March 18, 1947. R. W. SEARS 2,417,450

ELECTRON DISCHARGE DEVICE

Filed May 2, 1945 2 Sheets-Sheet 1

FIG. 1.

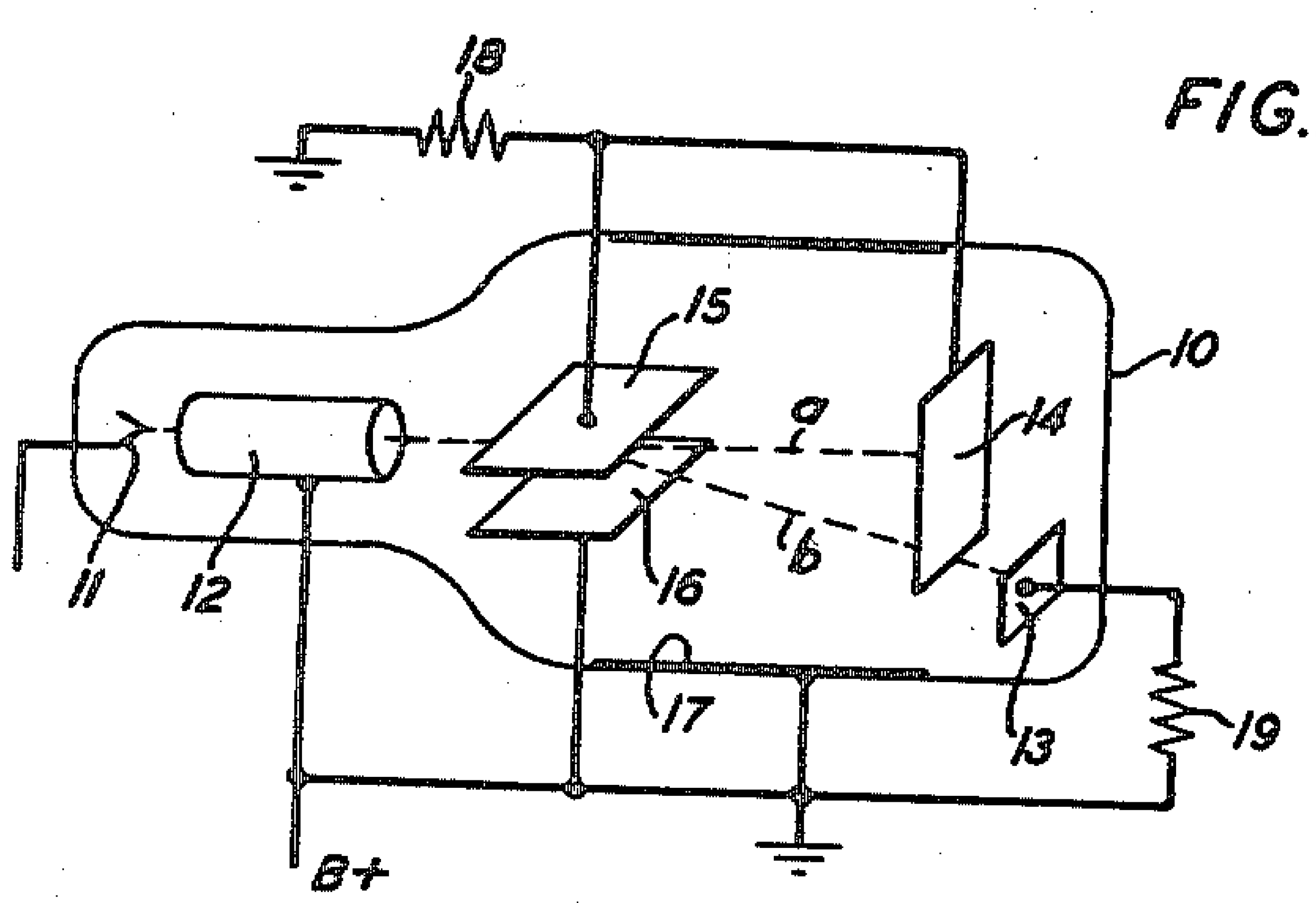

FIG. 2.

