

Aug. 19, 1952

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2,607,891

TRANSLATING CIRCUITS UTILIZING GLOW DISCHARGE DEVICES

Filed June 10, 1950

3 Sheets-Sheet 1

FIG. 1

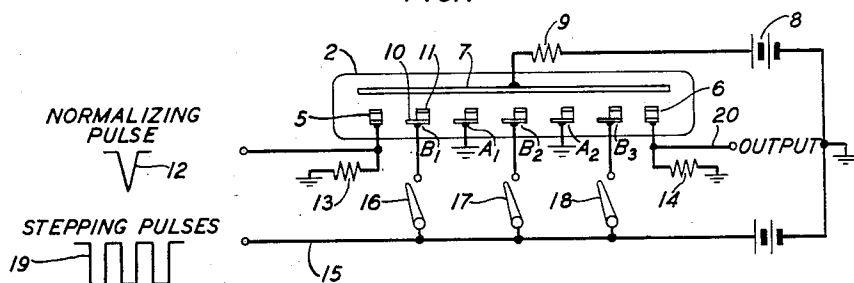
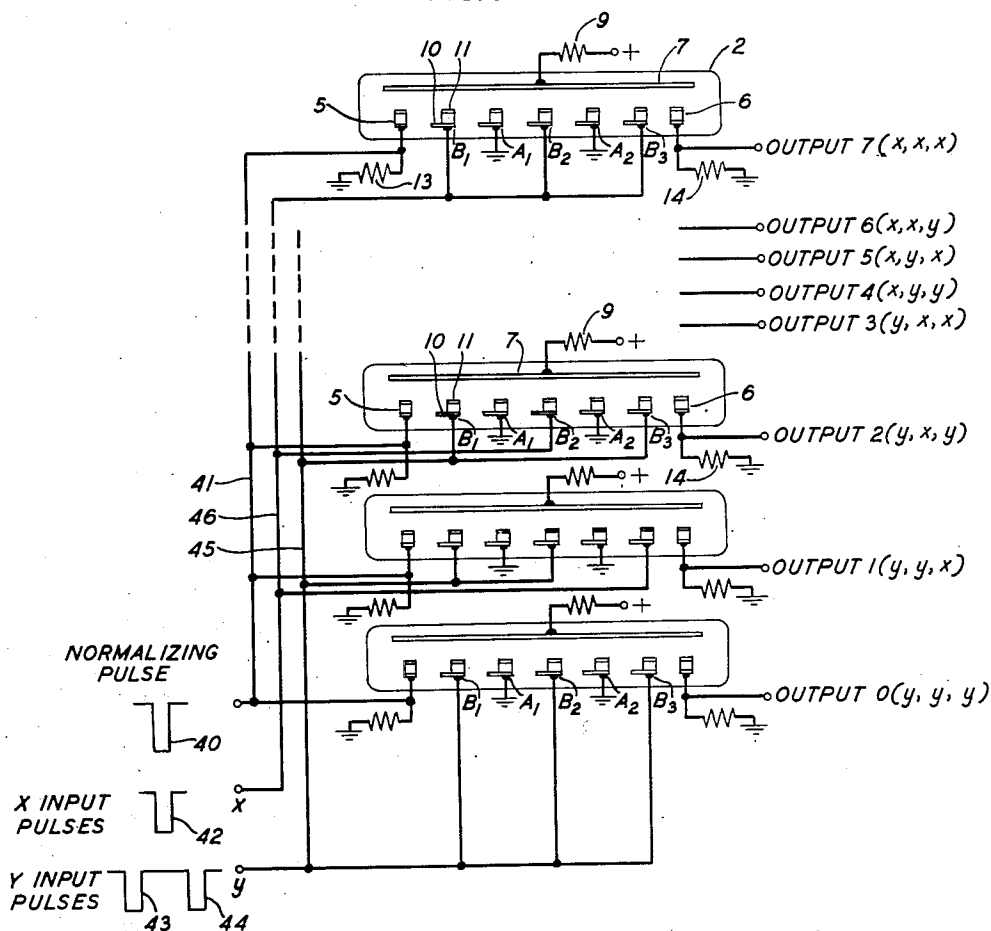


