No. 809,047. PATENTED JAN. 2, 1906.

E. S. ENSIGN.

CALCULATING MACHINE.

APPLICATION FILED APR. 26, 1905.

2 SHEETS—SHEET 1.

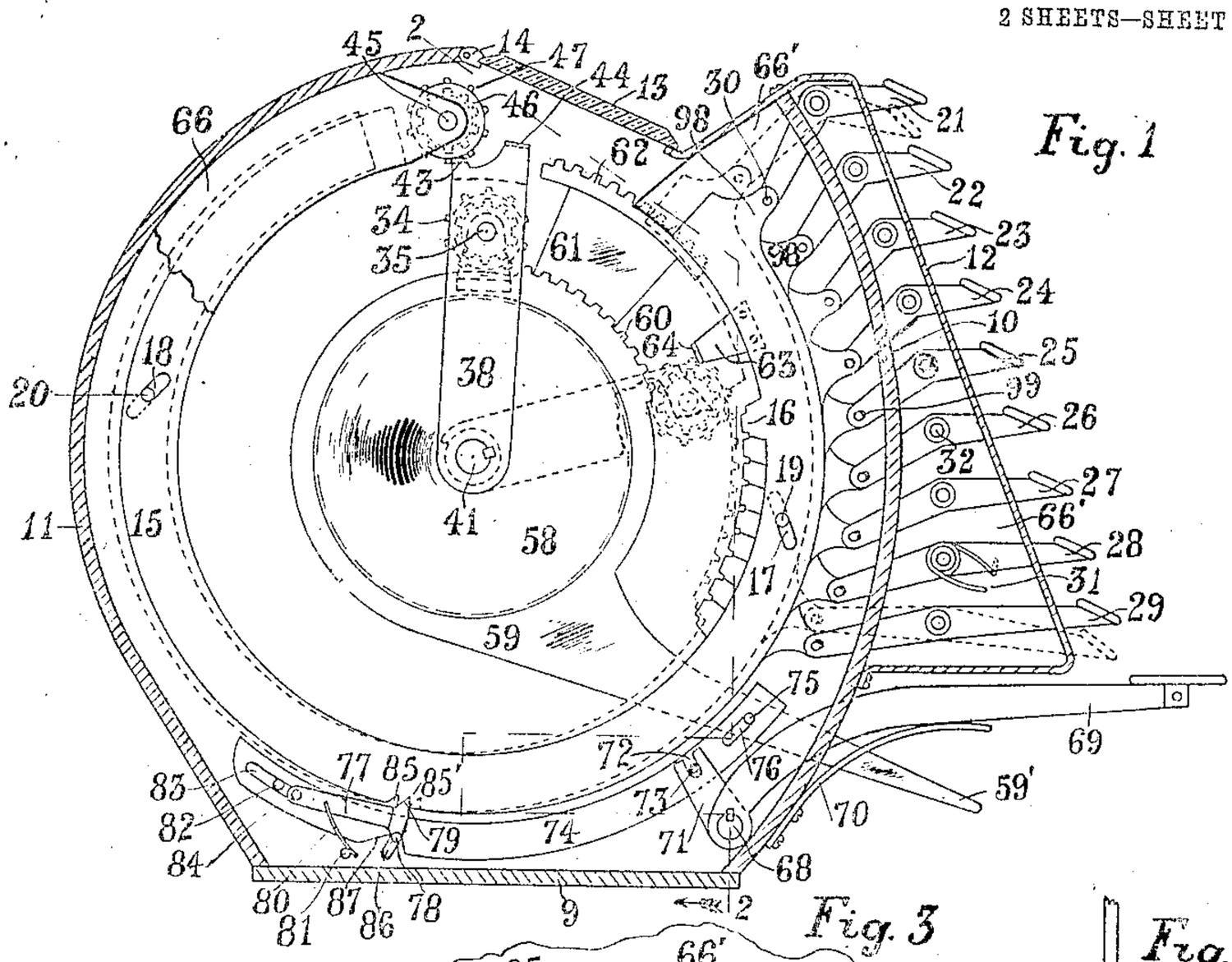

Fig. 1

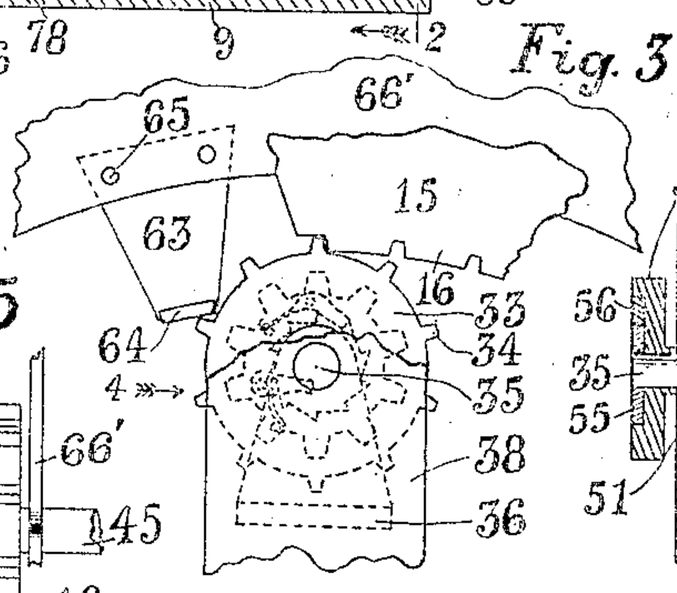

Fig. 3

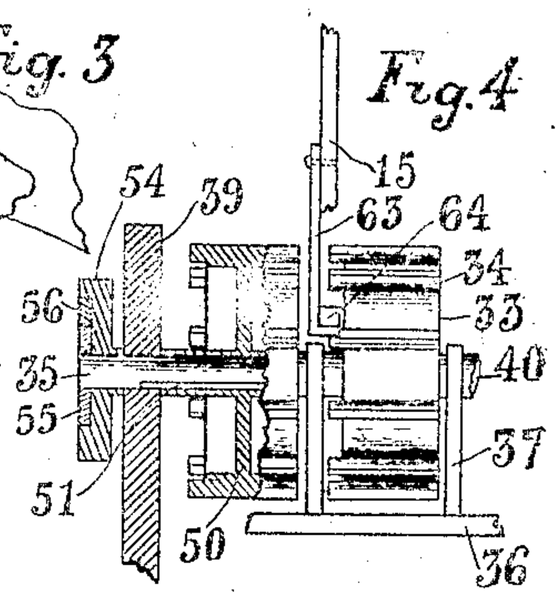

