

April 8, 1958

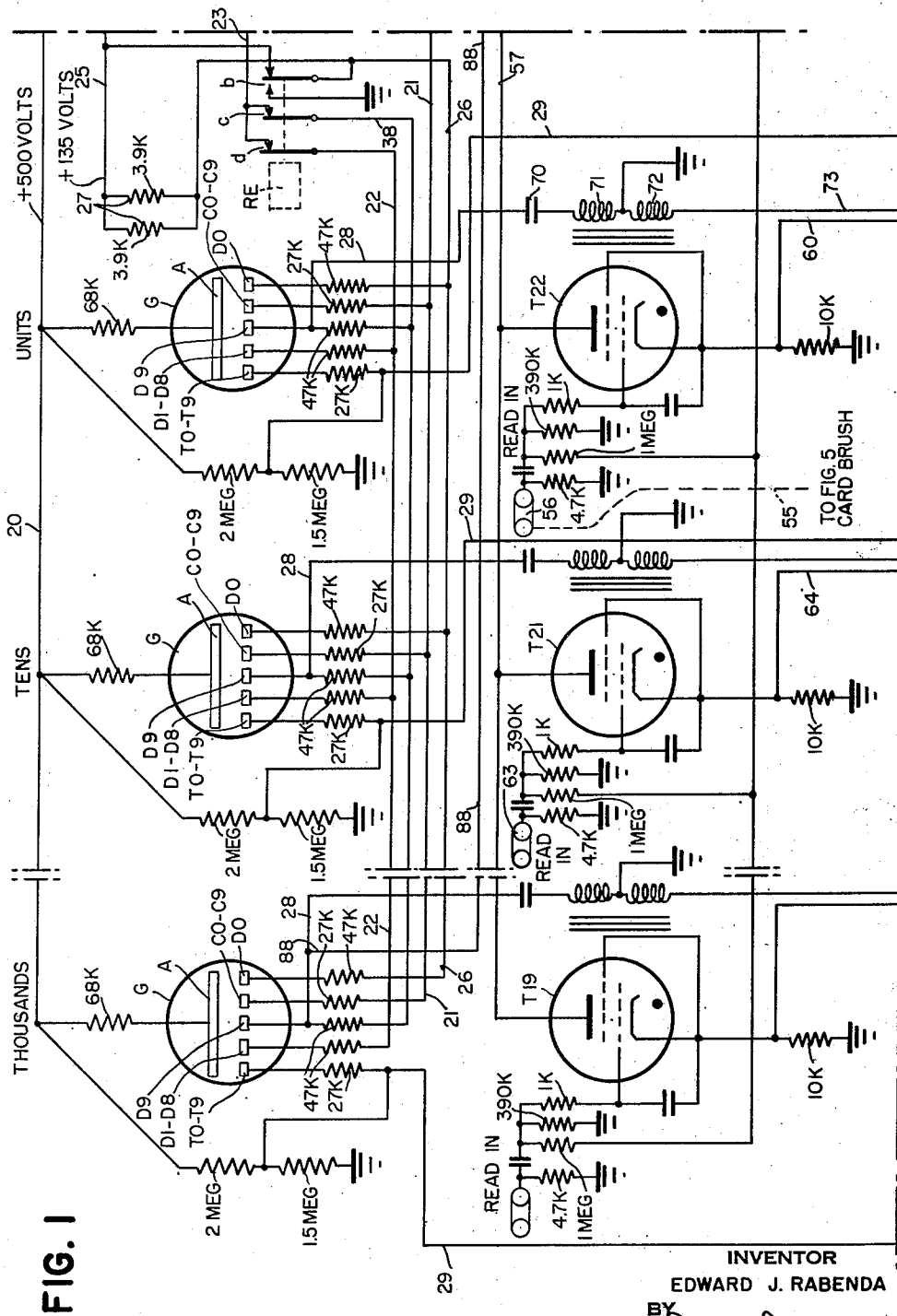
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2,829,830

SELF COMPLEMENTING ACCUMULATING MACHINE

Filed Aug. 29, 1952

7 Sheets-Sheet 1



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SELF COMPLEMENTING ACCUMULATING MACHINE

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7 Sheets-Sheet 2

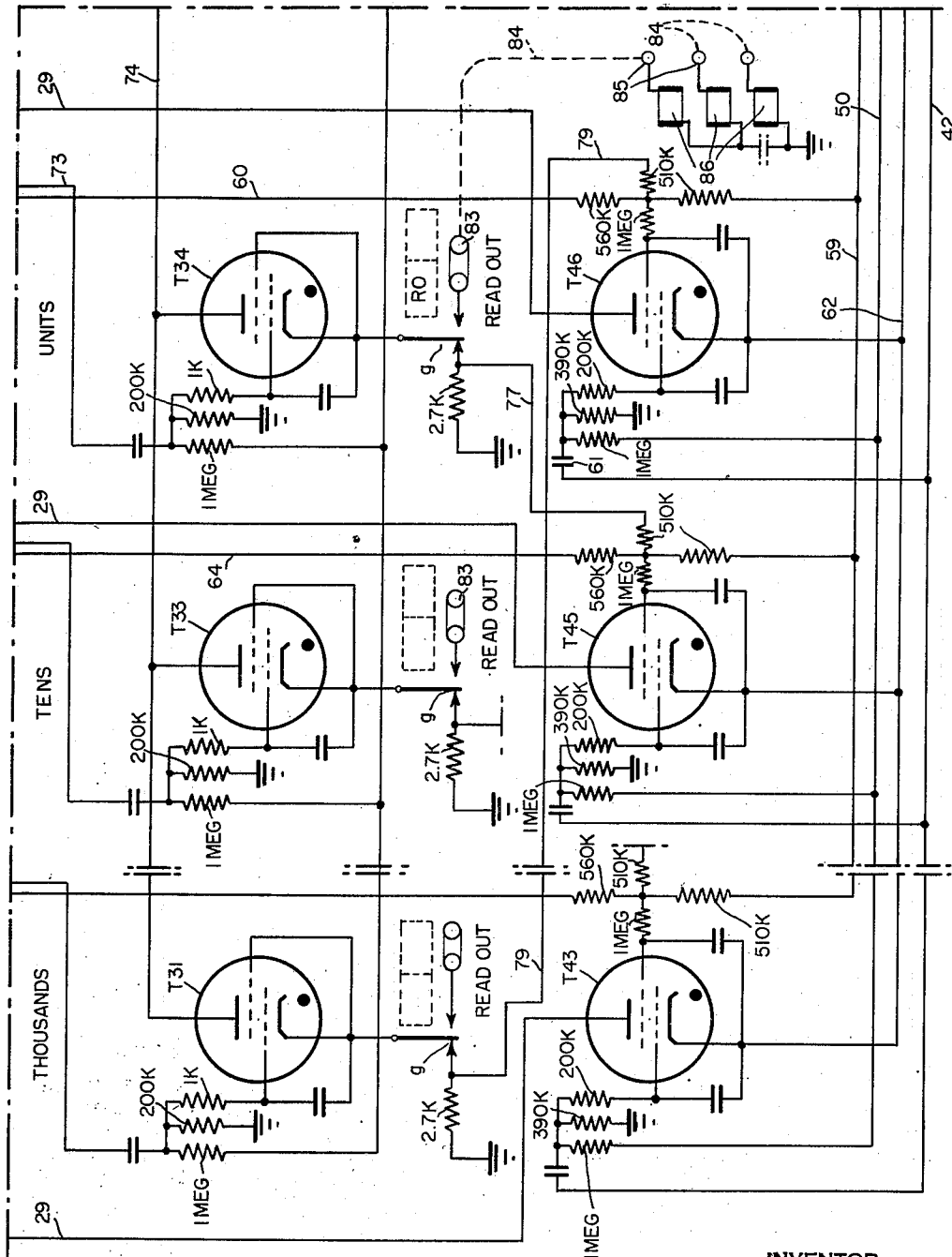


FIG. 2

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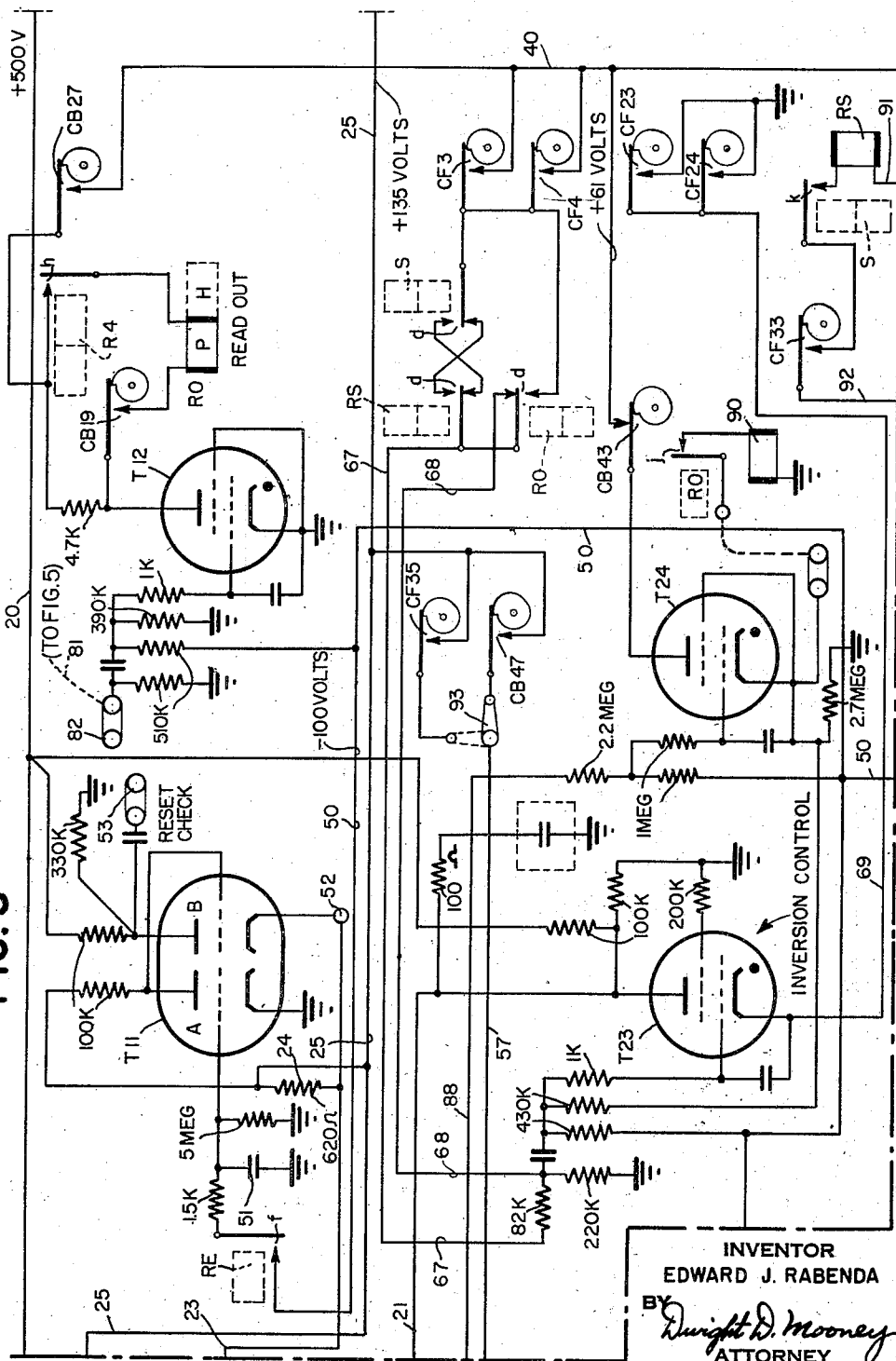
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SELF COMPLEMENTING ACCUMULATING MACHINE

