Feb. 16, 1932. J. H. MAGNUS 1,845,164

CALCULATING MACHINE

Filed March 20, 1929 5 Sheets-Sheet 1

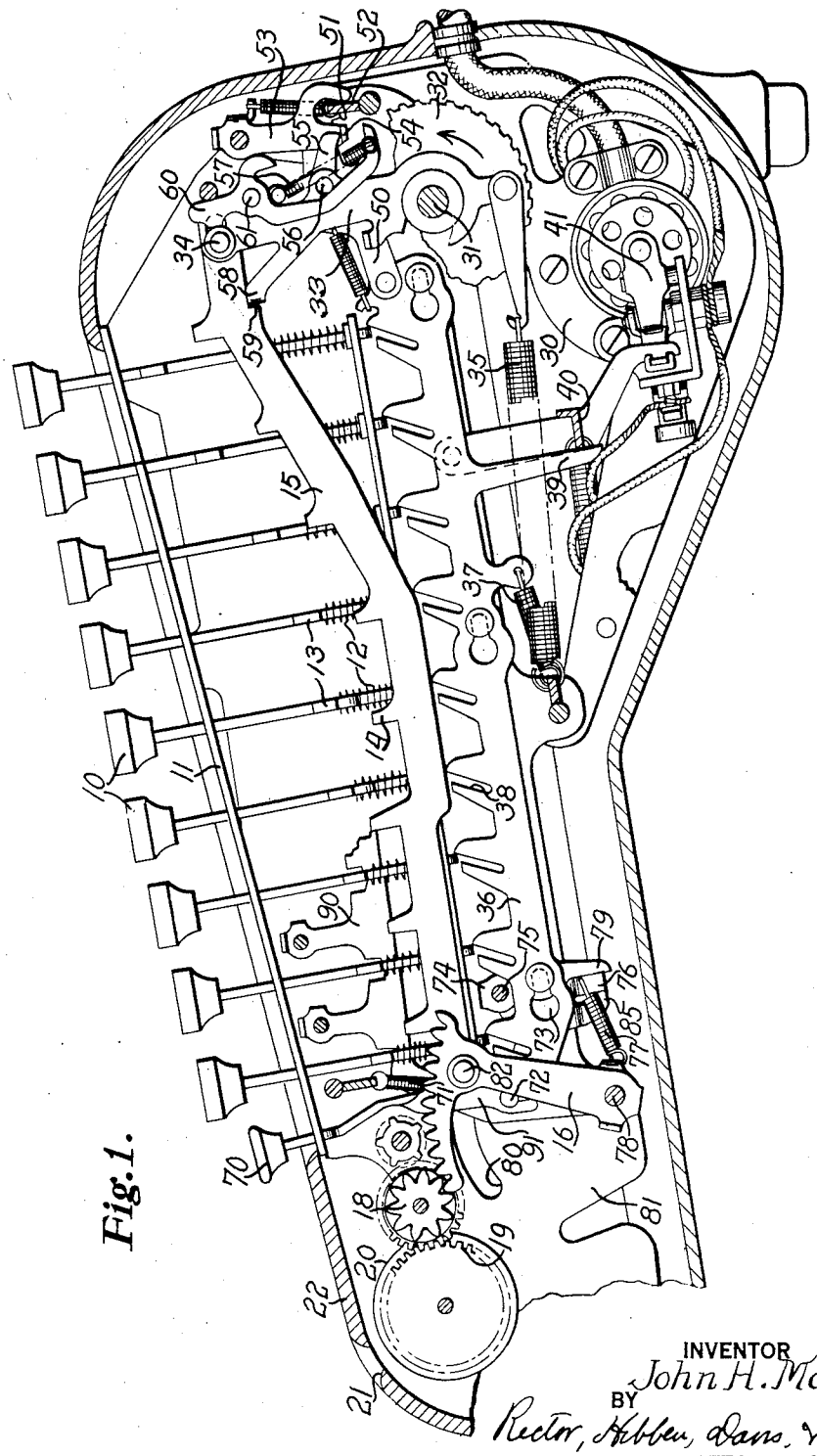


Fig. 1.

