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METHOD OF ASSEMBLING AN ELECTRICAL HEATING UNIT OF THE LIQUID IMMERSION TYPE

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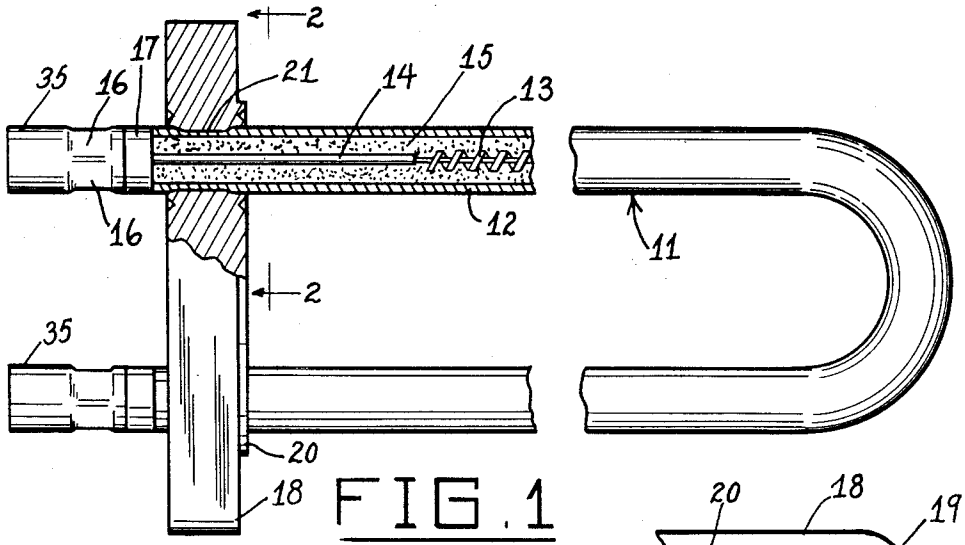


FIG. 1

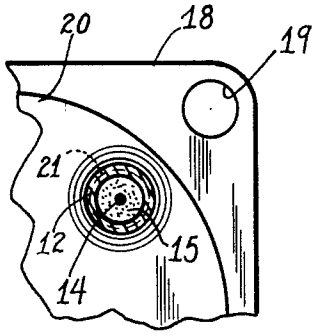


FIG. 2

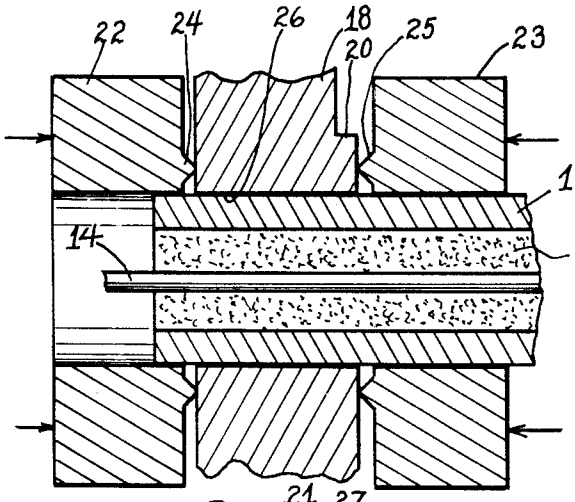


FIG. 3

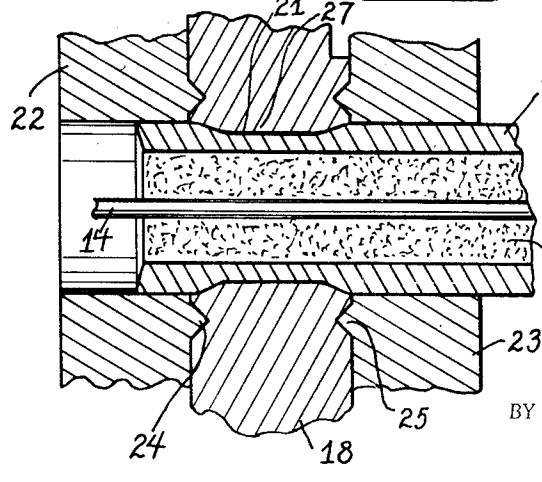


FIG. 4

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This invention relates to electrical heating units, and more particularly to a method of assembling an electrical heating unit of the liquid immersion type.

A main object of the invention is to provide a novel and improved method of pressure-sealing an electrical heating unit to a cover plate, said method providing a completely liquid-tight seal between the cover plate and the heating unit, as well as providing a very strong mechanical connection therebetween, and eliminating any necessity for brazing or welding around the joint.

