2 Sheets--Sheet 1.

E. D. BARBOUR.

Improvement in Calculating Machines.

No. 133,188. Patented Nov. 19, 1872.

Fig. 2.

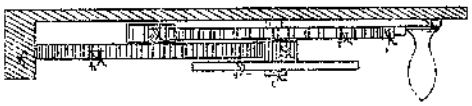
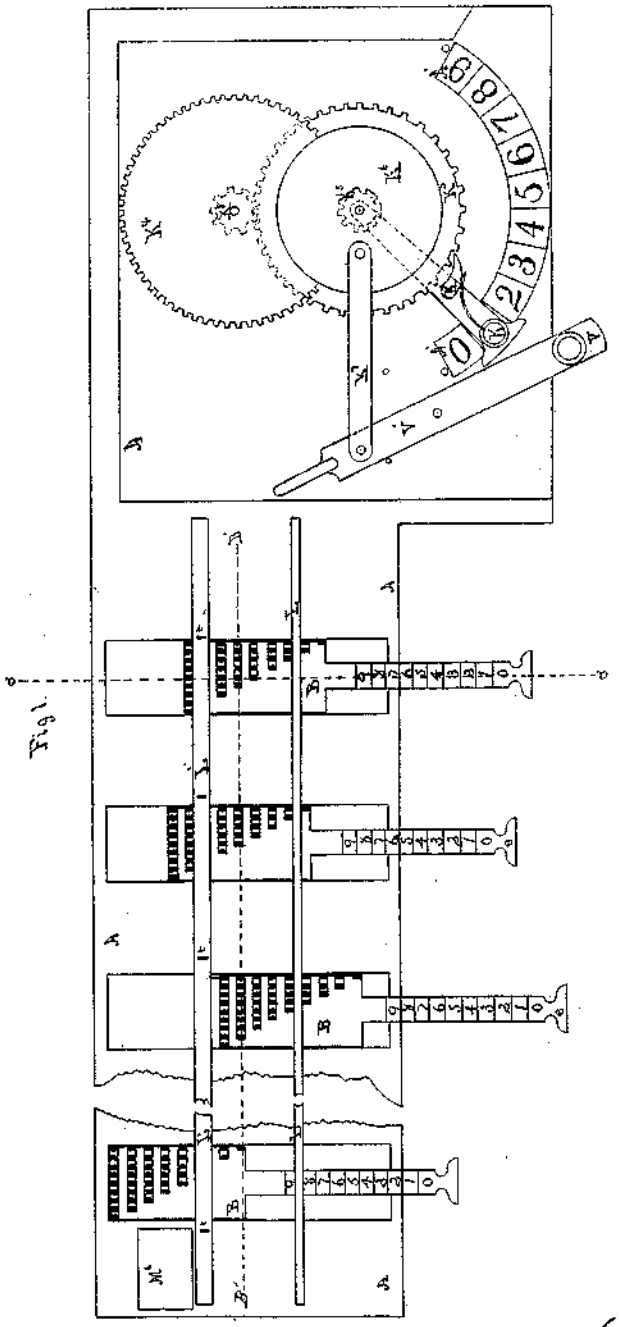


Fig. 1.



Witnesses
M. T. Barbour.
E. A. Rossi.

Inventor
Edmund D. Barbour.

2 Sheets--Sheet 2.

E. D. BARBOUR.

Improvement in Calculating Machines.

No. 133,188. Patented Nov. 19, 1872.

Fig. 4.

