicated in Figs. 2 and 12, is carried a gear-wheel 117, the laterally-extending teeth of which are adapted to gear with the peripheral teeth

of a segmental or partially-toothed gear-wheel 118, the latter being carried on a horizontal and longitudinally-arranged shaft 119, which is journaled in suitable bearings 120, which depend from the top plate 1. This shaft also carries thereon at separated points segmental wheels 121, 122, and 123. The wheels 121, 122, and 123 are adapted to gear, respectively, with the teeth of segmental pinion-wheels 124, which are loosely mounted on a horizontal shaft 125, which is journaled above the shaft 119. Each of the pinion-wheels 124 carries and is connected with a friction ratchet-wheel 126 and an indicating-wheel, the latter being numbered, respectively, at 127, 128, and 129, and each of said friction ratchet-wheels being engaged by a spring-pressed pawl 130. Each of the indicator-wheels has its periphery provided with numbers running from "0" to "9," one of the numbers on each of said wheels being visible through openings 131, which are formed in the top plate. Each of the indicating-wheels above mentioned is provided on one side with outwardly-projecting clutch-pins 132, which are adapted to enter openings formed in a clutch-disk 133, which, together with its grooved hub 134, is keyed to slide on the shaft 125. On the outer side of the bearing 120 the shaft 125 carries a toothed wheel 135, the latter having ten teeth to correspond with the ten numerals on the indicating-wheels.

136, 137, and 138 represent, respectively, spring-actuated clutch-operating levers, which are substantially of the bell-crank form shown more clearly in Figs. 2 and 14 of the drawings. These clutch-levers are fulcrumed at their angles, one arm of each of said levers engaging with one of the grooved clutch-hubs 134 and the remaining and curved arm thereof normally projecting forward in the path of an upwardly-projecting inclined lug 139, which is shown in dotted lines in Fig. 2 of the drawings and in section in Fig. 14.

On the inner end of the shaft 77, as shown in Fig. 2, is carried a wheel or disk 140, from which projects eccentrically a pin 141, the outer end portion of this pin being adapted when said shaft 77 and wheel 140 are rotated to come into contact with one of the teeth of the wheel 135 and move the latter a distance or space of one tooth thereof at each complete revolution of said wheel 140.

As shown more clearly in Figs. 8 and 2, we journal between the frame-hanger 45 and the adjacent hanger 67 a short shaft 142, on which is carried a gear-wheel 143. Between the other pairs of frame-hangers 67 are journaled, in line with the shaft 42, shafts 144, which carry thereon gear-wheels 145, 146, 147, 148, and 149, the last three of these wheels being shown more clearly in Fig. 16 of the drawings. These last-mentioned wheels correspond with the wheel 143, and all of said wheels from 143 to 149, inclusive, have twenty teeth each. Secured to the side of each of the wheels 145, 146, 147, and 148 are smaller gear-wheels 150. Each of the wheels 143, 145, 146, and 147 is provided on corresponding faces with two oppositely-located bevel-faced projections, which are indicated at 151, these projections being shown on the wheel 147 in Fig. 16 of the drawings and partially indicated in Fig. 8.

As indicated partially in Fig. 2 and partially in Fig. 12 of the drawings, the wheels 51, 52, and 53 are adapted to be made to gear in the manner hereinafter described with certain of the wheels 143, 145, 146, 147, and 148.

As shown more clearly in Fig. 8 of the drawings, we journal in suitable separated bearings or hangers 153 above the shaft 144 shafts 154, these shafts being arranged in horizontal alinement, but independently journaled. Upon each of these shafts is carried an indicating-wheel, said wheels being numbered, respectively, 155, 156, 157, 158, 159, and 160, said indicator-wheels having their peripheries numbered from "0" to "9," inclusive, and said numbers being adapted to show one at a time through openings 161, formed in the top plate 1. Each of the shafts 154 carries thereon a gear-wheel 162, each of the latter having a gear connection with one of the wheels which are included between the numbers 143 and 149, inclusive. On the side of each of the gear-wheels 162 is carried a segmental pinion 163, the teeth of which are adapted to gear with the teeth of segmental pinion-wheels 164, which are mounted upon a horizontally-journaled shaft 165, parallel with the shaft 154, said shaft 165 extending outward through one end of the machine and carrying thereon a thumb-nut 166. Of the segmental pinions 164 there are a number corresponding with the pinions 163, although but one of these pinions 164 is shown in Fig. 12 of the drawings. Adjacent to the end of the shaft 165 we provide the same with a cam-disk 167, which we employ in the manner hereinafter described.

Journaled at points in front of the frame-hangers 67, between the forward portion of the frame 68 and a suitable frame-arm 168, is a horizontal shaft 169, this shaft being shown more clearly in Figs. 2 and 12. That end of the shaft 169 which is adjacent to the frame 68 carries thereon a disk 170, which is provided with a peripheral notch at 171, as indicated in Fig. 13 of the drawings. On the inner side of the disk 170 is a disk or wheel 172, which is loose on the shaft 169 and which through the medium of a hub 173 is connected with a gear-wheel 174, the latter being shown in Fig. 6 of the drawings and together with said hub being loose on the shaft. The disk 170 is provided with a pivoted pawl 175, the latter being pressed by a spring-strip 176 in position for engagement with a notch or recess 177 formed in the periphery of the wheel 172. The peripheral notch 171 of the disk 170 is adapted to have engaged therewith the hook end of a spring-actuated vertical pawl 178.

