May 16, 1933. W. J. PASINSKI 1,909,714

AUTOMATIC CALCULATOR

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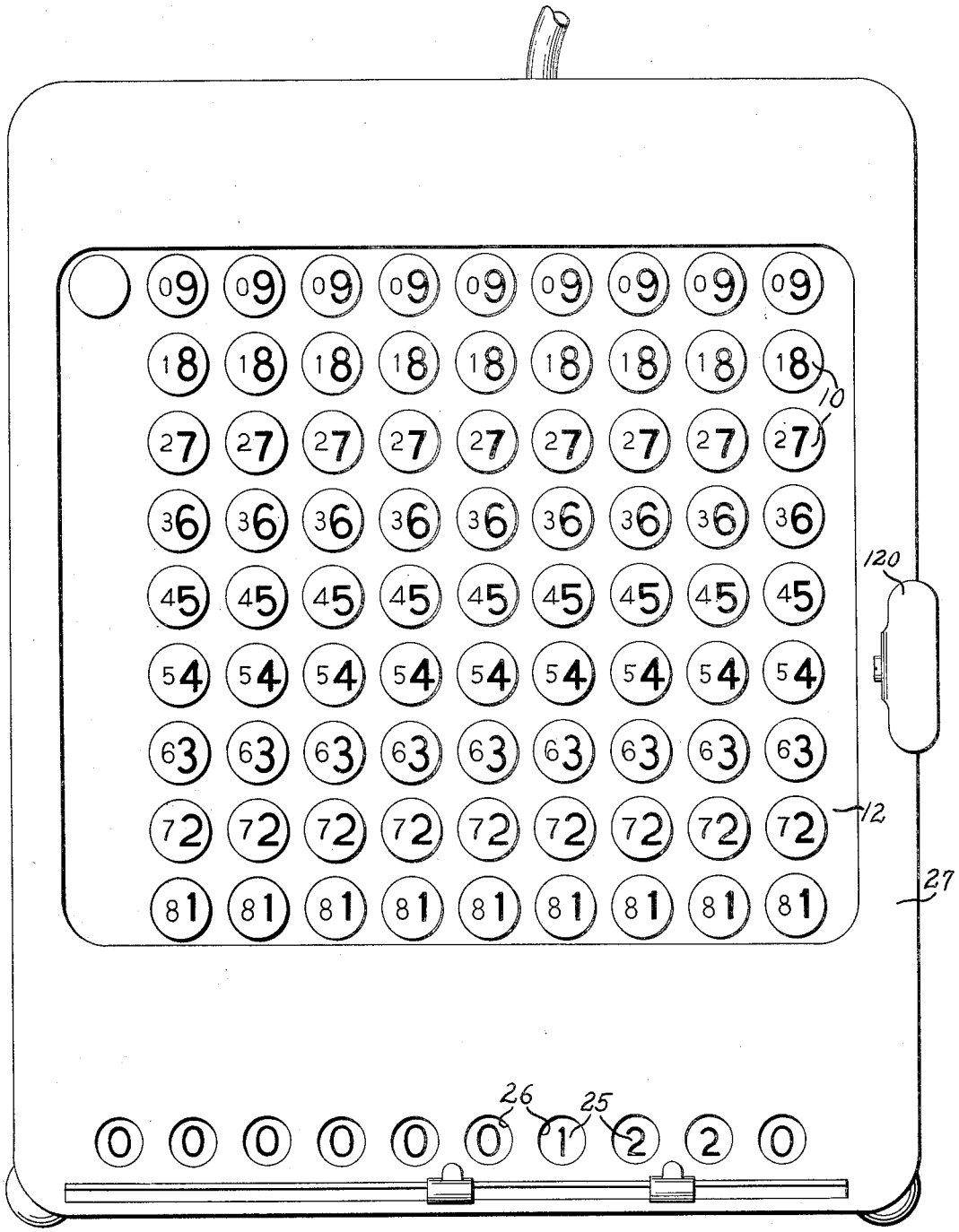

Fig. 1.

INVENTOR
Walter J. Pasinski
BY
Rector, Hibben, Davis, & Macauley
ATTORNEYS

May 16, 1933. W. J. PASINSKI 1,909,714

AUTOMATIC CALCULATOR

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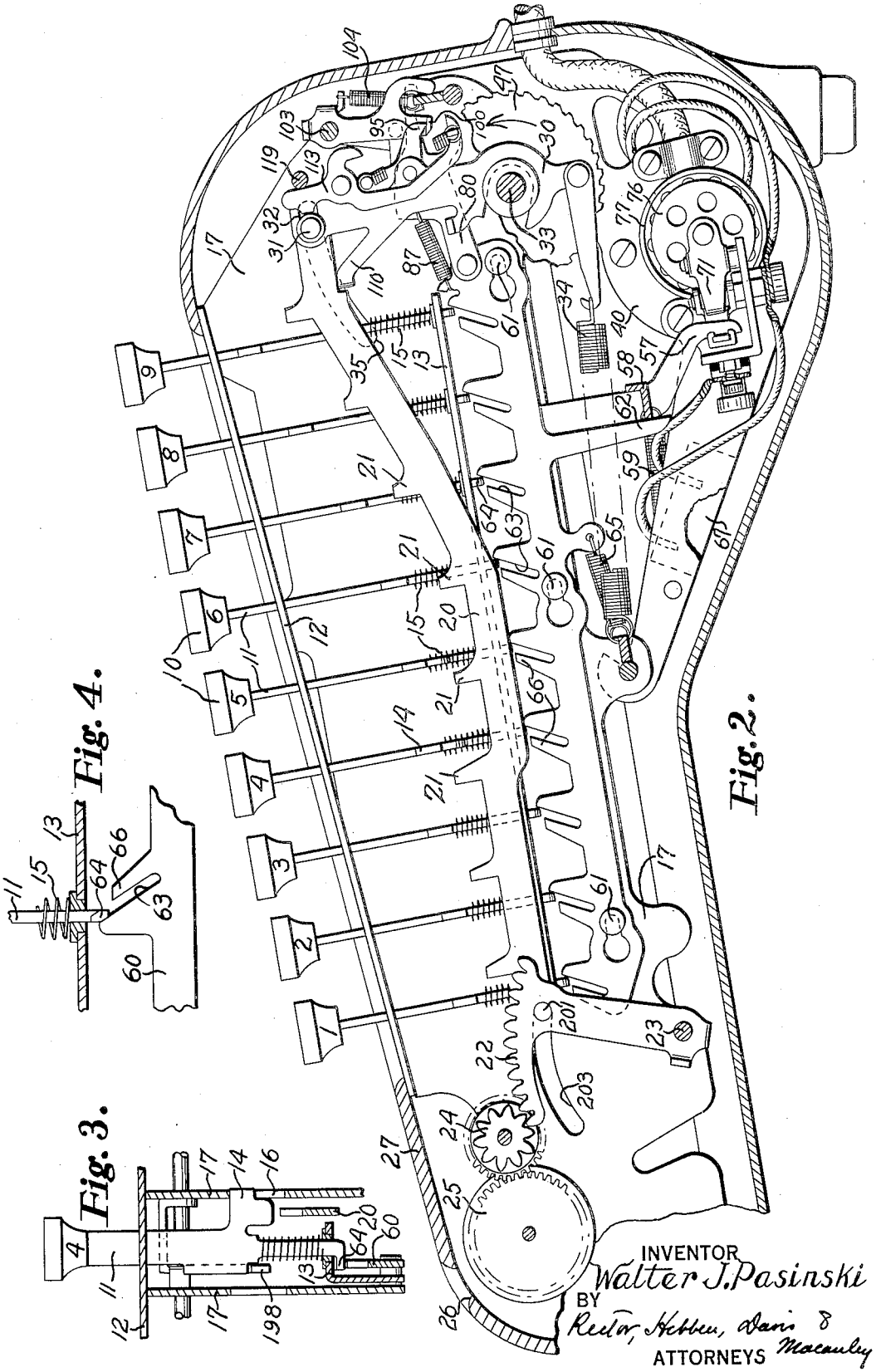

Fig. 2.

Fig. 4.

Fig. 3.

INVENTOR
Walter J. Pasinski
BY
Reuter, Hobbs, Davis & Macauley
ATTORNEYS

May 16, 1933. W. J. PASINSKI 1,909,714

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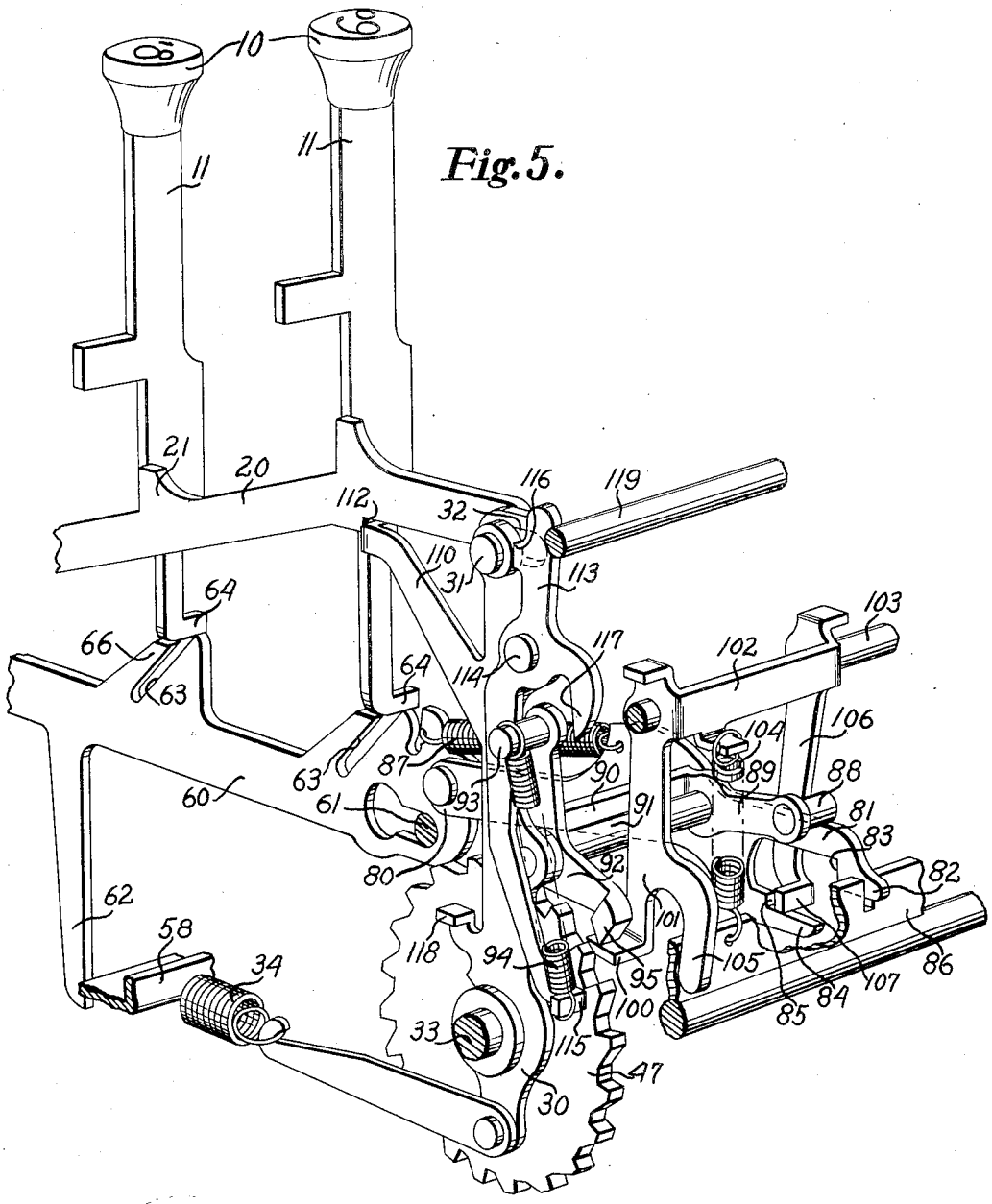

Fig. 5.

