Feb. 19, 1957 R. E. BENWAY ET AL 2,782,333

SHORTENED TRIPLE GUN FOR COLOR TELEVISION

Filed Aug. 18, 1954 2 Sheets-Sheet 1

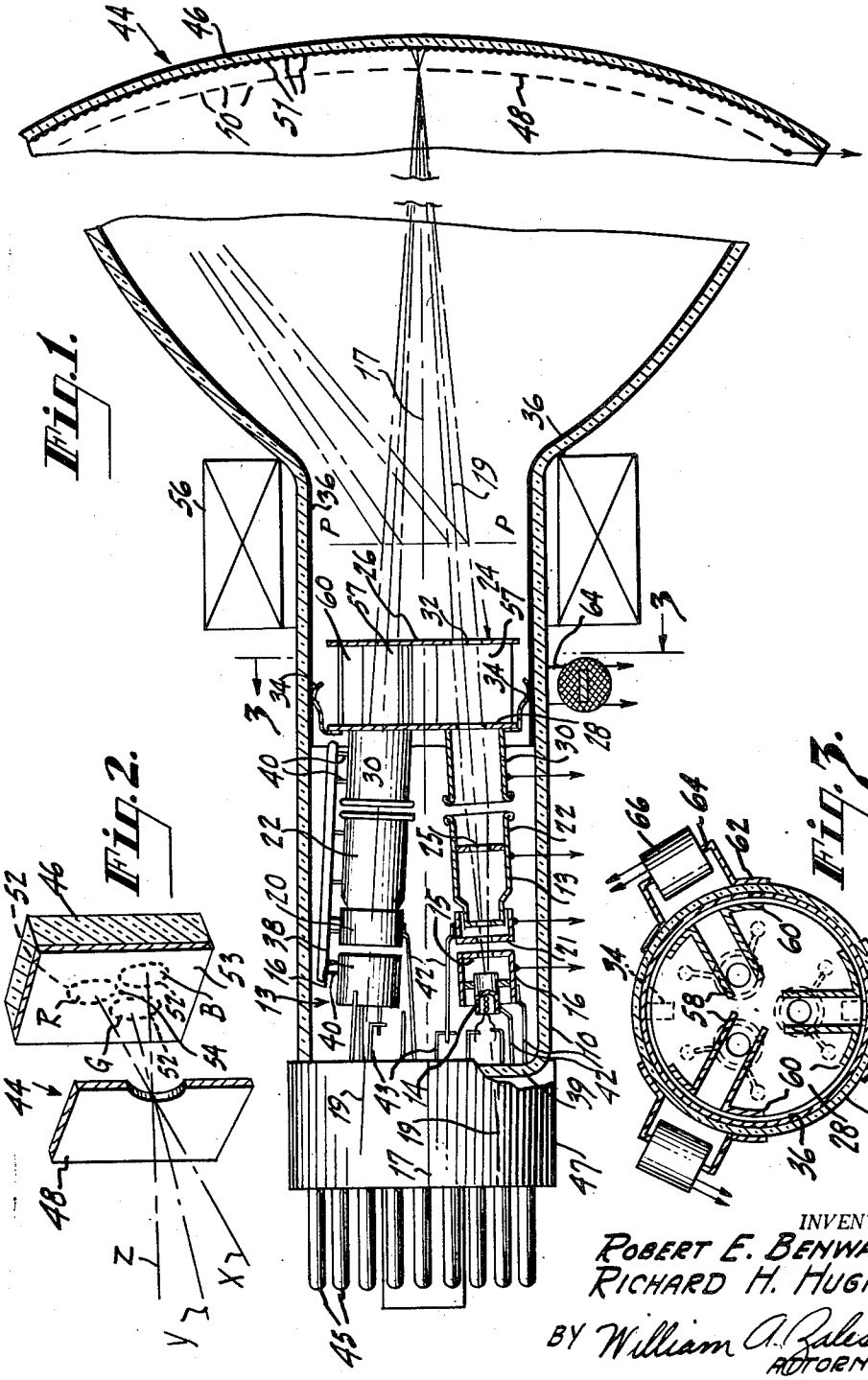


Fig. 1.

Fig. 2.

Fig. 3.

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Fig. 4.

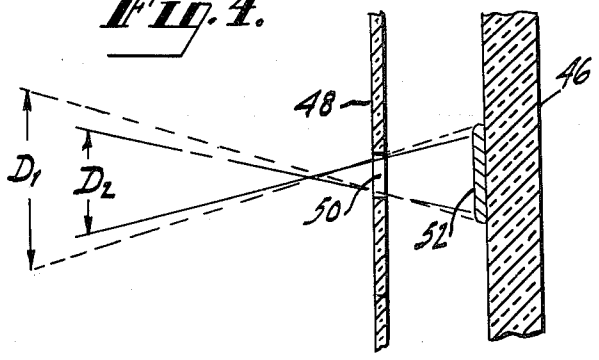


Fig. 5.

