Aug. 13, 1963 SHU K. LEAR VOO 3,100,602

CALCULATING MACHINE

Filed Feb. 4, 1960 7 Sheets-Sheet 1

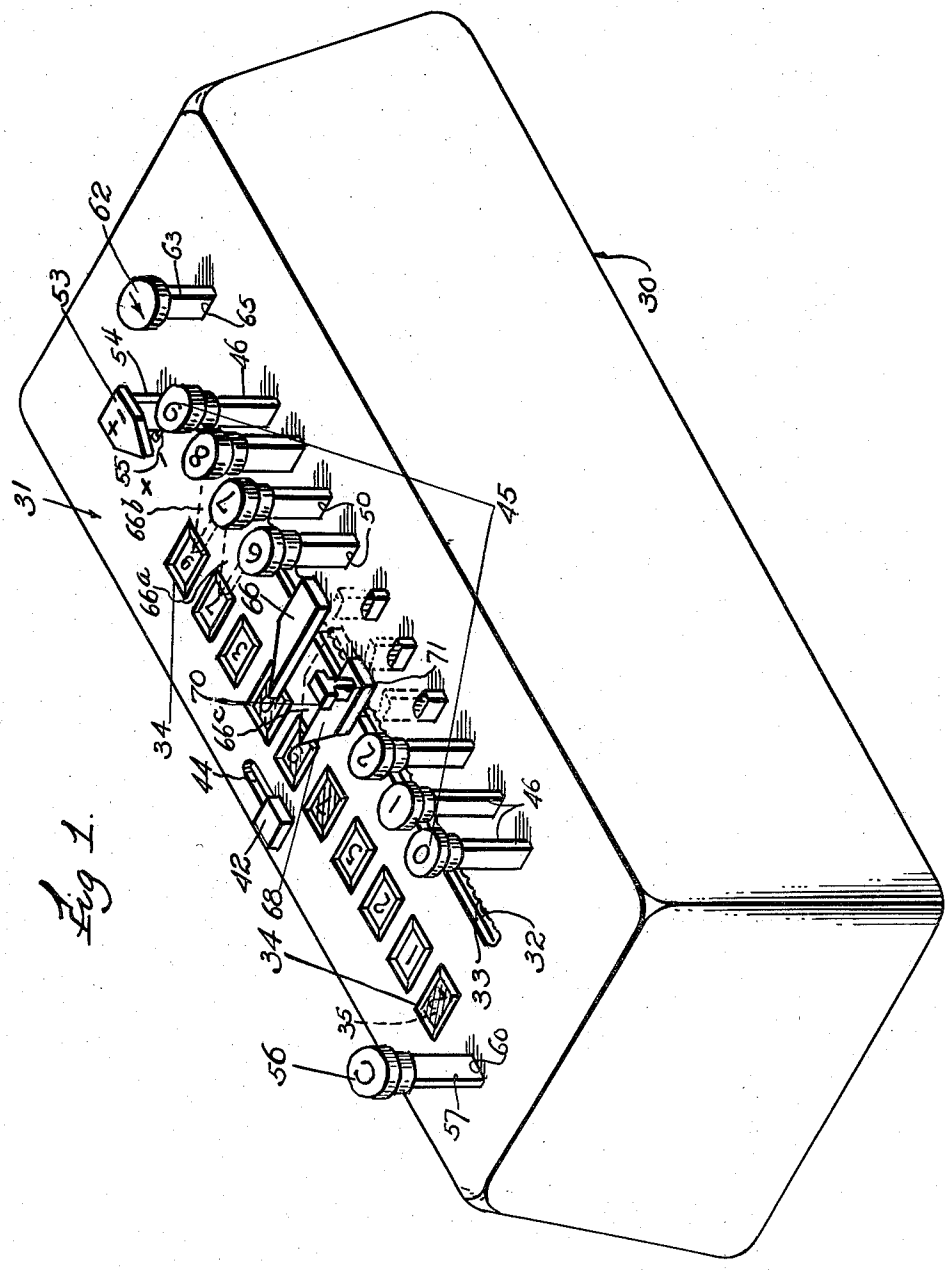


Fig 1.

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CALCULATING MACHINE

Filed Feb. 4, 1960 7 Sheets-Sheet 2

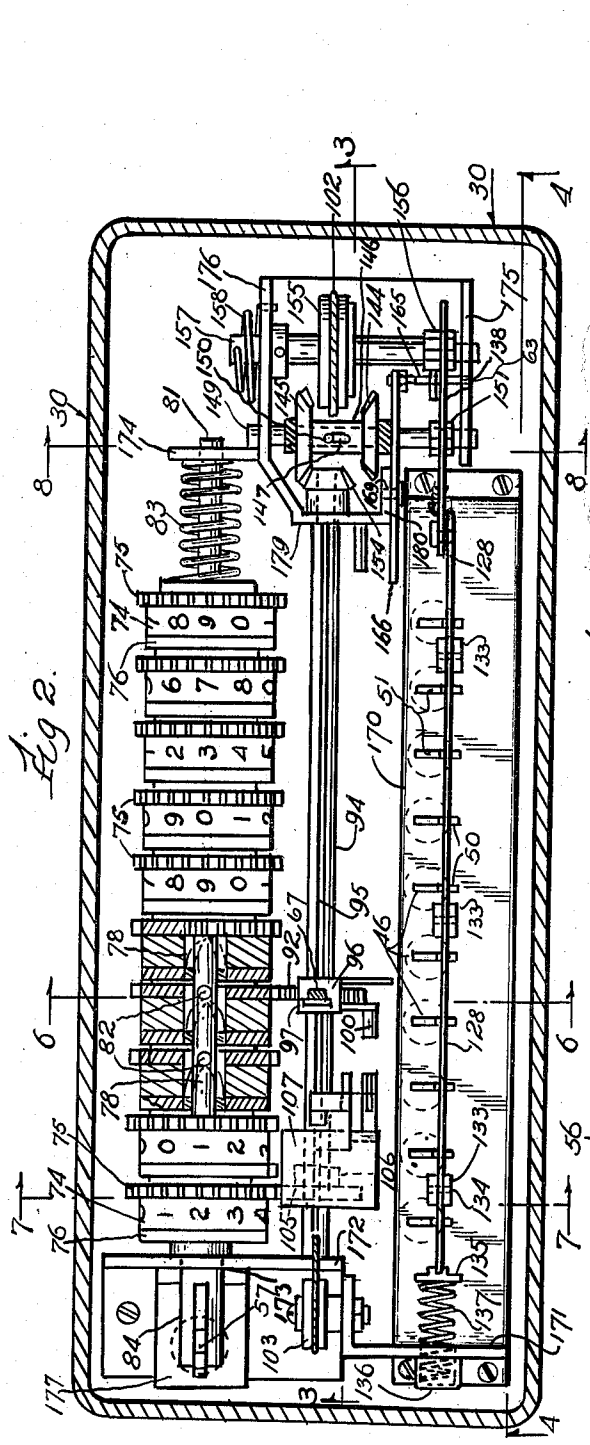


Fig 2.

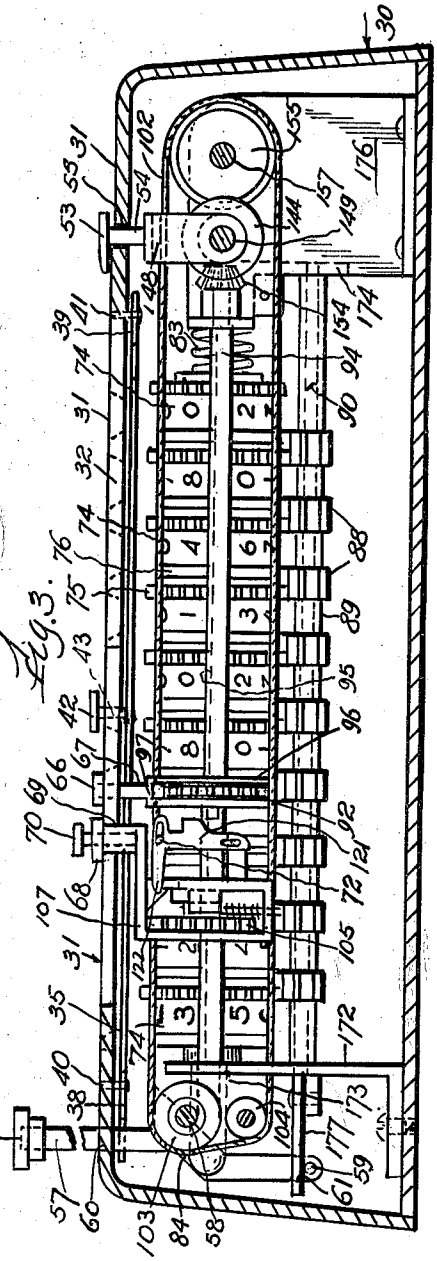


Fig 3.

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CALCULATING MACHINE

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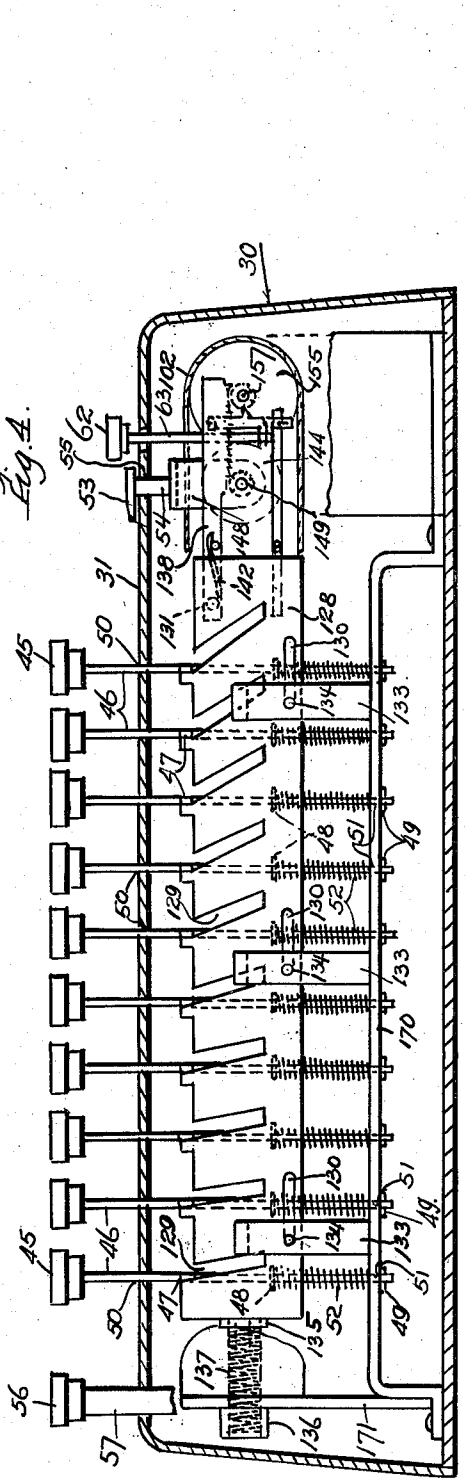


Fig. 4.

