

Sept. 24, 1957

D. H. LEE  
COUNTER CIRCUIT

2,807,748

Filed Oct. 1, 1954

3 Sheets-Sheet 1

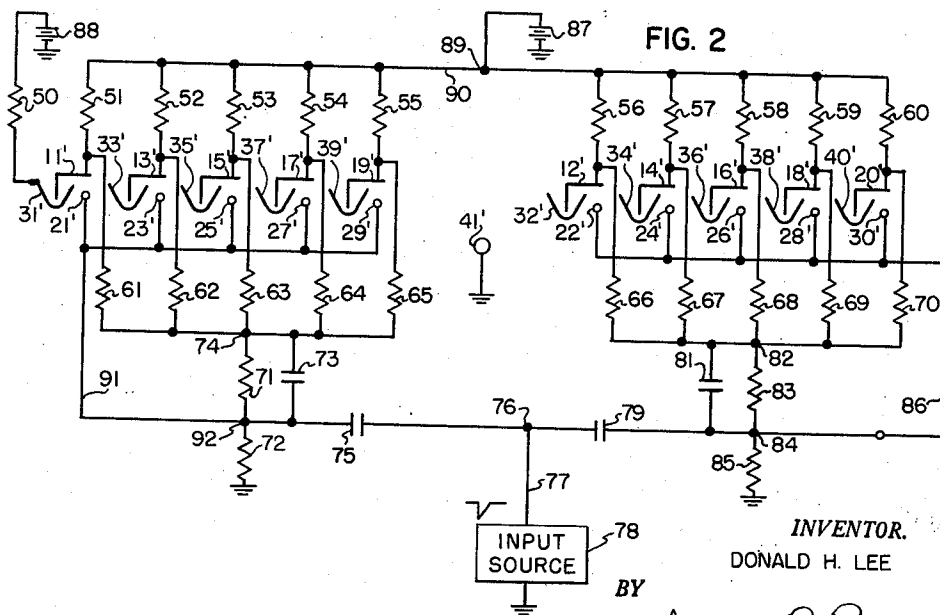
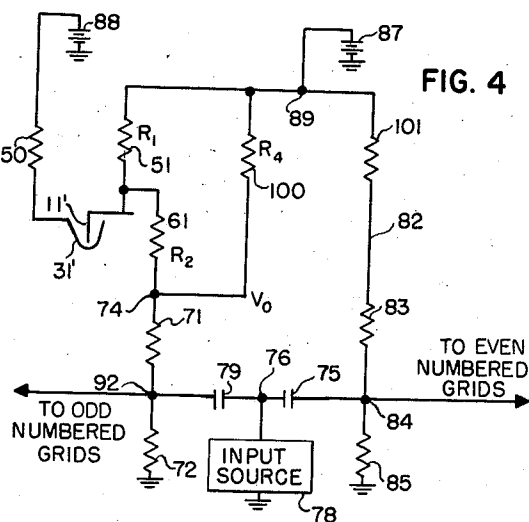
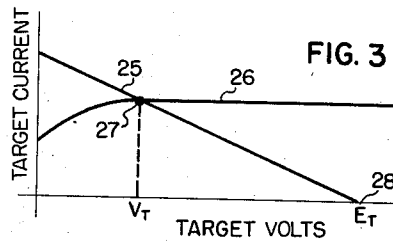
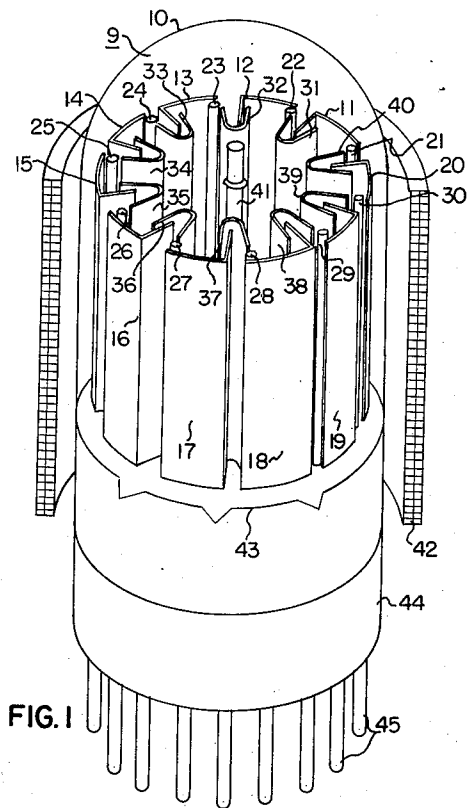


FIG. 2

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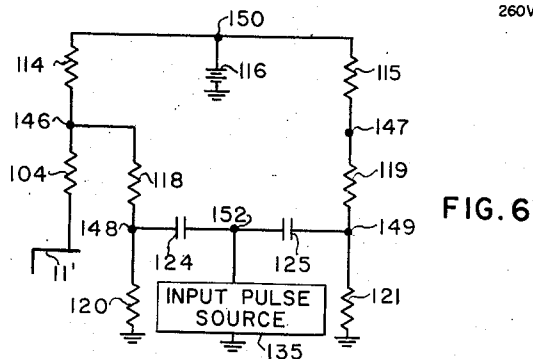
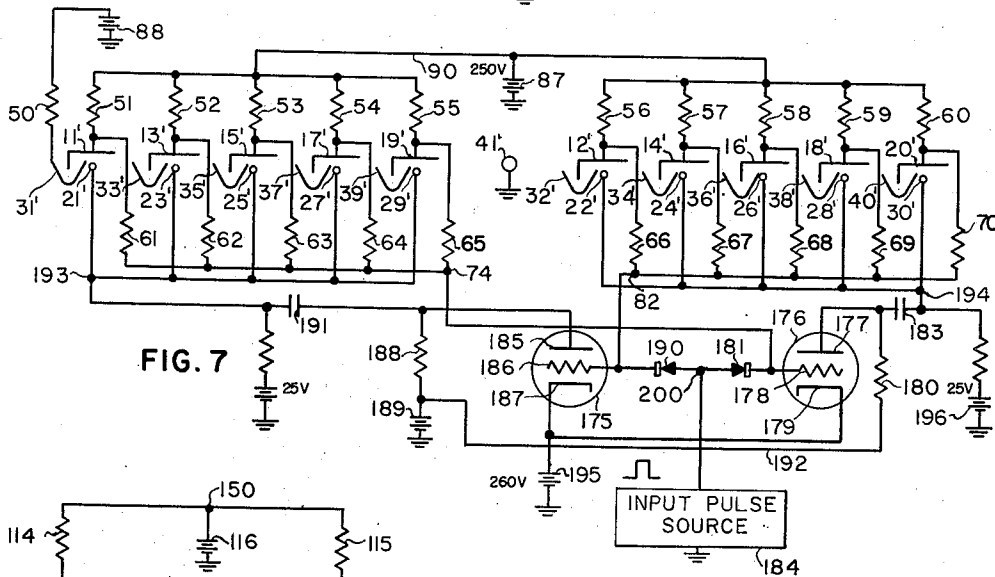
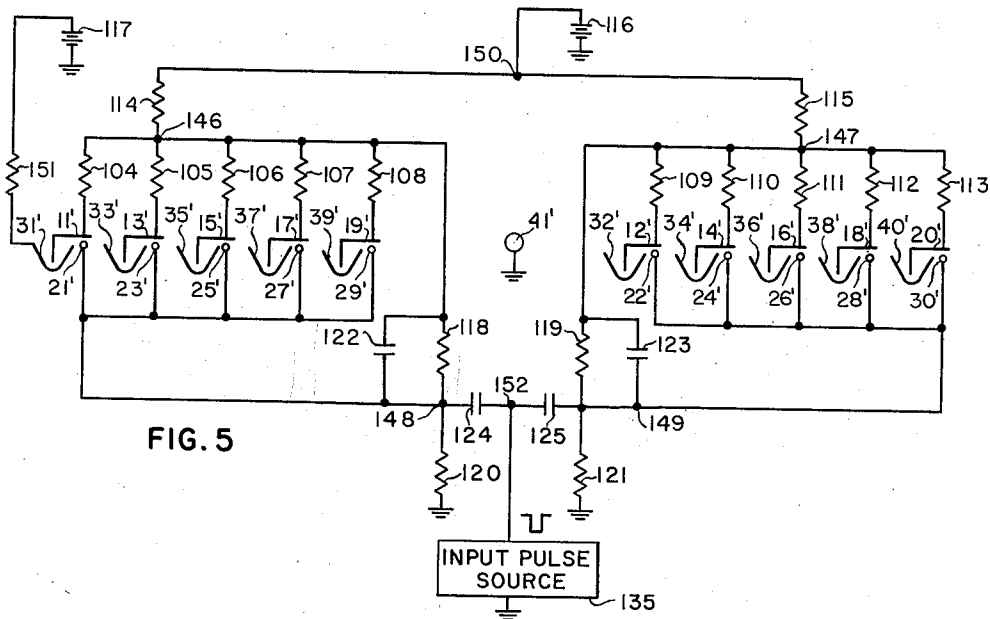
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3 Sheets-Sheet 2



