

May 15, 1956

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2,745,958

TRANSLATING ARRANGEMENT

Filed March 9, 1953

2 Sheets-Sheet 1

FIG. 1

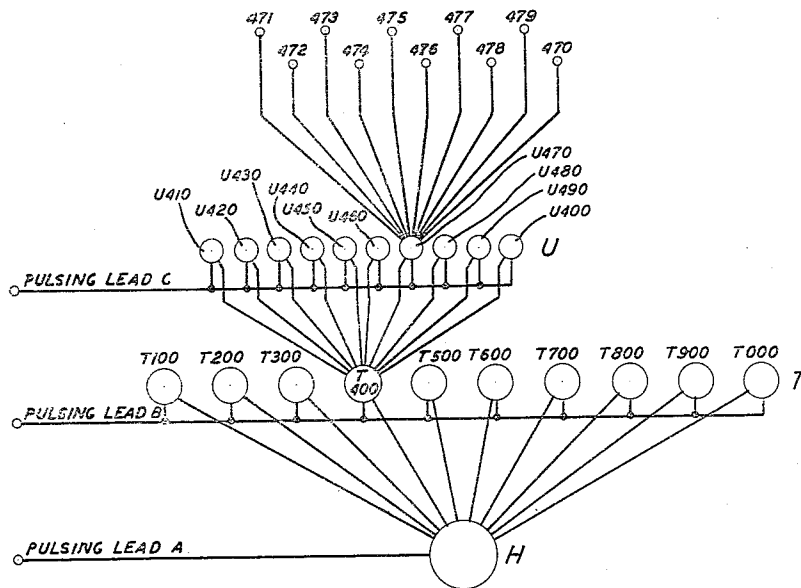
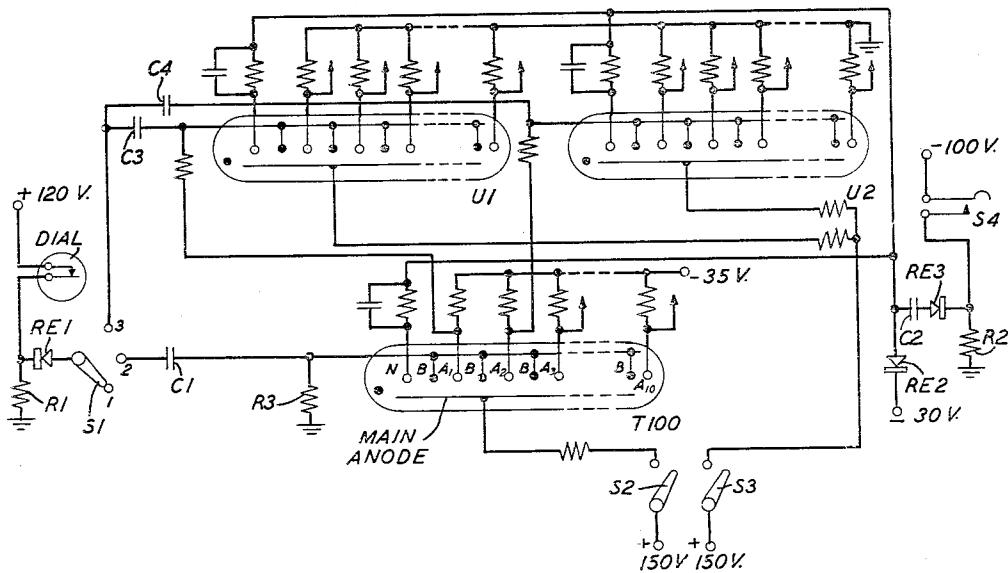