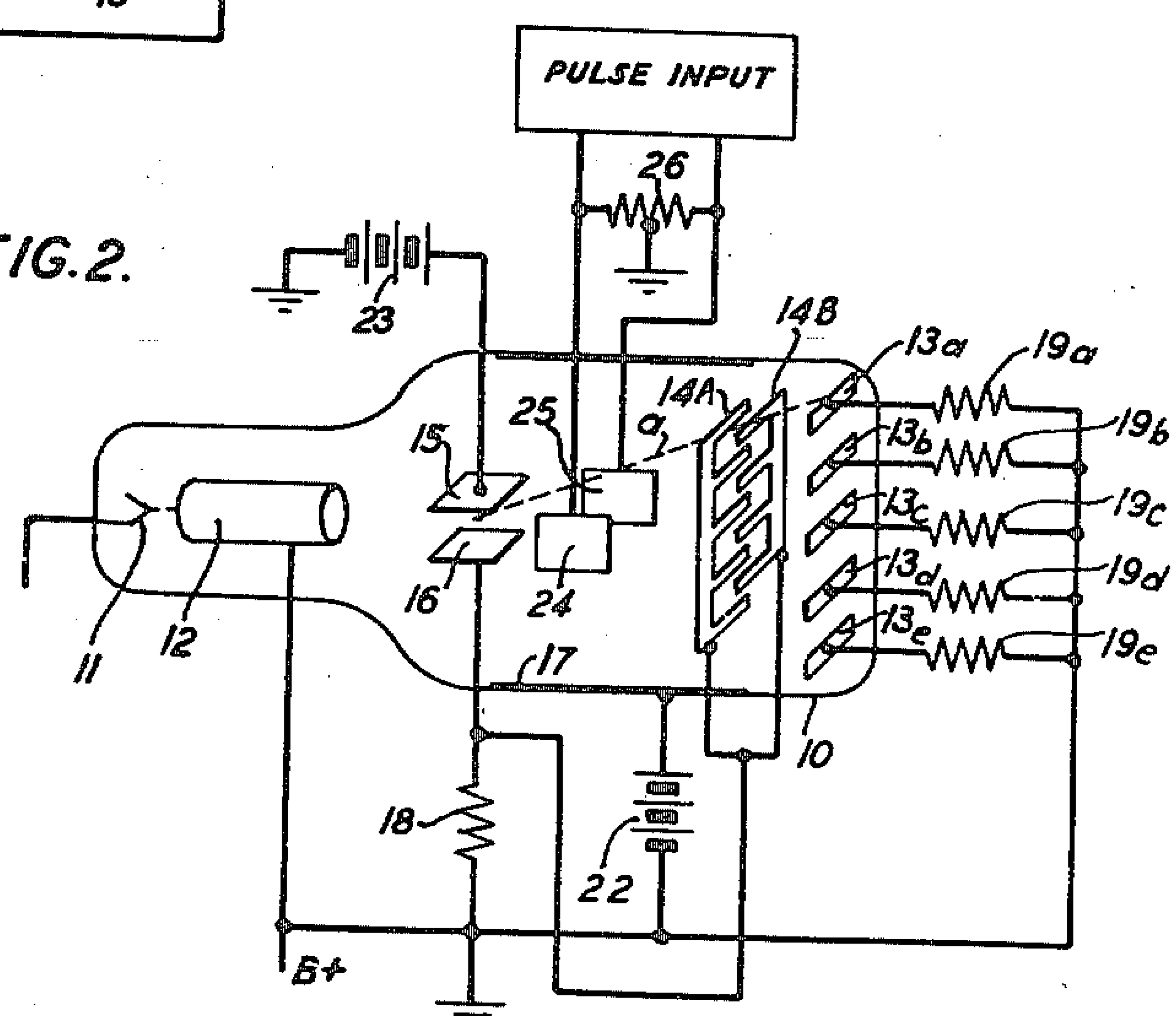

FIG. 3.

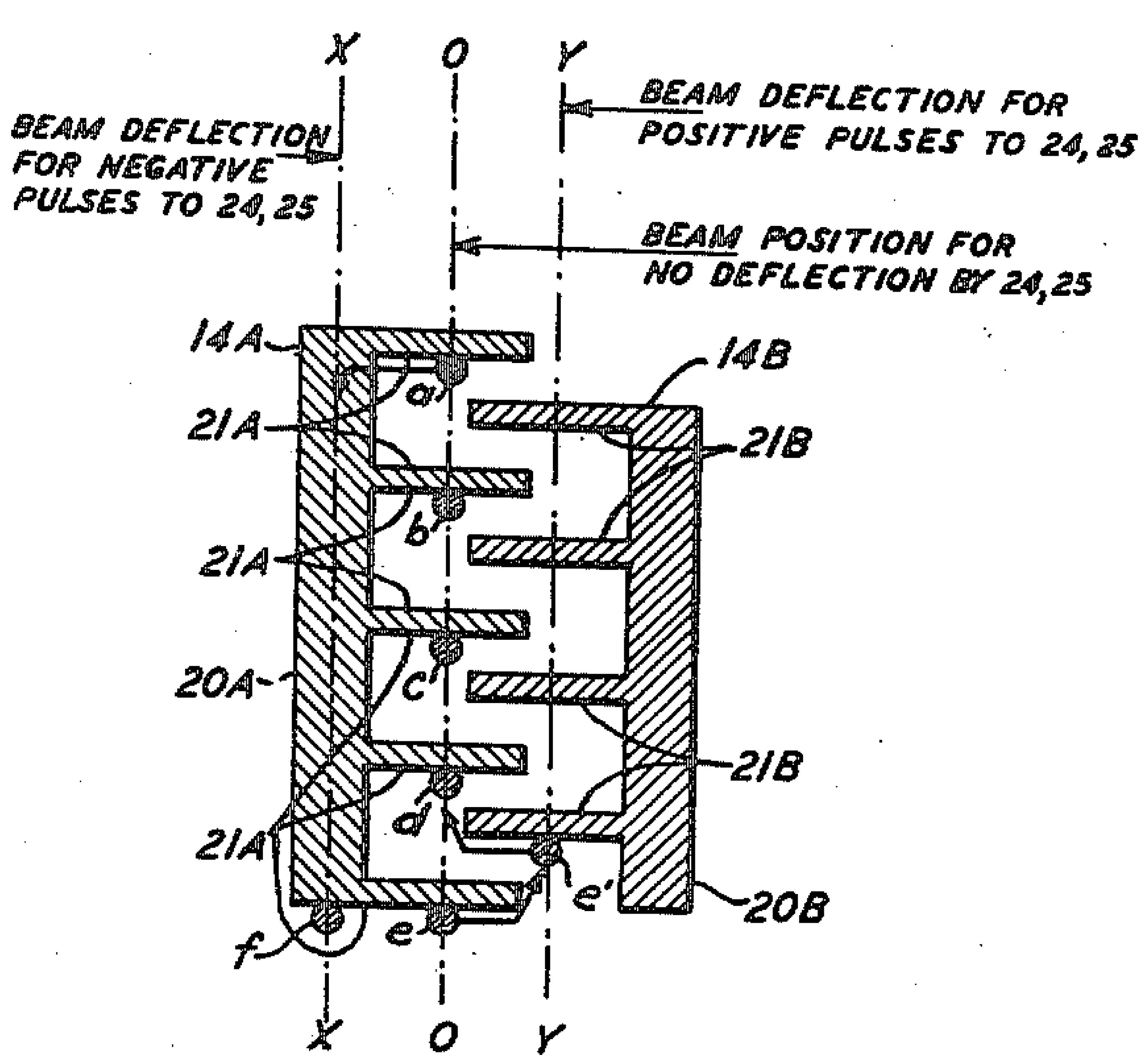

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FIG. 4.

