C. E. W. GARDNER.

ADDING MACHINE.

APPLICATION FILED SEPT. 29, 1910.

1,195,575.

Patented Aug. 22, 1916.

6 SHEETS—SHEET 1.

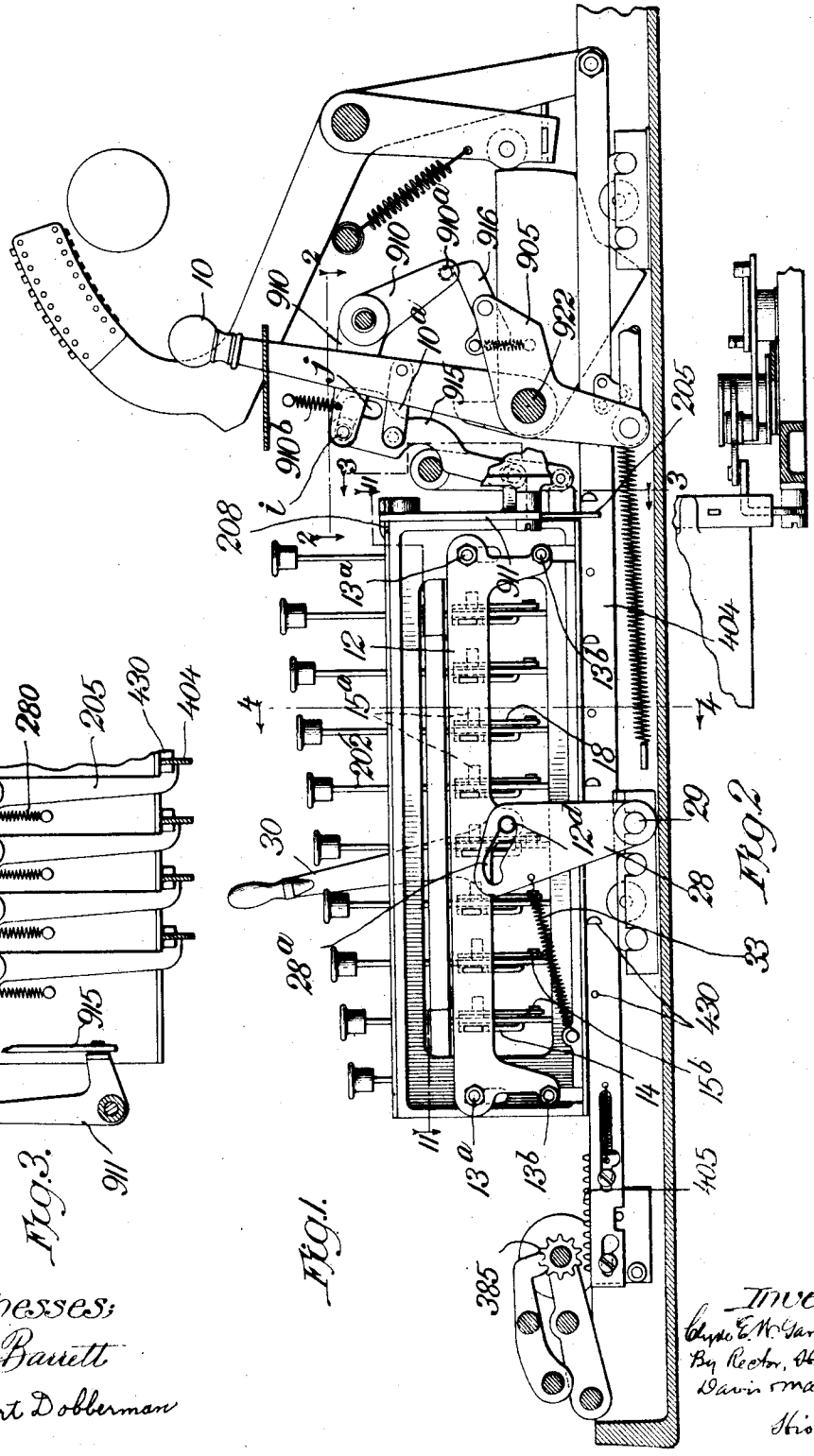


Fig. 1.

Fig. 3.

Fig. 2.

