Nov. 5, 1929. R. H. STROTHER 1,734,538

CALCULATING MACHINE

Filed Aug. 21, 1922 7 Sheets-Sheet 1

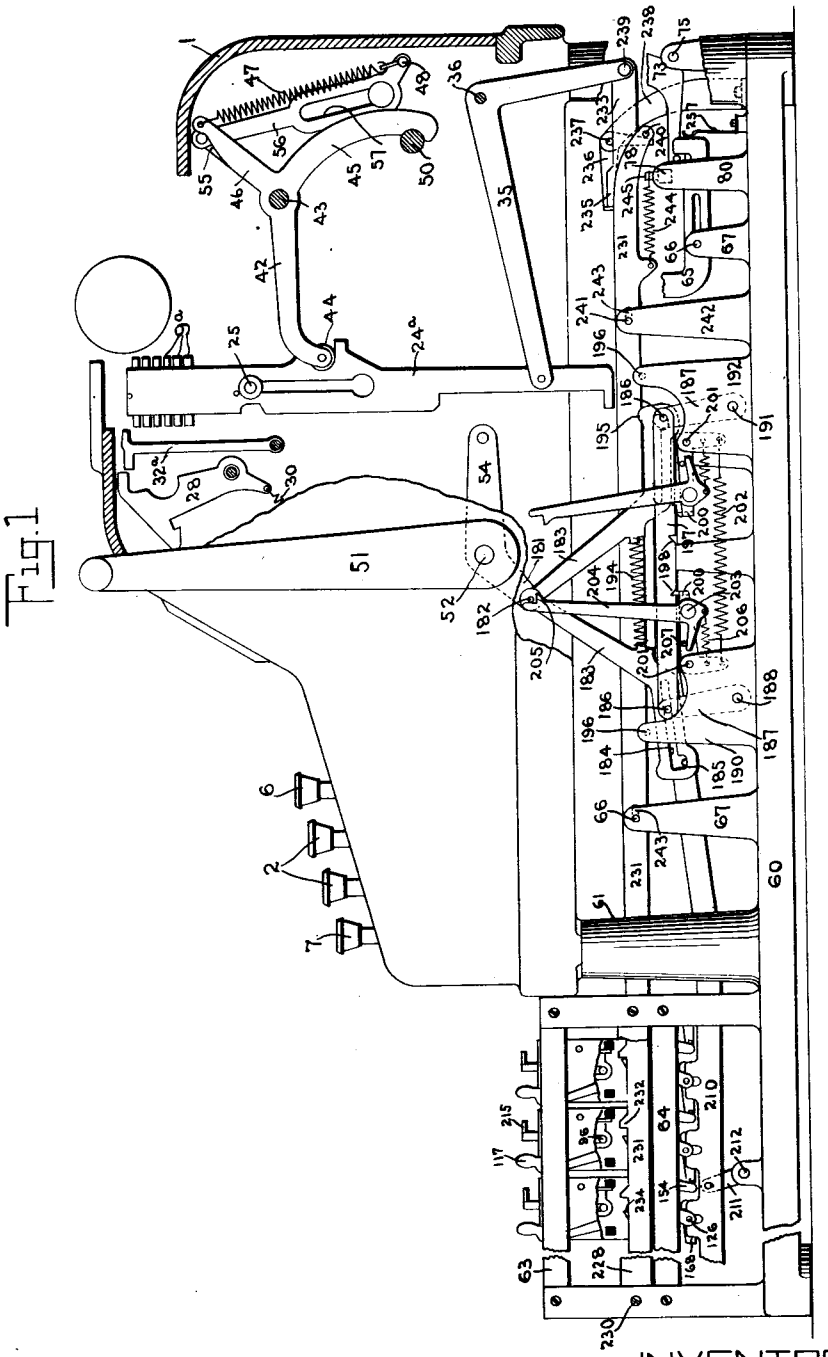


Fig. 1

WITNESSES
Lillian Nelson
E. M. Wells.

INVENTOR
Robert H. Strother
By Jacob Felbel
HIS ATTORNEY

Nov. 5, 1929. R. H. STROTHER 1,734,538

CALCULATING MACHINE

Filed Aug. 21, 1922 7 Sheets-Sheet 2

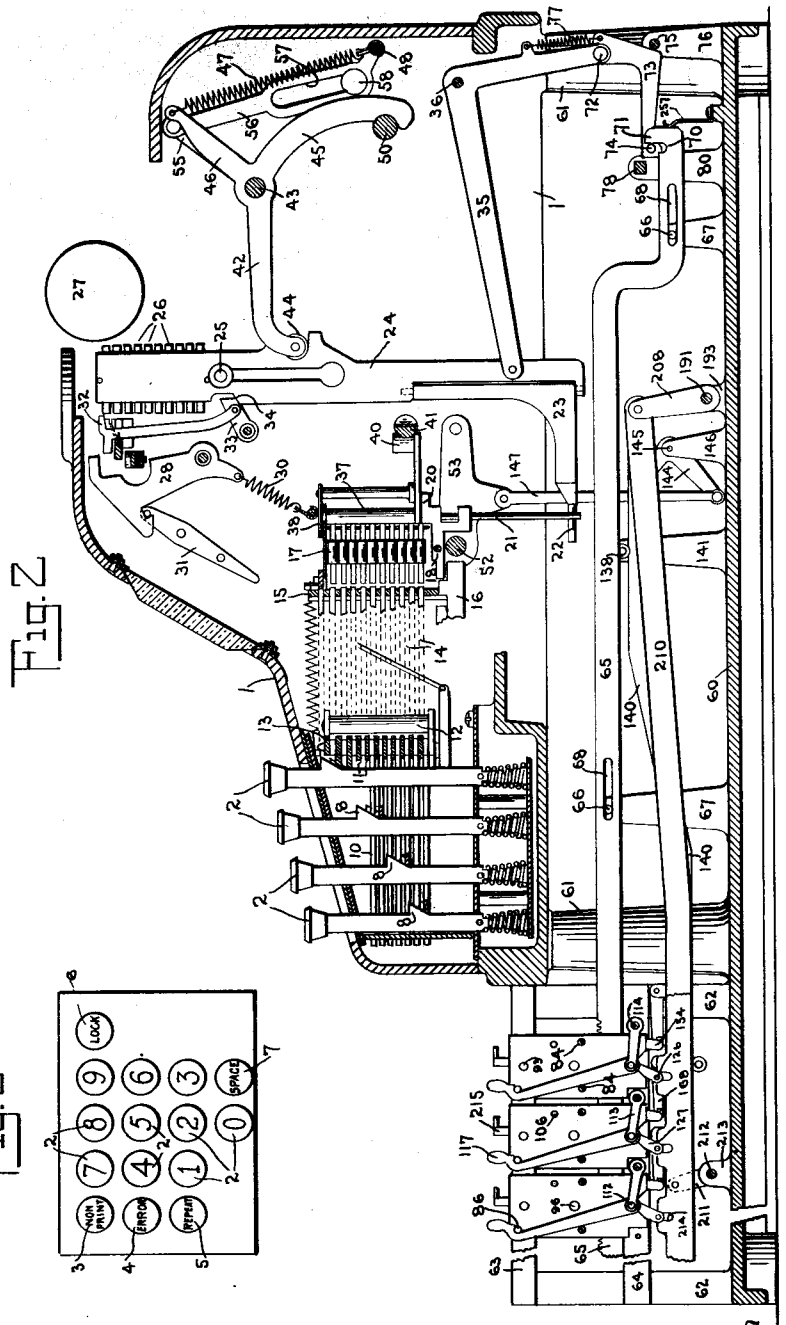


Fig. 2

Fig. 3

WITNESSES
Lillian Nelson
E. M. Wells.

Inventor
Robert H. Strother
By his Attorney
Jacob Felbel

Nov. 5, 1929. R. H. STROTHER 1,734,538

CALCULATING MACHINE

Filed Aug. 21, 1922 7 Sheets-Sheet 3

Fig. 4

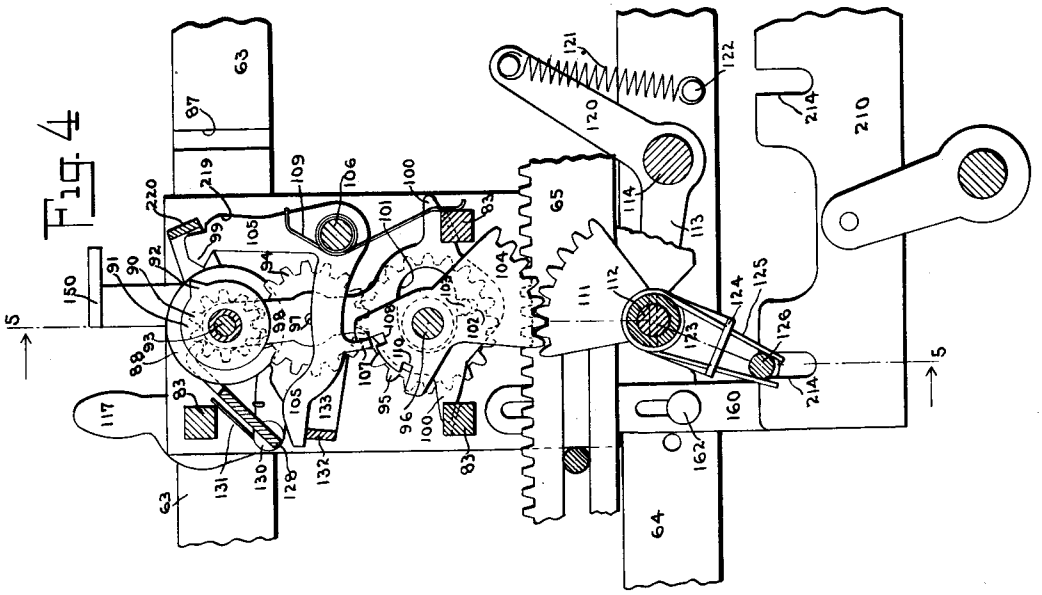
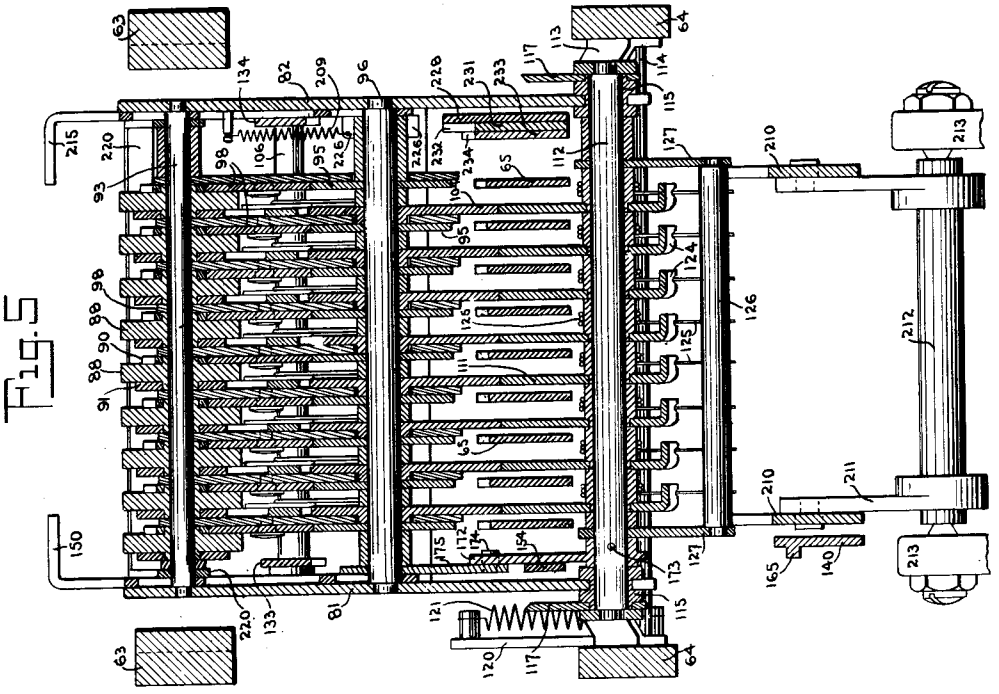


Fig. 5



WITNESSES

Lillian Nelson.

