

March 4, 1941.

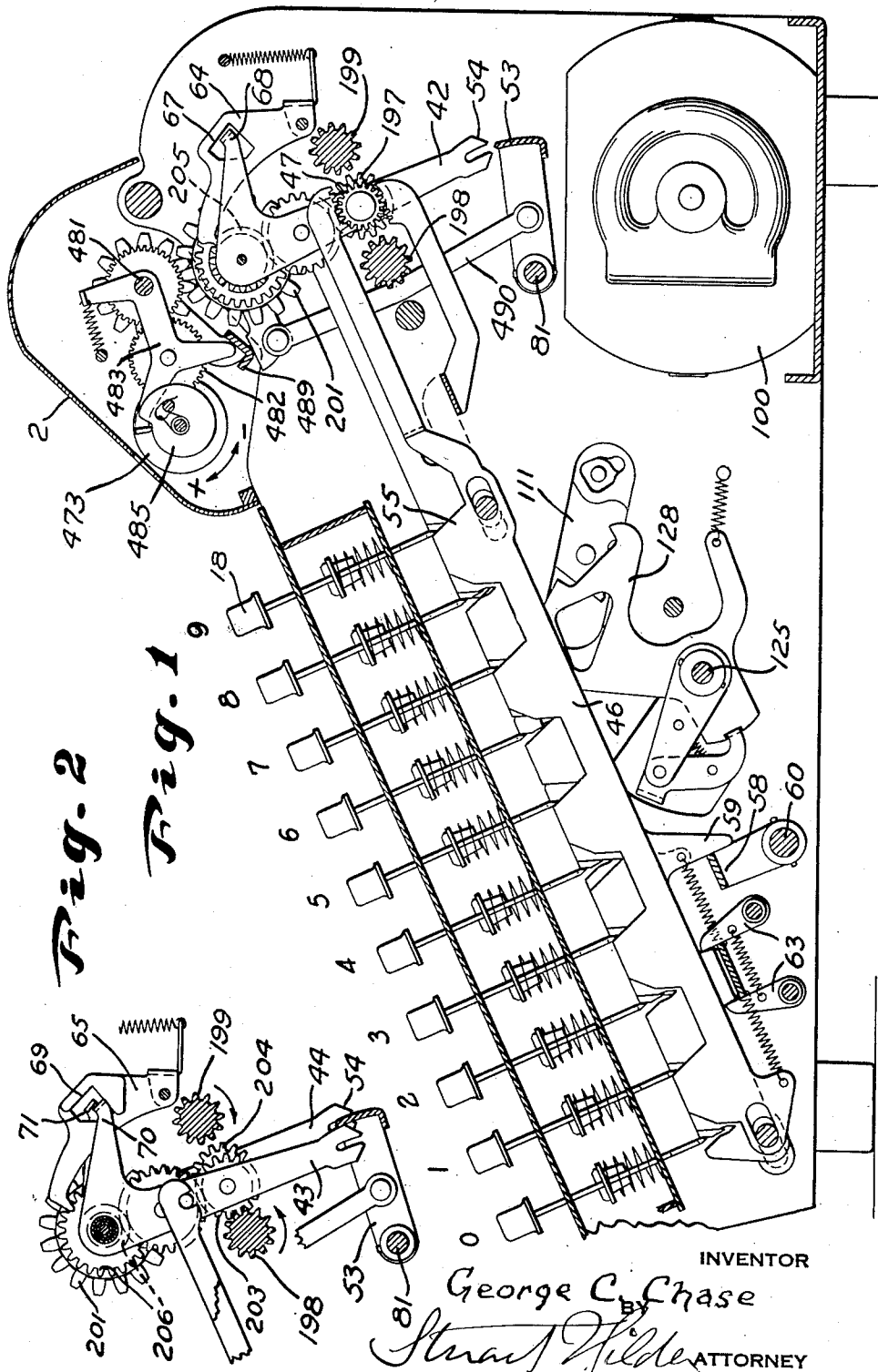
G. C. CHASE

2,233,912

CALCULATING MACHINE

Filed Nov. 24, 1937

5 Sheets-Sheet 1



March 4, 1941.

