C. F. KETTERING.

REGISTERING MECHANISM.

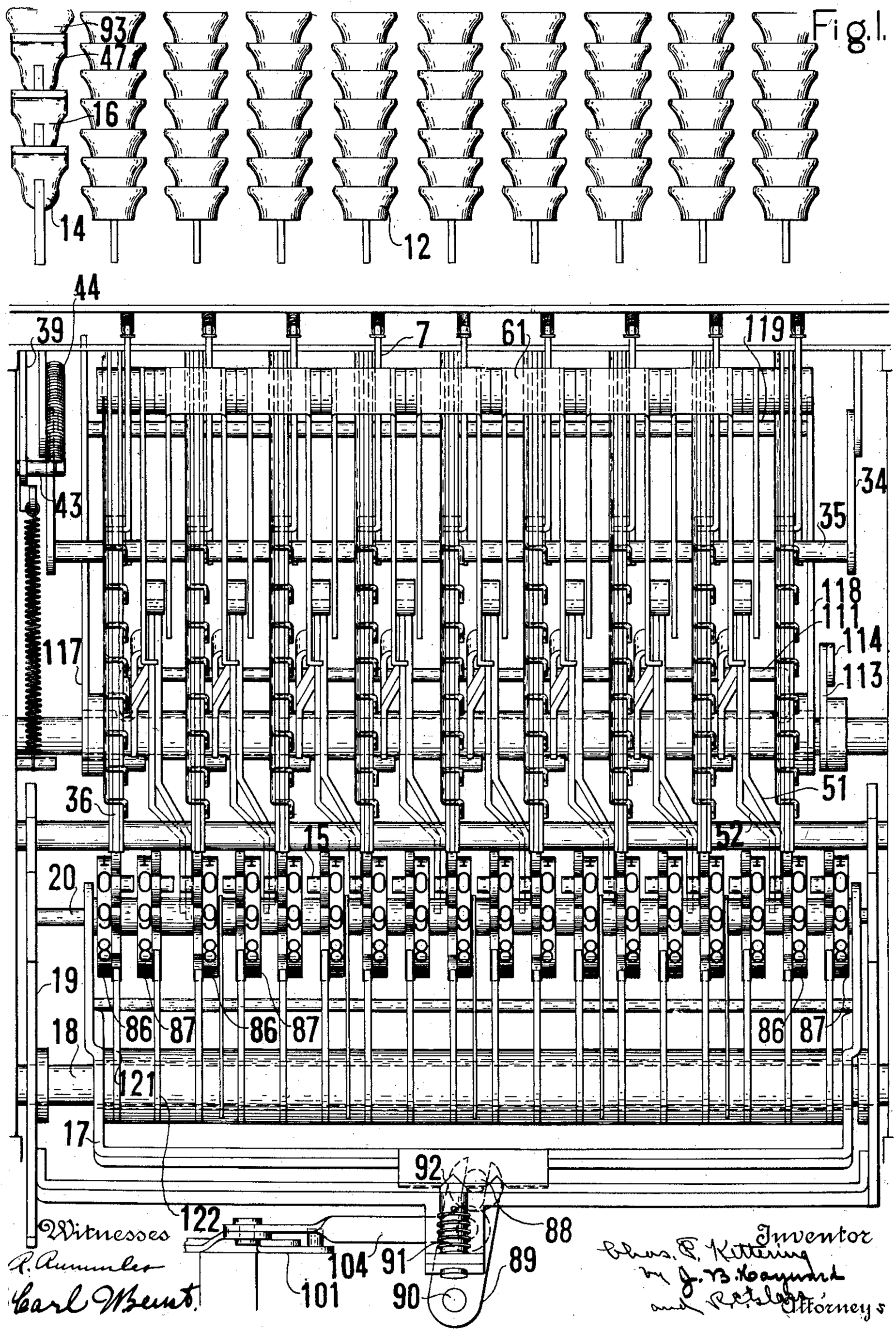
APPLICATION FILED JAN. 25, 1908.

1,166,527.

Patented Jan. 4, 1916.

4 SHEETS—SHEET 1.

Fig. 1.



Witnesses
P. Rummler
Carl Wendt.

Inventor
Chas. F. Kettering
by J. B. Hayward
and Rathbun
Attorneys

C. F. KETTERING.

REGISTERING MECHANISM.

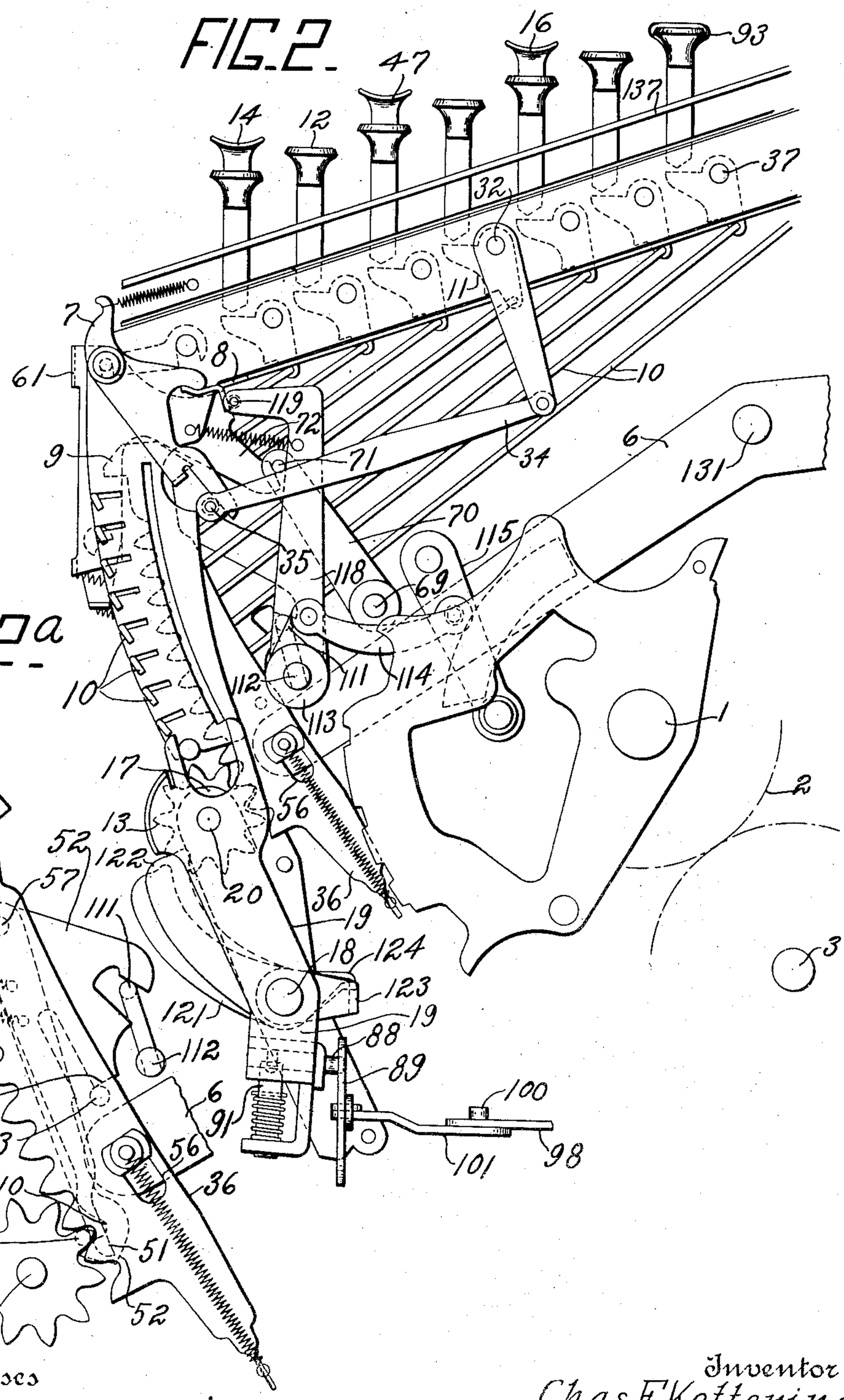
APPLICATION FILED JAN. 25, 1908.

1,166,527.

Patented Jan. 4, 1916.

4 SHEETS—SHEET 2.

FIG. 2.



Witnesses

C. Klostermann.

W. M. McCarthy

Inventor

Chas. F. Kettering

and Robson. Attorney

C. F. KETTERING.

REGISTERING MECHANISM.

APPLICATION FILED JAN. 25, 1908.

1,166,527.

Patented Jan. 4, 1916.

