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CALCULATING-MACHINE.

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To all whom it may concern:

Be it known that I, EMORY S. ENSIGN, a citizen of the United States, and residing at Newtonville, in the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Calculating-Machines, of which the following is a specification, reference being had therein to the accompanying drawings.

My invention relates to certain improvements in calculating machines of that type shown in my United States Letters Patent numbered 773,632 dated November 1st, 1904, particularly adapted to the performance of multiplication and addition but capable of the performance of the other arithmetical processes and has for its main object the obtaining upon a meter the product in multiplication in a more certain and perfect manner and with greater rapidity than has heretofore been done.

One object of the invention is to provide an improved adding and multiplying machine so simple that its operation may be quickly understood and acquired.

My invention consists, first, in an adding key board consisting of nine parallel rows and nine parallel banks of adding-keys, each key having precisely the same degree of inward movement (namely 3/16 of an inch) without regard to the values which they represent, while the effective movement transmitted to the meter will be proportioned to the value represented by each key; second, in a new and improved form of meter; third, in a new and improved form of multiplier meter; fourth, in a new and improved form of adding-keys indicator or reflector; fifth, in new resetting mechanism; sixth, in new multiplying mechanism; seventh, in new and simple driving mechanism; eighth, in new pointing-off mechanism.

In a machine built according to my invention, the adding keys and their respective adding plates may be allowed to instantly return to their normal positions by a single operating-lever (hereinafter called the "release bar") after the indicating devices have been moved to the desired positions in any of the various arithmetical problems and are automatically returned to their normal positions in problems of addition and subtraction as soon as the meter has been operated by the depressed adding-keys; the depressed adding plates displaced out of normal position by the pressure down upon their respective adding-keys are held so as to be met by the meter, when it is revolved with the driving-shaft, and one or more of its wheels operated by the teeth of the depressed adding plates; the movement of the multiplying-keys is transmitted to the indicating mechanism and all of these keys receive precisely the same degree of downward movement without regard to the values which they represent, while the multiplicand represented by the depressed adding-keys may be quickly and accurately multiplied by any one of the depressed multiplying-keys and the product shown on the meter; the depressed multiplying keys and their respective multiplier plates are automatically returned to their normal position as the meter is operated by contact with the toothed adding plates; the meter is automatically shifted, in problems of multiplication, immediately after the meter has been operated according to the depressed adding-keys and the depressed multiplying-key, one position to the right so that the next operation of depressing a multiplying-key will cause a multiplication to be made which would be ten times greater in each case than it would have been had the meter not been shifted; the meter may be automatically shifted to the right, without revolving it or its driving-shaft, when one or more "naughts" appear in the multiplier; the meter may be instantly reset backward from right to left to its normal position; the multiplier meter shows the number of revolutions the meter has been caused to make by the turning of its driving-shaft, and in multiplication showing the multiplier, *i. e.* the depressed multiplying-keys and the position of the meter when each of the keys was depressed; all of the wheels of the meter to be operated are simultaneously operated by the depressed adding plates upon each revolution of the driving-shaft; the meter and multiplier meter may be instantly reset to their normal or zero positions; the meter may be revolved independently of the multiplying-keys in problems of addition and subtraction.

My invention consists further, in the legitimate combinations of the features referred to with each other and with other features not yet alluded to, and in numerous

other subordinate but important combinations, all of which will be fully described hereinafter.

In the accompanying drawings in which most of the figures (for example, Figs. 3 to 16 inclusive) are made the exact size of the machine and illustrate a machine made in accordance with my invention,—Figure 1 is a top plan view of the complete machine with some parts broken away. Fig. 2 is a left end elevation showing motor, the box for same and table being in section. Figs. 3 and 4 form a continuous central vertical section on line 3—4 of Fig. 1, and matching on lines A, A, Figs. 3 and 4. In these figures some of the interior mechanism is shown in elevation and other portions entirely removed for purposes of clearer illustration. Fig. 5 is a vertical cross section on line 5—5 of Fig. 1. Fig. 6 is a vertical cross section on line 6—6 of Fig. 1. Fig. 7 is a plan view of the multiplying mechanism. Fig. 8 is a similar plan view of a portion of the same. Fig. 9 is a plan view of the balance wheel. Fig. 10 is a vertical cross section on line 10—10 of Fig. 1 with the meter in its original or normal position, and showing the position of the parts before the meter wheels have met and been operated by the toothed adding-plates. Fig. 11 is a similar partial section showing the different positions of one section of the meter while the wheel of this section is being operated by the teeth of one of the adding plates. Fig. 12 is another similar view showing the different positions of the same section of the meter after the wheel has been fully operated by the adding plate and the carry-up hammer (shown in Fig. 32) for that wheel has only been partly operated. Fig. 13 is another similar view of the same parts showing the carry-up hammer being reset by one of the recocking fingers, after the carrying process is completed. Fig. 14 is a vertical cross-section on line 14—14 of Fig. 1. Fig. 15 is a partial central vertical section on line 3—4 of Fig. 1 looking in direction of arrow 15. Fig. 16 is a front elevation of the multiplier meter. Fig. 17 is a section on line 17—17 of Fig. 16. Fig. 18 is a section of the shifting device taken on line 18—18 of Fig. 1. Fig. 19 is a plan view of Fig. 18. Fig. 20 is a partial elevation of the right end plate of the meter. Fig. 21 is an edge view of Fig. 20. Fig. 22 is a plan view of one of the buttons. Fig. 23 is a section on line 23—23 of Fig. 22. Fig. 24 is a plan view of one of the supports for the meter. Fig. 25 is an edge view of the same. Fig. 26 is a side view of one of the meter wheels. Fig. 27 is a section on line 27—27 of Fig. 26. Figs. 28 and 29 are a plan and section of the disk collar for the cam. Figs. 30 and 31 are a plan and section of the cam. Figs. 32 and 33 are a plan and edge view of one of the carry-up hammers. Figs. 34 and 35 are a plan and edge view of one of the carry-up pawls. Figs. 36 and 37 are a plan and edge view of one of the over-rotation pawls. Figs. 38 and 39 are a plan and edge view of one of the hammer cocking retaining pawls. Figs. 40 and 41 are a plan and edge view of one of the friction pawls. Figs. 42 and 43 are a plan and edge view of one of the cam operated pawls. Fig. 44 is a plan view of the adder-bar plate. Fig. 45 is a plan view of one of the adding plates, namely the plate to which one of the "4" adding-keys is connected. Fig. 46 is an under plan view of the motor, partly in section. Fig. 47 is a partial end view of motor opposite to Fig. 2 and inverted. Fig. 48 is a section on line 48—48 of Fig. 46. Fig. 49 is a plan view of one of the multiplier plates, namely the plate to which the "5" multiplying key is connected. Fig. 50 is a rear elevation of that portion of the meter which is shown in Fig. 3. Fig. 51 is an end elevation of the snap switch shown in Fig. 2. Fig. 52 is a section on line 52—52 of Fig. 51, with bar in position for complete electric connection, and on point of snapping to disconnecting position shown in Fig. 53. Fig. 53 is a side elevation, partly in section, of the same, in disconnecting position. Fig. 54 is a side elevation of the same, partly in section, with bar in complete electric connection.

In the specification and claims the following terms will be always used to denote these particular parts—"adding-keys" are the several series of keys fully shown in Fig. 1 in the forward central portion of the machine, and which are used for operating or throwing out of their normal positions a similar number of toothed segments or adding plates to which they are attached, and which plates for convenience will be designated the "adding plates". "Multiplying-keys" are the nine keys, also fully shown in Fig. 1 in the forward right end portion of the machine, and used for operating or throwing out of their normal positions a similar number of multiplier plates to which they are attached, these plates being used to allow the meter to operate and to limit its motion, and will be designated the "multiplier plates". "Shift key" is the zero key, bearing upon its face the numeral "0", and which is adjacent to and parallel with the "9" key of the multiplying-keys. "Meter" is the revolving epicycle indicator, seen through the large plate of glass and which I have shown as containing sixteen spools or wheels. This meter is independent of the adding-keys and is used for indicating the sum of the figures as they are added, the product in multiplication, the remainder in subtraction, and the quotient and its remainder in division. "Multiplier meter" is the indicator on the left forward portion of the machine, seen through the smaller plate of glass, and operable from the

meter for showing the number of figures in the column added, showing the multiplier in multiplication, and the quotient in division thus proving the answer in division. The "indicator" is in the form of a reflector, seen through the large plate of glass, immediately in the rear of the upper row of adding-keys and forward of the meter, and which reflects or shows numerals representing the depressed adding-keys. The "adder-bar" is the lever for revolving the meter independently of the multiplying-keys, principally for use in problems of addition and subtraction and for revolving the meter in resetting and is the upper finger bar, shown in Fig. 1, situated between the multiplying and adding keys. The "release-bars" is the lever for releasing the adding-keys and allowing the return of the adding plates when it is desired to reset the adding mechanism without operating the adder-bar, and is the bar situated immediately below the adder-bar, as shown in Fig. 1. The "resetting-lever" is the lever situated at the extreme left of the machine, on the outer side of the case, see Fig. 1.

Latitude is allowed herein as to details, as they may be changed or varied at will without departing from the spirit of my invention and the same yet remain intact and be protected.

In order that the construction and operation may be the more readily comprehended I shall endeavor, whenever practicable, to preface the description of the mechanism with a statement of the end to be accomplished thereby. The descriptions of the various mechanisms will be given in order of their operation in the machine.

Corresponding and like parts are referred to in the following description and indicated in all the views of the drawings by the same reference characters.

The framework and table.—Referring to the drawings, 107, see Fig. 2, represents the table, to the under side of which is attached the box 110 which incloses the motor, governor, power spring and other driving mechanism and upon which table rests the base plate or main bed 52 of the machine. This base plate supports the frame of the machine and the case or housing 53; the case being attached to the base plate by the screws 58. The case may be constructed in any suitable form and manner, but I preferably use a case constructed as shown in Figs. 1, 2, 5 and 6 of the drawings and within which is placed all the operating parts of the machine with the exception of parts of the driving mechanism which are inclosed in the box 110. The rear of the framework is semicircular, extending upward in the shape of a hood as clearly shown in Figs. 1 and 2. The multiplying mechanism is situated in the right end portion of the machine, as shown in Figs. 1 and 4 to 6 inclusive and is partly covered by the hood.

The adding mechanism is situated about midway of the machine, as shown in Fig. 1, and is partly covered by the hood but a glass sight-orifice 54 is provided for permitting the figures upon the meter and indicator to be read. This sight-orifice 54 extends nearly across the front upper part of the machine so that all of the numeral wheels of the meter may be read, even when the meter has been shifted to its extreme right position. A glass sight-orifice 55 on the forward left portion of the machine, extending from the left side of the adding mechanism to the left end of the case allows the multiplier meter to be read. Extending through a dust proof shift case 56, in the top portion of the case 53, is the pointer 57, hereinafter fully described.

By examining Figs. 1, 2, 5, 6 and 10, it will be noticed that the base plate 52 is extended quite a distance forward at the right end of the machine to allow for the multiplying mechanism, and is also likewise extended forward below the adding mechanism, and that the case 53 covers the greater portion of the front part of the multiplying and adding mechanisms.

Tie-rods 59 are used quite extensively throughout the machine to securely hold different sections of the machine together and so that the different sections of the machine can be quickly separated and access to any part of the machine obtained to be adjusted or repaired, without taking down the entire machine. Upon some of the tie-rods 59 are separators or spacers 60 to keep the parts in their respective positions.

Adding-keys and their mechanism.—My improved machine is so constructed that the finger disks of the adding-keys 61 are all at a uniform angle of about 45°, and each of the adding-keys should receive precisely the same degree of an inward movement, namely 3/16 of an inch, without regard to the values which they represent. These keys are used in all of the arithmetical problems and offer but little resistance to the depressive movement in order not to tax the strength of the operator, and each key without respect to the value represented receives the same amount of movement inwardly at an angle of 45°. The adding-keys 61 and their adding plates 62, see Figs. 1, 10 and 15 comprise in general a number of series of parallel keys and plates each series having nine keys respectively in value from "1" to "9" from the lower to the upper key and nine plates from left to right in value respectively from "1" to "9".

I have shown in my drawings nine series which are parallel to and independent of one another, although the machine may be built with any number of series, with the desired

extra number of meter wheels, multiplier meter wheels and other necessary parts to correspond, so that it could add any number of columns or multiply figures of any amount. By using parallel series of adding plates 62 I can have any number of series of adding-keys, while in a machine as shown in my first patent the number of series is limited according to the diameter of the toothed disks and the diameter of the meter wheels.

The series of adding-keys commencing at the right as shown in Fig. 1, are units, tens, hundreds, thousands, tens of thousands, hundreds of thousands, millions, tens of millions and hundred of millions, and commencing at the bottom of each series of nine adding keys and going towards the top, the keys are numbered respectively, "1", "2", "3", "4", "5", "6", "7", "8", "9". It will be very clearly understood by examining the drawings that the arrangement of adding keys and their plates can when so desired easily be changed so that the keys run in the reverse order without in any way interfering with or necessitating any change in the other parts of the machine.

Each set or series of adding plates 62 consists of nine separate and independent plates, and each set is incased or held between two side plates 63 and 64; the side plates on the left of each series of adding plates being numbered 63 and those on the right 64. These side plates 63 and 64 of each series are separated by spacers 60 on tie-rods 59. These adding plates 62, see Figs. 10 and 45, have on their inner edge in the form of a toothed segment one or more teeth 65 according to the value which they represent. For example, the adding plate of key "1" of each series is provided with one tooth, the adding plate of key "2" of each series with two teeth, the adding plate of key "3" of each series with three teeth, the adding plate of key "4" of each series with four teeth (see Fig. 45) and so on, and it will be noticed, by examining Fig. 10, that the adding plate of the depressed key "9" of the "tens" series is provided with nine teeth, and that this adding plate of nine teeth has been displaced out of normal position by the pressure down upon its adding-key, and is in driving contact to be met by the meter when it is revolved with the drving-shaft, which meter is arranged to be revolved around the inner side of the machine and to be operated by the teeth of the displaced adding plates.

The adding plate on the extreme left of each series is the one that has only one tooth, which tooth is near the lower end of the adding plate, and is operated by the respective key of that series which bears the numeral "1", and this tooth is in horizontal alinement with the tooth on each of the adding plates on the extreme left of each series which is operated by a key bearing the numeral "1"; the nex adding plate to the right has two teeth, the second or lower tooth being in horizontal alinement with the tooth on the first adding plate; the next adding plate to the right has three teeth, the third or lower tooth being in horizontal alinement with the tooth on the first adding plate and its second tooth being in horizontal alinement with the first tooth on the second adding plate; the next adding plate to the right has four teeth, and so on, so that the adding plate on the extreme right of each series, which is the ninth adding plate in the series, has nine teeth, the first tooth being above any of the other teeth on the other adding plates of the same series and the ninth tooth being in horizontal alinement with the tooth of the first adding plate and to the lower tooth of each of the other adding plates. It is thus seen that the lower teeth of all of the adding plates of all of the series are in horizontal alinement with each other so that each of the meter wheels leave the teeth of the adding plates simultaneously, see Figs. 10 and 15.

Each of the adding plates is provided on the side opposite to the teeth with a lip 66 curved at its outer end, see Figs. 10 and 45, and to the lower end of this lip is connected a spiral spring 67 fastened at its other end to the inner side of one of the side plates 63 or 64 which spring is distended when the adding plate is displaced and returns the adding plate and its corresponding key to initial position when the adding plate is released, as hereinafter explained, after the meter has come in contact with its teeth the desired number of times.

To the upper end of the lip 66 is attached, by a pin or other means 68, an oblong flat shank 69 having its upper end slotted as at 70 (see Fig. 10) to receive the pin 71 extending transversely across the slotted lower portion of the adding key 61 so that when the adding key is pressed down upon the shank and its slotted portion 72 fitted securely upon the upper portion of the shank, the pin 71 will just fit into the slot 70, these slots also acting as guides for the proper positioning of the keys. The multiplying-keys and their shanks, which will later be explained, are provided with similar pins and slots and attached in a similar manner.

The lower ends of the shanks 69 are curved and the side plates 63 and 64 are provided with openings 73 for clearance for the ends of the pins 68, as clearly shown in Fig. 10. A stud bolt 74 rigidly attached to the side plates 63, 64, by nuts 75 extends through the elongated slot 76 in the shank 69 acting as a guide for the shank and its adding-key; the length of the slot 76 being sufficient to allow of 3/16 inches inward movement of the shank.

Over the upper part of all of the shanks 69 is fitted a plate 77 provided with an opening

for each of the shanks to extend therethrough, and the upper portion of the plate, which is parallel to the finger disks of the adding-keys, is covered with a strip of green felt 78, as is common in adding machines.

The adding plates are provided with oblong slots 79 through which extend the squared guide pins 80 on the studs 81 rigidly attached between the side plates 63 and 64, the length of these slots 79 being just sufficient to allow of an inwardly inclined movement of 3/16 of an inch, see Fig. 10.

When the adding-keys and their adding plates are shaped as shown in Fig. 10, and as just described, the alinement of the teeth of the adding plates will be true to be meshed with the teeth of the corresponding wheels of the meter when it is revolved with the driving-shaft around the inner side of the adding plates.

The indicator.—The indicator or meter for showing to the operator the depressed adding-keys is seen through the larger plate of glass and reflects or shows the numerals representing the depressed adding-keys and the numerals "0" for the banks of keys in which no adding-key is depressed. When desired the machines can be built without this indicator in which case the operator would tell which adding plates were depressed by examining the adding key board. The mechanism connected with this indicator I will now explain,—the adding plates are provided near their upper outer end with an arm 82, see Fig. 45, having a finger 83 at right angles to it and parallel to the meter and carrying on its upper face a numeral; which numerals are reflected in a mirror or reflector 85, which I have termed the indicator, as the adding plate is depressed; the line of vision for same being as shown in Fig. 10. This indicator 85 extends from the right of the right-hand adding plate to the left of the left-hand adding plate being slotted on its lower side to fit tightly down onto the side plates 64, as shown in Figs. 1, 10 and 15.

The fingers 83 are covered by a hood 86 when they are in their normal positions so as their numerals will not show on the indicator, and this hood is also notched on its inner forward edge fitting tightly down onto the side plates 64 forward of the indicator and it extends from the right of the right-hand adding plate to nearly the left inner end of the machine (see also Fig. 14).

The side plates 63 are cut off at their upper ends (as will be seen by comparing Figs. 1, 10 and 15) and are provided with a finger piece 87 carrying the numeral "0" which shows in the indicator when none of the adding plates of that series are displaced out of normal position, and indicates that no adding plate in that series is in driving contact to be met by the revolving meter.

Should two or more adding plates in any one of the series be pushed into position to operate a wheel of the meter, the adding plate having the greatest number of teeth would have the numeral on its finger 83 appear on the indicator showing the number of positions the wheel of the meter operated by that series of adding plates would be turned on one revolution of the meter by its driving-shaft around the inner side of the machine, and as the teeth of each series are arranged in parallel positions beginning at the bottom, as heretofore explained, the wheel of the meter is only turned by the teeth of that series, on one revolution, the number of positions represented by the highest displaced adding-key of that series.

Adding plate locking mechanism.—In order that the adding plates shall be securely locked to operate the meter when the plates are displaced I provide on their under edges two notches 88 and 89, forming a V-shaped tooth between and against the lower side of which and within the lower notch 88 is normally held a spring operated pawl 90. This pawl is as wide as the combined nine adding plates of that series, so that one pawl answers for all the adding plates in one series, and when pressure is applied to an adding-key of that series its plate is pushed down, pressing out the pawl and allowing it to fly into the upper slot 89 of that plate, but when the pressure is released from the adding-key, the adding plate does not return to its normal position, but is held by the pawl in a rigid and firm downward position to be met by a wheel of the meter and held until the pawl is withdrawn, as later explained. As the pawls 90 of each series are independent of those of the other series, and movement of one not affecting the others, it is readily seen that I can instantly reset to their normal positions any other displaced adding plates in that series, and their corresponding adding-keys in that bank, by the displacement of any other adding-key in that bank; this giving what is commonly termed a "flexible key board".

In my first above-mentioned patent, I carried the adding plates almost entirely around the inner side of the machine, in the form of toothed disks or segments, but in my present perfected machine I only have the adding plates in the forward part of the machine, with the corresponding teeth of all of the adding plates parallel with each other, so that the meter has been fully operated by the adding plates when it has gone the first third of its distance around the inner side of the machine, and I preferably carry the side plates 63, 64, in the form of segments nearly around the inner side of the machine, as shown in Figs. 1 and 10. These side plates 63, 64, have downward extending lips which fit within a recess 91 formed in the upper side of the base plate 52 and tie-rods 108 are in-

serted through every two or more of the plates and secured to the base plate 52 by screws 109 (see Fig. 10), so that these plates, which are also secured by tie-rods 59 carrying spacers 60 inserted between the plates, are held in rigid position making true alinement for the teeth 65 of the adding plates 62. Similar tie-rods 108 secured by similar screws 109 are inserted through other plates in different parts of the machine to secure the plates to the base plate 52 in a firm manner, as hereinafter explained.

Key-boards and their keys.—The adding-keys 61 are circular having the slot 72 in their under side with a pin 71 extending across the slot, and their upper portion cup-shaped, as at 92 for receiving the insert or disk 93, preferably of card-board, carrying an upper disk 94, preferably of celluloid on the upper face of which is stamped or painted one or more numerals 95 in a different color from the upper surface of the disk 94, so that the numerals will stand out prominently.

As shown in Fig. 1, I preferably use in the units and tens columns, adding-keys having an outer white rim, a black disk surface with a white numeral thereon, as these two banks of keys commonly represent the cents and tens of cents columns, when addition is being performed. The next three columns representing dollars, tens of dollars, and hundreds of dollars, I use an outer white rim, a white disk surface with a black numeral thereon, the next three columns are similar to the cents column, while the last column or series of left hand keys, representing the million dollar column, are similar to the dollar column, so that in performing problems the adding keys can be instantly selected and depressed but it is obvious that the keys may be readily shifted about so that any arrangement can be had and if desired the key board can be arranged into the three periods of units, thousands, and millions, with the 2nd period having different colored digits from the digits on the adding keys of the 1st and 3rd periods. It is very essential however in order not to have a deceptive key-board that all of the rims should be of the same color, preferably white, so that all of the keys will appear to have exactly the same size, especially when a green back-ground 78 is used.