INVENTOR
Walter J. Pasinski
BY
Rector, Hibben, Davis, & Macauley
ATTORNEYS

May 16, 1933. W. J. PASINSKI 1,909,714

AUTOMATIC CALCULATOR

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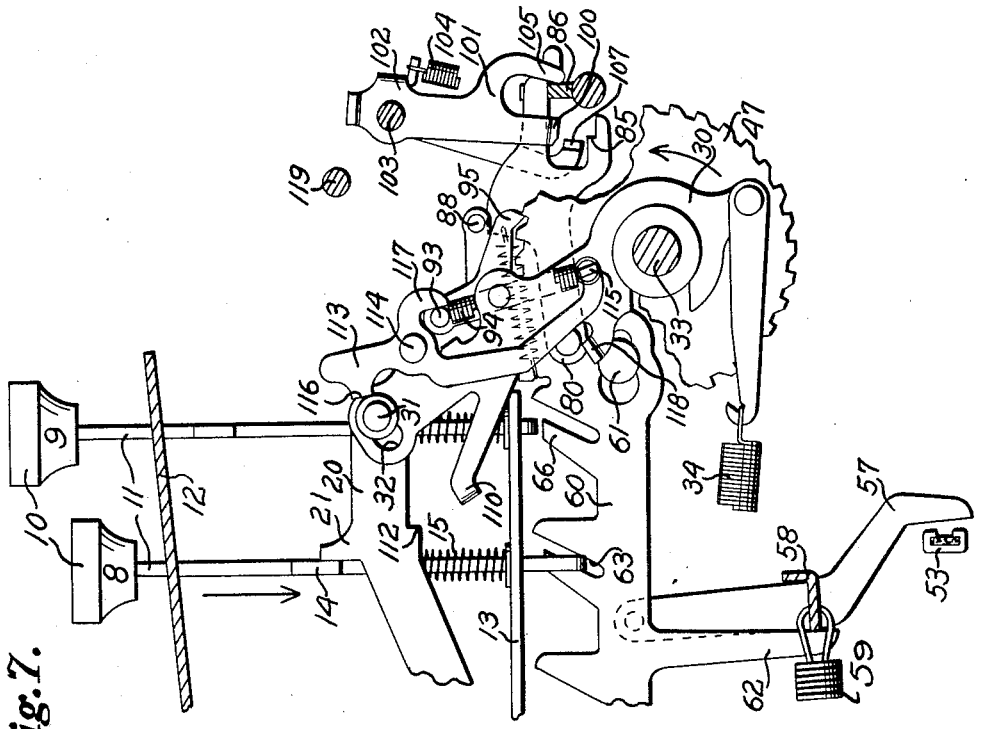

Fig. 7.

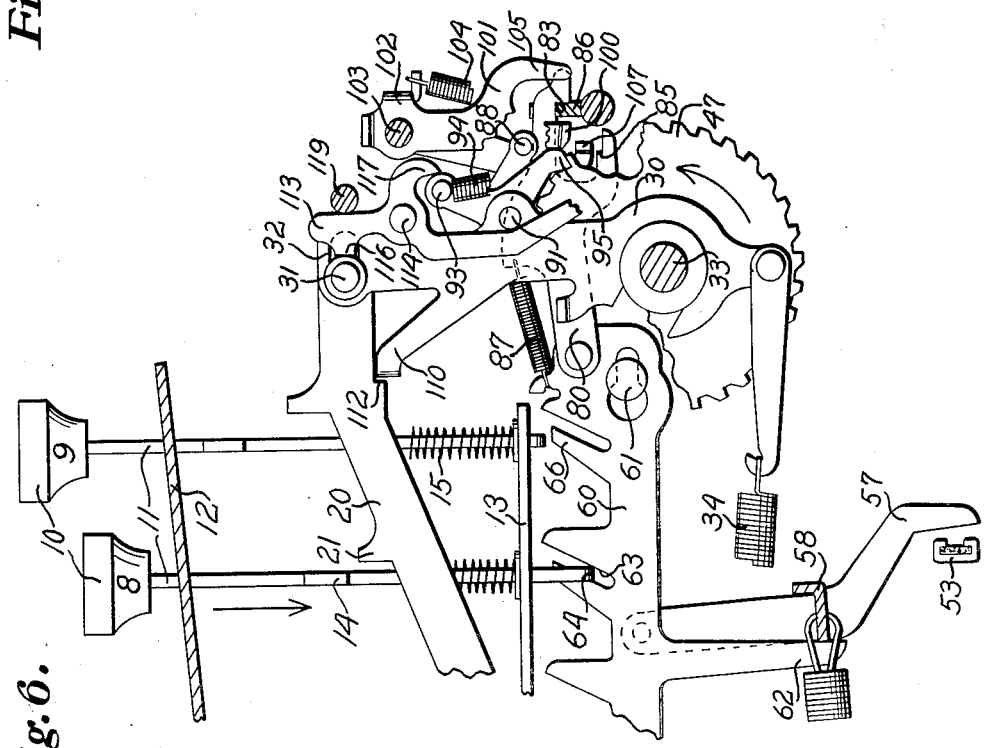

Fig. 6.

INVENTOR
Walter J. Pasinski
BY
Rector, Hibben, Davis & Macauley
ATTORNEYS

May 16, 1933. W. J. PASINSKI 1,909,714

AUTOMATIC CALCULATOR

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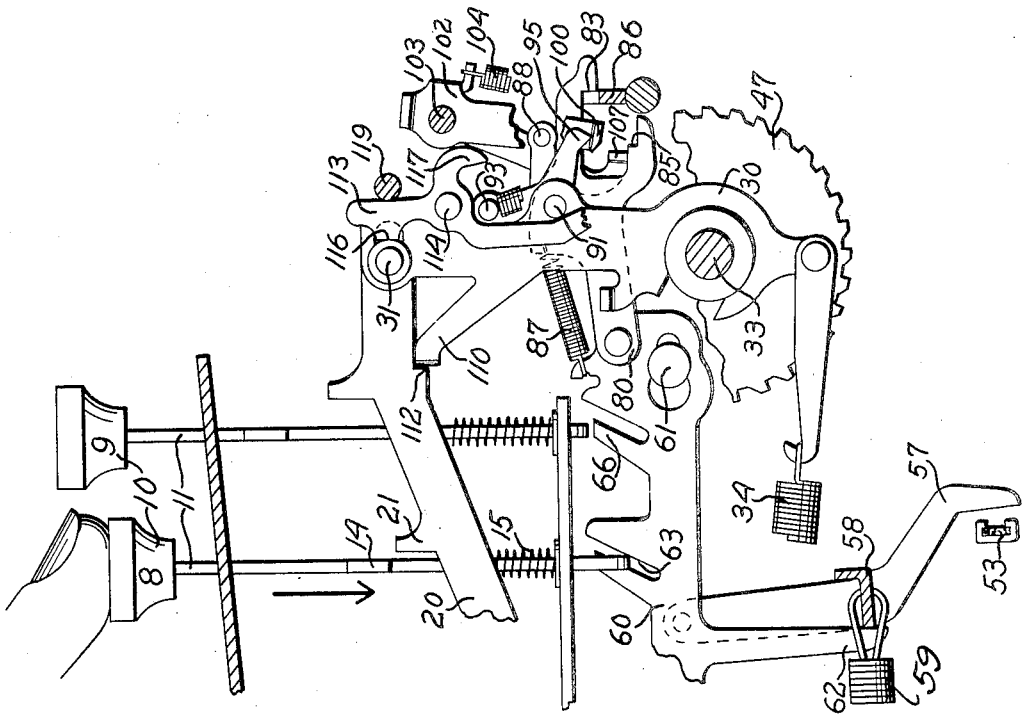

Fig. 9.

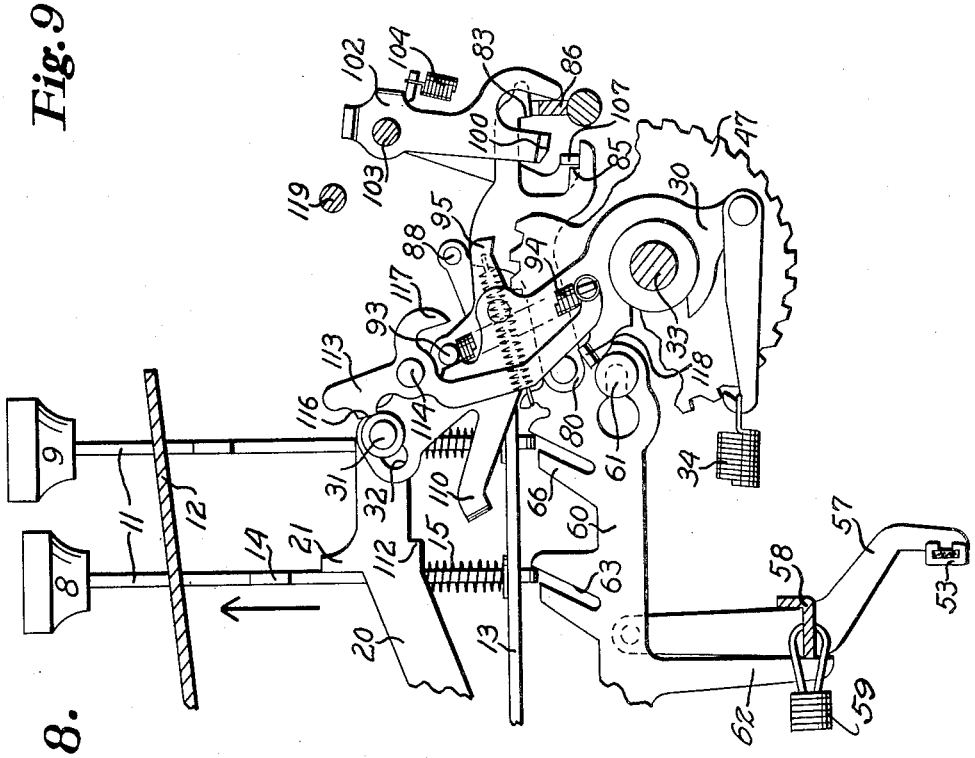

Fig. 8.

INVENTOR
Walter J. Pasinski
BY
Rector, Hibben, Davis & Macauley
ATTORNEYS

May 16, 1933. W. J. PASINSKI 1,909,714

AUTOMATIC CALCULATOR

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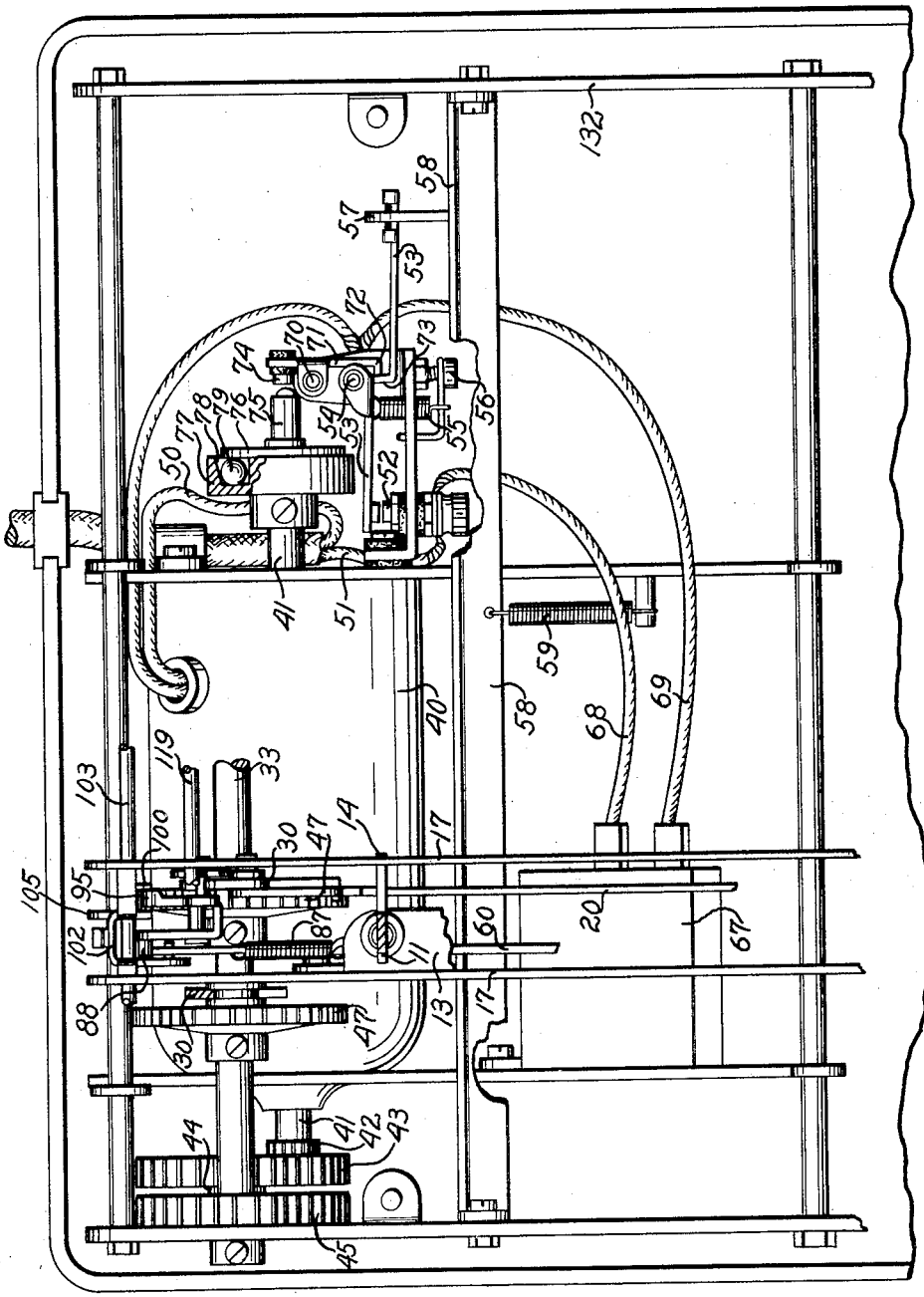

Fig. 10.

