Oct. 1, 1957 D. H. LEE 2,808,535

RESETTABLE VARIABLE RADIX COUNTER

Filed Oct. 18, 1954 2 Sheets-Sheet 1

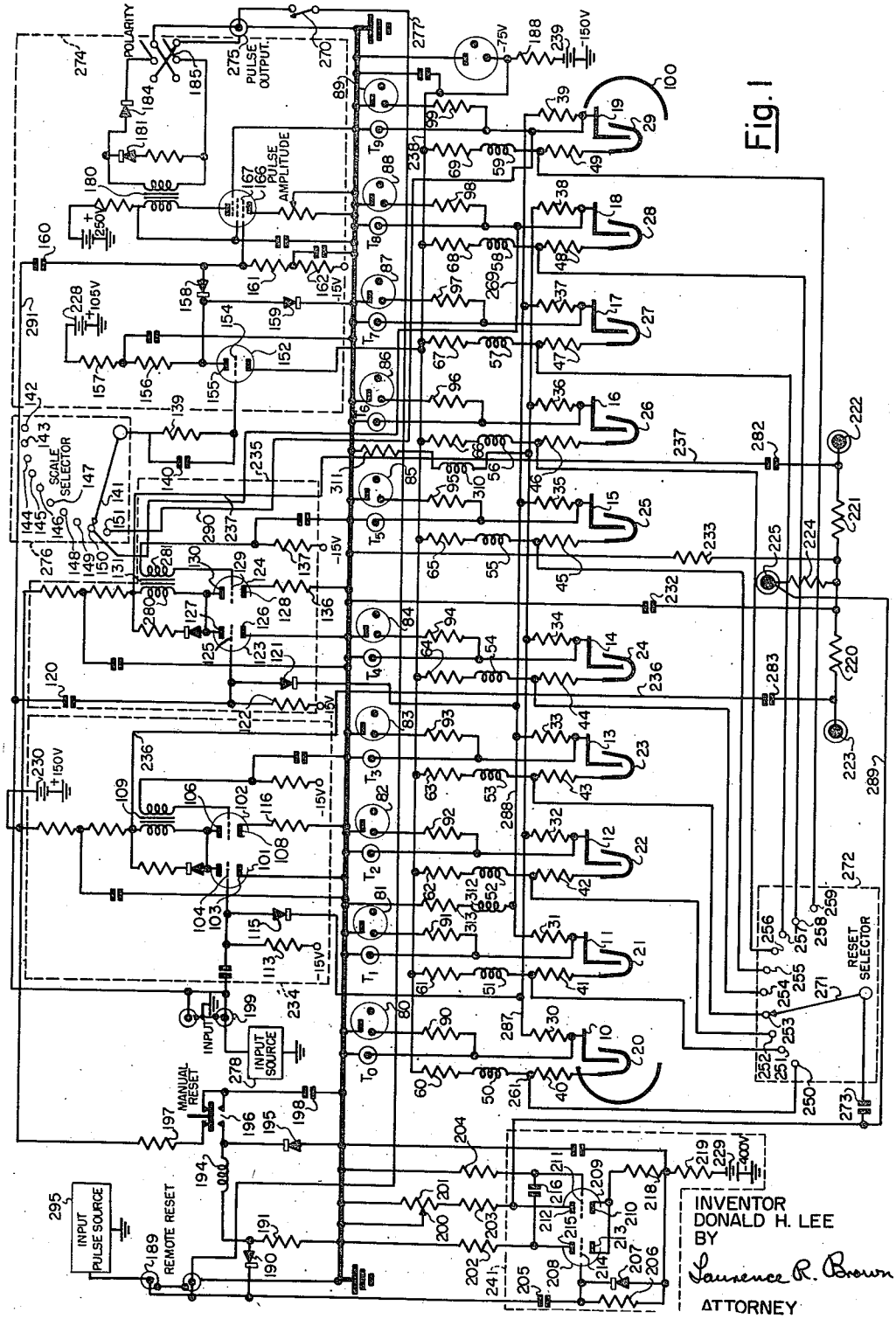

Fig. 1

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RESETTABLE VARIABLE RADIX COUNTER