Fig. 4

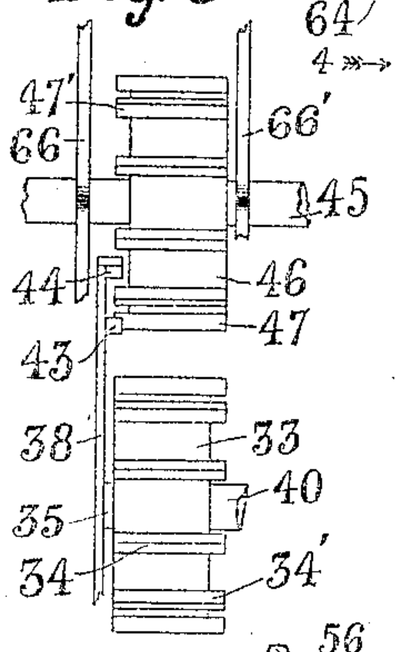

Fig. 5

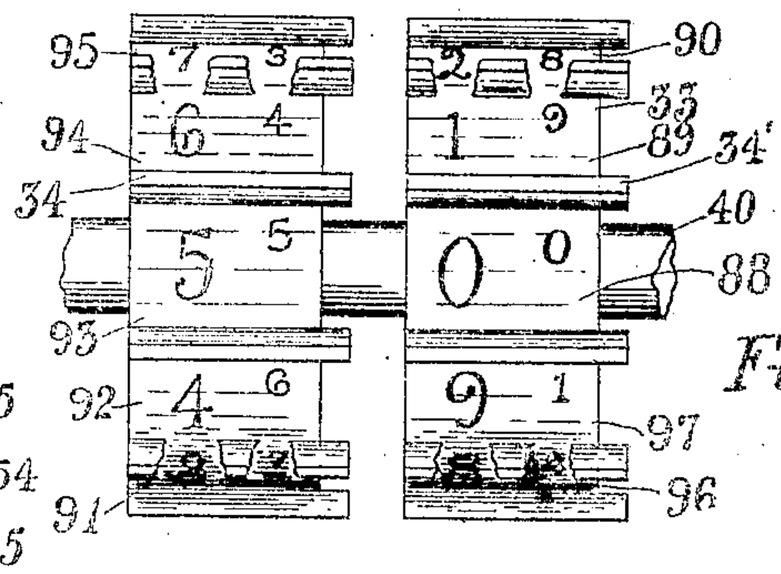

Fig. 8

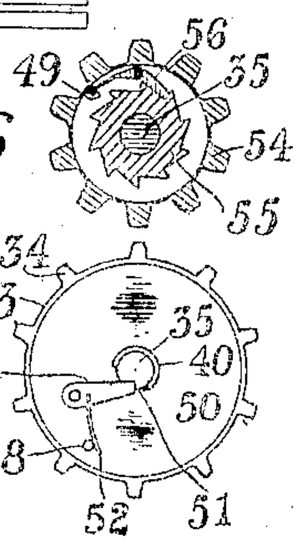

Fig. 6

Fig. 7

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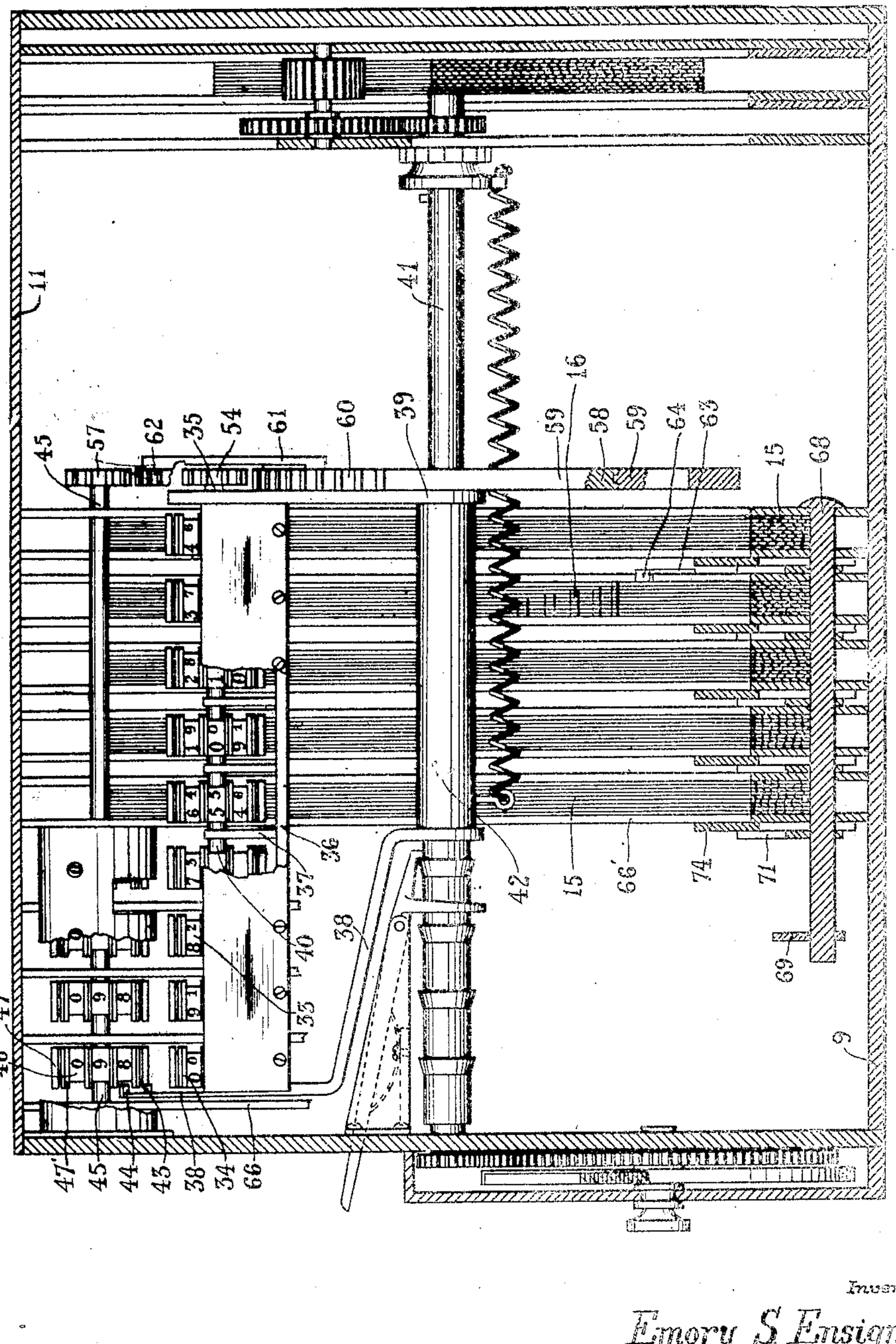
2 SHEETS—SHEET 2.

Fig. 2.



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CALCULATING-MACHINE.

No. 809,047. Specification of Letters Patent. Patented Jan. 2, 1906.

Application filed April 26, 1905. Serial No. 257,510.

