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L. J. TRANEL

3,374,535

METHOD OF MAKING ELECTRIC HEATERS

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FIG. 1

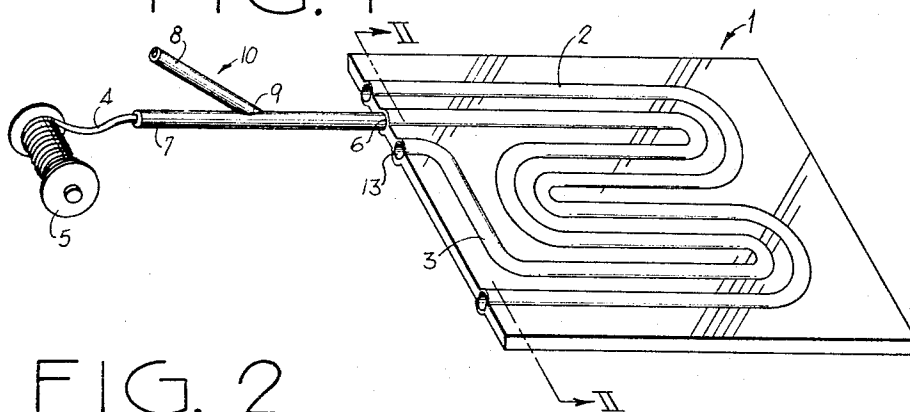


FIG. 2

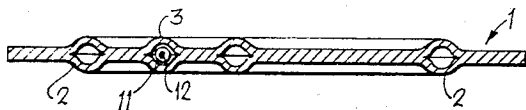


FIG. 3

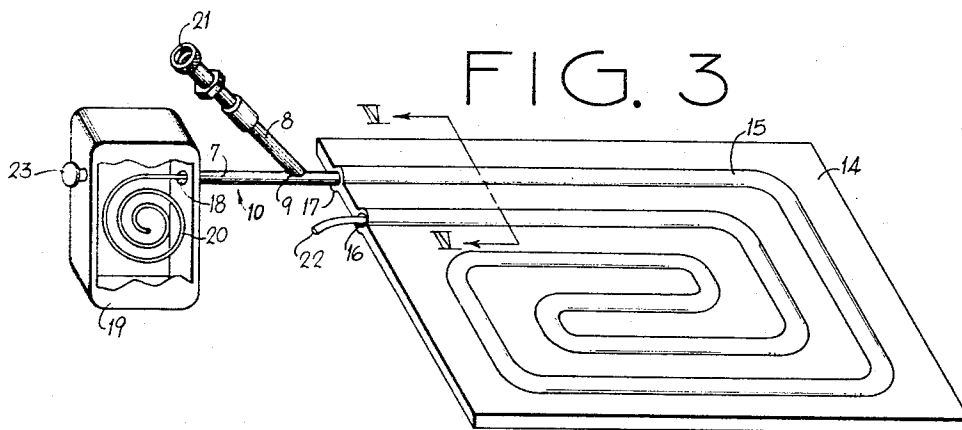


FIG. 4

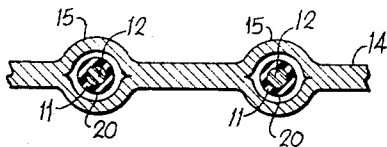
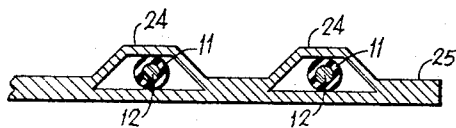


FIG. 5



INVENTOR.
LESTER J. TRANEL
BY *Henry Chusacoff &*
Louis E. Lof
ATTORNEYS

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METHOD OF MAKING ELECTRIC HEATERS

Lester J. Tranel, St. Louis, Mo., assignor to Olin Mathieson Chemical Corporation, East Alton, Ill., a corporation of Virginia

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This invention is directed to electric heaters and more particularly to making sheathed electric resistance heaters.

Heretofore the manufacture of sheathed electric resistance heaters comprised the usual steps of positioning an electrical resistance element coaxially within a straight deformable tube of generally rounded cross-section while still straight, the tube was then filled with a heat-conducting electrical-insulating material such as magnesium oxide. Thereafter, in the manufacture of electric range hot plates and the like, the tube was then bent into a flat spiral of any appropriate radius, and then compressed radially to obtain the desired cross-sectional configuration, usually in a flat-top shape. During deformation of the tube into a flat spiral by bending operations, the insulating filler material is subjected to stresses which often fragments it and causes voids which detract from reliability and efficiency of the unit. Also, during the alteration of the cross-section of the sheet by bending and pressing operations to obtain a desired shape, stresses are transmitted to the electrical element sheathed therein and cause the element to fracture, thus, opening the circuit and rendering the heating unit useless. For more tortuous and extensive heaters than range hot plates, these disadvantages are aggravated.

