

## [54] COLOR CATHODE RAY TUBE

[75] Inventor: Donald L. Say, Seneca Falls, N.Y.

[73] Assignee: GTE Sylvania Incorporated, Seneca Falls, N.Y.

[22] Filed: Aug. 31, 1971

[21] Appl. No.: 176,502

[52] U.S. Cl. .... 315/13 CG, 313/69 C

[51] Int. Cl. .... H01j 29/50

[58] Field of Search .... 313/69 C; 315/13 C, 315/13 CG, 31 TV

## [56] References Cited

### UNITED STATES PATENTS

|           |         |                   |              |
|-----------|---------|-------------------|--------------|
| 3,013,178 | 12/1961 | Eaton.....        | 315/13 CG    |
| 3,016,474 | 1/1962  | Hergenrother..... | 315/13 CG    |
| 3,028,521 | 4/1962  | Szegho.....       | 315/13 CG    |
| 3,575,625 | 4/1971  | Miyaoka.....      | 315/13 CG UX |

## OTHER PUBLICATIONS

Darr, Radio-Electronics, January 1966, pp. 46 to 49 TK6540.R24

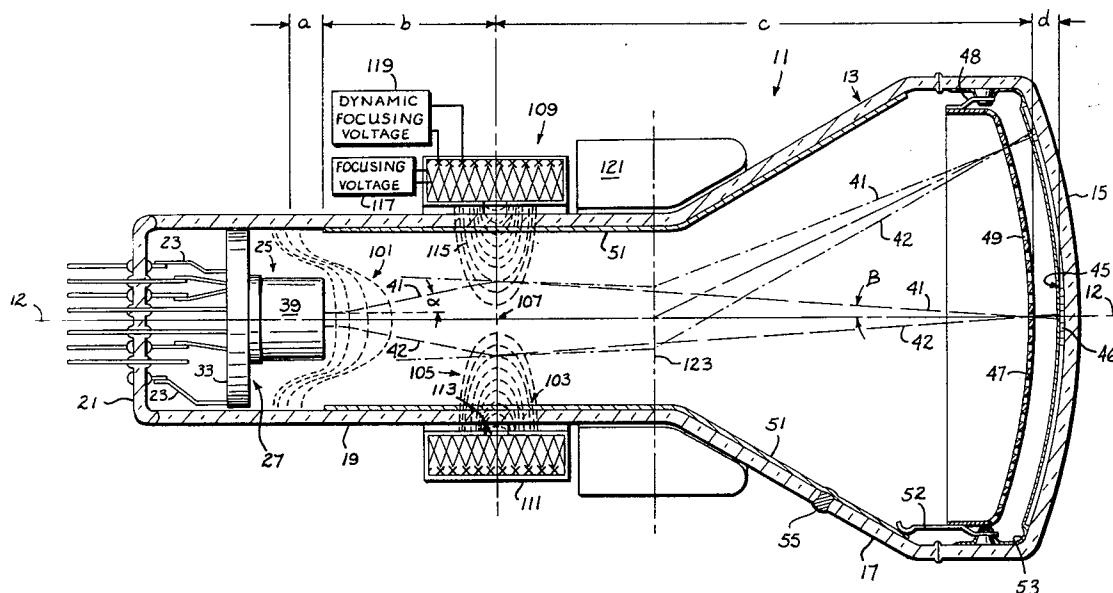
Primary Examiner—Leland A. Sebastian

Attorney—Norman J. O'Malley et al.

## [57] ABSTRACT

A multiple beam color cathode ray tube utilizes a compact electron gun to provide a compact bundle of closely spaced individually controlled electron beams emergent from a common final anode. A neck related coating, at screen potential which is greater than the final anode potential, effects a divergent electron lens that influences the individual beams emerging from the common anode. External magnetic focusing means, positioned ahead of the gun, provides an internal convergent magnetic focusing lens which influences the individual diverging beams by effecting convergence thereof at the apertures in the mask to produce a high resolution luminescent display in the patterned screen therebeneath.

