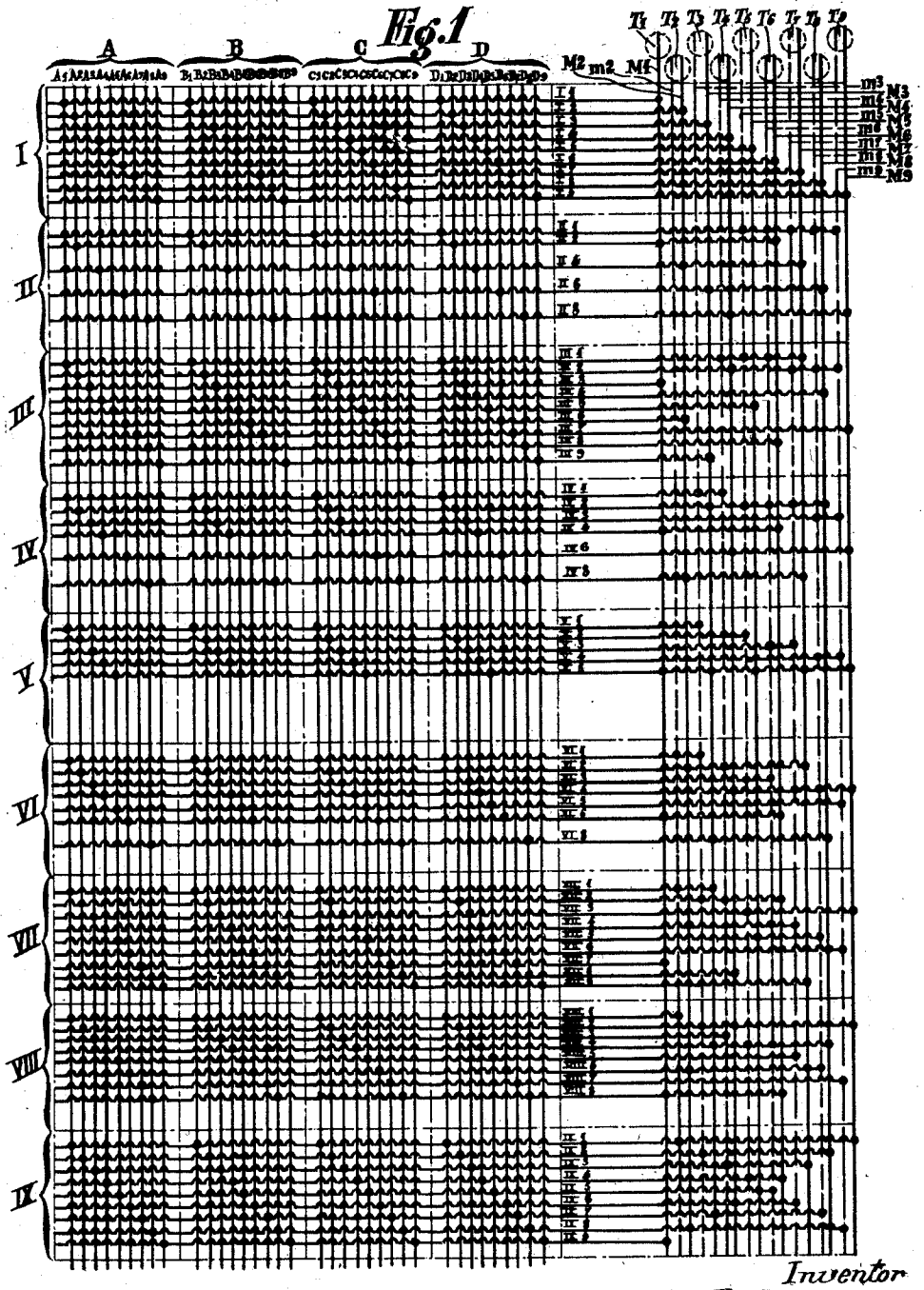
Oct. 20, 1931. R. E. BOUTET 1,827,836

ELECTRICAL CALCULATING MACHINE

Filed Jan. 26, 1929 4 Sheets-Sheet 1

Fig. 1



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Fig. 2

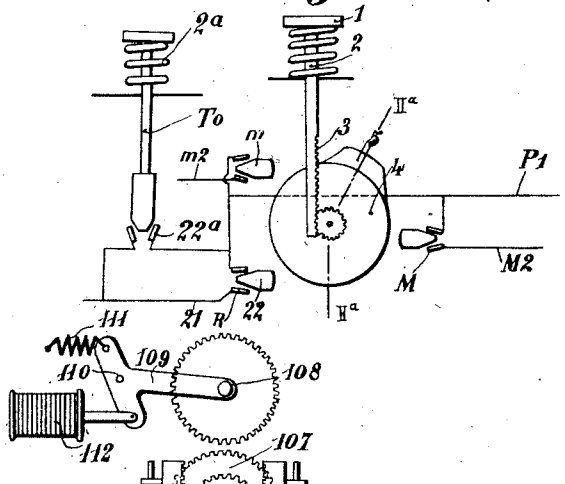


Fig. 2a

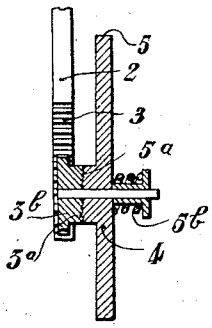


Fig. 4

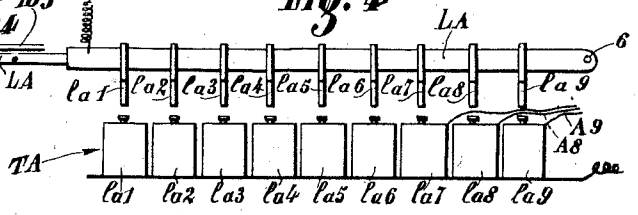


Fig. 5

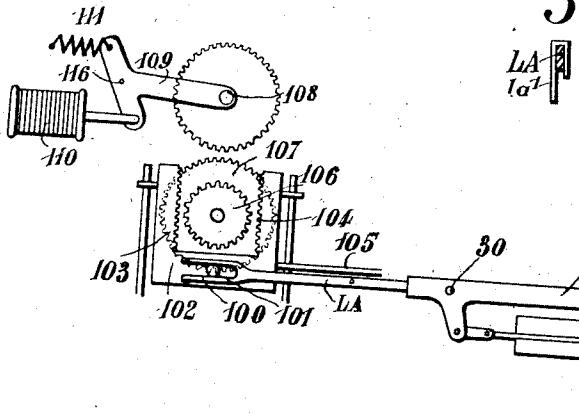


Fig. 10