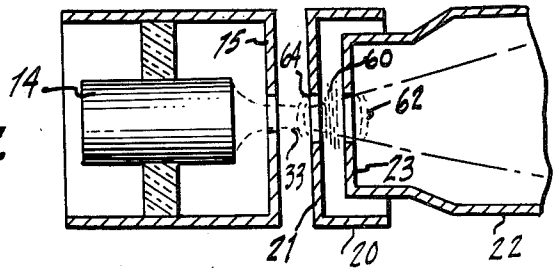
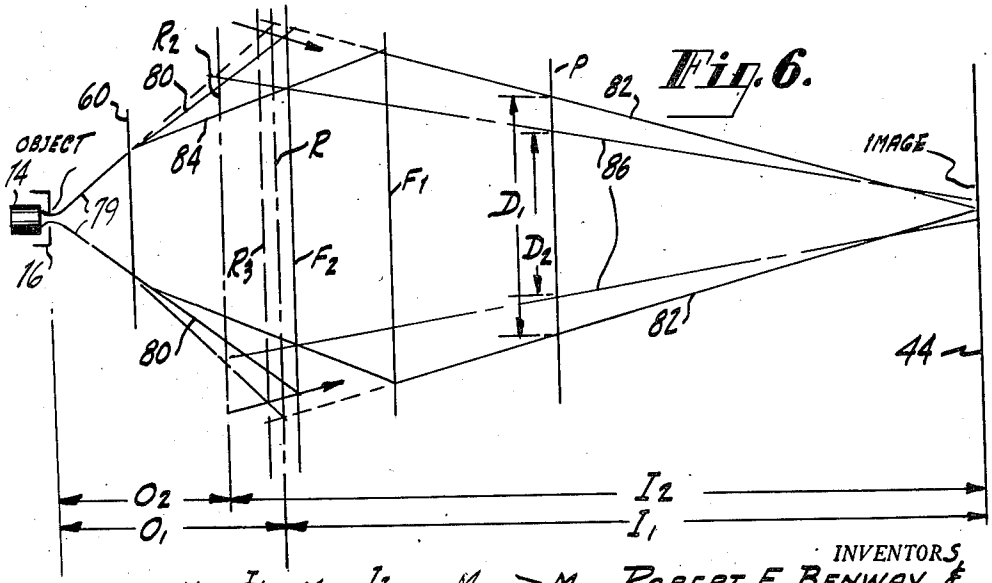


Fig. 6.



$M_1 = \frac{I_1}{O_1}$ $M_2 = \frac{I_2}{O_2}$ $M_2 > M_1$ $D_2 < D_1$

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SHORTENED TRIPLE GUN FOR COLOR TELEVISION

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Application August 18, 1954, Serial No. 450,661

10 Claims. (Cl. 313—70)

This invention is directed to an electron gun structure utilized for forming a plurality of electron beams in a cathode ray tube and, particularly, in tubes utilizing plural electron beams which have a common deflection over the tube target.

Plural electron beams have been used in cathode ray tubes for various purposes. One application of plural beams is in television picture tubes for color in which each beam forms a different colored fluorescent light on the phosphor screen and where each beam is modulated by color signals corresponding to the color of the light that the beam initiates. A type of tube for color television is that disclosed in the copending application of Hannah C. Moodey, S. N. 295,225, filed June 24, 1952. This type of color tube utilizes a masking electrode at the phosphor screen in combination with three electron beams. The electron beams are, respectively, modulated by color video signals corresponding to red, green and blue portions of the televised picture. The mask at the screen has a large number of small apertures therethrough. The phosphor screen is formed with a large number of phosphor dots on an adjacent surface of a supporting glass plate. The phosphor dots are arranged in groups of three in alignment with each aperture of the masking electrode. The dots of each group are of different phosphor material luminescing with either red, green or blue light when struck by high energy electrons. The three beams of the tube, of the type disclosed in the above cited application, approach the masking electrode and the phosphor screen at a small angle to the screen. The arrangement is such that the masking electrode masks each phosphor dot from all but one of the electron beams. Also, the phosphor dots are positioned so that each beam will strike only those phosphor dots formed of the same phosphor material.

Various types of electron guns have been utilized in color television picture tubes of the type described above. One form of plural gun structure is that disclosed in the copending application of Albert M. Morrell, S. N. 383,340, filed September 30, 1953. This gun structure has been successfully used in tubes of the type described, and consists essentially of a plurality of electron guns mounted, respectively, on axes which converge at small angles to each other and to a common point at the target of the tube. Each gun disclosed in the above cited Morrell application comprises a plurality of electrodes which form the electrons from a cathode electrode into a beam and which provide a prefocusing electron lens field and a principal focusing lens field. The prefocusing electron lens in each gun is formed between a cup-like screen grid electrode and a tubular focusing electrode. The cup-shaped prefocusing electrode provides a relatively strong prefocusing field and necessitates the utilization of a long gun structure to provide optimum beam spot magnification at the target and beam diameter in the deflection plane of the electron beam.

