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3 Sheets-Sheet 1

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CARRY DEVICE

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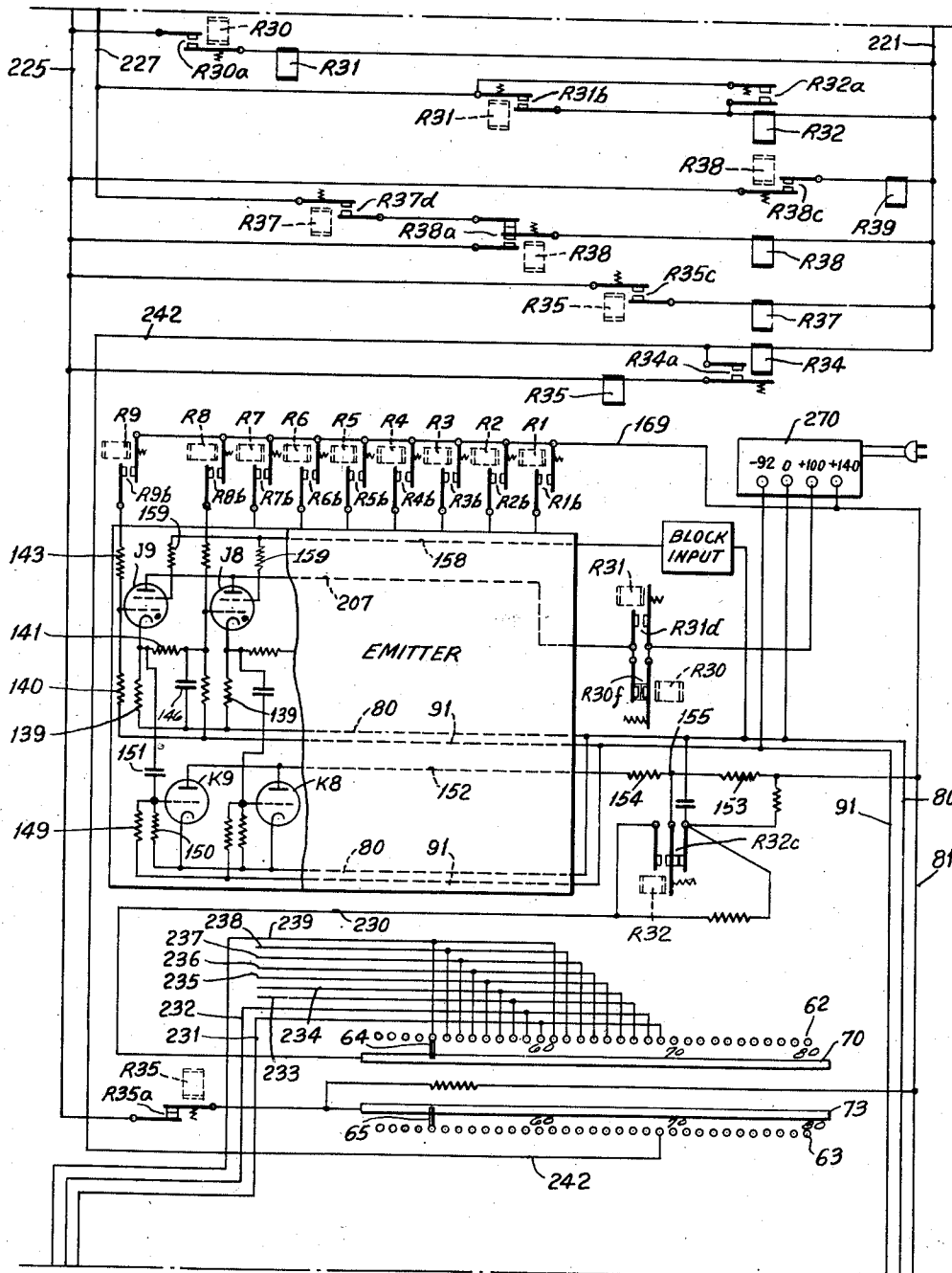


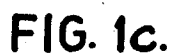
FIG. 1b.

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CARRY DEVICE

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Original application December 27, 1944, Serial No. 569,992. Divided and this application November 27, 1945, Serial No. 631,056

6 Claims. (Cl. 235—133)

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This application is a division of our copending application Serial No. 569,992, filed December 27, 1944 for Electronic accounting machine. The invention claimed in the present application is a carry device for an accumulator or register.

