

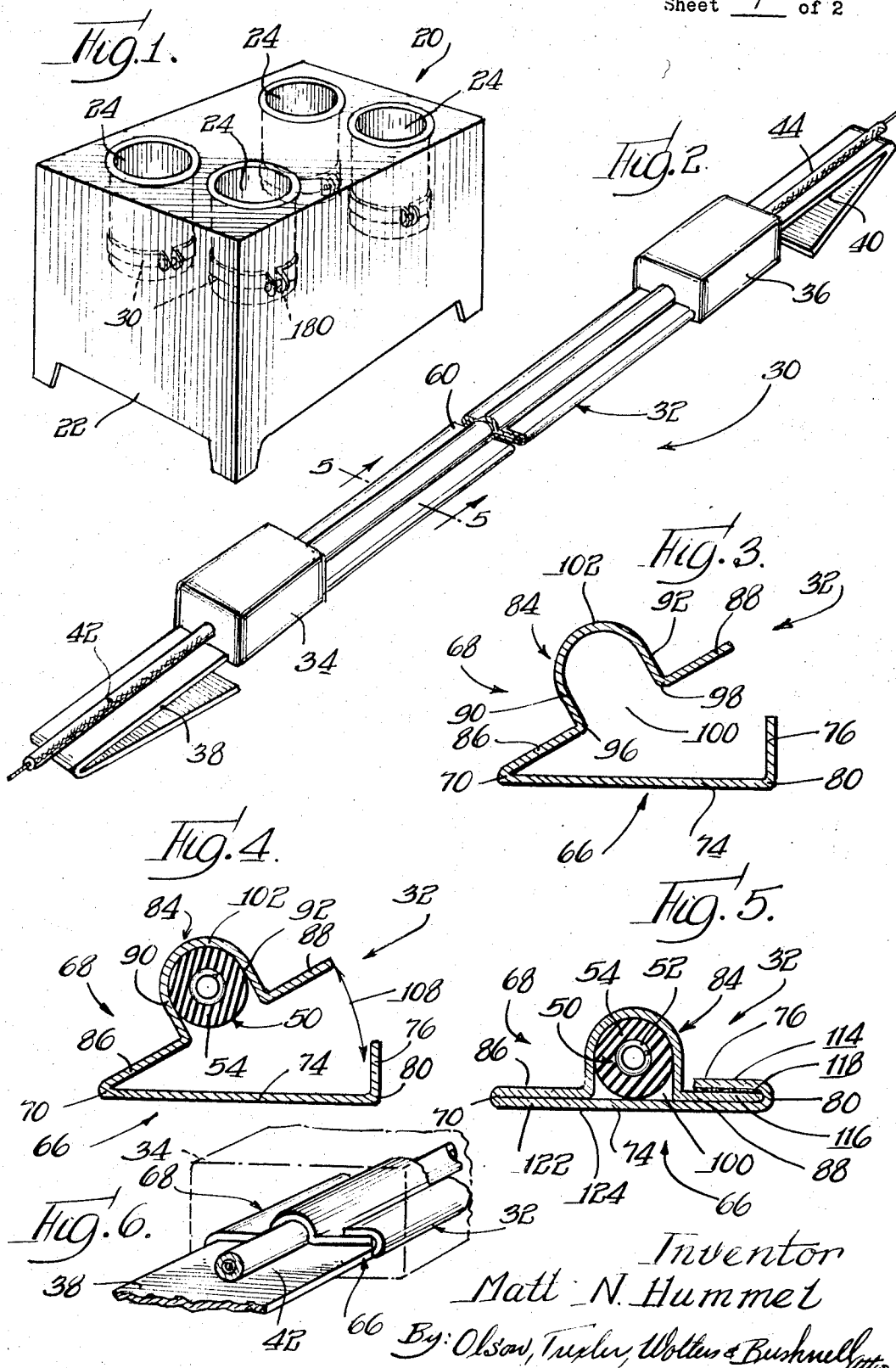
July 1, 1969

M. N. HUMMEL
ELECTRIC HEATER ASSEMBLY

3,453,417

Filed Dec. 7, 1966

Sheet 1 of 2



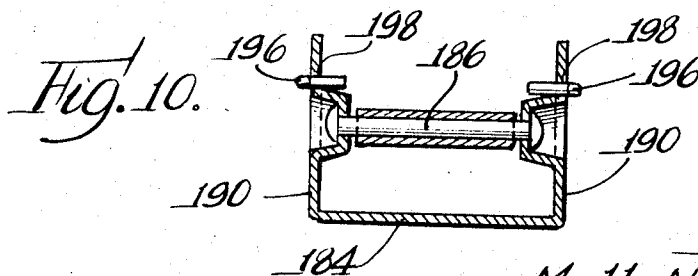
