A.D. 1843 . . . . . N° 9616.

Calculating Machines, applicable to Wheel-Work.

WERTHEIMBER'S SPECIFICATION.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, DAVID ISAAC WERTHEIMBER, of West Street, Finsbury Circus, in the County of Middlesex, Gentleman, send greeting.

WHEREAS Her present most Excellent Majesty Queen Victoria, by Her Letters Patent under the Great Seal of Great Britain, bearing date at Westminster, the Twenty-eighth day of January, in the sixth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said David Isaac Wertheimber, Her especial licence, full power, sole privilege and authority, that I, the said David Isaac Wertheimber, my exors, admors, and assigns, or such others as I, the said David Isaac Wertheimber, my exors, admors, or assigns, should at any time agree with, and no others, from time to time and at all times during the term of years therein expressed, should and lawfully might make, use, exercise, and vend, within England, Wales, and the Town of Berwick-upon-Tweed, the Invention of "IMPROVEMENTS IN CALCULATING MACHINES, PART OF WHICH IMPROVEMENTS IS APPLICABLE TO PURPOSES WHERE WHEEL-WORK IS REQUIRED," communicated to me by a certain Foreigner residing abroad; in which said Letters Patent is contained a proviso that I, the said David Isaac Wertheimber, shall cause a particular description of the nature of the said Invention, and in what manner the same is to be performed, to be inrolled in Her said Majesty's High Court of Chancery within six calendar months next and immediately after the date of the said in part recited Letters Patent, as in and by the same, reference being thereunto had, will more fully and at large appear.

NOW KNOW YE, that in compliance with the said proviso, I, the said David Isaac Wertheimber, do hereby declare that the nature of the said Invention, and the manner in which the same is to be performed, are fully described and ascertained in and by the following statement thereof; and as it is imposible to give a description of these machines without the assistance of a Drawing, I shall therefore have recourse to one in describing their different parts, the manner in which these parts are connected with each other, the way in which they act one upon the other, or separately, as well as in explaining the principle of the whole mechanism, and in pointing out the different modifications as to shape which the machines may undergo. The subject of this description is a mechanism by which all the operations of arithmetic from numeration to logarithms may be effected by combinations more or less complicated of the elements. As all arithmetical problems are grounded on numeration, addition, subtraction, multiplication, and division, I shall only speak of these elementary machines. The other arithmetical problems are naturally connected with them, without constituting another Invention.

First Element, Counter.

A wheel of copper, wood, iron, or any other substance having twenty cogs or teeth (see Figure 1), is fixed by means of two lateral holes *a*, *a*, Figure 1, to a tube furnished with a plate, Figure 2. Under this wheel is fixed a double excentric or snail cam, Figure 3, which is separated from the wheel by the thickness of the plate. Under the double excentric or snail cam is fastened the catch plate, Figure 4; to keep this separate from the double excentric or snail cam, a collar shaped as in Figure 5 is placed between. All these are fixed upon a tube by the middle holes *b*, *b*, *b*, and joined together by two screws passing through their lateral holes *a*, *a*, *a*, *a*, so as to form a single piece of the whole as in Figure 6, which is a side view of the apparatus. I then take a small plate, Figure 7, and insert into the middle hole a steel pin *e*; this pin will enter the tube connected with the pieces already described, and will form an axis round which the wheel, the double excentric or snail cam, and the catch plate, may freely revolve. These pins are afterwards fixed by means of two screws, which pass through the lateral holes of the plate to a plate of metal, as represented in Figure 8. If another plate be placed above this one, and held apart from it by small pillars, Figure 9, *d*, *d*, *d*, *d*, *d*, the frame of the machine will be formed. Figure 9 is a side view of the frame with the pins *e*, *e*, *e*, fastened to the lower plate of the frame. The same Figure shows how the pins *e*, *e*, *e*, ascend into the interior of the frame, and reach the top of it. On taking off the upper plate of such a frame I perceive, as in Figure 10, *d*, *d*, the wheels

placed on the axes of their pins, to fix to any given point these wheels, which are capable of revolving on their axes, two pressing springs, Figure 10, *f*, *f*, which press on the teeth of the wheel and give it twenty fixed points. These pressing springs are fixed to a stud, Figure 11, the lower part of which is fixed in the holes of the lower plate of the frame, while to the upper part of the stud is fastened the extremity of a thin spring. Between each pair of wheels is a lever, Figure 10, *g*, *g*, which, considering it separately, is composed of the following parts:—A piece of metal nearly right angular, Figure 12, is rounded off at one end *h*, and bears on its upper surface a pin *i*; in the middle of the right angular piece of metal is a round hole *k*; the other arm bears a pin *l* on its lower surface, but its extremity has the form of a hook *m*, which hook is furnished with two pins *n*, *n*, and a round hole *o*; in this hole is a small stud which bears a small spring. This part resembles on a small scale the pressing springs, Figure 11, with this difference, that the small spring in miniature is larger at its extremity, while the springs of the pressing springs are of an equal strength in their whole length. The two pins of the hook *m*, *m*, serve to limit the action of the small spring; the hole *k* in the middle of the lever serves to fix it on a small tube, Figure 13. This Figure presents a side view of the lever; through the middle of this tube passes a screw pin, Figure 14, which is fixed into the lower plate, the lower part of which is seen in Figure 8 at *r*, *r*, and the upper part Figure 10, *s*, *s*; to prevent the lever from revolving freely round its axis there is another stud with its spring, Figure 15, and Figure 10, *t*, *t*, *t*, which acts on the lower pin of the lever, Figure 12, *l*, and fixes it. After having described each part separately, I will make known their different functions. The pin *i* of the lever, Figure 12, is continually in contact with the double excentric or snail cam. I will suppose that this lever is at the nearest point of the axis of the wheel; if the motion communicated to the wheel be from right to left at each tooth put in motion, the pin of the lever in contact with the excentric or snail cam will recede the tenth from the centre of the axis of the wheel; at the ninth division of time it will be at its greatest distance, and if the wheel advances one tooth farther, the lever compressed by its spring meeting no longer with any resistance from the excentric or snail cam, will again enter into its notch and resume its first position. The spring of the lever is stretched during nine divisions of time, at the tenth the tension ceases, and the spring is brought back. In a gun which is cocked and fired, the spring is stretched during two divisions of time, and at the third the trigger falls, when the firing takes place, In the machine that I describe, the spring is stretched during nine divisions of time, and it is at the tenth only that the opposition of the

excentric or snail cam ceases, and the spring forces the lever to its position; thus, when a wheel describes the half of its circumference the lever is naturally stretched during nine divisions of time, at the tenth it escapes and will push the following wheel one tenth. It is the ordinary course of calculation, where in addition the tens are always brought over to the line following. Nothing is easier than to construct a mechanism in which by the turn of a wheel divided into ten parts, one ten is brought over on the following wheel, and to produce a similar transmission on two or three wheels. But as soon as it becomes necessary to produce this transmission upon a greater number of wheels representing as many figures, the difficulties increase in proportion to the number of figures. I have had constructed ten different mechanisms of transmission; one of them for four figures answered completely, but the one with five figures worked with more difficulty and overrun itself; others went as far as six, seven, and eight figures. The greatest possible number of transmissions that I have been able to produce with safety is with nine figures. The construction of the machine required much care, and the results still uncertain; if then a self-acting machine for addition is to be tried it must be in the following manner:—All the wheels are placed at 9, the machine for instance is placed at 999,999,999, then one unit must be added to the first on the left, all the 9^{s} must be changed into 0, the transmission must be produced on all the wheels at the same time, and the sum of 1,000,000,000 ought to appear; if this transmission is not effected easily and without error, the machine may be unhesitatingly thrown aside as bad. In all the machines of our predecessors, and in the first ten essays, the transmission was produced simultaneously, from which resulted a resistance proportioned to the number of springs, and which require great exercise of strength to be surmounted. I will speak only of two of the first attempts of simultaneous transmission, because they are perfectly applicable to machines of less than six wheels, and I claim this as part of the Invention. Figure 16 represents the fragment of a similar machine: *a*, *a*, are the wheels with twenty teeth, on which are engraved twice the series of figures 1, 2, 3, 4, 5, 6, 7, 8, 9, 0. In order to economise the expense of engraving the engraved numbers can be printed on a band of paper that must be afterwards pasted on the wheels; *b*, *b*, are the axes of the wheels fixed on the pins; *c*, *c*, are the pressing springs destined to fix the wheels; *d*, *d*, are the spring levers which are always placed between two wheels, the form of which may be varied. When the first wheel has made its demi-circumference, the pin *e*, *e*, acts on the lever and makes the wheel following advance a tenth, but as soon as the pin *e* has passed it is again compressed by the spring *f*, *f*, and is

