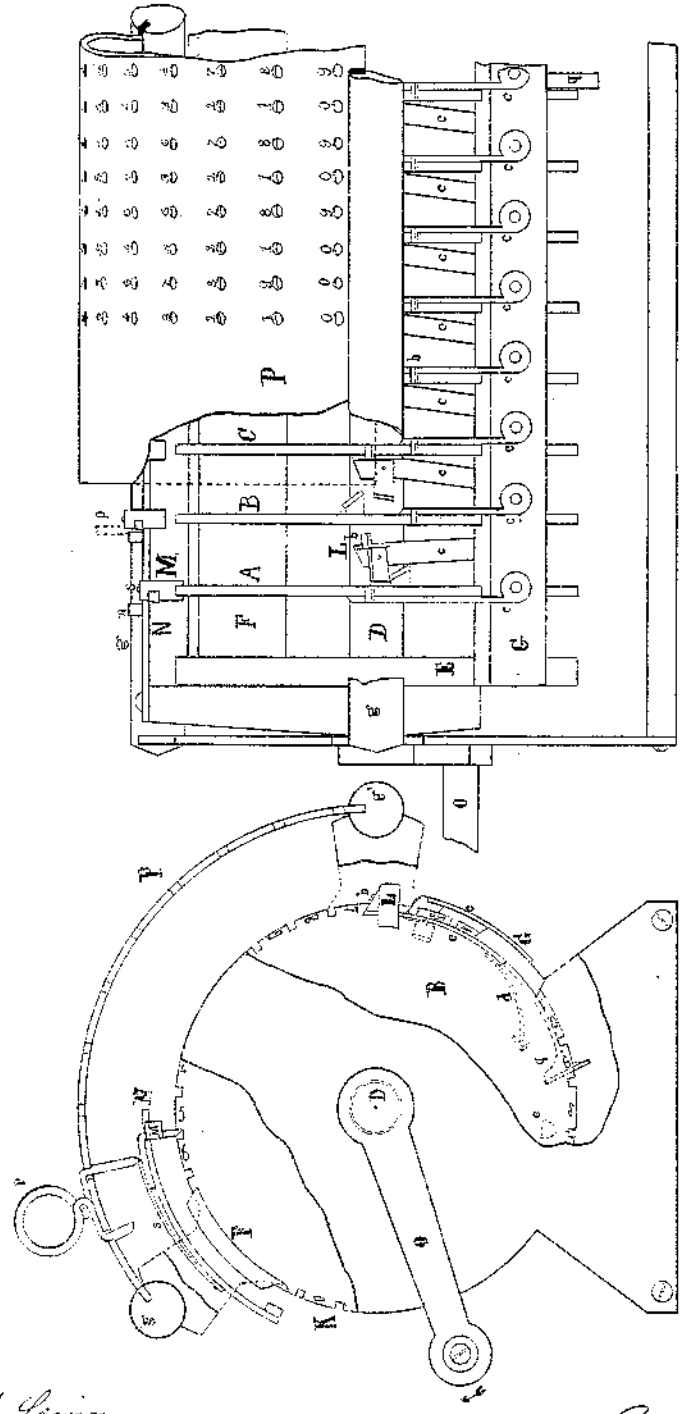
G. B. GRANT.

Improvement in Calculating-Machine.

No. 129,335. Patented July 16, 1872.



Witnesses:
Sally W Savin
Susan L Savin

Inventor:
Geo B Grant

UNITED STATES PATENT OFFICE.

GEORGE B. GRANT, OF CAMBRIDGE, MASSACHUSETTS.

IMPROVEMENT IN CALCULATING-MACHINES.

Specification forming part of Letters Patent No. 129,335, dated July 16, 1872.

Specification describing certain Improvements in Calculating-Machines, invented by GEORGE B. GRANT, of Cambridge, county of Middlesex and State of Massachusetts.

My invention relates to certain mechanical devices by which the processes of multiplication and division may be performed without the aid of mental computation. The machine consists of devices by which one number can be added to another any given number of times in succession, for both multiplication and division may be performed by that process. Multiplication is the addition of the multiplicand to itself as many times as there are units in the multiplier. Division is the addition of the complement of the divisor to the dividend till it is reduced to a negative quantity. The quotient is one less than the number of additions made. When one number is to be added to another the figures of one are added to the corresponding figures of the other at one operation and all at once; and a note being made of any carriage that becomes necessary, it is attended to afterward by itself, at another operation.

