July 9, 1946.

R. E. MUMMA

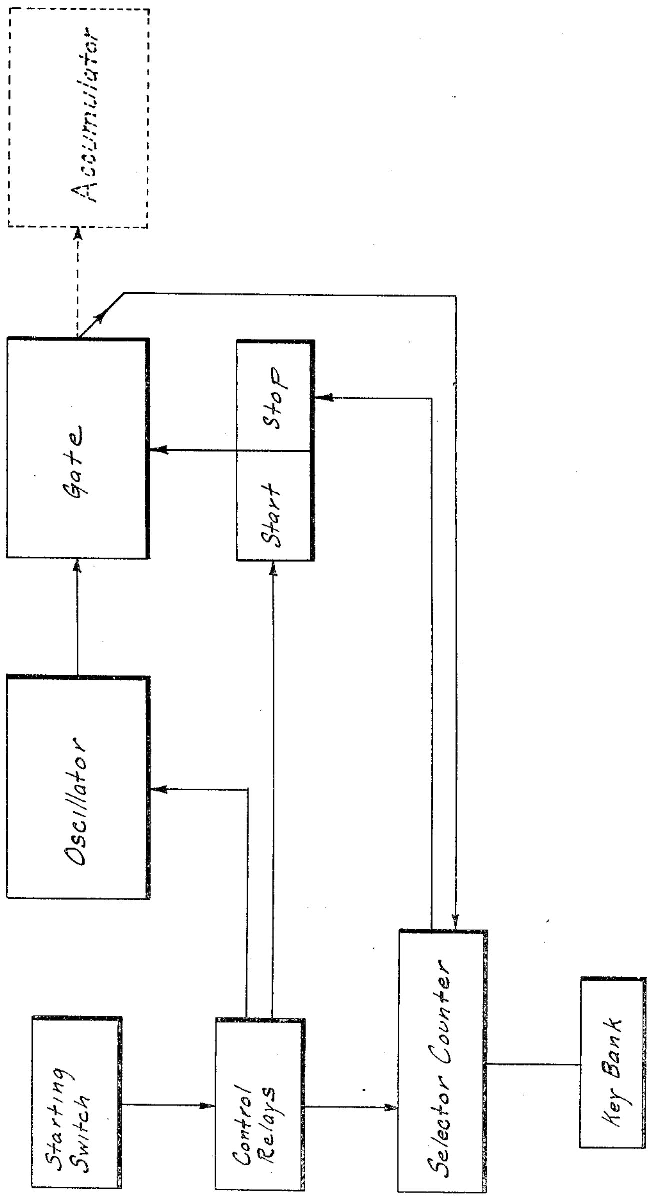
IMPULSE EMITTER

Filed Aug. 6, 1942

2,403,873

9 Sheets-Sheet 1

FIG. 1



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IMPULSE EMITTER

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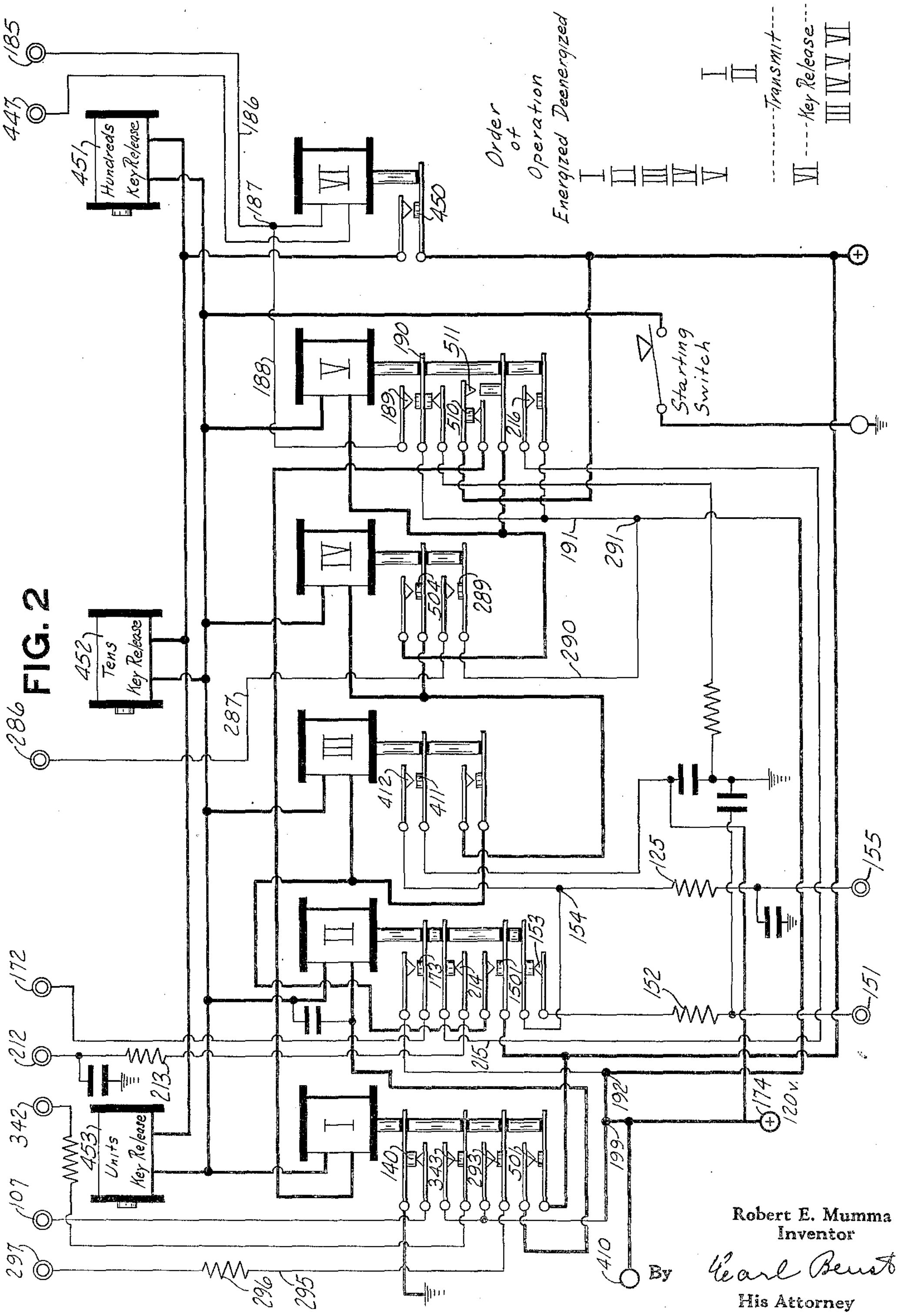
FIG. 2



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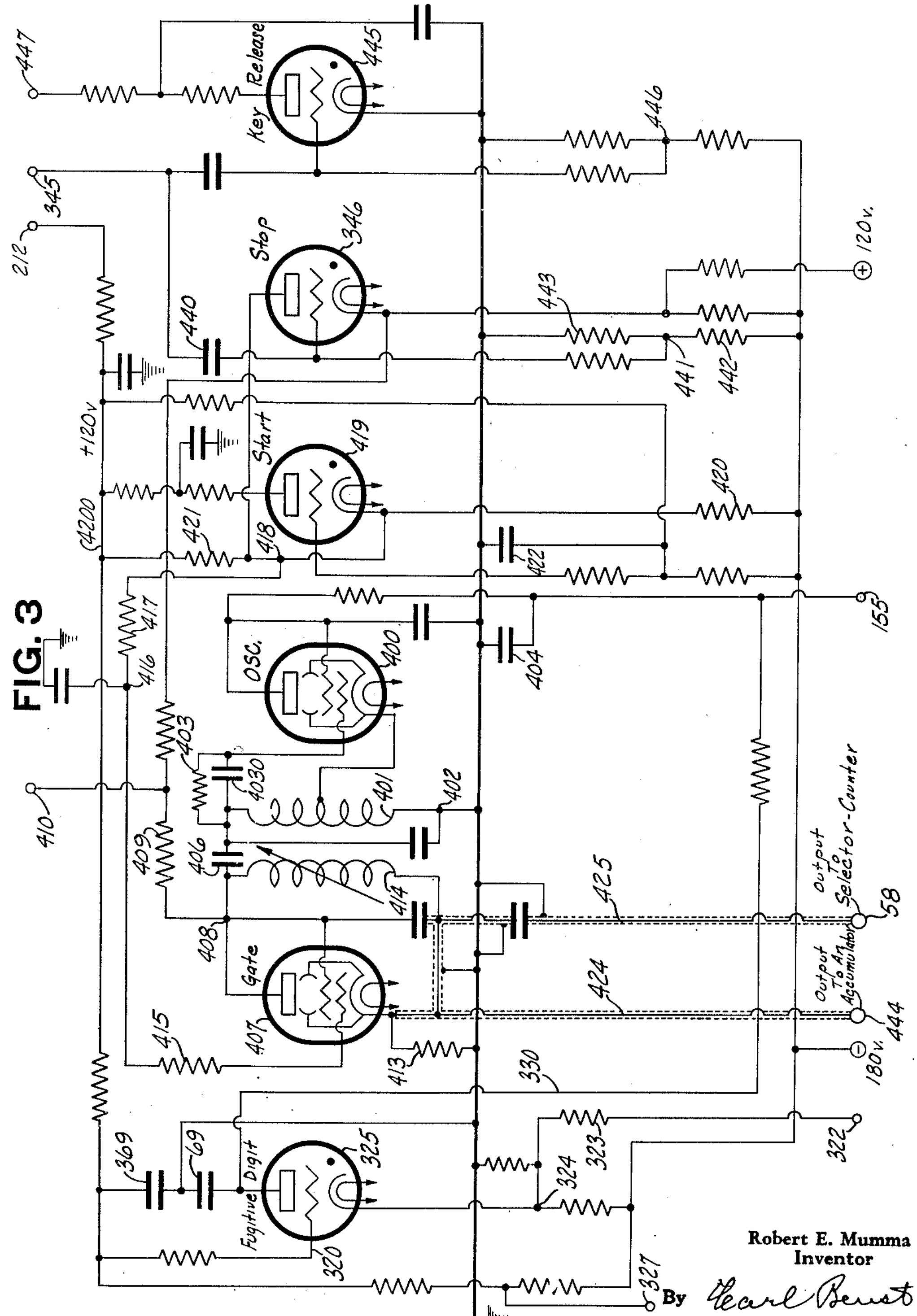

