

Jan. 13, 1948.

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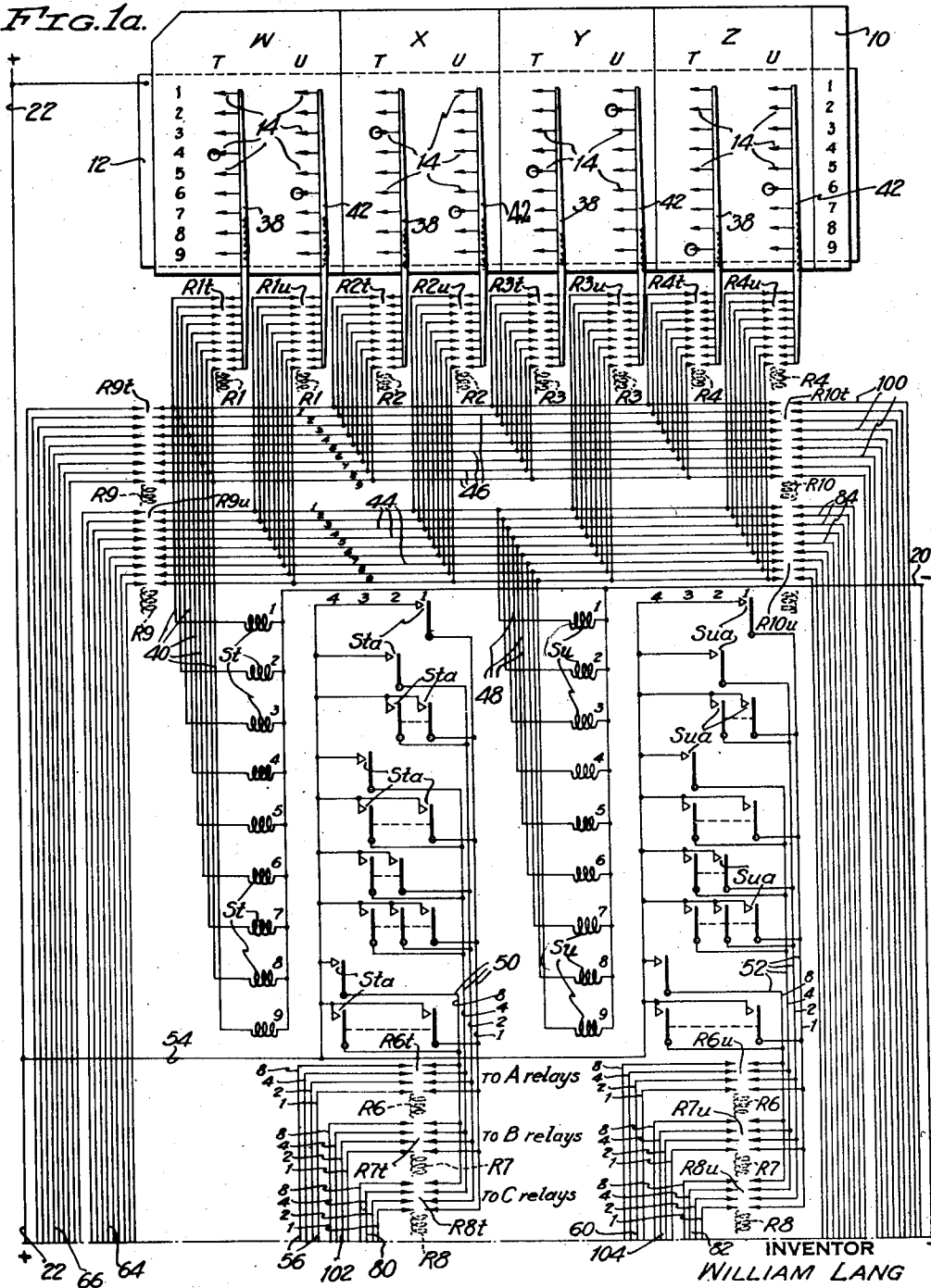
2,434,499

RELAY COMPUTING MECHANISM

Filed Nov. 10, 1944

5 Sheets-Sheet 1

FIG. 1a.