E. M. Wells.

INVENTOR

Robert H. Strother

By Jacob Fillel

HIS ATTORNEY

Nov. 5, 1929. R. H. STROTHER 1,734,538

CALCULATING MACHINE

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Fig. 9

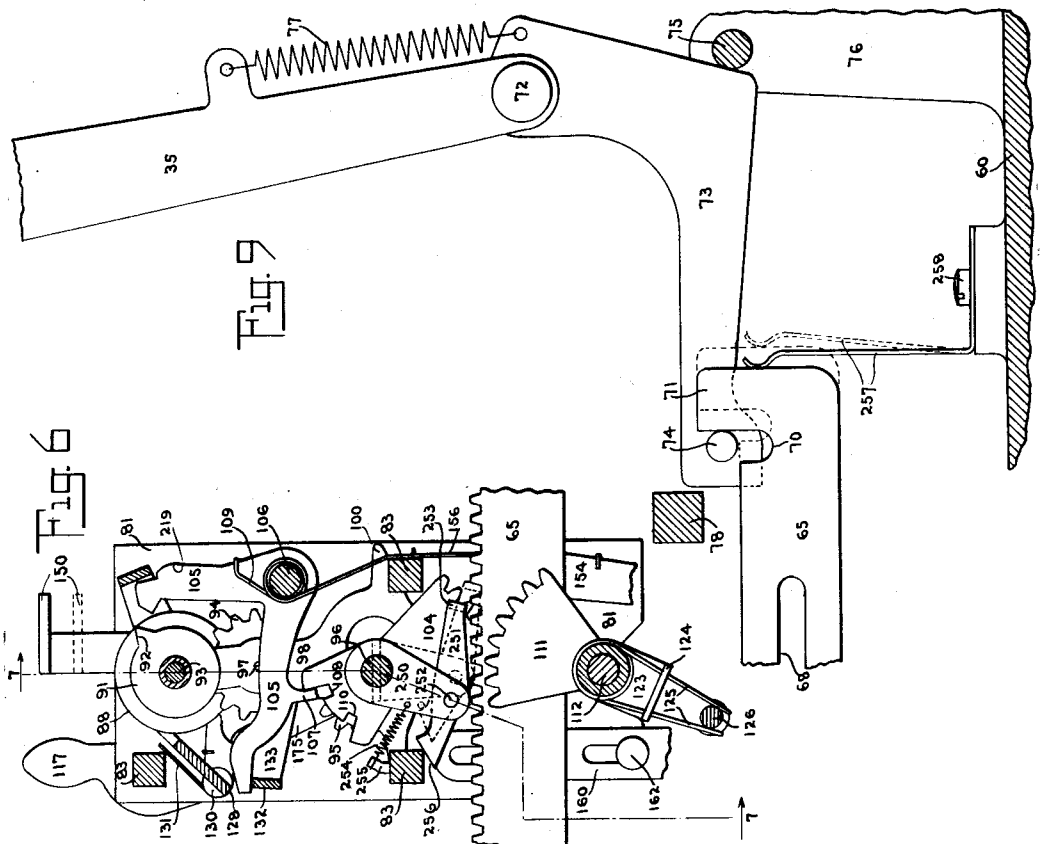


Fig. 6

Fig. 7

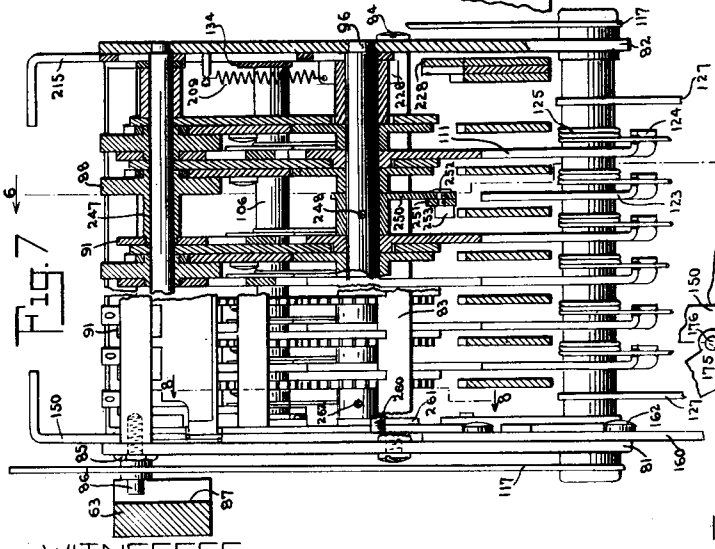
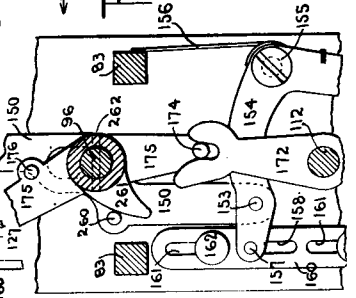


Fig. 8



WITNESSES

Lillian Nelson.

E. M. Wells.

INVENTOR

Robert H. Strother

By Jacob Fellel

HIS ATTORNEY

Nov. 5, 1929. R. H. STROTHER 1,734,538

CALCULATING MACHINE

Filed Aug. 21, 1922 7 Sheets-Sheet 5

Fig. 12

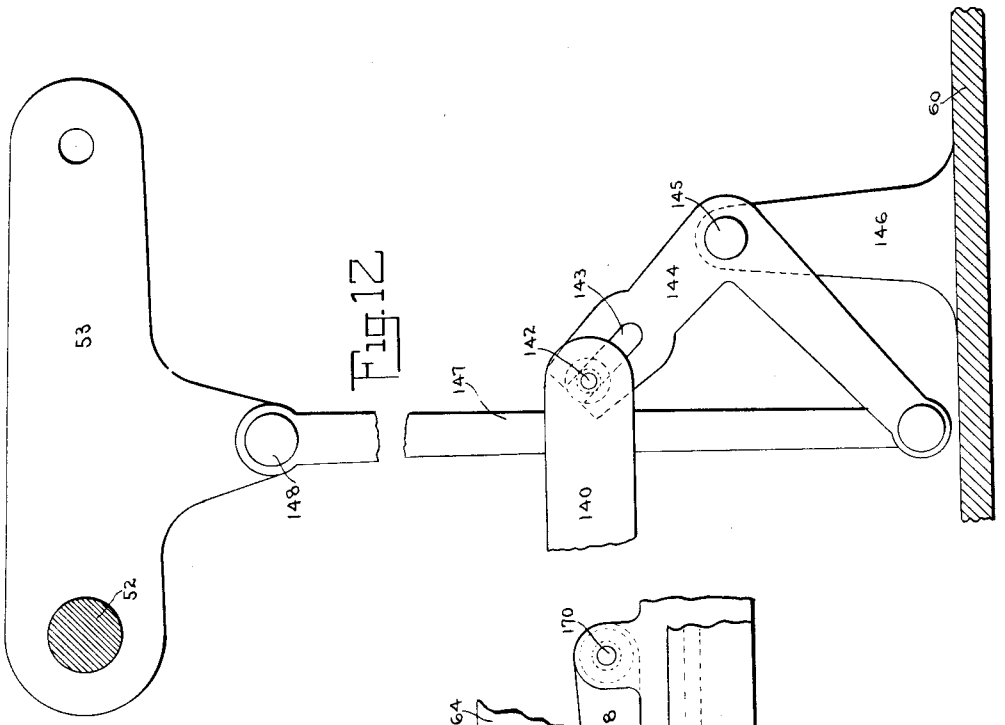


Fig. 11

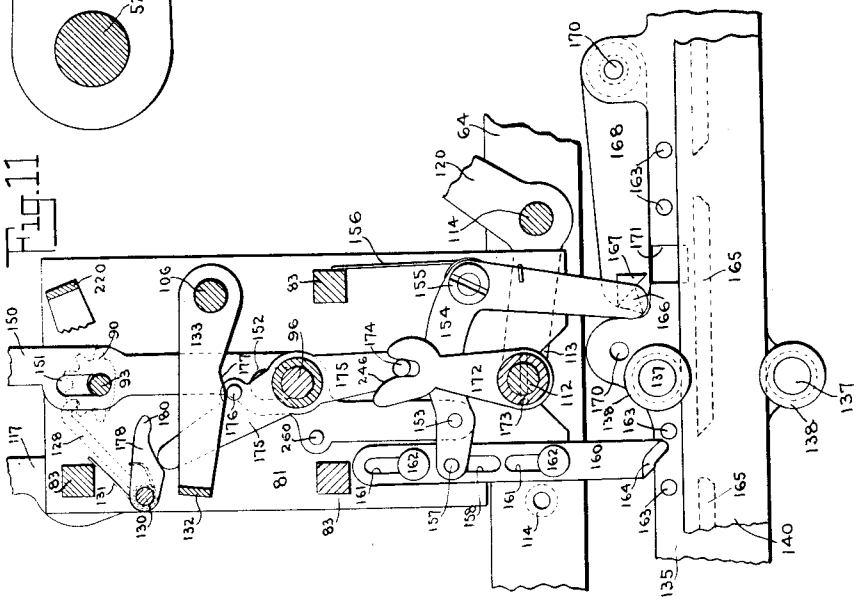
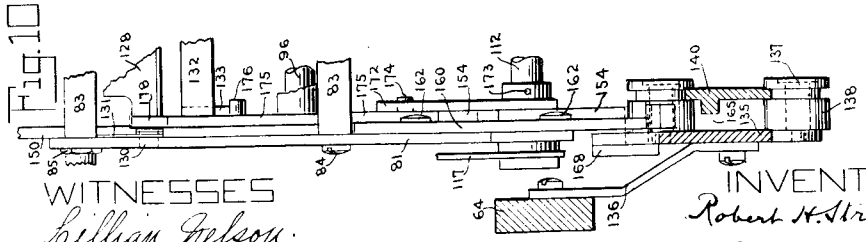


Fig. 10



WITNESSES
Lillian Nelson.
E. M. Wells.

INVENTOR
Robert H. Strother
By Jacob Felbel
HIS ATTORNEY

Nov. 5, 1929. R. H. STROTHER 1,734,538

CALCULATING MACHINE

Filed Aug. 21, 1922 7 Sheets-Sheet 6

Fig. 13

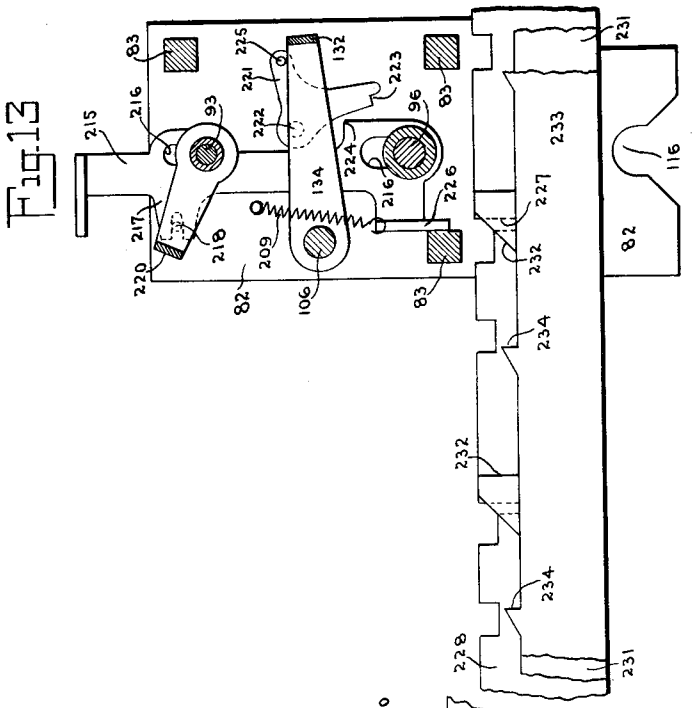
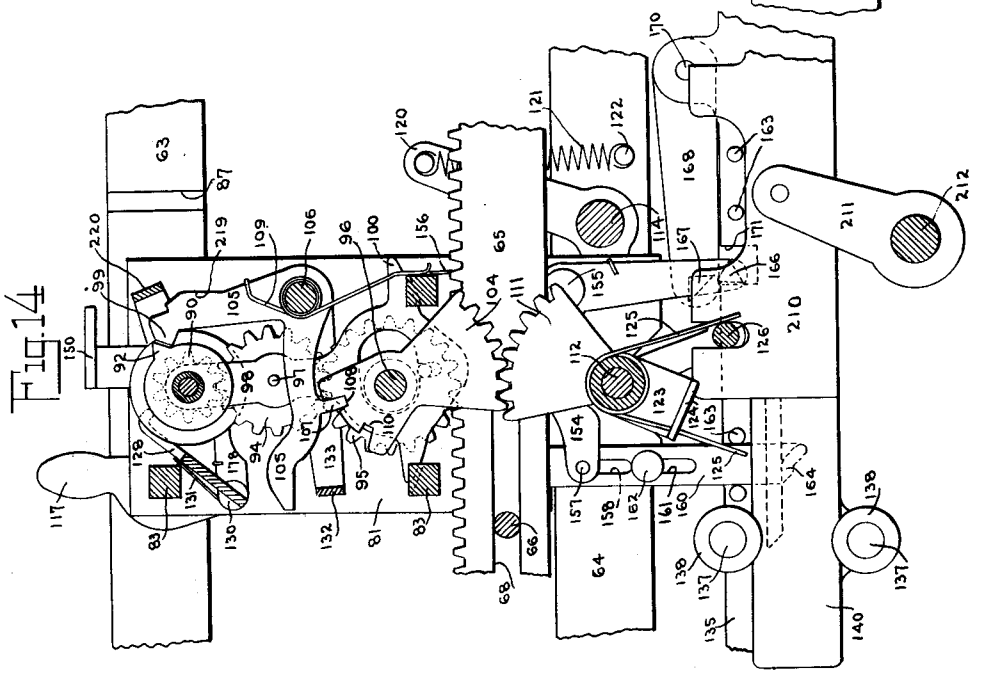