Where a heating element was desired to be tortuously or convolutedly distributed within a common structure, the aforesaid sheathed heating unit has heretofore been shaped into the desired configuration of the desired structure, and molten metal was poured into the mold so as to be cast about the shaped sheathed heater unit.

Heretofore no process has been known or advanced for sheathing an electrical resistance element within a tubular structure extending in a tortuous curvilinear or multi-directional pattern.

Accordingly, it is an object of this invention to provide a novel process eliminating disadvantages of the prior art relating to the manufacture of such heaters.

Another object of this invention is to provide a novel process for the manufacture of electric heaters.

Another object of this invention is to provide a novel method for sheathing an electric resistance element within a tortuously extending tubular cavity.

A further object of this invention is to provide a novel method for sheathing an electrical resistance heating unit without need for subsequent processing.

The above objects and other objects and advantages will become more apparent from the following description and drawings in which:

FIGURE 1 is a perspective view illustrating one embodiment of this invention for sheathing an insulated electrical resistance element within a tortuous passage contained in a solid sheet structure;

FIGURE 2 is a sectional view taken along lines II—II of the embodiment of FIGURE 1;

FIGURE 3 is a perspective view illustrating another embodiment of this invention for sheathing an electrical resistance element within tortuous passages contained in a solid sheet structure;

FIGURE 4 is a partial sectional view taken along lines IV—IV of the embodiment of FIGURE 3; and

FIGURE 5 is a partial sectional view illustrating an alternate cross-sectional configuration of the tubular passages illustrated in the preceding embodiments.

In accordance with this invention, the above objects

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and other objects can be obtained by freely drawing a flexible and continuous length of an insulating electric heating element into a plate-like sheath solely under the forces exerted on it by a pulsating current of air flowing in unobstructed passage through the sheath. This is done by inserting the aforesaid heating element into an inlet of a tubular hollow extending in a tortuous curvilinear or multidirectional pattern, contained within a suitable structure, wherein the element is in freely movable relationship within and throughout the extent of the hollows. Thereafter, a pulsating current of air, as for example intermittently, is injected into the inlet of this pattern of hollows in unobstructed flow through the hollow about and past the element therein so that the element alone forms the sole resistance to the current of fluid. It has been discovered that the action of this pulsating current of air causes the element to more or less float or be suspended within this current of air with the forces of the air acting upon the element, drawing or threading it through the extent of the hollows to sheath the element therein. These tubular hollows may be of any cross-sectional configuration such as rectangular, hexagonal, spherical and the like, and may be contained within any structure, either cast or between a plurality of component sheets, cold or hot pressure welded together. However, the invention will be described with reference to the pattern panels obtained by the hot pressure welding process disclosed in Letters Patent to Grenell, U.S. No. 2,690,002 granted on Sept. 28, 1954. As is well known, it is the current practice to employ such panels in conjunction with refrigerator systems as evaporator panels. As is obvious, the purpose of sheathing the electrical resistance elements in such panels, in accordance with this invention, is to remove ice or frost from these panels at a predetermined time.

In the process of the aforesaid patent, a pattern of weld-inhibiting material is interposed between superposed component sheets of metal and the sheets secured together to prevent relative movement therebetween. The secured superposed sheets are then welded together, as by hot rolling, in the adjacent areas thereof which are not separated by the weld-inhibiting material. The particular pattern of weld-inhibiting material may be applied in any desired configuration to define any desired complex system of passageways depending on the particular application desired for the welded unit. Upon welding of the unseparated portions of the welded unit, the applied pattern of weld-inhibiting material results in an unjoined portion or laminations extending between the sheets and between the unjoined portions thereof. These unjoined portions are then permanently distended by expansion thereof with fluid pressure, and the like, to form the desired system of tubular passageways. The welded sheets may be utilized in various ways, such as baseboard heaters or refrigerator evaporator plates and the like. Also, these welded sheets may be, either prior to or subsequent to expansion of the laminations therein, further fabricated into any structural configuration desired, as for example bending of the refrigerator evaporator plate to define a freezer compartment within a refrigerator. For the purpose of this invention, the passages of the panel in which the heater element is sheathed are fully inflated. However, it is to be understood that such expanded or formed passages may also be obtained by embossing two component sheets into complementary configurations of the desired passages, and corresponding portions of the sheets suitably joined together so as to form these passages.

