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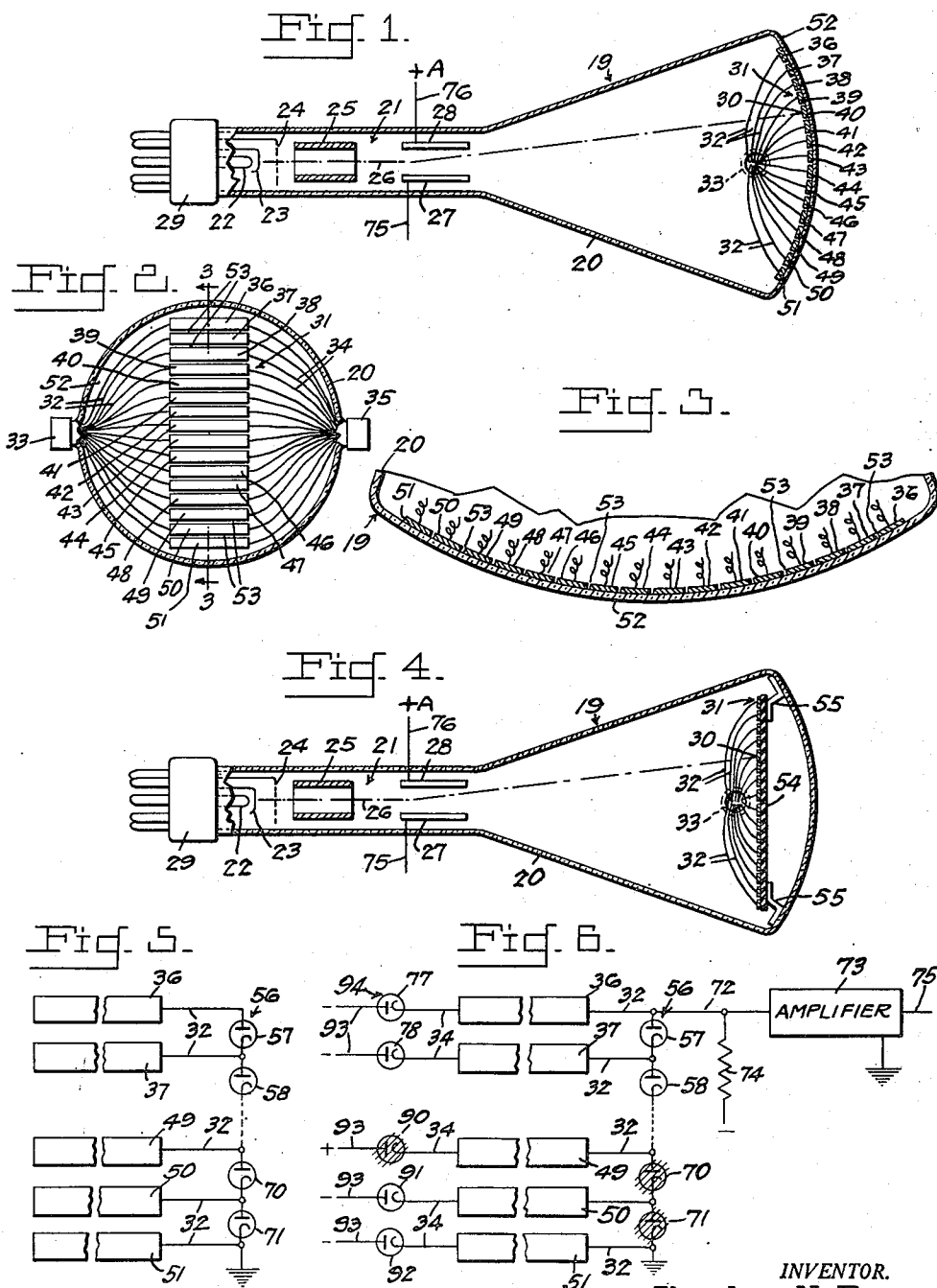
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2,656,485

MEMORY TUBE CONTROL DEVICE

Filed Oct. 8, 1951

2 Sheets-Sheet 1



INVENTOR.
Chester H. Page
BY
K. J. Kessenich, A. W. Dew
and J. H. Refan
ATTORNEYS

