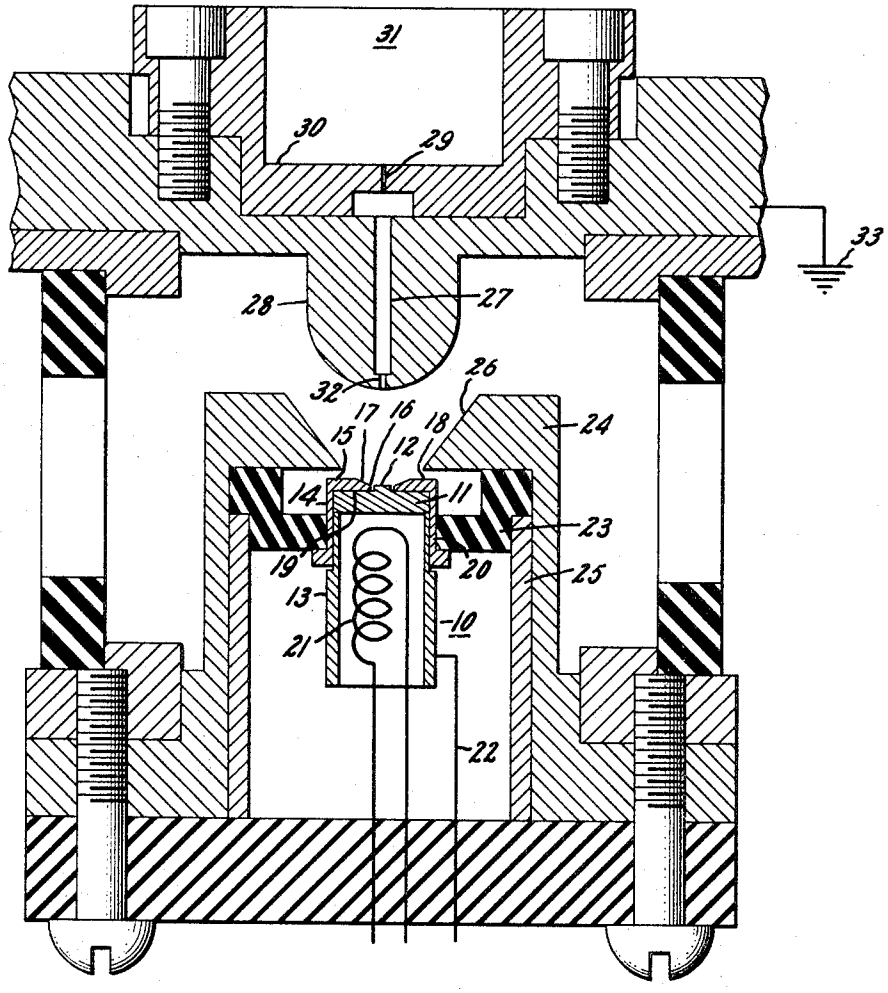
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ELECTRON GUN

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ELECTRON GUN

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ABSTRACT OF THE DISCLOSURE

An electron gun having an electron source which includes a disk of electron emitting material having a small projection on one face and an annular support underlying the disk periphery on the opposite face. The disk is capped by a cup-shaped member having an apertured end wall to receive the projection. A portion of the wall of the aperture formed by the cup-shaped member is beveled outward in order to shape the emitted beam of electrons.

The present invention relates to an improved electron gun and more particularly to a structure for simplifying and improving the beam focusing capabilities of such a gun.

Among the growing number of uses to which electron guns have been put is that of recording information on thermoplastic or photographic film by directing a high density electron beam over the film surface. Depending on the type of film used as a target, the impinging beam may cause tactual, electrostatic, or visual changes in the film surface. It is desirable that the electron beam be sharply defined so that there will be no overlap to prevent accurate information recording. In prior electron guns, the beam is formed by a focusing electrode spaced between an electron source and an accelerating electrode, which is at a much higher electrical potential than the source or focusing electrode. The forming capabilities of the electrostatic focusing field established between the accelerating electrode and the focusing electrode depends primarily on the configuration of the focusing electrode. Due to the precision with which the focusing electrode must be made, the cost of its manufacture and maintenance has been relatively high.