FIG. 3



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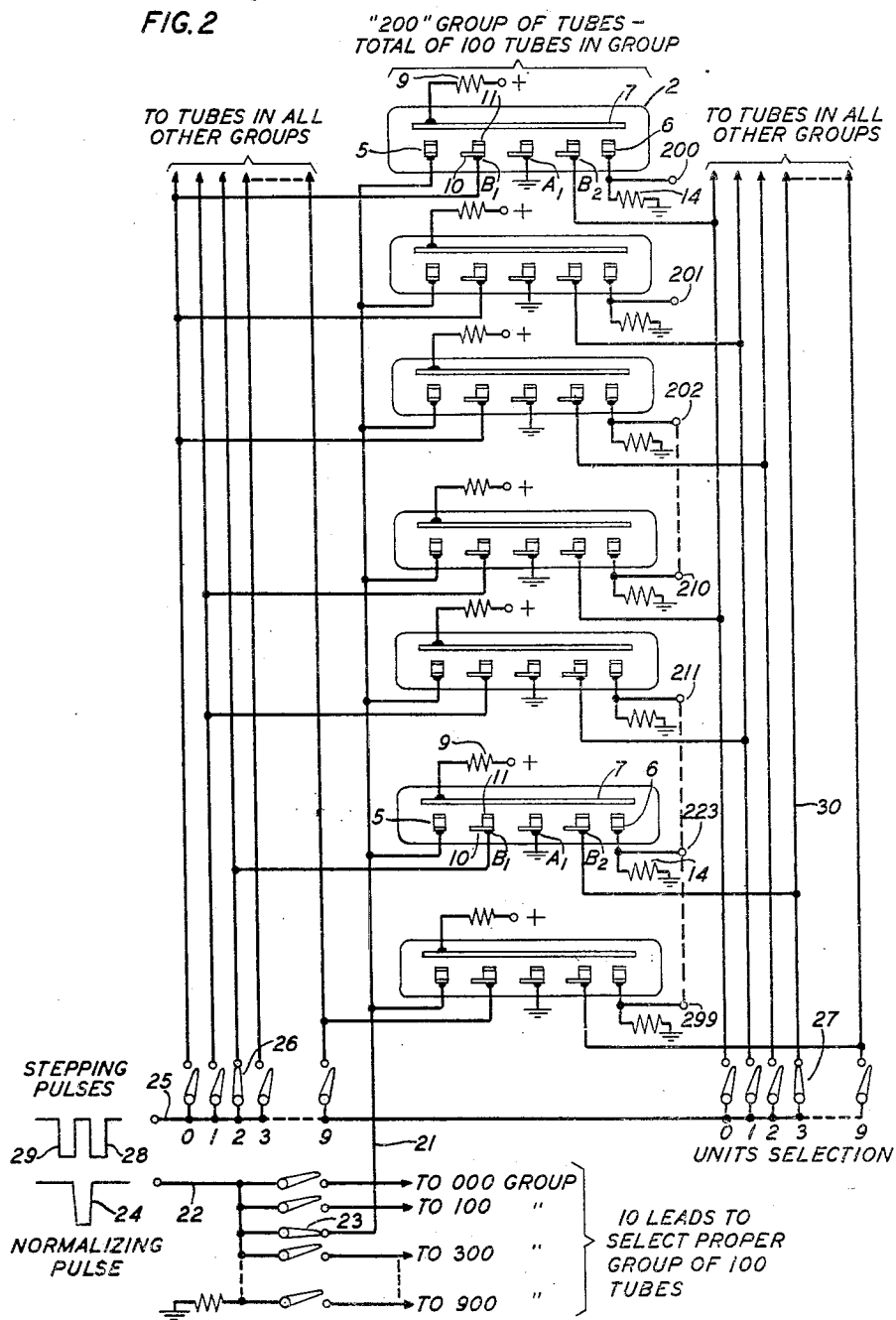
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FIG. 2