Fig. 14



WITNESSES

Lillian Nelson

E. M. Wells.

INVENTOR

Robert H. Strother

By Jacob Felbel

HIS ATTORNEY

Nov. 5, 1929. R. H. STROTHER 1,734,538

CALCULATING MACHINE

Filed Aug. 21, 1922 7 Sheets-Sheet 7

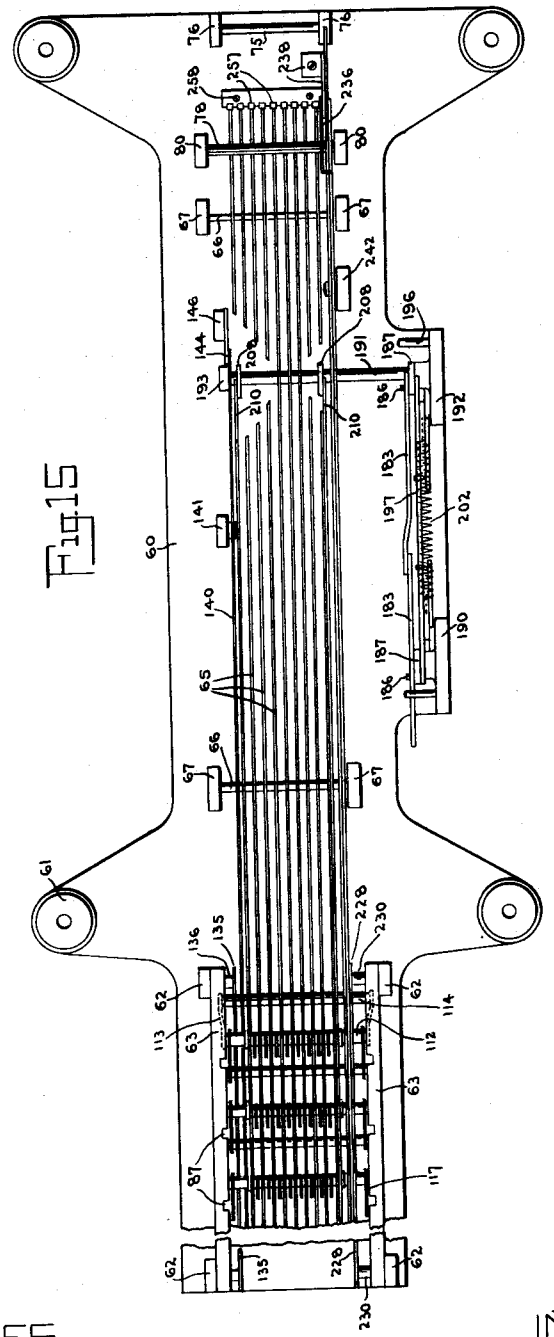


Fig. 15

WITNESSES
Lillian Nelson
E. M. Wells.

INVENTOR
Robert H. Strother
Jacob Feldman
HIS ATTORNEY

Patented Nov. 5, 1929 1,734,538

UNITED STATES PATENT OFFICE

ROBERT H. STROTHER, OF MONTCLAIR, NEW JERSEY, ASSIGNOR TO REMINGTON ACCOUNTING MACHINE CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

CALCULATING MACHINE

Application filed August 21, 1922. Serial No. 583,391.

This invention relates to calculating machines.

One object of the invention is in a calculating machine in which the registration of numbers is controlled by a series of denominational racks, to provide for the use in conjunction with the same racks of different registers or totalizers arranged for different styles of punctuation.

In addition to operating registers of different styles of punctuations by the same set of denominational racks provision is also made, in a machine in which said racks are connected with denominational type carriers, for printing said numbers from said type carriers in different styles of punctuation, depending upon the particular register that is in use at the time. If one register has certain blank spaces either for the purpose of punctuation or for any other purpose, means are provided whereby when this particular register is in use the rack and printing mechanism in any blank space of said register will be disabled so that where there is any blank space in the register there will be a corresponding blank in the printing.

Another object of the invention is to provide, in a calculating machine in which the numbers are printed by means including a series of denominational type carriers, a special key which when operated will prevent printing in any particular denomination while permitting printing in all other denominational positions, either higher or lower.

Another object is to provide in a calculating machine in which a plurality of registers may be brought selectively under the control of a set of denominational racks, for printing a total indicated on any one of said registers. In the machine shown in the drawings such total may if desired be transferred either additively or subtractively to any other register having the same style of punctuation.

Another object is to provide in a machine in which a plurality of registers are controlled by a set of denominational racks, means whereby different one of said registers may have different styles of punctuation so that the same set of racks may at one time control the registration of numbers in one style of punctuation and at another time in another style of punctuation.

Another object of the invention is to provide, in a machine of the character last indicated, for printing the numbers in any style of punctuation corresponding to that of the particular register that is brought under the control of the racks in any given operation.

Another object of the invention is to provide, in a machine in which a plurality of registers are controlled from the same set of denominational racks and in which said racks are connected to type carriers to print numbers, improved means for the printing of the total from any desired register and automatically printing in conjunction therewith a designating character to show from which register the total was taken.

In the machine shown in the drawings provision is made for the use of several totalizers and these are detachable so that the user of the machine may have different kinds of totalizers of different sizes and arranged for different styles of punctuation or other spacing, and the operator may readily detach any totalizer and substitute for it another totalizer of a different style, and all of these totalizers may be controlled from the same set of racks and print from the same printing mechanism including denominational type carriers.

The invention also has minor objects which will appear in the course of the description.

To the above and other ends the invention consists in certain features of construction and combinations and arrangements of parts all of which will be fully set forth herein and particularly pointed out in the claims. The principal features of the invention are of such sort that they can be embodied in forms differing considerably from each other and only one such form has been shown. It will be apparent from reading the following description that many and in some instances rather wide modifications can be made within the scope of the invention.

In order to show a complete machine embodying the invention said invention is shown applied or added to a calculating and listing machine of the sort shown in the re-

issued patent to G. D. Sundstrand No. 14,237, reissued Dec. 26, 1916. The invention has been shown in connection with this Sundstrand machine merely for the purpose of illustration. It will be understood that any desired part or all of the Sundstrand mechanism may if preferred be replaced with mechanism of other design.

In the accompaning drawings

Figure 1 is a side elevation partly broken away illustrating a portion of the Sundstrand mechanism and a portion of the new mechanism combined therewith.

Figure 2 is a general view in irregular section longitudinal of the machine and with parts broken away and parts omitted.

Figure 3 is a plan view of the keyboard.

Figure 4 is a longitudinal section through one of the totalizers, together with fragmentary views of some of the associated parts.

Figure 5 is a section taken about on the line 5—5 of Fig. 4 and looking toward the rear.

Figure 6 is a longitudinal section taken through another of the totalizers arranged for a different style of punctuation, the section being on line 6—6 of Fig. 7.

Figure 7 is partly a front elevation and partly a middle section of Fig. 6. In both of these figures some of the parts associated with the totalizer are shown.

Figure 8 is a fragmentary longitudinal section of the inside of the totalizer shown in Figs. 6 and 7, said section being taken about on the line 8—8 of Fig. 7 and looking toward the left.

Figure 9 is a fragmentary side elevation showing part of the connections between one of the denominational rack bars of the new mechanism and one of the denominational type carriers of the Sundstrand machine.

Figure 10 is a fragmentary front view of the extereme left-hand part of one of the totalizers and associated mechanism.

Figure 11 is a longitudinal section looking toward the left and showing in face view the mechanism shown in the front view in Fig. 10.

Figure 12 is a fragmentary view in right-hand side elevation showing the connections of some of the mechanism of Figs. 10 and 11 with the operating mechanism of the Sundstrand machine.

Figure 13 is a longitudinal section near the right-hand side of a totalizer and looking toward the right and illustrating the total key and associated devices.

Figure 14 is a view somewhat similar to Fig. 4 but showing the register depressed into engagement with the racks and some of the mechanism in a position it occupies at a point in the operation of the operating mechanism.

Figure 15 is a plan view of the lower part of the machine with the Sundstrand machine and the totalizers removed.

The Sundstrand machine described in the reissue Patent No. 14,237 above referred to comprises frame-work and a casing which is here generally designated by the reference numeral 1. It also comprises a series of ten digit keys 2, a non-print key 3, an error key 4, a repeat key 5 and a lock key 6. All of these keys and their connections are retained in the machine illustrated in the drawings. By far the greater part of the mechanism controlled by these keys is not illustrated here because it is not necessary to an understanding of the present invention, said mechanism being fully described in the patent referred to. In said patent there are also shown a non-add key and a total key, and mechanism controlled by said keys for performing the indicated functions. These two keys and all of said mechanism are omitted from the present machine in which as will hereinafter appear a non-add key is not necessary and in which each totalizer is provided with its own total key.

There has been added a special space key 7 and some connections therefrom which will be described hereinafter.

In the Sundstrand machine the stem of each digit key 2 has a wedge-shaped part 8 whereby each of said keys when depressed operates one of a series of slides 10, which slides operate a series of levers 11, all of which levers act on a sort of universal bar 12 connected to a universal lever 13. The levers 11 and 13 operate push pins 14. Of these the uppermost one is connected with the universal bar and works a carriage escapement and the remainder pass at their rear ends through a guide 15 supported by a pivoted bracket 16 which under the control of the escapement above mentioned has a step by step motion from left to right. In the stationary frame there are mounted a plurality of vertical rows of settable stops 17 and the step by step motion of the bracket 16 and guide 15 brings the push pins 14 into register with one after another of said vertical rows of stops. The whole construction is such that the bracket or carriage 16 normally occupies its extreme left-hand position and when the keys 2 are operated one after another each operation of a key sets one of the stops 17 and spaces the carriage to the right so that the next operation of a digit key sets one of said stops in the next row, and so on for as many operations as there are digits in the number to be registered.

Articulated with the bracket 16 in a manner fully described in the Sundstrand patent and sliding on a rod 18 is a carriage 20 including among other things a transverse bar having in it a series of vertical holes through which pass pins 21, the upper end of each pin being normally below the lowermost one of the stops 17, and the lower end of each pin be-

ing slidably mounted on the projecting end 22 of an arm 23 pivotally mounted to swing right and left on one of a series of denominational type carriers 24, the latter being vertically movable on a guide rod 25 and carrying in its upper part a series of digit types 26 adapted to be driven selectively, according to the height to which the bar 24 moves, against the paper which is on a platen 27. Said types are driven by hammers 28 actuated by springs 30 and drawn back and released by a frame 31 all in the manner fully described in the Sundstrand patent referred to. The hammers 28 act on the types 26 through the instrumentality of certain bumpers 32 each at its lower end pivoted to an arm 33 which is controlled by a shoulder 34 on one of the type carriers 24. The bumpers 32 normally occupy an inoperative position shown in Fig. 2 but if any type carrier has been moved upward under the control of the digit keys the shoulder 34 will raise the corresponding bumper to operative position and means are described in the patent whereby this motion will be communicated to bumpers to the right of the one operated so as to print the significant zeros and not to print the non-significant zeros.

In the Sundstrand machine each of the type carriers 24 is provided near its lower end with a guide link 35 pivoted at the rear of the machine on a rod 36. In the present instance these guide links have been retained but have been modified into bell cranks having depending arms which connect the Sundstrand mechanism with the new mechanism.

The carriage 20 has on it certain devices including a wiper 37, a pointer 38 for showing the denominational position to the operator, and a pin or stud 40, the last co-operating with a frame 41 which is pivoted on the guide rod 25 and which normally occupies the forward position shown in Fig. 2, but as soon as any key has been operated is pressed back a short distance toward the rear of the machine. In the Sundstrand machine as described in the patent above referred to this frame has on it a certain locking device to prevent certain operations of the machine in case one of the type carriers 24 has been moved below its normal position to transfer. This locking device is omitted in the present instance.