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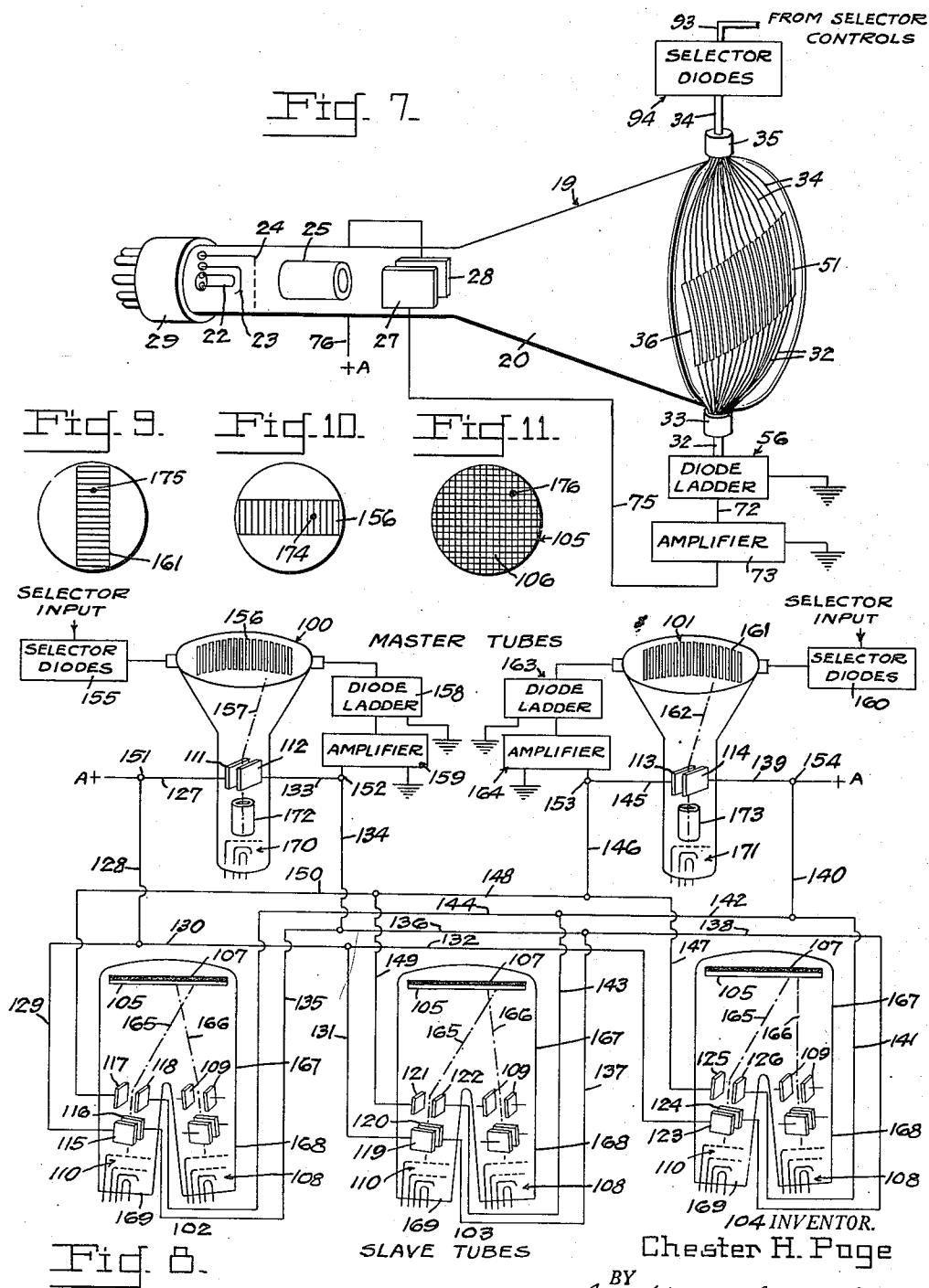
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INVENTOR.
Chester H. Page
BY
G. J. Kessenich, A. W. Dew
and J. H. Ryan
ATTORNEYS

UNITED STATES PATENT OFFICE

2,656,485

MEMORY TUBE CONTROL DEVICE

Chester H. Page, Silver Spring, Md., assignor to
the United States of America as represented
by the Secretary of the Army

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sec. 266)

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The invention described in the specification and claims may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

This invention relates to cathode ray tubes of the type known as memory tubes and more particularly to means for controlling the position of an electron beam in such tubes.

