ELECTRON GUN

Filed April 13, 1960

Fig. 1.

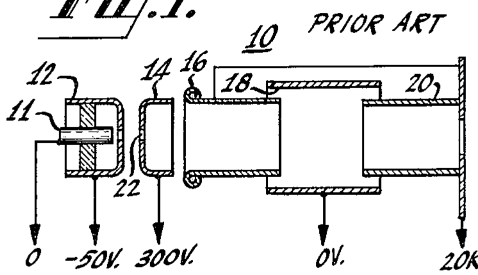
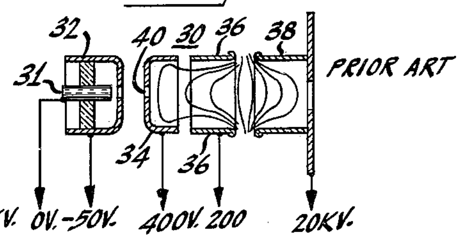


Fig. 2.



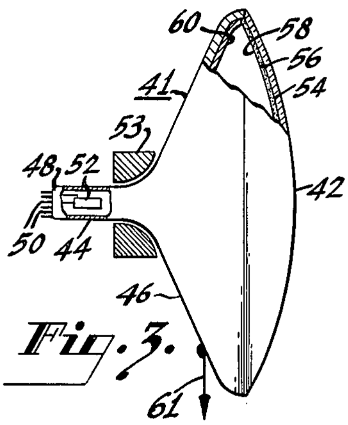


Fig. 3.

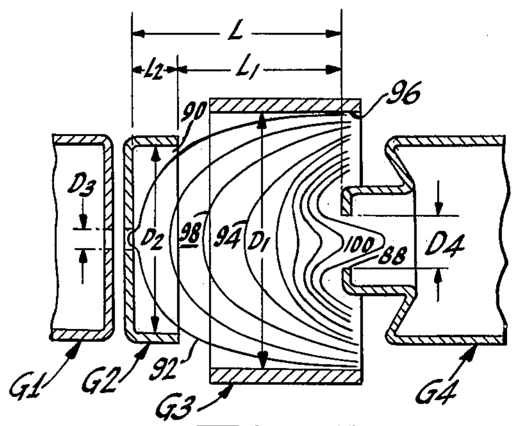
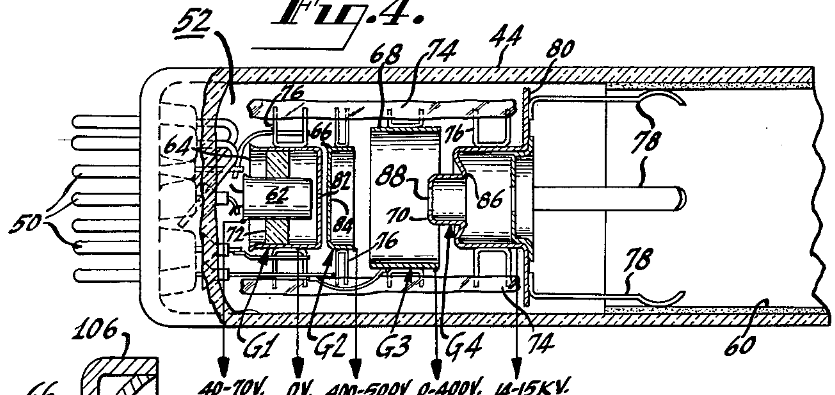


Fig. 5.

Fig. 4.



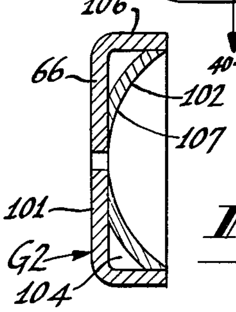


Fig. 6.

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ELECTRON GUN

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10 Claims. (Cl. 313—82)

This invention relates to electron guns for cathode ray tubes of the type used, for example, in television receivers.