In tubes of the type described, however, it has been found to be advantageous to utilize as short an electron gun structure as is possible. This provides a shorter picture tube length from base to faceplate and thus permits a smaller cabinet size for the television set. However, merely reducing the dimensional size of the electron gun structure does not result in the optimum conditions for tube operation. Several factors are involved, such as, picture definition, beam spot size at the target and beam size in the deflection plane. These factors are varied differently by changing the over-all dimensions of the electron gun. A shorter gun requires a compromise between the factors involved to provide optimum tube operation.

It is, therefore, an object of this invention to provide a plural gun structure having a minimum size.

It is another object of this invention to provide a plural gun structure for a cathode ray tube in which the over-all length of the structure is a minimum.

It is a further object of this invention to provide a plural electron gun structure of small length and optimum characteristics.

It is another object of the invention to provide a cathode ray tube having a plural electron gun structure of small length and providing electron beams of optimum spot size at the target and optimum beam size in the deflection plane.

The invention is specifically related to providing a plural gun structure of minimum dimension. In shortening the gun structure, it has been found necessary to provide a weaker prefocusing lens for each electron beam. The electrode structure forming the prefocusing lens includes annular electrodes having portions which are telescoped together so as to provide a lens of relatively small curvature between the telescoping portions of the electrode. This enables the use of shorter electrodes on each gun axis so that the over-all gun structure is a minimum.

Figure 1 is a sectional view of a cathode ray tube utilizing a plural gun structure in accordance with the invention;

Figure 2 is an enlarged partial view of the target of the tube of Figure 1;

Figue 3 is a sectional view along line 3—3 of Figure 1;

Figure 4 is an enlarged sectional view of a portion of the screen structure of the tube of Figure 1;

Figure 5 is an enlarged sectional view of a portion of the electron gun structure of the tube of Figure 1; and

Figure 6 is a schematic showing of the operation of the gun structure of Figure 1 in accordance with the invention.

Figure 1 discloses a cathode ray tube having a plurality of electron beams and used as a picture viewing tube for color television. The tube consists of an evacuated envelope having a neck portion 10, for example, of glass and a shell portion 12 which may be either conical or substantially the frustum of a pyramid, and which may be of metal or glass. Within the neck portion 10 of the envelope are a plurality of electron guns 13 each consisting of a cathode electrode 14 mounted within a tubular control grid electrode 16. Each control grid 16 is closed at one end by a wall 15 having a single aperture at its center. The adjacent end of each cathode tube 14 is closed by a solid wall portion and is coated on its outer surface, facing electrode wall 15, with electron emitting material, such as a mixture of barium and strontium oxides, to provide a source of electron emission.

Closely spaced from the control grid 16 of each electron gun and along a common axis 19, there is mounted a short tubular or cup-like accelerating electrode 20 having a centrally disposed aperture in the bottom wall 21 of the cup

in line with the aperture in the control grid wall 15. Spaced along the axis 19 of each gun from accelerating electrode 20 is a relatively long tubular accelerating electrode 22, closed at its end facing accelerating electrode 20 by a centrally apertured wall portion 23, whose aperture is aligned with the apertures in electrode portions 21 and 15. Spaced from the other end of electrode 22 of each gun 13 is a common electrode 24, having a plate portion 26 at the far end and having mounted in an oppositely disposed plate portion 28 a plurality of short tubular members 30. One of the tubular members 30 is aligned on the common axis 19 of each electron gun with the other gun electrodes 16, 20 and 22 respectively. Through plate 26 of electrode 24, there is formed an aperture 32 on the axis of each gun in alignment respectively with the apertures of electrode portions 15, 21 and 23. Electrode 24 is electrically connected by spring fingers or spacers 34 to a conductive wall coating 36, which extends over the inner surface of the tubular envelope neck portion 10 from a point adjacent electrode 24 into the conical envelope portion 12.

The several electrodes described are mounted within the neck portion 10 by rigidly fastening them together by means of a plurality of glass mounting rods 38 of which one is shown in Figure 1. Each electrode has studs 40 having one end welded to the electrode and the other end sealed into a glass rod 38, a lead wire 42 extends from each electrode respectively, to supporting base wires 43 sealed through the end wall 39 of the tubular envelope neck portion 10. The base wires 43 are conductively fixed to base pins 45 extending through a base 43 to make electrical contact to external sources of potential. By lead wires 42 and the spring spacing fingers 34, the electron guns are rigidly supported within the envelope neck portion 10.

In Figure 1, voltages are indicated as those which can be applied to the respective gun electrodes. These voltages are those which have been successfully used in tubes of the type described and need not be limiting.

