Aug. 9, 1966 J. P. FIORE 3,265,920

ELECTRON-DISCHARGE DEVICE CATHODE ASSEMBLY
WITH RADIATION SHIELD
Filed June 22, 1964

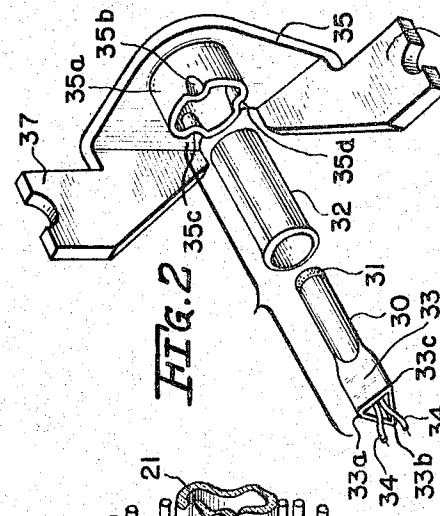


FIG. 2

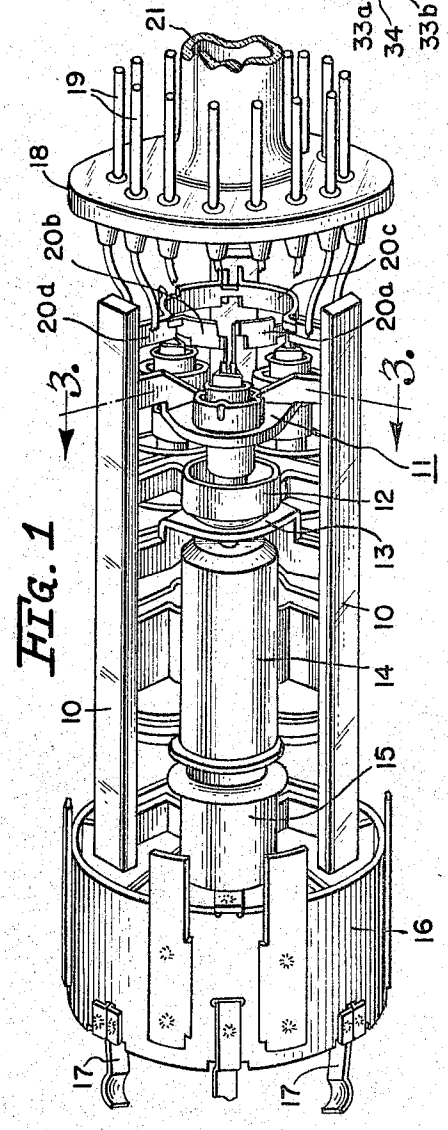


FIG. 1

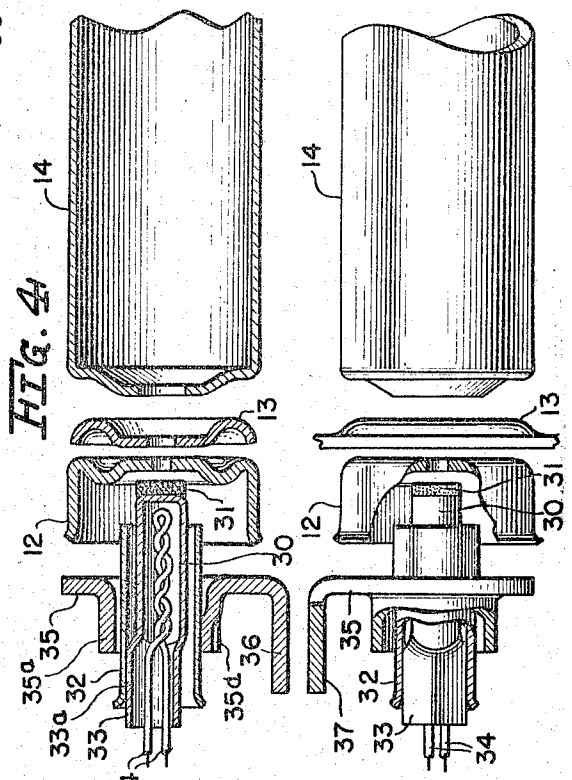


FIG. 4

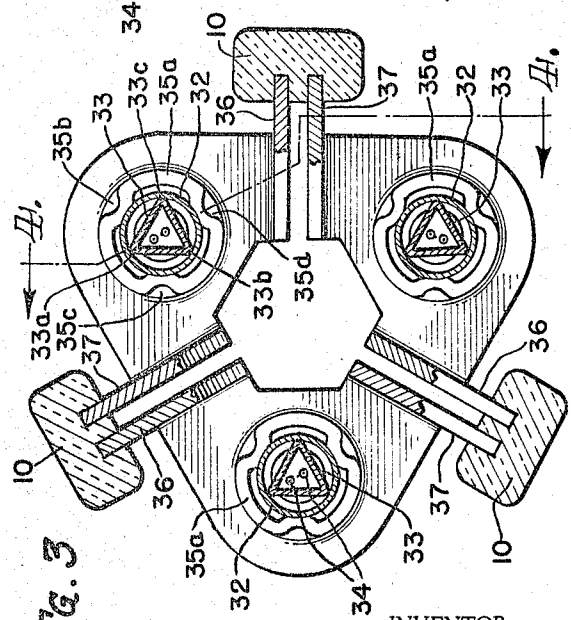


FIG. 3

INVENTOR.
Joseph P. Fiore
BY
Francis W. Crosby
Atty.

United States Patent Office 3,265,920 Patented August 9, 1966

3,265,920

ELECTRON-DISCHARGE DEVICE CATHODE ASSEMBLY WITH RADIATION SHIELD

Joseph P. Fiore, Wheeling, Ill., assignor to The Rauland Corporation, a corporation of Illinois

Filed June 22, 1964, Ser. No. 376,799
8 Claims. (Cl. 313—240)

The present invention is directed to the cathode assembly of the electron gun of an electron discharge device, such as a cathode-ray tube. While of general utility, the cathode assembly of this invention is most particularly applicable to the three-gun variety of color picture tube.

Color tubes employing three guns are designed with the objective of establishing and maintaining color balance particularly as that characteristic is influenced by the structural features of the electron guns. Optimum operation of the tube and the receiver in which it may be incorporated is dependent upon stability of the gun characteristics which by distinct preference are maintained uniform for each of the guns.

This desirable characteristic has not been readily attained in cathode structures employed heretofore. One structural arrangement, for example, features a cylindrical cathode concentrically disposed within a cylindrical first grid and maintained in position by means of a ceramic washer. The cathode is inserted into an aperture of the washer and any of a number of mechanical expedients are resorted to in order to locate and affix the washer within the grid cylinder. It has been found that dimensional changes experienced within the cathode assembly because of temperature changes between the de-energized and the operating states of the tube may occasion cracking or deformation of the ceramic washer which may result in positional changes of the elements constituting the electron gun. Of course, any such change adversely affects the balance of the gun characteristics. Even though there may be no fractures suffered in the structural elements due to temperature changes, if their expansions are non-uniform or if there is any non-uniform displacement of the gun parts, as between the three guns, the desired balance is upset.