The type of electron gun for tubes such as described above is well known in the art and usually comprises a plurality of axially aligned electrodes mounted in fixed spaced relation usually on a plurality of glass rods. Such a gun generally includes a cathode for thermionically emitting electrons, a control electrode for modulating the flow of electrons from the cathode, a screen grid or first accelerating electrode for initially accelerating the electrons and for converging them to a crossover, and two or more additional electrodes for electrostatically focusing and further accelerating the electrons into a high velocity electron beam. The focusing action of such an electron gun is provided by two or more electrodes having different potentials applied thereto which create an electrostatic field which serves as an electron optical lens.

Electrode shapes, sizes, and spacings, as well as the voltages applied thereto, determine the characteristics of operation of the electron gun. The obtaining of one desired characteristic of an electron gun may conflict with the obtaining of another desired characteristic. Accordingly, the prior art has resorted to compromises in order to provide some degree of both characteristics in the same structure. Such compromises have, for example, been provoked by the recent desire for shorter cathode ray tubes for the purpose of permitting shallower depth television receiver cabinets.

One expedient for obtaining shorter tubes has been to provide shorter electron guns. The prior art has exercised this expedient by either shortening the electrodes or spacings thereof or by omitting one or more of the electrodes in the electrostatic focusing system of the gun. For example, it has been common to eliminate one electrode of a conventional 3-electrode focusing system. However, such elimination of an electrode results in blooming and sacrifice of depth of focus characteristics of the gun. Blooming may be generally described as the increase of beam diameter with the increase of beam current such as is produced by normal modulation thereof. Depth of focus is generally defined as the permissible range of voltage which can be applied to a focus electrode and still obtain a degree of beam focus within a predetermined acceptable range. Blooming and sacrifice of depth of focus adversely affect picture quality. Previous attempts to provide short electron guns of the 2-electrode focusing system type have resulted in rather severe blooming and shallow depth of focus characteristics.

Accordingly, it is an object of my invention to provide a novel electron gun structure which exhibits improved operating characteristics as compared with similar-type electron guns of the prior art.

Another object of my invention is to provide an electron gun of the relatively short 2-electrode focusing system variety which exhibits reduced blooming and increased depth of focus characteristics as compared with similar variety guns of the prior art.

Briefly, according to my invention an electron gun comprises, in the order named, axially aligned cathode, control grid, screen grid, focusing, and accelerating electrodes. A beam focusing action is produced primarily by an electrostatic lens created by different voltages on the focusing and accelerating electrodes. The screen grid is a centrally apertured relatively shallow cup with its open end

adjacent the focusing electrode, which is itself tubular and open ended. The accelerating electrode is tubular and its end adjacent the focusing electrode is partially closed. The diameter of the focusing electrode is larger than the diameter of the screen electrode and approximately equal to the axial distance between the apertured ends of the accelerating and screen electrodes.

In the drawings:

FIG. 1 is a partially schematic, longitudinal section of a prior art electron gun having a conventional 3-electrode focusing system;

FIG. 2 is a partially schematic, longitudinal section of a prior art electron gun of the short 2-electrode focusing system variety described above;

FIG. 3 is an elevation view with parts broken away of a cathode ray tube suitable for incorporating an electron gun according to my invention;

FIG. 4 is a longitudinal section of an electron gun according to my invention;

FIG. 5 is a schematic representation of a portion of the gun of FIG. 4 together with an actual field plot of the electrostatic focusing field; and

FIG. 6 is an axial section of a modification of the screen electrode according to my invention of the gun of FIG. 4.

When compactness of the electron gun is not of primary concern, a 3-electrode focusing system gun **10**, as illustrated in FIG. 1, has been widely used. Such a gun comprises a cathode sleeve **11** mounted concentrically within a control grid cup **12**, a screen grid cup **14**, a first anode **16**, a focusing ring **18**, and a second anode **20**. The focusing ring **18** surrounds and overlaps adjacent ends of the two anode electrodes **16** and **20**.

In one example of the operation of the gun **10**, voltages of 0, −50, 300, 20,000, 0, and 20,000 may be applied, respectively to the electrodes **11**, **12**, **14**, **16**, **18**, and **20** as illustrated. Such operation results in a converging of the electrons leaving the cathode **11** to a crossover in or near the aperture **22** of the screen grid cup **14** and then focusing and accelerating of the electrons by the 3-electrode focusing system **16**, **18**, and **20**. The focusing field comprises a pair of electron optical lenses, one between the focusing ring **18** and each of the anodes **16** and **20**.