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**Sept. 24, 1957**

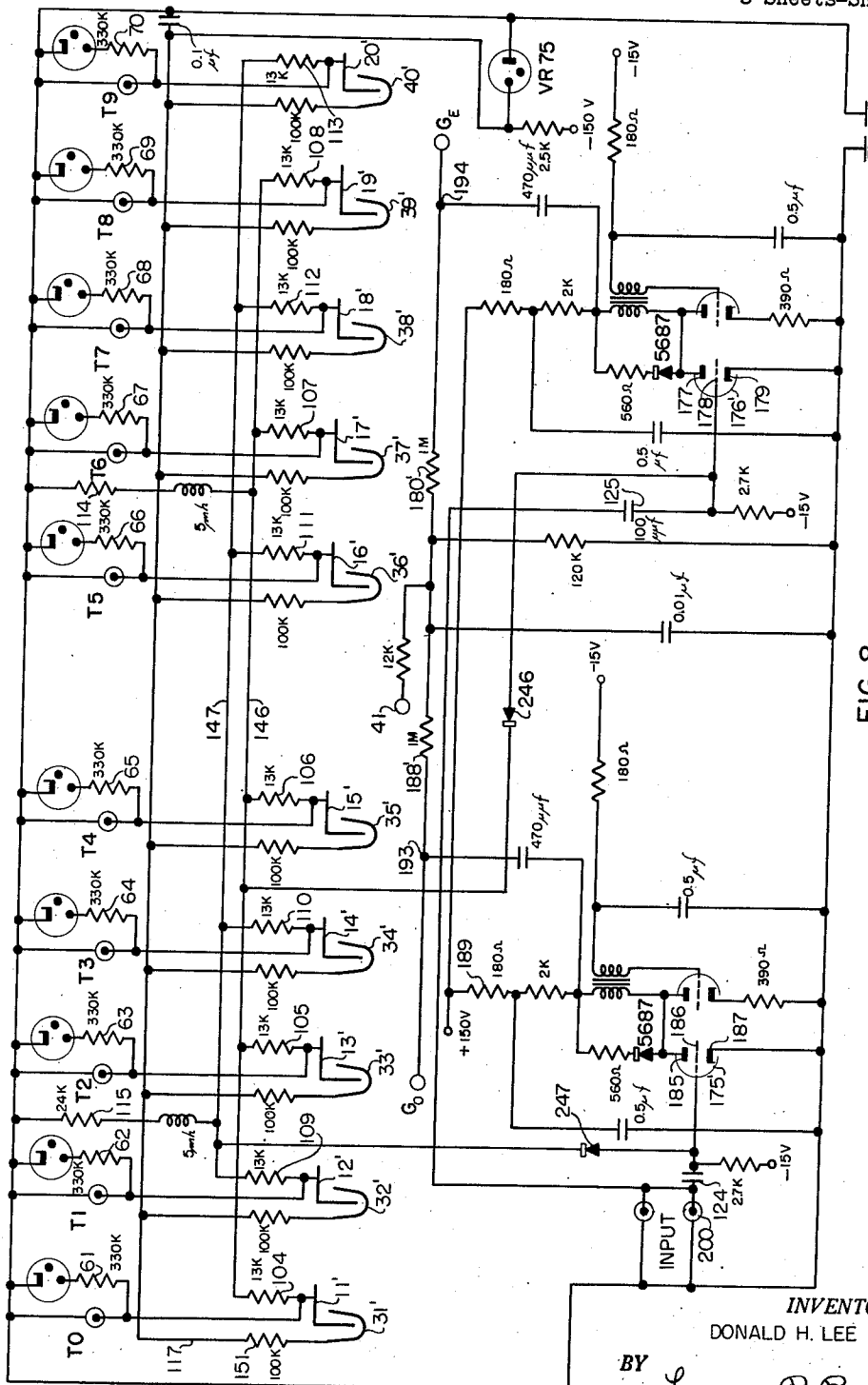
D. H. LEE

**2,807,748**

## COUNTER CIRCUIT

Filed Oct. 1, 1954

3 Sheets-Sheet 3



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2,807,748

## COUNTER CIRCUIT

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Application October 1, 1954, Serial No. 459,697

15 Claims. (Cl. 315—8.5)

This invention relates generally to multi-position electron beam position tubes and more particularly to single input pulse counter circuits utilizing a multi-position electron beam position tube. In particular this invention relates to improved counter circuits of the type described in the co-pending United States application of George Hoberg for Beam Switching Circuits, Serial No. 455,546, filed September 13, 1954.

In recent years there has been developed a type vacuum tube having a plurality of compartments each containing one of a plurality of target electrodes arranged concentrically around an elongated cathode. Each of the target electrodes is associated with a corresponding spade electrode used for locking the cathode ray beam in position upon its target electrode in a selected compartment. A magnetic field is created substantially parallel to the elongated cathode throughout the tube so that an electron beam formed at the cathode of the tube will tend to follow a substantially equipotential path. For this reason, the tubes are known as magnetron beam switching tubes. Means are provided including the spade electrodes to create a substantially equipotential line from a particular target electrode to the cathode so that the electron beam will flow from the cathode to a single compartment defined by the said particular target. A small portion of the electron beam locks upon the associated spade electrode and reduces its potential by means of a load impedance to thereby direct the remainder of the electron beam upon the corresponding target electrode.

Because of the magnetic field, the electron beam has a tendency to continuously rotate in a tight spiral around the cathode in one direction and would re-enter the cathode if it were not locked upon a particular spade electrode. When a substantially equipotential line is created between the cathode and the compartment adjacent to the compartment upon which the electron beam is impinging, the electron beam is caused to advance to the said adjacent compartment where it locks upon the spade electrode thereof. In some of the earlier tubes of this type locking may be accomplished by lowering the potential of either the spade electrode or the target electrode. A more recent development has resulted in the provision of a switching or control grid electrode in each compartment. Such tubes are described in the S. P. Fan and S. Kuchinsky Patent No. 2,721,955, issued October 25, 1955. The switching electrode of one compartment, upon being reduced sufficiently in potential, performs the function of establishing an equipotential path between the cathode and a spade electrode of an adjacent compartment to cause the electron beam to become locked in upon the adjacent compartment. If the potentials of successive ones of said switching electrodes are caused to assume a potential such as to establish an equipotential path between the associated compartment and the cathode, the electron beam will be caused to step consecutively from one compartment to the next. This has been accomplished in one manner by connecting one set of alternate switching electrodes (hereinafter referred

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to as even numbered electrodes) to one output terminal of a circuit such as a flip-flop or binary circuit and connecting the other set of odd numbered alternate switching electrodes to the other output of the flip-flop or binary circuit. Successive changes in direct current level from the flip-flop circuit would then cause the electron beam to advance progressively from one compartment to the next.

A general object of the invention is to provide improved electronic counters utilizing beam switching tubes of the type described hereinbefore.

An object of the present invention is to provide a system including a multiple position electron beam tube in which the electron beam may be caused to step consecutively along its various positions in response to pulses applied to a single input terminal.

Another object of the invention is to provide a magnetron type electron beam switching tube system operable as a counter and having but a single input terminal for external signals to be counted.

In one embodiment of the invention each of the odd numbered target electrodes is connected through an individual impedance means to a supply potential. At a junction point upon the said impedance means a feedback circuit is connected to all of the odd switching electrodes to produce a gating potential. The even numbered target electrodes are connected in a similar manner to the even numbered switching electrodes. When the electron beam is impinging upon an odd numbered target electrode, the potential of all the odd numbered switching electrodes is reduced to a gating condition at a potential lower than that of the even numbered switching electrodes. An external pulse source is connected to provide input pulses to both the even numbered switching electrodes and the odd numbered switching electrodes. Thus, when the electron beam is impinging on an even numbered target electrode the even numbered switching electrodes are at a potential lower than that of the odd numbered switching electrodes. The potentials of both sets of switching electrodes are higher than the potential to which the electrodes must be reduced to cause the electron beam to advance from a given target electrode to the next adjacent target electrode. However, when a pulse is transmitted from the pulse source to both the even and odd numbered switching electrodes at a time when the electron beam is impinging upon an even numbered target electrode only the even numbered switching electrodes will decrease to a potential sufficiently low to cause the electron beam to advance to the next adjacent target electrode. Thus the internal gating potentials derived from the target potential variations assure that subsequent pulses from the external pulse source will cause the electron beam to continue to advance from one target electrode compartment to the next.