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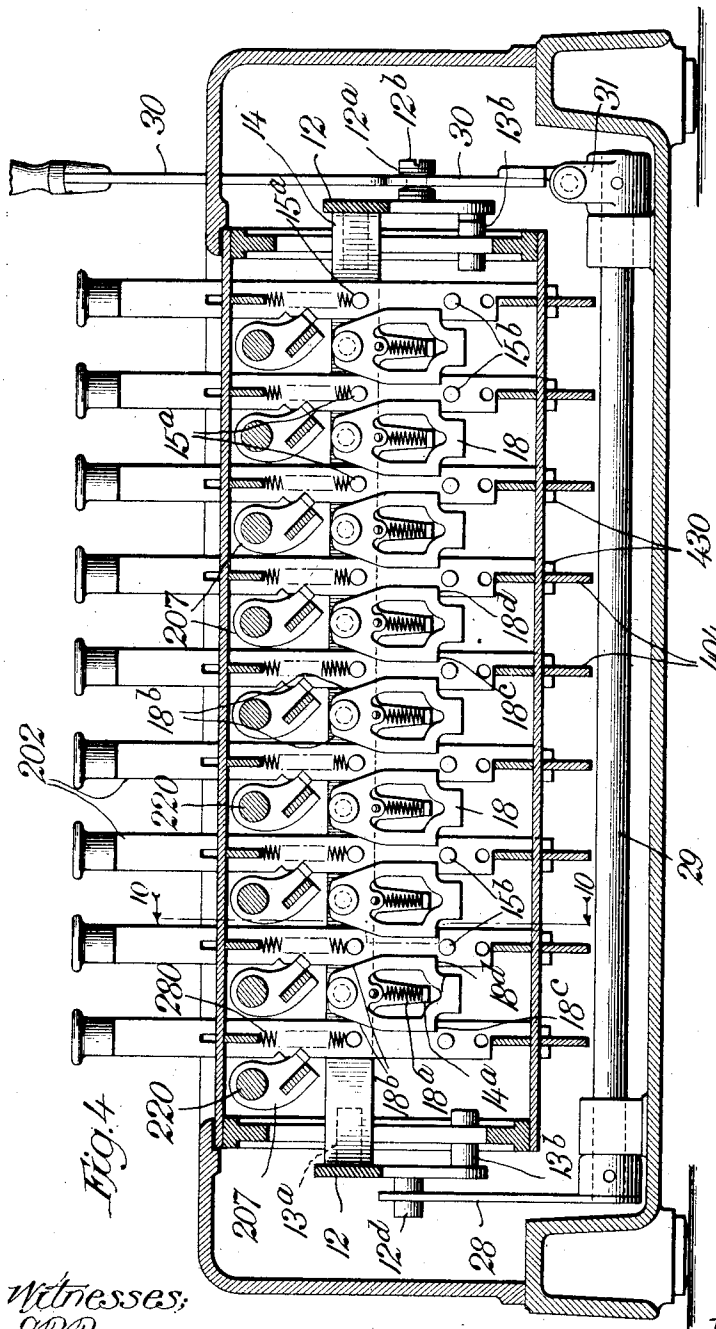


Fig. 4

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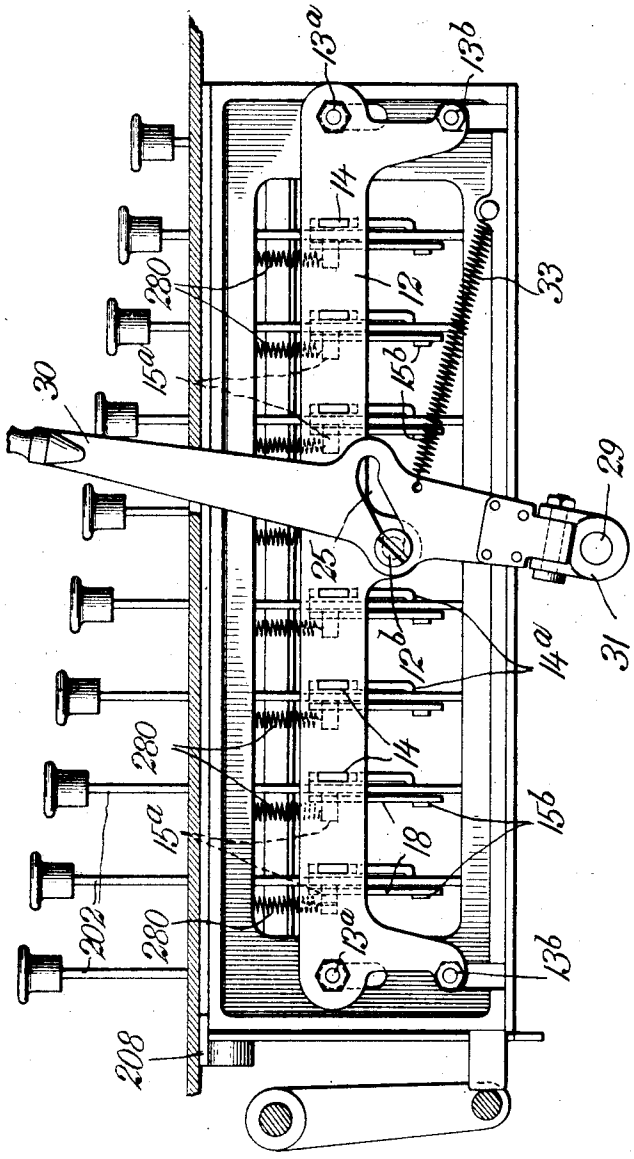


Fig. 5.

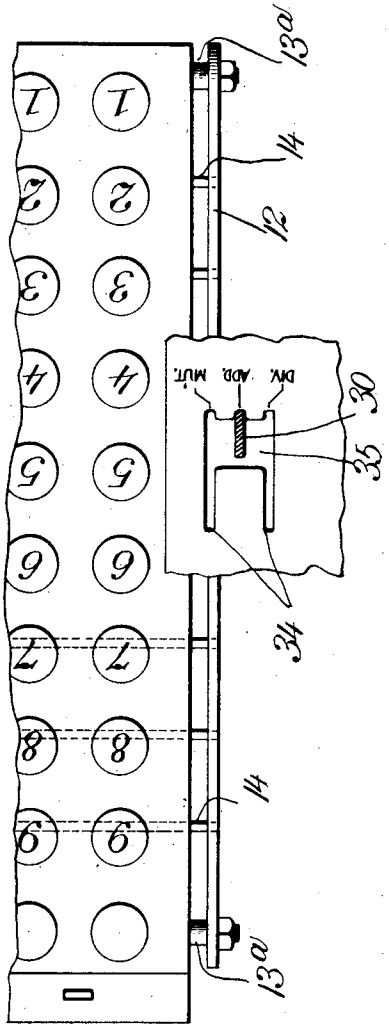


Fig. 6.

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6 SHEETS—SHEET 4.

Fig. 7.