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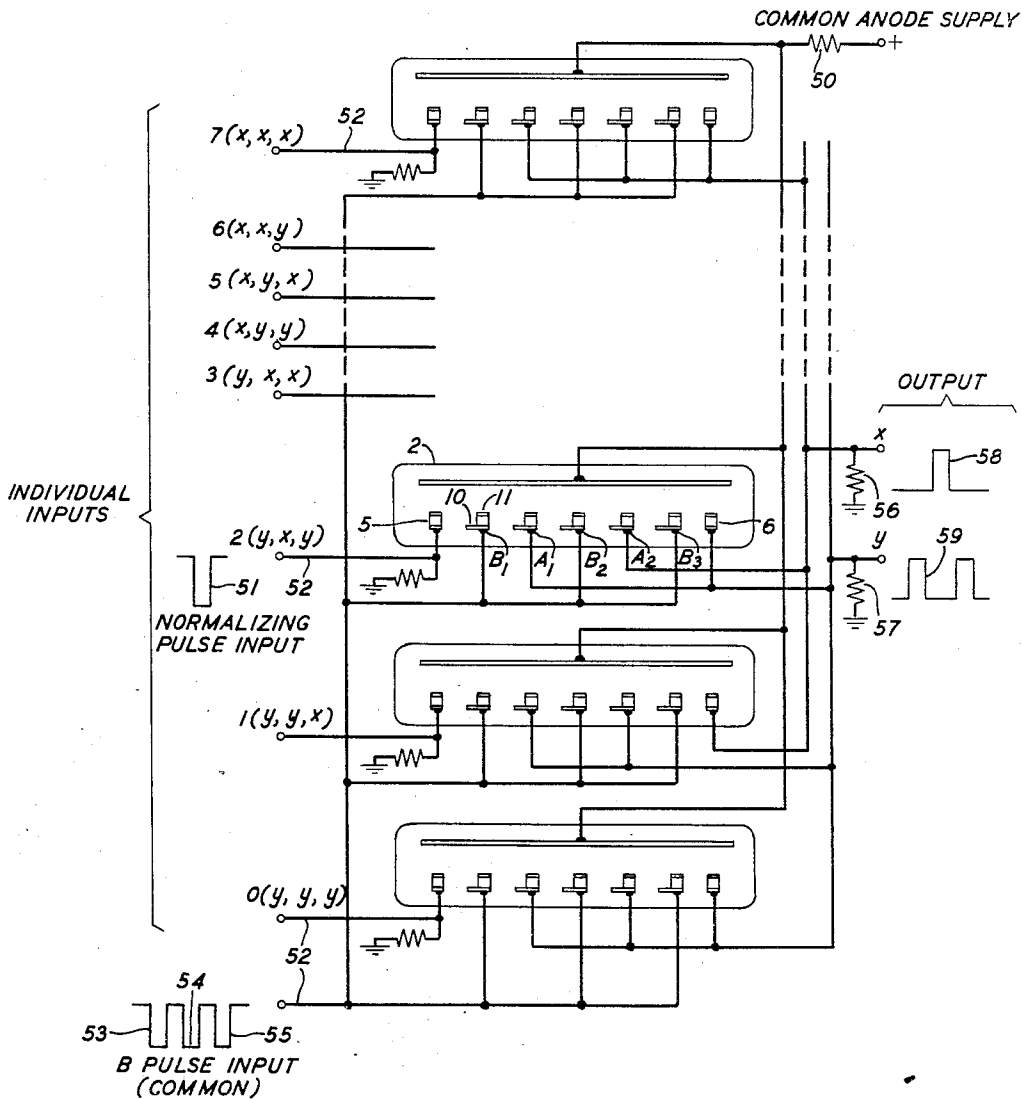
2,607,891

TRANSLATING CIRCUITS UTILIZING GLOW DISCHARGE DEVICES

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3 Sheets-Sheet 3

FIG. 4



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TRANSLATING CIRCUITS UTILIZING GLOW
DISCHARGE DEVICES

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Application June 10, 1950, Serial No. 167,380

12 Claims. (Cl. 250—27)

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This invention relates to translating circuits and more particularly to translating circuits utilizing glow discharge devices of the type disclosed in the application, Serial No. 101,322, filed June 25, 1949 of M. A. Townsend, now Patent Number 2,575,370, issued November 20, 1951.

In general, glow discharge tubes of the type described in the above-identified application comprise one or more rows of cathodes, each row having a common anode. The individual cathodes are composed of two portions of different glow discharge sustaining efficiencies. Thus, a glow discharge initiated between an anode and a cathode will be largely confined with respect to the cathode, to that portion of the cathode having the higher glow discharge sustaining efficiency. By arranging the cathodes in such a manner that lesser and greater efficiency portions of the cathodes are alternated, it is possible to step a glow discharge along the entire row of cathodes by application of the proper voltages to succeeding cathodes.

One object of this invention is to simplify and facilitate the construction of translating circuits whereby reduction in volume of space occupied and cost are effected.

Another object of this invention is to provide a translating circuit utilizing glow discharge tubes which will operate quickly and efficiently.

A further object of this invention is the improvement of translating circuits generally.

In one illustrative embodiment of this invention, a plurality of rows of cathodes are used, each row having an anode common to all the cathodes in that row. Subject to practical construction considerations, one or all of the rows of cathodes and their respective anodes may be placed in a single envelope. Each row of cathodes begins with a normalizing cathode which is utilized to initiate a discharge in a given row. The remaining cathodes are divided into two groups, one designated as the A group and the other designated as the B group the cathodes in the A group being electrically connected together in any given row. The cathodes of the two groups are arranged alternately so that in response to an input pulse applied to a first cathode of the B group, the glow discharge (assuming one existed at the normalizing cathode) will transfer to the first B cathode. Upon the termination of the pulse, the glow discharge will transfer to the next succeeding A cathode. Thus, if the input pulses are properly applied to the B group of cathodes, the glow discharge will step along the series of cathodes, advancing from one A cathode to the next succeeding A cathode with each pulse.

