Sept. 2, 1958

E. J. NAILL

2,850,664

GRID STRUCTURE

Filed May 7, 1954

4 Sheets-Sheet 1

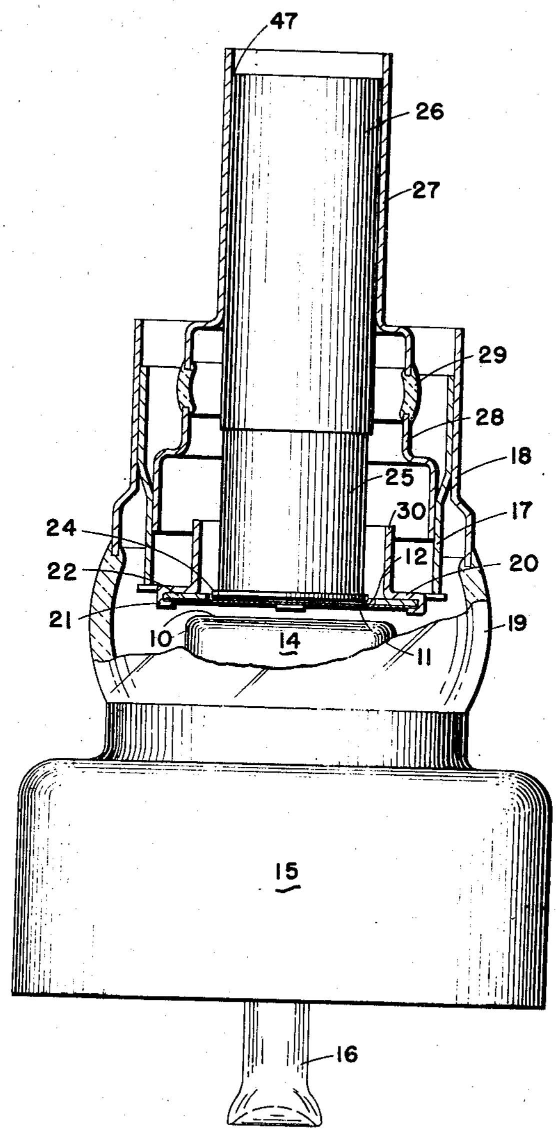

FIG. I

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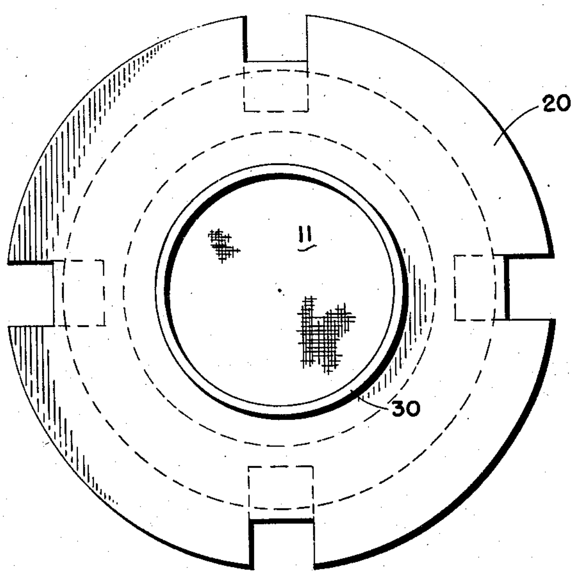

FIG. 2

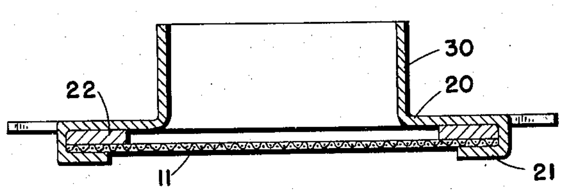

FIG. 3

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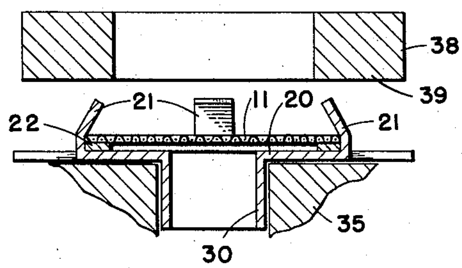

