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ELECTRON DISCHARGE DEVICE

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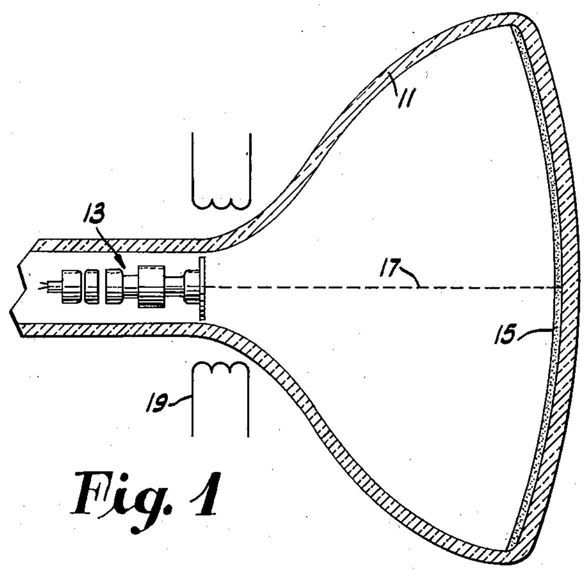
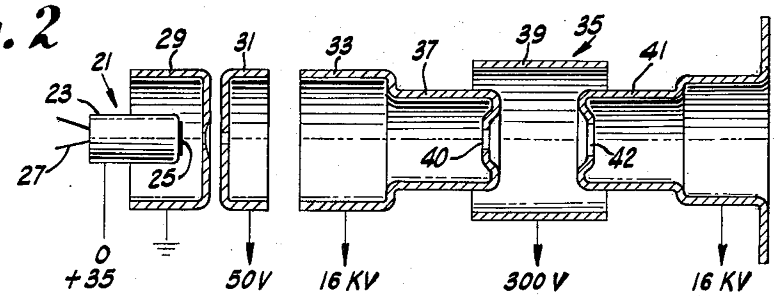


Fig. 1

Fig. 2



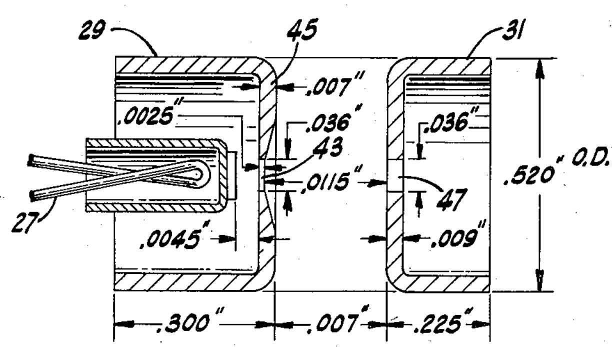


Fig. 3

INVENTOR
WILLIAM A. DICKINSON
GEORGE E. HASSLER
BY Robert E. Strauss
ATTORNEY

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ELECTRON DISCHARGE DEVICE

William A. Dickinson, Seneca Falls, and George E. Hassler, Auburn, N.Y., assignors, by mesne assignments, to Sylvania Electric Products Inc., Wilmington, Del., a corporation of Delaware

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This invention relates to electron discharge devices and more particularly to cathode ray tubes having relatively high transconductance.

One type of cathode ray tube adapted to be employed in electrical apparatus such as television receivers utilizes a "low G_2" electron gun for achieving relatively high transconductance. This gun has applied to the second grid a voltage, e.g. 100 volts positive, which is low compared to the conventional tubes utilizing approximately 300 volts positive on the second grid. Since the transconductance of this type of cathode ray tube increases with a decrease in the second grid voltage, it is desirable to lower this voltage as much as practicable. One of the advantages of a high transconductance tube resides in its ability to operate satisfactorily with a relatively small video drive signal. This is extremely desirable since the present trend in television circuit design is to utilize either lower output video amplifiers or to delete the amplifier and couple the cathode ray tube control electrode, e.g., the cathode or first grid, directly to the second detector.

Previous attempts to fabricate a "low G_2" tube have been unsuccessful since the electron gun design was so critical that it could not be economically made, or since the spacings between electrodes and the electrode aperture sizes selected were such that a large percentage of rejects occurred from shorts due to close spacings, from low beam current due to wide spacings, and from poor electron beam focusing.

Accordingly, it is an object of the invention to reduce the aforementioned disadvantages and to achieve relatively high transconductance in a cathode ray tube capable of economic fabrication.

A further object is to reduce rejects normally occurring from the critical construction of a "low G_2" cathode ray tube.

The foregoing objects are achieved in one aspect of the invention by the provision of a cathode ray tube having an electron gun assembly including a cathode, a first grid and a second grid. The first grid is a cylinder having an end wall formed to provide an aperture aligned with the cathode. The end wall surrounding the aperture has a given thickness with the cathode to first grid spacing being from 1.25 to 3.0 times this given thickness. The distance between the first and second grids is from 3 to 7 times the given thickness. With this unique construction, the tube operates satisfactorily with a voltage on the second grid at 50 volts positive or lower.

For a better understanding of the invention, reference is made to the following description taken in conjunction with the accompanying drawings in which:

Fig. 1 is a plan view of a cathode ray tube;

Fig. 2 is an enlarged view of the electron gun utilized in the tube shown in Fig. 1; and

Fig. 3 shows in detail the cathode, first grid and second grid structures of the gun mount shown in Fig. 2.

