Nov. 4, 1958 B. W. SQUIER, JR 2,859,366

SIMPLIFIED CATHODE RAY TUBES AND GUNS THEREFOR

Filed Jan. 4, 1956 2 Sheets-Sheet 1

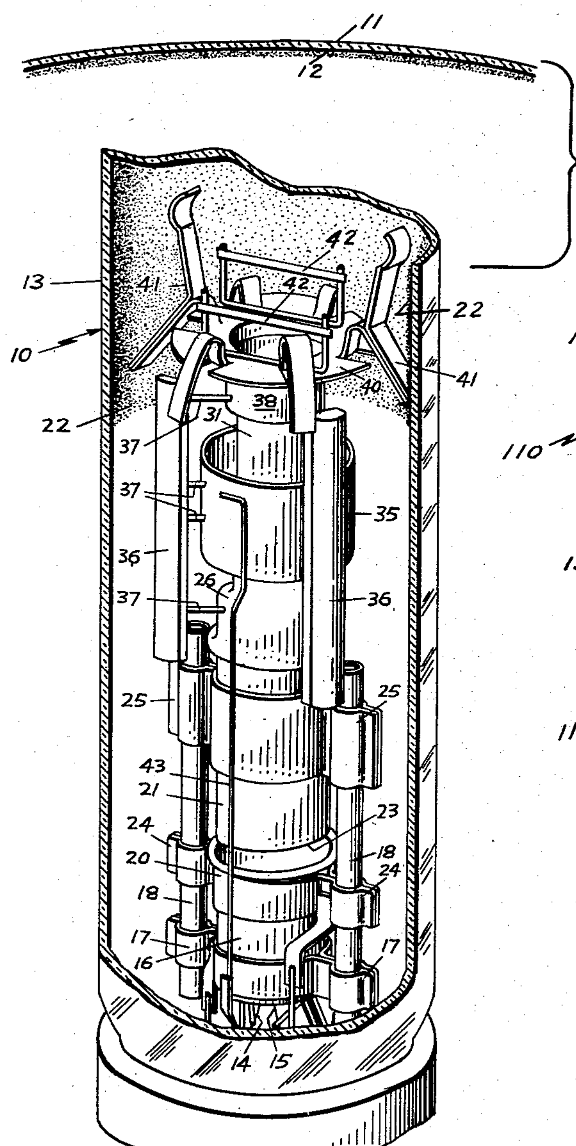


FIG. 1.

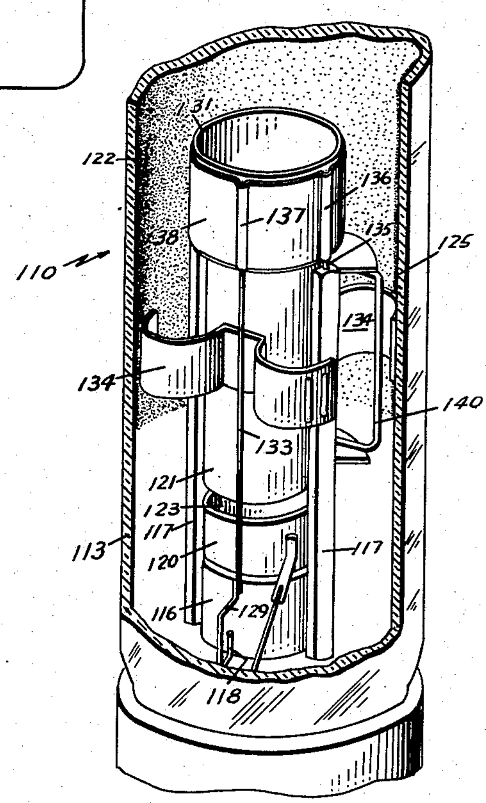
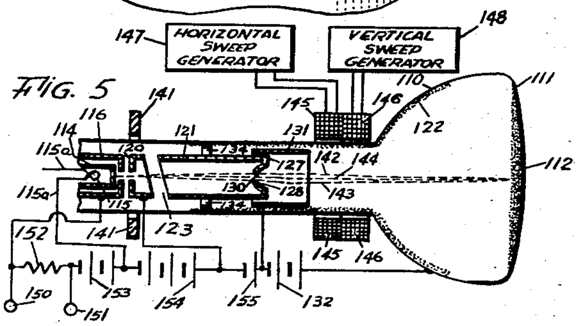