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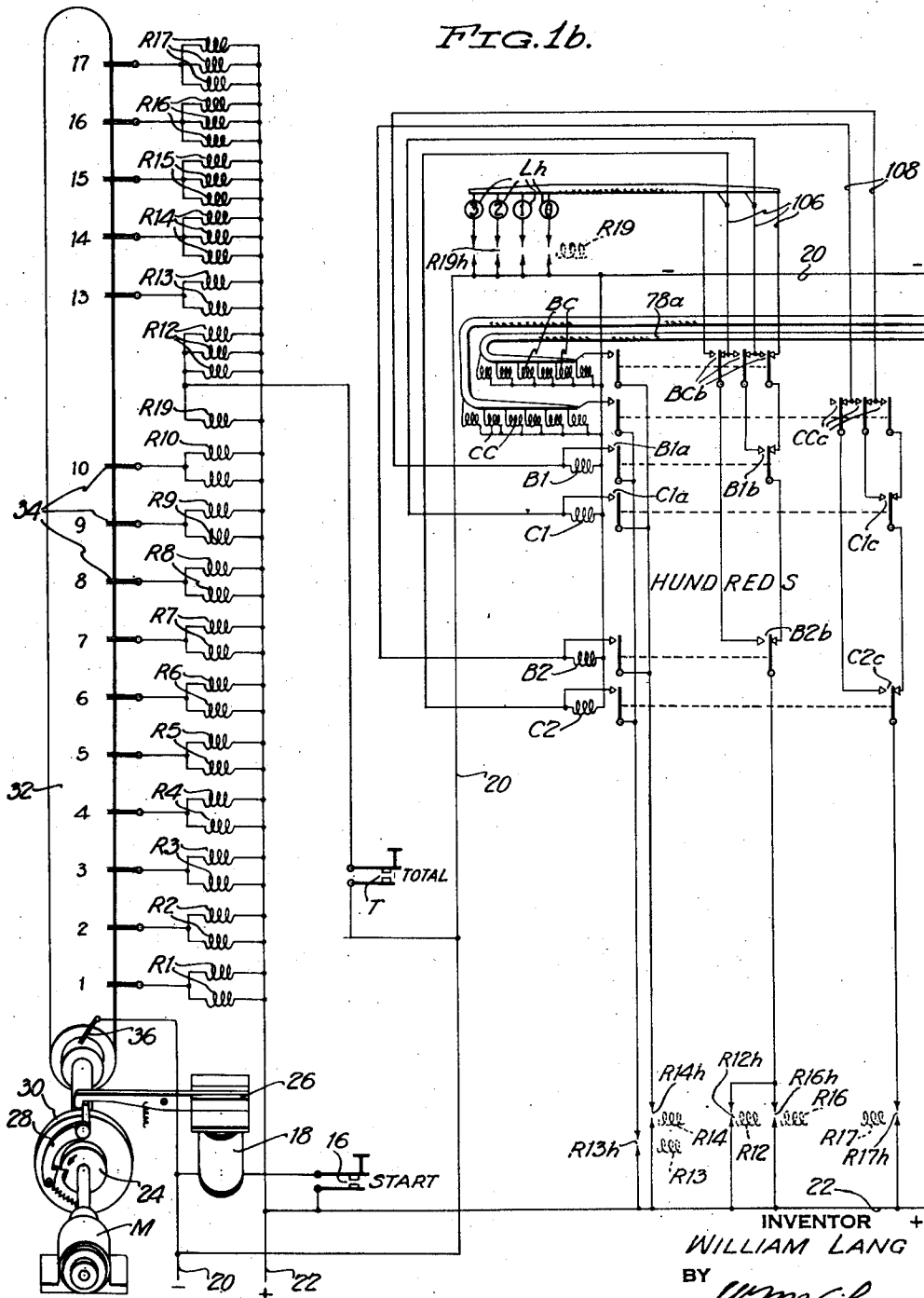
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RELAY COMPUTING MECHANISM

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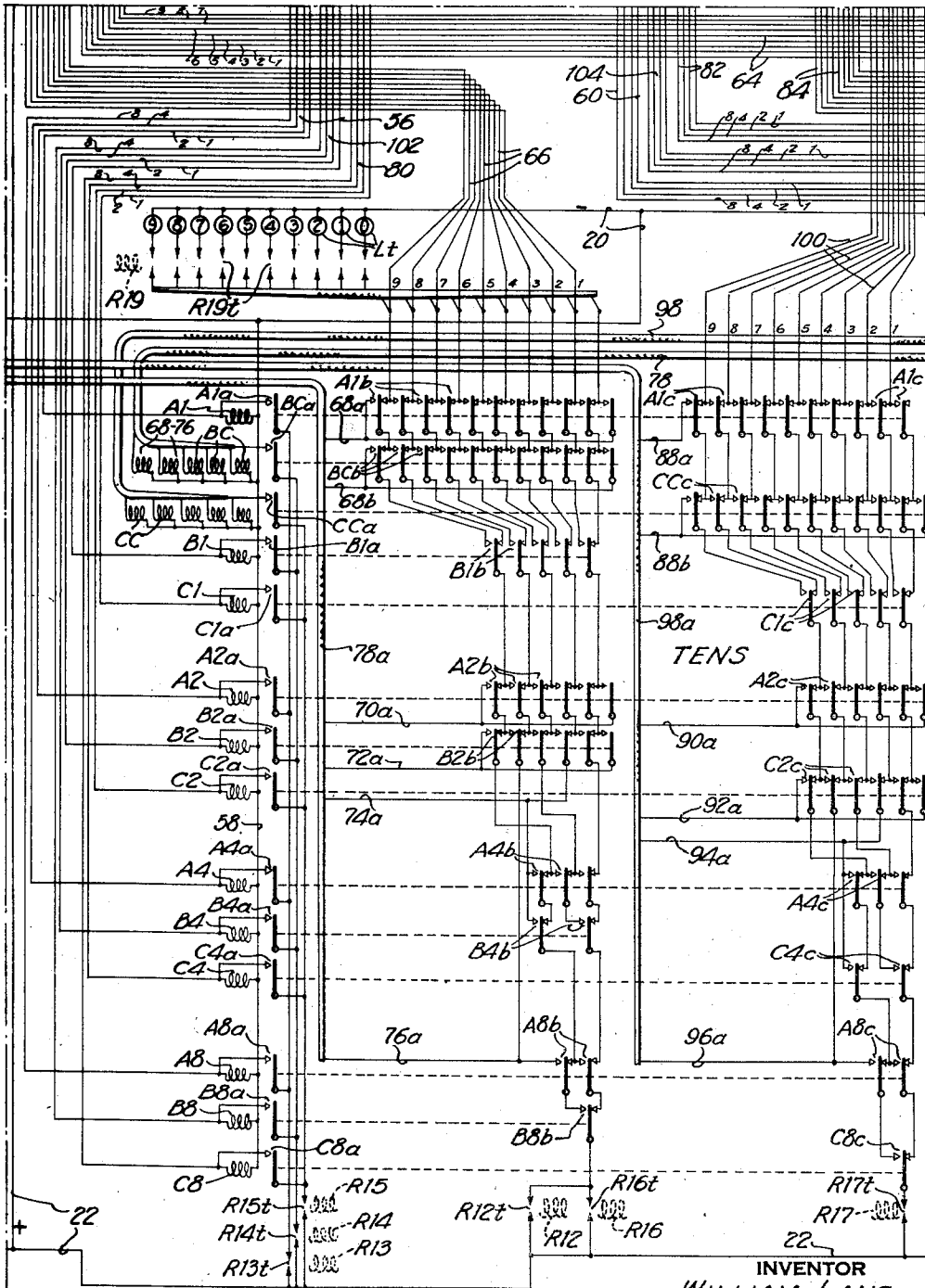


FIG. 1c.