More specifically, with reference to FIGURE 1, a pressure welded panel, such as obtained by the process of the aforesaid patent is generally indicated as 1. This panel was formed from two component sheets, such as 1100 type aluminum alloy in accordance with the Alumi-

num Association's standard designations, between which were interposed two independent and separate patterns of weld-inhibiting material defining two corresponding independent systems of tubular passages 2 and 3 coextending together sinuously across a substantial portion of the panel 1 with the pattern 3 returning by means of a straight portion back to a position adjacent its point of entry. This specific system of tubular passages is the type employed as refrigerator evaporator panels with the tubular passageways 2 adapted for flow of a refrigerant therethrough with pattern 3 intended for subsequent sheathing of an insulated and flexible electrical resistance element 4 therein, which for convenience, may be wound on a spool. This heating element is of the conventional type and is generally indicated as comprising an appropriate resistance wire 11 covered with suitable heat-conducting electric insulation 12.

In one embodiment obtained by pressure welding the above said 1100 type aluminum alloy component sheets to the tubular passages 3 in which the element is to be sheathed with its radial width parallel with the panel was $\frac{3}{8}$ inch with its expanded height of 0.180 inch. As indicated above, it is essential that this electrical resistance element be a continuous length of any conventional flexible and insulated electric heating element. For example, it may be a wire of nickel alloy chrome type wound on an asbestos core and insulated with a $\frac{1}{32}$ inch coating of a silicone rubber insulation with the total outside diameter of the insulated element being about 0.110 inch. Such wires are conventional and may be obtained from readily available suppliers, as for example, The Springfield Wire and Tinsel Company, Springfield, Mass.

However, as will be understood, the specific cross-sectional dimensions of the heater element are necessarily dependent on the cross-sectional dimensions of the hollows or tubular passages in which it is to be sheathed. It is only necessary in accordance with this invention that the heater element be flexible and in freely movable relationship therein and therethrough. Thus, it is necessary that the cross-sectional dimensions of the heating element be less than the smallest cross-sectional dimensions of the hollows or tubular passages. Although both systems of passages 2 and 3 are shown as expanded, it is obvious that only pattern 3, in which the element is to be sheathed, needs to be expanded, and that the system of passages 2 can be expanded after sheathing of the heater element in the other system of passages.

In sheathing the element into the tubular passages, it is inserted into the inlet or end opening 6 of passages 3 through a Y-shaped tubular feeder nozzle, generally indicated as 10, which may comprise a straight tube 7 having a branch tube 8 intersecting it at an intermediate portion 9. This feeder nozzle is preferably inserted into the inlet of passages 3 in airtight connection by any conventional means, as by a vise grip obtained by clamping a portion of passages 3 adjacent the inlet 6 with the portion of feeder nozzle 10 therein between clamps which grip and hold the end of the feeder nozzle within the tube and also prevent air from leaking out at this point. Alternately, as will be understood, the feeder nozzle may be soldered into the inlet 6 of passages 3. The inserted end of the heater element is necessarily maintained free of any obstruction, such as a leader plug and the like, so as to not, during its sheathing, obstruct the flow of fluid past it and about it. An air hose, not shown, is then attached in airtight relationship to the branch tube 8 of feeder nozzle 10 from a source of a fluid under pressure adapted by conventional means to flow through the inlet 6 into the passages 3 as a pulsating current flowing through the system of passages 3 for discharge through their outlet or the end openings 13. For example, if the pulsating current of fluid is of the intermittent type, the means of adaptation are merely a valve which can be closed or opened, either mechanically or manually, at predetermined time intervals. As will be understood, fluid such as air,

water, steam and the like may be employed provided as long as the fluid is not injurious to the insulation of the heating element. The specific pressure necessary to accomplish the objects of this invention is necessarily dependent on the specific combination of the element with the cross-sectional dimensions and length of the passages, and it is only necessary that the pressures employed be sufficient so that the pressure of the current of fluid through the passages be sufficient to draw the element through these passages. For example, with respect to the specific example, the fluid employed was air under 100 pounds per square inch pressure intermittently flowing into the panel on a three second cycle control with such pulsation obtained, as indicated above, by conventional means either manually, by a solenoid valve operated by well known means in the desired cycle.

