

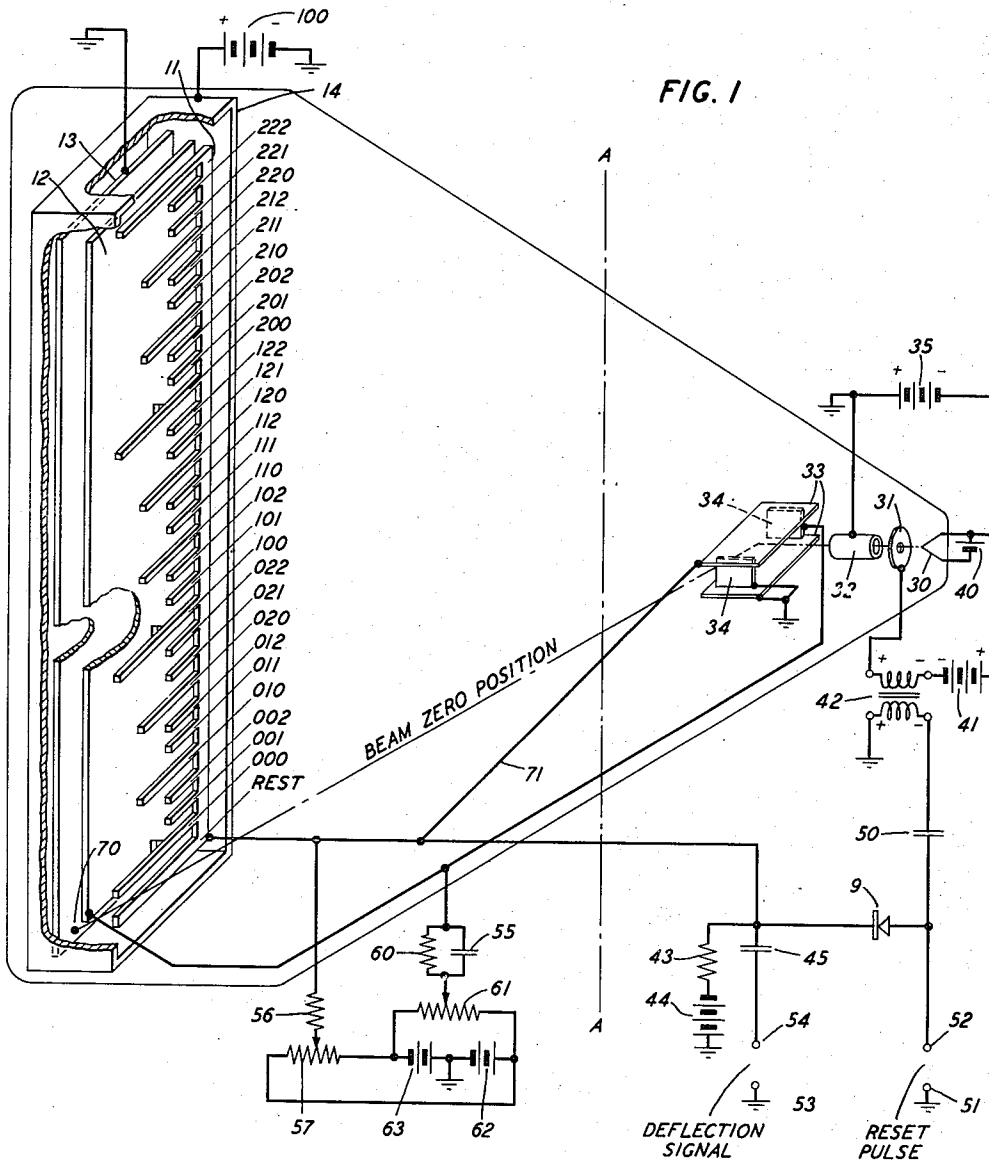
Nov. 20, 1951

M. E. MOHR
CATHODE-RAY DEVICE

2,576,029

Filed March 1, 1950

5 Sheets-Sheet 1



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FIG. 2

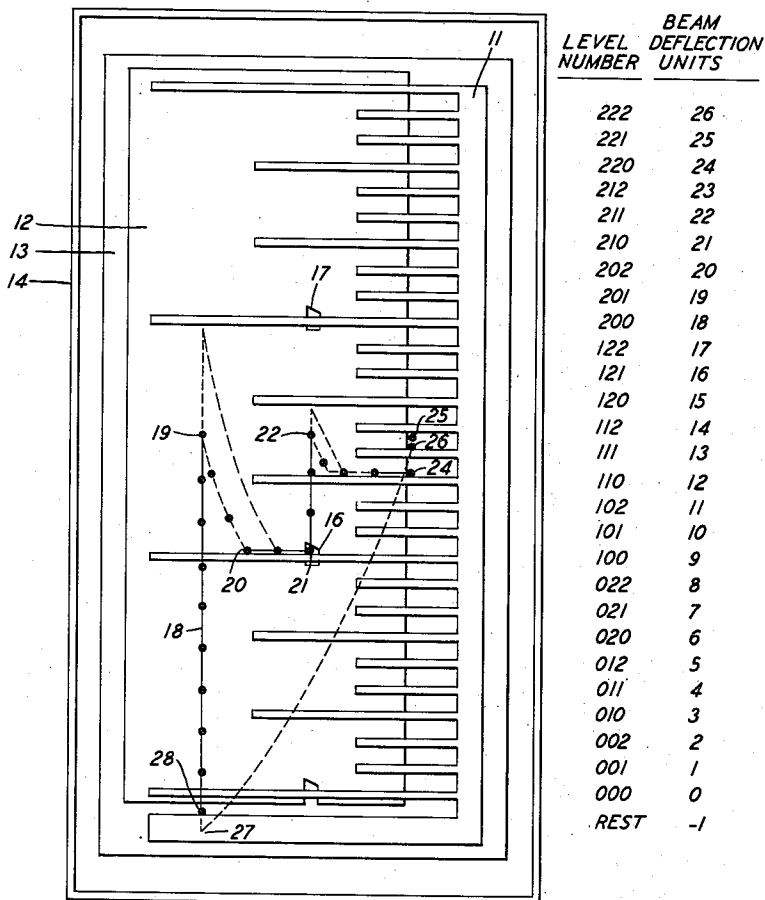


FIG. 3

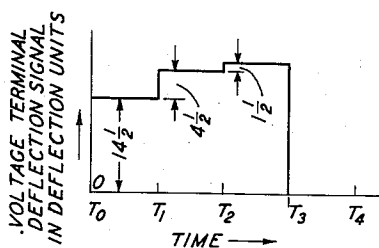
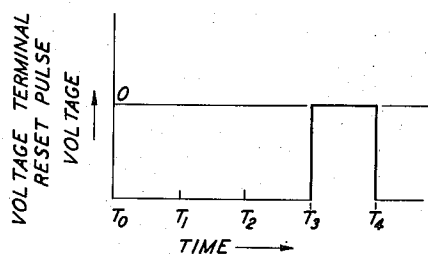