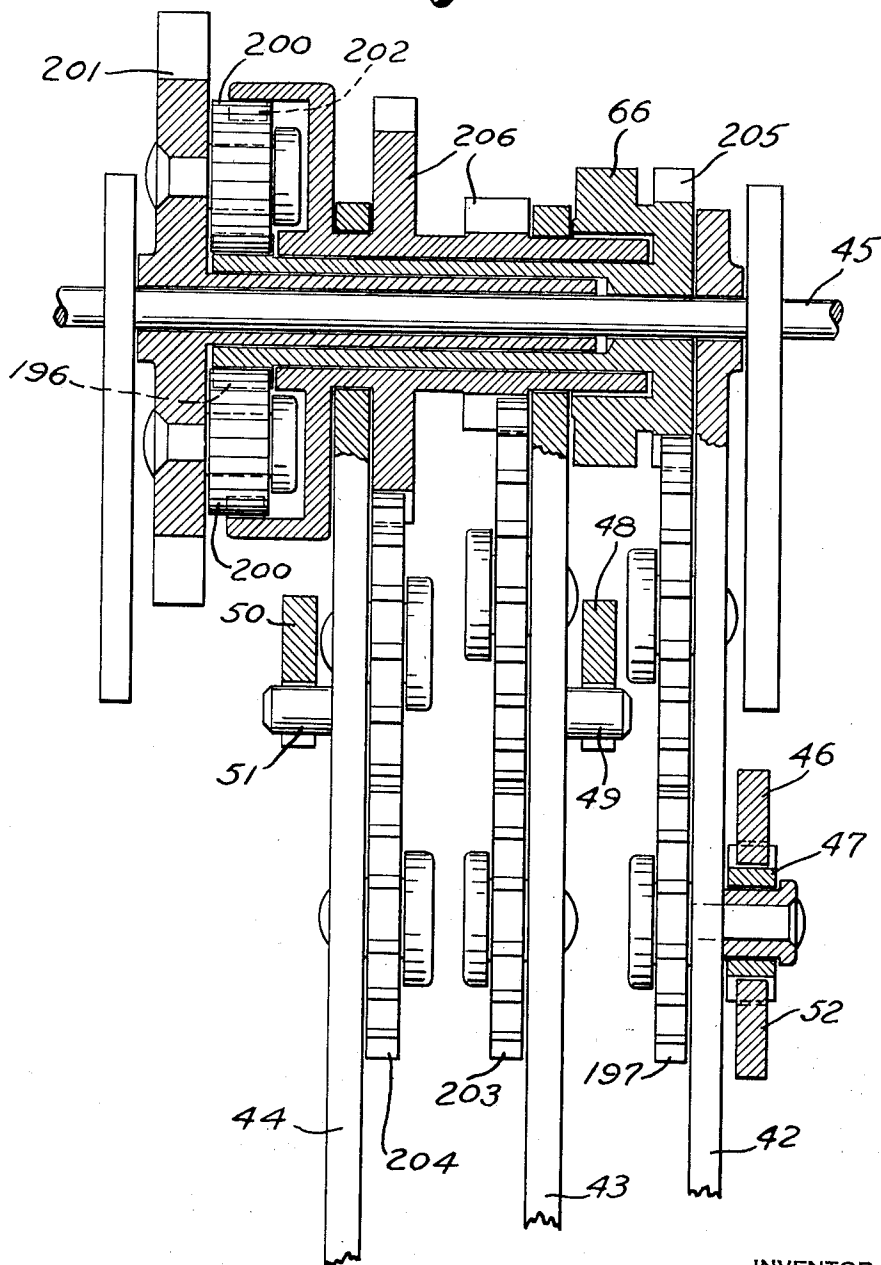
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Fig. 3



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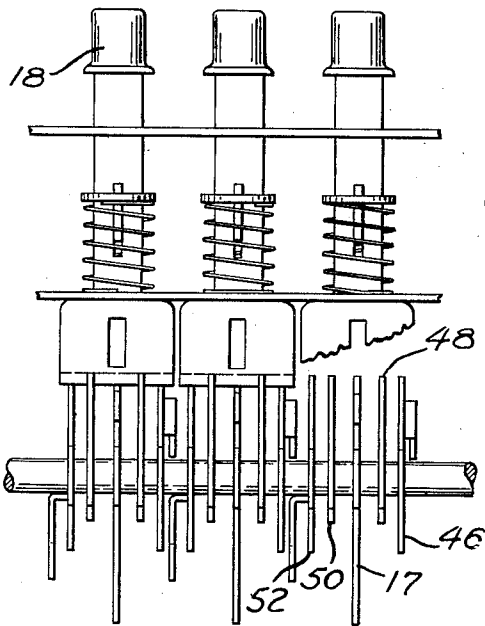


