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CATHODE RAY TUBE SIMULTANEOUSLY GENERATING
A PLURALITY OF SHAPED ELECTRON BEAMS
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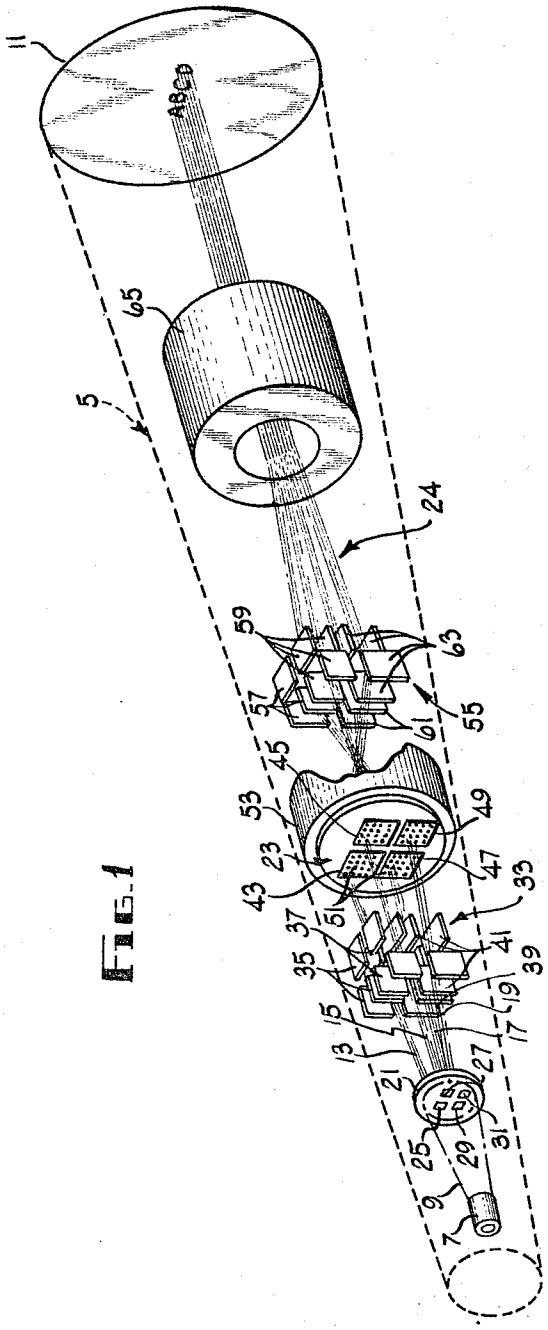


FIG. 1

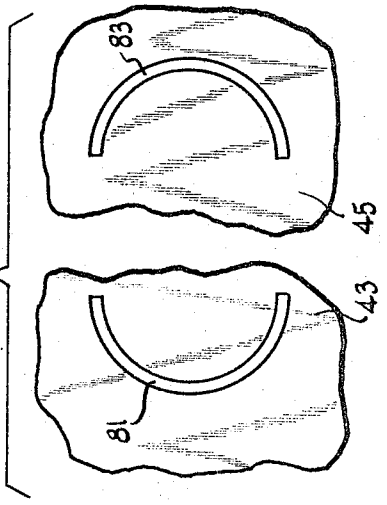


FIG. 3

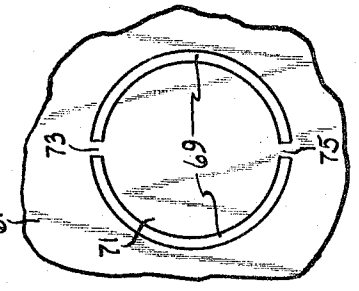


FIG. 2

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CATHODE RAY TUBE SIMULTANEOUSLY GENERATING A PLURALITY OF SHAPED ELECTRON BEAMS

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ABSTRACT OF THE DISCLOSURE

A shaped beam tube in which an electron beam is divided into a plurality of separate electron beams and the separate electron beams are then passed through a means for forming a cross section of each beam. The shaped beams are then directed and focused so as to impinge on a screen to thereby produce displays corresponding to the cross sections of the beams.

This invention relates to shaped beam tubes such as are used to store or display characters or similar information. More particularly, the invention relates to an improved shaped beam tube and to a means and method for producing a plurality of shaped electron beams therein.

A shaped beam tube is a cathode ray tube wherein an electron beam is shaped as it passes from an electron gun to a phosphor coated screen such that the cross section of the beam is of a pre-selected configuration. The area of the screen energized by impingement of the beam thereon, therefore corresponds in shape to the shaped cross section of the beam. Shaped beam tubes of this type are manufactured and sold by Stromberg-Carlson Corporation under the registered trademark Charactron.

