

Sept. 27, 1955

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2,719,005

ELECTRICAL MULTIPLYING ARRANGEMENTS

Filed Sept. 26, 1950

9 Sheets-Sheet 1

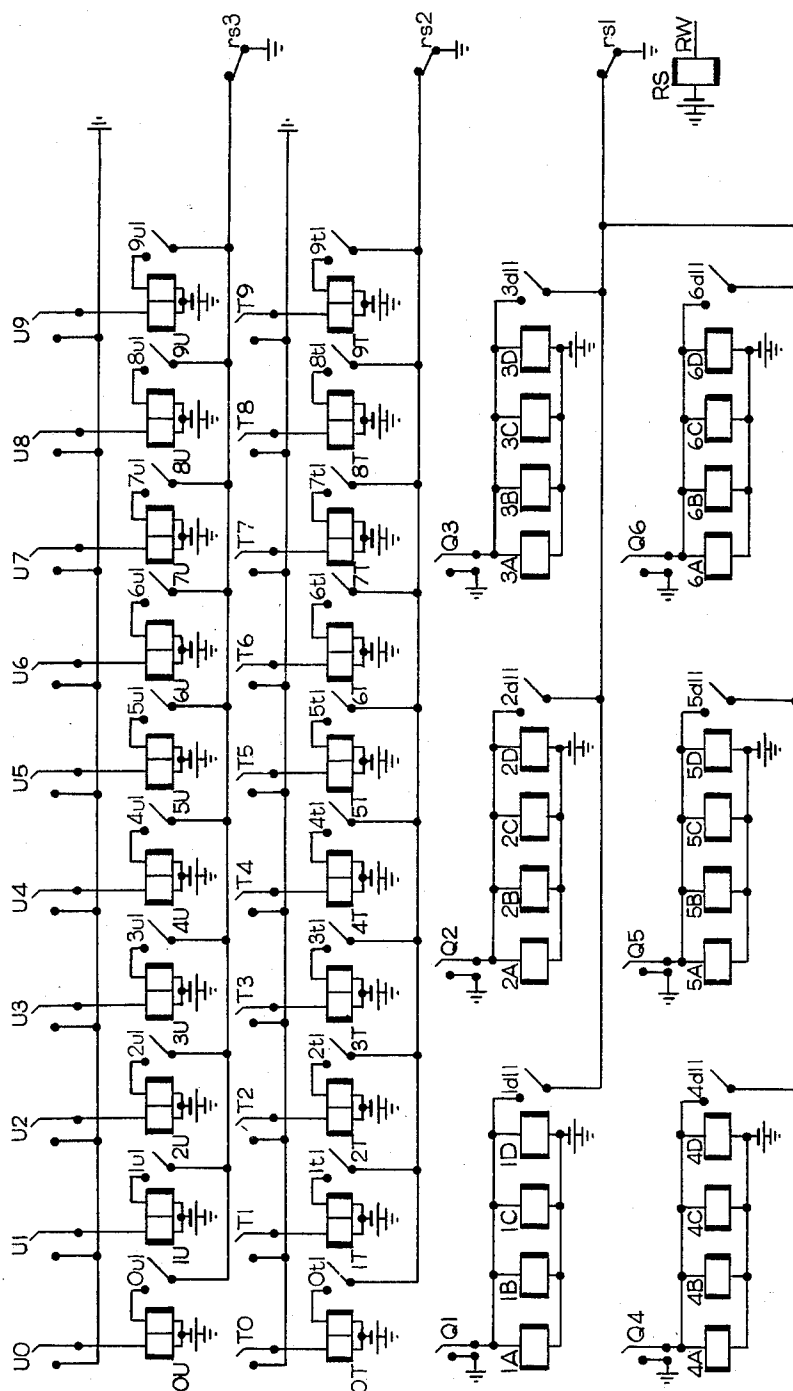