The focusing action provided in the gun **10** exhibits an extremely great depth of focus. This might be attributable to the fact that since the focusing fields are rather much confined within the focusing ring **18**, even when the voltage on the focusing cylinder **18** is altered, the strength of the focusing lenses are not appreciably changed.

The 3-electrode focusing system gun **10** also exhibits a minimum of blooming by virtue of the high voltage anode **16** being positioned adjacent the screen grid cup **14**. Due to the relative position of these two electrodes, the high voltage field from the first anode **16** extends into the aperture **22** of the screen grid cup **14**, the region of the crossover of the beam. This strong positive field is believed to counteract space charge effects in the beam at the crossover and thus provides a more nearly perfect point crossover thereof.

Where compactness of an electron gun is considered a prerequisite of tube design, a 2-electrode focusing system gun **30**, as illustrated in FIG. 2, has been commonly employed. The gun **30** may comprise a cathode sleeve **31** concentrically mounted within a control grid cup **32**, a screen grid cup **34**, a tubular focusing electrode **36** and a tubular accelerating electrode **38**.

In operation of such a 2-electrode focusing system gun **30**, voltages of 0, −50, 400, 200, and 20,000 might be applied, respectively, to the electrodes **31**, **32**, **34**, **36**, and **38**. By such operation, electrons emitted from the cathode **30** are modulated by the control grid cup **32** and converged to a crossover by the screen grid cup **34** at or near the aperture **40** of the screen grid. The electrons emerging from the crossover are then focused and accelerated by the two electrodes **36** and **38**. The principal focusing field is a single lens created between the focusing electrode **36** and the accelerating electrode **38**.

The gun **30** of FIG. 2 somewhat resembles the 3-electrode focusing system gun **10** with the first anode **16** eliminated. Although resulting in a considerably shorter electron gun, the elimination of this electrode **16** also results in the sacrifice of two very desirable characteristics of gun operation, good depth of focus, and low blooming characteristics.

In the gun **30** of FIG. 2, the focusing field between electrodes **36** and **38** extends into the focusing electrode **36** toward the screen grid cup **34**. As the voltage on the focusing electrode **36** is adjusted in order to obtain best operating condition of the gun, the focusing field not only changes in intensity, but also in its shape since there is nothing which confines the field. Rather, the field is permitted to extend even further into the screen grid cup **34**. Accordingly, changing of the voltage on the focusing electrode **36** results in a rapid or severe changing of the focusing action of the primary focusing field. This is interpreted as a very shallow depth of focus.

Moreover, inasmuch as there is no high voltage electrode adjacent the screen grid cup **34** in the 2-electrode focusing system gun **30**, there is no appreciable high voltage field which dips or extends into the crossover region of the beam. Thus, space charges are not counteracted, and a relatively poor crossover is produced. This ultimately results in rather severe blooming characteristics of the gun. Although the accelerating electrode **38** is a high votlage electrode, it is separated from the screen grid cup **34** by a low voltage electrode, i.e., the focusing electrode **36**. Thus, the high voltage field from the accelerating electrode **38** cannot penetrate to the crossover region at the aperture **40** to any great extent.

I have discovered that by properly designing the electrodes of a 2-electrode focusing system gun, depth of focus can be substantially improved. This is made possible by an electrode structure wherein a relatively great change of voltage on the focusing electrode **36**, although changing the intensity of the electrostatic focusing field, does not substantially change the shape of this field. Moreover, according to my invention a gun structure is provided which not only accomplishes this improvement in depth of focus but at the same time alleviates the blooming problem in prior art 2-electrode focus system guns by enabling the high voltage field from the accelerating electrode to dip well into the aperture of the screen grid cup where the crossover of the beam occurs.

