PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in or relating to Calculating and/or Accounting Machines

We, BELL PUNCH COMPANY LIMITED, a British Company, of 39, St. James's Street, London, S.W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention is for improvements in or relating to calculating or accounting machines of the key controlled multi-bank type and has for its object the provision of a machine wherein calculations may be rapidly effected and checked in a simple manner.

According to the present invention there is provided a calculating or accounting machine of the key-controlled multi-bank type, wherein the banks of keys comprise a plurality of distinct sets, one set being operable to reveal on the numeral wheel of any particular order, both the number of the key of that order which has been depressed, and the residue figure after the numeral which that key represents or a specific multiple of the numeral that that key represents has been divided by a prime number in excess of nine, or a multiple of a prime number in excess of nine, another set of keys being operable to reveal on the numeral wheel of any particular order thereof, both the number of the key of that order which has been depressed and the difference figure between the numeral which the key represents and the said prime number, or the multiple of said prime number, or the next higher multiple of the said prime number, or of the multiple of said prime number, and means for effecting other than on one or more of the normal orders of the machine the summation of the said residue and the said difference figures, revealed after keys in both sets have been depressed, and indicating whether the total is equivalent to the said prime number or a multiple thereof.

Further, according to the present invention, there is provided a calculating or accounting machine of the key-controlled multi-bank type, wherein the banks of keys comprise a plurality of distinct sets, one set being operable to reveal on the numeral wheel of any particular order, both the number of the key of that order which has been depressed and the residue figure after the numeral which that key represents or a specific multiple of the numeral that that key represents has been divided by thirteen, another set of keys being operable to reveal on the numeral wheel of any particular order thereof, both the number of the key of that order which has been depressed and the difference figure between the numeral which the key represents and thirteen or the difference figure between the numeral which the key represents and the next higher multiple of thirteen and means for effecting other than on one or more of the normal orders of the machine the summation of the said residue and the said difference figures, revealed after keys in both sets have been depressed and indicating whether the total amounts to thirteen or a multiple thereof.

The invention will be more particularly described with reference to the accompanying drawings, in which:—

Figure 1 illustrates in perspective the exterior of a calculating machine of the key controlled multi-bank type constructed in accordance with the present invention;

Figure 2 illustrates a section on the line A—A of Figure 1 looking in the direction of the arrows and showing one order of the calculating machine illustrated in Figure 1.

Figure 3 illustrates a section on the line C—C of Figure 1 looking in the direction of the arrows and showing the last left-hand order of the calculating machine illustrated in Figure 1;

Figure 4, in conjunction with Figures 1 and 2, illustrates the mechanism for disconnecting the transfer mechanism between the fourth and fifth orders of keys taken from the left-

hand side of the machine illustrated in Figure 1; and

Figures 5, 6 and 7 illustrate on an enlarged scale developments of the faces of the numeral wheels of the various orders of three different kinds of currency machines constructed in accordance with the present invention.

Referring to the drawings, there is illustrated in Figures 1, 2, 3 and 4, a calculating machine of the key controlled multi-bank type, wherein the banks of keys illustrated in Figure 1 comprise two distinct sets—the one set disposed on the right-hand side of the line B—B of Figure 1 being operable to reveal on the numeral wheel of any particular order, both the number of the key of that order which has been depressed, and the residue figure after the numeral which that key represents has been multiplied by 960 and then divided by thirteen, the second set of keys disposed to the left of the line B—B of Figure 1 and to the right of the line C—C of Figure 1 is operable to reveal on the numeral wheel of any particular order thereof, both the number of the key of that order which has been depressed and the difference figure between the numeral which the key represents and thirteen, or the next higher multiple thereof.

Thus, if the numeral wheels of the machine illustrated in Figures 1 and 2 are designated in the manner indicated in Figure 5, then it will be observed from Figure 5 that the numeral wheel of the third column of keys from the right-hand side of the machine illustrated in Figure 1 will have designated thereon the figures set out in the third column from the right-hand side of the development of the numeral wheels illustrated in Figure 5. Thus it will be seen that the figures which occur on the said numeral wheel will be as follows:—

0_0 1_8 2_3 3_{11} 4_6 5_1 6_9 7_4 8_{12} 9_7

The secondary figures of 0, 8, 3, 11, 6, 1, 9, 4, 12 and 7 (each hereinafter referred to as the "residue figure") are obtained by multiplying each of the primary figures 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 (each hereinafter referred to as "the number of the key") by the order of the keys in which the keys are located, thus for example, in the case of the third order of keys, the number of the key is multiplied by one hundred, so as to obtain "the numeral which that key represents" and the numeral which the key represents is multiplied by 960 and thereafter divided by thirteen. Thus, if the first key of the third order is depressed, there is displayed in the window 22^a of the third order, the number of the key, namely 1, and the residue figure 8, which is obtained by multiplying the number of the key, namely 1, by 100 so as to obtain "the numeral which the key represents," namely one hundred, and then multiplying the numeral so obtained by 960, thereby obtaining 96,000, and dividing this figure by 13. If this process is continued for the remaining numbers of the order, it will be found that the residue figure shown in the third column of Figure 5 will be obtained. The residue figure for the eight orders disposed to the right-hand side of the dotted line of Figure 5 are obtained by following the procedure outlined above.

Consequently, it will be observed that in referring to "the number of the key," reference is made solely to the primary number allotted to a particular key in an order, whereas "the numeral which that key represents" comprises the primary number allotted to the key when multiplied by the value of the particular order of keys. Thus, for example, all the keys of the first order comprise units, the second order tens, the third order hundreds and so on until the eighth order where the numbers on the keys represent tens of millions. In the three orders of keys disposed upon the left-hand side of the line B—B, the secondary figure arranged adjacent to the number of the key comprises the difference between the numeral which the key represents (where the first order to the left of the dotted line is regarded as a units order, the second order as a tens order and so on) and the check figure 13 or the difference between the numeral which the key represents and the next highest multiple of 13. Thus, in the ninth column of keys, it will be observed that the figure by the side of number 1 is 12, beside the number 2 is 11, whereas in the tenth row, the figure beside the number 1, which may be regarded in effect as 10, is 3, and the figure beside 2, which may be regarded as 20, is 6.

However, it is to be observed that with the twelfth row, which comprises the row to the left of the line C—C of Figure 1, the secondary figure and the number of the key prove to be the same. Such being the case, the numeral wheel of the twelfth row is shown to contain merely the numbers 1 to 12 and a star for the purpose hereinafter specified.

Referring to Figures 1, 2, 3 and 4 of the drawings, the calculating machine comprises an outer casing 20 having the keys 20^a arranged at its upper side. The front of the case is inclined towards the forward end thereof and is provided with windows 22^a, through which the numbers on the numeral wheels 21 can be viewed. Each of the eleven orders of keys taken from right to left contains nine keys numbered 1 to 9 and each order of keys is associated with a line mechanism directly operable by any of the keys in an order to rotate the numeral wheel 21 associated with that order.

The twelfth order of keys contains only six keys and the line mechanism is operable by the said keys to cause any of the numerals 1 to 12 or the distinctive star, hereinbefore referred to, to be displayed in the associated

window 22° as and for the purpose hereinafter referred to.

In the orders of keys illustrated in Figures 2 and 3, each key comprises a stem 23 arranged to slide in a slot in a cover plate 24, the stem being provided with the usual key top 25 and with a shoulder 26 arranged to engage upon depression of a key with a key bar 27 extending longitudinally of the order below all the keys therein. The lower portion of each key stem 23 is guided in a slot in a plate 28 secured to, or formed integrally with, a frame plate which serves to separate each order from the next adjacent order. Each key is also provided with a hole 30 situated immediately above the shoulder 26 and is shaped at its lower end to the form of a fork. Also, each key stem is associated with a spring 32 for the purpose of restoring the key to its normal position after it has been depressed, the upward movement of the key being limited by the abutment of a second shoulder 33 on the key stem against a part of the under side of the top plate 24. When the keys are in their rest positions, their lower ends are, as shown in Figure 2, at the same horizontal level.

The key bar 27 is arranged for movement in a vertical plane and is mounted in such a manner that during its vertical downward movement, it also moves longitudinally through a small distance in a rearward direction. In the example shown, the key bar 27 is pivotally connected at its rear end at 34 to one arm of a bell crank lever 35, rotatably mounted on a fixed spindle 36 extending transversely through all the lines in the machine. The key bar 27 is supported at the forward end thereof by a T-shaped member 37, pivotally mounted on a fixed spindle 38, extending parallel to the spindle 36 transversely through the machine. One arm of the T-shaped member 37 is pivotally connected, as shown, to the key bar 27, through the intermediary of a short link 39. The key bar 27 is formed with a series of hook-shaped projections 40, one for each key, each hook 40 being shaped to form an upper abutment surface 41 and below this surface a protuberance 42. The mounting of the key bar 27 is such that upon depression of a key, the key bar 27 moves rearwardly through a short distance to cause the appropriate protuberance 42 to move into the hole 30 in the stem of the depressed key.

Below the key bar 27 and extending parallel thereto is a stop bar 43 pivotally connected at the rear end thereof by means of a pin 44 to the lower arm of the bell crank lever 35 and at the forward end thereof at 45 to one arm of the T-shaped member 37. The arrangement is such that when the key bar 27 is depressed on actuation of a key, the stop bar 43 moves forwardly in a direction towards the numeral wheel 21. The keys are so arranged that during the latter part of their downward movement the forked lower ends 31 thereof straddle the stop bar 43. Also, the stop bar 43 is formed in its upper side with a series of notches 46, terminating in vertical abutments 47 arranged to contact with the stem of a depressed key to limit the downward movement of the key, the movement of the key bar 27 and the stop bar 43. The stop bar 43 is formed on its underside and near the rearward end thereof with a notch 48 arranged to be engaged by a pawl 49 which is pivotally mounted at its rear end on a pin 50 carried upon the upper ends of the arms of a U-piece 51 rotatably mounted on a spindle 52 extending transversely through the machine. The U-piece 51 is also formed with a tail 53, the rear end of which is arranged to abut against the upper side of a bar 54 extending behind all the lines in the machine. The bar 54 is provided with bent ends 55 rotatably mounted on the spindle 52, the bar 54 being subjected to the action of a spring tending to swing the bar in a counter-clockwise direction. The pawl 49 is also associated with a spring normally tending to hold the forward end of the pawl so that it bears against the under side of the stop bar 43.