FIG. 1

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9 Sheets-Sheet 2

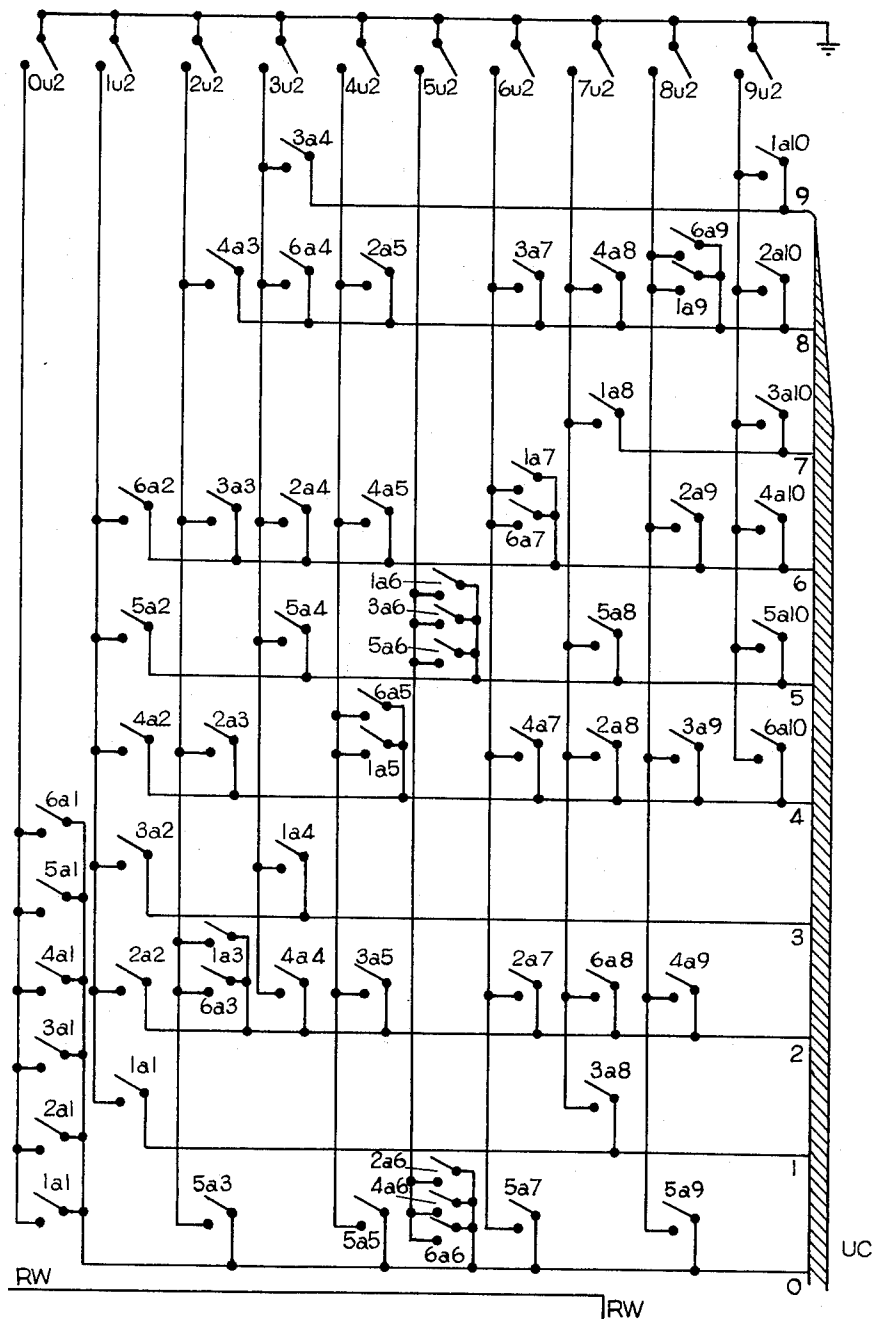
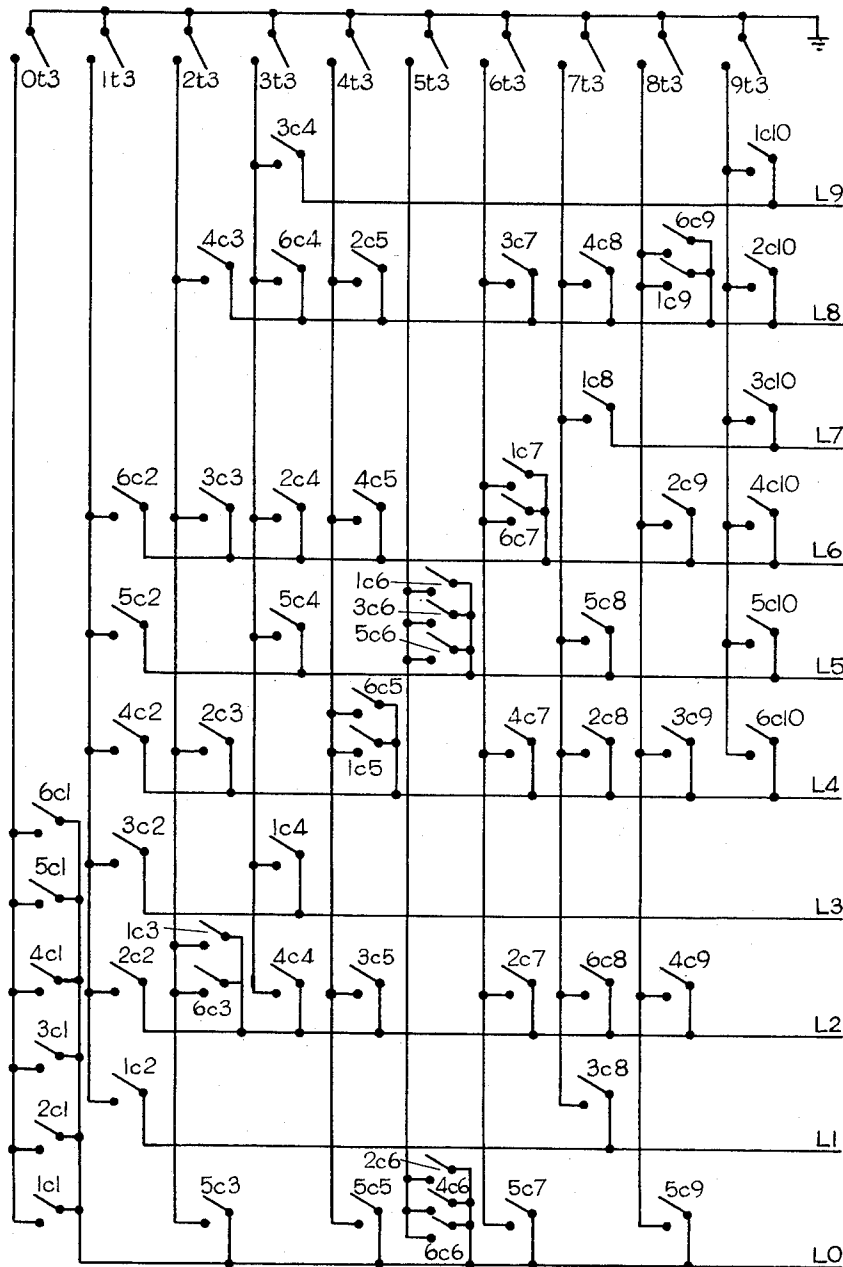