Accordingly, it is a principal object of the invention to provide an improved cathode assembly for the electron gun of an electron discharge device such as a cathode-ray tube.

It is a specific object of the invention to provide a cathode assembly which may be used in a three-gun color picture tube to attain uniform gun characteristics and color balance.

It is another specific object of the invention to provide an improved cathode assembly for a cathode-ray tube which is highly efficient and reduces heater requirements to attain a preselected operating temperature.

A cathode assembly for the electron gun of an electron discharge device, constructed in accordance with the invention, comprises a cathode cylinder which bears electron emitting material on one end. A radiation-shield cylinder is disposed in nested concentric relation to, and has a mean diameter greater than that of, the cathode cylinder. A first plurality of support elements is angularly disposed about the periphery of one of these cylinders, at the end portion which is remote from the emitting surface of the cathode. These support elements project radially into limited-area contact with the opposed end portion of the other of the cylinders to secure them in a mechanical subassembly. A support for that subassembly is disposed about the shield cylinder and a second plurality of support elements is arranged about the subassembly, projecting radially between and into limited-area contact with the shield cylinder and the support in

order to mechanically secure the subassembly to the support. The second plurality of support elements is displaced with respect to the first plurality to establish a series of separated, thermally conductive paths between the cathode cylinder and the support individually having a length that is long compared to the physical separation of the cathode cylinder and its support. By arranging to have a long, thermally conductive path between the cathode cylinder and the support, the heater efficiency is increased and this objective may be accomplished by displacing the first and second plurality of support elements through an angular and/or a longitudinal displacement. In the preferred construction, these elements have both an angular and longitudinal or axial displacement.

