

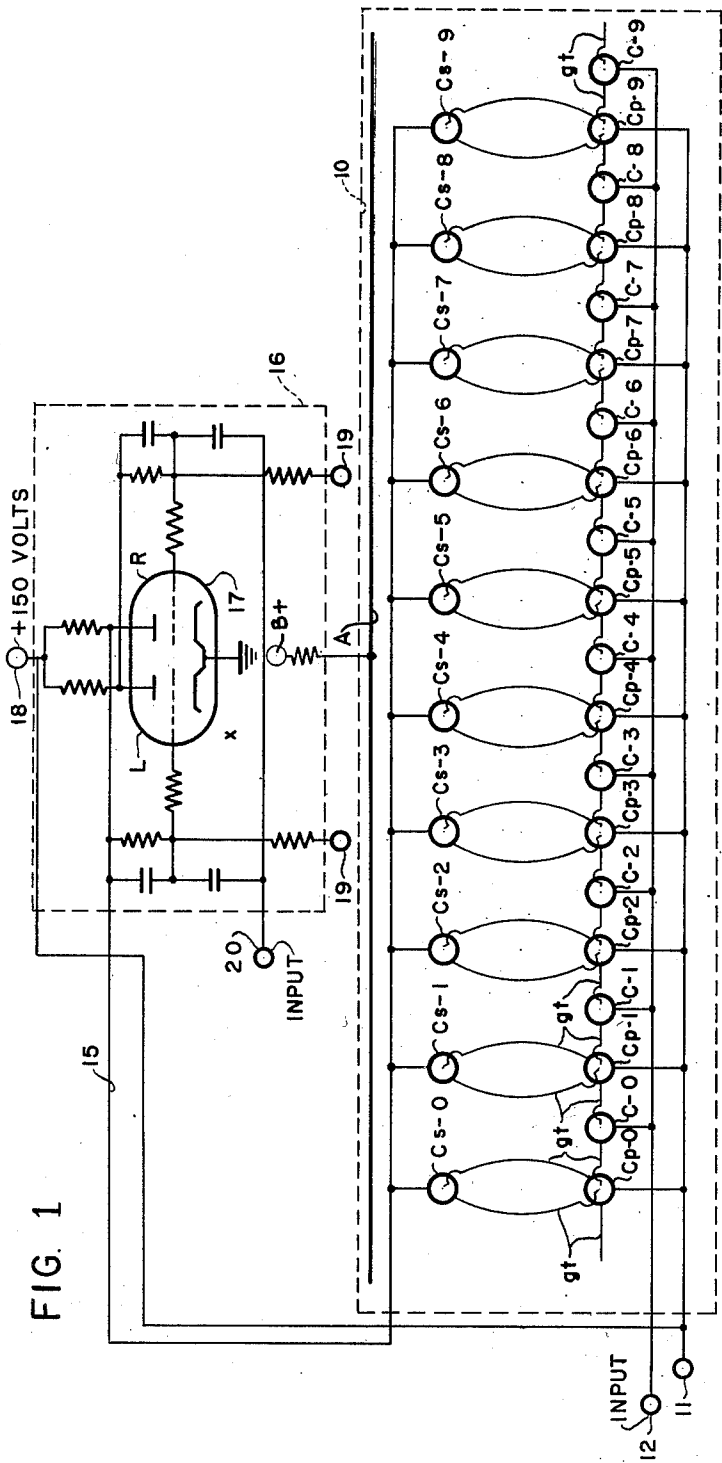
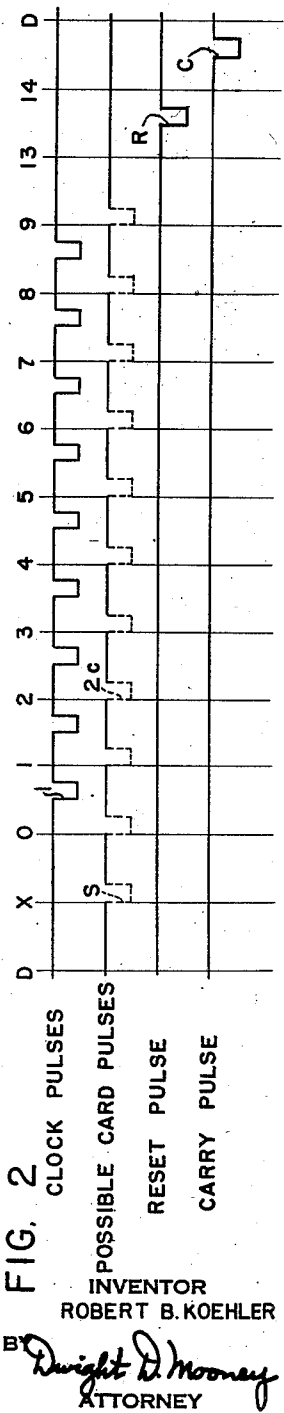
Sept. 8, 1953