Filed Oct. 18, 1954 2 Sheets-Sheet 2

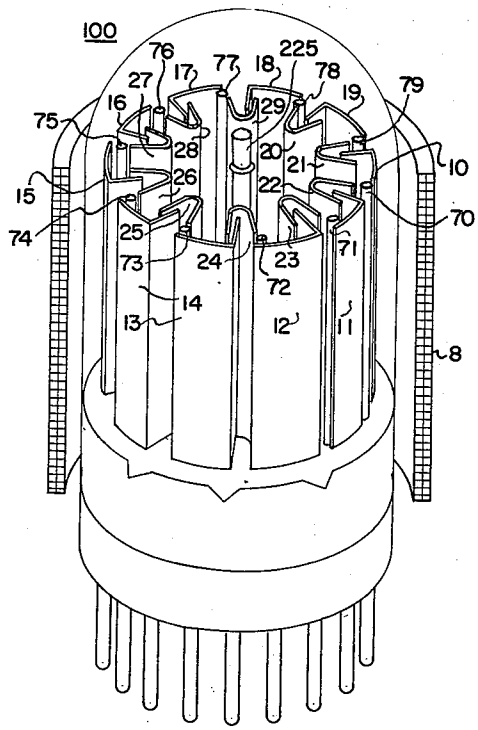

Fig. 2

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RESETTABLE VARIABLE RADIX COUNTER

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Application October 18, 1954, Serial No. 462,877

5 Claims. (Cl. 315—8.5)

This invention relates to pulse counting circuits, and more particularly to resettable pulse counting circuits including means for selectively altering the radix.

To enable high speed counting, a multi-position electron beam magnetron switching tube is used of the general type described in the United States Patent No. 2,721,955 issued to Sin-pih Fan and Saul Kuchinsky on October 25, 1955. A beam switching tube of this type may comprise a cathode with a plurality of beam receiving compartments positioned concentrically in a circular row about the cathode. Each of the compartments comprises a spade electrode for locking the beam in position, a target electrode for receiving the beam, and a switching electrode for stepping the beam from one position to another. The spade electrodes are positioned concentrically about the cathode and spaced apart from each other to permit two adjacent spades to define the edges of a beam receiving compartment. The target electrodes are arranged concentrically about the spade electrodes and are positioned to individually extend across the spacings between adjacent ones of said spade electrodes to thereby receive substantially the entire beam passing into the compartment. The switching electrodes are arranged concentrically about the cathode and each switching electrode is individually positioned in a separate compartment in the vicinity of one spade electrode and the target electrode. A magnetic field is caused to permeate the tube with flux lines substantially parallel to the electrodes. As well known in the art, this magnetic field in conjunction with the electric field set up between the cathode and target electrodes will cause the electron beam to follow a path extending between two spades when one is at a high potential and the other is at about the cathode potential. As the beam enters the compartment, part of it will be received by the low potential spade to hold its potential at a low value and keep the beam locked in.

To provide switching of the beam to the next compartment, the switching electrode is placed to alter the beam path so that the otherwise high potential spade receives beam current. This lowers the potential of the spade enough to cause the beam to step into the adjacent compartment. The beam normally progresses from one compartment to the next in that direction defined by the polarity of the magnetic field. By coupling the switching electrodes into two sets, each including alternate electrodes, the electron beam can be caused to advance from one compartment to the next by changing the potential of the two sets of switching electrodes alternately.

This hereinbefore described tube is utilized in a resettable counter system providing a selectively variable radix in accordance with the present invention. In this system the counting may begin from some pre-selected number such as one and terminate at any other pre-selected number such as two or ten. In this manner the counter may be set for any desired radix. The electron beam of the above described tube therefore can be caused to advance consecutively from a first selectable target

electrode through the intervening target electrodes to a second selectable target electrode and then is caused to automatically proceed directly from the second target electrode back to the first target electrode.

A general object of the invention is to provide improved counter systems.

A further object of the invention is to provide variable radix counters utilizing magnetron beam switching tubes.

Another object of the present invention is to provide means whereby the electron beam of a multi-position electron beam switching tube may be reset automatically to a particular electron beam starting position each time the electron beam advances to a different predetermined beam position.