4 SHEETS—SHEET 3.

FIG. 2b

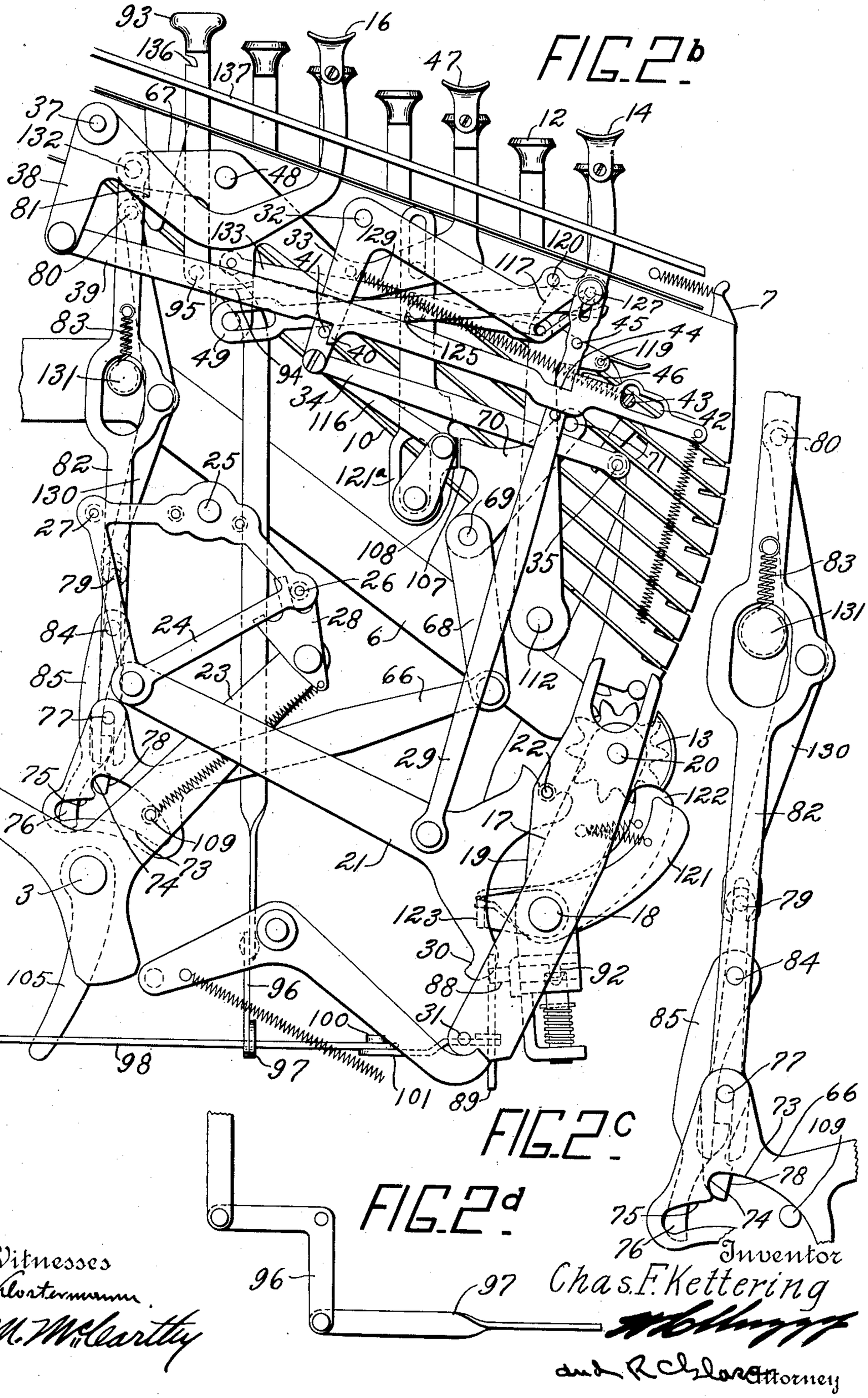


FIG. 2c

FIG. 2d

Witnesses
C. Klostermann.
W. M. McCarthy

Inventor
Chas. F. Kettering
by R. Clarke Attorney

C. F. KETTERING.

REGISTERING MECHANISM.

APPLICATION FILED JAN. 25, 1908.

1,166,527.

Patented Jan. 4, 1916.

4 SHEETS--SHEET 4.

Fig. 3.

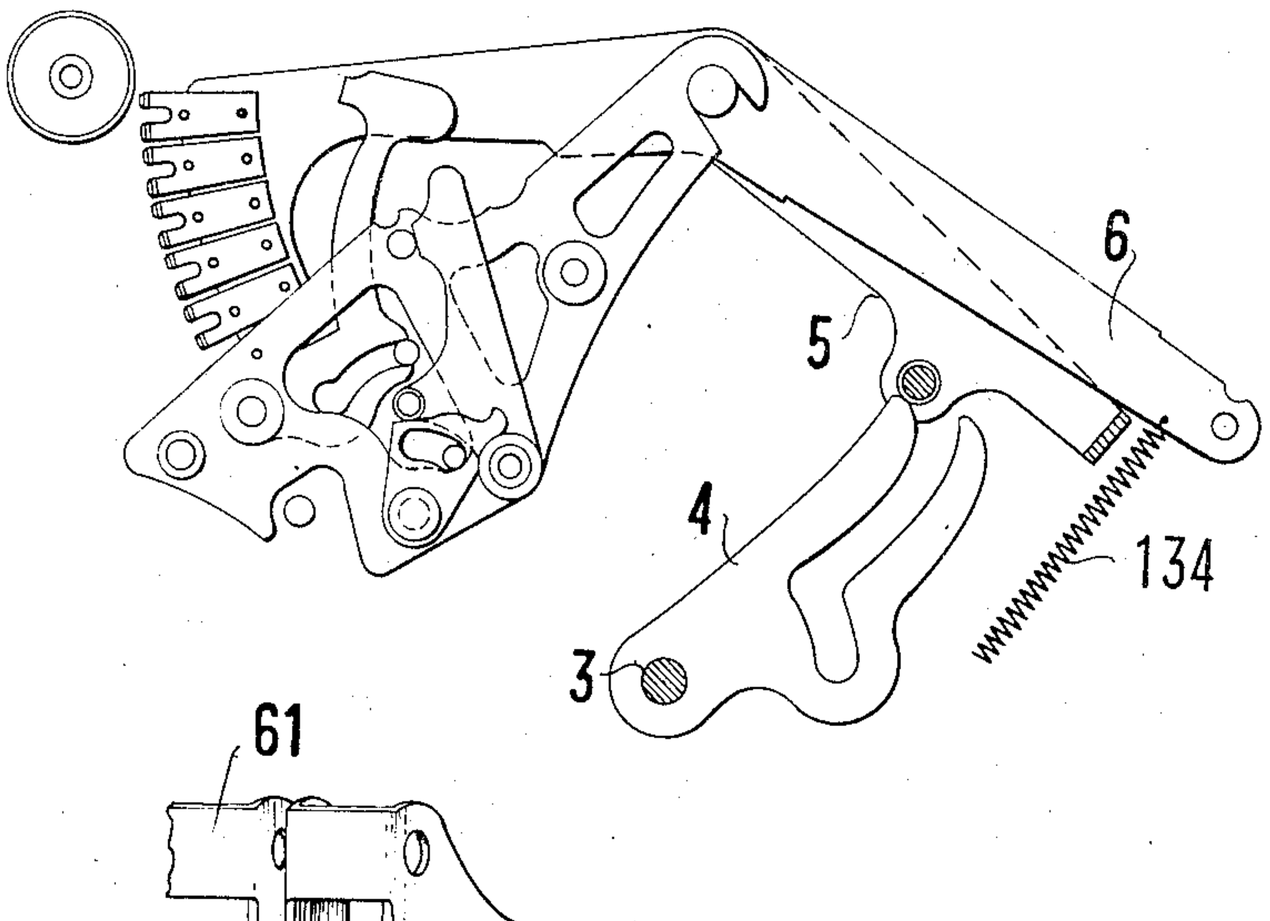


Fig. 4.