FIG. 3

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FIG. 4A

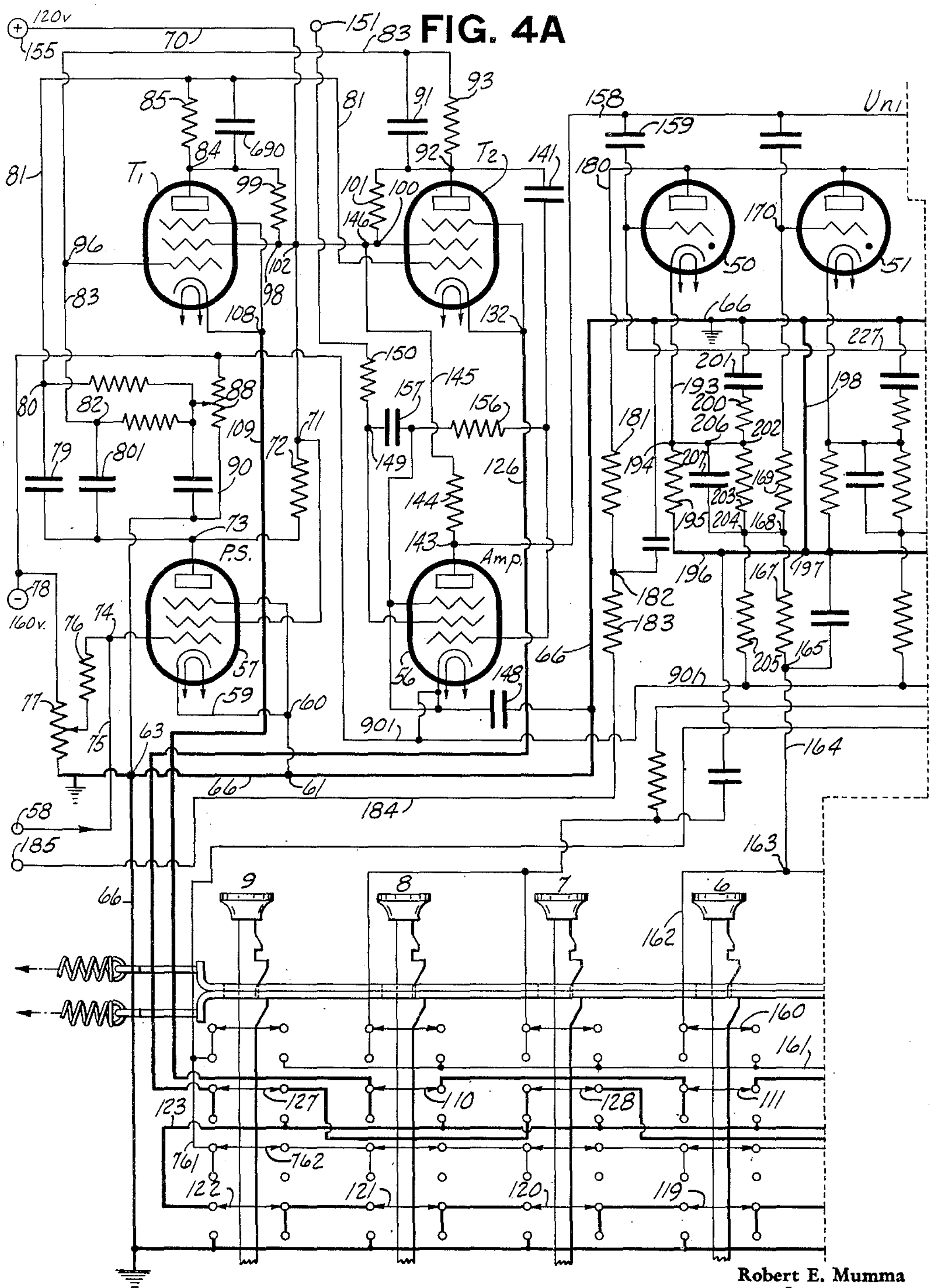

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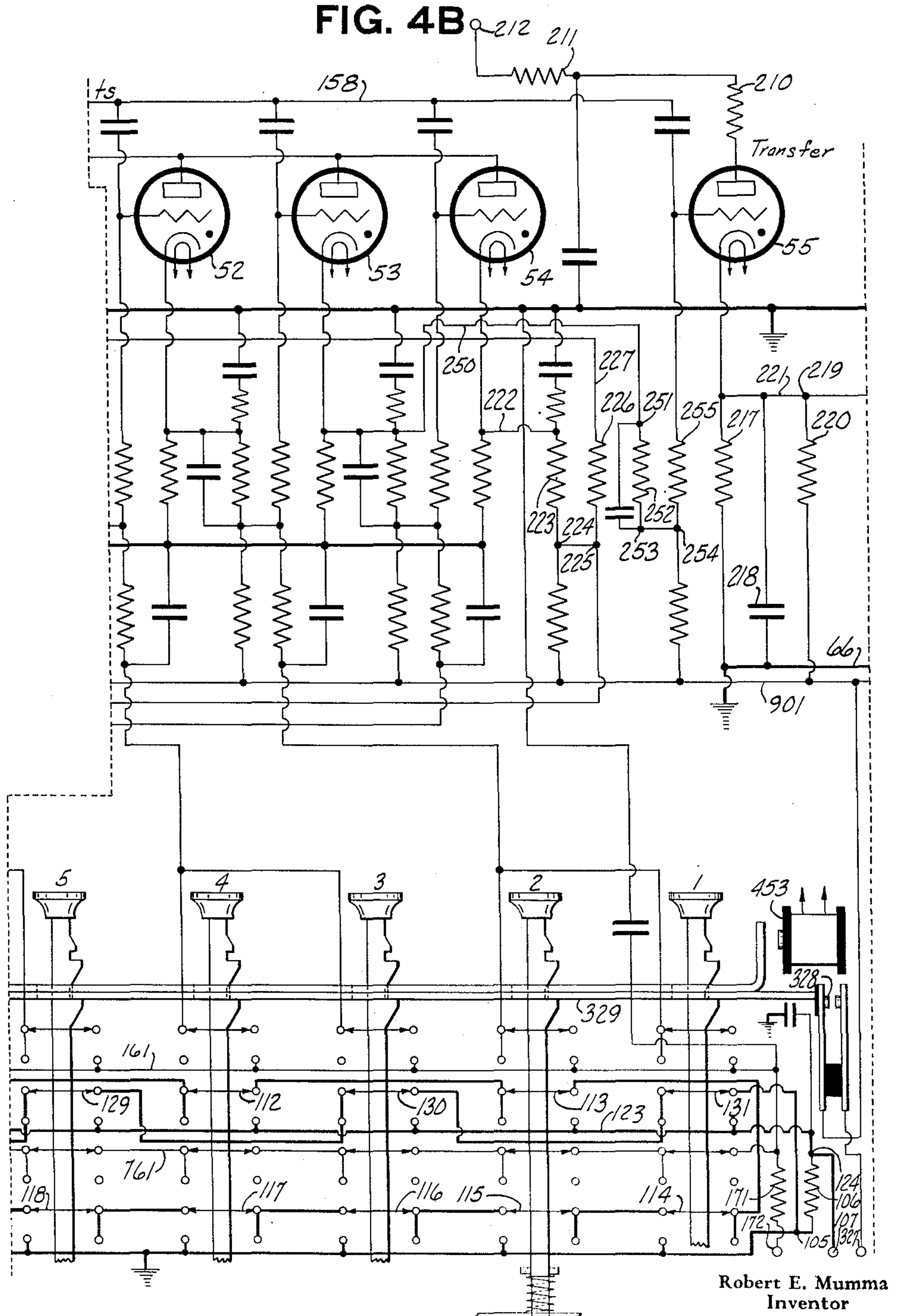
FIG. 4B