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RELAY COMPUTING MECHANISM

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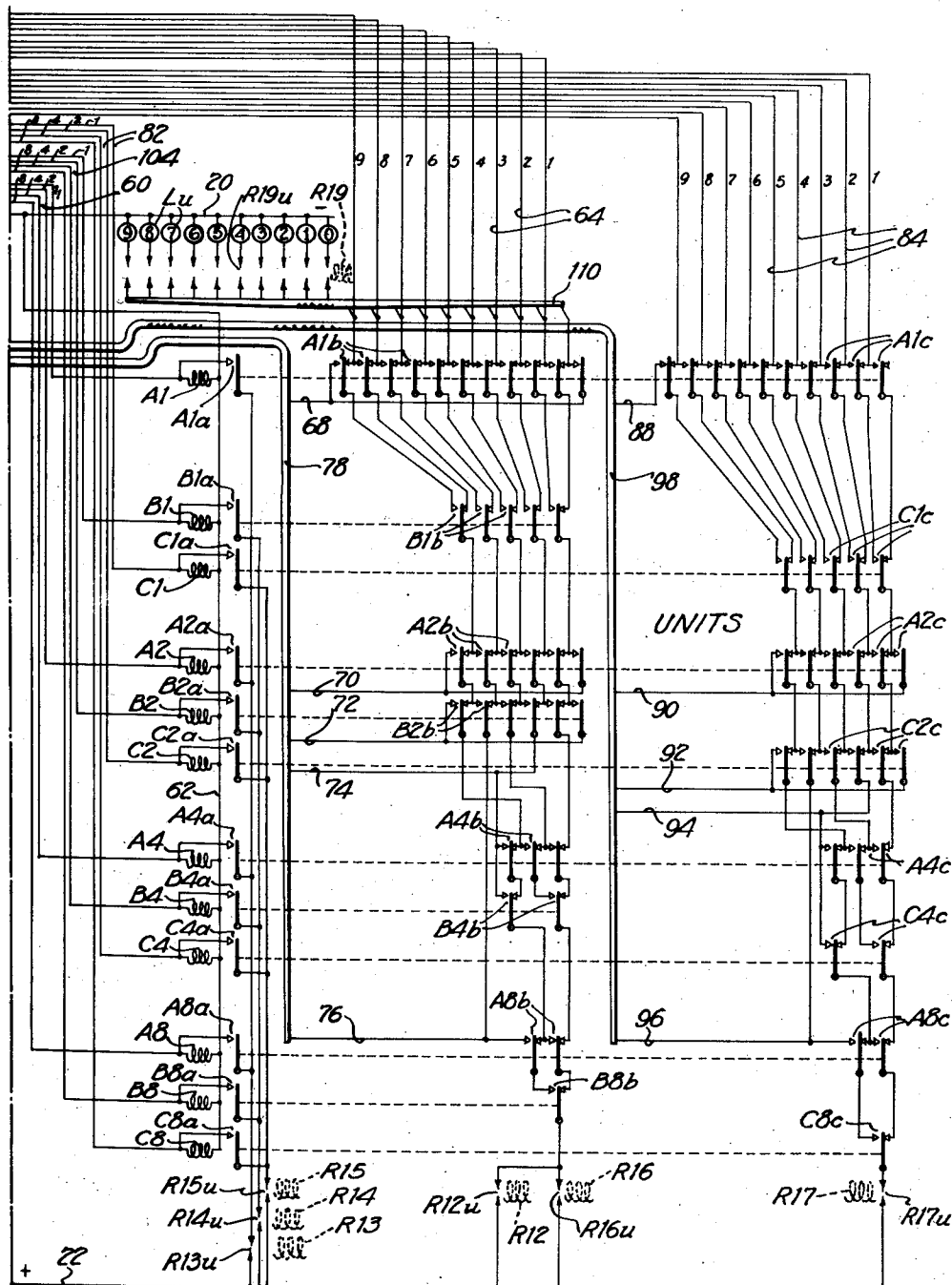


FIG. 1d.

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RELAY COMPUTING MECHANISM

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FIG. 2.

