Oct. 19, 1965 M. V. DUERR 3,213,311

ELECTRON DISCHARGE DEVICE

Filed April 13, 1962 2 Sheets-Sheet 1

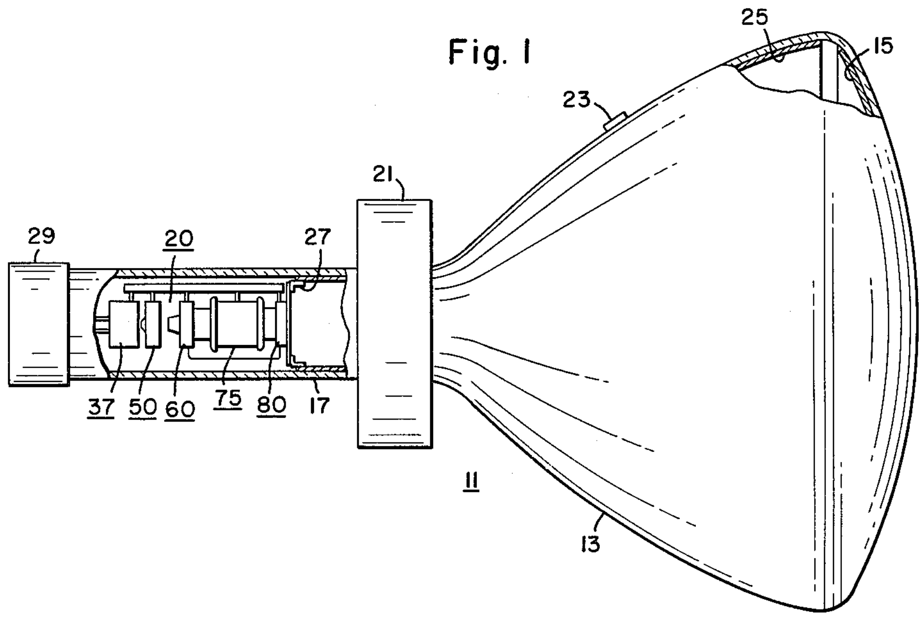

Fig. 1

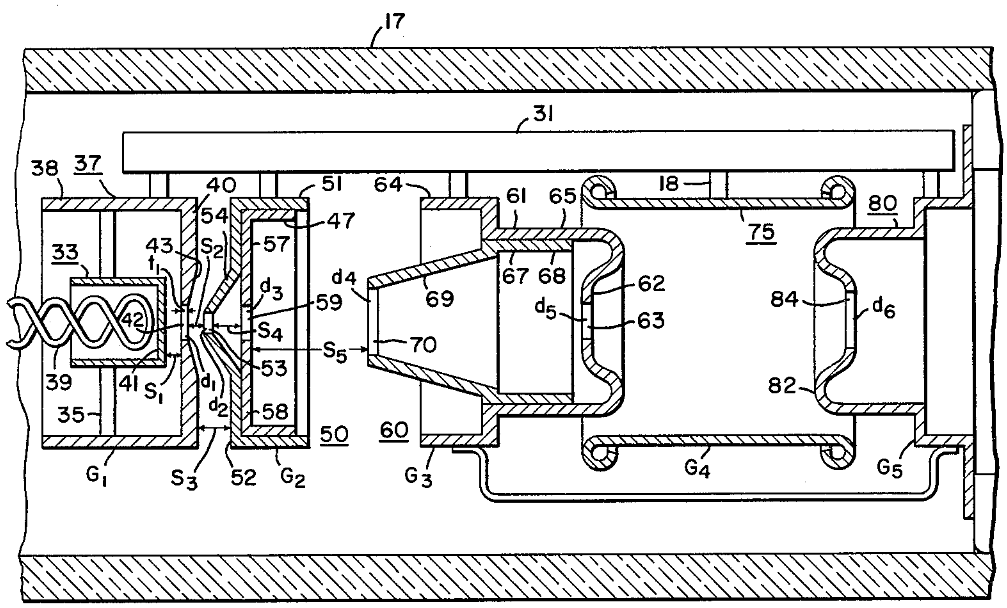

Fig. 2

WITNESSES

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ELECTRON DISCHARGE DEVICE

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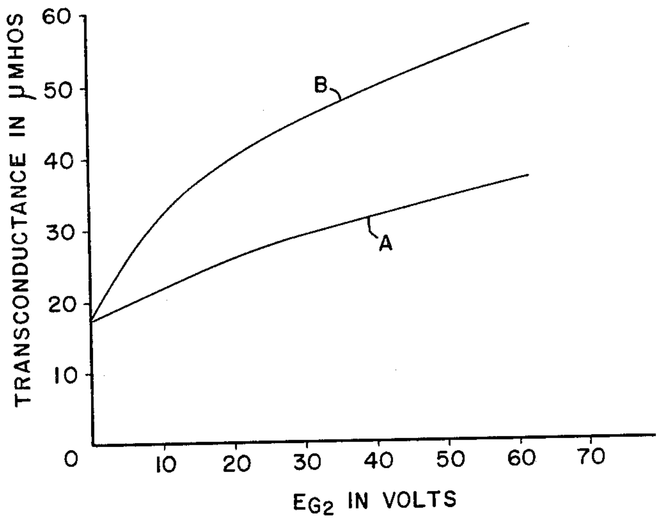