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ELECTRICAL CALCULATING MACHINE

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Fig. 3

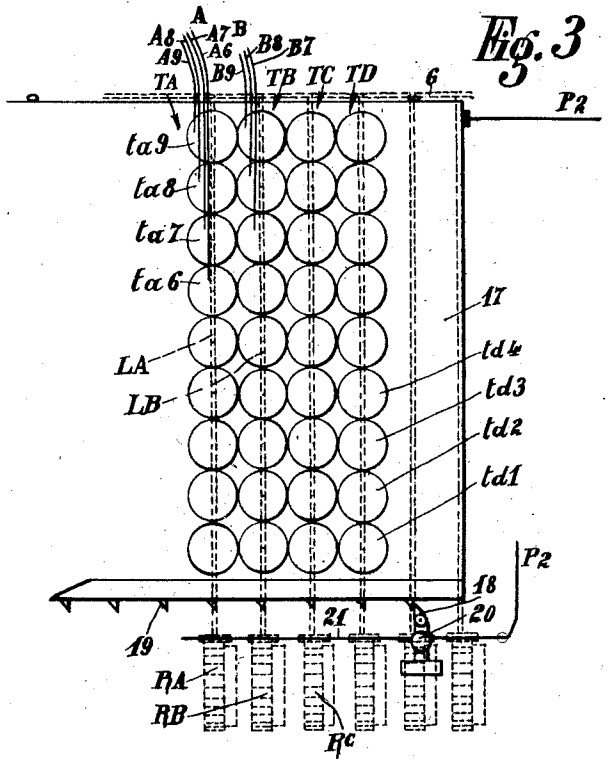


Fig. 6

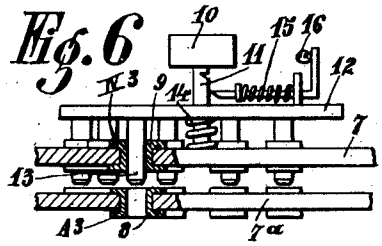
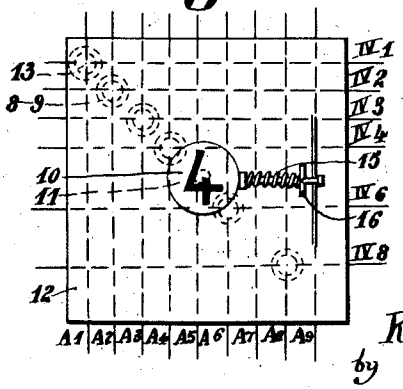


Fig. 7



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Fig. 8

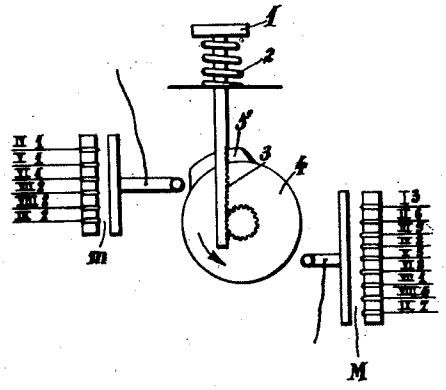
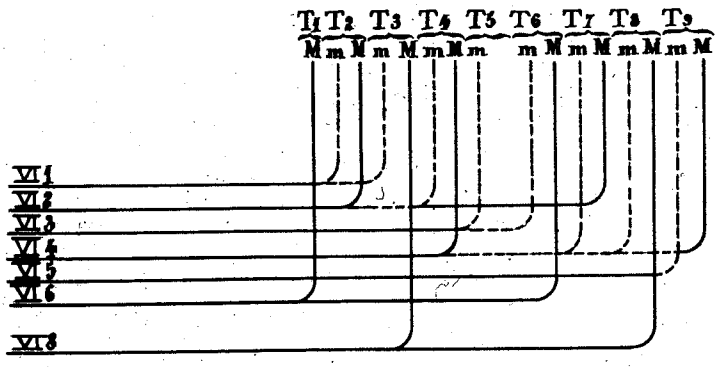


Fig. 9.