FIG. 4



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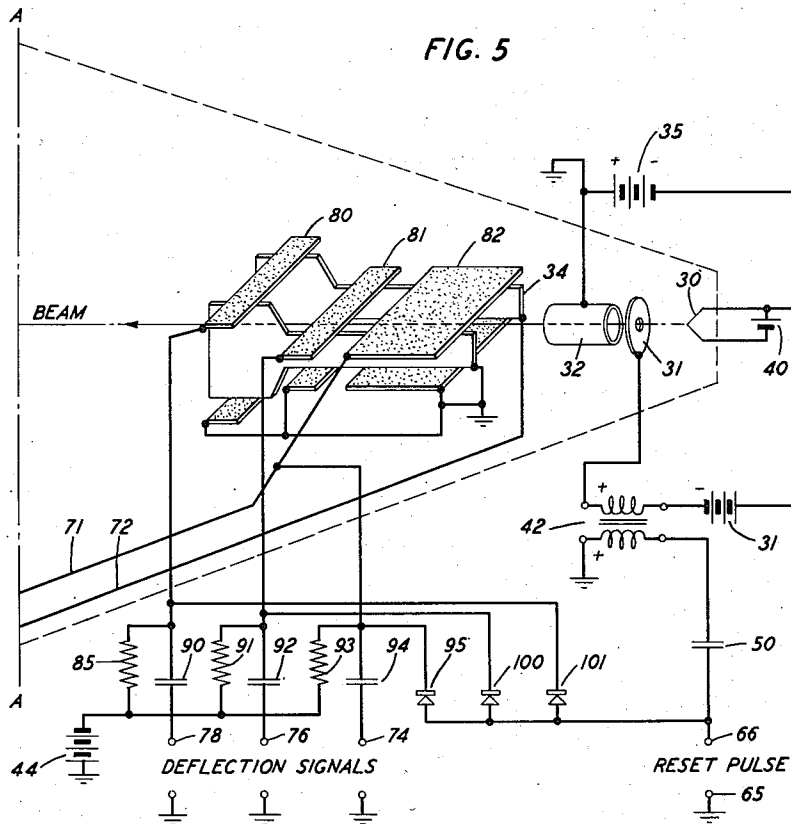
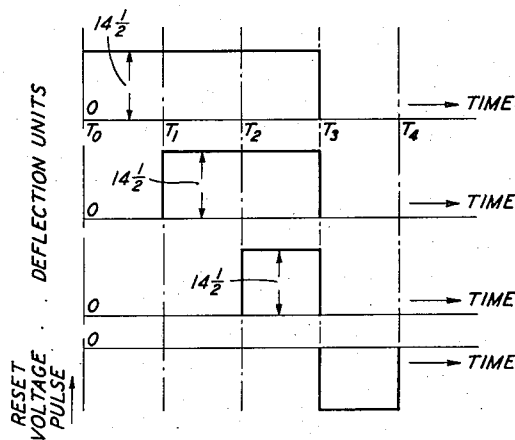


FIG. 6



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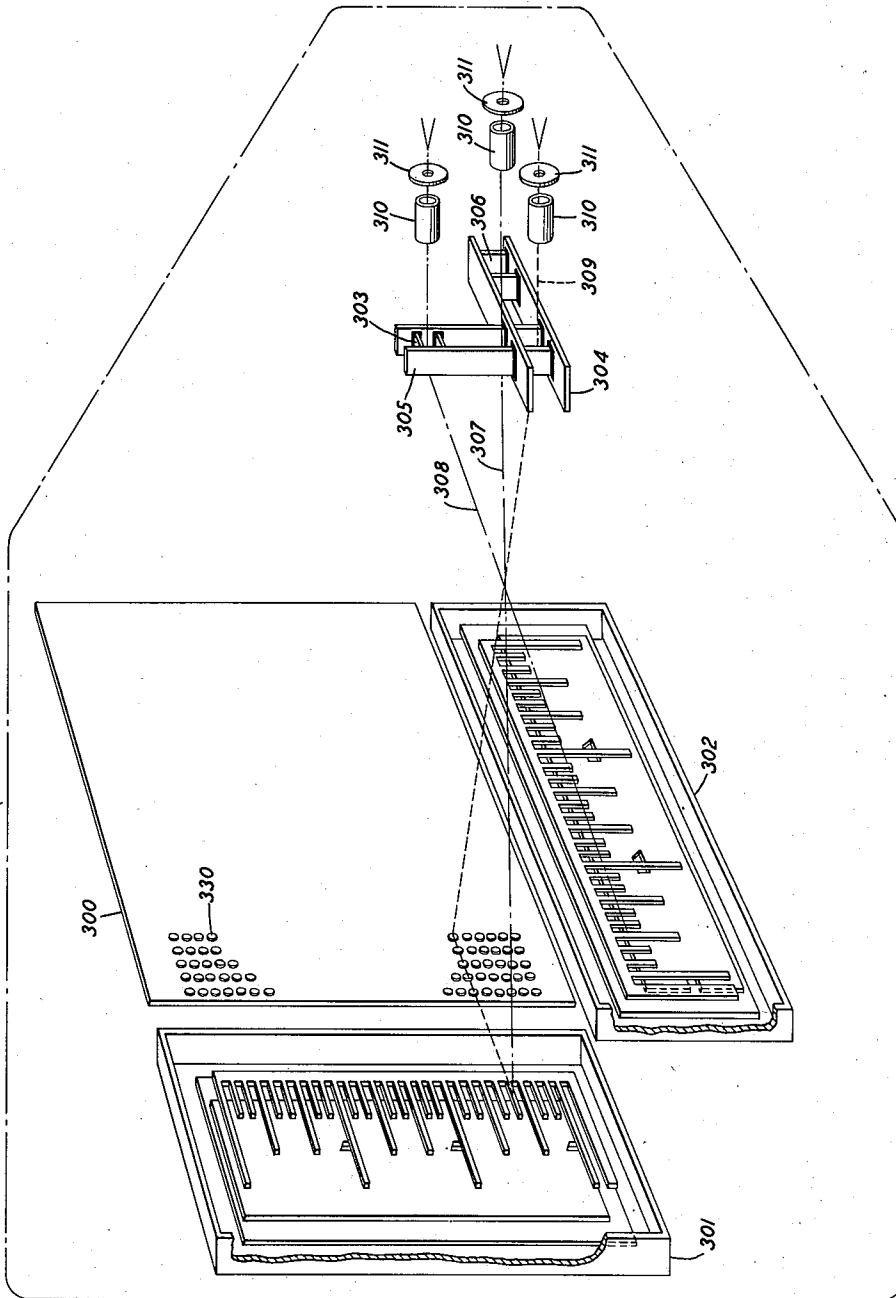
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FIG. 7



