2 Sheets--Sheet 1.

E. D. BARBOUR.

Calculating-Machine.

No. 168,080. Patented Sept. 28, 1875.

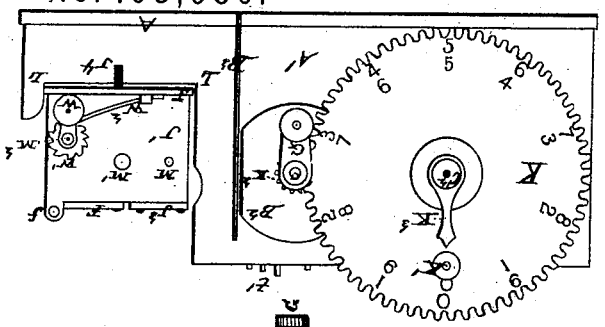

Fig. 3

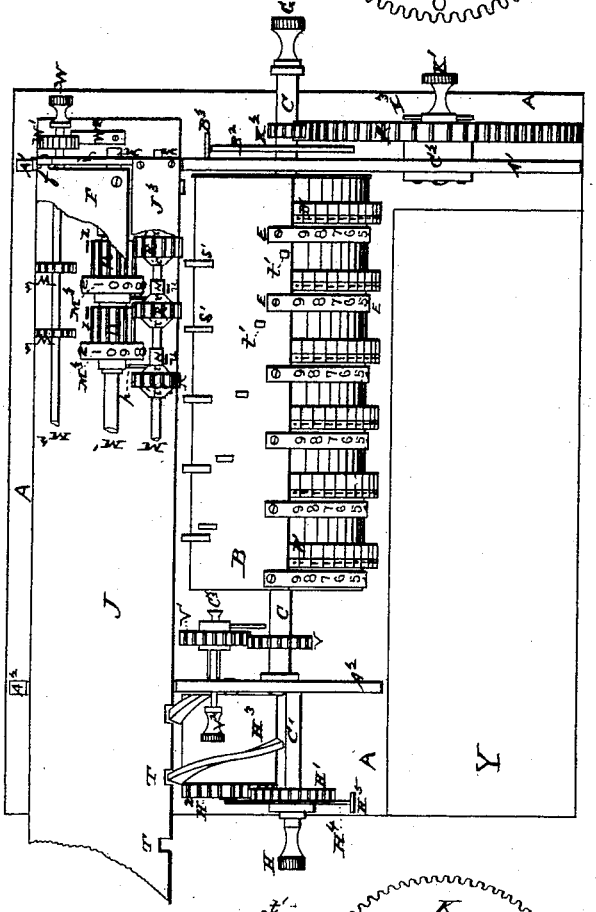

Fig. 1

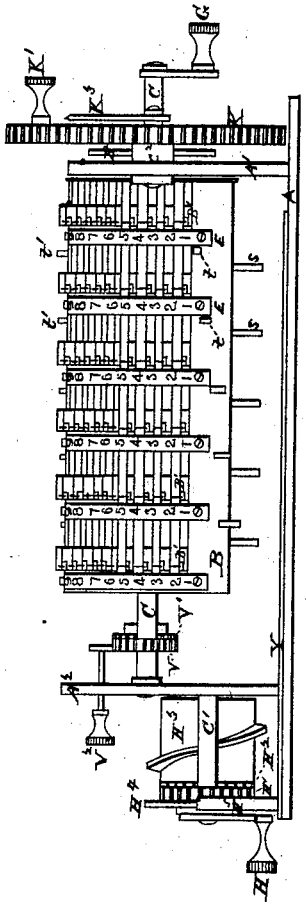

Fig. 2

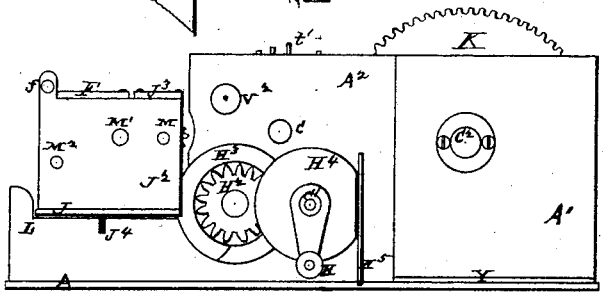

Fig. 4

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2 Sheets--Sheet 2.