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1,827,836

UNITED STATES PATENT OFFICE

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ELECTRICAL CALCULATING MACHINE

Application filed January 26, 1929, Serial No. 335,277, and in Germany March 27, 1928.

The present invention is concerned with a calculating machine characterized by the fact that there is associated therewith an electrical device which takes the place of the Pythageras tables or equivalent mechanical members (revolving drums and the like) which are fitted to calculating machines for obtaining products after actuation of the multiplicand and multiplier keys.

The electrical device according to the invention is constituted by a circuit board which is characterized by the combination of three sets of separate circuits: one set of circuits for the multiplier including nine groups of main circuits (one group for each digit) each actuated by a corresponding key, a second set of circuits for recording the product and comprising n groups (n varying according to the capacity of the machine) of nine vertical circuits, each group corresponding to a denominational order of the multiplicand and the nine wires of each of said vertical groups corresponding to the nine digits, and finally a third set of circuits comprising nine horizontal groups (one for each of the nine figures) for registering the multiplicand, each of the wires of the horizontal groups which intersect the vertical groups but which normally are not electrically connected thereto, being connected with one of the circuits of the multiplier, whilst means, such as multiplicand keys, are provided for connecting said wires to the vertical wire which in each vertical group corresponds to the figure forming the product of the multiplier digit (to which corresponds the principal multiplier circuit concerned), and the multiplicand digit to which corresponds the horizontal group to which the wire in question pertains.

It should be noted that in the preceding explanation the expressions "horizontal" and "vertical" have been used to designate two separate sets of circuits, but it should be understood that these terms have only been used for the sake of clearness and that any desired orientation of the circuits may be adopted. Similarly, the terms multiplication, multiplier and multiplicand have been used from the start, this is only by way of example, for the electric device according to the invention may be used, as moreover will be seen hereinafter, to perform other operations.

For registering the products obtained, to each of the n vertical groups there corresponds a set of nine electromagnets (one for each of the nine wires of each of said groups), each of said sets of electromagnets co-operating with the wheel of a totalizer or similar member of any known type, so that, when in a given vertical group, current is fed to one of the wires, the electromagnet which is energized shall rotate the corresponding wheel of the totalizer for indicating or registering the product figure to which the vertical wire in question corresponds.

Accordinng to the invention, means are provided for simultaneously registering the two digits (tens and units) which the product formed by multiplying one figure by another may comprise, said means consisting in associating with each group of principal circuits of the multiplier (save that corresponding to the digit 1) a group of auxiliary circuits connected to the wires of the set of horizontal circuits so as to give the tens product digit, whilst the corresponding principal circuit supplies the units product digit.

Other characteristics and peculiarities of the invention will become apparent from the following description in conjunction with the accompanying drawings in which:

Fig. 1 illustrates the electric circuits which the electric board according to the invention comprises.

Fig. 2 is a detail view showing a multiplier key.

Fig. 2ª is a sectional end view of the multiplier key on the line IIª—IIª, Fig. 2.

Fig. 3 is a plan view of the slide-rest supporting the actuating electromagnets for the totalizers.

Figs. 4 and 5 illustrate an actuating lever of the totalizers in longitudinal elevation and cross-section respectively.

Figs. 6 and 7 illustrate a multiplicand key in part sectional elevation and plan respectively.

Figs. 8 and 9 illustrate how the electrical connections between the multiplier keys and

the circuits of the mtltiplicand are obtained in practice.

Fig. 10 illustrates a modified form of construction.

The electric circuits board illustrated in Fig. 1 may be used under the same conditions for all operations which the customary calculating machines have to perform. However, the case of a multiplying machine will be considered by way of example and the board will be described in this connection.

In the first place, the board comprises multiplier circuits M_1, m_2, M_2; m_3, M_3; m_4, M_4 and so on. For each of the first nine digits there is a main multiplier circuit M_1 M_2 M_3 . . . and so on, and with each of said main circuits (except the circuit M_1) there is associated an auxiliary circuit m_2, m_3, m_4 . . . and so on for the purpose which will presently become apparent; said auxiliary circuits are illustrated in dotted lines in Fig. 1. As a matter of fact, it will be seen presently that each circuit M_1, m_2, M_2, represents not a single circuit but a group of circuits. It seems simpler however at the outset of the explanation to represent each group of multiplier circuits by a single circuit.

Each of the circuits M_1, m_2, M_2 . . . and so on is normally open and it may be closed by means of the corresponding multiplier key T_1, T_2, T_3 . . . and so on. There are obviously nine multiplier keys each of which may advantageously be constituted as illustrated in detail in Fig. 2, that is to say it may include a knob 1 having a stem 2 in which is cut a rack 3 which, when the knob 1 is depressed, rotates a disc 4 the cam 5 of which closes in succession the contacts *m* of the corresponding auxiliary circuit, then the contact R which will be considered again presently and finally the contact M of the main multiplier circuit. Said contacts are instantaneous, the circuit opening again as soon as the cam 5 ceases to act. In Fig. 2 P_1 designates the current lead-in wire.

