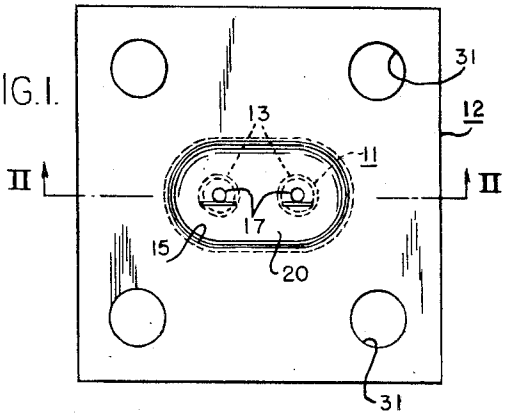
Nov. 11, 1958 J. J. FOX 2,860,227

ELECTRICAL HEATING APPARATUS

Filed June 11, 1957

FIG. 1.



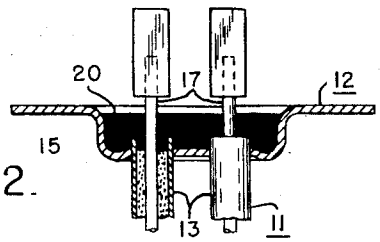


FIG. 2.

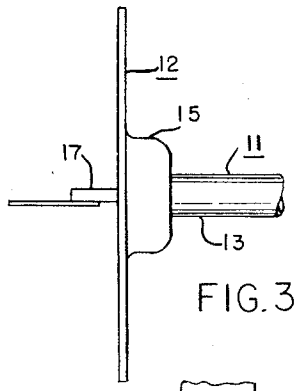


FIG. 3.

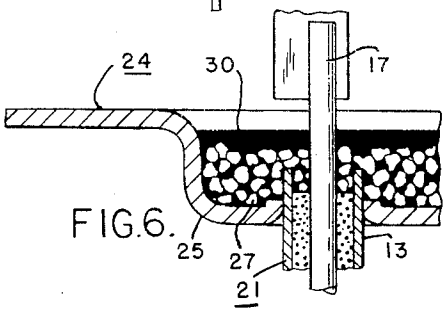


FIG. 6.

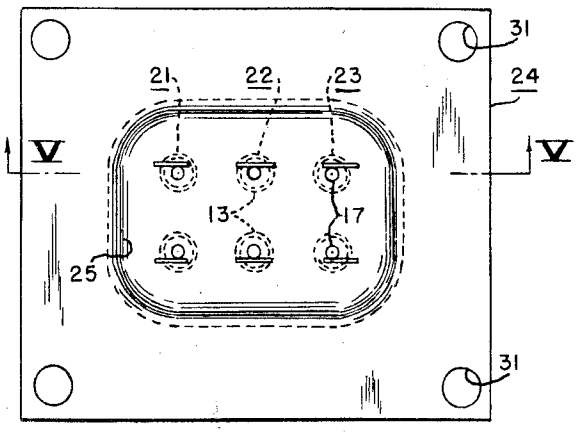


FIG. 4.

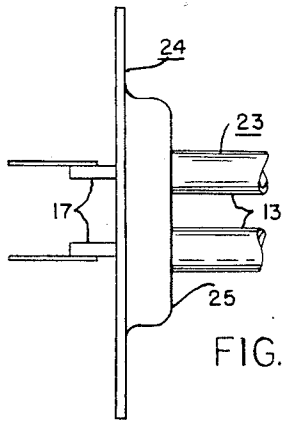


FIG. 7.

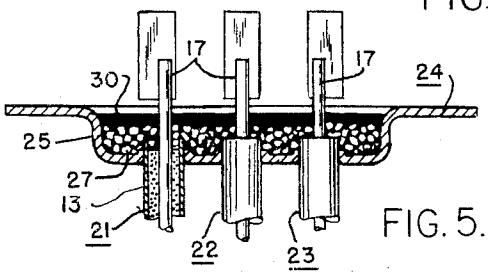


FIG. 5.

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ELECTRICAL HEATING APPARATUS

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Application June 11, 1957, Serial No. 664,942

4 Claims. (Cl. 219—38)

This invention relates to an improved immersion heater structure designed for mounting in an opening in the wall of a liquid heating vessel.

Among the objects of this invention is to provide an improved mounting structure for a heater of the above type.

Another object of this invention is to provide an improved hermetic seal in an immersion heater of the above type.

In accordance with this invention, a flat mounting plate for a tubular sheathed electrical resistance heater is formed of thin sheet metal stock and is provided with a centrally disposed drawn well or recess within which the ends of the heater sheath terminate and within which a material forming a hermetic seal about the ends of the heater is located.