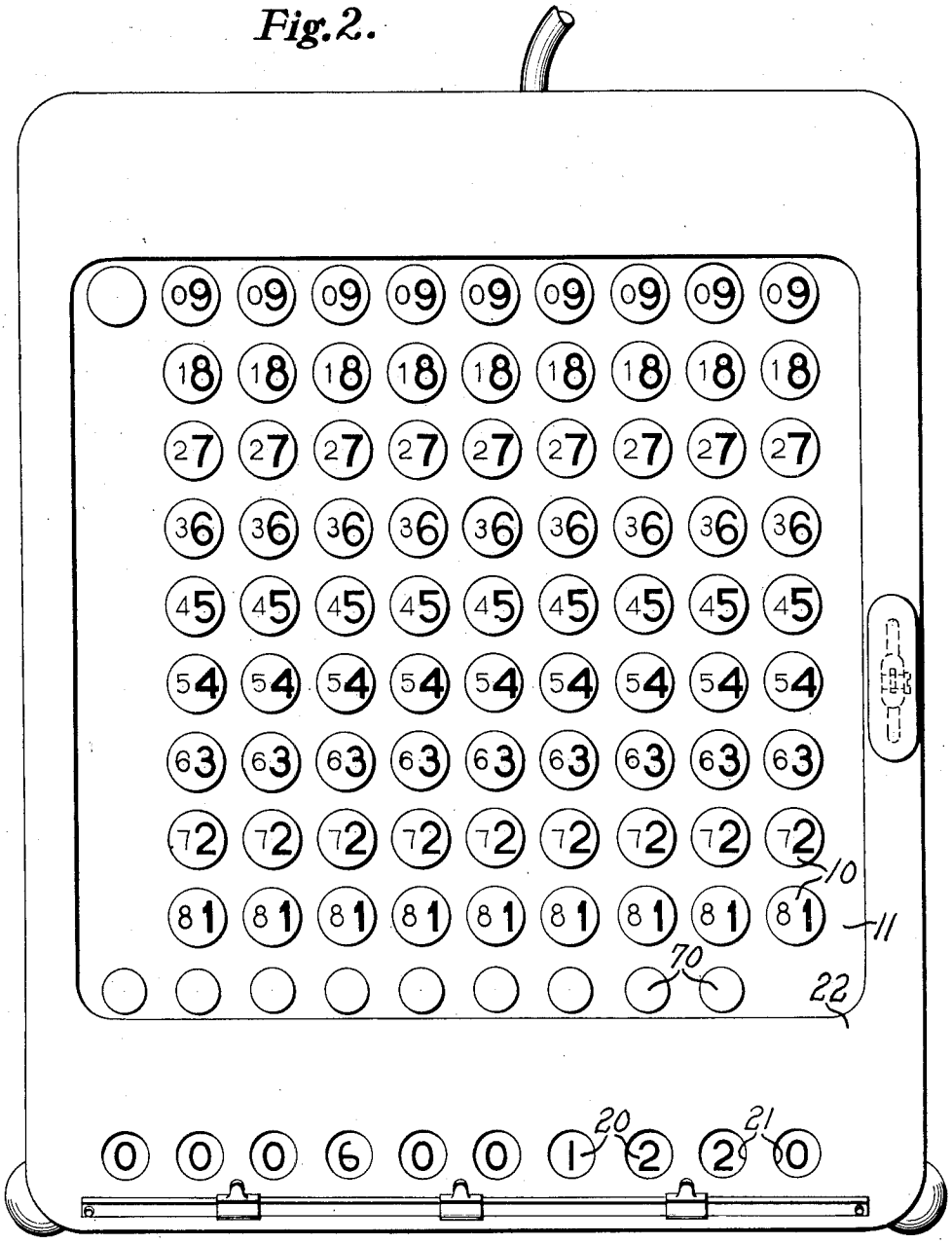
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*Fig.2.*




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CALCULATING MACHINE

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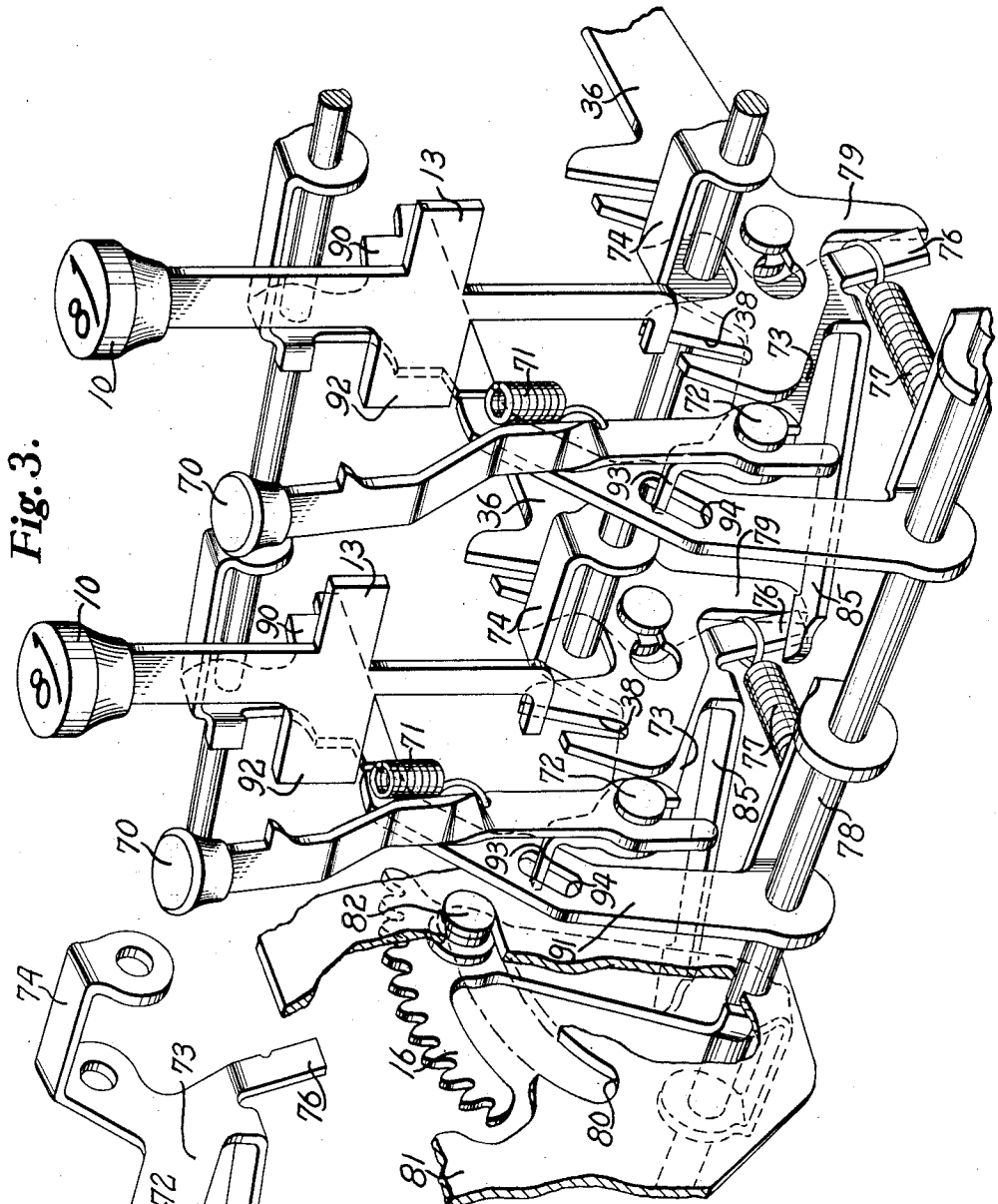