Fig. 8

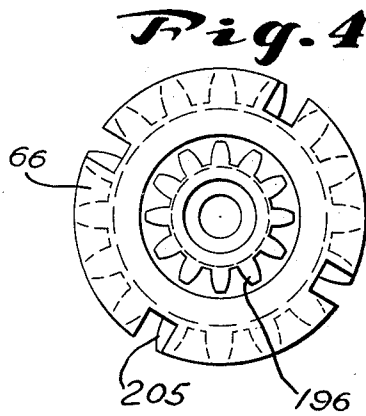


Fig. 4

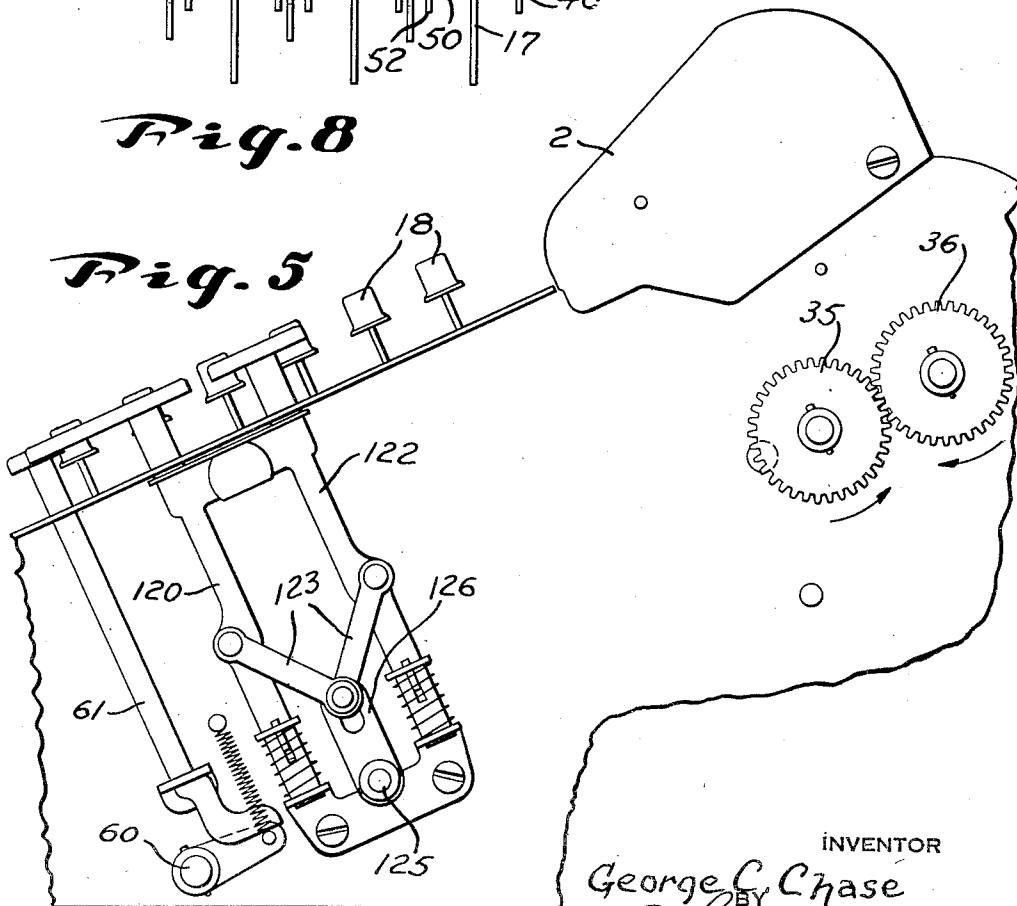


Fig. 5

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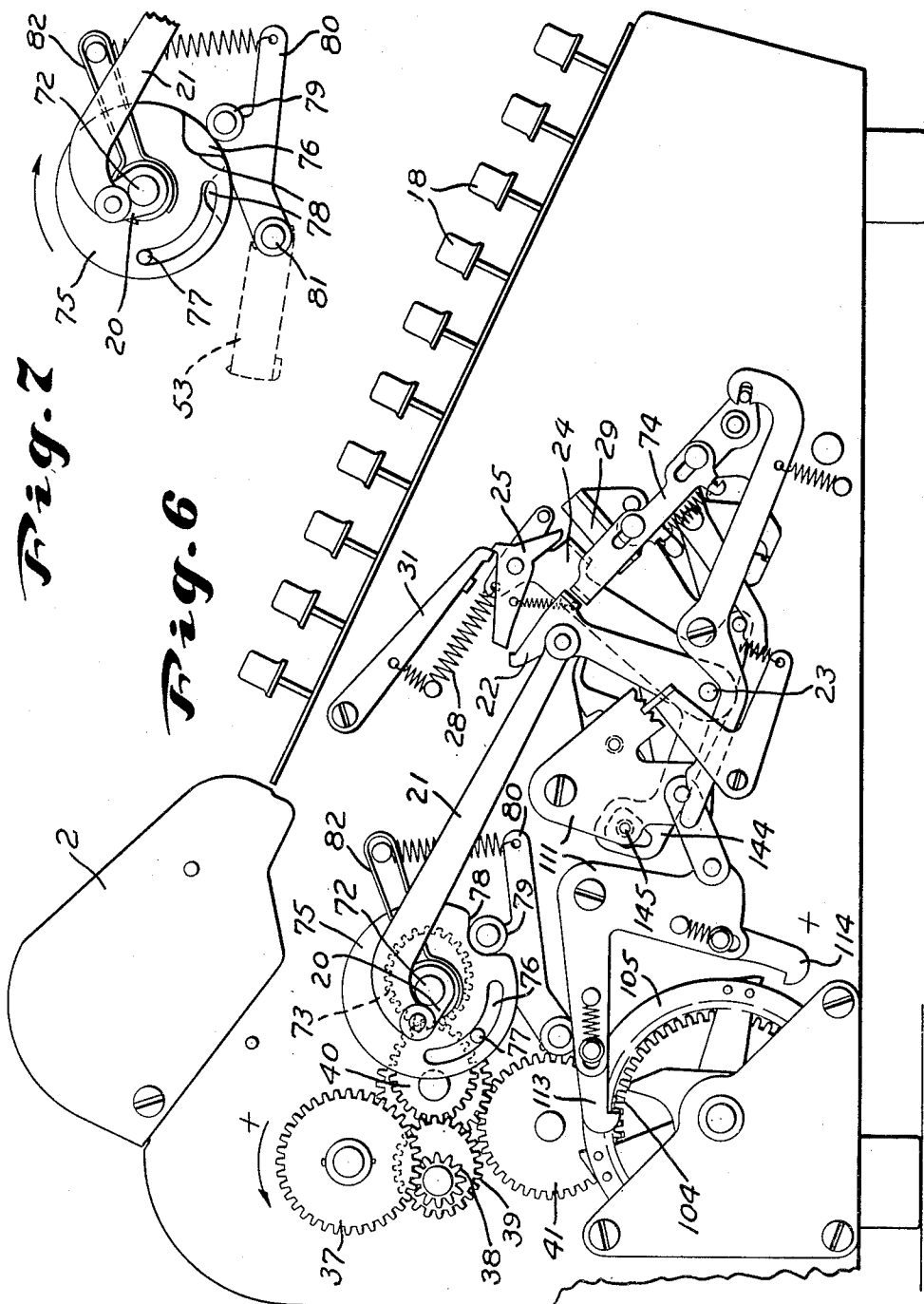
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CALCULATING MACHINE

