A sheathed electrical resistance heating element consisting of a helical electrically resistant heating strip having segmented portions projecting outwardly in a tangential direction along the helices of the coil strip. The helical heating coil is placed in a heat resisting sheath of a transparent crystalline tube. The helical heating coil strip is positioned within the heat resisting tube by the segmented portions which project from the surface of the coil and contact the inner wall of the tube.

8 Claims, 5 Drawing Figures
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SHEATHED ELECTRICAL RESISTANCE HEATING ELEMENT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed particularly to electrical resistive heating elements that are to be positioned within an outer casing or sheath. More particularly, the present invention is directed to a sheathed electrical resistant heating element having a helical configuration and consisting of a heat resisting electrically conducting alloy. The helical configuration has a number of tangentially projecting tongues or projections for positioning the heating coil within a tubular shaft formed of a heat resistant ceramic material.

2. Description of the Prior Art

Previous sheathed electrical resistant heating elements generally comprised an inner helical shaped electrical heating wire formed of a heat resisting alloy and having an outer protective tubular shaft made of opaque quartz. This type of heating unit is used widely in household utensils for example, in electrical stoves. Generally, this type of heating unit has its helical heating element in direct contact with the inner wall surface of its sheath, and the heat from the heating element is directly given off to the tubular sheath through the contact area. Because of this particular contact, the heating element with the sheath, it generally takes a long time for the heating unit to reach a state of thermal equilibrium and thereby results in a low initial heating efficiency. A further problem is encountered with this type of heating unit in that the high temperature deterioration of the tubular sheath material often occurs. Because of this reason, the surface temperature of the heating element or coil must generally be limited to relatively low temperatures.

SUMMARY OF THE INVENTION

One of the objects of the present invention is to provide an improved high efficiency sheathed electrical resistance heating element which can be used widely in household heating devices, such as, for example, electrical stoves and electrical toasters.

Another object of this invention is to provide a sheathed electrical resistance heating element which can be both small in size and light in weight and which will not be subject to high temperature deterioration of the outer casing or sheath.

A further object of this invention is to provide a sheathed electrical resistance heating element having a fast response time to initial heating and wherein it is possible to maintain a higher surface temperature in the heating element.

In order to accomplish these objectives, the present invention provides a sheathed electrical resistance heating element having a helical electrical heating strip formed of a heat resistance alloy. The helical heating strip has portions of the strip which project outwardly in a direction tangential to the helices. The heating strip is disposed within a heat resistant sheath, for example, a ceramic tube, and is positioned along the direction of the axis thereof. The heating strip or coil may be maintained in contact with the inner wall of the tube only at those points contacting the projected tongue portions that extend tangentially from the helices.

BRIEF DESCRIPTION OF THE DRAWINGS

The specific nature of the present invention as well as other advantages and features thereof, will become more readily apparent from the following description when taken together with the accompanying drawings, in which;

FIG. 1 shows a longitudinal section of one embodiment of a sheathed electrical resistance heating element within a sheath;

FIG. 2 shows a cross-sectional view of FIG. 1;

FIG. 3 shows a plan view of the electrical heating strip of FIG. 1 prior to its being formed in the helices;

FIG. 4 shows a plan view of another embodiment of the heating strip prior to its being formed in the helices, and

FIG. 5 shows a plan view of a third embodiment of a heating strip prior to its being formed in the helices.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, and especially to FIGS. 1 and 3, a heat resisting ceramic tube 1 is disclosed with an electrical heating strip 2 wound into a helical coil form and disposed within the ceramic tube 1 along the direction of its axis. The heating strip 2 is provided with cuttings 4, shown in FIG. 3, at a suitable pitch along the edge portion of the strip. The projecting tongue portion 3 formed from the cutting 4 is projected outwardly in a tangential direction to the helices when the heating strip is formed into a helical shape. Thus, the helical heating coil strip 2 disposed within the ceramic tube 1 is in contact with the inner wall of the tube only at those points where the projected tongue portions 3 contact the wall.

It is possible to cut the strip 2 along the central portion of the strip as shown in FIG. 4, or along the edges of both sides, as shown in FIG. 5.

With a helical heating coil formed as described above, it has been found that when comparing the helical heating coil strip of this invention with the helical heating coil wires of the prior art, under substantially the same conditions of identical voltage, power dissipation, tube size and material, and substantially constant surface load density, the helical heating coil strip of the present invention will have a relatively large surface area per unit length for the same cross-sectional area, without the deteriorating heat transfer characteristics and accordingly, it is possible to make the weight of the heating device less than one half the corresponding prior art element. It is also possible to reduce the initial heat energy dissipation and thereby reduce the amount of energy required to heat the element, itself.