179 represents a curved rack-segment the

rearwardly-extending arm of which is provided with a hub 180, which is journaled on a short shaft 181. The teeth of the rack-segment 179 are, as shown, adapted to engage with the teeth of the gear-wheel 174, while a downwardly-extending arm 182 of the hub 180 is jointedly connected at 183 with a downwardly-bowed arm 184, the rear end of which is fulcrumed on the pin 141 of the wheel 140.

In front of the shaft 165 is journaled a shaft 185, this shaft being shown in Figs. 2 and 12. Said shaft 185 carries thereon four separated and normally rearwardly-projecting arms 186. Fulcrumed to the outer end of each of the arms 186 is a downwardly-extending bar 187, the latter being illustrated in detail in Fig. 16[A] of the drawings and also shown in Figs. 12 and 2. Fulcrumed immediately beneath the top plate 1, as indicated in Fig. 12, and located opposite and in front of each of the wheels 150 is a hanger-bar 188, each of the latter being provided with a triangular wing or projection 189, which normally extends in close proximity to the shaft 169. The upper end of the hanger-bar 188 is provided with an outwardly-extending arm 190, which through the medium of a spring 191 is pressed in contact with the under side of the casing-top and normally retains said hanger-bar in a vertical position. The lower end of the hanger-bar is provided with a yoke, (indicated more clearly in Fig. 12 at 192,) the upper and lower arms 193 and 194 of said yoke being fulcrumed to said hanger-bar. Each pair of these fulcrumed yoke-arms is connected by a coiled spring 195, and while the upper arm thereof passes through a slotted opening 187[a] in the bar 187 the lower arm passes through a slot or recess 187[b] in the lower end of said bar. Either the upper or lower arm of each of the yokes is normally in position for engagement with one of the teeth of a wheel 150, depending upon the angle at which the yoke-supporting arms 186 are supported from their shaft 185. The positions or angles at which these arms are retained are governed by the reverse-mechanism-operating bar 89, which is shown in detail in Fig. 10 and which is fulcrumed to an arm 197, extending from one end of the shaft 185. Upon the shaft 169 are keyed to slide sleeves 198, 199, 200, and 201. Each of these sleeves is provided with a projecting lug 202 and with a pin 203, which extends in the direction of the length of the sleeve. Extending downward from the top plate and having their hooked and curved ends loosely embracing the under side of the shaft 169 are cam-fingers 204.

205, 206, 207, and 208 represent sleeve-shifting levers which are pivoted at their rear ends to the frame-arms 67 and which have their outer bifurcated ends loosely embracing the shaft 169. Each of the frame-arms 67 has fulcrumed thereto a spring-actuated friction-pawl 209, these pawls being retained in engagement with the teeth of the gear-wheels, which are numbered between 143 and 149.

The wheel 148 is provided on one of its faces with oppositely-located projecting lugs 210, each of these lugs being adapted when said wheel 148 is rotated to come into contact with one of the teeth of a wheel 211, which is mounted on the end of a short horizontal shaft 212, which also carries a gear-wheel 213, said wheel 213 gearing with the wheel 149. The shaft 212 is, as shown in Fig. 16, mounted in a rocker-frame 215, which is journaled in the downwardly-extending framework of the top plate, the wheel 213 being normally retained in engagement with the wheel 149 through the pressure of a spring-strip 216. With the frame 215 is formed a rearwardly-extending arm 217, which is retained in contact with the periphery of the cam-wheel 167 and which when said gear-wheels 213 and 149 are in engagement is adapted to engage with a peripheral notch 167[a] therein.

220, 221, and 222 represent parallel rack-carrying bars, which in the order mentioned may be termed "units," "tens," and "hundreds" bars, and the teeth of the side racks of which engage, respectively, with the gear-wheels 19, 18, and 17, as shown in Fig. 18 of the drawings. Each of the rack-carrying bars above mentioned is provided with an inwardly-extending arm or rod 223, the outer ends of which extend through and are adapted to slide in slotted openings or ways 224, formed in a frame-plate 225, which is shown more clearly in Fig. 3[A]. With each of the rods 223 is connected the rear end of a forwardly-extending curved arm 226, and the outer end of each of said arms 226 is fulcrumed at 227 (see Figs. 9 and 18) to one side of a substantially triangular type-carrying frame or segment, these segments being indicated at 228, 229, and 230, the curved outer arm of each of these segments being provided at intervals with projecting type-faces, (indicated at 231,) said type-faces representing numerals on the segment 228 from "0" to "9," inclusive, and on the segments 229 and 230 from "1" to "9," inclusive. The type-supporting arm of the segment 229 is, as indicated more clearly in Fig. 11 of the drawings, cut away or recessed at a point in front of the numeral "1" to admit of the movement therein of a type-block 233, upon which the zero character is formed. This block 233 is secured on one arm of a substantially bell-crank-shaped lever 234, the remaining arm of said lever being fulcrumed to the under side of the segment-arm 229, as indicated at 235. The type-block 233 is normally depressed or drawn upward until its printing face or type is out of the plane of the remaining type by means of a spring-strip 236, which bears against the lower side of the lever 234. This spring also serves to hold a projecting pin 237 of the lever 234 in contact with an arm 238, which projects from the segment 230.