Fig. 3.

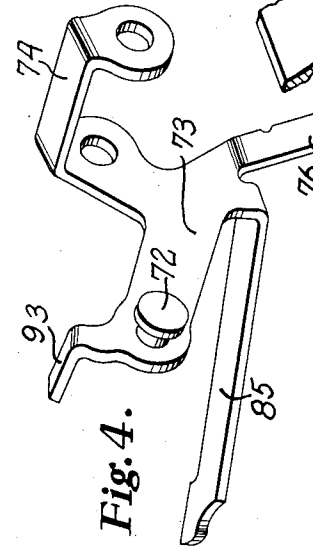



Fig. 4.

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CALCULATING MACHINE

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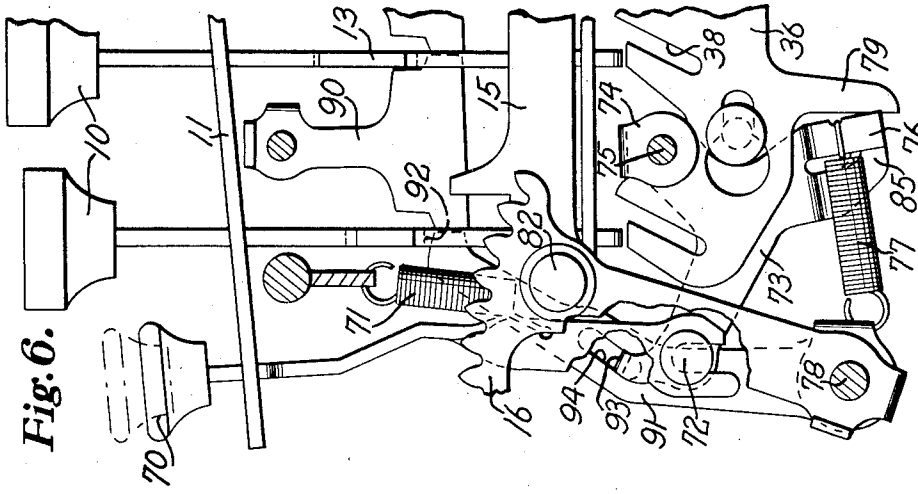



Fig. 6.

