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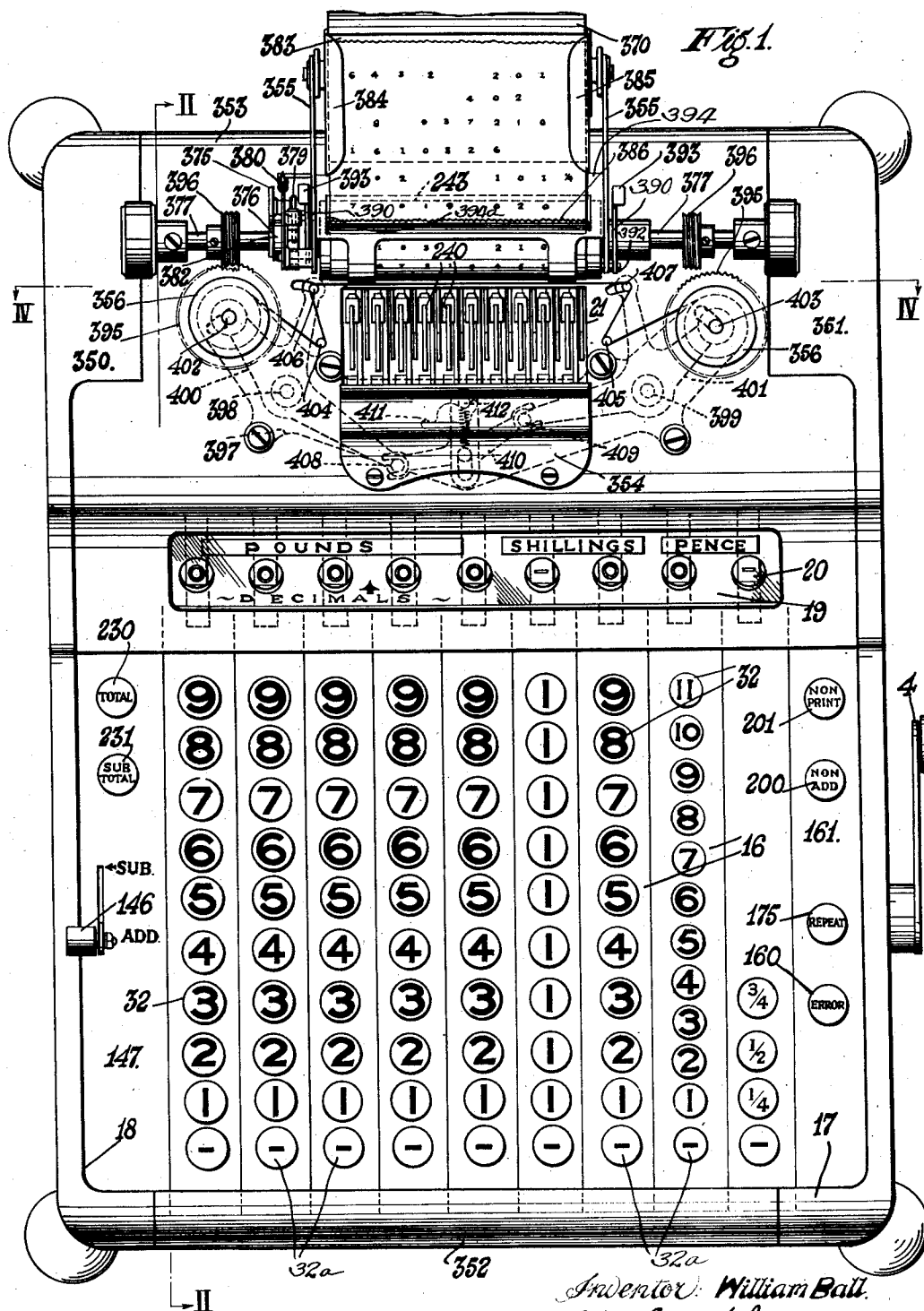
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1,930,870

CALCULATING MACHINE

Filed May 31, 1930

10 Sheets-Sheet 1



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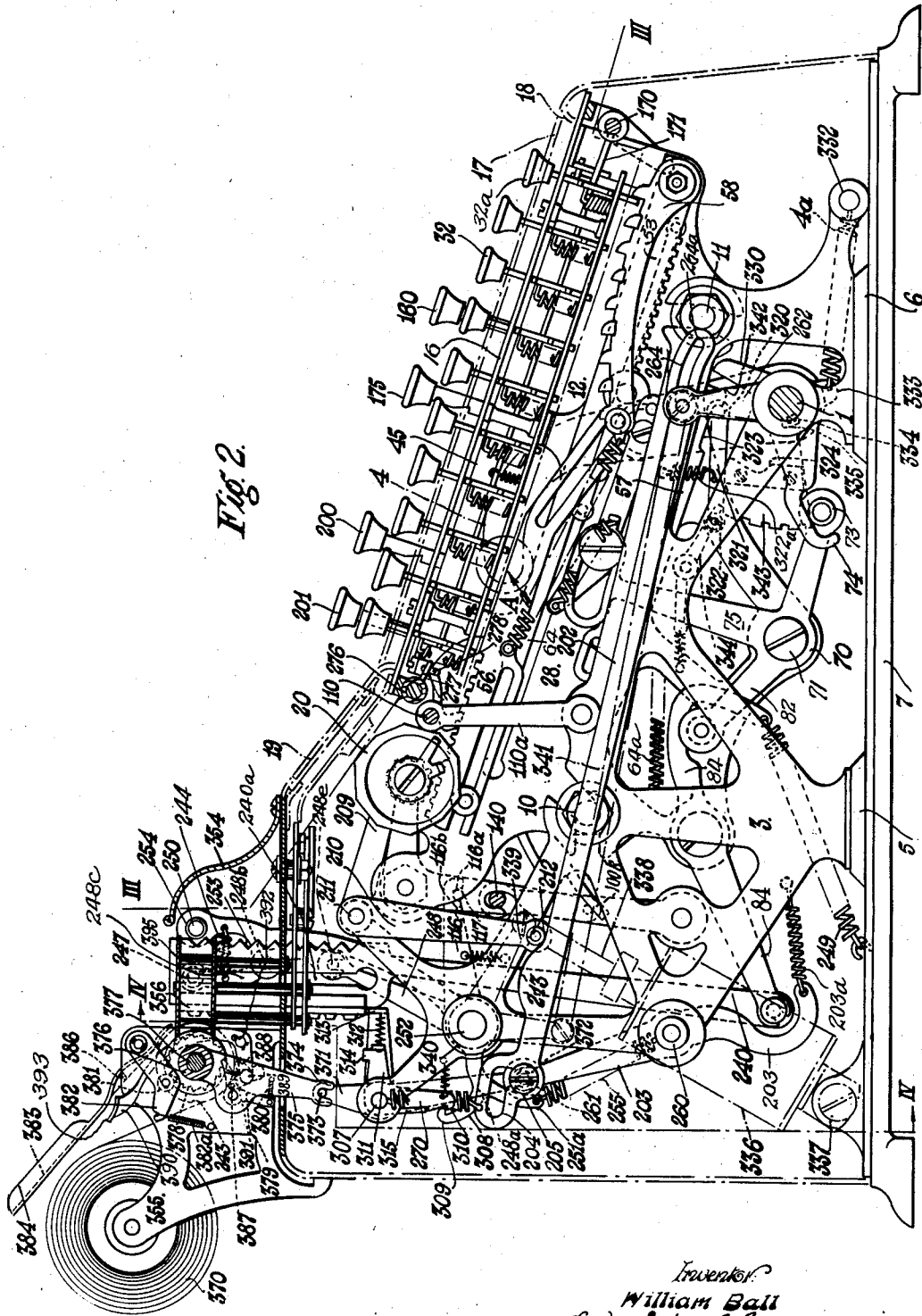
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CALCULATING MACHINE

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10 Sheets-Sheet 2



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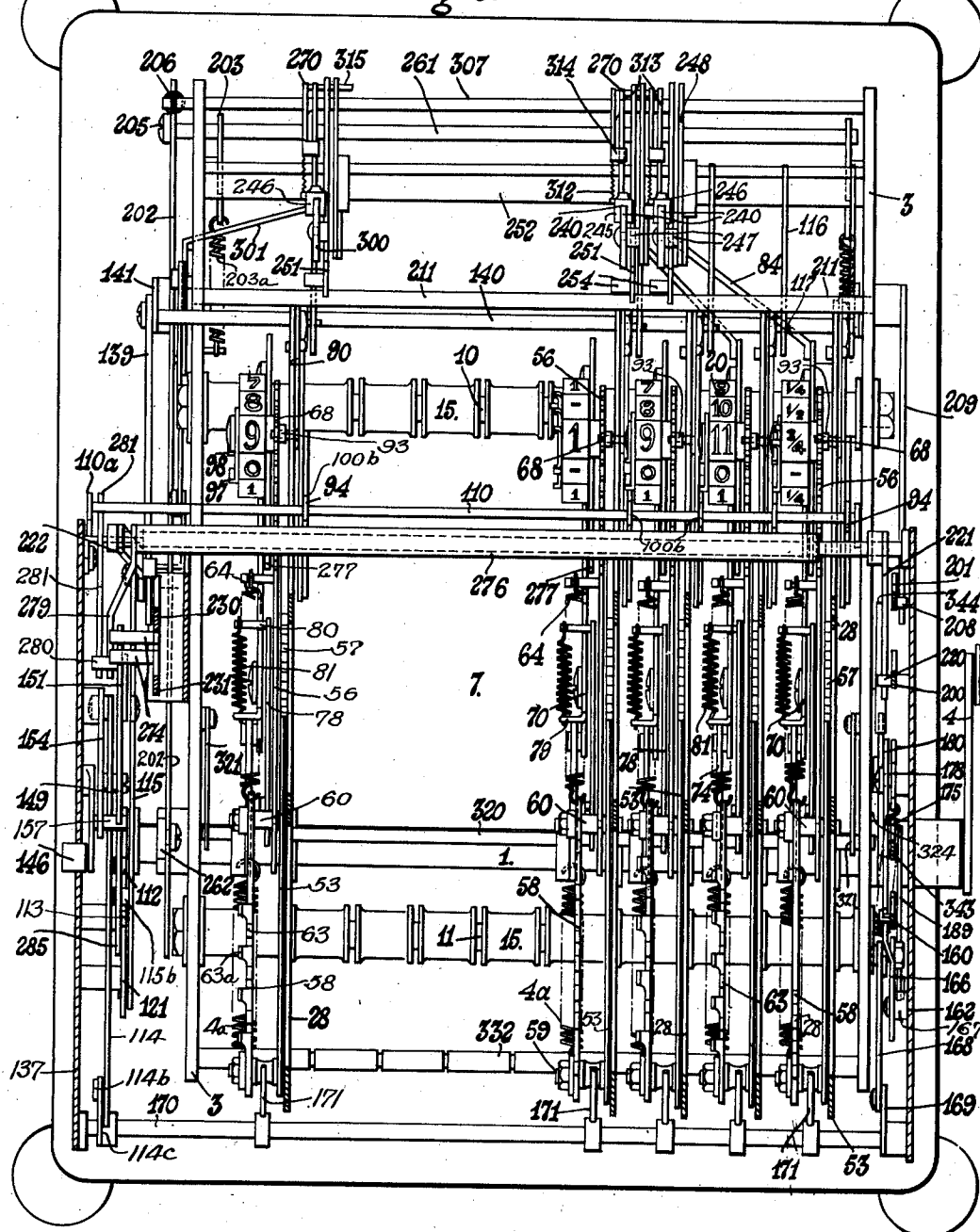
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CALCULATING MACHINE

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Fig. 3.



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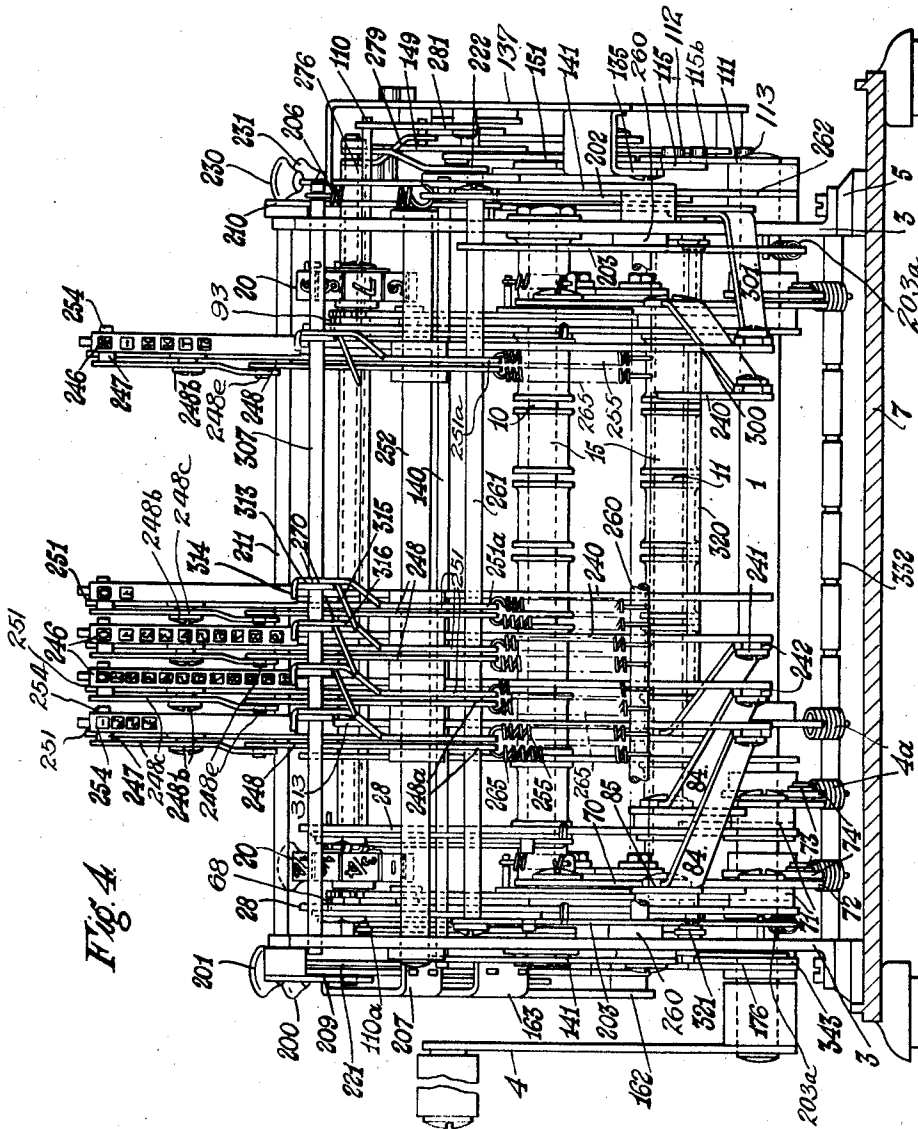
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CALCULATING MACHINE

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10 Sheets-Sheet 5



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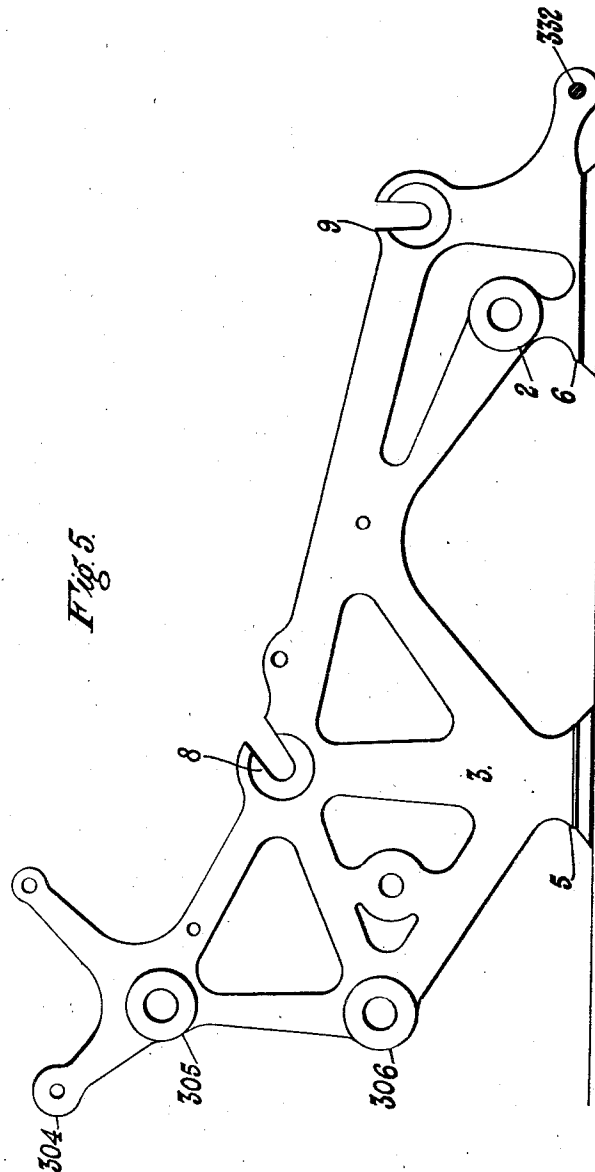
Oct. 17, 1933.