FIG. 2



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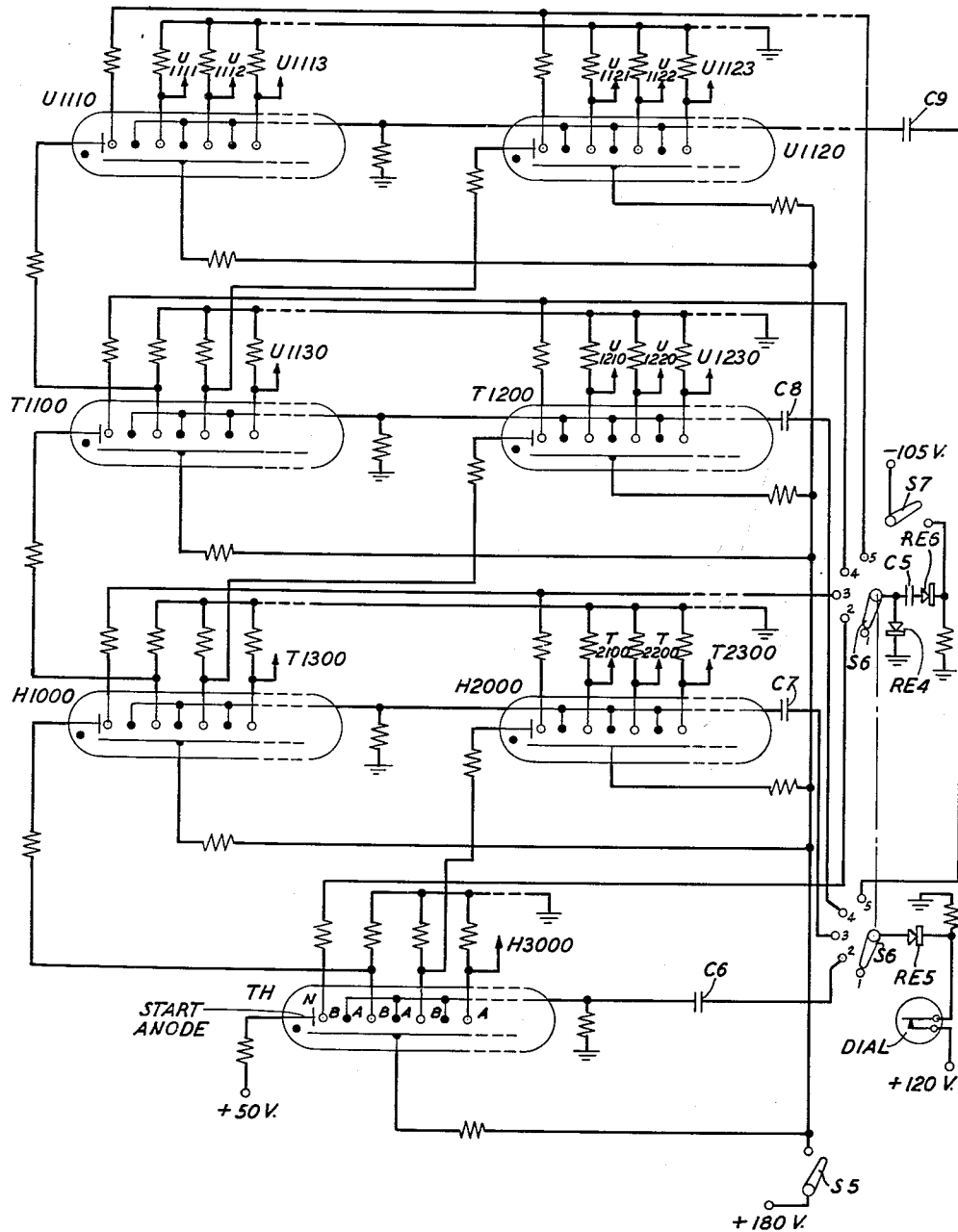
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TRANSLATING ARRANGEMENT

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2 Sheets-Sheet 2

FIG. 3



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TRANSLATING ARRANGEMENT

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Application March 9, 1953, Serial No. 341,079

4 Claims. (Cl. 250—27)

This invention relates generally to selection systems and more particularly to arrangements of such systems for detecting and counting signal impulses and then selecting the particular unit represented by the signal impulses detected and counted.

This invention has for its main object the improvement of gas tube counting and selection circuits.

Another object of the invention is to increase the speed of operation of impulse counting and selection circuits.

Another object of the invention is to use gaseous discharge devices having a plurality of conductive positions in an impulse counting and selection circuit so as to eliminate the many relays or tubes that have been required in the prior art.

