May 28, 1968 J. T. McNANEY 3,385,990

DEFLECTION THROUGH SELECTED MASK APERTURES OF CATHODE RAYS IN PREDETERMINED CHARACTER SHAPES

Filed Sept. 1, 1967 2 Sheets-Sheet 1

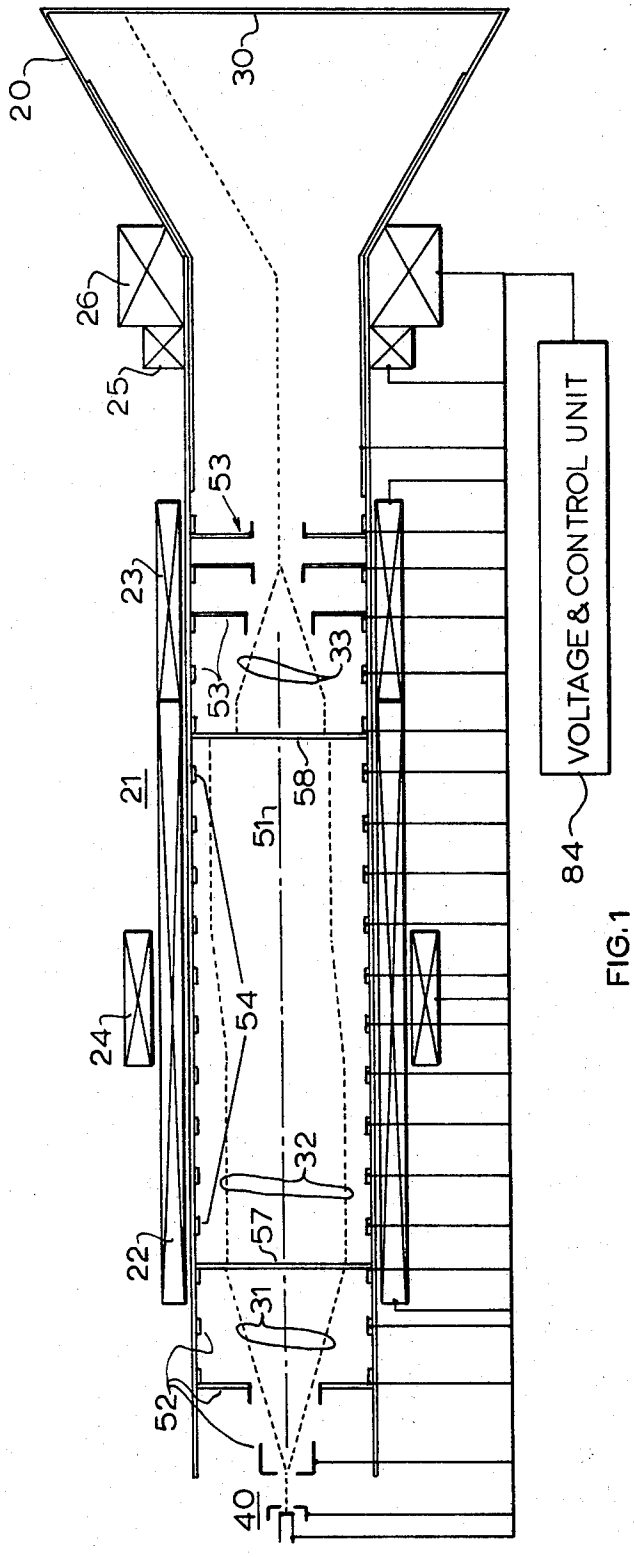


