1,075,003.

Fig.1.

Witnesses:
Thomas Durant
Pearl C. Thwaite

Inventors:
Mark Barr and
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1,075,003.

Fig. 2.

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M. BARR & E. R. CLARKE.
CALCULATING MACHINE.
APPLICATION FILED MAR. 26, 1910.

1,075,003.

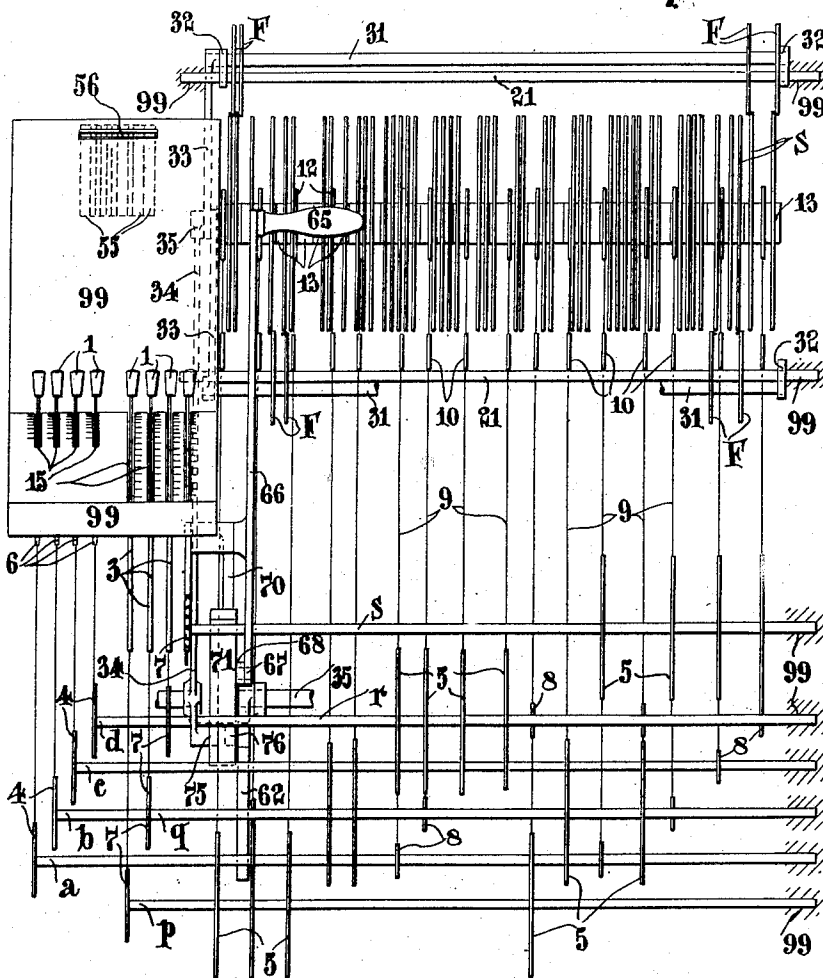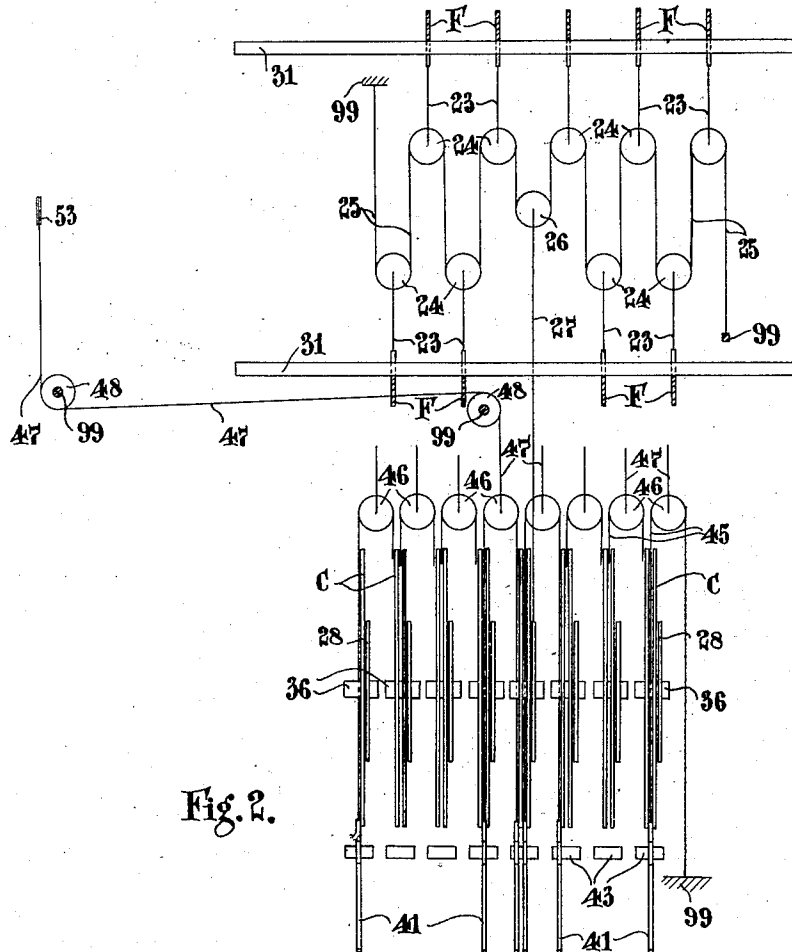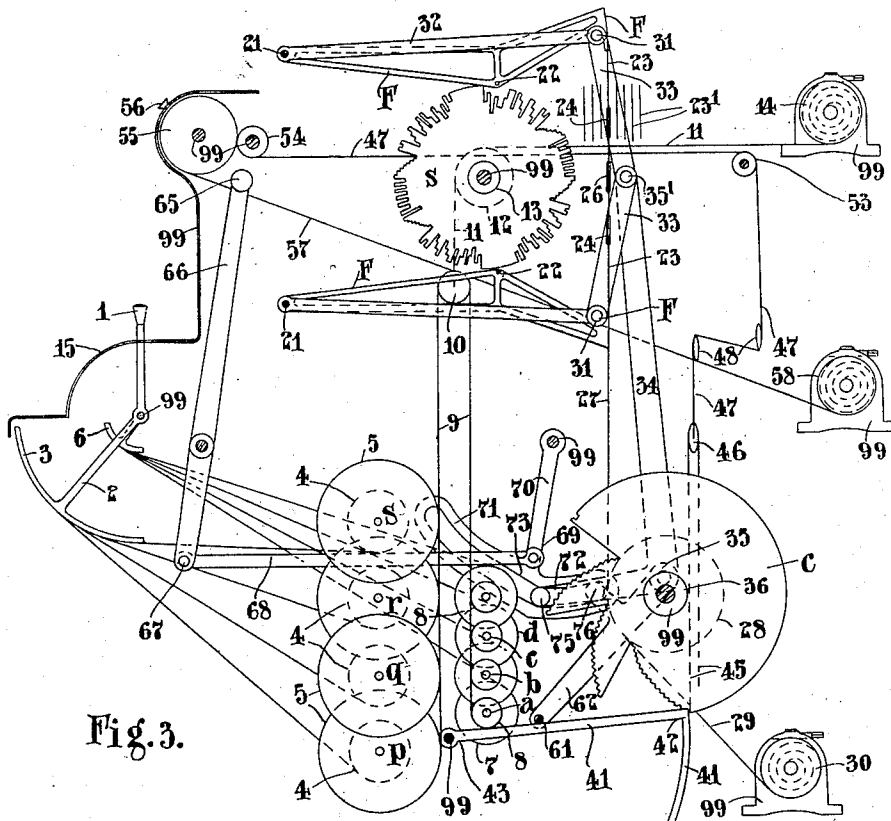Patented Oct. 7, 1913.
3 SHEETS—SHEET 3.