Normally, in such shaped beam tubes the electron beam is shaped by passing the same through a selected one of a series of stencil-like apertures in an electron opaque plate. The stencil-like apertures correspond to characters, such as letters of the alphabet. A number of characters are shaped such that an island is formed by the aperture forming the character. To retain such islands in position bridges are provided, which bridges cause discontinuities in the characters displayed on the screen. These discontinuities may be aesthetically objectionable and preclude certain characters, such as Chinese characters from being displayed.

It is sometimes preferred to utilize a shaped beam tube having several electron beams in order to increase the brightness of the data displayed, the quantity of data displayed, or the repetition rate. In such a tube, the positional relationship of the energized areas on the screen is affected by the positional relationship between the sources of each of the separate electron beams. Where each electron beam is produced by a separate electron gun, variation in the relative positional relationships of the guns may occur due to thermal expansion and contraction of structural elements, or may occur as a result of outside vibration and shock. Moreover, during assembly, the precision of mechanical adjustment of the position of several electron guns may be limited.

Although tolerable for some types of displays, variation and limited precision in the relative positional relationship of several electron guns may be intolerable where the positional relationship between two energized areas on the target screen is critical to the quality of the resultant display. For example, the accuracy of a map or graph, or the quality of a character, depends on an accurate relationship between the various lines of which it is composed. If different portions of a character or different line segments in a graph or map are produced by separate

electron beams, display quality may be severely impaired due to the aforementioned variation or limited precision in the relative position of several independent electron beam sources. Moreover, the use of an independent source for each of several electron beams may render a tube too expensive or complex for some purposes.

It is an object of this invention to provide an improved shaped beam tube. Another object is the provision of a means for producing a plurality of shaped electron beams in a shaped beam tube. Still another object is to provide a shaped beam tube which is capable of producing complex images of a high quality. A further object is to provide a shaped beam tube utilizing a plurality of electron beams which are not susceptible to excessive variation in positional relationship at their source. A more specific object is to provide an improved shaped beam tube using an apertured electron-opaque plate, and which is capable of producing high quality images of items, such as certain alphanumeric characters, without the necessity for bridge support in the plate. A still further object is to provide a shaped beam tube, utilizing a plurality of electron beams, which is low in cost and of relatively simple construction.

Other objects of the invention will become apparent to those skilled in the art from the following description taken in connection with the accompanying drawing wherein:

FIGURE 1 is a perspective schematic view of a shaped beam tube constructed in accordance with the invention;

FIGURE 2 is a plan view of a portion of an apertured plate of a type which has been previously employed in a shaped beam tube; and

FIGURE 3 is a composite view of two apertured plates used in one embodiment of the tube shown in FIGURE 1.

Very generally, the shaped beam tube comprises an elongated, evacuated envelope **5**, which includes at one end thereof an electron gun **7** for producing a beam **9** of electrons and, at the other end thereof, an energizable target screen **11**. The electron beam produced by the electron gun is divided into a plurality of separate electron beams **13, 15, 17** and **19** by means **21**. The separate electron beams are passed through a beam shaping means **23** for forming the cross section of each beam into a preselected shape. The shaped beams are then directed and focused by a means **24** and impinge on the screen **11** to thereby produce displays corresponding to the cross sections of the beams.

Referring now more particularly to FIGURE 1, the various elements of the shaped beam tube are shown contained within the elongated evacuated envelope **5** indicated by the dashed lines. The electron gun **7** for producing the beam of electrons, indicated at **9** is disposed at one end of the envelope **5**. The electron gun may be of any suitable construction, and appropriate provision is provided for electrical connection, not illustrated, to provide proper potentials for the various parts of the electron gun. For example, the electron gun may comprise an emissive cathode which is heated to produce emission of electrons. Such electrons are accelerated and focused into the beam **9**, which is diverging and relatively large in cross section, by suitable electrodes (not shown).

The electron beam **9** produced by the gun is divided into four separate electron beams **13, 15, 17** and **19** by the dividing means **21**. In the illustrated embodiment, the dividing means comprises an electron opaque plate having four apertures **25, 27, 29** and **31** therein.

Selecting means **33** are included in the envelope **5** for directing the four electron beams so that each impinges on a selected portion of the apertured plate or beam shaping member **23** described hereinafter. The selecting means **33** include four sets **35, 37, 39** and **41** of deflecting plates, one set for each beam. Each of the sets of plates includes a pair

of parallel plates for vertical deflection of the associated electron beam and a pair of parallel plates for horizontal deflection of the associated electron beam. Suitable electrical connections, not illustrated, are made to the plates in each set for establishing potentials thereacross to accomplish a desired beam deflection.