INVENTOR
Walter J. Pasinski
BY
Rector, Hibben, Davis, & Macauley
ATTORNEYS

May 16, 1933. W. J. PASINSKI 1,909,714

AUTOMATIC CALCULATOR

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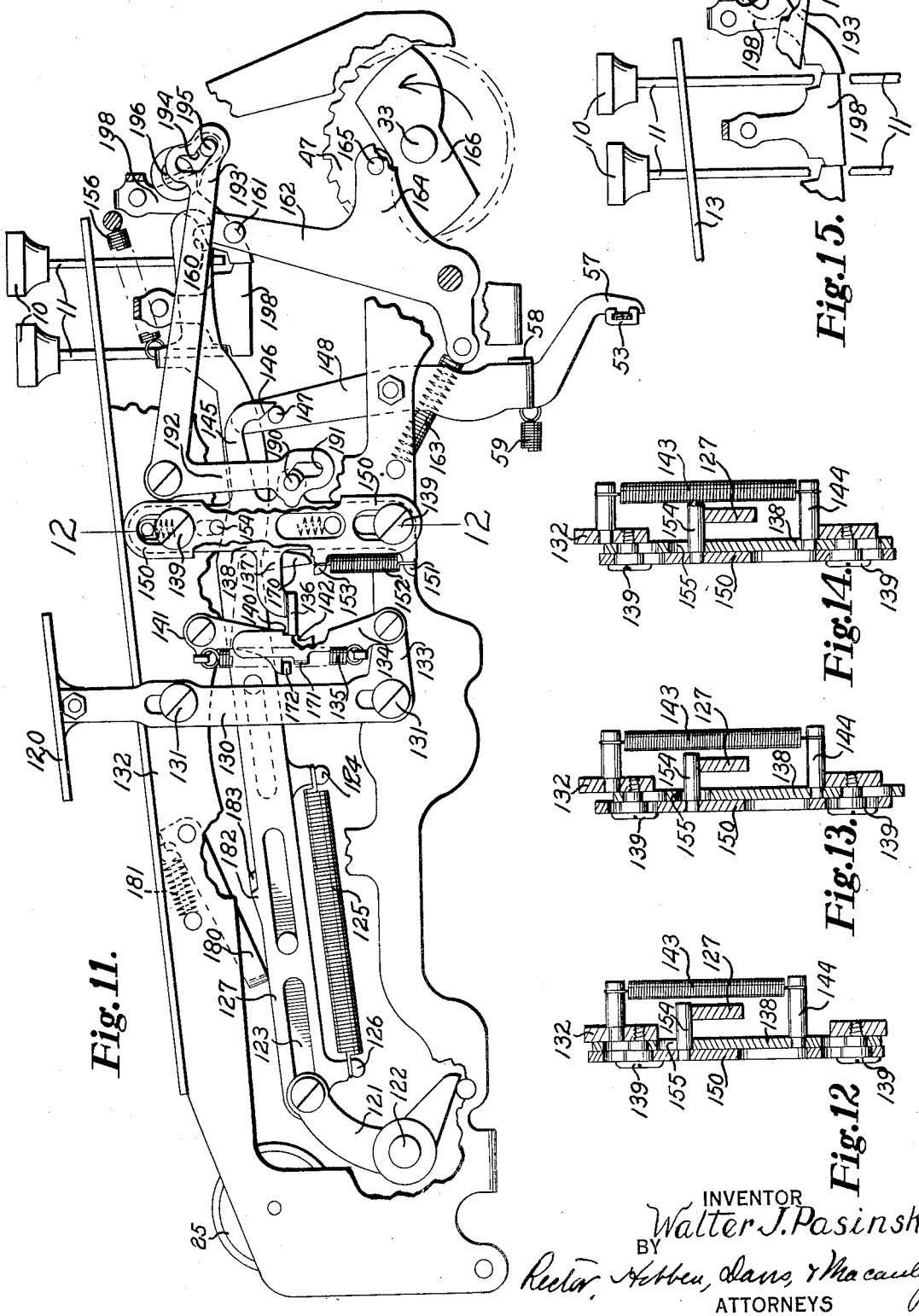

Fig. 11.

Fig. 15.

Fig. 14.

Fig. 13.

Fig. 12

INVENTOR
Walter J. Pasinski
BY
Rector, Hibben, Davis & Macauley
ATTORNEYS

May 16, 1933. W. J. PASINSKI 1,909,714

AUTOMATIC CALCULATOR

Filed July 2, 1928 8 Sheets-Sheet 8

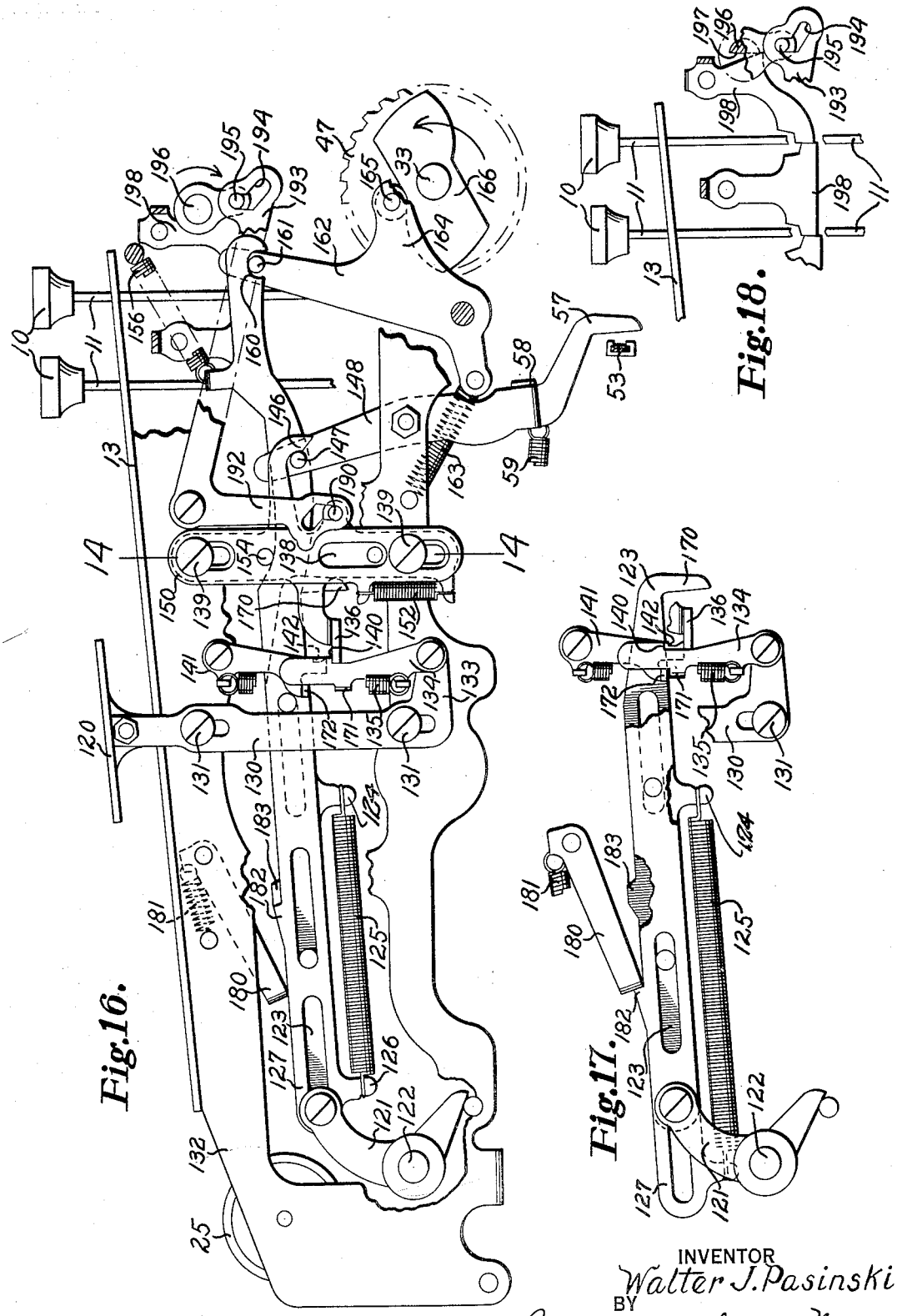

Fig.16.

Fig.18.

Fig.17.

INVENTOR
Walter J. Pasinski
BY
Rector, Hibben, Davis & Macauley
ATTORNEYS

Patented May 16, 1933 1,909,714

UNITED STATES PATENT OFFICE

WALTER J. PASINSKI, OF DETROIT, MICHIGAN, ASSIGNOR TO BURROUGHS ADDING MACHINE COMPANY, OF DETROIT, MICHIGAN, A CORPORATION OF MICHIGAN

AUTOMATIC CALCULATOR

Application filed July 2, 1928. Serial No. 289,865.

This invention relates to an automatic calculator, that is, to a key-responsive calculator in which the operations take place automatically when the operator depresses the amount keys to enter items in the machine.

Calculating machines may be divided roughly into two classes, namely, key-set and key-driven machines. The key-set machines are those in which the amount keys are first depressed after which the machine is given one or more strokes of operation by hand or power to effect calculations. The necessity for operating the machine after depressing the amount keys slows up the work considerably and it is desirable to avoid this if possible. Key-driven machines are those in which the calculating machine mechanism is actuated by depression of the amount keys. Operation of the machine after depression of the amount keys is avoided in the key-driven machines, but certain other difficulties are encountered. For example, the amount of force required to depress the keys is increased, keys of different denominations must be depressed different distances, keys of high denominations require more pressure than lower denominations, and, unless provision is made for preventing it, errors may occur through partial depression of a key or because a key has been depressed before being allowed to fully restore to normal.

The present invention has been designed to eliminate the objectionable features of both the above types, that is, to make it unnecessary to give the calculating machine a stroke or strokes of operation after an item has been entered on the amount keys and to avoid making it necessary to actuate the calculating mechanism by the depression of the keys. This result is accomplished by a novel construction which will be hereinafter described in detail.

The general object of the invention is to provide an improved automatic calculator.

A more particular object is to provide a motor driven calculator which will operate automatically when the amount keys are depressed to enter an item in the machine, the mechanism for each key operating automatically as soon as that key is depressed.

A still further object is to provide a machine of this type in which the motor used to drive the mechanism is not required to run continuously but is set into operation only when an operation of the machine is required.

Other objects and advantages of the invention will appear from the specification and drawings.

An embodiment of the invention is shown in the accompanying drawings in which,—

Figure 1 is a plan view of the machine showing the banks of amount keys and the general appearance of the top of the machine.

Fig. 2 is a sectional side elevation showing the parts in normal position with the amount keys undepressed.

Fig. 3 is a detailed sectional front elevation of one of the amount keys.

Fig. 4 is a detail of the bottom end of one of the amount keys and a portion of one of the bars operated thereby.

Fig. 5 is a perspective view of a portion of the mechanism at the rear of the machine showing the parts in normal condition.

Fig. 6 is a sectional side elevation of a portion of the rear of the machine showing the parts in the position they occupy when the "8" key has been depressed.

Fig. 7 is a view similar to Fig. 6 showing the parts in the position they occupy when the actuator stop bar has been indexed by the "8" key and the motor, the parts being in the position they occupy just before the bar is released from the motor drive.

Fig. 8 is a view similar to Fig. 7 showing the position of the parts immediately after the "8" key has been restored to normal and the stop bar released from the motor and before the bar and associated parts have been returned to normal.

Fig. 9 is a view similar to Fig. 6 showing the condition of the parts when the "8" key is held depressed.

Fig. 10 is a plan view showing principally the motor driving mechanism for the machine.

Fig. 11 is a side elevation showing the cancelling mechanism, the parts being in normal condition.

Figs. 12, 13 and 14 are sections of a portion of the cancelling mechanism showing the parts in different positions, the sections being taken on the line 12—12 of Fig. 11.

Fig. 15 is a detail side elevation of the key locking mechanism, the parts being in normal condition.

Fig. 16 is a side elevation of the cancelling mechanism with the parts in operated position.

Fig. 17 is a detail side elevation of a portion of the cancelling mechanism illustrated in Fig. 16.

Fig. 18 is a detail side elevation of the key locking mechanism with the parts shown in locking condition.

The invention is shown incorporated in a Burroughs calculator of the type disclosed in Horton Patents Nos. 1,016,501, 1,156,600 and 1,326,504 and, while it is illustrated as applied to a machine of this type, it is to be understood that it is not limited to such a machine but may be applied to or incorporated in other makes of calculators.

Keyboard

The calculator includes a plurality of banks of amount keys 10, one bank being illustrated in Fig. 2 where the keys are numbered from 1 to 9, inclusive, the complemental numbers also being inscribed on the key tops as shown in Fig. 1. Each key has a stem 11 projecting through a top keyboard plate 12 and a bottom guide plate 13, in which plates the key is slidably mounted. Each stem has a lateral stop 14, one of said stops being illustrated in detail in Fig. 3. Each key is urged upwardly by a spring 15 such as shown for the "9" key in Fig. 2 and each may be depressed against the tension of its spring. The stops 14 project into slots 16 (Fig. 3) in partition plates 17 which acts to guide the keys and to limit their movement in both directions. These keys serve, in the well known Burroughs key-driven calculator, to operate the calculating mechanism, but, in the present invention, the keys do not operate the mechanism. Instead the key stops 14 serve to differentially arrest the movement of stop bars that are moved against them.

