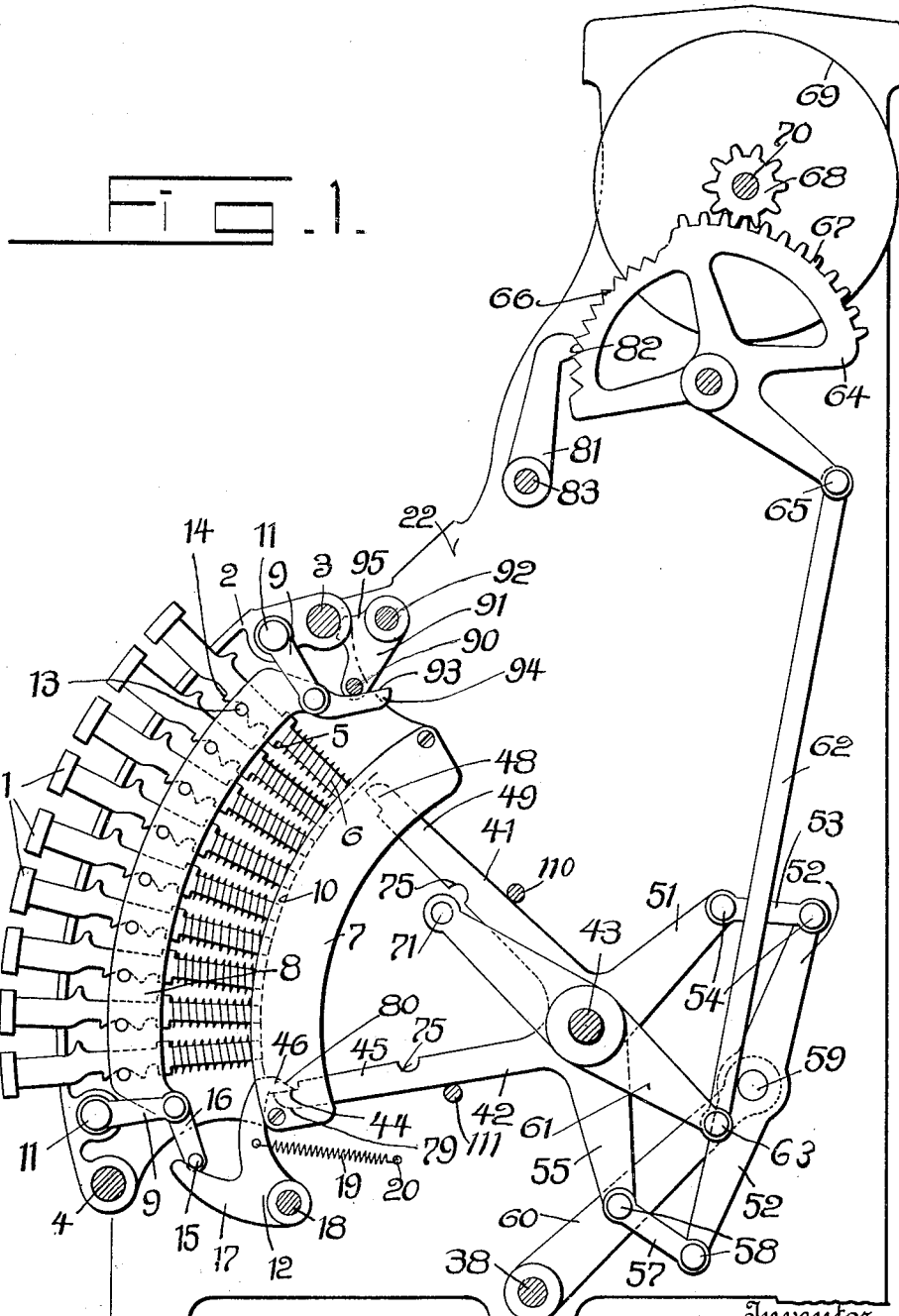


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T. MIDGLEY, JR.
DIFFERENTIAL MECHANISM.
APPLICATION FILED OCT. 13, 1913.

Patented July 4, 1916.
2 SHEETS—SHEET 1.



