Aug. 4, 1953 N. E. PRYSLAK ET AL 2,647,298

ULTRAHIGH-FREQUENCY ELECTRON DISCHARGE DEVICE

Original Filed March 28, 1947

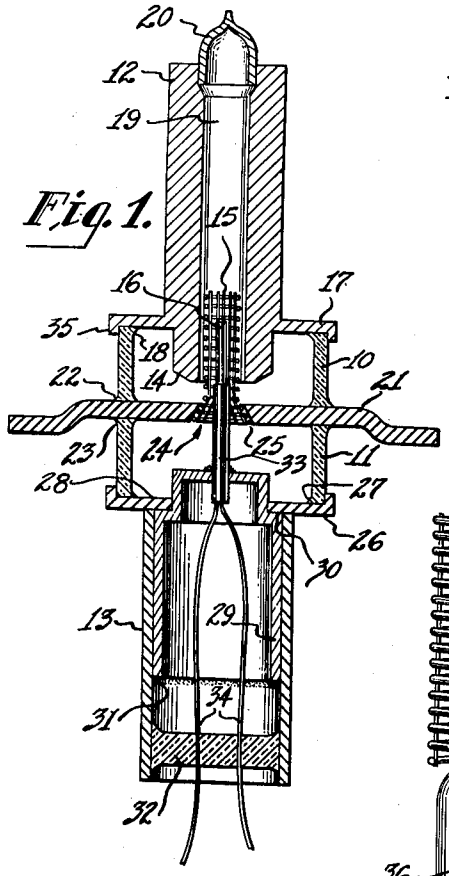


Fig. 1.

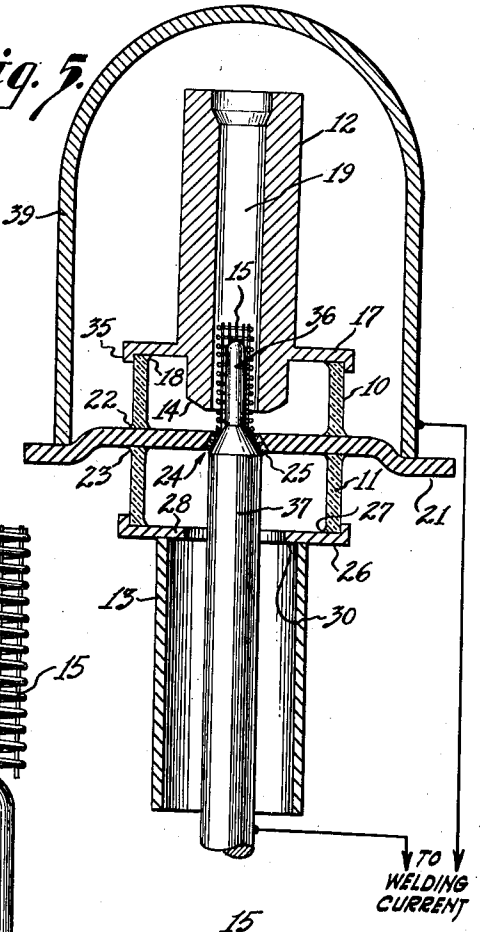


Fig. 5.

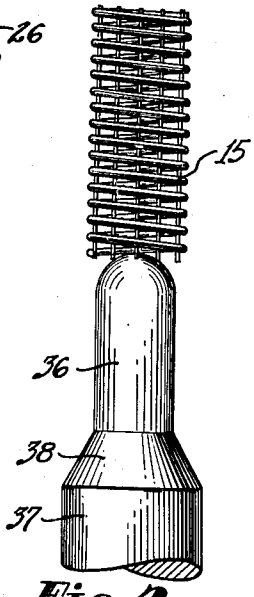


Fig. 2.

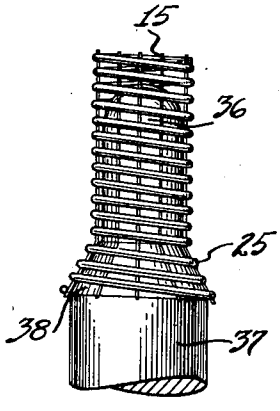


Fig. 3.