Another object of the invention is to use gaseous discharge devices having a plurality of conductive positions in an impulse counting and selection circuit wherein the signal impulses are applied to a plurality of such devices in a single stage simultaneously but only the tube desired will respond to the impulses by virtue of its having a voltage mark placed on it by a tube in a preceding stage of the selection system.

A feature of the invention is the utilization of cold cathode gaseous discharge stepping devices that have a plurality of cathodes.

Another feature of the invention is the use of multicathode gaseous discharge devices for successively counting the groups of pulses that represent the code number of a desired unit.

Another feature of the invention is a means for causing a pulse counting multicathode gaseous discharge device in one stage to effect the operation of only one of a plurality of gaseous discharge counting devices in a succeeding stage when all of said discharge devices in the succeeding stage have signal impulses applied to them.

A preferred embodiment of the invention is shown on the accompanying drawings in which:

Fig. 1 is a diagrammatic showing of the principles of the invention;

Fig. 2 illustrates one preferred exemplary embodiment of the invention; and

Fig. 3 represents another preferred exemplary embodiment of the invention.

This invention relates to a step-by-step type circuit translator which translates plural digit codes into a single indication exclusive to the information contained in the plurality of digits. The invention comprises a series of step-by-step switching stages. In the first stage is a single ten-position cold cathode stepping tube that is responsive to the pulses of the first digit and enables a selected one out of ten tubes in the second stage to be stepped in response to the pulses of the second digit which are applied to all tubes of the second stage simultaneously. The stepping of the selected tube in response to the pulses of the second digit enables a stepping tube in the third stage that is individually associated with the final con-

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ductive position of the tube in the second stage. A similar stepping action takes place for each succeeding stage so that the final conductive position of the stepping tube that was energized in the last stage represents a translation exclusive to the code of the digits.

Such a device could find wide utility or application in any field where the services of a selection system are utilized. Selection systems today are utilized in computers, in automatic parimutual betting machines, in dial telephone systems, in automatic merchandising systems, and in a host of other applications too numerous to mention. The present invention will find utility in any application wherein it is desired to select one unit out of a plurality of units for the purpose of effecting some further operation or control over said unit selected.

The present invention as shown in Fig. 3 comprises a series of step-by-step counting devices each of which has ten conductive positions. The first stage of the invention has one tube capable of counting the digits one through ten in response to the pulses of the first digit. In the second stage of the selective system are ten separate multiconductive position counting tubes each one of which is connected to a separate conductive position of the multiconductive position counting tube in the first stage of the selection system. The final conductive position of the tube in the first stage will determine which one out of ten tubes in the second stage will respond to the pulses of the second digit which are applied to all tubes in the second stage simultaneously. The third stage of applicant's selection device has 100 separate multiconductive position tubes each of which is connected to a separate conductive position of one of the ten stepping tubes in the second stage of the selection circuit. The final conductive position of the energized tube in the second stage of the selection network will determine which tube in the third stage will respond to the pulses representing the third digit which are applied to all tubes in the third stage simultaneously. The fourth stage of the selection system has 1000 stepping tubes each of which is connected to a separate conductive position of a tube in the third stage. Each succeeding stage will have ten times the number of stepping tubes its preceding stage has. As many tubes and stages may be utilized as may be desired.

The invention as shown in Fig. 2 is similar to that described above except that it contains only two stages.

Description of Fig. 1

A reference to Fig. 1 may be helpful in explaining the general principles of operation of the selection system. While this figure illustrates only a three-stage selection network whose capacity is 1000 units, it should be remembered that this showing is merely illustrative of the principles involved and that as many stages as desired could be furnished without departing from the spirit and scope of the invention. Also, if desired, each stepping tube could have a number of conductive positions other than 10, in which case the capacity of the system would be changed accordingly.

