Nov. 21, 1961 R. W. SAWYER 3,010,091

TUBE-IN-STRIP ELECTRIC RESISTANCE HEATER

Filed March 4, 1959 2 Sheets-Sheet 1

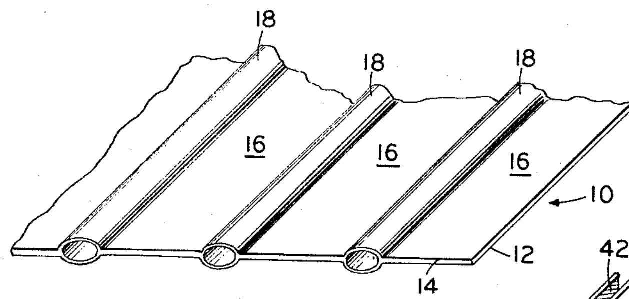

Fig. 1

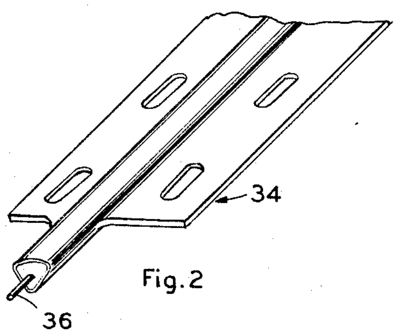

Fig. 2

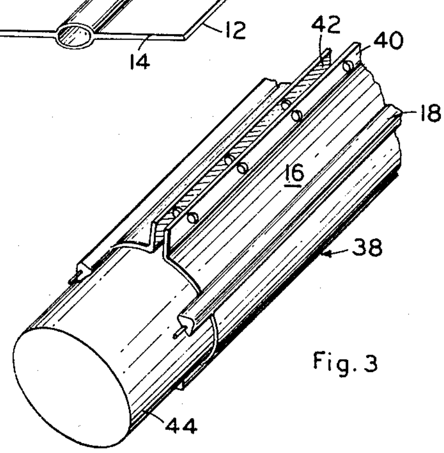

Fig. 3

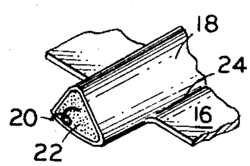

Fig. 4

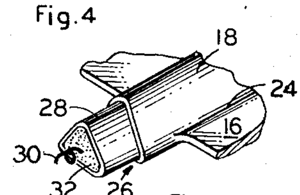

Fig. 5

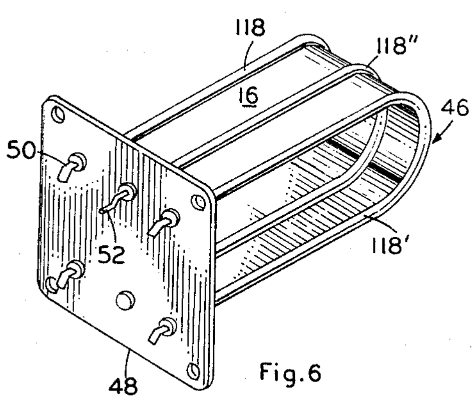

Fig. 6

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TUBE-IN-STRIP ELECTRIC RESISTANCE HEATER

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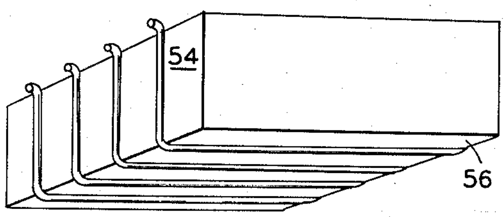