brought back to its place; Figure 17 represents the most simple mechanism that can be imagined, here the lever acts at the same time the part of the pressing springs; but beyond six wheels these systems, as I have already mentioned, require great exercise of strength, sudden shocks are the result when they are worked rapidly, and in consequence of the frequent errors arising from the wheels overrunning themselves, one or the other of them going more quickly than is necessary. I have then improved upon the principle of simultaneous transmission for machines, of which the number of wheels are not beyond five or six; I employ at present a mechanism which allows of producing a transmission of twenty, thirty, one hundred figures, without exercise of strength, with the greatest rapidity and complete safety. This transmission reposes on the principle of succession, and this successive transmission is peculiarly the Invention. It is effected thus: the wheels with twenty teeth, see Drawings and descriptions, are placed horizontally on fixed pins in a straight or circular line on a plate; above each wheel is engraved twice the series of numbers 0 to 9; each wheel is furnished with a pressing spring; above each wheel are fixed double excentric cams, of which the point nearest the centre corresponds with the cipher 0. Above these excentric cams are fixed double catch plates (see for these objects the Drawings and description; the point of the excentric cams which corresponds with 0 is gradually removed from the centre, and at the greatest distance it corresponds with the figure 9; in the intervals between the wheels is formed a detent lever placed likewise on a pin, and furnished with with a spring; this detent lever of a right angular form bears on its right extremity a pin, and on its left extremity a little spring driver. When the wheel with teeth is at 0, the detent lever is pressed by its spring, and its right extremity furnished with the pin is at the point of the cam the nearest to the centre; as the wheel moves the detent lever slides to the most distant point of the cam corresponding with the figure 9. If the wheel advances one unit the detent lever ceases to be removed from the centre by the cam, it returns pressed by its spring to the point 0 of the cam, and pushes the next wheel one unit. The little spring driver placed at the other extremity of the detent lever is destined to let the second wheel pass without disturbing the first. In this manner the transmission is easy and always safe, since the operator has only to conquer the resistance of one single spring; the excentric cam may be replaced by a pin placed on the lower face of the upper wheel. If a wheel with twenty teeth is furnished with two similar pins, and they are made to act on the detent lever, which must then be furnished with only one excentric notch, the same effect will be obtained as with the excentric cam; the principle remains the same, the form of the mechanism only is changed.

As before commencing an operation all the wheels must be placed at 0, it would be very tiresome work if each wheel was obliged to be placed at 0 successively; the following mechanism produces this operation all at once:— The lower plate has formed in it several semicircular notches, as may be seen at Figure 8 and Figure 10, *m*, *m*, *m*. On the upper front of this same plate is fixed a bar, Figure 9, and Figure 10, *n*, *n*, *n*, screws which go through the semicircular notches without tightening the bar on the lower plate, so that it can perform a semicircular movement in the notches, Figures 8, 9, 10, 0, 0, 0, at equal distances. This bar is provided with pins, Figures 9, 10, *p*, *p*, *p*, which, when a semicircular motion is given to it, act on the catch plates, Figure 4, of the wheels, and place at once all the wheels at 9. In this position all the wheels have their detent levers forced as far as possible, and in adding a unit to the first wheel on the right, that is to say, in making this wheel go a twentieth of its circumference, all the wheels are placed at 0 successively, but so rapidly that the eye can scarcely perceive it. In order to direct the bar in question in its semicircular movement, there is on the lower front of the lower plate another bar, provided with a handle at its extremity; when this bar is disengaged from the hook it becomes moveable, and if it is drawn in a horizontal line it gives the semicircular movement to the long bar. This mechanism also may be modified in different manners. The principal point is the new idea of putting at 0 all the wheels of the machine by two movements.

In this rapid motion the wheels could easily overrun themselves, that is to say, that the force of the spring might make them go beyond the points noted 9, which would prevent the object being attained. I have endeavoured to remedy this inconvenience, and in order to do so I have placed a spring below each wheel, which renders this accident impossible. Each of these springs are fixed to a stud, fixed under each wheel to the lower plate. As soon as the wheel arrives at 9, this spring leans on the catch plate and prevents the wheel from going farther. The pins of the bar serve at the same time, when the bar is drawn in, to separate the springs, and to restore its liberty of motion to the wheel, as may be seen, Figure 10, *p*, *p*, *p*, *p*.

If a plate is taken and pierced with holes which correspond with the figures of the wheels placed below, and if all the mechanism that I have described is covered, the first element of the calculating machine will be produced, which may be called a counter (see Figure 18 and Figure 10. All that is to be done is to furnish the first wheel on the right with a lever handle, which makes it always go a twentieth of its circumference. The form of this lever varies much, according to the purpose to which such a machine is applied. It is easier to give an idea of the form of the lever employed by me in the expla-

nation of the machine, by the appearance of the Drawing, Figure 10 A, then it would be to describe it.

SECOND ELEMENT, ADDITION.

With the exception of the lever destined to put the first wheel in motion, the interior mechanism differs in no manner from the preceding. Only the upper plate bears, besides the round openings, the semicircular grooves, Figure 18, *z*, *z*, *z*, *z*, *z*. Through these grooves are perceived the teeth of the wheels which move under the plate. On the edge of each groove are engraved in the copper the figures 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, upwards, so that the 0 is placed at the lower extremity and the 9 at the upper extremity of the half circle. The first groove on the right corresponds with the units, the second to the tens, the third to the hundreds, &c. In order to make the teeth which are perceived through the grooves move, a pointer is used, Figure 19, furnished with a moveable point. In placing it in the space of the groove marked with the figure 1, and in pushing it from right to left as far as the lower extremity of the groove, where an obstacle is met with, then the dial will be advanced one number. If, on the contrary, the pointer is placed in the groove at No. 9, and conducted as far as the lower extremity of the semicircular groove, 9 teeth of the dial will be advanced. This manner of conducting the teeth represents the rotation of the figures. If an addition is to be made with the machine, first of all it must be placed at 0, with the aid of the handle and the bar above named, Figure 9, *a*, *a*, Figure 8, *a*, *a*. There is nothing to be done after but to describe the figures on the machine, and the addition will take place of itself. For instance, if there are to be added together

1630
29897
388

the pointer is placed in the space of the grooves of the thousands at No. 1, and the tooth is brought as the extremity of the groove; afterwards 6 is written in the notch of the hundreds, 3 in that of the tens, and as there are no units, nothing in that of the units. Then two is written in the groove of the tens of thousands, 9 in that of the thousands, 8 in that of the hundreds, 5 in that of the tens, and 7 in that of the units; then in the lower holes will appear the sum 31,487, and in writing in the same manner 388 the sum total will be obtained, 31,875. For the fractions of the English monetary system, a groove must be divided into four parts for the farthings, the wheel below having eight teeth; a second groove into twelve parts for the pence, with a wheel below of twenty-four teeth; and a third into twenty parts for the shillings, with a wheel below of forty teeth. The units will then subsequently form the pounds sterling.

THIRD ELEMENT, SUBTRACTION.

Subtraction is produced by means of two series of figures, from 0 to 9 and from 9 to 0, engraved round the notches in this manner :—

0, 1, 2, 3, 4, 5, 6, 7, 8, 9.
9, 8, 7, 6, 5, 4, 3, 2, 1, 0.

The sum of each line is always 9 ; the upper series in encreasing progression serves for addition, the lower for subtraction. If 15,467 is to be deducted from the sum of 26,789, the machine must first be put at 0, and on the second series of figures must be placed the sum 26,789, and afterwards the sum to be subtracted, 15,467, must be marked on the series of addition, the product will be obtained, 11,322.

Until now I have spoken only of a counter addition and subtraction ; now I will give the description of a machine which makes calculations in the four rules of arithmetic, the decimal fractions, and arithmetical progress. Figure 20, exterior of the machine, reduced to nearly a third of its natural size ; Figure 21, a side view of the same machine ; A, A, handles placed on the sides ; B, B, B, B, exterior circle ; C, C, middle moveable part ; D, locking pin ; E, handle ; F, index ; G, conducting handle ; H, quotient handle ; I, I, handle to change the positions of the parts for addition or subtraction ; K, feet ; L, stopping catch of the lever handle E.

EXTERIOR FIXED CIRCLE.

Nine dials, bearing the Figures 1 to 9 on one semicircle of each dial, and on the other semicircle, in a contrary direction, the Figures 0 to 9 ; two hooks to each dial. These dials of the exterior circle are destined to addition and subtraction. They are perfectly analagous to those of which I have given a description, with this only difference, that instead of being placed on a straight line they are on a curved line. Besides these dials for addition and subtraction, on the exterior fixed circle are seen small openings for the quotient, through which are perceived the figures of the dial of the wheel of the quotient, Figure 22.

DESCRIPTION OF THE MACHINE WITH THE EXTERIOR FIXED CIRCLE TAKEN OFF.

Figure 23 represents a series of wheels for addition and subtraction, the same as in the machines used simply for addition and subtraction. One of these wheels are represented on a larger scale at Figure 24, and at the side view Figure 25 ; but below will be seen each wheel, Figure 24, *b*, and Figure 25, *b*, a cogged wheel divided into twenty parts, and acting upon a pinion, Figure 23, *c*. The same Figure represents the locking catch M, which fixes the middle moveable part. This middle moveable part, Figure 20, C, C, bears

on its exterior part the handle E, and the handles already named, five dials *d*, with five openings *e*, and a central dial N, N. If the exterior plate of this middle part is taken away, there are seen five developement wheels *f*, *f*, Figure 26, one central wheel, a part of the regulator *h* and the catch *i*, and the (nine) notches *k* for stopping the locking catch. The whole is supported by an axis.

Developement Wheels.