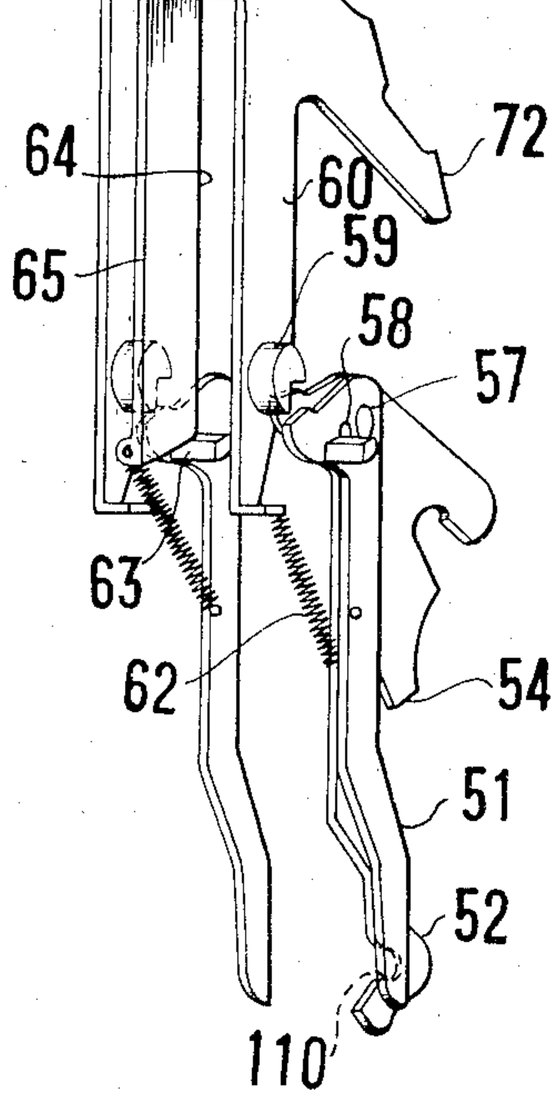
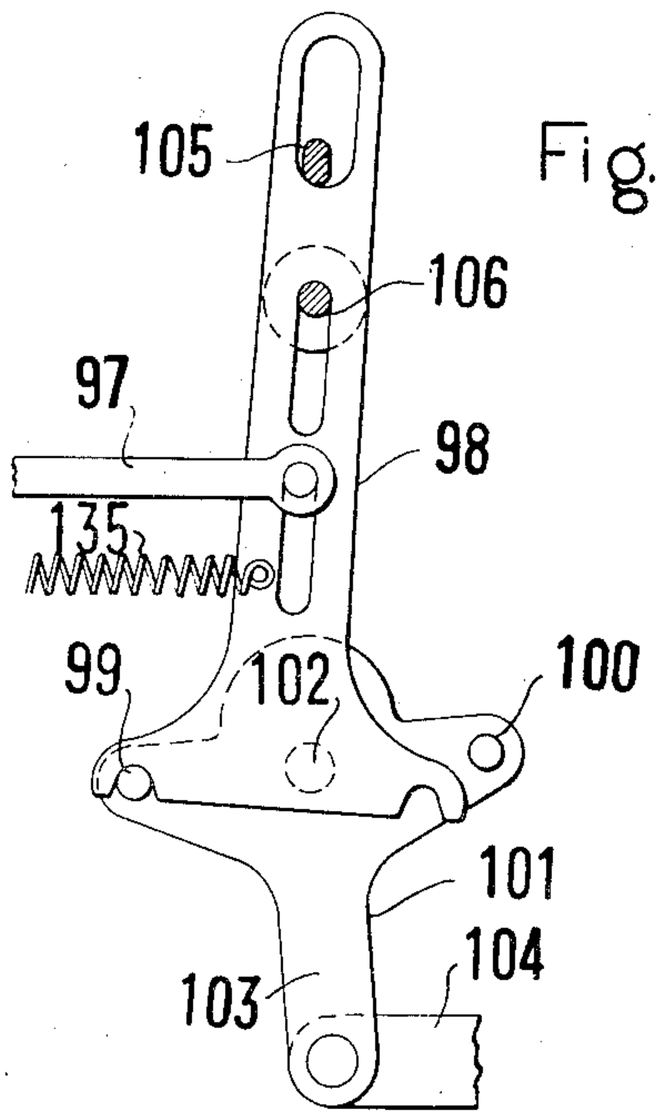


Fig. 5.



Witnesses
R. Rummler
Carl W. Beust.

Inventor
Chas. F. Kettering
by J. B. Hayward
and Kelsey
Attorneys

UNITED STATES PATENT OFFICE.

CHARLES F. KETTERING, OF DAYTON, OHIO, ASSIGNOR TO THE NATIONAL CASH REGISTER COMPANY, OF DAYTON, OHIO, A CORPORATION OF OHIO, (INCORPORATED IN 1906.)

REGISTERING MECHANISM.

1,166,527. Specification of Letters Patent. Patented Jan. 4, 1916.

Application filed January 25, 1908. Serial No. 412,544.

To all whom it may concern:

Be it known that I, CHARLES F. KETTERING, a citizen of the United States, residing at Dayton, in the county of Montgomery and State of Ohio, have invented certain new and useful Improvements in Registering Mechanism, of which I declare the following to be a full, clear, and exact description.

This invention is an improvement in calculating machines, and relates primarily to subtracting mechanism and a novel construction of multiple counters.

The invention is shown in the drawings as applied to the class of machines described in the patents to W. S. Burroughs Nos. 504,963 and 507,078 of September 12, 1893, which patents describe a well known machine provided with a set of counter wheels and a key board and mechanism under the control of the key board for setting up amounts on the counter wheels, with printing mechanism arranged to print items or the total amount accumulated by the counter wheels. In patent to C. W. Gooch, No. 825,205 of July 3, 1906 the same machine is shown provided with means for disabling the interacting parts between some of the counter wheels and their respective type segments with other counter wheels and their type segments whereby the machine may be divided into sections thereby giving practically several independent machines, which enables the operator to list items of different character such as debit and credit accounts on separate counters, although by so dividing the machine the capacity of the counters is of course greatly reduced.

One of the prime objects of the present invention is to provide for the independent listing and summing of items of different character without enlarging the machine or reducing its capacity. This object is accomplished by a novel arrangement of multiple counters which consist of a plurality of counter wheels mounted in axial alinement, there being several adjacent counter wheels to each actuating rack, and means being provided for shifting all the counter wheels in an axial direction so that different sets of counter wheels will be brought into operative relation with actuating racks.

A further object of the invention is to provide means by which amounts set up on the key board may be subtracted from the total of either of the counters as well as added thereto.

Another object is to provide the machine with means by which the same set of transfer pawls may be used in subtracting operations as are used in operations of addition.

Another object of the invention is to provide counter shifting mechanism adapted to be operated by the main operating handle of the machine.

Another object is to provide means for locking the counter shifting device when the subtraction key is operated.

With these and incidental objects in view, the invention consists in certain novel features of construction and combinations of parts, the essential elements of which are set forth in appended claims and a preferred form of embodiment of which is hereinafter described with reference to the drawings which accompany and form part of this specification.

Of said drawings: Figure 1 is a front elevation of a machine embodying this invention. Fig. 2 is a side elevation of the same, the rear portion of the machine being omitted. Fig. 2^a is an enlarged detail view of a totalizer pinion, its actuating rack and transfer pawls coöperating therewith. Fig. 2^b is a view similar to Fig. 2 but looking from the opposite side of the machine. Fig. 2^c is an enlarged detail view of the releasing mechanism for the subtracting key. Fig. 2^d is a detail view of the mechanism controlling the shifting of the totalizers. Fig. 3 is a detail of the printing mechanism. Fig. 4 is a perspective view of the transfer pawls. Fig. 5 is a top plan of the counter shifting lever.

As this invention is shown applied to the Burroughs adding machine, a general description of the Burroughs machine excluding the present improvements will first be given. ~~This~~ description will be followed by a general description of the present improvements. Then the machine will be described in detail with reference to the drawings and finally a detailed description of the present improvements will be given.

The Burroughs adding machine comprises the following prime elements: a key-board, differential mechanism controlled thereby, driving means for t e differential mecha-

nism, a counter which is actuated by the differential mechanism, and a printing device.

The keyboard comprises a number of banks of amount keys, one bank for each denomination represented, with nine keys in each bank. The lower keys are placed at the forward end of the machine and run up to nine at the rear. Each bank of amount keys controls a counter actuating segment, all of which segments form the differential mechanism above referred to. The lowest keys control one unit of movement of their respective segments while the highest keys control nine units of movement of the same. The amount keys are connected to segment stops which are arranged in an arc concentric to the pivotal center of the actuating segments and are movable into the paths of lugs carried by the segments. In operation the segments move down until engaged by such stops as have been moved into their paths, the segments being stopped at distances from their starting points which correspond to the amounts of the amount keys which have been depressed. It is upon the return stroke of the segments that the same are meshed with the counters. The segments are spring actuated in a downward direction and are arranged to be picked up and returned to their starting positions by a rocking frame which is actuated by the main operating mechanism.