7 Claims, 3 Drawing Figures



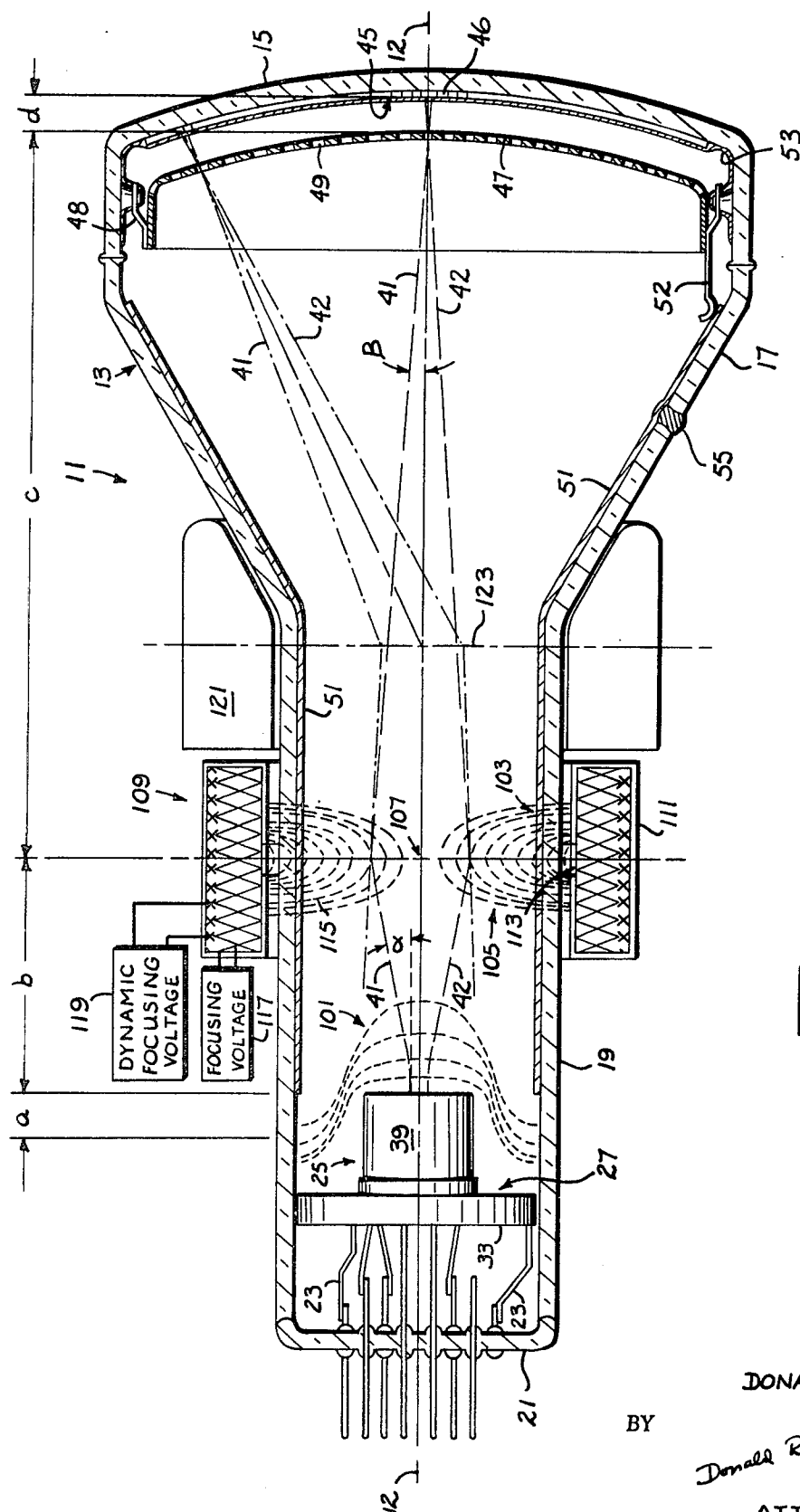


Fig. 1

INVENTOR.  
DONALD L. SAY

BY

Donald R. Castle

ATTORNEY

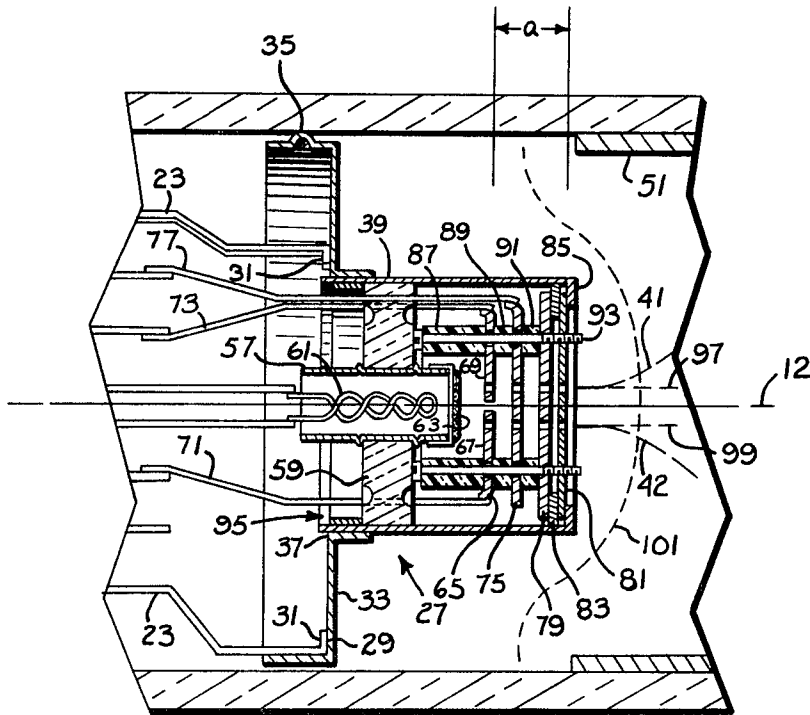


Fig. 2

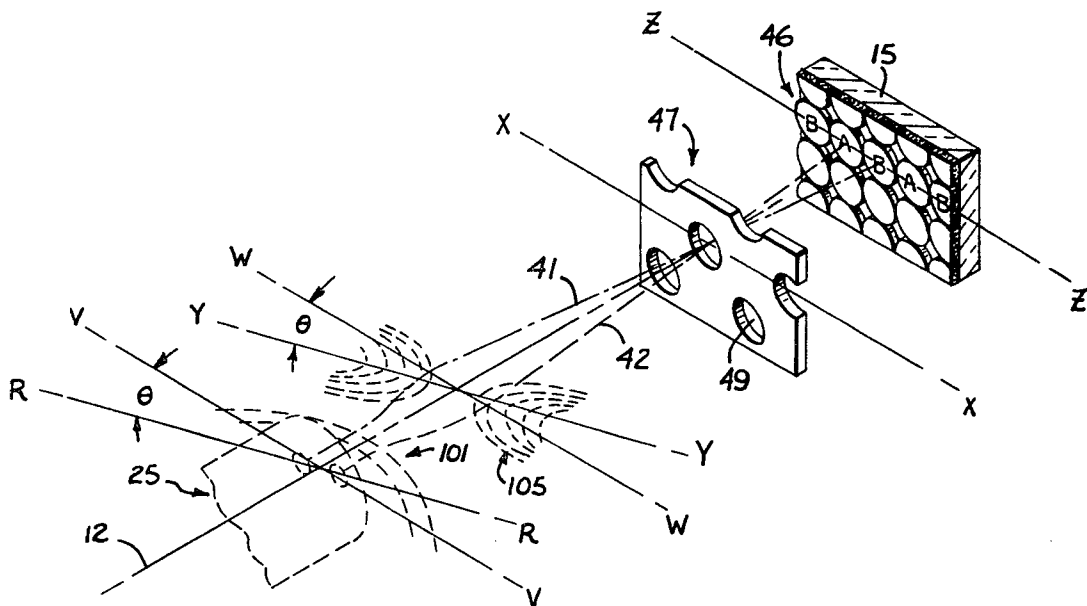


Fig. 3

INVENTOR.  
DONALD L. SAY

BY

Donald R. Castle

ATTORNEY

## COLOR CATHODE RAY TUBE

### CROSS-REFERENCE TO RELATED APPLICATION

This application contains matter disclosed but not claimed in a related application filed concurrently herewith and assigned to the assignee of the present invention. This related application is Ser. No. 176,503, "Electron Gun Support and Shielding Means."

### BACKGROUND OF THE INVENTION

This invention relates to a color cathode ray tube and more particularly to a multiple beam color cathode ray tube utilizing a compact electron gun structure and magnetic focusing means to achieve a high resolution color display.