It is to be noted that an input pulse voltage must be as large as the minimum B cathode transfer voltage but not greater than the breakdown voltage for the B cathode so that a glow

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discharge between a B cathode and the anode can only be established by a transfer of a glow discharge and transfer can take place only from the preceding adjacent A cathode because of the preference mechanism described hereinbefore. Consequently, pulses must be applied to all of the B cathodes in any given row and in the proper sequence in order to cause a glow discharge to step the length of the row.

In accordance with one feature of the invention, corresponding cathodes of various rows are electrically connected together to produce a selective system. Thus, for example, the first cathodes of all the rows of cathodes are subdivided into ten groups of cathodes, each group being connected together. A first group of B cathodes is divided into ten groups, each group composed of one cathode from each of the groups of rows associated with each of said first ten groups of cathodes. The second group of B cathodes in each row are also connected together in ten groups, any one group being composed of one cathode from each of said second ten groups of rows associated with each of said ten groups of B cathodes. Thus, by selecting three of thirty input leads it is possible to select any particular one of 1,000 possible outputs. The input code pulse may be thus transmitted to the device on a single conductor.

Another embodiment of the invention utilizes time-sequence input whereby pulses must occur in a proper sequence in order to cause the glow discharge to step along an entire row of cathodes. This embodiment of the invention may be utilized to translate an n -ary code to a decimal code.

A further feature of the invention involves the utilization of this construction thereof to produce a binary code. In this embodiment of the invention, the tubes which comprise one or more rows of cathodes, the starting position of the discharge is determined by the input code, and the output n -ary code is determined by the interconnection of the B cathodes.

These and other features and objects of the invention will be more clearly understood from the following detailed description with reference to the drawings in which:

Fig. 1 illustrates a basic circuit of devices constructed in accordance with the invention utilizing only one row of cathodes and a common anode;

Fig. 2 illustrates a number group circuit utilizing a plurality of rows of cathodes, each row of cathodes having a common anode and the output position being determined by the pre-setting of switches in leads selectively connected to groups of cathodes;

Fig. 3 illustrates a circuit for translating a time-sequence input code to any one of a number of output positions; and

Fig. 4 shows a circuit for translating from a number of input positions to a time-sequence output.

Referring now to Fig. 1 there is shown a row of cathodes 5, B₁, A₁, B₂, A₂, B₃ and 6. Common to all these cathodes is anode 7 which is connected to positive battery 8 through resistance 9. Each of the cathodes of the A and B groups is composed of two parts, 10 and 11, typical constructions being disclosed in the application identified hereinabove. If a glow discharge is initiated between the anode and any cathode of the A or B groups, it will be concentrated on part 11 which has a higher glow discharge sustaining efficiency than does part 10. This preference for the glow discharge can be accomplished in several ways; in one, which is described in detail in the above-identified application, part 11 is channel-shaped and part 10 is plane. It is not necessary that cathodes 5 and 6 embody the preference mechanism feature since the initial glow discharge is initiated between cathode 5 and anode 7 by an external means which applies a normalizing pulse 12 to cathode 5. Cathode 6 requires no preference mechanism since it is the last cathode in the row and the glow discharge therefor need not transfer to any subsequent cathode. The electrodes are hermetically sealed in a gas-filled vitreous envelope indicated at 2.

Cathodes A₁ and A₂ are electrically connected together and cathodes 5 and 6 are connected to cathodes A₁ and A₂ through resistances 13 and 14, respectively. Cathodes B₁, B₂ and B₃ are connected to conductor 15 through switches 16, 17 and 18, respectively so that negative input pulses 19 are applied to the cathodes B₁, B₂, and B₃, if the respective switches 16, 17 and 18 are closed.

If all three switches are closed, the discharge will step down the row and an output voltage will be obtained after three input pulses 19. The normalizing pulse 12 is first applied to normalizing cathode 5 causing a glow discharge between it and anode 7. Then the first of the input pulses 19 will cause cathodes B₁, B₂ and B₃ to become negative with respect to cathodes 5, A₁, A₂, and 6. Since the input pulse is large enough only to cause a transfer of the glow discharge from some nearby electrode, only cathode B₁ will become energized. This is accomplished by the glow discharge being transferred from cathode 5 to cathode B₁. Since portion 11 of cathode B₁ has a higher glow discharge efficiency than portion 10, the glow discharge will become largely confined between anode 7 and portion 11 of cathode B₁. With the passage of a short interval of time, the first pulse will terminate causing cathode B₁ to become positive with respect to cathode 5 and cathodes A₁ and A₂. Since the portion 10 of cathode A₁ is positioned close to portion 11 of cathode B₁, the glow discharge will transfer from cathode B₁ to cathode A₁ and due to the preference mechanism of the cathodes the glow discharge will concentrate at portion 11 of cathode A₁. When the second incoming pulse is applied to conductor 15, cathodes B₁, B₂ and B₃ will again become negative with respect to other cathodes of the tube. However, since the portion 10 of cathode B₂ is positioned close to the portion 11 of cathode A₁, transfer of the glow discharge will occur only to cathode B₂ and upon termination of the pulse, transfer takes place to cathode A₂. In a similar manner, the glow discharge is stepped along to the anode 7-cathode 6 gap. Thus, the glow discharge has been stepped across the tube from cathode 5 to the cathode 6 which is elec-

trically connected to output 20. It is to be noted that if any of the switches 16, 17 or 18 had been open, the glow discharge would not have moved across the tube to the output 20.