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Fig. 5.

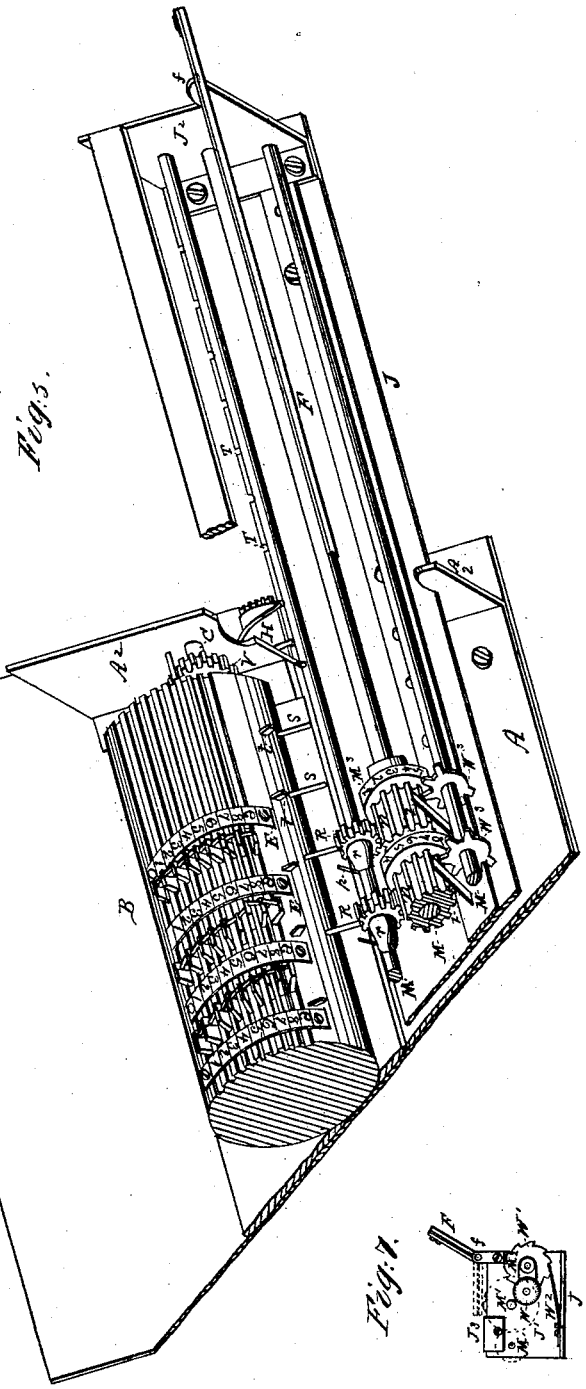

Fig. 6.

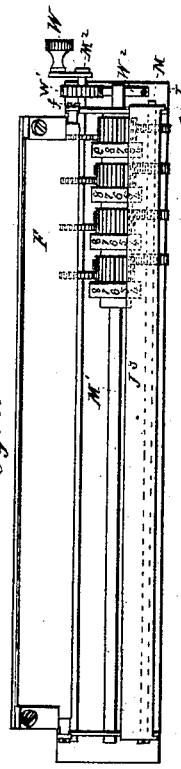

Fig. 7.

Witnesses
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UNITED STATES PATENT OFFICE.

EDMUND D. BARBOUR, OF BOSTON, MASSACHUSETTS.

IMPROVEMENT IN CALCULATING-MACHINES.

Specification forming part of Letters Patent No. **168,080**, dated September 28, 1875; application filed February 1, 1873.