A further object of the invention is to provide an improved method of assembling an electrical heating unit of the liquid immersion type, the method being capable of performance by the use of very simple apparatus and providing a substantial saving in time and costs, as over present methods of assembling such heating units.

A still further object of the invention is to provide an improved method of pressure-sealing an electrical heating unit to a cover plate which takes advantage of the compression-resisting characteristics of the densified granular insulating material employed in the heating unit, whereby the outer wall portion of the heating unit may be deformed by pressure applied thereto without causing the inner wall portion thereof to be deformed inwardly.

Further objects and advantages of the invention will become apparent from the following description and claims, and from the accompanying drawings, wherein:

Figure 1 is a side elevational view, partly in longitudinal cross-section, of an electrical heating unit constructed in accordance with the improved method of the present invention.

Figure 2 is a cross-sectional detail view taken on line 2—2 of Figure 1.

Figure 3 is an enlarged longitudinal cross-sectional detail view taken through the end portion of one of the arms of the heating unit during the assembly of the unit, and showing the pressure-sealing dies in position for pressure-sealing the cover plate of the unit to said one of the arms.

Figure 4 is a cross-sectional detail view similar to Figure 3, but showing the relationship of the elements of Figure 3 at the end of the pressure-sealing step.

Referring to the drawings, and more particularly to Figures 1 and 2, the electrical heating unit is designated generally at 11, and comprises a U-shaped tube 12 of suitable malleable metal, such as copper, brass, or the like, in which is positioned a helically wound heater wire 13 having rod-like end terminals 14. The heater wire 13 and its terminals 14 are embedded in a densely compacted mass of powdered heat-refractory insulating material 15, such as powdered magnesium oxide, or the like. Secured to the ends of the rod-like members 14 are the terminals 35, said terminals being of suitable malleable metal, such as copper, brass, or the like and being formed with axial bores receiving the rod-like members 14. The terminals are rigidly clamped to the rod-like members 14 by being compressed inwardly to define the flat surfaces 16, said flat surfaces defining a substantially square cross-sectional shape for the terminals thereat. Heat-resisting ceramic spacers 17 of porcelain or the like are interposed between the terminals 35 and the ends of the tubular member 12.

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Designated at 18 is a relatively thick cover plate of malleable metal, such as copper, brass, or the like, secured to the end portions of the arms of the tubular member 12, as shown. The cover plate 18 may be of any suitable shape, and is adapted to overlap the margins of an opening in the boiler or other liquid tank to be heated, and may be provided with apertures 19 for bolting same to the tank. As shown at 20, the cover plate may be formed with a circular thickened central portion adapted to fit into a circular opening in the tank. The end portions of the tubular member are secured to the cover plate within said circular thickened portion.

The cover plate 18 is pressure-sealed to the end portions of the tubular member 12 to provide liquid-tight, mechanically rigid joints, without requiring brazing or other similar heat-employing processes. As shown in Figure 1, the end portions of the tubular member extend through openings in the cover plate and the metal of the cover plate is deformed inwardly, causing the wall thickness of the tubular member to be locally reduced at 21 over a substantial length along the tubular member. Due to the rock-like density of the insulating material 15, no inward deformation of the wall of the tubular member occurs.

Referring now to Figures 3 and 4, the means for pressure-sealing the cover plate 18 to an end portion of the tubular member 12 may comprise a pair of annular dies 22 and 23 disposed around the end of the tubular member 12 on opposite sides of the cover plate 18 and held in a suitable clamping fixture adapted to produce squeezing force on the dies. The die 23 comprises two semi-circular segments adapted to be fitted around the tubular member 12 inwardly of the cover plate 18 and held in the clamping fixture

in encircling relation to the tubular member. The dies 22 and 23 are formed with annular V-shaped ribs 24 and 25 adapted to engage the surfaces of the cover plate at annular opposing narrow areas spaced a short distance radially outwardly from the opening 26 in the cover plate through which the tubular member 12 is inserted. When inward squeezing force is applied to the dies 22 and 23, the metal of the cover plate bulges inwardly at the interior portion of the opening 26, as shown at 27 in Figure 4, causing the metal of the tubular member 12 to flow laterally away from the bulge, inward deformation of the tubular member being prevented by the densely compacted insulating material 15. The resultant joint has substantially the cross-sectional shape shown in Figures 1 and 4, and it will be apparent from these figures that the metal of the cover plate has been placed in intimate sealing contact with the inwardly deformed outer wall surface of the tubular member along a substantial area, thereby providing the desired liquid-tight joint, as well as providing a connection having great mechanical rigidity.

