United States Patent [19]

Runtzel et al.

[11] 3,746,909

[45] July 17, 1973

[54] **AREA ELECTRON FLOOD GUN**

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[22] Filed: **Oct. 26, 1970**

[21] Appl. No.: **83,910**

[52] **U.S. Cl.** ..... **315/13 R**, 315/31 R, 313/70 R, 315/14, 313/83

[51] **Int. Cl.** **H01j 29/50**

[58] **Field of Search** ..... 315/12, 13 R, 14, 315/31 R; 313/69, 70 R, 71, 83, 84

[56] **References Cited**

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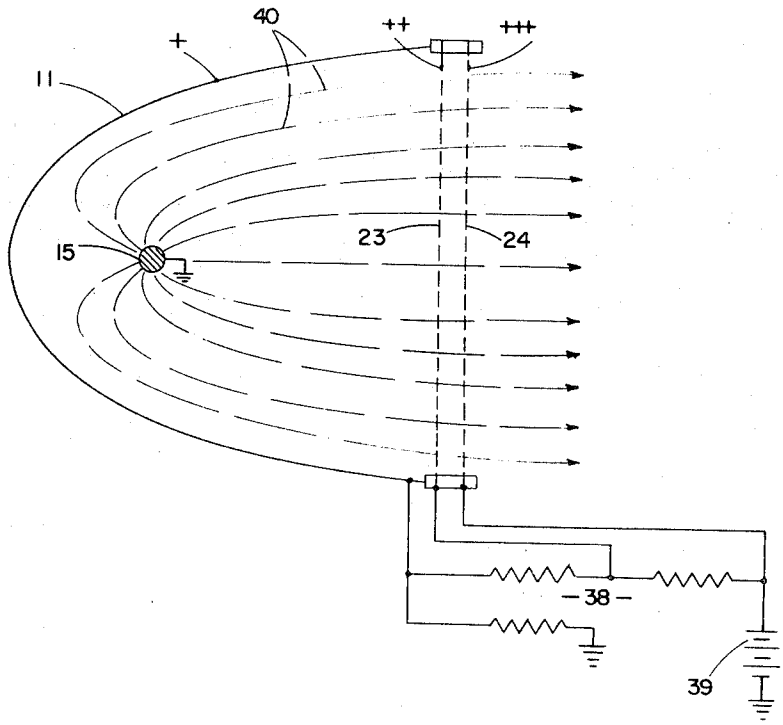
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[57] **ABSTRACT**

A strip filament provides a source of electrons. A deflector electrode, which may be in the general form of a parabolic dish, is placed behind the filament and a screen electrode placed forward of the filament, i.e., in the direction in which electron flow is desired. The electrodes are positioned relative to the filament and have potentials applied thereto such that the electrons emitted from the filament are evenly distributed over a predetermined area throughout which electron flow is desired.

