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CATHODE ASSEMBLY FOR ELECTRON TUBE

Filed June 11, 1962

2 Sheets-Sheet 1

Fig. 1.

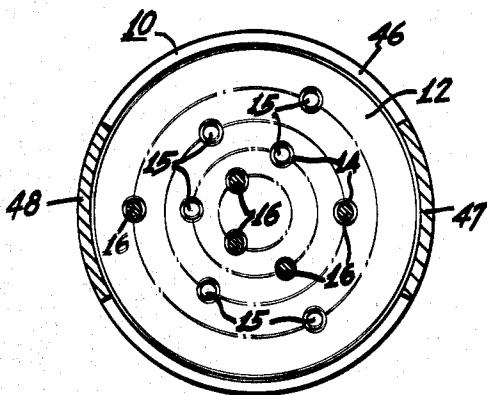
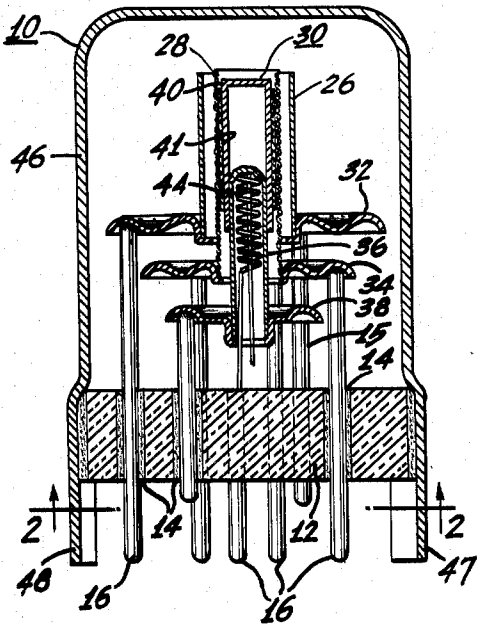


Fig. 2.

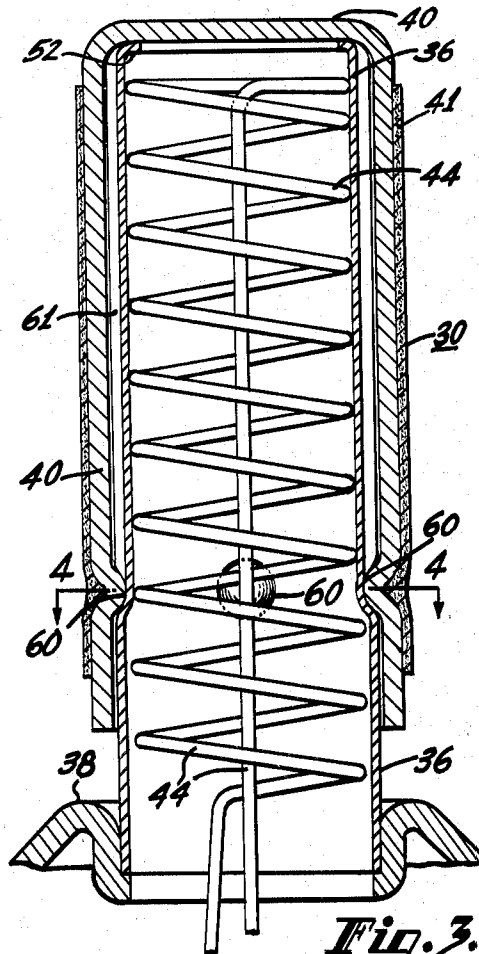


Fig. 3.

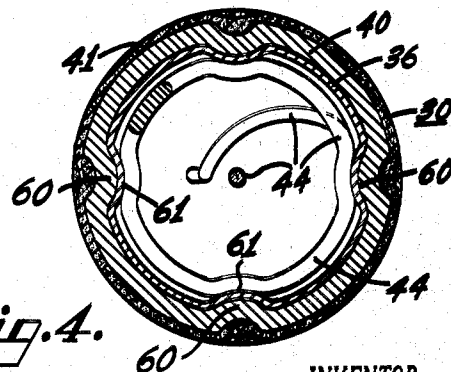


Fig. 4.