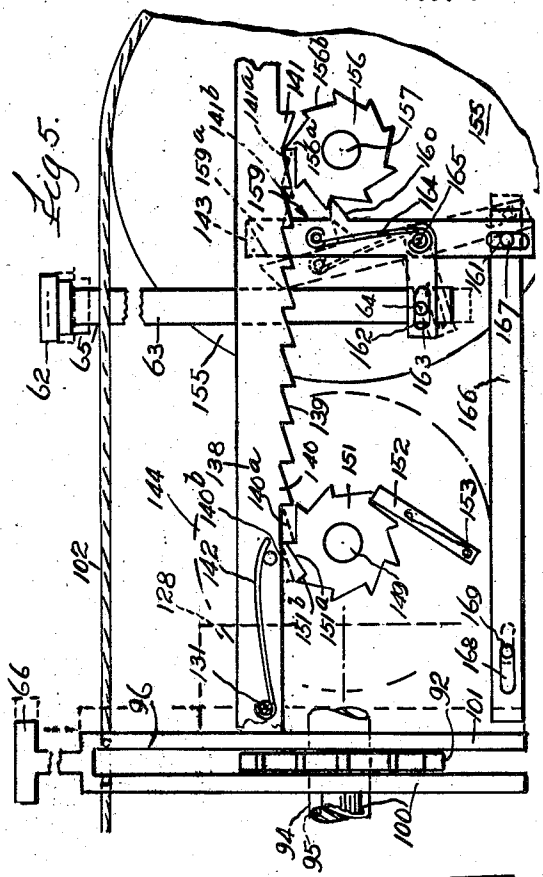


Fig. 5.

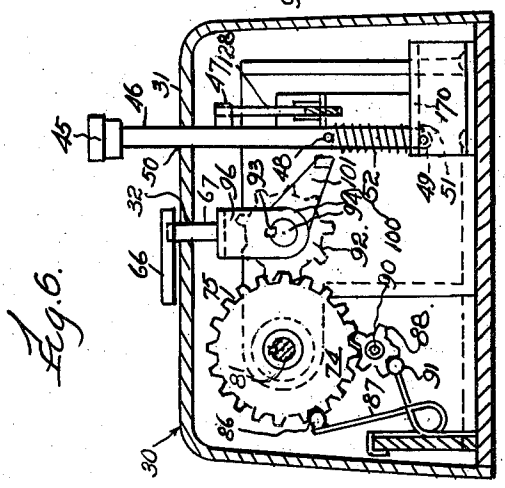


Fig. 6.

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CALCULATING MACHINE

Filed Feb. 4, 1960 7 Sheets-Sheet 4

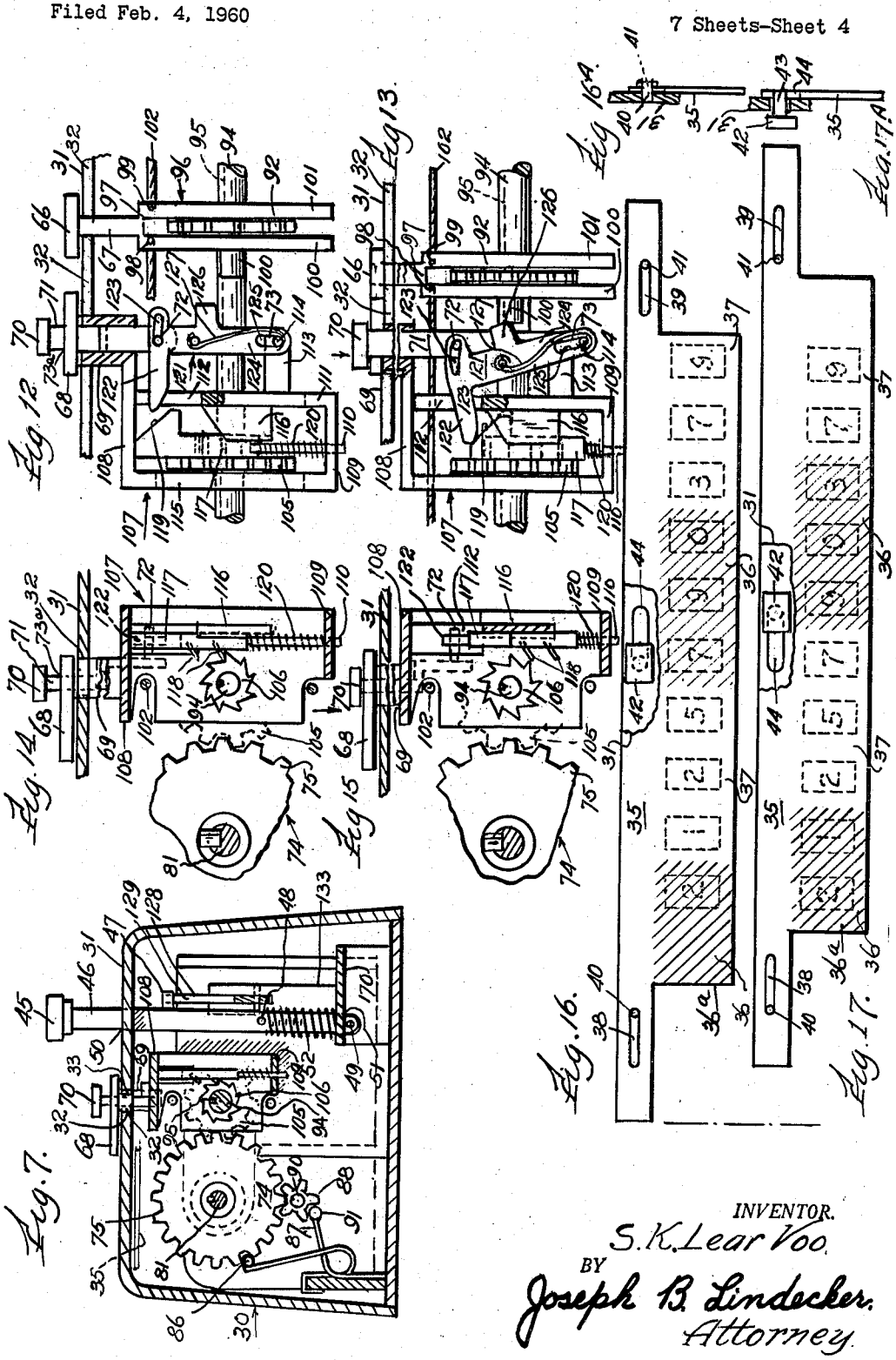


Fig. 12

Fig. 13

Fig. 14

Fig. 15

Fig. 16.

Fig. 17.

Fig. 17A

Fig. 7.

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CALCULATING MACHINE

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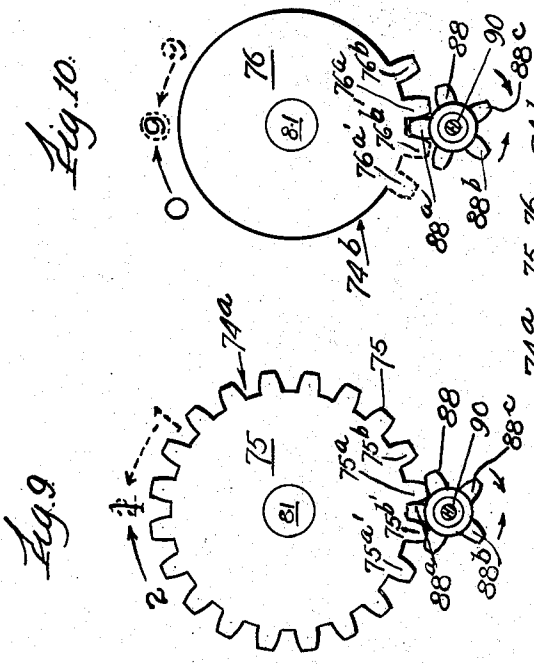


Fig. 10.