FIG. 2

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9 Sheets-Sheet 4

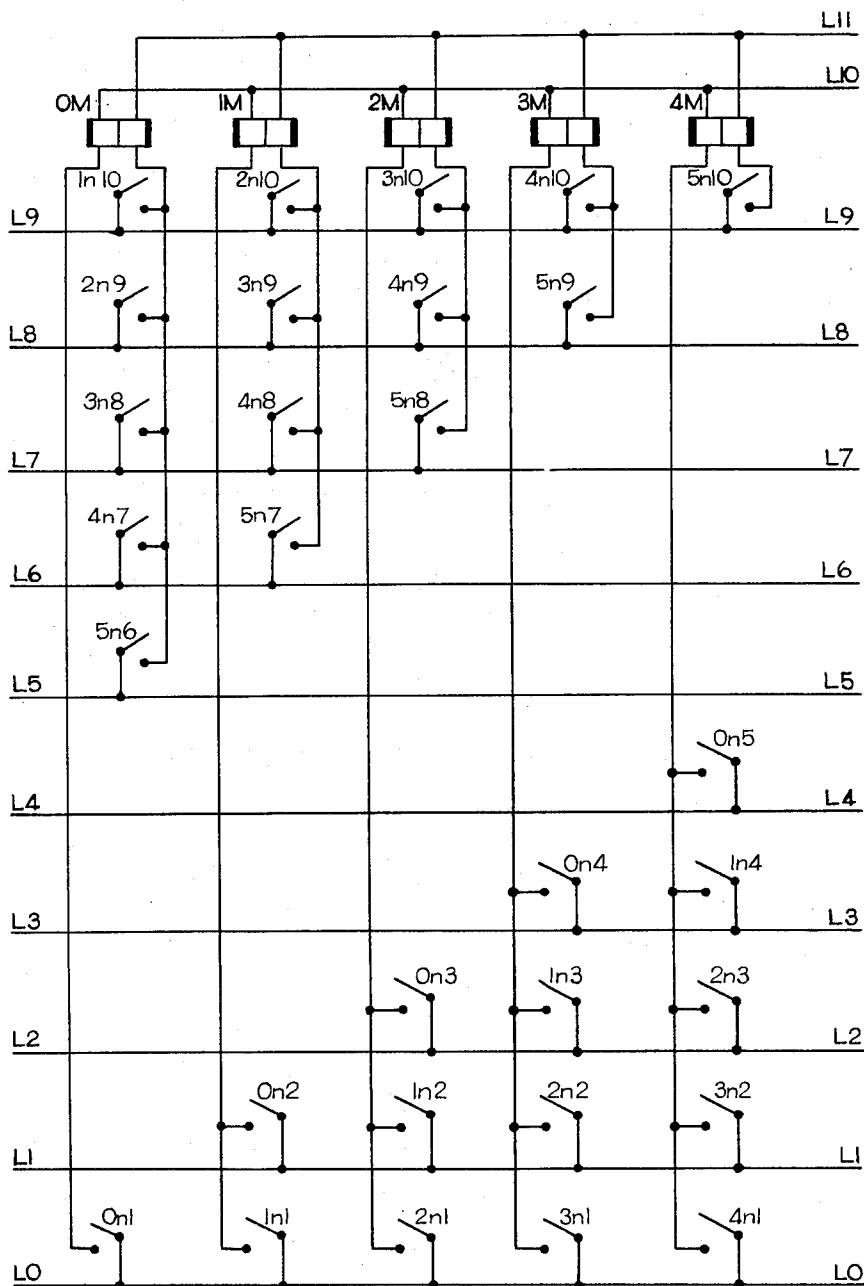


FIG. 4

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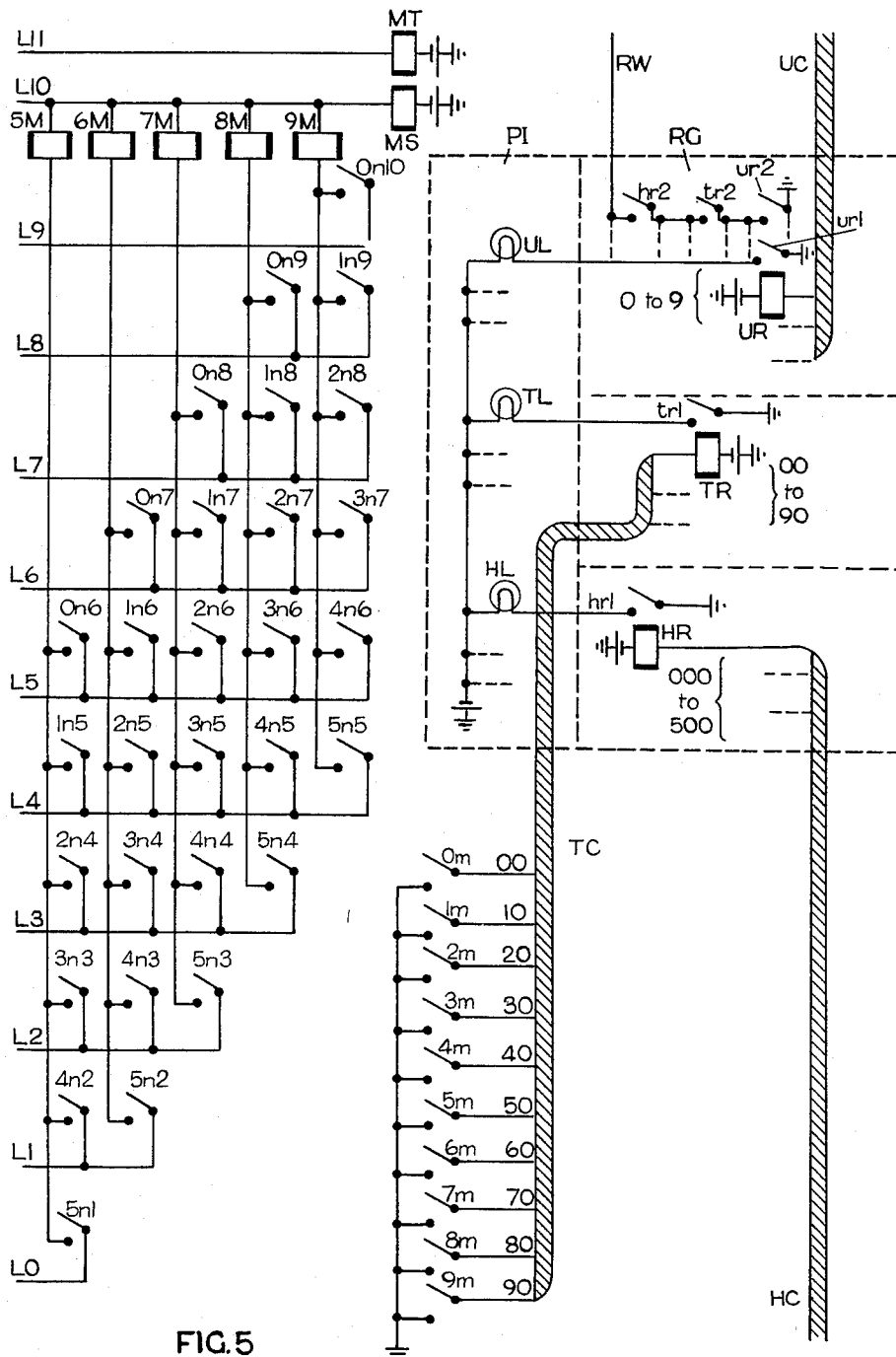


FIG. 5

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9 Sheets-Sheet 6

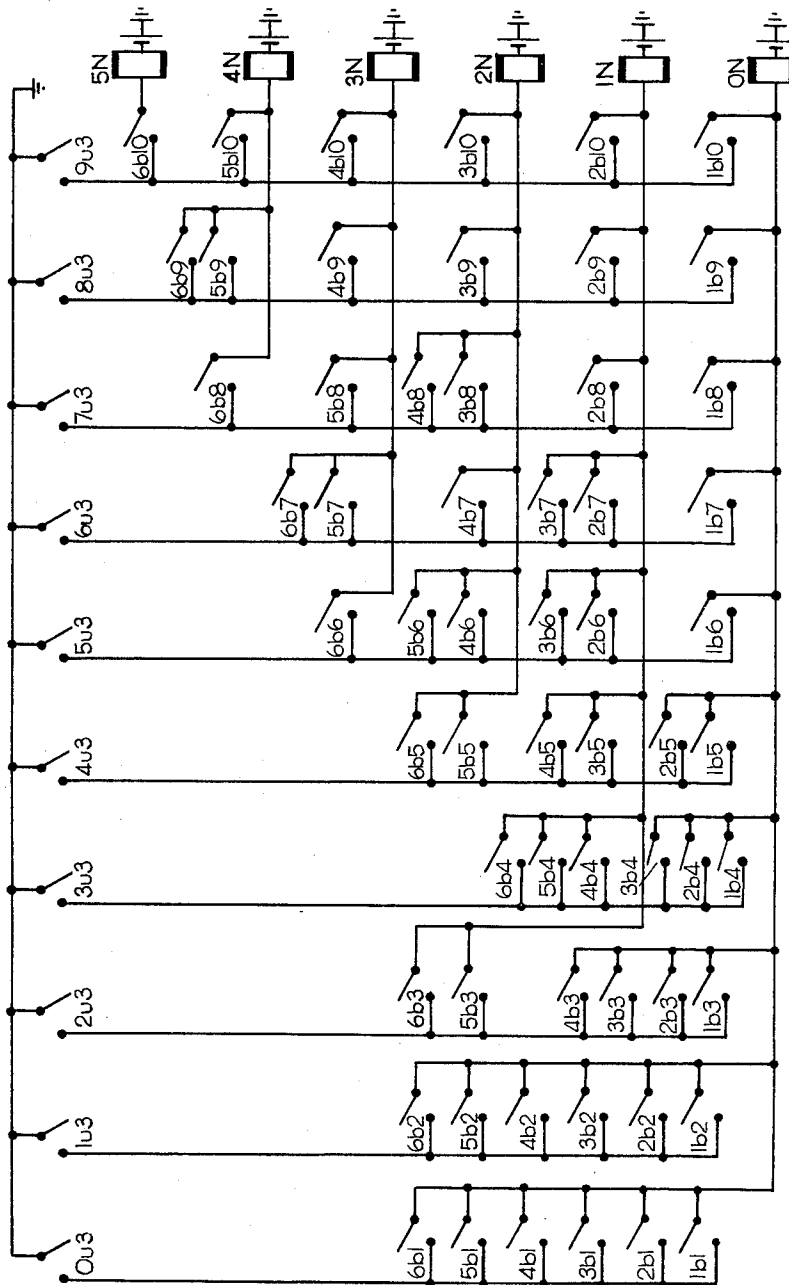


FIG. 6

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ELECTRICAL MULTIPLYING ARRANGEMENTS