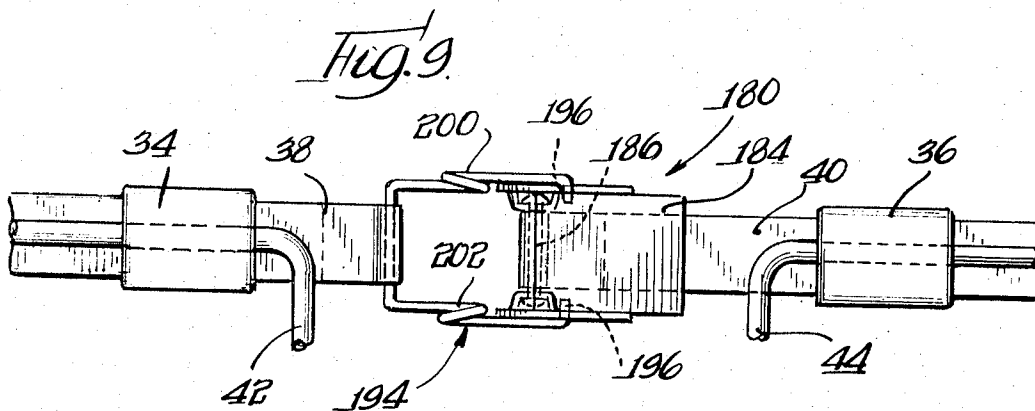
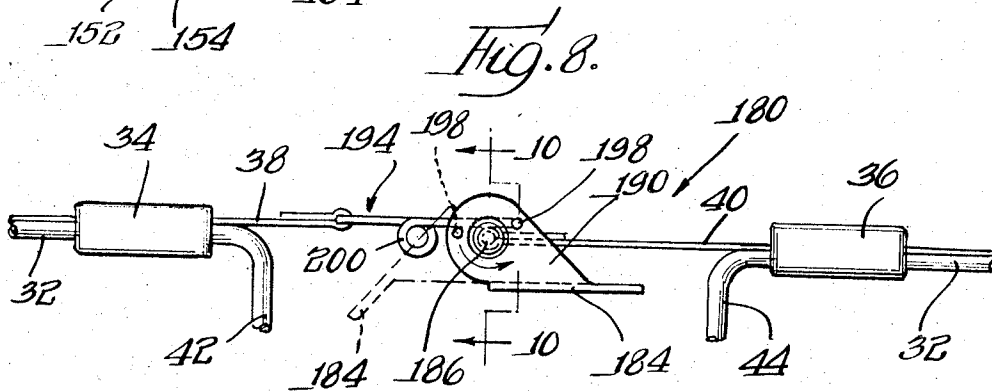
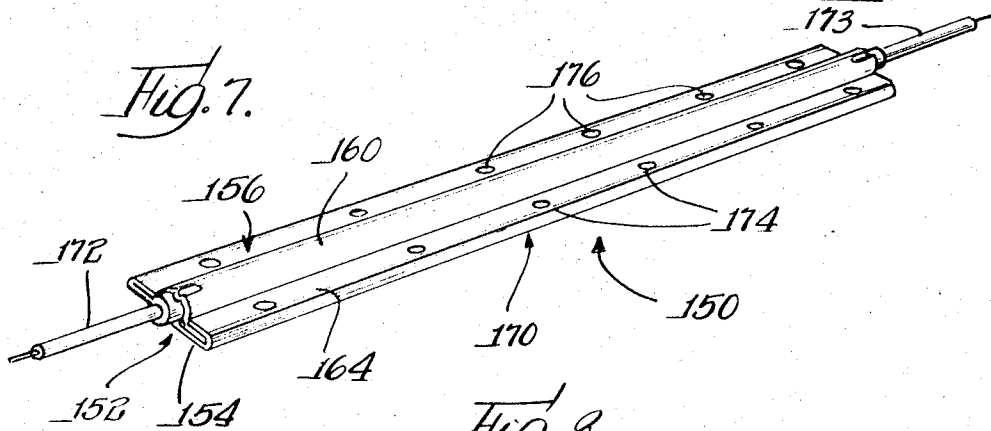
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Sheet 2 of 2