Witnesses
H. M. Lindsey Jr.
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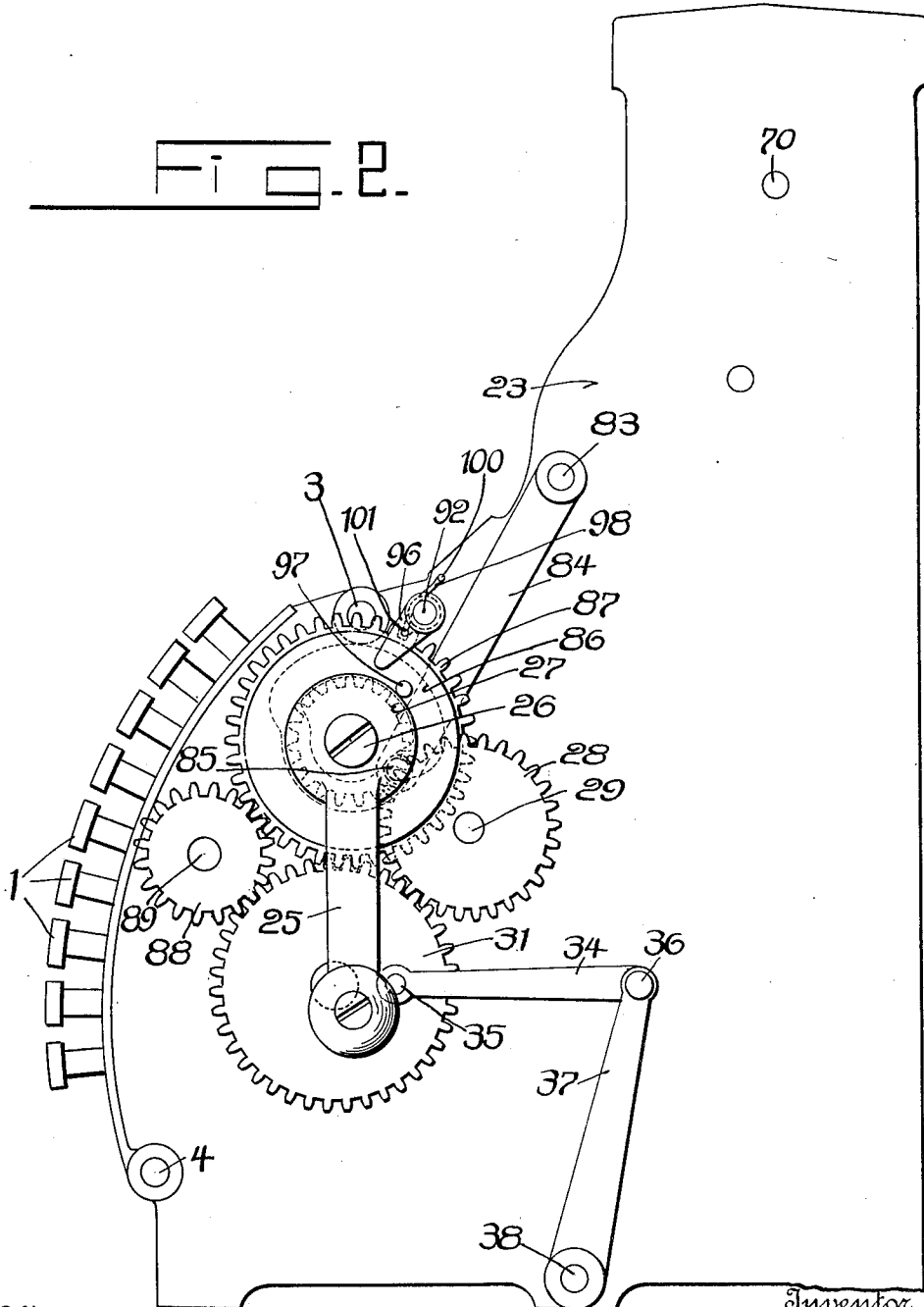
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UNITED STATES PATENT OFFICE.

THOMAS MIDGLEY, JR., OF WORTHINGTON, OHIO, ASSIGNOR TO THE NATIONAL CASH REGISTER COMPANY, OF DAYTON, OHIO, A CORPORATION OF OHIO, (INCORPORATED IN 1906.)

DIFFERENTIAL MECHANISM.

1,189,279.

Specification of Letters Patent.

Patented July 4, 1916.

Application filed October 13, 1913. Serial No. 794,815.