Fig. 7

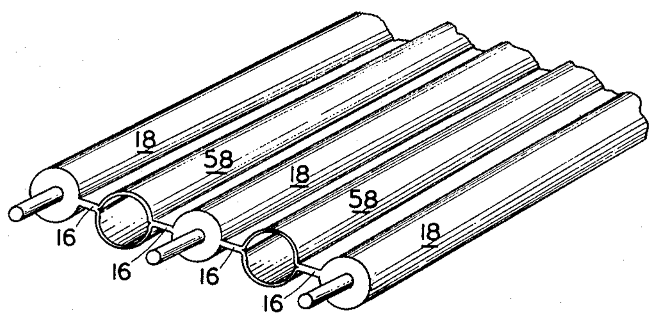

Fig. 8

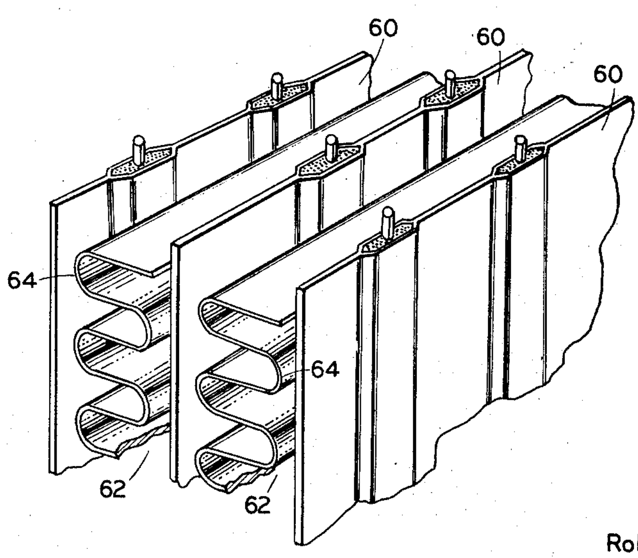

Fig. 9

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TUBE-IN-STRIP ELECTRIC RESISTANCE HEATER

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3 Claims. (Cl. 338—243)

This invention relates to an electric resistance heater of novel and improved construction.

Electric resistance heaters are used for a wide variety of applications, such as pipe heaters, radiant heating using vane type heaters, immersion heaters, fluid heaters, etc. In the past, such applications usually have required a specially constructed heating device tailored to the specific use. For example, pipe heaters often comprise enclosures for encircling a pipe with a reflecting surface on the inside of the enclosure facing the pipe and with a tubular heater mounted adjacent the reflecting surface and spaced from the pipe.

It is the primary object of this invention to provide a sheathed electric resistance heater of novel and improved construction which will provide substantial reductions in manufacturing cost while providing marked versatility of use over a wide variety of applications, such as described above, which have heretofore required more expensive and substantially more complex heating devices. Other objects of the invention will be in part pointed out in detail and in part obvious from the following description.

The primary object of this invention is met in the embodiment of a sheathed electric resistance heater comprising an outer sheath and heat radiating or heat conducting member consisting essentially of expanded tube-in-strip material with an electric resistance wire heating element embedded within a tube portion of the expanded tube-in-strip material by compact electrical insulating and heat conducting material. The advantages and some of the specific applications of a tube-in-strip heater of this invention will be apparent from the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a fragmentary perspective view of expanded tube-in-strip material of the type with which this invention is concerned;

FIG. 2 is a fragmentary perspective view of a vane heater constructed in accordance with the teachings of this invention;

FIG. 3 is a fragmentary perspective view of a wrap-around pipe heater constructed in accordance with the teachings of this invention;

FIG. 4 is a fragmentary perspective view of a portion of a resistance heater embodying this invention;

FIG. 5 is a fragmentary perspective view similar to FIG. 4 illustrating an alternative construction of a resistance heater embodying this invention;

FIG. 6 is a perspective view of a temperature controlled immersion heater embodying the present invention;

FIG. 7 is a perspective view of a receptacle constructed in part from a tube-in-strip heater of this invention;

FIG. 8 is a fluid heater embodying the teachings of this invention; and

FIG. 9 is an alternative form of a fluid heater embodying the teachings of this invention.

With reference to FIG. 1 of the drawings, there is shown a section of material of the expanded tube-in-strip type with which this invention is concerned. The expanded tube-in-strip material 10 may be manufactured by sandwiching a pattern or strip of non-bonding or separation material, often called "resist" material, between two

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sheets 12, 14 of thin metal sheet and subsequently pressure-bonding the two sheets of metal to a single integral layer in the web area 16 of the sheet located between the non-bonding or separation material strips. Fluid pressure may then be applied on the inner surfaces of the sandwich, which are held apart by the separation material to expand the metal in this area to form integral tube-like conduits 18 extending through the material. In an alternative method of manufacturing tube-in-strip material, an initially tubular member is either pressure welded into one surface of a single plate member or is sandwiched between a pair of plate members and the three elements pressure-welded to form a unitary structure. Subsequently, the now flattened tubular member is expanded by fluid pressure to provide the conduits or tubes through the material. In still a further method of manufacture of tube-in-strip material, the base metal of the end product is cast around rods of resist material and the resulting casting rolled into a sheet. As in the other methods, the portions of the sheet separated by the resist material are expanded hydraulically to provide the tube-in-strip configuration. This expanded tube-in-strip process permits the manufacture of a very thin material having a thickness as little as .012" to .015" in the sheet-like web portions thereof between the tubular conduit portions, thus providing a structure which may be easily worked by bending, pressing, drawing, etc., into many intricate and special shapes. This invention is limited to the use of materials which are truly "expanded tube-in-strip" materials and which have this particularly advantageous characteristic of permitting easy working thereof to the desired end configuration while at the same time providing very light-weight structures.