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5 Sheets-Sheet 4



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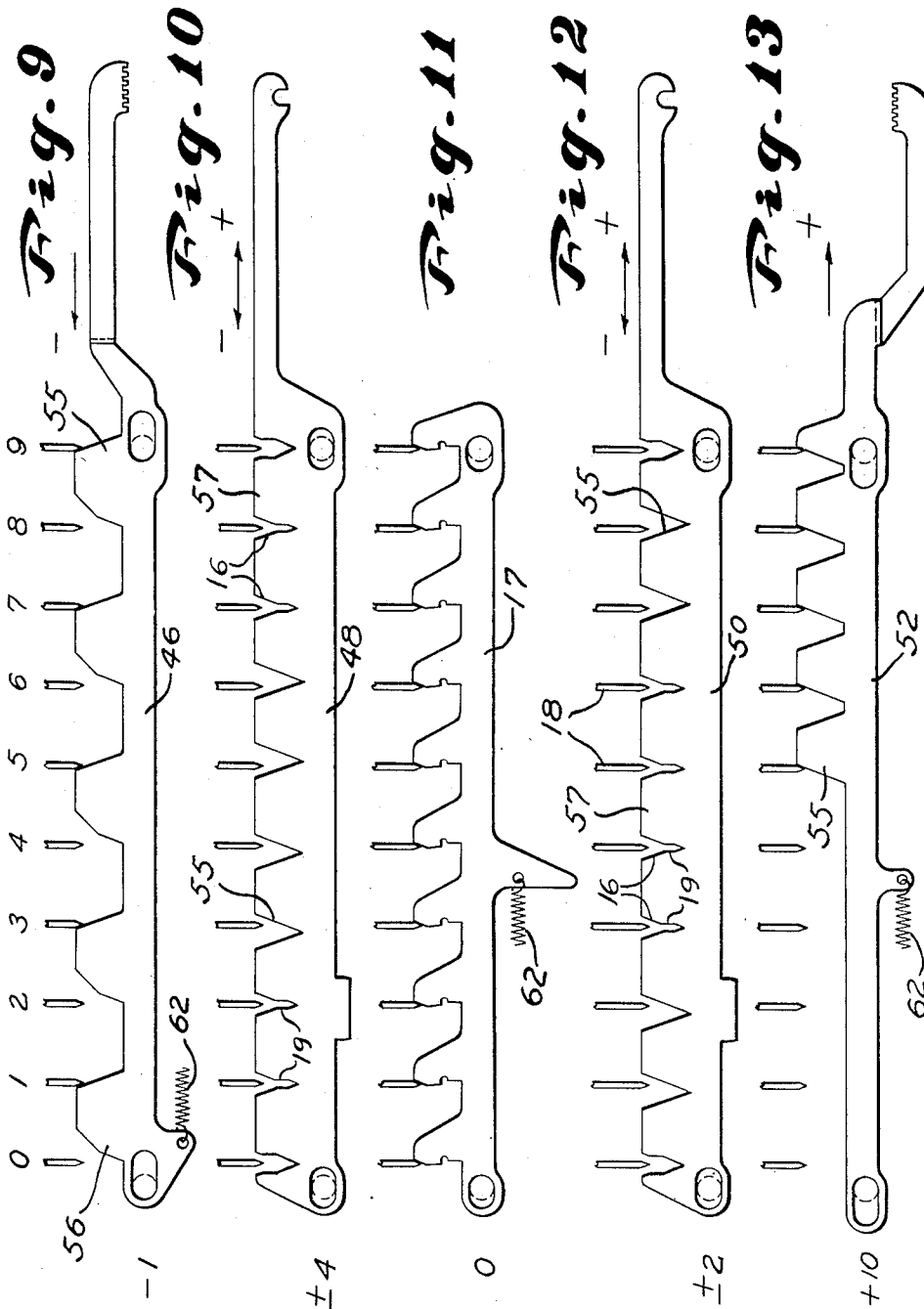
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CALCULATING MACHINE

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5 Sheets-Sheet 5



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UNITED STATES PATENT OFFICE

2,233,912

CALCULATING MACHINE

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Application November 24, 1937, Serial No. 176,156
In Sweden November 25, 1936

8 Claims. (Cl. 235—79)

The invention relates to calculating machines and more particularly to an improvement upon the digit entering mechanism disclosed in applicant's co-pending application Serial No. 51,810, filed November 27, 1935 (Patent No. 2,150,578).

As in one form of said earlier disclosed invention, the digits are here registered on the numeral wheels of the machine according to the semi-complemental system, wherein the lower value digits (as 1, 2, 3, 4) are registered normally, while the higher value digits (as 5, 6, 7, 8, 9) are registered by actuating the numeral wheels in accordance with the digital complements of the selected values.

Thus, in registrations of a plus character:

1 =	+1
2 =	+2
3 =	+3
4 =	+4
5 =	+10 -5
6 =	+10 -4
7 =	+10 -3
8 =	+10 -2
9 =	+10 -1

In order to reduce the number of different adjustments necessary to insure the registration of the several digits, the differential actuators for the numeral wheels consist of a series of orbital gear differential units, the input gears of each differential being designed to transmit different values, which are transmitted singly to the numeral wheels or are combined in the differential to represent the sum or the difference between the input gear values. Thus, the output gear of the differential is given varied angular movement in accordance with the above table, resulting from the setting of a smaller number of digit values and part digit values, as will be seen hereinafter.

The present disclosure corresponds in part to that of a Swedish patent numbered 92,679, issued upon an application filed November 25, 1936; and the invention consists in the novel construction and combination of parts, as set forth in the appended claims.

In the accompanying drawings, illustrating the invention:

Fig. 1 is a section taken through the keyboard and register carriage of a calculating machine embodying the invention.