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ELECTRIC HEATER ASSEMBLY

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7 Claims

ABSTRACT OF THE DISCLOSURE

An electric heater assembly having a band or strip-type heater structure. The heater assembly contemplates the use of a strip of sheet metal stock which provides a pair of hingedly connected elongated plate members. The free longitudinal margins of these plate members may be separated to permit lateral insertion therebetween of an insulated electrical resistance heating element. These sheets, when swung into juxtaposition, provide a metallic sheath and the free margins of the plate sections may be secured against unauthorized separation.

Electric heater elements or assemblies of the strip or band type are commonly used in food warmers, vending machines, refrigeration compressors, and other locations where a concentrated application of heat is desired. The strip or band type heater element is particularly satisfactory because it has a relatively thin flat structure which provides a maximum contact area for heat transfer between the heater element and the object to be heated. This relatively large flat heat transfer area promotes rapid thermostatic response of the heater while minimizing heat loss through radiation.

Prior art band or strip-type heater elements commonly include a resistor wire which is mounted on or sandwiched between a pair of mica heater plates. The plates and resistor wire are usually encased within a metallic sheath. The sheath generally includes an upper terminal plate and a lower base plate. The separate upper and lower sheath plates are interconnected by longitudinally extending flanges which are integrally formed with the base plate and are folded into overlapping engagement with opposite longitudinally extending sides of the upper terminal plate. Two longitudinally extending joints are formed between the flanges of the base plate and the terminal plate. These joints are usually sealed to prevent moisture from leaking into contact with the plates and resistor wire.

These prior art heater elements, while being particularly advantageous for many applications, are relatively expensive and difficult to manufacture. The manufacturing expense and difficulty is due, in part at least, to the construction of the metallic sheath and plates used in the heater element. The manufacturing of the heater element requires that the mica plates and the upper terminal plate be centrally positioned on the base plate of the sheath. Then the longitudinally extending outer edges of the base plate are bent or folded into overlapping relationship with the terminal plate. After these steps have been performed, the joint between the overlapping base plate and terminal plate are sealed to provide a waterproof heater element. The relatively large number of manufacturing operations and joints in the sheath all increase the cost of the heater element.

Therefore, it is an object of this invention to provide a relatively inexpensive band or strip-type heater element.

Another object of this invention is to provide a sheath for a band or strip-type heater which has a relatively large heat transfer area and which is inexpensive to fabricate.

Another object of this invention is to provide a waterproof heater element which can be easily and inexpensively fabricated.

