May 21, 1957 E. SEIF 2,793,318

METHOD AND MEANS FOR SWITCHING THE ELECTRON BEAM IN MAGNETRON TYPE BEAM SWITCHING TUBES

Filed June 27, 1955

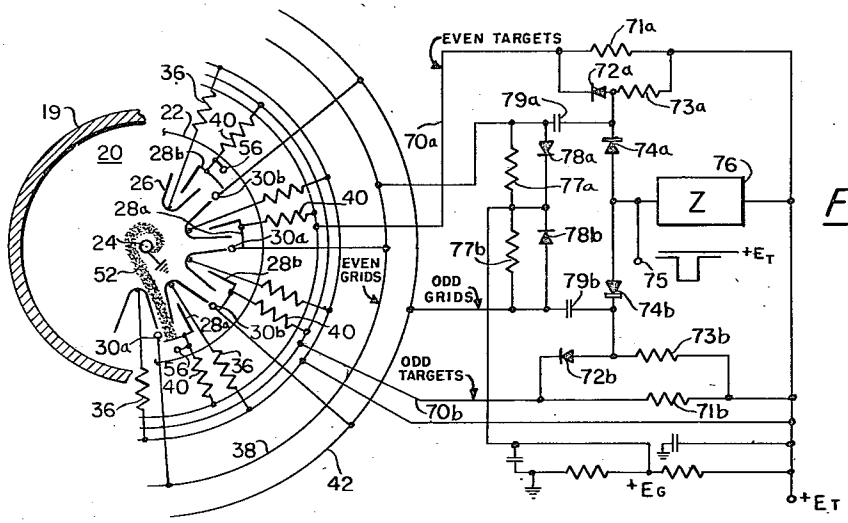


Fig. 1

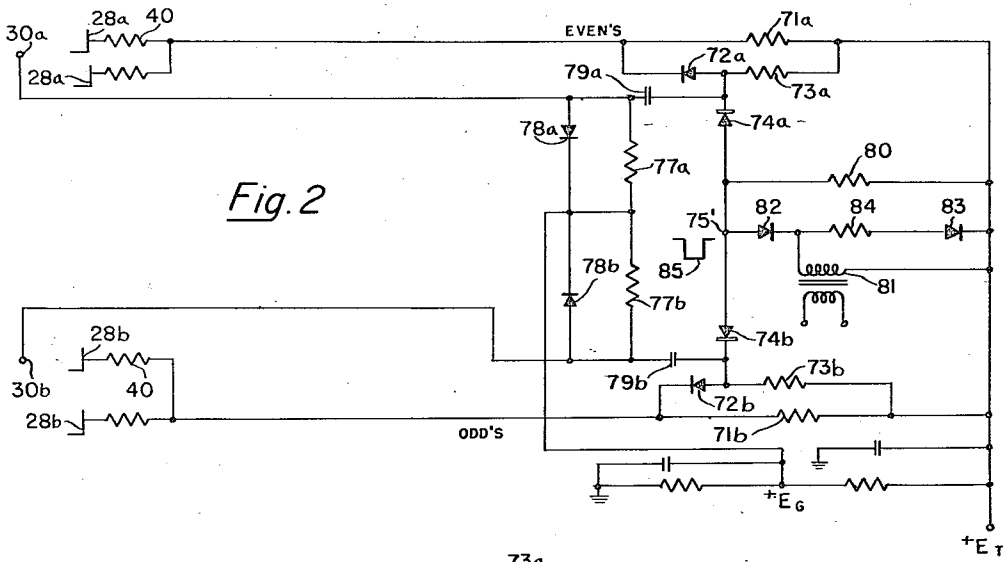


Fig. 2

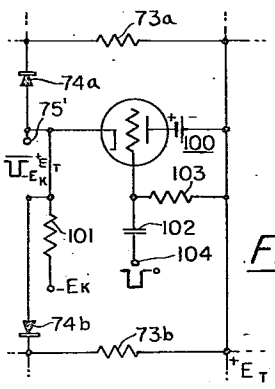


Fig. 3b

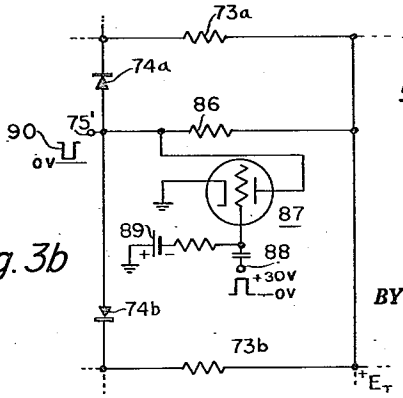


Fig. 3a

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United States Patent Office 2,793,318
Patented May 21, 1957

2,793,318

METHOD AND MEANS FOR SWITCHING THE ELECTRON BEAM IN MAGNETRON TYPE BEAM SWITCHING TUBES

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Application June 27, 1955, Serial No. 518,104

11 Claims. (Cl. 315—21)

This invention relates to magnetron type multiple position beam switching tubes and particularly to means for and a method of reliably switching the electron beam in such tubes a single beam position per input switching signal.