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2 Sheets-Sheet 2

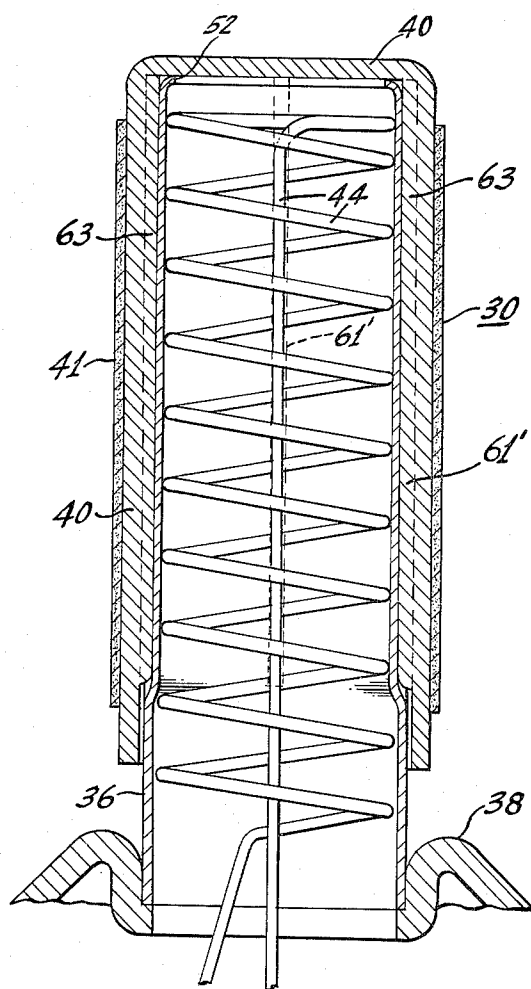


Fig. 5.

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CATHODE ASSEMBLY FOR ELECTRON TUBE
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11 Claims. (Cl. 313—337)

This invention relates to improved cathode assemblies for electron tubes.

One type of presently available electron tubes includes a plurality of concentric electrodes supported on lead-ins and support conductors sealed through a ceramic disk header wafer. In the fabrication of such a tube the electrodes and lead-ins are assembled in a jig in desired strain-free contacting relationship and then brazed together into a rigid electrode mount assembly. A cup-like envelope member, which may be of metal or ceramic, is disposed over the electrode mount assembly and sealed to the periphery of the header wafer after tube bake-out and exhaust to form a vacuum-tight envelope. However, the cathode of such a tube is of the indirectly heated type and includes an electron emissive coating thereon. Inasmuch as this emissive coating cannot withstand the high temperatures encountered during the brazing step, the cathode is added after brazing of the rest of the mount assembly and before the envelope is put in place.

The cathode assembly of such an electron tube may comprise a telescoped assembly including two tubular or sleeve parts and a heater element. A first tubular member serves as the support sleeve and is part of the brazed assembly. An insulated heater element is inserted within the support sleeve and is supported by two lead-ins through the header wafer, the heating element also being a part of the brazed assembly. A second tubular member closed at one end and providing the cathode is telescoped over the support sleeve after the mount assembly has been brazed together. This second member is coated with electron emissive material on the external surface thereof. The envelope is then placed over the mount assembly and in contact with the header. During the subsequent heating and exhaust processing the support and cathode sleeve are permanently sintered together. Sealing of the envelope is performed after bake-out and exhaust.

During the evacuation and sealing processing, the tube may be oriented in an inverted position. Because of size variations encountered in mass production of the support and cathode sleeves, the sleeves are not always of such size as to insure tight frictional engagement to maintain them in secure telescoped contact until sintered together. As a result, often times before actual sintering together of the sleeves takes place, the cathode sleeve falls off of its inner support sleeve where a loose fit exists.