These and other objects and features of the invention will become more apparent upon a consideration of the following detailed description taken in connection with the accompanying drawings wherein:

FIG. 1 is a perspective view of a food warmer in which a plurality of containers of food are warmed by a heater assembly forming a preferred embodiment of the invention;

FIG. 2 is an enlarged perspective view of the heater structure or assembly used in the food warmer of FIG. 1;

FIG. 3 is an enlarged cross-sectional view of a sheath used with the heater assembly of FIG. 2, the sheath being shown in an open position before a heating element has been inserted into the sheath;

FIG. 4 is an enlarged cross-sectional view of the sheath in the open position, similar to FIG. 3, with the heating element inserted or positioned in the sheath;

FIG. 5 is an enlarged cross-sectional view, along the line 5—5 of FIG. 2, illustrating the interrelationship of the heating element and the sheath when the sheath is in a closed position;

FIG. 6 is an enlarged perspective view illustrating the relationship of the sheath to a longitudinally outwardly extending mounting or connector end section of the heater assembly;

FIG. 7 is an enlarged perspective view, similar to FIG. 2, of a heater assembly which forms a second embodiment of the invention;

FIG. 8 is an enlarged elevational view illustrating the relationship of a toggle-type mounting clamp assembly to the heater assembly of FIG. 2;

FIG. 9 is an enlarged plan view of the clamp assembly of FIG. 8; and

FIG. 10 is an enlarged cross-sectional view, taken along the line 10—10 of FIG. 8, illustrating an interconnection between two sections of the clamp assembly.

Referring now to the drawings in greater detail, a food warmer 20 is shown in FIG. 1. The food warmer 20 includes a tank 22 into which a plurality of receptacles or containers 24 project for holding food. A heater assembly or structure 30, forming a preferred embodiment of the invention, is mounted on a lower end portion of each of the containers 24 to heat the contents of the containers. The tank 22 is filled with water or another suitable fluid to promote conduction of heat around upwardly extending sides of the containers 24.

The heater assembly is shown in greater detail in FIG. 2. The heater assembly 30 includes a flexible metal sheath or cover structure 32 which can be formed of aluminum, steel, or any of the many suitable commercially available metal alloys. A pair of molded sealing blocks or bodies 34 and 36 are mounted at opposite ends of the sheath 32 to seal the ends of the sheath. The blocks 34 and 36 are formed of a suitable elastomeric compound, such as any one of the commercially available silicone or neoprene synthetic rubber compounds. A pair of mounting or connector end sections 38 and 40 extend longitudinally outwardly from the blocks 34 and 36 to facilitate mounting the heater assembly 30 on a body, similar to the containers 24, which is to be heated. A pair of connector or lead wires 42 and 44 also extend longitudinally outwardly from the blocks 34 and 36. The lead wires 42 and 44 are connected to a heating element 50 which is best seen in FIG. 5. The heating element 50 can advantageously be formed of a helical coil 52 of nickel chromium resistance wire which is surrounded with an electrically insulating sleeve 54 of fiberglass. The heating element 50 extends for substantially the entire length of a central heating section 60 (see FIG. 2) of the heater assembly 30.

As will be apparent to those skilled in the art, the coil 52 is heated by a flow of electrical current through the coil when the lead wires 42 and 44 are connected to a source of electrical energy. Heat from the coil 52 is then conducted through the sheath 32 to the body which is to be heated.

The sheath 32 is illustrated, in FIG. 3, in an opened position before the heating element 50 has been inserted into the sheath. The sheath 32 is a unitary structure which includes a base section 66 integrally formed with a body section 68. The base section 66 and body section 68 are interconnected by a longitudinally extending fold or pivotal hinge section 70 which enables the body section 68 to be pivoted relative to the base section 66 from the open position shown in FIG. 3 to a closed position shown in FIG. 5. The fold or hinge section 70 also provides a water-tight connection between the base section 66 and the body section 68. The base section 66 includes a floor or mounting wall section 74 which is connected to a leg flange or flap section 76 by a corner or hinge section 80. The body section 68 includes a central U-shaped heating element receiving section or protuberance 84. A pair of longitudinally extending flange arms or sides 86 and 88 are connected to generally parallel leg sections 90 and 92 of the U-shaped heating element receiving protuberance 84. The leg sections 90 and 92 of the protuberance 84 extend perpendicularly to the flange arms 86 and 88 and are connected to the flange arms 86 and 88 by corner sections 96 and 98 which define an inner open end or mouth 100 of the protuberance 84. An outer end of the protuberance is enclosed by a semicircular end or connector wall 102 to complete the generally U-shaped heating element receiving protuberance 84.