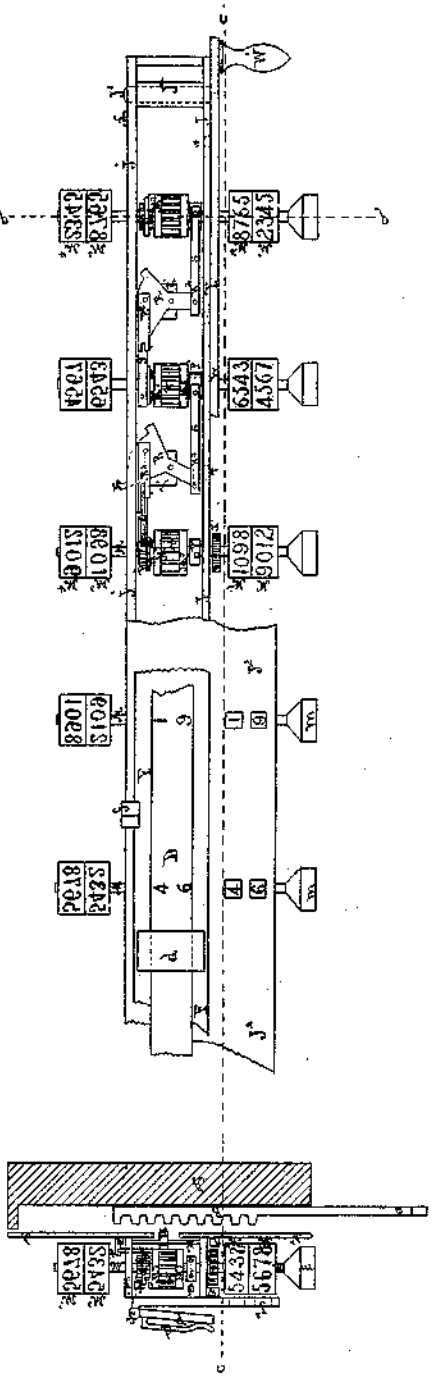


Fig. 5.

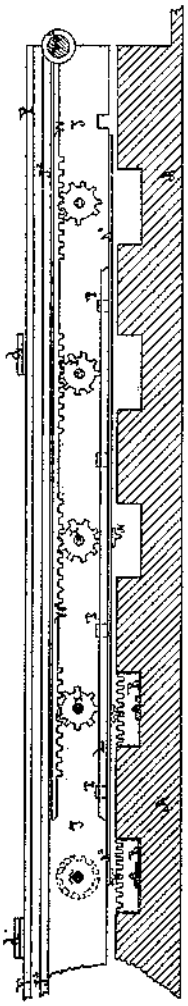


Fig. 6.

Fig. 6.

Witnesses
M. J. Barbour
E. A. Ross.

Inventor
Edmund D. Barbour

UNITED STATES PATENT OFFICE.

EDMUND D. BARBOUR, OF BOSTON, MASSACHUSETTS.

IMPROVEMENT IN CALCULATING-MACHINES.

Specification forming part of Letters Patent No. **133,188**, dated November 19, 1872.

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 of case A and of device for moving the registering-slide; Fig. 2 is a section of device for moving the registering-slide; Fig. 3 is a section of case A on line *a a* of Fig. 1, and of the registering-slide on line *b b* of Fig. 4; Fig. 4 is a plan of the registering-slide; Fig. 5 is an elevation of case A and front plate of the registering-slide on line *c c* of Figs. 3 and 4; and Fig. 6 is an elevation of lever for carrying from one denomination to another.

This invention relates to a calculating-machine which is constructed upon the same broad principle as one for which Letters Patent of the United States, No. 130,404, dated the 13th day of August, 1872, were granted to me, but differing from that machine materially in construction and operation; and the invention consists principally in a certain modification of the toothed cylinders or plates described in that machine, by which modification not only are the toothed plates themselves reduced in size, but the entire machine is much changed and simplified in its construction, and requires, in some respects, a different manipulation for its operation. I have, moreover, added some operative features not shown in my former machine, and have dispensed with some which are used therein.

My present invention, then, consists more particularly, first, in the use of a series of plates, cylinders, or their equivalents, (and whenever in the following specification the word "plates" is used, I desire to be understood as referring also to cylinders or other equivalent devices,) having upon their faces only a part of the rows of teeth described and shown in my former patent—that is to say, only as many rows of teeth, less one, as there are units in the first number of the second denomination of the system of notation, with reference to which the machine is constructed; or, in other words, as many rows, less one, as there are numbers in the primary denomination of such system, the several rows representing, by the number of their teeth, the several primary numbers referred to. Thus, in a machine constructed on the decimal system, each plate would have upon its face rows of teeth corresponding to the first nine rows of the cylinders or plates shown in the drawing attached to my former patent, these nine rows containing teeth from one to nine in number, and these teeth performing the same function as those described in the former patent—that is, the desired row being selected and brought into the path of a pinion connected with a dial, as hereinafter described, the action of said row of teeth upon said pinion when moving in its path causes the dial to register the number of teeth in the row. In thus dispensing with those of the rows of teeth shown in my former invention which represent the products of the primary numbers multiplied by each other and by themselves, I have a smaller and more compact machine; but, inasmuch as the entire product of a desired multiplication cannot be set up on the toothed plates, said product cannot be transferred to the registering mechanism by a single movement of the slide which carries it over the selected row of teeth, but this movement must be repeated as many times as there are units in the figure used as a multiplier. To accomplish this repeated movement by a single movement of the hand is the object of the second feature of my invention, which consists of a certain mechanism for imparting a reciprocating movement to the registering-slide by a single movement of a lever which moves over a scale, by which the number of reciprocating movements given to the slide is controlled and indicated. This same mechanism is used in performing operations in division, and may also be used in addition and subtraction. The reciprocating movements of the slide also call for a provision by means of which the pinions which are acted upon by the cogged plate shall act upon the registers in one direction only. This provision constitutes the third feature of my invention; and the fourth consists in a modification of the carrying movement, by which it carries in one direction only; and the fifth consists in a cer-

