Nov. 17, 1959 M. F. AMMENWERTH ET AL 2,913,616

GRID MOUNT AND METHOD OF TUBE ASSEMBLY

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Fig. 1.

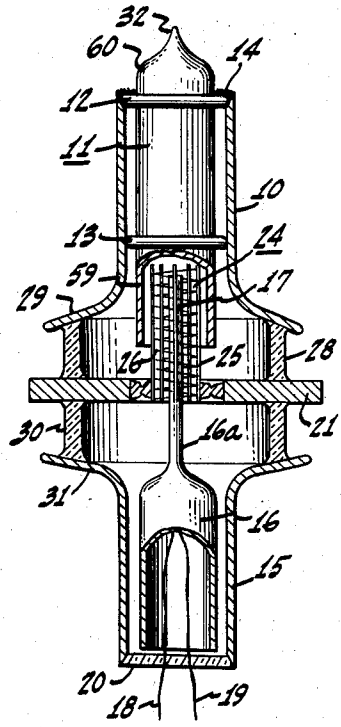


Fig. 2.

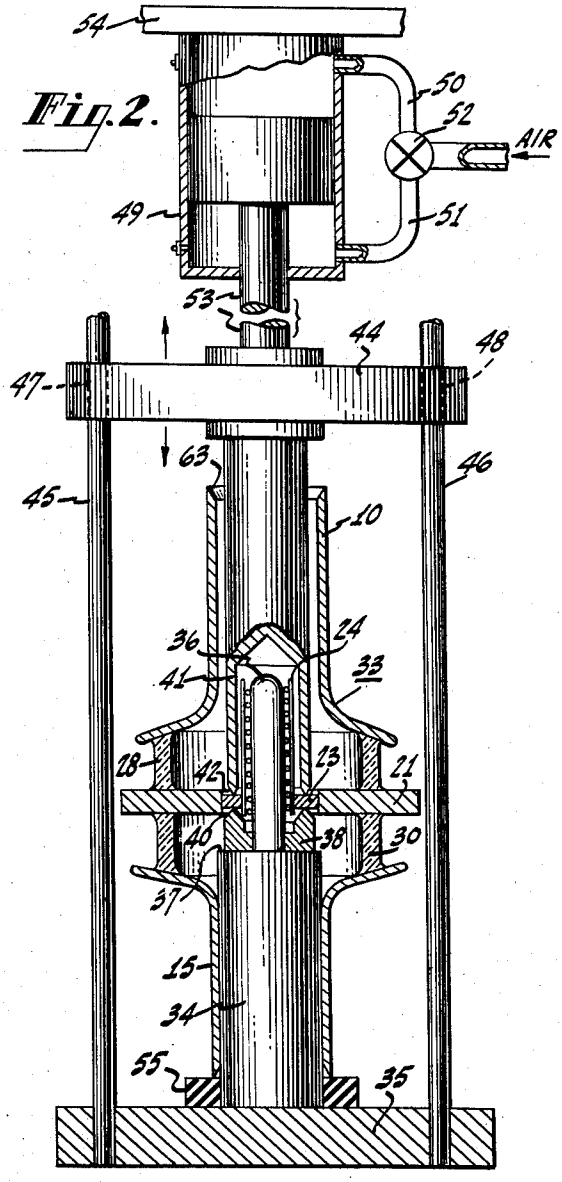
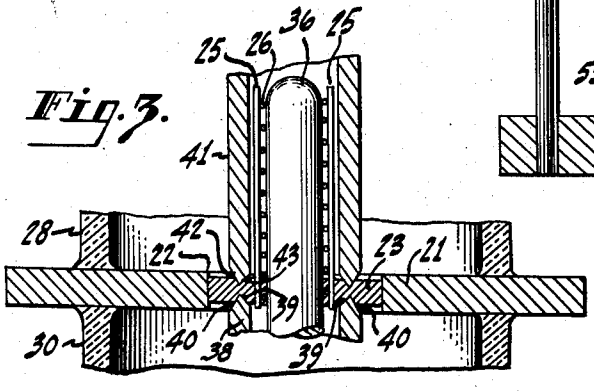


Fig. 3.