On releasing the knob 1, the latter will return to its original position under the action of the spring 2^a which is compressed when the knob 1 is depressed. In order to prevent the return movement of the knob 1 from causing the disc 4 to rotate, the result of which would be to cause the cam 5 to close the contacts *m*, 22 and M again, the free-wheel device illustrated in Fig. 2^h has been provided. In this device, the pinion 3^b engaging with the rack 3 has a serrated portion 3^a engaging with a similar serrated member 5^a carried by the cam 5, while a spring 5^b presses the member 5^a against the member 3^a. It will be readily understood that when the stem 2 is depressed, the member 3^a will rotate the member 5^a whereas, when the stem 2 rises, the serrations of the member 3^a will slide over those of the member 5^a so that the latter and, consequently, the cam 5 will not be rotated. Matters will of course be arranged so that for a predetermined displacement of the knob 1, the cam 5 will make a complete revolution.

The electric board includes, furthermore, a second set of circuits comprising *n* vertical groups of nine wires. Said groups have been designated by A, B, C . . . and so on, and the wires in each group by A_1, A_2, A_3 . . . and so on, B_1, B_2, B_3 . . . and so on. The nine wires of each group correspond respectively to the nine digits and they are electrically connected to electromagnets located in sets of nine as may be seen in Fig. 3. Each set, comprehensively designated by TA, TB, TC . . . and so on, corresponds to one of the groups of vertical wires A, B, C . . . , and in each set, each of the nine electromagnets *ta*1, *ta*2, *ta*3 . . . and so on, *tb*1, *tb*2, *tb*3 . . . and so on, corresponds to the respective wires A_1, A_2, A_3 . . . or B_1, B_2, B_3 . . . of the corresponding vertical group A, B, C. It will be noted that in the drawings it has been assumed that the board has only four vertical groups which corresponds to four sets of electromagnets but obviously there may be any number of groups depending on the capacity of the apparatus required (normally 12 groups). In Fig. 3, P_2 designates the return wire of the general supply circuit.

Opposite each set of electromagnets TA, TB, TC . . . is located an oscillating lever LA, LB, LC . . . illustrated in dotted lines in Fig. 3 and in detail in Fig. 4 (elevational view).

Each lever can pivot about a fixed axis 6 and it includes nine links 1*a*1, 1*a*2, 1*a*3 . . . each located opposite one of the electromagnets *ta*1, *ta*2, *ta*3 . . . The links (see Fig. 5) are hook shaped so that each one may pivot the lever LA when it is attracted by the corresponding electromagnet, without such movement being hindered by the other links relative to which the lever may move. Each of the levers LA, LB, LC . . . has on the free end thereof a toothed sector SA, SB, SC . . . gearing with toothed wheels each connected to the wheel of any standard type of totalizer. Said wheels, which vary in number according to the size of the machine, are designated by RA, RB, RC, RD . . . On these wheels are mounted all the known devices such for example as the tens transferring device, the automatic device for resetting to zero and the like. These devices have not been illustrated since they form no part of the present invention. The electromagnets of a set TA are so arranged with respect to the corresponding lever LA that, according to the position of the electromagnet energized, the amplitude of the movement which said lever is caused to perform, varies, as, consequently, does likewise the amplitude of the movement of the totalizing wheel RA. In other words, when for example it is the wire A_3 of the group A of vertical wires through

which current flows whereby the electromagnet ta_3 of the set TA is excited, the totalizing wheel RA registers or displays the Figure 3. Naturally, each sector SA acts on the corresponding wheel in one direction only so that when the lever LA rises again, it shall not rotate.

To this end, the lever LA has a forked end 100 adapted to engage a stud 101 projecting from a block 102 in which two racks 103 and 104 are formed. The block 102 can be shifted to the left or right by a link 105 whereby the rack 103 or 104, as the case may be, is brought into engagement with a pinion 106 concentrically with which is mounted a toothed wheel 107 to rotate therewith. The various totalizing wheels RA, RB . . . are mounted on a common spindle 108 which carries a lever 109 pivotally mounted at 110. Said lever has two crank arms on which act respectively a spring 111 and a solenoid 112. The solenoid 112 is adapted to be energized when either of the circuits m or M is closed. When the solenoid 112 is energized, the lever 109 is swung downward so that the wheel RA is brought into gear with the wheel 107. Since at the same time the lever LA has been caused to pivot, it will carry with it the block 102, and if the latter has been previously shifted by the link 105 to bring one or other of its racks 103 or 104 into mesh with the pinion 106, the latter and consequently the wheel 107 will be rotated thereby rotating the wheel RA. As soon as the circuit m or M, as the case may be, is broken, the solenoid 112 will be deenergized and the totalizing wheels RA, RB . . . will move out of engagement with the wheel 107 under the action of the spring 111 so that as the lever LA returns to its normal position the wheel RA will not be rotated. Thus the totalizing wheels RA, RB . . . are only rotated for one direction of swing of the levers LA, LB. . . The object in providing two racks 103 and 104 is to enable both multiplication and division to be performed.