R. B. KOEHLER
DUAL-POLARITY GAS TUBE COUNTER

2,651,741

Filed May 15, 1951

2 Sheets-Sheet 1



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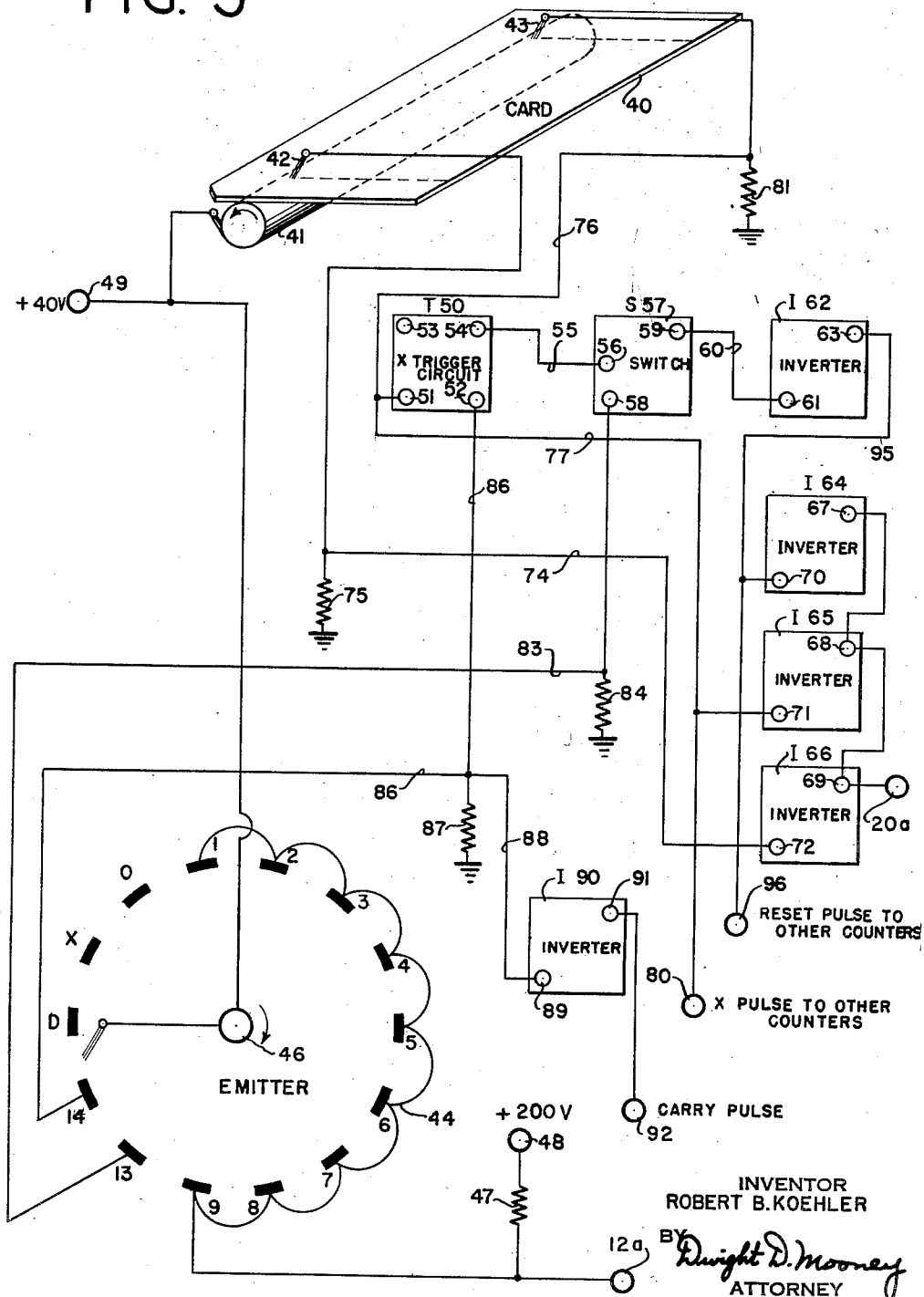
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FIG. 3



UNITED STATES PATENT OFFICE

2,651,741

DUAL-POLARITY GAS TUBE COUNTER

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7 Claims. (Cl. 315-168)

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This invention relates to gaseous discharge counter tubes and more particularly to such tubes of the glow transfer type including means for effecting the read-in and storage of both positive and negative manifestations.

In conventional gaseous discharge counter tubes certain preselected manifestations are stored in the tube, there being no provisions or structure within the tube to distinguish between manifestations representing positive quantities and manifestations representing negative quantities. The position of the glow discharge within the tube indicates the quantity stored in the tube and the transfer of the glow discharge in response to positive and negative manifestations is the same for a given quantity to be stored.