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FIG. 8

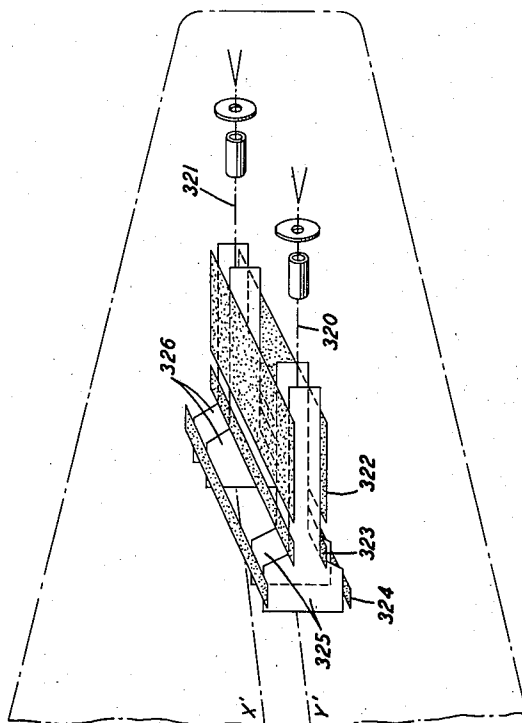
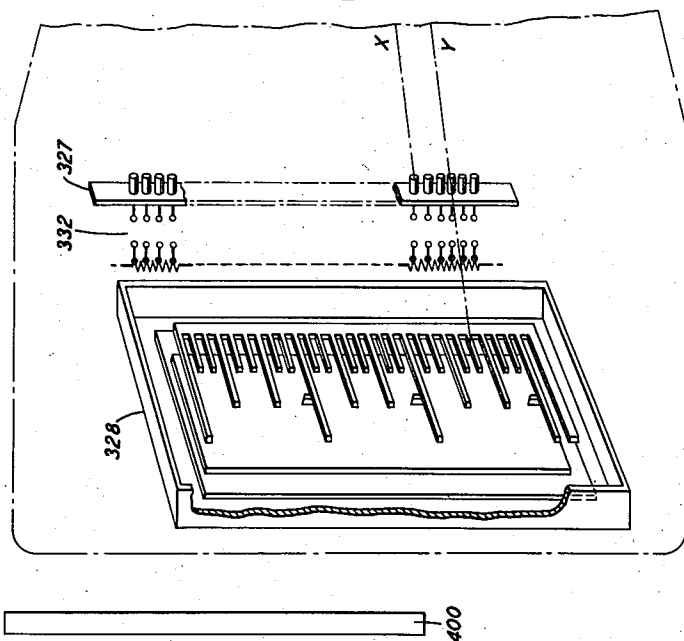


FIG. 8A



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UNITED STATES PATENT OFFICE

2,576,029

CATHODE-RAY DEVICE

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Application March 1, 1950, Serial No. 146,967

11 Claims. (Cl. 315—3)

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This invention relates to electron discharge devices and, more particularly, to cathode ray or electron beam devices including a plurality of targets or target elements to which the electron beam is directed selectively.

One object of the invention is to facilitate the deflection or guiding of an electron beam precisely to any one of a plurality of positions or target elements.

Another object of this invention is to achieve very accurate control of the beam position despite variations in input signals in response to which the beam is deflected.

A further object of this invention is to resolve an input voltage, or series of such voltages, of approximately given magnitude into a corresponding voltage, or series of voltages, having precisely prescribed magnitude.

Still another object of this invention is to enable the accurate reproduction of electron beam deflection voltages.

In one illustrative embodiment of this invention, an electron discharge device comprises a target means, an electron gun for projecting an electron beam toward the target means, and deflection elements for deflecting the beam in two coordinate directions, hereinafter referred to as horizontal and vertical for ease of discussion. In one illustrative construction, the deflection elements may be pairs of deflector plates in space quadrature.

In accordance with one feature of this invention, the target means is cooperatively associated in feedback relation with the deflection system and is so constructed and arranged that, in response to groups of signals applied to the elements for deflecting the beam in one coordinate direction, each group being representative of a respective magnitude, the beam position is controlled to fix the voltage between said elements at the value corresponding precisely to said magnitude. This voltage is utilized to control deflection of a second electron beam, termed a slave beam, to distinguish from the first, termed a master or control beam.

In accordance with a more specific feature of this invention, the target means comprises a conductive member having a plurality of sets of parallel spaced fingers of different lengths, extending in one of the coordinate directions, the sets being interleaved in accordance with a prescribed relation, and comprises also a conductive plate having apertures therein opposite certain of the fingers. The conductive member is connected in feedback relation to one of the deflec-

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tion elements, say the one for deflecting the beam in the vertical direction; the conductive plate is connected in feedback relation to the other deflection elements, i. e., the one for deflecting the beam horizontally.