tain arrangement of devices which I have provided for printing results of any of the operations of the machine.

It may be added also that, as the result of these changes in the construction of my machine, I am enabled to perform the operation of division without the aid of the supplementary dials described in my former machine, the quotient being shown, like results of all other operations, upon the common register of the machine, all of which is clearly set forth in the following description.

Similar letters of reference indicate corresponding parts.

A, Figs. 1, 2, 3, and 5, represents a case or frame in which the machinery operates. The case or frame has a cover, A^2, Figs. 3 and 5, extending across the top, except where the teeth of pinions N engage with the cog-plates beneath. B, Figs. 1, 3, and 5, are plates with graduated handles *e e* sliding in the case A. These plates have upon their faces raised teeth or cogs, arranged according to the nature of the computations to be performed. The teeth on the plates, shown in Fig. 1, are arranged in nine rows, having from one to nine teeth each, that being the number required for computations on the decimal system. J and J^1, Figs. 3 and 4, is the registering-slide, being formed of two plates, with a space between, secured together by the screws J^3, Fig. 4, passing through the pillars J^4. This slide is moved to the right or left in guides L and L′, Figs. 1 and 3, and may be lifted in these guides, for a purpose hereinafter explained. Between the plates J and J^1, and at equal distances apart, are arranged horizontal shafts or spindles M, Figs. 3 and 4, carrying the double dials M^1 and M^2 and the double type-wheels M^3 and M^4, and having handles *m* on the front end. There are to be twice as many spindles as there are cog-plates B. Upon the spindles M are gear-wheels *n*, which run loosely upon their axes and engage with pinions N below. M′ is a disk and pawl, attached rigidly to the gear-wheel *n*, which engages with the ratchet-wheel P, and turns the spindle M only when the slide is moved from left to right. When the slide is moved from right to left, the gear-wheel *n* and the disk M^7 attached to it may be turned upon their axes by the pinions N below without affecting the spindles M. The pinions N, Figs. 3 and 5, are secured to the lower spindles N′, and engage with the raised teeth upon the cog-plates below and with the gear-wheels *n* above. Upon the spindles M are also secured the ratchet-wheel P, Figs. 3 and 4, and the projection P′. Attached to the side of gear-wheel *n* is a thin disk, M^5, Figs. 3 and 4, to prevent the rod S from coming in contact with the teeth on that wheel. Upon the face of ratchet-wheel P is another disk to prevent the pawl U from coming in contact with the pawl attached to M^7. R, Figs. 3, 4, and 6, is a lever, pivoted to the bracket R^1, having an arm, *r*, and two pivots, R^2, supporting the rods S and S′. A projection near the end of rod S, on the under side, Fig. 6, is brought in contact with the projection P′ at every revolution of the spindle M; and by action of the projection P the arm *r* is forced through a slot in plate J^1, and placed in a position to be tripped by one of the studs *t t*, arranged in the guide L′, when the slide is moved to the right. These studs are arranged a little nearer together than the spindles M and levers R, and have the effect of tripping the arms *r*, one after another, commencing at the right, in carrying the tens. By this tripping movement motion is communicated through the rod S′, (which is attached to the lever R,) pawl U and ratchet P, thereby moving the dial on the left one-tenth of a revolution. In this manner the tens are carried. M^1, Figs. 3 and 4, is a dial having a set of numbers, from 0 to 9, on its periphery. M^2 is a dial connected with M^1, having a set of the same numbers running in the reverse order. M^3 and M^4 are type-wheels for printing the results of all operations, having raised numbers or type arranged to correspond with the order of the numbers on dials M^1 and M^2. M^6 is an ink roller or puff for inking the type-wheels. In printing, the impression is taken on a strip of paper, D, Figs. 3 and 4, which is held by means of spring *d* to the plate F on top of the registering-slide. The plate F, Figs. 3, 4, and 5, is hinged to the slide at *f*, and may be turned over so as to press the paper D against the faces of the type on the type-wheels. J^2, Figs. 3, 4, and 5, is a cover to the registering-slide, having windows through which the figures on dials M^1 and M^2 are made to appear. The device for restoring the several dials to zero, after performing operations, is shown in Fig. 5, and consists of a slotted rack, W, having a handle at W′. The rack has teeth arranged on its lower edge, which engage with the cog-wheels X attached to the spindle M on the outside of plate J. These cog-wheels have nine teeth and one blank, the blank being directly opposite the zero on the dials. V, Figs. 1 and 2, is a lever pivoted to the case at V′ near the side of the slide J for the purpose of imparting a reciprocating movement to the latter. It is connected with the slide by lifting the latter in the guides L, and replacing it in such a manner that the end of the lever will pass through one of the holes T, shown in Fig. 5. K is a handle operating, by means of pawl K^1, on the first wheel K^2 of a train of wheels and pinions, causing the lever V, which is attached by a connecting-rod to the last wheel of the train, to move from left to right and back again as many times as the figures indicate on the graduated arc below the handle K. This graduated arc is shown at A^1 in Fig. 1. The train of wheels and pinions may be composed as follows: K^2 may have twenty-seven teeth, and gear with pinion K^3 of nine teeth; K^4, secured to K^3, may have eighty-one teeth, and gear with pinion K^5 of nine teeth; K is secured to K^5, and has a pin on its upper side to which the connecting-rod K^7 is attached.