Filed Aug. 29, 1952

7 Sheets-Sheet 3

FIG. 3



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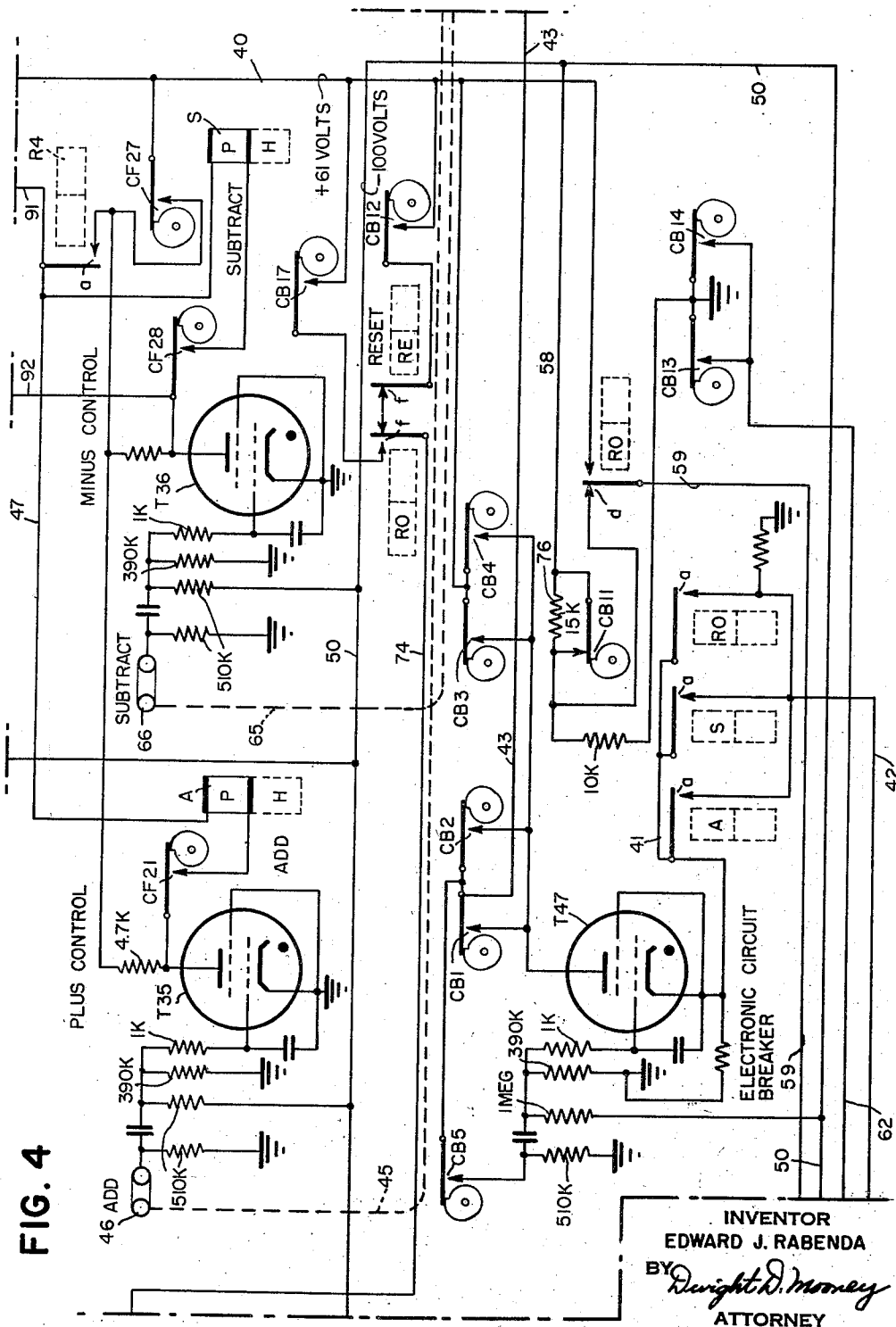
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SELF COMPLEMENTING ACCUMULATING MACHINE

Filed Aug. 29, 1952

7: Sheets-Sheet 4



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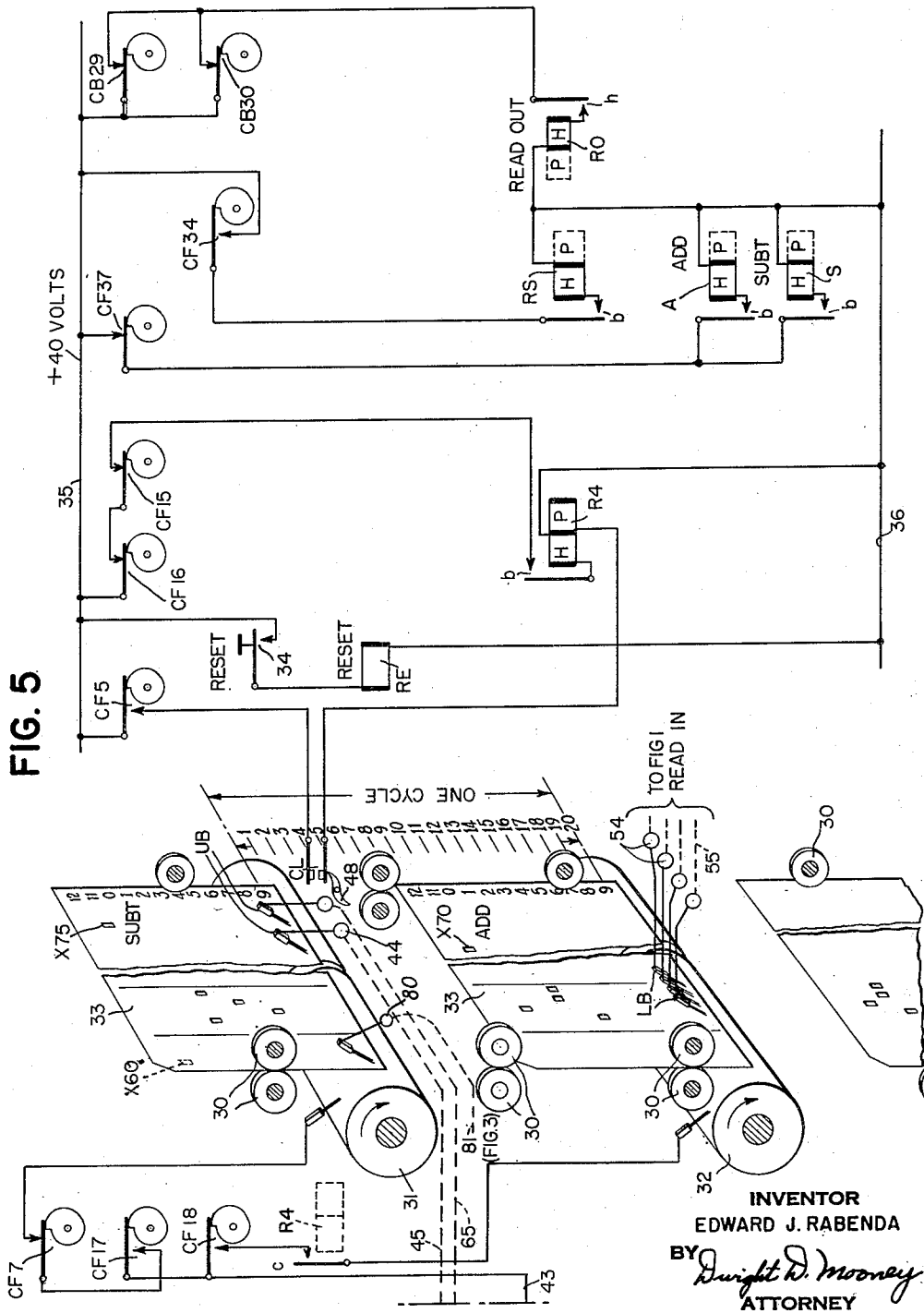
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SELF COMPLEMENTING ACCUMULATING MACHINE

