

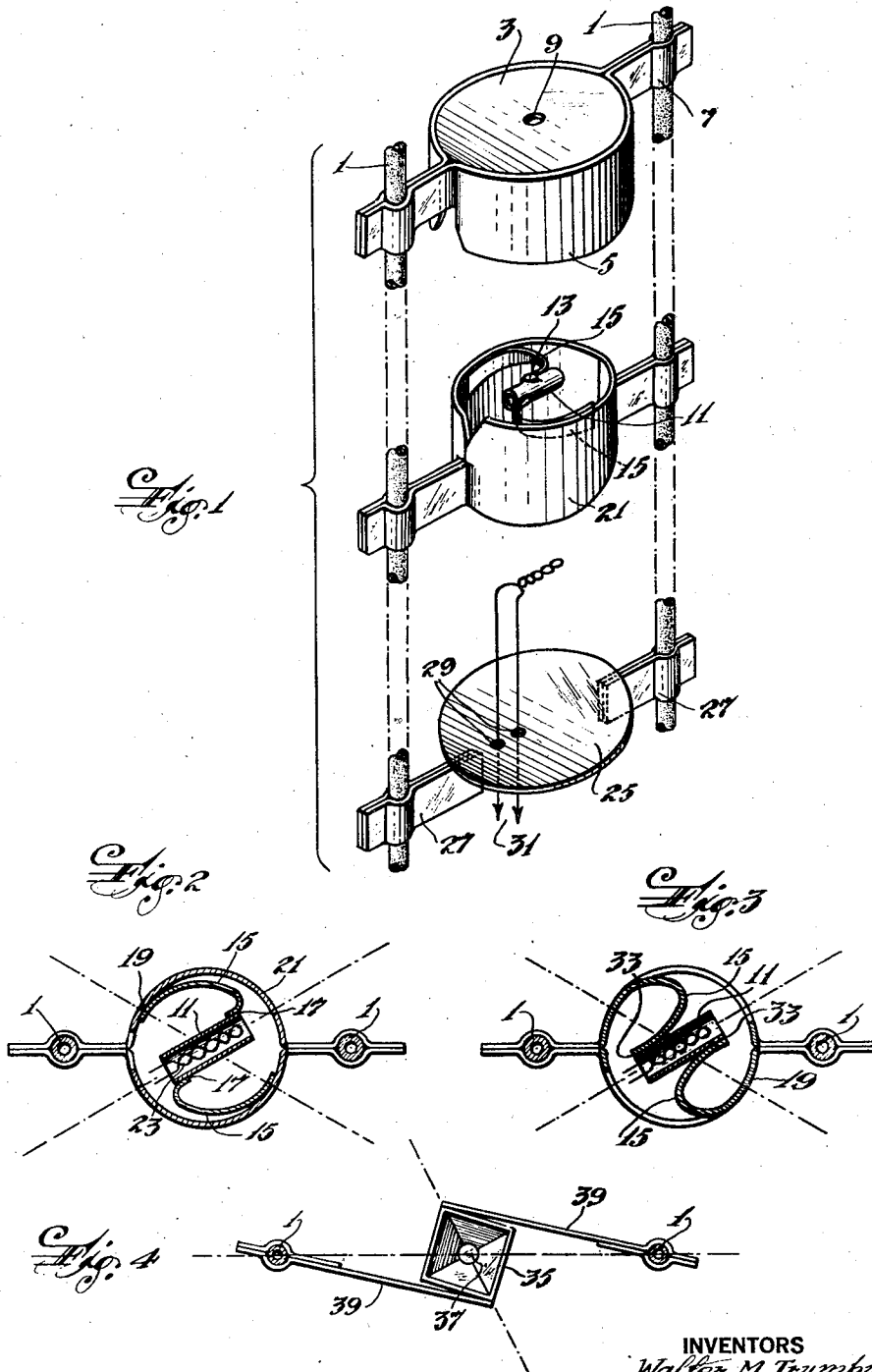
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CATHODE ASSEMBLY

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CATHODE ASSEMBLY

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Our invention relates to electron emitting cathodes and more particularly to electron emitting cathodes serving as limited area emitters for use in cathode ray tubes and similar electron discharge devices.