5 Claims, 6 Drawing Figures



Patented July 17, 1973 3,746,909

3 Sheets-Sheet 1

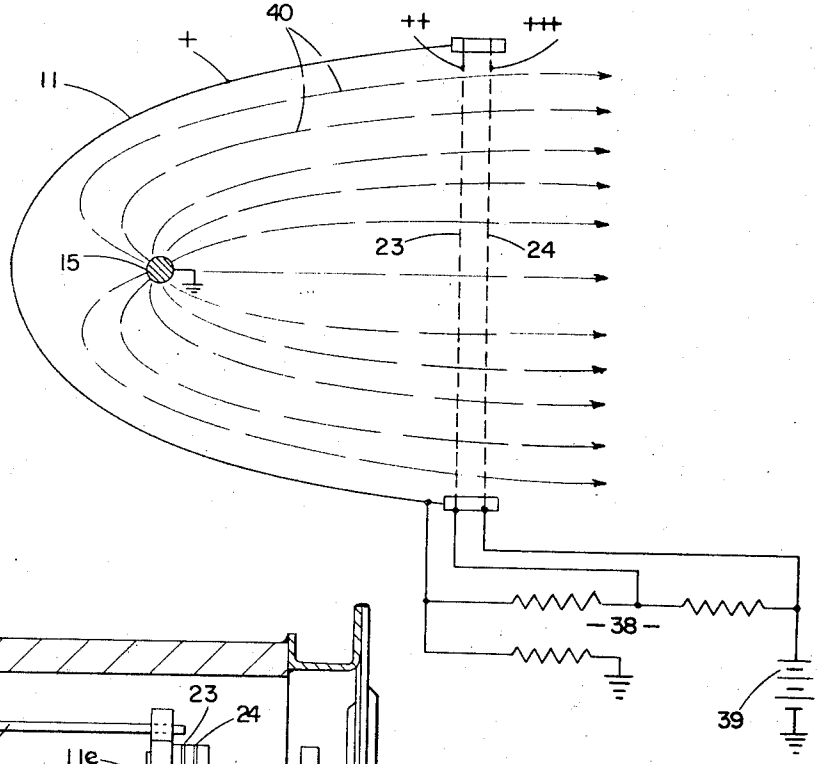