In the arrangement shown in Fig. 1 the pulses representing the first digit of the unit to be selected are applied to pulsing lead A. Should the unit to be selected be designated by the number 474, four pulses would be applied to pulsing lead A. These four pulses would be representative of the digit in the hundreds order of the number 474 which represents the unit desired, and would step the stepping device which is diagrammatically represented by circle H in Fig. 1, to position 4. The stepping device in the first stage, in coming to rest in its fourth conductive position, will prepare for operation only the stepping device in the second stage that is con-

nected to the fourth conductive position of the stepping device in the first stage.

Since the unit to be selected is designated by the number 474 seven pulses would be applied to pulsing lead B. Inasmuch as the stepping device designated T400 in Fig. 1 is the only one which has been prepared for operation by the stepping device in the first stage, only it will respond to the seven pulses received over lead B, and in doing so it will come to rest in its seventh conductive position. Stepping device T400 in stepping to its seventh position will prepare for operation the stepping device designated U470 in the third stage. Since stepping device U470 in the third stage is the only one that is connected to the seventh position of stepping device T400, only it will be prepared for operation and hence only it will respond to the pulses received over pulsing lead C.

Inasmuch as the unit designated 474 is the one that is desired, four pulses will now be applied to pulsing lead C which will operate only the stepping device designated U470 since this is the only stepping device in the third stage that has been prepared for operation by stepping device T400 in the second stage. Stepping device U470 will respond to the four pulses received over stepping lead C and will come to an eventual rest in its fourth conductive position and thereby place a voltage mark, or some other indicia of operation, on the unit designated 474.

Once the unit 474 has been selected for operation, it will operate or effect the operation of some remote device, all in accordance with the particular purpose for which the selection system is utilized. In a telephone system, for example, unit 474 when selected could complete a communication path to the telephone subscriber whose number is 474. In an automatic parimutual betting machine, as another example, the number 474 could represent information relative to the amount of a bet, information concerning whether the bet is a win, place or show bet, and information pertaining to the horse upon which the bet is wagered. The selection of the unit designated 474 could then cause a ticket to be dispensed to the bettor operating the selection system. In a computing system, still as another example, the unit designated 474 when selected for operation in response to the three series of pulses could enter the number 474 or some other desirable item of information into the computer. In an automatic merchandising system, as a last example, the selection of unit 474 for operation could effect the dispensing of the particular item of merchandise whose identity has been established by the code number 474.

Description of the stepping tubes used

Since the arrangements shown in Figs. 2 and 3 utilize tubes that are fairly new in the art, a short description concerning the nature of their operation is considered appropriate. These tubes are cold cathode multiconductive position stepping tubes and are of the same general type as shown in the application by H. L. Von Gugelberg, Serial No. 141,123, filed January 28, 1950, now Patent 2,646,523, and by M. A. Townsend, Serial No. 109,337, filed August 9, 1949, now Patent 2,575,372. In order to provide a brief description of the principles of operation of the tubes used herein, reference is made to only tube T100 and its associated pulsing circuits as shown in Fig. 2. The remaining equipment shown in Fig. 2 may be ignored for the purposes of simplicity. Tube T100 of Fig. 2, has a main anode, a normal cathode designated N, a cathode designated A in each conductive position, and a B cathode interposed between each of the A cathodes and also between the normal cathode and the A cathode of the first conductive position. The other tubes of Fig. 2 are similarly constructed.

When it is desired to operate the tube, switch S2 is operated which places a potential of plus 150 volts on

the anode of tube T100. No action will take place at this time inside the tube because this potential, while large enough to sustain an already initiated discharge, is not large enough to initiate a discharge. Tube T100 fires when switch S4 is momentarily closed which causes conduction to take place between the N cathode and the anode. Condenser C2 is normally charged through rectifier RE3 and resistor R2 to ground to a potential of minus 30 volts. When switch S4 is closed the ungrounded side of resistor R2 assumes a potential of minus 100 volts which places an effective charge on condenser C2 of minus 130 volts with respect to ground. It is this momentarily increased potential on condenser C2 and on the normal cathode that causes the tube to breakdown due to the increased potential difference between the main anode and the N cathode. As the pulse terminates and condenser C2 discharges, the conduction continues between the normal cathode N and the main anode since enough voltage is applied from the -30 volt supply to the normal cathode and from the +150 volt supply to the main anode at all times to maintain the conduction once it is initiated. However, this potential difference is not large enough to initiate a conduction at any time without the aid of the negative 100-volt pulse.