The developing wheel is placed on the lower plate of the middle moveable part, Figure 27, by pins, Figure 27 and Figure 28. It is composed of three principal parts, Figure 29. First, lower part or pinion, which acts upon the central wheel; second, middle part, which has teeth that may be drawn in and out at will, *l*; third, upper part, which supports the dial, the figures of which are visible through the five openings of the upper plate of the middle moveable part *m*, and Figure 30, Figure 31 *m*, Figure 26 *m*. The lower part offers nothing remarkable; it is merely a pinion divided into twenty parts. The middle part *l* is a copper disk, of which the fifth part is furnished with nine slides or grooves, Figure 32, notched in its thickness. In these slides are nine moveable bolts, which force outside forms so many teeth, but when inside the slides leave the edge of the disk perfectly free. If one of these bolts is forced out of its slide the disk has one tooth; it has two if two bolts are forced, and nine if all are out of their slides. Each bolt is furnished in the middle with a pin, Figure 32, on which acts a little inclined plane *o*, notched in a moveable plate *p*, which covers the disk and its slides. It is with the aid of this inclined plane that the teeth are forced out of the slides and return into them. In short, the upper part of the dial *m* communicates by a pinion and rack *q* with the notched plate, and through the upper plate may be seen how many teeth are out of their slides. Now imagine the five developement wheels *f*, *f*, *f*, *f*, *f*, Figure 26, placed in a circular line on the lower part of the moveable part. The great central wheel *g* has two hundred teeth, which act upon the pinions of twenty teeth of the lower part of the wheels of developement. Divide the great wheel in ten equal parts, and it will be easy to understand that, whilst it makes the tenth part of a turn, the developement wheels make a complete turn on their axis. Moreover, as these developement wheels have only the fifth of their circumference furnished with teeth, and are placed in such a manner that the part with teeth of the second wheel can only come in contact with the circular line described by the exterior circle which supports the system of addition wheels and their pinions, when the part with teeth of the first is removed from it, and so on, it results from this that whilst the great wheel

performs only a tenth of its revolution, the parts with teeth of the developement wheels make a complete turn. If a machine is to be constructed with six, eight, or twelve developement wheels, the part with teeth may also necessarily occupy only the sixth, eighth, or twelfth of the circumference of the developement wheels. It is not necessary to give the machine a circular form; it can very well admit of a horizontal form.

Now suppose, by means of the pinions *c*, Figures 23 and 25, the developement wheels put in contact with the mechanism of the addition of the exterior circle, so that the first developement wheel is placed opposite the units, the second opposite the tens, the third opposite the hundreds, &c. If none of the five developement wheels have teeth, the great central wheel *g*, Figure 26, can be put in motion at will, without producing any change in the wheels destined to addition. But if each of the developement wheels has a tooth, whilst the great wheel performs the tenth part of the revolution, the five developement wheels, each of which has, as I have already said, a tooth, will act by means of the pinion upon the addition wheels; and if the latter are placed at O, they will cause it to advance a unit, so that 11,111 appear. In this case eleven thousand one hundred and eleven will have been multiplied by one. If the great wheel had performed the two tenths, or the three teeth of its circumference, the five developement wheels would have been multiplied two or three times, and the products obtained would be 22,222 or 33,333. I will show an example:—If 26,546 are to be multiplied by 272, we will begin by marking on the five developement wheels of the middle moveable part, Figure 20, *d*, *d*, *d*, *d*, *d*, these figures, 26,546, which will appear through the openings *e*, *e*, *e*, *e*, *e*. The first will have two bolts or teeth, the second six, the third five, the fourth four, and the fifth six.

In the centre of the moveable part is a handle E, Figure 20, destined to put in motion the great central wheel *g*, Figure 26, which gears with the pinions of the developement wheels, Figures 29 and 31; this handle has in the centre, Figure 33, a ratchet wheel *r*, of ten teeth, and fixed on the tube of the great central wheel with its click *s*, fixed on itself on the handle, and only allowing this latter to move from left to right. If it is conducted in the contrary direction it will no longer move alone, but it then, with the assistance of the click *s*, puts in motion the great central wheel *g*. The handle is furnished with an index hand F, which marks on the circular dial, divided into ten parts, and marked with the figures 0 to 9, how many tenths the central wheel advances, and consequently how many revolutions the developement wheels make. It must also be remembered that the moveable part has in its lower plate several notches *k*, *k*, *k*, Figures 25 and 26, in which is lodged the

locking catch M, Figure 23. By means of the locking pin D, Figures 20, 23, and 25, this locking catch is depressed, and the mobility of the middle part no longer meeting with any obstacle, the first developement wheel is placed on the right opposite the units of the exterior circle.

In order to perform the multiplication given, the index hand F must be placed on the figure 2 on the dial, and the handle turned until this hand F arrives at 0, when it will be stopped by the stopping catch L, Figures 20 and 34, the catch *i* of which, see Figures 35 and 26, prevents the developement wheels from continuing their rotatory motion. The multiplication will have been performed by two, and the upper openings of addition will show the sum of 53,092.

This first result once obtained, the locking pin must be pushed to D, Figure 20, which renders the middle part free, and with the assistance of the conducting handle G, Figure 20, this middle part must be turned from right to left, so that the units of the sum to be multiplied indicated on the developement wheels come opposite the tens of the sum 53,092.

The handle must be placed on the figure 7, and turned until it comes to 0, where it must be stopped again. The multiplicand will thus be multiplied by 70, and the product of this multiplication will be added at the same time to the product of the multiplication by 2. Thus in the openings of addition the sum of 1,911,312 will be read. The central plate must be again (by the conducting handle *g*) advanced one tenth; the index hand must be put on number 2; and in proceeding as already stated, the product of the multiplication by 200, added to the product of the multiplication by 72, will be obtained: thus will be found in the addition openings the entire product 7,220,512.

The Figures 17 and 18 represent two other systems of developement wheels, on which the wheels are pushed back in the inside by springs; but I prefer the developement wheels previously described.

To make a division I must proceed thus:—

Be it required to divide 7,220,512 by 26,546. The divisor 26,546 must be marked on the developement wheels as in multiplication, and the dividend on the lower series of figures of the exterior circle wheels destined to subtraction, are discovered in closing the upper figures of addition by the handle of the blade, Figure 20, I, I. The middle moveable plate must be placed in such a manner that the first figure from left to right is placed opposite the first figure of the dividend. It must then be marked completely the same as in multiplication, except that, instead of advancing, the central plate must always recede one figure from left to right. The result of the operation, that is to say, the number of times the 26,546 has been subtracted from 7,220,512, will

be given by the quotient 272, which will be seen in the special openings *a*, *a*, *a*, *a*, Figure 20. Previous to commencing the operation of division, the handle H, Fig. 20, must be moved to division as hereafter described.

In order to shew how many times one number has been subtracted from another, (that is to say,) the quotient, there is a particular mechanism in the machine which remains inactive during all the other operations, and that is marked only for division. Figure 20, H, represents a handle which conducts an index hand; when this hand is opposite the 0 the machine is at rest; it works when the index hand marks division. This handle H puts in motion a lever *u*, Figure 27, placed on the lower surface of the lower plate of the middle moveable part. When the hand marks division, the lever forces out of the circumference of the circle, Figure 27, a wheel *x*, which acts upon a pinion of the first developement wheel, Figure 31, *v*, and which has a pin *y* which counts on the wheels of the quotient, Figure 36, the number of turns made by the developement wheels, which constitutes the quotient.

Besides the mechanical methods of multiplications and division that I have described, I have another, much more simple and less expensive, of which I subjoin a description. It is always by the aid of the system of successive transmission, of which I have been the first to apply it to calculating machines, and which I have described above, that the new method of multiplying and dividing can be usefully put into execution.

The following is a description of the other improvement:—

To each dial of my adding apparatus a series of wheels must be added; these wheels, with the assistance of the pinions, form a series of continued gearings, and their speed increases upwards or diminishes downwards progressively one tenth.

The following is the construction of the new machine:—

Dial of the 9.	Dial of the 9.	Dial of the 9.	Dial of the 9.
Do. „ „ 8.	Do. „ „ 8.	Do. „ „ 8.	Do. „ „ 8.
Do. „ „ 7.	Do. „ „ 7.	Do. „ „ 7.	Do. „ „ 7.
Do. „ „ 6.	Do. „ „ 6.	Do. „ „ 6.	Do. „ „ 6.
Do. „ „ 5.	Do. „ „ 5.	Do. „ „ 5.	Do. „ „ 5.
Do. „ „ 4.	Do. „ „ 4.	Do. „ „ 4.	Do. „ „ 4.
Do. „ „ 3.	Do. „ „ 3.	Do. „ „ 3.	Do. „ „ 3.
Do. „ „ 2.	Do. „ „ 2.	Do. „ „ 2.	Do. „ „ 2.
Thousands.	Hundreds.	Tens.	Units.

Transmission the same as in the addition apparatus.

It will be easily understood by this position of the wheels, that when the dial of the 9 of the nine tenths is put out of its place, as the wheel 9 will go

nine times as quickly as the dial of the units, there will be seen in the openings of the adding apparatus (in consequence of the transmission of the units) the sum of 81, or the product of 9 times 9; consequently, if 226 is to be multiplied by 2, it must be done thus:—The wheel of two of the series of hundred must be turned two tenths; the wheel of the 6 of the series of tens turned also two tenths; in short, the wheel of 6 of the series of units still two tenths, and the sum of 532 will be found in the openings of the adding apparatus.

I here declare that I reserve to myself the exclusive privilege, not only of the construction of these new mechanisms, as well as the power of varying their forms, dimensions, and materials, but also of the application of the developement wheels, and of the anulling of figures; that is to say, the different means and methods of putting the machine at 0 at one or two strokes.

And I also declare that I reserve to myself the exclusive privilege, not only of the construction of these new machines, as well as the power of varying the forms, dimensions, and metallic materials, or others of which they are composed, but also the application of a series of continued gearings of wheel work, which diminish or increase progressively (in arithmetical progression) the speed by a tenth.