This coding principle is extended in Fig. 2 to include 1,000 separate rows of cathodes each with a separate anode. It is to be noted that only 7 of the 1,000 rows of cathodes are shown. These 7 rows have been arbitrarily chosen from the "200" group. This arrangement is a "number group" which permits a selection of one out of a thousand output positions by closing the proper three out of thirty input switches. The cathodes 5, B₁, A₁, B₂ and 6 and anode 7 are numbered the same as in Fig. 1. Also resistances 9 and 14 are numbered the same as in Fig. 1. In Fig. 2, however, the cathodes A₂ and B₃ are omitted. The process of stepping a glow discharge along from one cathode to another in any given row of cathodes is the same as disclosed with reference to Fig. 1. The 1,000 rows of cathodes are subdivided into ten groups of 100 each in this modification of the invention. Cathodes 5 of each tube in a given group of 100 are electrically tied together to a common bus-bar 21. Since there are ten groups of 100 rows, there will be ten of these bus-bars. Each of these ten bus-bars is tied to a common lead-in conductor 22 through switches such as 23, each bus-bar having an individual switch. A normalizing pulse 24 is applied to the conductor 22 initiating a glow discharge in the cathode 5 of all said groups of said 100 tubes in which the associated switch such as 23 is closed. By closing one of the ten switches, it is possible to select any group of 100 rows out of the possible 1,000.

The cathodes B₁ are also connected in groups of 100, each of the groups of 100 B₁ cathodes being comprised of 10 B₁ cathodes from each of said first groups of 100 rows. All the B₁ cathodes in any group of 100 are connected to a common bus-bar individual thereto. There will thus be ten bus-bars, each of said bus-bars being connected to a group of 100 B₁ cathodes. This second group of ten bus-bars is connected through individual switches 26 to a common conductor 25. A pulse applied to conductor 25 will apply a negative voltage to all groups of 100 B₁ cathodes wherein the associated switch such as 26 is closed. This negative voltage is insufficient to cause a breakdown between the B₁ cathode and the anode, but is sufficient to cause transfer of an existent glow discharge between the anode and cathode 5.

Cathodes B₂ are also subdivided into ten groups of 100 cathodes, each of said groups of 100 B₂ cathodes being comprised of one of the B₂ cathodes from one row associated with each of said 100 groups of ten B₁ cathodes.

When a pulse is applied to any one of the groups of 100 B₂ cathodes, a glow discharge will only be initiated between the anode and those B₂ cathodes in the row wherein a glow discharge existed between the anode and the A₁ cathodes.

In Fig. 2 only a few of the "200" group of cathodes are illustrated. The positions shown are 200, 201, 202, 210, 211, 223, and 299. Selection of output number 223 is illustrated in the figure. The particular switch marked 23 has been closed, the particular switch designated 26 has been closed, and the switch designated 27 has been closed. The first pulse transmitted to the number group circuit is normalizing pulse 24 which ionizes the gap between the anode 7 and the cathode 5 of all the rows in group "200." Sub-

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sequently stepping pulse 29 is applied to conductor 25 since the switch designated 26 is the only one of that group of ten which is closed. The voltage pulse will be applied only to rows 220 to 229, inclusive, row 223 being the only one shown. The glow discharge will transfer to the B₁ cathode-anode gap only in this group of cathodes 220 to 229, inclusive. Upon termination of the pulse, the cathodes B₁ will rise to a potential greater than that of cathodes A₁ thus causing transfer of the glow discharge to the anode-cathode A₁ gap in rows 220 to 229, inclusive. It will be noted that stepping pulse 29 also applied a negative voltage to cathodes B₂. However, since the voltage across the cathode B₂-anode 7 gap is insufficient to cause a breakdown therein and because cathode B₂ was not close enough to the glow discharge existing between cathode B₁ and anode 7, no glow discharge will be transferred to the cathode B₂-anode 7 gap.