Pivotally mounted on a spindle 58 extending completely through the machine is a bell crank lever 59 having the end 60 of one arm shaped as shown, the end 61 of its other arm being bent at right angles to the said arm. The bell crank lever 59 is associated with a spring tending to rotate it in a counter-clockwise direction. Normally the bell crank lever 59 is located in the position illustrated in Figures 2 and 3 with the end 60 abutting against the face of the bar 54 directed towards the front of the machine. Also extending completely through the machine at the rear of each order is a releasing bar 63 pivotally mounted by means of the in-turned ends 64 thereof on the spindle 52. One end 64 of the releasing bar 63 is provided with a vertical extension 64^a connected by a link 64^b to a handle 65, Figure 1, projecting through a slot in the casing 20 of the machine. Upon actuation of the handle 65, the bar 63 is swung in a counter-clockwise direction to move the same into engagement with the lower arm 60 of the bell crank lever 59.

It will be appreciated that the bell crank lever 59, the pawl 49 and the associated parts thereof above described are reproduced in each order of the machine in the same way as are the key bar 27, stop bar 43 and their associated parts.

The numeral wheel 21 of the order illustrated in Figure 2 is rotated on actuation of a key by a rack 67 having ten teeth adapted to engage and rotate a ten-tooth pinion 68 connected to the numeral wheel 21. The rack 67 is formed at the front end of an arm 69 rotatably mounted at the rear end thereof on a pin 70 carried in the lower ends of the arms

of an inverted U-piece 71 pivotally mounted near its upper end on a spindle 72 extending completely through the machine. The arm 69 is connected at the forward end thereof to the *T*-shaped member 37 through a series of links 73, 74 and 75. The end of the link 73 is pivotally connected to the arm 69 at 76, whilst the other end is pivotally connected to the link 74 which is pivotally mounted on a spindle 76^a, extending transversely through the machine. The link 75 is pivotally connected to the link 74 at a point along the length thereof and to an arm of the T-shaped member 37, the arrangement being such that rotation of the T-shaped member in a clockwise direction around the spindle 38 serves to swing the link 74 in a counter-clockwise direction around its spindle 76^a to cause the link 73 to swing the arm 69 upwardly. In the position of rest shown in Figure 2, the location of the U-part 71 is such that the rack 67 is held out of engagement with the teeth of the pinion 68 and can be swung through an angle into an upward position without effecting any movement of the pinion 68.

Extending longitudinally of each order and below the free ends of the key stems thereof is a bar 78 mounted so as to be rocked transversely about the longitudinal axis thereof. The bar 78 is provided with a number of laterally projecting lugs 79, one of which is arranged directly below the free end of each key stem of the order, so as to lie in the path of the latter during the downward movement thereof. As illustrated in Figure 2, the bar 78 is not arranged parallel to the key bar 27 but is inclined thereto so that the distances between the lower ends of the stems of the keys and the corresponding lugs 79 situated below those keys range from a minimum to a maximum. When a key is depressed, the distance moved by the key bar 27 and the stop bar 43, and hence the angle through which the rack 67 is swung upwardly before the lower end of the key stem engages its corresponding lug 79 on the bar 78, will thus vary with each key. The bar 78 is associated with a spring tending to rock the bar in a direction to move the lugs 79 upwardly. Also, the bar is formed near its rear end with a lug 81 arranged to overlie the pawl 49 and to engage and depress the same when a key has been fully depressed.

One arm of the inverted U-part 71 is formed with a right-angular shaped slot 82 as clearly shown in Figures 2 and 3, into which projects a part 83 secured to, or formed integrally with, the bar 78. The U-part 71 is also formed with a tail piece 84 to the end of which is secured one end of a spring 85, the other end of which is secured to a hook 86 carried on a pin 45, which serves to connect the lower arm of the T-shaped member 37 to the stop bar 43. The anchorages of the spring 85 are arranged, as shown in the drawing, with respect to the pivot points 38 and 72.

The operation of the mechanism is as follows:—Normally the mechanism occupies the position shown in Figures 2 and 3 with the projection 83 lying in the vertical arm of the slot 82, the rack 67 being held in its lowermost position and out of engagement with the pinion 68. The forward end of the pawl 49 is arranged to bear against the under side of the stop bar 43 and the end of the tail 53 is resting on the upper edge of the bar 54, with the end 60 of the bell crank lever 59 abutting against the front face of the bar 54.

When a key, for example the 9 key of Figure 2, is depressed, the shoulder 26 thereof engages with the key bar 27 and moves the latter rearwardly and downwardly and, in consequence, the stop bar 43 is moved longitudinally in a forward direction. The rearward movement of the key bar 27 causes the protuberance 42 on the hook 40, corresponding to the 9 key, to extend into the hole 30 in the stem of the said key. Just before the lower end of the stem of the operated key engages with the corresponding lug 79 on the bar 78, the rack 67, whilst out of engagement with the pinion 68, has been swung upwardly and the spring 85 has been extended by reason of the forward movement of the hook 86. The tail 84 and U-part 71 are retained in their initial positions by the engagement of the projection 83 in the vertical arm of the slot 82. Also, the end of the pawl 49 abuts against the under side of the stop bar 43, the tooth 48 on the stop bar having passed over the free end of the pawl 49 during forward movement of the bar.

At the completion of the downward stroke of the operated key, the lower end of the stem thereof engages the corresponding lug 79 and rocks the bar 78 about its longitudinal axis, so as to move the projection 83 downwardly out of the upper end of the vertical arm of the slot 82. The U-part 71 is thereupon released and swung in a clockwise direction by the spring 85 acting through the tail 84 to move the rack 67 into engagement with the pinion 68. The depth of engagement of the teeth of the rack 67 with those of the pinion 68 is limited by the abutment of the rear end of the slot 82 against the projection 83. The rocking of the bar 78 by the stem of the depressed key also causes the lug 81 to engage the pawl 49 and move the same out of engagement with the under side of the stop bar 43, the engagement of the pawl 49 by the projection 81 serving merely to rotate the pawl 49 about its pivot 50 without operating the locking mechanism.

When the key is released, the spring 85 causes the T-member 37 to rotate in a counter-clockwise direction so to swing the rack 67 in a counter-clockwise direction and thereby rotate the numeral wheel 21 a distance proportionate to the number of the key depressed. After the rack reaches the bottom of its stroke,

a pin 87, carried by the stop bar 43, which latter has been moving rearwardly during the return stroke of the rack 67, engages the end of a slot in a link 88, pivoted at 70, and restores the U-part 71 to its initial position. The return of the U-part 71 serves to withdraw the rack 67 from the pinion 68 and a spring serves to rock the bar 78 to reposition the projection 83 in the upper end of the vertical arm of the slot 82. Restoration of the U-part 71, through engagement of the slotted link 88 by the pin 87 on the stop bar 43, is effected by reason of the fact that the force tending to move the stop bar 43 in a rearward direction is greater than the force exerted by the spring 85 on the tail 84, this difference in the opposing forces being achieved by the arrangement shown in the drawings, and the dimensions and disposition of the parts concerned, and of the anchorages of the front and rear ends of the spring 85. Resetting of the bar 78 also permits the pawl 49 to spring upwardly into engagement with the under side of the stop bar 43, the end of the pawl 49 engaging such under side at a position in front of the notch 48.

As previously explained, and as will be apparent from the foregoing, the angle through which the rack 67 is swung before it is moved into engagement with the pinion, and therefore the angle through which the numeral wheel 21 is rotated during the return stroke of the rack 67 will vary according to the key depressed. In effect, each key serves to preselect the rack through a predetermined distance before moving it into engagement with the pinion 68 and the parts are so arranged that actuation of the first key rotates the numeral wheel through an angle of 36°, the second key 72°, and so on up to the ninth key which rotates the numeral wheel through an angle of 324°.

Also, the arrangement is such that the angular velocity of the numeral wheel is reduced to zero or substantially to zero by suitable deceleration of the rack 67 before the latter disengages the pinion 68. This has the effect of preventing over-throw of the wheel, the latter in the present instance being brought to rest in its correct position before it is free of the rack. The rack is decelerated towards the end of its stroke by the arrangement and disposition of the links 73, 74 and 75.

If the operator fails, inadvertently, to depress a key to its fullest extent, the key stem does not engage its corresponding lug 79 on the bar 78, and the rack 67 is therefore not released into engagement with the pinion 68. The bar 78 does not, therefore, cause the pawl 49 to be moved away from the stop bar 43 and, hence, when the key is released and the stop bar 43 starts to move rearwardly, the pawl 49 engages the notch 48 and is moved bodily in a rearward direction to swing the part 51 in a clockwise direction around its pivot 52. The tail 53 of the part 51 depresses the bar 54 against the influence of its spring into contact with a stop edge 90. The parts come to rest with the stop bar 43 held against further rearward movement and away out of its normal position of rest. As the key bar 27 is held in its rearward position by the stop bar being held by the pawl 49, the key which has been depressed cannot be restored fully owing to the engagement of the associated protuberance 42 in the hole 30 in the key stem.

As will be readily appreciated, if an attempt is now made to depress another key in the order containing the incompletely depressed key, the shoulder 26 of the said other key will engage the upper side of its corresponding protuberance 42 and will move the driving bar 27 downwardly an extremely small amount, the abutment surface 41 above the said protuberance 42 engaging the key stem of the other key after a very small downward movement of the key bar 27, by reason of the rearward movement of the key bar 27. Such abutment of the surface 41 against the key stem will therefore serve to prevent the downward movement of the said other key so that the said other key is locked. Hence, therefore, after a key has been incompletely depressed and released, the remaining keys in the order containing that key are locked against depression.

Further, any movement of the bar 54 downwardly will permit the bell crank lever 59 to be swung in a counter-clockwise direction by its spring, such movement of the bell crank lever 59 serving to move the bent end 61 thereof into a position behind the pin 44 at the rear end of the stop bar 43. Such movement of the bell crank lever 59 is limited by the abutment of its lower arm against the release bar 63.

Downward movement of the bar 54 also serves to release the bell crank lever 59 in all the remaining lines of the machine and each of these bell crank levers swings into a position wherein its bent end 61 lies in front of the pin 44 on the corresponding stop bar 43, so as to hold the stop bar against forward movement. Hence, all the keys in the remaining orders of the machine are locked against depression. Thus, failure of the operator to depress a key to its fullest extent results in the locking up against further movement of the entire keyboard with the exception of that particular key which has been incorrectly actuated. Further, the top of the mol-operated key in question is held at a position below that which it normally occupies, so that the key is capable of immediate visual identification.