In accordance with one embodiment of the invention, the target electrode of a particular compartment is chosen by selector means to provide a signal in response to beam impingement in that compartment. This signal operates a gating circuit which, in turn, transmits a pulse to both the cathode and that particular spade electrode which is chosen by further selector means. The pulse on the cathode functions to turn off the electron beam thus preventing it from stepping from one target to the next until eventually arriving at the chosen spade as it normally would due to the influence of the magnetic field in the sole presence of the signal to the spade. However, as the potential of the particular spade electrode is reduced by the signal pulse in the absence of the beam and retained at reduced potential after the electron beam is turned on again, a beam path between the cathode and the chosen spade electrode is formed causing the beam to impinge upon the chosen spade electrode, thereby holding it at reduced potential. This affords a selective reset operation which permits variable radix operation with assurance that the beam will step directly from one compartment to another compartment not adjacent thereto.

To cause the beam to step from one position to the next, a counter system is used such as described in the copending application of Donald H. Lee for United States Letters Patent, Serial No. 459,697, filed October 1, 1954. In this counter system the switching electrodes are divided into two sets of alternating electrodes hereinafter designated as the odd numbered and even numbered electrodes. A feedback circuit is provided from the target electrodes of one set to the switching electrodes of one set thereby to cause the switching electrodes of only one set to become primed with internal signals derived from the switching tube beam, to thereby enable an external pulse applied commonly to all the switching electrodes to advance the beam from one target electrode to the next. In this manner the beam may be stepped a single position in response to each received external stepping pulse.

Other objects and features of the invention will be more fully understood from consideration of the following detailed description and the accompanying drawing, in which:

Fig. 1 is a schematic sketch of a circuit diagram of a system constructed in accordance with the invention; and

Fig. 2 is a perspective view of a multi-position beam switching tube used in a preferred embodiment of the invention.

Referring now to the figures simultaneously, like reference characters identify similar component parts in order to facilitate comparison.

The magnetron beam switching tube **100** is supplied with an external magnet **8** which supplies flux lines parallel to the elongated electrodes. The cathode **225** is centrally located within the tube envelope and has positioned about it three concentric rows of electrodes. These electrodes are respectively beam forming and hold-

ing electrodes 20 through 29 commonly termed spades, which direct the beam to corresponding target electrodes 10 through 19. Each target is located in a compartment for receiving the beam in a stable position. The beam is formed and directed to a particular target by causing all spade electrodes except one to be at a high potential such as the —75 volts at lead 238 with respect to the cathode potential of about —175 volts at lead 289 when tube 209 is normally conducting. The beam is therefore formed and directed between the low potential spade and the adjacent high potential spade so that the low potential spade receives enough beam current flowing through a spade resistor 40 through 49 to maintain its low potential and assure that the beam is locked in a stable position as long as static tube potentials are maintained.

The beam is moved from one stable position to the next by means of switching electrodes 70 through 79, which are associated with the respective beam receiving compartments containing target electrodes 10 through 19. By decreasing the potential to the switching electrode of any particular compartment receiving the beam, the beam is defocussed or spread so that the normally high potential spade receives enough of the beam to lower its potential and thus cause it to transfer the beam into the adjacent compartment. By connecting the switching electrodes into two sets, respectively containing the alternate odd and even switching electrodes, the beam may be made to advance only one compartment, even though the switching pulse duration is longer than the required switching time. The respective sets of switching electrodes for this reason are diagrammatically shown in Fig. 1 as odd electrodes 223 and even electrodes 222.

Output signals may be taken from the respective target electrodes by means of separate connectors which are coupled to the output terminals T_0, T_1 etc. in Fig. 1. Thus, the tube may be used as a counter or commutator. With the operation of the tube in the foregoing manner in mind, the details of the circuit connections may be considered. The ten switching electrodes of Fig. 2 are represented in Fig. 1 as two combined groups of commonly connected even numbered and odd numbered electrodes each schematically represented at the terminals identified by reference characters 222 and 223. The cathode 225 is connected to a negative source of potential at lead 289 as supplied at the anode of 212 of normally conducting tube 209. The cathode 225 is connected by an alternate circuit to ground potential through the parallel combination of resistance 233 and capacitor 232 connected in series with the resistance 224. The odd numbered switching electrodes 223 are connected to the cathode 225 through series resistances 220 and 224 and the even numbered switching electrodes 222 are connected to the cathode 225 through series resistances 221 and 224. The odd numbered switching electrodes 223 further are connected by capacitor 283 to conductor 236 and the output lead of a pulse standardizer circuit contained within the dotted box 234. The even numbered switching electrodes are connected through capacitor 282 and lead 237 to the output lead of a similar pulse standardizer circuit contained within the dotted box 235.