When it is desired to step tube T100, switch S1 is rotated to position 2 and a high negative voltage pulse is applied to the B cathode line which causes the potential difference between the main anode and the B cathode nearest to the normal cathode N to become much greater than the potential difference between the main anode and the normal cathode, and thereby transfer the conduction to the B cathode interposed between the normal cathode and the A cathode of the first stepping position. The pulses to the B cathodes may be furnished by an arrangement as shown in Fig. 2 in which condenser C1 is normally charged to a potential of 100 volts through the normally made contacts of the dial and through the back resistance of rectifier RE1, the other plate of condenser C1 being connected through resistor R3 which is of high ohmic value to ground. Under this normal condition the plate of condenser C1 connected to resistor R3 will be at ground potential while the other plate will be at a potential of plus 100 volts. When the dial contacts are opened the plate of condenser C1 connected to switch S1 will be placed at an effective ground potential through the low forward resistance of rectifier RE1 and through resistor R1 which is of low ohmic value. This effective grounding of one plate of condenser C1 through the above-mentioned path places the other plate of said condenser and thereby the B cathodes at an instantaneous potential of minus 100 volts with respect to ground. This causes the discharge to transfer to the B cathode adjacent to the N cathode since the potential difference between the B cathode and the anode is greater than that between the N cathode and anode. As the dial contacts close condenser C1 will recharge and await the next opening of the dial contacts, at which time it will again apply a negative pulse to the B cathodes.

As the first negative pulse on the B cathode terminates, its voltage falls to a low value that is unable to sustain conduction and, therefore, the conduction moves forward so that it now takes place between the main anode and the A cathode of the first position since the potential difference between the main anode and the A cathode in the first stepping position is greater than that between said anode and the preceding B cathode.

This stepping action is repeated when the second and all succeeding pulses are received until the digit is fully counted. The tendency of the discharge to move in a forward rather than a backward direction is governed by the ionization density and the geometry of the tube. When it is desired to reset the tube at the termination of the counting of any one digit, a negative 100-volt pulse is again applied to the normal cathode which increases the potential difference between the main anode

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and the normal cathode to such a value that the conduction in the tube is returned to the normal position.

Circuit description of Fig. 2

Fig. 2 illustrates a simple two-stage selection circuit having a capacity of 100 units, any one of which may be selected by the dialing of the two digits. If tubes having a different number of conductive positions are used, the capacity of the system will be changed accordingly.

Switches S2 and S3 are operated when it is desired to place the circuit in operation. However no breakdown is effected in any of the tubes when switches S2 and S3 are operated since the potential difference between the main anode and any of the cathodes is insufficient at this time to initiate a discharge. When switch S4 is momentarily operated the negative 100-volt pulse is applied to the normal cathodes of all tubes, which causes the potential difference between the normal cathode and the main anode of all tubes to become sufficiently large to initiate a discharge. This discharge is maintained even after the negative 100-volt pulse subsides since the negative 30-volt battery connected to this circuit by means of rectifier RE2 and the plus 150-volt potential on the anode is sufficient to maintain a discharge that is once initiated, even though it is not great enough to initiate any discharge on its own.

When it is desired to step tube T100, switch S1 is rotated to its second position and the dial is caused to send out the number of pulses equal to the digit desired. These pulses are applied by means of condenser C1 to the B cathode line of tube T100, and cause the tube to step to the conductive position that is representative of the digit dialed. If the digit 2 were dialed, two pulses would be sent out and tube T100 would now be maintaining a conduction between the anode and the A cathode in the second conductive position.

A cathode current flowing through the cathode resistor of the second conductive position causes an IR drop through the resistor which raises the potential of cathode A2 from a negative 35-volt potential to a potential of approximately zero volts. This causes a corresponding potential rise on the B cathode line of tube U10 so that it also rises to a potential of zero volts at this time. The B cathode lines of all other tubes in the second stage of the selection system will remain at a potential of negative 35 volts since they are connected to A cathodes of tube T100 which are not conducting at this time.