FIG. 2

FIG. 5



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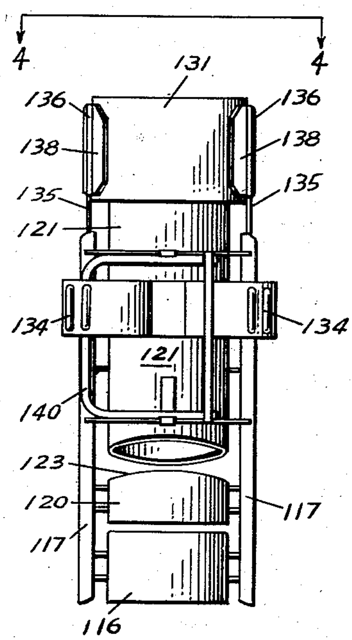


FIG. 3

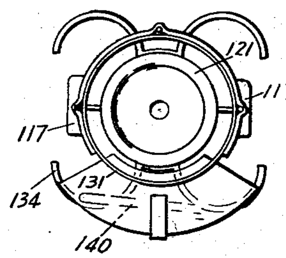
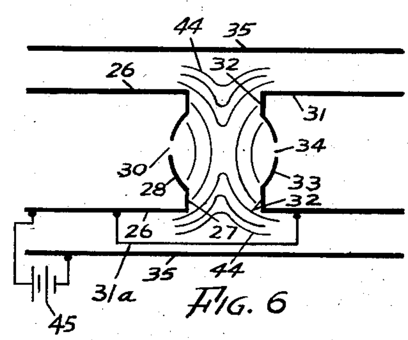


FIG. 4



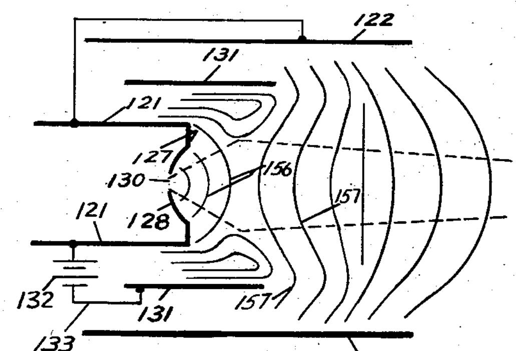


FIG. 7

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SIMPLIFIED CATHODE RAY TUBES AND GUNS THEREFOR

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Application January 4, 1956, Serial No. 557,408

6 Claims. (Cl. 313—82)

This invention relates to cathode ray tubes with electrostatic focus, and more particularly to electron guns for such tubes.

In the construction of electron gun assemblies for cathode ray tubes, it is customary to provide a series of paraxial metallic cylinders or thimbles which successively accelerate the scanning beam. When the gun system includes a device for producing deflection of the generated beam for ion trapping, the beam must be axially realigned. Following the ion trapping apparatus, for instance, the so-called "slashed field gun structure," in a sequence of lens-anode elements, the beam is usually subjected to a multiple lens system to re-establish paraxial and converging action to achieve the desired physical dimensions and intensity of the beam. For this purpose, a pair of equi-potential lens elements have been utilized with a thick lens disposed between them to give the equivalent of a directed and inverted lens system. This is accomplished by locating a relatively wide aperture lens between the lens rings of a unipotential lens system, preferably at a lower potential with respect to the lens rings of the unipotential lens system to form a symmetrical field. The outer lens ring of the system is terminated in a ring formed with spring fingers that serve to support the gun structure against the neck of the tube and also to make electrical contact with a conductive coating on the inside of the tube. The outer lens system is separately assembled on a set of insulating rods while held in a jig. This jig presents a maintenance problem as it is successively heated and cooled, distorting it out of its critical alignment. When the gun is inserted into the neck of the envelope and the fingers strike the neck walls, uneven pressures are exerted through the fingers that tend to force the outer lens ring out of alignment with the other elements of the lens system. This distortion is particularly important, as the axis of the outer and central lens in this type of gun is shifted slightly with respect to the axis of the first lens element to correct for the bend in the beam path introduced by the slash. Thus, this distortion can introduce error in the location of the points at which the beam strikes the phosphor screen to create the picture. This results in a distorted picture.