Generally speaking, the pulse standardizer circuits 234 and 235 operate to apply pulses of standard waveshape to the switching electrodes for assuring that the beam may be switched from one tube compartment to the next. Because of input circuits connected to the pulse standardizing circuits 234 and 235, only one of the pulse standardizing circuits will be operable at any time. Each pulse standardizing circuit requires a threshold pulse of sufficient magnitude to its associated control grid electrodes to produce an output signal, as will be discussed in more detail hereinafter.

Each of the spade electrodes 20 through 29 is connected to a common regulated —75 volt bus line 238 through an individual series circuit comprising one each of resistances in the group 40 through 49 and 60 through 69 and an inductance of the group 50 through 59. For example, the spade electrode 20 is connected to the common bus 238 through the series combination of resistance 40, inductance 50, and resistance 60. Similar circuits connect the remaining nine spade electrodes to the common bus bar 238, which in turn is connected to the —150 volt power supply or battery source 239 through resistance 188 to maintain the spades at a positive potential with respect to the cathode 225. The inductance 50 and the resistance 60 serve the function of developing a spade switching potential from a pulse applied to the junction point 261 from a pulse amplifier and shaping circuit contained within the dotted line 241 by way of capacitor 273, switch arm 271 and contact 250. The switch 272 permits a negative pulse from source 241 to be impressed upon any one of the spade electrodes 20 through 29 with sufficient magnitude to cause the electron beam to be selectively directed to a corresponding compartment. This serves as a reset signal developed in response to a pulse at terminal 189 from an external source 295. In order to assure that the beam is reset without passing through intermediate compartments, the beam is cut-off by application of the reset pulse directly to the cathode 225 along lead 289. Cut-off is effected by reducing the conduction of tube 209 thereby causing the cathode 225 to be nearer ground potential.

The electron beam can be caused to impinge upon a selected target electrode by two different methods in the circuit of Fig. 1. One of these two methods is to apply the proper potentials to one of the spade electrodes 20 to 29 through the corresponding position of reset switch 272 to form the beam in the compartment containing that spade electrode. The other method is to apply switching pulses alternately to the respective switching electrodes 222 and 223 by way of standardizing circuit 234 or 235 to cause the electron beam to advance consecutively from one target electrode to another. Each of the switch contacts 250 through 259 are connected to an individual spade electrode through an isolating resistance of the group 40 through 49. As a specific example the contact 250 is connected through the junction point 261 and the resistance 40 to the spade electrode 20. Similarly, contacts 251 through 259 are connected to the spade electrodes 21 through 29, through resistances 41 through 49 respectively.

The pulse shaping circuit 241 can receive an input excitation pulse from one of three sources. The first of these three sources is obtained internally and is used in order to provide a ring counter. In this case a pulse is taken from output terminal 275 of the counter system as supplied by the pulse forming circuit within the dotted line 274. Thus, a pulse is received from any target electrode which is selected by means of the switch within the dotted line 276. The second source is the external input source 295 at remote reset terminal 189. The third source comprises an internal pulse forming circuit associated with the manual reset switch 196.

The pulse standardizing circuit 241 is comprised of two triode sections 208 and 209 of a 5687 type vacuum tube. The triode 208 has an anode 215, a control grid 214, and a cathode 213. The control grid 214 is connected by capacitor 205 to the output terminal 275 of the pulse standardizing circuit 274 through conductor 277, which may include the switch 270, and to the remote reset means through terminal 189. Further, the grid 214 is connected by the pulse forming network of diodes 190, 195, resistor 191, and inductor 194 to the manual reset switch 196, which connects a capacitor 198 normally charged through resistor 197 and the +150 volt source 230, to supply a single positive reset pulse.

The grid 214 is connected to the cathode 213 through series resistances 206 and 218. A clamping diode 207 is connected across resistance 206. Accordingly, the tube 208 conducts through the grounded anode resistance

202 because of the negative cathode potential of about —250 volts supplied through resistor 219 from the potential source 229.

