No. 616,132. Patented Dec. 20, 1898.

A. S. McCASKEY.

CALCULATING MACHINE.

(Application filed Dec. 27, 1894.)

(No Model.) 10 Sheets—Sheet 1.

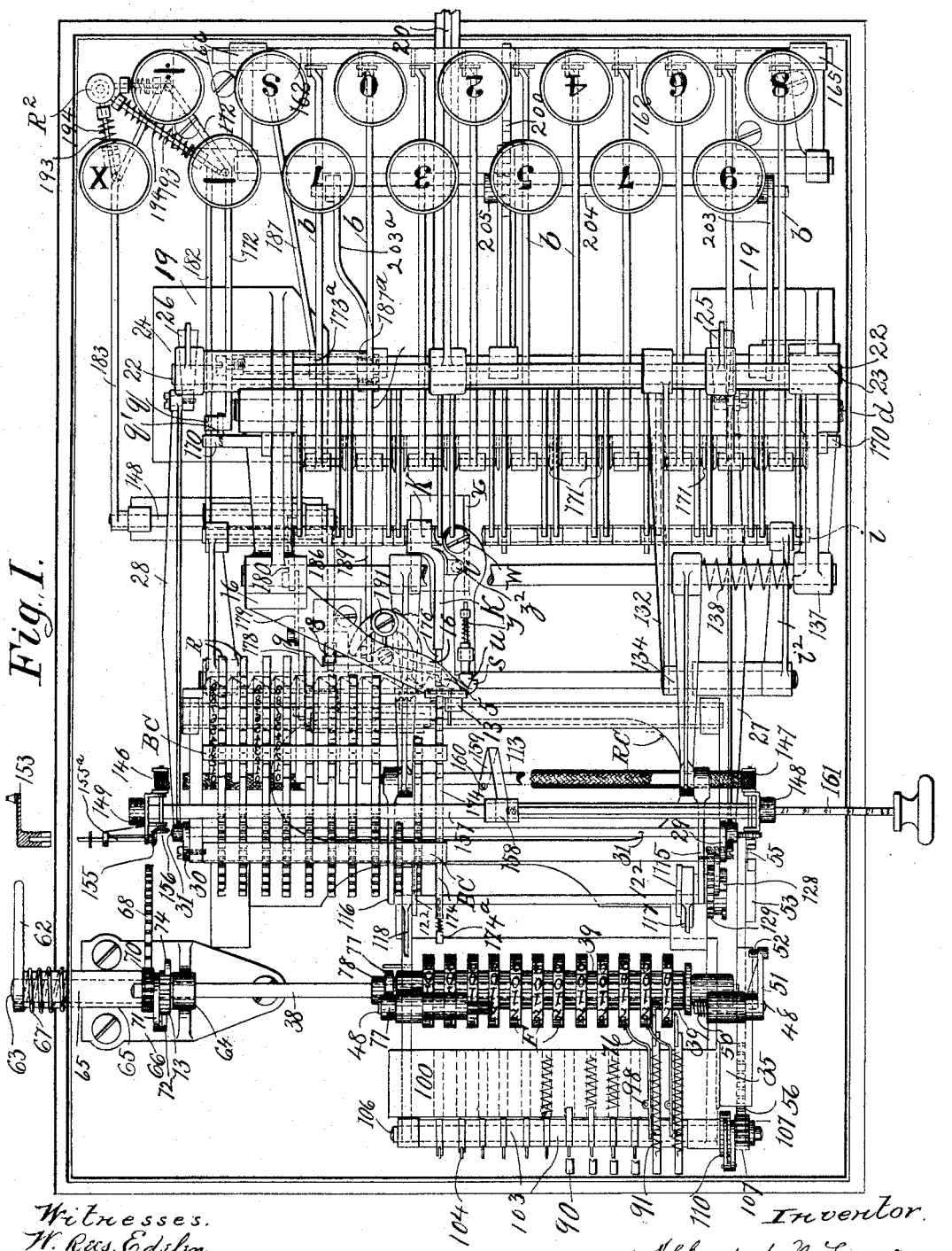

Fig. 1.

Witnesses.
W. Ras. Edelin.
Reeve Lewis.

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by Pollock & Mauro
his attorneys

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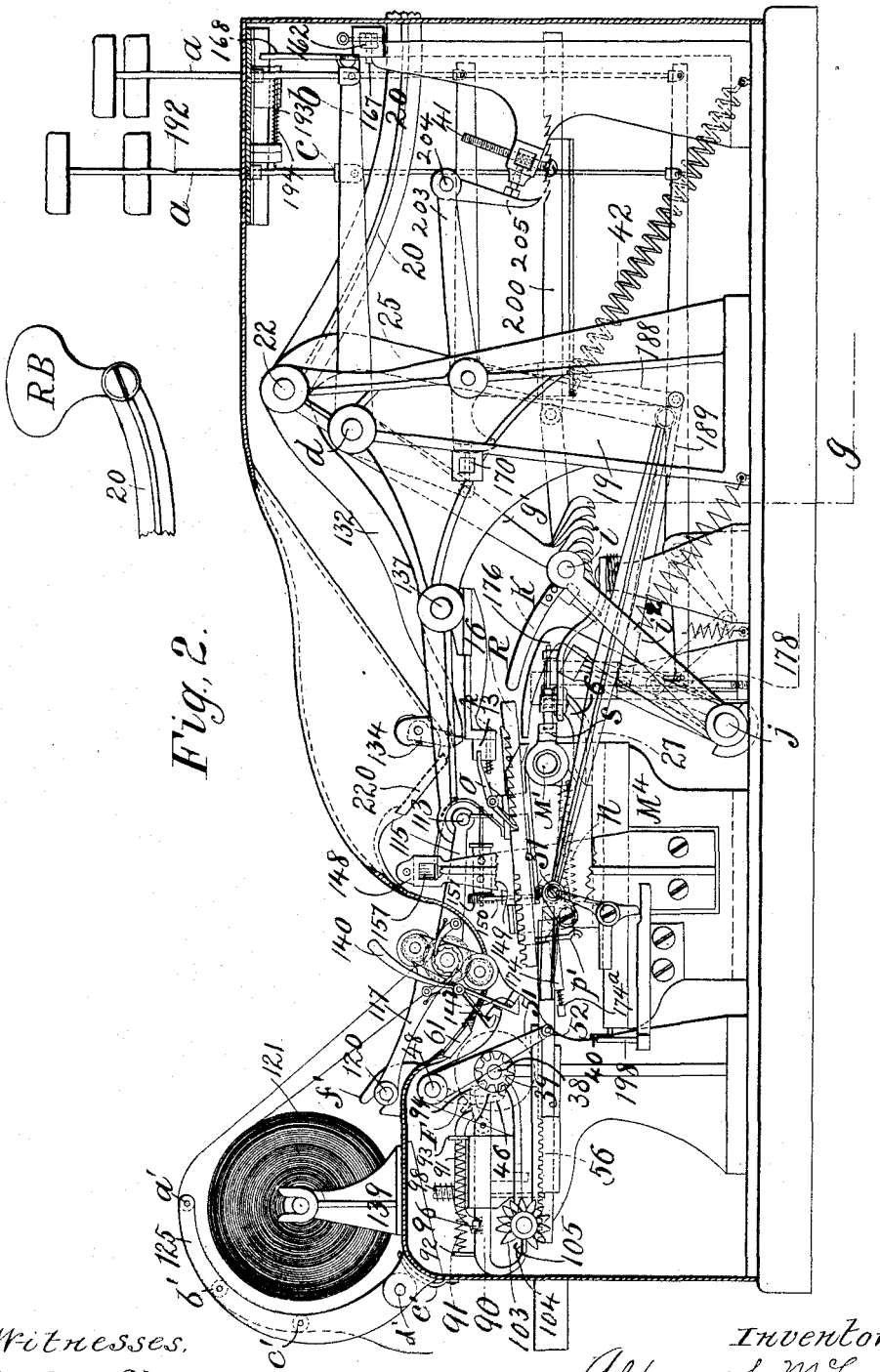

Fig. 2.

Witnesses.
W. Rees Edelen.
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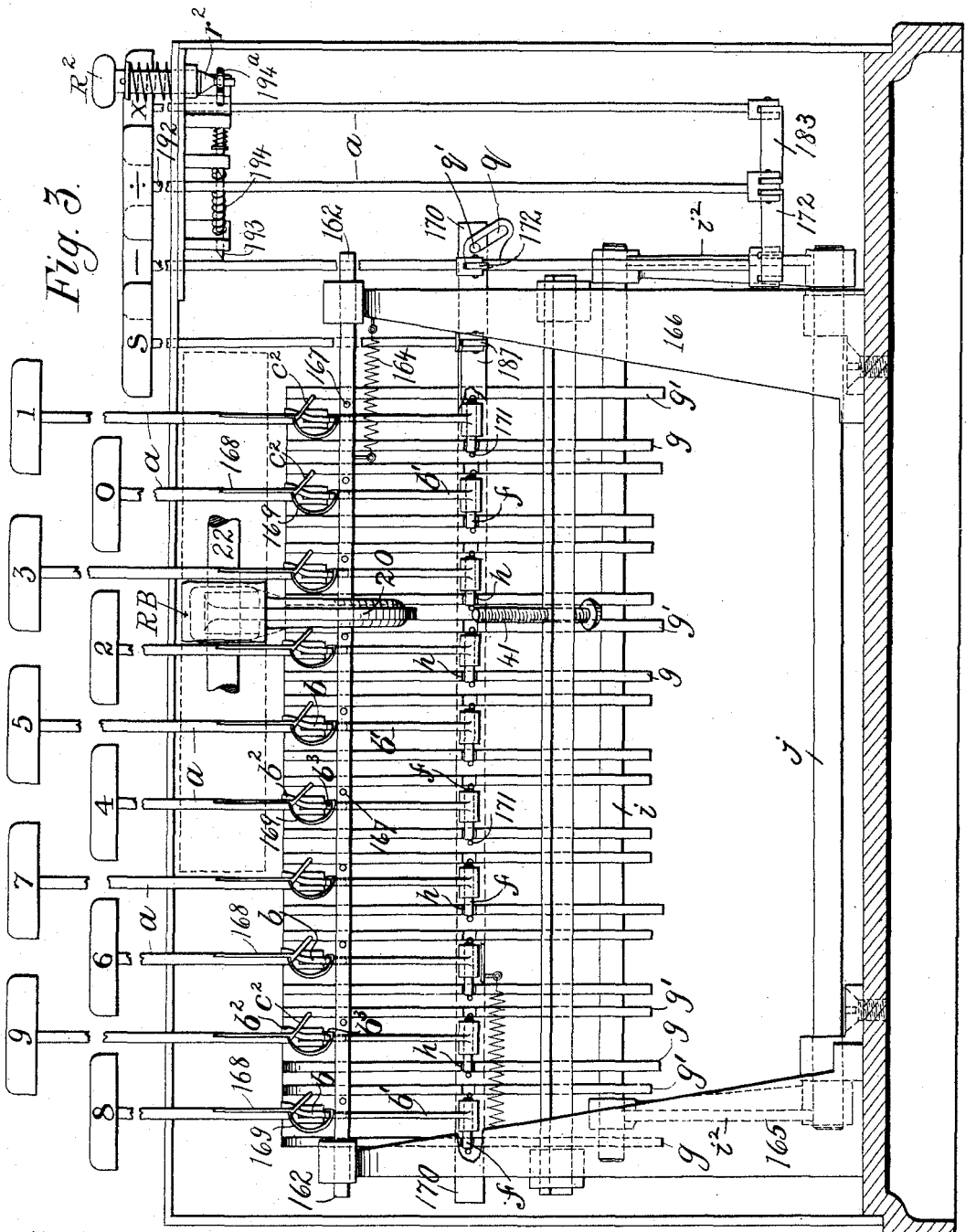
Fig. 3.



Witnesses
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Fig. 5.