When it is desired to enter a digit into the proper tube in the second stage, switch S1 is rotated to its third position and the dial is rotated to the digit that is to be entered into the second stage of the selection network. As the second digit is dialed, pulses representing this digit are applied to B cathode leads of all the tubes in the second stage simultaneously. The first minus 100-volt pulse received will step the conduction in all tubes in the second stage to the B cathode interposed between the normal cathode and the A cathode in the first stepping position since the potential difference between the anode and the B cathodes in all the tubes will be sufficiently large at this time. As the negative pulse subsides, the voltage of the B cathodes of unit tube U2 will rise through zero to a positive value during the discharging time of condenser C4, and then back to zero as C4 becomes charged. This causes the discharge to transfer to the A cathode of the first stepping position since the potential difference between the A cathode and the anode will be greater than that between the B cathodes and the anode inasmuch as the B cathodes at the time are at a positive potential due to the discharging of condenser C4. As the first pulse subsides, the other tubes in the unit stage of the selection system will not step since the B cathode lines of these other tubes are maintained at an approximate negative potential of 35 volts by virtue of their being connected to the cathodes of

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tube T100 which are in the non-conductive positions. Inasmuch as their B cathodes are maintained at a negative 35-volt potential, the discharge in these tubes will remain on the B cathode interposed between the normal cathode and the A cathode of the first stepping position since the potential difference between the main anode and the B cathodes will never become small enough to allow the A cathodes to assume control of the discharge.

As additional pulses are received the discharge in tube U2 will step along and come to rest in the conductive position representative of the digit dialed. However, the other tubes in the unit stage will be unable to follow any additional pulses and the discharge in them will remain on the first B cathode. The additional negative pulses applied to these tubes will merely periodically intensify the discharge at the conductive B cathode. At the termination of dialing of the second digit, tube U2 will be conducting in the position representative of the digit dialed.

As conduction takes place over the selected conducting cathode of tube U2, the IR drop through the cathode resistor will cause the cathode voltage to rise from approximately zero volts to approximately 35 volts, thereby causing a potential differential of 35 volts between the conducting cathode and the non-conducting cathodes. As has been hereinbefore explained in connection with Fig. 1, this voltage mark or differential on the conducting cathode of tube U2 may be caused to perform some preselected function or cause the operation of some unit whose number is represented by the digit dialed.

Circuit description of Fig. 3

A four-stage selection network having a capacity of 10,000 units is illustrated in Fig. 3. Any one of the 10,000 units may be selected by dialing four preselected digits. If the tubes used have a different number of conductive positions than 10, the capacity of the system will, of course, be changed accordingly.

The tubes used in Fig. 3 are slightly different than the tubes used in Fig. 2 inasmuch as they have an extra element designated as a start anode. The only difference in operation between the two types of tubes is that in the type shown on Fig. 3, the discharge is first initiated between the start anode and the normal cathode and is then transferred to the main anode and the normal cathode, while in the types shown in Fig. 2 the discharge is initiated between the main anode and normal cathode. From there on out the operation of the two tubes is identical.

The operation of the circuit shown in Fig. 3 is initiated by operating switches S5, S6, and S7. The operation of switch S5 places a positive 180-volt potential on the main anodes of all the stepping tubes. The rotating of switch S6 to position 2 closes a path to ground for the N cathode of tube TH through rectifier RE4. No discharge occurs at this time since the potential difference between the start anode and the normal cathode is only 50 volts. This potential difference is unable to initiate a discharge between the two elements. Tube TH has its A cathodes connected through condenser C6 to the dial pulsing network through switch S6.

A discharge in tube TH will occur when switch S7 is closed momentarily to apply a negative 105-volt pulse through rectifier RE6 and condenser C5 to the normal cathode of tube TH. This will increase the potential difference between the start anode and the normal cathode to approximately 155 volts which will cause a discharge to take place between the two elements for the duration of the negative 105 pulse. Rectifier RE4 prevents the negative pulse from being shunted to ground. As the negative pulse decays in value, the potential difference between the start anode and the normal cathode will decrease and the discharge will transfer from the start anode to the main anode which is at a potential of 180 volts.