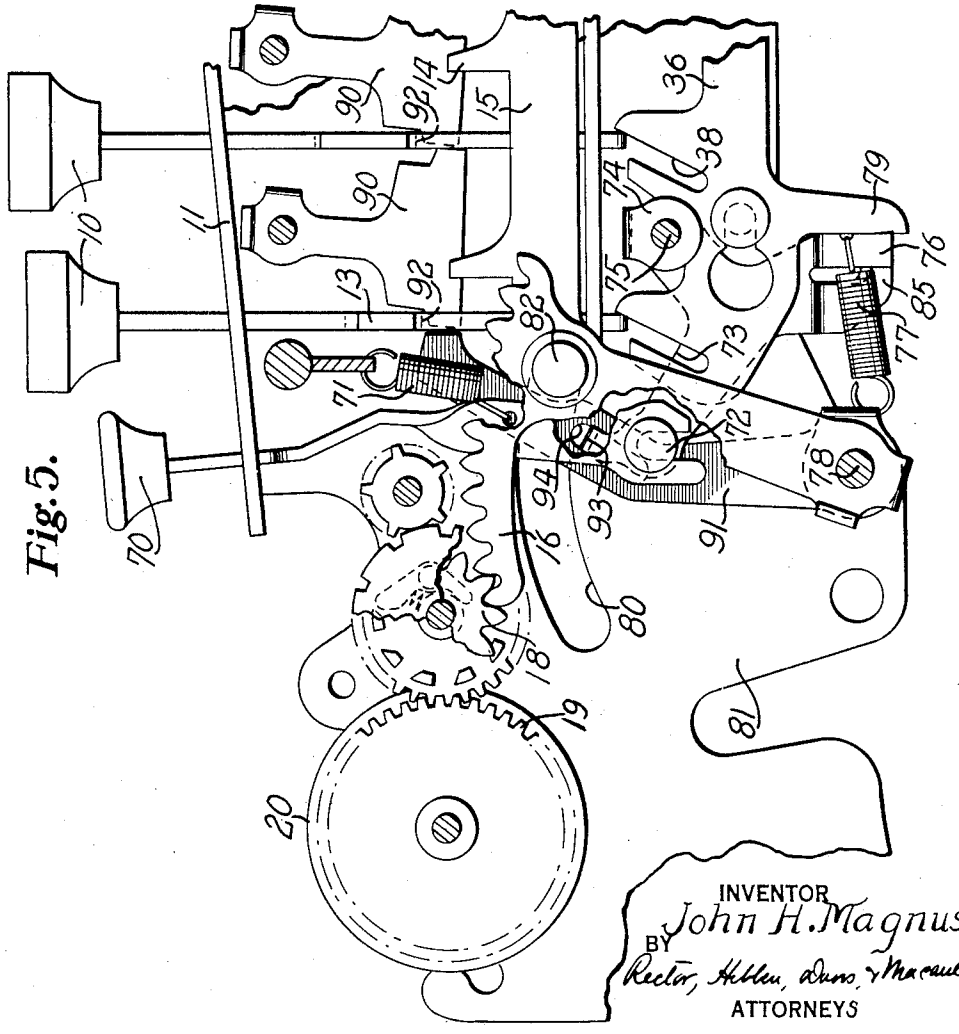



Fig. 5.

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CALCULATING MACHINE

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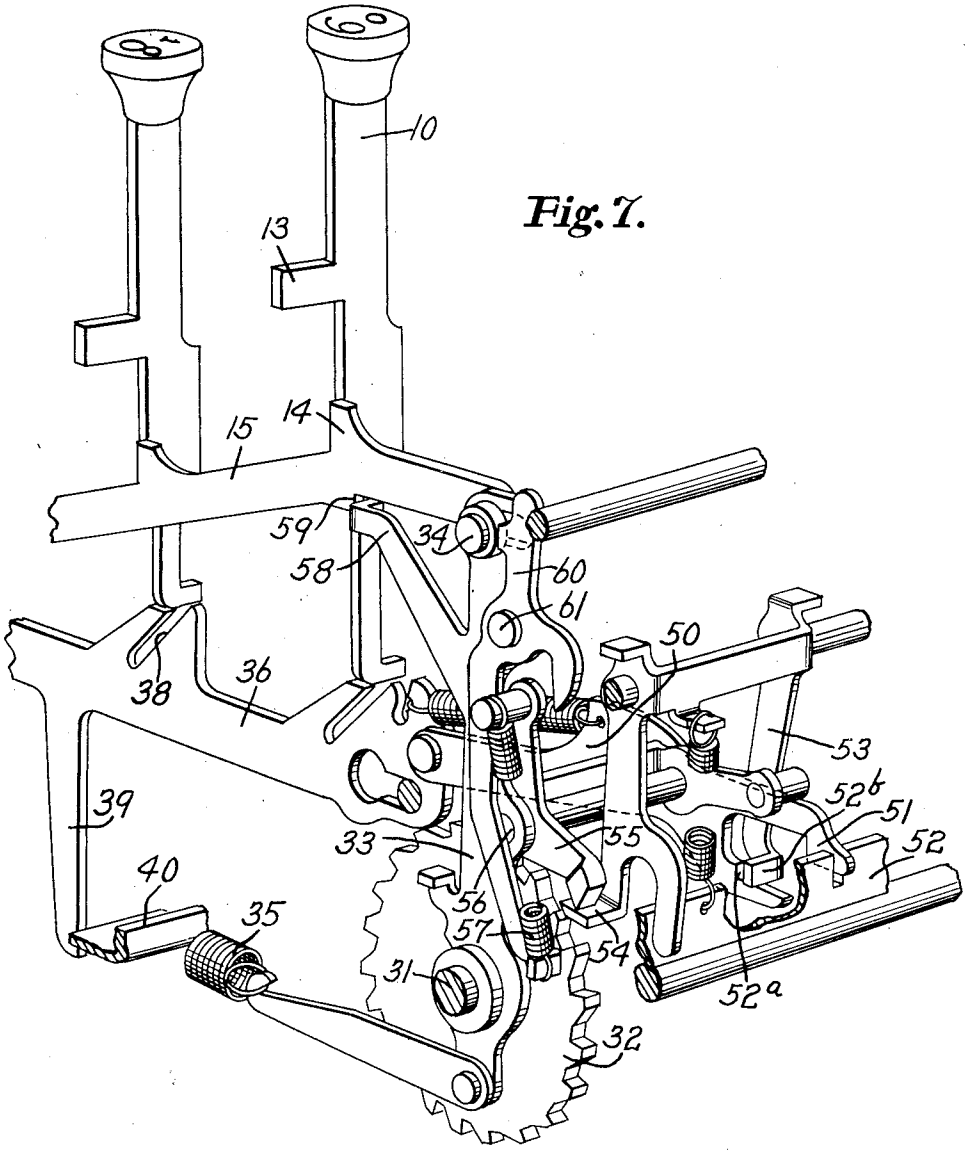



Fig. 7.