In accordance with a more specific embodiment of the invention each odd target electrode has a first individual resistance connecting the said target electrode to a supply potential and a second resistance individual thereto connecting the target electrode to a first common junction point. Each even target electrode is connected by separate resistor networks to a second common junction point in a similar manner. All of the odd numbered switching electrodes are connected to the first common junction point to effect feedback and likewise all of the even numbered switching electrodes are connected to the second common junction point. An external pulse source is adapted to transmit pulses to the even numbered control grid electrodes through a first direct current blocking capacitor or other impedance means for providing isolation and to the odd control grid electrodes through a second similar impedance means. The electron beam impinging on a target electrode of the odd numbered or even numbered target

electrodes will thereby cause the associated odd or even numbered control grid electrodes respectively to become primed with a direct current potential level so that when a negative input pulse is transmitted from the external pulse source, it further reduces the potential enough to cause the electron beam to advance to the next adjacent target electrode.

Therefore, in accordance with the invention, the electron beam is caused to advance from one target electrode to the next adjacent target electrode each time a pulse is transmitted from an external pulse means, because gating potentials are internally derived from the changes in electrode potentials.

Other objects and features of the invention will be more fully understood from the following detailed description thereof when read in conjunction with the drawings, in which:

Fig. 1 is a perspective assembly view of a multi-position magnetron beam switching tube utilized with the invention;

Fig. 2 is a schematic diagram of a counter circuit embodiment incorporating the invention;

Fig. 3 is a plot of the target electrode characteristic of switching tubes of the type shown in Fig. 1;

Fig. 4 is a schematic sketch of a simplified equivalent circuit of a section of the circuit shown in Fig. 2;

Fig. 5 is a schematic sketch of another circuit embodying the invention;

Fig. 6 is a schematic sketch of an equivalent circuit of a portion of Fig. 5; and

Figs. 7 and 8 are schematic sketches of still further circuit embodiments of the invention.

Referring now to Fig. 1, there is shown a perspective view of a magnetron beam switching tube which is used in accordance with this invention.

This type tube is well known in the art, as evidenced by descriptions in publications such as *Electronic Design* for January 1954. Consequently, only a brief description will be given herein of the structure and theory of operation of the tube 9 of Fig. 1. The cathode 41 is positioned within the hermetically sealed envelope 10. A plurality of elongated spade electrodes 31 through 40, having a U-shaped cross section, are positioned concentrically about the cathode 41. In the structure shown in Fig. 1 there are ten such spade electrodes.

Similarly, there are ten elongated target electrodes 11 through 20, having an L-shaped cross section, likewise positioned concentrically around the cathode 41, and each associated with one of the ten spade electrodes. Each target with its two adjacent spades defines a compartment for receiving the beam in each of its ten stable locked in positions. Ten switching electrodes 21 through 30 are also positioned concentrically around the cathode 41 and are each individually positioned in one of the compartments between the open end of a target electrode and one extending leg of a spade electrode. For example, switching electrode 21 is positioned between the extending leg of spade electrode 40 and the open end of target electrode 11. The concentric magnet 42 placed about the envelope 10 produces a magnetic field in the tube that is substantially parallel to the elongated cathode 41. This magnetic field is of a polarity which will cause an electron beam extending outwardly from the cathode 41 to sweep around the tube in a clockwise direction (viewed from the top of the tube) in accordance with well known principles. Each of the spade electrodes is adapted to lock the electron beam in a particular compartment by a lowering of its potential. The beam remains locked in by means of the electron beam flowing through a spade impedance (shown in Fig. 2) connected to the particular spade electrode upon which the electron beam is impinging thereby causing enough potential drop across said impedance to establish a substantially equipotential path between the particular spade electrode and the cathode. The switching electrodes perform the function of causing the electron beam

to impinge upon the next consecutive spade electrode by distorting the electric field within a particular compartment to cause the electron beam to advance to that spade electrode in the compartment adjacent the one upon which it impinges in the absence of a switching potential. It is to be noted that when the electron beam is directed to a compartment that the electron beam is actually impinging upon both the spade electrode and the target electrode. The target electrodes normally receive most of the electron beam since only a small portion thereof is required to lock the electron beam upon a particular spade electrode.

Referring now to Fig. 2, the various elements of the tube of Fig. 1 are presented in a different manner than in Fig. 1 in order to make the drawing more easily understood. More specifically the spade electrodes, the target electrodes, and the switching electrodes are arranged in a straight line and further are separated into two functional groups. The group at the left of Fig. 2 consists of the odd numbered target electrodes 11', 13', 15', 17', and 19'; the odd numbered spade electrodes 31', 33', 35', 37', and 39' and the odd numbered switching electrodes 21', 23', 25', 27' and 29'. The group at the right consists of even numbered target electrodes 12', 14', 16', 18', and 20', the even numbered spade electrodes 32', 34', 36', 38', and 40', and the even numbered switching electrodes 22', 24', 26', 28', and 30'. It is to be noted that the elements having primed reference characters in Fig. 2 correspond to elements in Fig. 1 having the same unprimed reference character.

Each of the odd numbered target electrodes 11', 13', 15', 17', and 19' is connected to a common power supply such as battery 87 through individual resistors 51 through 55 respectively and is connected to common junction point 74 through the individual resistors 61 through 65 respectively. The even numbered target electrodes 12', 14', 16', 18', and 20' are individually connected to the common battery 87 through the resistances 56 through 60 respectively and are connected to the common junction point 82 through the resistances 66 through 70 respectively. The common junction point 74 is connected to ground through the series combination of resistance 71 and resistance 72 which constitute a voltage divider network. All of the odd numbered switching electrodes 21', 23', 25', 27', and 29' are connected to the junction point 92 between the resistance 71 and the resistance 72. Similarly, the common junction point 82 is connected to ground potential through the series combination of the resistance 83 and the resistance 85 which also constitute a voltage dividing network. The even numbered switching electrodes 22', 24', 26', 28', and 30' are connected to the junction point 84 between the resistance 83 and the resistance 85. The capacitors 73 and 81 which are connected across the resistances 71 and 83 respectively perform the function of improving the potential waveform at the junction points 84 and 92. Junction points 92 and 84 are connected to a common junction point 76 through direct current blocking capacitors 75 and 79 respectively. Input pulse source 78 is connected to the common point 76 through the conductor 77. Each of the spade electrodes is connected to the common battery source 88 through a resistance individual thereto. As a specific example the spade electrode 31' is shown connected to the battery source 88 through the resistance 50. In order to avoid unnecessarily complicating the drawing the resistors connecting the other spade electrodes to the common battery source 88 have been omitted.

From an inspection, it can be seen that each target electrode is connected to the battery source 87 through two principal impedance paths, the first being through the associated one of the impedances 51 through 60 and the second being through the remainder of the impedances connected directly to the target electrodes of the same group of the even or odd numbered groups of target electrodes. Specifically, for example, the target electrode 11' is connected to the battery source 87 through the resist-

ance 51 and also is connected to the battery source 87 through the resistance 61 and resistances 52—62, 53—63, etc. It is to be noted that common junction point 74 is positioned between resistance 61 and the resistance network set forth immediately above. The values of these resistances are so proportioned that the potential of the odd numbered control grid electrodes are of a proper value to cause the electron beam to advance from an odd numbered target electrode to an even numbered target electrode when a pulse is transmitted from the input pulse source 78. The values of the potentials at various points in the circuit for one particular design are as follows:

$E_T=250$  volts  
 $E_{sp}=100$  volts  
 $V_T=60$  volts  
 $V_o=100$  volts  
 $V_g=21$  volts  
 $V_o'=250$  volts  
 $V_g'=53$  volts  
 $V_T'=109$  volts

Where  $E_T$  is the target electrode battery source 87,  $E_{sp}$  is the spade electrode battery source 88, and for the odd numbered group of electrodes wherein the electron beam is assumed to be impinging on the target electrode 11',  $V_T$  is the potential of the target electrode 11',  $V_o$  is the potential of the common junction 74 and  $V_g$  is the potential of the junction 92 to which the switching electrodes are connected. Likewise for the even numbered electrodes  $V_o'$  is the potential of the common junction point 82,  $V_g'$  is the potential of the junction point 84 to which the even numbered switching electrodes are connected and  $V_T'$  is the potential of the target electrodes 13', 15', 17', and 19'. It is to be understood that the values of potentials given above are but one of many sets of values that can be chosen.

With respect to the potential of the switching electrodes, it is necessary that one set of the switching electrodes (odd if the electron beam is impinging on an odd numbered target electrode) be at a potential which will be lowered sufficiently when an input pulse is applied to junction 76 from input pulse source 78 to cause the electron beam to step to an even numbered target electrode and that the other set of control grid electrodes (the even numbered set) be not lowered sufficiently to cause the electron beam to continue stepping to the next following odd numbered target electrode. It is to be noted that when the electron beam is impinging on an odd numbered target electrode, the odd numbered switching electrodes are at a lower potential than the even numbered switching electrodes and will upon application of an external negative pulse from source 78 cause the electron beam to advance from an odd numbered target electrode to an even numbered target electrode.