To all whom it may concern:

Be it known that I, EMORY S. ENSIGN, a citizen of the United States, residing at Cambridgeport, 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 machines in which arithmetical operations are accomplished mechanically, and particularly to improvements to be used in a calculating-machine having a swinging rotatable meter, such as is shown in United States Letters Patent No. 773,632, to me issued on November 1, 1904, whereby said calculating-machine may perform in a simple, accurate, and easy manner the four arithmetical processes of addition, multiplication, subtraction, and division.

One object of the invention is the arrangement of parts so that both the meters and indicator-wheels of the meters may be instantly returned to the initial positions by the movement of a single lever after they have been moved from their normal positions in the performance of any one of the various arithmetical problems.

A still further object of the invention is the arrangement of numbers upon the indicator-wheels of the primary meter in such manner that a machine built in accordance with the Letters Patent aforementioned, with or without the other improvements shown in this application, would allow of the accurate, easy, and quick obtaining of results in the arithmetical operations of subtraction and division.

One of the principal objects of my invention is the providing of a meter having its indicator-wheels so numbered and to be operated by any means in any kind of a calculating-machine or computing-machine or register, or what is commonly termed an "adding-machine," so that the results obtained in problems of subtraction and division may be quickly shown or indicated.

A full understanding of my invention can best be given by a detailed description of a preferred construction embodying the various features of my invention, and such a description will now be given in connection with the accompanying drawings, and I obtain my object by the mechanism there illustrated, showing such preferred construction, and the features forming the invention will then be specifically pointed out in the claims.

In the accompanying drawings, Figure 1 is a side elevation of the left end of the machine with the side casing removed. Fig. 2 is a front elevation of my invention with the front portion of the casing removed and partly in section on the line 2 2 of Fig. 1 looking in the direction indicated by the arrow. Fig. 3 is an enlarged detail view of the meter and contiguous parts in the same position as shown in dotted lines in Fig. 1. Fig. 4 is a view, partly in section, of the parts shown in Fig. 3 looking in the direction indicated by the arrow 4 in Fig. 3. Fig. 5 is a front elevation of part of the meter and indicator and finger for operating the indicator. Fig. 6 is a right end elevation of the ratchet and gear on the meter's shaft. Fig. 7 is a right end elevation of one of the meter's indicator-wheels. Fig. 8 is a front elevation of two of the indicator-wheels of the meter, showing the method of numbering the wheels.

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.

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 machine for convenience will be divided, as in my previous patent, into a number of sections comprising—

First, the "primary" keys, which operate to throw out of their normal condition a number of series of disks to which they are attached, which are used in each of the processes of addition, subtraction, multiplication, and division, and in multiplication may indicate the multiplicand. In the present patent I have shown in Fig. 1 the series of finger-keys for only one series of disks, which series of disks are the ones operated by the extreme left bank of finger-keys. The extreme right bank of keys are those of the units-column, the next to the left those of the tens-column, the next in order those of

the hundreds-column, and so on, so that if there were seven columns the column to the extreme left as shown in Fig. 1 would be those of the millions-column. In Fig. 2 are shown in sectional view five series of disks, also the horizontal slidable meter and means for sliding the meter, which means being similar to the means shown in my said former patent reference can be had thereto for the operation of the same.

Second, the indicating-meter is designated in the specification and claims as the "meter" and is independent of the primary keys, but shows the figures as they are added, indicates the final sum in addition, indicates the product in multiplication, indicates in subtraction, first, the minuend and, second, the difference after deducting the subtrahend, and in division shows, first, the dividend and, second, after dividing, the divisor shows the balance left over, which is smaller than the divisor. The meter can be properly termed an "epicycle" meter, as it is a meter revolving around the inner circumference of the series of disks.

Third, the "secondary" keys, which is the finger-key mechanism for operating and limiting the motion of the meter; but the same is not shown in the drawings, as the same was fully shown in my said patent and forms no part of this invention..

Fourth, the "indicator" operable from the indicating-meter for showing the number of figures in the column added, showing the multiplier in multiplication, and showing in division the result—that is, the number of times in which the divisor will go in the dividend.

The machine may be built in any size and with any number of series of disks. Each series has, however, preferably, nine disks. These disks are somewhat in the form of a toothed segment, although the disk operated by key 1 of each series has only one tooth, while the disk of key 2 of each series has two teeth, and so on, and they are so arranged that the teeth of the disk or disks displaced out of normal position by the pressure down upon its respective key or keys will be met by the meter when it is revolved around the inside of the disks.

The parts of the casing which I have shown in the drawings as inclosing most of the mechanism are the base 9, the upward-curved front portion 10, the upward-extending semicircular rear portion 11, having the hinge 14 at its upper part carrying the glass lid 13, through which the operator looks to read the meter and indicator. There is also attached to the front portion of the curved front cover a secondary cover 12 for partly protecting the shanks of the primary keys 21 to 29, which primary keys are in the form of levers swinging on the pins 32, which extend outward from the side wall 66′ between the curved front cover 10 and the secondary cover 12, and each lever is varied in shape from the other levers of its series.