Fig. 3

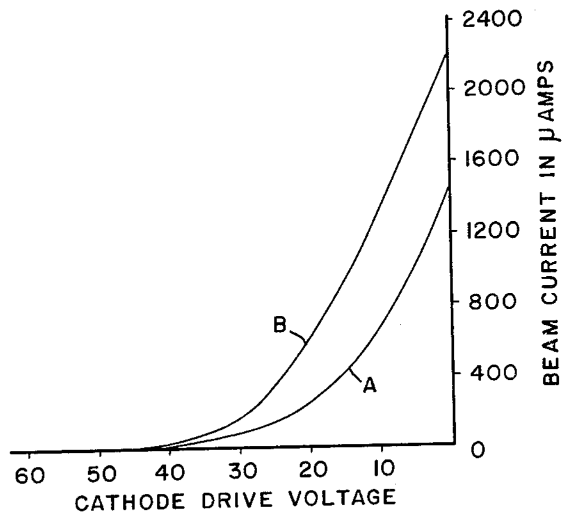

Fig. 4

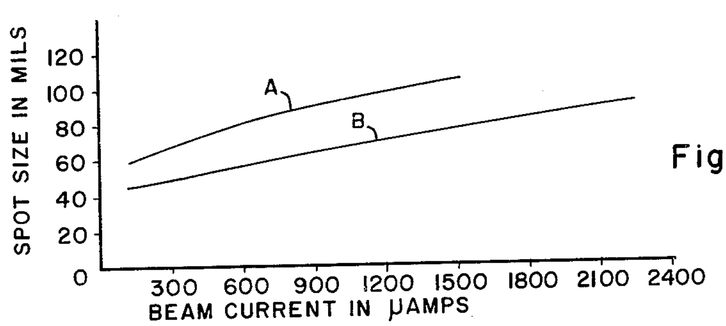

Fig. 5

United States Patent Office

3,213,311

Patented Oct. 19, 1965

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3,213,311
ELECTRON DISCHARGE DEVICE

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Filed Apr. 13, 1962, Ser. No. 187,257
7 Claims. (Cl. 313—82)

This invention relates to electron discharge devices and more particularly to a cathode ray tube of the type employing electrostatic means for forming and focusing an electron beam onto a target.

In television receivers, and other electronic devices in which information is displayed upon a luminescent screen by exciting the screen with an electron beam, it is highly desirable to attain maximum modulation of the light output of the cathode ray tube in response to a given change of amplitude of the control signal applied to the device. If one is able to provide an alectron gun which provides a relatively large change in beam current in response to a relatively small input signal variation, then it is possible to simplify the circuitry of the television set. It is possible to eliminate a video amplifier and in addition to simplify other circuitry of the television set and particularly in the power supply of the television receiver. Stated in another way, the cathode ray tube should have a high transconductance while maintaining brightness and resolution suitable for normal television viewing.

It is presently known in the art that for a given drive voltage, increased cathode and beam currents may be achieved by modulating the cathode of the electron gun rather than the control grid which is normally that grid adjacent the cathode and referred to as the first grid or G_1. In the use of the electron gun in which cathode modulation is used, the attainment of minimum drive voltages and high transconductance is dependent upon a gun in which the potential of the second electrode or grid from the cathode and referred to as G_2 is less than 100 volts positive when G_1 is held at ground. The G_2 electrode prior to this "low G_2" type design normally operated at about 300 volts positive.

Guns designed for lower G_2 voltages have higher transconductances. As the transconductance of the gun increases, the less signal or drive voltage is required.

The conventional electron gun includes third and fifth grids or electrodes G_3 and G_5 which operate at a high positive potential of about 16,000 volts and an intermediate fourth grid or electrode G_4 operating at a potential of about 300 volts. The third, fourth and fifth grids provide the principal focusing lens of the electron gun. It is therefore important in the "low G_2" type of gun that the penetration of the high voltages from the G_3 electrode and those subsequent do not penetrate into the cathode to any extent since it would then require a higher drive voltage to cut the tube off. Electron guns in which the high voltages of the G_3 and subsequent electrodes do not penetrate into the cathode area are referred to as low G_3 penetration guns.