The voltage conditions set forth above can be obtained by selecting the proper values for resistances 51 through 70. These values can be obtained by mathematical analyses well known in the art.

The final equations of such an analysis are given below: Let

$$V = \frac{V_o - V_T}{4E_T + V_T - 5V_o}$$

where  $V$  is an abbreviated expression of the quantity to which it is equal  
 Then

$$R_1 = 5 \frac{1+V}{1+5V} R$$

where  $R_1$  represents any of the resistances 51 through 60 and

$$R_2 = VR_1$$

where  $R_2$  represents any of the resistances 61 through 70 where

$$R = \frac{E_T - V_T}{I}$$

which can be determined from the characteristic curve of Fig. 3

To obtain the proper values for  $V_g$  and  $V_g'$  the resistances 71, 72, 83, and 85 must be proportioned properly. In the embodiment shown in Fig. 2, the ratio of resistance 71 to resistance 72 is such to give a voltage division of 0.21 and equal to that of resistance 83 to resistance 85. Consequently,

$$\begin{aligned} 15 \quad & V_g = 21 \text{ volts} & V_o = 100 \text{ volts} \\ \text{and} & & \\ & V_g' = 53 \text{ volts} & V_o' = 250 \text{ volts} \end{aligned}$$

Solving the above equations it is found that the resistances 51 through 60 have a value of 120,000 ohms and resistances 61 through 70 have a value of 8200 ohms. Resistances 71 and 83 have a value of one megohm, and resistances 72 and 85 have a value of 270,000 ohms. Capacitors 73 and 81 each have a value of 100 micromicrofarads, and capacitors 75 and 79 each have a value of 470 micromicrofarads.

Referring now to Fig. 4, there is shown a schematic view of the equivalent circuit of Fig. 2 of a particular section of the circuit including target electrode 11'. Certain elements of the circuit of Fig. 4 correspond to certain elements of the circuit of Fig. 2 and have the same reference characters. However, the resistance 100 of Fig. 4 represents the combined resistance of series resistances 52—62, 53—63, etc., of Fig. 2. Resistance 101 likewise represents the combined resistance of resistances 56—66, 57—67, etc., of Fig. 2.

Assume that the circuit of Fig. 4 shows in a simplified form the circuit of Fig. 2 with the electron beam impinging on the target electrode 11'. It can be seen that the electron beam can flow in two paths from the target electrode 11' to the battery source 87. One of these paths is directly through the resistance 51 and the other path is through the series combination of resistance 61 and resistance 100. The potential of the junction point 74 is thereby lowered below that of the junction point 82 due to the increased current flow through the equivalent resistance 100. Similarly the potential of junction point 92 is lowered below that of junction point 84. The junction points 92 and 84 are connected to the odd and even numbered switching electrodes respectively. Therefore, the potential of the odd numbered control grids is gated or primed such that the electron beam will step to the even numbered target electrode 12' (shown in Fig. 2) adjacent the target electrode 11' when a negative pulse is applied from the input pulse source 78 to the junction point 76.

Referring now to Fig. 5 there is shown a schematic diagram of a second embodiment of the invention. Each of the odd numbered target electrodes 11', 13', 15', 17', and 19' are connected through resistances 104, 105, 106, 107, and 108 respectively to the common junction point 146. Each of the even numbered target electrodes 12', 14', 16', 18', and 20' are connected to the common junction point 147 through the resistances 109, 110, 111, 112, and 113 respectively. The junctions 146 and 147 are connected to common junction 150 through the resistances 114 and 115 respectively. The junction 150 is connected to positive battery source 116. All of the spade electrodes 31', 32', 33', 34', 35', 36', 37', 38', 39', and 40' are connected to the positive battery source 117 through individual resistances. To simplify the drawing, only one such resistance 151 is shown connecting spade electrode 31' to the battery source 117. All of the odd numbered switching electrodes 21', 23', 25', 27', and 29' are connected to a common junction point 148 and likewise all of the even numbered switching electrodes 22',

24', 26', 28', and 30' are connected to a common junction point 149. The common junction points 148 and 149 are coupled through capacitances 124 and 125 respectively to a common junction point 152 which is connected to the external pulse source 135.

The junction point 146 associated with the odd numbered target electrodes is connected to the junction point 148 associated with the odd numbered switching electrodes through a circuit consisting of the parallel resistance 118 and capacitor 122. In the same manner the junction point 147 associated with the even numbered target electrodes is connected to the junction point 149 associated with the even numbered switching electrodes through a circuit consisting of the parallel capacitor 123 and resistor 119.

It is to be noted that the junction points 146 and 147 which are common to odd numbered target electrodes and the even numbered target electrodes respectively have potential levels thereon which cause the switching electrodes to assume potentials adapted to cause the electron beam to step from one target electrode to the adjacent target electrode upon the coincidence of the electron beam impinging upon a target electrode and the application of a negative pulse to the junction 152 from input pulse source 135. An inspection of Fig. 5 will show that junction points 146 and 147 represent common taps on a number of voltage divider circuits. For example, the resistance 104 and the resistance 114 form a series circuit between target electrode 11' and battery source 116 with the junction point 146 located therebetween. A second circuit for the battery source 116 may be traced from the battery source 116 through the resistance 114, resistance 118, junction point 148, and resistance 120 to ground. In the absence of an electron beam no current will flow through the resistance 104 and only a small proportion of the voltage of source 116 will be developed across the resistance 114 since the combined resistances 118 and 120 is very high in comparison with resistance 114. Thus, the potential of the junction point 146 will be only slightly less than the potential of the battery source 116. This voltage is impressed across the voltage dividing network comprising resistance 118 and resistance 120 and is adapted to establish a potential at junction point 148 which, by itself, is of too high a magnitude to effect gating and cause the electron beam of the tube to advance when a pulse is transmitted from the input pulse source 135.

If, however, the electron beam is impinging on one of the odd numbered target electrodes such as target electrode 11' there will be a current flow from battery source 116 through resistance 114 and resistance 104 to the target electrode 11' which will lower the potential of junction 146 and therefore, also lower the potential of junction 148 to a value which will cause the electron beam to step from the odd numbered target electrode 11' to the even numbered target electrode 12' in response to an input pulse applied to junction 152 from the input pulse source 135. As in the case of the circuit of Fig. 2, the odd numbered switching electrodes and the even numbered switching electrodes of Fig. 5 are individually arranged in alternate manner around the cathode 41' so that every other control grid electrode will be at a low potential when the electron beam is impinging upon a particular target electrode and the remainder of the control grid electrodes will be at a high potential.

Referring now to Fig. 6, there is shown an equivalent of the circuit of Fig. 5. Those elements corresponding to elements of the circuit of Fig. 5 have the same identifying reference characters. It is to be noted that the equivalent circuit of Fig. 6 includes only that portion associated with target electrode 11'. In other words the circuit shown in Fig. 6 is the circuit that would be presented to an electron beam impinging upon the target electrode 11'. Inasmuch as the resistances 105 through 113 end in open circuits at their respective associate target electrodes

they do not constitute an active part of the equivalent circuit and consequently are not included therein.

In the preferred embodiment of the invention shown in Fig. 5 there are many different suitable sets of potential values. The following values of potentials have been selected as one typical set:

$$E_T = 250 \text{ volts}$$

where  $E_T$  is the potential of battery source 116 of Fig. 5;

$$E_S = 100 \text{ volts}$$

where  $E_S$  is the potential of battery source 117 of Fig. 5;

$$V_T = 60 \text{ volts}$$

where  $V_T$  is the potential of a target electrode when the electron beam is impinging thereon;

$$V_o = 100 \text{ volts}$$

where  $V_o$  is the potential of either the junction 146 or 147 when the electron beam is impinging on an associated target electrode.

By means of well known mathematical analysis methods it can be established that:

$$R = \frac{E_T - V_T}{I}$$

where  $I$  is the value of the current flowing through the particular target electrode upon which the electron beam is impinging and where  $R$  is the impedance presented to the electron beam as it impinges upon a target electrode;

and

$$R_2 = \frac{V}{1 + V} R$$

where  $R_2$  is any of the resistances 104 through 113 of Fig. 5;

where

$$V = \frac{V_o - V_T}{E_T - V_o}$$

in which  $V$  is an abbreviation for the expression to which it is equal;

and where

$$R_1 = R - R_2$$

where  $R_1$  is resistance 114 or 115 of Fig. 5.

From these equations it can be determined that for the potential values set forth above  $R_1 = 5600$  ohms and  $R_2 = 22,000$  ohms.

The voltage of the switching electrodes associated with the set of target electrodes upon which the electron beam is impinging is 20 volts. The potential of the switching electrodes associated with the set of target electrodes upon which the electron beam is not impinging is 50 volts. These two potentials are determined by the values of resistances 118, 120, 119, and 121 which have values of 1,000,000 ohms, 270,000 ohms, 1,000,000 ohms, and 270,000 ohms respectively.