Fig. 3.

UNITED STATES PATENT OFFICE.

MARK BARR AND EDWARD RUSSELL CLARKE, OF LONDON, ENGLAND, ASSIGNORS, BY DIRECT AND MESNE ASSIGNMENTS, TO THE AUTOKAL SYNDICATE LIMITED, OF LONDON, ENGLAND.

CALCULATING-MACHINE.

To all whom it may concern.

Be it known that we, MARK BARR and EDWARD RUSSELL CLARKE, subjects of the King of Great Britain, and residents of London, England, have invented certain new and useful Improvements in Calculating-Machines; and we do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming a part of this specification, and to the figures and letters of reference marked thereon.

This invention relates to a machine which can be adapted for multiplying mere numbers, for example 9813 by 3296, and also for the multiplication of money values and the like expressed in a non-decimal system, for example 9813 articles at £17.15.6–15/16 each, or 9813 packages each weighing 5 tons, 19 cwts., 3 qrs., 21 lbs. Further it can be adapted for a calculation of the form 19 tons, 15 cwts., 3 qrs., 17 lbs. at £9.12.6. per cwt.

In the machine the subject of our invention, we use, as has already been proposed in such machines, mechanism which performs the process of multiplication by a method representing mechanically the arithmetical process of multiplication by partial products placed in appropriate columns, and then adding such columns to obtain the result.

Our invention differs from previous inventions (1) in providing simplified means for the setting of the mechanical representations of the various partial products into position for the performance of a particular operation, (2) in the means adopted for the summation of the partial products, whereby such summation is effected simultaneously, (3) and in the means for avoiding or greatly reducing the operations of "carrying" subsequent upon such addition.

The invention further consists in the adaptation of the known use of mechanical representations of all possible partial products, to the multiplication of quantities expressed in a compound system of units.

In operating the machine the subject of our invention, the setting up in the machine of the digits of the multiplier and multiplicand is caused to set the mechanical representations of the various partial products into the appropriate positions and then by moving an operating handle the said partial products are simultaneously added, and the result of the calculations is exhibited in the machine.

Throughout the specification the multiplier will be denoted by X and the multiplicand by Y and the digits of the multiplier by a, b, c, d, etc., and those of the multiplicand by p, q, r, s, etc.

The machine therefore has to deal with the partial products of abc things at a price of pqr. The complete multiplication as carried out in the machine the subject of this invention and working within the above limits requires mechanism to deal with the partial products which are all arranged mechanically in the machine in the appropriate columns to give them their correct significant figures. The principle of performing the process of multiplication by partial products placed in appropriate columns, and then adding such columns to obtain the result is the principle adopted in the machine the subject of this invention, but we do not claim this as part of our invention.