The construction of the invention overcomes these difficulties. The first lens ring of the focussing lens system is formed integral with the second accelerating electrode to avoid the necessity for welding at this point. The central lens system is supported by the same insulating rods that support the accelerating electrode saving a second subassembly operation. A conductive coating on the inside of the neck forms the second lens element of the unipotential lens system. Fingers extend from the first lens element to make contact with the conductive coating on the neck wall to afford electrical connection and mechanical support. As the geometrical arrangement of the first and second lens elements with the central ring is different, the fields are asymmetrical. It has been found that the usual shift of approximately three degrees in the beam axis, due to the slash, does not need to be corrected in order to achieve a satisfactory picture with such an asymmetrical lens system; thus the lens alignment is less critical. No pressure is exerted on the central lens ring and so there is no risk of distortion during the insertion of the gun into the neck. As there is a potential difference between the third lens element and the conductive coating, the presence of sharp points likely to be left by welding is likely to cause arcing between these two elements. Consequently, welding at this point is avoided by making mechanical and electrical connections to the third lens element by means of a band formed with loops that are crimped in against the inserted support and connecting rods. The result is a gun structure that may be inserted into a tube having a narrower neck for the same performance as a tube of conventional construction. This narrower neck, other things being equal, permits the deflecting yoke to be positioned nearer the axis of the beam of electrons, so that less deflecting force is needed to obtain the same deflection, or a greater deflection can be obtained with the same deflecting force. As the maximum deflecting angle largely determines the minimum length of the cathode ray tube, this construction permits the length of the tube to be shorter for the same size screen than with the conventional gun construction. Due to the greater internal diameter of the second lens element, that is, the conductive coating, the alignment of the elements of the focussing lens system is less critical. This is an obvious advantage in production.

Other and further advantages of this invention will be apparent as the description thereof progresses, reference being had to the accompanying drawings wherein:

Fig. 1 is an isometric view of the electron gun portion of a cathode ray tube of the prior art showing portions of the envelope;

Fig. 2 is an isometric view of the electron gun portion of a cathode ray tube embodying the construction of this invention;

Fig. 3 is a detail of the gun structure of Fig. 2;

Fig. 4 is a top view of the gun structure shown in Figs. 2 and 3;

Fig. 5 is a schematic diagram of a cathode ray tube made according to the invention with associated circuitry;

Fig. 6 is a diagram of a focussing lens system with symmetrical electrical fields; and

Fig. 7 is a schematic diagram of a focussing lens system with unsymmetrical fields.

In the drawing, the reference numeral **10** designates generally the glass envelope of a cathode ray tube having a front screen **11** formed with a phosphor layer **12** on its inner side and a neck **13**. In the neck portion **13** there is mounted a preformed subassembly generally referred to as the "gun." This gun assembly consists of a cathode, not shown, which may be of any of the several well-known types of construction within which is mounted a heater, not shown, which may be of any of the well-known designs. This heater is connected by wires **14** and **15** to a source of heating potential in the usual manner. The cathode is mounted in an apertured grid **16** attached by straps **17** to a pair of insulating rods **18** mounted on the stem and extending axially into the neck on either side of the gun assembly. This grid **16** has applied to it a negative bias with respect to the cathode that controls the emission intensity of the beam layer.

The electrons are accelerated through the positive potentials on a succession of anodes **20**, **21**, and **22**. Anode **22** comprises a coating of conductive material on the inner surface of the neck portion **13** of the envelope **10**. It will be noted that there is a biased slash **23** between the anodes **20** and **21** which produces the so-called ion trap effect. The beam is returned toward the axis by a magnetic field produced by a magnet, not shown. The anodes **20** and **21** are also supported on the rods **18** by straps **24** and **25**, respectively.

A focussing lens subassembly is mounted on the outer end of the anode **21**. The first element of this lens system comprises a thimble-shaped piece of metal **26** formed with a closed outer end **27** having a depressed central portion **28** formed with an opening **30** at the center, as best seen in the diagram of the focussing lens system in Fig. 5. A second element of this lens subassembly is formed as a metallic thimble 31. The inner closed end of this thimble has a central depressed region **33** with an aperture **34** at its center. The third lens element comprises a metallic sleeve **35** mounted concentrically about a space between the lens elements **26** and **31**. The three lens elements are held in position by means of three rods of insulating material **36** to which the elements are connected by lateral members **37**. The lens elements are attached to the supporting rods **36** in a jig by a beading operation. This means that the jig must be alternately heated and cooled, causing distortion. The maintenance operation necessary to correct for this is expensive. The focussing lens system is supported by the inner member **26** being welded to the anode member **21**. The outer lens element **31** is formed with an enlargement **38** at its outer end terminating in a flange **40** with fingers **41** formed integral with this flange. The fingers serve to support and center the gun assembly within the neck **13**. The getter support structures **42** are attached to this flange **40**. The lens elements **26** and **31** are electrically connected together by a conductor **31*a***, and to a source of positive potential **45** through the conductive coating **22** by means of the fingers **41**. The central lens element **35** is connected to a source of less positive potential through a conductor **43**. The resulting focussing field is represented in Fig. 5 by the lines **44** of equal potential.