The counters are mounted in a rocking frame which is arranged to be rocked for the purpose of bringing the counters into mesh with the actuating segments at the proper time so that the counter elements will be rotated in a forward direction only, in all ordinary operations of the machine. The counter frame is rocked by mechanism which is actuated by the driving mechanism. This mechanism in operation of addition serves to position the counters so that they will not be meshed with the segments during the down stroke of the same but will be held in mesh with the segments during the return stroke. If it is desired to reset the counters to zero all of the actuating segments are released, the segments rotating their respective counter pinions in a backward direction until the pinions arrive at zero positions. In resetting, the counters are stopped at zero by the engagement of lugs carried by the pinions with pawls which are in their paths. The resetting of the counters serves to position type carriers for printing the total amount which had been added on the counters. The type are mounted on the rear of the segment carrying arms and the particular type brought to the printing line is determined by the extent to which the segments are moved downwardly. The downward movement is limited by the lugs mentioned, in a totalizing operation, and by the amount keys in ordinary operations when the type are set to print the amount added on the counters instead of the total amount. A key, called the total key, controls the operation of the machine when the counters are reset. This key when depressed releases all of the segments and positions the counter shifting mechanism so that upon the operation of the machine the counters will be kept in mesh during the downstroke of the segments and held out of mesh during the return stroke. This is just the reverse of what happens in operations of addition.

A subtotal key is provided which when depressed controls the machine very much the same as the total key does except that it will cause the counters to remain in mesh both during the forward stroke of the segments and the return of the same after a total printing has been taken. In this operation the counters are returned to the reading which they indicated before the total was printed.

The printing mechanism is located at the rear of the machine. The type are mounted on the rear end of the segment carrying arms, the said arms being pivoted about midway between the counters and the printing mechanism. The segments and their carrying arms are not rigidly connected together but have a slot and pin connection which will permit of a certain amount of lost motion between the two. This lost motion connection is used in transferring. The transfer operation will be described later but the lost motion connection necessitates leaving a space between the zero type and the printing line so that the lost motion will not prevent the setting of the type to correspond to the amount keys that are depressed.

When a counter wheel has made a complete rotation a lug mounted on the wheel engages a transfer pawl which will effect the adding of a unit on the next higher counter wheel. The transfer pawls normally serve as stops for the counter actuating segments but when one of said pawls is engaged by the lug carried by its respective counter pinion, it is moved out of the path of the segment which operates the next higher pinion, and allows said segment to rotate its respective pinion one-tenth of a revolution.

The present improvements provide means by which amounts set up on the keyboard may be subtracted from the counters if desired. The amount keys serve to limit the movement of the actuating segments both in adding and subtracting operations. A special subtracting key is provided which controls the positioning of the counters for subtracting operations. If the subtraction key is depressed the counter shifting mechanism will be positioned so that the counters will be meshed with the actuating segments only during the downstroke, during which time

the counters are turned in a backward direction. The transfer pawls are arranged to be tripped by the counter pinions when the counter pinions are reversely rotated in subtracting operations just the same as they are tripped when the counters are forwardly rotated in adding operations.

Transferring units of movement from one counter wheel to another in operations of addition, as has been explained is accomplished through counter pinions arriving at zero positions, when lugs carried by the pinions move transfer pawls out of the way of the segments which operate the next higher pinions. The segments will then under spring action rotate their respective pinions an additional one-tenth of a rotation. Now if several adjacent counter pinions are at the nine position and one is added to the lowest wheel moving the wheel up to zero this wheel will throw its respective pawl out of the path of the next higher segment which will then under spring action rotate its counter pinion an extra unit and bring it to zero. This wheel in moving to zero position likewise releases the next higher segment which moves up an additional unit under the action of its spring. The transferring will so continue through all the wheels that stand at nine, finally reaching a wheel which reads less than nine when one will be added to such wheel but as the wheel will then not be moved to zero position it will not trip its respective transfer pawl.

In subtracting operations the counter wheels are rotated in a direction reverse to that in which they are rotated in operations of addition. The transfer is carried from a wheel of lower order to the next higher wheel when the lower wheel passes from zero to nine, which will cause one to be subtracted from the next higher wheel. In subtracting operations the segments mesh with the counter pinions during the downstroke of the segments and if any of the transfer pawls are tripped their respective segments will upon their return to upper position, when the counters are out of mesh move up the additional unit under the action of their springs. Then upon a second operation of the machine, the parts remaining in subtracting relation, the segments will impart the additional units of backward movement, which they received on the previous operation of the machine, to their respective counter pinions so as to subtract such units of movement from the pinions. If several adjacent wheels stand at zero and a number is subtracted from the wheel of lowest order this wheel will trip its respective transfer pawl so that one will be subtracted from the next higher wheel, which higher wheel will therefore pass from zero to nine causing its respective transfer pawl to be tripped, but as this pawl is tripped upon the second operation of the machine such transfer would not ordinarily be turned in except by a third operation of the machine and if by turning in the second transfer, a third transfer were necessitated, the machine would have to be operated a fourth time in order to turn in such transfer. This operation would have to be repeated until all the necessary transfers were turned in, making transferring in a subtracting operation very slow. To avoid such repeated operations of the machine in subtracting operations, to turn in additional transfers which are made necessary by transferring operations, mechanism is provided which will automatically throw a plurality of transfer pawls independently of any movement of the operating segments, provided several adjacent counter wheels stand at zero and a transfer pawl of one of the lower wheels has been tripped. To make this point clearer, attention is called to such successive transfers in operation of addition. In addition the extra units of movement of the segment, caused by the tripping of transfer pawls, occurs while the segments are in mesh with the counter pinions and as movement of a counter pinion from nine to zero causes the tripping of its respective transfer pawl and release of the next higher segment successive transfers will be automatically effected upon one operation of the machine. In subtraction the extra units of movement of the segments, caused by the tripping of transfer pawls, occur when the segments are out of mesh with the counter pinions so that at such time the counters could not serve to communicate movement from one segment to another as they do in successive transfer operations in addition. For the above reason cams are provided which will operate the transfer pawls in subtracting operations as the counter pinions operate the same in adding operations. These cams are so arranged in regard to the counter pinions and the transfer pawls as to operate their respective transfer pawls only when the transfer pawl of next lower order has been tripped and their respective counter pinions stand at zero.

The multiple counters of this invention consist of a plurality of counter pinions for each denomination represented on the keyboard. All of the counter pinions are mounted on the same shaft with like denominations adjacent. The counters are movable in an axial direction so that any one of the counters of like denomination may be brought into mesh with the operating segment for such denomination with but a slight shifting of the counters.

In the drawings, 1 indicates the main operating shaft of the machine upon which is mounted the operating handle. In operating the machine this handle is moved forward and returned through an arc of about

60°. The shaft 1 is geared by a pair of segment gears 2, the pitch lines only of which are shown, to a shaft 3. Thus when the operating handle is moved forward and returned the shaft 3 will be oppositely oscillated. The shaft 1 drives a cam 4 (see Fig. 3) which cam rocks a frame 5 backward and forward at each complete oscillation of the shaft 1. All of the counter segment carrying arms 6 rest upon the frame 5 and upon the lowering of the frame all of such segments as are released will lower with the frame until stopped at points determined by the amount keys depressed. The segments are normally held in their upper position by latches 7 which latches are each drawn out of engagement with their respective segments when any key of the bank which controls the segment is depressed. Plates 8 which are cammed rearward by the keys, hook under the latches 7 and serve to draw the latches 7 out of engagement with the segments and permit the lowering of the segments when the frame 5 is rocked downwardly. The lowering of the arms 6 is aided by springs as shown in Fig. 3. The frame 5 is rocked the same distance at each operation of the machine, which distance is greater than the full distance traveled by the segments when the amount keys bearing the numeral 9 are depressed. Each segment is provided with a lug 9 which will abut one of the bent rods 10 if the rod is moved into its path and so stop the segment at a position determined by the rod. The rods 10 are connected by rock levers 11 to the keys 12, the lower value keys being located at the forward end of the machine, running up to nine at the rear of the machine.

In the ordinary operation of addition the counter wheels 13 are out of mesh with the actuating segments during the downstroke of the segments and in mesh during the return stroke, the counters being rotated during the return so as to add thereon the amount set up on the keyboard. A total key 14 is provided which when depressed, releases all of the segments from the latches 7 and also controls the timing of the counter movement so that the counters will be in mesh during the downstroke of the segments and be out of mesh during the return of the segments. In the operation of totalizing, the extent of movement of the segments is determined by the transfer trip pins 15 which are mounted on the counter pinions and which abut stops when the counter pinions are reversely rotated to their zero positions.

The printing type are mounted on the rear of the arms 6 and the printing mechanism is arranged to take an impression when the segments are at rest in lowered positions.

A subtotal key 16 when operated serves to hold the counters in mesh both during the forward and return stroke of the segments and by so doing insures the return of the counters, after the printing of a total, to their former reading while when the total key is operated the counters will be left at their zero position.