The heating element 50 is inserted or mounted in the longitudinally extending protuberance 84 when the sheath or cover structure 32 is in the open position, see FIG. 4. The heating element 50 is inserted into the protuberance 84 by moving the heating element through an arcuate opening 108 which extends between the flange or flap 76 and the flange arm or slide 88. After the heating element 50 has been moved to a position intermediate the body section 68 and base section 66, the heating element 50 is laid into the longitudinally extending protuberance 84. The longitudinally extending protuberance 84 is shaped to receive the heating element 50 so that the leg sections 90 and 92 of the protuberance extend tangentially from the heating element while the semicircular end wall 102 of the protuberance engages the outer surface of the heating element.

Once the heating element 50 has been positioned in the protuberance 84, the body section 68 is pivoted about the hinge or fold 70 to close the opening 108 and position the flange arms 86 and 88 into confronting juxtaposition with the floor 74 of the base section 66, as shown in FIG. 5. After the body section 68 has been pivoted or rotated to the closed position shown in FIG. 5, the heating element 50 is enclosed by the protuberance 84 and the floor 74 of the base section 66 which blocks the previously open end or mouth 100 of the protuberance 84. It should be noted that the insulation 54 of the heating element 50 extends through the mouth 100 into abutting engagement with an inner surface of the floor or mounting wall 74. The flange arm or flap 76 is then pivoted about the longitudinally extending hinge section 80 to move an inner surface 114 of the flange 76 into confronting juxtaposition with an outer surface 116 of the flange arm 88. The resulting joint between the flap 76 and flange arm 88 is sealed by a water and heat resistant adhesive layer 118 to securely interconnect the base section 66 and body section 68 of the sheath or covering structure 32.

When the heating element 50 is energized heat is radiated from the resistor coil 52 outwardly to the base section 66 and body section 68 of the heater assembly 30. This heat from the coil 52 is conducted by the relatively wide longitudinally extending area of the mount-

ing wall 74 of the base section 66 to a body which is to be heated. By experimentation it has been determined that the heater assembly 30 should be positioned with the mounting wall 74 in close abutting juxtaposition with the body to be heated. Air gaps between the mounting wall 74 and the body to be heated cause poor heat transfer, lower the efficiency of the heater assembly and may shorten the operating life of the heater assembly. To prevent the occurrence of these air gaps, an outer surface 122 of the mounting wall 74 is coated with a layer 124 of a heat and water resistant adhesive which securely connects the mounting wall 74 to the body to be heated.

After the heating element 50 has been mounted in the sheath 32 in the manner previously explained, the blocks 34 and 36 are molded onto the outer end of the sheath 32 to seal or close the sheath. The longitudinally extending joint between the flap 76 and the flange arm 88 is sealed by a longitudinally extending layer of water resistant adhesive 118 so that the water cannot seep into the interior of the sheath 32 through the joint between the base and body section. Since the longitudinally outer ends of the sheath are sealed by the blocks 34 and 36 which are molded in tight sealing engagement with the leads 42 and 44, the sheath 32 is completely waterproof. It should be noted that the hinge 70 is integrally formed with the base section 66 and body section 68 so that water cannot seep into the interior of the sheath 32 along the side of the sheath which is opposite from the layer of adhesive 118.

