Aug. 23, 1966 R. H. HUGHES 3,268,753

PLURAL ELECTRON GUN ASSEMBLY AND MAGNETIC CONVERGENCE CAGE

Original Filed July 6, 1962 2 Sheets-Sheet 1

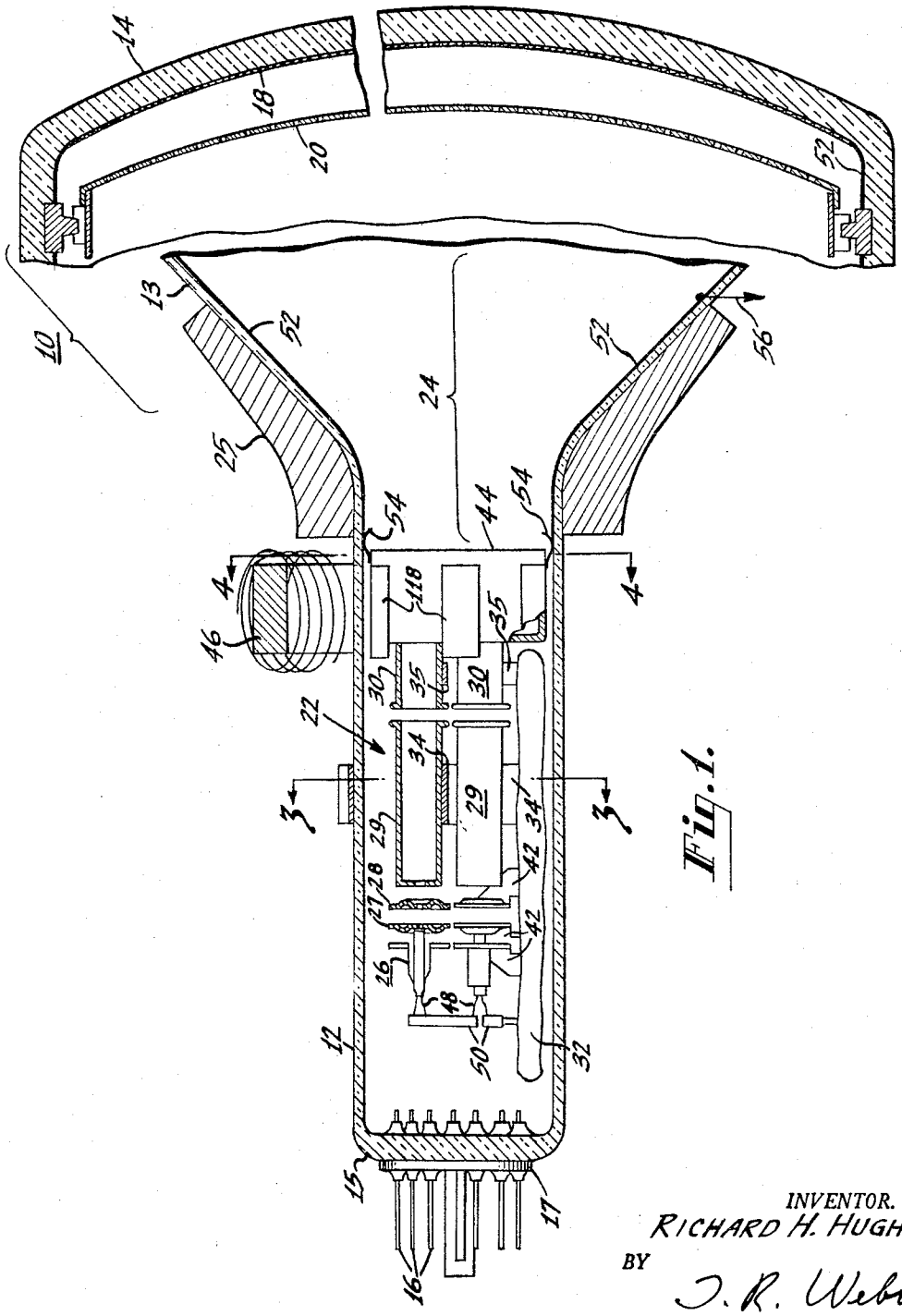


Fig. 1.