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IMPULSE EMITTER

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FIG. 4C

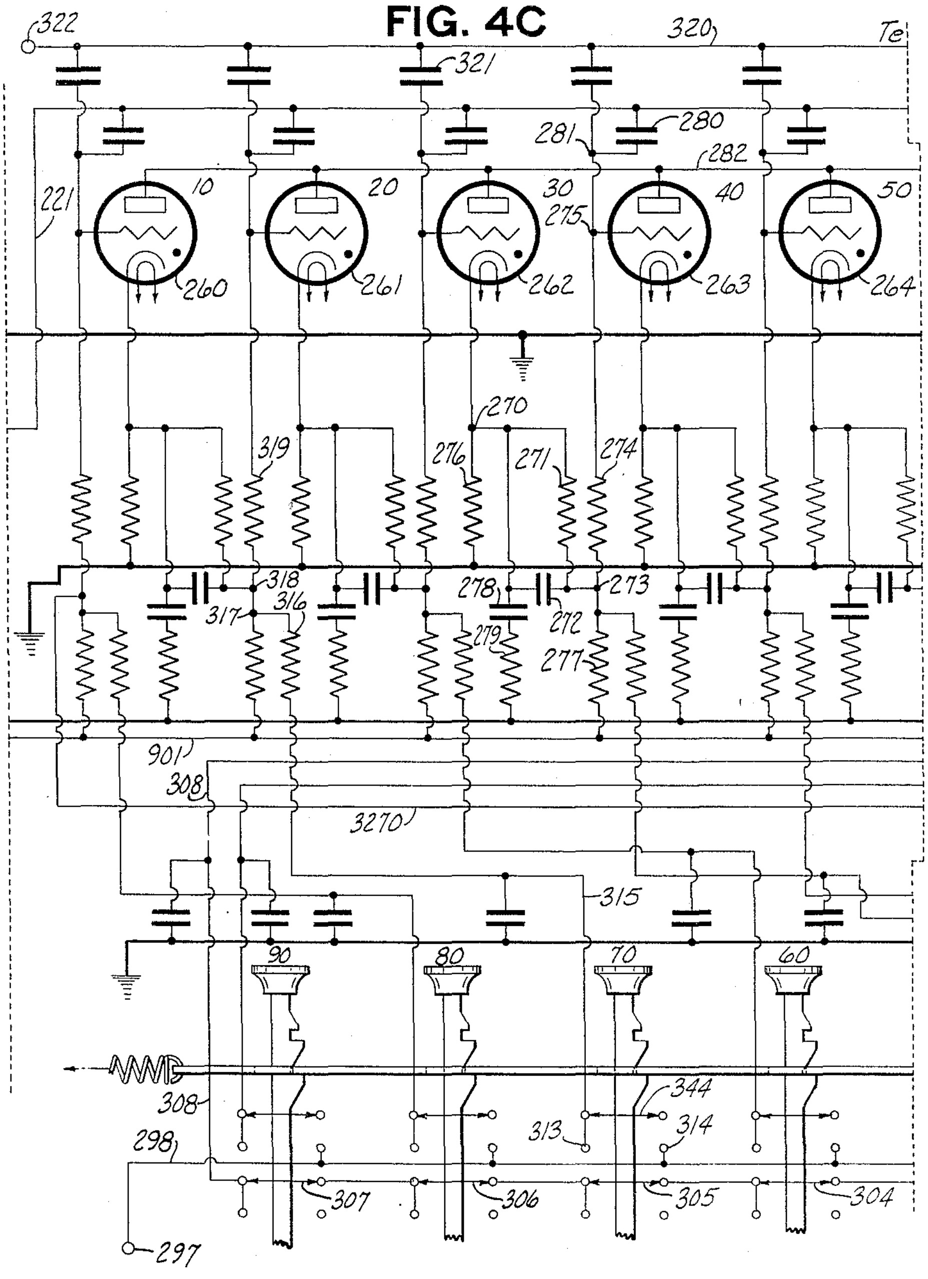

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FIG. 4D

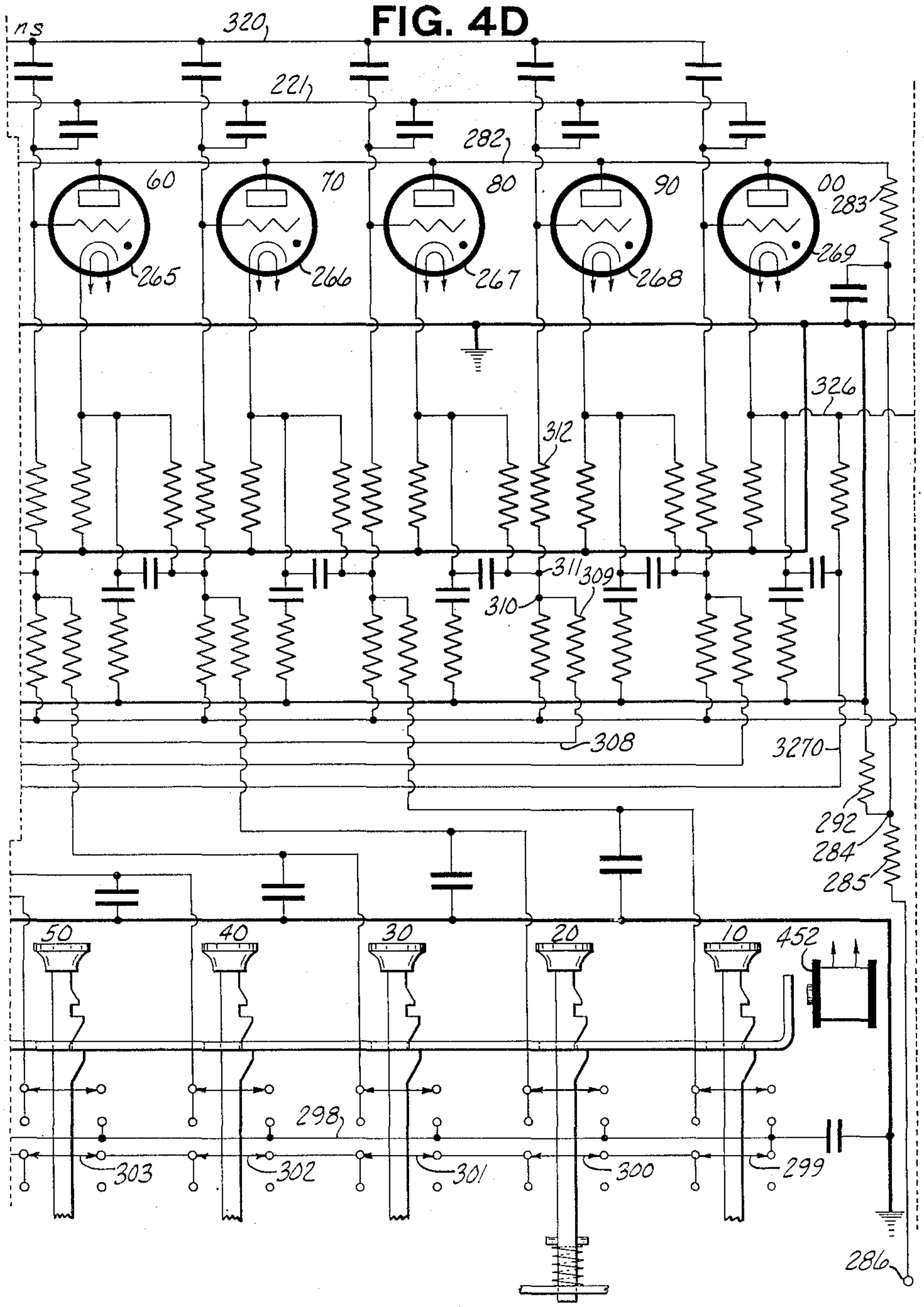

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FIG. 4E

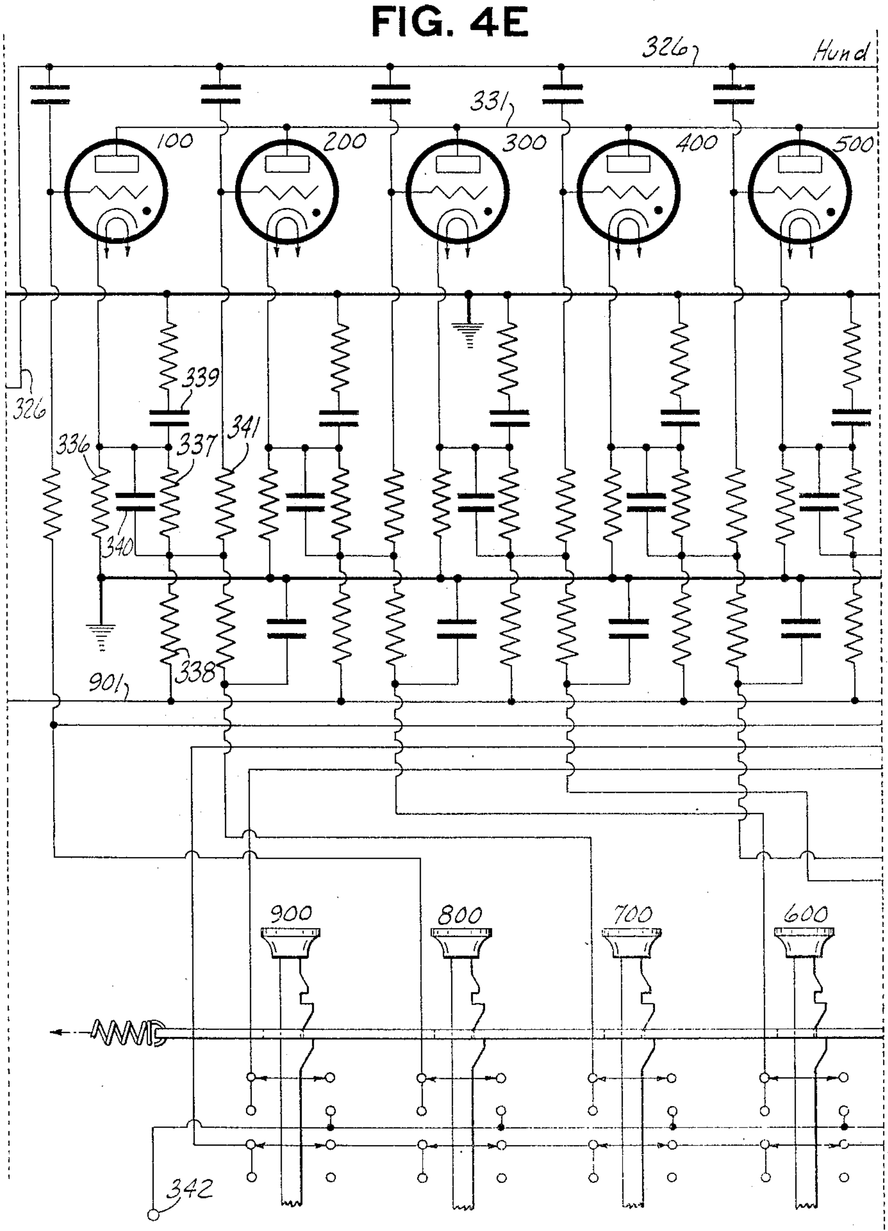

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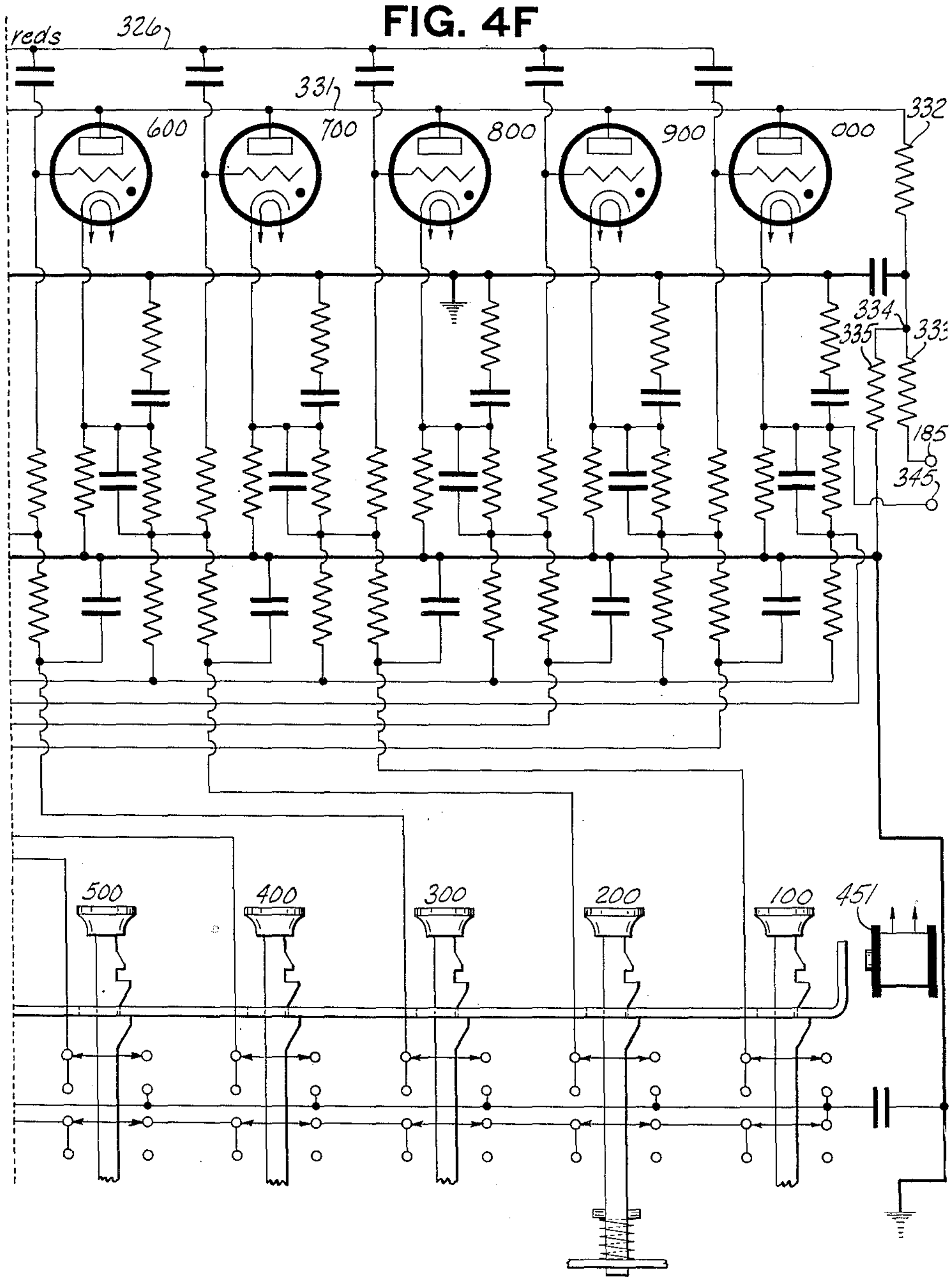
FIG. 4F