FIG. 1

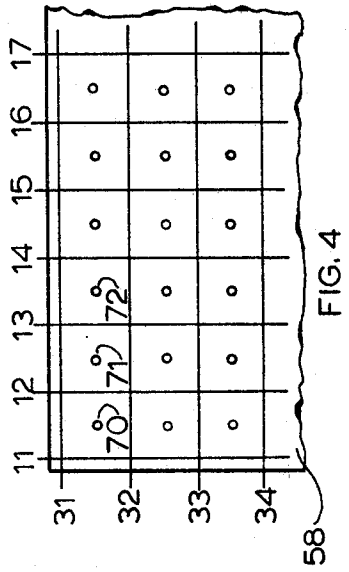


FIG. 4

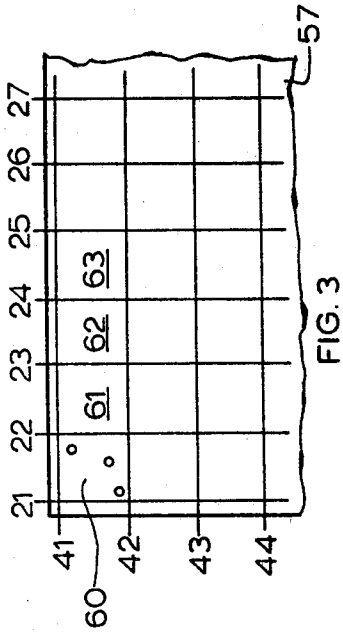


FIG. 3

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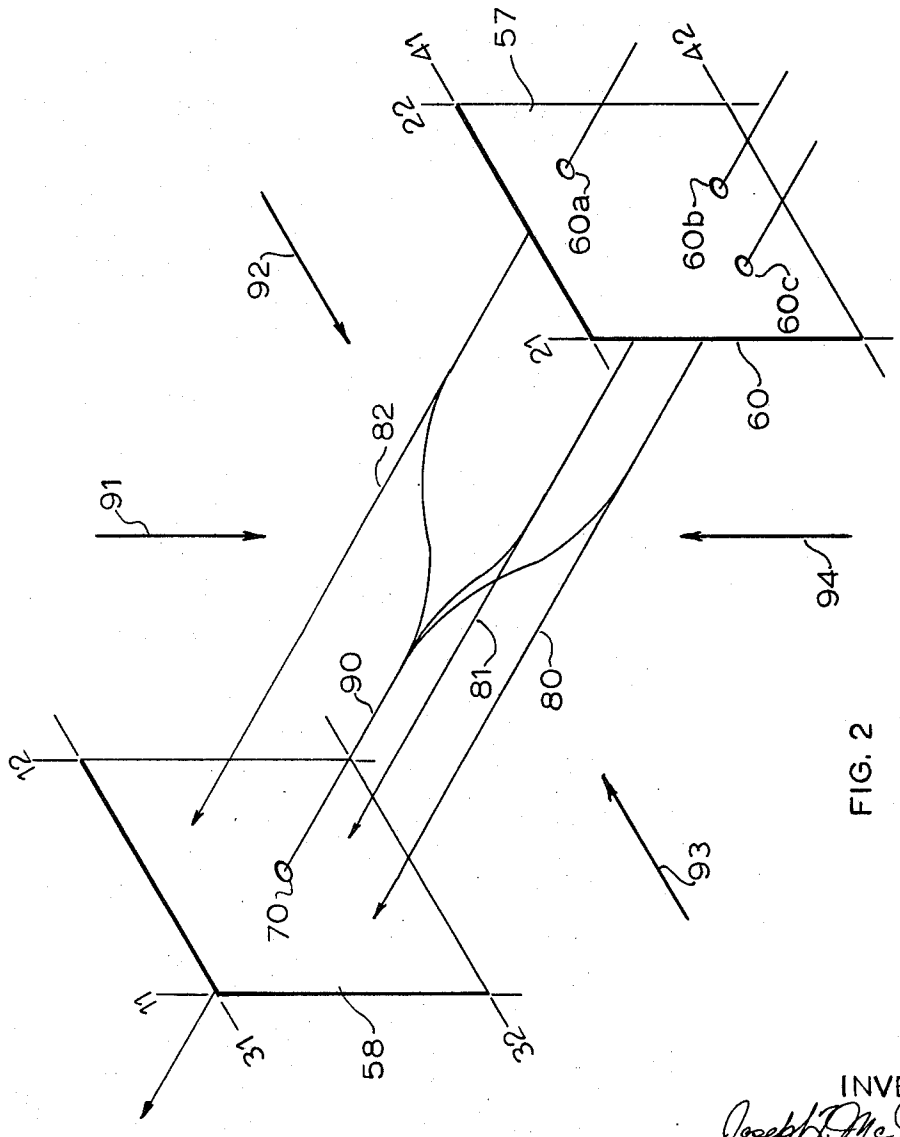