The features of this invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood, however, by reference to the following description taken in conjunction with the accompanying drawing, in the several figures of which like reference numerals identify like elements, and in which:

FIGURE 1 is a perspective view of an electron gun mount assembly for a color television picture tube embodying the invention;

FIGURE 2 is an exploded view of the cathode arrangement of the gun;

FIGURE 3 is a cross-sectional view taken on section line **3—3** of FIGURE 1; and

FIGURE 4 is a view, partially in cross-section, of the gun arrangement taken on section line **4—4** of FIGURE 3.

The gun mount assembly of FIGURE 1 is for use in a tri-color television picture tube and is particularly applicable to the shadow-mask variety of color tube presently in use. The assembly incorporates three electron guns positioned in a triangular or delta array but only one such gun is visible in the view of FIGURE 1. The guns are secured in the desired array by means of three longitudinally extending insulating support members or pillars **10**, only two of which are visible in FIGURE 1. The electron guns are structurally alike and each includes a thermionic cathode assembly **11** to be described more particularly hereinafter, a first control grid **12**, a screen grid or first anode **13** and a pair of focusing electrodes **14, 15**. There is a convergence subassembly, the details of which are of no particular concern to the subject invention. Suffice it to say the subassembly comprises a cylindrical member **16**. The cylinder is supported in coaxial alignment with the remainder of the gun mount by mechanical connections with each of electrodes **15** which are individually welded to the closure plate of the cylinder. Contact springs **17** extend forwardly of convergence cylinder **16** to engage the final anode or ultor electrode of the tube when the gun mount is positioned within the tube neck. Usually, the ultor electrode is in the form of a conductive coating on the inner surface of the tube envelope. The electrodes **12–15** of each gun are, of course, arranged in coaxial alignment and each is axially apertured to admit the passage of an electron beam. The convergence cylinder **16** is, likewise, suitably apertured along the axis of each gun to complete the beam path through the mount structure. The construction of the particularly illustrated convergence subassembly is described and claimed in the copending application of Joseph P. Fiore, Serial No. 376,829, filed concurrently herewith and assigned to the same assignee.

There is a unique heater assembly for the array of electron guns which is the subject of an application Serial No. 376,828, filed concurrently herewith in the names of Charles A. Lowery and Mark J. Videka, and assigned to

the same assignee as the present application. The structural details of the heater are fully disclosed in that application; suffice it here to say that it features a segmented conductor which is circular in configuration and comprised of segments 20*a*, 20*b* and 20*c*. Each segment accommodates a tab 20*d* which is embedded in one of pillars 10 to secure the segment in position. One end of each such segment is electrically connected to a heater or filament conductor of one of the electron guns and the opposite end of that particular segment connects with a heater conductor of the next succeeding gun in the array. As explained in the copending Charles A. Lowery and Mark J. Videka application, this connects the heaters in series through the segmented structure 20.

The various electrodes and filaments of the three guns comprising the gun mount connect in well-known manner to lead-in conductors 19 through which the guns are supported by the usual glass press 18. The press also has an exhaust tubulation 21. Except for the heater circuit and the convergence subassembly, the gun mount as thus far described and its various electrodes are of conventional construction and operation. More particular attention may now be directed to the cathode assembly 11 which features the subject invention.

The principal components of this assembly are a cathode cylinder 30 which bears an electron emitting coating 31 in the form of a cap at a closed end, a radiation-shield cylinder 32 and a support member 35. The cathode and radiation-shield cylinders are mechanically interconnected to constitute a subassembly and to that end there is a first plurality of support elements angularly disposed about the periphery of one of these cylinders at the end remote from the emitting material 31, projecting radially into limited-area contact with the opposed end portion of the other of those cylinders. These support elements may be provided as projections extending from either cylinder radially in the direction of the other; as shown, however, the end of cathode cylinder 30 remote from the coating 31 of emitting material is deformed to provide these support elements. More particularly, this end of the cathode cylinder has a triangular shape and a larger cross-sectional dimension than the remainder of the cylinder and the apices 33*a*, 33*b*, 33*c* constitute elements which may make line contact with shield cylinder 32. The shield has a mean diameter which is greater than that of the cathode cylinder 30 except for the termination 33 thereof and as to that, the parts are dimensioned to accomplish line contact along portions 33 and the adjacent surfaces of the shield cylinder. Welds are made along these line contacts, securing the two cylinders in nested concentric relation.