In one preferred embodiment of the invention shown in Fig. 5 there can be utilized the following circuit constants. Resistance 151 has a value of 100,000 ohms, resistances 114 and 115 have values of 22,000 ohms, resistances 104 through 113 have values of 5600 ohms, capacitors 122 and 123 have values of 100 micromicrofarads, and capacitors 124 and 125 have values of 470 micromicrofarads respectively.

Referring now to Fig. 7 there is shown an embodiment of the invention wherein vacuum tubes 176 and 175 are utilized as feedback circuit means to establish the potentials of the odd numbered and even numbered groups of control grid electrodes from the common junction points 74 and 82 in lieu of the resistive voltage divider circuits as hereinbefore utilized. Many portions of the circuit of Fig. 7 are the same as the corresponding portions of the circuit of Fig. 2, and therefore have been given the same reference characters. The vacuum tube 175 com-

prises an anode 185, a grid 186 and a cathode 187. The vacuum tube 176 comprises an anode 177, a grid 178 and a cathode 179. The grid 178 of tube 176 is connected directly to the common junction point 74 and is connected to the input pulse source 184 through the series decoupling diode 181. The cathode 179 is connected to a 260 volt potential source 195 in order to provide cutoff bias for the grid 178.

It will be observed that since tubes 175 and 176 function to invert a signal impressed upon the respective grids 186 and 178 thereof, it is necessary to have the signal from the common junction point 74 associated with the odd numbered target electrodes impressed upon the grid 178 of tube 176, the anode 177 of which is connected through capacitor 183 to the even numbered switching electrodes, which are normally maintained at about +25 volt by the potential source 196. Similarly, the junction point 82 which is associated with the even numbered target electrodes is connected to the grid 186 of tube 175, the anode 185 of which is connected to the normally positive odd numbered switching electrodes through capacitor 191. Thus, when the electron beam is impinging upon an odd numbered target electrode the potential of junction point 74 is decreased, thus decreasing the potential of the grid 178 of tube 176 to assure that it remains cut off by the bias source 195. There is therefore no signal transmitted from its anode 177 through capacitor 183 to the even numbered switching electrodes. Thus, the switching electrodes are maintained at a normally positive potential of about 25 volts by the source 196 until such time as the conductive state of tube 176 changes. Even in the presence of a positive input pulse from source 184 the grid 176 cannot be brought above cutoff because of the simultaneously present negative target feedback potential. This is a desired result since the even numbered switching electrodes should be at a potential relative to the odd numbered switching electrodes when the electron beam is impinging on an odd numbered target electrode. However, under these same conditions the potentials of the junction point 82 associated with the even numbered target electrodes is higher than that of junction point 74 associated with the odd numbered target electrodes since the electron beam is not impinging on the even numbered target electrodes. Consequently, the potential of the grid 186 of tube 175 is higher than that of the grid 178 of the tube 176. This will cause the tube 175 to conduct in the presence of a positive pulse from source 184, and therefore will cause the odd numbered switching electrodes to assume a lower potential because of coupling through capacitor 191. Thus, when a positive input pulse is applied to the grids 186 and 178 from input pulse source 184, the odd numbered control grid electrodes will be lowered to the electron beam switching potential whereas the even numbered control grid electrodes will be maintained at their normal positive potential and thereby cannot effect beam switching. The battery source 189 supplies plate potential to the plates 185 and 177 of the tubes 175 and 176 respectively through the plate resistances 188 and 180. The input pulse source 184 is connected by disconnect diodes 190 and 181 to the grids 186 and 178 of the respective tubes 175 and 176.

In Fig. 8 is schematically represented a further embodiment of the invention incorporating features of the circuits of Figs. 5 and 7. Accordingly, like reference characters are used to permit comparison of similar features, and primed reference characters are used to indicate features which have been modified. The circuit parameters are included on the drawing in order to facilitate duplication of this circuit by those skilled in the art.

The circuit of Fig. 8 shows the manner in which individual output signals may be taken from each target electrode. Thus, terminals  $T_0$ ,  $T_1$ , etc., may be used for coupling output signals to external circuits. Across each target output terminal is a neon lamp which is used for visually indicating the condition of the counter.

The coupling tube circuits have been modified in the form of single shot oscillators for producing a standard output signal to drive the switching electrodes. In this manner the input pulse need only be sufficient to trigger the oscillator and therefore there are less critical pulse width tolerances necessary for providing an advance of the beam from one target position to the next adjacent position. The optimum switching pulse for advancing the beam is obtained therefore in response to input signals at the tubes 175' or 176'. An external input signal is derived from an external input source at terminal 200, and is capacitively coupled by devices 124 and 125 to the respective input terminals of tubes 175' and 176'. These tubes operate in the well known manner of one-shot oscillators, to produce an output signal developed respectively across the resistive impedance devices 180' and 188' and to thereby become impressed upon the plurality of switching electrodes in the even and odd sets schematically represented at  $G_E$  and  $G_O$  respectively.

In order for the blocking oscillator tubes 175' and 176' to conduct and overcome the -15 volt bias potential, two coincident signals are required at the respective input electrodes 186 or 178. One of these signals hereinbefore described, is obtained at terminal 200 from an external source and the other of the signals is derived internally as developed across the respective target load impedance 114 or 115 in response to beam current. The common target terminals 146 and 147 are decoupled from the external signal source by means of diodes 246 and 247.

Referring again to Fig. 2 the operation thereof will be described in detail. Assume that an electron beam originating at the cathode 41' is impinging upon the target electrode 11'. Assume further that it is desired to advance the electron two steps to target electrode 13'. To do this the electron beam is first advanced to the target electrode 12' which is next adjacent the target electrode 11'. The electron beam is then advanced to the target electrode 13' which is next adjacent the target electrode 12'. When the electron beam is impinging on the target electrode 11' the potential  $V_g$  of the junction 92 is 21 volts and the potential of the odd numbered switching electrodes which are connected to the junction 92 is also 21 volts. The potential  $V_g$  of the junction point 84 and the even numbered switching electrodes is 53 volts since the electron beam is not impinging upon any of the even numbered target electrodes. The potential threshold of a switching electrode which will cause the electron beam to advance from one target electrode to the next adjacent target electrode is at about -10 volts. The potentials of both junction point 92 and 84 in the absence of a pulse from input pulse source 78 are above this threshold value and consequently will not cause the electron beam to advance. Assume that a negative 35 volt pulse is transmitted from the input pulse source 78 to the junction point 76. Since the junction point 76 is coupled to the junctions 92 and 84 through capacitors 75 and 79 respectively, the potential of the junctions 92 and 84 will be momentarily lowered by an amount substantially equal to the value of the input pulse from input pulse source 78. Since the value of this input pulse is a negative 35 volts the potential at junction 92 will be -14 volts and the potential at junction 84 will be +18 volts. It is to be noted that the potential of junction 92 which is connected to the odd numbered switching electrodes is below the -10 volt threshold potential whereas the potential of junction 149 which is connected to the even numbered switching electrodes is above the -10 volt threshold potential.

It is to be noted at this time that it is possible to advance the electron beam in a tube of the type shown in Fig. 1 by lowering the potential of all the switching electrodes simultaneously for a duration of time shorter than the time required for the electron beam to advance from a given target electrode to the next adjacent target electrode. If the potential of all the switching electrodes were



lowered to switching potential for a greater period of time than the time required to switch the electron beam from one target electrode to an adjacent target electrode the electron beam would continue to rotate beyond the said adjacent target electrode. Consequently, it can be seen that if the potential of all the control grid electrodes were lowered to switching potential the time interval of such lowered potentials must not be greater than the electron beam switching time interval.

In the circuit of Fig. 2 the electron beam switches from target electrode 11' to target electrode 12' the even numbered target electrodes will initially be at a potential higher than the potential required to cause the electron beam to advance since the electron beam current will have no substantial immediate effect on the potential of the target electrode 12' due to the inherent capacitance in the circuit. Consequently, the electron beam will initially be unable to advance farther than the target electrode 12'. However, the electron beam current will, in a short interval of time, cause the potential of the target electrode 12' to decrease and thus cause the potential of the point 84 to decrease to a point where, when added to the decrease in potential of the junction point 84 caused by a subsequent pulse from the input pulse source 78, the electron beam will be caused to advance to the target electrode 13'.

It is to be specifically noted that since it takes a finite amount of time for the electron beam to lower the potential of the junction 84 to a value where an input pulse from source 78 would cause the electron beam to switch from the target electrode 12' to the target electrode 13' the maximum time duration permissible for an input pulse at junction 84 is greater by that aforesaid finite time than the otherwise maximum allowable time interval. Consequently, the input pulse requirements are not so highly critical that it is difficult to operate equipment in the manner described. This is an important feature of the invention since it permits greater reliability and less original cost in pulse forming equipment.