The longitudinally outwardly extending mounting or end sections 38 and 40 of the heater assembly 30 are integrally formed with the sheath 32, as is best seen in FIG. 6. The end sections 38 and 40 are in fact a continuation of the mounting wall 74 of the base section 66. As will be explained in greater detail subsequently the end sections 38 and 40 are adapted for engagement with a clamping unit to mount the heater assembly 30 on cylindrical bodies, such as the containers 24 of FIG. 1.

A heater assembly 150 forming a second embodiment of the invention is shown in FIG. 7. The heater assembly 150 is generally similar in construction to the heater assembly 30. However, the end portions and joints of the heater assembly 150 are not sealed. Therefore, the heater assembly 150 is not waterproof as is the heater assembly 30. The heater assembly includes a base section 152 having a mounting wall 154 and a body section 156 having a heating element receiving protuberance 160. The base section 152 and the body section 156 are interconnected by a flap or flange 164 to provide an integral sheath or covering structure 170. A heating element, similar to the heating element 50 of the embodiment of FIGS. 2 through 6, is mounted within the protuberance 160. A pair of lead wires 172 and 173 connect the heating element to a source of electrical energy.

The heater assembly 150 is provided with a plurality of apertures 174 and 176 which extend through opposite sides of the heater assembly to facilitate the mounting of the heater assembly on a body which is to be heated. The apertures or holes 174 extend through the flap 164, a side portion of the body section 156 and the mounting wall or floor 154 of the base section 152. The holes or apertures 176 on the opposite side of the heater assembly 150 extend through only a side flange of the body section 156 and the mounting wall 154 of the base section 152. Although the heater structure 150 is intended for use in locations wherein the heater is not submerged in water or other fluid, it will be apparent to those skilled in the art that the heater assembly 30 of FIG. 2 could be readily provided with apertures, similar to the apertures 174 and 176, to mount the heater assembly 30 on a body to be heated. Of course, since the heater assembly 30 is intended for use in locations where it is contacted by fluid, a heat and fluid resistant layer of adhesive would be provided between the base and body sections of the heater assemblies where the apertures, similar to the apertures 174 and 176, extend through the base and body

sections to seal off the apertures from the interior of the sheath 30.

A toggle type clamp assembly 180 for the heater assemblies 30 and 150 is shown in FIGS. 8 through 10 in connection with the first embodiment of the heater assembly. The clamp assembly 180 includes a clamp or actuator arm 184 which is mounted for pivotal movement about a pin 186 which extends through a central axis of a pair of spaced apart outwardly extending flanges or ears 190 which are integrally formed with and extend from the actuator arm 184 (see FIGS. 8 and 10). A resilient generally U-shaped frame or connector section 194 engages the ears 190 of the actuator arm 184. The frame 194 has a pair of inwardly extending connector fingers 196 which project toward each other to engage a pair of apertures or holes 198 in the ears 190 of the actuator arm 184. The frame 194 is connected to the end section 38 of the heater assembly 30 and the pin 186 is connected to the opposite end section 40 of the heater assembly 30. Thus, the two ends of the heater assembly 30 are interconnected by the clamp assembly 180 to form an annular heater structure which can be readily mounted on cylindrical bodies, such as the receptacles 24 of FIG. 1.