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Fig. 4.

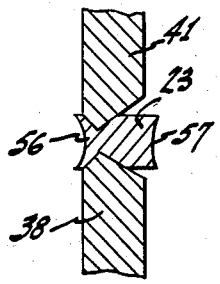
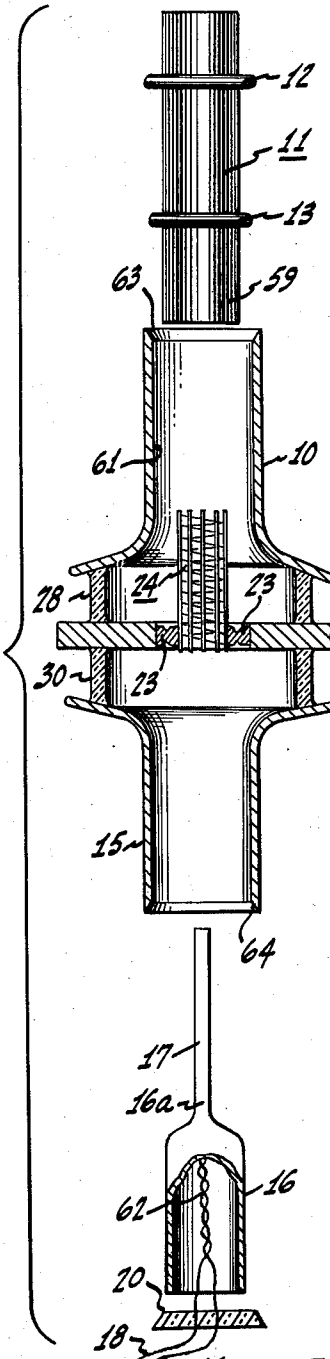


Fig. 5.



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GRID MOUNT AND METHOD OF TUBE ASSEMBLY

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Application June 10, 1957, Serial No. 664,667

9 Claims. (Cl. 313—284)

The present invention relates to grid mounts and particularly to means for fixing a grid on a support, and to an improved method of assembling parts to form an electron tube.

The invention is useful in electron tubes and especially in tubes of the type having a grid mount wherein a disc constitutes a support for a tubular grid received in an opening in the disc. One example of a tube of this type is the so-called "Pencil" tube.

"Pencil" tubes comprise an elongated structure including tubular metallic end portions and an intermediate tubular portion made of insulating material and across which a metal disc having a central opening, is sealed. In one of the metallic end portions aforementioned, a tubular metallic anode insert is disposed in force fitted relation. In the other of the end portions, a cathode support is received. Heretofore, the anode insert has been force fitted into its associated tube end portion, prior to a sealing of the end portion to the intermediate portion of insulating material. This was dictated by a desire to avoid application of appreciable force to the end portion, after sealing to the intermediate portion, to preserve the seal from harm. This consideration did not affect a mounting of the cathode support. Accordingly, this support was mounted at a later stage in assembling the tube.

The aforementioned practice involved substantial closure of one tube end portion by the anode insert referred to, at least to the extent of barring access through this end portion for tools for fixing the grid to its disc support. However, the other end portion of the tube was not subject to this limitation since the cathode support aforementioned could be mounted therein after the grid mounting operation, thereby making available a space of adequate width in one end portion for permitting the extension of grid mounting tools therethrough.

The foregoing limitation on tool access to the interior of the tube made it necessary to resort to several expedients in the past in mounting a grid on its disc support. One of these expedients was to weld an end portion of the grid to the walls defining an opening in disc grid support. To permit a weld to be accomplished by tools requiring access to the tube interior from one end thereof only, the walls defining the disc opening were bevelled so as to flare outwardly towards the tube end from which the tools were extendable. With an end portion of the grid flared in a similar way, good contact between the grid end portion and the bevelled disc walls could be achieved by a force directed on the welding tools from one end only of the tube.