Now that one pulse of the proper time duration and amplitude has been applied to the junction 76 from pulse source 78 the electron beam is impinging on target electrode 12'. As stated hereinbefore the odd numbered target electrodes are at the high potential and the even numbered target electrodes are at the low potential. Consequently, when another input pulse is applied to the junction 76 from pulse source 78, the even numbered switching electrodes will be lowered below the threshold value to cause the electron beam to advance to the next adjacent target electrode 13' in the same manner. Subsequently pulses from the source 78 will cause the electron beam to advance from one target electrode to another in like manner.

Referring now to Fig. 5 the detailed operation of the embodiment of the invention shown therein will be described. Assume that the electron beam is impinging on the first target electrode 11' and assume further that it is desired to advance the electron beam to the third target electrode 13'. When the electron beam is impinging on the target electrode 11' the electron beam current path can be traced from the cathode 41' to the target electrode 11'; through the resistance 104 and the resistance 114 to the battery source 116. As described hereinbefore the junction point 146 is then at a potential of 100 volts and the junction point 147 is at a potential of about 250 volts. The odd numbered switching electrodes which are connected to the junction 148 are also at a potential of 20 volts. The even numbered switching electrodes are at a potential of 50 volts. When a negative 35 volt pulse is applied to the junction 152 from the input pulse source 135, the junction points 148 and 149 will be lowered by an amount substantially equal to the value of the negative input pulse from input source 135. This will lower the potential of junction 149 and therefore that of the even numbered switching electrodes will be about 15 volts which is above the threshold value necessary to cause the

electron beam to step from one target electrode to an adjacent target electrode. The negative input pulse from source 135 will lower the potential of junction 148 to -15 volts which is below the threshold value and consequently will cause the electron beam to advance from the target electrode 11' to the target electrode 12'. As in the case of Fig. 2 the pulse from pulse source 135 must be within definite width and amplitude ranges in order to prevent the electron beam from continuing to advance beyond the target electrode 12'. This range depends upon the characteristics of the switching tube used and may easily be found by varying the width of the input pulse to determine the best operating range. When the electron beam is impinging on the target electrode 12' and after the cessation of the first input pulse from input pulse source 135, the even numbered switching electrodes are at a potential of 20 volts and the potential of the odd numbered control grid electrodes is 50 volts. Both of these potentials are above the threshold potential and consequently the electron beam will not be caused to advance. A second pulse applied to the junction 152 from pulse source 135 will cause the electron beam to advance from the target electrode 12' to the target electrode 13'. This will result in the even numbered switching electrodes having a potential of 50 volts and the odd numbered switching electrodes having a potential of 20 volts. Subsequent pulses applied to the junction 152 will cause the electron beam to advance consecutively from target electrode to target electrode.

Referring now to Fig. 7, the operation of the circuit shown therein will be described. Assume that electron beam is impinging on the target electrode 11'. The potential of the junction point 74 at this time is at low potential, and likewise the potential of the grid 178 of triode 176. The normally cutoff plate 177 of the triode 176 which is connected to the even numbered control grid electrodes remains at a fixed high potential due to the cutoff and does not provide a signal through capacitor 183 for overcoming the beam switching threshold potential even when a positive pulse arrives from source 184. The potential of the junction 82 is high however since the electron beam is not impinging on an even numbered target electrode. The potential of the grid 186 of the triode 175 which is connected to the junction 82 is therefore also high so that a positive input pulse causes the triode to conduct. The changing potential of the plate 185 of the triode 175 is therefore transmitted to the odd numbered switching electrodes because of capacitor 191, and consequently, the threshold switching potential is reached. It is to be noted that when the potential of the odd numbered switching electrodes is lowered, that of the even numbered switching electrodes remains fixed at a value substantially greater than the threshold potential because triode 176 remains cut off. As the potential of the odd numbered switching electrodes is driven below the threshold value, the electron beam will be caused to advance from the odd numbered target electrode 11' to the even numbered target electrode 12'. The potential of the even numbered switching electrodes, it will be noted, is more positive than the threshold potential and consequently the electron beam will not be caused to advance until a succeeding input pulse comes from source 184.

When the electron beam is impinging on the even numbered target electrode 12' the grid 186 of triode 175 is at a low potential and the grid 178 of triode 176 is at a high potential. Thus, the triodes 175 and 176 respectively are at high and low potential for operation conversely to the manner described hereinbefore. Subsequent pulses impressed upon the grids 186 and 178 of triodes 175 and 176 respectively will cause the electron beam to advance consecutively from target electrode to target electrode.

In Fig. 8 the pulse shaping single shot oscillator circuits operate similarly. However, less critical operation is obtained because the feed-back pulses together with the input pulses, need only trigger the oscillator, which there-

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after ascertains a positive switching action with a standardized pulse.

It is to be understood that the forms of the invention shown herein are but preferred embodiments of the same and that various changes may be made in the circuit constants and circuit arrangements without departing from the spirit or scope of the invention.

What is claimed is:

1. An electronic system comprising a multi-position magnetron beam switching tube having a beam forming structure, the tube having a plurality of beam receiving targets to accept the beam in any of its positions, a target impedance device coupled to each of said beam receiving targets, the tube further having switching means to cause the beam to advance from one target position to another, potential dividing means coupled to derive a first gating potential from an electrode upon which the beam is impinging, an external source providing a second gating potential, and a potential divider circuit operating the switching means to cause the beam to switch from one target position to another only in response to both said gating potentials, wherein the tube has two alternate sets of switching elements and two corresponding sets of targets, and the potential divider circuit comprises an impedance dividing network coupling individual target impedance devices of one set of targets to a common input impedance element for one set of switching electrodes.

2. A system as defined in claim 1 wherein the tube has two alternate sets of switching elements and two corresponding sets of targets, and wherein a target potential source is supplied, and an impedance network is provided including a first impedance element providing a main beam current path from target potential source to each set of targets, a separate impedance element for each target coupled to said first impedance element, the voltage dividing network being coupled from said first impedance element, and including an input impedance element for one set of switching electrodes, and connections between the input impedance element and one set of switching elements.

3. A system as defined in claim 2 wherein an amplifier device couples the voltage dividing network to the input impedance element.

4. A system as defined in claim 3 wherein the amplifier device is in the form of a one-shot oscillator tube providing a shaped output pulse.

5. An electronic system comprising a multi-position electron beam switching tube, said multi-position electron beam switching tube comprising an elongated cathode and a plurality of compartments arranged concentrically around said elongated cathode, said plurality of compartments comprising a set of even numbered electrodes and a set of odd numbered electrodes, each of said compartments defined by two adjacent elongated spade electrodes, one of the spades being adapted to cause the beam to impinge upon an associated elongated target electrode, and an elongated switching electrode adapted to cause the beam to move to the other of the spades, the plurality of elongated spade electrodes being positioned concentrically around said cathode and spaced a distance apart from each other, the plurality of target electrodes being positioned concentrically around said plurality of spade electrodes and spaced apart from each other and between two adjacent spade electrodes so that one each of said target electrodes will intercept a path from said cathode, the plurality of switching electrodes being positioned concentrically around said cathode and further individually positioned between individual ones of said plurality of target electrodes and the other of said spade electrodes, means to create a magnetic field substantially parallel to the cathode, means comprising a source adapted to apply a potential on said spade electrodes, a target potential source, a plurality of target impedance means individually connecting each of the odd target electrodes to said target potential source, a junction point upon the target im-

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pedance means, a feedback circuit connecting said junction point to the odd numbered switching electrodes, a further plurality target impedance means individually connecting each of said even target electrodes to said target potential source, a common junction point upon each of the further target impedance means, a further feedback circuit connecting the last mentioned junction point to the even numbered switching electrodes, and an input pulse source common to all of said switching electrodes.

6. In an electronic system comprising a multiple position electron beam position switching tube having a cathode, a plurality of target electrodes, a plurality of beam locking spade electrodes each being individually associated with a target electrode, and a plurality of switching electrodes each being associated with a particular target electrode and adapted to cause the beam to step to a further target electrode, a circuit for causing the electron beam of said multiple position electron beam position switching tube to step consecutively along its multiple positions comprising in combination, a power supply, a circuit coupling the target and switching electrodes into two distinct sets, each set comprising alternate electrodes, a plurality of impedance elements individually connecting each of the target electrodes of a first set of targets to said power supply, each of said impedance elements having a junction point, a further impedance element connecting the switching electrodes associated with the first set of targets to said junction point, a second plurality of impedance elements individually connecting each of the target electrodes in the other set to the power supply, each of said further impedance elements having a junction point, impedance elements connecting the switching electrodes associated with the targets in the other set to the last mentioned junction point, and an input pulse source common to all the switching electrodes.