However, the cathodes 213 and 210 of the triodes 208 and 209 are connected together to source 229 through the series combination of resistance 219 and resistance 218. Since the grid 211 of tube 209 is connected to ground potential through the resistance 204, the tube normally conducts to ground through resistors 201 and 203. This supplies a bias potential through resistor 218 which keeps current through tube 208 normally at a low value. Tube 209 is maintained at a safe conduction value by grid leak bias through resistor 204. The tap 200 of variable resistance 201 is also connected to ground potential and constitutes a voltage adjustment means for the plate 212 of tube 209. The plate 215 of tube 208 is connected to the grid 211 of tube 209 through coupling capacitor 216.

When a positive pulse is applied to the grid 214 of triode 208 from the output terminal 275, or from the remote reset terminal 189, or from the manual reset means 196, the potential of plate 215 of tube 208 will be caused to become more negative. This in turn will cause the grid 211 of tube 209 to become more negative due to the coupling capacitor 216. When the grid 211 becomes negative the plate 212 will become more positive to about ground potential thus producing a corresponding pulse upon the armature 271 of the selector means 272 through the capacitance 273 and also upon the cathode 225 of the beam position switching tube. The coupling capacitor 216 will shortly discharge, however, in a predetermined interval of time, thus causing the potential of the grid 211 and the anode 212 of triode 109 to return to their initial values and accordingly end the cut-off pulse to the cathode 225 of the beam position switching tube. However, because of the inductors 50 through 59, resistors 60 through 69, and capacitor 273, the potential at the armature 271 of the selector means 272 will become low for a long enough time at the end of the pulse to assure that a newly formed beam is directed to that spade designated by the selected one of switch contacts 250 through 259.

The pulse standardizing circuits within the dotted lines 234 and 235 are similar and thus will be discussed together. It will be noted that the grid 104 of triode tube section 101 is connected by way of the diode 115 through one of the resistors 30, 32, 34, 36, and 38 to each of the even numbered target electrodes. Conversely, the grid 125 of the tube 123 of the pulse standardizing circuit within the dotted line 235 is connected by diode 121 to the odd numbered target electrodes through resistors 31, 33, 35, 37, and 39. Since the even numbered target electrodes and the odd numbered target electrodes are all connected together through separate load impedance devices comprising either inductor 310 and resistor 311 or inductor 312 and resistor 313, and further since the electron beam at any one time will be impinging upon only one target electrode, only one of the grid electrodes 104 or 125 will be at a low potential due to the electron beam impinging upon one of the targets, and other grid will be a relatively high potential. Assume that the electron beam is impinging upon an even numbered target electrode such as 10. Under these circumstances the grid 104 of tube 101 of the pulse standardizing circuit within the dotted line 234 will be held at a relatively low potential. Both grids 104 and 125 are normally below plate current cut-off value because of the —15 volt bias potential coupled thereto by resistors 113 and 122 respectively. The potential of the grid 125 of the tube 123 of the pulse standardizing circuit within the dotted line 235 however, will be relatively high and will be closer to the plate current conductive value so that there will be a plate current flow therein in response to a further positive pulse at capacitor 120 as derived from source 278 at input terminal 199.

When a pulse is transmitted from the input source 278 it will simultaneously be impressed upon both the grid 104 of tube 101 and the grid 125 of tube 123. However, only the plate current of the tube 123 will flow thereby since the grid 104 of the tube 101 is biased sufficiently below cut-off so that the applied pulse will not raise it above cut-off. Consequently, of the tubes 101 and 123 only the potential of the plate 127 of the tube 123 will be changed due to the applied pulses from source 278. This decrease in potential of the plate 127 will cause a current flow through the winding 280 of the transformer 131. This current will induce a voltage in the winding 281 of such a polarity that a positive pulse will be applied to the grid 129 of the other tube section 124. The tube 124 is ordinarily in a non-conductive condition because of the —15 volt grid bias potential at resistor 137. The positive pulse causes the tube 124 to conduct in the manner of other well known blocking oscillators and produce a single output pulse at lead 237, which is applied to the even switching electrodes 222 through capacitor 282. This pulse output will cause the electron beam to advance from the even numbered target electrode 10 to the next odd numbered target electrode 11 which conversely will cause the grid 125 of the triode tube 123 to become biased below cut-off and the grid 104 of triode tube 101 to become biased so that a succeeding input pulse from source 278 will cause tube 101 to conduct. Thus, when another pulse is applied simultaneously from the input source 278 to the grids 104 and 125 of tubes 101 and 123 respectively the tube 102 will be caused to generate a pulse at its anode 106 which will be applied to the odd control grid electrodes 223 through the lead 236 and capacitor 283.