Differential mechanism

Stop bars 20 are provided for each key bank, said bars having projections 21 which are numbered from 1 to 8, inclusive in Fig. 2 to indicate the stops that correspond to the respective keys of the bank illustrated. These projections are spaced along each stop bar so that, as the bar is moved forward, the stop corresponding to a particular key will engage the stop 14 of said key if the key is depressed and thereby arrest the stop bar in a position corresponding to the value of the key depressed. The projections 21 are spaced apart farther than the distance between the key stems and, in order to avoid interference, each bar 20 is shaped as illustrated in Fig. 2. This positions some of the projections below the level of the key stops 14, such, for example, as the "5" and "6" projections which are below the range of movement of the stops 14 of the "6" and "7" keys, so as to insure that there will be no interference. The body of the bar 20 is shaped below the "4" and "5" keys so as to be out of range of the stops 14 of the "4" and "5" keys. This arrangement permits all the keys to have the same range of downward movement which, in this case, is about one-fourth of an inch.

The forward end of each stop bar 20 is connected to a toothed actuator segment 22 pivoted at 23 and meshing with a pinion 24 which actuates a counter or register pinion 25, the counter pinions being visible through an opening 26 in the housing 27. The details of the actuator racks, the counter or registering mechanism, and the transfer mechanism therefor are not important for an understanding of the present invention as any suitable type of counter mechanism may be used. The mechanism illustrated in Fig. 2 is of the type described in Gooch Patent No. 1,128,679 to which reference is made.

The rear end of each stop bar 20 is connected to an arm 30 by a pin and slot connection including a stud 31 on the bar which operates in a slot 32 in the arm 30. The arm 30 is pivoted on a cross shaft 33 and is urged clockwise by a spring 34. When one of the keys in the bank illustrated in Fig. 2 is depressed, the stop bar 20 is moved forward, by a mechanism that will be hereinafter described, until the appropriate projection 21 contacts the key stop of the depressed key. In the case of the "9" key no stop is provided on the bar 20, the bar being limited, when the "9" key is depressed, by the engagement of the stud 31 on the bar with the end of a slot 35 in one of the partition plates of the machine. Upon release of the stop bar and the key as will be later described, the spring 34 returns the arm 30 and the stop bar 20 to normal. The above operation actuates the toothed segment 22 to add the number in the counter 25 in the well known manner described in detail in the patents referred to.

It should be noted that the stop bars are moved forward by power after which they are automatically disconnected, as will be later described, whereupon they return to normal under the influence of the springs 34. During their return movement the register pinions are rotated to register the number that has been indexed.

Power drive

Each of the stop bars 20 is moved forward by power derived from an electric motor which is controlled by the amount keys.

An electric motor 40 is located in the lower rear portion of the housing 27 that encloses the machine. This motor is a very small, high-speed, series motor capable of starting and stopping quickly. It is normally inactive, that is, it is de-energized and not running. Its armature shaft 41, shown in Fig. 10, has a small pinion 42 fixed to it which meshes with a large gear 43 fixed to a small pinion 44 meshing with a second large gear 45 fixed to the shaft 33 extending across the machine. The shaft 33 carries a series of toothed driving ratchets or pinions 47 which are fixed to the shaft, there being one wheel 47 for each bank of keys.

The motor is controlled by a switch which also forms part of a governing mechanism for regulating the speed of the motor. One side 50 of the power supply is connected directly to the motor winding while the other side 51 is connected to a stationary contact 52. Positioned for engagement with the contact 52 is a switch arm 53 pivoted at 54 and urged into engagement with the contact 52 by a spring 55 whose tension may be adjusted by means of the set screw 56. Although the arm 53 is urged toward engagement with the contact 52, it is normally held out of such engagement by a projection 57 on the end of a bail 58 extending across the machine and urged clockwise as viewed in Fig. 2 by a spring 59 illustrated in Fig. 10. The spring 59 is of superior strength to the spring 55 so that the switch arm 53 is normally maintained out of engagement with the contact 52, that is, the control switch for the motor is normally open.

Whenever one of the amount keys is depressed the switch is closed to start the motor and this is accomplished by means of control bars 60 of which there is one for each bank of keys. Each bar is slidably mounted on studs 61 and each has a downwardly extending projection 62 adapted to engage the bail 58. Each has a series of inclined slots 63 in its upper edge positioned to receive lateral projections 64 (Figs. 4 and 5) on the key stems 11 of the keys of its bank. The projections 64 are beveled to slide freely in the inclined slots and so that when a key is depressed, its bar 60 will be moved rearwardly, the position of the key and the bar under such conditions being illustrated for the "8" key in Fig. 6. The slots 63 are relatively narrow and the projections 64 are beveled to such width that they fit nicely in the slots so as to prevent lost motion between the two. It will be clear that if one of the bars 60 is held rearward after being moved by depression of a key, said key will be held depressed by the engagement of its lug 64 with the edge of the inclined slot 63 in the bar 60. The portions 66 of the projections on the top sides of the bars 60 in which the slots 63 are cut, serve as locking projections for preventing depression of other keys. When one key is depressed in a bank, these projections move under the undepressed keys as is illustrated for the "9" key in Fig. 6. Accordingly, whenever one key in a bank is depressed, the bar 60 with its projection 66 prevents depression of the other keys in the same bank.

These bars 60 are urged forward by springs 65 but, when one of the amount keys is depressed, the bar is moved to the rear against the tension of this spring and the projection 62 moves the bail 58 counter-clockwise to release the switch arm 53 which is then moved into engagement with the contact 52 by the spring 55. In this manner the motor is started every time a key is depressed. Upon release of the bars 60 they are moved forward by their springs 65 thereby releasing the bail 58 which is moved clockwise by its spring 59 whereupon the projection 57 engages the switch arm 53 and moves it out of engagement with the contact 52 to stop the motor.

In order to decrease sparking between the switch contacts a condenser 67 (Figs. 2 and 10) is connected across said contacts by a conductor 68 connected to the stationary contact 52 and a conductor 69 electrically connected to the switch member 53.

The speed of the motor is automatically governed by opening and closing the motor circuit. Pivoted at 70 (Fig. 10) is a lever 71 having a laterally bent end 72 adapted to engage a shoulder 73 on the switch lever 53. The other end of the arm 71 carries a small bearing plate 74 which is insulated from the arm as illustrated. Engaging the plate 74 is a ball contact fixed in one end of a sleeve 75 slidably mounted upon a reduced portion of the armature shaft 41, the other end of said sleeve supporting a circular plate 76. Fixed to the shaft 41 is a circular disk 77 having an annular recess 78 in its face in which a plurality of balls 79 are mounted. The outer side of the annular recess 78 is inclined so that, when the race is rotated rapidly, the centrifugal force on the balls 79 tends to cause them to roll on the inclined surface and push against the plate 76. This pushes the sleeve 75 into contact with the plate 74 and rocks the arm 71 clockwise as viewed in Fig. 10, which tends to move the switch arm 53 out of engagement with the contact 52. Accordingly, when the motor gets above a predetermined desired speed, the governor automatically opens the circuit which de-energizes the motor and causes the speed to decrease. The point at which the governor acts to de-energize the motor may be varied by adjusting the screw 56 which regulates the tension of the spring 55 against

which the governor must act, said spring also acting to close the switch and move the balls 79 into the annular recess when the speed of the motor decreases to the desired degree. This mechanism has proved very efficient in maintaining the motor at practically constant speed, the opening and closing of the switch being very rapid with the effect of just supplying the motor with enough current to maintain it at the right speed.

Mechanism for connecting and disconnecting the stop bars with the power drive

The depression of an amount key, in addition to starting the motor as previously described, also connects the stop bar for its bank to the motor driving mechanism, the connections being such that the stop bar is automatically disconnected after it has received a stroke of operation. The mechanism for accomplishing this is the same for each key bank and in order to simplify the description, the mechanism for only one bank will be described, it being understood that there is a similar mechanism for each bank.

Pivotally connected to the rear end of the bar 60 is a latch 80 (Fig. 5) having a forked rear end, the upper branch 81 of which has a nose 82 and a shoulder 83, and the lower branch 84 of which has a shoulder 85. The nose 82 slides in a slot in a stationary spacing plate 86 at the rear of the machine. When the bar 60 is moved rearwardly the nose 82 slides in the slot in plate 86 until the shoulder 83 is in a position to hook over the plate, the latch being moved down to effect this action by mechanism hereinafter described. When such action occurs the bar 60 is held rearward. The latch 80 is urged counter-clockwise by a spring 87, but it is normally prevented from moving in this direction by a stud 88 which contacts the top edge of the branch 81 of the latch. This stud is carried by an arm 89 of a yoke 90 pivoted on a stud 91 carried by the arm 30. The yoke 90 is integral with a pawl 92, said pawl having a stud 93 on its upper end to which one end of a spring 94 is connected. The spring 94 normally urges the pawl 92 clockwise, as viewed in Fig. 5, and since the pawl and yoke 90 move as a unit, this also urges the yoke 90 clockwise. The spring 94 is superior in strength to the spring 87 and the stud 88 therefore normally prevents the latch 80 from being moved counter-clockwise by its spring.

The lower end of the pawl 92 has a nose 95 adapted to engage its driving ratchet 47 on the shaft 33 that is driven by the motor. Inasmuch as the pawl 92 is urged clockwise by the spring 94, the nose 95 is normally urged toward engagement with the ratchet pinion 47. Since the pawl is pivoted on stud 91 carried by arm 30 which is connected to the stop bar 20, said stop bar will be moved forward if the pawl 92 engages the teeth of the pinion 47 when the latter is rotating counter-clockwise, which is its direction of rotation as viewed in Fig. 5.

The nose 95 of the pawl is normally maintained out of engagement with the driving ratchet 47 by a ledge or shoulder 100 on an arm 101 of a yoke 102 pivoted on a cross shaft 103 of the machine, said yoke, its arm and shoulder forming a detent for pawl 92. This yoke is urged clockwise by a spring 104, its movement in said direction being limited by an extension 105 on the arm 101 which engages the plate 86 as illustrated in Fig. 5. The spring 104 thus normally maintains the yoke 102 in a position such that its ledge 100 is under the nose 95 of the pawl where it holds the pawl out of position to engage the driving ratchet 47. The yoke 102 has another arm 106 having a lateral projection 107 positioned so as to be engaged by the shoulder 85 on the lower branch 84 of the latch 80, said projection being normally positioned to the rear and in the path of the shoulder as shown in Fig. 5.

It will be apparent that, when the bar 60 is moved rearwardly by the depression of a key, the shoulder 85 will engage the lug 107 and move the yoke 102 counter-clockwise which moves the ledge 100 out from under the nose 95 of the pawl whereupon the pawl is moved clockwise by its spring 94 into engagement with the driving ratchet 47. At the same time that the pawl is released, the upper branch 81 of the latch 80 has moved rearward far enough to permit this branch to be moved down by the stud 88 so that its shoulder 83 hooks over the plate 86. When the latch 80 moves down, the stud 88 moves down also, said movement being necessary in order to permit the yoke 90 and the pawl 92 to move clockwise under the influence of the spring 94 to move the pawl into engagement with the ratchet 47. When the latch 80 moves down the shoulder 85 on branch 84 moves below the lug 107 on the arm 106 of yoke 102 which frees said yoke and it is moved clockwise by its spring 104 to move the ledge 100 back to normal, the nose 95 of pawl 92 having in the meantime engaged the driving ratchet 47 and moved away.

It will thus be observed that, when a key is depressed and the bar 60 is moved rearwardly, the motor is started as previously described and the stop bar 20 is automatically connected with the driving ratchet 47 through the release of the pawl 92. At the same time, bar 60 is latched in its rearward position to keep the motor running and to maintain the connection that has been effected. Incidentally, the depressed key is locked depressed and all the other keys of the bank are locked against depression. The condi-

tion of the parts at the time they are connected together and before movement of the stop bar 20 has started is illustrated in Fig. 6.

The depression of the amount key having started the motor through the connections heretofore described the driving ratchet 47 is rotated counter-clockwise immediately. The pawl 92 having been connected with the ratchet 47 as above described, the rotation of the ratchet rocks the arm 30 forward, or counter-clockwise in Fig. 5. This carries the shaft 91 counter-clockwise together with the yoke 90, the stud 88 riding the cam shaped top of the latch 80 to the position illustrated in Fig. 7, said stud maintaining the latch in its latched position over the plate 86.

As the arm 30 moves forward it carries the stop bar 20 forward and, for this purpose, two different connections are provided. One of these is a positive connection comprising an extension 110 on the arm 30 which has a lateral lug 111 adapted to engage a shoulder 112 on the stop bar 20 when said bar is in its rearward position. This positive connection is for the purpose of insuring that the bar will be moved under all conditions and it is only a temporary connection because, as the arm 30 rocks counter-clockwise, it rocks the lug 111 out of engagement with the shoulder 112. The second connection is a yielding one and it includes a member 113 pivoted at 114 on the arm 30. The lower end of this member has a lateral lug 115 to which one end of the spring 94 is connected, which spring normally urges the pawl 92 clockwise and the member 113 counter-clockwise. The upper end of the member 113 has an abutment 116 adapted to engage the stud 31 on the stop bar 20. These two connections between the arm 30 and the stop bar 20 cooperate as follows:

Normally the lug 111 is spaced slightly from the shoulder 112 and if there is no substantial resistance to the movement of bar 20, said bar is moved by the yielding connection. When there is a substantial resistance to movement of the bar 20 and associated parts such, for example, as the inertia of said parts in rapid operation of the machine, the yielding connection gives slightly and the lug 111 immediately engages the shoulder 112. When the arm 30 rocks forwardly the extension 110 pushes the stop bar 20 forward through positive engagement with the shoulder 112. After the bar has moved forward a slight distance, the arm 30 rocks counter-clockwise far enough to disengage the lug 111 from the shoulder 112 whereupon the member 113 continues to move the stop bar 20 forward, the spring 94 being sufficiently strong to maintain the member 113 in position to keep the stud 31 at the forward end of slot 32. In this manner proper operation is insured when the machine is operated rapidly, the connection being a positive one at the start and then, after the parts have moved a short distance, the positive connection is disabled and a yielding connection maintains the forward movement of the stop bar.