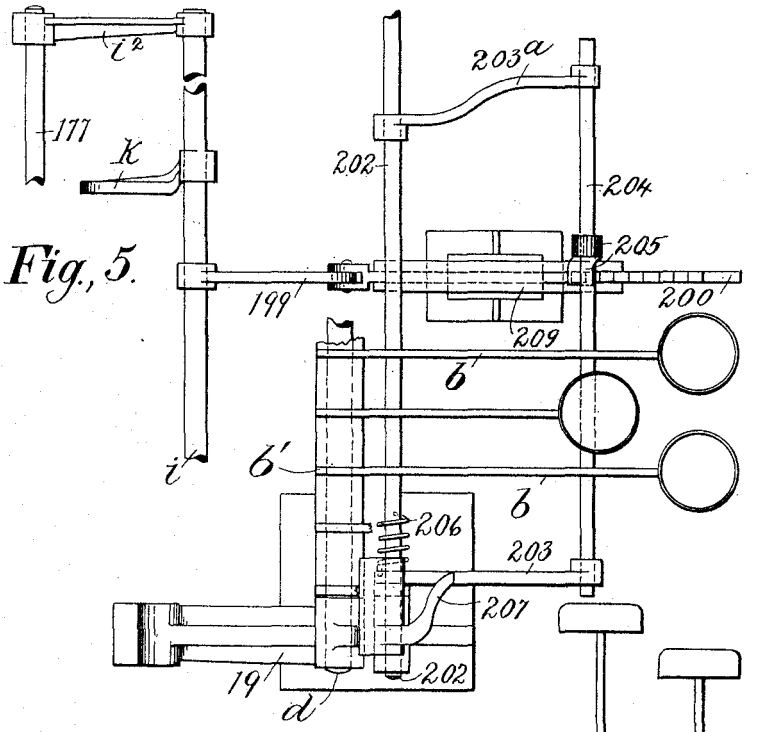
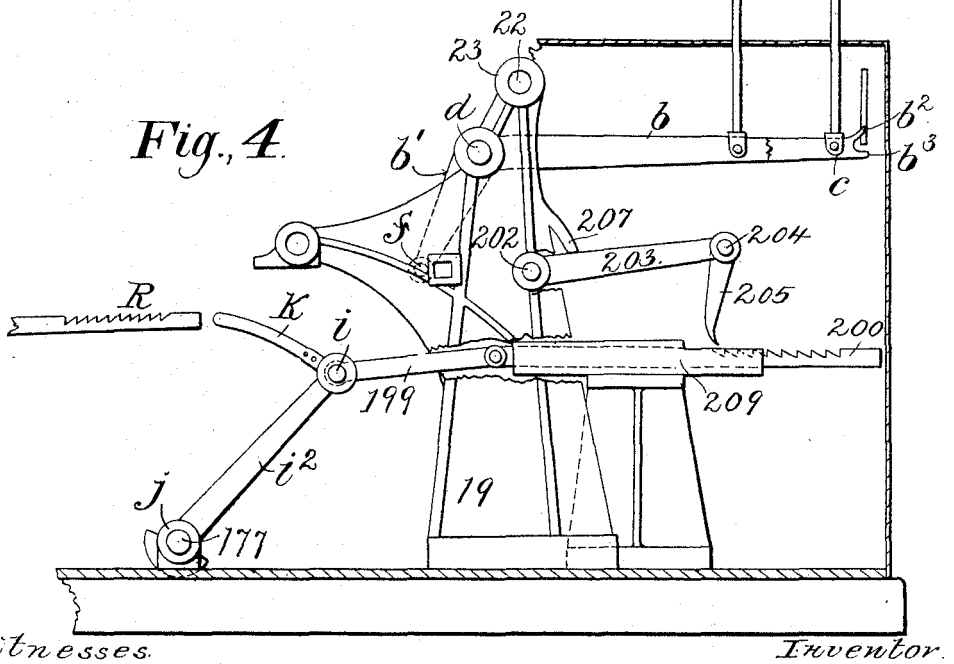


Fig. 4.



Witnesses.
W. Pires Edelin.
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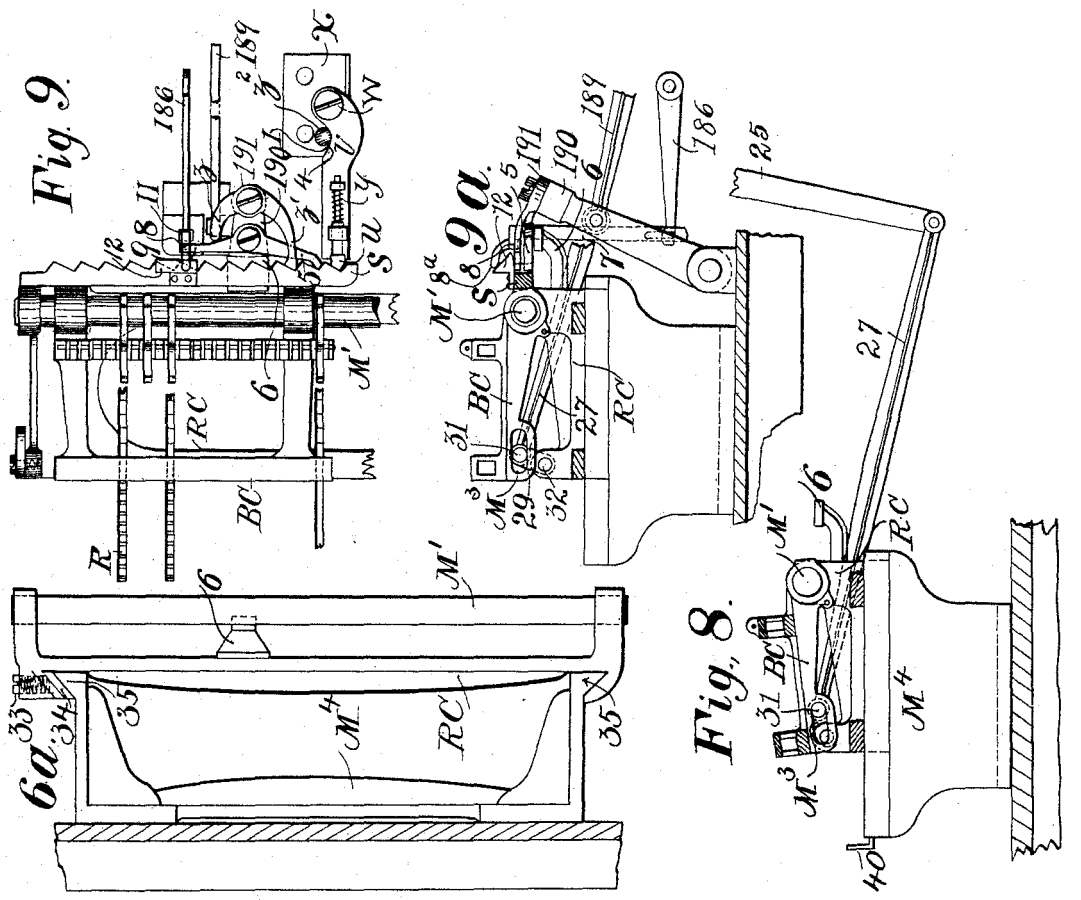

Witnesses.
W. Rees Edelen.
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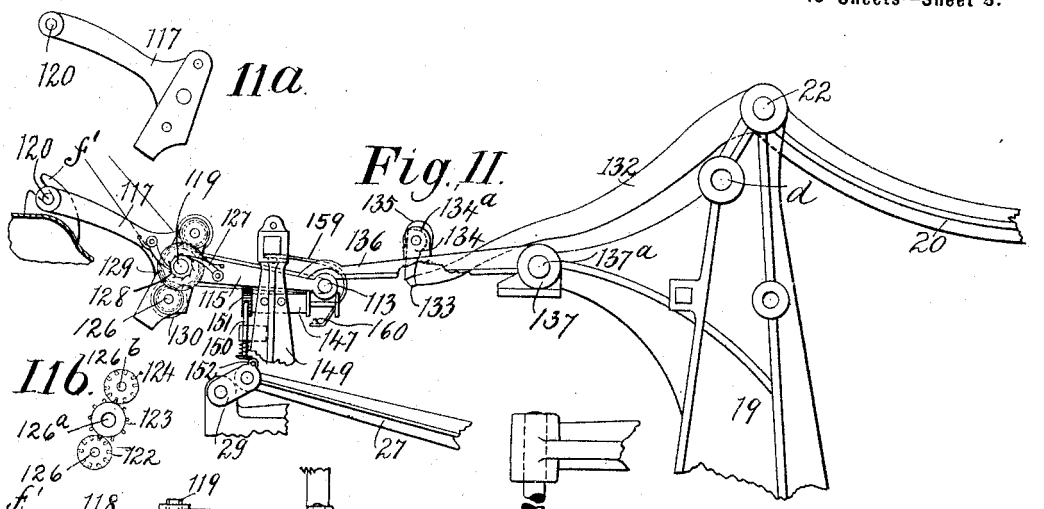