The aforementioned expedients of bevelling the walls defining the opening in the disc and flaring one end of the grid, and performing a welding operation from one end of the tube, were found to be satisfactory to a certain degree, but nevertheless were characterized by several problems.

One of these problems resided in the need for extreme care in handling the welding tools so as to avoid exerting

an excessive force thereon in seating the flared end of the grid on the bevelled walls aforementioned in effecting a weld therebetween. Such excessive force, applied directly to the disc support, might deform it or adversely affect its seals to the intermediate portion of the tube, which may be of glass. In attempting to avoid such excessive force, reliance was placed exclusively on the sense of feel of the operator handling the welding tools referred to.

Another problem manifested itself in the flaring of one end of the grid. A grid suitable for use in the "Pencil" tube includes a plurality of side rods disposed in a circular array and grid lateral wire wound around the array in a number of turns defining a helix. In flaring an end of this type of grid, it is first necessary to cut the lateral wire turns adjacent to this end, since it is not feasible to flare by merely stretching the lateral wire. Such cutting of the lateral wire sometimes leaves loose ends, which may produce grid-to-cathode shorts in the completed tube.

Accordingly, it is an object of the invention to provide an improved grid mount and method of tube assembly that avoid the problems aforementioned.

Another object is to provide a grid mount wherein a tubular grid is fixed to the walls of an opening in a disc support, by means of a body of ductile metal deformed to engage an end portion of the grid and the walls referred to.

A further purpose is to provide a novel method of tube assembly, wherein a grid is affixed to a grid support in an elongated tube, before mounting electrodes in end portions of the tube, to thereby render the end portions free to accommodate tools required for mounting the grid.

Another aim is to provide a method of mounting a grid on a disc support previously assembled in a tube and which method involves the application of appreciable forces from opposite sides of the disc, without adversely affecting the assembled position of the disc support in the tube.

In one embodiment of the invention, a tubular grid is mounted in an opening in disc support, by deforming a body of ductile metal, which may be ring-shaped, and which surrounds an end portion of the grid and engages the walls defining the opening aforementioned. The deformation of the body referred to occurs in such fashion as to spread the body radially, so that it enters the openings in the grid and is forcefully urged against the walls aforementioned. This deformation of the ductile metal body, therefore, causes the body to ruggedly engage the grid and the walls defining the disc opening referred to, for firmly supporting the grid on the disc.

One aspect of the method of the invention is directed to preserving the previously made seals between the grid disc and the intermediate portion of the tube envelope from harm, during a mounting of the grid. This aspect involves the application of substantially balanced forces on the body of ductile metal only, from opposite sides of the disc. While the major thrust produced by the forces aforementioned is thus directed to the body of ductile metal, a portion of these forces may be translated to the disc itself by virtue of the engagement between the disc and ductile body, which engagement becomes stronger as the deforming operation proceeds. To take care of any possible unbalance in the forces applied to the ductile body in these circumstances, both ends of the tube are free to respond in translation to such unbalance.

Further objects and advantages will become evident as the present description continues.

Referring now to the drawing for a more detailed consideration of an embodiment of the invention,

Fig. 1 shows an elevation partly in section, of an elec-

tron tube having the grid mount according to the invention;

Fig. 2 is an elevational view partly in section of the tools and work pieces that may be used in carrying out the method of the invention;

Fig. 3 is a fragmentary view partly in section and on an enlarged scale, showing the work pieces after they have been acted on in accordance with the invention to provide a completely mounted grid;

Fig. 4 is a fragmentary view in cross-section and shows the adverse effects of work-piece length in a mounting operation according to the invention; and

Fig. 5 is an exploded view partly in section and shows the relation of the grid mounting step to other steps involved in assembling an electron tube according to the invention.

