March 12, 1957 N. J. BURGER 2,785,270

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

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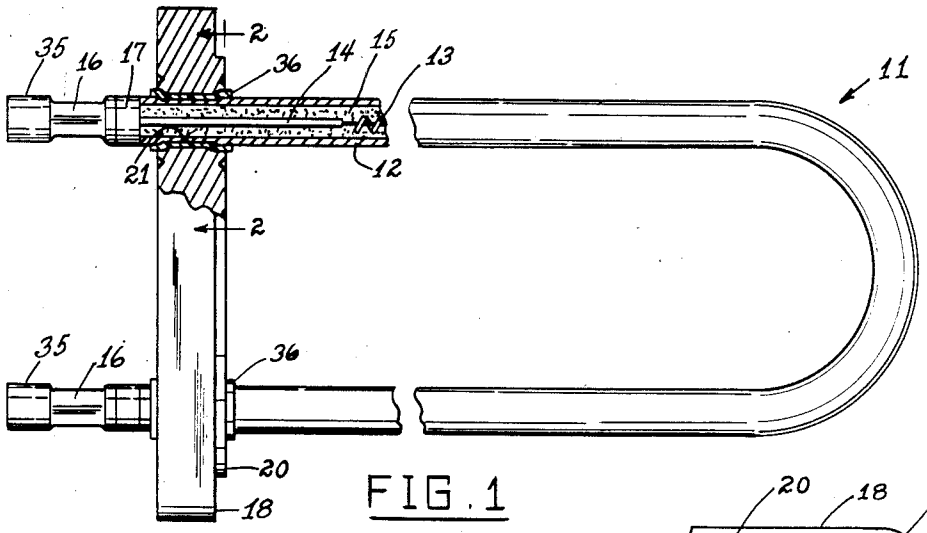


FIG. 1

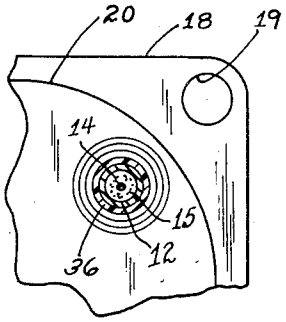


FIG. 2

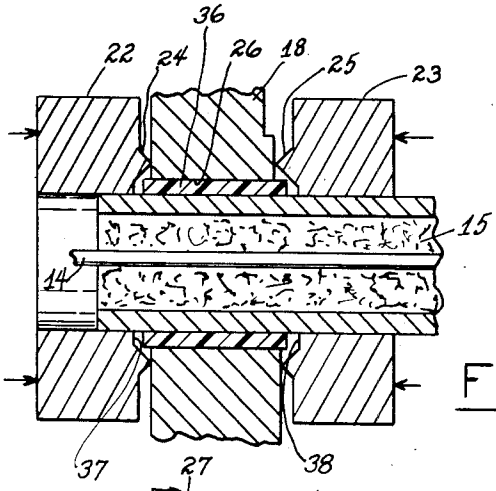


FIG. 3

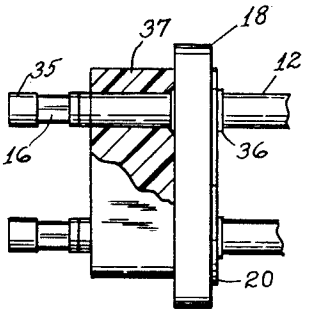


FIG. 5

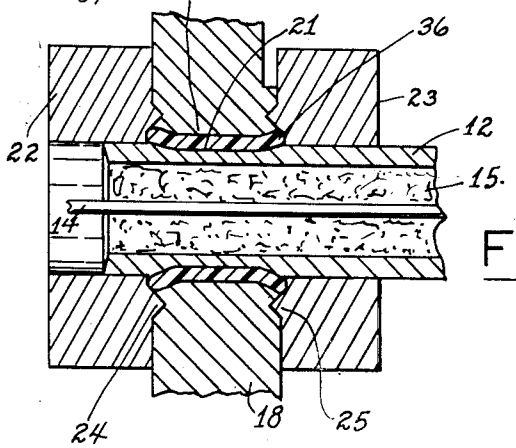


FIG. 4

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

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12 Claims. (Cl. 219—38)

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 an electrically insulated, completely liquid-tight seal between the cover plate and the heating unit, as well as providing a secure mechanical connection therebetween.