In witness whereof, I, the said David Isaac Wertheimber, have hereunto set my hand and seal, this Twenty-eighth day of July, in the year of our Lord One thousand eight hundred and forty-three.

D. I. (L.S.) WERTHEIMBER.

AND BE IT REMEMBERED, that on the Twenty-eighth day of July, in the year of our Lord 1843, the aforesaid David Isaac Wertheimber came before our said Lady the Queen in Her Chancery, and acknowledged the Specification aforesaid, and all and every thing therein contained and specified, in form above written. And also the Specification aforesaid was stamped according to the tenor of the Statute made for that purpose.

WINGFIELD.

Enrolled the Twenty-eighth day of July, in the year of our Lord One thousand eight hundred and forty-three.

LONDON:
Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1856.

A. D. 1843. Jan. 28. N° 9616.
WERTHEIMBER'S SPECIFICATION.

FIG. 18.

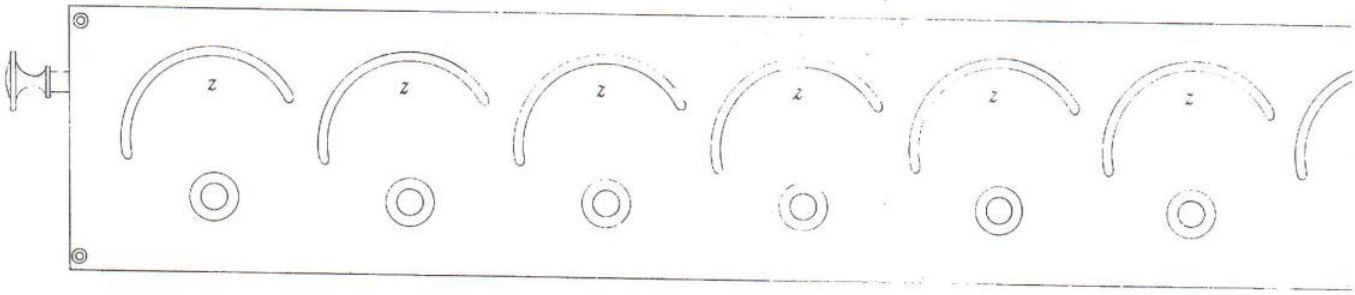


FIG. 9.

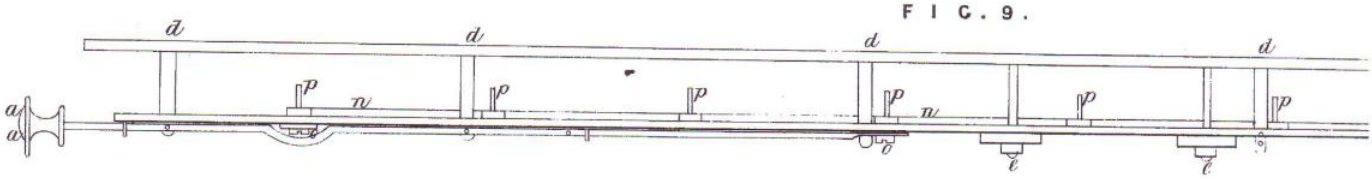


FIG. 8.

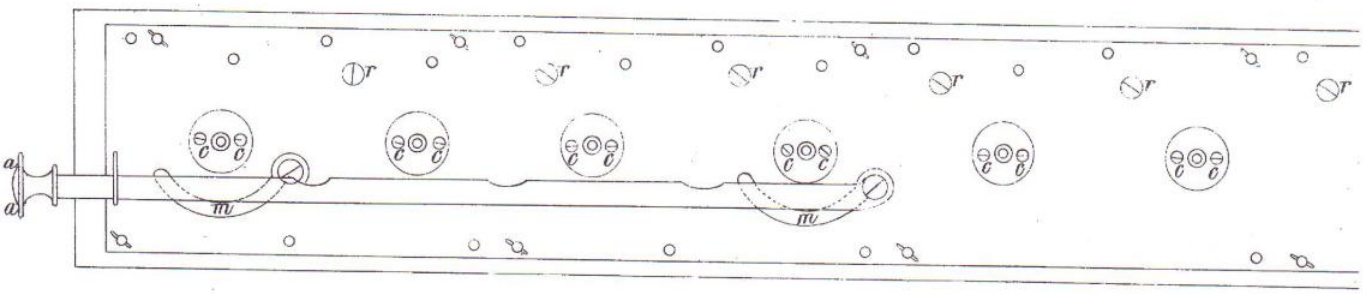


FIG. 10.

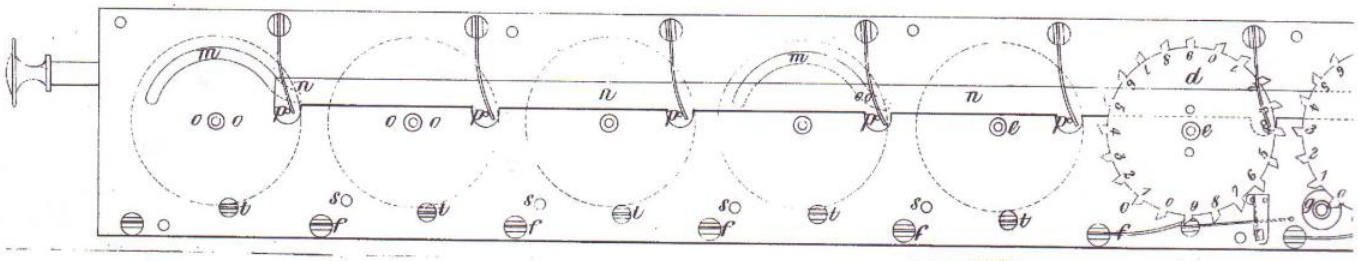


FIG. 1.

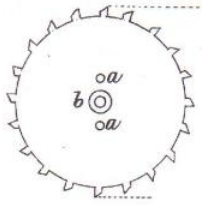
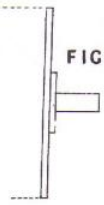


FIG. 2.



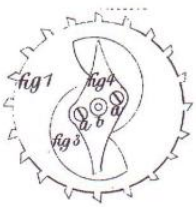


FIG. 6.

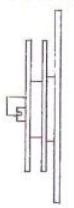


FIG. 3.

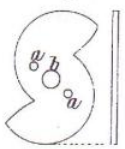
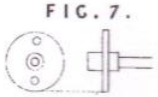


FIG. 4.

FIG. 5

FIG. 7.



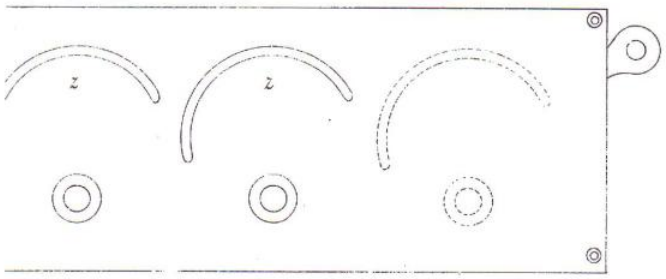
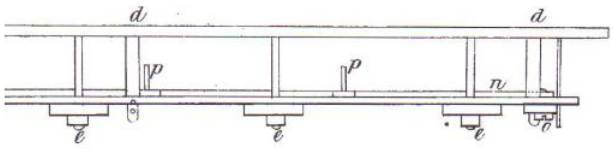
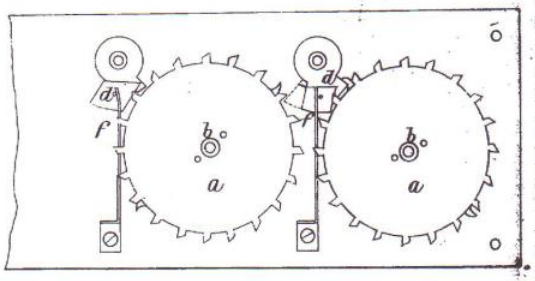


FIG. 17.





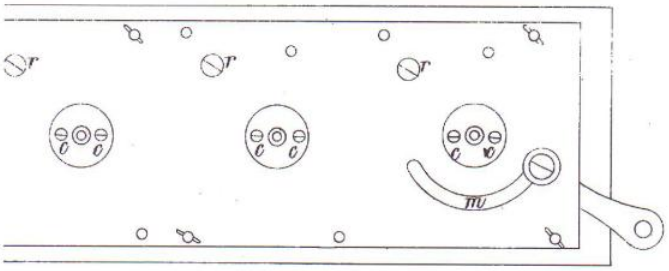
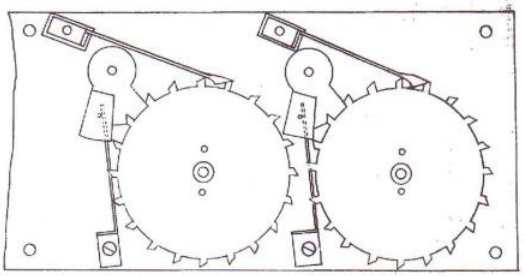


FIG. 16.