It will be observed that the free end of the triangle portion 33 of the cathode cylinder is open to facilitate inserting the heater filament within the cylinder. Although the filament itself does not appear in FIGURE 2, its lead-in conductors 34 are shown.

This subassembly is secured to support 35 which is disposed coaxially of the subassembly approximately at the midpoint or central longitudinal portion of shield cylinder 32. A second plurality of support elements is disposed about the subassembly, projecting radially between and into limited area contact with the central longitudinal portion of shield cylinder 32 and support 35 mechanically to secure the subassembly to that support. This second plurality of support elements is displaced with respect to the first described plurality of support elements to establish a series of thermally conductive paths extending between cathode cylinder 30 and support 35, each such path having a length that is long compared to the physical separation of the cathode cylinder and its support. More particularly, support 35 has a central cylindrical section 35*a* which has three depressed portions 35*b*, 35*c* and 35*d* with an angular separation of approximately 120°. The subassembly 30, 32 is inserted into cylindrical section 35*a* and angularly oriented to accomplish a desired axial and angular displacement of support elements 33*a*–33*c* relative to support elements 35*b*–35*d*. Positioning the subassembly so that support elements 35*b*–35*d* are located mid-way of shield cylinder 32 provides an acceptable axial displacement of the support elements and rotation of the subassembly about its own axis permits support elements 33*a*–33*c* to be interposed mid-way between the members of the second series of support elements 35*b*–35*d*. The subassembly is mechanically secured to its support by welds made at each of the depressed sections 35*b*–35*d* establishing the desired limited-area contact of the subassembly with its support.

There is a pair of straps or mounting lugs 36, 37 projecting from support 35 in a direction which is generally transverse or across the axis of the cathode assembly and in a direction away from the cap 31 of emitting material. These mounting lugs have such angular disposition as to facilitate securing them to pillars 10, 10 of the gun mount assembly. As shown in FIGURE 1, this arrangement of mounting lugs permits a desirable in-line arrangement of mounting lugs for the cathode assembly and electrodes of the various electron guns, that is to say, the mounting lugs which engage pillars 10 are in alignment or essentially co-planar. This mechanical arrangement is desirable since it avoids the past practice of having several such lugs engage a given portion of pillar 10 in parallel arrangement at any particular longitudinal section of the pillar. The described structure has more mechanical strength and facilitates production.

In addition to this structural advantage of integrating the gun within its mount, the described arrangement is particularly attractive in arriving at uniform characteristics of the gun especially as those characteristics are controlled by structural elements of the cathode subassembly. The ceramic washer characteristic of prior art structures has been avoided and in its place the cathode components are secured by positive and firm mechanical connections such as welds. The shield cylinder 32 is formed of bright stainless steel and is a heat reflector which tends to create an oven surrounding the cathode cylinder. This leads to higher efficiency of the heating system and reduces the wattage requirement to attain a desired operating temperature.

By having a restricted number of limited-area contacts between cathode cylinder 30 and shield cylinder 32 the thermal efficiency of the system is preserved. Actually, there are only three such contacts which, in effect, provide three thermally conductive paths between the cylinders and each of these is a high impedance path. The axial and angular displacement of the three limited-area contacts between support 35 and shield 32, with respect to those between cathode 30 and shield 32, further preserves the efficiency of the heater arrangement. The thermally conductive paths that may be traced from the cathode cylinder through shield cylinder 32 and to the support 35 are separated from one another because of the use of limited-area contacts and each of these paths has a length that is very long compared with the physical separation of the cathode cylinder and its support.

The described structure permits practical control of the thermal paths by the contact areas between components 30, 32 and 35 and also by choice of the wall thickness of shield cylinder 32. This is a very useful feature in determining the operating temperature of the cathode and other important parameters such as the physical spacing between the emitting surface of the cathode and control electrode 11.