Mechanism for allowing of the return of the adding mechanism.—A shaft 101 operated by a release-bar 100 without the case 53 (see Figs. 1 and 10) extends through the side of the case 53 and all of the side plates 63 and 64, but below the adding plates 62, being journaled in the side plates 63, 64, and in the side plates 102 and 103 of the multiplying mechanism. Mounted upon the shaft 96 and one for each series of adding plates, are the pawls 90 having a downward extending pin 97 to which is attached a spring 98 for keeping the pawl in its uppermost position within the notch 88 or 89 as the case may be and the spring is attached to its corresponding side plate 64 as shown in Fig. 10. Upon the shaft 101, and one for each of the pins 97, are the inverted U-shaped plates or wires 99 so positioned that when the release-bar 100 is slightly pressed downward and the shaft 101 is slightly turned that the wire 99 will move the lower end of the pin 97 rearward, against the force of its spring 98, withdrawing the pawl 90 from the notches 88, 89 allowing the displaced adding plates and their operated adding-keys to be returned to their normal or original positions ready for the next operation on the adding-key board. Attached to each short end of the rods of the release-bar 100 is a spiral spring 531 having its other end attached to the outer side of the case so that the release-bar is returned to its original position as soon as pressure is withdrawn from the finger piece of the release-bar. As these springs 531 and the release-bar 100 are without the case 53, being situated on the front portion of the machine between the rows of adding and multiplying-keys, I preferably inclose both of the springs in nickel-plated tubing 112.

It is readily seen that I can by pressure down upon the release-bar 100 instantly and simultaneously reset all of the adding plates and their respective adding-keys or I can reset to its normal position any adding plate and its corresponding adding-key by the displacement of any other adding plate of the same series; this latter being of great benefit in addition and other problems to instantly correct the machine when a wrong adding key has been pressed, and a correction can thus be made on my machine because the pressing of any adding-key does not affect the meter until the meter has been set in motion by the operation of another part of the machine.

The shaft 101 is one of the last pieces of mechanism to be assembled in the machine and is inserted through a key-shaped opening 519 in the left-hand side of that portion of the case 53 that embraces the adding plates and this opening is normally covered by a small plate 520, see Fig. 2. The shaft is passed along through similar key shaped openings 519 (see Fig. 10) in the side plates 63 and 64 and through a circular opening in the right-hand side of that portion of the case 53 that embraces the adding plates and the release-bar is attached thereon by pins 106, see Figs. 1 and 10. The shaft is then inserted through another circular opening in the left-hand side of that portion of the case 53 that embraces the multiplier plates and is then turned backward, as shown in Fig. 10,

so that when it has been pushed in to its final position the wires 99 carried by it will be behind their respective pins 97 to operate those pins upon pressure down upon the release-bar 101.

It is important to provide means for instantly returning automatically and simultaneously, in problems of addition, all of the adding plates and their corresponding adding-keys as soon as the meter has once met the teeth of the adding plates, in its movement around the inner side of the machine, and without waiting for the meter to have reached its original or upright position, and for this purpose I have provided such means, which I shall only partly explain at the present time, as an explanation of the multiplying mechanism is essential to a clear understanding of the same, which explanation I shall give in the latter part of this specification.

The right end of the shaft 101 may be inserted into an opening in the hub of a lever 115 properly secured upon a suitable stud-pin carried by the plates 102 and 103, but in Fig. 8 of the drawings it will be seen that I have shown the shaft 101 as extending through the side plates 103 and 102 and into a collar 111 on the right side of the side plate 102, to which collar the shaft is fastened by the pin 113 to prevent endwise motion of the shaft, and attached upon the shaft to the left of the side plate 103 and held by the pin 114 is the lever 115. This lever is normally held by the spring 116 (see Fig. 6) down against the pin 117 which protrudes from the left side of the side plate 103, to which plate the lower portion of its spring 116 is also fastened, as shown in Fig. 6.

Upon a tie-rod 59, extending towards the left outward from the plate 103, is the plate 119 provided on its lower side with the upper notch 120 and the lower notch 121, in one of which a pawl 122 is held by its spring 123, this pawl being held in the journal bearings 124 carried by the plate 103, (see Fig. 8). From the left upper side of the plate 119 extends a pin 125 beyond the upper edge of and bearing upon a bell crank lever 126; this lever is also carried by the same tie-rod 59 but separated from the plate 119 a suitable distance by the separator 127, so that the lever 411, when carried around by the balance wheel 134, and striking upon the surface of the pin 125 will not touch the lever 126 the latter only being operated when in the position shown in Fig. 6, upon movement of the balance wheel by the lug 133 carried by the balance wheel. When the lever 411 strikes upon the surface of the pin 125, when the plate 119 is in the position shown in Fig. 6, the forward end of the plate 119 and its pin 125 are held from downward movement by the pin 527 extending towards the left above the plate 119 from the side plate 103. If the plate 119 and the lever 126 were displaced out of the downward position, shown in Fig. 6, so that the pawl 122 rested in the notch 120, the lug 133 would not affect the lever 126 as the balance wheel revolved, neither would the lever 411 hit upon the pin 125.

A spring 128 attached at its upper end to the tail end of the lever 126 and at its lower end to the lower portion of the plate 119 acts to hold the nose end of the lever 126 in its uppermost position against the pin 125. From the right side of the plate 119 extend the two studs 129 and 130 which protrude through the openings 131 and 132 in the plate 103 (see Figs. 5 and 8) and these studs are operated (the stud 130 by the nose 136 of the adder-bar plate 135 and the stud 129 by the nose 348 of any one of the multiplier plates 118) as hereinafter explained to raise or lower the upper inner edge of the plate 119 carrying the pin 125 so as to raise or lower the nose of the lever 126.

If pressure had been applied to the stud 130 by the nose 136 the upper end of the plate 119 would have been forced down, to the position shown in Fig. 6, and the pin 125 would have carried down the nose of the lever 126 so that the nose would be struck by the lug 133 on the right hand side of the toothed balance wheel 134 when it is revolved around with the meter. The upper end of the plate 119 was forced down, to the position shown in Fig. 6, by the tenth plate of the multiplying mechanism, (and which plate is the plate on the extreme right and termed the adder-bar plate 135) having its nose 136 strike upon and press down the stud 130. When the nose of the lever 126 held down by the pin 125 is struck by the lug 133 on a revolution of the balance wheel it raises the forward end or tail of the lever 126 raising the lever 115, turning the shaft 101 and allowing the displaced adding plates and their respective adding-keys to be returned to their original positions. This lever 126 would remain in this operating position until another multiplier plate 118 had been operated and its nose 348 pushed down the stud 129.

The meter.—The meter, which for convenience will be designated in the specification and claims as the "meter," is independent of the adding-keys and is used for showing the figures added and indicating the final sum in addition, indicating the product in multiplication, indicating in subtraction, first, the minuend, and second, the remainder after deducting the subtrahend, and in division showing, first, the dividend, and second, after dividing the divisor, shows the quotient.

At each end of the base plate 52 are secured the two uprights 140 and 141, see Figs. 3 and 4, carrying at their upper portions re-

spectively the ball bearing journal boxes 146 and 147 for the ends of the driving-shaft 137. The right end of the driving-shaft adjacent to the multiplying mechanism is reduced in size, as at 142, (see Fig. 4), forming a shoulder 143 against which presses a ratchet 148 carrying a pinion 149 both on the portion 142 of the driving-shaft 137.

Upon the driving-shaft to the left of the ratchet is a locked plate 144 pressing against the right side of the ratchet 148 and held in place by a locking pin 150. Upon the hub 151 of the plate 144 is carried the balance wheel 134 provided with the ratchet teeth 135 extending around its periphery. Upon the hub 151 between the balance wheel and the ratchet 148 is tightly fitted the arm 152. This mechanism just described forms no part of the meter but belongs mostly to the multiplying mechanism, and the operation of same will be later described.

The driving-shaft at its extreme left end is slightly reduced in size where it extends into the journal box 147 and upon this end is secured by the screw 153 a pinion 154. A hub 145 secured to the driving-shaft by a pin 155 carries a downward extending arm 156 to the lower part of which is secured by screws 158 a balance rod 157, see Fig. 3, and this rod extends towards the right below and parallel with the driving-shaft through the openings 159 in the lower portion of the arms 160 and 161 and secured at its right end in the balance wheel 134.

Slidably mounted upon the driving shaft 137 are the two hubs 163 and 164 which carry the carriage hub or cylinder 138, which cylinder carries the arms 160 and 161 and the supports 165 for the meter, the cylinder 138 extending through the openings 166 in the lower portion of the supports, and the supports being separated by the spacers 139 carried by the cylinder 138.

The two arms 160 and 161 slide along the balance rod 157 when the meter is moved horizontally to the right or left and these two arms project upward above the driving-shaft 137 and in them is journaled the shaft 167 of the numeral wheels 168 of the meter, which shaft for convenience will be hereinafter called the "meter-shaft". The arm 160, which is at the extreme left of the meter, is provided with a hammer 169 having a short finger 170 at its upper forward end projecting towards the right, which finger is used to turn a wheel of the multiplier meter as the meter is revolved. The meter, in this invention, is revolved towards the operator or front of the machine as soon as it is set in motion, so that the finger 170 operates a wheel of the multiplier meter before any of the numeral wheels 168 of the meter are operated.

Upon the upper end of the hammer 169 and also extending towards the right and arranged to come in contact with another tooth of the operated wheel of the multiplier meter to stop the movement of this wheel set in motion by the first finger 170 and thus prevent over-rotation, is a long curved finger 171. The operation of the multiplier meter by the fingers will be later fully explained.

The numeral wheels 168 of the meter are loosely mounted on the meter-shaft 167 and their hubs 172 project a considerable distance to each side, beyond the line of the rims of the wheels, and are separated by the supports 165. These numeral wheels 168 each carry upon their periphery a series of teeth 173, preferably ten in number, and between these teeth are spaces on which the mathematical symbols "0," "1," "2," "3," "4," "5," "6," "7," "8," "9," are affixed or printed in any desirable manner, and when the meter is in its uppermost position and the numeral wheels 168 are in their normal positions the naughts would show, in a reading line, just above the hood 174, when looking from the line of vision through the sight-orifice 54. These numeral wheels 168 turn from left to right when engaged by the teeth 65 of the adding plates 62, and the next number that would show would be the numeral "1" and the next "2" and so on.

The teeth 173 of the numeral wheel 168 extend beyond the rim on each side, projecting in such a way on the left of each wheel that the tongue 221 of an over-rotation check-pawl 530 will come in contact with one of its teeth to instantly check the wheel in its movement from left to right as soon as its teeth 173 have finished meshing with the teeth 65 of the adding plate 62, (see Fig. 12), and the teeth also projecting on the right of each wheel in such a way that a carry-up pawl 175 will strike against one of the projecting teeth, (see Fig. 13) turning the wheel one-tenth of its circumferential distance, for transferring the movement of its lower numeral wheel to the next succeeding higher numeral wheel, as from a units to a tens numeral wheel, or from a tens to a hundreds numeral wheel, and so on. A full explanation of the over-rotation check-pawl 530, the carry-up pawl 175, and their contiguous parts will be hereinafter given.

The meter shaft 167 is journaled in the arms 160 and 161, its left end being inserted into the hub 176 of the gear 271 and held by a pin or set-screw 177; the gear and its hub being on the outer side of the arm 160; the right end of the shaft 167 being secured in collar 528 by similar means 177. Between each of the numeral wheels 168 are placed the supports 165 provided with the slot 178 for the purpose hereinafter stated, and having the opening 219 through which passes the meter shaft 167.

Between the arms 160 and 161 and through the holes 187 in the supports 165

extend the shaft or tie-rod 180 carrying spacers 181 inserted between the supports. When the meter is in its normal position, the forward portions of the supports and a large part of the mechanism carried by the supports is covered by a U-shaped hood 174 held on the tie-rod 180 by the lips 183 and this hood also covers the lower half of the numeral wheels 168, so that in looking from the line of vision through the sight-orifice 54 at the meter the desired number to be shown upon each numeral wheel will be seen just above the upper line of the hood.

The arms 160 and 161 and the supports 165 are separated by the spacers 139 on the cylinder 138 and are held in their proper positions by the five tie-rods 180, 182, 184, 185, and 186, which extend through their respective openings 187 to 191 in the supports.

Mounted upon the tie-rod 182 on the left of each support 165 are the carry-up hammers 192, see Figs. 10, 32 and 50, (one for each of the numeral wheels 168 except the first one) situated between each of the supports 165 and the adjacent numeral wheels on their left. These carry-up hammers 192 are each provided with a spiral spring 193 attached to the lower front portion of the carry-up hammer and the other end being attached to the forward finger 194 of the support 165 so that the carry-up hammers 192 have a forward motion when not held by other means (as hereinafter explained) and are guided by the separators 220 on the tie-rod 185 (see Fig. 10).

About midway of the carry-up hammer 192 is secured the carry-up pawl 175 secured to it by a stud-pin 195 inserted through an opening 196 in the pawl and into the opening 197 in the hammer, and allowing the pawl to pivot on it. This carry-up pawl 175 is adapted to have its finger 201 strike against the right side of a projecting tooth 173 of the numeral wheel 168 upon its left, turning the numeral wheel one-tenth of its circumferential distance upon each full forward movement of the carry-up hammer 192, by which it is carried, thus transferring the movement of the lower numeral wheel upon its right to the next succeeding higher numeral wheel upon its left.

The carry-up pawl is provided at its lower end with a spring 198, attached at the other end to the lower rear portion of the carry-up hammer, forcing the upper finger portions back out of contact with the numeral wheel so that the rear finger 199 rests upon the lower surface edge of the curved hook 200 on the carry-up hammer. This curved hook 200 is adapted to have its upper curved edge meet one of the teeth 173 (as shown in Fig. 13) of the numeral wheel 168 operated by the finger 201 and prevent the wheel from overrotation, only allowing it to be moved one-tenth of its circumferential distance on each forward movement of its respective carry-up pawl 175.

Each carry-up hammer 192 is provided with an upper curved arm 202 ending in an upward extending finger projection 203 which is adapted to run upon the segmental run-way 204, as shown in Fig. 12, whenever the carry-up hammer has been released and drawn forward by the spring 193, while the meter is passing the teeth 65 of the adding plates and thus preventing the carry-up hammer 192 from going its full forward distance and the carry-up pawl 175 from coming in contact with its corresponding numeral wheel 168, as it is not desirable to carry up from one numeral wheel to the next succeeding higher numeral wheel while the numeral wheels are passing by the adding plates, but the run-ways 204, which are attached to the right of the side plates 64 only extend a short distance below the teeth of the adding plates, as shown in Figs. 10, 12 and 15, so that the carrying process is completed immediately after the numeral wheels of the meter have passed the adding plates.

As the meter is revolved around the inner side of the machine the finger 203 of the carry-up hammer of each wheel that could have been operated on that revolution of the driving shaft meets a recocking finger 206 attached in any desirable manner upon the right side of the side plate 64, as shown in Fig. 13, by which the carry-up hammer is recocked. It will be noticed by examining Fig. 4 that the side plates 207 in the right portion of the machine, between the adding plates and the multiplying mechanism, do not carry any recocking fingers 206 as it is not necessary to recock the hammers 192 of that portion of the meter passing around these side plates 207 when the meter has been horizontally moved to the right.

In order to have a recocking finger for each of the carry-up hammers, of the wheels that can be operated by the teeth 65 or by carry-up mechanism, on a revolution of a driving-shaft, I have provided the necessary additional plates 208 in the left end portion of the machine, as shown in Fig. 3, to support on their right side the additional recocking fingers 206; the additional plates 207 on the right of the adding mechanism is used to guide the carriage of the meter as it is revolved with the driving-shaft, as later explained.

From the forward portion of the carry-up hammer 192 and parallel with the upper arm 202 extends a short curved arm 209 carrying at its outer end a stud pin 210 upon which is pivotally mounted the hammer-cocking retaining-pawl 211, shown in Figs. 38 and 39, having a projection or hook 212 extending towards the right and adapted to be seated within the slot 178 of the support 165.

Pivotally mounted upon the tie-rod 184 on

the right of each support 165 is the cam-operated pawl 230, having a spring 233 carried by the tie-rod 186, attached to its extension 232 so that its nose 231 is pressed down upon the upper surface of the cam 213; which cam is carried on the disk collar 215 which disk collar is on the numeral wheel 168. each of the wheels 168 being on the meter-shaft 167 and each numeral wheel turns its respective cam 213; and the nose 231 remains in this position, as shown in Fig. 10, with the lower surface edge of the hook 212 of the hammer-cocking retaining-pawl 211 resting upon it, until the cam 213 has been turned so that its tooth 214 raised the nose of the pawl 230 so that the pawl 211 is freed from the slot 178 and rides over the edge of the curved portion 218 and allows the carry-up hammer 192 to shoot forward, to the position shown in Fig. 12 and also to the position shown in Fig. 13, as soon as the finger 203 has passed the segmental run-way 204. It is also readily seen by examining the drawings that the nose 231 of the cam-operated pawl 230 drops down into place against the periphery of the cam 213 as soon as it has cleared the tooth of the cam, even though the hammer-cocking retaining-pawl 211 is still in its forward position, as shown in Fig. 13. The hammer-cocking retaining-pawl 211 is also provided with a short arm 216 normally pressed against a pin 236 by a spring 217 which is attached at its opposite end to the carry-up hammer so that the long arm of this pawl and its hook 212 will be held downward upon the rear upper edge of nose 231 of pawl 230 until the hook 212 is lifted out of the slot 178 by the pawl 230, when the hammer 192 shoots forward by force of its spring 193 and causes the hook 212 to ride over the upper surface of the curved portion 218.

The hook 200 which extends from the left of the carry-up hammer 192 outward just above the location of the carry-up pawl 175 is adapted to come in contact with another projecting tooth 173 of the numeral wheel 168 when the carry-up pawl 175 is thrown forward from the position shown in Fig. 11 to the position shown in Fig. 13. The carry-up pawl and the hook come in contact only with the portion of the teeth 173 that project beyond the rim on the right side of the numeral wheels 168 and never come in contact with the portions of the teeth 173 that project beyond the rim on the left side of the wheels.

The extreme left-hand support 165 is not provided with a carry-up hammer or any of the parts carried by it for the obvious reason that there is no need of these parts beyond the highest numeral wheel, but the parts of the mechanism which I shall now describe as being carried by the supports are also carried by the support at the extreme left.

On the right of each of the supports 165 pivotally mounted on the tie-rod 185 there is provided the over-rotation check-pawl 530 which is provided with a tongue 221 adapted to be thrown between two teeth 173 of a numeral wheel 168 by the pressing back of its arm 222 as it comes in contact with a forward projecting lip 224 attached on the left side of the side plate 63 adjacent to the teeth 65 (see Figs. 10 and 15) and to the right of the side plates 208 on the left end portion of the machine, see Fig. 15, so that as the numeral wheels leave the adding plates, as shown in Fig. 11, the pawls 530 are thrown in contact with that portion of the teeth 173 that project beyond the rims of the numeral wheels 168 on their left sides in such a manner as shown in the drawings that will instantly stop the forward movement of the numeral wheels and prevent over-rotation. The over-rotation check-pawl 530 is however normally held out of contact with the teeth 173 by its spiral spring 225, the other end of which is attached on the tie-rod 186 to draw it downward and backward against a lug 434 on the right side of the support 165.

A friction pawl 234 is held in an upward position against the teeth 173, as shown in Fig. 10, by its spring 235 so as to prevent back lashing of the numeral wheel 168; the opposite end of spring 235 being carried by the tie-rod 186.

Each of the numeral wheels 168 consists of a web on the hub 172 carrying a rim provided with the teeth 173 between which are the spaces carrying the mathematical symbols. Beneath the rim on the right side of each wheel and extending outward from the web is a spring-pressed pawl 227 which extends through a slot in the hub and against the shaft 167 of the meter and is normally held in place by its spring 228 attached at the other end to the inner side of the web of the wheel 168.

As the shaft 167 is turned by movement of the gear 271, the pawls 227 fall into the slot 237 in the shaft 167, so that the numeral wheels may all be simultaneously turned back to their normal positions, and the meter is thus set at naught, that is, so that all of the numeral wheels "0" are in line on the reading line of the meter. A similar spring-pressed pawl 250 is within each of the wheels 239 of the multiplier meter, so that it can be set in a similar way by movement of the gear 259 back to its original position after each arithmetical problem.

The multiplier meter.—In the left forward portion of the machine and seen through the sight-orifice 55 is situated the multiplier meter consisting of the shaft 238 carrying the freely-movable hubs 249 of the wheels 239. Each wheel is adapted to be turned from left to right and its periphery is divided into ten spaces in which spaces the mathematical symbols "0", "1", "2", "3", "4", "5",

"6", "7", "8", "9", are marked in their order and when the wheels 239 are in their normal positions the naughts will show through sight-orifice 55 on an even reading line.

In the drawings I have shown the multiplier meter as having seven numeral wheels as in a machine of the size shown, a multiplication can be performed with nine digits in the multiplicand and seven digits in the multiplier and it is therefore necessary to have seven numeral wheels on the multiplier meter, to fully show the multiplier, should a multiplier of seven figures be used. As the operation of the number of wheels is limited by the horizontal movement of the meter, additional wheels could not be operated unless the meter was allowed to move the corresponding number of shifts: in other words, the number of operated wheels on the multiplier meter is limited to the number of shifting places of the meter.

In building machines of various sizes having different numbers of wheels in the meters, the arrangement and operation of the hereinafter explained gears, pinions, wheels, and shafting would necessarily be changed but the same general principles follow throughout, and in order to give a clear understanding of the construction of such a multiplier meter I shall fully explain a meter built with seven wheels 239. This explanation will be fully understood by an examination of Fig. 1 and Figs. 14 to 17 inclusive, in which a front elevation of the same is given in Fig. 16, a rear elevation in Fig. 15 and a side elevation in Fig. 14 on the line 14—14 of Fig. 1. In all my former patents, on this type of calculating machine, the numerals on the multiplier meter had to be read in reverse order; for instance, if I was multiplying by "978" the numeral "8" would show on the wheel to the extreme left, the numeral "7" on the next wheel, and the numeral "9" on the third wheel from the left, so that unless one understood the machine they would read the multiplier as "879" but in my present invention I use a system of connecting means by which when I operate a gear on the extreme left of the multiplier meter the first wheel at the extreme right of the same would be operated so that in the above example the multiplier "978" would show in proper readable order on the three wheels at the right.