The type carriers 24 are moved upward differential distances by means of spring operated arms 42 pivoted on a rod 43 and having rolls 44 that engage in open ended slots in the type carriers. Each of the arms 42 is part of a three-armed lever including also a depending arm 45 and an upwardly and rearwardly extending arm 46, the latter being adapted to be drawn downward by a spring 47, the lower end of which is connected to a cross rod 48. In the Sundstrand machine the arms 42 and 46 are integral but they have, to the extent of one unit of movement, lost motion with respect to the arm 45, this being a part of the Sundstrand transfer scheme. In the present instance, however, all of Sundstrand's registering mechanism is omitted, including his transfer mechanism, and the arms 42, 45 and 46 are made integral. In the Sundstrand machine the arms corresponding to the arms 45 are normally pushed back by means of a certain cross bar 50 far enough so that on occasion the arm 42 may move one unit's distance below its normal position in order to carry to a register wheel, thus bringing the uppermost one of the types 26, namely, the type that prints "0", one space below printing position. In the present machine where there is no lost motion between the arms 45 and 42 the type carriers normally occupy the position last described, that is, they are normally below printing position, so that even if the bumpers 32 were in operative position and the hammers 28 were operated no printing would occur. The reasons for this will appear hereinafter.

The Sundstrand machine has operating mechanism including a handle 51 mounted on and, through certain mechanism described in the patent above referred to, connected with a main rock shaft 52, said handle and shaft being rocked something like 90° toward the front of the machine by the operator and then moving back to normal position. At the left of the differential mechanism the shaft 52 has fixed thereon an arm 53, Fig. 2, and at the right of said mechanism said shaft has a somewhat similar arm 54 fast thereon, these arms being connected by certain links with the bar 50 above referred to, so that said bar is moved toward the front of the machine by the forward motion of the handle and is returned on the return stroke of the handle. The bar 50 is by means described in said patent connected with arms 55, each having pivoted thereto a link 56, said link having a slot 57 adapted to slide over a guide pin 58. The bar 48 above alluded to is carried by these links 56 and at each operation of the handle it is moved downward to increase the tension on the springs 47, all as set forth in the patent referred to. In said patent these links, which are here numbered 56, have also certain other devices connected therewith and entering into the action of the transfer mechanism, which devices are here omitted. The shaft 52 in the Sundstrand machine is controlled by certain full stroke devices and by certain speed governing means which are retained in the present machine although they are not shown in the drawing. The speed governing mechanism is important in the present machine in order to give time for certain spring operated devices to act and it may be desirable that certain parts of the motion of the operating mechanism be even slower in the present machine than in the Sundstrand machine for that reason.

In the Sundstrand machine the frame 41

controls a certain plate not here shown but which in the patent is numbered 48ª, and which, as soon as a numeral key has been operated and the frame 41 moved towards the rear, moves forward over the ends of all of the pins 21 which are to the left of the first vertical row of stops 17. In the present machine this plate is retained but is so located and the length of the pins 21 so determined as that said stop plate holds the bars 24 in their normal non-printing positions.

In the Sundstrand machine there are in each vertical tier nine of the stop pins 17, namely, one for each of the digits, 0—8. In the present machine there has been added at the bottom of the series a tenth stop 17, push pin 14, lever 13 and slide 10, these parts being operated by the space key 7 hereinbefore mentioned. When operating the keys of the Sundstrand machine, the "0" key 2 is depressed for every denomination in which a "0" is to be printed and added and this operates the lowermost one of the stops 17 and holds the type carrier 24 in position to print "0". In the present machine the same mode of operation is followed, but there may be instances where for some reason it is desired not to print at all in a certain denomination, thus practically dividing the work into two columns. In such case the special space key 7 may be depressed instead of the "0" key, in which event the type carrier of that denominational position will be held in its normal non-printing position and nothing at all will be printed in that space. As will hereinafter appear, the register-actuating rack of that denomination will also not be operated under these conditions.

In the present machine most of the mechanism that has been added to the Sundstrand machine is contained in special framework which comprises a base 60 having four posts 61, on which the ordinary frame 1 of the Sundstrand machine rests, so that some of the added mechanism is beneath the Sundstrand machine. The frame 60, however, extends some distance forward of the Sundstrand machine where it has, amongst other things, four upright posts 62, namely, two left-hand and two right-hand posts, each such pair of posts supporting an upper longitudinal frame bar 63 and a lower longitudinal frame bare 64. The totalizers are situated in this forwardly projecting part of the frame between the two frame bars 63 and between the two frame bars 64.

Said totalizers are controlled by a series of differentially movable denominational rack bars 65 which extend from the front of the machine horizontally nearly to the back thereof. These bars are supported for longitudinal movement in any suitable way, the means here shown consisting of cross rods 66 each supported at its ends in lugs or brackets 67 projecting up from the base 60 and said rods passing through longitudinal slots 68 in said racks. The latter may be spaced apart on the rod 66 by suitable washers. At its rear end each of the bars 65 is offset downward to a suitable extent and it has a notch or open-ended slot 70, the rear wall of said slot being extended upward above the general level of that part of the bar by a lug 71. The depending arm of each of the levers 35 has pivoted thereto at 72 an angled link 73 having a pin 74 near its forward end, said pin normally standing as shown in Figs. 2 and 9, just above the slot 70. Said pin is held in the position described by means of a fixed cross bar 75 mounted in lugs 76 projecting upward from the base 60 and so located that the link 73 strikes said bar 75 in the course of the return stroke of the lever 35 and just as the first type 26, namely, the "0" type is at the printing position. The next increment of downward motion of the type carrier 24 carries the pivot 72 a little to the rear and lifts the pin 74 out of the notch 70. The link is urged downward by its own gravity and also by a spring 77 connected with the link and with the lever 35. When in the operation of the machine by the operating mechanism a type carrier 24 begins to move upward the first increment of its motion, namely that which brings the "0" type to printing position, drops the pin 74 into the notch 70 without imparting any motion to the rack bar 65 but from that point on the type carrier and rack bar move in unison though in different directions and at different velocities. A stationary bar 78 supported in lugs 80 from the base 60, is so situated that in the normal position of the parts it is just in front of the front end of the link 73 so that said link cannot move forward without first dropping into the slot 70 and once having moved forward far enough to move the rack bar 65 said link is by said bar 78 positively retained in engagement with said bar 65. When the parts are in the normal position shown in Figs. 2 and 9 the rack bar 65 cannot move forward on account of the lug 71 engaging the pin 74 and said pin itself cannot move forward on account of the link 73 engaging the bar 78.

The totalizer or registering mechanism can be understood by reference to Figs. 4, 5 and 14, in which the registering mechanism is shown in Figs. 4 and 5 in normal position and in Fig. 14 in operating position. The detail construction of each totalizer can be varied considerably within the scope of the invention. As here shown the frame of each totalizer comprises a left-hand end plate 81, a right-hand end plate 82 and cross bars 83 here shown as square bars each fastened at its ends to the frame plates by screws 84; but the uppermost one of the three frame bars shown has the heads of its screws 85, Figs 2 and 7, made of a special shape, each terminat-

ing in a pin 86 lying in a slot 87 in the inner face of a frame bar 63. These pins guide the upper part of the totalizer as it moves up and down between its operating position shown in Fig. 14 and its normal position shown in the other figures. The totalizer is preferably covered with a casing plate at front, top and back, with a suitable sight-opening for the dials, but the plate is not shown in the drawing.

Each of the numeral wheels comprises a dial or drum 88, a pinion 90 rigid with said drum on the right-hand side thereof and a transfer disk 91 having a tooth 92 on the left-hand side of said drum. These numeral wheels or dials are strung along a shaft or rod 93 secured at its ends in the frame plates 81 and 82. The totalizers shown in the drawing are arranged for decimal notation and the pinions 90 therefore have each ten teeth. Said pinions mesh continuously with intermediate gear wheels 94 and these in turn mesh with idler gears 95, the latter together with certain other devices being strung along and journaled on a cross shaft 96 mounted at its ends in the frame plates 81 and 82. When the totalizer is depressed to its working position shown in Fig. 14, the gears 95 mesh with the racks 65 and when the totalizer is moved to its normal position the racks and gears are disconnected. Each of the intermediate gears 94 is separately movable bodily in a direction parallel to its plane in order to transfer. To this end each of said gears is individually journaled on a stud 97 projecting leftward from one of a series of plates 98, said plates 98 being each pivoted on the rod 93 between two of the numeral wheels, with freedom to swing a short distance front and back. These plates 98 may be guided in any suitable way but as here shown each of them at its lower part has projecting wings 100, which are adapted to slide through suitable slots which are cut for the purpose in two of the frame bars 83. Each of said plates is made with an opening 101 through which the shaft 96 passes, said opening being made merely for clearance as the plates in the form here shown have no connection with said shaft.

The swinging motion of each plate or hanger 98 is controlled by means including a slot or notch 102 into which a stud 103 projects leftward from a sector 104. There is a set of said sectors pivoted on the shaft 96 between the several idler wheels 95; but the extreme right-hand hanger 98 is stationary to which end it may be fastened by any suitable means to one of the frame bars 83. In the present instance the hangers 98 are swung front or back to transfer by springs as will presently appear and their motion is controlled by transfer dogs 105 pivoted on a shaft 106 supported at its end in the end plates 81 and 82. Each of these dogs is in the general form of a bell crank having a horizontal arm extending forward just above the sector 104 and a vertical arm extending behind a transfer disk 91, where it is provided with a tooth 99 adapted to be deflected by the tooth 92 when the wheel turns in either direction through the space between "9" and "0". Each dog is pressed toward the wheel by a light spring 109. The horizontal arm of each dog 105 has a tooth 107 adapted to enter two notches 108 and 110 in the upper edge of the sector 104. The motion of said sector in both directions is limited by prolonging the rear wall of the notch 108 and the front wall of the notch 110 radially so that even when the dog is in its elevated position shown for example in Fig. 4 it is still engaged by one of these prolongations notwithstanding it is lifted out of the notch. In Figs. 4 and 14 a hanger 98 is shown in its rear position controlled by the notch 108 in the sector 104 but it will be seen that with the dog elevated as shown in Fig. 4 said sector can be swung until the notch 110 is under the tooth 107 and that such swinging motion would swing the hanger 98 forward a short distance through the pin 103 and notch 102.

The sectors 104 are actuated by means of a series of gear sectors 111 each having a hub pivoted on a shaft 112 which shaft lies beneath the rack bars 65, the sectors 111 coming up between said rack bars. The shaft or rod 112 is rigidly mounted in the forward ends of two arms 113 fixed to a rock shaft 114, which rock shaft is journaled at its ends in the frame bars 64. The shaft or rod 112 has a hub or collar 115 pivoted thereon near each end thereof. The frame plates 81 and 82 extend downward and each of them has a notch 116 therein, Fig. 13, that fits over the corresponding collar 115, which collar is grooved as indicated in Fig. 5. The construction is such that any totalizer can be set on to the machine by placing it in position from the top and pushing down the totalizer until the notches 116 come into suitable engagement with the hubs 115, meanwhile also guiding the pins 86, Fig. 7, into the slots 87. In order to secure the totalizer in place each of the hubs 115 has fixed thereto a hand operated latch 117. These latches extend upward as best shown in Fig. 2 each terminating at its upper end in a handle and each having a hook or shoulder adapted to hook over one of the screw heads 85 which screw heads may be annularly grooved for the purpose. There is one of these latches on each side of the totalizer and by moving them toward the front of the machine any totalizer may be almost instantly removed by the operator and another put in its place. The rock shaft 114 above described may have near one or both ends thereof an arm 120 connected by a strong tension spring 121 with a pin 122 on the frame bar 64, this spring or these springs

serving normally to hold the totalizer in its elevated or non-working position. It will be seen that the shaft 112 moves up and down with the totalizer so that the sectors 104 and 111 are always in engagement when the totalizer is on the machine but they separate when a totalizer is removed from the machine, the sectors 104 being built into the totalizer and the sectors 111 being built into the non-detachable part of the machine.

Each of the sectors 111 has projecting downward therefrom an arm 123, each of said arms at its lower end being bent off to the right to form an ear 124. Around the hub of each sector a spring 125 is coiled, the two ends of the spring projecting downward and entering notches in the front and back sides respectively of the ear 124. This spring is under tension to cause the two branches thereof to approach each other, but they are normally held apart by being pinched against the ear 124. Said springs project beyond the ears 124 and each of them straddles a cross rod 126 forming part of a bail having also end arms 127, Fig. 5, said arms being pivoted on the shaft or rod 112.