The counters are mounted in the upper part of a frame 17 which frame is pivotally mounted on the shaft 18, and is arranged to be either rocked on said shaft to move the counters into or out of mesh or to be slid on said shaft to bring the different sets of counter elements into operative relation with the segments. A rocking frame 19 which is also pivotally mounted on the shaft 18 is connected to the frame 17 by a shaft 20 and controls the rocking of the frame 17. In an operation of addition the link 21 will engage a pin 22 on the frame 19 and rock the frame outwardly and hold it out during the forward stroke of the operating handle and return the frame and hold it in during the return stroke of the handle. The drive shaft 3 imparts a backward and forward movement to the link 21 through a lever 23 rigid with the shaft 3. The rear end of the link 21 is pivotally mounted on a rocking lever 24 which is pivoted at 25 to the frame of the machine and carries two pins 26 and 27. A pawl 28 mounted on the lever 23 engages the pin 26 at the beginning of the forward stroke of the operating handle and rocks the lever 24 forward and through said lever and link 21 rocks the counters out of mesh. At the beginning of the return stroke of the operating handle the pawl 28 engages the pin 27 and returns the lever 24 to normal position and of course by so doing brings the counters into mesh with the segments so that the amount set up on the keyboard will be added to the counters upon the return of the segments.

A link 29 connects the link 21 with the total key 14 and if the total key is depressed the link 21 will also be lowered so that the hook 30 at the lower forward end of said link will be brought in position to engage the pin 31 on the frame 19. The pin 31 is beneath the pivotal center 18 of the frame 19 and when the hook 30 engages the pin 31 and draws said pin rearward the counters will be moved out of mesh. When the total key is depressed the link 21 being moved to its lowest position, the forward movement of the link 21, when the pawl 28 engages the pin 26, will not affect the position of the counters but when the pawl engages the pin 27 the link 21 will be rocked rearwardly, the hook 30 engaging the pin 31 and through it moving the counters out of mesh and leaving them at the zero position. The counter is brought to zero position in a totalizing operation by means of the segments 36 which backwardly rotate the counter pinions until the lugs 15 engage the pawls 52. The lugs

15 are so positioned on the counter pinions as to stop the pinions at zero when the lugs engage the pawls 52.

The total key 14 is pivotally mounted at 32 and has a downwardly extending arm 33 which is connected by links 34 to a rod 35. This rod 35 extends in under all of the latching pawls 7 and serves to withdraw said pawls from engagement with the counter segments 36 when the total key is depressed.

The total key 14 is held in its upper position as shown in Fig. 2[b] by a coiled spring 129 which is secured, at one end, to the arm 33 of the total key and at its other end to a pin 43 mounted on the frame of the machine. A pin 127 which is mounted on a link 49 extends through a slot in the shank of the total key and a slot in the link 29. It is obvious that the link 49, pin 127 and link 29 must be normally held in the position shown in Fig. 2[b]. The holding means must be of yielding nature however, preferably a spring (not shown), to permit of the proper and under certain conditions independent movement of the parts during manipulations of the keys 14, 16 and 47. The link 29 is hung from said pin and will lower whenever the pin is lowered. The pin 127 is moved downwardly by the depression of either the total key 14, the subtotal key 16, or the subtraction key 47. The depression of the total key will cause said key to engage the pin and lower the same a distance far enough to permit the member 21, which is hung from the link 29, to lower into position for engaging the pin 31 on the counter rocking frame 19. At this position the member 21 will cause the counters to be rocked out of mesh with the actuating segments 36 at the completion of the forward stroke of the segments, when all of the counter pinions have reached zero positions. The segments then return to their upper initial position without engaging the counter pinions, leaving the same at their zero positions. The subtotal key 16 is so connected to the total key 14 that depression of the subtotal key 16 will cause a corresponding lowering of the total key and so cause the pin 127 to be forced downwardly as is done when the total key 14 is alone depressed. The connection between the two keys is effected by the link 39 which is pivoted to the downwardly extending arm 38 of the subtotal key 16 and at 40 hooks over a pin 41 extending from an arm 33 of the total key 14. This connection permits the depression of the total key 14 without affecting the subtotal key 16 while when the subtotal key is depressed it will cause the total key to lower also. Depression of the subtotal key while causing depression of the total key and corresponding lowering of the pin 127 causes the part 46 of the link 39 to move into the path of a pin 45 which is mounted on the link 29 and prevents the link from lowering the full distance it would lower if the total key is depressed. For this reason when the subtotal key is depressed the member 21 will be lowered free of the pin 22 on the counter rocking frame but not far enough to engage the pin 31 on said frame. Thus, depression of the subtotal key 16 moves the lever 21 to an intermediate position where it will neither engage the pin 22 or the pin 31 thus leaving the counters in mesh both during the downstroke of the segments and the return of the segments, the printing of the total taking place when the counters have reached their zero position, which position is determined by the pins 15.

The subtotal key 16 is pivotally mounted at 37. It has, as has been stated, a downwardly extending arm 38 to which is pivoted the link 39, the link 39 having a projection 40 for engaging a pin 41 on the arm 33 and through it releasing the pawls 7 from the segments 36, as is the case when the total key 14 is operated. The link 39 is slotted at 42 to receive a pin 43 which extends from the frame of the machine and upon which the forward end of the link rests. The link is cut away at 44 to allow the passage of the pin 45 on the lever 29 when said lever is permitted to lower by the depression of the total key. When the subtotal key is depressed the link 39 moves rearwardly, the edge 46 of the link moving into the path of the pin 45 and so limiting the downward movement of the link 29 that the hook 30 will not engage the pin 31 and move the counters out of mesh as happens when the total key is depressed.

In operations of addition, when a counter wheel passes the nine position after having made a complete rotation, it records such complete rotation by causing the wheel of next higher denomination to move one unit in a forward direction. All of the counter actuating segments under the action of springs 55 normally urge their respective counter pinions one unit of movement farther in a forward direction, than the counters are rotated in an operation of addition, but are prevented from doing so by the pawls 52 the edges 54 of which are normally in the paths of pins 53 carried by the segments. When a counter wheel passes the nine position the lug 15 carried by the wheel strikes the pawl 52 and forces the same backwardly so that the edge 54 of the pawl will move out of the path of the pin 53 on the next higher segment and allow the segment to move the additional unit and add such unit on its respective counter wheel.

The subtracting mechanism which is part of the present invention will now be described.

The subtraction key 47 like the total key 14 controls the counter rocking mechanism so as to move the counters out of mesh at

the end of the forward stroke of the operating handle. The subtraction key is pivotally mounted at 48 and is connected to the link 29 by a link 49 which carries the pin 127 extending through the slot in the link 29. The link 49 is provided with a slot at its connection with the subtraction key so that the position of the subtraction key will not be affected when the total key 14 is depressed. When the subtraction key is depressed the link 49 draws down the link 29 serving to shift the counters precisely as does the total key, that is leaving the counters in mesh during the downstroke of the segments and out of mesh during the return of the segments.

The subtracting feature of this invention relates chiefly to the method of carrying or transferring from one counter wheel to another, which in a subtracting operation should occur every time a counter-wheel passes from zero to nine when one should be subtracted from the wheel of next higher order. On occasions, for instance, when several wheels read zero and one is subtracted from the lowest wheel reading zero the transfer would occur successively through the several wheels. In adding the same requirements are present, except that the transfers would occur when the counter-wheels pass from nine to zero. The carrying operation from one counter wheel to that of next higher order in operations of addition is accomplished as follows: Each actuating segment 36 carries a pin 53, Fig. 2[a] which pin when no transfer occurs will engage the edge 54 of the corresponding transfer pawl 52 and stop the segment at its normal home position but if the pawl is moved out of the path of the pin 53 the segment will be forced one unit of movement farther, which movement will of course rotate the corresponding counter-pinion one extra tooth space. This extra unit of movement which effects the transfer is accomplished by the springs 55, the slots 56 limiting the action of the springs. In operations of addition if several adjacent wheels stand at nine the transferring if started at the lowest wheel will automatically repeat itself throughout the several wheels, but this could not occur in subtracting operations as to subtract the counters are meshed with the actuating segments during the downstroke of the segments and the transfer pawls do not control extra units of movement of the segments in this direction; therefore if one of the transfer pawls is tripped in a subtracting operation the segments move this extra unit upon their return to home positions. During the return of the segments, the segments are not meshed with the counters, but by an extra operation of the operating handle these additional units of movement are subtracted from the counters on the downstroke of the segments. As far as explained the transfer mechanism used in adding serves in subtraction operations as well, except in cases where one transfer necessitates another. It therefore follows that means should be provided coacting between the several transfer pawls which will, when the counters are in such condition that several of the counter wheels stand at zero and a number has been subtracted from the one of the lowest order, trip the transfer pawls of higher order. The said means are shown in the drawings as auxiliary pawls 51, one for each regular pawl 52. The pawls 51 are engaged and swung rearwardly by the trip pins 15 whenever their respective counter wheels are at zero position. Both the transfer pawls 52 and the auxiliary pawls 51 are hung from the same pivotal centers 57. The two pawls have a slot and pin connection at 58 which permits the independent movement of the pawl 52 but is such that if the pawl 51 is engaged by the pin 15 the pawl 51 will carry with it the main pawl 52 a portion of the distance required to move the projection 54 out of the path of the pin 53.