FIG. 1

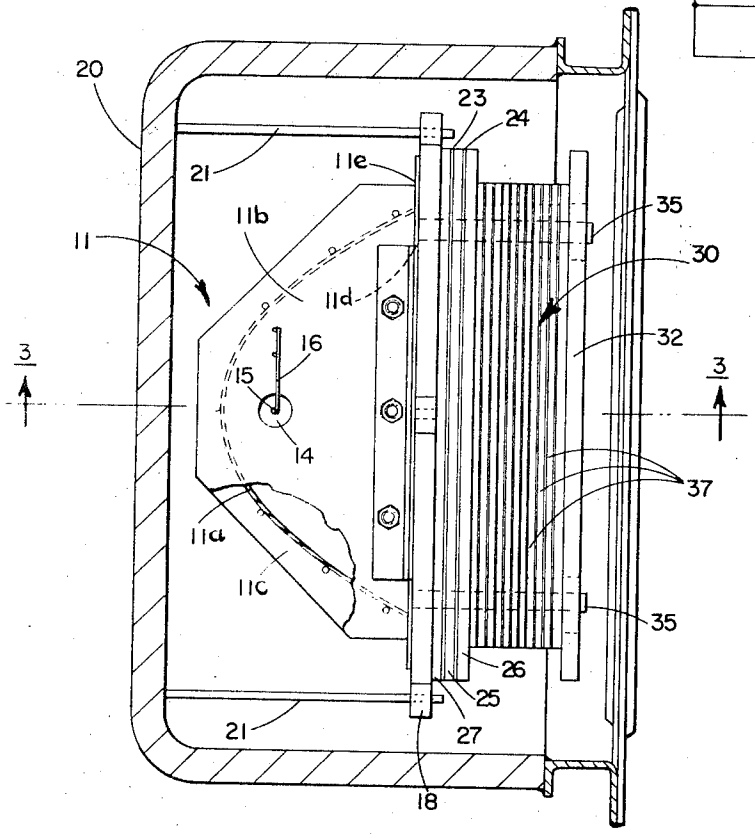
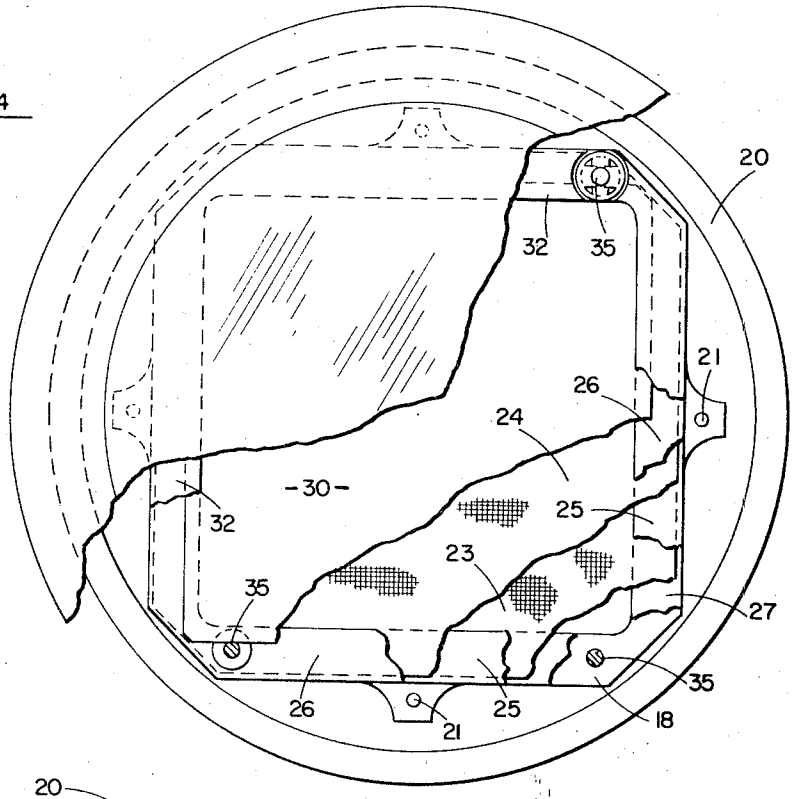