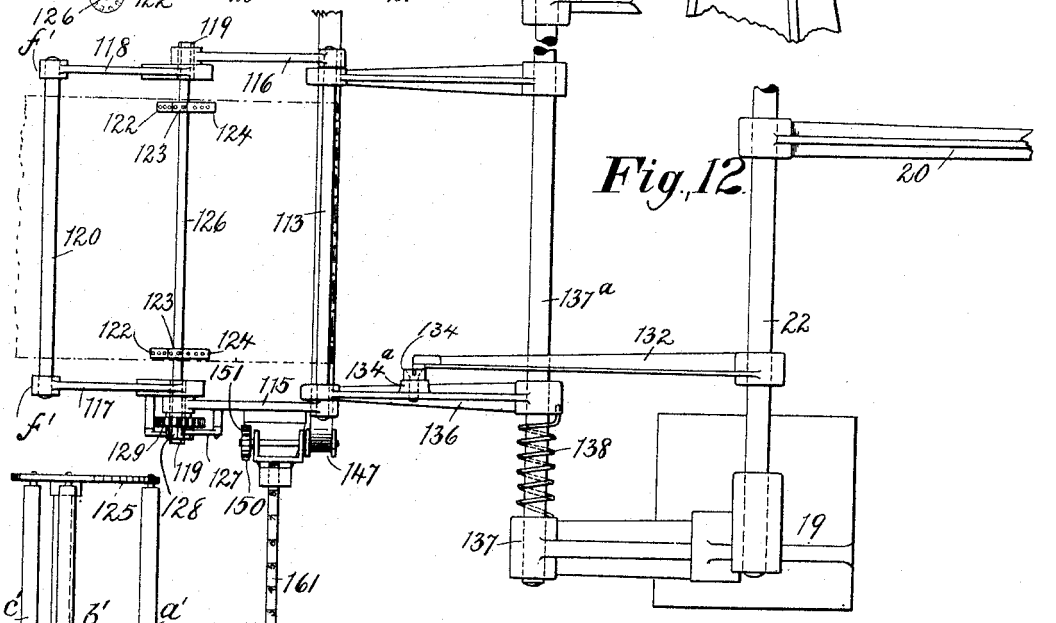

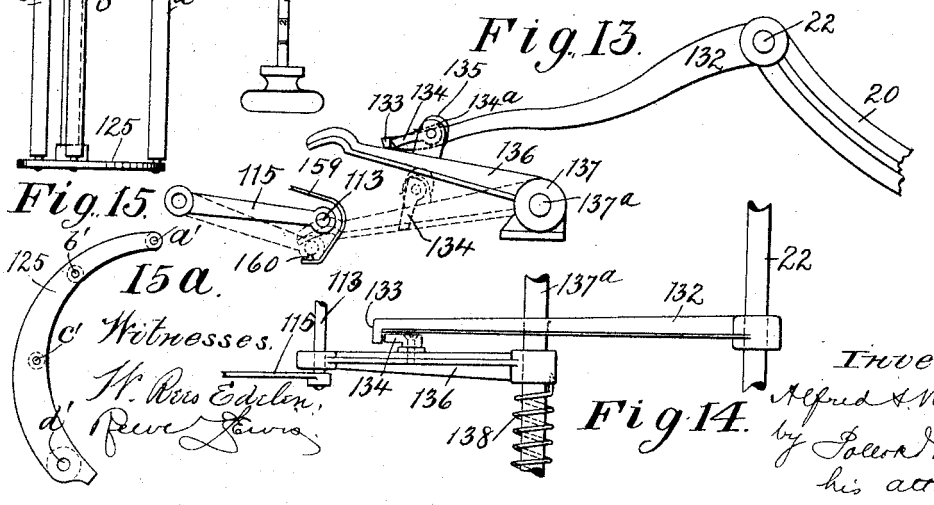

Witnesses.
W. Wm. Edelen.
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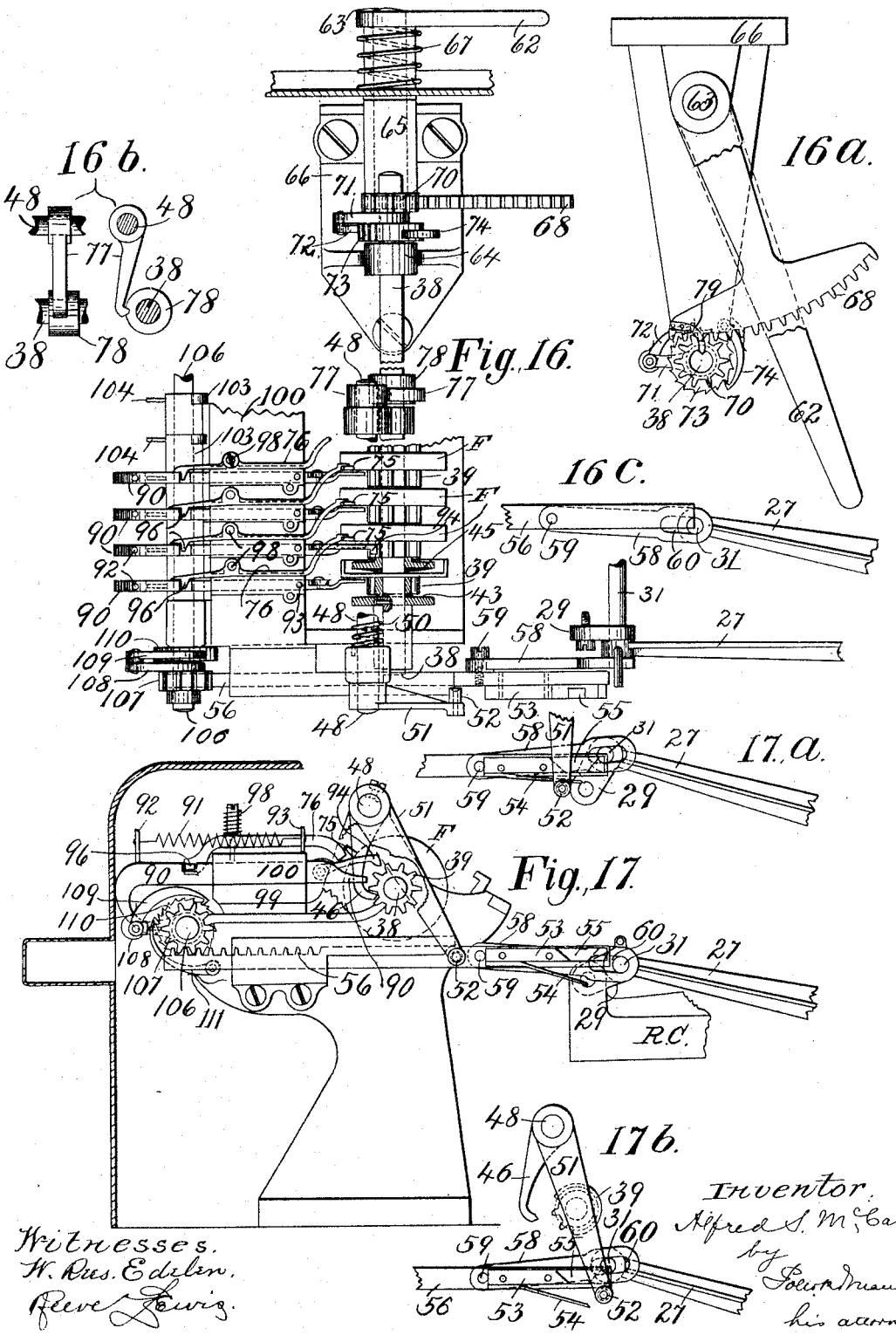

Witnesses.
W. Dieu. Edelen.
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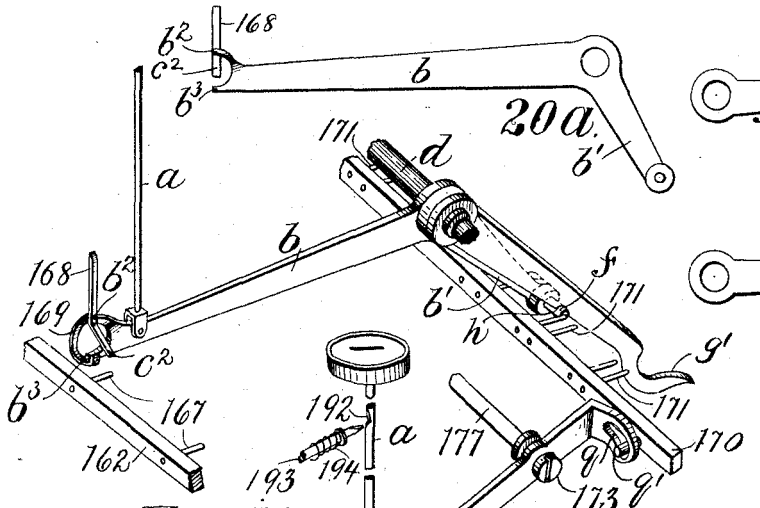
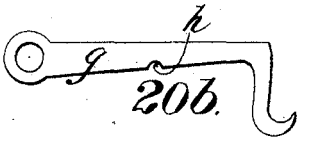
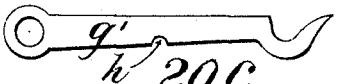


Fig. 18.





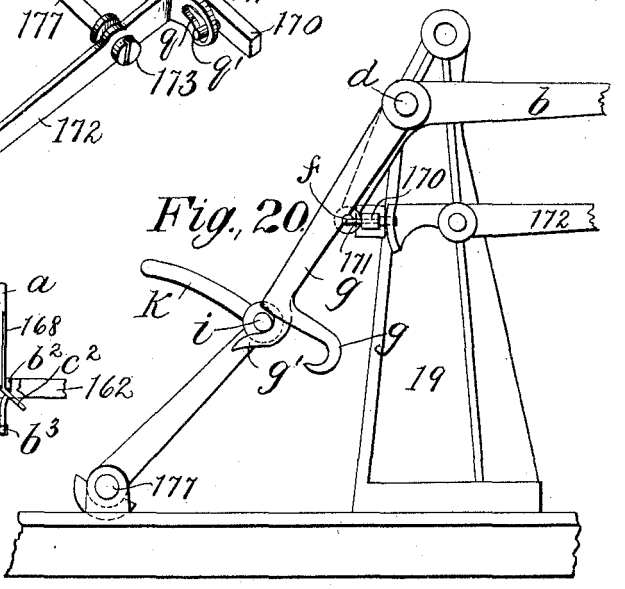
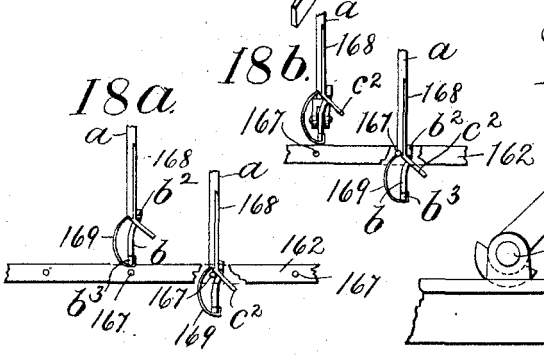
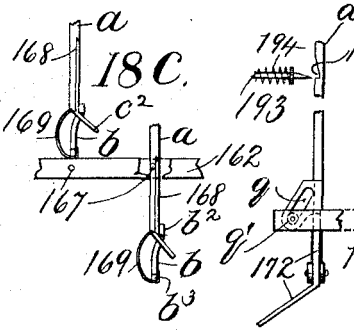


Fig. 20.





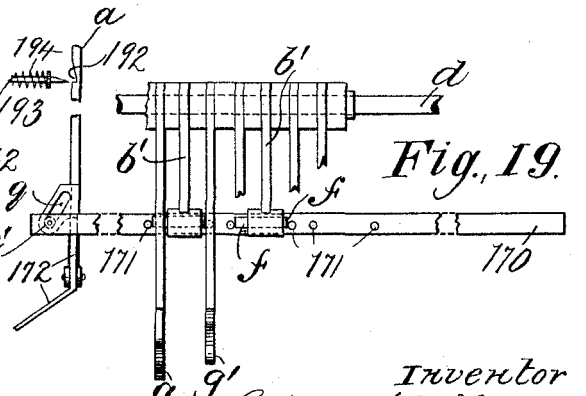


Fig. 19.

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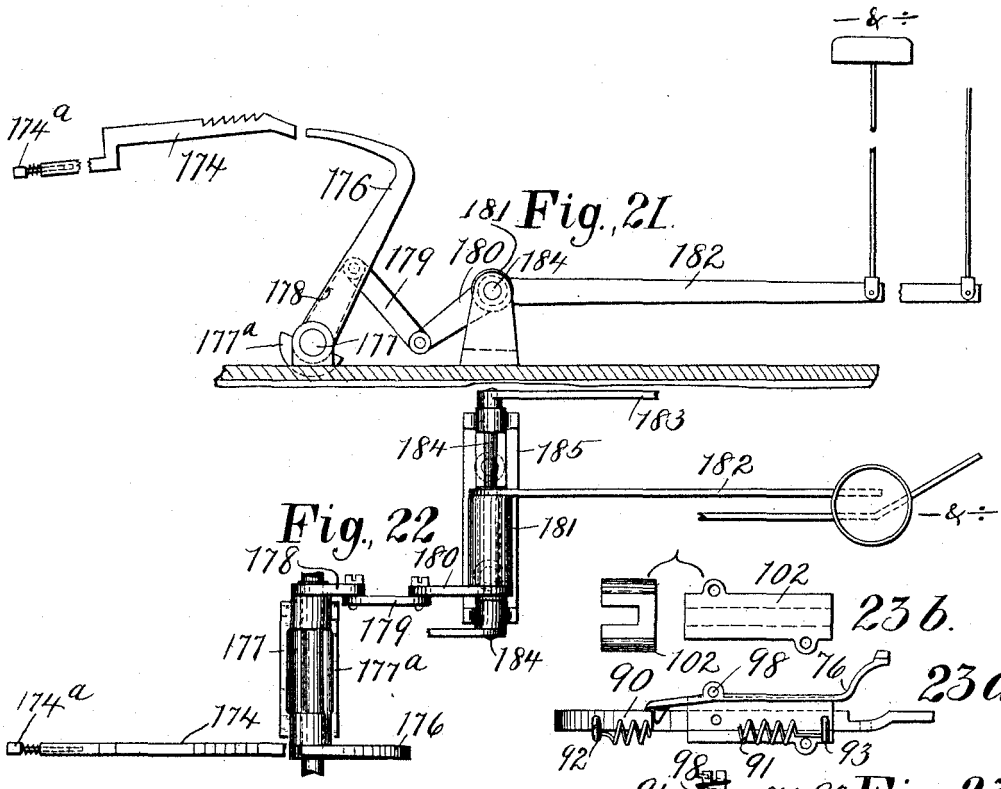