When it is desired to step tube TH, the dial is caused to send forth the desired number of pulses which represent the predesignated final conductive position of tube TH. These dial pulses are applied by means of rectifier RE5 and condenser C6 to the B cathode line in a manner similar to that previously described for the circuit of Fig. 2. Inasmuch as the theory of operation of the two pulsing circuits is the same it will not be repeated.

Tube TH steps along in response to the dialing of the first digit in a similar fashion as already explained for the tube used in Fig. 2. If the first digit dialed were 1 the tube would step one step and conduction would take place between the A cathode of the first conductive position and the main anode. The current through the resistor connected in the circuit of the conducting cathode will cause an IR drop which will raise the potential of this cathode to approximately 50 volts. This 50-volt potential will be applied to the start anode of tube H1000 in the hundreds stage. The start anodes of all the other tubes in the hundreds stage of the selection network will be at a zero potential at this time since they are connected to cathodes of tube TH that are in a non-conducting state.

Switch S6 is rotated to position 3 and switch S7 is momentarily operated when it is desired to cause tube H1000 to break down.

As switch S7 is momentarily operated a discharge will take place between the start anode of tube H1000 and its normal cathode which will immediately transfer from the start anode to the main anode. Tube H1000 is the only tube in its stage to discharge since it is the only tube that has a potential of 50 volts on its start anode. The other tubes in the second or hundreds stage of the selection network will not discharge at this time since their start anodes are at a potential of zero volts.

As the second digit is dialed, tube H1000 will step and will sustain a discharge in the stepping position representative of the digit dialed. If the second dialed digit should also be the digit 1, tube H1000 would sustain a discharge over its A cathode in its first conductive position. The resulting current through the cathode resistor of the first conductive position of tube H1000 will raise the potential of the A cathode of the first position, and hence the potential of the succeeding start anode in the next tube, to approximately 50 volts. The potential of all the other A cathodes in tube H1000 will remain at zero volts since they are non-conducting at this time. As a result, the start anodes of all the stepping tubes in the third or tens selection stage with the exception of tube T1100 will be at zero volts. When switch S6 is rotated to position 4 and switch S7 is momentarily operated, only tube T1100 will sustain a discharge between its start anode and normal cathode since this is the only tube in the tens stage of the selection network that has a potential of 50 volts on its start anode at this time.

Tube T1100 will step in response to dial pulses and will sustain an eventual discharge in the stepping position representative of the third digit dialed. Should the third digit dialed be a 2, the potential of the A cathode in the second stepping position will rise from a zero to 50 volts, which potential rise will be in turn transmitted to the start anode of tube U1120. All the other A cathodes in tube T1100 will be at a potential of zero volts, as will be all the other start anodes of the tubes of the last stage of the selection network.

As switch S6 is rotated to position 5 and switch S7 is momentarily operated, only tube U1120 will break down, sustain a discharge, and respond to the fourth digit dialed. The ultimate conducting position of tube U1120 will be representative of the last digit dialed. Should this last digit be a 3, tube U1120 will sustain a discharge between the main anode and its A cathode in the third conductive position. The voltage on the third A cathode will rise to approximately 50 volts, while the voltage on the other A cathodes of this tube will remain at a potential of zero volts. This voltage rise on the conducting cathode

can be utilized to effect the operation of some apparatus or to perform some preselected function as hereinbefore explained.