In an illustrative case wherein deflection in the vertical direction is in accordance with a ternary number system, the operation, in general, is as follows: groups of three voltages of approximate amplitudes in accordance with the number system are applied to the vertical deflection elements. The voltages in each group are applied in time sequence. In response to the first voltage in the group, the master beam is deflected into a particular region determined by the voltage magnitude, the region being between two of the fingers. It then falls back until it engages the lower of these fingers, whereby feedback action is initiated, and the beam is held on this finger. Concurrently, the beam moves horizontally along the fingers by virtue of feed back between the conductive plate and the horizontal deflecting element. Thus, the beam is guided to a particular position and level and held thereat until the next voltage increment is applied to the vertical deflection plates. Then another smaller voltage increment is applied and finally a third and still smaller increment, the beam position and the resulting voltage between the vertical deflection plates being controlled in the manner described with respect to the first voltage.

Thus, the final beam position is determined by a group of three pulses or voltage increments, and the final voltage between the vertical deflecting elements is of precisely the magnitude represented by that group in the ternary number system.

It will be understood, of course, that number systems other than ternary may be employed, with a corresponding number of voltage increments and sets of fingers on the conductive member. Also, these increments may be in accordance with a code.

A particularly important advantage of devices constructed in accordance with this invention is that a final voltage of precisely prescribed amplitude is produced across the deflection elements despite substantial variations in the applied voltage increments. For example, in a particular embodiment hereinafter described, exact final voltages are obtained despite variations of as great as about 30 per cent in the applied voltage increments.

The invention may be embodied in devices involving deflection of a beam in two coordinate

dimensions. In this case, two master beams controlled in the manner above described are utilized to produce two deflection voltages of precisely prescribed amplitudes. These two voltages may be used to deflect the slave beam, or several slave beams, in the two coordinate dimensions. Thus, the slave beam may be accurately directed to any one of a large number of targets or positions in an array, as, for example, in a switching device, computing machine, or the like.

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

Fig. 1 is a diagram showing the essential component parts of the cathode-ray device and the relationship of such parts to each other;

Fig. 2 illustrates the target, the collector electrode, a back electrode, and a typical path of electron beam when translating a typical input signal;

Fig. 3 shows a typical input voltage signal;

Fig. 4 is a chart showing the voltage terminal reset pulse which prepares the electron discharge device for the next input voltage signal;

Fig. 5 illustrates another electron beam deflection system, illustrative of one embodiment of this invention;

Fig. 6 illustrates the input signal voltages and reset pulses which are to be used in conjunction with the embodiment shown in Fig. 5;

Fig. 7 shows a system whereby a first master beam controls the vertical deflection voltage of a slave beam and a second master beam controls the horizontal deflection voltage of the slave beam so that the slave beam can be accurately directed to a desired spot in a coordinate system;

Fig. 8 is a diagram showing the component parts and the relation thereof of a system whereby the vertical deflection of a slave beam is controlled by a master electron beam which correctly translates the input signal voltages; and

Fig. 8A illustrates a modification of the embodiment shown in Fig. 8.

Referring now to the drawing, the electron discharge device illustrated in Fig. 1 comprises a conventional cathode 30, control grid 31, beam forming anode 32, vertical deflection plates 33, horizontal deflection plates 34, vertical beam guide 11, collector electrode 14, back plate 13, and horizontal position guide 12.

The vertical beam guide 11 is connected back to the upper plate of the vertical deflection plates 33 over the lead 71. The horizontal deflection position guide 12 is connected back to the more remote plate of the horizontal deflection plates 34. The back plate 13 is connected to ground and is provided to shunt to ground that part of the beam current not being used. The secondary emission collector 14 is held at a potential, by a source 100, sufficiently positive to accumulate all the secondary electrons which are emitted from the various beam guides and back plates. The surfaces of these elements have a secondary electron emission ratio which is considerably greater than unity, for example, three or greater. The beam forming system 32 is operated at ground potential, and the cathode is held at a high negative potential with respect to ground by means of the high voltage battery 35. The battery 40 supplies the heater power for the cathode. The battery 41 provides suitable grid bias. A pulsed signal, cutting off the master

beam periodically, as will be explained later, is supplied to the grid through transformer 42. The battery 41 is so proportioned that the beam current is normally flowing.

The rest position of the beam is controlled by the two potentiometers 57 and 61, of Fig. 1, which are supplied by the batteries 62 and 63. The type of input signal which is used to deflect the beam is illustrated in the voltage-time diagrams in Fig. 3. This deflection signal is first applied to terminal 54 and is then coupled through capacitor 45 to the upper of the vertical deflection plates 33, which are shunted by the resistance 43 in series with the battery 44 and by the resistance 56. The capacitor 45 is also shunted by the diode 9, which is normally held in a blocked condition by the highly negative voltage bias existing on input terminal 52. The function of this diode is to discharge the capacitor 45 to zero voltage at the end of each cycle. This function is accomplished by means of the reset pulse applied to terminal 52, which operates to reduce the voltage on terminal 52 to zero at the same time the signal voltage on terminal 54 is reduced to zero, thus allowing the negative charge on the top plate of condenser 45 to flow off through the diode 9 in the conducting direction. The reset pulse is also applied to the pulse transformer 42 through the large blocking condenser 50 and thus operates to cut off the beam current during the reset interval.

As stated above, the device functions to accurately locate the vertical coordinate of the master beam and set up the corresponding potentials on the vertical deflection plates 33. Referring to Fig. 2, it is seen that there are provided, in the illustrative structure indicated, twenty-seven possible levels which can be accurately determined. Each of these levels, in this illustrative case, can be conveniently given a number in a ternary number system. This has been done in the column called "Level number" in Fig. 2. The voltage required on the deflection plates 33 of Fig. 1 which is required to deflect the beam exactly from one level to the next level is defined as being equal to one "Beam deflection unit" (D. U.). Therefore, the beam deflection units with reference to the 000 level which are required to place the beam on any one of the twenty-seven possible levels are tabulated as "Beam deflection units" in Fig. 2. In the beam guide structure 11, there is one additional bar provided called the "rest" bar, the top edge of which is one deflection unit below the top edge of the 000 level bar. This rest bar is wider than any of the other bars used in the beam guide structure. The structure of the beam guide, it is seen, is such that the lengths of the bars corresponding to the various levels vary in accordance with the ternary number system used to number the levels. How this structure is used to guide the beam to a particular desired level will now be described.