During the operation of the several electron guns, potentials are applied to several gun electrodes in the amounts indicated. The electron emission from each cathode 14 is formed by electrostatic fields respectively between electrode portions 15, 21, and 23 into an electron beam directed through the apertured portions of the gun electrodes. The difference of potential between electrode 22 and the corresponding electrode portion 30 provides a principal focusing lens field in the path of each electron beam, whereby the electrons of each beam are converged to a small focused spot at a target electrode 44 mounted in the large shell portion 12 of the envelope.

Target electrode 44 consists of a glass support plate 46 and a metallic masking electrode 48 closely spaced from the surface of plate 46 facing the electron guns. Support plate 46 may be the end wall or face plate of bulb 12 or an additional plate supported within bulb 12. Masking electrode 48 is a thin copper-nickel sheet having a large number of small apertures 50. Fixed to the adjacent surface of the glass plate 46 is a luminescent screen 51 consisting of groups of phosphor dots 52 (Figure 2), with each group consisting of three dots positioned in a triangular arrangement about a center point 54. The positioning of each group of phosphor dots is such that the center of each aperture 50, in the masking electrode 48, will be aligned with point 54 of the corresponding group of phosphor dots.

The phosphor dots 52 of each group are formed of phosphor material fluorescing with a different colored light when struck by the high energy electrons from guns 13. The dots of each group have a red, green, or blue fluorescence under electron bombardment as indicated respectively by R, G, and B in Figure 2. Furthermore, the positioning of the phosphor dots 52 is that in which each dot is aligned with its corresponding aperture 50 in electrode 48 along a different directional line X, Y, or Z, respectively. The fluorescent screen may be covered with a thin film 53 of reflective metal to intensify the luminescence of the phosphor by reflecting light from the phosphor screen through plate 46 toward the observer.

The three electron beams leaving the electron guns 13 are caused to converge by mounting each gun 13 at a small angle to envelope axis 17 so that the axes 19 of the three guns will converge to a common point at the masking electrode 48. Thus, each beam, normally following the axis 19 of its gun, will approach the masking electrode 48 at a small angle of incidence and from one of the different directions X, Y, or Z. Electrons from each beam passing through the apertures 50 of electrode 48 along one of the paths extending in the directions X, Y, or Z, will strike one phosphor dot in each group of dots. The arrangement is such that the eletcrons from each gun can strike only those phosphor dots 52 luminescing with a single color of light. The angle which each gun makes with tube axis 17 is small and is determined by the dimensions of the tube. In tubes of the type described which have been successfully operated, this angle is in the order of 1°10′. The Figure 1 exaggerates the angle between the guns and axis 17 for purpose of illustration.

The three beams are simultaneously scanned over the surface of the masking electrode 48 by conventional scanning means indicated as a neck yoke 56, which consists of two pairs of deflecting coils, with the coils of each pair mounted on opposite sides of the envelope neck 10. Each pair of deflecting coils of yoke 56 is connected in series to sources of saw-tooth currents for providing line and frame scansion of the three electron beams simultaneously over the surface of the masking electrode 48. The scanning coils of yoke 56 are conventional and do not constitute a part of this nivention and need not be further described. The scansion of electron beams may be in any desired manner but for color television viewing is normally a rectangular raster. The operation of tubes of the type described are more fully set forth in copending application Serial Number 231,925, filed June 16, 1951, by Harold B. Law.

As the three beams are simultaneously scanned over the surface of target 44, the beams which normally have convergence on the axis 17 of the tube will lose convergence at the target, since the distance of beam convergence from masking screen 48 varies due to geometry effects connected with the deflection of several converging beams. Also, because of the complexity of using three beams, the convergence of any two beams is different from the convergence of any other two of the three beams during scansion of all three beams across target 44. A correcting dynamic magnetic field is established respectively in the path of each beam and the strength and direction of each field is varied in synchronism with the deflection of the beam so that the three beams at all times may be converged to a common point during the scanning of the beams over the surface of the apertured mask 48.

The dynamic converging field is provided by pairs of pole pieces with one pair mounted on opposite sides of the electron beam paths. As shown specifically in Figures 1 and 3, each pair of pole pieces include parallel portions 57 extending substantially radially to the axis 17 of the envelope neck 10 and on opposite sides of each electron beam. The portions 58 are fixed between plate portions 26 and 28 of focusing electrode 24. Furthermore, the pole pieces 58 have arcuate portions 60 extending along the inner wall portions of the tubular neck 10 and as shown in Figure 3. Each pair of arcuate pole piece portions 60 are matched with armature portions 62 forming a part of an armature 64 of an electromagnet 66 mounted on the outer wall portion of the tubular neck 10 and overlying the pair of pole pieces 60.

The passage of current through coils in the magnet 66 will cause deflection of the corresponding electron beam in a direction parallel to the plate portions 58. With the correct polarity given to the plates 58 of each

pair of pole pieces, the field established between plates 58 will direct the corresponding electron beam radially toward or away from the axis 17 of the tube.