Fig. 9

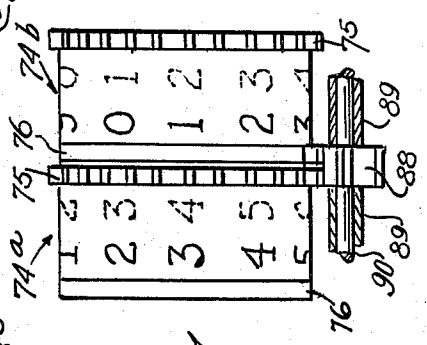


Fig. 11

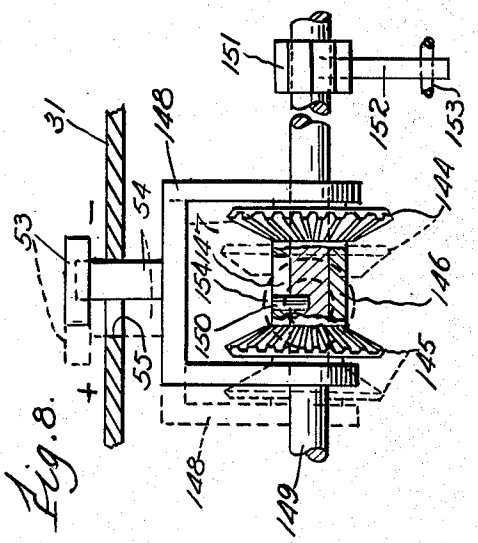


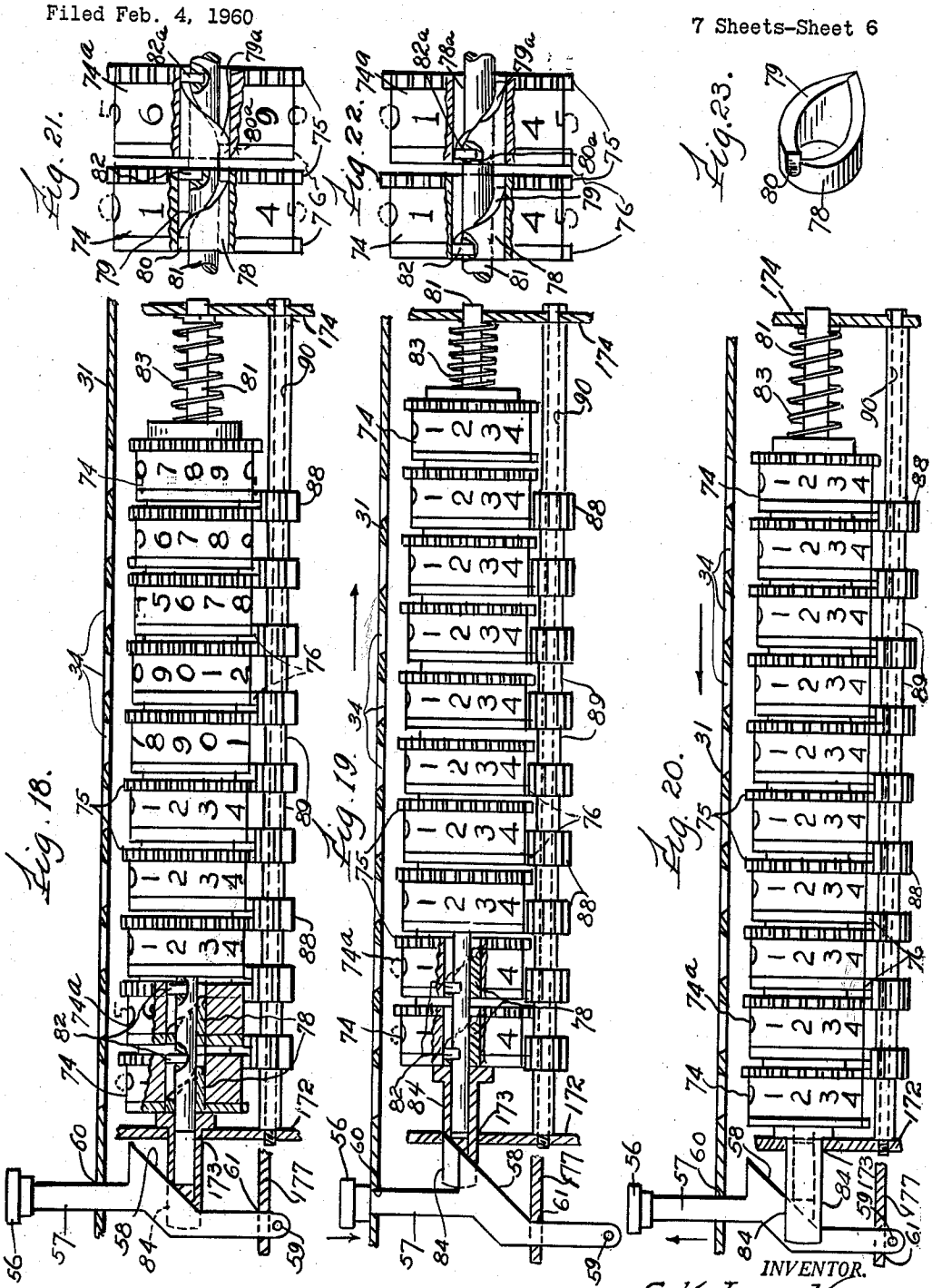
Fig. 8.

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CALCULATING MACHINE

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CALCULATING MACHINE

Filed Feb. 4, 1960 7 Sheets-Sheet 7

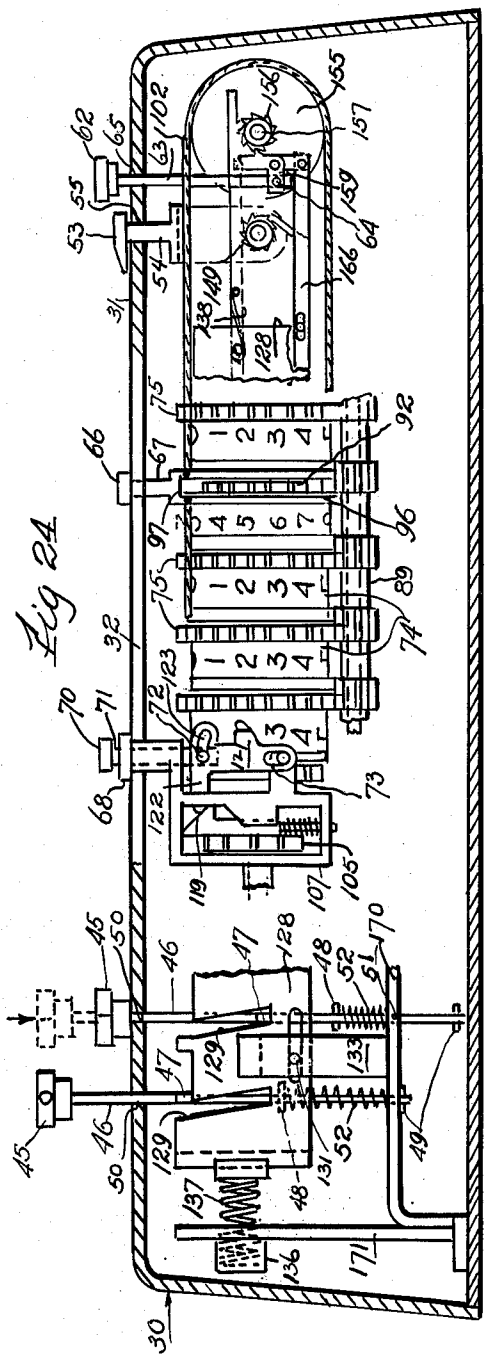


Fig 24

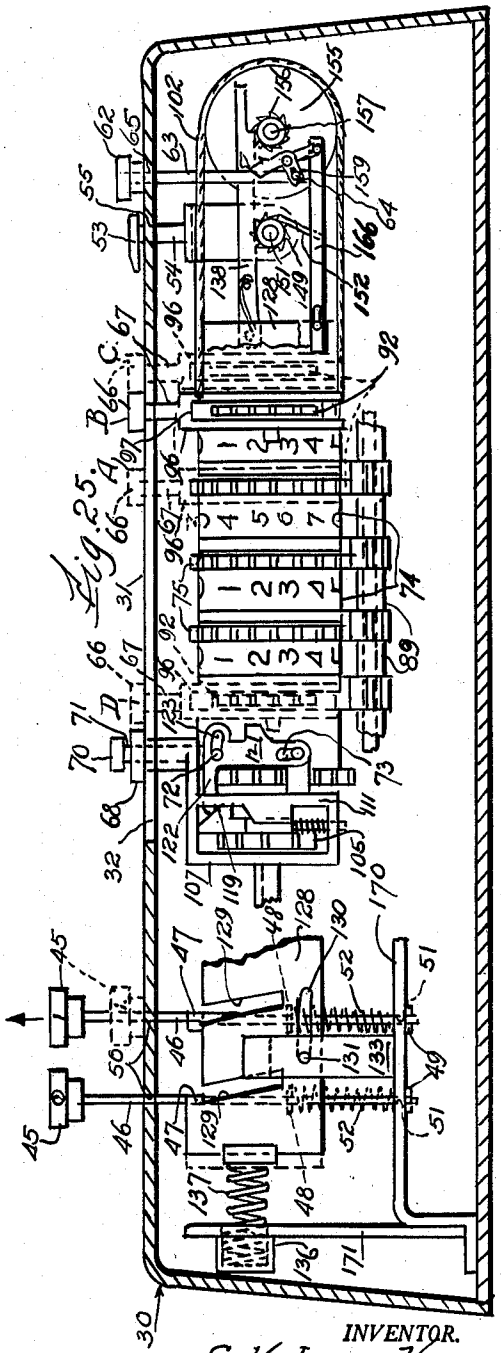


Fig. 25

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United States Patent Office 3,100,602 Patented Aug. 13, 1963

3,100,602

CALCULATING MACHINE

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Filed Feb. 4, 1960, Ser. No. 6,758
5 Claims. (Cl. 235—63)

This invention relates to calculating machines and more particularly to the key-powered, or key-operated, type of calculating machine wherein a numeral wheel is actuated directly by depression of a numeral key.

Conventionally, this type of key-powered, or key-operated, calculating machine has a plurality of numeral wheels and a plurality of banks of numeral keys, each bank having nine keys marked 1 to and through 9 respectively, one bank of said keys for actuation of one of said wheels, and is capable of performing addition, subtraction, and multiplication with their respective results displayed on said wheels but is incapable of performing division with its quotient indicated on said wheels.

It is the principal object of this invention to provide a ten-key keyboard key-powered, or key-operated, calculating machine having a plurality of numeral wheels arranged in denominational order and a series of ten numeral keys marked 0 to and through 9 respectively, and means whereby upon depression of any one of said numeral keys, any one of said numeral wheels in operative relation therewith may be actuated to indicate thereon a number that has been increased by the number marked on said depressed numeral key and alternately to indicate thereon a number that has been decreased by the number marked on said depressed numeral key, and whereby upon release of depression of said depressed numeral key, all of said numeral keys are brought from a numeral wheel initially in operative relation therewith to a numeral wheel of next lower order to be in operative relation therewith, and to a numeral wheel of higher order to be in operative relation therewith when said depressed numeral key was initially in operative relation with the numeral wheel of the lowest order; and further having an independent manipulative member whereby upon actuation thereof all of said numeral keys are brought from a numeral wheel initially in operative relation therewith to a numeral wheel of higher order to be in operative relation therewith; and further having means to automatically increase the value of a numeral wheel by one when an adjacent numeral wheel of next lower order shall have an accumulated value exceeding nine and alternately to automatically decrease the value of a numeral wheel by one when an adjacent numeral wheel of next lower order shall have a residual value of less than zero; and further having means to simultaneously zeroise all those of said numeral wheels that are not indicating zero; and further having means to automatically register quotient of division on said numeral wheels; and further having means to variably numerate the numerals indicated on said numeral wheels; said machine being capable of performing all four processes of arithmetic, that is, addition, subtraction, multiplication, and division, with their respective results, including quotient of division, indicated on said numeral wheels.

A still further object is to provide a ten-key keyboard key-powered, or key-operated, calculating machine, constructed according to this invention, in extremely compact size that snugly fits a pocket or a purse without sacrificing the sizes of its numeral wheels and operable keys, all of which are of standard large size.

