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FLEXIBLE CONNECTION BETWEEN CATHODE AND PLURAL SECTION FOCUSING ELECTRODE

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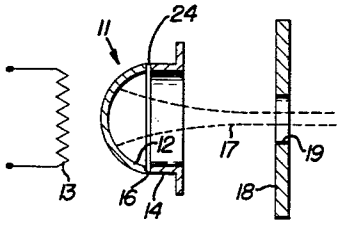

Fig. 1

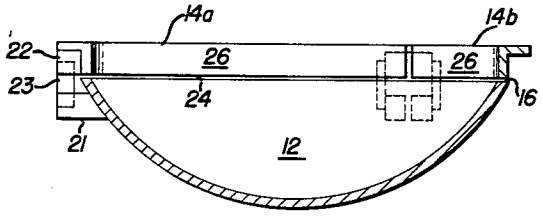

Fig. 2

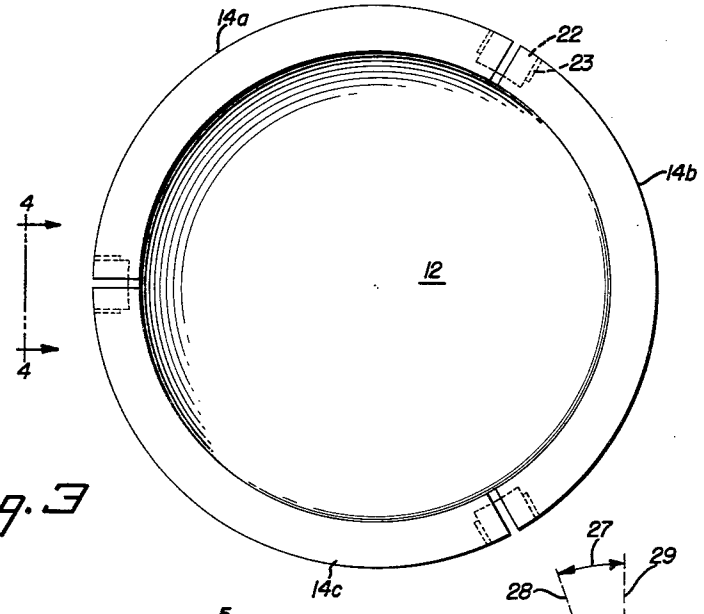

Fig. 3

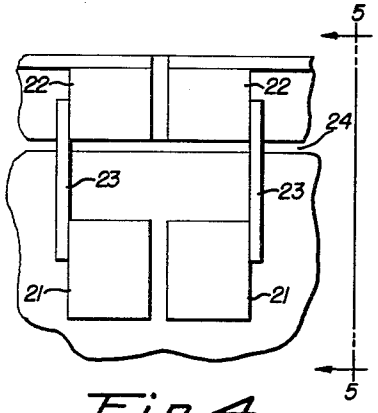

Fig. 4

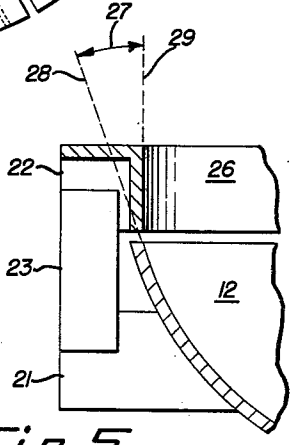

Fig. 5

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This invention relates generally to an electron gun, and more particularly to a cathode and focusing electrode arrangement for said gun.

In many applications, concave cathode emitting surfaces are employed so that the electric fields between the cathode and anode have a configuration such that the electrons emitted by the cathode are focused to form a beam of small cross-section.

However, near the rim of the cathode surface there are fringing fields. As a result, electrons emitted near the rim portion of the cathode are not properly focused and tend to scatter.

To overcome this difficulty, it is conventional practice to provide a solid ring placed adjacent the rim of the cathode and electrically connected thereto. The ring provides a continuation of the cathode surface whereby the fields near the rim of the cathode are not distorted. The ring is generally called a focusing electrode. It is preferably made of a metal which has a high work function and is kept relatively cool so that it does not emit electrons.

A difficulty with this conventional structure is that the cathode and focusing electrode have different coefficients of thermal expansion and that the focusing electrode operates at a cooler temperature than the cathode. Thus, as the temperature changes, the diameters of the cathode and focusing electrode change by different amounts and the focusing electrode no longer provides a precise continuation of the cathode surface. As a result the fields at the rim of the cathode are again distorted.

It is, therefore, a general object of the present invention to provide an improved electron gun in which the detrimental effects due to differences in thermal expansion of the cathode and focusing electrode are minimized.

It is another object of the present invention to provide an improved cathode assembly which includes a segmented focusing electrode supported from the cathode.

It is another object of the present invention to provide a cathode assembly having a segmented focusing electrode with the segments attached to the cathode in such a manner that relative movement in a tangential direction with respect to the cathode is encouraged, whereas all other relative movement is inhibited.

These and other objects of the invention are, in general, achieved by making the focusing electrode in slightly spaced arcuate segments. The objects are even more fully achieved by mounting the segments on the cathode with flexible plates, that is, plates which may be bent or flexed in a direction perpendicular to their faces and which are relatively rigid in directions parallel thereto. The plates are disposed so that the plane of their faces extends radially of the focusing electrode and cathode. Thus, when the cathode is heated to become emissive, and the segments and cathode expand at different rates, the relative motion between the segments and cathode occurs only in a tangential direction, which motion is permitted by the flexible plates. Any tendency for the segments to move in a radial direction with respect to the cathode is prevented by the rigidity of the plates in an edgewise direction.