It can be seen in Fig. 1 and Fig. 2 that the beam in the rest position is located so it is just grazing the top of the rest bar and is placed horizontally so that it is nearly mid-way between the ends of the longest beam guide bars and the second longest beam guide bars of structure 11. The beam in this position completely misses the back plate 12 and is shunted to ground at point 70 shown in Fig. 1. The horizontal position, when feedback from the back plate 12 is absent, is determined by the adjustment of potentiometer 61 of Fig. 1. The adjustment of potentiometer 57, controlling the vertical position, is such that if

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the feedback circuit from the beam guide 11 to the vertical deflection plate were opened, the beam would intercept the rest bar. Then, when the feedback circuit is reconnected, the beam will hit on the rest bar, and secondary electrons will be emitted which, in turn, will cause the potential of the rest bar to be increased positively, thereby charging the condenser 45 and, in turn, causing the upper deflection plates 33 to be increased in a positive direction. This causes the beam to be deflected upward. This feedback process continues until the beam grazes the top of the rest bar, causing just enough secondary current to flow to supply the leakage current through the parallel resistances 56 and 43, which are shunted across the condenser 45. Referring to Fig. 2, the vertical position of the beam when it is cut off or the position of the beam when the feedback circuit is opened is indicated as 27. The position of the beam with the feedback circuits connected through is indicated at 28.

Assume the signal shown in Fig. 3 is applied to terminal 54 of Fig. 1. The voltages applied here are given in terms of beam deflection units, one deflection unit being just sufficient to deflect the beam from one level to the next level, as described before. It is most convenient to follow the path of the beam by referring to Fig. 2. The objective in the sample signal shown is to drive the beam to level III. It is seen that this is done by applying three successive changes to the terminal 54 of Fig. 1. At time T_0 , a voltage which rises sharply, of magnitude equal to $(1+1\frac{1}{2})$ deflection units, is applied to terminal 54. This, referring to Fig. 2, causes the beam to follow the path 18 and ride over the beam guide bars at level 000 and at level 100 and arrive at point 19. The beam now does two things. First, since the capacitor 45 changes its charge at a rate corresponding to the leakage through the shunting resistances 43 and 56 of Fig. 1, the beam will fall downward as the positive voltage existing on the upper side of condenser 45 changes in a negative direction. Secondly, since the beam is now intercepting the horizontal guide consisting of back plate 12, there will be secondary emission from this back plate which will cause its potential to change in a positive direction, thus charging the capacitor 55 of Fig. 1 positively. This positive potential is connected to the remote plate of horizontal deflection plates 34 and thereby causes the beam to move to the right in Fig. 2. Thus, the beam will follow a curved path between points 19 and 20, as shown in Fig. 2, and this process will continue until the point 20 is reached, at which time the beam will partially intercept the guide bar at level 100. When the beam strikes the bar 100, it causes secondary electrons to be emitted from this bar, thereby holding the charge on condenser 45 such that the beam cannot fall farther. However, the beam still continues to travel sideways until the aperture 16 in the back plate 12 is reached. At this time, the beam goes through the back plate 12 and is intercepted by back plate 13 and shunted to ground. The beam, therefore, remains stationary at point 21, as shown in Fig. 2. At time T_1 , an additional voltage of $\frac{1}{2}$ deflection units is applied to terminal 54, and this causes the beam to be deflected vertically to position 22 shown in Fig. 2. The beam again falls, as described before, and moves sideways and finally comes to a resting place at point 24. Then, at time T_2 , an additional deflecting voltage of $1\frac{1}{2}$ deflection units is applied to terminal 54, and this deflects the beam to position

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25. At this time, no horizontal motion of the beam occurs, but the beam merely falls back and comes to rest at position 26 corresponding to beam level III. Thus, a vertical deflection voltage of exactly that required to hold the beam at level III exists on the deflection plates at this time, and this potential is held there by the action of the feedback from the beam guide bar 11 at level III. Observe that this has been done by applying three successive coarsely controlled voltages instead of one very accurately controlled voltage to the deflection system of the tube. That is, the limits on the voltage which is applied at time T_0 can vary all the way from the nominal voltage applied to $+4\frac{1}{2}$ deflection units from this value. The additional voltage increment applied at the second time T_1 can vary by $+1\frac{1}{2}$ deflection units. The additional voltage increment applied at T_2 can vary by $+\frac{1}{2}$ deflection unit. All these figures are large percentages of the deflection voltage applied at that time. In Fig. 2, the dotted lines along the beam path indicate the extreme maximum variation that can occur in these deflection voltages and still result in the desired answer.

The voltage extant between the deflector plates 33 after the three voltage increments have been applied is utilizable to control the position of a slave beam. Illustrative applications will be described hereinafter.

In order to return the beam to the rest position, it is necessary to place a reset pulse, as shown in Fig. 4, which is a positive pulse, on terminal 52, performing the following two functions. First, the right side of diode 9 of Fig. 1 is brought to ground potential, while, at the same time, terminal 54 is also reduced to ground potential. Thus, since the capacitor 45 has been charged with the top terminal negative, discharging current will flow through diode 9 in a forward direction, and condenser 45 will thereby discharge to zero potential. Secondly, a negative pulse is placed on the grid 31 of the cathode-ray tube through transformer 42 such that the beam current is cut off, thus allowing the capacitor 55 to discharge. A possible path of virtual beam deflection which may be followed is shown between points 26 and 27 of Fig. 2.

It is to be noted that at the beginning of the first time interval T_0 , it is necessary to apply one more deflection unit to the vertical deflection plates than is required by the signal alone. This is necessary to bring the beam from the rest bar up to the 000 level, and the signal is added on top of this. It has been shown that when the beam is driven upward across the bars of the beam guide system, it is travelling so rapidly that the amount of current fed back into the capacitor 45 is negligible.

Fig. 5 shows another deflection system which may be used to accomplish the same result accomplished by means of the deflection system shown in Fig. 1. Fig. 5 depicts a combination which may be substituted for everything lying to the right of the section AA of Fig. 1. As will be seen later, the illustrative deflection system of Fig. 5 proves to be useful in pulse code demodulation systems. In this case, instead of applying signal increments which change in magnitude to a single pair of vertical deflection plates, three separate signals of the same relative magnitude are applied, and the control sensitivity is varied by using three different sets of vertical deflection plates of different deflection sensitivities. Thus, the vertical deflection system in this case (Fig. 5)

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consists of the three pairs of vertical deflection plates 82, 81, and 80. The deflection plates 81 are approximately one third as long in the beam direction as the deflection plates 82, and thus, the deflection sensitivity of the plates 81 is only one third of the deflection sensitivity of deflection plates 82. On the other hand, the deflection plates 80 are spaced about three times as far apart as deflection plates 81, and the deflection sensitivity of plates 80 is, therefore, only one third that of the deflection plates 81. Thus, the deflection sensitivity of deflection plates 81 is one third of the deflection sensitivity of plates 82, and the deflection sensitivity of plates 80 is one ninth of the deflection sensitivity of plates 82. The operation of the horizontal deflection plates 34 is the same as the operation of the horizontal deflection plates explained in connection with Fig. 1.