A further object is to provide for a calculating machine having a plurality of numeral wheels, a new novel and efficient means to simultaneously zeroise all those of said numeral wheels that are not indicating zero.

A further object is to provide for a calculating machine having a plurality of numeral wheels, means to automatically register quotient of division on said numeral wheels.

A further object is to provide for a calculating machine having a plurality of numeral wheels, a new novel and efficient device to variably numerate the numerals indicated on said numeral wheels.

Other objects and advantages of this invention will become apparent from the detailed description of the preferred embodiment illustrated in the accompanying drawings, in which:

FIGURE 1 is a perspective view of a ten-key keyboard key-operated calculating machine embodying the features of this invention in substantially its actual size.

FIGURE 2 is a plan view of the machine with its outer case removed, showing an operative mechanism with certain parts omitted for clarity.

FIGURE 3 is a vertical sectional view of the machine taken in a plane on the line 3—3 of FIGURE 2 showing an assembly of numeral wheels and its related mechanism.

FIGURE 4 is a vertical sectional view of the machine taken in a plane on the line 4—4 of FIGURE 2 showing a series of numeral keys and their associated mechanism.

FIGURE 5 is an enlarged fragmentary vertical sectional view of a carriage embodying a principal actuating gear, a pointer attached to said carriage, a shift key, a horizontal actuating rack pivoted on a horizontal actuating bar in operative relation with two ratchets and an escapement mechanism.

FIGURE 6 is a vertical sectional view of the machine taken in a plane on the line 6—6 of FIGURE 2 showing a numeral wheel in operative relation with a principal actuating gear and a transfer gear, a carriage for said actuating gear, a pointer attached to said carriage, and a numeral key.

FIGURE 7 is a vertical sectional view of the machine taken in a plane on the line 7—7 of FIGURE 2 showing a numeral wheel in operative relation with a second actuating gear and a transfer gear, a second carriage for said second actuating gear, a stopper attached to said second carriage, a division key mounted on said stopper, and a numeral key.

FIGURE 8 is an enlarged vertical sectional view of a bevel pinion, a pair of bevel gears, a carriage for said pair of bevel gears, an add-subtract key attached to said carriage, and a ratchet associated with said pair of bevel gears.

FIGURE 9 illustrates a first integral gear member of a numeral wheel on the right side thereof having twenty teeth operatively associated with a transfer gear.

FIGURE 10 illustrates a second integral gear member of a numeral wheel on the left side thereof having two teeth operatively associated with a transfer gear.

FIGURE 11 illustrates two adjoining numeral wheels, a tens-digit wheel and a unit-digit wheel, operatively associated with a transfer gear.

FIGURE 12 is an enlarged vertical sectional front view of a carriage embodying a principal actuating gear attached with a pointer, a second carriage embodying a second actuating gear attached with a stopper and a division key, and actuating mechanism associated therewith.

FIGURE 13 is a similar view of FIGURE 12 showing the division key depressed and the changed position of actuating mechanism associated therewith.

FIGURE 14 is a vertical sectional side view of FIGURE 12.

FIGURE 15 is a vertical sectional side view of FIGURE 13.

FIGURE 16 is a plan view of a substantially trans-

parent multi-colored facia strip with a numerating key attached thereto moved to the left, illustrating a numerating device which enables the numerals indicated on the numeral wheels viewed through said transparent facia strip appearing alternately color-shaded and unshaded, readily recognizable as a number without a decimal fraction and respectively marked for billions, millions, thousands, and units.

FIGURE 17 is a similar view as FIGURE 16 with the numerating key moved to the right showing said numerals to be a number with a decimal fraction and respectively marked for millions, thousands, units, and hundredths.

FIGURE 16–A is fragmentary sectional view showing the mounting of the transparent facia strip on the supporting pins.

FIGURE 17–A is fragmentary sectional view showing the mounting of the numerating key on the transparent facia strip.

FIGURE 18 is a vertical sectional view of a train of numeral wheels with two of said numeral wheels, one wheel indicating a "0" and a second wheel indicating a numeral "5," exploded to show the relative positions of the cam bushings associated therewith, and a clearance key.

FIGURE 19 is a similar view of FIGURE 18 showing the clearance key depressed and the train of numeral wheels moved rightward with the numeral wheel initially indicating a numeral "5" now zeroised.

FIGURE 20 is a similar view of FIGURES 18 and 19 showing the clearance key restored to normally raised position after release of depression of said clearance key and the train of numeral wheels returned to initial position with the entire train of numeral wheels all zeroised.

FIGURE 21 is an enlarged fragmentary view of the two exploded numeral wheels shown in FIGURE 18.

FIGURE 22 is an enlarged fragmentary view of the two exploded numeral wheels shown in FIGURE 19.

FIGURE 23 is an enlarged perspective view of a cam bushing for a numeral wheel.

FIGURE 24 is a vertical sectional view similar to FIGURES 3 and 4 illustrating the depression of a numeral key.

FIGURE 25 is a vertical sectional view similar to FIGURE 24 illustrating the release of depression of a numeral key.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will hereinafter describe in detail the preferred embodiment, but it is to be understood that I do not hereby intend to limit the invention to the specific form disclosed but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the applied claims.

Referring to the drawings, the calculating machine of this invention in the preferred embodiment, as shown in FIGURE 1, comprises an outer case **30** in which is encased an operative mechanism which is mounted on a frame work including supporting plates suitably secured together.

On the top side of said outer case **30** there are arranged a series of ten depressible numeral keys **45** marked 0 to and through 9 respectively. As shown in FIGURES 4, 6, and 7, each of said numeral keys **45** has a stem **46** extending downwardly into said outer case through a slot **50** in the top plate **31** and a second slot **51** in a supporting plate **170**, slidable therethrough vertically with a pin **49** on said stem **46** near the lower end thereof and beneath said supporting plate **170** to limit the upward movement of said stem. Each of said numeral keys **45** is provided with a spring **52** mounted near the lower end of the stem **46** of said numeral key between a pin **48** on said stem **46** and said supporting plate **170** for maintaining said numeral key in a normally raised position and restoring said numeral key to said raised position upon release of depression thereof. On said stem **46** of said numeral key **45** is a projecting lug **47** (see FIGURES 6 and 7), adapted to drive a horizontal actuating bar **128** to move in a longitudinal direction when said lug **47** slides into and in contact with the left edge of a slanting slot **129** in said horizontal actuating bar **128**, upon depression of said numeral key **45**.

On the top side of the outer case **30**, there are also arranged an add-subtract key **53**, a clearance key **56**, a shift key **62**, a numerating key **42**, a pointer **66**, a stopper **68**, and a division key **70**, all of which have stems extending downwardly into the outer case through slots in the top plate **31** provided therefor and suitably mounted, as described in detail hereinafter.

In the top plate **31**, there is a plurality of windows **34** through which numeral markings on the numeral wheels **74** are exposed to view. As shown in FIGURE 3, immediately beneath said windows **34** and above said numeral wheels **74** is a substantially transparent facia strip **35** mounted at the opposite ends thereof on two supporting pins **40** and **41** on said top plate **31** extending through two slots **38** and **39** at the opposite ends of said transparent facia strip for longitudinal movement thereon movable by the numerating key **42** which has a stem **43** extending downwardly through a slot **44** in the top plate **31** into the outer case and rigidly secured to said transparent facia strip **35**, as shown in FIGURE 16, 16*a*, 17, and 17*a*. Said transparent facia strip **35** is constructed of a plurality of colored sections **36** and **36***a* and colorless sections **37** arranged alternately so that the numerals marked on said numeral wheels **74** viewed therethrough appear to be color-shaded and unshaded respectively and accordingly. Each of said sections **36** and **37** has an area large enough to cover the area of three adjoining windows **34**, whereas the leftmost section **36***a* thereof has an area large enough to cover an area of at least one window in excess of the remaining windows **34**, if any, uncoverable by the other sections **36** and **37** thereof. The arrangement is such that when said transparent facia strip **35** is moved to the left by said numerating key **42**, as shown in FIGURE 16, the exemplified numerals "2—1—2—5—7—9—0—3—7—9," viewed through said transparent facia strip **35** and said windows **34**, appear to have the numeral "2" color-shaded, the numerals "1—2—5" unshaded, the numerals "7—9—0" color-shaded, and the numerals "3—7—9" unshaded, readily recognizable as two billion, one hundred twenty-five million, seven hundred ninety thousand, three hundred and seventy-nine. And when said transparent facia strip **35** is moved to the right by said numerating key **42**, as shown in FIGURE 17, said exemplified numerals appear to have the numerals "2—1" color-shaded, the numerals "2—5—7" unshaded, the numerals "9—0—3" color-shaded, and the numerals "7—9" unshaded, readily recognizable as twenty-one million, two hundred fifty seven thousand, nine hundred and three, and seventy-nine hundredths. It is apparent that by moving said numerating key **42** to the left, a number will appear without a decimal fraction, and when said numerating key **42** is moved to the right, a number will appear with a decimal fraction.

In FIGURE 2, there is shown a train of numeral wheels **74** which are mounted on a first stationary spindle **81** on which said numeral wheels **74** are individually rotatable and collectively movable longitudinally. Said stationary spindle **81** is fixedly supported at the opposite ends thereof in apertures in supporting plates **172** and **174**. At the right end of said train of numeral wheels **74** is a compression coil spring **83** mounted on said stationary spindle **81**, preventing said train of numeral wheels from longitudinal movement thereon in normal position without interfering with individual rotation of said numeral wheels, and restoring said train of numeral wheels to said normal position after having been moved longitudinally to the right thereon. As shown in FIGURES 3, 18, 19, and 20, at the left end of said train of numeral wheels **74**

is a cap type member 84 slidably mounted on the left end of said stationary spindle 81 extending leftward through an aperture 173 in the supporting plate 172 with its left end engaging a projecting cam surface 58 of the stem 57 of the clearance key 56, keeping said clearance key 56 in a normally raised position and with its right end resting against the leftmost numeral wheel 74 of said train of numeral wheels.