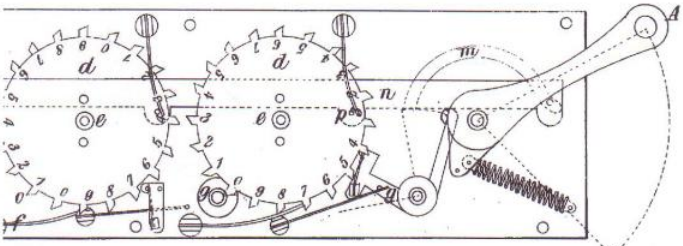


FIG. 30.

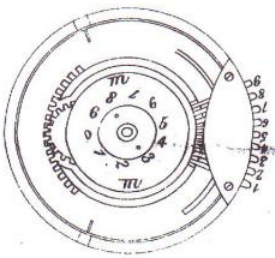


FIG. 29.

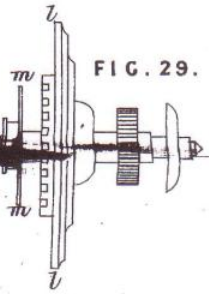


FIG. 12.

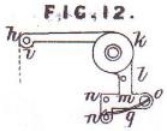


FIG. 5

FIG. 7.

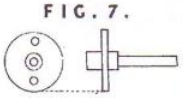


FIG. 13.

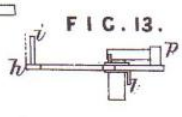


FIG. 19.

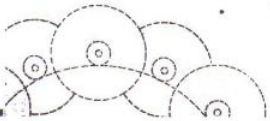


FIG. 14.

FIG. 32.

FIG. 1

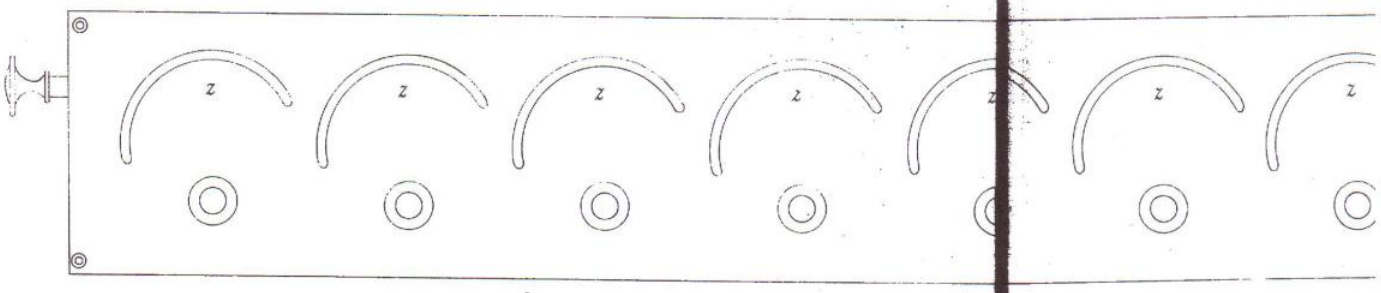


FIG. 9

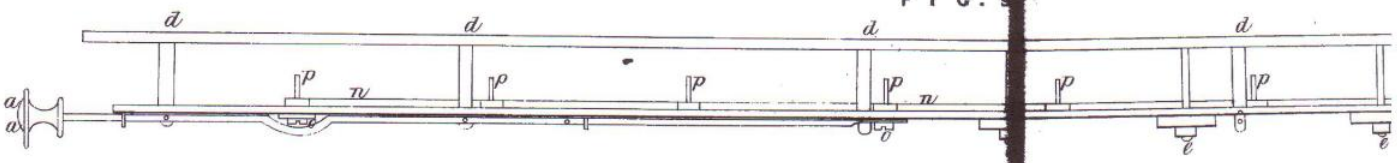


FIG. 8

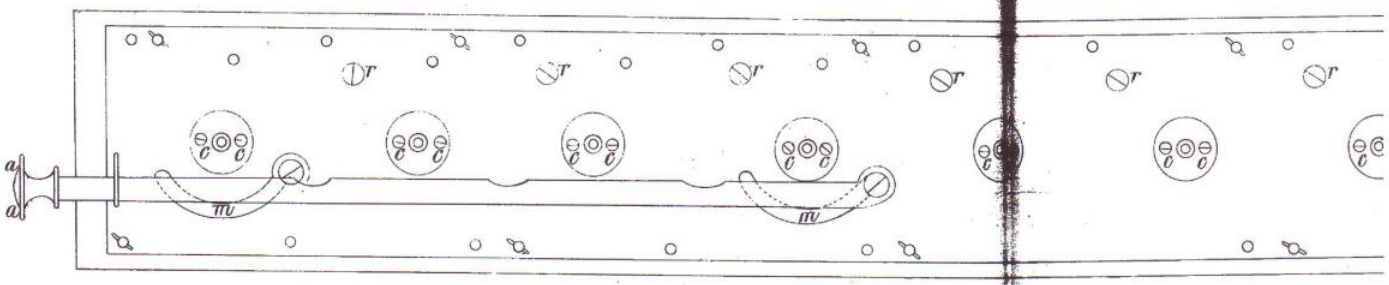


FIG. 10.

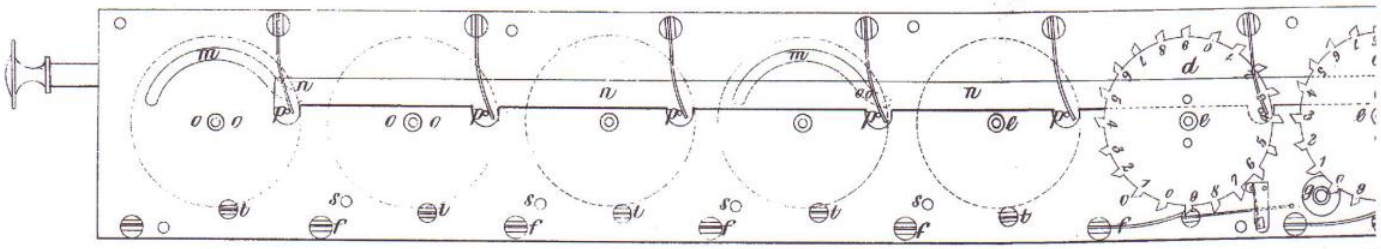


FIG. 1.

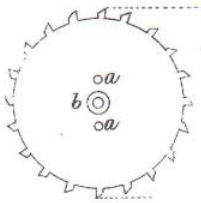
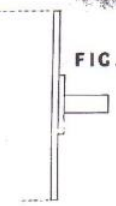


FIG. 2.



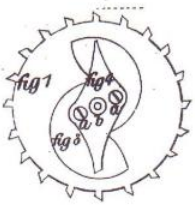


FIG. 6.

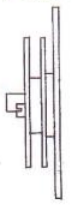


FIG. 3.

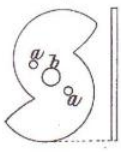


FIG. 4.

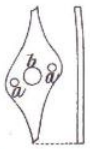
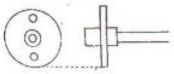


FIG. 5

FIG. 7.



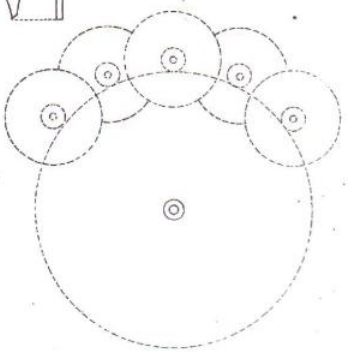


FIG. 15.

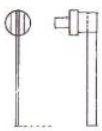
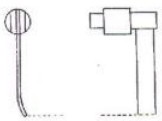
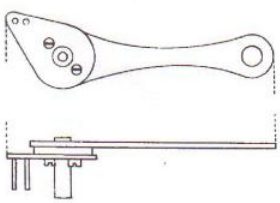


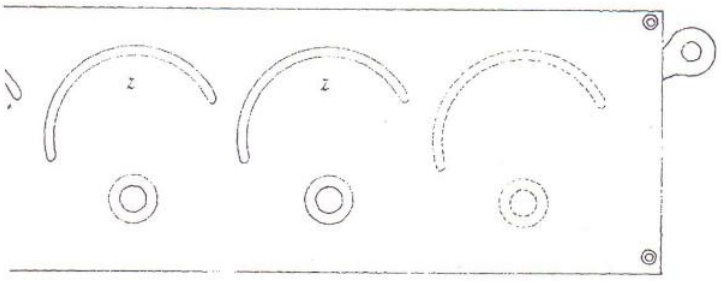
FIG. 11.

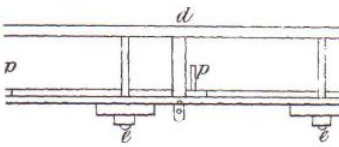




The enrolled drawing is colored

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1856.





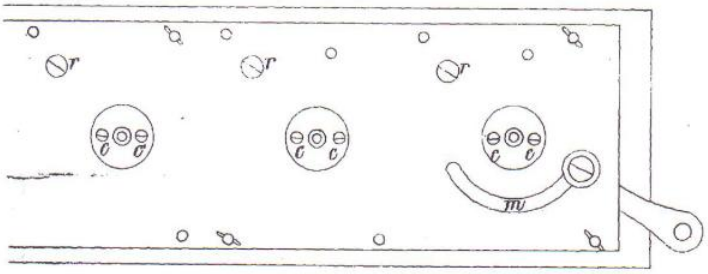


FIG. 17.