Another feature of this invention is directed to a hermetic seal for a sheathed heater comprising a granular insulating material disposed about the end of the heater sheath and another sealing material filling the voids among the granular particles and covering the latter. A seal may thus be formed having reduced cost since the granular material may be a relatively inexpensive product. The materials may be so selected that the hermetic seal will have a temperature coefficient of expansion approximating that of the mounting plate to which the heater is secured and with which the sealing material is in sealing contact.

The foregoing and other objects are effected by the invention as will be apparent from the following description and claims taken in connection with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a plan of an immersion heater made in accordance with this invention;

Fig. 2 is a section taken on line II—II of Fig. 1 with the heater partially cut away;

Fig. 3 is a side elevation of the heater of Fig. 1;

Fig. 4 is a plan of a heater illustrating a second embodiment of the invention;

Fig. 5 is a section taken on line V—V of Fig. 4 with the heating elements partially cut away;

Fig. 6 is an enlarged view of a portion of the structure shown in Fig. 5; and,

Fig. 7 is a side elevation of the heater shown in Fig. 4.

Referring to Figs. 1 through 3, a tubular sheathed electrical resistance heater **11** is secured to a mounting plate **12** by means of which, the heater may be fastened in an opening in a liquid heating vessel (not shown). The heater mounting arrangement may be the same as shown in W. D. Thurston Patent 2,613,312, granted October 7, 1952, and assigned to the assignee of the present invention.

The structure of the tubular sheathed heater **11** is conventional and comprises a metal sheath of copper or the like having a heating loop (not shown) bent in any desired configuration with the opposite ends **13** of the sheath extending generally parallel adjacent each other. A resistance element is enclosed by the tubular sheath and is electrically insulated therefrom by a suitable material such as granular magnesium oxide. The main heating portion of the heaters and details of the resistance elements are omitted from the drawings as they are well-known and are not essential to the description of the present invention.

The mounting plate **12** supporting the heater is made of a suitable corrosion resistant metal such as brass having a thickness of the order of .060 to .080 inch. The plate is generally flat except for a central portion thereof which is drawn to form a recess or well **15** for a purpose to be described. The ends **13** of the heater sheath extend through openings in the bottom wall of the well **15** as seen in Fig. 2 and terminate within the well with the sheath sealed in the well wall by suitable means such as brazing or silver soldering.

Electrical terminals **17** extend from the open ends of the heater sheath and project from the well beyond the plane of the flat portion of the plate. The terminals comprise wire rods for making electrical connections to the resistance element within the sheath and connectors of any desired configuration secured to the exposed portions of the wire rods as by welding.

The well is filled to a level substantially above the ends of the heater sheath with an electrically insulating sealing material **20**, indicated in black in Fig. 2, engaging the wall of the well, the end of the sheath and the terminals to provide a hermetic seal between the terminals and the plate. One suitable material for this seal is a thermal setting epoxy resin of 100% solids which has good electrical resistance, high resistance to moisture vapor penetration, good shock resistance and whose properties are not detrimentally affected by heat over a period of several years. This material may be prepared in a liquid state, poured into the well and then cured for a few minutes under the influence of heat or for a few hours at normal room temperatures. This epoxy resin seal has very good adhesion to metal. The coefficient of thermal expansion of the epoxy resin used in one embodiment of the invention is approximately 80×10^{-6} inches per inch per degree centigrade. Although the thermal coefficient of expansion of the brass plate **12** is approximately 18×10^{-6} inches per inch per degree centigrade, this difference in thermal coefficients will be satisfactory where the well **15** is of relatively small size as shown in Figs. 1 through 3.

In the embodiment of the invention shown in Figs. 4 through 7, three tubular sheathed heaters **21**, **22** and **23** are supported by a mounting plate **24**. The heaters may be identical to the sheathed heater **11** of the first embodiment and the mounting plate **24** is similar to plate **12**, but of necessity has a larger well **25** to accommodate the six heater sheath end portions **13**. If the epoxy resin is used alone as a seal around the terminals **17** in the larger well **25** shown in Figs. 4 through 7, the large difference of temperature coefficients of expansion of the epoxy resin and the brass plate **24** may result in cracking of the seal due to thermal stresses. In order to help equalize the expansion coefficient between the brass plate **24** and the sealing material, the well **25** is filled with a suitable granular insulating material **27** such as silica to a level above the ends of the heater sheaths, as seen in Figs. 5 and 6, and a sealing material **30** such as the above-mentioned epoxy resin is poured over this silica to fill the voids, as indicated in black in Figs. 5 and 6, among the silica granules and form a smooth-surfaced, electrically insulating, hermetic seal between the heater terminals **17** and the plate. The granular silica or sand is washed and dried and graded so that virtually all the particles are between 8 and 50 mesh in screen size with the bulk of the particles being between 12 and 30 mesh in screen size. The coefficient of expan-

sion of silica is low, approximately $8\times10-6$ inches per inch per degree centigrade and, thus, when mixed with the epoxy resin provides a resulting mixture that is much nearer the coefficient of thermal expansion of the brass plate 24.