To all whom it may concern:

Be it known that I, THOMAS MIDGLEY, JR., a citizen of the United States, residing at Worthington, in the county of Franklin and State of Ohio, have invented certain new and useful Improvements in Differential Mechanism, of which I declare the following to be a full, clear, and exact description.

This invention relates to accounting machines and more particularly to the differential mechanism thereof.

Among the objects of the invention is to eliminate as far as possible the danger of overthrow of the indicators in machines of this class; to provide in such machines for adjusting oscillatory indicating units from one position directly to another position without first returning them to a constant position; and to provide mechanism whereby when no key in a bank is depressed the operation of the machine will serve to insure that the indicator for the bank in which no key is depressed will indicate zero after the operation.

Briefly, the above objects are accomplished in the preferred form of embodiment herein disclosed by mounting on a transverse shaft bell crank levers of similar construction, there being two of the levers for each bank of keys. The rear arms of each pair of bell cranks extend in different directions and are connected by similar links to the opposite ends of a lever which is centrally pivoted on an oscillatory driving arm. The forward ends of the bell crank levers carry shoulders and with the parts referred to in normal position the shoulder on one bell crank lever is in engagement with the zero stop pawl positioned below the last key in the bank, while the shoulder of the other arm is in such a position as to be in contact with the uppermost key in the bank when this key is depressed. When a key in a bank is depressed a detent is actuated to move the zero trip pawl for that bank out of engagement with the arm of the lower bell crank lever to permit movement of the latter.

On operation of the machine the driving arm is first rocked forward and the bell crank levers through the link connections and the lever centrally mounted on the driving arm move simultaneously from normal position until movement of one of them is

stopped by the engagement of the shoulder of this bell crank lever with the inner end of the depressed key, after which the other bell crank will continue to move until its shoulder also engages the end of a depressed key. In this manner the bell crank levers are always moved complementary extents.

A lever which is centrally mounted on the same shaft as the bell crank levers carries at its forward end a pin which projects between the forward arms of the bell crank levers so that a notch on one of the bell crank levers engages the pin and moves the lever carrying the pin until movement of the bell crank lever is stopped by the depressed key in which position a notch on the other bell crank lever will also engage the pin. The rear end of the lever carrying the pin is connected to an oscillatory segment toothed on a portion of its periphery to engage with a pinion on its corresponding indicator unit which is thus rotated in accordance with the adjustment of the segment gear. When the pin on the lever connected to the actuating segment gear is in engagement with the notch in the lower bell crank lever when it is in zero position at the end of an operation of the machine the corresponding indicator indicates zero, and when the pin is in engagement with the notch in the arm of the other bell crank in its normal position at the end of the operation of the machine the indicator is in its nine position. When the lever carrying the pin is intermediate these two positions at the beginning of the operation of the machine it is picked up by either one of the bell crank levers dependent upon its position at the beginning of the operation of the machine and the key depressed and moved to adjust the indicator until the pin is in a position in which it is engaged by both bell crank levers.

If the upper bell crank lever picks up the lever connected to the actuating segment for the indicator and moves it downward until the movement of the bell crank lever is stopped by the key, the indicator is adjusted from a higher to a lower position, while if the indicator is to be adjusted from a lower to a higher position the movement is accomplished by the other bell crank lever. After the indicators have been adjusted to their proper positions they are positively locked

against movement by a pawl which is actuated by the operating mechanism.

To provide for adjusting an indicator to zero when no key in the corresponding bank is depressed, a pivoted member taking the place of a zero key is provided for each bank of keys. The pivoted member of each bank carries a projection or nose normally in engagement with the shoulder of the lower bell crank lever and when no key in the bank is operated only the other bell crank lever will be moved and such movement will carry the roller on the lever connected to the actuating segment for the indicator into engagement with the lower bell crank lever in its normal position. Depressing of a key in the bank, however, moves the detent for that bank to rock the pivoted member out of engagement with the shoulder of the lower bell crank lever.

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

Of said drawings:—Figure 1 is a transverse vertical section of a cash register having the present invention applied thereto. Fig. 2 is a right hand side elevation of the machine showing the operating mechanism.

The value keys 1 are employed as usual to control the operation of the differential mechanism in order that the indicators may be rotated differentially. Each bank of keys is mounted in a frame 2 supported by cross shafts 3 and 4. The keys are provided with shoulders 5 which extend across the upper ends of springs 6 which are carried about the key shanks, the lower ends of the springs being in engagement with flanges 10 of the plates 7, which are mounted on the key frame 2. The inner ends of the keys pass through holes in the flange 10 to guide them in their movements. Thus when a key is depressed it causes compression of its spring 6 and consequently the spring serves to restore the key to normal position when the latter is finally released at the end of the operation of the machine.