FIG. 3 illustrates a suitable type of cathode ray tube for incorporating my invention. The tube **41** comprises an envelope which includes a faceplate **42**, a tubular neck **44**, and an interconnecting funnel **46**. The neck **44** is closed with a stem structure **48** which includes a plurality of stiff lead-in conductors **50**. A 2-electrode focusing system electron gun **52** according to my invention is disposed in the neck **44** and connected to the lead-in conductors **50**. The electron gun **52** is adapted to project a beam of electrons toward the faceplate **42**. Deflection means, such as an electromagnetic yoke **53**, is provided for scanning the electron beam through a raster. A luminescent screen **54**, which comprises a phosphor layer **56** and a metal backing layer **58**, is disposed on the internal surface of the faceplate **42**. A conductive coating **60** of suitable material is disposed on the internal surface of the funnel **46** and electrically connected to the metal backing layer **58**. A high voltage contact terminal **61** is provided through the funnel **46** for making electrical contact with the conductive coating **60**.

FIG. 4 illustrates the 2-electrode focusing system gun **52** according to my invention. The electron gun **52** comprises a plurality of axially aligned electrodes including an indirectly heated cathode **62**, a control grid

electrode **64**, a screen grid electrode **66**, a focusing electrode **68**, and an accelerating electrode **70**. In the 2-electrode focusing system gun **52** the electrodes **64**, **66**, **68**, and **70** are next adjacent to each other, i.e., there are no other electrodes which are interposed between these electrodes. For the sake of brevity and clarity, the control, screen, focusing, and accelerating electrodes **64**, **66**, **68**, and **70**, respectively, will hereinafter be referred to simply as the G1, G2, G3, and G4 electrodes, respectively.

The various electrodes of the electron gun **52** are mounted according to well-known techniques. The cathode **62**, which comprises a tubular member closed at one end, is supported within the cup-shaped G1 by a centrally apertured ceramic disk **72**. The G1, G2, G3, and G4 are supported in spaced relation on a pair of insulator rods **74** into which U-shaped metal studs **76**, fixed to the various electrodes, are bonded. Two of the stiff lead-in conductors **50** are directly connected to the G1 studs **76** and thus support the cathode end of the gun **52**. The other end of the gun **52** is supported within the neck **44** by a plurality of spring contact members **78** which are fixed to a top aperture plate portion **80** of the G4.

Operating potentials are applied to all of the electron gun electrodes except the G4 through the lead-ins **50**. G4 is energized through the high voltage terminal **61**, the conductive coating **60** (FIG. 1), and the contact springs **78**. However, for purposes of schematic illustration, schematic lead lines are shown in FIG. 4 to illustrate one set of suitable operating voltages for the electron gun **52**. As therein illustrated, the following D.C. voltages may be applied: Cathode **62**, 40–70 volts; G1, 0 volts; G2, 400–500 volts; G3, 0–400 volts; and G4, 14,000–20,000 volts.

In the operation of the electron gun **52** electrons are emitted from the cathode **62** and accelerated through aligned apertures **82** and **84** in the G1 and G2, respectively. The electrons converge to a crossover in the vicinity of the G2 aperture **84** and then diverge therefrom. The divergent electrons are then reconverged and focused upon the luminescent screen **56** by a strong electrostatic focusing field established by the potentials on the G3 and G4 electrodes.

In accordance with my invention and as shown in detail in FIG. 5, the above-stated objects are attained by a novel arrangement and structure of the G2, G3, and G4 electrodes. The G2 comprises a relatively shallow apertured cup open toward the G3. The G3 comprises a tubular member open at both ends. The G4 is likewise a tubular member but includes a transverse end portion **86** adjacent the G3 and has a central aperture **88** therein providing a relatively small aperture for the electron beam as it enters the G4. The transverse end portion **86** extends slightly into the G3. The diameter of the G2 is larger than the G4 aperture **88**; the diameter of the G3 is even still larger than the diameter of the G2; and the axial distance between the ends of the G2 and G4 closest to the cathode, i.e., their apertured ends, is approximately equal to or less than the diameter of the G3. The shaping and arrangement of the G2, G3, and G4 electrodes shown in FIG. 5 results in the creation of an electrostatic focusing field schematically shown and the shape of which is not as severely altered in response to a substantial adjustment change of the voltage on the G3 as is the case with similar type prior art guns. Thus, depth of focus is substantially increased as compared to similar type prior art guns such as the gun **30** of FIG. 2, Moreover, such novel electrode shaping and arrangement also results in the creation of a high voltage focusing field which extends into the crossover region of the beam (in the region of the G2 aperture **84**) to provide a decrease of blooming as compared to similar type prior art guns such as the gun **30** of FIG. 2.