In conventional cathode ray tubes it is necessary to develop an electron beam of high current density and of small cross-sectional area in a direction normal to the beam trajectory. Conventional practice is to utilize an elongated sleeve closed at one end with a cap bearing electron emitting material and supported either intermediate of its length or at the opposite end on the tube stem or press. Since it is necessary to control the electron emission from such a cathode, it is customary to provide an apertured control electrode closely spaced from and having its aperture in alignment with the closed end bearing the electron emitting material. In such a structure as described, any expansion of the elongated cathode sleeve reduces the spacing between the aperture and the emitting material when the cathode is heated and oftentimes produces electrical contact between the cathode and the control electrode rendering the tube inoperative. Variations in heating of the cathode such as occasioned by line voltage variations in cathode ray tube use cause variable tube characteristics because of the variable expansion of the cathode under such conditions. While it has been proposed to support the cathode adjacent the electron emitting end, use of such support means increases the heat lost by conduction thereby reducing the cathode temperature during operation. Furthermore, such supports usually determine the distance between the cathode and the control electrode and must therefore be made very accurately, especially where a uniform produce is desired in large quantity production.

It is an object of our invention to provide an indirectly heated cathode which maintains a fixed position during use in the direction of electron emission therefrom. It is a further object to provide a cathode assembly wherein any movement of the component parts caused by thermal expansion during use is diverted into movement which will not change the spacing between the cathode and any associated electrode structures. It is a further object to reduce the mass of material that must be heated in a cathode assembly, thereby providing more efficient operation. It is a further object to provide a cathode-control grid assembly for use in cathode ray tubes wherein the distance between the cathode and control electrode is fixed irrespective of variations in

operating temperature of the cathode. It is a still further object to minimize heat losses from an indirectly heated cathode while maintaining a fixed spatial position of the cathode in a direction along the electron beam trajectory; and it is a still further object to provide a cathode assembly which is cheaper to manufacture and more stable in operation than cathodes made heretofore.

These and other objects, features, and advantages of our invention will appear to those skilled in the art when considered in conjunction with the following description and the accompanying drawing wherein Figure 1 is a perspective view of the principal component parts of our cathode-control electrode assembly; Figure 2 is a cross-sectional view of a portion of the structure shown in Figure 1; and Figures 3 and 4 are similar views of two different embodiments of our invention.

In accordance with our invention we provide a cathode supported in such a manner that thermal expansion either of the cathode or of its supports produces a rotary motion of the cathode in a plane normal to the electron emission from the cathode. More particularly, we provide a cathode having a centrally positioned coating of electron emissive material supported on opposite sides of the material such that expansion of the cathode or its supports produces a rotary motion in the plane of the emitting material. Such a cathode may be positioned with its emitting area closely adjacent an apertured electrode with the said area in alignment with the aperture and during use there is substantially no movement of the cathode in the direction of the apertured electrode so that the spacing therebetween is constant notwithstanding expansion of the cathode or its supports.

The principle underlying our invention is the support of the cathode at opposite points preferably by supporting members having low heat expansion characteristics attached thereto at one end of the supports and on opposite sides of the emitting area, these points of support preferably lying on opposite sides of a line joining the opposite ends of the supporting members.

To accomplish the above objects and advantages of our invention, we utilize a metal cathode member preferably of cylindrical or box shape and provide an embossed or raised flat section midway between the ends or diagonal portions thereof. The embossed portion of the cathode is provided with the electron emitting coating or material. We further provide elongated metal supports or connectors affixed at their proximal

ends to the cathode at the diagonally opposite portions thereof which expand when heated, thereby rotating the cathode in a plane parallel with the emissive coating or material; that is, in a plane normal to the direction of electron emission from this coating. The distal ends of the connectors are rigidly affixed to support rods or other members provided to position and align the additional electrode structure used in the tube. Surrounding the cathode we provide a conventional apertured control electrode preferably provided with a skirt or cylindrical portion overlapping the cathode and its supporting members to intercept any light emitted by the cathode during operation. Additional electrodes to form an electron gun may be used in combination with our cathode assembly, such additional electrodes forming no part of our invention.