Fig. 2 is a detail view, of parts shown in Fig. 1, in position assumed during operation of the machine.

Fig. 3 is an enlarged detail axial section

through a differential actuator unit, the lateral dimensions being of larger scale than the longitudinal dimensions.

Fig. 4 is an enlarged detail left side elevation of the sun gear element of the differential.

Fig. 5 is a fragmentary right side elevation of the machine, with casing removed.

Fig. 6 is a left side elevation of the machine, with casing removed.

Fig. 7 is a detail view of parts shown in Fig. 6, in position assumed during operation of the machine.

Fig. 8 is a detail section through the keyboard, showing three columns of digit keys.

Figs. 9 to 13 are detail right side elevations of the five slides associated with a column of digit keys.

The digit entering mechanism provides means whereby amounts set up in the digit keys 18 (Fig. 1) may be registered on the numeral wheels 473. This mechanism is designed to provide a constantly interlocked, continuous drive, and the numeral wheels are therefore preferably provided with tens transfer mechanism of the "crawl" type, illustrated in U. S. Patent No. 2,089,682, issued to the present applicant on August 10, 1937. This transfer mechanism, however, is not essential to the invention, since other forms might be employed.

Related to each column of digit keys 18 is an orbital gear differential actuator unit, shown as a simple planetary train of two input legs and one output leg.

The sun gear 196 (Figs. 3 and 4) of this differential is driven through a single train of pendant gears 197, adapted to be meshed with one of two oppositely rotated pinion wire gears 198, 199 (Figs. 1 and 2) this sun gear meshing with planet pinions 200, pivotally mounted on the face of an output gear 201.

The planet pinions 200 also mesh with an annular or internal toothed gear 202, said annular gear being driven through either of two trains of pendant gears 203, 204, having different gear ratios and each adapted to be meshed with either of the two oppositely rotated pinion wires 198, 199.

As shown, the pinion wire gears 198, 199 are each formed with twelve teeth, and the upper gear of the pendant train 197 meshes with a sixteen tooth gear 205, fast upon the hub of the sun gear 196. The upper gears of the trains 203, 204 mesh with the teeth of a compound gear 206, provided with twelve and twenty-four teeth respectively, said compound gear being fast

with the annular gear 202. The sun gear 196 is formed with twelve teeth, the annular gear 202 with thirty-six teeth and the output gear 201 with sixteen teeth.

According to these ratios, one-third rotation of a pinion wire 198 or 199, transmitted through the train 197 and the sun gear, will effect a one tooth movement of the output gear 201, which is intended to be equivalent to a single step of movement of the numeral wheel of the machine. Likewise, one-third rotation of a pinion wire, transmitted through the pendant train 203 and the annular gear will effect a four tooth movement of output gear 201 and a four step movement of the numeral wheel, and one-third rotation of a pinion wire, transmitted through pendant train 204 and the annular gear will effect a two tooth movement of the output gear.

The gear trains 197, 203 and 204 may be engaged singly or in groups with the pinion wires, the effective values of the trains being aggregated or the difference obtained by the differential actuator gearing.

Thus the digits 1 to 9 are registered by the following plus and minus registering actions of the sun gear and the annular gear, singly or in combination.

	1 =	+2 - 1
	2 =	+2
30	3 =	+4 - 1
	4 =	+4
	5 =	+10 -4 - 1
	6 =	+10 -4
35	7 =	+10 -2 - 1
	8 =	+10 -2
	9 =	+10 -1

The value +10 is registered as +1 in the differential unit of next higher order, through the train 197 thereof, unless -1 is called for in the setting of the higher order column, in which case the +1 and -1 cancel each other, as will hereinafter appear, train 197 standing in neutral position, out of engagement with the pinion wire gears 198 and 199, and being locked against rotation.

It will be noted that 1 (as distinguished from 10) is always registered subtractively, so that the setting of this single train will effect all necessary single step registrations, whether of -1 or of +10 from the next lower column.

It may be remarked that the values plus or minus 1, plus or minus 2, plus or minus 4, form the only combination of three digits capable of registering all of the digits 1 to 9 by the short cut system set forth in the preamble of this specification and employing a three-legged differential selector gearing. Further, the advantages of the invention are not confined to mechanisms operating according to the decimal system. Since one leg of the differential represents the unit 1 and the other input leg consists of trains of gearing having gear ratios representing contiguous even number digits, it is obvious that one such train of gearing gives a capacity for registration in sixths; two trains providing for decimal registration, etc. Obviously, the extension of the even number series by providing additional gear trains in driving connection with the annular gear 202 will extend the capacity of the differential actuator, so that fourteenths, eighteenth, etc. may be registered, each additional train giving four additional units capacity.

By reversing the directions of rotation of the pinion wires, the arithmetical signs of the digit

and part digit registration will be reversed, and the amount set in the keys 18 will be subtracted from the value registered on the numeral wheels 473. Multiplication may be performed by repeated addition, and division by repeated subtractions; that is to say, by repeated registering cycles of the machine. The pinion wire gears 198 and 199 are therefore driven cyclically (the cycle corresponding to a third rotation of these gears); being started and stopped in full-cycle position, relative to the registering action.