To all whom it may concern:

Be it known that I, EDMUND D. BARBOUR, of the city of Boston, county of Suffolk and State of Massachusetts, have invented a new and useful Improvement in Calculating-Machines; and I do declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawing, forming part of this specification, in which—

Figure 1 is a plan. Fig. 2 is a front elevation. Fig. 3 is a projection of the right-hand side, and Fig. 4 is a projection of the left-hand side. Fig. 5 is a perspective view of a portion of the machine, as seen from the right and rear sides, with the driving-wheel and end plate removed. Fig. 6 is a plan of the rear registering and printing dials, with the impression-plate raised. Fig. 7 is a right-end elevation of the same.

This invention relates to a calculating-machine, differing in many respects from the machines for which Letters Patent were granted me August 13, 1872, and November 19, 1872. (Nos. 130,404 and 133,188.) A single cylinder with sliding teeth is substituted for a number of cylinders with fixed teeth, and a single set of dials in the register is used instead of the double set in the first patent and the quadruple set in the second patent.

The essential points of a calculating-machine are, first, absolute accuracy; second, easy and rapid manipulation; third, a simple movement for carrying the tens from one denomination to another; fourth, a construction so arranged that all the moving parts are double acting and reversible, with only a single set of dials in the register; fifth, a simple canceling device for restoring the dials to zero; sixth, a printing device; and, seventh, strength and compactness. It is believed that this machine covers all these requirements, and that it is the first that has fully and practically done so.

My present invention, then, consists more particularly, first, in the use of a single cylinder, with teeth sliding in grooves, so as to be brought into a position to operate upon the gear-wheels of the register.

In multiplication and division the register must be moved or fed step by step to the right or left as the operation proceeds, and the means employed for imparting this feed-motion constitutes the second feature of this invention.

In order to reduce the manipulation of turning the cylinder in multiplication and division, a contrivance, similar in principle to, but different in construction from, that employed in my second patent for imparting a reciprocating motion to the register, is used, and consists of a single driving-wheel gearing into a pinion connected with the shaft to which the cylinder is fastened. This constitutes the third feature of the invention.

The fourth feature relates to the registering of the quotient upon the same dials that are used for all other operations, and consists of wheels turning with the cylinder and operating upon the register.

The fifth feature relates to the carrying of the tens; and consists of having beveled hubs on each side of certain pinions in the register so placed that a projection from the dials strikes upon one of the bevels and moves the pinion on its axis into the track of certain fixed teeth on the cylinder, and after being turned one-tenth of a revolution by the said fixed teeth the said pinion is struck on the opposite bevel by other fixed teeth on the cylinder, and forced back into its original position, ready for the carrying of another ten. The actual carrying of the ten takes place when the fixed teeth on the cylinder first mentioned operate upon the pinions, and turn the next left-hand dials one-tenth of a revolution.

In describing this machine I have confined myself to naming the exact means employed in the drawing submitted herewith; but I beg it to be understood that I claim all equivalent devices that can be substituted, whether mentioned in the specification or not. It is also to be understood that I do not confine myself to the exact means described in this specification, but shall resort to their equivalents freely, substituting planes for cylinders, common type for type reading the right way, other material than colored impression-paper for printing, other feed-motions than that described for the register, and so on.

For certain uses — astronomical, for instance — where repeated multiplications are repeatedly added to show a single result, and subtraction and division are seldom resorted to, certain modifications in the mechanism can be made without changing the principle on which the machine acts, so as to reduce the labor and cost of construction.

The machine in its simplest form consists of the cylinder and register, without the feed-motion, printing device, gearing for registering the quotient, or the large driving-wheel, and it is desired by the Letters Patent now asked for to cover the machine in such simple form, as well as to cover it with any or all of the contrivances just named; but I do not in this patent claim to secure the exclusive right to machines having a revolving cylinder, with sets of separate teeth movable separately or together into a position to operate upon a register, except when such teeth are arranged to slide in grooves, substantially as they are shown in the drawings and herein described, or except when certain specific improvements, hereinafter claimed, are applied to such machines.