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9 Sheets-Sheet 7

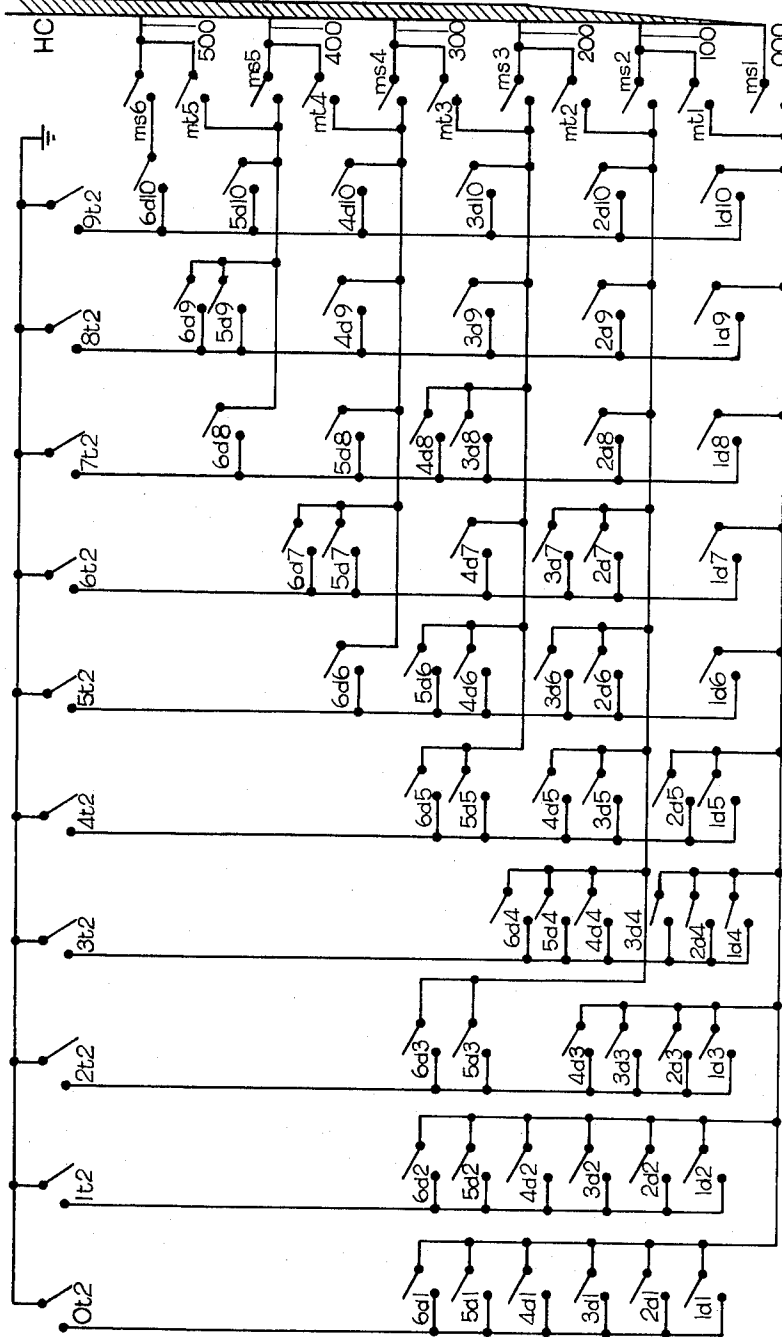


FIG. 7

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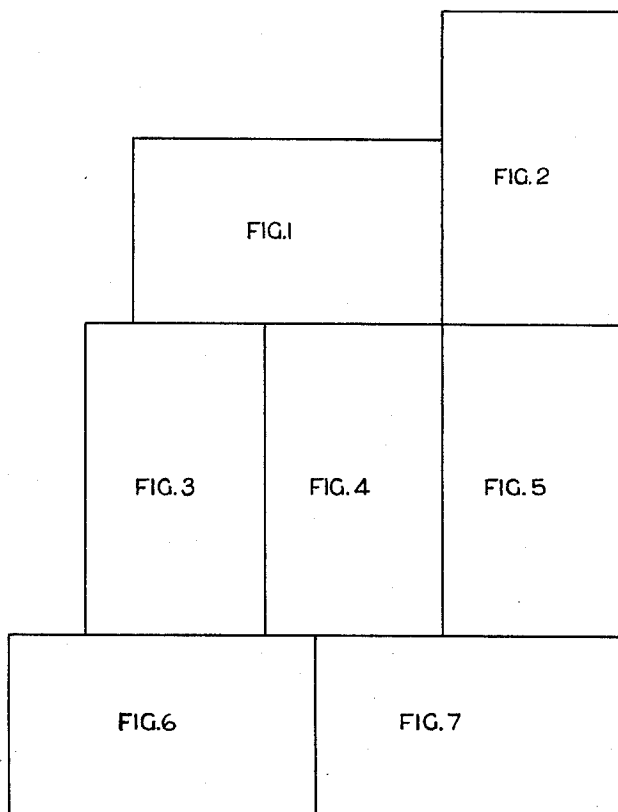


FIG. 8

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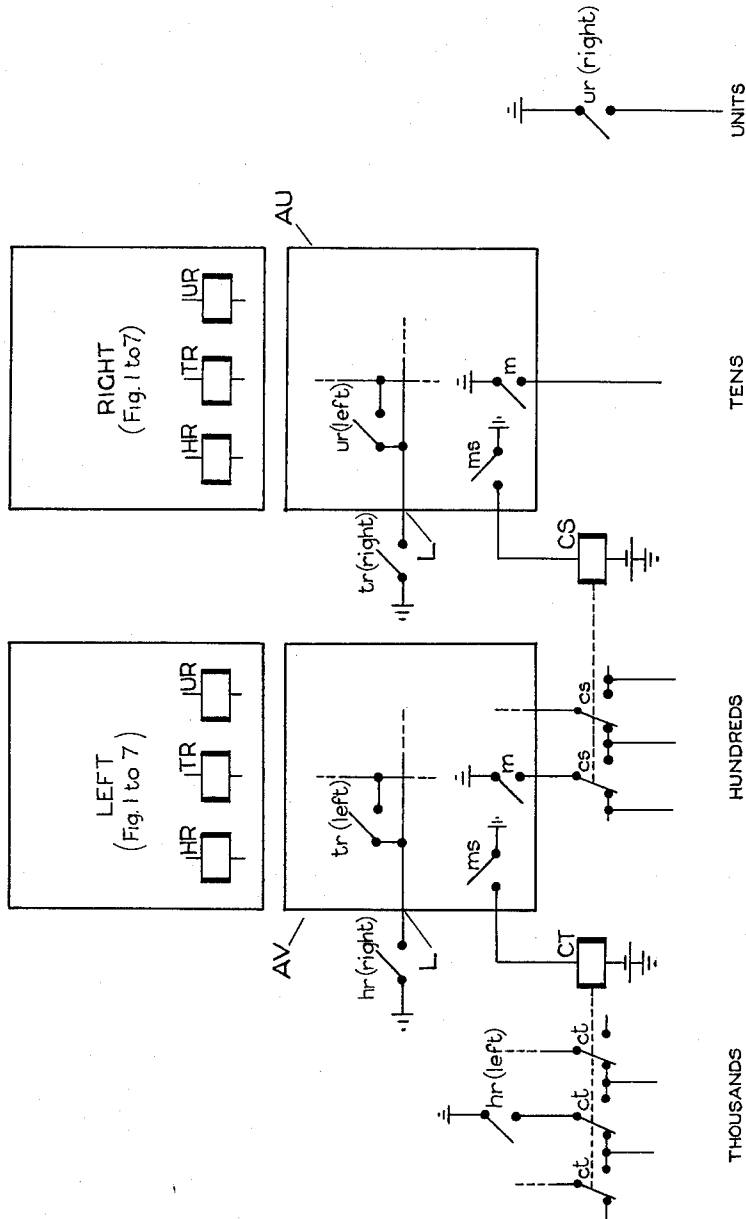


FIG. 9

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ELECTRICAL MULTIPLYING ARRANGEMENTS

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Application September 26, 1950, Serial No. 186,705

Claims priority, application Australia October 10, 1949

4 Claims. (Cl. 235—61)

The invention relates to electrical multiplying arrangements and more particularly to digital multiplying arrangements operating completely on electrical principles.

Digital calculating machines are known in which the multiplication is carried out by a series of additions, and in other machines multiplication is carried out by electrically-controlled mechanical apparatus. Although these machines operate satisfactorily for normal calculating purposes, they are too complicated or too slow in operation when the multiplying operations have to be carried out for example in connection with the selling of goods or with article dispensing systems.

In connection with the quick selling of orders, for example in cases where a customer selects the articles himself and presents them to the cashier the latter must be able not only to add up the prices of the various articles, but he must also be in a position to multiply the price of an article in accordance with the quantity of this kind of article selected by a customer.