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CALCULATING MACHINE

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1,930,870

10 Sheets-Sheet 6



In witness whereof
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Oct. 17, 1933.

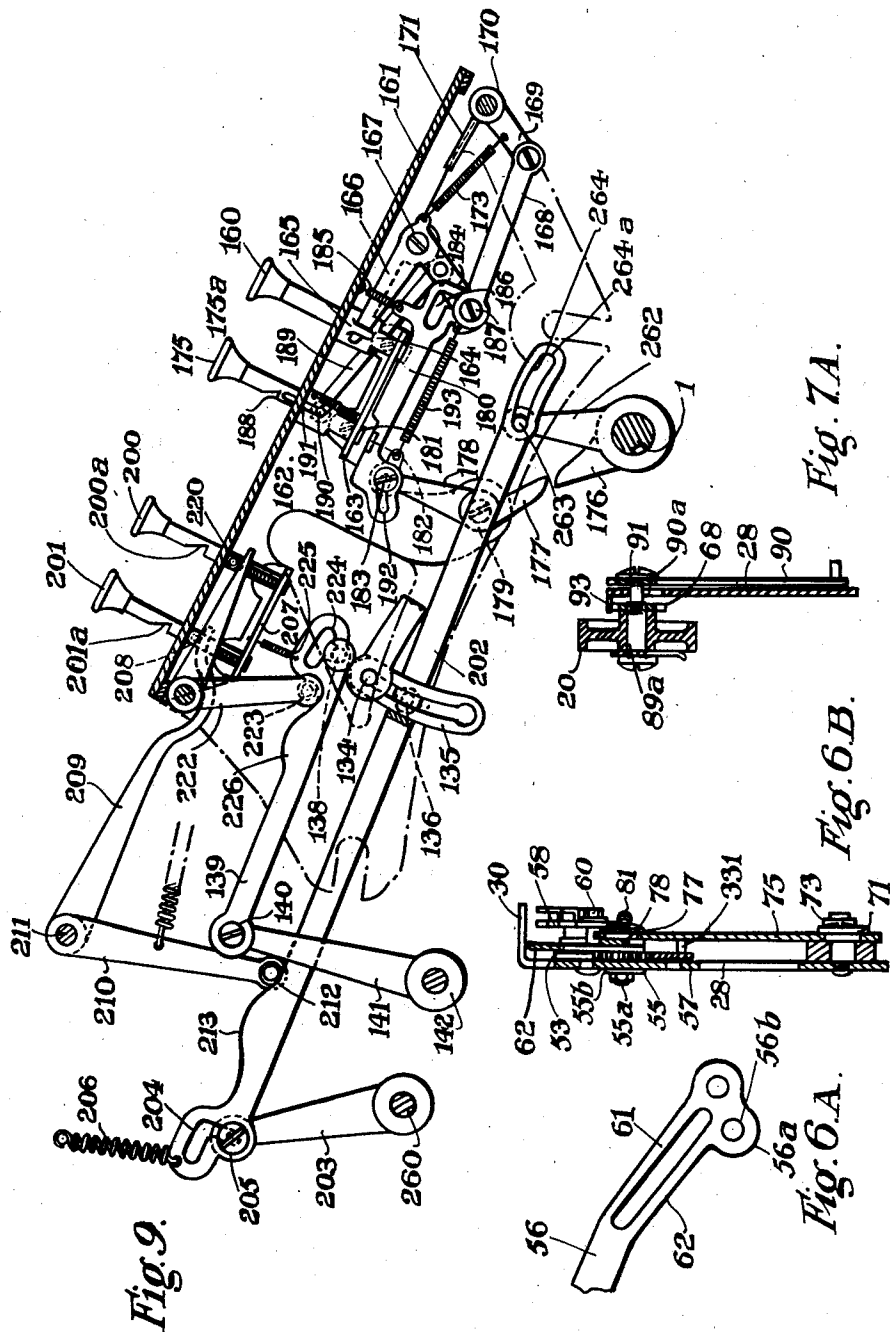
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CALCULATING MACHINE

Filed May 31, 1930

10 Sheets-Sheet 8



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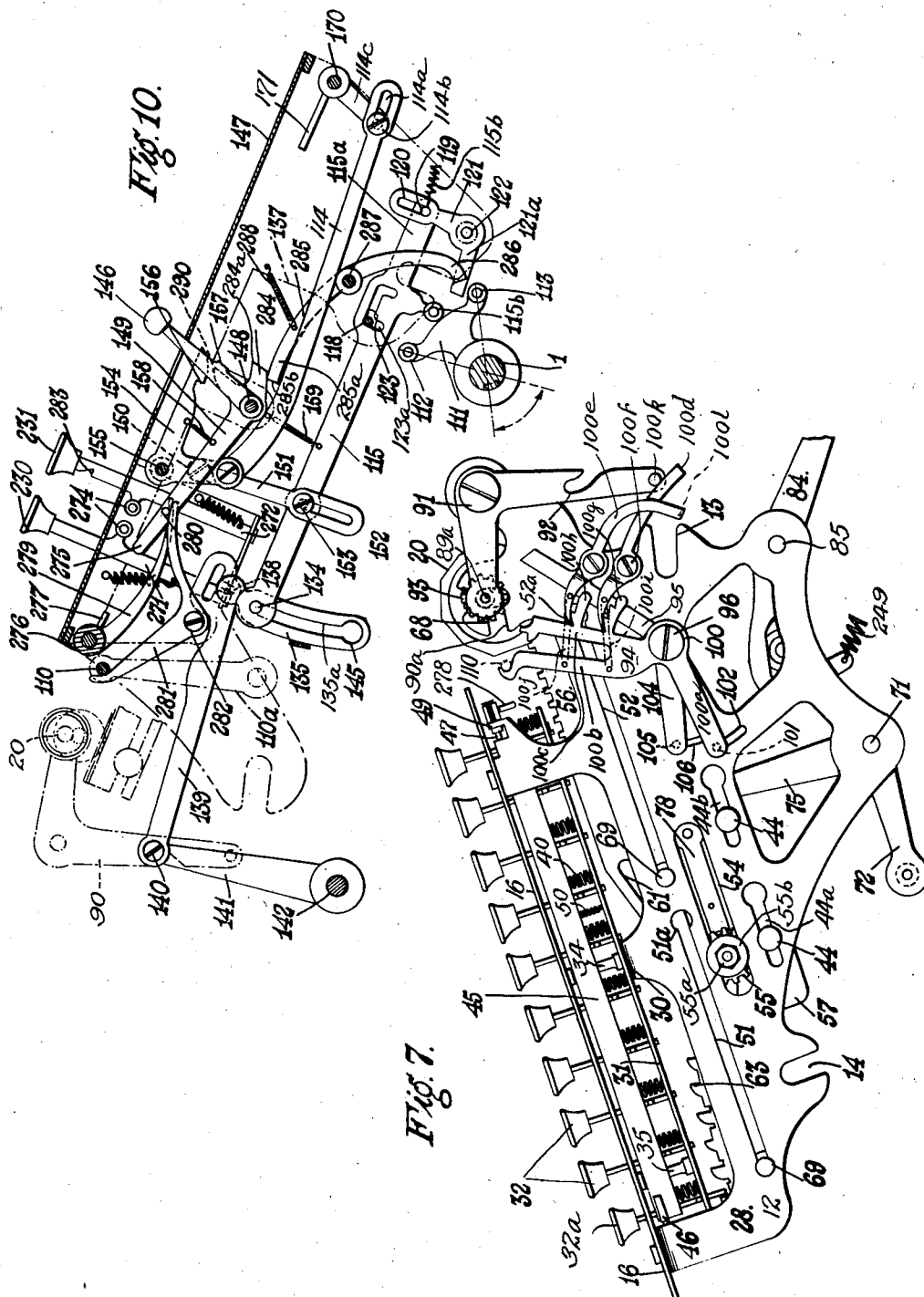
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1,930,870

CALCULATING MACHINE

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10 Sheets-Sheet 9



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CALCULATING MACHINE

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10 Sheets-Sheet 10

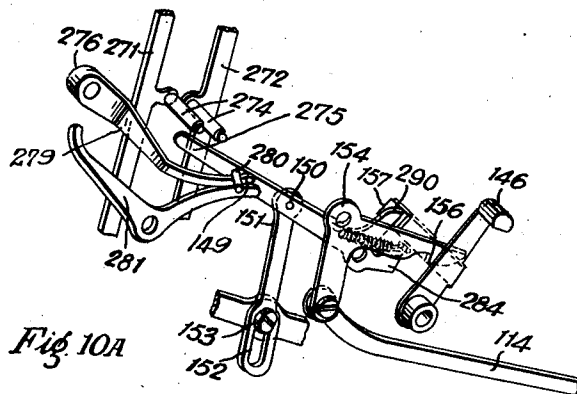


Fig. 10A

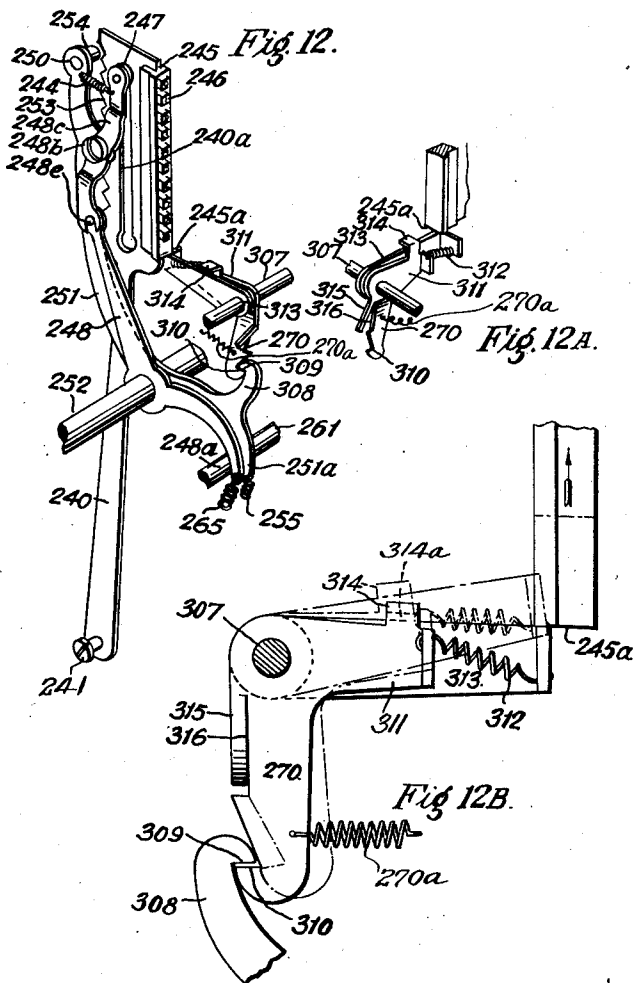


Fig. 12.

Fig. 12A.

Fig. 12B.

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UNITED STATES PATENT OFFICE

1,930,870

CALCULATING MACHINE

William Ball, Wallington, England, assignor, by direct and mesne assignments, to British Adding and Calculating Machines, Limited, London, England

Application May 31, 1930, Serial No. 458,629, and in Great Britain June 14, 1929

8 Claims. (Cl. 235—60)

This invention relates to calculating machines of the kind wherein differentially geared actuating and setting mechanism is employed for the totalizer wheel of each denominational section of a machine, such mechanism being shown, for example, in my U. S. patent specification Serial No. 243,660 and in British Patent No. 288,672, wherein the actuating member for each totalizer wheel is differentially movable with respect to the associated setting element.

The chief object of the invention is to provide an improved construction of machine wherein manufacturing and assembling operations are facilitated and machines of different capacities and machines arranged for calculating in different systems may be readily assembled as desired, and, further, such a construction in which adjustments and examination of parts during assembly are reduced to a minimum.

According to the invention a calculating unit for a calculating machine comprises a plate hereinafter termed a stretcher plate, carrying in combination differentially geared actuating and setting mechanism for a denominational totalizer wheel, a main operating member for said mechanism formed for detachable connection with the main shaft of the machine, a totalizer wheel arranged for actuation by said mechanism, a key column with which said mechanism is arranged to cooperate, and transfer mechanism adapted for co-operation with the totalizer wheel of an adjacent unit.

In a preferred embodiment the stretcher plate of a unit is provided with open housings arranged for receipt by a carrying frame.

A machine constructed according to the invention comprises an assembly of such calculating units mounted on bearer rods extending transversely of a pair of side mounting frames, said bearer rods carrying spacing means such as washers, interposed between each unit to give lateral rigidity to the machine.

By providing such a unitary machine wherein each unit includes all the main elements of a denominational section, the units being complete in themselves, it will be seen that the capacity of the machine can be readily varied as desired, and in a preferred embodiment wherein the stretcher plate of each unit is provided with the open housings, each unit may be readily detached and replaced or interchanged with another unit as desired, without in any way interfering with the remaining units.