The construction is as follows:—I provide on the shaft 238 between each of the side plates 208 a wheel 239, having the numerals as hereinbefore explained, and a toothed gear 248 separated from the wheel 239 by its hub 249. This toothed gear 248 is not only provided with the teeth 251 around its periphery but is provided with the ten pins 252 extending outward from its left side towards the wheel 239 on its left and these pins are adapted to receive between them the pawl 253 which not only falls of its own weight between two of the pins but is forced therein by the spring 254 so as to instantly stop over-rotation of this gear 248, preventing the numeral wheel which it operates from moving more than one position on each revolution of the driving-shaft and preventing backward movement but to also cause the numeral wheels to run true making a full complete movement so that the reading line of the multiplier meter will be even. Each of the numeral wheels 329 except the central one is provided with a gear 255 upon its left side so that when this gear is turned by a pinion 257 the wheel is operated. Between the extreme right and left side plates 208, as shown in Fig. 16, is a shaft 241 journaled in these two plates and carrying a pinion 256 opposite to and meshing with the teeth 251 of the toothed gear 248 to the extreme left and having another pinion 257 meshing with the gear 255 carried by the right-hand numeral wheel so that when the gear 248 on the extreme left is operated it turns the numeral wheel 239 on the extreme right. In like manner the shaft 242 takes the movement from the second gear 248 and moves the second wheel 239; the shaft 243 operating through the gears to operate the third wheel 239; the shaft 245 to operate the fifth wheel; the shaft 246 the sixth wheel, and the shaft 247 the seventh wheel, which is the wheel to the extreme left and represents the multiplier in the hundred thousands. It will be noticed however, that it is not necessary to have teeth on the peripheries of the central or fourth gears (when the number of wheels in the multiplier meter is an uneven number) as the central gear 248, when it is operated by the finger 170 striking against one of its pins 252 turning it, directly through its shaft 244 operates and turns the central numeral wheel 239.

As the meter is revolved with the driving-shaft 137 around the inner side of the side plates and adding plates, the arm 160 is turned carrying with it the hammer 169 whose finger 170 strikes upon a pin 252 turning its gear 248. Each gear is prevented from over-rotation by the finger 171, upon the hammer 169 in the rear of and somewhat above the finger 170, coming in contact with the projecting part of another one of the pins 252 on the gear immediately after the revolving of this same gear by the pressure of the finger 170 so as to instantly check the movement of gear and its respective numeral wheel 239.

The multiplier meter is supplied with spring-pressed pawls 250 similar to those of the wheels 168 of the meter, which pawls extend through slots in the hubs and into a slot 258 (see Fig. 1) in the shaft 238 so that the

shaft can be turned and all the wheels of the multiplier meter simultaneously turned forward to initial position; (see Figs. 1 and 14).

The multiplier meter does not shift from right to left similar to the meter but remains in a stationary position so that when the meter is revolved in its first position, the first or right hand wheel of the multiplier meter would be operated; when the meter has been shifted one position the second wheel (that is the second wheel from the right end of the machine) would be operated, and so on, as previously explained.

Loosely mounted upon the shaft 238 is a gear 259 carrying a cam 260 having its tooth 266 adapted to be met by a spring-pressed pawl 261 pivotally mounted on the right side of the wheel 262 having its hub rigidly attached to the shaft 238 by a pin 275 so that when the gear 259 is turned a sufficient distance from left to right by the teeth 265 on the arm 264 of the sector 263, or by any other means, the wheels 239 will be turned around by the shaft 238 as previously explained. Upon the backward movement of the sector the pawl 261 is thrown out by the cam and the shaft 238 and the wheels 239 are not moved.

The sector 263 is pivotally mounted on a stud 266 against the right side of the upright 141 (see Fig. 3) and its toothed forward edges are normally held in their uppermost positions by the spring 267; the lower end of the spring being attached to the upright 141. The stud 266 extends through the left end of the case 53 and secured on its outer end by the pin 268 is the lever 269 having the finger piece 270 so that when pressure is applied down upon the finger piece 270, and carried downward as far as it will go, the forward portion of the lever is carried downward so that its teeth 265 on its arm 264 meshes with the teeth on the gear 259 turning the gear from left to right and carrying forward all the wheels of the multiplier meter to their original or zero positions.

The outer forward rim 272 of the sector proper has on the inner side the inner extending teeth 273, ten in number, which meet, when the sector is carried downward by pressure on the finger 270 and held downward while the meter is revolved once around the inner side of the plates, the gear 271 on the left end of the meter-shaft 167 turning the gear from left to right and resetting or carrying forward all of the wheels 168 of the meter so that the meter is also set at its original or zero position. This gear 271 is secured to the meter-shaft by the pin 177 extending through its hub 176. If the sector is not held down while the meter is revolved around the inner side of the plates the teeth of the gear 271 will not mesh with the teeth 273 and consequently the meter would not be reset to its original position. As soon as pressure is withdrawn from the sector the spring 267 returns it to its normal or upmost position so that its teeth 273 will not be in meshing contact with the gear 271 of the meter. Attached to the arm 160 is the left end of the spiral spring 274 which has its right end attached in any desirable manner to the locking plate 144 of the balance wheel 134 to draw the meter and its carriage towards the right of the machine upon each downward motion of the latch or detent 286.

Meter shifting mechanism.—The locking plate 144 of the balance wheel 134 carries a hinge 525 (see Fig. 6) having its stud pin 524 pivotally supporting below the shaft 137 a latch-casing consisting of a base 281, sides 282, 283, end 284, and end latch 302 carrying the latches or detents 286 pivotally mounted therein on the studs 290 (see Fig. 4); the other end of the latch casing extending through and supported by the arm 161. Immediately in the rear of the latch-casing, parallel with it, and supported at its right end by the balance wheel is a rock-shaft 293 having a key-way 529; the left end of the rock-shaft being supported by and extending through the arm 161, see Fig. 21.

Upon the rock-shaft is adapted to slide a trip-pawl 296, properly keyed to the rock-shaft and supported by the bracket 294 attached by screws or other means 295 to the right side of the arm 161.

The meter is controlled in its horizontal movement from left to right by the angular latches 286 pivotally supported on the studs 290 within the latch-casing; each latch being held in an upward position by a spring 288 which draws the lower or tail end against the stud 287 (as clearly shown in Fig. 4) so that its latch face is held against the right lower side of the swinging bar 297 (when the bar has moved to that respective latch), until it is drawn down and out of contact with the bar by its pin 291, which extends through the slot 292 in the side 283 of the latch-casing, being drawn down by the trip pawl turned by its rock-shaft when the rock-shaft is rocked by the movement of the pinion 303, as later explained.

The latch-casing consists of the base 281, the sides 282, 283, between which extend the studs 290 supporting the latches 286, and the left end plate 284. At its opposite end is rigidly secured to the latch-casing by the pins 285 the stationary end latch 302, which is the last latch the bar 297 strikes against on the meter's movement to the right and this latch prevents further endwise movement of the meter and its carriage towards the right. Pins 285 are used wherever necessary to properly unite the parts.

The swinging bar 297 (see Figs. 20 and 21) has its upward extending parallel arms 298 pivotally mounted on the stud pins 299 which extend into the brackets 301 on the right side

of the arm 161; the upper end of the fingers being attached to the spiral springs 300 which extend through openings in the arm 161 and are attached to the first right hand support 165.

Multiplying mechanism.—On the right of the machine are the nine multiplying keys 104 and the shift key 105; each multiplying key being shaped similar to the adding keys so that their pin fits within the slot 70 of the shank 362, which shank is guided in its downward movement by the pins 364 which are passed transversely through its elongated slot 365. These pins 364 extend from the side plate 102 to the opposite side plate 103 and are fastened thereto in any desirable manner and carry separators for properly alining the shanks 362 and their multiplying keys one above another as shown in Figs. 5 and 7.

To the lower end of each shank is attached by pin 363 the lip 343 on the forward side of the multiplying plate 118; each multiplying plate having oblong slots 353 through which extend the squared guide pins 354 on the studs 355 rigidly attached between the side plates 102 and 103; the length of the slots being similar to the slots 79 in the adding plates and just sufficient to allow of an inwardly inclined movement of $\frac{3}{16}$ of an inch, so that the multiplying keys have the same amount of downward movement as the adding keys.

Mounted on the shaft 358 extending between the side plates 102 and 103 and separated by the spacers 360, are the pawls 359 (ten in number), there being one for each of the multiplying plates and one for the adder-bar plate, and the spacers are extended partly up between the plates to allow space between the plates and diminish the amount of friction caused by the downward movement of any one of the plates. Extending through the openings 438 in the plates is another shaft having similar spacers 400 for the same purpose and between these spacers are the disks 399 upon the upper side of which a portion of each plate rests.

Springs 361 attached to the tail end of pawls 359 normally press the nose of the pawls up into the V-shaped notches 347 on the under side of the multiplying plates 118 and the similar V-shaped notch 357 on the under side of the adder-bar plate 135, so that the plates are normally held in their upper positions except when they are depressed by downward pressure.

The multiplying-keys 104 are adapted to impart different degrees of rotative movement to the driving-shaft, according to the designating numerals "1" to "9" upon the several keys, ranging from the bottom key to the top or ninth key.

The shift key 105 which is adjacent to and parallel with the "9" key of the multiplying-keys, bears upon its face the numeral "0". This key does not revolve the driving-shaft but when pressed down, it operates through intermediate mechanism the pinions 303 to move the rock-shaft 293, as will now be explained. This shift key is removably attached to the shank 317, guided in its movement by the studs 437 extending through its elongated slots 318 and is normally held in its uppermost position by the spring 319 attached to a stud 346 extending outward to the right from a downwardly extending lug 345; the upper portion of the spring being attached to a spacer on the upper stud 437.

A lever 316, having a downwardly extending V-shaped finger 321, is pivotally mounted on a stud 436 of the shank 317 and is provided with a lug 526 above the lug 345 to which it is connected by the spring 320. The finger 321 is adapted to engage a tooth of the segment 315 of the segmental lever 312 having the guide set-pins 313 extending through its slots 314 so that when it is pushed down by pressure upon the shift key, its pin 311 on its lower left side would push down the tail 310 of the segment 308 pivoted on the stud 309, moving the teeth of the segment 308 upward and revolving upward the toothed segment 304 on the stud 305; the segment 304 in its turn moving the pinion 303 and the rock-shaft 293 to which it is attached, so that it is readily seen that pressure down upon the shift-key 105 will move the trip-pawl 296 and trip one of the latches 286 so that it is drawn down to allow a movement of the meter and its carriage one position to the right for each downward pressure of the shift key.

The swinging arm 297 passes over the latch and strikes against the face of the next latch to the right. The carriage of the meter is carried to the right by force of the spring 274, and is stopped by the next latch 286 so that the trip-pawl rests upon the pin 291 of the next latch. It will be thus seen that with this arrangement the swinging arm 297 can only move the distance between two latches with each downward movement of the trip pawl, this distance being equal to the distance from the center of the numeral wheel of the meter to the center of the next numeral wheel, so that upon each movement of the arm to the right the numeral wheels are moved one position to the right, and the displaced adding plates would then operate, if the driving-shaft was revolved, the numeral wheels next in order to the left.

The shift-key 105 is used when one or more naughts appear in the multiplier, so that the meter may be shifted to the right without revolving the driving-shaft, and is also of use in pointing off after the problem is completed when it is desired to shift the meter to the right.

A spring 307 attached at its upper end to the left side of the balance wheel has its lower end attached to the lower portion of

the segment 304 to return it and the mechanism which operated it to their original positions when pressure is removed from the shift-key; the segment 304 being limited in its return movement by the pin 306. The pins 306, 313, and studs 305, 309, are attached to the left side of the balance wheel 134 and they, together with the parts carried by them, revolve with the balance wheel.

The lever 316 is preferably pivoted on the stud 436 carried by the shank 317, rather than made integral with the shank because as the balance wheel revolves forward in the direction indicated by the arrow in Fig. 6, the finger 321 has to pass over the teeth of the segment 315 and if it was made as a one piece lever, the segmental lever 312 would be pushed in on each revolution of the driving-shaft and partly rotate the rock-shaft 293, but when made as shown in the drawings, the lever 316 is always quickly returned to its upright position against the pin 435, (when slightly turned on the revolving of the balance wheel or after its finger 321 has been pushed down) by the force of its spring 320.

Extending on an incline, parallel to the top of the multiplying-keys, and just above the series of guide-pins 364 is a plate similar to the plate 77 of the adding mechanism, having its upper surface preferably covered with green felt for covering the front portion of the multiplying mechanism situated between the two side-walls.

Before describing further the multiplying-keys and their mechanism I shall explain the operation of the adder-bar plate which is situated on the right of the multiplying plates and is clearly shown in Figs. 5 and 44. This plate is provided with a lip 342 which, unlike the lips 343 of the multiplying plates 118, is squared on its upper edge to receive the downward pressure of the pin 341 on the lever 339 attached to the shaft 338 which shaft extends without the case, as shown in Fig. 1, and is operated by the adder-bar 340, so that slight pressure down upon the adder-bar will press down the adder-bar plate and cause the driving-shaft to revolve once. The adder-bar plate is recessed on its rear upper edge and within the recess, resting upon the lower edge 344 and pressing against the edge 356 is the plate 369 which extends across between the side plates 102, 103, and also rests upon and presses against similar edges 344 and 356 of the recesses in the multiplying plates so that pressure down upon the adder-bar or any one of the multiplying-keys will press the plate 369 rearward carrying rearward its ear 370 which extends through a slot in the side plate 103 and is provided with the slot 371 and the spring 521 for returning it to its normal forward position, as clearly shown in Fig. 7. When pressure is applied to the adder-bar 340, or to any one of the nine multiplying-keys 104, the multiplying mechanism is released as hereinafter explained, which allows the driving-shaft 137 to be revolved from right to left by the force of the coiled driving spring 461 so that the meter and its carriage are revolved from right to left and any of the numeral wheels of the meter which meet and mesh with the teeth of the depressed adding plates would be revolved from left to right according to the number of teeth on the depressed plate which the numeral wheel meets, as hereinbefore explained. When one of the multiplying-keys is depressed, its respective multiplier plate 118 is pushed backward so that the pawl 359 on shaft 358 is pushed out of the notch 347 and is held out of the notch while the plate is held by nose 374 of another pawl 367 in its upper notch 351 on the upper side of the plate. When one of these plates 118 or the adder-bar plate 135 have been operated by being pushed backward and the nose 374 has entered the upper notch 351 of that plate, the other plates and their keys are locked (preventing movement) by the nose 374 resting within the other lower notches 352. The plate, as soon as the nose 374 is withdrawn from the notch 351, and the plate partly pushed up as later explained, would be pushed the remaining distance by the spring 361 pushing the pawl 359 upward into the recess 347 of the multiplier plate or 357 of the adder-bar plate.

As each of the nine multiplier plates and the adder-bar plate have separate pawls 359, there are consequently nine pawls 359 on the shaft 358 and nine spiral springs 361, although for clearness of drawings I have deemed it best to only show three of the same, but the arrangement of those pawls and their springs may be in any desirable manner and the opposite ends of the springs may be attached to pins extending from plate 102 or 103, as desired.

As the slots 353 are just twice as long as their width and as the squared guide pins just fill the lower half of the slots, when a plate is pushed down the pins would pass from the lower half to the upper half of the slots in that plate, so that the plate at all times has true alinement to meet and be met by such parts of the mechanism as is necessary and when one of the plates has been depressed and the nose 374 of the pawl 367 has passed into it, all the other plates including the adder-bar plate 135 would be prevented from being pushed in until such a time as the pawl 367 on the shaft 366 has been tripped out of the notches by pressure on the tail of the pawl by a pin 410 carried by the gear 381 which normally holds the nose 374 upward and against a pin 368 extending outward from the right side of the side plate 103. It will be noticed by examining Fig. 5, that while the side plate 102 extends nearly to the top of the inner side of the case, it is only

necessary to carry the side plate 103 a little more than half way upward.

The nose 374 of pawl 367 is wide enough to fit in the recesses 352 of all of the plates at the same time for the purpose of locking against movement all of the unoperated plates while the multiplying mechanism is in operation, and as soon as the multiplying mechanism begins to move the gear 381 begins to turn from left to right so that the pin 410 is instantly redrawn from the pawl 367 so that it descends and its nose rests within the recesses 352 of the unoperated plates and the recess 351 of the operated plate. Should two multiplier plates be simultaneously depressed the multiplying mechanism would continue to operate and the driving-shaft would turn the number of times represented by the greater multiplying plate, for the reason that the plate 369 would not be returned until all of the plates 118 and 135 have been returned and they are only returned when pushed partly back by their respective pins on the gear 381.

Upon the left side of the gear 381 are nine pins 401 to 409 extending outward and beginning with the pin 401 each succeeding pin (the pins extending about ⅓ around the gear) being slightly longer that the previous pin so as to meet its respective plate 118 at the point 349 and return the plate to its original position: should the pin not quite return the plate, the plate would be fully returned by the pawl 359.

The gear 381 moves from left to right as indicated by the arrow and only moves a portion of its distance around when the desired pin comes in contact with the operated plate returning the plate, the plate passing into place preventing another revolution of the driving-shaft and through mechanism, later explained, raising the pawl 397 from the ratchet 148 and allowing the gearing to be returned to its original position by force of the spring 373 so that the gear 381 would be revolved backward from right to left until it reaches its former position so that the pin 410 would strike upon and then rest upon the tail of the pawl 367 raising the pawl out of contact with the plates 118 and 135.

The pin 401 is adapted to return either the depressed adding-bar plate 135 or multiplier plate 118 operated by the "1" multiplying key or return simultaneously both of them should they have by mistake both been depressed. The pin 402 returns the multiplier plate 118 operated by the "2" multiplying key, and so on.

When the plate 369 and its ear 370 are pushed rearward by one of the multiplier plates or by the adder-bar plate the finger 523 of the arm 152 which rests upon it will be released and allowed to pass through the slot 371 in the ear so that the arm 152 will be allowed to drop or be pushed downward by force exerted on it by the lever 393 whose finger 394 runs in the elongated slot 395 in its upper edge, see Figs. 4, 5 and 7.

The lever 393 is on the right side of balance wheel 134, being attached to a stud 392 extending through the balance wheel, a lever 391 being attached to the other end of the stud on the left of the balance wheel, the free end of the lever 391 being forced downward by a spring 389 attached at its other end to a pin 390 carried by the balance wheel, so that it is readily seen that when the balance wheel revolves it carries with it, the spring 389, levers 391 and 393 and the arm 152. When the arm 152 has been released the balance wheel and driving-shaft revolve from right to left as indicated by the arrow on the balance wheel in Fig. 5, and would continue to so revolve, until such a time as all of the depressed multiplier plates, adder-bar plate and plate 369 with its ear 370 have been returned to initial positions, when the finger 523 of the arm 152 would strike upon the ear and the arm 152 would be held in the horizontal position (shown in Fig. 5) while the meter and its driving-shaft were completing the remainder of their last revolution. The ear 370 of the plate 369 is partly supported by the bracket 522 attached to the left side of the plate 103. As the lever, when thus stopped, has its finger 394 in the rear portion of the slot 395, and the guide pin 425 being in the lower portion of the slot 419 (having been carried down with the arm when the arm drops and carrying thereon a spring 423 for keeping the arm in proper position as it drops), the arm 152, as the balance wheel completes its movement, pushes the lever 393 upward and its finger 394 forward in the slot 395, thus stretching the spiral spring 389 which acts as a buffer for gradually stopping the meter, its carriage and the greater part of the multiplying mechanism.

Upon the shaft 392 between the balance wheel and the lever 391 and between the balance wheel and the lever 393 are placed separators 396 to keep the levers at their proper distance from the balance wheel. The balance rod 157 at its upper part is also cut away, as at 162, adjacent to the balance wheel to allow of the full downward movement of the guide pin 425.

A bell crank lever 420 on stud 427 of balance wheel, and normally held against a pin 422 by spring 421 attached at its other end to pin 424 on balance wheel, has its nose 426 in position to be met by the guide pin 425 forming an additional buffer or stop for the arm 152, the guide pin forcing the opposite end of the bell crank lever away from the pin 422 and extending the spring 421.

Extending outward from the right side of the balance wheel 134 are two or more pins 412 carrying the lever 411; the lever having elongated slots 413 through which the pins

extend, allowing a limited movement of the lever inwardly towards the driving-shaft 137. A spring 414 attached, at its upper end to a pin carried by the lever, and its lower end to one of the pins 412, serves to keep the lever normally in its lower position, with its lower curved edge slightly beyond the toothed edge of the balance wheel. This bell crank or angular lever 411 has its lower extension curved and partly cut away, as shown in Fig. 6, so that when its lower edge meets the pin 125, as the balance wheel 134 revolves, it will readily rise and push up the pawl 416 over its curved face 415 so that the pawl 416 will not meet and operate the cam 428 (shown in Fig. 6) affixed on that end of the rock-shaft 293 that is extended through the balance wheel, but the pawl will pass over and above the cam, and the rock-shaft not being turned on this revolution of the balance wheel, none of the latches 286 would be depressed, consequently the meter would not be shifted on that revolution. As this lever 411 is only operated or caused to be moved in by the pin 125, the meter would be shifted one position every time one of the multiplying-keys is operated, as these keys cause, when depressed, the pin 125 to be thrown down and out of striking contact of the lever 411. Thus, when the meter is revolved by the operation of one of these multiplying-keys, the pawl 416, which is mounted on the stud 418 carried by the rear end of the arm 152, and held in a downward position by the spring 417, would hit the cam 428, as the finger 523 on the arm 152 meets the ear 370 and cause the arm to be carried upward, turning the rock-shaft 293, throwing down that latch 286 which holds the carriage of the meter and allows the meter horizontal movement of one position to the right; it is thus seen, that there is an automatic longitudinal movement of the meter as the meter reaches its uppermost position as the driving-shaft completes its last revolution, when the driving-shaft has been allowed to be revolved by a multiplying-key.

Carried by the right-hand plates 207 is a stud 429 carrying a pawl 431 having its nose 432 engaging the teeth on the periphery of the balance wheel 134 and preventing the balance wheel from back lashing or moving backward from left to right. The pawl carries on the right side of the balance wheel an upward extending arm in which is journaled the friction roller or disk 433 which is caused, by the contraction of its spring 430 which encircles the stud 429, to bear against the lower side of the balance wheel and throw the nose 432 of the pawl 431 out of contact with the teeth on the balance wheel as the balance wheel moves forward from right to left, the nose being pushed downward by friction on the disk caused by the revolution of the balance wheel until the tail of the pawl bears against one of the tie-rods 108. Should the balance wheel move backward from left to right the disk would instantly cause the nose 432 to rise and prevent backward movement of the same.