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Patented July 9, 1946

2,403,873

UNITED STATES PATENT OFFICE

2,403,873

IMPULSE EMITTER

Robert E. Mumma, Dayton, Ohio, assignor to The National Cash Register Company, Dayton, Ohio, a corporation of Maryland

Application August 6, 1942, Serial No. 453,834

5 Claims. (Cl. 177—380)

1

This invention relates to means for producing discrete electric signals at high speed in any selected number.

The invention more particularly pertains to means for producing discrete electric impulses at the rate of 150,000 or more per second in a non-denominational burst of a selected denominational number. The number of impulses so produced in a burst may be counted denominationally by an electronic counter of the type disclosed in applicant's co-pending application for United States Letters Patent, Serial No. 395,995, which was filed May 31, 1941, and which issued as United States Patent No. 2,401,657 on June 4, 1946.

The impulse producer consists of an impulse generator and a transmitter, constituting a unit, which unit is controlled by denominational banks of digit-representing electron tubes forming a selecting counter, said generator-transmitter as a whole being in turn controlled by denominational banks of selectively operable keys. Upon the completion of transmission of a selected number of electric impulses produced by said generator, as selected by the keys, the electron tube selecting counter will act to render the transmitter ineffective. Although the selector counter is denominationally arranged and controlled by the denominational banks of keys, the impulses are not produced by denominations, but in the exact number of discrete units expressed by the denominational numerical notation. The impulses, because they have no denominational characterization, may be transmitted over a single transmitting medium, such as a wire or other transmission channel, by identical signals having no significance but unity. The counter or accumulator of the produced and transmitted impulses, such as that described in the above identified application, consists of denominational banks of electron tubes, the tubes of each bank being connected in an endless operating counting ring. The tubes in a bank represent digits of that denomination. The impulses produced by the structure disclosed herein are impressed through the lowest denominational bank of such an accumulator, and the counting is completed by carrying overflow data from bank to bank by high-speed electronic transfer devices. It will become apparent that the denominational base of the selector counter and receiver need not be the same.

Therefore, it is the principal object of this invention to provide a selectively controlled high-speed electric impulse generator and transmitter.

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Another object of the invention is to provide a high-speed electric impulse generator-transmitter producing a selected number of discrete unit-representing electric impulses under control of denominationally arranged bank of keys.

Another object of the invention is to provide means to selectively control an electric impulse producer, which is producing impulses at very high speed, so as to accurately stop transmission of said impulses when the exact required selected number of impulses has been transmitted.

Another object of the invention is to provide means to control the starting and stopping of a transmitter of impulses produced by an electronic oscillator, whereby an exact selected number of impulses is transmitted.

Another object of the invention is to provide a producer of electric impulses, an electronic "gate" for controlling the transmission of said impulses, and a closing and opening means for operating said "gate" to pass an exact selected number of electric impulses produced at intervals as short as one-hundred-and-fifty-thousandth of a second.

Another object of the invention is to provide an electron tube oscillator for producing electric impulses, an electron tube "gate," control devices associated with the oscillator and the "gate" to control the starting and stopping of transmission of said produced impulses through the "gate," and a selecting counter actuated by the impulses and in turn actuating the control devices so as to let a selected number of electric impulses through the "gate."

With these and incidental objects in view, the invention includes certain novel features, circuits, and combinations of parts, the essential elements of which will be set forth in the claims and in the description which follows, and which is further disclosed in the circuit drawings to be described in connection with the specification, as the preferred form or embodiment of the invention.

Of said drawings:

Fig. 1 is a diagrammatic showing of the relationship between the various units of the device.

Fig. 2 is a representation of part of the operation control relays and the switching circuits operated thereby.

Fig. 3 shows the electric impulse producing means, the transmission "gate" and controls, the key release control means, and the tube controlling the entry of an extra unit impulse in the tens decimal denominational order of the selector counter when no data is selected by the units denominational keys.

Figs. 4A, 4B, 4C, 4D, 4E, and 4F are split views which together show the selector counter denominational banks and associated key banks.

General description

In the transmission of rapidly produced electric signals from one point to another for the purpose of conveying intelligence, it is desirable, in order to simplify transmission, that each of the impulses represent the same unit of data and that the impulses be rapidly propagated. Consequently, when it is desired to convey data expressed in denominational form by means of discrete signals each representing the same unit, it becomes necessary to translate the denominational data to such units, to transmit the data, and thereafter, for economy of space, to arrange it in denominational form for storage, accumulation, or indication.

In the sending of numerical intelligence by signals having no denominational characterization, a great many more impulses must be sent than are represented by the addition of the digits representing the number denominationally. For example, if the decimal number "851" is to be transmitted by denominationally characterized impulses, it would require possibly three channels or three periods of communication and in addition would require the sending of one signal for the "units" order, five signals for the "tens" order, and eight signals for the "hundreds" order, making in all a total of fourteen signals. On the other hand, if the same data is to be transmitted by discrete unit-representing signals over a single transmission channel, then there would have to be eight hundred and fifty-one discrete signals sent. This invention is directed to that last-named mode of transmission of data. In the sending of such signals by units only, it is obvious that very rapid propagation of the signals is necessary to render it commercially usable, and consequently there must be a means for rapidly producing the signals so as to be accurate to the unit. The general method of accomplishing this will be described first in connection with the schematic diagram of Fig. 1.

The output of an electronic oscillator producing electric impulses at a high frequency—say, at 150,000 a second—is fed through an electron tube relay, acting as a "gate," under control of a key-controlled selecter counter, which counts the produced signals, and a start-stop "gate" control means. The produced and "gated" impulses are to be transmitted to an accumulator or receiver such as that indicated by the dotted lines. The transmitted impulses are fed into the lowest denominational bank of the accumulator, and the data is accumulated by denominations. Such an electronic accumulator is shown in the reference patent application and forms no part of the present invention, but is mentioned to demonstrate the utility of the disclosed electric signal propagating device.

A starting switch is provided, said starting switch having several functions, among which are to operate relays which energize the selector counter, to enter selected data therein, and to operate certain sequence of operation control relays, one of said relays starting the oscillator, another of said relays causing operation of the transmitting "gate" starting device, which permits the "gate" to transmit the electric signals to the accumulator, and another of said relays conditioning the selector counter, whereby, upon a certain number of impulses being issued from the "gate," which not only are transmitted to the accumulator but are additionally transmitted simultaneously to the selector counter, the selector counter energizes a stopping device to close the "gate" so that an exact selected number of impulses is transmitted. Signals from the oscillator produced before the "gate" is opened and after the "gate" is closed are not utilized or transmitted.

The selector counter consists essentially of an electronic accumulating counter having banks of electron tubes, each bank representing a denomination and there being in a bank a tube representing the digits or in certain instances pairs of digits in the denomination. Said tubes in a bank are arranged in an endless operating chain by reason of the cathode of one tube being connected to the grid of the next tube, so that they are rendered conducting in sequence, one at a time, in response to each of received impulses impressed on the lowest denominational bank by the produced and "gate-passed" signals. Transfer devices are caused to operate upon each complete sequential operation of a ring of tubes to transmit carry-over data from a lower denomination to a higher denomination of the selector counter. In the selection of the number of impulses to be sent, the selector counter is provided with a key-operated multiple switch for each digit of the denomination. Those keys representing the selected digits in the various denominations which make up the data to be transmitted are operated, causing corresponding digit tubes to become conducting. The issued signals are thereafter transmitted from the "gate" tube into the selector-counter until the selector counter reaches its full capacity, upon which event happening the stop device cuts off the transmission of signals through the "gate." The tubes associated with the keys are selected so that the selected number of impulses will thereafter fill the counter to capacity.

Provision is made for addition of a fugitive unit in the presetting of data in the selector, as will be further described.

The operation control relays are operated in a certain sequence, the operation of a given relay in some instances depending upon the operation of a previously operated relay, so that the electron tubes in the various units will be made ready to become conducting in a definite order.

It will be apparent that any accumulator that is used may be placed at a distance from the novel device disclosed and coupled thereto by wire or radio. It will also be obvious that the selector counter need not be based on the decimal system of numerical notation illustrated, but may be based on any other numerical notation having denominations, and further that the selector counter and accumulator need not be based on the same numerical notation system. For instance, the selector counter may be based on the decimal system and the accumulator may be based on the binary system of numerical notation. The latter use of the invention, wherein different denominational bases are used, makes it particularly adapted to translation of data from one numerical notation to a notation of a different denominational base. Alphabetical data may be handled by enlarging the counting rings to twenty-six tubes each to accommodate the twenty-six letters of the alphabet. In a similar manner, other coded data may be handled on a numerical count.

In the first denominational ring of the selector counter, advantage has been taken of the faster response to electric signals of a trigger-connected pair of high-vacuum tubes, which trigger pair is used in cooperation with five Thyratrons connected in a counting ring, to take the place of what normally would be a ring of ten Thyratrons. By counting one Thyratron tube of the five-tube ring once with each tube of the trigger-connected pair, ten conditions are obtained to represent the ten decimal digits. Such a counting circuit system, having but seven tubes to represent a decimal denominational order, is described in applicant's co-pending application for United States Letters Patent, Serial No. 402,791, filed July 17, 1941, wherein the five-tube counting ring is of vacuum tubes, to which reference is made for a more complete description, although sufficient disclosure will be given herein to give a complete understanding of such a ring system.