In tubes of the type described, it is desirable to obtain a maximum screen brightness. However, since the masking aperture plate 48 at the target absorbs a large percentage of the beam current, the brightness of the picture obtained is not a maximum. Also, as set forth in the article by H. B. Law, page 466 of the RCA Review, Part II, September 1951, the screen efficiency can be expressed as the product of a constant K and the quantity

$$\left(\sqrt{3}-\frac{D}{S}\right)^2$$

where D is the beam diameter in the deflection plane and S is the beam-to-axis spacing in the deflection plane.

As shown in Figure 1 when each beam is deflected by the fields of yoke 56 the direction of the beams is changed from the axis 17 of the tube to approach the target 44 from a different direction. Each beam may then be considered as originating from a deflection plane P, which is substantially at the center of the coils of the yoke 56. This plane can be determined, as schematically shown in Figure 1, by projecting each deflected beam path backwards onto its respective undeflected beam path. The points where the projected paths of the deflected beams meet their undeflected paths determine this plane of deflection.

From the above relationship, expressed for the screen efficiency of a tube of the type described, it can be seen that the reduction of each beam diameter, D, within the deflection plane increases the screen efficiency. This is due to the fact that, an electron beam of smaller diameter in the deflection plane, will cover less area of each phosphor spot 52. This effect is shown more specifically in Figure 4 where D_1 represents a beam of a given diameter. Fringe electrons from the edge of the beam D_1 striking the edge of an aperture 50 will strike the edge of a corresponding phosphor dot 52. The paths of these fringe electrons are indicated by the solid lines drawn through aperture 56 to the edge of the spot 52. The solid lines thus determine the spread of the beam D_1 in passing through aperture 50. Aperture 50, then, must be sufficiently small to prevent the fringe electrons from spreading beyond the spot 52 to strike additional neighboring phosphor spots and thus cause color dilution in the picture. However, if the beam diameter is made smaller such as that indicated by D_2, for example, the spread of the beam, is smaller as indicated by the dotted lines representing the beam paths of the fringe electrons. Beam D_2 strikes a smaller surface area of the corresponding spot 52. Because of this, then, the aperture 50 may be opened until the fringe electrons of the beam D_2 strike the edge of spot 52. By opening the aperture 50, more of the beam passes through the aperture to strike the phosphor spot 52 and thus produce a brighter fluorescence from spot 52. This procedure increases the screen efficiency as described.

During tube operation, the electrons emitted from each cathode 14 pass through the aligned apertures in electrode wall portions 15 and 21. The configuration of the electrostatic field formed between plates 15 and 21, at operating potentials, causes the electrons from each cathode to form a beam having a minimum cross sectional area or "crossover point" 33 adjacent plate 21 and as schematically shown in Figure 5. From each crossover point 33 the electrons of each beam pass respectively into the tubular electrode 22 as a diverging beam.

Due to the difference of potential between electrode portions 21 and 23 of each gun 13 there is formed a prefocusing electron lens field 60 therebetween and as schematically shown in Figure 5. One portion of the lens field 60 extends through the aperture in accelerating electrode portion 23 to form a diverging field portion 62. Another portion of lens field 60 extends thru the aperture in electrode portion 21 to provide a converging lens field portion 64. Since the electrons of the beam are moving slower in the lens portion 64, the converging action of this portion is more effective on the beam than the diverging portion 62.

Between the third accelerating electrode 22 of each gun and the accelerating electrode portion 30, there is established a principal focusing electron lens field which converges or focuses the beam to a minimum spot size at the target 44.

Figure 6 schematically shows the effect of the several electron lenses on the electron beam between the cathode 14 of each gun and the target assembly 44. The electron beam, on leaving the cross-over point 33, is widely divergent as indicated by lines 79 forming the envelope of the beam paths in this region. The beam passes first through the prefocusing field between electrode portions 21 and 23 as indicated by the lines 60. The prefocusing field lessens the divergence of the electron beam as indicated by the solid lines 84. The beam next enters the principal focusing field between the tubular electrode portions 22 and 30 and indicated in Figure 6 by the dotted line F_1. In each gun, this principal focusing field converges the electrons of the beam to a minimum point at the target assembly 44 and as indicated by the lines 82 forming the envelope of the electron paths of the beam.

The effect of the prefocusing field 60 and the focusing field F_1 is to image the cross-over point 33 of the electron beam at the target electrode. Furthermore, the effects of the two fields F_1 and 60 on the electron beam are additive. The effect of the two fields 60 and F_1 on the electron beam is similar to the use of a single focusing lens field, indicated by the dotted line R_1 in Figure 3, and which is between the two focusing fields 60 and F_1. The position of the plane of this resultant single lens field is determined by projecting the lines 79, indicating the original beam direction until they meet the projection of lines 82 indicating the final direction of the beam. The intersection of these projections determine the plane R_1, as indicated. A single lens field R_1 would provide the same imaging of the cross-over point 33 at the target 44, as do fields 60 and F_1.