Each of said numeral wheels 74 has on its peripheral flange markings of a sequence of ten numerals of 0 to and through 9 (see FIGURE 2), on its right side a first integral gear member 75, and on its left side a second integral gear member 76. Said first integral gear members 75 has a plurality of teeth whose number equals to the number of the numeral markings on said numeral wheel 74, or a multiple thereof (see FIGURE 9), and said second integral gear member 76 has one tenth as many adjoining teeth as said first gear member 75 (see FIGURE 10). Said first integral gear member 75 is adapted for actuation by a principal actuating gear 92 (see FIGURE 6), a second actuating gear 105 (see FIGURE 7), and a transfer gear 88 (see FIGURES 6 and 7). Said second integral gear member 76 is adapted for actuation of said transfer gear 88. The teeth of both integral gear members 75 and 76 protrude beyond the peripheral flange of said numeral wheel 74. To keep said numeral wheels 74 from wobbling on the stationary spindle 81 when not rotating thereon, an idle spindle 86 (see FIGURES 6 and 7) is provided therefor, said idle spindle 86 being mounted at the opposite ends thereof on yielding supports 87 and being in constant engagement with the integral gear members of said numeral wheels 74.

As shown in FIGURES 21 and 22, located inside the bore of each of the numeral wheels 74 and rigidly secured thereto is a cam bushing 78 which has a cam surface 79 (see FIGURE 23) engageable by a pin 82 on the first stationary spindle 81 on which said numeral wheels 74 are mounted and which further has a slot 80 (see FIGURE 23), to accommodate said pin 82. Said pin 82 is located inside the bore of said numeral wheel 74 in a position not to interfere with the rotation thereof, nor to engage the cam surface 79 of said cam bushing 78 associated therewith when said numeral wheel 74 is indicating a zero and is moving longitudinally towards said pin 82, but to engage said cam surface 79 when said numeral wheel 74 is not indicating a zero and is moving longitudinally towards said pin 82. When said pin 82 is thus engaging the cam surface 79 of the cam bushing 78, it urges the numeral wheel 74 associated with said cam bushing 78 to rotate to a position indicating a zero, which is attained when said pin 82 is lodged into the slot 80 of said cam bushing 78, as shown in FIGURE 22.

As shown in FIGURES 18, 19, and 20, the clearance key 56 has a stem 57 extending downwardly through a slot 60 in the top plate 31 and a second slot 61 in a supporting plate 177, slidable therethrough vertically with the upward movement thereof limited by a pin 59 thereon near the lower end thereof and beneath said supporting plate 177. The intermediate portion of the right edge of said stem 57 of said clearance key 56 is formed with a cam surface 58, the underside of which resting on the left end of the cap member 84 to keep said clearance key 56 in a normally raised position. As shown in FIGURES 18 and 21, two of the numeral wheels 74, one numeral wheel 74 indicating a zero and a second numeral wheel 74*a* indicating a numeral "5," are exploded to reveal the respective positions of the cam bushings 78 associated with said two numeral wheels, with the cam surface 79 of the cam bushing 78 associated with the numeral wheel 74 indicating the zero facing upward and the cam surface 79*a* of the cam bushing 78*a* associated with the numeral wheel 74*a* indicating the numeral "5" facing downward. Upon depression of the clearance key 56, as shown in FIGURE 19, the stem 57 of said clearance key 56, urges, through its cam surface 58, said cap member 84 to move longitudinally rightward and said cap member 84 in turn pushes the entire train of numeral wheels 74 to move collectively likewise rightward, compressing the spring 83 at the right end thereof, during which rightward movement, said numeral wheel 74*a* indicating the numeral "5" is urged to rotate to a position indicating a zero by the pin 82*a* on the first stationary spindle 81 engaging the cam surface 79*a* of the cam bushing 78*a* of said numeral wheel 74*a* until said pin 82*a* is lodged in the slot 80*a* of said cam bushing 78*a*, while the numeral wheel 74 indicating the zero remains in zero position since the cam bushing 78 therein is not actuated by the pin 82 on said stationary spindle 81 when in zero position, as shown in FIGURE 22.

Upon release of depression of said clearance key 56, as shown in FIGURE 20, the spring 83 at the right end of said train of numeral wheels 74 expands, urging said train of numeral wheels 74 and the cap member 84 at the left end thereof to move longitudinally leftward back to their initial and normal position with all of said numeral wheels 74 zeroised, meanwhile said cap member 84 engages the cam surface 58 of the stem 57 of said clearance key 56, displacing said stem 57 in an upward direction, thereby restoring said clearance key 56 to its normally raised position.

As shown in FIGURE 3, a plurality of transfer gears 88 are rotatably mounted on a second stationary spindle 90 which is parallel to the first stationary spindle 81 and is fixedly supported at the opposite ends thereof in apertures in supporting plates 172 and 174, said transfer gears 88 being kept apart one from another by spacers 89, and being kept from wobbling on said second stationary spindle 90 when not rotating thereon by an idle spindle 91 (see FIGURES 6 and 7) which is mounted at the opposite ends thereof on the yieldable supports 87 and is in constant engagement with said transfer gears 88. As shown in FIGURE 11, each of said transfer gears 88 is operatively associated with the second integral gear member 76 of a numeral wheel 47*b* and the first integral gear member 75 of an adjacent numeral wheel 74*a* of next higher order.

Said transfer gear 88 has the function of automatically increasing the value of a numeral wheel 74*a* by one when its adjacent numeral wheel 74*b* of next lower order shall have an accumulated value exceeding nine, and the function of automatically decreasing the value of a numeral wheel 74*a* by one when its adjacent numeral wheel 74*b* of next lower order shall have a residual value of less than zero. Said functions are illustrated in FIGURES 9, 10, and 11.

As shown in FIGURE 10, when a numeral wheel, such as the unit-digit wheel 74*b*, is indicating a numeral "9," tooth 76*a* of the second integral gear member 76 of said unit-digit wheel 74*b* is in engagement with tooth 88*a* of the transfer gear 88 at the one side thereof so that when said unit-digit wheel 74*b* rotates one-tenth of one revolution in the direction indicated by an arrow in full lines in said FIGURE 10 from its initial position indicating the numeral "9" to a position indicating a zero (in dotted lines) as shown in FIGURES 10 and 11, its second integral gear member 76 rotates with said unit-digit wheel 74*b* a distance of two tooth-spaces, moving the two teeth 76*a* and 76*b* thereof to a position indicated by 76*a'* and 76*b'* respectively (see FIGURE 10), and drives said transfer gear 88 to rotate an equal distance of two tooth-spaces, moving its tooth 88*a* to a position indicated by 88*b* (see FIGURES 9 and 10), said transfer gear 88 in turn drives the first integral gear member 75 of the tens-digit wheel 74*a* an equal distance of two tooth-spaces, moving two of the teeth thereof, teeth 75*a* and 75*b*, to a position indicated by 75*a'* and 75*b'* respectively (see FIGURE 9), and with said first integral gear member 75 said tens-digit wheel 74*a* rotates one-tenth of one revolution in the direction indicated by an arrow in full lines (see FIGURE 9) from

its initial position indicating the numeral "1" to a position indicating a numeral "2" (in dotted lines, see FIGURES 9 and 11), resulting in a number "20" (in dotted lines) indicated on said tens-digit and unit-digit wheels **74***a* and **74***b*, as shown in FIGURES 9 and 10 and 11. This illustrates the so-called carrying device in an additive operation.

When a numeral wheel, such as the unit-digit wheel **74***b* of FIGURES 10 and 11, is indicating a zero (in dotted lines) tooth **76***b'* (in dotted lines) of the second integral gear member **76** of said unit-digit wheel **74***b* is in engagement with the tooth **88***a* of the transfer gear **88** on the opposite side thereof so that when said unit-digit wheel **74***b* rotates one-tenth of one revolution in the direction, indicated by a dotted arrow in said FIGURE 10, from its initial position indicating a zero (in dotted lines) to a position indicating a numeral "9" (in full lines), its second integral gear member **76** rotates with said unit-digit wheel **74***b* a distance of two tooth-spaces, moving said two teeth **76***a'* and **76***b'* to a position indicated by **76***a* and **76***b* respectively, and drives said transfer gear **88** to rotate an equal distance of two tooth-spaces moving the tooth **88***a* of said transfer gear **88** to a position indicated by **88***c*, said transfer gear **88** in turn drives the first integral gear member **75** of the tens-digit wheel **74***a* an equal distance of two tooth spaces, moving the teeth **75***a'* and **75***b'* of said first integral gear member **75** to a position indicated by **75***a* and **75***b* respectively, as shown in FIGURE 9, and with said first integral gear member **75** said tens-digit wheel **74***a* rotates one-tenth of one revolution in the direction, indicated by a dotted arrow in FIGURE 9, from its initial position indicating the numeral "2" (in dotted lines) to a position indicating the numeral "1" (in full lines), resulting in a number "19" indicated on said two numeral wheels **74***a* and **74***b*, as shown in FIGURES 9, 10, and 11. This illustrates the so-called borrowing device in a subtractive operation.

As shown in FIGURE 2, a principal actuating gear **92** having preferably nine teeth and being adapted to drive a numeral wheel **74** to rotate through the first integral gear member **75** thereof with which said principal actuating gear **92** is in engagement, is mounted on a first rotatable spindle **94** in which there is a key-way **95** extending longitudinally through the entire length thereof to accommodate a key **93** (see FIGURE 6) in the bore of said principal actuating gear **92** and enabling said principal actuating gear **92** to move longitudinally thereon and to revolve therewith. Said first rotatable spindle **94**, being parallel to the first stationary spindle **81**, is journalled at the opposite ends thereof in bearings in the supporting plates **172** and **179**. As shown in FIGURES 12 and 13, a carriage **96** embodying said principal actuating gear **92** is mounted on said first rotatable spindle **94** and movable longitudinally thereon with said principal actuating gear **92**. In an aperture **99** in the right side of the upper member **97** of said carriage **96** is secured a frictional cord **102** which extends rightward over the frictional surface of the peripheral flange of a spool **155** (see FIGURES 2 and 3) which is fixedly mounted on a third rotatable spindle **157** which is perpendicular to said first rotatable spindle **94** and is journalled at the opposite ends thereof in bearings in the supporting plates **175** and **176**, and returns, after passing over two guide-pulleys **103** and **104** at the left end of the machine (see FIGURES 2 and 3), to an aperture **98** in the left side of the upper member **97** of said carriage **96** to be secured therein. Said carriage **96** has a left arm **100** extending leftwardly for actuation of a lever **121** associated with a second carriage **107** embodying a second actuating gear **105**, as described hereinafter. Rigidly secured to said carriage **96** is the stem **67** of the pointer **66** (see FIGURE 12) which extends upwardly through a slot **32** in the top plate **31** to support said pointer **66** (see FIGURE 1). Said slot **32** extends longitudinally through said top plate **31** and is located between the windows **34** and the numeral keys **45** (see FIGURE 1). Said pointer **66** which moves longitudinally in and above said slot **32**, has for purpose of pointing to a window **34** at which an operation of calculation is to be performed. A plurality of notches **33** (see FIGURE 1) are provided in the one side of said slot **32** to hold said pointer **66** and the stopper **68** properly stationed. Said stopper **68** has a stem **69** extending downwardly through said slot **32** into the outer case and rigidly secured to a second carriage **107** associated with a second actuating gear **105** (see FIGURES 12, 13, 14, and 15), and is manually movable longitudinally in and above said slot **32** and settable in front of any one of said windows **34** at which the leftward movement of said pointer **66** is to be arrested (see FIGURE 1).