The oscillator produces sine wave impulses, whereas the input signals into the tubes composing the trigger pair of the selector counter require impulses of steep wave front, so a certain modification of the sine waves generated by the oscillator is made by using a pulse sharpener electron tube circuit whose output is fed into the trigger pair, which pair changes its mode of operation once in response to each positive portion of the produced sine waves.

The disclosed device has a capacity of 999 in the decimal system, but it is evident that the system as outlined is indefinitely expansible as such.

The selector counter

Broadly, the selector counter based on the decimal notation includes a units denominational order, shown in Figs. 4A and 4B; a tens denominational order, shown in Figs. 4C and 4D; and a hundreds denominational order, shown in Figs. 4E and 4F. The units order (Figs. 4A and 4B) includes five gaseous triode electron tubes **50**, **51**, **52**, **53**, and **54**, connected in an endless operative chain, and a transfer tube **55**, to provide for a denominational transfer of a unit at the conclusion of the entry of data into the said units order to its full capacity, which tubes work in conjunction with two trigger-connected high-vacuum pentodes T—**1** and T—**2** to provide ten conditions to represent the units order digits of the decimal system.

Thus, if tube **50** (Fig. 4A) is conducting at the sametime that tube T—**2** is conducting (tube T—**1** perforce being at that time non-conducting), then the said units order bank will represent the entry and accumulation of one certain unit of data, whereas, if tube **50** and tube T—**1** are both conducting (tube T—**2** perforce at that time being non-conducting), then the condition of conduction represents the entry and accumulation of another unit of data. In a similar manner, the concurrent conduction of tube **51** and tube T—**2** represents an accumulation of another unit of data, whereas concurrent conduction in tube **51** and tube T—**1** represents the accumulation of still another unit of data. In this manner, the two tubes T—**1** and T—**2**, used in conjunction with tubes **50**, **51**, **52**, **53**, and **54** (Figs. 4A and 4B), will accommodate the representation of ten units of data, constituting the units denominational bank of the selector counter. The tubes T—**1** and T—**2** alternate in operation in response to each of the steep wave front potential impulses impressed commonly upon their control grids.

The gaseous triodes **50** to **54** inclusive, as has been said, are connected in an endless operative series, cathode to control grid, and are so arranged in a potential supply circuit that they are caused to become conducting one at a time in sequence, in response to potential impulses impressed commonly on their control grids, said impressed impulses being of positive polarity produced under control of negative impulses issuing from the anode of tube T—**2** as said tube T—**2** becomes conducting, said negative impulses being due to a resistor in the anode potential supply conductor of said T—**2** tube. The negative impulses from tube T—**2** are relayed as positive impulses by an amplifier tube **56** (Fig. 4A), which issues a positive pulse from its anode as it becomes non-conducting due to the negative impulse from tube T—**2** impressed on its grid.

Keys are provided, numbered "1" to "9" (Figs. 4A and 4B) inclusive, each of which keys operates a multiple switch to control the preliminary introduction of data into the date-representing tubes T—**1**, T—**2**, **50**, **51**, **52**, **53**, and **54**. This units order key-selected data is entered into the units bank of the selector counter previous to the reception of generated impulses, so that, when the generated impulse signals are first impressed upon the input circuit to the units order of the selector counter, the number of signals necessary to fill the said units denomination of the selector counter to its capacity and cause a transfer will be that number represented by the operated key. For instance, if key "5" were operated, the tubes T—**1** and **51** will, because of the application of a potential on their grids, become conducting when the operation is commenced, as will be shown, and it therefore requires the entry of five units of data into the counter to bring it to the full capacity, wherein the tube T—**2** and the tube **54** are conducting, said occurrence causing the overflow of one unit of data to the next higher denominational order due to the temporary conduction in transfer tube **55** on receipt of the next impulse from the generator, which simultaneously causes tube T—**2** and tube **54** to become conducting.

The tens denominational order, shown in Figs. 4C and 4D, includes ten tubes of the gaseous triode type arranged in an endless chain operating circuit connecting the cathode of a tube to the grid of the next tube of the chain, so that they become conducting one at a time in sequence, there being a step of operation in response to each of the electric potential impulses from the transfer tube of the units bank which are impressed commonly on the tubes. In the tens denominational order, each tube represents a digit of the denomination, as the speed of response necessary in the tens order is only one-tenth that of the units bank, all received data coming through the units bank. There is no need for using the high speed of the trigger-connected vacuum tubes, as was done in the units bank, and the simpler ten-tube counting ring may be used, but it is evident that a seven-tube ring like the one described for the units bank could be substituted. The tens denominational keys "10," "20," "30," "40," "50," "60," "70," "80," and "90" control the preliminary entry of data into this order as in the units bank, so that the number of tens transfer impulses from the units bank as is represented by the key used will fill the tens bank to capacity. For instance, pressing the key "50" would condition the "40" tube to become conducting by impressing a positive potential upon its control grid, which, when an operation is commenced, causes said tube to become conducting. In the event no key in the tens bank is operated, the "90" tube is thereby conditioned to become conducting. The hundreds order bank shown in Figs. 4E and 4F is similar to the tens bank, having ten gaseous triodes representing the ten digits of the denomination and having nine keys "100," "200," "300," "400," "500," "600," "700," "800," and "900" for controlling the introduction of data therein.

Input electric signals in sine wave form, as produced by the impulse-generating device to be described and transmitted through the gate, are received by the selector counter at terminal 58 (Fig. 4A) and cause a high-vacuum pentode electron pulse sharpener tube 57 to become highly conducting on the positive portion of each signal. The cathode of tube 57, heated by means shown conventionally, is connected to ground by means of conductor 59, point 60, point 61, and ground conductor 66. The anode of tube 57 is supplied with a positive potential of 120 volts through terminal 155 (see also Fig. 2), conductor 70, point 71, resistor 72 of 2,500 ohms, and point 73. The suppressor grid is connected to the cathode, and the screen grid is connected to the positive 120-volt conductor 70 through point 71. The control grid is connected through point 74 to the input terminal 58 by means of conductor 75. The control grid is given a normal potential bias of 12 volts negative by being connected, through current-limiting resistor 76 of 50,000 ohms and grounded potentiometer 77 of 25,000 ohms, to terminal 78, supplied with 160 volts negative potential, which holds the tube in non-conducting condition. A sharp drop in potential will occur at point 73, due to resistance 72, as the tube becomes fully conducting on the positive half of each of the sine wave impulses. Such drop in potential is impressed through capacitors 79 and 801, each of 10 micro-microfarads, respectively, onto the control grids of the trigger tubes T—1 and T—2. Capacitor 79 is coupled to the control grid of the tube T—2 through point 80 and conductor 81. Capacitor 801 is coupled to the control grid of the tube T—1 through point 82, conductor 83, and point 96. The anodes of tubes T—1 and T—2 receive their potential through point 102, connected to the positive 120-volt terminal 155, energized on operation of solenoid III (Fig. 2), tube T—1 having its anode connected thereto through resistor 99 of 2,500 ohms and tube T—2 having its anode connected thereto through resistor 101 of 2,500 ohms. The anode of tube T—1 is connected through point 84, resistor 85 of 50,000 ohms in parallel with capacitor 690 of 50 micro-microfarads to the control grid of tube T—2, and the anode of tube T—2 is connected to the control grid of tube T—1 through resistor 93 of 50,000 ohms in parallel with capacitor 91 of 50 micro-microfarads. The control grids of tubes T—1 and T—2 are given a negative bias by being connected each through a resistor to a potentiometer 88 of 25,000 ohms, which potentiometer is connected on one side to ground by conductor 90 and on the other side to negative 160-volt terminal 78.

Point 102 is connected to the screen grid and, through point 98 and the resistor 99 of 2,500 ohms, to the anode of said tube T—1, and point 102 is connected through point 100 and the resistor 101 of 2,500 ohms to the anode of tube T—2, to the screen grid of tube T—2. The suppressor grids of each of the tubes are connected to their respective cathodes.

Prior to the institution of the impulse-generating and transmitting operation, either the tube T—1 or the tube T—2 must be conducting, depending upon what data is preset in the units order. To cause the proper one of the trigger tubes to be in conducting condition, the cathode supply is switched to the trigger tubes, so that, if an even-numbered units digit key is depressed or no key at all is depressed, then the tube T—2 is conditioned to be conducting at the commencement of the operation, whereas, if an odd-numbered digit key is depressed, it is arranged that the tube T—1 be conducting at the beginning of the operation. To accomplish this result, as a key is depressed, the cathode supply circuits are so switched that a resistance is placed in the cathode circuit of the T tube which it is desired to be non-conducting, which resistor limits the initial current of said tube and allows the other tube to come to full conductivity, which, through the trigger coupling, causes the extinction of conduction in the tube that has the resistor in its cathode circuit. After certain relays have functioned in the inception of the operation, and after the trigger pair has assumed the proper mode of operation, the resistance is cut out of the cathode circuit of the non-conducting T tube by a relay to be described. The grounded point 105 (Fig. 4B) is the source of cathode potential of the T tubes. Resistor 106 of 5,000 ohms is connected in series in the cathode supply circuit of the T tube that is meant to be nonconducting at the inception of the operation, and terminal 107, which is later grounded, serves to shunt out the resistance 106 so that the supply conductor to both of the cathodes will be grounded without resistance after the inception of the operation to balance the trigger pair for normal operation. The cathode of the tube T—1 (Fig. 4A) is normally connected to ground through the following circuit, containing resistor 106: point 108, conductor 109, upper contacts of switch 110, upper contacts of switch 111, upper contacts of switch 112 (Fig. 4B), upper contacts of switch 113, upper contacts of switch 114, upper contacts of switch 115, upper contacts of switch 116, upper contacts of switch 117, upper contacts of switch 118, upper contacts of switch 119 (Fig. 4A), upper contacts of switch 120, upper contacts of switch 121, and upper contacts of switch 122, through conductor 123 (see Fig. 4B) to point 124, which is grounded through said resistor 106. The cathode of the tube T—2 normally is given its potential supply through point 132, conductor 126, the upper contacts of switch 127, the upper contacts of switch 128, the upper contacts of switch 129 (see Fig. 4B), the upper contacts of switch 130, the upper contacts of switch 131, to point 105 and ground. Therefore, if no key is depressed, the cathode supply circuits, just described, place the resistance in the cathode circuit of tube T—1, and tube T—2 will become conducting when operation is initiated upon application of anode potential.

If any one of the even-numbered keys is depressed, the following occurs in the cathode supply circuit for the T—1 tube. If key "8," for instance, is depressed, switch 118 will be moved to the lower contacts, causing the supply conductor 123 to be connected to the cathode of the T—1 tube, and, as supply conductor 123 is connected through resistor 106 to point 105, the cathode of the tube T—1 will still have resistance 106 in its cathode supply, and consequently tube T—2 will become conducting when anode potential is supplied, which event is desired. The lower switch 121, operated by the "8" key, is moved to the lower contacts, which grounds the portion of the T—1 cathode supply conductor which was cut out by the movement of switch 110 to the lower contacts, said cut-out portion including switches 111, 112, 113, 114, 115, 116, 117, 118, 119, and 120. The same condition is brought about by depression of the "6" key or the "4" key or the "2" key, which moves, respectively, the switches 111, 112, or 113 to the lower contact.