Returning now to the construction of the electrical board, it will be seen from Fig. 1 that it includes a third set of horizontal circuits formed by nine groups of circuits I, II, III, IV . . . corresponding to the first nine digits and each including a certain number of wires $I_1, I_2, I_3 \ldots II_1, II_2, II_4 \ldots$ the number of wires varying according to the groups. Each wire of each of said horizontal groups is connected to one of the multiplier wires $M_1, m_2, M_2 \ldots$ and may be connected, in each of the vertical groups A, B . . . which it intersects, to that wire of the group which corresponds to the figure forming the product of the corresponding multiplier figure and the figure to which the horizontal group in question corresponds. Thus, for example, in the horizontal group II, the wire II_4, (corresponding to the multiplicand 2) which is connected to the multiplier figure M_2 (multiplier digit 2) may be connected to the wires $A_4, B_4 \ldots$ of each vertical group, said wires being instrumental in registering the figure 4 being the product obtained from the multiplication 2 x 2. The conditions determining the connections of the horizontal wires to the multiplier circuits and to the vertical circuits may be easily followed in Fig. 1, especially as the same indices have been given to the horizontal wires $I_1, I_2 \ldots II_1, II_2 \ldots$ as to the vertical wires $A_1, A_2 \ldots B_1, B_2 \ldots$ to which they are connected, said indices representing moreover the product figure 1 . . . 2 to which said vertical wires correspond respectively. When the product is formed by a single digit, as obtains in the case considered above, only the principal multiplier circuits $M_1, M_2, M_3 \ldots$ come into action. On the contrary, when the product of two figures is a two digit number, the auxiliary circuit m and the main circuit M of the multiplier come into action in succession, the former giving the tens' product digit and the latter the units' digit. With this aim in view, the auxiliary circuits are suitably connected to the horizontal wires of the several groups I, II, III, IV, V and so on . . . which already serve to obtain the product of the units.

It will be seen for example that the auxiliary circuit m_5 of the multiplier 5 is connected to the horizontal wire VII_3, which is connected to the vertical wires $A_3, B_3, C_3 \ldots$ the tens' digit of the product of 5 x 7 being 3; similarly, the main circuit M_5, corresponding to the multiplier 5 is connected to the wire VII_5, the units' digit of the product of 7 x 5 being 5. The manner in which the tens' digit and the units' digit are suitably registered by the totalizer will be seen presently.

It has been seen above that the groups of horizontal wires I, II, III . . . intersect the groups of vertical wires A, B, C . . . but are normally not connected thereto. The intersection of the wires forms so to speak a checker board comprising n vertical row of n intersection squares. In each of said intersection squares, it must be possible for the horizontal wires $I_1, I_2, I_3 \ldots$ to be suitably connected to the corresponding vertical wires $A_1, A_2, A_3 \ldots$ A device which may be used to advantage for obtaining such electrical connection has been illustrated in Figs. 6 and 7. As may be seen in these figures, the groups of vertical wires such as A, B, C . . . are mounted on the lower face of a panel 7^a made of vulcanite or the like and which is common to all the groups, whereas the groups of horizontal wires, such as IV_1, IV_8 are mounted on the upper face of another vulcanite panel 7. In each of the intersection squares, the ebonite panels include suitably disposed holes which accommodate metallic sockets mounted on springs such as 8 and 9 and to which the vertical or horizontal wires

are electrically connected. In the intersection squares which determine the horizontal group 4 (which has been illustrated in plan by way of example in Fig. 7), the sockets such as 8 and 9 are located in the following manner. The socket 8 connected for example to the vertical wire A_1 is located opposite the socket 9 connected to the wire IV_1. Similarly, the socket 8 connected to the wire A_2 is located opposite the socket 9 connected to the wire IV_2 and so on.

If, therefore, the sockets 8 and 9 of an intersection square are electrically connected by means of any device, all the wires of the horizontal group and of the vertical group concerned will be connected together in the manner desired. The device enabling all the sockets 8 and 9 to be simultaneously connected together is constituted, in the case illustrated, by a key including any standard type of knob 10, on the stem 11 of which is mounted a plate 12 including as many contact studs such as 13, as there are pairs of sockets 8 and 9 in the corresponding intersection square. A spring 14 holds the plate 12 in the position in which the contact studs 13 do not connect together electrically the pairs of sockets 8 and 9. Under these circumstances, the vertical and horizontal wires are normally not connected together. On the other hand, when the knob 10 is depressed, the contact studs 13 which are still engaged in the sockets 9 will engage in the corresponding sockets 8 and establish the electrical connection desired. A conventional type of locking device comprehensively designated by 15 maintains the plate 12 in its depressed position. Any suitable device such as a cam shaft 16, enables the plate to be released and automatically raised to its position of rest.

By thus locating a plate 12 opposite each of the intersection squares, a nest of knobs 10 is obtained comprising n vertical rows of nine knobs 10. Thus to a certain extent a multiplicand keyboard is obtained similar to the keyboard of ordinary calculating machines. In the keyboard, each vertical row of nine keys includes a key for each digit, and each of said rows corresponds to a denominational order of the multiplicand.

For greater simplicity, a black circle has merely been featured in Fig. 1 at the intersection of the horizontal and vertical wires which are to be connected together, in order to illustrate how the horizontal and vertical wires can be connected together in each intersection square.