FIG. 2

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FIG. 4



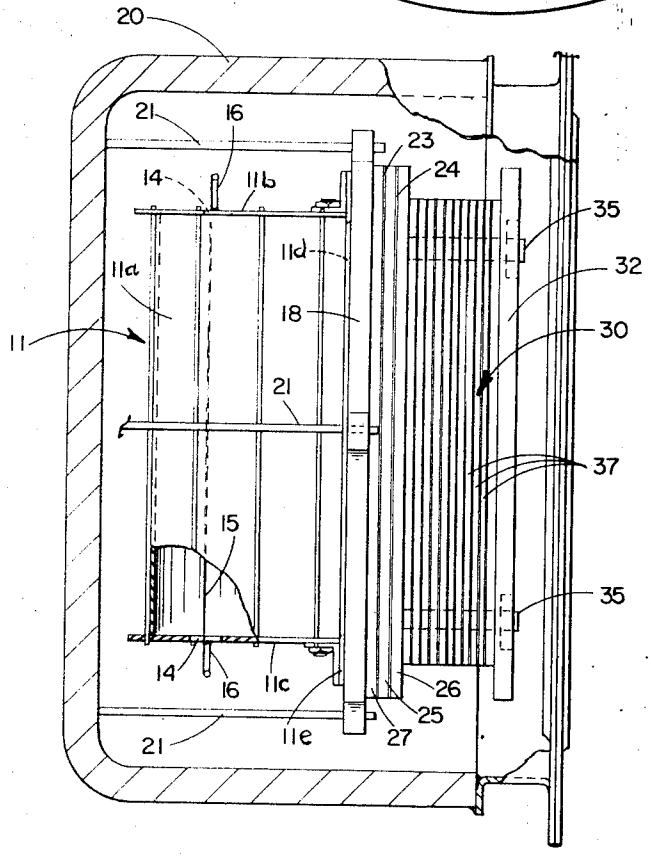


FIG. 3

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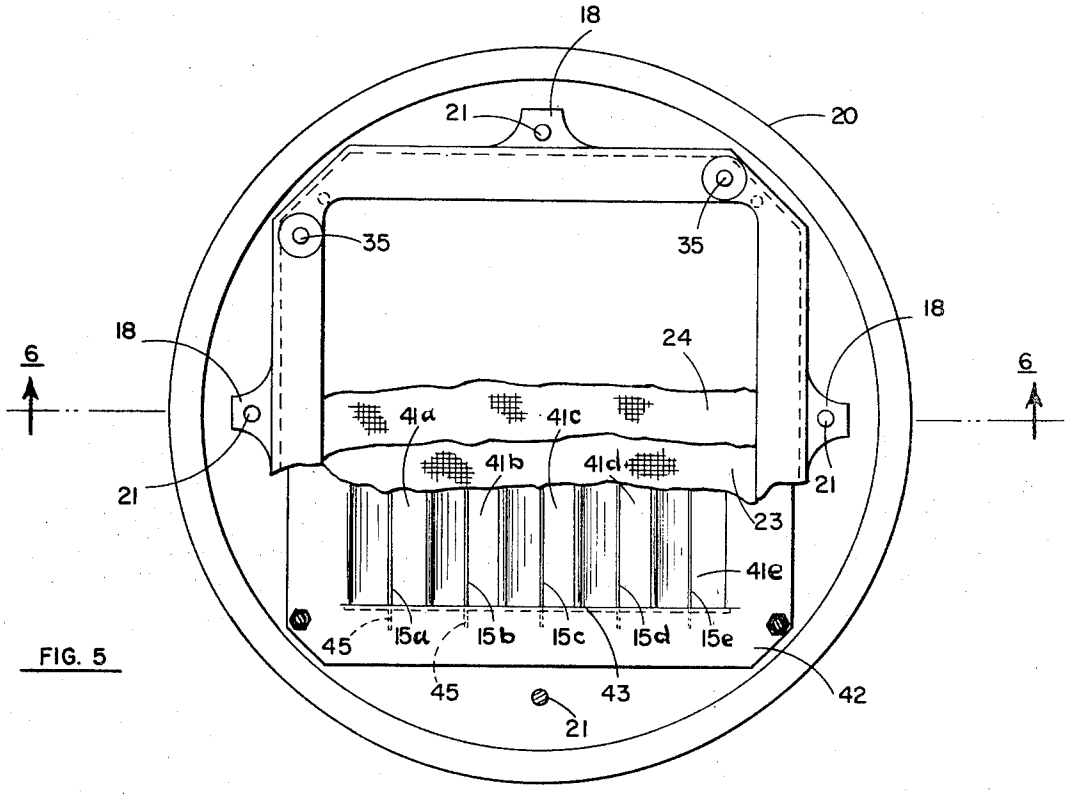


FIG. 5

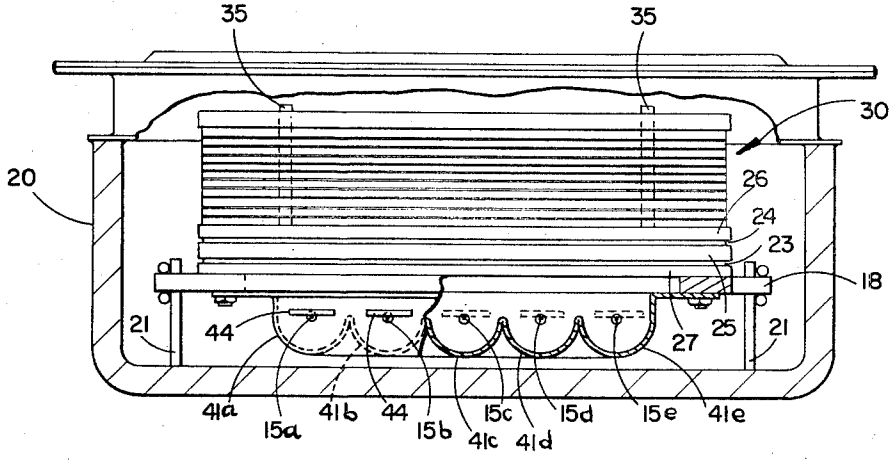


FIG. 6

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AREA ELECTRON FLOOD GUN

This invention relates to electron guns, and more particularly to such a gun capable of uniformly distributing electrons emitted from a strip filament over a predetermined area.