The cathodes 103 and 108 of tubes 101 and 102 are connected to ground potential directly and through resistance 116 respectively. Likewise the cathodes 126 and 128 of tubes 123 and 124 are connected to ground potential directly and through resistance 136 respectively.

In the output pulse forming circuit within the dotted line 274, the grid 154 of tube 152 is connected for receiving an input pulse from the armature 141 of the selector switch 276. When the armature is making contact with one of the contact buttons 142 through 151, the grid electrode 154 will be at the potential of a corresponding target electrode 10 through 19. Only two representative leads are shown connected for purpose of circuit simplicity, but each switch contact is coupled to a corresponding target. If the electron beam is not impinging upon a particular selected target electrode, the potential of the grid 154 will be high at about ground potential and the tube 152 will be in a conductive condition. Thus, the plate 155 will be at a potential considerably lower than that when the potential of the grid 154 is lowered to the value of a target electrode having the electron beam impinging thereon. At its high value the potential of the plate 155 of tube 152 is substantially at ground potential due to the presence of the diode 159. At its low potential the plate 155 decreases to about a negative 30 volts by current flow from the +105 volt source 228 through resistors 157 and 156 and the tube 152 to the regulated —75 volts of the —150 volt source 239 appearing at terminal 238. When the voltage impressed on the control grid 154 of tube 152 is low the plate current is reduced, and by means of a circuit extending through diode 158 a positive signal is conducted to tube 166. The normal condition of tube 166, when an electron beam is not impinging on a target electrode connected to a contact means of selector means 276 with which the armature 141 is making contact, is cut-off because of the —15 volts bias applied to grid 167 through resistors 161 and 162. When the plate 155 of tube 152 is in its high condition the potential of the grid 167 of tube 166 which is connected thereto through the diode 158 is brought near ground potential. This will cause the tube 166 to become conducting in response to a further synchronizing pulse of positive polarity applied by

lead **291** and capacitor **160** from input source **278**. The synchronizing pulse itself is not of sufficient amplitude to cause tube **166** to conduct, but does serve to assure that the output pulse is timed with the input source for synchronous operation therewith. The tube **166** is basically a pulse amplifier. The output pulse is not referenced to any direct current level because of transformer **180**, but will appear as positive at the upper terminal of the double pole double throw switch **185**. Thus, an output pulse of either polarity may be taken from terminal **275**. It is to be recognized that the hereinbefore described ring-count action necessitates a positive pulse at lead **277**, but for other output conditions a negative pulse might be convenient. Diodes **181** and **184** serve to shape the pulse and isolate the circuit from an external load, respectively.

Each of the neon tubes **80** through **89** forms a visual means of indicating upon which target electrode **10** through **19** the electron beam of the beam switching tube is impinging. Each of the neon tubes has one of its electrodes connected to ground potential and the other electrodes connected to a target electrode through one of the resistors **90** through **99**.

A more detailed discussion of the operation of the circuit of Fig. 1 is made hereinafter with the assumption that it is desired to have the electron beam cycle from the "3" position target electrode, through the intervening target electrodes to the "8" position target and then directly back to the "3" position target electrode to begin the cycle again. The armature **271** of the reset selector means **272** is set to make contact with contact **253** which is connected to the "3" position spade electrode **23** through resistance **43**. The armature **141** of the scale selector means **276** is set to make contact with the contact **150** which is connected to the "8" position target electrode **18**.

The electron beam may initially be impinging upon any of the target electrodes. In order to start the electron beam upon the "3" position target electrode the manual reset button **196** is depressed thus closing the lower contacts and permitting the capacitor **198** to produce a reset pulse. This pulse is impressed upon the grid **214** of the tube **208**. This results in a positive pulse at the plate **212** of triode **209** which is connected directly to the cathode **225** of the beam position tube and also to the armature **271** through the capacitor **273**. This pulse applied to the cathode **225** of the beam switching tube will extinguish the electron beam. The pulse applied to the armature **271** can be traced further through the contact **253** and the resistance **43** to the spade electrode **23**. The potential of the spade electrode **23** will, when the pulse is first applied thereto from the pulse standardizing circuit **241**, increase in a positive direction without effect on the beam formation. However, at the expiration of this pulse when the cathode is returned to operating potential, the potential of the spade electrode **23** will decrease because inductor **53**, resistor **63** and capacitor **273** and the spade electrode **23** will tend to assume a negative potential. The reformed electron beam will therefore be caused to flow to the spade electrode **23** due to the decreased potential thereon, and will be locked into position because of beam current through resistor **43**.