Referring to Figure 1, we have shown insulator supporting rods 1, such as are utilized in conventional cathode ray tubes, to support the electrode structure in alignment with the electron beam trajectory. The rods 1 may be of ceramic construction supporting the conventional apertured control electrode 3 at one end of a cylindrical skirt 5 through flanges 7 extending in the direction of and surrounding the ceramic rods 1. The aperture 9 of the apertured control electrode is centrally positioned thereof to form and define an electron beam such as utilized in cathode ray tubes. A cathode assembly made in accordance with our invention is supported immediately adjacent the aperture 9 but spaced from and out of electrical contact with the electrode 3. We have shown the structure of Figure 1 with the various component parts displaced along an axis through the aperture 9 and parallel with the ceramic support rods 1 merely for the purposes of clarity, it being appreciated that the cathode and its supports are positioned within the cylindrical skirt 5 of the control electrode assembly.

In accordance with our invention the cathode 11 is preferably of cylindrical shape as shown in Figures 2 and 3, or of box formation as shown in Figure 4. Intermediate the ends of the cathode 11 we provide a planar coating 13 of electron emitting material preferably positioned upon the upper face of an embossing pressed from the elongated cathode 11 located intermediate the ends thereof. The cathode 11 is supported with the coating 13 in alignment with the aperture 9 and as best shown in Figure 2, by ribbon supports or connectors 15 affixed at their proximal ends to diagonally opposite points 17 of the cathode 11 and which are bent away in an arcuate shape or curve and affixed at their opposite or distal ends 19 to a circular band member 21 which is rigidly secured, as appears hereinafter, to the ceramic rods 1.

The cathode 11 may be heated such as by a heater 23 enclosed therein, the central portion of the heater, which is usually at a higher temperature than the end portions during operation, being directly opposite the emissive coating 13. It will be noted that the rigid points of support of the ribbon connectors 15 at the distal ends 19 are on opposite sides of the line joining the diagonal points 17 on the cathode, and that the line joining the distal ends 19 and that joining the free points 17 intersect one another in alignment with or bisecting the electron emitting material 13. Consequently, any expansion of the ribbon connectors 15 produces a turning moment on the cathode tending to rotate it through a small angle about an axis normal to

the coating 13 through the aperture 9. Furthermore, any expansion of the cathode due to heating will likewise produce a turning moment rotating the cathode about this axis. Preferably all of the points of support, namely the points 17 and the fixed points at the distal ends 19, are in a common plane, although the proximal and distal points of support may be in different parallel planes which are normal to the axis so that there will be no motion of the cathode in the direction of the axis and, consequently no variation in spacing between the emission material 13 and the aperture 9 along this axis. The emission material 13 over the embossed portion of the cathode is made uniform and no variation in emission or change in operating characteristics are produced as a result of the cathode rotation. Thus, notwithstanding expansion not only of the cathode but of its supports, no variation in tube characteristics can be produced.

As indicated above, the maximum heating of the cathode occurs over the area occupied by the emissive coating 13, although it is desirable to reduce heat loss from the ends of the cathode by providing a minimum of contact area at the points 17 between the cathode 11 and the ribbon connectors 15. Consequently, the connectors 15 may be tapered, as best shown in Figure 1, the narrow ends being affixed to the cathode over a small area referred to above as the points of support.

While we have shown separate ribbon connectors 15, the edge portion of the cylindrical member 21 may be cut away to form the connectors, thereby forming the curved ribbon-like connectors integrally with the cylindrical member 21 as shown in Figure 3.

Following assembly of the cathode with the above described supports, the assembly contained within the cylindrical member 21 may be adjusted longitudinally of the ceramic support rods 1 so that the emissive portion of the cathode is at the desired distance from the apertured electrode 3 such as by a calibrated microscope focused on the cathode through the aperture 9. Following such longitudinal positioning, the flanges of the cylindrical member 21 may be affixed to the ceramic rods 1 such as by welding on either side of the rods. Actual measurements on a cathode assembly made in accordance with our invention and as shown in Figures 1 and 2 using a silicon-nickel cathode length of 6 millimeters (mm.) show a rotational angle of $1\frac{1}{2}$ degrees when the cathode is operated at 1100° K. Under these same conditions the cathode to control electrode spacing decreased slightly due to increase of cathode diameter by heating, although this axial movement was only 0.008 mm. for a cathode of 2.8 mm. diameter. In conventional cathode construction where the length of the cathode is along the axis of beam formation and the cathode is supported 6 mm. from the emissive end, this decrease in spacing may be as much as 0.150 mm. between cold and operating conditions. Since the desired spacing under operating conditions is 0.025 mm. or less, the cold spacing must be at least seven times the spacing desired during operation. However with our construction the axial change in spacing due to increase in cathode diameter is only 5% of the change in spacing usually encountered and a spacing provided during manufacture will be substantially maintained during the life of the tube.