Magnetron type multiple position beam switching tubes make use of crossed electrostatic and magnetic fields in their operation. Usually the magnetic field is provided by a hollow cylindrical magnet whose flux permeates the tube in lines which are substantially parallel to the elongated cathode in the spade-cathode region of the tube. Tubes of this general type are disclosed and claimed in the U. S. patent of Fan and Kuchinsky No. 2,721,955, entitled Multiposition Beam Tube, and assigned to the assignee of the present application. This tube is further described in Electronic Design of January 1954 in an article titled "A New Beam Switching Tube." Such tubes have three arrays of electrodes surrounding the elongated thermionic cathode. A cylindrical array of symmetrically disposed beam forming and locking electrodes, known as spade electrodes, surrounds the cathode and is concentric with respect to it. Each spade electrode is insulated from the other spade electrodes and is usually connected to a source of potential which is positive with respect to the cathode through a spade impedance device which usually is a resistor. The spade electrodes are usually coextensive in length with the electron emissive portion of the cathode and have a curved, usually U-shaped, transverse cross-sectional configuration. The open part of the spade faces outwardly with respect to the cathode.

An array of symmetrically disposed electron receiving or target electrodes surrounds the spades and constitutes the outer array of electrodes of the tube. In most cases, the target electrodes are equal in number to the spade electrodes and each target is aligned with the space between two adjacent spades whereby electrons which pass through the space may impinge on the target electrode which is associated therewith. Usually each target electrode, like each spade, is connected to a source of potential which is positive with respect to the cathode through an impedance member which is usually a resistor. The output signal from each target electrode then may be developed across its target impedance member.

The third array of electrodes comprises a plurality of rodlike beam switching electrodes which are equal in number to the number of spades. Normally, each of the switching electrodes is disposed between an edge of a spade and an adjacent target. The beam switching electrodes are normally maintained at a positive potential, and this potential is reduced to enable the switching electrode to change the beam from a locked-in position at one spade to a locked-in position on the next adjacent spade.

When all of the spades are at the potential of the spade power supply, the relationship between the electrostatic and magnetic fields is such that electrons emitted from the cathode follow curved paths around the cathode and substantially no electrons impinge on the spades or other electrodes of the tube. If, however, the potential on

only one of the spades is lowered to, or near to, the potential of the cathode, the configuration of the electrostatic field is changed, especially in the vicinity of the spade having the lowered potential, and a stream or beam of electrons is formed between the cathode and the opening between the two spades at different potentials to impinge partially upon the leading edge of that spade with the reduced potential. The edge of the spade to which the beam is attracted is determined by the direction of rotation of the electrons within the tube (which is determined by the polarity of the magnetic field which permeates the tube). The electron beam locks in at the edge of the spade which is furthest in the direction from which the electrons have come, i. e., furthest "upstream" in the electron flow, and this edge is called the "leading" edge. The opposite edge of the spade is the lagging edge. The electrons impinging on the leading edge of the spade cause electron flow through the spade impedance and, if the spade resistor value is properly chosen, the electron flow therethrough maintains the reduced potential of the spade sufficiently to lock in the beam even though the external means for reducing the potential of the spade be removed. However, if the switching electrode or grid upstream from where the beam is locked in has its potential reduced, the electron beam which is locked on the earlier described spade (and which also impinges on the target electrode associated with that spade) changes its shape. If the reduction in potential on the switching electrode is sufficient, the beam will spread as the electrons flow from cathode to target to the extent that part of the electrons of the beam impinge on the adjacent spade with which the switching electrode is associated, causing a voltage drop on that adjacent spade. Because of the tendency of the electron flow to be curved by the magnetic field as previously mentioned, the beam then switches to this adjacent spade which has a lowered potential and which is further upstream along the electron beam. It should be noted that the direction of rotation of the beam also is in the upstream direction, relative to electron flow from cathode to target in crossed magnetic and electric fields.