When the electron beam impinges on the spade electrode **23**, it also impinges on the associated "3" position target electrode **13**. The target electrode **13** is an odd numbered target electrode and all of the odd numbered target electrodes are connected to a common bus bar **288** which in turn is connected to the grid **125** of tube **123** through the asymmetrical device **121**. Thus, the grid **125** of tube **123** is biased well below plate current cutoff value. On the other hand, the grid **104** of the tube **101** which is connected to the even numbered target electrodes through the asymmetrical device **115** is biased only about ten volts below cutoff. Thus, when a thirty volt positive pulse is impressed upon the grids **104** and **125** of tubes **102** and **123** from the input pulse source **278**, the grid potential of tube **123** will not be raised above the plate current cutoff value but the potential of the grid **104** of the tube **101** will cause the tube to form a pulse. Consequently, there will be a negative pulse generated at the plate **106** of tube **102** and transmitted to the odd numbered switching grid electrodes **223** through the conductor **236** and the capacitor **283**. No corresponding pulse will be transmitted to the even numbered control grid electrodes. When the pulse is applied to the odd numbered switching grid electrodes **223**, the electron beam will be caused to advance from the odd numbered "3" position target electrode **13** to the even numbered "4" position target electrode **14**. Thus, when the electron beam impinges upon the target electrode **14** conversely the potential of the grid **104** of the tube **101** is decreased to a value far below cut-off since the grid **104** is connected to all of the even numbered target electrodes by diode **115** at bus **287**. The potential of the grid **125** of the tube **123** is similarly increased to a value just below plate current cut-off potential. When a positive pulse is now applied simultaneously to the grids **104** and **125** of tubes **101** and **123** from source **278** there will be a negative output pulse generated at the plate **130** of the tube **124** which will be impressed upon the even numbered switching grid electrodes **222** through the conductor **237** and the capacitance **282**. This will cause the electron beam to advance from the even numbered target electrode **14** to the odd numbered target electrode **15** which will produce the same conditions with respect to the pulse standardizing circuits **234** and **235** as when the electron beam was impinging upon the odd numbered target electrode **13**. Subsequent pulses from the input pulse source **278** will cause the electron beam to continue to advance along consecutive target electrodes until it reaches the "8" position target electrode **18**.

As has been discussed hereinbefore, the electron beam will be impinging simultaneously upon the "8" position target electrode **18** and also upon the "8" position spade electrode **28**. Thus, the potential of target electrode **18** is low and is impressed upon the grid **154** of the triode tube **152** through a circuit extending from the target electrode **18**, the conductor **269**, the contact button **150** of the scale selector means **276**, armature **141**, the parallel combination of resistance **139** and capacitor **140** to the grid **154** of the triode **152**. The plate current of the triode **152** is cut-off thereby and the potential of the plate **155** thereof is caused to increase to ground potential by action of the diode **159**. Under these conditions the control grid **167** of the pentode **166** can rise to conduction potential in the presence of a subsequent trigger pulse at input terminal **199**. However, until target **18** becomes low, the tube **152** is conductive and the plate **155** is at a potential well below cut-off of the grid **167** of the tube **166** and therefore the input pulse from terminal **199** would not cause tube **166** to conduct. With the output polarity switch **185** in the proper position a positive pulse will thereby be generated at output terminal **275** in response to both an input pulse from source **278** and beam impingement upon a target chosen by scale selector **276**. This positive pulse will be transmitted through the conductor **277** and capacitor **205** to the grid **214** of the triode **208**. This pulse is of the proper magnitude to generate a pulse at the plate **212** of tube **209** in a manner described hereinbefore which will cause the electron beam to impinge upon the "3" position target electrode **13** in the same manner as described at the beginning of the description of operation. Thus, a variable scale count is effected with a reset to any desired tube compartment from any other desired tube compartment.