Referring to the drawing in more detail, there is shown in Fig. 1 an electron tube of the "Pencil" variety, which incorporates the invention. The tube comprises an anode mount including tubular metallic end portion 10 and a combined anode, and exhaust tubulation unit 11 having bulges 12, 13 for spacing the unit within the end portion 10. A ring of brazing material 14 serves to fix the unit 11 in the end portion 10. An anode mount of this type is shown and claimed in application Serial No. 664,250, filed June 7, 1957, in the name of G. M. Rose, Jr. and W. J. Helwig, and assigned to the same assignee as the present application.

The tube also includes a cathode mount comprising a metallic tubular end portion 15 within which is received a tubular cathode support 16 to which a cathode 17 is fixed. The support 16 may include a portion 16*a* made of a material, such as Kovar, of relatively low heat conductivity. A heater 62, shown in Fig. 5, extends within the cathode 17, and is provided with leads 18, 19 which extend through a disc 20 of insulating material such as glass, for service as external contact elements. The disc 20 is sealed across the end of end portion 15, remote from end portion 10.

A grid mount according to the invention, includes a metal disc 21 having a central opening 22 occupied in part by a body of ductile metal 23 of ring-shape. The ductile metal may comprise copper, or other suitable metal or alloy exhibiting ductile characteristics and free from harmful tendencies in the tube. Also, disposed within the opening referred to is an end portion of a tubular grid 24 comprising a plurality of parallel side rods 25 disposed in a circular array, and a helix of lateral grid wires 26 fixed to the side rods. The body of ductile metal 23 extends through the lattice work defined by the side rods and lateral wires aforementioned, for firmly engaging the grid end portion referred to. The body 23 also forcefully engages the walls 27 defining the opening 22. As a consequence, the grid 24 is effectively and ruggedly supported on the disc 21.

A collar or cylinder 28, of glass or other insulating material, is sealed at its ends to a flange 29 of metal end portion 10, and to the disc 21. A similar collar 30 is sealed to the disc 21 and the flange 31 on metal end portion 15.

After evacuation of the tube, the exhaust tubulation portion of the unit 11 is tipped off as at 32 in a pressure weld and without deliberate application of heat.

In mounting the tubular grid 24 in the opening 22 in the disc 21 serving as a grid support, suitable equipment is employed. In one form, this equipment comprises elements adapted to receive and properly position work pieces and to stake or deform one of the work pieces in effecting a mounting of the grid on the disc support.

The work pieces involved in a grid mounting operation according to the invention comprise a tube envelope 33 including metallic end portions 10 and 15 and an intermedate portion comprising collars 28, 30 made of an insulating material such as glass and across which the disc 21 is sealed. The work pieces also include a tubular grid 24 and a ring 23 of ductile metal such as copper. The ring 23 has an inner diameter of sufficient size to permit the ring to be slipped over the grid 24 snugly and has a thickness less than that of the disc 21, for a purpose which will become apparent. It has an outer diameter for suitably engaging the walls defining the opening 22 in the disc.

To perform its functions aforementioned with respect to the work pieces described, the equipment referred to includes a mandrel assembly comprising a first cylindrical portion 34 mounted at one end thereof on a base 35 and having a diameter for snugly engaging the inner walls of envelope end portion 15. The mandrel assembly also comprises a second cylindrical portion 36 mounted on the free end of the first portion 34 in coaxial relation therewith. The second cylindrical portion 36 is of appreciably smaller diameter than portion 34, for snugly receiving grid 24 in telescoped relation thereon, and for providing a shoulder 37 having a surface for receiving a staking unit or insert 38. The staking unit 38 is ring shaped for snugly embracing the second cylindrical portion 36, of the mandrel assembly aforementioned. The insert 38, furthermore is provided with an annular staking surface defined by two bevels 39, 40. The two bevels terminate in an annularly shaped end of the insert 38 having a relatively small surface for an effective staking operation. The insert 38 is adapted to support the ring 23 with the annularly shaped end of the staking insert engaging the ring. The staking insert has a length of predetermined magnitude so that when its annular staking end engages the ring 23 the ring is disposed midway between the planes of the opposite faces of the disc 21.