The keys cooperate with a detent 8 supported by arms 9 pivoted by pins 11 to key frame 2. The detent temporarily retains keys in depressed position and operates a zero stop pawl 12 for the differential mechanism and for this purpose the detent is provided with a plurality of pins 13 for cooperating with shoulders 14 on the keys. When a key is depressed the inclined edge of the shoulder 14 of the key depressed engages a pin 13 on the detent thus forcing the detent 8 downward swinging the arms 9

around their pins 11. A pin 15 on a projection 16 at the lower end of each detent extends across the upper edge of a tail 17 on the corresponding zero stop pawl 12. The zero stop pawls are pivoted on a cross shaft 18 and each is connected by a spring 19 to a bar 20 supported by and extending between the side frames 22 and 23 of the machine. Thus the spring 19 normally holds its zero stop pawl 12 in the position shown in the drawings and engagement of the tail 17 of the pawl 12 with the pin 15 of the detent holds the detent in its upper position as shown. When a key is depressed, downward movement of the detent occurs until the shoulder 14 on the key has passed the pin 13 when the detent rises slightly under the action of the spring 19, retaining the key in its depressed position. The downward movement of the detent by the pin 15 engaging the tail 17 serves to rock the zero stop lever 12 forwardly and it is retained in this position as long as the key is depressed, the slight movement of the detent when the pin passes in front of the shoulder 14 not being sufficient to return the zero pawl 12 into operative relationship with the differential mechanism to be presently described.

After the proper amount keys have been depressed the differential mechanism is actuated differentially to rotate the indicators, through a crank 25. The crank is journaled on a stub shaft 26 and is fast to a pinion 27 meshing with a pinion 28 journaled on a stub shaft 29 and in turn meshing with a broad gear wheel 31 having twice as many teeth as the pinion 27. By means of this gearing two clockwise rotations of the crank 25 serve to cause a single rotation of the gear wheel 31 and in the same direction.

While the machine in the illustrative form is shown as being operated by the crank handle, it is to be understood that a motor properly geared to the gear wheel 31 can be employed.

A link 34 pivoted to the side of the gear wheel 31 by a pin 35 is connected at its rear end by a pin 36 to the outer end of an arm 37, fast on a shaft 38 which extends longitudinally through the bottom of the machine. From the above construction it can be seen that the arm 37 and therefore the shaft 38 is first rocked forward about 25° and is then returned to initial position at the end of the operation of the machine, and that this movement is slow at the beginning of the operation of the machine gradually increasing until the shaft has been rocked forward about 12½° after which the speed decreases until the shaft has reached the end of its forward movement, the speed of the return movement of the shaft being the same as the forward movement. The rocking movement of this shaft 38 serves to ac-

tuate the differential mechanism of the machine and this mechanism will now be described in detail.

Two bell crank levers 41 and 42 for each bank of keys are pivotally mounted upon a transverse shaft 43. The bell crank levers are similarly constructed but are reversely mounted upon the shaft so that a shoulder 44 on the forward arm 45 of the lower bell crank lever 42 is normally in engagement with the lower edge of a nose 46 projecting from the zero stop pawl 12, while the shoulder 48 of the forward arm 49 of the other bell crank lever is in such a position that when the uppermost key, which is the key of greatest value in each bank, is depressed it is in contact with the inner end of this key. The arm 51 of the upper bell crank lever is connected to a lever 52 by a link 53; the link being pivotally mounted to the arm 51 and to the lever 52 by pins 54. The rear arm 55 of the lower bell crank lever is connected by a link 57, which is similar to the link 53, to the lower end of the lever 52 by pins 58. The lever 52 at its center is pivotally mounted by a pin 59 to the upper end of an arm 60, which is rigidly mounted on the oscillatory shaft 38. The distances from the shaft 43 to the pins 54 and 58 on the arms 51 and 55 are equal to the distances from the pivot 59 to the pins 54 and 58 on the lever 52.