Welding together of the two sleeves is not suitable because their contact may be too slight to enable a good weld to be made.

It had been the practice to make the cathode support sleeve of seamless tubing. In order to reduce heat conduction from the cathode, it has been the practice to use tubing having a wall thickness of approximately only .0005 inch. This is a fragile support. Great care is required in positioning the cathode cup on the support sleeve to prevent damage and misalignment of the sleeve with respect to the other tube elements. Despite careful positioning of the cathode cup over the sleeve, damage frequently occurs particularly where a press fit is used, that is, where the inside diameter of the cathode cup is very close to the outside diameter of the support sleeve. Further, sintering of the sleeves is not always satisfactory, especially in those cases where due to toler-

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ances a loose fit between the cathode cup and the sleeve results.

A further problem associated with the type of tube described, and also with many other tube types wherein an elongated heater extends into a tubular cathode and is supported only at one end, is that the heater is prone to excessive vibrations upon mechanical shock of the tube. Such vibrations cause microphonic noise in the electrical output of the tube. It has not been feasible in the prior art to provide a press contact fit between the heater and the cathode in order to prevent vibration of the heater because of the requirement that the heater be readily insertable into the cathode. The reason for this is that the heater is coated with a brittle insulating material, such as aluminum oxide, and must be easily and loosely insertable into the cathode to prevent scraping of the insulation off the heater during insertion.

It is therefore an object of this invention to provide a novel and improved cathode assembly structure which avoids or overcomes the problems of prior art structures as set forth above.

Further objects of this invention are to provide a novel and improved indirectly cathode assembly the parts of which can be manufactured with ordinary mass production tolerances and yet which can be readily assembled without either damaging the cathode support sleeve or scraping the insulation off the heater while constantly providing interference fitting contacts between the assembly parts.

For achieving these objects according to one embodiment of this invention, an indirectly heated cathode assembly is provided which may include an insulated coiled heater inserted within a cathode support sleeve over which a tubular cathode sleeve or cup is telescoped. The outer diameter of the heater coil is slightly less than the inner diameter of the support sleeve to permit easy insertion of the heater into the sleeve. To position the cathode cup on the support sleeve and to obtain a positive contact or pressure fit between the cathode cup and the support sleeve and between the support sleeve and the heater, the cathode cup is provided with several inwardly directed projections in the form of dimples or longitudinally extending ribs or the like. The diameters of the cathode cup and the support sleeve and the size of the inwardly directed projections are such that when the cup is positioned over and forced down over the support sleeve a tight contact fit is provided between the cathode cup projections and the support sleeve. Further, where the inwardly directed projections engage the support sleeve inwardly directed projections or ridges are formed in the wall of the support sleeve which engage and squeeze or clamp the heater therebetween. In this manner a tight contact fit is also provided between the support sleeve and the insulated heater. In the drawings:

FIG. 1 is a longitudinal section of an electron tube incorporating one embodiment of the invention;

FIG. 2 is a transverse section taken along line 2—2 of FIG. 1;

FIG. 3 is an enlarged longitudinal section taken along line 3—3 of FIG. 4 and showing an indirectly heated cathode assembly made according to one aspect of this invention and as incorporated in the electron tube shown in FIG. 1;

FIG. 4 is a transverse section taken along the line 4—4 of FIG. 3; and,

FIG. 5 is a view similar to FIG. 3 but showing a modification of the cathode assembly.

In FIGS. 1 and 2 is shown an electron tube incorporating this invention. The tube 10 includes a ceramic disk header 12 having a plurality of bores 14 therethrough. A plurality of electrode support conductors 15 and lead-

in conductors 16 are sealed in vacuum-tight relation in the bores 14, the walls of which have been metallized.