When the plate 369 and its ear 370 have been pushed backward by one of the multiplier plates or by the adder-bar plate and the arm 152 allowed or caused to drop, the pawl 397 on the stud 398 would be drawn by force of its spring 532 into mesh with the ratchet 148 loosely carried on the end 142 of the driving-shaft, so that, as the balance wheel commences its forward movement from right to left its pawl 397 would cause the ratchet 148, and the pinion 149 carried by it, to be revolved from right to left, the pinion turning the gear 385 and its pinion 384, mounted on the stud 387, from left to right, which latter pinion turns the gear 383 and its pinion 382, mounted on the stud 386, from right to left; the pinion 382 turns the gear 381 and its pinion 379, mounted on the stud 380, from left to right.

The pinion 379 is mounted on the end of the stud 380 that protrudes through the side plate 102, as shown in Figs. 5 and 7, and the movement of this pinion from left to right would cause the toothed segment 387 of the lever 372, mounted on the set-screw 388, on the right of the side plate 102, to be carried rearward and the uppper end of the lever drawn forward against the action of its spring 373.

The toothed segment 378 would continue to be carried rearward until the depressed multiplier plate or adder-bar plate had been met by its respective pin (*i. e.* one of the pins designated with the numerals 379 to 409) on the gear 381 hitting its respective edge 349 or 350 and pushed forward into its original position, so that the spring 521 will carry forward its ear 370 to be met by the finger 523 on the last revolution, holding up in its normal horizontal position the arm 152 throwing the pawl 397 out of mesh with the ratchet 148 and the spring 373 will pull backward the upper end of the lever 373 and allow its lower end 378 to move backward ready for the next operation all of the gearing 379, 381 to 385, and the ratchet 148 and its pinion 149 to the original positions; the gearing being stopped in its movements by the pin 410 of the gear 381 striking upon the tail end of the lever 367 and pressing the tail end down until the other end of the lever is met by the pin 377, in which position the gearing remains until another operation by pressure on the adder-bar or on one of the multiplying-keys.

Pointing off mechanism.—On a pair of set-studs 329 carried in an off-set on the upper end of the arm 161 are rotatably mounted the pair of rollers 330, 331, having on each revolution one of the plates 207 pass between them, and adapted to guide the meter and its

carriage in its revolutions around the inner side of the plates. The rods 328 extend from the side plates 63, 64, to the side plate 102, and are secured by the nuts 324, and carry slidably mounted thereon the plate 325 having downwardly extending arms 326, 327, through which the rods pass. The plate 327 extends considerably forward of the rods 328, as shown in Fig. 10, and is met by the rollers 330, 331, on each revolution, immediately after they leave a plate 207, and when the meter is in its normal position the rollers are on each side of the arm 327. When the meter is shifted to the right at the end of its rotation around the plates, the arm 327 is carried along horizontally to the right by the roller 330, to its next position on the right in front of the upper edge of the next plate 207.

The pointer 57 is inwardly threaded at its lower end and when partly inserted through the elongated slot in the shift case 56 and through the hole in the slide 322 can be screwed upon the threaded pin made integral with and extending from the upper side of the plate 325. Pressure on this pointer towards the left will through its arm 327 and the roller 330 move the meter and its carriage to the left until the original left-hand position is obtained. The slide 322 is slidably placed within the shift case 56, as shown in Fig. 8, to prevent dust from entering within the case 53. The upper edge of the shift case forward of and extending the entire length of its elongated slot is raised (as shown in Fig. 10) and carries numerals thereon (as shown in Fig. 19) forming a scale for use in combination with the pointer 57 for the proper positioning of the meter, and so that the result upon the meter may be easily and quickly read as will now be explained. The first segmental run-way 204 at the right has a finger at its top forming a pointer 205 which is used as the decimal point, so that, when the pointer 57 had been moved two positions to the right to the numeral "2" on the scale 323 the decimal point on the first pointer 205 would show two places to its right on the meter, which would be equal to the cents and tens of cents columns. Every third run-way 204 thereafter, to the left, has a similar pointer 205 for use as a comma in pointing off the hundreds, thousands, millions, and so forth, see Fig. 15.

Driving mechanism.—This machine is what is termed an "electric calculating machine" and the mechanism shown in the box 110 forms a necessary part of the mechanism of the machine, but for convenience and in order to reduce (in appearance) the size of the machine it is placed in such box, but can if desired with a few slight changes in the case of the machine be placed within said case. This machine is different from all other known adding or calculating machines in that the power for driving or turning the driving-shaft of the meter is obtained from a coiled spring 461 kept in driving position by mechanism situated with the spring within the box 110 and this mechanism which forms an essential part of the machine is preferably operated by electric current supplied to the motor from an outside source.

The gear 333 has its threaded hub extending through the hole 278 in the left upright 141 (see Fig. 15) and secured by a nut (see Fig. 3); this gear meshes with the pinion 334 made integral with the gear 335 whose threaded hub extends through the hole 279 in the left upright 141 and the gear 335 meshes with and drives the pinion 154 whose threaded end or locking screw 153 is inserted in the end of the driving-shaft.

Revolubly mounted on the screw-stud 84 is the sprocket wheel 332 which is attached to the gear 333 by screws 336. Over the upper teeth of the sprocket wheel extends the driving chain 337; the chain passing through holes in the table 107 and around a sprocket wheel 455 attached to an insulated hub 456 by pins 457. The gear 333, sprocket wheel 332 and the upper portion of the chain 337 are protected by the cap 276 attached by screws 277 to the case 53.

A plate 439 attached by screws to the under side of the table 107 within the box 110 has the downwardly extending sides 440 and 441, and rotatably mounted in the bearings 445 and 446 of the sides 440, 441, is the shaft 444 which extends through the side 441 and is provided with the threaded end 463, as shown in Fig. 46. The shaft 444 carries a cylinder 443 attached to it by a pin 449 extending through its collar 448 adjacent to the bearing 445. A gear 454 is attached by screws (not shown) to the flange 450 of the hub 453, which is fastened to the shaft and cylinder by the pin 451. The insulated hub 456, carrying the sprocket wheel 455, is attached to the cylinder 443 by a pin 453.

A gear 458 is loosely mounted on the shaft 444 and is provided on its side opposite to the side 441 of the plate 439 with outward extending pins 223 carrying a circular plate 459. Suitable separators 226 are carried by the pins separating the plate a proper distance from the gear to allow of the reception of a coiled spring, termed the driving spring, 461 being attached at its inner end to the shaft 444 and its outer end around one of the separators 226. The plate is secured on the pins and against the separators by the nuts 460, as shown in Figs. 2 and 46. It is thus seen, by an examination of Fig. 2, that when the gear is revolved from right to left (looking at the machine from the right) that the spring would be wound and without rotating the gear 454 or the sprocket wheel 455.

A motor 442 is attached upside down to the bottom side of the plate 439 and its shaft 493 carries pinion 494 meshing with gear 484

whose hub 486 is attached by pin 487 to shaft 476 which shaft extends between and through both sides 440, 441. A collar 480 secured by pin 481 together with the collar 482 secured by pin 483 prevents horizontal movement of the shaft. Gear 484 carries by its pins 492 a ratchet 485 preferably cut away at its center so shaft 476 can extend therethrough.

A stud 488, extending outward from the side 440 beneath the gear and ratchet, carries a pawl 489 in contact with the teeth of the ratchet 485. This pawl is provided with the arm 490 having a friction disk 491 and when the ratchet moves forward the disk causes the pawl to drop out of meshing contact with the teeth of the ratchet but immediately the ratchet moves backward the disk through friction causes the pawl to instantly engage a tooth of the ratchet and stops its backward movement. If desired a spring, similar to the spring 430 for the pawl 431, can be used to cause the disk to come tighter against the side of the ratchet.

From one of the poles 495 of the motor 442 extends the current wire 496 having its free end 497 encircle the cylinder 443. From the other pole 517 extends the current wire 518 which passes with the wire 510 (later explained) through an opening in the box 110 for supplying the electric current from some outside source to the motor.

Pinion 477 having its hub 478 attached by pin 479 to the shaft 476 on the left of the side 441, meshes with the gear 458 so that the motor is able to wind up the driving-spring 461, as desired, but backward movement of the gear 458, pinion 477, shaft 476 and gear 484 is prevented by the pawl 489 previously explained. The end of the shaft 476 may be squared as at 498 to receive a handle for winding the spring by hand but it is preferable to keep the spring wound by electricity as the spring can be wound at intervals automatically and the electric current is only used at intervals during the operation of the machine, while in all other adding or calculating machines known to me the current is necessarily used continuously during the operation of the machine. In my machine the current is only used after the driving-shaft has taken a certain number of revolutions, to wind the spring 461 and the number of turns of course depends upon the spring, arrangement of gearing, the speed of driving-shaft desired and the control by the governor.

Gear 454 has its teeth mesh with those of a pinion 465 whose hub is secured by a pin 464 to the shaft 462 and on which shaft is mounted a governor for regulating the speed of the driving-shaft 137. This governor consists of a disk 468 on the shaft 462 against which is pressed, as the speed increases, another disk 469 having its hub freely movable on the shaft 462. Disk 469 has a pair of parallel arms 474 over which is placed a plate 473, the arms 474 being inserted through holes in the plate so that the plate has free movement on the arms, but the plate as it is revolved causes the disk to revolve with it.

The plate is drawn toward the disk 469 by the springs 475 attached between them. Plate 473 is attached to an arm 466 by pin 467 which also secures them to the shaft and on pins carried by the plate 473 is pivotally mounted the pair of bell crank levers 470 having their short arm 471 pressing against the outer side of the disk 469 and acting on the disk against the force of the springs 475. The long arm of each lever 470 carries a weight 472 which swings outward as speed of the shaft 462 is obtained and forces the disk 469 toward the disk 468, causing friction and regulating the speed of the machine.

Fig. 2 of the drawings shows the spring 461 wound up, while Fig. 46 shows it as nearly run down. In Fig. 2 the mechanism which I shall now describe is in its upright position while in Fig. 46 most of the same mechanism is upside down owing to the gear 458 and plate 459 having been revolved one half way around. On the threaded end 463 of the shaft 444 is the ring 511 see Fig. 2 carrying an arm 506 with insulating material 447 placed between the ring and its arm. From the lower end of the arm extends the wire 508 having a swivel 509 at its end and in which swivel is attached one end of the current wire 510, so that the wire 510 does not revolve around when the arm 506 and the wire 508 revolves with the plate 459. In the upper end of arm 506 is a pin 512 on which is mounted the bar 513 having its outer end 507 (as shown in Fig. 2) extending outward between the two strips of insulating material 501 and 503, on the inner sides of the fingers 500 and 502, and between the inner link 504 and the outer link 505. The fingers 500, 502, carry lugs 499 which are attached by screws to the plate 459 beyond the arm 506. The bar 513 has a V-shaped tail or lip 516 against which presses the spring-pressed finger 514 held in its outermost position by the spring 515 see Figs 51 and 52, and forming a snap switch. The finger 514, which is inserted with its spring, in a hole in the arm 506 serves to quickly throw the end 507 of the bar 513 over against one of the links 504 or 505 after the arm 506 has been turned and unwound a certain distance on the threaded end 463 of the shaft 444.

When the driving spring 461 has been wound up the desired amount by the current received from the outside source to the motor, the bar 513 is thrown or snapped over so that its upper end 507 rests against the outer link 505 as shown in Fig. 53 and power for winding the driving spring instantly discontinued, as the insulating material 501 and 503 prevent the current from passing from

the plate 459 to the bar 513. Fig. 52 shows the bar on the point of being snapped from a position allowing of a complete electric connection to the disconnecting position shown in Fig. 53.

When the ear 370 has been drawn forward, as previously explained, allowing of the starting of the driving shaft 137, the coiled spring 461 will cause the shaft 444 to which its inner end is attached to revolve, and as it revolves the threaded end 463 works around in the ring 511 of the arm 506 (as the plate 459 and gear 458 are not moved by the revolution of the shaft on account of the pawl 489 engaging the ratchet 485) and winds the arm 506 outward until a point is reached on the same that will instantly cause the bar 513 to jump from the outer link 505 to the inner link 504 as shown in Fig. 54 and make the electric connection complete: the jumping of the bar 513 being caused by the pressure of the finger 514 on the lip 516 as it snaps from one side of the lip to the other side. It is thus seen that the snap switch allows of a complete winding of the spring and that the amount of winding can be readily changed by moving the link 505 from or towards the link 504.

To operate the machine for addition, the following example is stated: Add "4003," "253," and "5907." Press down the adding-key 61 of the fourth row, which is marked with the numeral "4." Also before, afterwards or simultaneously press down the adding-key 61 of the first row, which bears the numeral "3." As they are pressed down they become locked by the pawls 90 so that their teeth 65 will be met respectively by the teeth 173 of the fourth and first numeral wheels 168 of the meter when it is revolved. To revolve the meter, press down on the adder-bar 340, and the driving-shaft instantly revolves once around, so that upon the meter could be read, through the sight-orifice 54, the figures "4003." The adding-keys and their adding plates having been automatically released, press down the adding-key of the third row, which is marked with the numeral "2," then the one marked "5" on the second row, and the one marked "3" in the first or right hand row. Again press down the adder-bar 340 and the meter being revolved, will read "4256." Then press down the adding-key 61 of the fourth row bearing the numeral "5," and the key of the third row bearing the numeral "9," and the key of the first row bearing the numeral "7." Again press adder-bar 340 and the meter will be revolved and will show the total "10163" upon the first five numeral wheels of the meter, while the right hand wheel 239 of the multiplier meter will have the numeral "3" upon its reading line showing that the meter had been revolved three times, *i. e.*, that there were three items added. To reset the machine hold down the finger 270 and press down once upon the adder-bar 340 and the machine is ready for the next problem.

When it is desired to employ the machine for multiplication, the adding-keys should first be pressed down for the multiplicand, which for example we will say is "1234," then the multiplicand multiplied by the unit figure by pressing down the proper multiplying-key 104, which we will say in this problem is "4;" then the multiplicand multiplied by the tens figure of the multiplier, which we will call "5;" the next figure of the multiplier being the figure "6" we press down another multiplying-key 104: the multiplicand is then multiplied by the thousand figure by pressing down the proper multiplying-key 104, which for example is the figure "7." The meter will then read through the sight-orifice 54 with the figures "9,445,036" upon the reading line of the meter, showing upon the seven right hand wheels of the meter. The multiplier meter will then read through the other sight-orifice 55 with the figures "7654" upon its reading line showing upon the four right hand wheels of the multiplying meter and indicating that this figure was the amount of the multiplier. Should a "0" appear in the multiplier it is only necessary to press the shift-key 105. To reset the machine press down the release-bar 100 to free the adding plates and their adding-keys; also move the pointer 57 to the left, then hold down on the finger 270 pressing down once upon the adder-bar 340 and all parts of the machine are then in their normal positions.

It is to be understood that my invention is not limited to the specific details of construction shown in the accompanying drawings, but that said details may be varied in the practical carrying out of my invention. It is also to be understood that the combinations specifically set forth in the several claims are intended to be separately claimed without limitation to the use in connection therewith of other features and details of construction illustrated.

While the machine shown as embodying the invention is termed a calculating machine and I have especially aimed at the production of a machine capable of performing all the arithmetical problems at high speed with accuracy and a minimum of wear of all the working parts, it will be understood that the invention is not limited to calculating machines of all kinds including adding and listing machines, but may be applied also to registers, typewriters and billing machines or the like, and the words "calculating machine" is used in this specification and the claims in this broad sense. In many obvious ways the features of this invention are susceptible of a considerable degree of modifica-

tion and of a far more extended application than is or can be herein shown, since a description and illustration of the diverse applications that might be made of them would unduly extend this specification. They may, for example, be applied to all of the above named machines, and the claims should be read in the light of this applicability of these devices to other branches of the art.

I claim as my invention—

1. In a calculating machine, an epicycle cylindrical meter, a cylindrical multiplier-meter, means for operating the meter, means whereby the multiplier-meter is operated by the meter when the meter is operated, a sight-orifice for the meter, and an independent sight-orifice for the multiplier-meter.

2. In a calculating machine, an epicycle cylindrical meter, adding-keys, adding plates operable by the adding-keys, a numeral on each of said adding plates, means for operating the meter against the adding plates, and an indicator in the form of a reflector for showing a series of numerals representing the depressed adding plates and their respective adding-keys.

3. In a calculating machine, an epicycle cylindrical meter, adding-keys, adding plates operable by the adding-keys, operating means for carrying the meter against the adding plates, an adder-bar for starting the operating means and a release-bar below and extending parallel with the adder-bar for resetting the adding-keys.

4. In a calculating machine, an epicycle cylindrical meter, several series of adding plates, a series of adding-keys for each series of adding plates and all of the series parallel with each other, a series of multiplying-keys parallel with the several series of adding-keys and each of the keys of all the series of both adding and multiplying keys bearing the same numeral being in the same horizontal row, driving mechanism for carrying the meter against the adding plates, and multiplying mechanism operated by the multiplying-keys for regulating the operation of the driving mechanism.

5. In a calculating machine, an epicycle cylindrical meter capable of occupying a plurality of lateral positions; adding-keys, adding plates operated by the adding-keys, a driving-shaft, mechanism for revolving the meter by its driving-shaft around the inner side of the adding plates, a multiplier meter operated by the meter, a depressible lever 269 for resetting the multiplier meter and adapted to reset the meter if held depressed while the meter is revolved when in its extreme left-hand lateral position by its driving-shaft around the inner side of the adding plates.

6. In a machine of the character described, side walls 140, 141, ball-bearings carried by the walls, a driving-shaft mounted in the bearings, an arm 156 attached to and near one end of the driving-shaft, a balance wheel attached to the driving-shaft near its other end, a balance rod carried by and between the arm and balance wheel, hubs 163, 164, slidably mounted on the driving-shaft, a cylinder 138 carried by the hubs, arms 160, 161, carried by the cylinder having their lower portion encircling the balance rod and longitudinally sliding on the same, a cylindrical meter mounted in the arms 160, 161, adding-keys, adding plates operated by the adding-keys, and means for turning the driving-shaft and bringing the meter into contact with the adding plates.

7. In a machine of the character described, a driving-shaft, a cylindrical meter outside of and longitudinally slidably mounted thereon, a latch casing, and spring operated bell crank levers 286 mounted therein for controlling the longitudinal movement of the meter in one direction.

8. In a machine of the character described, a driving-shaft, a cylindrical meter outside of and longitudinally slidably mounted thereon, a casing having its base 281 below the driving-shaft, studs 290, angular shaped detents 286 mounted within the casing on the studs, pins 291 carried by the detents, springs for holding the detents upward in positions for stopping the longitudinal movement of the meter, means for independently moving down each pin and its detent against which the meter presses, and a stationary detent 302 for preventing the meter from further longitudinal movement in one direction.

9. In a calculating machine, a driving-shaft, a carriage mounted on the driving-shaft and having longitudinal movement thereon, a cylindrical meter mounted in the carriage, a swinging bar 297 pivotally mounted on the carriage, springs for swinging the bar outward, a series of detents against which the bar successively strikes and presses on the longitudinal movement of the carriage and means for depressing the detents as desired to allow of this movement of carriage.

10. In a calculating machine, a driving-shaft, a balance wheel 134, an arm 161, a cylyndrical meter outside of and revolved in a circle by the driving-shaft and having horizontal movement on the driving-shaft, a latch casing pivotally mounted as at 524 to the balance wheel, detents pivotally mounted in the latch casing for limiting the horizontal movement of the meter in one direction, a rock-shaft, a pawl 296 slidably mounted on the rock-shaft for depressing the detents, a bar 297 carried by the meter and normally swung towards it by one of the detents, springs 300 for swinging the bar outward away from the meter when the detent

against which it presses is depressed, a cam 428 carried on rock-shaft, multiplying-keys, a pawl 416, and means operated by the multiplying-keys for causing the pawl to turn the cam and depress the detent against which the bar presses.

11. In a calculating machine, provided with a casing, an epicycle cylindrical meter, means for revolving the meter in a circle, adding plates for operating the meter as it is revolved, rollers 330, 331, carried by the meter, and plates 207 extending nearly around the inner side of the casing and one of which, on every revolution of the meter, passes between the rollers and guides the meter.

12. In a calculating machine, an epicycle cylindrical meter, a series of adding-keys, a series of depressible adding plates operated by the adding-keys adapted to be met when depressed by the meter and each plate provided on its under side with the notches 88, 89, a spring pressed pawl 90 normally resting within the lower notches 88 and adapted to enter the upper notch 89 of each depressed plate and hold the same in operable position to be met by the meter.

13. In a calculating machine, a revolving cylindrical meter, several series of adding-keys, a series of depressible adding plates for each series of adding-keys, each plate provided with a lower notch 88 and an upper notch 89, a pawl 90 below each series of adding plates held upward within the notches 88 of all of the plates of that series, a downwardly extending pin 97 for each pawl, a spring 98 attached to each pin and causing the pawl to enter the notch 89 of each plate when depressed and lock the plate in its lowest position until the pawl is withdrawn, and a release-bar for simultaneously withdrawing all of the pawls from the notches 89 of the displaced plates.

14. In a calculating machine, an epicycle cylindrical meter, several series of adding-keys, a series of depressible adding plates for each series of adding-keys, each plate provided with a lower notch 88 and an upper notch 89, a pawl 90 below each series of adding plates held upward within the notches 88 of all of the plates of that series, a downwardly extending pin 97 for each pawl, a spring 98 attached to each pin and causing the pawl to enter the notch 89 of each plate when depressed and lock the plate in its lower position until the pawl is withdrawn, a shaft 101, wires 99 carried by the shaft, a release-bar 100 for turning the shaft causing the wires to throw up the pins and withdraw all the pawls simultaneously from the notches and simultaneously reset all depressed adding plates and their adding-keys.

15. In a calculating machine, a driving-shaft, a cylindrical meter, several series of adding-keys, adding plates depressible by the adding-keys to be met by the meter when revolved by its driving-shaft, a reflector 85, an arm 82 on the upper end of each adding plate, a finger 83 on its outer end at right angles to it and parallel to the meter carrying on its upper face a numeral adapted to be reflected in the reflector, and the fingers of each series so arranged that only the numeral of the depressed adding-key of highest denomination of each series will reflect.

16. In a calculating machine, a driving-shaft, a revolving cylindrical meter, several series of adding-keys, adding plates depressible by the adding-keys to be met by the meter when revolved by the driving-shaft, side plates for each series of adding plates, a reflector, a finger piece 87 on a side plate of each series carrying the numeral "0" which shows on the reflector when none of the adding plates of that series are displaced out of normal position, and indicating that no adding plate of that series is in driving contact to be met by the meter when revolved.