Centrally mounted on the shaft 43 and beside each pair of bell crank levers 41 and 42 are levers 61. The rear end of each of these levers 61 is connected to a link 62 by a pin 63 and the upper end of the link 62 is connected to a corresponding actuating segment gear 64 by a pin 65. The segment gear 64 is provided with alining notches 66 and also with teeth 67 and the teeth 67 are in engagement with a pinion 68 fast to indicating wheel 69 which is loosely mounted on a shaft 70. The forward end of the lever 61 carries a pin 71 which projects between the forward arms of the bell crank levers 41 and 42.

The operation of this differential mechanism is as follows. When a key is depressed the zero stop pawl 12 is rocked forward so that its nose 46 is carried out of engagement with the shoulder 44 of the lower bell crank lever 42 and upon rotation of the crank handle 25 the shaft 38 is rocked forward about 25° as has been described. Such movement of the shaft carries the arm 60 for each bank of keys forwardly about 25° and causes the forward arms of the bell crank levers 41 and 42 to approach each other and engage the depressed key at each operation of the machine and with the arms in engagement with the depressed key the lower side of the forward arm of the upper bell crank lever is in juxtaposition with the upper side of the forward arm of the lower

bell crank lever. After a key is depressed the bell crank levers 41 and 42 are moved simultaneously from normal position and with approximately the same speed as the links 53 and 57 are similar and are connected to the lever 52 at equal distances from the pivotal center 59 of the lever.

When the shoulder of one of the bell crank levers engages the inner end of a depressed key further movement of the bell crank lever is prevented and movement of the other bell crank lever continues until the shoulder of this latter bell crank lever also engages the inner end of the depressed key. For example, if the "8" key has been depressed the bell crank lever 41 is given one step of movement before its shoulder engages the "8" key and the lower bell crank lever 42 is given a movement complementary to the movement of the bell crank lever 41, that is movement of eight steps. When a "2" key is depressed the lower bell crank lever is given two steps of movement and the upper bell crank lever is given seven steps of movement. If the machine is operated with no key in the bank depressed the zero stop pawl 12 for that bank remains in operating relationship with the lower bell crank lever 42 so that the upper bell crank lever 41 is given nine steps of movement and the lower none.

When the bell crank levers are moved, as has just been described, a semicircular notch 75 in one of the arms of the bell crank levers engages the pin 71 on the forward end of the lever 61 and moves the lever until the pin is in engagement with the semicircular notch 75 in the forward arm of the other bell crank lever in which position both bell crank levers engage the depressed key. Which of the bell crank levers is to pick up the lever 61 depends, of course, upon the key depressed and also upon the position of the lever 61 at the beginning of the operation of the machine. As the lever 61 is connected to the actuating segment 64 for the indicator by the link 62 it can be seen that the movement of the lever 61 from one adjusted position to another rotates the indicator 69 directly from one indicating position to another without first restoring the indicator to a constant position.

Upon return movement of the arm 60 to normal position the differential mechanism is restored to its initial position and the curved surface 79 of the shoulder 44 on the lower bell crank lever engages the inclined edge 80 of the nose 46 on the zero stop lever 12 which has been restored to normal position as will be explained, and the pawl is thrown forward by such engagement until the shoulder 44 passes out of engagement with the inclined edge 80 and the spring 19 then throws the zero stop pawl 12 rearward into normal locking position with this bell crank lever as shown in Fig. 1. The rods

110 and 111 which extend longitudinally through the machine are normally engaged by the arms 49 and 45 respectively and serve as stops to prevent movement of the arms past their normal positions when the shaft 38 is rocked back to normal position.

In order to aline the indicators 69 in their adjusted positions at the end of the forward stroke of the driving arms 60 alining pawls 81 having wedge-shaped noses 82 for engaging the alining notches 66 in the forward portion of the periphery of the actuating segment 64, are provided. These pawls 81 are rigidly mounted upon a shaft 83, extending longitudinally through the machine.

As shown in Fig. 2 an arm 84 is fast to the right hand end of the shaft 83 and at its lower end carries an anti-friction roller 85 which plays in the groove 86 formed in the left hand face of a gear wheel 87. This gear wheel is of the same size as the broad gear wheel 31 and both of these gear wheels mesh with a gear wheel 88 journaled on a stub shaft 89 so that the gear wheel 87 is given one complete rotation at each operation of the machine. The configuration of the cam groove 86 is such that at the very beginning of the operation of the machine the arm 84 is rocked rearward and as the alining pawls 81 are fast on the shaft 83 they are by this rocking of arm 84 carried forward and out of engagement with the alining notches 66 to permit movement of the indicators. After the indicators have been differentially positioned and before the bell cranks 41 and 42 start to move to home position the cam groove 86 again rocks the alining pawls 81 into locking engagement with the alining notches 66 and in this way, while the arms 60 and the bell cranks 41 and 42 are being restored to normal position and until the next operation of the machine the indicators are positively locked against movement.