Filed Aug. 29, 1952

7 Sheets-Sheet 5



April 8, 1958

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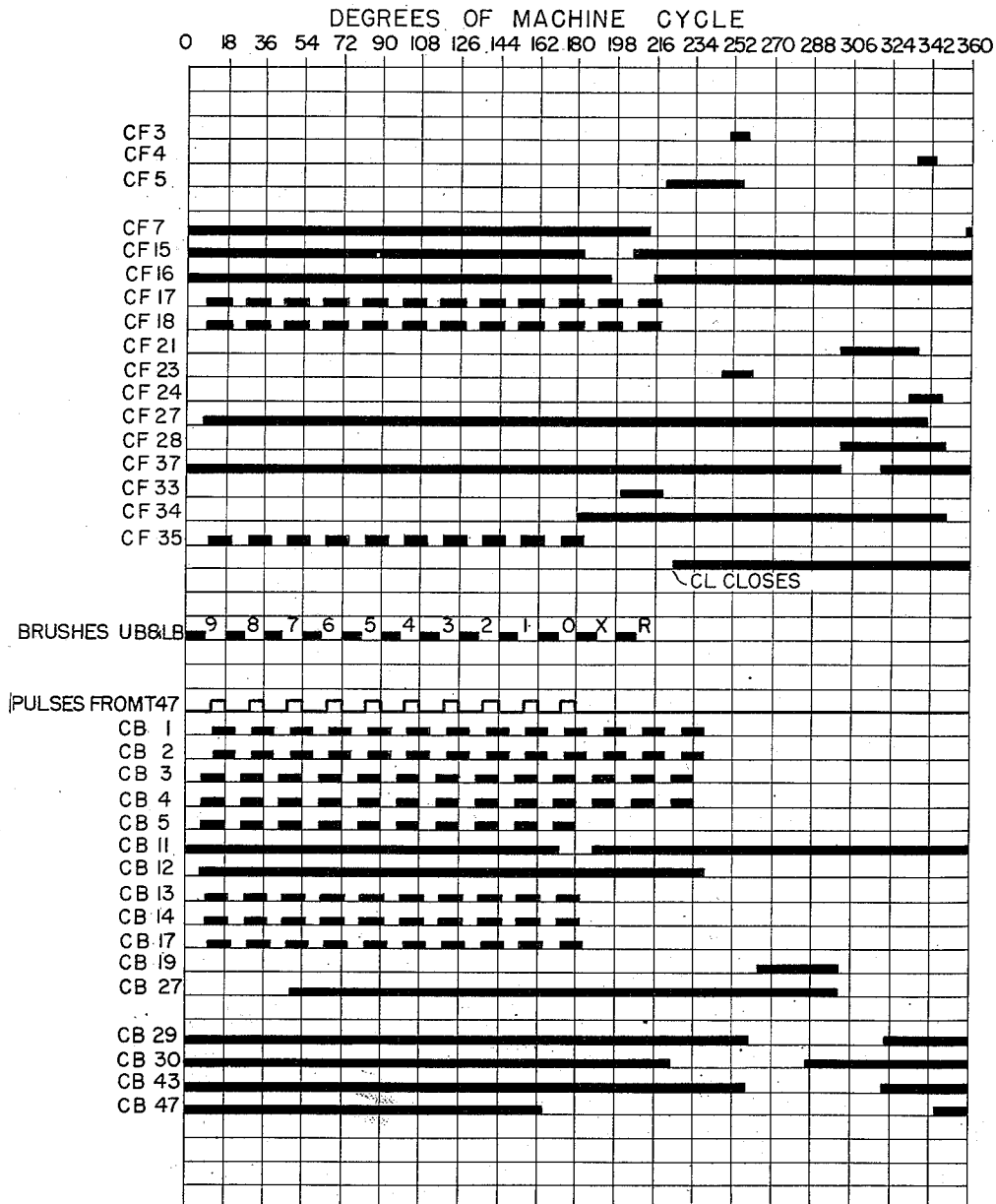
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SELF COMPLEMENTING ACCUMULATING MACHINE

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7 Sheets-Sheet 6

FIG. 6



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SELF COMPLEMENTING ACCUMULATING MACHINE

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7 Sheets-Sheet 7

FIG. 7

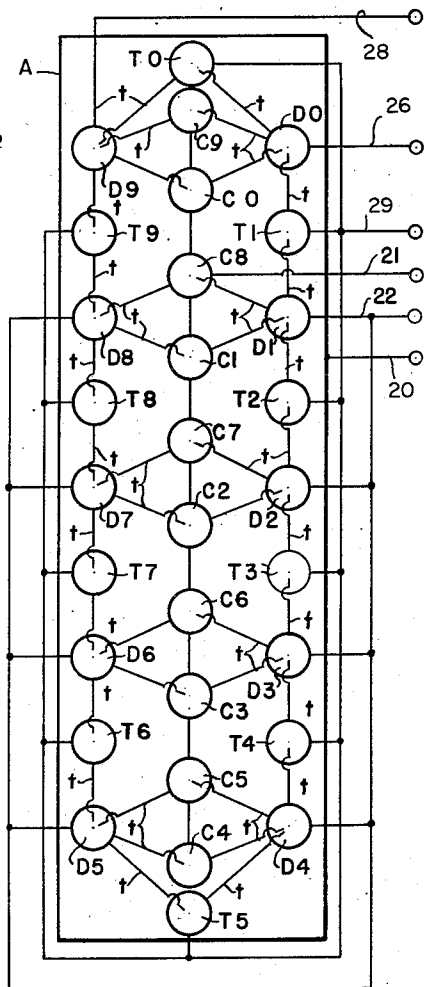


FIG. 8

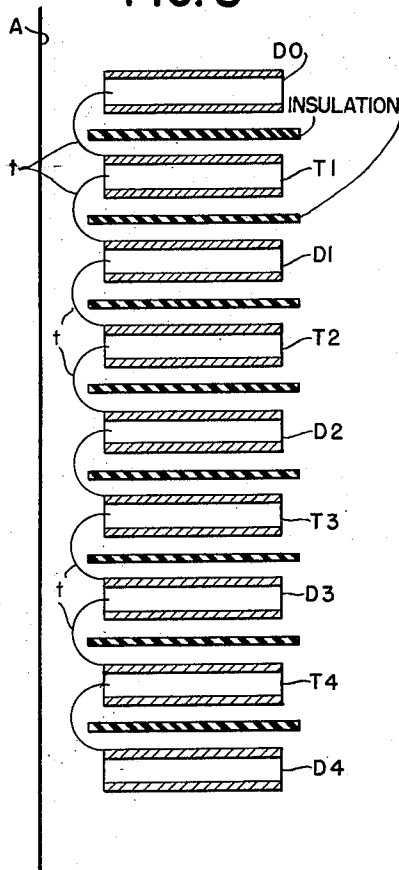


FIG. 1	FIG. 3	
FIG. 2	FIG. 4	FIG. 5

FIG. 9

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SELF COMPLEMENTING ACCUMULATING MACHINE

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Application August 29, 1952, Serial No. 306,983

12 Claims. (Cl. 235-61.6)

The present invention relates to accounting machines and more particularly to machines controlled by record cards bearing designations representing amounts that are to be added and subtracted to obtain a balance.

The principal object of the invention is to provide an improved accounting machine in which the mathematical procedure employed in the handling of positive and negative amounts constitutes a departure from the methods heretofore employed in the usual form of commercial accounting machines.

In carrying out the principal object of the invention, an accumulator is utilized which is of the type that may be termed "self complementing" or "inverting," in that it is controllable to effect a change in its setting from any value standing therein to the complement of such value, usually to the base 9.

According to the present invention, such an accumulator is arranged to accumulate all amounts in their true value in a forward or additive direction, regardless of the algebraic sign of the value entered. Heretofore, it has been the practice to enter positive amounts additively in their true form and negative amounts additively in complementary form. To effect the complementary entries of negative amounts it has been necessary to provide complementing or inverting devices to create the 9's complement of a negative number prior to entry thereof so that, for example, in order to enter the negative value 347 the complementing device must obtain and enter the amount 99999652, for an 8-place accumulator.

With the present invention such a complementing device is not required. Instead, the accumulator is caused to complement or invert itself prior to each negative entry and so then recomplement itself after such negative amount entry unless entry of another negative amount immediately precedes or succeeds entry of that negative amount. For example, given a series of values such as +11, +12, -13, +14, -15, +16 and -17, whose sum is +8, the steps involved in the procedure are as follows, for a 4-place accumulator.

Reading of accumulator at start	0000	
Enter +11	11	
	0011	Total
Enter +12	12	
	0023	Total
Invert for - sign	9976	
Enter -13	13	
	9989	
Reinvert	0010	Total
Enter +14	14	
	0024	Total

Invert for - sign	9975	
Enter -15	15	
	9990	
5 Reinvert	0009	Total
Enter +16	16	
	0025	Total
Invert for - sign	9974	
10 Enter -17	17	
	9991	
Reinvert	0008	Total
15		
20		
Reading of accumulator at start	0000	
Enter +79	79	
	0079	Total
25 Invert for - sign	9920	
Enter -10	10	
	9930	Total
(Reinversion suppressed)	50	
30 Enter -50	50	
	9980	Total
(Inversion & reinversion suppressed)	24	
Enter -24	24	
	0004	
35 Elusive 1 entered	1	
	0005	Total
(Inversion & reinversion suppressed)	38	
Enter -38	38	
	0043	
40 Reinvert upon change in sign	9956	Total

The foregoing demonstrates that there occurs an inversion or self complementing operation of the accumulator upon the occurrence of a change in sign between successive records. Thus, an inversion occurred upon the change from +79 to -10 and later upon the change from -38 to no sign. Similarly in the first problem the same rule applies, with the first inversion occurring upon the change from +12 to -13 then upon the change from -13 to +14, etc.

It will be noted in this latter problem that the result is negative and the answer stands in the accumulator in the form of a complement which indicates the negative character thereof. It will also be noted in the procedure that there is provided a tens carry from the highest to the lowest order to enter the so-called elusive "1" as indicated in connection with the entry of the amount 24.

In carrying out the objects of the invention, the amounts to be accumulated are read from well known perforated record cards which are provided with columns of index point positions in which the amounts are recorded. The record cards are also provided with a perforation in one of two designated positions to indicate that the value is either + or -. Record cards are fed in succession so that for each cycle of the machine a card passes a reading or sensing position, where the value is read for entry into the accumulator. A pre-reading station is also provided to read the sign representing designation and, where

the sign is negative, controls will be rendered effective to cause inversion of the amount standing in the accumulator before the amount data of that card is entered.