Before passing on to the general mode of operation of the apparatus, a description will be given of the device which enables the tens' digit and the units' digit of the product of two numbers to be suitably registered. Said device is formed by mounting the sets of electromagnets TA, TB, TC ... on a slide-rest 17 which can shift relative to the totalizing wheels RA, RB, RC ... The movement of the slide-rest 17 (Fig. 3) which can be shifted to the right by a spring or the like, is regulated by an anchor escapement mechanism of any known type comprehensively designated by 18, and which, by co-operating with teeth 19 of the slide-rest 17 only allows the latter to shift by successive jerks of amplitude corresponding to the transverse distance between two sets of electromagnets TA, TB, so that each displacement of the slide-rest 17 brings each set of electromagnets opposite the totalizing wheel RA, RB ... immediately following that opposite which said set of electromagnets was previously positioned. The following device is provided for actuating the anchor escapement device 18, that is to say for displacing the slide-rest 17 at the desired instant. An electromagnet 20 is positioned opposite said escapement and, when energized, it can withdraw the same, said electromagnet 20 being mounted in a circuit 21 which may be closed by one or other of the contacts such as 22. There is a contact 22 for each of the multiplier keys T_1, T_2 .. and each time one of said keys is depressed the corresponding contact 22 is actuated, that is to say, the circuit 21 is closed by withdrawal of the anchor escapement 18 whereby the slide-rest 17 is allowed to shift. An examination of Fig. 2 will show that the contact 22 is actuated after the contact m corresponding to the auxiliary multiplier circuit, but before the contact M corresponding to the main multiplier circuit.

As is usual in connection with computing machines, the slide-rest 17 may also be displaced by depressing a key T_0 independent of the multiplier keys T_1, T_2, T_3 ... and which causes a contact 22^a shunted across the contact 22 to close the circuit 21 whereby the latter can be controlled independently of the switches m, 22, M, and the electromagnet 20 energized to actuate the escapement 18. Thus when there is a zero in the multiplier it is allowed for by depressing the key T_0 to shift the slide-rest 17. When the key T_0 is released a spring 2^a returns it into the position in which the contact 22^a is inoperative.

In describing the operation of the above machine, it will be assumed that it is required to multiply 452 by 34, the slide-rest 17 being in its extreme left position, the set of electromagnets TA corresponding under these circumstances to the totalizer wheel RA. The first step is to register the multiplicand 452. To this effect, the key 4 of the row A is depressed as are also the key 5 of the row B and the key 2 of the row C. The keys thus depressed remain in the position in which the contact studs 13 connect together electrically the horizontal and vertical wires of the groups concerned in the desired manner. The key T_3 corresponding to the first multi-

plier digit 3 is then depressed. The result is to close first of all the auxiliary circuit m_3 which is connected more particularly to the wire IV_1 of the horizontal group 4 and to the wire V_1 of the group 5 whereas it is not connected to any wire of the group 2. The totalizing wheel RA will consequently register the digit I as also will the totalizing wheel RB. The next consequence of depressing the key T_3 is to close the circuit 21 and consequently to withdraw the anchor escapement device 18 and to displace the slide-rest 17 one step. The sets of electromagnets are thereby shifted to the right relative to the totalizing wheels, the set TA in particular now facing the wheel RB. The final result of depressing the key T_3 is to close the circuit M_3 which is connected to the wire IV_2 of the group 4, to the wire V_6 of the group 5 and lastly to the wire II_6 of the group II; hence the result of closing the circuit M_3 will be to cause the digits 2, 5 and 6 to be registered respectively by the wheels RB, RC and RD. The registrations of the totalizing wheels may moreover be tabulated as follows:

Totalizing wheels:

RA	RB	RC	RD	RE
1	1			
	2	5	6	

The key T_3 then returns to its normal position without producing any particular effect. To this effect a free wheel or similar device may be mounted on the toothed wheel of the disc 4 whereby said disc will make a complete revolution each time the key is depressed and will not go back.

The key T_4 corresponding to the second multiplier digit 4 is then depressed thereby first of all closing the circuit m_4 which is connected to the wire IV_1 of the group IV and to the wire V_2 of the group 5 whilst it is not connected to any wire of the group II. Hence the totalizing wheel RB will again register the digit 1 and the totalizing wheel RC the digit 2. With the circuit 21 then closing, a fresh displacement of the slide-rest 17 will occur, the set of electromagnets TA in particular taking up a position opposite the totalizing wheel RC whilst the other sets of electromagnets are shifted in a corresponding manner. Finally the result of depressing the key T_4 will be to close the circuit M_4 which is connected to the wire IV_6 of the group IV and to the wire II_8 of the group II whereas it is not connected to any wire of the group V. The totalizing wheel RC which now corresponds to the vertical group A will therefore register the figure 6, the totalizing wheel RD will not register any digit, whilst the totalizing wheel RE corresponding to the vertical group C will register the figure 8. The complete result of the registrations of the totalizing wheels may be tabulated as follows:

Totalizing wheels:

RA	RB	RC	RD	RE
1	1			
	2	5	6	
	1	2		
		6		8

Since the totalizing wheels themselves transfer the tens through the medium of the device they include and which has not been illustrated, since it forms no part of the present invention, the totalizer will give the product of the multiplication which in the case in point is 15368.

In order to start a new operation, the displaced slide rest and magnets are returned by hand against the action of the spring just as in an ordinary typewriter.