The invention will be further described with reference to the accompanying drawings, where

a preferred form of calculating and listing machine is illustrated by way of example, and where:

Fig. 1 is a general plan of the machine;

Fig. 2 is a vertical section on the line II—II of Fig. 1; and Fig. 2A is a detailed part perspective view showing the stretcher plate of a calculating unit, and more particularly the means for resetting the transfer rack of a unit;

Fig. 3 is a sectional plan taken on the line III—III of Fig. 2;

Fig. 4 being a sectional elevation looking from the rear taken on the line IV—IV of Figs. 1 and 2;

Fig. 5 shows a suitable main frame, such a frame being duplicated at each side of the machine and the calculating mechanism being carried between them.

Fig. 6 is a view from the left of a calculating unit detached, the column showing nine numeral keys in addition to the column release key at the extreme right hand end and corresponding to one of the pounds columns in the machine in the preceding figures;

Fig. 6A is a detailed view of a part of the actuating rack associated with the differentially geared actuating and setting mechanism of a calculating unit as shown in Fig. 6;

Fig. 6B is a detailed sectional view on the line 6B—6B of Fig. 6 with the keyboard section removed;

Fig. 7 is a corresponding view from the right of the calculating unit shown in Fig. 6, the type bar being omitted and the totalizer wheel shown disengaged from the actuating rack to indicate clearly the normal position of the totalizer wheel when the unit is mounted in the machine;

Fig. 7A is a detailed view taken from Fig. 7 showing the means for locking a totalizer wheel in set position;

Fig. 8 an end view of a calculating unit.

Fig. 8A is a detail sectional perspective view of the front end of the unit only with the column release key omitted and showing more particularly the construction of the stubs of the numeral keys and the staggering of the abutments on the setting rack;

Fig. 9 is a detailed section of the side plate carrying the non-add, non-print, repeat and error keys and their associated mechanism, which plate is preferably located at the right of the machine.

Fig. 10 is a corresponding detailed view of the other side plate, which carries the total and subtotal keys and the change-over control from addition to subtraction or vice versa; while

- Fig. 10A is a detail perspective view taken from Fig. 10 of the mechanism associated with the total and sub-total keys and change-over controls, the parts being shown assembled, but slightly separated for clearness;
- Fig. 11 is an enlarged right hand end view of Fig. 6 showing only the column release key in depressed condition, and the associated clearing bar which co-operates with all the keys in the section;
- Fig. 11A is a similar view to Fig. 11 with the column release key in a non-depressed released condition;
- Fig. 11B is a detail perspective view of the clearing bar;
- Fig. 12 is a perspective constructional view of a single type bar and its associated pressure printing and non-print devices looking from the left of Fig. 4;
- Fig. 12A is a detail perspective view of a non-print device from the right of Fig. 4; and
- Fig. 12B is a diagrammatic view showing the operated and non-operated positions of a non-print device.
- Although the machine is readily adaptable to power operation, the preferred form illustrated has been shown as hand operated.
- Referring now to the drawings, but first more particularly to Figs. 1 to 5, the main operating shaft is identified by the numeral 1 and is carried in bushings 2 on each of the main side frames 3, see more particularly Fig. 5, an operating handle 4 keyed to the shaft 1 projecting at the right, as customary.
- Each side frame 3 is provided with a pair of seats 5 and 6 by which they are rigidly secured to a base plate 7, the lateral dimensions of which are dependent on the number of columns within the capacity of the machine.
- The machine illustrated is a nine column machine as used extensively, although it will be understood that by a simple variation in the size of the base plate 7 the capacity of the machine can be readily varied, as hereafter clearly explained.
- The side frames 3 are identical, and each is provided with a pair of open housings 8 and 9 arranged to receive hardened steel bolts 10 and 11 running the width of the machine, and serving to carry an assembly of calculating units 12, one of which is shown in Figs. 6, 7 and 8, and each of which is provided with open housings 13 and 14 adapted to fit over the bolts 10 and 11.
- As is clearly shown in Fig. 1, the keyboard is constituted by a number of separate key sections or columns 16, each of which forms part of and is controlled by the mechanism of a unit 12 and a series of spacing washers 15 (see Figs. 3 and 4) of dimensions corresponding to the width of each section 16 of the keyboard are arranged along the bolts 10 and 11 to fixedly locate the several units.
- As clearly shown in Fig. 1, 17 is a dished metal cover provided with an aperture 18 for the keyboard, and a window or series thereof 19, through which the totalizing wheels 20, one of which is associated with each unit 12, may be seen, the cover shown being also provided with a further aperture 21 to accommodate the printing section hereafter described.
- Referring now more particularly to Figures 6, 7 and 8, where one of the detachable units 12 forming the main feature of the present invention is illustrated, 16 is a keyboard section as beforementioned, being secured by bolts or rivets to the outturned flanges 26 and 27 of the stretcher plate 28 forming the foundation of the unit 12.
- This stretcher plate 28, as clearly shown in Figures 6 and 7 and also in Fig. 2A, is a plain stamping of sheet metal, blanked and pierced to carry the various parts of the calculating mechanism of the unit, and flanged at 30 to carry a guide plate 31, through which the stubs of the keys of the section project.
- The guide plate 31 is also tied to the top plate 16 by pillars 33, 34 and 35, whereby substantial rigidity of the unit is attained, and the numeral keys 32 and the column release keys 32a both have flat shanks 36 passing through aligned lateral slots 37 and 38 in the top plate and guide respectively.
- To provide a flexible keyboard, i. e. one in which depression of a key in a column clears any other key which has been depressed in the same column, a description will now be given of the construction of the keys and of the means employed for releasing a depressed key in a column.
- With continued reference, therefore, to Figs. 6, 7, and 8, and more particularly to Figs. 11, 11A and 11B, it being understood that the construction of the numeral keys 32 is similar to that of the column release key 32a, shown in Figs. 11 and 11A, each key shank 36 of the keys of each column or section 16 is provided with an outstanding lug 39, on the flat face of the shank, with which lug a compression spring 40 fixed to the guide plate 31, is connected, so that the key is normally pushed upwardly by the spring 40 to lie adjacent the under-side of the top plate 16.
- On both the side edges of each key shank 36 two projections 42, 42a are formed, one for limiting the upward movement and the other for limiting the downward movement of the key, while a cam surface 41 and a recess 41a are also provided for co-operating with a clearing bar 45 extending the length of the keyboard section 16.
- The clearing bar 45 is substantially of channel or L-shape section (see Fig. 11B) and is pivotally mounted on the stretcher plate 28 by means of cylindrical extension pieces 46 and 47 respectively mounted in bearings formed in inturned flanges 48 and 49, one at each end of the stretcher plate 28 and adjacent the top plate of the keyboard section 16.
- As shown in Fig. 11A, when a key is not depressed the short arm 45a of the clearing bar 45 bears against the lower portion of the cam surface 41 on the key shank 36 by means of a tension spring 50, fixed to the guide plate 31 and connected to the short arm 45a substantially centrally of the clearing bar 45 (see Fig. 6), but on depression of the key (see Fig. 11), the cam surface 41 causes the clearing bar to rock to the right about its pivotal axis until the recess 41a is reached, when the short arm 45a snaps into the recess to retain the key in the depressed condition against the compression in its spring 40.
- Thus, with the numeral keys 32 in undepressed condition, and the associated column release key 32a depressed as shown, for example, in Fig. 6, the short arm 45a engages with the cam surfaces 41 on the numeral keys and with the recess 41a in the column release key, but upon depression of a numeral key the consequent rocking of the clearing bar disengages the short arm 45a from the recess 41a in the column release key so that the latter restores by means of its spring 40.
- Similarly, if another numeral key is depressed, or the column release key again operated either

manually or automatically, as explained hereafter, the depressed numeral key will be restored by the consequent rocking of the clearing bar, or as is described hereinafter in connection with

- 5 a total or sub-total taking operation, if a key in a column is in a depressed condition and the associated clearing bar 45 is rocked by the operation of the sub-total or total key, the depressed key will be restored.
- 10 By this arrangement, therefore, a flexible keyboard is obtained whereby unwanted depression of any two keys in a column is prevented, and, further, all the keys in a column may be restored as desired to facilitate the setting of
- 15 the machine.

With reference now more particularly to Figs. 6 and 7, the stretcher plate 28 is provided with a number of slots 51, 52, 54, 44a and 44b, which form guides for mounting a differentially geared actuating and setting rack mechanism for the

20 totalizer wheel 20, this mechanism including a linearly movable pinion for operating the racks, and the arrangement being such that the actuating rack is adapted to move differentially with respect to the associated setting element.

This differentially geared mechanism including the linearly movable pinion is similar to that described in my United States patent specification No. 1,742,053 and again employed in the

30 arrangement described in my United States patent specification (Serial No. 243,660), and comprises an upper normally movable rack 53 provided with headed pins 69 riding in the slots 51, 52, a normally stationary lower rack 57, hereafter, referred to as the transfer rack, provided with headed pins 44 riding in the slots 44a and 44b, and an actuating rack 56 formed with a slot 66 engaging with a headed pin 67 mounted on the stretcher plate 28.

40 The mechanism also includes a rising setting rack 58 for co-operating with any key in the associated column, as will be described subsequently.

The linearly movable pinion designated 55 is mounted on the stretcher plate 28 by means of a bolt 55a riding in the slot 54, a nut and washer 55b maintaining the pinion in position on the plate 28 and the pinion engaging with both the upper and lower racks 53 and 57 respectively, and being connected to and mounted on the actuating rack 56 by means of the bolt 55a which, before being mounted in the slot 54, is first passed through a hole 56b in a downward extension 56a at the right hand end of the rack 56 (see Figs. 6 and 6A).

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It will be seen that with this arrangement the movement of the upper rack 53 is in all cases double that of the pinion 55 when the transfer rack 57 is stationary, and consequently double the movement of the actuating rack 56.

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In this manner well spaced keys to each column or section of the keyboard may be attained without the actuating and setting mechanism being unduly large, and as hereinafter described, transfer may be effected through the mechanism during the setting of the totalizer wheels in a manner similar to that described in patent specification Serial No. 243,660 referred to above.

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With reference now to the setting rack heretofore mentioned, in contradistinction to either of the constructions disclosed in the prior specifications heretofore referred to, in the present arrangement a rising setting rack 58 to each differentially geared actuating and setting mechanism is employed, the forward end of which is

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pivoted at 59 to the upper rack 53, while the other end is provided with a stub 60 arranged to ride in an inclined guide slot 61 formed in the body 62 of the actuating rack 56, the arrangement being such that during the movement of the differentially geared actuating mechanism from the zero position illustrated the setting rack 58 rises towards the keyboard by means of the guide slot 61, it being understood that since the upper rack 53, and therefore the setting rack 58, gains on the actuating rack 56 the stub 60 on the rear end of the setting rack 58 will be caused to ride up the inclined slot 61 in the actuating rack 56, to bring the setting rack into co-operation with a key which may be depressed in the associated column.

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In the prior specifications heretofore referred to, a single stop or abutment was mounted on the upper moving rack for co-operating with any depressed key in the column, which resulted in the travel of the upper rack being unduly large, and in considerable impact arising between the abutment and a depressed key, especially if such key was of a high numerical value, but according to this arrangement the provision of a separate setting member rising towards a depressed key considerably reduces the impact against the key and enables the travel of the upper rack 53, and consequently of the setting rack 58, to be reduced, and, further, it is possible to use a separate stop or abutment 63 for each key of the column, whereby the wear on any individual abutment is considerably reduced, and the durability and freedom from adjustment of this part of the counting mechanism ensured by reducing the impact between the setting rack abutments 63 and the keys.

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The abutments 63, are arranged so that the forward or right hand abutment 63, seen in Fig. 6, co-operates with the 0 or column release key, the second abutment with the 1 key, and so on, the last or left hand abutment co-operating with the 8 key, and the end of the slot 61 in the actuating rack 56 being employed as the final or 9 abutment corresponding with the full travel of the setting rack 58, and thereby eliminating the necessity for a further abutment on such setting rack, although, if desired, of course such an abutment could be provided to co-operate with the stub of the 9 key.

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64 is a coil spring connected between the end of the setting rack 58 and a pin 65 on the actuating rack 56 which spring actuates the transfer rack 57 for addition transfer, and also renders the differentially geared actuating and setting mechanism substantially self-acting by reason of the fact that the spring is normally in tension, as will be explained later.

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It will be understood that for a pence column twelve keys will be provided, and correspondingly eleven or twelve abutments 63, according to whether the end of the slot 61 is employed as a limit, and that the number of keys and co-operating abutments is adapted to the requirements of each particular case, the particular unit illustrated being one of the pounds columns of the pounds, shillings and pence machine illustrated as the preferred embodiment.

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The elements of the differentially geared actuating and setting mechanism are shown in the normal or zero position, the 0 or column release key at the right of the column being depressed and engaging its abutment to maintain the setting rack 58 and the remainder of the mechanism therein.

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Movement of the differentially geared actuating and setting mechanism after a key 32 has been depressed is controlled from the main operating shaft 1 of the machine through a main operating member constituted by a rocker 70 pivoted to a shouldered pin 71 at the foot of the stretcher plate 28, and having three arms, the first 72 being provided with an anti-friction roller 73 which when the unit is assembled in the machine abuts with a control arm 74 (see Figs. 2 and 6) on the main operating shaft 1, the roller, if permitted tending to follow the arm 74 under spring action as hereafter explained during the initial stroke of the handle 4, which, as customary, is in the direction of the arrow A in Figs. 2 and 6.

A second arm 75 forms the operative connection with the pinion 55 of the differentially geared actuating and setting mechanism, being formed with a slotted end 76 in which rides a pin 77 carried by a link 78 in turn carried on the pivot 55a of the pinion 55 (see Figs. 6 and 6B).

A pin 79 on the arm 75 and a second pin 80 on the link 78 are connected by a coil spring 81, which normally maintains the pin 77 to the right of the slotted end 76 as shown, the lost motion provided by the slotted end 76 enables such operations as clearing of the keyboard and resetting of displaced transfer racks to be accomplished after the setting racks have been returned, whilst the spring 81 also ensures that the setting rack 58 is maintained in the normal position during depression of the column release keys to clear the keyboard towards the end of the ultimate return stroke of the main shaft, as will be hereafter explained.

It will be noted that the position of the rocker 70 and of the pin in the slotted end 76 thereof, as shown in the drawings, is that when the handle 4 has been moved slightly forward without a key being depressed. Thus, if the handle is restored the slotted end would move across the pin 77 until the latter abuts against the opposite end to that shown, this slotted end herefore providing a lost motion to ensure proper zeroizing and to eliminate spacing strokes with regard to resetting displaced transfer racks, as hereafter explained. It will be further noted, however, that when the pin 77 is at the opposite end of the slotted end 76, the spring 81 is under tension, thus enabling the lost motion to be taken up upon the handle again being moved forward.

A third arm 82 completes the rocker 70, and is provided with an anti-friction roller 83 which cooperates with an oscillating lever 84 pivoted to the stretcher plate 28 at 85 to actuate the printing mechanism hereafter described.