Variation of the potential across the pairs of plates in each of the sets **35**, **37**, **39** and **41** causes deflection of the associated electron beam **13**, **15**, **17** or **19** to thereby select one portion of the beam shaping means **23**. The beam shaping means includes four matrices or members **43**, **45**, **47** and **49**, one member being provided for each beam. Preferably all four matrices are etched or formed from a single sheet of metal. Each beam shaping member includes a plurality of apertures **51** arranged in rows and columns. Each aperture **51** forms the beam passing therethrough into its shape, the shape depending upon the desired reproduction upon the screen **11**, and each may comprise all or part of an alphanumeric character, or other representation such as a spaced segment of the lines of graph or map. In any event, the potential across the plates in the respective sets **35**, **37**, **39** and **41** in the selection assembly **33** is controlled to select a desired aperture with each beam. In this connection, a DC centering voltage is applied to each set of plates to direct the associated beam at the center of the matrix **43**, **45**, **47** or **49**, and a variable voltage is applied to select the proper row or column in the matrix.

Each shaped beam is then converged toward a point on the opposite side of the envelope axis from the associated set of selection plates **35**, **37**, **39** and **41** by an electron lens **53** positioned between the shaping means **23** and the screen **11**. The lens **53** may be electrostatic or electromagnetic and is illustrated as being a tube disposed within the envelope **5**.

Disposed at the points whereat the shaped beams are directed is a reference assembly **55** which deflects the beams so that the four beams are closely spaced and lie in a plane which extends parallel to the axis of the envelope **5**. The illustrated reference assembly **55** comprises four sets **57**, **59**, **61** and **63** of deflection plates, each set including a pair of parallel plates for vertical deflection and a pair of parallel plates for horizontal deflection. The shaped electron beams **13**, **15**, **17** and **19** pass through the respective sets of plates to be deflected thereby. To obtain the required deflection of the beams, a signal composed of three components is applied to each set of plates. First, a variable signal is applied to cancel the component of electron velocity extending perpendicular to the axis of the envelope **5** which was caused by the variable voltages applied to the associate set of selecting plates **35**, **37**, **39** and **41**. The second component is a fixed DC signal which causes the four separate beams to bend so as to intersect at a common point on the screen **11**. In the alternative, this second component may be replaced by the action of a convergence lens. The third component is a minor positioning signal which causes the beams to be slightly displaced from each other in the same plane. This positioning signal may be a fixed DC voltage or a voltage controlled by computer signals.

After the reference assembly **55** has established the relative position between the shaped beams **13**, **15**, **17** and **19**, the beams pass through a deflection means **65**. The deflection means, which may be a yoke positioned within the envelope **55** as shown, or may surround the outside of the tube envelope, operates in accordance with known principles to deflect the group of electron beams passing therethrough to any desired area on the target screen **11**. Since the beams passing through the deflection means **65** are off center, the deflection means **65** is preferably constructed to provide a uniform field.

The target screen **11** may be of any type suitable to the particular application of the shaped beam tube. The screen may, for example, comprise a device for producing a visible display for observation or for photographic recording, or may comprise part of electronic printing apparatus. The surface of the screen may be coated with a material which is energizable in response to electron bombardment. Such a screen may, in the case of a direct viewing screen, be comprised of a suitable phosphor which emits light in response to electron bombardment.

In reviewing the operation of the device, the electron gun **7** produces a primary electron beam **9** which is divided by the apertured plate **21** into a plurality of secondary electron beams **13**, **15**, **17** and **19**. These beams are then each passed through a respective one of the apertures **51** in a respective matrix **43**, **45**, **47** or **49** in the plate **23**. The aperture of each matrix which is used is selected by the selection assembly **33**. The beams shaped by the apertures **51** are then converged by the lens **53** and a relative position therebetween is established by the reference assembly **55**. The relative position of the beams thus being established, the deflection yoke **65** deflects all of the beams to a desired position on the screen **11**. Each beam thereby impinges upon a shaped area of the screen in accordance with the cross sectional shape of the beam.

The shaped beam tube may be employed, for example, to display a "typewriter format." The first four letters are unblanked simultaneously, adjacent one another. Then new selector signals are applied, and the position set by the deflection means is stepped four positions to the right, as viewed from the front of the screen, and the next four characters are unblanked. This operation is continued horizontally across the screen and then the beams are stepped down one position and a second line of characters is started.

By producing a plurality of electron beams from a single beam generated at a single source, rather than producing each beam at an independent source, the beams suffer common position deflection. With separate and independent sources, thermal expansion or outside shock may result in a variation of the relative position between the beams. To compensate for such change in relative position electronically, even if possible, may result in undue complexity in electronic circuitry and problems of delay in sensing and correcting such errors.

The above described construction also makes it easier to establish a desired positional relation, between the sources of the beams, during assembly than is possible with separate electron guns. In the latter case, mounting structure is often subject to tolerance variation and assembly difficulties that affect the relative gun position. The described construction avoids such variation and difficulties since the relative beam source position is established by the apertures **25**, **27**, **29** and **31** when the plate **21** is fabricated. As a practical matter, close tolerances are usually easier to hold during fabrication of one part, rather than in the assembly of many parts.