The stop bar 20 continues to move forward until one of the projections 21 on it engages the stop of a depressed key, which, in the example illustrated, is the "8" key. When this happens the forward movement of the stop bar 20 is arrested, but the motor continues to swing the arm 30 forward, such movement being permitted by the pin and slot connection between the arm 30 and the stop bar 20. As the arm 30 moves forward, the stud 31 on the stop bar 20 moves to the rear of slot 32 and carries the upper end of the member 113 with it which moves said member clockwise from the Fig. 6 to the Fig. 7 position, the movement of the member being limited to prevent overthrow by a lug 118 on the arm 30. The arm 113 is provided with a hooked extension 117 positioned to engage the stud 93 on the pawl 92 to positively move said pawl counterclockwise to disengage it from the ratchet 47 when the member 113 is rocked clockwise at the end of the stroke of the stop bar 20. The counterclockwise movement of the member 113 swings the lower end of spring 94 clockwise from its Fig. 6 to its Fig. 7 position which results in moving the spring across the axis of the stud 91 on which pawl 92 is pivoted. Accordingly, the direction of action of the spring 94 is changed and it urges the pawl 92 still farther counterclockwise out of engagement with the driving ratchet 47. Referring to Fig. 5, the counterclockwise movement of the pawl 92 moves the yoke 90 counterclockwise which raises the stud 88 to free the latch 80. Said latch is then immediately rocked counterclockwise by its spring 87 to disengage it from the plate 86 whereupon the bar 60 is moved forward by its spring 65 which results in stopping the motor and releasing the depressed key.

It will thus be clear that, when the stop bar 20 reaches the end of its movement, the slight additional movement of the arm 30 results in disconnecting the stop bar from the driving ratchet and in releasing the latch 80 so that the starting bar 60 may return to normal and the motor be stopped. It will be understood that these operations take place very quickly and that immediately upon a key being depressed, the stop bar 20 is moved forward by the motor drive and then automatically disconnected.

An important advantage that should be noted is that the depressed keys are released early in the operation of the machine so as to enable the operator to work rapidly and to depress the keys for the subsequent operation without waiting for the completion of the re-

turn stroke of the machine. The keys are released at the end of the forward stroke given to the stop bars. The keys may be depressed again immediately without waiting for the return of the bars but, even though the keys are depressed, no operation of the machine will result until after the bars are returned because the bars must return in order for the pawls 92 to be returned to position to engage their ratchet pinions. Of course, the return of the bars is very rapid and there is little time in which to depress the keys before the bars return but the early release does provide the increment of time that enables most rapid operation. An early key release is thus effected without impairing the accuracy of operations.

After the stop bar 20 is disconnected it is returned to normal position with the arm 30 which is moved back to normal under the influence of its spring 34. Near the end of the return movement of the arm 30 the member 113 strikes the stationary cross shaft 119 which rocks said member counterclockwise back to its original position, the arm 30 having moved relative to stop bar 20 as soon as the pawl 92 was released so that the stud 31 contacts the forward end of slot 32 as the arm moves back toward normal. As the member 113 moves counterclockwise the rear face of the arm engages the stud 93 and rocks the pawl 92 clockwise until the spring 94 is carried over the center line of shaft 91, after which the spring urges the pawl farther clockwise to a position on top of ledge 100. This clockwise movement of the pawl 92 does not cause it to re-engage the driving ratchet 47 because the ledge 100 on the yoke 102 occupies its normal position so as to block the pawl in the position illustrated in Fig. 5. However, the clockwise movement of pawl 92 moves the yoke 90 clockwise to again position the stud 88 above the branch 81 of the latch 80. In other words, at the end of the return stroke of the arm 30, the parts are normally conditioned as illustrated in Fig. 5, so as to be in shape for another operation when another key is depressed.

In the event a key is held depressed, a repeat operation will not take place. The mechanism operates in the same manner as heretofore described and the latch 80 is released at the end of the forward stroke of the arm 30 but, instead of said latch moving back to normal, it remains in its rearward position shown in Fig. 9 owing to the fact that the key is held depressed. Accordingly, the motor continues to operate. The stop bar 20 is disconnected from the driving ratchet 47 in the same manner as usual and it is returned to normal together with arm 30 under the influence of the spring 34. As arm 30 moves to its normal position, the pawl 92 is again rocked back towards position for engaging the driving ratchet 47 but it is prevented from reaching this position by the ledge 100 which is in the position of Fig. 5. Owing to the fact that the latch 80 has not moved forward to normal, the shoulder 85 on the branch 84 has not moved back of the lug 107 on the arm 106 of the yoke 102 but is in the position illustrated in Fig. 9. Consequently, the yoke 102 remains in its normal position with the ledge 100 blocking the pawl 92 and said yoke cannot be moved to permit the pawl to engage the driving ratchet until after the key is released to permit the shoulder 85 to snap behind the lug 107. The motor continues to operate but the pawl 92 does not connect with the driving ratchet 47 so that no operation of the mechanism takes place.

The machine will be more clearly understood by describing its operation in performing some of the functions of which it is capable.

Addition

In order to perform addition it is merely necessary to depress the amount keys to enter the items that it is desired to add. The addition takes place automatically without requiring the manipulation of a handle or of a starting bar for causing an operation of the machine.

For example, assume that the number 56 is to be entered in the machine. The "5" and the "6" keys in the two right hand banks are depressed. Either may be depressed first or both together because, as soon as one of the keys is depressed, the bar 60 for its bank is moved rearward and the motor is started. Coincidentally, the stop bar 20 for that bank is connected with the driving ratchet 47 and the stop bar is moved forward, automatically disconnected, and returned to normal position and the motor stopped. The same thing happens when the next key is depressed. If the two keys are depressed together but not exactly at the same time, the motor continues to operate until it is released by the release of the latch of the last key depressed. If both keys are depressed simultaneously both of the stop bars for the respective banks of keys are moved forward together. It will be understood, of course, that the return movement of these stop bars enters the respective items in the counter at the forward part of the machine, such action taking place in the usual manner.

When another item is to be added to the first, the operation is repeated, that is, the proper amount keys are depressed whereupon the machine operates automatically to add the second item to the first. It will be appreciated that this permits very rapid work because the operator need do nothing except enter the various items on the keys. He need not stop to give or cause the machine to be given a stroke of operation. Each bank of

keys takes care of itself as the key in that bank is depressed.

In addition to increasing the speed of operation, the ease of operation is increased because it is not necessary to operate the mechanism of the machine by the force exerted to depress the keys. The keys merely set certain devices and the motor operates the machine. Accuracy of operation is also promoted because all the keys are depressed the same distance. An operator soon gets accustomed to depressing the keys a certain distance and when all the keys are arranged for the same depression there is not so much chance for a partial depression as when the keys of different values must be depressed different distances. Also, the same pressure can be applied to all the keys whereas in the key driven type of machine, the pressure required for the "9" key is almost twice that required for the "1" key. In the present machine an operator soon becomes familiar with the sound resulting from an operation of the machine after a key is depressed and if a partial depression should occur he knows it by the lack of any sound of operation. It is necessary to allow a key to fully restore to normal before it can be again depressed to obtain a stroke of operation in its bank because, unless it is allowed to return to normal, the shoulder 85 on the branch 84 of the latch 80 will not engage behind the lug 107 and the pawl 92 cannot be connected to the driving ratchet 47.

Another advantage is that, when the driving connections are engaged with the power operated means, the character of the engagement is the same each time and is independent of the character of the key manipulation by the operator. It does not make any difference whether the operator depresses the key with a quick, staccato touch, or with a slow touch, or with a depression that may not be 100% complete. In all cases the driving pawl moves into engagement with its toothed wheel under influence of its spring, and the nature of the engagement is the same because all that the depression of the key does is to remove the detent from under the pawl to permit the pawl to be moved by its spring into engagement with the wheel. This takes the actual engaging action between the pawl and the toothed wheel out of the hands of the operator. If the depression of the key moved the pawl into engagement with the wheel by direct actuation, it will be readily appreciated that the pawl might be moved into engagement quickly or very slowly, or only partially.

A further advantage of the new construction is that it makes the key depression easy because all the key depression does is to remove the detent from under the pawl whereupon a spring moves the pawl into engagement with the toothed wheel. A light and easy key touch is thus obtained.

Another advantage, already referred to briefly, is that, in a power operated automatic calculator of the type in question, the depressed key is released before the differential mechanism returns to normal and this key, or another key in the same bank, can be depressed before said differential mechanism returns to normal. This greatly increases the speed of operation of the machine. For example, if a key is depressed, the driving connection for its stop bar is made and the stop bar moves to differential position, whereupon the bar is automatically disconnected from the driving means. The depressed key is immediately released and returns to normal and the stop bar starts to move back toward normal position. If the same key or another key of the same bank is depressed, the result is that the bar 60 is moved rearward again. Rearward movement of bar 60 causes the detent shoulder 100 to be moved out of the path of pawl 92. This happens before the differential stop bar 20 and associated parts return to normal. As these parts return to normal, the pawl 92 is rocked on its pivot to cause it to move toward the toothed wheel. If no key of its bank had been depressed, the pawl would engage the shelf 100, but, when a key has been depressed, the detent has been moved out and the result is that the pawl engages the toothed wheel immediately and the stop bar is given a second movement. Expressed in another way, the means for conditioning the driving connections for engagement with the toothed wheel can be conditioned for a second engagement before the stop bar and pawl return from a prior engagement.

Still another advantage of a mechanical nature is that the pawl 92 is pivoted to a member 30 which swings about the same axis 33 as does the toothed wheel 47 so that, while the toothed wheel is driving the pawl, no relative movement between the pawl and wheel occurs, such as would take place if these parts were swinging about different centers. This avoids wear between these parts that might be caused by relative movement of them while they are in driving relation.

And a further advantage is that the pawl is moved positively and quickly out of engagement with its toothed wheel. The pawl is pivoted and the means acting on it acts on the opposite side of the pivot to where the engagement with the toothed wheel takes place so that the pawl is positively swung out of engagement with a lever action.

Subtraction

Subtraction may be performed in the same general manner as addition, that is, by sim-

ply depressing the keys and allowing the machine to operate automatically.

Subtraction is performed by a process of complemental addition. It will be observed, by referring to Fig. 1, that the keys have small figures on them which represent the complements of the larger figures. When an item is to be subtracted the keys are depressed according to the small figures less one in the right hand bank and then the "9" keys to the left of the last valuating digit to the left are depressed so that the complement of the number to be subtracted is added in the counter. This results in subtracting the number in a manner that is well understood in the art.

Multiplication

Multiplication is performed by a process of repeated addition, which is accomplished in the following manner:

Assume that it is desired to multiply 22 by 33. The "2" keys in the first and second rows from the right are each depressed three times. Each time the mechanism for said banks operates automatically to add 22 into the counter. The three depressions put a total of 66 in the counter. Next, the "2" keys in the second and third columns from the right are depressed three times which enters 220 into the counter three times making a total of 660 which, added to the 66 already therein, makes a grand total of 726 the correct product.

These operations may be very quickly performed as it is not necessary for the operator to give the machine a stroke of operation but merely to depress the keys the required number of times. In doing this he is not required to operate the machine by the force of depressing the keys but merely to depress the keys whereupon the machine operates automatically.

Division

Division is performed by a process of repeated subtraction which, in this case, is a process of repeated complemental addition. There are a number of ways of doing this on a machine such as illustrated but only one will be described because the different methods of operating are well known.

Assume, for example, that it is desired to divide 144 by 12. The dividend 144 is entered in the last three banks of the machine to the left, that is, the 9th, 8th and 7th banks in a nine bank machine. The divisor 12 is entered by the use of the complemental numbers on the keys and the rule is to enter it as 1 less than the actual divisor. In this case the number entered would be 11. By observation it will be noted that 12 will go into 14 and hence the keys in the 9th and 8th banks having the complemental numbers "1" on them are depressed. The actual result of this mechanically is to cause 880 to be added to the 144 in the machine which makes 1024. A carry takes place from the counter pinion in the 9th bank and the tenth pinion registers the "1" of the 1024. The dividend remaining on the dials appears as 024. It is evident that 12 will not go into 02 and hence the operator moves to the right with the calculation, that is, to the 8th and 7th banks. The dividend in these banks is 24. Obviously, 12 will go into this and hence the keys in the 8th and 7th banks having the complemental numbers "1" on them are depressed. The first depression causes 88 to be added to 24 giving 112. This still leaves 12 in the dividend in the 8th and 7th banks into which 12 will go again. Accordingly, the two keys are depressed again which adds 88 to 112 giving 200. The quotient thus appears as 12 on the 10th and 9th counter pinions.

Other methods of operation may, of course, be employed, the feature of this machine being that the operations in each bank take place automatically as soon as a key is depressed.

Cancelling mechanism

After a series of calculations have taken place it is necessary to clear the counter and provision has been made for doing this by simply depressing a clearance key 120 illustrated in Figs. 1, 11 and 16.