Assuming the calculating unit now being described to be assembled in the machine, then to enable the roller 73 to follow the arm 74 and the differentially geared actuating and setting mechanism to be substantially self-acting, the spring 64, in the normal position of the mechanism, is under tension so that when the setting rack 58 is unlocked, by releasing the column release key 32a, and the handle 4 is moved forward, the setting rack 58, the actuating rack 56 and the pinion 55 together with the rocker 70 automatically move rearwardly due to the tension in the spring 64, the roller 73 thus following the arm 74, and the rate of the movement of the parts being governed by the movement of the handle. During the return stroke of the handle 4, the arm 74 abuts against the roller 73 to move the rocker 70 forwardly and thereby restores the actuating

and setting mechanism against the tension of the spring 64. To facilitate the automatic movement of the parts and also to cause movement of the transfer rack 57 for a subtraction transfer as subsequently described, a further tension spring 64a is provided connected between points on the stretcher plate 28 and the rocker 70, or the spring 64a, may be used in place of the spring 64.

Further assuming that in place of the column release key shown depressed in Figure 6 the 8 key is depressed and the operating handle 4 turned in the direction of the arrow A, the setting rack 58 and the actuating rack 56' will move to the left (Figure 6), the rocker 70 turning in an anti-clockwise direction as the arm 74 rotates away from the roller 73, until the respective abutment 63, i. e. the left hand one, engages the stub of the 8 key, when the further movement of the actuating rack will be arrested and the arm 74 will leave the roller 73.

In this position the actuating rack 56 will have moved a space equivalent to eight facets of the totalizer wheel 20, and if the wheel 20 through its pinion 68 be then engaged with the actuating rack 56 and the operating shaft 1 returned to its initial position the totalizer wheel would show a reading corresponding with the item set up in the key column, i. e. the number 8.

The operation will be more fully described with reference to the complete machine, but it will be noticed that the unit 12 of which the stretcher plate forms the base is in itself a one column calculator.

With reference to Figs. 7 and 7A, the totalizer wheel 20 of a unit is carried on a spindle 89a mounted on a bell crank 90, and moving within a slot 90a in the stretcher plate 28, the bell crank 90 is pivoted to the stretcher plate 28 at 91, and is arranged for actuation by a common bar hereafter referred to, which engages a slot 92 in said bell crank 90 to throw the totalizer wheel 20 into engagement with the actuating rack 56 during its return stroke for addition, and during its forward stroke for subtraction, the totalizer wheel 20 being normally held out of engagement with the actuating rack 56, and its setting being held by a lug 93 which projects from the left face of the stretcher plate 28 and forms a locking and alignment pawl by engaging the teeth of the pinion 68 of the totalizer wheel 20 (see more particularly Fig. 7A).

The spindle 89a normally abuts against the top face of the slot 90a and upon the bell crank 90 being operated to engage the totalizer wheel 20 with the actuating rack 56, the spindle 89a moves until it abuts against the lower face of the slot 90a. This slot, therefore, determines the radial movement of the bell crank arm carrying the totalizer wheel 20 and the mesh of the pinion 68 of said wheel with the actuating rack 56.

With the exception of the addition and subtraction transfer mechanisms, which are illustrated in Figure 7 and generally designated 94 and 95 respectively, this completes the mechanism carried by the stretcher plate 28 and forming one unit 12 which can be very easily produced cheaply and in large numbers.

As appears more clearly from Figs. 6 and 7 the slots 51 and 52 in the stretcher plate 28 are arranged of greater length than the travel of the rack 53, and their extremities are provided with apertures 51a and 52a respectively, through which the heads of the pins 69 which carry the rack 53 can pass and the rack thereby be removed

or fitted, suitable spacing washers being provided preferably integral with the pins of standard thickness throughout the machine, to reduce the friction where desirable.

5 Similarly, the heads 44 of the pins carrying the lower or transfer rack 57 and riding in the slots 44a and 44b, can pass through similar apertures in the stretcher plate 28, and in this manner assembly of the unit 12 or replacing of any parts is greatly simplified.

10 With reference more particularly to Fig. 8A, in order to increase the clearance between the teeth 63 of the setting rack 58 and the stubs of the numeral keys 32 alternate teeth of the setting rack are staggered as shown at 63a, and the stubs of alternate keyshanks 36 are correspondingly staggered as at 43.

20 Thus, the outer stubs will co-operate with the staggered abutment 63a while the inner stubs will co-operate with the normal abutments, so that in this way, as the setting rack rises towards a depressed key, the abutment corresponding to the next higher numeral key is permitted to pass the depressed key. This arrangement allows of a longer abutment being employed, so that more positive co-operation with the keys results whilst permitting abutments of higher numeral keys to pass a depressed lower numeral key without interference.

30 In Fig. 3 the setting racks 58 respectively associated with the farthings and tens of shillings totalizer wheels 20 are shown with the normal teeth 63 only, since the number of effective keys required for the columns associated with these totalizer wheels will be small, and consequently the travel of the respective setting racks will be correspondingly limited; the setting racks associated with the remaining totalizer wheels are shown with the staggered abutments as described above.

40 As an alternative to staggering the abutments on the setting rack, two or more of such racks may be provided, each having abutments for the keys with which it is to co-operate.

45 By the provision of such a setting rack or racks increased clearance of the key stems is obtained and the durability and freedom from adjustment of this part of machine improved by giving a clearance adequate to take up any wear in the parts.

50 Reverting, again more particularly to Figures 2 and 3, each of the units 12 making up the calculating portion of the machine is arranged with addition and subtraction transfer mechanisms, previously generally referred to under the designations 94 and 95, and each comprising a pair of bell crank levers mounted on a common pivot 96, (see Fig. 7).

60 Each totalizer wheel 20 is provided at its left side (see Figures 2 and 6) with a pair of lugs 97 and 98, herein called the addition transfer lug and the subtraction transfer lug respectively. These lugs co-operate with the transfer mechanisms 94 and 95 of the left adjacent unit 12, i. e. the unit of next higher denomination, so that on a totalizer wheel 20 changing from 9 to 0 during addition, or from 0 to 9 during subtraction, the respective transfer mechanism 94 or 95 of the next higher denomination is actuated to add or subtract one, as the case may be, from its totalizer wheel 20.

70 This transfer is effected, as previously mentioned through the medium of the lower and normally stationary transfer rack 57 of the next higher denomination by the mechanism now to

be described, which is substantially in accordance with that disclosed in patent specification Serial No. 243,660.

80 With reference now to Fig. 7, the addition transfer mechanism 94 of each unit 12, which it will be more convenient to describe first, includes a three armed bell crank 100 having one arm 100a arranged substantially at right angles to the forking arms 100b and 100c and pivoted at 96 to the right face of the stretcher plate 28, the arm 100a carrying a pin 101 projecting through a slot 102 in the stretcher plate and engaging a co-operating notch 103 in the transfer rack 57 (see Fig. 6).

90 Normally the pin 101 engages the notch 103 and locks the transfer rack 57 in its neutral mid position. When an addition transfer is to be effected, the addition transfer lug 97 on the totalizer wheel 20 of next lower denomination, which to do this must be passing from 9 to 0, engages the shorter arm 100c and rocks the bell crank 100 so that the pin 101 moves down the slot 102 and out of engagement with the notch 103, whereat by movement of the pinion 55 by the rocker 70 and, under the action of the spring 64, the transfer rack 57 moves forwardly and permits the actuating rack 56 to turn the totalizer wheel 20 one tooth space in the direction of addition, whereby the next higher numeral reading is shown thereon.

95 The subtraction transfer 95 is also mounted on the common pivot 96 and includes a second bell crank 104 carrying a pin 105 passing through a slot 106 in the stretcher plate 28, and engaging a co-operating slot 107 formed in the transfer rack 57 (see Fig. 6).

100 The slot 107 includes a pair of offset lateral branches 108, 109, the pin 105 normally lying at the head of the slot 107 adjacent the branch 108 in abutment with the wall 108a terminating this branch, so that on the locking pin 101 of the addition transfer being removed from its notch 103 the transfer rack 57 is permitted to move by reason of the branch 108 passing along the pin 105, the dimensions of this branch being such as to permit a movement of the transfer rack 57 corresponding to one tooth space of the actuating rack 56.

105 As shown in Figure 7, two retaining pawls 100d and 100e are provided for retaining the transfer mechanisms 94 and 95 in their operative positions when either addition or subtraction transfer is effected. The retaining pawl 100d is pivoted at 100f to the stretcher plate, while the retaining pawl 100e is pivoted, as shown, to the bell crank 104 of the subtraction transfer mechanism 95, the bell crank 100 of the addition transfer mechanism 94 being provided with a pair of outstanding lugs 100g and 100h formed with ratchet teeth for engaging respectively with the retaining pawls 100d and 100e. The pawls 100d and 100e are maintained in engagement with their respective ratchet teeth by means of springs 100i and 100j connected between points on the pawls and the bell crank 100, the spring 100j also serving to bring the subtraction transfer 95 into a condition for subtraction transfer when the bell crank 100 is rocked by a bail 110 (see Figs. 2, 3, 7 and 10) actuated from the subtraction key hereafter referred to.

145 When the machine is set for addition, the addition transfer mechanism 94 is as shown in Figure 7, and thus, when the bell crank 100 is rocked for an addition transfer, the retaining pawl 100d drops into the first of the ratchet teeth on the

lug 100g to maintain the bell crank in its rocked position.

When the machine is conditioned for subtraction, as will hereafter be described, the bail 110 engaging with the arm 100b of the bell crank 100 is caused to rock the latter about the pivot 96, so that the pin 101 moves down the slot 102, and by reason of the spring 100j the bell crank 104 of the subtraction transfer mechanism 95 is simultaneously rocked about the pivot 96, thereby moving the pin 105 past the branch 109 down to the bottom of the slots 106 and 107. Thus, although the transfer rack 57 has been released by the pin 101, it is still maintained in its normal position by reason of the pin 105 engaging with the transfer slot 107 in the transfer rack.

Since the bell crank 104 of the subtraction transfer mechanism has been rocked about the pivot 96 as explained above, the right-hand arm of the bell crank will be in a position to engage the transfer lug 98 of the next lower denominational totalizer wheel 20. When, therefore, a subtraction transfer is to be effected, which is when the said wheel is passing through 0 to 9, the lug 98 engages with the right-hand arm of the bell crank 104 to rock the latter and bring the pin 105 opposite the branch 109 whereby the transfer rack 57 may be permitted to move to the left, or rearwardly, the branch 109 running along the pin 105, until it is engaged by the wall 109a so that the actuating rack 56 is moved one tooth space in the direction of subtraction. This movement is prevented until after printing has taken place, as will be explained hereinafter.

It will be noted here, however, that when a subtraction transfer has been initiated, the pawl 100e will be engaging with the ratchet tooth on the lug 100h, and since the pawl 100d is already engaging with the second tooth on the lug 100g by reason of the rocking of the bell crank 100 by the bail 110, both the subtraction and addition transfer mechanisms will be retained in operative position.

Thus, for an addition or subtraction transfer, the totalizer wheel pinion 68 will be moved one tooth space either to the rear or forwardly, as the case may be. To effect this the relative movement between the different racks of the differentially geared actuating and setting mechanism is as follows:—

It will be clear from the preceding description of such mechanism that there is a 2 to 1 ratio between the upper rack 53 and the pinion 55 when the transfer rack 57 is stationary; consequently, if transfer, either addition or subtraction as the case may be, is effected when the upper rack 53 is stationary, the transfer rack 57 will become the moving rack with a 2 to 1 movement, whereas if transfer is effected when the upper rack is moving, both upper and transfer racks 53 and 57 will move simultaneously, thereby neutralizing the 2 to 1 movement.

It will be noted that the dimensions of the branches 108 and 109 in the transfer rack 57 are such as to permit of the 2 to 1 movement of the transfer rack.

It will be seen from the above that transfer either for addition or subtraction can be effected any time during the setting of the totalizer wheels 20, although in the latter case transfer is withheld until after printing has taken place for the reasons stated hereafter.

It will be understood that the actuating rack 56 being in engagement with the totalizer wheel 20 during the forward stroke only for subtraction,

and during the rearward stroke only for addition, the resetting of the transfer rack 57 at the end of the return stroke for addition only will not affect the totalizer wheel 20, as it is out of engagement with the actuating rack 56, as will be hereafter explained.

The means employed for resetting the transfer rack 57 to normal if such rack has been displaced, will also be explained subsequently, but it will be noticed that when the transfer rack has effected a subtraction transfer, that is moved to the left during the forward stroke, it is brought back to its normal position by movement of the pinion 55 during the return stroke, and is retained in said position by the left-hand wall of the slot 107 abutting against the pin 105, until such time as it is latched by the pin 105 or pin 101.

It may be mentioned here, however, that when the totalizer wheel 20 is brought out of engagement with the actuating rack 56, the consequent rocking of the bell crank 90 causes the pin 100k thereon to abut against the pawl 100d, if transfer has taken place.

If the machine is set for addition, this will disengage the pawl 100d from the first tooth on the lug 100g, and thus allows the bell crank 100 to be restored by the tension in the spring 100i.

On the other hand, if the machine is set for subtraction, that is the pawl 100d is engaging with the second of the ratchet teeth on the lug 100g and a subtraction transfer has been effected, in which case the pawl 100e will be engaging with the ratchet tooth on the lug 100h, and an outstanding lug 100i on the pawl 100e will be engaging with the pawl 100d, then upon the pin 100k of the bell crank 90 abutting against the pawl 100d, the pawl 100e will be disengaged from its ratchet tooth, and if the bail 110 has been restored, both transfer mechanisms 94 and 95 will be restored to normal, as shown, through the tensions in the springs 100i and 100j respectively, and the pin 101 on the bell crank 100 will consequently engage in the notch 103 in the transfer rack 57 to lock the same.

The bail 110 remains in the subtraction position for the return stroke of the handle, so that during this stroke the addition transfer mechanism 94 is maintained in subtraction operative position.

It will thus be seen that when the transfer rack 57 is restored during the return stroke, the bell crank 104, due to the pawl 100e being disengaged, will rock in an anti-clockwise direction by the tension in the spring 100j, so that the pin 105 moves down to the bottom of the slot 106 and the slot 107 in the transfer rack 57 to lock the latter in normal position and condition the bell crank 104 for effecting a subtraction transfer on any subsequent stroke, when necessary.

Thus, the transfer rack 57 is locked immediately it is restored during the return stroke, and since, when the repeat key is depressed, the bail 110 will not be restored towards the end of the return stroke, then the subtraction transfer mechanism 95 will remain in the above position with the rack 57 locked and the bell crank 104 in a condition to effect a subtraction transfer, if necessary, during the subsequent forward stroke.

Referring now to the mechanism general to the whole of the calculating machine, and describing first the mechanism by which the totalizer wheels 20 of the several units 12 are placed in connection with the actuating racks 56 dur-

ing the rearward stroke thereof for addition calculations, and during the forward stroke thereof for subtraction calculations, and referring more particularly to Figs. 9 and 10, 111 is a cam keyed to the main operating shaft 1 having operative peaks comprised in rollers 112 and 113 at each end which through a small bell crank 121 are effective to operate a link 115, hereafter referred to as the change-over link, so that the latter is directly and positively actuated from the main shaft.