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Patented Feb. 16, 1932 1,845,164

# UNITED STATES PATENT OFFICE

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## CALCULATING MACHINE

Application filed March 20, 1929. Serial No. 348,510.

This invention relates to a calculating machine.

It relates particularly to a calculating machine of the type disclosed in my co-pending application, Serial No. 289,865, filed July 2, 1928, and it concerns an improvement on said machine for facilitating the use of the machine in performing subtraction and division.

The machine of said application is an automatic electric calculator having a plurality of banks of keys with an individual differential mechanism for each bank, each differential mechanism operating a register pinion. The machine is driven by a normally inactive electric motor. When a key in a bank is depressed the motor is started and the differential mechanism for that bank is connected to the motor. The motor then drives the differential mechanism until it is arrested by the depressed key, whereupon it is automatically disconnected, the motor is stopped, and the differential mechanism returned to normal. During this series of operations the register pinion of the bank in which the operations took place is advanced an amount corresponding to the key depressed. Subtraction is performed on this prior machine by a process of complemental addition and division is accomplished by repeated subtraction. As is well understood in the art, it is necessary, after adding the complement of a subtrahend to a minuend, to add "9" in all columns of the machine to the left of the last column in which an amount key was depressed in entering the complement of the subtrahend. This sometimes makes it necessary to depress quite a number of "9" keys and, while an experienced operator may do this very quickly and reasonably easily, it takes a certain amount of time and it offers the possibility of error, both of which are factors to be eliminated, if possible. The present invention is directed to an improvement by means of which the necessary "9" keys are automatically operated upon manipulation of a single member thereby speeding up the work and reducing the chance for error.

The object of the invention is to provide an improved calculating machine capable of performing subtraction in a rapid and easy manner.

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

An embodiment of the invention is shown in the drawings in which:

Figure 1 is a sectional side elevation of a calculating machine with certain of the parts omitted, the view showing how the invention is applied to the machine;

Figure 2 is a plan view showing the keyboard of the calculating machine;

Figure 3 is a perspective of a portion of the front end of the calculating machine illustrating particularly the mechanism used in connection with subtraction operations;

Figure 4 is a perspective view of one of the irregular shaped arms used in the machine;

Figure 5 is an enlarged partial side elevation and section of the forward part of the calculating machine, illustrating the parts in normal position, the parts being those of a bank other than the units bank;

Figure 6 is a view similar to Fig. 5, showing the parts in the position they occupy when one of the column keys is depressed in connection with a subtraction operation;

Figure 7 is a perspective view of a portion of the mechanism for connecting the differential stop bars to the motor drive.

### *General construction*

The calculator is provided with a plurality of banks of depressible amount keys 10, there being nine keys in each bank and preferably nine banks though the number of banks may be varied. These keys are mounted in a keyboard 11 and each is urged upwardly by a spring 12. Each key has a lateral projection 13 adapted to be positioned for engagement by shoulder stops 14 on an indexing bar 15.

There is an indexing bar 15 for each bank of keys and each bar is pivotally connected at its forward end to a pivoted toothed segment 16. Each segment meshes with a gear 18 which, through suitable connections, rotates one of the register pinions 19 that

control indicating dials 20 visible through the opening 21 in the casing 22 of the machine. The indexing bar and its associated parts constitute what may be termed a differential mechanism, that is, a mechanism which is movable to differential positions under the control of the amount keys in order to operate the register.

The series of pinions 19, of which there is one for each bank of keys, comprise a register associated with which is a transfer mechanism (not shown) but which may be of any suitable type such for example as that disclosed in Gooch Patent No. 1,128,679.

The calculator is driven by a small electric motor 30 having connections for rotating a shaft 31 carrying a series of toothed pinions 32 there being a pinion for each bank of the machine. When the motor is running the pinions are rotated counterclockwise as indicated by the arrow in Fig. 1. Pivoted loosely on the shaft 31 is a series of arms 33 there being an arm for each bank and each arm having a slot in its upper end into which projects a stud 34 on the respective indexing bar 15 of its bank. Each arm is urged clockwise by a spring 35 which acts to return the arm and its corresponding indexing bar to normal after they have been moved forward and released as will be later described.

The electric motor is normally inactive, but, upon depression of any of the amount keys, its circuit is closed and it is started. This is accomplished through the medium of a longitudinally movable bar 36 urged to the left in Fig. 1 by a spring 37. There is one of these bars for each bank of keys and the upper side of each bar is provided with a plurality of cam slots 38 with which the lower ends of the amount keys cooperate. When any of the amount keys is depressed, its lower end engages in one of the slots 38 and moves the bar 36 to the right in Fig. 1. The bar has a downwardly extending projection 39 positioned to engage a bail 40 that controls the combined governor and switch 41 for starting the motor.