17. In a calculating machine, a revolving meter, several series of adding plates, adding-keys for each series of adding plates, a reflector, side plates for each series, a numeral "0" for each series affixed to a side plate and showing in the reflector when none of the adding plates of that series are depressed, a numeral carried by each adding plate and the reflector adapted to show the numeral of each adding plate of highest denomination depressed.

18. In a calculating machine, a revolving meter, several series of adding plates, adding-keys for each series of adding plates, a reflector, side plates for each series, a numeral "0" for each series affixed to a side plate and showing in the reflector when none of the adding plates of that series are displaced, a numeral carried by each adding plate, a hood 86 for covering the numerals carried on each adding plate that is in its normal position, and the reflector adapted to show the numeral of each adding plate of highest denomination displaced.

19. In a machine of the character described, a meter having a cylindrical wheel provided with teeth around its periphery, means for causing an epicyclic movement of the meter, means outside of the meter in which the teeth of the wheel mesh as the meter is operated in its epicyclic movement, a disk collar, a cam, a cam operated pawl, a carry-up hammer, and a hammer-cocking retaining pawl.

20. In a machine of the character described, a meter having a toothed cylindrical wheel provided with a hub, means outside of the meter for revolving the wheel, a carry-up hammer, a support for the wheel provided with a slot, a hammer-cocking retaining pawl normally held within the slot, a disk collar on the hub, a cam, and a cam operated pawl for

raising the hammer-cocking retaining pawl out of the slot and allowing forward movement of the carry-up hammer.

21. In a calculating machine, several series of displaceable toothed adding plates, adding-keys for displacing the adding plates as desired, a meter, numeral wheels on the meter having teeth around their peripheries and provided with hubs, means for meshing the teeth of the displaced adding plates with the teeth of the wheels, disk collars 215, cams 213, cam operated pawls 230, carry-up hammers 192, and hammer-cocking retaining pawls 211.

22. In a calculating machine, several series of displaceable toothed adding plates, adding-keys for displacing the adding plates as desired, segmental run-ways 204, lips 224, recocking fingers 206, an epicycle cylindrical meter, supports 165 carried by the meter having slots 178, toothed numeral wheels carried by the supports provided with hubs, driving means for meshing the teeth of the wheels with the teeth of the displaced adding plates, disk collars 215, cams 213, carry-up hammers 192 having fingers 203, hooks 200 carried by the hammers, cam operated pawls 230, hammer-cocking retaining pawls 211, carry-up pawls 175, and over-rotation pawls 530.

23. In a machine of the character described, adding-keys having in their upper portion a cup-shaped opening, a disk 93 inserted in the opening and having on its upper face a numeral in a different color from the disk, adding plates provided with teeth on their inner edge, each numeral denoting the number of teeth of the adding plate to which its respective adding-key is attached, and a meter adapted to be meshed with and operated by the adding plates.

24. In a machine of the character described, an adding-key having in its upper portion a cup-shaped opening, a disk 93 inserted in the opening, a disk 94 carried by the other disk having its upper surface of a different color from that of the rim of the cup-shaped opening and carrying thereon a numeral of the same color as the rim of the opening.

25. In a machine of the character described, adding-keys, all of the keys provided with cup-shaped openings and having rims all of the same color, disks inserted in the openings and having characters on their upper surface, the color of the disks of some of the keys being of a different color from the disks of the other keys, and the characters on the disk of each key being of a different color from the disk on that key.

26. In a calculating machine, several banks of adding-keys, all of the keys provided with cup-shaped openings having rims all of the same color, disks inserted in the openings and having numerals on their upper surface, the color of the disks of some of the banks being of a different color from the disks of the other banks, the numerals on the disks of each bank being of a different color from the disks of that bank, and the numerals of the hundreds and millions banks being of a different color from the cents and thousands banks.

27. In a calculating machine, a meter provided with a number of wheels, rotating means for the wheels of the meter, a driving-shaft without the meter for swinging the meter in a circle and against the rotating means, means for revolving the driving-shaft, an adder-bar plate for operating said means and allowing the driving-shaft to be revolved once and an adder-bar for operating the plate.

28. In a calculating machine, a meter provided with a number of wheels, rotating means for the wheels of the meter, a driving-shaft without the meter for swinging the meter in a circle and against the rotating means, means for revolving the driving-shaft, an adder-bar plate for operating said means and allowing the driving shaft to be revolved once, a lever for operating the plate, and an adder-bar for operating the lever.

29. In a calculating machine, a meter provided with a number of wheels, rotating means for the wheels of the meter, a driving-shaft without the meter for swinging the meter in a circle and against the rotating means, means for revolving the driving-shaft, an adder-bar plate for operating said means and a pawl for holding the adder-bar plate while the driving-shaft is making a portion of its revolution.

30. In a calculating machine, a meter provided with a number of wheels, rotating means for the wheels of the meter, a driving-shaft without the meter for swinging the meter in a circle and against the rotating means, means for revolving the driving-shaft, an adder-bar plate for operating said means and a pawl for holding the adder-bar plate in a locked position when depressed until it is pushed to its original position by said means.

31. In a calculating machine, a meter provided with a number of wheels, rotating means for the wheels of the meter, a driving-shaft without the meter for swinging the meter in a circle and against the rotating means, means for revolving the driving-shaft, an adder-bar plate for operating said means, a pawl for holding the adder-bar plate while the driving-shaft is making a portion of its revolution, and a pin wheel for normally holding the pawl out of mesh with the adder-bar plate.

32. In a calculating machine, a meter provided with a number of wheels, rotating means for the wheels of the meter, a driving-shaft without the meter for swinging the meter in a circle and against the rotating means, means for revolving the driving-shaft,

an adder-bar plate for operating said means and allowing the driving-shaft to be revolved once, and a pin wheel having a pin strike the plate and partly return the same after the driving-shaft has been started in its operation.

33. In a calculating machine, a meter provided with a number of wheels, rotating means for the wheels of the meter, a driving-shaft without the meter for swinging the meter in a circle and against the rotating means. means for revolving the driving-shaft, an adder-bar plate for operating said means and allowing the driving-shaft to be revolved once, an adder-bar for operating the plate, a pawl for holding the plate while the driving-shaft is making a portion of its revolution, a pin wheel having a pin 379 strike the plate and partly return the plate after the driving-shaft has been started in its operation, and having another pin 410 normally holding the pawl out of engagement with the plate.

34. In a calculating machine, a meter, adding plates, driving means for swinging the meter in contact with a portion of the plates, means for limiting the movements of the meter, a series of multiplying plates of different denominational value for starting said driving means, and a pin wheel for returning the multiplying plates.

35. In a calculating machine, a meter, a shaft, adding plates means for swinging the meter upon the shaft and around the inner side of the adding plates. a series of alined multiplier plates of different denominational value for limiting the movements of the meter around the inner side of the adding plates and a pin wheel for returning the depressed multiplier plates.

36. In a calculating machine, a shaft, a meter outside of and rotatable with the shaft, means for rotating the shaft, a series of multiplier plates, multiplying-keys of different denominational values for the multiplier plates, and a pin wheel for returning the depressed multiplier plate and its key.

37. In a calculating machine, a cylindrical meter, adding plates, a driving-shaft for swinging the meter in contact with the adding plates, multiplier plates for limiting the movement of the driving-shaft, and a pawl 367 adapted to be thrown into contact with all of the multiplier plates as soon as one of the multiplier plates has been depressed.

38. In a calculating machine, a cylindrical meter, adding plates, a revolving shaft for swinging the meter into contact with one or more of the adding plates, multiplier plates for limiting the revolutions of the shaft, and each multiplier plate provided with notches 352 and a pawl 367 adapted when one of the multiplier plates has been depressed to be dropped into the notches 352 of all of the undepressed multiplier plates and prevent them from being depressed until the return of the depressed multiplier plate.

39. In a calculating machine, a cylindrical meter, adding plates, a revolving shaft for swinging the meter into contact with one or more of the adding plates, multiplier plates for limiting the revolutions of the shaft. each multiplier plate provided with notches 351, 352, and a pawl 367 adapted when one of the multiplier plates has been depressed to be dropped into the notch 351 of the depressed multiplier plate and simultaneously into the notches 352 of all of the other multiplier plates to prevent these unoperated multiplier plates from being operated until the return of the depressed multiplier plate.

40. In a calculating machine, a cylindrical meter, adding plates, a revolving shaft for swinging the meter into contact with one or more of the adding plates, a series of nine multiplier plates of values from "1" to "9" commencing at the right for limiting the revolutions of the shaft according to its value, and a pin wheel 381 having a series of nine pins, each pin adapted to return a different depressed multiplier plate back to its original position.

41. In a calculating machine, a cylindrical meter, adding plates, a revolving shaft for swinging the meter into contact with one or more of the adding plates, a series of nine parallel multiplier plates of values from "1" to "9" commencing with the plate at the right for limiting the revolutions of the shaft according to its value, a pin wheel 381, and nine pins of different lengths carried on the wheel and each pin adapted to return at a different time in the revolution of the pin wheel its respective multiplier plate.

42. In a calculating machine, a cylindrical meter, adding plates, a revolving shaft for swinging the meter into contact with one or more of the adding plates, a series of nine parallel multiplier plates of values from "1" to "9" commencing with the plate at the right for limiting the revolutions of the shaft according to its value, a pin wheel 381, nine pins of different lengths carried on the wheel and each pin adapted to return at a different time in the revolution of the wheel its respective multiplier plate, a pawl 367 adapted to fall, when one of the multiplier plates has been depressed, into contact with the other unoperated plates and prevent operation of them, and a pin 410 carried by the wheel and adapted to withdraw the pawl after the depressed plate has been returned.

43. In a calculating machine, a cylindrical meter, adding plates, a shaft adapted by its own revolution to revolve the meter into contact with one or more of the adding plates, an adder-bar plate for allowing the shaft to be revolved once, a series of nine multiplier plates for allowing the shaft to be revolved from one to nine times according to their value, and a pin wheel 381 carrying a series of nine pins of different lengths for returning

the multiplier plates when depressed and one of the pins adapted to also return the adder-bar plate.

44. In a calculating machine, a cylindrical meter, adding plates, a shaft adapted by its own revolution to revolve the meter into contact with one or more of the adding plates, an adder-bar plate for allowing the shaft to be revolved once, a series of nine multiplier plates for allowing the shaft to be revolved from one to nine times according to their value, all of the plates provided with notches 351, 352, and a pawl 367 adapted when one of the plates has been depressed to drop into the notch 351 of that plate and simultaneously into the notches 352 of the other nine plates.

45. In a calculating machine, a cylindrical meter, adding plates, a shaft adapted by its own revolution to revolve the meter into contact with one or more of the adding plates, an adder-bar plate for allowing the shaft to be revolved once, a series of nine multiplier plates for allowing the shaft to be revolved from one to nine times according to their value, all of the plates provided with notches 351, 352, and a pawl 367 normally held out of the notches and adapted when one of the plates has been depressed to drop into the notch 351 of that plate and simultaneously into the notches 352 of the other nine plates and adapted to be redrawn from all of the notches after the depressed multiplier plate has been returned to its original position.

46. In a calculating machine, a cylindrical meter, adding plates, a shaft adapted by its own revolution to revolve the meter in contact with one or more of the adding plates, an adder-bar plate for allowing the shaft to be revolved once, a series of nine multiplier plates for allowing the shaft to be revolved from one to nine times according to their value, a pin wheel 381 carrying a series of nine pins of different lengths for returning the multiplier plates when depressed and one of the pins adapted to also return the adder-plate bar plate when it is depressed, the adder-bar plate and the multiplier plates provided with notches 351, 352, and a pawl 367 normally held out of the notches, adapted to drop into the notch 351 of any one of the plates when it is depressed and simultaneously into the notches 352 of the other nine plates, and adapted to be redrawn from the notches after the depressed plate has been returned to its original position.

47. In a calculating machine, an epicycle cylindrical meter, rotating means for the meter, a driving-shaft adapted by its own revolution to revolve the meter in contact with the rotating means, an adder-bar plate for allowing the driving-shaft to be revolved once, a series of nine multiplier plates for allowing the shaft to be revolved from one to nine times according to their value, a pin wheel 381 carrying a series of nine pins of different lengths for returning the multiplier plates when depressed, one of the pins adapted to also return the adder-bar plate when it is depressed, all of the plates provided with notches 351, 352, a pawl 367 adapted when one of the plates has been depressed to drop into the notch 351 of that plate and simultaneously into the notches 352 of the other nine plates, and a pin 410 on the wheel for normally holding the pawl out of contact of the notches and adapted to strike on the tail of the pawl and lift the nose of the pawl out of the notches after the depressed plate has been returned.

48. In a calculating machine, a cylindrical meter, a shaft outside of the meter and adapted to revolve and turn the meter with it, an adder-bar plate for allowing the shaft to be revolved once, shifting-means automatically operated for allowing the meter to move longitudinally one position, on the revolving of the shaft, when it has nearly finished its revolving, means for preventing the operations of the shifting-means, and a nose carried by the adder-bar plate for operating the means for preventing the operation of the shifting-means.

49. In a calculating machine, a cylindrical meter, a shaft outside of the meter and adapted to revolve and turn the meter with it, an adder-bar plate for allowing the shaft to be revolved once, shifting means automatically operated for allowing the meter to move longitudinally one position on the revolving of the shaft when it has completely finished its revolving, means for preventing the operation of the shifting-means, a nose 136 carried by the adder-bar plate for operating the means for preventing the operation of the shifting-means, a series of multiplier plates, and a nose 348 on each multiplier plate for returning the means operated by the nose 136 and allowing free automatic operation of the shifting means until another operation of the adder-bar plate.

50. In a calculating machine, a cylindrical meter, a shaft outside of the meter and adapted to revolve and turn the meter with it, multiplier plates, shifting-means automatically operated for allowing the meter to move longitudinally one position for each operation of a multiplier plate, an adder-bar plate for allowing the shaft to be revolved once, a pawl 416 for operating the shifting-means, a lever 411 adapted to operate to throw out the pawl and prevent operation of the shifting means for that revolution of the shaft, a plate 119, a pin 125 carried by the plate to operate the lever when the plate 119 is depressed, a stud 130, and a nose 136 on the adder-bar plate for depressing the stud and its plate 119 when the adder-bar plate is operated.

51. In a calculating machine, a toothed wheel, a pawl, an arm carried by the pawl and a friction disk carried by the arm.

52. In a calculating machine, a toothed wheel, a pawl, an arm carried by the pawl, a friction portion carried by the arm and pressing against the face of the wheel, and a pin without the wheel for preventing the friction portion from passing off of the face of the wheel.

53. In a calculating machine, a toothed wheel, a pawl below the wheel, an arm carried by the pawl, a friction disk carried by the arm and pressing when the wheel is in motion against the face of the wheel, a stop adapted to be met by the tail of the pawl when the wheel is revolved forward and limit the movement of the pawl.

54. In a calculating machine, a toothed wheel, a pawl, an arm carried by the pawl, and a revolving disk carried by the arm.

55. In a calculating machine, a toothed wheel, a stud, a pawl, an arm carried by the pawl, a friction disk carried by the arm, and a spring adapted to press the disk against the face of the wheel.

56. In a calculating machine, a gear, a ratchet carried by the gear, a pawl, an arm carried by the pawl, a friction portion carried by the arm and adapted on the forward motion of the ratchet to throw the pawl out of contact with the teeth of the ratchet and on backward motion of the ratchet to throw the pawl into contact with a tooth of the ratchet and stop the movement of the gear and ratchet.

57. In a calculating machine, a meter, adding plates, a shaft adapted by its own revolution to revolve the meter in contact with one or more of the adding plates, a balance wheel, an arm 152 having an elongated slot 395 in its upper surface, a finger 523 carried by the arm, a stop for the finger, a lever 393 having its finger 394 running in the slot, and a spring 389 for pressing down the arm as soon as the stop has been withdrawn from the finger 523.

58. In a calculating machine, a cylindrical meter, adding plates, a shaft adapted by its own revolution to revolve the meter in contact with one or more of the adding plates, a balance wheel affixed to the shaft and having a slot 419, an arm pivotally mounted on the shaft, a stop for the arm, a guide-stop pin on the arm and extending into the slot, and a spring pressed lever 420 carried on the balance wheel and met by the pin in its upward movement.

59. A calculating machine having a rotatable shaft, a cylinder slidable upon the shaft, arms carried by the cylinder, a cylindrical meter carried in the upper portion of the arms, and a balance rod carried by the shaft and extending through the lower portion of the arms.

60. In a calculating machine, adding plates, adding-keys for operating the adding plates, a driving-shaft, a cylinder upon the shaft, a rotatable meter carried by and outside of the cylinder, means for rotating the meter against the operated adding plates, a spring for sliding the cylinder upon the driving-shaft, detents for limiting the movement of the cylinder, a rock-shaft, a pawl for withdrawing a detent upon the rocking of the rock-shaft, and a toothed segment for partly turning the rock-shaft upon each movement and allowing the cylinder to slide upon the driving-shaft one position to the next detent.

61. In a calculating machine, adding plates, adding-keys for operating the adding plates, a driving-shaft, a cylinder upon the shaft, a rotatable meter carried by and outside of the cylinder, means for rotating the meter against the operated adding plates, a spring for sliding the cylinder upon the driving-shaft, detents for limiting the movement of the cylinder, a rock-shaft, a pawl for withdrawing a detent upon the rocking of the rock-shaft, a toothed segment for partly turning the rock-shaft upon each movement and allowing the cylinder to slide upon the driving-shaft one position to the next detent, and a finger 321 for moving the toothed segment.

62. In a calculating machine, adding plates, adding-keys for operating the adding plates, a driving-shaft, a cylinder, a rotatable meter, means for rotating the meter against the operated adding plates, a spring for sliding the cylinder upon the driving-shaft, detents for limiting the movement of the cylinder upon the driving-shaft, a rock-shaft, a pawl, a toothed segment for partly turning the rock-shaft upon each movement and allowing the cylinder to slide one position to the next detent, a lever 317, a key 105 for the lever, and a lever 316 pivotally mounted on the lever 317 and carrying a finger for depressing the toothed segment.

63. In a calculating machine, adding plates, adding-keys for operating the adding plates, a driving-shaft, a cylinder, a rotatable meter, means for rotating the meter against the operated adding plates, a spring for sliding the cylinder upon the driving-shaft, detents for limiting the movement of the cylinder upon the driving-shaft, a rock-shaft, a pawl for withdrawing a detent upon movement of the rock-shaft, a pinion 303, a toothed segment 304, a segment 308 having a tail 310, a toothed segment 312 carrying a pin 311, and a two-part lever for depressing the toothed segment 312.

64. In a calculating machine, an epicycle cylindrical meter, adding plates, a driving-shaft for revolving the meter against the adding plates, multiplier plates for limiting the movement of the meter and driving-shaft according to their denominational value, a bal-

ance wheel carried by the driving-shaft, a pinion, a ratchet carried by the pinion, a pawl 397 adapted to mesh with the ratchet on the forward movement of the driving-shaft and carry forward the ratchet and gear, a pin wheel 381, gearing connecting the pin wheel and pinion, a pinion 379 carried by the pin wheel, a series of pins on the wheel for returning the multiplier plates, and a toothed segmental lever 372 meshing with the pinion 379 for returning the gearing and pin wheel as soon as the depressed multiplier plate has been returned.

65. In a calculating machine, a longitudinally slidable epicyclic cylindrical meter, means for causing an epicyclic movement of the meter, and pointing off mechanism for the meter.

66. In a calculating machine, a longitudinally slidable epicyclic cylindrical meter, means for causing an epicyclic movement of the meter, stationary pointing off mechanism for the meter, and a lever for carrying the meter to the desired position.

67. In a calculating machine, a longitudinally slidable meter, and pointing off mechanism without the machine for placing the meter in any desired position.

68. In a calculating machine, a longitudinally slidable meter, a scale without the meter, pointing off mechanism within the meter, and a pointer for indicating on the scale the position of the meter.

69. In a calculating machine, a longitudinally slidable meter, a scale having a series of numerals thereon and a pointer for the scale and connected with the meter to move the meter to any desired position as represented by a numeral on the scale.

70. A calculating machine provided with a case, a cylindrical meter within the case, a shift case 56, a slide 322, a scale 323, and a pointer 57 for the scale and connected with the meter.

71. In a calculating machine, a casing, rods, a plate 325 having its arms sliding on the rods, a scale 323, a pointer for the scale, and a cylindrical meter longitudinally moved backward by the plate as the pointer moves along the scale.

72. In a calculating machine, a casing, a rod, a plate, an arm 327 carried by the plate and sliding upon the rod, an epicycle cylindrical meter slidably mounted within the case, a spring 274 for pulling the meter in one direction, detents for limiting its movement in that direction, and a lever 57 attached to the plate for sliding the meter in the other direction.

73. In a calculating machine, a casing, an epicycle cylindrical meter, means for sliding the meter longitudinally forward, means for limiting its movement, rollers 330, 331, carried by the meter, a plate, an arm 327 carried by the plate and normally extending between the rollers, a lever 57 extending through an elongated opening in the case and used for pressing the arm 327 against one of the rollers and pushing the meter backward longitudinally to its original position, and a slide 322 for making the opening in the case dust-proof.

74. In a calculating machine, a casing, a scale on the surface of the casing, an elongated dust-proof slide, an epicycle cylindrical meter, rollers carried by the meter, means for sliding the meter longitudinally forward, a plate, a pointer for the scale extending through the slide and attached to the plate, an arm carried by the plate and extending between the rollers when the meter is in a slidable position and adapted to slide the meter longitudinally backward, and pointing off means within the casing for the meter.

75. In a calculating machine, an epicycle cylindrical meter, adding plates, adding-keys for depressing the adding plates, driving-means for sending the meter against the depressed adding plates, a reflector for showing the depressed adding plates that will be met by the meter, multiplier plates, multiplying-keys for depressing the multiplier plates, means connecting the driving-means and the multiplier plates, and a multiplier meter for showing what multiplying-keys have been depressed.

76. In a calculating machine, an epicyclic cylindrical meter, a cylindrical multiple meter consisting of two or more numeral wheels upon which the multiplier will show in proper readable order, multiplying mechanism, multiplying-keys, and means allowed to operate by the operation of the multiplying mechanism for causing an epicyclic movement of the meter whereby the multiple meter will be operated.

77. In a calculating machine, an epicyclic cylindrical meter, a multiple meter having a numeral wheel, a toothed gear and means operated by the epicyclic cylindrical meter in its epicyclic movement for operating the numeral wheel.