From the above it will be seen that in a subtracting operation the pawl 52 is caused to be partially tripped whenever the counter pinion arrives at zero, and that it is desirable that it be fully tripped only if the pawl 52 of lower order has been tripped. The pawls 52 in normal position stand in the way of pins 59 on the arms 60 of the cam members 61. The members 61 are urged rearwardly by the springs 62 but are normally prevented from such movement both by the pawls 52 and the projections 63 on the auxiliary pawls 51. This being the case, if one of the counter-wheels is backwardly rotated so that its pin 15 engages the auxiliary pawl 51 and thereby moves the projection 63 below the edge 64 of the cam-arm 65 and if the pawl 52 of lower order is tripped and moved out of the path of the pin 59, the member 61 will be free to rock under the action of the spring 62 and cam the auxiliary pawl 51 of higher order a farther distance which is enough to complete the tripping of its companion pawl 52. It will be noted that the auxiliary pawls 51 are only used in subtracting operations in which transfers carried from wheels of lower order necessitate transfers from wheels of higher order. For instance when several adjacent wheels stand at zero and a number has been subtracted from the wheel of lowest order a carrying operation through the several higher wheels will be necessary. The camming action of the members 61 is therefore only desirable in a subtracting operation. A stop 107 normally in the path of an extension 108 of one of two arms 70 permits only a limited backward swing of the mem-

bers 61 and prevents the above described camming of the pawls in an operation of addition. The subtraction key is designed to move the stop 107 out of the path of the extension 108 so that the members 61 will be free to swing rearwardly a distance sufficient for camming the pawls. The stop 107 is an extension of the member 121ª which member is forced downwardly upon the depression of the subtraction key against the tension of a spring (not shown). The lower edge of the subtraction key engages a pin 125 on the member 121ª to effect this movement. The members 61 also serve to hold such transfer pawls as are tripped in their tripped positions until after the carrying operation has been completed, the members 61 being restored to normal position upon the next operation of the machine.

As has been stated transferring in a subtracting operation is effected by a second operation of the operating handle while in an operation of addition only one operation of the machine is necessary both for adding an amount on the counters and effecting any carrying operations as may be necessary. For the above reason it is desirable in operations of addition to restore such of the members 61 as were released in a preceding operation at the completion of each forward stroke of the handle while in an operation of subtraction said members should not be restored until the operating handle has been twice brought forward. Mechanism is provided which is an operation of addition restores the members 61 at the completion of one stroke of the operating handle while when the subtracting key is depressed the mechanism will not restore the members 61 until the operating handle has been twice operated. This mechanism comprises in part the member 66 which is hung from the rearwardly projecting end 67 of the subtraction key by a link 82 and is connected at its forward end to a lever 68. The lever 68 is pivotel at 69 from which point it has two upwardly extending arms 70 which arms carry a rod 71 extending across the rear of projections 72 of the members 61. With the above construction it will be seen that by rocking the lower end of the lever 68 rearwardly such of the members 61 as have been displaced will be returned to normal position. A pin 109 mounted on the arm 23 extends through a slot 73 on the member 66, and in the position in which the part 66 is shown in the drawing, which is its normal position in an operation of addition, the pin 109 would strike the end 74 of the slot 73 and therebv rock the member 66 sufficiently to restore the members 61 at the completion of the forward stroke of the operating handle. By the depression of the subtraction key 47 the member 66 will be raised so that the elongated part 75 of the slot 73 will come into the path of the pin 109. The pin will therefore not shift the members 66 rearwardly to restore the members 61 at the first operation of the operating handle but will strike the pawl 76 pivoted at 84 on the arm 82, and disengage it from the pin 77 on the arm 66 and allow said arm to lower into normal position so that upon the next operation of the operating handle the pin 109 will strike the part 74 of the member 66 and also the pawl 78. The pawl 78 is pivoted at 77 on the arm 66 and at 79 is pivotally connected to a bell-crank lever 130, the other arm of which has a projecting pin 80 which when the subtraction key is depressed rides over the end of a hook 81, holding the arm 66 raised and also locking the subtraction key in its depressed position. When the pin 109 strikes the pawl 78 the bell-crank lever 130 is rocked so that the pin 80 will move free of the hook 81 releasing the subtraction key and allowing the arm 82 to be restored to normal position (the position shown in the drawings) by the spring 83 which is secured at one end to the arm 82 and at its other end to the shaft 131. Arm 82 is pivoted at 132 to the arm 67 of the subtraction key. At its lower end it straddles the pin 77 on the arm 66. A hook 85 which is pivoted at 84 to the arm 82 will when the subtraction key is depressed engage the pin 77 and raise the arm 66 for the purpose already described.

In order to prevent depression of the total key 14 or the subtotal key 16 during a subtracting operation the downwardly extending arm of the subtraction key is connected by a link 133 to the arm 117 which is pivoted at 112 and which will when the subtraction key is depressed swing on its pivot 112 so that the upper end of the arm 117 will move into the path of the pin 220 on the total key and prevent depression of the total key.

The operation of the subtracting mechanism may be briefly described as follows: First before a subtracting operation the main operating handle is brought forward and returned so that any transfer pawls or segments which may have been moved from normal position by a transfer operation will be returned to normal position. When the main operating handle is operated for this purpose, the cam 4 (Fig. 3) is caused to lower the frame 5 upon which the segment carrying arms 6 rest. The segment carrying arms are then free to lower under the action of their springs 134 and to carry with them, back to normal position, any of such actuating segments as have been moved the extra unit upward in a transferring operation. A printing of the total may then be taken so as to preserve a record of the reading of the counter before an amount is subtracted from the same. The value keys representing the amount it is desired to sub-

tract from the counter and the subtraction key 47 are then depressed. The value keys control the extent of downward movement of the counter actuating segments in operations of subtraction the same as in operations of addition but as the subtraction key is depressed the counter will be caused to mesh with the actuating segments during the downstroke of the same instead of during the return stroke as in operations of addition. This will cause the counter to be rotated in a backward direction an amount corresponding to the amount represented by the depressed value keys. If any of the counter pinions should pass from zero to nine they would trip their respective transfer pawls 52 and then upon the return of the actuating segments when the counter is out of mesh the tripped pawl would permit the segment which operates the next higher counter wheel to move up an extra unit. The said extra unit of movement will then be subtracted from the higher counter wheel upon a second operation of the machine. When one transfer makes another transfer necessary in subtracting operations the cam members 61 serve to communicate the movement from pawl to pawl as the counter wheels do in operations of addition. Detail of amounts subtracted are printed when the segments are at rest in lowered positions as is the case in operations of addition. The extent of lowering of the segments and corresponding setting of the type carriers is always controlled by the value keys except in totalizing operations when the pins 15, which ordinarily serve to trip the transfer pawls act as stops for the segments. In order to obtain the result of a subtracting operation upon the detail strip the machine is operated as is usual for a total or subtotal printing.

Two sets of counter wheels, 86 and 87 are shown in the drawings and as explained are all mounted on the same shaft 20 with the wheels of like denominations adjacent. The counters are slidable on the shaft 20 with the frame 17. Centrally located on the frame 17 is a projecting pin 88. One end of a forked lever 89 straddles the pin 88 the other end of the lever being pivoted at 90 to the frame of the machine. The lever 89 can be swung on its pivot 90 for the purpose of shifting the counter frame so as to bring one or the other set of counter wheels into operative relation with the racks 36. A spring pressed alining plunger 91 engages notches 92 in the frame 17 in either of its positions. The lever 89 is rocked by means of the main operating handle of the machine but a shifting key 93 controls the position of intermediate mechanism between the lever 89 and the main operating handle of the machine and by positioning said mechanism controls the shifting of the counters upon the operation of the main operating handle. The reason for shifting the counters by means of the main operating handle instead of directly from the key 93 is that the counters are normally in mesh with the actuating racks when the machine is at rest as shown in Fig. 2, while in an ordinary operation of addition the counters are out of mesh during the forward stroke of the operating handle. It is in this second position of the counters that they may be most easily shifted. The key 93 positions the counter shifting mechanism through a bell-crank lever 96 which is connected by a link 97 to a lever 98 and is adapted to swing the same on its pivot 106. The lever 98 is adapted when moved in a longitudinal direction to engage one or the other of pins 99 or 100 on lever 101, which is pivoted at 102. The forward end 103 of the lever 101 is connected by a link 104 to the before described lever 89 by means of which the counters are shifted. Longitudinal movement is imparted to the lever 98 by means of a cam 105 rigidly mounted on the main drive shaft 3 of the machine.