From the description thus far given it will be apparent that, when one of the amount keys 10 is depressed, the bar 36 for that bank is moved to the right and the motor started. At the same time the projection 13 on the stem of the depressed key moves down into the path of the appropriate stop shoulder 14 on the indexing bar 15 so as to arrest the bar when it has been moved forward as will be presently described.

When the bar 36 is moved to the right, as viewed in Figs. 1 and 7, it is latched in motor-starting position by means of a latch 50 pivoted to the rear of the bar and having a hooked nose 51 that engages over a plate 52, there being a latch for each bar. This prevents the bar from immediately moving back to normal under the influence of its spring when pressure on the key is released. As the latch 50 moves rearward, a shoulder $52^a$ on it engages a lug $52^b$ on a pivoted yoke-shaped latch 53 and swings this latch counterclockwise. The latch 53 has another arm carrying a ledge 54 that is normally positioned under the nose of a pawl 55 which, as illustrated in Figs. 1 and 7, is pivoted at 56 to the arm 33 and urged clockwise by a spring 57. As the latch 53 swings counterclockwise, the ledge 54 is moved from under the nose of pawl 55 and when the pawl 55 is released, the spring 57 snaps it into engagement with the toothed pinion 32 of its bank. Since the pawl 55 is carried by the arm 33, the result is that the arm is connected to the toothed pinion that is rotated by the motor. When this connection occurs the arm 33 is swung forward in a counterclockwise direction carrying the indexing bar 15 with it. The connection beween the arm 33 and the indexing bar 15 is a positive one at the beginning of the movement owing to the fact that the arm 33 has an extension 58 that engages a shoulder 59 on the bar 15. After movement has been started the arm 58 swings away from the shoulder 59 and the connection between the arm 33 and the indexing bar 15 becomes a yielding one, that is, the drive is through a member 60 pivoted at 61 to the arm 33 and urged in a counterclockwise direction into engagement with the stud 34 on indexing bar 15 by means of the same spring 57 that is connected to the pawl 55.

The indexing bar 15 moves forward until it is arrested in differential position by the engagement of one of its shoulders 14 with the depressed amount key. When this occurs the upper end of the arm 33 moves forward slightly relative to the bar 15 and this rocks the member 60 clockwise on its pivot 61 and swings the spring 57 across the center of pivot 56 so that the spring 57 then acts to rock the pawl 55 counterclockwise out of engagement with the toothed pinion 32. This disconnects the differential mechanism from the motor drive and frees the indexing bar and the arm 33 so that they may be returned to normal by the spring 35. The rocking of the member 60 clockwise also acts to raise the latch 50 to release the motor starting bar 36 and the latter is then returned to normal by its spring 37 and the motor switch opens to stop the motor. It will be understood that after the indexing bar 15 has been moved to differential position, the register mechanism is conditioned so as to be operated by the toothed segment 16 upon the return of the indexing bar to normal. The mechanism for doing this has not been illustrated as it is well known, the same being disclosed in Horton Patents Nos. 1,016,501, 1,156,600 and the Gooch patent previously mentioned.

It will thus be understood that an electric

calculator has been provided that is entirely automatic and which acts instantaneously upon the depression of an amount key to register the amount of said key in the registering mechanism. When a key in any bank is depressed, the differential mechanism for that bank is automatically connected to the motor drive and the motor is started. The differential mechanism is then driven forward until arrested by the depressed key whereupon it is automatically disconnected from the motor drive and the motor is stopped. The whole operation takes place instantaneously and without requiring any attention on the part of the operator except the depression of the amount keys.

*Subtraction feature*

As previously mentioned, subtraction is performed on a machine of this type by a process of complemental addition. For example, if it is desired to subtract a subtrahend of 345 from a minuend of 956, the complement of the subtrahend is added to the minuend, that is 655 is added to 956. The result would be 1611, but the actual difference between 956 and 345 is 611. In order to eliminate the 1 at the left of the number 1611 "9" is added to the "1", which then causes the register in that order to register "0" but a carry takes place and the "1" appears in the next order to the left so that it is necessary to add "9" in all of the banks to the left of those actually used in entering the complement of the subtrahend. This operation is a familiar one in calculating machines.

As illustrated in Fig. 2, the amount keys are provided with complemental numbers that are slightly smaller than the regular numbers but which facilitate the use of the machine in subtraction. When an operator wishes to subtract he first enters the minuend on the amount keys. He then enters the subtrahend by depressing the keys according to the small numbers (less 1 in the units order) and then depresses the "9" keys in all of the banks to the left which gives the result above explained.