Wheels and pinions having other numbers of teeth may be used; for instance, K^2 may have thirty-six teeth, and the other wheels and pinions may have six, thirty-six, and six teeth, respectively. It is obvious that the registering-slide may be moved in three ways; first, by the lever V detached from the connecting-rod; second, by the handle K, which reduces all repeated action of lever V to one left-to-right movement of the hand; third, by the hand, without using either handle or lever.

Operation.

The operation of the machine is as follows:

Multiplication.—Draw out the handles *e e*, commencing at the right, until the graduations on them indicate the sum to be multiplied, and the cog-plates B will be moved so that the rows of teeth corresponding to the graduations are placed directly in the track of the pinions N of the registering-slide. The dotted line B′, Fig. 1, shows the rows of teeth that are in position to be operated upon. Then turn the handle K slowly from 0 to the figure on the arc below, which corresponds to the right-hand figure of the multiplier. The handle K causes the train of wheels to operate upon lever V, which is connected to the registering-slide at T, and imparts a reciprocating motion to the slide as many times as the figure on the arc indicates. Every time the slide moves from left to right the teeth of pinions N engage with the cog-teeth on the plates B and turn the gear-wheels *n* and other connections of the spindles M as many tenths of a revolution as there are teeth engaged. When the slide is moved back again from right to left the pinions N retraverse the teeth on the cog-plates, and cause the gear-wheels *n* to revolve upon their axes in an opposite direction without affecting the spindles and dials. The lower openings in the plate J^2 now show the result of the multiplication by the first figure of the multiplier.

To multiply by the second figure of the multiplier, raise the registering-slide and move it one step to the right, dropping it so that the lever V will enter the next left-hand notch T. Then move the handle K (after returning it to zero) to that figure on the arc which corresponds to the said second figure. The lower openings in the plate J^2 will now show the second multiplication performed and added to the first.

To multiply by the remaining figures of the multiplier, repeat for each what was done with reference to the second figure, and the cumulative results of the repeated multiplications will successively appear at the lower openings in J^2.

The tens are carried as follows: Whenever a spindle, M, with its dials and other attachments, has made a complete revolution, the projection P′ on the spindle, directly opposite to the zero on the dial, moves the rod S to the left, and causes the arm *r* of lever R to be forced out through the slot in J^1 into a position where it may come in contact with the studs *t t* in the guides L′. These studs, when the slide is drawn to the right, move the arm *r* of lever R and connecting-rod S back to their original positions, (after the pinions N have traversed all the teeth on the cog-plates below,) and communicate motion to the extent of one-tenth of a revolution by means of rod S′, pawl U, and ratchet P, to the next left-hand spindle and dials. By this arrangement there is never more than one ten of each denomination to carry at a time, and the carrying of that is kept back by the lever R until the next left-hand spindle, being no longer turned by its own pinion N, is ready to receive the ten from below.