The object distance of this simplified lens field is indicated by O_1 and is the distance between the image or first cross-over point 33 and the plane of the resultant lens field R_1. Likewise, the image distance of the system is indicated as I_1, and is the distance between the plane of the resultant lens field R_1 and the target assembly 44. The magnification of such a lens system is analogous to the corresponding relationships in optics and is approximately

$$\frac{I_1}{O_1}$$

modified by the voltage relationships. The beam indicated by the lines 82 passes through the deflection plane P of deflection yoke 56. As indicated in Figure 6, the beam diameter in the deflection plane P is represented by the distance D_1.

The effect of making an electron gun physically shorter is that of moving the principal focusing field F, of a conventional gun toward the first cross-over point 33 and the prefocusing lens 60. Such an effect is indicated in Figure 6 where line F_2 represents the plane of the principal focusing lens when displaced toward the cross-over point 33 from its previous position F. With the same strength of prefocusing field 60, the plane of the resultant lens can be similarly represented by the line R_2 giving new object and image distances as O_2 and I_2 respectively as well as a new beam diameter D_2 in the deflection plane. Although the moving of the principal lens toward the first cross-over point 33 from F_1 to F_2 does decrease the value of the beam diameter in the deflection plane P from D_1 to D_2, the beam magnification at target 44 is increased and picture resolution is greatly decreased.

In accordance with the invention then, it has been found that in providing an electron gun of small axial length, it is desirable to move the resultant lens field R_2

back toward R_1, or even beyond it, to give an optimum beam focus at target 44. This is done by weakening the prefocusing field 60. Figure 6 indicates the result of this procedure. A weakened prefocusing field will provide less divergence to the electron beam and beyond the first cross-over point 33, than results from a zero prefocus field. Thus, the beam will follow a less converging path indicated by lines 80 which represent the envelope of the beam paths after passing through the prefocusing field 60. The lines 80 intercept the plane indicated by the line F_2 which represents the principal field F_2 in a short gun structure. The field of F_2 then focuses the electrons of the beam on the target 44. As before, by projecting the beam paths back to the projection of lines 79, it is possible to determine the resultant field R_3 which represents the additive effect of the weakened prefocusing field 60 and the principal focusing field F_2. It is noted from Figure 6 that the plane of this new resultant field R_3 is now much closer to the original resultant plane R_1 than is the resultant plane R_2 when the original prefocusing field was used. Thus, by varying the strength of the prefocusing field 60 and, namely, as under these conditions, by weakening the prefocusing field, the resultant effective focusing field 60 is moved closer to the target.

Moving the resultant field R_3 away from the cross-over point 33 decreases the magnification of the spot size at target 44 as the new I/O ratio is smaller. This now provides a much better picture with greater definition than possible when the gun structure that is merely shortened with a resultant lens field at R_2. Although weakening the prefocusing field does provide a larger beam size D_3 in the deflecting plane P_1 with a resultant loss in screen efficiency, this loss is not as critical as the gain in picture resolution. The lens field 60 can be adjusted to provide the optimum relation between screen efficiency and picture resolution. In that way the short gun can be made to have the same beam diameter and resolution as a much longer gun having a strong prefocus lens.

Therefore, in accordance with the invention, the specific gun structure shown in Figures 1 and 5 provides a prefocusing field of relatively small lens effect. To provide this effect, the gun end of the accelerating electrode 22 is narrowed down and is telescoped into the cup of accelerating electrode 20. In this manner then, the field between the electrode plate portions 21 and 23 is relatively flat and the only curvature of the field is that provided by the apertures in plates 21 and 23 (Figure 5).

The spacing of the end of electrode 22 within the cup 20 can be varied to provide the optimum curvature of field necessary or desirable to provide the optimum convergence of lens 60. In one design of gun structure made as indicated in Figure 1 and which has been successfully operated there is provided a spacing between plates 21 and 23 of substantially two millimeters. A closer spacing of less value than two millimeters has little effect as the field between plates 21 and 23 is not changed substantially. However, if the spacing between plates 21 and 23 is increased, the curvature of field 60 is increased by the side walls of the cup of electrode 20. It has been found, however, that in the particular gun used, that the optimum range of spacing is between two and three millimeters for plates 21 and 23.

In color tubes of the type described, it is possible to provide with the structure described a relatively short gun structure. However, the shortening of the gun must be compensated by varying the strength of the prefocusing field as disclosed above. An added advantage of a shorter gun is that better gun alignment is possible with smaller or shorter structures. Because of this, there is less off-centering of the beam in the focus lens than would be present in a longer gun. A shorter gun also allows better alignment of the electron beam in the various apertures and cylinders of the gun, by virtue of the short axial distances which are involved. Thus, there is less collection of the beam by the gunparts and, particularly, the limiting aperture 25 of electrode 22. This increases the efficiency of the short gun as the ratio of final beam current at the screen to cathode current is greater. Thus, in accordance with the invention, by moving the effective focusing field of the electron beam closer to the main focusing lens of the system there is provided the several advantages listed above.