The pinion wire gears 198 and 199 are connected by gears 35 and 36, mounted upon their spindles (Fig. 5), and pinion wire gear 199 is provided with a drive gear 37 (Fig. 6), mounted upon its opposite or left hand spindle. Gear 37 is driven through pinion 38, elliptic gears 39 and 40 and a train of spur gears 41, preferably from electric motor 100 (Fig. 1). A differential gear clutching and reversing transmission mechanism is interposed between motor 100 and gear train 41, this mechanism being designated by the numeral 105, and being more particularly illustrated in Patent No. 1,964,211, issued to Austin A. Overbury on June 26, 1934. The clutch is effected by a compound clutch lever 111, movable in either direction from neutral position to engage either of its opposite jaws 113, 114 with stop lugs adapted to engage different members of the differential gear train, engagement of jaw 113 resulting in subtractive rotation of the output gear 104, and engagement of the jaw 114 effecting additive rotation of said gear. Output gear 104 meshes with one of the gears of the train 41, and thereby transmits additive or subtractive movement to the pinion wire gears 198, 199. Clutch lever 111 is controlled through a setting lever 128 (Fig. 1), mounted on a rock shaft 125 which extends to the right hand side of the machine. A crank arm 126 (Fig. 5) is mounted on the right hand end of shaft 125, and is connected by links 123 with the stems of two keys or bars 120, 122, controlling plus and minus operation of the clutch, respectively.

The pendant trains 197, 203 and 204 are mounted upon plates 42, 43 and 44 respectively, as seen in Figs. 1-3, these plates being mounted for pivotal movement about the shaft 45 which supports the differential actuator units (parts 196, 203-202). Plates 42-44 are rocked to bring the respective gear trains into mesh with the pinion wire gears 198 or 199 by means of slides controlled by the digit keys 18.

For each bank of digit keys, four setting slides are provided (Figs. 1 and 8-13); a slide 46 having a rack and pinion connection 47 with plate 42 and movable toward the front of the machine to engage pendant train 197 with pinion wire gear 198, to effect registration of -1; a slide 48, having pin and slot connection 49 with plate 43 and movable forwardly or rearwardly to engage train 203 with gear 198 or 199 to register ± 4 ; a slide 50, having pin and slot connection 51 with plate 44 and movable forwardly or rearwardly to engage train 204 with gear 198 or 199 to register ± 2 , and a slide 52, having rack connection with the pinion 47 in the next higher order column, and movable toward the rear of the machine to rock plate 42 and engage train 197 with pinion wire 199, to register +10.

The initial forward or rearward setting of these slides is effected by the keys 18, the setting being completed, upon operation of the machine, by the action of a universal bail 53, engaging cam faces 54 of the plates 42-44.

The bottoms of the stems of the digit keys 18 are beveled, and are designated to engage cam projections or setting cam faces 55 of the slides, to effect the preliminary setting movement thereof. The arrangement of these cam projections to give the correct setting for the different digits is illustrated in Figs. 9, 10, 12, 13, wherein it will be noted that the cam slopes of the projections 55 are laid out upon the same angle, both for the one direction and for the two direction slides.

The key stems engage the cam faces of the slides 46 and 52 during the entire key stroke, but the cam faces of the slides 48 and 50, which must be moved alternatively in one or the other direction upon depression of the same keys, are so disposed that if the slides lie in neutral position, depression of one of the related keys will bring the key stem into contact with the cam projection 55 when the key has been depressed about two-thirds of its stroke. The greater movement of the slides 46 and 52 and the lesser movement of the slides 48 and 50, under the influence of the keys 18 is equalized by the location of the connecting elements 47, 49 and 51 at different distances from the shaft 45.

The cam projections 55 of the slides 46 are extended at 56 toward the adjacent keys 18, in order to provide an interlock to prevent full depression of two keys in a single column, the slides 48 and 50 being provided with locking projections 57 for the same purpose. The projections 57 are of particular importance, since they prevent simultaneous engagement of the pendant trains 203 and 204 with the pinion wire gears, the trains providing drives of different gear ratio for the same output gear. It will be noted that different slides must be relied upon to lock different keys under the various conditions. For instance with the 9 key depressed, the 0, 2, 4, 6, 8 keys are locked by slide 46; the 1 and 7 keys are locked by slide 50 and the 3 and 5 keys are locked by slide 48. It will further be noted that the cam faces 55 of the slides 48 and 50 are extended downward, beyond the limit of the key stroke, so that the slides are not held against further movement by the opposite walls of the V-notches illustrated in Figs. 10 and 12.

The lower ends of the locking slots between the projections 57 have parallel walls 19, and in order that the depression of a key shall cause no cramping, due to the movement of a slide 48 or 50 against a previously depressed key, the walls of these locking slots are extended upwardly to form auxiliary cam faces 16. Thus, the depressed 7 key, for instance, engages the walls 19 of slide 48, and holds slide 50 in forward position. Now, depression of the 6 key will first engage the auxiliary cam 16 of slide 50 and cam the 7 key, through the setting cam, sufficiently to lift it out of register with the walls 19 of slide 48. Thereafter the 6 key will engage the setting cam 55 of slide 48, which is now free to move.

The keys are latched in depressed position by means of a slide 17 (Fig. 11), in the manner well known in "flexible" keyboard arrangements, the key stems effecting the release of any previously depressed keys when they have travelled approximately one-third of their stroke. The keys may be released in all columns by means of a bail 58 (Fig. 1) engaging lugs 59 of the latching slides, bail 58 being operable by rock shaft 60 and clear key 61 (Fig. 5).

The slides 46, 52 and 17 are normally held retracted by means of springs 62, while the slides

48 and 50 are normally centralized by means of the opposed spring jaws 63 illustrated in Fig. 1.