Such tubes find considerable use in counters, as distributors, and generally as high-speed, multiple-position switches. A problem in reliability arises in the very speed and ease with which the switching electrodes or grids can spread the beam and cause it to switch when their potential is reduced. Unless precautions are taken, the beam will switch more than one position around the tube.

One way to achieve single-step switching is to connect all switching grids in a common circuit and drive them with negative pulses which are closely controlled as to amplitude and duration. If the pulse is below minimums for width and amplitude, the beam will not switch at all. If the amplitude is adequate, then the pulse width must be more than the minimum but less than the time required for more than one step of beam switching. If the reduced potential were held on all grids for a comparatively long time, the beam would step rapidly from one position to the next. The time per step is limited mostly by the RC time constants of the electrodes and associated circuitry, and is about 0.1 microseconds per step. It can be appreciated that the generation of precise, 0.1 microsecond pulses requires fairly complex and expensive equipment.

Another way to provide reliable single-step switching is to connect alternate grids in common connections, i. e., one connection including all odd grids and another connection including all even grids, and to drive these two connections with an alternating voltage or waveforms derived from opposite sides of a flip-flop circuit. In this way, the grids are driven in a push-pull manner, and the

next grid beyond the grid which is intended to switch the beam always will have such a polarity voltage applied that it will inhibit more than the desired single switching step. Circuitry for this balanced or push-pull drive is less critical in the waveform requirements than that for single-ended switching on all grids, but has limitations such as encountered in variable frequency counters, where the design of the push-pull drive circuitry which operates over a large frequency range is critical and expensive. As a result hybrid circuits have been developed for producing, with internal feedback, the gating of unipolar pulses to alternate sets of switching electrodes, such as disclosed and claimed in the copending U. S. application filed by George G. Hoberg on September 13, 1954, for Beam Tube Switching Circuits, S. N. 455,546, and assigned to the assignee of the present application. However, these prior art techniques required large amplitude switching signals. In addition, where variable scale counters are used for a reset to zero after an odd count, the push-pull drive may result in a switching signal on the wrong set of grids for a succeeding step, resulting in an erroneous count. This means that preset circuitry is necessary for operation in response to zero set and external switching signals to assure proper variable scale counting operation. In such operation the count is slowed down by the necessity of presetting the counter.

Therefore, a principal object of this invention is to provide an improved method of and means for controlling the electron beam in a magnetron beam switching tube.

Another object of this invention is a provide an economical and reliable means for switching the beam a single step from a unipolar pulse switching signal.

A further object of this invention is to provide a simple and rapid variable scale counter system utilizing a magnetron beam switching tube with unipolar pulses for switching the beam, a single step without external preset.

In accordance with an embodiment of this invention, a magnetron beam switching tube has a first group of alternate switching grids, hereafter referred to as the even grids, connected together, and a second group of alternate switching grids, hereafter referred to as the odd grids, connected together. A first impedance network is connected to the target electrodes associated with the even grids, called the even targets, and provides a common connection in the beam current path from a positive voltage supply to each of the even target. A second impedance network is connected to the other target electrodes, associated with the odd grids and called the odd targets, and provides a common connection in the beam current path from a positive voltage supply to the odd targets. A diode circuit is coupled with each of these common connections, to their respective switching grids, and to a common input circuit for switching signals, so that when the beam is held upon some particular target, beam curent flows in a forward direction through the associated diode circuit. This current injects current carriers into the crystalline structure of a diode in the current carrying diode circuit. The other diode circuit also has a crystalline-structure diode but is not receiving beam current and hence does not store current carriers until the beam is switched to a targe whose beam current path includes this other diode circuit. When a voltage pulse sufficient to cut off the diode circuits is applied to the input circuit, it encounters a high impedance in the diode circuit not conducting current, but finds a momentarily low impedance in the crystal diode in which beam current has injected current carriers. These current carriers allow the pulse to pass and to be applied to the associated switching grids, causing the beam to advance one step. The high back impedance on the other diode circuit isolates the switching signal from the next switching grid, so only this single step occurs. As soon as these current carriers are swept out, this crystal diode also presents a high back impedance to the pulse input circuit so that all switching grids are isolated from further voltage changes. In this manner the crystal diode is utilized as an amplifier device in the manner described and claimed in the copending U. S. application, S. N. 488,292, filed February 15, 1955, for Diode Amplifier by W. Ogletree and assigned to the assignee of the present application.