The lens assembly is welded to the anode **21**, while the parts are held in a jig. As the gun assembly is inserted in the neck **13** of the evelope **10**, the fingers **41** come into contact with the neck and compress, exerting pressure on the gun assembly which has a tendency to distort it and force the lens elements out of alignment. It can also be seen that the neck must be considerably larger in diameter than necessary to accommodate the anode and focussing lens structures alone.

These difficulties are overcome by the construction of the invention shown in Figs. 2, 3, 4, and 6. The references numeral **110** designates generally the envelope with a face plate **111** coated on its inner surface with a phosphor screen **112** and having a neck **113**. A gun is mounted in the neck **113**.

This gun assembly consists of a cathode **114** within which is mounted a heater **115** connected to a source of heating energy by connectors **115*a***. The cathode is mounted in an apertured grid **116** attached to a pair of insulating rods **117** mounted axially in the neck **113** on either side of the gun assembly. This grid **116** has applied to it the usual negative bias by means of a connector **118**. There are three successive anodes **120**, **121**, and **122**. Anode **122** comprises a coating of conductive material on the inner surface of the neck **113** of the envelope **110**. There is a biased slash **123** between the anodes **120** and **121** to produce the so-called ion trap effect. Other known constructions may be used to obtain this effect. The anodes **120** and **121** are also attached to the rods **117**. The anode **121** is formed as a thimble with a closed outer end **127** having a depressed central portion **128** formed with an aperture **130** at the center, as best seen in Figs. 4, 5, and 7. The second element of the focussing lens is formed by the conductive coating **122** on the inside of the neck **113** that also serves as the third anode. The third element of the focussing lens comprises a metallic sleeve **131** maintained at a potential negative with respect to the anode **121** and

the conductive coating **122** as indicated by the battery **132** in Figs. 4 and 6 connected by means of a conductor **133**. The gun assembly is positioned within the neck **113** and connected to the coating **122** by means of fingers **134** attached to the anode **121**. The third focussing lens element **131** is supported on the rods **117** by means of rods **135** extended axially from the rods **117**. These rods and conductor **133** are fastened to the sleeve **131** by being crimped into loops **136** and **137** formed in a band **138** of metal previously attached either by soldering or welding to the element **131**. This attachment may be treated to remove burrs and other irregularities while still a separate part. The getter support **140** is attached to the anode **121**, as shown in Fig. 3. As best seen in Fig. 5, a magnet **141** is applied for returning the electron beam indicated by the dotted lines **142** and **143** to the axis indicated by the dotted line **144**. The electron beam **142** and **143** is subjected to the focussing effect of the lens elements **121**, **131**, and **122** to bring the beam to a virtual point on the phosphor screen **112**. Deflection is accomplished by coils **145** and **146** supplied with suitable deflecting currents from horizontal sweep generator **147** and vertical sweep generator **148**, respectively. The signal for modulating the intensity of the light produced is applied at terminals **150** and **151** across a resistor **152** connected in series with a source **153** of biasing potential between the grid **116** and the cathode **114**. The first anode **120** is maintained at a positive potential with respect to the cathode **114** by means of a battery **154**. The lens element **131** is maintained at a positive potential with respect to the anode **120** by means of a battery **155** to complete the electron lens system and give approximately the fields indicated by the lines **156** and **157**, indicating the locus of points of equal potential. It will be noted that the lines **156** bend away from the apertured lens disc **121** until they assume the **S** shape of lines **157**, due to the asymmetry of the geometry of the lens system. The focussing effect is improved if the neck coating is carried back behind the focussing lens system.

It can be seen by a comparison of Figs. 1 and 2 that a more compact gun structure is obtained with the construction of this invention. For example, while a neck diameter of 1½ inches is required for a representative cathode ray tube, a tube of the same performance characteristics can be constructed with the principles of this invention having a neck diameter of 1⅛ inches. As pointed out above, this permits the use of a shorter tube or less power for the same deflection. When this gun is inserted into the neck **113**, any distorting forces applied by the fingers **134** are applied to the sturdier anode **121** and not to the less securely fastened third lens assembly **131**. Thus, there is no likelihood of distortion being introduced during the insertion of the gun into the neck. It will also be apparent by such comparison that a gun constructed according to the principles of this invention consists of fewer parts in that there is no separate outer lens element to be supported on the gun structure, nor are separate supporting rods needed for holding the focussing lens assembly in alignment. A further saving in parts is made by being able to form the first lens element integral with the second anode **121**.