When stepping pulse 28 is applied to conductor 25, the negative voltage will be applied to the cathodes B₁ and B₂. The glow discharge cannot transfer back to the cathodes B₁ from cathodes A₁ because of the preference mechanism of the individual cathodes discussed hereinbefore. However, the glow discharge will transfer to cathodes B₂ in all the rows wherein a glow discharge existed between the anode 7 and the cathode A₁. Since glow discharge obtained only in rows 220 to 229, inclusive, it is possible to transfer a glow discharge between anode 7 and the B₂ cathodes only in those rows. Since the bus-bar 30 associated with switch 27 is electrically connected only to the B₂ cathode in row 223, the transfer of the glow discharge will only occur in that particular row. Upon termination of the pulse 29 the cathode B₂ will rise to a potential greater than that of cathode 6 of row 223 so that the glow discharge will then transfer to the gap between anode 7 and the cathode 6 of row 223. Thus, one particular row has been selected out of a possible thousand positions by presetting three switches 23, 26 and 27 and the application of three input signal pulses.

Referring now to Fig. 3, there is illustrated therein a translating circuit for converting time-sequence input pulses to one of a number of output positions. This in effect is translating binary code to a decimal code. Eight possible output positions are shown, zero to seven, inclusive. Each row of cathodes and the common anode thereto may be enclosed in an individual envelope. The operation of any given row is similar to that described with reference to Figs. 1 and 2. In order to establish a glow discharge between cathode 6 and anode 7 of any given row, it is necessary to excite or break down the gap between cathode 5 and anode 7 and then to apply a series of negative pulses to the cathodes B₁, B₂ and B₃ in a given row and in that particular order. The elements of the rows are designated the same as in Figs. 1 and 2.

In the operation of the device of Fig. 3, an input or normalizing pulse 40 is applied to the conductor 41, which breaks down and initiates a glow discharge in the anode 7-cathode 5 gaps of the eight rows. Input pulses such as 42, 43, and 44 are applied to either of the input leads (designated X and Y) and the B stepping cathodes are connected in different selective combinations to these inputs. With three stepping stages and two input leads, eight possible combinations are available. Four of these are shown completely connected and the other connections are indi-

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cated. The input code sequence (Y, X, Y) chosen for illustrative purposes in the figure selects only output 2. This can be seen by noting that the first Y pulse 43 causes tubes associated with outputs 0, 1, 2 and 3 to advance one step. The tubes associated with outputs 4, 5, 6 and 7 are not advanced because their Y connected cathodes are not adjacent to the discharge. The X input pulse 42 causes the tube associated with output 2 to make a second step through conductor 46 and the tubes associated with outputs 4, 5, 6 and 7 to make the first step. This can be seen clearly from an examination from the tube associated with output 7 wherein cathode B₁ is electrically connected to the X input conductor 46. The final Y pulse 44 applies a negative potential to the cathode B₃ associated with output 2 causing the glow discharge to transfer from the anode 7-cathode A₂ gap to cathode B₃. Termination of Y input pulse 44 allows the glow discharge to transfer to cathode 6 which is connected to output 2. This final Y pulse 44 caused the tubes associated with outputs 0, 1, 4 and 5 to make a second step. However, a glow discharge reaches the output position only in the tube associated with output 2.

As mentioned hereinbefore, the device of Fig. 3 is a binary to decimal translator in which an X pulse corresponds to a "1" and a Y pulse corresponds to a "0" in the binary system. If three input pulse leads were used, the circuit would represent a ternary system. In general, the number of output positions can be increased by using more stepping stages or more input leads or both. If S represents the number of stepping stages and N the number of input leads, then the number of output positions is given by the expression:

$$\text{Number of outputs} = (N)^S$$

The translation system of Fig. 3 accepts input information presented on a time-sequence basis and translates it into output data in the form of a signal on one of a large number of output leads. The converse arrangement is illustrated in Fig. 4; input information in the form of a signal on one of a number of input leads is translated into a time sequence of output pulses. Eight rows of cathodes are indicated, each row having a separate input connection. Only one common anode resistor 50 is needed since only one row operates at a time. In operation, normalizing pulse 51 is applied to the selected input lead 52, initiating a discharge at only one normal cathode 5. Driving pulses such as 53, 54 and 55 are applied to all of the B cathodes, causing the discharge to step along only the selected row, for example 2, since that is the only row in which a discharge has been initiated by a normalizing pulse such as 51. The A cathodes are interconnected to the output buses X and Y in accordance with the desired code. Each time the discharge is present on an A cathode, a voltage such as 58 or 59 is developed across one of the series resistors 56 or 57 in the output circuit. As shown in Fig. 4, applying the normalizing pulse to input 2 followed by driving pulses 53, 54 and 55 results in output pulses first at Y, then at X and again at Y. The number of output positions can be increased by using more stepping stages (S) or more output leads (N). The same relation as discussed hereinbefore may be written:

$$\text{Possible number of input positions} = (N)^S$$

It will be noted that the case of two output code leads can be identified with decimal to

binary translator. An n -ary translator would require N output leads.