The electrode mount assembly comprises coaxial cylindrical anode and grid electrodes 26 and 28 and cathode electrode assembly 30, respectively. The anode 26 is mounted on a radially extending flange 32, which is in turn mounted on one lead-in conductor 16 and two support conductors 15. The grid electrode 28 is similarly mounted on a radially extending flange 34 which is in turn mounted on one lead-in conductor 16 and two support conductors 15. The cathode assembly 30 includes a tubular cathode support sleeve 36, a cup-like tubular sleeve 40, and a coiled heater 44. The support sleeve 36 is mounted on a radially extended flange 38, which is supported on one lead-in conductor 16 and two support conductors 15. The tubular cathode sleeve 40 is disposed over the support sleeve 36, tubular sleeve 40 being coated with a suitable electron emissive material 41, and the coiled heater 44 is disposed in the cathode support sleeve 36 and connects to a pair of lead-in conductors 16 which are sealed through the header 12. Heater 44 is coated with a suitable insulating material, such as aluminum oxide, and to prevent scraping of the insulation against the support sleeve 36 during insertion of the heater into the sleeve, the outer diameter of heater 44 is slightly less than the inner diameter of sleeve 36.

As previously stated, all of the above-described elements except the cathode sleeve 40 are assembled in a jig in loose contacting relationships and brazed together at high temperatures into a strain-free rigid mount assembly. A vacuum-tight envelope is provided by a cup-shaped shell 46 sealed to the periphery of the ceramic disk header 12. The shell 46 includes a pair of longitudinal extending arcuate positioning lugs or tongues 47 and 48 which serve to protect the externally extending conductors 16 and facilitate socketing of the tube.

The presence of the emissive coating 41 on the outer cathode sleeve 40 precludes incorporation of the cathode sleeve in the tube prior to the brazing step. After the brazed assembly is removed from the brazing oven, the cathode sleeve 40 with its emissive coating 41 thereon is telescoped over the support sleeve 36. The envelope is then sealed to the header after bake-out and exhaust as described above.

This sealing step is performed by an oven heating step, at a temperature below the temperature involved in the prior brazing step. The sealing step is performed simultaneously with an exhaust and bake-out of the tube. During the exhaust, bake-out, and sealing of the shell 46 to the ceramic header 12, a sufficiently high temperature is reached to sinter the support 36 and cathode sleeve 40 together in a secure, permanently bonded assembly.

Referring to FIGS. 3 and 4, the cathode assembly structure 30 includes emissive cathode sleeve 40 closed at one end so that when the two sleeves 36 and 40 are telescoped together, a bottoming of the support sleeve 36 within the emissive cathode cup 40 will provide automatic longitudinal indexing of the telescoped arrangement facilitating telescoping of the two sleeves 36 and 40. One end of the support sleeve 36 is provided with an intumed rim 52 to eliminate sharp edges and act as a guide for the telescoping action. Support sleeve 36 serves as a mechanical support for the electron emissive sleeve 40, as a heat transferring medium for conducting heat from heater 44 to cathode sleeve 40, and as an electrical connection between cathode sleeve 40 and the cathode lead-ins 15. To prevent loss of heat from the cathode sleeve by conduction downwardly through support sleeve 36, the support sleeve may be made of a relatively poor thermal conductive material such as an alloy comprising essentially 80% nickel and 20% chromium. In one embodiment the support sleeve wall is only .0005 inch thick for further reducing the heat conduction along the length thereof.

The cathode cup 40, which may have a wall thickness of 4 to 5 times that of the support sleeve 36, is provided

on its inside surface and about one third of the sleeve length away from its open end with circumferentially spaced inwardly extending projections or dimples 60, preferably 3 or 4 equally spaced dimples being used. Such dimples may be conveniently provided in the tubular cathode sleeve 40 by means of conventional punch and die processes.