On difficulty that is found in present cathode ray tubes and primarily believed due to the electrostatic gun design is a defect known as spot blooming. This phenomena manifests itself as a considerable increase in the spot size on the luminescent screen or even a holo when the control grid potential approaches zero. This causes severe defocusing in the highlight portions of the television picture.

It has been found that this undesirable aberration or defocusing in the electron gun can be largely eliminated by suitably adjusting the strength of the lens between the G_2 and G_3 electrodes of the electron gun. The exact mechanism of this process is not entirely clear but the following explanation is believed to be correct in substance.

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As in cathode drive, the cathode approaches zero voltage, the beam angle from the triode comprised of the cathode, G_1 and G_2 becomes large. Furthermore, at zero cathode voltage, electrons may strike the side of the G_1 electrode which is connected to ground or zero voltage. These electrons, on striking the G_1 electrode are reflected therefrom and enter the main or principal lens of the electron gun at rather large divergent angles and are not focused in the same image plane as the desired electrons from the center of the emitting cathode. The result, of course, is that a halo is found around the main spot on the luminiscent screen. This halo as previously indicated is undesirable. It has been found that by suitably shaping the lens between the G_2 and G_3 electrodes of the electron gun and especially by bringing the apertures in these two electrodes near to the electron beam, one is able to correct and prevent the marginal electrons from diverging from the beam axis to the extent that they effect this lens aberration. It is found that by the use of an intrusion-type G_3 electrode one is able to obtain a good beam spot over prior art designs.

In addition, one would expect that by providing an intrusion-type G_3 electrode that an increased penetration of the G_3 field through the G_2 aperture would result in the cutoff being considerably dependent upon the G_3 potential. This would of course result in a reduction of the modulation sensitivity of the electron gun A reduction in modulation sensitivity would result if G_3 penetration were allowed to become too great. This invention describes an arrangement of electrodes which controls the amount of G_3 penetration when the lens between G_2 and G_3 is adjusted for good beam spot so as not to destroy the good modulation sensitivity.

The penetration of the G_3 electrode and subsequent electrodes into the cathode of prior art designs is of the low penetration type and the G_2 electrode is the electrode which substantially defines the cutoff voltage. Hence, to secure the improved modulation sensitivity arising from cathode modulation, it is essential to operate G_2 at a low potential that is of the order of 100 volts or less. Heretofore, it has been generally thought that in such low G_2 voltage guns some penetration from G_3 was necessary in order to prevent soft focus tubes and that the requirement of good cathode modulation sensitivity by minimizing high voltage penetration and the attainment of good focus conditions were contradictory. It has been found, that these two factors do not necessarily oppose each other and particularly so in the electron gun described herein. It has been found that with the device defined herein that one is able to simultaneously achieve small high voltage penetration with consequently high cathode modulation sensitivity while at the same time using a powerful intrusion-type lens between G_2 and G_3 to hold the beam together and minimize spot blooming at high drive conditions.

It is accordingly an object of this invention to provide an improved cathode ray tube.

It is another to provide an improved electron gun of high transconductance.

It is another object to provide an improved electron gun which provides high transconductance and high beam current.

It is another object to provide an improved electron gun which provides a small area beam spot on the luminescent screen of a cathode ray tube and is substantially uniform in intensity over its area.

Briefly, the present invention accomplishes the above-cited objects by providing an electron gun having improved modulation sensitivity with cathode modulation and a structure providing high G_2 penetration. This high penetration factor is attained by optimum design of the spacing between the cathode G_1 and G_2, and in addition, the size of the apertures in G_1 and G_2. In addition, improved spot characteristics of the electron gun as well as higher beam current is obtained by providing an intrusion part in the G_3 electrode and by providing optimum spacing between G_2 and G_3, as well as the apertures therein.

Further objects and advantages of the invention will become apparent as the following description proceeds and the features of novelty which characterized invention will be pointed out in particularity in the clams annexed to and forming a part of this specification.

For a better understanding of the invention, reference may be had to the accompanying drawings in which:

FIGURE 1 is a plan view partially in section of a cathode ray tube embodying the teaching of this invention;

FIG. 2 is an enlarged sectional view of a portion of the neck of the tube shown in FIG. 1 and illustrating the electron gun in accordance with the teachings of this invention; and,

FIGS. 3, 4 and 5 are graphical representations of operating characteristics of the devices shown in FIGS. 1 and 2 in comparison with like characteristics of the prior art design.