It is to be understood that the above-described arrangements are but illustrative of the application of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A device for translating a plural digit code into an indication exclusive to the plurality of digits in said code comprising, a plurality of switching stages equal in number to the number of digits in said code with each stage comprising at least one step-by-step device having a plurality of discrete stepping positions, each device being responsive to digital impulses to enable it to step from position to position with the final stepping position dependent upon the pulse content of said digital input, the first stage comprising one of said devices, each succeeding stage comprising one of said devices exclusive to each stepping position of each device of the immediate preceding stage, a source of impulses representative of plural digit codes, means exclusive to said first stage and associable with said source whereby the step-by-step device in said first stage is controlled by the pulses representative of the first digit of the code and is caused by said pulses to step to a final stepping position determined by the pulse content of said first digit, means including the final stepping position of a step-by-step device in all stages except the last for conditioning for response to impulses only the step-by-step device exclusive thereto in the next succeeding stage, means individually associated with each successive switching stage and common to all devices in its associated stage and associable with said source of impulses for applying impulses to all devices in its associated stage simultaneously whereby each successive stage is controlled by the impulses representative of successive digits of the code to step to a final stepping position only the device in each stage that is exclusive to the final stepping position of a device in the immediate preceding stage, the final stepping position of one responsive device in the last stage being an indication exclusive to said code.

2. In a device for translating a plural digit code into an indication exclusive to the plurality of digits in said code comprising, a plurality of switching stages equal in number to the number of digits in said code with each stage comprising at least one electron discharge tube having a plurality of discrete electron discharge conductive positions therein and responsive to digital impulses to step the electron discharge therein from position to position dependent upon the pulse content of the said digital input; the first stage comprising one of said tubes, each succeeding stage comprising one of said tubes exclusive to each conductive position of each tube in the immediate preceding stage, a source of pulses representative of plural digit codes, means exclusive to said first stage and associable with said source whereby said first stage is controlled by impulses representative of the first digit of the code to step its tube to a final conductive position according to the pulse content of said first digit, and means associated with the final conductive position of all tubes in every stage except the last for enabling only the stepping means of the tube exclusive thereto individually associated with the next succeeding stage; means in each successive stage and common to all tubes in its associated stage and associable with said source of impulses for applying impulses to all tubes in its associated stage simultaneously whereby each successive stage is controlled by successive digits of the code to step to a final conductive position only the tube of each stage that is exclusive to a final stepping position of a tube in an immediate preceding stage, the final conductive position of the responsive device in the last stage being an indication exclusive to the plurality of digits in said code.

3. In a code translator for translating a plural digit

code into an indication exclusive to the plurality of digits in said code, a plurality of step-by-step devices each having a plurality of discrete stepping positions with each of said stepping devices being responsive to pulses to enable it to step from position to position with the final stepping position dependent upon the pulse content of the digital input, a first switching stage comprising one of said stepping devices, means for applying pulses representative of the first digit to said one stepping device to enable it to step to a final stepping position in accordance with the pulse content of the first digit; a plurality of stepping devices in the second switching stage equal to the number of stepping positions in the stepping device of the first stage with each stepping device in said second stage being exclusively connected to an individual stepping position of the stepping device in said first switching stage, means for applying the pulses representative of the second digit of the code to all stepping devices in the second stage simultaneously whereby only the stepping device in the second stage that is connected to the final stepping position of the stepping device in the first stage will respond and step in response to the pulses of said second digit of the code; a plurality of succeeding switching stages each of which has a plurality of stepping devices each of which is exclusively connected to an individual stepping position of a stepping device in an immediate preceding switching stage, means for applying pulses to each succeeding switching stage in succession so that only the stepping device in each switching stage that is connected to a final stepping position of a device in the preceding stage will respond to said pulses; the final stepping position of the responsive device in the last switch-

ing stage being an indication exclusive to the plurality of digits in said code.

4. In a code translator for translating a plural digit code into an indication exclusive to the plurality of digits in said code, a plurality of stepping devices each having a plurality of discrete stepping positions with each of said stepping devices being responsive to pulses to enable it to step from position to position in accordance with the pulse content of the digital input, a plurality of switching stages equal in number to the number of digits in said code with each stage comprising at least one of said step-by-step switching devices and with each stepping device in each switching stage other than the first being exclusively connected to an individual stepping position of a stepping device in an immediate preceding stage, a pulse generator, means for connecting said pulse generator to successive stages individually whereby said generator applies pulses representative of a different digit in said plural digit code to each stage in succession, whereby in the stages subsequent to the first stage only the stepping device connected to a final stepping position of a stepping device in its preceding switching stage will respond to the pulses, the final stepping position of the responsive stepping device in the last switching stage being an indication exclusive to the plurality of digits applied.

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