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CATHODE RAY CONTROL APPARATUS

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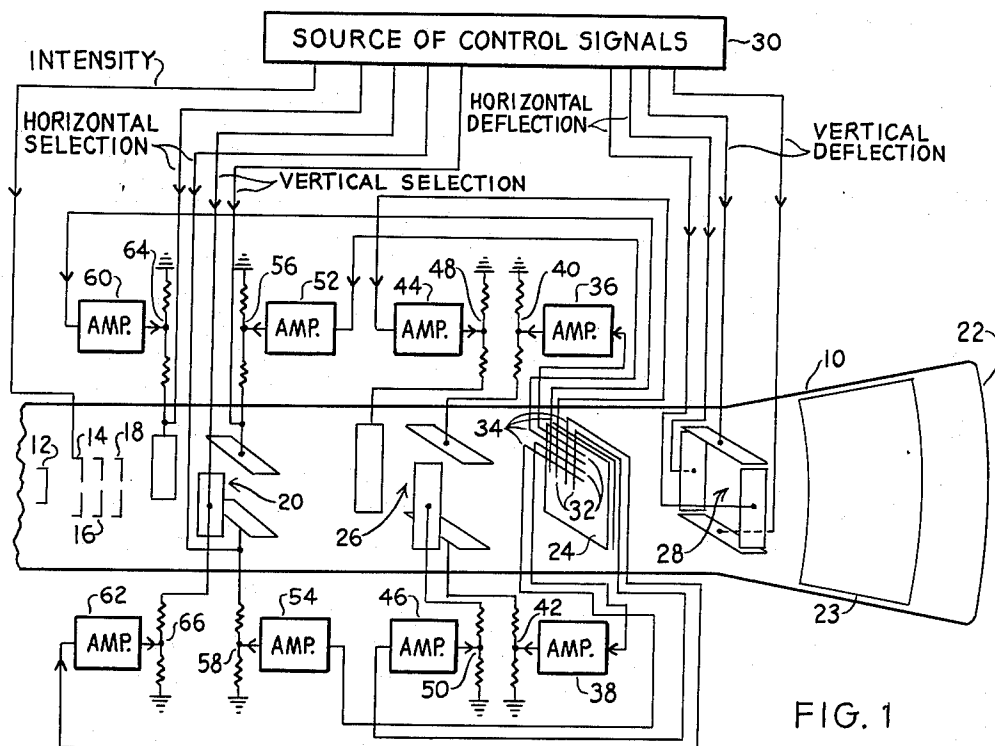


FIG. 1

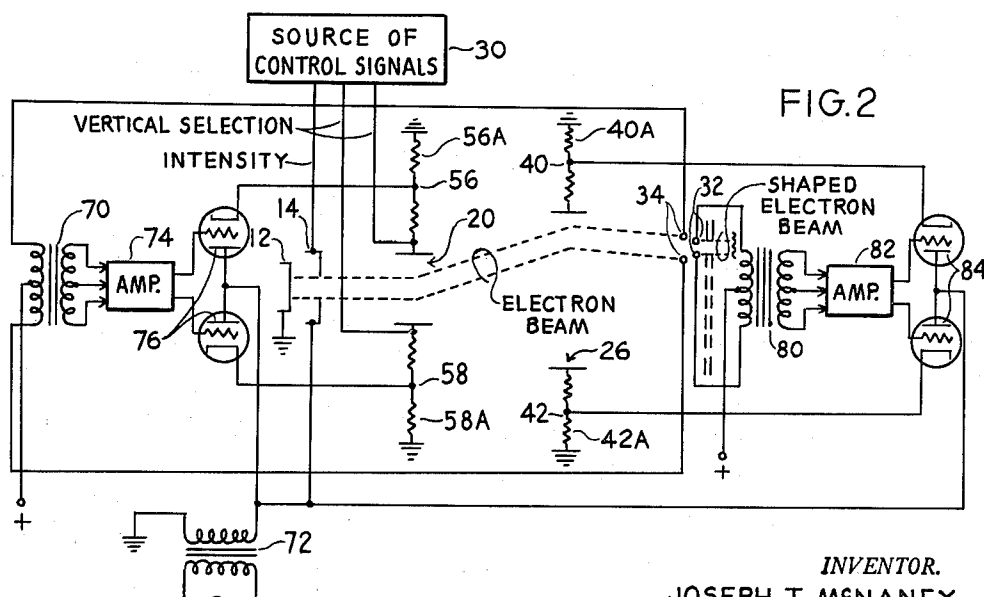


FIG. 2

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CATHODE RAY CONTROL APPARATUS

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Application January 13, 1953, Serial No. 330,993

10 Claims. (Cl. 315-21)

This invention relates to arrangements for controlling the deflection of the beam of electrons in cathode-ray apparatus.

