

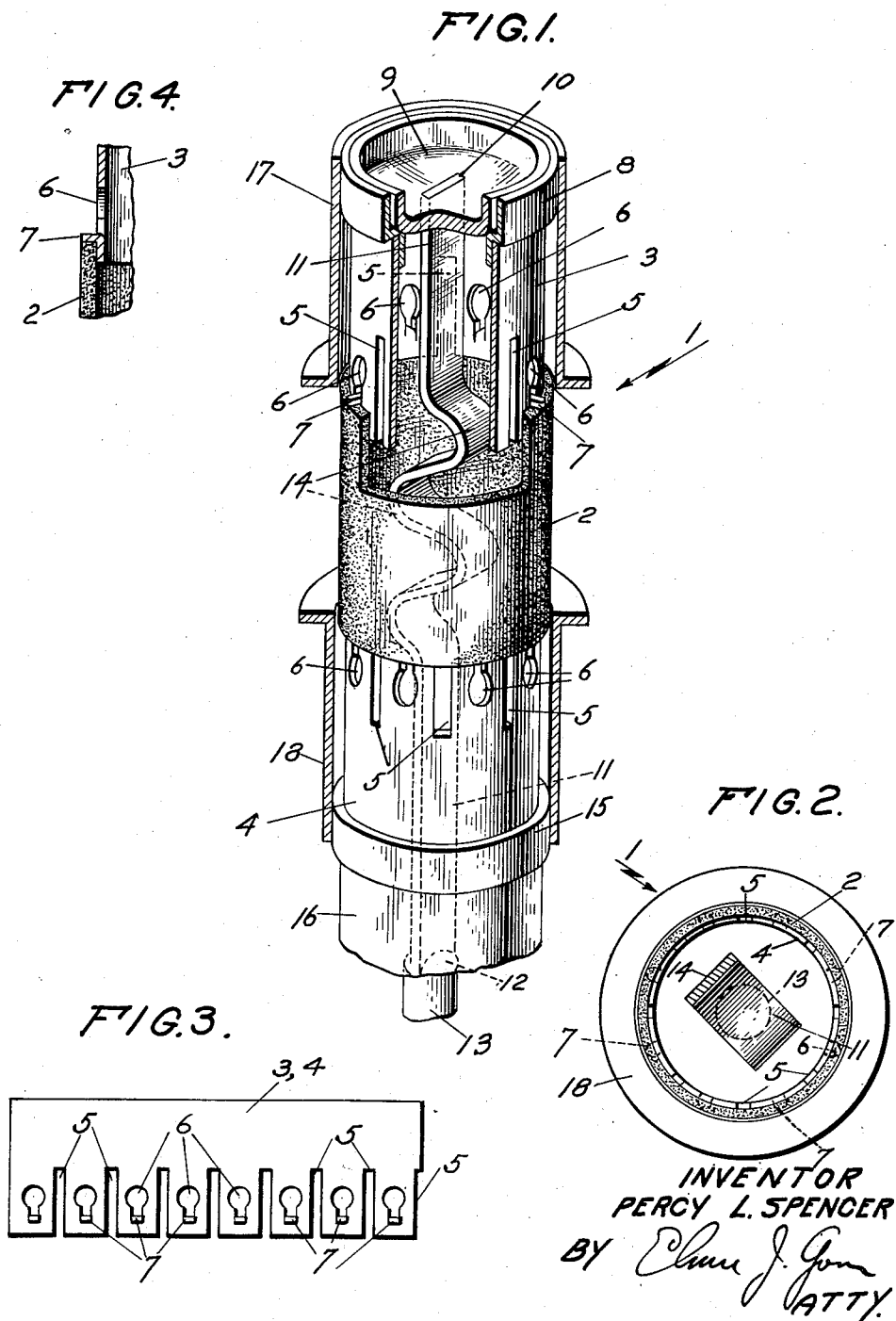
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CATHODE SUPPORT

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CATHODE SUPPORT

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This invention relates to a support for an electron discharge tube cathode, and more particularly to a supporting structure for a directly-heated cathode of the compressed type.

The cathode support of this invention is intended to be used with a directly-heated cathode of a thorium compound which must be heated to a rather high temperature for high electron emissivity. Compressed cylindrical sleeve cathodes of the aforementioned type must be connected to other members for purposes of both electrical connection and support. When the cathode is heated by the flow of current thereto, it expands more than the supporting structure, through which current also flows, because of the smaller resistance and therefore the lower temperature of the supporting structure. It is essential that allowance be made for this differential expansion between the cathode and its supporting structure, so that the fastening or joint between the cathode and the supporting structure will not be adversely affected. It is also desirable to reduce the cathode thermal losses, through conduction away from the cathode proper by the metallic supporting structure, as much as possible, in order to decrease the overall cathode heat losses.