It is apparent from the foregoing, that the staking insert referred to is adapted to engage one end of the ductile ring 23 in a staking operation. The equipment presently considered, also includes an annular staking member 41 adapted to engage the opposite end of the ring 23 for a staking purpose. Staking member 41 is provided with an end of relatively small area defined by bevels 42, 43, and is supported on a support 44 in coaxial relation to staking insert 38. This coaxial relation of the staking member 41 and the staking insert 38, disposes the annular staking surfaces thereof in registering opposition. The support 44 is mounted on standards 45, 46 for rectilinear movement therealong. The rectilinear character of this movement is assured by bearings 47, 48 which extend an appreciable distance lengthwise of the standards 45, 46, and preserves the coaxial relation of staking insert 38 and staking element 41, during movement of the support 44 along the standards referred to. Movements of the support 44 are imparted and controlled by a pneumatic system including a cylinder 49 having ducts 50, 51 communicating with its end portions and a source of air under pressure (not shown) through a valve 52. A piston 53 extending into one end of the cylinder 49 is adapted to be moved rectilinearly in directions determined by the valve referred to. The cylinder 49 is supported at its other end by a fixed structural element 54. In this situation, movements of the piston 53 are transmitted to the staking member 41.

To assure that forces that may be transmitted to the tube envelope 33 during a staking operation are harmlessly dissipated, a ring 55 of resilient material, such as soft rubber, is disposed around the mandrel portion 34 adjacent to the end thereof engaging the support 35. One end of the envelope 33 engaging this ring of resilient material, is therefore free to move towards the support 35. The other end of the envelope is under no restraint whatsoever to movement.

The function of the equipment described is to stake or deform the ductile ring 23 in such fashion as to cause

translations of portions of the ring material. One of such translations is radial inwardly and causes the ring material to enter the mesh or lattice work of the grid **24** and to abut an annular portion of mandrel portion **36**. Another translation is radial outwardly and causes the ring material to ruggedly engage the walls defining the opening **22** in disc **21**. A further translation is longitudinal of the ring **23** and results in a thickening thereof at the regions where it engages the walls and grid aforementioned, as shown in Fig. 3.

In performing a staking operation in accordance with the invention, the support **44** is raised to separate the staking unit **38** and staking member **41** sufficiently to mount the work pieces aforementioned. In mounting the work pieces, the following sequence of operations has been found to be convenient. The grid **24** is first telescoped over the mandrel portion **36** and is moved downwardly, as viewed in Fig. 2, until its lower end is substantially in the plane of the annular staking end of staking insert **38**. Thereafter, the ductile ring **23** is threaded over the grid **24** until it seats on the annular staking surface of the insert **38**. The envelope **33** is then positioned with its end portion **15** in telescoped relation with respect to the mandrel portion **34** and with its lower end as viewed in Fig. 2, resting on the resilient ring **55**.

With the work pieces thus positioned, the valve **52** is actuated to energize the piston **53** to move downwardly. This results in a lowering of the support **44** and the staking element **41**. This lowering movement continues until the annular staking surfaces of the staking insert **38** and the staking element **41** enter and deform the material of the ductile ring **23** to produce the translation previously described and as shown in Fig. 3.

In effecting the translation aforementioned of the material of the ductile ring **23**, there are formed in the sides of the ring, depressions **56**, **57** as shown in Fig. 4. The depth of these depressions is dependent to some extent on the length of the ring. Since, such depressions are objectionable in that they constitute areas out of desired engagement with the walls defining the opening in the disc **21** and with the grid **24**, the ring **23** is preferably made of reduced thickness or length as shown in Fig. 2. For example, with a disc thickness of 60 mils, the axial dimension or length of the ring **23** should be about 30 mils. While the ring, therefore, has an axial dimension less than that of the disc **21** prior to a staking operation, it will be seen from Fig. 3 that the axial dimensions referred to are nearly the same after the staking operation has been completed.