It is possible to utilize the neck coating as the central lens element mounting the ring **131** in front by a similar structure.

This invention is not limited to the particular details of construction, materials and processes described, as many equivalents will suggest themselves to those skilled in the art. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. In a cathode ray device, a gun assembly structure comprising an electrostatic lens disc, an annular lens ring, insulating means for supporting said ring substantially co-

axial with said lens disc and extending beyond said lens disc in the desired direction of travel of the electron beam comprising at least one rod of insulating material with its axis parallel to the axis of said lens disc and ring, at least one laterally extending member connecting said lens disc to said insulating rod, an axially extending member connecting said lens ring to said insulating rod, and an envelope for said device having a neck with a conductive coating on the inside.

2. In a cathode ray device, an envelope having a neck with a conductive coating inside, an electrostatic focussing lens including an apertured disc, an annular lens ring, and insulating means for supporting said ring substantially coaxial with said lens disc and extending beyond said lens disc in the desired direction of travel of the electron beam comprising at least one rod of insulating material with its axis parallel to the axis of said lens disc and ring, at least one laterally extending member connecting said lens disc to said insulating rod, an axially extending member connecting said lens ring to said insulating rod, a band about said lens ring formed with a crimped loop to hold said axially extending member, and the conductive coating on the inside of the neck.

3. In a cathode ray device with a phosphor screen, a gun assembly structure comprising an electrostatic lens disc formed integral with a tubular accelerating electrode, an annular lens ring, insulating means for supporting said annular lens ring substantially coaxial with said lens disc so that it extends beyond said lens disc in the desired direction of travel of the electron beam comprising at least one rod of insulating material with its axis parallel to the axis of said lens disc and ring, at least one laterally extending member connecting said lens disc and accelerating electrode to said insulating rod, an axially extending member connecting said lens ring to said insulating rod, an envelope for said device having a neck with a conductive coating on the inside extending back from the screen at least as far as the outer end of the lens ring, and means for supporting said lens disc within said neck and electrically connecting it to said conductive coating.

4. In a cathode ray device with a phosphor screen, a gun assembly structure comprising an electrostatic lens disc formed integral with a tubular accelerating electrode, an annular lens ring, insulating means for supporting said lens ring substantially coaxial with said lens disc and extending beyond said lens disc in the desired direction of travel of the electron beam comprising at least one rod of insulating material with its axis parallel to the axis of said lens disc and ring, at least one laterally extending member connecting said lens disc and accelerating electrode to said insulating rod, an axially extending member connecting said lens ring to said insulating rod, a band about said lens ring formed with a crimped loop to hold said axially extending member, an envelope for said device having a neck with a conductive coating on the inside extending back from the screen at least as far as the outer end of the lens ring, and means for supporting said lens disc within said neck and electrically connecting it to said conductive coating.

5. An electron gun assembly for a cathode ray device comprising an electrostatic lens disc formed integral with a tubular accelerating electrode, an annular lens ring, insulating means for supporting said lens ring substantially coaxial with said lens disc and extending beyond said lens disc in the desired direction of travel of the electron beam comprising at least one rod of insulating material with its axis parallel to the axis of said lens disc and ring, at least one laterally extending member connecting said lens disc and accelerating electrode to said insulating rod, and an axially extending member connecting said lens ring to said insulating rod.

6. An electron gun assembly for a cathode ray device comprising an electrostatic lens disc, an annular lens ring, insulating means for supporting said lens ring substantially coaxial with said lens disc and extending beyond said lens disc in the desired direction of travel of the electron beam comprising at least one rod of insulating material with its axis parallel to the axis of said lens disc and ring, at least one laterally extending member connecting said lens disc to said insulating rod, an axially extending member connecting said lens ring to said insulating rod, and a band about said lens ring formed with a crimped loop to hold said axially extending member.

References Cited in the file of this patent

UNITED STATES PATENTS

2,160,021	Iams	May 30, 1939
2,219,111	Nicoll	Oct. 22, 1940
2,225,901	Bruche	Dec. 24, 1940
2,249,552	Zworykin	July 15, 1941
2,638,559	Giacchetti	May 12, 1953
2,656,481	Leighton	Oct. 20, 1953
2,733,365	Hoagland	Jan. 31, 1956
2,793,312	Hangen et al.	May 21, 1957