The present invention eliminates the necessity for depressing the "9" keys and enables the operator to perform subtraction in a more easy, a more rapid, and a more automatic manner. The construction for accomplishing this is as follows:

Referring to Figs. 2 to 6, inclusive, it will be observed that an extra series of keys 70 has been provided at the front of the keyboard which, for convenience, will be referred to as "column" keys as there is one key for each column except the first column on the right for which none is necessary. The keys 70 are mounted in the keyboard so as to be depressible and each is urged upwardly by a spring 71. The lower end of each key stem is slotted to receive a stud 72 on the arm 73 of a yoke 74 pivoted on a shaft 75 at the forward end of the machine as illustrated most clearly in Fig. 3, there being a yoke for each bank except the units bank. The arm 73 has a downwardly extending projection 76 to which one end of a spring 77 is connected, the other end being connected to a yoke 91 at the forward part of the machine. The spring 77 serves to urge its yoke 74 in a clockwise direction as viewed in Fig. 3. Each of the motor starting bars 36 except the one in the units bank is provided with a downwardly extending projection 79 at its forward end which is in the path of the projection 76 on the arm 73 as shown in Fig. 3. When one of the keys 70 is depressed its yoke 74 is rocked counterclockwise which causes its projection 76 to push its starting bar 36 rearwardly through the medium of the projection 79 to start the motor. It will be evident that, whenever one of the keys 70 is depressed, the motor is started and the differential mechanism for that bank is connected so as to be driven by the motor, such action taking place automatically upon rearward movement of bar 36 as previously explained.

When the motor is started and the differential mechanism for the bank in question is operated under the conditions above described, it will be appreciated that operation takes place without the depression of any of the amount keys and the indexing bar for said bank will not be arrested by any of the amount keys. Instead the indexing bar will be moved forward to the limit of its movement which, in this case, corresponds to its "9" position. The "9" position of the indexing bar is not made dependent upon the position of the amount keys, but is determined by a slot 80 in the partition plate 81 for the bank in question. Each indexing bar carries a stud 82 (Figs. 3 and 5) which operates in a slot 80, the slot and stud being positioned so that when the stud reaches the forward end of the slot, the indexing bar is arrested in its "9" position with the result that, whenever the bar is so operated, "9" is entered in the register. It will therefore be evident that when one of the column keys 70 is depressed, the differential mechanism for said column will be automatically operated and the register pinion corresponding to said column will be moved nine steps.

In order that the differential mechanisms for each of the banks to the left of the depressed column key 70 may be automatically operated to register "9" in the corresponding pinions of the register, the arm 73 of each of the yokes 74 except the last one to the left is provided with a relatively long lateral extension 85 which extends to the left and in front of the projection 76 on the arm 73 of the yoke 74 immediately to its left (Fig. 3). Accordingly, when one of the column keys 70 is depressed as, for example, the right hand

key 70 in Fig. 3 and its yoke 74 is rocked counterclockwise, this rocking action not only causes an automatic operation of the differential mechanism in its bank, but the lateral extension 85 swings the yoke 74 immediately to its left so as to cause an automatic operation of the bank immediately to the left and this action takes place in succession for all the banks to the left so that upon depression of any key 70 the mechanism of all the banks to the left is automatically operated to enter "9" in the register for all of said banks. This makes it unnecessary to depress the "9" keys. Instead, the operator merely enters the complement of the subtrahend and then depresses the column key 70 for the next column to the left whereupon automatic operations take place in all the columns to the left to add the necessary "9's" in performing subtraction. This speeds the operation and eliminates the chance of error because only one key need be depressed instead of a multitude of keys as is necessary when all of the nine keys to the left are depressed. The operation is automatic in that, as soon as the column key is depressed, each of the mechanisms for each bank to the left is automatically connected to be driven to its "9" position.

*Interlocking mechanism*

The machine is provided with an additional feature that prevents the amount keys in the left hand columns where "9's" should be registered from being depressed while one of the column keys 70 is depressed. Also, means is provided for preventing depression of a column key in one of the columns in which an amount key is being depressed.

Referring to Fig. 1, it will be observed that the machine is provided with the familiar pendants 90 between each of the keys of a given bank for preventing more than one key from being depressed at a time. Pivoted at the front of the machine on the shaft 78, as illustrated in Fig. 3, is a series of arms 91 whose upper ends are adjacent the last of the forward pendants 90 so as to limit the forward movement of the pendants and so as to provide just sufficient space for the lateral projections 92 on the stems of the "1" keys to enter. The forward ends of each of the arms 73 of yokes 74 are provided with lateral projections 93 operating in slots 94 in the arms 91. When a column key 70 is depressed, as, for example, the right hand key in Fig. 3, the projection 93 on the corresponding arm 73 cams the arm 91 clockwise to position its upper end under the projection 92 on the stem of the "1" key. This prevents depression of the "1" key and it also prevents depression of any of the other keys in said bank owing to the fact that the pendents 90 have no space in which to move and the stems of the other keys cannot enter between them. This action also prevents depression of any of the other keys of the machine in banks to the left because the rocking of arm 73 rocks all the arms 73 to the left so that the pendants 90 in each of the banks to the left prevent depression of any of the amount keys of their banks.