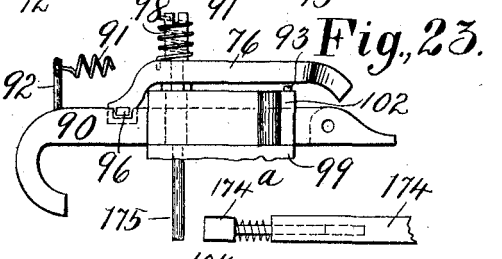

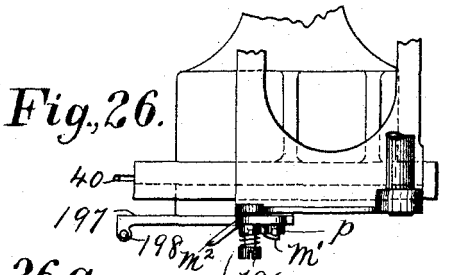

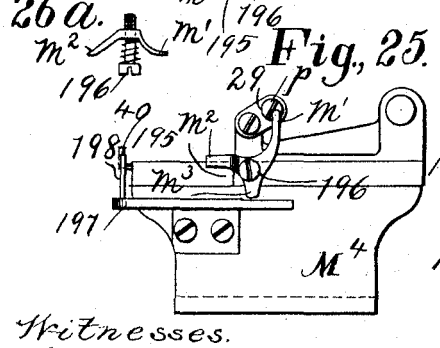

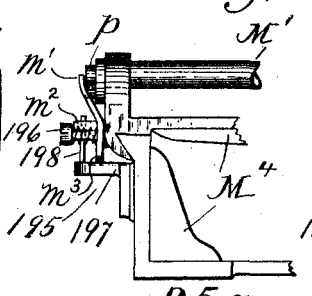

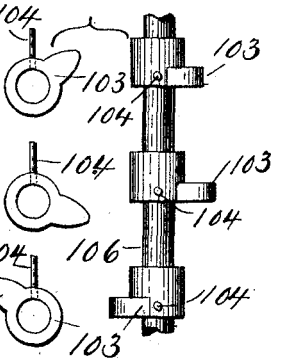

Witnesses.
W. Rus Edelin.
Pierce Lewis

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his attorneys

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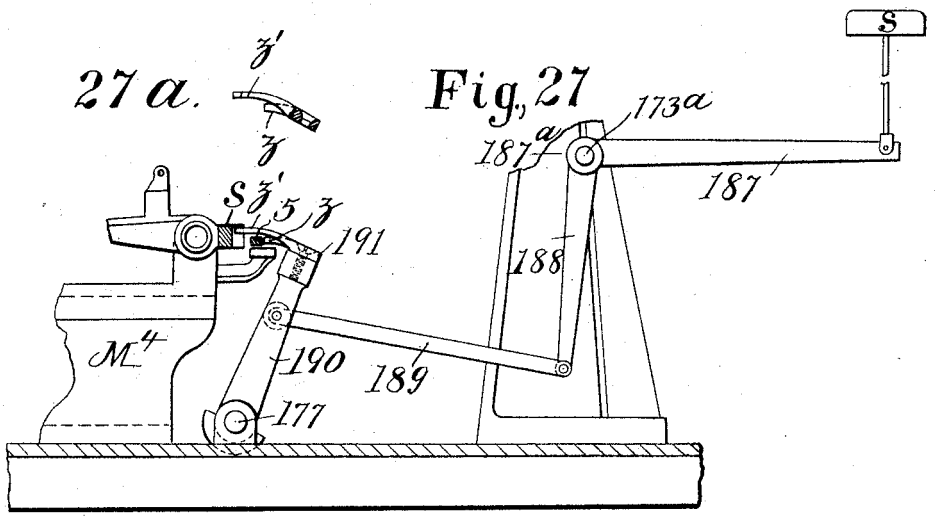

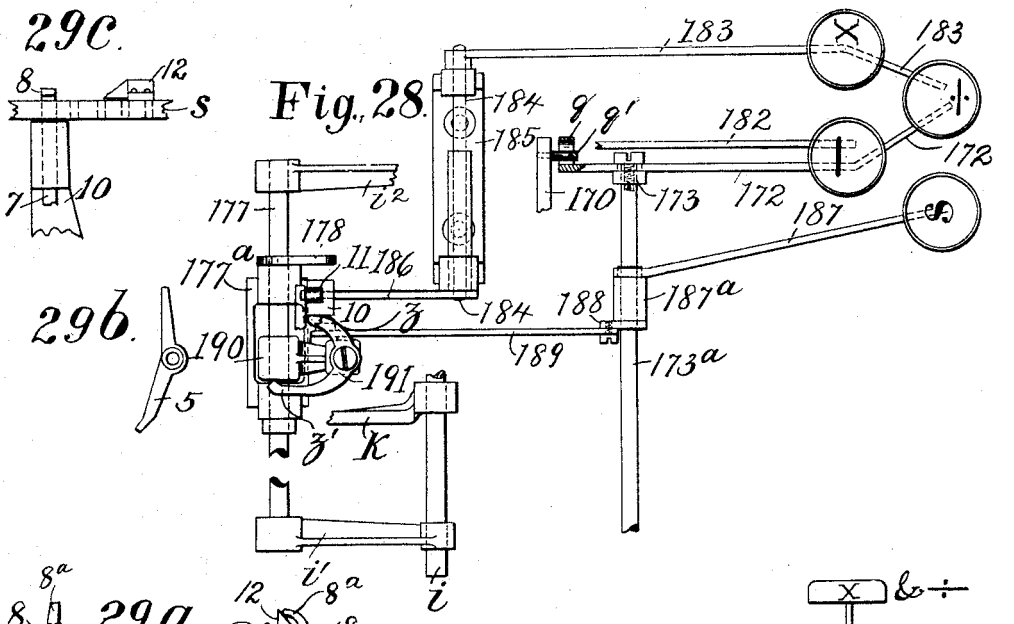

UNITED STATES PATENT OFFICE.

ALFRED SAMUEL McCASKEY, OF LA GRANGE, ILLINOIS, ASSIGNOR TO THE UNIVERSAL CALCULATOR COMPANY, OF CHICAGO, ILLINOIS.

CALCULATING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 616,132, dated December 20, 1898.

Application filed December 27, 1894. Serial No. 533,107. (No model.)

To all whom it may concern:

Be it known that I, ALFRED SAMUEL McCASKEY, of La Grange, Illinois, have invented a new and useful Improvement in Calculating-Machines, which is fully set forth in the following specification.

This invention relates to calculating machines or apparatus for performing mechanically the ordinary arithmetical operations of addition, subtraction, multiplication, and division.

The prime object of the invention is to produce a calculating-machine of comparatively simple construction, which can be manipulated without great difficulty and with a minimum liability of error.

The calculating-machines found upon the market contain a large number of keys, with the operation of which the user must thoroughly familiarize himself. Usually there are ten keys to each indicator or figure-wheel, so that in a machine designed to deal with and exhibit numbers of six places there would be sixty keys. Each added key increases largely the chances of error, besides rendering rapid work impossible.

In the direction of simplifying the machinery and the manipulations to be learned by the operator my present invention contemplates the operation of the indicator or figure-wheels, irrespective of the number of the latter, by ten keys only. Attempt has also been made heretofore to construct a ten-key machine; but my invention differs radically in principle from the construction heretofore proposed and mainly in that a number is set up on the registering devices in its true digital order, beginning with the highest or left-hand figure.

The ten keys above referred to, which may be called "figure-keys," comprise one for the zero (0) and one for each of the nine digits. They include only the keys by which the registering devices are actuated and are of course exclusive of special keys for different purposes. For example, the machine herein described has a subtraction-key, a division-key, and a registering-key; but in case it is desired to construct only an "adding-machine" these keys and their connections may be dispensed with. The particular mechanisms in which these broad features of the invention are embodied are of course susceptible of modification and may take many different forms. I shall, however, hereinafter describe and claim the best means now known to me of carrying out the principle of said invention.

In this machine the registering devices are in the form of bars, herein termed "register-bars," these bars being brought successively under the control of the keys. The number of bars will vary according to the capacity of machine desired, there being one bar for each figure in the largest number which the machine is designed to register. The term "register-bars" is used generically to include devices other than bars which are capable of performing the same functions. The register-bars are movable into ten different positions corresponding to zero and the nine digits, so that when brought under the control of the keys each bar may be caused to register any figure from "0" to "9." Besides the independent motion of the bars, they have a common movement on their support or carriage, herein termed the "bar-carriage," the object of this movement being to bring the bars successively into position to be actuated by the register-actuating device or "hammer." This hammer and the keys by which it is actuated are stationary relatively to the bar-carriage. Both the hammer and the step-by-step feed of the bar-carriage are actuated from the figure-keys—that is to say, when a key is struck the bar-carriage moves a step, bringing a particular bar into the path of the hammer, and the latter is also actuated, moving said bar to a particular position depending upon the key which has been manipulated. Each of the digit-keys moves the hammer (and consequently the bar opposite thereto) over a distance whose value corresponds to that of the key, while the zero-key moves the hammer only far enough to move the bar opposite thereto one space. When that key is struck, the carriage moves one step; but the bar thereby brought opposite the hammer remains at zero.

By the devices thus far outlined any number can be set up on the register-bars by striking the proper keys in their regular digital

order. Means are provided whereby each item thus set up can be recorded or tabulated on a slip of paper, this recording operation being mainly useful in addition of columns of figures. Having set up a number, the next operation is to register it on the totalizer and if previous items have been so registered to totalize the result. The totalizer comprises a series of "figure-wheels," usually one or two more than the bars, since the latter register only the factors, while the former register the result, and connections are provided between the wheels and bars whereby the former may be actuated from the latter upon the operation of an appropriate device, herein termed the "register-key." To this end in the form of machine hereinafter described the register-bars have racks having each ten teeth arranged to engage at the proper moment with pinions on or connected with the figure-wheels, and the bar-carriage is movable relatively to the figure-wheels to effect this engagement and to turn the latter to positions determined by the positions of the register-bars, which during this operation are firmly locked in place. Means are provided to effect the automatic release of the bars after totalizing and to restore all the parts to their normal positions after an operation has been performed. Means are also provided to prevent, when desired, the return of the bar-carriage to its starting-point, which normally occurs after totalizing. By thus preventing the return of the bar-carriage the number set up on the bars can be used repeatedly as often as required in multiplication and division.

Heretofore the possible failure of the operator to depress a key the full distance has been a source of error in machines in which, like the present, each key should impart to the registering device a movement of definite length different for each key. In the present invention this source of error is avoided by a key-lock which acts when a key has been struck to lock all the other keys, the latter only being released after the key so struck has been depressed the full required distance. The principal novel element in this part of the mechanism is a lock-bar having a series of stop-pins and acting both to lock all the keys except the one depressed and also to maintain the lock until such key is fully depressed, the lock-bar being then released and restored.

Heretofore it has been customary to perform subtraction by adding the complement of the subtrahend, and this invention embraces means (thrown into operation by the subtraction-key) whereby the complement is automatically added and the excessive "1" in the extreme left-hand order or place eliminated. The operation of automatically adding the complement is not broadly new; but the means hereinafter described and claimed are believed to be new.

The invention embraces many features of construction and combinations and arrangements of parts, which will be explained in the following detailed description, reference being had to the accompanying drawings, in which—

Figure 1 is a plan view of a machine constructed in accordance with the invention, the cover or top plate being removed. Fig. 2 is a side elevation, the casing being in section. Fig. 3 is a front elevation on a somewhat larger scale. Figs. 4 and 5 are respectively a side elevation and plan of mechanism for preventing the hammer from being carried by momentum beyond the proper distance. Figs. 6 and 6^a are respectively a plan and rear view of the register-carriage and its support. Fig. 7 is a side view of the same. Figs. 8, 9, and 9^a are detail views of the bar-carriage and accessory parts. Fig. 10 is a perspective in detail, partly broken away, of the bar-carriage, illustrating the means for returning such bars to the normal positions. Fig. 11 is a side elevation of the recording or printing mechanism, and Figs. 11^a and 11^b show details thereof. Fig. 12 is a plan view of the printing mechanism. Fig. 13 is a side elevation, and Fig. 14 a plan, of portions thereof. Figs. 15 and 15^a illustrate in plan and elevation the paper-guide. Figs. 16 and 17 illustrate in plan and side elevation the figure-wheels and other parts of the totalizing mechanism. Figs. 16^a, 16^b, and 16^c and 17^a and 17^b illustrate various details of said mechanism. Fig. 18 is a perspective view of a portion of the key-lever and shifting mechanism. Figs. 18^a, 18^b, and 18^c illustrate details of said mechanism. Figs. 19 and 20 are respectively a plan and elevation of parts of the same mechanism. Figs. 20^a, 20^b, and 20^c illustrate the levers detached. Figs. 21 and 22 illustrate in side elevation and plan the lever mechanism employed in subtraction and other operations. Figs. 23, 23^a, and 23^b are views illustrating parts of the "carrying" mechanism. Fig. 24 shows some of the cams and stop-pins employed in the carrying mechanism. Figs. 25 and 25^a illustrate in side and front elevation devices connected with the register-carriage for purposes hereinafter explained. Figs. 26 and 26^a illustrate details of the same devices. Figs. 27 and 28 represent in side elevation and plan the shifting and stop mechanism connected with the multiplication, subtraction, and division keys. Fig. 27^a is a detail of part of said mechanism. Figs. 29, 29^a, and 29^b illustrate details of the same parts in various positions. Fig. 29^c is a rear view in detail of the rack *s* with its accompanying lug 12 in position to disengage the stop 8 from the detent-pawl 5.

The figure-keys (ten in number) are designated by the figures "0" to "9". As shown, they are arranged in two rows, the even numbers in the first row, and the odd ones in the second row; but any other convenient arrangement may be adopted. In addition to the figure-keys, to which the description for the present will be confined, there are sub-

traction, division, and multiplication keys, marked in Fig. 1 with the conventional symbols −, ÷, ×, with which these operations are designated, and a shift-key S.