78. In a calculating machine, an epicycle cylindrical meter, a driving-shaft for revolving the meter around the inner side of the machine, a series of numeral wheels, a series of gears independent of the numeral wheels, a series of pins extending outward from each gear, means for turning one of the gears upon each revolution of the driving-shaft, a pawl in contact with the pins of each wheel for preventing the numeral wheel which it operates from moving more than one position on each revolution of the driving-shaft, and means whereby when one of the gears is operated a numeral wheel will also be moved one position.

79. A multiplier meter having a series of numeral wheels in combination with a series

of gears having teeth extending around their peripheries and a series of teeth extending from one of their sides adjacent to a numeral wheel, a pawl for each gear to stop over-rotation, teeth extending around the periphery of each numeral wheel near one edge thereof, a pinion meshing with the teeth of each numeral wheel, a pinion meshing with each gear, and shafting connecting each set of pinions so that when one of the gears is operated its respective numeral wheel will be operated.

In testimony whereof I affix my signature in presence of two witnesses.

EMORY S. ENSIGN.

Witnesses:

CHARLES F. A. SMITH,

FRANCIS E. SMITH.

No. 889,668. PATENTED JUNE 2, 1908.

E. S. ENSIGN.

CALCULATING MACHINE.

APPLICATION FILED APR. 26, 1907.

17 SHEETS—SHEET 1.

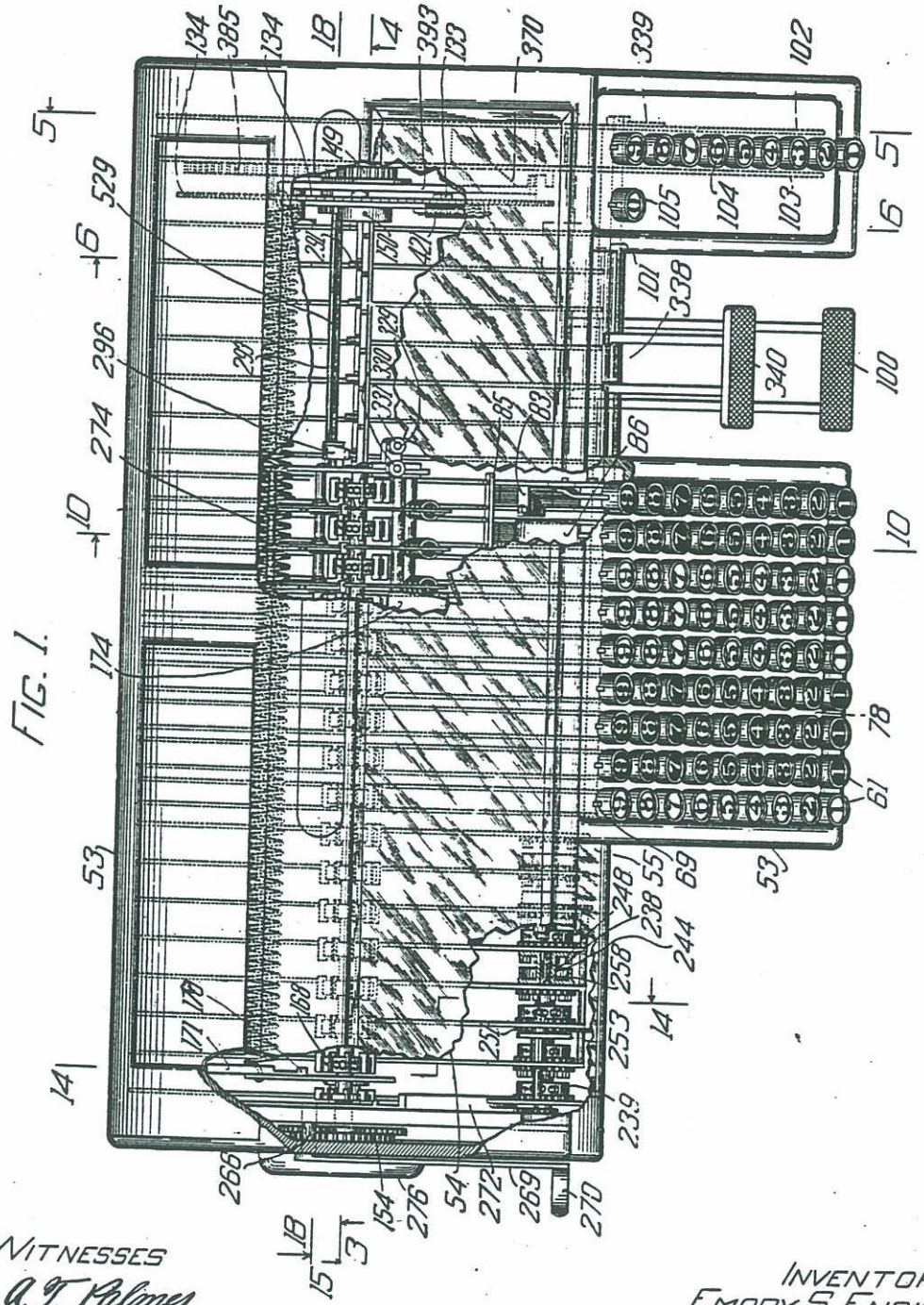

FIG. 1.

WITNESSES

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EMORY S. ENSIGN

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ATT'Y.

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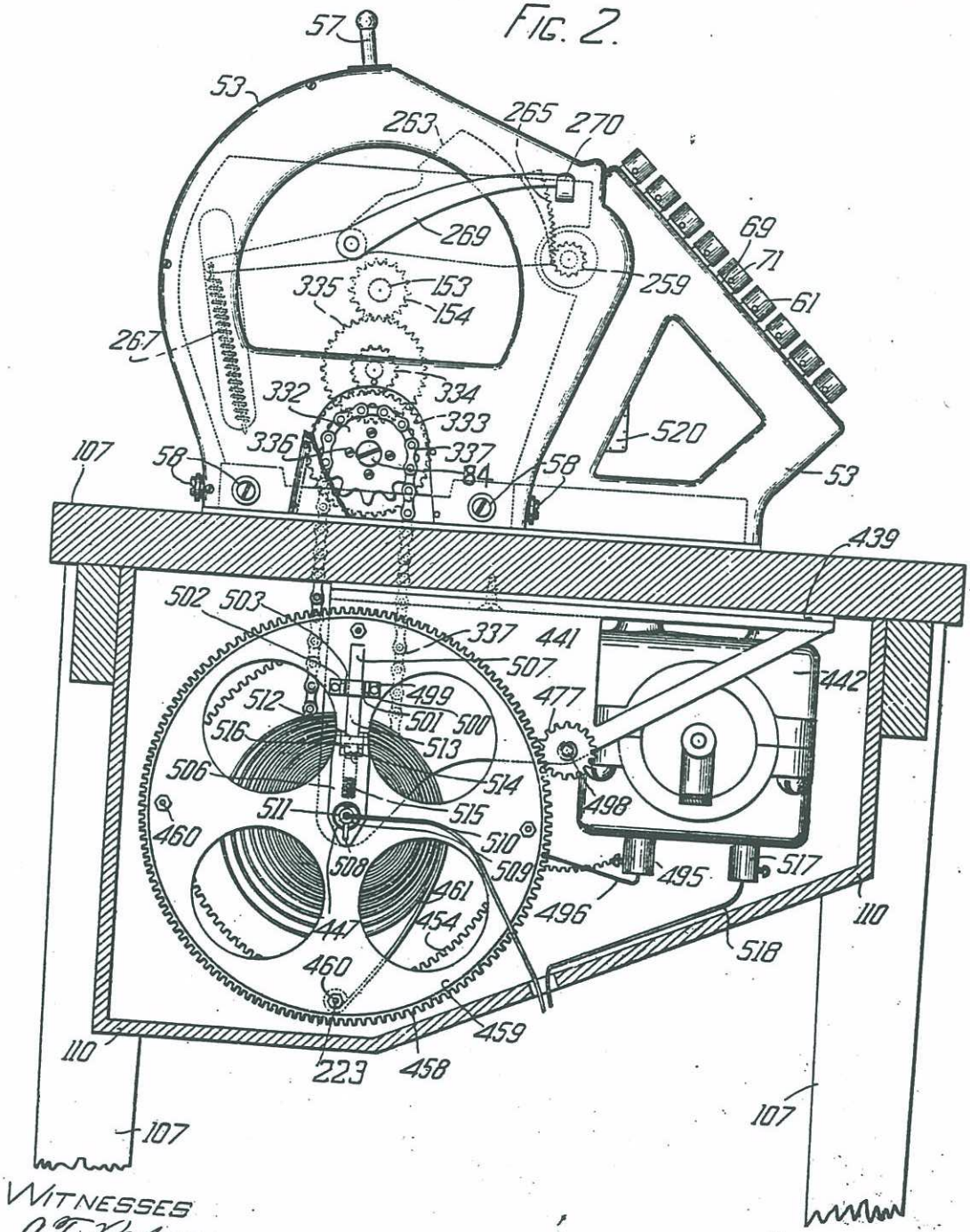
17 SHEETS—SHEET 2.

FIG. 2.



WITNESSES
A. T. Palmer
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No. 889,668.

E. S. ENSIGN.

PATENTED JUNE 2, 1908.

CALCULATING MACHINE.

APPLICATION FILED APR. 26, 1907.

17 SHEETS—SHEET 3.

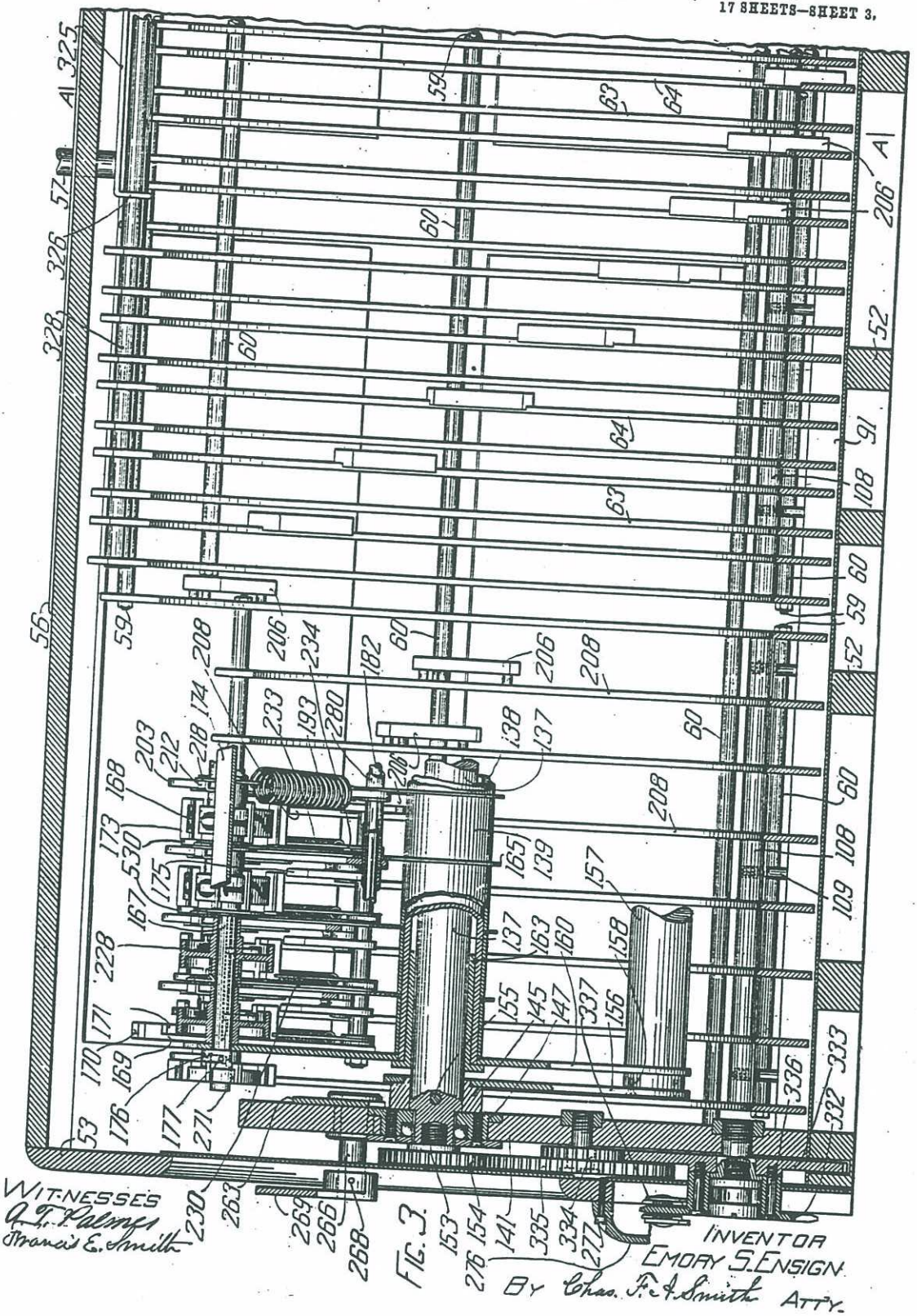

FIG. 3.

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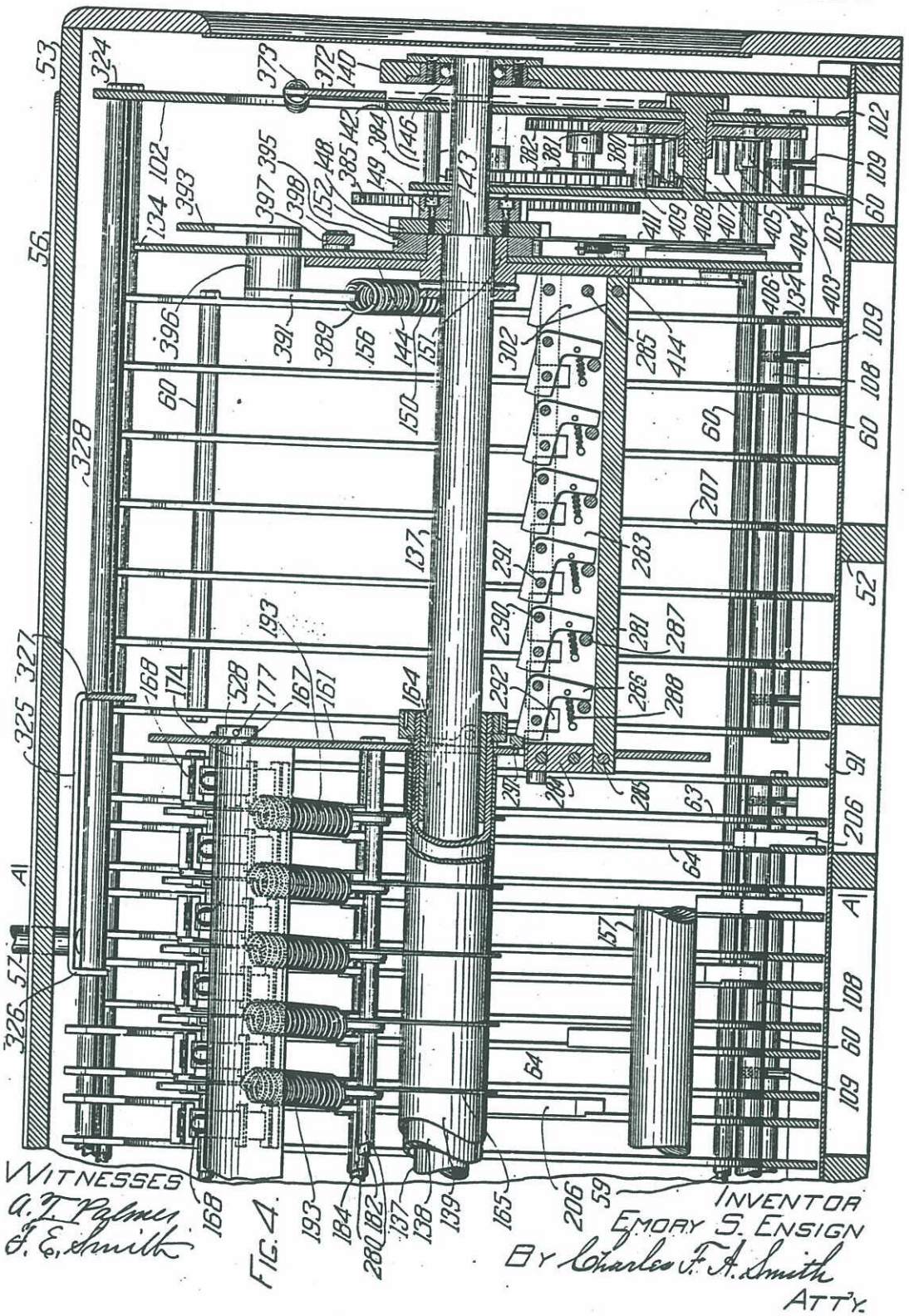
17 SHEETS—SHEET 4.



WITNESSES

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FIG. 4.

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17 SHEETS—SHEET 5.

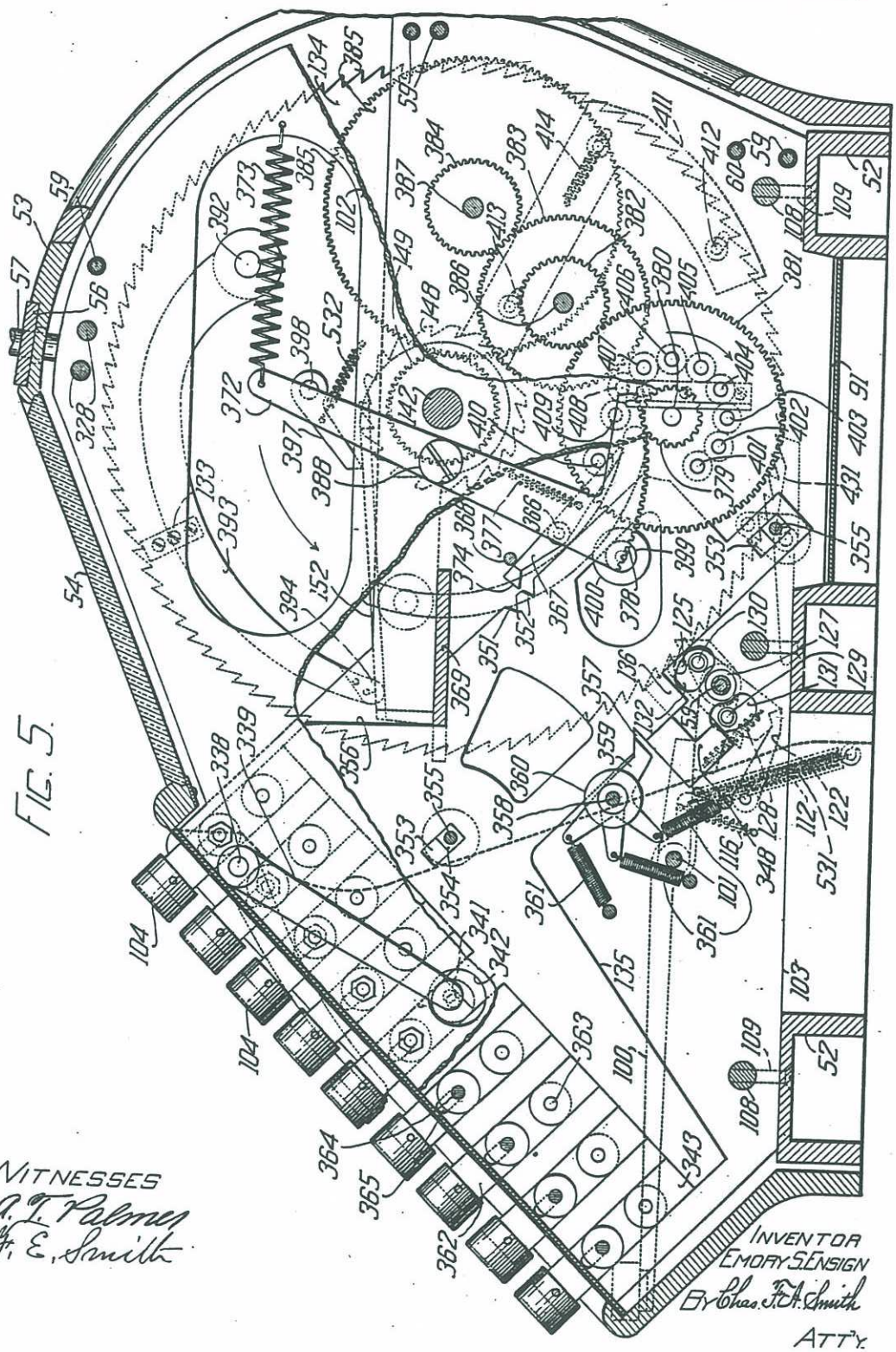

FIG. 5.

WITNESSES

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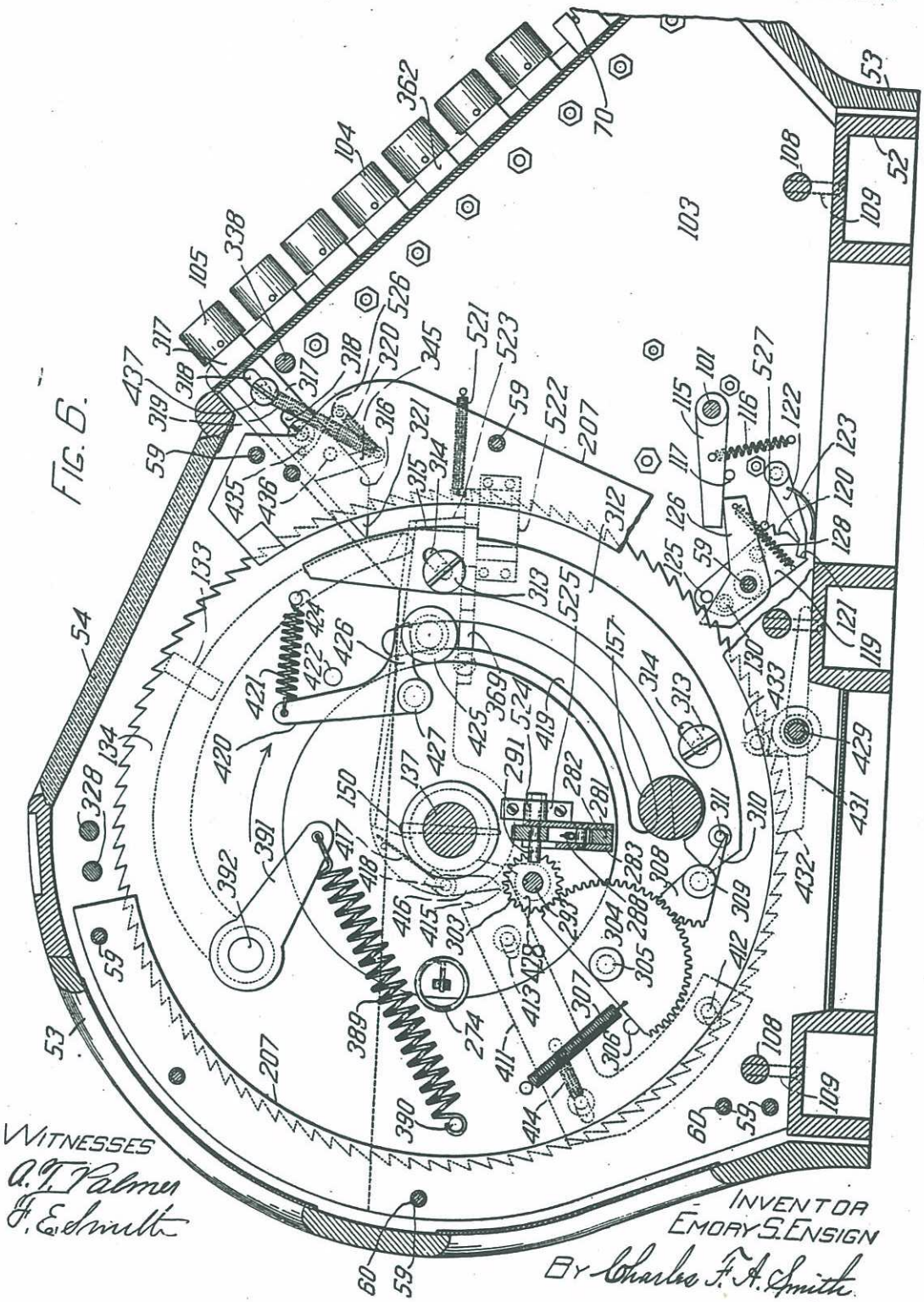
17 SHEETS—SHEET 6.