A principal object of the invention is to provide a gaseous discharge counter tube of the glow transfer type for effecting the storage of positive manifestations in true form and the storage of negative manifestations in complement form.

Another object is to provide a gaseous storage device of the glow transfer type for effecting storage of positive and negative manifestations by a preselected transfer of the glow discharge along a single glow transfer path in response to the manifestations, said device including means for transferring the glow discharge from said path during preselected intervals following the storage of said positive manifestations and prior to the storage of said negative manifestations.

A further object is to provide a gaseous storage device of the glow transfer type including only a single glow transfer path having a plurality of stable glow discharge positions and glow transfer means operable at each of said stable positions for transferring a glow discharge from that stable position in response to a preselected voltage change occurring just after the storage of one or more positive manifestations or just prior to the storage of one or more negative manifestations.

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:

Fig. 1 is a diagrammatic showing of one embodiment of the invention, and

Fig. 2 is a timing chart illustrative of one pulse arrangement for utilizing the invention, and

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Fig. 3 is a diagrammatic representation of one arrangement for producing the pulses shown in Fig. 2.

Briefly, the invention comprises a gaseous discharge counter tube of the general type set forth in the application of Richard K. Steinberg, Serial No. 192,199 filed October 26, 1950 and the application of Robert B. Koehler and Edward J. Rabenda, Serial No. 201,963, filed December 21, 1950. The tube set forth in the former application comprises ten digit position cathodes, ten glow transfer cathodes and an anode common to all the cathodes. One transfer cathode is interposed between consecutive position cathodes so that the twenty cathodes collectively define a single closed glow transfer path. In operation each negative pulse applied to the transfer cathodes effects a transfer of the glow discharge from one position cathode to the adjacent position cathode representing the next higher digit. The glow discharge is transferred in this manner along the closed glow transfer path in response to each negative pulse applied to the transfer cathodes. Each negative pulse applied causes a certain preselected glow transfer and such transfer is insensitive to the polarity of the quantity represented by the negative pulse applied.

The present invention provides an additional cathode for each position cathode. These additional cathodes are formed as the position and transfer cathodes, i. e., each is in the form of a hollow cylinder and coated with some suitable material so that a glow discharge thereto is confined to the inner surface thereof. Glow transfer wires are provided between each of these additional cathodes, termed holding cathodes because they hold the glow discharge opposite a particular digit position cathode during the time of application to the transfer cathodes of clock pulses which are not to be counted, and one position cathode so that a glow discharge may be transferred from that position cathode to that holding cathode and vice versa upon the application of appropriate voltages to the electrodes of the tube. All holding cathodes are commonly connected together and to a voltage source. When pulses representing negative quantities are to be stored in the tube the holding cathodes are energized and the glow discharge is transferred from a position cathode to the holding cathode associated with it. After a predetermined time interval has passed the holding cathodes are again energized and the glow discharge is transferred to the position cathode from which

it was previously transferred to the holding cathode. Thereafter each negative pulse applied to the transfer cathodes causes a stepped glow transfer as described in the application referred to above. As a result, pulses representing negative quantities are entered in the tube as the 9's complement of the quantity represented.

Referring more particularly to Fig. 1 the diagrammatic showing of the novel storage tube of the invention is designated by the numeral 10. The embodiment shown has a storage capacity of ten digits, viz. the digits 0-9. The position cathodes $Cp-0$ to $Cp-9$, inclusive, are each representative of the respective designating suffix digit. Transfer cathodes $C-0$ to $C-9$, respectively, are positioned within the tube so that one transfer cathode is intermediate each two consecutive position cathodes, the transfer cathode $C-9$ being intermediate the position cathodes $Cp-8$ and $Cp-0$. As shown, all position cathodes are commonly connected to a terminal 11 to which a suitable positive direct current voltage is applied over a lead 11a. All transfer cathodes are commonly connected to an input terminal 12 to which negative clock pulses are applied at uniform intervals, the actual selection of pulses to be stored being determined by the position of a glow discharge within the tube as described hereinafter. The anode A, common to all of the cathodes of the tube 10, is equidistant from each and connected through a suitable anode load resistor to an appropriate source of positive voltage designated as $B+$.