FIG. 6

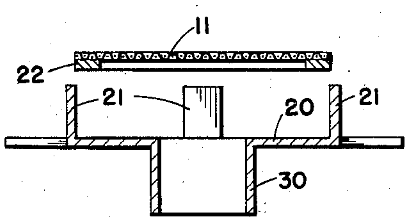

FIG. 4

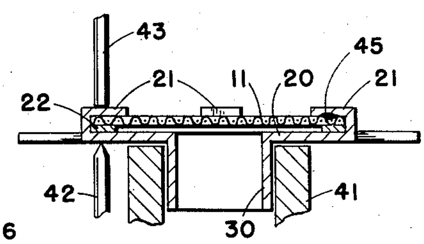

FIG. 7

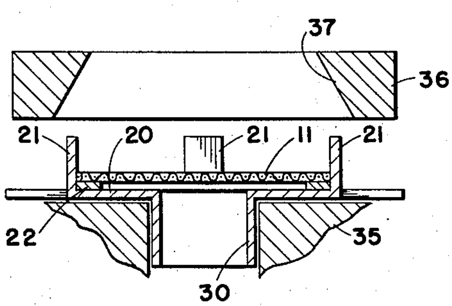

FIG. 5

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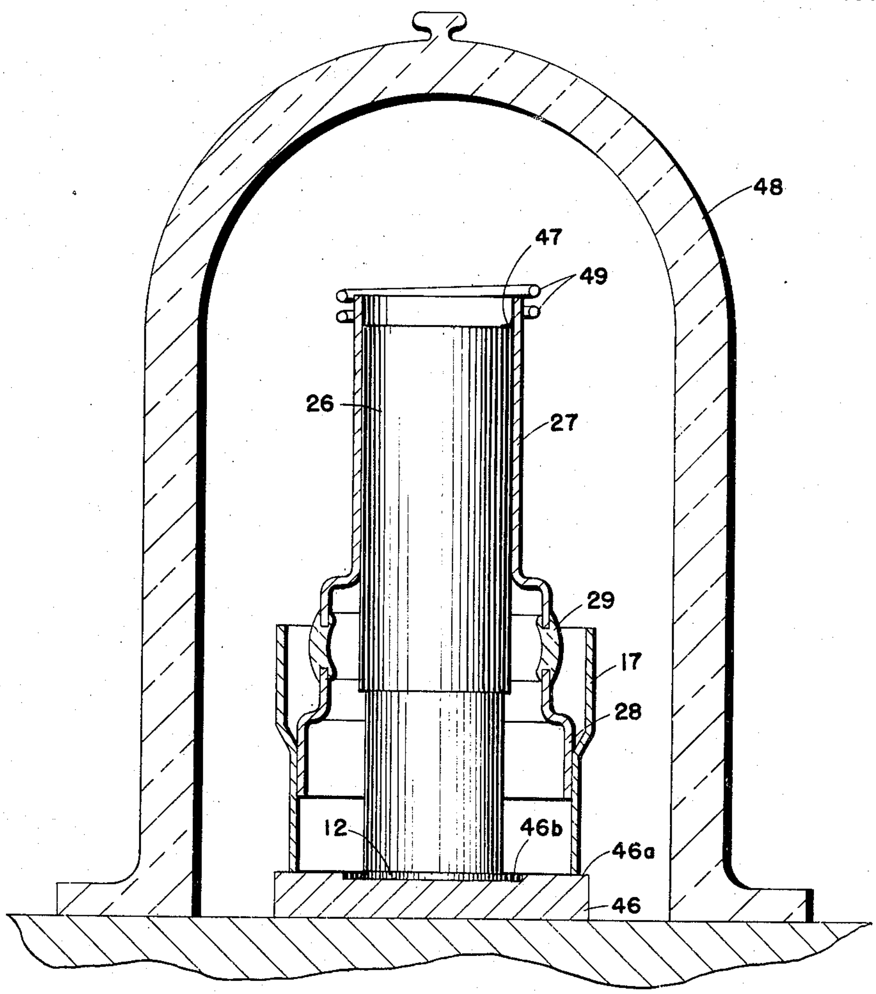

FIG. 8

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GRID STRUCTURE

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Application May 7, 1954, Serial No. 428,313

3 Claims. (Cl. 313—265)

This invention relates to a novel grid structure which is simple yet rugged and which may be cheaply fabricated and easily assembled.