It is to be understood that the embodiments of this invention shown and described are to be taken as preferred embodiments and that various changes in circuit elements and arrangement of parts may be resorted to without departing from the scope or spirit of the invention.

What is claimed is:

1. A translating device comprising a plurality of gaseous discharge devices each having a plurality of cathodes arranged in a row, each of said cathodes having two portions of different efficiencies, said cathodes being arranged so that the low and high efficiency portions are in alternate order, an anode common to each row of said cathodes, said cathodes being further divided into a first group and a second group, each of said rows of cathodes comprising cathodes of each of said groups alternately arranged, and circuit means to apply a series of input pulses in accordance with a code to different pluralities of said cathodes of said first group, said circuit means comprising a plurality of conductors connected to said different pluralities of cathodes in accordance with said code whereby a specific series of input code pulses applied to said plurality of conductors will cause a glow discharge to transfer along an entire row of cathodes.

2. A translating device comprising a plurality of rows of a plurality of cathodes, each cathode having a greater and a lesser glow discharge sustaining efficiency, said cathodes being divided into two groups, each of said rows being comprised of cathodes of said two groups alternately arranged in such a manner that the lesser and greater glow discharge sustaining efficiencies are also alternately arranged, a normalizing cathode at the beginning of each row, and circuit means to apply a series of input pulses in accordance with a code to the first of said two groups of cathodes, said circuit means comprising a plurality of conductors electrically connected to the cathodes of said first group in accordance with said code, whereby a specific series of input pulses will cause a glow discharge to step along the entire length of a given row to produce a specific output signal.

3. An electrical circuit comprising a plurality of rows of cathodes, each row of cathodes comprising alternate cathodes of an A group and a B group and a normalizing cathode at the beginning of each of said rows, each of the cathodes of said A and B groups having a lesser and a greater portion of glow discharge sustaining efficiency alternately arranged in each row, an anode common to each row of cathodes, circuit means to initiate a glow discharge between the normalizing cathode and the associated anode of a first grouping of preselected rows of cathodes, a first plurality of conductors each having connected in parallel thereto a first group of B cathodes, said first group of cathodes consisting of one cathode from each of a number of a second grouping of preselected rows, a second plurality of conductors each having connected in parallel thereto a second group of B cathodes, said second group comprising one cathode from each of a plurality of a third grouping of preselected rows, a common conductor, switching means individually connecting each of said first and second plurality of conductors to said common conductor, said

switching means being capable of being predetermined to selectively enable a glow discharge to traverse the entire distance of only one predetermined row upon application of input pulses to said common conductor, and circuit means to apply input pulses to said common conductor.

4. An electrical circuit comprising a plurality of rows of cathodes, said cathodes being divided into an A group and a B group, an anode common to each row of cathodes, each of said cathodes having a lesser and a greater portion of glow discharge sustaining efficiency alternately arranged in each row, the cathodes in each row being comprised alternately of cathodes of said A and B groups, a plurality of normalizing cathodes, one of said normalizing cathodes beginning each row of cathodes, a first circuit means to initiate a glow discharge between the normalizing cathode and the associated anode of preselected rows of cathodes, a second circuit means to apply a series of pulses in accordance with specific code to said plurality of cathodes of said A and B groups, the first B cathodes of the rows being divided into groups, each group being connected in parallel to individual first common conductors, the second B cathodes of the rows being divided into groups, each group being connected in parallel to individual second common conductors, a plurality of individual switches connecting said common conductors to a third common conductor, said switches being capable of being preset to cause a glow discharge to step along the entire length of a predetermined row upon application of input pulses, and circuit means to apply input pulses to said third common conductor.

5. An electrical circuit comprising a plurality of rows of cathodes, said cathodes divided into an A group and a B group of cathodes, said A group of cathodes normally biased negatively with respect to said B group of cathodes, each row having a common anode individual thereto, each of said cathodes having a lesser and a greater portion of glow discharge sustaining efficiency alternately arranged in each row, the cathodes in each row being comprised alternately of cathodes of said A and B groups, a plurality of normalizing cathodes beginning each row of cathodes, a first circuit means to initiate a glow discharge between said normalizing cathode and the associated common anode, said first circuit means comprising lead means connecting the normalizing cathodes of the said rows in parallel, a first group of B cathodes connected to a first input lead, and a second group of B cathodes connected to a second input lead, said first and second groups of B cathodes being selectively connected to said input leads in accordance with a code so that input pulses impressed in the proper sequential order upon said first and second input leads in accordance with said code will cause a glow discharge to step along the entire length of a given row of cathodes.