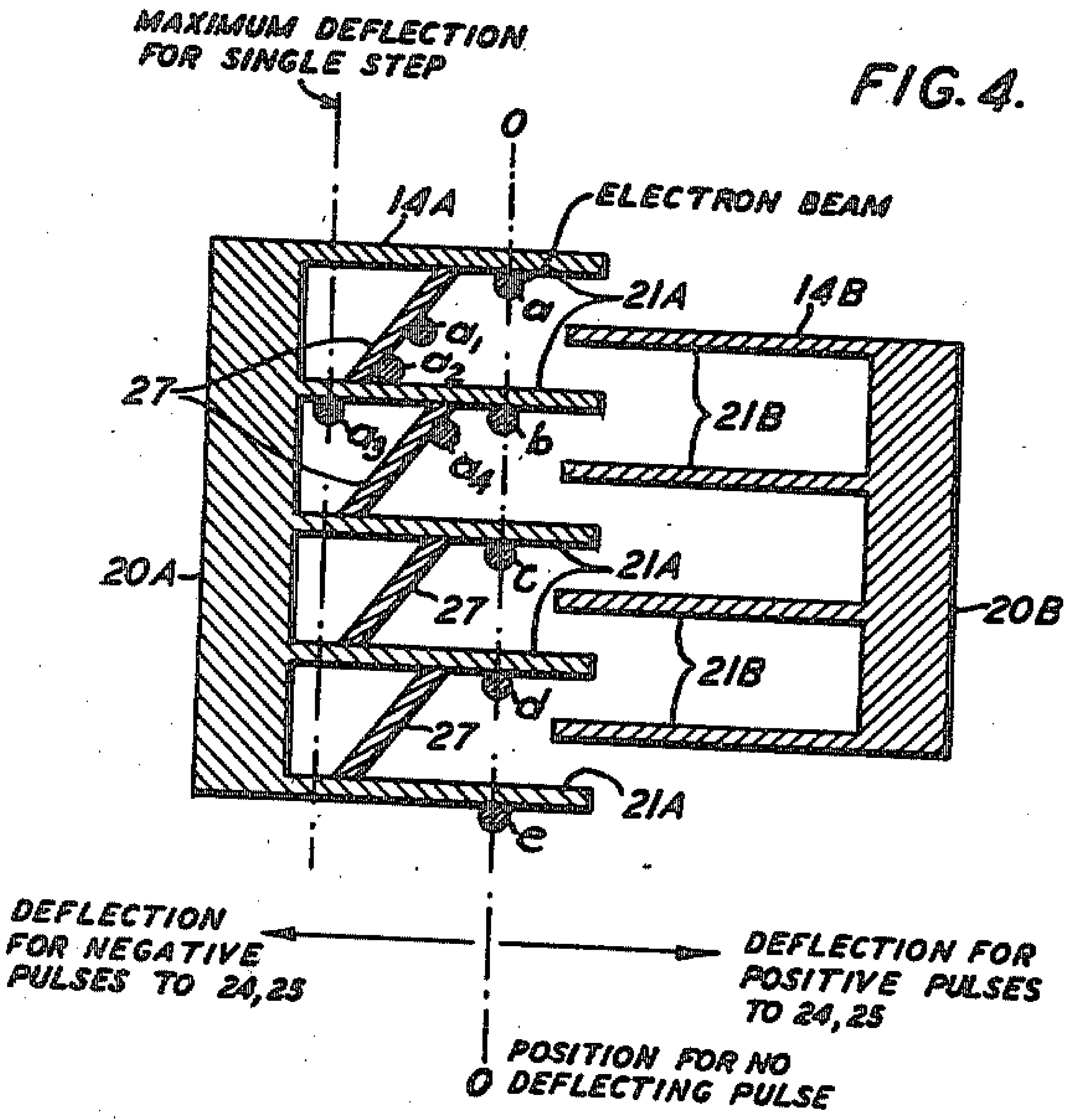


FIG. 5

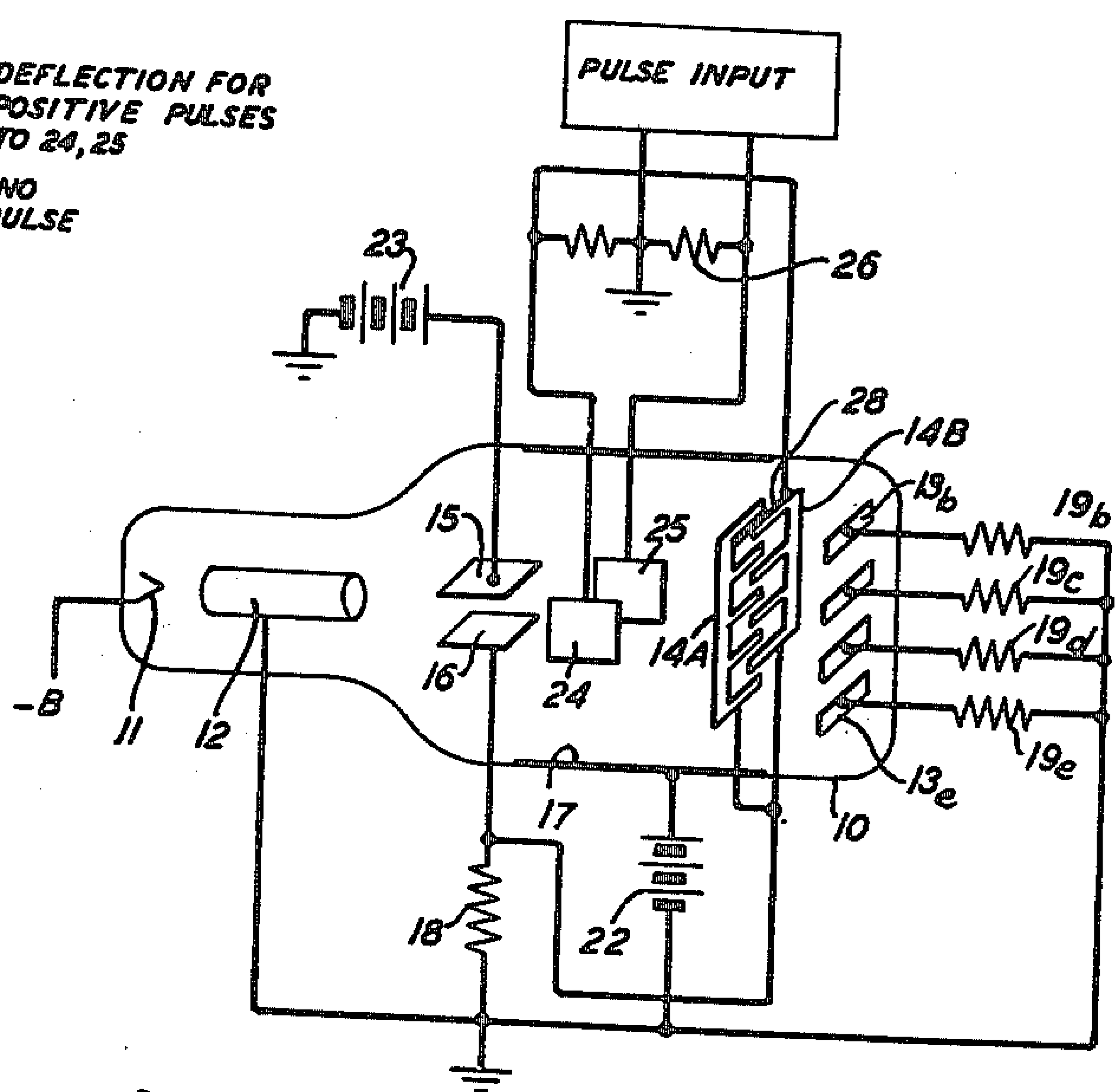
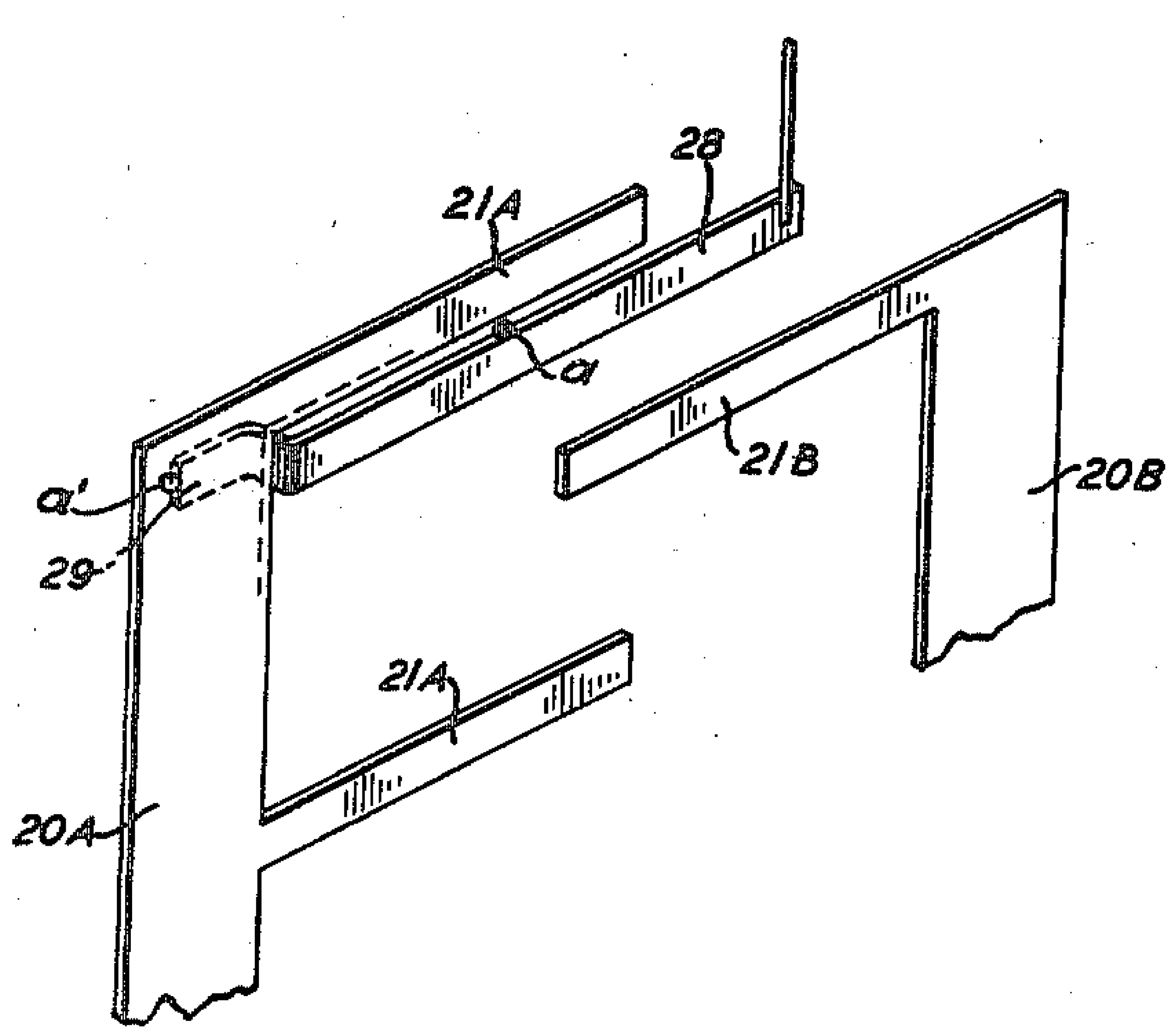


FIG. 6.



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UNITED STATES PATENT OFFICE

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ELECTRON DISCHARGE DEVICE

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Application May 2, 1945, Serial No. 591,505

20 Claims. (Cl. 315—21)

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This invention relates to electron discharge devices and more particularly to such devices of the multi-anode beam type.

One general object of this invention is to improve multi-anode electron beam discharge devices and particularly such devices especially suitable for switching and signaling purposes.

More specifically, objects of this invention are to:

Simplify electronic switching apparatus;

Increase the operating flexibility of multi-anode electron beam discharge devices whereby a single device is capable of operation in a variety of manners to perform a multiplicity of functions;

Enable the selective transfer of the electron beam in a multi-anode electron discharge device from one anode to another or to a series of anodes in a prescribed sequence;

Realize automatic locking of the beam in such devices in a desired position to which it has been deflected, upon cessation of the condition or signal resulting in the deflection;

Achieve automatic resetting of the electron beam in such devices to a desired position after it has been deflected to another desired position or to a sequence of positions; and

Increase the frequency of switching attainable in electron beam discharge devices of the multi-anode type.

In one illustrative embodiment of this invention, an electron discharge device comprises a plurality of anodes or target electrodes mounted in a line, an electron gun for projecting a concentrated electron beam toward the anodes or target electrodes, a pair of deflector plates arranged to effect deflection of the electron beam in the direction of alignment of the anodes or target electrodes, and a second pair of deflector plates arranged to effect deflection of the beam in a dimension at an angle, e. g., a right angle, to the direction noted.

In accordance with one feature of this invention, means are provided for causing deflection of the electron beam in the direction noted when a signal voltage or pulse is applied to the second pair of deflector plates.

In accordance with a more specific feature of this invention, an auxiliary electrode is provided, for example between the deflector plates and the anodes or target electrodes, and is associated with the first deflector plates in such manner that when the beam is deflected by a signal voltage or pulse applied to the second deflector plates, a deflecting voltage of preassigned amplitude is established between the first pair of deflector plates.