In accordance with the invention, the tubular portions 18 of the tube-in-strip material are utilized to provide the outer sheath of an electric resistance heater. With particular reference to FIG. 4, in one embodiment of the invention, an elongated helical resistance wire heating element 20 extends longitudinally through the tubular portion 18 and is embedded in a compact electrically insulating heat conducting material 22. The heater is formed by first inserting the heating element within the tubular portion then filling the tubular member with an insulating material such as magnesium oxide, compacting the magnesium oxide such as by tamping, and finally pressing the tubular member 18 in a set of dies to compact the magnesium oxide to a rock-like rigid mass. This process is generally similar to the conventional process for manufacturing tubular heaters. However, the usual rolling or swaging of the tubular sheath to compact the magnesium oxide is, of course, not preferable in connection with this invention, but rather it is preferred that the sheath be pressed in order to avoid tearing or wrinkling along the junctures 24 between the tube 18 and the web or intermediate portions 16 of the tube-in-strip material. The specific cross section of the tubular portions 18 is, of course, primarily a matter of choice, the triangular cross section shown in FIG. 4 being merely by way of illustration. It is also, of course, recognized that other compactible electrically insulating and heat conducting materials might be utilized and further that such materials might be of the cementious type, whereby pressure compacting of the same would not be required.

With reference to FIG. 5, the embodiment therein shown differs from that of FIG. 4 in that the tubular portion 18 receives a performed heater 26 having an elongated metallic sheath 28 and an electrical wire resistance heating element 30 extending within the sheath 28 and embedded in compact electrically insulating and heat conducting material 32. The heater 26 may be secured within the outer sheath 18 by pressing the outer sheath into firm and intimate engagement with the inner sheath 28 in a set of dies or by press-fitting the heater 26 within the outer sheath 18 and indenting or crimping the tube-in-strip material along one or more junctures 24 of the tube-in-strip material between the tubular portions 18 and webs 16. As in the embodiment of FIG. 4, the specific cross sectional shape of the heater portions are shown merely by way of example. Also, final compacting of the insulating material, if desired or necessary, might be accomplished at the same time the tubular portion 18 is pressed onto the heater sheath.

An expanded tube-in-strip electric resistance heater of the type described is suitable for a wide variety of applications. For example, the tube-in-strip material may be severed in the web region 16 thereof along a line generally parallel to the tubular portions 18 to provide the vane type heater 34 shown in FIG. 2. In the vane type heater of FIG. 2, the specific construction of the heater portion, which is shown merely by way of example, comprises a solid straight electric resistance wire heating element 36, with the heater being constructed generally the same as the heater shown in FIG. 4.

With reference to FIG. 3, it can be seen that an expanded tube-in-strip heater embodying the teachings of this invention is particularly adapted for use as a wrap-around pipe heater. The pipe heater 38 of FIG. 3 is formed by providing flanges 40, 42 extending parallel to the heater-containing tubes 18 at the edges of the strip, which flanges may be drawn together by any suitable means so as to intimately engage the expanded tube-in-strip heater with the pipe 44. In this particular configuration, it is to be preferred that the cross section of the heater-containing tubes provide a flat bottom surface generally coextensive with a surface of the web portions 16 in order to provide intimate thermal contact of the heater around substantially the entire periphery of the pipe. The wrap-around heater of this construction has the advantage of providing a heater of relatively long length with even distribution of heat around the pipe in combination with a simple assembly of the heater around the pipe. Thus, such a heater offers a marked improvement over previous pipe heaters having a plurality of individually mounted heaters with elaborate clamping and locating arrangements, reflectors, etc.

With reference to FIG. 6, there is shown the application of an expanded tube-in-strip electric resistance heater to an immersion heating assembly. As can be seen, the tube-in-strip heater 46 is formed in a generally U-shaped configuration and mounted to a flange plate or mounting base 48, with the tubular portions 118 and 118′ each forming a part of a tubular heater having terminals such as 50 extending outwardly of the flange plate 48. In the particular embodiment shown, a temperature controlled immersion heater is provided in that the center tube 118″ provides a temperature-sensing element, such as by filling the tube with a fluid which will expand and contract in response to temperature changes. One end of the tube 118″ is sealed, while the other end is provided with a tubular connection 52 adapted to be connected to a bellows or other pressure-responsive device for actuating an electric switch for controlling energizing of the heater tubes 118, 118′. A temperature controlled immersion heater embodying the teachings of this invention has the advantage of being substantially more economical than previous thermostatically controlled immersion heaters, inasmuch as the sensing element is an integral part of the heater assembly. Further, the web portion 16 of the tube-in-strip material provides rapid conduction of heat from the heating tubes 118, 118′ to the sensing tube 118″ and, for obvious reasons, provides a self-protecting feature against low fluid level. As will be recognized, the temperature sensing feature may be omitted if desired, and the immersion heater utilized without the temperature sensing feature.