After the false stroke, the key can then be depressed to its full extent and released, this serving to record the correct figure on the numeral wheel 21. Full depression of the key

will cause the bar 78 to be rocked about its longitudinal axis to release the rack 67 and permit it to move into engagement with the pinion 68 and also to move the pawl 49 out of engagement with the under side of the stop bar 43. When the key is released, subsequent to the full depression, the rack 67 is swung downwardly to rotate the numeral wheel 21 and the stop bar 43 moves rearwardly until it is arrested by engagement of the pin 44 against the bent end 61 of the bell crank lever 59. The stop bar 43 is arrested immediately before the pin 87 carried by the stop bar 43 is due to engage with the tail 84 and, consequently, when the stop bar 43 is arrested, the rack 67 is still in engagement with the pinion 68, although it has completed the rotation of the same. Hence, any further attempt to depress the key will tend to rotate the pinion 68 in a direction opposed to that in which it is rotated during the normal operative stroke of the rack 67 and as a counter-clockwise movement of the pinion 68 is prevented by the usual non-return pawl, no further downward movement of the key can be effected, and therefore the entire keyboard is now locked. Further, as the stop bar 43, in the line containing the incompletely depressed key is not fully restored to its normal position, the said key will again be retained, on its release in a position below its normal position, by reason of the engagement of the appropriate protuberance 42 in the hole 30 in its key stem.

It will be apparent that the mal-operation of the key can have no influence on the calculation, since the rack is not moved into engagement with the pinion on release of the key subsequent to a false stroke; hence, the subsequent correct depression of the key on which the false stroke was made will bring the calculation to exactly the same result as if the false stroke had never been made.

The keys of the machine are all unlocked after the correction of the error has been effected and the calculation is permitted to proceed by depressing an error key 64^c, the lower end of the key stem of which engages with an inclined surface of an extension 64^a of the bar 63, thereby effecting the pivotal displacement of all the bell crank levers 59 in a clockwise direction. Such a movement of the levers 59 permits the bar 54 to rise under the influence of its spring and, furthermore, the stop bar 43 associated with the mal-operated key, and which has been held in a displaced position, is now permitted to return to its initial position and in turn permit the restoration of the mal-operated key.

It should be noted that the unlocking of any keys as described above also occurs when the zeroising handle 65 is operated through the medium of the link 64^c, but, by reason of the slot in this link, the error key does not cause the figure wheels to zeroise as does the handle 65, and the calculation can therefore proceed after the correction of the error without the necessity of starting the calculation afresh.

The foregoing describes the effect produced by the incomplete depression of a single key, this key being the only one of the keyboard which is actuated. If, however, a plurality of keys is actuated simultaneously, one of which does not receive a full depression, all the keys which were actuated, including not only the key on which the false stroke was made but also the remaining keys which were fully depressed, are prevented, on their release, from being fully restored to their initial positions. This result is achieved by reason of the fact that the faulty key stroke serves, as previously described, to move the bar 54 downwardly to release the bell crank levers 59 in all the lines in the machine, which bell crank levers 59 thereupon swing in a counter-clockwise direction and as this swinging movement is completed before the full restoration of the stop bars 43 in the lines containing the correctly depressed keys, the pins 44 on each of said stop bars are obstructed by the corresponding bent ends 61 of the bell crank levers 59 to prevent full restoration of the stop bars 43. The latter are held in a position wherein their respective racks 67 have rotated the pinions 68 through the correct amounts, but have not become disengaged therefrom, so that the keys in the order of keys containing the correctly depressed keys have become locked, since any attempt to depress these keys will tend to rotate the pinions 68 in a counter-clockwise direction which will be prevented by the non-return pawls hereinbefore referred to. As, however, the stop bars 43 in the orders of keys containing the correctly depressed keys have not been completely restored to their initial positions, each of the associated keys is also prevented from being fully restored and the entire combination of keys, in which the mal-operation was effected becomes immediately apparent from a visual inspection of the keyboard. It will be obvious that the keys in the orders of keys in which a key was not depressed are also held locked by reason of the location of the bent ends 61 of the bell crank levers 59 in front of the pins 44 of the associated stop bars 43, so that in effect, all the keys of the machine are locked, with the exception of the mal-operated key.

If now the error key 64^c is actuated, the bell crank levers 59 are swung in a clockwise direction and in all those orders of keys in which the keys were properly depressed, the stop bars 43 are permitted to return to their initial positions, thus allowing the keys in those orders of keys to rise into their normal positions. However, the stop bar 43 in the order of keys containing the mal-operated key will not be permitted to restore to its initial position because of its engagement with the pawl 49 and hence, actuation of the error key

64° will not affect the position of the mal-operated key. Hence, when a plurality of keys is simultaneously or substantially simultaneously depressed and released and one of these keys receives an incomplete depression, all the said keys will fail to restore completely, and if subsequently the error key 64° is actuated, the keys which did receive complete depressions will be restored to their initial positions, whilst that key which was mal-operated will remain in a depressed condition.

After the error has been corrected by depression of the key which was incorrectly actuated, the calculation may be proceeded with, as hereinbefore described, after a further actuation of the error key 64°, without the necessity of zeroising the machine.

In addition to the mechanism hereinbefore described, there is provided between each adjacent order of keys a transfer mechanism which, when the numeral wheel of any one order has been rotated through one complete revolution, causes the numeral wheel of the nearest highest order to move through a distance corresponding to one unit. Such mechanism may take any desired form, as many of such mechanisms are well known in the art. Means are also provided whereby the transfer mechanism between any two adjacent orders of keys may be thrown out of action by the operator depressing a transfer release button 100 and holding the same depressed.

The keyboard of a normal calculating machine is divided into two distinct sets of keys, in the manner illustrated in Figures 1, 2 and 4. When the button 100 between any two orders of keys is depressed, it renders the movement of the transfer mechanism between the two adjacent orders of keys ineffective. In the particular arrangement illustrated in Figures 1, 2 and 4, the inner end of the eighth button 100, taken from the right-hand side of the machine, is arranged to engage with a lever 101 (Figures 2 and 4), which is adapted to engage with a transfer wheel 102 and move the same in the longitudinal direction of the axis of a spindle 103 and out of the path of a pin 104 of a wheel 105 mounted on a spindle 106 of the nearest lower order of keys.

The button 100 which is disposed between the seventh and ninth orders of the machine illustrated in Figure 1 is provided with a circumferential slot 107, in which, when the key has been depressed, a rockable catch 108 can be moved so as to hold the eighth button in a depressed condition, and thereby isolate the first eight orders of keys from the last four orders, thus ensuring that the machine is provided with two distinct, and in no way interconnected except by the locking mechanism, sets of keys, one disposed to the right-hand side of the line B—B and the other disposed to the left-hand side of the said line, so as, in effect, to divide the machine into substantially two separate calculating units having two sets of the numeral wheels. One set of numeral wheels is provided with two sets of distinctive figures, one comprising "the number of the key" and the other "the residue figure," whilst the other set of numeral wheels is made up of the first three numeral wheels to the left of the line B—B of Figure 1 and the extreme left-hand numeral wheel and its associated order of keys. The three numeral wheels to the left of the line B—B of Figure 1 each have two sets of Figures, one comprising "the number of the key" and the other the "difference" between the numeral which the key represents in that particular order of keys and the prime number or the next higher multiple of the said prime number chosen as the check figure.

The extreme left-hand numeral wheel differs from the remaining numeral wheels of the machine in a manner hereinafter described.

Referring specifically to the column of keys associated with the fourth order of keys disposed to the left-hand side of the line B—B of Figure 1, it will be appreciated that in a normal machine such keys would not be required in connection with the associated numeral wheel, which would merely act as a "carry" wheel from the next lower order. However, in accordance with the present invention all, or some at least, of the last order of keys are employed to perform a special function without increasing the size of the machine or restricting its operation in other respects.

Referring to Figure 5 of the drawings, it will be observed that in the numeral wheel of the last order to the left of the line B—B, both the number of the key and the difference between the numeral which the key represents and the prime number, or the next higher multiple of the prime number always results in the same figure and, consequently, the said difference figure is omitted from the numeral wheel of the last order.

Further, it will be observed from Figure 3 that in accordance with the present invention the extreme left-hand numeral wheel 21^a is arranged to be moved into thirteen digital positions and the zero position of the numeral wheel 21^a is designated by a distinctive character, such as a green star, in place of the conventional 0.

Referring to Figure 3 of the drawings, it will be observed that the pinion 68^a of the numeral wheel 21^a is provided with thirteen teeth, whereby the numeral wheel 21^a is arranged to receive from the quadrant rack 67 angular or digital increments of movement which total up to thirteen for each complete revolution of the numeral wheel. Referring to Figures 5, 6 and 7, the extreme left-hand column of each figure indicates the development of the numeral wheel 21^a, in the case

of three machines designed to operate from different unitary values.

It will be observed from Figure 1 that only six keys are fitted to the extreme left-hand column in the example illustrated as they are the only ones which, in machines of this character, are normally employed for addition. This follows the operational practice well known in the art wherein all the keys are employed for multiplication, but only the lower value keys are used for addition.

Except for the above modifications, the line mechanism for the extreme left-hand order of the machine is the same as that employed in the other orders of the machine.

With a machine of the character hereinbefore described calculations may be checked in a very simple manner, and for the purpose of illustration, there will be described how calculations in addition, subtraction, multiplication and division may be checked by the arrangement hereinbefore specified.

Firstly, let it be supposed that it is desired to add 438 to 564. In the first instance, the keys 4, 3 and 8 of the set of keys disposed to the right hand-side of the line B—B of Figure 2 are depressed with the result that there will be shown through the first three windows 22^a, in addition to the numbers 4, 3, 8, the residue figures 6, 5, 10, which, when added together, give a total of 21 which comprises 13 plus 8. If now the machine is zeroised in the normal manner by means of the handle 65 and the keys 5, 6, 4 of the first three orders are depressed, there will be shown through the first three windows 22^a, in addition to the numbers 5, 6, 4, the residue figures 1, 10, 5, which, when added together, make 16, which comprises 13 and 3. Therefore, the residue figure for 438 may be regarded as 8 and the residue figure for 564 as 3. If now keys 438 and 564 of the first three orders of keys are depressed, there will be displayed in the first four windows 22^a, the numbers, 1, 0, 0, 2, and in addition the residue figures of which will be 2, 0, 0, 9, which if added together give a residue figure for 1,002 of 11. If now the residue figures of 8 and 3 of the sums 438 and 564, respectively, are introduced in the second set of keys, commencing with the fourth order of keys from the left-hand side of the machine, there will be shown in the first two windows to the left of the line B—B a total of 11 and the difference figures of 3 and 12.

If now the residue figures 2, 0, 0 and 9 and the difference figures of 3 and 12 are added together in the extreme left-hand order, it will be found that the numeral wheel 21^a will receive two complete revolutions and the green star will be displayed in the extreme left-hand window, thus indicating that the sum shown under the first set of keys, namely 1,002, is correct.