It is obvious that the feed-motion to the register can be governed by a contrivance so that the multiplier can be set up at the beginning of an operation just as the multiplicand is done, and the handle to the cylinder-shaft or driving-wheel then turned until the machine has completed its work, and a suitable stop arrests its action. It is obvious, also, that the same contrivance can be made to operate in division, so as to move the register automatically as fast as those portions of the dividend successively operated upon become smaller than the divisor.

A simple device can also be used for returning all the sliding teeth on the cylinder to the left of their respective grooves simultaneously after they have been used.

In the following description similar letters of reference indicate corresponding parts.

A represents the base of the machine. A^1 and A^2 are two upright plates, between which the cylinder B revolves. They are cut down at L to form a bed for the register to slide on. The cylinder B turns with the shaft C, and has nine grooves running parallel with its axis. These grooves are divided into a number of sets of short grooves, according to the extent of the operations for which the machine is required. Six divisions are shown in the drawings, but there may be more, if needed. Each of the short grooves has a sliding tooth, B, whose motion is limited by the strips E, which serve also to show the number of the grooves and the teeth on the right. Each tooth, except the first in each set, has a pin and a shoulder, the pin of one tooth, as before stated, reaching over and fitting into the shoulder of the next lower tooth in such a way that any particular tooth, when moved to the right, will cause all the teeth of a lower denomination in that set to slide with it, and any particular tooth, when moved to the left, will cause all of a higher denomination in that set to slide with it. When placed at the right of the grooves the sliding teeth are in a position to turn certain wheels R R in the register when the cylinder revolves as many tenths of a revolution as there are teeth so placed. Studs *t t*, Fig. 2, are fixed to the cylinder below the grooves numbered 1, for turning the wheels in the register above referred to when there are tens to be carried in subtraction and division. Studs *t' t'*, Figs, 1 and 2, above the grooves numbered 9, are for the same purpose, but only operate in addition and multiplication, when the cylinder turns the other way. Studs *s s*, Fig. 2, are for striking against the bevels of the pinions R after they have assisted in subtraction and division in the carrying of the tens. The studs *s' s'*, Fig. 1, strike the same bevel, and are for the same purpose, which is to return the pinions R, by sliding them on their axes to their original positions of rest on the right. The studs *s'* only act in addition and multiplication. Attached to the shaft C, on the outside of plate A^1, is a broken disk, B^2, on which a spring, B^3, fastened to the base A, acts as a stop at the end of each revolution of the cylinder. At one end of the shaft C is a handle, G, for turning the cylinder in either direction. K is a driving-wheel turning on center C^2 attached to plate A^1, having ten times as many teeth as the pinion K^2 attached to the shaft C, and causing the cylinder to revolve from one to ten times, according to the distance traveled by the handle K^1 from any fixed point on the circle. The side of the wheel K has a set of numbers from 0 to 9 running in one direction near its edge, and a corresponding set, but running in an opposite direction, just within it. A pointer, K^3, turning upon the same center as the wheel K, but not with that wheel, can be shifted to any desired position, and serves as an index for guiding the movements of handle K^1. In commencing an operation the handle K^1 and the pointer should always be in the same line, and the number of turns then given in either direction to the handle G can be read from the side of wheel K.

When the handle of the driving-wheel is used instead of the handle G for turning the cylinder, the pointer, in multiplication, is to be shifted to the outer number corresponding to the first right-hand digit of the multiplier, and the handle moved until it rests over the pointer. The pointer is then to be shifted to the outer number that corresponds to the second right-hand digit of the multiplier, and the handle K^1 again moved in the same direction until it overtakes the pointer, and so on with each successive digit, until all have been used.