It has been conventional practice in color television and similar dynamic display applications to use shadow mask type color cathode ray tubes employing a plurality of separate electron beams which are controlled to selectively excite a plural phosphor patterned screen. Such tubes usually include electron gun assemblies made up of individual electron guns integrated by several spaced apart insulative rods and oriented in a manner to project the respective individual electron beams to converge at the foraminous mask in the forward portion of the tube. Gun structures of this type normally use electrostatic focusing and magnetic convergence and are inherently complicated and bulky. The individual beam widths are usually quite wide and the closeness of the respective beams, in the pattern of beams as they leave the gun assembly, is limited by the integrated nature of the multi-gun construction. Each gun has its own accelerating, imaging and convergence system and requires considerable external convergence hardware and circuitry to assure satisfactory convergence of the several beams over the face of the mask.

### OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the invention to reduce the aforementioned disadvantages and to provide an improved color cathode ray tube.

Another object is to provide a plural beam color cathode ray tube utilizing an inexpensive electron gun assembly and realizing a high resolution display.

The foregoing objects are achieved in one aspect of the invention by the provision of an improved color cathode ray tube employing magnetic focusing and convergence. A compact multiple beam electron gun, positioned within the neck portion of the tube, has a number of related electrodes effecting control, acceleration, and collimation of a plurality of closely spaced electron beams which provides a compact bundle or array of individually controlled beams emergent from the common final anode electrode of the gun. A conductive coating, disposed on the neck of the tube, is at screen potential, which, being greater than the final anode voltage of the gun effects a diverging electron lens that influences the trajectories of the individual beams emerging from the final anode. At a specific region on the neck of the tube, magnetic focusing means are externally oriented to provide an internal convergent magnetic focusing lens thereat which imparts a converging influence on the plural beams to effect convergence thereof at the apertures of the mask. The several converged beams traverse the mask apertures and impinge the respective phosphor areas of the patterned

screen therebeneath to excite a high resolution luminescent color display therein.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of a color cathode ray tube utilizing the invention;

FIG. 2 is an enlarged sectional view of the electron gun portion of the tube shown in FIG. 1; and

FIG. 3 is a perspective illustrating the electron beam trajectories within the tube shown in FIG. 1.

### DESCRIPTION OF THE PREFERRED EMBODIMENT

For a better understanding of the present invention together with other and further objects, advantages and capabilities thereof, reference is made to the following specification and appended claims in connection with the aforescribed drawings.

With reference to the drawings, there is shown in FIG. 1, a sectional view illustrating the improved color cathode ray tube 11 having a longitudinal axis 12 extending therethrough. An encompassing envelope structure 13 includes an integration of related parts, i.e., panel 15, funnel 17, neck 19, and neck closure 21 portions. The neck closure portion is usually in the form of a conventional stem wafer having a plurality of connective and support leads 23 sealed therein.

In referring to FIG. 1 for general orientation and to FIG. 2 for greater detail, a compact multiple beam electron gun 25 is positioned within the neck portion 19 by supporting and shielding means 27 which is supportively attached, as by welds 29, to the terminal portions 31 of at least three spaced-apart leads 23 of which two are shown. The supporting and shielding means 27 includes a skirted annular member 33 which has an over-all diametric dimension which closely approaches the internal diameter of the neck portion 19. This dimensioning relationship facilitates positioning and provides lateral support for the gun assembly 25 to prevent transverse shifting thereof. To further achieve the above-mentioned lateral support, a plurality of extending means, such as at least three spaced-apart dimples 35 are formed in the skirt of the annular portion 33 to protrude peripherally outward therefrom and more closely approach the internal diameter of the neck portion.

Upstanding from the inner periphery 37 of the annular member 33, and integrated thereto, is an open-ended cylindrical portion 39 dimensioned to shield and accommodate the whole of the compact electron gun assembly 25 therein. For example, a typical compact gun assembly emitting a plurality of closely spaced electron beams may be of the type basically disclosed in patent application Ser. No. 126,609 by A. D. Johnson et al. and assigned to the assignee of the present invention.