Accordingly, it is one object of the present invention to provide an improved electron gun having a relatively inexpensive beam-focusing system which minimizes problems in manufacturing the gun while providing accurate alignment of the electron beam.

It is another object of the present invention to provide an improved electron gun having a cathode structure capable of withstanding severe treatment.

To fulfill these and other objects of the invention, there is provided an improved electron gun which includes an electron source with an electron emitting disk having a projection on a first face, and an annular support underlying the peripheral portions of a second face. The source is capped by an inverted cup-shaped member having an apertured end wall which covers all of the first face of the disk except the projection which is received within the end wall aperture. The side walls of the cup-shaped member extend downwardly along the walls of the annular support. A heater is provided to raise the temperature of the disk to a level at which electrons will be emitted from the surface of the projection. To focus these emitted electrons, there has been provided a focusing arrangement which includes the cup-shaped member and an accelerating electrode spaced from the electron source and having a passageway therethrough axially aligned with the projection. The focusing system also includes a focusing electrode interposed between the accelerating electrode and the electron source. Means are provided for establishing a field of electrostatic force lines linking the focusing electrode and the cup-shaped member to the accelerating electrode.

While the specification concludes with claims particularly pointing out and distinctly claiming that which is regarded as the present invention, the organization, advantages and further objects of the invention may be more readily ascertained from the following detailed description when read in conjunction with the accompanying drawing which represents a sectional view of an electron gun constituting one embodiment of the present invention.

Referring now to the drawing, there will be seen an improved electron gun including an electron source **10**. The source **10** includes a disk **11** of electron emitting material having a projection **12** on one face thereof. The underside of the disk **11** is seated against the end wall of an annular support **13** and is held there by the inner surface **19** of an inverted cup-shaped source cap **14** having an end wall **15** overlying all of the upper face of the disk **11** except for the projection **12** itself, which is exposed at a centrally located aperture **16** formed in the end wall **15**. Approximately one-half the length of aperture **16** is cylindrical, whereas the other half is beveled to form sloping walls **17** which terminate at the outer surface of the end wall **15**. The end of projection **12** is at the point at which sloping walls **17** begin. To prevent electron emission or heat loss through the 8–9 mil thick end wall **15**, the cap **14** may be carburized. The inner surface of the side wall **20** of the cap **14** fits slidingly over the edges of the disk **11** as well as the outer walls of the annular support member **13**. A heater coil **21** is positioned within member **13** directly beneath the disk **11** to provide enough heat to raise the temperature of the disk **11** into a range in which a sufficient number of electrons will be emitted from the surface of the projection **12** for recording purposes. The annular support member **13** is maintained at a negative potential of 6,000 to 8,000 volts through the electrical lead **22**.

The electron source **10** is supported by an annular insulating collar **23** which, in turn, is supported at its outer end between the underside of a circular shaping electrode **24** and a tubular support **25**. The shaping electrode **24**, which includes an aperture defined by beveled side walls **26**, is maintained at or near the same negative potential as is the electron source **10**.