It is, therefore, an object of the present invention to devise a cathode supporting structure which allows for the differential expansion between the cathode and said structure, and which is relatively simple in construction.

Another object is to provide a cathode supporting structure in which the cathode heat losses are greatly reduced.

The foregoing and other objects of the present invention will be best understood from the following description of an exemplification thereof, reference being had to the accompanying drawing, wherein:

Fig. 1 is a partial perspective view, partly broken away, of a cathode assembly according to the invention;

Fig. 2 is a transverse sectional view taken through the horizontal midplane of Fig. 1;

Fig. 3 is a development of one of the sheet-metal sleeves of Fig. 1; and

Fig. 4 is a partial vertical section showing a detail.

Now referring to the drawing, the numeral 1 generally designates a cathode assembly according to the invention. An electron-emissive cathode 2, in the form of a cylindrical sleeve, is the heart of the assembly. Cathode 2 preferably consists of compressed, intimately admixed powdered thorium (thorium oxide) and a powdered

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refractory metal, metal compound or metal alloy, as disclosed in the copending application of John F. Hanson, Ser. No. 753,864, filed June 11, 1947, or in my copending application, Ser. No. 769,348, filed August 19, 1947, and is fabricated or molded as disclosed in the aforesaid Hanson application.

A cylindrical sheet metal supporting sleeve 3, of molybdenum for example, is rigidly secured, as by platinum soldering, to the upper end of cathode 2, while a similar supporting sleeve 4 is similarly secured to the lower end of cathode 2. The external diameter of these sleeves is such that they fit inside cathode 2, with the outer surface of the sleeves engaging the inner cylindrical wall of said cathode. The sleeves 3 and 4 extend into the opposite ends of cathode 2 for only short distances, just sufficient to provide for rigid joints between the supporting sleeves and the cathode.

Supporting sleeves 3 and 4 are stamped out of thin sheet metal and thereafter bent into cylindrical shape. Fig. 3 is a development of sleeves 3 and 4, or in other words illustrates such sleeves after they have been stamped out but before they have been bent into cylindrical shape. Sheet metal elements 3 and 4 are provided with a plurality, for example eight, equidistantly spaced parallel rectangular slots 5 which extend from one of the longer side edges of the rectangular blank, perpendicularly thereto, these slots having a length approximately equal to one-half the smaller dimension of the rectangular blank.

Sheet metal elements 3 and 4 are also provided with a plurality of spaced keyhole-shaped slots 6, the number of slots 6 being equal to the number of rectangular slots and each keyhole slot being located midway between an adjacent pair of rectangular slots. The rectangular portion of each of the keyhole slots 6 extends parallel to the rectangular slots 5 and the lower end of said rectangular portion of each of the slots 6 is spaced from the lower longer side edge of the rectangular blank. The lower end of the rectangular portion of each of the keyhole slots 6 is left attached to the blank, and the sheet material of each such rectangular portion is bent outwardly at right angles to the plane of the blank to provide an outwardly-projecting tab 7.

When the blank is bent into cylindrical sleeve shape, as shown in Fig. 1, a plurality of spaced outwardly-projecting tabs 7 are thus provided around the periphery of the cylinder. Sleeves 3 and 4 are so turned with respect to cathode 2 that slots 5 and 6 in each sleeve are adjacent said cathode, as shown in Fig. 1. Slots 5 and the rectangular portions of slots 6 extend parallel to the

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longitudinal axis of the assembly, as shown in Fig. 1. Keyhole slots 6 are so located that, when the cathode 2 is assembled with sleeves 3 and 4, the lower surfaces of the tabs 7 of upper sleeve 3 will engage the upper end surface of cathode 2 and the upper surfaces of the tabs 7 of lower sleeve 4 will engage the lower end surface of said cathode. Therefore, the tabs 7 aid in properly positioning sleeves 3 and 4 with respect to cathode 2 prior to the soldering operation. By serving as stop members, they aid in preventing motion of cathode 2 with respect to sleeves 3 and 4 prior to and during the soldering operation, and they also aid in fastening cathode 2 to sleeves 3 and 4 after the soldering operation by being soldered themselves to said cathode. The cathode is, in effect, held between the tabs of the upper and lower sleeves. Fig. 4 illustrates clearly how the tabs 7 engage the end surface of the cathode 2.