The application of Joseph W. Skehan and Andrew Kudola, Jr., Serial No. 294,884 filed June 21, 1951, describes a device for and a method of making a grid. This grid structure results in a superior grid which will not warp or otherwise deflect from its normal plane sufficiently to change the tube characteristics or short to the adjacent electrode. The grid of that application consists of a mesh of fine wires which is brazed to an annular supporting ring. This supporting ring, in turn, has to be supported upon a structure which is sufficiently flexible to permit its expansion but which makes good electrical contact with the active grid surface. Without such a support structure, many advantages of the grid itself are lost.

The present invention provides a support structure which permits free expansion of the grid supporting annulus and at the same time makes good contact with the active grid. This support consists primarily of a planar mounting deck which may be composed of sheet metallic material satisfactory for use in vacuum tubes. This deck forms a flat base against which the grid supporting ring may be mounted. The grid is not fixed directly to the planar surface of this deck because such a mounting would be rigid and tend to oppose the tendencies of the grid ring to expand. Instead the grid is held in place by metallic tabs which may be bent over the grid support and which are small enough to be quite flexible so that the expansion of the grid ring is not impaired. The grid mesh is advantageously on that side of the support ring which is away from the mounting surface of the mounting deck so that the planar surface of the mounting ring may be used to obtain square positioning of the grid structure. Some contact is, of course, afforded to the grid structure through the mounting deck which is made of conductive material. However, actual joints occur only between the tabs and the grid mesh. This is particularly advantageous since the active grid portion is in this manner directly connected to the support structure.

Accurate spacing between the cathode and grid electrode is also particularly important in most applications employing planar electrodes. The structure of this invention permits very accurate interelectrode spacings by virtue of the tube construction employed. More specifically, the cathode and stem structure is so mounted that as an assembly its outside surface is cylindrical.

The grid support structure of the present invention consists of a tubular mounting member which penetrates the vacuum envelope. This support is advantageously connected to a tubular metallic member forming a portion of the envelope. This grid potential tubular envelope portion is, in turn, sealed to a dielectric ring which is, in turn, sealed to another tubular member. This final tubular member has a portion which will snugly engage the cathode and stem structure. Since the grid mesh thickness is constant within small tolerances as is the thickness of its mounting ring and the mounting deck, the axial distance between the end of the tubular grid support member and the active grid mesh structure can be predicted quite accurately. The difference of the cathode-grid spacing and the dimension between the end of the grid support and the active grid structure will, of course, be the distance between the end of the active grid structure and the cathode. A fixture is provided which permits the correct relative positioning of the cathode and the end of the tubular grid support before the two tubular metallic members which are in sliding contact with one another are brazed together. Thereafter, the brazing operation may be completed, and then the structure turned upside down and the grid welded in place. The planar grid mounting deck prevents any cocking or other misalignment which could introduce inaccuracy.

For a better understanding of the present invention reference is made to the following drawings:

Fig. 1 is an elevational view in partial section of an electron tube structure employing the present invention;

Fig. 2 is a plan view of the grid mounting structure from above;

Fig. 3 is a side elevational view of the grid structure of Fig. 2 in axial section;

Fig. 4 schematically illustrates the placing of the grid structure assembly on the grid mounting deck;

Fig. 5 schematically shows in section the fixture employed in the first stage of bending the tabs in place;

Fig. 6 illustrates a second step in bending the tabs into place;

Fig. 7 illustrates a method of welding the tabs to the grid structure;

Fig. 8 schematically illustrates in partial section the use of a fixture with the supports to obtain accurate grid-cathode spacing.

Referring now to Fig. 1 there is illustrated an electron tube of coaxial construction, commonly called an inverted lighthouse tube. Within the vacuum envelope of this tube are three active planar electrodes; the anode 10, the grid 11 and the cathode 12. The anode is advantageously the bottom of a cup member 14 which has a large diameter tubular skirt which is engaged by and brazed to a terminal 15. Within the cup member 14 is affixed a highly conductive block member for the purpose of removing heat from the anode surface where it is generated by electron bombardment. An exhaust tubulation 16 may be affixed to the anode block and terminated in a duct through the anode block and cup member 14, as described in Patent No. 2,667,593 to Howard D. Doolittle. After exhaust of the completed vacuum tube, this exhaust tubulation, which is advantageously composed of copper, may be pinched off with pliers having rounded jaws in order to make a permanent vacuum tight seal.