In my copending application Serial No. 297,480, filed on July 7, 1952, I disclosed one form of cathode-ray apparatus for selectively displaying predetermined images, such as characters, on the screen of a cathode-ray tube. This apparatus is particularly suitable for displaying information at high speeds; and it may be employed with suitable recording apparatus to provide a printed record of the displayed information.

The cathode-ray apparatus disclosed in the aforesaid patent application employs a thin solid member located along the path of the beam of electrons in a cathode-ray tube. A plurality of apertures are provided in the solid member for controlling the cross-sectional shape of the electron beam, and the individual apertures are shaped in the form of the configurations to be displayed, say in the form of characters. A pair of deflection systems are located between the electron gun of the tube and the solid member, and when the electron beam passes through a selected aperture, its cross-section is shaped in the form of the aperture. The two deflection systems may be employed to direct the electron beam through the selected individual apertures and also to position the electron beam on the screen of the tube. However, I prefer to provide an additional deflection system located between the solid member and the screen of the tube for directing the electron beam toward predetermined locations on the screen of the tube.

When employing two deflection systems for the dual means of selecting individual apertures in the matrix and directing them to a common point on the screen of the tube, it is, at the present time, necessary to apply one control voltage to plates nearest the gun that are not necessarily linear with respect to the required control voltages of the plates next to the matrix. Due to this non-linear relationship it was difficult to accurately select and to accurately direct every available character to a common reference point on the screen.

In accordance with the present invention, I provide an arrangement which compensates for this non-linear relationship, and furthermore, causes the electron beam to be centered on the selected apertures so that the beam of electrons, after it has been shaped by passing through an aperture in the solid member, is directed toward a common location on the screen of the tube. Such an arrangement permits the use of a simplified deflection system for directing the beam of electrons toward the screen of the tube after it has been shaped by passing through the solid member.

A plurality of conductors are located at the side of the solid member facing the electron gun, with the conductors defining a pair of frames around the respective apertures and with one frame of each pair being located closer to the solid member than the other frame. Amplification means is coupled between the conductors defining the frames which are located farthest from the solid member and the deflection system which is located closest to the electron gun for providing correction signals which cause the electron beam to be centered on the respective selected frames toward which it is projected. Amplification means is also coupled between the conductors forming the frames which are closest to the solid member and the other deflection system for providing control signals which cause the electron beam to be centered

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on these frames. Thus, the control arrangement serves to cause the electron beam to be centered upon the respective selected apertures and it also causes the electron beam to be projected through the solid member along the alignment axes of the respective pairs of frames and the apertures associated therewith.

I prefer to arrange the conductors so that the frames which are located closest to the solid member are smaller than the other frames. Also, I prefer to align the respective pairs of frames and the apertures associated therewith so that their alignment axes converge at a common point in the tube which is located between the solid member and the screen. With such an arrangement, the electron beam is caused to pass through the common point irrespective of the location of the aperture through which it is projected. This facilitates positioning the electron beam on the screen of the tube by means of a deflection system located adjacent the common point.

The invention is explained with reference to the drawings, in which:

Fig. 1 is a simplified diagram showing the control apparatus of my invention; and

Fig. 2 is a schematic diagram illustrating one arrangement for providing control signals for the apparatus of my invention.

The cathode-ray tube 10 shown in Fig. 1 has a conventional electron gun comprising a cathode 12, a control electrode 14, a focusing electrode 16, and an accelerating electrode 18. A conventional electrostatic deflection system 20 is located adjacent that electron gun, and a conventional screen 22 is located at the other end of the tube. Preferably an intensifier anode 23 is provided adjacent the screen of the tube.

A solid member 24 having a plurality of apertures which extend through the thickness of the member is located along and disposed substantially perpendicularly with respect to the path of the electron beam. The member 24 may be composed of a conductive or of a non-conductive material. The material of the solid member should be thin so that it will not cause undesirable distortion of the electron stream as it passes through the selected apertures. Ordinarily the apertures are shaped in the form of the letters of the alphabet and any desired numbers and punctuation marks. Only one character-shaped aperture is shown in Fig. 1 in order to simplify the present description.