It is to be observed that the pulse from the input source **278** that caused the electron beam to go from the "8" position target electrode **18** to the "3" position target electrode **13** is the same pulse that would cause the elec-

tron beam to advance to the "9" position target electrode **19** from the "8" position target electrode **18** with the scale selector **276** set for decimal counting. However, due to the fact that the pulse transmitted from the circuitry within the dotted line **274** in turn causes a pulse to be transmitted from the circuitry within the dotted line **241** of the cathode **225** to cause the electron beam to be cut-off, the time required for a pulse to be impressed upon the cathode **225** and cause the beam to advance is longer than the time required for the electron beam to advance from one target electrode to another target electrode in the intermediate steps. Consequently, the counter speed is lower when the reset feature is used than when the tube is used for freely counting in a repetitive closed loop established by tube electrodes alone.

If at any time during the operation of the device it is desired to reset the electron beam to the position selected by the selector means **272** such a function can be obtained in one of the three hereinbefore described methods. Assume that the selector means **272** and **276** are set for counting from "3" to "8" and that the electron beam is impinging upon the "6" position target electrode **16**. If now a positive pulse is applied to the remote reset terminal **189** from the external pulse source **295**, the grid **214** of the tube **208** will be caused to become positive which will generate a positive pulse at the plate **212** of tube **209** in a manner described hereinbefore which will cut-off the electron beam and further will cause the potential of the "3" position spade electrode **23** to be sufficiently negative at the termination of the pulse from the plate **212** of tube **209** to cause the electron beam, when reformed, to be in the "3" compartment.

Likewise, if the manual reset switch **196** is depressed to close the lower contacts, the capacitor **198** will discharge to transmit a pulse through diodes **193** and **190**, and capacitor **205** to the grid **214** of the tube **208** to similarly cause the electron beam to be turned off and then be reformed on the "3" position target electrode.

Novel features and advantages contributed by the invention are to be recognized from the foregoing detailed description of its organization and operation. Those features believed descriptive of the nature and scope of the invention are therefore defined with particularity in the appended claims.

What is claimed is:

1. A resettable variable scale counter system comprising in combination, a multi-position magnetron beam switching tube having a plurality of output target electrodes each defining beam receiving compartments for one of the beam positions and beam holding electrodes connected for holding the beam in position in each compartment, inductance means coupled to the beam holding electrodes for selectively forming the beam in any particular one of said compartments in response to a positive electronic signal and means for selectively cycling the beam from any chosen one of said compartments directly to the compartment at which the beam is formed and successively from one compartment to another to the chosen one of said compartments in response to successive input pulses, the latter means including a feedback loop from the chosen compartment to the particular compartment at which the beam is formed.

2. A system as defined in claim 1 wherein the system includes an output circuit having a triggered pulse forming device in said loop, and separate output circuits from each of the target electrodes.

3. A system as defined in claim 1 including means for stepping the beam successively from one position to the next in response to successive input pulses comprising switching electrodes in said tube, a pulse forming device responsive only to a combination of internal signals derived from the beam positioning upon an electrode and an external trigger signal, and a circuit coupling said pulse forming device to selected switching electrodes.

4. A resettable counter system having a multi-position magnetron beam switching tube with a cathode and a beam forming electrode comprising in combination, means for passing a positive pulse simultaneously to the cathode and beam forming electrode, the circuit parameters being selected so that the pulse amplitude at the cathode is sufficient to extinguish the beam, and inductance means responsive to the expiration of the positive pulse to cause the beam forming electrode to pass into a negative excursion, whereby the beam is reformed at the beam forming electrode.

5. Means for providing a number of consecutive beam positions in a multi-position magnetron beam switching tube less than the number of consecutive electrode positions available in the tube comprising, in combination; an equal number of beam forming, beam switching and beam receiving electrodes respectively disposed in corresponding beam receiving positions in said tube; means coupled to the beam switching electrodes to step the beam from one consecutive position to another, means coupled to one beam receiving electrode to produce an output signal pulse, means coupled to one beam forming electrode in a non-adjacent beam position to said one beam receiving electrode to reduce the beam forming electrode potential in response to said output signal pulse, and means coupled to said tube to extinguish the beam in response to said output signal pulse during a time period expiring while the beam receiving electrode potential is still reduced by the effect of said output signal pulse.

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