The grid terminal 18 is a tubular member arranged coaxially with anode terminal 15. Grid terminal 18 is joined vacuum tight to anode terminal 15 by a dielectric ring member 19 which is sealed vacuum tight between them. Grid terminal 18 is sealed directly to and supports grid support member 17 which is also a tubular coaxial member. The end of tubular grid support member 17 is closed by a grid mounting deck 20. Grid mounting deck 20 is provided with tabs 21 which are arranged to engage the active grid structure 11 which is supported on annular mounting ring 22.

The active cathode is preferably an oxide coated disk 24 which is indirectly heated by a heater member (not shown). Disk 24 is advantageously directly supported by a high heat flow impedance tubular support member 25. High heat flow impedance member 25 is, in turn, connected to tubular cathode support 26. Tubular cathode support 26 has cylindrical side walls which snugly engage tubular cathode terminal member 27.

The support between tubular cathode terminal member **27** and tubular grid support **17** is provided through grid connector member **28** which is advantageously a tubular member sealed at one end to grid support member **17** and at its other end to dielectric ring **29**. Dielectric ring **29** is, in turn, sealed to the end of cathode terminal member **27**.

It should be noted that a tubular flange **30** is provided on grid mounting deck **20** to provide increased capacitive coupling between the grid and cathode members.

The grid structure shown in Figs. 2 and 3 is particularly advantageous. As has been previously mentioned, the Skehan and Kudola invention has provided a method of obtaining extremely tight grid structures which will not sag or buckle upon heating due to expansion effects. The mounting annulus **22** on which the grid structure is secured by brazing, however, should also be free to expand in order to insure that there will be no buckling or sagging at the grid wires. Since this is to be the case, it is not desirable to fix the ring **22** rigidly to the planar grid mounting deck **20** by welding or some similar relatively rigid means. Instead, support of the grid is accomplished through flanges **21** which may be quite narrow and flexible and which are easily formed during the fabrication of the grid mounting deck when tubular portion **30** is formed. These tabs are easily cut out of the sheet forming the deck and bent to a vertical position (see Fig. 4). By use of the tab members **21**, a mechanically secure support with sufficient flexibility to permit expansion but sufficient rigidity to maintain accurate position is provided. It should be noted that the uniform spacing requirements are attained by mounting the annular mounting ring **22** against the grid mounting deck instead of putting the grid thereagainst. This arrangement has the added advantage of permitting the ends of tabs **21** to be brazed to the grid structure as will hereafter be described. This joint at the end of the tabs will not greatly reduce the flexibility of the structure and will secure improved electrical contact between the grid structure **11** and the planar mounting deck **20** through tabs **21**. It is possible to make a joint at this point between the grid and the tabs **21** using low current spot welding because the brazing solder which attaches the grid **11** to ring **22** may be caused by the process to flow and wet tabs **21**.

The mounting of the grid mounting ring, with the grid in place, on the planar mounting deck is illustrated in Figs. 4–7. Fig. 4 shows how the ring is put in position. When the ring **22** is in position on the mounting deck **20**, the mounting deck may be positioned on anvil member **35** as shown in Fig. 5. A hole is provided in anvil **35** to receive tubular member **30** so that the deck **20** lies flat against the planar surface of the anvil. An opposed anvil member **36** having a frusto-conical surface **37** at the radius of the tabs **21** is then brought axially down toward the anvil member **35** and against the tabs **21**. This action may be facilitated by placing anvils **35** and **36** in some sort of a press. After removal of anvil **36**, the tabs assume the positions shown in Fig. 6. Then an anvil member **38** having a planar contact surface **39** is substituted for anvil **36**. Axial downward movement of anvil **38** will cause planar surface **39** of said anvil to flatten tabs **21** against the grid as shown in Fig. 7. Then the assembly may be put in tubular fixture **41** for ease in rotation and rotated between the electrodes **42** and **43** of a spot welder. The spot welder will produce a flow of the brazing material holding the grid to its ring **22** and cause a brazed joint to occur between the grid **11** and the tabs **21** as indicated by numeral **45**.