If an odd-numbered key is depressed—for instance, the "9" key—it is desired that tube T—1 become conducting on the application of anode potential, and, when key "9" is depressed, switches 127 and 122 move to their lower contacts. Switch 127 connects T—2 cathode supply conductor 126 to conductor 123, which thereby connects the said cathode of tube T—2 to ground through resistor 106. At the same time, switch 122 connects the cathode of the tube T—1 directly to ground through switches 121, 120, 119, 118 (Fig. 4B), 117, 116, 115, 114, 113, 112, 111 (Fig. 4A), and 110 and conductor 109. Keys 7, 5, 3 and 1 similarly switch the resistor 106 normally in the cathode supply circuit of tube T—1 to the cathode supply circuit of tubes T—2. However, terminal 107 (see also Fig. 2), when grounded through normally closed contacts 140, shunts out resistor 106 (Fig. 4B). Contacts 140 (Fig. 2) are opened as solenoid I is energized at the inception of the control relay operation, thereby causing that one of the tubes T—1 and T—2 to become conducting according to its association with the depressed key. After such operation has been initiated in the T tubes, the solenoid I is deenergized, as will be described, the contacts 140 are closed, and terminal 107 is again grounded, which grounds both cathodes of the T tubes for normal trigger operation.

At each commencement of conduction of tube T—2 (Fig. 4A), the anode point 92 will fall in potential due to the anode resistor 93, which fall in potential will be impressed through a capacitor 141 of 10 micro-microfarads onto the normally zero biased control grid of vacuum amplifier tube 56, normally conducting, causing it to cease conducting and thus causing a positive potential impulse at point 143, due to anode resistor 144 of 5,000 ohms, which is impressed on conductor 158.

The amplifier tube 56 receives its anode supply through point 143, resistor 144, conductor 145, and point 146, which is connected through point 102 and conductor 70 to terminal 155 (Fig. 2) supplied with 120 volts positive potential, as has been described. The cathode of tube 56 is connected to the negative 160-volt conductor 901 and through capacitor 148 of 4 microfarads is electrostatically coupled to ground conductor 66. The screen grid of amplifier tube 56 is connected to point 149 and, through resistor 150, of 3,750 ohms, to terminal 151 (see also Fig. 2), which is connected through resistor 152 of 500 ohms, contacts 153, and point 154 energized with 120 volts on operation of solenoid III, as has been described. As solenoid II is energized, positive potential of the screen grid of the amplifier tube 56 is removed and then reinstated only when solenoid II is deenergized, to prevent an anomolous impulse in the impulse conductor 158, due to the preliminary firing of T—2 if an even-numbered key is used to preset data therein. This will be further described in connection with the operation of the relays which control the program of the complete operation of the device, when it will be observed that tube T—2 cannot fire for its preset condition until solenoid II operates, at which time the amplifier tube 56 is incapacitated. The suppressor grid of tube 56 is tied to the cathode. The control grid connects to the cathode through resistor 156 of 50,000 ohms. The screen grid is by-passed to cathode through capacitor 157, of 4 microfarads. After the presetting has taken place, every time the tube T—2 changes from a non-conducting condition to a conducting condition, the sharp potential fall of point 92 is impressed through capacitor 141 onto the control grid of the amplifier tube 56, which tube thereupon temporarily becomes non-conducting, resulting in a positive potential impulse at point 143, which is impressed upon the input conductor 158 coupled to the control grids of each of the tubes 50, 51, 52 (see Fig. 4B), 53, and 54 through an individual small capacitor such as capacitor 159 of 10 micro-microfarads. For each two impulses issuing at point 73 from the pulse sharpening tube 57 (Fig. 4A) and commonly impressed through capacitors 79 and 801, of 10 micro-microfarads each, onto the control grids of tubes T—1 and T—2, there will be one impulse issued from the point 143 of the amplifier tube 56, which impulse is impressed upon the conductor 158 and through the capacitors like capacitor 159 onto the grids of the digit-representing tubes 50 to 54 (Figs. 4A and 4B) inclusive. In the event that tube T—2 is caused to be preset in a conducting condition, the first impulse received from point 73 will cause it to extinguish and the second received impulse will cause it to conduct and thereby cause the amplifier tube to become temporarily non-conducting, which sends an impulse onto conductor 158.

In entering data initially into the units order of the selector counter by means of the digit keys, not only is the proper tube of the tubes T—1 and T—2 made ready to be conducting, but the proper one of the tubes 50 to 54 inclusive is made ready to be conducting. This is done by applying a positive potential at a point in the grid-priming circuit of the concerned one of said tubes 50 to 54 inclusive. Thus, for instance, if the "6" key (Fig. 4A) were depressed, the switch 160 would be moved to the lower contacts, which would connect conductor 161 to the grid of digit tube 51 by means of conductor 162, point 163, conductor 164, point 165, resistor 167 of 62,000 ohms, point 168, resistor 169 of 500,000 ohms, and point 170. Tube 51 is that one necessary to preset together with tube T—2, so that six impulses from point 73 will cause an operation of the transfer tube, as will be described. Conductor 161 is connected through resistor 171 (see Fig. 4B) of 250 ohms and terminal 172 (see Fig. 2) to open contacts 173 closed by operation of solenoid II, as will be described. The said terminal 172 is given a positive potential of 120 volts from source terminal 174 as contacts 173 close. The positive potential applied to the grid of tube 51 (Fig. 4A) will, when the anode potential is applied to said tube, cause the tube to become conducting. In the same manner, the operation of any other key of the bank causes the proper one of the tubes 50 to 54 inclusive to become conducting (together with the associated T tube) when anode potential is applied. For instance, the operation of either of the keys "1" or "2" will place a positive presetting potential on the grid of tube 53. The operation of either of the keys "3" or "4" causes positive presetting potential to be applied to the grid of tube 52. The operation of either of the keys "5" or "6" causes the application of positive presetting potential to the grid of tube 51, and the operation of either of the keys "7" or "8" causes application of the presetting potential to the grid of tube 50. The operation of key "9" will cause presetting potential to be applied to the grid of tube 54. When no key is operated, tube 54 also receives the presetting potential on its grid through conductor 761 and associated closed switches like switch 762. Anode potential is supplied to the tubes 50 to 54 inclusive by means of conductor 180, resistor 181 of 5,000 ohms, point 182, resistor 183 of 2,500 ohms, conductor 184, terminal 185 (see also Fig. 2), conductor 186, point 187, conductor 188, contacts 189, which, when switch blade 190 is in the upper position due to operation of solenoid V, connects said contact 189 with conductor 191, which, through point 192 and point 199, is connected to the 120-volt positive supply terminal 174. The time of the application of the potential to the anode of the units bank tubes will be made apparent when the operation of the relays of Fig. 2 is described. The cathode of each of the digit tubes 50 to 54 inclusive (Figs. 4A and 4B) is grounded; as, for instance, the cathode of the tube 50 is grounded by means of conductor 193, point 194, resistor 195 of 20,000 ohms, conductor 196, point 197, and conductor 198, which is connected to ground conductor 66. Each point like point 194 is coupled through a resistor of 2.500 ohms, like resistor 200, and a capacitor like capacitor 201 of .001 microfarad, to ground. Points like point 202 are connected through a resistor like resistor 203 of 62,000 ohms, a point like point 204, a resistor like resistor 205 of 62,000 ohms to conductor 901, which is connected to terminal 78 supplied with a negative potential of 160 volts. Points like point 206 are connected by a capacitor like capacitor 207 of 250 micro-microfarads to points like point 204. Points like point 204 are connected to the grid of the next higher digit tube in the denominational order through a point like point 168 and through a resistor like resistor 169 of 500,000 ohms. By this network of resistors and potential supplies, the grids and cathodes of the units tubes 50 to 54 inclusive are given a normal grid bias potential far more negative than the critical point. When a tube becomes conducting by being fired by the presetting operation, it causes a rise in potential of the grid of the next higher tube, which tube, being thus primed, fires on receipt of a positive potential upon its grid by reason of a positive impulse from point 143 (Fig. 4A) impressed on conductor 158, which in turn raises the potential of the grid of the next higher tube sufficiently near to the firing point so that the next positive impulse from point 143 impressed on conductor 158 will fire only said next tube. Such a counting ring is described in the above identified applications. The cathode of the last tube of the series is connected to the grid of the first tube of the series to form an endless operating chain.

A gaseous triode transfer tube 55 (Fig. 4B) is provided, to be fired by an impulse occurring on conductor 158 while tube 53 is conducting. The rise in potential of the cathode of tube 53 (Fig. 4B) is conveyed by means of conductor 250 to point 251, through resistor 252 of 120,000 ohms, points 253 and 254, and resistor 255 of 500,000 ohms to the grid of transfer tube 55. It is apparent that both the tube 54 and the transfer tube 55 become conducting on the same impulse in conductor 158, both of said tubes thus being conditioned to be responsive to the next impulse by the fact of conduction existing in tube 53. The anode of the transfer tube obtains its potential through a resistance 210 of 2,000 ohms, a resistor 211 of 250 ohms, and terminal 212 (see also Fig. 2). The terminal 212 (Fig. 2) is connected through resistor 213 of 500 ohms through normally closed contacts 214, conductor 215, open contacts 216, which are closed on operation of the solenoid V, to connect with conductor 191, which is connected through points 192 and 199 with the 120 volts positive potential of terminal 174. The cathode of the transfer tube 55 (Fig. 4B) is connected to ground conductor 66 through a 100,000-ohm resistor 217 in parallel with a capacitor 218 of .00025 microfarad. The cathode is also connected through point 219 and a resistor 220 of 600,000 ohms to conductor 901, which carries a negative potential of 160 volts. The coupling of the transfer tube cathode to ground through the parallel resistor-capacitor network, together with the distributed inductance of the wiring, leads to an oscillatory phenomenon in the cathode circuit of the transfer tube 55 as the tube comes to full conductivity, which, as capacitor 218 becomes charged, causes a rise in the cathode potential to such a degree that it overshoots the potential of the anode, which has in the meantime dropped to within 16 volts of ground, allowing the control grid of the transfer tube to resume control. Thus the transfer tube is self-extinguished and has, by reason of the rise in its cathode potential, passed on through point 219 and conductor 221 (see also Fig. 4C) a positive impulse to cause one step in the operation of the tens bank counter tubes shown in Figs. 4C and 4D.