Three different synchronized deflection signals are applied to the system as illustrated in the voltage-time diagrams shown in Fig. 6. The object in the illustration is again to reach the level III on the beam guide system of Fig. 1. The beam deflection unit is again used here but refers to the deflection obtained on the deflection plates 82. Thus one deflection unit applied to deflection plate 82 will deflect the beam through one level difference at the beam guide. However, one deflection unit on plates 81 will deflect the beam by one third of a level difference at the beam guide and only one ninth for plates 80. The deflection signals shown in Fig. 6 are applied respectively in the time relation indicated in Fig. 6 to the terminals 74, 76 and 78 at the bottom of Fig. 5. The reset pulse is applied to terminal 66. The three diodes 95, 100 and 101 are normally in a blocked condition due to the highly negative voltage applied to terminal 66. The reset pulse, as described in connection with Fig. 1, causes the voltage on the lower side of the diodes to be zero at the same time the signal voltages on terminals 74, 76 and 78 are zero. Thus the condensers 90, 92 and 94 discharge to zero voltage during the reset interval. The circuit connected to the upper of the vertical deflection plates 82 is the same as that connected to the deflection plates 33 described in Fig. 1. That is, in Fig. 5 the input is connected to terminal 74, through capacitor 94, which is shunted by the resistance 93, and thence over lead 71 to Fig. 1 and also to the upper plate of the vertical deflection plates 82. The diode 95 is connected in shunt with capacitor 94. The signal circuits connected to the other two sets of vertical deflection plates 81 and 80, through condensers 92 and 90 shunted by resistances 91 and 85 respectively, are exactly the same as previously described except for the connection to feedback lead 71 which is here omitted. Thus, the complete feedback control of the beam, in this arrangement, is to the upper of the vertical deflection plates 82.

The signals which are applied, in order to obtain a deflection of the beam to level III, are shown in Fig. 6. The path of the beam to reach this level is shown on Fig. 2, and is the same as that described in connection with Fig. 1. Thus, at time T_0 a nominal deflection voltage is applied suddenly to input terminal 74, at the bottom of Fig. 3, of $14\frac{1}{2}$ deflection units which causes the beam to follow the path 18 shown in Fig. 2 and finally to come to the resting point 21, as described previously. At time T_1 a deflection signal of $13\frac{1}{2}$ units is applied to terminal 76. The deflection sensitivity of the associated deflection plates 81 is only one third of that of

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the deflection plates 82 and, therefore, the application of $13\frac{1}{2}$ deflection units to deflection plates 81 at time T_1 is equivalent to applying one third of this, or $4\frac{1}{2}$ deflection units, to deflection plates 82. Thus, the net effect is the same as that described in the discussion of Fig. 1. That is, in Fig. 2, the beam travels over the path 16 to 22 and 23 finally arriving at point 24. Now at time T_2 a voltage of $13\frac{1}{2}$ deflection units is applied to terminal 78. The sudden increase in voltage at time T_2 is coupled through condenser 90 to the upper of the deflection plates 80. The deflection sensitivity of plates 80, however, is only one ninth of the deflection sensitivity of the deflection plates 82 and therefore the application of $13\frac{1}{2}$ deflection units to deflection plates 80 is equivalent to the application of $1\frac{1}{2}$ deflection units to deflection plate 82. Thus again the effect is the same as that described at time T_2 in Fig. 1. That is, in Fig. 2 the beam follows the path from 24 to 25 to 26 coming to rest at 26, the desired location at level III. At time T_3 the reset pulse appears on terminal 66, reducing this potential to zero, and at the same time, all the signal voltages on terminals 74, 76 and 78 are reduced to zero. Thus, in a previously described manner, the condensers 90, 92 and 94 discharge through diodes 101, 100 and 95. Also the reset pulse operates through the pulse transformer 42 of Fig. 3 and cuts the beam current off. The restoration of the beam position to its rest value is as described previously in connection with Figs. 1 and 2.

Fig. 7 shows the principal parts required for an explanation of how the beam guides described above can be used to build a very large access translator. In such a translator, there will be a coordinately arranged array of individual targets such as 330 at the end of the cathode-ray tube, each of which will be associated with a suitable information source. Fig. 7 shows the means by which an electron beam can be very accurately located on one of these targets. The targets, in this illustration, are arranged in the square array 300, and of this square array only a few of the targets are shown. Two of the electron beam guides, the same as shown in Figs. 1 and 2, are placed alongside of this target array, 303, as shown at positions 301 and 302. For the sake of matching this figure with Figs. 2 and 1 described previously, a ternary arrangement of the beam guide is also shown here. This, however, is not essential to the operation of the device as the beam guide bars may as well be arranged in a binary, decade or any other suitable code arrangement. At the right side of the drawing are shown electron beam focusing and accelerating electrodes 310 and 311. There are two sets of vertical deflection plates, pair 303 and pair 304. There are also two pairs of horizontal deflection plates, pair 305 and pair 306. This structure is part of a three gun cathode-ray tube of which the three beams are represented by 307, 308 and 309 entering from the right side of the drawing. The beam 307 is one of two master beams and operates on the beam guide 301 in the same manner as is described in connection with Fig. 1. Observe that when the master beam 307 is in a particular position on a beam guide bar, then the potential on the deflection plates 304, due to the feedback from beam guide 301 is exactly such as to deflect the master beam to the desired vertical position and this deflection voltage is common to the slave beam 309. The function of the horizontal de-

deflection plates 306 is to drive the master beam 307 horizontally in a suitable manner as is described in Fig. 1.