One object of the invention is to provide an improved carry device adapted to coact with counters which are operated by electrical impulses, the carry device being conditioned by an output impulse from a lower order and, when so conditioned, responding to a carry operate impulse at the end of an adding cycle, to transmit an impulse to the next higher order.

Another object is to provide carry means for an accumulator composed of impulse operated counters, the carry means providing for a carry on a carry by the cascade method.

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 and 1c constitute a circuit diagram of an accumulator associated with a card punch, the accumulator being provided with carry means in accordance with the invention.

The accumulator which embodies the carry means to be described is shown in Fig. 1c. It is composed of ten counters, only the first, second, ninth and tenth orders being shown. Each order of the accumulator is a counter which responds to electrical impulses applied to an input terminal 95 and, on counting ten impulses, transmits an impulse through an output lead 117. The counter may be an electronic counter of the kind shown in the application Serial No. 569,992. The drawing does not show the construction of the counter but it consists of a series of trigger circuits which operate in accordance with a modified binary system, in response to input impulses applied to the terminal 95, so as to give an output impulse on the wire 117 for every tenth input impulse. The electronic elements of the trigger circuits are connected to a cable leading from a power supply 270 (Fig. 1b). The wire 81 is at a potential of +140 volts, the wire 80 at 0 potential, and the wire 91 at -92 volts. The wire 93 can be connected to the wire 91 through normally open contacts R17a of a relay R17.

The output impulses on wire 117 are transmitted to a carry storage device, in the form of a trigger circuit E, there being one such trigger circuit for each order from the first to the ninth. As shown

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in the first order, trigger circuit E comprises two triodes E1 and E2, which may be two halves of a single tube. The cathodes are connected to the wire 80 and the anodes are connected through resistors 82 and 83 to the wire 81. The grid of the tube E1 is coupled by resistor 88 and a condenser 92 to the plate of the tube E2 and the grid of the tube E2 is coupled to the plate of the tube E1 by resistance 88a and condenser 92a. The grid of the tube E1 is coupled by condenser 94 to the wire 80 and by a resistance 90 to the wire 91. The grid of the tube E2 is coupled by a condenser 94 to the output lead 117 and by a resistance 90a and wire 118 through normally closed contact R38b and contact R17a, when closed, to the wire 91.

When power is turned on at the power supply the potential of the grid of the tube E1 is depressed below the cutoff point, while the potential on the grid of the tube E2 is positive, because of the open condition of the contact R17a at this time. Thereafter, when the contact R17a closes, in a manner to be described, the trigger E remains in the condition in which its right hand tube E2 is conductive, as indicated by the small circle at the right side of the tube. When a negative voltage wave is transmitted through wire 117 and condenser 94 to the grid of the tube E2, this tube is cut off. The rise in its plate potential is transmitted to the grid of the tube E1 and the latter tube becomes conductive. By the time the negative voltage wave ends, or leaks off the right hand condenser 94, the potential of the plate of the tube E1 is down and biases the grid of the tube E2 below cutoff.

The plate of the tube E2 is connected through a resistance 122 to the grid of a carry tube F, which is connected by a resistance 123 to the negative bias wire 91. The plate of this tube is connected through resistances 124 and 125 to the wire 81 and its cathode is connected to the wire 80. The grid of the tube F is also connected through a resistance 135 and wires 134 and 133 to the plate of a carry operate tube H. This is a power tube which has its cathode connected to the wire 80, its screen grid and plate connected through resistances 132 and 131, respectively, to the wire 81. Associated with the carry operate tube H is a carry operate trigger circuit G, which is similar to the trigger circuit E, except that the grid of the left hand tube G1 is connected through a resistance 90 to the wire 93 and the grid of the right hand tube G2 is connected through a resistance 90a and normally closed contact R37a to wire 91. Thus, when power is turned

on, the trigger assumes the condition in which the left hand tube G1 is conducting. The control grid of the tube H is connected to an intermediate point 130 of a voltage divider 128, 129 extending between the plate of the tube G2 and the wire 81. When the trigger G is switched to the left, as at the start, the control grid of the tube H is brought up to a potential which causes the tube H to be conducting. Due to the joint influence of the plate potentials of the tubes E2 and H, the grid of the tube F is biased considerably below the cut off point. If either tube E2 or H becomes non-conductive an increment of voltage will be added to the grid of the tube F, which is less than sufficient to raise the potential of the grid of the tube F above the cutoff point. If both of the tubes E2 and H are made non-conductive the potential of the grid of the tube F rises above the cutoff point and the tube becomes conductive. When this occurs a negative impulse is transmitted from an intermediate point 128 of an anode resistor 124, 125 of the tube F, through a wire 127, to the input terminal 95 of the second order of the accumulator.