Each figure-key is on the end of a vertical spindle *a*, jointed at *c* to a key-lever *b*, which is pivoted on the horizontal rod *d*, Figs. 2, 3, 4, and 5. Each lever *b* has a downwardly-inclined arm *b'*, at the end of which is a short transverse pin *f*, (best seen in Fig. 3,) which is intended to engage and lift the actuating-arms of the register mechanism. As shown, there are two of these actuating-arms, *g* and *g'*, to each key-lever; but for the present it will be convenient to follow only that series of arms which are lettered *g* and which are used in performing addition. Arms *g* are each to the left of its lever *b*, Fig. 3. Arms *g* are all pivoted on rod *d*. They are curved at the lower ends, as shown, Figs. 2 and 20, and adapted, when raised by the depression of a key, to strike and move the rocking bar *i*, which is carried by arms i^2, attached to rock-shaft *j*. The curvature of arms *g* is different for each of the series, as clearly shown in Fig. 2, so that each arm moves the rock-bar *i* through an arc of definite length. The construction is such that the value of the arc through which bar *i* moves is measured by the value of the key which is struck. Thus the zero-key does not move it at all. Key "1" moves it the minimum distance, or, as it may be said, through one degree, key "2" a distance twice as great as key "1" or through two degrees, and so on.

Bar *i* carries the plunger or hammer K, by which the register-bars R are actuated. These bars are all mounted on a bar-carriage BC (see Figs. 1 and 9) and are alike in construction. Their number will vary with the capacity of the machine. In the machine illustrated in the drawings there are ten register-bars, so that numbers containing as many as ten figures can be set up.

Bar-carriage BC has a step-by-step motion transverse of the machine imparted by mechanism hereinafter described. For present purposes it suffices to say that each time a figure-key is struck the carriage moves one step to the left, Fig. 1, the length of the step being the distance from the center of one bar to the center of the next. Consequently the front ends of bars R come successively into the path of hammer K.

Each bar R has ten ratchet-teeth *k*, Fig. 10, the distance between them corresponding to one degree of movement of hammer K. A pawl *o* engages these teeth and detains the bar in the position to which it is advanced by the stroke of the hammer until released, as hereinafter explained, when the bar is returned to its normal position by means of a spiral spring *n*, attached at one end to a pin *p'* on bar R and at the other to the frame of carriage BC, Fig. 2.

From the explanations thus far given it will be easy to understand how the digits composing any number are set up on the register-bars by striking in regular order the keys corresponding to that number. Thus if the number be "546" key "5" is first struck. Carriage BC moves one space to the left, presenting the first bar R to the hammer K, which strikes that bar, advancing it five spaces or degrees, in which position it is held by pawl *o*. Key "4" is next struck, advancing the second bar four spaces, and key "6" in like manner advances the third bar six spaces. Bars R have on the ends opposite the ratchet-teeth *k* ten rack-teeth *k'*, designed to operate the pinions of the figure-wheels, hereinafter described. The step-by-step movement of bar-carriage BC (which slides on the horizontal rod M') is effected by means of a rack *s*, Figs. 9 and 9^a, attached to the carriage, and a dog *u*. Dog *u* is carried by an arm *v* and is pressed into engagement with rack *s* by spring *y*. Arm *v* is pivoted at *w* on a support *x*, Figs. 1 and 9. Arm *v* has a cam-shaped edge 4, against which bears a roller z^2, carried by hammer K, (see Fig. 1,) so that during the first part of the movement of the hammer the arm *v* is oscillated, moving the carriage BC one step to the left, in which position it is held by the detent 5, which is pivoted to a bracket 6 (see Figs. 9 and 9^a) on the register-carriage RC, hereinafter described. Thus the feed of the carriage BC takes place upon depressing any key before the hammer acts on the register-bar. Dog *u* is held in contact with rack *s* by a spring *y*, so that when arm *v* returns to its normal position dog *u* can yield, so as to pass the adjacent tooth of the rack and engage in the next notch.

In order to transfer the number set up on the register-bars R to the figure-wheels F, it is necessary that the carriage BC should be movable (carrying with it the register-bars) in a direction at right angles to its feed movement. To this end carriage BC is mounted on a movable support, herein termed the "register-carriage" RC, Figs. 6 to 9 and 9^a. This carriage RC consists of a suitable framework upon which the slide-rod M' of the bar-carriage is supported and which bar-carriage can slide lengthwise of the machine on a support or bed M^4. The advance movement of the register-carriage RC is effected by a register key or bar RB. (Broken off in Fig. 1 and shown detached in Fig. 2. See also Fig. 3.) This key is attached to an arm 20, carried by a rock-shaft 22, extending across the keyboard and journaled in bearings 23 and 24. Shaft 22 has two downwardly-projecting crank-arms 25 26, to the lower ends of which are pivoted connecting-rods 27 28, which reach forward (see Fig. 8) to the register-carriage RC, where they are jointed to a rod 31, extending the full length of said carriage. Rod 31 passes through slots M^3 in the frame of bar-carriage BC, Figs. 8 and 9^a, and has connected to its respective ends short links 29 30, the other ends of which are pivoted at 32 to ears on carriage RC. The office of the rod

31 and the slotted bearings M^3 through which it passes is to give the bar-carriage BC a slight rising-and-falling motion on rod M' as a center, the entire carriage being hinged on that rod. The depression of register-key RB first raises bar-carriage BC to a horizontal position, so that the register-bars are brought into alinement with the pinion 39 of the figure-wheels F. When the bar-carriage has reached a horizontal position, rod 31 comes against the end of slots M^3, and consequently the continued depression of key RB advances the carriage RC until the register-bars have acted upon the figure-wheels. The object of this oscillating movement of carriage BC is to cause the rack-teeth k' of the register-bars R to drop out of engagement with pinions 39 before the return of the register-carriage. Detent-pawl 5, which is mounted on carriage RC, holds the bar-carriage BC by engagement with rack s during this advance movement. On the return or downward movement of register-carriage RC the finger 8 of a vertical trip-rod 7, Figs. 9, 9^a, and 29, comes in contact with the rear extension of detent 5, (the forward motion of this pawl with the carriage having allowed rod 7 to drop,) disengaging it from the rack s and permitting return of carriage BC to its normal position. Near the end of this return movement, which is effected by a spring such as ordinarily used for that purpose, trip-rod 7 is lifted by a lug 12, attached to the rack s, which lug passes under the extreme projection 8^a of finger 8, Figs. 29^a and 29^c. The latter therefore releases detent 5, allowing it again to engage rack s. After passing lug 12 finger 8 falls and rests loosely upon the upper surface of detent 5, and this will be the relative positions of these parts until register-key RB is again struck and register-carriage RC advanced, carrying with it detent 5, whereupon rod 7 will drop, bringing finger 8 into position to release detent 5 on the return of the register-carriage, which is effected by the action of springs 42, Fig. 2, attached at one end to the base of the machine and at the other to arms 25 26. It is necessary also at this point of the operation to release the register-bars R from their detents o in order that they may be returned by their retracting-springs n. This release is effected by an inclined trip-plate 13, Figs. 1, 2, and 10, which is carried at the end of a long arm 16, Figs. 1 and 2, extending obliquely from standard 19. Trip-plate 13 is pivoted against the vertical end of arm 16 by means of a pin 14 and normally upheld by a spiral spring surrounding said pin. During the advance movement of the feed or bar carriage BC the rear extensions of detents o ride over the upper edge of the release-plate 13 and depress it against the pressure of its spring; but on the return movement of the carriage they pass under the plate 13 and by its inclined lower surface are tripped, lifting the teeth of the detents out of the notches of bars R. Thus by the time the carriage BC returns to its normal position the register-bars R are all restored to zero.

To briefly recapitulate the operation of the parts already described, a number is set up on the register-bars by depressing in regular order the keys corresponding to the digits composing such number. As each figure-key is depressed bar-carriage BC moves one step to the left by the action of dog u on rack s, so that the carriage moves as many steps as there are places in the number set up. Each register-bar, after being advanced by the hammer K through a distance corresponding to the value of the key which impelled it, is locked in that advanced position by its detent o. When the last figure is thus registered on its bar, the carriage BC, held firmly in its advanced position to the left by detent 5 engaging rack s, is moved backward with its carriage RC by the depression of register-key RB and is turned on its hinge M', so as to bring bars R to a horizontal position. On the completion of this backward movement when key RB is released carriage BC drops to its inclined position, freeing the rack-teeth of bars R from engagement with pinions 39, and register-carriage RC returns to its normal position under the influence of springs 42, automatically releasing bar-carriage BC from the hold of detent 5. Bar-carriage BC then returns to the right, and during this movement the rear ends of detents o, passing successively under plate 13, are tripped, permitting the return of the register-bars R. Thus all the parts are restored to their normal positions ready to set up another number on the register-bars.

The mounting of register-carriage RC on its dovetailed ways 35 of support M^1 is shown in Fig. 6^a. It is desirable to cause a slight frictional resistance to the movement of carriage RC, so as to insure that the bar-carriage will be raised to the horizontal position before the register-carriage moves forward and to insure also that the bar-carriage will drop back to its normal position, disengaging the racks k' from pinions 39 before the register-carriage begins its return movement. This friction is created by the pressure of spiral springs upon a steel plate or shoe 34, Fig. 6^a, pressing the latter against the dovetailed way 35. One of these springs is shown in the drawings under the end of a screw 33, tapped into the frame of the carriage, the spring bearing at one end against the end of the screw and at the other against the shoe 34.

We will now follow the operation to the figure-wheels F, on which the results are finally registered and totalized. These wheels, (shown in Figs. 1, 2, 16, and 17,) twelve being employed in the machine shown, are mounted to turn independently of one another on rod 38. In the normal position, or that which they occupy at the beginning of an operation, the zero ("0") on each figure-wheel shows through an aperture 61, Fig. 2, in the cover-plate of the machine. (Removed in Fig. 1.) Each

wheel has secured to it a pinion 39, already referred to, for engagement with the rack-teeth k' of the register-bars R. The relative arrangement of the figure-wheels and register-bars is shown in Fig. 1 and is such that the movement of bar-carriage BC one step brings the first bar at the left of the carriage into line with the pinion 39 of the first or units figure-wheel, and however many figure-keys may be struck the last register-bar acted upon comes into line with this pinion. On one side of each wheel F and fixed to the shaft 38 is a washer 43 and on the other side of the wheel a spring-washer 45, Fig. 16, pressing against the wheel with sufficient force to hold it when pinions 39 are not engaged by the rack-bars or by the permanent locking mechanism.

The permanent locking mechanism for the figure-wheels F comprises locking-arms 46, one for each wheel, Figs. 17 and 17^b, carried by a rock-shaft 48, partly broken away in Fig. 1. A spiral spring 50, (see Fig. 16,) acting on shaft 48, keeps arms 46 normally in engagement with pinions 39, so that the figure-wheels are normally locked. Shaft 48 is turned against the pressure of spring 50 to unlock the figure-wheels F when the carriage, with the register-bars R, advance, this release being effected by means of an arm 51 on shaft 48, whose pin 52 is struck by a bar 53, advancing with the registering mechanism. The forward movement of the register-carriage is arrested by stop-pins 40, (see Figs. 1, 7, and 8,) and it will be observed that at this point, carriage RC being in its most advanced position, the registry on pinions 39 is completed and the teeth of bars R are in engagement with pinions 39, locking them firmly for the time being in the positions to which they have been turned. Thus figure-wheels F cannot be rotated past their intended position by inertia, the prevention of which irregularity has been a matter of great difficulty in calculating-machines heretofore constructed. It will also be noted that the registering of the result on the figure-wheels is not effected on separate wheels successively, but is effected at one operation upon all the wheels that may be called into use for the particular number registered. When arm 51 has turned so far that pin 52 passes under the edge of bar 53, the said bar continues to advance without further acting on arm 51, simply riding over the pin 52, as shown in Fig. 17^a. Bar 53 has in its side a vertical slot or groove 55, beneath which is a flat spring 54, and as shown in Fig. 17^a this spring during the advance movement of the carriage is interposed between pin 53 and slot 55. Pin 52 passes a short distance beyond spring 54, releasing it, as shown in Fig. 17^b. Consequently upon the first return movement of the carriage pin 52 passes through slot 55, applying the permanent locks 46 to the wheels 39 at once. Bar 53 is attached to the side of a rack-bar 56, which acts, as hereinafter explained, to restore the carrying mechanism, and the said rack-bar 56 is connected to and receives its motion from the rod 31 through a link 58, pivoted to said bar 56 at 59, as best shown in Figs. 16 and 16^c.