In order to carry this into effect in a machine a series of mechanical representations of the multiplication table are employed. Take for instance the multiplication table from 0×0 up to 9×9. This may be arranged in the form of two tables as shown in the accompanying table, where A represents the "units" and B the "tens" of the product of any such multiplication. The reason for splitting the multiplication into two parts, a "tens" part and a "units" part, is because the tens of the product has to be added in a different column from the "units" of the product, and is therefore best represented by a separate mechanical entity. Such a mechanical representation of the multiplication table from 0×0 to 9×9 is not in itself novel and a number of forms are known in which it may be made and which are fully set out in the U. S. Patent specification of Saunders No. 775,939.

Table A.

	0	1	2	3	4	5	6	7	8	9
0	0	0	0	0	0	0	0	0	0	0
1	0	1	2	3	4	5	6	7	8	9
2	0	2	4	6	8	10	2	4	6	8
3	0	3	6	9	2	5	8	1	4	7
4	0	4	8	2	6	0	4	8	2	6
5	0	5	0	5	0	5	0	5	0	5
6	0	6	2	8	4	0	6	2	8	4
7	0	7	4	1	8	5	2	9	6	3
8	0	8	6	4	2	0	8	6	4	2
9	0	9	8	7	6	5	4	3	2	1

"Units."

Table B.

	"Tens."									
	0	1	2	3	4	5	6	7	8	9
0............	0	0	0	0	0	0	0	0	0	0
1............	0	0	0	0	0	0	0	0	0	0
2............	0	0	0	0	0	1	1	1	1	1
3............	0	0	0	0	1	1	1	2	2	2
4............	0	0	0	1	1	2	2	2	3	3
5............	0	0	1	1	2	2	3	3	4	4
6............	0	0	1	1	2	3	3	4	4	5
7............	0	0	1	2	2	3	4	4	5	6
8............	0	0	1	2	3	4	4	5	6	7
9............	0	0	1	2	3	4	5	6	7	8

The form shown in the drawings consists of a series of steel disks called "templets" with slots cut in their peripheries to correspond with the figures in the foregoing table.

The "units" templet has the measured lengths shown in Table A, a "tens" templet the lengths shown in Table B. Each templet is provided with a feeler which is some mechanical arrangement for measuring the lengths presented to it by the corresponding templet and for transmitting the said length to another portion of the mechanism for the purpose of addition. Each group is so arranged that by setting its templets relative to its feelers in a position determined by the two factors of the partial product, the feelers are then made to engage with the templets and transmit the measured lengths corresponding to that product.

Taking the "units" templet A the numbers in Table A can be written 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 2, 4, 6, 8, 0, 2, 4, 6, 8, 0, 3, 6, 9, 2, 5, 8, 1, 4, 7, etc., the lengths being arranged side by side in a line, or around a circle in ten groups of ten numbers each. The feeler will then select a certain group and a certain position in a group. Thus to multiply 3 by 6 the feeler will select the third group and the sixth number in the group, reckoned from the initial or zero groups and positions respectively, and will feel the number 8 in the "units" division and the number 1 in the "tens" division.

Each templet is set by means of a movement representing an X digit, compounded with a movement representing a Y digit, and we provide means for supplying these movements to the templets simultaneously, by means of a differential pull on a pulley connected to the templets as hereinafter described.

In order that the various feelers in a column may simultaneously add their motions it is necessary to provide an arrangement in the machine by which all these motions can be added simultaneously. For adding the motions in a given column we arrange a wire, cable or tape, passing around a number of pulleys of which every alternate one is suitably mounted on the frame of the machine, and the others are connected one by one to, and are moved by, the various feelers of that column. The resultant pull of the tape will represent the added motions of that particular column. Or alternatively and preferably, in order to reduce the number of pulleys, the various feelers of a column may be arranged on opposite sides of the templets the wire, cable, or tape passing over pulleys alternately suspended from feelers on opposite sides of the templets, and over a "sum pulley," the movements of which will be equal to the added movements of the feelers of that particular column. The pulleys for any particular column are preferably arranged to move in a vertical plane, for which purpose the feelers are mounted on a pair of spindles parallel to the axis of the templets, and the end of each feeler is a circular arc having its center on the axis of the spindle. Each feeler has its corresponding pulley suspended by a wire or tape in contact with its circular end. The ends of the wire passing over the various feeler pulleys and over the sum pulley may be fixed to the frame, or the said wire may be an endless loop, two or more guide pulleys as found necessary mounted on the frame being added to the system. In any case, the arrangement of the "wave wire," as it may be called, is such that each straight portion passing from one pulley to another is vertical, whatever be the position of the feelers and their dependent pulleys. The additions of the various columns are therefore represented in the machine by a definite movement of a part of the machine, one such part corresponding to each column. For convenience of description these movements are called "column pulls," although there is no need for the motion to be a pull, as it can also be a push, or a twist or a rotation. It is clear that if the pulls thus produced by adding the various feeler movements are transferred to the wheels of an indicating mechanism, arranged with a wheel corresponding to each column, and provided with carrying arrangements in the usual manner, that the final total will be correctly indicated by such wheels. It will be seen however that a considerable amount of carrying may be necessary, and as this involves a number of rotations of the indicating wheels, it may be desirable if possible to avoid such carrying. By our invention we are enabled to avoid such carrying, or at any rate to largely reduce it in the following way:— Instead of transferring the column pulls direct to the indicating mechanism we may arrange that each column pull shall operate to position a "secondary templet." The function of each templet is to convert the movement of the column sum pulley as far as possible into terms of a higher denomination. The secondary templets are not multi-