At the beginning of the description it was stated that it was only with a view to simplicity and to make the explanations clearer that the assumption was made that for each multiplier key $T_1, T_2, T_3 \ldots$ there was only a single main circuit $M_1, M_2, M_3 \ldots$ and a single auxiliary circuit $m_2, m_3 \ldots$ Under these circumstances, each of said circuits happens to be connected simultaneously to a wire of several horizontal groups. Thus the circuit M_6 of the key T_6 is connected (Fig. 1) to the wire I_6 of the group I, to the wire II_2 of the group II, to the wire III_8 of the group III and so on. Similarly, certain of the horizontal wires are connected simultaneously to several multiplier circuits. Thus for example the wire VI_6 of the group VI is connected both to the multiplier circuit M_1 of the key T_1 and to the circuit M_6 of the key T_3. Under these circumstances, when the circuit M_6 is closed, shunt currents might flow in the circuit M_1 which would be a cause of error. This drawback is obviated by replacing in each key $T_1, T_2 T_3 \ldots$ each circuit $M_1 m_2, M_2 \ldots$ by a group of circuits each connecting to a single horizontal wire. The circuit m_3 of the key T_3 for example is composed, as shown in Fig. 8, of six wires connected respectively to the horizontal wires, IV_1, V_1, VI_1, VII_2, $VIII_2$, IX_2. Similarly, the circuit M_3 of the same key T_3 comprises nine circuits respectively connected to the horizontal wires I_8, II_6, III_9, IV_2, V_5 VI_6, VII_1, $VIII_4$, IX_7. Of course the contacts m and M are designed to close simultaneously all the multiplier circuits of a group.

If a horizontal group be considered, the group VI for example, as shown in Fig. 9, it will be seen that each wire is connected in certain cases to several multiplier circuits but none of said multiplier circuits is connected to another horizontal wire. Shunt currents are thus completely avoided.

The wire VI_4 for example is connected simultaneously to the contacts M of the key T_4, m of T_7, m of T_8 and M of T_9; as no mul-

tiplier wire is connected to another horizontal wire, since for each key the multiplier circuits have been split up (Fig. 8), all risk of error is eliminated.

It should be observed that the mechanical device which has been described and illustrated for actuating the totalizing wheels from the electromagnets has only been given by way of example and any other device could be substituted therefor. Thus, for example, in Fig. 10 there has been illustrated a modified form of construction of the device illustrated in Fig. 4 for actuating the totalizing wheels RA, RB . . .

The lever LA pivots about an axis 30 and its pivot movement is brought about at the suitable moment by a comparatively powerful electromagnet 31. The amplitude of the pivot movement is limited, according to the figure which has to be registered by the totalizing wheel RA, by the electromagnet of the group ta_1 ta_2, ta_3 . . . which corresponds to said figure.

To this effect, each of said electromagnets, when energized, causes a stop 32 to project into the part of the nose 33 of the lever LA upon pivoting of the latter. As in the previous case, the desired figure is registered by the totalizing wheel, and it is only necessary that the corresponding electromagnet ta_1, ta_2, ta_3 . . . be energized. Similarly, the electric board has been described on the assumption that multiplications are to made, but it will be obvious that said board may be used without any changes for additions, subtractions and divisions.

In the case of additions, for example, no changes need even be made in the mechanical devices for driving the totalizers. Addition is accomplished simply by depressing the key T_1 so that the circuit M_1 shall always be closed and by registering in succession all the numbers to be summated on the keyboard of the multiplicand; the result of said summations will be immediately recorded by the totalizing wheels.

As for divisions and subtractions, the only changes required are concerned with the construction of the mechanical devices for driving the totalizing wheels, the electric board which constitutes the essential characteristic of the present invention remaining unchanged.

It will be observed finally that constructional details such as the automatic device for raising the keys of the multiplicand, the device for transferring the tens in the totalizer have not been described, for said devices may be of any type well known in the art of calculating machines.

It is moreover self evident that the invention has only been described and illustrated here in a purely explanatory but by no means limitative manner, and that it could be subjected to various modifications of detail without departing from the spirit thereof.

I claim:

1. In an electrical calculating machine, the combination of a first set of nine groups of circuits corresponding to the nine digits, a second set of nine groups of circuits, each group of said first set of circuits being connected to each group of said second set of circuits, a third set of circuits comprising n groups of nine wires each, selective means for connecting a wire of a group of said second set of circuits to the wire of every group of said third set of circuits whose digit value in its group is equal to a digit in the product obtained by multiplying the digit value of the group of said second circuit wire by the digit value of the wire of said first set of circuits to which said second circuit wire is connected, selective means for closing one of said first set of circuits, and means energized by the wires of said third set of circuits for effecting registration of the results obtained by selective closing of one of said first set of circuits and selective connection of wires of said second to wires of said third set of circuits.

2. In an electrical calculating machine, the combination of a first set of nine groups of circuits corresponding to the nine digits, a second set of nine groups of circuits, each group of said first set of circuits being connected to each group of said second set of circuits, a third set of circuits comprising n groups of nine wires each, selective means for connecting a wire of a group of said second set of circuits to the wire of every group of said third set of circuits whose digit value in its group is equal to a digit in the product obtained by multiplying the digit value of the group of said second circuit wire by the digit value of the wire of said first set of circuits to which said second circuit wire is connected, selective means for closing one of said first set of circuits, n groups of nine electromagnets respectively connected to the n groups of nine wires of said third set of circuits, totalizing mechanism, and means controlled by said respective electromagnets when energized for rotating said totalizing mechanism through different angles to register the results obtained from selective closing of one of said first set of circuits and selective connection of wires of said second and third set of circuits.

