W. H. DRAUGHON.

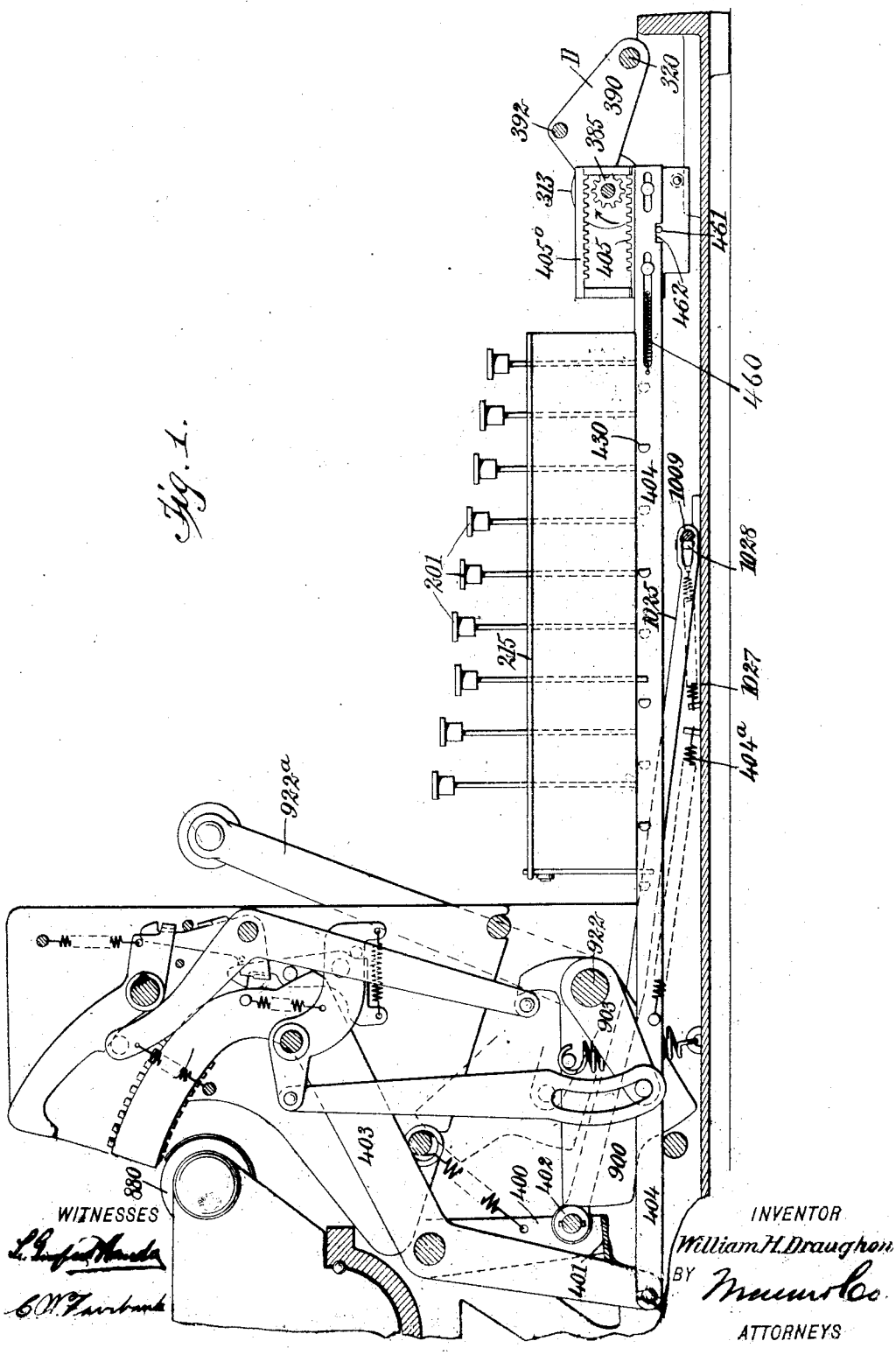
CALCULATING AND RECORDING MACHINE.

APPLICATION FILED AUG. 10, 1908.

1,195,567.

Patented Aug. 22, 1916.

14 SHEETS—SHEET 1.



W. H. DRAUGHON.

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14 SHEETS—SHEET 2.

Fig. 2.

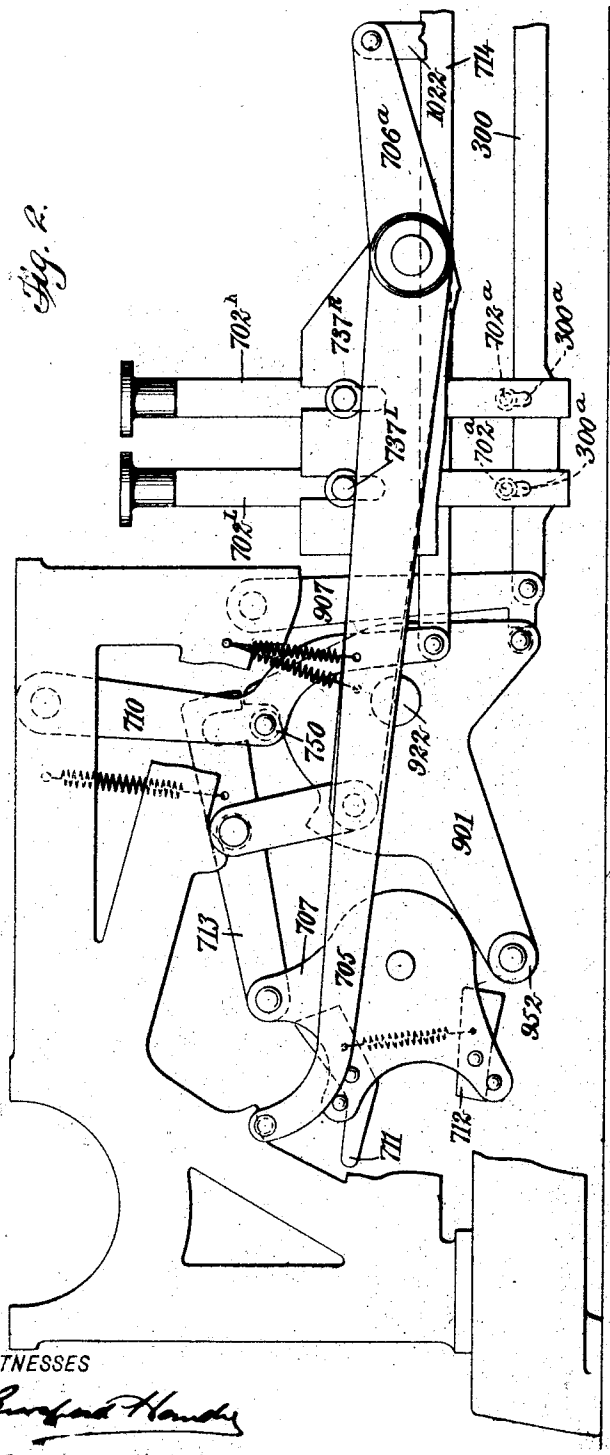
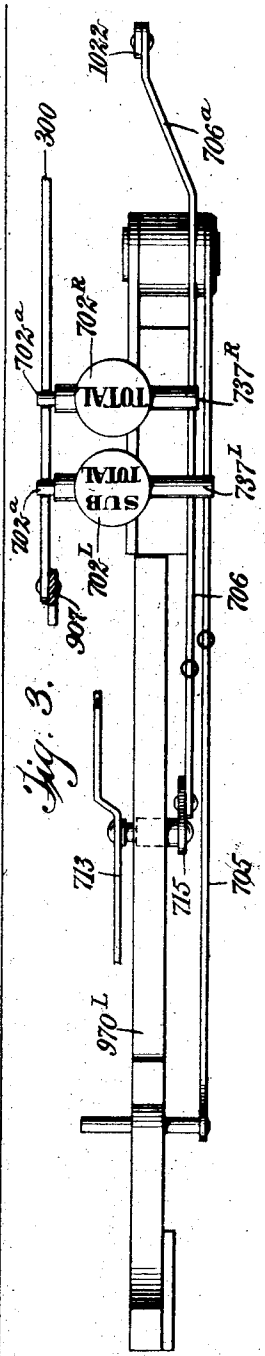


Fig. 3.



WITNESSES

L. Bradford Handy

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14 SHEETS—SHEET 3.

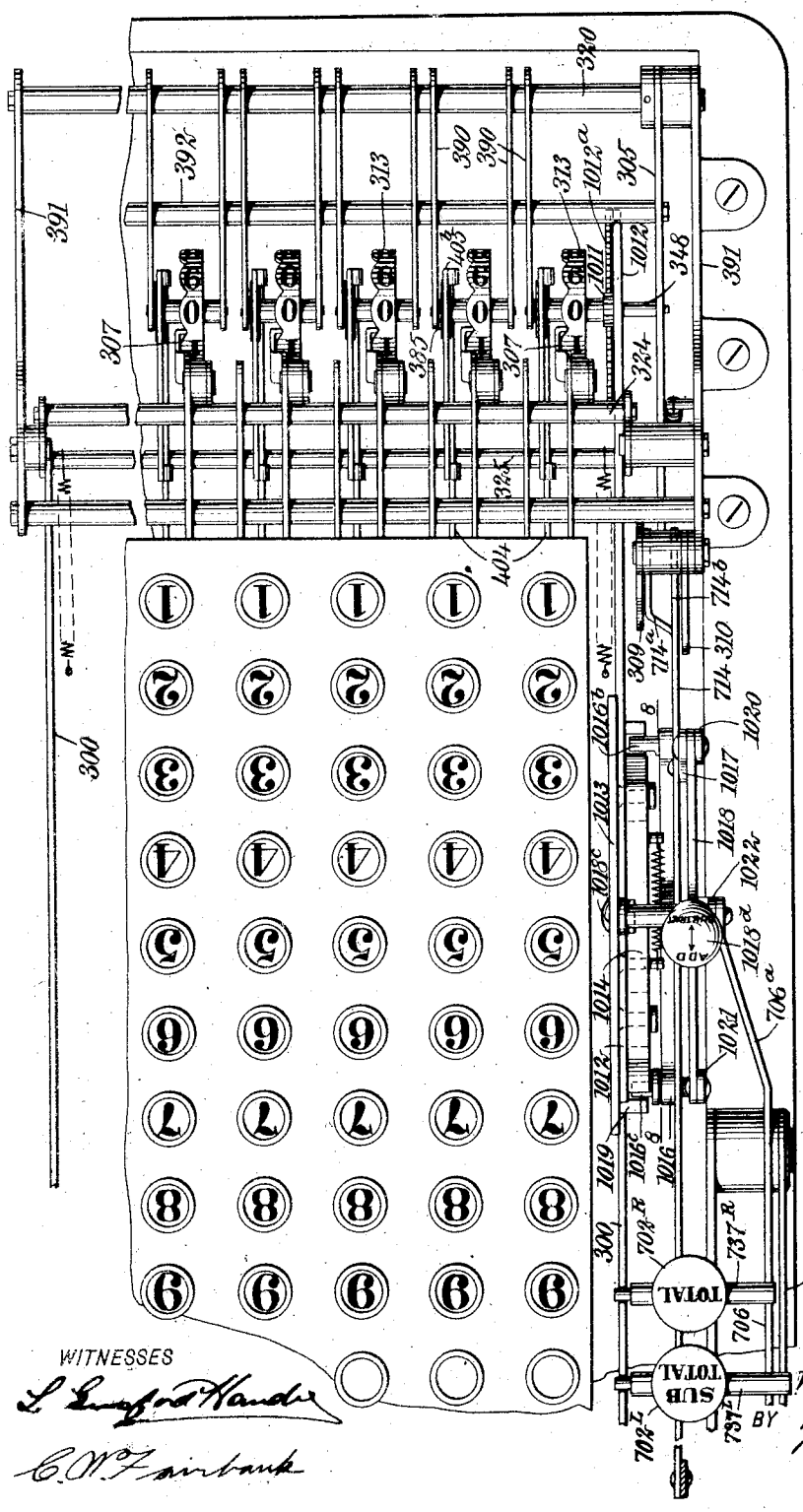


Fig. 4.

WITNESSES

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14 SHEETS—SHEET 4.

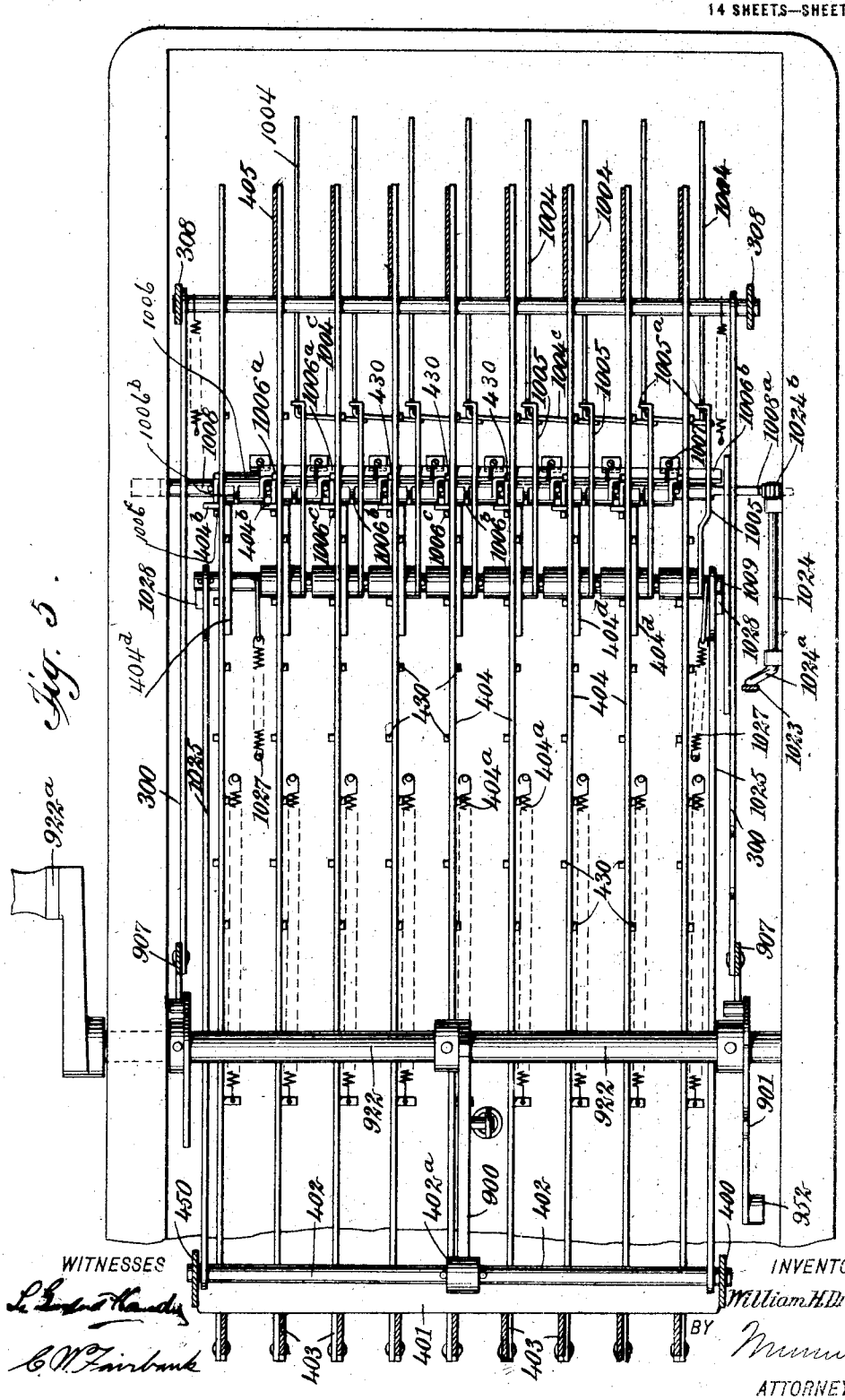


Fig. 5.