plication tables, but they merely operate to transfer the tens digit and units digit of any column pull into the appropriate column. Each secondary templet has two divisions, one for the units digit and one for the tens digit of that column pull. Thus if the column pull is 57 units, the two templets are rotated or otherwise positioned through 57 units, and in this position the tens templet presents the measured length 5 units and the units templet presents the measured length 7 units to the respective feelers of the secondary templet. If the column pull immediately to the left is 46 units, the two templets of the corresponding column group of templets are rotated or otherwise positioned through 46 units, and in this position the tens and units templets present the measured length 4 units and 6 units to their respective feelers. The 5 units movement from the tens feeler of the first mentioned column templet group has to be added to the six units movement from the units feeler of the column templet group immediately to the left, and the sum transmitted to the indicating or " answer wheels " or " type wheels " as they are hereinafter called. It will be seen that in no case is it necessary to carry more than 1 from any column to the next column to the left. Thus the type wheels can be numbered around their circumference 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, 1, 2, 3, 4, 5, as far as may be necessary for any particular type wheel. If any type wheel is rotated beyond the number 9, arrangements are made so that the next type wheel to the left is advanced by unity. Thus it will be seen that no indicating or type wheel ever makes a complete revolution. This is a great advantage as the resetting of the type wheels is greatly simplified thereby and wear is reduced to a minimum.

The processes gone through in the machine may be summarized as follows:—1. The multiplier and multiplicand are set up, thereby setting the templets in position. 2. The templets are measured or felt, thereby causing a column pull to set each secondary templet. 3. The secondary templets are felt, thereby causing a measured pull on the indicating wheels, which are advanced or not by unity according as the wheel to the right has passed the 9 position or not.

The accompanying drawings illustrate a machine constructed in accordance with this invention certain parts, which are merely constructional and have no bearing on the features of the invention, being omitted for the sake of clearness.

In these drawings, Figure 1 is a front elevation of the machine showing mainly those parts of the mechanism which lie toward the front. Fig. 2 is a similar elevation showing those parts of the mechanism which lie to-

ward the back of the machine. In full front elevation the parts shown in Fig. 1 would appear superimposed on the parts shown in Fig. 2. Fig. 3 is an end elevation.

Like letters indicate like parts throughout the drawings.

The machine hereinafter more particularly described and illustrated is intended for calculating the value of any number of articles up to 9999 at any price ranging from 1/16th of a penny up to £19.19.11 15/16ths of a penny.

The digits of the multiplier and of the multiplicand are set up by means of handles 1, 1^a, on bell crank levers 2. These handles, which in the present machine are eight in number, are disposed in two groups of four the handles 1 in one of these groups being intended for controlling or setting up the price while the handles 1^a in the other group are intended for setting up a quantity. All these handles work in slots 15 cut in a suitable cover 99^a mounted on the frame 99. Each bell-crank lever 2 for setting up a price carries a circular arc 3 while each bell-crank lever for setting up a quantity carries a circular arc or quadrant 6 the latter being of smaller radius than the circular arcs 3. To the circular arcs 3 are attached wires 3^a which run to and pass around pulleys or drums 4 mounted on shafts p, q, r, s. The arcs 6 are similarly connected by wires 6^a with pulleys or arms 7 mounted on shafts a, b, c, d. Thus by moving one of the handles 1 and setting it in accordance with a digit representative of price one of the pulleys 4 will be rotated to an amount corresponding to that price digit. Similarly if a handle 1^a is moved and set in accordance with a digit representative of quantity one of the pulleys 7 will be rotated to an amount corresponding to that quantity digit. The edges of the slots 15 are suitably engraved with numbers and mechanism is provided for retaining each lever in any position in which it is set such mechanism being of any suitable type but not being indicated in the drawings. Mounted on each shaft p, q, r, s, are four pulleys 5 the diameter of each of which is larger than that of the pulley 4. Mounted on each of the shafts a, b, c, d, are four pulleys 8 the diameter of each of which is less than the diameter of the pulley 7. The pulleys 5 and 8 are arranged in pairs so that one pulley 5 and one pulley 8 making up a pair lie in one and the same vertical plane the arrangement being shown in Fig. 1. A wire 9 which passes over a pulley 10 has its ends connected respectively to a pulley 5 and a pulley 8 forming one of these pairs and the pulleys in each pair are similarly connected. Each pulley 10 is suspended by a wire 11 from a pulley 12 which may be termed a primary templet pulley.

This wire 11 may be either connected to and wound on this pulley 12 or may pass over it in the manner indicated in Fig. 3 the end of the wire 11 in this case being wound on a spring controlled drum 14. The latter tends to maintain in tension the wires 11 and 9 and the wires 3ᵃ and 6ᵃ leading from the setting levers 2. The setting of a handle 1 and a handle 1ᵃ, will result in each end of a wire 9 being let out and this will cause rotation of a primary templet pulley 12. Owing to the relative dimensions of the radii of the circular arcs 3 and 6 and the relative diameters of the pulleys 4 and 5 and of the pulley wheels 7 and 8, that end of the wire 9 which is connected to a price pulley 5 will be let out by large increments while the end of the wire 9 which is connected to a quantity pulley 8 will be let out by relatively small increments. The extent to which a primary templet pulley 12 is rotated as a result of letting out the ends of a wire 9 in the manner described, will be a measure of the product of multiplying together the price at which the handle 1 has been set and the quantity at which the handle 1ᵃ has been set which setting has resulted in the letting out of the ends of the wire 9.

The normal position of the handles 1 and 1ᵃ is at zero the position of the corresponding primary templet pulleys 12 being consequently also at zero.