A difficulty encountered in cathode ray tubes is returning the spot formed by the electron beam upon the screen of the tube to a predetermined location on the screen. It is accordingly a primary object of the present invention to develop means for positioning the beam of a cathode ray tube as desired. This difficulty becomes of importance where it is necessary to scan a selected portion of a charged mosaic screen such as may be found in iconoscopes and in some types of memory tubes. A second object of the invention is therefore development of means to position the beam of a cathode ray tube to scan a predetermined part of the screen of the tube. Other objects of the invention will be evident hereinafter.

I have found that a particular type of cathode ray tube in conjunction with a special control circuit will serve to position the spot developed by the electron beam. This cathode ray tube is constructed with a segmented metallic target for the cathode beam and constructed in segments, each of which is connected to a ladder of diodes grounded at one end. These diodes are held normally non-conducting but are selectively rendered conducting by positive signals fed to the segments. The output of the diodes is supplied to an amplifier. Positioning of the beam in the tube is determined by the output of the amplifier connected to one of a pair of electrostatic deflection plates in the tube and by a positive bias supplied to the other of the same pair of deflection plates from any convenient external source. The construction of the control cathode ray tube and of its circuit will be understood more easily from a consideration of the following description and the appended drawings in which:

Figure 1 is a longitudinal section of the cathode ray tube of the present invention;

Figure 2 shows a view of the target of the cathode ray tube;

Figure 3 is a section along line 3—3 of Figure 2;

Figure 4 is a longitudinal section of another embodiment of the tube of the invention;

Figure 5 is an enlarged view of part of the target showing connections with the diode ladder;

Figure 6 is an enlarged view of part of the target showing selector inputs and some of the

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selector and ladder diodes in the conducting state;

Figure 7 is a block diagram of the entire control circuit of the tube, the latter being in perspective;

Figure 8 shows the tube of this invention used as a master control tube for several slave memory tubes;

Figure 9 shows the electron spot of the tube of this invention in position on a vertical segmented target;

Figure 10 shows the electron spot in position on a horizontal segmented target; and

Figure 11 shows the spot of a slave tube positioned horizontally and vertically as by a master tube.

The cathode ray tube 19 (Figure 1-4) of this invention consists of an evacuated envelope 20 of ordinary design containing a conventional electron gun 21 with heaters 22, cathode 23, grid 24 and anode 25. An electron beam 26 is emitted by gun 21 and passes through a single pair of electrostatic deflection plates 27 and 28. Connections to the elements of the electron gun may be made through base 29. Electron beam 26 impinges at a spot 30 on a narrow segmented target 31 attached through leads 32 to receptacle 33 and through leads 34 to receptacle 35. The tube as shown has a target 31 with sixteen segments but any desired number may be used. Since it will be necessary to refer to some of the segments of the target separately, they are designated by the numbers 36-51 inclusive although identical physically.

Target 31 is carried by screen 52 and may be formed by depositing a metallic coating in the shape of a long narrow rectangle onto a dielectric surface. The coating is then cut through to the dielectric by straight scratches 53 to form the numbered segments. While the envelope 20 may be of any suitable material, it is essential that screen 52, carrying the target, be a non-conductor and that the segments of the target itself be conductive. If desired the target may be formed on a separate screen 54 (Figure 4) suspended by retainers 55 within the envelope 20. One each of leads 32 and 34 must be electrically connected to a respective segment only and make a separate external contact through conventional receptacles 33 and 35.

Segments 36-51 are connected through leads 32 to receptacle 33 and through the receptacle to a ladder 56 of diodes only four of which 57, 58, 70, and 71 are shown. (Figures 5 and 6.) As illustrated the upper segment 36 is connected to the plate of diode 57. The cathode of this diode 57 is joined to the plate of the second diode 58 the

cathode of which in turn is connected to the plate of the next lower diode (not shown). Thus the junction between diodes 57 and 58 is connected to the second lower segment 37 of the target. A number of segments and associated circuitry have been omitted from Figures 5 and 6 as indicated by the dotted lines but the connections are made in the same manner down the entire diode ladder. The top segment may be considered as associated with the top diode, that is connected to the plate or anode, the second segment with the second diode and so on, cathodes being connected to successive plates. The lowest segment 51 is shown connected directly to ground but it may also be associated with a diode if desired, as will be evident from the description of the operation of the circuit given hereinafter.