It will be remembered that in a subtracting operation the counters are left in mesh during a forward stroke of the operating handle and for this reason means are provided which will prevent the depression of the counter shifting key 93 when the subtraction key 47 is in its depressed position. The means mentioned comprise a flange 94 on the subtraction key 47 which when the subtraction key is depressed passes in under a pin 95 on the counter shifting key 93 and prevents its depression.

In totalizing the type at the rear of the arms 6 are positioned through a backward rotation of either of the counters to zero positions, the pins 15 serving to stop the counter pinions at zero. To stop the pinions at zero, means connected to the total key are provided for swinging the pawls 52 forward so that edges 110 of said pawls will be moved into the path of the pins. The total key for the above reason is connected to a frame 111 and is arranged to rock said frame and through it the pawls 52. The frame 111 is rigidly mounted on the shaft 112 upon which is also secured a crank arm 113 which is connected by a link 114 to a lever 115. The lever 115 is in turn connected by a link 116 to the arm 33 of the totalizing key. It will be seen from the above that when the total key is depressed the pawls 52 will be locked in the paths of the pins 15 until the total key is released.

The members 117 and 118 with the rod 119 constitute a frame which will be rocked rearwardly by the plates 8 when any of the amount keys are depressed. The plates 8 are each provided with a lug which extends down into position for engaging the rod 119

so that if any of the plates 8 are cammed rearwardly by the depression of an amount key the rod 119 will also be carried rearward and with it the members 117 and 118. The purpose of the frame is to prevent the depression of the totalizing key when any of the amount keys are depressed. A pin 120 on the totalizing key will engage the member 117 and prevent the complete depression of the key if the frame has been rocked rearward.

Two sets of counter pinion alining pawls 121 and 122 are loosely mounted on the shaft 18. The set 121 is mounted in alinement with the pinions 86 and the set 122 in alinement with the pinions 87. The alining pawls have rearwardly extending parts 124 which rest on a rack or toothed member 123 (see Fig. 2.) One set of pawls rest in the notches formed by said teeth while alternate pawls forming the other set rest on top of the teeth. The rack 123 is stationary while the pawls move with the counters when the same are longitudinally shifted, and when the counters are shifted the parts 124 of the pawls will engage the teeth on the rack 123 and so reverse the position of the pawls disengaging the pinions which are moved into mesh and engaging those which are moved out of mesh.

The subtraction feature of this invention is very serviceable in connection with the multiple counter construction shown, for example credit accounts may be added on one counter while debit accounts are added on the other counter and then the total amount of one counter may be quickly subtracted from the total amount of the other counter.

Attention is called to the fact that the transfer pawls 52 (see Figs. 2 and 4) are beveled on both sides at the points of contact with the pins 15 so that the pins will cam the pawls into tripped position when engaging the same in either direction of rotation. Ordinarily the pawls 52 of the Burroughs machine are beveled at the points of contact with the pins 15 on the underside only, the upper surface being substantially radial to the shaft 20 so that when the counter pinions are rotated in a forward direction the pins 15 will cam the pawls 52 for transferring but when the counters are backwardly rotated as in a totalizing operation the pins 15 will engage the upper unbeveled surface of the pawls and stop the counter pinions at the zero position.

One feature of this invention is that the machine may be set by depressing or releasing the counter shifting key 93 and setting up an amount on the key-board so that a single operation of the machine will both shift the desired set of counters into operative position and add thereon the amount set up on the keyboard. As shifting from one counter to another takes place near the completion of the downstroke of the counter actuating segments and as in operations of addition the counters are not meshed with the segments except during the return stroke of the same no interference between the counter shifting mechanism and the counter actuating mechanism will occur in such combined operations. The counter shifting key 93 is normally held in its upper position by the spring 135 (Fig. 5) which is secured at one end to the counter shifting lever 98, its other end being secured to the frame of the machine. The key 93 may be retained in its depressed position if slightly pushed rearward when depressed so that the notch 136 in the shank of the key will engage the edge of the slot in the plate 137 through which the key passes. When it is desired to release the shifting key a slight forward movement thereof will carry notch 136 away from its holding plate 137 when spring 135 will immediately elevate the key.

Two sets only of counter wheels are shown in this case, but as in a total printing machine it is not necessary that the counter elements should bear numbers, it is clearly possible to insert either one or two additional counters making three or four in all by using mere accumulating gears, having each a transfer tooth and not providing the numbered wheels. The segment racks in the machine are spaced apart a distance sufficient to permit this addition. Evidently with three or four counters a different form of shifting device would be required.

While the form of mechanism herein shown and described is admirably adapted to fulfil the objects primarily stated, it is to be understood that it is not intended to confine the invention to the one form of embodiment herein shown and described, as it is susceptible of embodiment in various forms, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In an accounting machine the combination with a plurality of accumulating devices, of means for rotating said devices in both directions, carrying members arranged to carry units of movement from an accumulating device of lower order to an accumulating device of higher order, lugs carried by the accumulating devices and arranged to trip the carrying members in both directions of rotation of the accumulating devices, and means for locking the carrying members against movement when engaged by said lugs.

2. In an accounting machine the combination with actuating mechanism, of accumulating devices, carrying members for the accumulating devices, means under the control of the accumulating devices for partly actuating the carrying members in a carrying operation. and cams, one for each carrying

member and operated only when the corresponding carrying member is partially actuated, to complete the actuation of such carrying members as have been partly actuated.

3. In an accounting machine the combination with actuating devices of a plurality of sets of counters mounted in axial alinement, means for moving said counters in an axial direction, so as to bring different sets of counters into operative relation with the actuating devices, said means being actuated by the main operating shaft of the machine, and a manipulative device for determining the direction of movement of said means.

4. In an accounting machine the combination with actuating devices of a plurality of sets of counters, means for bringing different sets of counters into operative relation with the actuating devices, said means being actuated by the main operating shaft of the machine, and a manipulative device for determining the direction of movement of said means.

5. In an accounting machine, the combination with multiple counters of actuating devices, counter shifting mechanism for moving different counters into operative relation with the actuating devices, said actuating devices being differentially movable and normally engaging the counters in one direction of movement only, a subtraction key for causing the actuating devices to engage the counters in the opposite direction, and means under the control of the subtraction key for preventing operation of the counter shifting mechanism.

6. In an accounting machine, the combination with a counter of actuating mechanism, carrying devices, means for tripping the carrying devices, a locking device for holding the carrying members in their tripped position, means for releasing the carrying devices from the locking device at the end of an operation of the machine, and a manipulative device which regulates said means so as not to operate until the end of a second operation of the machine.

7. In an accounting machine, the combination with a plurality of differentially movable actuators and carriers therefor, the actuators having an increment of movement independent of the carriers, pawls normally preventing such independent movement of the actuators, wheels movable into and out of engagement with the actuators and having projections to displace said pawls upon complete rotation of the wheels in either direction, means for reversing the order of engagement and disengagement between the actuators and the wheels to provide for movement of the wheels in either direction by the actuators, latches for holding the pawls displaced, and means under the control of the wheels of lower order and actuated by the latches for displacing pawls cooperating with the wheels of higher order.

8. In an accounting machine, the combination with a plurality of differentially movable actuators and carriers therefor, the actuators having an increment of movement independent of the carriers, pawls normally preventing such independent movement of the actuators, wheels movable into and out of engagement with the actuators and having projections to displace said pawls upon complete rotation of said wheels in either direction, means for reversing the order of engagement and disengagement between the actuators and the wheels to provide for movement of the wheels in either direction by the actuators, latches for holding the pawls displaced, and devices, carried by the pawls and actuated by the latches under the control of wheels of lower order, for displacing the pawls coöperating with wheels of higher order.

9. In an accounting machine, the combination with a plurality of differentially movable actuators and carriers therefor, the actuators having an increment of movement independent of the carriers, pawls normally preventing such independent movement of the actuators, wheels movable into and out of engagement with the actuators and having projections to displace said pawls upon complete rotation of said wheels in either direction, means for reversing the order of engagement and disengagement between the actuators and the wheels to provide for movement of the wheels in either direction by the actuators, movable latches for holding the pawls displaced, devices for limiting the movement of the latches, and means, carried by the latches, for actuating the limiting devices for the purpose of displacing the pawls coöperating with the actuators of wheels of higher order for effecting successive transfers in an operation of the machine for subtraction.