In assembling a heating unit such as is illustrated in Figure 1, the following procedure is employed:

1. The heating windings with their rod-like terminals attached are placed in straight tubes and the tubes are filled with the powdered insulating material, such as magnesium oxide. The magnesium oxide is packed to a moderate density by vibrating the tubes during filling.

2. The tubes are squeezed by being passed through reducing dies, to thereby pack the insulating material to a rock-like density.

3. The tubes are bent to U-shape.

4. The cover plates 18 are then pressure-sealed to the end portions of the tubes by the process above described.

5. The porcelain spacers 17 are then placed around the rod-like terminals 14 of the heating windings.

6. The terminal lugs 35 are then placed on the rod-like elements 14 and are then pressure-locked thereto by deforming the lugs inwardly to produce the flat surfaces 16.

While a specific embodiment of an improved method of assembling an immersion-type electrical heating unit has been disclosed in the foregoing description, it will be understood that various modifications within the spirit of the invention may occur to those skilled in the art. Therefore it is intended that no limitations be placed on the invention except as defined by the scope of the appended claims.

What is claimed is:

1. A method of forming a liquid-tight seal between a metal cover plate and an electrical heating element of the type comprising a metal tubular member surrounding a resistance unit with densely packed granular insulation material between the resistance unit and the internal surface of the tubular member, comprising inserting the electrical heating element through an opening in the cover plate and exerting localized squeezing pressure on the annular area of the plate around and adjacent to said opening, said squeezing pressure being applied uniformly and to only a narrow continuous annular area concentric with and spaced outwardly a short distance from said opening, said distance being great enough to cause the interior portion of the annular mass of metal of the plate outwardly adjacent the tubular member to be forced inwardly against the tubular member, the squeezing force being sufficient to cause said interior portion of the annular mass to flow inwardly into sealing engagement with and to locally reduce the thickness of a substantial length of the wall of the tubular member continuously around said tubular member by the inward force exerted thereon by the inwardly displaced interior portion of the annular mass of metal of the cover plate, the points of greatest embedment of said annular mass of metal being at said interior portion, inward deformation of the tubular member being prevented by the densely packed insulation material.

2. A method of forming a liquid-tight seal between a metal cover plate and an electrical heating element of the type comprising a metal tubular member surrounding a resistance unit with densely packed granular insulation material between the resistance unit and the internal surface of the tubular member, said insulation material having a rock-like consistency, comprising inserting the heating element through an opening in the cover plate and exerting localized squeezing pressure on the annular areas on opposite sides of the plate around and adjacent said opening, said squeezing pressure being applied uniformly and to only opposed narrow continuous annular areas concentric with and spaced outwardly a short distance from said opening, said distance being great enough to cause the interior portion of the annular mass of metal of the plate outwardly adjacent the tubular member to be forced inwardly against the tubular member, the squeezing force being sufficient to cause said interior portion of the annular mass to flow inwardly into sealing engagement with and to locally reduce the thickness of a substantial length of the wall of the tubular member continuously around said tubular member by the inward force exerted thereon by the inwardly displaced interior portion of the annular mass of the metal of the cover plate, the points of greatest embedment of said annular mass of metal being at said interior portion, inward deformation of the internal surface of the tubular member being opposed by the densely packed granular insulation material.

3. A method of forming an electrical heating element of the liquid immersion type including a metal cover plate and a metal tubular member surrounding a helical resistance element, with granular electrically insulating, heat-conducting material between the resistance element and the tubular member, comprising placing the resistance element axially in the tubular member, filling the tubular member with the granular material, passing the tubular member through reducing dies to reduce its diameter and pack the granular material to a rock-like density sufficient to oppose inward deformation of the tubular member, bending the tubular member so that its ends are substantially parallel, inserting said ends through openings in the metal plate, and exerting localized squeezing pressure on the annular areas of the plate around and adjacent said openings, said squeezing pressure being uniformly applied and to only opposed continuous narrow annular areas concentric with and spaced outwardly a short distance from said openings, said distance being great enough to cause the interior portions of the respective annular masses of metal of the plate outwardly adjacent the tubular members to be forced inwardly against the tubular members, the squeezing pressure be-

ing sufficient to cause said interior portions of the annular masses to flow inwardly into sealing engagement with and to locally reduce the thickness of substantial lengths of the walls of the tubular members continuously around said tubular members by the inward force exerted thereon by the inwardly displaced interior portions of the annular masses of metal of the plate, whereby continuous interior metal-to-metal liquid-tight seals are formed between the cover plate and the ends of the tubular member, the points of greatest embedment of said annular masses of metal being at said interior portions, inward radial deformation of the tubular members being prevented by the packed granular material.

CROMWELL E. THOMAS.

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