To prevent light escaping from the apertured

control electrode skirt 5, and also to shield other electrodes from extraneous electron emission, the skirt 5 may be effectively closed by a disc 25 of corresponding or slightly larger diameter provided with flanges 27 likewise affixed to the ceramic support rods 1. Provision such as the apertures 29 may be provided to admit the current-carrying leads 31 connected with the heater 23. Obviously other electrode structure may be supported on the ceramic rods 1 such as anodes, cylinders or deflection plates conventionally used in cathode ray tubes. Since such structures and various methods of supports are well known, they are not shown in the drawing.

Referring to Figure 3, I have shown a cathode assembly somewhat similar to that of Figures 1 and 2 except for the specific points of attachment of the ribbon connectors 15, these connectors being attached at their proximal ends to the other diagonally opposite points 33 on the cathode 11 but still preferably in a plane common with the points of attachment 19 at the fixed ends of these connectors. In this arrangement of support even rotary motion of the cathode in the plane of support may be minimized or wholly eliminated by choosing materials for the cathode and the ribbon supports having coefficients of expansion such that the expansion coefficient of the cathode is less than that of the ribbon connectors. Obviously the ribbon connectors during operation of the cathode assembly will be at a somewhat lower temperature than the cathode because of their greater distance from the heater and also due to heat conduction to the cylindrical member 15. Expansion of the ribbon connectors 15 of Figure 3 tend to rotate the cathode in a counter-clockwise direction, whereas longitudinal, expansion of the cathode 11 tends to produce clockwise rotation. By apportioning the length of the cathode and its associated ribbon connectors with respect to the coefficients of expansion of the materials comprising these components it will be appreciated that the clockwise rotation may be made to equal the counter-clockwise rotational effects, thereby providing a cathode which maintains both an axially fixed and rotationally fixed position.

The material of the cathode 11 must be chosen to be compatible with good electron emission properties silicon nickel being the usually used cathode material. However, a cathode body of any heat-conductive material may be used with a nickel or other cathode foundation attached to the cathode body directly opposite the aperture and coated with the emitting material. Nickel has a relatively small coefficient of expansion although the linear expansion of the cathode is relatively large because of its operating temperature. Since the temperature of the ribbon connectors is relatively low in comparison to the cathode temperature, and since it is desired to provide compensating linear expansion of these connectors 15 with respect to that of the cathode, the connectors, especially in the structure of Figure 3, may be of aluminum which has a higher coefficient of expansion than the nickel cathode, thereby resulting in neutralization of the rotary motion of the cathode.

Referring to Figure 4, the cathode 35 is of box formation and may be heated by a conventional folded type heater not shown. As in the case of the previously described cathode, the cathode 35 may likewise have a centrally positioned embossed portion bearing electron emitting material 37 which in operation is positioned in alignment

with and close to the aperture 9. The skirt portion 5 of the control electrode assembly shown in Figure 1 may be cut away to allow the ribbon connectors to be attached to the ceramic rods 1.

5 The proximal ends of the ribbon connectors 39 are affixed to diagonally opposite ends or corners of the cathode 35, whereas the distal ends of the ribbon connectors are affixed to rigid points of support such as the ceramic rods 1. As in the previously described constructions the proximal ends of the connectors are on opposite sides of the effective electron emitting area of the cathode and a line joining the distal ends bisects the line joining the proximal ends of the connectors. Consequently, any expansion either of the cathode or of the connectors will produce a rotary motion especially inasmuch as both the distal and proximal ends of the supports are in a single plane.