The upper end of the diode ladder 56 is connected through line 72 to an amplifier 73 as well as to upper segment 36. This amplifier is of any conventional type, as for example a simple triode, so long as sufficient amplification is obtained for a purpose to be described. The amplifier furthermore need not be linear. Bias is supplied to the amplifier 73 through resistor 74. The output of amplifier 73 is applied by means of lead 75 to deflection plate 27 of the cathode ray tube 19. The other deflection plate 28 is connected through lead 76 (Fig. 7) to any convenient source of positive potential represented by A. Source A may consist of a battery grounded at the negative end or any other steady high voltage.

In addition to the connections to the diode ladder 56, each segment of the target has a lead 34 through receptacle 35 to one of the bank 94 of selector diodes only five of which 77, 78, 99, 91 and 92 are shown. Each segment is connected directly in one to one correspondence with the cathode of respective ones of the selector diodes. Thus segment 36 is connected to 77, 37 to 78, and so on down through 51 which is connected to diode 92. There is no interconnection between the diodes of this bank 76. The plates of these diodes 77 etc. are joined through individual selector leads 93 to a selector unit (not shown) conventional in the computer art and forming no part of this invention. As will be seen the selector acts like a switch, normally holding all the diodes in a non-conducting state as by putting a negative voltage on the plates thereof or by creating a break in the circuit. When it becomes desirable to activate one of the diodes the selector merely removes the negative voltage or closes the circuit. Figure 7 shows schematically connections of the tube itself.

The operation of the circuit thus far described is quite straightforward and follows to some extent principles already utilized, as in the patents to Sunstein 2,455,532, 2,528,020 and 2,540,016. The cathode ray tube 19 operates in a conventional manner. When the cathode is heated and the voltages on the usual controls are adjusted an electron beam is emitted and strikes the conductive target. The positive bias from a source A applied to one of the single pair of electrostatic deflection plates is sufficient to deflect the beam to the upper or amplifier connected segment of this target. The cathode beam, however, being composed of electrons, acts as a source of negative current. This current as long as it impinges on any segment of the target supplies a signal to the amplifier where it is amplified and inverted. The amplification of this amplifier is chosen of a size to develop a voltage able

to overcome the positive bias from source A. The amplified signal, now positive in sign, is supplied to the second 75 of the single pair of deflection plates in operation to the bias given by A and accordingly drives the cathode beam to the bottom or grounded segment 51 of the segmented target as plate 28 becomes negative with respect to plate 27. It may be noted that the amplified signal cannot drive the beam off the target completely. If for some reason the beam did get off the conducting segments the amplifier would no longer receive a negative signal and the positive A bias operating alone would immediately bring the beam back to the top segment. With these conditions obtaining enough of the spot formed at the point of impact of the beam on the target will always remain on the target to generate the amplified positioning signal. Essentially the tube is therefore a voltage generating device with a sequence of voltage appearing at the electrostatic plates of the right magnitude to deflect the electron beam to predetermined positions on the screen.

To illustrate the function of the selector diodes, reference is made to Figure 6. Assume first that all the selector leads 93 are in the normal condition holding the selector diodes non-conducting. In this situation the electrostatic deflection plates of the cathode ray tube are actuated by the positive bias supplied by A and the amplified positive signal originated by the electron beam. As pointed out above the electron beam will come to rest in a position where enough of the signal generated by the electrons can reach the amplifier to form an amplified voltage just overbalancing the A bias. In the figure, segment 51 is grounded. If all of the electron beam were impinging on segment 51, only the positive bias would be operative on the deflection plates and the beam would be immediately deflected to the top segment in the target, segment 36. Consequently the normal position of the electron beam will be at least touching segment 50, the lowest segment not directly connected to ground.