The projection **12** on the disk **11** is axially aligned with a passageway **27** in an accelerating electrode **28** having a hemispherical end portion. The electrode **28** is connected to a grounded terminal such as that shown symbolically at **33**. The passageway **27** communicates with an even smaller aperture **29** in a pressure-barrier plate **30**. The aperture **29** has an inside diameter of one to two mils in contrast to the 15 to 20 mils inside diameter of the passageway **27**. The aperture **29** can be made this small only because it is located at the crossover point of the electron beam; i.e., the point at which the beam has converged to its minimum width. At this point, the electrons cross over one another and the beam begins to diverge. Because of its unique location relative to the beam, the aperture **29** serves both as an effective pressure barrier and as a contaminating gas flow barrier. The structure and advantages of this feature are more fully disclosed and claimed in the appliction of William C. Hughes and Howard L. Lester Ser. No. 534,347, filed concurrently herewith on Mar. 15, 1966 and assigned to the same assignee as the present invention. The electron beam is directed through the aperture **29** into a chamber **31** in which the film target may be located. Although it is not readily apparent in the figure, chamber **31** is enclosed by

walls not shown and is maintained at subatmospheric pressures.

Because of the differences in potential of the elements of the electron gun, electrostatic force lines will be established between the hemispherical surface of the grounded accelerating electrode **28** and the highly negative elements comprising electrode **24** and source cap **14**. The electrostatic forces form an electrostatic "funnel" which is symmetrical about an axis drawn through a passageway **27** and the projection **12**. This funnel shapes the electrons emitted from the surface of projection **12** into a converging beam directed through the passageway **27**. To insure that the beam edges will be precisely defined, the passageway **27** is made narrow at its opening **32** in order to intercept the low density fringe of the beam.

Unlike known electron guns in which the shape of the electron beam is determined solely by a completely separate focusing electrode such as **24**, the shape of the beam generated by the above-described electron gun is determined primarily by the configuration of the cap **14**. While the cap **14** is only 8 to 9 mils thick, studies have shown that it plays a critical part in the beam shaping process. Correspondingly, the separate shaping electrode **24** plays a less critical part in the shaping process and thus does not need to be manufactured or assembled with the same degree of precision previously thought necessary. The use of the cap **14** as the critical element in the beam-shaping process gives rise to considerably fewer problems in aligning the shaping electrodes with the disk **12** since the cap **14** will be more or less automatically aligned when it is fitted over the disk **12** and the holder **13** and the electrode **24** does not need to be aligned as precisely as if it were the critical element. An additional advantage derived from the use of the cap **14** is that the inner walls **19** will hold the disk **12** securely in place so that the electron gun may safely be subjected to the severe jolts which inevitably occur when the electron gun is used in a recording device in an air or ground vehicle.

While there has been described at present what is regarded as a preferred embodiment of the present invention, modifications or variations may occur to those skilled in the art. It is therefore intended that the appended claims shall cover all such variations and modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is.

1. An improved electron gun including an electron source comprising a disk of electron emitting material having a small projecting portion on a first face thereof, an annular support means underlying the peripheral portions of said disk, a cup-shaped metallic cap for said disk, said cap having an end wall in overlying contact with a substantial part of the first face of said disk and including an aperture receiving said projecting portion of said disk, means for heating said disk to cause the emission of electrons from the surface of said projecting portion, means for focusing the emitted electrons into a high density beam, said last named means including said metallic cap and further including a first electrode spaced from said electron source and having a passageway therethrough in axial alignment with said projecting portion on said disk, a second electrode interposed between said first electrode and said electron source, and means for establishing an electrostatic field between said first electrode and said second electrode and metallic cap.

2. An improved electron gun as recited in claim **1** wherein said first electrode is hemispherically shaped for electrostatic field forming purposes.

3. An improved electron gun as recited in claim **1** and further including means for centering said electron source relative to said first and second electrodes.

4. An improved electron gun as recited in claim **3** wherein the aperture formed in the end wall of said cup-shaped metallic cap includes a cylindrical portion extending from the inner surface of said end wall to a point intermediate that surface and the outer surface; and a conical portion formed by outwardly sloping walls beginning at intermediate point and extending to the outer surface of said end wall.

5. An improved electron gun as recited in claim **4** wherein said projecting portion on said disk terminates at the intermediate point in the aperture.

6. An improved electron gun as recited in claim **1** wherein the metal of said cup-shaped cap is carburized.

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