A unison device is required to restore all the figure-wheels to their initial or zero positions before beginning a new operation. This is effected by means of a crank-handle 62, keyed to a shaft 63, Figs. 1, 16, and 16^a, journaled in bearings 64 65, supported on a base-plate 66. A spiral spring 67 on shaft 63 tends to turn it so as to keep handle 62 in the position shown in Fig. 1. Shaft 63 carries a toothed sector 68, which engages a pinion 70, turning freely on rod 38, said pinion having an arm 71, (see Fig. 16^a,) which in turn carries a pawl 72, engaging ratchet-wheel 73, the latter being fast on shaft 38.

It is necessary in restoring the figure-wheels that they should rotate in the direction opposite to that in which they are turned by the register-bars. To this end the operator moves handle 62 from him, turning pinion 70 by means of sector 68. During this movement pawl 72 slips over the teeth of ratchet-wheel 73, the latter being held stationary by a detent 74, fastened to the frame of the machine. The operator now draws handle 62 toward himself, turning pinion 70 by means of pawl 72 and with it shaft 38 and the figure-wheels or such of them as have been displaced in the previous operation. Each figure-wheel has on its periphery a stop-pin 75, and when the wheel is in its zero position this pin abuts against the end of a lever 76, there being one of these levers for each wheel. Consequently as each wheel by the rotation of shaft 38 reaches its zero position it will be arrested by contact of stop-pin 75 with lever 76, the wheels being connected with shaft 38 only by the slight friction of the washers above referred to. Pins 75 and levers 76 subserve functions in the carrying mechanism, as will be hereinafter shown. Before the unison or resetting device can be operated the pinions 39 must be released from the locking-arms 46, and since no one figure-wheel need be moved more than nine-tenths of a revolution to bring it to the unison or starting point a portion (one-tenth) of the revolution of shaft 38 can be utilized for releasing the locking-arms 46. This is done by attaching to rock-shaft 48, which carries locking-arms 46, an arm 77, whose end rests in a notch in the periphery of a disk 78, rigid on shaft 38, Figs. 16 and 16^b, so long as arms 46 are in their locking position. As soon, however, as shaft 38 is turned the inclined edges of the notch raise arm 77, turning shaft 48 sufficiently to raise arms 46 out of engagement with pinions 39.

In order that shaft 38 may not be displaced during the operation of the figure-wheels, a lock-spring 79 is provided on the sector 68, Fig. 16^a, its end entering a notch in shaft 38 and holding it firmly in place.

In totalizing on the figure-wheels it is essential that when any wheel of the system

completes its revolution, turning from "9" to "0," the adjacent wheel to the left should turn one-tenth of a revolution. This is the function of the carrying mechanism illustrated in Figs. 1, 2, 16, 17, 23, and 24. For each wheel is provided a sliding bar 90, having an actuating-spring 91, connected at one end to a pin 92 on the bar and at the other to a pin 93 on the frame of the machine. Slide 90 bears on its forward end a pawl 94, (see Figs. 2, 16, and 17,) hinged thereto and pressed toward pinion 39 of the figure-wheel by a spring. Pawl 94 is so shaped at its forward end as to turn pinion 39 through one space when slide 90 is advanced by spring 91. The forward end of slide 90 works just under pawl 94, Fig. 17, and is so set and shaped as to enter between the two teeth following the one on which said pawl has just acted, thereby locking the figure-wheel for the moment and preventing its being carried too far by inertia. Slide 90 is normally held from action on pinion 39 by lever 76, heretofore referred to, which lever has a pin 96 entering a slot in slide 90, Figs. 16, 17, and 23. Said lever 76 has a spiral spring 98, tending to keep its pin 96 engaged with slide 90. The free end of lever 76 is so set and shaped as to come in contact with the stop-pin 75 on the next figure-wheel F to the right of the lever. Consequently when such wheel in its rotation passes from "9" to "0" pin 75 presses lever 76 of the adjacent wheel to the left, raising pin 96 out of engagement with the slot in slide 90 and causing, through the operation of spring 91 on slide 90, the pawl 94, carried thereby, to turn pinion 39 one-tenth of a revolution, thus "carrying ten" over from one figure-wheel to the wheel representing the next higher order. Slide 90 works in a slot in bearing-block 99, carried by plate 100, Fig. 17, which in turn rests on the base of the machine.

For restoring the carrying mechanism to its normal position slide 90 is curved at its rear end, Figs. 2, 17, and 23. Against the concave side of this curve works a cam 103. There are twelve of these cams (one for each slide) set in spiral order one-fourteenth of three hundred and sixty degrees apart on a shaft 106. A series of twelve pins 104, set all in the same line parallel with the axis of the shaft, occupies one-fourteenth of three hundred and sixty degrees, and the space marked 105 in Fig. 2 is left vacant. The pins 104, standing all in line, are just in the path of the curved extremity of slide 90, as shown in Fig. 2. (See also Fig. 24.) Consequently they prevent motion of the slides, or, in other words, prevent "carrying" while registration is being effected on the figure-wheels, which, it will be remembered, are positively engaged at that time with the rack-teeth of register-bars R. The rack-bar 56, already referred to, connected by links 58 to the rod 31, moves forward with register-carriage RC. It engages a pinion 107, Fig. 17, which, through a pawl 109 on arm 108, carried by said pinion, turns a ratchet-wheel 110 on shaft 106, which carries cams 103 and stop-pins 104. Ratchet-wheel 110 has a detent 111, which prevents its turning during the forward movement of carriage RC, during which movement pawl 109 slips over the ratchet-teeth. On the return movement, however, the pawl and ratchet-teeth engage and stop-pins 104 immediately move from in front of the curved ends of slides 90, so that any of these slides which have been tripped by the revolution of the figure-wheels during registration in the manner explained above are free to perform their function of carrying. Immediately after this, shaft 106 continuing to revolve, the first cam 103 restores its slide 90 and the other cams act successively, (if their slides have been tripped,) so that when carriage RC completes its return movement all the slides have been restored and stop-pins 104 again stand in the way of their movement.

It will be understood that when one of the levers 76 has been tripped its slide 90 makes a slight movement forward (by the pull of its spring 91) until arrested by pin 104, this movement being sufficient to carry the slot in slide 90 past the pin 96, leaving the slide free from said pin and ready to advance as soon as stop 104 is removed.

I will now describe the recording or printing mechanism for the items set up on the register-bars, Figs. 1, 2, 11, and 12. This mechanism is useful mainly when the machine is used for adding, so as to make a column of the numbers added on the totalizer. For this purpose each register-bar R carries a set of type for printing the zero and nine digits. The type are arranged in order on a strip of steel attached to one side of each of the register-bars, as shown for some of the bars in Fig. 1. Normally the zeros of all the bars R are in line with the printing-point; but if, as in the example above given, the number "546" is set up on the first three left-hand bars the three separate digits "5," "4," "6" will be brought to the printing-point—that is, to a position from which an impression can be taken.

The mechanism for the paper-feed, inking-ribbon feed, &c., can be of any suitable description, many forms of mechanism for discharging these functions being in use in typewriters. The particular mechanism herein described is therefore not essential.

The impression is obtained on a slip of paper drawn from a roll or spool 121, Fig. 2, around a rod 113, (which is the impression or printing rod,) carried by arms 115 and 116, which are pivoted, respectively, to arms 117 and 118. (See Figs. 2 and 12.) The paper on its way to the printing devices passes at its edges between feed-wheels 122 on shaft 126 and 123 on shaft 126^a, the former having holes and the latter pins to mesh therein. After passing around rod 113 the paper returns between wheels 123 and 124, the latter on shaft 126^b, Figs. 11^b and 12, and thence over a

shield 125, Fig. 15. The feed of the paper is effected by the intermittent movement of shaft 126, carrying the wheels 122. On the opposite end of the shafts 126, 126^a, and 126^b is another set of wheels, the duplicates of 122, 123, and 124. To get a sufficient feed of paper from a small movement of printing-rod 113, recourse is had to the following arrangement: By means presently described a short downward stroke of rod 113 is made to obtain the printing impression. When arms 115 116 descend, pawl 127, attached to the latter, slides over teeth of ratchet-wheel 128. The movement of the pawl is of course very slight. On the return movement the pawl engages and turns the ratchet-wheel and with it shaft 119, on which it is mounted, and gear-wheel 129. The latter turns a small pinion 130, Fig. 11, which is fast on shaft 126, carrying the feed-wheels 122, the latter being consequently turned through the desired distance. The printing stroke must be given to rod 113 after the number or item has been set up on register-bars R and before it is tranferred to the totalizer. The printing stroke is therefore derived from the first part of the downward movement of the register-key RB through mechanism which will now be described. (See Figs. 12, 13, and 14.) Shaft 22, to which key RB is connected by arm 20, has an arm 132, carrying at its outer end a lug 133, which in its upward movement encounters the lower end of a short catch 134, pivoted to an ear 134^a on arm 136 on shaft 137^a, journaled in bearings 137; which arm has an outer curved end. This end overlies the printing-roller on rod 113. The printing arm or striker 136 is controlled primarily by spring 138, coiled around shaft 137^a, the spring being so regulated that the end of arm 136 normally presses lightly on rod 113. When arm 136 is raised by the movement of arm 132, the spring is put under tension or wound up. The position of the parts as arm 132 begins to ascend is shown in Fig. 11. After a short upward movement catch 134 escapes from contact with lug 133 of lever 132 (the position at this time being shown in Fig. 13 in full lines) and arm or striker 136 will make a quick downstroke, as indicated in dotted lines, Fig. 13, producing an impression on the paper passing around rod 113 of such type as have by the antecedent movement of the register-bars been brought to the printing-line. On the return of arm 132 lug 133 pushes catch 134 aside against the pressure of its spring 135 and resumes its normal position.

The whole printing mechanism may be removed or swung aside. As already stated, this mechanism is mainly useful in addition or in tabulating columns of figures, making itemized statements of accounts, &c. In such cases it is not often necessary to see the figures exposed on the figure-wheels. In other operations, however, where it is necessary to see the figure-wheels during the whole process, the paper feeding and printing mechanism may be quickly removed or swung into a horizontal position on the pivot-rods 120 by means of catch-handles 140, Fig. 2, which are hinged to arms 117 and 118. Paper-roll 121 is supported on forked arms 139. To remove or replace it, shield 125, Figs. 2 and 15, which is a skeleton frame having lengthwise supporting-rods a' b' c', may be swung out of the way on hinge d'. Spring-catches e' hold the frame normally in place. By taking hold of the upper ends of handles 140 and pressing them slightly forward their lower ends will be released from the catches 14, Fig. 2, when the whole attachment may be swung on rod 120 to expose the figure-wheels. This rod is supported in forked bearings f', so that the apparatus can be removed bodily when desired.

It should be stated that arms 115 and 116 and rod 113 work through and when removed would be drawn out of an opening of suitable size in the cover of the machine.

The inking-ribbon for the printing mechanism is of ordinary sort. It is stored on a spool 146, Fig. 1, and rolled slowly from that to a spool 147 on the opposite side of the machine. For feeding the ribbon intermittently at each printing impression the spindle of spool 147 has a small ratchet-wheel 151, Fig. 11, actuated by a dog 150, sliding vertically in a block attached to support 149. Arm 27, which, as already described, is actuated by the register-key RB, has a small projection 152, which at each forward motion of said arm lifts dog 150, causing it to turn the ratchet-wheel 151 one space. To return the ribbon to spool 146, crank 153, Fig. 1, is employed, this crank acting through spindle 155^a and bevel-gears 155 156 upon the spindle of spool 146.

For indicating decimals a decimal-point marker is employed, this being a steel point 160, Fig. 1, on the end of a curved spring 159, carried by a block 158, which slides on a square rod 157, carried by the supports 148 149. Decimal-point 160 is beneath the inking-ribbon and above the plane of the register-bars R, and as printing-rod 113 descends the point is carried down to the plane of the type, making an impression on the paper. The decimal-point can be shifted and set by means of a rod 161, having a scale marked thereon and attached to the block 158.