239 represents a roller-supporting frame, the parallel side arms 240 of which are fulcrumed on a shaft 241. (Shown more clearly

in Figs. 2 and 9 of the drawings.) This frame 239, which normally extends rearwardly and upwardly, may be supported at its outer end portion by a suitable spring 242, and in said outer end portion said frame has journaled a roller 243. Above the parallel arms of the frame 239 is journaled, between the sides of parallel frame-bars 244, a roller 245. Journaled between parallel frame-arms 246 are shafts 247 and 248, the latter being located, respectively, in the upper and lower portion of the casing, said shaft 247 having mounted thereon a ribbon-spool 249, and a small spool 250 being mounted on the shaft 248.

As indicated in Fig. 2 and in detail in Fig. 4 of the drawings, we employ a total-transmitting shaft formed of sections, said sections being of different lengths and telescoping one within the other. Of this shaft 251 represents the units or central shaft; 252, the tens-shaft, which is adapted to rotate about said shaft 251; 253, the hundreds-shaft, which surrounds a portion of said tens-shaft; 254, the thousands-shaft; 255, the tens-of-thousands shaft, and 256 the hundreds-of-thousands shaft. Each of these shafts carries on its outer end portion a gear-wheel, said gear-wheels having each ten teeth and being indicated, respectively, at 257, 258, 259, 260, 261, and 262. At the larger end of the sectional shaft, formed as above described, each shaft-section carries a total-indicating wheel, these wheels being indicated at 263 and each of said wheels 263 being provided with projecting type-faces representing the numerals from "0" to "9," inclusive. The shaft 251 is, as shown in the drawings, journaled horizontally beneath the shafts 144, and said wheels from 257 to 262 gearing, respectively, with the wheels from 143 to 149. The inner end of the shaft is journaled in the outer end frame 68^a. As indicated in Fig. 9 of the drawings, the total-printing wheels 263 are supported at a point in front of the ribbon-roll 250. Journaled in the lower portion of the casing, in front of the shaft 241, as shown in Figs. 2 and 9, is a horizontal shaft 265. This shaft carries on one end a pinion-wheel 266, (shown more clearly in Fig. 6 of the drawings,) said pinion-wheel gearing with a wheel 267, which is keyed on a short shaft 268. The wheel 267 is adapted to gear with the wheel 81, except when disengaged therefrom by the means hereinafter described. Said wheel 267 is provided on its inner side with a grooved clutch-hub 270.

Engaging with the grooved periphery of the clutch-hub 270 is one end of a clutch-bar 271, the latter being fulcrumed centrally and having its forward end engaging the inner side of the wheel 98. That portion of the clutch-bar which is between its fulcrum-point and the wheel 268 is pressed by a spring-strip 272, which projects from the inner side of the frame 68, said spring-strip exerting an outward pressure on the rear portion of said bar, which is normally counteracted by the engagement of the opposite end portion of said bar with the wheel 98. The remaining end of the shaft 265 is journaled in the frame-work at the opposite end of the machine from that on which is carried the wheel 266, and said shaft is provided at a point in front of the frame 239 with a cam-plate 273, the latter having an angular or squared shoulder portion and a rounded portion, as indicated more clearly in Fig. 9 of the drawings.

275 represents a hammer-bar which is fulcrumed at its rear end to the lower end of a suitable downwardly-extending hanger or frame bar 276. This hammer-bar, as shown more clearly in Figs. 9, 2, and 18 of the drawings, extends forwardly over the frame 239 and at its forward end is secured to the lower end of a vertical coiled spring 277, the upper end of which is secured to the upper side of the top plate 1. This hammer-bar is provided with an upwardly-projecting lug 278, which is normally over and opposite a cross-bar 279 of the frame 239. The bar 275 is also provided with an upwardly-projecting lug 280, which by means of the spring 277 is retained in contact with the cam 273. Upon the upper side of the plate 1 is journaled a spool 281, the latter adapted to have wound thereon a strip of paper 282. This paper strip extends downwardly through a slotted opening in the top plate of the casing, and, as indicated by the single line in the drawings, passes under a guide-rod 283 and thence forwardly and downwardly about the roller 243. (See Fig. 9.) From this roller said paper strip again extends rearwardly, passing, respectively, under and over rollers 284 and 285, the latter having a gear connection at their ends and being mounted on journaled shafts 284^b and 285^b. From the roller 285 said paper strip extends outward through a slotted opening 286 in the side of the casing. Upon the spool 249 is adapted to be wound an ink-ribbon 287, said ink-ribbon extending from said spool forwardly and downwardly past the spool 243 and over and about the spool 245, from which spool said ribbon extends rearwardly over the total-type wheel 263, from which it extends to and is wound upon the spool or reel 250. The gear-wheel 285^a, which is carried by the roll 285 and which meshes with the teeth of the gear-wheel 284^a on the roll 284, is adapted to engage with the teeth of a vertical rack-arm 288, the outturned upper end of which is fulcrumed to a vertical post or rod 289, which extends outward through an opening in the top plate 1. The rack-arm 288 has its teeth retained in engagement with said wheel 285^a through the medium of a spring-strip 290, which extends between said rack-arm and rod. The lower end of the rod 289 is provided with an enlargement or head 291, with which is connected the lower end of a coiled spring 292, the upper end of said spring being connected with the top plate 1 and said spring serving to retain said rack-carrying rod in its upper

position. When the rod 289 is pressed downward, its enlargement or head 291 is adapted to come into contact with a laterally-extending trip bar or arm 293 of the frame 239. On the outer end of the shaft 265 is carried a short crank-arm 294, and to this crank-arm is fulcrumed one end of a rearwardly-extending operating-bar 295. The remaining end of the bar 295 is fulcrumed to the lower end of a rocking lever 296, the latter being fulcrumed at 297. The upper end of the rocking lever has fulcrumed thereto one end of a horizontal spring-actuated pawl 298, the tooth of the latter normally engaging with the inclined teeth of a ratchet-wheel 299, which is loose on the outer end portion of the ribbon-spool shaft 247. Said rocking arm 296 has also fulcrumed thereto, near its point of connection with the bar 295, a horizontal spring-actuated pawl 300, the tooth of which is retained in engagement with the teeth of a ratchet-wheel 301, which is loose on the remaining ribbon-spool shaft 248. The ratchet-wheel 301 is provided with a radially-arranged projecting finger 302. On the outer end of the shaft 285^b is carried a gear-wheel 303, said shaft being adapted to be rotated by a thumb-nut 304. (Shown in Fig. 2 of the drawings.)