When the machine is at rest the differential actuator units and their pendant trains are locked against rotary movement by means of spring pawls 64, 65 (Figs. 1 and 2), the pawl 64 engaging one of four notches of a disk 66 (Figs. 3 and 4), which serves to lock the sun gear and its associated parts and to keep the gearing in time. Pawl 64 is provided with opposed cam faces 67 adapted to be engaged by an extension 68 of the plate 42, so that as said plate is rocked in either direction by bail 52 pawl 64 will be lifted from engagement with the disk 66, and the sun gear will be free to rotate.

Pawl 65 is adapted to engage between the teeth of one of the gears 206 which drive the ring gear 202, this said pawl being provided with opposed cam faces 69 adapted to be contacted by an extension 70 or 71 of the plates 43, 44, when either plate is rocked clockwise or counter-clockwise, disengaging the pawl from the teeth of gear 206 and freeing the ring gear for rotation.

It will thus be seen that when the machine is operated, rocking of bail 53 will throw the pendant trains 197, 203-204 into full mesh with pinion wire gears 198, 199, in accordance with the partial setting of the slides 46, 48, 50 and 52, and the sun gear or the ring gear or both will be simultaneously released. At this time, also, it is desired to adjust the drive of the register wheels 473 from aligned into crawl tens transfer position, as set forth in Patent No. 2,089,682, hereinbefore referred to.

For this purpose, bail 53 is provided with a linkage 490, operable to lift a bail 489, which is mounted in the register carriage 2 of the machine, bail 489 engaging a series of frames 483 pivoted at 481 and having each mounted thereon an intermediate gear 482, related to a numeral wheel 473. Each frame 483, has an extension acting as a follower or feeler for a cam 485, secured to the numeral wheel of next adjacent lower order. Lifting of bail 489, through bail 53, will lift all of the plates 483 away from the cams 485 and will hold them immovable in operating position. During the operation of the machine, partial or fractional transfer movement will be transmitted from wheel to wheel, in well known manner, and at the end of the operation, dropping of bail 489 will allow the plates 483 to move, under the influence of suitable springs, into contact with the cams 485, this movement effecting planetary movement of the intermediate gears 482 and thereby transmitting movement to the numeral wheel sufficient to compensate for the partial tens transfer displacement of the wheel.

It is desirable that the parts adjusted as above described by movement of the bail 53, shall be held in adjusted position until the machine is brought to rest, so that when multiple cycle operations are performed unnecessary adjustment of the parts may be avoided. This is accomplished as follows:

A shaft 72 (Fig. 6) is driven one complete rotation during each operative cycle of the machine by means of an elliptic gear 73 meshing with the elliptic gear 40, shaft 72 being provided with a crank arm 20 and link 21 whereby said shaft is connected to stopping mechanism corresponding to that shown in Patent No. 1,964,211, hereinbefore referred to. As set forth in said patent, link 21 is connected at its forward end to a rock lever 22, fulcrumed at 23 in the framing, said

lever being thus constantly reciprocated during the operation of the machine. During the final cycle of the operation, a trigger 31 is tripped, either by mechanism operated upon the release of the plus or minus bar, 120, 122, or by movement of one of the numeral wheels 473, in well known manner.

Tripping of trigger 31 will release a normally restrained spring pawl 25, pivotally mounted upon a stop arm 24, said arm being pivoted to the framing at point 23. Pawl 25 being released will drop into the path of movement of a lug of rock lever 22, thereby coupling arm 24 to said rock lever. Continued clockwise movement of lever 22 beyond full cycle position of the parts as viewed in Fig. 6, will rock the arm 24 forwardly, against the tension of a spring 28, until a lug of said arm encounters a fixed step 29, whereby the continued rotation of the machine in the original direction will be arrested. At the same time an extension 144 of arm 24 will rise, bringing one of two opposed cam portions of said extension into contact with a centralizing pin 145 secured upon the clutch lever 111, thereby releasing the clutch. The parts, having now overrun full cycle position, will be brought back into such position by an action of spring 28, in which position they may be held by a lock bar 74.

The bail 53 is controlled from shaft 72 by means of two disks 75, 76 having a pin and slot connection 77 with each other and being each provided with a cam notch 78, these two notches registering normally with each other and being engaged by roller 79, fixed upon a spring follower arm 80. Arm 80 is secured to the shaft 61 to which bail 53 is rigidly connected. Disk 76 is fast upon shaft 72, while disk 75 is loosely mounted thereon and is provided with a friction spring 82. Upon rotation of the parts in either direction, friction spring 82 will cause disk 75 to lag relatively to disk 76, and the two notches 78 will lie out of line with each other, so that roller 79 will in effect be held in operated position upon the periphery of an unbroken disk, as seen in Fig. 7 of the drawings. This will hold bail 53 and the parts operated thereby in adjusted position so long as the machine continues to operate. When the operation is concluded, and the parts are brought back from overrun to full cycle position, disk 75 will again lag, until the two notches 78 are brought into register with each other, which will occur as the parts come to full cycle position, whereupon roller 79 will drop and bail 53 will be retracted.

The elliptic gears 39, 40 and 73 have an important function in connection with the engagement and disengagement of the gear locking pawls 64 and 65, the swinging of the pendant trains 197, 203 and 204 into and out of mesh with the pinion wire gears 198 and 199, and the action of the stopping arm 24 and lock bar 74. An inspection of Fig. 6 will show that the actuator and numeral wheel drive will be slowest as the parts approach and leave full cycle position, whereas the parts controlled by bail 53 and the stopping mechanism will be most rapidly operated as the parts approach and leave full cycle position.