The link 115 carries a small roller 115b which rides on the cam 111 to ensure effective engagement operations of the totalizer wheels by the link 115 during both strokes of the main shaft 1.

A pin 134 at the other end of the link 115 normally i. e. for addition, lies at the upper end of a slot 135a in a link element 135 pivoted at 136 to a side frame 137, which, in the assembled machine lies at the left of the highest denominational unit 12.

The upper end of the rocker element 135 also carries a pin 138 to which is connected a second link 139 in turn operating a bail 140 running transversely of the machine (see Figs. 2, 3 and 4), and carried on an arm 141, there being preferably one arm at each end of the bail, the arms being pivotally mounted on stubs 142 secured to the frame.

As illustrated by dot and dash lines in Fig. 10, the side frame 137 can conveniently be arranged with open housings in a similar manner to the open housings provided in each stretcher plate 28.

The bail 140 co-operates with the bell crank arms 90 carrying the totalizer wheels 20 by engaging a hook-like recess 92 in their dependent portions (see more particularly Fig. 6), and in the normal addition position of the machine as shown in Fig. 2, the totalizer wheels are held out of engagement with the actuating racks 56.

116, Fig. 2, are spring pressed catch pawls pivoted to a common bar 252 (see Fig. 3) and each having a pair of recesses 116a, 116b, adapted to co-operate with pins 117 on the bell cranks 90. When the pins 117 are in the recesses 116a the totalizer wheels 20 are out of mesh, while when the pins are in the recesses 116b the totalizer wheels are in mesh.

The pawls 116 may be mounted on the stretcher plates 28 if desired instead of on the bar 252.

As previously mentioned, the totalizer wheels 20 require to be maintained out of engagement with the actuating racks 58 during the initial stroke of the operating shaft 1 for addition, brought in for the rearward stroke and put out again at the end thereof so as to remain out of mesh in the normal condition of the machine.

Reverting to Figure 10 the link 115 is carried towards its forward end on a pin 118 mounted in the side frame 137, which pin 118 forms the pivot point of the link 115. The extension 115a of the link is connected to the small bell crank lever 121 by means of a pin 119 engaging a slot 120 in one arm of the bell crank lever 121 which latter is pivoted to the side frame 137 at 122 and is provided with a nose 121a which lies in the path of the rollers 112, 113. Spring 115b connected between the pin 119 and the frame 137, holds the link 135 against unwanted displacement.

Assuming the link 115 to be in the position shown, i. e. as set for addition with the totalizer wheels out of engagement with the actuating

racks 56, during the forward stroke of the handle 4 the cam 111 brushes the roller 115b on the link until the roller 112 comes into abutment with the roller 115b and tends to knock the link 115 to the right, thereby ensuring that the link 115 is correctly positioned and that the wheels 20 are definitely held out of engagement with the actuating racks 56. The link 115 however, cannot move further than permitted by the pin 118 in the slot 122; consequently the link 115 is knocked upwardly by the roller 112, the slots 120 and 123a permitting this movement, without affecting the totalizer wheels 20, whereupon as the forward stroke continues the link 115 being still to the right again falls back into its original position. The roller 112 thus passes the roller 115b and the totalizer wheels 20 will remain and are maintained out of engagement during the forward stroke, until the roller 112 comes into abutment with the nose 121a. This is effective to rock the bell crank lever 121 about its pivot 122, and force the link 115 to the left (this movement being permitted by the slot 123) which acts through the link 139 to move the bail 140 to the left and rock the bell cranks 90 to throw the totalizer wheels 20 into mesh with the actuating racks 56 where they are maintained by the catch pawls 116 (see Fig. 2), until they are again brought out of mesh at the end of the return stroke.

This condition of affairs maintains during the rearward stroke of the handle the roller 112 abutting and again passing the roller 115b to ensure that the link 115 is as far to the left as possible until the actuating and setting racks are restored, whereafter the roller 113 abutting with the nose 121a rocks the bell crank 121 in the opposite direction and brings the link 115 to the right, thus again operating the bail 140, this time to throw the totalizer wheels 20 out of mesh.

It will be noted that the operating arms 74 are keyed to the operating shaft 1 at 334 (see Fig. 2) and are arranged with a certain amount of play in the key-way as shown at 335, to allow for this disengagement of the totalizer wheels while the arms 74 are idling and before re-setting of the transfer racks 57 is effected, as will be hereafter explained.

To set the machine for subtraction the link 115 requires to be swung to the other end, i. e. the bottom, of the rocking link 135, and to this end the subtraction change-over lever 146 is provided projecting through the top plate 147 of the sub-frame 137.

The change-over lever 146 is pivoted at 148 and is associated with a bell crank arm 149, which moves with the lever 146 in this case, but may be moved independently thereof, the arm 149 being pivotally connected at 150 to a link 151, the lower end of which is slotted at 152 to engage a pin 153 on the link 115 (see more particularly Fig. 10A).

In the position shown in Figure 10 the lever 146 is in the adding position, and it will be seen that when swung over about its pivot 148 the consequent rocking of the bell crank arm 149 causes depression of the link 151, and consequently depression of the link 115, which thus reverses its action on the bail 140 and ensures that the totalizer wheels 20 are engaged with the actuating racks 56 during their initial stroke, thereby setting the machine for subtraction.

This operation will be understood from the fact

that the slotted link 135 is curved as shown with its centre of curvature located below the picker 118, and that when the lever 146 is swung over, the pin 134 travels down to a point near the bottom of the link 135, and in so doing due to the eccentricity of the pivot 118 and the centre of curvature of the link 135 moves the link 135 about its pivot to throw its top end to the extreme left and thereby correspondingly move the link 139 and the bail 140 to rock the totalizer wheels 20 into engagement with the actuating racks 56. It will be obvious that when the pin 134 is moved to the top of the link 135 a converse operation will result.

To maintain the above described subtraction setting a spring pressed pawl 154 is provided pivoted at 155 to the side frame 137, a latch 156 of which pawl engages a lug 157 on the change-over lever 146 to maintain it and the arm 149 in subtraction position.

The pawl 154 is pivotally connected to an arm 114 having a slot 114a engaging a pin 114b, on an arm 114c secured to a rockable shaft 170 hereinafter referred to as a clearing shaft.

A spring 158 is connected between the bell crank arm 149 and an arm of the pawl 154 and serves both to operate the pawl 154 when the lever 146 is swung over end to return the bell crank arm 149, when released, to its normal adding position as shown in Fig. 10. It will be clear from Fig. 10 that when the arm 149 is returned it draws the link 151 upwardly so that the change over or reversing link 115 can follow by the tension in the spring 159 and thereby move the pin 134 to the top of the link 135.

The arm 149 is released by the lever 146 which is also released for return under spring action at the end of the return stroke of the handle, release of the lever 146 being effected by the pawl 154 which is rotated in an anti-clockwise direction by the lever 114 which is moved to the right when the clearing shaft 170 is rocked, as will be described with reference to the automatic clearing of the keyboard.

It will be obvious that in the reverse position of the link 115 the operations of engaging and disengaging the totalizer wheels 20 from the actuating racks 56 will be similar to those described for addition, except that their order will be reversed. Thus, the totalizer wheels will be engaged for the forward stroke and disengaged for the return stroke of the handle.

It will be seen that the slot 152 forms a guide for the pin 153 on the link 115 and that the pin is normally maintained at the head of the slot 152 by the spring 159.

The operation of the link 115 and the bail 140 both for subtraction and addition will be preferred to hereafter in connection with the general operation of the machine.

To enable any errors set up on the keyboard to be removed an Error key 160, shown in Figure 9, is provided being preferably mounted in the top wall 161 of a sub-frame 162, arranged for assembly at the right of the machine, preferably as a stretcher plate.

A flange 163 pressed out from the body of the sub-frame 162, which is shown constructed of sheet metal, forms a guide plate for the shank 164 of the Error key 160, while a lug 165 jumped up from the shank of the key 160, which may also be constructed of sheet metal, engages a short bell crank lever 166 pivoted to the sub-frame 162 at 167, and connected by a pin 187 at its other end to a short link 168 which is connected to a crank

arm 169 of the shaft 170, the latter being mounted in bearings on the two sub-frames 137 and 162, as shown in Fig. 3.

This clearing shaft 170 extends across the front of the assembled units 12, and is provided with a series of pegs or arms 171, which co-operate with slots 172 (see Fig. 11) in the column release keys 32a, so that when the clearing shaft 170 is rocked the column release keys, which have previously been released by the depression of a numeral key in the associated column, are depressed and to rock the clearing bars 45 against the action of their springs 50 and thus clear the keyboard.

Thus when the Error key 160 is depressed the bell crank 166 is rocked about its pivot 167 to move the link 168 to the right and thereby rock the clearing shaft 170 so that the arms 171 depress the column release keys to clear the keyboard, the key 160 being returned to normal position under the action of a spring 173, see Figure 9.

Adjacent the Error key 160 a second key 175 is provided, hereafter referred to as the Repeat key, which can be depressed to ensure a repeated addition or subtraction of a particular key setting should such be required.

This is employed in the embodiment of calculating machine illustrated in view of the fact that means are provided for the clearing of the keyboard at the end of each return stroke and the operating handle 4, such means comprising an abutment 176 on the operating shaft 1, which co-operates with an abutment 177 on a rocking lever 178 pivoted to the sub-frame 162 at 179, and acting through a link 180 to rock the clearing shaft 170 towards the end of each return stroke and prior to the resetting of the transfer racks.

The rocking of the clearing shaft 170 depresses the column release keys 32a to clear the keyboard, and, if the change-over lever 146 is in subtraction position, moves the arm 114 to the right to rotate the pawl 154 anti-clockwise to permit of the change-over lever 146 being restored.

Depression of the Repeat key 175 cuts out this operation of the clearing shaft 170, the end 181 of the key when depressed engaging a ledge 182 on the link 180, and thereby causing the link to pivot about the pin 183 so that its other end 184 is depressed against the action of a spring 185.

The end 184 of the link 180 is provided with a lost motion slot 186, and normally the pin 187, connecting the link 168 to the bell crank 166, rides in the lower end of the vertical arm of the slot 186 to enable the motion of the link 180 to be transmitted to the link 168, but, upon the link 180 being depressed by the Repeat key 175, the pin 187 is caused to ride in the top arm of the slot 186 so that the latter arm slides along the pin 187, when the link 180 is moved by the abutment 176 so that this motion of the link 180 is not transmitted to the link 168, and the clearing shaft 170 is not actuated thereby at the end of each stroke.

To permit the Repeat key 175 to retain its depressed position so long as desired, it is notched at 188 to engage the top plate 161 by the action of the spring 185, but it can be readily returned to its normal position by manipulation, or by depression of the Error key 160, the bell crank 166 of which is to this end provided with a connecting rod 189 carrying a pin 190 engaging in a substantially L-shaped slot 191 in the shank of the Repeat key 175, the slot comprising a long arm running along the shank of the Repeat key 175 and a short arm at an obtuse angle to the

long arm. Thus, when the Repeat key is depressed, the pin 190 moves to the top of the long arm of the slot 191, but upon depression of the Error key 160 the consequent rocking of the bell crank 166 to the right causes the Repeat key 175 through the connecting rod 189 to be drawn also to the right, so that its notch 188 is clear of the top plate 161, whereby the Repeat key and the link 180 are returned to normal by the spring 185. To ensure that the Repeat key is definitely restored, a spring 175a is preferably provided, which tends normally to maintain the key in non-depressed condition.

The short arm of the slot 191 is arranged so that an operation of the Error key 160 at such times as the Repeat key 175 is not depressed has no effect thereon.

It will be seen from Figure 9 that the pin 183 of the rocking lever 178 is connected to the link 180 through the lost motion slot 192, this being provided to permit the lever 178 to be rocked during the forward stroke of the handle 4 without affecting the clearing mechanism, and a spring 193 connected at one end to an extension on the end 184 of the link 180, and at its other end to the rocking lever 178 normally maintaining the pin 183 at the right hand extremity of the slot 192 to absorb the lost motion.

Fig. 9 also shows two spring controlled keys 200 and 201, referred to as the Non-add and Non-print keys respectively, the first, when depressed being locked by the notch 200a engaging the top plate 161 of the sub frame 162 and serving to permit of entries from the keyboard, such as identification numbers, being set up and printed without affecting the totalizer wheels, and the second being locked depressed by the notch 201a and enabling computations to be effected in the machine without a printed record being made.

It will be convenient now to refer to the printing link 202 by which the action of the operating handle 4 is connected to the printing action, hereafter more fully described which is effected by the link 202 drawing an arm 203 forwardly by reason of a slot 204 in the end of said link engaging a pin 205 at the end of said arm 203.

The slot 204 closely fits the pin 205 in its lower area, which is normally occupied by the pin 205 by reason of a spring 206 which maintains the link 202 in its upper position. Should the link 202 be forced downwardly by the Non-print key 201 the pin 205 occupies the enlarged portion of the slot 204, and operation of the handle 4 in this event does not effect printing.

The key 201 depends through the top plate 161 and through a guide plate 207 bent over from the sub-frame 162 and under the top plate 161 carries a pin 208, preferably with an anti-friction roller which engages an arm 209 of a virtual bell crank 210, it being understood that the arm 209 is at the right of the machine, while the bell crank arm 210 is at the left of the machine, the two being connected and fixed to a transverse shaft 211.

212 is a roller provided on the end of the bell crank 210, which co-operates with a cam face 213 on the link 202 when the Non-print key is depressed to rock the bell crank, so that such link 202 is depressed and the printing action rendered inoperative.

The Non-add key 200 is similarly constructed, being arranged with a pin 220 carrying an anti-friction roller which engages an arm 221 of a second bell crank 222, carrying a roller 223 bearing on the link 139, by which the engagement of

the totalizer wheels 20 with the actuating racks 56 is controlled.

The link 139 connects with the pin 138 of the rocking link 135 by a slot 224, and in the position shown, i. e. with the pin 138 in the bottom of the slot 224, the motions of the rocker 135 are transmitted to the bail 140 to throw the totalizer wheels 20 into or out of mesh.

The link 139 is normally maintained in this position by a spring 225, but on the non-adding key 200 being depressed the bell crank lever 222 is rocked and the roller 223 thereon rides a cam face 226 to swing the link 139, so that the pin 138 occupies the upper portion of the slot 224, in which sufficient clearance is provided to enable the rocker 135 to oscillate and with it the pin 138 without transmitting motion to the bail 140, so that the totalizer wheels 20 are maintained out of engagement with the actuating racks 56 during both strokes of the handle 4.

With this Non-add key 200 depressed therefore, an item can be set up in the keyboard and printed, the link 202 being operative without affecting any total which may be stored in the totalizer comprising the series of totalizer wheels 20.