6. An electrical circuit comprising a plurality of rows of cathodes, each cathode having a lesser and a greater portion of glow discharge sustaining efficiency alternately arranged in each row, an anode individual to each row, said cathodes being divided into an A group and a B group, each of said rows being comprised of cathodes of said A and B groups alternately arranged, a plurality of normalizing cathodes, one of said normalizing cathodes beginning each row, circuit means to initiate a discharge between said normalizing cathodes and the associated anode of

each row, a first input lead, and a second input lead, said group of B cathodes being selectively connected in accordance with a code to said first and second input leads so that, in response to input pulses applied to said first and second input leads in accordance with said code, a glow discharge is caused to step along the entire length of only one row of cathodes.

7. An electrical circuit comprising a plurality of rows of cathodes, each row of cathodes having an individual anode common to all the cathodes in the row, each cathode comprising a lesser and a greater glow discharge sustaining efficiency portions alternately arranged in each row, said cathodes being divided into an A group and a B group, each row of cathodes being comprised of cathodes of said A and B groups alternately arranged, a plurality of normalizing cathodes, one of said normalizing cathodes being positioned at the beginning of each row, a first circuit means to initiate a glow discharge between said normalizing cathodes and the associated anode, an input lead, said B group of cathodes being connected in parallel to said input lead, and a plurality of output leads, said cathodes of the A group in each row being connected to said plurality of output leads in selective order in accordance with a code so that a glow discharge stepping along the entire length of a row will produce a series of pulses on said output leads in accordance with said code.

8. An electrical circuit comprising a plurality of rows of cathodes, said cathodes being divided into an A group and a B group, a main anode individual to each row and common to all the cathodes in that row, each row of cathodes having alternate cathodes of the said A and B groups, said group of A cathodes normally being negatively biased with respect to said B group of cathodes, each of said cathodes having a lesser and a greater glow discharge sustaining efficiency portions arranged alternately in each row, a plurality of normalizing cathodes electrically independent of each other, a first circuit means to apply normalizing pulses to one of said normalizing cathodes to initiate a glow discharge between said normalizing cathode and the associated main anode, an input lead, means to apply input pulses to said input lead, the B cathodes of each group being connected in parallel to said input lead, and a pair of output leads, said A cathodes in each row being selectively connected to said pair of output leads in accordance with a code to produce a series of pulses on said output lead in accordance with said code.

9. A translating device comprising a plurality of gaseous discharge devices each having a plurality of cathodes arranged in a row, said cathodes being divided into two groups, a normalizing cathode at the beginning of each row, and circuit means to apply a series of input pulses in accordance with a code to the first of said two groups of cathodes, said circuit means comprising a plurality of conductors electrically connected to the cathodes of said first group in accordance with said code, whereby a specific series of input pulses will cause a glow discharge to step along the entire length of a given row to produce a specific output signal.

10. An electrical circuit comprising a plurality of rows of cathodes, said cathodes being divided into an A group and a B group, an anode common to each row of cathodes, a plurality of normalizing cathodes, one of said normalizing cathodes beginning each row of cathodes, circuit

means to initiate a glow discharge between the normalizing cathode and the associated anode of preselected rows of cathodes, the first B cathodes of the rows being divided into groups and the second B cathodes of the rows being divided into groups, a plurality of first and second common conductors, each group of said first B cathodes being connected in parallel to one of said first common conductors and each group of said second B cathodes being connected in parallel to one of said second common conductors, switching means individually connecting each of said common conductors to a third common conductor, said switching means being capable of being preset to cause a glow discharge to step along the entire length of a predetermined row upon application of input pulses and circuit means to apply input pulses to said third common conductor.

11. An electrical circuit comprising a plurality of rows of cathodes, said cathodes being divided into an A group and a B group, each of said rows being comprised of cathodes of said A and B groups alternately arranged, an anode common to each row of cathodes, a plurality of normalizing cathodes, one of said normalizing cathodes beginning each of said rows, circuit means to initiate a discharge between said normalizing cathodes and the associated anode of each row, a first input lead, and a second input lead, said group of B cathodes being selectively connected in accordance with a code to said input leads so that a glow discharge is caused to step along the entire length of any one row of cathodes in response to input pulses applied to said first and second input leads in accordance with said code.

12. An electrical circuit comprising a plurality of rows of cathodes, said cathodes being divided into an A group and a B group, a main anode individual to each row and common to all the cathodes in that row, each row of cathodes having alternate A and B cathodes and said A cathodes being normally biased negatively with respect to said B cathodes, a plurality of normalizing cathodes electrically independent of each other, circuit means to apply pulses to one of said normalizing cathodes to initiate a glow discharge between said normalizing cathode and the associated main anode, an input lead, means to apply input pulses to said input lead, said B cathodes being connected to said input lead and a pair of output leads, said A cathodes in each row being selectively connected to said pair of output leads in accordance with a code to produce a series of pulses on said output lead in accordance with said code.

MARK A. TOWNSEND.

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