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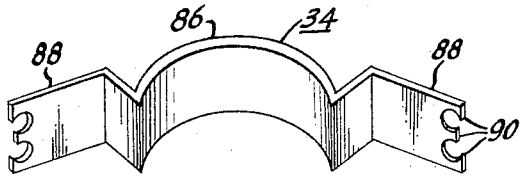


Fig. 2.

Fig. 3.

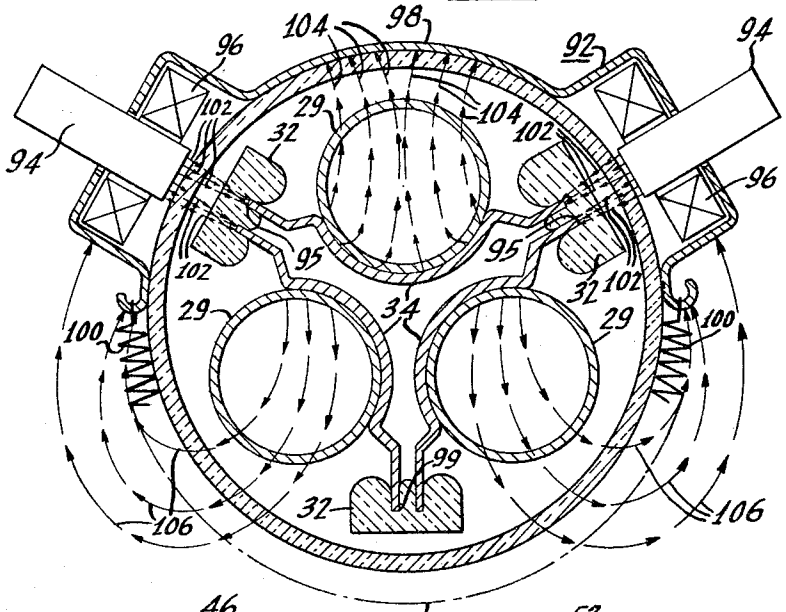
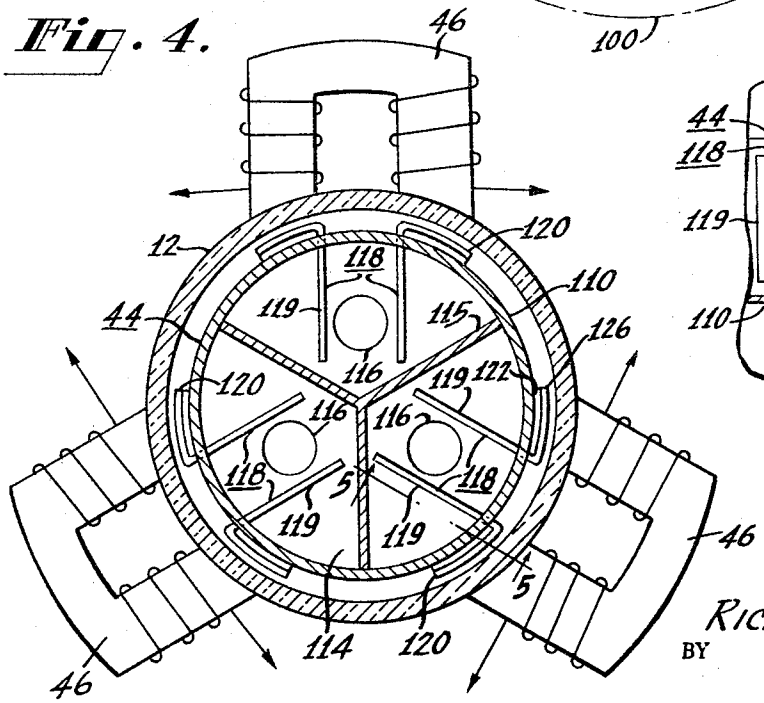


Fig. 4.