The second master beam 308 is driven horizontally along beam guide 302 in the same way as master beam 307 is driven vertically. Thus, the deflection voltage which will be established across the horizontal deflection plates 305 is exactly that which will deflect the beam 308 to the desired horizontal position. This deflection voltage is also common to the slave beam 309. The slave beam 309 is therefore directed to the point corresponding to the horizontal and vertical deflection voltages which have been established on deflection plates 305 and 304 respectively. It is readily possible to set up these deflection plates so that the deflection sensitivities on the guide beams and on the master beam are very nearly the same. This may be made by slight distortions of the deflection plates, and once made, is not subject to much change with age. In this way it is possible to resolve as many as 10,000 targets in a tube of this sort using two stage decade beam guides on the sides of the target array. The ultimate limitation on a construction such as this is, of course, the final dimensions of the beam at the targets. In the particular example shown the master beam is deflected to a vertical level of 011 and a horizontal level of 010. The construction of the deflection plates and the type of signals used for deflection of the master beams can be either as described in connection with Fig. 1 or Fig. 3. The construction of the beam guides is of course dependent upon the number system used for deflection purposes.

The principles embodied in the foregoing discussion can be readily adapted to demodulating general pulse code modulation systems and this will now be described.

Fig. 8 shows schematically the essentials of a device which can be used for this purpose. Two electron beams 320 and 321 are here indicated. The master beam 320 is used to ride over the beam guide structure 328, as explained in Fig. 5, with suitable deflection voltages applied on the vertical deflection plates 322, 323, and 324. The horizontal deflection plates 325 are used in the manner described in Fig. 5 to move the beam sideways over the beam guides. The horizontal deflection plates 326 are used to center the slave beam in the target structure 327, although these centering circuits are not shown. The vertical deflection voltages, it will be observed, are common to both beams. Therefore, if the master beam has been deflected to a certain level the slave beam is deflected into the associated target structure. The output signal level to which this level corresponds will depend upon the cross connection made in a cross connection field 332 indicated.

For some demodulation systems it may be desirable to use a resistance strip target 400 as a substitute for target structure 327. The output signal would be determined by the voltage developed along the resistance strip which in turn would be determined by the unit resistance of the resistance strip 400 and the current flow of the electron beam.

It is to be understood that the forms of this invention, herewith shown and described, are to be taken merely as illustrative embodiments of the same, and that various changes in circuit elements, size and arrangement of parts may be resorted to, without departing from the scope or spirit of the invention.

What is claimed is:

1. Electron discharge apparatus comprising a target electrode having an edge thereon and a series of apertures arranged in a row substantially parallel to said edge, a collector electrode, an auxiliary electrode having a series of parallel finger-like appendages of varying lengths extending across the front of said target electrode, some of said appendages passing over said apertures, cathode means for generating an electron beam, means for focusing an accelerating said electron beam toward said target electrode, deflection means between said target electrode and said focusing and accelerating means, said deflection means comprising deflection plates in a first coordinate and deflection plates in a second coordinate, means for applying a group of code pulses to said deflection means to cause said electron beam to move in a coordinate direction substantially normal to said finger-like appendages, feedback means between said target electrode and the deflection plates of said first coordinate to cause said electron beam to move in the direction of said first coordinate, feedback means between said auxiliary target and the deflection plates in said second coordinate to cause said electron beam to maintain a position on one of said finger-like appendages.

2. Electron discharge apparatus comprising a target electrode having an edge and having therein a row of apertures parallel to said edge, means for projecting an electron beam against one face of said target electrode, and means for selectively steering said beam in accordance with groups of signal pulses to any one of a plurality of positions adjacent said edge, each position corresponding to a respective group, said steering means comprising a plurality of strip-like auxiliary target members between said means and said face and mounted in a row opposite said face, said auxiliary members extending parallel to one another and normal to said edge and certain of said members each extending across a respective one of said apertures, a first deflection means for deflecting said beam in the direction parallel to said members, a second deflection means for deflecting said beam in the direction parallel to said edge, means for applying groups of signal pulses to said second deflection means, a first feedback coupling between said target electrode and said first deflection means, and a second feedback coupling between said auxiliary target members and said second deflection means.

3. Electron discharge apparatus comprising a target electrode having a row of apertures therein, a collector electrode positioned near said target electrode, cathode means to generate an electron beam, a first means for focusing and accelerating said electron beam, deflection means comprising horizontal and vertical deflection plates positioned between said first means and said target electrode, an auxiliary target positioned between said deflection means and said target electrode, said auxiliary target having a plurality of parallel finger-like appendages of varying length arranged in a row so that some of said appendages pass over the apertures in said target electrode, means to apply a group of code pulses to said vertical deflection plates to deflect the beam over said finger-like appendages, feedback means from said target electrode to said horizontal deflection plates, and feedback means from said auxiliary target to said vertical deflection plates to maintain the beam's position when it has intercepted one of said appendages

after having been swept across the target electrode due to a code pulse being applied to said vertical plates.

4. Electron discharge apparatus comprising a target electrode having a row of apertures therein, a collector electrode positioned near said target electrode, cathode means to generate an electron beam, a first means for focusing and accelerating said electron beam, a first deflection means in one coordinate and a second deflection means in another coordinate, said first and second deflection means being positioned between said first means and said target electrode, an auxiliary target positioned between said deflection means and said target electrodes, said auxiliary target having a plurality of parallel finger-like appendages of varying length arranged in a row so that some of said appendages pass over the apertures in said target electrode, means to apply a group of pulses to said first deflection means to deflect the beam over said finger-like appendages, feedback means from said target electrode to said second deflection means, and feedback means from said auxiliary target to said first deflection means to maintain the beam's position when it intercepts a finger after having been swept across the target electrode due to a pulse being applied to said vertical plates.

5. Electron discharge apparatus comprising a target electrode having a row of apertures therein, a collector electrode, cathode means to generate an electron beam, a first means for focusing and accelerating said electron beam, deflection means comprising a pair of deflection plates in one coordinate and a plurality of deflection plates of different sensitivities serially arranged in the other coordinate, all of said deflection plates being mounted between said first means and said target electrode, an auxiliary target positioned between said deflection means and said target electrode, said auxiliary target having a plurality of parallel finger-like appendages of varying length arranged in a row so that some of said appendages pass over the apertures in said target electrode, means to apply groups of code pulses to said plurality of deflection plates to deflect the beam over said finger-like appendages, feedback means from said target electrode to said deflection plates in said one coordinate, and feedback means from said auxiliary target to said plurality of deflection plates in said other coordinate to maintain the beam's position when it has intercepted a finger-like appendage after having been swept across the target electrode due to a code pulse being applied to said deflection plates in said other coordinate.