Referring to FIGS. 1 and 2, a cathode ray tube **11** is shown comprising an evacuated envelope **13** enclosing an electron gun **20** spaced from a fluorescent image display screen **15**. The electron gun **20** is provided within the neck portion **17** of the envelope **13**. The electron gun **20** provides the source, control, acceleration and focusing of an electron beam generated by the gun **20** which is directed toward the screen **15** and is deflected by any suitable deflection means such as electromagnetic deflection yoke **21**. The screen **15** as well as the final electrode of the electron gun **20** are normally maintained at a potential of about 14 to 18 kilovolts depending upon the particular application. This high potential accelerates the electrons to a high velocity and they impinge upon the screen **15** to excite the phosphor in screen **15** and cause emission of light therefrom. The high voltage applied to the screen **15** and to the high voltage electrodes of the electron gun **20** is normally applied to an anode button **23**. An internal electrically conductive coating **25** on the flared portion of the envelope **13** extends back into the neck portion **17** to provide the necessary voltage for the high voltage electrodes of the electron gun **20**. This potential is connected by means of snubbers **27** contacting the conductive coating **25** and electrically connected to the high voltage electrodes. The voltages for the remaining electrodes of the electron gun are normally provided by suitable lead-in-members through a base portion **29** of the envelope **13**.

The electron gun **20** which is shown in more detail in FIG. 2 comprises a series of electrodes which are supported in alignment with each other in a conventional manner by means of insulating support rod members **31** extending longitudinally of the neck portion **17**. Suitable stud members **18** are secured to the electrodes and imbedded in the rods **31**. The electrodes within the electron gun **20** are normally aligned with the longitudinal axis of the cathode ray tube.

The electron gun **20** includes a tubular indirectly heated cathode **33** supported by an annular ceramic member **35** within a control or first grid G_1 **37** of the gun **20**. A filament or a heater **39** of any well known type is contained within the tubular cathode **33** for heating the cathode **33**. The end tubular cathode **33** facing the screen **15** is closed and has an electron emissive coating **41** provided on the exterior surface thereof.

The control grid **37** is a cup-shaped member which faces rearwardly that is, whose open end faces away from the screen **15**. The grid **37** consists of a tubular portion **38** with a diaphragm **40** having a centrally located aperture **42** overlying the emissive coating **41** on the cathode **33**. The diameter of the aperture **42** in the diaphragm or plate **40** is about .036 inch and is referred to in the drawing as d_1. The plate **40** has central portion **43** surrounding the aperture **42** that has a concave configuration facing away from the cathode **33**. The object of the concave portion **43** is to provide a reduction in thickness of the diaphragm **40** near the boundary of the aperture **42** in relation to the overall thickness of the diaphragm **40** itself to obtain a minimum spacing between the surface of the emissive layer **41** and the surface of the diaphragm **40** adjacent the aperture **42** on the side of the diaphragm **40** facing the screen **15**. The distance between the surface of the coating **41** and the surface of the diaphragm **40** of the control grid **37** is designated as S_1 in the FIG. 2 and this distance is about .004 inch. The thickness of the diaphragm **40** in G_1 at the boundary of the aperture **42** is about .004 inch.

Closely spaced from the grid electrode **37** is the second grid G_2 **50**. The electrode **50** is also a metal cup-like member with the open end thereof facing the screen **15**. The electrode **50** includes a tubular portion **51** and a diaphragm **52**. The diaphragm **52** of the electrode **50** has a centrally located aperture **53** aligned with the aperture **42** in G_1. A central portion **54** of the diaphragm **52** surrounding the aperture **53** is deformed or depressed to provide concave or inverted frusto-conical portion facing the screen **15**. The aperture **53** is provided substantially at the center of the concave portion **54** and the diameter of the aperture **53** is about .028 inch and is hereinafter referred to as d_2. The spacing between the boundary surface of the aperture **53** facing the coating **41** and the surface of the electrode **37** adjacent the aperture **42** facing the screen **15** is about .004 inch and is hereinafter referred to as S_2.

The electrode **50** includes an additional cup-shaped element or shield **57** which is telescoped into the tubular portion **51** with the open end facing the screen **15**. The element **57** includes a tubular portion **47** which fits within the tubular portion **51** and a diaphragm or plate **58** closing the end of the portion **47** adjacent the diaphragm **52**. The diaphragm portion or plate **58** is in contact with the surface of the diaphragm **52** facing the screen **15** and is electrically and mechanically connected to electrode **50**. The plate or diaphragm member **58** of shield **57** has a centrally located aperture **59** which is hereinafter referred to as d_3. The spacing between the surface of the concave portion **54** of electrode **50** adjacent the aperture **53** and facing the screen **15** and the surface of the plate member **58** facing the cathode **33** is about .010 inch and is hereinafter referred to as S_4. It should be noted here that the spacing between electrode **37** and electrode **50** at the outer periphery of the two members is about .010 inch and hereinafter referred to as S_3. The outer diameter of electrodes **37** and **50** is about .5 inch.