Assume now that the equilibrium of the system is suddenly disturbed by the injection of a positive signal into one of the selector diodes, diode 90 for example, by means of its particular input lead 93. Diode 90 immediately begins conducting thus driving segment 49, to which it is directly connected, positive. The plate of diode 70 in the amplifier diode ladder in turn becomes positive, diode 70 begins conducting, drives the plate of diode 71 positive and causes diode 71 to conduct. The cathode of diode 71 is grounded. Since an electron stream is now travelling between segment 49 and ground, segment 49 is also effectively grounded. Unless a shift in the position of the electron beam takes place the situation obtains spoken of previously as impossible, that is, the situation in which the beam is impinging on a part of the target not affecting the amplifier at the same time the positive bias is operating on the electrostatic deflection plates. In actual fact however the bias pulls the beam back on the target immediately and a new equilibrium is set up with the beam touching the lowest segment still not grounded. With segment 49 grounded, the lowest segment conducting to the amplifier is 48. Consequently the new position assumed by the electron beam is one touching segment 48.

The sequence of events outlined in the immediately preceding paragraph is repeated whenever an inactive selector diode nearer the top of the

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bank than one presently active is rendered conductive. Thus if diode 78, connected to segment 37, is activated, segment 37 and all segments lower than 37 in the target are grounded and the cathode beam is immediately shifted to contact with segment 36. If the top diode 77 starts conducting the entire target is grounded and the amplifier has no influence on the position of the cathode ray spot, that is, the cathode beam takes the position determined by the positive bias.

The sequence of activation of segments can be reversed by cutting out selector diodes high in the bank in favor of lower diodes. The amplified cathode beam signal immediately pulls the beam down to the lowest ungrounded segment, the beam assuming the position necessary to generate enough amplified signal to overcome the positive bias. It will thus be observed that a cathode ray beam can be made to take instantaneously any one of a number of predetermined positions within a cathode ray tube merely by indicating the desired position by means of an electronic switch. Actually a simple manual switch could be used to replace the bank of selector diodes, a positive potential being supplied by a battery grounded at the negative end. Such a manual switch would however be entirely too slow for use in computers where rapid calculation is necessary.

A feature of the cathode ray tube as described thus far is utilization of a single pair of deflection plates. A single pair only is needed because positioning of the beam in only one direction, which may be described as either vertical or horizontal, is required. It will be evident to those skilled in the art that both vertical and horizontal positioning can be obtained in one tube by use of the customary two pairs of deflection plates. Such positioning requires a separate set of selector and amplifier diodes for each pair of plates. The target for such a tube is a lined mosaic resembling that of Figure 11. Since the tubes will however be normally used as controls and since two tubes with a single pair of plates will perform the duties of the more complicated tube with two pairs of plates, a detailed discussion of the latter is believed unnecessary.

Figure 8 gives a circuit diagram utilizing the tube previously described as a control for memory tubes. Tube 100 is the horizontal positioning control for the reading beam of the memory tubes 102, 103 and 104 while tube 101 is the vertical positioning control. In this circuit the control tubes may be called masters and the controlled tubes slaves. The cathode beam 157 of horizontal positioning tube 100 is driven to a pre-selected position on the target of the tube through selector diodes 155 as discussed above while the beam 162 of tube 101 is driven to another pre-selected position through diodes 160. The memory tubes are so connected to the masters that their respective reading beams assume automatically the same position horizontally as the beam of tube 100 and that vertically of the beam of 101. A bank of three memory tubes only is diagrammed but any desired number may be slaved to the same two masters. It is assumed that the dimensions of the screen and the linear sensitivity of the slave tubes are the same as the corresponding characteristics of the masters but predetermined positions will be in any case assumed by the beams of the slaves.

The memory tubes of Figure 8 are quite similar to those described by Haeff in "Electronics," September 1947, pages 80-83. A bifurcated envelope 167 is shown but the plain envelope of the

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cited publication may be utilized instead. These memory tubes 102, 103 and 104 contain identical mosaic screens 105 upon which can be stored desired information in the form of electric charges. Each screen 105 consists of numerous discrete metallic particles 106 deposited or otherwise mounted on a dielectric support 107. A pattern of electrostatic charges induced on the particles will be retained intact for some time since they cannot leak away. Each of the memory tubes carries in bifurcation 168 an electron gun 108 and associated deflection plates 109 utilized to establish the desired charge pattern on the screen 105 by means of electron beam 166. This process is called writing. External connections to the guns 108 and the plates 109 may be made in exactly the manner prescribed by the Haeff publication and are accordingly omitted from the drawing.