In division, when the handle K^1 is used, it must, at commencement, be placed in the same line with the pointer, and, in turning, the handle must be made to stop as soon as the dials on the register show that that left-hand portion of the dividend first chosen to be op-

erated upon has become reduced by the repeated revolutions of the cylinder to a number smaller than the divisor. The point from which the handle K^1 started will be seen by the position of the pointer; and the inner number opposite the pointer shows the first left-hand number of the quotient; or, in other words, the number of revolutions and repeated subtractions made by the cylinder. The pointer is then to be shifted to the place where the handle K^1 was stopped, and the said handle again turned until the second portion of the dividend has been reduced below the divisor, when the second left-hand figure of the quotient can be read on the wheel opposite the pointer.

This process is repeated in each step of the division until a final remainder smaller than the divisor appears on the dials of the register.

The wheel K, handle K^1, and pointer K^3 are not essential to the working of the machine; but, as they assist in keeping count of the revolutions of the cylinder, they may be regarded by some (especially in hurried operations) as an important check upon the other parts. As there are other means constituting the fourth feature of this invention for registering the quotient, the said wheel, handle, and pointer may be the more readily dispensed with.

The register is formed of a plate, J, sliding upon the bed L, and has two end plates, J^1 and J^2, for supporting the three shafts M, M^1, and M^2. On top of register, and secured to the end plates, is a strip, J^3, partially covering the gearing below. Protruding below the plate J at either end is a pin, J^4, which serves as a stop to the register when it has reached the extreme of its sliding motion. M is a shaft, having twice as many hollow spindles N sliding upon it as there are sets of teeth in the divisions of the cylinder.

These spindles have each a pinion, R, with a bevel or inclined hub, *r* and *r'*, on either side, and an upright spring, *u*, (smaller,) attached to the plate J, which bears lightly upon one end, so as to prevent the spindle slipping out of its proper position.

When the spindle is at the right of its limited motion on the shaft it is in position to be turned by the sliding teeth on the cylinder, and, being geared with the pinion *n* attached to the dial on shaft M^1, causes the said dial to turn as many tenths of a revolution as there were teeth on the cylinder that were operating.

When the dials M^3, commencing at 0, have made a complete revolution the ten is carried to the next left-hand dial, either in ascending or descending operations, by the projection *p*, connected with the dial, striking against the hub *r* of the pinion R, and forcing the spindle along the shaft M toward the left into a position to be turned one-tenth of a revolution by the studs *t* or *t'*. After these studs have performed their work the studs S or S', also attached to the cylinder, come in contact with the bevels or hubs *r'* and force the spindle back to its original position at the right. There should be twice as many dials as there are sets of teeth on the cylinder.

In order to prevent the dials from getting out of place an upright spring, *z*, fastened to the plate J, bears against two of the ten teeth of the pinion attached to the dial, and serves as a friction-stop.

The dials may have figures either engraved upon their peripheries, or they may have raised figures like type for printing. The drawing shows figures in relief, which read the right way.

Hinged to the plates J^1 and J^2, at *f*, is a plate, F, with a strip of black impression-paper on its under side.

In printing, a piece of white paper is placed upon the top of the dials, and the hinged plate turned over so as to press the said paper between the raised figures on the dials and the impression-paper. On raising the plate F the figures on the dials will be found to have caused the coloring matter to make an impression upon the top of the piece of paper between.