The cancelling mechanism is actuated by an arm 121 at the forward part of the machine (Fig. 11) which is given a forward and a return stroke of movement, such movement rocking the shaft 122 and operating a canceling mechanism of the type disclosed in Horton Patent No. 1,243,839. The arm 121 is rocked by means of a link 123 having a downwardly extending projection 124 to which one end of a spring 125 is connected. The other end of this spring is connected to a projection 126 on a link 127 having a pin and slot connection with the arm 121. When the arm 127 is moved forwardly it moves the link 123 forward through the spring 125 and thereby moves the arm 121 forward, the connection being a yielding one so that, in the event the canceling mechanism becomes blocked or is sluggish for some reason, the spring will yield and the parts will not be damaged. The link 127 is moved forward by being connected to the motor drive, the motor being started and such connection being effected by depression of the key 120.

The key 120 has a stem 130 slidably mounted on studs 131 on the side frame 132 of the machine. The lower end of the stem has a lateral extension 133 to which is pivoted a pawl 134. This pawl is urged clockwise by a spring 135 into engagement with the edge of a lug 136 of a lateral projection 137 on an inner slide plate 138 mounted on studs 139. The pawl 134 has a shoulder 140 for en-

gaging the lug 136. When the key 120 is depressed the shoulder 140 moves into engagement with lug 136 to move the slide 138 downwardly whereupon a pivoted latch 141 snaps into position to hold the slide depressed, such latching action normally taking place because the end of pawl 141 passes over the lug 136 as shown in Fig. 16. If the key 20 is only partially depressed the latching action also takes place, but in this case the lug 136 is held down by the engagement of a shoulder 142 of the latch 141 over the lug 136. The spring 135 which urges the pawl 134 clockwise is also connected to the latch 141 to urge it counter-clockwise, one spring serving for both parts. The slide 138 is moved down against the tension of a spring 143 connected at one end to a stud 144 on the slide and at its other end to a stud on the side plate 132.

The slide 138 has a rearwardly projecting cam hook 145 having a beveled surface 146 adapted to engage a stud 147 on a pivoted arm 148 which is connected to the bail 58 that controls the starting of the motor, the bail being urged clockwise by the spring 59. When the key 120 is depressed and the slide 138 is moved downwardly the cam hook 145 acting on the stud 147 cams the arm 148 counterclockwise sufficiently to move the bail 58 to effect a starting of the motor. In this manner the motor is started when the cancelling key 120 is depressed.

The cancelling mechanism is connected to the motor drive by a second slide 150 also mounted on the studs 139. The first slide 138 has a projection 151 to which one end of a spring 152 is connected, the other end of said spring being connected to a projection 153 on slide 150. When slide 138 is moved down by depression of the cancellation key 120, it pulls the slide 150 down with it through the yielding connection provided by spring 152. The slide 150 has a pin 154 projecting from it through a slot 155 in slide 138 and this pin projects over the cancelling link 127 as shown in Fig. 13. Accordingly, upon depression of the key 120 the link 127 is swung downward against the tension of a spring 156 which tends to hold it up and rearward the position of the slides when the key is depressed being shown in Fig. 14. The rear end of the link 127 has a notch 160 in it adapted to engage over a stud 161 on a pivoted arm 162. The arm 162 is urged clockwise by a spring 163 and it has an extension 164 carrying a stud 165 bearing on the edge of a two-faced cam 166 fixed to the shaft 33 which is rotated by the motor. When the key 120 is depressed the link 127 is thus connected to the arm 162 and, since the motor is started by depression of the key 120 as previously explained, the cam 166 rocks the lever 162 counterclockwise which moves the link 127 forward to operate the clearing mechanism.

As the link 123 moves forward with the link 127, a downward projection 170 on it engages a lateral lug 171 on the pawl 134, thereby moving the pawl counterclockwise. The edge of the pawl engages against a lateral lug 172 on the latch 141. The result is that the forward movement of the link 123 disables both the pawl 134 and the latch 141 by moving them out of the path of the lug 136, thereby freeing the slide 138 to permit the spring 143 to return the slide to normal. This frees the arm 148 connected with the motor starting bail 58 and stops the motor. As the slide 138 moves upwardly the bottom edge of its slot 155 contacts the pin 154 and carries it upwardly thereby freeing the link 127. The high surface of the cam 166 having passed the stud 165, the arm 162 is rocked clockwise back to normal by spring 163. The link 127 is moved back by its spring 156 which, near the end of the return stroke of the link, lifts the latter upwardly to disconnect it from the stud 161. The parts are thus returned to normal.

The cam 166 is constructed so that its high surface will act on the stud 165 twice during one revolution of the shaft 46. The purpose of this is to secure a quick action so as to waste as little time in cancelling operations as possible. In the event the notch 160 in the link 127 is not immediately over the stud 161 when the key 120 is depressed, the parts will not be immediately connected together but they will be connected very quickly. Depression of the key starts the motor which rotates the cam 166 and gives the arm 162 a stroke of movement. As the key is depressed the slide 138 moves downwardly and puts a tension on spring 152 to urge the slide 150 downwardly to cause its pin 154 to engage the top of the link 127 thereby urging the rear end of the latter downwardly. If the slot 160 and the stud 161 are in alignment, the link 127 is immediately connected to arm 162. If they are not in alignment the slides 138 and 150 assume the position shown in Fig. 13. The slide 138 moves down but the stud 154 is retained upward by link 127. The rear end of link 127 rides on the stud 161 until the arm 162 is returned to its rearward position whereupon the notch 160 snaps over the stud 161 and the parts are connected together. The motor continues to operate because the connections for operating it are not disconnected until the link 127 is given a forward stroke of movement. Accordingly, after the parts are connected together as above described, the link 127 is given a forward stroke to effect cancelling operations whereupon the motor is automatically stopped.

In the event the cancelling mechanism should be blocked in any way, the link 127 moves forward without moving the link 123

forward, the spring 125 stretching and the parts assuming the position illustrated in Fig. 12. When this occurs a latch 180, urged counterclockwise by a spring 181, latches behind a shoulder 182 on the link 127 and holds the link in its forward position. When the difficulty in the cancelling mechanism has been removed, the link 123 will snap forward under the tension of its spring 125, whereupon a raised projection 183 on the link 123 cams the latch 180 upward to release the link 127 to permit the latter to be moved back to normal under the influence of its spring 156. During normal operations when there is no difficulty with the cancelling mechanism, the raised projection 183 moves forward at the same time that the two links 123 and 127 are moved forward and it disables the latch 180 at the end of the forward stroke to prevent said latch from becoming effective to hold the link 127 forward.

Means for locking amount keys while cancellation takes place

Whenever the cancellation key 120 is depressed to effect a cancellation all of the amount keys are locked against depression by a mechanism as follows.

The slide 138 has a lateral projection carrying a stud 190 operating in a cam slot 191 in one arm 192 of a pivoted bell crank lever whose other arm 193 is provided with a cam slot 194 engaging a stud 195 on an arm connected to a pivoted shaft 196. This shaft extends across the rear of the machine and it has a series of slots 197 forming a series of semi-circular shaft sections which are aligned with the rearmost of the key interlocking pendants 198 illustrated in Figs. 15 and 18. These pendants are of the familiar type used in the Burroughs calculator, the same being illustrated and described in Horton Patent No. 1,243,839. There is one of these pendants between each two keys and one to the rear of the "9" key and their lower ends are spaced so that there is just enough clearance to permit one key to be depressed at a time. Whenever a key is depressed the pendants are moved together so closely that there is no space to depress a second key.

When the cancellation key 120 is depressed and the slide 138 is moved downwardly the bell crank lever 192—193 is moved clockwise which rocks the shaft 196 clockwise from its Fig. 15 to its Fig. 18 position. The edges of the slots 197 swing the rear pendants 198 forward and move all of them in each of the rows so close together that none of the keys in any of the banks can be depressed. In this manner, as soon as the cancellation key 120 is depressed, all of the amount keys are locked against depression. Also, when one of the amount keys is depressed the shaft 196 is blocked against turning which prevents depression of the cancelling key 120 when an amount key is depressed.

When the cancellation key 120 is released and the slide 138 is moved upwardly under the influence of its spring 143, said slide engages the pin 154 on the slide 150 and moves the latter upwardly which cams the bell crank lever 192—193 counterclockwise to swing the shaft 196 counterclockwise thereby releasing the interlocking pendants 198 and freeing the amount keys.

From the above it will be seen that an automatic calculator has been provided on which calculations may be performed very rapidly by simply depressing the amount keys. All the operations take place automatically without requiring manipulation of any handle, motor starting bar or other special device for operating the machine. The keys may be depressed in any order because the mechanism for each key is operated independently and automatically by the motor drive. Instead of having the motor running continuously the motor is operated only when needed and as soon as it has performed its work it is automatically stopped. After the operations have been performed the machine may be cleared by simply depressing a cancellation key whereupon clearing takes place automatically and the machine is in condition for another series of operations.

It is to be understood that the construction shown is for purposes of illustration only and that variations may be made in it without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. A key-responsive automatic calculator having a plurality of banks of depressible amount keys, a differential stop bar for each bank movable to differential positions determined by the keys of its bank, a registering mechanism having a plurality of pinions each of which is operated by its respective stop bar, a power driving means operable, upon depression of any key in any given bank, to automatically and instantly move the stop bar for said bank from a normal to a differential position, driving connections for each bank conditioned by depression of any of the keys of a given bank to connect the stop bar for said bank to said driving means for automatic and instantaneous movement to differential position upon depression of said key, means set into operation by the continued movement of a portion of said driving connection after said stop bar has been arrested in differential position acting to automatically disconnect said stop bar from said driving means, and means returning said stop bar to normal position after it has been disconnected.

2. A key-responsive automatic calculator having a plurality of banks of depressible

amount keys, a differential stop bar for each bank adapted to be arrested in differential positions by the keys of its bank, a power driving means operable, upon depression of a key in any given bank, to automatically and instantly move the stop bar for said bank from a normal to a differential position independently of the other stop bars, connecting means associated with each bank of keys conditioned by depression of any key in its bank for yieldingly connecting the stop bar of said bank to the driving means for automatic and instantaneous movement to differential position upon depression of a key in its bank, said yielding connection allowing portions of said connecting means to move relative to the stop bar after the stop bar has been arrested in differential position to automatically disconnect the stop bar from said driving means, and means for returning the moved stop bar to normal position.

3. A key-responsive automatic calculator having banks of depressible amount keys, a differential stop bar for each bank having a forward and a return movement, the forward movement of each bar being determined by the keys of its bank, means urging said bars rearward to a normal position, a registering mechanism having a plurality of pinions each of which is operated through connections with its respective stop bar, a motor operated driving means operable, upon depression of a key in any given bank, to automatically and instantly move the stop bar for said bank forward to differential position independently of the other stop bars and against the influence of said urging means, normally disconnected driving connections for each of said stop bars for individually connecting it to said driving means, means associated with each bank of keys and conditioned by depression of any key in its bank for conditioning the driving connections for the bank in which a key is depressed to connect the stop bar of said bank to said driving means to enable said stop bar to be instantly moved to differential position upon depression of said key, and means acting to automatically disconnect said stop bar from said driving means after said stop bar has been differentially positioned to thereby release said stop bar for return to normal under the influence of its urging means, said stop bar and its connections to its register pinion acting to operate said register pinion as the bar returns to normal under the influence of said urging means.

4. A key-responsive automatic calculator having banks of depressible amount keys, a differential stop bar for each bank having a forward and a return movement, the forward movement of each stop bar being determined by the keys of its bank, means urging said bars rearward toward a normal position, a registering mechanism having a plurality of pinions each of which is operated by connections with its respective stop bar, a motor operated driving means operable, upon depression of a key in any given bank, to automatically and instantly move the stop bar for said bank forward to differential position independently of the other stop bars and against the influence of said urging means, normally disconnected driving connections for each stop bar for individually connecting it to said driving means, means associated with each bank of keys and conditioned by depression of any key in any given bank for conditioning the driving connection for said bank to connect the stop bar of said bank to said driving means to enable said stop bar to be instantly moved to differential position upon depression of a key of its bank, and means set into operation by the continued movement of a portion of said driving connections, after said stop bar has been differentially positioned, acting to automatically disconnect said stop bar from said driving means to release said stop bar for return to normal under the influence of its urging means, said stop bar and its connections with its register pinion having portions acting to operate said register pinion as the bar returns to normal under the influence of said urging means.

5. An automatic calculator having a registering mechanism, depressible amount keys, a differential stop bar movable to differential positions determined by depression of said keys, a power driving means for moving said stop bar to differential positions, a connecting means acting, upon depression of any of said keys, to automatically connect said stop bar to said driving means by a yielding connection, and means set into operation by the continued movement of said connecting means after said stop bar has been arrested acting to automatically disconnect said stop bar from said driving means.

6. A differential mechanism having a movable stop bar, manipulative amount determining devices for arresting said bar in differential positions, a power driving means for moving said stop bar to differential positions, a connecting means acting, upon manipulation of one of said devices, to automatically connect said stop bar to said driving means by a yielding connection, and means set into operation by the continued movement of said connecting means relative to said stop bar after said stop bar has been arrested acting to automatically disconnect said stop bar from said driving means.