FIG. 2

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DEFLECTION THROUGH SELECTED MASK APERTURES OF CATHODE RAYS IN PREDETERMINED CHARACTER SHAPES

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ABSTRACT OF THE DISCLOSURE

The present invention utilizes novel means in a cathode ray tube for presenting information in the form of characters, such as letters, numerals, symbols, sketches of pictorial information, etc., that may be used for viewing or for record making purposes. These means include the use of a pair of aperture masks supported in the path of a source of electrons in the evacuated portion of the tube or chamber. One mask contains a plurality of arrays of character shaped arrangements of apertures and the other having a plurality of apertures uniformly arranged therein and optically related, respectively, to predetermined portions of the character shaped arrangements of apertures in the one mask.

The character shaped arrays of apertures occupy the same general area of the one mask which, when exposed to the beam of electrons, will provide a plurality of arrays of individual secondary beams that overlap one another in the same general area. An aperture of each such array, therefore, falls within one of a plurality of sub-areas within the general area, and each aperture of the other mask is related to one of these sub-areas and which is used as a beam selecting aperture insofar as its related sub-area and apertures therein are concerned.

The two masks are supported in a spaced apart relationship in the path of electrons and the apertures of one mask are optically related to those in the other mask by means of electron beam collimating and beam displacement control optics, whereby, electrons will enter the apertures of the first mask, travel to the second mask, and emerge from apertures in the second mask in character shaped arrangements along parallel lines. In the process of selecting different shaped arrangements thereof, between the two masks, the electrons are deflected from an initial parallel path to a predetermined secondary path by the beam displacement control means.

Immediately following the masks in the tube there is a focusing lens system for controlling imaging and size conditions of the shaped arrays of electron beams at the surface of a target area in the tube. This lens is then followed by beam deflection means for positioning these arrays on the target. The deflection means includes a minor beam deflection yoke and a major deflection yoke. Currents coupled to the minor yoke will effect a relatively small spiralling, or raster-scanning, of the many small cross section beams included in a shaped arrangement thereof so as to enlarge the target area that might otherwise be impinged by the beams. In doing so a fractional tone arrangement will be modified to appear as a more solid tone arrangement. Currents coupled to the major yoke will control the positioning of the shaped arrangments on the target.

This invention relates to cathode ray tube image display devices and more particularly to such devices wherein a predetermined number of different forms of characters are included in a matrix therein and then selected from the matrix for direction thereof toward a target in the device. The invention is an improvement in cathode ray tubes with predetermined character shaped beam arrangement means disclosed in my U.S. Patent No. 3,329,858.

An object of the present invention is to provide improvements in the utilization of aperture mask assemblies having large numbers of different character formations in a matrix.

Another object is to utilize character selection means for effecting the selection of characters from the mask assembly which is located intermediate the pair of aperture masks in the tube.

Still another object is to utilize selection means in combination with beam control means allowing beams emerging from the second mask to follow parallel lines which are also parallel with the principal optical axis of the tube.

A further object is to utilize beam deflection means in combination with the final beam positioning means to effect a more solid tone array of shaped arrays having otherwise fractional tone characterizations. Other objects and advantages will appear hereinafter as a description of the invention proceeds.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention itself, both as to its originality and method of operation, and additional objects and advantages, will best be understood from the following description when read in connection with the accompanying drawings in which:

FIGURE 1 is a sectional view of a cathode ray device including the beam arrangement means, selection control and final beam positioning means:

FIGURE 2 is a detail of the masking means utilized in the description of the invention:

FIGURE 3 represents a relatively small section of the mask which contains character shaped beam arrays; and

FIGURE 4 represents a relatively small section of the character selection mask.