Each primary templet pulley 12 is connected to one or more primary templets S which form a group of these templets, the templets in this group and the corresponding pulley 12 being conveniently mounted on a sleeve 13. All these sleeves 13 with their pulleys 12 and groups of templets S carried by them are freely rotatable on a common shaft 99ᵇ.

A series of levers F constituting feelers are arranged in two sets one set pivoted on a shaft 21 being disposed above the groups of templets S while the other set pivoted on a shaft 21ᵃ is disposed below the groups of templets S. There is a feeler F for each templet S each feeler having a pin 22 which is adapted to enter and feel the depth of any slot in its corresponding templet according to the rotary positioning of this templet. The templets are spaced far enough apart from each other to allow the feelers F to move between them. The slots in the templets are cut to circular arcs having their centers at the axis of oscillation 21 or 21ᵃ of the feelers. The templet S shown in Fig. 3 has its slots cut to correspond with one of the upper feelers F. The object in disposing some of the feelers below and some above the templets is to economize space.

The end of each feeler remote from its axis of oscillation 21 or 21ᵃ is a circular arc to which is connected a wire 23 at the end of which is suspended a feeler pulley 24. In Fig. 2 are shown the feelers and feeler pulleys 24 corresponding to the pounds column. It will be seen that five of these feelers are positioned above and four below the templets with which they respectively coöperate. A wire 25 having its two ends suitably fastened to the frame 99 passes over the various feeler pulleys 24 and over a pulley 26 which may be termed the sum pulley. The sum pulley 26 supports a wire 27 which passes over a secondary templet pulley 28 another wire 29 or a continuation of the wire 27 extending from the periphery of the pulley 28 to a spring controlled pulley 30 by means of which the necessary tension is maintained in these wires. The feeler pulleys 24, the sum pulley 26, the wire 25 and the wire 27 all lie in the same vertical plane. This group of pulleys such as the pounds group shown in Fig. 2 constitutes the means by which are added together the several partial products ascertained by the feelers F from the primary templets S with which they respectively coöperate. The corresponding adding system for each of the other columns or values such as the shillings and pence each lie in separate parallel planes as indicated in Fig. 3 by the dotted lines 23′. For this purpose the circular arc ends of the feelers F are made of radii to correspond with the particular plane of the corresponding column addition system the radii of the secondary templet pulleys 28 being proportioned to counteract the inequality so produced.

The feelers F are normally held away from the primary templets S in the positions shown in Fig. 3 by means of two control rods 31 on which the feelers rest. The ends of each rod 31 are suspended by two radius bars 32, each pair of radius bars being suitably mounted respectively on the shafts 21 and 21ᵃ. Toggle links 33 are jointed to the ends of the radius bars 32 and to the end of a bell-crank lever 34 which is mounted so as to rock on the shaft 35. The wires 23, 25, 27 and 29 being under tension from the spring pulley 30 it will be clear that if the bell-crank lever 34 is moved to the right the two feeler control bars 31 will move toward the axis of the templets S and consequently all the feelers F will be pulled toward these templets until the feeler pins 22 come to the bottoms of the slots presented by their respective templets.

Each secondary templet group has two templets C though for hundreds of pounds only one templet may be needed. In each case the two templets and the corresponding pulley 28 are mounted on a sleeve 36 so that they all turn together and all the groups are mounted so as to be capable of independent rotation on a common shaft 99ᶜ suitably fastened to the frame. Each secondary templet

C is provided with a feeler 41 which carries a feeler pin 42. The outer end of each feeler terminates in a circular arc while the other end is formed as a boss 43, the bosses of all the feelers 41 being mounted and freely rotatable on a common shaft 99ᵈ. The feelers 41 are held inoperative by means of a rod 61 carried on the ends of levers 62 pivoted conveniently on the same axis as but independent of the lever 34.

To the arc shaped end of each feeler 41 is attached the end of a wire 45. Each of these wires 45 passes around a pulley 46 suspended from the end of a wire 47 leading to an indicating wheel or segment the arrangement being such that the feeler movements after the positioning of two secondary templets having the same denomination or value are added and transmitted to the indicating wheel or segment by the wire 47. A modification of this arrangement occurs in connection with the secondary templet which deals with fractions of a penny which templet is shown at the right hand side of Fig. 2. Here one end of the wire 45 is attached to the frame 99, the other end being connected to the feeler 41 for this secondary templet. Were it not for the unit carry the movement of each wire 47 might be transferred direct to the appropriate answer wheel 55 but this movement has often to be increased by unity. The various answer wheels 55 must necessarily lie side by side on a common axis suitably mounted on the frame as indicated in Fig. 1. Each wire 47 as in the construction illustrated in Figs. 2 and 3 may therefore have to be led over two guide pulleys 48 and over two other guide pulleys 53 and 54 shown in Fig. 3 on its way to the answer wheel 55. The various guide pulleys 53 for all the wires 47 of the various secondary templets may be mounted on a common axis. Similarly the various guide pulleys 54 may be mounted on a common axis but it is not usually possible to mount the various guide pulleys 48 on a common axis.

A view window 56 formed in the casing 99ᵃ attached to the frame enables the operator to see the appropriate figure on the answer wheels. From each answer wheel a wire 57 is led to a spring controlled pulley 58 mounted on the frame 99. As the wires 45, 47 and 57 are under tension produced by the spring controlled pulley 58, when the various feelers 41 are allowed to approach their respective secondary templets C the answer wheels 55 move into their appropriate positions the correction necessary for the transfer of unit carry having then to be effected. The mechanism by which the transfer of unit carry is effected may be in any one of the forms at present well known such mechanism not forming any part of the present invention.