The foregoing and other objects of the invention will be more clearly apparent from the following description when taken in conjunction with the accompanying drawing.

Referring to the drawing:

FIGURE 1 is a schematic showing of an electron gun of the type to which the present invention may be applied;

FIGURE 2 is an enlarged view of a cathode assembly according to the present invention;

FIGURE 3 is a plan view of the cathode assembly of FIGURE 2;

FIGURE 4 is an enlarged view showing the mounting of the focusing electrode on the cathode according to the present invention; and

FIGURE 5 is a view taken along the line 5—5 of FIGURE 4.

Referring to FIGURE 1, there is shown a dish-shaped cathode **11** having an emitting surface **12**. The cathode illustrated is indirectly heated by the heater schematically shown at **13**. A focusing electrode **14** is disposed adjacent the rim **16** of the cathode. The dotted lines **17** schematically illustrate the trajectory of the electrons emitted from the surface **12**. The anode **18** includes an aperture **19** through which the electrons are projected.

Referring to FIGURES 2 and 3, the cathode structure is illustrated in more detail. Closely spaced adjacent the rim **16** of the cathode are focusing electrode segments *14a*, *14b*, and *14c*. It will become apparent that, although three segments are illustrated for purposes of description, the essential feature is that the focusing electrode be segmented to thereby enable expansion and contraction of the same.

The focusing electrode segments are mounted near their ends to the cathode. For this purpose, lugs **21** are suitably secured to the cathode surface as, for example, by welding. Similarly, lugs **22** are secured near the ends of the focusing electrode segments. A flexible metal plate **23** is then secured to the faces of the lugs **21** and **22** as, for example, by welding and serves to support the segments adjacent the rim **16**. It is observed that the plate is disposed perpendicular to the periphery of the cathode and focusing electrode. It prevents movement between the segments and rim so that the gap **24** between the focusing electrode and cathode remains substantially constant. The plates **23** also prevent relative radial movement between the cathode and focusing electrode segments since the plates are not flexible parallel to their faces, that is, in the plane of the paper in FIGURE 5. Consequently, the inner surface **26** of the focusing electrode segments will always lie in line with the inner edge of rim **16** of the cathode.

It is further observed that the flexible plates **23** are mounted so that they will flex or bend in a direction which is tangential to the outer surfaces of the cathode. Thus, means are provided whereby the ends of the focusing segments may move in a tangential direction to accommodate the differences in thermal expansion. The plates may flex or bend to accommodate the increased or decreased relative length of the circumference of the cathode and the segments.

Preferably, the surface **26** of the focusing electrode is disposed at an angle with respect to the adjacent continuation of the surface **12**. This angle is shown by the arrow **27**, FIGURE 5, which extends between the line **28** tangential to the cathode surface and a line **29** tangential to the surface of the electrode. In accordance with well known theory, the angle indicated by arrow **27** should be in the order of between 20° and 25° to provide proper focusing and minimize distortions of the field.

There is provided a segmented focusing electrode in which the spacing between segments provides room for thermal expansion. The segments are so mounted that they will form a continuation of the cathode surface regardless of the thermal expansion. Likewise, the seg-

ments are mounted so that the gap between the focusing electrode and the cathode remains substantially constant. However, the segments lengthen and shorten with respect to the rim of the cathode with the flexible mounting plates providing means for accommodating any differences in thermal expansion between the segments and cathode.

I claim:

1. An electron gun comprising a cathode including a dish-shaped emitting surface, an anode, and a focusing electrode, said focusing electrode comprising a plurality of arcuate segments spaced slightly apart at their ends, and means connecting said segments to the rim of said emitting surface, said connecting means being flexible in a direction which permits said segments to expand and contract along the line of their curvature.

2. An electron gun comprising a cathode including a dish-shaped emitting surface, an anode, a focusing electrode disposed adjacent said cathode and forming a continuation of said cathode emitting surface, said focusing electrode including at least two segments, flexible plates having one end mounted on the segment and the other end on the cathode serving to support said segments from the cathode.

3. A cathode assembly including a dish-shaped emitting surface, a focusing electrode disposed adjacent the rim of said emitting surface and forming a continuation of the cathode emitting surface, said focusing electrode including at least two segments, flexible plates having one end mounted near the ends of said segments and the other end mounted on the cathode serving to support said segments in spaced relationship with respect to the rim of the cathode, said flexible plates being mounted with their faces substantially perpendicular to the periphery of the cathode and associated segment whereby movement of the segments with respect to the cathode in a radial direction is minimized.

4. A cathode assembly including a dish-shaped emitting surface, a focusing electrode disposed adjacent the rim of the dish-shaped emitting surface and forming a continuation of said surface, said focusing electrode including at least two segments, cooperating mounting means mounted near the ends of each segment and on adjacent portions of the cathode, flexible plates having their ends secured to the adjacent mounting means on the segments and cathode, said plates being disposed with their faces substantially perpendicular to the periphery of associated segment and cathode to thereby prevent relative radial movement of the segments with respect to the cathode whereby the focusing electrode surface continuously forms a continuation of the cathode emitting surface.

5. An electron gun comprising a circular cathode and a circular focusing electrode, said focusing electrode comprising at least two individual arcuate segments, at least one support connecting each of said segments to said cathode, said support for each segment providing a rigid connection between said cathode and the respective segment in a radial direction whereby radial expansion and contraction of said cathode is transmitted to and followed by said focus electrode, and said support for each segment permitting the respective segment to expand and contract along its arcuate length relative to the cathode whereby the ends of the segments can move toward and away from each other.

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