This invention, as well as additional objects and advantages, will be apparent from the following description when read in connection with the accompanying drawing, in which:

Fig. 1 is a diagrammatic view of a magnetron beam switching tube with a generalized schematic circuit embodying the invention;

Fig. 2 is a schematic view of a magnetron beam switching tube and an associated specific circuit embodying the invention; and

Figs. 3*a* and 3*b* are simplified schematic diagrams of specific circuit embodiments of this invention.

Referring to Fig. 1, there is shown in partial section view to simplify the presentation, a magnetron beam switching tube **20** having an envelope **22** and a centrally disposed elongated rod-like thermionic cathode **24**, which is surrounded by an array of elongated spade electrodes **26**, having a generally U-shaped cross sectional configuration. An array of elongated target electrodes **28** having an L-shaped cross-sectional configuration surrounds the array of spade electrodes **26**. The target electrodes **28** are equal in number to the spade electrodes, **26**, and each target electrode **28** is disposed in alignment with the space between two adjacent spades. An array of rod-like switching grid electrodes **30** is disposed between the array of spade electrodes **26** and the array of target electrodes **28**, each of the switching grids being generally aligned with respect to an edge of a spade electrode. About the envelope **22** is a magnet **19** which causes a field, parallel with the cathode **24**, to permeate the tube.

In the circuit which is shown in Fig. 1 each of the spades **26** is connected to a source of positive potential $+E_t$. The spade resistors **36** may, if desired, be included within the tube envelope. Arranging the spade resistors **36** within the envelope results in a reduction of the stray capacitance of the tube and furthermore permits a reduction in the number of leads to be brought out to the base pins of the tube. Tubes which are designed for operation at high beam switching rates often have internal spade or target resistors, or both. The ohmic value of each of the spade resistors **36** is usually substantially the same, and is high enough that the voltage drop due to beam current passing therethrough reduces the potential on the spade on which the beam impinges to, or near to, the potential of the cathode **24** to thereby hold the beam in a stable locked-in position. Each target electrode **28** is connected to the positive potential terminal $+E_t$ through individual target impedance elements **40** which are illustrated as being resistors. The output signal from each beam position is developed across its target resistor and is taken from the output terminal **56** of the beam position. The spade impedances may include elements other than resistors, but always include a resistance element which provides the direct current voltage drop across the impedance which is required to maintain the spade at a lowered potential upon impingement of the beam and to lock in the electron beam at a particular spade.

Alternate ones of the switching elements or grids **30** are connected to two common leads **38** and **42**. The common lead **42** is connected to the arbitrarily designated odd grids, and is coupled to a positive potential terminal $+E_g$ by the resistor **77***b*. Likewise the common lead **38** is connected to the even grids and is coupled to the $+E_g$ terminal by resistor **77***a*.

Advancement of the electron beam from one beam position to another adjacent beam position is accomplished by applying a negative pulse to the input terminal

75 which is coupled to both the common leads 38 and 42, by respective diodes 74*a* and 74*b*. The input pulse potential may be developed across the impedance element 76 coupling input terminal 75 to the $+E_t$ terminal.

It is desirable to bias the switching grids 30 to the positive potential at terminal $+E_g$, which is chosen of such value that the beam remains in a position upon any target and adjacent holding spade without spreading to the advanced spade. While the actual switching grid pulse voltage required to reliably switch the electron beam by spreading the beam to the leading spade may vary because of tube, magnetic field, or circuit considerations, pulses of 40 volts negative amplitude are average, but switching with smaller pulses is possible and has been successfully accomplished. A negative pulse of 40 volts amplitude, for example, applied to the switching grids 30 would cause the electron beam 52 to fan out from the spade upon which the electron beam is locked in. As a result of the fanning out of the electron beam adjacent to the edge of the spade 26 on which the beam is locked in, part of the beam impinges on the next adjacent or "advanced" spade which lies in the direction of the rotation of the beam. When part of the electron beam 52 impinges on the advance spade the potential of that spade is dropped to, or near to the potential of the cathode due to the beam current producing a potential drop across the spade load resistor and the electron beam then transfers (or switches) and locks in on the "advanced" spade. Since the time required for the beam to switch from one beam position to another may vary in accordance with tube geometry and circuit parameters, the duration of the 40 volts negative switching pulse must be controlled accordingly with close limits if coupled to all the grids 30 simultaneously. Thus, negative pulses of longer duration would result in the beam switching more than one beam position.