20 While we have shown only three principal structural embodiments of our invention, it will be appreciated that the cathode assembly may take any form or shape compatible with our method of support producing rotation of the cathode through a small angle and in a plane normal to the direction of the electron beam propagation from the cathode, and consequently we do not limit our invention to the specific structural embodiments shown except as set forth in the appended claims.

We claim:

1. A cathode assembly comprising an indirectly heated cathode a portion of which emits electrons in an axial direction, and heat expansive means attached to opposite sides of said cathode, expansive in opposite directions and in substantially a single plane normal to said axial direction to rotate said cathode about said axis, the expansion of said means producing substantially no motion of said cathode in said axial direction.

2. A cathode assembly comprising a cathode body member, an emissive coating to develop a flow of electrons directed along an axis normal to the surface of said body member, a pair of thermally expansive supports affixed to said body member on opposite sides of said axis, said supports being substantially coplanar and the expansion of said supports upon heating being substantially coplanar and in opposite directions whereby said expansion is effective in producing rotation of said cathode body member about said axis.

3. A cathode assembly comprising a cathode body member, an emissive coating over a portion of said body member to develop an electron beam flow along an axis normal to the surface thereof, a pair of elongated thermally expansive members having their proximal ends attached to said body member on opposite sides of said emissive coating, means to rigidly support said thermally expansive members at their distal ends such that a line normal to said axis joining said distal ends substantially bisects a line joining said proximal ends whereby expansion of said expansive members produces rotation of said cathode body about said axis.

4. A cathode assembly for a cathode ray tube comprising a cathode body member, an electron emitting coating on said member to liberate electrons along a beam axis, a pair of elongated thermally expansive supports attached at their proximal ends to said member on opposite sides of said beam axis, means to rigidly fix the distal ends of said supports such that expansion of said sup-

ports is in opposite directions and in a plane normal to said beam axis thereby preventing movement of said member in a direction along said axis.

5. Electrode structure for a cathode ray tube comprising a cathode to emit electrons as a narrowly defined beam, a beam intensity control electrode, a pair of elongated thermally expansive members to support said cathode from said control electrode, the said members and their direction of expansion being in a plane normal to the narrowly defined beam whereby expansive forces developed upon heating said cathode and said expansive members develop substantially no movement of said cathode in the direction of said control electrode.

6. A cathode assembly for a cathode ray tube comprising an indirectly heated cathode a portion of which emits electrons in an axial direction, a ring member surrounding said cathode, and arcuate extensions supported at one end by said ring member and affixed at their opposite ends to said cathode on opposite sides of said axis whereby expansion of said extensions is in a plane normal to said axis thereby maintaining said cathode in a fixed position along said axis.

7. A cathode assembly as claimed in claim 6 wherein said arcuate extensions are of smaller cross-sectional area adjacent said cathode than adjacent said ring member.

8. A cathode assembly for a cathode ray tube comprising an elongated electron emitting cathode the emitting portion of which is centrally positioned along the length thereof for emitting electrons along a beam axis, a closed support member surrounding said cathode, a pair of substantially coplanar inwardly extending arcuate projections from said support member the adja-

cent ends being attached to said cathode at diagonally opposite portions thereof whereby expansion of said cathode and said extensions is incapable of producing motion in a direction along said axis.

9. A cathode assembly for a cathode ray tube comprising a tubular indirectly heated cathode, a centrally positioned substantially planar electron emitting section on said cathode, a support member surrounding said cathode having integral substantially coplanar ribbon-like portions extending inwardly toward said cathode, said portions being affixed to diagonally opposite ends of said cathode and supporting said cathode in a position free to rotate upon thermal expansion of said integral portions in a plane substantially parallel with said coplanar integral portions.

10. A cathode assembly for a cathode ray tube comprising a tubular indirectly heated cathode, an electron emitting material over a limited planar area of said cathode substantially midway between the ends thereof, and means to support said cathode in a fixed position in a direction normal to said area and free to rotate through a small angle about an axis through said area and normal said planar area.

11. A cathode assembly comprising a rectangular area cathode, and means to support said cathode comprising non-aligned ribbon connectors affixed at one end to diagonally opposite corners of said cathode the opposite ends of said connectors being adapted to be fixed with respect to each other whereby expansion of said connectors produces motion of said cathode in the plane of said cathode.

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