Near the end of the operation of the machine and before the curved surface 79 of the shoulder 44 on the lower bell crank lever engages the inclined face 80 of the nose 46 on the zero trip pawl 12, the depressed keys are released to permit their springs 6 to restore them to undepressed position. For this purpose a tie bar 90 carried at the lower ends of two arms 91 fast to a shaft 92 extends across the upper inclined edges 93 of the projections 94 of the upper ends of the locking detents 8. The arms 91 have projections 95 which normally engage the tie bar 3 to prevent the arms 91 from moving forward past normal position. An arm 96 fast to the outer end of the shaft 92 projects into the path of a stud 97 projecting from the right hand face of the gear wheel 87. A spring 98 which is coiled above the shaft 92 between the pawl 96 and the side frame 23 of the machine is fastened at one

end 100 to the side frame 23 of the machine and at the other end 101 to the arm 96 and in this way holds the arms 91 and the tie bar 90 forward in the normal position as shown in the drawings. Near the end of the operation of the machine the pin 97 on the gear 87, which moves clockwise, engages the pawl 96 and the shaft 92 is rocked counter-clockwise against the action of the spring 98 and, through the engagement of the tie bar 90 with the projection 94 of the detents lowers the detents against the action of the springs 19 for the zero stops 12 so that the keys are restored to undepressed position. When the pin 97 passes out of engagement with the pawl 96 the spring 98 restores the arms 91 and tie bar 90 to normal position and the detents 8 are raised to normal position under the influence of the springs 19, connecting the zero stop pawls to the frame of the machine.

The detailed description above fully sets forth the invention but to summarize, the operation of the machine will be briefly given. On depression of an amount key in a bank the detent 8 for that bank is moved downward to rock the zero stop pawl 12 out of engagement with the shoulder on the forward arm 45 of the lower bell crank lever 42. As the pin 13 on the detent passes out of engagement with the inclined edge of the shoulder 14 on the keys the detent is slightly raised under the influence of its zero stop spring 19 and the shoulder retains the key in depressed position.

Upon operation of the crank 25 the driving arms 60 are rocked forward and through the levers 52 and links 53 and 57 both bell crank levers for each bank of keys are moved to complementary extents. If one of the four lower amount keys in a bank has been depressed the lower bell crank lever 42 for that bank will have its movement limited by the depressed key before the upper bell crank lever 41 engages the key and if one of the five upper amount keys is depressed movement of the upper bell crank lever is limited before the lower bell crank lever engages the key. One of the bell crank levers for each bank engages the pin 71 on the lever 61, and carries it into engagement with the other bell crank lever and in this way one or the other of the bell cranks, dependent upon the position of the indicator at the beginning of the operation of the machine and also upon the key depressed, adjusts the indicator, while the other bell crank lever acts as a positive stop to prevent overthrow of the indicator.

After the indicator has been adjusted and at the end of the forward stroke of the driving arms 60 the alining pawls 81 are rocked into alining and locking engagement with the notches 66 on the indicator actuating segments 64 by the rocking of shaft 83 through

the cam 86. Near the end of the operation of the machine the stud 97 on the gear wheel 87 engages the pawl 96 fast to the shaft 92 and rocks the shaft so that the tie bar 90 carried by the arms 91 fast to the shaft 92 engages the projections 94 on all the detents 8 to lower the detents and in this way permit the depressed keys to be restored by their springs to initial position.

- 10 In the illustrative form disclosed herein the differential mechanism is only shown as being used to adjust an indicator mechanism but it is to be understood that it is not intended to limit in the claims the invention to such a use.

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

- 25 What is claimed is:—

1. In a machine of the class described, the combination with two differentially movable frames; of keys for positively limiting the extent of movements of both frames; operating mechanism for moving the frames differentially and to complementary extents; indicating mechanism; and connections between the frames to the indicating mechanism whereby one of the frames moves the indicator from lower to higher positions and the other frame adjusts it from higher to lower indicating position.