In FIG. 5 relative size and spacing dimensions of the various electrodes are designated as follows:

Diameter of G3	D1
Diameter of G2	D2
Diameter of G2 aperture 84	D3
Diameter of G4 aperture 88	D4
Axial spacing between apertured ends of G2 and G4 electrodes	L
Axial spacing between the G2 and G4	L1
The axial depth of G2	L2

As hereinbefore stated, improvement in blooming is obtained by providing a high voltage field in the vicinity of the G2 aperture **84**. According to my invention such a field is produced in the region of G2 aperture **84** by:

(1) Making D1 at least approximately as large as L so that relatively high voltage equipotential surfaces will extend the complete L distance, and

(2) Making L2 sufficiently short relative to D2 so as not to prevent such extending high voltage equipotential surfaces from dipping freely into the G2 cup.

With respect to feature 1, an established approximation is that an electrostatic field is diminished to about 10 percent its strength at a distance equal to the diameter of an aperture through which it extends, e.g., a condition of L=D1. Thus, according to my invention a field of approximately 1400–2000 volts (10 percent of G4 potential) extends into the region of the G2 aperture at the crossover of the beam. This contributes greatly to alleviating blooming problems.

Also, as hereinbefore stated, improvement in depth of focus is obtained by creation of a focusing field which does not change its overall shape too severely with a substantial adjustment change of the voltage on G3. According to my invention such a field is produced by making D1 larger than D2 and L2 of a size so that the rim **90** of the G2 extends almost to an equipotential surface **92**, which when undistorted from a smooth-curved cupped contour extends a distance substantially equal to L. By virtue of this relationship of G2 and G3 as illustrated in FIG. 5, the presence of the G2 does not distort the equipotential surface **92**. Thus, even when the focusing field is intensified by a change of the voltage on G3, the shape of the field does not materially change. The equipotential surfaces merely crowd closer together.

The general relationship of electrode shapes and spacings according to my invention which make possible this nonchanging field shape in response to an adjustment of G3 voltage may be described in several ways. The improved nonchanging field feature can be generally obtained by an electrode arrangement in which the G2 cup has a depth approximately one-fourth its diameter and in which G3 is greater in diameter than the G2 and in which the distance between the ends of the G2 and G4 closest to the cathode is approximately equal to the diameter of G3. This relationship may be somewhat more specifically defined by a dimensional ratio wherein the ratio of L2:D2:D1:L is approximately equal to 1:4:5:5.

The functional requirement according to the practice of my invention may likewise be defined in various ways. For example, the above-described relationship of electrode sizes, shapes, and spacings are such that the equipotential surfaces which extend into the G2 cup are substantially smooth-curved, cup-shaped imaginary surfaces, i.e., they possess no sharp changes in radius of curvature. In this respect the equipotential surfaces **92** extending into the G2 cup possess generally the same type contour as the equipotential surfaces **94** extending halfway through the G3. As illustrated by the equipotential surface **92**, a smooth-curve, cup-like imaginary surface is defined by the G2 aperture **84**, the G2 rim **90**, and the internal cylindrical surface portion **96** of the G3 radially opposite the apertured end of the G4. These points thus serve to maintain the shape of the focusing field constant when its intensity is changed.

In contrast to the smooth-curve, cup-like uniform field established by the gun **52** according to my invention, the field **97** illustrated in FIG. 2 is typical of operation of prior art guns of the same general class. As shown in FIG. 2, the equipotential surfaces which extend farthest into the focusing electrode **36** are distorted into a flattened shape bulged at their side adjacent the screen electrode **40**. Inasmuch as the distorted equipotential surfaces are those of farthest extent, such distortion appears, or becomes most pronounced, when the field is made more intense. This means that as the field **97** is increased in intensity its shape is changed. Such changing shape is one factor which contributes to the small depth of focus characteristic of prior art guns of this general class.