A set of electrostatic deflection plates 26 is located between the deflection plates 20 and the solid member 24, and another set of electrostatic deflection plates 28 is located between the solid member 24 and the screen of the tube.

The set of deflection plates 20 is employed to direct the electron beam toward selected individual apertures in the solid member 24, and the set of deflection plates 26 is employed to cause the electron beam to be directed through the selected apertures along predetermined axes. The set of deflection plates 28 is employed to direct the shaped electron beam toward the desired positions on the screen of the tube, so that the information is displayed along horizontal lines.

A source 30 of control signals is provided for producing suitable horizontal and vertical selection signals for the deflection plates 20, and for providing suitable horizontal and vertical deflection signals for the deflection plates 28. The source 30 of control signals also provides a signal to the control electrode 14 of the electron gun for controlling the intensity of the electron beam. Ordinarily the control electrode 14 of the electron gun is blocked until suitable potentials have been applied to the deflection plates 20 and 28, whereupon the control electrode 14 is unblocked to permit electrons to flow from the electron gun through the solid member 24 to the screen 22.

In order to simplify the present disclosure, apparatus for providing the accelerating and focusing potentials for the various elements of the tube are not shown. It will be apparent that these potentials may be provided in accordance with conventional cathode-ray tube techniques.

When the beam of electrons is directed toward a selected aperture in the solid member 24 by the deflection system 20, it is ordinarily not precisely centered on the character to be displayed. This condition is caused by non-linearities in the deflection system and by variations in the voltage of the sources which supply potentials for the deflection system. If this condition exists, the intensity of the portions of the electron beam which are projected through the aperture in the solid member and onto the screen of the tube are not uniform because the electron beam itself is not of uniform cross-sectional density. Hence it is desirable to direct the electron beam toward the solid member 24 so that it is centered on the character to be displayed.

In order to cause the electron beam to be centered upon the respective character-shaped apertures toward which it is directed, and in order to cause the shaped electron beam to pass between the deflection plates 28 at a substantially common location, I provide an auxiliary control arrangement which applies correction signals to the sets of deflection plates 20 and 26. In effect, the correction system is a servo-control which causes the electron beam to be centered on the selected apertures in the solid member and which also causes the electron beam to pass through the apertures in the solid member along axes which converge at a common location between the deflection plates 28.

A set of conductors 32 is arranged to define frames around the respective apertures, with the respective frames aligned with the apertures in the solid member.

Another set of conductors 34 is arranged to provide another set of frames which is spaced farther from the solid member than the first set. Preferably the spacing between the conductors 34 is slightly greater than that between the conductors 32 so that the frames which are nearer the solid member are smaller than the other frames.

The individual conductors which define each frame are located adjacent one another but they are electrically insulated from one another. If the solid member 24 is composed of conductive material, the conductors 32 and 34 may be supported by an insulating material affixed to the solid member. If the solid member is composed of a non-conductive material such as glass, the conductors may be located in grooves in the solid member.

The horizontal conductors of the set 32 are connected to amplifiers 36 and 38, and the outputs of these amplifiers are connected to voltage dividers 40 and 42. The voltage dividers 40 and 42 are connected to the vertical deflection plates 26, and the signals developed across these dividers serve to control the vertical position of the electron beam.

The vertical conductors of the set 32 are connected to amplifiers 44 and 46, and the outputs of these amplifiers are connected to voltage dividers 48 and 50. The voltage dividers 48 and 50 are connected to the horizontal deflection plates 26, and the signals developed across these dividers serve to control the horizontal position of the electron beam.

In a like manner, the horizontal and vertical conductors of the outer set of conductors 34 are coupled to the vertical and horizontal deflection plates 20 through amplifiers 52 and 54 and voltage dividers 56 and 58, and through amplifiers 60 and 62 and voltage dividers 64 and 66 respectively.

The conductors of the sets 32 and 34 and the amplifiers associated therewith are arranged to provide direct current control signals for the deflection systems 20

and 26 which vary in accordance with the number of electrons of the beam which impinge upon the respective conductors.

Thus, the apparatus associated with the outer conductors 34 serves to provide correction signals for the deflection system 20 which cause the electron beam to be centered on the outer frame around the aperture, and the apparatus associated with the inner conductors 32 serves to provide control signals for the deflection system 26 which cause the electron beam to be centered on the inner frame around the aperture. Since the frames defined by the conductors 32 and 34 are aligned, the electron beam is projected through the aperture in the solid member along the axis defined by the frames.