By way of illustration, a two beam electron gun structure 25 is shown to expedite clarification, but the principles involved are likewise applicable to a gun structure furnishing three or more beams. As shown, the two electron beams 41 and 42 are directed to selectively impinge a patterned cathodoluminescent screen 45 which is disposed on the inner surface of the viewing panel 15. The screen pattern, for example, is comprised of a multitude of phosphor elements or dots 46 arranged in a repetitive array of a plurality of specific phosphor areas. These cathodoluminescent phosphors,

when selectively electron excited, produce the luminescent hues desired in the resultant display. A foraminous shadow mask 47 is positioned within the panel portion 15 in spaced relationship  $d$  to the patterned screen 45 as by support means 48. Each of the apertures 49 in the mask is related to a particular array of pattern elements 46 of the screen.

Disposed on the interior surface of the funnel 17 and neck 19 portions is an internal conductive coating 51 which makes electrical connection, through mask connective means 52, with a thin metallic coating 53, such as aluminum, that is vaporized over the interior surface of the screen 45 and portions of the panel 15. Thus, the screen potential which is applied to the funnel button connection 55 is extended into the neck portion 19 to the vicinity of the electron gun 25.

In greater detail, the aforementioned plural beam electron gun 25 includes, for example, a common cathode or electron source 57 which is suitably mounted in an insulative positioner 59. Heater means 61 is positioned to furnish heat to the cathode 57 to thereby promote emission of electrons from the emissive material 63. Insulatively spaced from the cathode 57 is a first electrode plane 65 which has therein two separate control electrodes 67 and 69; each having one aperture to accommodate the controlled passage of one of the respective electron beams 41 or 42 therethrough. Individual control of the two control electrodes 67 and 69 is effected by separate connective leads 71 and 73.

A second electrode plane 75 is spaced forward of the first electrode plane 65, and, in this instance, is a common accelerating electrode having two apertures therethrough to accommodate the beams 41 and 42, respectively. This second plane 75 has a separate electrical connection 77 which extends through an appropriate lead in the closure portion 21.

Spacedly positioned forward of the second electrode plane 75 are the third and fourth common electrode planes 79 and 81, respectively, each containing a pair of apertures for beams 41 and 42. The third and fourth electrode planes are spatially positioned relative to one another with a metallic ring-like spacer 83 sandwiched therebetween and bonded thereto. If additional control of the electron beams is desired, more electrode planes can be added, and such sequential planes may have insulative provisions therein to further effect individual beam control. As disclosed, the several planes, i.e., one, two and three 65, 75, 79, are insulatively separated from one another by ring-like spacers 87, 89, and 91. These insulative spacers have a plurality of alignment bores therethrough to match with insulative larger dimensioned alignment holes formed in the respective first and second electrode planes 65 and 67. Plural alignment bolts 93 are inserted through the alignment bores and holes to provide an integrated electrode assembly.

As shown, the fourth electrode plane 81 forms the final anode of the gun structure and is abutted against a ledge portion 85 formed at the terminal end of the closed-wall portion 39 to instand from the perimeter thereof to provide a stop. The integrated and spaced electrodes and the cathode form the compact gun structure 25 which is confined within the closed-wall portion by gun retaining means 95; such means being formed to fit within the closed-wall portion, and be affixed therein, at the end region related to the annular member 33. By this structural integration, the encom-

passing gun supporting and shielding means 27 is at final anode potential which is of a value lower than the screen potential on the neck disposed coating 51.

The constructional nature of the disclosed compact multiple beam electron gun 25, facilitates the generation, control, and acceleration of a plurality of closely spaced beams having individual narrow widths. In this compact array of beams each of the individual beams 41, 42 traverses an alignment of electrode apertures oriented along respective axes 97, 99. These aperture axes are substantially parallel with one another and with the tube axis 12 to provide a compact collimation of individually controlled beams "a" within the gun structure 25. The axis of the array of beams is substantially coincidental with the tube axis 12.