The mechanism of the totalizer includes any suitable means for locking the dial wheels 88 against rotation at certain times. In the present instance this takes the form of a plate or bar 128 of sheet metal pivoted in the end plates 81 and 82 by means of hubs 130 and pressed toward the register wheels by a spring 131. This plate has a series of fingers each at its free end bent to form a tooth to engage between two of the teeth of a pinion 90.

The register also includes a bail bar 132 having a left-hand arm 133, Figs. 4 and 11, and a right-hand arm 134, Fig. 13, the bar 132 lying beneath the ends of the dogs 105 which are prolonged forward for the purpose. The arms 133 and 134 are pivoted on the rod 106.

The general principle of operation of the register and transfer mechanism can be understood from what has been said and from the following: The parts are normally in the position shown in Fig. 4 with the register wheels out of mesh with the racks 65, the dial wheels locked by the bar 128, the dogs 105 elevated by the bail 132, the sectors 104 having the notches 108 in register with the teeth 107 and the bail 126 in its forward position with the springs 125 each pinched together against it. If it is desired to subtract a number from the register that number is set up by the keys 2 as hereinbefore described. By the use of a key to be presently described the totalizer is next moved down to bring its wheels into engagement with the racks 65. The downward motion of the totalizer first causes the bail 132 to be dropped down from the position shown in Fig. 4 to that shown in Fig. 14, allowing the dogs 105 to swing to their operative positions with their teeth 107 engaging the notches 108 and with their teeth 99 in position to be deflected on occasion by the teeth 92 of the dial wheels; and afterward the bar 128 is caused to be lifted to unlock the pinions 90. The handle is then pulled which first causes the totalizer to be locked in its depressed position and the bail 126 is then swung toward the rear as shown in Fig. 14, which forces the rear branch of each spring 125 rearward. The forward branch cannot follow it because of its engagement with the ear 124, the sectors 104 and 111 being prevented from moving at that time by the transfer dogs 105. At a later stage in the motion of the handle the type carriers 24 move up as far as the stops 17 will allow, the first step of that motion being idle, and the remainder of the motion moving the rack bars 65 toward the front of the machine, each to the extent of a number of its teeth corresponding to the digit to be registered in that denomination. The racks 65 turn the register wheels 95, 94 and 90 to correspond with the several digits. In case one of the dial wheels passes from "0" to "9" it operates the dog 105 which releases the sector 104 and allows that particular sector to be operated by its spring 125, the ear 124 moving rearward to the rear branch of the spring 125, and bringing the notch 110 into position to be engaged by the tooth 107, which will occur immediately because the tooth 92 does not stop under the tooth 99. When the sector 104 swings in the manner described its pin 103 swings the hanger 98 forward moving the axis 97 of the wheel 94 one-half space toward the front of the machine. At this time the wheel 95 is under control of the rack 65, but the wheel 90 is free to turn. If the wheel 95 is standing still at the moment, the lower side of the wheel 94 which engages said wheel 95 will pivot on said wheel 95 and the opposite or upper side of said wheel 94 will be moved a full tooth space turning the dial pinion 90 one space. A similar thing will happen if the wheel 95 is in motion at the time, the action being that the pinion 90 will receive one tooth more of motion than it would if the hanger had not moved the axis of the wheel 94 forward. It will thus be seen that the transfer takes place whenever a dog 105 is tripped irrespective of whether or not the register is at the time being digitally operated by the rack 65 in the denomination to which the transfer takes place. At the end of the operation the racks 65 or some of them will have been moved different distances toward the front of the machine depending on the number subtracted and some perhaps of the hangers 98 will have been swung forward to transfer and others will not. At the end of the forward stroke of the handle the totalizer is released and is moved to its upper

position shown in Fig. 4 by its spring or springs 121. This motion results in first depressing the bar 128 to lock all of the dial wheels against rotation in either direction and an instant later the bail 132 lifts all of the dogs 105 out of engagement with their sectors. Some of these sectors will perhaps already have swung to their positions where the notches 110 are in register with the teeth 107 but such of them as have not already done so will immediately snap to that position driven by their springs 125 on account of the bail 126 being in its rear position. At the end of the forward stroke of the handle therefore this particular totalizer will be substantially as shown in Fig. 4, except that the bail 126 will be in its rear position, all of the sectors 104 will be in position where the notches 110 are in register with teeth 107, and the hangers 98 will be in their forward positions.

In case any wheel has not received an increment of motion by transfer and its sector 104 has been swung idly after the termination of the subtracting operation, the effect of such idle swinging will be to move the axis 97 of the gear 94 one-half space toward the front of the machine. At this time, however, it is the pinion 90 that is under control and the gear 95 is free. At this time therefore the upper side of the gear 94 will pivot on the pinion 90 and its lower side will move one tooth toward the front of the machine turning the pinion 95 one tooth in counter-clockwise direction.

In the case of a totalizer that was not depressed before the handle was pulled but remained in its upper or non-working position during the forward pull of the handle, its bail 126 would also have been swung toward the rear carrying all of the sectors 111 with it, and swinging all of the sectors 104 to their positions alternative to the ones shown in Fig. 4. This is true because all of said sectors 104 are free, the dogs 105 being elevated. It will thus be seen that at the end of the forward stroke of the handle all of the totalizers are in their elevated positions with the dial wheels locked, and with the transfer mechanism in the position alternative to that shown in Fig. 4.

In order to add a number on any desired register said register is depressed into engagement with the racks 65 at the beginning of the return stroke of the handle. In this instance as before the act of depressing the totalizer automatically causes the bail 132 to swing downward and all of the transfer dogs 105 to drop into their operative positions, their teeth 107 engaging the notches 110; after which the bar 128 is elevated to unlock the dial wheels. The very first operation of the return stroke of the handle is, by means to be hereinafter described, to depress the totalizer and hold it in its depressed position. The next is to swing the bail bars 126 back to their forward position shown in Fig. 4. In this operation the forward branches of the springs 125 will be operated by said bail bars, but the rear branches will be unable to follow on account of the engagement of the dogs 105. The next step in the operation is to return the racks 65 thus turning the register wheels in the opposite direction to that in which they were turned in the process of subtraction. The transfer mechanism operates in exactly the same way as in subtraction except that it operates in the opposite direction. At the end of the return stroke of the handle the totalizer is released and is elevated by its spring 121. This upward motion first depresses the bar 128 to lock the dial wheels and then operates the bail 132 to lift the dogs 105 out of engagement with the sectors 104. If any one of said sectors had been operated to transfer, it and its co-operating sector 111 would already have been moved to position shown in Fig. 4. Those sectors that were not operated by transfer will move to that position as soon as the bail 132 lifts the dogs 105 out of engagement. The parts will then have been restored to the Fig. 4 position, ready for the addition or subtraction of another number. As there are several totalizers distributed along the racks 65 it will be seen that any desired number can be added or subtracted in any one of said totalizers or in any combination of said totalizers. It may if desired be added in one totalizer and subtracted in another.

The principle of the transfer mechanism seems to merit a little discussion. Consideration of the mechanism will show that whereas the present embodiment of it includes three gears 90, 94 and 95 in each denomination, the gear 94 is the essential one. In the present instance the gear 95 is little more than a convenient means of communicating the motion of the rack 65 to the gear 94. The turning of the wheel is controlled by the rack 65 and the wheel 95 may be considered a part of such controlling means. The pinion 90 is merely a means to communicate the motion of the wheel 94 to a numbered dial wheel. Many calculating machines have merely the register wheels without dial wheels and if said dials are not desired the operation would not be modified by their omission in the present instance. In the present construction said dial wheels perform mechanically two functions, namely, they carry the teeth 92 which operate the transfer dogs and they are directly engaged by the locking bar 128; but it is obvious that theoretically said locking bar could engage the upper side of the wheel 94 directly and said wheel could itself carry the transfer tooth 92. In that event the gear 94 must of course have a number of teeth that is a mul-

tiple of the base of the system of notation—ordinarily ten or a multiple thereof.

The principle of the transfer may therefore be stated as follows: The gear 94 is controlled in its differential turning movement by the gear 95 which engages it on its lower side. The axis of said gear 94 is on occasion moved one-half space in a direction parallel to the plane of the wheel and opposed to the direction of motion of the controlling wheel 95. The opposite or upper side of said wheel 94 is thereafter locked or held by the bar 128 acting in the present instance through the pinion 90. The gear 94 is thereafter freed from the control of the gear 95. This could of course be done by lifting said gear 94 out of engagement with said gear 95, but it is done in the present instance by freeing the gear 95 itself from the control of the rack 65. After the upper side of the gear 94 is locked or held and the lower side is freed the axis is returned to its original position. When the axis was originally shifted to transfer it imparted to the upper side of the wheel a unit's motion if the gear 95 was stationary at the time, or an increment of one unit of motion in case the gear 95 was turning at the time. After the gear 94 is locked at its upper side and freed at its lower side and when the axis is restored to its original position, a unit's motion is imparted to the lower tooth of the wheel so that at the end of the operation the wheel bodily considered is in its original position, but rotatably considered it has been turned to the extent of one tooth. As far as the general principle of this transfer is concerned it is of course immaterial by what means or what details of mechanism the axis of the gear 94 is given the peculiar motions described.

The means for controlling the motion of the totalizers into and out of operative position can be of any suitable sort, means for this general purpose being well known in the art. That shown in the drawing has been designed to co-operate with the mechanism of the Sundstrand machine. Referring more particularly to Figs. 10, 11 and 12 and also to Fig. 14, the left-hand frame bar 64 has a stationary bar 135 secured thereto by means of depending brackets 136. On suitable studs 137 projecting from said bar there are mounted grooved guide rollers 138 adapted to guide a bar 140 for sliding motion front and back. As shown in Figs. 2, 12 and 15, this bar extends some distance back beneath the Sundstrand machine where it may be guided in any suitable way as by rollers 138 mounted on a lug 141 projecting upward from the base 60. At its rear end the bar 140 has a headed pin 142 projecting into a fork 143 in a bell crank 144 pivoted at 145 to a lug 146 projecting upward from the base 60. The other arm of said bell crank has pivoted thereto a vertical link 147 the upper end of which is pivoted at 148 to a branch formed on or attached to the arm 53 of the operating mechanism. The construction is such that the bar 140 moves rearward on the forward stroke of the operating handle 51 and frontward on the return stroke of said handle, the leverage being so designed that the excursion of said bar 140 is about equal to the front and back spacing from one totalizer of the series to the next.

Mounted against the inside face of the left-hand frame plate 81 of each totalizer is a totalizer connecting key 150 projecting above the totalizer and formed with any suitable finger piece. The stem of this key has a slot 151 through which the shaft 93 extends and another slot 152 through which the shaft 96 passes, the construction being such that the key has a limited extent of up and down movement. At its lower end said key is pivoted at 153 to a bell crank 154 pivoted to the side plate 81 on a stud 155 and controlled by a spring 156 which normally holds the key 150 in its upper position. At its free forward end the lever 154 has a pin or stud 157 projecting therefrom into a slot 158 in a vertical sliding piece 160 which piece also has guide slots 161 through which pass headed pins 162 riveted into the side plate 81. The construction is such that this slide 160 is normally held by the pin 157 in its upper position but when the key 150 is depressed said slide can drop down although it is not forced down by the key. The lower end of the slide 160 projects below the totalizer in a position where it is guided in one direction by the fixed bar 135 and in a front and back direction by two studs 163 projecting from said bar. At its lower end the slide 160 has projecting to the right therefrom a lug 164 which when the slide 160 is depressed is adapted to be engaged by one of a series of horizontal flanges 165 on the left-hand face of the bar 140. These flanges are all in alignment but as shown in Fig. 11 there is between the adjacent ends of two consecutive flanges an opening in a position to allow the lug 164 to drop down between them. The operator pushes down on the key 150 until the latter has moved as far as it can go with respect to the totalizer at which time the lug 164 will not have been depressed far enough to be caught by the flange 165 but if the operating handle is worked with the parts in that position said lug will ride on the top of one of said flanges. In case it is desired to subtract a number the operator does not stop when the key has reached the bottom of its stroke with relation to the totalizer but forces it on down so as to carry the totalizer with it; in other words, pushes it down as far as it will go and while holding down begins to pull the handle. As soon as the handle begins to move the flange 165

moves rearward over the lug 164 as shown in Fig. 14, thereby locking the totalizer in its depressed position until the handle reaches the end of its forward stroke. At this time the end of that particular flange 165 will have reached the lug 164 and the totalizer will be released and will be thrown up by its spring 121 and the key 150 will be restored to its normal position by the spring 156.