As is well known, an electrostatic field established between two circular electrodes comprises a convergent portion and a divergent portion. Because the electrons of a beam passing therethrough are either being accelerated or decelerated, they are always influenced to a greater extent by the convergent portion. Thus, the field always exerts an overall convergent action. When the focus voltage is changed, both the convergence and divergence forces are changed; they are both increased or both decreased. However, because of the inherent dominating characteristic of the convergent portion of the field, the convergence forces always experience a greater change than do the divergence forces. Hence, overall convergence is either increased or decreased depending upon whether the focus voltage is decreased or increased. According to my invention, the overall net change in convergence is reduced by a gun structure in which the change of convergence is made less pronounced and the change of divergence more pronounced than is the case for prior art guns of the same general class.

In the case of an accelerating field such as is established between the G3 and G4 electrodes of the gun **52**, the convergent portion is the first portion, i.e., the portion **98** extending toward the G2; the divergent portion is that portion **100** which extends in the opposite direction into the G4. Accordingly, it is the convergent portion **98**, or the portion generally contained by the G2 and G3, whose shape is maintained relatively constant in accordance with the teaching of my invention. This maintenance of shape is primarily effective to prevent distortions in the convergent field portion **98** and thereby reduce or avoid aberrations and the like.

Although the strength of the convergent action of the field portion **98** is still affected by a change of the G3 voltage, the effect is not as drastic as would be the case if the field portion **98** were to change its shape. This is true, since the strength of a field varies according to both the sharpness of curvature and the intensity or closeness of spacing of the equipotential surfaces. Therefore, since the curvature of equipotential surfaces of the convergent field portion **98** are maintained substantially constant according to my invention, the strength of the convergent field portion **98** is increased only due to the increase of the intensity of the field.

On the other hand this is not so with the divergent field portion **100**. When the G3 voltage is changed, the divergent field portion **100** changes both in shape and in intensity (spacing between equipotential surfaces). Thus, a change in G3 voltage affects the strength of the divergent field portion in two ways while it affects the strength of the convergent field portion in only one way. In addition to this, the G4 aperture **88**, according to my invention, is made relatively small (i.e., compared to the diameter of the G3), thus making the radius of curvature of the divergent field equipotential surfaces relatively small, thus producing a relatively strong divergence action as an electron passes from one equipotential surface to another. Accordingly, divergence is affected by a greater number of factors than is convergence. However, since convergence in any lens inherently dominates divergence, the net result is that somewhat of a balance is obtained wherein the overall net convergence action of the entire electrostatic focusing field does not change at as fast a rate as it otherwise would, and in fact does, in prior art guns of the same general class.

This means that a greater change of the voltage on G3 can be tolerated without exceeding the permissible range of focusing strength of the focusing field. This, in turn, means that the depth of focus has been increased.

The relative size of the diameter of the G4 aperture **88** is not critical. Generally speaking, the smallness of D4 simply determines the degree of the above-described balance of change in strength of the convergent and divergent field portions **98** and **100**. I have found that a ratio of D4:D1 equal to approximately 1:3 gives quite satisfactory results.

According to a preferred embodiment of my invention, electron gun **52** comprises an electrode arrangement of the following dimensions in inches:

D1=0.500	L=0.460
D2=0.375	L1=0.358
D3=0.025	L2=0.102
D4=0.175	

This results in a preferred ratio of L2:D4:D2:D1:L of 1:1.72:3.68:4.90:4.50. This, thus, can generally be approximated as a ratio of 1:2:4:5:5.