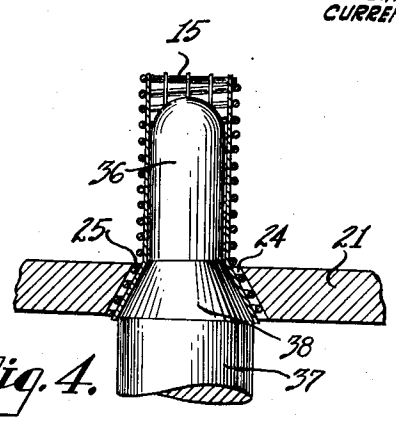


Fig. 4.

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Patented Aug. 4, 1953

2,647,298

UNITED STATES PATENT OFFICE

2,647,298

ULTRAHIGH-FREQUENCY ELECTRON DISCHARGE DEVICE

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Original application March 28, 1947, Serial No. 737,890. Divided and this application September 30, 1948, Serial No. 52,082

5 Claims. (Cl. 29—25.15)

1

The present invention relates to electron discharge devices and more particularly to electron discharge devices useful at ultra-high frequencies, and to a method of manufacture and assembly of such devices.

This is a division of our co-pending application, Serial No. 737,890, filed March 28, 1947, now Patent No. 2,473,969, issued June 21, 1949, and assigned to the same assignee as the present application.

The invention relates generally to electron discharge devices of the type wherein the electrodes comprise concentric tubular elements and wherein one of the electrodes is supported on a conducting plate which extends through the walls of the device envelope and is sealed thereto, and serves as an electrode lead. The invention particularly concerns an arrangement in such device wherein the grid is supported on the conducting plate.

The practice with respect to such electron discharge devices heretofore has been to provide the grid structure with an eyelet which is peened to a central aperture in the conducting plate for support thereon. The peening operation has involved the use of two tools, one to apply pressure to the eyelet from one direction to suitably deform it in peening and the other applied from the opposite direction to serve as a backing to absorb the pressure applied to the first tool. The use of two such tools has made accessibility to the grid and its supporting conducting plate or disc necessary simultaneously from the two opposite ends of the envelope of the device. In a structure involving this practice, the anode is supported at one end of the envelope and the cathode at the other end, the grid being mounted on the disc lead intermediate the anode and cathode.

Under the practice as heretofore followed requiring the use of two tools for peening the grid to its support, neither the cathode nor the anode can be mounted prior to fixing the grid to its support. This has resulted in the necessity for a two-part structure for forming each of the anode and cathode, one part comprising a portion of the tube envelope which is properly spaced and aligned during assembly of the envelope parts and serving as an electrode support and the other part comprising the electrode. These support parts are provided with longitudinal passageways therethrough which have sufficiently large cross sections to accommodate the tools employed in peening the grid to its disc support and for receiving the electrodes.

The use of a two-part structure for the electrodes which are mounted in the two extremities of the tube is characterized by many disadvantages. For example, a two-part structure has heretofore involved a discontinuity in the outer surfaces of the electrodes under consideration. Since ultra-high frequency devices of the type referred to are designed to function in association with concentric line conductors, the ridges or depressions in the outer surface of the electrodes referred to frequently interfere with proper engagement between such surfaces and contact fingers on the concentric line. Another respect in which a two-part electrode is undesirable is the fact that such an electrode includes a substantial area between the two parts thereof which are not joined integrally but are merely in surface contact, which in some instances is incomplete. This defective surface contact affects ultra-high frequency operation in a harmful manner. For instance it contributes to a reduction in the radio frequency power output of the tube. Furthermore, a relatively close tolerance is required between the several parts of each of the electrodes referred to, especially the anode, to reduce as much as possible the loss in radio frequency power output. Such relatively close tolerance is difficult to achieve and represents an added cost in the manufacture of the device.

2

While the practice in the manufacture of an electron discharge device of the type referred to of peening the grid to its disc support has made necessary a two-part structure for each of the anode and cathode electrodes in association with their supports, this manner of mounting the grid on its support is also accompanied by serious objections. Thus the peened engagement between the grid and its support involves a surface contact which sometimes is defective and thus contributes to poor operation of the device at ultra-high frequencies, as explained above. In addition the force required in performing the peening operation sometimes results in damage to the device thus further adding to the expense of manufacture.

It is evident from the foregoing that the practice of peening the grid of a type of device under consideration, to its support, limits the anode and cathode to structures having the undesirable features mentioned and therefore modification to avoid the peening step in the method of mounting the grid on its support is necesasry before the problems presented by the structures of the other electrodes of the tube can be suitably dealt with.