According to the invention the above stated object is achieved by an electrical multiplying arrangement which includes several switching means operable in accordance with each of the digits representing the multiplier. Contacts of these various switching means are arranged in such a way that the contacts of each digit switching means are combined with the contacts of the multiplier switching means to carry out the multiplication for each individual digit of the figure to be multiplied and additional means are provided to combine these partial products.

Another feature of the invention is the arrangement of contacts of the switching means in accordance with the multiplication table, to effect the process of multiplication in a single operation instead of a series of additions.

These and further features of the invention will be more apparent from the following description in connection with the drawings showing one embodiment of the invention.

Fig. 1 shows the operator's position with the keyset for the selection of a two digit figure to be multiplied and for the multiplier.

Fig. 2 gives the circuit for the multiplication of the "unit" digit and

Fig. 3 shows the corresponding circuits for the "tens" digit.

Figs. 4 and 5 give the circuits for the carry-over from multiplied "unit" amounts into the "tens" digit group.

Fig. 6 is an auxiliary circuit indicating the amount in the "tens" digit group resulting from multiplication of "unit" digits.

Fig. 7 operates the "hundreds" digit indication resulting from the multiplication of the "tens" digits, and

Fig. 8 shows how the Figures 1 to 7 have to be placed together to complete the circuit diagram for the electrical multiplying arrangement.

Fig. 9 is an additional embodiment of the invention for using a multiplier of more than one digit.

In the first embodiment shown, it is assumed that only two digit figures have to be multiplied and that the highest

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multiplier is the figure 6. These figures have been chosen as they represent a practical example of a multiplying arrangement used in connection with the sale of groceries whereby the price of each individual article does not exceed 99 cents and the greatest quantity of articles of the same kind in an order does not exceed 6. It must be understood however that the same principle can be used when other figures for the multiplier as well as the multiplicand are required, and that the arrangement is not restricted to the decimal system.

The apparatus is described herein as being operated from a keyset on which multiplier and multiplicand are set up; and the product is described as being represented by operated relays in a relay group. It is entirely feasible, however, to connect the apparatus as part of some other calculating device wherein the operating keys are replaced by contacts or switches operated by that device and wherein the relay group which records the product forms part of the same or of another calculating device.

The operator's position is shown in Fig. 1. Ten keys U0 to U9 are provided for the keying up of the "unit" digits of a two digit figure and each key is electrically connected with a relay 0U to 9U respectively, which has a holding winding and when operated closes its contacts 0u1 to 0u3 . . . 9u1 to 9u3.

A similar arrangement is provided for the "tens" digits with keys T0 to T9 and corresponding relays 0T to 9T, which operate their contacts 0t1 to 0t3 . . . 9t1 to 9t3. A third keyset Q1 to Q6 is used for the keying of the multiplier. Each key operates 4 relays (1A to 1D . . . 6A to 6D), which are connected in parallel, so that all their contacts 1a1 to 1a10, 1b1 to 1b10, 1c1 to 1c10, 1d1 to 1d10 . . . are closed simultaneously. An additional contact on the D relay, for example contact 1d11, closes a holding circuit for a group of operated relays.

These relays have contacts arranged in an electrical representation of the multiplication table, so that contacts representing any pair of digits are associated with leads representing their product. For example, the statement in the multiplication table that $7 \times 5 = 35$ is represented in the apparatus by electrical circuits through the relays corresponding to the multiplier digit 5 and the multiplicand digit 7, to relays representing 30 and 5 in the relay group which is the output of the apparatus.

The holding circuits for all relays are connected with earth over contacts rs1, rs2, rs3 respectively of relay RS, which when operated as described later, releases all operated relays and thus returns the arrangement to normal. The multiplication is carried out by a suitable combination of the relay contacts of the digit relays 0U . . . 0T . . . with the relay contacts of the relays 1A . . . 1D . . . 6A . . . 6D. The corresponding circuits are shown in Figs. 2 and 3. In addition the "tens" digits resulting from the multiplication of the keyed "unit" digits have to be marked to be added to the "tens" digits keyed up and multiplied. For this purpose the circuit arrangement of Fig. 6 is provided which includes the relays 0N to 5N, operated in accordance with the resulting "tens" digits. Only six relays are provided as the highest "tens" digit possible in this embodiment is 5 resulting from multiplication of the highest "unit" digit 9 with the highest multiplier $6 (9 \times 6 = 54)$.

Similarly Fig. 7 shows the circuit for the "hundreds" digits resulting from multiplication of the "tens" digits. Only six outlets are shown as the highest figure possible is $99 \times 6 = 594$. The "tens" digits stored in one of the relays 0N to 5N are added by the contact arrangement shown in Figs. 4 and 5 to the "tens" digits resulting from the multiplication of a keyed "tens" digit and the combined result operates one of the relays 0M to 9M which mark the resultant "tens" digit in a relay group RG or in any

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other suitable manner. Additional relays MS and MT operated together with the relays 0M to 9M are used to decide the final "hundreds" digit which is to be marked in the relay group RG and for this purpose contacts *ms1* to *ms6* and *mt1* to *mt5* are included in the outgoing circuit of Fig. 7. As only 5 "hundreds" digits can appear in the embodiment described as mentioned above only the first five relays 0M to 4M are equipped with two windings, one being connected with relay MT, the other with relay MS.

All indications of the final result are collected in the relay group RG which has one relay for each digit in each group, although for simplicity only one relay has been shown for each denomination. The "unit" digit relays are indicated by the relay UR with contacts *ur1* and *ur2*, the "tens" digit relays by the relay TR with contacts *tr1* and *tr2*, and the "hundreds" digit relays by the relay HR with contacts *hr1* and *hr2*. The contacts *ur1*, *tr1* and *hr1* are used to transfer the indication to a suitable indicating device, such as the lamps HL, TL and UL, or to an adding machine or any other suitable arrangement, the contacts *ur2*, *tr2* and *hr2* are connected in series and contacts of all the "unit" relays, the "tens" relays and the "hundreds" relays are connected in parallel, so that by operating one relay in each group a circuit is closed over their contacts and wire RW for the relay RS in Fig. 1 which thus operates opening its contacts *rs1* to *rs3* and returning the whole arrangement to normal.

Indicating lamps are shown associated with the contacts of the relays in this group, to give a visual indication of the product, but these relays and lamps may be replaced by relays or solenoids forming part of further calculating or indicating equipment controlled by the apparatus.

The operation of the circuits will now be described in detail in connection with several multiplying operations.

If, for example, the figure 38 has to be multiplied by 6 the following steps take place: The "unit" digit 8 multiplied by 6 equals 48. The "tens" digit 3 multiplied by 6 equals 180. 48 and 180 added together equals 228.

To carry this multiplication out firstly the "tens" key T3 (Fig. 1) is pressed to operate the relay 3T from earth over key T3, the first winding of relay 3T to battery. Relay 3T closes its contacts *3t1* to *3t3* and establishes a holding circuit from earth over break contact *rs2*, operated contact *3t1*, second winding of relay 3T to battery. This circuit keeps relay 3T operated when the key T3 is released. The key for the "unit" digit is now pressed.

In this example the key U8 (Fig. 1) is operated and relay 8U is energised from earth over key U8, first winding of relay 8U to battery and closes its contacts *8u1* to *8u3*. Over contact *8u1* a holding circuit is closed from earth over break contact *rs3*, closed contact *8u1*, second winding of relay 8U to battery. Thus relay 8U remains operated when key U8 is released again.

Following the operation of the keys representing the multiplicand the key Q6 representing the multiplier is operated and closes a circuit for the relays 6A, 6B, 6C and 6D which are connected in parallel. These relays close their contacts *6a1* to *6a10*, *6b1* to *6b10*, *6c1* to *6c10* and *6d1* to *6d11*. The function of these contacts will appear later. Contact *6d11* closes a holding circuit from earth over break contact *rs1*, relays 6A, 6B, 6C and 6D in parallel to battery, so that these relays remain energised, when the key Q6 is released again.