For the purpose of subtracting two figures from one another, the residue figures of the minuend and subtrahend are obtained separately in the manner indicated above. The subtraction is then effected upon the machine in the normal manner in which a subtraction is effected upon any calculating machine of the type specified and the residue figures obtained by the subtraction should be the same as the figure obtained by the subtraction of the subtrahend residue figure from the residue figure of the minuend. Should the subtrahend residue figure constitute a larger figure than the residue figure of the minuend, it is only necessary, mentally, to add 13 to the residue figure of the minuend before the subtraction of the residue figures is effected.

Thus, if it is desired to subtract 36 from 345, it will be found that if the keys 3, 4 and 5 of the first three orders of keys disposed on the right-hand side of the line B—B are depressed, there will be displayed in the first three windows 22^a, in addition to the numbers 3, 4 and 5, the residue figures 11, 11, 3, making a total of 25, which is equivalent to 13 plus 12. If now the machine is zeroised and the subtrahend 36 is inserted into the machine, there will be displayed in the first three windows, in addition to the numbers 3 and 6, the residue figures 5 and 1, making a total of 6. The difference between the two residue figures 12 and 6, is six. If the subtraction is now effected in the normal way on the calculating machine, it will be found that there will be displayed in the first three windows, 3, 0, and 9 and the residue figures of 11, 0 and 8, giving a total of 19. If now the code figure 13 is subtracted from the residue figure 19, a remainder of 6 is obtained, thus proving that the total of 309 displayed in the windows 22^a is correct.

If the sum of the residue figures 19 is inserted into the left-hand set of keys, it will be found that the difference figures indicated in the windows below the ninth and tenth orders of the machine will be 3 and 4. Taking the residue figures 11, 0 and 8 and the difference figures 3 and 4 and inserting them into the extreme left-hand order of the machine, it will be found that the numeral wheel will receive two complete revolutions, so that the green star is displayed in the left-hand order of the machine, thus proving that the total 309 is displayed in the right-hand window 22^a of the machine is correct.

For the purpose of multiplication, it will be assumed that it is required to multiply 732 by 246. The first operation is to depress the keys 7, 3 and 2 of the first three orders of the set of keys on the right-hand side of the machine, as a result of which, there will appear in the first three windows 22^a, the numbers 7, 3 and 2 and, in addition, the residue figures 4, 5 and 9, which, when added together, give a total of 18. If 13 is subtracted from 18 a residue figure of 5 is obtained for the number 732.

The machine is thereupon zeroised and the keys 2, 4 and 6 of the first three orders of the set of keys on the right-hand side of the machine depressed, whereupon there will appear in the first three windows 22^a, the numbers 2, 4 and 6 and the residue figures 3, 11 and 1, which, when added together, give a total of 15. If 13 is subtracted from this number it will give a residue figure of 2 for the number 246.

If the machine is once again zeroised and thereupon the number 732 is multiplied by 246 in the usual manner employed upon calculating machines of the type specified, there will be displayed in the first six windows 22^a, on the right-hand side of the machine, the numbers 180,072 with the residue figures of 5, 4, 0, 0, 3 and 9, which, when added together, give a total of 21. If 13 is subtracted from 21 there remains the residue figure of 8 for the number 180,072.

The machine is thereupon zeroised and the key 8 of the first column on the right-hand side of the machine is depressed, displaying the number 8 in the first window 22^a with the residue figure of 10. If now the residue figures of 2 and 5 for the numbers 732 and 246 are multiplied together, the result is 10, which, if entered upon the first two columns in the second set of keys to the left-hand side of the line B—B of Figure 1, there will be displayed in the first two windows of the second set of keys the numbers 1 and 0 with the difference figures of 3 and 0. If now the residue and difference figures of the two sets of keys are added together in the extreme left-hand set of keys, it will be found that the numeral wheel 21^a will receive one complete revolution and display the green star through the extreme left-hand window 22^a, thus proving that the result of 180,072 is correct.

For the purpose of dividing two figures one into the other, it will be assumed that it is desired to divide 12,420 by 345. The first operation is to depress the keys 1, 2, 4, 2 and 0 of the first five orders of the set of keys disposed upon the right-hand side of the line B—B. As a result, it will be found that there will be displayed in the first five windows 22^a the primary numbers 1, 2, 4, 2 and 0, and the residue figures 7, 4, 6, 12 and 0. If the residue figures are added together, a sum of 29 is obtained, which is the equivalent of twice thirteen plus 3, thus indicating that the residue figure for 12,420 is 3. A note should be made of this figure.

The machine is once again zeroised and the division of 345 into 12,420 is effected upon the machine in the normal manner when it will be found that a quotient of 36 is obtained. The machine is thereupon zeroised and the keys 3 and 6 on the set of keys disposed on the right-hand side of the line B—B are depressed, when it will be found that the residue figures for 36 are 5 and 1, thus giving a residue figure of 6 for the quotient 36. The residue figure of 6 for the quotient 36 is now multiplied by the residue figure 12 of the divider upon the keys disposed to the left-hand side of the line B—B of Figure 1 and, at the same time, the third key of the first order of the set of keys disposed upon the right-hand side of the line B—B is depressed. This key represents the residue figure 3 for the dividend 12,420. The result will be that, upon the numeral wheels disposed to the left-hand side of the line B—B, there will occur the primary numbers 7 and 2, the product of 12 and 6, and on the right-hand side the primary number 3, whilst the difference and residue figures for 7, 2 and 3 will read 8, 11 and 7, which, when added together upon the extreme left-hand order of the machine, will rotate the numeral wheel 21^a through two complete revolutions and display the green star through the extreme left-hand window 22^a.

Referring to Figures 6 and 7 of the drawings, there is illustrated in development in Figure 6, the numeral wheels for a calculating machine arranged to calculate in pounds, shillings and pence, whereas in Figure 7 there are set out in development the numeral wheels of a calculating machine arranged to calculate in pounds, shillings, pence and farthings. The method of operating the machine with either a sterling arrangement or a farthing arrangement is exactly the same as that employed in the currency arrangement in Figure 5 herein more particularly specified.

It will be appreciated from the developments of the numeral wheels set out in Figure 5 that the machine can be employed equally well for decimals as for whole numbers, there being provided adjacent to the windows 22^a of the various orders of keys, means for indicating where the decimal point commences.

In the operation of a calculating machine constructed as hereinbefore specified, numerical values are entered as required into the account section to the right of the line B—B of Figure 1, and the associated residue figures are added into the checking section of the machine disposed to the left of the line B—B of Figure 1. For the difference figures, three normal columns of keys are provided to the left of the line B—B, the fourth or extreme left-hand column of keys being distinctive by colour, shape or marking. Having reached the stage at which it is desired to summate all the residue and difference figures, this is effected by consecutively entering these amounts by means of the extreme left-hand column of keys, which, in effect, will add that number of one-thirteenths to the associated numeral wheel.

If before the summation a "carry" figure, for example 3, is already showing on the numeral wheel associated with the extreme left-hand column of keys disposed to the left of the line B—B (the difference figure for

which is also 3 but is not displayed), it will be appreciated that this amount has already been entered on the extreme left-hand numeral wheel and it is therefore only necessary to proceed (preferably from left to right) to enter the residue and difference figures of the other wheels. If the calculation has been correctly performed, the extreme left-hand numeral wheel will have made the requisite number of revolutions to display the green star or any character of distinct form and colour, signifying "correct."

It should be clearly noted that by this method of carrying the invention into effect by employing in the embodiment described the fourth numeral wheel to the left of the line B—B for the dual purpose of normal accumulation from lower orders, and for thereafter proving the accuracy of a calculation, use is made of the fact that the difference figures appertaining to the numeral which the key represents and the number of the key are the same. It should be further noted that by this method the total numerical capacity of the checking section disposed to the left-hand side of the line B—B of Figure 1 is 12,999 and this should prove sufficient to cover all transactions normally encountered in the use of the machine.

It will be appreciated that the provisions of a checking wheel in accordance with the present invention is for automatically determining the final summation of the residue and the difference figures and giving, without any mental process, a visible indication as to the accuracy of the accounting transaction.

As hereinbefore stated, the preferred check figure is 13 because by its employment any mistake resulting from the transposition of numerals, which is not discernible whilst checking, is rendered highly improbable. Further, any prime number in excess of 13 employed as a check figure would necessitate an excessive number of orders of keys to the left of the line B—B of Figure 1 in order to ensure that the difference figures of the left-hand column of keys was the same as the numeral on the key. Thus, with a check figure of 17, nine orders of keys would be required to the left of the line B—B of Figure 1, whilst with check numbers of 19 and 23, as many as ten and twelve orders to the left-hand side of the line B—B of Figure 1 would be required before the numeral on the key and the difference figure were the same. The employment of a check figure in excess of 13 would leave too few orders of keys to the right-hand side of the line B—B of Figure 1 for the machine to be of any practical value. Consequently, with the arrangement hereinbefore described, wherein the check number is 13, the numerals on the keys in the fourth order of keys to the left of the line B—B of Figure 1 is the same as the difference figure thereof and, therefore, such an arrangement provides an extremely simple and compact machine, upon which all the normal calculations of addition, subtraction, multiplication and division may be effected in the normal manner and which ensures that the result of any calculation may be checked, without in any way limiting the range of the machine or increasing its dimensions.

The facility requires, basically, the rotation of a wheel adapted to receive angular or digital increments of movement which total up to the check figure (for example 13 or a multiple thereof in the example hereinbefore described) for each complete revolution. Several alternative methods to the one outlined above of achieving this result may be adopted, three examples of which will be hereinafter set forth.

Firstly, in addition to the two sets of keys hereinbefore described, an additional column of keys may be provided which is operable to rotate a numeral wheel substantially as in the other orders of the machine, but wherein the numeral wheel is moved one-thirteenth for each digital change and, such wheel, having no mechanical association with the other orders, except that it is returnable to zero at the same time as the other numeral wheels. Starting from zero, this numeral wheel would again indicate zero after a number of digital movements corresponding to the check figure, or after every multiple of such check figure. This arrangement necessitates the production of a machine which is one column of keys wider than the existing machines.

Secondly, an arrangement similar to that described in the preceding paragraph may be provided, but wherein one of the existing columns of keys of a normal machine is employed for summating the residue and difference figures, so as to allow the special column to be accommodated in a standard size machine. Such an arrangement has the disadvantage of reducing the total capacity of the machine.

Referring to the third modification of the present invention, this proposes the employment of an additional check wheel which is adapted to be rotated as before in increments of one-thirteenth when required, but employs an existing column of keys for this purpose, preferably the extreme right-hand column.