Referring to Fig. 1, a uni-potential electrostatic focus cathode driven tetrode type cathode ray tube adapted

for use as a television picture tube is shown for purposes of illustration. The tube comprises an envelope **11** having an electron gun **13** mounted therein spaced from the fluorescent screen **15**. The electron gun provides the source, acceleration, control and focusing of the electron beam **17**, which is deflected by coils **19** to strike the screen **15** and provide the image display raster for the tube.

The electron gun **13**, Fig. 2, is shown comprising a cathode assembly **21** including a cylindrical sleeve **23** having electron emissive material **25** deposited on the end thereof. A heater **27** provides the heat necessary to cause electrons to be emitted from material **25**. Spaced from the cathode along the path of electron travel is a first grid **29**, a second grid **31**, an electron accelerating anode **33**, and a uni-potential electrostatic focus assembly **35**.

The electron beam **17** is focused by assembly **35** to provide a spot of minimum diameter at the impinging position on screen **15**. This assembly comprises the spaced lens cups **37** and **41** having apertures **40** and **42** formed therein surrounded at their aperture regions by a lens ring **39**. Assembly **35** functions in such a manner that the divergent electron beam **17** arriving from the cathode **23** is made convergent from the focusing assembly **35** to the fluorescent screen **15**.

Referring to Fig. 3, the first grid **29** is formed as a cylinder having an aperture **43** aligned with the cathode material **25**. The end wall **45** of the first grid is coined or operated upon by other means to reduce the thickness of the wall adjacent aperture **43**. The coining operation causes a recess to be formed in wall **45** facing grid **31**. The second grid **31**, which also has a cylindrical form, is provided with an aperture **47** aligned with the first grid aperture.

It has been found that the cathode to first grid and first grid to second grid spacings, and particularly the thickness of wall **45** adjacent aperture **43**, is instrumental in fabricating a "low G_2" high transconductance cathode ray tube. The dimensions and spacings shown in Fig. 3 illustrate a construction which provides excellent video drive requirements since it allows the application of a voltage on the second grid **31** as low as 50 volts. Grid **29** has an outside diameter of .520 inch with a length of .300 inch. The aperture **43** has a diameter of .036 inch and end wall **45** is coined down from .007 inch thickness to .0025 inch adjacent aperture **43**. The second grid also has an outside diameter of .520 inch and has a length of .225 inch. The wall thickness is .0090 inch while aperture **45** has a diameter of .036 inch.

The electron emissive material **25** at the end of cathode **21** is spaced from the internal edge of wall **45** a distance of .0045 inch. Second grid **31** is spaced from first grid **29** a distance of .0115 inch measured from the surface of wall **45** surrounding the aperture and facing grid **31**.

It has been found that the spacings and dimensions of anode **33** and the focusing assembly electrodes is not critical in constructing a "low G_2" tube. However, these electrodes should be assembled to provide adequate focusing at screen **15**. If desired, other forms of electrostatic or magnetic focusing may be employed in lieu of assembly **35**.

The structural dimensions shown in Fig. 3 are for purposes of illustration. However, it is preferable to achieve a first grid wall thickness adjoining aperture **43** as small as practicable. Excellent results have been obtained using a thickness of from .0020 inch to .0030 inch. Once this given thickness is acquired, the spatial distance between cathode **21** and first grid **29** is preferably from 1.25 to 3.0 times this given thickness and the distance between grids **29** and **31** is preferably from 3 to 7 times this given thickness to obtain reasonable tube characteristics.

A cathode ray tube of the type described herein has relatively high transconductance and therefore requires a small amount of video drive. When the tube is cathode driven as shown in Fig. 2, and with 50 volts positive on second grid 31, a video drive on cathode 21 need only be from approximately 35 volts positive to zero bias to traverse from approximately 1000 micro-amperes beam current to beam cut-off. These values exemplify excellent drive characteristics and allow utilization of low voltage sources.

The anode 33 and lens cups 37 and 41 have an accelerating potential of 18 kv. imposed thereon while lens ring 39 is operated at 300 volts. Conventionally, the 16 kv. electrodes are connected to the screen 15 of the tube to provide a uni-potential deflection region for beam 17.

Although several embodiments of the invention have been shown and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as defined by the appended claims.

What is claimed is:

1. An electron discharge device employing an electron beam comprising an image screen, and an electron gun formed to provide the source, acceleration, control and focusing of the electron beam spaced from said screen, said electron gun including a cathode, a first grid and a second grid arranged in the direction of electron travel toward said screen, said first grid comprising a cylinder having an end wall formed to provide an aperture aligned with said cathode, the surface of said end wall surrounding the aperture having a given thickness of from .0020 to .0030 inch, the spatial distance between the cathode and first grid being from 1.25 to 3.0 times said given thickness and between said first and second grids being from 3.0 to 7.0 times said given thickness.

2. An electron discharge device employing an electron beam comprising an image screen, and an electron gun formed to provide the source, acceleration, control and focusing of the electron beam spaced from said screen, said electron gun including a cathode, first grid, second grid, anode and an electrostatic focusing electrode assembly arranged in the direction of electron travel toward said screen, said first grid comprising a cylinder having an end wall formed to provide an aperture aligned with said cathode, the surface of said end wall surrounding the aperture having a given thickness of from .0020 to .0030 inch, the spatial distance between the cathode and first grid being from 1.25 to 3.0 times said given thickness and between said first and second grids being from 3.0 to 7.0 times said given thickness.

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