Assuming that a glow discharge exists between the position cathode $Cp-0$ and the anode A and that a negative pulse is applied to the input terminal 12, the leading negative front of the pulse increases the voltage difference between the common anode and the transfer cathodes until it is greater than that between the anode and the position cathode $Cp-0$. As a result, the glow discharge is transferred from the position cathode $Cp-0$, over the transfer wire gt , affixed at one end to the transfer cathode $C-0$, to the transfer cathode $C-0$ and exists between that transfer cathode and the anode until the positive going edge of the negative pulse is applied. This positive voltage causes the voltage difference between the position cathodes and the anode to be greater than that between the transfer cathode $C-0$ and the anode. As a result the glow discharge is transferred from the transfer cathode $C-0$, over the transfer wire gt , affixed at one end to the position cathode $Cp-1$, to the position cathode $Cp-1$. The glow discharge continues in stable equilibrium between the position cathode $Cp-1$ and the anode until another pulse is applied to the tube to change the voltage relationships sufficiently to cause a transfer of the glow discharge. Each subsequent negative pulse applied to the terminal 12 causes a similar transfer of the glow discharge to the next higher digit representing position cathode. Finally, the tenth such pulse effects a transfer of the glow discharge from the position cathode $Cp-9$ to the position cathode $Cp-0$, thereby placing the glow discharge in its initial or starting position.

The function of the transfer wires gt is as set forth in the application referred to above. Also, any conventional means may be employed to effect a predetermined positioning of the glow discharge at starting and to effect carry when the glow discharge leaves or arrives at a preselected position cathode. Such means and means for

reading out the values stored in the tube do not constitute part of this invention.

In effecting a reading in of digits of negative sign as 9's complements thereof the holding cathodes $Cs-0$ to $Cs-9$ inclusive are utilized. Each of these cathodes is connected by glow transfer means to the position cathode having the same digit designating suffix. A glow transfer wire gt is connected at one end to each holding cathode and has its other end extending into the region of intense ionization between the corresponding position cathode and the anode. This glow transfer wire functions to effect a transfer of the glow discharge from the position cathode to the holding cathode to which it is connected. Likewise, a glow transfer wire gt is connected at one end to each position cathode and has its other end extending into the region of intense ionization between the corresponding holding cathode and the anode. This glow transfer wire functions to effect a transfer of the glow discharge from the holding cathode to the position cathode to which it is connected.

The holding cathodes $Cs-0$ to $Cs-9$ inclusive are commonly connected by a lead 15. When a voltage is applied to the lead 15 such that the voltage difference between the holding cathodes and the anode is greater than that between the position cathode and the anode the glow discharge existing at one of the position cathodes is transferred to the holding cathode coupled to that position cathode by the transfer wires. Conversely, when the glow discharge exists at one of the holding cathodes and the voltage difference between the holding cathodes and the anode is less than that between the position cathodes and the anode the glow discharge is transferred to the position cathode coupled to that holding cathode by the transfer wires.

The lead 15 is also connected to a trigger circuit which applies a common voltage change to all the holding cathodes to effect a transfer of the glow discharge between the holding and position cathodes or vice versa depending upon the direction of the voltage change.

The trigger circuit 16 includes a vacuum tube 17 having two triode tube sections designated L and R respectively. These tube sections are alternately conductive and non-conductive respectively to represent two stable conditions. When the tube section L is conductive the tube section R is non-conductive and the trigger circuit is referred to as being in the Left condition. Likewise, when the tube section R is conductive the tube section L is non-conductive and the trigger circuit is referred to as being in the Right condition. The plate of each tube section is connected through a resistor to terminal 18 to which is applied a suitable positive voltage and through a resistor and a capacitor in parallel and a parasitic suppressor resistor to the control grid of the other tube section. Each of the control grids is also connected through a resistor to a terminal 19 to which is applied a suitable negative voltage. The control grids of the tube sections are commonly connected through their respective coupling capacitors to an input terminal 20. When initially put into operation the trigger circuit always assumes the Left condition as indicated by the X to the lower left of the tube section L, such ensured by any conventional means.

The trigger circuit is designed so that it is switchable from either stable condition to the other in response to negative pulses applied to the terminal 20 and is switchably non-respon-

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sive to similar positive pulses applied to that terminal. When the respective voltages are initially applied to the terminals 18 and 19 the trigger circuit assumes the Left condition automatically or is placed in that condition by any suitable conventional means subsequent to the application of the voltages. When the first negative pulse is applied to the terminal 20 it has no direct effect on the non-conductive condition of the tube section R of the tube 17 because the voltage at its control grid is already below the cutoff value. However, the voltage at the control grid of the tube section L is above the cutoff value because that tube section is conductive. This negative pulse reduces the voltage on the control grid of the tube section L. The voltage at the plate of the tube section L is therefore increased. This increased voltage is transferred through the parallel connected resistor and condenser to the control grid of the tube section R to render the tube section R conductive. The resulting decreased voltage at the plate of the tube section R is transferred through the parallel connected resistor and condenser to the control grid of the tube section L to render the tube section L still less conductive. This cumulative action is continued until the tube section L is rendered non-conductive and the tube section R is rendered fully conductive to place the trigger circuit in the Right condition. If a second negative pulse is now applied to the terminal 20 the voltage at the control grid of the conductive tube section R is reduced and a similar cumulative action occurs to place the trigger circuit in the Left condition. Subsequent negative pulses applied to the terminal 20 cause a repetition of the above described switching of the trigger circuit.