When the actuator arm 184 is moved to the open position, illustrated in dashed lines in FIG. 8, the aperture 198 is spaced apart from the end section 40. This loosens the heater assembly 30 on the cylindrical body by increasing the circumference of the heater assembly. When the actuator arm 184 is rotated to the closed position shown in solid lines in FIG. 8, the aperture 198 is moved to a position adjacent to the end section 40 of the heater assembly 30 to decrease the circumferential dimension of the heater assembly and, consequently, tighten the heater assembly on the body on which it is mounted. When the clamp assembly 180 is in the closed position the aperture 198 is offset radially inwardly relative to the end section 40. Therefore an increased circumferentially directed force, due to thermal expansion or other causes, on the heater assembly 30 merely pulls the actuator arm in the direction of the arrow in FIG. 8 to tighten the clamp assembly in a toggle action which is well known per se to those skilled in the art. A pair of resilient springs 200 and 202 are integrally formed with the frame structure 194. The springs 200 and 202 allow the heater assembly 30 and the body on which it is mounted to thermally expand and contract at different rates without damage to the heater assembly. The springs 200 and 202 enable the heater assembly 30 to resiliently expand and contract circumferentially with expansion and contraction of the body in which they are mounted due to thermal effects. However, the springs 200 and 202 are sufficiently stiff, that is, have a high enough spring rate, to maintain the heater assembly 30 in close abutting engagement with the body to be heated. It should be noted that the toggle type clamp assembly 180 pulls the heater assembly into tight abutting engagement with the body on which it is mounted when the actuator arm 184 is moved from the open position indicated in dashed lines in FIG. 8 to the closed position indicated in solid lines in FIG. 8.

For purposes of affording a more complete understanding of the invention, it is advantageous now to provide a functional description of the mode in which the component parts of the invention cooperate. When the heater assembly 30 is manufactured or fabricated the sheath will initially be in the open position shown in FIG. 3. With the sheath 32 in this position the heating element 50 can be readily located in the protuberance 84. The body section 68 of the sheath 32 will then be pivoted toward the base section 66 of the sheath 32 about the hinge section 70 to position the flange arms 86 and 88 in abutting engagement with the mounting wall 74 of the base section 66. A layer of adhesive 118 will then be applied to an outer surface 116 of the flange arm 88. Next the flap 76 will be pivoted about the hinge 80 so that an inner surface 114

of the flap is located in juxtaposition with the outer surface 116 of the flange arm 88. When the flap 76 is in this position, the joint between the flap 76 and the flange arm 88 will be sealed by the layer of adhesive 118. The end portions of the sheath 32 will be sealed by molding the blocks 34 and 36 around the ends of the sheath and leads 42 and 44 which are connected to the heating element 50. The clamp assembly 180 is then connected to the flexible end sections 38 and 40 of the heater assembly and layer of adhesive 124 is advantageously applied to the outer surface 122 of the base section 66 to facilitate securing the mounting wall 74 to a body which is to be heated.

When the heater assembly is to be mounted on a body which is to be heated, the flexible sheath 32 of the heater assembly will be bent to conform to the configuration of the body. The frame 194 of the clamp assembly 180 will then be connected to the actuator arm 184 of the clamp assembly with the actuator arm in the open position indicated by the dashed lines in FIG. 8. Next, the actuator arm 184 will be pivoted or rotated to the closed position, indicated by solid lines in FIG. 8, to draw the heater assembly 30 into secure abutting engagement with the body which is to be heated.

The second embodiment of the heater assembly 150 is assembled in the same manner as was previously set forth for the embodiment 30 of the heater assembly. However, it is contemplated that the heater assembly 150 will be used in locations which do not require a waterproof heater assembly so that the manufacturing steps of molding the blocks 34 and 36 on the end portion of the heater assembly are omitted as is the layer of adhesive between the flap and the body section. The heater assembly 150 is provided with a plurality of apertures 174 and 176 which extend through the base section 152 and body section 156 of the heater assembly. The apertures 174 and 176 are particularly advantageous for suspending the heater element 150 to heat the air within an enclosure. It should be noted that when the apertures 174 and 176 are utilized with a suitable connection means for fastening the heater assembly 150 to a body having a different coefficient of thermal expansion than the heater assembly 150, only one end of the heater assembly should be tightly fastened to the body which is to be heated. The other end of the heater assembly must be loosely fastened to the body which is to be heated to enable the heater assembly to expand freely during a heating cycle.