The closing of the various relay contacts mentioned above established the following circuits:

In Fig. 2 a circuit is closed from earth over operated contact *8u2*, operated contact *6a9*, wire 8, cable UC (Fig. 5) to the corresponding UR relay in the relay group RG, thus indicating that the "unit" digit of the final result is 8. The contact *8u3* (Fig. 6) and *6b9* close another circuit from earth over operated contacts *8u3* and *6b9*, relay 4N to battery, indicating the 4 has to be added to the "tens" group. Relay 4N closes its contacts *4n1* to *4n10* (Figs. 4 and 5).

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The operation of relay 3T establishes the following circuits: In Fig. 3 from earth over operated contact *3t3*, operated contact *6c4*, line L8 (Fig. 4), operated contact *4n9*, second winding of relay 2M, line L11 (Fig. 5), relay MT to battery. Relay 2M closes its contact *2m* and over wire 20 and cable TC operates the relay TR corresponding to the figure 20 in the relay group RG. Relay MT has closed its contacts *mt1* to *mt5* (Fig. 7) and thus completes a circuit from earth over operated contacts *3t2* and *6d4*, closed contact *mt2*, wire 200, cable HC (Fig. 5) to the relay HR in the relay group RG representing the figure 200. Thus the indication set up at the relays HR, TR, and UR in the relay group RG is 228, the final result of the multiplication of 38 by 6. This product is exhibited by the lamps HL, TL and UL in the product indicator PI. These lamps are operated respectively by the relays HR, TR and UR. Only three lamps are shown, but there is actually one lamp for each relay in the relay group RG.

While the relays HR, TR and UR pass this result over contacts *hr1*, *tr1*, *ur1* to a suitable indicator, adding device or the like, the closed contacts *hr2*, *tr2* and *ur2* connect earth with the wire RW (Figs. 2 and 1) and thus operate relay RS which interrupts at its contacts *rs1*, *rs2* and *rs3* the holding circuits for the relays 6A, 6B, 6C, 6D, 3T and 8U. These relays release opening their contacts and returning all circuits to their initial condition, so that the relay RS is de-energised again and closes its contacts *rs1*, to *rs3*. The arrangement is now ready for the next selection.

If, for example, the figure 9 has to be multiplied by 3 the keys T0, U9 and Q3 (Fig. 1) are operated energising the relay 0T, 9U, 3A, 3B, 3C and 3D respectively in the same manner as described above. Over contacts *9u2* and *3a10* the "unit" figure 7 is transferred to relay group RG (Fig. 5) via cable UC. Over contacts *9u3* and *3b9* (Fig. 6) the relay 2N is operated. From earth over contacts *0t3* and *3c1* (Fig. 3) line L0 (Fig. 4), contact *2n1*, first winding of relay 2M, line L11 (Fig. 5) and relay MS to battery the relays 2M and MS are energised and the figure 20 is transferred over contact *2m* into the relay group RG. Over closed contacts *0t2*, *3d1* and *ms1* earth is applied to the 000 wire and thus over cable RC (Fig. 5) to the relay group RG thus giving the result of the multiplication as 27.

The description so far given is of an embodiment of the invention in which the multiplier is a single digit. If it is desired to perform a multiplication by a number of more than one digit an arrangement, as for example shown in Fig. 9, may be used. This arrangement provides for the multiplication of two two-digit numbers, but can be readily extended to cover larger numbers by adding additional units of the nature already described.

In Fig. 9 each of the two rectangles marked Left and Right represents a system of the type already described and represented by Figs. 1-7. The multiplicand is entered into the multiplicand relays, 0U-9U and 0T-9T, of both systems (extra contacts on the relays of one unit could be used to avoid duplicating these relays) and the "tens" digit of the multiplier is entered on the multiplier relays 1A-ID, 6A-6D etc. of the system Left, while the "units" digit of the multiplier is entered on the multiplier relays 1A-ID, 6A-6D etc. of the system Right.

Each system will operate to effect a multiplication and each will produce one part of the required product. The "units" digit of the final product is recorded on the UR relays of the system Right, the contacts of the ten relays of this group being represented by the contact *ur* (right). The "tens" digit of the final product is found by adding the "tens" digit of the system Right and the "units" digit of the system Left. This is effected in the adding unit AU which is identical with the equipment already described and shown in Fig. 4 and the left-hand portion of Fig. 5. The ten leads L0-L9 of Fig. 4 are represented by the lead L in Fig. 9 and the arrangement of contacts in Figs. 4 and 5 by a single contact *ur* (left), indicating

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that the contacts in the unit AU are contacts of the relays UR in the system Left instead of the relays 0N-5N etc. as in Figs. 4 and 5. The contact *tr* (right) represents the ten contacts of the relays TR in the system Right. The co-operation of these contacts will add together the digits which make up the "tens" digit of the product, which is indicated by the operation of a contact *m* of one of the relays 0M-9M in this unit. Should the addition result in the carry-over into the next denomination relay MS will operate as described in connection with Figs. 4 and 5 and will operate its contact *ms* which in turn operates relay CS.

The "hundreds" digit is ascertained by an identical unit AV in which contacts of the relays TR in the system Left co-operate with contacts of the relays HR in the system Right. The circuit completed by the M relays in this unit passes through contacts *cs* of relay CS which increase the digit indication by one if a carry-over is to be made. Similarly the relay CT and its contacts *ct* may carry-over one into the "thousands" digit, which is ascertained by the particular HR relay operated in the system Left as indicated by the contact *hr* (left).

The wires marked Thousands, Hundreds, etc. in Fig. 9 may be taken to a lamp indicator if it is required to have a visual indication of the result, or to relays or solenoids to operate further apparatus.

The apparatus can be extended to cover more digits by adding more units and interconnecting them in a similar manner to that described above.

By suitable re-arrangement of the contacts in the various sections, other digital systems using any radix may be multiplied.

I claim:

1. An electrical multiplying arrangement for multiplying two-denomination multiplicands by single-denomination multipliers, comprising: selecting relay means actuable to record the digits of multiplicands and multipliers; a source of electrical potential; leads corresponding to the "units" and "tens" digits of the first partial products of multiplicands and multipliers; and leads corresponding to the "tens" and "hundreds" digits of the second partial products thereof; indicating means corresponding to the digits of the final products of multiplicands and multipliers; operating means for each said indicating means including first and second operating means for said indicating means corresponding to "tens" digits, each said operating means operating the corresponding indicating means when connected to said source of electrical potential; "tens" carrying relay means corresponding to "tens" digits, each operable when connected to said source of electrical potential; first and second "hundreds" carrying relay means corresponding to the "hundreds" digits "zero" and "one" respectively, each operable when connected to said source of electrical potential; contacts of said selecting relay means and electrical connections from and between said contacts to connect said leads corresponding to the digits of the partial products of any multiplicand and multiplier recorded by said selecting relay means with said source of electrical potential; an electrical connection from each of said leads corresponding to the "units" digit of a first partial product to said operating means for said indicating means corresponding to such digit; an electrical connection from each of said leads corresponding to the "tens" digit of a first partial product to said "tens" carrying relay means corresponding to such digit; contacts on said "tens" carrying relay means; an electrical connection from each said contact of a "tens" carrying relay means to one of said leads corresponding to the "tens" digit of a second partial product; an electrical connection from each said contact of a "tens" carrying relay means to one of said operating means for said indicating means corresponding to the "tens" digit of the sum of the "tens" digits to which said "tens" carrying relay means to which said contact belongs and said lead to which said contact is connected respectively

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correspond, said electrical connection being to said first operating means for said last mentioned indicating means for the cases in which the "hundreds" digit of said sum is "zero" and to said second operating means for said last mentioned indicating means for the cases in which the "hundreds" digit of said sum is "one"; parallel electrical connections from said first "hundreds" carrying relay means to said first operating means for said indicating means corresponding to "tens" digits; parallel electrical connections from said second "hundreds" carrying relay means to said second operating means for said indicating means corresponding to "tens" digits; contacts of said first "hundreds" carrying relay means and electrical connections from each said contact to one of said leads corresponding to "hundreds" digits of second partial products and to said operating means for said indicating means corresponding to the same "hundreds" digit as such lead; and contacts of said second "hundreds" carrying relay means and electrical connections from each said contact to one of said leads corresponding to "hundreds" digits of second partial products and to said operating means for said indicating means corresponding to the "hundreds" digit one higher than the "hundreds" digit to which such lead corresponds.

