TWIN-CONVEX ELECTRON GUN

BACKGROUND OF THE INVENTION

The present invention relates to an electron gun for a cathode-ray tube.

FIG. **1** shows the electrode configuration of a quadripotential-focus (QPF) electron gun of the cathode-drive type, which is one example of the prior art. FIG. **2** illustrates the principle of this QPF electron gun.

Referring to FIG. **1**, the QPF electron gun comprises a stem **1**, three cathodes **2**, and a first grid **3**, second grid **4**, third grid **5**, fourth grid **6**, fifth grid **7**, and sixth grid **8**. The first and second grids **3** and **4** are control electrodes comprising flat plates with apertures for passage of the three electron beams emitted from the cathodes **2**. The fourth grid **6** comprises a generally similar electrode. The third, fifth, and sixth grids **5**, **7**, and **8** comprise cylindrical electrodes with interior or end baffles having apertures for passage of the electron beams.

A fixed anode voltage E_B is applied to the sixth grid **8**. A focus voltage E_F generally equal to 20% to 30% of the anode voltage is applied to the third and fifth grids **5** and **7**. The fifth and sixth grids **7** and **8** form a main lens **12**, as indicated in FIG. **2**. A lower fixed voltage E_{G2} is applied to the second grid **4**. The same voltage E_{G2} or another voltage lower than the focus voltage is applied to the fourth grid **6**, forming the prefocus lens **11** indicated in FIG. **2**. A still lower fixed voltage E_{G1} is applied to the First grid **3**. Red, green, and blue video signal voltages, generally intermediate between E_{G1} and E_{G2}, are applied to the cathodes **2**. The part comprising the cathodes **2** and the first, second, and third grids **3**, **4**, and **5** is referred to as the triode **14**.

The operation of the QPF electron gun is illustrated schematically in FIG. **2**. An electron beam **101** emitted from one of the cathodes **2** is brought to a crossover **13** by the first and second grids **3** and **4**, then prefocused by the unipotential lens effect of the prefocus lens **11**. The prefocused electron beam is then focused onto a screen **10** by the bi-potential effect of the main lens **12**, forming a beam spot.

FIG. **3** shows the potential distribution in the triode **14** of this QPF electron gun, omitting the third grid **5**. It is convenient to discuss the electron optics in FIG. **3** in terms of an equivalent optical lens system, shown in FIG. **4**, comprising a convex lens **102**, a concave lens **103**, and a convex lens **104**. The concave lens **103** has a divergent effect that aligns the virtual object points of rays **15** emitted from the periphery of the cathode **2** and rays **16** emitted from near the center of the cathode **2** to substantially the same virtual object point **17**. (The virtual object point is the position of the object point as seen from the main lens **12**; this position affects the focal length of the main lens **12**.) Another effect of the concave lens **103** is to suppress movement of the virtual object point when the beam current is increased. The beam aberration of the triode **14** can thereby be reduced, a beam spot with a small diameter can be formed on the screen **10**, and resolution can be improved.

FIG. **5** shows electron trajectories in the conventional QPF electron gun at a low beam current level, while FIG. **6** shows electron trajectories at a high current level. At the low current level, under ideal conditions with no aberration, a beam emitted from a single point would be Focused to a single point. Under actual conditions, at low current levels, spherical aberration in the main lens **12** causes peripheral rays to be brought to a shorter focus, resulting in a slight enlargement of the beam-spot diameter on the screen **10**, as shown in FIG. **5**. As the beam current increases, so does the spherical aberration of the main lens **12**, leading to a great enlargement of the spot size on the screen **10** as shown in FIG. **6**. The result of this so-called blooming effect is poor resolution on the screen.

One conventional solution to this problem has been to increase the thickness of the second grid **4**, in order to reduce the aberration of the main lens **12**. Other conventional solutions have been to reduce the diameters of the beam apertures in the third, fourth, and fifth grids **5**, **6**, and **7** or to increase the thickness of the fourth grid **6**, in order to strengthen the prefocus lens **11**, thereby reducing the beam diameter at the position of its center of deflection. These solutions do not lead to fundamental improvements, however, because they enlarge the diameter of the virtual object point **17**, resulting in increased magnification, so that the beam-spot diameter is increased in the center of the screen **10**.

SUMMARY OF THE INVENTION

It is accordingly an object of the present invention to reduce the amount by which increased beam current increases the spot size on the screen, thereby obtaining good resolution at high current levels.

Another object of the invention is to reduce the variation in beam-spot size due to the current level.

The invented electron gun is for use in a cathode-ray tube, and comprises a triode and a main lens. The triode has a cathode that emits an electron beam, and first and second electrodes with apertures through which the electron beam passes. The main lens focuses the electron beam onto a screen. The separation between the first and second electrodes and the thickness of the second electrode are adapted to form a convex lens which does not cause the electron beam to diverge.

More specifically, the thickness of the second electrode, and the separation between the first and second electrodes, are at most one-half the diameter of the aperture in the second electrode for passage of the electron beam. The separation between the first and second electrodes is also at most one-half the diameter of the aperture in the first electrode for passage of the electron beam.

The potential difference between the cathode and the second electrode is at most four hundred volts in the cutoff state. Reducing this potential difference to at most four hundred volts reduces the angle of divergence of the electron gun.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates the electrode configuration of a conventional electron gun.

FIG. **2** illustrates the principle of the conventional electron gun.

FIG. **3** illustrates the potential distribution in the triode of the conventional electron gun.

FIG. **4** describes the conventional electron gun in terms of an equivalent optical lens system.

FIG. **5** shows electron trajectories in the conventional electron gun at a low beam current level.

FIG. **6** shows electron trajectories in the conventional electron gun at a high beam current level.

FIG. **7** illustrates the electrode configuration of an electron gun of the present invention.