With reference to FIG. 7, another particular advantage of the tube-in-strip electric resistance heater will be apparent. Generally speaking, the thinness of the material from which the heater is fabricated will, as has been mentioned, facilitate forming of the heater to a variety of intricate shapes, thus making it particularly adaptable for the surface heating of irregular objects. Also, the heater of this invention may be used as an integral structural member of a receptacle for containing material to be heated. For example, as shown in FIG. 7, an expanded tube-in-strip heater has been formed to provide the sides 54 and bottom 56 of a receptacle, the heater thus providing both the structural walls of the receptacle and at the same time integrally providing the heating means for material disposed within the receptacle. The increase in ease and economy of manufacture of a heated receptacle through this use of the present invention will, of course, be readily apparent.

The expanded tube-in-strip heater of this invention further lends itself to the fabrication of fluid heaters, such as shown in FIG. 8. In the specific embodiment of FIG. 8, the alternate tubular portions 18 of the expanded tube-in-strip material provide heaters and fluid conduits. The web portions 16 will, of course, provide good thermal conductivity between the tubular portions 18 and the conduit tubes 58. Additionally, a fluid heater of the type shown may be used as an integral part of a fluid supply system, thereby eliminating the need for special connections of heaters around the conduits. As will be apparent from a further consideration of FIG. 3, a tube-in-strip electric resistance heater may, if desired, be formed to provide the fluid conduit itself by forming the heater in a cylinder or other hollow configuration and then securing the longitudinal edges of the heater in fluid-tight relation, whereby the combination heater-conduit element could be connected in series in a fluid line. This latter construction would, of course, eliminate the temperature drop normally existing between a separate fluid conduit and the heater disposed therearound and would also eliminate any external clamping means for affixing the heater to a conduit.

Lastly, with reference to FIG. 9, there is shown, by way of example of the various applications of a heater of this invention, the use of a heater in a heat exchanger or fluid heater whereby a plurality of tube-in-strip heaters 60 are utilized as walls defining fluid passages 62. If desired, the passages 62 may be baffled by means of corrugated baffles shown at 64, the particular baffle configuration being shown, of course, only by way of example.

From the foregoing, it will be apparent that the expanded tube-in-strip heater of this invention provides a very versatile structure adapted to wide varieties of usage in areas heretofore requiring much more costly and complex structures. The specific applications shown and described are not, of course, to be taken as limiting but rather only as exemplary of the versatility of the heater of this invention. It is intended that the scope of the invention be defined and limited only by the terms of the appended claims, which shall include all structure which logically falls within the language of the claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A sheathed electric resistance heater comprising a sheath member of expanded tube-in-strip material of the type described, said sheath member including an elongated thin walled hollow tube having imperforate walls and an integral web comprising a single layer of sheet material extending laterally from the hollow tube, an elongated electric resistance heating element extending longitudinally within the hollow tube in radially spaced relation thereto, and a quantity of compacted granular electrically insulating and heat conducting material confined by said hollow tube for electrically insulating the heating element from the sheath member.

2. A sheathed electric resistance heater comprising a

plurality of straight parallel thin-walled hollow tubes having imperforate walls and an integral web comprising a single layer of sheet material laterally extending between the hollow tubes, an elongated electric resistance heating element extending longitudinally in at least one of said hollow tubes and positioned radially inwardly from the inner walls of said hollow tube, and a quantity of compacted granular electrically insulating heat-conducting granular material surrounded and confined by the walls of said hollow tube and electrically insulating the heating element from the walls of said tube.

3. A sheathed electric resistance heater comprising an outer sheath of expanded tube-in-strip material of the type described and including an elongated thin walled hollow tube having imperforate walls and an integral web comprising a single layer of sheet material extending laterally of and from the hollow tube, an elongated electric resistance heating element disposed in the hollow tube, an elongated hollow metal inner sheath coaxially surrounding the heating element and telescopically received in and surrounded by said tube, said sheath and said tube being positioned in intimate heat transfer relationship throughout substantially their entire peripheral surfaces, and a quantity of compacted granular electrically insulating and heat conducting material in intimate contact with said heating element and inner sheath and electrically insulating heating element from said inner sheath.

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