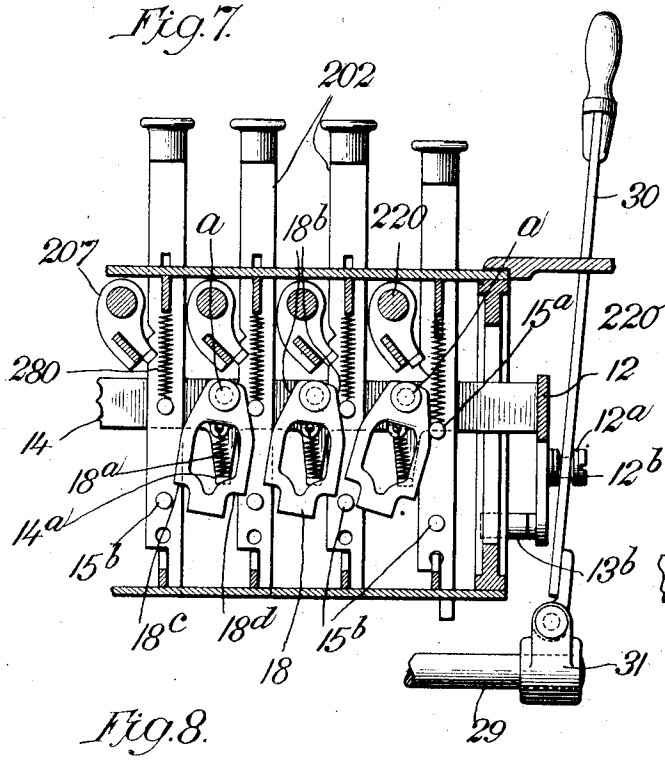


Fig. 10.

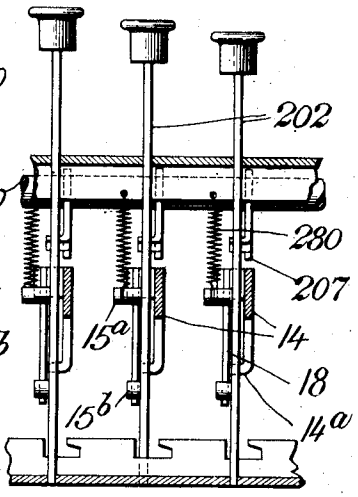


Fig. 8.

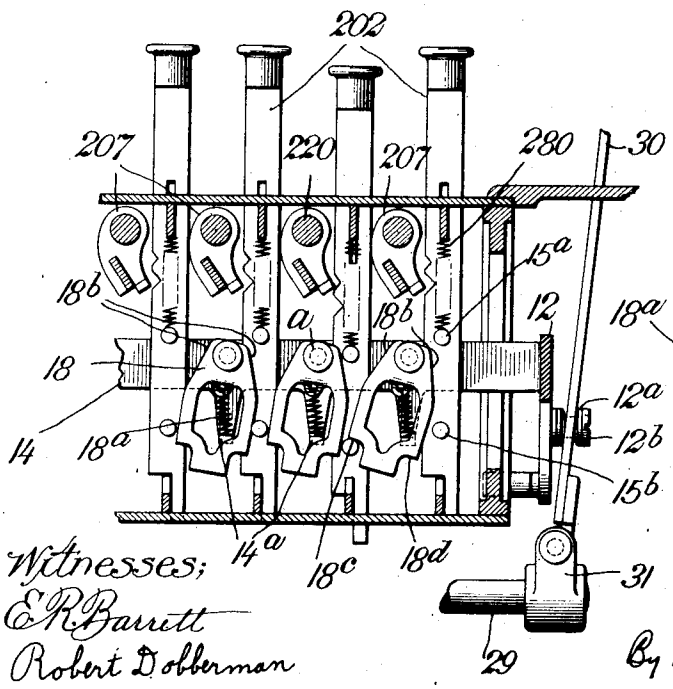
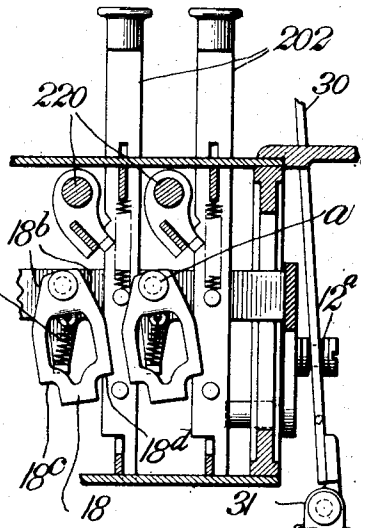


Fig. 9.



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6 SHEETS—SHEET 5.

Fig. 11.