The inside diameter of cup 40 is made slightly larger than the outside diameter of the sleeve 36 so that the cup may be readily inserted over the upper end of the sleeve 36 to guide the cup along the sleeve until the dimples 60 engage the sleeve 36. As the cathode sleeve 40 is pushed home, the dimples engage and form or mold longitudinally and inwardly extending projections, grooves, or ridges 61 in the support sleeve material. The dimples 60 are of such size and strength in comparison with the thickness and strength of the support sleeve wall that the sleeve material is stretched beyond its elastic limit to form permanent ridges in the sleeve. Further, the ridges are formed to such size as to engage and squeeze and clamp the relatively loosely fitting heater 44 within support sleeve 36 between the ridges 61. The heater coil is of sufficient strength so as not to collapse under this clamping pressure whereby a force or pressure contact fit between the support sleeve 36 and the heater 44 is obtained. A pressure contact fit is likewise obtained between the cathode cup 40 and the support sleeve 36 due to dimples 60 being tightly wedged within grooves 61. Further, the wall portions of the support sleeve 36 between grooves 61, it is believed, are bowed outwardly and into tight engagement with the inner wall of the cathode cup 40 (FIG. 4).

In one embodiment, by way of example, the outer diameter of coil heater 44 is 52 mils; the inner and outer diameters of support sleeve 36 are 54 and 55.5 mils, respectively; the inner and outer diameters of cathode cup 40 are 56 and 60 mils, respectively; dimples 60 have a raised height above the inside surface of cathode cup 40 of about 2 mils and thus provide ridges 61 having a raised height of about 1.75 mils on the inner wall of support sleeve 36.

Referring to FIG. 5, another cathode assembly 30 is shown. In this embodiment, cathode cup 40 is provided on its inside surface with inwardly extending projections in the form of circumferentially spaced longitudinally extending ribs 63 which extend about two-thirds the length of the cathode cup 40 from its closed end. Such ribs provide pressure contact fits between the cathode cup 40 and its support 36 and provide ridges 61' in support sleeve 36 to provide a pressure contact fit between support 36 and heater 44 in similar manner as dimples 60. Cathode cups 40 having such inwardly extending ribs 63 may be fabricated by known extruding processes.

A further advantage of the indirectly heated cathode assemblies described above is that consistently tight or pressure fits may be provided between the assembly parts in spite of normal manufacturing tolerances found within the individual assembly parts. The spring-like characteristic of the bowed-out portions of sleeve 36 between the formed ridges 61 and 61' results in the support sleeve 36 having a self-adjusting characteristic within cathode sleeve 40. Thus, in either the extreme case where the cathode sleeve is a maximum and the support sleeve is a minimum, or the extreme case wherein the cathode is a minimum the support sleeve is a maximum nevertheless, a good pressure contact therebetween is maintained. The flexibility of the support sleeve accommodates for such size relationship variations. The spring action of the support sleeve insures that a tight pressurized telescoped fit is maintained. Such an accommodation pressure fit is not possible with the prior art assemblies wherein two relatively and undistorted cylinders are telescoped together.

The same is also true for the fit of the heater coil 44 within support sleeve 36. Although sufficiently rigid to prevent collapse due to the squeezing action of ridges

61, 61' as mentioned, the heater coil is sufficiently flexible to accommodate variations in the size of the formed ridges 61, 61', the flexibility of the coil insuring that a tight pressure contact fit between the heater 44 and the ridges is maintained.

What is claimed is:

1. A cathode assembly comprising an outer cathode member, an inner support member within said outer member, and a heater element mounted within said inner member, said outer member having an inwardly extending projection in a force fit with said inner member, and said inner member having an inwardly extending projection in contact with said heater.

2. A cathode assembly comprising an outer cathode member, an inner support member within said outer member, and a heater element mounted within said inner member, said outer member having an inwardly extending projection in a pressure contact fit with said inner member, and said inner member having an inwardly extending ridge adjacent said inwardly extending projection in a pressure contact fit with said heater.