Once the grid is mounted on the planar mounting deck **20**, the deck **20** may be welded to grid support **17**. The structure previously described facilitates accurate spacing between grid **11** and cathode **12**. This is accomplished by completing the sub-assemblies including cathode disk **24** and tubular supports **25** and **26** on one hand, and cathode terminal **27**, dielectric ring **29**, grid connection means **28** and grid support tube **17**, on the other hand. All of these members in the sub-assemblies are tubular and may be held in accurate alignment during their assembly. The cathode support **26** is a tubular member of such diameter that it is snugly engaged by tubular terminal member **27**. The sliding fit permits axial adjustment between the two sub-assemblies without misalignment of the mounting edge of tubular member **17** relative to the cathode support structure, and cathode disk **24** in particular. As shown in Fig. 8 a fixture **46** provides shoulders **46*a*** and **46*b*** at axial levels so that the distance between them is the exact spacing between the end of tubular member **17** and cathode surface **12** of disk **24** which is required in order to obtain correct grid-cathode spacing. Therefore, when the assembly is placed on this fixture as shown in Fig. 8, the correct relative position of parts is obtained so that grid **11** will be in exact position when mounting deck **20** is affixed thereto. With fixture **46** in place against the cathode and mounting edge of grid support **17**, a brazed joint is completed at the junction **47** between cathode support member **26** and cathode terminal **27**. This brazed joint may be advantageously completed by placing the assembly on its fixture within a bell **48**, removing oxidizing gases from the bell and inductively or radiantly heating the region of junction **47** by coil **49** so that the solder placed therebetween will flow and join cathode support **26** and cathode terminal **27** in a vacuum tight joint **47**. Thereafter, the structure is removed and the grid mounting deck **20** placed in position on the end of grid support member **17** and welded in place. There is no tubular portion on mounting deck **20** to engage grid support **17**, so that there is no opportunity at all for misalignment if the mounting edge of grid support member **17** is square.

A novel grid mounting structure and method of securing the structure in place have been described. Modifications of the structure and the method described will occur to those skilled in the art. All such modifications within the scope of the claims are intended to be within the scope and spirit of the present invention.

I claim:

1. An electron tube embodying an envelope containing planar cathode and anode electrodes in spaced relation, a planar grid structure between the anode and cathode and comprising a stranded active grid and an annulus to which the peripheral portion of the grid is affixed, and means for supporting the grid structure comprising a hollow cylindrical terminal which is a part of the envelope, a hollow cylindrical grid support coaxial with the terminal and sealed adjacent one end to the inner surface of the terminal, the other end terminating in an annular edge, and a capacitive coupling between the grid and cathode which embodies a tubular member positioned between the cathode and grid support and having an outwardly turned flange attached to and supported by the edge of the grid support, the annulus and grid being located upon the flange, the flange having tabs at intervals thereon which are bent around the edge of the annulus and hold the annulus and grid in place.

2. An electron tube embodying an envelope containing planar cathode and anode electrodes in spaced relation, a planar grid structure between the anode and cathode and comprising a planar stranded active grid and an annulus to which the peripheral portion of the grid is affixed, and means for supporting the grid structure comprising a hollow cylindrical terminal which is a part of the envelope encircling the cathode, a hollow cylindrical grid support coaxial with the terminal and sealed adjacent one end to the inner surface of the terminal, the other end terminating in an annular edge, and a capacitive coupling between the grid and cathode which embodies a tubular metal member positioned between the cathode and grid support and having an outwardly extending deck attached to and supported by the edge of the grid sup-

port, the deck having tabs at intervals therein which are bent around the edge of and overlie the annulus and hold the annulus in place, the mesh being on the side of the annulus away from the deck and adjacent the overlying portions of the tabs.

3. An electron tube embodying an envelope containing planar cathode and anode electrodes in spaced relation, a tubular cathode terminal supporting the cathode and forming a part of the envelope, a planar grid structure between the anode and cathode and comprising a stranded active grid and an annulus to which the peripheral portion of the grid is affixed, and means for supporting the grid structure comprising a hollow cylindrical grid terminal which is a part of the envelope encircling the cathode, a hollow cylindrical grid support coaxial with the terminal and sealed adjacent one end to the inner surface of the terminal, the other end terminating in an annular edge, insulated connecting means forming a part of the envelope between the cathode and grid terminals, and a capacitive coupling between the grid and cathode which embodies a tubular metal member encircling the cathode within the grid support and having an outwardly turned flange in which are provided a plurality of flexible metal tabs, the flange attached to and supported by the edge of the grid support, the surface of the annulus opposite the grid being positioned upon the flange and the tabs being bent around the edge of the annulus into overlying relation to the grid and holding the annulus and grid in position.

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