In bifurcation 169 each of the memory tubes carries a second conventional electron gun 110 producing an electron beam 165 used to scan the mosaic and withdraw information stored there. This process may be termed reading and is possible because of the fluctuations in the beam 165 caused by the deposited charges. Beam 165 may be used in addition to restore the electrons that leak away with time no matter how good the dielectric properties of the screen, thus enabling data to be dynamically stored for any desired period. A third electron gun may however be used to carry out this holding function.

In order that a predetermined area of the memory mosaic may be scanned the electrostatic deflection plates of the tubes are connected in parallel with the plates of the control tubes. Thus plate 111 of tube 100 is connected through leads 127, 128, and 129 to plate 115 of tube 102, through leads 127, 128, 130 and 131 to plate 119 of tube 103 and through leads 127, 128, 130 and 132 to plate 123 of tube 104. The positive A bias of tube 100 is connected to plate 111 through junction 151. Deflection plate 112 of tube 100 connects with the amplifier 159 through junction 152 of leads 133 and 134 and through these leads and 135 to plate 116 of tube 102, through 133, 134, 136 and 137 to plate 120 of tube 103 and to plate 124 of tube 104 through leads 133, 134, 136 and 138. Plates 115 and 116, 119 and 120 and 123 and 124 are thus seen to be connected in parallel with the plates 111 and 112 of horizontal control tube 100. In like manner the deflection plates of vertical master tube 101 are connected in parallel with the vertical plates of the slave tubes. Plate 114 is connected through leads 139, 140 and 141 to plate 126 of tube 104. The positive bias of tube 101 enters at junction 154 of leads 139 and 140. Plate 114 is also connected through leads 139, 140, 142 and 143 to plate 122 of tube 103 and through leads 139, 140, 142 and 144 to plate 118 of tube 102. The connections to plate 113 are through leads 145 and 146, amplifier 164 being joined to the circuit at the junction 153 of these leads. Lead 146 connects through lead 147 to plate 125 of tube 104, through 148 and 149 to plate 121 of tube 103 and through 148 and 150 to plate 117 of tube 102.

The control systems of the master tubes 100 and 101 are those described previously. Selector diodes 155 are individually connected to the segments of target 156 in tube 100. Electron beam 157, generated by conventional electron gun 170, passes through anode 172 and is deflected by plates 111 and 112, to the desired seg-

ments of the target. The output of target 156 connects through diode ladder 158 and amplifier 159 to plate 112. Positive bias is supplied to the other plate 111. The connections of tube 101 are similar to those of tube 100 but it is to be emphasized that the tubes are entirely independent of each other. Selector diodes 160 are connected to the segments of target 161 which is struck by beam 162. This beam is generated by conventional gun 171, passes through anode 173 and is deflected by plates 113 and 114. Plate 113 is connected to the target 161 through amplifier 164 and diode ladder 163. Plate 114 carries the usual positive bias.

The operation of the entire circuit diagrammed in Figure 8 can be better understood by reference to Figures 9, 10 and 11. Figure 9 shows the target 161 of vertical control master tube 101 with the spot 175 made by beam 162 impinging thereon. Spot 175 is held in position on the line separating segments 12 and 13 in the target by proper choice of the selector diodes. Since the vertical plates of each of the slave tubes are connected in parallel with the plates of the vertical control, the spots 176 of the former are in the corresponding vertical position on mosaic 195. In like manner Figure 10 shows the target 156 of horizontal positioning control 100 with the spot 174 made by beam 157. This spot 174 is held in the horizontal position on the line dividing segments 12 and 13. Because of the parallel connections the spots 176 of the slave tubes assume the corresponding horizontal position on the mosaics. The targets of Figures 9 and 10 are shown at right angles to each other merely for purposes of clarity. Figure 11 illustrates the final position taken by the beams 165 of the slaves in response to the signals from the master tubes. It will be evident that any other desired position of the scanning beams of the slaves can be indicated merely by choice of the necessary selector controls. Since all controls are electronic, shifts in scanning position and scanning of information can be made in periods of microseconds.