WITNESSES

L. Bryant Handy

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14 SHEETS—SHEET 5.

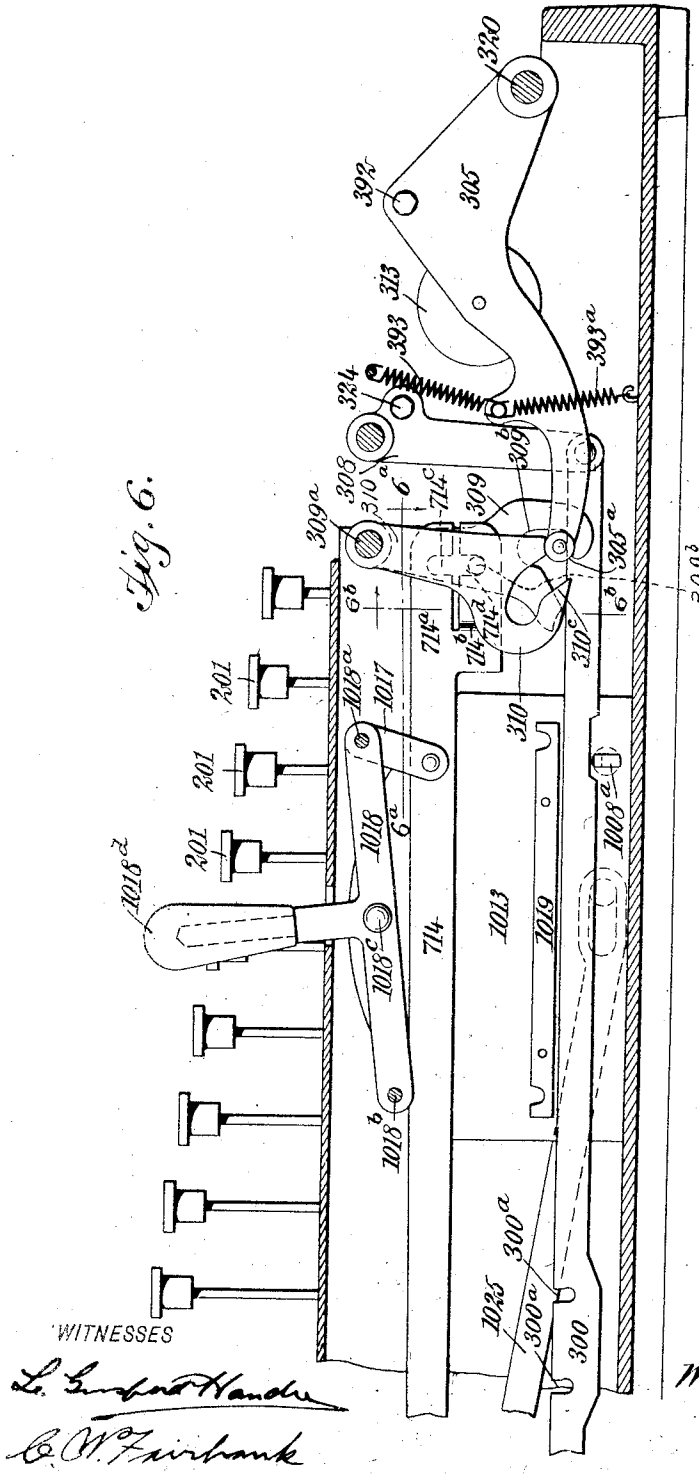


Fig. 6.

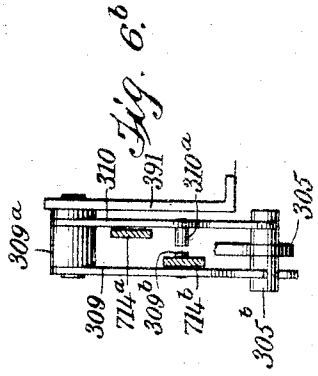


Fig. 6b.

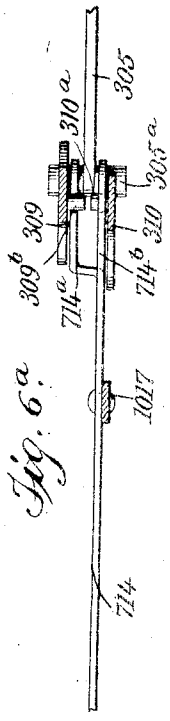


Fig. 6a.

WITNESSES

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14 SHEETS—SHEET 6.

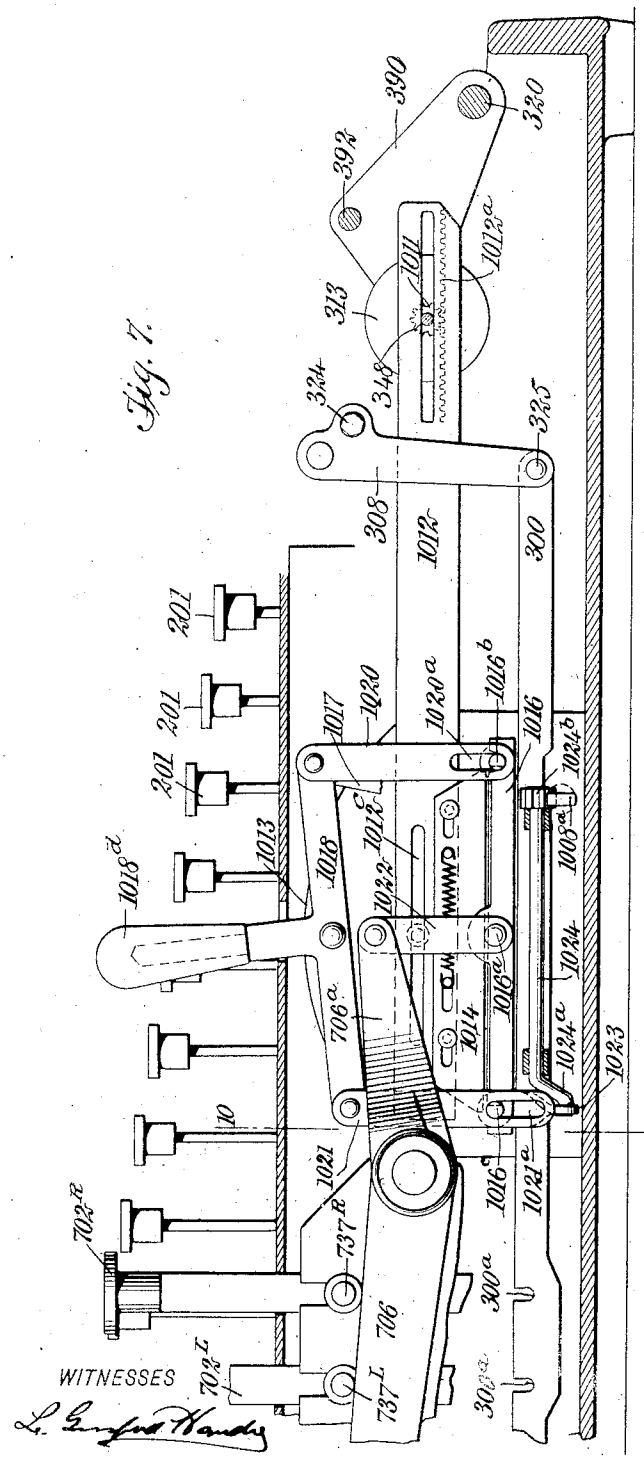


Fig. 7.

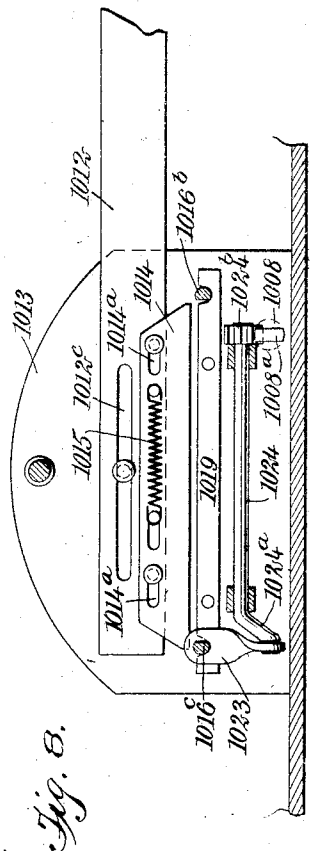


Fig. 8.

WITNESSES

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CALCULATING AND RECORDING MACHINE.

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1,195,567.

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14 SHEETS—SHEET 7.

Fig. 9.

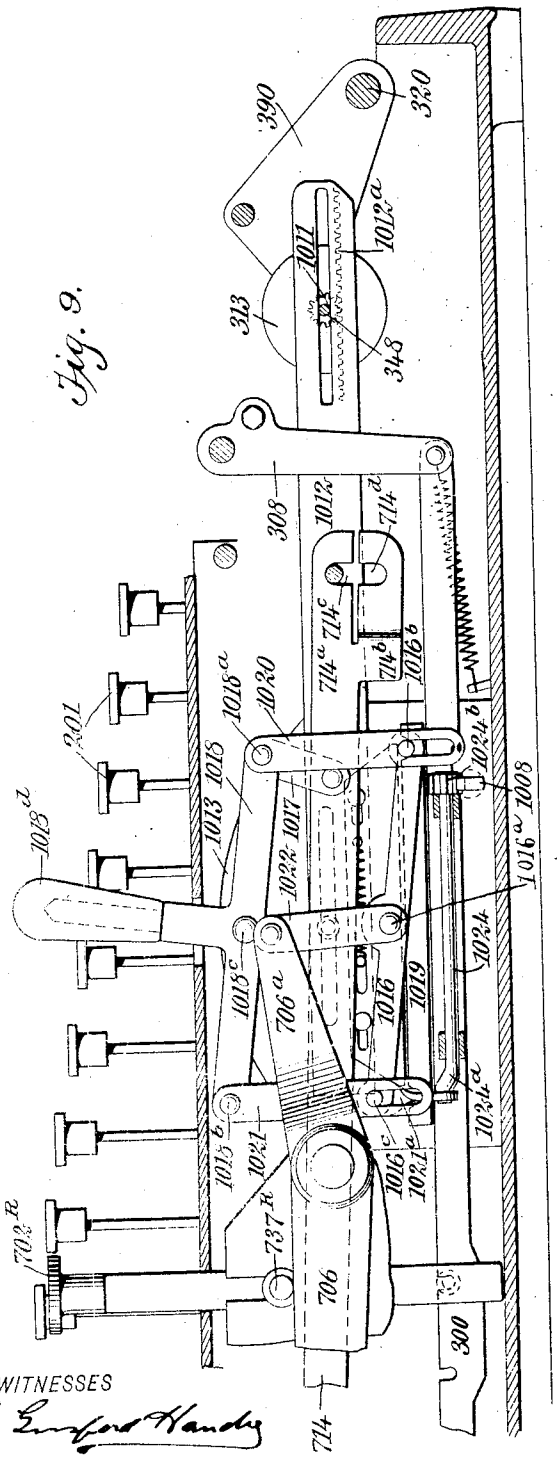


Fig. 11.

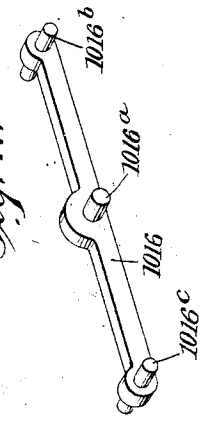
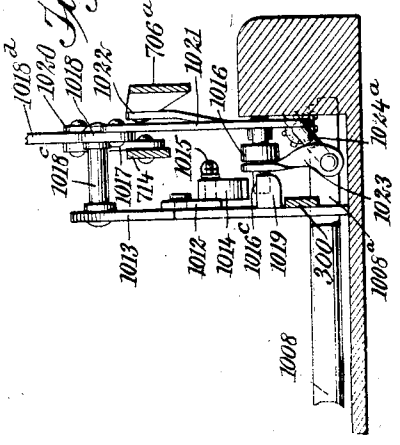


Fig. 10.



WITNESSES

L. Linford Handy

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ATTORNEYS

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CALCULATING AND RECORDING MACHINE.