However in accordance with the embodiment of the invention shown in Fig. 1, even targets 28*a* have their resistors 40 in a common connection 70*a* to resistors 71*a* and voltage supply $+E_t$. Another beam current path is from connection 70*a* through diodes 72*a* and resistor 73*a* for current from voltage supply $+E_t$. Still another beam current path is through diode 72*a* as before, but then through diode 74*a* and impedance element 76. Impedance element 76 has a low resistance to direct current and a high reactance to alternating or pulse current or voltage. A choke coil would be a typical element 76. Because impedance element 76 is of low ohmic resistance to direct current, the last mentioned path carries much of the beam current from supply $+E_t$ to target when the beam is on an even target. Diode 74*a* is a type of crystal diode in which current carrier storage takes place, such as IN91 germanium junction diode, and this beam current stores current carriers therein. Similarly, odd targets 28*b* are connected through resistors 40 to common connection 70*b* and have three beam current paths from voltage supply $+E_t$. The path for most beam current, when the beam is on an odd target, is through impedance element 76, diode 74*b* and diode 72*b*. Diode 74*b* also is a crystal diode capable of current carrier storage, such as an IN91. Beam current from supply $+E_t$ to an odd target will store current carriers in diode 74*b*. Even numbered switching grids 30*a* are coupled to the junction of diodes 72*a* and 74*a*, and resistor 73*a*, through capacitor 79*a*. Grids 30*a* are additionally connected to bias voltage $+E_g$ through resistor 77*a*, shunted by diode 78*a*. Similar connections are made from the odd grids 30*b*, to the junction of diodes 72*b*, 74*b* and resistor 73*b* through capacitor 79*b*; and thus the odd grids 30*b* are connected to bias voltage $+E_g$ through resistor 77*b* shunted by diode 78*b*.

The circuit of Fig. 1 operates as follows: presume an even target 28*a* is receiving the beam diodes 72*a* and 74*a* will be conducting; no current flows through diodes 72*b* and 74*b*. A negative trigger pulse is applied to input terminal 75 and results in a negative-going leading edge, which is applied to the anodes of diodes 74*a* and 74*b*. This pulse is of sufficient amplitude to cut off both diodes 74*a* and 72*a*. However, diode 74*b* is not conducting substantially. When the beam current which had been flowing through diode 74*a* is interrupted, the current carriers it has stored will cause reverse current to flow through diode 74*a* and develop a large negative voltage pulse across resistor 73*a*. This voltage is coupled through capacitor 79*a* to the even grids 30*a*. Since diode 74*b* has not been conducting it will present a high impedance to the negative-going pulse, no current will flow through it, and negligible signal voltage will be developed across resistor 73*b*. The negative pulse applied to even grids 30*a* causes the beam to advance to the next, odd position in the tube. Resistors 71*a* and 71*b* are comparatively low in ohmic value, about 3,000 ohms each, so the transfer of the beam from even to odd target electrodes does not produce enough signal at the grids to cause unwanted switching.

Conversely, with the beam on an odd target 28*b*, beam current will flow through diode 74*b* and the odd branch will respond to the next pulse from a pulse generator connected to terminal 75, resulting in a negative pulse on the odd grids 30*b*, causing the beam to advance one switching step. As with the even branch, the negative-going pulse cuts off both conducting diodes 72*b* and 74*b* in the branch carrying beam current.

Thus, when either diode 72*a* or 72*b* cuts off, the associated targets 28*a* or 28*b* will have only resistors 71*a* or 71*b* conducting current to voltage supply $+E_t$. This presents a higher resistance path for beam current, resulting in a slightly lower target potential. While this effect is slight, it does assist the negative pulse upon the associated switching grids to produce a rapid and reliable stepping of the beam. It is a characteristic of magnetron beam switching tubes that, for a given spade voltage, switching of the beam can be achieved by adequately reducing either target or switching grid voltage, or both.