The impulses which operate the counters of the accumulator are transmitted from an emitter shown in Fig. 1b. Closure of any contact of the series R1b—R9b will cause a corresponding number of impulses, 1, 2 . . . 9, to be transmitted from the emitter. For the purpose of the present disclosure the emitter can be understood to comprise a series of nine gas tubes, only two of which, J9 and J8, are shown in the drawing. The plates of these tubes are connected through a common lead 297 and normally closed contact R30f, to a 100 volt terminal of power supply 279. The cathodes are connected through resistances 133, to the 0 wire 80. Each control grid is connected to an intermediate point of a voltage divider comprising resistances 143 and 143, the lower end of which is connected to the -92 volt wire 91 and the upper end of which is connected through a related contact R9b, R8b, etc., and a common wire 165, to a +140 volt terminal of the power supply 279. The shield grids of the tubes are connected through resistances 153, a common wire 155, and a device labeled "Block input," to the 0 wire 80. The block input device is utilized in reading out the accumulator and will not be further referred to herein.

The cathode of the tube J9 is connected through a delay circuit comprising a resistance 141 and a condenser 145, to the control grid of the tube J8. If the contact R9b, for example, is closed, a circuit will be extended from the +140 volt terminal of the power supply through wire 169, contact R9b, voltage divider 143, 140, to wire 91. The control grid, which normally has the negative potential of the wire 91, is raised to a potential which causes the tube J9 to ignite, extending a circuit from the 100 volt terminal of the power supply through normally closed contact R30f, the plate to cathode path of tube J9, resistance 133, to wire 80. The voltage of the cathode of the tube J9 rises and this rise is transmitted, with a predetermined time delay determined by the time constant of the circuit, to the control grid of the tube J8, igniting the latter tube. In the same way the other tubes of the series are ignited in timed sequence.

As each tube is ignited and its cathode potential rises, a positive voltage wave is transmitted through a related condenser 151 to the grid of a related triode K9, K8, etc. The plates of the series of tubes K9, K8, etc., of which there are

nine, are connected through a common wire 152, a voltage divider 154, 153, to the wire 81. The cathodes are connected to the wire 80 and the grids are connected to an intermediate point of a voltage divider comprising resistances 160 and 159 extending between the wire 91 and the wire 80. Thereby the grids are normally biased to cut off potential. The positive voltage waves transmitted through the condensers 151 cause the tubes K9, K8, etc. to become conductive successively. As each one becomes conductive a negative voltage wave is transmitted from an output terminal 156 in the voltage divider 154, 153, to the particular order of the accumulator which is receiving impulses at the time, through a circuit to be described presently.

The emitter is controlled by relays operated by the keyboard of a duplicating punch which is more fully disclosed in the application Serial No. 569,992. Fig. 1a shows the keyboard of this punch, the keys being in a vertical row 55. The punch includes a card carriage (not shown) having associated with it a readout mechanism shown in Fig. 1b and represented by brushes 64 and 65 traveling along rails 70 and 73 and connecting the latter successively to an upper row of contacts 62 and a lower row of contacts 63, respectively, there being one contact in each row for each column of the card. Only the contacts pertaining to columns 48 to 89 are shown in Fig. 1b.

It is to be noted by examination of Figs. 1b and 1c that the contacts 62 are connected to the input terminal 95 of the various orders of the accumulator in a predetermined arrangement, there being groups of nine contacts each. For example, contacts 62 representing the 60th and 69th columns of the tabulating card are connected to the input terminal 95 of the first order of the accumulator; contacts 62 representing the 59th and 68th columns of the card are connected to the input terminal 95 of the second order of the accumulator; and contacts 62 representing 52nd and 61st columns of the card are connected to the input terminal 95 of the ninth order of the accumulator. With such an arrangement, the tabulating card may be said to be divided into fields whereby amounts, up to and including nine digits, may be entered into each field. However, where amounts are to be added, for example, it is necessary that similar denominations be entered into appropriate corresponding columns of each field of the card involved. The space key S affords a convenient means to effect spacings between appropriate columns so that entries may be made in proper denominational order in card fields.