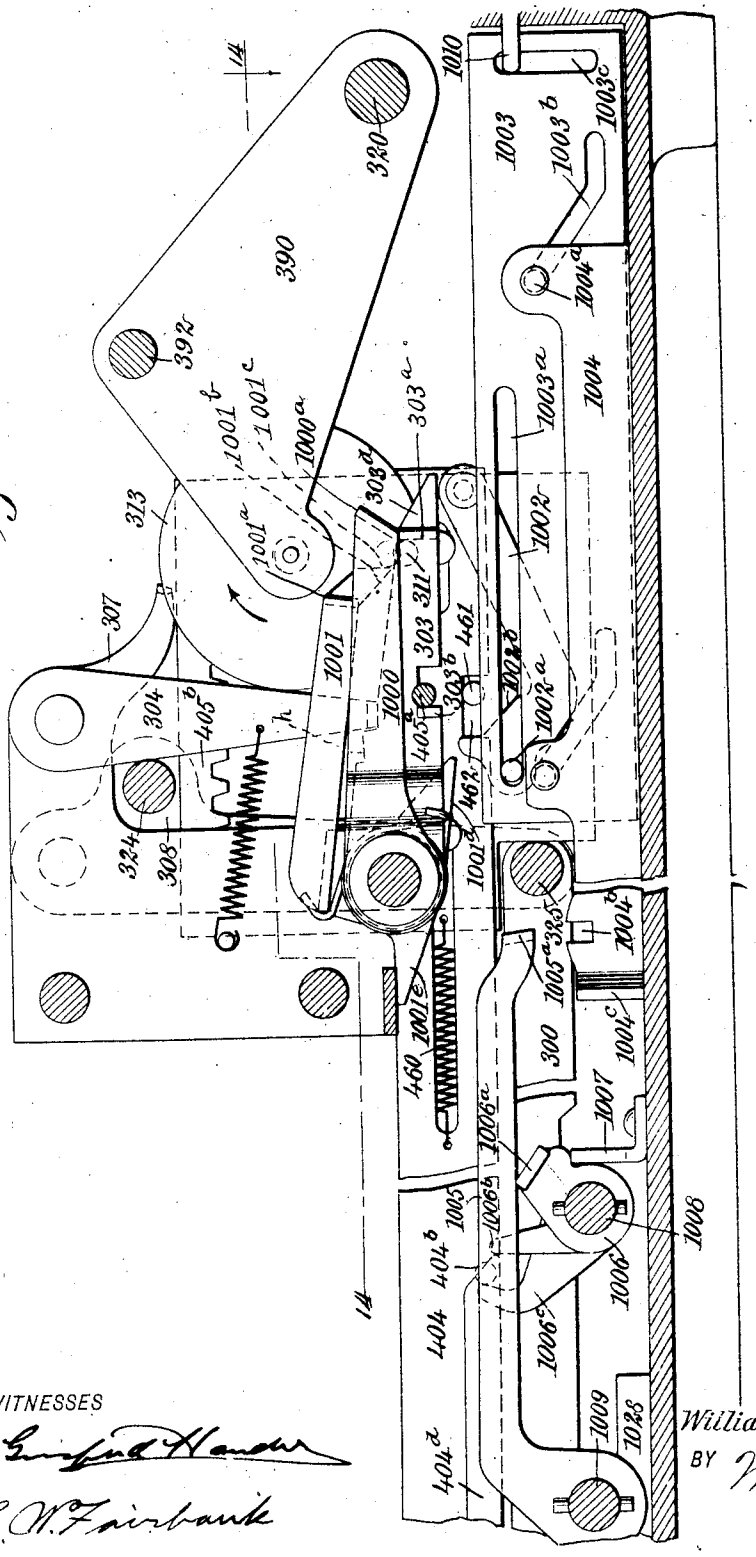
APPLICATION FILED AUG. 10, 1908.

1,195,567.

Patented Aug. 22, 1916.

14 SHEETS—SHEET 8.

Fig. 12.



WITNESSES

L. Griffin Hanson

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CALCULATING AND RECORDING MACHINE.

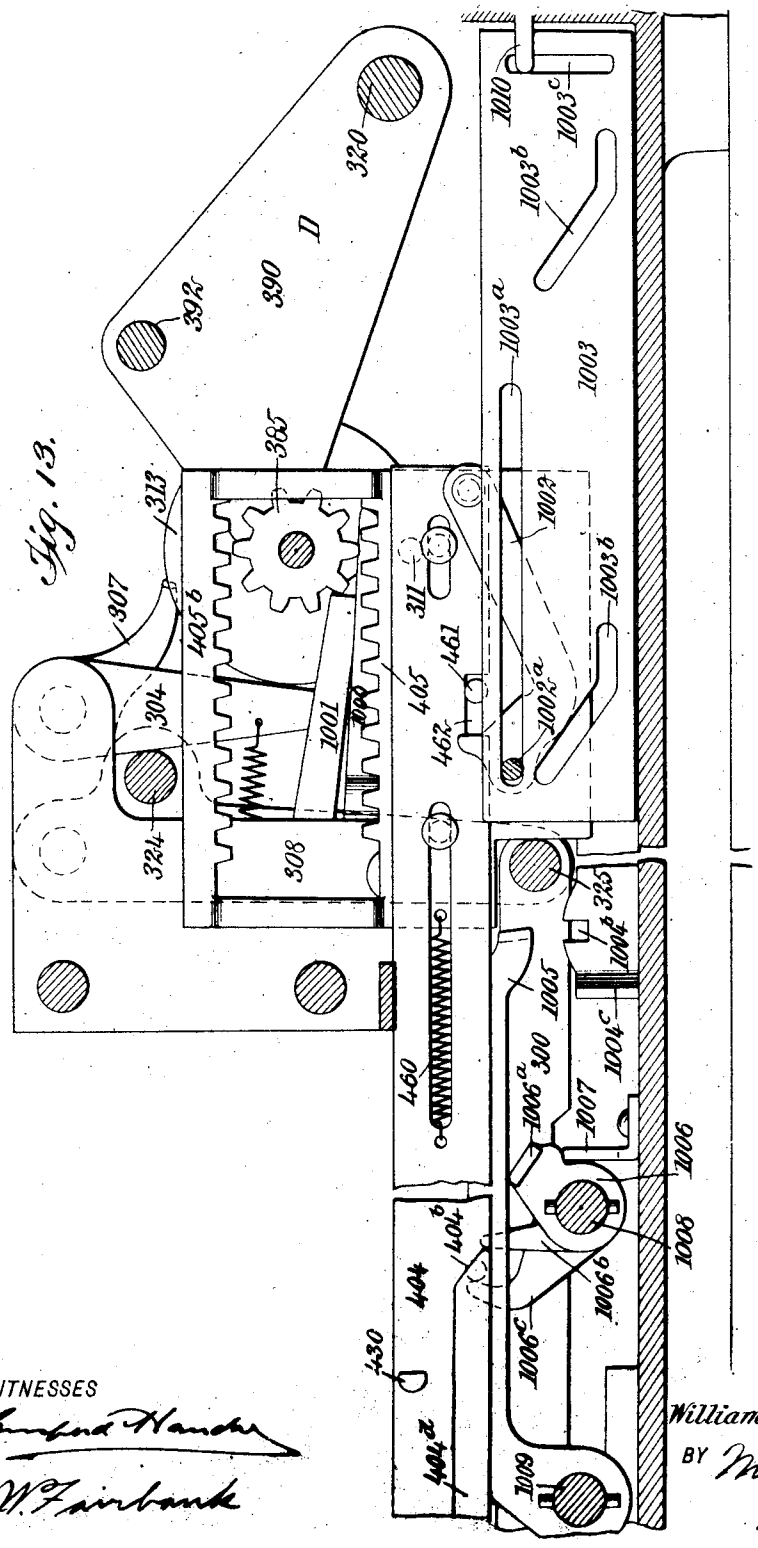
APPLICATION FILED AUG. 10, 1908.

1,195,567.

Patented Aug. 22, 1916.

14 SHEETS—SHEET 9.

Fig. 13.



WITNESSES

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CALCULATING AND RECORDING MACHINE.

APPLICATION FILED AUG. 10, 1908.

1,195,567.

Patented Aug. 22, 1916.

14 SHEETS—SHEET 10.

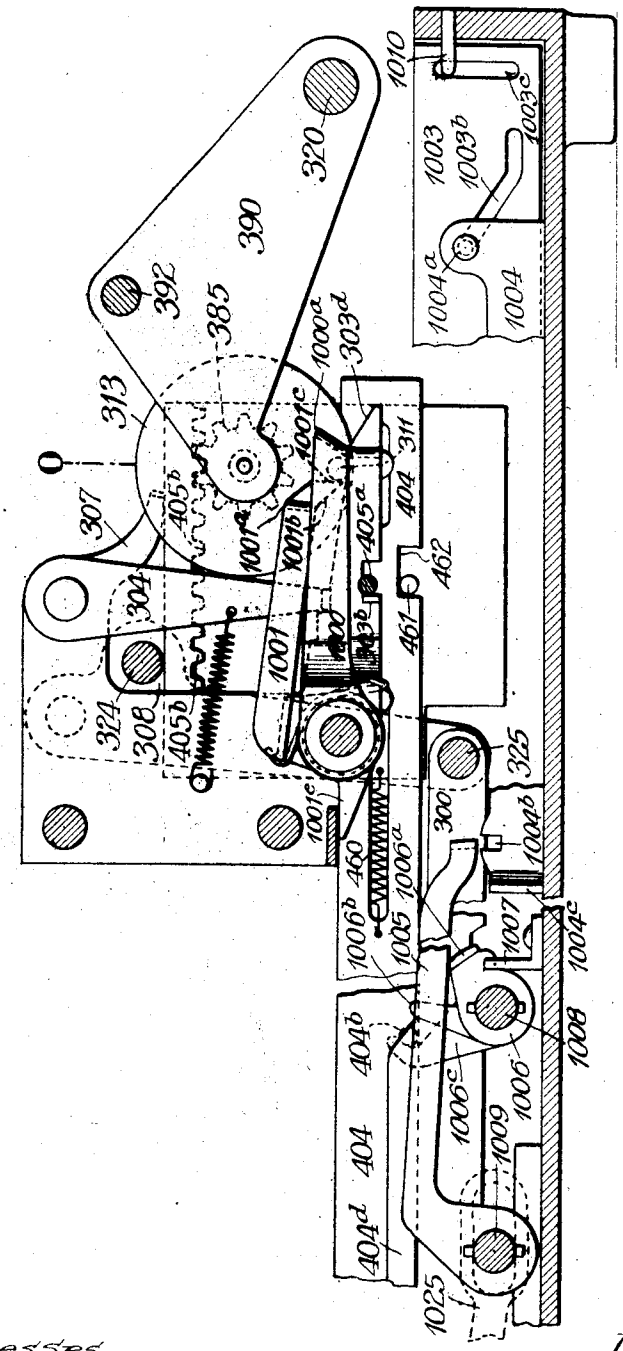


Fig. 13a

Witnesses
Martin H. Olsen.
Robert Dobberman

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his Attys

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CALCULATING AND RECORDING MACHINE.

APPLICATION FILED AUG. 10, 1908.

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14 SHEETS—SHEET 11.

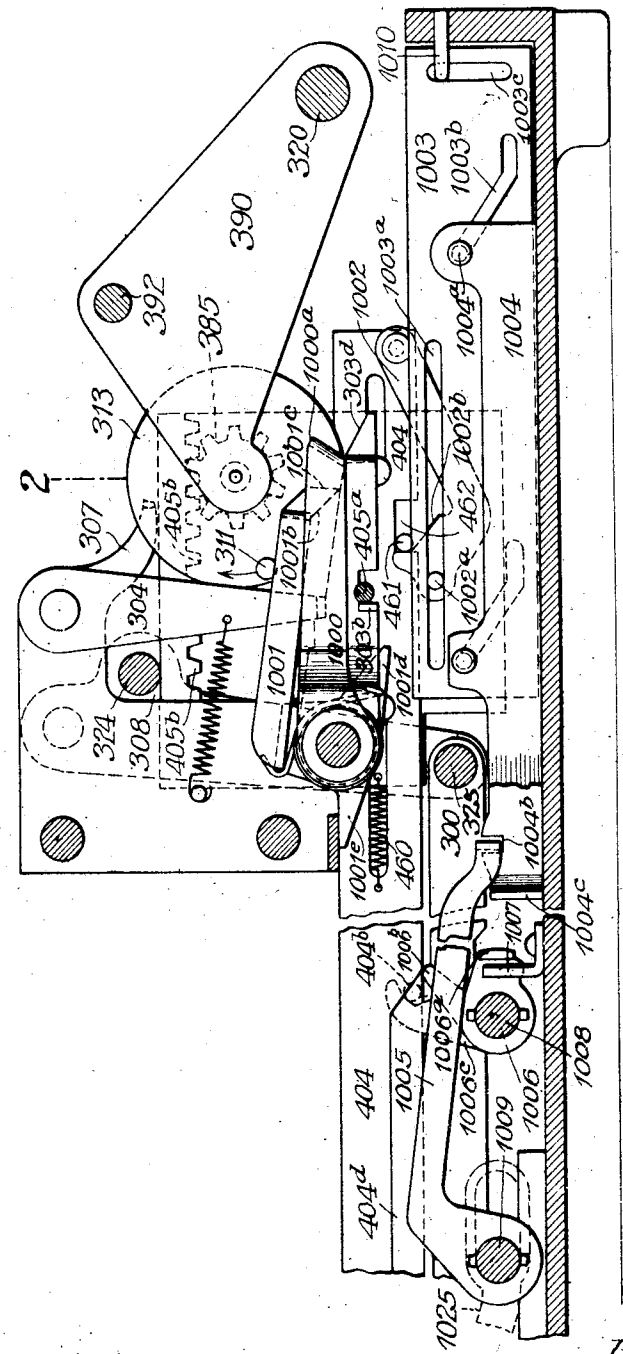


Fig. 13b.

Witnesses
Martin H. Olsen.
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his Att'ys.

W. H. DRAUGHON.

CALCULATING AND RECORDING MACHINE.

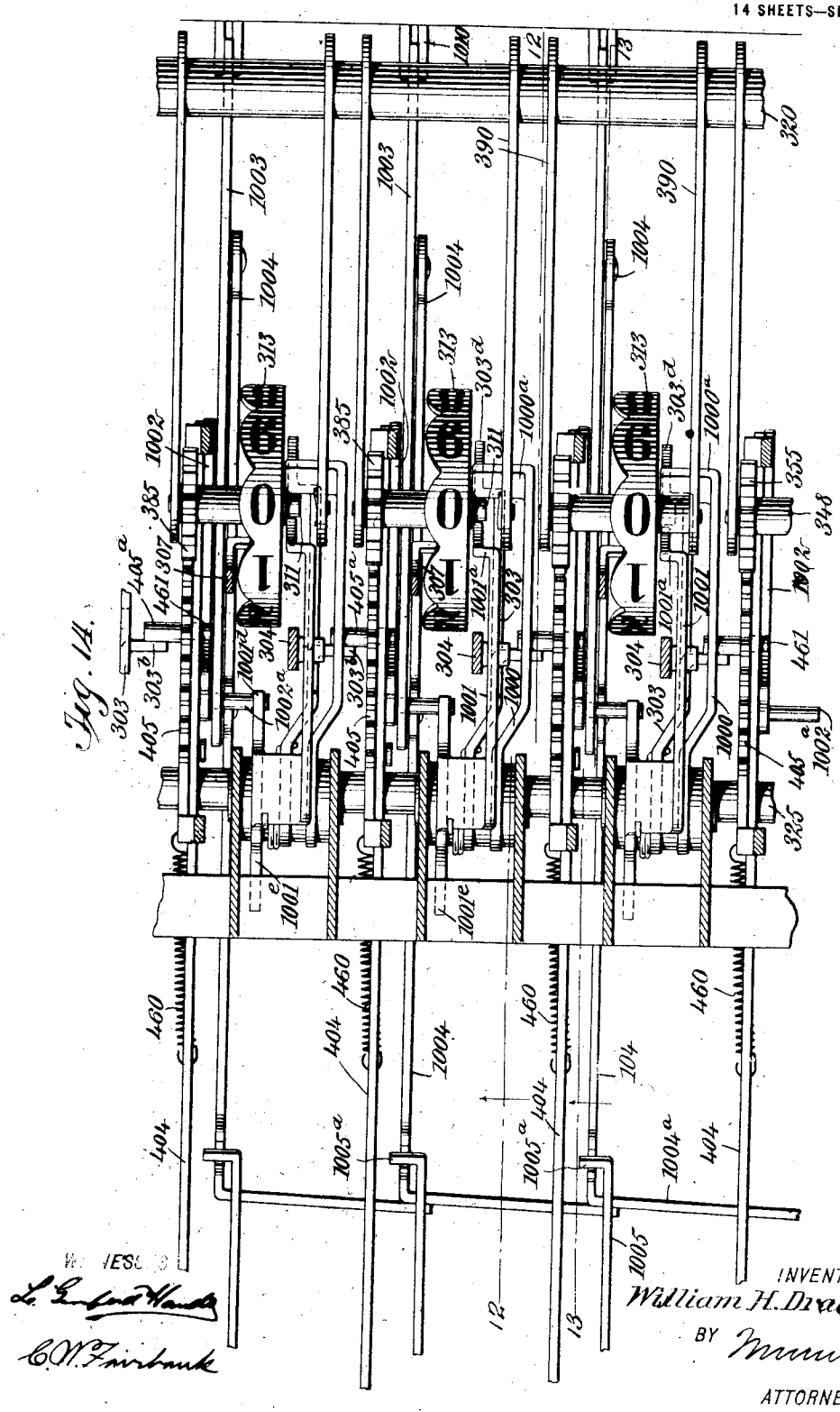
APPLICATION FILED AUG. 10, 1908.