10. In an accounting machine, the combination with a set of accumulating wheels and actuators therefor, of means for connecting the wheels and actuators and driving the former by the latter in different directions, dependent on whether it is desired to actuate the wheels for addition or for subtraction, means for moving the actuators an additional increment of movement for the purpose of effecting transfers in both addition and subtraction, pawls normally preventing the additional movement of the actuators and constructed to be displaced by the accumulating wheels, latches for holding the pawls displaced, and devices under the control of the wheels of higher order and actuated by the latches for displacing the pawls coöperating with said wheels of higher order in an operation of the machine for subtraction.

11. In an accounting machine, the combination with a set of accumulating wheels and actuators therefor, of means for connecting the wheels and actuators and driving the former by the latter in different directions, dependent on whether it is desired to actuate the wheels for addition or for subtraction, means for moving the actuators an additional increment of movement for the purpose of effecting transfers in both addition and subtraction, pawls normally preventing the additional movement of the actuators and constructed to be displaced by the accumulating wheels, latches for holding the pawls displaced, means for restoring the latches during each operation of the machine for addition, and means for preventing the operation of the restoring means when an item of subtraction is entered until the succeeding operation of the machine.

12. In an accounting machine, the combination with a set of accumulating wheels and reciprocatory actuators therefor, of means for engaging the wheels and actuators while the latter are moving in one direction for the purpose of accumulating the sum of various items on said wheels, a depressible subtraction key, means for latching said key in depressed position, means controlled by the subtraction key for reversing the time of engagement between the accumulating wheels and the actuators when an item is to be subtracted from said wheels, and means for operating the latching means for said key upon an operation of the machine following that in which the item is subtracted for the purpose described.

13. In an accounting machine, the combination with a set of accumulating wheels and reciprocatory actuators therefor, of means for engaging the wheels and actuators while the latter are moving in one direction for the purpose of accumulating the sum of various items on said wheels, means controlled by the wheels for recording the total accumulated on said wheels, a subtraction key and means controlled thereby for releasing the time of engagement between the accumulating wheels and the actuators when an item is to be subtracted from said wheels, and means requiring an extra operation of the machine after each subtraction operation before the total can be recorded.

14. In an accounting machine, the combination with a set of accumulating wheels and actuators therefor, of means for connecting the wheels and actuators and driving the former by the latter in different directions, dependent on whether it is desired to actuate the wheels for addition or for subtraction, means for moving the actuators an additional increment of movement for the purpose of effecting transfers in both addition and subtraction, pawls normally preventing the additional movement of the actuators and constructed to be displaced by the accumulating wheels in either direction of movement of said wheels, a total key, and means controlled thereby permitting the actuators reversely to rotate the wheels to zero and thereby to position type carriers for recording the total, and means controlled by the total key for preventing the displacement of pawls so as to arrest the wheels at zero.

15. In an accounting machine, the combination with a set of accumulating wheels and actuators therefor, of means for connecting the wheels and actuators and driving the former by the latter in different directions, dependent on whether it is desired to actuate the wheels for addition or for subtraction, means for moving the actuators an additional increment of movement for the purpose of effecting transfers in both addition and subtraction, devices normally preventing the additional movement of the actuators and constructed to be displaced by the accumulating wheels in either direction of movement of said wheels, type carriers for recording amounts added to or subtracted from the accumulating wheels, a total key, means controlled thereby permitting the actuators reversely to rotate the wheels to zero whereby the type carriers are positioned to record the total, and means positively operated by the total key for preventing displacement of the devices for preventing additional movement of the actuators so as to insure the arresting of the accumulating wheels at zero.

16. In an accounting machine, the combination with a set of accumulating wheels and actuators therefor, of means for connecting the wheels and actuators and driving the former by the latter in different directions, dependent on whether it is desired to actuate the wheels for addition or for subtraction, means for moving the actuators an additional increment of movement for the purpose of effecting transfers in both addition and subtraction, devices normally preventing the additional movement of the actuators and constructed to be displaced by the accumulating wheels in either direction of movement of said wheels, type carriers for recording amounts added to or subtracted from the accumulating wheels, a total key, means controlled thereby permitting the actuators reversely to rotate the wheels to zero whereby the type carriers are positioned to record the total, and a bail positioned by the total key for preventing displacement of the devices for preventing additional movement of the actuators so as to insure the arresting of the accumulating wheels at zero.

17. In a machine of the class described, the combination with a main operating mechanism, of a plurality of totalizers, a

set of actuators common thereto, means for automatically establishing operative relation between said actuators and any desired totalizer during an operation of the machine, alining devices for each totalizer, and means for rendering inoperative the alining devices of the totalizer in operative relation with the actuators and for rendering operative the remainder of said alining devices.

18. In a machine of the class described, the combination with a main operating mechanism, of a plurality of totalizers mounted in lateral alinement, a set of actuators common thereto, means for shifting automatically said totalizers during an operation of the machine for the purpose of establishing operative relation between said actuators and any desired totalizer, alining devices for each totalizer, and means for rendering inoperative the alining devices of the totalizer in operative relation with the actuators and for rendering operative the remainder of said alining devices.

19. In a machine of the class described, the combination with a main operating mechanism, of a plurality of totalizers mounted in lateral alinement, a set of actuators common thereto, means for automatically shifting said totalizers during an operation of the machine for the purpose of establishing operative relation between said actuators and any desired totalizer, alining devices for each totalizer, and means so controlling the alining devices that the devices corresponding to the totalizer in operative relation with the actuators are withdrawn from engagement with said totalizer while the other alining devices are in engagement with their respective totalizers.

20. In a machine of the class described, the combination with a main operating mechanism, of a plurality of totalizers mounted in lateral alinement, a set of actuators common thereto, means for shifting said totalizers for the purpose of establishing operative relation between said actuators and any desired totalizer, alining devices for each totalizer and movable therewith, and a stationary cam plate so controlling the alining devices that when one of the totalizers is brought into operative relation with the actuators its alining devices are withdrawn while the other devices are brought into engagement with their respective totalizers.

21. In a machine of the class described, the combination with a plurality of totalizers mounted in lateral alinement, of a set of reciprocatory actuating racks common thereto, manipulative means for variously limiting excursions of said racks, means for engaging a selected totalizer with the racks during movement of the same in one direction and disengaging said totalizer from the racks during movement of the latter in the opposite direction, means for automatically shifting the totalizers while disengaged from the actuating racks for the purpose of selecting the totalizer that is to be engaged with the actuating racks, alining devices for each totalizer, and means for rendering inoperative the alining devices of the totalizer brought into engagement with the actuating racks and for rendering operative the remainder of said alining devices.

22. In a machine of the class described, the combination with a plurality of totalizers mounted in lateral alinement, of a set of reciprocatory actuating racks common thereto, manipulative means for variously limiting excursions of said racks, means for engaging a selected totalizer with the racks during movement of the same in one direction and disengaging said totalizer from the racks during movement of the latter in the opposite direction, means for automatically shifting the totalizers while disengaged from the actuating racks for the purpose of selecting the totalizer that is to be engaged with the actuating racks, alining devices for each totalizer and movable therewith, and means for rendering inoperative the alining devices of the totalizer brought into engagement with the actuating racks and for rendering operative the remainder of said alining devices.

23. In a machine of the class described, the combination with a plurality of totalizers mounted in lateral alinement, of a set of reciprocatory actuating racks common thereto, one of said totalizers being normally in engagement therewith, manipulative means for variously limiting excursions of said racks, mean for first disengaging the totalizer from the racks and then shifting the totalizers while the racks are being adjusted under the control of the manipulative devices and finally engaging the selected totalizer with the adjusted racks and returning the latter to normal position thereby actuating the selected totalizer, alining devices for each totalizer, and means for rendering inoperative the alining devices of the totalizer brought into engagement with the actuating racks and for rendering operative the remainder of said alining devices.

In testimony whereof I affix my signature in the presence of two witnesses.

CHARLES F. KETTERING.

Witnesses:
ROY C. GLASS,
CARL W. BENST.

Corrections in Letters Patent No. 1,166,527.

It is hereby certified that in Letters Patent No. 1,166,527, granted January 4, 1916, upon the application of Charles F. Kettering, of Dayton, Ohio, for an improvement in "Registering Mechanism," errors appear in the printed specification requiring correction as follows: Page 12, line 44, claim 20, before the word "shifting" insert the word *automatically;* same page and claim, line 45, after the word "totalizers" insert the words *during an operation of the machine;* and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 8th day of February, A. D., 1916.

[SEAL.]

R. F. WHITEHEAD,

Acting Commissioner of Patents.

Cl. 235—60.