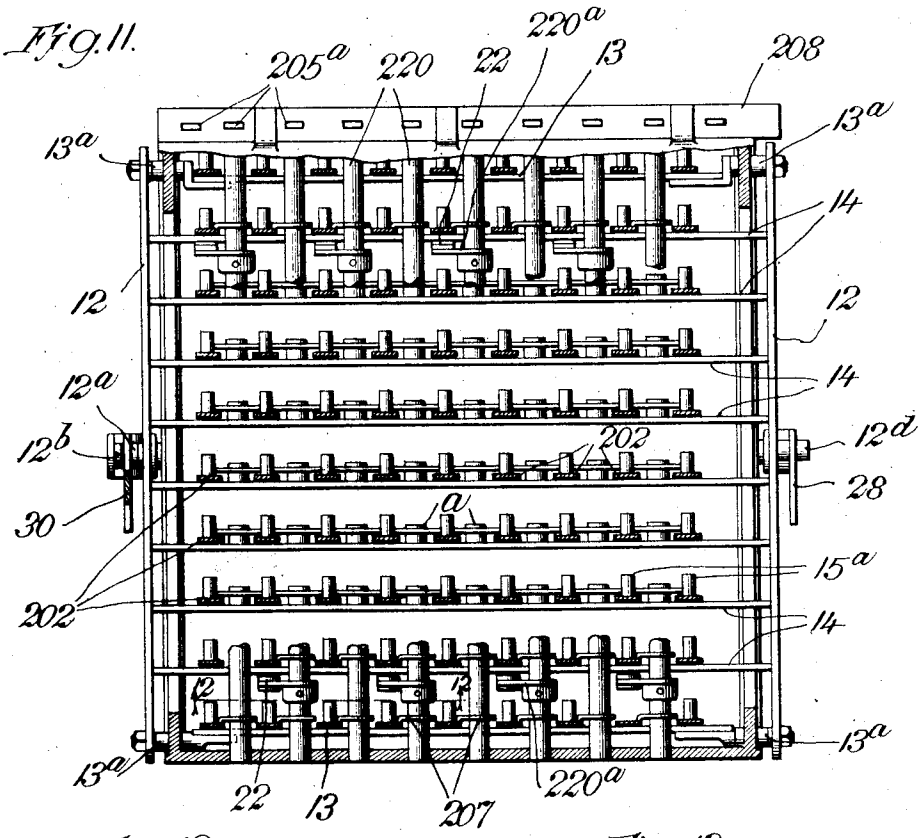


Fig. 12.

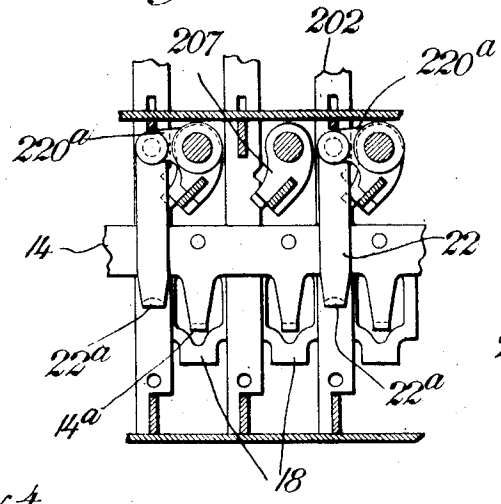
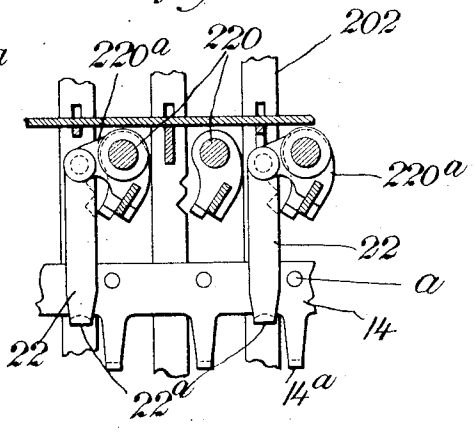


Fig. 13.



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ADDING MACHINE.

APPLICATION FILED SEPT. 29, 1910.

1,195,575. Patented Aug. 22, 1916.