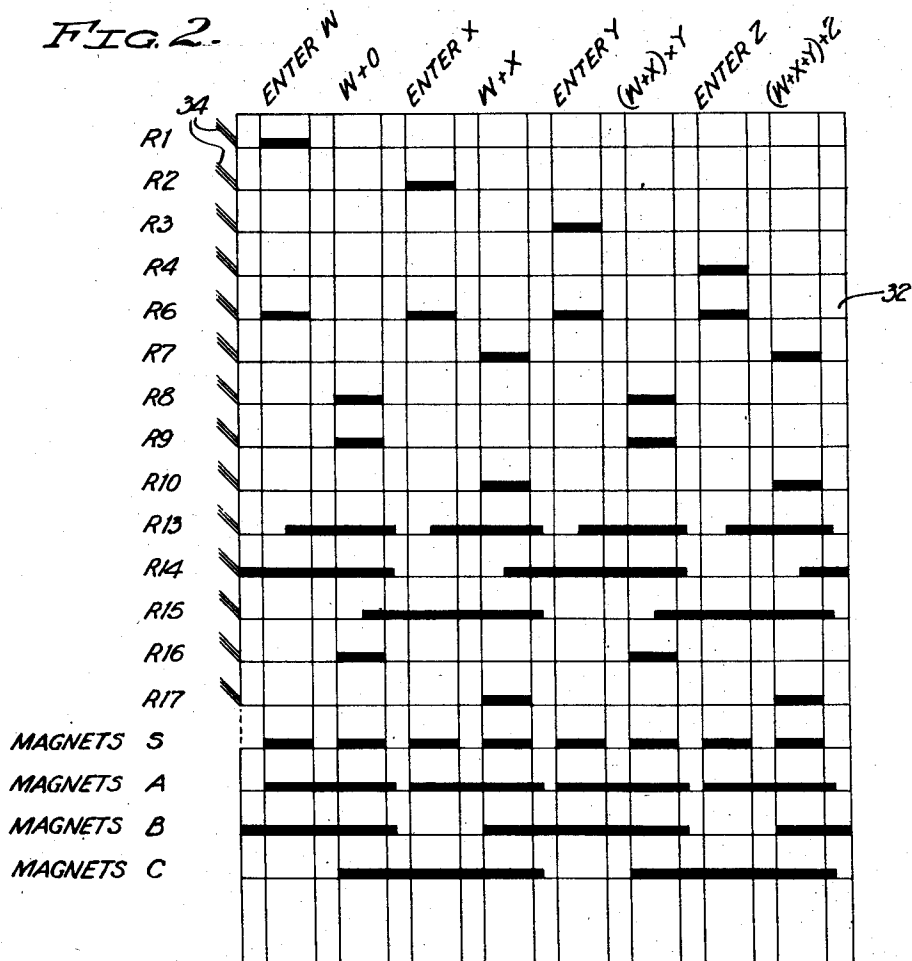
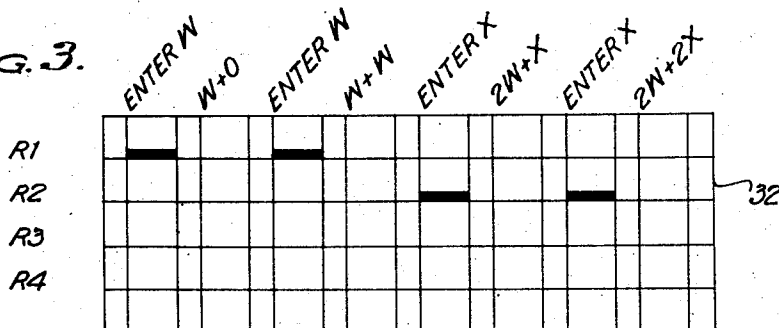


FIG. 3.



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RELAY COMPUTING MECHANISM

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5 Claims. (Cl. 235-61)

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This invention relates to calculating machines of the record controlled type and more particularly to machines in which adding operations are performed electrically.

The principal object is to provide an improved electrical relay accumulator for a calculating machine.

A more specific object is to provide novel controlling devices for a relay accumulator whereby a succession of amounts may be entered into an accumulator, each in the period required for two electrical impulses.

A more specific object is to provide mechanism for sensing a record card for amounts represented in decimal system of notation, convert the amounts into a combinational system of notation for accumulation in that system and convert the result back into the decimal system.

Other objects of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of example, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In the drawings:

Figs. 1a, 1b, 1c and 1d placed in the order

1a
1b, 1c, 1d

constitute a wiring diagram of the electric circuits of the apparatus.

Fig. 2 is a timing and sequence chart of the operations.

Fig. 3 is a timing chart of a modified sequence.

In the drawings the record card sensing devices are shown in a diagrammatic manner where in Fig. 1a, 10 represents a record card of the well known type, provided with rows and columns of index point positions in which digits are recorded by perforating selected positions. The vertical columns are divided into fields such as W, X, Y, and Z, shown diagrammatically as two-column fields in which perforations are made to represent the numbers 46, 37, 52 and 96, whose sum 231 is to be obtained by the devices of the invention.

The record card 10 is placed in sensing position between a common conductive plate 12 and sets of brush sensing elements 14 of which there is one set for each card column. As usual, the presence of a digit representing perforation in any card column will allow the related brush 14 to make electrical contact with conductive plate 12.

Before tracing circuits through the card perforations the sequencing commutator will be described together with the time chart in Fig. 2. Referring to Fig. 1b, after a card 10 has been placed in sensing position, start contacts 16 are closed to energize clutch magnet 18 by connecting it to opposite sides of current lines 20 and 22.

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A continuously running motor M drives a clutch disk 24 and when magnet 18 is energized it rocks its latching armature 26 to release spring pressed dog 28 for engagement with constantly running clutch disk 24. As a result disk 30, upon which dog 28 is pivoted, will rotate for one revolution and similarly turn commutator 32 with which a row of brushes 34 coast. In Fig. 2, the development of commutator 32 is represented with brushes 34 indicated in their relative starting position.

Each brush 34 is wired to a pair or trio of relay magnets identified as R1, R2, R3, etc., and as commutator 32 revolves circuits are completed from negative line 20 (Fig. 1b) to common brush 36, brushes 34, their related relay magnets to positive line 22.

As seen from Fig. 2, relay R14 is initially in energized condition to hold circuits set up during a previous operation. At the present time energization of relay R14 is of no effect.