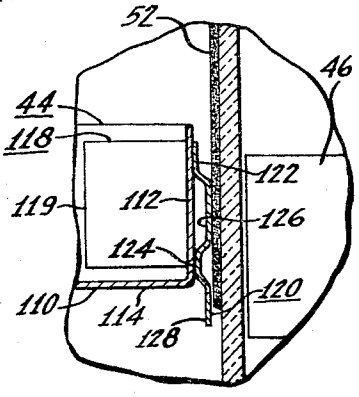


Fig. 5.

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PLURAL ELECTRON GUN ASSEMBLY AND MAGNETIC CONVERGENCE CAGE

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9 Claims. (Cl. 313—69)

This is a division of my application, Serial No. 208,017, filed July 6, 1962, assigned to the same assignee.

This invention relates to cathode ray tubes and to electron guns therefor. The invention is particularly directed to cathode ray tubes having a unitary assembly comprising a plurality of electron guns disposed side-by-side for projecting and converging a plurality of electron beams onto a luminescent screen. Such electron gun assemblies are, for example, used in direct view color cathode ray picture tubes of the shadow mask type for home television use.

It is an object of this invention to provide new and improved means such as a plural electron gun assembly of the type described for generating a plurality of electron beams.

Another object of the invention is the provision of a plural gun assembly which includes new and improved structure for effecting both lateral and radial electron beam convergence.

Features of this invention may, for example, be embodied in a plural electron gun assembly wherein each of the electron guns includes, in the order named, axially aligned cathode, control grid, screen grid, focus, and anode electrodes which are mounted in fixed relationship along a plurality of elongated insulator support rods. In a preferred embodiment of the invention, the plural gun assembly includes three similar guns disposed in delta array symmetrically about the central longitudinal axis of the cathode ray tube. Electrodes of the three guns are mounted on three glass support rods, each of which is disposed alongside a different two of the three guns. Each electrode is supported by members extending therefrom which are fixed to two of the support rods. A dynamic convergence cage, mounted on the anodes, includes a plurality of pairs of plate-like pole pieces, each pair of which straddles the beam path of one of the electron guns.

According to one feature of the invention, in a delta arrayed three-gun assembly, one set of corresponding electrodes (e.g., the three focus electrodes) are mounted on three magnetic support straps which also serve as magnet pole pieces in a lateral beam convergence arrangement. The straps are disposed in a somewhat triangular array with their ends fixed to a plurality of insulator support rods. Each of the focus electrodes is attached to one of the straps between the ends thereof and is disposed outside the triangular array thereof. A pair of cooperating magnet means externally of the cathode ray tube envelope are disposed adjacent to two of the apexes of the triangular array of straps.

According to another feature of the invention the dynamic convergence cage comprises a cup whose cylindrical wall is longitudinally slotted at spaced circumferential locations. The plate-like pole pieces thereof are disposed through the slots and each includes a flange which lies along the outer cylindrical surface of the cup. The flange has edge portions which lie flush with, and are welded to, the outer cylindrical surface of the cup, and a central raised portion between the edge portions which is spaced close to the cathode ray tube envelope, and hence, to external magnet means.

The various features may be employed singly or in combination.

In the drawings:

FIG. 1 is a partial longitudinal section view with parts broken away of a cathode ray tube embodying the invention;

FIG. 2 is an enlarged perspective view of the combination beading strap and lateral convergence pole piece of the electron gun assembly of FIG. 1;

FIG. 3 is an enlarged transverse section of the electron gun and lateral convergence assemblies of FIG. 1 taken along line 3—3 thereof;

FIG. 4 is an enlarged section view of the electron gun and dynamic convergence assemblies of FIG. 1 taken along line 4—4 thereof; and,

FIG. 5 is an enlarged section of a portion of the convergence cage assembly of FIG. 4 taken along line 5—5 thereof.