6 SHEETS—SHEET 6.

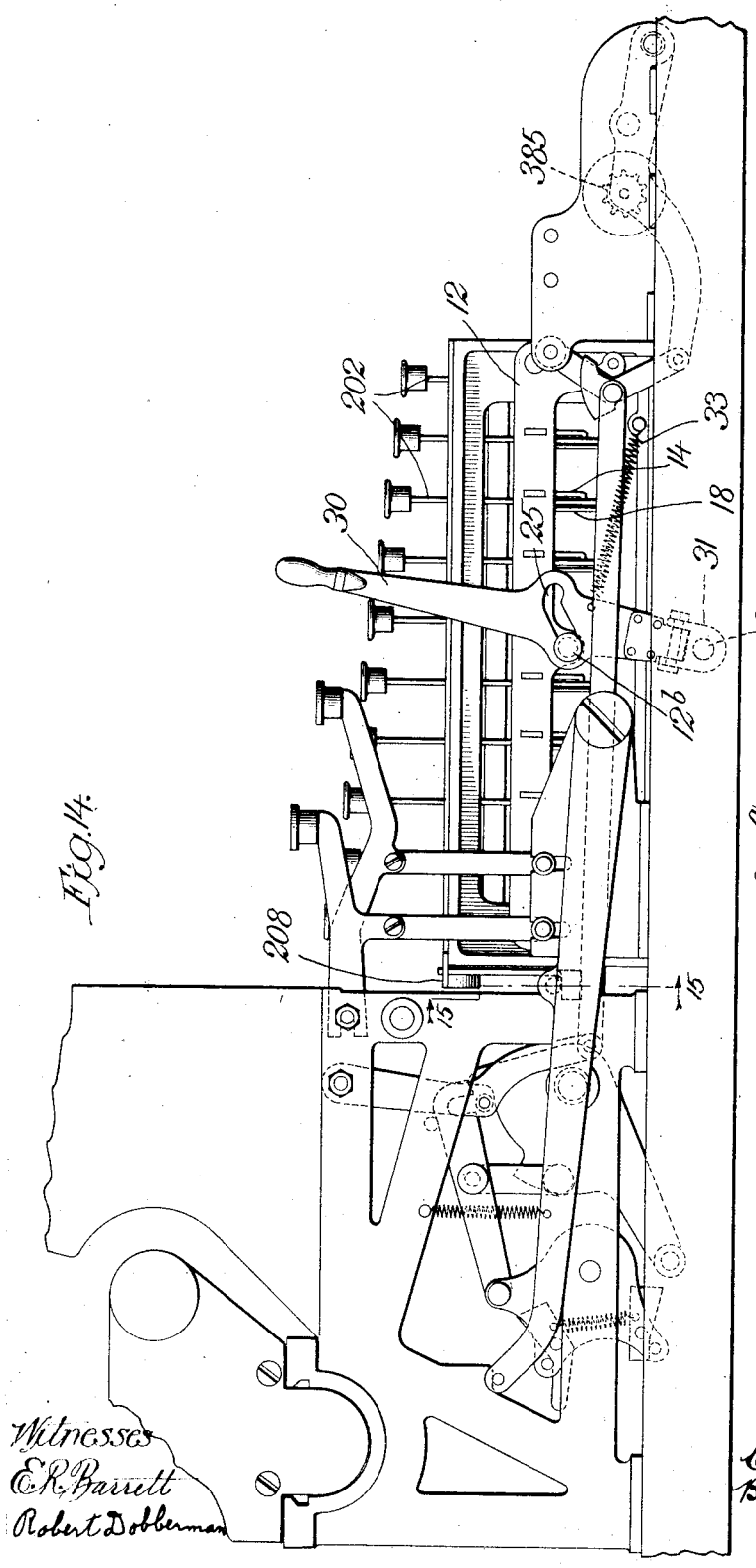


Fig. 14.

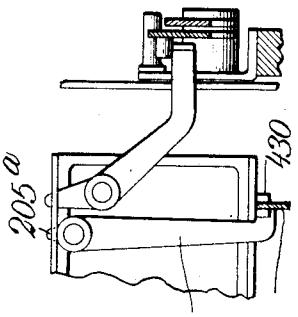


Fig. 15.

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UNITED STATES PATENT OFFICE.

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ADDING-MACHINE.

1,195,575. Specification of Letters Patent. Patented Aug. 22, 1916.

Application filed September 29, 1910. Serial No. 584,538.

To all whom it may concern:

Be it known that I, CLYDE E. W. GARDNER, a citizen of the United States, residing at Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Adding-Machines, of which the following is a specification.

The object of the present invention is to facilitate the use of an adding machine for purposes of multiplication and division.

It is well known in the art how the ordinary adding machine having rows of depressible keys can be used to perform multiplication by repeated addition of the multiplicand and division by repeated addition of the complement of the divisor. Thus, to perform multiplication keys are depressed setting up the multiplicand and the repeat key set to perform its usual function of disabling the amount key releasing means, then the machine is operated as many times as there are units in the multiplier, after which the repeat key and amount keys are released and the multiplicand again set up one point or order to the left and the repeat key again set and the machine operated as many times as there are tens in the multiplier, and so on. Subtraction is commonly done by adding the complement of the subtrahend and division can therefore be accomplished by repeatedly adding such complement, setting it over to the right as the higher portions of the dividend become exhausted or reduced below the divisor or repeated subtrahend. The registering wheels will show the quotient and it is customary to space it off from the beginning of the dividend by setting down the 9 key in the order to the left of the highest number in the divisor. For example, if the dividend is 76000 and it is to be divided by 12, 76000 is first accumulated and then the complement of 12, to-wit 88, is set up in the fourth and fifth banks or rows of keys counting from the right and the 9 key in the next row to the left is also depressed, so that the first part of the quotient will be carried over one space. The machine will then be operated until 76 is reduced to less than 12, a unit being added in each operation on the wheel of the seventh bank. After the machine has been operated six times the numeral 6 will appear upon that wheel and only 4 would remain of the 76. The amount keys would then be released and 988 set up by depressing keys in the third, fourth and fifth rows from the right, after which the machine would be operated until 40 was reduced to less than 12, the result being that the wheel of the 6th bank would show the numeral 3 and there would be a remainder of 4 shown upon the wheel of the third bank. The process would be continued until the dividend of 76000 was reduced to a small remainder of 4 on the units wheel and the fifth, sixth, and seventh wheels counting from the right would show the quotient of 633, which represents the number of times that 76000 is divisible by 12, leaving a remainder of 4.

Not only are uses of the well-known adding machine such as above referred to common, but various appliances have been heretofore devised for facilitating the shifting of the multiplicand or divisor, as the case may be, from order to order of keys, such appliances usually taking the form of a laterally movable frame or superposed keyboard. By the present invention it is proposed to do away with the employment of any superposed structure over the adding machine keyboard and to provide a multiplying and dividing equipment which can be fully contained within the casing of the machine except for the protrusion of an operating handle, such equipment making it possible to change the setting of the keys from right to left or left to right successively by the mere act of working a lever or the like.

I have chosen for the purposes of illustration an adaptation of my invention to the well-known Pike adding machine, the particulars of which may be ascertained by consulting prior Patents No. 763,692, June 28, 1904, and No. 767,596 of Aug. 16, 1904. It will be understood, however, that the invention is not necessarily confined to a machine of this particular style.

In the drawings which accompany and form part of this specification, Figure 1 represents in sectionalized right-side elevation a machine of the type above mentioned having incorporated therein an equipment for carrying out the present invention; Fig. 2 is a sectionalized plan view taken on the

line 2—2 of Fig. 1; Fig. 3 is a fragmentary vertical cross-section taken on the line 3—3 of Fig. 1; Fig. 4 is a vertical cross-section of the machine taken on the line 4—4 of Fig. 1; Fig. 5 is a sectionalized left-side elevation of the keyboard section or department of the machine; Fig. 6 is a fragmentary top plan view of the keyboard with the operating lever of the multiplication appliance in section; Figs. 7, 8 and 9 are views similar to Fig. 4 though not showing as much of the machine and illustrating changed relations of parts under different conditions; Fig. 10 is a fragmentary vertical section taken substantially on the line 10—10 of Fig. 4; Fig. 11 is a horizontal section taken substantially on the line 11—11 of Fig. 1; Figs. 12 and 13 are similar sections taken substantially on the line 12—12 of Fig. 11 but differing from each other in illustrating changed relations of parts under different conditions; Fig. 14 a left side elevation showing more particularly the shift lever and total key connection; Fig. 15 a section on the line 15—15 of Fig. 14.