Addition is accomplished on the return stroke of the handle and can be accomplished by pulling the handle forward and depressing the totalizer in the same manner as above described while the handle is held in its forward position and holding the totalizer down until the handle starts on its return motion. For reasons that will hereinafter appear, however, it is preferred to cause addition automatically by merely imparting to the key 150 a downward stroke equal to its motion relative to the totalizer before pulling the handle in the first place, means being provided to hold the key in its depressed position until the handle has reached the forward end of its stroke and for drawing the totalizer down automatically at the very first part of the return stroke of the handle.

The bell crank 154, which is connected with the key 150, has a depending arm projecting leftward from the lower end of which is a triangular lug 166 which normally occupies the position shown in Fig. 11 where it engages the front forward under side or face of a triangular lug 167 which projects toward the right from an arm 168 pivoted at 170 to an ear of the stationary bar 135. Beneath and to the rear of the lug 167 said bar 135 has a square notch or cutout 171. The lower corner of the triangular lug 167 is just a little to the rear of the forward wall of said slot 171. The construction is such that when the key 150 is depressed the first effect of its motion is to swing the lug 166 toward the rear which cams up the arm 168 until said lug 166 passes the lug 167, when the latter drops down in front of the lug 166 and prevents its return to normal position, thus locking the key 150 in its depressed position. If the parts be left in this position during the forward stroke of the handle the rearward motion of a flange 165 will engage the lug 164 which is made on an incline downward and backward as shown in Fig. 11, and cam upward the slide 160 so that said lug will ride on the upper surface of the flange. At the end of the forward stroke of the handle said flange will run from under the lug and allow the latter to drop down in front of it. On the return stroke of the handle and of the bar 140 the inclined forward end of the flange 165 will engage the inclined lug 164 and will immediately pull the totalizer down to its depressed position from which it will escape at the end of the return stroke of the handle. When the totalizer is thus pulled down the lug 166 will descend into the notch 171 as shown in Fig. 14, and when the totalizer is released the upper corner of said triangular lug will engage under the lower corner of the lug 167, raising said lug and the arm 168 until said lug 166 reaches its upper position when, escaping from the notch 171, it is free to swing to the left under the pressure of the spring 156, restoring the parts to normal position shown in Fig. 11. It will of course be understood that any other suitable means can be provided for causing the totalizer to go through these motions. It will also be understood that in the case of subtraction the lugs 166 and 167 and the notch 171 cooperate in the same way as in the case of addition except that in subtraction there is not use made of the locking function of said lug, the lug 166 proceeding immediately down into the notch 171. It may also be remarked that in case one of the keys 150 has been depressed and locked down and it is desired to release it without operating the machine this can be done by simply pushing it down as far as it will go, carrying the totalizer with it and then releasing it. The extra motion will depress the lug 166 out of control of the lug 167 and unlock the key. It will also be understood that the mechanism above described is repeated in the case of each totalizer.

It has been stated in the description of the principle of the registering mechanism that in the course of the downward movement of the totalizer the first effect is to allow the bail 132 to drop downward and the dogs 105 to lock the transfer sectors, and that subsequently the plate 128 is lifted out of engagement with the pinions 90 to unlock the latter and that the reverse operation occurs in the reverse order on the upward movement of the totalizer. The means for accomplishing these functions are shown in Figs. 5, 10 and 11. The shaft or rod 112 is fixedly mounted in the ends of the arms 113 and just inside or to the right of the lever 154, said shaft 112 has an upstanding arm 172 fastened thereon as for example by a pin 173. This arm is forked at its upper end and a pin 174 projects in the said fork from a lever 175 of the first order, said lever being pivoted on the shaft 96. Above said shaft said lever 175 has a pin or stud 176 projecting therefrom and acting cam fashion on an inclined part 177 of the left-hand arm 133 of the bail 132. It is this pin acting on the high part of the incline 177 that normally holds the bail 132 in its elevated position. When the totalizer moves down and up the arm 172, considered with relation to the stationary framework, swings about the shaft 114 as a center; but considered with reference to

the totalizer it swings about the shaft 112 as a center and anti-clockwise on the down stroke of the totalizer and clockwise on the upstroke. The incline 177 is so designed that the bail 132 begins to move downward in the totalizer the instant the totalizer itself begins to move downward, so that the dogs 105 almost immediately engage the sectors 104, and are disengaged from them the last thing in the upward motion of the totalizer. The bail 132 is given an excess of motion over that necessary to control the dogs as indicated in Fig. 14 where the totalizer is shown in its depressed position.

The upper end of the lever 175 co-operates cam fashion with an arm 178 projecting rearward from the pivot piece 130 of the plate 128. The part of said arm 178 that is shown in engagement with lever 175 in Fig. 11 is concentric with the shaft 96 but near the end of said arm there is a nose 180 which is engaged by the lever 175 at the end of the stroke of the latter, such engagement lifting the plate 128 by the last part of the depression of the totalizer and after the transfer sectors have been locked. On the upstroke of the totalizer this plate almost immediately drops into locking position and before the bail 132 lifts the dogs 105.

The means for swinging the bails 126 to control the springs 125 of the transfer mechanism can be varied considerably, and in fact any mechanism will answer that will give the described motions to these bails. As shown in Figs. 1 and 15 the shaft 52 has either as part of or adjacent to the arm 54 of the Sundstrand mechanism an arm 181 having pivoted thereto at 182, two slide links 183, one of said links extending from said pivot downward and forward and the other downward and backward, the two links and their connections being alike, except for a reversal of parts. Each of said links has a slot 184 longitudinal thereof near its free end, said slot at the end of the link being enlarged downward into a recess 185. Each of these slots plays over a pin 186 projecting laterally from the upper end of an arm 187 pivoted at its lower end. The forward arm 187 is pivoted at 188 to a lug 190 projecting upward from the base plate 60. The rear arm 187 is rigid on the right-hand end of a rock shaft 191, which shaft is pivoted at its right-hand end in a lug 192 and at its left end in a lug 193, Fig. 15. The two links 183 are pushed apart by a compression spring 194. When the handle 51 is in its normal position the rear pin 186 is in the rear end of the recess 185 in the rear link 183. When the handle begins to move the first part of the motion, which is devoted to operations already described, is taken up by the length of the recess 185 but early in the motion of the handle the forward wall of said recess picks up the pin 186 and rocks the shaft 191 rearward. At the free end of each link 183 there is on its upper edge an ear or lug 195 which as soon as the shaft 191 has been rocked a sufficient extent passes under and is depressed by a pin 196 projecting leftward from the lug 192, the effect being to depress the link 183 against the pressure of the spring 194 until the pin 186 escapes from the recess 185 and enters the long part of the slot 184. The construction is such that the shaft 191 is rocked in the early part but not in the very first part of the forward motion of the handle 51. A similar thing happens with the other link 183 on the return stroke of the handle which operates to rock shaft 191 back to the position shown in Fig. 1. This last is due to the fact that the two arms 187 are connected by a link or bar 197 so that the two arms 187 rock in unison. At the end of the forward stroke of the handle the forward recess 185 having reached the forward pin 186 the forward link 183 is by spring 194 thrown upward to engage the forward pin 186 in the recess 185 where it is ready to restore the parts as above mentioned on the return stroke of the handle. In order to lock the shaft 191 first in one of its positions and then in the other, the bar 197 is formed with two notches 198, and two pawls 200 pivoted at 201 in the lugs 190 and 192, respectively, are adapted to enter these notches and lock the bar. Said pawls are made in the form of bell cranks, their depending arms being connected by a tension spring 202 which moves them on occasion into engagement with the notches 198. In order to release these pawls each of them has pivoted thereto at 203 a link or releasing arm 204 which extends upward, being formed near its upper end with a shoulder 205 adapted to be engaged and depressed by the projecting end of the pivot 182. Arm 204 is pressed toward said pivot by a tension spring 206 and its motion under the pressure of said spring may be limited by any suitable means, that shown including a pin 207 projecting from the side of the pawl. The construction is such that early in the motion of the pivot 182 it strikes the shoulder 205 and depresses the pawl 200, releasing the bar 197 about as the pin 186 reaches the end of the recess 185. On account of the arc in which the pin 182 moves and on account of the fact that the arm 204 can turn only a limited distance, said pin presently slides off of the shoulder 205 and the pawl and its arm 204 are freed from said pin, the pawl pressing against the under side of the bar 197, when said bar reaches the extremity of its motion. The other pawl snaps into engagement with it and its arm 204 engages the pin 182 when the latter reaches the extremity of its motion.

As shown in Figs. 2 and 15, the shaft 191 has thereon two arms 208 each of which is pivoted at its upper end to a long bar 210

which extends toward the front of the machine underneath the totalizers. Said bars 210 can be guided near their forward ends by any suitable means as for example by arms 211 extending upward from a rock shaft 212 pivoted in lugs 213 of the base-plate 60 as shown in Figs. 2, 5, etc.; and if desired more than one such rock shaft and connections can be employed. Underneath the totalizers each of the bars 210 has a series of vertical slots 214, one for each of the bail bars 126, the slots being long enough to maintain control of said bars in both the upper and the lower positions of the several totalizers. The whole construction is such that at the proper time in the early part of the forward stroke and again in the early part of the return stroke of the handle 51 all of the bail rods 126 are swung in the manner hereinbefore described. In other words, said bars normally occupy their forward positions shown for example in Fig. 4. Early in the stroke of the operating handle, they move to their rear positions shown in Fig. 14, where they remain during the rearward motion of the rack bars 65 and as long as the handle remains in its forward position; and early in the return stroke of the handle they are returned to their Fig. 4 positions.

In order to print the total indicated on any register a total key 215 and connections controlled thereby (Fig. 13) may be employed. Said total key is here shown slidably mounted against the inner face of the right-hand frame plate 82, the key having slots 216 through one of which the shaft 93 passes and through the other of which the shaft 96 passes to furnish a guide and support allowing to said key a limited downward motion with respect to the totalizer, the key being restored by a spring 209. It will be perceived that the total key is mounted in the totalizer itself, there being one such key for each totalizer. The total key has projecting forward therefrom near the top of the totalizer a forked arm 217 into the crotch of which a pin 218 extends from the arm of a bail 220, said bail having its two arms pivoted on the shaft 93 and extending across behind the upper arms of the transfer dogs 105 as shown for example in Fig. 14. The extreme upper part of each dog 105 is so shaped and proportioned that it can move back to its inoperative position without being arrested by the bail 220 when the latter is in its upper position but each such dog is formed with a part 219 which may be said to be somewhat in the nature of a shoulder which will be engaged by the bail 220 when the latter is moved downward by an operation of the key 215, thus locking all of said dogs in their operative positions. When the total key is thus depressed the dogs 105 act as stops for the teeth 92 of the dial wheels to arrest said teeth at "0" when the wheels are rotated in subtracting direction. It will be perceived that the bail 220 cannot be moved down when the totalizer is in its upper position shown in Fig. 4 and in taking the total with this particular mechanism it is therefore necessary first to depress the totalizer into engagement with the racks to the position shown in Fig. 14 and afterward to depress the total key, prior to pulling the handle.

The key 215 is locked down by a dog 221 pivoted to the plate 82 at 222 and having a shoulder 223 adapted to engage over a shoulder 224 of the key when the latter is depressed. The dog 221 is in the form of a bell crank and it has a pin 225 that overlies the arm 134 of the bail 132. As this bail is always in its lower position when the key 215 is operated the dog is free to drop by gravity into engagement with the shoulder 224 where it will remain until during the upward motion of the totalizer the dog is released by the arm 134 acting on the pin 225. The parts are so designed that the release of the lock 221 is effected before the bail 132 begins to elevate the dogs 105.

The parts already described would suffice to take and print a total. In case such an operation is desired no numeral keys will be operated but the totalizer whose total is to be printed will be depressed as in a subtracting operation and its key 215 will then be operated and the handle pulled as if for subtraction. The action would be exactly as in subtraction except that the height to which the type carriers 24 move will be controlled by the racks 65, which in turn are controlled by the register wheels instead of the control being by the stops 17 as in a calculating operation. If the totalizer is allowed to rise at the end of the forward stroke of the handle, it will be left clear or at zero, but if it be held down by hand till the handle begins its return stroke, a sub-total will be printed.

It will of course be perceived that the total taken out of one totalizer can be added into or subtracted from any other totalizer by suitable manipulation of said other totalizer at the time; that is to say, by depressing the key 150 and allowing it to be locked down if it is desired to add the total and by pressing said key and totalizer clear down in case it is desired to subtract the total.

The Sundstrand machine contains mechanism for printing totals in a distinctive color and this mechanism may be retained in the present machine.

As the present machine contains a number of totalizers it is desirable when a total is printed to print also a character to show from which totalizer the printed total was taken. This is done automatically by means which will now be described.