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In accordance with another feature of this invention, the deflector plates and auxiliary electrode are so constructed and arranged that initially the beam impinges upon a preassigned anode or target electrode and upon application of a series of pulses to the second deflector plates the beam is stepped from one anode or target electrode to the next adjacent one, one step per pulse, and remains upon any anode or target electrode to which it is stepped until the next succeeding pulse.

In accordance with a further feature of this invention, the auxiliary electrode is constructed so that upon the application of a pulse of certain polarity and amplitude to the second pair of deflector plates, the beam is reset to a preassigned position.

In accordance with still another feature of this invention, the deflector plates and auxiliary electrode are cooperatively designed and associated so that the beam may be stepped from one target electrode or anode to either the next preceding or the next succeeding one by application of a pulse of appropriate polarity to the second pair of deflector plates.

In accordance with a still further feature of this invention, a second auxiliary electrode is provided in association with the first auxiliary electrode for automatically transferring the beam to one of the end anodes or target electrodes whenever it is deflected beyond the other end anode or target electrode.

The invention and the above-noted and other features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing in which:

Fig. 1 is a diagram of an electron discharge device and associated circuit illustrating certain principles involved in apparatus constructed in accordance with this invention;

Fig. 2 is in part a perspective view of an electron discharge device and in part a circuit diagram showing an illustrative embodiment of this invention;

Fig. 3 is an enlarged face view of the auxiliary electrode included in the device shown in Fig. 2, several positions of the electron beam being indicated thereon;

Fig. 4 is a view, similar to Fig. 3, illustrating the construction of another auxiliary electrode which may be incorporated in a device of the construction shown in Fig. 2;

Fig. 5 is a perspective view and diagram similar to Fig. 2 illustrating another embodiment of this invention; and

Fig. 6 is a fragmentary perspective view showing details of the auxiliary electrodes included in the device illustrated in Fig. 5.

Referring now to the drawing, the electron discharge device illustrated in Fig. 1 comprises an evacuated enclosing vessel 10 having mounted therein, at one end, an electron emitter, such as an electron gun or thermionic cathode 11, opposite and in alignment with which there is positioned a cylindrical accelerating anode 12 which functions to focus the electrons emanating from the cathode into a concentrated stream projected toward the opposite end of the enclosing vessel.

Also mounted within the vessel 10 are a target electrode 13 and an auxiliary or beam guiding electrode 14. Positioned between the auxiliary electrode 14 and the cathode 11 are parallel deflector plates 15 and 16 and a second focussing electrode 17, which may be defined by a conductive coating upon the inner wall of the enclosing vessel 10.

The electrodes 12 and 17 are operated at a positive potential relative to the cathode 11 and together with the deflector plate 16 may be connected to ground as shown. The other deflector plate 15 together with the auxiliary electrode 14 are connected to ground by way of a resistor 18. The target electrode 13 is connected to ground by way of a load indicated as a resistor 19.

When potentials are applied initially to the electrodes of the device, the electron beam will be directed upon the auxiliary electrode 14, the beam path being substantially as indicated by the broken line a in Fig. 1. As a result of the electron flow thereto, the auxiliary electrode becomes charged. If the secondary electron emissive ratio of this electrode is less than unity, the charge thereon is negative. The deflector plate 15, being tied to the electrode 14, likewise becomes charged negative so that the beam is deflected, downwardly in the device shown in Fig. 1, to a position such as indicated by the broken line b and impinges upon the target electrode 13. If the beam passes beyond the lower edge of the electrode 14, the charge upon the plate 15 is dissipated at a rate determined by the time constant of the resistor-capacitive circuit constituted by the resistor 18, the condenser defined by the deflector plates 15 and 16, and the capacitance between the plate 15 and ground. As the condenser discharges, the negative potential upon the plate 15 decreases and, as a result, the beam moves upwardly until it again impinges upon the electrode 14. Quickly an equilibrium condition will be reached at which the beam is at such position that the charge upon the deflector plate 15 is just sufficient to hold the beam fixed. This condition is reached when the beam just grazes the lower edge of the electrode 14, supplying sufficient current to this electrode to maintain the deflector plate 15 at the potential requisite to effect deflection of the beam to this position. Advantageously the resistance 18 is made large so that this current is small. The major portion of the beam current flows to the target electrode 13.

If, now, a potential is impressed between the deflector plates 15 and 16, as by the application of a signal pulse in circuit with the resistor 18, the stream will be deflected in one direction or the other, that is upwardly or downwardly in Fig. 1, depending upon the polarity of this potential. Upon the cessation of the pulse, the beam will be shifted automatically to the position corresponding to the equilibrium condition noted above.

In the operation described above, it has been assumed that the secondary emission ratio of the auxiliary electrode is less than unity. A similar operation can be realized if this ratio is greater than unity. For this case, the anode 17 is maintained at a positive potential relative to the auxiliary electrode 14 and the latter is connected to the deflector plate 16. In some cases, use of an electrode 14 having a secondary emission ratio greater than unity is particularly advantageous in that a relatively large charge may be obtained upon the electrode 14 by a small beam current.

If there were a series of electrodes 13 and 14 mounted in line parallel to the direction of beam deflection, it will be appreciated that there would be a plurality of beam positions, one for each target, for which an equilibrium condition would exist. Thus, the beam could be shifted from one target to another by application of a suitable signal pulse effective to cause deflection of the beam, and at the cessation of the pulse would continue to impinge upon the target electrode to which it was shifted.

Apparatus, illustrative of one embodiment of this invention, for realizing this and other results is shown in Fig. 2. The electron discharge device illustrated in this figure is similar to that shown in Fig. 1 but is provided with a plurality of target electrodes 13a to 13e inclusive, each having a respective load 19, indicated as a resistor, connected thereto. The auxiliary electrode comprises two similar parts 14A and 14B each having, as shown clearly in Fig. 3, a side or base portion 20A or 20B and a plurality of parallel finger portions 21A or 21B respectively, the fingers of the two parts being in equally spaced interleaved and partially overlapping relation. The auxiliary electrode is of a material, such as a silver-magnesium alloy, having a secondary emission ratio greater than unity and the two parts thereof are connected together and to the deflector plate 16 which in turn is connected to ground by way of the resistor 18. Secondary electrons emanating from the auxiliary electrode 14A, 14B are collected by the electrode 17, which is maintained at a positive potential by a source such as a battery 22.

A fixed potential, of preassigned amplitude noted hereinafter, is applied between the deflector plates 15 and 16 by a source such as a battery 23.