2. An electrical multiplying arrangement for multiplying two-denomination multiplicands by single-denomination multipliers, comprising: a source of electrical potential; first selectively operable multiplicand relay means representing "units" multiplicand digits; second selectively operable multiplicand relay means representing "tens" multiplicand digits; selectively operable multiplier relay means representing multiplier digits; a set of "units" partial product leads representing "units" digits; two sets of "tens" partial product leads representing "tens" digits; a set of "hundreds" partial product leads representing "hundreds" digits; means controlled by said first and second selectively operable multiplicand relay means and by said selectively operable multiplier relay means to connect said partial product leads representing the digits of the partial products of any selected multiplicand and multiplier with said source of electrical potential, said means comprising for each set of partial product leads a contact of each of one of said sets of multiplicand relay means, contacts on each said multiplier relay means, an electrical connection from each said contact of a multiplicand relay means to said source of electrical potential, parallel electrical connections from each said contact of a multiplicand relay means to one said contact of each said multiplier relay means, each contact of a multiplier relay means being connected to one contact only of a multiplicand relay means, and an electrical connection from each said contact of a multiplier relay means to a partial product lead of such set; product "units" indicating means representing "units" digits, each connected to said "units" partial product lead representing the same "units" digit, and each operable by said source of electrical potential over such partial product lead; "tens" carrying relay means representing "tens" digits, each connected to said "tens" partial product lead, of the first set of such leads, representing the same "tens" digit, and each operable by said source of electrical potential over such partial product lead; product "tens" indicating means representing "tens" digits; first and second operating means associated with each of said product "tens" indicating means, each operable by said source of electrical potential to operate the associated indicating means; contacts on each said "tens" carrying relay means; an electrical connection from each said contact of a "tens" carrying relay means to one said "tens" partial product lead of the second set of such leads; an electrical connection from each said contact of a "tens" carrying relay means to one of said operating means associated with said product "tens" indicating means representing the "tens" digit of the sum of the "tens" digits respectively represented by said "tens" carrying relay means to which said contact belongs and by said "tens" partial

product lead to which such contact is connected, said electrical connection being to said first operating means associated with said product "tens" indicating means for the cases in which the "hundreds" digit of such sum is "zero" and to said second operating means associated with said product "tens" indicating means for the cases in which the "hundreds" digit of such sum is "one"; first "hundreds" carrying relay means representing the "hundreds" digit "zero"; second "hundreds" carrying relay means representing the "hundreds" digit "one"; parallel electrical connections from said first "hundreds" carrying relay means to said first operating means associated with each of said product "tens" indicating means, said first "hundreds" carrying relay means being operable by said source of electrical potential over any of said parallel electrical connections; parallel electrical connections from said second "hundreds" carrying relay means to said second operating means associated with each of said product "tens" indicating means, said second "hundreds" carrying relay means being operable by said source of electrical potential over any of said parallel electrical connections; product "hundreds" indicating means representing "hundreds" digits each operable by said source of electrical potential; contacts on said first "hundreds" carrying relay means; electrical connections from each said contact of said "first" "hundreds" carrying relay means to one of said "hundreds" partial product leads and to said product "hundreds" indicating means representing the same digit as such "hundreds" partial product lead; contacts of said second "hundreds" carrying relay means; and electrical connections from each said contact of said second "hundreds" carrying relay means to one of said "hundreds" partial product leads and to said product "hundreds" indicating means representing the digit one higher than the digit represented by such "hundreds" partial product lead.

3. An electrical multiplying arrangement for multiplying three-denomination multiplicands by single-denomination multipliers, comprising; a source of electrical potential; first selectively operable multiplicand relay means representing "units" multiplicand digits; second selectively operable multiplicand relay means representing "tens" multiplicand digits; third selectively operable multiplicand relay means representing "hundreds" multiplicand digits; selectively operable multiplier relay means representing multiplier digits; a set of "units" partial product leads representing "units" digits; two sets of "tens" partial product leads representing "tens" digits; two sets of "hundreds" partial product leads representing "hundreds" digits; a set of "thousands" partial product leads representing "thousands" digits; means controlled by said first, second and third selectively operable multiplicand relay means and by said selectively operable multiplier relay means to connect said partial product leads representing the digits of the partial products of any selected multiplicand and multiplier with said source of electrical potential, said means comprising for each set of partial product leads a contact of each of one of said sets of multiplicand relay means, contacts of each of said multiplier relay means, an electrical connection from each said contact of a multiplicand relay means to said source of electrical potential, parallel electrical connections from each said contact of a multiplicand relay means to one said contact of each of said multiplier relay means, each contact of a multiplier relay means being connected to one contact only of a multiplicand relay means, and an electrical connection from each said contact of a multiplier relay means to a partial product lead of such set; product "units" indicating means representing "units" digits, each connected to said "units" partial product lead representing the same "units" digit, and each operable by said source of electrical potential over such partial product lead; "tens" carrying relay means representing "tens" digits, each connected to said "tens" partial product lead, of the first set of such leads, representing the same "tens" digit, and each operable by

said source of electrical potential over such partial product lead; product "tens" indicating means representing "tens" digits; first and second operating means associated with each of said product "tens" indicating means, each operable by said source of electrical potential to operate the associated indicating means; contacts on each of said "tens" carrying relay means; an electrical connection from each said contact of a "tens" carrying relay means to one said "tens" partial product lead of the second set of such leads; an electrical connection from each said contact of a "tens" carrying relay means to one said operating means associated with said product "tens" indicating means representing the "tens" digit of the sum of the "tens" digits respectively represented by said "tens" carrying relay means to which said contact belongs and by said "tens" partial product lead to which such contact is connected, said electrical connection being to said first operating means associated with said product "tens" indicating means for the cases in which the "hundreds" digit of such sum is "zero" and to said second operating means associated with said product "tens" indicating means for the cases in which the "hundreds" digit of such sum is "one"; first "hundreds" carrying relay means representing the "hundreds" digit "zero"; second "hundreds" carrying relay means representing the "hundreds" digit "one"; parallel electrical connections from said first "hundreds" carrying relay means to said first operating means associated with each of said product "tens" indicating means, said first "hundreds" carrying relay means being operable by said source of electrical potential over any of said parallel electrical connections; parallel electrical connections from said second "hundreds" carrying relay means to said second operating means associated with each of said product "tens" indicating means, said second "hundreds" carrying relay means being operable by said source of electrical potential over any of said parallel electrical connections; third "hundreds" carrying relay means representing "hundreds" digits, each operable by said source of electrical potential; contacts on said first "hundreds" carrying relay means; electrical connections from each said contact of said first "hundreds" carrying relay means to one of said "hundreds" partial product leads, of the first set of such leads, and to said third "hundreds" carrying relay means representing the same digit as such "hundreds" partial product lead; contacts on said second "hundreds" carrying relay means; electrical connections from each said contact of said second "hundreds" carrying relay means to one of said "hundreds" partial product leads, of the first set of such leads, and to said third "hundreds" carrying relay means representing the digit one higher than the digit represented by such "hundreds" partial product lead; product "hundreds" indicating means representing "hundreds" digits; first and second operating means associated with each of said product "hundreds" indicating means, each operable by said source of electrical potential to operate the associated indicating means; contacts on each of said third "hundreds" carrying relay means; an electrical connection from each said contact of a third "hundreds" carrying relay means to one said "hundreds" partial product lead of the second set of such leads; an electrical connection from each said contact of a third "hundreds" carrying relay means to one of said operating means associated with said product "hundreds" indicating means representing the "hundreds" digit of the sum of the "hundreds" digits respectively represented by said third "hundreds" carrying relay means to which said contact belongs and by said "hundreds" partial product lead to which such contact is connected, said electrical connection being to said first operating means associated with said product "hundreds" indicating means for the cases in which the "thousands" digit of such sum is "zero" and to said second operating means associated with said product "hundreds" indicating means for the cases in which the "hundreds" digit of such sum