The primary keys 21 to 29 have the numerals "1" to "9," respectively, upon their free ends. The primary key in Fig. 1 (marked 21) bears the numeral "1," indicating that there is only one tooth 16 on the inner side of the disk 15 to which it is attached. The next finger-key 22 bears the numeral "2," indicating that there are two teeth upon its respective disk, and so on. The shanks of these keys extend through the secondary casing 12 and have at their inner end a slot 99, in which travels a pin 30, carried by an ear 98, which ear is a part of the disk 15. The disks of each series are limited in their movements by the rods 19 and 20, which extend through the elongated slots 17 and 18 in the disks. The downward movement or travel of the free end of the finger-keys 21 to 29 are all the same; but it is preferable to have the keys of each series one below another, as clearly shown in Fig. 1, so as to have a column of units-keys, a column of tens-keys, a column of hundreds-keys, so that the keys can be easily operated. Each of these finger-keys has its shank, which is fulcrumed, as at 32, so varied in shape from the other levers in its series that the travel of each pin 30 in its corresponding slot 99 is the least possible under the conditions, so that each pin is equidistant from the fulcrum-point of its corresponding shank in each of the extreme positions which its disk or segment 15 will allow the pin to take. Each set or series of disks consists of nine separate and independent disks, and each set is inclosed or held between two side walls or plates 66 and 66′, and these side walls may be fastened together by any suitable means. The disks 15 are so arranged between the side walls as to offer but little resistance to the depressive movement upon the finger-keys 21 to 29 in order not to tax the strength of the operator, and each key, without respect to the value represented, receives the same degree of downward movement.

The teeth 16 upon the disks 15 project inwardly toward the driving-shaft 41 and each tooth has a semicircular part and a part nearly flat; but the teeth may be varied in shape as to best mesh with the teeth 34 of the meter, so that the indicator-wheels of the meter will be turned or moved backward when the meter is revolved around the inner side of the disks 15. There is shown in Fig. 1 in dotted lines a meter having just left the upper or last set of teeth, so that one of the indicator-wheels of the meter must have been turned around just nine-tenths of its circumference.

The driving-shaft 41 may be driven by any power in one direction around the inner side of the disks 15, carrying with it the hub 42,

from which extend outward the arms 38 and 39. These arms support the meter, the arm 39 on the right end of the hub 42 supporting the right end of the shaft 35, upon which shaft the indicator-wheels of the meter are revolved. The shaft extends through the end of the arm 39 and carries on its outer end the pinion 54, which pinion is provided with ten teeth for a purpose hereinafter explained. The pinion 54, which is loosely mounted on the shaft 35, carries a pawl 56, which locks into a ratchet 55 when the lever 59 is turned and the teeth 62, carried by the lever, mesh with and turn the pinion 54. The arm 38 at the other end of the hub 42 extends above the meter 33 and is provided near its upper end with a finger 43, projecting toward the right, and which finger is used to turn the indicator-wheels of the indicator as the meter is revolved. This indicator 46 is preferably made up of a series of indicator-wheels having upon their periphery ten teeth 47, which teeth extend over the right side of the indicator-wheels of the meter, as at 47'. (Clearly shown in Fig. 5.)

As the meter and its arm 38 are revolved by the driving-shaft 41 the finger 43 comes in contact with one tooth of one of the indicator-wheels of the indicator on each revolution of the meter. The indicator is different from the meter in that only one of its wheels can be turned one-tenth of its circumference on each movement of the meter, while several of the indicator-wheels of the meter may be moved one-tenth or more in the same length of time—that is, while the meter has made one complete revolution around the inside of the disks.

Upon the upper end of the arm 38 and so arranged as to come in contact with another tooth of the indicator to stop the movement of the indicator-wheel of the indicator moved by the first finger 43 is a second finger 44. As the wheel 46 revolves by the finger 43 pushing one of the projecting teeth 47' the finger 44 has come into that position as to be met by another tooth 47' and the wheel's revolutions immediately stopped; but the projecting teeth 47' and this finger 44 are so shaped and arranged that the finger 44 immediately passes between the projecting teeth 47' and the arm 38 is not stopped in its movement.

The indicator 46 is mounted upon a shaft 45 at the extreme upper rear end of the side walls 66 and 66', (see Figs. 1 and 2,) and at the extreme right end of this shaft is a pinion 57, similar to the pinion 54 on the meter-shaft, and it is provided with a similar ratchet and pawl. The ratchet and pawl in both pinions are preferably located within the pinions, and the pawl is a spring-pawl which presses against a pin 49.