In certain applications such as, for example, in an area electron beam scanner such as described in U.S. Pat. No. 3,408,532 issued Oct. 29, 1968, it is necessary to provide a source of electrons uniformly over a predetermined area. Efforts in the past to implement this type of cathode have included the use of radioactive or photo-emissive surfaces. The photo-emissive surfaces generally have too low an electron yield, and due to their dependency on incident light are limited to situations where the device is to be operated at all times in an area having ambient light. Radioactive type cathodes carry with them the hazards of radioactive exposure. They also are of relatively high cost and have a low electron yield if kept within tolerable radiation limits. This type of cathode also tends to generate gasses which adversely affect the vacuum in the electron beam device with which the cathode is utilized.

Area filaments and indirectly heated cathodes which encompass a fairly broad area require a fairly large amount of heat energy to provide an adequate electron yield. This involves a fairly large power requirement and undesirable heat dissipation. Also, with indirectly heated cathodes it is often difficult to get uniformity of electron emission over the cathode surface area.

The device of this invention overcomes the shortcomings of prior art area cathodes by enabling the utilization of a thermionic strip filament as the electron source, thus obviating the disadvantages of radioactive and photo-emissive cathodes. An area electron flow is developed from the strip filament by means of appropriately placed and voltage biased electrode members to provide a uniform electron supply over a predetermined area. In this manner, significant heat energy is only generated in a small area encompassed by the strip filament, so that there is substantially lower power consumption and heat dissipation than involved with indirectly heated cathodes and relatively wide area filament devices. Further, with the device of this invention, the electron beam can be more effectively uniformly distributed over the desired emission area than with the prior art devices.

It is therefore the principal object of this invention to provide an improved area electron flood gun which involves an efficient utilization of power and which is capable of providing a uniform distribution of electrons over a pre-desired area.

Other objects of this invention will become apparent as the description proceeds in connection with the accompanying drawings, of which:

FIG. 1 is a schematic illustration showing the operation of the area electron source of the invention,

FIG. 2 is a top plan view illustrating one embodiment of the device of the invention as incorporated into a scanning device,

FIG. 3 is a cross sectional view taken along the plane indicated by 3—3 in FIG. 2,

FIG. 4 is a front elevational view with sections partially cut-away of the device of FIG. 3,

FIG. 5 is a front elevational view illustrating a second embodiment of the device of the invention as incorporated into an electron beam scanning device, and

FIG. 6 is a cross sectional view taken along the plane indicated by 6—6 of FIG. 5.

Briefly described, the device of the invention comprises an electron emitting filament in the form of an elongated wire or strip, a conductive electron deflector electrode positioned behind and in most instances also to the side of the filament, and one or more electron director electrodes, generally in the form of a conductive mesh or screen in front of the filament, i.e., in the direction from the filament in which the flow of electrons is desired. The electrodes are positioned, shaped, and have potentials placed thereon such as to provide a uniform flow of electrons over a predetermined area and in a desired direction. In one disclosed embodiment, the deflector electrode is in the form of a shell having parabolic sides, with the filament being supported along the focal point of the parabola with the mesh elements being placed near the mouth of the parabolic shell. In another disclosed embodiment, a plurality of aligned filaments are utilized, each having a separate substantially semicircular deflector electrode with a single director electrode or set of such electrodes for all of the filaments.

Referring now to FIGS. 2–4, a first embodiment of the device of the invention as incorporated into an electron beam scanner of the type described in U.S. Pat. No. 3,408,532, is illustrated. Deflector electrode **11** has parabolically shaped side walls **11***a* and flat top and bottom walls **11***b* and **11***c* respectively. Deflector electrode **11** is in the form of a shell and has an open mouth portion **11***d*. Suspended between top and bottom wall portions **11***b* and **11***c* is a wire filament **15**. Filament **15** is mounted in insulator tabs **14** which are fixedly attached to wall portions **11***b* and **11***c* by suitable means such as cementing. A power source (not shown) is connected to filament leads **16** to suitably heat the filament to cause the emission of electrons therefrom. Deflector electrode **11** is fabricated of a suitable electrically conductive material.