The cathode ray device of FIGURE 1 is shown to represent an evacuated envelope **20**, having a target area **30** at one end and means for providing a source of electrons **40** at the opposite end. Electron masking means is disposed along the optical axis **51** intermediate the target area **30** and the source **40** which include one mask **57** and another mask **58** spaced a predetermined distance from one another. Externally of the envelope, or tube **20**, there is an electromagnetic coil assembly **21**, illustrated as having a first section **22** and a second section **23**. Also illustrated as being external to the tube **20** is a first electromagnetic deflection means, or yoke, **24**, a second electromagnetic deflection means, or yoke, **25**, and a third electromagnetic deflection means, or yoke, **26**.

Within the tube **20**, between the source of electrons **40** and the one mask **57**, there is a system of lens elements **52**, and between the other mask **58** and the target area **30** there is a second system of lens elements **53**. The first lens elements are designed to cause electrons from the source **40** to essentially flood all of the apertures in the one mask **57**, and the second lens elements **52** are utilized to control the imaging and size conditions of shaped beam arrangements emerging from the other mask **58** upon reaching the target area **30**. Also within the tube **20**, between the two masks **57** and **58**, there is illustrated a series of beam accelerators **54**. A plan view of but portions of the two masks **57** and **58** is shown in FIGURES 3 and 4, and each have predetermined arrays of apertures therein so that the flood beam **31** of electrons may be broken down to an array **32** of minor electron streams after passing through the one mask **57**, and then selectively converted into a particular character shaped arrangement **33** of electron beams after having passed through the apertures of the other mask **58**.

The mask **57** is shown to be divided into a plurality of rows and columns of sub-areas **60**, **61**, **62**, etc., and

each such area is provided with a predetermined number and a predetermined array of apertures therein. The complete system of sub-areas of a complete mask **57** will therefore contain a plurality of overlapping character shaped arrangements of holes, or apertures, therein. The mask **58** is shown to contain a plurality of apertures which correspond with the arrangement of sub-areas of a complete mask **57**. One sub-area of the mask **57** is shown, for example, bounded by lines **21–22** and lines **41–42**, and an aperture **70** of the mask **58**, within an area bounded by lines **11–12** and lines **31–32**, will be located therein to correspond with one another; and the sub-area **61** will correspond with the aperture **71** of mask **58**, etc.

Referring now to a single sub-area **60** of mask **57**, and to the aperture **70** of mask **58**, including the latter's sub-area bounded by lines **11–12** and **31–32**, in FIGURE 2 they are illustrated diagrammatically to show the relationship of apertures in a given sub-area of the one mask **57** to the selecting aperture in the other mask **58**. However, apertures appearing in each of the remaining sub-areas **61**, **62**, etc., of the entire mask **57** will have a similar relationship, respectively, to the selecting apertures **71**, **72**, etc., of the other mask **58**. In the sub-area **60** three apertures have been shown and each of these apertures represent an element of three separate characters which overlap one another throughout the general area of the mask **57**. Depending on the characteristics of these three overlapping arrays the remaining sub-areas may contain apertures at similar, or some other, portions thereof. Although there are but eighteen sub-areas illustrated in the mask of FIGURE 3, and this same amount of selecting apertures illustrated in FIGURE 4, a complete unit may have a 30 x 30 array of sub-areas and selection apertures, or many more if required from the standpoint of character resolution.

An objective of this invention is to include in a single display tube a wide variety of different figures, characters, symbols, etc. Therefore, and for illustrative purposes, the mask assembly **57** and **58** may contain 400 characters in a 20 x 20 array. To exemplify further, if the apertures used in the assembly have a dimension of 0.001" in diameter, and in the mask **57** the apertures are on 0.002" center to center spacings, a 20 x 20 array of positions at which apertures may be placed in each of the sub-areas will require a space of 0.040" x 0.040". A 30 x 30 array of such sub-areas will measure 1.2" x 1.2", and this will be about the total general area requirements of the matrix mask **57** and also the selection mask **58** dimensions.