The neck coating 51 extends into the neck portion 19 to a line substantially even with the electron gun final anode plane 81. Since the screen potential on the coating 51 is greater than the final anode voltage on plane 81 and the contiguous supporting and shielding means 27 a diverging electron lens 101 is effected in the region surrounding the forward portion of the electron gun 25. The amount of diverging influence on the trajectories of the collimated beams 41 and 42 emerging from the final anode 81, i.e., the angle of divergence  $\alpha$  thereof, is related to the strength of the lens 101. Since the shielding means 27 and the neck portion 19 are of circular cross sections the annular spacing therebetween is substantially consistent, the field of the resultant diverging lens 101 is concentrically symmetrical about the axis 12. The strength of the lens is related to the spacing between the neck coating 51 and the electron gun shielding means 27 and to the operational voltage differential therebetween. For example, the screen voltage on the neck coating 51 may be in the order of 20,000 volts and the final anode voltage in the order of 500 volts, being thus a ratio of 40:1. While it has been found that with the same coating-to-anode spacing that the coating-to-anode operational voltage differential may preferably range in the order of 30:1 to 70:1, satisfactory operation may be achieved within a broader range of 15:1 to 200:1.

Within the confines of the neck portion 19 at a specific region 103 ahead of the gun 25, for example three to four inches, an internal convergent magnetic focusing lens 105 is established to influence the individual diverging beams 41, 42 and impart a converging deviation thereon. The location of the converging lens 105 is referenced by the dimension  $b$  between the final anode plane 81 and the center plane 107 of the convergent lens 105, and by the dimension  $c$  between the center plane 107 and the apertured shadow mask 47. The amount of divergence of the beams apertured shadow mask 47. The amount of divergence of the beams in the array is determined by the angle of divergence  $\alpha$  and the distance  $b$  between the plane of the final anode 81 and the plane 107 of the formed magnetic focusing lens 105. The internal convergent focusing lens 105 is produced by externally positioned magnetic focusing means 109 in the form of coil dimensioned to telescope on the neck 19. The coil has a metallic outer sheathing 111 wherein a circumferential opening 113 is oriented toward the neck 19. The lines of force 115 emanating substantially from this opening form the substantially annular shaped convergent focusing lens 105. The strength of this lens 105 is determined with reference to each of the several individual beams 41, 42 by the

angle of divergence  $\alpha$ , the angle of convergence  $\beta$  and the velocity of the beam as regulated by the screen voltage. The appropriate focusing voltage is applied to the coil 109 from a focusing voltage source 117 which is part of the operational circuitry of the color tube 11. The focusing coil 109 also has an auxiliary dynamic winding therein to which is applied a dynamic focusing voltage from a source 119 which is also included in the operational circuitry. Thus, the strength of the convergent magnetic focusing lens 105 is variable in accordance with the dynamic focusing waveform applied to the focusing coil 109 to effect both focusing and convergence of the plural beams 41 and 42 as they are scanned across the face of the shadow mask 47.

Positioned ahead of the focusing coil 109 and adjacent thereto is a yoke or deflection coil 121 which is employed to deflect the electron beams 41, 42 over the raster area of the screen. The deflection of the beams is related to the plane of deflection 123 of the yoke 121.

The convergent focusing lens 105 imparts a common rotational influence on the trajectories of all of the plural beams 41, 42 of the array; an effect which takes place in the lens region associated with both sides of the lens plane 107. Whether the beam rotation be clockwise or counter-clockwise relative to the axis 12 is dependent upon the direction of current flow in the coil 109.

With reference to FIG. 3, the different phosphor dots A and B of the screen 46 are oriented in rows in a manner that the linear alignment or diametrical axes of the dots Z—Z and the alignment axes of the mask apertures X—X are substantially coincidental. Since the line of scan of the electron beams 41, 42 should follow the axes X—X and Z—Z of the mask and screen respectively, it is necessary to adjust the compact gun 25 position within the tube. This is accomplished by partially rotating the whole electron gun 25 about the axis of the tube 12 so that the aperture array in the final anode 81 is shifted by the angle  $\theta$  to compensate for the rotational influence imparted to the trajectories of the beam array by the focusing lens 105. As shown, alignment axes X—X and Z—Z are parallel with the axis of scan W—W. Since the converging focusing lens 105 imparts rotation to the beams 41, 42 as evidenced by beam alignment Y—Y and angle  $\theta$ , correction is made by rotating the aperture alignment  $\theta$  degrees from axis V—V to alignment axis R—R.