7. An electronic system comprising a multiple position electron beam switching tube and first means for causing the electron beam of the multiple position electron beam to step consecutively from position to position of its multiple positions, said multiple position electron beam switching tube comprising an elongated cathode means, a first plurality of beam receiving compartments and a second plurality of beam receiving compartments, said first and second pluralities of compartments being arranged concentrically in a single circular row around said elongated cathode means, each of said compartments of said first plurality of compartments being arranged in alternate manner in said circular row with each of the compartments of said second plurality of compartments, each of said compartments further being determinative of one position of the multiple positions of the electron beam of the multiple position electron beam switching tube, each of said compartments comprising an elongated target electrode, an elongated spade electrode, and an elongated switching electrode positioned substantially parallel to the said elongated cathode means, means adapted to create a magnetic field substantially parallel to the said elongated cathode means, said first means comprising first potential means adapted to impress a potential on said spade electrodes, second potential means, a first plurality of resistive circuits individually connecting each of the target electrodes in said first plurality of compartments to said second potential means, a second plurality of resistive circuits individually connecting each of the target electrodes in said second plurality of compartments to the said second potential means, a first junction point common to all of the said first plurality of resistive circuits, a second junction point common to all of said second plurality of resistive circuits, circuit means connecting all of the switching electrodes of the said first plurality of compartments to the said first junction point, a further circuit means connecting all of the switching electrodes of the said second plurality of compartments to the second junction point, an input pulse source, means to couple said input pulse source to the switching electrodes of

said first plurality of compartments, further means to couple said input pulse source to the switching electrodes of said second plurality of compartments, the resistive circuits having such values that the potential of said first or second junction point upon the coincidence of the electron beam impinging upon an associated target electrode and the transmission of an input pulse from the said input pulse source change the potentials of the associated switching electrodes enough to cause the electron beam to advance.

8. An electronic system comprising a multiple position electron beam switching tube and a means for causing the electron beam of said multiple position electron beam switching tube to step consecutively from position to position of its multiple positions, said multiple position electron beam tube comprising an elongated cathode, a first plurality of beam receiving compartments, a second plurality of beam receiving compartments, said first and second plurality of compartments being arranged with individual compartments alternately disposed in a single circular row around said elongated cathode means, each of said compartments comprising an elongated target electrode, an elongated spade electrode, and an elongated switching electrode, means to provide a magnetic field substantially parallel to the said elongated cathode, said means for causing the beam to step comprising potential means, a first plurality of resistive circuits each individually connecting individual ones of the target electrodes of the said first plurality of compartments to the positive terminal of the potential means, a second plurality of resistive circuits each individually connecting individual ones of the target electrodes of the said second plurality of anode means to the positive terminal of said potential means, a first junction point common to all of the said first plurality of resistive circuit means, a second junction point common to all of the said second plurality of resistive circuit means, a third resistive circuit connecting the said first common junction point to the switching electrodes of the said first plurality of compartments, a fourth resistive circuit connecting the said second common junction to the switching electrodes of the said second plurality of compartments, an input pulse source comprising an output terminal, a first coupling means coupling the output terminal of the said input pulse source to the switching electrodes of the said first plurality of compartments, a second coupling means coupling the output terminal of the said input pulse source to the switching electrodes of the said second plurality of compartments, the values of said potential source and the said first and second resistive circuits being such that the switching electrodes associated with the plurality of compartments upon one of which is impinging the electron beam will be at a potential which in cooperation with a pulse transmitted from the said input pulse source will cause the electron beam to advance to the next adjacent compartment, and the values of said potential source and the said first and second resistive circuits further being such that the switching electrode associated with the plurality of compartments upon which the electron beam is not impinging will be at such a potential that a pulse transmitted from the said input pulse source will not thereby lower the potential enough to cause an impinging electron beam to advance.

9. An electronic system comprising a multiple position electron beam switching tube and means for causing the electron beam of said multi-position electron beam switching tube to step consecutively from one of its multiple positions to another, said multiple position electron beam switching tube comprising an elongated cathode, a first plurality of odd numbered beam receiving compartments, and a second plurality of even numbered beam receiving compartments, said first and second pluralities of compartments having individual compartments arranged in alternation concentrically around said elongated

gated cathode, each of said compartments comprising an elongated spade electrode, an elongated target electrode, and an elongated switching electrode, the spade electrodes of the said first and second pluralities of compartments being arranged concentrically around the said elongated cathode and spaced a distance apart, the target electrodes of said first and second pluralities of compartments being positioned concentrically around said elongated cathode and further being positioned in such a manner that each individual one of said target electrodes will intercept any portion of the electron beam passing through individual ones of the spacings between adjacent spade electrodes, the switching electrodes of each of said pluralities of anode means being positioned concentrically around said elongated cathode in such a manner that each individual one of said switching electrodes is positioned between a spade electrode and a target electrode, said means for causing the beam to step comprising a potential source, a first junction point, a first plurality of resistive means connecting individual ones of said target electrodes of said first plurality of compartments to said first junction point, a second plurality of resistive means, one each of said second plurality of resistive means connecting individual ones of the target electrodes of the said first plurality of compartments to a said potential source, a second junction point, a third plurality of resistive means, one each of said third plurality of resistive means connecting individual ones of the target electrodes of the said second plurality of compartments to the said second junction point, a fourth plurality of resistive means, one each of said fourth plurality of resistive means connecting individual ones of said target electrodes of the said second plurality of compartments to said potential source, a first voltage divider network connecting the said first junction point to said potential source, said first voltage divider network comprising a first tap, the switching electrodes of said first plurality of compartments being connected to said first tap, a second voltage divider network connecting said second junction point to said potential source, said second voltage divider network comprising a second tap, the switching electrodes of said second plurality of anode means being connected to the said second tap, an input source common to both said first tap and said second tap, the values of said potential source, said resistive means, and said voltage divider networks being proportioned to cause the potential of the switching electrodes of that one of said first or second pluralities of compartments upon one compartment of which the electron beam is impinging to assume a potential which when a pulse is transmitted from the said input pulse source will cause the electron beam to advance to the next adjacent compartment.

10. An electronic system comprising a multiple position electron beam switching tube and a first means for causing the electron beam to advance from position to position of its multiple positions, said multiple position electron beam switching tube comprising an elongated cathode means, a first plurality of anode means, and a second plurality of anode means, said first and second pluralities of anode means being arranged in alternate manner concentrically around the said elongated cathode means, each of the said anode means comprising an elongated spade electrode, and an elongated target electrode, and an elongated control grid electrode, the spade electrode of said first and second pluralities of anode means being arranged concentrically around said elongated cathode means and spaced a distance apart, said target electrodes of said first and second anode means being positioned concentrically around said elongated spade electrode in such a manner that each individual one of said elongated target electrodes is positioned across the individual spacings between adjacent one of said elongated spade electrodes, said control grid electrodes being arranged concentrically around elongated cathode means and individually positioned one each between the target

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electrode of the same anode means and the edge of the spade electrode of the next adjacent anode means, and a second means adapted to create a magnetic field substantially parallel to the said elongated cathode means, said first means comprising a first junction point, a first plurality of resistive means each individually connecting one of the target electrodes of the said first plurality of anode means to the said first junction point, a second junction point, a second plurality of resistive means, each individually connecting one of the target electrodes of the said second plurality of anode means to the said second junction point, a potential source, a third resistive means connecting the said first junction point to a first terminal of said potential source, a fourth resistive means connecting the said second junction point to the first terminal of the said potential source, a first voltage divider means having a first tap therein connecting the said first junction point to the second terminal of the said potential source, the tap of said first voltage divider being connected to the control grid electrodes of the first plurality of anode means, a second voltage divider means comprising a second tap therein connecting the said second junction point to the second terminal of the said potential source, said second tap being connected to the control grid electrodes of the said second plurality of anode means, an input pulse source comprising an output terminal common to both the said first tap and the said second tap, the values of the potential source, the said resistive means, and the said voltage divider means being such that the control grid electrodes of the first or second plurality of anode means upon one of which the electron beam is impinging will have a potential such as to cause the electron beam to advance to the next adjacent anode means when a pulse is transmitted from the said input pulse source.