The units bank of the selector counter, as has been explained, has had rendered conducting therein originally, by means of the key operation, the proper selected tubes, so that it will take the number of impulses over the input circuit, as indicated on the key, to fill the units bank of the counter to capacity. As the units bank is filled to capacity and the transfer tube is operated, the same impulse causes tube 54 (Fig. 4B) to become conducting. The rise in cathode potential of tube 54 as it fires is conveyed by conductor 222, resistor 223 of 62,000 ohms, point 224, point 225, resistor 226 of 500,000 ohms, and conductor 227 to the grid of tube 50 (Fig. 4A), which tube fires and becomes conducting the next time tube T—2 becomes conducting. In the meantime, the transfer tube 55 (Fig. 4B) has become extinguished and is ready to fire, so that, when it receives another firing impulse and tube 53 is conducting, it will become conducting and consequently will carry over another impulse to the tens denominational order. The extinguishment of a preceding conducting tube of the units bank of tubes 50 to 54, by the conducting starting in the succeeding tube of the series, is caused by the common resistance 181 of 5,000 ohms (Fig. 4A) in the anode supply conductor and the individual capacity coupling to ground of the cathode of each tube. The anode supply resistor 181 causes a fall in potential of the anode supply conductor 180 as any of tubes 50 to 54 fires, such fall in potential being due to the charging of the cathode-ground capacitance. As any conducting tube before has had its cathode-ground capacitor charged and its cathode has risen to within about 16 volts of the anode, the drop in the anode supply conductor causes the anode of such conducting tube to drop below its cathode in potential. For further description of this extinguishing action, see applicant Mumma's co-pending application for United States Letters Patent, Serial No. 395,995, to which reference has been made.

The units bank of the selector counter, including tubes 50 to 54 (Figs. 4A and 4B) inclusive, will operate in endless chain sequence as long as operating potentials are applied and impulses are received from amplifier tube 56 (Fig. 4A).

The tens denominational order of the selector counter (Figs. 4C and 4D) includes ten digit-representing gaseous triodes 260, 261, 262, 263, 264, 265, 266, 267, 268, and 269, representing the digits "10," "20", "30", "40", "50", "60", "70", "80", "90", and "00", respectively, and is controlled by keys designated by the same digits. Each key controls the tube of complementary digit value on the base of nine.

The tubes of the tens denominational order are arranged in an endless chain operating circuit, constituting a counter, by cathode-to-grid connections as illustrated, for example, by the connection from the cathode of tube 262 (Fig. 4C), through point 270, resistor 271 of 50,000 ohms in parallel with capacitor 272 of 200 micro-microfarads, point 273, and resistor 274 of 500,000 ohms to the point 275 leading to the grid of the tube 263. Each cathode is given a negative potential by being connected, as is the cathode of tube 262, through a point like point 270 and a resistor like resistor 276 of 25,000 ohms to ground, and through a point like point 270, a resistor like resistor 271 of 50,000 ohms, a point like point 273, and a resistor like resistor 277 of 50,000 ohms to conductor 901 (see also Figs. 4A and 4B) supplied with 160 volts negative potential. Each point corresponding to point 270 is coupled to ground through a capacitor like capacitor 278 of .005 microfarad and a resistor in series with it like resistor 279 of 2,500 ohms. Each grid is coupled from a point like point 275, point 281, and a capacitor like capacitor 280 of 10 micro-microfarads to the common input conductor 221 connected to the cathode of the transfer tube of the units bank. With the connections shown, a conducting tube primes the next tube of the chain to become conducting as the next impulse is commonly received over the input conductor 221. For each operation of the transfer tube 55 (Fig. 4B), the tens denominational bank operates a step. As a tube becomes conducting, any previously conducting tube is extinguished by reason of the drop in the potential of the anode supply conductor in the same manner as was explained in connection with the units bank tubes 50 to 54 (Figs. 4A and 4B).

Anode potential for the tens bank is supplied through supply conductor 282, common to the ten tubes 260 to 269, through resistor 283 (Fig. 4D) of 5,000 ohms, point 284, resistor 285 of 2,500 ohms, terminal 286 (see Fig. 2), conductor 287, normally open contacts 289, which are closed by operation of solenoid IV, to be described, conductor 290, point 291, and conductor 191, which, as before said, leads to the 120-volt positive supply terminal 174. A voltage-dividing resistance 292 (Fig. 4D), connected to ground, is used to regulate the anode potential.

The selecting switches operated by the tens denominational keys (Figs. 4C and 4D) cause the "90" tube 268 to become conducting at the inception of the operation if no key of the denomination has been operated; or, if a key has been operated, that tube is caused to become conducting at the inception of the operation which is the number of steps in the ring below tube 268, which corresponds to the value of the key used.

The positive potential source terminal 174 (Fig. 2) leads through point 199, contacts 293, normally open but closed by energization of solenoid I, conductor 295, resistor 296 of 5,000 ohms, terminal 297 (see Fig. 4C), conductor 298 (see also Fig. 4D), closed switches 299, 300, 301, 302, 303 (see Fig. 4C), 304, 305, 306, and 307, conductor 308 (see Fig. 4D), resistor 309 of 62,000 ohms, points 310 and 311, and resistor 312 of 500,000 ohms to the grid of the "90" tube 268, so that the grid of the "90" tube 268 will receive a 120-volt positive potential during the time solenoid I (Fig. 2) is energized, if no key is depressed. If any tens key (Figs. 4C and 4D) is operated, the associated one of the switches 299 to 307 inclusive is opened, and the associated upper key switch is made to connect the positive potential conductor 298 to the grid of the proper tube. For instance, if the "70" key were depressed, switch 344 would connect contacts 313 and 314, energizing conductor 315 connected through resistor 316 of 62,000 ohms to points 317, 318, and through resistor 319 of 500,000 ohms to the grid of tube 261, representing the number "20." Thus, with the tube "20" rendered conducting, seven impulses will cause the "90" tube to become conducting and fill the denomination. On the next impulse, the "00" tube is fired, and, by direct connection of its cathode to the hundreds bank input conductor 326 (see also Figs. 4E and 4F), a positive potential transfer impulse is sent to the hundreds bank to operate it one step.

By means of conductor 3270 (Figs. 4D and 4C), the "10" tube is primed by the potential rise of the cathode of the "00" tube and is fired on the next impulse received from the units bank.

A "fugitive digit" correction input impulse conductor 320 (Figs. 4C and 4D) is coupled to the grid of each of the tubes of the tens bank through a capacitor such as capacitor 321 (Fig. 4C) of 10 micro-microfarads, said conductor being energized through terminal 322 (see also Fig. 3), which is connected through a resistor 323 of 5,000 ohms to point 324 and to the cathode of the "fugitive digit" gaseous triode electron tube 325, which is caused to conduct once each operation to send a positive potential pulse through terminal 322 unless its grid 320 is held negative through application of an excess negative potential on terminal 327 (see also Fig. 4B), thus preventing firing. Terminal 327 is connected through a switch 328 to the negative 160-volt conductor 901 whenever a key is operated in the units bank, said key operation causing detent plate 329 to move and close the normally open switch 328. The "fugitive digit" tube 325 (Fig. 3) receives anode potential of 120 volts over conductor 330, through terminal 155 (see Fig. 2), when relay III is energized, closing contacts 412 and 411 connecting the circuit to the 120-volt supply terminal 174.

The capacitors 69 and 369 (Fig. 3), coupling the anode and the grid of tube 325 to ground, are illustrative of others placed in the circuits for eliminating shock phenomena in the involved circuits, because, during the sudden application of potential, the capacitors insure a gradual rise in the potentials of the circuits as voltage is applied.

When no preset key selected data is to be entered in the units order, it is seen that the "fugitive one" correction is taken care of by the "fugitive one" tube.

When no preset key selected data is entered in the tens order, the "nine" tube 268 is caused to conduct, and, if the fugitive digit is entered into the tens order, it is passed on by the resulting firing of the "00" tube 269, which transfers the unit of data to the hundreds order, as will become apparent.

The sequential operation of the relays of Fig. 2 arranges the application of potentials so that the "fugitive digit" will be entered at the proper moment in the inception of the operation.

The hundreds bank of the selector counter includes ten gaseous triode tubes representing the hundreds digits as shown in Figs. 4E and 4F, which tubes are arranged in a counting ring by connecting the cathode of one tube to the grid of the next tube, as has been described for the tens bank. The common anode supply conductor 331 (Fig. 4F) is connected through resistor 332 of 6,200 ohms, resistor 333 of 2,500 ohms to terminal 186 (see also Fig. 2), which is energized with 120 volts positive potential, by the closing of contacts 189 as solenoid V is operated. Point 334 (Fig. 4F) is grounded through voltage-dividing resistor 335 of 50,000 ohms.

The cathodes of the tubes of the hundreds bank are given potential by being grounded on one side, as, for instance, the cathode of the "100" tube (Fig. 4E) is grounded through resistor 336 of 25,000 ohms and on the other side is connected to the negative 160-volt conductor 901 through resistor 337 of 50,000 ohms and resistor 338 of 50,000 ohms. The connection of each cathode to the ground through a capacitor, such as capacitor 339 of .005 microfarad in series with an oscillation-suppressing resistor, together with the resistance in the common anode supply conductor, causes any conducting tube to become extinguished as another tube of the counting ring "fires," as has been explained in connection with the lower denominational banks. The cathode of the "100" tube is connected to the grid of the "200" tube through resistor 337 in parallel with capacitor 340 of 200 micro-microfarads to prime the "200" tube grid, when the "100" tube is conducting, by elevating its normal controlling negative bias to near the critical point. Each grid is biased with a normally controlling potential by being connected, through a resistor like the resistor 341 of 500,000 ohms and a resistor like resistor 338 of 50,000 ohms, to the negative 160-volt conductor 901 and to ground through resistors like resistors 337 and 336, giving such grid a normal potential of 96 volts negative as against 32 volts negative for the cathode. The rise in potential of the preceding cathode will raise the potential of the succeeding tube of the ring to a point where a positive impulse on the input conductor 326, which is impressed on the grids of all the tubes of the bank each through a capacitor, will fire the primed tube. The digit keys are connected as in the tens bank to cause the tube to be fired at the inception of the operation which is that number of steps in the ring below the "900" tube which corresponds to the value of the key used, the firing potential being impressed on terminal 342 (see Figs. 4E and 2), which is energized as contacts 343 are closed when solenoid I is operated, connecting thereto the positive 120-volt terminal 174.

As the "000" tube fires (Fig. 4F), its cathode potential rises, giving terminal 345 (see also Fig. 3) a positive rise in potential, which causes conduction in "stop" tube 346 to block the transmission of generated impulses, as will be described.