The points of connection between the cylinder members 30, 32 and 35*a* have been described as limited-area contacts to connote a thermally conductive path of high-impedance to distinguish from previous practice in which the concentric cylinders are joined together throughout a major portion if not all of their peripheries in the plane of contact. The latter gives rise to a low impedance

thermal path and deteriorates the efficiency of the cathode system.

While a particular embodiment of the present invention has been shown and described, it is apparent that changes and modifications may be made therein without departing from the invention in its broader aspects. The aim of the appended claims, therefore, is to cover all such changes and modifications as fall within the true spirit and scope of the invention.

I claim:

1. A cathode assembly for the electron gun of an electron discharge device, such as a cathode-ray tube, comprising:

a cathode cylinder bearing electron emitting material at one end;

a radiation-shield cylinder disposed in nested concentric relation to, and having a mean diameter greater than that of, said cathode cylinder;

a first plurality of support elements angularly disposed about the periphery of one of said cylinders, at the end portion thereof remote from said emitting material, projecting radially into a limited-area contact with the opposed end portion of the other of said cylinders to secure said cylinders in a mechanical subassembly;

a support for said subassembly disposed about said shield cylinder;

and a second plurality of support elements disposed about said subassembly projecting radially between and into limited-area contact with said shield cylinder and said support to mechanically secure said subassembly to said support, said second plurality of support elements being displaced with respect to said first plurality to establish a series of separated, thermally conductive paths between said cathode cylinder and said support individually having a length that is long compared to the physical separation of said cathode cylinder and said support.

2. A cathode assembly for the electron gun of an electron discharge device, such as a cathode-ray tube, comprising:

a cathode cylinder bearing electron emitting material at one end;

a radiation-shield cylinder disposed in nested concentric relation to, and having a mean diameter greater than that of, said cathode cylinder;

the end of one of said cylinders remote from said emitting material being deformed to provide a first plurality of angularly displaced support elements, projecting radially into limited-area contact with the opposed end portion of the other of said cylinders to secure said cylinders in a mechanical subassembly;

a support for said subassembly disposed about said shield cylinder;

and a second plurality of support elements disposed about said subassembly projecting radially between and into limited-area contact with said shield cylinder and said support to mechanically secure said subassembly to said support, said second plurality of support elements being displaced with respect to said first plurality to establish a series of separated, thermally conductive paths between said cathode cylinder and said support individually having a length that is long compared to the physical separation of said cathode cylinder and said support.

3. A cathode assembly for the electron gun of an electron discharge device, such as a cathode-ray tube, comprising:

a cathode cylinder bearing electron emitting material at one end and having an enlarged opposite end deformed into a triangular cross-section;

a radiation-shield cylinder disposed in nested concentric relation to said cathode cylinder having a mean diameter approximately equal to that of said enlarged end of said cathode cylinder;

said cylinders being joined in approximately line contact at the apices of said triangular cross-section of said cathode cylinder to secure said cylinders in a mechanical subassembly;

a support for said subassembly disposed about said shield cylinder;

and a second plurality of support elements disposed about said subassembly projecting radially between and into limited-area contact with said shield cylinder and said support to mechanically secure said subassembly to said support, said second plurality of support elements being displaced with respect to said first plurality to establish a series of separated, thermally conductive paths between said cathode cylinder and said support individually having a length that is long compared to the physical separation of said cathode cylinder and said support.

4. A cathode assembly for the electron gun of an electron discharge device, such as a cathode-ray tube, comprising:

a cathode cylinder bearing electron emitting material at one end;

a radiation-shield cylinder disposed in nested concentric relation to, and having a mean diameter greater than that of, said cathode cylinder;

a first plurality of support elements angularly disposed about the periphery of said cathode cylinder, at the end portion thereof remote from said emitting material, projecting radially into limited-area contact with the opposed end portion of said shield cylinder to secure said cylinders in a mechanical subassembly;

a support for said subassembly disposed about said shield cylinder;

and a second plurality of support elements disposed about said subassembly projecting radially between and into limited-area contact with said shield cylinder and said support to mechanically secure said subassembly to said support, said second plurality of support elements being displaced with respect to said first plurality to establish a series of separated, thermally conductive paths between said cathode cylinder and said support individually having a length that is long compared to the physical separation of said cathode cylinder and said support.