In view of the disclosures in the prior patents above referred to and also in view of the fact that the Pike machine is more or less extensively known on the market, it will not be necessary to enter into a detailed description of the machine proper, though some of its well-known elements will be designated so that the relation thereto of added devices of the present invention may be thoroughly understood.

The reference numeral 404 designates the customary reciprocating bars which carry the actuating racks 405, and the numeral 385 designates the registering pinions turned by said racks. The excursions of the latter are regulated as usual by the stems 202 of depressible keys, which stems act as stops for lugs on the bars 404 to abut. The keys are normally upheld by springs 280 as usual and the key-stems are double notched for the engagement therewith of detent pawls 207 secured to rock shafts 220 normally constrained by springs 282 to press the detent pawls against the key-stems, said springs being applied to zero stop arms 205 (Fig. 3) fastened to the rock shafts 220 and normally standing in the paths of zero stop lugs 430 on the bars 404 as shown in Fig. 1. There is a transversely extending slide strip or plate 208 slotted to receive lugs 205^a on the arms 205 (Fig. 3) and adapted to serve the usual function of releasing depressed keys by simultaneously rocking the shafts 220. One arm of a bell-crank lever 911 operates said slide strip, the other arm of said bell crank lever being connected to a link 915 which has a right-angled slot *j* (Fig. 1) receiving a stud *i* on the arm of a bell-crank lever 910 whose other arm carries a stud 910^a acted upon by a wipe pawl 916. The latter is mounted upon an arm 905 secured to an oscillating drive shaft 922 of the machine. Loosely mounted upon this same shaft is the lever 10 which serves as a repeat key, being coupled by a link 10^a to the link 915 so that upon drawing forward the lever 10 the vertical portion of the slot *j* will be brought into register with the stud *i* and consequently rocking of the bell-crank lever 910 will impart no movement to the link 915 and the connected key-releasing devices.

All of the above designated elements and their functions are well known and the particulars of the repeat mechanism have been pointed out chiefly because their function is directly concerned in the uses of the machine for purposes of multiplication or division.

Passing now to the novel equipment of the present invention, there is arranged under the keyboard a vertically movable frame or grid composed of side bars 12, front and rear bars 13 and cross bars 14, (Fig. 11) one for each transverse row of keys except the 1 keys, it being understood that a transverse row of keys is composed of keys of the same value. The said frame or grid is guided for rectilinear up or down movement by the engagement of upper and lower studs 13^a and 13^b in slots of the supporting framework of the keyboard section or department of the machine, as clearly shown in Figs. 1 and 5, and it will be understood that the engagement of these studs with the slots is such as to permit lateral movement of the frame or grid. As the equipment of each of the cross bars 14 and the associated transverse row of key-stems 202 is the same, it will suffice to describe one set of the devices composing such equipment. The bar extends closely adjacent the key-stems and between each pair of the latter a pivot stud *a* protrudes from the bar and on this stud is hung a double-acting pawl 18 just beyond the plane of the key stems and connected by a spring 18^a to a depending leg 14^a of the bar, said spring exerting itself to hold the pawl central or extending straight down as shown in Fig. 4, which is the neutral position maintained so long as the machine is in use merely for ordinary operations of addition or subtraction. The upper portion of the pawl is tapered so as to provide an inclined cam edge 18^b at each side. Below these cam edges the side edges of the pawl are straight or parallel and in its lower portion the pawl is undercut at each side to form shoulders 18^c and 18^d on opposite sides of a central terminal portion. Each key stem is equipped with an upper stud 15^a and a lower stud 15^b, the upper stud adapted to co-act with the cam edges 18^b and the lower stud adapted to be acted upon by the shoulder 18^c or the shoulder 18^d when the frame or grid is depressed under a lateral adjust-

ment for multiplication or division. Normally depression of amount keys does not affect the pawls 18, the studs 15^a simply moving down freely between the pawls or, in the case of the outside rows of keys, moving down freely along the outer edges of the pawls. This condition obtains when the frame or grid is in its middle position, but if in either of its other two positions cam edges 18^b of the pawls will have been brought into engagement with the upper key-stem studs 15^a and slightly tilted so that while one set of shoulders 18^c or 18^d will upon depression of the frame or grid clear the associated lower key-stem studs 15^b, whether or not keys have been depressed, the other set of shoulders, though they would clear the associated studs 15^b if no keys had been depressed, will engage the associated studs 15^b if keys have been depressed.