The working parts of the machine now being described are arranged for the decimal system, but by a different arrangement of the teeth, and corresponding alterations in the other parts, the octonary, nonary, duodecimal, or any other numerical system can be substituted. The working parts, teeth, &c., can also be arranged so that computations in compound or mixed numbers of any special denominations may be performed.

There is no limit to the calculating power of this machine, it being only necessary to increase the number of cog-plates and their corresponding parts, which are alike throughout the machine.

Addition.—The knobs *e e*, dials M^1 and M^2, being at zero, draw out the said knobs until the first of the sums to be added appears on the graduations attached to them. Then move the handle K from 0 to 1 and back again, and the lower openings in J^2 will show the figures transferred from the cog-plates to the dials. Set up the second amount on the cog-plates by drawing out the knobs *e e;* then move the handle K as before. Repeat this process for each amount to be added, and the correct results will appear at the openings.

Subtraction.—Turn the handles *m* from right to left until the larger sum appears on the upper dials M^2. Then set up the smaller sum on the cog-plates by drawing out the knobs *e e* directly under the dials used, and move the handle K from 0 to 1 and back again. The remainder will appear on the upper dials.

Division.—Division is performed, as in practice, by operating first upon the left-hand figures of the dividend until they are reduced to a remainder smaller than the divisor, and then annexing the other figures, one by one, until a final remainder is shown smaller than the divisor. First, place all the figures of the dividend upon the dials M^2 by turning the handles *m* from right to left, putting the first left-hand figure of the dividend on the second left-hand dial. Then set up the divisor on the cog-plates by means of the knobs *e e*, having the figures of the divisor directly under those figures of the dividend which are first to be divided. Then draw out the first left-hand knob *e* until 1 is shown. The single tooth on the first left-hand cog-plate, which is

placed in position by this knob, will move the first left-hand lower dial one-tenth of a revolution every time a reciprocating motion is imparted to the slide; and afterward will move the other lower dials in succession as the slide is carried step by step to the left during the operation, thus registering each figure of the quotient in its proper order. Then move the handle K slowly from 0 toward the right, stopping as soon as the figures on the upper dials M^2 show a smaller sum than the divisor. The number of times that the registering-slide has moved from left to right and back again, or, which is equivalent, the number of times that the divisor has been subtracted from the figures operated upon, will then be shown on the first lower left-hand dial M^1, and also upon the arc below, where the handle K is stopped. To the remainder first obtained annex the next lower figure of the dividend, by moving the slide one step to the left, and operate with the handle K as before. The second figure of the quotient will then appear on the second lower left-hand dial M^1. Continue in the way described until all the figures in the dividend have been brought into the calculation and the final remainder appears on the dials M^2. The whole quotient will be found on the dials M^1 in proper order.

It is obvious that many equivalent devices might be substituted for some of those described in the foregoing specification; therefore, in making the following claims I desire to be understood as claiming not only the devices themselves, but any obvious mechanical substitute or equivalent of them when employed in the connection specified. For instance, the case or frame can be made circular, and a registering-slide of the same shape constructed so as to revolve around a fixed center on the case. Or other means of a similar nature may adopted for moving the slide, for turning the spindles only in one direction, or for printing the result. Or the registering-slide can be made double-acting, as shown in my former patent. Or there may be two registering-slides, one for addition and multiplication, and the other for subtraction and division. Or the register can be made stationary, and the cog-plates be made to slide instead of having the former to slide and the latter stationary. Or a train of gearing can be substituted for the lever R for carrying from one denomination to another. Or another set of graduations, but in reverse order, may be added to the handles *e e* for the purpose of transferring the minuend and dividend to the upper dials without having recourse to the handles *m*, in the same manner as the multiplicand is transferred to the lower dials.

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

1. The calculating-machine, having a series of plates or their equivalents, each plate being provided with a single series of rows of cog-teeth, the rows corresponding in the number of their teeth to the several primary numbers of the system in which the operations of the machine are to be performed, substantially as described.

2. In combination with the registering-slide, the lever V separately, and also in connection with the link K^7, handle K, and connecting-gearing, substantially as described.

3. In combination with the toothed plates described in the first claim, the pinions N *n* and disk M^7, carrying a pawl, for the purposes described.

4. In connection with the toothed plates described in the first claim, the lever R, carrying a single pawl.

5. In combination with the registering-slide, the plate F, spring D, hinge *f*, type-wheels M^3 and M^4, and roller M^6, or their equivalents, for printing or stamping the results obtained.

EDMUND D. BARBOUR.

Witnesses:

M. T. BARBOUR,

E. A. ROSS.