2. In a machine of the class described, the combination with a differentially movable frame; of operating mechanism therefor; an indicator; a second frame adapted to be moved by the operating mechanism to extents complementary to movements of the first frame, movement of one frame being adapted to be limited before the movement of the other frame is limited whereby one frame adjusts the indicator from the lower to higher position to indicate the extent of movement of the frame, or the other mentioned frame adjusts the indicator from higher to lower position to indicate the extent of movement of the first mentioned frame.

3. In a machine of the class described, the combination with an accounting element; of an actuator therefor; differentially adjustable frames movable to complementary extents to adjust said actuator; and a pivoted member having a bodily movement of invariable extent and a rotary movement of different extents, to move said differentially movable frames to complementary extents for the purpose described.

4. In a machine of the class described, the combination with an accounting element; of

an actuator therefor; differentially adjustable frames movable to complementary extents to adjust the actuator; keys for limiting movement of said frames; an oscillatory arm; a lever centrally pivoted on said arm and connected to said differentially adjustable frames so that when said oscillatory arm is moved the lever will have no relative movement thereto until movement of one of the frames is limited by the key operated after which the lever will be rotated differentially until movement of the other frame is limited by the key operated.

5. In a machine of the class described, the combination with an accounting mechanism; of pivoted bell crank levers for actuating the same and movable in opposite directions and to complementary extents; keys for limiting the movements of the bell crank levers; an oscillatory driving arm having a constant extent of movement at each operation of the machine; a lever centrally pivoted on said oscillatory arm; and links connecting the ends of said last mentioned lever and the bell crank levers so that said driving arm moves said bell crank levers to complementary extents.

6. In a machine of the class described, the combination with an accounting element; of an actuator for actuating the accounting element and having a pin; two differentially movable frames adjustable to complementary extents in opposite directions and having notches for engaging said pin on the actuator, to move said actuator directly from one position to another and positively preventing overthrow of the actuator; and means for actuating said differentially movable frames.

7. In a machine of the class described, the combination with an accounting mechanism; of pivoted bell crank levers for adjusting said accounting mechanism and movable to complementary extents; a driving arm; a pivoted member carried by said arm; and links connecting said pivoted member and said bell crank levers so that movement of said driving arm moves said bell crank levers complementary extents.

8. In a machine of the class described, the combination with two differentially adjustable frames, movable to complementary extents; of an indicator adapted to be actuated by either one of the frames dependent upon the position of the indicator at the beginning of the operation of the machine; a member normally in position to lock one of the frames against movement so that the other frame adjusts the indicator to zero; and means whereby the member is withdrawn from normal position when the indicator is to be adjusted to indicate other than zero.

9. In a machine of the class described, the combination with two differentially adjust-

able frames, movable to complementary extents; of an indicator adapted to be actuated by one frame while the other serves to limit the extent of actuation; and means for normally locking one of said frames so that the other frame is given nine extents of movement to restore the indicator to zero.

10. In a machine of the class described, the combination with a plurality of indicators; of a plurality of sets of actuating mechanisms each set comprising a plurality of movable parts; a plurality of sets of keys for controlling the extent of movement of the sets of actuating mechanisms; means for normally locking part of the actuating mechanism of each set against movement so that the remaining parts will restore the indicator of that set to zero when the machine is operated without the depression of a key in a corresponding set; and means whereby the last mentioned means of any set is disabled when a key in such set is depressed.

11. In a machine of the class described, the combination with an accounting element; of an actuator therefor; two movable members either of which is adapted to position the accounting element dependent on the position of the latter at the beginning

of the operation of the machine, the member not serving to adjust the accounting element, serving to positively limit the extent of movement of the other member; and means for moving the members differentially and in opposite directions to complementary extents for this purpose.

12. In a machine of the class described, the combination with an accounting mechanism; of pivoted bell crank levers for adjusting said accounting mechanism and movable to complementary extents; a shaft; a driving arm carrying a pivoted member and rigidly mounted on said shafts; links connecting said member and said bell crank levers so that movement of said driving arm moves said bell crank levers to complementary extents; an arm fast to said shaft; a pivoted rotary member; and a link pivoted eccentrically on said rotary member and connected to said last mentioned arm so that rotation of said rotary member will rock said shaft and said driving arm.

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

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