5. A cathode assembly for the electron gun of an electron discharge device, such as a cathode-ray tube, comprising:

a cathode cylinder bearing electron emitting material at one end;

a radiation-shield cylinder disposed in nested concentric relation to, and having a mean diameter greater than that of, said cathode cylinder;

a first plurality of support elements angularly disposed about the periphery of one of said cylinders, at the end portion thereof remote from said emitting material, projecting radially into limited-area contact with the opposed end portion of the other of said cylinders to secure said cylinders in a mechanical subassembly;

a support for said subassembly disposed about the central longitudinal portion of said shield cylinder;

and a second plurality of support elements disposed about said subassembly projecting radially between and into limited-area contact with said central longitudinal portion of said shield cylinder and said support to mechanically secure said subassembly to said support, said second plurality of support elements being displaced axially and angularly with respect to said first plurality to establish a series of separated, thermally conductive paths between said cathode cylinder and said support individually having a length that is long compared to the physical separation of said cathode cylinder and said support.

6. A cathode assembly for the electron gun of an elec-

tron discharge device, such as a cathode-ray tube, comprising:

a cathode cylinder bearing electron emitting material at one end;

a radiation-shield cylinder disposed in nested concentric relation to, and having a mean diameter greater than that of, said cathode cylinder;

a first plurality of support elements angularly disposed about the periphery of one of said cylinders, at the end portion thereof remote from said emitting material, projecting radially into limited-area contact with the opposed end portion of the other of said cylinders to secure said cylinders in a mechanical subassembly;

a support for said subassembly disposed about said shield cylinder;

and a second plurality of support elements disposed about said subassembly projecting radially between and into limited-area contact with said shield cylinder and said support to mechanically secure said subassembly to said support, said second plurality of support elements being displaced axially and angularly with respect to said first plurality to establish a series of separated, thermally conductive paths between said cathode cylinder and said support individually having a length that is long compared to the physical separation of said cathode cylinder and said support.

7. A cathode assembly for the electron gun of an electron discharge device, such as a cathode-ray tube, comprising:

a cathode cylinder bearing electron emitting material at one end;

a radiation-shield cylinder disposed in nested concentric relation to, and having a mean diameter greater than that of, said cathode cylinder;

a first plurality of support elements angularly disposed about the periphery of one of said cylinders, at the end portion thereof remote from said emitting material, projecting radially into limited-area contact with the opposed end portion of the other of said cylinders to secure said cylinders in a mechanical subassembly;

a support for said subassembly disposed about said shield cylinder;

a second plurality of support elements disposed about said subassembly projecting radially between and into limited-area contact with said shield cylinder and said support to mechanically secure said subassembly to said support, said second plurality of support elements being displaced axially and angularly with respect to said first plurality to establish a series of separated, thermally conductive paths between said cathode cylinder and said support individually having a length that is long compared to the physical separation of said cathode cylinder and said support;

and a pair of mounting lugs projecting from said support in a direction generally transverse to the axis of said cathode assembly and away from said emitting material.

8. A cathode assembly for the electron gun of an electron discharge device, such as a cathode-ray tube, comprising:

a cathode cylinder bearing electron emitting material at one end and having an enlarged opposite end deformed into a triangular cross-section;

a radiation-shield cylinder disposed in nested concentric relation to said cathode cylinder having a mean diameter approximately equal to that of said enlarged end of said cathode cylinder;

said cylinders being joined in approximately line contact at the apices of said triangular cross-section of said cathode cylinder to secure said cylinders in a mechanical subassembly;

a support for said subassembly disposed about the central longitudinal portion of said shield cylinder having depressed peripheral portions constituting a plurality of support elements disposed about said subassembly

and projecting radially into limited-area contact with said shield cylinder to mechanically secure said subassembly to said support, said plurality of support elements being displaced axially and angularly with respect to the apices of said triangular section to establish a series of separated, thermally conductive paths between said cathode cylinder and said support individually having a length that is long compared to the physical separation of said cathode cylinder and said support.

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JOHN W. HUCKERT, *Primary Examiner.*

A. J. JAMES, *Assistant Examiner.*