7. In a differential mechanism, a differentially movable stop bar, depressible keys for arresting said bar in differential positions, a power driving means including a toothed wheel for moving said stop bar to differential positions, normally disconnected driving connections for connecting said stop bar to said

toothed wheel, means urging said driving connections to connected position, means normally restraining said connections, and means operated by depression of any of said keys for releasing said driving connections to enable them to move into engagement with said toothed wheel independently of the character of movement of said keys.

8. In a differential mechanism, a differentially movable stop bar, depressible keys for arresting said bar in differential positions, a power driving means including a rotatable toothed wheel, normally disconnected driving connections for connecting said stop bar to said wheel, said driving connections including a pawl and a spring urging said pawl in a direction to engage said wheel, a detent having a shoulder normally restraining said pawl, and means actuated by depression of any of said keys to move said shoulder away from said pawl to release said pawl to enable the latter to move into engagement with its toothed wheel under the influence of said spring.

9. A key responsive automatic calculator having a bank of amount keys each of which is depressible the same distance, a stop bar movable to differential positions determined by said keys, a power driving means for moving said bar to its differential positions, driving connections for connecting said stop bar to said driving means said driving connections being urged toward connected position by a spring but being normally restrained from such movement, and means actuated by depression of any one of said keys for releasing said driving connections to enable said connections to move to connected position under the influence of said spring whereby said stop bar may be connected to said driving means by a light depression of said keys which is uniform in amount and length for each key.

10. A key responsive automatic calculator having banks of depressible amount keys, a differentially movable stop bar for each bank, a register having numeral wheels each of which is actuated by its respective stop bar, a power driving means, normally disconnected driving connections for each stop bar for connecting each bar to said power driving means, each driving connection including a pawl and means urging said pawl in a direction to engage a toothed wheel rotated by said driving means, a restraining means for each pawl, and means controlled by depression of said amount keys acting to release the restraining means in the bank in which a key is depressed to thereby release the pawl for said bank to enable it to move into engagement with its toothed wheel under the influence of its urging means and free of said key-controlled means, said driving connections including portions acting to cause said pawl to be automatically disconnected from said wheel after said stop bar has been arrested in differential position.

11. A key responsive automatic calculator having banks of depressible amount keys, a differentially movable stop bar for each bank, a register having a plurality of pinions each of which is operated by its respective stop bar, a power driving means including a rotatable toothed wheel for each bank of keys, normally disconnected driving connections for each stop bar for connecting the bars to said power driving means, each of said driving connections including a pawl and a spring urging said pawl in a direction to engage its toothed wheel, a detent for each pawl normally restraining it from movement into engagement with its ratchet wheel, and means actuated by depression of said amount keys acting to move the detent in the bank in which a key is depressed to release the pawl for said bank to enable said pawl to move into engagement with its toothed wheel under the influence of its spring, said driving connections including portions acting to cause said pawl to be automatically disconnected from its toothed wheel after said stop bar has been arrested in differential position.

12. An automatic calculator having banks of depressible amount keys, a stop bar for each bank adapted to be arrested in differential positions by the keys of its bank, a driving arm yieldingly connected to each stop bar, a power driven ratchet pinion for each arm, a pawl for each arm for connecting it to its driving ratchet, a means associated with each bank of keys and actuated by depression of any key in its bank for automatically connecting the pawl to the driving ratchet when a key is depressed in said bank, and means actuated by movement of the driving arm after the stop bar has been arrested for automatically disconnecting the pawl from the driving ratchet.

13. An automatic calculator having banks of depressible amount keys, a stop bar for each bank adapted to be arrested in differential positions by the keys of its bank, a driving arm yieldingly connected to each stop bar, a power driven ratchet pinion for each arm, a pawl for each arm for connecting it to its driving ratchet, means associated with each bank of keys and actuated by depression of any key in its bank for automatically connecting the pawl to the driving rachet of said bank when a key is depressed, and means carried by each driving arm and operated by engagement with its stop bar when the latter is arrested for automatically disconnecting its pawl from its driving ratchet.

14. An automatic calculator having banks of depressible amount keys, a stop bar for each bank adapted to be arrested in differential positions by the keys of its bank, a driving arm for each stop bar urged to a

normal position and yieldingly connected to its stop bar, a power driven ratchet pinion for driving each arm, a pawl carried by each arm, a spring normally urging said pawl in a direction to engage the driving ratchet of its arm, a restraining means for each pawl, mechanism associated with each bank of keys and actuated by depression of any key in the bank for conditioning the restraining means to release the pawl when a key in said bank is depressed, disconnecting means carried by each driving arm and actuated by engagement with its stop bar when said bar is arrested in differential position for automatically and positively disengaging its pawl from its ratchet to free the driving arm, and means for restoring the disconnecting means to normal position when the driving arm returns to normal.

15. A key responsive automatic calculator having a plurality of banks of depressible amount keys, a differential stop bar for each bank movable to differential positions determined by the keys of its bank, a registering mechanism having a plurality of pinions each of which is operated by its respective stop bar, a power operated driving means including a rotatable toothed wheel for each bank of keys, normally disconnected driving connections for each stop bar for connecting it to its toothed wheel, said connections including a pawl urged toward engagement with said toothed wheel but normally restrained from such engagement, means operated by depression of an amount key for releasing the pawl for the bank in which a key is depressed for movement into engagement with its toothed wheel to cause an operation of its stop bar, and means set into operation by the continued movement of a portion of said driving connections after said stop bar has been arrested in differential position acting to move said pawl out of engagement with said toothed wheel to thereby release said stop bar.

16. A key responsive automatic calculator having banks of depressible amount keys, a differential stop bar for each bank having a forward and return movement, the forward movement of each bar being determined by the keys of its bank, means urging said bars rearward toward a normal position, a registering mechanism having a plurality of pinions each of which is operated by its respective stop bar, a motor operated driving means including a toothed wheel for each bank rotatable in a direction to move said stop bars forward against the influence of their urging means, normally disconnected driving connections for each stop bar, each driving connection including a pawl adapted to engage the toothed wheel of its bank, means associated with each bank of keys and conditioned by depression of any key in its bank for causing the pawl of said bank to engage its toothed wheel to connect the stop bar of said bank to said driving means, and means acting to automatically disconnect said pawl from its toothed wheel after said stop bar has been differentially positioned to thereby release said stop bar for return to normal under the influence of its urging means, said stop bar operating its register pinion as the bar returns to normal.

17. An automatic calculator having depressible keys, a differential stop bar movable to differential positions determined by depression of said keys, a registerng mechanism controlled by said stop bar, a driving means for moving said stop bar, connecting means controlled by said keys for connecting said driving means to said stop bar, said connecting means including a pawl urged to connecting position by a spring and released upon operation of said connecting means by said keys, and means operating automatically when said stop bar is arrested in differential position to change the direction of action of said spring on said pawl to cause said pawl to be automatically moved to disconnected position to thereby disconnect the driving means from said stop bar.

18. An automatic calculator having banks of depressible amount keys, a stop bar for each bank movable to differential positions determined by the keys of its bank and returnable to normal position, a power driving means including a rotatable toothed wheel, driving connections for each stop bar for connecting it to said power driving means, said driving connections including a pawl movable to engage said toothed wheel, means actuated by said keys for causing said pawl to be moved into driving engagement with said toothed wheel, means maintaining said pawl in engaged position during the driving of said stop bar, and means acting to automatically move said pawl to disengaged position after said stop bar has been arrested in differential position, said maintaining means acting to prevent said pawl from moving to engaged position during the return of said stop bar to normal.

19. A key responsive automatic calculator having depressible amount keys, a stop bar for each bank movable to differential positions determined by said amount keys, a power driving means including a rotatable toothed wheel, a registering mechanism having pinions each of which is operated by its respective stop bar, driving connections for each stop bar for connecting it to its toothed wheel, said driving connections including a pivoted pawl adapted to engage said wheel, means operated by said amount keys for causing said pawl to engage said wheel to drive said stop bar to differential position, and means engaging said pawl, after said stop bar is arrested, on the side of its pivot oppo-

site that of the point of engagement between said pawl and said toothed wheel to positvely turn said pawl on its pivot to swing it out of engagement with said toothed wheel.

20. A differential mechanism having a differentially movable stop bar, depressible amount keys for arresting said bar in differential positions, a power operated driving means including a rotatable toothed wheel, normally disconnected driving connections between said stop bar and said power driving means, said driving connections including a pawl adapted to engage said toothed wheel, means actuated by depression of said amount keys for causing said pawl to be engaged with said wheel when one of said amount keys is depressed, said pawl being carried by an arm connected to said stop bar and rockable about the same axis as the axis of rotation of said toothed wheel whereby, when said pawl and wheel are in driving engagement, they turn about the same axis.

21. A differential mechanism having a differentially movable stop bar, depressible amount keys for arresting said bar in differential positions, a power-operated driving means including a rotatable toothed wheel, driving connections for connecting said stop bar to said toothed wheel including a pawl adapted to engage said wheel, means actuated by depression of said amount keys for causing said pawl to be engaged with said wheel when one of said amount keys is depressed, said pawl being pivoted on an arm connected to said stop bar which arm is rockable about the same axis as said toothed wheel, and means engaging said pawl after said stop bar has been arrested in differential position acting to positively turn said pawl on its pivot on said bar to move said pawl out of engagement with said toothed wheel with a positive quick turning action.

22. An automatic calculator having a plurality of banks of depressible amount keys, a differential stop bar for each bank, a power driving means for actuating said stop bars, and connecting means for each bank of keys operated by depression of any key in the bank for both positively and yieldingly connecting the stop bar of said bank to the driving means when a key in said bank is depressed, said positive connection being constructed so as to be automatically disabled after movement of the stop bar has been started.

23. An automatic calculator having a bank of depressible amount keys, a differential stop bar for said bank adapted to be arrested in differential positions by the keys of said bank, a power driving means, connecting means for connecting the stop bar to the driving means including a yielding connection between the driving means and the stop bar to permit relative movement of the two when the stop bar is arrested, means operated by movement of the driving means relative to the stop bar for automatically disconnecting the stop bar from the driving means when the stop bar is arrested, said connecting means also including positive connections between the driving means and the stop bar operable when the driving means starts the bar but movable to disabled position as said bar is moved.

24. An automatic calculator having a bank of depressible amount keys, a differential stop bar for said bank, a driving arm for said stop bar, a yielding connection between said driving arm and said stop bar by means of which said bar is moved as the driving arm is moved, and means for positively connecting the driving arm to the stop bar when the yielding connection yields as movement of the driving arm is started, said positive connection being automatically disabled after movement of the stop bar has been started.

25. An automatic calculator having a bank of depressible amount keys, a stop bar for said bank adapted to be differentially positioned by said keys, a pivoted driving arm having a yielding connection with one end of said stop bar, said driving arm having a projection adapted to engage a shoulder on the stop bar when the yielding connection yields as the driving arm starts to move said bar, said projection and shoulder being located so that, as the driving arm turns on its pivot during movement of the stop bar, the projection is moved out of contact with said shoulder.

26. An automatic calculator having banks of depressible amount keys, a stop bar for each bank adapted to be arrested in differential positions by the keys of its bank, a driving arm yieldingly connected to each stop bar, a power driven ratchet pinion for each arm, a pawl carried by each arm, a spring normally urging the pawl in a direction to engage the driving ratchet of its arm, a restraining means for each pawl, a key-controlled bar for each bank of keys movable longitudinally when a key in its bank is depressed, a latch for each key-controlled bar for holding it in its moved position, each of said latches having connections with the releasing means of its bank to move said means to release the pawl of said bank when a key in the bank is depressed, and means for automatically disconnecting the pawl from the ratchet when the stop bar is arrested.

27. An automatic calculator having banks of depressible amount keys, a stop bar for each bank adapted to be arrested in differential position by the keys in its bank, a driving arm yieldingly connected to each stop bar, a power driven ratchet pinion for each arm, a pawl for each arm, a spring normally urging the pawl in a direction to engage the driving ratchet, a restraining means for each pawl, a key-controlled bar for each

bank of keys adapted to be moved longitudinally when a key in its bank is depressed, and a latch for each key-controlled bar for holding it in its moved position, each latch having connections with the restraining means of its bank to move the latter when a key in the bank is depressed to thereby release the pawl for said bank, said key-controlled bar having cooperating connections with the keys of its bank to hold the depressed key depressed when the bar is latched in moved position and to prevent any of the other keys in the bank from being depressed.

28. An automatic calculator having banks of depressible amount keys, a stop bar for each bank adapted to be arrested in differential positions by the keys of its bank, a driving arm yieldingly connected to each stop bar, a power driven ratchet pinion for each arm, a pawl carried by each arm, a spring normally urging the pawl in a direction to engage the ratchet, a restraining means for each pawl, a key-controlled bar for each bank of keys movable longitudinally when a key in the bank is depressed, a latch for each key-controlled bar for holding it in its moved position, each latch having connections with the restraining means of its bank to move the latter to release the pawl of said bank when a key is depressed, and means carried by each driving arm and actuated by engagement with the stop bar of its bank when the latter is arrested for moving the pawl of said bank out of engagement with the ratchet and for releasing the latch of the bar of said bank to release the depressed key.

29. A key responsive automatic calculator having banks of depressible amount keys, a stop bar for each bank having a forward and a return stroke of movement, said bar being arrested in differential forward positions by the keys of its bank, a power operated driving means, driving connections for each stop bar for connecting it to said driving means, a key locking bar for each bank urged toward a normal position and moved away from normal by depression of a key of its bank to lock the keys of said bank, mechanism actuated by said locking bar for conditioning said driving connections to connect the stop bar for said bank to said driving means, latching means for holding said key locking bar and associated mechanism in the position to which they are moved by the depressed key, and means operated by the continued movement of a portion of said driving connections after said stop bar has been arrested in its differential forward position for releasing said latching means to release said key locking bar and associated mechanism for return to normal.