The two arms 38 39 carry a platform 37, from which extend upward the arms 37, which separate the hubs 40 on the meter-shaft 35, and these hubs carry the indicator-wheels of the meter. Within each wheel 33 is a spring-pressed pawl 53, which pawl extends through a slot in the hub and against the shaft of the meter and is held in place by its spring 52 pressing against the pin 48, extending outward from the inner side 50 of the wheel 33. When the pinion 54 is turned toward the operator, the pawl 56 falls into mesh with one of the teeth of the ratchet 55, turning the ratchet and the shaft 35 toward the operator, and as this shaft turns the pawls 53 of each of the indicator-wheels fall into the slots 51 in the shaft 35, so that the indicator-wheels are all turned back to their normal positions, and the meter is thus set at "0"—that is, so that all of the numerals "0" are in a line on the reading-line of the meter. A similar spring-pressed pawl is within each of the indicator-wheels of the indicator, so that the indicator can be set in a similar way back to its original position after each arithmetical problem.

The periphery of the meter is divided into ten parts by the teeth 34, which extend beyond the right side, as at 34', and these teeth project in such a way that a tooth will come in contact with the finger 64 of the finger-plate 63 immediately after leaving the last tooth 16 of its corresponding disk 15. Each set of disks is therefore provided with one of these finger-plates, which is attached to the side wall 66' just beyond the last tooth of that series of disks, and the finger is so arranged as to immediately stop the movement of the indicator-wheel without stopping the movement of the meter on the driving-shaft 41.

On the hub 42 and revolving with it is a disk 58, which is against the arm 39, and a plate 59 encircles this disk 58 and turns upon it, and it is provided with a lever-handle 59', which extends through the front casing 10, so that it can be moved sidewise, pushing the disk 58 and the hub 42 back to their original position after they have been moved sidewise, as exlained in my former patent. This lever or plate 59 has a series of teeth 60 arranged to be thrown as the lever-handle 59' is thrown upward into meshing contact with the pinion 54 and set all of the indicator-wheels of the meter back to initial position. This same plate 59 has an upward-extending arm 61, having a segmental rack whose teeth 61 mesh with the teeth of the pinion 57 on the indicator-shaft and turn all of the wheels of the indicator back to initial position at the same time that the meter-wheels are being turned back. It is thus seen that this meter after being moved horizontally along the line of the indicator, as is necessary in problems of multiplication and division, and after more or less of the wheels of both meter and indicator have been moved, that the ma-

chine can be set almost immediately back to its original position.

Each of the wheels of the meter is divided into ten parts, separated by the teeth 34, and these parts are numbered consecutively from "0" to "9." By using two sets of numbers on the indicator-wheels of the meter and using two reading-lines I am able upon a machine such as herein shown to quickly and accurately perform the arithmetical problems of subtraction and multiplication. I therefore preferably use a series of large numeral characters from "0" to "9," which are the characters that will be used in addition and multiplication, and I also provide another or smaller set of numerals "0" to "9" for the same spaces; but both naughts are on the same space, the larger figures reading away from the operator, the smaller figures toward the operator, so that both the large and small numerals "5" appear upon the same space—in other words, reading upon the meter away from the operator the large numerals appear consecutively "0" to "9," while the small numerals appear consecutively "0," then "9" to "1," as clearly shown in Fig. 8.

The reading-line of the meter when the meter is at initial position will show a line of the numerals "0," while the next line above it, which will be the other reading-line of the meter, will show a line of the numerals "9."

One of the reading-lines, preferably the one nearest to the sight of the operator, is used for both addition and multiplication, while the other reading-line, preferably the next one to the rear above the first reading-line, is used for both subtraction and division. In problems of subtraction and division we used the set of numerals which are numbered in the opposite direction to which the spools are rotated and which are shown in the drawings as the smaller set of figures reading toward the operator; but, if desired, the relative size of these sets of figures could be changed so that the set of figures used in subtraction could be the largest, or, if desired, each set could be of the same size, in which case one set would necessarily be of a different color from the other set. To do a problem in subtraction, the minuend is first executed upon the meter so that this set of numerical figures numbered in the opposite direction to which the spools are rotated will show upon the subtraction or second reading-line the minuend. Then the primary keys to the amount of the subtrahend are pressed down and the meter revolved once, when the remainder appears. In division the dividend is first executed on the meter, so as to show on the second reading-line (the same reading-line as used in subtraction) the dividend with the same set of characters used in subtraction. Then the primary keys corresponding to the divisor are pressed down, and the meter, having been shifted to the right to the proper position for the divisor to be divided into the higher figures of the dividend, is revolved as many times as the divisor will go in the numbers on the numerical wheels operated by the teeth of the segments during the revolving of the meter, and upon a wheel of the indicator is shown the first figure of the remainder. The meter is then shifted one or more places to the left and in a similar manner operated to obtain the next figure of the remainder, except when it has been shifted more than one space, in which case upon the indicator between these two figures would show a naught for each space shifted, and again shifted, and so on until the total remainder shows upon the indicator, which will be read in inverse order, and the sum remaining upon the meter being of a lesser sum than the divisor shows the amount left over. In other words, using the second set of numerals (shown upon the drawings as the smaller set) the operation is almost the reverse of the operation used in multiplication.