In FIG. 1, by way of example, the invention is shown as embodied in a direct view color cathode ray picture tube **10** of the shadow mask type. The tube **10** comprises an envelope which includes a neck **12**, a funnel **13**, a faceplate **14**, and a stem structure **15**. A plurality of lead-in pins **16**, over which an indexing wafer base **17** is disposed, are sealed through the stem **15**. A mosaic dot phosphor screen **18**, which may be aluminized according to known practices, is disposed on the inner surface of the faceplate **14**. An apertured shadow mask **20** having an array of apertures therethrough, which is related to the array of phosphor dots of the mosaic screen **18**, is mounted adjacent to the screen. Means in the form of a unitary electron gun assembly **22** comprising three substantially identical electron guns is disposed in the neck **12** and adapted to project three separate electron beams through a beam deflection zone **24** toward the mosaic screen **18**. A magnetic deflection yoke **25** is provided for establishing beam deflection fields in the deflection zone **24**. As shown, for example, in FIGS. 3 and 4, the electron guns of the assembly **22** are disposed symmetrically about the central longitudinal axis of the tube **10** in an equilateral triangular (delta) array. In FIG. 1 only two of the three guns are shown.

Each of the three guns comprises a cathode assembly **26**, a control grid **27**, a screen grid **28**, a focus electrode **29**, and an anode **30**, all of which are mounted in axially aligned spaced relationship along three insulator, e.g., glass, support rods **32**. As shown in FIG. 3, each of the insulator rods **32** are disposed along side a different two of the three electron guns outwardly therefrom. Only one of these rods is shown in FIG. 1. The focus electrodes **29** are supported from the rods **32** by combination support straps and lateral convergence pole pieces **34** as hereinafter described with reference to FIGS. 2 and 3. The anodes **30** are supported from the rods **32** by nonmagnetic straps **35** similar in shape to the pole piece straps **34**. The cathode assembly **26**, control electrode **27**, and screen grid electrode **28** are supported from the rods **32** by integral strap-like tabs **42**.

Heater filaments **48** for the cathodes are supported by a sectioned ring-shaped strap **50** mounted on the insulator support rods **32**.

A dynamic electron beam convergence cage **44** is mounted on the anodes **30** and cooperates with external magnet means **46** to maintain convergence of the three electron beams at all times during their scanning of a raster on the luminescent screen **18**. The construction and operation of the dynamic convergence arrangement is hereinafter more fully described with reference to FIGS. 4 and 5.

The lead-in conductors **16** are connected by connections (not shown) to the filaments **48**, the cathode assem-

blies **26**, the control electrodes **27**, the screen grid electrodes **28**, and the focus electrodes **29** of the electron guns. An electrical conductive coating **52** on the inner wall of the funnel **13** extends from the luminescent screen **18** into the neck **12** where it makes contact with a plurality of spring bulb-spacing elements **54**. An ultor potential applied to the coating **52** through a lead-in terminal in the funnel wall in the funnel **13**, schematically illustrated by the arrow **56**, is thus applied to the anodes **30**, the convergence cage **34**, and the luminescent screen **18**.

FIGS. 2 and 3 illustrate the mounting of the focus electrodes **29** on the insulator support rods **32** and the novel lateral beam deflection convergence arrangement provided thereby. Each of the three focus electrodes **29** is mounted on a separate combination support strap and lateral convergence magnetic pole piece **34** made of magnetic material.

As shown in FIG. 2, the combination support straps and lateral convergence pole pieces **34** comprise a central arcuate electrode-receiving section **86** and two end sections **88**. The end sections **88** are bent so as to extend in different directions at an angle of approximately 120° with each other. The end sections **88** are provided with E-shaped cutouts to produce a plurality of projections **90** which can be embedded in the insulator support rods **32**.

As shown in FIG. 3, the three magnetic support-strap-poles **34** are disposed in a somewhat triangular array with the ends of each strap being adjacent an end of a different strap and with these ends being embedded in the three insulator support rods **32**. The three support-strap-poles **34** are so disposed that the concave side of their arcuate electrode-receiving sections **86** face outwardly. The three tubular focus electrodes are thus mounted on the straps **34** on the outer facing sides thereof, that is, outside of the triangular array of the straps. Because the electrodes are disposed outside the triangular array of the straps **34**, the straps serve to magnetically isolate the three electrodes **29** from each other.