It is seen that when the trigger circuit is in the Left condition the voltage at the plate of the non-conductive tube section R is high and that when the trigger circuit is in the Right condition the voltage at the plate of the conductive tube section R is low. The voltage at this plate is transferred over the lead 15 to the holding cathodes Cs-0 to Cs-9, inclusive, and when the trigger circuit is in the Left condition the high voltage applied to the holding cathodes is greater than the voltage applied to the position cathodes so that the voltage difference between the holding cathodes and the anode is less than the voltage difference between the position cathodes and the anode. As a result the glow discharge continues to a position cathode if it was there before the switching of the trigger circuit or if the glow discharge was to a holding cathode before the switching of the trigger circuit it is transferred to the corresponding position cathode. Conversely, if the trigger circuit is switched to the Right condition the voltage difference between the holding cathodes and the anode is greater than that between the position cathodes and the anode. As a result, the glow discharge is transferred to the holding cathodes from the position cathodes if it was not already at a holding cathode.

Referring to Fig. 2 there is shown a plurality of pulses which might be produced during the operation of a calculator or a variety of circuits controlled by a conventional IBM card which utilizes fourteen index points per card cycle. Clock or timed pulses are provided intermediate successive index points from the index points 0-9 inclusive as shown. A card pulse is produced at any index point X-9 inclusive. A reset pulse is produced at the index point 13 and a carry

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pulse is produced at the index point 14. Index point D represents the point in the cycle where one card cycle ends and the next subsequent one begins. A pulse at X time in the cycle indicates that the data punched in that card is negative.

For purposes of explanation it is assumed that the storage tube is in its initial or starting condition with a glow discharge existing between the position cathode Cp-0 and the anode. The trigger circuit 16 is in the Left condition, the voltage difference between the holding cathodes and the anode being less than that between the cathode Cp-0 and the anode.

The storage of a positive quantity is begun by the application of clock pulses to the input terminal 12. The negative going leading edge of the 1 clock pulse, immediately succeeding the 0 card position, lowers the voltage on the transfer cathodes C-0 to C-9 inclusive and the glow discharge existing between the adjacent position cathode Cp-0 and the anode is transferred to exist between the transfer cathode C-0 and the anode because the voltage difference between the transfer cathode C-0 and the anode is greater than the voltage difference between the position cathode Cp-0 and the anode. This transfer of the glow discharge is effected along the transfer wire gt connected to the transfer cathode C-0 in accordance with the principles set forth in the above identified application.

Finally, the application of the positive going trailing edge of the 1 clock pulse is applied to the terminal 12. As a result the voltage on the transfer cathodes is increased so that the voltage difference between the position cathodes and the anode is greater than that between the transfer cathodes and the anode. The glow discharge is, therefore, transferred from the transfer cathode C-0 to the position cathode Cp-1 and exists between the position cathode Cp-1 and the anode. A similar transfer of the glow discharge takes place in response to each clock pulse applied to the terminal 12, each pulse advancing the glow discharge to the next adjacent position cathode.

Frequently, it is desirable not to effect storage throughout the card cycle. A hole is punched in the card at the index position where it is desired that storage of the positive manifestations shall cease. For example, if it is desired that +2 be stored by the tube 10 a hole or other suitable manifestation is placed in the 2 index position of the record card. As a result a negative card pulse 2c is produced at 2 time and applied to the terminal 20 of the trigger circuit 16. This pulse causes the trigger circuit 16 to switch from the Left to the Right condition. The value of the voltage on the lead 15 connecting the plate of the tube section R to the holding cathode is decreased so that the voltage difference between the holding cathode and the anode is greater than that between the position cathodes and the anode. Accordingly, the glow discharge existing between the position cathode Cp-2 and the anode is transferred to the holding cathode Cs-2 and exists between the holding cathode Cs-2 and the anode. Subsequent clock pulses applied to the input terminal 12 of the tube 10 during the remaining portion of the card cycle have no effect on the position of the glow discharge and no other storage is effected within the tube 10 during the card cycle.

Finally, at 13 time a negative reset pulse R is applied to the input terminal 20 of the trigger circuit 16 and switches it from the Right to the Left condition thereby increasing the voltage on

the holding cathodes and making the voltage difference between the position cathodes and the anode greater than that between the holding cathodes and the anode. As a result the glow discharge existing at the holding cathode Cs-2 is transferred, over the glow transfer wire connected to the cathode Cp-2 and extending into the area of intense ionization of the holding cathode Cs-2, to the position cathode Cp-2.

Next, the carry pulse C is applied to an appropriate carry circuit arrangement, not part of this invention, if a plurality of tubes are used as an accumulator.