By providing the slots 5 and 6 in the supporting sleeve members 3 and 4 adjacent the cathode 2 in the manner described, I am able to accomplish the objects of this invention. The slots 5 extend clear to the cathode ends of the supporting sleeves 3 and 4, providing in effect a plurality of flexible members (constituted by the strips of metal between slots 5), thus making the cathode ends of the supporting sleeves flexible to allow for the differential expansion of the cathode 2 and its supporting structure 3, 4 resulting from the unequal temperatures of the cathode and its supporting structure during operation of the electron discharge device. Thus, when the cathode 2 tends to expand or contract with respect to its supporting structure, the cathode ends of supporting sleeves 3 and 4, being flexible or being provided with flexible portions, tend to follow such expansion or contraction, resulting in no relative movement between the cathode and its supporting structure and no strain on the soldered joint therebetween.

Also, by separating the cathode ends of each sleeve into a plurality of spaced portions separated by air spaces, the area of the metal surface in contact with the cathode is reduced, thus decreasing the heat loss by conduction away from said cathode.

By the provision of additional slots 6 as above described, I conveniently provide the useful tabs 7. Slots 6 also function, particularly because of their keyhole shape or enlarged circular upper ends, to further reduce the area of metal adjacent to or in contact with the cathode proper, thus further decreasing the heat loss by conduction away from cathode 2. Slots 6 also help somewhat to make the cathode ends of the supporting sleeves more flexible.

Supporting sleeves 3 and 4, being metallic and being soldered to opposite ends of cathode 2, in addition to their supporting function, provide electrical connection to opposite ends of the cathode. In order to mount, and to provide electrical connection to, upper sleeve 3, a metallic horizontally-shouldered bushing 8, preferably made from the same sheet metal stock as sleeves 3 and 4, is soldered to the upper end of sleeve 3 with the lower face of its shoulder resting on and fixed to the upper annular face of sleeve 3. A cup-shaped member 9 is fastened inside bushing 8 with its lower face resting on and fixed to the upper face of the horizontal shoulder of said bushing.

The bottom or disk portion of member 9 has a centrally-located rectangular slot 10, in which is secured, as by soldering, the upper end of a

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rectangular (in cross-section) metallic conductor 11 which passes downwardly through the center of the interior hollow space of members 3, 2, and 4 and is fastened at its lower end, as at 12, to the upper end of a solid cylindrical metallic conductor or rod 13. Conductor 11 is longitudinally corrugated, as at 14, to permit longitudinal expansion and contraction of said conductor.

A bushing 15, similar to bushing 8, is secured in the lower end of lower sleeve 4. A tubular conductor 16, coaxial with rod 13, has its upper end resting on and fixed to the shoulder of bushing 15 and extends downwardly from said bushing.

The conductors 13 and 16 provide the conventional coaxial pair of conductors for cathode heating and for cathode supporting purposes. When a suitable voltage is applied between the conductors 13 and 16, the current passing through the body 2 heats said body to the temperature of thermionic emission, the structure thereby constituting a directly-heated cathode which has been found particularly suitable for use in electron discharge devices of the magnetron type.

A shield element 17, consisting of a cylindrical sleeve having an outwardly-extending horizontal flange at its lower end, surrounds and is secured at its upper end to the outside of bushing 8. The element 17 surrounds sleeve 3, and the horizontal flange thereof lies in substantially the same horizontal plane as the upper end of cathode 2, the inner cylindrical wall of said element being spaced a small distance from the outer surface of cathode 2.

A similar shield element 18 surrounds and is secured at its lower end to the outside of bushing 15. Element 18 has an outwardly-extending horizontal flange at its upper end which lies in substantially the same horizontal plane as the lower end of cathode 2; element 18 surrounds sleeve 4 and the inner cylindrical wall of said element is spaced a small distance from the outer surface of said cathode.