30. A key responsive automatic calculator having a plurality of banks of depressible amount keys, a differential stop bar for each bank having a forward and a return stroke of movement, said stop bar being arrested in differential forward positions by the keys of its bank, a power driving means including a rotatable toothed wheel for each bank, driving connections for each stop bar for connecting it to said driving means, said driving connections including a pawl urged toward its toothed wheel but normally restrained from engagement therewith, a key locking bar for each bank urged toward a normal position and actuated away from normal by depression of a key of its bank to lock the keys of said bank when one of them is depressed, mechanism associated with said locking bar for releasing said pawl when a key is depressed, means for latching said locking bar and the mechanism associated therewith in the position to which they are moved by depression of a key, said driving connections including portions which continue to move after said stop bar has been arrested in differential forward position, said portions acting to release said locking bar and its associated mechanism for return to normal and to cause said pawl to be disconnected from said toothed wheel, said locking bar and associated mechanism acting by their return to normal to condition said driving connections to hold said pawl out of engagement with its toothed wheel.

31. A key responsive automatic calculator having banks of depressible amount keys, a stop bar for each bank movable to differential positions determined by the keys of its bank, a power-operated driving means including a rotatable toothed wheel for each bank, driving connections for each stop bar for connecting it to its toothed wheel, said driving connections including a pivoted pawl and a spring normally urging said pawl toward its toothed wheel, a restraining means for said pawl, a key locking bar for each bank of keys operated by depression of a key to lock the keys of its bank, said bar having connections operating to release the restraining means for its bank, a latch for holding said bar in the position to which it is moved by depression of a key, means engaging said pawl after said stop bar has been arrested to move it about its pivot to disengage it from its toothed wheel and to position it so that its spring acts to hold said pawl in disengaged position, said pawl releasing means also releasing said key-locking bar to enable it and said restraining means to return to normal, and means acting when said stop bar returns to normal to turn said pawl on its pivot to move it to normal position.

32. A differential mechanism including a differentially movable stop bar, depressible amount keys for arresting said bar in differential positions, a power driving means including a rotatable toothed wheel, normally disconnected driving connections between

said stop bar and said wheel including a pawl urged toward a position for engaging said wheel, means normally restraining said pawl from such engagement, mechanism controlled by said amount keys for releasing said pawl when one of said keys is depressed, means urging said keys and the mechanism controlled thereby toward normal position, said driving connections including portions acting after said stop bar is arrested in differential position to cause said pawl to be disconnected from said toothed wheel and to free said keys and the mechanism controlled thereby for return to normal so that one of said keys may be depressed before said stop bar returns to normal to thereby again release said pawl restraining means whereby, when said stop bar returns to normal, said pawl will be immediately re-engaged with said toothed wheel to cause a second movement of said stop bar.

33. A key responsive automatic calculator having banks of depressible amount keys, a stop bar for each bank movable to differential positions determined by the keys of its bank and returnable to normal, a power driving means, driving connections for each stop bar for connecting it to said power driving means, means operated by depression of an amount key for conditioning the driving connections for the bank in which a key is depressed to connect the stop bar of said bank to said power driving means, and means acting to automatically disconnect said driving connections after said stop bar has been arrested in differential position, said driving connections remaining in disconnected position during the return of said stop bar to normal, said key operated means and said driving connections having portions enabling said key-operated means to be operated before said stop bar and driving connections have returned to normal to thereby condition said driving connections for a second engagement with said driving means immediately upon the return of said stop bar to normal.

34. An automatic calculator having banks of depressible amount keys, a differential mechanism for each bank movable to differential positions determined by the keys of its bank and returnable to normal position, a power driving means, normally disconnected driving connections between each of said differential mechanisms and said power driving means, mechanism actuated by said amount keys for conditioning said driving connections to connect the differential mechanism of the bank in which a key is depressed to said driving means, latching means for holding said key actuated mechanism in its moved position, said driving connections including portions acting to automatically disconnect said differential mechanism from said power operated means after said differential mechanism reaches differential position and before it starts to return to normal, said portions also releasing said key actuated mechanism to enable the latter to return to normal so that it may be again actuated by its keys before said differential mechanism returns to normal to thereby condition said driving connections so that when said differential mechanism returns to normal, it will be immediately reconnected to said power driving means.

35. An automatic calculator having banks of depressible amount keys, a differentially movable stop bar for each bank movable to differential positions determined by the keys of its bank and returnable to normal position, a power driving means including a rotatable toothed wheel, normally disconnected driving connections between each stop bar and said power driving means, said driving connections including a pawl and means urging said pawl in a direction to engage said toothed wheel, a restraining means for said pawl, mechanism actuated by said keys for moving said restraining means to release said pawl, latching means for holding said key actuated mechanism in the position to which it is moved, said driving connections including portions acting to automatically move said pawl to an inactive position after said stop bar has been differentially positioned, said portions of said driving connections also releasing said latching means, said driving connections also having provisions for returning said pawl to active position when said stop bar is returned to normal, said key actuated mechanism being operable prior to the return of said stop bar to normal to move said restraining means to released position so that, as said actuated stop bar returns to normal position and said pawl is moved toward said toothed wheel, it will immediately engage said wheel and connect the stop bar to said driving means.

36. A key-responsive automatic calculator having banks of depressible amount keys, a stop bar for each bank adapted to be given a forward and a return stroke of movement, said stop bars being arrested in differential forward positions by the keys of their respective banks, a power driving means operable, upon depression of any key in any given bank, to automatically and instantly move the stop bar for said bank from a normal to a differential position, connecting means for each stop bar conditioned by depression of a key in a given bank for connecting the stop bar for said bank to said driving means, latching means for holding a portion of said connecting means in the position to which it is moved, said held portion of said connecting means having provisions for holding the depressed key depressed, releasing means automatically disconnecting said stop bar from said driving means after said stop bar has

been arrested in differential position to thereby release said stop bar for return to normal, and means for returning said stop bar to normal, said releasing means having portions acting to release said latching means to release said depressed key prior to the return of said stop bar to normal.

37. A key-responsive automatic calculator having banks of depressible amount keys, a stop bar for each bank adapted to be arrested in differential positions determined by the keys of its bank, a power driving means operable, upon depression of any key of any given bank, to automatically and instantly move the stop bar for said bank from a normal to a differential position, driving connections for each stop bar for connecting it to the driving means so that the stop bar may be individually driven to differential position, a key controlled bar for each bank movable by depression of a key of its bank, each of said key-controlled bars being associated with the driving connections of its bank to condition the latter, when a key in its bank is depressed, to connect the stop bar of said bank to said driving means to enable said stop bar to be instantly driven to differential position, each of said key controlled bars also having portions preventing depression of other keys in its bank when a key in said bank is depressed and portions holding the depressed key in depressed position, a latch for each key controlled bar for holding it in position to which it is moved by depression of a key, releasing means acting to automatically disconnect each stop bar from said driving means after the stop bar reaches differential position, and means for returning said stop bar to normal position, said releasing means having portions acting to automatically release said latch prior to the return of said stop bar to normal.

38. A key-responsive automatic calculator having banks of depressible amount keys, a stop bar for each bank movable from a normal to differential positions determined by the keys of its bank, power driving means operable, upon depression of any key in any given bank, to automatically move the stop bar of said bank to differential position, driving connections for each stop bar conditioned by depression of a key in a given bank for connecting the stop bar of said bank to said driving means, means operating automatically to disconnect said driving connections after said stop bar reaches differential position to thereby free said stop bar for return to normal, and means for returning said stop bar to normal position, said depressed amount key being free for a second depression before said stop bar reaches its normal position, said driving connections having portions acting to prevent reconnection of said stop bar to said driving means by said second key depression until said stop bar has returned to normal.

39. A key-responsive automatic calculator having banks of depressible amount keys, a stop bar for each bank movable from a normal to differential positions determined by the keys of its bank, power driving means operable, upon depression of any key in any given bank, to automatically move the stop bar for said bank to differential position, driving connections for each stop bar conditioned by depression of a key in a given bank for connecting the stop bar of said bank to said driving means, means operating automatically to disconnect said driving connections after said stop bar reaches differential position to thereby free said stop bar for return to normal, means for returning said stop bar to normal position, and means preventing reconnection of said stop bar to said driving means prior to the return of said stop bar to normal.

40. An automatic calculator having banks of depressible amount keys, a stop bar for each bank adapted to be arrested in differential positions by the keys of its bank, a normally inactive electric motor, normally disconnected driving connections between the motor and each of said stop bars, means operated by depression of any of the amount keys for starting the motor and for conditioning the connections in bank of keys in which a key has been depressed to connect the stop bar of said bank to the motor, a latch for retaining said means in its operating position, and mechanism associated with the driving connections for automatically disconnecting said connections from the stop bar when the stop bar is arrested, said mechanism including portions acting to release said latch to enable said means to stop the motor.

41. An automatic calculator having banks of depressible amount keys, a stop bar for each bank adapted to be arrested in differential positions by the keys of its bank, a normally inactive electric motor, normally disconnected driving connections between each stop bar and said motor, means operated by depression of any of the amount keys for starting the motor and for conditioning the driving connections in the bank in which a key has been depressed to connect the stop bar of said bank to the motor, urging means urging said key operated means toward a normal position, a latch for holding said key operated means in its operated position, said key-operated means having connections with the amount keys to hold the depressed keys depressed, and mechanism associated with said driving connections acting to automatically disconnect the connections from the stop bar when the stop bar is arrested, said mechanism including portions acting to release said latch to enable said key operated

means to return to normal to release the depressed key and stop the motor.

42. An automatic calculator having banks of depressible amount keys, a stop bar for each bank adapted to be arrested in differential positions by the keys of its bank, a normally inactive electric motor, driving connections for each stop bar for connecting it to said motor, a movable bar for each bank of keys urged toward motor-stopping position but movable by depression of any key of its bank to motor-starting position, means operated by said movable bars for starting the motor when a key is depressed, a latch for holding each movable bar in its motor-starting position, means associated with each movable bar and operated thereby when a key is depressed for automatically conditioning the driving connections to connect the stop bar in the bank in which a key is depressed to the motor, means operating automatically when the stop bar is arrested to disconnect the stop bar from the motor, said last named means also operating to release the latch to permit the movable bar to return to normal to stop the motor.

43. An automatic calculator having depressible amount keys, a differential stop bar movable to differential positions determined by depression of said keys, a registering mechanism controlled by said stop bar, a normally inactive electrically operated driving means for moving said stop bar, a switch for starting said driving means, mechanism acting, upon depression of any of said keys, to automatically operate said switch to start said driving means and to automatically connect said stop bar to said driving means with a yielding connection, and means set into operation by movement of portions of said yielding connection after said stop bar has been arrested acting to automatically disconnect the stop bar from the driving means and open said switch.

44. An automatic calculator having depressible amount keys, a plurality of banks of differential stop bars movable to differential positions determined by said amount keys, a registering mechanism having a plurality of pinions each of which is operated by its respective stop bar, a normally inactive electric motor for rotating a rotary driving means, normally disconnected driving connections between each stop bar and said rotary driving means, and means conditioned by depression of any of said amount keys for starting said motor and conditioning said driving connections to automatically connect to said motor the stop bar appropriate to said depressed key, said driving connections including portions acting to cause said stop bar to be automatically disconnected and said motor to be stopped after said stop bar has been moved to differential position.

45. A key responsive automatic calculator having a plurality of banks of depressible amount keys, a differential stop bar for each bank movable to differential positions determined by the amount keys of its bank, a registering mechanism having a plurality of pinions each of which is operated by its respective stop bar, a normally inactive electric motor for rotating a rotary driving means, normally disconnected driving connections between each of said stop bars and said rotary driving means, a switch for starting and stopping said motor, means conditioned by depression of a key in any bank for causing said switch to start said motor and for causing the driving connections for the bank in which the key is depressed to be conditioned to connect the stop bar of said bank to said motor, and means set into operation by the continued movement of a portion of said driving connections after said stop bar has been arrested acting to disconnect said stop bar from said motor and operate said switch to stop said motor.

46. An automatic calculator having depressible amount keys, a plurality of banks of differential stop bars movable to differential positions determined by said amount keys, means urging said stop bars to a normal position, a registering mechanism having a plurality of pinions each of which is operated by its respective stop bar, a normally inactive electric motor, normally disconnected driving connections for each stop bar for connecting it to said motor, means conditioned by depression of any of said amount keys for starting said motor and conditioning said driving connections to connect to said motor the stop bar appropriate to said depressed key, means urging said key-conditioned means in a direction to stop said motor, and latching means for holding said key-conditioned means in the position to which it is moved, said driving connections having portions acting to cause said stop bar to be automatically disconnected from said motor after said bar has been differentially positioned to thereby release said bar for return to normal, said stop bar operating its register pinion during its return to normal, said portions of said driving connections also releasing said latching means to enable said key-conditioned means to return to normal prior to the return of said stop bar to normal to thereby stop said motor while the stop bar is returning to normal.

In testimony whereof, I have subscribed my name.

WALTER J. PASINSKI.