The foregoing described attributes of the present invention have particular advantage in producing a high quality accurate image upon the target screen **11** where the relative position of the energized areas produced by respective beams is critical. For example, the shaped beam tube may be employed to form characters which do not include the bridges inherent in previously available shaped beam tubes. Referring particularly to FIGURE 2, a portion of a prior art matrix or electron opaque plate **67** having an aperture **69** therein for shaping the beam in a manner to produce the letter O is shown. Naturally, to maintain the desired shape for the aperture **69**, the opaque center **71** of the letter O must be suitably supported. To this end, a pair of bridges **73** and **75** are provided. For high quality printing or visible reproduction, it is desirable to avoid such bridges. Moreover, where complex characters are to be reproduced, such as Chinese characters, extensive bridging may confuse and obscure the character being reproduced.

The foregoing problems may be avoided by utilizing

two of the separate beams **13**, **15**, **17** and **19** and their associated matrices **43**, **45**, **47** and **49** to form one character. Portions of two matrices **43** and **45** are shown in FIGURE 3, one portion including an aperture **81** in the shape of the left half of the letter O, and the other portion including an aperture **31** in the shape of the other half of the letter O. The two electron beams **13** and **15** passing through the respective apertures are positioned relative to each other by the reference assembly **55** so that, when they impinge upon the target screen, the ends of the arcuate segments of the letter O will exactly meet. This produces a letter O which is free from bridges. The same principle may be applied to reproducing other characters without the use of bridges. The invention is of particular advantage in such a technique in that relative displacement between the two or more electron beams used does not occur, due to their origin in a common beam and their division by a single apertured plate.

Alternately, one aperture of the pair forming a character may be shaped like that shown in FIGURE 2, and the other aperture may be shaped to pass a beam corresponding to the shape of the bridges. In other words, the apertures are provided in complementary pairs. The beams are then superimposed on the screen **11** by omitting the third component (the minor positioning signal) of the signal applied to the reference assembly **55**.

It may therefore be seen that the invention provides an improved shaped beam tube and a means producing a plurality of shaped electron beams therein. Excessive change in the relative position of the sources of the electron beams does not occur, thereby enabling the production of superior quality images on a display screen. This is because the relative position of energized areas on the display screen produced by two or more electron beams is not subject to excessive variation due to relative variation in the source of the beams. The invention thereby facilitates the reproduction of complex characters comprised of segments produced by separate electron beams. A particular advantage of the invention is that, in the reproduction of many types of characters, bridging may be avoided. Moreover, only a single electron gun is necessary, effecting a substantial cost reduction over a tube utilizing several electron guns and suitable mounting structure therefor.

Various embodiments of the invention in addition to that shown and described herein will become apparent to those skilled in the art from the foregoing description and accompanying drawings. Such other embodiments and modifications thereof, are intended to fall within the scope of the appended claims.

What is claimed is:

1. In a shaped beam tube, means for producing a plurality of shaped electron beams comprising, means for producing a primary electron beam from a single source of electrons, means for dividing said primary electron beam into a plurality of secondary electron beams, beam shaping means having a plurality of beam shaping apertures, and means for individually deflecting each of said secondary electron beams to pass through selected ones of said beam shaping apertures.

2. A shaped beam tube comprising, an electron gun for producing a primary beam of electrons, a target screen, means positioned between said electron gun and said target screen for dividing the primary electron beam produced by said electron gun into a plurality of secondary electron beams, beam shaping means positioned between said dividing means and said screen for forming the cross section of each of said secondary electron beams into predetermined shapes, and means for directing and focusing the plurality of secondary electron beams to impinge upon areas of said screen, each area corresponding in shape to the cross sectional shape of the associated electron beam.

3. A tube in accordance with claim **2** wherein said dividing means comprise an electron-opaque plate having a plurality of electron apertures therein.

4. A tube in accordance with claim **3** wherein said beam shaping means comprises a second electron opaque plate having a plurality of matrices of electron apertures therein of predetermined shape, said matrices corresponding in number to the number of electron apertures in said first electron opaque plate.

5. A tube in accordance with claim **2** wherein said directing and focusing means include a plurality of first deflection means, one for each of the plurality of electron beams, said first deflection means being positioned between said dividing means and said shaping means, a plurality of second deflection means, one for each of the plurality of electron beams, said second deflection means being positioned between said shaping means and said screen, and an electron lens positioned between said shaping means and said second deflection means for focusing said secondary beams at said second deflection means.

6. A tube in accordance with claim **4** wherein at least two of the matrices have complementary apertures and directing and focusing means appropriately positioning the secondary beams passing through said complementary apertures so as to form complete characters.

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