The structure described above provides a triode assembly in which the penetration of electrode **50** or G_2 is high. The maximum amount of penetration within this structure is limited primarily by the practical electrode spacing in order to prevent arcing and other associated problems. In general, it is desirable to use the cathode to G_1 spacing S_1 to obtain the desired cutoff. In this structure S_1, similar to S_2, is a means by which G_2 penetration is increased. Because of this high penetration factor, the cathode cutoff voltage is largely determined by the voltage on G_2 which normally is 20 to 50 volts while the voltage on G_1 is zero. Limitations imposed on the minimum aperture spacing are that they be consistent with manufacturing standards for avoiding arcing over between electrodes and changes in spacing due to temperature variations. The extended aperture **53** on G_2 allows the actual aperture spacing S_2 to be held to a very small value and yet maintain a relatively large electrode spacing S_3 to prevent shorting. To obtain the high G_2 penetration and high transconductance, S_1 and S_2 must not exceed $.17d_1$. Limitations imposed on the extended grid aperture d_2 are based on the fact that although the G_2 penetration factor D_1 is increased as a result of a small aperture, beam current interception and a corresponding decrease in transconductance will determine a minimum value. Also a significant reduction in the G_2 penetration factor D_1 will result as this aperture diameter approaches or is made larger than that of G_1. The relationship that d_2/d_1 be less than .9 and greater than .7 was found to give the most favorable or optimum performance. The penetration factor D_1 is equal to V_{C1}/V_2. D_1 is defined as the G_2 penetration factor where the expression V_2 is the potential difference between the cathode and G_2 and V_{C1} is the negative voltage required on the G_1 to turn the beam off with the final anode or G_3 and G_5 is set to zero potential. The penetration factor or D_1 of G_2 in the present design is approximately 5.

The next electrode adjacent to electrode **50** or G_2 is electrode **60** or G_3. The electrode **60** consists of an outer tubular member **61** having the end thereof facing the screen **15** closed by a diaphragm **62** with a centrally located aperture **63** therein. The aperture **63** has a diameter of about .090 inch and is referred to as d_5. The outer member **61** of G_3 consists of a first end portion **64** which is of substantially the same diameter as the tubular portion **51** and a second end portion **65** of reduced diameter and a portion connecting portions **64** and **65**. An inner tubular member **67** is provided within the outer member **61** and consists of a tubular portion **68** having an outer diameter substantially equal to the inner diameter of the reduced portion **65** of the outer member **61** so that it may be telescoped within the outer member **61**. The remaining portion of the inner member **67** is a frusto-conical portion **69** with the smaller portion of the conical portion **69** facing the second grid **50**. The frusto-conical portion **69** actually extends or protrudes beyond the outer member **61** with respect to the second grid **50**. This frusto-conical member **69** is provided with an entrance aperture or opening **70** facing the second grid **50**. The boundary of the aperture **70** is spaced at a distance of about .170 inch from plate **57** hereinafter referred to as S_5. The diameter of the entrance aperture **70** is about .120 inch and is hereinafter referred to as d_4.

By adjusting the electrode spacing S_5 and the size of the aperture **70** in the intrusion part **69**, considerable improvement in spot size characteristics have been obtained. The maximum gain or improvement that can be obtained is of course limited by how much high voltage penetration can be permitted before it largely determines the cutoff of the electron gun. Obviously, with the high modulation sensitivity attained with a triode structure as previously described, excessive high voltage penetration from G_3 is highly undesirable. The shield member **57** within G_2 is one means of restricting or determining the amount of high voltage penetration from G_3. Actually the plate member **57** in G_2 and the other portions of G_2 act as a shield to separate the triode section comprising the cathode **33**, first grid **37**, and concave portion **54** of the G_2 from the effects of the potential of G_3. The diameter of the aperture **59** or d_3 of the shield **57** is largely a compromise as a result of (1) a gain in the G_2 penetration factor D_1, (2) high voltage penetration, and (3) the prefocus lens strength. As the size of the aperture d_3 is made smaller, a slight increase in the G_2 penetration D_1 and a considerable reduction in high voltage penetration D_2 are experienced. The G_3 penetration factor D_2 is equal to V_{cm}/V_3 and is about .0075. V_3 is the potential difference between the cathode and G_3 and G_5 and V_{cm} is the negative voltage required on G_1 to turn the beam off with voltage on G_2 at zero. Because of the reduction in high voltage penetration D_2, the spot size could be expected to increase at high beam currents. The prefocus lens between G_2 and G_3 is adjusted to overcome this effect. The limitation imposed on the size of the aperture d_3 in G_2 is that in an attempt to increase the high voltage penetration by adjusting the spacing S_5, the resulting increase in prefocus lens strength will eventually result in an increase in spot size at the screen. The diameter of the aperture d_3 in the shield **57** therefore, must be within a range to give maximum G_2 penetration D_1 and yet allow enough high voltage penetration to control spot growth and blooming without unduly increasing the strength of the prefocus lens. This objective is attained by making the aperture d_3 in the shield **57** approximately equal to the size of the aperture d_1 in the first grid **37** and the spacing S_4 between the apertures d_2 and d_3 not greater than $.6d_3$. Also the aperture d_4 or **70** must be smaller than the diameter of the outer tubular portion **51** or G_2, and the grid spacing S_5 must be equal to or greater than $3d_3$.