A further object of the invention is to provide improved resetting controls for an accumulator of this type.

Another object is to provide improved checking devices for ascertaining that the accumulator has actually been zeroized or reset when such operation is called for.

A still further object of the invention resides in the provision of a settable arrangement, whereby the accumulator may be controlled to count the number of perforations in a record column additively or subtractively for each record to obtain a balance of such count.

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 examples, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In the drawings:

Figs. 1, 2, 3, 4 and 5 taken together and arranged in the order indicated in Fig. 9 constitute a wiring diagram of the circuits in the machine,

Fig. 6 represents a timing diagram of the cam controlled circuit making devices of the machine,

Fig. 7 is a diagrammatic representation of the arrangement of the cathodes in one of the denominationally ordered adding tubes,

Fig. 8 represents diagrammatically a transverse section through a row of cathodes to show their relative association,

Fig. 9 indicates the manner in which the figures comprising the circuit diagram are to be arranged to constitute a complete circuit.

Numerous grid controlled gas tubes are employed herein. In referring to these tubes the words "ionized," "fire" and "conductive" are synonymous and the words "deionized" and "non-conductive" are synonymous.

The accumulator

The particular type of accumulator employed in the present invention is of the cold cathode glow type, such as disclosed and claimed in copending United States patent application Serial No. 301,675, July 20, 1952. The arrangement of a single denominational order of such accumulator is shown in Fig. 7 and a more mechanical representation of one section is shown in Fig. 8. Briefly, each denominational order comprises a tube of the gaseous glow transfer type, wherein a single glow discharge exists at all times within the tube when the device is in operation.

Ten digit representing cathodes designated D0 to D9 and the ten transfer cathodes designated T0 to T9 are alternately interspersed with one another to form a closed glow transfer path having ten stable glow discharge positions therealong evidenced respectively by the existence of the glow discharge to each of the digit representing cathodes. A single anode designated A is shown as a rectangle in Fig. 7 simply to designate that it is equidistant from the cathodes and common to all of them. The cathodes are each formed as open-ended cylinders (see Fig. 8) having a coating of different material on their inside and outside surfaces, so that a glow discharge between any cathode and the anode will automatically confine itself to the inside surface of the cathode at the open end nearest the anode.

A number of glow transfer wires *t* are provided, each of which is connected at one end to a cathode and has its other or free end extending into the space between another cathode and the anode, so that a continuous glow transfer path is formed with each of the cathodes forming a terminal for the glow discharge as it traverses the path. Each input pulse is applied simultaneously to each of the transfer cathodes, prefixed T, through

a line designated 29 (see Fig. 1), so that each pulse will cause a transfer of the glow discharge from one digit representing cathode D to an adjacent transfer cathode T, and then to the other digit representing cathode D adjacent to that transfer cathode. Hence, when a glow discharge exists at a given digit representing cathode, it may be referred to as being in a position of stable glow discharge.

Within the tube are provided ten similarly formed complement cathodes prefixed by the designation C. Transfer wires *t* connect these complement cathodes into a preselected glow transfer relation with the digit cathodes as shown in Fig. 7. Glow transfer is provided for in either direction between each digit representing cathode D and the digit representing cathode corresponding to the 9's complement of the first. For example, the complement cathode C2 is arranged to transfer a glow discharge from the cathode D7 representing the digit 7 to the cathode D2 representing its 9's complement, and a further complement cathode C7 is arranged to transfer a glow discharge from the cathode D2 to its complement representing cathode D7.

The anode A of each tube (generally designated G in the circuit diagram, Fig. 1) is connected through a 68K or 68000 ohm resistor to a suitable source of positive voltage (+500 volts) on line 20. The complement cathodes, prefixed C, are connected together through a wire 21 common to all the tubes, which leads to the plate of the inversion control tube designated T23 (Fig. 3). The digit representing cathodes D1 to D8 are connected together and through the resistors shown in the circuit diagram (Fig. 1) through a wire designated 22, through the *d* contacts of a relay RE, wire 23, resistor 24 (Fig. 3), and wire 25 to a suitable source of voltage less positive than the source to which the anode is connected and indicated as +135 volts in Fig. 3.

The cathode D0 is connected to a wire 26 which in Fig. 1 connects through 3.9 K resistors 27 and *b* contacts RE to the +135 volt wire 25 (Fig. 3). The cathodes D9 are connected to a wire 38 which through the *c* contacts of relay RE connects to wire 23 and +135 volt wire 25. The transfer cathodes T0 to T9 are connected together in each denominational order and in each order to a separate wire 29 extending (see Fig. 2) to the plate of the tube T46 for the units order, T45 for the tens order, and T43 for the thousands order.

It may be mentioned at this point that for purposes of explanation the two lowermost orders, namely, Units and Tens, are shown and a higher order, such as Thousands, with the intervening order omitted to avoid repetition of similar circuits.

For purposes of explanation, let it be assumed that initially a stable glow discharge exists between the cathode D0 and the anode A. When a negative input pulse is applied to the input wire 29 (see Fig. 7) under control of tube T46 in the units order, for example, the voltage difference between the transfer cathode T1 and the anode A becomes greater than between cathode D0 and the anode, and the glow discharge is accordingly transferred along the transfer wire *t* attached to the cathode T1 until it arrives at the cathode T1. The glow discharge exists between the transfer cathode T1 and the anode only so long as the input pulse remains negative. When this pulse goes positive, the voltage difference between the transfer cathode T1 and the anode becomes less than that between the digit representing cathode D1 and the anode. Accordingly, the glow discharge is transferred from the cathode T1 over the transfer wire *t* attached to the cathode D1 and extending intermediate the cathode T1 and the anode, until it arrives at the cathode D1. The glow discharge remains in this stable position until the next input pulse is applied.

The next negative input pulse applied to line 29 causes a similar transfer of the glow discharge from the cath-

ode D1 to the cathode D2 via the transfer cathode T2 and the intermediate transfer wires.

Similarly, the third input pulse causes the glow discharge to be transferred to the digit representing cathode D3. The fourth input pulse causes a transfer of the glow discharge from the cathode D3 to the cathode D4. Subsequent input pulses cause the glow discharge to be transferred to the cathodes D5, D6, D7, D8, D9 and D0 in turn to complete the traverse of the glow transfer entry paths.

When the glow discharge arrives at the cathode D9 in response to the ninth input pulse, this cathode goes positive. The cathode D9 goes negative when the tenth input pulse is applied to cause the glow discharge to leave the cathode D9 on its way to the cathode D0 to complete the traverse of the glow transfer entry path. Hence, the output wire 28 goes positive when nine digits have been entered in an order and goes negative when storage of the tenth digit is begun.

If the digit standing in the order is in true form, it may be converted to its 9's complement and vice versa by applying a negative pulse to the wire 21 connected to the complement cathodes C0 to C9 inclusive. For example, if a glow discharge exists between the digit representing cathode D2 and the anode A and a negative pulse is applied to the wire 21, the glow discharge will be transferred to the digit representing cathode D7. Specifically, when this pulse goes negative, the glow discharge is transferred, over the transfer wire *t* connected to the complement cathode C2 and extending intermediate the digit representing cathode D2 and the anode A, and arrives at the complement cathode C2. When this pulse goes positive, the glow discharge is transferred from the complement cathode C2, over the transfer wire *t* attached to the cathode D7 and extending intermediate the cathode C2 and the anode, and arrives at the cathode D7 where it remains in a position of stable discharge until an input pulse is applied to the wire 29 or another negative pulse is applied to the wire 21.

If another negative pulse is next applied to the wire 21, a similar transfer of the glow discharge will occur to return it to a position of stable discharge at the cathode D2. This transfer is effected from the cathode D7 to the cathode D2 via the complement cathode C7 and the two associated transfer wires *t*. On the other hand, if an input pulse is next applied to the wire 29, the glow discharge will be transferred from the cathode D7 to the cathode D8.

The foregoing briefly describes the glow discharge tube and the manner in which it responds to impulses transmitted thereto for entry of amounts and/or complementing or inverting the sum standing in the accumulator.

Card feeding and sensing mechanism

The record cards together with their reading and sensing mechanism are shown diagrammatically in Fig. 5 where the record cards are represented as being of the well known type having a plurality of vertical columns with the usual ten digit-representing positions designated 0 to 9 and two control positions designated 11 and 12.

The cards are fed successively from the usual supply hopper to sets of feed rollers designated 30 which convey the cards past a row of upper sensing brushes designated UB and then past a row of lower sensing brushes designated LB. The brushes make contact through the usual perforations with contact rollers 31 and 32 and are spaced vertically so that they concurrently sense the same index positions of successive cards, i. e., when the 9 position of one card is in line with brushes UB, the 9 position of the preceding card is in line with the brushes LB. The distance between the two rows of brushes is defined as a cycle which forms the basis of the timing of the machine.

Driven with the feed rollers are a number of cam con-

trol contacts whose timing is shown in Fig. 6. These contacts are prefixed CF and CR, and the heavy lines in the diagram represent the period in a cycle when the contacts are closed.

Each record card has a field designated 33 constituting a plurality of columns in which amount representing perforations are made, and each card may also have a perforation designated X70 in the 11 position of a selected column, such as column 70, to designate that its related amount is positive, or the card may have a perforation designated X75 in the 11 position of a column, such as column 75, to designate that its related amount is negative.

If neither of these designations is present, the amount in each card will pass by the brushes without being entered in the machine. In the operation of the machine, as will be hereinafter more specifically explained, the sign designations X70 and X75 are sensed by the upper brushes UB in one cycle and the related amounts are sensed by the brushes LB in the next following cycle, so that circuits may be selectively conditioned to effect addition or subtraction as the case may be.