The total key has bent off toward the left therefrom a lug or flange 226 which when the key 215 is depressed is adapted to move

downward into a guide slot 227 in a stationary bar 228 suitably secured as for example by posts 230, Fig. 15, to the uprights 62 at the right-hand side of the machine. This fixed bar and two movable bars associated with it are shown in side view in Figs. 1 and 13 and in section in, for example, Fig. 5. Just at the left of the fixed bar 228 is a sliding universal bar 231 having lugs 232 projecting upward and lying across the slots 227, said lugs inclined upward and toward the front of the machine so that when any total key is depressed its flange 226 engaging said lug 232 will draw the universal bar 231 toward the front of the machine.

Lying just to the left of the universal bar 231 is a differential bar 233 having projecting upward from its upper edge a series of stop lugs 234, one for each totalizer, and said lugs are spaced differential distances from the several slots 227 one of which when a total key is depressed is occupied by one of the flanges 226. The first lug 234 will allow to its bar 233 a motion equal to one tooth space of the racks 65, the second lug two spaces, and so on, the result being that when the handle is pulled this bar 233 moves differential distances depending on what particular total key was used, that is to say, depending on what totalizer is having its total printed. This bar 233 extends substantially to the rear of the machine as shown in Fig. 1, its rear end being pivoted at 239 to a bell crank 35 similar in all respects to the other bell cranks. It will be noted, however, that the bar 233 is pivoted directly to the bell crank and not connected with it through a link 73. The bell crank 35 controls a type carrier 24^a, like all of the other type carriers except that its types 9^a instead of printing numerals print some designating characters such for example as the first letters of the alphabet and said types are in number equal to the number of the totalizers; also this type carrier has no arm 23. In the present instance there are six types 9^a as the present machine is designed to contain six totalizers, only three of which, however, are indicated in the drawings. This type carrier 24^a occupies the position occupied in the Sundstrand machine by a fixed bar which in that machine contains only one type. The present bar is a movable one like the numeral type carriers, and it is controlled by arms 42, etc., in exactly the same way as the numeral type carriers and like them it normally occupies a position below any printing position. In the Sundstrand machine there is provided for the type carrier in this position a special bumper that is moved upward to operative position by the total key. In the present instance the type carrier standing normally below printing position, it is not necessary that the bumper be made movable up and down and there is therefore shown a special bumper 32^a pivoted to a fixed part of the machine and normally in operative position. When a total key is operated the type carrier 24^a moves upward to an extent depending upon which key it was that was operated and it is returned to its normal non-printing position by the bar 50.

In order to hold this type carrier in its normal position the bar 233 is formed with a lug 235 which is normally engaged by a locking pawl or dog 236 pivoted at 237 to a sheet metal bracket 238 secured to the base 60, as shown in Figs. 1 and 15. This pawl is made in the form of a bell crank having a depending arm behind which lies a pin 240 projecting from the extreme rear end of the universal bar 231, Fig. 1, which bar extends to the rear of the machine. The rear part of this bar can be supported in any suitable way, as for example by a pin 241 projecting from a stationary lug 242 into a slot 243 of the bar. One of the rods 66 is also shown passing through a slot 243 in this bar. The universal bar 231 can be restored to normal position by any suitable spring 244 the one here shown being connected to a post 245 projecting upward from the cross bar 78 hereinbefore referred to. The whole construction is such that the total-sign type carrier 24^a is in all ordinary calculating operations held down in non-printing position by the dog 236; but whenever any total key is operated, said dog is released and said type carrier rises to a height determined by the particular total key in use, and a designating letter is printed to the right of the printed total.

When a totalizer standing in the normal position shown in Fig. 4 is removed from the machine by loosening the latches 117 and lifting the totalizer out, the lever 175 is relieved from the control of the forked arm 172, Fig. 11, with the result that the pin 176 thereof is canned rearward by the incline 177 because the bail 132 is under the pressure of all the springs 109. The result will be that all of the detents 105 will be depressed by their springs to force the teeth 107 into the notches 108 and thus lock the transfer sectors 104 in normal position. The wheels 90 were already locked by the bar 128 and if the lever 175 swung far enough it would release these wheels. In the normal operation of the machine, it will be recalled, the releasing of the locking plate or bar 128 is done by the last part of the motion of the lever 175 and after the dogs 105 have all been depressed. Said dogs therefore are incapable of exerting any pressure on the bail 132 to swing said lever 175 far enough to unlock the register. When the totalizer is lifted out therefore it is automatically locked up.

When the totalizer is put back into the machine the arm 172 is standing in the position shown in Fig. 11. As the totalizer descends into place the pin 174 occupies a position a little to the left of that shown in Fig. 11. The left-hand fork 246 is prolonged and

formed with an inclined edge so that as the pin 174 descends it will be cammed over to its proper position. When replacing a totalizer the key 150 must be depressed and the totalizer pushed clear down and released in order to bring lug 166 first down behind and then up in front of the lug 167.

In order to provide for leaving blank spaces in any totalizer, as for example for the purpose of punctuation, it is desirable to transfer across such blank spaces if there are wheels to the left of them and also to disable the racks and printing mechanism corresponding to such spaces so that the printing will automatically have the same style of punctuation as the totalizer. As far as I am aware it is broadly new to provide in a calculating and listing machine a full set of denominational racks and type carriers with means whereby different totalizers can be brought under the control of said racks, said totalizers having different styles of punctuation or being differently spaced in other respects, in combination with means whereby when a punctuated totalizer is brought into use it automatically disables the printing in the position corresponding to its own blank spaces. The particular means shown in the present instance is only one of a variety of means that can be employed for this purpose.

A punctuated totalizer and connections are shown in Figs. 6, 7, 8 and 9. This totalizer is similar in all respects to the one already described except in the respects now to be described. It includes at least one blank space, the one here shown being that ordinarily employed in handling amounts in United States money, namely, the space between dollars and cents; in other words, the third space from the right-hand side of the series. In this space the hub 247 of the tens of cents dial wheels 88 is prolonged toward the left and the disk 91 thereof is put on the left-hand end of said hub so as to bear the correct relation to said units of dollars wheel to operate its dog 105.

In this third space the devices on the shaft 96 which would ordinarily occupy this space are omitted, namely, one sector 104 and one idler gear 95, and in place of these parts there is mounted on said shaft and secured thereto by a pin 248 an arm 250 having a dog 251 pivoted thereto at 252. This dog extends rearward and has a tooth 253 bent off therefrom and normally standing just above an interdental space in the third rack bar 65. The shaft 96 is in this instance a rock shaft and it is normally held in the position shown in Fig. 6 by means of a spring 254 hooked at one end to the arm 250 and at the other to a pin 255 on one of the frame bars 83, said pin pulling said arm toward the front of the machine. The dog 251 is prolonged toward the front of the machine and terminates in an incline 256 which is normally pressed against the under side of said frame bar 83 so as to hold the tooth 253 of the dog just clear of the rack 65. The construction is such that if the shaft 96 be rocked counterclockwise in Fig. 6 the incline 256 will allow the dog to drop into engagement with the rack and said dog will push the rack about one tooth space toward the rear. This motion is permitted by the means shown in Fig. 9 where it will be seen that the racks 65 at their rear ends are ordinarily arrested in their normal positions by flat springs 257 secured by screws 258 to the base 60. These springs are stiff enough to arrest the racks under ordinary conditions but are capable of being flexed toward the rear as shown in broken lines in Fig. 9 when a rack 65 is forced rearward by a dog 251. When said rack is thus forced rearward the notch 70 moves back of the pin 74, the upper edge of the rack passing under said pin as shown by dotted lines in Fig. 9. The pin 74 and link 73 are thus locked against the downward movement which these parts ordinarily have during the first part of the motion of the bell crank 35. As the link is locked against forward motion by the bar 78 this particular bell crank and with it the type carrier 24 are positively locked in their normal non-printing positions, so that when the handle is pulled that particular type carrier will not rise and no number will be printed in that space.

In order to impart the described locking movement to the shaft 96 the key 150 is provided, Figs. 7 and 8, with a pin 260, and a cam shaped arm 261 is secured on said shaft near its left-hand end by a pin 262. The construction is such that whenever said key is depressed preliminary to the bringing of this totalizer into engagement with the racks, said pin 260 acting on said arm imparts the described rocking motion to said shaft before the totalizer moves downward. When the totalizer does move downward the pivot 252 of the dog 251 of course moves downward with it but this does not prevent the operation of the parts in the manner described. In case of subtraction this downward movement occurs immediately and in the case of addition it occurs at the beginning of the upstroke of the handle; but in either event as soon as the key 150 is pressed down to its broken line position, Fig. 6, the shaft 65 is moved to the rear and the printing mechanism controlled thereby is therefore disabled before the handle 51 is operated. The sector 111 in the space under discussion of course remains in place but is functionless when this particular totalizer is in use.

It will of course be understood that blank spaces can be provided for at any desired point or points in the totalizer and each such point or space will disable the printing in the manner described. For example, it might

for some reason be desirable to have a totalizer with only a small number of wheels in it, and in that totalizer all of the blank spaces could be provided with the disabling mechanism.

It is contemplated that if desired different kinds of totalizers may be present in the machine at one time so that if it is desired to print and compute different kinds of numbers, as for example, weights or the numbers of articles which are printed solid, and also to print the values of these articles in money, the solid numbers can be added on a totalizer such as that shown in Fig. 5, and the money values can be accumulated on a totalizer such as that shown in Fig. 7, and each number will be printed with its appropriate style of punctuation. If desired other kinds of numbers calling for other styles of punctuation can be taken care of by different totalizers. In the case of transferring totals from one totalizer to another or in any calculation where it was desirable to have the same number registered in two different totalizers it would of course never happen that two different styles of totalizer would be used in the same operation, because any one operation would involve only one kind of quantity and if this were to affect two totalizers those two totalizers would of course be of the same style. The next operation might be on a different kind of quantity and would be accumulated on one or more totalizers of a corresponding style.

The transfer mechanism above described is not claimed herein, but is claimed in a divisional application filed July 30th, 1925, Serial No. 47,132.

What I claim as new and desire to secure by Letters Patent, is:—

1. The combination with a machine frame, a series of denominational racks in said frame, and a series of denominational type carriers associated with said racks, of a totalizer removable and replaceable by the operator, a total key mounted in said totalizer and devices partly in said totalizer and partly in said machine frame controlled by said total key to cause the printing of the total accumulated on said totalizer.

2. In a calculating machine, the combination with registering mechanism, and denominational racks for operating it, of a series of denominational type carriers, each movable individually with its rack to bring different digits to printing position, said type carriers normally standing below printing position, means for first moving said type carriers to bring the first type thereon to printing position and thereafter moving said type carriers and racks in unison, and means controlled by said registering mechanism to prevent such first motion of a particular type carrier.

3. In a calculating machine, the combination with registering mechanism and denominational racks for actuating said mechanism, of denominational type carriers, each normally below printing position, connections between said type carriers and said racks including a link normally out of operative engagement, and means whereby the first step in the movement of said type carrier to bring said type carrier to position to print from the first type thereon moves said link into engagement.

4. In a calculating machine, the combination with registering mechanism and denominational racks for actuating said mechanism, of denominational type carriers, each normally below printing position, connections between said type carriers and said racks including a link normally out of operative engagement, means whereby the first step in the movement of said type carrier to bring said type carrier to position to print from the first type thereon moves said link into engagement, and means for locking said link and said type carrier when said link is out of engagement.

5. In a calculating machine, the combination with registering mechanism and denominational racks for actuating said mechanism, of denominational type carriers, each normally below printing position, connections between said type carriers and said racks including a link normally out of operative engagement, means whereby the first step in the movement of said type carrier to bring said type carrier to position to print from the first type thereon moves said link into engagement, means for locking said link and said type carrier when said link is out of engagement, and means controlled by said registering mechanism to hold said link out of engagement and thereby to prevent the first or preliminary step of said type carrier.

6. In a calculating machine, the combination with registering mechanism, printing mechanism including a differentially movable type carrier normally standing out of printing position, a denominational rack, means for first moving said type carrier to printing position and thereafter moving said type carrier and rack together differential distances, special means for imparting a preliminary motion to said rack, and means whereby such preliminary motion when so imparted prevents said type carrier from moving to printing position.

7. In a calculating machine, the combination of a differentially movable type carrier, a differentially movable rack, a link for connecting said type carrier and rack and having pin and notch connection with one of them, means whereby the last step in the return motion of said type carrier disconnects said pin and notch connection, and means for locking said type carrier as long as said pin and notch connection are disconnected.