6. Electron discharge apparatus comprising a target electrode, means for projecting an electron beam against one face of said target electrode, a plurality of parallel auxiliary target members mounted in a row adjacent said face, a plurality of pairs of deflector plates mounted serially between said means and said face and arranged to deflect said beam in the direction along said row, the deflection sensitivity of successive pairs of said plates decreasing in a preassigned ratio, a feedback coupling between said auxiliary target members and one of said pairs of deflector plates, said target electrode having therein apertures each opposite a respective one of said auxiliary members, means for deflecting said beam in the direction parallel to said target members, a feedback coupling between said target and said deflecting means, means for impressing signal pulses of substantially equal amplitudes upon

said pairs of deflector plates in succession, and means controlled in accordance with the position of said beam following the impressment of each series of signal pulses to said plates for producing a signal of amplitude determined by the net deflection of said beam.

7. Electron discharge apparatus comprising a multiplicity of target electrodes mounted in orthogonally related groups of rows, means for projecting an electron beam to said target electrodes, two pairs of deflector plates arranged in the same relation as said rows, and means for selectively directing said beam to impinge upon any one of said target electrodes, said directing means comprising means for producing a first control beam, means for deflecting said first control beam in accordance with groups of signal pulses, means responsive to deflection of said first control beam for resolving each of said groups into a potential of respective preassigned magnitude across one of said pairs of deflector plates, means for producing a second control beam, means for deflecting said second control beam in accordance with other groups of pulses and means responsive to deflection of said second control beam for resolving each of said other groups into a potential of respective preassigned magnitude across the other of said pairs of deflector plates.

8. Electron discharge apparatus comprising a plurality of target electrodes mounted in rows in two coordinate directions, means for projecting an electron beam toward said target electrodes, and means for selectively directing said beam to impinge upon any one of said target electrodes, said directing means comprising two pairs of deflector plates each effective when energized to deflect said beam in a respective one of said coordinate directions, a first pair of auxiliary deflector plates associated with one of said first pairs of plates and parallel to the other of said first pairs of plates, a second pair of auxiliary deflector plates associated with said other of said pairs and parallel to said one of said first pairs, means for projecting a first control beam between said first pair of auxiliary plates, means for projecting a second control beam between said second pair of auxiliary plates, means for applying groups of signal pulses to said one first pair of deflector plates, means for applying groups of signal pulses to said other first pair of deflector plates, means including said one first pair of plates, said first control beam and said first pair of auxiliary plates for resolving each group of pulses applied to said one first pair into a potential of respective preassigned amplitude between said one first pair of deflector plates and means including said other first pair of plates, said second beam and said second pair of auxiliary deflector plates for resolving each group of pulses applied to said other pair into a potential of respective preassigned magnitude between said other pair of deflector plates.

9. Electron discharge device apparatus comprising a first member having a plurality of targets coordinately arranged thereon, a first means to generate and focus a first electron beam toward said plurality of targets, a first deflection means in one coordinate, a second deflection means in a second coordinate, said deflection means positioned between said first means and said first member, a pair of beam-position guides arranged adjacent said first member in each of the two said coordinates, a second and third means to generate and focus second and third electron beams respectively towards each of said

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beam-position guides, a third deflection means positioned between said second means and one of said beam-position guides, a fourth deflection means positioned between said third means and the other of said beam-position guides, said third and fourth deflection means each comprising deflection plates in each of the two said coordinates, said beam-position guides each comprising a target electrode having a row of apertures therein, a collector electrode, an auxiliary electrode having a series of parallel finger-like appendages of varying lengths extending across the front of said target electrode, some of said appendages passing over said apertures, means for applying groups of code pulses to said third and fourth deflection means, feedback means between said target electrode and the deflection plates in one of said coordinates, and feedback means between said auxiliary target and the deflection plates in the other of said coordinate directions to cause said electron beam to maintain a position on one of said finger-like appendages.

10. Electron discharge apparatus comprising a first target electrode having a row of apertures therein, a first cathode means to generate an electron beam, a first means for focusing and accelerating an electron beam, a first electron beam deflection means comprising first members capable of deflecting the beam in a first coordinate direction and second members capable of deflecting the beam in a second coordinate direction, said first deflection means being positioned between said first means and said first target electrode, an auxiliary electrode having a series of parallel finger-like appendages of varying lengths extending across the front of said first target electrode, some of said appendages passing over said apertures, said auxiliary electrode being positioned between said first deflection means and said first target electrode, means for applying groups of code pulses to said deflection means to cause said electron beam to move in a coordinate direction substantially normal to said finger-like appendages, feedback means between said first target electrode and said first members to cause said electron beam to move in said first coordinate direction, feedback means between said auxiliary target and said second members to cause said electron beam to maintain a position on one of said finger-like appendages, a second cathode means to generate a second electron beam, a second means for focusing and accelerating said sec-

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ond electron beam, a second target electrode comprising a plurality of individual third targets, second electron beam collecting means positioned between said second cathode means and said second means, said first deflection means comprising a third member capable of deflecting the beam in a first coordinate and a fourth member capable of deflecting the beam in said second coordinate, said fourth members being electrically connected with said second member so that the deflection of said electron beam in said first coordinate direction is dependent upon the deflection of said first electron beam in said first coordinate direction.

11. Electron discharge apparatus comprising a tapered resistance member, an output circuit including said resistance member, means for projecting a first electron beam against said member, an input circuit closed by said beam to one end of said member whereby the output is determined by the position of said beam upon said member, and means for selectively determining the position of said beam upon said member comprising means for producing a second electron beam, a series of deflection means for deflecting said beam in one direction, the deflection sensitivities of successive deflection means decreasing in a preassigned ratio, target means against which said second beam is projected, means for energizing said deflection means successively in accordance with a binary code of pulses, means including a feedback coupling between said target means and said deflection means for resolving each group of such pulses into a potential across one of said deflection means of respective amplitude represented by such group and means for deflecting said first beam along said resistance member a distance proportional to the potential resulting from each group of pulses.

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