But heretofore greater difficulties have been

encountered in alternative proposals for mounting the grid on its support than have been associated with the peening method. For example, a recourse to welding the grid eyelet to the apertured grid support is accompanied by the danger that excessive heat might impair the glass-to-metal seals of the device. The electric power required for welding would involve current conduction through the conducting plate or disc lead on which the grid is to be mounted. If this plate should be excessively heated there is the hazard that its seals to the glass envelope might be harmfully affected. And due to the relatively large surface engagement between the eyelet of the grid and the disc lead a relatively large current value would be required for effecting a welded joint between these elements, and excessive heat in the disc, due to such large current value, would be difficult, if not impossible, to prevent.

Accordingly it is an object of the invention to provide an improved electron tube useful at ultra-high frequencies.

Another object is to provide an improved electron discharge device of the type employing concentric elements wherein one electrode is supported on a metal plate sealed through the walls of the envelope and in which the mounting of said electrode is accomplished in a novel manner.

A further object is to provide a novel method of making an electron discharge device in which structural limitations of at least certain of the electrodes are reduced.

An additional object is to provide a method of making an electron discharge device of the type described in which access to the interior of the device during manufacture is necessary only from one end thereof.

A further object is to provide an electron discharge device wherein no deflective surface contact exists between the respective input and output electrodes thereof and their supports.

An additional object is to provide an electron discharge device which can be employed advantageously in association with a concentric line.

Another object is to provide an electron discharge device in which the elements thereof have reduced tolerance requirements.

A still further object is to provide an electron discharge device having improved radio frequency output at ultra-high frequencies.

An additional object relates to a novel mounting of the grid on its support which avoids defective surface contact therebetween and eliminates the dependence on a two-part structure at least for one of the other electrodes for its accomplishment.

Further objects and advantages of the invention will become clear as the description continues.

While the invention is pointed out with particularity in the appended claims, it may best be understood from the detailed description of an embodiment thereof taken in connection with the accompanying drawing, in which:

Figure 1 shows a longitudinal section of an electron tube which includes the structure of our invention and has been made by our novel method; and

Figures 2 to 5 inclusive illustrate steps in our novel method of manufacturing an electron tube, Figures 2 and 3 showing the step of positioning the grid on a welding electrode with its lower portion flared by being forced down on a shoulder of the welding electrode; Figure 4 indicating in detail the engagement of the flared portion of the grid with beveled walls of the grid support, and Figure 5 depicting the relative position of the parts during the welding of the grid to its support.

Referring to the drawing in more detail there is shown in Figure 1 thereof an electron discharge device which employs our invention and which has been manufactured in accordance with our novel method.

Our novel electron discharge device includes an envelope formed by tubular glass members **10**, **11** and the elongated metallic bodies **12**, **13**, the latter bodies serving as end closures of the device. Tubular electrodes comprising anode **14**, grid **15** and cathode **16**, are mounted in concentric relation within the envelope.

Each of these electrodes and their supports and lead-ins are of novel construction contributing to ease of manufacture of the device and to good operation thereof. The advantages resulting from the novel structures ond organizations of our invention will become apparent from the following detailed description thereof.

The anode **14** is part of the integral elongated flanged body **12**, the several portions of which have different utility. The peripheral flange **17** on body **12** is sealed to glass member **10** at **18**. The flange **17** is positioned intermediate the ends of body **12** and closer to one end thereof than to the other. The shorter end portion **14** of body **12** extends into the envelope of the device and includes the work surface of the anode. Member **12** has a passageway **19** extending longitudinally therethrough which includes the required recess in anode **14** for receiving the grid and cathode, and in addition affording communication between the exterior and interior of the envelope for the purpose of evacuation. Since no tool is required to be inserted through passageway **19**, it need not be wide. The exhaust tube **20** employed in such evacuation is shown pinched off to seal the passageway after completion of the device. The portion of body **12** extending outside of the envelope serves as a lead-in for the anode.

The utilization of an integral body having portions thereof serving in the several respects mentioned is accompanied by many important advantages. The device described is intended to operate at ultra-high frequencies. At these high frequencies it is desirable to use concentric transmission lines in association with the device. Such transmission lines are usually connected to lead-ins of the device by means of fingers contacting the surface of such lead-ins. It is an aid in accomplishing the desired contact between these fingers and the lead-ins if the surface of such lead-ins is smooth. If discontinunities should be present in the lead-in surface, such as depressions or ridges, over which the contact fingers of the line are required to pass, there is danger of improper contact between lead-ins and the transmission line. If such contact is impaired, even to a slight degree between the anode lead-in and its associated transmission line, the output from the device will be inefficiently transmitted. The one-piece structure of the anode and its lead-in as provided for by our invention, avoids discontinuities in the surface of the lead-in.