3. In an electrical calculating machine, the combination of a first set of nine groups of circuits corresponding to the nine digits, each of said groups save the first being divided into a units and a tens section, a second set of nine groups of circuits connected to said units and tens sections of said first set of circuits according to the digits of partial products, a third set of circuits comprising n groups of nine wires each, selective means for connecting a wire of each group of said second set of circuits to the wire of every group of said

third set of circuits whose digit value in its group is equal to one of the digits in the product obtained by multiplying the digit value of the group of said second circuit wire by the digit value of the group of the wire of said first set of circuits to which said second circuit wire is connected, selective means for closing a section of a group of said first set of circuits, and means energized by the wires of said third set of circuits for effecting registration of the results obtained by selective closing of a section of a group of said first set of circuits and selective connection of wires of said second to wires of said third set of circuits.

4. In an electrical calculating machine, the combination of a first set of nine groups of circuits corresponding to the nine digits each of said groups save the first being divided into a units' and a tens' section, a second set of nine groups of circuits connected to said units and tens sections of said first set of circuits according to the digits of partial products, a third set of circuits comprising n groups of nine wires each, selective means for connecting a wire of each group of said second set of circuits to the wire of every group of said third set of circuits whose digit value in its group is equal to one of the digits in the product obtained by multiplying the digit value of the group of said second circuit wire by the digit value of the group of the wire of said first set of circuits to which said second circuit wire is connected, said digit being the units or tens digit according to whether said second circuit wire is connected to a units or tens wire of said first group of circuits, selective means for closing in succession the tens and units sections of a group of said first set of circuits, and means energized by the wires of said third set of circuits for effecting registration of the results obtained by selective closing of a group of said first set of circuits and selective connection of wires of said second to wires of said third set of circuits.

5. In an electrical calculating machine, the combination of a first set of nine groups of circuits corresponding to the nine digits, each of said groups save the first being divided into a units' and a tens' section, a second set of nine groups of circuits, each units and tens section of said first set of circuits being connected to the wire of each group of said second set of circuits whose digit value in its group is equal to the corresponding units or tens digit of the product of the digit values of the groups of the second circuit wire and the first circuit section in question, a third set of circuits comprising n groups of nine wires each, selective means for connecting together the wires of said second and third sets of circuits whose digit value in their respective groups are the same, selective means for closing in succession the tens and units sections of a group of said first set of circuits, n groups of nine electromagnets respectively connected to the n groups of nine wires of said third set of circuits, a plurality of totalizing wheels, plurality of means controlled respectively by said electromagnets for rotating a corresponding totalizing wheel through different angles depending on the electromagnet of the group energized, an electrical circuit closed by said selective means between closure of the tens and units sections of a group of said first set of circuits, and means energized by said circuit for displacing said groups of electromagnets relative to said totalizing wheel controlling means whereby the units and tens digits of the products obtained from said third set of circuits are registered on different wheels.

6. In an electrical calculating machine, the combination of a first set of nine groups of circuits corresponding to the nine digits, each of said groups save the first being divided into a units' and a tens' wire, a second set of nine groups of circuits, each units and tens section of said first set of circuits being connected to the wire of each group of said second set of circuits whose digit value in its group is equal to the corresponding units or tens digit of the product of the digit values of the groups of the second circuit wire and the first circuit section in question, a third set of circuits comprising n groups of nine wires each, selective means for connecting together the wires of said second and third sets of circuits whose digit values in their respective groups are the same, selector keys for closing in succession the tens and units sections of a group of first set of circuits, n groups of nine electromagnets respectively connected to the n groups of nine wires of said third set of circuits, a plurality of totalizing wheels, a plurality of means controlled respectively by said electromagnets for rotating a corresponding totalizing wheel through an angle depending on the electromagnet of the group selectively energized, a circuit adapted to be made by each selector key between the making of said tens and units sections of a group of said first set of circuits, a displaceable slide-rest adapted to carry said groups of electromagnets, and means including an escapement mechanism and an electromagnet energized by said circuit for effecting such displacement of said slide-rest as will bring each group of electromagnets into position for actuating the totalizing wheel controlling means succeeding that previously actuated so that the units and tens digits will be registered on different wheels.

7. In an electrical calculating machine, the combination of a first set of nine groups of circuits, each of said groups save the first being divided into a units and a tens section, a second set of nine groups of circuits, each units and tens section of said first set of cir-

cuits being connected to the wire of each group of said second set of circuits whose digit value in its group is equal to the corresponding units or tens digit of the product of the digit values of the groups of the second circuit wire and the first circuit section in question, a third set of circuits comprising *n* groups of nine wires each, the groups of said second circuit wires being arranged to cross the groups of said third circuit wires without being normally connected thereto, a contact key associated with each intersection square formed by two intersecting groups of said second and third set of circuits respectively, means actuated by depressing said key for simultaneously connecting each wire of the corresponding second circuit group to the wire of the intersecting third circuit group whose digit value in its group is the same as that of the second circuit wire in question, selective means for closing in succession the tens and units sections of a group of said first set of circuits, *n* groups of nine electromagnets respectively connected to the *n* groups of nine wires of said third set of circuits, a plurality of totalizing wheels, means controlled by said respective electromagnets for rotating a corresponding totalizing wheel through different angles depending on the electromagnets of the group energized, an electrical circuit closed by said selective means between closure of the tens and units sections of a group of said first set of circuits, and means energized by said circuit for displacing said groups of electromagnets relative to said totalizing wheel controlling means whereby the units and tens digits of the products obtained from said third set of circuits are registered on different wheels.

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