Considering therefore the locking bails 64 and 65, these will be rapidly disengaged and reengaged at the start and finish of an operation, while the gears with which they cooperate will be moving very slowly. Similarly, the pendant trains will be rapidly moved from partial to full engagement with the pinion wire gears 198 and 199 while said gears are rotating slowly. Also

the stopping arm 24 will be more sensitive to rotation of the parts, since the movement of link 21 about dead center of the shaft 22 will be compensated by more rapid movement of that shaft. This will allow sufficient cushioning of the stop, without any great overrun of the actuators beyond full cycle position. It will also be apparent that the lock bar 74, when engaged, will allow less movement of the gearing, because of the more rapid movement of arm 22 about the dead center of the linkage.

The known register whereon a multiplier or quotient value will be displayed is not directly concerned with the present invention, and has not been illustrated herein. Any register provided with reversible numeral wheels and a tens transfer mechanism, as shown for instance in U. S. Patent No. 1,504,741, issued on August 12, 1934, to the present applicant, will serve the purpose.

I claim:

1. In a calculating machine having drive mechanism including gears; the combination with digit entering means including a series of orbital gear differential units, two plates adapted for pivotal movement about the axis of each differential, trains of gears of different gear ratio including gears mounted upon the two plates and gears meshing therewith and having fixed connection with a single input leg of the related differential unit, and means for adjusting one or the other of said plates to mesh the related gear trains with gears of the drive mechanism, of a spring impelled pawl normally in locking engagement with a gear connected with said single input leg, and lugs upon each of said two plates, either lug operable in the meshing adjustment of the plate to lift the pawl out of locking engagement with its gear.

2. In a calculating machine having drive mechanism including gears; the combination with digit entering means including a series of orbital gear differential units, plates adapted for pivotal movement about the axis of each differential, trains including gears mounted upon the plates and gears meshing therewith and having fixed connection with the input leg gears of each differential unit, series of digit keys, means adjustable by the keys to move selected plates out of their normal position of rest, and a universal member operable by the drive mechanism to adjust any plate standing out of normal position to mesh the related gear train with a gear of the drive mechanism, of spring impelled pawls normally in locking engagement with gears connected with the input legs of the differential units, said plates having lost motion connection with said pawls operable to lift said pawls out of locking engagement with their gears by power transmitted through said universal member.

3. In a calculating machine having drive mechanism including gears and means for arresting the drive; digit entering means including variably driven gear units, plates adapted for pivotal movement about the axis of each gear unit, trains including gears mounted upon the plates and gears meshing therewith and having fixed connection with the gears of the related units, series of digit keys, means adjustable by the keys to move selected plates out of their normal position of rest, a spring retracted universal member operable to adjust any plate standing out of normal position to mesh the related gear train with a gear of the drive mechanism, means operable by the drive mechanism to operate the universal

member, means adjustable to hold said operating means in active position, and means cooperating with the drive arresting means to retract the holding means.

5 4. In a calculating machine having numeral wheels and differential actuators therefor having differentially settable driven elements, and cyclic drive means for said actuators; means for locating driven elements of said actuators in
10 given set positions, and drive mechanism for said actuators and said locating means including variable ratio gearing operable to drive the actuators at a diminished speed and simultaneously to drive the locating means at an augmented speed
15 as the drive means moves through a zone adjacent to full cycle position.

5. In a calculating machine, cyclically driven gears, digit entering means including a series of differential units each comprising gears selectively adjustable into mesh with said cyclic gears,
20 means for so adjusting the gears of the differential units including a universal member and an operating device therefor, and drive mechanism for said cyclic gears and said operating
25 device including variable ratio gearing operable to drive the cyclic gears at a diminished speed and simultaneously to drive the operating device at an augmented speed as the cyclic gears move through a zone adjacent to full cycle position.

30 6. In a calculating machine, cyclically driven gears, digit entering means including a series of orbital gear differential units each including a plurality of input legs adapted for driving engagement with the cyclically driven gears, spring
35 impelled pawls normally in locking engagement with a gear connected with each input leg, means for selectively releasing one or more of said pawls including a universal member and an operating device therefor, and drive mechanism for
40 simultaneously operating said cyclic gears and said operating device including variable ratio gearing operable to drive the cyclic gears at a dimin-

ished speed and simultaneously to drive the operating device at an augmented speed as the cyclic gears move through a zone adjacent to full cycle position.

7. In a calculating machine having numeral
5 wheels and drive mechanism including oppositely rotated gears of the same driving gear ratio; digit entering means comprising a series of differential units each related to a numeral wheel
10 and including orbital gearing and related gear trains, each orbital gear unit having an input leg comprising a plurality of alternatively controlling independent gear trains of consecutive
15 even digit gear ratios and a second input leg comprising a gear train of a comparative gear ratio of one, and means for meshing gear trains of one or more of said input legs with the drive
20 mechanism through the forwardly or alternatively through the reversely rotated member, selectively, to register any one of the lower value digits of a consecutive series positively or any one of the higher value digits of said series complementally.

8. In a calculating machine having numeral
25 wheels and drive mechanism including oppositely rotated members; digit entering means comprising a series of differential units each related to a numeral wheel and including orbital gearing and related gear trains, each orbital gear unit
30 having an input leg comprising two alternatively controlling independent gear trains of a comparative gear ratio of 2, 4 and a second input leg comprising a gear train of a comparative gear ratio of 1, and means for meshing gear trains
35 of one of more of said input legs with the drive mechanism through the forwardly or alternatively through the reversely rotated member, selectively, to register any one of the digits 1 to 4 positively or any one of the digits 5 to 9 complementally.

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