1,195,567.

Patented Aug. 22, 1916.

14 SHEETS—SHEET 13.

Fig. 14.



WITNESSES:

L. L. Lord Wands

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ATTORNEYS

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CALCULATING AND RECORDING MACHINE.

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1,195,567.

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14 SHEETS—SHEET 12.

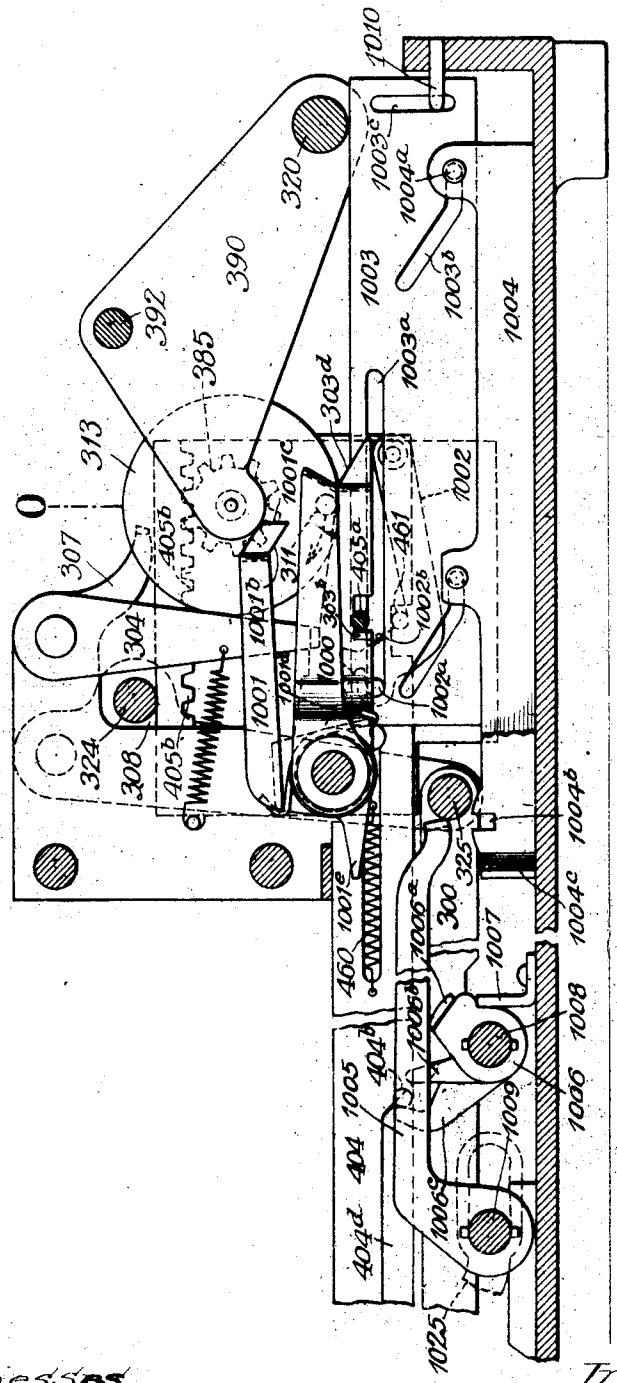


Fig. 13c.

Witnesses
Martin H. Olsen.
Robert D. Abernethy

Inventor
William H. Draughon

By Rector, Hibben, Davis & Macauley
his Attys.

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CALCULATING AND RECORDING MACHINE.

APPLICATION FILED AUG. 10, 1908.

1,195,567.

Patented Aug. 22, 1916.

14 SHEETS—SHEET 14.

Fig. 15.

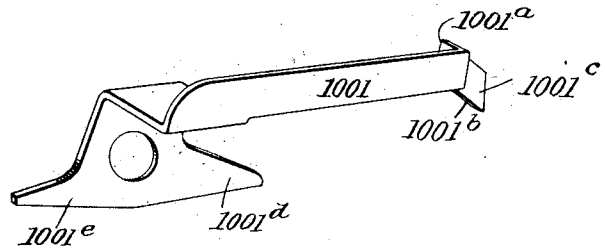


Fig. 16.

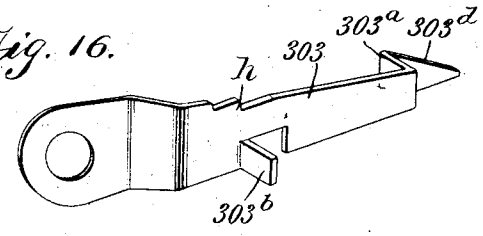


Fig. 17.

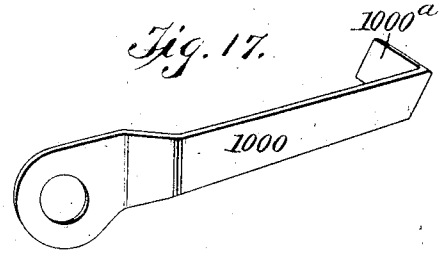
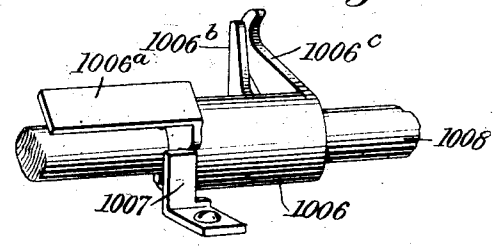


Fig. 18.



WITNESSES

L. Gurdon Hawley

C. W. Fairbanks

INVENTOR

William H. Draughon

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ATTORNEYS.

UNITED STATES PATENT OFFICE.

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CALCULATING AND RECORDING MACHINE.

1,195,567. Specification of Letters Patent. Patented Aug. 22, 1916.

Application filed August 10, 1908. Serial No. 447,915.

To all whom it may concern:

Be it known that I, WILLIAM H. DRAUGHON, a citizen of the United States, and a resident of Springfield, in the county of Robertson and State of Tennessee, have invented a new and Improved Calculating and Recording Machine, of which the following is a full, clear, and exact description.

This invention relates to certain improvements in combined adding and recording machines, and relates more particularly to mechanism whereby the machine may be employed for subtracting directly without any mental computation or may be employed for listing a series of positive and negative amounts, giving the balance or difference in their sums and indicating whether said balance be positive or negative.

In a machine involving all of my improvements, the numbers are punched directly on the numeral keys, and a reversing key or lever is moved to one position if the number is to be added, and moved to a second position if the number is to be subtracted. Upon operating the machine, the numeral wheels may be rotated in either direction to increase or decrease the total, dependent upon the position of said reversing key or lever. The machine operates to print the actual total, whether it be positive or negative, even though the numeral wheels show only the complement of the negative balance. In printing, the numeral wheels are rotated to the zero position and stopped there, the direction of rotation of said wheels being dependent upon whether the total or balance be above or below zero. The actual numbers are printed on the strip of paper, irrespective of the position of the reversing key or lever, but said key or lever is automatically shifted if the total or balance be on the opposite side of zero from the last number listed. The machine also operates independently of the printing mechanism to automatically indicate whether the total printed be a positive or a negative one.

The detail mechanism by means of which I secure the results above indicated may be varied to adapt the invention to various different types of machines, but the invention is especially adapted for that type of machine in which a series of numeral keys are provided for each numeral wheel, and in which an operating member rotates each wheel, the extent of movement of said operating member being dependent upon which one of the series of keys is depressed before starting said operating member.

In order that my invention may be fully understood, I have illustrated the details of one form which it may assume, and illustrated this form in connection with an adding and recording machine, the main features of which do not constitute any portion of my invention. The particular machine in connection with which I have illustrated my improvements is substantially that shown in the United States Patent to W. H. Pike, Jr., Number 763,692, issued June 28, 1904, but I wish it distinctly understood that my invention is not limited in any way by said patent, and that the details of said patent are illustrated merely as one example of an adding and recording machine. To facilitate reference to this patent and the description and operation of the mechanism, I have employed in the following description, as far as possible, the same reference characters as are used in said patent, to indicate the corresponding parts.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the figures, and in which—

Figure 1 is a side elevation of a machine constructed in accordance with my invention, a portion thereof being broken away; Fig. 2 is a side elevation of the controlling mechanism for the total and sub-total printing mechanism; Fig. 3 is a plan view of the parts shown in Fig. 2; Fig. 4 is a top plan view of the front portion of the machine; Fig. 5 is a top plan view of the rear portion of the machine, the numeral keys and the recording mechanism being removed; Fig. 6 is a sectional side elevation of parts shown in Fig. 4, portions thereof being broken away; Figs. 6^a and 6^b are detail sections on the line 6^a—6^a and 6^b—6^b of Fig. 6; Fig. 7 is a side elevation of the parts shown in Fig. 4, the reversing lever being in position for adding; Fig. 8 is a vertical section on the line 8—8 of Fig. 4; Fig. 9 is a sectional side elevation similar to Fig. 7, but with the parts in position for printing the minus or negative total or balance; Fig. 10 is a transverse section on the line 10—10

of Fig. 7; Fig. 11 is a perspective view of a lever employed in the automatic mechanism which controls the reversing key upon the printing of a total; Figs. 12 and 13 are vertical longitudinal sections on the lines 12—12 and 13—13, respectively, of Fig. 14; Fig. 13ª is a view similar to Fig. 12 but with said parts in changed relationship such as occurs in a negative totaling operation with respect to the units and tens numerical orders; Fig. 13ᵇ is a similar view illustrating changed relationships of parts in the tens and hundreds numerical orders; Fig. 13ᶜ is another view of the same character but illustrating corresponding changed relationships of parts in the hundreds and thousands numerical orders. Fig. 14 is a horizontal section on the line 14—14 of Fig. 12; Figs. 15, 16, and 17 are perspective views of the detents employed in connection with each numeral wheel; and Fig. 18 is a detail perspective of a sleeve, crank arm, and stop illustrated in Figs. 12, 13, and 14, and employed only in printing minus or negative totals.

Before proceeding to a detail description of the mechanism involving my invention, I will briefly describe certain portions of the machine in connection with which I have illustrated my invention. For a more full and detailed description, reference may be had to the Pike patent above referred to.

The numeral wheel rotating mechanism for adding.—At the front portion of the machine there are employed a plurality of numeral wheels 1ᶠ, each having a pinion 385 and all mounted within a swinging frame D. The frame includes a plurality of arms 390 journaled on a shaft 320 and held rigid in respect to each other by a transverse rod 392. Beneath each pinion there is mounted a rack 405 which, when the frame D is lowered, engages with its corresponding pinion to rotate said pinion and its numeral wheel upon the longitudinal movement of the rack. Each rack is carried by a longitudinally-movable strip 404 and is movable longitudinally in respect to said strip a distance equal to the distance between the centers of adjacent teeth. The extent of the movement is controlled by a stud 461 on the rack engaging in a recess 462 in the strip. A spring 460 normally tends to hold the rack in its rearward position relative to the strip. Each strip extends beneath a series of keys 201, and is provided with a plurality of stops 430, which may engage with the keys when the latter are depressed. The stops are so disposed in respect to the keys that when a key is depressed and the strip is permitted to move forwardly, the extent of the movement will be dependent upon the particular key depressed and will be one unit length greater than the numeral of that key; that is, if no key be depressed and the strip permitfed to move forwardly, it may move one unit length, in which case there will be no accompanying movement of the associated rack, while if the "1" key be depressed the strip may move two units, its rack moving one. If the "9" key be depressed, the strip may move ten units, the rack moving nine. Each strip at its rear end is connected to the lower end of the type lever 403, and all of the type levers are normally held rearwardly by a transverse strip 401 carried by depending arms 400. The arms 400 also carry a roller 402 with which a controlling plate 900 engages. The plate 900 is mounted on the main operating shaft 922, which latter may be oscillated in any suitable manner, as, for instance, by a main operating crank or lever 922ª. The plate 900 is so formed that when the shaft 922 has been rotated a short distance, the strip 401 is permitted to swing forwardly out of engagement with the type levers, and the strips 404 are allowed to come forwardly under the action of springs 404ª until they are stopped by the numeral keys. After the strips have completed their forward movement, mechanism comes into play to bring the pinions 385 into mesh with the rack, said mechanism including a longitudinally-movable strip 714 (Fig. 6) having its rear end connected to a depending link 710 (Fig. 2). The link carries a roller 750 engaging with a plate 901, which latter is rigid with the main operating shaft 922, but the engagement of the roller 750 with the plate 901 is such that the strip 714 is not moved forwardly until after all of the strips 404 have completed their forward movement and the racks are in the adjusted positions in respect to the pinions, but out of engagement therewith. All of this mechanism is substantially that shown in the Pike patent, and constitutes no portion of my invention.