FIG. 6.



WITNESSES

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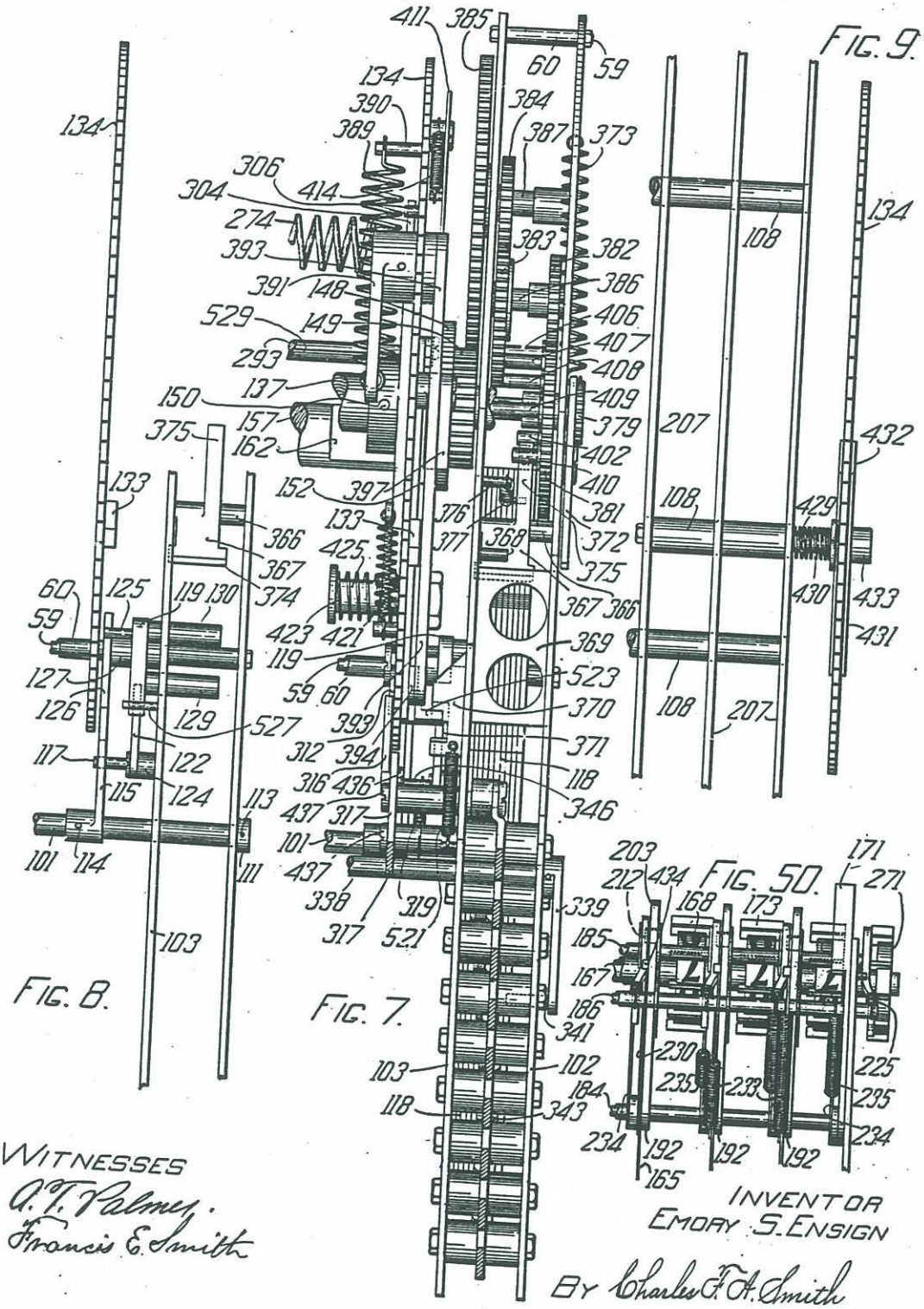
17 SHEETS—SHEET 7.



WITNESSES

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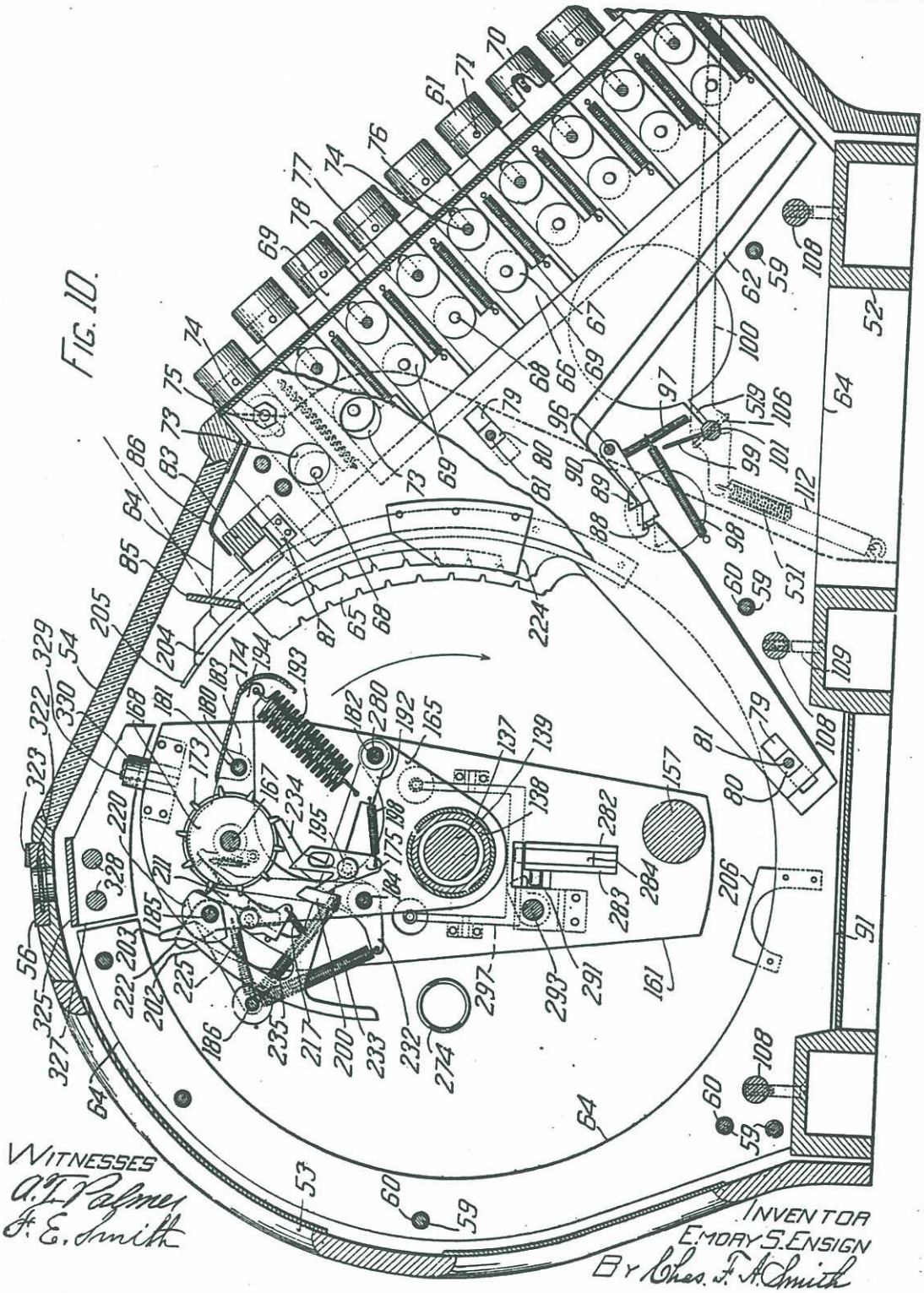
17 SHEETS—SHEET 8.

FIG. 10.



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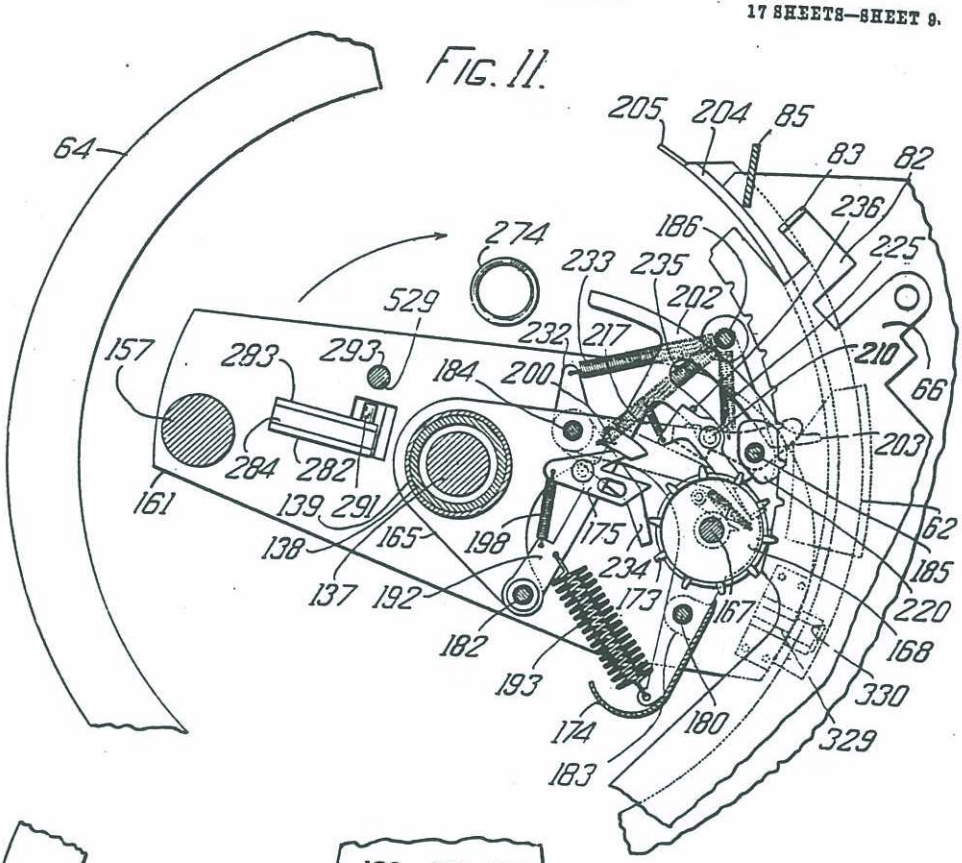
17 SHEETS—SHEET 9.

FIG. 11.



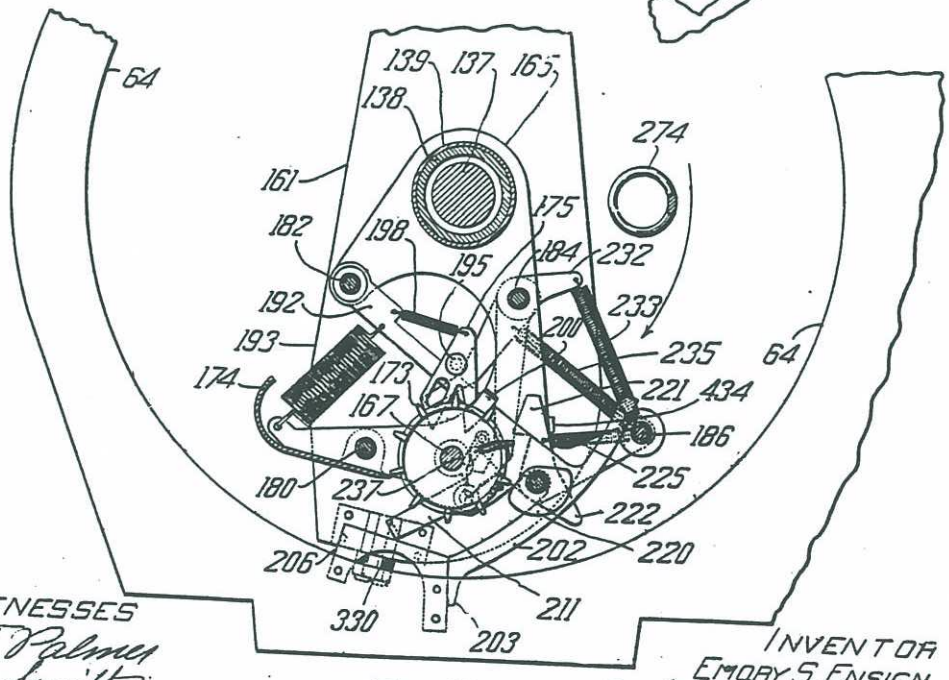


FIG. 13.

WITNESSES
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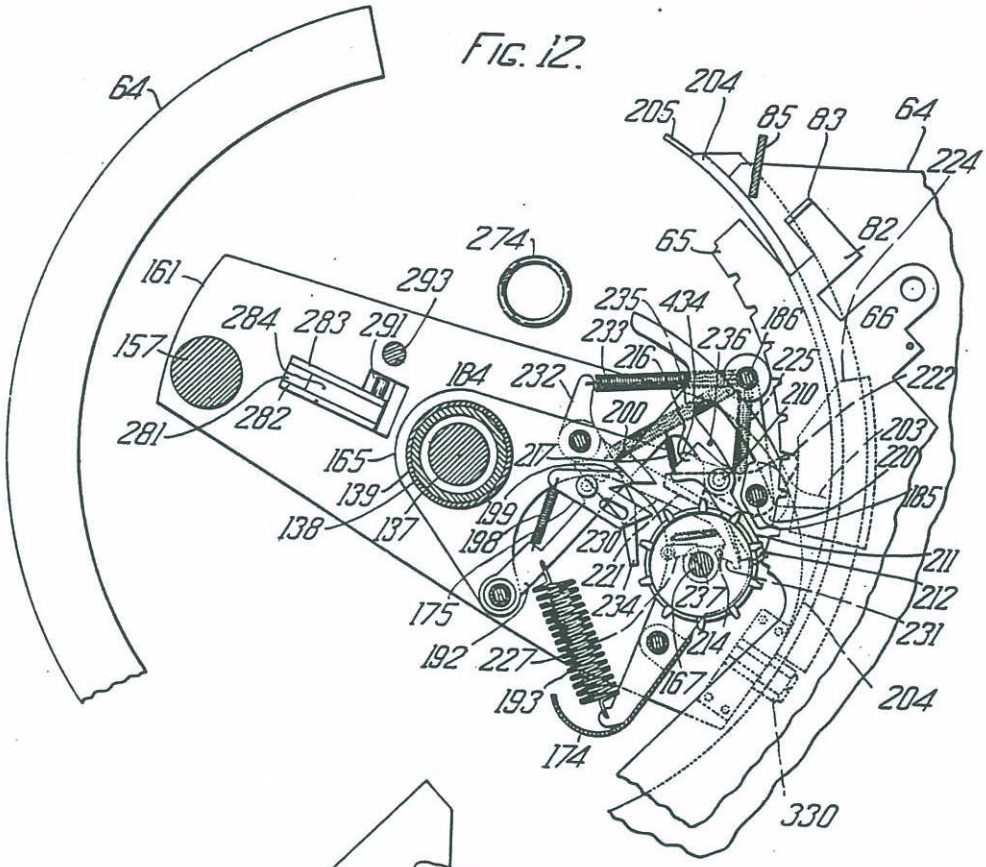
17 SHEETS—SHEET 10.

FIG. 12.



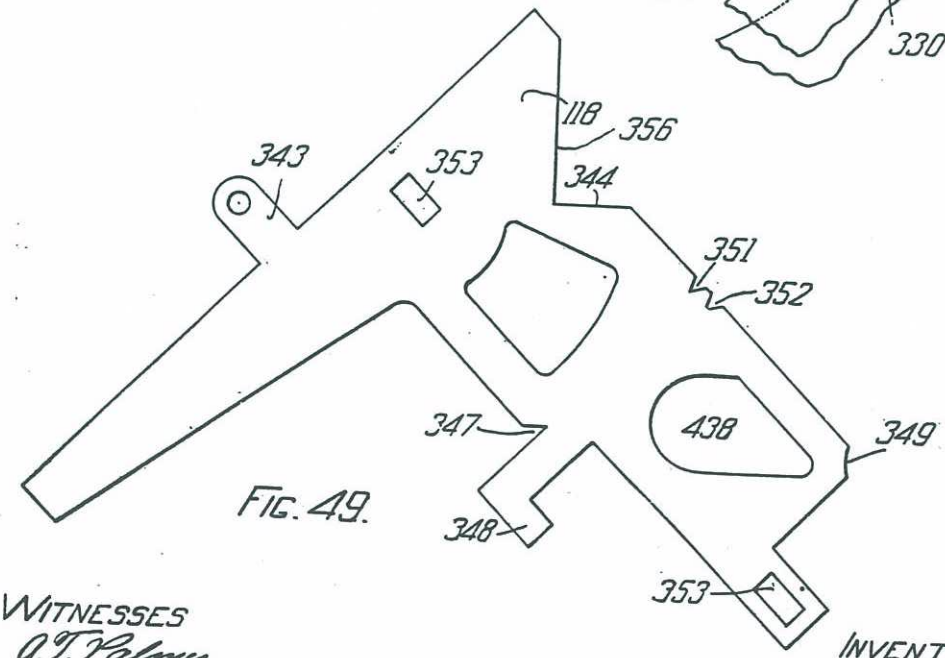


FIG. 49.

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17 SHEETS—SHEET 11.

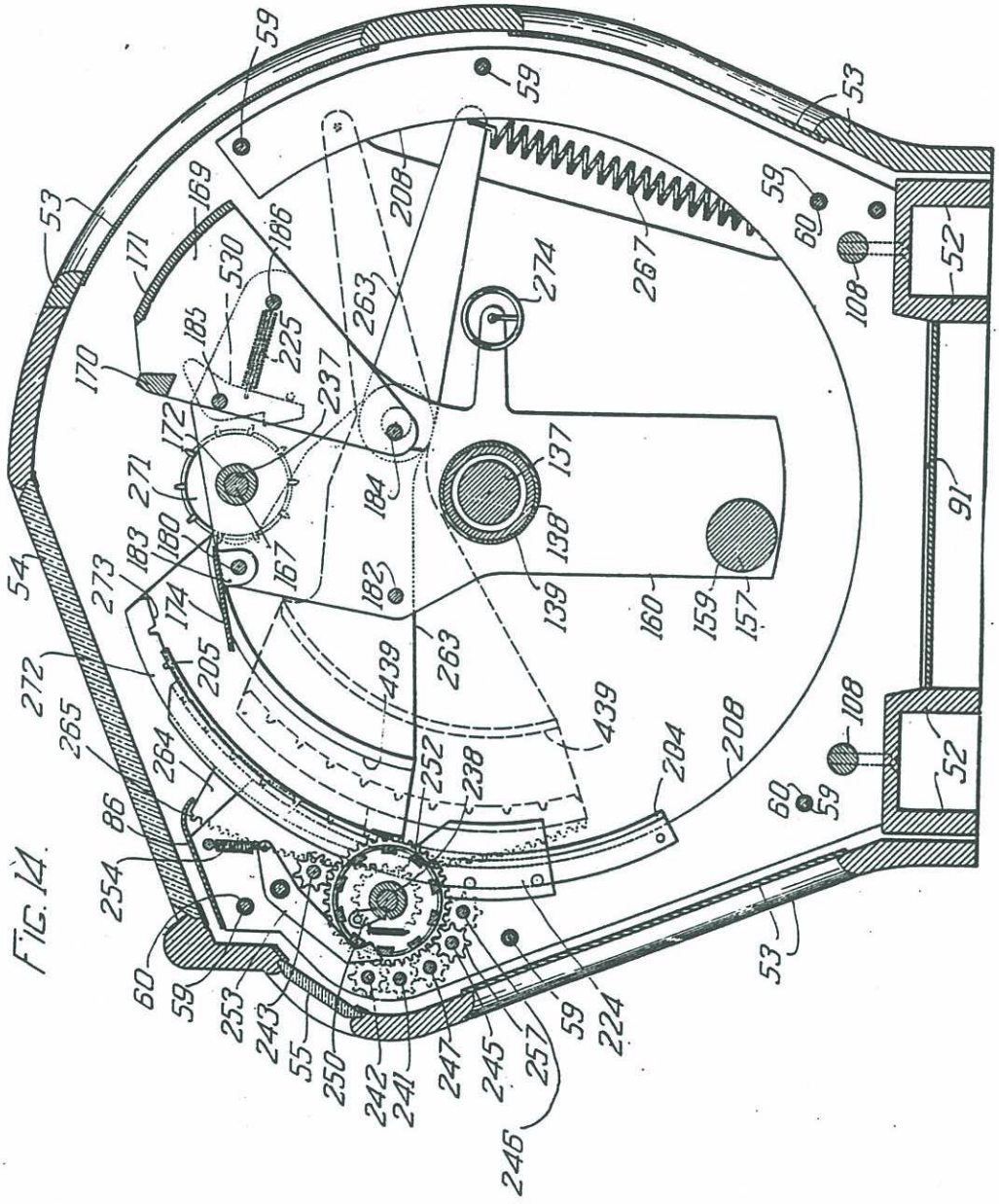

FIG. 14.