is "one"; first "thousands" carrying relay means representing the "thousands" digit "zero"; second "thousands" carrying relay means representing the "thousands" digit "one"; parallel electrical connections from said first "thousands" carrying relay means to said first operating means associated with each of said product "hundreds" indicating means, said first "thousands" carrying relay means being operable by said source of electrical potential over any of said parallel electrical connections; parallel electrical connections from said second "thousands" carrying relay means to said second operating means associated with each of said product "hundreds" indicating means, said second "thousands" carrying relay means being operable by said source of electrical potential over any of said parallel electrical connections; product "thousands" indicating means representing "thousands" digits, each operable by said source of electrical potential; contacts on said first "thousands" carrying relay means; electrical connections from each said contact of said first "thousands" carrying relay means to one of said "thousands" partial product leads and to said product "thousands" indicating means representing the same digit as such "thousands" partial product lead; contacts on said second "thousands" carrying relay means; and electrical connections from each said contact of said second "thousands" carrying relay means to one of said "thousands" partial product leads and to said product "thousands" indicating means representing the digit one higher than the digit represented by such "thousands" partial product lead.

4. An electrical multiplying arrangement for multiplying pre-determined two-digit multiplicands by pre-determined single-digit multipliers, comprising: selectively operable multiplicand "units" relay means each corresponding to a different "units" digit of said multiplicands; selectively operable multiplicand "tens" relay means each corresponding to a different "tens" digit of said multiplicands; selectively operable multiplier relay means each corresponding to a different one of said multipliers; product "units" indicating means each corresponding to a different "units" digit; product "tens" indicating means each corresponding to a different "tens" digit; alternative operating means for each of said product "tens" indicating means; product of "hundreds" indicating means each corresponding to a different "hundreds" digit; "tens" carrying relay means each corresponding to a different "tens" digit; "hundreds" carrying relay means corresponding to the "hundreds" digits "zero" and "one" respectively; first multiplicand "units" leads each corresponding to a different "units" digit of said multiplicands and each connected to one side of a source of electrical potential; a contact of the corresponding multiplicand "units" relay means located in each of said first multiplicand "units" leads; product "units" leads each corresponding to a different "units" digit and each connected through the corresponding product "units" indicating means to the other side of said source of electrical potential; sets of first multiplier leads, each set corresponding to one of said multipliers, each lead of each set being connected at one end to one of said first multiplicand "units" leads and at the other end to the product "units" lead corresponding to the "units" digit of the product of the multiplier to which the set to which said lead belongs corresponds by the "units" digit to which the first multiplicand "units" lead to which said lead is connected corresponds; a contact of the corresponding multiplier relay means in each lead of each of said sets of first multiplier leads; second multiplicand "units" leads each corresponding to a different "units" digit of said multiplicands and each connected to one side of a source of electrical potential; a contact of the corresponding multiplicand "units" relay means located in each of said second multiplicand "units" leads; first "tens" partial product leads each corresponding to a different "tens" digit and each connected through the corresponding "tens" carrying relay means to the other

side of said source of electrical potential; sets of second multiplier leads, each set corresponding to one of said multipliers, each lead of each set being connected at one end to one of said second multiplicand "units" leads and at the other end to the first "tens" partial product lead corresponding to the "tens" digit of the product of the multiplier to which the set to which said lead belongs corresponds by the "units" digit to which the second multiplicand "units" lead to which said lead is connected corresponds; a contact of the corresponding multiplier relay means in each lead of each of said sets of second multiplier leads; first multiplicand "tens" leads each corresponding to a different "tens" digit of said multiplicands and each connected to one side of a source of electrical potential; a contact of the corresponding multiplicand "tens" relay means located in each of said first multiplicand "tens" leads; second "tens" partial product leads each corresponding to a different "tens" digit; sets of third multiplier leads, each set corresponding to one of said multipliers, each lead of each set being connected at one end to one of said first multiplicand "tens" leads and at the other end to the second "tens" partial product lead corresponding to the "tens" digit of the product of the multiplier to which the set to which said lead belongs corresponds by the "tens" digit to which the first multiplicand "tens" lead to which said lead is connected corresponds; a contact of the corresponding relay means located in each of said sets of third multiplier leads; pairs of product "tens" leads, each pair corresponding to a different "tens" digit, the first lead of each pair being connected through one of said alternative operating means for the corresponding product "tens" indicating means and through said "hundreds" carrying relay means corresponding to the "hundreds" digit "zero" to the other side of said source of electrical potential and the second lead of each pair being connected through the other said alternative operating means for the corresponding product "tens" indicating means and through said "hundreds" carrying relay means corresponding to the "hundreds" digit "one" to the other side of said source of electrical potential; sets of "tens" adding leads, each set corresponding to a different "tens" digit, each lead of each set being connected at one end to one of said second "tens" partial product leads and at the other end to one of the pair of product "tens" leads corresponding to the "tens" digit of the sum of the "tens" digit to which the second "tens" partial product lead to which said lead is connected corresponds plus the "tens" digit to which the set to which said lead belongs corresponds, said lead being connected to the first lead of said pair in the cases in which the "hundreds" digit of such sum is zero, and to the second lead of said pair in the cases in which the "hundreds" digit of such sum is "one"; a contact of the corresponding "tens" carrying relay means in each of said sets of "tens" adding leads; second multiplicand "tens" leads each corresponding to a different "tens" digit of said multiplicands and each connected to one side of a source of electrical potential; a contact of the corresponding multiplicand "tens" relay means located in each of said second multiplicand "tens" leads; "hundreds" partial product leads each corresponding to a different "hundreds" digit; sets of fourth multiplier leads, each set corresponding to one of said multipliers, each lead of each set being connected at one end to one of said second multiplicand "tens" leads and at the other end to the "hundreds" partial product lead corresponding to the "hundreds" digit of the product of the multiplier to which the set to which said lead belongs corresponds by the "tens" digit to which the second multiplicand "tens" lead to which said lead is connected corresponds; a contact of the corresponding multiplier relay means in each lead of each of said sets of fourth multiplier leads; product "hundreds" leads each corresponding to a different "hundreds" digit and each connected through the corresponding product "hundreds" indicating means to the other side of said source of elec-

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trical potential; a set of "hundreds" adding leads corresponding to the "hundreds" digit "zero" and a set of "hundreds" adding leads corresponding to the "hundreds" digit "one," each lead of each set being connected at one end to one of said "hundreds" partial product leads and at the other end to the product "hundreds" lead corresponding to the "hundreds" digit of the sum of the "hundreds" digit to which the "hundreds" partial product lead to which said lead is connected corresponds plus the "hundreds" digit ("zero" or "one") to which the set to which said lead belongs corresponds; and a contact

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of the corresponding "hundreds" carrying relay means in each lead of each of said sets of "hundreds" adding leads.

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