Upon injection of fluid pressure into the passages 3, through the feeder nozzle 10, the pulsating current of fluid causes the heating element to literally float within it as the fluid flows past and about the element to draw it through the extent of passages 3. When the current of fluid flows through passages 3 at relatively high pressures to cause flow-back, it may be necessary to intermittently feed or insert successive sections of the heating element into the passages, whereupon the current of fluid draws these inserted sections of the element through corresponding successive portions of passages 3.

After the heating element is sheathed throughout the extent of passages 3, it will extend out of the outlet 13 of this system of passages, which as brought out above, is disposed adjacent the inlet 6 in order to facilitate subsequent attachment of the ends of the heating element to a suitable plug for attachment to a source of electric current. The resultant structure with the element sheathed herein advantageously provides an integral means for defrosting purposes when the panel is employed as an evaporator in refrigerators with the terminal portions of the system of tubular passages 2 attached into a circulating refrigerating system. Although the tubular passages 2 and 3 have been illustrated as parallelly coextending with each other and in the same stratum within the panel, it is to be understood that the separated system of passages may also be provided in different strata with each distended passageway system distended out of the opposite faces. Also, a single system of passages may be provided with panel 1 in which the heating element is to be sheathed as illustrated in FIGURE 3.

In this embodiment of the invention another panel 14 is fabricated in accordance with the process of the aforesaid patent to Grenell. However, the instant panel 14 differs over the panel 1 of the preceding embodiment in that the stop-weld material interposed between the component sheets is provided to define only a single pattern of tubular passages 15 extending as a convolutely wound system and having its outlet 16 returning adjacent its inlet 17.

As in the preceding embodiment, the feeder nozzle 10 is inserted in airtight connection in inlet 17 of tubular passages 15, however, having the inlet 18 of its tubular portion 7 attached in airtight relationship to an airtight chamber of a container 19 in which a continuous length of a flexible and insulated electric heating element 20 is disposed in coiled form. As will be understood, this container may be provided in a conventional manner with a detachable cover to facilitate placing the heating element therein and inserting it through the tubular portion 7 of feeder nozzle 10 into the inlet of passages 15. After the heating element is placed within the container and inserted into the inlet of tubular passages 15, the cover is then attached to the box, and an air hose, not shown, from a suitable source of a pulsating current of fluid is attached to any suitable connection 21 attached to the end of the branch tube 8 of feeder nozzle 10. The pulsating current of air is then injected into the panel in unobstructed flow past and about the element therein through the extent of

the tubular passages 15 until the leading end 22 emerges from the outlet 16 of the passages. The provision of the airtight box on the end of the tubular portion 7 of feeder nozzle 10 eliminates any flow-back of the fluid, thus also eliminating any need for inserting successive portions of the heater element.

In an alternate modification, the manner in which the current of fluid is injected into the passages, the end of branch tube 8 may be sealed by a suitable plug inserted into connection 21 thereon, thus eliminating need for this branch tube which may be eliminated from the feeder nozzle 10, and the air hose connected to a suitable connection 23 provided in the walls of container 19 through which the current of fluid is introduced. In this modification, if it is found necessary to restrain the drawing of the heating element through the passages 15 under the influence of the fluid current, the heating element may be coiled on a suitable reel, not shown, and the reel placed under suitable well known tensioning means to control the amount of restraint desired against the drawing of the heater element through the passages.

Although all of the tubular portions in both of the preceding embodiments have been shown as being expanded out of their respective panels to bulge in a spherical cross-sectional configuration out of both sides of their respective panels, it is to be understood that the invention is equally applicable to tubular passages of other cross-sectional configurations. For example, the unexpanded blanks obtained by the process of the aforesaid patent to Grenell may be expanded between spaced apart rigid surfaces to provide a hexagonal configuration in the tubular passages into which the heating element is to be sheathed. Alternatively, the tubular passages 24 may also be bulged out of only one side of a panel 25 into a flat-topped configuration by conventional manner, for example by expansion between suitably recessed dies.

Although the invention has been described with respect to various embodiments, materials and details, various modifications and changes will be apparent to one skilled in the art and are contemplated to be embraced within the invention.

What is claimed is:

1. A method of sheathing a flexible and continuous length of an insulated electric heating element in a hollow structure comprising a continuous tubular conduit extending in a multi-directional unbranched pattern with said conduit having exposed terminal ends, the method comprising introducing said element into one of said ends of said conduit in freely movable relationship therein and therethrough, and injecting a pulsating current of fluid into said one end in unobstructed flow through said conduit about and past said element therein, said current of fluid being injected under sufficient pressure to draw said element through said conduit.