Disposed between the auxiliary electrode 14A, 14B and the deflector plates 15 and 16 and at right angles to the latter are parallel deflector plates 24 and 25 which are connected across an input resistor 26, the mid-point of which is grounded as shown.

The auxiliary electrode and deflector plates 24 and 25 are constructed and arranged in such relation that, as indicated in Fig. 3, for no potential difference or a preassigned initial difference between the plates 24 and 25, the beam is at a point on the line O—O, for an input pulse of preassigned amplitude and one polarity it will move to a point on the line X—X passing through the side or base 20A of the electrode part 14A, and for a pulse of this amplitude and the opposite polarity, it will shift to a point on the line Y—Y. The potential applied between the deflector plates 15 and 16 by the source 23 is made of such amplitude and polarity that initially the beam impinges upon or just grazes the uppermost finger 21A in Fig. 3, of the electrode part 14A and impinges upon the target electrode 13a, as indicated by the point a and broken line a respectively in Figs. 3 and 2, so that the beam is in an equilibrium position. The beam current to the electrode part 14A is but a small fraction of the total beam current, the remainder flowing to the target electrode 13a.

When a signal pulse is applied across the input resistor 26, the beam will be deflected laterally in the direction determined by the polarity of the pulse. For purposes of discussion, it may be assumed that for a negative input pulse, the beam will be deflected to the left in Fig. 3 and will deflect to the right for a positive pulse, and that the pulse amplitude is such as to result in deflection to a position corresponding to either the line X—X or Y—Y. Now, when, in response to a negative pulse, the beam is deflected to the left from position a so that it impinges upon the side or base portion 20A, the auxiliary electrode part 14A will become positively charged, inasmuch as the auxiliary electrode material has a secondary emission ratio greater than unity. Consequently, the deflector electrode 16 will have a positive voltage component applied thereto and the beam will travel along the side or base 20A to an equilibrium position indicated at f, i. e., in grazing incidence with the electrode part 14A. Upon the cessation of the input pulse, the beam deflects, to the right in Fig. 3, to the equilibrium position indicated by e and remains in this position, so that the greater portion of the beam current flows to the target electrode 13e.

If, now, a positive pulse is applied to the input resistor 26, the beam will be deflected to the right in Fig. 3 to a point beyond the end of the lowermost finger 21A of the electrode part 14A. As a result, the charge previously placed upon the deflector plate 16 is dissipated at a rate dependent upon the time constant of the circuit constituted by the resistance 18, condenser defined by the deflector plates 15 and 16, the capacitance between the plate 16 and ground and the source 23, and the beam moves upwardly to the equilibrium position indicated by e in Fig. 3. When the input pulse ceases, the beam moves to the left beyond the lowermost finger 21B of the electrode part 14B, the charge on the plate 16 decreases still further and the beam comes to rest at the equilibrium position indicated by d, with the major portion of the beam current flowing to the target electrode 13d.

For each succeeding positive input pulse applied to the input resistor 26, the beam will be shifted to the next higher equilibrium position, i. e., c and then b, and, thus, is stepped from one target electrode 13 to the next adjacent one, e. g. from electrode 13d to electrode 13c, from the latter to electrode 13b, etc. Thus, the electron beam may be shifted from its initial position indicated at a to impinge upon the target electrode 13e and thereafter to impinge upon any other target electrode by the application of a pulse or series of pulses to the input resistor 26 whereby any one of the loads 19 may be energized or several of such loads may be energized in sequence.

If the beam has been shifted or stepped to any one of the positions indicated by a, b, c or d, it can be returned or reset to the position e by the application of a negative pulse to the input resistor 26 sufficient to cause the beam to impinge upon the side or base portion 20A of the electrode part 14A, inasmuch as, when the beam impinges upon the portion 20A, the deflector plate 16 is charged to the potential requisite to deflect the beam to the position indicated at f. Also, as is apparent, the beam may be reset to the position indicated at d from any of the positions indicated at a, b and c by the application of a positive pulse to the input resistor 26, of appropriate duration and of amplitude sufficient to cause the beam to fall upon the side or base portion 20B of the electrode part 14B.

Thus, the beam may be stepped in either direction, that is upwardly or downwardly in Fig. 3, to impinge upon the target electrodes 13 in any desired sequence, and, hence, to close the load circuits associated with these electrodes in like sequence, by application of pulses of appropriate amplitude and polarity to the input resistor 26.

Of course, in any particular device, certain relationships of parameters should be observed. The beam should be highly concentrated and the space between adjacent fingers 21A and 21B must be greater than the diameter of the beam. The stepping voltage pulse, i. e., the positive stepping pulse in the case described above, must be sufficiently great to deflect the beam from a point on the line O—O to beyond the ends of the fingers 21A but less than the value requisite to cause the beam to strike the side or base portion 20B. Also, the stepping pulse must be of sufficient duration to allow dissipation of the charge upon the plate 16 through the resistor 18 so that the charge can decrease from a value corresponding to one beam position such as e to a value corresponding to a next succeeding beam position such as e'. As noted heretofore, the rate of dissipation of the charge is determined by the time constant of the resistive-capacitive combination 18 and 15, 16. The reset pulse must be of amplitude just sufficient to deflect the beam from a position on the line O—O to the side or base portion 20A or 20B and must be of sufficient duration, at the maximum, to allow charging of the deflector plate 16 from its initial value to the value corresponding to beam position f.

The stepping frequency will be determined primarily by the capacitance of the condenser defined by the plates 15 and 16, the resistance 18, the secondary emission ratio of the auxiliary electrode 14, the total beam current and the fraction of the total beam current which is taken by the auxiliary electrode 14 when the beam is at an equilibrium position, e. g., at e. For example, in an illustrative device, stepping frequencies of the order of 10 kilocycles per second, corresponding to a stepping pulse length of about 0.1 millisecond, may be realized for the following parameters:

Capacitance of condenser 15, 16 micromicrofarads	10
Resistance 18 megohms	5
Secondary emission ratio	3
Total beam current microamperes	100
Fraction of beam current taken by auxiliary electrode per cent	20

Hence, extremely rapid stepping of the beam or, viewed in another way, switching from one load circuit to another, can be attained.