In my Patent No. 3,329,858 referred to herein, characters are selected from the mask assembly as a function of the angle, with respect to the principal optical axis of the tube, that an initial beam of electrons is directed at the assembly. And this selection angle, which should be kept small, will be related to the spaced apart dimension of the pair of masks. In view of the spacing requirements of the masks when including therein large numbers of different characters, symbols, etc., the present invention utilizes such dimensions of the tube to effect the selection of characters with means located intermediate the masks **57** and **58**, and furthermore, it utilizes beam control means that allows electron beams emerging from the mask assembly to follow lines parallel with the principal optical axis of the tube.

The electron beam **31** is illustrated as flooding the first mask **57** by reason of the lens system **52** and voltages supplied thereto from the unit **84**. Before reaching the mask **57** the electrons **31** will come under the influence of the magnetic field of the coil **22** which is designed to have the minor electron streams from the mask **57** follow parallel lines until they emerge from the second mask **58**. Control voltages from the unit **84** are also coupled to a series of accelerator elements **54** so as to provide field potentials necessary in the projection of electrons **32** through the tube. Control voltages are also coupled to the deflection yoke assembly **24** which, as a function of such voltages, controls the selection of characters through the second mask **58**. This yoke, therefore, deflects the beam **32** from an initial parallel path to secondary parallel paths equal in number to the total number of different characters in the mask **57**. After emerging from the second mask **58**, the character shaped arrangement of electron beams **33** is reduced to the cross sectional dimension necessary and imaged on the target area **30** by means of the lens system **53** and the voltages coupled thereto. In combination with the lens **53**, current from the unit **84** may also be coupled to the coil **23** in effecting the proper size and imaging requirements of the beams **33**.

Referring once again to FIGURE 2, electron beams of the bundle 32 that enter apertures **60***a*, **60***b* and **60***c*, follow initial parallel paths **80**, **81** and **82** until they reach solid areas of the mask **58**. When deflected to a secondary path which permits them to enter the aperture **70**, one beam at a time will then be made to follow the path **90** through the aperture **70**. If beam through aperture **60***a* is deflected by magnetic forces **91** and **92** so as to follow path **90**, the remaining beams will then be deflected to other solid areas of the mask **58**; if beam through **60***c* is deflected by magnetic forces **93** and **94** so as to follow path **90**, the other beams also will be deflected to solid areas of the mask **58**, and so on. The equivalent of a beam **90** path through each aperture of the mask **58** will be paths parallel with the principal axis of the tube.

Selected beam arrangements will be positioned in the target area by means of controlled currents from the unit **84**, and in combination with such positioning the deflection yoke **26** will be used for major deflections while the deflection yoke **25** is being used for minor spiralling or scanning of the selected beam over relatively small areas of the target. Because of the fact that beam arrangements emerging from the second mask **58** may consist of 0.001" diameter beams on perhaps 0.020" centers, or more, the spiralling or scanning of a beam arrangement will close the spacing between individual spots so as to change a fractional tone image to a more solid tone display. When, for example, a selected beam arrangement appearing at the output of the mask **58** is reduced in cross section by some factor, 10 for example, theoretically the 0.001" diameter beams will be reduced accordingly. Therefore, to obtain a solid tone effect of the character being presented the magnitude of deflections used in the spiralling or scanning of a beam arrangement may not be greater than 0.001" to 0.002" from an otherwise stationary position.

The target area **30** of the tube may be any of the well known cathode ray tube phosphors, or it may be a face plate of electrical or light conducting fibers, or it may be an electron responsive media with provisions for transporting such media in and out of the vacuum tube, or, any other type of electron responsive target means.

Although one particular electron source has been illustrated the source **40** may also be in the form of a planar type cathode adjacent the mask **57**. And it should be understood that the positions of the masks **57** and **58** may be reversed whereby the selection aperture mask **58** is actually in a position to be flooded with the electron beam **31** and the selected formations **33** will emanate from the character storage mask **57**. And it should be understood that the electrostatic lens systems and the electromagnetic deflection devices illustrated and referred to herein may be replaced, respectively, with electromagnetic type lens systems and electrostatic deflection means.

Techniques for chemically milling aperture masks **57** and **58** are well known in the trades, and photographic methods of locating apertures in masks such as these are also well known. Attention is called to at least one technique set forth in the U.S. Patent No. 2,969,531.