According to such an embodiment, a window is situated below the normal window of the right-hand column of keys, through which can be observed a checking wheel having thirteen facets and which normally displays zero. This wheel is entirely inactive during the normal use of the machine and until such time as the final summation of residue and difference figures is required.

The checking wheel is connected to a toothed gear having thirteen teeth, which is adapted to be connected to the line mechanism of the first order of the machine. It is

obvious that the normal numeral wheel gear, and the other gears engaged therewith are displaced one tooth for every digital advance. If, when required, the toothed gear wheel of the checking wheel having thirteen teeth is arranged to engage with one of these gears, it will also be advanced by the first column of keys, but in increments of one-thirteenth.

When it is required to use this extra wheel for checking it is arranged to place the same in mesh by a mechanical connection with the "transfer release" button between the first and second orders of keys, which, at the same time, throws out of action the transfer mechanism between the first and second columns.

Assuming a series of residue and difference figures to be ready for summation as already described, the depression of the first transfer release button will place the toothed checking wheel into geared relation with the numeral wheel of the first column. As the checking wheel is at zero at the time of such engagement, and the transfer mechanism is out of action, it is evident that the depression of a key in the first column will rotate both the normal wheel and the checking wheel a digital amount corresponding to the value of the key.

When about to commence the final summation of the said residue and the said difference figures, it may happen that some figure above zero is already standing in the first column, together with its residue figure. Therefore, in carrying out the summation according to this method, it is desirable to proceed from right to left, whereby the first key is depressed by an amount which corresponds to the right-hand residue figure. This operation will displace the first numeral wheel, but its initial position no longer serves a purpose, and the remaining residue and difference figures can then be added. Also, in this system, it is only essential to display the zero position of the extra checking wheel, whilst the digits 1 to 12 may be omitted if desired.

In the arrangements hereinbefore described and illustrated, the numeral which the key represents has been multiplied by 960 and divided by 13 in order to obtain the residue figure for that key. It will be appreciated that the figure 960 has been taken because there are 960 farthings in the pound, and thirteen has been adopted as a code check figure because it is the smallest prime number producing the best commercially practical results of detecting calculating errors which may be due to the transposition of any two figures in a six-digit group within the decimal order, but it will be appreciated that if it is desired to work in any other units, for example, inches, feet and yards, or, pounds, quarters, hundredweights and tons, the figure by which the numeral which the key represents has to be multiplied, will depend upon the unit of the quantity which is being dealt with.

Further, although the calculating machine hereinbefore described relates to a specific form of key controlled multi-bank calculating machine, nevertheless, the invention is applicable to other calculating or accounting machines of the same type, for example, to calculating machines in which the rack is constantly in mesh with the pinion of the numeral wheel. Again, although means are provided upon the machine for definitely isolating one set of keys from the other, it will be appreciated that provided the calculations to be dealt with do not exceed what is capable of being employed within the first set of keys, and there is no possibility of a carry over from one set of keys to the other, it is not essential in order that a machine should operate in accordance with the present invention, that the two sets of keys should be isolated one from the other.

It will be readily appreciated that with the machine hereinbefore set forth, besides the arithmetical result being checked, the machine can, by the allocation of code numbers to each particular customer, check not only the accuracy of the totals of an account, but also as to whether the items have been correctly debited to the correct customer.

What we claim is:—

1. A calculating or accounting machine of the key controlled multi-bank type, wherein the banks of keys comprise a plurality of distinct sets, one set being operable to reveal on the numeral wheel of any particular order, both the number of the key of that order which is depressed and the residue figure after the numeral which that key represents or a specific multiple of the numeral that the said key represents has been divided by a prime number in excess of nine or a multiple of a prime number in excess of nine, another set of keys being operable to reveal on the numeral wheel of any particular order thereof, both the number of the key of that order which is depressed and the difference figure between the numeral which the key represents and the said prime number or the multiple of the said prime number or the next higher multiple of said prime number or of the multiple of said prime number and means for effecting other than on one or more of the normal orders of the machine the summation of the residue and difference figures revealed after keys in both sets have been depressed and indicating whether the total is equivalent to the prime number or a multiple thereof.

2. A calculating or accounting machine of the key controlled multi-bank type, wherein the banks of keys comprise a plurality of distinct sets, one set being operable to reveal on the numeral wheel of any particular order, both the number of the key of that order which is depressed and the residue figure after the numeral which that key represents, or a specific multiple of the numeral that the said

key represents has been divided by thirteen, another set of keys being operable to reveal on the numeral wheel of any particular order thereof, both the number of the key of that order which has been depressed and the difference figure between the numeral which the key rperesents and thirteen or the difference figure between the numeral which the key represents and the next higher multiple of thirteen and means for effecting other than on one or more of the normal orders of the machine the summation of the residue and difference figures revealed after keys in both sets have been depressed and indicating whether the total amounts to thirteen or a multiple thereof.

3. A calculating or accounting machine as claimed in Claim 1, in which the last order of the second set of keys is so selected that the number of any key and the difference figure between the numeral which the key represents and the said prime number, or the difference figure between the numeral which the key represents and the next higher multiple of said prime number are the same.

4. A calculating or accounting machine as claimed in Claim 1 or Claim 2, wherein the residue figure comprises what remains after the numeral which the key represents has been multiplied by nine hundred and sixty and divided by the prime number.

5. A calculating or accounting machine as claimed in any one of the preceding claims 2, 3 or 4, wherein the second set of keys comprises four orders of keys, the last order of which includes a numeral wheel which is movable in thirteen digital movements to effect one complete rotation.

6. A calculating or accounting machine as claimed in Claim 5, wherein the numeral wheel is rotatable by the line mechanism of the last order of the machine.

7. A calculating or accounting machine as claimed in Claim 6, wherein the said line mechanism is operable by a plurality of depressible keys.

8. A calculating or accounting machine as claimed in any one of the preceding claims, wherein means are provided to ensure that the numeral wheels of one set of keys may be isolated from the numeral wheels of the other set of keys for the purpose specified.

9. A calculating or accounting machine as claimed in Claim 8, wherein means are provided for rendering ineffective the transfer mechanism arranged between adjacent orders of keys.

10. A calculating or accounting machine as claimed in Claim 9, wherein a button mounted upon the exterior casing of the machine is arranged to be depressed to render the said transfer mechanism ineffective.

11. A calculating or accounting machine as claimed in Claim 10, wherein means are provided for holding the said button in a depressed condition.

12. A calculating or accounting machine as claimed in Claim 9 or Claim 10 or Claim 11, wherein the means for rendering ineffective the transfer mechanism arranged between adjacent orders of keys is arranged to ensure that the first set of keys is disconnected from the second set of keys.

13. A calculating or accounting machine constructed, arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings.

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Reference has been directed in pursuance of Section 9, sub-section (1) of the Patents Act, 1949, to Patent No. 713,484.

PROVISIONAL SPECIFICATION

Improvements in or relating to Calculating and/or Accounting Machines

We, BELL PUNCH COMPANY LIMITED, a British Company, of 39, St. James's Street, London, S.W.1, do hereby declare this invention to be described in the following statement:—

This invention is for improvements in or relating to calculating and/or accounting machines and particularly, but not exclusively, to the type of machine described in the co-pending United Kingdom Patent Application No. 4415 of the 19th of February, 1952.

The principal object of the present invention is to provide means for mechanically adding certain residue figures in circumstances which hitherto have required either a mental process or the use of a separate machine.

In co-pending Patent Application No. 4415 of 1952, there is described a key controlled multi-bank calculating machine in which the columns of keys are divided into two sections which may, if desirable, be segregated, which provide both an accounting section and a checking section.

There is also described a mode of operation whereby, for example, a monetary factor is set up by the keys in the accounting section, the result of which is to display in windows the amount in numerals and also residue figures associated with each of the numerals of monetary factor. The residue figures are

summated by means of the keys in the checking section of the machine to obtain the residue figure related to the monetary factor.

When it is desired to add together two or more monetary factors, the accuracy of the total thus accumulated in the accounting section can be proved by afterwards adding the associated residue figures of each factor by means of the keys in the checking section of the machine. The proof lies in the summation of all the residue figures now displayed in the machine which should total 13, or an exact multiple thereof.

It is, therefore, seen that the entering of an amount in the accounting section, and the determination of the residue figure related to such amount, can be carried out by the depression of appropriate keys but the final summation of the residue figures for the purpose of checking an accumulation of such amounts has hitherto been performed either mentally or by the means of a separate machine. Also, the division by 13 of the final residue figure obtained has also been performed either mentally or by means of a separate machine.

It is the object of the present invention to provide means for automatically determining the final summation of the residue figures and displaying, without any mental process, a visible indication as to the accuracy of the accounting transaction.

This additional facility requires, basically, the rotation of a wheel adapted to receive angular or digital increments of movement totalling 13 or a multiple thereof for each complete revolution. There are several alternative methods of achieving this result, four of which are hereinafter set forth by way of example only:—

Firstly the provision of an additional column of keys operating a wheel substantially as in the other columns, but wherein the wheel is moved one-thirteenth for each digital change, and such wheel having no mechanical association with the other columns except that it is returnable to zero at the same time as the other numeral wheels. Starting from 0 this wheel would again show 0 after thirteen digital movements, or after every multiple of 13. This arrangement necessitates the production of a machine which is one column wider than the existing machines.

Secondly an arrangement similar to that described in the preceding paragraph, but wherein one of the existing columns of keys of a normal machine is employed for summating the residue figures so as to allow the special column to be accommodated in a standard size machine. Such an arrangement has the disadvantage of reducing the total capacity of the machine.

Thirdly the employment of the extreme left-hand or "carry" wheel in conjunction with extra keys for the dual purposes of ordinary calculation and check adding by means to be hereinafter described, and

Fourthly the provision of a thirteen position wheel which is adapted for engagement with and rotation by an existing column of keys when specially conditioned to do so.

The first and second arrangements have been sufficiently set forth as not to require any further detailed description.

The third or preferred arrangement will now be more particularly described with reference to the calculating machine described and illustrated in Specification No. 4415 of 1952.

Referring specifically to the column of keys associated with the extreme left-hand numeral wheel and comprising the fourth order of keys disposed to the left of the line B—B of Figure 1, it will be appreciated that such keys are not normally required in connection with a "carry" wheel, but in accordance with the present invention they perform a special function without increasing the size of the machine or restricting its operation in other respects.

In accordance with the present invention the left-hand or "carry" wheel is provided with thirteen digital positions. Referring to Figure 4 of co-pending United Kingdom Patent Application No. 4415 of 1952, it will be seen that in the 4th order wheel to the left of the line B—B, both the residue figures and the ordinary digit figures of the wheel are the same and consequently the former can therefore be omitted for reasons hereinafter specified. The zero position of the numeral wheel may also be designated by a distinctive character, such as a green star, in place of the conventional 0.