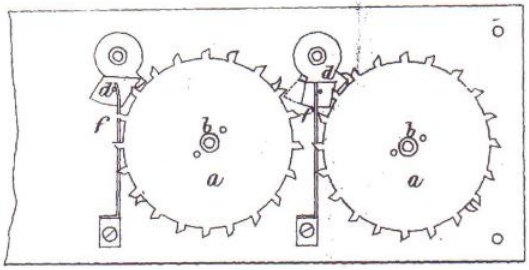
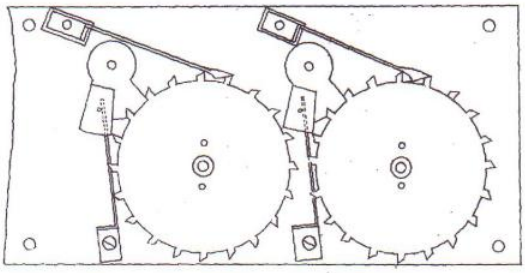


FIG. 16.



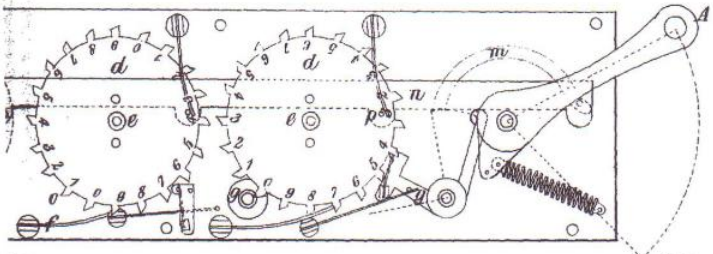


FIG. 30.

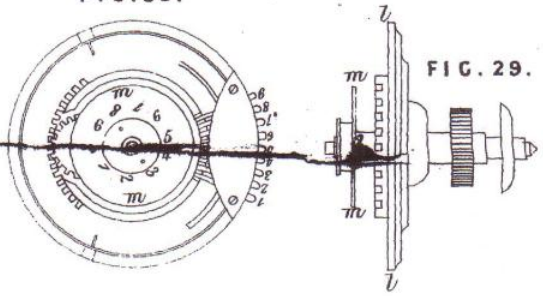
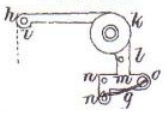


FIG. 29.

FIG. 12.



4.

FIG. 5

FIG. 7.

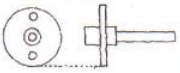


FIG. 13.

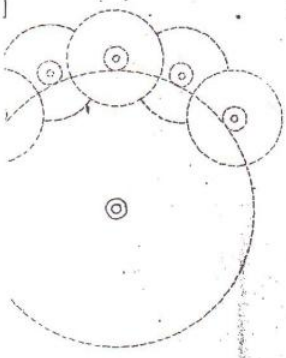


FIG. 14.

FIG. 19.

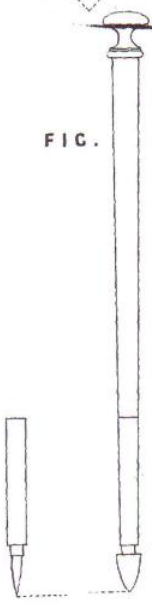
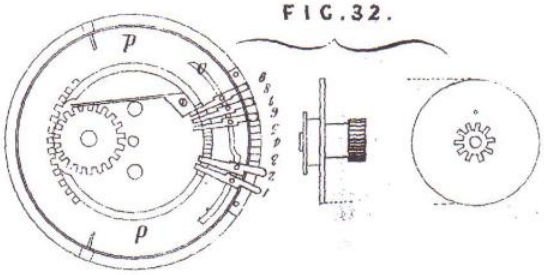


FIG. 32.



Drawn on Stone by Malby & Sons

William Spottiswoode.
ajesty. 1856.

FIG. 20.

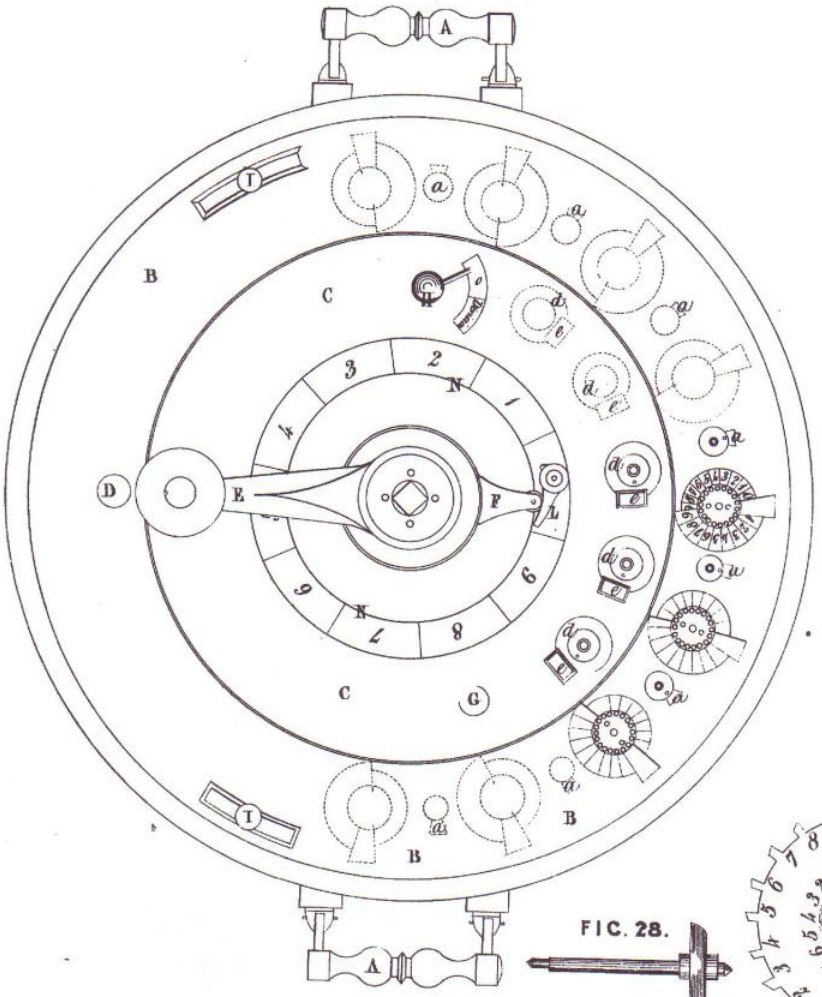


FIG. 21.

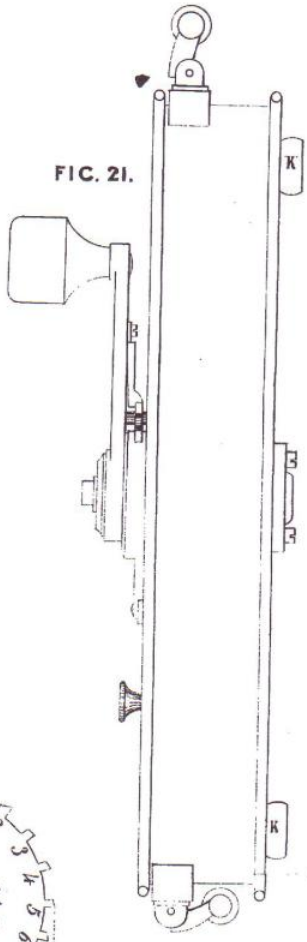


FIG. 3

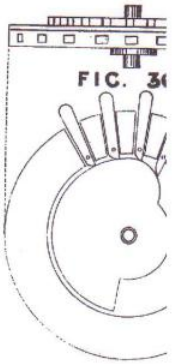


FIG. 35.

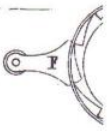


FIG. 28.

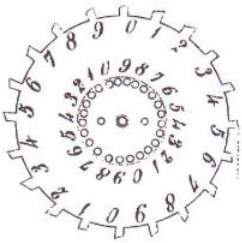


FIG. 24.

FIG. 23.

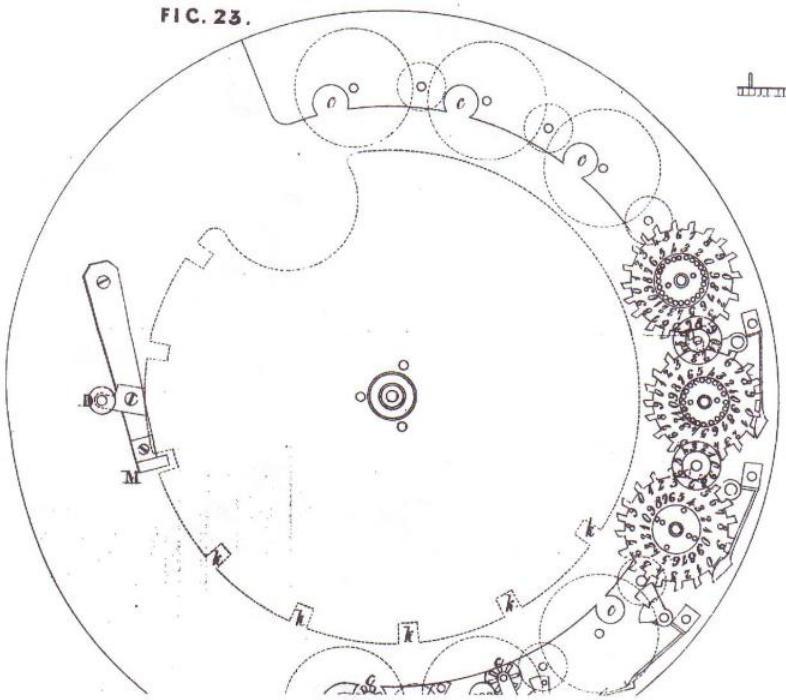


FIG. 25.