A tubular electrode **75** or G_4 is positioned adjacent to electrode **60**. A tubular electrode **80** having a diaphragm **82** with an aperture **84** is positioned adjacent electrode **75**. The diameter of the aperture is about .150 inch.

The following data may be considered as an example of suitable dimensions and voltages for an electron gun in accordance with the invention.

Diameter:

d_1=.036 inch	Spacing S_1=.004 inch
d_2=.028 inch	Spacing S_2=.004 inch
d_3=.036 inch	Spacing S_3=.010 inch
d_4=.120 inch	Spacing S_4=.010 inch
d_5=.090 inch	Spacing S_5=.170 inch
d_6=.150 inch	

Voltage cath.=0 to +60 v.

G_1=0 v.
G_2=+45
G_3=+16 kv.
G_4=+200
G_5=+16 kv.

The curves in FIGS. 3, 4 and 5 show the performance obtained from a gun constructed according to this invention as compared to a conventional "low G_2" gun. Curves A are for a conventional or prior art tube while curves B are for the electron gun described herein. This data shows that substanital increase in transductance is obtained giving the tube considerable drive advantage over the conventional type and this improvement was obtained with a considerable improvement in spot size. This improvement in transconductance is clearly shown in FIG. 3. FIG. 4 also illustrates the increased transconductance and in addition clearly illustrates that the maximum beam current obtainable from the tube is substantially increased over the prior art type of device. FIG. 5 also shows a comparison between the prior art and the invention described herein and illustrates the improvement in focus or spot size on the display screen. FIG. 5 also indicates the increased amount of current obtainable from the electron gun described herein in comparison to the prior art device.

While there have been shown and described what are presently considered to be the preferred embodiments of the invention, modifications thereto will readily occur to those skilled in the art. It is not desired, therefore, that the invention be limited to this specific arrangement shown and described and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

I claim as my invention:

1. An electron discharge device comprising an image screen, an electron gun formed to provide the source, acceleration, control and focusing of an electron beam spaced from said screen, said electron gun comprising a cathode, a first grid, a second grid and a third grid arranged in the direction of electron travel towards said screen, said first grid comprising a cylinder having an end wall formed to provide a central region having a concave surface facing said second grid and an aperture provided in said central region aligned with said cathode, the wall surrounding said aperture being of reduced thickness as compared with the remaining end wall, a second grid comprising a cylinder and having an end wall on the end of said cylinder facing said first grid, the end wall of said second grid formed to provide an aperture aligned with the aperture in said first grid, the central portion of said end wall of said second grid surrounding the aperture deformed to provide a frusto-conical portion with the smaller portion forming the boundary of the aperture closer to said first grid than the remaining portion of the end wall of said second grid, the ratio of the diameter of the aperture in said second grid to the diameter of the aperture in said first grid being greater than .7 and less than .9, the spacing between said cathode and said first grid not exceeding .17 times the diameter of the aperture in said first grid and the spacing between said first grid and said second grid adjacent the apertures therein not exceeding .17 times the diameter of the aperture in said first grid, a shield member provided within the cylinder of said second grid and formed to provide an aperture aligned with said aperture in said second grid, said shield member electrically and mechanically connected to said end wall of said second grid with the aperture in said second grid electrode and the aperture in said shield spaced apart by a distance no greater than .6 of the diameter of the aperture in the shield, the diameter of the aperture in said shield member being about equal to the diameter of the aperture in said first grid, said third grid comprising a tubular member having the end thereof facing said second grid provided with a frusto-conical portion with the opening in the frusto-conical portion aligned with the aperture in said second grid, the diameter of the entrance opening in the frusto-conical portion of said third grid being less than the cylindrical portion of said second grid and the spacing between the aperture in said shield member and the aperture in said third grid being greater than three times the diameter of the aperture in said shield member.