The heater assemblies 30 and 150 are normally connected to power sources which provide a heater output of approximately one to twenty-five watts per square inch of surface of the mounting wall 74 of the heater. Of course, the output of the heater takes into account the type of material which is to be heated, the surface characteristics of the surface container or mass in which the materials are held, and the environmental and operating conditions in which the heater assembly is operated. The output of the heater will, to some extent, determine the metal from which the sheaths 32 and 170 of the heater assembly are formed. An aluminum sheath should not be operated at temperatures in excess of approximately 550 degrees Fahrenheit while a stainless steel sheath can be utilized at operating temperatures of about 1,200 degrees Fahrenheit. Of course, the material from which the adhesive layer 118 and the blocks 34 and 36 are formed will also be determined by the temperature at which the heater assembly 30 is to be operated.

It is contemplated that heating elements having a structure other than the specific structure set forth for the heating element 50 will be used with the heater assembly 30. It is also contemplated that clamping assemblies, other than the toggle type clamping assembly 180 will be used with the heater assembly 30. Of course, the composition of the various components of the heater assembly can be varied from the specific examples given herein. Therefore, while particular embodiments of the invention have been shown, it should be understood that the inven-

tion is not limited thereto since many modifications may be made; and it is contemplated to cover by the appended claims any such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A heater assembly comprising: a longitudinally extending electrical resistance member providing a heating element; a longitudinally extending metallic sheath enclosing said heating element, electrically nonconductive insulative means between said heating element and sheath, said metallic sheath including a flat longitudinally extending base section and a longitudinally extending body section integrally formed with said base section, said body section including a generally U-shaped central section for receiving said heating element and a pair of outwardly extending coplanar arm sections connected to opposite legs of the U-shaped body section and positioned in juxtaposition with said base section, one of said arm sections being hingedly connected to said base section, and a second of said arm sections being positioned in sealing engagement with an inner surface of a flange section which is integrally formed with and hingedly connected to said base section; a longitudinally extending layer of a heat resistant waterproof adhesive means sealingly interconnecting an outer surface of said second arm section and an inner surface of said flange section; first and second lead wires for connecting opposite ends of said heating element to a source of electrical power; a first body of elastomeric material enclosing a first end portion of said sheath and a portion of said first lead wire to seal a first end of the heater assembly; a second body of an elastomeric material enclosing a second end portion of said sheath and a portion of said second lead wire to seal a second end of the heater assembly; a first mounting element extending outwardly from said first body of elastomeric material to facilitate mounting the heater assembly on a body to be heated; and a second mounting element extending outwardly from said second body of elastomeric material to further facilitate mounting the heater assembly on a body to be heated.

2. A heater assembly as set forth in claim 1 further including: a toggle type clamp assembly releasably interconnecting said first and second mounting elements, said toggle type clamp including an actuator arm mounted for pivotal movement about an outermost end portion of said first mounting element, and a body means connected to said second mounting element engaging an aperture means in said actuator arm, said aperture means being offset relative to an axis of rotation of said actuator arm, said actuator arm being pivotal from a released position in which said aperture means and said

body means of said toggle clamp are spaced apart from said first mounting element to a closed position in which said aperture means and said body means of said clamp assembly are positioned adjacent to said first mounting element to securely clamp the heater assembly to a body to be heated.

3. A heater assembly as set forth in claim 1 further including: resilient clamp means interconnecting said first and second mounting elements for securing the heater assembly to a body to be heated.

4. A heater assembly as set forth in claim 1 further including: a layer of heat resistant pressure sensitive adhesive mounted on an outer surface of said base section to still further facilitate the mounting of a heater assembly on a body to be heated.

5. A heater assembly as set forth in claim 1 wherein: said first and second mounting elements are integrally formed with said base section.

6. A heater assembly as set forth in claim 1 further including: a plurality of longitudinally spaced apertures extending through said first and second sections to facilitate mounting the heater assembly.

7. A heater assembly as set forth in claim 1 further including: a pair of flexible mounting sections integrally formed with said second section and extending longitudinally and outwardly of said first section, said mounting sections being adapted for engagement with a clamp assembly to mount the heater assembly on a body to be heated.

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