Initial reset

At the outset, it is necessary to reset the accumulator to zero, if it is not already in such condition. When current is initially applied to the machine, the tubes G will manifest a glow in some position that is indeterminate, and to ensure that at the commencement of operations they all represent a zero condition there is an initial reset operation. For the present purposes this is effected by closure of the reset key contacts 34 (Fig. 5) which complete a circuit from +40 volt line 35, to reset relay RE, and to the other side of line 36. This relay shifts its contacts in Fig. 1 so that there is a circuit traceable from ground, through the left hand side of the *b* contacts of relay RE (now shifted), to wire 26, and thence in parallel to all of the zero cathodes D0 in tubes G grounding these cathodes. With +500 volts on line 20, the voltage drop between anode A and cathodes D0 will establish a glow discharge therebetween which will remain after release of the reset key and deenergization of relay RE. Upon such release, wire 26 is reconnected to the +135 volt line 25 through the *b* contacts of relay RE to maintain the glow.

Resistors 27 are included in the reset circuit and bridge the normally closed *b* contacts of relay RE, so that wire 26 and consequently cathodes D0 are always connected to +135 volt line 25, thereby preventing the disconnection of cathodes D0 at any time.

Reset check

Provision is made to furnish an indication if any of the tubes G are conditioned at some other digit representing position than 0, upon release of the reset key. For this purpose, contacts *d* and *c* of relay RE are provided in circuit with wires 22 and 38 (Fig. 1), leading to the cathodes D1-D8 and cathode D9 respectively.

Assuming that at the time the reset relay is energized there is a glow at any of the cathodes D1 to D9, there will then be established a voltage drop between the +135 volt line 25 (Fig. 3), across the resistor 24, after the contacts of the relay RE have returned to their initial position, i. e., its *c* and *d* contacts have reclosed.

When relay RE was initially energized, it closed its *f* contacts (Fig. 3) which connect the -100 volt bias line 50 to the control grid of the A side of a twin triode T11, preventing further conduction between the anode and cathode of the A side of this tube. This circuit therefore further controls the voltage to the control grid of the second half or B side of the twin triode and establishes conduction from the +500 volt line 20, controlled through a voltage divider comprising the 100K and 330K resistors connected to the anode of

the B side of the twin triode, through the cathode and 620 ohm resistor 24 to the +135 volt line 25.

When the reset relay contacts *f* initially close, they also cause the upper plate of the condenser 51 to be negatively charged, the time for charge being controlled through the associated 1.5K resistor. Upon reopening of the contacts *f*, the condenser 51 previously charged, sustains the cut-off of the twin triode sufficiently long so that the reset relay contacts *c* and *d* (Fig. 1) permit reconnection of the lines 22 and 38 through wire 23 to the resistor 24 leading to the +135 volt line 25.

Whenever a glow is sustained through one or more of the digit cathodes D1—D9 of any one of the accumulator order positions, a voltage change is noted at terminal 52 of the B side of the twin triode T11. The voltage change at this point will control the signal emitted through the anode lead wire tapped through the voltage divider and condenser to Reset Check plug socket 53. The amplitude of this signal is adjusted so as to be adequate to initiate the operation of any further electronic triggering devices which may be used to initiate a reset check signal for stopping the machine or printing a designation.

Electronic circuit breaker

The electronic circuit breaker includes a gas tube designated T47 in Fig. 4 which generates timing pulses, and has its anode connected to contacts CB3 and CB4 which are connected to +61 volt line 40. The timing of these contacts is shown in Fig. 6. Circuit breakers CB1 and CB2 are wired in series with contacts CB3 and CB4 and timed as shown in Fig. 6 to close after CB3 and CB4 have closed and adequately established the voltage to the plate of tube T47.

In further series are contacts designated CB5 which close in timed relation with each index point position and have the same duration of closure as contacts CB3. This applies a positive potential from the +61 volt line 40 to the control grid of the tube T47, causing this tube to ionize, and raises the voltage at the cathode from ground potential to approximately +47 volts. These pulses are then directed from the cathode of tube T47 to the lead 41 from which they may be transmitted through any of the *a* contacts of either the add magnet A, the subtract magnet S or the readout magnet RO to a lead 42. The number and duration of the pulses created by tube T47 are indicated in Fig. 6 which shows that there are ten such pulses provided.

Reading and entry of amount +36

As explained hereinabove, the positive amounts are identified by an X70 perforation which is read by the upper brushes UB at the time such perforation is at the row of brushes. A circuit will accordingly be completed through the X70 perforation which is traceable from line 40 (Fig. 4), through contacts CB3 and CB4 in parallel, contacts CB1 and CB2 in parallel, to lead 43 (Fig. 5), contacts CF17, contacts CF7, common contact roller 31, the X70 perforation, upper brush UB to plug socket 44, from which a plug connection 45 (Fig. 4) is made to plug socket 46 designated Add. This continues the circuit to the control grid of gas tube designated T35. The anode of this tube T35 is connected through contacts CF27 to the line 40, so that the tube will fire as a result of sensing the X70 hole. Contacts CF21 control the time for energizing the pickup coil P of the add relay designated A as follows: from ground to the cathode of tube T35, anode to contacts CF21, the pickup coil designated P of relay A, lead 47, *a* contacts of the card lever relay R4 (now closed as will be explained presently), contacts CF27 to line 40.

The usual card lever designated 48 (Fig. 5) is located as indicated, to close card lever contacts CL at the time

indicated in Fig. 6. This will complete a circuit from line 35, through contacts CF5, contacts CL to the pickup coil P of relay R4 to line 36. The relay will close its *b* contacts to provide a holding circuit through contacts C15 and C16.

The magnet A energized as explained, in response to sensing of an X70 perforation will close its *a* contacts (Fig. 4) and will also close its *b* contacts (Fig. 5) to provide a holding circuit through the holding coil of the relay and contacts CF37. Accordingly and from the timing in Fig. 6, the magnet A when energized, will be maintained throughout the sensing period of the next following cycle to hold the *a* contacts thereof closed for such period.

As the card now passes the lower brushes and assuming a perforation in the 6 position of the units column of the field 33, there will be a circuit completed through such perforation as the card passes the lower brushes. This circuit is traceable as follows: from line 40, through contacts CB3 and CB4 (Fig. 4), contacts CB1 and CB2, lead 43 (Figs. 4 and 5), contacts CF18, contacts *c* of relay R4, lower brush contact roll 32, the 6 perforation or hole in the record card, brush LB, plug socket 54, plug connection 55, from plug connection 55 to the readin socket 56 (Fig. 1), and a 4.7K resistor to ground. The primary pulse is directed through a condenser and 1K resistor connected between readin socket 56 and the control grid of tube T22 to the control grid of that tube. This positive pulse directed to T22 causes ionization of this tube through a lead 57 (Fig. 3) connected to its anode and through contacts CB47 to the +135 volt line 25. The resulting conduction of tube T22 raises the potential at the cathode of T22 to approximately +125 volts.

Referring to tube T46 (Fig. 2) of the units order, the voltage at the shield or second grid is normally held to a negative potential of approximately -35 volts by connection of that grid to the -100 volt line 50 and the cathode of tube T22. This circuit is traceable from the -100 volt line 50 (Figs. 2 and 4), to lead 58, contacts CB11, the normally closed contacts *d* of relay RO, lead 59 (Figs. 4 and 2), the 510K and 1 megohm resistors connected to the second grid of tube T46 to that grid, and from the 510K resistor through the 560K resistor and lead 60 (Figs. 2 and 1) to the cathode of tube T22 and thence through the 10K resistor connected to that cathode to ground.

When the tube T22 was ionized or rendered conductive under control of the 6 hole in the record card and its cathode potential raised to +125 volts, the line voltage at the second grid of tube T46 changed from its normal negative value of -35 volts to a positive value of +20 volts, thereby placing tube T46 in its controlling state.

Simultaneously with the entry of the 6 from the record card, the electronic circuit breaker T47 (Fig. 4) previously described exhibits a voltage of approximately +47 volts at its cathode. This positive voltage is directed from the cathode of tube T47 to the control grid of tube T46 as follows: from the +61 volt line 40, contacts CB3 and CB4, anode of tube T47, through tube T47 to the cathode thereof, the *a* contacts of add relay A (now closed), lead 42 (Figs. 4 and 2), condenser 61 and the 200K resistor to the control grid of tube T46. This circuit causes the tube T46 to become plate current conductive. The resulting decreased potential at the plate of tube T46 is transferred over lead 29 and the 27K resistor (Fig. 1) to the transfer cathodes of the adding tube G (Fig. 1) of the units order. This causes the voltage at those transfer cathodes to decrease from its value of approximately +225 volts to approximately +95 volts. This negative swing in potentials, controlled through the conduction of the tube T46, causes the transfer of the glow from its cathode D0 position to the transfer position T1 of the next adjacent transfer cathode.

Immediately following the 6 index point time, contacts CB13 and CB14 open causing the drive tube T46 to deionize and become non-conductive thereby raising the potential of the transfer cathodes of tube G from approximately +95 to approximately +225 volts. This increase in voltage permits the glow to advance to the digit cathode D1 and sustain its glow at this point until the next index point, at which time the electronic circuit breaker operating in conjunction with CB13, CB14 will again initiate its operation to enter a second pulse into the adding tube G at the 5 time.

It is pointed out that, when contacts CB13, CB14 open to deenergize the drive tube T46 the electronic circuit breaker tube T47 also becomes deionized and non-conductive under control of CB3 and CB4. As a result of the 6 hole in the record card controlling the ionization of tube T22, which raised the voltage at the second grid of tube T46 to condition it to be rendered conductive, and with the concurrent operation of the electronic circuit breaker tube T47, a successive series of six pulses is supplied by tube T47. These pulses are supplied by tube T47 because of the fact that the voltage at the second grid of T46 thereof is maintained at a positive potential throughout the entire adding cycle. A successive series of six pulses is therefore entered into the units adding tube G under control of the drive tube T46, which is actuated by the electronic circuit breaker tube T47 through its control grid.