The key-lock mechanism will now be described. As explained, the function of this mechanism is to prevent error arising from failure of the operator to depress a key to its full distance. The effect of such failure would be that hammer K would move the bar R, upon which it is at the time acting, a smaller distance than that necessary to set up the proper figure. Such error is obviated according to this invention by mechanism which acts on the depression of any key to lock all the other keys until the key which has been struck is depressed its full distance. This mechanism may take many different forms. As illus-

trated in the drawings, Figs. 1, 2, 3, and 18, this action is effected by a lock-bar 162, which is loosely supported in bearings in uprights 165 166 and can slide horizontally. This bar carries a series of horizontal pins 167, one for each key-lever b. The latter have at their ends two wings b^2 b^3, Figs. 4 and 18, one above the other. Attached to the upper wing b^2 is an upright steel piece 168, bent at the bottom, so that pin 167 is in the path of this angular portion c^2, which during the descent of the key-lever acts as a cam upon said pin, moving lock-bar 162 to the left against the pull of its spring 164 (see Fig. 3) and bringing all the lock-pins 167 of the other keys into the locking position. Attached to the lower wing b^3 is an upwardly-curved spring 169, its upper free end resting against a shoulder at the upper end of cam-surface c^2. Fig. 18^a shows a key in the act of descending, and pin 167 will be seen traveling along the cam-surface c^2. When it reaches the end thereof, as in Fig. 18^b, it pushes spring 169 aside and thence travels along the left-hand vertical surface of strip 168, as seen in Fig. 18^c. It will also be observed in these figures that the stop-pin 167 of the other key shown therein has been brought under the lower wing of the key-lever, locking it in place. If the key is fully depressed, its pin 167 passes over the upper edge of strip 168 and permits spring 164 to withdraw lock-bar 162 to its normal position, releasing all the key-levers. If, on the other hand, the key is released before strip 168 passes entirely below pin 167, the pin will remain on the left edge of said strip, maintaining the lock, and when the stem a rises so far that the pin 167 comes against the end of spring 169 it can rise no farther. The operator then striking another key finds it locked and is thus apprised that the key previously struck was not fully depressed, and he also finds this key at a lower position than the others. He accordingly depresses it fully and the operation may proceed regularly. The movement of pin 167 past spring 169 is timed to occur before the feed of the bar-carriage, heretofore described.

The operation of the machine for addition will be fully understood from the foregoing explanations. We will therefore next consider how it is operated for subtraction by adding to the number registered on the figure-wheels the arithmetical complement of the subtrahend. As has already been stated, the arms which actuate the hammer K from the key-levers are in pairs, one pair for each key-lever. The arms g are normally in engagement with their respective key-levers through the pins f, as shown in Fig. 3 and as heretofore explained, arms g being the addition-arms. Each arm g' is the complement of its companion arm g—that is to say, if the arm g is shaped to move the hammer through one division its companion g' is shaped to move it through eight divisions, eight being the complement of one. In Fig. 20 is shown that pair of arms which belong to the zero-key, and it will be seen that while arm g is shaped so as not to move the hammer-shaft i at all arm g' is shaped to move it through the maximum distance—that is, nine divisions. It will be seen, then, that if the zero-key lever b is in engagement with arm g' and is struck it will register "9" instead of "0" on the register-bar then in operative position. Hence for subtraction it is only necessary to disconnect the engaging pins f from the arms g and connect them with arms g'. This shift is effected by a square shift-rod 170, extending horizontally across the machine, Figs. 2, 3, 18, 19, and 20, and slidingly supported in uprights 19 20. Rod 170 carries a pair of horizontally-projecting pins 171 for each pin f. Consequently a movement of rod 170 to the right, Fig. 3 or Fig. 19, will disconnect all the pins f from arms g and connect them with the complementary arms g'. At the keyboard (see Figs. 1, 3, and 18) is a lever 172, pivoted at 173 and connected with the subtraction-key. This lever has at its end a plate q, having an inclined or cam slot, in which works a pin q' on shift-rod 170, Figs. 3 and 18. Consequently by depression of the subtraction-key the shift is effected. Since division is performed by repeated subtraction, the lever 172 is prolonged, as shown in Fig. 1, and connected with the division-key.

Further, in subtraction by adding the complement it is necessary, as well understood, to exclude one (1) from the order or place in the result next to the left of the highest order or place in the subtrahend. To effect this, I use the first or left-hand register-bar R, and before setting up the subtrahend on the register-bars I strike the zero-key. This obviously will move the first bar R through nine divisions, and when registration is made on the figure-wheels this bar will move the corresponding figure-wheel through nine-tenths of a revolution, and in so doing would "carry one" to the next higher figure-wheel. To prevent this is the function of a bar 174, (shown in Fig. 1 and detached in Figs. 21, 22, and 23,) mounted in the bar-carriage BC to the left or in advance of the first register-bar R. The forward end of bar 174 is elbowed, as seen in Fig. 21, so that it will pass under without touching the pinions of the figure-wheels upon the advance movement of the register-carriage RC. This bar 174 is set in the bar-carriage and controlled by a dog O, exactly as are the register-bars. (See Fig 10.) Its forward end 174 is provided with a knob and, controlled by a spring, as shown, is designed to act upon a pin 175 of carrying-arm 90 (see Fig. 23) and prevent carrying. To advance or set this bar, a special hammer 176 is provided. It is shown in Fig. 2, but more clearly in Fig. 21. Its forward end is a little in advance of and a little lower than the end of hammer K, so that the register-bars pass above it. The special subtraction-bar

174, however, is downwardly bent to meet it, as seen in Fig. 21. The mechanism for moving the hammer is shown in Figs. 21 and 22. The hammer is riveted to a rock-shaft 177ª, which surrounds a shaft 177, hereinafter referred to, and to the other end of which is attached the crank-arm 178. The latter is connected by a link 179 to an arm 180 of a rock-shaft 181. To this shaft is also attached the arm 182, to which is fastened the subtraction-key, as shown. Fig. 22 also shows part of the key-arm 183 of the multiplication-key attached to a spindle 184, which passes through the hollow rock-shaft 181 and the operation of which will be presently described.

The operation of subtraction by the machine can now be comprehended. The minuend is first set up on the register-bars R and by them transferred to the figure-wheels, as in addition. Next the subtraction-key (—) is struck, as the result of which special bar 174 is set forward through the action of hammer 176, and a shift is made to the complementary arms g' of the register-actuating mechanism through the action of shift-rod 170 and the devices described above. Then the zero (0) key is struck, which advances the first register-bar R through nine divisions, which (when the register-carriage moves forward) turns the figure-wheel of the highest order in the answer nine-ninths of a revolution, while the special bar 174 prevents carrying, the combined effect being to exclude one (1) from the order or place in the result which is next to the left of the highest figure in the subtrahend. Then the subtrahend is set up—that is, the figures composing it are struck from the keyboard in their regular digital order until the last figure of value in the subtrahend is reached, when one less is struck to get the true complement. Then register-key RB is struck and the subtraction performed on the figure-wheels.

To illustrate by example, suppose the problem is:

	5784
Minus	1296
Remainder	4488

By the process of adding the complement we have

	5784
Plus	8704
Result	(1)4488

It will be noted that to set up the complement (8704) the keys 1 2 9 are struck, and then for the last digit key 5 instead of 6 is struck, thus producing the effect of 4 on the register-bar.

For multiplication and division some further mechanism is called into operation, and such mechanism will now be explained.

For multiplication it is necessary to prevent the return of bar-carriage BC, which return we have seen was automatically effected by the action of finger 8 of the vertical trip-rod 7 on detent 5. Now by depressing the multiplication-key trip-rod 7 is prevented from acting on detent 5, and as this is equally necessary for division the key-arm 183 of the multiplication-key is prolonged and brought under the division-key, (÷,) as shown in Figs. 1 and 28. We have already noted that this key-arm is connected with one end of a horizontal shaft 184. To the other end of this shaft is attached an arm 186. As shown in Fig. 29, the free end of this arm carries a pin resting normally at the bottom of a slot in trip-rod 7, so that when the multiplication or division key is depressed the arm 186 is raised to the upper end of said slot and keeps rod 7 in its raised position, or, in other words, prevents it from dropping into the position to trip detent 5. Thus the return movement of the bar-carriage may be prevented.

The operation of multiplying by this machine will be readily comprehended and is quite simple. First the multiplicand is set up on the register-bars, and we will suppose this to be "6582." Multiplication-key X is depressed, (and kept depressed by means hereinafter described until released,) thus preventing return of the bar-carriage during the operation. If the multiplier be "743," we depress the register-key RB three times. The three resulting movements of the register-carriage give us three units times "6582" on the figure-wheels. Now strike the zero-key, (0,) moving bar-carriage one space to the left, which act alone "multiplies," so to speak, the number set up on the bars (6582) by ten. In this position the register-key is struck four times, (4 being the tens-digit of the multiplier,) thus placing on the figure-wheels forty times "6582" and adding the result to the partial product already registered. Again strike the zero-key, shifting the bars another space to the left, and strike key RB seven times, which adds seven hundred times "6582" to the number registered on the figure-wheels, which now exhibit the complete product:

$$6582 \times 743 = 4,890,426.$$

The process could be reversed by bringing the carriage BC to a position corresponding to the highest order of the multiplier, multiplying by that, and then shifting to the next lower order by means of the shift-key which is used in division and will now be described.

For division, as has been already indicated, the bar-carriage BC must be moved step by step to the right, for a purpose which will be made clear hereinafter. This movement is effected through the operation of shift-keys, Figs. 1, 27, and 28. The key-lever 187 of this key is attached to a sleeve 187ª, mounted loosely on rod 173ª. To this sleeve is also secured the downwardly-extending arm 188, connected by a link 189 with an oscillatory arm 190, attached to the shaft 177, heretofore referred to. The oscillatory arm 190 carries

at its upper end the combined release and detent pawl 191, shaped somewhat like a horse-shoe. This pawl is shown in Fig. 28, where for sake of clearness the rack *s* is omitted; but the operation will be well understood by reference to Fig. 9. As there shown, one wing *z* of this device strikes the tail of detent 5, when arm 190 rocks forward, tripping the detent, and consequently releasing bar-carriage BC, but at the same moment the other wing *z'* reaches into the rack *s* and arrests the bar-carriage as soon as it has moved one space. It will now be understood that every time shift-key S is struck the bar-carriage is shifted or permitted to move one step to the right—that is, toward its starting-point.

The stems of the multiplication, division, and subtraction keys are notched, as shown at 192, Figs. 18 and 19, and each of these keys is provided with a detent rod or dog 193, each mounted in a lug on the under side of the cover of the machine (see Figs. 1 and 3) and impelled by a spiral spring 194 in the direction to engage said notches. Consequently when, say, the multiplication-key is depressed it is detained so long as that operation is being performed. These detent-rods all converge to the stem of the release-key R^2, and each is provided with a hook 194^a, as shown for one of the rods in Fig. 3, which embraces the stem of the release-key. When the latter is depressed, the conical portion r^2 thereof presses against this hook and retracts the rod. A depressed special key shows to the operator the condition of the machine, which may be restored to the normal condition by depressing release-key R.

Inasmuch as division is a short method of making many subtractions, the mode of procedure is somewhat similar. First the dividend is set up on the register-bars and transferred to the figure-wheels. Then division-key ÷ is struck, which has the double effect of shifting all the keys to the complementary arms *g'* and of raising trip-rod 7 to prevent its acting upon detent 5 and releasing the bar-carriage. Zero-key is then struck, as in subtraction, advancing the first register-bar R nine divisions, it being remembered that by the shift the zero-key has now the same effect on hammer K that the "9" key normally has. The divisor is now struck on the keyboard in regular digital order, excepting that (as in subtraction) instead of the key representing the last digit of the divisor the key representing the next smaller digit is struck. Thus we have set up on the register-bars the true arithmetical complement of the divisor. Bar-carriage BC is now shifted to the left until the bar carrying the right-hand figure of the divisor is under the right-hand figure of the first partial dividend as exhibited on the figure-wheels. This shift is made by the figure-key 9, (which now acts as the zero-key normally acts, simply making a shift without disturbing the register-bars.) Now the register-key RB is struck (making repeated subtractions) until the partial dividend is exhausted or is less than the divisor. Each time this key is struck the first bar (which was set to "9," as stated above,) carries one (1) to the figure-wheel to its left, thereby registering on that wheel the first figure of the quotient. At this point shift-key S is struck for a shift of the bar-carriage one step to the right—that is, opposite the figure-wheels of the next partial dividend—where the former process is repeated, the first bar R recording the next figure of the quotient on the figure-wheel next to the right, &c., until the last partial dividend is exhausted or a remainder occurs.

With this machine a remainder may be again set up on the left-hand figure-wheels and run rapidly to a decimal as far as desired.

It will be observed that the first (or left-hand) register-bar is utilized in division for two purposes—first, to exclude the excessive unit, (as in subtraction,) and, second, to record the quotient on the adjacent figure-wheel.