This construction also locks the column keys against depression in any column in which an amount key is depressed. When an amount key such as the "1" key in Fig. 3 is depressed, its lateral projection 92 moves into the space between the arm 91 and the adjacent pendant 90. Accordingly, if an attempt is made to depress the column key 70 corresponding to said bank, the operator finds the key blocked because the arm 91 cannot move clockwise and hence the projection 93 on the arm 73 cannot move down and this prevents depression of the column key 70.

Also, when an amount key in any column is depressed, the column keys for the banks of lower order cannot be depressed. For example, if an amount key in a given bank is depressed, the column key of that bank is locked against depression. This means that the arm 73 of said bank cannot be swung counterclockwise. On account of the overlapping projections, the column keys of banks of lower orders cannot be depressed unless said arm 73 in the first mentioned bank can be swung. Accordingly, the column keys in the banks of lower orders are locked against depression.

It will be understood that the embodiment of the invention 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 calculator having banks of depressible amount keys upon which the complement of a subtrahend may be entered to perform substraction, a register, calculating mechanism controlled by said keys for operating said register in accordance with the value of the keys depressed, and automatic means set into operation by manipulation of a single member for automatically operating said register to add "9" therein in all banks to the left of the last one to the left that is manipulated in the entry of a subtrahend.

2. A motor driven calculator having banks of depressible amount keys upon which the complement of a subtrahend may be entered to perform subtraction, a register having a plurality of pinions, a motor, calculating mechanism operated automatically by said motor in response to depression of said amount keys to actuate said register in accordance with the value of the keys depressed, and means controlled by a single manipulative member for causing said motor to automatically add "9" in each order of said regis-

ter to the left of the last order operated in entering a subtrahend.

3. A motor driven calculator having a plurality of banks of depressible amount keys, an individual calculating mechanism for each bank operated automatically and individually under the control of and upon depression of the keys of its bank, means controlled by manipulation of a single member for automatically causing operation of the calculating mechanism for a selected bank and all the calculating mechanisms for the banks to the left of it, and means causing said calculating mechanisms, when so operated, to advance the register 9 steps in each of the banks in which a calculating mechanism is so operated.

4. A motor driven calculator having banks of depressible amount keys, a differential mechanism for each bank, a register operated by said differential mechanisms, a motor, means causing said motor to automatically and individually operate the differential mechanism for a selected bank in response to depression of a key in said bank, and means controlled by the manipulation of a single member for causing said motor to automatically operate the differential mechanisms of a selected bank and of all banks to the left of it to add "9" on the register pinions corresponding to the selected bank and all banks to the left of it.

5. A calculator having banks of depressible amount keys, a differential mechanism for each bank, a register operated by said differential mechanisms, means automatically and individually operating the differential mechanism of any bank in response to the depression of a key in the selected bank, and column keys each having connections for causing automatic operation of the differential mechanism of its bank and of all banks to the left of it.

6. A calculator having banks of depressible amount keys, a register, a differential mechanism for each bank, means for automatically and individually operating said differential mechanisms in response to depression of an amount key in a selected bank, column keys, and means operating automatically upon depression of a selected column key to cause the differential mechanism of the bank in which the column key is depressed and the differential mechanisms of all banks to the left of it to be automatically operated to add "9" to the register in each of said banks.

7. A motor driven calculator having banks of depressible amount keys, a differential mechanism for each bank controlled by said keys, a motor, a starting bar for each bank controlled by the keys of its bank and operating upon depression of any key of its bank to start the motor and to connect the differential mechanism for the selected bank to the motor, column keys for said banks of amount keys, means operated by depression of a selected column key for operating the starting bar for the selected bank, and overlapping connections between said means whereby upon operation of one column key the starting bar operating means for all banks to the left of the depressed column key are operated, and means for indexing in their "9" positions the differential mechanisms of all the banks that are operated by depression of said column key.

8. A motor driven calculator having banks of depressible amount keys, a differential mechanism for each bank, a register operated by said differential mechanisms, a motor, a starting bar for each bank operated by depression of a key of its bank to start the motor and to connect the differential mechanism of its bank to said motor, column keys for said banks having connections for operating the starting bars of their respective banks, and means for indexing in its "9" position the differential mechanism of any bank that is operated by depression of its column key.

9. A motor driven calculator having banks of depressible amount keys, a differential mechanism for each bank controlled by its amount keys, a register operated by said differential mechanisms, a motor, a starting bar for each bank operated by depression of any key of its bank to start the motor and connect the differential mechanism of the selected bank to the motor, a depressible column key for each bank, a yoke member for each column key arranged to operate the starting bar of its column when the column key is depressed, overlapping connections between said yokes to cause all of the yokes to be operated to the left of the one being operated, and means for indexing in their "9" positions the differential mechanisms in the banks in which yokes are operated through depression of said column key.

10. A calculator having banks of depressible amount keys upon which the complement of a subtrahend may be entered to perform subtraction, a register, a calculating mechanism for each of said banks of keys, each mechanism operating independently when a key in its bank is depressed to actuate the register in accordance with the value of the depressed key, a manipulative member for each bank of amount keys, and means operating when the member in any bank is manipulated to cause the calculating mechanisms in banks to the left of it to add "9" into the register in their respective banks.

In testimony whereof, I have subscribed my name.

JOHN H. MAGNUS.