230 and 231, Figure 10, represent the Sub-total and Total key respectively, these being mounted in the top plate 147 of the sub-frame 137 adjacent the subtraction change-over key 146, but before describing the operation of these keys it will be convenient to refer to the printing action.

As before mentioned in connection with Figures 1 to 8, the rocker 70 of each calculating unit 12 is provided with a third arm 82 carrying a roller 83 engaging a lever 84 pivoted to each stretcher plate 28 at 85, the free end of each lever 84 being connected to a vertical type bar 240 by a pin 241 at the lower end thereof.

To facilitate detachment of the individual units 12 the ends of the levers 84 are slotted as at 242 whereby on the removal of a unit the lever 84 may be freed from its vertical type bar 240.

As will be seen more clearly from Fig. 4, the series of type bars 240 are arranged in compact relation at the rear of the machine, so that a series of figures set up in the keyboard may be printed on paper carried by the platen roller 243 in column relation, the levers 84 of the various units being bent inwardly to connect with the lower end of the type bars 240.

Each type bar 240 (see more particularly Figs. 6 and 12) has a flat face for the receipt of the type 246 which is formed as a block with a recess 245 on its rear face which engages with the flat face of the type bar, this arrangement enabling the type bars to be constructed cheaply from sheet metal.

In order to avoid the wear produced by percussive striking hammers and further to eliminate the consequent noise by the use of such hammers, the printing action embodies means for effecting a gradual application of pressure on the type bars, the movement of the handle subsequent to the setting of the type bars being effective to allow such gradual application of pressure, and the arrangement being such that normally the type bars are maintained in a non-print position and towards the end of the forward stroke of the handle, after they have been set, a spring controlled pressure device is allowed to gradually act on the type bars as the handle continues to the end of its forward stroke to thus effect the printing.

As shown in the drawings, with more especial reference to Figures 2, 4, 12, 12A and 12B, asso-

ciated with each type bar 240 is a spring controlled pressure device, embodying means for aligning the type prior to printing and comprising a bell crank lever 251 and a rockable member 5 both pivotally mounted on a common transverse shaft 252 carried by the main side frames 3 of the machine.

The rockable member, as shown, consists of a flexible lever constituted by two arms 248 and 10 248c, pivotally connected at 248e, the arm 248 being pivotally mounted on the transverse shaft 252 and connected at its lower end 248a to a tension spring 265 fixed to the cross shaft 260, while the arm 248c is pivotally connected at 248b to 15 the bell crank 251 and is provided with a pin 247 which rides in a guide slot 240a in the type bar 240. Preferably, the rear face of each type bar 240 is provided with serrations or teeth 253, while the associated bell crank 251 is provided at its 20 top end with an outstanding pin 250 in the form of a striker preferably having an anti-friction roller 254 for engaging with the serrations 253 of the type bar 240 to align the latter after setting and prior to printing and apply pressure to 25 the type bar by means of a tension spring 255 connecting the lower end 251a of each bell crank with the shaft 260, the pressure of the spring 255 also being augmented by the tension of the spring, 265, as will be explained hereinafter.

30 The pitch of the serrations or teeth 253 correspond with the spacing of the type, and by reason of the pins 250 or their rollers 254, engaging serrations, the setting of the various type bars is effected positively so that the correct type comes 35 opposite to the printing line.

As will be seen from Fig. 1, the heads of the type bars 240 project upwardly through an aperture 21 in the cover 17, and on a keyboard setting being made and the operating handle 4 rotated 40 the various rockers 70 rotate in a counterclockwise direction so far as is permitted by the particular key setting for each column, the levers 84 of the printing action following the rollers 83 on the rockers by reason of the springs 249 and 45 each type bar 240 is thus raised to a distance corresponding to the key setting in the particular column with which the type bar is associated.

For instance, supposing the 0 or column release key of a column to be depressed no movement of 50 the actuating mechanism and therefore of the rocker 70 to follow operation of the handle 4 would occur and thus, there would be no movement of the type bar 240 and the type 246 would remain with the 0 opposite the printing line of 55 the roller 243.

Should the 9 key of any particular column have been depressed operation of the handle 4 would cause the actuating mechanism and therefore the rocker 70 to move to its full extent, so that 60 the lever 84 of this particular column would cause its type bar 240 to raise to its full extent and place the 9 type on the printing line.

Printing is arranged to take place at the end of the initial stroke of the operating handle 4 except 65 when the Non-print key 201 is depressed, and is controlled by a transverse bail 261 carried by a pair of the arms 203 which are pivoted to the respective side frames 3 at 260 and operable from the main shaft 1, through the printing link 202 70 previously mentioned in connection with Fig. 9.

The pivotal arm 203 shown in Fig. 2, is extended below its pivot point 260, the other arm also preferably being so extended, and is connected to a tension spring 203a fixed to the 75 frame 3.

The transverse bail 261, normally engages the lower ends of both the bell cranks 251 and the levers 248 so as to maintain the pressure devices against the action of the springs 255 and 265 in a non-print position in which the type bars 240 are not pressed into contact with the paper 80 carried by the roller 243.

The link 202 is connected to the operating shaft 1 by a pin and slot device constituted by an arm 262 keyed to the shaft 1, the free end of 85 which arm carries a pin 263 riding in a slot 264 having a suitable radius in said link 202.

During the initial movement of the operating handle 4 in the direction of the arrow A in Figs. 2 and 6, the pin 263 first rides the slot 264, and 90 just prior to the end of the initial or forward stroke of the handle 4 (that is, subsequent to the movement necessary to effect the maximum setting of the type bars) abuts with the end 264a of said slot, and during the movement of the 95 handle to the end of the stroke causes the link 202 to move to the right to gradually move the bail 261 to the right against the tension in the springs 203a, which latter normally tend to keep the bail 261 abutting the lower ends 248a and 100 251a of the levers 248 and the bell cranks 251 respectively, until the pin 263 engages with the end 264a of the slot 264.

Assuming that the mechanism generally designated 270 has been operated, as will be described hereafter, as the bail 261 moves to the 105 right, the ends 248a and 251a of the lever 248 and the bell crank 251 respectively of each pressure device follow, by the tension in the springs 265 and 255, to cause the levers 248 and the bell 110 cranks 251 to rock about the common transverse shaft 252. The rocking of the bell cranks 251 causes the aligning rollers 254 thereon to move towards the type bars 240 while the rocking of the levers 248 causes the associated levers 248c 115 to pivot about the pivot points 248b on the bell cranks 251 and thereby move the type bars relatively towards the aligning rollers 254 until the latter engage with the serrations 253 corresponding to the setting of the type bars. This relative 120 movement may be assisted by the springs 244 connecting the top ends of the bell cranks 251 with the levers 248c.

Consequent upon the aligning rollers 254 engaging with the serrations 253, the levers 248 125 and 248c of each pressure device then move as one so that subsequent to their alignment the type bars 240 are moved towards the roller 243 for printing under the combined influence of the springs 255 and 265. Thus, during the movement 130 of the handle 4, subsequent to the setting of the type bars 240, the bail 261 is effective to gradually release the pressure devices to align the type bars simultaneously prior to printing and subsequently move the latter to printing position 135 so that the item set up in the keyboard is printed on the paper carried by the roller 243.

Upon the return stroke of the handle 4, movement of the arm 262 to the left (see Fig. 2) allows the springs 203a to act on the pivotal levers 140 203 so that the bail 261 is caused to abut against the lower ends 248a and 251a of the pressure devices and thereby rock the levers 248 and the bell cranks 251 in a clockwise direction to disengage the aligning rollers 254 from the serrations 253 of the type bars 240. The type bars 145 are thus allowed to be restored to their normal position against the tension of the springs 249, during the return stroke, by the rollers 83 on the arms 82 of the rocker 70 abutting against the 150

cam surfaces on the right hand ends of the levers 84.

At such times as the Non-print key 201 is depressed the bell crank lever 210 actuates the printing link 202 so as to bring the lost motion slot 204 over the pin 205, and in this event, as will be seen, movement of the operating shaft 1 is not transmitted to the levers 203, whereby the bell cranks 251 and levers 248 are not permitted to rock under the influence of their springs 255 and 265, so that although the various type bars are set the strikers 250 do not move forward and so no printing takes place.

Immediately the Non-print key 201 is released the printing link 202 assumes its normal position as shown in Figs. 2 and 9 under the action of the spring 206, whereafter subsequent movement of the operating handle 4 actuates the pressure devices in the manner described above, to bring the type which has been set up into contact with the paper on the roller 243.

The mechanism generally designated 270 provided to prevent the printing of ciphers to the left of the highest denominational digit set up in the keyboard will be described hereafter, as it will be convenient now to revert to the operation of the sub-total key 230 and the Total key 231 previously mentioned with more particular reference to Figures 10 and 10A.

The Total and Sub-total keys each have elongated shanks 272 and 271 which depend through guide slots in a flange 273 or bracket attached to the sub-frame 137 and, under the top plate 147, each key is provided with a projecting pin 274 preferably with an anti-friction roller (see also Fig. 10A). The bell crank lever 149 of the subtraction change-over lever 146 is provided with a projection 275 which normally lies under the pins 274 and in their path should either the Sub-total key 230 or the Total key 231 be depressed.

By this arrangement, therefore, depression of either key 230 or 231 acting on the projection 275 causes a depression of the change-over link 115 into the subtraction position without the subtraction change-over lever 146 being operated, and it being borne in mind that in the subtraction position the totalizer wheels 20 are in engagement with the actuating racks 56 during the forward stroke of the handle 4 and of the actuating mechanism, it will be seen that by using this stroke to run off the totalizer wheels 20 against the actuating racks 56, i. e. zeroize the totalizer wheels, the various actuating racks will be given a position corresponding to the total previously retained by the totalizer wheels 20.

To enable this to be achieved it is essential that the keyboard be cleared, otherwise the stubs 43 of any keys which might be depressed would obstruct the full motion of the actuating racks 56 which might be required to zeroize any particular totalizer wheel 20 and thus a wrong setting would be given.

To effect a clearing of the keyboard, therefore, when either the Sub-total key 230 or the Total key 231 is depressed, a second clearing shaft 276 (see Figs. 3 and 10) is provided similar to the clearing shaft 170 but at the upper end of the keyboard. This second shaft 276 is provided with pegs 277 one for each column, which pegs 277, upon the shaft 276 being rocked downwardly, engage with the pins 278 on the clearing bars 45. The clearing bars 45 will thus be rocked outwardly in a similar manner as caused by the depression of a key in the associated column, as previously explained, and consequently will re-

lease any depressed keys in the columns, either column release or numeral keys, so that the whole of the keys of the keyboard are restored to a non-depressed condition, it being remembered that no abutment is provided for the 9 keys and that the extent of the guide slot 61 in the actuating rack 56 governs the travel of the actuating mechanism and corresponds to the maximum reading within the capacity of any one totalizer wheel.

The clearing shaft 276 is provided with an arm 279 which projects forwardly under the pins 274 of the Sub-total and Total keys 230 and 231, so that on either key being depressed the clearing shaft 276 is rocked to effect the above clearance of the keyboard.

It will be understood that with the automatic clearing mechanism 176 actuating the clearing shaft 170 at the end of each stroke to depress the column release keys (that is if the Repeat key has not been operated), it will be the column release keys that are cleared to unlock the setting racks 58 on the second clearing shaft 276 being rocked by either the Sub-total key 230 or the Total key 231.

If it be desired to clear the keyboard when the change-over key 146 is moved to the subtraction position, a pin 280 on the projection 275 could be arranged to actuate the lever 279, but in this case the item to be subtracted must be set up in the keyboard after manipulation of the change-over key 146.

For subtraction transfer purposes between the several denominations the subtraction bail 110 previously referred to requires to be operated in order to set both the addition and subtraction transfer mechanisms 94 and 95 of the several units in operative position during subtraction as previously described, and to this end a cranked lever 281 is provided pivoted to the sub-frame 137 at 282 and having one end lying under the pin 280 mounted on the projection 275 of the bell crank 149.

The other end of the cranked lever 281 bears on the bail 110 which engages the arms 100b of the bell cranks 100 of the addition transfer mechanism 94, as clearly shown in Fig. 7 and also in Fig. 3, so that on the key 146 being set for subtraction or either of the keys 230 or 231 depressed, the cranked lever 281 is rocked about its pivot 282, thereby moving the bail 110 forwardly and also pull the arms 100b forwardly and thereby rock the bell cranks 100 on their pivots, thus moving the pins 101 down the slots 102 and freeing the transfer racks 57 which are, however, maintained from movement by the pins 105 in the branches 107, as previously described. The bail 110 runs transversely of the machine and is carried on arms 110a pivoted either to the main side frame 3 or to the sub-frames 137 and 162.

It will be noticed that in contradistinction to the Sub-total key 230, the Total key 231 is provided with a notch 283 by which its is retained in the depressed condition when set, while further, that the bell crank 149 is provided with a second projection 284 beyond its pivot point 148.

This projection 284 co-operates with a latch lever 285 pivoted to the left sub-frame 137 at 287, the end 285a of which lever normally engages the underside of the projection 284 by means of a tension spring 288 as will be seen in Fig. 10. When the bell crank 149 is rocked by any of the keys 146, 230 or 231, the latch lever 285 rotates about its pivotal axis 287, due to the tension in the spring 288, so that the end 285a, follows the projection 284, the arrangement being such that

in the rocked position of the arm 149 the face 285b of the end 285a, engages with the face 284a, of the projection 284 to form a wedge, which, if any of the above keys are released, maintains the bell crank arm 149 in the rocked position against the tension of its spring 158.

It will be noted that the wedge is produced by reason of the fact that the distance between the pivotal axes 148 and 287 is less than the length of the latch 285 plus the length of the projection 284.

In the case of the total and change-over keys, these are independently locked in their operated position, but since the Sub-total key is not provided with a locking device this key will be restored by its spring immediately after depression.

Thus, due to the latch lever 285 engaging the projection 284 with a wedging action, the arm 149 will remain in the rocked position upon the Sub-total key restoring after depression, and consequently the link 115 will remain in the subtraction position until the end of the forward stroke when the latch 285 is disengaged from the projection 284, as will now be described.

The lever 285 is provided with an extension 286 beyond its pivot point 287, the end of which extension, when the lever 285 is rotated, comes into the path of a projection, conveniently the roller 112, movable with the main operating shaft 1, so that at the end of the initial stroke the projection knocks the end of the extension 286 and thereby rocks the latch 285 against the tension of its spring 288 and thus disengages the face 285b from the face 284a of the projection 284. Consequently, the change-over link 115 and the bell crank arm 149 return to the normal adding position by the springs 159 and 158 respectively, whereby during the return stroke of the handle 4 the totalizer wheels 20 are retained in mesh with the actuating racks 56 and the amount stored on such totalizer wheels before they were zeroized to take the sub-total is returned thereto.

Should the Total key 231, however, have been depressed the notch 283 therein engaging the top plate 147 maintains the key depressed so that the change-over link 115 is kept in subtraction position and the disengagement of the latch 285 at the end of the forward stroke will therefore have no effect. Thus the link 115 remains in the subtraction position and the totalizer wheels 20 are thus maintained out of engagement with the actuating racks during return stroke of the handle 4, whereby they remain at zero.