Readout may now be effected in an appropriate manner such as rolling the counter tube 10 through ten counts.

The storage of negative manifestations is accomplished by storing the 9's complement of the true negative quantity. For the sake of clarity of understanding it is assumed that the counter tube is in the initial starting condition with a glow discharge existing between the cathode Cp-0 and the anode just prior to the storage of the negative manifestation.

When negative manifestations are to be read from the card the fact that the manifestation is of negative sign is indicated by the presence of a hole or other suitable manifestation at the X index position. The resulting pulse S, produced by any suitable means, is applied to the terminal 20 of the trigger circuit 16 and switches it to the Right condition thereby causing the glow discharge to transfer from the position cathode Cp-0 to the holding cathode Cs-0 and remains in a state of stable discharge until the trigger circuit is again switched to the Left condition. The clock pulses occurring immediately after 0 and 1 time therefore have no effect on the stable condition of the tube 10 when applied to its terminal 12.

If the value of the negative manifestation is 2 then a card pulse 2c will be obtained at the 2 index position or 2 time. This pulse switches the trigger circuit 16 back to the Left condition and transfers the glow discharge back to the position cathode Cp-0. The seven clock pulses subsequent to 2 time then cause the glow discharge to be transferred in a step by step fashion to the position cathode Cp-7 thereby storing the -2 as a +7, the 9's complement of the negative manifestation.

A system or the actual means for producing the pulses shown in Fig. 2 does not constitute part of this invention. Further, any suitable conventional means producing positive and negative pulses to be stored may be employed and it obviously is not required that such means be card controlled.

Referring to Fig. 3 one such card controlled means is shown therein and will be described briefly. A record card 40 is fed by any suitable means between the brush contact roll 41 and brushes 42 and 43. When brush 42 makes connection with contact roll 41 via a hole in the card a card pulse is produced; one such brush being provided for each counter to be used. Brush 43 when in contact with roll 41 produces an S pulse (Fig. 2) to indicate when a quantity is to be subtracted by the counter. Only one brush 43 is provided irrespective of the number of counters utilized by the accumulator employed.

The clock pulses (Fig. 2) are produced by an emitter 44 having contact bars 0 through 9 inclusive, 13, 14, D and X. A brush contact 45, rotatable with shaft 46 is adapted to contact each

of these bars during each rotation of the shaft. The bars 1 through 9 inclusive are connected together and to an output terminal 12a which is connected to the input terminal 12 of Fig. 1. These terminals are also connected through a resistor 47 to a terminal 48 which represents a suitable source of positive voltage, say 200 volts. The brush 45 is connected to the brush contact roll 41 and to a terminal 49 which represents a source of suitable positive voltage, say 40 volts.

The block T50 represents a trigger circuit of the Eccles-Jordan type similar to the trigger circuit 16 shown in Fig. 1 except that the grids of the respective tube sections are separately connected to receive input pulses. Such connection is indicated by the terminals 51 and 52 respectively. This trigger circuit is of conventional design and is responsive to a negative going voltage applied to the control grid of its tube section which is conductive. The x in the left of the block indicates that the lefthand tube section is initially conductive and hence the trigger circuit will be switched to the Right condition when a negative going voltage is applied to the terminal 51 and thereafter will be switchable to the Left condition by the application of a similar voltage to the terminal 52. The negative going voltage applied to this trigger circuit may consist of the leading edge of a negative pulse or the trailing edge of a positive pulse. As used herein this trigger circuit is switched in response to the trailing edge of a positive pulse. Terminals 53 and 54 of the trigger circuit T50 represent the plates of the respective lefthand and righthand tube sections. The terminal 54 representing the plate of the righthand tube section is connected through a lead 55 to a terminal 56 located in block S57.

The block S57 represents a conventional electronic switch. This switch may comprise any electronic tube which is connected to be rendered responsive to the simultaneous application of two pulses thereto such as, for example, the application of positive pulses to each of two grids represented by the terminals 56 and 58. The terminal 59 represents a connection to the plate of the electron tube employed as the switch. Terminal 59 is connected over a lead 60 to a terminal 61 in block I62.

The block I62 represents a conventional electronic inverter stage which may comprise a triode type tube connected to be responsive to negative pulses applied to its control grid represented by the terminal 61. The terminal 63 represents a connection to the plate of the triode tube which plate is also connected through a resistor to a source of positive voltage. Blocks I64, I65 and I66 each also represent a conventional electronic inverter stage. The plate terminals 67, 68 and 69 of these respective stages are commonly connected together and through a common resistor to a suitable source of positive voltage. It will be noted that the terminals 70, 71 and 72 of these respective stages are each connected to a separate input. Hence, an output will appear at the terminal 20a each time an input is applied to one of the terminals 70, 71 or 72. The terminal 20a is connected to the terminal 20 (Fig. 1). The brush 42 is connected by a lead 74 to the terminal 72 of the inverter I66 and through a resistor 75 to the ground. The brush 43 is connected by a lead 76 to the terminal 51 of the trigger circuit T50 and by leads 76 and 77 to the input terminal 71 of inverter I65 and to the terminal 80. The

brush 43 is also connected through a resistor 81 to ground.