305 represents a spring-pressed pawl, the tooth of which has a frictional engagement with the teeth of the wheel 303.

On the upper end of an arm 306, which rises from the operating-bar 295, is pivoted a spring-actuated pawl 307, the tooth of which engages with the teeth of the wheel 303. Journaled in the outer end frame of the machine, at a point in front of the wheel 303, is a ribbon-reversing gear-wheel 308, this wheel being shown in Fig. 18 and partly indicated in Fig. 19 of the drawings. This wheel is provided at a point near its center with an inwardly-projecting pin 309 and is of such size as to cause its peripheral teeth to project within the path of the outer end of the finger 302 of the wheel 301. Between the ratchet-wheel 299 and the end frame of the machine the shaft 247 has keyed thereon a clutch-ring 310, the teeth of the latter being adapted to engage with the teeth of a clutch-hub 311 on the inner side of the ratchet-wheel 299. A similar clutch-ring 312 is keyed to slide on the lower shaft 248. These clutches are adapted to be moved by a clutch-lever 313, which is fulcrumed centrally to a pin 314, which projects from an arm of the frame 68^a.

315 represents an **E**-shaped clutch-throwing frame, the central arm of which is also fulcrumed on the pin 314 and the end arms of which are wedge-shaped, as indicated at 316, said wedge-shaped arms being adapted in the manner hereinafter described to alternately enter the space between the clutch-throwing arm 313 and a vertical arm 317 of the frame 68^a. The **E**-shaped frame is provided centrally with an outwardly-projecting pin 318, which projects through a slotted opening or end recess 319 of the central rearwardly-extending arm of a fulcrum-yoke 320, the fingers of this yoke being curved to form a **C**-shaped head which loosely embraces the central shaft of the wheel 308, the inclined ends of said fingers being retained in the path of the pin 309.

In describing the operation of the above-described mechanism we will first explain the manner of utilizing the same for producing the operation of addition, and in order to illustrate this operation we will explain the process of adding the numbers "783" and "40." With this end in view the operator presses downward, first, the "7" key of the hundreds-bank; next, the "8" key of the tens-bank, and, finally, the "3" key of the units-bank. This depression of said keys results, through contact of the lower ends of the key-stems with the bars 37, in a depression of the latter and also results in the projecting pins 2^a of the key-stems traveling to the lower termination of one of the slotted openings 10 of the adjoining bar 8. The depression of the trip-bars 37 results, through the described engagement of the latter with the levers 35, in the disengagement of the latch-bar end 33 from the ends of the bars 8, admitting of said bars, through the action of the springs 27, moving outward. The extent of this outward movement, as will readily be seen, is limited to the length of the slotted openings 10 of the bar-blades 9. The outward movement of the units, tens, and hundreds bars above described results, through the connection of the latter with the rack-segments 43 and through the engagement of the teeth of the latter with the units, tens, and hundreds rods 46, 47, and 48, in a longitudinal sliding movement of said rods, which results in carrying the wheels 50 opposite the periphery of the amount-transfer wheel 70 and in position for engagement with the teeth 75 thereon. Owing to the different lengths of the slotted openings or recesses 10 of the bars 8 the distance traveled by the rods 46, 47, and 48 varies in accordance with the value of the key depressed, and in the case now being illustrated the units-wheel 50 would be thrown to such position or carried such distance as to cause its engagement with that row of the teeth 75 which contains but three teeth. In a like manner the tens-shaft will have forced its wheel 50 to a position for engagement with the tooth-row having eight teeth and the hundreds-shaft will have forced its wheel 50 to a position for engagement with the row employing seven teeth. The shaft 77 now having imparted thereto one complete revolution through the medium of its crank-handle, motion is contributed from the wheel 78, through the gear-wheels, 81, 82, and 71, to the shaft 69 and the amount-wheel 70. The rotary motion which is thus imparted to the different wheels 50, and thence to the shafts 46, 47, and 48, is, through the medium of the wheels 51, 52, and 53, transferred to the units, tens, and hundreds wheels 143, 145, and 146. From the

last-named wheels the various degrees of motion imparted thereto are contributed to the wheels 162, with which they gear, and through the independent shafts of the latter motion is contributed to the indicating-wheels 155, 156, and 157, resulting in the latter turning a sufficient distance to show through the openings 161 the figures "7," "8," and "3." The revolution of the operating-shaft 77, above described, in addition to producing the operation before mentioned, resulted in the engagement of the teeth of the wheel 78 with the wheel 98 and through the gear connection of the latter with the wheel 101 in the inward movement of the hook-arm 103 and in a consequent engagement of the resetting-frame 25 with the arms 23 of the bars 8. The pressure thus exerted on said arms 23 results in forcing the said bars 8 back to their normal positions and admitting of their again being latched in place by the heads 33 of the latch-bars 31. In this manner it is obvious that the keys will, through the medium of their stem-springs, be returned to their normal position.