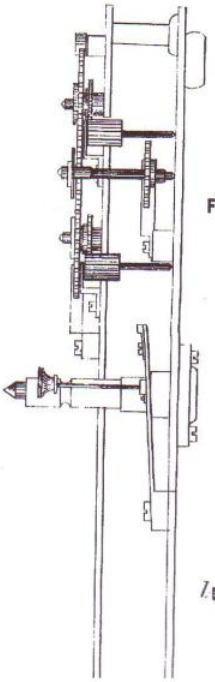


FIG 22.

FIG. 31.

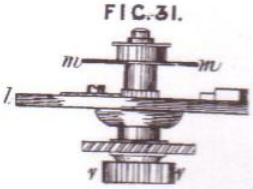


FIG. 36.

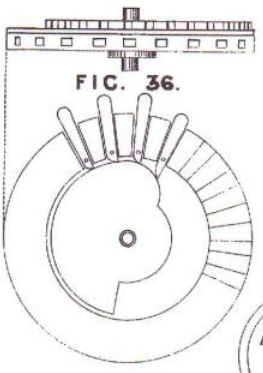


FIG. 26.

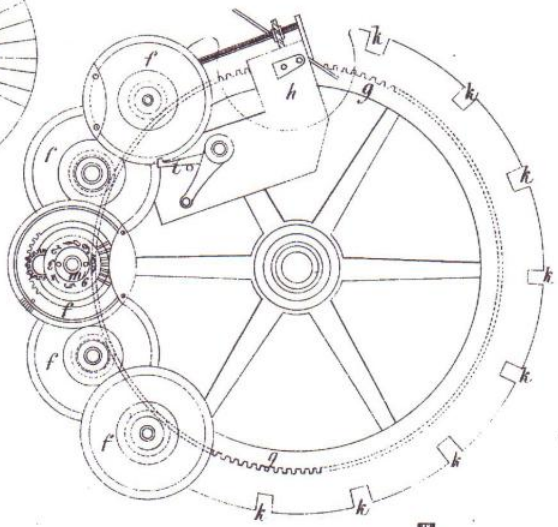


FIG. 34.

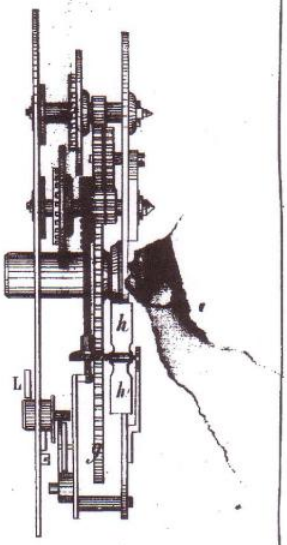


FIG. 35.

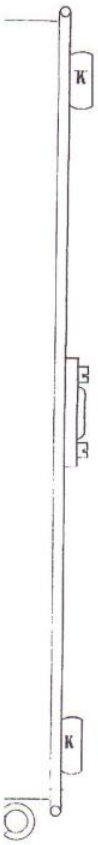
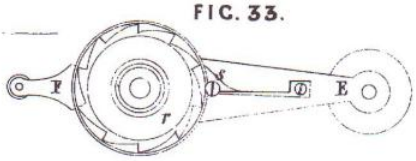


FIG. 33.



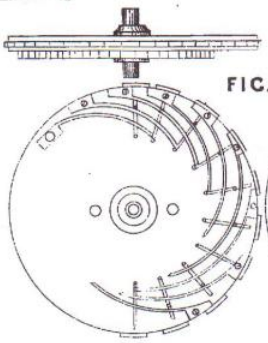
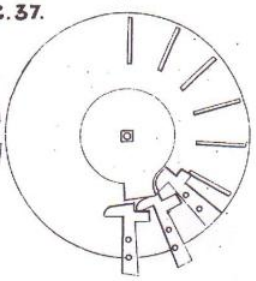


FIG. 37.



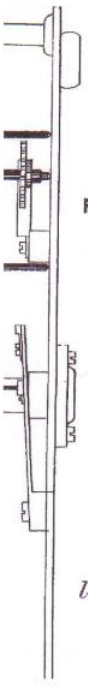


FIG. 25.

FIG. 27.

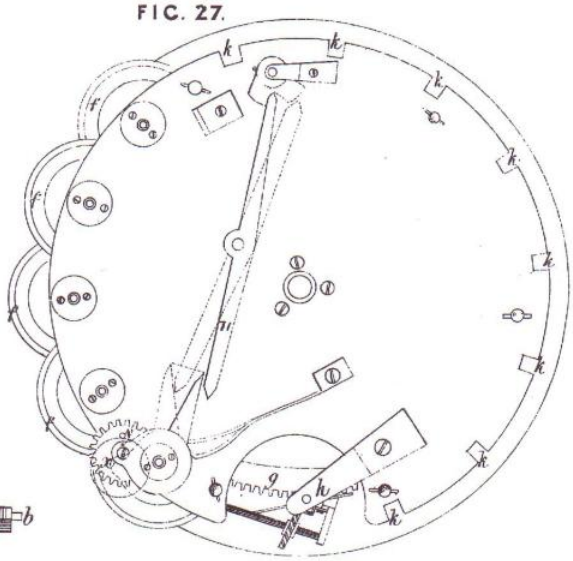
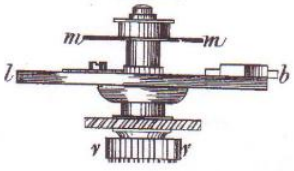
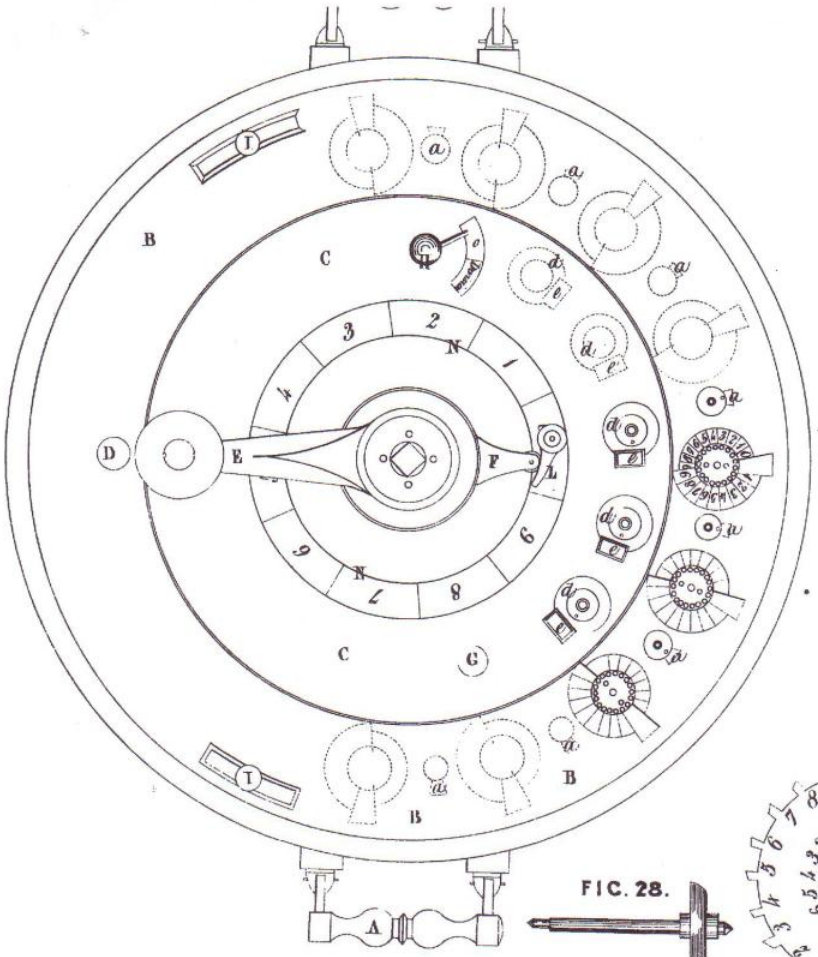
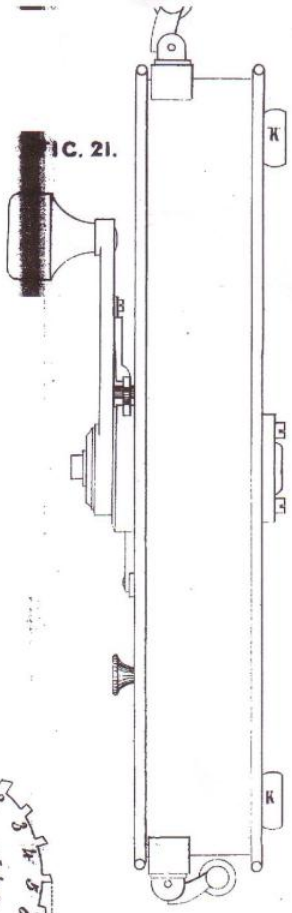


FIG. 31.

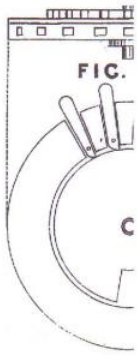




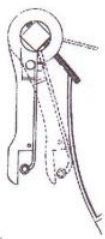
FIC. 21.