Thus, there is provided an improved color cathode ray tube that advantageously utilizes a compact electron gun to furnish a compact array of multiple beams. While a two-color tube has been described, the disclosure applies equally to a tri-color tube. By use of the divergent lens 101, the magnetic convergent focusing lens 105, positioned at a distance  $b$  beyond the gun 25, "sees" the compact array of beams arriving from a substantially common point of origin and therefore expeditiously focuses and converges the beams at the shadow mask aperture 49. This system of electron optics with its long object distance from gun to lens results in unusually small spot sizes at the screen. Another advantage is that the dynamic focus waveform applied to maintain focus over the screen also achieves dynamic convergence over the face of the mask.

While there have been shown and described what are at present considered the preferred embodiments of the invention, it will be obvious to those skilled in the

art that various changes and modifications may be made therein without departing from the scope of the invention as defined by the appended claims.

What is claimed is:

1. A multiple beam color cathode ray tube having a longitudinal axis therethrough and utilizing magnetic focusing means in the form of a discrete coil arrangement encircling a portion of the tube to produce a high resolution color display, said tube comprising:

an encompassing envelope structure including an integration of panel, funnel, and neck portions;

a patterned cathodoluminescent screen formed on the interior surface of said panel portion;

a foraminous shadow mask positioned within said panel portion in spaced relationship to said patterned screen, the apertures therein being related to the pattern of said screen;

a compact multiple beam electron gun axially positioned within said neck portion, said gun having a number of related electrodes effecting control, acceleration and substantial collimation of a plurality of closely spaced electron beams to provide a compact substantially collimated array of individually controlled beams emergent from the final anode electrode of said gun;

conductive means interiorly associated with said neck portion which in conjunction with said electron gun spatially related thereto provides an electron lens to effect a diverging influence on the trajectories of the individual collimated beams emerging from said final anode, said diverging conductive means being oriented relative to the final anode of said electron gun; and

specific region in said neck portion whereat said magnetic focusing means is externally oriented to provide an internal convergent magnetic focusing lens for influencing said individual diverging beams and impart a converging deviation thereon to effect convergence of said plural beams at said apertures in said shadow mask, said beams traversing said apertures and impinging respective areas of the patterned screen therebeneath to excite a high resolution luminescent display therein.

2. A multiple beam color cathode ray tube according to claim 1 wherein each of the individual beams comprising the array of beams in said compact multiple beam electron gun traverses an alignment of electrode apertures oriented along a respective axis, the individual axes of said aligned electrode apertures comprising said array are substantially parallel with one another and with the axis of said tube to provide a compact collimation of individually controlled beams within the gun structure.

3. A multiple beam color cathode ray tube according to claim 1 wherein said funnel and neck portions have an electrically conductive coating disposed on the interior surface thereof, said coating extending into said neck portion to a line substantially even with the final anode plane of said compact multiple beam electron gun, said electron gun being electrically isolated and spaced from said neck-disposed coating, said anode-to-coating spacing and the operational voltage differential therebetween determining the divergence strength of the formed electron lens influencing the array of beams, the angle of divergence of the several individual beams being determined by the strength of said divergent lens and the amount of divergence by the distance

7

between the plane of said final anode and the plane of said formed magnetic focusing lens.

4. A multiple beam color cathode ray tube according to claim 3 wherein said coating-to-anode spacing is such that coating-to-anode operational voltage differential is of a range in the order of 15:1 to 200:1.

5. A multiple beam color cathode ray tube according to claim 1 wherein the strength of said convergent magnetic focusing lens is determined with reference to each of the several individual beams by the angle of divergence, the angle of convergence and the velocity of the beam.

6. A multiple beam color cathode ray tube according to claim 1 wherein the strength of said convergent magnetic focusing lens is variable in accordance with a dy-

8

namic focusing waveform applied to said magnetic focusing means to effect both focusing and convergence of the several beams as they are scanned across the face of the mask.

7. A multiple beam color cathode ray tube according to claim 1 wherein said magnetic focusing lens imparts a common rotational influence on the trajectories of said plural beams substantially in the region of said focusing lens, and wherein said compact multiple beam electron gun has its array of apertures partially rotated about the axis of said tube in a manner to compensate for the rotational influence imparted to the trajectories of the beam array to achieve the desired line of scan across the surface of said mask.

\* \* \* \* \*

20

25

30

35

40

45

50

55

60

65