Accordingly, it is seen that diodes 74*a* and 74*b* function to direct the switching pulses from terminal 75 to the appropriate set of odd or even switching grids of tube 20. Not only do these diodes 74*a* and 74*b* direct the energy of switching pulses in the appropriate direction, but they perform this function with a net power gain. Because of this power gain, such circuits are properly considered as "Diode Amplifiers." The physical principles underlying diode amplifiers are described in detail in an article "Diode Amplifier" in National Bureau of Standards' Technical News Bulletin of October 1954, volume 38, Number 10. Briefly, this amplifying phenomenon may be visualized by examining the circuit of Fig. 1 for the even targets and grids when the beam is on an even target. Assume that a typical beam current of eight (8) milliamperes is flowing through resistor 40, and that about five (5) milliamperes of this current is flowing through diode 74*a* and impedance element 76, from voltage terminal $+E_t$. From conventional considerations of passive circuit elements and network theory, one would expect that the current developed by the negative switching pulse on terminal 75 would cut off diode 74*a* when this pulse current reached a peak value of five (5) milliamperes. Due to current carrier storage, however, it is found that cut-off does not occur until peak current from this switching pulse reaches about ten times the five milliamperes of beam current, or fifty milliamperes. Accordingly the IR voltage drop which pulse current produces across resistor 73*a* is about ten times what would be developed by beam current from target 28*a*. This diode amplification insures positive stepping of the beam a single step due to the vigorous pulse applied to the appropriate grid. The lack of beam current in the alternate branch insures that the full diode back impedance is presented to the switching pulse and thus pulse current is blocked from the other set of grids so that no unwanted

stepping will occur beyond the desired single step. Even after the beam steps to the odd targets as long as the switching pulse is present, it prevents current through diode 74*b*. Thus a high-speed, reliable beam switching circuit is provided for operation from unipolar or single-ended pulses at input terminal 75 at frequencies from 0 to more than 100,000 cycles per second.

As shown in Fig. 2 circuit elements embodied in one form of impedance 76 are utilized to provide the direct current path for beam current and to provide a pulse input to the junction of diodes 74*a* and 74*b*. In Fig. 2*a*, resistor 80 provides a direct current path from supply $+E_t$ to the junction point 75'. Pulse transformer 81 receives the incoming switching pulses. The secondary winding of transformer 81 is in series with isolation diode 82. Diode 82 is polarized to pass only negative-going pulses to diodes 74*a* and 74*b* and to thereby block beam current flow. The secondary winding of pulse transformer 81 is shunted by diode 83 and resistor 84, with diode 83 polarized to conduct for positive voltage at the transformer terminal connected to diode 82. This shunting circuit is to prevent "ringing" of transformer 81, i. e. to prevent oscillation or overshoot of an applied pulse, so the pulse 85 upon application to input terminal 75' at the junction of diodes 74*a* and 74*b* is a negative-going pulse as shown. As previously described, only that diode carrying beam current will allow a reverse current to pass and build up a switching voltage on the associated switching electrodes.

While reliable operation can be achieved over a range of values for circuit components, a typical set of circuit values used in connection with a type 6700 (MBS–MO–10) marketed by Haydu Brothers, Plainfield, N. J., and the embodiment of Fig. 2 where the impedance 76 is a transformer and associated elements is: resistors 40=5,600 ohms, resistors 71*a* and 71*b*=2,700 ohms, resistors 73*a* and 73*b*=15,000 ohms, resistors 77*a* and 77*b*=100,000 ohms, coupling capacitors 79*a* and 79*b*=1,000 M. M. F., with $+E_t$=75 volts and $+E_g$=15 volts on a divider from $+E_t$. Spade resistors 36 are 180,000 ohms. Load resistor 80 is 1,000 ohms, damping resistor 84 is 2,700 ohms and transformer 81 has a 3:1 step down ratio with a ferric core and 150 turns in the primary. This circuit operates successfully with a 60 volt input trigger signal at terminal 75'.

In Fig. 3*a*, resistor 86 provides the direct current path from supply $+E_t$ to diodes 74*a* and 74*b*. Vacuum tube 87 has its anode connected to the input terminal 75' at the junction of diodes 74*a* and 74*b* and their connection to resistor 85. Tube 87 also has its cathode grounded, and its control grid biased to near cut-off by a battery 89 and connected to input terminal 88 for receiving positive-going switching pulses. When a positive pulse is the tube 87 becomes fully conducting, and the voltage at the junction of diodes 74*a* and 74*b* drops to a very low value, well below the potential on the other side of diodes 74*a* and 74*b*. Depending on whether an even or an odd target is conducting beam current, diode 74*a* or 74*b* will have stored current carriers and will allow this drop in potential to pass through. This negative pulse then appears on the switching grid associated with the target which is conducting beam current. As previously described this controlled direction of switching signals to only one set of grids insures that only a single beam switching step will occur.