The numeral wheel rotating mechanism for subtracting.—In my improved mechanism I employ, in addition to the old rack 405, a second rack 405ᵇ substantially parallel to the rack 405 and spaced therefrom at such a distance that the corresponding pinion may lie between the two racks and out of engagement with either. The frame D is capable of being swung upon the shaft 320 as a pivot, so as to bring the pinion into engagement with either rack, so that in the normal operation of the machine, the racks having moved toward the front end of said machine under the influence of their springs, may, upon the return movement, operate to rotate the pinions in either direction, dependent upon the position of the frame D. In adding, I swing the frame D to bring the pinions into engagement with the racks 405, and the numeral wheels will be rotated in the direction indicated by the

arrow (Fig. 1). In subtracting, the numeral wheels are brought into engagement with the racks 405[b] and are rotated in the opposite direction. For raising and lowering the frame D, I eliminate the toggle joint illustrated in the Pike patent, and connect the rear end of the frame side arm 305 Fig. 6 to the forward end of the strip 714 by the mechanism illustrated particularly in Figs. 6, 6[a], and 6[b]. The front end of the strip 714 is subdivided into two forks or branches 714[a] and 714[b], and one of the two forks is offset so as to lie in a different plane from the other. The upper edge of the lower fork 714[b] is provided with a notch or recess 714[d], and the lower edge of the upper fork is provided with a recess 714[c]. Suspended from a transverse rod 309[a], I provide two arms 309 and 310. The two arms are so disposed as to lie adjacent to, but upon opposite sides of the two forks 714[a] and 714[b]. The arm 310 carries an inwardly-directed stud 310[a], and the arm 309 carries a similar outwardly-directed stud 309[b]. Normally these two studs are in direct alinement with each other and in alinement with the two recesses 714[c] and 714[d], so that when the strip 714 is in its raised position, as indicated in Figs. 6 and 6[b], the stud 309[b] will enter the recess 714[d], and the strip and the arm 309 will be locked together to create an adding condition. When the strip 714 is in its lowered position, the stud 310[a] will enter the recess 714[c] and the strip will be locked to the arm 310 to create a subtracting condition.

For raising and lowering the forward end of the strip 714, I employ a bar 1018 pivoted intermediate its ends upon a stud 1018[c] and having its forward end connected by a stud 1018[a] to a depending link 1017, which latter has its lower end connected to the strip 714. Intermediate the ends of the bar 1018 is an upwardly-extending lever 1018[d], hereinafter referred to as the "reversing lever", inasmuch as the position of this lever determines to which of the arms 309 and 310 the strip 714 is locked. The lower end of the arm 310 is provided with an upwardly and rearwardly-extending slot 310[c] adapted to engage with one end of a roller 305[a] carried by the arm 305 at its rear end, whereby when the arm 310 is swung toward the front of the machine by the action of the link 714, the roller upon entering the slot will raise the arm and the frame D and bring the pinions into engagement with the upper racks 405[b]. The arm 309 is also provided with a slot at its lower end, but this slot 309[c] extends upwardly and forwardly, so that when the arm 309 is swung forwardly the upper edge of the slot engages with the roller 305[a] and forces the arm 305 downwardly to bring the pinions into engagement with the lower racks 405. The two arms 309 and 310 are so constructed as to normally hold the arm 305 against either upward or downward movement, the arm 309 having a hook which normally lies beneath the roller 305[a], and the arm 310 having a projection normally engaging with the upper surface of the roller. The arm 305 is also preferably provided with two springs 393 and 393[a], which normally tend to return the arm to its intermediate position. It will thus be noted that as the link 714 moves forwardly at each operation of the machine, the particular rack into which each pinion is forced will depend directly upon the position of the reversing lever 1018[d]. In adding, the reversing lever is in the position indicated in Fig. 6, and the strip 714 is locked to the arm 309, so that the arm 305 is forced downwardly, bringing the pinion 385 into engagement with the rack 405, and the return movement of the strip 404 and its rack 405 rotates the numeral wheel to increase the amount indicated thereon. To subtract, it is merely necessary to bring the reversing lever forwardly to the position indicated in Fig. 9 and operate the keys 201. As the bar 714 is now locked to the arm 310, the pinion will be forced upwardly into engagement with the rack 405[b], and the return movement of the strip 404 will rotate the numeral wheels in the reverse direction and decrease the total indicated thereon.

The carrying mechanism for adding.—In all adding machines of this type it is necessary that each numeral wheel upon completing a revolution will operate to rotate the adjacent numeral wheel of higher denomination through one unit space. For accomplishing this during adding, I provide a detent 303 (Fig. 12) for each numeral wheel, said detent being pivoted at its rear end and of substantially the form indicated in Fig. 16. Each detent is provided with an offset or shoulder 303[a] adjacent its forward end, and the terminal portion 303[d] beyond this shoulder constitutes a cam portion. Intermediate the ends of each detent a portion is bent laterally to form a lug 303[b] extending at substantially right angles from the detent adjacent the lower edge thereof and upon the opposite side from the shoulder or stop 303[a].

Each numeral wheel is provided with a laterally-extending stud 311 which is disposed closely adjacent the shoulder 303[a] when the numeral wheel is in its zero position, and the rack 405 of one numeral wheel is provided with a stud 405[a] extending laterally and normally engaging the front side of the lug 303[b] of the detent of the numeral wheel of next lower denomination. The lug 303[b] normally limits the rearward movement of the rack bar and maintains the spring 460 under tension. When the adding wheels are

turned from zero in a direction indicated by the arrow (Fig. 12), the studs 311 are carried away from the shoulders 303^a, and when each wheel has turned nine units its stud 311 will nearly contact with the inclined edge 303^d. As each wheel moves through its tenth step or unit, its stud 311 will contact with the cam 303^d to depress the detent 303, so as to move the lug 303^b out of the path of the stud 405^a on the rack that coöperates with the adding wheel of the next higher order of numbers, and that rack will be permitted to move one step farther on its return stroke than it otherwise would have moved. This accomplishes the carrying of one unit to the next higher order during the adding operation. The operation of this detent is substantially the same as the corresponding detent in the Pike patent. The detent is held down after being depressed by the vertically disposed pawls 304 which engage with the upper edges of the detents 303 and bear against shoulders h on the latter. The detents are held depressed until the pawls 304 are forced forwardly out of engagement with the shoulders h by the movement of the rod 324, which action also causes the rod 325 to restore the racks to their normal position, leaving the studs 405^a in contact with the lugs 303^b. The numeral wheels, when not in engagement with either of the racks, are positively held against rotation by stationary pawls 307. These pawls are carried by the frame, and each has a laterally-extending portion which engages in a scalloped flange on the side of each numeral wheel Fig. 4. When the numeral wheels are raised, their flanges come above the lateral extensions of the pawls 307, and when they are lowered they come below said extensions, so that the wheels may freely rotate when in either the raised or the lowered position, but are held from rotation when in the intermediate position.

Borrowing mechanism.—In subtracting, the reversing lever 1018^d is in its forward position, and the numeral wheels are raised to bring their pinions into engagement with the racks 405^b, as above described. The studs 311 now come above the detents 303, and the numeral wheels rotate in the opposite direction. For effecting the borrowing operation during subtracting, I provide a detent 1000 adjacent each detent 303 and mounted upon the same pivot. Each detent 1000 is provided with a laterally-extending shoulder 1000^a disposed above the shoulder 303^a and inclined in the opposite direction from the inclination of the cam 303^d. As a numeral wheel is rotated in subtracting and as the zero gives way to "9", the stud 311 will come in contact with the inclined edge 1000^a and force the detent 1000 downwardly. This carries with it the detent 303, and identically the same effect is produced as when the detent 303 is depressed by direct engagement of the stud 311 therewith; that is, the rack of the adjacent numeral of higher denomination is liberated to go one unit space farther than it otherwise would, and as it is rotated to effect a subtracting action the unit that is transferred to the next higher order is subtracted instead of added. Mounted upon the same pivot with the detents 303 and 1000, I provide a third detent 1001 for zero setting purposes under subtraction adjustment of parts, having an offset shoulder 1001^a, a cam lower edge 1001^b, and a vertical terminal end edge 1001^c. This detent is unaffected by the stud 311 during the adding operation (being above the path of movement of stud 311), and during the subtracting the stud 311 engages with the cam 1001^b and merely lifts it up out of the road to pass beneath without any transfer effect. Adjacent the base of the detent 1001 (Figs. 12 and 15) there are provided two projections 1001^d and 1001^e. The former of these does not in any way affect the transfer operation, but is adapted to be engaged by a stud 1002^a in the printing of a negative total, as will be set forth more fully hereinafter. The projection 1001^e engages beneath a portion of the frame of the machine and serves to limit the downward movement of the free end of the detent, as will be seen from Fig. 12.

It is thought that the mechanism whereby the machine operates to either add or subtract will be understood from the above description, particularly when considered in connection with the Pike patent above referred to.

Clearing and total printing mechanism for positive totals.—So long as the machine registers on the numeral wheels added amounts, or so long as the added amounts are in excess of the subtracted amounts, the operation of clearing and printing totals is practically the same as in all adding machines of the type illustrated. The operation of the particular mechanism illustrated may be briefly described as follows, reference being had to Figs. 2 and 3: Upon depressing the total key 702^R, arm 713 is lowered so that its notch or recess embraces the roller 750, and in the ensuing operation of the machine the plate 707 carrying said arm is caused to rotate by the engagement of the roller 952 with the dog 712. Thus, with the reversing lever in the adding position, the pinions are brought into engagement with the racks 405 at the outset, and, the strips having been liberated by total key connections not shown (but see the aforesaid patent), they may come forward as the cam plate 900 moves upward, and rotate the numeral wheels until each of said numeral wheels is in its zero position. As each wheel rotates a distance dependent

upon the unit indicated by that wheel, and as the strips 404 and the type levers 403 move a distance dependent upon the extent of rotation of the numeral wheels, the type levers will be in a position to print the correct total upon the paper on the roller 880. After the printing operation, the return movement of the plate 901 will bring the roller 952 into engagement with the dog 711 and the pinions will be brought out of engagement with the racks, so that they will remain in their zero position and the entire machine will be clear, ready to start anew. Had the sub-total key 702^{L} been depressed instead of the total key, the dog 711 would not be operated upon during the return movement of the plate 901 (because displaced by the lever 705), and the pinions would have remained in engagement with the racks during the return movement of the latter, and the total would again be brought to view on the numeral wheels, ready for the addition thereto or the subtraction therefrom of other amounts. This clearing and total-printing while the reversing lever is in the adding position is not *per see* of my invention, but fully disclosed in the aforesaid patent.

Clearing and total-printing mechanism for negative totals.—If the subtracted amounts listed on the machine be in excess of the added amounts, the dials will show a quantity equal to the difference between the correct negative total and the total capacity of the machine (in the present instance 1,000,000,000), *i. e.*, the complement of the true negative total, and when the machine is cleared in this condition, of course, this complemental number would be printed on the paper strip if no mechanism other than that above described were provided. To prevent this and to cause the machine to print the exact negative total when the total or sub-total key is depressed, I provide mechanism illustrated particularly in Figs. 5, 12, 13, 14, and 18. Pivoted to each strip 404, except the units strip, is a lever 1002 having an inclined edge 1002^{b} which, when the lever is raised, engages with the pin 461 and locks the latter at the forward end of the recess 462, so that there can be no movement of the rack relative to the strip. Normally, the racks remain stationary during the first unit length of the movement of the corresponding strips 404, due to the slots 462, but these levers 1002, when in operation, prevent this lost motion. Adjacent each lever 1002 I provide a bar 1003 having a horizontal slot 1003^{a} therein for receiving the stud 1002^{a} carried by the lever 1002. The lever is thus free to move longitudinally of the bar, but its cam edge 1002^{a} cannot be raised into engagement with the stud 461 except upon a corresponding upward movement of the bar 1003. For raising and lowering the bar, a second bar 1004 is mounted adjacent thereto and substantially parallel therewith, and is provided with studs 1004^{a} which engage within cam slots 1003^{b} in the bar 1003. As the bar 1004 is moved longitudinally, the action of the cam slots and the studs is such as to raise the bar 1003 vertically. It is guided in its vertical movement by the engagement of a retainer 1010 carried by the frame of the machine and extending through a vertical slot 1003^{c} adjacent the end of the bar.

Extending across the machine and beneath the strips 404 is a transverse rod 1009 free to move longitudinally of the machine a limited distance, for a purpose hereinafter described. For moving this rod, I provide links 1025 (see Figs. 1 and 5) each having an elongated slot adjacent its front end for receiving the rod 1009 and each having its rear end pivoted to a pivot pin carried by the depending arms 400. The rod 1009 is normally held in its rearward position and against stops 1028 by coil springs 1027, and the rod is normally at the front end of the slots in the links 1025.

Loosely mounted upon the transverse rod 1009 and extending forwardly therefrom, I provide a plurality of levers 1005, one for each bar 1004, save the one corresponding to the units numeral wheel. These levers are normally held in an elevated position, so that they may freely move back and forth independently of the bars 1004, but each lever is provided with a transversely-extending end portion 1005^{a}, which when the lever is lowered may engage in a notch 1004^{b} in the bar 1004 so as to cause the bar 1004 to move with the lever 1005. Thus, the levers 1002 may be brought into engagement with the studs 461 to hold the latter in the forward ends of the recesses 462 by the forward movement of the arms 400 in case the levers 1005 are in their lowered position and locked to the bars 1004.

For normally holding the levers 1005 in their raised position out of engagement with the bars 1004, I provide a transversely-extending rod 1008 having a plurality of sleeves 1006 rotatable thereon but held from longitudinal movement in respect thereto. Each sleeve is provided with an upwardly-extending arm 1006^{a} terminating in a lateral extension adapted to engage with the under side of and uphold the lever 1005 belonging to the next higher numerical order (see Fig. 5). Adjacent each sleeve 1006 there are mounted a plurality of stationary lugs 1007 which normally engage with the under sides of the several arms 1006^{a} to support the latter and prevent the sleeves from rotating. By moving the rod 1008 longitudinally, each of the arms 1006^{a} is brought out of engagement with its supporting lug 1007 and the several sleeves are permitted

to rotate, so that the several levers 1005 may drop into engagement with the bars 1004.

Rigidly secured to each sleeve 1006, and in addition to the arms 1006[a], are two arms 1006[b] and 1006[c], and by means of these arms the sleeves may be rotated to either raise the arms 1006[a] and the levers 1005 or lower the arms 1006[a] into engagement with the supporting lugs 1007. For engagement with these arms 1006[b], each strip 404 is provided with an auxiliary strip 404[d] rigidly secured thereto on the left-hand side, and for engagement with the arms 1006[c] each strip is provided with a stud 404[b] projecting from the right-hand side in transverse alinement with the forward end of the auxiliary strip (Fig. 5). When the sleeves 1006 are slid longitudinally to the right, and their arms 1006[a] thereby moved out of engagement with the lugs 1007, the arms 1006[b] come adjacent and in line with the front ends of the corresponding auxiliary strips 404[d], the arms 1006[c] remaining behind and closely adjacent to the corresponding studs 404[b], which are elongated for the purpose of preserving the engagement. Now, when a strip 404 is moved forwardly, the front end of its auxiliary strip 404[d] engages with the arm 1006[b] of the associated sleeve 1006 to positively rotate the latter and let down the associated lever 1005 into engagement with the bar 1004. The parts are so proportioned that the lever 1005 does not become locked to the bar 1004 unless the strip 404 moves forward a distance of more than one space. Thus the sleeve 1006 has a rocking range of approximately 60° and advance of the strip only one step or unit of movement, as illustrated in Fig. 13[a], rocks it but approximately 30° and so does not lower the flange 1005[a] of the lever 1005 into the notch 1004[b]. During further advance of the strip a second unit of movement, however, the said flange will move down into the notch. After the strip 404 has reached its limit of movement in excess of one space and starts to return, the lever and bar remain locked together (by reason of the straight under edge of the strip 404[d] wiping over the end of the arm 1006[b]) until the strip 404 reaches less than two spaces from the end of its return movement. Here the stud 404[b] engages with the upper end of the arm 1006[c], and the sleeve 1006 is rotated and its arm 1006[a] rises, so that upon the longitudinal movement of the sleeve 1006 to the left, said arm may pass over the lug 1007 and be held thereby in its elevated position.