In the event of the change-over key 146 being in the subtraction position the change-over link 115 is retained in the subtraction position by reason of the lug 157 on the change-over key 146 being engaged by the pawl 156, and in this case the totalizer wheels 20 retain the position to which they have been set during the forward stroke, the actuating racks returning to their zero position while the totalizer wheels are held disengaged during the return stroke, as will be understood from previous description.

It may here be mentioned that the subtraction change-over lever or key 146 is not solid with the bell crank arm 149, but actuates such bell crank by reason of the lug 157 on the change-over key engaging an arm 290 thereon, this lug being also engaged by the pawl 156 to retain the subtraction key in position until cleared by the clearing shaft 170 at the end of the stroke except when the Repeat key 175 is depressed, and in that case by depression of the Error key 160.

With regard to the latch lever 285, it will be

seen that when the total or change-over keys are operated, as the return stroke of the handle is made, the roller 112 moves away from the extension 286, and consequently the latch will spring back into engagement with the projection 284 to hold the arm 149 depressed, even when the key 146 or 231 is released.

To release the arm 149 and so restore the link 115 to addition position, it will be necessary to make an idle forward and return stroke of the handle so that when the latch 285 is released at the end of the forward stroke, the arm 149 can restore under the action of the spring 158.

The addition transfer lugs 97 of the totalizer wheels 20 form the zero stops during total taking, coming into abutment with separate stops not shown, and this positively stopping the totalizer wheels 20 on their reaching zero when the total has been taken; in the case of the highest denominational counter the separate stop may take the form of a small pawl mounted on the main frame or on the sub-frame 137, while for the other denominations a similar pawl may be provided mounted on the addition transfer arm 100c of its denomination.

As previously mentioned when taking a total or a sub-total the actuating racks 56 are run off against the totalizer wheels 20 which are thus zeroized, so that a setting of the rack mechanism is obtained corresponding to the original setting shown by the totalizer wheels 20, from which it will be readily understood that the type bars 240 operated through the levers 84 of the respective units rise correspondingly so that when the pressure devices of the printing action are actuated by the printing link 202 just prior to the end of the initial stroke of the handle 4 the type has been properly set to print the sub-total or total as the case may be.

It will be understood that in the case of a pounds, shillings and pence machine as illustrated, the type 246 for the fractions of a penny type bar 240 contains only a four type block corresponding to a farthing, a halfpenny and three-farthings, that the pence type includes a twelve type block, the shillings a ten type block, the tens of shillings a two type block, and each of the pounds type bar a ten type block carrying the numbers 0 to 9.

Correspondingly, in this machine the farthings totalizer wheels 20 is provided with twelve facets each set being repeated three times, and there being three sets of transfer lugs, while the tens of shillings totalizer wheels 20 is provided with ten facets, each set being repeated five times and there being correspondingly five addition transfer lugs 97 and five subtraction transfer lugs 98.

The signs printed by the machine are clearly shown in Figure 4, four type bars only, corresponding to the farthings, pence, and the two "shillings" columns being shown at the left of the figure, and on the right a single type bar 300 is shown on which the signs corresponding to the Non-add key 200, the subtraction key 146, the Sub-total key 230, and the Total key 231, are mounted. A lever 301, similar to the crank levers 84 of the units 12, is pivoted on the side frame 137, and connected to the type bar 300 whereby the operation of the various keys may position such type bar 300 according to the key depressed, and a printing may be taken in a similar manner to the printing of denominational settings. The means whereby the type bar is set will not be described, as this can be readily effected in known manner and forms no part of the present invention.

The means adopted for preventing the printing of ciphers to the left of the highest denominational digit, previously referred to under the general designation 270, will now be described, more particularly in connection with Figs. 2 and 4, 12, 12A and 12B.

Each side frame 3 (see Fig. 5) is arranged towards its rear end with three main bushings, designated respectively 304, 305 and 306, the bushings 304 being connected by a transverse shaft 307 carrying the no-print pawls 270, while the bushings 305 carry the common transverse shaft 252 for the bell cranks 251 and levers 248 of the pressure devices of the printing action. Lastly, the bushings 306 carry the transverse shaft 260 on which are mounted the arms 203 carrying the printing bail 261, which engages under the lower ends 251a and 248a of the bell cranks 251 and the levers 248 respectively.

Each lower end 251a is provided with an upstanding lug 308 provided with a jaw 309 under which a tongue 310 on the no-print pawl 270 of that particular denomination engages. The pawl 270 has a cranked portion 311 connected by a spring 312 normally in tension to a stop member 313 also pivoted to the shaft 307, and, as seen from the rear of the machine, the left face of each stop member 313 abuts against the right face of the associated type bar 240 in its normal position and the end of the stop member 313 engages the lower outstanding extremity 245a of the type block 246.

The cranked portion 311 of each no-print pawl 270 is provided with a lip 314 which lies over the upper edge of the stop 313, with a small clearance 314a in the normal position. In the normal position of the printing mechanism as shown in the figures referred to, it will be seen that the spring 312 is tending to draw the tongue 310 under the jaw 309, but on such stop 313 being freed as a result of upward movement of the type bar 240 to its setting, the stop 313 rotates upwardly by the tension in the spring 312 and the no-print pawl 270 is also rocked about the shaft 307 by reason of the lip 314 being engaged over said stop 313, and the tongue 310 is disengaged from the jaw 309 this action may be assisted by a spring 270a connected between the pawl 270 and the machine frame. The particular pressure device is therefore free to operate when the bail 261 moves as the result of the handle 4 reaching the end of its initial stroke. It will be understood that the radial movement of the end of the stop 313 will be limited so that when the associated type bar 240 is restored, the extremity 245a of the type block 246 comes into abutment with the end of the stop 313 so as to move the stop and the pawl 270 to the normal position.

The normal and operative positions of the pawl and stop are shown in Figure 12B by full and dotted lines respectively, and from which the action of the springs 312 and 270a will be readily understood.

Thus it will be seen that immediately a type bar 240 is raised from the 0 position the associated pawl 270 is cleared from the lug 308 of the bell crank 251, whereby the pressure device of the associated type bar may be effective to cause the latter to print, as previously explained.

Should, however, the 0 or column release key of the particular unit 12 be depressed, whereat the respective type bar 240 is not raised during the movement of the handle 4, the respective bell crank 251 is prevented from operating by the no-print pawl 270 engaging the jaw 309 of the pro-

jection 308 of the respective bell crank 251, unless such pawl 270 has been rocked by the upward movement of a type bar 240 of higher denomination now to be described.

In this manner printing of any ciphers to the left of the higher denominational digit set up in the keyboard is prevented, but in order that after a setting of a digit in any denomination, the lower denominational type bars 240 shall be effective, i. e. shall print even when no digit has been set up therein, each of the pawls 270 is provided with an angularly projecting lug 315, which engages the recessed face 316 of the next lower denominational pawl 270, the recess being provided by a corresponding projecting lug 315 on that pawl which engages the next lower pawl, and so on.

By this means it will be seen that on any particular no-print pawl 270 being freed the no-print pawls 270 of all the lower denominations are actuated by reason of the projecting lugs 315, and the corresponding type bars 240 are freed for printing.

It will be noted that in the case of the type bars of the lower denomination which have not been set as explained above, and are therefore with the "0" opposite the printing line on the roller 243, the stop members 313 will be in abutment with the extremities 245a of the associated type 245 so that no rotation of the stop member 313 will occur, the pawls 270 only being rotated by the lugs 315 engaging with the recesses 316 and the associated type bar 240 being free to move to printing position by reason of the fact that the stops 313 only engage with the side face of the type bars.

While being particularly effective in operation the construction disclosed enables the type bars 240, the no-print pawls 270 and the stops 313 to be cheaply constructed from sheet metal, the tongue 310, the lip 314 and the projecting lugs 315 being simply stamped out from the body of the pawl 270, and the flanges to take the spring 312 being similarly formed whereby the construction and assembly of the listing portion of the machine may be readily constructed and assembled.

With the transfer mechanism employed which operates through the differentially geared actuating and setting mechanism, it is desirable that means be employed to prevent the transfer rack 57 of any denomination being shot prior to the printing taking place during subtraction, as this would cause a discrepancy between the items set up in the keyboard and the printed record although the total or differences retained by the totalizer wheels 20 would be correct.

Such means are shown in Figs. 2 and 2A and comprise a transverse bail 320 carried by arms 321 pivoted to the side frames 3 at 322, the bail 320 by means of springs 322a being arranged to co-operate with notches 323 formed on the lower edge of each transfer rack 57 where in its normal or mid position it projects beyond the limits of the stretcher plate 28.

It is convenient here to note that the printing takes place just prior to the end of the initial stroke of the handle 4, and further that owing to the 2:1 reduction between the rising setting rack 58 associated with the actuating rack 56 only a very short stroke of the handle 4 is necessary to actuate the differentially geared actuating and setting mechanism and therefore there is a quantum of idle movement available for such auxiliary operations as may be provided.

A portion of this idle movement is employed to clear the bail 320 after the printing has taken

place and prior to the bail 140 releasing the totalizer wheels 20 from mesh with the actuating racks 56.

With this object in view the full stroke pawl 5 quadrant 343 is provided with a cam track 324 which towards the end of the forward stroke, engages with the end of the bail 320, to rock the arms 321 downwardly thereby tensioning the springs 322a and bring the bail 320 out of engagement with the notches 323 in the several transfer racks 57 so that any transfer racks 57 as are set for a transfer are then shot to take one from the reading on their respective counters 20, it being understood, however, that the cam face 324 delays the release of the bail 320 from the notches 323 until after the printing is effected. By this delay a correct printed record of the item to be subtracted is obtained.

It will be noted here, that for a subtraction transfer the particular transfer rack is moved rearwardly to effect the transfer by the spring 64a, which, upon the racks 57 being released by the bail 320, pulls the rocker 70 to the left. The upper rack 53 and the setting rack 58 are maintained stationary in the set position by the tension in the spring 64, so that the left hand movement of the rocker 70 and consequently of the pinion 55 and actuating rack 56 causes the transfer rack 57 to move to the rear with a 2:1 movement with respect to the actuating rack 56, until the pin 105 abuts against the right hand end 109a of the branch slot 109, when one will have been subtracted from the totalizer wheel 20.

Consequent upon shooting of the transfer racks, it will be seen that the arms 82 of the associated rockers 70 will move downward slightly, but owing to the aligning rollers 254 being in engagement with the serrations on the type bars 240 under tension from the springs 255 and 265, no resultant upward movement of the type bars will occur, and thus a clear and correct record of the item entered is obtained.

In regard to both addition and subtraction transfers it may be mentioned that when the machine is set for subtraction and a subtraction transfer is effected at the end of the forward stroke as just described, the transfer racks 57 are moved to the normal position during the return stroke and are latched in the said position firstly by the pins 105 on the bell cranks 104, moving down to the bottom of the branches 107 in the transfer racks 57, the pawls 100e being disengaged by the totalizer wheels being out of mesh, and subsequently the transfer racks are locked in said normal position by the restoration of the bell cranks 100 to engage the pins 101 in the notches 103, all as previously described. It may be noted that when the transfer racks are moved to the normal position during the return stroke, the bail 320 snaps back into the notches 323 by the tension in the springs 322a.

If the machine is set for addition, however, and an addition transfer has been effected, then since for addition the totalizer wheels are in mesh on the return stroke, the transfer racks 57 which have been shot will remain in the shot position, i. e. to the right by the tension in the springs 64. Consequently, it is necessary to restore such racks to normal if the whole of the differential mechanism is to be in normal position after each operation of the machine.

To thus ensure complete and automatic restoration of the differentially geared actuating and setting mechanism at the end of each complete stroke of the handle 4, the operating shaft 1 is

provided with a series of short arms 330. When the setting racks 58 have been restored to their normal position towards the end of the return stroke of the handle 4, in addition, and just after the totalizer wheels 20 have been brought out of mesh with the actuating racks and the column release keys have been depressed to lock the setting racks 58 and the racks 53, the short arms 330 come into abutment with those transfer racks 57 or pins 331 provided thereon, which have been displaced for transfer. Further movement of the handle 4 towards its normal position thus causes these racks to be replaced into their mid positions and restoration of the actuating racks, the transfer racks being automatically latched by the pins 101 of the transfer mechanism.

To allow for the further movement of the operating shaft 1, wherein the clearing shaft 170 is operated for clearing the keyboard and the abutments 330 are effective to restore displaced transfer racks, as just described, the key-way 335 is provided, whilst a lost motion device comprising the slotted end 76, the pin 77 and the spring 81, connected between a pin 80 on the link 78 and a pin 79 on the slotted end 76, is provided on each of the rockers 70. For either addition or subtraction, therefore, and subsequent to the idle movement of the key-way 335, the slotted end 76 moves across the pin 77, the above operations taking place in the order named, the spring 81 being tensioned to definitely maintain the pinion 55 and the upper rack 53 to the right (see Fig. 6) and consequently to retain the setting rack in its normal position during the time the column release keys are being depressed to clear the keyboard.

The initial stroke of the handle 4 is effected against tension of the springs 4a (see Fig. 2) one for each unit connected between a transverse bar 332 and lugs 333 on the operating arms 74.

It will be seen that the cumulative tension generated in the springs 4a during the initial stroke of the handle 4 would tend to spin the handle rearwardly when released, which in spite of the resistance by reason of the inertia of the parts and the opposing tensions such as the springs 64 and 64a and the springs 255 and 265, considerable shock might be imparted to the mechanism which would result in undue wear.

To prevent this shock a dash-pot 336 shown in dot and dash lines is provided pivoted to the base 7 at 337 having the end of its piston rod 338 connected to a curved lever 339 pivoted to one of the side frames 3 at 340, a link 341 connecting the other and free end of the lever 339 to an arm 342 on the operating shaft 1 so that during the initial movement of the handle 4 the dash-pot is opened and the return movement of the handle can only take place slowly by reason of the resistance provided by the dash-pot. This is quite a common form of device, and since it forms no part of the present invention, will not be further described.

In this manner any objectionable flyback of the operating handle 4 is prevented and the manipulation of the machine rendered substantially foolproof against accidental strain while to ensure proper operation means may be provided by which a full initial stroke of the handle 4 must be taken before the return stroke can be commenced.

This means may take the form of the spring controlled full stroke pawl 344 (see Figs. 2, 2A and 3) pivoted to the side frame 3 and co-operat-

ing with a ratchet wheel or quadrant 343 on the main shaft 1.

As shown in Figs. 2 and 2A, the pawl 344 engages with the top face of the ratchet quadrant 343, so that during the forward stroke of the shaft 1 the pawl 344 slips over the ratchet teeth, but if, during the forward stroke, the handle is reversed, the pawl engages with the teeth of the quadrant to prevent such reverse movement, as will be readily appreciated. At the end of the forward stroke, the pawl 344 trips out of engagement with the quadrant 343 to permit the return stroke of the handle, the pawl again engaging and slipping over the teeth of the quadrant as the handle 4 is returned to its initial position, but preventing any possible reverse movement being effected.