3. A cathode assembly comprising an outer cathode member, an inner support member within said outer member, and an elongated heater element mounted within said inner member, said outer member having an inwardly extending projection in a pressure contact fit with said inner member, and said inner member having a longitudinally and inwardly extending ridge extending along a portion of the length of said heater and in a pressure contact fit with said heater.

4. A cathode assembly comprising an outer cathode member, an inner support member within said outer member, and a coiled heater element mounted within said inner member, said outer member having a plurality of inwardly extending dimples in pressure contact fit with said inner member, and said inner member having a plurality of inwardly and longitudinally extending ridges extending along a portion of the length of said heater and in a pressure contact fit with said heater.

5. A cathode assembly comprising an outer cathode member, an inner support member within said outer member, and a coiled heater element mounted within said inner member, said outer member having circumferentially spaced and inwardly and longitudinally extending ribs in a pressure contact fit with said inner member, and said inner member having inwardly and longitudinally extending ridges extending along a portion of the length of said heater and in a pressure contact fit with said heater.

6. An indirectly heated cathode assembly comprising an outer tubular cathode member, an inner tubular support member within said cathode member, and an insulated coiled heater within said support member, said cathode member being provided with circumferentially spaced dimples on its inner surface, and said support member having circumferentially spaced inwardly directed and longitudinally extending ridges extending along a portion of the length of said heater, said dimples being in a pressure contact fit with said support member, and said ridges being in a pressure contact fit with said heater.

7. An indirectly heated cathode assembly comprising an outer tubular cathode member, an inner tubular cathode support member within said cathode member, and an insulated coiled heater within said support member, said heater having an outer diameter slightly less than the inner diameter of said support member, said cathode member

having a wall thickness several times thicker than the wall of said inner member and being provided with dimples on the inner surface thereof, and portions of said support member being inwardly deformed by said dimples and being in a pressure contact fit with said heater.

8. An indirectly heated cathode assembly comprising an outer tubular cathode member, an inner tubular cathode support member within said cathode member, and an insulated coiled heater within said support member, said heater having an outer diameter slightly less than the inner diameter of said support member, said support member and said cathode member having a wall thickness in the order of .0005 inch and .002 inch respectively, said cathode member being provided with dimples on its inner surface, and portions of said support member being inwardly pressed by said dimples and being in a pressure contact fit with said heater.

9. An indirectly heated cathode assembly comprising an outer tubular cathode member, an inner tubular support member within said cathode member, and an insulated coiled heater within said support member, said cathode member being provided with inwardly and longitudinally extending ribs on its inner surface, portions of said support member being pressed inwardly by said ribs and forming corresponding inwardly and longitudinally extending ridges in said support member, and said heater being clamped between said ridges providing a pressure contact fit between said heater and said support member.

10. An indirectly heated cathode assembly comprising an outer tubular cathode member, an inner tubular cathode support member within said cathode member, and a flexible insulated coiled heater within said support member, said heater having an outer diameter slightly less than the inner diameter of said support member, said support member having a wall thickness several times less than the wall thickness of said cathode member, said cathode member being provided with inwardly and longitudinally extending ribs on its inner surface, said ribs being in a pressure contact fit with said support member and forming corresponding inwardly and longitudinally extending ridges in said support member, and said heater being clamped between said ridges providing a pressure contact fit between said heater and said support member.

11. An indirectly heated cathode assembly comprising an outer tubular cathode member, an inner tubular support member within said cathode member, and a flexible insulated coiled heater within said support member, said heater having an outer diameter slightly less than the inner diameter of said support member, said support member and said cathode member having a wall thickness in the order of .0005 inch and .002 inch respectively, said cathode member being provided with circumferentially spaced and inwardly and longitudinally extending ribs on its inner surface, said ribs being in a pressure contact fit with said support member and forming corresponding longitudinally and inwardly extending ridges in said support member, said ridges extending along a portion of the length of said heater and providing a pressure contact fit between said heater and said support member.

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