The schematic diagram of Fig. 2 shows a suitable circuit arrangement for providing the required control signals. In order to simplify the disclosure, only the control signals which are applied to the vertical deflection plates of the deflection systems 20 and 26 are shown.

The horizontal conductors of the set 34 are connected across the primary winding of a transformer 70, and a center tap on the primary winding is maintained at a positive potential with respect to the cathode 12 of the tube. The intensity of the electron beam is modulated by means of a signal which is applied through a transformer 72 to the control electrode 14 of the electron gun. Hence an alternating current signal is applied to the primary winding of the transformer 70, and the phase of the signal is determined by the conductor of the set 34 upon which the electron beam impinges.

The secondary winding of the transformer 70 is connected to an amplifier 74, and the output of the amplifier 74 is connected to a phase detector 76. The output of the phase detector 76 is connected across the legs 56A and 58A of the voltage dividers 56 and 58.

If the electron beam is initially directed by a vertical selection voltage from the source 30 so that it impinges upon the lower horizontal conductor of the set 34 but not upon the upper horizontal conductor of the set 34, the control apparatus serves to increase the voltage drop across the resistor 56A so that the vertical deflection plates 20 cause the electron beam to be deflected upward until it is centered between the upper and the lower horizontal conductors of the set 34.

The upper and lower horizontal conductors of the set 32 are also connected to the primary winding of a transformer 80, and a center tap on the primary winding of this transformer is maintained at a positive potential with respect to the cathode 12 of the tube. The secondary winding of the transformer 80 is connected to an amplifier 82. The output of the amplifier 82 is connected to a phase detector 84, and the output of the phase detector 84 is connected across the legs 40A and 42A of the voltage dividers 40 and 42.

The deflection plates 26 act upon the electron beam simultaneously with the action of the deflection plates 20. When the electron beam is initially directed toward a frame defined by the conductors 34, it impinges upon the upper horizontal conductor of the set 32 and it does not impinge upon the lower horizontal conductor of the set 32. For this situation, the voltage drop across the resistor 40A is reduced and the voltage drop across the resistor 42A is increased so that the vertical deflection plates 26 cause the electron beam to bend downward as it passes between the plates 26. Hence, the electron beam is positioned as illustrated in Fig. 2 of the drawings.

The frames defined by the sets of conductors 32 and 34 may be aligned with the respective apertures in the solid member 24 in any desired manner. I may prefer, for example, to align the respective pairs of frames and the apertures so that the electron beam is caused to pass through a common location between the solid member and the screen of the tube irrespective of the aperture through which it is directed. In other words, the respective pairs of frames and the apertures associated

therewith are aligned so that their alignment axes converge at a common location between the solid member and the screen of the tube.

If desired, the respective pairs of frames and the apertures associated therewith may be aligned so that the electron beam is caused to be disposed substantially perpendicularly with respect to the solid member 24 as it passes through the apertures. That is, so that the alignment axes of the respective pairs of frames and the apertures associated therewith are substantially parallel to one another. This arrangement has the advantage that undesired distortions of the cross-sectional shape of the electron beam due to the thickness of the solid member 24 are reduced.

The source 30 of control signals may be manually operated if desired. However, it is preferable that the source 30 operate automatically in response to code signals representing the information to be displayed. One suitable source 30 of control signals which operates automatically is disclosed in my copending application Serial No. 295,589, filed on June 25, 1952.

If an automatic source of control signals for the cathode-ray tube is employed, the tube may be employed to display information at a high speed, say of the order of 10,000 characters per second.

Although electrostatic deflection arrangements are illustrated in the drawings, it will be apparent that electromagnetic deflection systems may be employed also.

I claim:

1. Cathode-ray apparatus comprising an evacuated container, an electron gun for projecting a beam of electrons along the container, a solid member having a plurality of apertures therein located along the path of the electron beam, first deflection means located adjacent the electron gun for directing the electron beam toward selected apertures in the solid member, second deflection means located between said first deflection means and the solid member, a plurality of conductors located at the side of the solid member facing the electron gun, the conductors defining a pair of frames around the respective apertures with one frame of each pair being located nearer the solid member than the other frame, said pair of frames being aligned with each other and with said apertures to cause said beams to converge at a common point along the axis of said container, and means coupled between the conductors and the first and second deflection means for providing control signals for the deflection means and causing the electron beam to be centered on the respective selected pairs of frames.