WITNESSES

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17 SHEETS—SHEET 12.

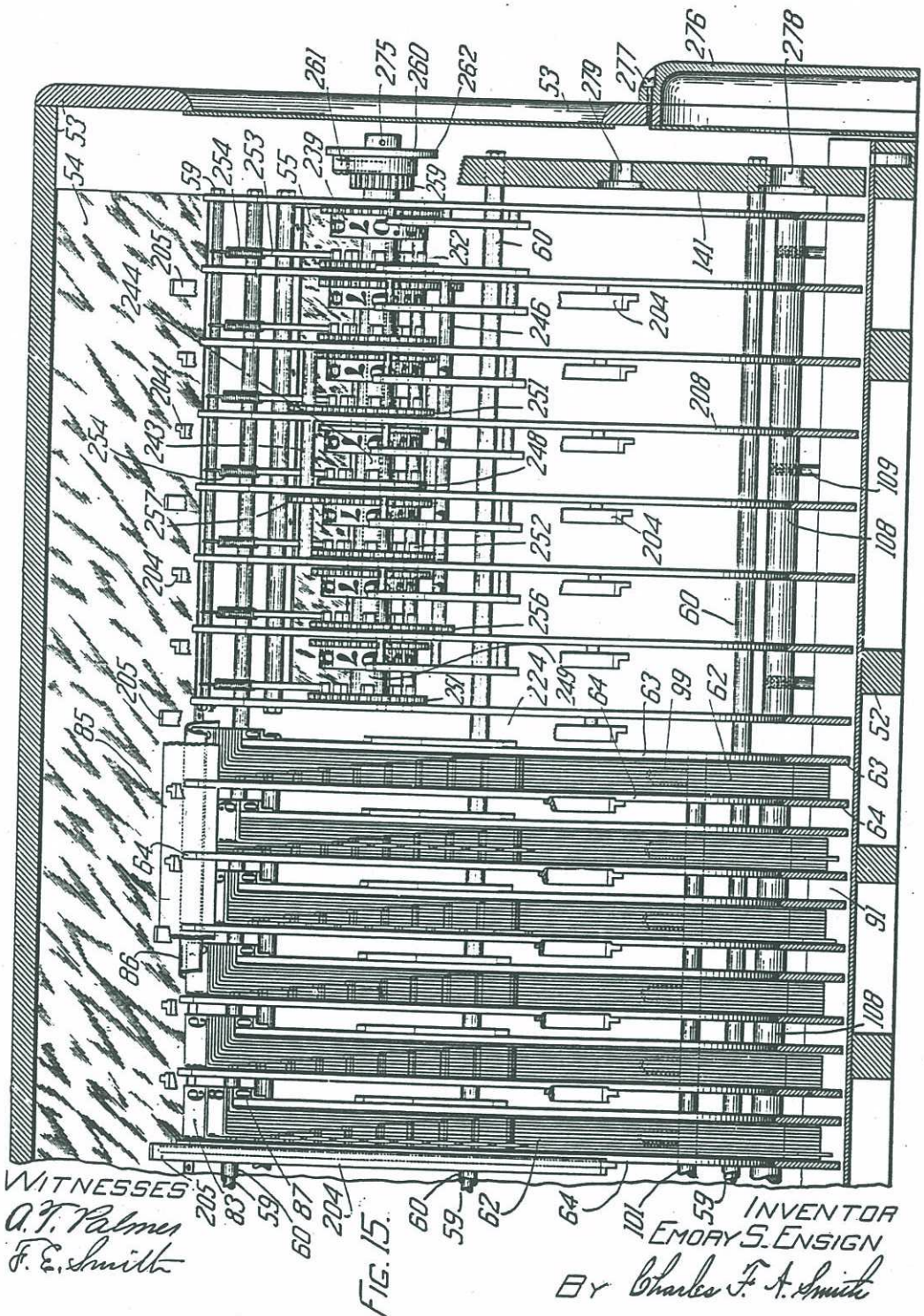

FIG. 15.

WITNESSES
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17 SHEETS—SHEET 13.

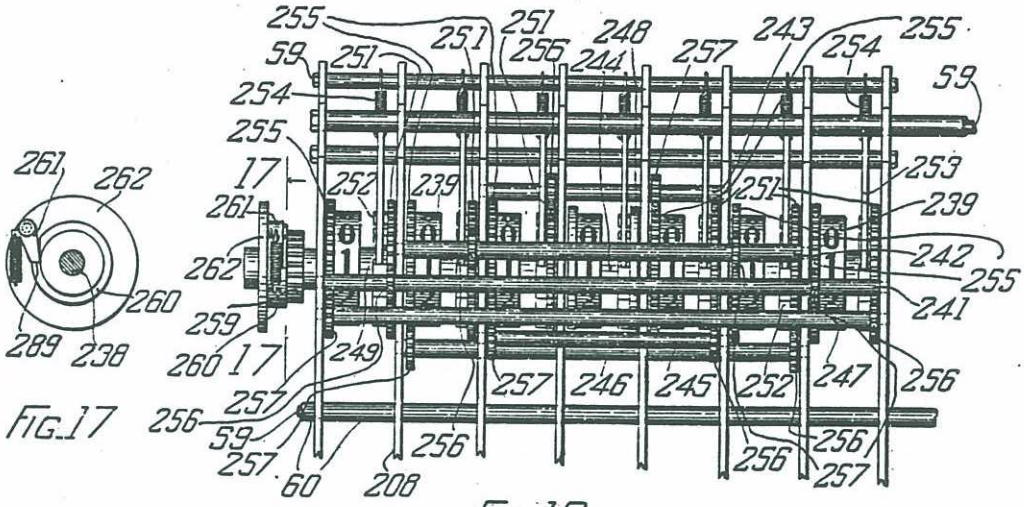

FIG. 17

FIG. 16

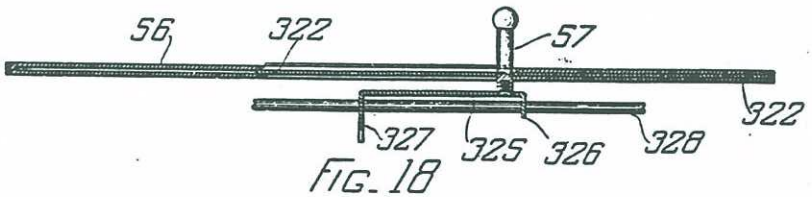

FIG. 18

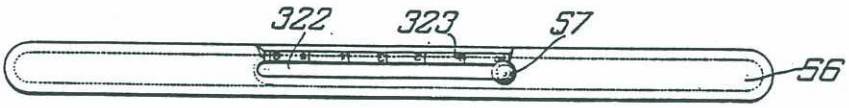

FIG. 19.

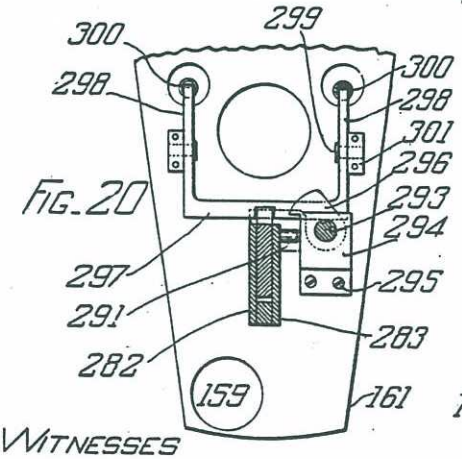

FIG. 20

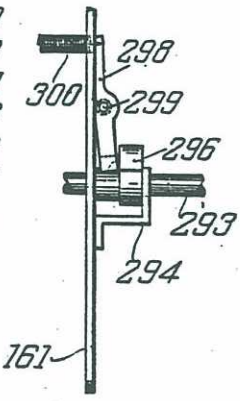

FIG. 21

FIG. 22

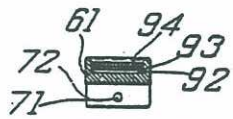

FIG. 23

WITNESSES

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17 SHEETS—SHEET 14.

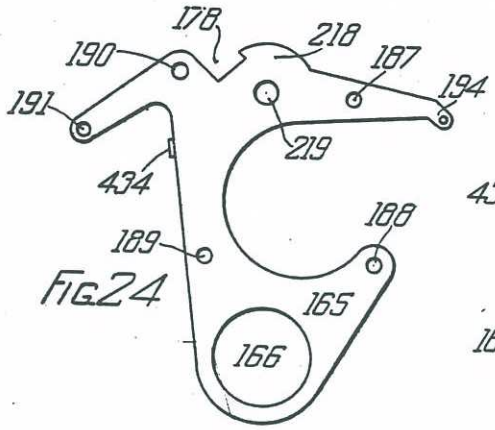

FIG. 24

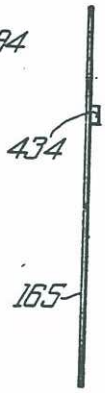

FIG. 25

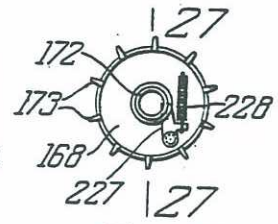

FIG. 26

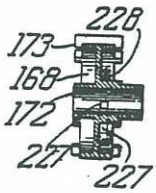

FIG. 27

FIG. 28

FIG. 29

FIG. 30

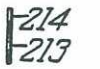

FIG. 31

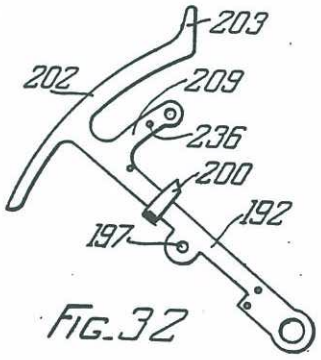

FIG. 32

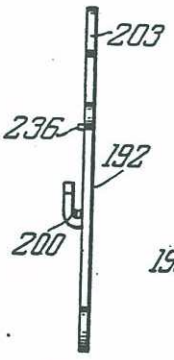

FIG. 33

FIG. 34

FIG. 35

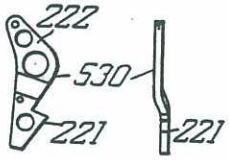

FIG. 36 FIG. 37

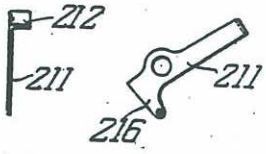

FIG. 39 FIG. 38

FIG. 40

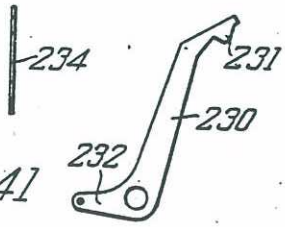

FIG. 41 FIG. 42

FIG. 43

WITNESSES

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CALCULATING MACHINE.

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17 SHEETS—SHEET 15.

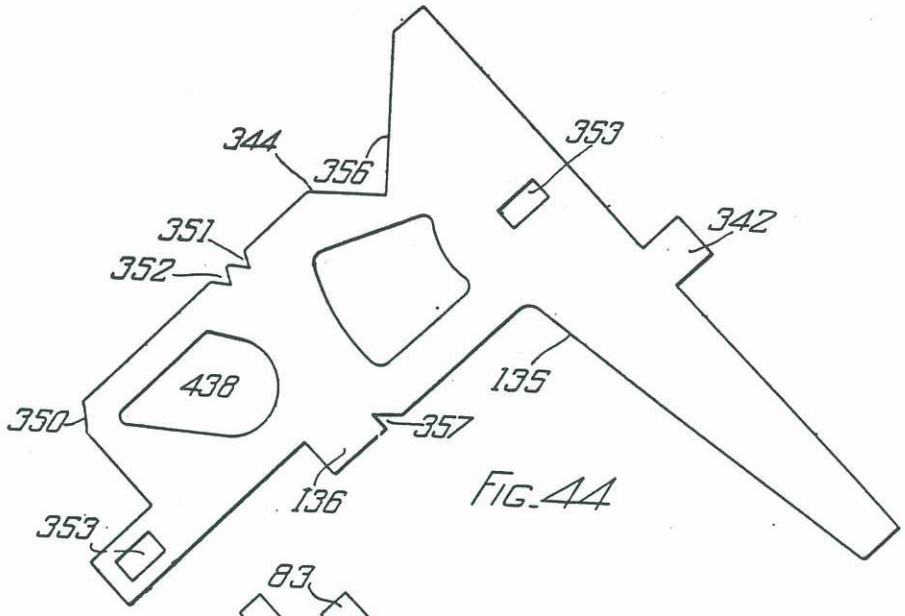

FIG. 44

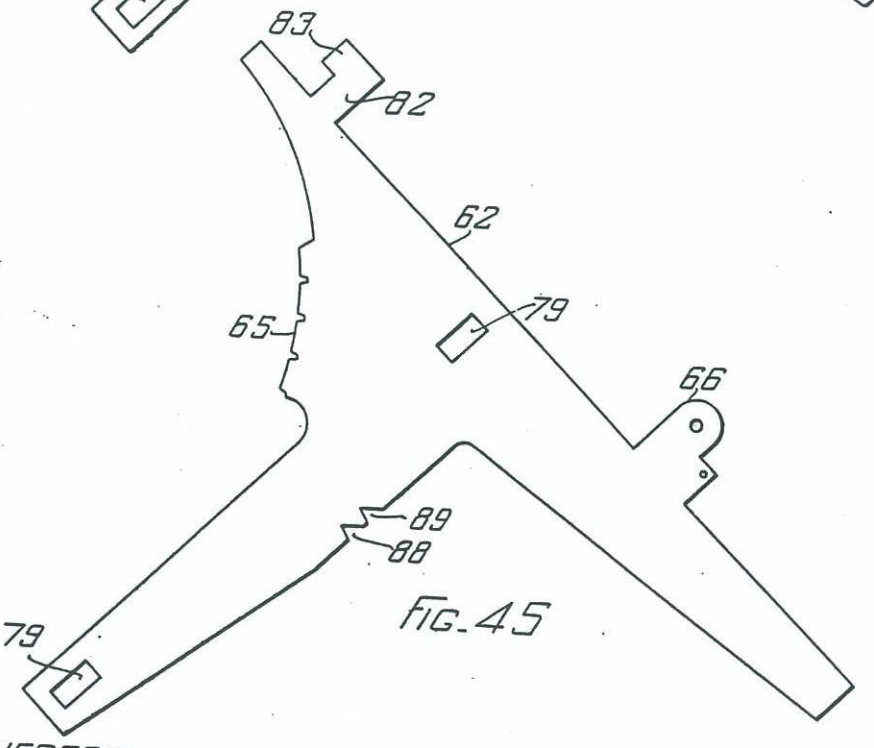

FIG. 45

WITNESSES

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17 SHEETS—SHEET 16.

FIG. 46

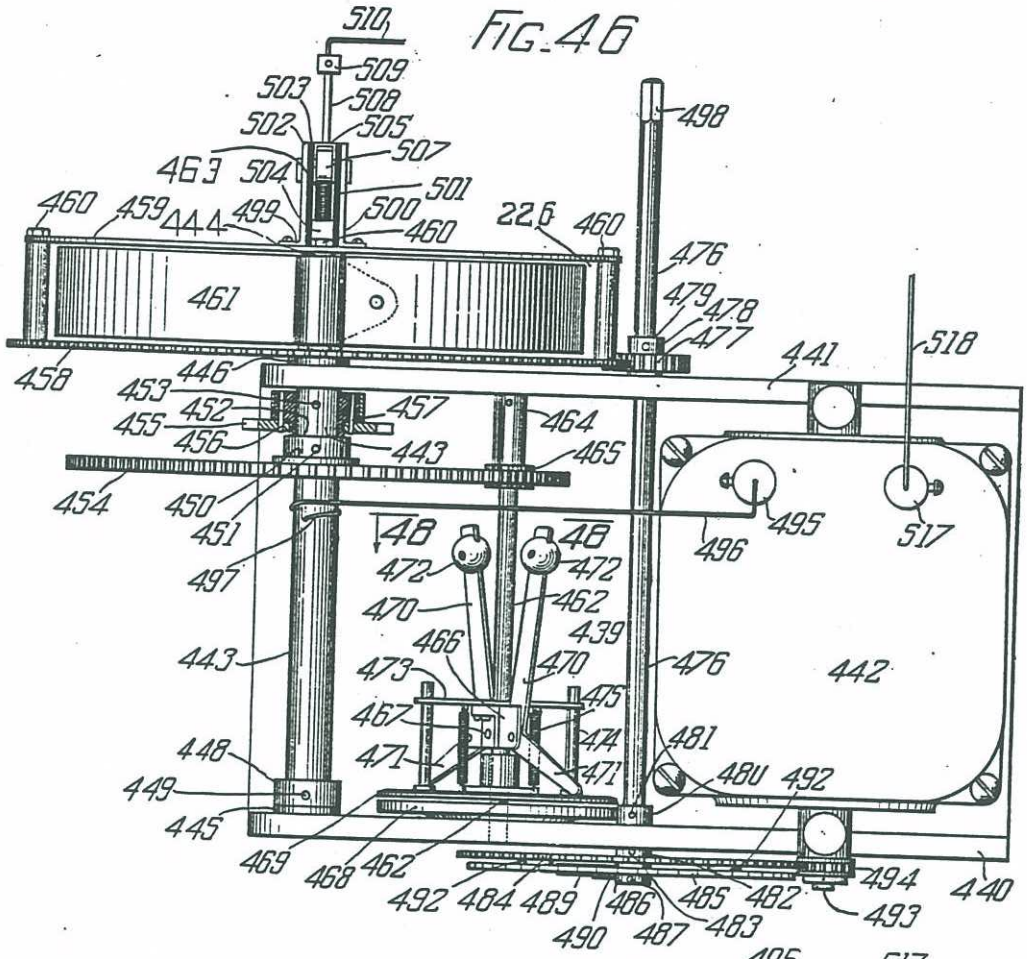


FIG. 48

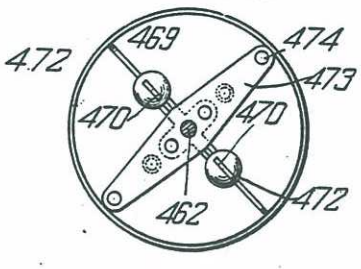
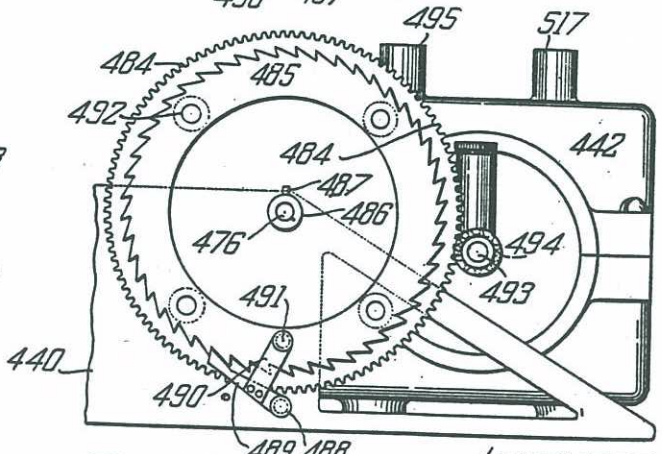


FIG. 47



WITNESSES

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CALCULATING MACHINE.

APPLICATION FILED APR. 26, 1907.

17 SHEETS—SHEET 17.

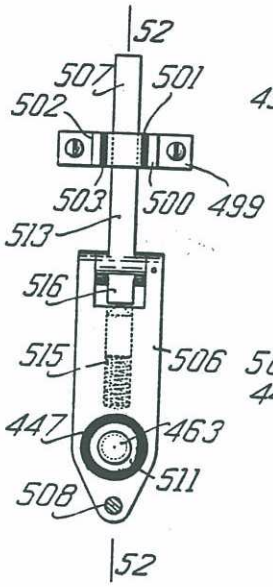

FIG. 51.

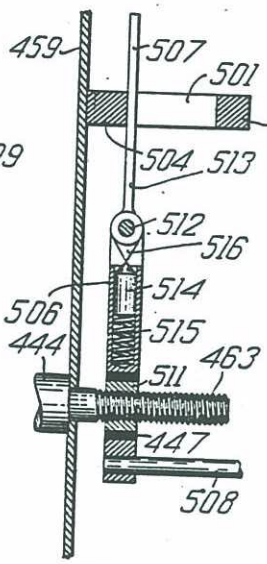

FIG. 52.

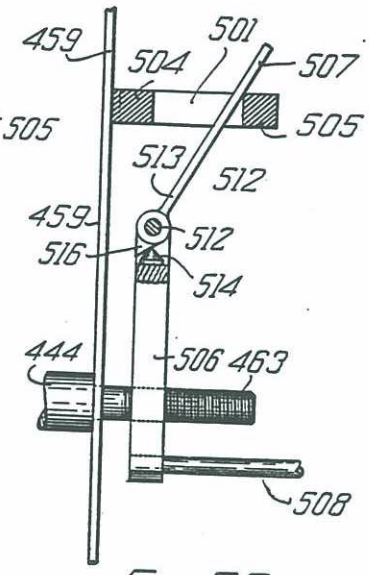

FIG. 53.

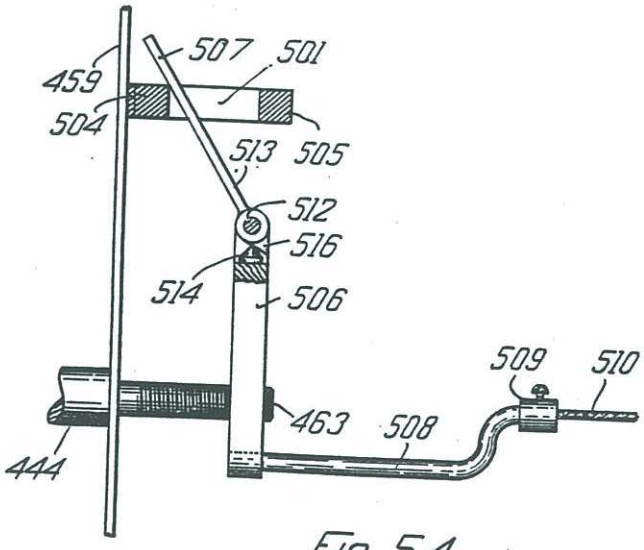

FIG. 54.

WITNESSES
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