As shown in FIG. 3, magnetic means **92** is provided externally of the neck **12** of the cathode ray tube for cooperation with the three support-strap-poles **34**. The magnetic means **92** includes as its basic components, two bar magnets **94**, which are disposed with like polarity poles substantially adjacent two of the apexes **95** of the triangular array of straps **34**. Their opposite polarity poles are disposed radially outward therefrom. The bar magnets **94** may be either or both, permanently magnetized or electromagnetized by a pair of solenoids **96**. The bar magnets **94** together with their solenoids **96** are retained in place by a magnetic strap **98** which is apertured near its ends to receive the bar magnets **94**. The retaining strap **98** extends between the magnets **94** with at least a portion thereof disposed adjacent the tubular electrode **29** which is on the opposite side of the assembly **22** from the other apex **99** of the triangular array of straps **34**. The retaining strap **98** is preferably contiguous with the neck **12**. The retaining strap **98** is held on the neck **12** by a tension spring **100**.

By virtue of the cooperative arrangement of the magnets **94** and the support strap poles **34**, magnetic circuits are established as illustrated by the flux lines **102**, **104** and **106**. Flux created by the magnets **94** enter the ends of the straps **34** along paths **102**. A portion of the flux is conducted by the upper strap toward the upper focus electrode **29** and then passes through space along the paths **104** to the retaining strap **98** through which it is conducted back to the magnets **94**. The other portion of the flux is conducted by the lower straps **34** to the vicinity of the two lower focus electrodes **29** and thence pass through space along the paths **106** to the retaining strap **98** through which it is conducted back to the magnets **94**. The direction of flux flow through the upper focus electrode is in a direction opposite to that through the two lower focus electrodes. Thus, the electron beam passing through the upper focus electrode will be deflected in one lateral direction while the electron beams passing through the two lower focus electrodes will be deflected in the opposite lateral direction. By virtue of such opposite lateral deflections, maximum convergence sensitivity is obtained as described in U.S. Patent 2,847,598, issued on August 12, 1958, to R. H. Hughes.

In the event that the lateral convergence correction required is opposite that which would be provided by the magnet arrangement shown in FIG. 3, the magnets **94** can be reversed in the retaining strap **98**. The flux flow and hence the lateral beam deflection will thus be opposite that illustrated.

Although the magnets **94** are shown disposed exactly, radially outward from the apexes **95**, they may instead be slightly shifted circumferentially around the neck **12** from the apexes **95** so as to obtain a desired shaping of the magnetic fields within the tubular electrodes **29**. Arrangements wherein the magnets **94** are described as disposed circumferentially adjacent the apexes **95** are meant to include arrangements in which the magnets **94** are so shifted.

The solenoids **96** may be energized either with a suitable time varying current or by direct current so that the lateral convergence may be either dynamically or statically provided.

FIGS. 4 and 5 illustrate the tube structure and external magnet means for providing dynamic radial convergence. Such convergence is known in the art and will therefore not be described in detail herein. A description of dynamic radial convergence may be found in the Hughes patent cited above and in U.S. Patent 2,752,520, issued on June 26, 1956, to A. M. Morrell.

As shown in FIGS. 4 and 5, the convergence cage **44** of tube **10** comprises a cup **110** having a cylindrical wall **112** and an end wall **114**. A Y-shaped magnetic shield **115** divides the cup **110** into three equal parts. The end wall **114** is provided with three apertures **116**, one in each of the three divisions of the cup **110**, through which the electron beams from the three electron guns pass. The cylindrical wall **112** is provided with six longitudinal slots through which three pair of pole pieces **118** are disposed. Each pole piece **118** includes a plate-like element **119** and a flange **120**. The plate-like elements **119** of each pair of pole pieces **118** are substantially parallel to each other and straddle the beam path of one of the electron guns. The flange **120** of each pole piece **118** lies along the external surface of the cylindrical wall **112**. The flange **120** includes alternate flush and raised portions. The spaced-apart flush portions **122** and **124** are contiguous with or lie flush with the cylindrical wall **112** and are welded thereto. The spaced-apart raised portions **126** and **128** are substantially parallel to but spaced from the cylindrical wall **112** and are disposed very close to the neck **12**.