The impulse generator

A vacuum tube 400 (Fig. 3) of the tetrode type, having its screen grid connected to the anode, is placed in a circuit as an oscillator of the Hartley type. The cathode is grounded through connection to a mid-point of induction coil 401, which is grounded by connection to point 402. The control grid is connected to the other end of the coil through resistor 403 of 10,000 ohms in parallel with capacitor 4030 of 300-micro-microfarads. The tube 400 will oscillate as soon as anode potential is applied to terminal 155 and the capacitor 404 is charged.

The high-frequency output of the oscillator is fed through capacitor 406 and impressed on the anode of the "gate" tube 407, which is a high-vacuum tetrode with the screen grid connected to the anode. Its anode is supplied with potential through point 408, resistor 409 of 50,000 ohms, and terminal 410 (see Fig. 2), which is energized with 120 volts positive potential by being connected to terminal 174. The cathode of the "gate" tube is grounded through resistor 413 (Fig. 3) of 8,200 ohms.

The variable inductance 414 of about 25 ohms resistance is supplied to neutralize the effect of the anode-grid capacity on the "gate" tube during the time when the oscillator is operating and no signals are to be sent, and is adjusted so that no signal appears at the cathode of the "gate" tube when the stop tube is conducting. The control grid of the "gate" tube is connected through resistor 415 of 10,000 ohms, point 416, resistor 417 of 2,500 ohms, point 418 to the anode of "stop" tube 346 and to the cathode of "start" tube 419. Tubes 419 and 346 are gaseous triodes. The resistor 420 of 25,000 ohms in the cathode potential supply line of tube 419 and the resistor 421 of 37,500 ohms common to the cathode potential supply of "start" tube 419 and the anode potential supply of "stop" tube 346, which potential is obtained from conductor 4200 energized through terminal 212 (see also Fig. 2), before described, causes a change in potential at point 418 when either of said tubes is conducting, as compared with the non-conducting condition. When the "start" tube is fired, the rise in potential in its cathode due to resistor 420 is transmitted through point 418 to the control grid of the "gate" tube, causing the "gate" tube to become conducting and to respond to the high-frequency application of potential to its anode as impressed thereon by the oscillator tube 400. The cathode of the "gate" tube 407 follows the oscillator-induced anode excursions of potential, which creates high-frequency impulses in output conductors 425 and 424, connected, respectively, to the selector counter through terminal 58 and to an accumulator through terminal 444, to actuate them.

Due to the fact that the control grid of the "gate" tube 407 accompanies the anode excursions of potential to some degree, and to the fact that said grid is connected to the cathode of the "start" tube 419, the transmission of impulses from the "gate" tube always begins at the negative part of an oscillatory excursion of the anode potential of tube 407 because tube 419 fires on the negative excursion of the cathode of tube 419 which follows the oscillation of the grid of the "gate" tube.

As the selector counter (Figs. 4A to 4F) receives the impulses over terminal 58, the said counter advances step by step from its preset condition until the "000" tube (Fig. 4F) fires, causing a rise in its cathode potential, which rise in potential is transmitted over terminal 345 (see also Fig. 3), through capacitor 440 of 250 microfarads to the grid of "stop" tube 346, firing said tube, which normally was kept non-conducting due to connection through point 441 and resistor 442 of 36,000 ohms to the negative 180-volt conductor and connected to ground through resistor 443 of 150,000 ohms. Upon the firing of the "stop" tube, its anode drops in potential, which potential drop is transmitted through point 418, resistor 417, point 416, and resistor 415, stopping conduction in the "gate" tube, which stops the transmission of impulses.

By this means, an exact number of impulses, corresponding in number to the selected denominational keys, is sent as a non-denominational burst.

A key release tube 445 (Fig. 3) of the gaseous triode type, having its cathode grounded, is normally biased against conduction by having its grid connected at point 446 to a source of negative potential, and receives anode potential through terminal 447 (see Fig. 2) through the winding of solenoid VI, point 187, conductor 188, and contacts 189 and 190 joining to the positive supply terminal 174. As the positive potential stopping impulse is received over terminal 345 (Fig. 3), the key release tube 445 is fired, causing solenoid VI to operate, closing contacts 450, energizing the key release solenoids 451, 452, and 453 (see also Figs. 4B, 4D, and 4F) to release any depressed keys.

The starting key may be made as a resilient key which is locked in position and released as are the digit keys; otherwise it must be held closed until the end of the operation.

Operation control switches

The solenoids shown in Fig. 2 and numbered I, II, III, IV, V, and VI are energized and deenergized in a certain sequence shown in the chart adjacent the switches.

The operation of solenoid I removes ground potential from terminal 107 (Fig. 4B), which results in resistor 106 being inserted in the cathode supply circuit of tube T—1 (Fig. 4A) for the purpose of insuring that, on the application of anode potential to tubes T—1 and T—2, the tube T—2 will become conducting. Tube T—2 is made to become conducting prior to the amplifier tube 56 becoming active, to prevent such an anomalous impulse from being transmitted to the selector counter. The solenoid I is denergized before transmission commences to remove the effect of resistor 106 and leave the trigger pair as nearly balanced as possible in their potential supply circuits, any selection of tube T—1 thereupon resulting in its firing and the extinguishment of tube T—2. Contacts 343 and 293 apply firing potential to the grids of the selected digit tubes of the tens and hundreds banks. Contacts 501 energize solenoid II.

Solenoid II, when energized, closes contacts 173 connecting the 120-volt positive supply to terminal 172 supplying firing potential to the grids of the selected one of tubes 50 to 54 inclusive (Figs. 4A and 4B) and opens contacts 214, removing the application of positive potential to terminal 212 (see also Fig. 3) until solenoid V is later energized and solenoid II is deenergized. A circuit is completed through contacts 1501 to operate the III solenoid. Contacts 153 open to disconnect the screen grid of amplifier tube 56 (Fig. 4A) from contact 411, later energized with 120 volts positive on energization of solenoid III. Contacts 153 are closed when solenoid II is deenergized just prior to the commencement of transmission of the impulses.

Solenoid III, when energized, closes contacts 411 and 412, which, in addition to energizing the upper contact 153 with 120 volts positive potential, as has been described, also energizes terminal 155 (see also Fig. 3), giving anode potential to the oscillator tube, the "fugitive digit" tube, the trigger pair (Fig. 4A), the pulse sharpening tube, and the T—2 impulse amplifier tube. A holding circuit is also closed for maintaining solenoid III in energized condition and energizing solenoid IV.

When contacts 289 close, the 120-volt supply conductor is connected to terminal 286 (see also Fig. 4D), supplying anode potential to the tubes of the tens bank of the selector counter. Contacts 504 energize solenoid V and hold solenoid IV energized.

When switch 190 moves from its lower contact, a dummy load to ground is cut out, and contact 189 and terminal 185 are energized with 120 volts positive supplying anode potential to the tubes of the units and hundreds banks of the selector counter. Contacts 510 are broken before contacts 511 are made. Contacts 510 breaking deenergizes solenoid I, and contacts 511 making locks in energized condition solenoids III, IV, and V. Contacts 216 make, and, when solenoid II is deenergized through deenergization of solenoid I, it energizes terminal 212, giving the impulse generator its start while capacitor 422 is being charged, permitting the "fugitive digit" tube to fire first. As the bias of the start tube 419 becomes critical, the tube fires at the low point of the swing of its cathode as influenced by said cathode's connection to the grid of tube 407. The grid of tube 407, as has been said, follows the excursion of the cathode of tube 407.

Solenoid VI is operated by means heretofore described.

The remaining energized solenoids are deenergized when the starting switch is opened.

If more than three denominational orders are used in the selector counter, means similar to the "fugitive digit" tube must be provided for each such additional order to correct the complementary entry of data into the selector counter. Otherwise the described device may be expanded into as many denominational orders as are required.

What is claimed is:

1. In combination, an accumulator of data including denominationally arranged electronic devices, the devices of a denomination being connected in a series for step-by-step operation by electric signals, each device representing a denominational number; means to enter data into said accumulator at a step by causing a selected device in each of the selected denominations to become operating; a signal producer for operating said accumulator, each signal causing an entry of a unit into the lowest denomination of said accumulator; connections between the signal-producing unit and the accumulator, said connec-

tions including a gate for blocking or admitting signals; and means under control of the accumulator, operative when the accumulator has been filled to capacity with data for causing said gate to block signals from passing.

2. In combination, a conductor; an electron tube having its cathode connected to said conductor; a second electron tube having its anode connected to said conductor; means for causing a potential rise in the said cathode as said first tube becomes conducting; means to cause a potential drop in the anode of said second tube when said second tube becomes conducting; an electron output tube having a continuous output of electric energy as modified periodically by an oscillating means, said electron tube being controlled as to output by a control grid to which said conductor is connected, the conduction in the first-mentioned tube causing the potential upon said control grid to rise and allow output from the output tube, and said second electron tube when conducting overcoming such potential rise on the control grid so as to prevent an output from said output tube; and selecting means actuated by the output from the output tube to control the said second electron tube to become conducting and terminate the output at the end of any seleced number of periodic modifications from the output.

3. In combination, a conductor; an electron tube having a cathode connected to said conductor; a second electron tube having its anode connected to said conductor; means for causing a potential rise in said cathode as said first tube becomes conducting; means for causing the potential drop in the anode of said second tube when the second tube becomes conducting; and an electron output tube having a continuous output of electric energy as modified periodically by an

oscillating means, said electron tube being controlled as to output by a control grid to which said conductor is connected, the conduction in the first-mentioned tube causing a potential upon said control grid to rise and allow conduction in the output tube, and said second electron tube when conducting overcoming such potential rise on the control grid and preventing conduction in said output tube.

4. In combination, a high-vacuum electron tube having an anode, a cathode, and a control grid; means to supply operating potential to the anode and the cathode; means to supply bias potential to the grid to keep said tube normally non-conducting; means to impress an oscillating potential on the anode-cathode supply means; and means associated with the bias potential supply means and responsive to the electrostatic swing of the grid as the oscillating potential is applied on the anode-cathode supply means, for causing the tube to become conducting on a predetermined point in the excursion of an oscillation.

5. In combination, a potential oscillation producing device; a high-vacuum electron tube having an anode-cathode supply circuit and a control grid; means to supply normally controlling bias potential on said grid; means to impress the potential oscillations on said anode-cathode circuit; and a gaseous triode electron tube having its cathode connected to the control grid of the first-named tube and having a resistance in its potential supply circuit and a capacitor in its grid potential supply circuit so that as a positive potential is applied to the grid of the gaseous tube it will rise exponentially in potential and fire on the negative excursion of an oscillation, thereby causing conduction in said high-vacuum tube.

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