The inner cylindrical walls of shield members 17 and 18 entirely surround the slotted portions of the respective supporting sleeves 3 and 4, so that all of the slots 5 and 6 are covered by said shield members. Members 17 and 18 therefore prevent the escape of electrons, emitted from the interior surface of sleeve cathode 2, through slots 5 and 6. The disk portion of member 9 closes the upper end of the cathode assembly and prevents the escape of electrons, emitted from the interior surface of sleeve cathode 2, upwardly. The horizontal flanges of shield members 17 and 18 prevent the travel of electrons, emitted from the exterior surface of sleeve cathode 2, in oblique upward and downward directions. Thus, by all of the structure herein described, the electrons which succeed in escaping from cathode 2 are limited to those emitted in the desired direction, namely, those emitted from the exterior surface of cathode 2 in a direction substantially horizontal or perpendicular to said exterior surface.

Of course, it is to be understood that this invention is not limited to the particular details as described above, as many equivalents will suggest themselves to those skilled in the art. For example, the slots 6 could be omitted if desired. Various other variations will suggest themselves. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of this invention within the art.

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What is claimed is:

1. A cathode assembly, comprising a cathode in the form of a cylindrical sleeve and a metallic supporting member attached to one end of said cathode, said member having a plurality of slots therein extending to the end thereof adjacent said cathode providing a plurality of flexible members in said supporting member at said end.

2. A cathode assembly, comprising a cathode in the form of a cylindrical sleeve and a pair of metallic supporting sleeves attached to opposite ends of said cathode, said supporting sleeves each having a plurality of slots therein extending to the respective ends thereof adjacent said cathode providing a plurality of flexible members in each of said supporting sleeves at said ends.

3. A cathode assembly, comprising a cathode in the form of a cylindrical sleeve and a pair of metallic supporting sleeves attached to opposite ends of said cathode, said supporting sleeves each having a plurality of spaced parallel slots therein extending parallel to the longitudinal axis thereof and extending to the respective ends thereof adjacent said cathode providing a plurality of flexible members in each of said supporting sleeves at said ends.

4. A cathode assembly, comprising a cathode in the form of a cylindrical sleeve and a metallic supporting sleeve attached to one end of said cathode, said supporting sleeve having a first series of equidistantly spaced parallel rectangular slots therein extending parallel to the longitudinal axis thereof and extending to the end thereof adjacent said cathode providing a plurality of flexible members in said supporting sleeve at said end, said supporting sleeve also having a second series of spaced slots therein interspersed between adjacent rectangular slots and adjacent said end to reduce the area of metal adjacent to said cathode.

5. A cathode assembly, comprising a cathode in the form of a cylindrical sleeve and a pair of metallic supporting sleeves attached to opposite ends of said cathode, said supporting sleeves each having a first series of equidistantly spaced parallel rectangular slots therein extending parallel to the longitudinal axis thereof and extending to the respective ends thereof adjacent said cathode providing a plurality of flexible members in each of said supporting sleeves at said ends, said supporting sleeves each also having a second series of spaced slots therein interspersed between the respective adjacent rectangular slots and adjacent said ends to reduce the area of metal adjacent to said cathode, a portion of the metal of each one of said second series of slots

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being bent outwardly forming spaced tabs on each of said supporting sleeves, said cathode being positioned between the tabs of one supporting sleeve and the tabs of the other supporting sleeve.

6. A cathode assembly, comprising a cathode in the form of a cylindrical sleeve, a metallic supporting sleeve attached to one end of said cathode, said supporting sleeve having a plurality of slots therein extending to the end thereof adjacent said cathode, and shielding means covering said slots, said means being electrically connected to said supporting sleeve.

7. A cathode assembly, comprising a cathode in the form of a cylindrical sleeve, a metallic supporting sleeve attached to one end said cathode, said supporting sleeve having a plurality of slots therein extending to the end thereof adjacent said cathode, and a metallic hollow cylindrical shield member entirely surrounding but spaced from said supporting sleeve and covering said slots, said member being electrically connected to said supporting sleeve.

8. A cathode assembly, comprising a cathode in the form of a cylindrical sleeve, a pair of metallic supporting sleeves attached to opposite ends of said cathode, said supporting sleeves each having a plurality of spaced parallel slots therein extending parallel to the longitudinal axis thereof and extending to the respective ends thereof adjacent said cathode, and a pair of spaced metallic hollow cylindrical shield members, one of said members entirely surrounding but being spaced from each of said supporting sleeves and covering the slots therein, each of said members being electrically connected to the corresponding supporting sleeve.

9. A cathode assembly, comprising a cathode in the form of a molded sleeve of powdered material and a metallic supporting sleeve attached to one end of said cathode, said supporting sleeve having a plurality of slots therein extending to the end thereof adjacent said cathode providing a plurality of flexible members in said supporting sleeve at said end.

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