The bar 13 of emitter 44 is connected through a lead 83 to a terminal 58 of the switch S57 and through a resistor 84 to ground. The bar 14 of emitter 44 is connected by a lead 86 to a terminal 52 of the trigger circuit T50 and through a resistor 87 to ground. The bar 14 is also connected through leads 86 and 88 to a terminal 89 of an inverter I90 similar to the inverter 62. The terminal 91 of the inverter 90 is connected to a terminal 92 at which negative carry pulses appear.

The terminal 63 of inverter I62 is connected by a lead 95 to the terminal 70 of inverter I64 and to a terminal 96. It will be noted that the S pulses which appear at the terminal 80 and R pulses which appear at the terminal 96 are also applied to the terminals 71 and 70 respectively of the inverters I65 and I64. The terminals 80 and 96 are provided to convey subtraction and reset pulses respectively to subsequent orders of an accumulator and are not employed herein.

It is understood that the rotation of the shaft 46 of the emitter 44 is synchronized by any suitable means with the travel of card 40 intermediate the brushes 42 and 43 and the brush contact roll 41. This is to say that the brush 45 will contact the numbered bar which corresponds to the card cycle points indicated in Fig. 2 when each of those points is intermediate the brush 42 and the card contact roll 41. For example, the brush 45 contacts the bar 43 at 3 time. When the brush 45 contacts one of the bars 1 through 9 inclusive, the terminal 12a is connected to the +40 volt terminal 49 and a negative clock pulse is produced. When the brush 45 is not in contact with a bar the terminal 12a is connected only through the resistor 47 to the +200 volt terminal 48, hence the glow discharge within the tube 10 (Fig. 1) will remain on a position cathode and each time the brush touches one of the bars and a clock pulse is produced the glow will be transferred to the next position cathode over the intermediate transfer cathode. When the emitter is operated at high speeds it is feasible to utilize an electronic smoothing circuit between the emitter and the counter tube 10 in order to make sure that the counter is not operated by a spurious response from the emitter. Such a circuit could be connected between the terminals 12a and 12.

When the brush 45 contacts the bar 13 a positive reset pulse is produced and applied over the lead 83 to the terminal 58 of switch S57 which will cause conduction through that switch if its other grid represented by terminal 56 is positive. When the brush 45 contacts the bar 14 a positive carry pulse is produced and transferred over the leads 86 and 88 to the terminal 89 of inverter I90 and appears at its terminal 92 as a negative carry pulse as indicated in Fig. 2.

At D time (Fig. 2) the trigger circuit T50 is in the Left condition. The voltage at terminal 54 (plate of righthand tube section) is therefore high. This same high voltage is applied over the lead 55 to the terminal 56 of the switch S57. Hence, a positive pulse applied to the terminal 58 of the switch S57 will render that switch operative and produce an output at its terminal 59. The actual circuit operation will be explained with references to the same examples used in connection with the operation of the tube 10 (Fig. 1).

If a +2 is to be stored in the tube 10 clock pulses appearing at the terminal 12 as a result of contact between brush 45 and bars 1 and 2 will

effect a glow transfer within the tube 10 as is previously described hereinbefore. A hole is punched in the card 40 at the 2 index position and the brush 42 will contact the brush contact roll 41 thereat to apply a +40 volt pulse to the terminal 72 of inverter I66 thereby causing a negative pulse 2c to appear at terminal 20a and prevent further storage in the tube in response to subsequent clock pulses appearing at terminal 12a.

At 13 time, when brush 45 contacts bar 13, a positive pulse is transferred over the lead 83 to the terminal 58 of switch S57 to render it conductive. A negative pulse is therefore transferred over the lead 60 to the terminal 61 of inverter I62 so that a positive pulse is transferred therefrom over the lead 95 to the terminal 70 of inverter I64 to cause a negative reset pulse to appear at the terminal 20a to effect a resetting of the trigger circuit 20 (Fig. 1).

At 14 time a negative carry pulse is produced as previously described.

If subtraction is to be performed a hole in the card so indicates and permits contact of the brush 43 with the brush contact roll 41 to transfer a +40 volt pulse to the terminal 51 of the trigger T50 to effect a switching of that trigger from the Left to the Right condition thereby placing a low voltage on the terminal 56 of the switch S57. This same +40 volt pulse is transferred over the leads 76 and 77 to the terminal 71 of inverter I65 to produce the negative pulse S (Fig. 2) at the terminal 20a. This negative pulse effects a switching of the trigger circuit 16 (Fig. 1) to the Right condition.