Stating the operation in another manner, the tube T47 controls the emission of a series of ten pulses impressed on line 42 (Figs. 4 and 2) as shown in the timing diagram (Fig. 6). For the example under consideration, at the 6 time a pulse will be rendered effective to control the units order tube G after three of the pulses from the tube T47 have already been ineffectually transmitted. The fourth pulse occurring at the 6 time will step the units order tube G one unit and the next five pulses will each advance the order an additional step to place the glow discharge therein at the position representing the digit 6. At this time, and before the last or tenth pulse from the tube T47 is effective, the contacts CB47 (Fig. 3) open to deionize the readin control tube T22 of Fig. 1 via the lead 57 connecting contacts CB47 and the plate of tube T22. This, therefore, changes the voltage applied at the second grid of tube T46 from approximately +20 to approximately -35 volts, thereby preventing the drive tube T46 from responding to the last or 0 impulse supplied by the electronic circuit breaker tube T47.

In a similar manner the lower brush LB traversing the tens order column of the record card, in which a 3 perforation is present, is plug-connected to the socket 63 in Fig. 1 which socket is connected to the readin tube T21 of the tens order. The perforation in the 3 position of the card will cause this tube to fire, and it in turn will affect the second grid of its related tube T45 (Fig. 2), through lead 64. Hence at the 3 time, due to the pulse supplied from tube T47, tube T45 will fire and transmit an impulse through its lead 29 to the transfer cathodes T in the tens order adding tube G. In this order, therefore, three impulses will be effective to advance the order prior to the opening of contacts CB47 (Fig. 3) which, as explained, deionize tube T21 along with the other entry tubes.

In the foregoing manner then, the accumulator is advanced in accordance with the value perforated in the field of the record card so that, for the example under consideration where the value sensed was 36, the accumulator will now represent such value.

Read and enter amount -12

Assume that the next record card is perforated to represent the negative value 12, and that this value is to be combined with the value 36 previously entered into the accumulator. As this record card contains the minus sign designation represented by an X75 perforation, upon

passing the upper brushes UB, a circuit will be completed from the brush UB traversing the X75 column, through a plug connection 65 (Fig. 4) to the Subtract socket 66 to direct an impulse to the control grid of tube T36, causing this tube to fire in the same manner as explained for the plus control tube T35.

In the same manner, upon closure of contracts CF28 the pickup winding P of the subtract relay designated S will be energized, closing its *b* contacts in Fig. 5 to provide a holding circuit through the contacts CF37. Briefly, the subtract magnet S is energized in the same manner as the add magnet A and is held for the same period. This magnet S also closes its *a* contacts in Fig. 4 in parallel with the *a* contacts of the add relay A, so that as a result the series of ten impulses controlled by the tube T47 will be transmitted to the lead 42, and in exactly the same manner as explained for adding, the sensing of the digit representing holes in the card will, through control of the operation of the drive tubes T45, T46, etc. meter pulses to the adding tubes G. For the example under consideration, the 2 perforation in the units order will cause the transmission of two impulses to the units order tube G, and the 1 perforation in the tens order will cause transmission of one impulse to the tens order tube G.

In accordance with the mathematical explanation of the operation presented hereinabove, the amount previously standing in the accumulator is complemented or inverted prior to the entry of the minus amount, that is, the value 0036 is first converted to its complement 9963. The manner in which this is brought about is as follows. The subtract relay S, upon energization, will shift a pair of contacts *d* (Fig. 3), to complete a circuit as follows: from line 40, through contacts CF4 (which close near the end of the cycle in which the X75 perforation is sensed, see Fig. 6), subtract relay contacts *d* (shifted), contacts *d* of a relay designated RS, *d* contacts of relay RO, lead 68, through condenser and 1K ohm resistor to the control grid of inversion control tube T23. This circuit controls the ionization of the inversion control tube which in turn controls a circuit from the adding tube inversion cathodes (C0—C9 (Fig. 1), causing complementing of the result in the accumulator by controlling the potentials at the inversion cathodes of all adding tubes in the accumulating unit as follows: from +500 volt line 20, through 68K resistors, anodes of tubes G and through the tubes to the inversion cathodes C of all tubes within the accumulator, to lead 21 (Figs. 1 and 3) (whose voltage normally is maintained at approximately +225 volts but is now lowered to approximately +95, through the ionization of tube T23), anode of tube T23 to the cathode thereof and to lead 69 and contacts CF24, to ground.

This ionization of tube T23 causes the glow to transfer from the normal digit cathodes D to the adjacent inversion transfer cathodes C, and this glow is maintained on the inversion transfer cathodes until such time as contacts CF24 open the circuit leading to the cathode of the inversion control tube T23. At this time, the voltage at the terminals of inversion cathodes will rise from approximately +95 volts to approximately +225 volts, thereby causing the glow to advance from the adjacent inversion cathodes to the associated digit cathodes representing the complementary amount.

The foregoing occurs prior to the movement of the card past the lower brushes. Accordingly, as the card now passes the lower brushes, the amount 12 thereon is added to the complement 9963 advancing the units and tens orders to represent the sum 9975. After the entering period of the cycle, when cam contacts CF3 (Fig. 3) close, at the time indicated in Fig. 6, the accumulator is reinverted or recomplemented in exactly the same manner as explained, for the closure of contacts CF4, with which the contacts CF3 are in parallel.

A second pair of contacts CF23, in parallel with contacts CF24, are coordinated with the contacts CF3 and

CF4 to complete the inversion through the circuits traced in connection with the initial inversion. Accordingly, at the end of the entering cycle, the value 9975 will have been reinverted to represent the algebraic sum 0024.

Entering Amount —39

Let us now consider the entering of a negative amount 39. With an initial value 36 standing in the accumulator the result will be —3. The selection of this value will illustrate the operations of tens carry, carry on carry, and what is generally termed fugitive or elusive 1 entry or end around carry. The record card bearing the amount 39 will, of course, have the X75 perforation which is sensed by the upper brushes, and in exactly the same manner as explained in connection with the entry of —12 will cause inversion of the +36 amount to its complement 9963.

As the card subsequently passes the lower brushes, the value 39 will be entered additively. In the units order, with 3 standing in the accumulator, the entry therein of nine pulses will step this order from its 3 position progressively to and through the 0 position to its ultimate 2 position. In passing from 9 to 0 and as the glow leaves the 9 digit cathode D9, the potential at the 9 cathode normally raised to approximately +225 volts now swings to its negative voltage of approximately +135. This change in voltage causes a pulse to be effective through lead 28 (Fig. 1) and the condenser 70 to the primary winding 71 of a pulse transformer as follows. This potential difference of 90 volts (225—135) is caused by the normal tube function, whereby the stepping of the tube is determined by the operation of the transfer cathodes under control of the drive tube T46. The negative pulse supplied by the glow leaving the cathode D9, because of the differential connections of the pulse transformer, electrical iron used and the proper ratios necessary to obtain the amplitude, will cause a positive voltage to be induced in the secondary winding 72, only as the glow leaves the cathode D9 causing this pulse to be directed to the carry or readout control tube T34, through lead 73 (Fig. 2), and renders tube T34 conductive as follows: from line 40 (Fig. 4) to contacts CB12, contacts *f* of relay RE, contacts *f* of relay RO, lead 74 (Figs. 4 and 2), the anode of tube T34, cathode of tube T34, *g* contacts of relay RO and a 2.7K resistor connected thereto to ground.

This tube T34 therefore maintains conduction and raises the voltage at the cathode of tube T34 from ground potential to approximately +47 volts. When the potential of tube T34 cathode is raised to +47 volts because the glow discharge within the adding tube in the units order had left its 9 cathode D9 a change in voltage at the second grid of the tens order drive tube T45 (Fig. 2) causes the voltage at the second grid to rise from —35 volts to —18 volts. Such is realized because of the voltage transfer from the *g* contact of relay RO through the lead 77, 510K and 1 megohm resistors to the second grid of tube T45. This change in voltage at this time, however, is not sufficient to cause the tens order driving tube to be conditioned and therefore is not rendered conductive in response to the series of pulses normally supplied from the T47 electronic circuit breaker.

It may be pointed out that the operation of the circuits just described may occur at any time during the entry portion of the cycle, depending upon the varying values of the digits standing in the adding orders and the digits being entered.

In the tens order the entry of the digit 3 to the 6 already standing herein will advance this order to 9, and in higher orders the setting will already be at 9 as a result of the initial complementing or inverting of the values originally standing in each accumulating order.

Tens carry operation

At the 0 time in the cycle (see Fig. 6), contacts CB11

(Fig. 4) open and change the —100 volt line 50 normally leading through the *d* contacts of relay RO to lead 59, so that the negative bias voltage at the lead 59 is altered from —100 to —50 volts. This change in bias voltage on the second grids of all drive tubes within the accumulating unit permits the voltage to change in the tens order position from —18 to +18 volts, due to the tube T34 maintaining conduction, to additively control carry at carry time. This change in voltage circuit is controlled as follows: from —100 volt line 50 (Fig. 4), through the 15K resistor 76, through the normally closed *d* contact of the relay RO, lead 59 (Fig. 2), through the 510K resistors (Fig. 2) in the tens order, lead 77, and the 2.7K resistor connected to lead 77 to ground.

At the zero index point time, when the tenth pulse from tube T47 has been supplied, this pulse is directed through lead 42 to the control grid of tube T45, permitting this drive tube to ionize and additively change the voltage of the adding tube in the tens order at the transfer cathodes T0 to T9 from approximately +225 volts to approximately +95 volts. As a result, the glow discharge present at the cathode D9 advances to the next adjacent transfer cathode.

As the glow leaves the cathode D9 in the tens order of adding tube G, it in turn causes the voltage level at the cathode D9 to change from the conducting state level of approximately +225 volts to its normal non-conducting level of approximately +135 volts. This negative voltage swing directs a pulse through the series condenser and primary coil of the pulse transformer in the tens order to ground. This primary pulse induces a positive secondary pulse as explained under the carry control for initiating a carry from the units order. This positive pulse is transferred from the secondary winding of the transformer controlled by the tens adding tube through the condenser and 1K resistor to the control grid of tube T33 to thereby effect the ionization of tube T33. As a result the voltage at the cathode of tube T33 increases. Since the cathode of tube T33 is connected to second grid of the drive tube of the hundreds order T44 (not shown) this drive tube will fire to effect advance of the next higher or hundreds order tube G, so that it advances from 9 to 0. This progression for 9's carry will continue from order to order in the same manner and within the duration of this tenth pulse controlled by tube T47.