One or two details of minor importance remain to be described. The first of these is the register-lock 195 (illustrated in Figs. 25 and 26) and the associated details. This lock is pivoted on a screw 196, tapped into the frame of the registering-carriage, and is free to move a short distance lengthwise of this screw, being governed by a spring. (Shown in Fig. 26.) Lock 195 has wings m' m^2 m^3. Wing m' normally rests on the head of a screw *p*, which is one of the pivot-screws of link 29, already referred to. When link 29 is raised at that end by the depression of the register-key, the wing m' falls under the head of screw *p*. At this time key RB has been but slightly depressed and the record of the item has been made on the paper strip preparatory to the advance of the register-carriage. If at this point the operator sees that the record of the item (which is visible to him through a window 220, Fig. 2) is incorrect, he may at once release key RB, preventing registry of the incorrect item on the figure-wheels. Should he do so, screw *p*, acting against the curved side of wing m', presses lock 195 outward again against its spring and carriage RC returns to its normal position, so that the incorrect record may be erased and the item correctly set up. If, however, key RB be not released, but further depressed, wing m^3 comes above and nearly into contact with a plate 197, screwed to the support M^4 of the carriage, before any bar R begins to register with the pinion of a figure-wheel, and if during this period of the movement key RB were released the pressure of screw *p* on wing m' would bring wing m^3 snugly into contact with plate 197 and lock the carriage against return movement. This locking action during registry is important, because otherwise any carrying mechanism which was tripped during an incomplete registry would give a false

result on the figure-wheels. The function is analogous to that of the key-locking mechanism described above.

When the register-carriage makes its full forward movement, the inclined inner surface of wing m^2 makes contact with pin 198 at the end of plate 197 and the lock 195 is forced outward against its spring, withdrawing wing m' from contact with screw p and permitting link 29 to drop.

It is found desirable to employ means for preventing the hammer K from driving register-bars R by inertia farther than necessary to set up the desired figure, which might occur in case of a violent stroke on a key. Such means are illustrated in Figs. 4 and 5. A toothed bar or rack 200, mounted slidingly in a suitable support 209, is connected by a link 199 with the bar i, carrying hammer K. A rocking frame consisting of a shaft 202, arms 203 and 203^a, and a connecting-rod 204 carries a dog 205. Rod 204 extends horizontally under all the key-levers b and at such a height that just as any lever completes its downward movement it depresses dog 205 into engagement with the tooth of the rack 200 corresponding with the key struck, instantly arresting the hammer. The rocking frame is controlled by a spiral return-spring 206 and a back-stop 207. It will be understood that the several key-levers and the bar-carriage are returned to their normal position by springs, as is common in type-writers, these springs being (to avoid unnecessary confusion and complication) omitted from the drawings.

The principle of this invention in its various parts may be applied in different ways and, in fact, has been embodied by me in mechanisms differing widely in details and arrangements; but the machine herein described exhibits the best and simplest mode known to me of carrying the said invention into effect. I do not, however, limit myself thereto.

What I claim as my invention is—

1. In a calculating-machine the combination with the figure-keys, of register-bars, a movable support therefor and means for bringing the bars successively under control of the keys, whereby numbers may be set up in digital order on said bars, substantially as described.

2. In a calculating-machine, the combination with ten figure-keys, of a series of registering devices or bars, a movable carriage by means of which the registering devices are brought successively in digital order under the control of the figure-keys, and mechanism actuated by the figure-keys for imparting to the carriage a step-by-step movement, substantially as described.

3. The combination with ten figure-keys, of a series of register-bars, a movable carriage therefor, connections for feeding said carriage one step on the depression of any key, an actuating device or hammer for moving said register-bars, and connections whereby said actuating device is moved by each key through a distance corresponding with the numerical value of such key, substantially as described.

4. The combination with the ten figure-keys, of the bar-carriage movable relatively to said keys, a series of register-bars on said carriage, and each movable independently thereof, a hammer or actuating device to which the register-bars are presented successively by the movement of the bar-carriage, connections between the hammer and the figure-keys whereby the former is moved by each key through a distance corresponding to the numerical value of the key, and mechanism for moving said carriage step by step as said keys are actuated, so that a number is set up upon said bars by depressing consecutively the keys corresponding to such number in their proper digital order, substantially as described.

5. In a calculating-machine, the combination with the figure-keys, a series of register-bars, a movable carriage supporting the register-bars, an actuating device common to the several figure-keys, and mechanism actuated by said keys for shifting the carriage to bring the register-bars *seriatim* into operative relation with said actuating device, substantially as described.

6. The combination with the figure-keys, of the register-bars, a carriage for said bars, movable relatively to said keys to bring the bars successively under the action of said keys, connections whereby the bars are moved a distance corresponding to the numerical value of the keys acting thereon, a register-carriage supporting the bar-carriage and bars, totalizing or figure wheels, and a register key or device for moving the register-carriage and causing the register-bars to act upon and transfer to the figure-wheels the number set up on said bars, substantially as described.

7. The combination of the ten figure-keys, the hammer carried by a rock-bar under the control of all said keys, the register-bars, the bar-carriage, means for imparting to the latter an intermittent movement, the register-carriage supporting the bar-carriage, the register-key, and the figure-wheels, substantially as described.

8. The combination with the figure-keys and registering mechanism actuated thereby, of the bar-carriage movable intermittently by said keys, the register-bars mounted and movable thereon transversely of the movement of said carriage, the register-carriage supporting the bar-carriage and bars and movable in a line parallel with the movement of the latter, the figure-wheels with which the bars are engaged by the movement of the register-carriage, and means for moving and returning the latter, substantially as described.

9. The combination with the figure-keys and registering mechanism actuated thereby, of the bar-carriage movable intermittently by

said keys, a detent normally preventing the return of said carriage, the register-bars on said carriage, the register-carriage supporting said bar-carriage, and movable in a direction transversely to the movement thereof, totalizing or figure wheels actuated by said register-bars upon the advance of the figure-wheels, means for advancing and returning the register-carriage, and a trip for automatically releasing the bar-carriage from its detent upon the return of the register-carriage, substantially as described.

10. The combination with the figure-keys and registering mechanism actuated thereby, of the bar-carriage movable intermittently by said keys, a series of register-bars movable independently upon said carriage, a detent for each bar for holding it in its advanced position, and a trip acting automatically upon the return of said carriage to disengage all said detents, substantially as described.

11. The combination with the figure-keys and registering mechanism actuated thereby, of the register-bars, each movable independently of the others by said keys and registering mechanism, a register-carriage supporting said bars, a series of figure-wheels, a key or device for advancing said carriage to bring said bars into action upon said wheels, and means for causing the bars to engage said wheels upon the advance movement of the carriage, and to be disengaged therefrom before its return movement begins, substantially as described.

12. The combination with the figure-keys and registering mechanism actuated thereby, of the register-bars, each movable independently of the others by said keys, the bar-carriage on which said bars are mounted, the register-carriage upon which said bar-carriage is hinged, the figure-wheels, a register-key for advancing the register-carriage toward the figure-wheels, and connections between said key and the bar-carriage whereby the latter is turned on its hinge in one direction before the register-carriage advances so as to bring the register-bars in position to engage said wheels, and in the other direction to release the bars from said wheels before the register-carriage begins to return, substantially as described.

13. The combination with the register-bars, the bar-carriage supporting said bars and the register-carriage supporting said bar-carriage, of the figure-wheels adapted to be engaged by the register-bars upon the advance of the register-carriage, a permanent lock for the figure-wheels and means for disengaging said lock upon the advance of the register-carriage, substantially as described.

14. The combination with the register-bars, the bar-carriage and register-carriage, of the figure-wheels mounted to turn independently on a common arbor, a key for advancing the register-carriage to bring the register-bars into engagement with the figure-wheels, and carrying mechanism comprising a series of dogs one for each figure-wheel, and mechanism for bringing each dog into action to turn its wheel one space, when the next adjacent figure-wheel completes a revolution, substantially as described.

15. The combination with the register-bars, the bar-carriage, and the register-carriage, of the figure-wheels mounted to turn independently on a common arbor, and having a frictional connection with said arbor, carrying mechanism for the figure-wheels, and unison mechanism comprising stops for each wheel to arrest it on reaching the unison or starting point when said arbor is turned in the direction opposite to the normal rotation of said wheels, substantially as described.

16. The combination with the figure-keys and hammer or register-actuating device of the register-bars, movable each to ten different positions, a carriage for said bars moved intermittently by said keys to bring the bars successively under the action of said hammer, a type-plate carrying figures attached one to each bar, and printing or recording mechanism for taking an impression of the numbers registered on said bars, substantially as described.

17. The combination with the figure-keys and hammer or register-actuating device, of the register-bars, movable each to ten different positions, a carriage for said bars moved intermittently by said keys to bring the bars successively under the action of said hammer, a type-plate carrying figures attached one to each bar, and printing or recording mechanism for taking an impression of the numbers registered on said bars, said printing or recording mechanism being removably supported on the machine, substantially as described.

18. The combination with the register-bars for registering the figures comprising a number, type-plates one for each bar and movable therewith, figure-wheels, a register-carriage for moving said bars into engagement with said wheels, a register-key for moving said carriage, recording mechanism for taking an impression of the number registered on said bars, and connections between the register-key and the recording mechanism whereby the latter is actuated from the former, substantially as described.

19. The combination of the register-bars for registering the figures composing a number, type-plates one for each bar and movable therewith, the figure-keys and hammer actuated thereby, means for bringing the bars successively under the operation of said hammer, the recording mechanism, and the shiftable decimal-point marker, substantially as described.

20. The combination with the figure-keys and the register bars or devices for registering a number struck upon said keys, of locking mechanism operated upon the depression of any key to lock all the other keys until the said key has been depressed the full distance, said locking mechanism comprising a lock-

bar having a series of stop-pins, one for each key, and cam-plates, one on each key-lever, acting when a key is depressed to move said lock-bar to its operative position until the key is far enough depressed to clear the lock-pin, substantially as described.

21. The combination with the register-actuating device or hammer, and the register-bars operated thereby, of the ten figure-keys, and a series of actuating-arms, one for each key, each adapted to impart to said hammer a definite movement, different for each arm and corresponding to the numerical value of said key, substantially as described.

22. The combination with the register-actuating device or hammer, and the register-bars operated thereby, of the ten figure-keys, a series of actuating-arms one for each key adapted to impart to said hammer a definite movement different for each key, a series of complementary arms one for each key, and means for shifting the keys into connection with the complementary arms, substantially as described.

23. The combination with the register-bars and the hammer for actuating them, of the ten figure-keys, a series of actuating-arms, one for each key, each adapted to impart to said hammer a definite movement different for each key, a series of complementary arms one for each key, a subtraction-key and a division-key, and means whereby when either of the last-mentioned keys is depressed the figure-keys are shifted into connection with the complementary arms, substantially as described.

24. The combination with the register-bars, the figure-wheels upon which the said bars register, the carrying mechanism for said figure-wheels, and the hammer for actuating said bars successively, of the ten figure-keys, a series of actuating-arms, one for each key, each adapted to impart to said hammer a definite movement corresponding with the arithmetical complement of the figure by which such key is designated, means for bringing the register-bars into engagement with the figure-wheels, and means for preventing the operation of the carrying mechanism upon the figure-wheel adjacent to the first register-bar, substantially as described.

25. The combination with the hammer, or registering device, and the ten figure-keys, of a series of actuating-arms, one for each key, for use in addition and multiplication, a second series of complementary arms for use in subtraction and division, and means for shifting the figure-keys from one to the other series of arms, substantially as described.

26. The combination with the figure-wheels, the register-bars for acting thereon, the bar-carriage movable intermittently, a detent for said bar-carriage, the register-carriage for advancing the register-bars to the figure-wheels, release mechanism for normally releasing the bar-carriage from said detent on the return of the register-carriage, and a multiplication key or device adapted when actuated to prevent the action of said release mechanism, substantially as described.

27. The combination with the figure-wheels, the register-bars for acting thereon, the bar-carriage, the figure-keys and connections for moving said carriage step by step in one direction and for registering numbers upon said bars, and a special key and connections for moving said carriage step by step in the other direction, substantially as described.

28. The combination with the figure-wheels, the register-bars for acting thereon, the bar-carriage, the register-carriage for advancing the bar-carriage and bars to the figure-wheels, and the register-lock, actuated upon the advance movement of the register-carriage to prevent its return until it has completed its full stroke, substantially as described.

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

ALFRED SAMUEL McCASKEY.

Witnesses:

CHARLES L. GOODSPEED,

T. V. GOODSPEED.