The subsequent clock pulses 1 and 2 will therefore have no effect upon the tube 10. However, since a negative 2 is to be stored, the brush 42 will contact the brush contact roll 41 at 2 time and impress a +40 volt pulse on the terminal 72 of inverter I69 to produce the card pulse 2c at the terminal 20a and thereby effect a switching of the trigger circuit 16 back to the Left condition so that subsequent clock pulses will be stored in the tube 10. At 13 time the +40 volt reset pulse applied over the lead 83 to the terminal 58 of the switch S57 will have no effect on that switch since the voltage on its terminal 56 is low. This pulse will therefore not be transferred to the trigger circuit 16 since it is blanked out by the switch 57.

At 14 time a negative carry pulse appears at the terminal 92. The +40 volt carry pulse appearing on the lead 86 is also transferred to the terminal 52 of the trigger circuit T50 to switch it from the Right to the Left condition and thereby reset the circuit arrangement to its initial condition.

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. A gaseous storage device of the glow transfer type wherein the position of a glow discharge within said device indicates the quantity stored therein comprising a group of position cathodes spaced substantially equidistant from each other along a closed glow transfer path; a group of

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glow transfer cathodes, one being spaced intermediate consecutive ones of said position cathodes and within said glow transfer path; glow transfer means intermediate successive cathodes to facilitate the transfer of a glow discharge from each cathode to the next successive cathode so that said glow discharge is transferable along said path in one direction only; a group of holding cathodes, one cathode being provided for and corresponding to each of said position cathodes; an anode common to all of said cathodes; and glow transfer means intermediate each holding cathode and the corresponding position cathode for transferring a glow discharge therebetween.

2. The storage device set forth in claim 1 including voltage means for applying a steady voltage to said position cathodes; coupling means from said transfer cathodes to a source of electrical manifestations to be stored to apply said manifestations to said transfer cathodes so that each manifestation will cause a glow discharge existing at a position cathode to be transferred to the next position cathode along said path; and voltage switching means connected to said holding cathodes to switch the voltage thereon alternately to different values to effect a preselected transfer of the glow discharge between corresponding holding and position cathodes.

3. The storage device set forth in claim 2 including electrical means connected to operate said voltage switching means to switch the voltage on said transfer cathodes from the higher to the lower of said different values to transfer a glow discharge from a position cathode to the corresponding holding cathode for a preselected time period.

4. A gaseous storage tube of the glow transfer type for effecting storage of positive and negative manifestations including a preselected number of cathodes arranged in a single closed glow transfer path; electrical means connected to effect transfer of a single glow discharge to a plurality of cathodes in response to each manifestation of one polarity to be stored; a plurality of electrodes, each arranged in glow transfer relationship with a selected cathode of said plurality of cathodes to effect transfer of a glow discharge therebetween, said electrodes being positioned out of said closed glow transfer path; and electromechanical means for applying a polarity indicating signal to said plurality of electrodes thereby effecting said transfer of a glow discharge between one of said cathodes and one of said elec-

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trodes, and anode means common to all said cathodes.

5. The storage tube set forth in claim 4 wherein said electrodes serve as cathodes, each cathode being formed as an open ended cylinder and containing different materials on its inner and outer surfaces so that a glow discharge thereto is substantially confined to the inner surface thereof; and a single anode is common to all said cathodes.

6. In a gaseous storage tube for storing positive and negative values wherein the stable position of a glow discharge indicates the storage effected therein; cathode means disposed in a closed glow transfer path and providing stable and unstable glow discharge positions therealong; electrical means for creating a stable glow discharge at a preselected place on said cathode means; a source of electrical manifestations to be stored and connections therefrom to said cathode means to advance said glow discharge a predetermined distance along said glow transfer path in response to said electrical manifestations; a plurality of cathodes, one in spaced glow transfer position with each of said stable glow positions; electrical polarity sensing means connected to said plurality of cathodes and responsive when said manifestations from said source represent a negative value to apply an electrical change to said plurality of cathodes so that the one in glow transfer position to the glow discharge will capture that glow discharge and thereby prevent the transfer of said glow discharge along said path in response to subsequent electrical manifestations occurring during a predetermined period.

7. In a gaseous discharge tube of the glow transfer type wherein a glow discharge is transferred in step-by-step fashion from one stable position to another along a predetermined glow transfer path to indicate the storage of electrical manifestations by the transfer of a glow discharge from a stable glow position on one cathode to a stable glow position on another cathode; electrical means for creating a preselected glow discharge within said tube; at least one additional cathode coupled in glow transfer relation to said one cathode; and electrical means connected to said cathodes to effect transfer of a glow discharge from said one cathode to said one additional cathode and vice versa.

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No references cited.