We will now describe the process of adding to the number "783" the number "40." Prior to the beginning of the operation of addition the thumb-nut 111 is turned until its pointer 112 is opposite the adjoining "A" mark on the top plate, which results in a rotation of the disk 114 beneath the top plate and in the wheel 98 being drawn into engagement with the teeth of the wheel 101 through the medium of the arm 115. This operation of the thumb-nut 111 being accomplished, the thumb-nut 94 is next turned until its pointer is midway between the letters "A" and "M," adjacent thereto. This turning of the thumb-nut 94, and consequently the turning of the shaft 93, results in a partial rotation of the notched disk 92 (shown in Fig. 10) and through the engagement with the teeth of said disk in the moving of the bar 89 and lever 88 to such position as to cause the wheel 78 to move into engagement with the wheel 81. The movement of the bar 89 also results, through its crank connection with the shaft 185, in dropping the yokes 192 until their lower arms are out of the path of the teeth of the wheels 150 and their upper arms 193 are in position to engage therewith. In order to accomplish this, the "4" key of the tens-bank is depressed, and in the manner heretofore described the tens-indicator wheel 156 is turned four points or four numbers, resulting in said wheel showing through the tens-opening 161 the figure "2." This operation, as will readily be seen, makes it necessary to carry one number over to the hundreds-wheel in order to get the proper result. This operation of carrying over tens to hundreds or hundreds to thousands is substantially as follows: During the rotation of the crank-shaft 77, hereinbefore described, the rack-segment 179 is, through its connections with the wheel 140, which is carried by said shaft 77, raised during the first half-revolution of said shaft 77, the gear-wheel 174, with which the rack gears, running loose on its shaft. During the remaining half-revolution of the shaft 77 said rack-segment descends and during its descent rotates the wheel 174 and shaft 169, together with the sleeves 198 to 201. In the operation of transferring the "4" from the wheel 145 to the tens-indicator wheel above described the rotation of said wheel 145 results in a contact of one of its projections 151 with a projecting lug of the shifting-lever 206 (shown in Fig. 2) and in a consequent movement of the sleeve 199 outward on the shaft 169. This movement of the sleeve 199 brings the lug 202 thereof in position for engagement with the inclined surface of the wing 189 of the adjoining bar 188, resulting in the upper arm 193 of the yoke moving inward a sufficient distance to force the wheel 150 the distance of one tooth thereof, thus turning the hundreds-wheel 146 a sufficient distance to add "1" to the hundreds-indicating wheel 157, thus giving a proper result when viewed through the openings 161 of "823." This carrying-over operation is substantially the same with reference to the remaining transfer-wheels. The sleeve 199 having completed the operation of projecting the yoke inward as above described, the projecting pin 203 of said sleeve comes into contact with the inclined face of the cam-hook 204, resulting in the sleeve being driven back on its shaft to its normal position. The method of transferring from the tens-of-thousands wheel 148 to the hundreds-of-thousands wheel 149 differs slightly from that followed in transferring or carrying over from the remaining wheels. As indicated more clearly in Fig. 16, the lugs 210, which are on the wheel 148, in operation come into contact with the teeth of the wheel 211, and through the medium of the shaft 212 and wheel 213 the amount is transferred to the hundreds-of-thousands wheel 149. Having described the operation of addition, we will now describe the manner of transferring the amounts to the printing mechanism and producing the printed result. This printing mechanism is only employed in connection with the operation of addition, and during other operations the printing mechanism is thrown out of gear by means hereinafter described. In the sliding movement above described, which is imparted to the wheel 98 prior to the operation of addition, it will be observed that the clutch-lever 271 is so thrown as to insure an engagement of the wheel 267 with the wheel 81 and also in engagement with the wheel 266. The outward movements of the bars 8, which are produced by the depression of the keys in the manner heretofore described, results in a rotation of the pinion-carrying shafts 14, 15, and 16, and through the engagement of the pinions 17, 18, and 19 thereof with the racks of the bars 220, 221, and 222 the arms 226 are moved to produce a rearward movement of their type-segments 228, 229, and 230. The operation of

the shaft 265, which is produced, as heretofore described, from the rotation of the wheel 267, results, through the connection of the crank-arm 294 and operating-rod 295, in a rocking action of the lever 296 (see Fig. 18) and, through the pawls 298 and 300, in a consequent intermittent rotation of the ratchet-wheels 299 and 301 in opposite directions. Assuming that the clutch-hub of the ratchet-wheel 299 is in engagement with the clutch-ring 210 of the shaft 247 and that the clutch-hub of the lower ratchet 301 is out of engagement with the ring 312, it is obvious that the above-described intermittent motion of the ratchet-wheel 299, which is imparted by the pawl 298, must result in drawing the ink-ribbon off the roll 250 onto the roll 249. In this manner the ribbon is gradually fed between the roll 243 (see Fig. 9) and the type-faces of the printing-segments. The feeding of the paper-roll is also accomplished by the movement of the operating-bar 295 through the engagement with the teeth of the wheel 301 with the pawl 307.