In a modification of the apparatus shown in Figs. 2 and 3 and described hereinabove, the auxiliary electrode 14A, 14B is constructed as illustrated in Fig. 4. The part 14A of this electrode is provided with parallel slanting portions 27 extending between successive fingers 21A. When the beam is deflected from its initial position, indicated at a, by an increasing signal pulse applied to the input resistor 26, it moves toward the slanting portion 27 extending between the two uppermost fingers 21A. When it reaches this position, the deflector plate 16 receives a charge which tends to deflect the beam downwardly. Under the influence of the deflecting force due to this charge and the deflecting force due to the signal pulse, the beam passes successively to a series of positions such as indicated at a_1, a_2 and a_3, the latter corresponding to substantially the maximum value of the stepping pulse. As this pulse then decreases, the beam is deflected to the right to the position indicated at a_4 and then to the equilibrium or zero pulse position indicated at b and will impinge upon the target electrode 13b. Succeeding pulses of polarity to deflect the beam to the left in Fig. 4 will step the beam from the position indicated at b to that indicated at c, then to the position indicated at d, and so on. If, while the beam is at any of the positions indicated at b to e a pulse of the opposite polarity is applied to the input resistor 26, the pulse being of amplitude to deflect the beam to the right, in Fig. 4, beyond the ends of the fingers 21A, the beam will be stepped to the next preceding equilibrium position in the manner described heretofore in the discussion of the device shown in Figs. 2 and 3. Thus, by appropriate selection of the polarity of the stepping pulse, the beam may be switched from one target electrode 13 to either the next succeeding or next preceding target electrode. Hence, the beam may be stepped in either direction, up or down in Fig. 4, and brought to rest upon any desired target electrode or upon several target electrodes in any desired sequence.

By application of a signal pulse sufficient to deflect the beam to the side or base 20A, with consequent charging of the deflector plate 16, the beam may be reset from any target to a desired position. For example, by appropriate correlation of the parameters, the beam may be reset in this manner to the position indicated at c in Fig. 4.

For some applications of the apparatus illustrated in Figs. 2 and 3 and described hereinabove, it is desirable that the beam be reset automatically to the position indicated at e whenever it reaches the position indicated at a. This may be effected by modifying the apparatus of Figs. 2 and 3 in the manner illustrated in Figs. 5 and 6. Specifically, a reset electrode is provided between the uppermost finger 21A and 21B and electrically separate from the auxiliary electrode 14A, 14B, the reset electrode having a portion 28 parallel to and slightly below the uppermost finger 21A and a portion 29 partially overlapping and spaced from the face of the side or base portion 20A toward the deflector plates. The reset electrode 28, 29 is connected to the deflector plate 24.

Whenever the electron beam is stepped to the position indicated at a in Figs. 2 and 6, a portion of the beam current is intercepted by the reset electrode and as a result it becomes charged positive and a positive charge is placed upon the deflector plate 24. Consequently, the beam is deflected along the reset electrode to the position indicated at a' in Fig. 6. Upon reaching this position, a portion of the beam current flows to the side or base portion 20A so that a charge is placed upon the deflector plate 16 and, as a result, the beam is deflected to the position indicated at e in Fig. 2. Of course, when the beam leaves the reset electrode 28, 29, the charge upon the deflector plate 24 is dissipated, specifically through the left-hand portion of the resistor 26 in Fig. 5, so that when the beam reaches position

e the deflector plates 24 and 25 are at the same potential.

It will be appreciated that this invention provides electronic devices capable of effecting energization of a plurality of load circuits selectively as, for example, in a desired sequence. The switching from one circuit to another is accomplished by signal pulses so that little expenditure of power is entailed and high operating efficiencies are attainable. Further, it is apparent that relatively simple circuits may be utilized to provide the requisite signal pulses and that auxiliary equipment necessary to effect stepping of the beam from one target to another is minimized. Moreover, as has been pointed out heretofore, high frequency switching can be attained.

Although specific embodiments of the invention have been shown and described, it will be understood that they are but illustrative and that various modifications may be made therein without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising a plurality of targets mounted in a row, means for projecting an electron beam toward said targets, and means for selectively directing said beam to impinge upon one or another of said targets, said directing means comprising a first deflecting means effective when energized to deflect said beam in the dimension parallel to said row, a second deflecting means effective when energized to deflect said beam in a direction at an angle to said dimension, means for energizing said second deflecting means and means responsive to deflection of said beam by said second deflecting means for energizing said first deflecting means.

2. An electron discharge device comprising a plurality of target electrodes mounted in a row, means for projecting an electron beam toward said target electrodes, and means for stepping said beam from one target electrode to another, said stepping means comprising deflector plate means for deflecting said beam in the direction parallel to said row, deflecting means for deflecting said beam in the direction substantially transverse to said row and means responsive to deflection of said beam in said transverse direction for charging said deflector plate means to effect deflection of said beam in said parallel direction.

3. An electron discharge device comprising a plurality of target electrodes mounted in a row, means for projecting an electron beam toward said target electrodes, and means for selectively directing said beam to impinge upon one or another of said target electrodes, said directing means comprising a first pair of deflector plates effective when energized to deflect said beam in the direction of said row, a second pair of deflector plates effective when energized to deflect said beam in a second direction at an angle to said first direction and means responsive to deflection of said beam in said second direction for establishing a potential difference between said first deflector plates.

4. An electron discharge device comprising a plurality of target electrodes mounted in a row, means for projecting an electron beam toward said target electrodes, a first deflecting means effective when energized to deflect said beam in the direction along said row, and means for controlling said deflecting means to step said beam from one target electrode to another, said con-

trolling means comprising an auxiliary electrode opposite said target electrodes, extending transversely with respect thereto and connected to said deflecting means to energize said deflecting means proportionately to the portion of the beam current to said auxiliary electrode at any time, a second deflecting means effective when energized to deflect said beam in a second direction at an angle to said first direction and means for supplying energizing pulses to said second deflecting means to deflect said beam out of impinging relation with said auxiliary electrode.

5. An electron discharge device comprising a plurality of target electrodes mounted in a row, means for projecting an electron beam toward said target electrodes, a first deflecting means effective when energized to deflect said beam in the direction along said row, means for energizing said deflecting means to direct said beam normally upon a preassigned one of said target electrodes, a second deflecting means effective when energized to deflect said beam in a second direction at an angle to said first direction, and means for stepping said beam from said one target electrode in succession to a series of other target electrodes, said stepping means comprising means for applying energizing pulses to said second deflecting means and means responsive to deflection of said beam in said second direction for applying to said first deflecting means an energizing signal for each of said energizing pulses sufficient to step said beam from one of said target electrodes to a preassigned other target electrode.