Electrical power for operating the punch and control relays to be described is derived from a direct current source indicated in Fig. 1a by the signs + and -. When a main switch is closed, a circuit is extended from positive wire 220 through normally closed latch contact 224 and relay contact R18a, wire 225, relay R16, to the negative wire 221, energizing said relay. Contact R16b closes, extending a circuit from the wire 225 through relay R17 to the wire 221 and energizing the latter relay. Contact R17a (Fig. 1c) closes, extending the negative bias potential to the grids of those trigger tubes which are normally conductive. Contact R17b closes, extending a circuit through the latch contacts 224, contact R17b, wire 226, and bus bar 223, to the key contacts of the row 55.

When power was first turned on a circuit was also extended from wire 225 through normally

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closed contact R32b and relay R30 through the negative wire 221, energizing said relay. Contact R30a (Fig. 1b) closes, extending a circuit from wire 225 through said contact, relay R31, to the negative wire 221, energizing said relay. Contact R31b closes, extending a circuit from the wire 226 through normally closed floating cam contact FC, wire 227, contact R31b, relay R32, to the negative wire 221, energizing said relay. Contact R32a closes, extending a holding for relay R32 past the contact R31b. Contact R32b opens, dropping out relay R31. The contact R32c transfers, conditioning the emitter output for transmission of impulses.

Assume that a card is in column 52 position and that the problem is to add 89 and 19. The operator will actuate the space key S seven times, to bring the card carriage to column 59 position. Each time the space key is operated a circuit is extended from wire 220 through the latch contact 224, contact R17b, wire 226, bus bar 228, the contacts of the key S, wire 241, punch magnet 30, to the negative wire 221. The punch magnet is energized and causes the punch operating mechanism to operate, but with the sole effect making the carriage escape from one column to the next at each operation of the punch magnet. The holding cam contact FC opens during each carriage escapement, with an effect on the control relays to be described presently.

When the carriage is in column 59 position (corresponding to the "tens" denomination to allow entry into the second order of the accumulator) the operator actuates the "8" key 55, extending a circuit from the bus bar 228 through the "8" key contact, the relay R8 and the magnet 8, bus bar 218, to the wire 221, energizing said relay and said magnet. The contact R8a closes, extending a holding circuit for the relay R8 and magnet 8 through wire 227 and floating cam contact FC, to the wire 226. The excitation of magnet 8 causes an interposer to be moved into position to actuate the punch in the "8" index point position of the card. The interposer closes a bail contact 38, extending a circuit from wire 225 through the punch magnet 30 and causing operation of the punch. Meanwhile, contact R8b (Fig. 1b) closes, setting the emitter in operation to emit eight impulses, in the manner previously described. These impulses are transmitted from the output terminal 155 through transferred contact R32c, wire 230, rail 70, upper brush 64, contact 62 in column 59, wire 232, to the input terminal of the second order of the accumulator. The eight impulses advance the second order counter from 0 to 8.

When the floating cam contact FC opens, as the card carriage escapes from column 59, the relay R32 becomes deenergized and its holding contact R32a opens. Contact R32c transfers, disconnecting the output terminal of the emitter from the accumulator. Contact R32b closes, completing a circuit from wire 225 through relay R30 and energizing said relay. Contact R30f opens, disconnecting the plates of the tubes J9, J8, etc., from the power supply and extinguishing the arcs in the tubes J8, etc. Contact R30a closes, completing a previously traced circuit through relay R31 and energizing said relay. Contact R31d closes, applying positive potential to the plates of the J tubes. Contact R31b closes, extending a circuit from the relay R32 to the wire 227, so that this relay will be energized as soon as the floating cam contact FC closes, when the card carriage arrives in column 60. When relay

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R32 is energized its contact R32a closes, extending a holding circuit to the wire 227; its contact R32b opens, dropping out relay R30; and its contact R32c transfers, connecting the emitter to the 60th column contact 62.

When the operator depresses the "9" key the same operations are repeated, except that this time nine impulses are sent from the emitter through the column 60 contact 62 and wire 231 to the input terminal 95 of the first order of the accumulator, advancing this order to 9.