After the digits of the multiplier and multiplicand are set up by movement of the handles 1 and 1ᵃ, the movements of the primary templet feelers F, of the secondary templet feelers 41 and of the indicating wheels 55 to their proper positions are performed by means of the mechanism already described when the operator pulls the operating handle 65 toward the front of the machine. This handle is fixed to the end of the double-armed lever 66, 67 suitably mounted on the frame. Jointed to the end 67 of this lever is a connecting link 68 the other end of which is jointed at 69 to a slotted cam 70 pivoted to the frame at 99ᵉ. The cam surface consists of two arc-shaped slots 71 and 72 of different radii united by an inclined part 73. In the normal non-calculating position of the operating handle 65 two pins 75 and 76 respectively fixed to or integral with the bell-crank lever 34 and the lever 62 rest in that portion 72 of the cam slot which has the larger radius. On pulling the operating handle to the front the pin 75 is forced to slide up the inclined surface 73 the consequent raising of the pin 75 moving the lever 34 in the direction which permits the feelers F to move inward toward the primary templets S. This results in the secondary templets C taking up their appropriate positions in the manner already described. During the latter part of the forward movement of the operating handle 65 the pin 75 having moved into that slot 71 which has the smaller radius the lever 34 remains stationary. In the meantime however the pin 76 is forced to move up the inclined surface 73 thus moving the lever 62 and permitting the feelers 41 to move into contact with their respective secondary templets and allowing the answers to be transmitted in the manner already described to the indicating wheels 55. Upon moving the operating handle 65 away from the front of the machine the above motions are reversed thus successively setting the feelers 41 into their normal positions clear of the secondary templets C and resetting the indicating wheels to zero and then setting the feelers F into their normal positions clear of the primary templets S. The setting handles 1 and 1ᵃ can then be placed at zero or moved into the necessary positions to carry out a new calculation.

In operating the machine the first process will be to pull or set the handles or keys corresponding to the price three shillings and fourpence and then the handles corresponding to the number 25. The initial result of setting these several handles may be detailed. By setting the pence handle at fourpence the wire connecting the lever 2 to the drum on the shaft r is let out thereby permitting rotation of the shaft r together

1,075,008

with each of the pulleys 5 mounted thereon to the extent of four increments each equivalent to one penny. This will cause that end of each wire 9 which is connected to a pulley 5 on the shaft r to be similarly let out to the extent of four penny increments. In consequence of the wires 9 being let out each pulley 10 will rise to a corresponding extent and each primary templet group S will 10 be rotated so as to position each templet in this group in readiness to present to its feeler the division corresponding to the price of each article. For example in the case in question the first primary templet in 15 the pence group will be turned until the feeler is in the zero position at the commencement of the division which is graduated or slotted for the price of 0 to 9 articles at four pence each. The feeler at this stage 20 will be opposite the zero point in this division of the templet because no quantity handle has so far been moved. In other words the templet in question is set for the price of 0 articles at fourpence each. It will 25 be understood that by setting the shillings price handle at three shillings a similar operation will be performed the shaft q being rotated as a result of letting out one of the wires 3ᵃ and the rotation of this shaft q 30 will cause rotation of the pulleys or drums 5 thereon causing letting out of the ends of the wires 9 connected thereto. Positioning of certain primary templets will then take place one of these templets for example be- 35 ing set with its feeler opposite the zero position of the division of the templet corresponding to 0 to 9 articles at three shillings each. One of the quantity handles is now set at 5 with the result that one of the wires 40 6ᵃ is let out to the extent of five increments causing rotation of the shaft b together with the pulleys 8 thereon. This will bring about the letting out to the extent of five increments of the other ends of certain of 45 the wires 9 and the consequence will be a further rising of each of the pulleys 10 around which each of these wires 9 passes and a further setting of each of the primary templets S in a group controlled by the pul- 50 ley 10. Thus in the case of the pence templet already referred to as having been set in the position for 0 articles at four pence this templet will be rotated five steps, so as to bring opposite to its feeler pin 22 the slot 55 corresponding to the price of five articles at fourpence, that is to say one shilling and eightpence. The slot in this templet presented to the feeler will only allow the feeler to move a distance corresponding to the sum 60 of eightpence the shillings templet in the same group being positioned for its feeler to move when released to the extent of one shilling. In the same way the other templets which have been partly positioned as 65 already described as a result of setting the

price handle at three shillings will receive further movement so that five times three shillings that is to say fifteen shillings will be felt on the shillings templet when the feeler is released. Finally the quantity 70 handle for twenty will be set and the shaft c rotated to the extend of twenty increments the result being the setting of primary templets for twenty articles at fourpence that is to say six shillings and eightpence and 75 for twenty articles at three shillings that is to say three pounds. The following multiplication sums will then have been satisfactorily performed by the machine:

(1.) 5 articles at 4d_____ 1s. 8d. 80
(2.) 20 articles at 4d_____ 6s. 8d.
(3.) 5 articles at 3s_____ 15s. 0d.
(4.) 20 articles at 3s_____ £3. 0s. 0d.