By virtue of this close spacing, maximum sensitivity of coupling between the pole piece **118** and the external magnet **46** is obtained. On the other hand, since the flush portions of the flange which are welded to the cylindrical wall **112** are recessed from the neck **12**, weld splash which might exist on the flange in the form of sharp peaks, is safely spaced from the conductive coating **52** on the neck **12**. Were the coating **52** to be scratched by weld splash peaks on the flange **120**, portions of the coating might be scraped-off and remain as harmful debris in the finished cathode ray tube **10**. The flush and raised portions of the flange **120** tend to prevent such scrape-off.

One of the raised portions **128** extends beyond the axial extent of its associated plate-like element 119. Thus the coupling between the external magnet **46** and the pole piece **118** is not limited by the axial length of the plate-like element **119**.

What is claimed is:

1. In an assembly for generating a plurality of separate electron beams, means including three tubular electrodes

disposed in delta array with their axes substantially parallel and mounted on a plurality of insulator support rods, said three tubular electrodes being supported from three magnetic straps which are disposed in a generally triangular array with their ends fixed in said insulator support rods, each of said tubular electrodes being disposed generally outside the triangular array of said straps and attached to a different one of said straps between the ends thereof.

2. In an assembly of three electron guns disposed side-by-side in delta array, each of said guns comprising a plurality of axially aligned electrodes including a tubular electrode mounted in spaced relation along a plurality of insulator support rods disposed along side said guns generally outwardly of the delta array thereof, the improvement comprising three combination electrode support and magnet pole piece straps of magnetic material each of which comprises a central arcuate-shaped, electrode-receiving section and two end sections which extend from said central arcuate section in different directions, said straps being disposed in a generally triangular array with the concave sides of their central arcuate sections facing outwardly of the array thereof and with each end section of each strap being anchored in one of said insulator support rods, said tubular electrodes being attached to said straps on the outwardly facing concave surfaces of the arcuate electrode-receiving sections thereof.

3. In an assembly comprising three electron guns disposed side-by-side in delta array, each of said guns comprising a plurality of axially aligned electrodes including a tubular electrode mounted in spaced relation along a plurality of insulator support rods disposed along side said guns generally outwardly of the delta array thereof, the improvement comprising three combination electrode support and lateral convergence pole piece straps of magnetic material each of which comprises a central arcuate-shaped, electrode-receiving section and two end sections which extend from said central arcuate section at an angle of approximately 120° with each other, said straps being disposed in a generally triangular array with the concave sides of their central arcuate sections facing outwardly of the array thereof and with each end section of each strap being disposed substantially parallel with the adjacent end section of another of said straps and anchored in one of said insulator support rods, said tubular electrodes being attached to said straps on the outwardly facing concave surfaces of the arcuate electrode-receiving sections thereof.

4. The combination of a cathode ray tube including an electron gun assembly comprising three electron guns disposed side-by-side in a delta array, each of said guns comprising a plurality of electrodes including a tubular electrode mounted in spaced relation along a plurality of insulator support rods disposed along side said guns generally outwardly of the delta array thereof, three straps of magnetic material, each of which comprises a central arcuate electrode-receiving section and two end sections which extend from said central arcuate section in different directions, said straps being disposed in a generally triangular array with the concave sides of their central arcuate sections facing outwardly of the array thereof and with their end sections anchored in said insulator support rods, said tubular electrods being attached to said straps on the outer concave surfaces of the arcuate electrode-receiving sections thereof, and magnet means comprising two magnets each of which is disposed with a pole thereof substantially adjacent to a different one of two of the apexes of said triangular array of straps, and magnet retaining means of magnetic material attached to said magnets and extending therebetween with a portion thereof disposed adjacent to the one of said tubular electrodes which is on the opposite side of said electron gun assembly from the other apex of said triangular array of straps.