In the outer side or edge of the disks 15 are two rows of notches in each series of disks, and these notches 85 85′ are to engage the spring-pressed pawl 77, which has its point 79 engaging the notch 85′ when the disks are in initial position, but which engages the notch 85 of each disk as it is raised by the primary key. This pawl 77 has a spring 80 working against a pin 81, and the pawl is pivoted at the point 84 and has at its forward lower end a pin 78, resting within a recess 87 of the segment 74, and this segment 74 when it is desired to release the disks and have them returned to original position by the springs 31, operating against the primary keys, is pressed downward by a lever 71, having a slot 72, in which travels a pin 73 of the segment 74, so that the segment 74 pushes down the pin 78 and its pawl 77. The pin 78 also travels in the guide-slot 86 in the lower portion of the side wall 66′.

Each of the levers 71 are affixed to a shaft 68, so that they can all be simultaneously operated by a common lever 69 upon the shaft 68, which lever extends through the front casing 10 and is held in an upward position by the spring 70; but when pressure is applied to its free end the disks are all released. The segments 74 have the slots 76 and 83, through which extend the guide-pins 75 and 82.

It is 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 limi-

tation to the use in connection therewith of other features and details of construction illustrated.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. In a calculating-machine, a horizontally-slidable epicycle cylindrical meter, means for operating the meter, and a lever for resetting the meter.

2. In a calculating-machine, a cylindrical epicycle meter movable horizontally and a lever for throwing the meter horizontally backward to its normal position.

3. In a calculating-machine, a meter, rotating means for the wheels of the meter, a driving-shaft without the meter for swinging the meter in a circle around the driving-shaft and against the rotating means, means for moving the meter horizontally and a lever for sending back the meter to initial position.

4. In a calculating-machine, a shaft, a cylindrical meter outside of and swinging upon the shaft, actuating means for rotating parts of the meter as the meter swings around the shaft, a frame inclosing the meter and shaft, and a lever having its handle extending without the frame for rotating all the parts of the meter to initial position.

5. In a calculating-machine, a meter, means for operating the meter, an indicator operable by the meter, and means for simultaneously resetting both the meter and indicator.

6. In a calculating-machine, a shaft, an arm journaled upon and extending outward from the shaft, a cylindrical meter outside of the shaft and journaled on the arm, actuating means for rotating the wheels of the meter when the same is swung in a circle around the shaft, means for moving the arm and meter along the shaft, a cylindrical indicator having its wheels rotated by the arm, and a lever for resetting the meter and indicator in their normal positions.

7. In a calculating-machine, an indicator having a series of teeth upon its periphery and partly projecting horizontal beyond one of its sides, a shaft below the indicator, an arm journaled on the shaft having a tooth projecting from its side and in contact with a tooth of the indicator-wheel on each revolution of the shaft.

8. In a calculating-machine, a shaft, an arm extending from and journaled upon the shaft and having a tooth extending outward at right angles to the arm, a meter journaled on the arm, an indicator above the meter having a series of teeth projecting beyond the wheel of the indicator and so arranged that on each revolution of the arm and meter around the shaft that the tooth on the arm will come in contact with one of the projecting teeth of the indicator and partly move the indicator.

9. In a calculating-machine, an indicator having a series of teeth extending outward beyond its side, a shaft, an arm extending outward from the shaft and provided with two teeth arranged to come in contact with two of the indicator-teeth on each revolution of the shaft, one tooth adapted to move the indicator a certain distance and the other tooth adapted to act as a stop for the indicator.

10. A calculating-meter, a series of segments having inwardly-projecting teeth arranged to be projected as desired, means for revolving the wheels of the meter against the inwardly-projected teeth, and inflexible means for stopping the revolving of the wheels.

11. In a calculating-machine, a shaft, a cylindrical meter outside of and swinging upon the shaft, actuating means for rotating parts of the meter as the meter swings around the shaft, and independent unyieldingly-stopping means for each of the rotating parts of the meter.