Enter amount W.—With card 10 in sensing position and commutator 32 rotating, it will be seen from Fig. 2 that relays R1 and R6 both become energized. Referring to Fig. 1a relays R1 close sets of contacts R1t and R1u and relays R6 close sets of contacts R6t and R6u.

Closure of contacts R1t and R1u will complete circuits through the perforations in the W field of the card to energize selected relays of a tens group St and of a units group Su. For the specific example, a circuit is traceable from positive line 22, common plate 12, perforation in the 4 position, 4 wire of a group in cable 38, the 4 contact R1t, to the 4 wire of a group 46, the fourth from the left of a group of wires 40, the 4 magnet St to negative line 20. Concurrently, there is a circuit from line 22, plate 12, the hole in the 6 position, the 6 brush 14, cable 42, the 6 contact R1u, the 6 wire of a group 44, the sixth wire from the left of a group 48, to the 6 magnet Su and negative line 20.

Thus, the tens and units digits 4 and 6 of the W amount are set up on magnets St and Su. The contacts of these magnets designated generally St_a and Su_a connect positive line 22 to combinations of four wires 50 and 52 in accordance with the well known binary code. Thus, the 1 magnet St connects line 22 to the 1 wire 50, 2 magnet St connects line 22 to the 2 wire 50, 3 magnet St connects line 22 to the 1 and 2 wires 50, 4 magnet St connects line 22 to the 4 wire 50, 5 magnet St connects line 22 to the 1 and 4 wires 50, 6 magnet St connects line 22 to the 2 and 4 wires 50, 7 magnet St connects line 22 to the 1, 2 and 4 wires 50, 8 magnet St connects line 22 to the 8 wire 50, 9 magnet St connects line 22 to the 1 and 8 wires 50.

For the amount 46 a circuit is accordingly traceable for the tens digit 4 from line 22 (Fig. 1a), wire 54, contacts St_a of the 4 magnet St,

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the 4 wire 50, contacts R6t (now closed) to the 4 wire of a group 56 (Fig. 1c) to a magnet A4 and wire 58 to negative line 20. A parallel circuit is also traceable from line 22 (Fig. 1a), wire 54, the 2 and 4 contacts Sua of the 6 magnet Su, the 2 and 4 wires 52, contacts R6u, the 2 and 4 wires of a group 60 (Figs. 1c and 1d), to magnets A2 and A4 and wire 62 to line 20.

The amount 46 is thus sensed, converted into binary code and entered on the A magnets A4 for the tens digit and A2, A4 for the units digit. These magnets close contacts suffixed *a* to provide holding circuits through relay magnet contacts R13u, R13t of which a representative one is traceable in Fig. 1d from positive line 22, contacts R13u, contact A4a, magnet A4, wire 62 to negative line 20. This holding circuit holds the A magnets energized for the period indicated opposite R13 in Fig. 2.

Combine amounts in A and B magnets.—The next step or portion of the cycle designated W+0 in Fig. 2 serves to add the amounts set in the A and B magnets and enters the result in the set of C magnets. Since there is no setting in the B magnets the amount 46 will be transferred from the A set to the C set and this is effected by the energization of magnets R8, R9 and R16, during this step of operation.

In Figs. 1c and 1d the A and B magnets control sets of contacts suffixed *b*, electrically interconnected to form an adding chain that may be termed the A, B adding chain and which connects line 22 to the wire of a group designated 64 for the units order and 66 for the tens order, corresponding to the units digit of the sum of the digit set on the A and B sets of magnets in each order.

Specifically, for the example of an entry of 6 on the A magnets of the units order, Fig. 1d (i. e., magnets A2 and A4 energized), upon closure of contacts R16u (Fig. 1d), a circuit is traceable from line 22, contacts R16u, right hand contacts B8b, right hand contacts A8b, right hand contacts B4b, right hand contacts A4b (shifted), contacts B2b, third from the left, contact A2b, third from the left (shifted), contacts B1b, second from the left, contacts A1b, fourth from the left, 6 wire 64 (Figs. 1c and 1a), contacts R9u (now closed), 6 wire 44, 6 wire 48 and 6 magnet Su to negative line 20. In this manner, upon energization of magnets R9 and R16 the units digit of the sum of the digits in the units order is entered on the Su magnets.

Concurrently, the energization of magnets R9 and R16 will energize the St magnet corresponding to the units digit of the sum of the A and B settings in the tens order; ($4+0=4$). This circuit is traceable from line 22 (Fig. 1c), contacts R16t, right hand contacts B8b, right hand contacts A8b, right hand contacts B4b, right hand contacts A4b (shifted), contacts B2b, third from the left, contacts A2b, third from the left, contacts B1b, second from the left, contacts A1b, sixth from the left, 4 wire 66 (Fig. 1a), contacts R9t, 4 wire 46, 4 wire 40 and 4 magnet St to negative line 20. Magnets St and Su are thus set to represent 46.

Inspection of the adding chain in Fig. 1d, for example, through the *b* contacts of the A and B magnets will show that for all combinations of A and B digits the circuit will extend from line 22 to the wire 64, representing the units digit of the sum of the two digits set up and the following table will assist in tracing the several combinations. In a column headed "Carry wire" is indi-

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cated a wire through which a carry circuit is completed where the sum is greater than 9. A specific circuit showing this will be traced following the table.