In order that the functioning of that portion of the mechanism just above described may be fully understood, a concrete example will be taken. Supposing that the machine has accumulated subtracted amounts in excess of the added amount to the extent of 5990. That is to say, the amount 5990 has been subtracted from zero, and the correct balance which it is desired to print on the paper strip is —5990. It is evident that the dials before clearing will show 999,994,010, and without the intervention of my improved mechanism this sum would be printed if the machine should be operated with the controlling lever 1018[d] back, *i. e.*, in the adding position, and the total or subtotal key down, but when either one of the total keys is depressed while the dials are carrying an amount resulting from subtracting more than has been added, the mechanism shown in Figs. 7 to 11, inclusive, which will be described later, will automatically set the reversing lever in the subtracting position and will automatically shift the shaft 1008 and all of its sleeves and cranks a short distance to the right of the operator. This movement brings all of the crank arms 1006[b] into operative relation with the strips 404[d], as above described, and will move the arms 1006[a] off of the lugs 1007. Hence, all of the sleeves are in readiness to be operated upon the movement of the strips 404. As the reversing lever is in the subtracting position, all of the pinions 385 will rise to engage with the upper racks 405[b], and during the forward stroke of the operating handle all dials will tend to rotate in the direction of the arrow in Fig. 12. If the studs 311 are already in contact with the edge 1001[e] of the detents 1001, those dials will remain substantially stationary (except under certain conditions hereinafter described), but those dials whose studs are at a distance from the edges or stops 1001[e] will rotate a number of steps equal to the difference between the figure shown on the numeral wheels carrying said studs and zero. In the example assumed, the units dial will show zero already, and its stud 311 will be already in contact with the edge 1001[e], and this dial will not rotate. The actuating strip 404 corresponding to this dial will travel only one step, and zero of the type will be brought to the printing point. As before explained, and as illustrated in Fig. 13[a], this limited or one-space advance of the strip is not sufficient to so far rotate the sleeve 1006 as to lower the lever 1005 of the tens-order into engagement with the bar 1004. Therefore, in the example above taken, the bar 1003 of the tens-order will be unaffected by the longitudinal movement of the associated lever 1005. (In Fig. 13[a] the tens bar 1004 and its operating bar or plate 1003 are broken out to disclose the units rack more fully and avoid confusing the units stud 461 with the similar stud of the tens rack.) Here it should be noted that the lost motion provided for by the slots in the links 1025 is such as to delay advance of the cross-rod 1009 until there has been time for the levers 1005 to become

engaged in notches 1004[b] by reason of advance of lower order slide-strips in excess of the single space or step.

In the example, the tens-dial shows "1" before clearing, and, consequently, it will rotate nine spaces before its stud 311 will strike the edge 1001[c], and its strip 404, together with the type, will travel ten spaces, thus bringing the type "9" to the printing point. This movement of the tens-strip 404 will bring its auxiliary strip 404[a] into full engagement with the arm 1006[b] of the sleeve 1006 and permit the hundreds-lever 1005 to lower into engagement with the corresponding bar 1004, as shown in Fig. 13[b] wherein the notched portion of the hundreds order bar 1004 appears broken away and the greater portion of the tens bar 1004 shows beyond it. The tens rack has advanced a single step so that the numeral "2" on the tens wheel is just passing the reading line. The ensuing forward movement of the said fully lowered lever 1005 will cause a longitudinal movement of the hundreds bar 1004 and a vertical movement of the bar 1003, so that the rack of the hundreds-strip 404 will become locked to said strip by the moving up of the cam edge 1002[b] of lever 1002 on said strip against the rack stud 461, as shown in Fig. 13[c], wherein the notched portion of the thousands bar 1004 appears broken away and the hundreds bar 1004 shows beyond it. It will be noted that the units dial or wheel did not rotate, though its slide strip moved a single step, and that the tens-dial or numeral wheel rotated a distance one space less than its slide strip 404 and corresponding type lever 403 moved.

In the hundreds column there would in the beginning be a movement of the slide-strip through one space independently of the rack; while lost motion between link 1025 and rod 1009 was being taken up, but a camming action of the edge 1002[b] against the rack stud 461 would then take place, so that the hundreds-dial and the hundreds-type lever would move through identically the same number of spaces, which means that the strip and type lever move one space less than they otherwise would. The hundreds-type lever therefore sets up a digit one unit less than it would have done if the lever 1002 had remained out of action, and a numeral will be printed in the hundreds order of the total one less than the number of spaces which the hundreds-dial rotates through in clearing. In the example taken, the hundreds-dial shows zero before clearing. Therefore its corresponding rack will not move at all in the early part of the clearing stroke, because its stud 311 is already pressing against the edge 1001[c], but the hundreds-lever 1002 will be raised and, since the stud 461 will not yield so long as the edge 1001[c] stands behind the wheel stud 311, the slide-strip spring will be overcome and the slide-strip forced back by the camming action between its lever 1002 and the rack stud 461, so that the upward movement of this lever 1002 brings the stud 1002[a] into engagement with the projection 1001[d] and raises said projection, together with the detent 1001 carrying said projection as illustrated in Fig. 13[c] wherein the hundreds wheel is represented in zero position. The raising of the detent will move the edge 1001[c] out of the path of the stud 311, whereupon the rack and slide-strip locked together will spring forward and turn the hundreds-dial through one complete rotation of ten spaces or until the stud 311 again strikes against the edge 1001[c]. The latter will have returned to effective position, since the hundred-strip 404 has, of course, moved so far forward during the rotation of the numeral wheel that the stud 1002[a] will have moved out of engagement with the projection 1001[d]. As previously explained, the hundreds-type lever will move the same number of spaces as the hundreds-dial, and will therefore print a numeral on the strip one less than the number of spaces through which the hundreds-wheel rotated. As the hundreds-wheel rotates through ten spaces, the numeral "9" will be printed on the paper. It may be well to refer here to the fact that the type levers stand normally where their zero types are one step short of the printing line, so that in order to bring to the printing line a type corresponding either with the key struck or with the numeral showing on the wheel (in case of totaling), it is necessary for the type lever to move an extra step, which ordinarily is provided for by the lost motion between the slide-strip and rack.

As will be noted from Fig. 5, each bar 1004 carries a laterally-extending lug 1004[e] which is normally in contact with the rear end of the bar 1004 of the next higher order. It will thus be seen that if one bar 1004 is brought into action by the operation of the strip 404 of the order below it, all of the bars 1004 of higher denomination will be moved in unison with the shaft 1009 independently of the operation of each set of sleeves 1006 and the lugs carried thereby. Thus each lever 1002 to the left of any one associated with a strip 404 that has moved far enough to set up a significant type (and so locked its bar 1004 to the shaft 1009) will also be brought into operation by said shaft, and so in each order to the left a type will be set up one unit less than the number of spaces traveled by its dial.

The cooperative action of the slide-plates 1004 is requisite, since the sum of complemental numerals in every order, except the lowest where a significant digit occurs, is necessarily reduced to nine, and hence in no

order except the one of the lowest digit in the complement should the type lever have its customary one-step advance movement independent of the associated wheel, and in any order next higher to one where a zero occurs in the complement of the negative total, the lever 1005 could not be relied upon to advance the slide 1004 because the advance of the slide-strip 404 a distance sufficient to rock the sleeve 1006 and lock the lever 1005 to the slide 1004 is delayed, as before explained, and consequently advance of the said lever 1005 occurs before it has been lowered sufficiently to interlock with the slide 1004. (It will be recalled that with the hundred wheel at zero in the above example, the associated slide-strip 404 moves backward after first advancing a step independently of the rack, and the lever 1005 of the thousands order would start forward during this backward movement, and while not interlocked with the slide 1004,—the necessary concurrent forward movement of the latter being caused by the action against it of the lug 1004[c] of the hundreds slide 1004.) Furthermore in cases where zeros are to be set up in type in two adjacent higher orders, (the digits 9 appearing in the complement on the corresponding dials), the lever 1005 of the higher order of the two could not be relied upon for the reason that, though the lower order slide strip 404 would move forward two spaces at the beginning of the stroke of the operating handle, the camming action which occurs between the associated lever 1002 and stud 461 causes backward movement of this strip one space resulting in the disengagement of the higher order lever 1005 from the associated slide 1004. The lug 1004[c], however, upon the lower order slide 1004 would step in and do the work of advancing the higher order slide.

In the example assumed, the thousands-dial reads "4" before clearing, and it will therefore move six spaces in clearing, and, since its lever 1002 is brought into action, its type will print the figure "5" on the paper strip. Although the lever 1002 of the thousands-strip 404 was brought into action, the stud 1002[a] did not come in contact with the projection 1001[d], because the lever 1002 of the thousands order was not brought into action until the stud 1002[a] had passed from beneath the projection 1001[d], and there would be no forcing back of the slide-strip as in the case of the hundreds order where the rack was blocked by reason of the wheel stud 311[c] being up against the edge 1001[c]. Thus, the stud 311 of the thousands-dial will not be permitted to escape past the edge 1001[c] as did the stud of the hundreds-dial.

The levers 1002 are not brought into action until the slide-strips 404 have had time to move in excess of a single space or step. Hence, the studs 1002[a] will never engage the projections 1001[d] in orders where the slide-strips 404 are permitted by the turning forward of associated wheels to advance in the first instance beyond zero. It should be here mentioned that in the case of the thousands order in the example under consideration, the taking up of the relative movement between slide-strip 404 and rack does not occur in the same way as described with reference to the hundreds order, for the reason that the stud 311 of the thousands wheel is not up against the edge 1001[c], and therefore movement of the rack is not obstructed. Hence, when, immediately following the preliminary advance of the thousands strip 404 a single step, the cam edge 1002[b] is forced up against the stud 461, the strip 404 will continue to advance, and the rack will be thrust ahead until it catches up with the strip, *i. e.*, until it encounters the front end of the notch 462. In this way the one-step advance of the slide-strip relative to the rack will be nullified. It follows that the "5" type will be set up, and not the "6" type.

In the example the ten-thousands-dial reads "9" before clearing. Therefore it will travel one space in clearing, and, for the reasons given above, its strip 404 will be positioned just one space ahead, and zero on the printing lever will be brought to the printing position. Likewise, zero on each and all of the other printing levers of higher denominations will be brought to the printing position. In the case of the tens of thousands order, the lever 1005 will be lowered far enough to become interlocked with the slide-strip 404, since the thousands order advances and remains advanced more than one space, so that here the slide 1004 will be advanced both by the said lever 1005 and by the lateral lug 1004[c] of the thousands slide 1004. In the case of still higher orders, however, their slides 1004 rely for advancement upon the lugs 1004[c] of adjacent lower orders, because the backward one-space movement of the lower slide strips 404 previously explained disengages the levers 1005 from the slides 1004 during the first part of the initial stroke of the operating handle. In clearing the dials while in the subtracting position, it will be observed that the inclined surface 1000[a] is in the path of the stud 311 in orders where other than zero is registered in the complement of the negative total, but, since the dials rotate in the direction of the arrow (Fig. 12) while clearing in this position, the studs 311 will contact with the under sides of the inclined surfaces 1000[a] and will merely lift the detent 1000 out of its path and pass on into engagement with edges 1001[c] of the stops 1001, by which their motion will be arrested.

When a negative sub-total is being printed, the studs 311 of each dial partici-

pating in the action will, on the return stroke of the handle, move away from the zero position (in rear of the inclined flange 1000[a] of the pawl 1000), and in so doing will contact with the inclined edge 1000[a] in exactly the same manner as during the process of subtracting. Unless some means is provided to prevent, this action will cause one unit to be subtracted from each dial, so that the dials will all show the wrong total when they finally come to rest after the sub-total has been printed. The means I have provided to prevent this undesirable borrowing while printing a negative sub-total is as follows: Near the lower extremity of the total keys 702[R] and 702[L] are studs 702[a]. When either one of the total keys is depressed, one of the studs will enter one of the notches 300[a] and thus prevent any rearward motion of the bar 300 and the rod 325. The rod 325 will therefore prevent any rearward motion of the racks beyond their normal position, and thus borrowing will be prevented while printing sub-totals.

Automatic controller for the negative total printing mechanism.—All of the mechanism described in detail under the heading "Clearing and total printing mechanism for negative totals" only need be brought into action when the dials of the machine register an amount resulting from subtracting more than has been accumulated thereon by addition,—in other words, only when it is desired to print a total or sub-total less than zero. As previously described, this mechanism is brought into operation by the longitudinal movement of the rod 1008. The following mechanism operates automatically to shift the rod 1008 and bring the above described mechanism into operation whenever the dials or numeral wheels indicate a total of the character referred to. The operator need pay no attention whatever to whether his total be positive or negative, for it is only necessary that he press the total key, and if the machine contains a positive result the above mechanism will not be brought into action, and the process of clearing the machine and printing the result is practically the same as in all machines of this class, but if when the total key is depressed the machine should contain a negative result like the example above referred to, this special mechanism is automatically brought into action, causing the machine to print on the paper strip the correct negative balance, instead of printing the difference between the maximum capacity of the machine and said negative balance, which difference is the number indicated on the dials. This automatic selecting or controlling mechanism is shown particularly in Figs. 7 to 11, inclusive, and operates to control two separate mechanisms to bring them both into the proper position for printing a negative result. It operates not only to shift the rod 1008 longitudinally, but it also operates to shift the reversing lever 1018[a] to the subtracting position, so that the dials will be cleared by the action of the racks 405[b]. The automatic selecting or controlling mechanism is brought into operation by depressing either the total or the sub-total key. In the specific form shown, the lever 706, which is depressed by depressing either the total or the sub-total key, is provided with a forward extension 706[a] terminating adjacent the rocking lever 1018, and this forward extension, upon rising when either the total or the sub-total is to be printed, operates to rock said lever 1018. Depending from the lever extension 706[a] is a short link 1022 having suspended from its lower end a balance lever 1016 shown particularly in Fig. 11. The balance lever is pivotally supported intermediate its ends upon a stud 1016[a] which connects it to the link 1022, and at its opposite ends it has transversely extending studs 1016[b] and 1016[c] which project on both sides of the lever. Depending from the ends of the reversing lever 1018 are two links 1020 and 1021 having slots 1020[a] and 1021[a], respectively, in their lower ends. The outwardly projecting part of the stud 1016[c] of the balance lever 1016 extends through the slot 1021[a], while the outwardly projecting part of the stud 1016[b] extends through the slot 1020[a]. The links 1020 and 1021 are of such length and the slots are so disposed that the balance lever 1016 may remain stationary and supported by a stationary supporting bar 1019 fastened to a frame plate 1013, while the reversing lever 1018 is moved to either of its two limiting positions. Thus the inwardly projecting parts of the studs 1016[b] and 1016[c] may remain seated in notches of the stationary bar 1019, as shown in Fig. 8, but if, while the reversing lever 1018 is inclined in one directon, one end of the balance lever 1016 be held stationary and the other end permitted to move upwardly to incline the balance lever in the opposite direction to the inclination of the reversing lever, the stud at that end of the balance lever which rises will engage in the upper end of the slot of the corresponding link and cause a corresponding upward movement and reversal of position of the reversing lever. For instance, if while the levers 1016 and 1018 are in the position indicated in Fig. 7 the left-hand end of the lever 1016 be raised to the position indicated in Fig. 9, the reversing lever 1018 will be changed from an adding to a subtracting position.