6. An electron discharge device in accordance with claim 5 comprising means for automatically resetting said beam to impinge upon one of said target electrodes whenever it is stepped to a preassigned position.

7. An electron discharge device comprising a plurality of target electrodes mounted in a row, means for projecting an electron beam toward said target electrodes, a first deflecting means effective when energized to deflect said beam in the direction along said row, means for energizing said deflecting means to direct said beam normally upon one end target electrode, a second deflecting means effective when energized to deflect said beam transversely to said row, and means for stepping said beam in succession from said one end target electrode to the other end target electrode and then to the intermediate target electrodes, said stepping means comprising means for applying energizing pulses to said second deflecting means and means for converting deflection of said beam in response to said pulses into energizing signals applied to said first deflecting means.

8. An electron discharge device in accordance with claim 7 comprising means for automatically resetting said beam to impinge upon said other end target electrode when said beam is stepped to a preassigned other electrode.

9. An electron discharge device comprising a plurality of target electrodes mounted in a row, means for projecting an electron beam toward said target electrodes, a first deflecting means effective when energized to deflect said beam in the direction along said row, a second deflecting means effective when energized to deflect said beam in a second direction at an angle to said first direction, and means for energizing said first deflecting means to selectively step said beam from one target electrode to either the next preceding or next succeeding target electrode, said energizing means comprising means for applying energizing pulses of one polarity or the other to said second deflecting means and means for converting deflection of said beam in response to said energizing pulses into signals applied to said first deflecting means and of effective polarity determined by the polarity of said pulses.

10. An electron discharge device comprising a plurality of target electrodes mounted in a row, means for projecting an electron beam toward said target electrodes, deflector plate means for deflecting said beam in the dimension parallel to said row, deflection means effective when energized to deflect said beam transversely to said row, means for applying energizing pulses of one or the opposite polarity to said deflection means, and means for applying to said deflector plate means a charge variable in accordance with the polarity of said pulses to step said beam from one of said target electrodes to a preceding or succeeding target electrode in accordance with the polarity of said pulses.

11. An electron discharge device comprising a plurality of target electrodes mounted in a row, means for projecting an electron beam toward said target electrodes, deflecting means effective when energized to deflect said beam in the direction transverse to said row, means for applying energizing pulses of one or the opposite polarity to said deflecting means, and means for stepping said beam from one target electrode to a preceding or succeeding target electrode in accordance with the polarity of said energizing pulses, said stepping means comprising a pair of deflector plates effective when energized to deflect said beam in the direction of said row and means responsive to deflection of said beam in said transverse direction for varying the potential between said plates in accordance with the polarity of said pulses.

12. An electron discharge device comprising a plurality of target electrodes mounted in a row, means for projecting an electron beam toward said target electrodes, a first deflecting means effective when energized to deflect said beam in the direction along said row, a second deflecting means effective when energized to deflect said beam substantially normal to said direction, and an auxiliary electrode between said first means and said target electrodes and connected electrically to said first deflecting means, said auxiliary electrode having spaced oppositely extending fingers in interleaved relation and defining a plurality of windows one opposite each of said target electrodes and said fingers extending normal to said direction.

13. An electron discharge device comprising a plurality of target electrodes mounted in a row, means for projecting an electron beam toward said target electrodes, a first deflecting means effective when energized to deflect said beam in the direction along said row, a second deflecting means effective when energized to deflect said beam in a second direction at an angle to said first direction, and an auxiliary electrode between said target electrodes and said first means and connected electrically to said first deflecting means, said auxiliary electrode comprising a plurality of spaced fingers extending parallel to said second direction and defining a plurality of openings one opposite each of said target electrodes.

14. An electron discharge device comprising an auxiliary electrode having therein a tortuous opening composed in part of substantially parallel portions, electron receiving means to one

side of said electrode and opposite said portions, means opposite the other side of said electrode for projecting an electron beam through said opening to said electron receiving means, a first deflecting means for deflecting said beam to sweep in one direction over said electrode across said parallel portions, said electrode being connected electrically to said deflecting means whereby said deflecting means is energized proportionately to the portion of said beam intercepted by said auxiliary electrode, and a second deflecting means for deflecting said beam in the direction parallel to said parallel portions.

15. An electron discharge device in accordance with claim 14 comprising a second auxiliary electrode adjacent one of said parallel portions and connected electrically to said second deflecting means.

16. An electron discharge device comprising electron receiving means, means for projecting an electron beam toward said electron receiving means, an auxiliary electrode between said first and second means and having parallel side portions and parallel fingers extending from each of said side portions, toward the other side portion and terminating short thereof, the fingers extending from the two side portions being in alternate relation, a first deflecting means for deflecting said beam in the direction parallel to said fingers, and a second deflecting means connected electrically to said auxiliary electrode to be energized in accordance with the beam current intercepted by said auxiliary electrode, said second deflecting means being positioned to deflect said means normal to said first direction.

17. An electron discharge device in accordance with claim 16 comprising a second auxiliary electrode connected to said first deflecting means and positioned adjacent one of said fingers.

18. An electron discharge device in accordance with claim 16 wherein said auxiliary electrode comprises portions adjacent one of said side portions, inclined with respect thereto and each extending between a corresponding pair of fingers extending from said one side portion.

19. An electron discharge device comprising electron receiving means, means for projecting an electron beam toward said electron receiving means, a pair of deflector plates positioned to deflect said beam in one direction, means for deflecting said beam in a second direction at an angle to said first direction, and means for placing a charge upon one of said plates in response to deflection of said beam by said deflecting means, said last means comprising an auxiliary electrode between said electron receiving and beam projecting means, connected to said one plate and having a pair of side portions extending in said one direction and fingers extending from each side portion in said second direction toward the other side portion and terminating short thereof, the fingers extending from the two side portions being arranged in alternate relation.

20. An electron discharge device comprising electron receiving means, means for projecting an electron beam toward said electron receiving means, a first pair of deflector plates between said electron receiving and beam projecting means and positioned to deflect said beam in one direction, a second pair of deflector plates between said electron receiving and beam projecting means and positioned to deflect said beam at substantially right angles to said first direction, and an auxiliary electrode between said electron receiving and beam projecting means and connected electrically to one of said first pair of deflector plates, said auxiliary electrode comprising parallel side members extending in said one direction and parallel fingers extending from each of said side members and normal to said one direction toward the other side member and terminating short thereof.

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