Although the invention has been described relative to a delta arrangement of guns and a particular form of target electrode, these are not limiting. The particular design of gun described is of utility in other plural gun arrangements where the beams are off the axis of a common deflecting field. For example, an in-line gun arrangement can be used where a plurality of guns are mounted with their axes in a common plane. Also, other forms of masking electrodes, at the target, can be used, as for example a parallel wire mask screen. It does not appear that the specific design of mask is critical to the operation of the invention.

What is claimed is:

1. In an electron gun for a cathode ray tube comprising electrode means including a cathode electrode for forming a beam of electrons along a path, a plurality of electrodes spaced along said beam path for providing an electron lens system for focusing the electron beam to a small point, said plurality of electrodes including a cup-shaped electrode having an aperture in the central portion thereof and a tubular electrode having a portion thereof telescoped within said cup-shaped electrode and being insulatingly spaced from said cup-shaped electrode for providing a prefocusing lens in said beam path, said telescoped portion of said tubular electrode including a plate portion closing said tubular electrode and having an aperture in the center of said plate portion and aligned with the aperture of said cup-shaped electrode, said plurality of electrodes including means adjacent to said tubular electrodes to form a principal electron focusing lens in the path of said electron beam.

2. A cathode ray tube for color television comprising gun means for forming and directing a plurality of spaced electron beams along paths having a common general direction, said electron gun means including a plurality of electrodes spaced along each of said beam paths for providing an electron lens system for focusing the respective electron beam to a small point, said plurality of electrodes including a cup-shaped electrode having an aperture in the central portion and a tubular electrode having a portion thereof telescoped within said cup shaped electrode and being insulatingly spaced from said cup-shaped electrode, and a target electrode spaced along said beam paths from said gun means and including phosphor material over areas thereof for producing color luminescence, said plurality of electrodes including an electrode means adjacent to each of said tubular electrodes and between said tubular electrodes and said target to form an electron focusing lens in the path of each electron beam.

3. A cathode ray tube for color television comprising a plurality of electron guns for forming and directing a plurality of electron beams along spaced paths having a common general direction, each of said electron guns including a cathode electrode and a plurality of electrodes spaced along said respective beam path for providing an electron lens system for focusing the electron beam to a small point, said plurality of electrodes including a cup-shaped electrode having an aperture in the central portion thereof and a tubular electrode having a portion thereof telescoped within said cup-shaped electrode and being insulatingly spaced from said cup-shaped electrode, a target electrode spaced along said beam paths from said electron guns, said plurality of electrodes including an electrode means adjacent to each of said tubular electrodes and between said tubular electrodes and said target to form an electron focusing lens in the path of each

electron beam, said target electrode including a phosphor screen and an apertured masking electrode closely spaced from said phosphor screen and between said phosphor screen and said plurality of guns, and means between said plurality of guns and said target electrode for simultaneously scanning said electron beams over said target electrode.

4. A cathode ray tube for color television comprising a plurality of electron guns for forming and directing a plurality of electron beams along paths having a common general direction, each of said electron guns including a cathode electrode and a plurality of electrodes spaced along a respective one of said beam paths for providing an electron lens system for focusing the respective electron beam to a small point, said plurality of electrodes including a cup-shaped electrode having an aperture in the central portion thereof and a tubular electrode having a portion thereof telescoped within said cup-shaped electrode and being insulatingly spaced from said cup shaped electrode, said telescoped portion of said tubular electrode including a plate portion closing said tubular electrode and having an aperture in the center of said plate portion aligned with the aperture of said shaped electrode, and a target electrode spaced along said beam paths from said electron guns, said plurality of electrodes including an electrode means adjacent to each of said tubular electrodes and between said tubular electrodes and said target to form an electron focusing lens in the path of each electron beam, said target electrode including a phosphor screen and an apertured masking electrode closely spaced from said phosphor screen between said screen and said plurality of guns.

5. A cathode ray tube for color television comprising a plurality of electron guns for forming and directing a plurality of electron beams along paths having a common general direction, each of said electron guns including a cathode electrode and a plurality of electrodes spaced along a respective one of said beam paths for providing an electron lens system for focusing the respective electron beam to a small point, said plurality of electrodes including a cup-shaped electrode having an aperture in the central portion thereof and a tubular electrode having a portion thereof telescoped within said cup-shaped electrode and being insulatingly spaced from said cup-shaped electrode, said telescoped portion of said tubular electrode including a plate portion closing said tubular electrode and having an aperture in the center of said plate portion aligned with the aperture of said cup-shaped electrode, a target electrode spaced along said beam path from said electron guns, said plurality of electrodes including an electrode means adjacent to each of said tubular electrodes and between said tubular electrodes and said target to form an electron focusing lens in the path of each electron beam, said target electrode including a phosphor screen and an apertured masking electrode closely spaced from said phosphor screen between said screen and said plurality of guns, and means between said plurality of guns and said target electrode for scanning said electron beams over said target electrode.