12. A revolving meter having a series of independently-revolving indicator-wheels in combination with a series of disks for separately turning the indicator-wheels and a series of stationary rigid fingers for separately stopping the indicator-wheels as the meter is revolved around the inner edge of the disks.

13. In a calculating-machine an epicycle meter, a series of toothed segments having outwardly-extending pins, a series of finger-levers for operating the segments having slots within which extend the pins and the segments adapted to be thrown by the finger-levers into operable contact with the meter as the meter is revolved around the inner circumference of the segments whereby the meter will be actuated.

14. In a calculating-machine, a series of toothed disks, levers for operating the disks, a cylindrical meter adapted to be driven around the inner side of the disks and in contact with the teeth of the operated disks, and means independent of the levers for holding the operated disks in operable contact with the revolving meter.

15. In a calculating-machine, several series of toothed disks, levers for operating the disks, a cylindrical meter adapted to be driven around the inner side of the disks and in contact with the teeth of the operated disks, locking means for each series independent of the levers for holding all the operated disks in meshing contact with the revolving meter and a lever for simultaneously throwing the locking means out of contact with all of the operated disks allowing them to return to initial positions.

16. In a calculating-machine, a series of

segments, each segment provided with an ear, a pin attached to each ear, a lever for each segment having a slot within which extends one of the pins, and a cylindrical meter revolving within and operated by the segments.

17. In combination with the frame of a calculating-machine of a series of disks within the frame provided with ears, pins projecting from the ears, finger-keys extending without the frame and arranged to actuate the pins for inwardly projecting a portion of the disks, a driving-shaft, a meter without the shaft, means connecting the meter and shaft, means for operating the driving-shaft and rotating the meter, and means for resetting the disks and finger-keys.

18. In a calculating-machine, a series of finger-keys of different denominational value provided with slots in their shanks, a series of toothed segments provided with ears, each segment having a different number of teeth than the other segments in its series, a pin projecting from each ear and extending into the slot of its corresponding finger-key, each pin traveling in a different direction from the other pins, each shank so varied in shape from the other shanks in its series that the travel of each pin is the least possible under the conditions so that each pin is equidistant from the fulcrum-point of its corresponding shank in each of the extreme positions which its segment will allow the pin to take, and a meter adapted to be actuated by the segments, substantially as shown.

19. In a calculating-machine having several series of toothed disks, of side walls inclosing each series, a meter having an indicator-wheel for each series of disks, a driving-shaft for revolving the meter and its shaft around the inner edges of the disks, a lever connected with each disk whereby the teeth of that disk may be projected inwardly in meshing contact with one of the wheels as the meter is revolved, a finger-plate for each indicator-wheel attached to one of the side walls extending inward toward the driving-shaft and having its finger adapted to stop the revolving of its corresponding indicator-wheel.

20. In a calculating-machine a recording-meter having a series of indicator-wheels, each wheel provided with two sets of numbers, segments surrounding the meter means for swinging the meter in contact with a portion of the segments, a second meter at one end of the segments and operated by the recording-meter on each revolution of the recording meter, the recording-meter adapted to give the final sum in addition, the product in multiplication, and the minuend and sum in subtraction, and the second meter adapted to show the multiplier in multiplication and the result in division, substantially as described.

21. In a calculating-machine, several series of segments provided with inward-extending teeth and notches in their outer periphery, a spring-latch for each series adapted to engage a notch in each of the segments of that series, a revolving recording-meter having teeth in meshing contact with the teeth of the operated segments, a lever for disengaging the latches, and means connecting the lever and latches, substantially as shown.

22. In a calculating-machine, a series of segments, means for operating the segments, a driving-shaft within the segments, a hub carried by and horizontally slidable upon the shaft, arms extending outward from the hub and carrying a shaft, a cylindrical meter upon the shaft and revolved by the driving-shaft against the operated segments, a pinion upon the meter-shaft, a disk upon the driving-shaft, a hub encircling the disk having a series of teeth to be thrown as desired into meshing contact with the pinion whereby the meter may be set in initial position.

23. In a calculating-machine, a series of segments, a driving-shaft, a shaft, a cylindrical revolving meter upon the shaft arranged to be projected by the driving-shaft against a portion of the segments, a pinion upon the meter-shaft, an indicator above the meter, a pinion upon the indicator-shaft, a lever turning about the driving-shaft having two sets of teeth for operating the pinions and resetting the meter and indicator to their normal positions.

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

EMORY S. ENSIGN.

Witnesses:

CHARLES F. A. SMITH,

FRANCIS E. SMITH.