Bearing in mind that the transverse sectional views, Figs. 4 and 7 to 9, are taken looking toward the front of the machine, let it be assumed that division is to be performed. The dividend is first accumulated and keys depressed representing the complement of the divisor and also the 9-key in the next higher order. The repeat key 10 is pulled forward. The machine is then operated until repeated addition of the complemental number reduces the higher digits of the dividend to a quantity less than the divisor, as previously explained, but in order to bring into operation the equipment provided by the present invention, the frame or grid is shifted to the left (or to the right as the parts are viewed in Figs. 4 and 7 to 9). This is done prior to the depression of any keys for setting up the divisor. The result is to move the pawls 18 against the upper key-stem studs 15^a, tilting said pawls to a slight degree as illustrated with regard to the two pawls at the left in Fig. 7. This alone does not change the relation between the pawls and the lower key-stem studs 15^b in so far as cooperative action is concerned. However, it does bring about such a relation between the pawls and the upper studs that upon depression of a key its upper stud will act with a camming effect upon the associated pawl as illustrated in Fig. 7 with reference to the right-hand pawl. (The key here shown depressed is one in the highest order, being that order farthest to the left as the machine is viewed from the right). The effect of this further tilting of the pawl in question is to force its shoulder 18^c, which is farthest from the key, into a position over the stud 15^b of the corresponding key in the next lower order, as illustrated in Fig. 7. Therefore, lowering of the frame or grid to the position shown in Fig. 8 will result in depression of this lower order key. The same effect would be produced between other orders of keys if the divisor called for depression of the keys in a number of orders or denominational rows. Of course, all of the entire set of pawls will move down with the grid or frame but such of them as have not been affected by depression of keys in the beginning will simply pass down between the studs 15^b as illustrated with reference to the pawls at the left in Fig. 8. Depression of the frame or grid releases all of the depressed keys, through means hereinafter described, but keys which are depressed by the pawls 18 in the lowering of the grid will be immediately reëngaged by the detaining detents 207 as the frame or grid rises. The depression of a lower order key by the pawl 18 which has been set through depression of a higher order key, will in turn set the next pawl 18 for depression of the corresponding key of the still lower order. If adjacent digits of the divisor happen to be of the same value then of course the same key in a lower order would remain down during successive series of dividing operations of the machines. It will be clear from the above that division can be expeditiously carried on without repeated manipulation of keys for setting up the complement of the divisor but by setting it up once in the highest orders required by the dividend and then lowering the frame or grid to step the divisor over from order to order.

In the case of multiplication the operation is the same except of course that the stepping over is from right to left instead of from left to right. To prepare the machine for performing multiplication the grid or frame is shifted to the right (or to the left as the parts are seen in Fig. 9) which has the effect of tilting the pawls 18 oppositely to their tilting in the before-described process of preparing the machine for performing division. The machine having been operated to the number called for by the units digit of the multiplier, the frame or grid is lowered with the result that the keys which had been depressed to set up the multiplicand will be released but corresponding keys of a row or rows one order to the left will be depressed by the pawls 18 that were further tilted through the first depression of keys and of course it may be that the same higher order key that was originally depressed will be kept down since it may represent the same digital value as the next lower order key that was depressed.

The frame or grid is controlled as to its lateral position by a lever 30 protruding through the upper keyboard plate or the top panel of the machine, said lever being pivoted at its lower end to a hub 31 secured to a rock shaft 29. This pivoting of the lever is such as to provide for lateral swinging thereof and the lever loosely embraces a flanged rolled 12^a journaled on a stud 12^b which is

secured to the left-hand side bar 12 of the frame or grid. It is obvious that sidewise swinging of the lever 30 will laterally shift the grid or frame. The slot in the machine panel through which said lever protrudes is formed with three notches to determine the position of the lever and the plate is inscribed as shown in Fig. 6 to indicate adding, multiplying and dividing adjustments of the lever, the adding adjustment being the middle one, the multiplying adjustment the right-hand one and the dividing adjustment the left-hand one. The lever has movement forward and back to engage it with and disengage it from the notches and also for the purpose of raising and lowering the frame or grid, this lever serving the double purpose of laterally adjusting the same and also operating it to set over the keys. For the latter purpose the lever has a widened central portion with an inclined cam slot 25 as shown in Fig. 5 which embraces the aforesaid flanged roller 12^a, and to provide for even movement of the grid the rock shaft 29 is extended across the machine and has secured to its right-hand end an arm 28 (Fig. 1) with a cam-slot 28^a just like the slot 25 and receiving a roller-stud 12^d on the right-hand side bar 12 of the frame or grid. Springs 33 applied to said arm 28 and to the lever 30 hold the same forward. It is obvious that by pushing the lever rearward the frame or grid will be lowered and that upon releasing the lever the frame or grid will be raised. At their rear ends the cam slots have sufficient extent of concentric portions to provide for the slight forward and backward movement of the lever sufficient to engage it with and disengage it from the notches of the panel-opening without affecting the frame or grid. In order to guard against movement of the lever far enough rearward to affect said frame or grid when the lever is occupying the adding position or when it is out of either the multiplying or dividing position, said panel opening is specially made, the same comprising slots 34 extending rearward in line with the multiplication and division notches and a contracted forward portion 35 only sufficient in extent from front to rear to permit rearward movement of the lever for disengaging it from the addition notch.

The following described construction is employed for the purpose of causing the frame or grid in lowering to release depressed keys: To each of the detent rock shafts 220 there is secured a short arm 220^a (Figs. 11, 12 and 13) from which depends a link 22 having a lug 22^a at its lower end extending under an adjacent cross-bar 14 of the frame or grid. As here shown, alternating rock shafts have their links coöperating with the foremost cross-bar 14 or the one at the front of the machine and the other rock shafts have their links coöperating with the rearmost cross bar 14, though this is not of course an essential arrangement but is adopted merely for convenience in assembling. It will be obvious that depression of the frame or grid will cause these certain cross bars to act upon the lugs of the links 22 and rock the shafts 220, thereby disengaging the detents 207 from the keys, though as before stated in the case of depression of keys by the frame or grid the detents will reëngage the upper notches of the key-stems as the frame or grid rises.

As to release of depressed keys for correction of errors or for restoring the keys at the conclusion of a series of operations without again operating the machine for the purpose, that is done as in the familiar Pike machine through the use of the total or sub-total key (it is not customary in this particular type of machine to provide a separate correction or error key). In Fig. 14 the total and sub-total keys are shown in the form of levers 702 and 702^s and a lever 702^a which they operate upon acts in turn upon a bent lever 702^b (Fig. 15) which has a nose engaging a slot in the detent releasing plate 208.