In organizations where the anode and its lead-in are separate structures, such breaks in the surface are difficult to eliminate. This is for the reason that structures of the general type under consideration have heretofore included a brazed joint between the anode and its lead-in at a

surface portion over which the contact fingers of the transmission line are required to pass.

Another respect in which the one-piece structure of the anode and its lead-in is advantageous is that it reduces losses in radio frequency power output. In the two-piece anode construction as heretofore employed, one piece comprised an outer sleeve for receiving the anode. Both parts were silver plated to provide a low resistance path to radio frequency and to facilitate sealing to glass portion of the envelope. It was necessary to ream this outer sleeve to extremely fine tolerances to receive the anode barrel in a snug fit. In some instances bare steel was exposed as a result of the reaming operation, which caused a noticeable loss in radio frequency power output. The inclusion of the anode in a one-piece structure, as our invention provides, avoids this power loss and eliminates the expense of the close tolerance reaming operation.

Employment of this novel and desirable one-piece structure of the anode is possible as a consequence of a further novel feature of our invention. This feature concerns structural characteristics of the grid **15** and its support **21**, which permit mounting the grid on its support by an operation that requires accessibility to the interior of the envelope from one end thereof only. These structural characteristics are, a grid of cage or wire construction throughout its entirety having one end **25** thereof spread or flared outwardly, and a grid support **21** of a plate-like structure having an aperture or passageway **24** therethrough provided with beveled or frusto-conical walls.

These structural characteristics of the grid and its support permit a method of mounting the grid on its support to be used, which mechanically requires only a forced contact between the flared portion of the grid and the beveled walls of the passageway in its support. Such forced contact between these elements can be accomplished by applying a force longitudinally of the device through one end thereof to the flared end of the grid to seat this end in contact with the beveled walls in the support. Good contact between these parts results from the application of such longitudinal force because of the translation of a part of such force by the beveled and flared parts referred to, into a transverse component. The sum of such longitudinal and transverse components results in a force normal to the surfaces of the beveled walls of the passageway and the flared portion of the grid. To properly allow the grid end portion **25** to contact the beveled walls of the passageway **24**, the plate **21** is mounted with the wider end of passageway **24** therein, facing the open end of the device remote from the elongated member **12**.

The forced contact between the flared end **25** of the grid and the beveled walls of passageway **24** is all that is required mechanically to fix the grid to its support but such surface contact alone is insufficient to complete the mounting of the grid on its support and a further non-mechanical means is employed to complete the mounting of the grid.

Heretofore one method of accomplishing a complete mounting of the grid on its support has involved the provision of an eyelet at one end of the grid and a peening of this eyelet to its support through a passageway therein having walls normal to a surface of the support. This has required the use of two tools applied from opposite end openings in the envelope. But the contact resulting from such peening operation between the grid eyelet and the grid support was a pressure type friction contact and was objectionable in that it contributed to a loss in power output of the device.

Our invention eliminates the need for an eyelet on the grid and does not rely entirely on mechanical contact between the grid and its support. It is feasible according to our invention to provide a weld between the flared end of the grid and its support. The relatively small surface engagement between the wire strands in the flared portion of the grid and the walls of the passageway in its support, requires a welding current of less magnitude than would be required for welding a grid eyelet to the grid support.

The value of the current employed in the welding of the grid to its support is important in connection with the device of the type described. It will be noted that the grid support **21** is sealed to glass members **10**, **11** at **22**, **23**. In welding the grid to its support, electric current would be required to transverse the supporting plate **21** including the portion thereof at which these seals are located. Too high a value of such current would heat the plate **21** to such an extent as to impair the seals referred to. Such undesirable high value of current would be required in welding a grid eyelet to the grid support due to the relatively large surface engagement involved therebetween, but is avoided according to our invention by the limited surface contact of the parts to be welded as explained above.

The welded joint between the grid and its support thus permitted by the novel structures of the grid and its support is advantageous from the several standpoints of providing a direct metal to metal contact between these elements, resulting in higher power output of the device, permitting a method of manufacture to be followed that requires only one open end of the device, and allowing the use of a one-piece structure for the anode and its lead as described above.