This invention has been described by defining certain electrode relationships; specific ratios of electrode size and spacing have been given to define a preferred embodiment. However, the broad concept of the invention can be practiced with considerable variance from these stated preferred ratios. For example, the principle of my invention can be practiced in a gun structure whose ratio of D1:D2 is any practical amount greater than unity even though it is less than the preferred 500/375 or 1.33. Likewise, my invention may be practiced to degrees less than preferred when the ratio of D1:L is made greater than that shown by prior art 2-electrode focusing system guns even though the ratio is somewhat more or less than the preferred 500/460 or 1.09. Generally speaking, the invention may be practiced by any substantial change of electrode size and spacing relationships from that of prior art 2-electrode focusing system guns toward the stated preferred relationships according to my invention so as to obtain material improvement of depth of focus and decrease of blooming.

FIG. 6 illustrates a modification of the G2 electrode according to my invention which is preferred from the standpoint of performance. In the modification of FIG. 6, a G2 cup **101** includes a concave member **102** which forms the exposed interior surface thereof. The concave member **102** may be provided either as a separate, centrally apertured, cup-shaped insert element, as shown, or as an integral part of the G2 cup **101**. Although the G2 cup **101** is shown to include an open space **104** between the insert **102** and the basic cup housing **106**, this may in fact be filled such as by the provision of a solid one piece G2. In any of the alternate forms herein described, the modified G2 electrode **101** is characterized by an interior surface **107** which is opened toward the G3 and which comprises a continuous, smooth-curved, cup-shaped surface. This is in contrast to the G2 electrode **66** which is characterized by a cylindrical wall portion and a transverse end wall substantially perpendicular to the cylindrical section.

The modified G2 electrode **101** has proved to give somewhat better performance as compared to the G2 electrode **66**. This results from the fact that the continuous curved concave surface **107** more nearly corresponds in shape to the convergent field portion **98** than does the interior of the G2 electrode **66**. Thus, as the voltage on the G3 is changed for focus adjustment and

the intensity of the convergent field portion **98** is increased or decreased, even less distortion of shape results by use of the G2 electrode **101** than by the G2 electrode **66**.

While the G2 electrode **101** is preferred from the standpoint of performance, the simpler G2 **66** may still be preferred from the standpoint of economy. Depending upon the particular electron gun into which the electrode is incorporated and the compelitive elements involved in the manufacture thereof, it may be preferred to avoid the added expense of providing the insert element **102**. Thus, whereas the concave G2 **101** may be preferred in some instances, the simpler straight walled G2 cup **66** may be preferred in others.

I claim:

1. An electron gun comprising axially aligned cathode, contol, screen, focusing, and accelerating electrodes next adjacent to each other in the order named; said screen electrode comprising a centrally apertured cup open toward said focusing electrode; said focusing electrode comprising a tubular member open at both ends; said accelerating electrode comprising a tubular member having a transverse end section adjacent said focusing electrode, said end section having an aperture therein; the diameter of said focusing electrode being larger than the diameter of said screen electrode cup and being at least approximately equal to the axial distance between the ends of said screen and accelerating electrodes closest to said cathode.

2. An electron gun comprising axially aligned cathode, contol, screen, focusing, and accelerating electrodes next adjacent to each other in the order named; said screen electrode comprising a centrally apertured cup open toward said focusing electrode; said focusing electrode comprising a tubular member open at both ends; said accelerating electrode comprising a tubular member having a transverse end section adjacent said focusing electrode, said end section having an aperture therein; the diameter of said focusing electrode being larger than the diameter of said screen electrode cup and being at least approximately equal to the axial distance between the apertured ends of said screen and accelerating electrodes, the diameter of said screen electrode cup being larger than the diameter of said accelerating electrode aperture.

3. An electron gun comprising axially aligned cathode, control, screen, focusing, and accelerating electrodes next adjacent to each other in the order named; said screen electrode comprising a centrally apertured cup open toward said focusing electrode; said focusing electrode comprising a tubular member open at both ends; said accelerating electrode comprising a tubular member having a transverse end section adjacent said focusing electrode with an aperture therein; the diameter of said focusing electrode being larger than the diameter of said screen electrode cup and being at least approximately equal to the axial distance between the apertured ends of said screen and accelerating electrodes, and being at least approximately four times the diameter of said accelerating electrode aperture.