2. Cathode-ray apparatus comprising an evacuated container, an electron gun for projecting a beam of electrons along the container, a solid member having a plurality of apertures therein located along the path of the electron beam, first deflection means located adjacent the electron gun for directing the electron beam toward selected apertures in the solid member, second deflection means located between said first deflection means and the solid member, a plurality of conductors located at the side of the solid member facing the electron gun, the conductors defining a pair of substantially square frames around the respective apertures with one frame of each pair being smaller and located nearer the solid member than the other frame, the conductors of each frame being insulated from one another, said pair of frames being in alignment with each other and said apertures for causing said beams to converge on the axis of said container at a common point, and amplification means coupled between the individual conductors of each frame and the first and second deflection means for providing control signals for the deflection means in accordance with the quantity of electrons which impinge upon the respective conductors and causing the electron beam to be centered on the respective selected pairs of frames.

3. Cathode-ray apparatus comprising an evacuated container, an electron gun for projecting a beam of electrons along the container, a beam-shaping member located along the path of the electron beam for altering the cross-sectional shape of the beam in accordance with the portion of the beam-shaping member through which the electron beam is projected, first deflection means located adjacent the electron gun for directing the electron beam through selected portions of the beam-shaping member, second deflection means located between said first deflection means and the beam-shaping member, a first lattice composed of a plurality of conductors disposed at the side of the beam-shaping member which faces the electron gun, a second lattice composed of a plurality of conductors disposed between the first lattice and the electron gun, the conductors of each lattice defining a plurality of substantially square frames with the respective frames being aligned with the portions of the beam-shaping member through which the electron beam may be projected said alignment being adapted to cause said beams to converge at a common point along the axis of said container, the conductors defining each frame being insulated from one another and the frames defined by the second lattice being larger than the frames defined by the first lattice, and means coupled between the lattices and the deflection means for providing control signals for the deflection means and causing the electron beam to be centered on a selected pair of frames.

4. In cathode-ray apparatus having an evacuated container with an electron gun located at one end for projecting an electron beam along the container, a solid member having at least one aperture therein located along and disposed substantially perpendicularly with respect to the path of the electron beam, first deflection means located adjacent the electron gun for directing the electron beam toward said aperture in the solid member, and second deflection means located between said first deflection means and the solid member, the improvement which comprises a first set of four conductors located at the side of the solid member facing the electron gun, a second set of four conductors located between said first set and the electron gun, the conductors of each set being insulated from one another and providing a substantially square frame around said aperture, said first set of conductors, said second set of conductors and said apertures being so aligned as to cause convergence of said beams at a common point along the axis of said container, amplification means coupled between each of the conductors of said second set and the first deflection means for providing correction signals for the first deflection means in accordance with the area of the portions of the respective conductors upon which the electrons of the beam impinge to cause the electron beam to be centered on the square frame defined by the second set of conductors, and amplification means coupled between each of the conductors of the first set and the second deflection means for providing control signals for the second deflection means in accordance with the area of the portions of the respective conductors upon which the electrons of the beam impinge and causing the electron beam to be directed along the axis defined by the two sets of frames around the aperture.

5. Cathode-ray apparatus comprising an evacuated container, an electron gun for projecting a beam of electrons along the container, a solid member having a plurality of apertures therein located along the path of the electron beam, deflection means located between the electron gun and the solid member for directing the electron beam toward selected apertures in the solid member, a plurality of conductors located at the side of the solid member facing the electron gun, the conductors defining a pair of frames around the respective apertures with one frame of each pair being located nearer the solid member than the other frame, said pair of frames being in substantial alignment with each other and said apertures to cause said

beams to converge at a common point along the axis of said container the conductors of each frame being insulated from one another, and means coupled between the conductors and the first and second deflection means for providing control signals for the deflection means and causing the electron beam to be centered on a selected aperture.

6. In cathode-ray apparatus having an evacuated container with an electron gun located at one end for projecting an electron beam along the container, a solid member having a plurality of apertures therein located along the path of the electron beam, first deflection means located adjacent the electron gun for directing the electron beam toward selected apertures in the solid member, and second deflection means located between said first deflection means and the solid member, the improvement which comprises two sets of conductors located adjacent the solid member on the side facing the electron gun, and means coupled between the conductors and the first and second deflection means for providing control signals for the deflection means and causing the electron beam to be aligned with a selected aperture the conductors of each set extending substantially perpendicularly with respect to the path of the electron beam and defining a plurality of substantially square frames, the respective frames formed by one of the sets of conductors being aligned with the frames formed by the other set of conductors and with the apertures in the solid member to cause said beams to converge at a common point along the axis of said container, and the conductors of each frame being insulated from one another.