The operator now operates the space key seven times bringing the carriage into column 68 position (corresponding to the "tens" denomination to allow entry into the second order of the accumulator). Now when the operator presses the "1" key a single impulse is transmitted from the emitter through wire 232 to the second order of the accumulator, advancing this counter from 8 to 9. The carriage steps forward to column 69 and the operator presses the nine key. This causes nine impulses to be transmitted through wire 231 to the first order of the accumulator, advancing the latter from 9 through 0 to 8.

When the first order counter passes through 0 it transmits an output impulse, in the form of a negative voltage wave, through wire 117 and condenser 94 to the grid of the tube E2, switching the trigger E to the left. As the plate potential of the tube E2 rises the voltage on the grid of the tube F is lifted by an increment which still leaves it below the cutoff potential.

When the carriage arrived at column 69, and before the operator had depressed the "9" key, as just mentioned, the lower brush 65 of the column readout mechanism came upon the contact 63 pertaining to column 69, completing a circuit from wire 225 through normally closed contacts R35a, rail 73, brush 65, wire 242, relay R34, to the wire 221, energizing said relay. Contact R34a closes, preparing a circuit for relay R35, but this relay was not energized immediately, because it was shunted by the wire 242.

When the carriage steps out of column 69 position, as a result of the last mentioned operation of the "9" key, the brush 65 leaves contact 63 pertaining to column 69, breaking the shunt circuit around the relay R35, so that this relay becomes energized. Contacts R35a transfer, in preparation for the readout operation. Contact R35c closes, completing an obvious circuit to relay R37, which becomes energized. This relay controls the carry operate impulse. The contact R37a (Fig. 1c) opens, removing the bias potential from the grid of the tube G2 and causing this trigger to switch to the right. The plate potential of the tube G2 drops, biasing off the tube H. The plate potential of the tube H rises, lifting the potential of the grids of all of the F tubes by a certain increment. In the first order this increment is sufficient to render the F tube conductive, causing a negative impulse to be transmitted through wire 127 to the input terminal 95 of the second order. The second order is advanced from 9 to 0 and sends an output impulse through its wire 117 and condenser 94 to the grid of the right hand tube of the related carry trigger E. This trigger is switched to the left and the resulting rise in the plate potential of tube E2 is transmitted to the grid of the related tube F. This increment of rise is sufficient to render the last mentioned tube conductive and a negative voltage wave is transmitted from its output terminal 126 through wire 127 to the input terminal 95 of the third order of the accumulator.

The accumulator has now stored 108, the sum of 89 and 19.

When the relay R37 was energized its contacts R37d were closed, completing a circuit from wire 227 through normal contacts R38a and relay R38 to wire 221, energizing said relay. Contacts R38a transfer. These are made before break contacts and the relay R38 is held energized through a circuit extending to wire 225. Contact R38b opens, disconnecting the wire 118 from the bias potential and causing all of the carry triggers E which have been switched to the left to switch back to their normal right hand position, in preparation for the readout operation, in which the carry circuits are used again. Contact R38c closes, completing an obvious circuit through relay R39, energizing said relay. Contact R39a closes, restoring bias potential to wire 118.

The punch is now operated automatically under control of the accumulator, to read out the amount in the accumulator and to punch that amount in the card field comprising columns 70 to 73. The manner in which this is done is described in application Serial No. 569,992 and will not be repeated here, since it forms no part of the invention claimed in this application.

When the card carriage enters column 39 position the last column contact 250 is closed in the well known manner, as described in the aforesaid application, completing a circuit from wire 220 through said contact and eject magnet 251, as well as relay R18, to wire 221, energizing said magnet and said relay. The eject magnet causes the card to be ejected and sets under way a train of operations in the course of which another card is fed into punching position. The contact R18a (Fig. 1a) opens, removing the positive line potential from the control relay bus wire 225 and deenergizing all of the relays which are energized at the time through this wire. This includes the relays R16 and R17. The contact R17a opens, removing bias potential from the wires 93 and 118, thereby restoring all trigger circuits to normal condition, including those in the counters.