A further object of the invention is to provide an improved method of assembling an insulated 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 previous 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 and at the same time electrically insulating the unit with respect to the plate, the method utilizing the compression-resisting characteristics of the densified granular insulating material employed internally in the heating unit as well as the physical characteristics of the external insulating material, whereby the outer wall portion of the heating unit may be deformed by pressure transmitted thereto by a body of such external insulating material without causing the inner wall portion of the heating unit 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 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 view similar to Figure 3, but showing the relationship of the elements of Figure 3 at the end of the pressure-sealing step.

Figure 5 is a fragmentary side elevational view, partly in cross-section, showing the terminal end portion of an electrical heating unit constructed in accordance with a modification of the improved method of this invention.

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 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**.

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 electrically insulated, liquid-tight, mechanically rigid joints, without requiring any heat-employing processes. As shown in Figure 1, the end portions of the tubular member extend through insulating sleeves **36**, **36** secured in respective openings in the cover plate, and the metal of the cover plate and the material of the insulating sleeves **36** are 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 internal insulating material **15**, no inward deformation of the wall of the tubular member occurs.

The insulating sleeves **36** are of relatively deformable material such as plastic, fiber, or the like, and are preferably suitably confined during the pressure-sealing process, as will be presently described, so that pressure is transmitted therethrough from the metal of the cover plate to the wall of the tubular member to cause the wall thickness of the tubular member to be reduced.

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 insulating sleeve **36** and the tubular member **12** are 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, transmitting squeezing force to the relatively deformable insulating sleeve **36**. The ends of the sleeve **36** are confined in the annularly recessed inner portions **37** and **38** of the dies, whereby endwise expansion of the sleeve is prevented, and whereby the squeezing force is transmitted through the material of the sleeve to the wall of the tubular member **12**. As shown in Figure 4, the inward bulge **27** of the wall of opening **26** produces a similar inward bulge of

the insulating sleeve **36**, and the squeezing force transmitted through the bulge of the sleeve **36** causes 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 internal 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 along a substantial area with the inwardly deformed portion of sleeve **36**, and that said inwardly deformed sleeve portion has been similarly 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, electrically insulated 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** and insulating sleeves **36** are then pressure-sealed to the end portions of the tubes by the process above described.

5. The procelain 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**.

As shown in Figure 5, the cover plate **18** may be pressure-sealed to the end portions of the tube **12** by the process above described at a substantial distance from the ends of the tube, and, as a final step, an insulating block **37** of heat-resisting, electrically insulating material may be pressure-fitted on said end portions, to derive the final structure shown in Figure 5, wherein the insulating block **37** serves as an insulating spacer as well as a mechanical strengthening member to rigidify the structure of the unit adjacent the cover plate **18**.

While certain specific embodiments of an improved method of assembling an insulated immersion-type electrical heating unit have 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, electrically insulated, mechanical connection 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 a sleeve element of relatively deformable insulating material through an opening in the cover plate, inserting the heating element through the sleeve element, and exerting localized squeezing pressure on the annular area of the plate around and adjacent said opening, said squeezing pressure being applied uniformly and only to a narrow continuous annular area concentric with and spaced outwardly a sufficient distance from said opening so that the annular mass of metal of the plate outwardly adjacent the tubular member which is subjected to the squeezing pressure is forced inwardly against the intermediate portion of the sleeve element and is transmitted by the sleeve element to the tubular member, the squeezing force being sufficient to cause said annular mass to flow inwardly and to cause sufficient inward deformation of the sleeve element to locally reduce the wall thickness of the tubular member continuously around said tubular member, inward deformation of the tubular member being prevented by the densely packed granular insulating material therein.

2. A method of forming a liquid-tight, electrically insulated mechanical connection 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 a sleeve element of relatively deformable insulating material through an opening in the cover plate, inserting the heating element through the sleeve element, and exerting localized squeezing pressure on the annular area of the plate around and adjacent the ends of the sleeve element while confining said ends against endwise expansion, said squeezing pressure being applied uniformly and only to a narrow continuous annular area concentric with and spaced outwardly a sufficient distance from the ends of the sleeve element so that the annular mass of metal of the plate outwardly adjacent the tubular member which is subjected to the squeezing pressure is forced inwardly against the intermediate portion of the sleeve element and is transmitted by the sleeve element to the tubular member, the squeezing force being sufficient to cause said annular mass to flow inwardly and to cause sufficient inward deformation of the sleeve element to locally reduce the wall thickness of the tubular member continuously around said tubular member, inward radial deformation of the tubular member being prevented by the densely packed granular insulating material therein.