It is obvious that the degree of movement of the printing-segments 228, 229, and 230 is governed by the length of the slots 10 of the bars 9, these slots limiting the outward movements of said bars, and consequently limiting or regulating the movement of the parts which connect said bars with the printing-segments. The rotation imparted to the shaft 265, as above described, during the turning of the main operating-crank finally results in the dropping of the lug 280 of the bar 276 into the recess of the cam 273, thus admitting of the hammer or lug 278 striking the arm 279 of the frame 239 a blow which will cause the roller 243 to move upward against the opposite type-faces of the printing-segments. This upward movement of said roller 243 results in bringing the paper strip 282 in contact with the ribbon 287 and in bringing the ribbon in contact with the type-faces, causing the imprint of said type-faces to be imparted to said paper strip. Owing to the fact that the type-segments have, through the manner heretofore described, been moved until those figures thereon are opposite the roll 243 which correspond with the ones of the keys depressed, it is obvious that the amount shown by the depressed keys will be transferred to said strip, and it will also be seen that said strip will be gradually fed outward through the opening 286 of said casing.

It is obvious that in the printing operation above described the cipher or zero type face of the tens-segment 229 is not desired for use in printing excepting when all three of the segments are used and the amount to be printed is over one hundred. We have therefore formed said hundreds zero-type on the block 233 which, as heretofore described, is normally out of the plane of the remaining type-carrying faces. However, when the hundreds-segment is operated it is obvious that the arm 238 (see Fig. 11) will come into contact with the pin 237 and press the zero-block 233 downward to a printing position, thus providing for automatically bringing said hundreds zero-type into use when the same is desired.

Owing to the fact that each of the total-type wheels 263 is carried on a separate shaft and that each of said shafts has a gear connection with one of the wheels which are numbered between 143 and 149, it is evident that the amounts added by said last-named wheels will be transferred to said total-type wheels. In order to produce on the paper strip 282 an impression from said total-type wheels showing the total of the addition, it is necessary to press downward the rod 289. This downward movement of said rod causes an engagement of its enlargement 298 with the arm 293 of the frame 239 and forces the roller 243 and its paper strip 282 against the ink-ribbon, which is over the type-faces of the wheels 263, thus printing on said paper strip the results of the addition, as shown by the total-wheels. In order that a desirable space may exist on the paper strip between the last of the amounts to be added and the total amount, we have provided the rod 289 with the ratchet-arm 288, which during the descent of said rod operates to impart an increased rotation to the roller 285 and a consequent increased movement of the paper strip just prior to the production of the total impression on said paper.

In order to accomplish the operation of subtracting one number from another, the amount or minuend is first made to appear on the indicator-wheels through the openings 161 by the proper depression of the keys in the manner prescribed for the beginning of addition. This being accomplished, the thumb-nut 111 is turned until its pointer is opposite the group of letters "S M D," this operation resulting in throwing the wheel 98 out of gear with the wheel 101 and allowing the spring 272 to throw the clutch-lever 271 outward to cause a disengagement of the wheel 267 from the wheel 266, thereby preventing motion, and operation being transmitted to the printing mechanism through the shaft 265. The thumb-nut 94 is now rotated until its point or hand is opposite the letters "S D," this operation resulting through the movement of the bar 89 in the shaft 185 being so turned as to cause the upper arms 193 of the yokes to be raised out of the path of the teeth of the wheels 150 and bring the lower arms 194 in the path of said teeth. This movement of the bar 189 through its connection with the lever 88 also operates to throw the teeth of the segmental wheel 78 into gear with the wheel 84, which through the medium of the wheel 85 imparts a reversed rotation to the wheel 83. In the above manner it will be seen that the amount of the adding mechanism is reversed, so that when the keys representing the subtrahend or amount to be subtracted are depressed and

the shaft 77 rotated the last amount shown on the depressed keys will be deducted from the amount previously shown by the indicator-wheels, said indicator-wheels being thus made to revolve in the reversed direction from that employed in adding.

In order to illustrate the operation of multiplying by our improved machine, we will describe the operation of multiplying the figures "783" by "23." The first operation consists in turning the thumb-nut 94 until its point 95 is opposite the letters "A M." The thumb-nut 111 is next turned until its point or hand is opposite the letters "M S D," the disk 58 being so turned as to cause an engagement of its units-notch with the tooth of the pawl 62^a. The keys indicating the amount "783" are now depressed and the shaft 77 given one complete rotation. In this manner the figures "7," "8," and "3" are made to show through the hundreds, tens, and units openings 161. Through the operation of the mechanism which we are about to describe the one complete rotation of the shaft 77 also results in displaying the figure "1" through the first opening 131 on the wheel 127, thus indicating that one revolution of the shaft 77 has been accomplished. The rotation of the disk 58, imparted as above described, to cause the engagement of the pawl with the units-notch, has resulted in the rotation of the wheel 57, which engages with the rack 56, and in moving the sleeve 55 until the wheels 53, 52, and 51 are in engagement with the hundreds, tens, and units-wheels 146, 145, and 143, this operation being clearly seen in Fig. 1. This movement of the sleeve has also resulted by contact of the lug 139 with the pawl 136 in throwing the clutch 134 into engagement with the units-indicating wheel 127, thus keying the latter on the shaft 125. During the above-described rotation of the shaft 77 its pin 141, by contact with one of the teeth of the wheel 135, causes the indicator-wheel 127 to be moved until the figure "1" was indicated thereon through the units-opening 131 of the case. In view of the fact that the amount "783" is to be multiplied by "23" it is necessary first to add to the amount "783," already indicated, twice this sum in order to multiply first by "3." This we accomplish by imparting two more complete revolutions to the shaft 77 while the keys representing the amount "783" are still depressed, said keys being retained in this depressed position during the operation of said shaft owing to the disengagement of the wheel 98 and the wheel 101. At the end of the third rotation thus imparted to the shaft it will be seen that the result of adding the amount "783" three times is "2,349." It will also be seen that the units-indicator wheel 127 will show the figure "3" through the first of the openings 131, indicating the number of revolutions of the shaft 77. As in ordinary multiplication, the amount "783" is now multiplied by "2." This figure being in tens place, we accomplish by first turning the disk 58 until its tens-notch is in engagement with the pawl 62^a, which results in the sleeve 55 moving the wheels 51, 52, and 53 into engagement with the wheels 145, 146, and 147 and in the lug 139 being released from the pawl 136 and brought into contact with the pawl 137, thus keying the tens-indicator wheel 128 onto the shaft 125. The shaft 77 has now imparted thereto two complete revolutions, thus taking the amount "783" twice and adding it in its proper place to the amount "2,349," previously attained. As a result of the above operation the openings 161 will display the correct product, while the openings 131 will indicate the multiplier. In order to perform a different operation of multiplication, it becomes necessary to reset the keys previously depressed, also to reset the wheels showing the multiplicand and those showing the multiplier, to zero. The first and second of these operations we accomplish by rotating the shaft 108 and causing through the engagement of the wheel 111 and the wheel 118 a rotation of the shaft 119. This operation results in the teeth of the segmental wheels 122 and 123 engaging with the teeth of the segmental wheels 124 of the shaft 125, which have been rotated by the operations heretofore described, and in the turning of said shaft 125 until those indicator-wheels which have been operated are returned to the zero-point. The rotation of the shaft 108 also results in forcing the arm 110 forward and causing the frame 25 to move inward against the arms 23, thus forcing the bars 8 inward to their normal positions and causing the keys to assume their elevated positions. In a similar manner the indicating-wheels 155 156 157, &c., are returned to the zero-points by rotation of the button on the outer end of the shaft 165, which results in an engagement of the wheels 164 with the wheels 163.