In the case of the highest order, a carry from such order to the units order will be controlled whenever the digit cathode of the adding tube G in the highest order leaves 9 to control a pulse through its related pulse transformer and effectively ionize its related carry control tube T31 (Fig. 2). The cathode of T31 representing the position of the highest order is connected by lead 79 to the second grid of drive tube T46 of the lowest or units order and will control the ionization of T46 to effect carry from the highest order to the lowest.

This progression of carries from units to tens, etc. will continue until interrupted by a position within which no carry had been initiated. For the example under consideration, the carry circuits will cause the tens and higher orders to be advanced from 9 to 0 and a fugitive 1 will be entered into the units order, advancing it from the position representing 2 to the position representing 3.

Thereafter, and in the same manner as explained in the problem involved in entering the —12, the closure of contacts CF3 (Fig. 3) will bring about reinversion of the amount standing in the accumulator to change the setting from 0003 to 9996. In accordance with the well known practice, the presence of the complementary setting of the accumulator indicates that the true value of the amount is negative.

Total readout operation

For the purpose of the present invention, a so-called total card may be provided containing a special desig-

nation in the 11 position identified as X60 (Fig. 5), which is traversed by related brush UB wired to a plug socket 80 (Fig. 5) which through a connection 81 to socket 82 (Fig. 3) will control the ionization of the readout control tube T12. The readout control relay energized RO is energized in the following manner: from lead 40 to contacts CB27, *h* contacts of relay R4, to the pickup winding P of the readout relay RO, contacts CB19, the anode of the readout control tube T12, the tube T12 to the cathode thereof and then to ground.

The energization of the pickup coil of relay RO causes the holding coil of relay RO to become energized (Fig. 5) as follows: from line 35 to contacts CB29 and CB30, contacts *h* of relay RO, holding coil H of relay RO to the line 36. This will hold the relay energized through the reading or entry portion of the next cycle. Relay RO closes its *a* contacts in Fig. 4, which are in parallel with the *a* contacts of the add relay A and the subtract relay S, so that the timed pulses emitted by tube T47 are again directed to the lead 42 (Figs. 4 and 2) in the same manner as explained in connection with the sensing of the X70 and X75 perforations.

In other words, the ten impulses from the tube will be transmitted through the lead 42 to the drive tubes T45, T46, etc. Relay RO also closes its *d* contacts (Fig. 4) which will change the potential at the second grids from the -100 volt bias control line 50 to the +61 volt line 40. This change in voltage conditions all of the drive tubes T43 to T46 (Fig. 2), so that they will be conditioned to fire under control of the pulses supplied by the electronic circuit breaker T47. The ten pulses will in the manner to be presently explained, advance all of the orders ten steps, during which each will pass through the 9 position and return to its initial position.

During this operation, the tens carry controls will be suppressed so that they will have no effect. In Fig. 2 the relay RO shifts *g* contacts to connect the cathodes of the carry or readout tubes T31—T34 to plug sockets 83. These sockets are connected by wires 84 to sockets 85 which in turn are wired to magnets 86. These magnets represent controlling or stopping magnets of well known differential printing or other form of recording mechanism and will, in the well known manner position type bars moving in timed relation with the card feed in response to differentially timed impulses. As the first electronic circuit breaker pulse is supplied, it controls ionization of each of the drive tubes, turning the tube T46, for example, on thereby controlling the voltage change necessary to cause the glow in the accumulator to transfer from its present position to the next adjacent higher transfer cathode within the adding tube.

The series of pulses generated by the electronic circuit breaker T47 will successively control the firing of the drive tubes of all orders, due to the fact that the second grid is held to a positive potential throughout the normal readout portion of the readout cycle. As the succession of pulses generated by the tube T47 causes the glow within any one of the accumulator orders or adding tubes to leave its 9 digit cathode D9, a potential difference of approximately 90 volts (225—135) causes a negative swing in voltage which supplies a pulse through a condenser to the primary coil of the pulse transformer in the same manner as was generated for the tens carry, and in the same manner, it triggers the carry or readout tube T34, for example, so that the ionization of this tube will cause a difference in potential at its cathode, and at that time the print magnet 86 (Fig. 2) will be energized to initiate stopping the printing elements to effect printing of the digit originally set in the respective accumulator order. Unlike the carry, the ionization of the carry or readout tube is sustained for only one index point, namely, the point at which a pulse was supplied by the glow leaving the 9 position of the adding tube. The holding circuit for the readout tubes is as follows: from the line 40 (Fig. 4), contacts CB17 (Fig. 4), *f* contacts of

relay RO (shifted) lead 74 (Figs. 4 and 2), anode of the carry or readout tubes T31—T34, to the cathodes thereof, *g* contacts of relay RO (shifted), readout plug sockets 83, plug wires 84, plug sockets 85, print magnet 86, to ground.

The duration of the holding circuit through contacts CB17 which are timed as shown in Fig. 6 is sufficient to permit full energization of the print magnets 86.

The foregoing has described the readout operations where the amount standing in the accumulator is in its true value. Where the amount standing in the accumulator is a complement, evidenced by the presence of 9 in the highest order, the accumulator will be first complemented or inverted to its true value prior to the reading out thereof. The manner in which the presence of a 9 in the highest order is ascertained is as follows. Whenever the position of the highest order has the glow standing at 9, the potential difference at this point is approximately 225 volts. The circuit from this 9 cathode connects to a negative balance control tube T24 (Fig. 3), causing T24 to be ionized through a circuit traceable as follows: from the +500 volt line 20 (Fig. 1) to the 68K resistor, anode of highest order tube G, 9 cathode D9, lead 88 (Figs. 1 and 3), 2.2 and 1 megohm resistors to the control grid of tube T24. A holding circuit for this tube is maintained throughout the next ensuing machine cycle. The holding circuit for this T24 balance control tube is as follows: from line 40 to contacts CB43, anode of T24 to the cathode thereof and 2.7 megohm resistor to ground.

The ionization of this negative balance control tube T24 changes the potential at the cathode from ground potential to approximately 47 volts. This signal is transferred from the cathode of tube T24 through the 430K and 1K resistors to the control grid of the inversion control tube. When the *d* contacts of readout relay RO shift, a circuit is completed which initiates the ionization of the inversion control tube T23, causing the inversion or complement cathodes to transfer the glow from the digit cathodes to the corresponding complement digit cathodes, as was accomplished when the glow was transferred to effect inversion for subtraction. The circuit for initiating the ionization of the inversion control tube for negative balance readout is as follows: from line 40 (Fig. 3) to contacts CF4 which make prior to the normal 9 readout time, the now shifted *d* contacts of relay RO to lead 67, through the 82K resistor, and condenser to the control grid of the inversion control tube T23.

The ionization of this tube will cause the inversion or complement cathode to invert as explained for subtraction. This inversion occurs prior to the occurrence of the ten readout pulses from tube T47. As explained above these ten pulses cause a reading out of the amount standing in the accumulator. Following this, there is a reinversion to restore the accumulator to its initial complementary setting. CF3 closes to cause reinversion through the shifted *d* contacts of the readout relay RO which have been maintained shifted for the completion of the readout cycle. These contacts of relay RO are in parallel with the *d* contacts of the subtract relay S, so that the contacts CF3 connect lead 67 to line 40 to bring about reinversion in the manner already explained.

Readout relay RO closes a pair of contacts *j*, through which an impulse is transferred from the output of tube T24 to magnet 90 which upon energization will operate well known print mechanism to cause printing of a negative sign or symbol.

Entering a succession of negative amounts

As stated hereinabove, when there is a succession of amounts of like sign, specifically negative sign, the reinversion following the entry of the first negative amount is suppressed and further inversion and reinversion are suppressed until after the last of the succession of negative amounts has been entered, i. e. until there occurs

a change in sign of the successive amounts following which there will be a reversion. The manner in which this is controlled is as follows. As explained, the sensing of the minus sign of the first negative amount will control firing of the minus control tube T36 (Fig. 4) and energize the subtract relay S, establishing a holding circuit for this relay and shifting the related contacts *d* (Fig. 3). The closure of the subtract relay contacts *d* directs the first inversion pulse through CF4, subtract relay contacts *d*, through the normally closed reversion suppression relay contacts *d* and wire 67, the control grid of the inversion control tube T23 as already explained.

Relay S also closes contacts *k* (Fig. 3) so that in the following cycle, if the minus control tube T36 (Fig. 4) is fired under control of the X in the card column 75, a circuit would be completed to energize a reversion suppression relay RS whose sole purpose is to permit reversion only upon a change in sign which occurs after the last of a succession of subtraction cards has passed through the lower brushes. The pickup circuit is as follows: from line 40 (Fig. 4) to contacts CF27, contacts *a* of lower card lever relay R4, lead 91 (Figs. 4 and 3), inversion suppression relay RS, contacts *k* of subtract relay S, now closed, contacts CF33, lead 92 (Figs. 3 and 4) to the anode of tube T36, through the tube (now conducting) and the cathode thereof to ground.

The energization of the reversion suppression relay RS establishes a holding circuit as follows: from line 35 (Fig. 5) to contacts CF34, *b* contacts of the relay RS, and through the holding coil of relay RS to line 36. The *d* contacts of relay RS (Fig. 3) will transfer only for the second and succeeding X75 subtraction cards, where there is a series of them, and will remain in this shifted position, thereby preventing the reversion control cam CF3 from becoming effective until such time as the reversion relay has not been initiated, due to the succeeding entry being represented by a different sign, such as accompanies a plus quantity or having no X70 or X75 perforation.

During the last cycle in which the last subtracted entry has been made, a circuit is completed to initiate reversion in the following manner: from line 40 to *d* contacts of subtract relay S, shifted because the last card is a subtract card, the normally closed *d* contacts of the reversion relay RS which are now restored, and lead 67 to the inversion control tube T23 which effects inversion, as has been previously described in connection with subtraction.