As shown in FIGURE 2, a driven bevel pinion **154** is fixedly mounted on the first rotatable spindle **94** at the right end thereof and is adapted for actuation by either of a pair of driving bevel gears **144** and **145**, each of said pair of bevel gears **144** and **145** having twice as many teeth as said bevel pinion **154**. As shown in FIGURE 8, said pair of bevel gears **144** and **145** are embodied in a third carriage **148** and are rigidly secured together by a sleeve **146** in which there is a slot **147** through which extends a pin **150** on a second rotatable spindle **149** on which said pair of bevel gears **144** and **145** are mounted and movable transversely thereon and with which said pair of bevel gears **144** and **145** revolve. Said second rotatable spindle **149** is journalled at the opposite ends thereof in bearings in the supporting plates **175** and **176** and is arranged perpendicularly to said first rotatable spindle **94** on which said bevel pinion **154** is fixedly mounted (FIGURE 2). Said pair of bevel gears **144** and **145** are movable forwardly and rearwardly on said second rotatable spindle **149** by the add-subtract key **53** which has a stem **54** extending downwardly through a slot **55** in the top plate **31** and rigidly secured to said third carriage **148**. When said add-subtract key **53** is moved rearward to "add" position, the front bevel gear **144** as shown in dotted lines in FIGURE 8 comes into engagement with the bevel pinion **154** which can then be actuated thereby to rotate in one direction; and when said add-subtract key **53** is moved forward to "subtract" position, the rear bevel gear **145** comes into engagement with said bevel pinion **154** which can then be actuated thereby to rotate in the reverse direction thereof. A numeral wheel **74** rotates in one direction in an additive operation and rotates in the reverse direction thereof in a subtractive operation. As the rotation of said numeral wheel **74** is effected and controlled by the principal actuating gear **92** which rotates with the bevel pinion **154**, both of which being mounted on the first rotatable spindle **94**, a reversal of the rotational direction of said bevel pinion **154** reverses the rotational direction of said principal actuating gear **92** and hence the rotational direction of the numeral wheel **74** in operative relation with said principal actuating gear. It is, therefore, apparent that when the add-subtract key **53** is moved to "add" position, a numeral wheel **74** in operative relation with the principal actuating gear **92** will rotate in the direction in which the value of the numeral indicated thereon is increasing, and when said add-subtract key **53** is moved to the "subtract" position, said numeral wheel **74** will rotate in the reverse direction in which the value of the numeral indicated thereon is decreasing.

As shown in FIGURES 2, 5, and 8, a first ratchet **151**, having an equal number of teeth as the principal actuating gear **92**, that is, nine teeth, is fixedly mounted on the second rotatable spindle **149** on which the pair of bevel gears **144** and **145** are also mounted, and is provided with a spring-pressed pawl **152**. (FIGURE 5), pivoted on a pin **153** for controlling said first ratchet **151** and said pair of bevel gears **144** and **145** to revolve with

said second rotatable spindle 149 in one direction only. Said first ratchet 151 is adapted for actuation by a horizontal actuating rack 138 pivoted on a horizontal actuating bar 128 (see FIGURE 5), as explained hereinafter.

As shown in FIGURE 4, an elongated horizontal actuating bar 128 is seated in a plurality of yokes 133 which are secured to a supporting plate 170, and is mounted for longitudinal movement thereof on a plurality of pins 134 which are secured to said yokes 133 and which extend through a plurality of horizontal slots 130 in said horizontal actuating bar 128 in the lower portion thereof. At the left end of said horizontal actuating bar 128, there is mounted inbetween an adapter 135 on said horizontal actuating bar and a second adapter 136 on the supporting plate 171 a compression spring 137 adapted to restore said horizontal actuating bar to normal position when said horizontal actuating bar has been moved leftward. Extending downwardly and angularly from the upper edge of said horizontal actuating bar 128 are ten inclined, or slanting, slots 129 which are engageable by the projecting lugs 47 on the stems 46 of the numeral keys 45. Said slanting slots 129 are disposed at varying angles such that upon depression of a numeral key 45, the projecting lug 47 on the stem 46 of said key slides into and in contact with the left edge of a corresponding slanting slot 129, displacing said horizontal actuating bar 128 in a longitudinal direction leftward to a distance predetermined by the angle of said slanting slot 129, said horizontal actuating bar 128 thereby bringing a horizontal actuating rack 138 pivoted thereon at the right end thereof to move a corresponding distance. As shown in FIGURES 4 and 5, said horizontal actuating rack 138 is pivoted on a pin 131 on said horizontal actuating bar 128 at the right end thereof and is provided with a spring 142 to keep said horizontal actuating rack 138 downwardly and yieldably upwardly. Said horizontal actuating rack 138 has ten ratchet-type teeth, of which nine teeth 139 are inclined in one direction and one tooth 141, the rightmost tooth, is inclined in the opposite direction thereof. Said nine teeth 139 are adapted for actuation of the first ratchet 151 in the forward, or leftward, movement of said horizontal actuating rack 138 and said rightmost tooth 141 is adapted for actuation of a second ratchet 156 in the return, or rightward, movement of said horizontal actuating rack 138. At rest position, the leftmost tooth 140 of said nine teeth 139 is positioned one tooth-space away from the first engageable tooth 151*a* of the first ratchet 151 and the rightmost tooth 141 is positioned one tooth-space away from the first engageable tooth 156*a* of said second ratchet 156 on the unengageable side thereof. Said second ratchet 156, as shown in FIGURES 2 and 5, is fixedly mounted on the third rotatable spindle 157 on which the spool 155 is also fixedly mounted and on which at the rear end thereof is mounted a torsion spring 158 (FIGURE 2) of which one free end is secured to said third rotatable spindle 157 and the other free end thereof secured to the supporting plate 176. It is to be appreciated that by such an arrangement of the teeth of said horizontal actuating rack 138, said horizontal actuating rack 138 will actuate said first ratchet 151 in the forward, or leftward, movement thereof only when said horizontal actuating rack 138 has moved a distance of more than one tooth-space and will actuate said second ratchet 156 in the return, or rightward, movement thereof irrespective of the distance which said horizontal actuating rack 138 might have moved forward.

As illustrated in FIGURE 24, upon depression of the exemplified numeral key 45 marked "1," the projecting lug 47 of the stem 46 of said numeral key, on the downward movement of said stem, slides into a slot 129 in the horizontal actuating bar 128, compressing the spring 52 at the lower end of said stem 46 and at the same time displacing said horizontal actuating bar 128 in a longitudinal direction leftward, compressing the spring 137 at the left end of said horizontal actuating bar 128, meanwhile, the horizontal actuating rack 138 pivoted at the right end of said horizontal actuating bar 128 is being moved leftward likewise by said horizontal actuating bar 128, moving the leftmost tooth 140 thereon to a position indicated by 140*b* (see FIGURE 5), a distance of two tooth-spaces, and actuating the first ratchet 151 to revolve a distance of one tooth-space, moving the first engageable tooth 151*a* thereon to a position indicated by 151*b*. It will be noticed that if said depressed numeral key is key marked "0," said horizontal actuating rack 138 will move a distance of one tooth-space, moving said leftmost tooth 140 to a position indicated by 140*a*, contacting the first engageable tooth 151*a* of said first ratchet 151 without actuating said first ratchet to revolve. When said first ratchet 151 revolves a distance of one tooth-space, that is, one ninth of one revolution, the pair of bevel gears 144 and 145 which are mounted on the same second rotatable spindle 149 on which said first ratchet 151 is fixedly mounted, also revolves one ninth of one revolution, and one of said pair of bevel gears 144 and 145 drives the bevel pinion 154 in engagement therewith to revolve two ninths of one revolution (said bevel gear having twice as many teeth as said bevel pinion as described herein before) in one direction or in the reverse direction thereof depending upon which gear of said pair of bevel gears 144 and 145 being then in engagement with said bevel pinion 154. As the principal actuating gear 92 which is mounted on the first rotatable spindle 94 on which said bevel pinion 154 is fixedly mounted, said principal actuating gear 92 likewise revolves an equal distance of two ninths of one revolution, that is, a distance of two tooth-spaces, which said bevel pinion 154 has revolved, and drives the first integral gear member 75 of a numeral wheel 74 in engagement therewith to rotate a distance of two tooth-spaces, and with said first integral gear member 75 said numeral wheel 74 rotates a distance of one tenth of one revolution and indicates thereon a number that is one more or one less than the number initially indicated thereon depending upon whether the operation is additive or subtractive. As shown in said FIGURE 24, the principal actuating gear 92 is in engagement with the first integral gear member 75 of the second rightmost numeral wheel 74 which is assumed to be initially indicating a number "2." Upon depression of the numeral key 45 marked "1," said second rightmost numeral wheel will rotate to indicate thereon a number "3" which is one more than the number "2" initially indicated thereon, assuming this being an additive operation. On the other hand, if it is a subtractive operation, it is obvious that upon depression of said numeral key marked "1," said second rightmost numeral wheel will indicate a number "1" which is one less than the number "2" initially indicated thereon. It, therefore, follows that upon depression of any one of said numeral keys 45, a numeral wheel 74 in operative relation therewith will rotate to indicate thereon a number that has been increased or decreased by the number marked on said depressed numeral key, depending upon whether it is an additive or subtractive operation.