In Fig. 3*b* vacuum tube 100 is connected between a voltage supply positive with respect to $+E_t$ and the input terminal 75' at the junction of diodes 74*a* and 74*b*, to conduct beam current. Resistor 101 connects the cathode of tube 100 to a negative voltage supply $-E_k$. Resistor 103 provides a direct current path for the control grid of tube 100 to keep the tube normally conductive and terminal 75' substantially at $+E_t$ and coupling capacitor 102 connects this control grid to a terminal 104 for receiving negative pulses. When a negative-going switching pulse is applied at terminal 104, tube 100 rises greatly in plate resistance and may even cut off. This causes the cathode of tube 100 to approach the potential $-E_k$, and this negative-going pulse is applied to the junction of diodes 74*a* and 74*b*. As described before, beam current will have stored current carriers in either diode 74*a* or 74*b*, depending on whether an even or odd target is receiving the beam. When the negative pulse is applied to the junction of diodes 74*a* and 74*b*, the stored current carriers will pass reverse current and thereby pass this negative switching pulse to the proper switching electrode for the next step.

From the above examinations of the several figures, it is seen that a variety of circuits can utilize the teachings of this invention. The essentials are, that direct current paths be provided from $+E_t$ through diodes 74*a* and 74*b* to the even and odd targets, and that a pulse input circuit be connected to apply a negative switching pulse at the junction of diodes 74*a* and 74*b*, with the appropriate switching grids coupled to the other side of diodes 74*a* and 74*b* to receive an amplifier switching pulse. Thus, a reliable beam switching circuit operable with single-ended input trigger pulses is afforded by the invention.

What is claimed is:

1. In combination, a magnetron beam switching tube comprising a central cathode, an inner circle of spade electrodes, an intermediate circle of switching electrodes aligned respectively with one side of said spade electrodes, and an outer circle of target electrodes covering the spaces between spade electrodes, a first common connection to alternate switching electrodes, a second common connection to the other switching electrodes, impedance means connecting the target electrodes and a positive voltage supply, a third common connection in the impedance means connecting together those target electrodes associated with said alternate switching electrodes, a fourth common connection in the impedance means connecting together those target electrodes associated with said other switching electrodes, a pulse input circuit including a circuit path for direct current and crystal diode circuit means operable to store current carriers, said pulse input circuit inter-connecting both of said common target connections with said circuit means to conduct beam current from said voltage supply, and a circuit connecting the pulse input circuit with both of said common switching electrode connections to apply pulses from said pulse input circuit to one of said common connections to switching electrodes only when beam current is flowing through the diode circuit means interconnecting a particular common target connection and the pulse input circuit and said current is storing current carriers therein.

2. A combination as defined in claim 1 wherein the pulse input circuit comprises a pulse transformer winding, diode and resistor circuit means shunting said transformer winding to provide negative output pulses, and additional impedance means shunting said transformer and said diode and resistor circuit means to provide a parallel direct current path therewith.

3. A combination as defined in claim 1 wherein the pulse input circuit comprises impedance means including a direct current path, an amplifier connected to said impedance means to apply pulse voltage thereto, and an input circuit to drive said amplifier with switching pulses to increase the current conduction of said amplifier.

4. A combination as defined in claim 1 wherein the pulse input circuit comprises an amplifier having at least an output and control electrode, connected to conduct beam current, and an input circuit connected to the control electrode of said amplifier to apply switching signals thereto to increase the resistance thereof.

5. Magnetron beam switching means as defined in claim 1 wherein said impedance means are resistors, said diode circuit means includes a plurality of circuits and each circuit includes a plurality of diodes one of which plurality is a crystal diode capable of carrier storage, and

including a source of unipolar switching pulses connected to said pulse input circuit.

6. Magnetron type beam switching means comprising a magnetron beam switching tube having a cathode, a plurality of spade electrodes, a plurality of switching electrodes and a plurality of target electrodes, first impedance means connecting first alternate targets to a positive voltage supply and having a first point therein common to all the first alternate targets, second impedance means connecting the other alternate targets to a positive voltage supply and having a second point therein common to all the other alternate targets, an impedance device, a pulse input circuit connected by said impedance device to said positive voltage supply, first circuit means connected to said first alternate targets and including first diode means, means commonly connecting said first diode means to said pulse input circuit and to the switching grids associated with said first alternate targets, and second circuit means connected to said second alternate targets and including second diode means, and means commonly connecting said second diode means to said pulse input circuit and to the switching grids associated with said other alternate targets, said diode means being polarized to conduct beam current and so constructed as to store current carriers therein when beam current flows.