The total of these several sums when 85 added together amounts to £3. 22s. 16d. and is arrived at and dealt with after the feelers are in operation as hereinafter described. The actual positioning of the groups of primary templets may however be enumerated. 90

The first group of primary templets which deals with multiples of fractions of a penny are not in operation as no fraction of a penny enters into the sum which is being here considered. 95

The first sum (1) will be performed in positioning the second group of primary templets, the sum of 1s. being positioned on the shillings templet in this group and the sum of 8d. being indicated on the pence tem- 100 plet in this group.

The second sum will be performed in positioning the third group of primary templets, no pounds being positioned on the pounds templet, the sum of 6s. being posi- 105 tioned on the shillings templet and the sum of 8d. being positioned on the pence templet.

The third sum will be performed in positioning the fourth group of primary templets no pounds being positioned on the 110 pounds templet and the sum of 15s. being positioned on the shillings templet.

The fourth sum will be performed in positioning the fifth group of primary templets, no pounds being positioned on the tens of 115 pounds templets, £3. being positioned on the unit pounds templet and no shillings being positioned on the ten shillings templet. The feelers are now brought into operation and ascertain from the positioned primary tem- 120 plet groups the several products of these sums. The movement of the feelers causes movement in the several pulley groups with the result that addition takes place in these groups. 125

In the first group of pence pulleys the addition of the pence is performed, the total being sixteen pence and the first group of secondary templets is positioned to indicate 1s. 4d. 130

In the second group of shillings pulleys the additions of the shillings is performed, the total being twenty two shillings and the second group of secondary templets is positioned to indicate £1. 2s.

In the third group of unit pounds pulleys there is no addition to be performed but a letting out of the tape passing over this group of pulleys takes place corresponding to the sum of £3. and the third group of secondary templets is positioned to indicate £3. Feelers are now brought into operation on the secondary templet groups and the pence feeler sets the answer wheel at 4d. The shillings feeler in the first group of secondary templets indicates 1s. and the shillings feeler in the second group of secondary templets indicates 2s. with the result that the tape connected to the shillings answer wheel is let out to an extent such as to position that answer wheel at 3s. Similarly the pounds feeler in the second group of secondary templets indicates £1. while the unit pounds feeler in the third group of secondary templets indicates £3. with the result that these figures are added together and the unit pounds answer wheel is positioned at £4.

Thus the answer is presented on the answer wheels as £4. 3s. 4d.

What we claim as our invention and desire to secure by Letters Patent is:—

1. In a calculating machine the combination of a series of primary templets disposed in groups, means for positioning each group in accordance with the partial products of sums determined by setting means, feelers adapted to ascertain the amounts represented by the positioned primary templets, a series of secondary templets disposed in groups, means for adding the amounts ascertained by the primary feelers and for positioning the secondary templets in accordance with the resultant sums so ascertained and means for setting a series of answer wheels in accordance with the amounts represented by the positioned secondary templets.

2. In a calculating machine the combination of a series of primary templets disposed in groups, means for positioning each group in accordance with the partial products of sums determined by setting means, feelers adapted to ascertain the amounts represented by the positioned primary templets, a series of secondary templets disposed in groups, a series of pulley groups each group being composed of one or more pulleys each connected to a primary templet feeler and a pulley connected to a group of secondary templets, a series of tapes the ends of which are fixed, each tape passing around all the pulleys in a group and means for setting a series of answer wheels in accordance with the amounts represented by the positioned secondary templets.

3. In a calculating machine the combination of a series of primary templets disposed in groups each group adapted to be positioned by means of a tape on the end of which is a pulley, a tape passing over each of these pulleys and having each end connected to a rotatable device, means for rotating each such device to an extent to the value of an operated key, a series of keys, means for feeling the primary templets when positioned, means for adding together the amounts ascertained by the feelers and means for communicating the result so obtained to a series of answer wheels.

4. In a calculating machine the combination of a series of primary templets disposed in groups, means for positioning each group in accordance with the partial products of sums determined by setting means, feelers adapted to ascertain the amounts represented by the positioned primary templets, a series of secondary templets disposed in groups, feelers adapted to ascertain the amounts represented by the positioned secondary templets, means for adding the amounts ascertained by the primary feelers and for positioning the secondary templets in accordance with the resultant sums, a series of answer wheels, pulleys connected to certain of the answer wheels, tapes connecting certain secondary feelers to their corresponding answer wheels and other tapes severally running over answer wheel pulleys and serving to connect certain secondary feelers so as to add the amounts ascertained by them and cause the corresponding answer wheels to be set in accordance with the result of such addition.

5. In a calculating machine the combination of a series of primary templets disposed in groups, each group adapted to be positioned by means of a tape on the end of which is a pulley, a tape passing over each of these pulleys and having each end connected to a rotatable device, means for rotating each such device to an extent proportional to the value of an operated key, a series of keys, feelers adapted to ascertain the amounts represented by the positioned primary templets, a series of secondary templets disposed in groups, means for adding the amounts ascertained by the primary feelers and for positioning the secondary templets in accordance with the resultant sums and means for setting a series of answer wheels in accordance with the amounts represented by the positioned secondary templets.

6. In a calculating machine the combination of a series of primary templets disposed in groups each group adapted to be positioned by means of a tape on the end of which is a pulley, a tape passing over each of these pulleys and having each end connected to a rotatable device, means for ro-

tating each such device to an extent proportional to the value of an operated key, a series of keys, feelers adapted to ascertain the amounts represented by the positioned primary templets, a series of secondary templets disposed in groups, a series of pulley groups each group being composed of one or more pulleys each connected to a primary templet feeler and a pulley connected to a group of secondary templets, a series of tapes the ends of which are fixed each tape passing around all the pulleys in a group and means for setting a series of answer wheels in accordance with the amounts represented by the positioned secondary templets.