5. The combination of a cathode ray tube with magnet means external of said tube, said tube comprising an envelope including a neck section and an electron gun assembly comprising three substantially similar electron guns disposed side-by-side in a delta array within said neck section, each of said guns comprising a plurality of axially aligned electrodes including a tubular electrode mounted in spaced relation along three insulator support rods, each of which is disposed along side a different two of said guns generally outwardly of the delta array thereof, three combination electrode support and magnet pole piece straps of magnetic material, each of which comprises a central arcuate electrode-receiving section and two end sections which extend from said central arcuate section at an angle with each other, said straps being disposed in a generally triangular array with the concave sides of their central arcuate sections facing outwardly of the array thereof and with their end sections anchored in said insulator support rods, said tubular electrodes being attached to said straps on the outer concave surfaces of the arcuate electrode-receiving sections thereof, said magnet means comprising two bar magnets each of which is disposed with a pole thereof substantially adjacent to a different one of two of the apexes of said triangular array of straps, and a magnet retaining strap of magnetic material attached to said magnets and extending therebetween and disposed circumferentially along and adjacent to said neck section on the side of said electron gun assembly opposite the other apex of said triangular array of straps.

6. A magnetic convergence cage comprising a member having a cylindrical wall with a plurality of longitudinal slots therein, and a plurality of magnetic pole pieces each comprising a plate-like element disposed through one of said slots and a flange extending circumferentially along the outer surface of said cylindrical wall, said flange comprising a first portion which lies flush with said cylindrical wall and welded thereto and a second portion which is generally parallel to and spaced from said cylindrical wall.

7. Means for generating a plurality of electron beams along separate beam paths, said means including a magnetic convergence cage comprising a cylindrical cup having a plurality of longitudinal slots in the cylindrical wall thereof and a plurality of apertures in the end wall thereof disposed respectively coaxially with said electron beam paths, a plurality of pairs of magnetic pole pieces, each pole piece comprising a plate-like element with a flange extending therefrom, the plate-like elements of each of said pole pieces extending through one of said slots into said cup substantially parallel to the plate-like element of the other pole piece of the same pair with each pair of plate-like elements straddling a different one of said beam paths, said flange being disposed circumferentially along the outer surface of the cylindrical wall of said cup, said flange comprising spaced flush portions which lie flush with said cylindrical wall and are welded thereto and a raised portion between said flush portions which is generally parallel to and spaced from said cylindrical wall.

8. An assembly comprising a plurality of electron guns disposed side-by-side with each of said guns including a plurality of axially aligned electrodes and a magnetic convergence cage mounted on the ends of said guns, said cage comprising a cylindrical cup having a plurality of longitudinal slots in the cylindrical wall thereof and a plurality of apertures in the end wall thereof disposed respectively coaxially with the electron beam paths of said electron guns, a plurality of parallel pairs of plate-like magnetic pole piece elements extending through said slots into said cup with a separate pair of said pole piece elements straddling a different one of said beam paths, each of said plate-like pole piece elements having a flange extending circumferentially along the outer surface of the cylindrical wall of said cup, said flange comprising a plurality of alternate flush and raised portions, said flush portions being contiguous with and welded to said cylin-

drical wall and said raised portions being parallel to and spaced from cylindrical wall, one of said raised portions extending longitudinally along said cup beyond the longitudinal slot in which its plate-like pole piece element is disposed.

9. In an assembly for generating a plurality of separate electron beams, means including three tubular electrodes disposed in delta array with their axes substantially parallel and mounted on a plurality of insulator support rods, said three tubular electrodes being supported from three straps which are disposed in a generally triangular array with their ends fixed in said insulator support rods, each of said tubular electrodes being disposed

generally outside the triangular array of said straps and attached to a different one of said straps between the ends thereof, at least one of said straps being magnetic.

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