It will be appreciated from the foregoing that axial displacements of the material of the ring **23** in a staking operation, detract from the radial displacements thereof. Thus, if the displacements were restricted to radial directions, such displacements would be larger than when axial displacements are also permitted to occur. This presents a problem in producing the requisite magnitudes of inward radial displacement for causing the ring material to enter the mesh of the grid **24**. We have determined that an answer to this problem resides in a suitable engagement of the ring **23** by the staking elements **38**, **41**. Thus, we have found that by causing the annular staking surfaces of the elements **38**, **41** to engage the ring **23**, adjacent to its inner edge, the major translation of the ring material between the annular staking surfaces and the edge referred to, will be in a radially inward direction through the grid mesh, and of a magnitude to fully enter such mesh for an effective mechanical interlock therewith. The outer edge portion of the ring **23** does not require the appreciable radial displacement referred to, and therefore, the disposition of the annular staking surfaces of the staking elements in remote relation to the outer edge of the ring, is not objectionable. While this disposition results in an appreciable axial displacement adjacent to the outer edge of the ring material, at the expense of a radially outward displacement, the latter displacement is sufficient for a rugged engagement between the walls defining the opening in disc **21** and the ring material, particularly if the ring is initially in a relatively snug relation with respect to such walls.

It is feasible, according to the invention, to provide a plurality of envelopes **33**, each having a grid disc **21** defining an opening of uniform size in the several envelopes. Then, if it is desired to mount grids of different diameter in different ones of such envelopes, all that is needed is a supply of ductile rings having a uniform outer diameter, but with inner diameters of different magnitudes to receive the grids of different diameter. This is an appreciable contribution to manufacturing efficiency.

It is also feasible, according to the invention, to correct any slight misalignment that may exist between the disc opening, and the envelope end portion **15**. To this end, it will be noted that the mandrel portions **34** and **36** support the grid **24** and envelope portion **34** in a very exact alignment. The ring **23** having such tolerances as to embrace the grid in this position and also to enter the opening in the disc **21**, will, after a staking operation, be sufficiently deformed to absorb any inaccuracy in alignment of the grid opening with the envelope end portion **15**.

The alignment of the grid **24** with the envelope end portion **15** is more important than its alignment with envelope end portion **10**. This is because the end portion **15** is utilized for positioning the cathode in the tube. In a tube of the type discussed, the cathode-grid spacing is appreciably less than the anode-grid spacing. Therefore, the more important cathode-grid spacing provided by an accurate concentric relation of the cathode and grid, is effectively assured by the invention.

After the grid **24** is mounted in the opening in disc **21**, as described, the following sequence in mounting other tube elements, has been found convenient. Thus, after the mounting of the grid, the cathode **17** and its support **16** are extended into envelope end portion **15** to dispose the cathode **17** in concentric relation to and within the grid **24**. Thereafter, the unit **11** comprising an anode portion **59** and an exhaust tubulation portion **60**, are extended into envelope end portion **10**, with the smaller embossment **13** on this unit engaging the straight inner walls **61** of end portion **10**, and with the larger embossment **12** engaging the flared portion **63** of such inner walls, for suitably positioning the unit in the end portion referred to. When so positioned, the anode portion **59** is disposed around and concentric with the grid **24**, as shown in Fig. 1.

Finally, the heater mount comprising a heater **62**, a stem **20** of insulating material and heater legs **18**, **19**, may be extended into end portion **15** to dispose the heater within the cathode **17** and the stem **63** in engagement with the flared inner wall portion **64** of end portion **15**.

The order in which the unit **11**, the cathode assembly, and the heater assembly are mounted, may be varied without departing from the invention. However, it is essential, in accordance with the invention that the grid **24** be mounted prior to a mounting of either unit **11** or the cathode assembly in their associated envelope end portions.

It will be appreciated from the foregoing that an electron tube having an improved grid mount and an improved method of tube assembly, are provided.

We claim:

1. A grid mount comprising a support, said support having an opening therein defined by walls, a mesh type grid having a portion thereof extending into said opening, and a member made of ductile metal in said opening, said member being non-integral with said support and extending into the mesh of said grid and forcefully engaging said walls, whereby said grid is ruggedly supported by said support.