7. Cathode-ray apparatus comprising an evacuated container having a screen located at one end and an electron gun located at the other end for projecting a beam of electrons toward the screen, a solid member having a plurality of character-shaped apertures therein located between the electron gun and the screen and disposed substantially perpendicularly with respect to the path of the electron beam, first deflection means located adjacent the electron gun for directing the electron beam toward selected apertures in the solid member, second deflection means located between said first deflection means and the solid member, and a plurality of conductors located at the side of the solid member facing the electron gun, the conductors defining a pair of frames around the respective apertures with one frame of each pair being smaller and located closer to the solid member than the other frame, and the respective pairs of frames and the apertures associated therewith being aligned so that their alignment axes converge at a common location in the container between the solid member and the screen said location being equidistant and in the electrical center of a positioning deflection means.

8. Cathode-ray apparatus comprising an evacuated container having a screen located at one end and an electron gun located at the other end for projecting a beam of electrons toward the screen, a solid member having a plurality of character-shaped apertures therein located between the electron gun and the screen and disposed substantially perpendicularly with respect to the path of the electron beam, first deflection means located adjacent the electron gun for directing the electron beam toward selected apertures in the solid member, second deflection means located between said first deflection means and the solid member, a plurality of conductors located at the side of the solid member facing the electron gun, the conductors defining pairs of frames around the respective apertures with one frame of each pair being smaller and located closer to the solid member than the other frame, the respective pairs of frames and the apertures associated therewith being aligned so that their alignment axes converge at a substantially common location in the container between the solid member and the screen to cause said beams to converge at said common location along the axis of said container, and means coupled between the

conductors and the first and second deflection means for causing the electron beam to be selectively centered on the axes of the respective selected apertures and the pairs of frames associated therewith.

9. Cathode-ray apparatus comprising an evacuated container having a screen located at one end and an electron gun located at the other end for projecting a beam of electrons toward the screen, a solid member having a plurality of character-shaped apertures therein located between the electron gun and the screen and disposed substantially perpendicularly with respect to the path of the electron beam, first deflection means located adjacent the electron gun for directing the electron beam toward selected apertures in the solid member, second deflection means located between said first deflection means and the solid member, a plurality of conductors located at the side of the solid member facing the electron gun, the conductors defining pairs of frames around the respective apertures with one frame of each pair being smaller and located closer to the solid member than the other frame, the respective pairs of frames and the apertures associated therewith being aligned so that their alignment axes converge at a common location in the container between the solid member and the screen to cause said beams to converge at said common location, means coupled between the conductors and the first and second deflection means for causing the electron beam to be selectively centered on the axes of the respective selected apertures and the pairs of frames associated therewith, so that the cross-section of the beam of electrons is shaped in the form of the individual apertures through which the beam of electrons is projected, and third deflection means located adjacent said common location for directing the shaped beam of electrons toward predetermined locations on the screen.

10. In cathode-ray apparatus having an evacuated container with an electron gun located at one end for projecting an electron beam along the container, a solid member having a plurality of apertures therein located along the path of the electron beam, first deflection means located adjacent the electron gun for directing the electron beam toward selected apertures in the solid member, and second deflection means located between said first deflection means and the solid member, the improvement which comprises two sets of conductors located adjacent the solid member on the side facing the electron gun, the conductors of each set extending substantially perpendicularly with respect to the path of the electron beam and defining a plurality of substantially square frames, the respective frames formed by one of the sets of conductors being aligned with the frames formed by the other set of conductors and with the apertures in the solid member to cause said beams to converge at a common point along the axis of said container, amplification means coupled between the individual conductors of one of the sets of conductors and the first deflection means for providing control signals for the first deflection means in accordance with the quantity of electrons which impinge upon the individual conductors of the first set, and further amplification means coupled between the individual conductors of the other set of conductors and the second deflection means for providing control signals for the second deflection means in accordance with the quantity of electrons which impinge upon the individual conductors of the second set.

References Cited in the file of this patent

UNITED STATES PATENTS

2,237,671	Kallmann	Apr. 8, 1941
2,275,017	McNaney	Mar. 3, 1942
2,283,383	McNaney	May 19, 1942
2,379,880	Burgess	July 10, 1945
2,513,743	Rajchman	July 4, 1950
2,519,172	Brown	Aug. 15, 1950
2,522,291	Marrison	Sept. 12, 1950