In the operation of a calculating machine constructed in accordance with the present invention, numerical values are entered as required into the account section to the right of the line A—A of Figure 1, and the associated residue figures are added into the checking section of the machine to the left of the line B—B of Figure 1. For the residue figures three normal columns of keys are provided to the left of the line B—B, the 4th or extreme left-hand column of keys being distinctive by colour, shape or marking. Having reached the stage at which it is desired to summate all the residue figures, this is effected by consecutively entering these amounts by means of the fourth or left-hand column of keys, which in effect will add that number of one-thirteenths to the associated numeral wheel.

If before the summation a "carry" figure, for example 3, is already showing on the numeral wheel associated with the fourth column of keys to the left of the line B—B (the code figure for which is also 3 but is not displayed), it will be appreciated that this amount has already been entered on the left-hand numeral wheel and it is therefore only necessary to proceed (preferably from left to

right) to enter the residue figures of the other wheels. If the calculation has been correctly performed the left-hand numeral wheel will have made the requisite number of revolutions to display zero, or preferably a character of distinct form and colour, signifying "correct."

It should be clearly noted that by this method of carrying the invention into effect by employing the fourth numeral wheel to the left of the line B—B for the dual purpose of normal accumulation from lower orders, and for thereafter proving the accuracy of a calculation, use is made of the fact that the residue figures appertaining to the numeral which the key represents and the number of the key are the same. It should be further noted that by this method the total numerical capacity of the checking section is 12,999 and this should prove sufficient to cover all transactions normally encountered in the use of the machine.

Referring to the fourth embodiment of the present invention this proposes the employment of an additional "proof" wheel which is adapted to be rotated as before in increments of one-thirteenth when required but employs an existing column of keys for this purpose, preferably the extreme right-hand column.

According to this embodiment of the present invention a window is situated below the normal window of the right-hand column of keys, through which can be seen a checking wheel having thirteen facets and which normally dispays zero. This wheel is entirely inactive during the normal use of the machine and until such time as the final summation of residue figures is required.

The checking wheel is connected to a toothed gear having thirteen teeth which is adapted to be connected to the line mechanism of the first order of the machine. It is obvious that the normal figure wheel gear, and the other gears engaged therewith are displaced one tooth for every digital advance. If, when required, the tooth gear of the checking wheel having thirteen teeth is arranged to engage one of these gears, it will also be advanced by the first column of keys but in increments of one-thirteenth.

When it is required to use this extra wheel for checking, it is arranged to place same in mesh by a mechanical connection with the "transfer release" button between the first and second order of keys, which at the same time throws out of action the transfer mechanism between the first and second columns.

Assuming a series of residue figures to be ready for summating as already described, the depression of the first transfer release button will place the toothed checking wheel into geared relation with the numeral wheel of the first column. As the checking wheel is at zero at the time of such engagement, and the transfer mechanism is out of action, it is evident that the depression of a key in the first column will rotate both the normal wheel and the checking wheel a digital amount corresponding to the value of the key.

When about to commence the final summation of residue figures it may happen that some figure above zero is already standing in the first column, together with its residue figure. Therefore, in carrying out the summation according to this method, it is desirable to proceed from right to left, whereby the first key depressed corresponds to the right-hand residue figure. This operation will displace the first numeral wheel, but its initial position no longer serves a purpose, and the remaining residue figures can then be added. Also, in this system it is only essential to display the zero position of the extra checking wheel, whilst the digits 1 to 12 may be omitted if desired.

It is, therefore, evident that by these methods proof of the accuracy of accounting work can be positively determined by mechanical means, and the result visibly displayed, with no mental requirement except the selection of the keys to be depressed.

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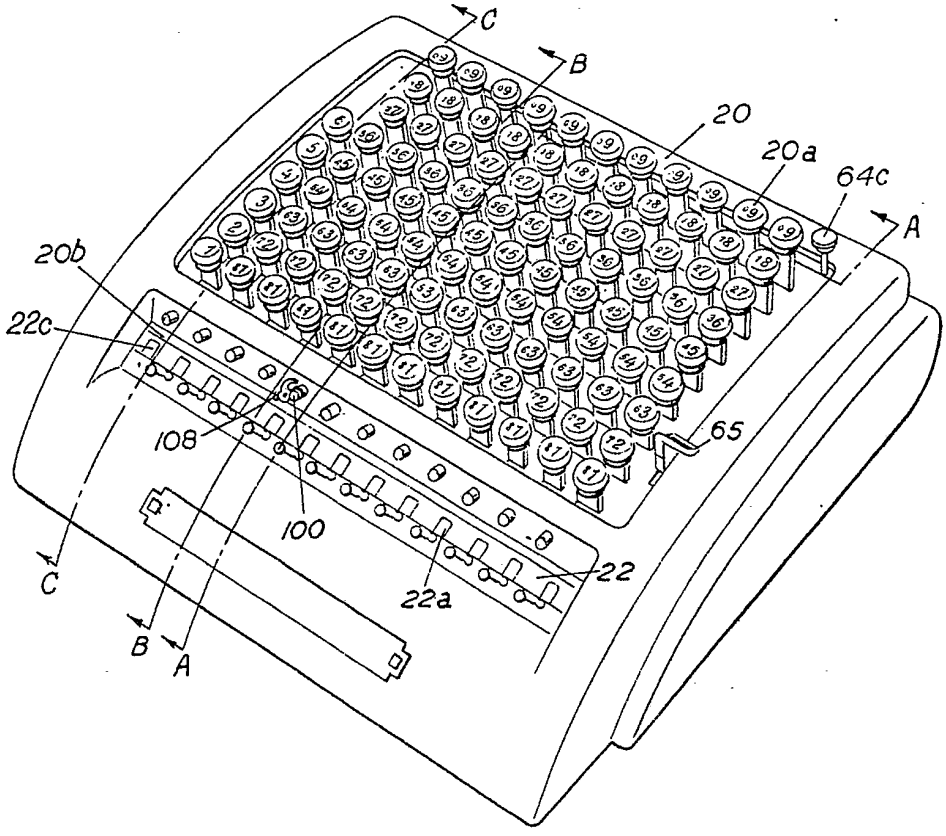
FIG. 1.



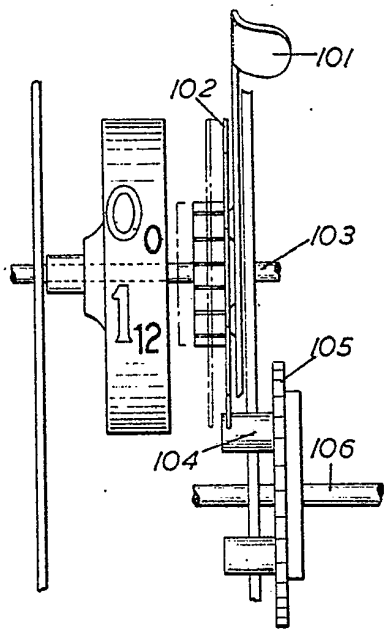
740,007 COMPLETE SPECIFICATION

4 SHEETS

This drawing is a reproduction of the Original on a reduced scale.

SHEETS 1 & 4

FIG. 4.



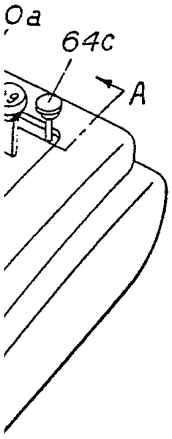
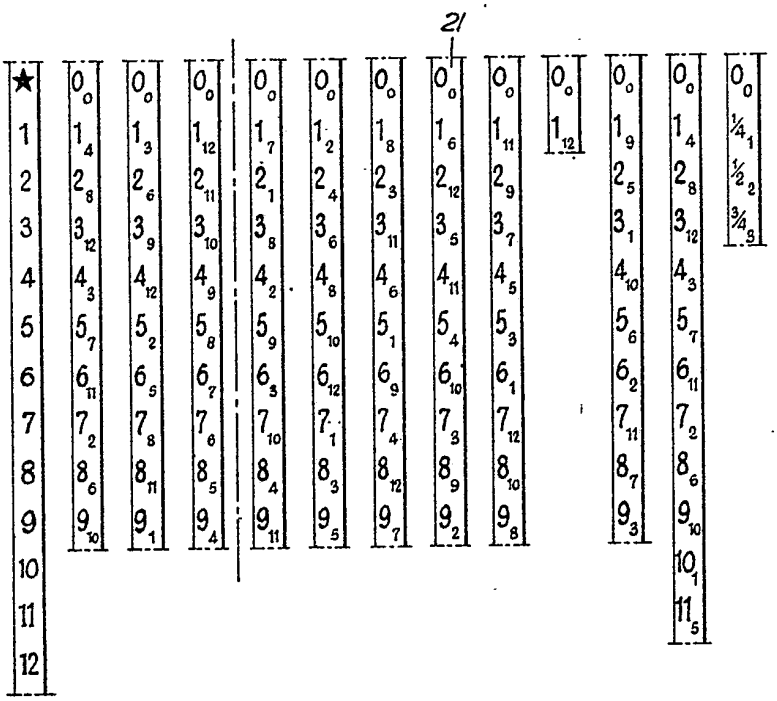


FIG. 7.



740,007 COMPLETE SPECIFICATION
4 SHEETS

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SHEETS 1 & 4

FIG. 1.

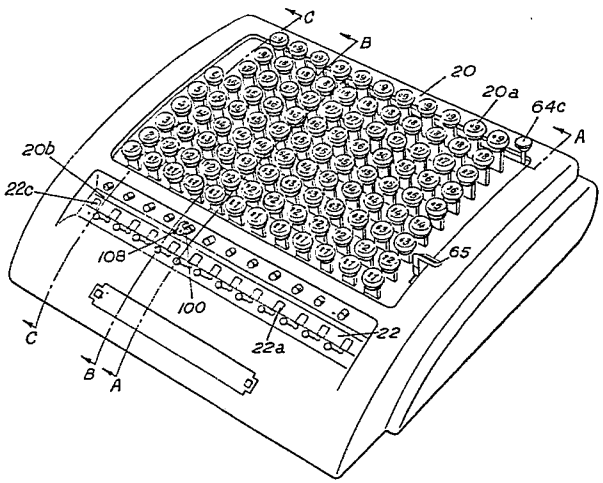

FIG. 4.

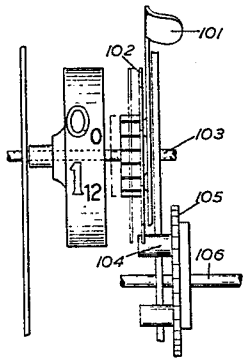

FIG. 7.