Since the heating strip of the present invention is not in direct contact with the inner wall of the tube, it is possible to accelerate the initial heating of the heating strip itself and to effectively utilize the thermal energy radiated from the heating strip when used in combination with a heat resisting, thermal transparent ceramic tube, such as fused quartz glass tube or a transparent crystalline glass tube, etc., that is, primary thermal radiating may be utilized effectively in the present invention. Because the heating element of the present invention is arranged so that the majority of the effective heat radiating area of the heating strip is not in direct contact with the inner wall of the sheath tube, it is accordingly possible to utilize a higher surface load den-
sity on the heating strip or higher surface temperatures when compared with prior art devices having the same heating characteristics and using the same sheath tube material. The present invention effectively prevents any temperature deterioration of the tube material while permitting the heating element to be formed into a compact size that still permits a high heat radiation.

Illustrative of the advantages of the present invention is the following example, in which:

A sample of heating coil strip was formed from a heat resisting alloy having a thickness of 0.01 mm and a width of 1.8 mm with an electrical resistance characteristic of 7.64Ω/m. The heat resisting alloy was composed of Fe-Cr-Al (25 percent chromium, 5 percent aluminum, and 70 percent iron, as weight percent). This heat resistant alloy had a volumetric specific resistivity of 142Ω/cm. The heating strip was provided with cuttings as shown in FIG. 3, wherein the pitch p = 4.0 mm, the width w2 = 0.4 mm and the remaining width of the strip w1 = 1.4 mm. The total length of the strip was 1.08 m. The strip was wound on a mandrel of 3.00 mm diameter and was formed into a helical coil having a 4.0 mm diameter. A sheath tube having a 9 mm outside diameter and a 1 mm thickness was formed of transparent crystalline glass. The glass comprised, by weight, about 70 percent SiO2, 20% Al2O3, 3% Li2O and 2% ZrO2. The glass composition was heat treated at 850°C for 6 hours.

The helical coil heating strip of the present invention was disposed within the glass tube and stretched out to a coil length of 230 mm. Both ends of the helical coil were securely clamped. The electrical resistance of the resulting heat element was 9.8Ω at room temperature. Upon the application of 50 volts alternating current to the heating element, the power dissipation was 250 watts and the surface load density was 8.3 amps/cm² in the heat generating area of W1 (shown in FIG. 3) and 5.0 watts/cm² in the area of W0. The maximum surface temperature of the heating strip was 970°C when it reached thermal equilibrium. The heating strip reached a state of redness within seconds after applying the voltage, and accordingly, a quick heating response was observed.

The transparent crystalline glass used in this experiment had the property that it would damage change into a milky glass if it was kept at 950°C for 4 hours. In the present case of using the heating strip without the projected tongue portions of the present invention, at the same strip surface thermal density as described, the transparent crystalline glass tube changed after about 20 hours into a milky glass coloration at those portions in which the heating coil strip was in contact with the inner wall of the tube. In the embodiment of this invention, as described above, however, no change was noted in the glass even after 2,000 hours of operation.

It should be noted that various modifications can be formed on the present invention, for example, it may be possible to have the heating coil cross-sectional shape other than circular, for example, square, hexagonal, octagonal, and also to make the projected tongue portions in other shapes.

While the present invention has been described with reference to the above specific examples, it should be understood that these embodiments are only for illustrative purposes and the present invention may have various modifications and changes without departing from the spirit and scope of the present invention, as defined by the following claims.

What is claimed is:

1. A sheathed electrical resistance heating unit comprising:
   an outer electrically insulating sheath;
   an inner heating strip formed into a coil and having portions cut therefrom and projecting from the helices of the coil to provide the sole supporting contact with said sheath intermediate the ends of said heating strip, and means for electrically connecting said heating strip to a source of electrical power.

2. A heating unit as in claim 1, where said sheath is a ceramic tube permitting thermal radiation.

3. A heating unit as in claim 1, where said sheath is formed from fused quartz.

4. A heating unit as in claim 1, where said sheath is formed from crystalline glass and said heating strip is disposed along the longitudinal axis of said sheath.

5. A heating unit as in claim 1, where said projected portions are integral with said strip and substantially tangential to the helices of said coil.

6. A heating unit as in claim 1, where said projected portions are cut from the center of said strip.

7. A heating unit as in claim 1, where the projected portions are cut along both sides of said strip.

8. A heating unit as in claim 1, where said strip is formed of a heat resisting alloy of 25% Cr, 5% Al and 70% Fe, percent by weight and said sheath is formed substantially of SiO2 and Al2O3.

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