Where the record card passing through the machine contains perforations in the data field 33, but does not contain either an X70 or X75 perforation, neither the add relay A nor the subtract relay S will be energized, so that their *a* contacts in Fig. 4 remain open. As a result, the series of impulses from the tube T47 is not transmitted to the accumulator and the data perforated in the field 33 is not accumulated.

It is to be particularly noted that the single *a* contact of either the add or subtract magnet is all that is required to couple the series of impulses for controlling the operation of the accumulator, and that these impulses are common to all orders. Where the amount is not to be added, there is no additional controlling mechanism required. Simply the failure to energize A or S magnet will prevent accumulation of the amount.

Unit counting operation

In connection with statistical analysis, it is frequently required that the number of perforations in a given column be counted additively for some records and subtractively for others. The present invention makes provision for enabling such a count to be effected by simply adjusting switch 93 in Fig. 3 from its full line to its dotted line position. This movement of switch 93 in-

cludes contacts CF35 in the circuit to the anodes of the readin tubes T21, T22, etc.

To illustrate the operation, let it be assumed that a given column in the record card contains perforations in any one or more of the index point positions 0 to 9, and that the card also contains an X70 perforation. In such case, the sensing of the X70 hole will condition the machine to add, and upon the first perforation in the column being sensed by the related lower brush, which is connected for entry, let us say in the units order, an impulse will be transmitted from the circuit breaker tube T47 to advance the glow in the units order one step.

Due to the fact that contacts CF35 break after each index point position of the cycle, the readin circuit will not be maintained and the tube will not advance beyond one step. Upon encountering a second perforation in the column, which may be in the next index point position or some later sensing position, the tube T22 will be again rendered conductive to enter another unit in the tube G and CF35 will ionize the tube T22 after the single impulse has been controlled thereby.

In this manner a number of individual pulses will be counted in accordance with the number of perforations in the card column sensed. If the card contains an X75 perforation, the circuits will be controlled as explained to cause an inversion of the accumulator, following which the sensing of each separate perforation will cause a single step of advance in the units adding tube, due to the repeated opening of contacts CF35. This count will be followed by the reversion operation to return the counter to its initial condition.

There is thus provided in the apparatus means for obtaining an algebraic count of individual perforations occurring in a record card. The result of such count may, of course, be regarded in the same manner as any other total, and its algebraic sign may be taken into account in connection with such recording as has already been explained.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to a preferred embodiment, 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 a record controlled calculating machine having a multi-electrode gaseous discharge tube accumulator, entering means therefor and inverting means for causing the entry standing in the accumulator to be inverted into the complement thereof, the combination with means for reading a succession of records for designations representing amounts, means for reading said records for designations representing the algebraic signs of the related amounts, prior to the reading of the amounts, means controlled by the first reading means for causing the entering means to enter the amounts sensed additively regardless of their algebraic signs, means controlled by the second reading means for rendering said inverting means effective upon the sensing of a negative sign designation to invert the amount standing in the accumulator prior to and immediately after the entry of the negative amount.
2. In a record controlled calculating machine having a multi-electrode gaseous discharge tube accumulator, entering means therefor and inverting means for causing the entry standing in the accumulator to be inverted into the complement thereof, the combination with means for reading a succession of records for designations representing amounts, means for reading said records for designations representing the algebraic signs of the related amounts, prior to the reading of the amounts, means controlled by the first reading means for causing the entering means to enter the amounts sensed additively

regardless of their algebraic signs, means controlled by the second reading means for rendering said inverting means effective upon the sensing of a selected one of the sign designations to invert the amount standing in the accumulator prior to and immediately after the entry of each amount related to the selected sign.

3. In a record controlled calculating machine having a multi-electrode gaseous discharge tube accumulator, entering means therefor and inverting means for causing the entry standing in the accumulator to be inverted into the complement thereof, the combination with means for reading a succession of records for designations representing amounts and for designations representing the algebraic signs of the related amounts, said reading means being arranged to read the sign designations prior to reading the amount designations, means controlled by the reading means for causing the entering means to enter the amounts sensed additively, regardless of their algebraic signs, and further means controlled by the reading means for rendering said inverting means effective upon the sensing of a predetermined selected one of the said sign designations to invert the amount standing in the accumulator prior to and immediately after the entry of each amount related to the selected sign.

4. In a record controlled calculating machine having a multi-electrode gaseous discharge tube accumulator, entering means therefor and inverting means for causing the entry standing in the accumulator to be inverted into the complement thereof, the combination with means for reading a succession of records for designations representing amounts and for designations representing amounts of a predetermined sign, said reading means being arranged to read the sign designation prior to reading the related amount designation, means controlled by the reading means for causing the entering means to enter the amounts sensed additively for only records having the said predetermined sign designation, and further means controlled by the reading means for rendering the inverting means effective upon the sensing of a change from said predetermined sign designation to invert the amount standing in the accumulator prior to the entry of the related amount.

5. In a record controlled calculating machine having a multi-electrode gaseous discharge tube accumulator, entering means therefor and inverting means for causing the entry standing in the accumulator to be inverted into the complement thereof, the combination with means for reading a succession of records for designations representing amounts, means for reading said records for designations representing the algebraic signs of the related amounts, prior to the reading of the amounts, means controlled by the first reading means for causing the entering means to enter the amounts sensed additively regardless of their algebraic signs, means controlled by the second reading means for rendering said inverting means effective upon the sensing of a selected one of the sign designations to invert the amount standing in the accumulator prior to and immediately after the entry of each amount related to the selected sign, and further means controlled by the sign reading means and effective upon the reading of an uninterrupted succession of said one sign designations for suppressing all inversions after the first and rendering the inverting means effective after the entry of the amount related to the last of said succession of records.

6. In a record controlled calculating machine having a multi-electrode gaseous discharge tube accumulator, entering means therefor and inverting means for causing the entry standing in the accumulator to be inverted into the complement thereof, the combination with means for reading a succession of records for designations representing amounts, means for reading said records for designations representing the algebraic signs of the related amounts, prior to the reading of the amounts, means controlled by the first reading means for causing the

entering means to enter the amounts sensed additively regardless of their algebraic signs, means controlled by the second reading means for rendering said inverting means effective upon the sensing of a selected one of the sign designations to invert the amount standing in the accumulator prior to and immediately after the entry of each amount related to the selected sign, and further means controlled by the sign reading means for preventing the second operation of the inverting means when the next succeeding sign read is the same as said selected sign.

7. In a record controlled calculating machine having a decimal accumulator comprising multi-electrode gaseous discharge tube elements, each denominational order element of which is responsive to electric impulses, with each impulse thereto causing the element to manifest the next succeeding digit, the combination with means for creating a succession of ten impulses, record controlled means for selectively directing one or more of the first nine of said impulses to the elements to effect advance thereof in accordance with the number of impulses selected, means controlled by each element to direct the tenth impulse to another element to effect tens carry, and total readout devices for causing all ten impulses to be directed to all accumulator elements concurrently to advance all elements ten steps.

8. In a record controlled calculating machine having a decimal accumulator comprising multi-electrode gaseous discharge tube elements, each denominational order element of which is responsive to electric impulses, with each impulse thereto causing the element to manifest the next succeeding digit, the combination with means for creating a succession of ten equally spaced impulses, record controlled means for selectively directing one or more of the first nine of said impulses to the elements to effect advance thereof in accordance with the number of impulses selected, ten carry means for each element and controlled thereby as an element advances from its 9 to its 0 setting for rendering the tenth impulse effective to advance the next higher order element one step.

9. In a machine of the class described having an accumulator provided with denominationally ordered elements comprising multi-electrode gaseous discharge counter tubes responsive to electric impulses, entering means for selectively transmitting impulses to said elements to enter therein digit values in accordance with the number of impulses transmitted, and inversion means responsive to a single impulse for causing the accumulator to change its setting to represent the 9's complement of the entry therein, in combination with means for initiating and effecting the taking of a total from said accumulator, testing means for ascertaining whether the entry in the accumulator is a complement, means controlled by the testing means upon ascertaining the presence of a complement for rendering said inversion means effective to invert the accumulator setting, prior to the effecting of the total taking operation, and means effective after the total has been taken for causing repeat operation of said inversion means to reinvert the complementary total in the accumulator to its previous total.

10. In a machine of the class described, having an accumulator provided with a plurality of denominationally ordered cathode glow tubes, each with a set of ten digit representing cathodes, means for causing a glow to advance to position in the tubes to represent an entry in the accumulator, inversion means to cause the glow to shift in each tube from the cathode representing the digit therein to the cathode representing the complement thereof, in combination with means for initiating and effecting the taking of a total from said accumulator, testing means for ascertaining whether the entry in the accumulator is a complement, means controlled by the testing means upon ascertaining the presence of a complement for rendering said inversion means effective to invert the accumulator setting, prior to the effecting of the total taking

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operation, and means effective after the total has been taken for causing repeat operation of said inversion means to reinvert the complementary total in the accumulator to its previous total.

11. In a machine of the class described, an accumulator having a plurality of denominationally ordered cathode glow tube elements each having ten digit representing positions conditionable in either an active or inactive state, resetting means for simultaneously conditioning the zero representing positions in all elements in their active state and all significant digit representing positions in their inactive state, a current responsive signal device, means controlled by the resetting means and rendered effective immediately following the resetting operation for testing all significant digit representing positions of all the elements, and means controlled thereby when any one or more of such positions is in its active state for establishing a circuit to said current responsive device.

12. In a record controlled calculating machine having a multi-electrode gaseous discharge tube accumulator, entering means therefor and inverting means for causing the entry standing in the accumulator to be inverted into the complement thereof, the combination with means for reading a succession of records for designations in a column thereof in digit representing positions, means for reading said records for designations representing the

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algebraic sign of the entry in said column prior to the reading of the entry, means controlled by the first reading means for causing the entering means to enter the digital value sensed, further means controlled by the first reading means for causing the entering means to enter a single unit for each designation sensed, selectively settable means for rendering either of said two last named means effective, and means controlled by the second reading means for rendering the inverting means effective upon sensing a negative sign designation to invert the value standing in the accumulator prior to the entry therein and immediately after entries from the column sensed.

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