For preventing both ends of the lever 1016 from rising simultaneously, and for determining which of these ends shall rise, the dial or numeral wheel 313 at the left-hand side of the machine is provided with a pinion 1011 which engages with a rack

1012[a] carried by a longitudinally movable bar 1012. This bar extends adjacent the levers 1016 and 1018, and is provided with a slot 1012[c] through which a stud extends from the stationary supporting plate 1013, so that the bar may move longitudinally upon the rotation of the dial of highest denomination, but its rear end is held from vertical movement. Adjacent its rear end the bar 1012 carries a second and shorter bar 1014 connected thereto by studs extending through slots 1014[a] in the shorter bar, so that the bar 1014 may move longitudinally a limited distance in respect to the bar 1012, but is held against vertical movement in respect thereto. A spring 1015 is employed for holding the bar 1014 in one of its two limiting positions in respect to the bar 1012. The bar 1014 is disposed directly in the path of the two studs 1016[b] and 1016[c], and is of such length and so disposed that with the left-hand dial 313 in zero position said bar will lie with one end directly above the stud 1016[c] and the other end closely adjacent to but out of the path of movement of the stud 1016[b], substantially as illustrated in Figs. 7 and 8. Now, if the lever extension 706[a] be raised, the end of the lever 1016 which has the stud 1016[b] may rise, while the opposite stud 1016[c] acts as a fulcrum. When the bar 1012 is shifted forward to the position indicated in Fig. 9, the bar 1014 will allow the stud 1016[c] to rise, while the stud 1016[b] is held down as a fulcrum. Thus, the lever 1016 may swing to either one of two positions and bring the lever 1018 to corresponding positions, and the bars 1014 and 1012 serve to determine which end of the lever 1016 shall constitute the fulcrum. The positions of the two bars 1012 and 1014 are controlled directly by the left-hand numeral wheel or dial in the following manner: The front end of the bar 1012 is supported solely by the shaft 348 of the left-hand dial, and is therefore free to rise and fall with said dial, and the rack 1012[a] is held in constant engagement with the pinion 1011. So long as the extreme left-hand dial remains at zero, the bar 1012 occupies the position shown in Fig. 7 and the stud 1016[c] is positively prevented from rising. As added amounts are accumulated on this dial, the bar 1012 is automatically shifted toward the rear of the machine, and the stud 1016[c] is still prevented from rising. As subtracted amounts are registered on the last dial, the bar 1012 is shifted in the opposite direction, and as soon as the subtracted amounts exceed the added amounts the bar 1014 passes to the position indicated in Fig. 9, so that it prevents the stud 1016[b] from rising and permits the stud 1016[c] to swing upwardly. When the machine is cleared, with the stud 1016[c] in its elevated position, the rotation of the pinion 1011 will return the bar 1012 to its normal position before the stud 1016[c] returns to its normal position as a result of release of the total key, and therefore the stud 1016[c] will find the end of the bar 1014 in its path. But the stud 1016[c], coming in contact with the inclined end of the bar 1014, will force the bar to the right against the spring 1015, the elasticity of which will return the bar 1014 to its normal position above the stud 1016[c].

For shifting the rod 1008 by the movement of the lever 1016, I provide a short rock shaft 1024 having a pinion 1024[b] on one end thereof which engages with a rack 1008[a] on the end of the rod 1008. At the opposite end of the rock shaft 1024 I provide a crank arm 1024[a] having a link 1023 pivoted thereto and also pivoted to the stud 1016[c] of the lever 1016. Thus, when the dials indicate a negative total, the bar 1012 will have moved forwardly from its normal position so as to uncover studs 1016[c], and upon depressing either the total or sub-total key the rear end of the lever 1016 is raised to rotate the rock shaft, shift the rod 1008, and engage with the upper end of the slot 1021[a] to shift the lever 1018 to its subtracting position. Thus, the lever 1018 may be shifted by either one of two entirely independent methods,—that is, either by the handle 1018[d], when it is desired to list negative amounts, or by the lever 1016 when the last number listed was on the opposite side of zero from the balance to be printed, upon the depressing of the total or sub-total key. If the last number printed was a negative one and the total balance be positive, the lever 1018 will be automatically shifted in one direction, while, if the last number listed was positive and the total balance be negative, the lever 1018 will be automatically shifted in the reverse direction. Thus, when the total or the sub-total key is depressed, the handle 1018[d] will be compelled to occupy a position dependent solely upon whether the balance be plus or minus, and thus the handle serves as an indicator, so that the operator as soon as he prints the balance will note from the position of the handle 1018[d] whether his balance be plus or minus. In practice, I would preferably provide a printing mechanism for indicating after each number printed whether it is positive or negative, and print the corresponding sign in front of the balance or total, but, as such mechanism does not affect the operation of the mechanism above described, I have not incorporated it in this application.

My improved mechanism does not in any way limit or restrict any of the operations which are possible in that type of machine for which my improvements are especially designed; they only serve to open up new

fields and permit new operations. My improvements are especially adapted for use where a series of debits and credits are to be balanced, or where the balance of any series of amounts is to be found, some of the amounts being positive and some negative. For instance, in taking off trial balances book-keepers having a machine incorporating my improvements may go through the ledger, taking each account as they come to it, listing the debit balances with the reversing lever in adding position, and listing the credit balances with the lever in the subtracting position. When the work is completed, if the ledger is on a balance, the machine will register zero, but if the books are out of balance the machine, when cleared, will automatically print the amount out of balance and will show whether the debit or credit side is in excess. Otherwise it would be necessary to go through the ledger once, listing all debit balances, then clearing the machine, and going through the ledger a second time, listing the credit balances, and clear the machine again and compare results. In balancing accounts, the debit items may be listed with the lever in adding position, and the credit items with the lever in the subtracting position, and upon clearing the machine the correct balance will be automatically printed. In balancing pass-books in banks, the debits may be listed on the machine with the lever in the adding position, and the checks listed with the lever in the subtracting position. Upon clearing the machine, the correct balance is given. In ordinary adding machines, if a wrong amount is listed, there is no simple way of correcting it save by making mathematical computations, as, for instance, by subtracting the incorrect amount from the total number which the machine is capable of recording, and entering this difference. In my improved machine, if a wrong amount is listed, the correction can be made by reversing the lever and repeating the wrong amount. The two incorrect amounts will cancel each other, and by replacing the lever in its former position, the correct amount may be listed and the balance or total at the completion of the work will show the same result as if the amount had been listed correctly in the first place.

The above operations are only a few of which my machine is capable. The main advantages are that a true negative total can be printed automatically (not a negative total that is a unit short owing to complemental numerical conditions in the decimal system), and the machine is rendered self-governing so that without any special manipulation on the part of the operator and without requiring any preventive devices to guard against a totaling operation of the machine under the wrong conditions, a positive total will be forthcoming if the registration is positive, and a negative total if the registration is negative.

As previously stated, I have illustrated my improved mechanism in connection with a machine substantially as shown in a previous patent, but I wish it distinctly understood that my invention is not in any limited to the construction shown in said patent, but may be employed in connection with any machine operating upon substantially the same principles.

Having thus described my invention, I claim as new and desire to secure by Letters Patent:

1. In a machine of the class described, the combination of a registering gear wheel, racks on opposite sides thereof and united for concurrent reciprocation, and controlling means for keeping the wheel and either rack engaged during movement of the latter in one direction and the wheel disengaged from both racks during movement in the opposite direction.

2. In a machine of the class described, the combination of a registering gear wheel, racks on opposite sides thereof and united for concurrent reciprocation, and controlling means for keeping the wheel and either rack engaged during movement of the latter in one direction and the wheel disengaged from both racks during movement in the opposite direction, with provisions for preserving engagement between either rack and the wheel during movement of the rack in both directions.

3. In a machine of the class described, the combination of a registering gear wheel, racks on opposite sides thereof and united for concurrent reciprocation, and controlling means for keeping the wheel and either rack engaged during movement of the latter in one direction and the wheel disengaged from both racks during movement in the opposite direction, with provisions for reversing the order of engagement and disengagement.

4. In a machine of the class described, the combination of a registering gear wheel, racks on opposite sides thereof and united for concurrent reciprocation, and controlling means for keeping the wheel and either rack engaged during movement of the latter in one direction and the wheel disengaged from both racks during movement in the opposite direction, with provisions for reversing the order of engagement and disengagement, and with provisions for preserving engagement between either rack and the wheel during movement of the rack in both directions.

5. In a machine of the class described, the combination of a registering gear wheel,

racks on opposite sides thereof and united for concurrent reciprocation, and both normally disengaged from the wheel, and controlling means for keeping the wheel disengaged from both racks during movement thereof in one direction and engaged with either rack during movement thereof in the opposite direction.

6. In a machine of the class described, the combination of united reciprocating racks confronting each other and spaced apart, a registering gear wheel between said racks and normally disengaged from both, a fixed pawl normally locking said wheel against turning, a movable support for said wheel, and controlling means for said support whereby the wheel may be disengaged from said fixed pawl and moved into engagement with either rack.

7. A calculating machine, having a plurality of numeral wheels, each having a laterally extending flange provided with a series of recesses therein, a movable frame for supporting said numeral wheels, means for rotating said wheels when said frame is in either of two limiting positions, and stationary pawls for engaging within the notches in the flanges of said wheels to hold said wheels against rotation when said frame is in its intermediate position.

8. A calculating machine, having a plurality of pairs of oppositely-disposed racks, a movable frame, pinions carried by said frame, a bar movable longitudinally to move said frame and bring the pinions into engagement with either rack of each of said pairs, and reversible connections for controlling the movement of the frame in respect to the bar.

9. A calculating machine, having two racks, a pinion therebetween, said racks and the pinion being relatively movable to operatively engage either of said racks with said pinion, a movable arm for effecting said movement, an operating bar for moving said arm, and connections whereby the movement of said bar in one direction may move said arm in either direction.

10. A calculating machine, having two racks, a pinion therebetween, said racks and pinion being relatively movable to operatively engage either of said racks with said pinion, a swinging arm for effecting said movement, a longitudinal movable bar, and connections whereby the movement of said bar in one direction may swing said arm in either direction.

11. A calculating machine, having two racks, a pinion therebetween, an operating bar movable longitudinally, an arm adapted to swing transversely of the path of movement of said bar to bring said pinion into engagement with either of said racks, connections whereby the movement of said bar in one direction swings said arm, and a controller for determining the direction of movement of said arm.

12. A calculating machine, having two racks, a pinion therebetween, an operating bar movable longitudinally, an arm adapted to swing transversely of the path of movement of said bar to bring said pinion into engagement with either of said racks, connections whereby the movement of said bar in one direction swings said arm, and a controller for determining the direction of movement of said arm, said connections including two swinging arms, one having a cam surface for raising the first mentioned arm, and the other having a cam surface for lowering said first-mentioned arm, and said controller serving to operatively connect said bar to either of said second mentioned arms.

13. The combination with a series of numbered keys and adding pinions, of two sliding racks for each of said pinions, and independent means for effecting engagement between said pinions and either of their racks during movement of the latter one way and disengagement during movement the other way.

14. In a calculating machine, the combination of a plurality of numeral wheels rotatable in one direction to accumulate a total in adding and rotatable in the opposite direction to decrease a total in subtracting, and carrying mechanism for rotating each wheel of higher magnitude one step or unit by the rotating of the wheel of next lower magnitude a predetermined distance in either direction, said carrying mechanism including a pivoted detent adapted to be directly displaced by said numeral wheel of lower magnitude in rotating in one direction and indirectly displaced by said wheel in rotating in the opposite direction.

15. In a calculating machine, the combination of a plurality of numeral wheels rotatable in one direction to accumulate a total in adding and rotatable in the opposite direction to decrease a total in subtracting, and carrying mechanism for rotating each wheel of higher magnitude one step or unit by the rotating of the wheel of next lower magnitude a predetermined distance in either direction, said carrying mechanism including a pivoted detent adapted to be depressed by said numeral wheel of lower magnitude in rotating in either direction to increase or decrease a total, said detent also constituting a stop for limiting the return rotation to zero of one of said totals.

16. A calculating machine having a plurality of numeral wheels, and an operating mechanism therefor, said numeral wheels being rotatable in one direction to increase the accumulated total in adding and rotatable in the opposite direction to decrease the total in subtracting, with provisions for

clearing from a negative total to zero by rotation of wheels one way and from a positive total to zero by rotation of wheels the opposite way.

17. A calculating machine having a plurality of numeral wheels, an operating mechanism therefor, said numeral wheels being rotatable in one direction to increase the accumulated total in adding and rotatable in the opposite direction to decrease the total in subtracting, the direction of rotation taken in clearing from a negative total to zero being opposite to that taken in clearing from a positive total to zero, and means for stopping said wheels at zero position in clearing independently of the direction of rotation taken by the wheels in reaching said zero position.

18. A calculating machine having a numeral wheel adapted to rotate in opposite directions accumulating positive and negative totals, respectively, and separate stops for limiting the return movement to zero from either total, one stop operating only during rotation in one direction and the other stop operating only during rotation in the opposite direction.

19. A calculating machine having a numeral wheel adapted to rotate in opposite directions in accumulating positive and negative totals, respectively, and separate stops limiting the return movement to zero from either total, one stop operating only during rotation in one direction and the other stop operating only during rotation in the opposite direction, and both of said stops being inoperative during the accumulation of totals.