A Digit	A Mag-nets	B Digit	B Mag-nets	Wire 64	Carry Wire
1	1	0	---	1	---
1	1	1	1	2	---
1	1	2	2	3	---
1	1	3	1,2	4	---
1	1	4	4	5	---
1	1	5	1,4	6	---
1	1	6	2,4	7	---
1	1	7	1,2,4	8	---
1	1	8	8	9	---
1	1	9	1,8	---	68
2	2	0	---	2	---
2	2	1	1	3	---
2	2	2	2	4	---
2	2	3	1,2	5	---
2	2	4	4	6	---
2	2	5	1,4	7	---
2	2	6	2,4	8	---
2	2	7	1,2,4	9	---
2	2	8	8	---	70
2	2	9	1,8	---	70
3	1,2	0	---	3	---
3	1,2	1	1	4	---
3	1,2	2	2	5	---
3	1,2	3	1,2	6	---
3	1,2	4	4	7	---
3	1,2	5	1,4	8	---
3	1,2	6	2,4	9	---
3	1,2	7	1,2,4	---	68
3	1,2	8	8	---	70
3	1,2	9	1,8	---	70
4	4	0	---	2	---
4	4	1	1	4	---
4	4	2	2	5	---
4	4	3	1,2	6	---
4	4	4	4	7	---
4	4	5	1,4	8	---
4	4	6	2,4	9	---
4	4	7	1,2,4	---	72
4	4	8	8	---	72
4	4	9	1,8	---	74
5	1,4	0	---	3	---
5	1,4	1	1	5	---
5	1,4	2	2	6	---
5	1,4	3	1,2	8	---
5	1,4	4	4	9	---
5	1,4	5	1,4	---	68
5	1,4	6	2,4	1	72
5	1,4	7	1,2,4	2	72
5	1,4	8	8	3	74
5	1,4	9	1,8	4	74
6	2,4	0	---	6	---
6	2,4	1	1	7	---
6	2,4	2	2	8	---
6	2,4	3	1,2	9	---
6	2,4	4	4	---	70
6	2,4	5	1,4	1	70
6	2,4	6	2,4	2	72
6	2,4	7	1,2,4	3	72
6	2,4	8	8	4	74
6	2,4	9	1,8	5	74
7	1,2,4	0	---	7	---
7	1,2,4	1	1	8	---
7	1,2,4	2	2	9	---
7	1,2,4	3	1,2	---	68
7	1,2,4	4	4	1	70
7	1,2,4	5	1,4	2	70
7	1,2,4	6	2,4	3	72
7	1,2,4	7	1,2,4	4	72
7	1,2,4	8	8	5	74
7	1,2,4	9	1,8	6	74
8	8	0	---	8	---
8	8	1	1	9	---
8	8	2	2	---	72
8	8	3	1,2	1	72
8	8	4	4	2	74
8	8	5	1,4	3	74
8	8	6	2,4	4	74
8	8	7	1,2,4	5	74
8	8	8	8	6	76
8	8	9	1,8	7	76
9	1,8	0	---	9	---
9	1,8	1	1	---	68
9	1,8	2	2	1	72
9	1,8	3	1,2	2	72
9	1,8	4	4	3	74
9	1,8	5	1,4	4	74
9	1,8	6	2,4	5	74
9	1,8	7	1,2,4	6	74
9	1,8	8	8	7	76
9	1,8	9	1,8	8	76
0	---	0	---	---	---
0	---	1	1	1	---
0	---	2	2	2	---
0	---	3	1,2	3	---
0	---	4	4	4	---
0	---	5	1,4	5	---
0	---	6	2,4	6	---
0	---	7	1,2,4	7	---
0	---	8	8	8	---
0	---	9	1,8	9	---

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Assume, for example, a setting in the units order of 9 on the A magnets and a setting of 2 on the B magnets. The carry circuit would then be traceable from line 22, contacts R16u, contacts B8b, right hand contacts A8b (shifted) left hand contacts B4b, left hand contacts A4b, left hand contacts B2b (shifted), wire 72, cable 78 (Fig. 1c), to one coil of a multiple coil magnet BC, wire 58 to negative line 20. This circuit branches after passing through left hand contacts B2b (shifted) to the right hand contacts B2b (shifted), contacts A2b (second from the right), right hand contacts B1b, contacts A1b (shifted, second from the right), the 1 wire 64 (Figs. 1c and 1a), contacts R9u to the 1 wire 44 and wire 48 to the 1 relay Su and line 20.

The adding chain for the A and B settings in the tens order (Fig. 1c) is just the same as for the units order except that the contacts Bcb are interposed to add a unit to the sum in the tens order when there is a carry from the units order. In the tens adding chain there are in turn carry circuits branching through wires 68a, 70a, 72a, 74a and 76a, corresponding to wires 68 to 76 for the units order and these together with an added wire 68b run through cable 78a (Fig. 1b) to the coils of magnet BC in the hundreds order to shift contacts Bcb in that order when there is a tens carry from the tens order.

As explained, the sum of the A and B settings is now entered in the St and Su magnets and with magnet R8 also energized at this time (see Fig. 2), circuits extend from line 22 (Fig. 1a), wire 54, contacts Sta, wires 50, contacts R8t, wires 80 (Fig. 1c) to the C magnets in the tens order, corresponding to the digit set on the St magnets, and wire 58 to line 20.

Concurrently, circuits extend from line 22 (Fig. 1a), wire 54, contacts Sua, wires 52, contacts R8u, wires 82 (Figs. 1c and 1d) to the C magnets in the units order corresponding to the digit set on the Su magnets, and wire 62 to line 20. For the example chosen the C magnets are now energized to represent 46. They close their contacts C1a, C2a, C4a and C8a as the case may be to provide holding circuits completed when magnet R15 is energized, traceable in the units order, from line 22 (Fig. 1d), contacts R15u, contacts C1a to C8a, magnets C1 to C8, wire 62 to line 20. The C magnets will thus be held for the period indicated in Fig. 2 after the holding circuits for the A and B magnets are broken by deenergization of magnets R13 and R14.