2. A grid mount comprising a disc shaped support having walls defining an opening therethrough, a tubular

grid extending into said opening in spaced relation with respect to said walls, and a ring of ductile metal disposed between and engaging said walls and said grid, said ring being non-integral with said support, a portion of said grid being in embedment in said ductile metal, said ring having a shorter axial extent than said disc, whereby said embedment is substantially uniform throughout said grid portion.

3. A grid mount comprising a metal disc having walls extending normal to the disc and defining an opening therein, a tubular grid extending into said opening and in a normal relation with respect to said disc, and means for fixing said grid in said normal relation, said means comprising a metallic ring non-integral with said disc and grid and having an outer edge forcefully engaging said walls and an inner edge defining a portion of the inner surface of said tubular grid.

4. A grid mount comprising a metal disc having walls normal to said disc and defining an opening in the disc, a tubular grid having walls parallel to said first named walls and extending into said opening, and a fixing member in said opening between said disc walls and said grid walls, said fixing member engaging said disc walls frictionally only, and said grid walls mechanically and frictionally only, said fixing member having opposite edge portions of larger cross-sectional area than a portion intermediate said edge portions, whereby the engagements between said fixing member and said disc walls and said grid walls extend across relatively large areas, for ruggedly supporting said grid on said disc.

5. Method of assembling parts to form a grid mount, wherein said parts comprise an elongated envelope having opposite ends open, an electrode support having opposite walls within said envelope and fixed to a region of the envelope intermediate said ends, a tubular grid, and a member made of ductile metal; said method comprising mounting said grid to dispose opposite portions thereof in predetermined positions, supporting said member of ductile metal adjacent to said positions, extending said envelope over said grid and member, to dispose said opposite walls adjacent to said member and with said member between said walls and said opposite grid portions, and simultaneously engaging said member from said opposite envelope ends with sufficient force to cause translations of portions of said member into firm engagement with said walls and said opposite grid portions, for ruggedly mounting said grid on said support.

6. Method of mounting a mesh type grid on a support having a wall, comprising positioning said grid in spaced relation in one direction with respect to said wall, resiliently engaging said support for movements in directions normal to said one direction, applying a compressive force in said normal directions to a member made of ductile metal between said grid and wall to cause said metal member to firmly engage said wall and to enter the meshes of said grid while preserving said support from damage.

7. Method of mounting a mesh type grid on a support having a wall, comprising mounting said wall in spaced relation to said grid, and compressing a ductile metal member between said wall and grid by engaging opposite sides of a portion of said member more closely adjacent to said grid than to said wall, for causing a greater displacement of the material of said member to said grid than to said wall, whereby said material enters meshes of said grid for firmly fixing said grid to said support.

8. Method of asembling parts to form an electrode mount, wherein said parts comprise an elongated envelope having opposite ends open and an electrode support fixed to an intermediate portion of and extending into said envelope, an electrode, and a member made of ductile metal; said method comprising supporting said electrode in a predetermined position, supporting said member of ductile metal adjacent to said electrode, supporting said envelope for axial movements and around said electrode and member to dispose said electrode support adjacent to a side of said member remote from said electrode, and forcefully engaging opposite sides of said member from directions parallel to said envelope for deforming said member into snug engagements with said electrode support and said electrode, whereby said envelope is free to move in response to a portion of said engaging force transmitted thereto.

9. Method of making a grid mount, comprising threading a ring of deformable metal over a tubular mesh type grid to cause the ring to snugly engage a peripheral portion of said grid to provide a sub-assembly, and then threading over said sub-assembly a support having an opening to cause the walls of said opening to engage said ring, whereby said peripheral portion, said ring and said support are arrayed in a predetermined plane, and engaging oposite sides of said ring parallel to said plane with appreciable pressure for deforming and enlarging the dimension of said ring in said plane to cause the material thereof to enter the mesh of said grid and to firmly engage said walls, for ruggedly supporting said grid on said support.

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