8. In a calculating machine, the combina-

tion of a differentially movable type carrier, a differentially movable rack, a link for connecting said type carrier and rack and having pin and notch connection with one of them, means whereby the last step in the return motion of said type carrier disconnects said pin and notch connection, means for locking said type carrier as long as said pin and notch connection are disconnected, and special means for imparting a preliminary motion to said rack, such preliminary motion locking said pin and notch connection in disconnected position and thereby locking said type carriers.

9. In a calculating machine, the combination of registering mechanism, denominational racks for controlling said mechanism, type carriers associated with said racks, spring means for determining the normal position of said racks, a special means for moving a predetemined rack beyond normal position against the pressure of said spring means, and means whereby such motion disables the printing by said type carrier.

10. In a calculating machine, the combination of a series of denominational differentially movable racks, a plurality of totalizers each controllable by said racks, certain of said totalizers having therein blank spaces for punctuation purposes, and means whereby a punctuated totalizer may disable the rack or racks corresponding to a punctuation point or points.

11. In a calculating machine, the combination of a series of denominational racks and type carriers connected therewith, a totalizer capable of being connected with and disconnected from said racks, said totalizer having one or more punctuation spaces, and means whereby said totalizer may disable the rack and type carrier corresponding to a punctuation point.

12. In a calculating machine, the combination of a series of type carriers one for each denomination, a totalizer, connections whereby numbers registered in said totalizer are printed by said type carriers and means whereby a totalizer having a punctuation point can prevent printing from the type carrier corresponding to such point.

13. In a calculating machine, the combination with totalizers, denominational type carriers common to said totalizers, and means whereby numbers can be registered in said totalizers and by the same operation printed by the types in said carriers, said totalizers being arranged for different styles of punctuation, of means whereby a totalizer may prevent printing in a denominational position corresponding to a punctuation point.

14. In a calculating machine, the combination with totalizers having different styles of punctuation, and means including denominational type carriers common to said totalizers for printing numbers and by the same operation of the machine actuating said totalizers in accordance with printed numbers, of means whereby any punctuated totalizer may disable the printing mechanism corresponding to a punctuation point of that totalizer.

15. In a calculating machine, the combination with a series of denominational type carriers, a plurality of totalizers having different styles of punctuation, and means for moving said type carriers and actuating a selected one of said totalizers in accordance with the several digits of a number, of means whereby the selected totalizer may prevent motion of the type carrier corresponding to a punctuation point of that totalizer to bring a type thereon to printing position.

16. In a calculating machine, the combination with a series of type carriers each movable differentially to bring the different types thereon into position to print and normally out of position to cause printing from any type, and means for locking one of said type carriers against such differential motion.

17. In a calculating machine, the combination of a series of type carriers normally out of position to print and each differentially movable to bring different types thereon into printing position, a totalizer having one or more blank spaces therein, and means whereby said totalizer may cause the type carriers corresponding to said blank spaces to be held against motion to printing position.

18. In a calculating machine, the combination of a series of differentially movable type carriers, a series of racks connected with the several type carriers, totalizers adapted to be operated by said racks, certain of said totalizers having blank spaces, means in said blank spaces to actuate the corresponding racks, and means whereby such actuation of said racks prevents printing by the corresponding type carriers.

19. In a calculating machine, the combination of a series of differentially movable type carriers, a series of racks severally connected with said type carriers by lost motion connection, a totalizer adapted to be operated by said racks and having blank spaces, means in said blank spaces for actuating the corresponding racks independently of their type carriers, and means whereby such independent actuation of a rack prevents its type carrier from moving to printing position.

20. In a calculating machine, the combination of printing mechanism including denominational differentially movable type carriers, registering mechanism including a plurality of totalizers having register wheels differently distributed in the different totalizers, means for actuating said registers in accordance with numbers and causing said printing mechanism to print said numbers, the last recited means including means whereby numbers will be printed only in those posi-

tions in which the particular totalizer in use at the time has register wheels.

21. In a calculating machine, the combination of a series of denominational racks, totalizers that can be mounted in and removed from the machine at the will of the operator, and means in certain of said totalizers for disabling certain of said racks.

22. In a calculating machine, the combination with printing means including denominational differentially movable type carriers, totalizers that can be mounted in and removed from the machine at the will of the operator, means for actuating said totalizer in accordance with the numbers printed by said printing mechanism, and means whereby certain of said totalizers when in use disable certain of said type carriers.

23. In a calculating machine, the combination with registering mechanism, and a series of differentially movable type carriers for printing numbers entered in said registering mechanism, of keys for controlling said registering and printing mechanism including a special key to prevent any printing by a particular one of said type carriers while permitting printing by other type carriers both of higher and of lower denominations.

24. In a calculating machine, the combination with mechanism for registering numbers and printing mechanism including a series of differentially movable type carriers for printing such numbers, said type carriers normally standing below printing position, of keys for controlling said registering and printing mechanism, said keys including a special key, and means controlled by said special key to prevent a particular one of said type carriers from moving to printing position.

25. In a calculating machine, the combination with mechanism for registering numbers, a series of differentially movable type carriers for printing such numbers, said type carriers being normally out of printing position, a single group of digit keys, and step-by-step moving means to bring one denomination after another of said printing and registering mechanism under the control of said digit keys, of a special key that can be operated in any denominational position, and means controlled by said special key to prevent motion to printing position of the type carrier of that denomination.

26. In a calculating machine, the combination with registering mechanism, denominational racks, and denominational type carriers, of a single group of digit keys, step-by-step traveling means for causing said digit keys to control said denominational devices in successive denominations for successive groups of said keys, and operating mechanism for operating said racks and type carriers after the completion of the operation of said keys, of a special key which can be operated at any denominational step in the succession, and means controlled by said key to prevent operation of the rack and type carrier of that denomination.

27. In a calculating machine, the combination with calculating mechanism, printing mechanism including a differentially movable type carrier, operating mechanism for said registering mechanism and printing mechanism, and a set of digit keys including a zero key for causing the printing and registration of the ten digits, of a special key, and means controlled by said special key to cause said type carrier to occupy at the time of printing a non-printing position.

28. In a calculating machine, the combination of a series of differentially movable type carriers normally below printing position, digit keys, key controlled stops for controlling the motion of said type carriers to print the digits from "0" to "9" inclusive, and an additional key and associated stop for arresting a selected type carrier below printing position, whereby a space may be left when desired between the digits written in a line by the types on the operated type carriers.

29. In a calculating machine, the combination of a series of totalizers, a series of denominational racks common to all of said totalizers, printing means, a total key for each totalizer, means whereby said key when actuated causes said printing means to print the total indicated on said totalizer, a differentially movable type carrier having types to designate the several totalizers, differential mechanism controlled by said total keys to set said type carrier to print the character appropriate to the particular totalizer whose total key was operated, and means released by the actuation of any total key for normally locking said differential mechanism.

30. In a calculating machine, the combination of mechanism for printing numbers, a series of totalizers, denominational racks for actuating said totalizers, said totalizers being detachably connected with the machine and each having therein a total key, a differentially movable type carrier carrying one type for each totalizer, means normally holding said type carrier out of position to print, means controlled by all of the total keys of the totalizers that are mounted in the machine for releasing said holding means, and differential mechanism controlled by said total keys when the latter are operated and controlling the motion of said type carrier.

31. In a calculating machine, the combination of a series of denominational racks, a series of detachable totalizers adapted when mounted in the machine to be controlled by said racks, each of said totalizers having therein a total key, means controlled by said

key for causing said racks to be actuated in accordance with the total in the totalizer, means for printing said total, and means whereby each total key causes to be printed in conjunction with its total a distinguishing character to show from which of said totalizers the total was taken.

32. In a calculating machine, the combination of a series of detachable totalizers, a series of racks for controlling said totalizers, means associated with said racks for printing numbers, a total key in each of said totalizers, means controlled by said key for causing said printing mechanism to print the total, a differentially movable device controlled by all of said keys but movable different distances under the control of the different keys, and a type carrier having a series of designated types and connected with said differentially movable device.

33. In a calculating machine, the combination of a series of detachable totalizers, a series of racks for controlling said totalizers, means associated with said racks for printing numbers, a total key in each of said totalizers, means controlled by said key for causing said printing mechanism to print the total, a differentially movable device controled by all of said keys but movable different distances under the control of the different keys, a type carrier having a series of designated types and connected with said differentially movable device, a universal bar controlled by all of said total keys, and means under the control of said universal bar for normally locking said differentially movable device.

34. In a calculating machine, the combination with a full set of register operating racks, of a totalizer having blank spaces therein, and means in each of said blank spaces for holding the corresponding rack against operation.

35. In a calculating machine, the combination with a full set of register operating racks, of a totalizer having a blank space, a pawl in said blank space, and means for operating said pawl prior to a calculating operation to lock the corresponding rack against actuation.

36. In a calculating machine, the combination with a full set of register actuating racks and a full set of denominational printing devices, of a totalizer having a blank space, a pawl in said blank space, means for operating said pawl prior to a calculation, said pawl imparting motion to the corresponding rack, and means whereby such motion prevents printing by the corresponding denominational printing device.

37. In a calculating machine, the combination with a full set of register actuating racks and a full set of denominational printing devices, of a plurality of totalizers engageable with said racks, certain of said totalizers having a blank space and having a pawl in said blank space, means for actuating said pawl and thereby moving the corresponding rack prior to a calculating operation, and means whereby such motion of said rack disables the corresponding denominational printing device.

38. In a calculating machine, the combination with register actuating means and a set of denominational printing devices, of a totalizer, a key for bringing said totalizer into co-operative relation with said actuating means, said totalizer having a blank space, and means operated by said key for disabling the printing device of the denomination corresponding to said blank space.

39. In a calculating machine, the combination with actuating mechanism and a totalizer mounted for motion into and out of engagement with said mechanism, of a totalizer connecting device having a lug, operating mechanism including a reciprocating bar having a flange, and means for moving said device to bring said lug into co-operating engagement with said flange to lock the totalizer in its operative position.

40. In a calculating machine, the combination with actuating mechanism and a totalizer mounted for motion into and out of operative relation to said mechanism, of a key in said totalizer, a lug movable by said key, and operating mechanism including a reciprocatory bar having a flange adapted to engage said lug when said key is depressed, to draw said totalizer to operative position.

41. In a calculating machine, the combination with actuating mechanism and a series of totalizers each independently mounted for motion into and out of operative relation with said actuating mechanism, of totalizer connecting keys one for each totalizer, operating mechanism including a reciprocating bar, and means whereby when one of said totalizer connecting keys is operated said totalizer is connected with said reciprocating bar to be drawn thereby into operative position.

42. In a calculating machine, the combination of a series of denominational racks, a totalizer having register wheels, said totalizer movable into and out of position to gear said wheels with said racks, operating mechanism including a reciprocating bar having a flange, a totalizer connecting key and a lug controlled thereby, the construction being such that if said key and the totalizer be completely depressed prior to the operation of said operating mechanism said lug will be caught by said flange and the register wheels will be operated in one direction by said racks, but if said key be depressed without depressing the totalizer said flange will engage said lug at the beginning of the return stroke of said bar and draw said totalizer to operative position where its register wheels will be operated

in the opposite direction by the return motion of said racks.

43. In a calculating machine, the combination with actuating mechanism and a totalizer mounted for motion into and out of operative relation with said mechanism, of a totalizer connecting key, a lug operative by said key, and a latch on the stationary framework adapted to engage said lug to hold said key in depressed position, said lug moving out of engagement with said latch when said totalizer is moved to operative position and said lug escaping from said latch during the return motion of said totalizer.

44. In a calculating machine, the combination with actuating mechanism and a totalizer mounted for motion into and out of operative relation to said mechanism, of a totalizer connecting key, a lug controlled by said key, a latch mounted on the stationary framework and adapted to engage said lug to lock said key in its depressed position, and a stationary abutment, said lug when said totalizer moves to operative position passing out of engagement with said latch and engaging said stationary abutment and said lug escaping from said latch when on the return motion of said totalizer said lug passes out of engagement with said abutment.

45. The combination with a full set of register operating racks, of a totalizer having blank spaces therein, and means in each of said blank spaces for varying the operation of said racks.

46. A totalizer provided with blank spaces between registering members and means arranged in said spaces for controlling the set of operating racks of the calculating machine with which said totalizer is to be associated.

47. The combination with a set of denominational type carriers each movable differentially to bring the appropriate types thereon into position for printing a digit of a number, and settable stops for determining the positions to which the several type carriers are moved, of additional stops settable to determine that a particular selected type carrier shall not move to printing position.

Signed at the borough of Manhattan, city of New York, in the county of New York and State of New York, this 18th day of August, A. D. 1922.

ROBERT H. STROTHER.