Enter amount X.—When magnets R2 and R6 now close the second field of the card 10 (Fig. 1a) will be sensed and the amount 37 therein, entered into the S magnets through circuits traceable from line 22, common plate 12, perforations in the 3 and 7 positions, related cables 38 and 42, contacts R2t and R2u, wires 46 and 44, wires 40 and 48 to magnets St and Su and line 20. These magnets (the 3 magnet St and the 7 magnet Su) close their contacts Sta and Sua to complete circuits to magnets A1 and A2 in the tens order and magnets A1, A2 and A4 in the units order. These circuits are traceable from line 22 (Fig. 1a), wire 54, contacts Sta and Sua, wires 50 and 52, contacts R6t and R6u, wires 56 and 60 (Figs. 1c and 1d) to the A magnets in the tens and units orders, wires 58 and 62 to line 20. Thereafter, when magnet R13 is energized the A holding circuits are established for the period indicated.

Thus, as seen from Fig. 2, when magnets R2 and R6 have deenergized only magnets A and C are held when magnets R7, R10 and R17 now

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close. These will cause the sum of the amounts and the A and C magnets to be entered into the B magnets whose setting will then represent the sum of amounts W and X or 83.

Referring to Fig. 1d the contacts suffixed c of the A and C magnets are interconnected to form an adding chain that is exactly similar to the A and B adding chain so that when contacts R17u close a circuit is completed from line 22, through the chain to the 3 wire 84, traceable specifically from contacts R17u, contacts C8c, right hand contacts A8c, right hand contacts C4c (shifted), center contacts A4c (shifted), left hand contacts C2c (shifted), right hand contacts C2c (shifted), contacts A2c, fifth from the left (shifted), contacts C1c, fourth from the left, contacts A1c, eighth from the left (shifted), to the 3 wire 84 which extends (Figs. 1c and 1a) to contacts R10u (now closed) to the 3 wire 44, 3 wire 48 and 3 magnet Su to line 20.

A carry circuit branches at contacts C2c (Fig. 1d) through wire 92, cable 98 (Fig. 1c) to a coil of multiple magnet Cc, wire 58 to line 20. Magnet Cc shifts its contacts Ccc to add a unit in the tens order adding chain.

In the tens order with magnets C4, Cc, A1 and A2 energized, the circuit is traceable from line 22, contacts R17t, contacts C8c, right hand contacts A8c, right hand contacts C4c (shifted), center contacts A4c, contacts C2c, third from the left, contacts A2c, third from the left (shifted), contacts C1c, second from the left, contacts Ccc, fourth from the left (shifted), contacts A1c, third from the left (shifted), 8 wire 100 (Fig. 1a), contacts R10t, 8 wire 46, 8 wire 40 to the 8 magnet St.

With magnets R7 energized circuits continue from line 22 (Fig. 1a), wire 54, contacts Sta and Sua, wires 50 and 52, contacts R7t and R7u, wires 102 and 104 (Figs. 1c and 1d) to the magnets B in the tens and units orders and wires 58 and 62 to line 20.

Thus, the sum 83 is set on the B magnets and when magnet R14 is now energized contacts R14u and R14t provide circuit paths to hold the B magnets after the A and C magnets become deenergized.

Enter amount Y.—This step of the operation is a repetition of the step in which the W amount was entered, the only difference being in the energization of magnet R3 instead of R1, whereby contacts R3t and R3u will direct the circuit to the St and Su magnets to set up the Y amount 52 therein and these magnets in turn, through their contacts Sta and Sua and contacts R6t and R6u, will set up the amount 52 in the A magnets, and thereafter magnet R13 is energized to provide a holding circuit. Thus, just after the period headed "enter Y" in Fig. 2, the magnets A1 and A4 and B8 in the tens order and the magnets A2, B1 and B2 in the units order will be in-energized condition.

The A plus B adding chains are now called into operation and in the units order (Fig. 1d), the circuit through contacts R16u extends to the 5 wire 64 and thence as explained to the 5 magnet Su and finally to the C1 and C4 magnets of the units order. There is no tens carry for this summation.

In the tens order closure of contacts R16t will complete a circuit to the 3 wire 66 and ultimately to the C1 and C2 magnets of the tens order. A tens carry circuit branches through wire 74a (Fig. 1c) and cable 78a (Fig. 1b) to energize a coil of magnet Bc in the hundreds order so that

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in this order there is a circuit traceable from line 22, contacts R16h, contacts B2b, B1b, right hand contacts BCb (shifted), 1 wire 106 to the magnet C1 and line 20. Thus, the C magnets are now set to represent the sum of W, X and Y or 135 and the next step follows.

Enter amount Z.—This step is a repetition of the step wherein amount X was entered. Through the now familiar circuits the Z amount 96 is entered on the S magnets and then on the A magnets and held. In the adding part of the period the A1, A8, C1 and C2 magnets are set in the tens order, the A2, A4, C1 and C4 magnets are set in the units order and the C1 magnet is set in the hundreds order.

Consequently, when magnets R7, R10 and R17 now become energized the sum 231 becomes set on the B magnets which are held as the commutator 32 completes its revolution. Briefly, tracing the circuits involved for the units order, the A plus C adding chain directs the circuit through the 1 wire 84 and carry wire 90 to energize the B1 magnet of the units order and the Cc magnet of the tens order.

In the tens order the A plus C adding chain directs the circuit through the 3 wire 100 and carry wire 92a to energize the B1 and B2 magnets of the tens order and the Cc magnet of the hundreds order.