The preferred construction of cover 17 for the machine is illustrated in Figs. 1 and 2, and to enable standard pressings of sheet metal to be employed for machines of different capacities, the cover 17 is formed from interlocking sections, the two side sections 350 and 351, see Fig. 1, being standard constructions, and the centre pieces 352 and 353 being dimensioned to suit the various widths of keyboard required. A housing such as 354 may be provided on the section 353 to partially house the printing action and improve the appearance of the machine.

The paper platen or roller 243 can conveniently be arranged in a separate structure 355 arranged for ready securement to the centre section 353 of the cover as shown more particularly in Figs. 1 and 2, and such structure 355 conveniently carries a paper roll 370.

The paper feed is operated from the printing bail 261 a bell crank 371 pivoted on the axis 307 having a forked end 372 straddling said bail so as to oscillate therewith, and a pin 373 at the other end of said bell crank being engaged by the forked end 374 of the depending lever 375 pivoted on a boss 376 of the shaft 377 carrying the platen 243.

The boss 376 may be integral with the feed ratchet 378, into the teeth of which the paper feed pawl 379 pivotally mounted on the drop lever 375 is urged by spring 380.

The drop lever 375 conveniently depends through a slot in the casing 353 and the forked end 374 enables the platen carrying structure 355 to be readily detached.

With this arrangement the rearward or printing stroke of the bail 261 causes the paper feed pawl 379 to escape over the teeth of the feed ratchet 378, while the return movement of the bail 261 after printing has taken place rocks the bell crank 371 and causes the paper feed pawl 379 to propel the ratchet 378 one tooth, which feeds the platen 243 one step forward, the teeth on the ratchet 378 being of a pitch corresponding to the feed required for the paper.

Accuracy of the paper feed is ensured by a locating roller 381 carried by an arm 382 on the casing 355 and maintained in engagement with the ratchet teeth by a spring 383, this roller also preventing any unwanted backward movement of the platen 243.

383 is an upstanding writing plate and paper guide shown formed integral with the paper guides 384 and 385 and pressing the side plates of the structure 355 transversely, a serrated transverse edge 386 being conveniently provided to facilitate tearing off of the paper when desired.

Resistance to the platen movement and engagement of the paper by the platen is ensured

by a pair of rollers 387 and 388 carried by the bail 389 mounted between a pair of bell cranks 390 and urged by a spring 391 so that the rollers 387 and 388 bear on the paper.

The bell cranks 390 are keyed to a transverse shaft 392 and carry thumb plates 393, one at each side, pressure on either thumb plate overcoming the tension of the spring 391 so as to free the paper.

394 is a combined brace for the structure 355 and paper guide and carries the serrated edge 386, the paper passing from the platen through a transverse slot 394a in the brace 394 on to the plate 383.

A preferred form of ribbon feed and ribbon reverse are also shown in Figs. 1 and 2, the spools 356 carrying toothed discs 395 for engagement with worms 396 mounted on the platen shaft 377.

397 is a plate secured to the underside of the casing 353, said plate carrying a pair of pivots 398 and 399 for a pair of three-armed levers 400 and 401. On one arm of the lever 400 an upwardly projecting pin 402 is provided for carrying the left-hand spool 356 while on the corresponding arm of the lever 401 a pin 403 is provided for carrying the right-hand spool, the pins 402 and 403 projecting upwardly through radial slots in the casing 353.

404 and 405 are ribbon guiding pins provided on the plate 397 and projecting upwardly through the casing 353 while 406 and 407 are similar pins but mounted respectively on the second arms of the levers 400 and 401. The third arms of said levers carry pins 408 and 409 engaging a rocker 410 which is provided with a pair of locating recesses 411 engaged by a spring pressed pin 412.

In the position shown the ribbon is being fed from the right-hand spool to the left-hand spool 356, its tooth disc 395 being in engagement with its worm 396 so that rotation of the platen shaft 377 effecting the paper feed also effects movement of the ribbon.

As soon as the ribbon on the right-hand spool 356 is exhausted, however, the tension in the ribbon actuates the pin 407 to rock the lever 401 about its pivot 399 which actuating through the rocker 410 also swings the lever 400 so that the right-hand spool 356 is thrown into engagement with its worm 396 and the left-hand spool 356 simultaneously disengaged, whereby the ribbon is reversed.

Projections on the housing 354 may shroud the spools 356 or separate domes may be provided.

As it is desirable to remove any possibility of a key being depressed during rotation of the main operating mechanism, the clearing bars 45 are locked during such rotation, by providing an abutment for the pin 278 controlled by suitable cam or other mechanism operable by rotation of the main shaft. This mechanism forms no part of the present invention, and, since it is quite usual in calculating machines, is not shown.

Describing shortly the operation of the nine column calculating and listing machine forming the preferred embodiment as illustrated, and referring first to an addition calculation, the only operations necessary are the setting up of the item on the keyboard and the reciprocation of the handle 4, a full stroke of which is ensured by the full stroke pawl 343.

Addition

During the forward stroke of the handle 4 the sequence of movements is as follows:—

(1) The keyboard is locked against depression of any keys therein other than those depressed therein.

(2) The actuating and setting racks advance, the type bars 240 are set and the no-print pawls 270 released.

(3) The printing bail 261 is released and the pressure devices associated with the type bars operate to effect printing.

(4) The totalizer wheels 20 are brought into engagement with the actuating racks 56.

(5) The full stroke pawl 343 is tripped to permit the return stroke of the handle.

During the return stroke of the handle:—

(1) The bail 261 is replaced releasing the type bars 240 for resetting.

(2) The actuating and setting racks and type bars are returned.

(3) The keyboard is cleared and the setting racks locked by the clearing shaft 170 depressing the common release keys, while the no-print pawls 270 are latched.

(4) The totalizer wheels 20 are thrown out of engagement by the bail 140.

(5) The pawls of those transfer mechanisms 94 which have been operated are released.

(6) The displaced transfer racks 57 are reset.

(7) The full stroke pawl escapes.

By this sequence of movements the item set up on the keyboard is first printed and then stored in the totalizer formed by the totalizer wheels 20 while the machine is cleared for the next operation.

Subtraction

To set the machine for subtraction the change-over lever 146 is moved to the subtraction position which throws the totalizer wheels 20 into engagement with the actuating racks and simultaneously operates the bail 110 to set both the addition and subtraction transfer mechanisms 94 and 95.

The item to be subtracted is then set up on the keyboard, no further settings being required.

During forward movement of the handle 4 the sequence of movements is as follows:

(1) The keys are locked.

(2) The actuating racks advance and the type bars are simultaneously set. Any transfer mechanisms which have been operated by the lugs 98 release their transfer racks 57 ready for subtraction.

(3) The bail 261 gradually releases the pressure devices and printing takes place.

(4) The released transfer racks 57 effect the subtraction transfers.

(5) a. The totalizer wheels 20 are thrown out; b. the pawls of the transfer mechanisms 95 are released.

(6) The full stroke pawl is tripped to permit rearward stroke of the handle 4.

During the rearward stroke of the handle:

(1) The bail 261 is replaced to permit resetting of the type bars 240.

(2) a. The actuating racks return and the transfer racks are reset and latched; b. the type bars 240 return and the no-print pawls are latched.

(3) a. The keyboard is cleared and the setting racks locked by depression of the column release keys; b. the subtraction change-over lever 146 is returned to addition position.

The sequence of movements outlined above for addition and subtraction are modified by depression of the various keys, for instance with the

non-add key 200 depressed, the totalizer wheels 20 are retained out of mesh both during the forward and rearward stroke of the handle 4, the link 139 being rendered inoperative.

With the non-print key 201 depressed the printing link 202 is rendered inoperative and although the type bars 240 are set the pressure devices are not operated and printing does not therefore take place.

The sequence of movements is otherwise the same as described above for addition.

To print the total or sub-total the only setting required is the depression of the respective key either 231 or 230, the keyboard being thereby automatically cleared. As before mentioned the printing of totals and sub-totals is effected by running off the actuating racks 56 against the totalizer wheels 20 to zeroize these latter, the movement of the various actuating racks 56 being transmitted to the type bars 240 and corresponding setting thereof resulting.

As previously mentioned, in place of the offset abutments 63, 63a, the setting rack 58 may be duplicated if desired, one rack carrying the abutments 63 and the second rack carrying abutments 63a.

Moreover, although the preferred embodiment illustrated employs laterally movable actuating racks, these actuating members may sometimes be in the form of swinging sectors.

A considerable advantage of the construction of calculating machine from a series of columnar units according to the preferred form of the invention, lies in the lateral rigidity of the assembled units and in the increased capacity in which the machine may be constructed without intermediate supports, the assembled units lying in close juxtaposed relation, and the spacing washers 15 preventing any distortion or displacement.

Moreover, due to the fact that the stretcher plate 28 of each unit is provided with open housings, each unit may be detached, replaced or interchanged with another unit as desired, without disturbing the remaining units.

To further standardize the parts of machines built to varying requirements the base 7 may be formed in sections, the outer sections carrying the side frames 3 being reproduced in each machine, and an intermediate section or sections being interposed of dimensions corresponding to the number of denominations within the capacity of the machine.

To prevent tampering with the machine, for instance when a total remains stored in the counters 20 a lock may be provided conveniently retaining the Non-add key 200 in its depressed condition, in which event the counters are maintained out of engagement with the remainder of the mechanism, and therefore cannot be disturbed.

Further, it will be understood that although the invention has been shown and described in connection with a direct adding and subtracting machine, the scope of the invention is not limited thereto, since it will be obvious that it is applicable to other forms of machine, such as machines which add only.

The appended claims relate to the feature of the calculating unit, the remaining features herein described being claimed in the associated divisional applications.

What I claim is:—

1. A calculating unit for a calculating machine having a main operating shaft comprising a stretcher plate carrying in combination

a movable rack, a normally stationary rack, a movable pinion engaging with both of said racks, a totalizer wheel, an actuating rack for the totalizer wheel carried by said pinion, a main operating member for said pinion formed for detachable and disconnectible connection with the main shaft of the machine, an operative connection between said member and the pinion, whereby movement of said member causes the pinion and the actuating rack normally to move differentially with respect to the movable rack, a key column, means on said movable rack for co-operating with any key of said column to limit the movement of the movable rack according to a key depressed for effecting a setting of the totalizer wheel corresponding to the key designation, and transfer mechanism holding the normally stationary rack stationary and adapted for co-operation with the totalizer wheel of an adjacent unit to release the stationary rack for transferring a digit to the totalizer wheel of its own unit.

2. A calculating unit for a calculating machine having a main operating shaft comprising a stretcher plate carrying in combination a movable rack, a normally stationary rack, a movable pinion engaging with both of said racks, mounting pins on said racks and pinion riding in guide slots formed in the stretcher plate, said guide slots respectively being of a greater length than the maximum travel of the member carried by the associated pin and having an enlarged end to permit of the removal or replacement of said member, a totalizer wheel, an actuating rack for the totalizer wheel carried by said pinion, a main operating member for said pinion formed for detachable and disconnectible connection with the main shaft of the machine, an operative connection between said member and the pinion whereby movement of said member causes the pinion and the actuating rack normally to move differentially with respect to the movable rack, a key column, means on said movable rack for co-operating with any key of said column to limit the movement of the movable rack according to a key depressed for effecting a setting of the totalizer wheel corresponding to the key designation, and transfer mechanism holding the normally stationary rack stationary and adapted for co-operation with the totalizer wheel of an adjacent unit to release the stationary rack for transferring a digit to the totalizer wheel of its own unit.

3. The structure of claim 1 and including a controlling member for a settable type bar pivoted on said plate and an operative connection between said main operating member and said controlling member whereby the type bar may be set in accordance with the setting of the totalizer wheel.

4. A calculating unit for a calculating machine having a main operating shaft comprising a stretcher plate carrying in combination a movable rack, a normally stationary rack, a movable pinion engaging with both of said racks, a totalizer wheel, an actuating rack for the totalizer wheel carried by said pinion, a multi-armed operating rocker pivotally mounted on the stretcher plate, one arm of said rocker being adapted for detachable connection with the main shaft of the machine, an operative connection between said pinion and a second arm of said rocker whereby movement of said rocker causes the pinion and the actuating rack normally to move differentially with respect to the movable rack, a key column, means on said movable rack for co-operating with any key of said column to limit the movement of the movable rack according to a key depressed for effecting a setting of the totalizer wheel corresponding to the key designation, and transfer mechanism holding the normally stationary rack stationary and adapted for co-operation with the totalizer wheel of an adjacent unit to release the stationary rack for transferring a digit to the totalizer wheel of its own unit, a controlling lever for a settable type bar pivotally mounted on the stretcher plate, and an operative connection between said lever and the operating rocker whereby the type bar may be set in accordance with the setting of the totalizer wheel.

7. A calculating machine having a main operating shaft comprising an assembly of calculating units each consisting of a stretcher plate carrying in combination differentially geared actuating and setting mechanism for a totalizer wheel, a main operating member for said mechanism formed for detachable and disconnectible connection with the main shaft of a machine, an operative connection between said mechanism and the operating member, a totalizer wheel arranged for actuation by said mechanism, a key column, means on said mechanism for co-operating with any depressed key of said column to set the totalizer wheel in accordance with the key designation and transfer mechanism adapted for

cooperation with the totalizer wheel of an adjacent unit of lower denomination to actuate the totalizer wheel of its own unit, a frame to said machine, bearer rods carrying the stretcher	
5 plates extending transversely of and mounted on said frame, spacing means interposed between each unit to give lateral rigidity to the machine, bearings in said frame, a main operating shaft mounted in said bearings, a plurality of control	
10 arms, one to each unit, an operative connection between said control arms and said main shaft whereby the control arms move with the main shaft, and means for detachably and disconnectibly connecting each control arm to the main	
15 operating member of the associated unit, whereby the said operating members move with the main shaft to actuate said differentially geared actuating and setting mechanisms until arrested by depressed keys.	
20 8. A calculating unit for a calculating machine having a main operating shaft comprising a stretcher plate carrying in combination a movable rack, a normally stationary rack, a movable pinion engaging with both of said racks, a rockable member pivotally mounted on the stretcher	
25 plate, a spindle on said rockable member, a totalizer wheel carried on said spindle, an actuating rack for the totalizer wheel, carried by said pinion, said spindle engaging in a slot in the stretcher plate for determining the engaged and disengaged positions of the totalizer wheel with respect to the actuating rack, a projection for	80
aligning and locking the totalizer wheel in a definite position when disengaged, a main operating member for said pinion formed for detachable and disconnectible connection with the main	85
shaft of the machine, an operative connection between said member and the pinion, whereby movement of said member causes the pinion and the actuating rack normally to move differentially with respect to the movable rack, a key	90
column, means on said movable rack for co-operating with any key of said column to limit the movement of the movable rack according to a key depressed for effecting a setting of the	95
totalizer wheel corresponding to the key designation, and transfer mechanism holding the normally stationary rack stationary and adapted for co-operation with the totalizer wheel of an adjacent unit to release the stationary rack for	100
transferring a digit to the totalizer wheel of its own unit.	105
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