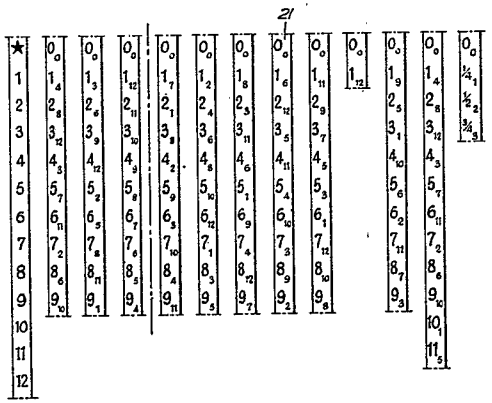

FIG. 2.

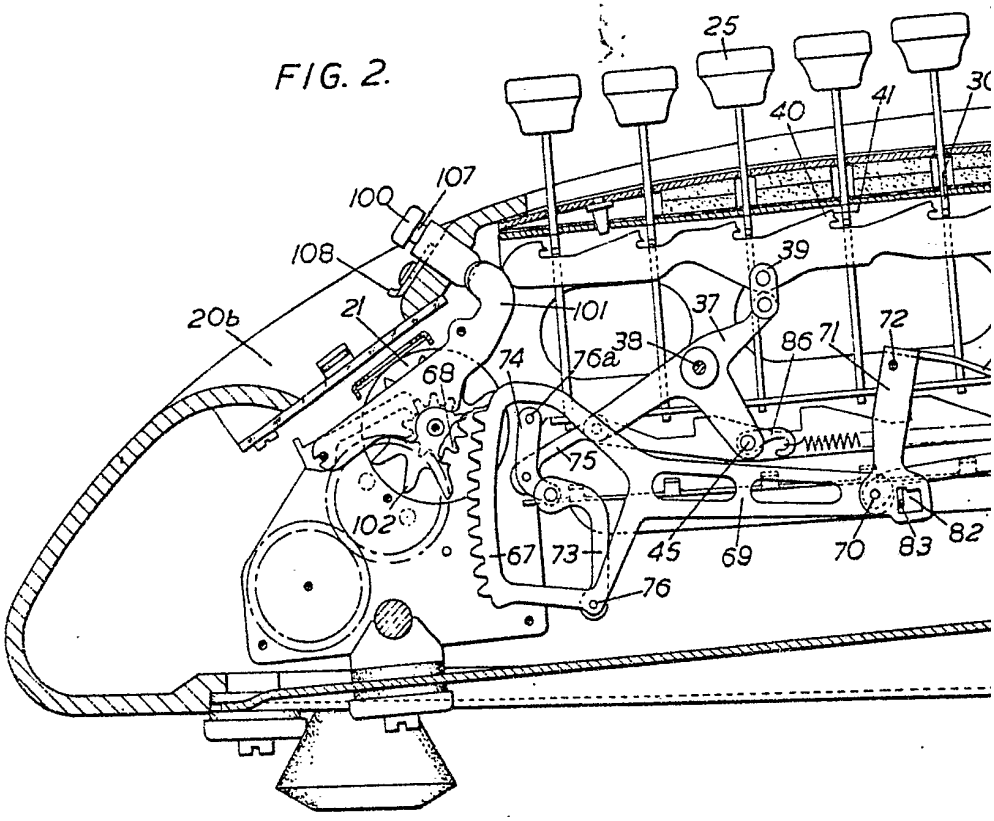
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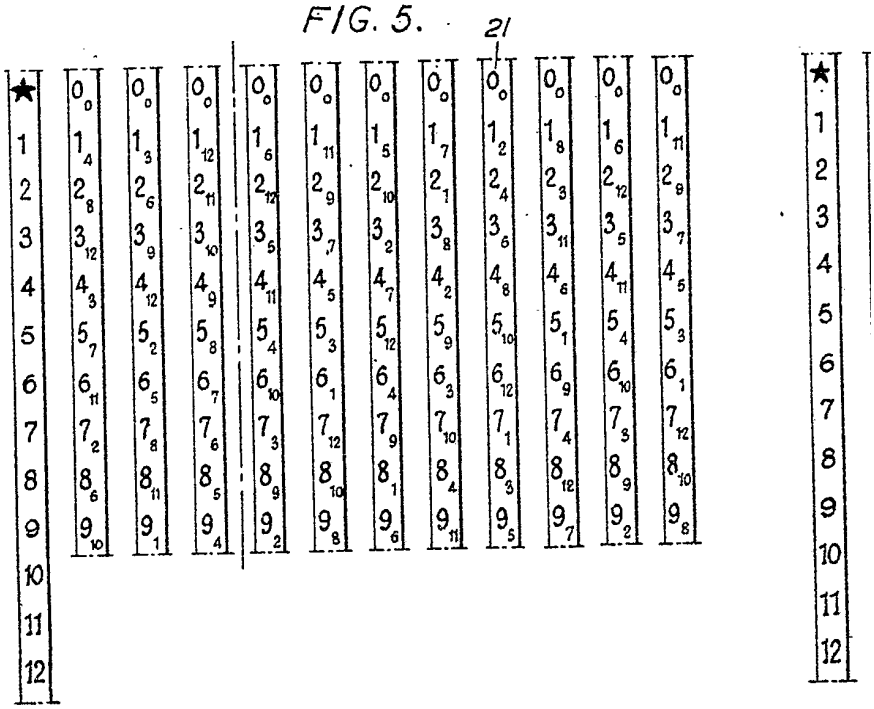
FIG. 5.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4 SHEETS

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SHEET 2

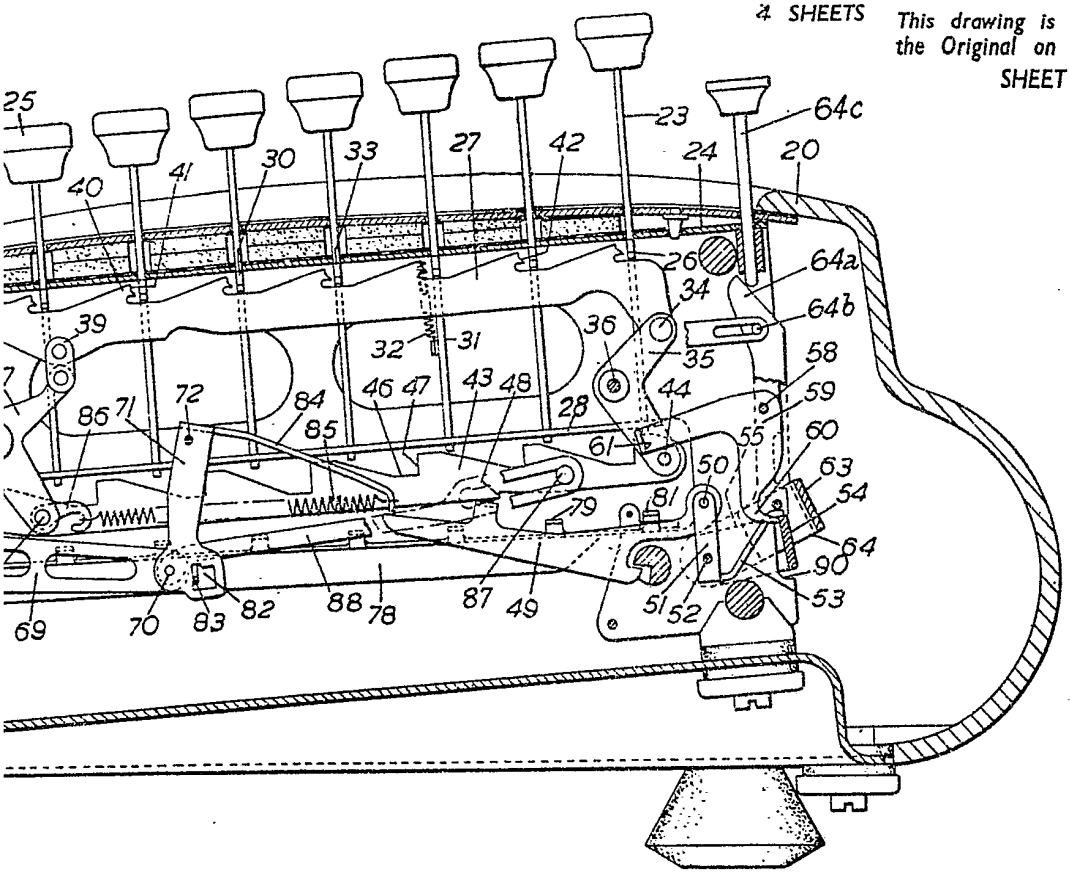
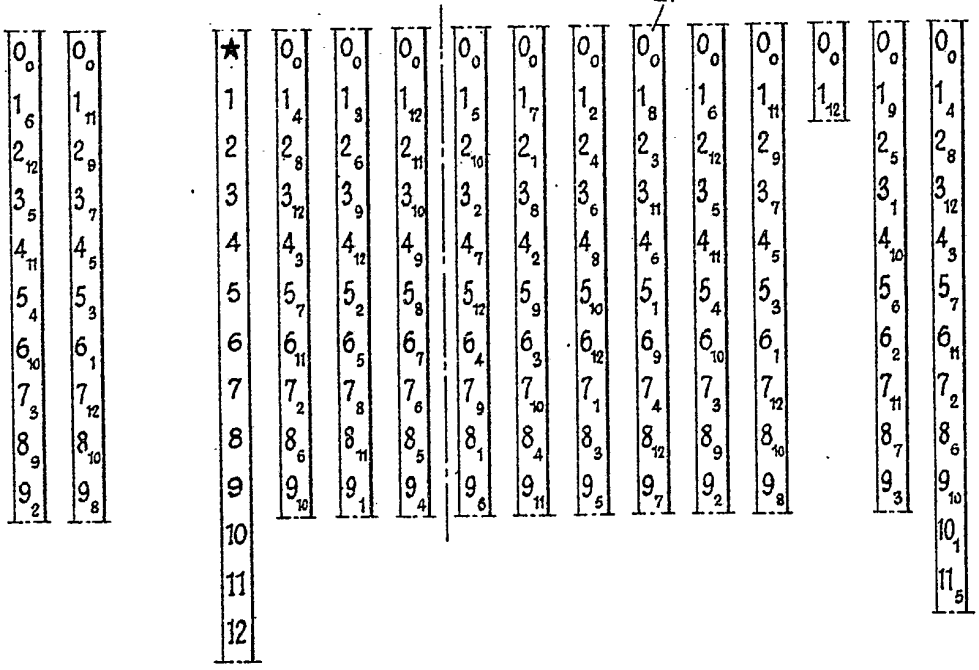


FIG. 6.