The machine may be divided into three main divisions or parts—a part on which the multiplicand, divisor, or number to be added is set up; a part on which the number to be added to is set up, upon which the calculations are made, and in multiplication the result appears; and an intermediate part, which receives motion, and adds the number on the first part to that upon the second.

The first part receives the number to be added, and consists mainly of the plate P. This plate is movable in the guides *g* and *g'* in the direction of the length of the machine. It is provided with rows of holes, eleven holes in a row, and each hole, except the highest one, is numbered. The first, third, and alternate odd rows may be designated as positive rows, and are numbered from zero to nine, in order. The second, fourth, and even rows are negative, and are numbered in the reverse order, first from zero to one, and the others from nine to zero. To each row belongs a pin, *p*, which can be fixed in any hole. The place of the holes and pins may be taken by their equivalents, a slot and slide, for the same purpose. The multiplicand is set up in the positive rows—5 3 7, for example, is set up by putting a pin in hole 7 of the first row, a pin in hole 3 of the third row, and a pin in hole 5 of the fifth row. The divisor is set up in the same manner, but in the negative rows.

It is evident, from the reversion of the numbering of the negative rows, that if the machine uses a number as it is set up in the positive rows it will use the complement of any number as set up in the negative ones, so that the complement of the divisor need not be computed directly. By using two sets of holes we are enabled to set up both a number and its complement at once. If a number is set up on the plate and then it is moved one place to the right or left, each pin will be one place higher or lower than before, and the number will be multiplied or divided by ten.

The second part receives the number to be added to, and consists mainly of the wheels A B C, turning on the fixed arbor D. This arbor supports the piece E, and this piece supports three guides, F G H. The guides are so formed on their inner faces as to keep the wheels in position, and they serve as supports to other mechanism. The number of wheels determines the capacity of the machine. If it contains ten wheels, it is capable of multiplying two numbers together which give a product of not over ten decimal places, and it will divide a number of ten or less places. Each wheel is divided into any convenient number of divisions, and each division into ten spaces. The drawing shows three divisions and thirty spaces. Each space is numbered, and furnished with a nick or tooth. The spaces are numbered from zero to nine, in order. The wheel A represents units, the wheel B tens, and so on. The position K is chosen as the point from which to take all numbers, and the number to be added to is set up by moving the wheels till the proper figures appear at K.

The third main division receives motion and performs the calculations. It consists of the drivers M M M, one driver to each wheel, and so connected that they move between the plate and wheels. Each driver is movable slightly up and down. When down, it is between the teeth of its wheel, and will move it till lifted off by a lifter, L, fixed to the guide G. When up, it is in position to hit the pin projecting

from the plate and be thrown back onto the wheel. The lifter is so placed in relation to the positive holes that when a pin is placed in hole one it will throw the driver off, so that it will add one to its wheel before being lifted off. If the pin be placed in hole two, it will throw the driver off one tooth further from the lifter than before, and two will be added; and, similarly, if a pin be placed in any positive hole the number of that hole will be added to the wheel under it at the next turn of the drivers. In this position the driver will not hit any negative pin, but will if the plate be moved up or down half a place, and the complement of the number of its hole will be added. By this means the number on the plate is added to the number on the wheels at each turn of the drivers.

The particular mode preferred of hanging the drivers to accomplish this purpose is to attach them all to one carriage, N, which is in connection with a handle, O. Each driver is forced toward the wheel by a spring, *s*, and is held up by catching upon the carriage. The pin throws it off by passing between it and the piece *n* upon the carriage. Each wheel is provided with a stop, *b*, which is not in action when the wheel is in motion, but is let onto the wheel as the driver is coming out, for the purpose of preventing the motion of the wheel by its own momentum. I prefer to make the lifter L serve this purpose by attaching it to G by a spring, *c*, by which it is kept off the wheel till put on by the action of the driver in coming off. Each wheel is provided with a catch, *d*, which stops the wheel at zero if it is moved backward. The last wheel is provided with what may be called the "quotient-stop" *q*. H is a lever that is thrown out by a pin, *e*, on the wheel whenever it reads nine, so as to stop the carriage when it next comes round—that is, to stop the carriage whenever a negative number appears on the wheel; for negative numbers being represented by their complements the last wheel will read nine whenever one occurs.