What is claimed is:

1. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof; of means for effecting depression of a key in one row under control of a previously depressed key of corresponding value in an adjacent row depressed in a preceding operation.

2. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof; of means for effecting depression of a key in one row under control of a previously depressed key of corresponding value in either of the two adjacent rows depressed in a preceding operation.

3. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof; of detent means for holding keys depressed, and means for effecting depression of a key in one row under control of a depressed key of corresponding value in an adjacent row and releasing the said depressed key.

4. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof; of detent means for holding keys depressed, and means for effecting depression of a key in

one row under control of a depressed key of corresponding value in either adjacent row and releasing the said depressed key.

5. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof; of detent means for holding keys depressed, a depressible member adapted to release the detent means, and means operated by said depressible member for depressing a key of one row under control of a key of corresponding value in an adjacent row.

6. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof; of detent means for holding keys depressed, a depressible member adapted to release the detent means and means operated by said depressible member for depressing a key of one row under control of a key of corresponding value in either adjacent row.

7. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof; of detent means for holding keys depressed, and a depressible frame carrying movably mounted pawls adjacent the keys and adapted to be engaged and set thereby and when set to engage for depression keys of rows adjacent those whose keys do the setting, said frame adapted when depressed to release the detent means.

8. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof; of detent means for holding keys depressed, and a depressible frame carrying movably mounted pawls adjacent the keys and adapted to be engaged and set thereby and when set to engage for depression keys of rows adjacent those whose keys do the setting, a pawl being double-acting to engage for depression a key of either row adjacent the intermediate row, and a key of corresponding value in the latter adapted to set either of two adjacent pawls, and the frame adapted to release the detent means.

9. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof; of detent means for holding keys depressed, and a depressible frame carrying pivotally mounted pawls adjacent the keys and adapted to be engaged and set thereby and when set to engage for depression keys of rows adjacent those whose keys do the setting, said frame adapted when depressed to release the detent means.

10. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof; of detent means for holding keys depressed, and a depressible frame carrying pivotally mounted and spring-held pawls adjacent the keys and adapted to be engaged and set thereby and when set to engage for depression keys of rows adjacent those whose keys do the setting, said frame adapted when depressed to release the detent means.

11. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof; of detent means for holding keys depressed, and a depressible frame carrying pivotally mounted pawls adjacent the keys and adapted to be engaged and set thereby and when set to engage for depression keys of rows adjacent those whose keys do the setting, a pawl being double-acting to engage for depression a key of either row adjacent the intermediate row, and a key of corresponding value in the latter adapted to set either of two adjacent pawls, and the frame adapted to release the detent means.

12. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof; of detent means for holding keys depressed, and a depressible frame carrying pivotally mounted and spring-centralized pawls adjacent the keys and adapted to be engaged and set thereby and when set to engage for depression keys of rows adjacent those when set to engage for depression keys of rows adjacent those whose keys do the setting, a pawl being double-acting to engage for depression a key of either row adjacent the intermediate row, and a key of corresponding value in the latter adapted to set either of two adjacent pawls, and the frame adapted to release the detent means.

13. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof, the keys having upper and lower studs; of detent means for holding keys depressed, and a depressible frame carrying movably mounted pawls adjacent the keys and beveled for engagement with upper key studs and shouldered for engagement with lower key studs, the frame adapted when depressed to operate the detent means.

14. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof, the keys having upper and lower studs; of detent means for holding keys depressed, and a depressible frame carrying movably mounted pawls adjacent the keys and double-beveled for engagement with the upper key studs and double-shouldered for engagement with lower key studs, the frame adapted when depressed to operate the detent means.

15. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof, the keys having upper and lower studs; of detent means for holding keys depressed, and a depressible frame carrying pivotally mounted spring-centralized pawls adjacent the keys and double-beveled for engagement with the upper key studs and double-shouldered for engagement with lower key studs, the frame adapted when depressed to operate the detent means.

16. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof; of detent pawls for holding keys depressed, pawl-operating connections and a depressible frame carrying movably mounted pawls adjacent the keys and adapted to be engaged and set thereby and when set to engage for depression keys of rows adjacent those whose keys do the setting, said frame adapted when depressed to actuate the detent-pawl operating connections.

17. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof; of detent means for holding keys depressed, a depressible frame carrying movably mounted pawls adjacent the keys and adapted to be engaged and set thereby and when set to engage for depression keys of rows adjacent those whose keys do the setting, said frame adapted when depressed to release the detent means; and a cam-lever for depressing the frame.

18. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof; of detent means for holding keys depressed, and a depressible and laterally movable frame carrying movably mounted pawls adjacent the keys and adapted to be engaged and set thereby and when set to engage for depression keys of rows adjacent those whose keys do the setting, said frame adapted when depressed to release the detent means.

19. In a machine of the character described, the combination with registering wheels and actuators therefor and denominational rows of depressible keys to determine extent of movement thereof; of detent means for holding keys depressed and a depressible and laterally movable frame carrying movably mounted pawls adjacent the keys and adapted to be engaged and set thereby and when set to engage for depression keys of rows adjacent those whose keys do the setting, a pawl being double-acting to engage for depression a key of either row adjacent the intermediate row, and a key of corresponding value in the latter adapted to set either of two adjacent pawls, and the frame adapted to release the detent means.

20. In an adding machine, keys arranged in numerical orders, actuating appliances for said keys moved incidentally to the operation of said keys, and means for operating said actuating appliances effectively to set certain keys to represent numbers, substantially as specified.

21. In an adding machine, keys arranged in numerical orders, parts moved incidentally to the operation of said keys, means for operating said parts effectively to set certain keys to represent numbers, and mechanism for adding said numbers, substantially as described.

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Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."