740,007 COMPLETE SPECIFICATION

4 SHEETS

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SHEET 2

FIG. 2.

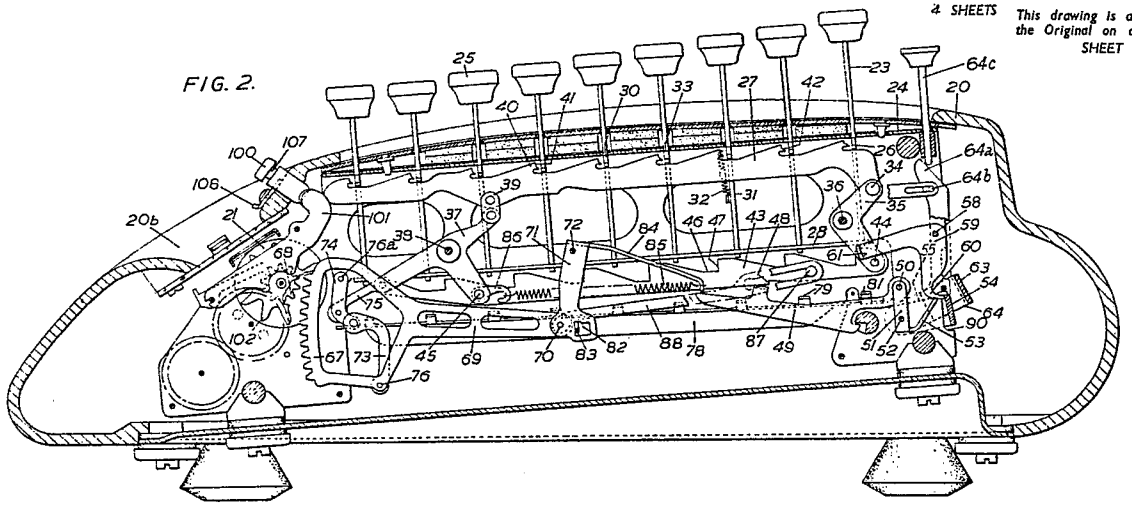


FIG. 5.

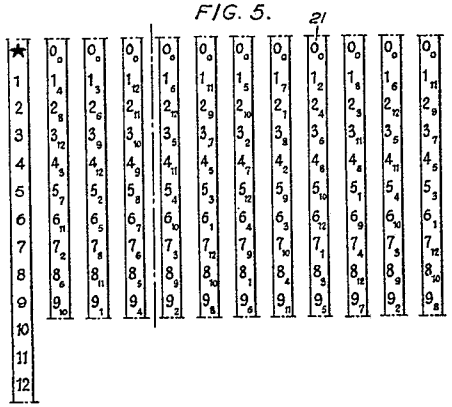


FIG. 6.

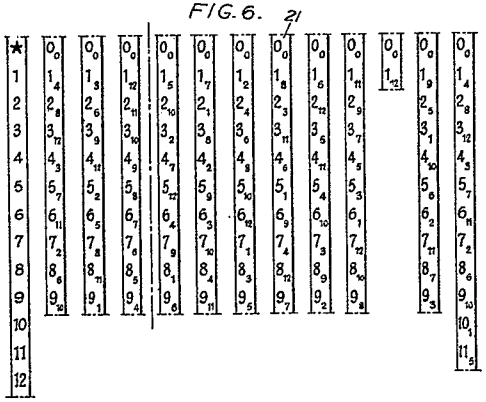
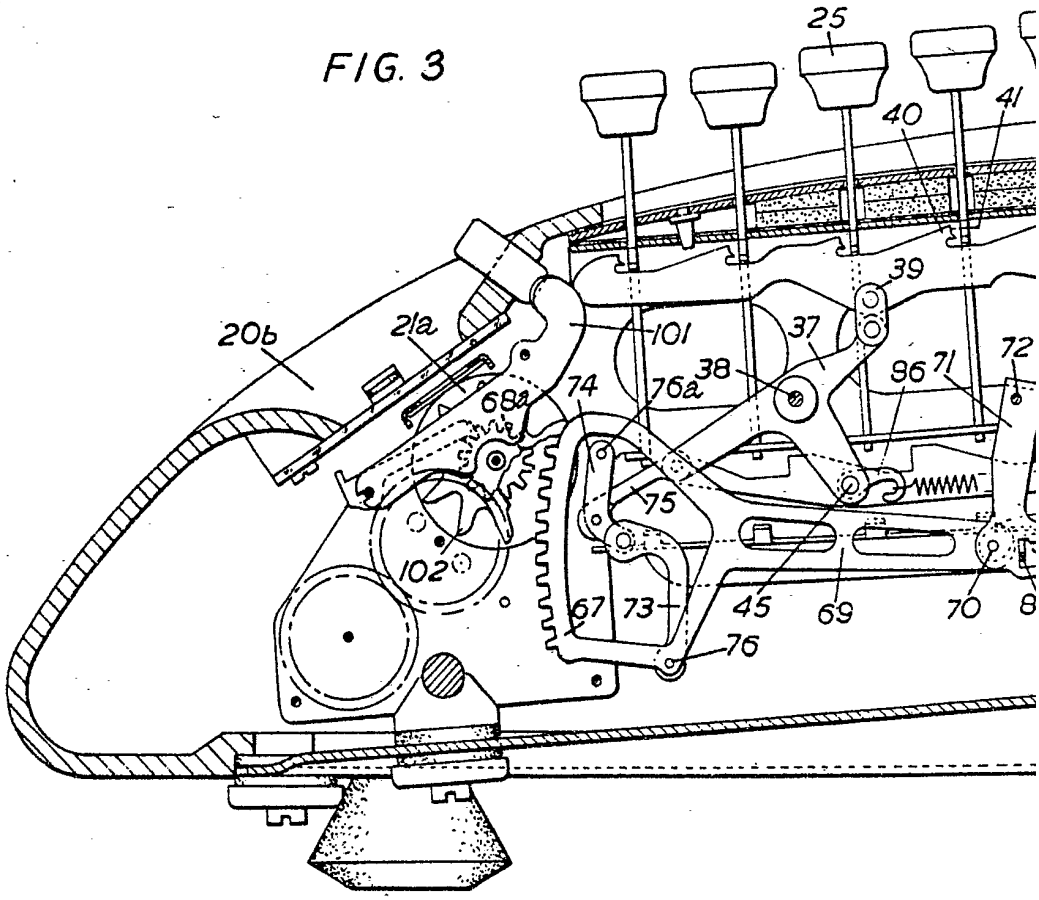


FIG. 3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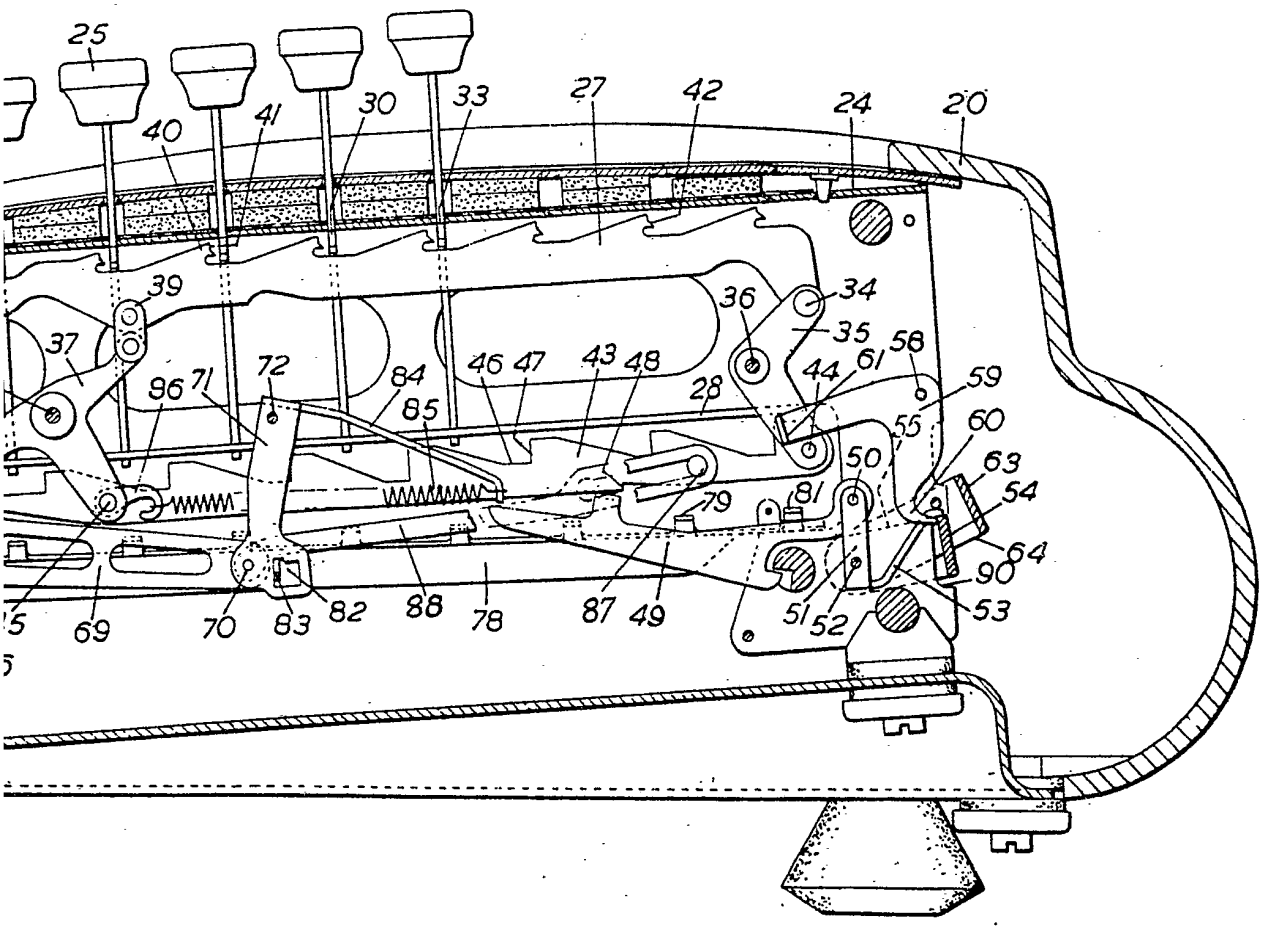
4 SHEETS *This drawing is a reproduction of the Original on a reduced scale.*

SHEET 3



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4 SHEETS

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SHEET 3

FIG. 3