Although I have limited myself to the showing of certain embodiments of the invention, it should be understood by those skilled in the arts that the invention is not limited in this regard since many of the other embodiments embracing the general principles and construc-

tions hereinbefore set forth may be utilized and still be within the ambit of the present invention.

The particular embodiments of the invention illustrated and described herein are illustrative only, and the invention includes such other modifications and equivalents as may readily appear to those skilled in the arts, and within the scope of the appended claims.

I therefore claim:

1. In a cathode ray tube having an electron beam generator for providing a primary beam of electrons, including:

(a) means for utilizing said beam in providing a plurality of arrays of individual secondary beams of electrons wherein each of said arrays comprises a formation of individual beams representative of a predetermined character shaped arrangement thereof;

(b) said last stated means including a combination of at least two masks each having electron beam limiting apertures therein and supported in the path of electrons from said generator;

(c) one of said masks having a plurality of individual arrays of apertures in the same general area thereof for providing said plurality of arrays of individual secondary beams and wherein an aperture of each said individual array of apertures falls within one of a plurality of sub-areas within said general area whereby said individual arrays of apertures comprise character shaped arrangements of apertures overlapping one another within said general area;

(d) another of said masks having a plurality of apertures wherein each of said apertures is related to a sub-area of said one mask so as to be optically related to apertures of but a portion of a character shaped arrangement of said individual arrays of apertures;

(e) electron beam collimating means and electron beam deflection means;

(f) said masks supported in the path of said electrons at a predetermined distance from one another so as to provide a space between said masks in which electron beams will be deflected from one plurality of paths to another plurality of paths;

(g) said collimating means being adapted to establish said electron beams along said one plurality of paths, and said deflection means being adjacent the space between said masks for deflecting said electron beams to said other plurality of paths.

2. The invention as set forth in claim 1 additionally includes:

(h) a target area;

(i) post-deflection means disposed intermediate said target area and said masks for directing each of said character shaped arrangement of beams toward predetermined positions within said target area.

3. The invention as set forth in claim 2 additionally including:

(j) said post-deflection means including a major beam deflection means for deflecting said shaped arrangement of beams to one of a plurality of different positions within said target area, and minor beam deflection means for imparting minor deflections to said shaped arrangement of beams about said one position.

4. In a cathode ray device having an electron generator for providing a beam of electrons, including:

(a) means for utilizing said beam in providing a plurality of arrays of secondary beams of electrons, each array comprising a formation of individual beams representative of character shaped arrangements of the secondary beams of electrons;

(b) said means including a combination of at least two masks, each having apertures for the passage of electrons therethrough and being supported in the path of electrons from said generator;

(c) electron beam collimating means for directing electrons through the apertures of said masks along predetermined paths;

(d) said apertures in one of the masks being in a same general area thereof for providing, in combination with another of said masks, said plurality of arrays of character shaped arrangements of electron beams and said apertures in the one mask being comprised of character shaped arrangements of apertures overlapping one another and an aperture of each of said character shaped arrangements of apertures is in one of a plurality of sub-areas within said general area;

(e) said other masks having a plurality of apertures wherein each of said apertures is related to a sub-area of said one mask so as to be optically related to apertures of but a portion of a character shaped arrangement of apertures in said one mask;

(f) electron beam deflection means;

(g) said masks supported in the path of electrons so as to provide a space between said masks in which electron beams will be deflected from first predetermined paths to second predetermined paths; and

(h) said deflection means being adjacent said space between the masks for deflecting the electron beams from said first paths to said second paths and thereby change the relationship between the apertures in said sub-areas of the one mask and their corresponding sub-area related apertures in said other mask.

5. The invention as set forth in claim 4 additionally including:

(i) a target area;

(j) means for directing said arrays of character shaped arrangements of electron beams to said target area; and

(k) another electron beam deflection means, intermediate said target area and said masks, for effecting displacements of a character shaped arrangement of electron beams about said second paths thereof and beyond cross sectional limits, respectively, of the individual beams of said array so as to change a fractional tone arrangement of said individual beams in the target area to a less fractional tone arrangement thereof.

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ROBERT SEGAL, *Primary Examiner.*