4. An electron gun comprising axially aligned cathode, control, screen, focusing, and accelerating electrodes in the order named; said screen electrode comprising a centrally apertured cup open toward said focusing electrode; said focusing electrode comprising a tubular member open at both ends; said accelerating electrode comprising a tubular member having a transverse end section adjacent said focusing electrode with an aperture therein; the ratio of the axial length of said screen electrode cup, to the diameter of said screen electrode cup, to the diameter of said focusing electrode, to the axial distance between the apertured ends of said screen and accelerating electrodes, being approximately equal to 1:4:5:5.

5. An electron gun comprising a plurality of circularly symmetric electrodes arrayed in axial alignment next adjacent to each other in the order named and including,

a cathode, a control grid cup enclosing said cathode and having an apertured closed end facing in the direction of beam travel, a centrally apertured screen grid cup disposed with its open end facing in the direction of beam travel, an open ended tubular focusing electrode, and a tubular accelerating electrode having its end adjacent said focusing electrode partially closed by a centrally apertured member extending into said focusing electrode, said focusing electrode having a diameter larger by a predetermined amount than said screen grid cup, and said focusing electrode and said screen grid cup having predetermined axial lengths and being spaced by a predetermined distance, said predetermined dimensions being such that the edge of the aperture of the said screen grid cup, the rim of said screen grid cup, and the end portion of the internal cylindrical surface of said focusing electrode radially opposite the accelerating electrode aperture lie in a substantially smooth-curved, cup-shaped imaginary surface.

6. An electron gun comprising next adjacent to each other in coaxial alignment in the order named a cathode, an axially apertured control grid cup open toward said cathode, an axially apertured screen grid cup disposed with its open end facing away from said cathode, a focusing cylinder electrode, and an accelerating cylinder electrode having its end adjacent said focusing electrode partially closed, said screen grid and focusing electrode being adapted to be operated at potentials in the same order of magnitude and said accelerating cylinder being adapted to be operated at a potential many times higher, the diameter of the screen electrode cup being smaller than the diameter of the focusing electrode, and the axial length of the screen electrode and the axial relationships of the screen and focusing electrodes being such that the screen grid aperture, screen grid open end, and the end portion of the focusing electrode inside cylindrical surface radially opposite said partially closed end of said accelerating electrode when energized cause the equipotential surfaces extending into said screen grid cup to be smooth-curved, cup-like imaginary surfaces.

7. The electron gun according to claim 5 and wherein the internal surface of said screen grid cup comprises a continuous smooth-curved, cup-shaped surface.

8. The electron gun according to claim 6 and wherein the internal surface of said screen grid cup comprises a continuous smooth-curved, cup-shaped surface.

9. An electron gun for a cathode ray tube comprising axially aligned cathode, control, screen, focusing and accelerating electrodes in the order named, said screen electrode comprising a centrally apertured cup open toward said focusing electrode, said focusing electrode comprising a tubular member, said accelerating electrode comprising a tubular member having a transverse end section adjacent said focusing electrode, said end section having an aperture therein and wherein:

D1=the diameter of the focusing electrode
D2=the diameter of the screen electrode
L=the axial spacing between the apertured ends of the screen electrode and the accelerating electrode
L2=the axial depth of the screen electrode

and wherein D1 is greater than either L or D2 and L2 is approximately ¼ of D2.

10. An electron gun for a cathode ray tube comprising axially aligned and coaxial cathode, control, screen, focusing and accelerating electrodes in the order named, said screen electrode comprising a centrally apertured cup-shaped member open toward said focusing electrode, said focusing electrode comprising a tubular member open at both ends, said accelerating electrode comprising a tubular member having a transverse end section adjacent said focusing electrode, said end section having an aperture therein, said focusing electrode being of larger diameter than said screen and accelerating electrodes, said screen, focusing, and accelerating electrodes being so formed and dimensioned that the aperture in said screen electrode, the lip of said cup-shaped screen electrode, and the inner wall of said focusing electrode adjacent said accelerating electrode aperture, lie in an imaginary surface, the axial longitudinal section of which is generally semi-elliptical.

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