2. An electron discharge device comprising an image screen, an electron gun for generating and forming an electron beam which is directed onto said image screen, said electron gun comprising a cathode, a first grid, a second grid and a third grid arranged in the direction of electron travel towards said screen, said first grid comprising a tubular member having an end wall transverse to said electron beam and formed to provide a central region having a concave surface facing said second grid and an aperture provided in said central region aligned with said cathode, a second grid comprising a tubular member and having an end wall transverse to said electron beam and on the end of said tubular member facing said first grid, the end wall of said second grid formed to provide an aperture aligned with the aperture in said first grid, the central portion of said end wall of said second grid surrounding the aperture deformed to provide a frusto-conical portion with the smaller portion of said frusto-conical portion forming the boundary of the aperture closer to said first grid than the remaining portion of the end wall of said second grid, the ratio of the diameter of the aperture in said second grid to the diameter of the aperture in said first grid being greater than .7 and less than .9, a shield member provided within the tubular portion of said second grid formed to provide an aperture aligned with said aperture in said second grid, said shield member electrically and mechanically connected to said end wall of said second grid with the aperture in said second grid electrode and the aperture in said shield spaced apart by a distance less than .6 of the diameter of the aperture in said shield, the diameter of the aperture in said shield member being about equal to the diameter of the aperture in said first grid, said third grid comprising a tubular member having the end thereof facing said second grid provided with a frusto-conical portion with the opening in the frusto-conical portion aligned with the aperture in said second grid, the diameter of the entrance opening in the frusto-conical portion of said third grid being less than the diameter of said tubular portion of said second grid and the spacing between the aperture in said shield member and the aperture in said third grid being greater than three times the diameter of the aperture in said shield member.

3. An electron discharge device comprising an image screen, an electron gun for generating, forming and directing an electron beam onto said screen, said electron gun comprising a cathode, a first grid, a second grid and a third grid arranged in the direction of electron travel towards said screen, and first grid comprising a cylindrical member having an end wall in the end facing said grid and formed to provide a central region having a concave surface facing said second grid and an aperture providing in said central region aligned with said cathode, the end wall in said first grid surrounding said aperture being of reduced thickness as compared with the remaining portion of said end wall, the spacing between the surface of the end wall of said first grid facing said cathode and the emissive surface of said cathode less than .17 times the diameter of the aperture in the end wall of said first grid, a second grid comprising a cylindrical member having a diaphragm therein, the diaphragm of said second grid formed to provide an aperture aligned with the aperture in said first grid, the central portion of said diaphragm of said second grid surrounding the aperture deformed to provide a tubular portion having a smaller diameter portion forming the boundry of the aperture closer to said first grid than the remaining portion of said diaphragm of said second grid, the diameter of the aperture in the diaphragm of said second grid being less than the diameter of the aperture in the end wall of said first grid, the spacing between said first grid and said second grid adjacent the apertures therein less than .17 times the diameter of the aperture in said first grid, a shield member provided within the cylindrical member of said second grid formed to provide an aperture aligned with said aperture in said second grid, said shield member electrically and mechanically connected to said diaphragm of said second grid with the aperture in said second grid electrode and the aperture in said shield spaced apart by a distance less than .6 of the diameter of the aperture in the shield, the diameter of the aperture in said shield member of about the same diameter as the aperture in said first grid, said third grid comprising an outer cylindrical and an inner tubular member, said tubular member having the end thereof facing said second grid of smaller diameter than the remaining portion and providing an opening aligned with the aperture in said second grid, the diameter of the entrance opening in said inner tubular member of said third grid being less than the diameter of said cylindrical member of said second grid and the spacing between the aperture in said shield member and the aperture in said third grid being greater than three times the diameter of the aperture in said shield member.

4. An electron discharge device comprising an electron gun and target, said electron gun comprising an electron emissive source, a first grid, a second grid and a third grid arranged in the direction of electron travel towards said target, said first grid comprising a tubular member having an end wall formed to provide an aperture aligned with said electron source, the wall surrounding said aperture being of reduced thickness as compared with the remaining portion of said end wall, a second grid comprising a tubular member and having an end wall on the end of said tubular member facing said first grid, the central portion of said end wall of said second grid formed to provide an aperture aligned with the aperture in said first grid and closer to the first grid than the remaining portion of the end wall of said second grid, the diameter of the aperture in said second grid being less than the diameter of the aperture in said first grid, a shield member provided within the tubular portion of said second grid electrode having a diaphragm with an aperture therein and aligned with said aperture in said second grid, said shield member electrically connected to said end wall of said second grid with the aperture in said second grid and said shield spaced apart by a distance less than .6 of the diameter of the aperture in said shield, the diameter of the aperture in said shield member being greater than the diameter of the aperture in said second grid, said third electrode comprising an outer tubular member and an inner tubular member, said inner tubular member tapered to provide a smaller entrance aperture adjacent said second grid and aligned with the aperture in said second grid, the diameter of the entrance aperture of said third grid being less than the diameter of the tubular portion of said second grid and the spacing between the aperture in the shield member and the aperture in said third grid electrode greater than three times the diameter of the aperture in said shield member.