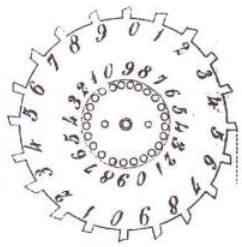
FIC.



FIC. 35.

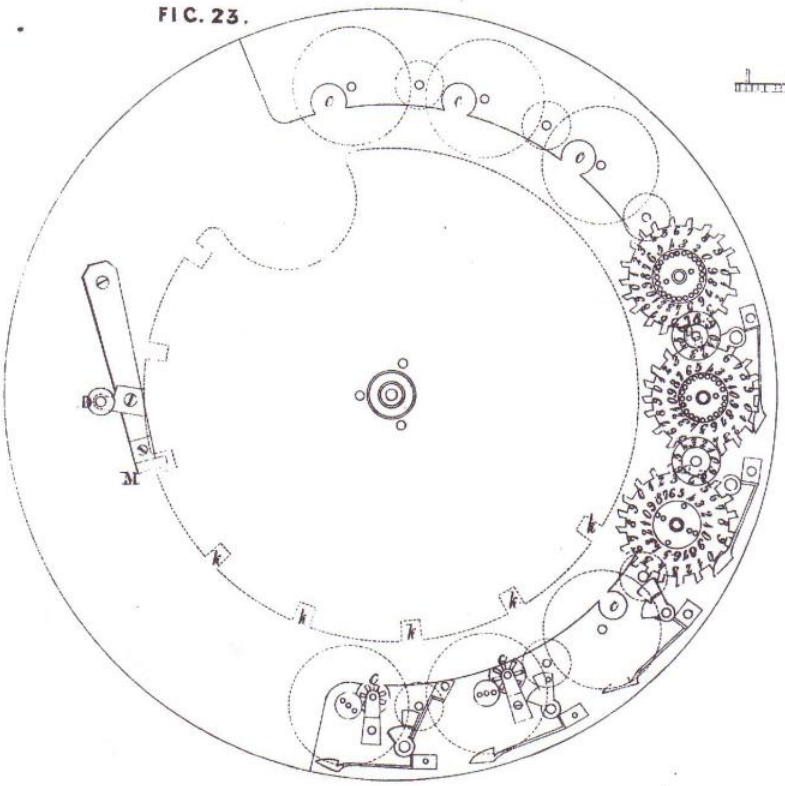


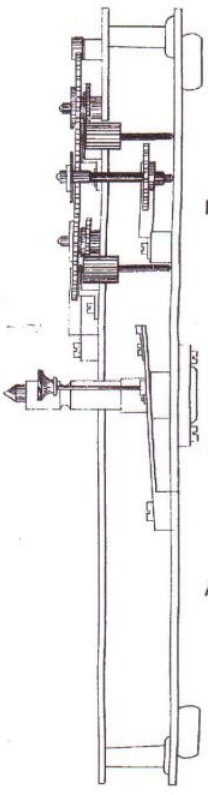
FIC. 28.



FIC. 24.

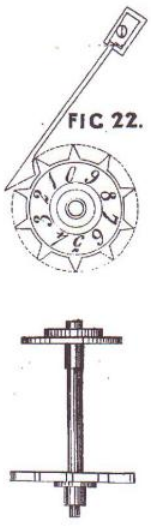
FIC. 23.



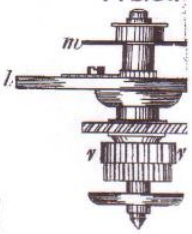


FIC. 25.

FIC. 22.



FIC. 31.



The enrolled drawing is not colored

LONDON: Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE, Printers to the Queen's most Excellent Majesty. 1856.

FIG. 21.

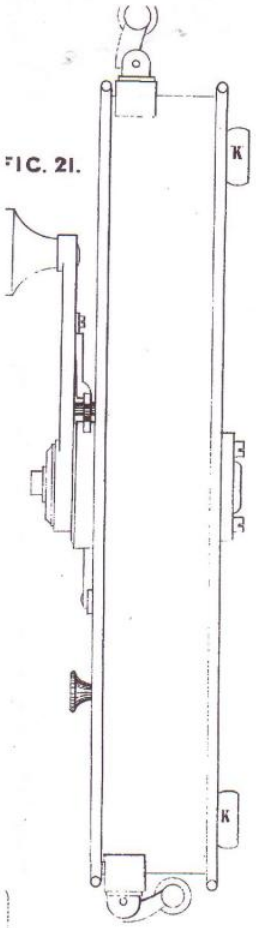


FIG. 36.

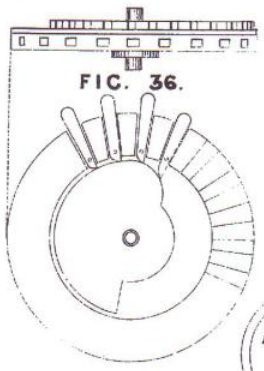


FIG. 26.

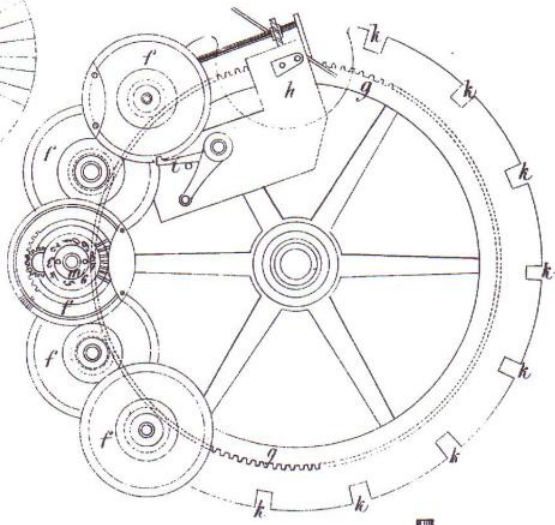


FIG. 34.

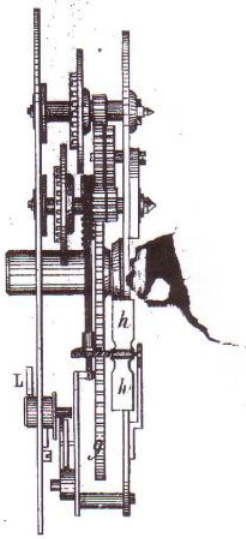


FIG. 35.

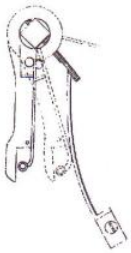


FIG. 37.

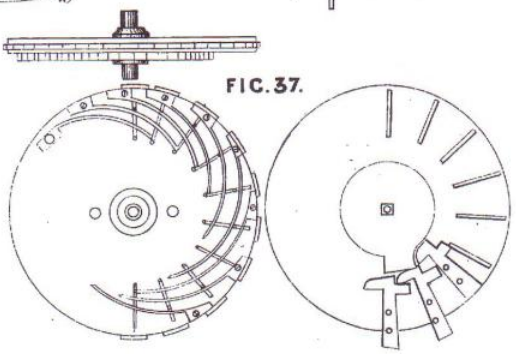


FIG. 33.

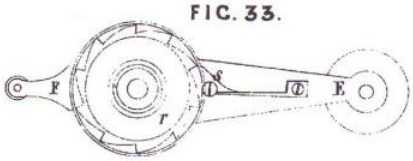


FIG. 25.

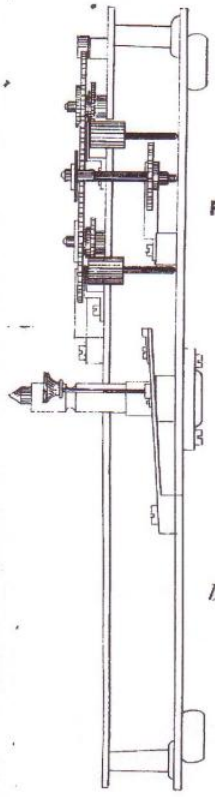


FIG. 27.

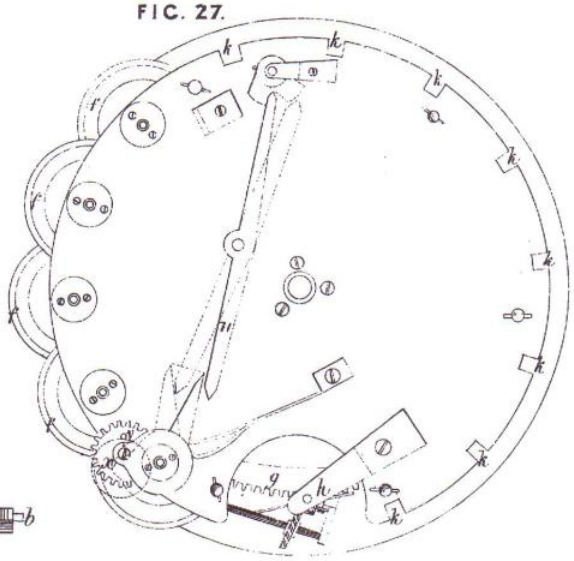
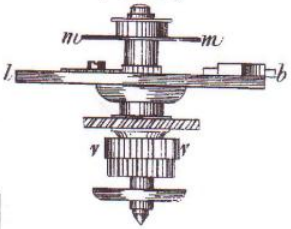


FIG. 31.



Drawn on Stone by Malby & Sons

GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
To the Queen's most Excellent Majesty. 1856.