In order to illustrate the operation of division by our machine, we will describe the process of dividing the number "783" by "23." In starting this operation the thumb-nuts are turned until their hands point, respectively, to the letters "A M" and "M S D" and the disk 58 is turned until the pawl 62^a is in engagement with the units-notch. The keys "7," "8," and "3" are now depressed, as previously described for other operations, and the shaft 77 is given one complete revolution. This will result in the indication through the openings 161 of the amount "783," or the dividend, and will indicate in the first of the openings 131 the figure "1," which, however, should immediately be set back to zero by the rotation of the shaft 108 in the manner heretofore described. The next operation consists in turning the thumb-nut 94 until its pointer is opposite the letters "S" and "D," thereby reversing the mechanism in the manner described for subtraction. The keys indicating the amount "23" are now depressed and the disk 58 is turned until the pawl is in engagement with the tens-notch

62 thereof, thus transmitting the operation to the tens-wheel. This operation is made necessary from the fact that the divisor will not go into the first number of the dividend, which is "7," and it is necessary to divide the number "78" by "23." The shaft 77 has now imparted thereto one complete rotation, which results in subtracting the amount "23" from the amount "78," leaving as a result showing through the openings 161 the numbers "553" and showing in the tens-opening 131 the figure "1." In view of the fact that the number "23" will go into the number "55," another revolution is imparted to the shaft, which shows a result of "323" in the rear openings and a result of "2" in the tens-opening of the front row. As "23" will go into the number "32," the shaft is again rotated, which leaves "9" in the tens-opening 161 and "3" in the tens-opening 131. As "23" will not go into "9," the disk 58 is now turned until the pawl is in engagement with the units-notch. Now repeating the operation of rotating the shaft 77 it is found that the number "23" can be deducted from "93" four times and four over, thus leaving the figure "1" showing on the units-indicator wheel through the opening 161 and the figure "4" showing on the units-wheel through the opening 131. It will thus be seen that the figures "3" and "4" which show through the tens and units openings 131 and the figure "1" in the units-opening 161 will indicate that the result of dividing "783" by "23" is "$34\frac{1}{23}$." The depressed keys are now returned to their normal positions by rotation of the crank-shaft 108.

From the construction and operation herein described and shown it will be seen that the printing mechanism is only thrown into operation during the adding process. It will also be observed that a machine constructed and operated as herein described will be exceedingly useful and that reliable means are provided for accurately and positively accomplishing the process of addition, multiplication, subtraction, and division.

Having now fully described our invention, what we claim, and desire to secure by Letters Patent, is—

1. In a computing-machine, the combination with a framework, an amount-wheel journaled in said framework, said amount-wheel being provided with parallel tooth-rows containing different numbers of teeth, of a series of sliding transfer-wheel-carrying shafts having gear-wheels on their corresponding ends, a set of numbered keys for each of said sliding shafts, and connections between said keys and shafts whereby the end gear-wheels of the latter may be projected into the paths of the desired rows of teeth on the amount-wheel by a depression of said keys, substantially as and for the purpose specified.

2. In a computing-machine, the combination with a journaled amount-wheel provided with rows of teeth numbering from one to nine, a series of sliding shafts and gear-wheels on the corresponding ends thereof, a series of numbered indicator-wheels, and gear connections between said sliding shafts and the shafts of said indicator-wheels whereby the degree of rotation imparted to said shafts is transmitted to said indicator-wheels, of banks of numbered keys and connections between said keys and sliding shafts whereby the end gear-wheels of said shafts are moved within the paths of the tooth-rows of the amount-wheel and means for rotating the latter, substantially as and for the purpose specified.