20. The combination with a plurality of numeral wheels adapted to rotate in one direction to accumulate a total in adding and carrying mechanism for intermittently transmitting motion to a wheel of higher magnitude from one of lower magnitude, said mechanism including a detent, of means for rotating the wheels in the reverse direction to reduce the positive total or accumulate a negative one, and means for operating said carrying mechanism upon the rotation of said wheels by said first-mentioned means including a second detent for operating the first detent.

21. The combination with a plurality of numeral wheels adapted to rotate in one direction to accumulate a total in adding and carrying mechanism for intermittently transmitting motion to a wheel of higher magnitude from one of lower magnitude, of means for rotating the wheels in the reverse direction to reduce the positive total or accumulate a negative one, and means for operating said carrying mechanism upon the rotation of said wheels by said first-mentioned means, including a second detent for operating the first detent, one of said detents also constituting a stop for limiting the return rotation to zero.

22. In a calculating machine, a plurality of numeral wheels rotatable in opposite directions in the accumulation of positive and negative totals, respectively, and a plurality of pivoted members adjacent each wheel, one of said members serving to intermittently operate in conjunction with the wheel of next higher denomination to effect a carrying operation during addition, and also serving to stop this wheel at the zero position when clearing from a positive total, another of said members operating in conjunction with the first-mentioned member in effecting a carrying operation during subtraction, and the third of said members serving to stop this wheel at zero position when clearing from a negative total.

23. In an adding, subtracting and listing machine, a plurality of numeral wheels rotatable in opposite directions in the accumulation of positive and negative totals, respectively, and a plurality of pivoted members adjacent each wheel, one of said members serving to intermittently operate in conjunction with the wheel of next higher denomination to effect a carrying operation during addition and also serving to stop this wheel at the zero position when clearing from a positive total, another of said members operating in conjunction with the first-mentioned member in effecting a carrying operation during subtraction, and the third of said members serving to stop this wheel at zero position when clearing from a negative total, and also serving to permit this wheel to rotate through ten spaces if said wheel stands at zero and a wheel of lower denomination stands at more than zero in printing a negative total.

24. In an adding, subtracting and printing machine a plurality of numeral wheels adapted to show a positive total or the complement of a negative total, and means controlled by the wheels for printing the positive total when a positive total is shown, or printing the actual negative total automatically when the complement of the actual negative total is shown.

25. In a machine of the character described, the combination with registering wheels, wheel-actuators and type-carriers, transfer mechanism, and amount-determining means; of means for regulating engagement of wheels and actuators for the turning of the wheels in either direction to extents determined by the last mentioned means,—in the one direction for addition and the opposite direction for subtraction; and means for setting up in type the complement of a registration on said wheels by turning them in the adding direction under a subtraction adjustment of the regulating means.

26. In an adding, subtracting and printing machine, the combination with a plurality of numeral wheels, keys for controlling the extent of rotation of said wheels, type levers, and means controlling the movement of said type levers by said numeral wheels upon each total printing operation, and a reversing key operating to control the direction of rotation of said numeral wheels in positioning said type levers.

27. In an adding, subtracting and printing machine, numeral wheels for showing a balance constituting the difference between the sum of the added amounts and the sum of the subtracted amounts, printing mechanism including operating levers, and means for connecting said levers and numeral wheels during the clearing and total printing, said connecting means permitting a predetermined relative movement of the levers and their respective wheels, if the balance be on one side of zero, but preventing said relative movement if said balance be on the opposite side of zero.

28. In an adding, subtracting and printing machine, numeral wheels for showing a balance constituting the difference between the sum of the added amounts and the sum of the subtracted amounts, printing mechanism including operating levers, and means for connecting said levers and numeral wheels during the clearing and total printing, said connecting means permitting a predetermined relative movement of the levers and their respective wheels if the balance be above zero but preventing said relative movement if the balance be below zero.

29. In an adding, subtracting and printing machine, numeral wheels for showing a balance constituting the difference between the sum of the added amounts and the sum of the subtracted amounts, printing mechanism including operating levers, and means for connecting said levers and numeral wheels during the clearing and total printing, said connecting means permitting a relative movement of one step between said levers and their respective wheels if the balance be on one side of zero but preventing said relative movement if the balance be on the other side of zero.

30. In an adding, subtracting and printing machine, numeral wheels for showing an actual positive balance or the complement of a negative balance, printing mechanism including operating levers, and means for connecting said levers and numeral wheels during the clearing and total printing, said connecting means serving to permit or prevent a relative movement of said levers and their respective wheels, dependent upon the character of the balance shown, whereby the number printed is the same as that shown on the wheels if the balance be positive, and whereby the number is the actual negative balance if the complement of a negative balance is shown on said wheels.

31. In an adding, subtracting and printing machine, a plurality of numeral wheels adapted to show a positive total or the complement of a negative total, and means for printing the total when a positive total is shown or printing the actual negative total when the complement of the actual negative total is shown, said means operating automatically and dependent upon the character of said total.

32. In an adding, subtracting and printing machine, a plurality of numeral wheels adapted to show a positive total or the complement of a negative total, means for printing the total when a positive total is shown or printing the actual negative automatically when the complement of the actual negative total is shown, and an indicator independent of the printing mechanism for showing the character of the total.

33. In an adding, subtracting and printing machine, a plurality of numeral wheels adapted to show a positive total or the complement of a negative total, means for printing the total when a positive total is shown or printing the actual negative total when the complement of the actual negative total is shown, said means operating automatically and dependent upon the character of said total, and an indicator independent of the printing mechanism for showing the character of the total.

34. In a calculating machine, a plurality of numeral wheels upon which a positive total or the complement of a negative total may be indicated, printing mechanism for printing the actual total in either case, and means for controlling the operation of the printing mechanism in accordance with the character of the total indicated.

35. In a calculating machine, a plurality of numeral wheels upon which a positive total or the complement of a negative total may be indicated, printing mechanism for printing the actual total in either case, means for controlling the operation of the printing mechanism in accordance with the character of the total indicated, and a separate indicator operating automatically to show the character of the total.

36. A calculating and printing machine having means adapted to indicate an accumulated total, key mechanism upon which a number may be directly listed to vary said total, a reversing mechanism which when in one position operates to increase the total to the extent of the number listed and when in a second position operates to decrease the total to the extent directly listed on said key mechanism, and means for automatically controlling said reversing mechanism upon the printing of the total.

37. A calculating and printing machine

having means adapted to indicate an accumulated total, key mechanism upon which a number may be directly listed to vary said total, a manually-controlled reversing mechanism which when in one position operates to increase the total to the extent of the number listed and when in a second position operates to decrease the total to the extent of the number directly listed on said key mechanism, and means for automatically shifting said reversing mechanism upon the printing of a total if the total be on the opposite side of zero from the last number listed.

38. A calculating and printing machine having numeral wheels adapted to indicate an accumulation or total, key mechanism upon which a number may be directly listed to vary said total, a reversing mechanism which when in one position operates to increase the total to the extent of the number listed and when in a second position operates to decrease the total to the extent of the number directly listed on said key mechanism, and means for automatically controlling said reversing mechanism upon the printing of a total, said means including a pinion rotatable with one of said wheels and a rack in mesh therewith.

39. A calculating and printing machine having numeral wheels upon which a positive total or the complement of a negative total may be indicated, printing mechanism for printing the actual total in either case, and means for controlling the operation of the printing mechanism in accordance with the character of the total indicated, said means including a pinion rotatable with one of said wheels and a rack in mesh therewith.

40. A calculating and printing machine having numeral wheels upon which a positive total or the complement of a negative total may be indicated, printing mechanism, an indicator for showing the character of the total printed, and operating mechanism therefor, said operating mechanism including a pinion rotatable with one of said wheels and a rack in mesh therewith.

41. In a calculating and listing machine, a plurality of numeral wheels upon which a total either above or below zero may be accumulated, means for printing the total, an indicator independent of said printing means for showing whether said total be positive or negative, and an operating mechanism for said indicator, including a pinion rotatable with the numeral wheel of highest magnitude and a rack in mesh therewith.

42. In a calculating and printing machine, numeral wheels for showing a positive total or the complement of a negative total, printing mechanism for printing the actual total in either case, and a total key for bringing said printing mechanism into operation, said printing mechanism being subject to the combined control of said key and said wheels in accordance with the character of the total shown thereon.

43. In a calculating and printing machine, wheels for showing a positive total or the complement of a negative total, printing mechanism for printing the actual total in either case, a main operating mechanism, a total key for bringing said total printing mechanism into operation, and means for controlling said operation in accordance with the character of the total indicated on said wheels.

44. A calculating and printing machine having numeral wheels capable of rotation in either direction and adapted to accumulate a total, key mechanism for listing a number, a reversing key, means whereby the total is increased upon the listing of the number with said reversing key in one position, and whereby the total is decreased by the listing of the number with the reversing key in a second position, total printing mechanism, and means for automatically controlling said total printing mechanism and said reversing key in accordance with the character of the total indicated by said wheels.

45. In a calculating and printing machine, a plurality of numeral wheels for indicating a positive total or the complement of a negative total, means for rotating each of said numeral wheels, operating strips for each of said racks, total printing mechanism, and means for automatically controlling the relative movement of the racks in respect to their strips in accordance with the character of the total indicated upon the printing of said total.

46. In a calculating and printing machine, a plurality of numeral wheels upon which a positive total or the complement of a negative total may be shown, racks for rotating said wheels, and operating strips for, said racks and having a relative movement in respect thereto upon the accumulation of a positive or a negative total and held from movement in respect thereto upon the printing of a negative total.

47. A calculating and printing machine having a plurality of numeral wheels upon which a positive total or the complement of a negative total may be shown, racks for rotating said wheels, operating strips for said racks and having a relative movement in respect thereto, and means for locking said strips and racks against relative movement, said means operating only during the printing of a negative total.

48. A calculating and printing machine having a plurality of numeral wheels upon which a positive total or the complement of

a negative total may be shown, racks for rotating said wheels, operating strips for said racks and having a relative movement in respect thereto, and means controlled by said numeral wheels in accordance with the character of the total indicated for operating said locking means.

49. In a machine of the character described, the combination with registering mechanism capable of adding or subtracting individual items, and printing mechanism coördinating therewith to print the items; of totaling mechanism for causing operation of said printing mechanism under control of the registering mechanism to print either a positive or a negative total.

50. In a machine of the character described, the combination with registering wheels, racks to turn the same, rack and type carriers having lost motion connection with the racks to provide for relative movement a numerical unit's length, transfer devices controlling such movement, and amount-determining means; of means for regulating engagement of wheels and racks for the turning of the wheels in either direction under control of the amount-determining means,—in the one direction for addition and the opposite direction for subtraction; and means for setting the type-carriers by the turning of the wheels in the adding direction, including provisions for taking up lost motion between type-carriers and racks, for the purpose described.

51. In a machine of the character described, the combination with registering wheels, racks to turn the same, rack and type carriers having lost motion connection with the racks to provide for relative movement a numerical unit's length, transfer devices controlling such movement, and amount-determining means; of means for regulating engagement of wheels and racks for the turning of the wheels in either direction under control of the amount-determining means,—in the one direction for addition and the opposite direction for subtraction; and means for setting the type-carriers by the turning of the wheels in the adding direction, including provisions for causing the type-carrier of the numerical order wherein the lowest order significant digit of the registration on the wheels occurs, to take up the lost motion between the next higher order type-carrier and its rack.

52. In a machine of the character described, the combination with registering wheels, racks to turn the same, rack and type carriers having lost motion connection with the racks to provide for relative movement a numerical unit's length, transfer devices controlling such movement, and amount-determining means; of means for regulating engagement of wheels and racks for the turning of the wheels in either direction under control of the amount-determining means,—in the one direction for addition and the opposite direction for subtraction; and means for setting the type-carriers by the turning of the wheels in the adding direction, including provisions for causing the type-carrier of the numerical order wherein the lowest order significant digit of the registration on the wheels occurs, to take up the lost motion between the next higher order type-carrier and its rack, and also for causing lost motion between still higher order carriers and racks to be simultaneously taken up independently of movement of lower order carriers.

53. In a machine of the character described, the combination with registering mechanism capable of adding or subtracting, and printing mechanism; of totaling mechanism for causing operation of said printing mechanism under control of the registering mechanism to produce either a positive or a negative total, and means for automatically determining the adjustment of the totaling mechanism according to whether the registration is plus or minus.

54. In a machine of the character described, the combination with registering wheels, wheel-actuators and type-carriers, transfer mechanism, and amount-determining means; of means for regulating engagement of wheels and actuators for the turning of the wheels in either direction to extents determined by the last mentioned means,—in the one direction for addition and the opposite direction for subtraction; and means for setting up in type the complement of a registration on said wheels by turning them in the adding direction under a subtraction adjustment of the regulating means, together with means automatically rendering said last means effective whenever the highest order wheel passes zero in subtracting.

55. In a machine of the character described, the combination with registering wheels, racks to turn the same, rack and type carriers having lost motion connection with the racks to provide for relative movement a numerical unit's length, transfer devices controlling such movement, and amount-determining means; of means for regulating engagement of wheels and racks for the turning of the wheels in either direction under control of the amount-determining means,—in the one direction for addition and the opposite direction for subtraction; and means for setting the type-carriers by the turning of the wheels in the adding direction, including provisions for taking up lost motion between type-carriers and racks, for the purpose described, together with means automatically render-

ing said last mentioned means effective whenever the highest order wheel passes zero in subtracting.

56. In a machine of the character described, the combination with registering wheels, racks to turn the same, rack and type-carriers having lost motion connection with the racks to provide for relative movement a numerical unit's length, transfer devices controlling such movement, and amount-determining means; of means for regulating engagement of wheels and racks for the turning of the wheels in either direction under control of the amount-determining means,—in the one direction for addition and the opposite direction for subtraction; and means for setting the type-carriers by the turning of the wheels in the adding direction, including provisions for causing the type-carrier of the numerical order wherein the lowest order significant digit of the registration on the wheels occurs, to take up the lost motion between the next higher order type-carrier and its rack, together with means automatically rendering said last mentioned means effective whenever the highest order wheel passes zero in subtraction.

57. In a machine of the character described, the combination with registering wheels, racks to turn the same, rack and type carriers having lost motion connection with the racks to provide for relative movement a numerical unit's length, transfer devices controlling such movement, and amount determining means; of means for regulating engagement of wheels and racks for the turning of the wheels in either direction under control of the amount-determining means,—in the one direction for addition and the opposite direction for subtraction; and means for setting the type-carriers by the turning of the wheels in the adding direction, including provisions for causing the type-carrier of the numerical order, whenever the lowest order significant digit of the registration in the wheels occurs, to take up the lost motion between the next higher order type-carrier and its rack, and also for causing lost motion between still higher order carriers and racks to be simultaneously taken up independently of movement of lower order carriers, together with means automatically rendering said last mentioned means effective whenever the highest order wheel passes zero in subtracting.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM HENRY DRAUGHON.

Witnesses:

CLAIR W. FAIRBANK,

JOHN P. DAVIS.