Running around the mouth portion of parabolic electrode **11** is a flange **11***e*, this flange being attached to support plate **18**. Support plate **18** is used to support the entire assembly in casing **20** and is attached thereto by means of rods **21**. Electron directing electrodes **23** and **24** are in the form of wire meshes or screens which are mounted in insulator frames **25** and **26** respectively. Frames **25** and **26** act as insulative separators between the edges of the meshes. Insulative separator frame **27** acts to separate mesh **23** from support plate **18**. Supported on support plate **18** in front of electrodes **23** and **24** is electron beam scanner assembly **30**, which includes target **32** and a plurality of beam control plates **37** sandwiched between the target and the cathode. As already noted, this assembly may be similar to that described in U.S. Pat. No. 3,408,532. Casing **20** is suitably evacuated to provide a vacuum environment for the flow of electrons. Electron beam scanning assembly **30**, as well as electron directing electrodes **23** and **24**, are held to support plate **18** by means of ceramic rods **35**.

Referring now to FIG. **1**, the operation of the device of the invention is schematically illustrated. Filament **15** is located at the focal point of parabolic deflector electrode **11**. Grid director electrodes **23** and **24** are located in succession at the mouth of parabolic electrode **11**. Bias potentials supplied from voltage divider **38** which is connected across power source **39**, are

placed on electrodes **11**, **23**, and **24**, to make electrode **11** more positive than filament **15**, electrode **23** more positive than electrode **11** and electrode **24** more positive than electrode **23**. These potentials are selected empirically for an optimum area beam capable of producing a uniform flow of electrons over the area encompassed by grids **23** and **24**. As can be seen from the lines **40** which indicate the electron path, the electrons are deflected by electrode **11** but for the most part prevented from impinging to any great degree on the inner walls of this electrode in view of the higher electrostatic fields provided at the mouth of the parabola by electrodes **23** and **24**. In an operative model of the device of the invention, with the focal point location of filament **15** being spaced .4 inches from the vertex of the parabola, the mouth of the parabola being 2.9 inches wide, and 1.2 inches high, a potential of 20 volts was applied to electrode **11** and potentials of 25 volts and 30 volts applied to electrodes **23** and **24** respectively.

It is to be noted that while it presently appears that optimum operation can be achieved with filament **15** lying along the focal point of the parabolic sides of electrode **11**, it is believed that reasonably good operation can be obtained with some variation from this point. Further, reasonably satisfactory operation could also be obtained with some variations from a parabolic shape for electrode **11**, to some other shape such as a semicircular shape.

Referring now to FIGS. **5** and **6**, a second embodiment of the device of the invention is illustrated. In this second embodiment, rather than utilizing a single filament and deflector electrode for generating the electrons, this end result is rather achieved by means of a plurality of elongated wire filaments, each operating in conjunction with a separate deflector electrode. This results in a flatter overall structure than possible with the single parabolic electrode of the first embodiment, thus making for a more compact unit.

Each of thermionic filaments **15*a*–15*e*** is suspended between the flat top and bottom wall portions **43** of an associated one of deflector electrodes **41*a*–41*e***. Deflector electrodes **41*a*–41*e***, as for the deflector electrode of the first embodiment, are electrically conductive and the filaments are insulated therefrom by means of insulator tabs **44**. Power is supplied to the filaments from a power source (not shown), which is connected to terminals **45**. The side walls of deflector electrodes **41*a*–41*e*** are substantially semicircular rather than parabolic in configuration, with the filaments **15** being positioned substantially at the center of the semicircular arcs. Director electrodes **23** and **24** are mesh grids similar to those described for the first embodiment and are insulatively separated from each other and the structural elements between which they are sandwiched by means of insulative frame members **25**, **26** and **27**, as for the first embodiment. As for the first embodiment, each of electrodes **41*a*–41*e*** has a more positive potential than that of the filaments, with electrode **23** having a more positive potential than electrodes **41*a*– 41*e***, and electrode **24** having a more positive potential applied thereto than electrode **23**.