I claim:

1. In a system for positioning the electron beam of a first cathode ray tube, a second cathode ray tube containing a pair of electrostatic plates for deflecting the electron beam thereof, an electrically conductive target for the electron beam formed of discrete rectangular segments separated by non-conductors, one end of said target being grounded means for grounding any selected number of segments including said grounded end, means for developing a potential on the electrostatic plates to retain the electron beam striking a spot about the non-conductor between adjacent grounded and non-grounded segments, and means for adjusting the potential on electrostatic plates in said first cathode ray tube in direct relationship to the potential of the electrostatic plates of said second cathode ray tube.

2. In a system for positioning the electron beam of a first cathode ray tube, a second cathode ray tube comprising a pair of electrostatic plates for deflecting the electron beam thereof and an electrically conductive target for the electron beam formed of discrete metallic rectangular segments separated by insulators, means for grounding in sequence all of the segments beginning with that at one end of said target, means for generating on the electrostatic plates voltage for retaining the electron beam on a position at least touching the ungrounded segment adjacent a grounded segment and means synchronizing the position of

the beam of the first cathode ray tube with that of the second.

3. In a system for positioning the electron beam of a first cathode ray tube, a second cathode ray tube comprising a pair of electrostatic plates for deflecting the electron beam thereof, an electrically conductive target for the electron beam formed of discrete segments, one end of said target being grounded, means for grounding any selected number of segments including said grounded end, means for developing a potential on the said electrostatic plates to retain the electron beam striking about a spot between adjacent grounded and non-grounded segments, and means for adjusting the potential on the electrostatic plates in said first cathode ray tube in direct relationship to the potential of the said electrostatic plates of said second cathode ray tube.

4. In a system for positioning the electron beam of a first cathode ray tube having electrostatic deflection plates, a second cathode ray tube comprising a pair of electrostatic plates for deflecting the electron beam thereof and a conductive target for the said beam formed of discrete metallic segments, means for grounding any selected number of the said segments, means for generating on the electrostatic plates of the said second tube voltage for retaining the electron beam on a position at least touching the ungrounded segment adjacent a grounded segment, and means for adjusting the potential on said electrostatic plates in said first cathode ray tube in direct relationship to the potential of the electrostatic plates of said second cathode ray tube.

5. In a system for positioning the electron beam of a first cathode ray tube having deflection plates, a second cathode ray tube comprising a pair of deflection plates for deflecting the electron beam thereof and a conductive target for the said beam formed of discrete electrically conducting segments, one end of said target being grounded, a diode ladder for grounding any selected number of segments including said grounded end, means for developing a potential on the deflection plates to retain the electron beam striking at about a spot between adjacent grounded and non-grounded segments, and means for adjusting the potential on said deflection plates in said first cathode ray tube in direct relationship to the potential of the said deflection plates of said second cathode ray tube.

6. In a system for positioning the electron beam of a first cathode ray tube having deflection plates, a second cathode ray tube comprising a pair of deflection plates for deflecting the electron beam thereof and a conductive target for the said beam formed of discrete electrically conducting segments separated by insulators, one end of said target being grounded, a diode ladder for grounding any selected number of segments including said grounded end, means for developing a potential on the deflection plates of the said second tube to retain the electron beam striking a spot about the insulator between adjacent grounded and non-grounded segments, and means for adjusting the potential on the said deflection plates in said first cathode ray tube in direct relationship to the potential of the said deflection plates of said second cathode ray tube.

7. In a system for positioning the electron beam of a first cathode ray tube having electrostatic deflection plates, a second cathode ray tube comprising a pair of electrostatic deflection plates for deflecting the electron beam thereof and a conductive target for the said beam formed of dis-

crete electrically conducting segments separated by insulators, one end of said target being grounded, a diode ladder for grounding any selected number of segments including said grounded end, means comprising an amplifier for developing a potential on the electrostatic deflection plates of said second tube to retain the electron beam striking a spot about the insulator between adjacent grounded and non-grounded segments, and means for adjusting the potential on the said deflection plates in said first cathode ray tube in direct relationship to the potential of the said electrostatic deflection plates of said second cathode ray tube.

CHESTER H. PAGE.

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