When the carriage leaves column 30 position, the last column contact 250 opens and magnet 251 and relay R18 are deenergized. The contact R18a closes, but at this time, in accordance with the well known operation of the duplicating punch described in application Serial No. 569,992, the latch contact 224 is open and remains open throughout the carriage return movement. During this time the contact R17b is open and the keyboard is disconnected from the power supply. When the latch contact 224 closes, potential is restored to wire 225 and relays R16 and R17 are energized. Contact R17a closes, restoring bias potential to the trigger circuits and contact R17b closes, restoring line potential to the wire 225.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to a single modification 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. A carry device for transmitting units from a lower order of an accumulator to the next

higher order comprising an electronic discharge element having an anode, a cathode, and a control electrode; an electronic trigger operated by the lower order of the accumulator; means normally biasing said one control electrode below cutoff potential; means controlled by said trigger when the latter is operated, to add a positive increment to the potential of said one control electrode sufficient to overcome a part of the bias of the latter below the cutoff potential; carry operating means including means to add another positive increment to the potential of said one control electrode sufficient, when added to said first increment, to raise said potential above the cutoff potential, and means responsive to a change in the anode potential of said electronic discharge element for adding a unit to the next higher order.

2. A carry device for transmitting units from lower orders of an accumulator or register to the respective next higher orders comprising a plurality of electronic discharge elements, one for each order except the highest, each of said elements having an anode, a cathode, and a control electrode; an electronic trigger for each order except the highest; means normally biasing said one control electrode of each of said elements below the cutoff potential; means controlled by the respective trigger, upon operation thereof, to add a positive increment to the potential of said one control electrode of the related element, sufficient to overcome a part of the bias of the latter below the cutoff potential; carry operating means including means operative at the end of an addition, to add a second positive increment to the potential of the control electrode of each of the said elements, sufficient to raise the potential of any control electrode to which a first increment has been added, above the cutoff potential, and means responsive to a change in the anode potential of any of said elements for adding a unit to the next higher order, said carry operating means being adapted to hold said second increment of potential on said one control electrode, whereby if any carry storage means is operated in response to a carry into its order from a lower order, the related element is rendered conductive and transmits a unit to the next higher order.

3. In a carry device for transferring units from one order of an accumulator to a higher order comprising an electronic discharge device having an anode, a cathode, and one control electrode; electronic trigger means, operative by the first mentioned order of the accumulator; means to bias the said one control electrode normally below cut-off, means controlled by said trigger means, when it is operated, to reduce partially the bias upon said one electrode without rendering the said device conductive; carry operating means including means to further reduce the bias upon said one electrode to render the said device conductive, and means controlled by a change in anode potential of the said device to transfer a unit to the said higher order.

4. A carry device for transmitting units from lower orders of an accumulator to the respective next higher orders comprising a plurality of electronic discharge devices, one for each order except the highest; each of said devices having an anode, a cathode, and one control electrode; electronic trigger means for each order except the highest, operative by its respective order; means to bias said one control electrode of each of the said devices normally below cut-off, means con-

trolled by the respective trigger means upon operation thereof to reduce partially the bias upon said one electrode of the related device without rendering it conductive; carry operating means including electronic trigger means operative at the end of an addition to further reduce the bias upon said one control electrode of each of the said devices to render those devices conductive which have received initial bias reductions; and means controlled by a change of anode potential of any of the said devices for adding a unit to the next higher order, the said carry operating means being adapted to maintain its influence until all carry storage means have operated in response to carry impulses from lower orders to transmit units to the next higher orders.

5. A carry device for transferring units from one order of an accumulator to a higher order wherein potential means under the control of carry operating means counteracts the bias potential on one control electrode of an electronic discharge device to render it conductive, means controlled by the said device, upon becoming conductive, to transfer a unit to the said higher order; means normally retaining the said device nonconductive by applying to said one electrode a bias potential greater than the said potential means can counteract, electronic trigger means operative by the first mentioned order of the accumulator, and means controlled by said trigger

means, when it is operated, to reduce the said bias potential to a value within the range of the said potential means to counteract.

6. A carry device for transmitting units from a lower order of an accumulator to the next higher order wherein entry is made into an order by a voltage pulse comprising a triode having an anode, a cathode, and one control grid; electronic trigger means operated by the lower order of the accumulator, means to bias said one grid of the said triode normally below cut-off, means controlled by said trigger means to raise the potential of said one grid to a value just below cut-off; a second electronic trigger comprising carry operating means including means to raise further the potential of the said grid to a value above cut-off, and a resistor network in the anode circuit of the said triode for transmitting a voltage pulse to the said higher order.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,402,988	Dickinson	July 2, 1946

Certificate of Correction

Patent No. 2,484,115

October 11, 1949

RALPH L. PALMER ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 8, line 50, for the words "In a carry" read *A carry*;
and that the said Letters Patent should be read as corrected above, so that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 19th day of December, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

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