7. In a calculating machine the combination of a series of primary templets disposed in groups, means for positioning each group in accordance with the partial products of sums determined by setting means, feelers adapted to ascertain the amounts represented by the positioned primary templets, a series of secondary templets disposed in groups, feelers adapted to ascertain the amounts represented by the positioned secondary templets, a series of pulley groups each group being composed of one or more pulleys each connected to a primary templet feeler and a pulley connected to a group of secondary templets, a series of tapes the ends of which are fixed, each tape passing around all the pulleys in a group, a series of answer wheels, pulleys connected to certain of the answer wheels, tapes connecting certain secondary feelers to their corresponding answer wheels and other tapes severally running over answer wheel pulleys and serving to connect certain secondary feelers so as to add the amounts ascertained by them and cause the corresponding answer wheels to be set in accordance with the result of such addition.

8. In a calculating machine the combination of a series of primary templets disposed in groups each group adapted to be positioned by means of a tape on the end of which is a pulley, a tape passing over each of these pulleys and having each end connected to a rotatable device, means for rotating each such device to an extent proportional to the value of an operated key, a series of keys, feelers adapted to ascertain the amounts represented by the positioned primary templets, a series of secondary templets disposed in groups, feelers adapted to ascertain the amounts represented by the positioned secondary templets, a series of pulley groups each group being composed of one or more pulleys each connected to a primary templet feeler and a pulley connected to a group of secondary templets, a series of tapes the ends of which are fixed each tape passing around all the pulleys in a group, a series of answer wheels,

pulleys connected to certain of the answer wheels, tapes connecting certain secondary feelers to their corresponding answer wheels and other tapes severally running over answer wheel pulleys and serving to connect certain secondary feelers so as to add the amounts ascertained by them and cause the corresponding answer wheels to be set in accordance with the result of such addition.

9. In a calculating machine the combination of a series of keys of which some designate price and others designate quantity, rotatable devices corresponding to the price keys each of such devices being constructed to increase the movement transmitted through it, rotatable devices corresponding to the quantity keys each of such devices being constructed to increase the movement transmitted through it, means for rotating each such device to an extent proportional to the value of an operated key, a series of primary templets disposed in groups each templet adapted to be positioned by means of a tape on the end of which is a pulley, a tape passing over each of these pulleys and having one end connected to one of the rotatable devices controlled by a price key and the other end connected to one of the rotatable devices controlled by a quantity key, feelers adapted to ascertain the amounts represented by the positioned primary templets, a series of secondary templets disposed in groups, means for adding the amounts ascertained by the primary feelers and for positioning the secondary templets in accordance with the resultant sums and means for setting a series of answer wheels in accordance with the amounts represented by the positioned secondary templets.

10. In a calculating machine the combination of a series of keys of which some designate price and others designate quantity, rotatable devices corresponding to the price keys each of such devices being constructed to increase the movement transmitted through it, rotatable devices corresponding to the quantity keys each of such devices being constructed to decrease the movement transmitted through it, means for rotating each such device to an extent proportional to the value of an operated key, a series of primary templets disposed in groups each templet adapted to be positioned by means of a tape on the end of which is a pulley, a tape passing over each of these pulleys and having one end connected to one of the rotatable devices controlled by a price key and the other end connected to one of the rotatable devices controlled by a quantity key, feelers adapted to ascertain the amounts represented by the positioned primary templets, a series of secondary templets disposed in groups, a series of pulley groups each group being composed of one or more pulleys each connected to a

primary templet feeler and a pulley connected to a group of secondary templets, a series of tapes the ends of which are fixed each tape passing around all the pulleys in a group and means for setting a series of answer wheels in accordance with the amounts represented by the positioned secondary templets.

11. In a calculating machine the combination of a series of keys of which some designate price and others designate quantity, rotatable devices corresponding to the price keys each of such devices being constructed to increase the movement transmitted through it, rotatable devices corresponding to the quantity keys each of such devices being constructed to decrease the movement transmitted through it, means for rotating each device to an extent proportional to the value of an operated key, a series of primary templets disposed in groups each templet adapted to be positioned by means of a tape on the end of which is a pulley, a tape passing over each of these pulleys and having one end connected to one of the rotatable devices controlled by a price key and the other end connected to one of the rotatable devices controlled by a quantity key, feelers adapted to ascertain the amounts represent-

ed by the positioned primary templets, a series of secondary templets disposed in groups, feelers adapted to ascertain the amounts represented by the positioned secondary templets, a series of pulley groups each group being composed of one or more pulleys each connected to a primary templet feeler and a pulley connected to a group of secondary templets, a series of tapes the ends of which are fixed, each tape passing around all the pulleys in a group, a series of answer wheels, pulleys connected to certain of the answer wheels, tapes connecting certain secondary feelers to their corresponding answer wheels and other tapes severally running over answer wheel pulleys and serving to connect certain secondary feelers so as to add the amounts ascertained by them and cause the corresponding answer wheels to be set in accordance with the result of such addition.

In witness whereof we have hereunto set our hands in the presence of two witnesses.

MARK BARR.
EDWARD RUSSELL CLARKE.

Witnesses:
JOHN M. HADDOCK,
ARCHIBALD SHARP.