6. An electron gun for a cathode ray tube comprising electrode means including a cathode electrode for forming a beam of electrons along a path, a plurality of electrodes spaced along said beam path for providing an electron lens system for providing a pre-focusing electron lens in said beam bath, said plurality of electrodes including a cup-shaped electrode enclosing said cathode electrode and having an aperture therein overlying a portion of said cathode electrode, a second cup-shaped electrode positioned adjacent to said first cup-shaped electrode with the walls thereof extending in a direction opposite to the walls of said first cup-shaped electrode, said second cup-shaped electrode having an aperture therein aligned with said aperture through said first cup-shaped electrode and said cathode portion, and a tubular electrode having a portion thereof telescoped within said second cup-shaped electrode and being insulatingly spaced from said second cup-shaped electrode, said tubular electrode portion having an aperture therethrough aligned with the apertures of said first and second cup-shaped electrodes.

7. A plural gun mount comprising a plurality of electron guns for forming a plurality of beams along separate paths having a common general direction, each of said guns comprising a plurality of electrodes spaced along said respective beam path for providing an electron pre-focusing lens system for said respective beam, said plurality of electrodes of each one of said guns including a cathode electrode, a cup-shaped electrode enclosing said cathode electrode and having an aperture therein overlying a portion of said cathode electrode, a second cup-shaped electrode positioned adjacent to said first cup-shaped electrode with the walls thereof extending in a direction opposite to the walls of said first cup-shaped electrode, said second cup-shaped electrode having an aperture therein aligned with said aperture through said first cup-shaped electrode and said cathode portion, and a tubular electrode having a portion thereof telescoped within said second cup-shaped electrode and being insulatingly spaced from said second cup-shaped electrode, said tubular electrode portion having an aperture therethrough aligned with the apertures of said first and second cup-shaped electrodes.

8. A plural gun mount comprising a plurality of electron guns for forming a plurality of beams along separate paths having a common general direction, each of said guns comprising a plurality of electrodes spaced along said respective beam path for providing an electron pre-focusing lens system for said respective beam, said plurality of electrodes of each one of said guns including a cathode electrode, a cup-shaped electrode enclosing said cathode electrode and having an aperture therein overlying a portion of said cathode electrode, a second cup-shaped electrode positioned adjacent to said first cup-shaped electrode with the walls thereof extending in a direction opposite to the walls of said first cup-shaped electrode, said second cup-shaped electrode having an aperture therein aligned with the aperture through said first cup-shaped electrode and said cathode portion, and a tubular electrode having a portion thereof telescoped within said second cup-shaped electrode and being insulatingly spaced from said second cup-shaped electrode, said tubular electrode portion having an aperture therethrough aligned with the apertures of said first and second cup-shaped electrodes, said plurality of electrodes of each electron gun being mounted on a common axis, said electron guns being joined together about an axis of symmetry with said common axes inclined thereto.

9. An electron gun for a cathode ray tube comprising electrode means including a cathode electrode for forming a beam of electrons along a path, a plurality of electrodes spaced along said beam path for providing an electron lens system to form a prefocusing electron lens in said beam path, said plurality of electrodes including a control electrode plate having an aperture therein overlying a portion of said cathode electrode for controlling the electron flow from the cathode electrode, a cup-shaped electrode positioned adjacent to said control electrode plate and on the side thereof away from the cathode electrode, said cup-shaped electrode having the wall thereof extending in a direction away from said control electrode plate and having an aperture in the bottom portion thereof aligned with said aperture through said control electrode plate and said cathode portion, and a tubular electrode having a portion thereof telescoped within said second cup-shaped electrode and being insulatingly spaced from said second cup-shaped electrode, said tubular electrode portion having a wall portion closing said tubular electrode and an aperture through said wall portion aligned with the apertures of said first and second cup-shaped electrodes.

10. An electron gun for a cathode ray tube comprising electrode means including a cathode electrode for forming a beam of electrons along a path, a plurality of electrodes spaced along said beam path for providing an electron lens system for providing a pre-focusing electron lens in said beam path, said plurality of electrodes including a cup-shaped electrode enclosing said cathode electrode and having an aperture therein overlying a portion of said cathode electrode, a second-cup-shaped electrode positioned adjacent to said first cup-shaped electrode with the walls thereof extending in a direction opposite to the walls of said first cup-shaped electrode, said second cup-shaped electrode having an aperture therein aligned with said aperture through said first cup-shaped electrode and said cathode portion, and

a tubular electrode having a portion thereof telescoped within said second cup-shaped electrode and being insulatingly spaced from said second cup-shaped electrode, said tubular electrode portion having an aperture therethrough aligned with the apertures of said first and second cup-shaped electrodes, and means forming an electron lens field in said beam path to focus said beam.

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