7. A beam switching circuit for a magnetron beam switching tube having a cathode, spades, switching grids and targets, a source of positive voltage, said switching circuit comprising a resistance network connecting said targets to said source of positive voltage, a network connecting said switching grids in two sets of alternate grids, means biasing the switching grids to such value that the beam remains in position upon any target without spreading, a first crystal-diode connecting to a point in said resistance network common to a first set of alternate targets corresponding to one set of alternate grids and coupled to the set of alternate switching grids associated with said first set of atlernate targets, a second crystal-diode connecting to a point in said resistance network common to the other set of alternate targets and coupled to the other set of alternate switching grids, and a two terminal pulse input circuit including a direct current path and connecting to both said diodes at one terminal and to said source of positive voltage at the other terminal, said crystal diodes being polarized to conduct beam current and so constructed as to store current carriers when beam current flows.

8. In combination, a magnetron beam switching tube having a cathode, spades, targets and switching grids, a switching circuit responsive to unipolar pulses and comprising resistors connected one to each of said targets, a first common connection of all resistors connected to a first set of alternate targets, a second common connection of all resistors connected to the second set of alternate targets, crystal diodes connected to said common connections to conduct electron beam current from said targets to a common point and to store current carriers when said electron beam current flows, an impedance element connecting said common point to a source of positive voltage to conduct electron beam current, a third common connection of all switching grids associated with said first set of alternate targets, coupling means connecting said third and said first common connections, a fourth common connection of all switching grids associated with said second set of alternate targets, coupling means connecting said second and fourth common connections, and a resistive network connecting said switching grids to a source of positive bias voltage.

9. Magnetron type beam switching means comprising a magnetron beam switching tube having an axial cathode, a plurality of beam controlling spade electrodes arranged along the path of electron beam current from said cathode in a position most proximate to said cathode along said path, a plurality of target electrodes positioned along the path of electron beam current more remotely from said cathode, a plurality of switching electrodes in a position along said beam current path intermediate between said spade electrodes and said target electrodes, first impedance means for connecting a first set of alternate targets to a positive voltage supply and having a first common point therein, second impedance means for connecting the other set of alternate targets to a positive voltage supply and having a second common point therein, a pulse input circuit connected to a positive voltage supply and including a direct current path, first crystal diode circuit means connected to said first common point and to said pulse input circuit and coupled to the switching grids associated with said first set of alternate targets, second crystal diode circuit means connected to said second common point and to said pulse input circuit and coupled to the switching grids associated with said other set of alternate targets, said crystal diode circuit means being polarized to conduct beam current and to store current carriers therein when beam current flows, and a source of switching pulses connected to said pulse input circuit.

10. In a beam switching system which includes a magnetron beam switching tube, having a cathode, a plurality of spade electrodes, a plurality of switching electrodes and a plurality of beam receiving electrodes, the combination comprising first resistive means connecting at least one beam receiving electrode to a positive voltage supply, a diode and second resistive means connecting to an intermediate point of said first resistive means and to said positive voltage supply to conduct beam current, a pulse input circuit including a direct current path therethrough and connected to said positive voltage supply, a crystal diode connecting between said diode and said input circuit to conduct beam current and to store current carriers, coupling means connecting the switching electrode associated with said beam receiving electrode to the junction between said diode and crystal diode, and third resistive means connecting said switching electrode to a source of positive bias voltage.

11. In combination, a magnetron beam switching tube comprising a central cathode, an inner circle of spade electrodes, an intermediate circle of switching electrodes aligned respectively with one side of said spade electrodes, and an outer circle of target electrodes covering the spaces between spade electrodes, a first common connection to one group of periodically disposed switching electrodes, a second common connection to another group of periodically disposed switching electrodes, impedance means connecting the target electrodes and the spade electrodes and a positive voltage supply, a third common connection in the impedance means connecting together one group of those electrodes associated with said one group of switching electrodes, a fourth common connection in the impedance means connecting together another group of those electrodes associated with said another group of switching electrodes, a pulse input circuit including a circuit path for direct current and unidirectionally conductive circuit means operable to store current carriers, said pulse input circuit inter-connecting both of said common electrode group connections with said circuit means to conduct beam current from said voltage supply, and a circuit connecting the pulse input circuit with both of said common switching electrode connections to apply pulses from said pulse input circuit to one of said common connections to switching electrodes only when beam current is flowing through the unidirectionally conductive circuit means inter-connecting a particular common electrode group connection and the pulse input circuit and said current is storing current carriers therein.

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