When one number is added to another a number of carriages generally become necessary, but for one addition more than one unit is never carried to one wheel.

The carrying apparatus on this machine works with a principle of action which is that it does not do the carrying itself, but through it the wheels determine when the drivers are to perform that carriage, thereby saving many pieces that are necessary in a direct carrying apparatus. The particular mode chosen of applying this principle is to make the lifter L movable, so that it can be drawn aside by the next wheel out of the path of the driver, which will consequently add one more to its wheel than it would have done. When the wheel A reads nine a pin or hook, *h*, upon it is just in contact with the driver belonging to B, and as it passes from nine to zero it will draw the lifter away from B. If B reads nine, its hook will be in contact with the lifter belonging to C, and when the drivers come round one will be carried to B and one to C, and so on, a unit would be carried to every wheel in succession that reads nine, and one to the first one that does not. After the carriages have been made a projection, *v*, on the carriage, hits the pins *u* on the lifter and brings it back to its wheel again, ready for another addition. This may be termed the simultaneous carrying apparatus, because all the carriages are made at one operation, and all at once.

I will briefly describe a form of carrying apparatus that might be called the consecutive carrying apparatus, because it carries first from the units to the tens, and then from the tens to the hundreds' wheel, and so on in a consecutive manner from wheel to wheel. A stud is thrown out by a pin on the wheel, so that it shall throw the driver off when it comes round and cause it to add one to its wheel. This is more even in its action than the other, but the principle of carrying consecutively is not new.

I will now describe the method of performing any calculation on this machine. Multiplication: example, 537 by 431. Set up one of the numbers 537 in the positive holes, and turn the handle once. This will multiply 537 by 1, the unit figure of the multiplier, and the product 537 will appear on the wheels. Set the plate up one place, and turn three times, 5370 will be multiplied by 3, and the product added to the previous product. Set the plate up another place and turn four times, 53700 will be multiplied by 4, and the product added to the previous products, and this sum will be the required product, 211447. Division: example, 211447 divided by 537. Set up 537 both in the positive and in the negative holes. Set up 211447 on the wheels. Set the plate up so that 537 in the negative rows shall be over 114 on the wheels, and turn till the carriage stops, which will be after the fifth turn, giving us the first quotient figure 5, minus 1, or 4. Now set down the plate one-half place and turn once. This will add the divisor to the dividend, and correct the error made by adding its complement once too often. Set down the plate another half place, and obtain the remaining quotient figures, 3 and 1, by the same process. This method is perfectly automatic and independent of the judgment of the operator, but some persons might prefer the following method of division: The divisor need not be set up in the positive holes, and the operator must watch the figures of the dividend as he turns, and when it is less than the divisor he must stop, and the quotient figure is the number of turns he has given. Addition and subtraction could be performed, of course, but not with a speed to compete with the mental method.

I claim as my invention, and desire to secure by Letters Patent—

1. The divisor-plate P, in combination with the fixed guides *g g*, so as to make it movable longitudinally, substantially as described.

2. The combination of two pins, *p*, and two

separate rows of holes or their equivalents upon the plate P, with each driver M, so that by shifting the plate the driver will strike either pin, substantially as described.

3. The combination of driver M with pin *p* and lifter L, so that it shall be thrown onto the wheel A by the pin and off it by the lifter, substantially as described.

4. The combination of spring *s* with driver M, so that the driver shall catch on the carriage N and be thrown off by the pin *p*, substantially as set forth.

5. The combination of quotient-stop *q* with pin *e* so that the carriage N shall be stopped when the last wheel stops on nine, substantially as described.

6. The lifters L, arranged upon the guide G, for the purpose of throwing the drivers off the wheels, substantially as set forth.

7. The stop *b*, which does not ordinarily touch the wheel, but which is forced into it as the driver is coming out, substantially as described.

8. The spring-catch *d*, attached to the guide G, in combination with a projection on the wheel A, so that the wheel shall be stopped by it at zero if it be moved backward, substantially as described.

9. The combination of hook *h* with movable lifter L so that the lifter shall be drawn aside as the wheel passes from nine to zero, substantially as set forth.

GEO. B. GRANT.

Witnesses:
J. B. SAWIN,
SUSAN N. SAWIN.