The pinion V is secured to the shaft C, which gears into the pinion V^1, and, as the cylinder makes a revolution, causes a pin connected with V^1 to turn whichever pinion R that happens to be in a line with it one-tenth of a revolution in a direction opposite to the motion of the other spindles on the same shaft that are being operated upon in division. As the register is shifted step by step to the left for the different portions of the dividend to be operated upon, so, also, are pinions R moved successively to the left, and the several digits of the quotient are thus set up in their proper order on the consecutive left-hand dials. If the dividend is large and the divisor small it will sometimes happen that the same dials, after having the numbers gradually subtracted from them until 0 appears, may be called upon to register the quotient. This being the case, the first left-hand figure of the dividend should be set up on the third left-hand dial, thereby always leaving a space between the dividend, which is disappearing step by step to the right, and the quotient, which is appearing upon the dials step by step to the left. The pinion V^1 slides upon shaft C^3, and has a handle, V^2, passing through the plate A^2, which throws the said pinion out of gear with the pinion R on the register while it still remains in gear with the pinion V. This contrivance will also register the multiplier on the dials, as the work of multiplication goes on, by a proper adjustment of the register and cylinder.

The register may be moved step by step to the right in multiplication, or to the left in division, by hand, or by using the contrivance for feeding attached to the outside of the plate A^2.

The handle H is attached to a wheel, H^1, which turns upon shaft C^1, and gears with an-

other wheel, H^2, attached to a worm-gear, H^3. Every turn of the handle H causes the worm-gear to turn in the notches T on the edge of the plate J of the register, and to carry the register one step to the right or left, according to the direction in which the handle is turned.

Between the handle H and the wheel H^1 is a broken disk, H^4, acted upon by an upright spring, H^5, so as to serve as a stop at the end of each revolution of the said worm-gear, and hold the register in place on its bed. The manner of canceling all operations—that is, of returning all the dials to 0—is to turn the handle W attached to the end of shaft M^2 one revolution. The shaft has a ratchet, W^1, secured to it, and is prevented by the spring W^2 from turning, except in one direction. The shaft has attached to it at regular intervals broken pinions of nine teeth and a blank, which turn together and gear into the pinions *n* attached to the dials. The pinions *n* have a portion of one of their teeth cut away, so that the pinions on shaft M^2 cease to operate on the former when the blanks on the two pinions come together. Y is a slate fastened to the base A, for proving the work of the machine, if desired.

The operation is as follows: *Addition.*—Set up the first of the quantities to be added by sliding to the right the corresponding number of teeth in the consecutive grooves of the cylinder, and turn the handle G one revolution. The number will now be found transferred to the dials on the register. Set up the second quantity to be added in the same way, and give another turn to the handle G. Repeat this process for each quantity to be added, and the aggregate of the repeated additions will successively appear upon the dials.

Subtraction.—Set up the minuend in the same manner as the first quantity in addition, and turn the handle G one revolution. Then set up the subtrahend on the cylinder and turn the handle G in an opposite direction one revolution. The larger sum will be found reduced by the subtraction of the smaller, and the figures on the dials will indicate the correct remainder.

Multiplication.—Set up the multiplicand on the cylinder by means of the sliding teeth, and turn the handle G in the same direction as in addition, as many times as corresponds to the numerical value of the first right-hand digit of the multiplier. The register will then show the multiplication performed by the first figure of the multiplier. Then shift the register one step to the right, by giving one turn to the handle H attached to the feed-gear, and turn the handle G as many times as corresponds to the second figure of the multiplier. The result of the second multiplication will now appear on the dials added to the first result. Repeat what has been said with reference to the second figure with each of the remaining figures of the multiplier, and the final result will be found upon the dials. Instead of using the handle G the driving-wheel may be resorted to, as has been before explained.

Division.—Push in the handle V^2 so as to throw the projection from pinion V^1 into line with the first left-hand pinion R of the register; then set up the dividend on the cylinder by means of the sliding teeth, placing the first left-hand figure of the dividend so that it will be transferred to the third left-hand dial; then turn the handle G and effect the transfer; then set up the divisor on the cylinder directly under those left-hand figures of the dividend which are first to be operated upon, and turn the handle G in an opposite direction as many times as is required to reduce that portion of the figures being operated upon to a number smaller than the divisor. The number of turns made will be found upon the first left-hand dial, and also upon the wheel K, and corresponds to the number of times that the divisor has been substracted; then shift the register one step to the left by means of the handle H, and turn the handle G until a second remainder smaller than the divisor is shown. The second left-hand dial will be found to have turned as many tenths of a revolution as the cylinder has revolved times, and will show the second left-hand figure of the quotient. Continue to shift the register step by step to the left, and turn the handle G, as before directed, until a final remainder, smaller than the divisor, is shown on the dials. The quotient will then be found set up on the left-hand dials in proper order, and the remainder will appear on the right-hand dials, so that both may be printed at one time. If the wheel K is used to turn the cylinder instead of the handle G, the pointer can be used in connection with the handle K^1, as before described.