3. A method of forming an insulated 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 sleeve elements of relatively deformable insulating material through openings in the cover plate, inserting said ends through said sleeve elements, and exerting localized squeezing pressure on annular areas of the plate around and adjacent the ends of the sleeve members while confining said last-named ends against endwise expansion, said squeezing pressure being uniformly applied and to only opposed continuous narrow annular areas concentric with and spaced outwardly a sufficient distance from said last-named ends so that the respective annular masses of the metal of the plate outwardly adjacent the tubular member which are subjected to the squeezing pressure are forced inwardly against the intermediate portions of the sleeve elements, the squeezing force being sufficient to cause said annular masses to flow inwardly and to cause sufficient inward deformation of the sleeve elements to locally reduce the wall thickness of the tubular member continuously around said tubular member, inward radial deformation of the tubular member being prevented by the densely packed granular insulating material therein, and whereby a continuous, insulated, liquid-tight seal is formed between the cover plate and the ends of the tubular member.

4. In an electrical heating unit, a metal cover plate, a metal tubular member containing a resistance unit and tightly packed, rock-like insulation material, said tubular member extending through said cover plate, and a sleeve

element of relatively deformable insulating material sealingly secured between the tubular member and the cover plate and being inwardly deformed at its intermediate portion.

5. In an electrical heating unit, a metal cover plate, a metal tubular member containing a resistance unit and tightly packed, rock-like insulation material, said tubular member extending through said cover plate, and a sleeve element of relatively deformable insulating material sealingly secured between the tubular member and the cover plate and being inwardly deformed at its intermediate portion as a result of squeezing pressure applied on the opposite sides of the cover plate.

6. In an electrical heating unit, a metal cover plate, a metal tubular member containing a resistance unit and tightly packed, rock-like insulation material, said tubular member extending through said cover plate, and a sleeve element of relatively deformable insulating material sealingly secured between the tubular member and the cover plate and being inwardly deformed at its intermediate portion as a result of squeezing pressure applied on a portion of the cover plate.

7. In an electrical heating unit, a metal cover plate, a metal tubular member containing a resistance unit and tightly packed, rock-like insulation material, said tubular member extending through said cover plate, and a sleeve element of relatively deformable insulating material sealingly secured between the tubular member and the cover plate and being inwardly deformed at its intermediate portion as a result of squeezing pressure applied on opposite portions of the cover plate adjacent the tubular member.

8. In an electrical heating unit, a metal cover plate, a metal tubular member containing a resistance unit and tightly packed, rock-like insulation material, said tubular member extending through said cover plate, and a sleeve element of relatively deformable insulating material sealingly secured between the tubular member and the cover plate and being inwardly deformed at its intermediate portion by an inwardly deformed portion of the cover plate adjacent the tubular member.

9. In an electrical heating unit, a metal cover plate, a metal tubular member containing a resistance unit and tightly packed, rock-like insulation material, said tubular member extending through said cover plate, and a sleeve element of relatively deformable insulating material sealingly secured between the tubular member and the cover plate and being inwardly deformed at its intermediate portion by opposed inwardly deformed portions of the cover plate.

10. In an electrical heating unit, a metal cover plate, a metal tubular member containing a resistance unit and tightly packed, rock-like insulation material, said tubular member extending through said cover plate, and a sleeve element of relatively deformable insulating material sealingly secured between the tubular member and the cover plate and being inwardly deformed at its intermediate portion by opposed inwardly deformed annular portions of the cover plate.

11. In an electrical heating unit, a metal cover plate, a metal tubular member containing a resistance unit and tightly packed, rock-like insulation material, said tubular member extending through said cover plate, and a body of relatively deformable insulating material sealingly secured between the tubular member and cover plate and being inwardly deformed at its intermediate portion by an inwardly deformed portion of the cover plate adjacent the tubular member.

12. In an electrical heating unit, a metal cover plate member, a metal tubular member containing a resistance unit and tightly packed, rock-like insulation material, said tubular member extending through the cover plate member, and a relatively deformable insulating member sealingly secured between said cover plate member and tubular member and being inwardly deformed at its intermediate portion by an inwardly deformed portion of at least one of said members.

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