2. A method of sheathing a flexible and continuous length of an insulated electric heating element in a sheet metal structure provided with a continuous tubular passage extending in a multi-directional unbranched pattern therein with said passage having its ends terminating in corresponding openings at a surface of said structure the method comprising, introducing said element into one of said openings of said passage in freely movable relationship therein and therethrough, and injecting a pulsating current of air into said one opening in unobstructed flow through said passage about and past said element therein, said current of air being injected under sufficient pressure to draw said element through said passage.

3. The method of claim 2 comprising introducing said element into said passage through a tubular nozzle in airtight connection with the said one opening of said passage and extending from an airtight chamber with said element being disposed in coil form in said chamber, and injecting said current of air into and toward said passage through said nozzle at an angle therewith at a portion of said nozzle between said chamber and said

one opening of said passage while maintaining said air under sufficient pressure to draw said element through said passage.

4. The method of claim 2 comprising introducing said element into said passage through a nozzle in airtight connection with the said one opening of said passage and extending from an airtight chamber with said element being disposed in coil form in said chamber, and said current of air is injected into said chamber and is discharged through said nozzle for unobstructed flow through said passage while maintaining said air under sufficient pressure to draw said element through said passage.

5. The method of claim 2 comprising introducing said element into said passage through a tubular nozzle in airtight connection with said one opening of said passage, and injecting said current of air into and toward said passage through said nozzle, said air being injected at an angle with said nozzle and at an intermediate portion of said nozzle, and including the step of intermittently inserting successive sections of said element through said nozzle into said passage, while maintaining said air under sufficient pressure to draw said inserted sections of said element through corresponding successive portions of said passage.

6. A method of sheathing a flexible and continuous length of an insulated electric heating element in a continuous tubular passage extending in a multi-directional unbranched pattern within joined superimposed sheets and between joined portions thereof and having its ends terminating in corresponding openings at the external surface of said sheets comprising, introducing said element into one of said openings of said passage in freely movable relationship therein and therethrough, and injecting a pulsating current of air into said one opening in unobstructed flow through said passage about and past said element therein, said current of air being injected under sufficient pressure to draw said element through said passage.

7. A method of sheathing a flexible and continuous length of an insulated electric heating element in a continuous tubular passage extending in a multi-directional unbranched pattern within welded superimposed sheets and between welded portions thereof and having its ends terminating in corresponding openings at the external surface of said sheets comprising, introducing said element into one of said openings of said passage in freely movable relationship therein and therethrough, and injecting a pulsating current of air into said one opening in unobstructed flow through said passage about and past said element therein, said current of air being injected under sufficient pressure to draw said element through said passage.

8. The method of installing a heater wire in a serpentine passage, comprising the steps of: providing a coil of heater wire; disposing the end of the coil of heater wire adjacent an outlet end of the passage; and forcibly pulsating fluid against the wire and into the outlet end of the passage to carry the wire therewith longitudinally into the passage.

9. The method of installing a heater wire in a serpentine passage, comprising the steps of: providing a coil of heater wire; disposing a Y-shaped carrier with the base thereof toward one end of said passage; extending one end of the coil of heater wire through one arm and the base of said carrier; and forcibly pulsating fluid through the other arm and said base of the carrier to impinge against the wire and flow into the outlet end of the passage to carry the wire therewith longitudinally into the passage.

10. A method of sheathing a flexible and continuous length of an insulated electric heating element in a sheet metal structure provided with a continuous tubular passage extending in a multi-directional unbranched pattern therein with said passage having its ends terminating in

corresponding openings at a surface of said structure the method comprising, introducing said element into one of said openings of said passage in freely movable relationship therein and therethrough, and injecting a pulsating current of air into said one opening in unobstructed flow through said passage about and past said element therein, said current of air being injected under sufficient pressure to draw said element through said passage.

11. The method of claim 10 comprising introducing said element into said passage through a nozzle in air-delivery connection with said one opening of said passage and extending from an airtight chamber with said element being disposed in coil form in said chamber, and said current of air is injected into said chamber and is discharged through said nozzle for unobstructed flow through said passage while maintaining said air under sufficient pressure to draw said element through said passage.

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JOHN F. CAMPBELL, *Primary Examiner.*

J. MULHOLLAND, J. W. BOCK, *Assistant Examiners.*