Another advantage that is gained with the seal using the silica is the low cost of the silica relative to the cost of the epoxy resin. Also there is less shrinkage of the silica and epoxy resin mixture during curing than with a seal formed of epoxy resin alone.

In both of the above described embodiments of the invention the drawn wells 15 and 25 in the heater mounting plates form molds into which the sealing material may be readily poured. The ends 13 of the heater sheaths may thus be hermetically sealed very easily with the sealing material providing mechanical support for the terminals 17 extending from the ends of the sheaths. This construction eliminates the necessity for electrically insulating terminal blocks and other expensive structural supports for the heater terminals 17 as commonly found in the prior art.

Each of the plates 12 and 24 is provided near its periphery with apertures 31, located at spaced points around the well and spaced from the latter, for receiving bolts for securing a clamping plate and the heater to a vessel as shown, for example, in the aforementioned Thurston patent. These apertures 31 position the above described immersion heater structures relative the vessel so that the plates 12 and 24 form closures for openings in the liquid heating vessels in which the heaters are to be mounted. The flat portion of each plate 12 and 24 surrounding the sealing wells 15 and 25, between the latter and apertures 31, has continuous smooth lower and upper surfaces for engagement, respectively, with a suitable gasket, located between the plate and the vessel, and the clamping plate, which may abut the outer face of the plate.

While the invention has been shown in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof.

What is claimed is:

1. An electrical immersion heater structure comprising a tubular sheathed electrical resistance heater, a corrosion resistant mounting plate for said heater, said plate having a central drawn portion forming a recess therein, the tubular sheath of said heater having end portions extending through the plate into said recess and terminating therein, electrical terminals for the resistance heater extending from the ends of said sheath and having exposed portions projecting from the recess, and electrically insulating sealing means in said recess providing a hermetic seal between said sheath and said terminals and mechanically supporting the latter, said sealing means comprising silica granules surrounding the ends of the heater sheath and a thermal setting epoxy resin filling the voids among said granules and forming a smooth exposed electrically insulating surface around said terminals, said plate having mounting means near its periphery and having a continuous flat sealing surface encircling said recess.

2. An electrical heater comprising a tubular metallic sheath enclosing an electrical resistance element, said sheath having end portions extending generally parallel adjacent each other, a flat corrosion resistant metal plate having a central drawn portion forming a wall therein, the ends of said sheath extending through a wall of said well and terminating within the well, an electrical terminal extending from each end of said sheath for making electrical connections to said element, said terminals having exposed portions extending from said well, electrically insulating means in said recess forming a hermetic seal between said plate and said terminals, said sealing means comprising a granular electrically insulating material around the ends of the heater sheath and a settable electrically insulating sealing material that may be poured into said recess filling the voids among and covering said granular particles.

3. An electrical immersion heater structure comprising a plurality of tubular metal sheaths, each sheath enclosing an electrical resistance element, and having end portions extending generally parallel adjacent each other, a flat plate having a central drawn portion forming a recess therein, the adjacent end portions of each of said sheaths extending through a wall of the recess and terminating within the recess, electrical terminals for making connections to said elements extending from the ends of the sheaths in said recess, said terminals having exposed portions extending from said recess, electrically insulating sealing means in said recess, said sealing means comprising granular silica material surrounding the ends of said sheaths and a thermal setting electrically insulating material filling the voids among said silica granules and covering the latter to form a hermetic seal between the terminals and the plate.

4. An electrical heater comprising a plurality of tubular metal sheaths, each sheath enclosing an electrical resistance element, a flat plate for supporting said sheaths, said plate having a drawn portion defining a recess, each of said sheaths having an end portion extending through a wall of said recess and terminating within the recess, an electrically conducting terminal member extending from each of said sheath ends for making an electrical connection to one of said elements, said terminals having exposed portions extending beyond said recess, electrically insulating sealing means in said recess, said last-mentioned means comprising granular silica material of from approximately 8 to 50 mesh in screen size surrounding the ends of said sheaths in the recess and a thermal setting epoxy resin sealing material filling the voids among the silica granules and covering the latter to form a hermetic seal between each of said terminals and said plate.

References Cited in the file of this patent

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