Where it is desired to multiply several quantities at one time by the same multiplier it will be necessary to have a larger number of sets of teeth in the cylinder and of dials in the register than is required for an ordinary machine. With an increased number of sliding teeth and dials it will often be found convenient in multiplying mixed fractions to set up the whole number and the numerator at different ends of the cylinder, so that they may be operated upon together.

This machine, like the other two for which Letters Patent have been granted me, can be adapted by certain modifications in the number of teeth of the gear-wheels to the performance of operations in the octonary, nonary, duodenary, or any other numerical system. There is, practically, no limit to its computing power, it being only necessary to increase the number of sets of sliding teeth and the relative number of dials in the register when great power is required.

Squares may be formed by adding 2 to the cylinder at each step of a process, thus: Set up the tooth numbered 1 on the right of the cylinder, and give one turn to handle G. The square of 1 will now be found upon the reg-

ister. Then slide the teeth numbered 2 and 3 to the right, and give the handle G a second turn, when the square of 2 will appear upon the register; then slide the teeth numbered 4 and 5, and turn the handle once more, when the square of 3 or 9 will be found upon the dials; continue in this way, adding a difference of two to the cylinder, so that the numbers 7, 9, 11, 13, &c., are set up on the cylinder, and giving one turn of the handle for each addition, and the squares will be made to appear upon the register one after another.

Cubes may be formed by adding 6 to the cylinder at the first step, 2×6 at the second step, 3×6 at the third step, and so on, giving one turn to the handle for each addition. For example, set up the tooth numbered 1 on the right of the cylinder, and give one turn to the handle. The cube of 1 will be found upon the register. Then add 1×6 to the cylinder, (which will then read 7,) and give a second turn to the handle. The cube of 2 or 8 will then be found upon the register. Add 2×6 to the cylinder, (which will then read 19,) and give a third turn to the handle; the register will then show the cube of 3 or 27. Continue in this way, adding 3×6 to the cylinder, then 4×6, and so on, effecting a transfer from the cylinder to the register every time by a turn of handle G, and the cubes will be found duly registered upon the dials.

The quotient-pinion V^1 may be used in either of the above processes to show the root of the power that stands upon the dials, or, in other words, the number of turns given to the handle G.

In the drawings, the entire dials are shown; but it is to be understood that between the hinged plate for the impression-paper and the dials another plate is to be interposed, with openings permitting only a single figure on each of the dials to be seen; or other common methods of indicating the amount registered may be employed.

Having thus fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The calculating-machine, having a single revolving cylinder, with sets of separate teeth sliding in grooves, separately or together, into a position to operate upon a register, substantially as described.

2. The handle H, gear-wheels H^1 and H^2, and worm-gear H^3, for imparting a feed motion to a register.

3. The driving-wheel K, handle K^1, pinion K^2, and pointer K^3, for the purposes described.

4. The wheels V and V^1, and handle V^2, for registering the quotient upon the common dials of a calculating-machine.

5. The hollow spindle N, having pinions R, with beveled hubs r and r', and the studs t and t' and s and s' attached to the cylinder, for effecting the carrying of the tens.

6. In combination, with the spindle N and pinion R, with beveled hubs, the pinion n, dial m^3, and projection p, or their equivalents, substantially as described.

7. The carrying-wheels R, with beveled hubs, substantially as described.

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