3. In a computing-machine, the combination with an amount-wheel provided with tooth-rows containing different numbers of teeth and means for rotating the same, a series of sliding shafts carrying on their forward ends gear-wheels, a series of independently-journaled indicating-wheels, and gear connections between the latter and said sliding shafts, of a bank of spring-actuated keys for each of said sliding shafts, a normally-latched spring-actuated key-bar 8 for each of said key-banks, means for unlatching said key-bars by depression of the keys of the corresponding banks, slotted openings in said key-bars limiting their outward movement and connections between said key-bars and sliding shafts whereby said shafts are moved outwardly distances proportioned by the distances traveled by said key-bars, substantially as and for the purpose specified.

4. In a computing-machine, a journaled amount-wheel having nine rows of teeth thereon, said rows containing from one to nine teeth, of a series of sliding shafts carrying gear-wheels on their outer ends, a bank of spring-actuated keys for each of said shafts, a series of independently-journaled indicator-wheels, means for operating the latter through the rotation of said sliding shafts, and means for sliding said shafts by the depression of said keys, of a main operating-shaft 77, a train of gear-wheels connecting said operating-shaft with the shaft of said amount-wheel whereby said amount-wheel is rotated when said shaft 77 is rotated and means for reversing the motion imparted to said amount-wheel from said shaft 77, substantially as and for the purpose specified.

5. In a computing-machine, the combination with a journaled amount-wheel having tooth-rows thereon containing from one to nine teeth, of a series of sliding shafts carrying end wheels 50, the latter adapted by the sliding of said shafts to be projected within the path of said tooth-rows and gear-wheels 51, 52 and 53 keyed to slide on said shafts, of a sliding rack-carrying sleeve 55, a gear-wheel 57 engaging with the rack thereof and means for rotating said gear-wheels, arms projecting from said rack-sleeve and embracing said keyed gear-wheels, a series of independently-journaled indicator-wheels, a series of independently-journaled transfer gear-

wheels 143, 145, 146, 147, 148 and 149 having gear connections with the shafts of said indicator-wheels, said wheels 51, 52 and 53 being adapted by movement of said rack-sleeve 55 to be brought into engagement with the desired ones of said transmitter-wheels, substantially as and for the purpose specified.

6. In a computing-machine, the combination with a fixed shaft 54, a rack-carrying sleeve movably mounted thereon, a lug 139 projecting from said sleeve, a gear-wheel 57 engaging with the teeth of said sleeve-rack and means for rotating said wheel 57, of a shaft 125, indicator-wheels 127, 128 and 129 normally loose thereon, a clutch-ring keyed on said shaft 125 adjacent to each of said indicator-wheels, a clutch-lever engaging with each of said rings and projecting in the path of the sleeve-lug 139, an outer end toothed wheel 135 on said shaft 125, a journaled operating-shaft 77, a wheel 140 carried thereby, and a pin projecting eccentrically from said wheel in the path of the teeth of said wheel 135, substantially as and for the purpose specified.

7. In a computing-machine, the combination with a series of journaled indicating-wheels, a series of transfer-wheels operating said indicating-wheels, and toothed wheels 150 connected with said transfer-wheels, of fulcrumed yokes 192, means for setting the latter in position for the engagement of their upper or lower arms with the teeth of the wheel 150 and means for moving said yoke inward and outward, substantially as and for the purpose specified.

8. In a computing-machine, the combination with a series of numbered and journaled indicating-wheels, a series of transfer-wheels adapted to transmit motion to said indicating-wheels, toothed wheels 150 connected with said transfer-wheels, depending fulcrumed arms 188, yokes fulcrumed thereto, and means for raising and lowering the arms of said yokes to cause an engagement of either their upper or lower arms with the teeth of the wheels 150, of a journaled shaft 169 and means for rotating the same, sleeves keyed on said shaft and having lugs 202 projecting therefrom, means for forcing said sleeves to positions on said shaft 169 to cause engagement of said lugs with the sides of said yoke-carrying arms 188, and means for automatically returning said sleeves to their normal positions, substantially as and for the purpose specified.

9. In a computing-machine, the combination with a set of independently-journaled printing-segments, a spring-actuated journaled frame 239, a paper-strip-carrying roll journaled in said frame, and an ink-ribbon passing between said paper-strip-carrying roll and printing-segments, journaled rolls for feeding the paper strip outward after the printing operation, a toothed wheel on one of said rolls, and a spring-actuated ratchet-bar 288 engaging with the toothed wheel of said roll, of a series of numbered keys arranged in banks, a normally-latched spring-actuated key-bar for each of said key-banks, said key-bars adapted to be released by a depression of said keys, and a jointed connection between each of said key-bars with one of said printing-segments, and means for automatically moving the frame 239 to cause a contact between the paper strip, ink-ribbon and type-faces of the segments, substantially as and for the purpose specified.

10. In a computing-machine, the combination with a series of indicator-wheels and a set of independently-journaled type-carrying shafts having a gear connection with the shafts of said indicator-wheels, a series of numbered keys and means for transmitting motion therefrom to said indicator-wheels, of journaled separated ink-ribbon spools, an intermediate roll 245 over which said ink-ribbon passes, said ink-ribbon also passing over the type-wheels 263 of said separately-journaled shaft, a spring-actuated fulcrumed frame 239, a paper-carrying roll journaled therein and means for tripping said frame 239 to cause a contact of the paper strip on said roll 243 with the ink-ribbon on the type projections of the wheels 263, substantially as and for the purpose specified.

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In presence of—
C. C. SHEPHERD,
EDWARD M. TAYLOR.