5. An electron discharge device comprising an electron gun and target, said electron gun comprising an electron emissive source, a first grid, a second grid and a third grid arranged in the direction of electron travel towards said target, said third grid being at a substantially higher potential than said first or second grids, said first grid including a diaphragm having an aperture therein and aligned with said electron source, a second grid including a diaphragm, the central portion of said diaphragm of said second grid formed to provide an aperture aligned with the aperture in said first grid and spaced closer to said first grid than the remaining portion of the diaphragm of said second grid, the diameter of the aperture in said second grid being less than the diameter of the aperture in said first grid, a shield member including a diaphragm positioned on the side of said second grid facing said third grid and having an aperture therein and aligned with said aperture in said second grid, said shield member electrically connected to said second grid with the aperture in said second grid and the aperture in said shield spaced apart by a distance less than the diameter of the aperture in said shield member, the diameter of the aperture in said shield member being greater than the diameter of the aperture in said second grid, said third electrode including a tubular member, said tubular member tapered to provide a smaller entrance aperture adjacent said shield member and aligned with the aperture in said shield member, the diameter of the entrance aperture of said third grid being about three times the diameter of the aperture in said shield member.

6. An electron discharge device comprising an electron gun and target, said electron gun comprising an electron emissive source, a first grid, a second grid and a third grid arranged in the direction of electron travel towards said target, said first grid comprising a tubular member having an end wall formed to provide an aperture aligned with said electron source, the wall surrounding said aperture being of reduced thickness as compared with the remaining portion of said end wall, a second grid comprising a tubular member of the same diameter as the tubular member in said first grid and having an end wall on the end of said tubular member facing said first grid, the central portion of said end wall of said second grid formed to provide an aperture aligned with the aperture in said first grid and closer to the end wall of said first grid than the remaining portion of the end wall of said second grid, the diameter of the aperture in said second grid being less than the diameter of the aperture in said first grid, a shield member provided within the tubular portion of said second grid electrode having a diaphragm with an aperture therein and aligned with said aperture in said second grid, said shield member electrically and mechanically connected to said end wall of said second grid with the aperture in said second grid and said shield spaced apart by a distance less than .6 of the diameter of the aperture in said shield, the diameter of the aperture in said shield member being greater than the diameter of the aperture in said second grid, said third electrode comprising an outer tubular member of the same diameter as the tubular member in said second grid and an inner tubular member, said inner tubular member of less diameter than said outer tubular member tapered to provide a smaller entrance aperture adjacent said shield and aligned with the aperture in said second grid, the diameter of the entrance aperture of said third grid being less than the diameter of the outer tubular member and spaced closer to said shield than said outer tubular portion and the spacing between the aperture in the shield member and the aperture in said third grid electrode greater than three times the diameter of the aperture in said shield member.

7. An electron discharge device comprising an electron gun and a target, said electron gun comprising an electron with a source, a first grid, a second grid and a third grid arranged in the direction of the electron travel to said target, said second grid operating at a potential of less than 100 volts positive with respect to said electron emissive source, said third grid operating at a potential of several thousand volts positive with respect to said electron emissive source, said first grid including a diaphragm having an aperture therein and aligned with said electron source, a second grid including a diaphragm with a central portion of said diaphragm of said second grid formed to provide an aperture aligned with the aperture in said first grid and spaced closer to said first grid and the remaining portion of the diaphragm of said second grid, the diameter of the aperture in said second grid being less than the diameter of the aperture in said first grid, a shield member including a diaphragm positioned on the side of said second grid facing said third grid and having an aperture therein aligned with said aperture in said second grid, said shield member electrically connected to said second grid with the aperture in said second grid and the aperture in said shield spaced apart by a distance less than the diameter of the aperture in said shield member, the diameter of the aperture in said shield member being greater than the diameter of the aperture in said second grid, said third electrode including a tubular member, said tubular member tapered to provide a smaller entrance aperture adjacent said shield member and aligned with the aperture in said shield member, the diameter of the entrance aperture of said third grid being about three times the diameter of the aperture in said shield member.

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