In an operative model of this embodiment, with electrodes **41*a*–41*e*** having an arc radius of 0.625 inches, the following potentials were utilized:

Filament **15**	5 volts AC
Electrodes **41*a*–41*e***	20 volts DC
Electrode **23**	25 volts DC
Electrode **24**	30 volts DC

The semicircular configuration for the deflector electrode facilitates fabrication as compared with the use of a parabolic configuration and appears to provide good results, at least in the multi-filament embodiment of FIGS. **5** and **6**. The use of a parabolic deflector, at least in the situation where only a single filament is utilized, appears at present to give optimum results in providing a uniform electron flow over the desired area.

Experiments indicate that it may be possible to utilize a plurality of elongated wires arranged substantially along the circumference of a circle or of a parabola in lieu of deflector electrodes **11** or **41*a*–41*e***, as the case may be, these wires having the same potentials as presently applied to the described deflector electrodes. In such case, the wires would effectively perform the function of the deflector electrodes and thus would be the equivalent thereof.

The devices of this invention thus provide a simple yet highly effective means for obtaining a uniform flow of electrons over a predetermined area for use in an area electron beam scanner.

We claim:

1. An electron flood gun for providing a uniform flow of electrons over a predetermined area comprising:

elongated linear filament means for generating electrons,

deflector electrode means positioned proximate to said filament means and partially surrounding said filament means so as to prevent electron flow away from the direction in which the flow of electrons is desired, said deflector electrode means being in the form of a single conductive parabolic shell substantially co-extensive with said filament means, said filament means being positioned along the focal point of the parabola formed by such shell,

director electrode means placed proximate to said filament means in a direction therefrom towards which the flow of electrons is desired, said director electrode means having a surface area substantially equal to the area over which the electron flow is desired,

means for applying successively higher potentials than that on said filament means to said deflector electrode means and said director electrode means respectively whereby the electrodes from said filament means are accelerated through said director electrode means and arranged in a substantially uniform pattern over the predetermined flow area.

2. The device of claim **1** wherein said director electrode means comprises wire mesh screens positioned substantially at the mouth of said parabolic shell.

3. An electron flood gun for providing a uniform flow of electrons over a predetermined area comprising:

elongated linear filament means for generating electrons,

a conductive elongated parabolic shell substantially co-extensive with said filament means and having an open mouth portion, said filament means being supported in said shell along the focal point of the parabola formed thereby,

conductive grid means placed proximate to the mouth portion of said shell, said grid means substantially encompassing the area of said mouth portion,

means for applying potentials to said shell and said grid means for accelerating the electrons out of said shell through said grid means,

said shell forming a deflector electrode and said grid means forming director electrode means for arranging the electrons in a substantially uniform pattern over said predetermined area.

4. An electron flood gun for providing a uniform flow of electrons over a predetermined area comprising:

a plurality of elongated linear filaments for generating electrons,

deflector electrode means positioned proximate to said filaments and partially surrounding said filaments so as to prevent electron flow away from the direction in which the flow of electrons is desired, said deflector electrode means being in the form of a plurality of elongated arcuate shell members arranged in side by side relationship, a separate one of said filaments being positioned within an associated one of each of said shell members,

director electrode means placed proximate to said filaments in a direction therefrom towards which the flow of electrons is desired, said director electrode means having a surface area substantially equal to the area over which the electron flow is desired,

means for applying successively higher potentials than that on said filaments to said deflector electrode means and said director electrode means respectively, whereby the electrons from said filaments are accelerated through said director electrode means and arranged in a substantially uniform pattern over the predetermined flow area.

5. The device of claim **4** wherein said shells are substantially in the form of half cylinders.

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