In the hundreds order the right hand adding chain completes a circuit from line 22, contacts R17h, C2c, C1c (shifted) center contacts Ccc (shifted), 2 wire 108 and magnet B2 to line 20. Accordingly, at the end of the cycle the B magnets alone are set to the total and held.

Another record card may now be placed in sensing position and another revolution of commutator initiated to progressively increase the total.

When it is desired to obtain an indication of the total standing in the B magnets at the end of any cycle, total key T is closed. This causes energization of magnets R12 and R19 and will complete a circuit through the A plus B adding chains to light lamps Lu, Lt and Lh in the several orders in accordance with the digital value set in the orders. The total circuit for the units order would be traceable from line 22 (Fig. 1d) contacts R12u, B8b, right hand contacts A8b, right hand contacts B4b, right hand contacts A4b, contacts B2b, second from the right, contacts A2b, second from the right, right hand contacts B1b (shifted), contacts A1b, third from the right, 1 wire 64, cable 110, 1 contact R19u and 1 lamp Lu to line 20. The circuits in the tens and hundreds orders are similarly traceable.

The foregoing, accordingly, describes an apparatus in which successive entries may be made and in which each entry is effected by a pair of electrical impulses. Thus, the impulse indicated in Fig. 2 under "enter W" enters W in the A magnets and the following pulse under "W+0" effects summation and entry into the C magnets. The next entry results in the sum appearing in the B magnets and so on with each progressive total being set in an alternate one of the B or C set of magnets.

Fig. 3 shows a modification of the section of the commutator 32, whereby the record card would have the amount in its W field read and entered twice and then the amount in the X field read and entered twice to obtain $2W+2X$, and the Y and Z fields would not be read. Other combinations of sequence in which the amounts may be read will occur to those skilled in the

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art and where amounts are to be subtracted the fields may obviously be perforated in accordance with the tens complement of the number.

The entire apparatus may be cleared by disconnecting either line 20 or 21 from the source of current whereupon all relay magnets will become deenergized.

While there have been shown and described and pointed out the fundamental novel features of the invention, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. In an electrical computing apparatus, a set of relay magnets, means for repeatedly setting said magnets to represent a succession of amounts to be added, a second set of relay magnets settable to represent amounts, a third set of relay magnets settable to represent amounts, means jointly controlled by the first and second set of magnets and rendered effective upon the first and alternate entries into said first set, for entering the sum of the amounts set in said first and second sets, into the third set, means jointly controlled by the first and third set of magnets and rendered effective upon the second and alternate entries into said first set, for entering the sum of the amounts set in said first and third sets, into the second set, and means for clearing each of said pair of sets of magnets subsequent to the entry of its sum into the remaining set of magnets.

2. In an electrical computing apparatus, a first, second and third set of relay magnets, each settable to represent an amount, means for entering a first and second amount into the first set of relay magnets in succession, computing devices controlled by the magnets of the first and second sets, and effective upon entry of the first amount for obtaining the sum of the amounts set in said first and second sets of magnets, and entering said sum into the magnets of the third set, further computing devices controlled by the magnets of the first and third sets and effective upon entry of the second amount, for obtaining the sum of the amounts set in said first and third sets of magnets and entering said sum into the magnets of the second set, and means for clearing each of said pair of sets of magnets subsequent to the entry of its sum into the remaining set of magnets, whereby successive sums will be alternately represented on the second and third sets of relay magnets.

3. In an electrical computing apparatus, a first set of relay magnets settable to represent an amount, a set of contacts adjusted thereby, a second set of relay magnets settable to represent an amount, a set of contacts adjusted thereby, a third set of relay magnets settable to represent an amount, a set of contacts adjusted thereby, circuit connections interconnecting the contacts of the second set and part of the contacts of the first set in accordance with the table of addition to form a first adding chain, circuit connections interconnecting the contacts of the third set and another part of the contacts of the first set in accordance with the table of addition to form a second adding chain, means for repeatedly energizing the magnets of the first set to represent thereon a succession of amounts, means effec-

tive upon setting the first and alternate amounts on said first set of magnets for rendering the first adding chain effective and causing it to control the magnets of the third set, and means effective upon setting the second alternate amounts on said first set of magnets for rendering the second adding chain effective and causing it to control the magnets of the second set, and means for clearing each adding chain and its controlling magnets subsequent to its control of the remaining set of magnets, whereby the totals of the amounts successively entered into the first set of magnets will be progressively represented on the second and third sets of magnets in alternation.

4. In an electrical computing apparatus, a pair of relay adding chains, each comprising two sets of contacts upon which two amounts are setttable and interconnected in accordance with the table of addition, means responsive to a single electrical impulse transmitted through the first relay chain for setting one of the sets of contacts of the second chain in accordance with the sum of the two amounts set on the contacts of the first chain, further means responsive to a single electrical impulse transmitted through the second relay chain for setting one of the sets of contacts of the first chain in accordance with the sum of the two amounts set on the contacts of the second chain, means for sending electrical impulses to said chains in alternation, means for clearing the setting in each chain subsequent to its control of the other chain, and means effective intermediate said impulses for setting the other set of contacts of the next chain that is to receive an impulse, in accordance with a further amount.

5. In an electrical computing apparatus, a first and second set of relay contacts, a first set of adding circuit connections controlled thereby, a third set of relay contacts, a second set of adding circuit connections controlled by said first and third sets of relay contacts, means controlled through the first set of adding circuit connections for setting the relay contacts of the third set, means controlled through the second set of adding circuit connections for setting the relay contacts of the second set, means for repeatedly and selectively setting the relay contacts of the first set, sequencing means for rendering the first and second adding circuit connections alternately effective after alternate settings of the first set of contacts, and means for clearing each set of relay contacts subsequent to the control thereby of another set.

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