The cathode end of the device, while subject to the requirement of providing a working space therethrough for accommodating tools required for mounting the grid upon its support, includes a novel structure that not only provides this necessary communicating space, but in addition contributes to ease of manufacture of the device and good operation thereof. The end of the device which includes the cathode **16** is provided with sleeve **13** having a peripheral flange **26** at one end thereof which is sealed to the envelope glass member **11** at **27**. Sleeve **13** also has an inwardly extending flange **28** which serves as an abutment for sleeve **29** disposed within sleeve **13**. Sleeve **29** is provided with a shoulder **30**, the surface of which is involved in the abutment referred to. Sleeve **29** is sealed to the inner wall of sleeve **13** at **31**, as by brazing. It will be noted that the sealing point is entirely within sleeve **13** and somewhat removed from the end thereof remote from the envelope. The end of the sleeve **13** remote from the envelope is suitably sealed as by a vitreous body **32**. This manner of mounting the sleeve **29** within sleeve **13** does not require a vacuum type seal at **31**, since the vacuum type seal at this end of the device is made by body **32**. Cathode support sleeve **33** is mounted on the end of sleeve **29** which extends into the envelope of the device. Cathode **16** is in turn mounted on support **33**. The cathode **16** is indirectly heated by means of a heater wire **34**.

The advantages resulting from this structure

of the cathode end of the device are important. The use of two sleeves 29, 13, permits the outer sleeve 13 to describe a relatively wide passageway to the interior of the device. This is important for permitting the entry of suitable tools into the device for mounting the grid upon its support. In addition this structure permits the outer surface of sleeve 13 to be unbroken and therefore renders it suitable for good engagement with contact fingers of an associated concentric transmission line, the advantages of such contact being more fully described in connection with the structure of the anode end of the device.

It will be noted from the foregoing that the structure of the end portions of the device and the grid and its support observe relationships whereby the features of one structure are dependent on the features of one or both of the other structures. Thus the one-piece structure of the anode end of the device is dependent upon the structure of the grid and its support which permits mounting of the grid from one end only of the device. This manner of mounting the grid is in turn dependent upon an adequate communicating space to the interior of the envelope through the cathode end of the device.

The structure of the parts of the device forming the electrodes and their lead-ins or supports permits a novel and advantageous method to be employed in their assembly to form the completed device. The envelope parts including the one-piece anode part 12, the glass members 10, 11, the conducting plate 21 and the sleeve 13 are first assembled and sealed together by the use of a centering and spacing mandrel or jig, not shown. This results in a proper spacing and centering of anode 14, conducting plate 21 and sleeve 13. The glass members 10, 11 are properly centered by engaging annular ridges 35 on the flanges 17, 19.

After these parts have been assembled and sealed as indicated the grid 15 is fixed to plate 21. Before applying the grid to the plate 21 the grid is threaded on a portion 36 of a welding tool 37 having a shoulder 38, as shown in Figure 2. Grid 15 is manually forced against shoulder 38 until one end thereof engages the wider part of shoulder 38. This step results in the formation of a flare 25 at this end of the grid as shown in Figure 3. With grid 15 thus engaging the portion 36 and shoulder 38 of welding tool 37, this tool is inserted into the passageway 24 in plate 21 with its shoulder 38 forcing the flared end 25 of grid 15 against the beveled walls of the passageway. Suitable longitudinal pressure is applied to tool 37 to assure good contact between the flared end of the grid and the beveled walls referred to, as shown in Figure 4.

The welding tool 37 comprises one terminal of an electrical circuit which includes the flared end 25 of grid 15, the conducting plate 21, and a cup shaped electrode 39 as shown in Figure 5. Due to the relatively small area of surface engagement between the wires of the grid at its flared portion and the walls of passageway 24, a welding current of a value below that which would heat plate 21 to an extent to impair seals 22, 23, is sufficient for accomplishing a weld between the flared end of the grid and the walls of the passageway.

After the weld has been accomplished the welding tool 37 is removed from the device and a centering tool, not shown, is inserted for centering the grid 15 with respect to the anode 14. This centering tool engages the inner walls of sleeve 13, which have previously been centered with respect to the anode.