Upon release of depression of any one of said numeral keys 45, for example, the numeral key 45 marked "1," as shown in FIGURE 25, said depressed key is forced to move upwardly to its normally raised position by expansion of the spring 52 mounted on the lower end of the stem 46 of said numeral key, and the horizontal actuating bar 128 is forced to move backward, or rightward, by expansion of the spring 137 at the left end thereof, whereby the horizontal actuating rack 138 pivoted on said horizontal actuating bar 128 at the right end thereof likewise moves rightward whereupon the rightmost tooth 141 thereof drives the second ratchet 156 to revolve a distance of one tooth-space, moving the first engageable tooth 156*a* thereof to a position indicated by 156*b* (see

FIGURE 5), and with said second ratchet 156 the spool 155 which is fixedly mounted on the third rotatable spindle 157 on which said second ratchet 156 is also fixedly mounted, revolves and pulls, through the intermediation of the frictional cord 102, the carriage 96 and the principal actuating gear 92 embodied therein and the pointer 66 attached thereto, rightward, from their initial position "A" (FIGURE 25) in operative relation with said second rightmost numeral wheel to a second position "B" in operative relation with the rightmost numeral wheel for actuation by a subsequent depression of any one of said numeral keys 45, and at the same time moving the pointer 66 from the second rightmost window to the rightmost window as indicated by 66*a* and 66*b* respectively in FIGURE 1.

In the case of said numeral key 45 marked "1" being initially in operative relation with the numeral wheel 74 of the lowest order, that is, when the principal actuating gear 92 is in operative relation with the rightmost numeral wheel 74, as shown by position "B" in FIGURE 25, upon release of depression of said numeral key marked "1," the carriage 96, the principal actuating gear 92, and the pointer 66 are firstly pulled rightward to a position "C" by the spool 155 which has revolved upon actuation of the second ratchet 156 associated therewith by the rightmost tooth 141 of the horizontal actuating rack 138 in the return, or rightward, movement thereof, as explained hereinbefore, whereupon said carriage 96 strikes a horizontal bar 166 (FIGURE 5), said horizontal bar 166 being operatively connected at the right end thereof to the lower end of a lever 159 by a pin 167 on said horizontal bar 166 extending through a slot 161 on said lever 159 at the lower end thereof, and being supported at the left end thereof by a pin 169 on a supporting plate 180 (FIGURE 2), and being thereby movable longitudinally. Said lever 159 is pivoted on a rod 165 secured to the supporting plate 175 and has an ear 160 on the right edge thereof in constant engagement with the second ratchet 156, permitting said second ratchet and the spool 155, both being fixedly mounted on the third rotatable spindle 157, to revolve in one direction when thus engaged, and permitting said second ratchet 156 and said spool 155 to revolve in the reverse direction thereof when disengaged therewith, and further has a leftwardly extending arm 162 pivotally connected to the stem 63 of the shift key 62 by a pin 64 on said stem 63 through a slot 163 on said left arm 162 of said lever 159, said stem 63 of said shift key 62 extending upwardly through a slot 65 in the top plate 31 to support said shift key 62. The upper end 159*a* of said lever 159 is contiguous to a dog 143 on the horizontal actuating rack 138 latchable by said dog 143 when the top portion of said lever 159 pivots to the left. Upon the rightward movement of said carriage 96, said horizontal bar 166 is struck and thereby causes the top portion of said lever 159 to pivot leftward, whereupon the ear 160 of said lever 159 disengages said second ratchet 156 (FIGURE 5), permitting the third rotatable spindle 157, on which both said second ratchet 156 and the spool 155 are fixedly mounted, to rotate in the reverse direction thereof by actuation of the spring 158 associated with said third rotatable spindle 157 at the rear end thereof, and with said third rotatable spindle 157 said spool 155 revolves in the same reverse direction and pulls, through the intermediation of the frictional cord 102, said carriage 96, said principal actuating gear 92, and said pointer 66 all the way leftward until stopped by the stopper 68, bringing said principal actuating gear 92 to a numeral wheel 74 of higher order to be in operative relation therewith and bringing said pointer 66 to a window 34 under which is said numeral wheel of higher order. As shown in FIGURE 25, upon release of depression of the numeral key 45 marked "1" the carriage 96, the principal actuating gear 92 and the pointer 66 are firstly moved rightward from the initial position "B" to a second position "C" and thence are moved leftward to a third and final position "D." As shown in FIGURE 1, the pointer 66 is moved from its initial position at 66*b* to a final position at 66*c*. During the pivoting of said lever 159, the upper end 159*a* thereof raises the horizontal actuating rack 138 momentarily whereby said upper end 159*a* of said lever 159 is latched by the dog 143 on said horizontal actuating rack 138, preventing said lever 159 from pivoting back to its initial position, thereby keeping said second ratchet 156 continually disengaged with the ear 160 of said lever 159 until said lever 159 is permitted to pivot back to its initial position restored thereto by a spring 164 thereon when said dog 143 on said horizontal actuating bar 138 unlatches the upper end 159*a* of said lever 159 in the leftward movement of said horizontal actuating rack 138 upon a subsequent depression of a numeral key 45, whereupon said ear 160 of said lever 159 again engages said second ratchet 156. This disengagement of said second ratchet 156 with said ear 160 of said lever 159 can also be effected by depression of the shift key 62, said depression of said shift key 62 actuates said lever 159 to pivot in the manner as just described.

A mechanism for automatic registration of the quotient in division on the numeral wheels 74 is illustrated in FIGURES 12, 13, 14, and 15. Said mechanism comprises a second actuating gear 105 having an equal number of teeth as the principal actuating gear 92, that is, nine teeth, and being adapted to drive a numeral wheel 74 through the first integral gear member 75 thereof to rotate one tenth of one revolution and to accumulate thereon a numerical value of one upon each actuation thereof by said second actuating gear 105. Said second actuating gear 105 having a ratchet-type hub 106 which has an equal number of teeth as said second actuating gear 105, that is, nine teeth, is rotatably mounted on the first rotatable spindle 94 and movable longitudinally thereon. A second carriage 107 embodying said second actuating gear 105 and a vertical actuating rack 117 is mounted on said first rotatable spindle 94 and movable longitudinally thereon. Said vertical actuating rack 117 having two teeth 118 (FIGURES 14 and 15) made of flexible material, is mounted for vertical movement thereof at the lower end thereof in an aperture 110 in the lower member 109 of said second carriage 107 and is supported and guided at the upper end thereof by a grooved bearing plate 116 secured to the right member 111 of said second carriage 107, and is provided with a compression coil spring 120 mounted at the lower end thereof to keep said vertical actuating rack 117 in a normally raised position and to restore said vertical actuating rack 117 to said normally raised position when said vertical actuating rack 117 has been depressed. Said vertical actuating rack 117 is adapted to drive the ratchet hub 106 of said second actuating gear 105 to rotate a distance of two tooth-spaces upon being actuated by a lever 121. Said lever 121 comprising a horizontal upper member 122 and a vertical member 124 is slidably and pivotally connected at the lower end of said vertical member 124 to an extending arm 113 on the right edge of the right member 111 of said second carriage 107 by a pin 114 on said arm 113 extending through a slot 125 in said vertical member 124 at the lower end thereof, and is operatively connected to the stem 71 of a division key 70 by a pin 72 on said stem 71 extending through a curved slot 123 in said horizontal upper member 122 of said lever 121. Said vertical member 124 of said lever 121 has on the right edge thereof an ear 126 which is normally out of the path of the leftward movement of the left arm 100 of the carriage 96 associated with the principal actuating gear 92 and which comes into said path and becomes engageable thereby when said lever 121 is lowered upon depression of the division key 70. Said division key 70 has a stem 71 extending downwardly through an aperture 73*a* in the stopper 68 and movable vertically therethrough and slidably connected at the lower end thereof to the arm 113 on

the right member of the second carriage **107** by the pin **114** on said arm **113** extending through a slot **73** in said stem **71** of said division key **70**, said slot **73** coinciding with the slot **125** in the vertical member **124** of said lever **121**. Said lever **121** is provided with a spring **127** for restoring said lever **121** to its initial position after pivoting thereof. As shown in FIGURE 13, upon depression of said division key **70**, said lever **121** is lowered whereby the ear **126** thereof comes into the path of and becomes engageable by the left arm **100** of the carriage **96** associated with the principal actuating gear **92** in the leftward movement of said carriage **96**. When said left arm **100** of said carriage **96** strikes said ear **126** of said lever **121**, said lever **121** pivots whereupon the upper horizontal member **122** of said lever **121** contacts the upper end **119** of the vertical actuating rack **117** and pushes said vertical actuating rack **117** to move downwardly and to drive, with the two teeth **118** thereon, the ratchet hub **106** of said second actuating gear **105** to rotate a distance of two tooth-spaces, whereby said second actuating gear **105** rotates with said ratchet hub **106** thereof an equal distance of two tooth-spaces and drives the first integral gear member **75** of a numeral wheel **74** in engagement therewith to rotate an equal distance of two tooth-spaces, and with said first integral gear member **75** said numeral wheel **74** rotates one tenth of one revolution and accumulates thereon a numerical value of one. In the rightward movement of said carriage **96** in a subsequent operation, said lever **121** is forced by the spring **127** thereon to pivot back to its initial position, withdrawing the upper horizontal member **122** thereof from pressing against the upper end **119** of said vertical actuating rack **117** which is thereby forced to move upwardly to its normally raised position by expansion of the spring **120** associated therewith which has been compressed in the downward movement thereof. In said upward movement of said vertical actuating rack **117**, the two teeth **118** thereon, being of flexible nature, yield and slip over the engageable tooth of said ratchet hub **106** without actuating said ratchet hub.

In an operation of division, for example: to divide a number, dividend, "5,634" by another number, divisor, "27," it is proceeded as follows.

Firstly, zeroise, or clear, all numerals appearing in the windows **34** by depression of the clearance key **56**. The stopper **68** and the pointer **66** are set at the third leftmost window **34**, which is for purpose of providing the leftmost window **34** to accommodate the first significant figure of the quotient and to leave at least one blank window **34** separating the last significant figure of the quotient from the first significant figure of an undivided residual dividend, if any. Move the add-subtract key **53** to "add" position. The dividend "5,634" is entered by successive depressions of the numeral keys **45** respectively marked "5," "6," "3," and "4" corresponding to said dividend "5,634," after which depress the shift key **62** to bring the pointer **66** back to the starting window, that is, the third leftmost window. Move the add-subtract key **53** to "subtract" position and depress the division key **70**. The depression of said division key **70** lowers the lever **121** and its ear **125** into the path of and to be engageable by the left arm **100** of the carriage **96** associated with the principal actuating gear **92** as shown in FIGURE 13. Compare the divisor "27" with the thousands and hundreds digits "56" of said dividend "5,634." Since the partial dividend "56" is larger than said divisor "27," the operation of dividing may be proceeded. On the other hand, if the divisor is larger than the partial dividend, the stopper **68** and the pointer **66** are to be moved to a next window on the rightside thereof before starting the operation of dividing.