11. An electronic system comprising a multiple position electron beam switching tube and a first means for causing the electron beam to advance from position to position of its multiple positions, said multiple beam position switching tube comprising an elongated cathode means, a first plurality of anode means, and a second plurality of anode means, said first and second pluralities of anode means being arranged in alternate manner concentrically around the said elongated cathode means, each of the said anode means comprising an elongated spade electrode, an elongated target electrode, and an elongated control grid electrode, said spade electrodes of said first and second pluralities of anode means being arranged concentrically around said elongated cathode means and spaced a distance apart, said target electrodes of said first and second pluralities of anode means being arranged concentrically around said spade electrodes and individually positioned to extend across individual spacings between adjacent pairs of spade electrodes with respect to said elongated cathode means, said control grid electrodes of said first and second pluralities of anode means being arranged concentrically around said elongated cathode means and being individually positioned between the edge of a spade electrode of a particular anode means and the target electrode of the anode means preceding said particular anode means, and a second means to provide a magnetic field substantially parallel to the said elongated cathode means, said first means comprising a potential source, a first resistive network connecting the target electrodes of the said first plurality of anode means to the said potential source, a first feedback circuit connecting the said first resistive network to the said control grid electrodes of the said first plurality of anode means, a second resistive network connecting the target electrodes of the said second plurality of anode means to the said potential source, a second feedback circuit connecting the said second resistive network to the control grid electrodes of the said second plurality of anode means, an input pulse source common to all of the control grid electrodes of the first plurality of anode

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means when the electron beam is impinging on one of said first plurality of anode means being such that when a pulse is transmitted from the said input pulse source the electron beam will be caused to advance to the next anode means of the said second plurality of anode means, and the potential of the control grid electrodes of the said second plurality of anode means when the electron beam is impinging on one of said second plurality of anode means being such that when a pulse is transmitted from the said input pulse source, the electron beam will be caused to advance to next anode means of the said first plurality of anode means.

12. An electronic system comprising a multiple position electron beam switching tube and a first means for causing the electron beam to advance from position to position of its multiple positions, said multiple beam position switching tube comprising an elongated cathode means, a first plurality of anode means, and a second plurality of anode means, said first and second pluralities of anode means being arranged in alternate manner concentrically around the said elongated cathode means, each of the said anode means comprising an elongated spade electrode, an elongated target electrode, and an elongated control grid electrode, said spade electrodes of said first and second pluralities of anode means being arranged concentrically around said elongated cathode means and spaced a distance apart, said target electrodes of said first and second pluralities of anode means being arranged concentrically around said spade electrodes and individually positioned to extend across individual spacings between adjacent pairs of spade electrodes with respect to said elongated cathode means, said control grid electrodes of said first and second pluralities of anode means being arranged concentrically around said elongated cathode means and being individually positioned between the edge of a spade electrode of a particular anode means and the target electrode of the anode means preceding said particular anode means, and a second means to provide a magnetic field substantially parallel to the said elongated cathode means, said first means comprising a first resistive feedback circuit connecting all of the target electrodes of the said first plurality of anode means to the control grid electrodes of the said first plurality of anode means, a second resistive feedback circuit connecting all of the target electrodes of said second plurality of anode means to the control grid electrodes of the said second plurality of anode means, a potential source adapted to energize the said target electrodes of the said first and second pluralities of anode means, said potential source being connected to said target electrodes through at last a portion of said first and second resistive means, an input pulse source common to all the control grid electrodes, the potential of said control grid electrodes of said first plurality of anode means when the electron beam is impinging upon one of the target electrodes of said first plurality of target electrodes being such that when a pulse is transmitted from the said input pulse source the electron beam will be caused to advance to the next appearing target electrode of the said second plurality of anode means in the circular row of target electrodes, and the potential of said control grid electrodes of said second plurality of anode means when the electron beam is impinging upon one of the target electrodes of said second plurality of target electrodes, being such that when a pulse is transmitted from the said input pulse source the electron beam will be caused to advance to the next appearing target electrode of the said first plurality of anode means in the circular row of target electrodes.

13. An electronic system comprising a multiple position electron beam switching tube and a first means for causing the electron beam to advance from position to position of its multiple positions, said multiple beam position switching tube comprising an elongated cathode means, a first plurality of anode means, and a second

plurality of anode means, said first and second pluralities of anode means being arranged in alternate manner concentrically around the said elongated cathode means, each of the said anode means comprising an elongated spade electrode, an elongated target electrode, and an elongated control grid electrode, said spade electrodes of said first and second pluralities of anode means being arranged concentrically around said elongated cathode means and spaced a distance apart, said target electrodes of said first and second pluralities of anode means being arranged concentrically around said spade electrodes and individually positioned to extend across individual spacings between adjacent pairs of spade electrodes with respect to said elongated cathode means, said control grid electrodes of said first and second pluralities of anode means being arranged concentrically around said elongated cathode means and being individually positioned between the edge of a spade electrode of a particular anode means and the target electrode of the anode means preceding said particular anode means, and a second means to provide a magnetic field substantially parallel to the said elongated cathode means, said first means comprising a potential source, a first resistive network connecting the target electrodes of the said first plurality of anode means to the said potential source, a second resistive network connecting the target electrodes of the said second plurality of anode means to the said potential source, a first feedback circuit connecting one of said resistive networks to the control grid electrodes of said first plurality of anode means, a second feedback circuit connecting the other of said resistive networks to the control grid electrodes of the second plurality of anode means, an input pulse source common to both the control grid electrodes of said feedback circuits adapted to create a potential on the control grid electrodes of said first plurality of anode means when the electron beam is impinging upon a target electrode thereof which in cooperation with a pulse from said input pulse source will cause the electron beam to advance to the next adjacent target electrode and adapted to create a second potential on the control grid electrodes of the said second plurality of anode means when the electron beam is impinging on a target electrode of said first plurality of anode means which when a pulse is transmitted from the said input pulse source will not tend to cause the electron beam to advance, said feedback circuits further adapted to create said potential on the control grid electrodes of the said second plurality of anode means when the electron beam is impinging on a target electrode thereof, which when a pulse is transmitted from the input pulse source will cause the electron beam to advance to the next adjacent target electrode, and said feedback circuits further adapted to create a potential on the control grid electrodes of the said first plurality of anode means when the electron beam impinges on a target electrode of said second plurality of anode which when a pulse is transmitted from the input pulse source, will not tend to cause the electron beam to advance.

14. An electronic system comprising a multiple position electron beam switching tube and a first means for causing the electron beam to advance consecutively from position to position of its multiple positions, said multiple beam position switching tube comprising an elongated cathode means, a first plurality of anode means, and a second plurality of anode means, said first and second pluralities of anode means being arranged in alternate manner concentrically around the said elongated cathode means, each of the said anode means comprising an elongated spade electrode, an elongated target electrode, and an elongated control grid electrode, said spade electrodes of said first and second pluralities of anode means being arranged concentrically around said elongated cathode means and spaced a distance apart, said target electrodes of said first and second pluralities of anode means being arranged concentrically around said spade electrodes and

individually positioned to extend across individual spacings between adjacent pairs of spade electrodes with respect to said elongated cathode means, said control grid electrodes of said first and second pluralities of anode means being arranged concentrically around said elongated cathode means and being individually positioned between the edge of a spade electrode of a particular anode means and the target electrode of the anode means preceding said particular anode means, and a second means to provide a magnetic field substantially parallel to the said elongated cathode means, said first means comprising a potential source, a first resistive network connecting the target electrodes of said first plurality of anode means to the said potential source, a second resistive network connecting the target electrodes of said second plurality of anode means to said potential source, said first and second resistive networks each comprising a tap individual thereto, first feedback circuit connecting the tap of the said first resistive network to the control grid electrodes of said second plurality of anode means, a second feedback circuit connecting the tap of the said second resistive network to the control grid electrodes of the said first plurality of anode means, and an input pulse source common to the control grid electrodes of said first plurality of anode means and to the control grid electrodes of said second plurality of anode means, the said feedback circuits being adapted to create a potential on the control grid electrodes of said second plurality of anode means when the electron beam is impinging upon a target electrode of the said second plurality of anode means which, in cooperation with a pulse from the said input pulse source, will cause the electron beam to advance to the next adjacent target electrode and being adapted to create a potential on the control grid electrodes of said first plurality of anode means when the electron beam is impinging upon a target electrode of the said second plurality of anode means which when a pulse is transmitted from the said input pulse source, will not tend to cause the electron beam to advance, said feedback circuit means further being adapted to create a potential on the control grid electrodes of said first plurality of anode means when the electron beam is impinging upon a target electrode of the said first plurality of anode means, which in cooperation with a pulse from said input pulse source will cause the electron beam to advance to the next adjacent target electrode and being adapted to create a potential on the control grid electrodes of said second plurality of anode means when the electron beam is impinging upon a target electrode of the said first plurality of anode means, which when a pulse is transmitted from the said input pulse source, will not tend to cause the electron beam to advance.

15. An electronic system in accordance with claim 14 in which said each of said first and second feedback circuits comprises a vacuum tube circuit, said vacuum tube circuit comprising a cathode, a grid, an anode means, an anode potential source, and an anode resistance, said grid of said first feedback circuit means being connected to the tap of the resistance of said first resistive network, said anode of said first feedback circuit means being connected to the control grid electrodes of said second plurality of anode means, said grid of said second feedback means being connected to the tap of said second resistive network, said anode of said second feedback circuit means being connected to the control grid electrodes of said first plurality of anode means, said anode potential source and said anode resistance of each of said feedback circuit means being connected across said anode of cathode of the associated vacuum tubes.

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