The centering tool is then withdrawn and the cathode structure comprising sleeve 29, support 33, cathode 16 and heater 34, is inserted in sleeve 13. This structure is centered with respect to sleeve 29 as by a jig, not shown. Sleeve 29 engages the inner walls of sleeve 13 in a relatively tight fit and the cathode is centered by such fit with reference to the grid 15 and anode 14. The cathode structure is so dimensioned that when shoulder 30 on sleeve 29, engages the flange 28 on sleeve 13, the cathode 16 extends to a desired operating position within the anode 14 and grid 15. With shoulder 30 in abutment with flange 28 the end of sleeve 29 remote from the cathode is brazed at 31 to sleeve 13. Thereafter a stem of insulating material 32 such as glass is sealed across the open end of sleeve 13 with the heater leads 34 passing therethrough.

The final step in the manufacture of the device is the evacuation of the interior of the envelope through exhaust tube 20, which is then sealed as by pinching.

The foregoing description of an embodiment of the invention is presented with a view to apprising persons skilled in the art of one way in which it may be carried out. Of necessity much detail not required for practicing the invention has been included in this description. It is not intended, therefore, to limit the invention to the precise structures and organizations shown and described, but to permit it a scope indicated by the appended claims.

What we claim is:

1. Method of mounting a tubular and relatively fragile grid on a disc-shaped support having a passageway defined by walls of frusto-conical shape, whereby one end of said passageway adjacent one flat side of said support is wider than the other end thereof, said method comprising mounting said support transversely and intermediate the ends of an elongated electron tube envelope having an open end with said one flat side of the support facing said open end and with said passageway in the support in coaxial relation with said envelope and said open end, flaring a peripheral portion of said grid to said frusto-conical shape, extending said grid through said open end and through said passageway with the wider end of said frusto-conical peripheral portion thereof in trailing relation to the narrower end of said portion, until said peripheral portion seats on the walls of said passageway in a relatively large area engagement, and passing electric welding current through said support and said peripheral portion of the grid to weld said grid to said support.

2. Method of mounting a tubular and relatively fragile grid on a disc-shaped support having a central passageway extending axially therethrough and defined by walls of frusto-conical shape for providing a relatively wide mouth of said passageway adjacent one flat side of said support, said method comprising the steps of first mounting said support within and appreciably spaced from the ends of an elongated electron tube envelope having an open end, and with said relatively wide mouth facing said open end and coaxial therewith, deforming a peripheral portion of said grid to said frusto-conical shape, engaging the inner surface of said peripheral portion and extending said grid through

said open end and said passageway while so engaged until the outer surface of said peripheral portion engages said walls of said support in a forced contact, whereby the grid is free from additional deformation during the extending step and a relatively large area engagement is effected between said grid and said support, and welding said grid to said support at said relatively large area engagement for providing an improved weld.

3. Method of mounting a tubular and relatively fragile grid in a partly completed elongated electron tube having an open end and a disc-shaped support extending across said tube intermediate the ends of the tube and having a passageway coaxial with said open end and defined by walls diverging about 45° from the face of the support remote from said open end, whereby said passageway has a relatively narrow end for snugly receiving said grid, said method comprising deforming an end portion of said grid to provide a structure having walls diverging about 45° towards the free end of said end portion, extending said grid into said open end and through said passageway with the other end of said grid leading while engaging said grid at said end portion thereof, whereby said diverging walls of said end portion of the grid engage the diverging walls of said passageway in a forced contact of relatively large area for a good weld and with reduced hazard of further and undesirable deformation of said grid, and welding said diverging walls of said support and said grid for fixing said grid to the support.

4. Method of mounting a tubular grid on a relatively thin disc-shaped support having a passageway extending therethrough defined by walls of frusto-conical shape, whereby said passageway has a wider end adjacent one face of said disc than adjacent the other face thereof and said walls have a relatively large area, said method comprising the steps of: simultaneously extending said grid through said passageway, with the leading end of said grid first entering the wider end of said passageway and deforming a portion of said grid adjacent the trailing end only of said grid to cause said portion to engage said relatively large area walls of said passageway in a relatively large area forced contact; and welding said grid portion and said passageway walls to fix said grid to said support.

5. Method of mounting a tubular grid to extend through and be fixed to a relatively thin disc-shaped support in a relatively large area engagement, comprising puncturing said disc to provide a passageway extending therethrough for snugly receiving said grid and having walls flaring outwardly towards one face of said support at an angle less than 90° from the axis of said support, flaring an end portion including one end of said grid to said angle from the axis of said grid, extending the other end of said grid through said passageway from said one face of the support until the flared end portion of the grid seats on said walls of said passageway in a large area engagement, and welding said end portion and said walls to fix said grid to said support.

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