To proceed with dividing, the divisor "27" is entered by successive depressions of numeral keys **45** respectively marked "2" and "7" corresponding to said divisor "27," after which the shift key **62** is to be depressed to bring back the pointer **66** to the starting window, that is, the third leftmost window. In the backward, or leftward, movement of said pointer **66**, the carriage **96**, to which said pointer is secured, moves leftward. Near and at the end of said leftward movement of said carriage **96**, the left arm **100** thereof strikes the ear **126** of the lever **121**, whereupon said lever **121** pivots leftward whereby the upper member **122** of said lever **121** pushes the vertical actuating rack **117** downwardly to drive the ratchet hub **106** of the second actuating gear **105** to rotate a distance of two tooth-spaces, whereupon said second actuating gear **105** rotates with its ratchet hub **106** an equal distance of two tooth-spaces and drives the first integral gear member **75** of the leftmost numeral wheel **74** to rotate an equal distance of two tooth-spaces, and with said first integral gear member **75** said leftmost numeral wheel **74** rotates one-tenth of one revolution and registers thereon a numeral "1" which appears in the leftmost window **34** and which is the quotient of one dividing. Meanwhile, the numerals "5" and "6" respectively appearing in the third and fourth leftmost windows have been changed into numerals "2" and "9" respectively, indicating a number "29" which is still larger than the divisor "27," therefore the entry of said divisor is to be repeated in the same manner as just described, whereupon the numeral "1" appearing in the leftmost window is changed into a numeral "2" and the numerals "2" and "9" appearing in the third and fourth leftmost windows respectively are changed into numerals "0" and "2" respectively, indicating a number "2" which is smaller than the divisor "27" and cannot be divided. The stopper **68** and the pointer **66** are then moved to a next window **34**, that is, the fourth leftmost window. As the numerals appearing in the fourth and fifth leftmost windows are "2" and "3" respectively, indicating a number "23" which is still smaller than the divisor "27" and cannot be divided, the stopper **68** and the pointer **66** are further moved to a next window, that is, the fifth leftmost window, whereupon the divisor "27" is repeatedly entered for eight times. After the eighth entry of said divisor "27," there appear in the leftmost window and its five adjoining windows six numerals "2," "0," "8," "0," "1," and "8" respectively, clearly indicating a quotient of "208" and an undivided residual dividend of "18," with the stopper pointing to the fifth window.

Operations of addition and subtraction are simplicity itself.

For example: to add two numbers "250" and "65" together. Firstly, depress the clearance key **56** to zeroise, or clear, all numerals appearing in the windows **34**. Set the stopper **68** and the pointer **66** at the hundreds-digit window. Move the add-subtract key **53** to "add" position. Depress successively the numeral keys **45** respectively marked "2," "5," and "0," corresponding to the first number "250," whereupon there appear in the hundreds-digit, tens-digit, and unit-digit windows the numerals "2," "5," and "0" respectively. Upon depression of the numeral key marked "2," a numeral "2" appears in the hundreds-digit window and upon release of depression of said numeral key marked "2," the pointer **66** automatically moves to the tens-digit window. Similarly, upon the depression and the release of depression of the numeral key marked "5," "5" appears in the tens-digit window and the pointer **66** automatically moves to the unit-digit window. Upon depression of the numeral key marked "0," "0" appearing in the unit-digit window remains unchanged, and upon release of depression of said numeral key marked "0," the pointer **66** automatically moves to the hundreds-digit window, so that the entry of the second number "65" can be made in the same manner as the entry of the first number. As the first figure of said second number "65" is a tens-digit, the entry of said second number has to be started at the tens-digit window. The pointer **66** has to be moved to the tens-digit window,

which is done by depression of numeral key **45** marked "0." Thereupon, the numeral keys **45** respectively marked "6" and "5" corresponding to said second number "65" are successively depressed. Upon depression of the numeral key marked "6," the numeral "5" appearing in the tens-digit window is changed into "1" and at the same time the numeral "2" appearing at the hundreds-digit window is changed into "3" by the function of the carrying mechanism of the machine. When the numeral key marked "5" is depressed, the zero appearing in the unit-digit window is changed into "5," resulting in three numerals "3," "1," and "5" appearing respectively in the hundreds-digit, tens-digit, and unit-digit windows, indicating a number "315" which is the total of addition of said two numbers.

Subtraction is operated in the similar manner as addition with the exception that before subtracting, the add-subtract key **53** is to be moved to "subtract" position. For example: to subtract a number, subtrahend, "365" from another number, minuend, "615." The minuend "615" is firstly entered in the same manner as addition with the add-subtract key **53** moved to "add" position. After the entry of said minuend "615," the add-subtract key **53** is moved to "subtract" position, and then the subtrahend "365" is entered in the same manner as addition. After completion of the entry of said subtrahend "365," there appear in the windows of hundreds-digit, tens-digit, and unit-digit three numerals "2," "5," and "0," respectively, indicating a number "250" which is the answer of said subtraction. It will be noticed that upon depression of the numeral key marked "6" for the tens-digit "6" of said subtrahend "365," the numeral "1" appearing in the tens-digit window is changed into "5" and at the same time the numeral "3" appearing in the hundreds-digit window after depression of the numeral key marked "3" for the hundreds-digit "3" of said subtrahend "365" is changed into "2" by the functioning of the borrowing mechanism of the machine.

Multiplication, which is a process of repeated addition, is operated in the following manner. For example: to multiply a number, multiplicand, "56" by another number, multiplier, "32." Firstly, zeroise, or clear, all numerals in the windows **34** by depression of the clearance key **56**. Move the add-subtract key **53** to "add" position. Set the stopper "68" and the pointer "66" at the hundreds-digit window. Enter the multiplicand "56" in the same manner as addition by successive depressions of the numeral keys **45** respectively marked "5," "6," and "0" three times corresponding to the tens-digit "3" of said multiplier "32" whereupon there appear in the windows **34** of thousands-digit, hundreds-digit, tens-digit, and unit-digit the numerals "1," "6," "8," and "0" respectively. The stopper **68** and the pointer **66** are then moved to the tens-digit window, and the multiplicand "56" is again entered by successive depressions of the numeral keys respectively marked "5" and "6" repeated two times corresponding to the unit-digit "2" of said multiplier "32," whereupon there appear in the windows of thousands-digit, hundreds-digit, tens-digit, and unit-digit the numerals of "1," "7," "9," and "2" respectively, indicating a number "1,792" which is the product of the multiplication of said two numbers.

What is claimed is:

1. In a ten-key keyboard calculating machine having a register comprising a plurality of demoninational orders of numeral wheels and a keyboard of ten selectively depressible keys, each identifiable from the other by an indicium thereon of one of a sequence of ten digits of from zero to nine, both inclusive, in combination, a rotary shaft means, a principal actuator mounted on the shaft for movement thereon and to rotate therewith, detachable coupling means to couple said principal actuator selectively to said numeral wheels for actuation thereof; a transporter means for transporting said principal actuator from the one position thereof in engagement with one of said numeral wheels axially to another position in engagement with a succeeding numeral wheel of next lower denominational order in succession in descending denominational order; spring means responsive to motion of the principal actuator in the descending direction to store energy; release means to be engaged by the principal actuator after actuation of the last numeral wheel to release said spring means for transporting said principal actuator from the position in engagement with the numeral wheel of the lowest denominational order back to its starting position; a member actuatable by said keys and movable by the respective keys in differing amounts; and motion modifying means to convert movement of the member in the one direction into a rotary motion of said rotary shaft means.

2. In the calculating machine as set forth in claim 1, means for registering quotient of division on said numeral wheels including a secondary actuator rotatably mounted on said rotary shaft means and adapted for actuation of a numeral wheel in engagement therewith upon actuation thereof by said principal actuator in its return movement; means for moving said secondary actuator into and out of engagement with numeral wheel; and means for rendering said secondary actuator actuatable by said principal actuator, said secondary actuator being normally not actuatable by said principal actuator.

3. In a calculating machine, in combination, a support; a register comprising a train of numeral wheels mounted on the support, each of said numeral wheels having a cam bushing, said numeral wheels being individually rotatable and collectively movable axially on said support; a plurality of projections on said support, each of said projections being operatively associated with cam bushing of each of said numeral wheels; spring means operatively associated with said train of numeral wheels at the one end thereof and a depressible key operatively associated therewith at the opposite end thereof, whereby upon depression of said key said train of numeral wheels is collectively moved axially on said support in the one direction, whereby all of said numeral wheels are rotated to zero position by co-operation of the cam bushings of said numeral wheels with the projections on said support associated therewith respectively, and whereby upon subsequent release of said key, said train of numeral wheels is restored to its normal position by said spring means with said numeral wheels rotated to zero position.

4. In a calculating machine, in combination, a support having a plurality of projections; a register comprising a train of numeral wheels rotatably mounted on the support; means to mount the support for movement axially with respect to said train of numeral wheels; cam bushings carried by the respective numeral wheels and respectively said projections on the support; a spring means to engage with said support at the one end thereof; a depressible key to engage the opposite end thereof, whereby upon depression of said key, said support is moved axially in the one direction relative to the numeral wheels to cause the numeral wheels to be rotated to zero position by co-operation of the cam bushings of said numeral wheels with the projections on said support, and upon subsequent release of depression of said key, said support is restored to its normal position by said spring means.

5. In a calculating machine, in combination, a train of numeral wheels mounted on a supporting means individually rotatable and collectively movable longitudinally thereon, a cam bushing associated with each of said numeral wheels, a plurality of pin-type projections on said supporting means, one of said pin-type projections being operatively associated with each of the cam bushings of said numeral wheels, a spring means operatively asso-

ciated with said train of numeral wheels at the one end thereof and a depressible key operatively associated with said train of numeral wheels at the opposite end thereof, whereby upon depression of said depressible key said train of numeral wheels is collectively moved in one direction longitudinally whereupon all those of said numeral wheels that are not indicating zero are rotated by co-operation of the cam bushings of said numeral wheels with their respective pin-type projections on said supporting means to position indicating zero, and upon release of depression of said depressible key said train of numeral wheels is restored to its initial position by said spring means with the entire train of said numeral wheels zeroised.

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